



MOTOR TRUCK SERVICE MANUAL

CTS-11 FOR L-LINE TRUCKS

AND

**CTS-12 Supplemental Pages, for
R-LINE TRUCKS ONLY**

John & Susan Hansen, November, 2009



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**CTS-12 Supplemental Pages, for
R-LINE TRUCKS ONLY**

**NOTE: Use CTS-11 Manual for R-LINE units
other than shown in CTS-12 Supplemental pages.**



L-LINE MOTOR TRUCKS SERVICE MANUAL CTS-11

This manual has been compiled in a simple, non-technical manner and every effort has been made to cover the most important items. It will provide a convenient reference source for the serviceman. Wherever possible, repetition of service instructions has been avoided by combining truck or unit models.

An index at the front of each group permits locating items covered in a particular Group. Where necessary, groups have been subdivided into sections. As additional data is compiled, new or revised pages will be issued. These should be inserted in their respective group and section.

IMPORTANT: Before starting any overhauling work, always remove the dirt that has accumulated around the parts to be disturbed. When parts are taken off, dirt not removed may fall into the units, contaminating the lubricating oil, and getting into bearings and other working parts. As dirt contains grit and abrasives, considerable unnecessary wear and reduction in efficiency is invariably the result.

Motor Truck Division

INTERNATIONAL HARVESTER COMPANY

180 NORTH MICHIGAN AVE.

CHICAGO 1, ILLINOIS

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CHECKING LIST AND INDEX FOR R-LINE SUPPLEMENT TO THE CTS-11 L-LINE MOTOR TRUCK SERVICE MANUAL

**NOTE: INSERT THESE R-LINE SUPPLEMENTAL PAGES IN THEIR RESPECTIVE SECTIONS
IN THE CTS-11 SERVICE MANUAL**

- The attached pages contain only those major units used on R-Line trucks which are not common to units used on the respective L-Line trucks.
- Only the service specifications and data for the R-Line major units are covered in these pages. Additional R-Line coverage will be released when available.

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WARRANTY

THE INTERNATIONAL HARVESTER COMPANY

warrants each new INTERNATIONAL MOTOR TRUCK to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any part or parts thereof which shall be returned to it with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective, provided that such part or parts shall be so returned to it not later than ninety (90) days after delivery of such vehicle to the original purchaser, and that at the time of such return, the said vehicle shall not have been operated in excess of five thousand (5,000) miles. This warranty is expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and it neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale of its vehicles.

This warranty shall not apply to any vehicle which shall have been repaired or altered outside of its factory in any way so as, in its judgment, to affect its stability or reliability, nor which has been subject to misuse, negligence or accident, nor to any commercial vehicle made by it which shall have been operated at a speed exceeding the factory rated speed, or loaded beyond the factory rated load capacity.

It makes no warranty whatever in respect to tires, rims, ignition apparatus, horns or other signaling devices, starting devices, generators, batteries, speedometers or other trade accessories inasmuch as they are usually warranted separately by their respective manufacturers.



INSPECTION OF NEW TRUCKS BEFORE DELIVERY

When trucks come off the assembly line at the factory they have already been given numerous unit inspections and in addition are subjected to a driving test and final inspection. Districts and Dealers should, however, recheck each truck prior to delivery to a customer. This is particularly advisable if trucks have been driven through or "double decked" by a drive-away company.

It is the responsibility of each District and Dealer to see that new trucks are delivered to users in a fault-free condition. This will mean a satisfied owner and will tend to eliminate unnecessary trips to the Service Station for minor adjustments during the warranty period.

The pre-delivery service at each District must include all of the operations listed below:

1. Clean and polish truck if necessary.
2. Lubricate chassis, and check oil in air cleaner.
3. Check lubricant level in transmission.
4. Check lubricant level in differential.
5. Check oil level in engine. Drain and refill if oil is not of proper viscosity for locality or season, or if truck has been driven any great distance.
6. Check cooling system for water.
7. Install battery, checking specific gravity and level of electrolyte.
8. Warm up engine and check operation of instruments and lights.
9. Tighten cylinder head and manifold nuts uniformly, using tension indicating wrench. (If truck has not been driven since leaving the factory, this operation is unnecessary.)
10. Adjust valve lash if necessary. Note: If head is tightened in operation (9), valves in overhead-valve engines will require adjustment.
11. Check and adjust carburetor for idle.
12. Check tire alignment on wheels. Correct if necessary. Tighten rim lugs.
13. Tighten all hub stud nuts.
14. Check front wheel alignment for toe-in of wheels.
15. Install tools, spare rim, and owner's manual, etc.
16. Give truck short road test, checking brakes, controls, and general handling, to assure that all are functioning properly.

INSTRUCTIONS TO OWNER AT TIME OF DELIVERY OF NEW TRUCK

As a rule, the purchaser's first impression is a lasting one, therefore it can easily be understood that trucks should be in perfect mechanical condition at the time of delivery. The operation and care of the truck should be thoroughly explained to the owner at this time.

It is suggested that the following instructions be given the purchaser at the time of delivery of the truck:

1. General information covering the construction and operation of the truck.
2. Advice as to the proper grade of lubricating oil. (See Lubrication Section.)
3. Explanation of the function, purpose, and maintenance of the oil filter.
4. Explanation of the function, purpose, and maintenance of the air cleaner.
5. Cover proper draining of the cooling system and the importance of using recommended anti-freeze solutions when necessary.
6. Importance of proper clutch pedal clearance in prolonging clutch life.
7. Cover lubrication of truck completely, pointing out hazard and costliness of neglect.
8. Advise owner to register such units as tires, batteries, electrical units, etc., with the local authorized dealers of that equipment.
9. Point out advantages of bringing truck to the International Service Station at specified intervals during the warranty period of inspection, at which time there may possibly be some minor adjustments advisable. These, if made, will aid in prolonging the life of the truck.
10. Stress the benefits of using only International Service parts and the advantages of having service work performed in International Service Stations or by International Dealers.

GENERAL
Section
Page 2

L-LINE MOTOR TRUCK SERVICE MANUAL



Form CT-6-MJ. 2500-11-16-49.
PRINTED IN UNITED STATES OF AMERICA

REPORT OF MOTOR TRUCK COMPLAINT INTERNATIONAL HARVESTER COMPANY

MAIL 5 COPIES TO GENERAL OFFICE, CHICAGO
MOTOR TRUCK SERVICE SECTION

SERIOUSNESS OF FAILURE IS BASED UPON THE NUMBER OF COMPLAINTS RECEIVED. REPORT EACH CASE UNTIL YOU HAVE BEEN INFORMED OF REMEDY BY BULLETIN OR GENERAL LETTER. IF REMEDY FAILS, EACH CASE MUST BE REPORTED.

DISTRICT OFFICE District DATE 6-8-49

BRANCH _____ IS REPLY DESIRED? _____

WHEN REPORTING ON UNITS SUCH AS CAB, AXLE, TRANSMISSION, ETC., SERIAL NUMBER OF UNIT MUST BE GIVEN.

Be sure to give
UNIT SERIAL NO. this information.

COMPLAINT DETAILS Engine - loss of power and
failure to start when hot.

DELIVERY DATE 7-3-48 TOTAL MILES TO DATE 14,289

OWNER Name CITY Address STATE _____

MODEL L-210 WHEELBASE 149" ENGINE NO. RD-450,20977 CHASSIS NO. 8675
(INCL. PREFIX & SUFFIX LETTERS)

DISTRIBUTION

SUPERVISOR OF INSPECTION	5TH FLOOR, G. O.
SERVICE ENGINEER	FT. WAYNE
SALES SERVICE SECTION	FT. WAYNE
CHIEF INSPECTOR	FT. WAYNE WORKS
CHIEF INSPECTOR	INDIANAPOLIS WORKS
CHIEF INSPECTOR	SPRINGFIELD WORKS
SERVICE PARTS DEPT.	FT. WAYNE
WORKS MANAGER	METROPOLITAN BODY CO.

THE FOLLOWING INFORMATION MAY BE OMITTED IN CASE OF FAILURE ON MINOR UNITS SUCH AS CABS, HORNS, RADIATORS, WINDSHIELD WIPERS, GLASS, SHEET METAL INSTRUMENTS, ETC. BUT ON MAJOR UNITS SUCH AS AXLES, ENGINES, CLUTCHES, TRANSMISSIONS, PROPELLER SHAFTS, FRAMES, WHEELS, ETC., FILL OUT COMPLETELY.

<u>STRAIGHT TRUCK</u>	<u>TRACTOR & TRAILER</u>	
MAX. PAYLOAD _____	MAX. PAYLOAD <u>32,000</u>	GEAR RATIO <u>6.5 - 8.86-1</u>
TOTAL GROSS WT. _____	TOTAL GROSS WT. <u>51,000</u>	TIRE SIZE <u>10:00x20</u> <u>10:00x20</u> <small>(FRONT) (REAR)</small>
TRUCK BODY TYPE _____	TRAILER BODY TYPE <u>Closed</u>	COMMODITY HAULED <u>Misc. Freight</u>
TRUCK BODY SIZE _____ <small>(LENGTH—WIDTH—HEIGHT)</small>	TRAILER BODY SIZE <u>32' Tandem</u> <small>(LENGTH—WIDTH—HEIGHT)</small>	AXLE <u>Who Mounted Body</u> <u>Trailmobile</u>
LOCAL OR LONG DISTANCE <u>Long Distance</u>	TYPE OF ROADS <u>Paved</u>	MAX. SPEED <u>50</u> M.P.H. AVER. SPEED <u>40</u> M.P.H.
WHO MAINTAINS SERVICE <u>IHC and Owner</u>	COST OF MATERIAL _____	LABOR _____ GRATIFIED \$ <u>None</u>

WHAT ALTERATIONS HAVE BEEN MADE BY DISTRICT OFFICE, DEALER OR CUSTOMER ON ANY PART RELATED TO THE FAILURE?

INVESTIGATED BY Name POSITION _____

REMARKS _____

WE WILL WELCOME SUGGESTED REMEDIES WHICH HAVE BEEN TRIED AND PROVED SUCCESSFUL.

Use Reverse Side for Additional Remarks.
A Separate Letter Complicates and Delays Action.

SIGNED Signature
SERVICE MANAGER OR FOREMAN

APPROVED Signature
DISTRICT MANAGER



MOTOR TRUCK COMPLAINT FORMS

Two forms, CT-6 and GF-70, are used to provide a continuous flow of information from the Districts through the General Office to the various Works and Departments regarding the performance of our product in service and as a final check on the condition of our product as received by the Districts.

This information is of utmost importance to our Manufacturing and Engineering Departments in maintaining the high quality of our Product. Therefore, the task of guarding the quality of our product rests largely with our District Organization. This task can best be performed by the District reporting complaints on the regular complaint forms.

All complaints, both CT-6 and GF-70 forms, received by the Motor Truck Service Section, Chicago, are given wide circulation through our Engineering and Manufacturing Departments and to interested parties in our Chicago General Office. These complaints provide a rapid and accurate flow of information to our Works Inspection Departments so that necessary corrective action can be taken to eliminate the cause of such complaints promptly.

The necessity for a remedy is based entirely on the seriousness of the complaint. The seriousness of a complaint is based on the number of those complaints received.

The following instructions and suggestions are for your assistance in making out and submitting these forms:

Motor Truck Complaint form CT-6 is to be used in cases of serious failures where assistance is solicited by the District in the solution of a pressing service difficulty for which the District is unable to find an answer. This form should also be used in reporting complaints where the complaint is contributed to by loads or operating conditions and the information requested on the form is necessary for the complaint to be properly analyzed.

Product Report form GF-70 is to be used largely during the warranty period in reporting failures or complaints on current models on which no immediate assistance is needed. This form should also be used in reporting failures or complaints on new parts and assemblies from our Service Parts Department and in reporting unfavorable customer reaction to design or

material, unsatisfactory performance or difficulty of servicing our trucks.

1. ALL COMPLAINTS concerning which the territory has not been advised of a remedy, must be reported. In other words, you are to continue the reports on all trouble until advised of a remedy or correction.
2. Complaints concerning which the territory has been advised of a remedy should not be reported; except in cases where the remedy itself fails; and except in such cases where the Service Bulletin announcing the remedy advises that Complaint Forms are necessary in order to obtain credit from the Vendor. Then so state under "Remarks."
3. Complaints on each unit must be covered on a separate and proper Complaint Form except in the case of trucks where the same unit fails on several trucks of the same fleet; you may use the same form but list the chassis, engine and unit serial number of each truck involved.
4. It is important that the unit serial number be given in the space provided on form CT-6. Bulletins have advised the location of the serial numbers on the various units. The major part numbers affected should be shown in the space provided on GF-70 forms.
5. State the complaint clearly on form CT-6 under the heading Complaint Details and on form GF-70 under the heading Complaint. For instance, if you are reporting the failure of a "Rear Axle Shaft" state "Rear Axle Shaft Failure" (left or right). Do not just state "Rear Axle Failure."
6. If you believe certain material should be returned for inspection, state under "Remarks" that the material is being held, and hold material for thirty days after acknowledgement of complaint has been received, unless disposition is given in the meantime. Hold parts covered by GF-70 forms for 30 days after submitting form.
7. All material returned should be properly packed and tagged so that it can be identified and, in addition, should bear the "Returned for Inspection" tag, Form CTS-1, filled in properly and completely. (See General letter MT No. 11, 4-21-49).

L-LINE MOTOR TRUCK SERVICE MANUAL



Form GF-70-J 100M-9-1-49. PRINTED IN UNITED STATES OF AMERICA



MOTOR TRUCK PRODUCT REPORT

DISTRIBUTION
SUPERVISOR OF INSPECTION 1TH FLOOR G. O.
SERVICE ENGINEER FT. WAYNE
SALES SERVICE SECTION FT. WAYNE
CHIEF INSPECTOR FT. WAYNE WORKS
CHIEF INSPECTOR INDIANAPOLIS WORKS
CHIEF INSPECTOR SPRINGFIELD WORKS
SERVICE PARTS DEPT FT. WAYNE
WORKS MANAGER METROPOLITAN BODY CO.

COMPLAINT SPEEDOMETER CABLE BROKEN DUE TO CABLE HAVING
BEEN INSTALLED WITH A SHARP KINK AT FLYWHEEL
HOUSING.

REMEDY: NEW CABLE ASSEMBLY INSTALLED AND
PROPERLY ROUTED.

MAJOR PART NO. AFFECTED 75207-H

DISTRICT OFFICE DISTRICT _____

SIGNED _____ NAME _____ SERVICE FOREMAN
TITLE _____

DATE 1-15-49

SERVICE MILEAGE 840
(ON PART INVOLVED)

TYPE OF SERVICE:
LONG DISTANCE
DUMP
OFF HIGHWAY
MULTISTOP
STRAIGHT TRUCK
TRAILER { SEMI
 { FOUR-WHEEL
OTHER

TRUCK MODEL L-160

CHASSIS NO. 67567

ENGINE MODEL SD-240

ENGINE NO. 231897

See Reverse Side for Instructions

INSTRUCTIONS

- Use this form to report any type of failure or complaint on current models on which no immediate assistance is needed. Do not expect an acknowledgment.
Use CT6-M complaint form to report on matters where assistance is necessary or where an acknowledgment is expected.
- Mail five (5) copies immediately to:

INTERNATIONAL HARVESTER COMPANY
Motor Truck Division
Service Section
3rd Annex
180 N. Michigan Ave.
Chicago 1, Illinois
- Retain sufficient copies for your District Office files.
- Do not report failures on unimproved parts or assemblies when an improvement has already been announced to the field by bulletin or otherwise.



8. It has been the practice in the past for the Service Supervisor to make out the CT-6 forms and submit them to the District Manager for his signature. This has caused some delay where the Service Supervisor is in charge of both motor truck and general line service, as it has been necessary for him to spend much time on the territory, resulting in the Complaint Forms not being made out and submitted promptly after the failure occurs. The logical time to determine if a failure should be covered on a CT-6 or GF-70 and to gather information for the Form is when the truck is in the Service Station and the repairs are being made. Therefore, when the Service Supervisor is away, the Service Foreman should gather the information and make out the CT-6 or GF-70 form, in order that they can be submitted as quickly as possible after the failure occurs.
9. Much information, which would be valuable in assisting the various Departments in diagnosing and developing remedies for the complaint, can and should be given under the caption "Remarks" or on an attached sheet. For instance: a clear description of the failure; the Service Supervisor or the Service Foreman's opinion of the cause of the failure; his idea of a remedy, if any; the results of his remedy if applied; any local climatic conditions that are peculiar and have bearing on the complaint; any unusual operating conditions that might play a part in the complaint; and, in short, any information, additional to that requested on the form, which has any bearing on the complaint, should by all means be given. This means that a thorough investigation of the complaint should be made by the Service Supervisor or Foreman before attempting to make out the Complaint Forms.
10. In the past it has been the general practice for the Branches to make out CT-6 forms and forward them to the District for the Service Supervisor to check and for the District Manager's signature. This, in some instances, has caused considerable delay in submitting these forms to the Chicago Office. We suggest that the Service Station Foreman at each Branch should make out the Complaint Forms and submit them to the Branch Manager for signature and forward direct to the Chicago Office. An extra copy, however, should go to the District office for the District Manager's files. GF-70 forms may be made out and signed by the Service Supervisor, Service Station Foreman and A & H Foreman. Branches should send one copy of each GF-70 form to the District office for the District Manager's files.
11. Copies of the complaint reports, GF-70 and CT-6, are to be distributed as follows:
 - 5 copies to Chicago Service Section.
 - 1 copy for District Manager.
 - 1 copy for Service Station files.
12. The District Manager should review his complaint file monthly with the Service Supervisor and personally follow up with the respective Service Divisions of the Chicago Office all cases where no remedy has been provided.

We cannot emphasize too strongly the importance of making prompt and complete reports on all complaints that should be brought to the attention of the Engineering, Manufacturing or Sales Department at Chicago.

Examples of CT-6 and GF-70 Complaint Forms properly filled out are illustrated on preceding pages.

Materials Returned for Inspection

RETURNED FOR INSPECTION TAG, FORM CTS-1 is especially prepared and adapted to portray all necessary information if and when properly filled in. It is designed to be used on all shipments of materials sent in for inspection other than surplus repairs.

The following special instructions must be adhered to in the use of the card:

 1. Obsolete or defective parts must not be returned unless authority is granted.
 2. The CTS-1 Tag must be attached to all shipments of materials sent in for inspection other than surplus repairs or exchange units such as crankshafts.
 3. Shipping charges must be prepaid.
 4. All blank spaces on tag must be filled in to portray necessary information.
 5. Tag should be made out in ink or hard pencil to avoid obliteration during shipment.
 6. Attach tag to parts rather than to package to avoid loss when unwrapping.
 7. Refer to date of CT-6 Complaint Form or GF-70 Form if such has been issued.
 8. Where possible, report unit serial numbers of such units as Engines, Cabs, Transmissions, Axles, etc., when reporting concerning these units.

To avoid the necessity of writing separate letters, it is generally possible to include all general information under the caption "REMARKS."



VEHICLE SPECIFICATION CARD
LOCATED ON DASH INSULATOR PANEL, ABOVE CLUTCH AND
BRAKE PEDALS ON MODELS L-160 AND UP

VEHICLE SPECIFICATIONS			
DESCRIPTION	SERIAL NO.	CODE	VARIATIONS
L181 142 WB 19000 GVW		1 1802	1
BLD 269 ENGINE		1 209	C
DELUXE OIL FILTER		1 250	
F51 OD TRANS		1 307	AD
TWO SPEED AXLF		1 412	BC
6166/8577 REAR RATIO		1 446	B
20 GAL UNDERSKIRT FUEL TANK		1 501	
SEE BELOW FOR PAINT			
REGULAR CAB		1 603	A
REAR VIEW MIRROR EXT TYPE		1 669	A
SPOKE TYPE WHL W/700T RIM FRT		1 728	E
900X20 10 PLY TIRES FRT			
SPOKE TYPE WHL W/700T RIM RR		1 928	F
900X20 10 PLY TIRES RR			
GOODRICH TIRES			
FRAME REINFORCEMENT		0 102	ACDG
VACUUM LINE AIR CLEANER		0 418	
S25 3YD 9X6 1/2 DUMP BODY		3 277	
720 ANTHONY HOIST		3 092	
BODY AND HOIST TO BE FURNISHED			
AND MTD BY TECO ORDERED BY OVD			
PAINT ENTIRE TRUCK 90 ORANGE			

EXAMPLE

A new procedure for handling Service Parts has been placed in operation at the International Motor Truck Service Parts Department. With this new system in operation, it is expected that the vehicle owner will realize many benefits from a service standpoint, particularly when ordering replacement parts for his truck.

The system consists of assigning code numbers to the units included in the vehicle, such as: engine, transmission, cab, rear axle, wheels, etc. This same code number is used during the manufacture of the vehicle and will be further carried over into the parts catalogs which apply to the particular model trucks. By this means, a common language has been set up for all parties involved in the design, the use, and the servicing of this particular vehicle.

Code numbers are assigned only to those units to which the customer has an optional choice. The code numbers assigned to the units on the L-160 Models and up have been printed on a "Vehicle Specification Card" which is included with the truck and is located on the dash insulator panel directly above the clutch and brake pedals. The parts catalogs are subdivided into

sections identical with code numbers shown on the "Vehicle Specification Card."

When ordering parts for the truck, it is important to include with the order the information contained on the "Vehicle Specification Card" which pertains to the unit for which the parts are being ordered. For example, if it became necessary to order a countershaft for the transmission on the vehicle shown on the sample "Vehicle Specification Card" it would only be necessary to indicate on the order that a countershaft for the L-181, F-51 OD transmission, under code number 1307 AD was needed. From this information it can be quickly determined just which part should be supplied.

The "Vehicle Specification Card" will prove of great value to the customer when entering the Service Station for Service work, since reference to the card will indicate to the Service Station just what units are included with the vehicle and will put them in a position to render the best possible service.

Be sure to keep the "Vehicle Specification Card" with the vehicle at all times.



FREE INSPECTION DURING WARRANTY PERIOD

I. First Inspection During Warranty Period

A. Mileage, 1000 miles or 30 days, whichever first occurs.

Note: It is recommended that the first inspection at 1000 miles or 30 days consist of the following checks and adjustments, because this will be the first opportunity the foreman will have to show the new customer the service facilities and to sell him in the advantages of International Truck Service.

B. Checks and adjustments:

1. Distributor point gap.
2. Tighten cylinder head nuts uniformly (all engines).
3. Adjust valves (valve-in-head only).
4. Tighten manifold and carburetor flange nuts (all engines).
5. Check carburetor idle adjustment.
6. Check oil pressure, generator charging rate, and heat indicator.
7. Check clutch pedal free movement.
8. Change engine oil (charge for oil).
9. Lubricate chassis (charge, if it was former practice).
10. Check lubricant level in transmission and in differential.
11. Check rim clamps, nuts, disc wheel studs and axle shaft studs and nuts.
12. Check brake pedal free movement.
13. Check window regulator, windshield wiper, lights, and horn.
14. Short road test noting general performance and handling.

II. Final Inspection During Warranty Period

A. Mileage 4000 to 4500 miles or within 90 days.

Note: This final inspection is recommended in order to give the truck a thorough check before expiration of warranty, and to enable the foreman to sell the customer on the importance of preventative maintenance during life of truck.

B. Checks and adjustments:

1. Check spark plug gaps -- adjust if necessary.
2. Check distributor point gaps -- adjust if necessary.
3. Check ignition timing -- correct if necessary.
4. Tighten cylinder head.
5. Adjust valves (all engines).
6. Tighten manifold and carburetor flange nuts uniformly.
7. Check fan belt tension.
8. Check carburetor idle adjustment.
9. Check cooling system for leaks.
10. Check air cleaner -- clean and change oil in sump if necessary.
11. Clean fuel pump sediment bowl (renew gasket).
12. Check engine for oil leaks.
13. Change engine oil (Charge for oil). (If condition of oil indicates necessity for new filter cartridge, notify customer).
14. Check oil pressure, charging rate, and heat indicator.
15. Check governor control.
16. Check clutch pedal free movement.
17. Check brake pedal free movement.
18. Check fluid level in master cylinder.
19. Lubricate chassis (charge if it were former practice).
20. Check lubricant in transmission and differential (charge for grease, if added).
21. Check rim clamp nuts, disc wheel nuts and studs and axle shaft nuts.
22. Check battery water level, cables and mountings.
23. Check window regulators, windshield wipers, lights, and horn.
24. Make a short road test noting general performance and handling -- make necessary adjustments.



COLD WEATHER RECOMMENDATIONS

Important

There are a few simple precautionary measures which should be taken in preparation of a truck for cold weather operation. Instructions should be given truck owners covering this procedure.

1. Engine

Selection of proper engine lubricating oil demands consideration of two important factors -- namely, easy starting during low atmospheric temperatures, and adequate engine lubrication after the engine is placed in service.

Lighter viscosity oils facilitate cold-weather starting and also provide better immediate lubrication as the engine starts. They do not, however, provide adequate lubrication under sustained higher engine speeds or severe service. Increased oil consumption can also be expected when using lighter viscosity oils.

Consideration must therefore be accorded the cold weather housing facilities for the idle truck, the service in which the truck is engaged, and the selection of higher viscosity oils which have better free-pouring characteristics at low temperatures.

In consideration of the foregoing, the following general recommendations are made:

MODERATE SERVICE (Trucks operating in multi-stop or other service where sustained higher engine speeds will not be encountered.)

ENGINE	TEMPERATURES			
	90°(F.) and up *	32°(F.) to 90°(F.)	HO°(F.) to 32°(F.)	-10°(F.) to +10°(F.)
SD	SAE-30	SAE-30	SAE-20W	SAE-10W
BD	SAE-40	SAE-40	SAE-20W	SAE-10W
RD	SAE-40	SAE-40	SAE-20W	SAE-10W
R-6602	SAE-40	SAE-40	SAE-20W	SAE-10W

*See Hot Climate — High Speed
Instructions, see below

For temperatures lower than minus 10°(F.), use SAE-10W plus kerosene. (SAE-10W may be safely diluted with colorless kerosene up to 30%). Mix kerosene thoroughly with the oil before adding to the engine.

Hot Climate — High Speed.

For trucks operating on highway or other services demanding sustained higher engine speeds use engine lubricating oils having a viscosity of as near SAE-50 as possible (SAE-40 for SD Engines) in keeping with the starting ability.

Note: High viscosity oils are available which also have very good cold-pour characteristics.

2. Electrical

- (a) Clean and adjust spark plugs. (See "Electrical System.")
- (b) Check all wiring for loose or broken connections. Make necessary replacements.
- (c) Clean and tighten battery cable terminals.
- (d) Check battery for being fully charged and electrolyte to star level in cell covers. (Note: During cold weather, the battery must not be allowed to stand after adding distilled water without running engine to charge battery. This is important because otherwise the water will not be thoroughly mixed with the electrolyte, and freezing may result.)
- (e) On models having an adjustable third-brush generator, the charging rate should be adjusted to meet the demands of the cold weather operation.

3. Cooling System

- (a) Drain and flush cooling system to remove all sediment and foreign material. (Note: The "reverse flushing" system is the most effective method and can be performed either in your own service station or by reputable radiator repair shops.)
- (b) Anti-freeze solutions of known value and manufacture only should be used. Specific gravity checks should be made periodically to assure protection from freezing. (Note: Salts or chlorides, sugar, glucose, honey, fats, etc., should not be used as an anti-freeze.)

Where anti-freeze solutions are not used and cooling system is to be drained, you are cautioned to refer to instruction books for location of drain cocks or plugs on engine blocks, radiators, or oil coolers.

- (c) If the thermostat has been removed from the engine, it should be reinstalled after ascertaining that it is in good operating condition.



4. Winter Fronts

The use of an efficient winter front will enable the operator to better control the operating temperature. It will also result in higher under-hood temperatures, effecting more efficient operation of the engine, and will make it less susceptible to sludge formation and condensation.

5. Rear Axle and Transmission

Severe cold weather may make a change of lubricant advisable in the transmission

and differential. A lubricant of lighter viscosity will provide better lubrication to the moving parts and will create less friction and resistance to the movement of the various gears, shafts, etc.

6. Propeller Shaft Bearing (not 6-wheel units)

The propeller shaft center bearing on International trucks should be lubricated with a medium short fibre wheel bearing grease having the following characteristics: cold-milled, sodium-soap content, having a work penetration consistency of 250 that will not break down below 300.

BALL AND ROLLER BEARING MAINTENANCE

Important

In order to assure bearings being free of rust, dirt, or damage, the following procedure relative to storage, handling, and installation is recommended:

1. Storage

- (a) Stock only limited quantity of bearings. Bearings should be ordered and stocked in quantities in keeping with requirements consistent with Branch Zone Repair Orders.

This will assure fresh stock and will guard against obsolescence.

- (b) Store ball and roller bearings in their original wrappers or cartons. Do not remove protective coverings until ready to use the bearing.
- (c) If necessary to inspect bearings in stock, they should be again carefully wrapped to guard against dirt.
- (d) Bearings which have been allowed to remain unwrapped must be washed, relubricated, and rewrapped. This does not apply to prelubricated bearings.
- (e) Store bearings in a cool and dry place. A hot storage space will cause the protective lubricant to melt and drain off the bearings. A damp storage space will permit moisture to collect on the bearings, resulting in rust and corrosion. Water or moisture will ruin a bearing.

2. Delivery of Bearings to Customer or to Service Station.

- (a) Deliver bearings in original cartons or wrappers.

- (b) Handle bearings carefully. Rough handling will damage containers and permit dirt and foreign matter to enter bearing.

3. Cleansing and Lubrication of Bearings

- (a) Use clean kerosene or Stoddard Solvent in a clean container.
- (b) Use clean rags or towels, and never use waste. Lint from waste may enter bearing.

(Note: Suitable wheel bearing cleaner equipment is available, which will facilitate bearing cleansing.)

- (c) Dip bearing in kerosene several times, rocking bearing race rings slowly to dislodge grease from ball sockets.
- (d) Spin bearing while repeatedly dipping into kerosene. Continue operation until bearing runs smoothly and quietly or until it is clean and ready for inspection.
- (e) If bearing is found satisfactory, dip in a neutral oil or thin grease and wrap. (Note: Suitable wheel bearing grease packer equipment is available, which will produce excellent results.)

4. Removal and Installation of Bearings

- (a) Shafts or housings must be clean and free from burrs.
- (b) Use properly arranged press plates or arbors for installation or removal of bearings.

In pressing bearings into place the pressure or load should be so applied



that it will not be transferred through the balls.

For example, if bearing is applied to or removed from shaft, pressure should be applied to inner bearing cone.

If bearing is being installed in or removed from a housing or case bore, pressure should be applied to outer bearing cup.

- (c) Do not hammer on bearings. Lead or babbitt hammers may chip off and allow pieces to lodge in bearing. Wooden hammers may leave splinters in bearings. Steel hammers will chip, crack, or Brinell the bearing.
- (d) If necessary to heat bearing for installation or removal, use a light or medium-weight oil heated to 225° (F.). Allow bearing to stand in this oil until thoroughly heated.
- (e) Upon installation of bearing, lubricate bearing seat with light oil.
- (f) Apply steady pressure. If bearing sticks or binds, ascertain cause. Correct fault

and then proceed with operation. A bearing started in a cocked position will bind.

Burrs in housings or on shafts will cause severe binding and sticking.

Bearing should rest squarely against shoulder or in recess.

- (g) Bearing should roll freely after installation unless individual specifications call for a preload. Test bearing for bind or drag by holding bearing outer race between thumb and finger, and test for side play. (A radial clearance of .0001" will produce side play of approximately .005" to .006".) Shafts mounted in bearings should rotate freely after installation unless individual specifications call for a preload. Test by revolving shaft assembly.

5. Intermixing of Component Parts -- Roller Bearings

Wherever possible, intermixing of roller bearing component parts should be discouraged. Therefore, where possible, IH parts should be used to service IH assemblies, Timken parts to service Timken assemblies, etc.

STEEL AND ITS HEAT TREATMENT

To the average man, steel means but little more than something hard, heavy, and strong, and capable of being formed into practically any desired shape. This is quite true as far as it goes. However, there are many conditions that determine and control the degree of hardness and of strength.

It is the object of this discussion to tell in non-technical terms as nearly as possible just how and what these determining and controlling factors are, how they are applied, and the results accomplished thereby.

In automotive manufacture it is absolutely essential that the very best steels available be used, and in their respective classes. One part will require extreme hardness to resist abrasion or wear, another will require extreme toughness to resist shock and vibration, and to support heavy loads, another must develop great powers of flexibility, yet must resist bending, etc. In these various uses, the parts are subjected to different kinds of stresses, both "static" and "dynamic" (dead quiet and vibratory, respectively) in combination with their loads carried under compression or in tension, or subjected to transverse, shearing or torsional stresses.

Before selecting a steel for a given purpose,

attention must be given to its requirements in the finished part, and in the completed mechanism in operation. The most commonly known and used steels contain in addition to their ferrite or pure iron base either one or more of the following elements -- carbon (the most important), nickel, chromium, vanadium, molybdenum, and tungsten, each being included either separately or combined with others in order to impart the distinctive properties of the included elements. It should be noted that upwards of 95 percent of all steel is pure iron. Castings, either grey iron, malleable iron or steel, originate with pure iron as their base.

In the manufacture of steels, the inclusion, in varying previously determined percentages of these elements, results in, with the proper heat treatment, definite closely predetermined physical properties. For example, one effect of chromium in steel is to increase its hardening power.

A steel rendered hard by the presence of chromium is far less brittle than one rendered hard by the presence of carbon alone. Hence, hardness combined with toughness may be secured by reducing the carbon and increasing the chromium content. However, chromium alone (or any other alloy) in the absence of carbon has no hardening power. The presence of both nickel and chrom-



ium in steel makes it highly resilient and ductile and gives it greater hardness and better wearing qualities than plain carbon steel. Nickel-chromium steels are especially valuable for parts to be hardened and tempered, as the finer structure thus produced has greater shock-resisting power than that of plain carbon steels. These are all valuable elements and there are doubtless many others equally as valuable as yet undiscovered.

The presence of phosphorus and sulphur is injurious to steel and must be guarded against. These impurities unite with other elements and form compounds which render the steel extremely brittle and liable to break. Phosphorus and sulphur inclusions are guarded against by their removal during manufacture, and by the inclusion of other elements which unite with these impurities to form harmless compounds, thus counteracting their bad effects.

The hardening power of steel rests almost entirely with its carbon content. As for example, a steel containing a 0.40 to 0.50 percent carbon ($\frac{4}{10}$ to $\frac{5}{10}$ of 1 percent) is capable of becoming much harder than one containing 0.10 to 0.20 percent. The carbon content is often referred to as forty or fifty points carbon, a point being equivalent to $\frac{1}{100}$ of 1 percent.

The heat treatment of steel consists of annealing, hardening and tempering.

Annealing

Annealing consists of heating above the "critical range," then cooling slowly, for the purpose of refining the grain, softening the steel to machinability and relieving the internal strains set up in the steel by forging and hammering, these strains sometimes amounting to several thousand pounds per square inch.

Hardening

Hardening consists of heating above the critical range and cooling quickly, as by quenching in oil or water, the degree of hardness depending upon the carbon content of the steel and the severity of the quench.

Tempering

Water quenching is more severe than oil quenching and is frequently followed by tempering or drawing to reduce the brittleness imparted by the severity of the quench, this brittleness being ever attendant to the high degree of hardness thus obtained.

The tempering heat must not rise above the critical range, or the effects of the previous heat treatment will be destroyed and the refined crystalline structure will be obliterated, becoming more coarse and suffering a considerable loss of hardness.

By critical range is meant the range above and between the critical heating point, or point of "decalescence," and the critical cooling point, or point of "recalescence." The presence of these critical points in the heating and cooling of steel is a phenomenon and is explained as follows:

While heating, the steel uniformly absorbs heat. Up to the decalcescence point all of the energy of the heat is exerted in raising the temperature of the steel. At this point the heat taken in by the steel is expended, not in raising the temperature of the steel, but in work which produces the internal changes here taking place, the dissolving of the carbon in the iron. Therefore, when the heat is exhausted in this manner, the temperature of the piece, having nothing to increase it, will remain unchanged for a time, or may even fall slightly, owing to surface radiation, after which it will again increase.

When the piece has been heated above the decalcescence point, and is allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the recalescence point is reached the temperature falls. At this point also the structure of the steel undergoes a change, the carbon crystallizes out of the iron, and the energy previously absorbed is converted into heat. This heat set free in the steel supplies, for the moment, the equivalent of that being radiated from the surface, and the temperature of the piece ceases to fall, remaining stationary, and should the heat resulting from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling, but will actually rise slightly at this point. In either event the condition exists only momentarily and when the carbon and iron constituents have resumed their original relation, the internal heat decreases, and the temperature of the piece falls steadily, due to surface radiation.

From the foregoing, it is evident that there is a definite temperature at which any steel should be hardened, and that that temperature is dependent upon or governed by the percentage of carbon in the steel; also, that a great loss occurs of both labor and material unless the hardening is carried out at that temperature. Of greatest importance is the necessity of rigid inspection and tests to assure properly heat-treated parts.

These critical points are determined and the temperature controlled by the use of recording pyrometers and other apparatus. The recording pyrometer presents graphically a temperature curve showing the exact temperature of the decalcescence and recalescence points, the decalcescence point being recorded on the chart while the piece being tested is in the furnace, and the recalescence point being recorded after removal of the piece from the furnace and in



the process of quenching. In obtaining these records the thermo-couple, or the furnace end of the pyrometer, is securely clamped to the test piece to insure that the reading will be that of the temperature of the test piece and not that of the atmosphere of the furnace.

Casehardening or Carburizing

Carburizing, carbonizing or casehardening are names applied to the process wherein a piece of low-carbon steel is packed in a carbonaceous material such as bone or leather, or a commercial carburizing material and heated for a number of hours, just above the "critical range" of the steel, or above its point of decalescence, thereby causing the low-carbon steel to absorb carbon on the outer surface for a depth directly dependent upon the number of hours it is heated. Under such conditions, a carbonized case is produced which is capable of responding to ordinary hardening or tempering operations.

The object of casehardening is the production of a hard wearing surface with a backing or core of tough, low-carbon steel. There are two results gained by its use, the first of which is the production of the part from more easily machined steel of cheaper grade; and second, the production of the part from a cheaper steel which is superior to a part produced from high-carbon steel, high enough in carbon to have the proper surface hardness, in that the casehardened surface has the hardness to resist wear, backed by a low-carbon core which has the toughness to resist shock, two factors of vital importance in the manufacture of motor truck parts, such as piston pins, camshafts, gears, etc.

Upon receipt of each shipment of steel from the steel mills, a representative number of specimens are prepared for chemical analysis and for tests for physical properties. All steels must meet the requirements of the standards for their respective classes, both as to chemical analysis and physical properties, as specified by the Society of Automotive Engineers, both before and after heat treatment. The inspection and tests from the rough stock are precautionary measures to prevent defective material from getting into production, from which it would be impossible to obtain the proper results by heat treatment. The inspection and tests made on parts after having been machined and heat-treated are for the direct protection of the quality of the product.

The most generally used tests, standardized and authorized by the S. A. E., are the Brinell hardness test, the Shore Scleroscope hardness test, and the Tensile test. The Brinell and Shore tests are check tests and for hardness only, while the Tensile test gives a complete history of the physical properties of the specimen tested as follows:

Modulus of elasticity.

The elastic limit in pounds per square inch.

The tensile strength in pounds per square inch.

The percentage elongation.

The percentage reduction of area.

Brinell Test

The Brinell test is commonly made with a hydraulic testing machine in which a steel ball of ten millimeter diameter is pressed into the test piece by a load of three thousand kilograms. The diameter of the impression the ball produces in the test piece is then measured and checked against a standard. Thus an impression four millimeters in diameter indicates softer steel than a diameter of three and one-half millimeters.

The Brinell test is definitely related to the ultimate strength of the material.

Scleroscope Test

The Shore Scleroscope test is made with a small instrument which drops a diamond-tipped hammer approximately ten inches through a small glass tube upon a smooth surface of the steel to be tested, and the height of the rebound of the hammer measured against a scale at the back of the glass tube. Hard steel is taken as being 100 hard on the Scleroscope and soft steel approximately 30 to 35 hard. Thus the higher the rebound, the harder the steel. After noting the remarks on the Tensile test, it will be seen readily that the Brinell and Scleroscope tests are excellent methods of check-testing rapidly and accurately, finished and semi-finished parts that it would be impractical to test otherwise. The resulting values obtained by means of the Tensile test are invaluable in both the designing and testing engineers.

The designer must take into consideration the load that the part will be required to carry, the function it must perform, and the nature of the stress to which it will be subjected. The weight of the part must be held to a minimum, and the steel selected must be one capable of withstanding these stresses, at the same time maintaining a wide margin of safety.

A very rigid inspection must be maintained on parts subject to shock and vibration, as tool marks and scratches, under-cut radii, or sharp corners, are frequently the cause of early failures of properly designed and heat-treated parts such as axles, jackshafts, steering knuckles, etc.

Tensile Test

It is a comparatively easy matter to check up



on machined parts with gauges and measuring instruments, as the defects and imperfections are generally more or less visible. However, checking up on heat treatments is an entirely different proposition. The Tensile test is the most accurate and most approved method, and is made as follows:

A test bar of the standard S. A. E. form is machined from the material to be tested, and is held in threaded grips in a vertical position in the testing machine. The machine is set in motion and the test bar is slowly stretched until it is broken. The point at which the elongation ceases to be proportional to the load is designated as the elastic limit. This is the highest point at which, if the load were removed, the bar would resume its original length. This is also the point at which, if exceeded, failure of the part commences. The weight of the load at this point is read on the weighing beam of the testing machine and converted into pounds per square inch, to be checked against S. A. E. specifications for that particular steel from which the test bar was made.

The elastic limit point is determined by the use of an extensometer, a delicate instrument which shows the amount the test bar stretches, and is capable of measuring to the ten-thousandth part of an inch. While noting the elastic limit the test continues, and the ultimate tensile strength is noted. This is the greatest load the bar will withstand before it breaks. From this point on to the breaking point, the bar fails rapidly. After breaking, the bar is measured to determine the total elongation and the reduction in area of cross section, and these two values are converted to percent of the original bar dimensions.

Research work is constantly being carried on in the chemical and physical laboratories to produce better materials and better methods of heat treating; and many special tests are devised, such as torsion tests, fatigue tests, impact tests, and vibratory tests. The qualities of designs and their manufacture are frequently proved and checked by tests that approximate as nearly as possible the actual working conditions of the parts.

Fatigue Failures

A fatigue failure of a shaft or axle is characterized by suddenness, lack of warning, apparent brittleness of material, and, in many cases, a fracture with a crystalline appearance over a part of its surface.

This crystalline appearance led to the old theory that under repeated stress steel "crystallized in service," changing from a ductile "fibrous" structure to a brittle "crystalline" one. This theory, however, has been quite thoroughly demolished as a result of study of the structure of steel under the microscope. As revealed

by the microscope, all metals have a crystalline structure; the fibrous structure was caused by segregations or inclusions of non-metallic impurities (example: slag in wrought iron). Microscopic examination of steel under stress shows no change of the general scheme of internal structure, but under sufficiently severe stress, there appears a gradual breakdown of the crystals in the structure. This manner of failure is rightly termed a "fatigue failure."

If the fractured surface of a fatigue failure is carefully examined, it is usually seen to be made up of two parts; that is, it appears to have two different-size crystalline structures -- (1) near the extreme outside of the fractured surface it appears dark, dull, and lusterless, with a poorly defined crystalline structure; while the appearance (2) at and immediately surrounding the center of the break is bright and shows a definite crystalline formation. This appearance is caused by the method and nature of the failure, and in that the (1) outside of the fractured surface was caused very slowly and has started from many centers and due to the constant vibration and rubbing together of the two faces of the fracture, the sharp corners of the crystals become worn and smooth; whereas the break at the center and immediately surrounding (2) was suddenly torn in two on the natural surfaces of cleavage with no subsequent vibration or rubbing, thus leaving exposed the original structure of the steel.

Cause of Fatigue Failure

The cause of a fatigue failure may be attributed to a repetition of stresses which exceed the elastic limit of the steel. This may be subdivided as follows:

Manufacturer's Responsibility

1. Defective raw material.
2. Defective heat treatment.
3. Defective design.
4. Defective machining.

Truck Operator's Responsibility

1. Overloading.
2. Overspeeding.
3. Rough handling and driving.
4. Road conditions.

Hardness is that property of a material by virtue of which it resists penetration.

Toughness is that property of a material by virtue of which it resists shock and vibration.



Transmission and differential gears must have hard surfaces and tough cores or centers. They are designed with a 20-degree tooth pressure angle, which causes the teeth to roll together and apart, rather than to slide together and apart from each other, as do gears whose teeth have different angles; thus gear tooth wear is minimized, both by heat treatment and design. Some common causes for gear failures of inferior manufacture are as follows:

1. Lack of hardness, battering and shearing, soft cores.
2. Excessive hardness and attendant brittleness, chipping.
3. Thin "case" and soft core, cracking, and chipping.
4. Case too deep, no tough backing to resist shock.

Extreme care is given the inspection of gears, both as to machined dimensions and heat-treated conditions. Test gears are broken and the structures examined, depth of "case" noted and held to approximately 3/64 - inch deep. They must not batter at corners, and they must not chip. They are hardness-tested by Scleroscope method.

One steel used in making transmission and differential gears is designated by the S.A.E. No. 3120; it is an ideal steel for the manufacture of all parts which are drop-forged and after-

wards treated, to develop in them a high degree of strength, and is one of the best carbonizing steels obtainable. Following is the chemical analysis and the physical properties to correspond to a Brinell hardness of 275 or an approximate Shore hardness of 40:

Chemical Analysis

Carbon	0.15 to 0.25%
Nickel	1.00 to 1.50%
Phosphorus	Below 0.04%
Sulphur	Below 0.045%
Chromium	0.45 to 0.75%
Manganese	0.50 to 0.90%

Physical Properties

Elastic limit, lbs. per sq. in.	120,000
Tensile strength, lbs. per sq. in.	160,000
Elongation in 2 in percent	15.00
Reduction of area	52.50
Brinell hardness numeral	275
Shore hardness numeral	40

The chemical analysis and physical properties shown above are those that will be retained by the core or the centers of the gears after carburizing, and are the factors responsible for the toughness and fatigue resistance of the gears. The surfaces are hardened to 75-85 Scleroscope, to an approximate depth of 1/16-inch, this combination of surface hardness and center toughness being the ideal condition and insuring long gear life.

GLOSSARY OF TECHNICAL AND MECHANICAL TERMS

Addendum

That part of a tooth of a gear or of a screw thread between the pitch circle or line and the extreme point of the tooth or thread.

Allowance

Covers variation in dimensions to allow for different qualities of fits.

Alloy Steel

A steel which owes its characteristic properties chiefly to the presence of one or more elements other than carbon; i.e., nickel, chromium, vanadium, molybdenum, etc.

Ampere

The practical unit of electrical current, the current produced by one volt acting through a resistance of one ohm.

Altitude

The perpendicular distance between the bases, or between the vertex and the base of a solid or plane figure.

Angle

The difference in direction of two lines which meet or tend to meet. The lines are called sides, and the point of meeting, the vertex of the angle. They are measured by degrees and by radians. One degree is equivalent to the angle at the center of a circle, subtended by an arc whose length equals one three hundred sixtieth (1/360) of the circumference. One radian is equal to the angle at the center of a circle when subtended by an arc equal in length to the radius of the circle. One radian equals 57.2958 degrees, also 1 radian equals 180/π.

The Protractor is used for the measurement of angles. A right angle is one which is formed by the radius moving through 1/4 of the circumference. It is a square angle and contains 90°.



An acute angle is one containing less than 90° .
An obtuse angle is one containing more than 90° .

An oblique angle may be any other than a right angle. A reflex angle is one containing more than 180° .

A helical angle is the angle of a thread at the pitch line, with the axis of a threaded part; the lead angle of a thread is the total or included angle between the sides or walls of a thread, measured on the axial line.

A dihedral angle is one formed by the opening between two intersecting planes.

The vertex of an angle is the point of intersection of the two lines which form the angle.

Annealing

See Heat Treatment.

Austenite

See Metallography.

Bending Moment

A moment is equivalent to the product of a force multiplied by a distance, and is measured in inch-pounds or foot-pounds. The bending moment at any cross section of a piece under flexure measures the tendency to cause flexural failure, and is equal in magnitude to the summation of the moments of the forces on one side of the cross section.

Brinell Test

A hardness-testing instrument, employing the hardened steel ball indentation method.

B.T.U.

Abbreviation for British Thermal Unit which represents the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 37° F. There are 778 foot-pounds of energy in a B.T.U. and 42.4 B.T.U. to one horsepower.

Calibrate

To ascertain the accuracy of and to rectify same, as regards a precision measuring instrument, etc.

Calorie

Any of several thermal units, as: (a) The amount of heat (small calorie) required to raise the temperature of one gram of water one degree Centigrade. (b) The amount of heat (large or great calorie) required to raise a kilogram of

water one degree Centigrade. (1 great calorie = 1000 small calories.)

Cantilever

A projecting beam, bar, or member supported at one end only.

Center of Gravity

That point in a body about which all the parts exactly balance each other.

Center of Oscillation

If a body oscillates about a horizontal axis which does not pass through its center of gravity, there will be a point on the line drawn from the center of gravity perpendicular to the axis, the motion of which will be the same as if the whole mass were concentrated at that point. This point is called the center of oscillation.

Center of Percussion

If a body oscillates about an axis then the point at which, if a blow is struck by the body, the percussive action is the same as if the whole mass of the body were concentrated at that point, is called the center of percussion. This point is located at the same point as the center of oscillation.

Center of Gyration

The center of gyration with reference to an axis is the point at which the entire weight of a body may be considered as concentrated, the moment of inertia, meanwhile, remaining unchanged; or, in a revolving body, the center of gyration is the point at which the whole weight of the body may be considered as concentrated, the angular velocity remaining the same.

Centrifugal Force

When a body revolves in a curved path, it exerts a force called the centrifugal force upon the arm or cord which restrains it from moving in a straight (tangential) line.

C or CL

Abbreviation for center line.

C. G. S.

An abbreviation for the Centimeter Gram Second or Absolute System of units much employed in physical science, based upon the centimeter as the unit of length, the gram as the unit of weight, and the second as the unit of time.

Cementite

See Metallography.

**Chamfer**

A bevel, or a corner or edge removed, a relief.

Coefficient of Friction

The force of friction, F bears -- according to the conditions under which sliding occurs -- a certain relation to the pressure between the bodies; this pressure is called the normal pressure, N . The relation between force of friction and normal pressure is given by the coefficient of friction, generally denoted by the Greek letter μ .

Thus: $F = \mu \times N$, and $\mu = \frac{F}{N}$

Cold Bending

See Cold Working.

Cold-Drawn Steel

See Cold Working.

Cold-Rolled Steel

See Cold Working.

Cold Working

Changing the shape of steel parts by compressing, stretching, bending, or twisting, using stresses beyond the yield point and temperatures below the critical range. Cold-drawn steel is finished by being drawn through a die, while cold-rolled steel is finished between rollers.

Contour

Outline or profile of an object.

Critical Range

See Metallography

Crystal

See Metallography.

Cycle

Applied to the internal-combustion, four-cycle engine, a cycle comprises four strokes for each piston (1, intake; 2, compression; 3, explosion; 4, exhaust) performed during two revolutions of the crankshaft. An interval or period of time occupied by one round or course of events, recurring in the same order in a series.

Decalescence

The sudden absorption of heat observed when metals in process of heating pass certain temperatures.

Dedendum

The dedendum of a gear tooth or of the tooth of a threaded part is the distance from the pitch circle to the root of the tooth or thread.

Deformation

The change of form of a member accompanying the application of external load. The term "strain" is used in this manual as synonymous with deformation. Deformations may be stretches under tension, compressions under compressive loads, deflections under bending (or flexure), twists under torsional moment, or detrusions under shear. Twist is a special case of shearing detrusion. In the physical laboratory the deformation per unit of length over any gauge length on a specimen is called the unit deformation, or unit strain.

Drawing

See Heat Treatment.

Ductility

Ability to withstand stretch without rupture. Ductility is usually measured by the percentage of elongation, after rupture over a gauge length laid off on a specimen before stretching, or by the reduction of area of the original cross section of a specimen when tested in tension.

Dynamic Balance

A crankshaft may be in perfect static balance, but if it is mounted in bearings and revolved at high speed great vibration may develop which would soon cause failure of engine bearings and possibly cause breakage of the shaft itself due to fatigue action.

Dynamic unbalance means that the weight sums of diagonally opposite portions are not equal. Take, for example, a pulley that is in perfect balance. Visualize the pulley mounted on a shaft supported by bearings. Attach a weight to the outer periphery on one edge of the pulley, then attach an exact counterweight to the opposite side of the pulley on the opposite edge. The pulley continues to be in static balance as evidenced by the fact that it turns freely and stops with the counterweights either up, down, or in any other position; but if the pulley is revolved at a high rate of speed its dynamically unbalanced condition will be very much evidenced by the vibration. This dynamic unbalance is eliminated in a crankshaft first by determination of the heavy points and next by drilling into these points until the necessary amount of metal and weight has been removed.

**Dyne**

The force which acting on one gram for one second imparts to it a velocity of one centimeter per second, or approximately that force exerted by a one milligram weight under the influence of gravitation.

Elastic Limit

The term "elastic limit" is unfortunately used very loosely in general practice. In scientific usage the term is used to denote the highest unit stress at which material will completely recover its form after the stress is removed.

Proportional elastic limit is used to denote the highest unit stress at which stress is proportional to deformation. The values found for both the true elastic limit and the proportional elastic limit are dependent upon the accuracy of the apparatus used, and the precision with which stress strain diagrams are plotted.

For practical purposes elastic limit and proportional limit may be regarded as interchangeable terms.

The yield point is that unit stress at which the material shows a sudden marked increase in the rate of deformation without increase in load. It is usually determined by the sudden drop in the balance beam of the testing machine, as strain is applied to the specimen at a uniform rate or by a sudden increase of deformation which can be seen by the use of a pair of dividers on the specimen.

Elongation

See Ductility.

Endurance

In the physical laboratory this term is used to denote the number of cycles of repeated stress withstood by a specimen before failure.

Endurance Limit

The highest unit stress which, applied in cycles of completely reversed stress, can be withstood an indefinite number of times without failure.

Endurance Strength

A general term denoting ability to resist repeated stress, synonymous with fatigue strength.

Erg

A theoretical unit of work or energy being the work done by one dyne working through a distance of one centimeter.

Extensometer

An instrument for measuring small changes of length of specimens under tension; capable of measuring accurately to one ten-thousandth part of an inch.

Factor of Safety

Working stresses should never exceed the elastic limit. They are generally based on the ultimate strength of the material. The ratio of the ultimate strength of a given material to the allowable working strength is called the "Factor of Safety." The factor of safety may be considered as the product of four primary factors which may be designated as factors a, b, c, and d, designating the factor of safety by F.

$$F = a \times b \times c \times d$$

The first of these factors (a) is the ratio of the ultimate strength of the material to the elastic limit, meaning in this case, by the elastic limit, that boundary line within which the material is perfectly elastic and takes no permanent set. For ordinary materials, the factor a = 2; for nickel steel and oil-tempered forgings, it is reduced to 1-1/2.

The second factor (b) depends on the character of the stress within the material. This factor is 1 for a dead load; 2 for a load varying between zero and maximum; and 3 for a load which produces alternately a tension and a compression equal in amount.

The third factor (c) depends upon the manner in which the load is applied to the piece under stress. For a load gradually applied the factor is 2. If the load is applied, not only suddenly but with impact, this factor must be still further increased in value.

The last factor (d) may be called the factor of ignorance, or the "fool factor." The other factors provide against known conditions and this provides against the unknown. It commonly varies in value between 1-1/2 and 3 and occasionally should be given as high a value as 10. It provides against accidental overload, against unexpectedly severe service and unreliable or imperfect materials, etc. When all the conditions are thoroughly known and there is no danger of overload, this factor may be made equal to 1-1/2 for wrought iron and mild steel and 2 for cast iron.

As an example of the use of the formula given for the factor of safety that should be used for an internal-combustion engine connecting rod, the elastic limit will probably be slightly more than one-half the ultimate strength, therefore, a=2. The rod will be alternately in tension and compression, therefore, b=3. The explosional



force will be applied suddenly, therefore, $c=2$.
The material is very reliable, therefore, $d=1-1/2$.

Then $F = 2 \times 3 \times 2 \times 1-1/2 = 18$.

Fatigue of Metals

The action which takes place in metals causing failure after a large number of applications of stress. Fatigue failures are characterized by their suddenness and by the absence of general deformation in the piece which fails. A wire broken by bending backward and forward is a characteristic fatigue failure.

Ferrite

Pure metallic iron, in the sense here used, entirely free from carbon inclusion.

Fibre Stress or Fiber Stresses

This is the stress in the extreme fiber, or the maximum stress in the cross section considered, due to the application of the load. Fibre stresses with a cantilever would denote tension in the upper fibers and compression in the lower ones, with a neutral plane between.

With a beam supported at both ends, the fiber stress would be the reverse of that in a cantilever. Thus a fibre stress of 50,000 pounds per square inch at point of stress on a cantilever loaded at the free end would denote the maximum stress to which the cantilever was subjected.

Fit

The different classes of fit of shafts in their holes most generally used are as follows:

SHRINK FIT -- For parts which have to be fitted together by means of an application of heat to expand the hole, at which time the shaft is inserted. On cooling the hole contracts, making a perfect union which requires no keys or other anchors of any kind. The bores are always machined to a smaller diameter than that of the shaft.

FORCE FIT -- For parts which have to be fitted together by means of a press; they must be keyed if they are to be subjected to a twisting force.

DRIVING FIT -- For parts which have to be fitted together with a lead hammer, but which can be afterwards disassembled.

PUSH FIT -- For parts which have to be fitted together by hand without special force, and without having perceptible shake when assembled, they should remain motionless in each other.

SLIDING FIT -- For all parts which in functioning

have to slide constantly on one another, without turning.

RUNNING FIT -- For parts which in functioning have to revolve constantly one in the other, at a medium speed and with very little play.

EASY RUNNING FIT -- Parts revolving with a relatively large amount of play.

Fillet

A narrow band of material, frequently in shop practice used to designate a radius on a shaft or other part.

Flute

The groove cut in taps and reamers to form the cutting edge and allow room for chips.

Friction

Is the resistance to motion which takes place when one body is moved upon another, and is generally defined as "That force which acts between two bodies at their surface of contact, so as to resist their sliding on each other."

Gauge or Gage

Master, Standard or Reference; terms applying to a nearly perfect gauge used for calibration of working gauges.

Gauge -- Limit

A gauge having two sizes, the difference between them representing the tolerance or allowable variation. One size must go into or over the work being checked, and the other size must not go. These gauges are frequently referred to in shop practice as "tolerance gauges" and as "go" and "no go" gauges.

Gear Tooth Parts

PITCH DIAMETER--PITCH CIRCLE: When one of two gears that are in mesh with each other are revolved, it will drive the other gear at a certain rate of speed. Imagine that, as well as the two gears, two discs without teeth are also in contact, so that when one disc is revolved it will drive the other disc by frictional force. The diameters of the discs may be so selected that when one revolves at the same rate as the gear to which it corresponds, it will drive the other disc at the same rate as the second gear is driven. The diameters of the discs are then the same as the pitch diameters of the gears, and the circumferences of these discs represent the pitch circles of the gears.

The outside diameter of a gear is the diameter measured over the top of the teeth.



The root diameter of a gear is the diameter measured at the bottom or roots of the teeth.

The center distance is the distance between the centers of two meshing gears, the pitch circles of which are tangent to each other.

The diametral pitch of a gear is the number of teeth for each inch of pitch diameter, and is found by dividing the number of teeth by the pitch diameter.

Bastard gear teeth are sometimes generated for special purposes, having their teeth of different pitches with regards to width and depth. Example, a gear of 6/8 pitch the teeth correspond in width or thickness to 6 pitch, and in depth to 8 pitch.

The circular pitch is the distance from the center of one tooth to the center of the next, measured as an arc along the pitch circle.

The chordal pitch is the distance (on the pitch line) from the center of one tooth to the center of the next, measured along a straight line.

The thickness of a gear tooth is generally understood to be the thickness at the pitch circle, measured along the circular arc.

The chordal thickness of a tooth is the thickness at the pitch circle measured along a straight line or as a chord.

The addendum of a gear tooth is the distance from the pitch circle to the top of the tooth.

The dedendum of a gear tooth is the distance from the pitch circle to the root of the tooth.

The working depth is the depth to which the teeth in a meshing gear enter into the spaces between the teeth of the opposing gear.

The clearance is the amount by which the tooth space is cut deeper than the working depth.

The face of the tooth is that part of the tooth curve that is between the outside circumference and the pitch circle.

The flank of the tooth is that part of the working depth of the tooth which comes inside of the pitch circle.

Gravity

The attraction of bodies toward the center of the earth. Under the influence of gravity alone, all bodies fall to the earth with the same velocity and with the same acceleration. The acceleration increases with the latitude and decreases with the elevation above the level of the sea. Its value at the level of the sea in the latitude of New York is 32.16 feet per second. (In the metric system, Gravity = 9.81 meters per second at 45

degrees latitude and sea level.)

Grain

See Metallography.

Hardness

Is that property of a material by virtue of which it resists penetration. The two common tests for hardness are the Brinell test and the Scleroscope test. In the Brinell test a hardened steel ball of a standard diameter is forced against the surface of a test specimen, using a standard pressure. The diameter or the depth of the resulting impression is an inverse measure of the hardness. In the Scleroscope test a small weight fitted with a diamond point is allowed to fall from a standard height upon the surface of the specimen, thus causing a minute indentation. The height of rebound is a measure of the hardness.

Heat-Treatment

HEAT-TREATMENT of steel is the proper control of heating and cooling so as to produce the desired structure, pearlite, sorbite, troostite, martensite, or austenite, and includes:

ANNEALING, which consists of a very slow cooling from above the critical range and which gives a large-grained, soft pearlitic structure.

NORMALIZING, which consists in cooling from above critical range in still air and which gives a fine-grained, pearlitic structure.

OIL-QUENCHING, which consists in cooling from above the critical range by cooling in oil at room temperature and which yields steel of sorbitic or troostitic structures, depending on the carbon content (certain special alloy steels yield a martensitic structure or even an austenitic structure with oil-quenching).

WATER-QUENCHING, which consists in cooling from above the critical range by cooling in water at room temperature and which yields steel of martensitic, troostitic or sorbitic structure, depending on the carbon content (certain special alloy steels yield a martensitic or austenitic structure with water-quenching).

DRAWING, which consists in reheating quenched steel to a temperature slightly below the critical range and cooling. This process tends to bring martensitic, troostitic or sorbitic steel towards the pearlitic state, and, by varying the temperature of drawing both thermally and as to time, it is possible to control the state of the steel with an excellent degree of precision.

Other liquids are sometimes used for quenching steel: such as molten lead, molten barium chloride, ice water, mercury, and brine.



Alloying elements, including carbon, slow up the transition period so that high-carbon steels and alloy steels are more susceptible to heat treatment than are low-carbon steels.

See Metallography.

Helix

A spiral. A coiled spring or a screw thread forms a helix.

High-Precision Work

This term generally applies to the manufacture of measuring instruments, magnetos, special machine tools, electrical instruments, automotive practice, etc., and generally for all kinds of apparatus for which the fits must be made with extreme accuracy and in which accordingly the interchangeability of the various parts must be uniform to a high degree.

Horsepower

See Mechanics.

Hydraulics

The science dealing with liquids in motion.

Hydrostatics

The science of the pressure and equilibrium of liquids (incompressible fluids).

Hyper-Eutectic Steel

Steel more highly carburized than eutectoid steel is called hyper-eutectoid, or hyper-eutectic steel, and therefore contains free cementite, i.e., high-carbon steel.

Hypo-Eutectic or Eutectoid

Steel containing less than 0.85 to 0.90% Carbon and therefore some free ferrite is called hypo-eutectoid or hypo-eutectic steel, i.e., low-carbon steel.

Hypoid

Hypoid (contraction of the word hyperboloid) meaning that the pinion is offset with respect to the center line of the ring gear.

Hysteresis -- Mechanical

If a load is applied to a specimen, and is removed, then, if the specimen is perfectly elastic under the stress caused by the load, the energy expended in loading the specimen is all given back when the load is removed. If the specimen is not perfectly elastic under the stress caused by the load, then some of the energy applied is

dissipated as heat. This dissipated energy is called "mechanical hysteresis."

Inch-Pounds

A term used to denote work or energy.

Inertia

See Mechanics.

Iron

See steel for distinction between iron and steel.

Joule

A unit of work or energy, approximately equal to .738 foot-pounds or .24 small calorie, or approximately the energy expended in one second by an electric current of one ampere in a resistance of one ohm, is a joule.

Land

One of the sharpened ridges which make up the cutting section of a tap, die, reamer or milling cutter after the flutes or chip clearance spaces have been removed.

Lead

The longitudinal distance which a screw thread advances when turned one complete revolution.

Limit

A maximum or minimum dimension slightly above or below a standard size, not the distance between dimensions. See Tolerance.

Martensite-Martensitic

See Heat-Treatment; also Metallography.

Mechanics

Is the science of applied mathematics which treats of the action and effect of forces on bodies.

A force is defined as any cause tending to produce or modify motion. The units by which a force is usually measured are pounds or tons.

Besides force there are two other elementary quantities in mechanics from which numerous compound quantities are derived. These are distance, measured in linear units as inches, feet, etc., and time, expressed in hours, minutes, or seconds.

WORK, in mechanics, is the product of force by distance, and is expressed by a combination of units of weight (force), and distance, as inch-pounds, foot-pounds, foot-tons, etc.



POWER, in mechanics, is the product of force by distance, divided by time, or the performance of a given amount of work in a given time and is expressed as inch-pounds per minute, foot-pounds per minute or second, etc. The term "power" is frequently used by writers or mechanics to designate a force. In connection with the so-called "mechanical power" -- the lever, wheel and axle, wedge, screw, etc. -- it is usual to speak of the applied force as the power; this is, however, not strictly correct, as power should always, in mechanics, be used in accordance with the definition given above.

HORSEPOWER (abbreviated H.P.) is the unit of power adopted for engineering work. One horsepower is equal to 33,000 foot-pounds per minute, or 550 foot-pounds per second. The metric horsepower is equal to 75 kilogram-meters per second, or 542.5 foot-pounds per second, or 32,550 foot-pounds per minute. The kilowatt used in electrical work equals 1.34 horsepower; or one horsepower equals 0.746 kilowatt.

VELOCITY is distance divided by time, and is expressed in feet per minute, miles per hour, etc.

INERTIA is that property of a body which causes it to tend to continue in its present state of rest or motion, unless acted upon by some force.

Metallography

Deals with the physical state and the proximate constituents of a metal or an alloy. It has to do with the physical grouping, distribution of constituents and relative dimensions, of the substances as revealed by microscopic examination. It may be characterized as a study of the anatomy of metals.

Steel is an alloy, the essential constituents of which are iron and carbon, the latter being the controlling element. The carbon exists in steel as a carbide of iron, Fe_3C , to which the name cementite is applied. The free iron or ferrite, together with the cementite, has the power of forming a conglomerate called pearlite, a very intimate mechanical mixture composed of about 7 parts of ferrite to one part of cementite.

If molten iron is cooled there is formed first a solution of carbon in molten iron; then, as the metal solidifies, the carbon exists as cementite in solid solution in the iron. This solid solution is called austenite, and it crystallizes into imperfect crystals or grains.

With further cooling the steel passes through a critical or transformation range of temperature (extreme range about $1650^{\circ}F.$ to $1250^{\circ}F.$) and the two constituents of the metal pass successively through several transition stages, namely: martensite, in which long needle-like crystals are

formed, giving a very hard and brittle substance; troostite, in which dark-colored masses resembling sorbite are surrounded by a ground-work of martensite, the troostitic state yielding a substance hard but tougher than the martensite; sorbite, in which cementite and ferrite are in a state resembling an emulsion, yielding a substance fairly hard and very tough; and pearlite, in which bands of ferrite and cementite exist, usually in stratified layers or bands.

If the steel has a carbon content of about 0.90%, all the grains will be pearlite; if the carbon content is lower than 0.90% there will be grains of pearlite and grains of ferrite; if the carbon content is greater than about 0.90% there will be grains of pearlite and grains of cementite.

The presence of carbon or of other alloying elements slows down the process of transition. By varying the rate of quenching steel, the transition process may in general be halted at any desired state, and the resulting cooled steel may be given any desired characteristic structure. See Heat-Treatment, also Micrograph.

Micrographs

Are obtained by polishing the surface of a metal, etching the polished surface with a suitable reagent to bring out the metallographic structure, then reproducing, usually by photographic methods, the appearance of the surface as seen through the microscope. Photomicrograph and microphotograph are terms sometimes used for micrographs made by a photographic process.

Mil, Circular

A circular mil is the area of a circle 0.001 inch in diameter and is a unit in the measurement of diameters and cross-sectional areas of electric wires.

Millivoltmeter

An electrical instrument for measuring small electric potentials. Used for measuring the small voltages of thermo-couples developed by changes of temperature. (See Pyrometer.)

Modulus of Elasticity

Is the quotient obtained by dividing the stress per square inch by the elongation in one inch caused by this stress. For all stresses below the elastic limit, the unit stress bears a constant ratio to the unit deformation.

Moment of a Force

The moment of a force with respect to a point is the product of the force multiplied by the perpendicular distance from the given point to the direction of the force. The perpendicular distance is called the lever arm of the force.



The moment is the measure of the tendency of the force to produce rotation about the given point, which is termed the center of moments. Moments are expressed in inch-pounds, foot-pounds, etc., and are designated as clockwise or contraclockwise, according to their direction. The term torque is equivalent to the term moment.

Moment of Inertia

The moment of inertia of a body with respect to an axis is the sum of the products obtained by multiplying the weights of each elementary particle by the square of its distance from the axis. Therefore, the moment of inertia of the same body varies according to the position of the axis. It has its minimum value when the axis passes through the center of gravity. The moment of inertia is numerically equal to the weight of the body which if it could be conceived of as concentrated at a distance of unity from the axis of rotation, would, if actuated by the same forces, rotate with the same angular velocity as that of the actual body. In other words, the moment of inertia bears the same relation to angular acceleration as weight does to linear acceleration. When the term "moment of inertia" is used in regard to areas, it is equal to the sum of the products obtained by multiplying each elementary area by the square of its distance from the axis. The moments of inertia of surfaces are especially useful in calculating the strength of beams.

Momentum

The momentum of a moving body is the intensity of that constant force which, resisting its movement, would bring it to rest in one second.

Momentum = mass X velocity in feet per second.

Momentum = $\frac{\text{weight}}{32.16} \times \text{velocity in feet per second.}$

Momentum should not be confused with the moment of a force, defined above.

Motion, Newton's Three Laws

1ST LAW: Every body continues in a state of rest or uniform motion in a straight line, except if it is acted upon by a force to change its state of motion or rest.

2ND LAW: If a body is acted upon by several forces, it is acted upon by each of these as if the others did not exist. This is true whether the body is at rest or in motion. In other words, if two or more forces act upon a body at the same time, each produces exactly the same effect as if it acted alone; the total effect or resultant motion of all the forces may be found by a diagram in the same way as the resultant of forces is found.

3RD LAW: To every action there is always an

equal reaction or, in other words, if a force acts to change the state of motion of a body, the body offers a resistance equal and directly opposite to the force.

Neutral Plane

See Fibre Stress.

Nonferrous Metals

Metals in which iron is not a constituent.

Ohm

The practical unit of electrical resistance, being the resistance of a circuit in which a potential difference of one volt produces a current of one ampere.

Pearlite

See Metallography.

Physics

The science of phenomena of inanimate matter involving no chemical changes, comprising mechanics, magnetism, electricity, light, heat, and sound.

Pi- π

The 16th letter of the Greek Alphabet, corresponding to the English P, is used as a constant to denote the ratio (3.14159+) of the circumference of a circle to its diameter.

Pitch, Diametral, Circular

See Gear Tooth Parts

Pitch Diameter

See Gear Tooth Parts.

Pneumatics

That branch of physics treating of the mechanical properties of air and other gases, as of their weight, pressure, elasticity, etc.

Pound-Inches-Feet

See Moments of a Force; Mechanics, etc.

Power

See Mechanics.

Prony Brake

See Horsepower.

Pyrometer

An instrument for measuring high temperatures. Briefly, one type of pyrometer (that in use by International Harvester) is of the Thermoelectric type, which utilizes the electromotive force generated by a junction of two dissimilar



metals when exposed to heat. In each pyrometer there are two junctions made by welding together wires of two dissimilar metals, platinum and platinum-rhodium; for example, one junction is then exposed to the temperature to be measured and is called the "hot junction"; the other junction, which is opposed to the first named junction, is kept at a constant temperature and is called the "cold junction." A mill voltmeter for measuring electromotive force is attached by conductors to the free ends of the opposed junctions and by its reading indicates the electromotive force generated and hence the temperature of the "hot junction."

Recalescence

The sudden unproportional liberation of heat by steel when cooling through its critical range.

Scleroscope

See Hardness.

Shear

Shearing Stress; See Stress.

Sorbite

See Metallography.

Static Balance

Balancing of crankshafts is a very important factor in providing long engine life. Crankshafts must be balanced for equalization of weight so that when supported on knife blades the shaft will not revolve. This is the same condition of balance that would obtain with an automobile wheel if a slight counterweight were placed directly opposite the valve stem so that the wheel if jacked up and given a spin would stop and remain stationary wherever it was overtaken by inertia after the energy from the force of the spin had spent itself. If not in perfect balance the wheel would either turn over another revolution or turn back until the heavy point was down.

Elimination of the heavy place on a crankshaft is termed static balancing. This is accomplished by grinding off portions of the balancing pads forged into both sides of each throw for that purpose.

Static Test

A test of a specimen in which the rate of application of load is so slow that it may be regarded as zero. The term refers in general to a test made with an ordinary Tensile Testing Machine.

Steel

The term "steel" is used to denote any ferrous

metal with a carbon content less than about 1.7%, which is made by a process involving complete fusion. Wrought iron has a low carbon content, and is made from a pasty mass at a temperature below complete fusion. Ferrous metals with carbon content higher than about 1.7% are called "cast iron."

Stress

An internal force which resists the destructive action of external force. Stresses are always accompanied by strains and deformations. There are tensile stresses, compressive stresses, and shearing stresses. At any point on a stressed member the stress per unit area is called the "unit stress." See "Deformation." Stress is the force applied, and:

Strain

Is the resulting deformation.

Specific Gravity

Is a number indicating how many times a certain volume of material is heavier than an equal volume of water at a temperature of 62° F. The weight of one cubic inch of pure water at 62° F. is 0.0361 pound. If the specific gravity of any material is known, the weight of a cubic inch of the material can, therefore, be determined by multiplying its specific gravity by 0.0361.

Tensile Strength

See Ultimate Tensile Strength.

Tolerance

The range of distance between specified limits, as applied to machine shop practice.

Torsion

That force with which a twisted part tends to return to a state of rest.

Torque

Torque is that which produces or tends to produce rotation or torsion; the product of tangential force multiplied by the radius of the part it rotates. An engine is therefore essentially a device for producing torque, and torque is the energy available for producing work. See also "Moment of Force."

Toughness

Denotes a combination of strength and ductility, resistance to fatigue, tension, and shear.

Troostite

See Metallography.



L-LINE MOTOR TRUCK SERVICE MANUAL

<p>2. Capacity 5,826 cu. in. 87 dry qts. 2,709 bu. Head diam. 16.25 in. Bilge diam 18.62 in. Stave lgth. 28.5 in.</p> <p>3. Flour Barrel Weight 200 to 220 lbs. Head diam. 18 in. Bilge diam. 21 in. Stave lgth. 28.5 in.</p>	<p>4. Sugar Barrel Weight 300 to 360 lbs. Head diam. 20.5 in. Bilge diam 25.0 in. Stave lgth 30.0 in.</p> <p>5. Syracuse Salt Barrel Weight 280 lbs. Head diam. 18 in. Bilge diam. 21 in. Stave lgth. 29 in.</p>
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ABBREVIATIONS FOR TERMS OF WEIGHT AND MEASURE

Following the name of each unit in the list below is given the abbreviation which the Bureau has adopted. Attention is particularly called to the following principles:

1. The period is omitted after the abbreviations of the metric units, while it is used after those of the customary system.
2. The exponents "2" and "3" are used to signify area and volume, respectively, in the case of the metric units instead of the longer prefixes "sq." or "cu." In conformity with this principle the abbreviation for cubic centimeter is "cm³" instead of "c.c." or "c.m." The term "cubic centimeter" as used in chemical work is, in fact, a misnomer, since the unit actually used is the "milliliter," which has a slightly larger volume.
3. The use of the same abbreviation for both singular and plural is recommended. This practice is already established in expressing metric units and is in accordance with the spirit and chief purpose of abbreviations.
4. It is also suggested that, unless all the text is printed in capital letters, only small letters be used for abbreviations except in the case of A, for acre, where the use of the capital letter is general.

<u>Unit</u>	<u>Abbreviation</u>
cubic dekameter	dkm ³
cubic foot	cu. ft.
cubic hectometer	hm ³
cubic inch	cu. in.
cubic kilometer	km ³
cubic meter	m ³
cubic mile	cu. mi.
cubic millimeter	mm ³
cubic yard	cu. yd.
decigram	dg.
deciliter	dl
decimeter	dm
decistere	ds
dekagram	dkg
dekaliter	dkl.
dekameter	dkm.
dekastere	dks
dram or drachm, apothecaries'.	dr. ap. or Z
dram, avoirdupois	dr. av.
dram, fluid	fl. dr.
fathom	fath.
foot	ft.
firkin	fir.
furlong	fur.
gallon	gal.
grain	gr.
gram	g.
hectare	ha
hectogram	hg
hectoliter	hl
hectometer	hm
hogshead	hhd.
hundredweight	cwt.
inch	in.
kilogram	kg
kiloliter	kl
kilometer	km
link	li.
liquid	liq.
liter	l
meter	m
metric ton	t
micron	u
mile	mi.
milligram	mg.
milliliter	ml
millimeter	mm
millimicron	mu

<u>Unit</u>	<u>Abbreviation</u>
acre	A
area	a
avoirdupois	av.
barrel	bbL
board foot.	bd. ft.
bushel	bu.
carat, metric	c
centare	ca
centigram	cg
centiliter	cl
centimeter	cm
chain	ch.
cubic centimeter	cm ³
cubic decimeter	dm ³

L-LINE MOTOR TRUCK SERVICE MANUAL



Unit	Abbreviation	Unit	Abbreviation
minim	min. or mu	square chain	sq. ch.
ounce	oz.	square decimeter	dm ²
ounce, apothecaries'	oz. ap. or Z	square dekameter	dkm ²
ounce, avoirdupois	oz. av.	square foot	sq. ft.
ounce, fluid	fl. oz.	square hectometer	hm ²
ounce, troy	oz. t.	square inch	sq. in.
peck	pk.	square kilometer	km ²
pennyweight	dwt.	square meter	m ²
point	pt.	square mile	sq. mi.
pound	lb.	square millimeter	mm ²
pound, apothecaries'	lb. ap.	square rod	sq. rd.
pound, avoirdupois	lb. av.	square yard	sq. yd.
pound, troy	lb. t.	stere	s.
quart	qt.	ton	tn.
rod	rd.	ton, metric	t
scruple, apothecaries	s. ap. or Z	troy	t.
square centimeter	cm ²	yard	yd.

UNITS OF WEIGHT AND MEASURE

(From Circular No. 47 of Bureau of Standards, Department of Commerce, Washington, D.C.)

THE METRIC SYSTEM: Metric units are naturally related. For example: 1 cubic decimeter equals, for all practical purposes, 1 liter, and 1 liter of water weighs 1 kilogram. The metric terms are formed by combining the words "meter," "gram" and "liter" with the six numerical prefixes, as in the following table:

Prefixes	Meaning	Units
milli- = one-thousandth	$\frac{1}{1000}$.001	"meter" for length
centi = one-hundredth	$\frac{1}{100}$.01	
deci- = one-tenth	$\frac{1}{10}$.1	"gram" for weight or mass
Unit = one	$\frac{10}{1}$ 1	
deka- = ten	$\frac{1}{1}$ 10	
hecto- = one hundred	$\frac{100}{1}$ 100	"liter" for capacity
kilo- = one thousand	$\frac{1000}{1}$ 1000	

Definitions of Units

The following lists of units include most of those in general use. Simple conversions may be made from the values here given. For example, if a conversion into nautical miles is wanted, the conversion factor for statute mile given in the conversion tables may be used by multiplying it by the factor 1.151553 here given to show relation of nautical mile to statute mile.

Length

FUNDAMENTAL UNITS

A meter (m) is a unit of length equivalent to the distance between the defining lines on the international prototype meter at the International Bureau of Weights and Measures when this standard is at the temperature of melting ice (0°C.).

1 m. = $\frac{3937}{3600}$ yd.

A yard (yd.) is a unit of length equivalent to $\frac{3600}{3937}$ of a meter.

HIGHER AND LOWER UNITS

- 1 kilometer (km) = 1000 meters.
- 1 hectometer (hm) = 100 meters.
- 1 dekameter (dkm) = 10 meters.
- 1 decimeter (dm) = 0.1 meter.
- 1 centimeter (cm) = 0.01 meter.
- 1 millimeter (mm) = 0.001 meter = 0.1 centimeter.
- 1 micron (u) = 0.000 001 meter = 0.001 millimeter.
- 1 millimicron (mu) = 0.000 000 001 meter = 0.001 micron.

1 foot (ft.) = $\frac{1}{3}$ yard = $\frac{1200}{3937}$ meter.

1 inch (in.) = $\frac{1}{36}$ yard = $\frac{1}{12}$ foot = $\frac{100}{3937}$ meter.

- 1 link (li) = 0.22 yard = 7.92 inches.
- 1 rod (rd.) = 5-1/2 yards = 16-1/2 feet.
- 1 chain (ch.) = 22 yds. = 100 links = 66 feet = 4 rods.
- 1 furlong (fur.) = 220 yards = 40 rods = 10 chains.
- 1 statute mile (mi.) = 1760 yards = 5280 feet = 320 rods.
- 1 hand = 4 inches.

1 point = $\frac{1}{72}$ inch.



1 mil = 0.001 inch.
 1 fathom = 6 feet.
 1 span = 9 inches = 1/8 fathom.
 1 nautical mile
 1 seal mile
 1 geographical mile

}	United States=6080.20
	feet=1.151 553 statute
	miles=1353.249 meters

Area**FUNDAMENTAL UNITS**

A square meter (m²) = 1.195985 sq. yd.
 A square yard (sq. yd.) = 0.8361307 m².

HIGHER AND LOWER UNITS

1 square kilometer (km²) = 1 000 000 square meters.
 1 hectare (ha) or square hectometer (hm²) = 10 000 square meters.
 1 area (a), or square dekameter (dkm²) = 100 square meters.
 1 centare (ca) = 1 square meter.
 1 square decimeter (dm²) = 0.01 square meter.
 1 square centimeter (cm²) = 0.0001 square meter.
 1 square millimeter (mm²) = 0.000 001 square meter = 0.01 square centimeter.
 1 square foot (sq. ft.) = $\frac{1}{9}$ square yard.
 1 square inch (sq. in.) = $\frac{1}{1296}$ square yard = $\frac{1}{144}$ square foot.
 1 square link (sq. li.) = 0.0484 square yard = 62.7264 square inches.
 1 square rod (sq. rd.) = 30.25 square yards = 272.25 square feet = 625 square links.
 1 square chain (sq. ch.) = 484 square yards = 16 square rods = 100 000 square links.
 1 acre (A) = 4840 square yards = 160 square rods = 10 square chains.
 1 square mile (sq. mi.) = 3 097 600 square yards = 640 acres.

Volume**FUNDAMENTAL UNITS**

A cubic meter (m³) = 1.307 9428 cu. yd.
 A cubic yard (cu. yd.) = .017645594 m.

HIGHER AND LOWER UNITS

1 cubic kilometer (km³) = 1 000 000 000 cubic meters.
 1 cubic hectometer (hm³) = 1 000 000 cubic meters.
 1 cubic dekameter (dkm³) = 1000 cubic meters.
 1 stere (s) = cubic meter.
 1 cubic decimeter (dm³) = 0.001 cubic meter.
 1 cubic centimeter (cm³) = 0.000 001 cubic meter = 0.001 cubic decimeter.

1 cubic millimeter (mm³) = 0.000 000 001 cubic meter = 0.001 cubic centimeter.

1 cubic foot (cu. ft.) = $\frac{1}{27}$ cubic yard.

1 cubic inch (cu. in.) = $\frac{1}{46656}$ cubic yard = $\frac{1}{1728}$ cubic foot.

1 board foot = 144 cubic inches = $\frac{1}{12}$ cubic foot.

1 cord (cd.) = 128 cubic feet.

Capacity**FUNDAMENTAL UNITS**

A liter (l) is a unit of capacity equivalent to the volume occupied by the mass of 1 kilogram of pure water at its maximum density (at a temperature of 4° C. practically and under the standard atmospheric pressure of 760 mm). It is equivalent in volume to 1.00 027 cubic decimeters. One liter = 0.264168 gal.

A gallon (gal.) is a unit of capacity equivalent to the volume of 231 cubic inches. It is used for the measurement of liquid commodities only. 1 gal. = 3.785 332 liter. A British gallon is approximately 20 percent larger.

A bushel (bu.) is a unit of capacity equivalent to the volume of 2150.42 cubic inches. It is used in the measurement of dry commodities only. The bushel is the so-called stricken or struck bushel. Many dry commodities are sold by heaped bushel, which is generally specified in the State Laws to be the usual stricken bushel measure "duly heaped in the form of a cone as high as the article will admit" or "heaped as high as may be without special effort or design." The heaped bushel was originally intended to be 25 percent greater than the bushel. A British bushel is 3 percent larger.

HIGHER AND LOWER UNITS

1 hectoliter (hl) = 100 liters.
 1 dekaliter (dkl) = 10 liters.
 1 deciliter (dl) = 0.1 liter.
 1 centiliter (cl) = 0.01 liter.
 1 milliliter (ml) = 0.001 liter = 1.000 027 cubic centimeters.
 1 liquid quart (liq. qt.) = 1/4 gallon = 57.75 cubic inches.
 1 liquid pint (liq. pt.) = 1/8 gallon = 1/2 liquid quart = 28.875 cubic inches.
 1 gill (gi.) = 1/32 gallon = 1/4 liquid pint = 7.21875 cubic inches.
 1 fluid ounce (fl. oz.) = $\frac{1}{128}$ gallon = 1/16 liquid pint.
 1 fluid dram (fl. dr.) = 1/8 fluid ounce = $\frac{1}{128}$ liquid pint.
 1 minim (min.) = $\frac{1}{60}$ fluid dram = 1/4 80 fluid ounce.
 1 firkin (fir.) = 9 gallons.



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- 1 peck (pk.) = 1/4 bushel = 537.605 cubic inches.
- 1 dry quart (dry qt.) = 1/32 bushel = 1/8 peck = 67.200 625 cubic inches.
- 1 dry pint (dry pt.) = 1/64 bushel = 1/2 dry quart = 33.600 312 5 cubic inches.
- 1 barrel (bbl.) (for fruit, vegetables and other dry commodities) = 7056 cubic inches = 105 dry quarts (By U.S. Statute, March 4, 1915).

Mass or Weight

FUNDAMENTAL UNITS

A kilogram (kg) is a unit of mass equivalent to the mass of the International prototype kilogram at the International Bureau of Weights and Measures. One kg. = 2.204 622 341 lb. av.

An avoirdupois pound (lb. av.) = 0.453 592 427 7 kilogram. A gram (g) is a unit of mass equivalent to one-thousandth of the mass of the International prototype kilogram at the International Bureau of Weights and Measures.

A troy pound (lb. 61) is a unit of mass equivalent to 5760/7000 of that of the avoirdupois pound.

HIGHER AND LOWER UNITS

- 1 metric ton (t) = 1000 kilograms.
- 1 hectogram (hg) = 100 grams = 0.1 kilogram.
- 1 dekagram (dkg) = 10 grams = 0.01 kilogram.
- 1 decigram (dg) = 0.1 gram.
- 1 centigram (cg) = 0.01 gram.
- 1 milligram (mg) = 0.001 gram.
- 1 avoirdupois ounce (oz. av.) = $\frac{1}{6}$ avoirdupois pound.
- 1 avoirdupois dram (dr. av.) = 1/2 56 avoirdupois pound = 1/16 avoirdupois ounce.
- 1 grain (gr.) = $\frac{1}{7000}$ avoirdupois pound = $\frac{10}{4375}$ avoirdupois ounce = $\frac{1}{5760}$ troy pound.

- 1 apothecaries' pound (lb. ap.) = 1 troy pound = $\frac{5760}{7000}$ avoirdupois pound.
- 1 apothecaries' or troy ounce (oz. ap. or z, or oz. t.) = $\frac{1}{12}$ troy pound = $\frac{480}{7000}$ avoirdupois pound = 480 grains.
- 1 apothecaries' dram (dr. ap or Z) = $\frac{1}{96}$ apothecaries' pound = 1/8 apothecaries' ounce = 60 grains.
- 1 pennyweight (dwt.) = $\frac{1}{20}$ troy ounce = 24 grains.
- 1 apothecaries' scruple (s. ap. or S) = $\frac{1}{3}$ apothecaries' dram = 20 grains.
- 1 metric carat (c) = 200 milligrams = 0.2 gram.
- The old carat in use in this country previous to July 1, 1913, was of 205.3 milligrams.
- 1 short hundredweight (sh. cwt.) = 100 avoirdupois pounds.
- 1 long hundredweight (1 cwt.) = 112 avoirdupois pounds.
- 1 short ton (sh. tn.) = 2000 avoirdupois pounds.
- 1 long ton (l. tn.) = 2240 avoirdupois pounds.

FRENCH AND AMERICAN EQUIVALENT MEASUREMENTS

Measures of Length

FRENCH	AMERICAN
1 meter	39.37 inches, or 3.28083 feet
.3048 meter	1 foot
1 centimeter	.3937 inch
2.54 centimeters	1 inch
1 millimeter	.03937 inch, or $\frac{1}{22}$ inch nearly
25.4 millimeters	1 inch
1 kilometer	1093.61 yards, or .62137 mile

EQUIVALENT VALUES OF ELECTRICAL, MECHANICAL AND HEAT UNITS

Units	Equivalent Value in Other Units
1 Kilowatt Hour =	1,000 watt hours
	1,341 horsepower hours
	2,655,180 ft.-lbs.
	3,600,000 joules
	3,415 heat units
	367,100 kilogram meters
	0.234 lb. carbon oxidized with perfect efficiency
	3.52 lbs. water evaporated from and at 212 degrees F.
22.77 lbs. water raised from 62 degrees to 212 degrees F.	
1 Horsepower Hour =	0.7457 kilowatt hour
	1,980,000 ft.-lb.
	2,546.5 heat units per hour
	273,740 kilogram meters
	0.174 lb. carbon oxidized with perfect efficiency
	2.62 lb. water evaporated from and at 212 degrees F.
	17.0 lb. water raised from 62 degrees to 212 degrees F.



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Unit	Equivalent Value in Other Units	
1 Kilowatt =	1,000 1,3410 2,655,180 44,253 737.56 3,415 56.92 0.9846 0.234 3.52	watts horsepower ft.-lbs. per hour ft.-lbs. per minute ft.-lbs. per second heat units per hour heat units per minute heat units per second lb. carbon oxidized per hour lbs. water evap. per hour from and at 212 degrees F.
1 HORSEPOWER	745.7 0.7457 33,000 550 2,546.5 42.44 0.707 0.174 2.62	watts kilowatt ft.-lbs. per minute ft.-lbs. per second heat units heat units per minute heat units per second lb. carbon oxidized per hour lb. water evap. per hour from and at 212 degrees F.
1 Joule =	1 0.000000278 0.102 0.0009486 0.73756	watt second kilowatt hour kilogram meter heat unit ft.-lb.
1 Ft.-Lb.=	1.3558 0.13826 0.000003766 0.0012861 0.0000005	joules kilogram meter kilowatt hour heat unit horsepower hour
1 Watt =	1 0.001341 3.415 0.73756 0.0035 44.254	joule per second horsepower heat units per hour ft.-lb. per second lb. water evap. per hour ft.-lbs. per minute
1 Watt per Sq. In. =	8.20 6,373 0.1931	heat units per sq. ft. per minute ft.-lbs. per sq. ft. per minute horsepower per sq. ft.
1 B.T.U. or 1 Heat Unit =	1,054.2 777.54 107.5 0.0002928 0.0003927 0.0000685 0.001030	watt seconds ft.-lbs. kilogram meters kilowatt hour horsepower hour lb. carbon oxidized lb. water evap. from and at 212 degrees F.
1 Heat Unit per sq. ft. per min.	1.1220 0.01757 0.02356	watt per sq. in. kilowatt per sq. ft. horsepower per sq. ft.
1 Kilogram Meter =	7.233 0.000003653 0.000002724 0.009302	ft.-lbs. horsepower hour kilowatt hour heat unit

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Unit	Equivalent Value in Other Units	
1 lb. Carbon Oxidized with perfect efficiency=	14,600	heat units
	1.11	lbs. anthracite coal oxidized
	2.5	lbs. dry wood oxidized
	22	cubic feet illuminating gas
	4.275	kilowatt hours
	5.733	horsepower hours
	11,352,000	
1 lb. Water Evap. from and at 212 degrees F. =	15.05	lbs. of water evap. from and at 212 degrees F.
	0.2841	kilowatt hour
	0.3811	horsepower hour
	970.4	heat units
	104,320	kilogram meters
	1,023,000	joules
	754,525	ft.-lbs.
0.066466	lb. carbon oxidized	



MATHEMATICAL FORMULAS USED IN SALES ENGINEERING

ROAD SPEED FORMULAS

$$\text{MPH} = \frac{\text{RPM} \times r}{R \times 168}$$

$$\text{RPM} = \frac{\text{MPH} \times R \times 168}{r}$$

$$R = \frac{\text{RPM} \times r}{\text{MPH} \times 168}$$

$$\text{WHEEL RPM} = \frac{\text{MPH} \times 166}{r}$$

TRACTIVE EFFORT FORMULAS

$$\text{TE} = \frac{T \times 12 \times R \times E}{r}$$

$$T = \frac{\text{TE} \times r}{12 \times R \times E}$$

$$R = \frac{\text{TE} \times r}{T \times 12 \times E}$$

TRACTIVE FACTOR FORMULAS

$$\text{TF} = \frac{T \times 12 \times R \times E}{\text{GVW} \times r}$$

$$T = \frac{\text{TF} \times \text{GVW} \times r}{12 \times R \times E}$$

$$\text{GVW} = \frac{T \times 12 \times R \times E}{\text{TF} \times r}$$

$$R = \frac{\text{TF} \times \text{GVW} \times r}{T \times 12 \times E}$$

GRADE ABILITY FORMULAS

$$\text{GA} = \text{TF} - \text{RR}$$

$$\text{TF} = \text{GA} + \text{RR}$$

$$\text{GA} = \frac{T \times 12 \times R \times E}{\text{GVW} \times r} - \text{RR}$$

$$\text{GVW} = \frac{T \times 12 \times R \times E}{\text{TF} \times r}$$

$$T = \frac{\text{TF} \times \text{GVW} \times r}{12 \times R \times E}$$

$$R = \frac{\text{TF} \times \text{GVW} \times r}{12 \times T \times E}$$

HORSEPOWER FORMULAS

$$\text{IHP} = \frac{\text{MEP} \times A \times S \times N}{33000 \times C}$$

$$S = \text{Stroke (Ft.)} \times \text{RPM}$$

$$\text{IHP} = \text{BHP} + \text{Friction HP}$$

$$\text{BHP} = \frac{\text{BMEP} \times A \times S \times N}{33000 \times C}$$

$$\text{BHP} = \frac{2 \times \text{RPM} \times \pi \times T}{33000}$$

$$\text{BHP} = \frac{T \times \text{RPM}}{5252}$$

$$\text{BHP} = \frac{D \times \text{RPM} \times 0.75 \text{ (Approx.)}}{5252}$$

TORQUE FORMULAS

$$T = \frac{D \times \text{BMEP}}{150.8}$$

$$T = D \times 0.75 \text{ (Approx.)}$$

$$T = \frac{\text{BHP} \times 5252}{\text{RPM}}$$

DRAWBAR PULL

$$\text{DBP} = \text{TE} - \text{RR}$$

CLUTCH TORQUE CAPACITY

$$T = \left\{ \begin{array}{l} \text{Total Spring Pressure} \times \\ \text{Mean Radius of Lining} \\ \times 2 \text{ Faces} \times .25 \text{ Coeffi-} \\ \text{cient of Friction} \div 12 \end{array} \right.$$

GRADE ABILITY—

HORSEPOWER FORMULAS

$$\text{GA} = \frac{33750 \times \text{BHP}}{\text{GVW} \times \text{MPH}} - \text{RR}$$

$$\text{GVW} = \frac{33750 \times \text{BHP}}{\text{MPH} \times \text{TF}}$$

$$\text{MPH} = \frac{33750 \times \text{BHP}}{\text{GVW} \times \text{TF}}$$

$$\text{HP} = \frac{\text{GVW} \times \text{MPH} \times \text{TF}}{33750}$$

KEY TO SYMBOLS USED ABOVE

A = Area of piston head in sq. in.
 BHP = Brake horsepower.
 BMEP = Brake mean effective pressure.
 C = No. cycles (4 for IH).
 D = Piston displacement in cu. in.
 DBP = Drawbar pull.
 E = Mechanical efficiency (.90 direct, .85 in other gears).
 GA = Grade ability, factor (G x 100 = % Grade).
 GVW = Gross weight, lb.
 IHP = Indicated horsepower.
 MEP = Mean effective pressure.
 MPH = Miles per hour.

N = Number of cylinders.
 r = Effective tire radius (loaded) (inches)
 R = Total reduction to 1.00.
 RPM = Engine speed revolutions per minute (r.p.m.)
 RR = Rolling or road resistance (.012 lbs. for good concrete roads).
 S = Piston speed in feet per minute.
 T = Torque—lb.-ft.
 TE = Tractive effort, lb.
 TF = Tractive factor, lb. per lb. gross.
 π = Pi = 3.1416; ratio of diameter to circumference of circle.

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**POUNDS OF GROSS VEHICLE WEIGHT WHICH ONE HORSEPOWER
DELIVERED TO CLUTCH WILL PULL UP
VARIOUS GRADES AT VARIOUS SPEEDS**

SPEED—MILES PER HOUR

Grade %	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	35	40	45	50	Grade %			
0.1												998	962	927	895	865	742	649	577	519	0.1			
0.2		MORE THAN										964	928	893	861	832	804	689	603	536	482	0.2		
0.3		1 0 0 0 LBS.										978	938	900	865	834	804	777	750	643	563	500	450	0.3
0.4							1000	958	917	879	844	810	781	753	728	702	603	527	469	422	0.4			
0.5						993	947	903	863	827	795	764	736	710	685	662	567	496	441	397	0.5			
0.6				988	937	894	853	817	782	750	722	695	670	648	625	536	469	417	375	0.6				
0.7			993	935	890	847	808	773	741	711	683	658	635	612	593	507	444	395	355	0.7				
0.8		993	936	889	843	803	766	733	702	674	648	625	602	581	561	482	422	375	338	0.8				
0.9	1000	945	890	845	802	765	730	698	669	642	617	594	573	553	535	459	402	357	321	0.9				
1.0	959	903	854	808	768	730	697	667	639	613	590	567	548	529	511	438	384	341	307	1.0				
1.1	978	917	862	813	772	732	697	665	638	611	586	562	542	522	504	488	419	367	326	293	1.1			
1.2	937	878	827	782	740	702	670	639	611	586	562	540	521	502	484	469	402	352	313	281	1.2			
1.3	900	844	795	750	710	675	643	613	587	563	540	519	500	482	465	450	386	338	300	270	1.3			
1.4	867	812	764	722	684	650	619	591	565	542	520	500	481	463	448	433	371	325	288	260	1.4			
1.5	833	781	736	694	658	625	595	568	543	521	500	481	462	446	431	410	357	313	278	250	1.5			
1.6	803	754	709	670	634	602	573	547	524	502	482	463	446	430	416	401	344	301	268	241	1.6			
1.7	776	727	685	647	612	581	554	529	506	484	465	447	431	416	401	388	333	290	259	233	1.7			
1.8	750	703	662	625	592	562	536	511	488	468	450	432	416	401	387	375	321	281	250	225	1.8			
1.9	727	681	641	606	573	544	519	495	473	453	435	419	403	389	375	363	311	272	242	218	1.9			
2.0	703	659	620	586	555	527	502	479	458	439	422	406	390	377	364	352	301	264	234	211	2.0			
2.1	680	639	600	567	537	511	486	465	444	425	409	393	378	366	352	341	292	256	227	205	2.1			
2.2	661	620	584	551	523	496	473	452	432	414	397	382	368	355	342	331	284	248	221	199	2.2			
2.3	642	601	566	535	507	482	459	438	419	401	386	371	357	345	332	322	276	241	214	193	2.3			
2.4	625	585	552	520	494	469	446	426	407	391	375	361	348	335	323	312	268	234	208	188	2.4			
2.5	608	570	536	507	480	456	434	415	397	380	365	351	338	326	314	304	261	228	203	182	2.5			
2.6	591	555	522	493	467	444	423	404	386	370	356	342	329	317	306	296	254	222	197	178	2.6			
2.7	576	540	508	480	455	432	412	394	376	360	346	333	320	309	298	288	247	216	192	173	2.7			
2.8	561	527	495	468	443	421	401	383	367	351	337	324	312	301	291	281	241	211	188	169	2.8			
2.9	548	514	484	457	433	411	392	374	358	343	329	317	304	294	283	274	235	206	183	165	2.9			
3.0	535	503	472	446	422	400	382	365	349	334	321	309	297	287	277	268	230	201	179	161	3.0			
3.1	523	490	462	436	413	392	374	357	341	327	314	302	290	280	271	262	224	196	174	157	3.1			
3.2	511	479	451	425	404	383	365	348	333	319	307	295	284	274	264	256	219	192	170	153	3.2			
3.3	500	468	441	416	395	375	357	341	326	312	300	288	277	267	258	250	214	188	167	150	3.3			
3.4	489	457	431	407	386	366	349	333	319	305	293	282	272	262	253	244	210	183	163	147	3.4			
3.5	478	449	422	399	378	359	342	326	312	299	287	276	266	257	248	239	205	180	160	144	3.5			
3.6	468	439	413	390	370	351	334	319	305	292	281	270	260	251	242	234	201	176	156	141	3.6			
3.7	458	430	405	382	362	344	327	313	299	287	275	265	255	246	237	229	197	172	153	138	3.7			
3.8	450	422	397	375	355	337	321	307	293	281	270	260	250	241	233	225	193	169	150	135	3.8			
3.9	441	413	389	367	348	330	315	300	287	275	264	254	245	236	228	221	189	165	147	132	3.9			
4.0	432	405	381	360	341	324	309	294	282	270	259	249	240	231	223	216	185	162	144	130	4.0			
4.1	424	397	374	353	335	318	303	289	276	265	254	244	236	227	219	212	182	159	142	127	4.1			
4.2	416	390	367	347	328	312	297	284	272	260	250	240	231	223	215	208	179	156	139	125	4.2			
4.3	409	383	361	341	323	307	292	279	267	255	245	236	227	219	211	204	175	153	136	123	4.3			
4.4	401	376	354	335	317	301	287	274	262	251	241	232	223	215	208	200	172	151	134	121	4.4			
4.5	394	370	348	328	311	295	282	269	257	246	237	227	219	211	204	197	169	148	132	118	4.5			
4.6	387	363	342	323	306	290	277	264	253	242	232	223	217	207	201	194	166	145	129	116	4.6			
4.7	381	357	336	318	300	286	272	260	249	238	228	220	212	204	197	191	163	143	127	114	4.7			
4.8	375	351	331	312	295	281	268	255	244	234	224	216	208	200	194	188	160	140	125	113	4.8			
4.9	369	346	325	307	291	276	263	251	240	231	221	213	205	198	191	184	158	138	123	111	4.9			
5.0	363	340	320	302	286	272	259	247	235	226	218	209	202	194	188	181	156	136	121	109	5.0			
5.1	357	335	315	298	282	268	255	244	233	223	214	206	198	191	185	179	153	134	119	107	5.1			
5.2	351	330	310	293	277	264	251	240	229	220	211	203	195	188	182	176	151	132	117	105	5.2			
5.3	346	325	305	289	273	260	247	236	226	216	208	200	192	185	179	173	148	130	115	104	5.3			
5.4	341	320	301	284	269	256	244	233	223	213	205	197	189	183	176	170	146	128	114	102	5.4			
5.5	336	315	296	280	265	252	240	229	219	210	202	194	187	180	174	168	144	126	112	101	5.5			
5.6	331	310	292	276	261	248	236	226	216	207	199	191	184	177	171	165	142	124	110	99	5.6			
5.7	326	306	288	272	257	244	233	223	213	204	196	188	181	175	169	163	140	122	109	97	5.7			
5.8	321	301	283	268	254	241	229	219	210	200	193	185	179	172	166	161	138	121	107	96	5.8			
5.9	317	297	280	264	250	238	226	216	207	198	190	183	176	170	164	158	136	119	106	95	5.9			



SPEED—MILES PER HR.

Grade %	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	35	40	45	50	Grade %
6.0	312	293	275	260	246	234	223	213	204	195	188	180	174	167	162	156	134	117	104	94	6.0
6.1	308	289	272	257	243	231	220	210	201	193	185	178	171	165	159	154	132	116	103	92	6.1
6.2	304	285	268	254	240	228	217	207	198	190	182	175	169	163	157	152	130	114	101	91	6.2
6.3	300	281	264	250	237	225	214	204	196	187	180	173	167	161	155	150	129	113	100	90	6.3
6.4	296	278	261	247	234	222	211	202	193	185	178	171	164	159	153	148	127	111	99	89	6.4
6.5	292	274	258	244	230	219	209	199	191	183	175	169	162	156	151	146	125	110	97	88	6.5
6.6	288	270	254	240	227	216	206	197	188	180	173	166	160	154	149	144	124	108	96	86	6.6
6.7	284	266	251	237	224	213	203	194	186	178	171	164	158	153	147	142	122	107	95	85	6.7
6.8	281	263	248	234	221	211	201	192	183	176	169	162	156	151	146	140	121	105	94	84	6.8
6.9	278	260	245	231	219	208	198	189	181	174	167	160	154	149	144	139	119	104	92	83	6.9
7.0	274	257	242	228	216	206	196	187	179	171	165	158	152	147	142	137	118	103	91	82	7.0
7.1	271	254	239	226	214	203	194	184	177	169	163	156	151	145	140	136	116	102	90	81	7.1
7.2	267	251	236	223	211	201	191	182	175	167	161	155	149	143	139	134	115	100	89	80	7.2
7.3	264	248	234	221	209	199	189	180	173	165	159	153	147	142	137	132	113	99	88	79	7.3
7.4	263	245	231	218	207	196	189	178	171	163	157	151	145	140	135	131	112	98	87	78	7.4
7.5	259	242	228	216	204	194	185	176	169	162	155	149	144	139	134	129	111	97	86	77	7.5
7.6	256	240	226	213	202	192	183	174	167	160	153	148	142	137	132	128	110	96	85	77	7.6
7.7	253	237	223	211	200	190	181	172	165	158	152	146	140	135	131	126	108	95	84	76	7.7
7.8	250	234	221	208	197	188	179	170	163	156	150	144	139	134	129	125	107	94	83	75	7.8
7.9	248	232	218	206	195	185	177	169	161	155	148	143	137	132	128	124	106	93	82	74	7.9
8.0	245	229	216	204	193	183	175	167	159	153	147	141	136	131	127	122	105	92	81	73	8.0
8.1	242	227	213	202	191	182	173	165	158	151	145	140	134	130	125	121	104	91	81	72	8.1
8.2	239	224	211	199	189	180	171	163	156	150	144	138	133	128	124	120	103	90	80	72	8.2
8.3	236	222	209	197	187	178	169	161	154	148	142	137	132	127	122	118	102	89	79	71	8.3
8.4	234	220	207	195	185	176	167	160	153	146	141	135	130	126	121	117	100	88	78	70	8.4
8.5	232	217	205	193	183	174	166	158	151	145	139	134	129	124	120	116	99	87	77	69	8.5
8.6	230	215	203	191	181	172	164	157	150	143	138	132	128	123	119	115	98	86	76	69	8.6
8.7	227	213	201	189	179	171	162	155	148	142	137	131	126	122	118	114	97	85	76	68	8.7
8.8	225	211	199	188	178	169	160	153	147	141	136	130	125	121	116	113	96	84	75	67	8.8
8.9	223	209	197	186	176	167	159	152	145	139	134	129	124	119	115	111	95	83	74	67	8.9
9.0	220	207	195	184	174	165	158	150	144	138	132	127	123	118	114	110	94	83	73	66	9.0
9.1	218	205	193	182	172	164	156	149	142	137	131	126	121	117	113	109	94	82	73	65	9.1
9.2	216	203	191	180	171	162	155	148	141	135	130	125	120	116	112	108	93	81	72	65	9.2
9.3	214	201	189	179	169	161	153	146	140	134	129	124	119	115	111	107	92	80	71	64	9.3
9.4	212	199	187	177	168	159	152	145	138	133	127	122	118	114	110	106	91	79	71	64	9.4
9.5	210	197	186	175	166	158	150	143	137	131	126	121	117	113	109	105	90	79	70	63	9.5
9.6	208	195	184	174	164	156	149	142	136	130	125	120	116	112	108	104	89	78	69	62	9.6
9.7	206	193	182	172	163	155	147	141	135	129	124	119	115	111	107	103	88	77	69	62	9.7
9.8	204	192	180	170	161	153	146	139	133	128	123	118	114	110	106	102	88	77	68	61	9.8
9.9	202	190	179	169	160	152	145	138	132	127	122	117	113	109	105	101	87	76	67	61	9.9
10.0	201	188	177	167	159	151	143	137	131	126	120	116	112	108	104	100	86	75	67	60	10.0

ROAD—ENGINE SPEED FORMULAS

- S —Road speed in miles per hour.
- RPM—Engine speed in revolutions per minute.
- r —Tire rolling radius in inches.
- R —Total gear reduction=Rear axle ratio x Transmission ratio.

ABILITY FORMULAS

- GVW—Gross weight of vehicle (or combination) in pounds.
- S —Road speed in miles per hour.
- HP —Power delivered to clutch at road speed S in particular transmission ratio being used.
- G —Grade in per cent.

In the following ability formulas, a value of 1.2 lbs. per 100 lbs. of gross weight is used for rolling resistance. Power lost in overcoming friction between the clutch and the driving wheels is taken at 0.1 of the power delivered to the clutch by the engine and an efficiency factor of 0.9 has accordingly been incorporated in the formulas.

$$1—GVW = \frac{33750 \times HP}{S(G+1.2)}$$

$$3—S = \frac{33750 \times HP}{GVW (G+1.2)}$$

$$2—\frac{GVW}{HP} = \frac{33750}{S(G+1.2)} = \text{Lbs. per Horsepower}$$

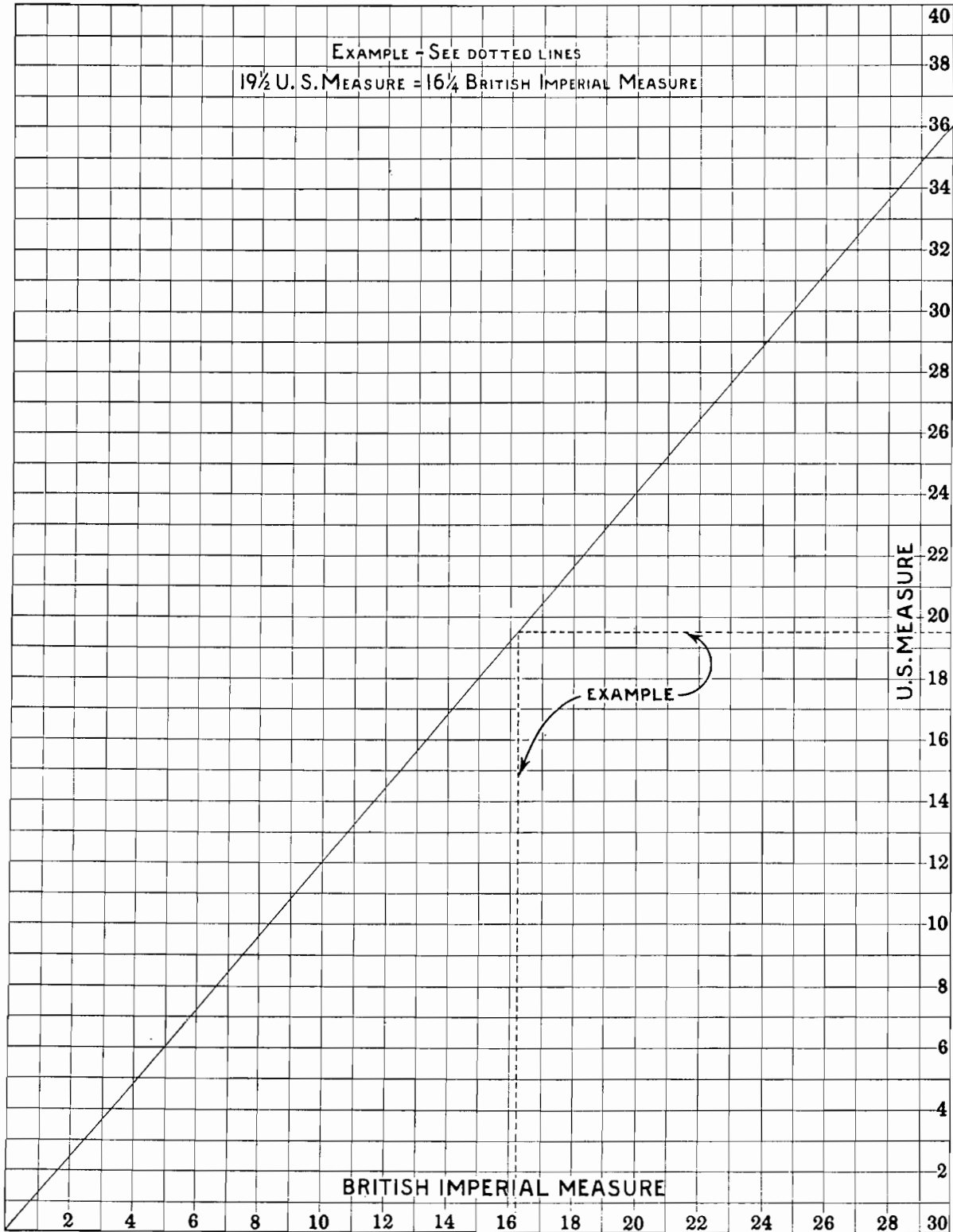
$$4—G = \frac{33750 \times HP - 1.2}{GVW \times S}$$

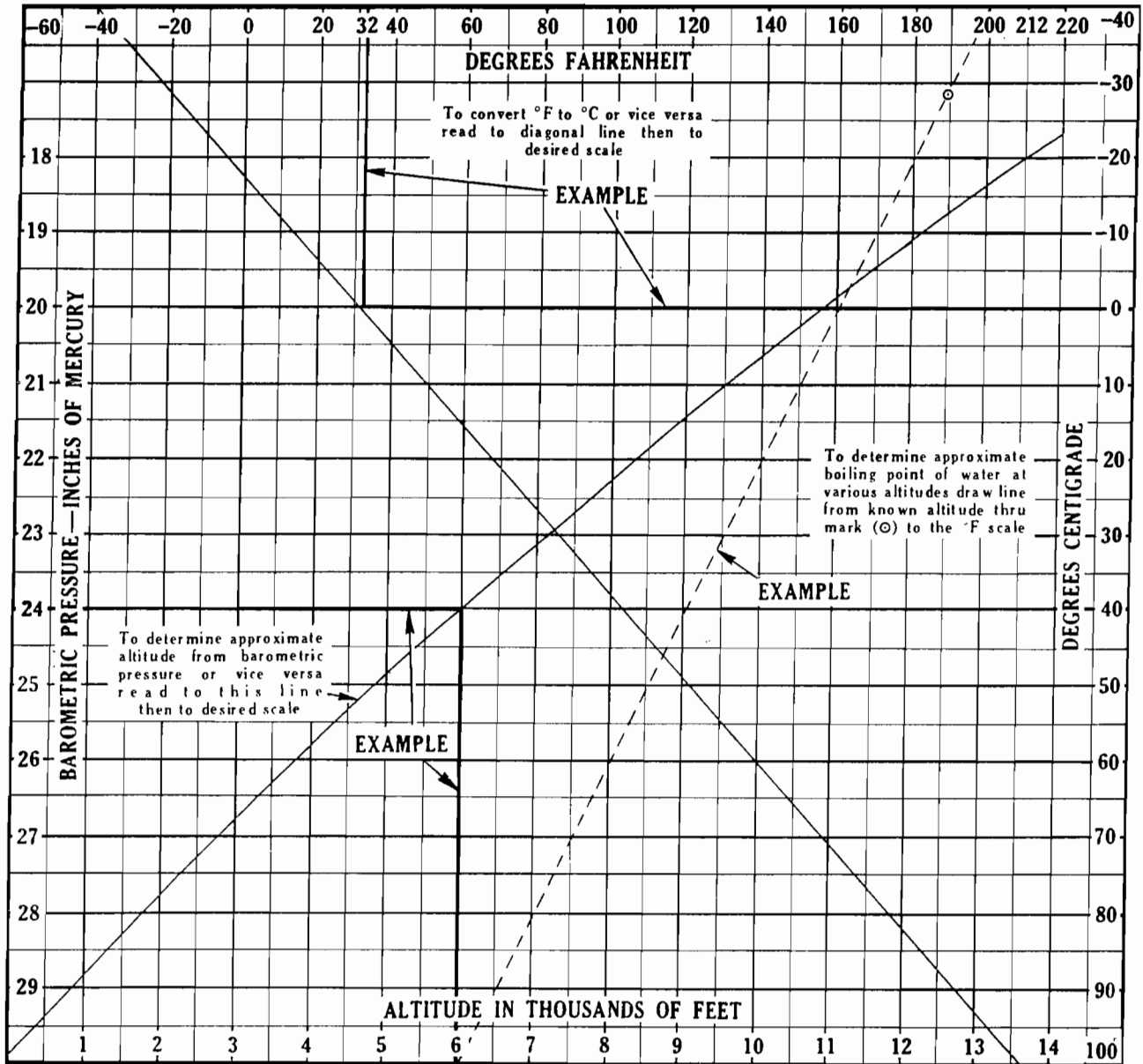
$$5—S = \frac{RPM \times r}{168 \times R}$$

$$6—RPM = \frac{168 \times R \times S}{r}$$



CONVERSION CHART—LIQUIDS BRITISH IMPERIAL and U.S. MEASURE





A-23216



FRONT AXLE

Specifications covering IHC F-553-A Front Axle for Truck Models R-1853 to RF-194 inclusive and the Timken FE-900 Front Axle for Truck Models R-190 to RF-210 inclusive are listed in the following chart:-

FRONT AXLE SPECIFICATIONS

FRONT AXLE MODEL	F-553-A	FE-900
Tie Rod Diameter	1-1/8"	1-1/2"
Knuckle Pin Diameter	1-15/16"	1-39/64" (large end)
Knuckle Pin Length	4-21/32"	9-3/4"
Knuckle Pin Thrust Bearing Type	Ball	Roller
Steering Knuckle Spindle Diameter: At Inner Bearing Diameter	2-1/16"	2-3/8"
At Outer Bearing Diameter	1-5/16"	1-3/4"
I-Beam Section	3-3/8x2-1/4"	4x3-9/16"
Alignment Data:		
*A-Center of Steering Arm Ball to level of Spring Pad	4-1/16"	4-3/4"
*B-Spring Centers	31-1/8"	31-1/8"
*E-Camber at Rim (Degrees)	1°	1°
*F-Knuckle Pin Inclination (Degrees)	4°	5-1/2°
*G-Caster (Degrees)	2° to 3°	2° to 3°
*H-Center of Steering Arm Ball to Center Line of I-Beam	.....	.....
*MN-Toe-In (Measured from Thread Centers with Cambers and Caster according to Specifications)	1/16-1/8"	1/16-1/8"

* Key letters refer to illustrations appearing under Axle-Front, Section A, page 3, L-Line.



FRONT AXLE GROUP

Motor truck models and their corresponding front axle models are shown in the following list. Axle model specifications will be found on page 2 of this section.

TRUCK MODEL	AXLE MODEL	TRUCK MODEL	AXLE MODEL
L-110	F-160	L-184	F-580
L-120	F-170	L-185	F-580
LM-120	F-170	LC-180	F-580
L-130	F-170	L-190	F-553
LB-140	F-170	L-193	F-553
L-150	F-280	L-194	F-553
L-153	F-280	L-195	F-553
LM-150	F-270	LC-190	F-553
L-160	F-360	LF-190	F-553
L-163	F-360	L-200	F-653
L-164	F-360	L-204	F-653
L-165	F-360	L-205	F-653
LC-160	F-360	LC-200	F-653
L-170	F-580	L-210	F-751
L-173	F-580	LF-210	F-751
L-174	F-580	L-220
L-175	F-580	L-225
LF-170	F-580	LF-220	F-750
L-180	F-580	L-230	F-750
L-183	F-580	LF-230

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FRONT AXLE SPECIFICATIONS

FRONT AXLE MODEL	F-160	F-170	F-270	F-280	F-360	F-580	F-553	F-653	F-750	F-751
Tie Rod Diameter	3/4"	3/4"	1"	1"	1"	1-1/8"	1-1/8"	1-1/4"	1-1/2"	1-1/2"
Knuckle Pin Diameter	.861	.861	1.110	1.110	1.110	1.234	1.234	1.484	1.359	1.359
Knuckle Pin Diameter O.S.	.876	.876								
Knuckle Pin Diameter O.S.										
Knuckle Pin Length	5-7/16"	5-7/16"	6-1/4"	6-1/4"	6-1/4"	6-3/4"	7-21/32"	7-1/2"	9-5/8"	9-5/8"
Knuckle Pin Thrust Bearing Type	Ball	Ball	Roller	Roller	Roller	Roller	Roller	Roller	Roller	Roller
Steering Knuckle Spindle Diameter:										
At Inner Bearing Diameter	1.3125	1.3125	1.562	1.562	1.562	1.750	2.000	2.125	2.250	2.250
At Outer Bearing Diameter	.8122	.8122	.937	.937	.937	1.000	1.1875	1.375	1.750	1.750
I-Beam Section	2-1/4" x 1-11/16"	2-7/16" x 1-13/16"	2-11/16" x 1-7/8"	2-7/8" x 2"	3" x 2-1/8"	3-1/4" x 2-1/8"	3-3/8" x 2-1/4"	3-13/16" x 2-1/2"	3-3/4" x 2-3/4"	3-3/4" x 2-3/4"
Alignment Data:										
A-Center of Steering Arm Ball To Level of Spring Pad	2-5/8"	2-5/8"	2-5/8"	2-29/32"	2-29/32"	3-1/4"	4-1/16"	4-9/32"	4-27/32"	4-27/32"
B-Spring Centers	28"	28"	28-1/16"	31-7/8"	31-7/8"	31-7/8"	31-1/8"	31-1/8"	31-1/8"	31-1/8"
E-Camber At Rim (Degrees)	2°	2°	1°	1°	1°	1°	1°	1°	1°	1°
F-Knuckle Pin Inclination	4°	4°	4°	4°	4°	4°	4°	4°	4°	4°
G-Caster - Degree	2 to 3°	2 to 3°	2 to 3°	2 to 3°	2 to 3°	2 to 3°	2 to 3°	2 to 3°	2 to 3°	2 to 3°
H-Center of Steering Arm Ball to Center Line of I-Beam	2-17/32"	2-17/32"	2-1/2"	0	0	0	0	0	0	0
MN-Toe-In (Measured From Tread Centers With Camber and Caster According to Specifications)	1/8 to 3/16"	1/8 to 3/16"	1/16 to 1/8"	1/16 to 1/8"	1/16 to 1/8"	1/16 to 1/8"	1/16 to 1/8"	1/16 to 1/8"	1/16 to 1/8"	1/16 to 1/8"





FRONT AXLES

F-160, F-170

Steering Knuckle Pins and Bearings
(See Figs. 1 and 2)

Steering knuckle thrust bearings, located between knuckles and lower faces of I-beam, support the entire front end load. The end play must be kept within proper limits to prevent excessive wear. The use of spacing washers to correct this condition is described in subsequent paragraphs. A tapered draw key with nut and lockwasher hold knuckle pin rigidly in end of I-beam.

The draw keys should be inspected occasionally to assure their being tight. If one becomes loosened, knuckle pin hole as well as draw key hole will become worn and necessitate replacing or machining of I-beam.

Steering knuckle pins and bushings are available in sets to facilitate replacement service.

Oversize steering knuckle pins are available for use if the I-beam hole has been worn. Installation of oversize pins necessitate reaming hole in the I-beam and bushings to the new diameter.

Bronze bushings are used in steering knuckle at upper and lower knuckle pin holes. Seals at top and bottom consist of expansion plugs pressed into steering knuckle.

Removal of expansion plugs can be readily accomplished by drilling a 1/4" hole through one of the plugs. Remove knuckle pin draw key. Insert a punch in hole in expansion plug and drive pin against opposite plug, forcing it from its recess. Reverse direction of pin travel and force out drilled expansion plug.

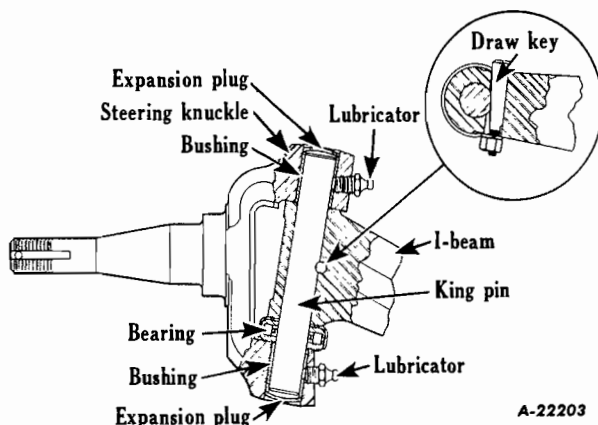


Fig. 1

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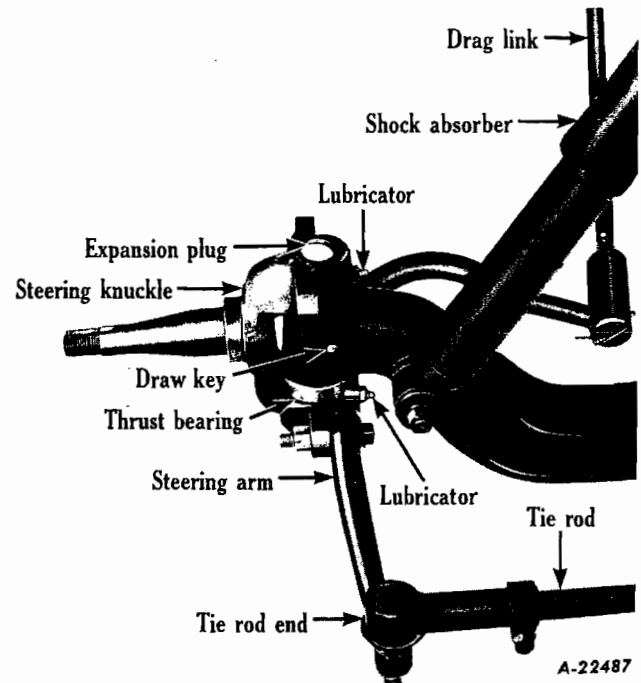


Fig. 2

Refitting Steering Knuckle Pin Bushings

After ascertaining that steering knuckle bushings require replacement, the following procedure will be found efficient and helpful:

For service stations doing a large volume of steering knuckle bushing service work, there is a special set of installing arbors and burnishing tools available. Reamers are not necessary with this equipment.

1. Remove hub caps and grease caps.
2. Remove spindle nut cotter keys and spindle nuts.
3. Remove wheels, inner bearings, and grease retainers from spindles.
4. Remove dirt shield screws and shields.
5. Remove bolts holding brake backing plate assemblies to steering knuckles. Lay assemblies back over ends of axle I-beams.
6. Remove tapered draw keys holding knuckle pins.
7. Remove expansion plugs from top and bottom of steering knuckles.
8. Drive out knuckle pins.



9. Remove steering knuckles, thrust bearings, and any spacer shims present.
10. Clean all parts thoroughly in kerosene or Stoddard Solvent.
11. Remove old bushings, using an arbor or drift.
12. Install new bushings, with the grease holes lined up with the lubricating holes in the steering knuckles. Use an arbor press or vise for forcing the new bushings into place, piloting with a proper size arbor.
13. Line-ream new bushings. Use either special burnishing equipment or a reamer equipped to pilot in one bushing while reaming the other or a reamer long enough to ream both bushings at the same time.
14. Install steering knuckles, thrust bearings, spacer shims as required, and knuckle pins.
15. Install knuckle pin draw key and tighten securely. NOTE: Draw key nut and lock-washer should be located on front side of axle.
16. Insert expansion plugs in top and bottom of steering knuckles. Expand into recess by striking with a hammer.
17. Place brake backing plates in position and install bolts. Tighten bolts securely.
18. Install dirt shields and holding screws.
19. Clean and repack front wheel bearings.
20. Install new grease seals.
21. Install wheels and spindle nuts. Rotate wheel by hand while tightening nut until drag or bind is felt. Back off nut to first castellation and install new cotter key.
22. Install grease caps and hub caps.
23. Lubricate steering knuckle bushings.
24. Check and correct toe-in of wheels.

Steering Knuckle Stop Screws

Adjustable stop screws in steering knuckle limit movement of front wheels when turning and prevent tires from rubbing against nearest point on chassis and to prevent steering gear from bottoming. These screws should be adjusted so there will be ample clearance between front tires and nearest point on chassis when wheels are turned to extreme right or left under any conditions. NOTE: This should be checked when tire size is changed.

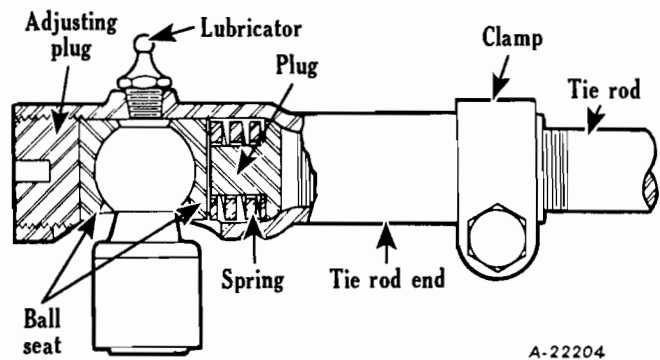


Fig. 3 - Details of tie rod end.

Tie Rod (Fig. 3)

Tie rod is of three-piece construction, consisting of two rod end assemblies. Rod is threaded into ends and locked with clamp bolts. Right and left-hand threads are provided to facilitate toe-in adjustment. The rod ends are self-adjusting and require no attention in service other than periodic lubrication and occasional inspection to see that ball studs are tight in steering knuckle arms.

Proper adjustment can be effected by:

1. Remove cotter key.
2. Tighten adjusting plug until it "bottoms" or is snug.
3. Loosen adjusting plug to the nearest cotter keyhole (not over 1/4 turn).
4. Install new cotter key.

NOTE: Always check and correct toe-in of front wheels after any adjustment of tie-rod ends.

Front Wheel Alignment

Front wheels must be kept in proper alignment in order to assure ease of steering and satisfactory tire life. Important factors of front wheel alignment are: Toe-in, camber and axle caster.

These points should be checked occasionally to guard against excessive tire wear.

Wheel Toe-In (Fig. 4)

Front-wheel toe-in is the setting of front wheels so that they are closer together at the front of the axle than at the rear.

Incorrect toe-in of front wheels will result in rapid tire wear. Excessive toe-in will produce a scuffing or "feather-edge" at the inside edge of the tire tread. Toe-out will produce a like wear but at the outside of the tire tread.

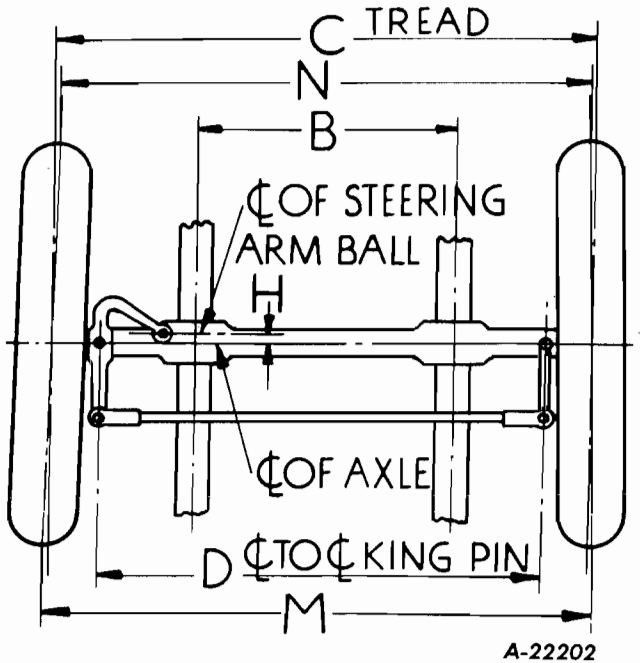


Fig. 4

Follow instructions of Tool Equipment Manufacturer for checking and correction of toe-in.

NOTE: Always recheck toe-in after any change in caster or camber angles, or after any alteration in tie-rod end adjustment.

Wheel Camber (Fig. 5)

Front-wheel camber is the inclination of the wheel from a vertical plane.

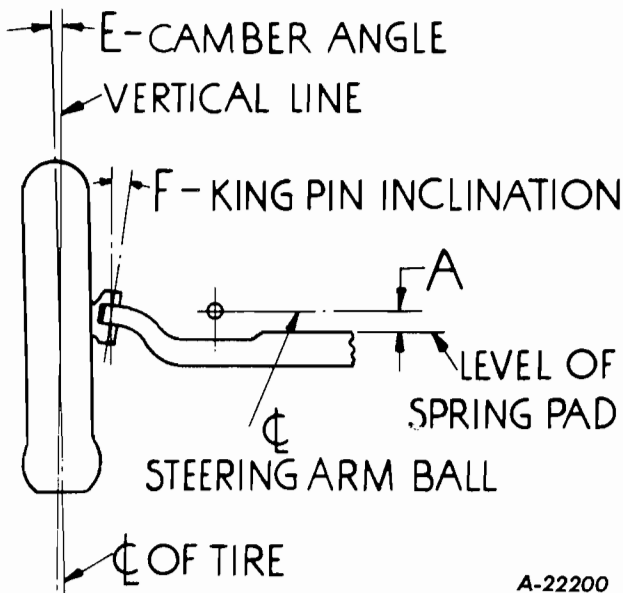


Fig. 5

"Positive" camber is an outward tilt or inclination of the wheel at the top.

"Negative" or "reverse" camber is an inward tilt of the wheel at the top.

Axle Caster (Fig. 6)

Caster is the amount of backward tilt at the top of the steering knuckle pin. When the top of the knuckle pin is tilted to the rear, the caster is positive. When the top of the knuckle pin is tilted to the front, the caster is negative.

The purpose of caster is to provide stability of steering.

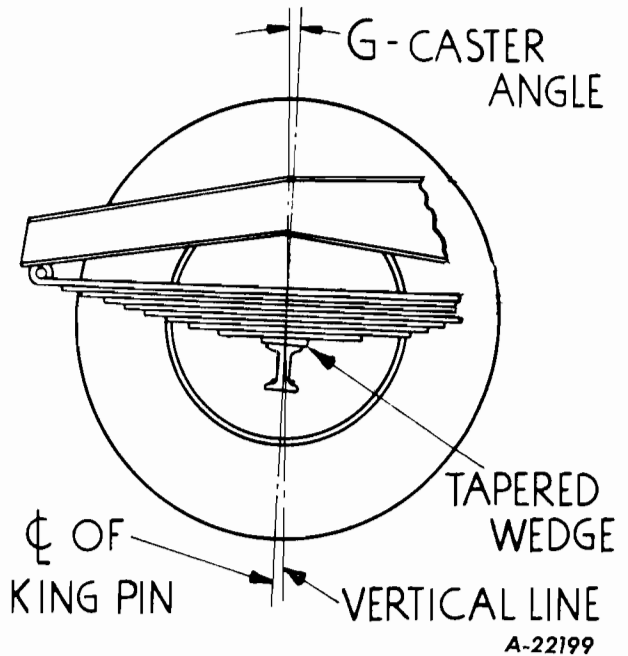


Fig. 6

Tapered wedge plates are available for use in altering the caster angle. They are to be installed between the springs and axle spring seats.

Installation with the thick end toward the rear will produce increased caster. If installed with thick end toward the front, will decrease caster.

Knuckle Pin Inclination (Fig. 5)

The angle which the kingpin makes with the vertical is known as kingpin inclination.

FRONT AXLES

F-270, F-280, F-360, F-580, F-553, F-653, F-750, F-751

Steering Knuckle Pins and Bearings (See Figs. 1 and 2)

Steering knuckle thrust bearings, located between knuckles and lower faces of I-beam, support the entire front end load. The end play must be kept within proper limits to prevent excessive wear. The use of spacing washers to correct this condition is described in subsequent paragraphs. A tapered draw key with nut and lockwasher hold knuckle pin rigidly in end of I-beam.

The draw keys should be inspected occasionally to assure their being tight. If one becomes loosened, knuckle pin hole as well as drawkey hole will become worn and necessitate replacing of I-beam.

Steering knuckle pins and bushings are available in sets to facilitate replacement service.

Bronze bushings are used in steering knuckle at upper and lower knuckle pin holes. Seals at top and bottom consist of gasket and plate, held in position by flat head screws and lockwashers.

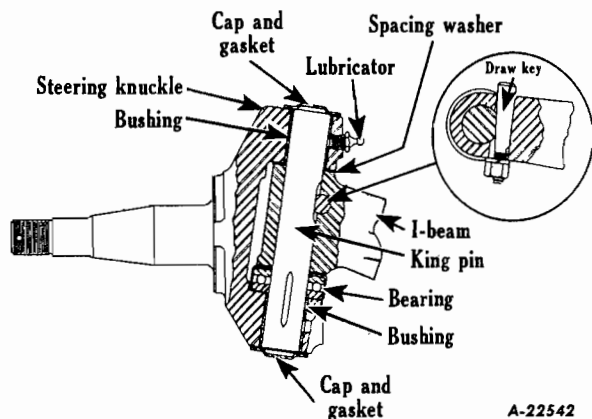


Fig. 1

Refitting Steering Knuckle Pin Bushings

For service stations doing a large volume of steering knuckle bushing service work, there is a special set of installing arbors and bur-nishing tools available. Reamers are not nec-essary with this equipment.

After ascertaining that steering knuckle bushings require replacement, the following procedure will be found efficient and helpful:

1. Remove hub caps and grease caps.

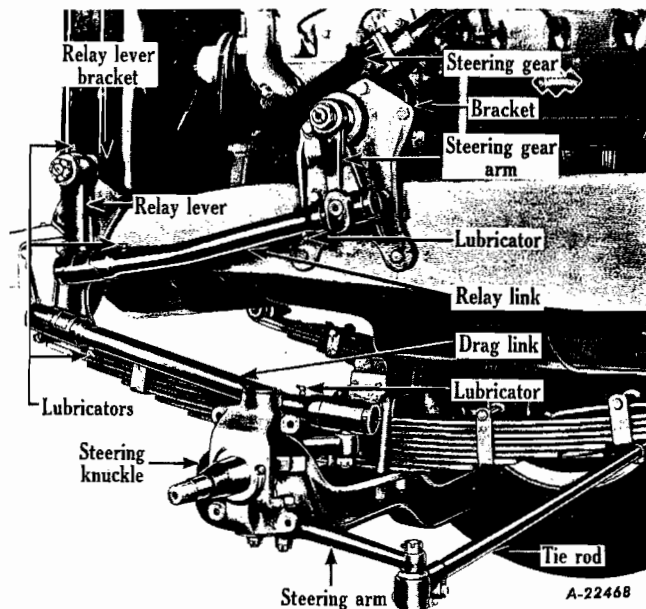


Fig. 2 - Showing details of relay lever, relay link and drag link.

2. Remove spindle nut cotter keys and spindle nuts.
3. Remove wheels, inner bearings, and grease retainers from spindles.
4. Remove dirt shield screws and shields.
5. Remove bolts holding brake backing plate assemblies to steering knuckles.
6. Remove tapered draw keys holding knuckle pins.
7. Remove caps from top and bottom of steer-ing knuckles.
8. Drive out knuckle pins.
9. Remove steering knuckles, thrust bearings, and spacer shims.
10. Clean all parts thoroughly in kerosene or Stoddard Solvent.
11. Remove old bushings, using an arbor or drift.
12. Install new bushings, with the grease holes lined up with the lubricating holes in the steering knuckles. Use an arbor press or vise for forcing the new bushings into place, piloting with a proper size arbor.



13. Line-ream new bushings. Use either a reamer equipped to pilot in one bushing while reaming the other or a reamer long enough to ream both bushings at the same time.
14. Install steering knuckles, thrust bearings, spacer shims as required, and knuckle pins.
15. Install knuckle pin draw key and tighten securely.
16. Replace caps on top and bottom of steering knuckles.
17. Place brake backing plates in position and install bolts. Tighten bolts securely.
18. Install dirt shields and holding screws.
19. Clean and repack front wheel bearings.

20. Install new grease seals.
21. Install wheels, and spindle nuts. Rotate wheel by hand while tightening nut until drag or bind is felt. Back off nut to first castellation and install new cotter key.
22. Install grease caps and hub caps.
23. Lubricate steering knuckle bushings.
24. Check and correct toe-in of wheels.

Steering Knuckle Stop Screws

Adjustable stop screws in steering knuckles limit movement of front wheels when turning and prevent tires from rubbing against nearest point on chassis and prevent steering gear from bottoming. These screws should be adjusted so there will be ample clearance between front tires and nearest point on chassis when wheels

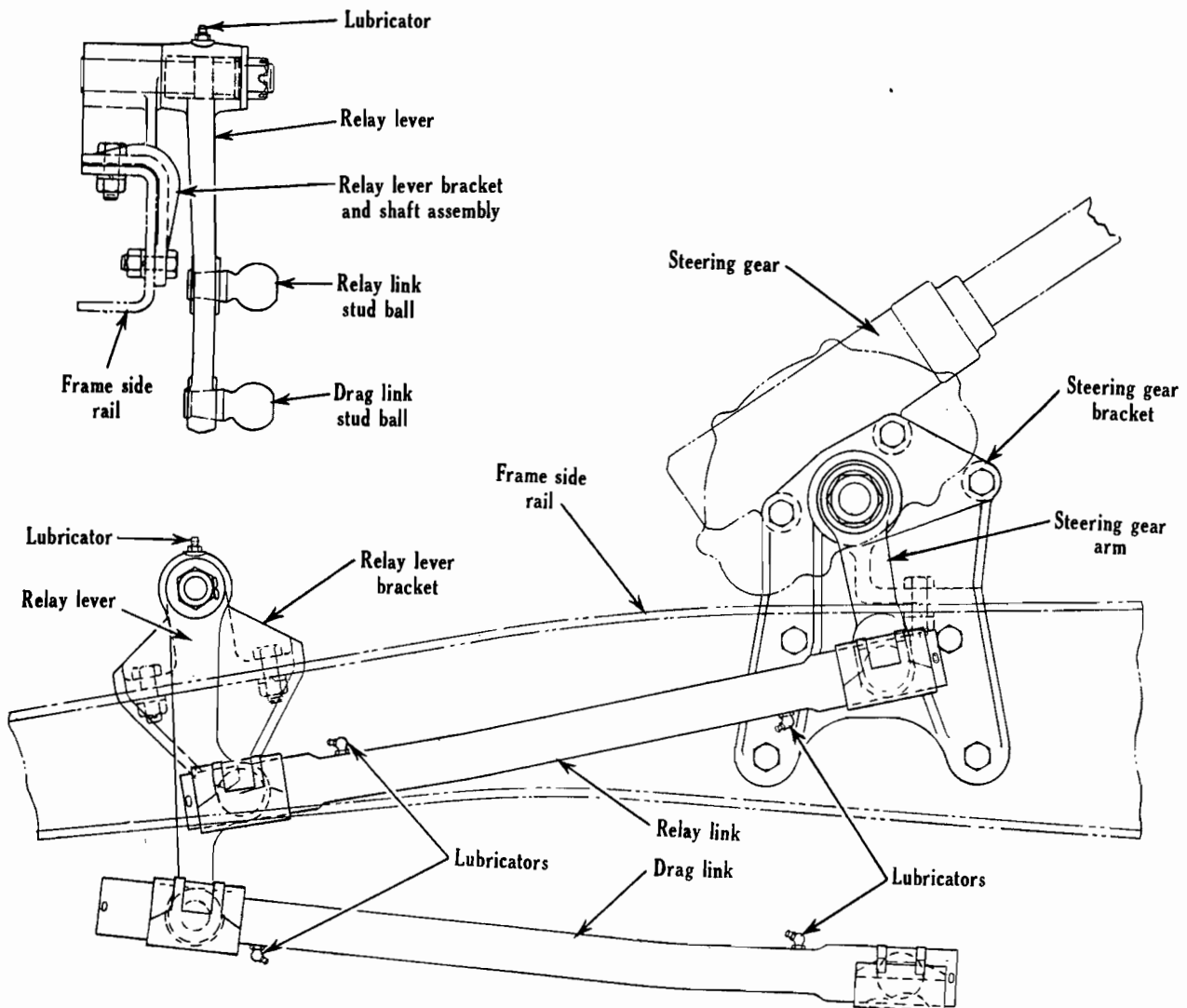


Fig. 3 - Front axle linkage and steering gear for L-190 Series and up.



are turned to extreme right or left under any conditions. NOTE: This should always be checked when tire size is changed.

Linkage for Models L-190 and Up (Figs. 2 and 3)

Figs. 2 and 3 illustrate front axle linkage with the steering gear for models L-190 series and up. In order to maintain the proper degree of angle on steering column for best riding and driving comfort, the relay lever assembly is used.

Tie Rod (Figs. 4 and 5)

Tie rod is of three-piece construction, consisting of two rod end assemblies and tube. Rod is threaded into ends and locked with clamp bolts. Right and left-hand threads are provided to facilitate toe-in adjustment. The rod ends are self-adjusting and require no attention in service other than periodic lubrication and occasional inspection to see that ball studs are tight in steering knuckle arms.

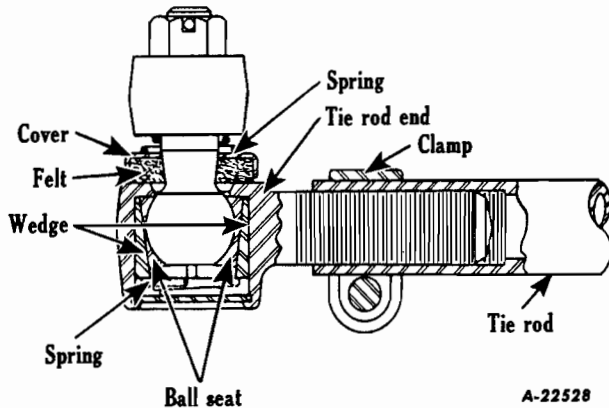


Fig. 4 - Tie rod assembly - Models F-270, F-280, F-360.

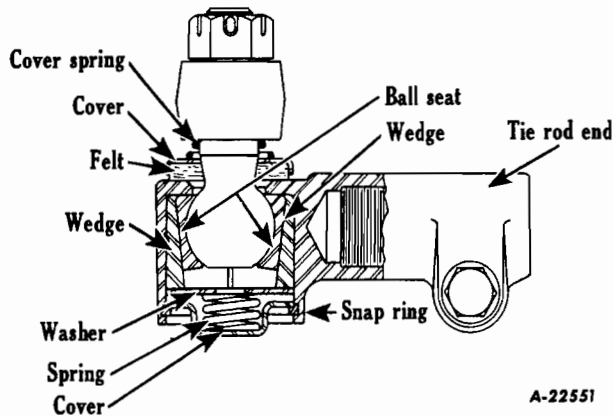


Fig. 5 - Tie rod assembly - Models F-553, F-580, F-653, F-750, F-751.

Front Wheel Alignment

Front wheels must be kept in proper alignment in order to assure ease of steering and

satisfactory tire life. Important factors of front wheel alignment are: Toe-in, camber and axle caster.

These points should be checked occasionally to guard against excessive tire wear.

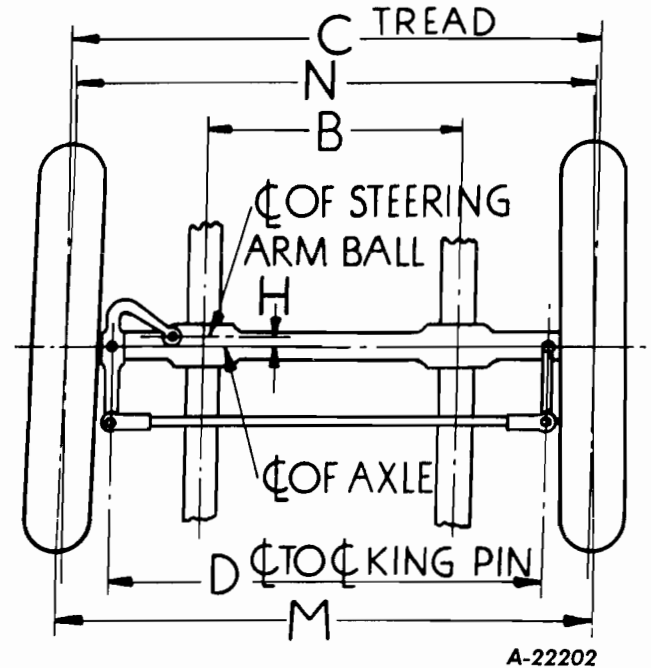


Fig. 6

Wheel Toe-In (Fig. 6)

Front-wheel toe-in is the setting of front wheels so that they are closer together at the front of the axle than at the rear.

Incorrect toe-in of front wheels will result in rapid tire wear. Excessive toe-in will produce a scuffing or "feather-edge" at the inside edge of the tire tread. Toe-out will produce a like wear but at the outside of the tire tread.

Follow instructions of Tool Equipment Manufacturer for checking and correction of toe-in.

NOTE: Always recheck toe-in after any change in caster or camber angles, or after any alteration in tie-rod end adjustment.

Wheel Camber (Fig. 7)

Front-wheel camber is the inclination of the wheel from a vertical plane.

"Positive" camber is an outward tilt or inclination of the wheel at the top.



"Negative" or "reverse" camber is an inward tilt of the wheel at the top.

Axle Caster (Fig. 8)

Caster is the amount of backward tilt at the top of the steering knuckle kingpin. When the top of the knuckle pin is tilted to the rear, the caster is positive. When the top of the knuckle pin is tilted to the front, the caster is negative.

The purpose of caster is to provide stability of steering.

Tapered wedge plates are available for use in altering the caster angle. They are to be installed between the springs and axle spring seats.

Installation of the tapered wedge with the thick end toward the rear will produce increased caster. If installed with thick end toward the front, decreased caster will result.

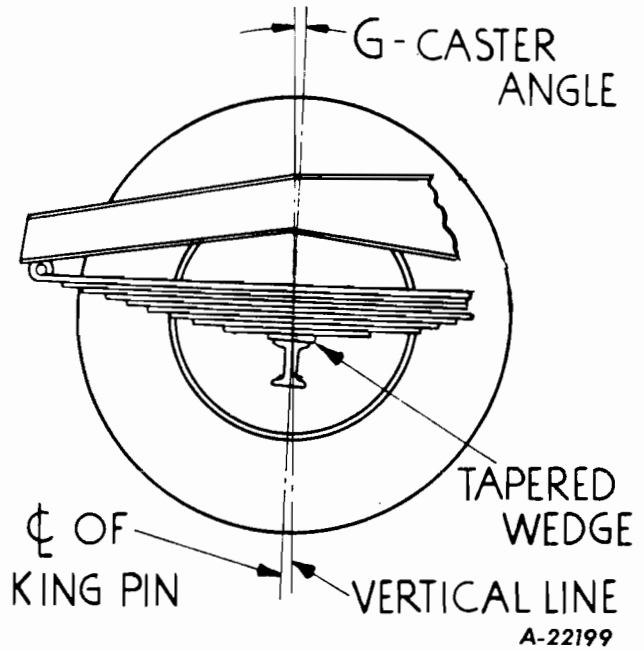
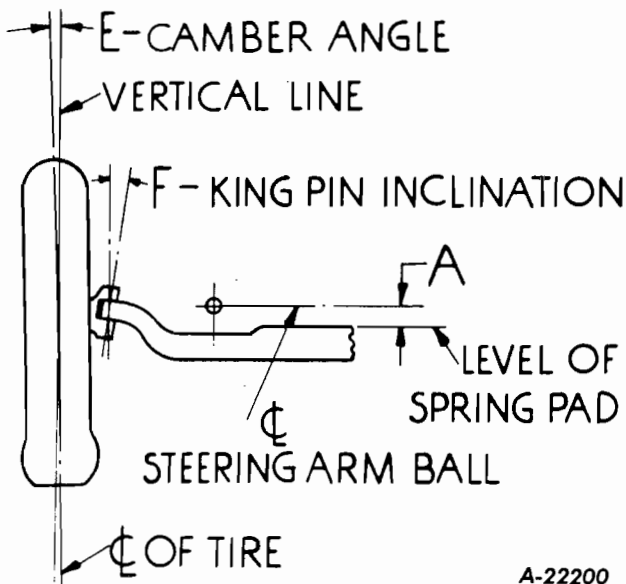


Fig. 8

Knuckle Pin Inclination (Fig. 7)

The angle which the kingpin makes with the vertical is known as kingpin inclination.



A-22200

Fig. 7



SUGGESTED WHEEL ALIGNMENT TROUBLE SHOOTING CHART

Remember that all alignment angles are so closely related that any change of one will automatically change the others. Because of this fact, it will probably be found that there is more than one cause for the complaint. The following

list is not all-encompassing but is representative of the more common causes of difficulty encountered in wheel and axle alignment and should prove of value in locating and correcting complaints on steering or tire wear.

<u>COMPLAINT</u>	<u>POSSIBLE CAUSE</u>
(1) Shimmy (Generally exists at speeds below 30 miles per hour.)	(a) Tire pressure incorrect. (b) Tires of unequal size or weight. (c) Wheel bearings loose. (d) Steering arms loose. (e) Steering gear loose. (f) Too much caster. (g) Drag link ends loose. (h) Drag link springs weak or broken. (i) Spring shackles loose. (j) Kingpins and bushings worn. (k) Tie-rod ends loose.
(2) High-Speed Wheel Tramp (Generally exists at speeds above 35 miles per hour.)	(a) Tire and wheel assemblies out of balance. (b) Shock absorbers ineffective.
(3) Wander or Weave	(a) Tire pressure incorrect. (b) Tires of unequal size. (c) Bent spindle. (d) Wheel bearings loose. (e) Kingpins and bushings worn. (f) Kingpins bent. (g) Kingpins tight. (h) Pitman arm loose. (i) Steering gear assembly too tight or too loose. (j) Too little caster. (k) Too much or too little camber. (l) Too much or too little toe-in. (m) Drag link ends tight. (n) Drag link springs weak or broken. (o) Tie-rod ends too tight or too loose. (p) Front axle bent. (q) Front axle shifted. (r) Springs broken. (s) Rear axle shifted. (t) Rear axle housing bent. (u) Frame diamond-shaped.
(4) Hard Steering	(a) Tire pressure low. (b) Wheel spindle bent. (c) Kingpin assembly poor fit. (d) Steering assembly too tight. (e) Tie-rod ends tight. (f) Caster excessive.
(5) Uneven Tire Wear	(a) Tire pressure low. (b) Excessive camber. (c) Wheels out of balance. (d) Tires overloaded. (e) Eccentric wheels or rims. (f) Caster incorrect. (g) Toe-in incorrect.



**REAR AXLE APPLICATION AND LUBRICATION CAPACITIES
(R-LINE TRUCKS)**

CODE	IH MODEL ENGINEERING NUMBER		MANUFACTURER'S NUMBER		DESCRIPTION	TRUCK MODELS	LUB. CAPACITY (PINTS)
	HYD.	AIR	HYD.	AIR			
1401	R-1060		IH		Single Reduction	R-110	4
1402	R-1070		IH		Single Reduction	R-120, RM-120, RA-120	4
1403	R-1170		IH		Single Reduction	RA-140, R-150, 153, RM-150	5
1404	R-1440		IH		Single Reduction	R-160, 163, 165, RC-160	8
1405	R-1470		IH		Single Reduction	R-164, 170, 173, 175	8
1406	R-1530	R-1531	IH		Single Reduction	R-174 Hydraulic, R-180, R-183, 185, 1853, RC-180	11
1409	R-1740	R-1741	T-R-100	T-R-100	Single Reduction	R-194, 200, 201, 202, 205	36
1410	R-2464		E-13600		Eaton Two Speed	R-160, 163, 165, RC-160	13
1411	R-2467		E-13600		Eaton Two Speed	R-164, 170, 173, 175	13
1412	R-2585	R-2586	E-16600	E-16600	Eaton Two Speed	R-174, Hydraulic, R-180, R-183, 185, 1853, RC-180	16
1415	R-1540	R-1541	E-2613	E-2614	Eaton Double Reduction	R-184, 190, 193, 195	19
1416	R-1640	R-1641	E-2695	E-2696	Eaton Double Reduction	R-194, 200, 205	19
1418	R-2780	R-2781	E-20500	E-20501	Eaton Two Speed	R-190, 200	20
1420	R-1810	R-1811	T-U-200P	T-U-200P	Timken Double Reduction	R-210	38
1423	R-2800	R-2801	T-U-300P	T-U-300P	Timken Two Speed	R-210	37

(Continued on following page)

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(R-LINE TRUCKS)

CODE	IH MODEL ENGINEERING NUMBER		MANUFACTURER'S NUMBER		DESCRIPTION	TRUCK MODELS	LUB. CAPACITY (PINTS)
	HYD.	AIR	HYD.	AIR			
1425	R-2470				IH Two Speed With Timken E300 Differential	R-160, 163, 165	8
1426	R-2475				IH Two Speed With Timken E300 Differential	R-164, 170, 173, 175	8
1428	RF-1475		E-22M		IH Single Reduction	RF-170	11 ea. axle
1429	RF-1575		E-22M		Eaton Single Reduction	RF-174, 190	14 ea. axle
1430	RF-1685		E-36M		Eaton Single Reduction	RF-194, 210	20 Forward 21 Rear
1433	R-1165		IH		IH Single Reduction	R-130	6
1435	R-2610	R-2611	TQ-301N	TQ-301P	Timken Two Speed	R-194, 200, 205	32
1436	R-1547	R-1548	TL-101	TL-101	Timken Single Reduction	R-190, 193, 195	23
1438	R-2995	R-2996	TL-301	TL-301	Timken Two Speed	R-184, 190, 195	29
1450	R-2795	R-2796	TR-300	TR-300	Timken Two Speed	R-200	34
1451		RF-1690		E-36M	Eaton Single Reduction	RF-194, 210	20 Forward 21 Rear
1452	R-1470		IH		IH Single Reduction	R-164, 170, 173, 175	8
1453	R-2466		E-13600		Eaton Two Speed	R-164, 170, 173, 175	11
1454		RF-1570		E-28M	Eaton Single Reduction	RF-174, 190	14 ea. axle
1455	R-2575	R-2576	E-17500	E-17501	Eaton Two Speed	R-184, 190, 193, 195	17
1456	R-2620	R-2621	E-18500	E-18501	Eaton Two Speed	R-194, 200, 205	16
1457	R-2366		E-1350		Eaton Two Speed	R-150, 153	13
1458	R-1572	R-1573	E-1790	E-1791	Eaton Single Reduction	R-184, 190, 193, 195	22
1459	R-1632	R-1633	E-1890	E-1891	Eaton Single Reduction	R-194, 200, 205	21





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REAR AXLE SPECIFICATIONS

REAR AXLE MODEL	R-1060	R-1070	R-1165	R-1170	R-1440	R-1470	RF-1475	
							Forward RF-1476	Rear RF-1477
Code	1401	1402	1433	1403	1404	1405	1428	1428
Type (Semi or Full-Floating) . .	Semi	Full	Full	Full	Full	Full	Full	Full
Pinion Mounting	Straddled	Straddled	Straddled	Straddled	Straddled	Straddled	Overhung	Straddled
Axle Shaft:								
Diameter at splines	1-9/32"	1-9/32"	1-33/64"	1-33/64"	1-3/4"	1-3/4"	1-3/4"	1-3/4"
Number of splines	10	10	16	16	16	16	16	16
Pinion Cone Center (amount of variation marked on pinion).	2.609	2.609	2.984	2.984	3.253	3.253	4.156	3.253
Lubricant Capacity (Pints) . . .	4	4	4	3	8	8	8-Axle 3-P.D.	8
Axle Ratios	3.73 4.1	4.1 4.777 5.13	4.88 5.571 6.166	4.88 5.57 6.16	5.285 6.166 6.666 7.166	6.166 6.666 7.166	6.166 7.166	6.166 7.166
Pinion Adjustment: Press pressure (tons)*	10	10	10	10	10	10	10	10
Cage Rotating Torque Scale Reading (Lbs.)	10-25	10-25	10-25	10-25	10-25	10-25	10-25	10-25
Pinion Nut Torque (Ft. Lbs.) . .	200-230	200-230	200-230	200-230	200-230	280-300	350-400	280-300
Differential Bearing Pre-load. (Total) . . . . .	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"

* Pressure against bearing race when checking rotating torque of pinion cage.



REAR AXLE SPECIFICATIONS

REAR AXLE MODEL	R-1530	R-1540	R-1555	RF-1575		RF-1685		R-1630
				Forward RF-1576	Rear RF-1577	Forward RF-1686	Rear RF-1687	
Code	1406	1415	1407	1429	1429	1430	1430	1408
Type (Semi or Full-Floating) . .	Full	Full	Full	Full	Full	Full	Full	Full
Pinion Mounting	Straddled	Overhung	Straddled	Overhung	Straddled	Overhung	Overhung	Straddled
Axle Shaft:								
Diameter at splines	1-7/8"	1-63/64"	1-63/64"	1-3/4"	1-3/4"	2-1/8"	2-1/8"	2-1/8"
Number of splines	16	16	16	16	16	16	16	16
Pinion Cone Center (amount of variation marked on pinion).	3.472	2.500	3.844	4.656	3.473	4.875	4.875	2.937
Lubricant Capacity (Pints) . . .	11	19	20	12-Axle 3-P.D.	12	20-Axle 3-P.D.	21	18
Axle Ratios	5.571 6.5 7.166	7.049 7.754 9.025	5.571 6.5 7.166	6.166 7.166	6.166 7.166	5.756 6.940	5.756 6.940	5.571 6.5 7.166
Pinion Adjustment: Press pressure (tons)*	10	10	10	10	10	10	10	10
Cage Rotating Torque Scale Reading (Lbs.)	10-25	10-25	10-25	10-25	10-25	10-25	10-25	10-25
Pinion Nut Torque	280-300	280-300	350-400	350-400	280-300	600-900	400-500	350-400
Differential Bearing Pre-load, (Total) . . . . .	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"	.005"-.007"

* Pressure against bearing race when checking rotating torque of pinion cage.

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REAR AXLE MODEL	R-1640	R-1730	R-1731	R-1740	R-1810	R-2465	R-2466	R-2470
Code	1416	1419	1421	1420	1410	1411	1425
Type (Semi or Full-Floating) . .	Full	Full	Full	Full	Full	Full	Full	Full
Pinion Mounting	Overhung	Overhung	Overhung	Straddled	Overhung	Overhung	Overhung	Overhung
Axle Shaft:								
Diameter at splines	2-1/8"	2-3/8"	2-3/8"	2-3/8"	2-3/8"	1-3/4"	1-3/4"	1-3/4"
Number of splines	16	16	16	16	16	16	16	16
Pinion Cone Centers (amount of variation marked on pinion).	2.625	. . . . .	. . . . .	. . . . .	. . . . .	4.281	4.281	. . . . .
Lubricant Capacity (Pints) . . .	19	38	38	36	38	13	13	. . . . .
Axle Ratios	7.049 7.754 9.436	5.91 6.51 7.79 8.69 9.76	5.91 6.51 7.79 8.69 9.76	5.28 6.83 7.41	5.91 6.51 7.21 7.79 9.76	5.14-7.15 5.83-8.11 6.33-8.81	5.14-7.15 5.83-8.11 6.33-8.81	6.13-8.10 6.70-8.86
Pinion Adjustment: Press pressure (tons)*	10	10	10	10	10	10	10	. . . . .
Cage Rotating Torque Scale Reading (Lbs.)	10-25	4-5 &	4-5 &	4-5 &	4-5 &	10-25	10-25	. . . . .
Pinion Nut Torque (Ft. Lbs.) . .	400-500	700-900	700-900	700-900	700-900	280-300	280-300	. . . . .
Differential Bearing Pre-load. (Total) . . . . .	.005"-.007"	See Note	See Note	See Note	See Note	.005"-.007"	.005"-.007"	. . . . .

* Pressure against bearing race when checking rotating torque of pinion cage.
& Timken Axle.

NOTE: Tighten one notch each from .000" end play.



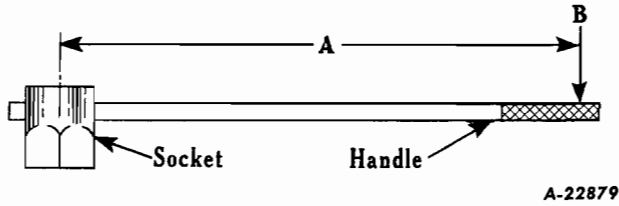
REAR AXLE SPECIFICATIONS

REAR AXLE MODEL	R-2475	R-2580	R-2585	R-2590	R-2600	R-2740	R-2741	R-2800
Code	1426	1413	1412	1427	1414	. . . . .	1422	1423
Type (Semi or Full-Floating) . .	Full	Full	Full	Full	Full	Full	Full	Full
Pinion Mounting	Overhung	Overhung	Overhung	Overhung	Overhung	Overhung	Overhung	Overhung
Axle Shaft:								
Diameter at splines	1-3/4"	1-63/64"	1-7/8"	1-7/8"	2-1/8"	2-3/8"	2-3/8"	2-3/8"
Number of splines	16	16	16	16	16	16	16	16
Pinion Cone Centers (amount of variation marked on pinion)		5.281	4.812	. . . . .	5.281	. . . . .	. . . . .	. . . . .
Lubricant Capacity (Pints)		22	20	. . . . .	22	37	37	37
Axle Ratios	6.13-8.10 6.70-8.86	5.571-7.594 6.5-8.866	5.571-7.749 6.166-8.577 6.5-9.041	5.95-7.30 6.13-8.15 6.66-8.85	5.571-7.594 6.500-8.866	4.93-5.91 6.42-8.38 6.99-8.38	4.93-5.91 6.42-8.38 6.99-8.38	4.93-5.91 6.42-8.38 6.99-8.38
Pinion Adjustment: Press pressure (tons)*		10	10	. . . . .	10	25	25	25
Cage Rotating Torque Scale Reading (Lbs.)		10-25	10-25	. . . . .	10-25	4-5 &	4-5 &	4-5 &
Pinion Nut Torque (Ft. Lbs.)		350-400	280-300	. . . . .	350-400	800-1100	800-1100	800-1100
Differential Bearing Pre-load. (Total) . . . . .		.005"-.007"	.005"-.007"	. . . . .	.005"-.007"	See Note	See Note	See Note

* Pressure against bearing race when checking rotating torque of pinion cage.
& Timken Axle.
NOTE: Tighten one notch each from .000" end play.

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A-22879

FT. LBS. TORQUE	WRENCH A	EFFORT ON WRENCH (APPROX.) B
200	1 foot	200 lbs.
	2 feet	100 lbs.
250	1-1/2 feet	170 lbs.
	2 feet	125 lbs.
300	1-1/2 feet	200 lbs.
	2 feet	150 lbs.
	3 feet	100 lbs.
350	2 feet	175 lbs.
	2-1/2 feet	140 lbs.
	3 feet	118 lbs.
	3-1/2 feet	100 lbs.
450	2-1/2 feet	180 lbs.
	3 feet	150 lbs.
	3-1/2 feet	129 lbs.
	4 feet	113 lbs.
500	3 feet	167 lbs.
	3-1/2 feet	144 lbs.
	4 feet	125 lbs.
	4-1/2 feet	112 lbs.
550	3-1/2 feet	158 lbs.
	4 feet	137 lbs.
	4-1/2 feet	123 lbs.
	5 feet	110 lbs.
600	4 feet	150 lbs.
	4-1/2 feet	134 lbs.
	5 feet	120 lbs.
	5-1/2 feet	110 lbs.

Wrench Torque Chart

The above chart illustrates the length of the wrench handle (A) and the effort that must be applied at (B) when tightening to secure the indicated torque.

AXLES—REAR

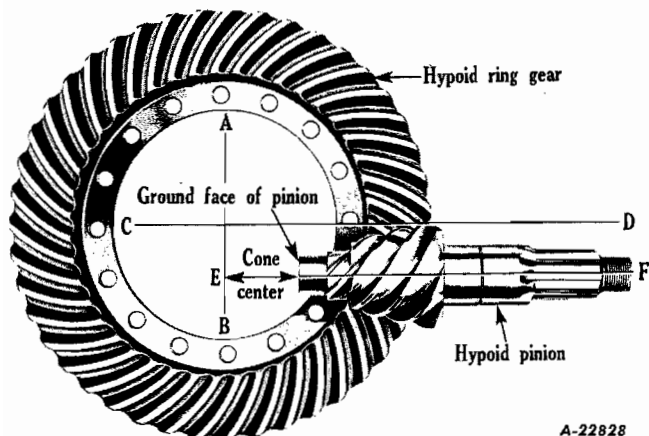
GENERAL INSTRUCTIONS FOR ALL HYPOID AXLES

HYPOID REAR AXLES (ALL MODELS)

All rear axles have a hypoid ring gear and pinion, whether single reduction, double-reduction, double-reduction (single and two-speed final drive) and two-speed differential. Hypoid gears have a greater inherent torque capacity, due largely to the fact that the hypoid pinion is much larger in diameter and the pinion teeth are correspondingly larger than those found in a spiral bevel pinion for the same number of teeth and the same diameter ring gear.

The hypoid pinion has a longer face because of its offset location. It also has larger tooth surface areas and usually has more teeth in instant contact with the gear. It is these design characteristics which contribute to greater strength and quieter final drive operation. Because of this greater tooth contact, it is more difficult to secure correct pinion setting at time of overhaul or when replacing differential bearings and every effort must be made to be sure the final setting results in best possible tooth contact.

Note that the pinion center line (E, F) is offset from the ring gear center line (C, D).



A-22828

Fig. 1 - Illustration shows location of pinion in relation to center line of ring gear. Center line of pinion is below center line of ring gear.

NOTE: When adding to or replacing lubricant in a rear axle having hypoid gears, use only hypoid lubricants. (See under "Lubrication" on page 9)

REAR AXLE HYPOID GEAR REPLACEMENT AND ADJUSTMENT

Hypoid Gear Tooth Contact (All Models)

The proper adjustment of hypoid gears in assembly is a vital factor in obtaining quiet and durable gears and the same methods of adjustment applies to both straight, spiral bevel and to hypoid type gears.

There are two distinct considerations in obtaining the proper tooth contact, cone center and backlash.

Hypoid as well as bevel and spur gears are cut with a predetermined amount of backlash. The backlash usually varies from .004" to .005" on small gears and increases on large gears. Generally, the gears are machined to run flush with each other at the outer end (heel or large end) of the tooth, and gears should be set according to their theoretical cone center (Figs. 2, 3, and 4).

Cone Center Specifications

Matched and mated hypoid ring gears and hypoid pinion gears are furnished both for service and for production.

Mated gears are marked with figures showing the amount of variation from their theoretical cone center.

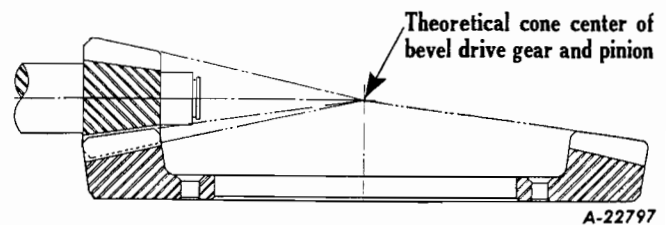


Fig. 2

Fig. 2 illustrates a hypoid ring gear and pinion adjusted to theoretical cone center, wherein the cone centers of both gears coincide. The specifications in this case would be the distance from the line (A, B) (Fig. 1) drawn through the center of the hypoid ring gear to the ground face of the hypoid pinion on center line (E, F). On some axles, the pinion is located above the center line (C, D) (Fig. 1). In these cases the term "hypoid" still applies.

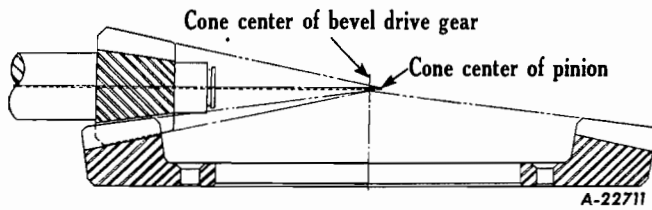


Fig. 3

Fig. 3 illustrates a setting wherein the mating of the gears has necessitated the pinion cone center being farther than the ring gear center. The pinion marking in this case will be minus (-) because the distance from the ring gear center is less.

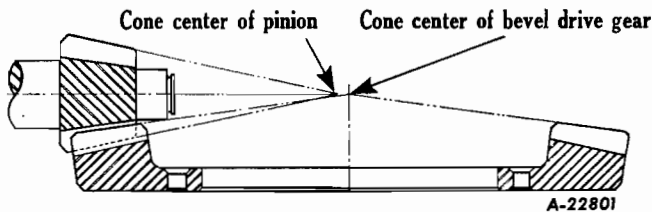


Fig. 4

Fig. 4 illustrates a condition where the mating of the gears required the pinion cone center to be farther OUT. The pinion marking will be plus (+) because the distance is greater.

SE-1065 Pinion Setting Gauge

The SE-1065 pinion setting gauge is a precision gauge designed for use in adjusting differentials to the proper cone setting of the ring gear and pinion. It is used only in adjustment of matched sets of gears. A step plate and bracket have been added to the set so that the gauge may be used on all hypoid differentials with satisfactory results. NOTE: Be sure to allow for thickness of the step plate .400" when making calculations (Fig. 5).

The use of SE-1065 gauge makes possible the exact duplication of the setting etched on the pinion. This results in the best possible setting with a minimum loss of time. It is advisable to check all pinion settings with a paint impression before considering the work complete. By so doing, visible proof of the pinion gauge setting accuracy is obtained, also long and quiet gear performance is assured.

Adjustment of differentials is a simple matter with the SE-1065 gauge. Briefly, it is only necessary to:

1. Install pinion and bearing assembly in differential carrier.

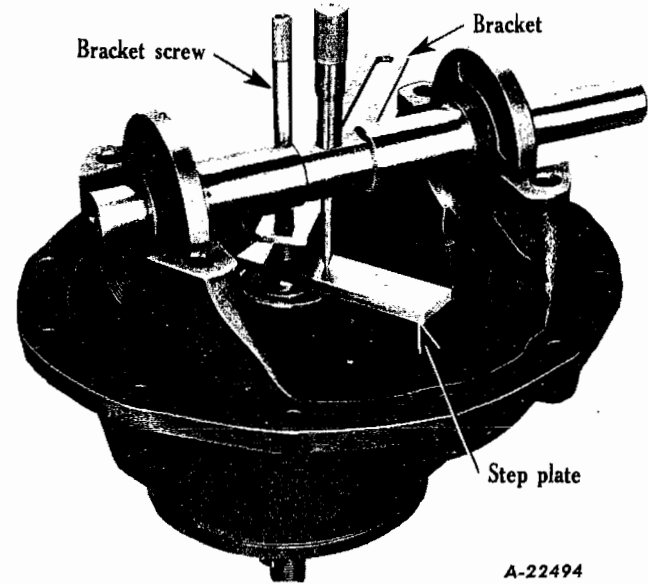


Fig. 5

Fig. 5 shows SE-1065 tool equipment in position on hypoid differential case. Make certain that the bearing bores are clean and free of nicks or burns. The step plate must be placed on the pinion end so that the lugs in the step plate straddle the bearing staking indentations on the smaller axles.

2. Install step plate and bracket as shown in Fig. 5. CAUTION: Be sure lugs on step plate straddle the bearing staking indentations.
3. Mount assembled SE-1065 gauge in bearing bores of carrier.
4. Take micrometer reading to check point of pinion. Add .400" (thickness of step plate) to reading. Write down reading.
5. Locate specified cone center specification for particular model on chart. Write down specified figures.
6. Locate on pinion the etched marking which indicates variation from zero cone center. If a minus figure, subtract from specified cone center, and if a plus figure, add to specified cone center. Results of calculation give corrected cone center.
7. Comparison of corrected cone center (6) with actual measurement (4) indicates amount of change necessary for pinion position.
8. Install ring gear and carrier in position.
9. Adjust backlash according to marking on ring gear.

(See following page)



Example of Mathematics involved;

Truck model to be L-110.

- (a) Micrometer reading (add .400" for step plate) 3.4400"
- (b) Specified cone center on chart 3.400"
- (c) Pinion marked (-5)005"
- (d) Subtraction (b-c) gives corrected cone center 3.395"
- (e) Subtract corrected cone center (d) from actual measurement (a)045"
- (f) It is necessary to move pinion IN.045"
- (g) Remember -- It is essential to arrive at a measurement as nearly equal the corrected cone center as possible.
- (h) DO NOT FAIL TO VERIFY ACCURACY OF THE ADJUSTMENT SECURED WITH THE SE-1065 gauge by checking the gear tooth contact using the paint impression method as set forth under General Rear Axle Hypoid Pinion and Ring Gear Adjustment, which follows.

GENERAL REAR AXLE HYPOID PINION AND RING GEAR ADJUSTMENTS

(PAINT IMPRESSION METHOD)

The following general instructions and suggestions are for the benefit of those service stations not equipped with an SE-1065 pinion setting gauge. Bear in mind that the accuracy of the adjustment obtained with the following procedure is dependent upon the skill of the operator.

Hypoid gears when mounted should show a bearing toward the toe or small end of the tooth, never at the heel or large end, the reason being that it is practically impossible to make gears and gear mounting rigid enough so that there will not be some slight deflection when full load is applied. This always has a tendency to cause the bearing to come on the heel of the tooth and when gears are adjusted so that the bearing is toward the heel of the tooth it results in a concentration of load on the top corner of the heel and breakage will follow.

Checking tooth contact is accomplished by means of oiled red lead applied lightly to the bevel gear teeth (Fig. 6). When the pinion is rotated, the red lead is squeezed away by the contact, of the teeth, leaving bare areas the exact size, shape, and location of the contacts.

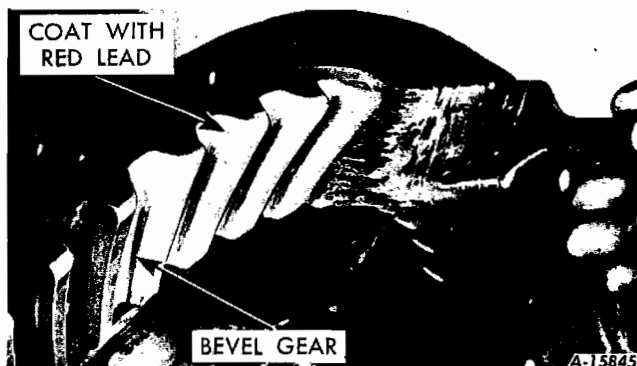


Fig. 6

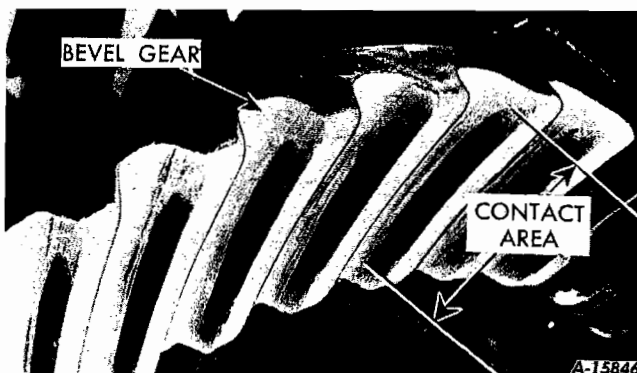


Fig. 7

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the bevel gear teeth. Coast side contact should be automatically corrected when drive side contact is correct. As a rule, coating about twelve teeth is sufficient for checking purposes.

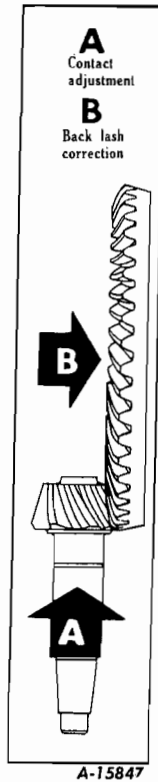
With adjustments properly made, the correct tooth contact shown in Fig. 7 will be secured. The area of contact starts near the toe of the gear and extends about 80 per cent of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.

Figs. 8 to 11 illustrate method of adjustment in securing the proper gear tooth contact.



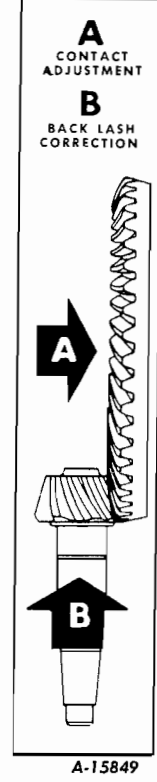
A HIGH NARROW CONTACT IS NOT DESIRABLE. If gears are allowed to operate with an adjustment of this kind, noise, galling and rolling over of the top edges of the teeth will result. To obtain correct contact, move pinion toward bevel gear to lower contact area to proper location. This adjustment will decrease backlash between pinion and bevel gear teeth, which may be corrected by moving bevel gear away from pinion. Backlash of .006" to .012" is correct.

Fig. 8



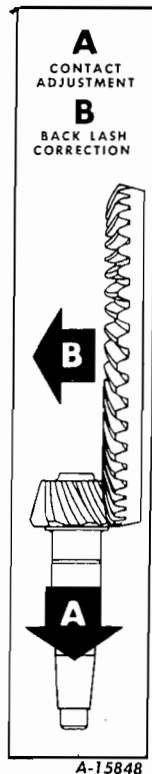
A SHORT TOE CONTACT IS NOT DESIRABLE. If gears are allowed to operate with an adjustment of this kind, chipping at tooth edges and excessive wear due to small contact area will result. To obtain correct contact, move bevel gear away from pinion. This will increase the lengthwise contact and move contact toward heel of tooth. Correct backlash of .006" to .012" can be obtained by moving pinion toward bevel gear.

Fig. 10



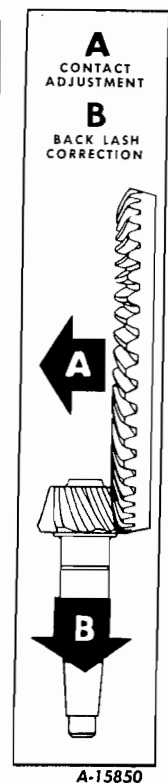
A LOW NARROW CONTACT IS NOT DESIRABLE. If gears are allowed to operate with an adjustment of this kind, galling, noise and grooving of teeth will result. To obtain correct contact, move pinion away from bevel gear to raise contact area to proper location. Correct backlash of .006" to .012" may be obtained by moving bevel gear toward pinion.

Fig. 9



A SHORT HEEL CONTACT IS NOT DESIRABLE. If gears are allowed to operate with an adjustment of this kind, chipping, excessive wear and noise will result. To obtain correct contact, move bevel gear toward pinion to increase the lengthwise contact and move contact toward toe. Correct backlash of .006" to .012" can be obtained by moving pinion away from bevel gear. Several adjustments of both pinion and gear may be necessary before correct contact and backlash are secured.

Fig. 11

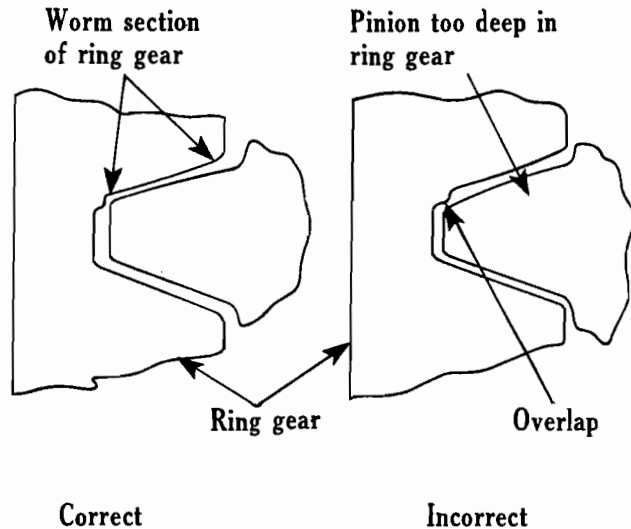




Gear Adjustment for Lash

Generally if original gears are being reinstalled, red leading of teeth will not indicate the same contact as new gears and can be misleading. Gears that have been in service for long periods form running contacts due to wear of teeth; therefore, the original shim pack should be maintained to check gear lash. Gear lash, when using original gears, can be reduced only to a point of smooth rotation of gears.

If the gear lash is in excess of maximum tolerance as stated under Gear Adjustment, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section (Fig. 12). Rotate the gears and check for smooth or rough operation. If a slight overlap, as illustrated (Fig. 12), takes place at the worn tooth section, rotation will be rough.



A-19693

Fig. 12

Fig. 12 illustrates worn condition of gear teeth and overlapping condition.

When installing new gears, check gear lash with dial indicator (Fig. 13) and adjust to obtain amount of backlash marked on ring gear as follows:

1. Set pinion according to procedure outlined under SE-1065 Pinion Setting Gauge.
2. To move ring gear, tighten or loosen differential bearing adjusting nuts as required.
3. After correct gear lash is secured, check and adjust as necessary to obtain the correct tooth contact. (See Gear Adjustment for correct tooth contact.)

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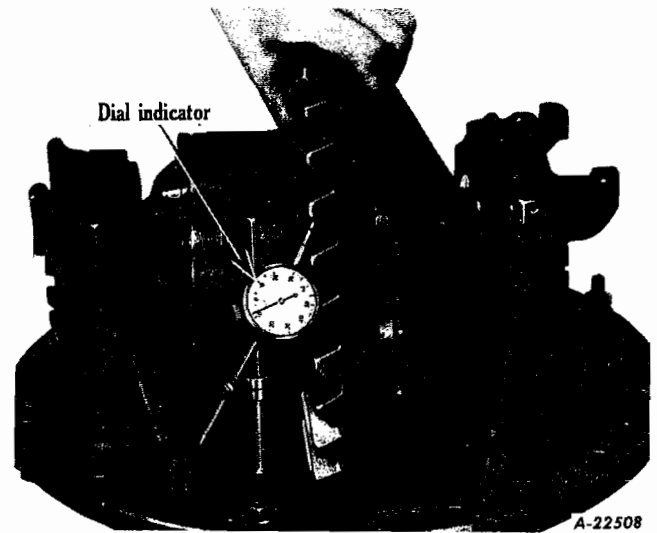


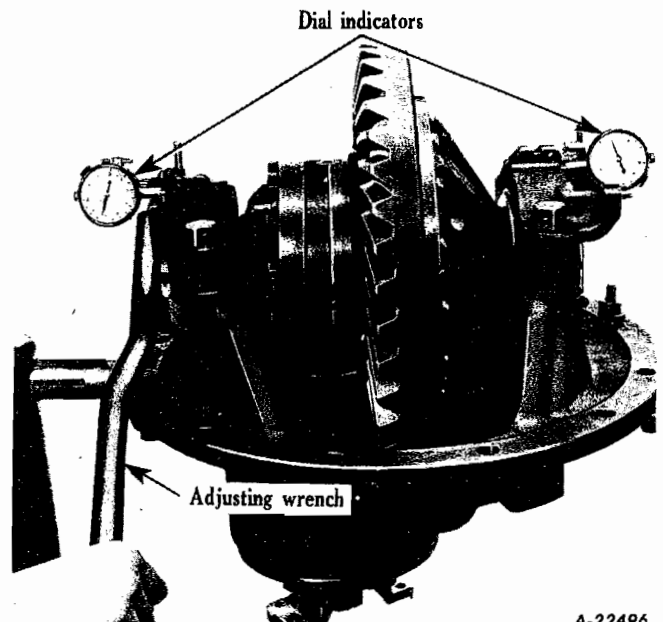
Fig. 13 - Checking gear lash.

Adjust Differential Bearing Pre-Load

Using dial indicators at side of each bearing cap (Fig. 14), adjust to obtain bearing pre-load as follows:

1. Loosen adjusting nuts only enough to notice end play on indicators.
2. Tighten adjusting nuts only enough to obtain .000" end play reading on indicators.

Note: While gear is held in .000" end play and before loading bearings, check gear for runout. If runout exceeds .008", remove differential and check for cause.



A-22496

Fig. 14 - Adjusting differential bearing pre-load.



3. Tighten BOTH adjusting nuts from .000" end play to pre-load differential bearings. Adjust pre-load to secure equal pre-load reading at indicators. (See specifications for pre-load data on the various axles.)
4. Tighten bearing cap stud nuts to specified torque.
5. Install adjusting nut locks.

Pinion Bearing Adjustment for Correct Pre-Load (Torque Method)

After the pinion, the pinion bearings and spacers have been assembled in the pinion bearing cage, place the assembly in a press being sure to use a sleeve adapter as shown in Fig. 15. Press the bearing down firmly and rotate the pinion cage to align the bearings and assure normal bearing contact. Set press at correct pressure and attach a spring scale to pinion cage as indicated in Fig. 15. Read scale only while pinion cage is turning. If preload reading is incorrect, the bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer.

The correct press ram pressure and scale reading for the various axles may be found in the Rear Axle Specifications.

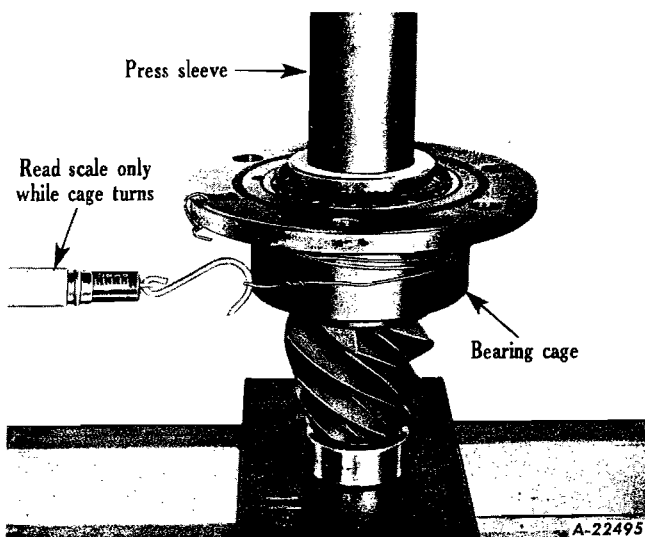


Fig. 15

Fig. 15 shows method of checking pinion bearing preload using scales to measure torque.

Pinion Bearing Adjustment for Pre-Load Using Dial Indicator (This method should only be used on the smaller axles).

An outside or bench assembly should be made of bevel pinion, bearings and cage. With cups assembled in cage, assemble the pinion and inner bearing cone and roller assembly in place, using the proper spacer to space the pinion bearings. Next assemble the outer pinion bearing cone and rollers, spacer, companion flange, washer and nut.

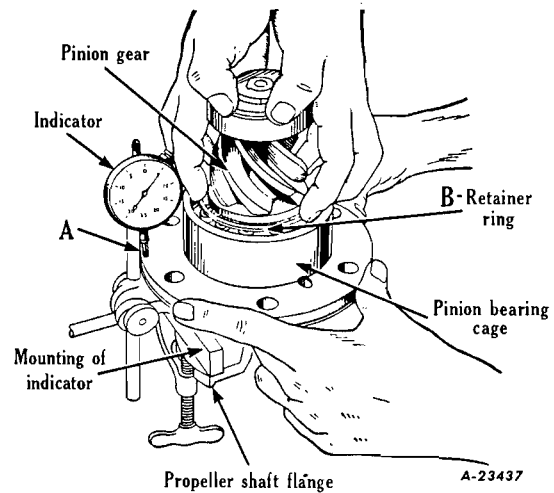


Fig. 16

Fig. 16 shows method of attaching dial indicator when adjusting bearing pre-load. This method can be used when press equipment is not available.

NOTE: Do not install pinion bearing oil seal until all adjustments have been completed. Then check bearing fit to see that bearings have no end movement with flange nut drawn up tight. To secure this fit, proper spacer must be found by trial as follows:

- (1) Place assembly in vise in position shown.
- (2) Mount indicator on propeller shaft flange with indicator finger resting on upper face of cage. (See A, Fig. 16.)
- (3) With the tips of the fingers grasp the bearing retainer and work bearings up against the back face of pinion. (See B, Fig. 16.)
- (4) With the bearings held firmly against the pinion, move the cage up and down, observing the indicator reading. It is impossible to accurately determine the end play unless the bearing is worked loose and up against the pinion. Assemblies having as much as .005" end play cannot be moved enough to show on the indicator until the bearing has been worked up and away from the cup.

CAUTION

Bearings must be absolutely clean!



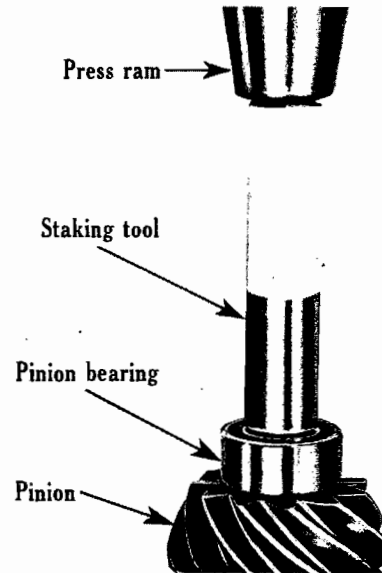
Preload the pinon bearings by replacing the spacer between the pinon bearings with one smaller to the extent of the amount of the end play plus .002" for the loading. For example, should there be .005" end play as indicated in the sketch in the assembly, replace the spacer with one .007" smaller. Do not depend upon the spacers to be right according to number but check each and every one with an accurate micrometer. Before reassembling the bearings to the pinion shaft they should be dipped in rear axle lubricant. Propeller shaft flange nut must be pulled down securely to assure tight bearings. A wrench with 30" of leverage should be used.

In order to determine if insufficient or excessive preload has been applied, make the following test:

- (1) Place assembly in vise with jaws clamping together on the flange of the pinion bearing cage and with assembly in a horizontal position.
- (2) Grasp the propeller shaft flange with one hand and attempt to turn.
- (3) If the pinion turns freely, assembly is too loose. If pinion cannot be turned, assembly is too tight.
- (4) The ideal condition is to secure a firm drag when turning the pinion cage by hand.

After proper bearing fit has been obtained, place pinion bearing cage shims approximately .020 in thickness over end of cage and place cage and pinion assembly in carrier, it being necessary to match flange holes in cage, since one hole is out of equal spacing to assure proper position of cage. Next assemble two cage bolts only until gear setting is completed. Assemble differential and bevel gear assembly and place bearing cap and adjuster in position. Tighten bearing cap bolts and back off slightly to provide sufficient looseness to allow turning the adjuster for a temporary backlash adjustment of approximately .010". After this adjustment has been made, tighten each bearing adjuster snug then give them a final tightening operation, drawing them up to secure the .005" to .007" total bearing pre-load. This is important in order to make certain that the bearings are seating properly.

IMPORTANT: Hypoid drive pinion oil seals must be soft and pliable before being installed if the seals have become dried out and hard while in stock, use kerosene and work it in thoroughly. When seal has become soft and pliable, dip it in hot oil and work this oil in thoroughly.



A-22727

Fig. 17 - Using the pinion staking tool.

Pinion Bearing (Straddle bearing)

The straddle pinion bearing is held in place on the pinion by a staking operation.

The staking operation is accomplished through the use of a hydraulic or screw press applying 18 to 20 tons pressure on the special staking tool as illustrated in Fig. 17. The result will be uniformly spaced ball indentations that securely lock the pinion bearing to the shaft.

Differential Ring Gear Rivet Removal

If necessary to remove hypoid ring gear or herringbone gear rivets, drill the rivet heads from the gear side, using a drill slightly larger than the rivet itself. Use a punch for the removal of the remaining portion of the rivet. (See Fig. 18).

Knocking off or "busting" rivets is a dangerous practice both from the standpoint of personal safety and because such practice may cause distortion to the gear carriers or gears and will elongate the rivet holes.

Rivet Pressures

Proper installation of differential ring gear rivets demands that sufficient pressure be applied to the rivets to expand them and cause them to completely fill the holes in which they are installed. Riveting should be done with COLD rivets. Hot rivets will shrink when cool, leaving a space and inviting shearing upon the application of torque.

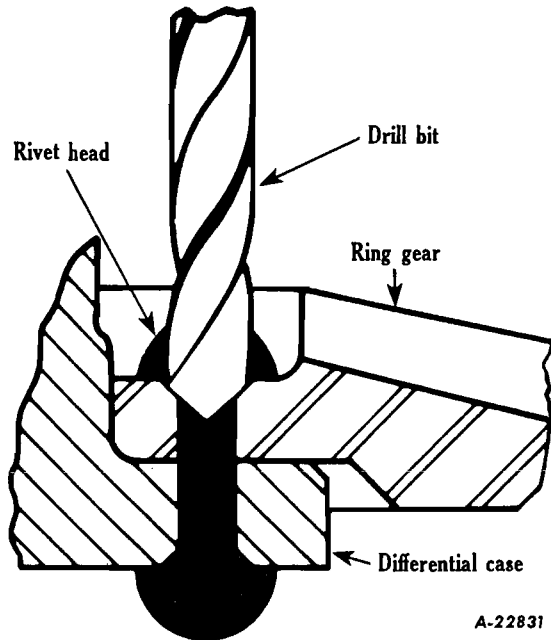


Fig. 18 - Drill rivet head and punch-out rivet as shown.

Riveting Jig SE-1575 is available and is designed for use with hydraulic or mechanical press equipment.

The following pressures are recommended for differential ring gear rivet installation:

RIVET SIZE (INCH)	PRESSURE PER RIVET (TONS)
5/16	12 to 15
3/8	17 to 20
7/16	30 to 35
1/2	45 to 50
9/16	60 to 70
5/8	60 to 70

Axle Shaft Removal (Timken Axles)

Axle shafts are attached to the wheel hubs by studs and nuts at the flanged end. Stud holes in each axle shaft flange are taper-reamed to receive split tapered dowels.

When disassembling the axle, some of the bearing cage studs or axle shaft studs may turn loose from the housing rather than at the nuts. When the axle is reassembled, the nuts should be removed from the studs and the studs replaced in their tapped holes before installing the cage or carrier.

When removing the axle shafts from the Timken axle, remove the stud nuts and lockwashers and proceed as indicated in Figs. 19, 20, 21.

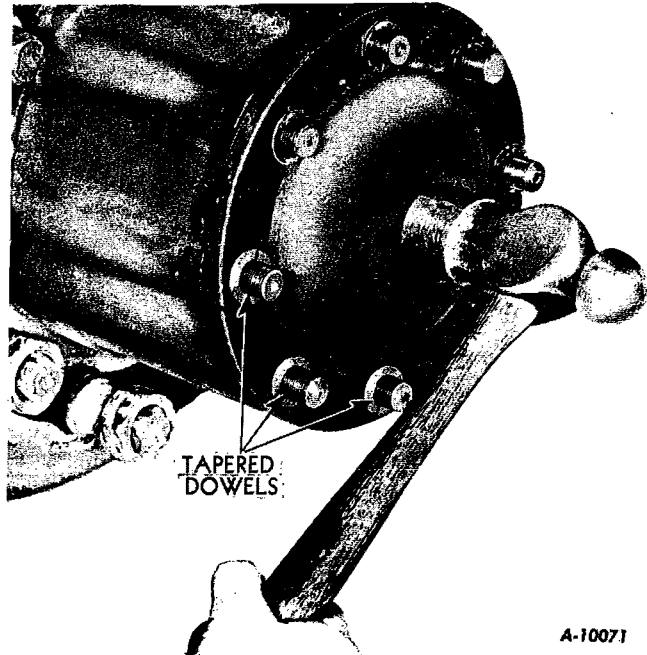


Fig. 19 - Using a heavy hammer, strike sharply on the center of the flange of the axle shaft. This will unseat and loosen the tapered dowels in each stud hole.

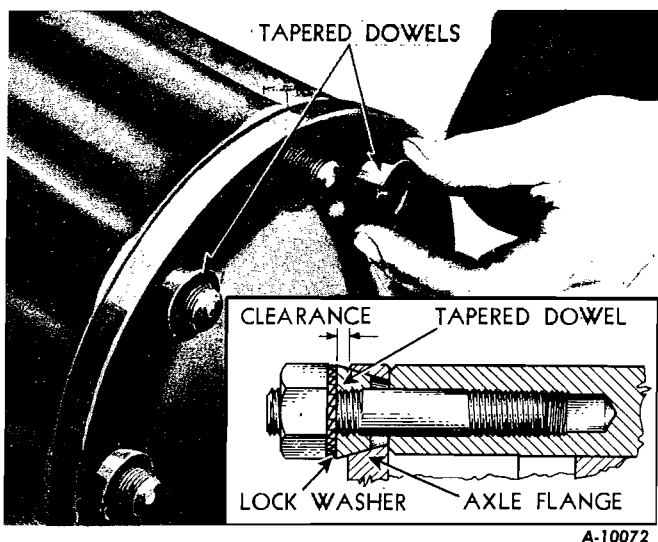


Fig. 20 - Remove the tapered dowels.

Note: When reassembling there must be a slight clearance between the lockwasher and axle shaft driving flange. Excessive wear on studs, dowels, or holes in the flange will indicate a lack of clearance at this point.

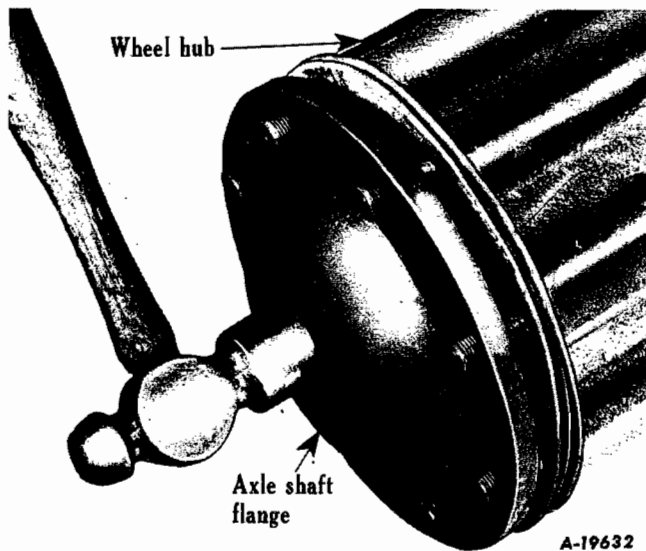


Fig. 21 - Push the axle shaft flange back into position against the wheel hub, and again, strike a sharp blow in the center of the axle shaft flange. This will cause the axle shaft to spring away from the wheel hub and allow removal of the axle shaft without resorting to the use of a pry bar or screwdriver. Do not pry between the axle shaft flange and wheel hub. To do so is apt to damage the seal assembly or machined surfaces of the wheel hub or axle shaft flange.

When reinstalling the axle shafts there must be a slight clearance between the lockwashers and driving flange, see Fig. 20. Excessive wear on studs, dowels or holes in the axle flange will take place when no clearance exists.

Axle Housing Breather Valve

When the rear axle becomes warm, after a short period of operation, a pressure is built inside the axle housing. To prevent this pressure from forcing lubricant past the rear wheel oil seals and damaging the brake linings, a breather valve has been provided. The valve is so constructed that warm air may pass out of the axle to relieve built up pressure, yet dirt and moisture are prevented from entering. The location of the breather valve is shown in Fig. 18, inset shows detail of valve.

The breather valve should be kept open and clean. When the vehicle is operated or unimproved highways or in ice and snow it is possible that dirt will be forced under the valve cap, thus rendering the valve ineffective. Remove valve occasionally and clean thoroughly in a cleaning solution.

NOTE: Where power divider is mounted on rear axle, the breather is mounted on upper side of the power divider.

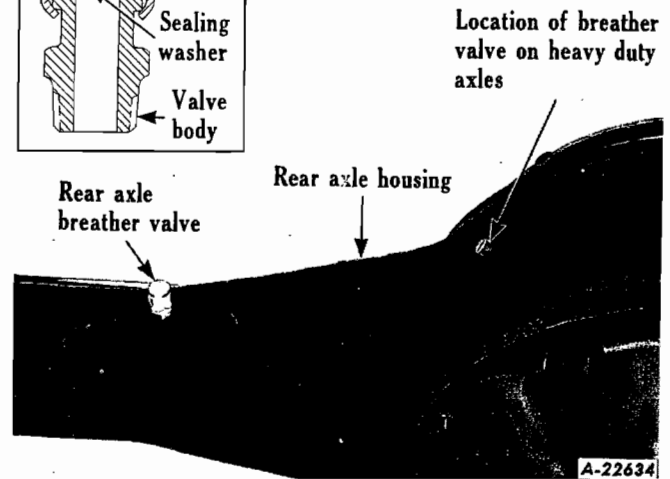
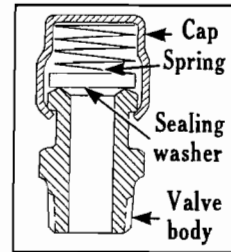


Fig. 22 - Keep breather valves clean and free of obstruction. Breathers are usually located in housing as illustrated.

IMPORTANT

Lubrication Of Hypoid Axles

The lubricant used in hypoid axles is an important factor in obtaining long gear life and satisfactory drive unit service. Past experience proves that a large portion of service problems can be traced to using incorrect, or lubricant of poor quality.

In the selection of Hypoid Lubricants, it is advisable to consider using products of unquestionable quality.

Because of the higher unit pressures and sliding tooth characteristics of hypoid gearing, the lubricant must have properties which enable it to withstand these actions.

It is important that the axle hypoid gearing receive initial lubrication after overhaul, or when a vehicle has been standing in storage, and BEFORE THE AXLE IS SUBJECTED TO HEAVY LOADS; Good practice is to check the lubricant level in the axle housing then, JACK UP BOTH rear wheels and operate the vehicle in high transmission gear at approximately 25 miles per hour for five minutes. This will assure thorough lubrication of the gearing before the unit is placed into service. (Do not allow one wheel to race faster than the opposite wheel.)

Where the axle pinion cage is provided with a plug at the pinion cage, insert one pint of lubricant to provide initial lubrication for the pinion bearing.



Specified Lubricant For Hypoid Axles

For hypoid axles (not Eaton) use SCL, EP gear oil or a multi-purpose gear lubricant suitable for hypoid axles and supplied by a reputable refinery. SAE-90 for cold climate and SAE-140 for warm climate. For Eaton hypoid axle, use a hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent. A number of hypoid lubricantes are prepared by reputable companies which contain Elco additive concentrates. (See "Lubrication", section A).

NOTE: When reassembling the differential gears, thrust washers, cross shaft spur gears and bearings, lubricate the wearing surfaces with a light coat of the specified axle lubricant.

Differential Assembly -- L-110 and L-120

The L-110 and L-120 Series Trucks use differential assemblies that are identical in construction except that a spacer or thrust block is used when the unit is installed in a L-110 axle.

Since the L-110 axle is of semi-floating construction, a means of taking up the end thrust of the axles and wheels must be provided. The block serves this purpose. The wheel bearings pick up the end play or thrust on the L-120 (full-floating) axles and no thrust block is needed. Also the axle shafts in the full-floating design are slightly longer than those used in the semi-floating design and for this reason the thrust block must be removed when the differential unit is used in the L-120 series vehicle.

Removal of the thrust block is as follows:

1. Drive cross pin retainer pin from differential case so as to clear the cross pin (Fig. 23).

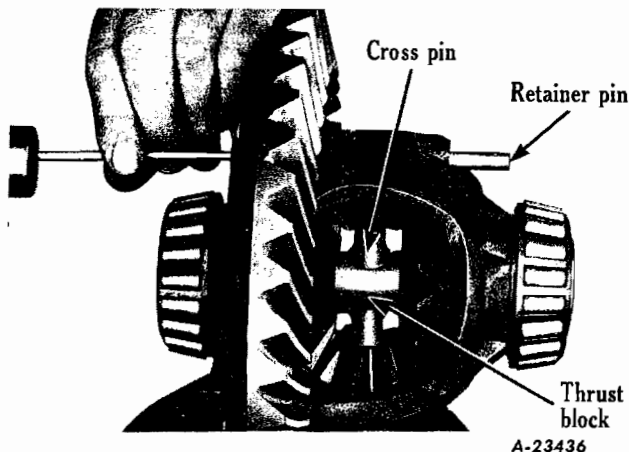


Fig. 23 - Driving retainer pin from differential case using a hammer and punch.

2. Using punch, drive the cross pin out of differential case far enough to remove the thrust blocks (Fig. 24).

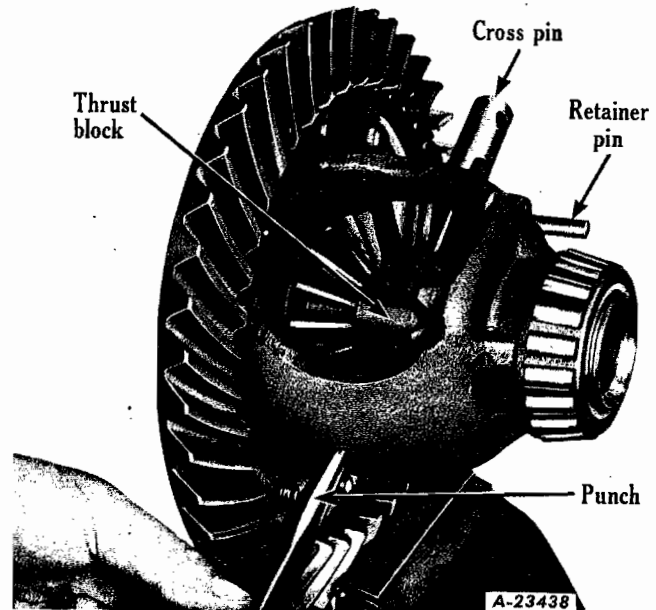


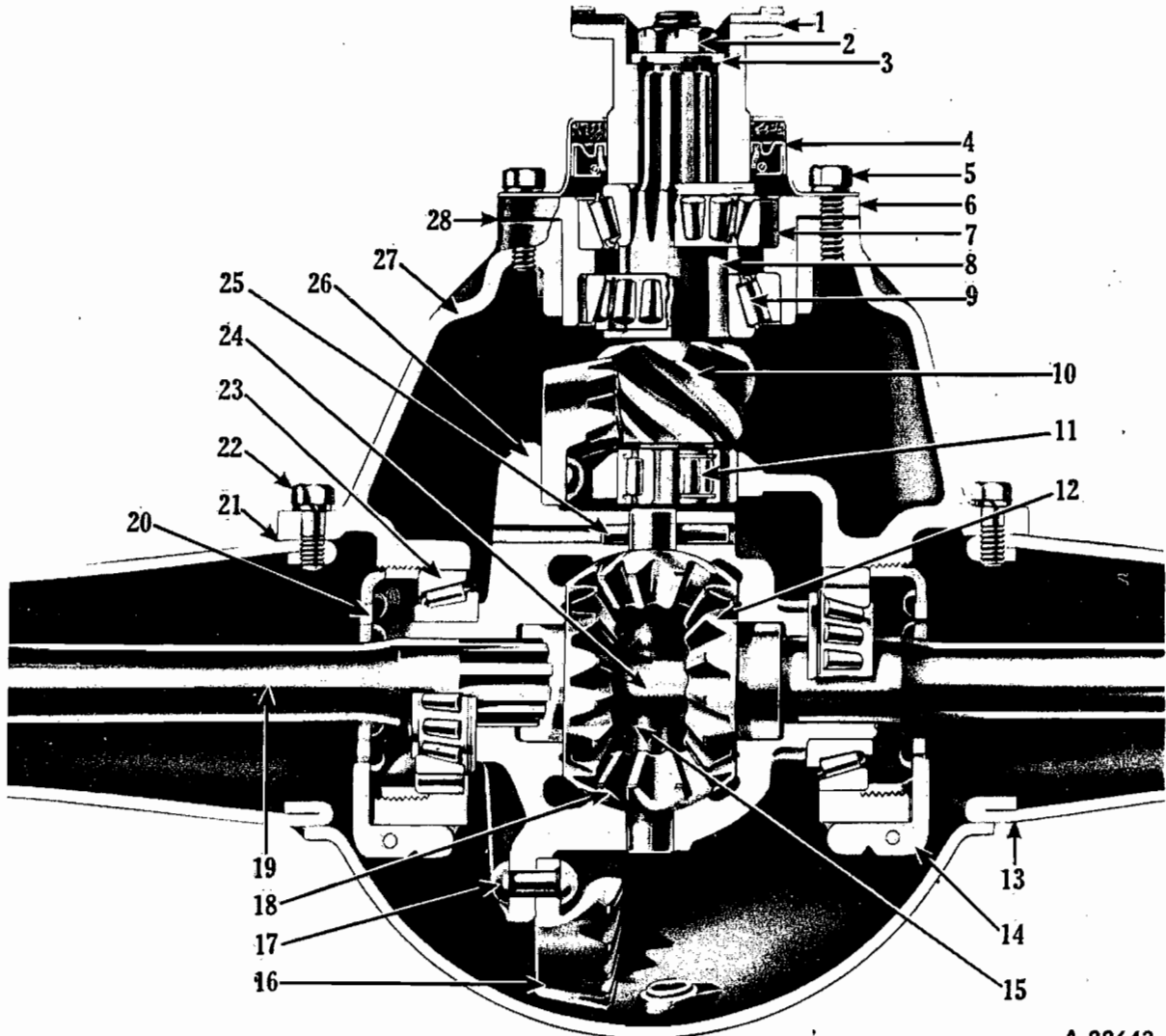
Fig. 24

3. Push cross pin back into position in the differential case. Drive retainer pin into position and stake case to secure retainer pins (Fig. 25).



Fig. 25

SINGLE-REDUCTION HYPOID AXLE (UNIT SHOWN IS MODEL R-1060 OR R-1070)



A-22643

Fig. 26 - Sectional View of Hypoid Rear Axle.

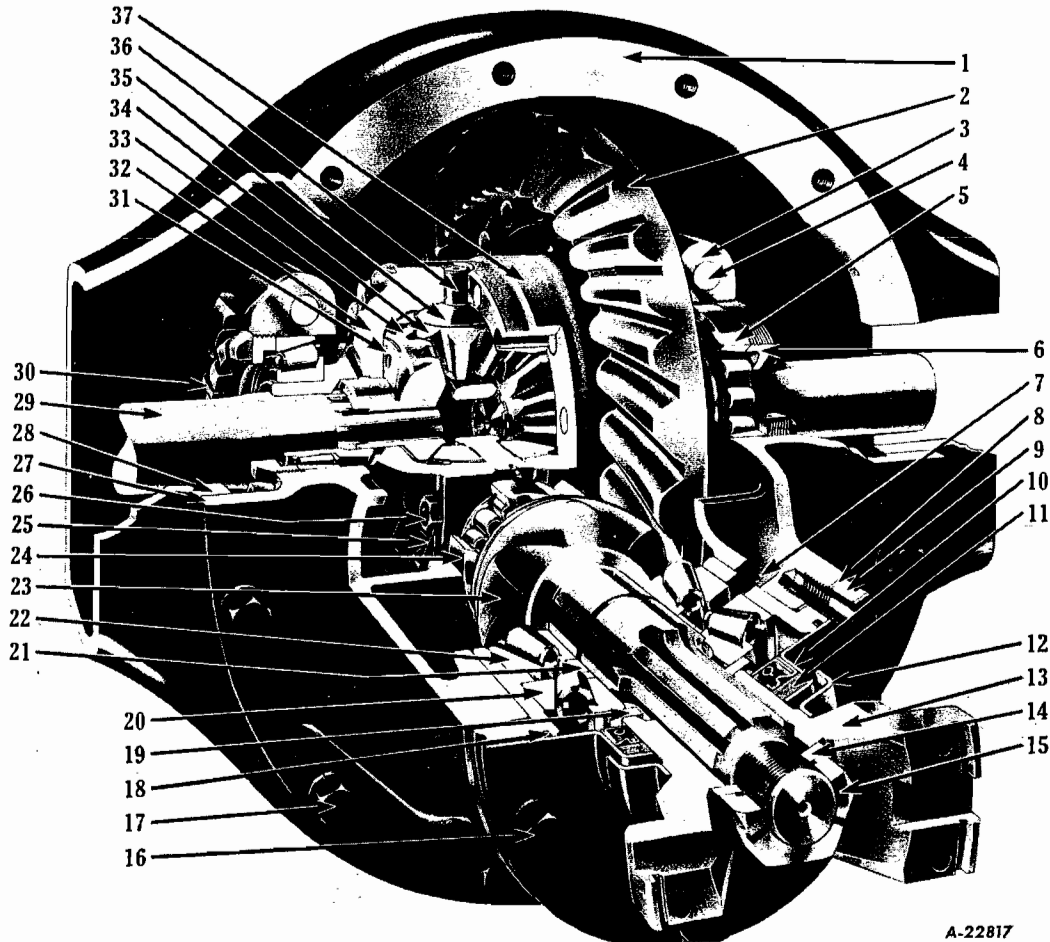
- | | |
|---|---|
| 1. Companion flange. | 15. Differential cross pin. |
| 2. Propeller shaft mounting nut. | 16. Hypoid ring gear. |
| 3. Propeller shaft mounting nut washer. | 17. Hypoid ring gear rivet. |
| 4. Pinion shaft bearing oil seal. | 18. Differential pinion. |
| 5. Pinion bearing cage to carrier capscrew. | 19. Axle shaft. |
| 6. Pinion bearing cage. | 20. Differential bearing adjuster. |
| 7. Pinion bearing, outer. | 21. Differential carrier to housing gasket. |
| 8. Pinion bearing spacer. | 22. Differential carrier to housing capscrew. |
| 9. Pinion bearing, inner. | 23. Differential roller bearing. |
| 10. Hypoid pinion gear (straddle mounting). | 24. Differential center block. |
| 11. Pinion bearing. | 25. Differential cross pin retaining pin. |
| 12. Differential side gear. | 26. Differential case. |
| 13. Axle housing. | 27. Differential carrier housing. |
| 14. Differential bearing adjuster lock. | 28. Pinion bearing cage shim. |

NOTE: Rear Axle R-1070 is identical with above description except differential center block (24) is not used.



SINGLE-REDUCTION HYPOID AXLE

(MODELS R-1165, R-1170, R-1440, R-1470, R-1530, R-1555, R-1630)



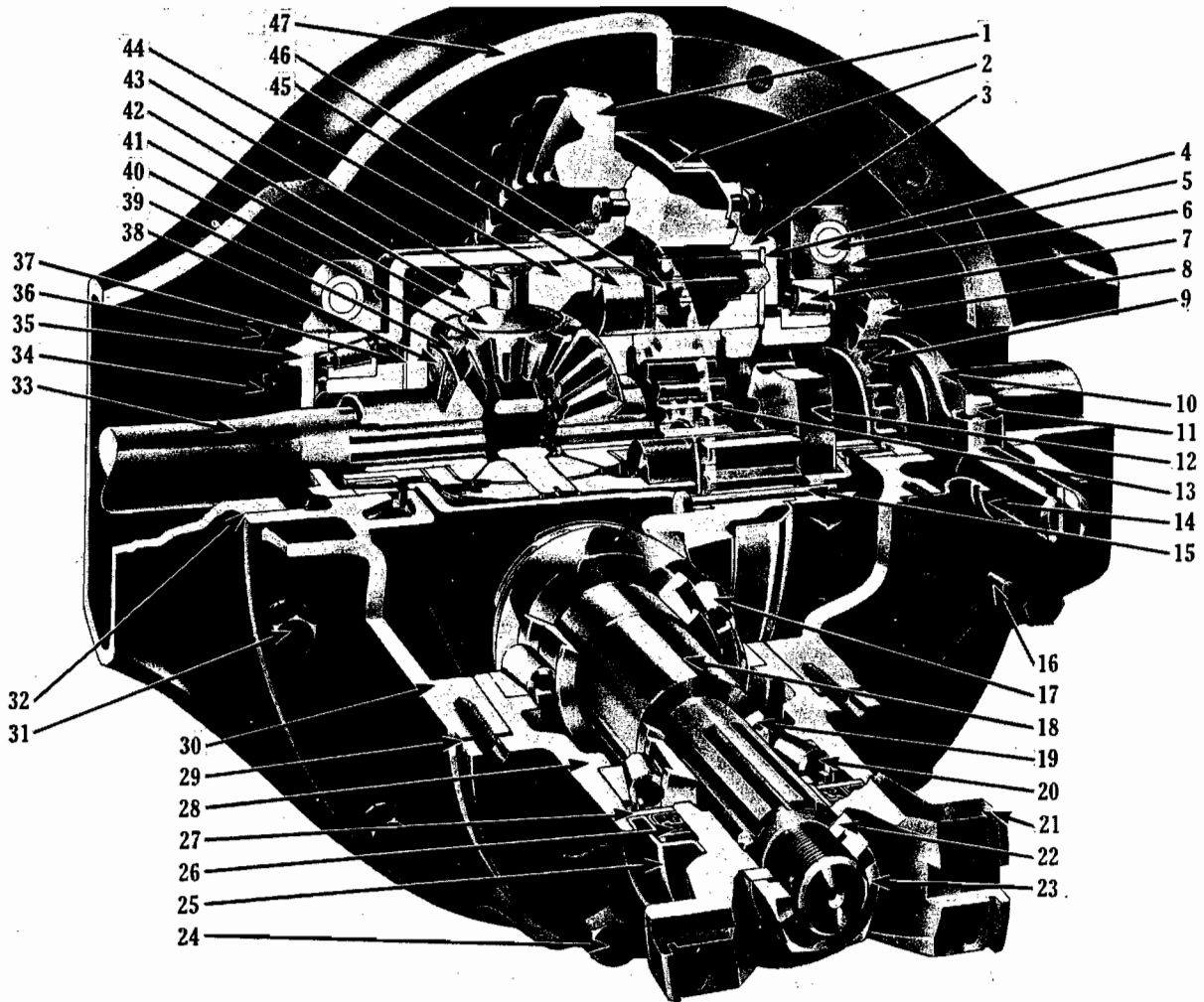
A-22817

Fig. 27 - Sectional View of Hypoid Rear Axle

- | | |
|---|---|
| 1. Axle housing. | 20. Pinion bearing, outer. |
| 2. Hypoid ring gear. | 21. Pinion bearing spacer. |
| 3. Differential bearing cap. | 22. Pinion bearing, inner. |
| 4. Differential bearing cap mounting stud. | 23. Hypoid pinion (straddle mounting). |
| 5. Differential bearing. | 24. Pinion bearing. |
| 6. Differential bearing adjuster. | 25. Differential case bolt lockwire. |
| 7. Oil passage to pinion bearings. | 26. Differential case bolt. |
| 8. Pinion bearing cage shims. | 27. Differential carrier. |
| 9. Pinion bearing cage. | 28. Differential carrier mounting gasket. |
| 10. Pinion oil seal retainer. | 29. Axle shaft. |
| 11. Pinion oil seal. | 30. Differential bearing adjuster lock. |
| 12. Slinger. | 31. Differential side gear thrust washer. |
| 13. Companion flange. | 32. Differential case, plain half. |
| 14. Thrust washer. | 33. Differential side gear. |
| 15. Propeller shaft companion flange nut. | 34. Differential spider pinion. |
| 16. Pinion cage mounting capscrew. | 35. Differential spider pinion thrust washer. |
| 17. Differential carrier mounting capscrew. | 36. Differential spider. |
| 18. Pinion bearing cage cork seal. | 37. Differential case, flanged half. |
| 19. Thrust washers. | |

TWO-SPEED AXLES

SEE SECTION "H" FOR ELECTRIC SHIFT



A-22814

Fig. 1 - Two-Speed Axle (Eaton)

- | | | |
|-------------------------|-----------------------|------------------------------|
| 1. Hypoid ring gear. | 17. Bearing, inner. | 33. Axle shaft. |
| 2. Oil collector drum. | 18. Hypoid pinion. | 34. Bearing adjuster lock. |
| 3. Ring gear case. | 19. Bearing spacer. | 35. Bearing adjuster. |
| 4. Thrust washer. | 20. Bearing, outer. | 36. Bearing cap. |
| 5. Bearing cap stud. | 21. Companion flange. | 37. Thrust washer. |
| 6. Bearing cap. | 22. Washer. | 38. Side gear thrust washer. |
| 7. Carrier bearing. | 23. Nut | 39. Side gear. |
| 8. Clutch plate. | 24. Cage capscrew. | 40. Differential pinion. |
| 9. Sliding clutch | 25. Slinger. | 41. Pinion thrust washer. |
| 10. Shift fork. | 26. Seal. | 42. Differential case. |
| 11. Shift fork shaft. | 27. Washer. | 43. Pinion gear spider. |
| 12. Clutch plate. | 28. Pinion cage. | 44. Ring gear case. |
| 13. Sliding clutch. | 29. Shims. | 45. Idler pinion pin. |
| 14. Diaphragm seal. | 30. Carrier. | 46. Idler pinion gear. |
| 15. Gear case bolt. | 31. Carrier capscrew. | 47. Axle housing. |
| 16. Shifter motor stud. | 32. Gasket. | |



EATON TWO-SPEED REAR AXLE

The two-speed rear axles are full-floating hypoid drive type, having four planetary gears which mesh with an internal gear on the hypoid ring gear.

The primary reduction is accomplished through the hypoid ring gear and a straddle-mounted hypoid pinion. The secondary reduction is accomplished with a sliding clutch serving to lock or unlock the planetary gears.

Servicing

The correct servicing of this unit, as is true with any mechanical equipment, is important to satisfactory operation and life. Servicing the two-speed unit does not require special tools. The ordinary equipment found in most shops is sufficient for this work. Use the following step-by-step procedure for disassembling. Direct reversal of the action will be the proper reassembly procedure. (See Shop Talk No. 1 for step-by-step illustrations on disassembly.)

Disassembly

Remove differential carrier assembly complete from the truck, following the same procedure as you would to take out a single or double reduction unit, except in this case, the two wires on the shift unit must be disconnected. For convenience in handling, the head may be placed in the end of a clean small drum. The opening should be large enough to accept the bevel drive gear and bearing caps. Then proceed as follows:

1. Remove the two shift housing to carrier stud nuts and lockwashers and pull off shift unit assembly. (See section "H" for electric shift instructions.)
2. Remove plug, washer, spring, capscrew, lockwasher and oil distributor.
3. Pull out shift fork shaft after removing shift fork shaft retainer (Fig. 2). The shift fork may then be slipped from the sliding clutch gear and removed through the back of the differential carrier.
4. Slip out sliding clutch gear.
5. Mark right hand differential bearing adjuster with punch. (This is for relocating when reassembling.)
6. Remove bearing cap bolt lockwires on both right and left hand sides. Loosen cap bolts only. Take off right hand bearing adjuster, lock and cotter pin.
7. Remove left hand differential bearing cap adjuster and lock as an assembly to assure correct positioning of gear on reassembly. (When reassembling hold adjuster and bearing cap up away from threads in bore of carrier unit; cap bolts are started. Drop cap; the threads of the adjuster and those in carrier will mesh freely.)
8. After removing bearing caps, tip up left hand end of planetary unit and lift out.
9. Remove pinion bearing cage capscrews.
10. Using a suitable puller, remove pinion assembly from carrier. May also be removed by using a brass drift and tapping lightly from the inside. (Note shims under pinion bearing cage.)
11. Remove pinion shaft nut and slide off companion flange.
12. Lift off pinion bearing cage, bearing, washer and spacer.
13. Drive off pinion bearing cage by tapping lightly between teeth of pinion alternately on opposite sides of inner race. CAUTION: Exercise care so as not to damage bearing during this operation.
12. Remove pinion bearing cone and washer cage assembly. Take out pinion bearing cage cork. (Replace this cork with every repair.)
15. Remove lockwires, nuts and bolts from planetary unit (support case).
16. Tap alternately on opposite sides of ring gear with head of rawhide hammer until gear is free of flange on support case. (When reassembling, use two bolts to assure proper alignment of bolt holes.)
17. Lift off left hand support case and bevel drive gear.
18. Pry off high speed clutch plate and take out idler pinions and pins.
19. Lift out entire differential assembly and remove support case thrust washer.
20. Take out differential case bolt lockwire and remove bolts. (Note short bolts between spider arms.)
21. Lift off right hand differential case. Pick up long hub side gear, right hand, and slip off thrust washer. (Note-chamfered side of washer against back face of gear.)
22. Pull out spider and differential side pinions noting thrust washers behind pinions. Slip washers and pinions off spider arms. Take out short hub side gear, left hand

and remove thrust washer. (Note chamfered side of washer against back face of gear.)

23. Remove differential bearing cones by striking inner race on alternate sides through holes provided in the support case.
24. In reassembling the pinion, use SE-1065 pinion setting gauge in adjusting matched sets of pinions and ring gears to proper cone settings. (Theoretical cone centers for various axles are found under Specifications, Rear Axle Section.)

REASSEMBLY -- IMPORTANT

Assembling Differential Unit

Lubricate both sides of all thrust washers well. Chamfered sides of washers must be against back face of side gears. Lubricate spider arms, side-pinion bores and side-gear hubs. Draw bolts tight with long-handled wrench and securely fasten with lockwire.

Assembling Planetary Unit

Before placing thrust washer, lubricate both sides well. Cover idler-pinion pins with lubricant. Chamfered teeth on high-speed clutch plate must face pinions. Place notches in oil-collector drum between bolt holes in bevel gear. Draw bolts tight with long-handled wrench and secure wire.

Pinion Shaft Bearing Adjustment

Desired bearing tension is obtained by using a spacer of the correct thickness between the bearing inner races. There are 12 spacers, each of different thickness, available for this purpose. To make the assembly, proceed as follows:

1. Place the pinion and bearings in position in the cage using original spacer, providing the pinion did not have any perceptible end movement before disassembly.
2. Then assemble flange washer and flange. Tighten retaining nut securely. There should be no perceptible end play and bearing should roll freely. If correction is to be made select proper size spacer to obtain desired fit.

Assembling Differential Carrier Unit

Lubricate all bearings as they are assembled in carrier. After adjusting gear, be sure cap bolts are tight. Wire bolts securely, including capscrews, in adjuster lock.

Pinion Bearing Pre-Load

Follow instructions given in Hypoid Rear Axle Section "A", page 6.

Differential Carrier Bearing Pre-Load

The correct procedure for securing the specified carrier bearing pre-load, as listed in the Rear Axle Specification for these axles, will be found in Section "A", Hypoid Rear Axles.

Gear Tooth Contact

To secure best possible tooth contact, use SE-1065 pinion setting gauge and follow instructions under this heading, Section "A", page 2. Check results obtained by making a paint impression test of tooth contact. See Gear Adjustment for correct tooth contact - Paint Impression Method, Section "A", page 3.

Lubrication

An oiling system is provided to supply lubricant within a half a turn of the truck wheels to the essential places during conditions when splash and dip alone would be insufficient. A heavy coating of oil is picked up by the oil collector drum and transmitted to the oil scoop. The oil scoop scrapes the oil from the drum and splits it into two courses. One half of this lubricant goes to the pinion bearings; the other half, to the right hand differential and planetary unit to the left differential bearing and then returning to the reservoir.

Whenever a two-speed differential (new or rebuilt) has been installed in the axle housing, fill the oil reservoir to bottom of filler plug opening and replace plug. Then add one additional pint of lubricant using filler hole provided at top of carrier housing just above pinion cage.

Use a hypoid gear lubricant available as ElcoGear Safety "28" or its equivalent. A number of hypoid lubricants are prepared by reputable companies which contain Elco additive concentrates. Viscosity of the hypoid lubricant should be SAE-90. When high atmospheric temperatures (above 100° F.) prevail, SAE-140 may be used. See "Lubrication" section A.

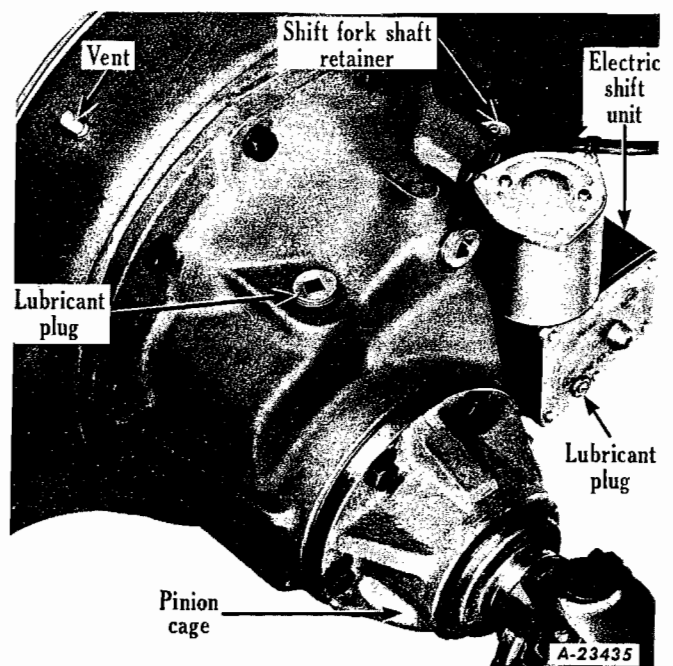
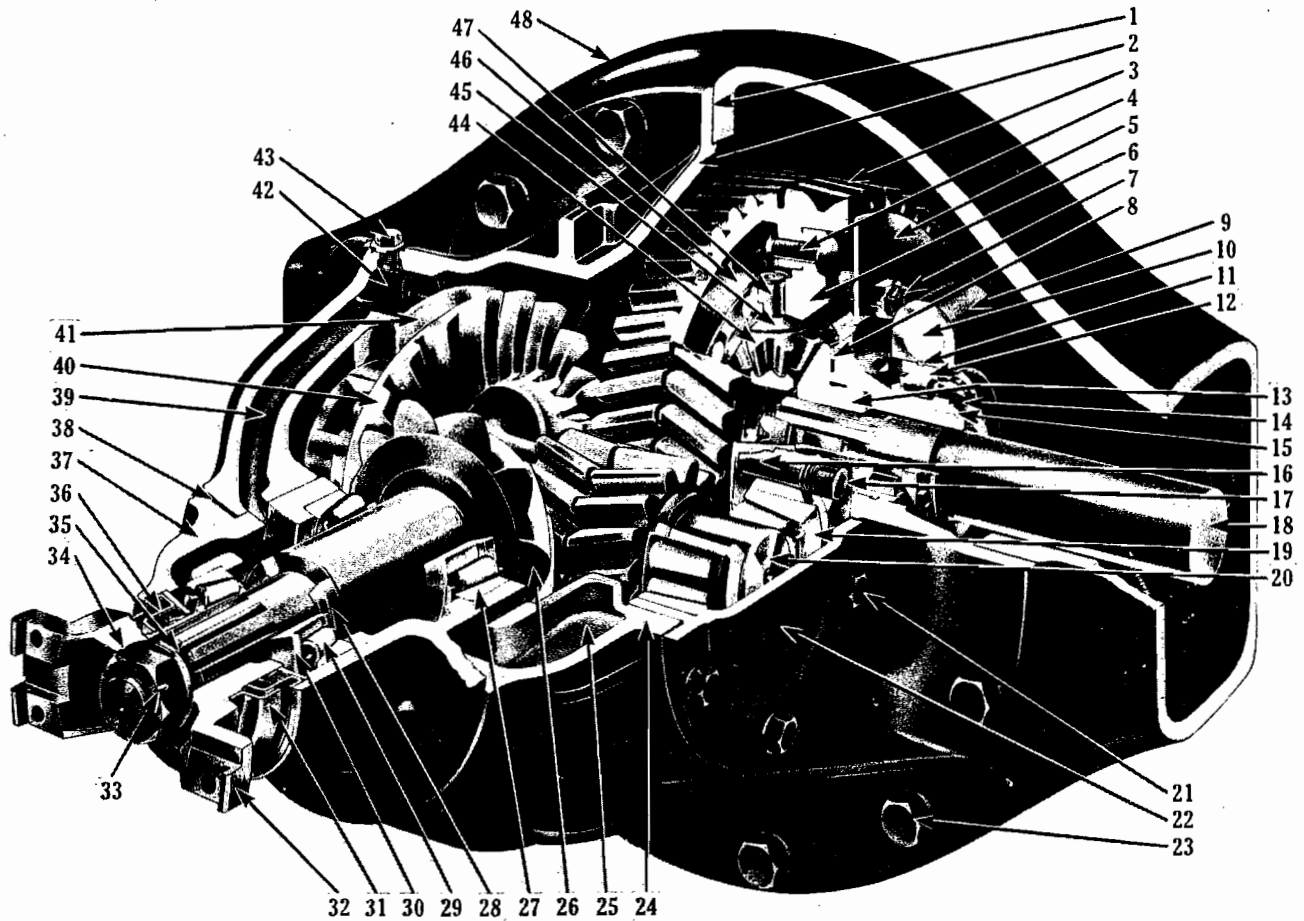


Fig. 2

DOUBLE-REDUCTION AXLE (EATON)



A-22813

Fig. 1 - Double-Reduction Axle (Eaton)

- | | | |
|--------------------------|---------------------------|---------------------------|
| 1. Carrier gasket. | 17. Spring and plug. | 33. Cotter pin. |
| 2. Carrier. | 18. Axle shaft. | 34. Nut. |
| 3. Herringbone gear. | 19. Countershaft bearing. | 35. Washer. |
| 4. Gear rivet. | 20. Pinion countershaft. | 36. Oil seal. |
| 5. Oil distributor disc. | 21. Cage capscrew. | 37. Bearing cage. |
| 6. Case, flanged half. | 22. Bearing cage. | 38. Cage shims. |
| 7. Case bolt and nut. | 23. Carrier capscrew. | 39. Oil passage. |
| 8. Thrust washer. | 24. Cage shims. | 40. Hypoid ring gear. |
| 9. Bearing cap. | 25. Oil reservoir. | 41. Oil distributor disc. |
| 10. Cap stud. | 26. Hypoid pinion. | 42. Oil scoop. |
| 11. Lock ring. | 27. Bearing, inner. | 43. Oil scoop capscrew. |
| 12. Bearing. | 28. Bearing spacer. | 44. Spider pinion. |
| 13. Side gear. | 29. Bearing, outer. | 45. Pinion thrust washer. |
| 14. Thrust washer. | 30. Washer. | 46. Case, plain half. |
| 15. Lock ring. | 31. Slinger. | 47. Spider. |
| 16. Oil scoop. | 32. Companion flange. | 48. Axle housing. |



EATON DOUBLE-REDUCTION REAR AXLE

The Eaton double-reduction rear axles, shown in Fig. 1, are heavy-duty, double reduction type. The primary reduction is through a hypoid ring and pinion gear while the secondary reduction is through a set of herringbone gears.

Primary Reduction

The primary reduction gears are the hypoid type, consisting of a hypoid pinion mounted on the forward end of the carrier housing, and meshed with a hypoid ring gear which is riveted to an integral flange on the ring gear shaft. This shaft also carries, as an integral part, the herringbone drive pinion for the secondary reduction.

Secondary Reduction

The secondary herringbone reduction gears consist of a drive pinion and a mating gear. The teeth on the secondary reduction gears are right and left-hand spiral cut in line with each other, forming a "V", the apex of which is at the center of the gear face. A center cut through the apex breaks the tooth line into two separate and opposed spiral gears, each exerting equal and opposed pressure thus balancing the end thrust.

Installing New Herringbone Drive Gear (Differential Case)

If new gears are being installed, the pilot diameter on differential case drive gear flange should be checked to see that it runs true. If inspections indicate a run out of .004", a new differential case should be installed. When assembling drive gear on face of flange, make sure each rivet is tight. The best results are obtained if a press is used to install rivets. Follow the instructions outlined under Rivet Pressures on page 8, Section "A".

Hypoid Pinion Shaft and Adjustment

Adjustable hypoid pinion bearings are assembled to pinion shaft and retained by universal joint flange and nut on forward end of pinion shaft.

A spacer (available in several thicknesses) is used to maintain correct distance between front and rear bearings and to secure the pinion bearings pre-load as indicated in Rear Axle Specifications. The pinion cage is mounted in the conventional manner and the correct cone center adjustment is secured by means of a shim pack under pinion cage flange. See SE-1065 Pinion Setting Gauge, Section "A", page 2).

IMPORTANT: Hypoid drive pinion oil seals must be soft and pliable before being installed if the seals have become dried out and hard while in stock, use kerosene and work it in thoroughly. When seal has become soft and pliable, dip it in hot oil and work this oil in thoroughly.

Pinion Bearing Lubrication

NOTE: When reassembling differential to axle housing, or new and dry differential is used from stock, be sure to inject about one pint of differential lubricant into the pinion bearing housing through the filler plug opening at the side of the carrier. This will provide immediate lubrication for the pinion bearings upon placing the unit in operation.

Herringbone Gear Shaft (Cross Shaft)

The herringbone drive pinion gear shaft is mounted at right angles to the hypoid pinion shaft in the carrier housing. This shaft is a one-piece steel forging consisting of an integral herringbone gear in the center and an integral flange on one end to which is bolted a hypoid ring gear.

To remove this shaft, it is necessary to remove the differential and herringbone ring gear assembly. Then withdraw the hypoid pinion and cage assembly far enough to clear the hypoid ring gear, when being removed. (Removal of universal joint flange is unnecessary.) Remove both bearing covers and using a soft hammer, tap ring gear end of shaft until the bearing cup at opposite end of shaft is removed from carrier housing. This will permit sufficient opening to partly pass shaft through until bearing is clear of carrier housing at ring gear end of shaft. Tilt ring gear end of shaft to rear and withdraw from carrier.

The cross shaft bearing covers control the hypoid pinion and ring gear backlash and tooth contact as well as the bearing pre-load. This is accomplished by means of a shim pack under each bearing cover.

Herringbone Gear Adjustment

Herringbone gears are not adjustable for backlash. This clearance is taken into account in the construction and remains constant as long as the gears remain undamaged or the differential carrier bearings are not worn excessively.

The self-aligning differential carrier bearings eliminate the need for adjustment to align the herringbone pinion and herringbone ring gear. The heavy duty roller bearings permit



the differential carrier to move sidewise within the bearing race sufficiently to keep both gears in perfect alignment at all times.

Differential

Differential is conventional four-pinion type with thrust washers back of side gears and pinions. Cases are supported on heavy duty roller bearings.

Differential Lubricators

The double reduction axles have special provision incorporated to supply oil to the herringbone pinion shaft bearings as well as the hypoid pinion shaft bearings. This is accomplished by scooping lubricant from oil collector discs mounted on the herringbone gear and the hypoid ring gear. The lubricant is picked up from these discs by oil scoops and circulated through special passages to the differential carrier bearings and the herringbone pinion shaft bearings. Fig. 2 illustrates the flow of oil and the principal of this means of bearing lubrication.

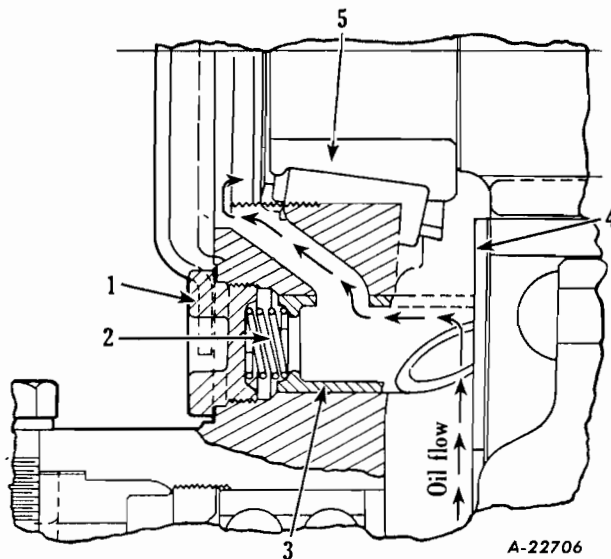


Fig. 2

Lubrication of Hypoid Axles

The lubricant used in hypoid axles is an important factor in obtaining long gear life and satisfactory drive unit service. Past experience proves that a large portion of service problems can be traced to using incorrect, or lubricant of poor quality.

In the selection of Hypoid Lubricants, it is advisable to consider using products of unquestionable quality.

Because of the higher unit pressures and sliding tooth characteristics of hypoid gearing, the lubricant must have properties which enable it to withstand these actions.

It is important that the axle hypoid gearing receive initial lubrication after overhaul, or when a vehicle has been standing in storage, and **BEFORE THE AXLE IS SUBJECTED TO HEAVY LOADS**. Good practice is to check the lubricant level in the axle housing then, jack UP BOTH rear wheels and operate the vehicle in high transmission gear at approximately 25 miles per hour for five minutes. This will assure thorough lubrication of the gearing before the unit is placed into service. (Do not allow one wheel to race faster than the opposite wheel.)

Where the axle pinion cage is provided with a plug at the pinion cage, insert one pint of lubricant to provide initial lubrication for the pinion bearings.

NOTE: When reassembling the differential gears, thrust washers, cross shaft spur gears and bearings, lubricate the wearing surfaces with a light coat of the specified axle lubricant. This will help provide initial lubrication.

Use a hypoid gear lubricant available as ElcoGear Safety "28" or its equivalent. A number of hypoid lubricants are prepared by reputable companies which contain Elco additive concentrates. Viscosity of the hypoid lubricant should be SAE-90. When high atmospheric temperatures (above 100 F.) prevail, SAE-140 may be used.



TIMKEN SINGLE-REDUCTION AXLES

Description

The Timken Single-Reduction Rear Axle (R-100) is a full-floating, hypoid-type final drive, assembled in a one-piece axle housing.

The differential used in the R-100 Timken Single-Reduction Axle is of four-pinion-type with thrust washers used between the pinions and case. The pinions contain bushings which can be renewed when necessary. Thrust washers are also used between the side gears and case. The two halves of the differential case are machined as a complete assembly and must be replaced as such.

Removal of Differential Carrier - Hypoid

To remove the differential carrier assembly, remove plug from bottom of axle housing and drain out the lubricant. Disconnect the propeller shaft at front end of pinion shaft. (Be sure to replace the universal joint trunnions on their respective journals and hold them in place with a short loop of wire until ready to reassemble.) Remove axle shafts and differential carrier to housing capscrews (or stud nuts on heavy-duty axles), and take out carrier.

When removing the differential from the axle housing, it will be necessary to utilize the two puller screws to loosen the differential carrier as shown in Fig. 2.

The differential thrust block screw shown in Figs. 3 & 4 must be removed before the differential can be removed from the carrier.

Differential

The differential assembly of this axle consists of four nine-tooth pinions mounted on a spider and two 16 tooth side gears all assembled into the differential case -- one half being flanged to mount the hypoid ring gear.

Hardened steel thrust washers are installed between the side gears and the case and between the pinions and the case. The differential case is held together by twelve bolts, eight of which are longer than the remaining four.

Differential Disassembly

Mark each half of the differential case before teardown so that they can be reassembled in the original position. Wash and inspect all parts and replace any which are at all questionable. Oil all parts with gear oil before reassembly. Use new lockwashers when reassembling.

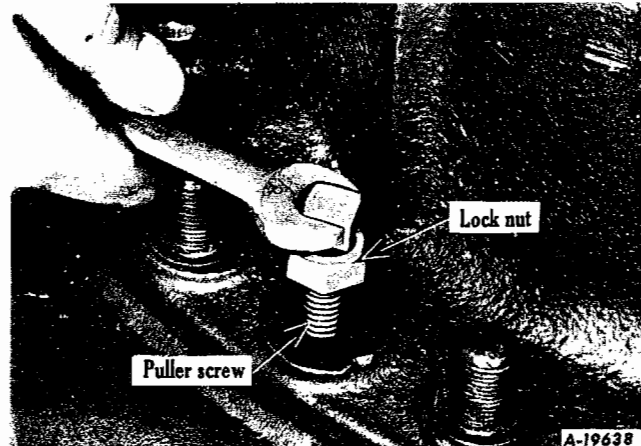


Fig. 2 - Loosen lock nuts on two puller screws provided, and turn puller screws down into carrier. It may be necessary to break carrier loose from housing by striking the carrier with a heavy soft hammer (lead or leather).

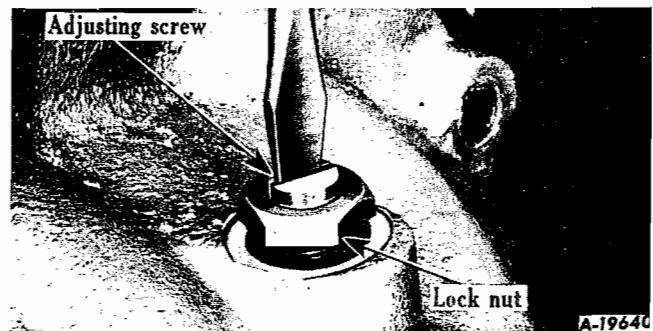


Fig. 3 - Place differential carrier in suitable holding fixture or overhaul stand, and loosen the lock nut on the drive gear thrust block adjusting screw. Remove thrust block adjusting screw from carrier. This will permit the thrust block to fall into the carrier.

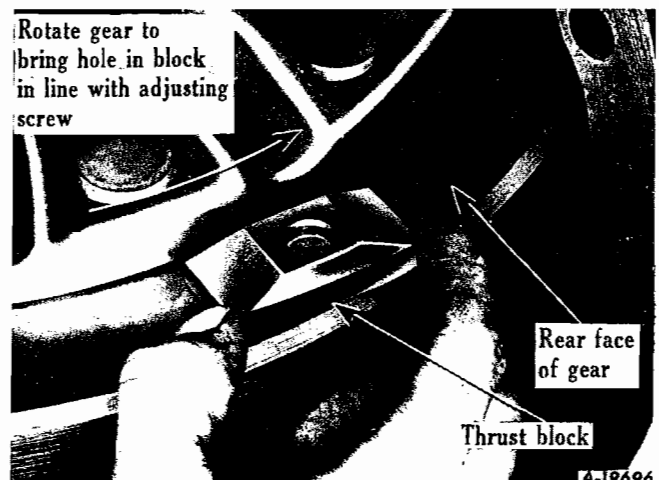


Fig. 4 - When replacing thrust block, place block on gear and rotate gear to bring block in line with adjusting screw.

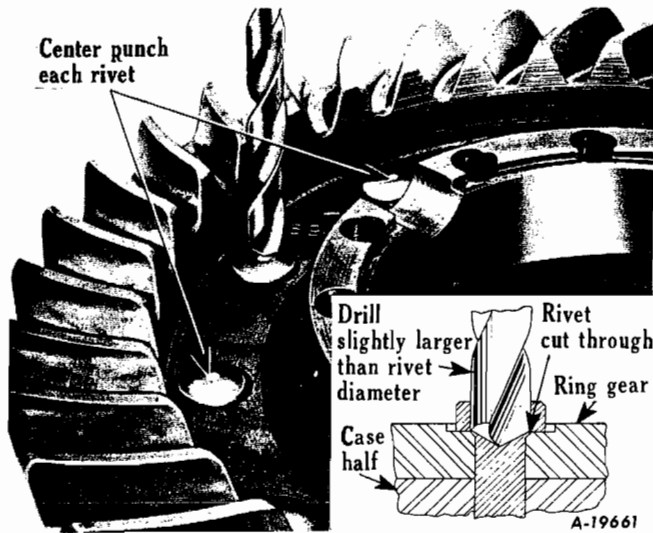


Fig. 5 - If it is necessary to remove the ring gear from the differential case half, carefully center punch each rivet in the center of the rivet-formed head as shown. Drill through the center of each rivet-formed head, using a drill slightly larger than the body of the rivet. Punch or press rivet out of gear and case half.

If inspection reveals that the ring gear should be replaced, exercise care when removing the ring gear rivets. Fig. 5 shows the correct way to remove the ring gear rivets to avoid damage to the differential case.

The four differential spider pinion gears run on bronze bushings and where they are found to be worn excessively, the bushings can be replaced. Cut the old bushings out of the pinions and using the special tool shown in Fig. 6, install and burnish the new bushings in the pinions.

Bronze bushings are burnished by means of a stud ball which, when being pressed through the pinion bushings, compresses the bushing metal, giving a denser surface and tighter fit in the pinion. The burnishing operation also locks the bushings in place in the pinion, since some of the bushing metal is compressed into the locking groove located on the inside bore of the pinion. The correct size ball should be approximately .005" larger than the spider pinion bushings. Do not attempt to ream the spider pinion bushings.

Pinion

The pinion cage can easily be withdrawn, from the differential carrier with the use of puller screws provided.

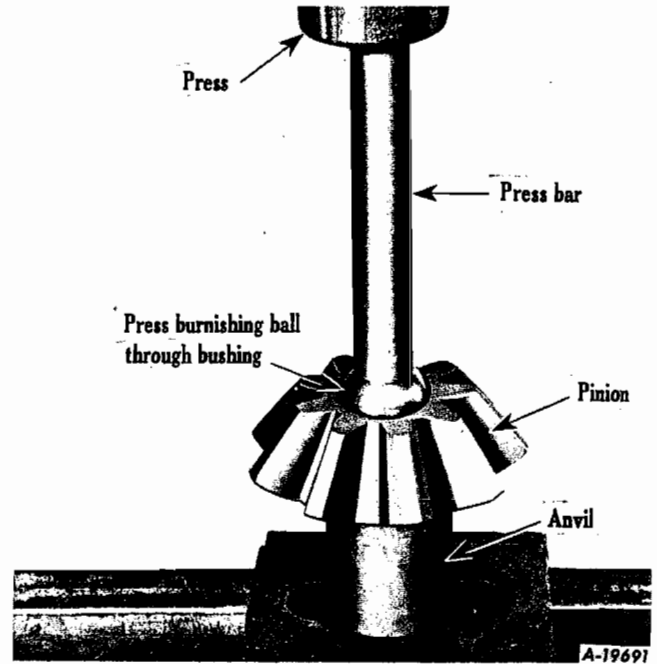


Fig. 6 - Use bar to press burnishing ball through bushing. The correct size ball should be approximately .005" larger than the differential spider trunnion.

Remove the pinion shaft from the pinion cage on a press. Remove the inner pinion bearing with a suitable puller. The inner radial bearing retainer is removed after removal of the retainer screw.

Pinion Bearing Pre-Load

When the pinion shaft, bearings, bearing spacers and pinion cage have been reassembled,

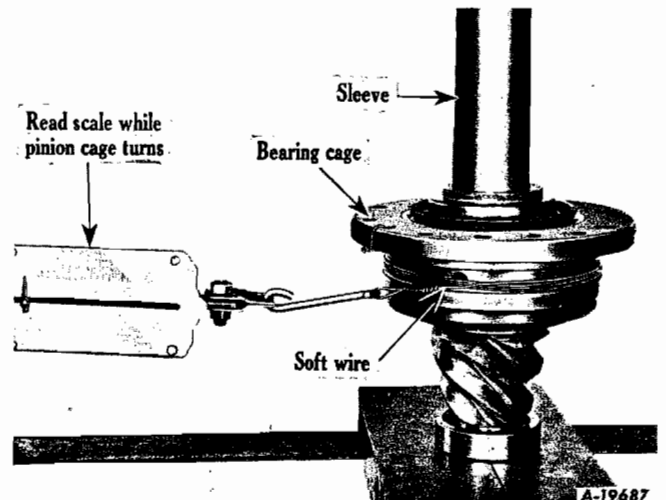


Fig. 7 - Checking pinion bearing pre-load using torque method.



be sure to check the bearing pre-load. Attach a scale to the end of a soft wire wrapped around the pinion cage as in Fig. 7. Read the scale only when pinion cage is moving (rotating torque). If first adjustment does not result in correct pre-load, select a thicker combination of spacers to decrease, or use thinner combinations of spacers to increase the bearing pre-load. The rear axle specifications list the correct bearing pre-load for these axles.

Gear Adjustment for Correct Tooth Contact

Checking tooth contact is accomplished by means of oiled red lead applied lightly to the bevel gear teeth. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts.

Gear Adjustment for Lash

Generally, if original gears are being re-installed, red leading of teeth will not indicate the same contact as new gears and can be misleading. Gears that have been in service for long periods form running contacts due to wear of teeth; therefore, the original shim pack should be maintained to check gear lash. Gear lash, when using original gears, can be reduced only to a point of smooth rotation of gears.

If the gear lash is in excess of maximum tolerance as stated under gear adjustment, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section. Rotate the gears and check for smooth or rough operation. If a slight overlap, takes place at the worn tooth section, rotation will be rough.

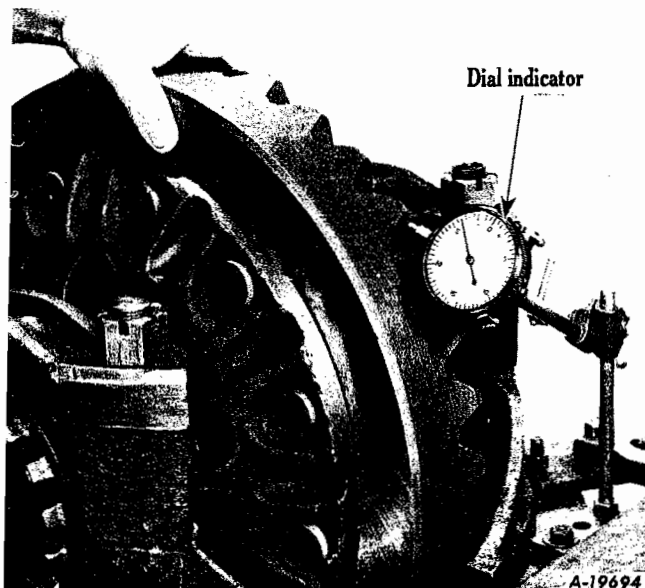


Fig. 8 - Checking gear lash.

When installing new gears, check gear lash with dial indicator (Fig. 8) and adjust to obtain .006" to .012" lash as follows:

1. To move pinion toward gear, remove shims from pack under pinion cage.
2. To move pinion away from gear, add shims under pinion cage.
3. To move gear, tighten or loosen differential bearing adjusting nuts as required.

After correct gear lash is secured, check and adjust as necessary to obtain the correct tooth contact. (See gear Adjustment for correct tooth contact.)

Adjust Differential Bearing Pre-Load

Using dial indicator at back face of ring gear (Fig. 9), adjust to obtain bearing pre-load as follows:

1. Loosen adjusting nut on side opposite gear teeth only enough to notice end play on indicator.
2. Tighten same adjusting nut only enough to obtain .000" end play reading on indicator.

NOTE: While gear is held in .000" end play and before loading bearings, check gear for runout. If runout exceeds .008", remove differential and check for cause.

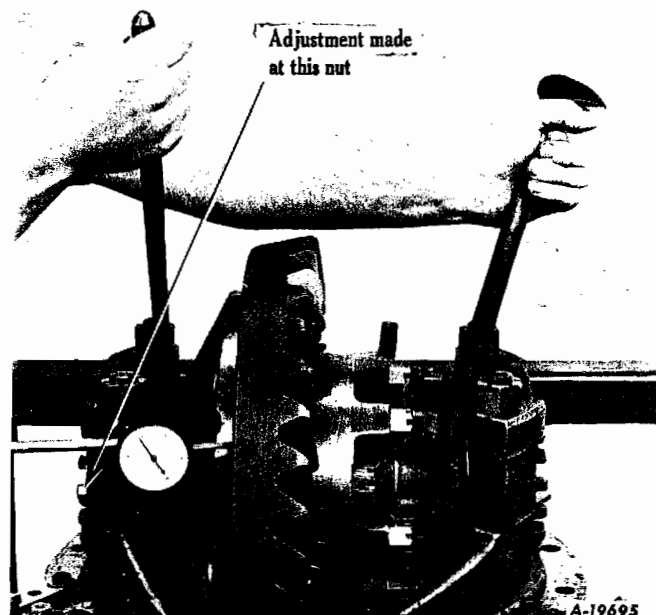


Fig. 9 - Adjusting differential bearing pre-load.



3. Tighten BOTH adjusting nuts one notch each from .000" and play to pre-load differential bearings.
4. Tighten bearing cap stud nuts to specified torque (L-100 and R-100 Axle). (Rear Axle Specifications).
5. Install adjusting nut locks, capscrews and lock wires.

Thrust Block Installation

Turn carrier assembly to bring back face of ring gear facing upward and install the thrust block as follows:

1. Place thrust block on rear face of gear and rotate gear until hole in thrust block is aligned with the adjusting screw hole. NOTE: A light coating of grease placed on the thrust block face will serve to hold the block in position on the rear face of the gear.

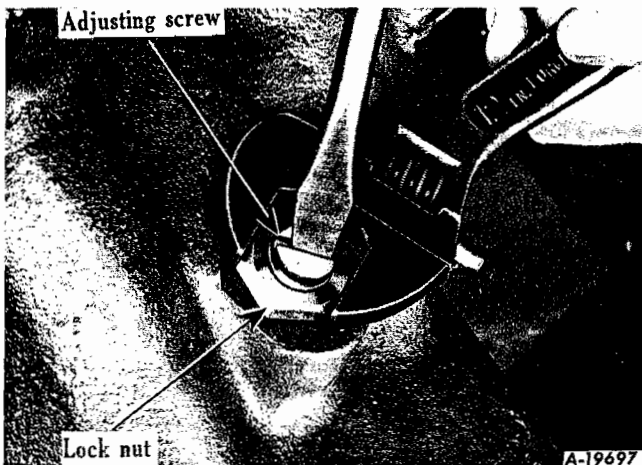


Fig. 10 - Adjusting clearance of thrust block. Turn adjusting screw out of carrier 1/4 turn to obtain .010 to .015 inch clearance.

2. Install adjusting screw and lock nut. Tighten adjusting screw to force thrust block against gear, then back off one quarter (1/4) turn and lock securely with lock nut (Fig. 10). Clearance between back face of gear and thrust block is .010 to .015". CAUTION: Be sure that the adjusting screw end is seated properly in the thrust block hole.

Lubrication

1. Remove inspection and oil filler plug (Fig. 1) and fill to level of plug hole with specified lubricant. Capacity for the R-100 axle is 30 pints (30 lbs.). Capacity of the L-100 axle is 23 pints (23 lbs.).
2. Jack up BOTH rear wheels and operate vehicle in high transmission gear at approximately 25 miles per hour for five minutes to assure proper lubrication of all parts before the unit is put into service.

Both wheels should rotate at approximately the same speed while the vehicle is jacked up. Do not allow one wheel to race faster than the opposite wheel. To do so might cause serious damage to the differential spider and gears.

Use SCL, EP gear oil or a multi-purpose gear lubricant suitable for hypoid axles and supplied by a reputable refinery. SAE-90 for cold climate and SAE-140 for warm climate.



DOUBLE-REDUCTION TWO-SPEED AXLE (TIMKEN 300 SERIES AXLES)

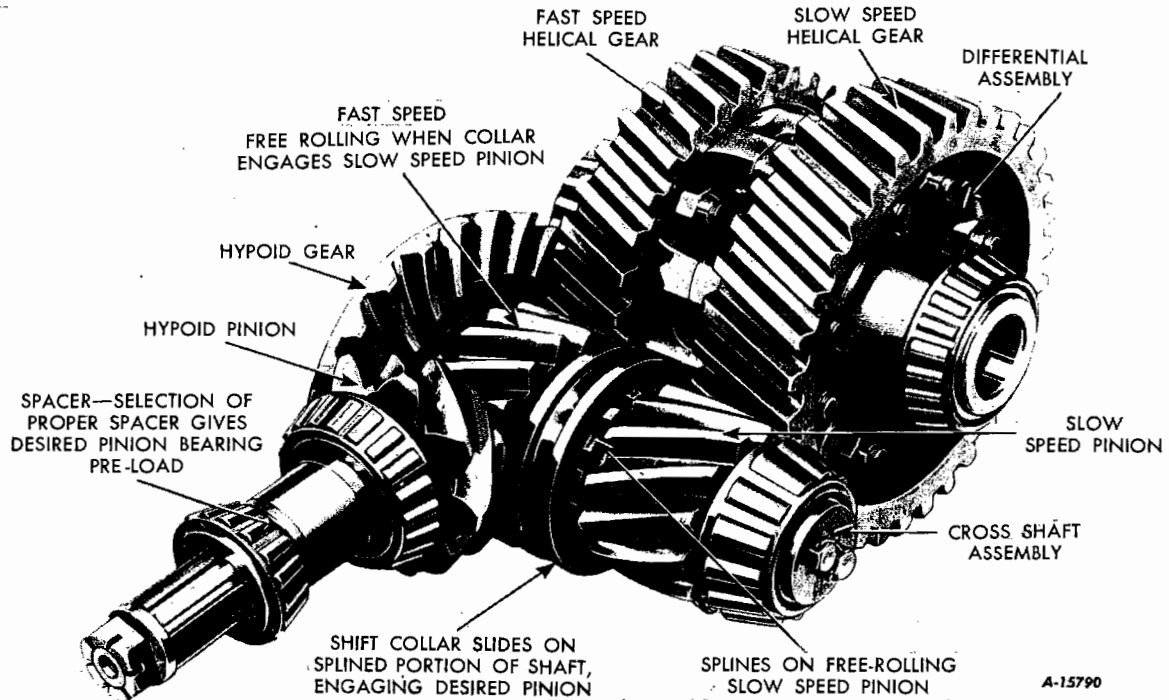


Fig. 1 - Two-speed Double-Reduction Drive Unit

Description

The Timken Two-Speed Double-Reduction Final Drive Differential (Fig. 7) provides two gear ratios--actually two full size final drives in one unit; a "fast" ratio for maximum speed and a "slow" ratio for maximum pulling power. This feature enables the truck driver to use the proper axle gear combination required for speed, load and road conditions.

Operation

The first reduction in the Timken Two-Speed Double Reduction Drive Axle is through a heavy duty hypoid bevel pinion and gear. The hypoid bevel pinion and gear set operates in conjunction with either of two sets of wide-face helical spur gears and pinions of different ratios. This second reduction is selective between a fast or slow ratio.

The bevel pinion is mounted on two tapered roller bearings in a pinion cage. The bevel gear is locked on the cross shaft by a key. The cross shaft is mounted on tapered roller bearings and carries two free-rolling helical spur pinions. Both spur pinions engage helical spur

gears attached to the tapered roller bearing mounted differential.

On the inner side of each of the spur pinions are integral splines. On the cross shaft are two rows of splined teeth. A shift fork, actuated by an electric power shift unit, moves the shift collar on the splined portion of the cross shaft to engage the splines on the fast or slow speed spur pinion. See Fig. 4.

When the fast axle speed is selected and torque released, the shift collar is moved toward the fast speed spur pinion, and at the same time disengages the splines on the slow speed spur pinion. The fast speed spur pinion then revolves as part of the cross shaft to drive the fast speed spur gear. During this operation the slow speed spur pinion is disengaged so as to rotate freely on the cross shaft. Power is transmitted through the hypoid pinion and gear, cross shaft, clutch collar, fast speed spur pinion and gear, differential and axle shafts.

When the slow speed is selected and torque released the shift collar moves in the opposite direction disengaging the fast speed spur pinion and locking the slow speed spur pinion as part of the cross shaft. Power is then transmitted through the slow speed spur pinion and gear, differential and axle shafts.



The design of the shift collar prevents disengagement until the opposite gear ratio is selected and torque released.

Adjustments and Clearances

Various clearance adjustments are provided for both in the axle gearing and shifting mechanism. These adjustments once made, seldom need attention. Where a disassembly job is to be performed, the detailed information found in Shop Talk No. 34 will be most helpful.

Hypoid Pinion and Cage

The pinion and bearings are installed in the pinion cage with a pre-load secured by following the instructions under Pinion Bearing Pre-Load, Sec. A. The pre-load is controlled by proper selection of spacers, or combination of spacers, located between the outer pinion bearing and bearing seat on the pinion shaft (Fig. 1). These spacers are ground to close tolerances and are available in graduated thicknesses. Thicker spacers decrease bearing pre-load and thinner spacer increase bearing pre-load. For correct procedure see pinion bearing adjustment for correct pre-load, Sec. A.

When installing the pinion cage assembly in the differential carrier, be sure that the oil passage holes in the carrier housing, gasket, shim pack and pinion bearing cage are aligned. When the original gears are being reinstalled use the original shim pack plus a new gasket under the pinion cage.

Hypoid Ring Gear and Cross Shaft

The hypoid ring gear is assembled on the cross shaft by pressing the gear firmly against the cross shaft shoulder (Fig. 2). To facilitate

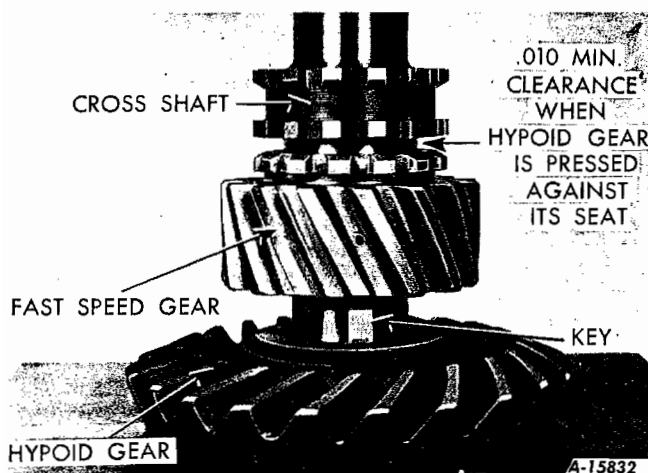


Fig. 2 - Pressing hypoid gear on cross shaft.

installation the gear may be heated to 200 to 250° F. Be sure the key is in line with the key slot in the gear before pressing the gear into place.

The fast speed pinion located between the hypoid ring gear and splined teeth on the cross shaft should have an end play of at least .010". Normal end play will be from .015" minimum to .030" maximum. The slow speed pinion end play must also check to a minimum of .010". The shift collar is installed over the springs and poppets with the longer splines on the inside diameter of the collar toward the hypoid ring gear.

The cross shaft bearing pre-load is measured by wrapping wire around the slow speed pinion and pulling with a scale to a reading of approximately 8 pounds rotating torque (not starting torque), (Fig. 3).

To obtain correct pre-load add or remove shims at shim pack under bearing cage on cross shaft end opposite ring gear. Use original shim packs plus a new gasket when re-installing original gears.

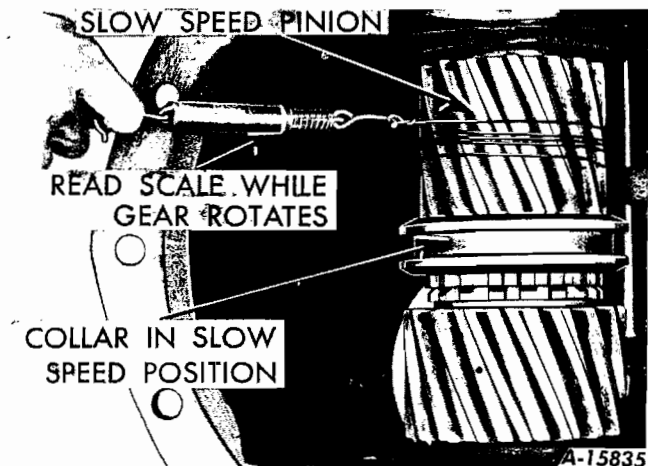


Fig. 3 - Checking cross shaft pre-load.

Gear Tooth Impression and Lash

When the hypoid gear set has been renewed, adjust gear back lash with dial indicator, and adjust to obtain .006" to .012" lash. Movement of the gears is controlled as follows:

1. To move pinion toward ring gear, remove shims from pack under pinion cage.
2. To move pinion away from ring gear, add shims to pack under pinion cage.
3. To move ring gear away from pinion, remove shims from pack under cross shaft bearing cage (side opposite ring gear) and add shims of equal thickness to pack under

cross shaft bearing cage (ring gear side). Shims should be transposed in this manner to maintain the established pre-load.

- To move ring gear toward pinion, remove shims from pack under cross shaft bearing cage (ring gear side) and add shims of equal thickness to pack under cross shaft bearing cage (side opposite ring gear). Shims should be transposed in this manner to maintain the established bearing pre-load.

When correct gear lash is obtained, check and adjust as necessary to obtain correct tooth contact using oiled red lead applied lightly to the ring gear teeth. Gear tooth impression illustrations are shown in Section "A," pages 3 and 4.

Shift Collar Adjustment

The shifting collar serves as the lock between the cross shaft and either the high or the low speed spur pinions. When engaged with either speed spur pinion the collar must be flush against the spur pinion face (Fig. 4). The collar is held flush against the pinions by three spring loaded poppets located in the cross shaft, and unless there is misadjustment in the location or travel of the shifting fork the collar will seat itself against whichever gear is selected.

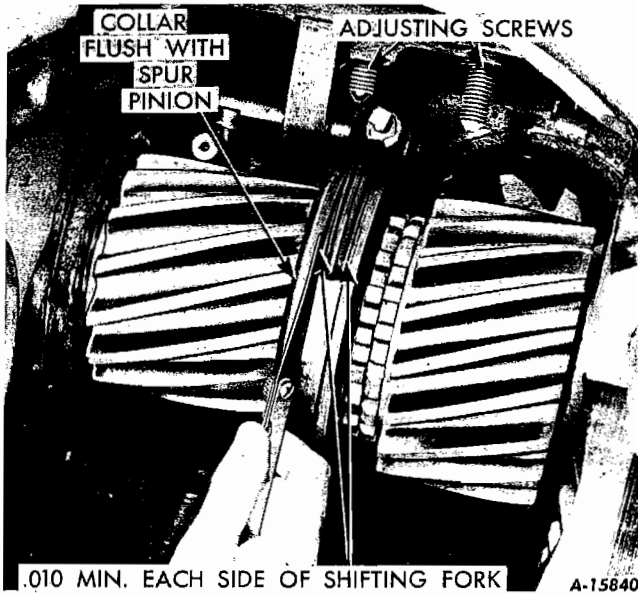


Fig. 4 - Checking clearance between shift collar and spur pinion. Clearance should not be less than .010".

To check the travel of the collar when the differential is mounted on the axle housing it is necessary to remove the pinion cage assembly. Illustrations show details of the checking procedure with the carrier removed from the axle housing and the differential gear assembly removed.

Check clearance of shift fork collar (flat) faces in shift collar with feeler gauge (Fig. 4). The clearance should not be less than .010" minimum on each side of the fork in both the fast and slow speed positions. When checking this clearance the shift collar must be flush with the end face of the spur pinion in both fast and slow positions.

Shims located at the shifting chamber bracket regulate the travel range of the shift rail and fork. Add or remove shims to allow the shift collar to seat flush against the spur pinions in both high and low positions (Fig. 5 & 6). The electric shift chamber and bracket assembly must be removed from the carrier in order to remove shims.

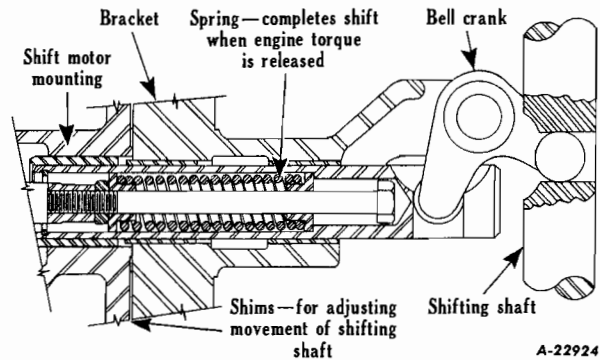


Fig. 5 - Details of front mounted electric shifting mechanism. Note location of shims for travel adjustment.

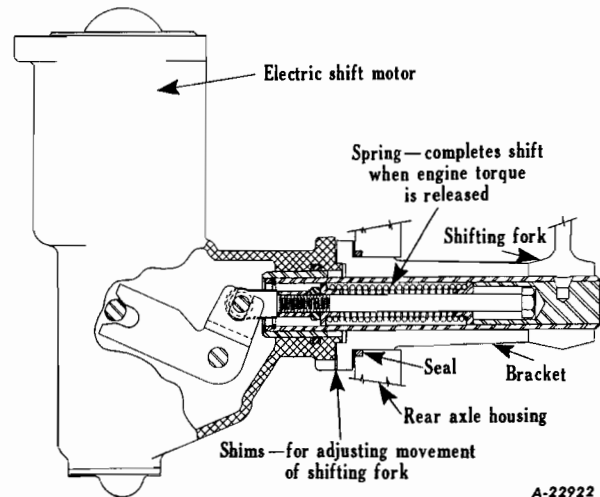


Fig. 6 - Showing details of side mounted electric shift mechanism. Shims are provided to adjust travel of shift fork. Overhaul procedure for the electric shifting unit is given in the Electric Shift Section "H".

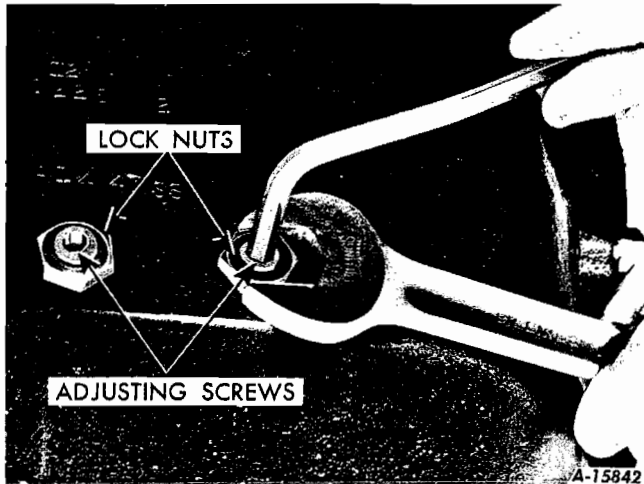


Fig. 7 - Adjusting stop screws to limit travel of shifting fork. Fig. 4 shows point of contact of the screws with the shifting collar.

Adjusting screws located on top of the carrier housing (Fig. 7) provide means of limiting the travel of the shifting fork and rail. Turn in or out on each adjusting screw to stop the travel of the shifting fork so that the fork does not bear against the sides of the shifting collar after the collar is seated flush with the spur pinion face in both high and low positions. There must be a minimum of .010" clearance between the fork and shift collar. This clearance is to assure that the collar is free of shifting fork interference and allows the poppets to hold the collar against either of the spur pinions. Also the .010" minimum clearance is running clearance between the forks and collar sides to prevent unnecessary wear to the two parts.

Differential Adjustment

The differential assembly is installed in the carrier with the helical gears located to provide approximately 1/16" clearance between the helical gear sides and shift collar faces in both the fast and slow speed positions. Move the differential assembly from side to side to obtain this adjustment by turning on the adjusting nuts.

Using dial indicator at the side face of one of the helical gears adjust to no end play (.000" end play), in the differential bearings. Rotate assembly several times to assure normal bearing contact. Tighten adjusting nuts one notch each from .000" end play to secure the correct differential bearing pre-load.

With the dial indicator contacting the side face of the helical gear check for runout. If runout exceeds .008" remove differential and check for cause.

Lubrication

1. Before starting new truck and after overhaul, remove pipe plug at pinion cage and insert one pint of specified lubricant.
2. Fill axle housing to correct level with specified lubricant. Capacity is 18-1/2 quarts (37 lbs.).
3. Jack up BOTH rear wheels and operate vehicle in high transmission gear at approximately 25 miles per hour for five minutes to assure proper lubrication of all parts before the unit is put into service.

Both wheels should rotate at approximately the same speed while the vehicle is jacked up. Do not allow one wheel to race faster than the opposite wheel. To do so might cause serious damage to the differential spider and gears.

Use SCL, EP gear oil or a multi-purpose gear lubricant suitable for hypoid axles and supplied by a reputable refinery. SAE-90 for cold climate and SAE-140 for warm climate.

When reassembling the differential gears, thrust washers, cross shaft spur gears and bearings lubricate the wearing surfaces with a light coat of specified axle lubricant. This will help provide initial lubrication.

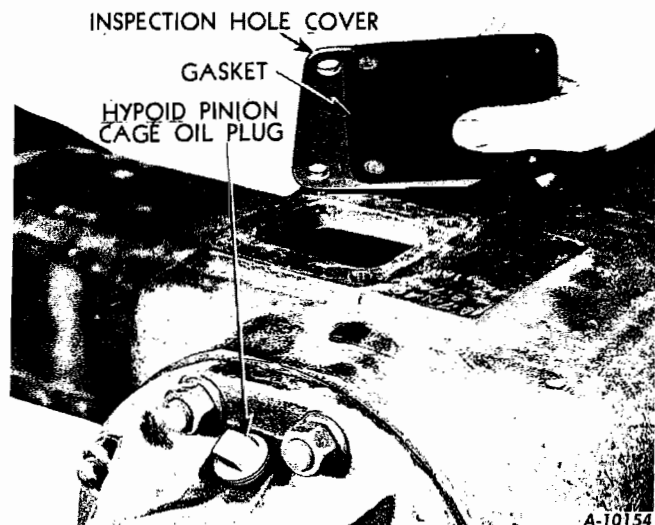


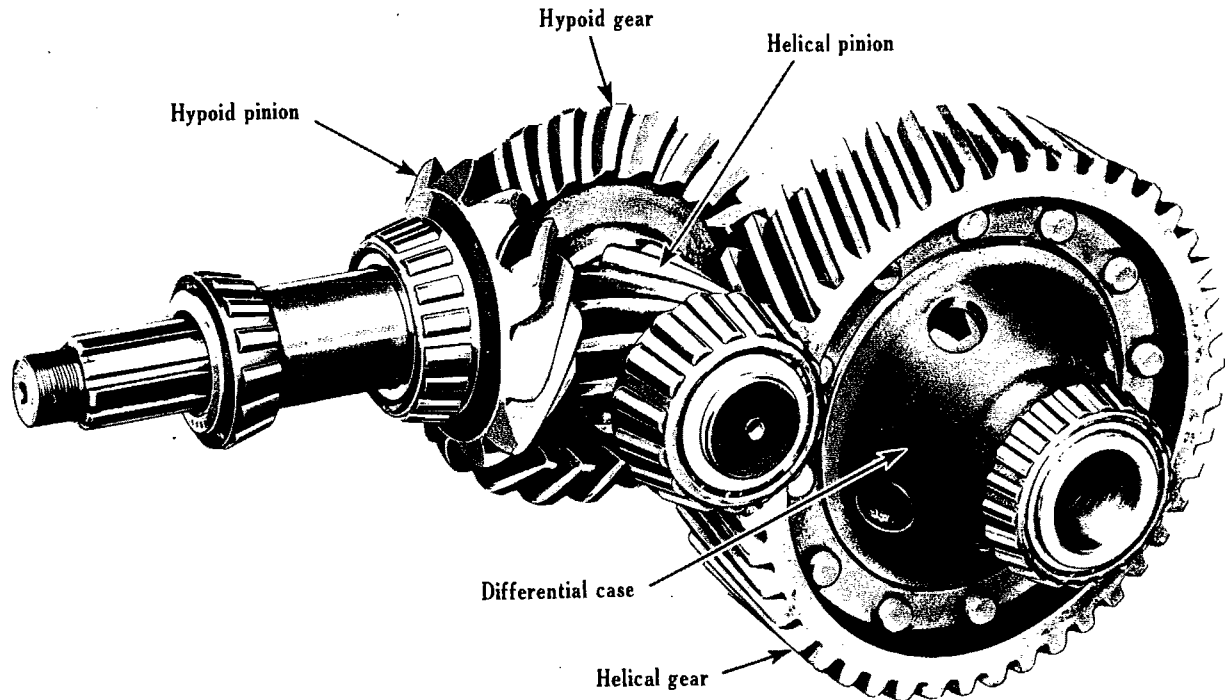
Fig. 8 - Insert one pint of lubricant in pinion cage before starting new truck or after overhaul.

Electric Shift

The electric shift mechanism used on all Timken double-reduction two speed axles is identical with the electric shift used on Eaton two speed axles. For detailed information see Electric Shift Section "H".

DOUBLE-REDUCTION AXLE (TIMKEN 200 SERIES AXLES)

(See Shop Talk No. 25 for complete illustrated disassembly)



A-10067

Fig. 1 - Double-Reduction Drive Unit (Timken).

The Timken S-200-P and U-200-P series double-reduction rear axles (Fig. 1) introduce improvements in design and construction over conventional rear axles for on-highway and off-highway service in heavy-duty motor trucks.

These axles provide increased torque capacity and eliminate the former need, because of specific chassis requirements, for both top-mounted and front-mounted double-reduction final drive units. The differential carrier on the S-200-P and U-200-P axles is mounted at an elevation which is a satisfactory compromise between the two extremes.

The S-200-P and U-200-P rear axles employ the same differential and carrier assemblies. They differ only in that the rear axle housing of the S-200-P is of lighter construction for the S-200-P axle is not intended for off-highway service.

Drive Unit

The drive unit, or differential carrier assembly, is mounted on the sloping front face of the axle housing and is readily removable for periodic inspection. The differential bearing

legs are dowelled in the axle housing to eliminate deflection under torque load.

Pinion Shaft Location

The pinion shaft is located at an elevation midway between that used on the front-mounted type axles, where the pinion shaft is on the axle center line, and that used on the top-mounted type axles, where the pinion shaft is considerably above the axle center line (Fig. 1).

Final Drive

The final gear-drive consists of a large diameter hypoid bevel gear and bevel pinion for the first reduction, and a wide-faced helical gear and helical pinion for the second reduction.

A range of gear ratios is available to meet all operating requirements. (See Specifications.)

Axle Housing

The axle housings in both axles are similar in design, although the U-200-P axle housing has larger sections to produce its greater load carrying capacity.



Differential

The differential assembly of this axle consists of four 9-tooth pinions mounted on a spider and two 16-tooth side gears all assembled into the differential case, both halves of which are identical.

Hardened-steel thrust washers are installed between the side gears and the case and between the pinions and the case. The large helical gear is mounted between the differential case halves and the assembly is held together by twelve rivets. The differential assembly is mounted in tapered roller bearings.

Oil Seals

The rear wheel outer oil seal is illustrated in Fig. 2. This is the latest type oil seal assembly and when installing this seal, be sure to cement the new cork gasket to the inner flange of the new wiper ring.

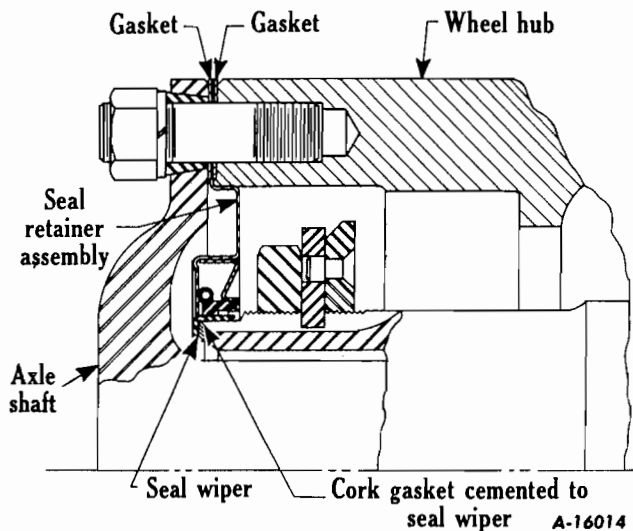


Fig. 2 - Illustrates sectional view of seal installed.

The seal wiper and cork gasket are pressed over the end of the axle tube. Be careful not to bend or damage the seal wiper when installing. (Fig. 3).

The seal retainer assembly is placed over the axle flange studs, as shown in Fig. 4, using a gasket on both sides of the seal retainer assembly.

The rear wheel inner seal construction is illustrated in Fig. 5. Before installing the inner seal, check the location of the bearing and oil seal spacer to be certain that the seal lip on the oil seal assembly faces toward the oil seal wiper ring in the wheel hub, as shown.

Special adapters should be used in seal installation as described in Service Bulletin B-97-1946 and Addendum No. 1.

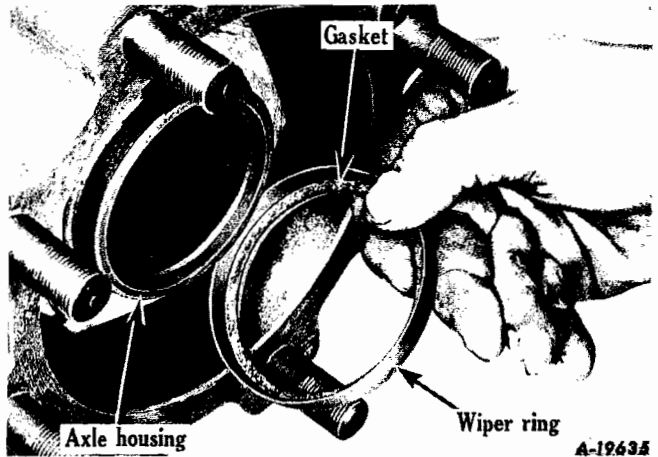


Fig. 3 - Illustrates wiper ring and gasket.

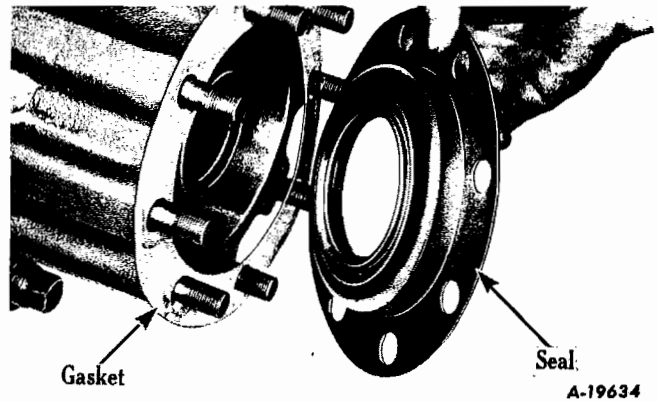


Fig. 4

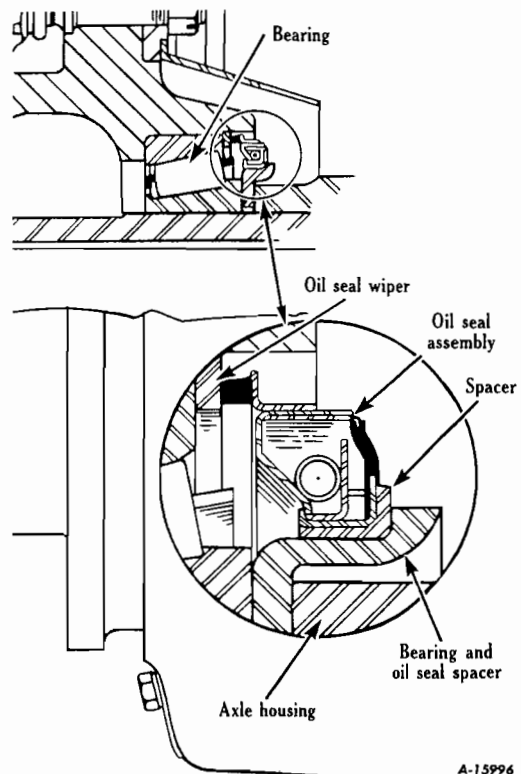


Fig. 5 - Rear wheel inner seal.



Lubrication

1. Before starting new truck and after overhaul, remove pipe plug at pinion cage and insert one pint of specified lubricant.
2. Fill axle housing to correct level with specified lubricant. The various axle capacities are found in Lubrication Section.
3. Jack up BOTH rear wheel and operate vehicle in high transmission gear at approximately 25 miles per hour for five minutes to assure proper lubrication of all parts before the unit is put into service.

Both wheels should rotate at approximately the same speed while the vehicle is jacked up. Do not allow one wheel to race faster than the opposite wheel. To do so might cause serious damage to the differential spider and gears.

Use SCL, EP gear oil or a multi-purpose gear lubricant suitable for hypoid axles and supplied by a reputable refinery. SAE-90 for cold climate and SAE-140 for warm climate.

Hypoid Pinion and Cage

The pinion and bearings are installed in the pinion cage with a pre-load as indicated in Rear Axle Specifications for these axles. The pre-load is controlled by proper selection of spacers, or combination of spacers, located between the outer pinion bearing and bearing seat on the pinion shaft. These spacers are ground to close tolerances and are available in graduated thicknesses. Thicker spacers decrease bearing pre-load and thinner spacers increase bearing pre-load. For correct procedure, see Pinion Bearing Adjustment for correct pre-load, Section "A", page 6.

When installing the pinion cage assembly in the differential carrier, be sure that the oil passage holes in the carrier housing, gasket shim pack and pinion bearing cage are aligned. When the original gears are being reinstalled use the original shim pack plus a new gasket under the pinion cage.

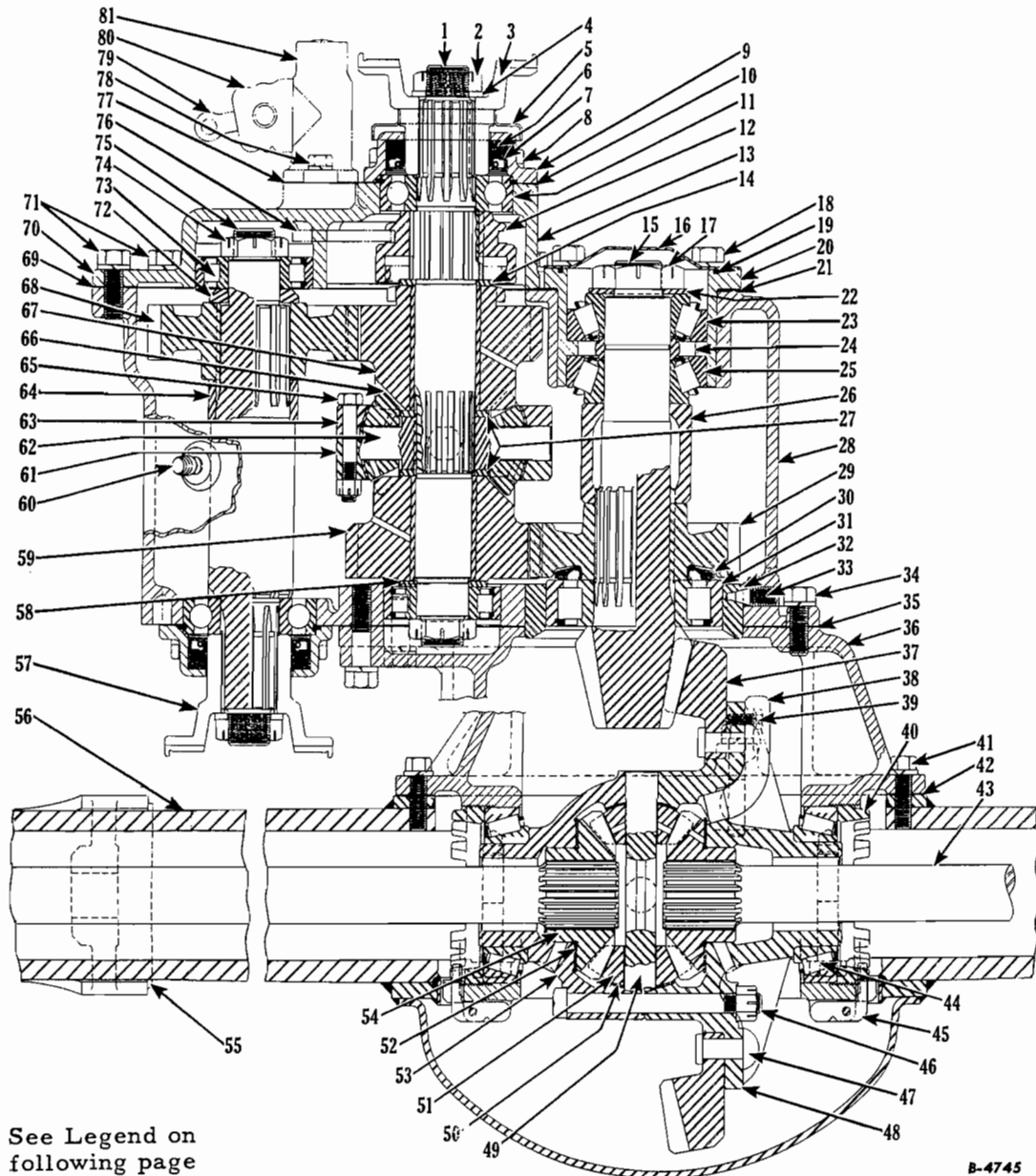
Helical Gear Shaft (Cross Shaft)

The helical gear or cross shaft is mounted at right angles to the hypoid pinion shaft in the carrier housing. This shaft is a one-piece steel forging consisting of an integral helical drive pinion gear in the center. The hypoid ring gear is aligned with key in shaft before pressing gear onto shaft.

To remove the cross shaft, it is necessary to first remove the differential and helical ring gear assembly; second, withdraw the hypoid ring gear when being removed. (Do not remove universal joint flange.) Then remove both bearing cages, move shaft enough to allow bearing at ring gear end of shaft to clear the carrier housing and tilt shaft to rear for removal from carrier.

The correct bearing pre-load is obtained by adding or removing shims at shim pack under the cross shaft bearing cage at end opposite hypoid ring gear. Use original shim pack plus a new gasket when reinstalling original gears. To measure correct bearing pre-load, follow method outlined for Timken Double-Reduction Two-Speed Axles, Section E, Fig. 3.

TANDEM AXLES



See Legend on following page

B-4745

Fig. 1 - Details of axle mounted power divider mounted on forward rear axle.

AXLES--RF-1475, RF-1575, RF-1685. FOUR-WHEEL, AXLE-MOUNTED POWER DIVIDER

The above axles have a power divider built as an integral part of the differential assembly. This results in a more simplified tandem axle design, with less moving parts. The compactness of the combined power divider and differential makes possible the use of fewer propeller shafts and eliminates the need for a propeller shaft hanger at the rear of the vehicle. The

power from the engine is delivered through the transmission (and auxiliary transmission where the truck is so equipped) to the power divider which, as the name implies, divides the power between the two axles. A differential unit is included in the power divider to compensate for the difference in speeds between the two axles. This difference in axle speeds is brought about by wheels slipping on either of the axles or slightly different tire diameter due to tire wear. (Both rear axles on six-wheel (6x4) trucks have the same axle differential ratio.)



Legend For Fig. 1

- | | |
|--|---|
| 1. Mainshaft. | 42. Differential carrier to axle housing mounting gasket. |
| *2. Companion flange retaining nut. | 43. Axle shaft. |
| 3. Companion flange. | 44. Differential carrier bearing. |
| *4. Thrust washer. | 45. Adjuster lock. |
| 5. Slinger. | 46. Differential case bolt and nut. |
| 6. Felt. | 47. Bevel ring gear rivet. |
| 7. Oil seal. | 48. Differential case, flange half. |
| 8. Bearing cover retaining nut. | 49. Differential spider. |
| 9. Bearing cover. | 50. Differential spider pinion gear thrust washer. |
| 10. Bearing cover gasket. | 51. Differential spider pinion gear. |
| 11. Mainshaft bearing, front. | 52. Differential case, plain half. |
| 12. Differential lock. | 53. Differential side gear thrust washer. |
| 13. Transfer case cover. | 54. Differential side gear. |
| 14. Thrust washer. | 55. Axle torque arm. |
| 15. Forward axle bevel pinion shaft. | 56. Axle housing. |
| 16. Pinion bearing cage cover. | 57. Rear-rear axle drive shaft companion flange. |
| 17. Outer pinion bearing nut. | 58. Rear helical and side gear thrust washer. |
| 18. Pinion bearing cage capscrew. | 59. Rear helical and side gear. |
| 19. Pinion bearing cage cover seal. | 60. Breather. |
| 20. Pinion bearing cage. | 61. Differential case (male). |
| 21. Shims. | 62. Differential spider. |
| 22. Thrust washer. | 63. Differential case (female). |
| 23. Pinion bearing, outer. | 64. Rear-rear axle helical drive gear. |
| 24. Pinion bearing spacer. | 65. Differential case bolts. |
| 25. Pinion bearing, inner. | 66. Differential spider pinion gear. |
| 26. Spacer. | 67. Front helical and side gear. |
| 27. Differential spider thrust washers, power divider. | 68. Rear-rear axle helical drive gear. |
| 28. Transfer case. | 69. Transfer case cover mounting gasket. |
| 29. Forward axle helical drive gear. | 70. Transfer case cover. |
| 30. Oil seal assembly. | 71. Transfer case cover mounting capscrews. |
| 31. Pinion bearing. | 72. Thrust washer. |
| 32. Pinion bearing sleeve. | 73. Drive shaft bearing, inner. |
| 33. Pinion bearing sleeve set screw. | 74. Drive shaft nut, inner end. |
| 34. Power divider to differential carrier mounting capscrew. | 75. Rear-rear axle drive shaft. |
| 35. Power divider to differential carrier mounting gasket. | 76. Shifter fork. |
| 36. Differential carrier. | 77. Shift fork bracket mounting gasket. |
| 37. Bevel ring gear. | 78. Shift fork bracket retaining capscrew. |
| 38. Differential lubricator. | 79. Shift fork lever. |
| 39. Differential lubricator retaining capscrew. | 80. Shift fork lever boot. |
| 40. Differential carrier bearing adjuster. | 81. Shift fork bracket. |
| 41. Differential carrier mounting capscrew. | |

* Rear-rear axle drive shaft outer bearing cover assembly, flange nut and thrust washer are identical with the units on outer end of mainshaft.

NOTE: Rear-rear axle drive shaft inner bearing (73) and nut (74) are identical with mainshaft inner bearing and nut.

A differential lock is available for the power divider. This locking arrangement is used to lock both the front rear and rear rear axles together and is generally used when the vehicle is operating in mud, snow or off the highway.

CAUTION: The differential must not be held in the locked position longer than necessary. Driving the vehicle on improved or paved roads with the differential lock engaged will subject the axles and gears to unnecessary strain. The differential lock shift fork is spring loaded and automatically releases the lock when shift lever is released by operator.



DISASSEMBLY OF POWER DIVIDER (AXLE MOUNTED)

To disassemble the power divider, proceed as outlined in the following steps:

1. Remove nine power divider to differential carrier mounting capscrews and lift off the power divider. Be sure mounting gasket is also removed.
2. Place power divider in a transmission stand or other suitable fixture and remove the four pinion bearing cage mounting capscrews and remove pinion shaft cover.
3. Remove self-locking setscrew in the transfer case to release pinion bearing sleeve.
4. Remove pinion shaft outer bearing nut and using a soft hammer, tap end of shaft to release pinion bearing sleeve and bearing from housing. Withdraw pinion shaft assembly from transfer case. Complete disassembly of shaft by removing inner pinion bearing, spacer, front axle helical drive gear and pinion bearing.
5. Remove pinion bearing cage from transfer case.
6. Remove mainshaft bearing retainer nut inner end.
7. Remove companion flange mounting nut, and using a suitable puller, remove companion flange and slinger assembly.
8. Remove four bearing cover capscrews and lift off bearing cover.
9. Using a bronze bar, drive inner end of mainshaft until shaft passes through rear helical and side gear and thrust washer. This gear and washer can now be removed through pinion bearing sleeve opening in transfer case.
10. Continue pushing mainshaft toward front of transfer case until differential case assembly and thrust washers are free of shaft. Differential case will also pass through pinion bearing sleeve opening in case. Mark differential case halves so original assembly can be duplicated. Keep differential spider thrust washers with differential case to assure correct reassembly.
11. Withdraw mainshaft all the way. Front helical and side gear, thrust washer and differential lock (where power divider is so equipped) can now be removed through pinion bearing sleeve opening.
12. Using a suitable puller, remove both front and rear mainshaft bearings. This completes disassembly of mainshaft.
13. Remove the nine transfer case cover retainer screws. Carefully remove cover so as not to damage cover or gasket face of transfer case, as cover must be removed from front bearing of rear rear axle drive shaft.
14. Remove nut at front end of rear rear axle drive shaft. The companion flange at rear of shaft should be used to hold shaft while removing nut.
15. Remove companion flange retaining nut and flange at rear of rear rear axle drive shaft. Remove companion flange with suitable puller.
16. Remove the four bearing cover retaining capscrews and remove bearing cover.
17. Remove bearing at front end of rear rear axle drive shaft using a suitable puller. Also remove helical gear retaining washers.
18. Tap front end of rear rear axle drive shaft with a soft hammer to remove helical drive gear and spacer. This action will also drive the rear bearing out of case so that the shaft may now be lifted out.
19. Place rear rear axle drive shaft in vice having soft jaws and pull the rear bearing off the shaft.

The power divider is now completely disassembled. Place all parts in a cleaning solution to remove all dirt and sludge deposits. Be sure transfer case is free of any loose metal particles. Carefully inspect all parts and replace any that are doubtful as to further satisfactory serviceability.

To reassemble the power divider, the exact reverse procedure as outlined for disassembly should be used. However, it is advisable to observe the following precautions:

Be sure all sealing surfaces are free of nicks and that the old gasket material has been completely removed. NOTE: The transfer case to differential carrier mounting gasket is .008" thick.

The differential case was marked as to forward side and also for correct reassembly of the two case halves. It is of utmost importance that the eight differential case mounting bolts be so installed that the bolt heads are also on forward side of differential assembly after installation in power divider. NOTE: Female half of differential case should be forward.



To secure the pinion bearing pre-load reading specified in the Rear Axle Specifications for this model axle, see Pinion Bearing Adjustment for Correct pre-load. Make a bench assembly of bevel pinion shaft, bearings, spacers and pinion bearing cage. Place all parts in the same position as in the final assembly. The pinion shaft assembly may now be placed in the press shown in Fig. 2. After the correct pinion bearing pre-load reading has been secured remove outer pinion bearing and pinion bearing cage only. The pinion shaft is now ready for installation. Complete assembly of pinion shaft to transfer case by inserting pinion shaft through pinion bearing sleeve opening until sleeve is in correct position. Install pinion bearing cage, outer pinion bearing, thrust washer and nut. Do not fail to install pinion bearing sleeve set screw after the cone center and back lash adjustments have been made. Use a new bearing cage cover oil seal when completing assembly.

After the correct pinion bearing pre-load has been obtained, mount power divider on differential carrier. The pinion cone center adjustment may now be made. Follow procedure set forth under SE-1065 Pinion Setting Gauge. Bear in mind the adjustment of the bevel pinion is controlled by means of a shim pack under the pinion bearing cage at forward side of power divider. The differential assembly may now be completed and the bevel ring gear adjusted for back lash -- as marked on outer rim of ring gear. Be sure to obtain a tooth contact pattern as outlined under General Rear Axle Hypoid Pinion and Ring Gear Adjustment Point Impression Method.

The differential carrier and power divider assembly is now complete and ready for installation in forward rear axle housing. Use a new differential carrier mounting gasket.

Center Cross Bar

The assembly of the center cross bar and saddle is shown in Fig. 2. The sleeve is located in the saddle and is locked in place by two thru-bolts. Inside the steel sleeve there is a center cross bar, which must rotate freely in the sleeve. In the LF-170 the center cross bar is solid steel and on the LF-190 and LF-210 it is a steel tube. In removing the tube or cross bar, it is first necessary to jack up the rear end of the truck, remove the spring shackle pins, remove the two equalizer beam end bolts, then remove the saddle, equalizer beam and the springs. The tube or cross bar is then removed from the supporting sleeve.

Equalizing Beam Ends

Equalizing beam end construction is shown in Fig. 3. The beam end ball is supported in a two-piece bronze socket which is pressed into the beam end. Lock bolts prevent the sockets

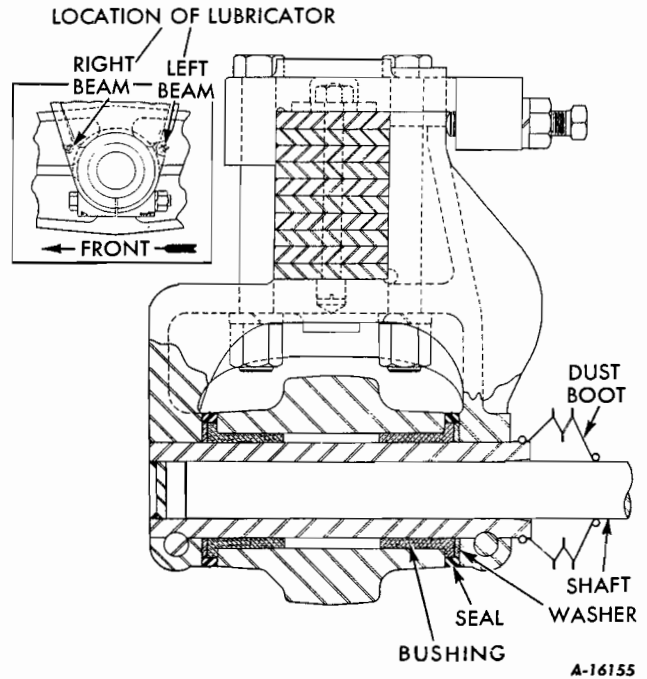


Fig. 2

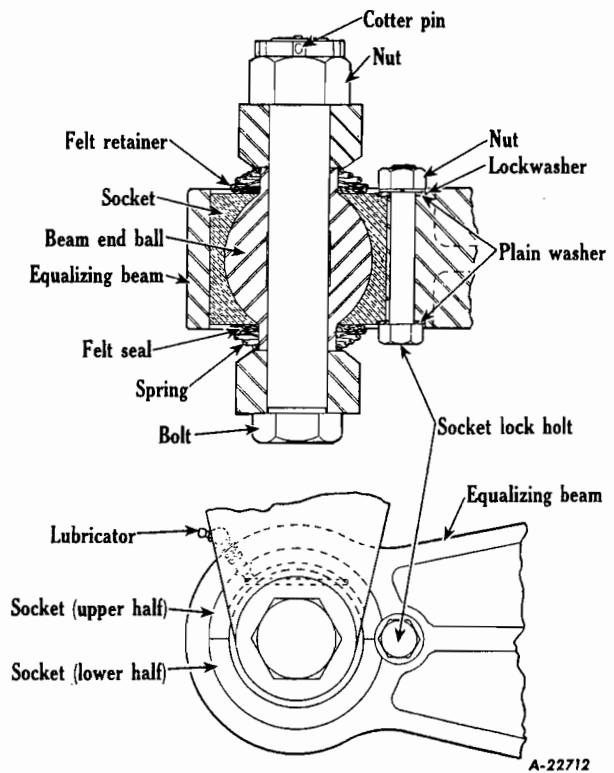


Fig. 3

from moving and felt seals with spring retainers are used to guard against leakage of lubricant and entrance of dirt.

When replacing a socket or ball, assemble both halves of the socket to the ball and press the assembly into the beam end. Make sure that the grease hole in the socket indexes with the lubricator hole in the beam end - **THIS IS VERY IMPORTANT**. Both sides of the socket must be counterbored flush with counterbore in beam so that the socket lock bolt and plain washers will prevent the socket from shifting.

Install felt seals and spring retainers before assembling the beam end to the bracket. The beam end bolt nut should be drawn up as tight as possible and securely locked with a cotter pin.

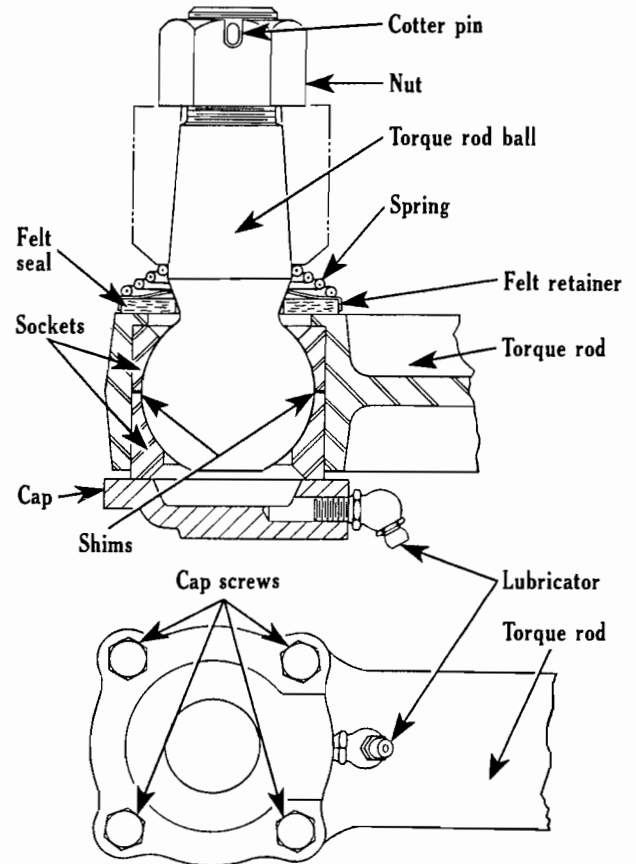
Torque Rods

Figure 4 illustrates the torque rod end assembly used on six-wheel L-line models. Shims are used between the ball sockets to provide proper adjustment.

To disassemble, remove the torque rod ball cap, then tap the torque rod near the bronze socket and the lower half of the socket will slip out. The ball stud nut should then be removed and the ball stud driven out of torque rod.

Reassembly is accomplished in the reverse manner. Press upper half of ball socket into torque rod and insert ball stud. Install shims (approximately .035") and insert lower half of socket. Assemble cap and tighten securely. Check movement of ball stud, using a piece of tubing about 16" long as a lever. If ball stud moves too freely, remove a .005" shim, and if too tightly, add another .005" shim. Only a slight drag should be felt.

NOTE: Be sure that the felt seal retainer and spring are replaced to prevent leakage of grease and entrance of dirt.



A-22729

Fig. 4

ELECTRIC SHIFT (EATON) USED ON EATON AND TIMKEN TWO-SPEED AXLES

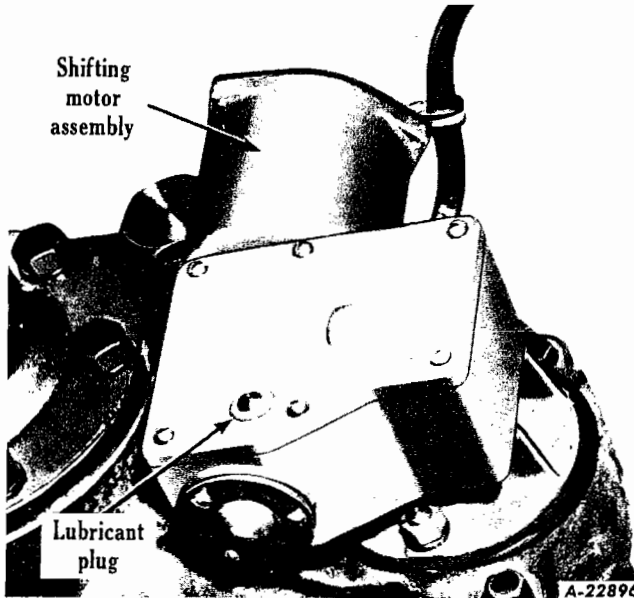


Fig. 1 - Electric Shift Unit. Mounted on two speed axle.

Description

The electric shift device consists, in the main, of an electrically operated shifting fork and shifting unit located on the two-speed axle (Fig. 1). The shift fork is activated by a two-directional coil spring and lever assembly (Figs. 6 and 7). The purpose of this spring and lever assembly is to move the shiftfork quickly into the high or low speed position when gear load is momentarily removed from the differential.

The actual shifting or gear movement is performed by the coil spring located in the housing of the electric shift unit. The coil spring which performs the shift must be placed under tension or in a loaded state before gear shift can be accomplished. This is provided for by a reversible electric motor which drives a power screw which in turn actuates a drive nut in either direction. Trunnions on either side of the drive nut engage slots in the spring lever. Movement of the lever in either direction energizes the spring which performs the shifting movement.

The control of the electric shift unit is by means of a two-way switch located on the transmission gear shift lever (Figs. 2, 3 and 4). Moving control button up or down causes motor at axle shift unit to rotate in either direction. A limit switch located in the electric shift unit

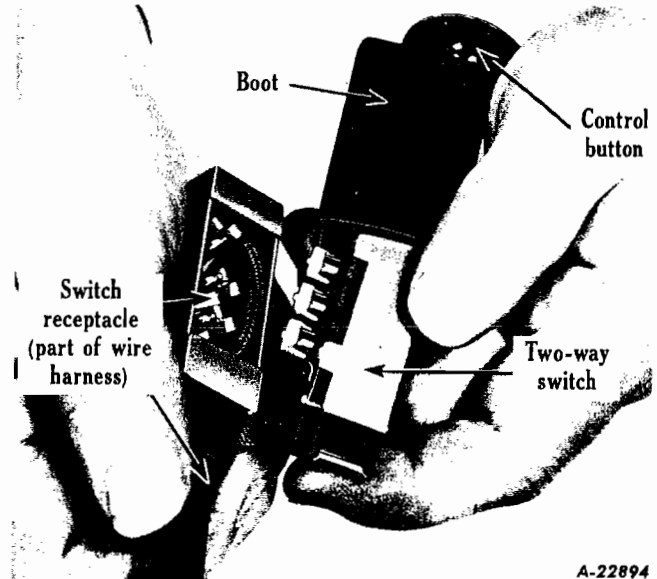


Fig. 2 - Electric Shift Unit Two Way Control Switch

(Figs. 3 and 6) opens the circuit and stops the motor when the shifting spring is fully energized. Any time thereafter, the shift is completed by the energy of the spring when torque is momentarily released from the differential gears either by releasing the clutch or closing the throttle.

A two-speed adapter electrically operated is located at the speedometer and is wired in series with the ignition switch (Figs. 2, 3 and 5). The balance of the electrical circuit is also wired in series with the ignition switch, thereby preventing any closed electrical circuits in the system when the truck is idle and the ignition switch is turned to the "OFF" position.

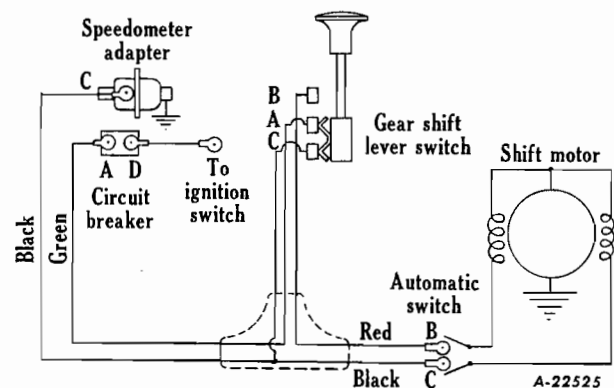


Fig. 3 - Electric Shift Circuit Diagram

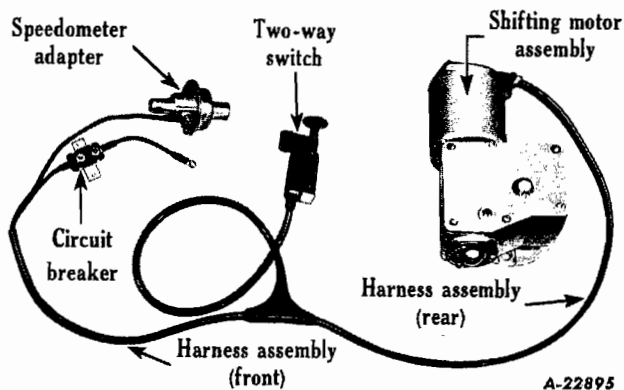


Fig. 4 - Illustration Of Electric Shift Parts

The system is further protected by a self-resetting circuit breaker which becomes operative when normal current flow continues for a period longer than is required to complete a shift, or in case of an overload or direct short.

Details of the various units of the "Electric Shift" their function, and the servicing of each follows:

The switch (Fig. 2) with which the operator controls the axle is located on the transmission gear shift lever.

This control switch has two positions -- up and down. Three wires are connected to the switch. When the selector button of the switch is up, the battery wire (A -- Fig. 3) is connected to wire (B -- Fig. 3) leading to one field of the motor in the axle shift unit proper.

When the button is down, the battery wire is connected to wire (C -- Fig. 3) leading to the other field of the axle shift unit motor and also to the speedometer adapter.

As shown in Fig. 2, the control switch is connected to the harness or wiring system by plugging into the three-pronged connector which is part of the harness. The switch is removable by slipping the rubber boot up to the knob and pulling apart.

Wiring System

The wiring system or harness as shown in Fig. 3 has four terminals. Two of them (b) and (c) in a double line run to the axle shift unit on the axle. Of these the longer red one is connected to the bottom terminal, and the shorter black one is connected to the top terminal. The short single black wire (c) is connected to the speedometer adapter and the green wire (a) is connected to the circuit breaker. Wire (d) connects the copper stud of the circuit breaker to the cold side of the ignition switch. The

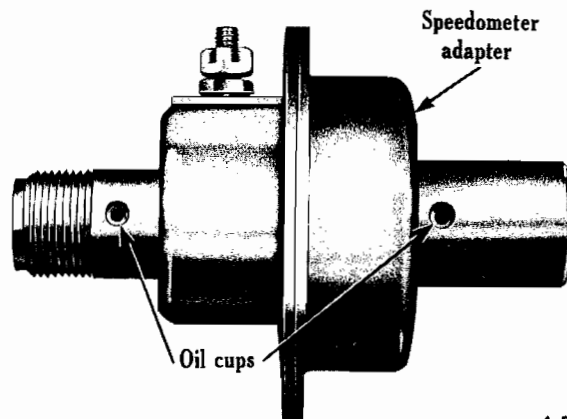


Fig. 5 - Speedometer Two-Speed Adapter

circuit breaker protects the system in the event of a short circuit. Should a short circuit occur, it will open the circuit until the trouble has been corrected.

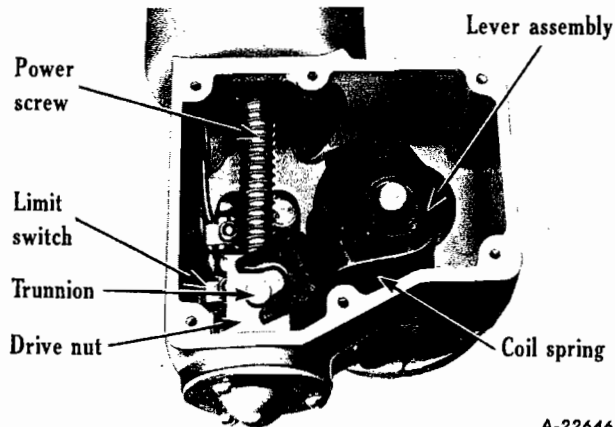
Speedometer Adapter

The speedometer adapter (Fig. 5) compensates for variations in the speed of the drive shaft between high and low-speed range of the axle.

This adapter is held in the high range by a spring and in the low range by an electro magnet. The inner mechanism is lubricated and sealed for life, but the two shaft ends should occasionally receive a small amount of light oil at the oil-wick cups.

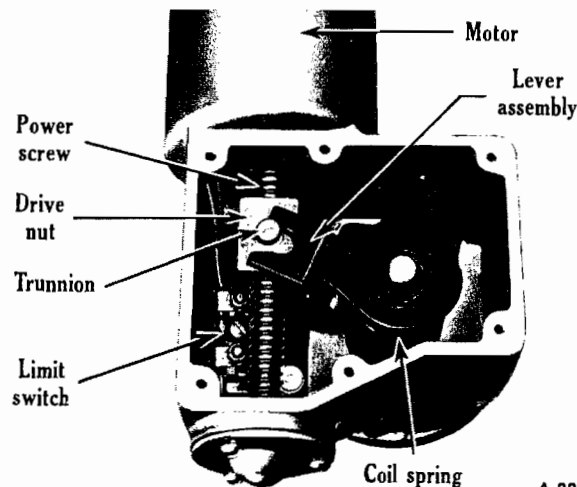
Axle Shift Unit

This unit shifts the axle into high or low-range. Fig. 6 shows the axle shift unit in the high range of the axle. In this position wire (b) (Fig. 3) carries current to one field of the motor (6) (See Fig. 20 for Part Identification) so that the armature and drive screw (20) turn in a clockwise direction and move the nut down. When the nut has traveled a sufficient distance to wind the spring (23), a contact bumper on the nut breaks an electrical connection on the automatic switch (17) so that the motor is no longer energized and the armature stops rotating. To make sure that the nut cannot travel back on the screw due to vibration, a ball screw detent spring (Fig. 12) mounted on the cover (26) holds the nut at the end of its travel on the screw. The nut moves the spring winding lever (24) down which pivoting on the pin (21), winds the torsion spring (23) for high. Thus an increased load is put on the spring, and in this position the axle is ready to snap into the high speed ratio as soon as the load on the axle gears is relieved. The torsion spring is assembled in the unit so that it is under 45 to 65 pounds pressure, depending on the size of the axle. When the spring winding lever is moved so that the spring is wound, the pressure



A-22646

Fig. 6 - Axle Shift Unit In High-Range Position



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Fig. 7 - Axle Shift Unit In Low-Range Position

of the spring is raised to from 90 to 135 pounds again depending on axle size.

This additional means is used to shift the axle, and when the shift is completed, the ends of the spring come together leaving the original tension of 45 to 65 pounds on the spring. This preload tension holds the axle in either gear.

Shift To Low

When the button is pushed down, the motor is energized so that the screw moves counter clockwise and the nut travels to the top winding the spring for a shift to low in the same manner as before.

SERVICE AND TROUBLE SHOOTING

General Information

If the electric shift should fail to operate properly, the trouble should first be located. A very handy tool for this is a test light consisting of a light bulb, either 6 or 12 volts, depending on the electrical system of the truck, with two wires a few feet long and small battery clips on the ends. Refer now to the wiring diagram Fig. 3 and first connect the test light to Point (d) on the circuit breaker under the dash or hood, depending on the test light to ground. Turn on ignition switch, or accessory switch in the case of a diesel, and the light should show. If it fails to light at this point, there is a poor connection or broken wire between the ignition switch and circuit breaker. Next connect test light to Point (a) on the circuit breaker -- Fig. 3 -- and again the light should show. If it fails to show immediately, watch the light carefully and listen to the circuit breaker for a minute to see if it is flashing off and on. The light should stay on continuously at this point. If it flashes off and on, or you hear the breaker clicking, it indicates that too much current is flowing and the circuit breaker is opening. This is due either to a short circuit, or the motor in the shift unit not being free to run. To determine which of these it is, remove the two wires (b) and (c) from the axle shift unit and recheck. If the light still flashes off and on or you still hear the breaker clicking, it is due to a short in the harness, but if the light now stays on continuously the trouble is in the shaft unit.

If there is no light at all at this point and the circuit breaker cannot be heard clicking, disconnect the green wire from terminal (a) Fig. 3 and again clip the test light to terminal (a) post on the circuit breaker. If the light fails to show here and did show on terminal (d) the circuit breaker is bad and should be replaced.

If the test light glowed normally at point (a), next remove the two wires (b) and (c) from the axle shift unit and connect a test light wire to one of these wires and the other test light wire to ground. The red shift unit wire should light the light only in high gear or up position on the gear shift lever switch and the black wire should light the light only in the low gear or down position of the gear shift lever switch. If the light fails to glow in either of the above tests, it indicates a broken circuit in the harness or gear shift lever switch. If both wires light the test light in one position of the gear shift lever switch, it indicates a short circuit in the harness or gear shift lever switch.

Next connect the test light to the speedometer adapter terminal (c) and ground. Here



the light should glow in the low gear or down position of the gear shift lever switch only. If it fails to glow, it indicates a broken circuit in the harness or gear shift lever switch.

These checks above will quickly locate the trouble. When checking the harness for short or open circuits, watch for broken insulation and do not overlook the gear shift lever switch which can best be tested by substituting a new one in its place.

If the vehicle shifts normally but the speedometer adapter fails to operate properly make the above check with the test light to see if it is getting current in the low range and if it is, replace the adapter. When the trouble has been traced to the shift unit, disassemble as shown under disassembly and inspect the parts carefully. All parts can be washed in cleaning solvent except the motor.

When inspecting the parts, most failures will be readily apparent; however, a few assemblies should be checked as follows:

Automatic Switch

The automatic switch (17) Fig. 20 (serviced only as an assembly) should have clean, free moving points which close firmly under spring tension.

Drive Screw

The drive screw (20) Fig. 20 (serviced only as an assembly) should turn freely by rotating the screw while holding the nut. When the nut gets to the end of the screw, the screw can continue to turn but the nut should not jam or run off the end. By turning the screw in the opposite direction, the nut will go to the other end and stop as before while the screw can continue to be turned.

The fiber bumper in the nut should be a tight press fit. Be sure in assembly that this fiber bumper is in toward the switch.

Motor

The motor (6) Fig. 20 (serviced only as an assembly) is reversible so that with the motor housing connected to one battery terminal and either one of the two motor wires connected to the other battery terminal, the motor will run in one direction. With the other motor wire connected to the battery, the motor will run in the opposite direction. The motor has a stall torque of approximately 6" lbs. The way to check this motor is to put a small crescent wrench on the rectangular drive on the armature shaft. Hold the wrench in one hand, hold the motor itself firmly in the other hand or in a vise and then connect one motor wire to a battery terminal and connect the motor housing

to the other battery terminal. The wrench should then tend to turn with a torque or pull of about 6" lbs. Allow the wrench to turn very slowly, making sure that this pull or torque is present the full 360° turn of the wrench. If one armature winding of the motor is burned out, this torque will disappear for a small part of the 360°. While making this test, care should be taken not to overheat the motor. This motor is lubricated and sealed for life.

Rubber Diaphragm

The rubber diaphragm between the shift unit and the carrier assembly, which can be seen in Fig. 8 under disassembly, should be in good condition and a tight fit over the shift fork. This diaphragm seals off axle lubricant from the shift unit.

NOTE: During reassembly, extreme care should be taken not to allow any dirt to enter the axle shift unit.

For correct positioning of diaphragm refer to lettering printed on its face.

Lubrication

The speedometer adapter requires no more attention than would be required by the speedometer or the speedometer cable. Several drops of light oil should be applied in the provided oil-wick cups.

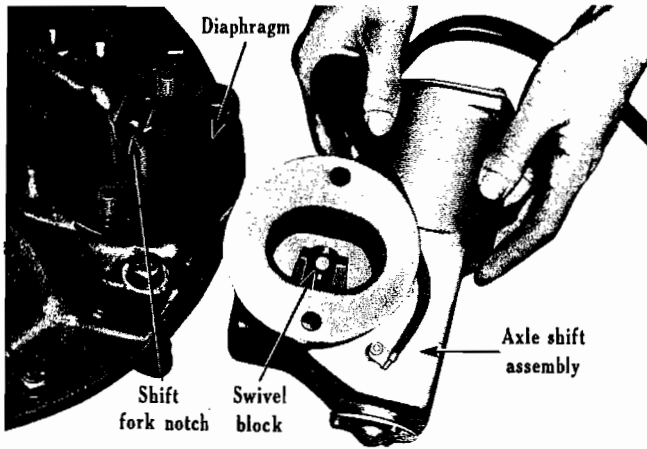
On the axle shift unit, there is an oil filler plug (27), so marked, provided in the front cover (26) near the bottom. Upon installation, the unit should be filled level with lubricant and should be checked every 10,000 miles or 3 months, whichever comes first, to maintain this level.

The lubricant used should be SAE 10 motor oil, except where temperatures below 0° F will be encountered, in which case use 3 parts SAE 10 motor oil to 1 part kerosene. This cold weather mixture can safely be used in temperatures up to 32° F.

To change lubricant, remove front cover (26) and drain. Whenever front cover is removed, care should be taken not to allow any dirt to enter.

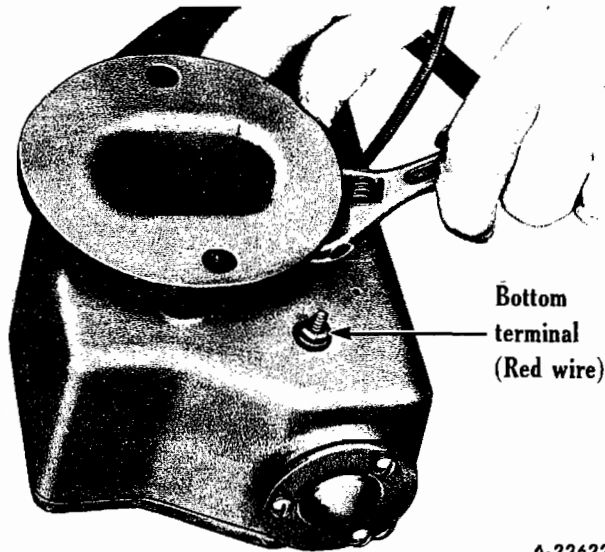
AXLE UNIT DISASSEMBLY

The axle unit (Fig. 1) is removed from the differential carrier for disassembly and servicing as follows:



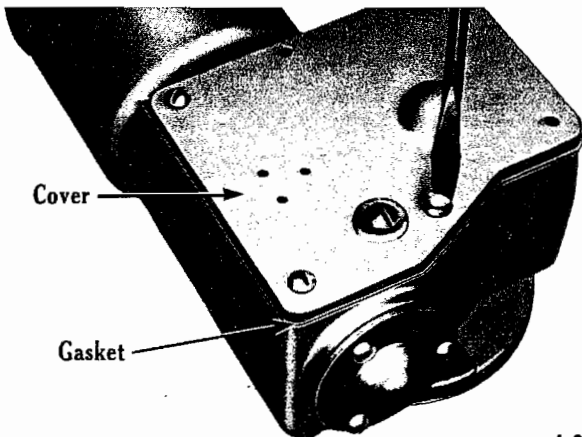
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Fig. 8 - Remove shift housing to carrier stud nuts and lockwashers and lift off shift unit. Upon reassembly, the swivel block must engage the shift fork notch.



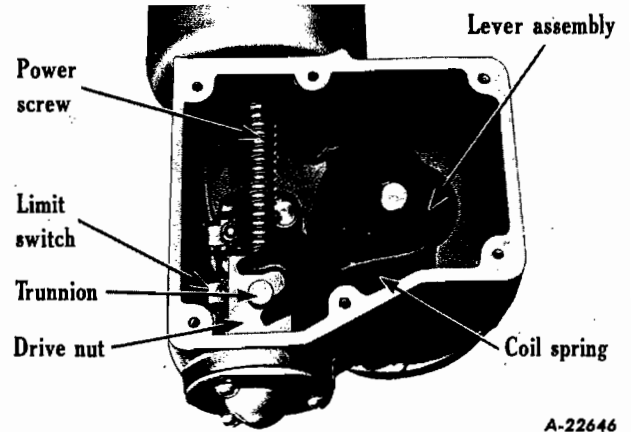
A-22622

Fig. 9 - Remove lock nuts and two wires from housing. In reassembling, the long or rod wire goes to the bottom terminal.



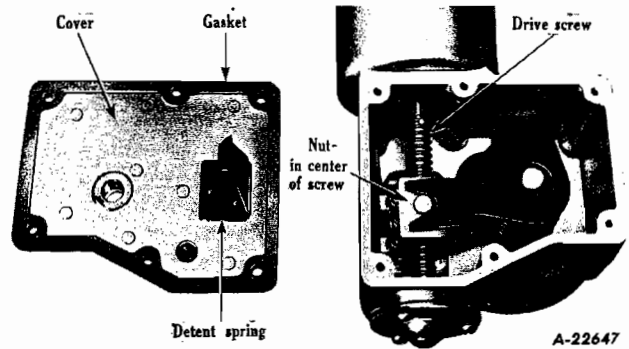
A-22628

Fig. 10 - Remove cover screws, lockwashers, cover and gasket. Drain lubricant from housing.



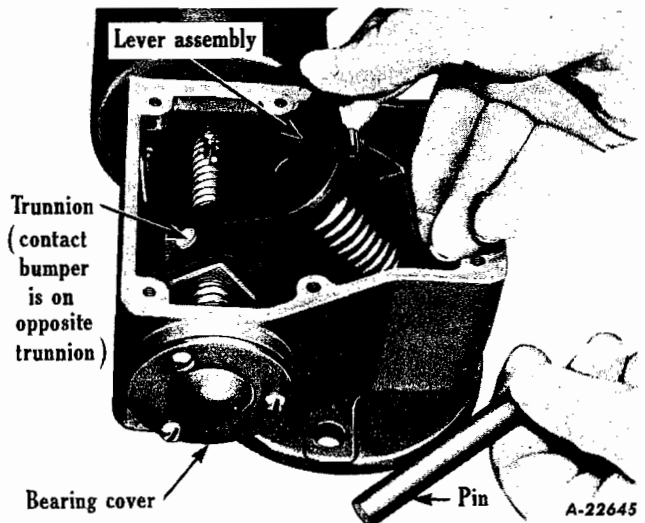
A-22646

Fig. 11 - After removal of cover, note that nut and lever assembly will be at either top or bottom of screw, depending upon position in which the shift button was last used.



A-22647

Fig. 12 - By turning drive screw, run nut from either top or bottom position to center of screw. **IMPORTANT:** This step is essential to prevent damage to drive nut contact bumper located in center of lower or inner trunnion. The nut must be in the center position upon assembly also.

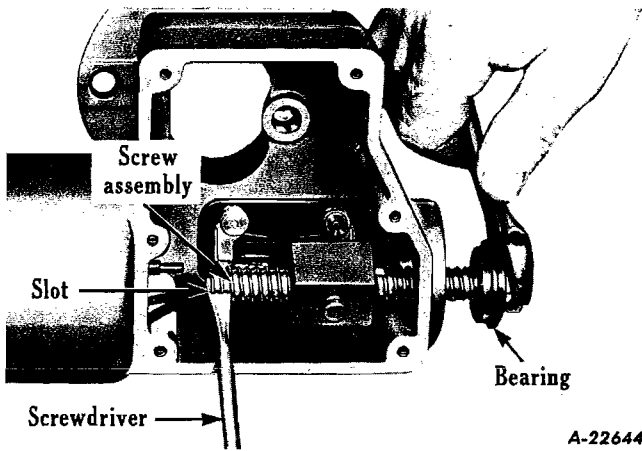


A-22645

Fig. 13 - Pull out pivot pin and remove lever assembly.



NOTE: When reassembling lever assembly, make certain that the contact bumper on nut is toward the switch.



A-22644

Fig. 14 - Remove drive screw bearing cover and push down on screw assembly until bearing is free of housing. Insert screwdriver in drive slot of screw and remove bearing retainer nut and bearing.

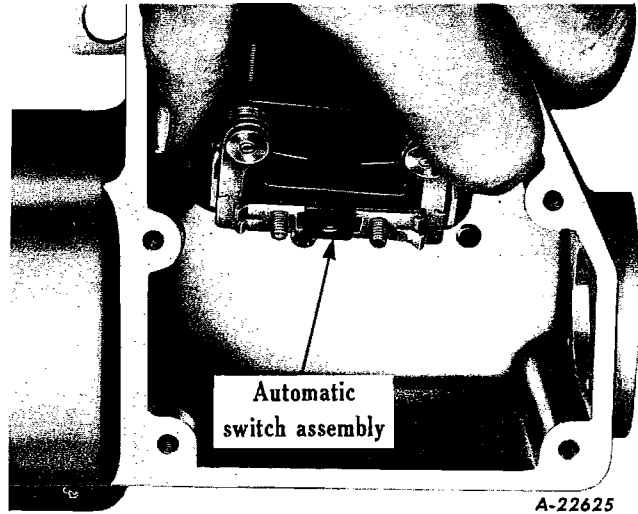


Fig. 17 - Remove "jam" nuts (switch retainer nuts) and fiber washers from back side of housing. Remove switch center screw and lift out switch assembly.

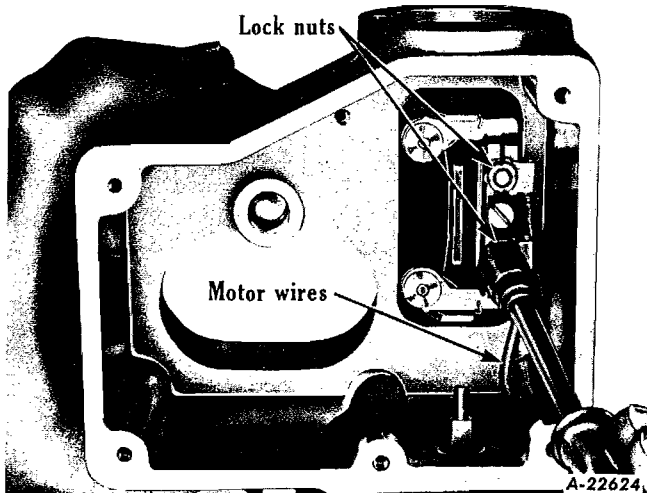


Fig. 15 - Remove two lock nuts from switch terminals and remove wires.

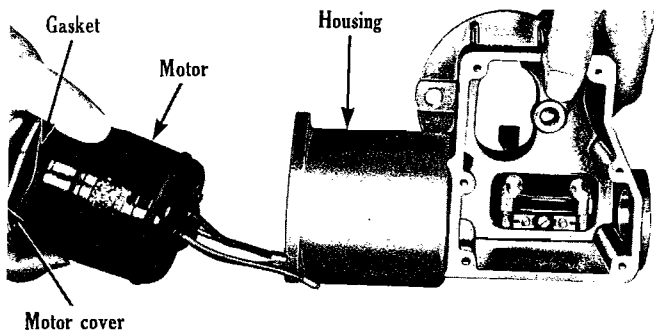


Fig. 16 - Remove three motor retainer screws, remove cover and gasket, and pull motor assembly out of housing.

Lever and Spring Assembly

Good practice is to perform the disassembly and reassembly of the lever and spring unit only when necessary to replace one of the parts.

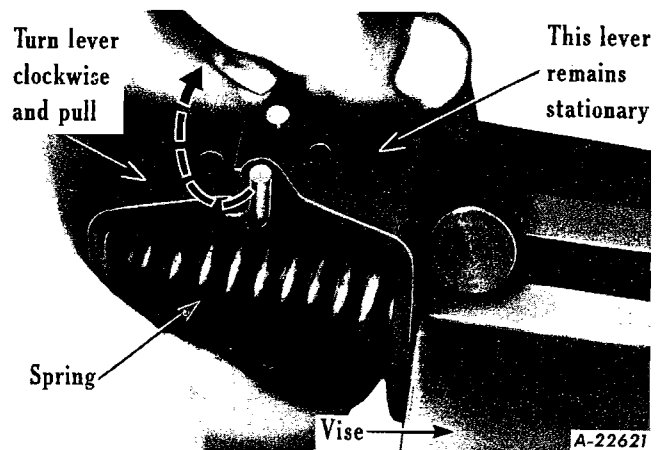


Fig. 18 - Place lever assembly in vise as shown. Turn spring winding lever clockwise and pull; then allow spring to unwind. This operation will permit disassembly of the levers and spring. IMPORTANT: Do not disassemble this unit until necessary to replace one of the parts.

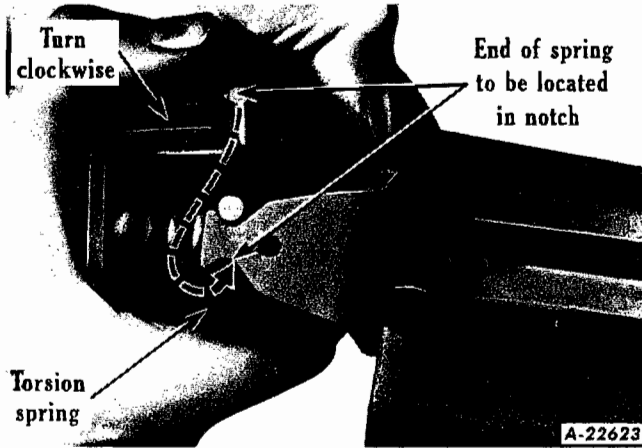


Fig. 19

1. When reassembling the spring and levers, locate parts as shown (Fig. 19). Turn lever and spring clockwise, bringing end of spring around end of lever nearest vise. Push end of spring into notch of actuating lever nearest vise. This will preload spring.

Reassembly of the axle shift unit is the reverse of disassembly.

SHIFTING INSTRUCTIONS FOR EATON TWO-SPEED AXLE ELECTRIC SHIFT

TO SHIFT INTO LOW-SPEED RATIO:

1. Keep accelerator pedal down, push button down.
2. To complete shift, disengage and reengage clutch as quickly as possible, holding accelerator pedal down; or release and reopen accelerator as quickly as possible.

TO SHIFT INTO HIGH-SPEED RATIO:

1. Keep accelerator pedal down, pull button up.
2. To complete shift, release accelerator and pause until shift is completed.

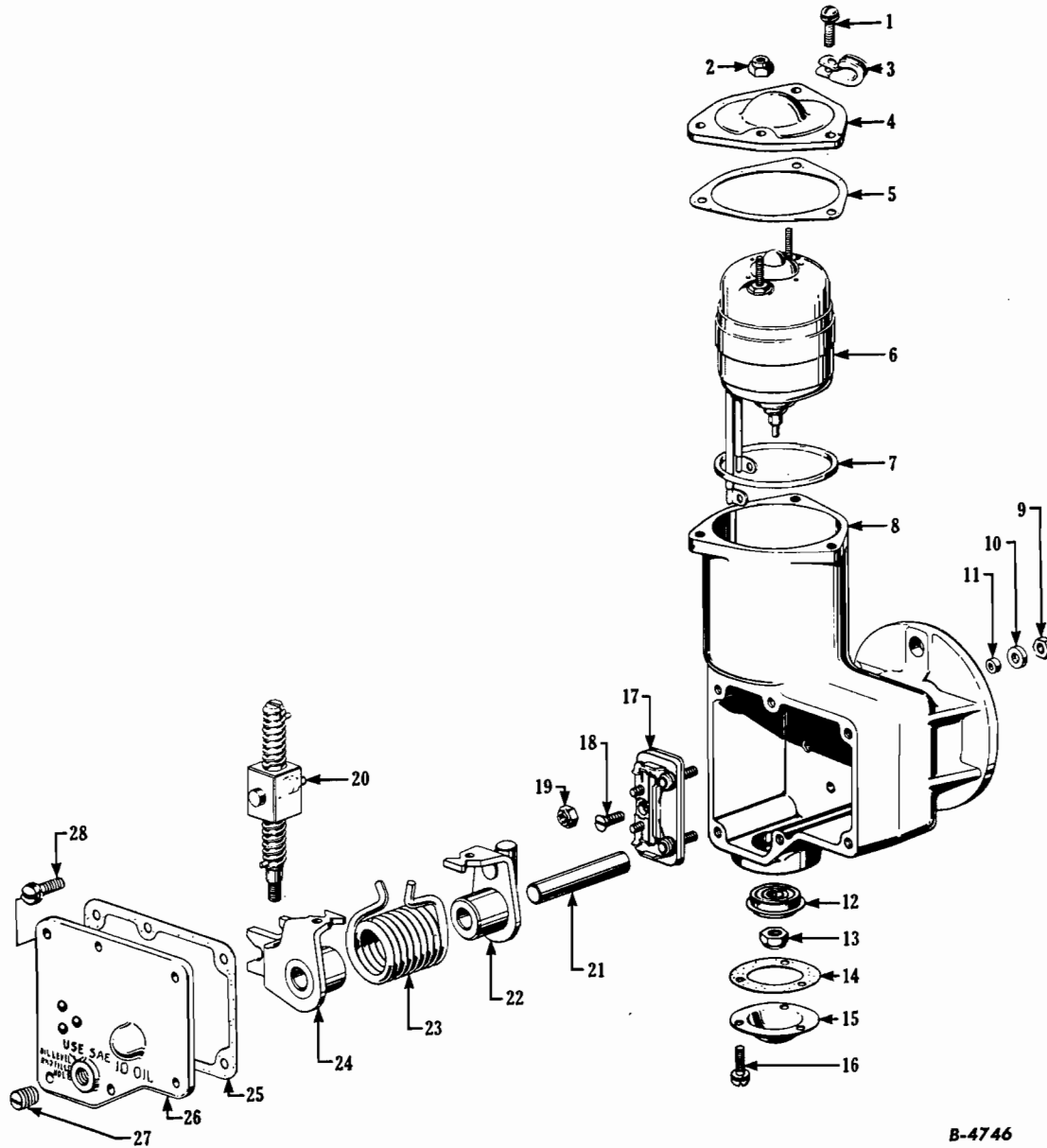
SPLIT-SHIFTING

To shift to next higher gear in the transmission and at the same time from high to low speed axle, make the transmission shift in usual way and just before engaging clutch push the button down.

To shift to next lower gear in the transmission and at the same time from low to high-speed axle, pull the button up, then complete the transmission shift in usual way.

IMPORTANT:

1. Always keep accelerator down when control button is moved, except when split-shifting to low-speed ratio.
2. For best results, start loaded trucks in low-speed ratio.



B-4746

Fig. 20 - Electric Shift Parts Identification List And Illustrations

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Screw with lockwasher (motor cover to housing). 2. Elastic stop nut (motor to cover). 3. Motor cover cable clip. 4. Motor support and cover. 5. Motor support and cover gasket. 6. Electric motor assembly. 7. Electric motor grommet. 8. Shift motor housing. 9. Jam nut (automatic switch terminal -- outside). 10. Fibre washer (automatic switch terminal -- outside). 11. Bushing (automatic switch terminal hole in housing). 12. Bearing with snap ring. 13. Bearing lock nut. 14. Bearing cover gasket. 15. Bearing cover. | <ol style="list-style-type: none"> 16. Screw with lockwasher (bearing cover to housing). 17. Automatic switch, terminal screws, and base gasket assembly. 18. Flat head screw (automatic switch to housing -- inside). 19. Elastic stop nut (automatic switch terminals -- inside). 20. Drive screw assembly. 21. Spring winding and shift fork actuating lever shaft. 22. Shift fork actuating lever assembly. 23. Torsion spring. 24. Spring winding lever assembly. 25. Shift housing cover gasket. 26. Shift housing cover. 27. 1/8" pipe plug. 28. Screw with lockwasher (shift housing cover to housing). |
|---|--|



L-LINE MOTOR TRUCK SERVICE MANUAL

BODY AND CAB GROUP

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Cab door weather strips	3
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BODIES, CABS AND COWLS R-110 to R-184 TRUCKS

A new type centrally located hood latch assembly has been incorporated in the above R-line trucks. Turning the latch handle to its vertical position unlocks the hood permitting it to be raised. Turning both latch handles upward permits removal of the hood assembly.



BODIES AND CABS

Cab Door Glass

The replacement of cab door glass is a simple operation if the following instructions are carried out.

TO REMOVE:

1. Remove remote control handle and escutcheon by pressing inward on escutcheon and removing retaining pin from remote control handle and shaft (Figs. 1 and 2).
2. Lower door glass and remove regulator handle and escutcheon by pressing inward on escutcheon and removing retaining pin from regulator handle and shaft (Figs. 3 and 4).
3. Remove door trim panel as shown in Figs. 5 and 6.
4. Remove four retaining screws from door-glass bumper (Fig. 7).
5. Remove door-glass bumper through opening in inner panel.
6. Lower door glass and disconnect door glass from regulator roller.
7. Raise regulator arm to extreme upward position to provide working space for following steps.
8. Lower glass to bottom of door and leave resting in bottom of door.
9. Remove door-glass front channel lower retaining screws.
10. Remove door-glass front channel retaining screws at vent-glass window opening located under ends of vent-glass window weather strip (Fig. 8).
11. Lower and position door-glass front channel at front of door inside body.
12. Lift door-glass out of door inner panel opening.

TO INSTALL:

Door glass installation is accomplished by reversing the foregoing removal procedure.

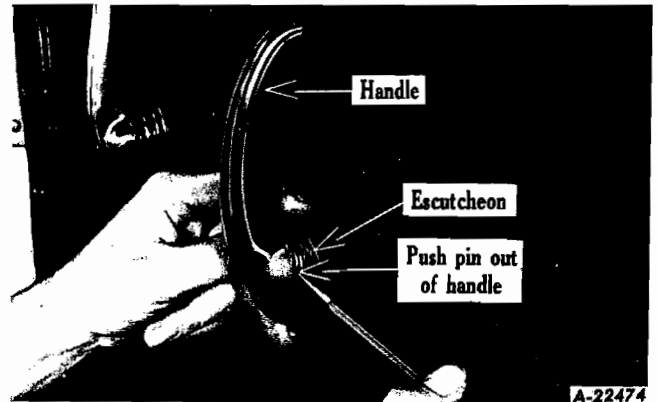
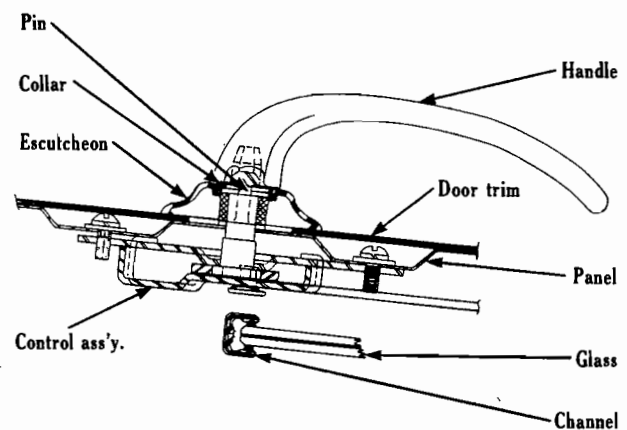


Fig. 1



Section thru door inner handle and remote control

A-22822

Fig. 2

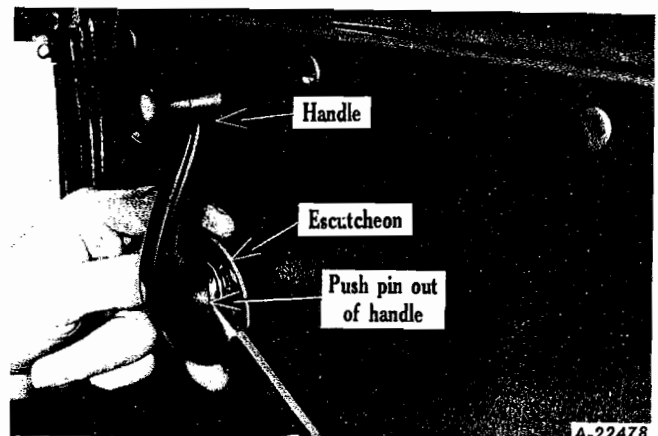


Fig. 3

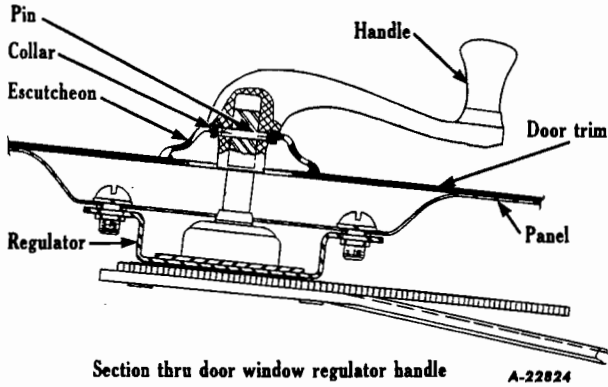


Fig. 4

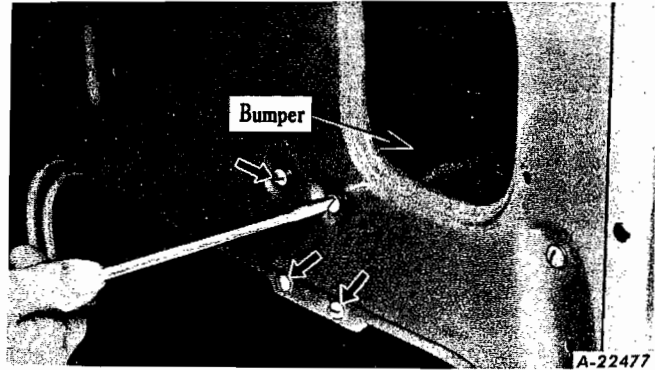


Fig. 7

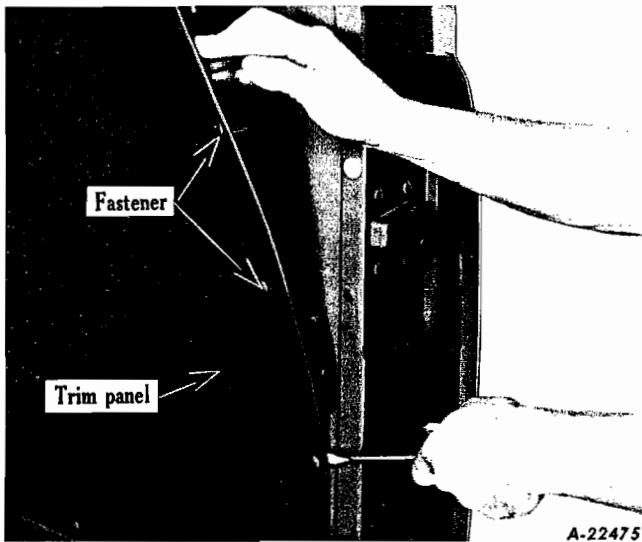


Fig. 5

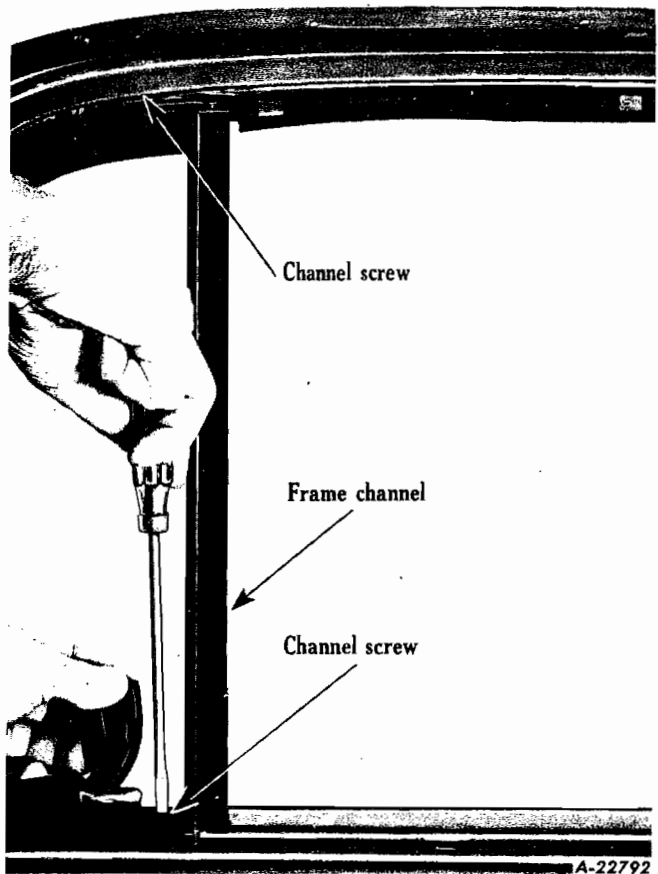


Fig. 8

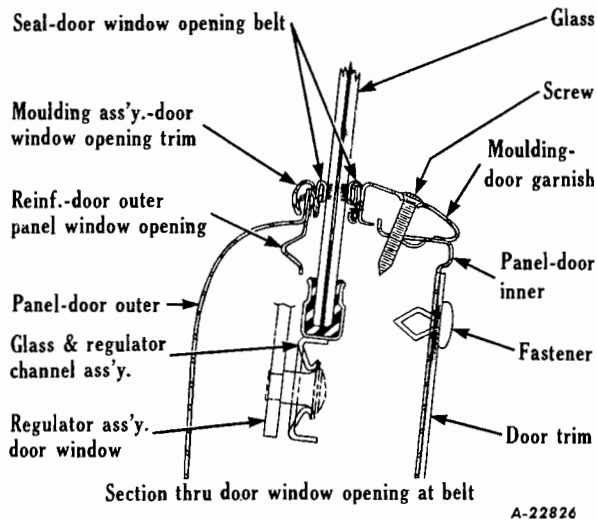


Fig. 6

Cab-Door-Glass Window Regulator

The cab door-glass regulator should be serviced as a unit either with the door glass in place or with it removed. If it is not desired or necessary to replace the door glass window, the window must be lowered sufficiently to disconnect the regulator as outlined on the previous page. Then raise door glass by hand to its extreme upward position. Block door glass in this position to facilitate removal of regulator.



L-LINE MOTOR TRUCK SERVICE MANUAL

TO REMOVE:

1. Remove remote control handle and escutcheon by pressing inward on escutcheon and removing retaining pin from remote control handle and shaft (Figs. 1 and 2).
2. Remove door-glass regulator handle and escutcheon by pressing inward on escutcheon and removing retaining pin from regulator handle and shaft (Figs. 3 and 4).
3. Remove door trim panel as shown in Figs. 5 and 6.
4. Remove four retaining screws from door-glass bumper (Fig. 7).
5. Remove door-glass bumper through opening in inner panel.
6. Lower door glass and disconnect door glass from regulator roller.
7. Raise door glass to extreme upward position. Block door glass in this position to facilitate removal of regulator.
8. Remove four retaining screws, two above and two below regulator handle shaft (Fig. 9).
9. Lower regulator assembly and remove through opening in door inner panel.

TO INSTALL:

Door-glass window regulator installation is accomplished by reversing the foregoing removal procedure.



Fig. 9

Cab Door Weather Strips

Rubber weather strips are cemented and riveted in cab door opening channel and form a weathertight seal when doors are closed.

TO REMOVE:

1. Remove rivet and pull old weather strip from channel.

TO INSTALL:

1. Paint weather strip channel with rubber cement.
2. Insert new weather strip in channel and install rivets.

Cab Door-Glass Window Channel

The door-glass window channel is held in place by clips, which snap into holes in the upper door frame. The lower portion of the channel is clipped in a removable frame attached to door inner panel.

TO REMOVE:

1. Remove door garnish moulding (Figs. 10 and 6).
2. Lower door glass with regulator.
3. Remove trim moulding from door glass opening (Figs. 11 and 6).

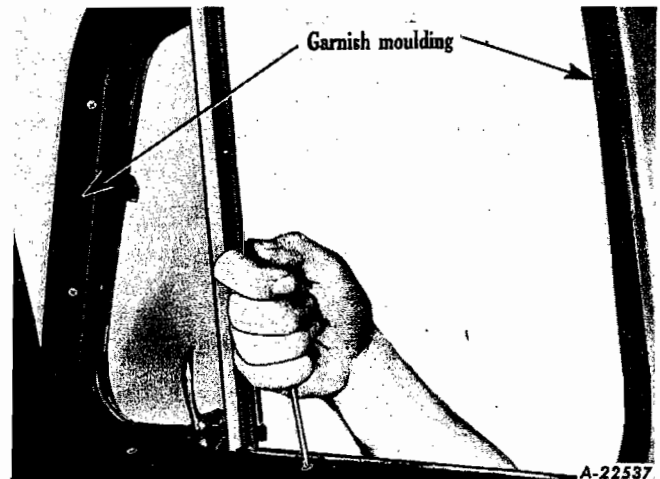


Fig. 10

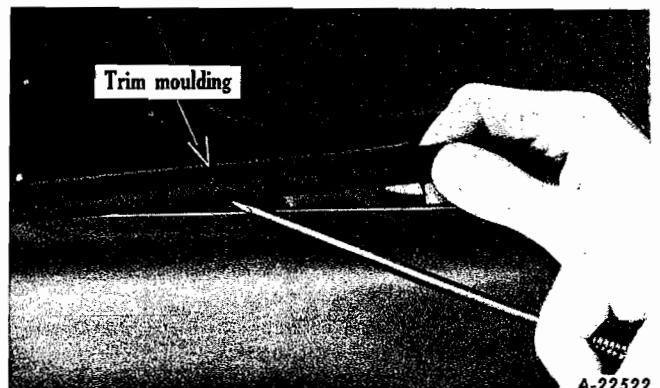


Fig. 11



4. Remove remote control handle and escutcheon by pressing inward on escutcheon and removing retaining pin from remote control handle and shaft (Figs. 1 and 2).
5. Remove door-glass regulator handle and escutcheon by pressing inward on escutcheon and removing retaining pin from regulator handle and shaft (Figs. 3 and 4).
6. Remove door trim panel as shown in Figs. 5 and 6.
7. Remove four retaining screws from door-glass bumper (Fig. 7).
8. Remove door-glass bumper through opening in inner panel.
9. Lower door glass and disconnect door glass from regulator roller.
10. Raise regulator arm to extreme upward position to provide working space for following steps.
11. Lower glass to bottom of door and leave resting in bottom of door.
12. Remove door-glass front channel from frame (Fig. 12).
13. Remove two retaining screws at lower end of door-glass front channel frame bracket.
14. Remove door-glass front channel frame retaining screws at vent-glass window opening located under ends of vent-glass window weather strip (Fig. 8).
15. Lower and position door-glass front channel frame at front of door inside body.
16. Lift door glass out of door inner panel opening.
17. Place upper end of front door-glass channel frame at front uppermost corner inside of door, and lower end at lower opposite corner.
18. Remove door-glass front channel frame through door inner panel opening rearmost corner. Spring upper portion of inner panel opening slightly outward at point of contact with door-glass front channel frame to permit removal (Fig. 13).
19. Remove door-glass rear channel and clips (Fig. 14).
20. Remove door-glass rear channel through opening in door inner panel.
21. Remove two retaining screws (one at each end) from door-glass rear channel frame.

22. Remove door-glass rear channel frame through opening in door inner panel.

TO INSTALL:

Cab door-glass window channel installation is accomplished by reversing the foregoing removal procedure.

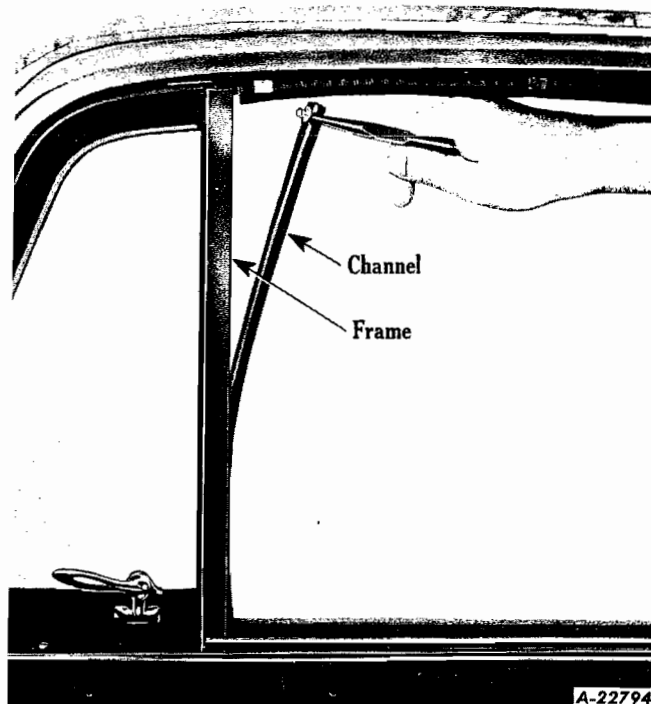


Fig. 12

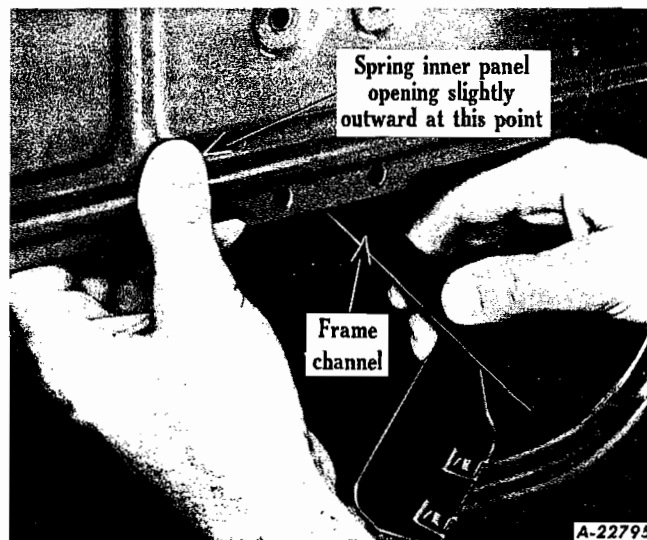


Fig. 13

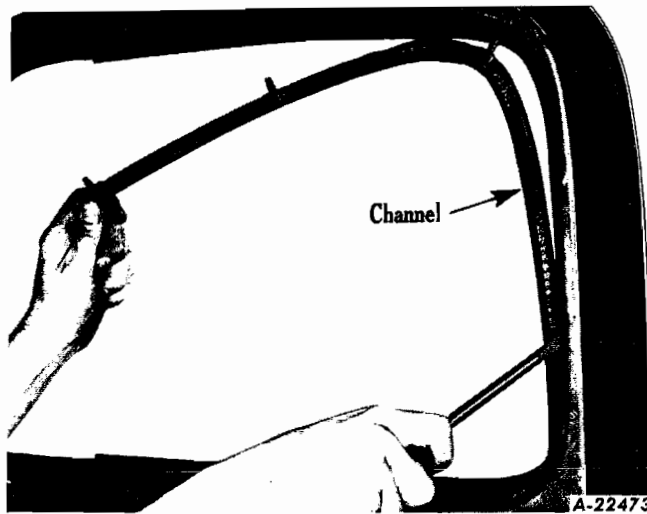


Fig. 14

Cab Rear-Window Glass Installation

The cab rear-window glass is secured to the cab with a one-piece weather strip in the same manner as the windshield glass (Fig. 15).

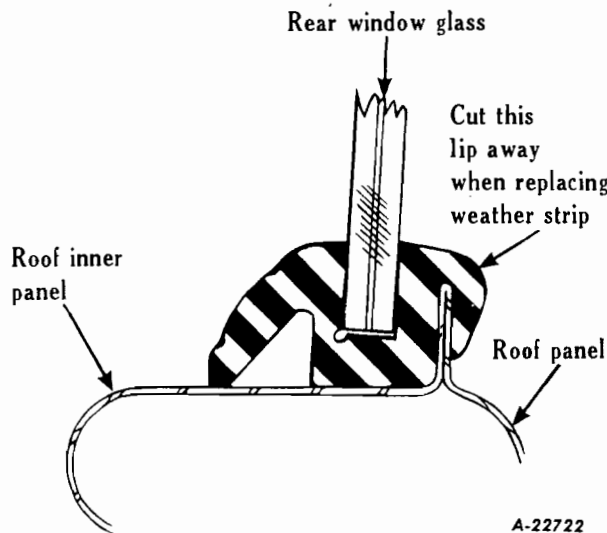


Fig. 15

Installation of the cab rear window glass necessitates using a length of chalk line cord or a light flexible soft wire.

When replacing the rear window glass, a new weather strip should be used. Old weather strips are apt to be stretched or deteriorated and should not be reused when installing new window glass.

The flange at the window glass opening in the cab must be cleaned free of all old sealing compound or dirt before installing a new glass.

Place chalk line cord in the weather strip flange channel, working the cord into the channel around the full length of the weather strip. Be careful to keep the cord straight and free of kinks (Fig. 16).

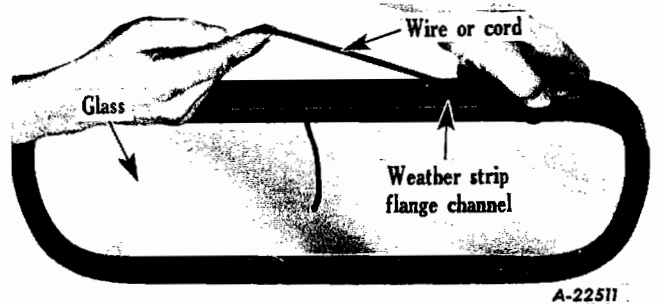


Fig. 16

Place the cab glass and weather strip assembly in position in the cab opening with the drawing cord protruding to the rear of the opening (Fig. 17).

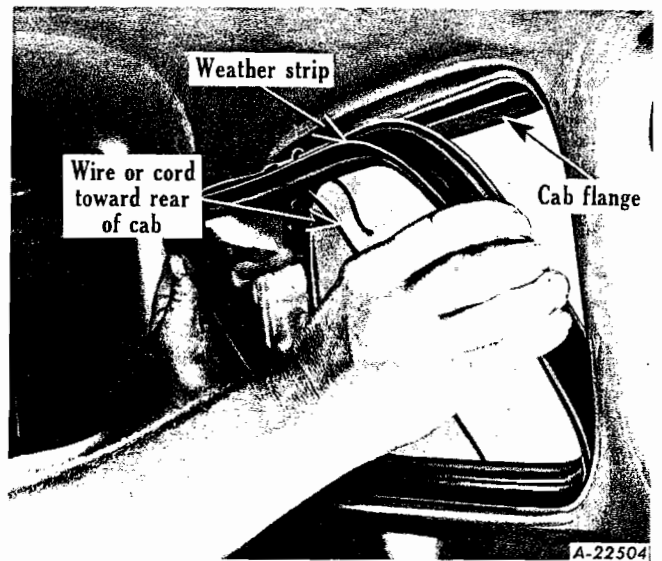


Fig. 17

While an assistant presses on the inside of the glass to hold it in position in the cab opening, grasp the end of the cord and carefully draw the cord from the flange channel in the weather strip bringing the lip of the channel over the cab flange. Complete this operation around the cab opening to the lower center of the opening (Fig. 18).

Leave the one-cord end at the bottom center of the glass, then grasp the opposite end of the cord to complete the drawing operation around the glass to within approximately 6" of completing the drawing operation. Hold the cord which was first pulled around the edge of the glass in one hand to prevent it being drawn out of position, then carefully pull the opposite end of the cord to complete the drawing operation (Fig. 19).

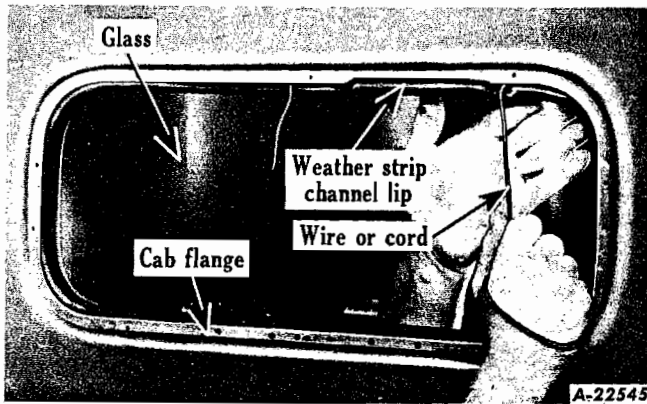


Fig. 18

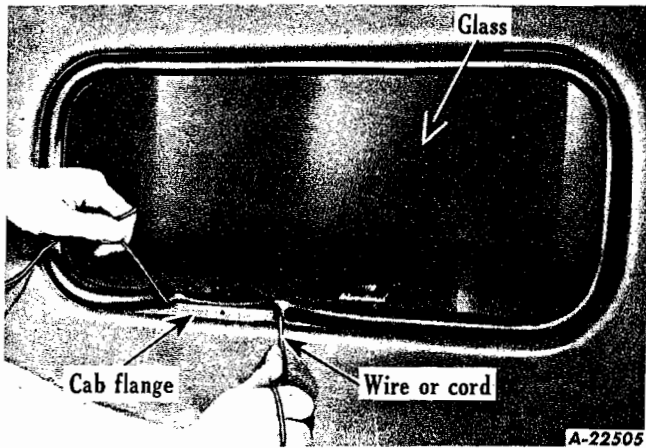


Fig. 19

Press the weather strip downward and outward around the cab opening.

In event that the weather strip does not fully engage the contour of the cab opening, a small amount of non-hardening sealing compound can be injected between the weather strip and the cab to further insure a seal.

Panel Body Rear-Door Glass Installation

The panel body rear door window glass is secured to the door with a one-piece weather strip in the same manner as the cab rear window glass.

When making replacement of the rear door window glass, remove all old sealing compound from flange at the window glass opening in the door before installing a new glass.

TO INSTALL:

1. Carefully place the molded weather strip around the edge of the glass.
2. Insert chalk line cord into the weather strip flange channel working the cord into the channel around the full length of the weather strip. Be careful to keep the cord straight and free of kinks.

3. Place the rear door glass and weather strip assembly in position in the rear door opening with the drawing cord protruding to the rear of the opening.
4. With an assistant pressing on the inside of the glass to hold it in position in the rear door opening, grasp the end of the cord and carefully draw the cord from the flange channel in the weather strip bringing the lip of the channel over the rear door flange. Complete this operation around the rear door opening to the lower center of the opening.
5. Leave the one cord end at the bottom center of the glass, then grasp the opposite end of the cord to complete the drawing operation around the glass to within approximately 6" of completing the drawing operation. The cord which was first pulled around the edge of the glass should be held in one hand to prevent it being drawn out of position, then carefully pull the opposite end of the cord to complete the drawing operation.
6. Press the weather strip downward and outward around the door opening to insure the seal being fully seated.

In event that the weather strip does not fully engage the contour of the rear door opening, a small amount of rubber sealing compound can be injected between the weather strip and the rear door to further insure a tight seal.

Windshields

The windshield used on the L-line cab is one-piece construction and is a curved glass bent to fit the contour of the windshield opening in the cab. A weather strip fits around the edge of the glass and is so moulded that it secures the glass to the cab windshield opening by fitting over a flange located in the windshield opening on the cab. NOTE: The windshield weather strip shown in the following illustrations is a one-piece weather strip. Production chassis will be equipped with either a two-piece or a one-piece weather strip. However, the one-piece weather strip will be provided for servicing either type.

The windshield is installed from the front of the cab. In replacing the windshield, it is recommended that a new weather strip be used at all times. A used weather strip is apt to be stretched or deteriorated and should not be re-used when installing new windshields.

In the event that a windshield is not damaged and it is desired to replace the weather strip only, it is advisable to first cut away the portion of the weather strip which is moulded around the flange in the cab (Fig. 20).

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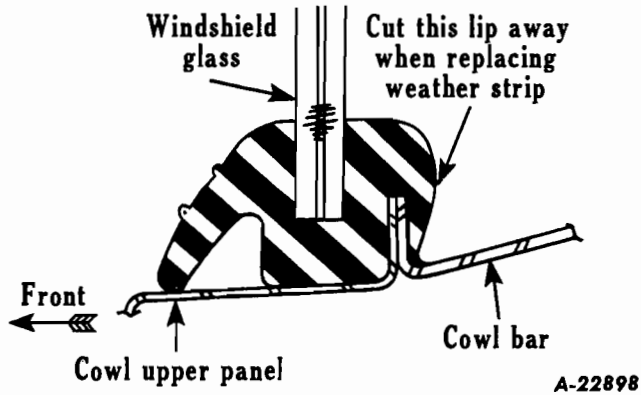


Fig. 20

The operation of cutting away the windshield weather strip will allow easier removal of the windshield and diminish the possibility of breaking or cracking the glass being removed.

Windshield Installation

Procedure for windshield installation on the L-line cabs is as follows:

1. A rubber sealing compound may have been used when the windshield was installed. This sealing compound will have hardened on the flange of the windshield opening in the cab and should be scraped or cleaned to assure a tight seal upon installation of a new weather strip. Scrape or clean all old sealing compound as shown in Fig. 21.

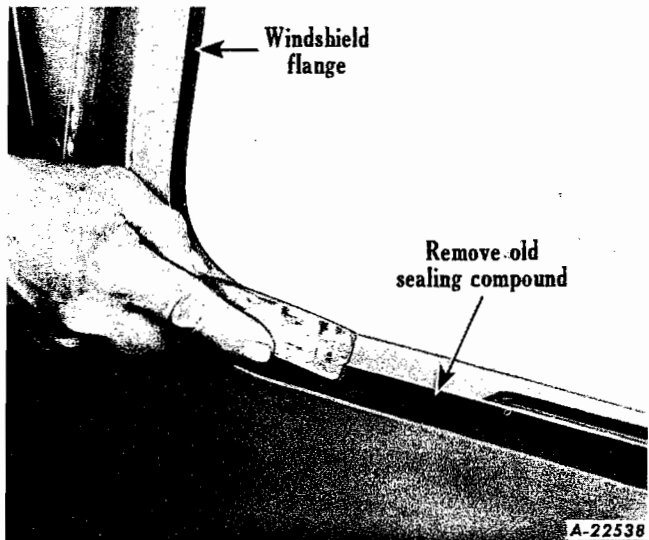


Fig. 21

2. Carefully place the moulded weather strip on the glass as shown in Fig. 22.

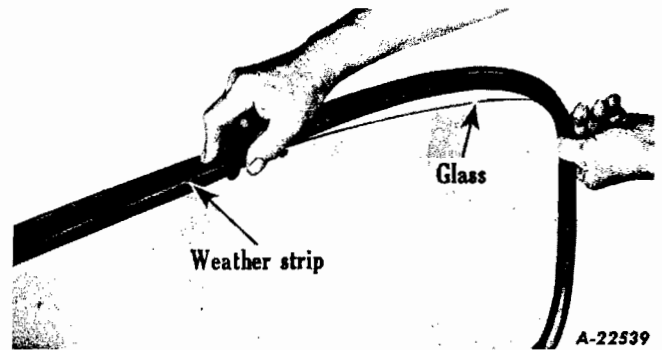


Fig. 22

3. Place a chalk line cord in the weather strip cab flange channel. Work the cord into the channel around the full length of the weather strip, being careful to keep the cord straight and free of kinks. (See Fig. 23.)

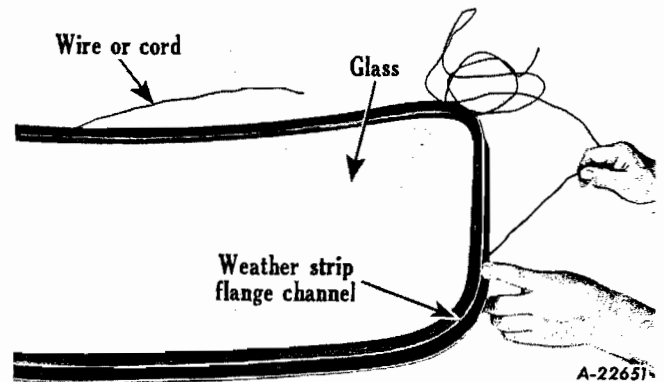


Fig. 23

4. By means of an assistant, carefully place the windshield with weather strip attached in position in the cab opening. The illustration shows the cord used for installing the glass terminating at the top of the windshield. The cord may be installed with the ends at the bottom of the glass. The manufacturer mark or name on the glass is at either of the lower corners of the glass and is generally installed in this position on all windshields of this type. See Fig. 24.
5. With one man working from inside the cab, and the other serving to press the glass inward and to steady the glass from the outside, grasp the end of the cord (either end of cord) as shown in Fig. 25.

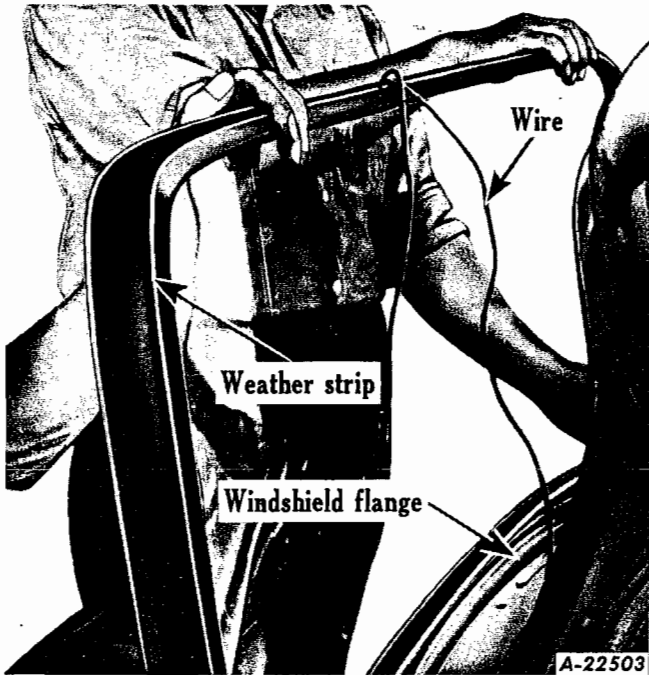


Fig. 24

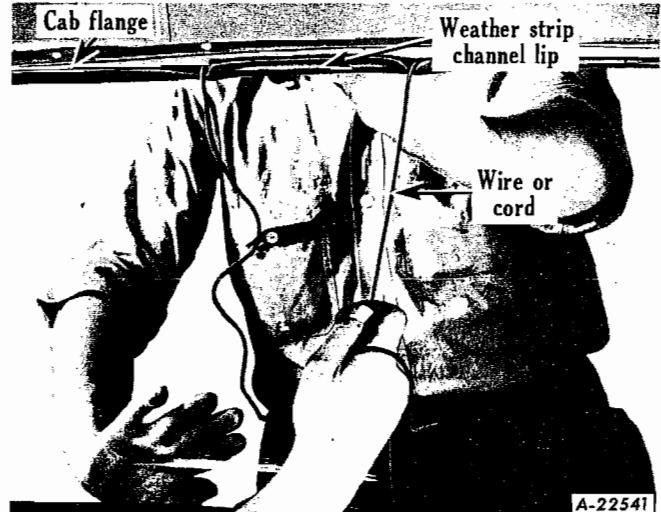


Fig. 26

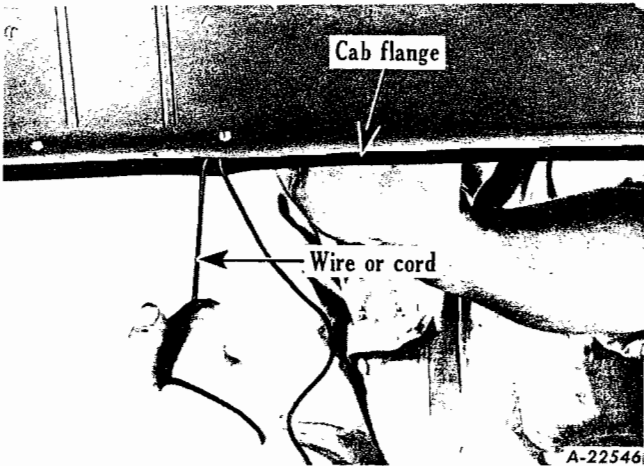


Fig. 25

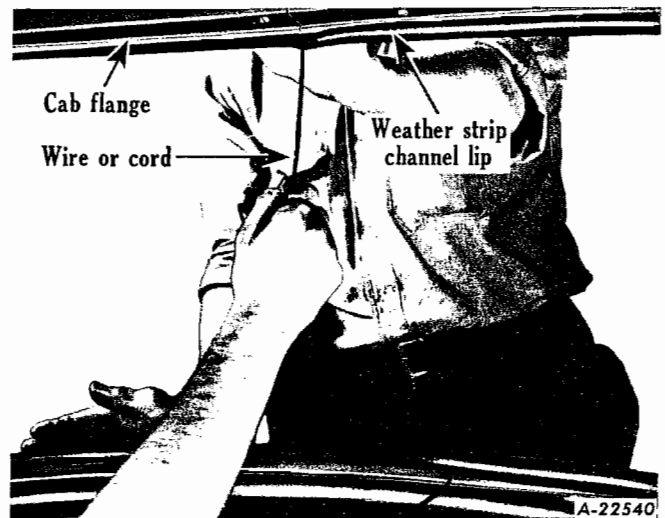


Fig. 27

6. Carefully draw the cord from the flange channel in the weather strip bringing the lip of the channel over the cab flange. Draw one side of the cord out of the weather strip until the cord has traveled completely around to the bottom center of the glass as shown in Fig. 26.
7. Leave the one end of the cord at the bottom center of the glass, then grasp the opposite end of the cord to complete the drawing operation around the opposite side of the glass to within approximately 12" of completing the drawing operation. It is not important which side of the weather strip is drawn over the cab flange first. See Fig. 27.
8. Before completing the drawing operation at the bottom of the windshield weather

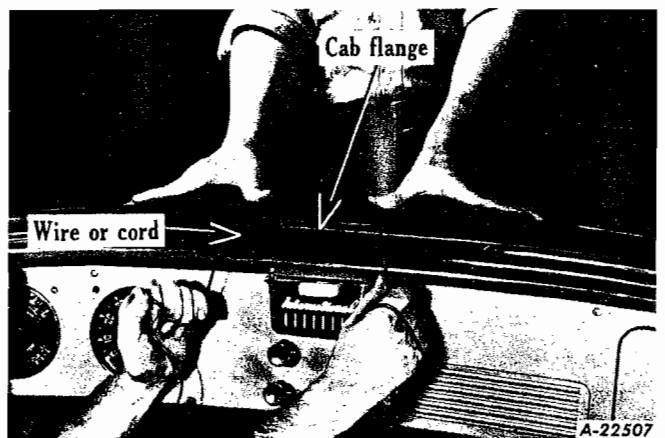


Fig. 28

seal, secure the cord which was first pulled around the edge of the glass in one hand to prevent its being drawn out of position; then carefully pull the opposite end of the cord to complete the drawing operation. See Fig. 28.

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During the drawing operation, the man outside the cab must carefully press inward on the glass near the weather strip to assist working the windshield into position while the drawing operation is in process.

9. Upon completion of the drawing operation, the weather strip must be pressed downward and outward on the sides and upward along the top to bring the weather strip to its seat in the cab opening. In event the weather strip does not fully engage the contour of the cab opening at the corners, a small amount of sealing compound can be injected between the weather strip and cab to further insure a seal at each of the corners. Be sure to wipe away excess sealing compound before it becomes set. See Fig. 29.



Fig. 29

Cab Door Vent Glass Window

The cab door vent glass window is held in place by six retaining screws.

TO REMOVE:

1. Remove door garnish moulding (Figs. 10 and 6).
2. Remove remote control handle and escutcheon.
3. Remove door glass regulator handle and escutcheon.
4. Remove door trim panel (Figs. 5 and 6).

5. Loosen door vent glass window adjusting screw (Fig. 30).

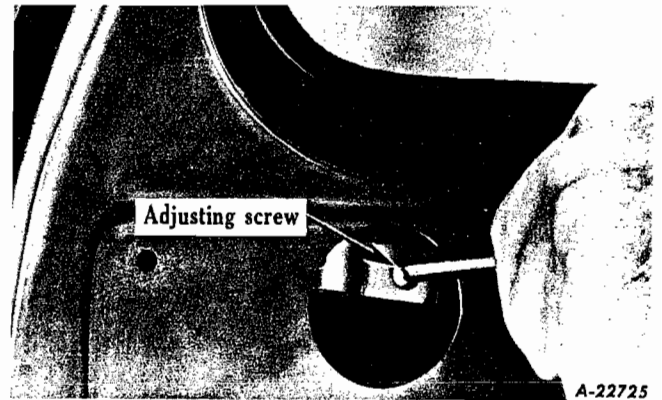


Fig. 30

6. Remove two door vent glass window hinge retaining screws (Fig. 31).

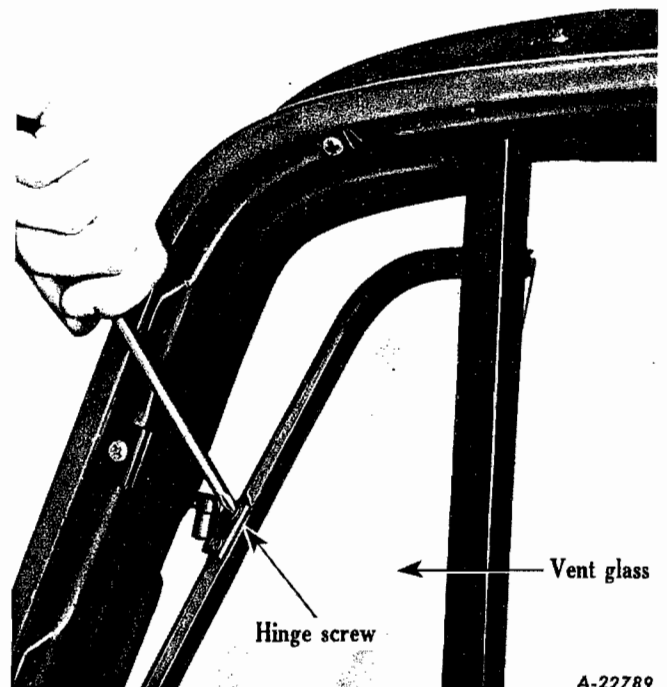


Fig. 31

7. Remove door vent glass window. Note: Do not lose thrust washer at vent glass window pivot pin.
8. Remove door vent glass window weather strip (Fig. 32).
9. Remove six door vent glass window cradle frame retaining screws (Fig. 33).
10. Remove door vent glass window cradle frame.

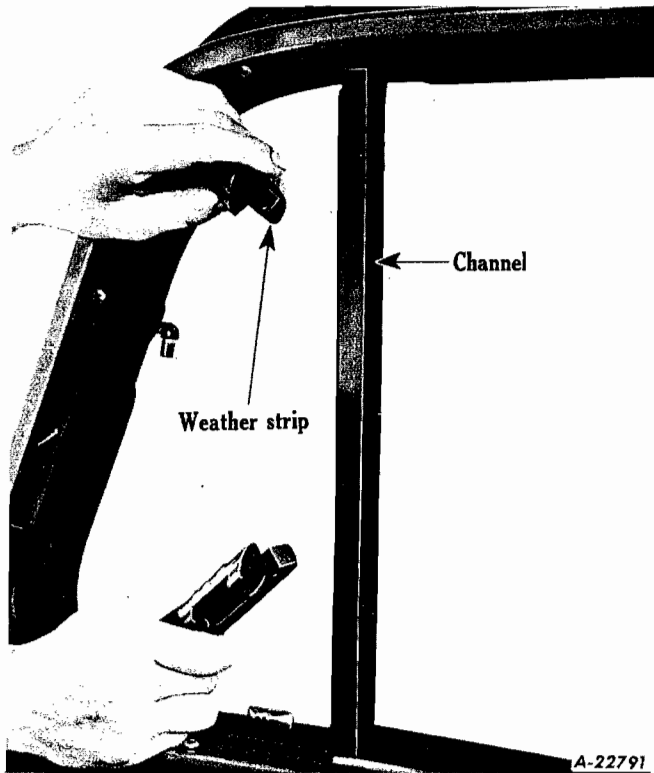


Fig. 32

TO INSTALL:

1. Install door vent glass window cradle frame.
2. Install door garnish moulding.
3. Install door vent glass window weather strip. To facilitate assembling the weather strip the channels engaging the flange opening should be coated with soap solution and installation started at point indicated in Fig. 34. Press weather strip into vent glass window frame to conform to contour of opening.

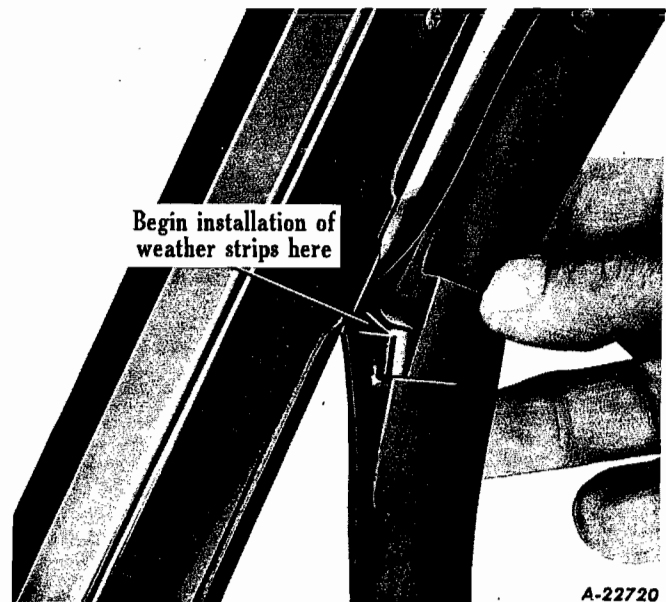


Fig. 34

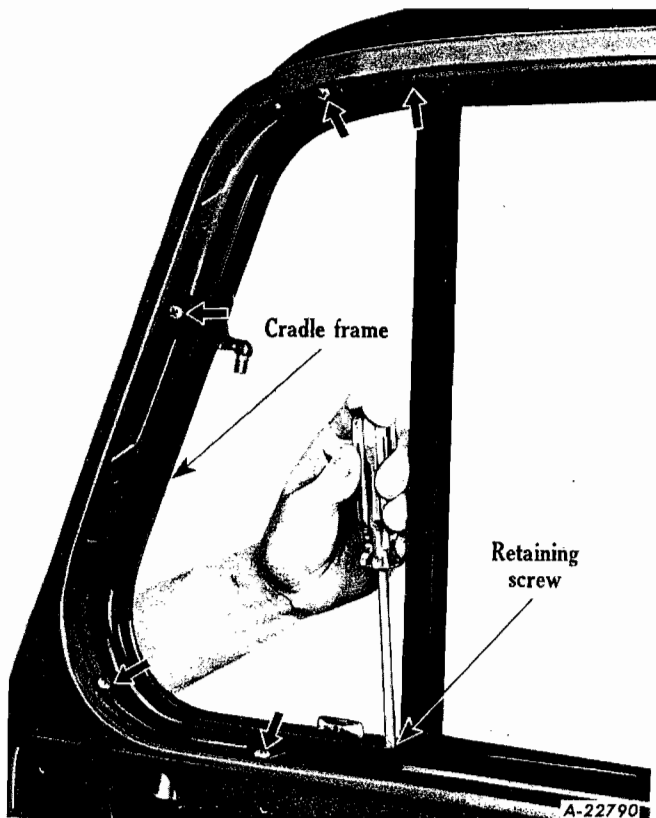


Fig. 33

4. Install door vent glass window. Note: Be sure washer is positioned over vent glass window pivot pin after vent glass window pivot pin has been installed in weather strip.
5. Install vent glass window hinge lower half on upper half.
6. Install vent glass window hinge retaining screws.
7. Tighten adjusting screw to provide proper pull tension on vent glass window pivot pin.
8. Install door trim panel.
9. Install escutcheon and door glass regulator handle.
10. Install escutcheon and remote control handle.

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Cab Door Latch and Remote Control

The replacement of a cab door latch and remote control assembly is a simple operation. The following suggestions will be helpful.

The cab door latch and remote control assembly must be removed and installed as a unit. The work can be done either with the door glass removed or in its extreme upward position as described in the instruction for door glass regulator replacement.

To remove door latch and remote control assembly after the glass is positioned as outlined above, proceed as follows:

1. Remove remote control handle and escutcheon by pressing inward on escutcheon and removing retaining pin from remote control handle and shaft (Figs. 1 and 2).
2. Remove door glass regulator handle and escutcheon by pressing inward on escutcheon and removing retaining pin from regulator handle and shaft (Figs. 3 and 4).
3. Remove door trim panel as shown in Figs. 5 and 6).
4. Remove door handle shaft retaining screw cover plug (Figs. 35 and 36).
5. Remove door lock case shaft cover plug (Figs. 35 and 37) at edge of door inner panel.
6. Remove door handle shaft retaining screw and washer (Figs. 38 and 36).
7. Remove door handle plate retaining screws and door handle (Figs. 39 and 36).
8. Remove door lock case spring retainer and door lock (Figs. 37 and 40).

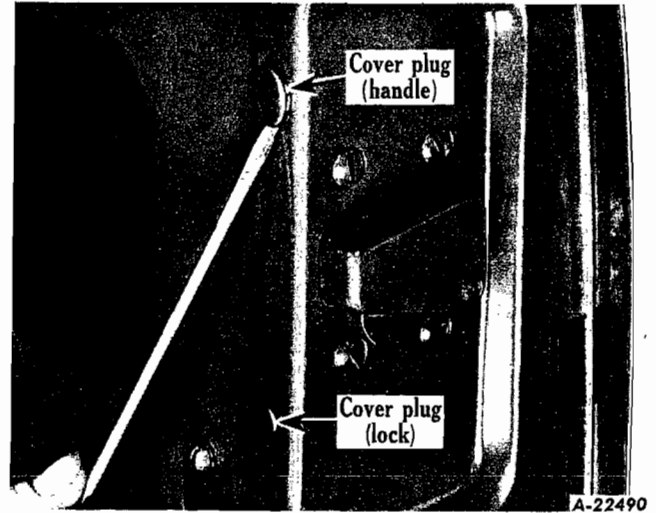
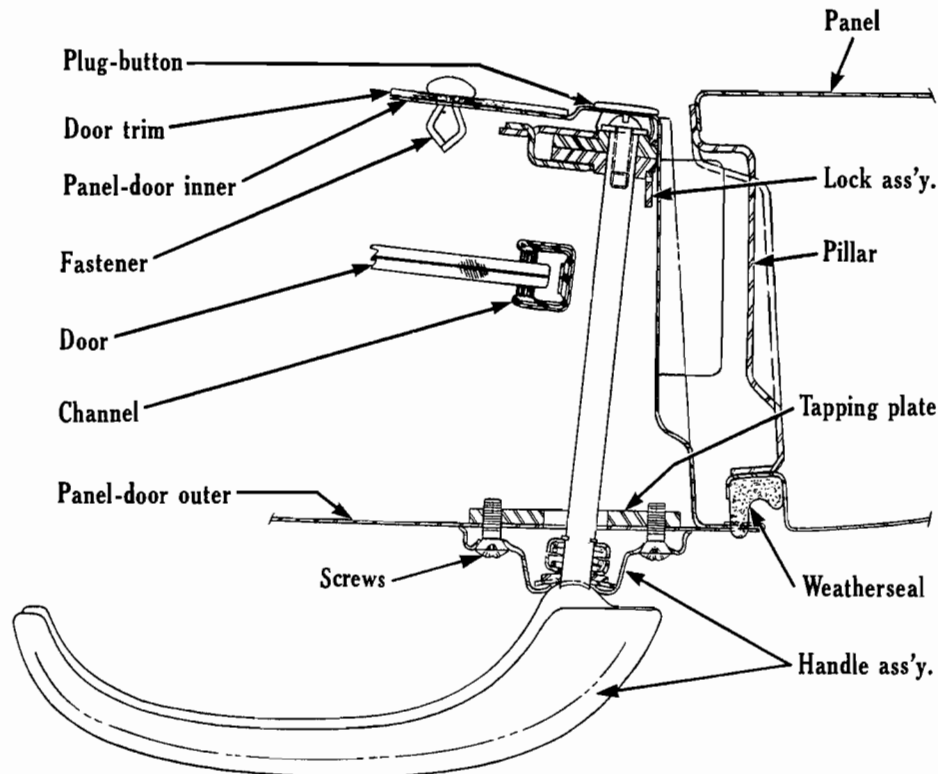


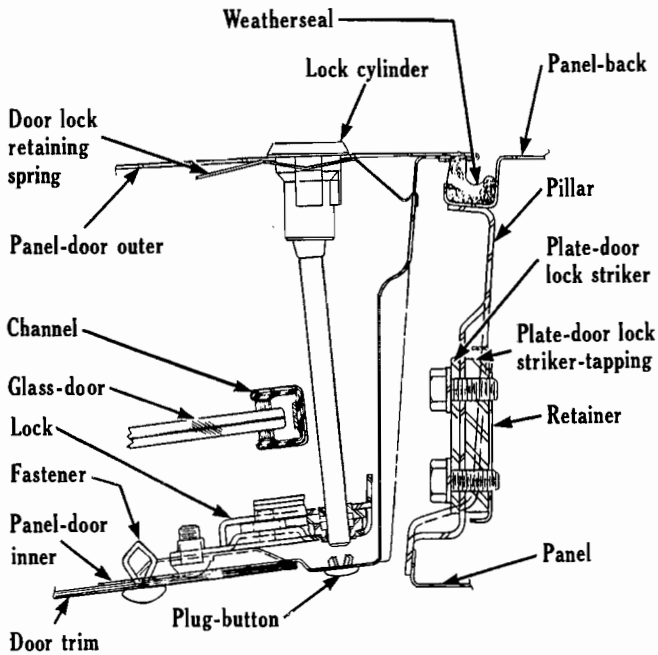
Fig. 35



Section thru door outside handle

A-22812

Fig. 36



Section at lock cylinder (right side)

A-22825

Fig. 37

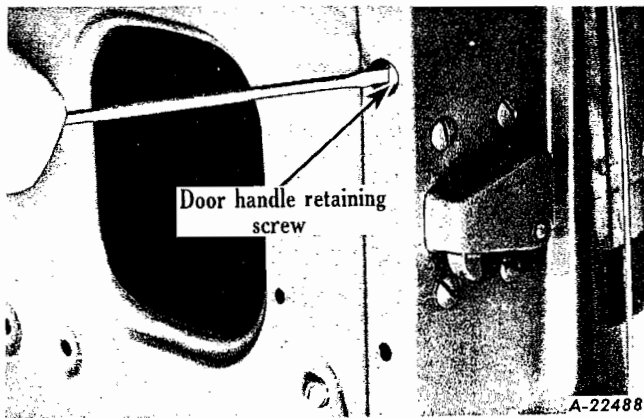


Fig. 38

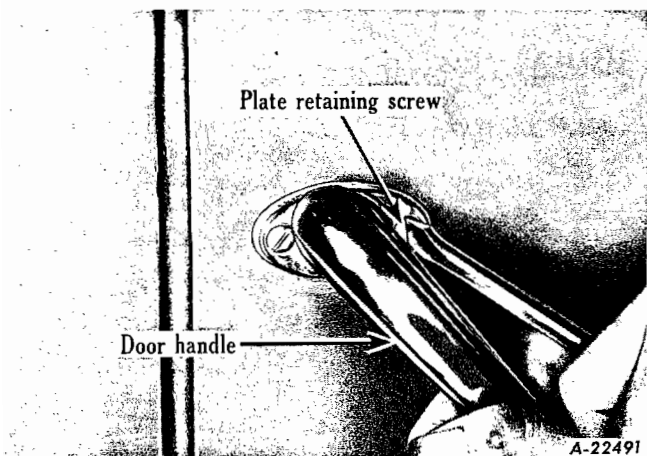


Fig. 39



Fig. 40

9. Remove five door lock retaining screws (Fig. 41).
10. Remove retaining screw at lower end of door glass rear channel frame.

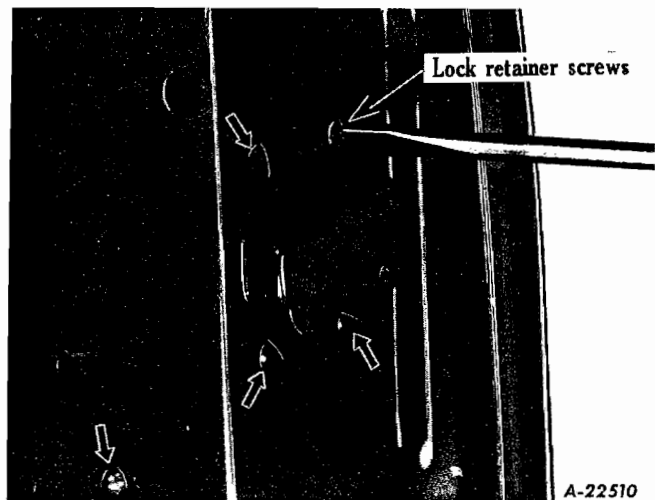


Fig. 41

11. Lower door lock assembly to panel opening. Rotate lock assembly 1/4 turn counter-clockwise to allow removal of door lock from remote control link (Fig. 42).
12. Turn remote control shaft in locked position.
13. Remove three retaining screws from remote control assembly (Fig. 43).
14. Remove two retaining screws at lower end of door glass front channel frame bracket to allow sufficient movement of channel to permit removal of remote control assembly as shown in Fig. 44. CAUTION: Do not move channel to the extent distortion is encountered as this will cause interference with door glass operation after reassembly.
15. Remove remote control assembly through inner panel opening.

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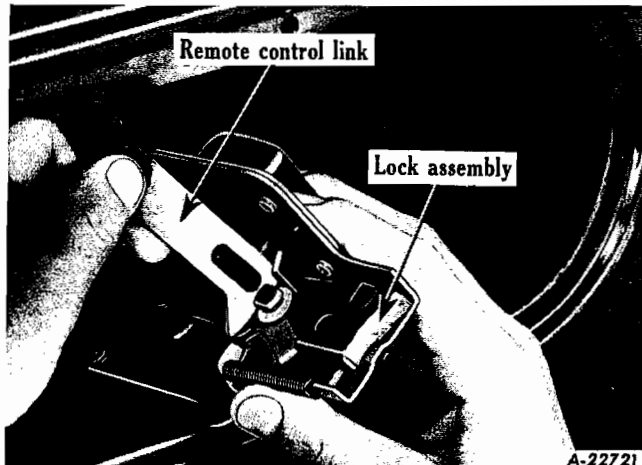


Fig. 42

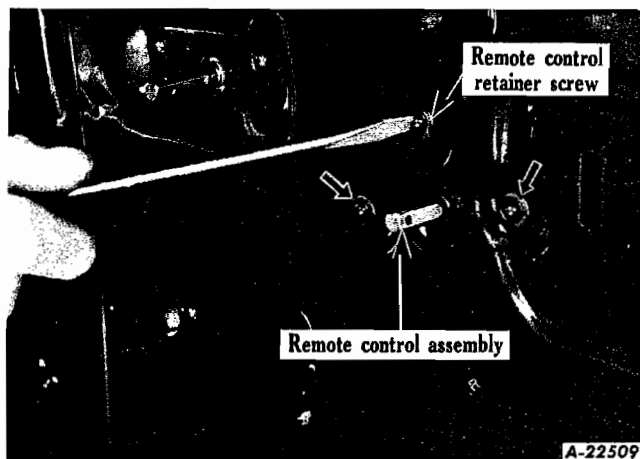


Fig. 43

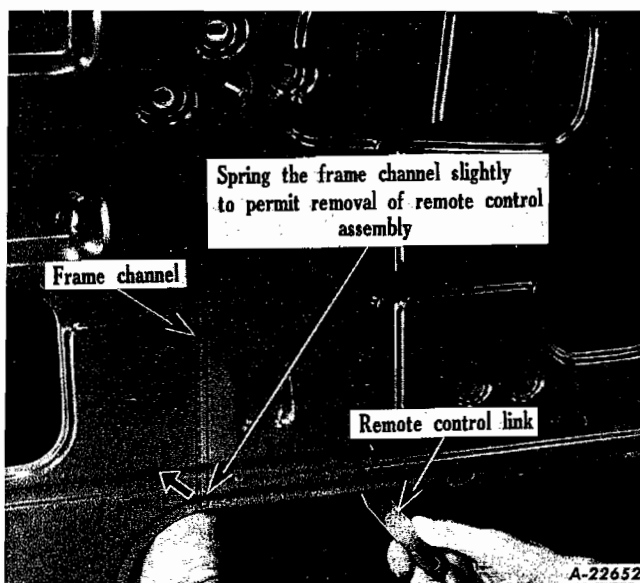


Fig. 44

Removal of Outside Door Handle

Removal of outside door handle can be easily accomplished as outlined below.

1. Remove door handle shaft retaining screw cover plug (Figs. 35 and 36).
2. Remove retaining screw and washer from door handle shaft (Figs. 38 and 36).
3. Remove door handle plate retaining screws and withdraw door handle (Figs. 39 and 36).

Installation of Outside Door Handle

1. To simplify installation of outside door handle, a simple tool can be made by grinding a point on the end of a piece of welding rod approximately 1/16" diameter by 6" long, which can be used to pilot the door handle into the door latch mechanism.
2. Insert the tool in the door handle shaft retainer screw cover plug opening and align tool with door handle shaft installed from opposite side.
3. Install door handle plate retaining screws.
4. Install door handle shaft retaining screw and washer.
5. Install door handle shaft retaining screw cover plug.

Lock Cylinders and Keys

Lock cylinders in ignition switch and door are coded so that the ignition key will operate both. The instrument panel compartment and spare tire lock cylinders requires separate keys.

Key numbers should be recorded to facilitate replacement in case they are lost.

A code number is stamped on the body of the ignition switch and compartment lock cylinders, just back of the cap. A code number is stamped on the face of the spare tire lock cylinder. The door handle lock cylinder does not have a code number stamped on the body inasmuch as the cylinder is coded to the ignition switch key.

To expose the code number on the ignition switch lock, remove the ignition switch cap nut with a small spanner wrench and the number will then be visible. If the compartment keys are lost and the key number is not known, it will be necessary to either drill out the lock cylinder and replace with a new cylinder and keys or replace the complete compartment knob and lock assembly. It is impossible to remove the compartment lock cylinder intact, without the regular key.



If the spare tire lock keys are lost and the key number is not known, it will be necessary to replace with new lock assembly.

The ignition switch, door handle and compartment lock cylinders can be removed provided the regular key is used. If keys are lost the cylinders must be drilled out, using a 5/16" drill, 1/2" to 3/4" deep. This will permit the tumblers to drop out.

In case it becomes necessary to replace a lock cylinder and it is desired to use the original key, the tumblers on the new lock cylinder can be coded accordingly. (NOTE: This does not apply to spare tire locks.)

This is accomplished by inserting the original key in the new lock cylinder and filing off the tumblers that protrude from the lock cylinder body. When doing this, make sure that there are no burrs left on the tumblers and that all filings are blown out with air. Apply a small quantity of powdered graphite to the tumblers and insert lock cylinder in receptacle as directed.

Lock cylinders are removed, with keys as follows:

Ignition Switch

Remove complete ignition switch from instrument panel. Place key in lock cylinder and insert a piece of wire in the small hole in switch body. Turn key to (right) "On" position and press cylinder retainer down with the wire. The lock cylinder can then be slipped out of the ignition switch body.

To install a new lock cylinder, simply push cylinder into ignition switch body and turn towards the (right) "On" position until cylinder retainer snaps into place. NOTE: The ignition switch turns to the left or right of the "Off" position. When the switch key is turned to the left, all accessories and gauges are "On" but the ignition is "Off". When the switch key is turned all the way to the right, the ignition also is "On".

Door Lock

Place key in lock cylinder and insert a piece of wire through the hole in the face of the cylinder. Press spring retainer down with wire, turn cylinder slightly to left and pull out.

To replace lock cylinder, insert and turn until retainers snap into place.

TO REMOVE:

1. Remove door lock case shaft cover plug (Figs. 35 and 37) at edge of door inner panel.

2. Remove door lock case spring retainer and door lock case assembly (Figs. 40 and 37).

TO INSTALL:

1. Position door lock case spring retainer in door.
2. Insert door lock case assembly through opening in outer door panel.
3. Align square end of lock case shaft with opening in lock assembly and install lock case assembly.
4. Install door lock case spring retainer into grooves in lock case and snap into position.

Cab Door Removal

TO REMOVE:

1. Remove door glass regulator handle, remote control handle and door trim panel.
2. Remove door check arm pivot pin (Fig. 45).
3. Remove nuts and washers at upper and lower hinge assemblies from inside of door (Figs. 46 and 47).

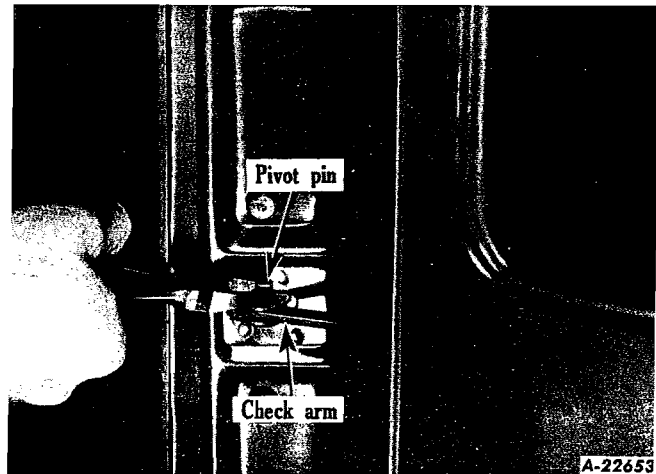


Fig. 45

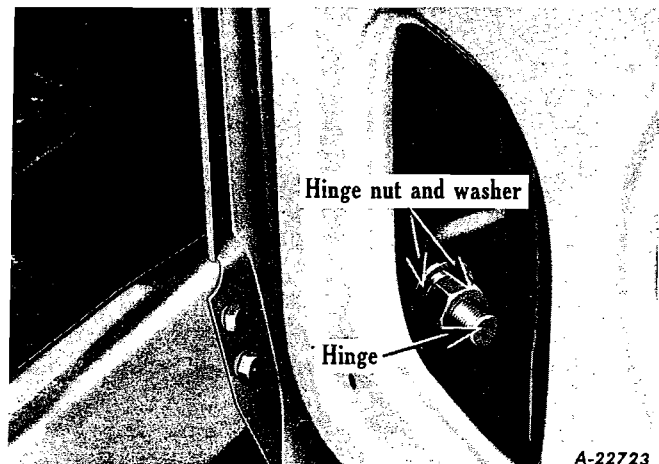


Fig. 46

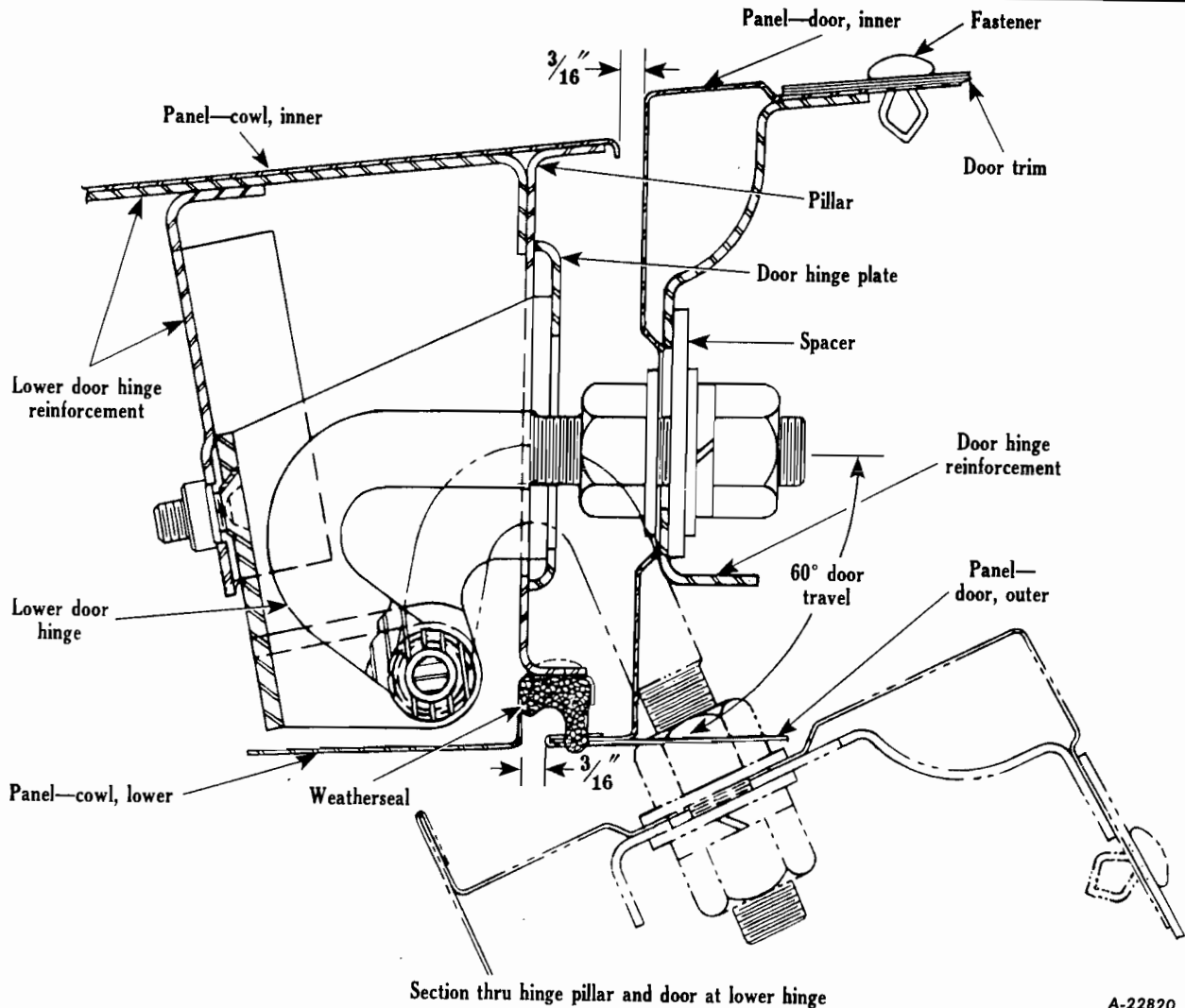


Fig. 47

4. Remove door assembly.

TO INSTALL:

1. Position door assembly on upper and lower hinges.
2. Reinstall nuts and washers on door hinges.
3. Position door check arm into bracket and install pivot pin.
4. Reinstall door glass regulator handle, remote control handle and door trim panel.

ADJUSTMENT:

The upper and lower hinges are threaded sufficiently to permit adjusting the door towards the front or rear of the door opening. The hinge mounting holes in the door are oblong to permit aligning the door to the cab surface or outer contour and centering the door vertically.

Cowl Ventilator

The cowl ventilator is controlled by a lever, which is held under tension by springs located at the lever pin and ventilator hinge pin. A rubber strip cemented in the ventilator trough assures a weather-tight seal.

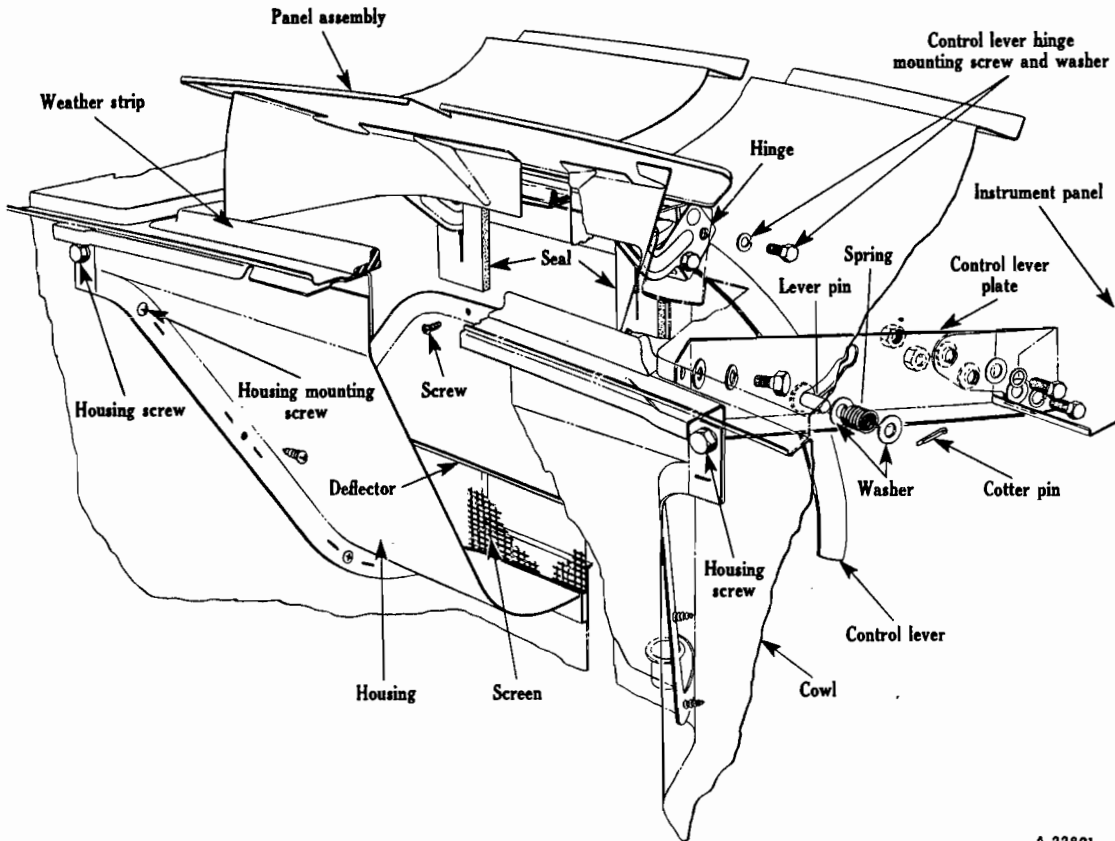
This type ventilator (see Figs. 48 and 49) requires no adjustment or attention other than occasional lubrication of the lever and hinge pins.

TO REMOVE:

1. Remove two ventilator housing capscrews and sheet metal screws (Fig. 48).
2. Remove ventilator housing (Fig. 48).
3. Remove four deflector retaining screws. Remove deflector and screen (Fig. 48).



4. Remove four retaining screws (two on each side in ventilator hinge (Fig. 48).
5. Remove cotter pin, washers and spring
6. Remove ventilator panel assembly (Fig. 48).



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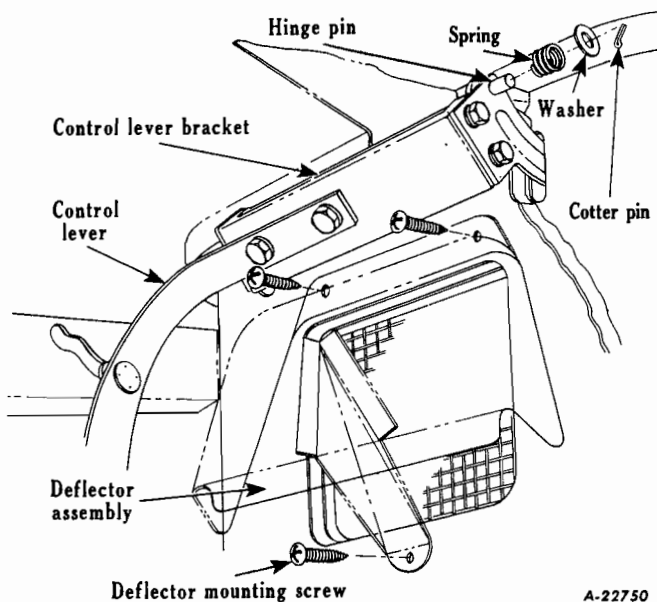
Fig. 48

TO INSTALL:

1. Place ventilator panel assembly in position through top of cowl.
2. Install ventilator hinge pin, washers, spring and cotter pin.
3. Install four retaining screws (two on each side) in ventilator hinge.
4. Install screen and deflector.
5. Install ventilator housing.

Seat Adjuster (L-110 to L-180)

The seat adjuster assembly is retained in position by eight studs. Four of the studs are installed into brackets mounted on the floor board and the remaining studs installed into the seat frame.



A-22750

Fig. 49

TO REMOVE:

1. Remove seat cushion and seat back cushion.



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2. Remove seat adjuster tension spring (Fig. 50).
3. Remove two retaining nuts, washers and spacers from front of seat frame (Fig. 50).
4. Remove two retaining nuts and washers from rear of seat frame (Fig. 50). Remove seat frame assembly.
5. Remove four retaining nuts and washers from brackets mounted on floor board.
6. Remove seat adjuster assembly. **NOTE:** Either left or right adjuster assembly can be removed individually after removal of the adjuster assembly retainer nuts and washers (bracket to adjuster). Move the adjuster assembly to its extreme rearward position to permit disengagement of the equalizer pinion teeth from the pinion rack.

TO INSTALL:

Seat adjuster installation is accomplished by reversing the foregoing procedure.

The seat adjuster rack should be cleaned with a commercial solvent and lubricated with non-hardening lubricant periodically in order to obtain the maximum efficiency.

Seat Adjuster (L-190 up)

The seat adjuster assembly used on the driver's seat on the above models is similar to the seat adjuster used on L-110 to L-180 models. Therefore the removal and installation instruction outlined for L-110 to L-180 models can be followed.

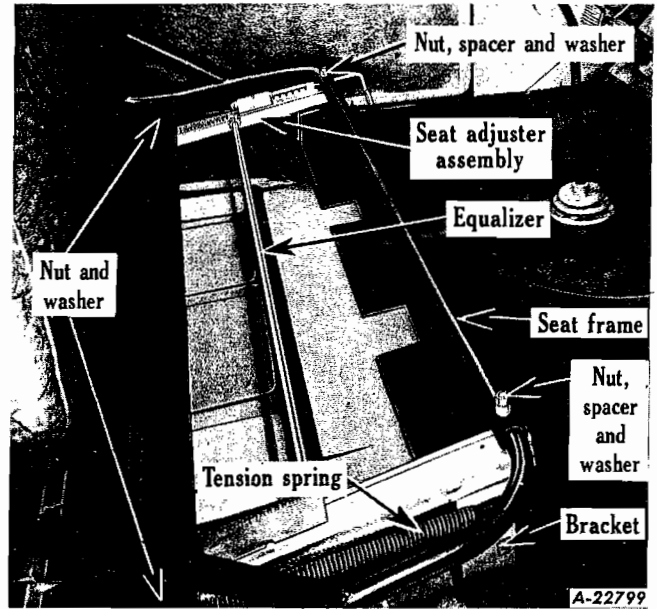
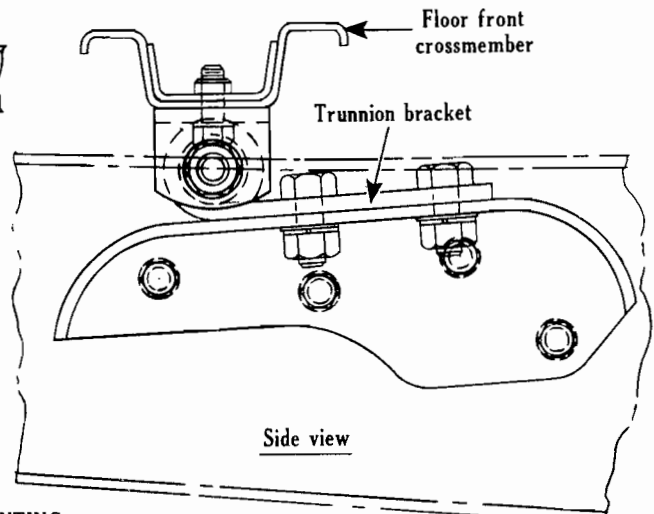
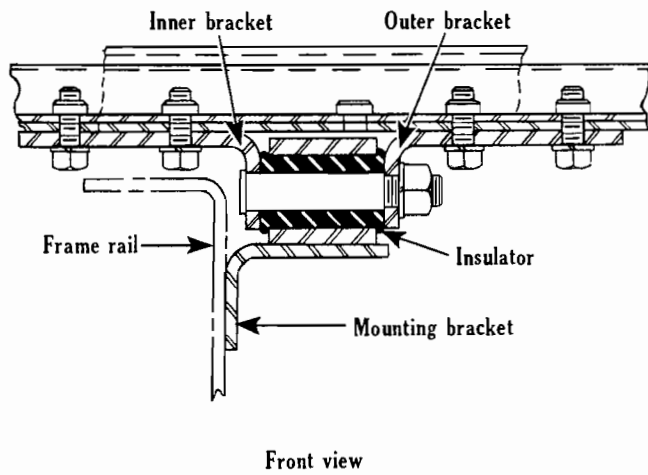


Fig. 50

Cab Mountings

Reference to the various drawings of cab mountings will reveal their construction details.

Mountings illustrated in Figs. 51, 52, 53, 54, 55, 56 and 57 should be assembled as shown and the mounting nuts tightened to slightly compress the insulators. Install cotter pins for mountings illustrated in Figs. 52 and 57.



FRONT MOUNTING

A-22703

Fig. 51 - L-110, L-120, L-130 Series

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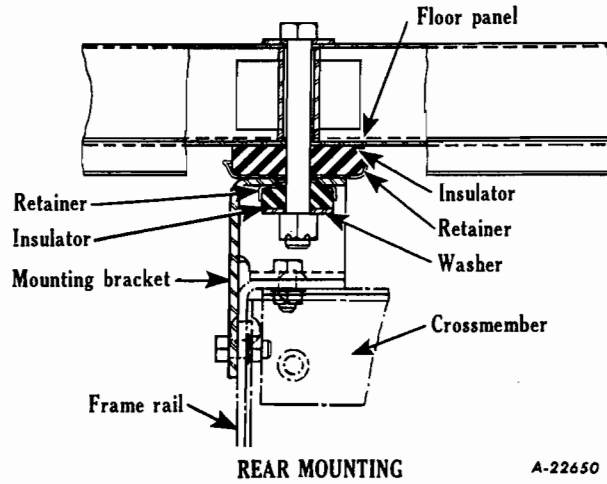


Fig. 52 - L-110, L-120, L-130 Series

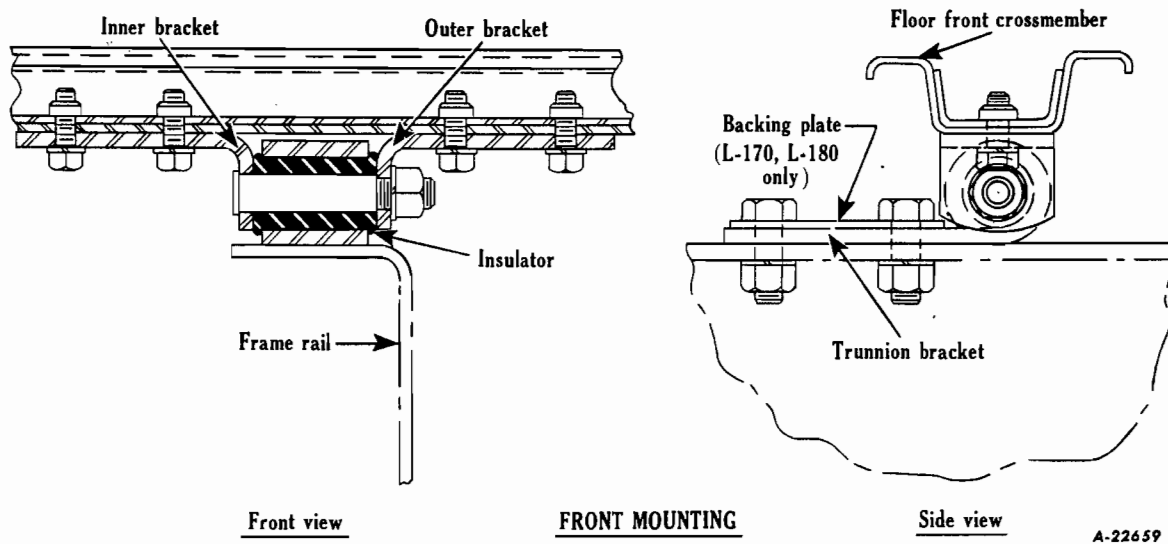


Fig. 53 - L-150, L-160, L-170, L-180 Series

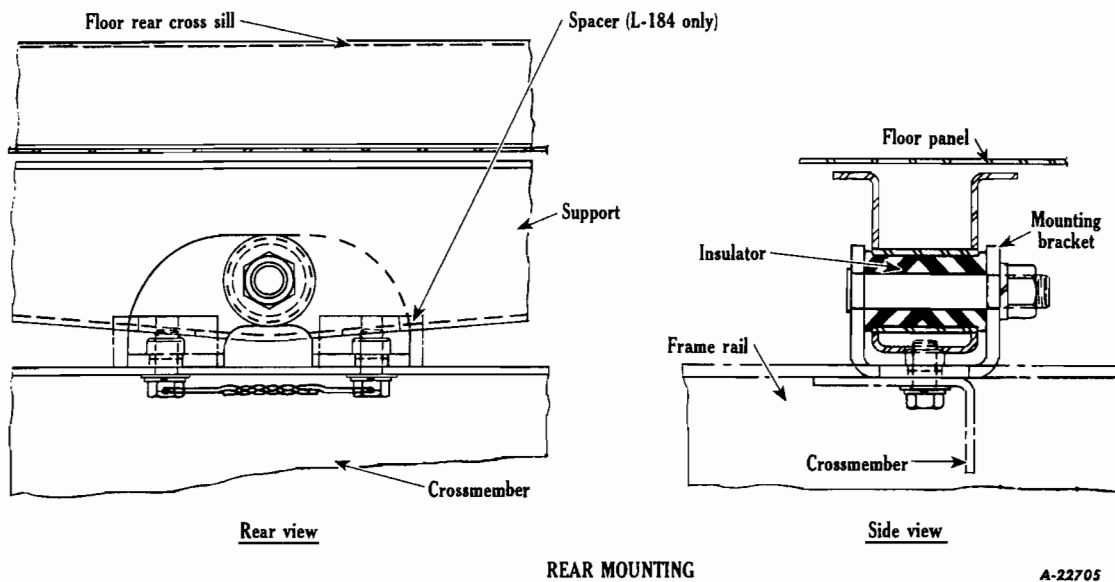
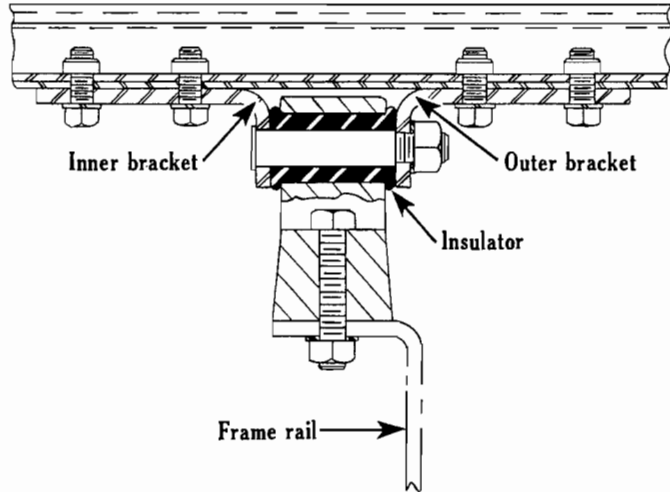


Fig. 54 - L-150, L-160, L-170, L-180 Series

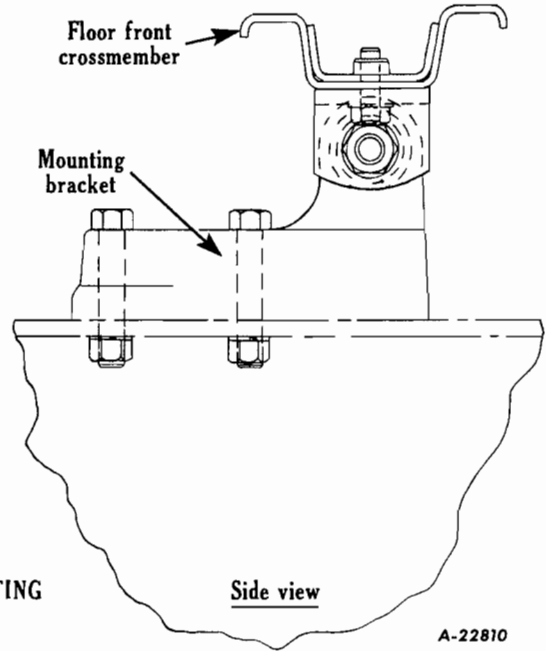


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Front view

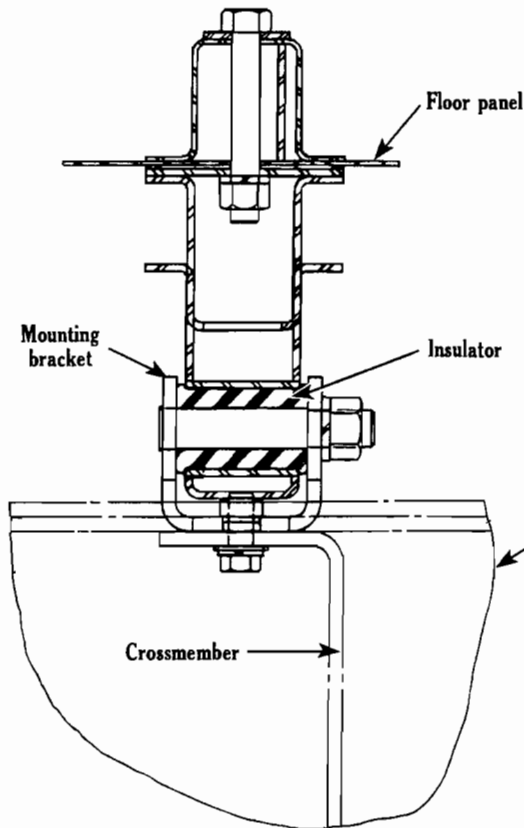
FRONT MOUNTING



Side view

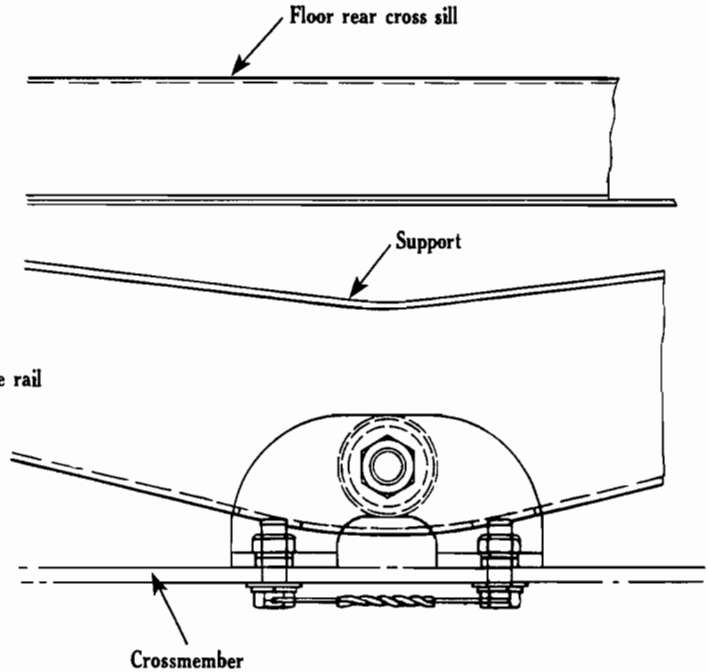
A-22810

Fig. 55 - L-190, L-200, L-210, L-220, L-230 Series



Side view

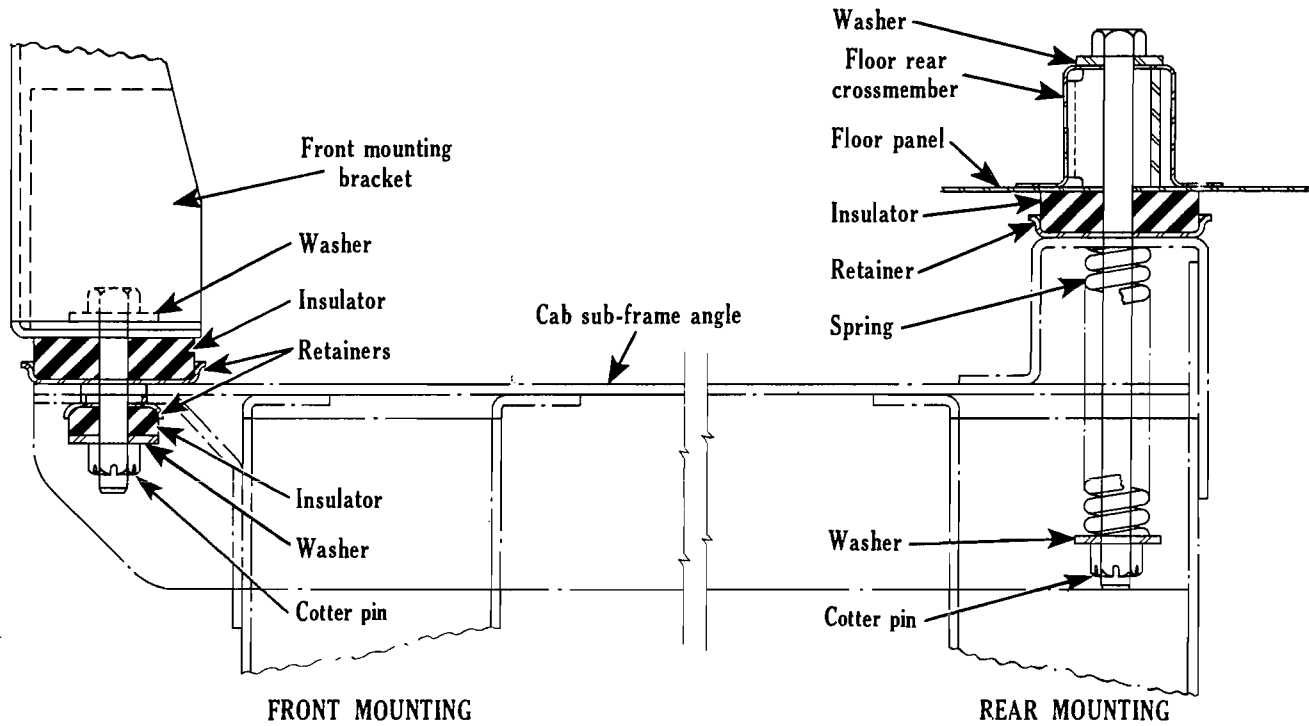
REAR MOUNTING



Rear view

A-22823

Fig. 56 - L-190, L-200, L-210, L-220, L-230 Series



A-22738

Fig. 57 - LC-160, LC-180 Series

Hood Assembly (L110 to L-180)

The hood assembly is hinged on both sides of the fender side shields. Turning the hood latch handles upward on either the left or right side of hood will permit raising the hood assembly.

TO REMOVE:

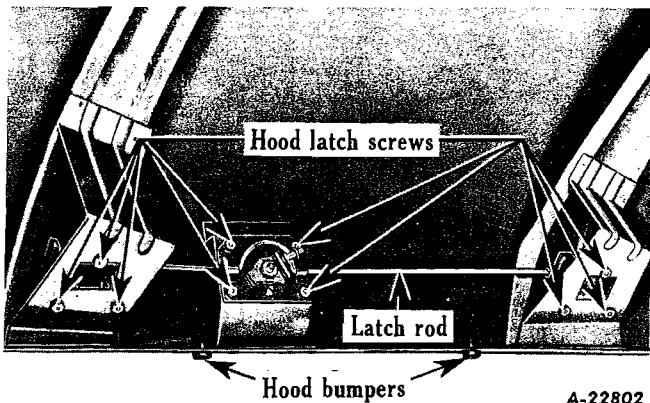
1. Release hood latch on both sides of hood by turning handles upward. Remove hood assembly.
2. Remove 10 hood latch retaining screws and lockwashers and remove hood latch assembly (Fig. 58).

TO INSTALL:

1. Install hood latch assembly to hood using 10 retaining screws and lockwashers.
2. With hood latch handles turned up, position hood assembly over hinges located on fender side shields and turn hood latch handles down to lock hood assembly.

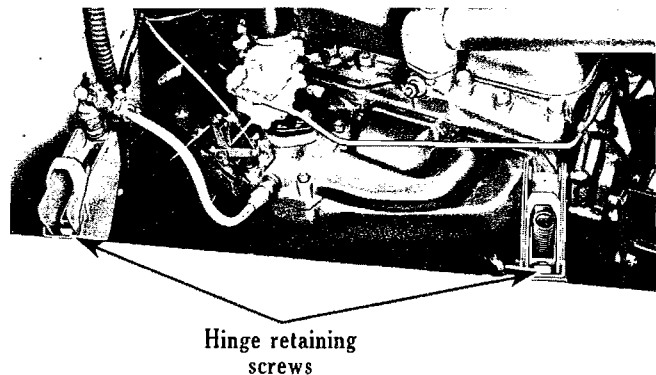
ADJUSTMENT:

1. Remove hood assembly.
2. Loosen hinge retaining screws at brackets and fender side shields (Fig. 59).



A-22802

Fig. 58



A-22726

Fig. 59



L-LINE MOTOR TRUCK SERVICE MANUAL

- The hood hinge mounting holes in the hinge mounting brackets and fender side shields are considerably larger than the mounting bolts to permit adjustment of the hinge brackets and alignment of the hood.
- Loosening hood latch retaining screws (Fig. 58) will permit aligning hood latch to hood hinges.
- Remove three wires from horn relay and pull horn wire towards the front of truck between the fender splash shield and radiator frame support. Mark wires for re-assembly.
- Pull head lamp wiring harness towards the rear through fender splash panel and remove all harnesses from the three clips located on fender side shield (Fig. 61).
- Remove two grille retaining screws, nuts and cotter keys from bracket located on front crossmember.

Hood Assembly (L-190 up)

The hood assembly is hinged in the center and attached to the cowl and radiator shell by retainers.

TO REMOVE:

- Release hood latch on both sides of hood by turning handles upward.
- Remove retaining screws and lockwashers from hood end of prop assembly.
- Remove retaining nuts and lockwashers from hood hinge retainers.
- Remove hood assembly.

TO INSTALL:

- With hood latch handles turned up, position hood assembly over cowl and radiator shell.
- Install hood hinge retainers to hood hinge, cowl and radiator shell.
- Install hood prop assembly and retaining screws to hood.

ADJUSTMENT:

Hood adjustment is accomplished by loosening the hood hinge retainer nuts and radiator shell stay rod nuts at brackets mounted on cowl and shortening or lengthening stay rods by re-adjusting retaining nuts.

Fender and Radiator Grille (L-110 to L-160)

The fenders and radiator grille are readily removed as a complete unit by following the procedure as outlined:

- Remove hood assembly.
- Remove head lamp wiring harness terminals from junction block on grille brace (Fig. 60). Mark wires for reassembly.
- Remove head lamp wiring harness from clip located on left side of grille brace (Fig. 60).
- Remove fender brace retaining screw (both sides) from cab (Fig. 62).
- Remove four fender stone deflector to cab retaining screws on both sides (Fig. 62).
- Remove fender to cab retaining screw and two cab to fender retaining screws from inside of cab on both sides (Fig. 62).

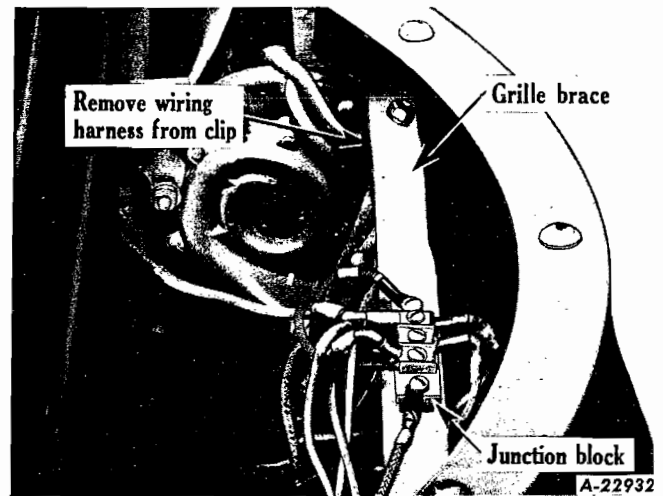


Fig. 60

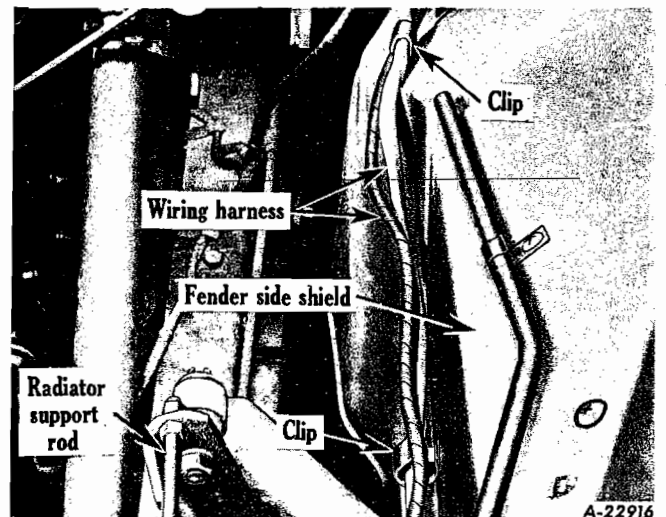


Fig. 61

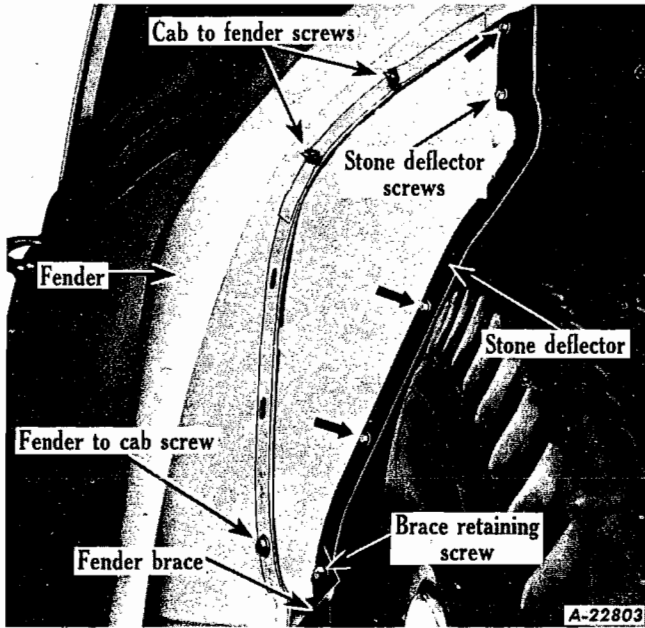


Fig. 62

10. Remove two fender side shield to cowl retaining screws on both sides (Fig. 63).

11. Remove front end section as a complete unit.

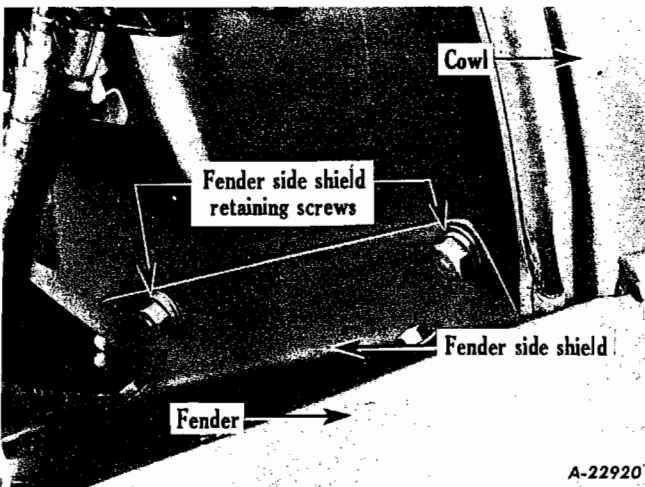


Fig. 63

Fenders and Radiator Grille (L-170 and L-180)

The fenders and radiator grille are readily removed as a complete unit by following the procedure as outlined:

1. Remove hood assembly and drain radiator.
2. Disconnect the head lamp, parking lamp and ground wires at the junction block on grille brace. Note identification numbers on wire for reassembly (Fig. 64).

3. Remove head lamp wiring harness and junction block ground cable from clip located on left side of grille brace (Fig. 64).

4. Remove three wires from horn relay and pull horn wire towards the front through fender splash panel. Mark wires for reassembly.

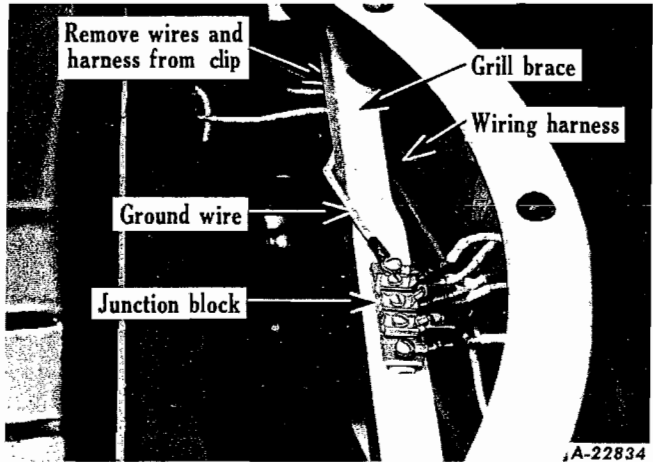


Fig. 64

5. Pull head lamp wiring harness towards the rear through fender splash panel and remove all harnesses from three clips located on fender side shield (Fig. 65).

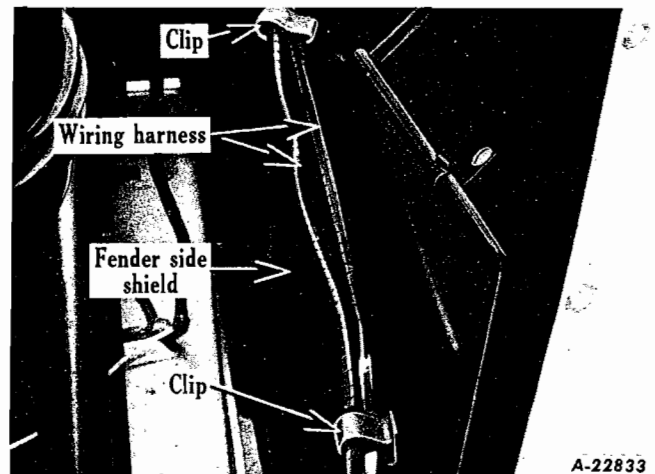


Fig. 65

6. Disconnect radiator hose clamp at radiator inlet. Pull radiator forward to facilitate removal of radiator support frame rubber pads (Fig. 66).

7. Remove the two front retaining nuts and washers (both sides) from radiator frame support pads (Fig. 66).

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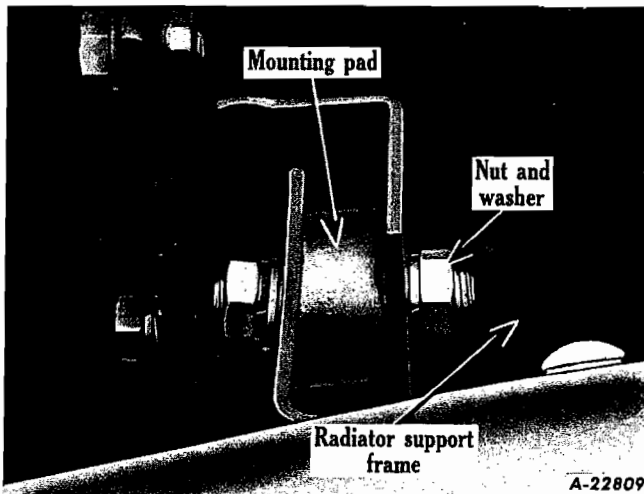


Fig. 66

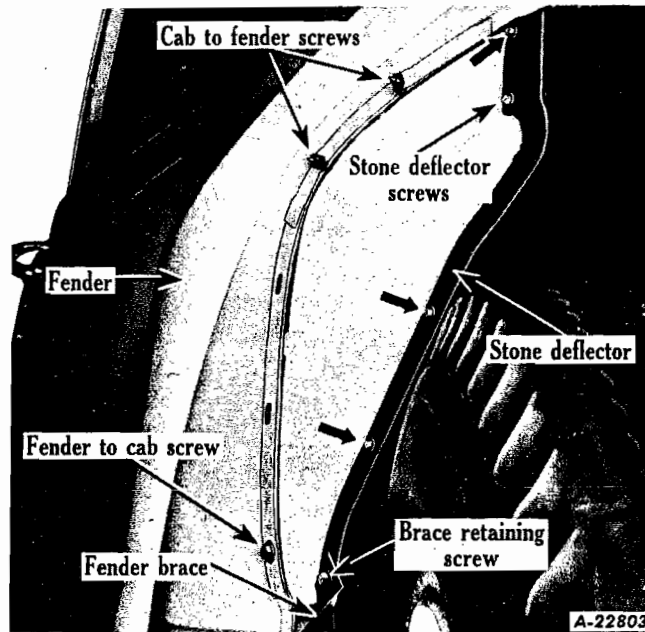


Fig. 68

8. Remove two grille crossmember retaining screws at frame rail (Fig. 67). (Illustration shows bumper removed to secure better view of operation.)

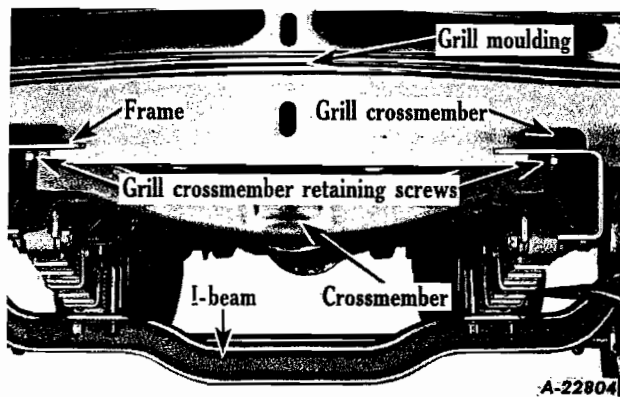


Fig. 67

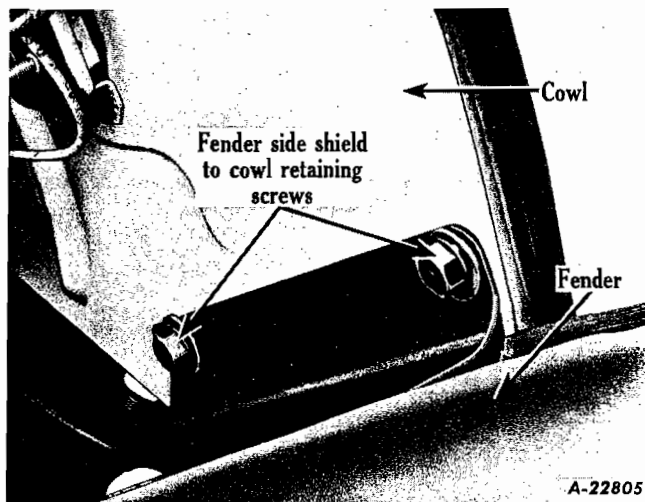


Fig. 69

9. Remove fender brace retaining screw (both sides) from cab (Fig. 68).
10. Remove four fender stone deflector to cab retaining screws on both sides (Fig. 68).
11. Remove fender to cab retaining screw and two cab to fender retaining screws from inside of cab on both sides (Fig. 68).
12. Remove two fender side shield to cowl retaining screws on both sides (Fig. 68).
13. Remove front end section as a complete unit.

Fender and Radiator Grille (L-190 up)

The fenders and radiator grille are readily removed as a complete unit by following the procedure as outlined:

1. Remove hood assembly AND DRAIN RADIATOR.
2. Remove radiator shell stay rods.
3. Disconnect radiator hose at radiator inlet.
4. Remove radiator frame support pad rear retaining nuts and washers on both sides of radiator (Fig. 70).



5. Loosen radiator frame support bracket retaining nuts at radiator shell to facilitate removal of brackets from radiator frame support pads (Fig. 70).
6. Remove grille to bracket at cross-member retaining screws and pads.

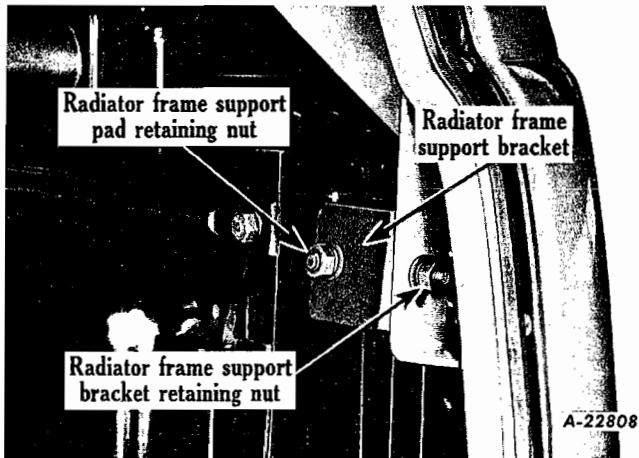


Fig. 70

7. Remove three bracket to fender retaining screws on both sides (Fig. 71).

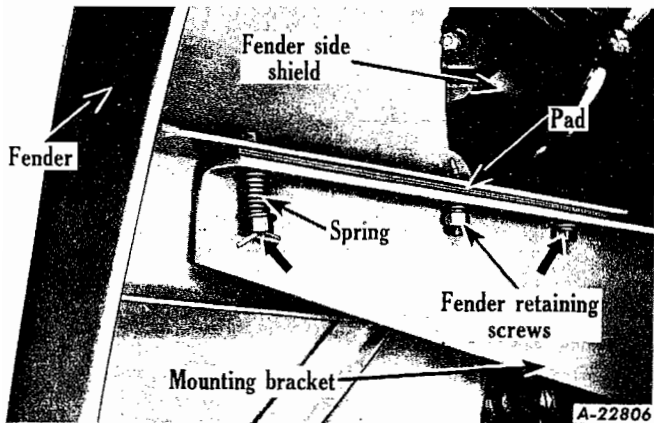


Fig. 71

8. Remove the three head lamp feed wires from junction blocks on both fender side shields (Fig. 72).
9. Remove front end section as a complete unit.

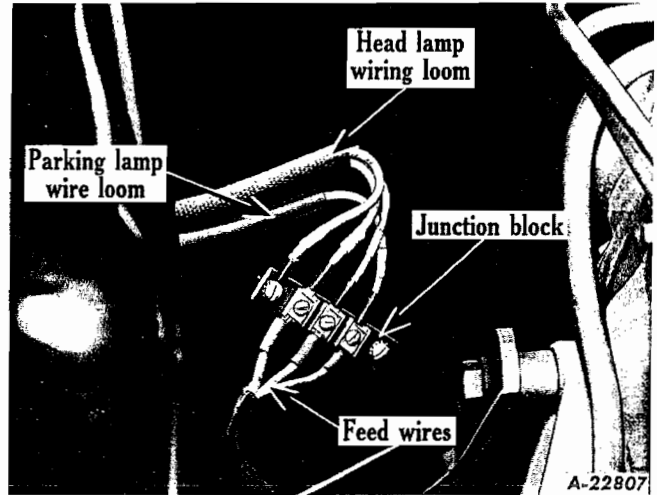


Fig. 72

Body Mountings

When mounting bodies on frames always place tight-fitting spacer blocks inside the frame channels at points where the U-bolts are to be installed. These filler blocks will support the frame flanges and prevent bending by the U-bolts.

The filler blocks should be so constructed that they will be form fitting in the channel and so constructed that the body U-bolt will rest in a recess in the block to prevent its loss should the bolt become loose. Fig. 73 illustrates the construction of such a block.

Well-seasoned wood should be used for filler block construction.

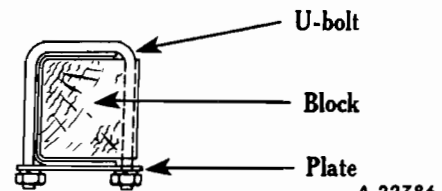
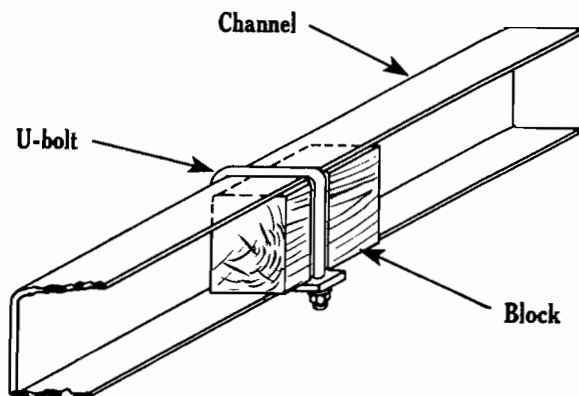


Fig. 73



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FIFTH WHEEL MOUNTING FOR TRACTOR AND TRAILER COMBINATIONS

Correct fifth-wheel mounting requires attention to two major factors--first, proper attachment of fifth-wheel unit to frame, and second, correct fifth-wheel king-pin location with respect to the centerline of the rear axle. Determination of the proper position involves consideration of several distinct factors and for full details, reference should be made to Sales Engineering Bulletin No. 9 (CT-209), dated October 1946.

Subsequent paragraphs describe general details of satisfactory fifth-wheel installations.

Fifth wheel sub-sills may be either of wood or angle iron construction and should always extend to within 1" from the back of the cab. Wood sub-sills (Fig. 74) should be of either kiln-dried oak or white ash and the same width as the frame rail. Notches should be cut into the sub-sill to provide clearance for frame cross-member rivets or other obstructions.

Wood sills of less than 4" in height should not be used.

Angle iron sills (Fig. 75), where desired, should be constructed in accordance with the following chart:

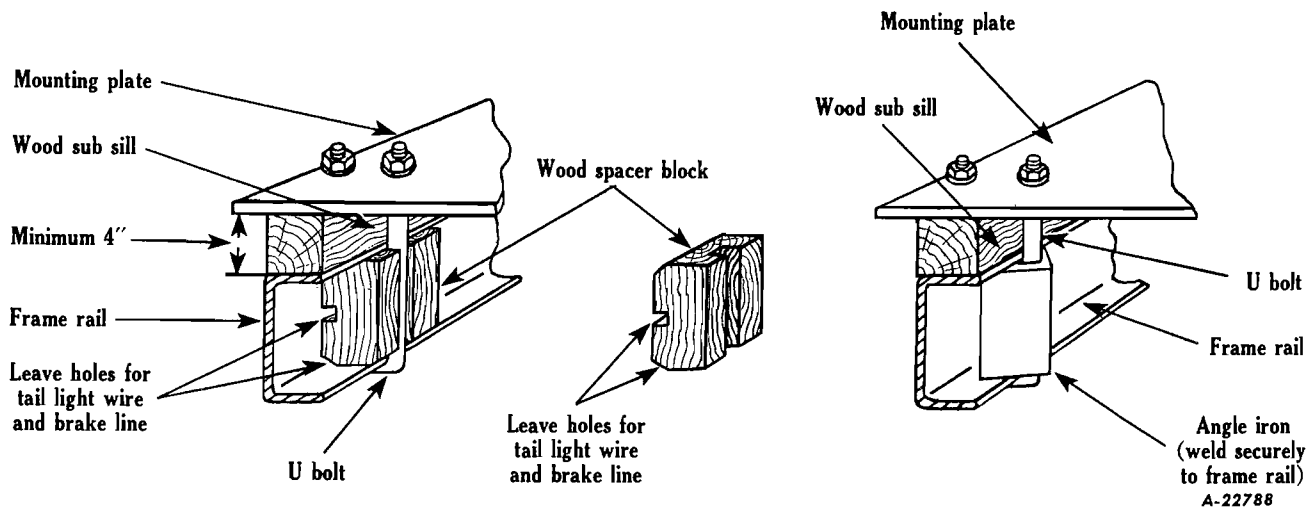


Fig. 74

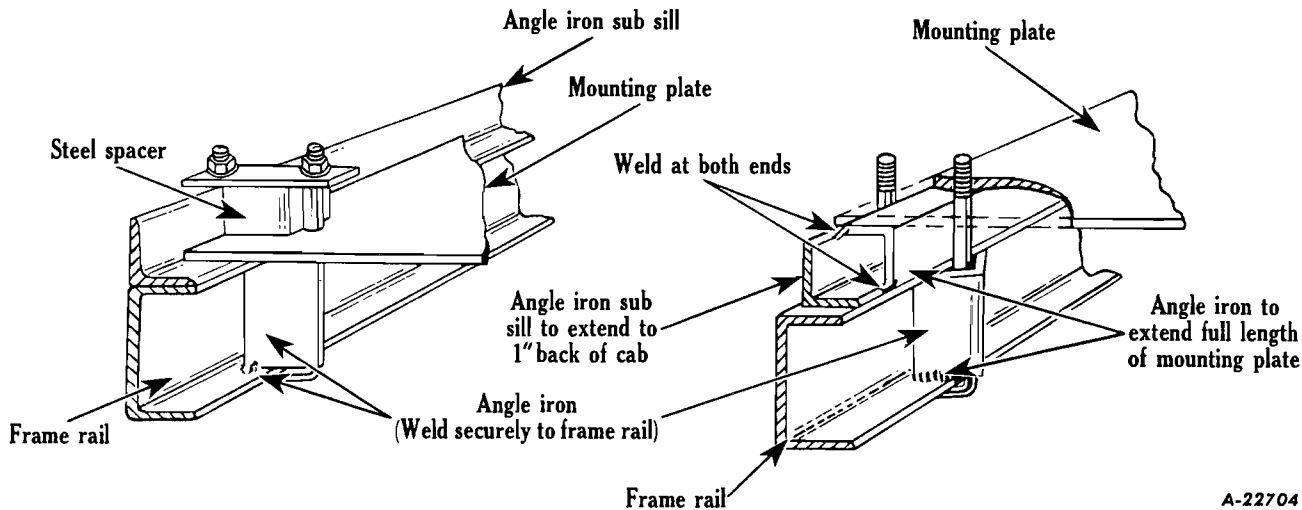


Fig. 75

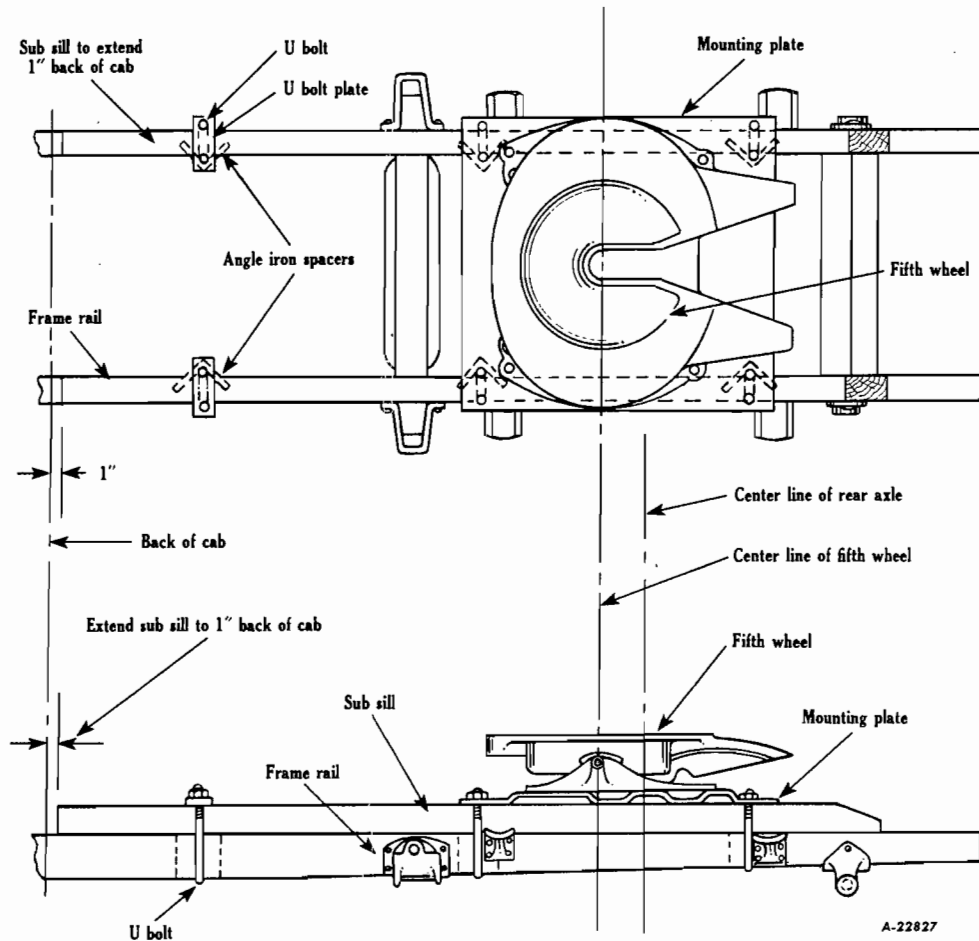


Fig. 76

- For 1-1/2 to 2 ton tractors--Use angle iron 3/8" x 3" x 3"
- For 2-1/2 to 3 ton tractors--Use angle iron 1/2" x 3-1/2" x 3-1/2"
- For 5 to 7 ton tractors--Use angle iron 5/8" x 3-1/2" x 3-1/2"

Fifth wheel mountings are generally referred to as being either "high-type" or "low-type". "Intermediate" or "medium" mountings are obtained by using variations of the "low-type" mountings.

Fig. 76 illustrates top and side view of a fifth wheel mounting to show relative position of the fifth wheel king-pin to the center line of the rear-axle.

The "high-type" mounting is shown in Fig. 76. Fig. 74 illustrates installation details and instructions for "high-type" mountings.

Fig. 77 illustrates an adaptation of the "low-type" mounting to provide a medium height.

Optional use of angle-iron and wood frame channel spacer blocks is illustrated in Figs. 74 and 75 and may be used in any type mounting. The angle-iron spacers where used should be tack-welded (electrical preferably) to the frame

flange as shown. Construction detail of wood spacer blocks is also shown in Fig. 74 and it must be noted that the direction of the wood grain is vertical.

CAUTION: Do not drill holes in frame rail or remove rivets.

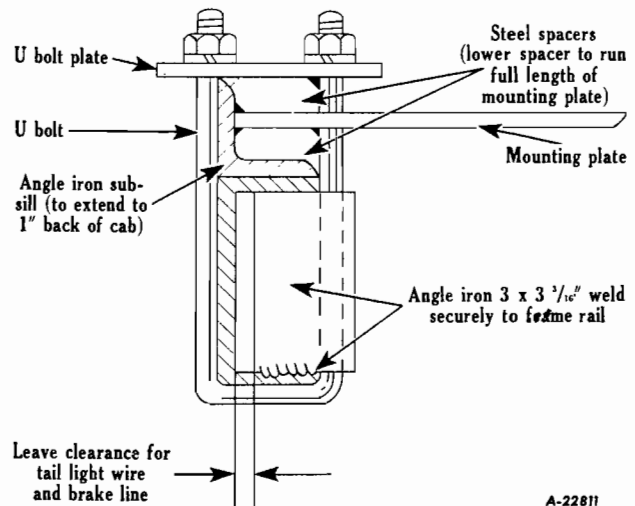


Fig. 77

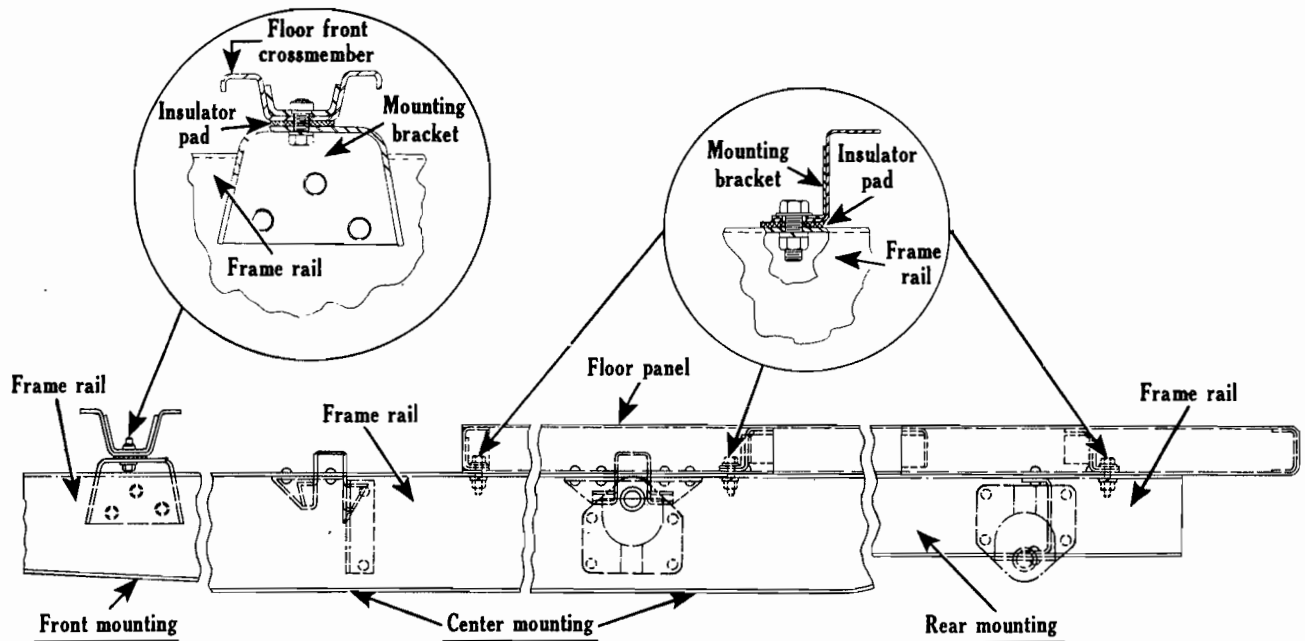


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Panel and Pick-Up Body Mountings

The panel and pick-up bodies are secured

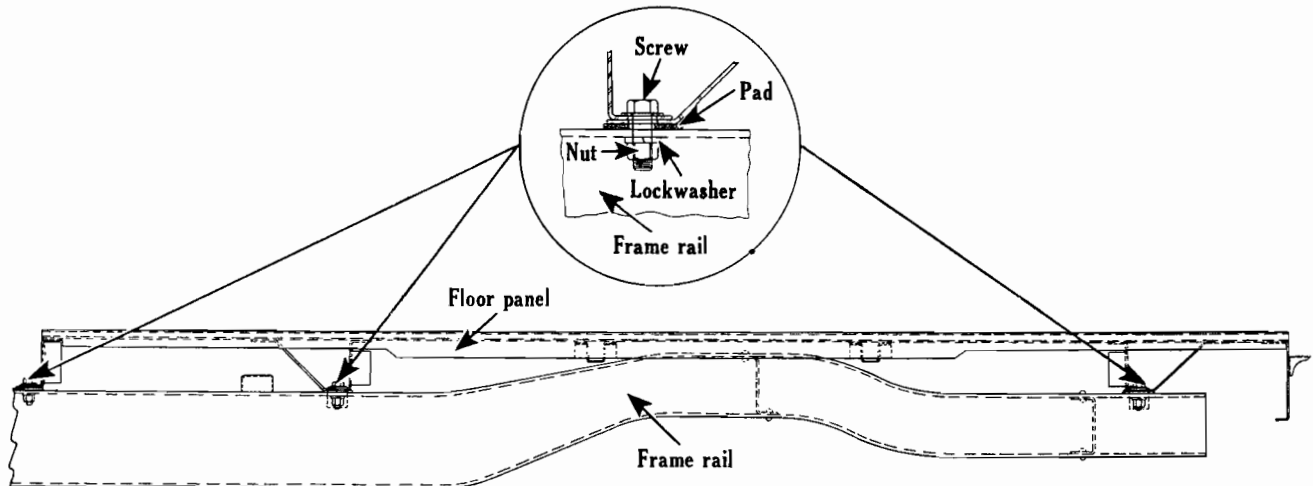
to frame rail by mounting pads, screws, nuts and lockwashers. Figs. 78 and 79 illustrate the construction of such mountings.



PANEL BODY (L110, L120)

A-22815

Fig. 78



PICK-UP BODY (L110, L120)

A-22819

Fig. 79



WINDSHIELD WIPER "TRICO"

(L-110 to L-160)

The windshield wiper motor, shafts and links assembly is readily removed providing the procedure outlined is followed:

1. Remove wiper link retaining clips at wiper motor shaft lever (Fig. 80).
2. Disconnect links from wiper motor shaft lever (Fig. 80).
3. Remove two windshield wiper motor retaining screws (Fig. 80). Lower wiper to facilitate next steps.
4. Loosen switch control cable retaining screw (Fig. 81). Remove control cable.
5. Remove vacuum hose from windshield wiper motor.
6. Remove windshield wiper motor.
7. Remove windshield wiper arms and blades.
8. Remove two windshield wiper arm shaft retaining nuts (Fig. 81).
9. Remove two windshield wiper arm shaft caps and gaskets (Fig. 81).
10. Remove windshield wiper arm shafts and links as an assembly.

TO INSTALL:

The windshield wiper motor, shafts and links assembly installation is accomplished by reversing the above procedure.

Lubrication

The windshield wiper arm links should be disconnected at the wiper motor and link sockets lubricated periodically with a light grade of machine oil (SAE-10).

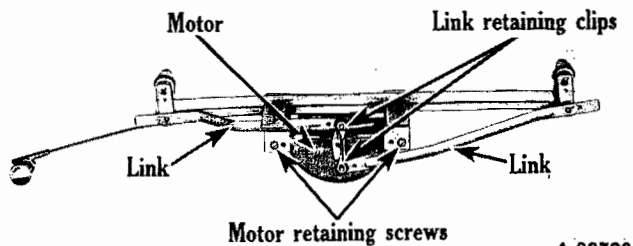
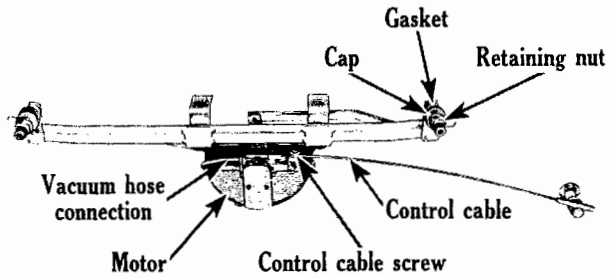


Fig. 80

A-22708



A-22707

Fig. 81

WINDSHIELD WIPER (L-170 up)

"AMERICAN BOSCH - WWB6A"

The windshield wiper motor is readily removed as a complete unit by following the procedure as outlined.

TO REMOVE:

1. Remove windshield wiper arms and blades.
2. Remove retaining nuts from windshield wiper arm shafts (Fig. 82).
3. Remove windshield wiper arm shaft caps and gaskets.

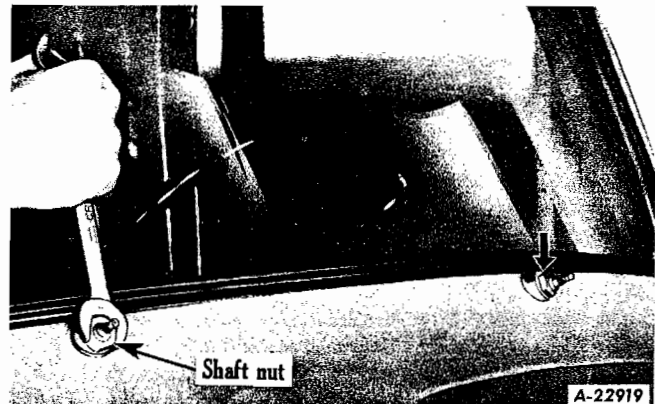


Fig. 82

4. Remove two windshield wiper retaining screws, nuts and washers (Fig. 83).
5. Remove four link arm spring retaining clips and washers from windshield wiper motor and windshield wiper arm shafts and remove link arms.
6. Remove windshield wiper motor (Fig. 84).
7. Remove windshield wiper electrical cables (Fig. 84). The terminal posts on the windshield wiper motor are marked "F", "A",



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and "P" to facilitate reassembling the harness wires. The wires in the harness are coded according to colors. The wire colored "Red" is to be installed in terminal post "F"; the wire colored "Black" is to be installed in terminal post "A"; and wire colored "Green" is to be installed in terminal post "P".

TO INSTALL:

Windshield wiper installation is accomplished by reversing the above procedure.

Lubrication

The windshield wiper arm links should be removed periodically and link sockets dipped in machine oil (SAE-10).

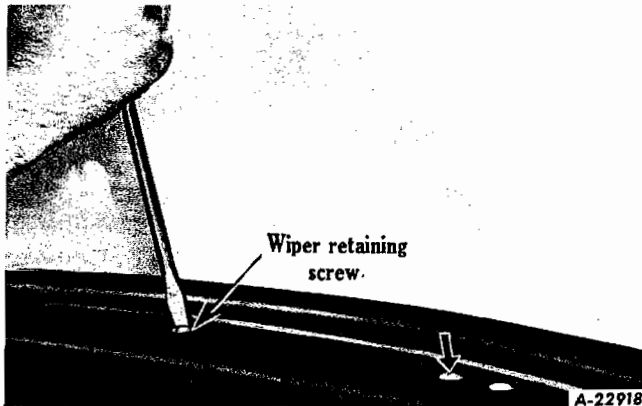


Fig. 83

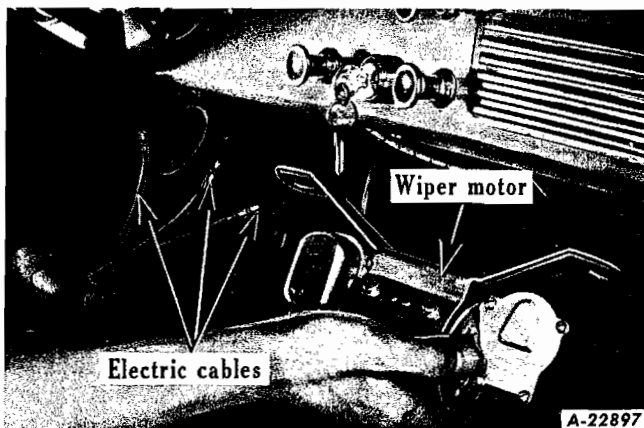


Fig. 84

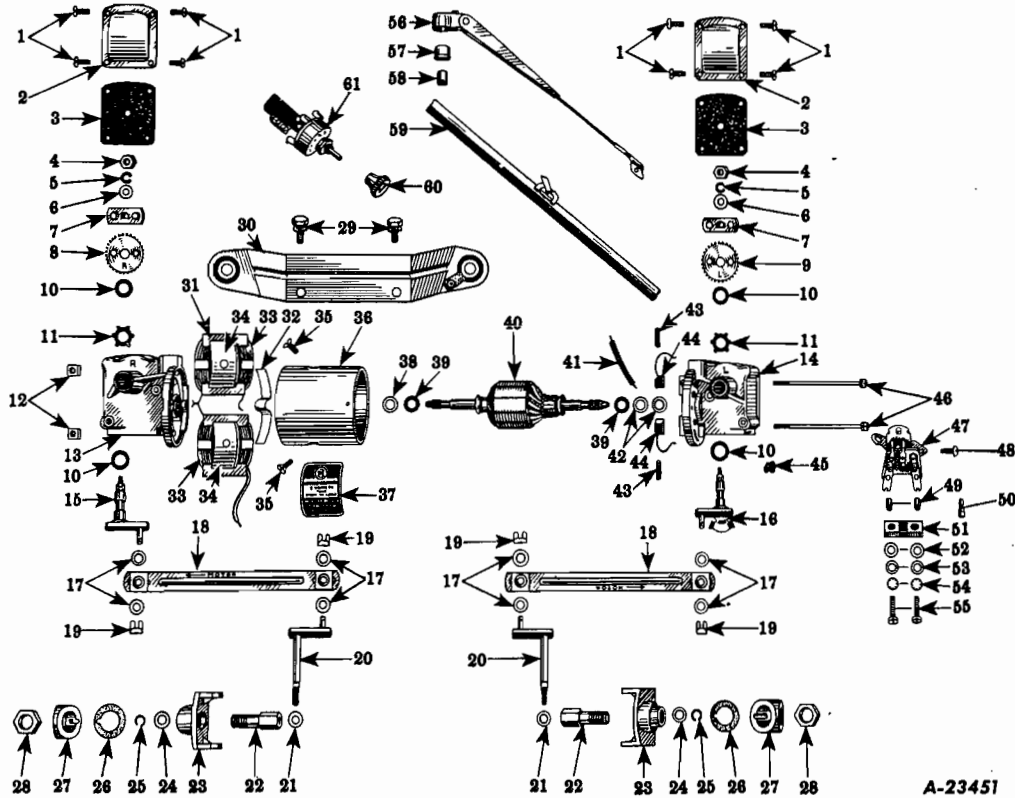
CAUTION! (INSTRUCT CUSTOMER)

Do not attempt manual movement of the blades or arms of a wiper that is not equipped with clutches. To do so will cause damage to the wiper arm shaft serrations and possibly other related parts.

When cleaning the windshield, always employ the standby feature of the wiper arm which lifts the blade clear of the windshield.



DUAL ELECTRIC WINDSHIELD WIPERS — TYPE WWB (AMERICAN BOSCH)



A-23451

Fig. 85

Item No.	Description	Item No.	Description	Item No.	Description
1.	Screw, gear housing cover.	19.	Clip, spring.	39.	Washer, insulation.
2.	Cover, gear housing.	20.	Shaft and crank-arm, wiper arm.	40.	Armature.
3.	Gasket, cover.	21.	Washer, spacing.	41.	Cable, brush holder.
4.	Nut, gear shaft and crank-arm assembly.	22.	Stud assembly, wiper arm.	42.	Washer, spacing.
5.	Washer, lock.	23.	Spacer, inner.	43.	Spring.
6.	Washer, plain.	24.	Washer, spacing.	44.	Brush, carbon.
7.	Plate, drive gear.	25.	Ring, spring.	45.	Grommet.
8.	Gear, right.	26.	Washer, sealing.	46.	Bolt, thru -.
9.	Gear, left.	27.	Spacer, outer.	47.	Switch, parking.
10.	Washer, spacing, fibre.	28.	Nut, fastening.	48.	Screw, parking switch.
11.	Washer, spring.	29.	Screw and lockwasher.	49.	Sleeve, insulation.
12.	Nut, thru-bolt.	30.	Bracket assembly.	50.	Terminal, cable.
13.	Housing, gear, right.	31.	Strip, insulation.	51.	Resistor.
14.	Housing, gear, left.	32.	Strip, insulation.	52.	Washer, insulation.
15.	Shaft and crank-arm gear, right.	33.	Coil, field.	53.	Washer, plain.
16.	Shaft and crank-arm gear, left.	34.	Shoe, pole.	54.	Washer, star.
17.	Washer, link assembly.	35.	Screw, pole shoe.	55.	Screw, fastening.
18.	Link assembly, connecting.	36.	Housing assembly, motor.	56.	Arm, wiper.
		37.	Name plate.	57.	Adapter, wiper arm.
		38.	Washer, spacing.	58.	Nut, wiper arm.
				59.	Blade, wiper.
				60.	Knob, switch.
				61.	Switch, manual.

DUAL ELECTRIC WINDSHIELD WIPERS (AMERICAN-BOSCH TYPE WWB)

General Description

The American Bosch WWB dual electric windshield wiper is a two-speed, unit designed to simultaneously operate two arms and blades in either a parallel or opposed wiping motion.

The electric windshield wiper consists of the following components:

- Motor assembly.
- Two connecting link assemblies.
- Two wiper-arm shaft and crank-arm assemblies.
- Mounting bracket.
- Manually operated switch.

This new dual wiper is available for 6 and 12 volt installations (See Fig. 85) and incorporates the following features:

1. Dual speed shunt wound motor.
2. Double extension type armature shaft with a single thread worm at each end.
3. Self-aligning bronze bearings.
4. Two-speed control located in manually operated three-position switch (61).
5. Thermostatic overload circuit breaker located on manually operated switch.
6. Low current draw:
 - (a) Approximately 4.0 amperes at 6-volts and 2.0 amperes at 12-volts (depending on load) in low-speed position.
 - (b) Approximately 3.0 amperes at 6-volts and 1.5 amperes at 12-volts (depending on load) in high-speed position.
7. Wiping angles from 85° up to 118°.
8. Automatic parking switch (47). This switch is connected in parallel with the manual switch when the latter is in the "OFF" position. The wiper motor will continue to operate until the cam located on the gear shaft (16) engages the parking switch button. Also refer to Fig. 86
9. Four parking positions for the wiper blades:
 - (a) Right or left hand (parallel wiping motion).
 - (b). Inboard or outboard (opposed wiping motion).

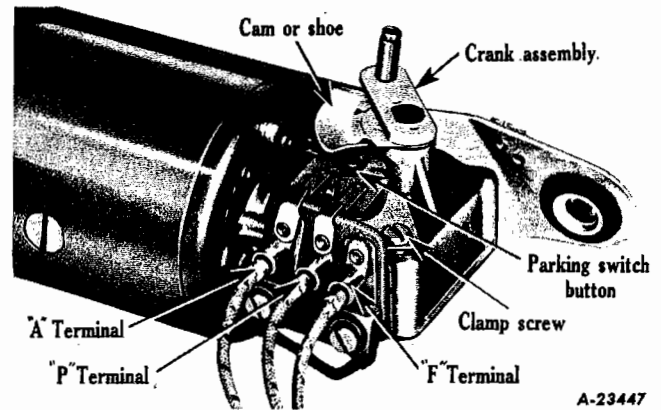


Fig. 86

Disassembly

1. Before removing the motor assembly from the vehicle and with the wiper blades parked, carefully note the relative positions of the crank-arms which are part of the gear shafts (15 and 16). This is necessary in order that the correct wiping motion and parking of the blades is retained following reassembly.
2. Remove the connecting link assemblies (18) from the gear shafts and crank-arms and remove the motor assembly from the vehicle.
3. Remove the gear housing covers (2) and gaskets (3).
4. Remove the gear shaft and crank-arm fastening nuts and tap out both assemblies from the gear housings.
5. Remove both thru-bolts (46).
6. Remove the right (R) gear housing (13) from the motor housing (36) being careful not to remove the armature (40). This can be accomplished as follows:
 - (a) Set the motor assembly in an upright position on the left (L) gear housing (14).
 - (b) Grasp the motor housing in the left hand.
 - (c) Carefully remove the right gear housing (13) with the right hand and at the same time maintain a downward pressure on the armature with the index finger.
7. Unsolder the field lead from the "F" terminal of the parking switch (47).
8. Remove the left (L) gear housing (14) and armature, as a unit, from the motor housing (36).



9. Hold both brushes (44) clear of the commutator so that they do not rub on the armature shaft and worm, and remove the armature from the gear housing. The brushes must be kept free of grease at all times.

Cleaning

All parts except the field coils (33), armature (40) and parking switch (47) should be washed in a good commercial cleaning solvent. Bearing equipped parts should be washed with a brush dipped in a good commercial cleaning solvent taking care that as little as possible of the cleaning fluid comes in contact with the bearings.

DO NOT IMMERSE BEARING EQUIPPED PARTS IN A CLEANING FLUID. Thoroughly dry all parts that have been washed in the cleaning fluid.

The field coils, armature and parking switch may be wiped with a clean dry cloth or compressed air may be used if available.

Inspection

ARMATURE (40)

Check the armature insulation by applying a 110-volt (60 cycle) test lamp between the commutator and armature shaft.

HOUSING AND FIELD COIL ASSEMBLY

Check the resistance of the field coils with an accurate ohmmeter. The total field coil resistance of a 6-volt wiper is approximately 2.8 ohms; of a 12-volt wiper, approximately 11.2 ohms.

GEAR HOUSING AND BRUSH HOLDER ASSEMBLY (14)

Check the insulated brush holder by applying a 110-volt (60 cycle) test lamp between the brush holder and the gear housing.

BRUSH SPRINGS (43)

Brush springs with a free length of less than 1" should be replaced.

BRUSHES

Damaged brushes or brushes worn down beyond 2/3 of their overall length must be replaced.

Examine all other parts for damage and wear; replace as necessary.

Lubrication

GEARS (8 and 9) AND GEAR HOUSINGS (13 and 14): 1/3 full of US 515 grease - spread over gear teeth and worm.

ARMATURE SHAFT BEARINGS: 2 or 3 drops of SAE-10 oil in surrounding felt.

GEAR SHAFT AND CRANK-ARMS (15 and 16): Fill recessed section of shafts with US 515 grease.

CONNECTING LINK ASSEMBLY BEARINGS (18): Several drops of SAE-10 oil.

STUD ASSEMBLIES (22): Fill space between bushings with US 515 grease.

Reassembly

Reassembly is accomplished in the reverse order of disassembly up to and including the reassembly of both thru bolts to the motor housing. The gear shafts and crank-arms (15 and 16) are reassembled to their respective gear housings as follows:

1. Reassemble the gear drive plate (7) to the gear (8 or 9).
2. Replace either the right (R) or left (L) gear shaft and crank-arm in the correct position.
3. Carefully reassemble the spring washer (11) and spacing washer (10) to the large diameter of the gear shaft.)
4. Line up the flat on the shaft with the flat on the gear drive plate, then drop the gear drive plate (7) and gear (8 or 9) in place on the shaft.
5. Secure the assembly with the plain washer (6), lockwasher (5) and the fastening nut (4).
6. If the position of the crank-arm shifted during the above procedure, reposition by turning the armature shaft as required.
7. Reassemble the remaining gear and crank-arm into its gear housing in accordance with instructions in items 1 to 5.
8. Before securing the assembly, make certain both crank-arms are in correct relation to each other. If a correction is necessary, proceed as follows:
 - (a) Remove the gear drive plate (7) and gear (8 or 9).
 - (b) Reposition the crank-arm until it is in correct relation to the other.



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- (c) Reassemble the gear and gear drive plate to the shaft and secure the assembly as in item

Testing

Before installing the motor assembly in the vehicle, check the operation of the assembly as follows:

1. Temporarily connect either the plus (+) or minus (-) terminal of a battery to the motor housing. The battery should be fully charged and of appropriate voltage.
2. Temporarily connect a "jumper" between the "A" and "F" terminals on the motor terminal plate (See Fig. 86).
3. Connect the remaining battery terminal to "A" on the motor terminal plate; this will result in the low speed operation of the motor. At this speed the crank-arms should revolve at approximately 45 cycles per minute.
4. To check high speed operation, remove the battery connection from terminal "A" on the motor terminal plate.
5. Remove the temporary "jumper" from terminals "A" and "F" on the motor terminal plate.
6. Reconnect the battery to terminal "A" on the motor terminal plate. This should result in the high speed operation of the motor. At this speed the crank-arms should revolve at approximately 65 cycles per minute.

The parking feature of the wiper should be checked after the motor assembly has been remounted on the vehicle and the connecting link assemblies (18) replaced on the gear shafts. The wiper should be operated thru the manual switch (61).

There have been instances where the electric windshield wiper has continued to operate after the switch has been turned to the "OFF" position. This is caused by the parking switch button shoe or cam located on the left hand shaft and crank assembly to break the circuit. To overcome this complaint, the shoe (Fig. 2) should be carefully bent towards the switch only enough to bear harder against the switch button but not contact or rub against the switch body. The shoe must be parallel to the face of the switch body.

In event the windshield wiper will not start from the parking position after the switch is turned "ON", the switch button should be checked to see if it is stuck in the depressed position.

If such is the case, pull the wire from the "B" terminal at the control switch and "snap" or "flip" the switch button to break it loose.

The parking switch is provided with an adjustment feature to permit close adjustment of the parking position of the wiper blades. This adjustment has been made at the factory and should not require change. A clamp screw (Figure 2) holds the parking switch assembly in position after adjustment.

The overload circuit breaker, located in a 6 volt manually operated switch (61), should carry approximately 10 to 12 amperes before opening; and in a 12 volt switch, approximately 5 to 6 amperes before opening.

CAUTION: (Instruct Customer)

Do not attempt manual movement of the blades or arms of a wiper that is not equipped with clutches. To do so will cause damage to the wiper arm shaft serrations and possibly other related parts.



BRAKE GROUP

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13" x 2-1/2" (TYPE "F")

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HYDRAULIC BRAKE SPECIFICATIONS

TRUCK MODEL	L-110 L-111 L-112	L-120 L-121 L-122	LM-120 LM-121 LM-122	L-130 L-131 L-132	LB-140	L-150	L-151 L-152 L-153	LM-150 LM-151
Brake Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Brake Size (Standard):								
Front	12x1-3/4x3/16	12x1-3/4x3/16	12x1-3/4x3/16	12x1-3/4x3/16	12x1-3/4x3/16	12-1/8x2x1/4	12-1/8x2x1/4	12-1/8x2x1/4
Rear	12x1-3/4x3/16	12x2x3/16	12x2x3/16	14x2-1/4x1/4	14x2-1/4x1/4	14-1/8x3x3/8	14-1/8x3x3/8	14x2-1/4x1/4
Brake Size (Increased Capacity):								
Front (Same as Standard) . . . . .	.....	.....	.....	.....	.....	12-1/8x2x1/4	.....	12-1/8x2x1/4
Rear . . . . .	.....	.....	.....	.....	.....	14-1/8x3x3/8	.....	14-1/8x3x3/8
Number of Shoes:								
Front	2	2	2	2	2	2	2	2
Rear	2	2	2	2	2	2	2	2
Type of Anchor:								
Front	Single	Single	Single	Single	Single	Single	Single	Single
Rear	Single	Single	Single	Single	Single	Single	Single	Single
Wheel Cylinder Size (Standard):								
Front	1	1	1	1	1	1	1	1
Rear	1	1-1/8	1-1/8	1-1/4	1-1/4	1-1/4	1-3/8	1-1/4
Wheel Cylinder Size (Increased Capacity):								
Front (Same as Standard) . . . . .	.....	.....	.....	.....	.....	1	.....	1
Rear . . . . .	.....	.....	.....	.....	.....	1-3/8	.....	1-3/8
Number of Wheel Cylinders (Standard):								
Front	1	1	1	1	1	1	1	1
Rear	1	1	1	1	1	1	1	1
Number of Wheel Cylinders (Increased Capacity):								
Front (Same as Standard) . . . . .	.....	.....	.....	.....	.....	1	.....	1
Rear . . . . .	.....	.....	.....	.....	.....	2	.....	2
Master Cylinder: Size (Bore and Stroke)	1-1/8x1-7/16	1-1/8x1-7/16	1-1/8x1-7/16	1-1/8x1-7/16	1-1/8x1-7/16	1-1/8x1-7/16	1-1/4x1-7/16	1-1/8x1-7/16
Type	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel
Hydrovac:								
Standard or Optional . . . . .	.....	.....	.....	.....	.....	Optional	Optional	.....
Model No. (Bendix) . . . . .	.....	.....	.....	.....	.....	374000	374000	.....
Series	"C"	"C"
Cylinder Diameter	6-3/4"	6-3/4"
Single or Tandem Piston	Single	Single

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HYDRAULIC BRAKE SPECIFICATIONS - Continued

TRUCK MODEL	LM-152	L-160 L-161 L-162 L-163 L-165	L-164	LC-160 LC-161 LC-162	L-170 L-171 L-172 L-173 L-175	L-174
Brake Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Brake Size (Standard):						
Front	12-1/8x2x1/4	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16
Rear	14-1/8x3x3/8	14-1/8x3x3/8	15x3x3/8	14-1/8x3x3/8	15x3x3/8	15x4x3/8
Brake Size (Increased Capacity):						
Front (Same as Standard) . . . . .	. . . . .	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16	12-1/8x2-1/4x5/16
Rear . . . . .	. . . . .	15x4x3/8	15x4x3/8	15x4x3/8	15x4x3/8	15x5x3/8
Number of Shoes:						
Front	2	2	2	2	2	2
Rear	2	2	2	2	2	2
Type of Anchor:						
Front	Single	Double	Double	Double	Double	Double
Rear	Double	Double	Double	Double	Double	Double
Wheel Cylinder Size (Standard):						
Front	1	1-1/8	1-1/8	1-1/8	1-1/4	1-1/4
Rear	1-3/8	1-3/8	1-3/8	1-3/8	1-1/2	1-1/2
Wheel Cylinder Size (Increased Capacity):						
Front (Same as Standard) . . . . .	. . . . .	1-1/8	1-1/8	1-1/8	1-1/4	1-1/4
Rear . . . . .	. . . . .	1-3/8	1-3/8	1-3/8	1-1/2	1-1/2
Number of Wheel Cylinders (Standard):						
Front	1	2	2	2	2	2
Rear	2	2	2	2	2	2
Number of Wheel Cylinders (Increased Capacity):						
Front (Same as Standard) . . . . .	. . . . .	2	2	2	2	2
Rear . . . . .	. . . . .	2	2	2	2	2
Master Cylinder:						
Size (Bore and Stroke)	1-1/4x1-7/16	1-1/4x1-7/16	1-1/4x1-7/16	1-1/4x1-7/16	1-1/2x1-7/16	1-1/2x1-7/16
Type	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel
Hydrovac:						
Standard or Optional . . . . .	. . . . .	Standard	Standard	Standard	Standard	Standard
Model No. (Bendix) . . . . .	. . . . .	374000	374000	374000	375279 *	375279 *
Series . . . . .	. . . . .	"C"	"C"	"C"	"C"	"C"
Cylinder Diameter . . . . .	. . . . .	6-3/4"	6-3/4"	6-3/4"	9-1/2"	9-1/2"
Single or Tandem Piston . . . . .	. . . . .	Single	Single	Single	Single (Guided)	Single (Guided)

* These hydrovacs contain a residual pressure check valve and must be used with a master cylinder that does not have a residual pressure check valve.



HYDRAULIC BRAKE SPECIFICATIONS - Continued

TRUCK MODEL	LF-170 LF-171 LF-172	L-180 L-181 L-182 L-183 L-185	L-184	LC-180 LC-181 LC-182	L-190 L-191 L-192 L-193 L-195	L-194
Brake Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Brake Size (Standard): Front	12-1/8x2-1/4x5/16	13x2-1/4x5/16	13x2-1/4x5/16	13x2-1/4x5/16	15x2-1/4x5/16	15x2-1/4x5/16
Rear	15x3x3/8	15x4x3/8	16x4x3/8	15x4x3/8	16x4x3/8	16x5x3/8
Brake Size (Increased Capacity): Front (Same as Standard)	12-1/8x2-1/4x5/16	13x2-1/4x5/16	13x2-1/4x5/16	13x2-1/4x5/16	15x2-1/4x5/16	15x2-1/4x5/16
Rear	15x4x3/8	15x5x3/8	16x5x3/8	15x5x3/8	16x5x3/8	16x6x3/8
Number of Shoes: Front	2	2	2	2	2	2
Rear	2	2	2	2	2	2
Type of Anchor: Front	Double	Double	Double	Double	Double	Double
Rear	Double	Double	Double	Double	Double	Double
Wheel Cylinder Size (Standard): Front	1-1/4	1-1/8	1-1/8	1-1/8	1-1/4	1-1/4
Rear	1-3/8	1-1/2	1-1/2	1-3/4	1-3/4	1-3/4
Wheel Cylinder Size (Increased Capacity): Front (Same as Standard)	1-1/4	1-1/8	1-1/8	1-1/8	1-1/4	1-1/4
Rear	1-3/8	1-1/2	1-1/2	1-1/2	1-3/4	1-3/4
Number of Wheel Cylinders (Standard): Front	2	2	2	2	2	2
Rear	2	2	2	2	2	2
Number of Wheel Cylinders (Increased Capacity): Front (Same as Standard)	2	2	2	2	2	2
Rear	2	2	2	2	2	2
Master Cylinder: Size (Bore and Stroke)	1-3/4x1-7/16	1-1/2x1-7/16	1-1/2x1-7/16	1-1/2x1-7/16	1-3/4x1-7/16	1-3/4x1-7/16
Type	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel
Hydrovac: Standard or Optional	Standard	Standard	Standard	Standard	Standard	Standard
Model No. (Bendix)	375278 *	375279 *	375279 *	375279 *	375278 *	375278 *
Series	"C"	"C"	"C"	"C"	"C"	"C"
Cylinder Diameter	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"
Single or Tandem Piston	Single (Guided)	Single (Guided)	Single (Guided)	Single (Guided)	Single (Guided)	Single (Guided)

* These hydrovacs contain a residual pressure check valve and must be used with a master cylinder that does not have a residual pressure check valve.

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HYDRAULIC BRAKE SPECIFICATIONS - Continued

TRUCK MODEL	LF-190 LF-191 LF-192	LC-190 LC-191 LC-192	L-200 L-201 L-202 L-205	L-204	LC-200 LC-201 LC-202	L-201 L-211
Brake Type	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Brake Size (Standard):						
Front	15x2-1/4x5/16	15x2-1/4x5/16	15x2-1/4x5/16	15x2-1/4x5/16	12x2-1/4x5/16	16-1/2x3-1/2x5/8
Rear	15x4x3/8	16x4x3/8	16x5x3/8	16-1/2x7-1/8x5/8	16x5x3/8	16-1/2x7-1/8x5/8
Brake Size (Increased Capacity):						
Front (Same as Standard)	15x2-1/4x5/16	15x2-1/4x5/16	15x2-1/4x5/16	. . . . .	15x2-1/4x5/16	. . . . .
Rear	15x5x3/8	16x5x3/8	16x6x3/8	. . . . .	16x6x3/8	. . . . .
Number of Shoes:						
Front	2	2	2	2	2	2
Rear	2	2	2	2	2	4
Type of Anchor:						
Front	Double	Double	Double	Double	Double	Double
Rear	Double	Double	Double	Double	Double	Double
Wheel Cylinder Size (Standard):						
Front	1-1/4	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2
Rear	1-1/2	1-3/4	1-3/4	1-5/8	1-3/4	1-5/8
Wheel Cylinder Size (Increased Capacity):						
Front (Same as Standard)	1-1/4	1-1/4	1-1/4	. . . . .	1-1/4	. . . . .
Rear	1-1/2	1-3/4	1-3/4	. . . . .	1-3/4	. . . . .
Number of Wheel Cylinders (Standard):						
Front	2	2	2	2	2	2
Rear	2	2	2	2 Siamese Twin-type	2	2 Siamese Twin-type
Number of Wheel Cylinders (Increased Capacity):						
Front (Same as Standard)	2	2	2	. . . . .	2	. . . . .
Rear	2	2	2	. . . . .	2	. . . . .
Master Cylinder:						
Size (Bore and Stroke)	1-3/4x2-1/2	1-3/4x1-7/16	1-3/4x1-7/16	1-3/4x2-1/2	1-3/4x1-7/16	1-3/4x2-1/2
Type	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel
Hydrovac:						
Standard or Optional	Standard	Standard	Standard	Standard	Standard	Standard
Model No. (Bendix)	374229 *	375278 *	375278 *	374230 *	375278 *	374230 *
Series	"C"	"C"	"C"	"C"	"C"	"C"
Cylinder Diameter	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"	9-1/2"
Single or Tandem Piston	Tandem	Single (Guided)	Single (Guided)	Tandem	Single (Guided)	Tandem

* These hydrovacs contain a residual pressure check valve and must be used with a master cylinder that does not have a residual pressure check valve.



HYDRAULIC BRAKE SPECIFICATIONS - Continued

TRUCK MODEL	LF-210 LF-211 LF-212	L-220 L-225	LF-160 LF-221 LF-222	L-230 L-231	LF-230 LF-231
Brake Type	Hydraulic	. . . . .	Hydraulic	. . . . .	. . . . .
Brake Size (Standard):					
Front	16-1/2x3-1/2x5/8	. . . . .	16-1/2x3-1/2x5/8	. . . . .	. . . . .
Rear	16x4x3/8	. . . . .	16x4x3/8	. . . . .	. . . . .
Brake Size (Increased Capacity):					
Front (Same as Standard) . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Rear . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Number of Shoes:					
Front	2	. . . . .	2	. . . . .	. . . . .
Rear	2	. . . . .	2	. . . . .	. . . . .
Type of Anchor:					
Front	Double	. . . . .	Double	. . . . .	. . . . .
Rear	Double	. . . . .	Double	. . . . .	. . . . .
Wheel Cylinder Size (Standard):					
Front	1-1/2	. . . . .	1-1/2	. . . . .	. . . . .
Rear	1-3/4	. . . . .	1-3/4	. . . . .	. . . . .
Wheel Cylinder Size (Increased Capacity):					
Front (Same as Standard) . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Rear . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Number of Wheel Cylinders (Standard):					
Front	2	. . . . .	2	. . . . .	. . . . .
Rear	2	. . . . .	2	. . . . .	. . . . .
Number of Wheel Cylinders (Increased Capacity):					
Front (Same as Standard) . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Rear . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Master Cylinder:					
Size (Bore and Stroke)	1-3/4x2-1/2	. . . . .	1-3/4x2-1/2	. . . . .	. . . . .
Type	Barrel	Barrel	. . . . .	. . . . .	. . . . .
Hydrovac:					
Standard or Optional	Standard	. . . . .	Standard	. . . . .	. . . . .
Model No. (Bendix)	374230 *	. . . . .	374230 *	. . . . .	. . . . .
Series	"C"	. . . . .	"C"	. . . . .	. . . . .
Cylinder Diameter	9-1/2"	. . . . .	9-1/2"	. . . . .	. . . . .
Single or Tandem Piston	Tandem	. . . . .	Tandem	. . . . .	. . . . .

* These hydrovacs contain a residual pressure check valve and must be used with a master cylinder that does not have a residual pressure check valve.

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AIR BRAKE SPECIFICATIONS

TRUCK MODEL	L-180 L-181 L-182 L-185	LC-180 LC-181 LC-182	L-184 L-190 L-191 L-192 L-195	LF-190 LF-191 LF-192	LC-190 LC-191 LC-192	L-194 L-200 L-201 L-202 L-205	LC-200 LC-201 LC-202
Standard or Special. . . .	Special	.....	Special	.....	.....	Special	.....
Brake Size:							
Front.	16x2-1/4x5/16	.....	16x2-1/4x5/16	.....	.....	16x2-1/4x5/16	.....
Rear	16x5-1/2x1/2	.....	16-1/2x6x3/4	.....	.....	16-1/2x6x3/4	.....
Brake Chamber-Front:							
Location.	Back. Plate	.....	Back. Plate	.....	.....	Back. Plate	.....
Type	E	.....	E	.....	.....	E	.....
Size	6-3/16	.....	6-3/16	.....	.....	6-3/16	.....
Brake Chamber-Rear:							
Location.	Axle Pad	.....	Axle Pad	.....	.....	Axle Pad	.....
Type	C	.....	C	.....	.....	B	.....
Size.	8-1/16	.....	9-3/16	.....	.....	9-3/16	.....
Slack Adjuster Length:							
Front.	3-3/8	.....	4	.....	.....	5	.....
Rear	6	.....	6	.....	.....	7	.....
Brake Valve:							
Model.	D-1	.....	D-1	.....	.....	D-1	.....
Control.	Foot Pedal	.....	Foot Pedal	.....	.....	Foot Pedal	.....
Air Reservoir:							
Number Used.	1	.....	1	.....	.....	1	.....
Length and Diameter.	41-1/2x8	.....	41-1/2x8	.....	.....	41-1/2x8	.....
Air Compressor:							
Type (Westinghouse).	2-Cyl.	.....	2-Cyl.	.....	.....	2-Cyl.	.....
Capacity in Cu. Ft . .	7-1/4	.....	7-1/4	.....	.....	7-1/4	.....
Cooling.	Water	.....	Water	.....	.....	Water	.....
Mounting.	Engine	.....	Engine	.....	.....	Engine	.....
Drive.	Belt	.....	Belt	.....	.....	Belt	.....



AIR BRAKE SPECIFICATIONS - Continued

TRUCK MODEL	L-204	L-210 L-211	LF-210 LF-211 LF-212	L-220 L-225	LF-220 LF-221 LF-222	L-230 L-231	LF-230 LF-231
Standard or Special.	Special	Special	.....	.....	.....	.....	.....
Brake Size:							
Front.	16x2-1/4x5/16	17-1/4x3x3/8	.....	.....	.....	.....	.....
Rear	16-1/2x7x3/4	16-1/2x7x3/4	.....	.....	.....	.....	.....
Brake Chamber-Front:							
Location.	Back. Plate	Back. Plate	.....	.....	.....	.....	.....
Type	E	A	.....	.....	.....	.....	.....
Size	6-3/16	6-15/16	.....	.....	.....	.....	.....
Brake Chamber-Rear:							
Location.	Axle Pad	Axle Pad	.....	.....	.....	.....	.....
Type	G	G	.....	.....	.....	.....	.....
Size	9-7/8	9-7/8	.....	.....	.....	.....	.....
Slack Adjuster Length:							
Front.	5	5	.....	.....	.....	.....	.....
Rear	6-1/2	6-1/2	.....	.....	.....	.....	.....
Brake Valve:							
Model.	D-1	D-1	.....	.....	.....	.....	.....
Control.	Foot Pedal	Foot Pedal	.....	.....	.....	.....	.....
Air Reservoir:							
Number Used.	1	1	.....	.....	.....	.....	.....
Length and Diameter. .	41-1/2x8	41-1/2x8	.....	.....	.....	.....	.....
Air Compressor:							
Type (Westinghouse) . .	2-Cyl.	2-Cyl.	.....	.....	.....	.....	.....
Capacity Cu. Ft.	7-1/4	7-1/4
Cooling.	Water	Water
Mounting.	Engine	Engine
Drive	Belt	Belt

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HYDRAULIC BRAKES

HYDRAULIC BRAKE SYSTEM

The hydraulic system used to actuate the brake mechanism consists of a compensating type master cylinder in which the hydraulic pressure is originated; individual wheel cylinders, in which the hydraulic pressure is applied, which serve to actuate the brake shoes against the brake drum of each wheel; and the "Line" consisting of steel tubing, flexible hose, brackets and unions, interconnecting the master cylinder and wheel cylinders. The master cylinder and wheel cylinders are fitted with pistons, all of which are provided with cup packings, which act as a seal to maintain pressure and prevent loss of brake fluid.

Depressing the brake pedal moves the piston within the master cylinder, thus displacing the brake fluid from the master cylinder through its outlet orifices, tubing and flexible hose connections into the wheel cylinders. The brake fluid, being noncompressible, enters each of the wheel cylinders, causing the cylinder pistons to move outward and actuate the brake shoes. As pressure on the pedal is increased, greater hydraulic pressure is built up within the wheel cylinders, and consequently greater force is exerted against the shoes.

When the pressure on the pedal is released, the brake shoe retracting springs return the brake shoes to their normal or released position. The return movement of the brake shoes, in turn, causes movement of the wheel cylinder pistons toward their released position, thus forcing the fluid back thru the tubing into the master cylinder.

Hydraulic Fluid

Always use genuine "Lockheed" or other high grade automotive type brake fluid. The use of other than genuine "Lockheed" or any high grade automotive type brake fluid or the introduction of mineral base oil into the system will cause rubber parts to swell and become inoperative.

Combination Type Master Cylinder (Fig. 1)

The combination type master cylinder consists of barrel and tank casting, double check valve (L), piston cup return spring (I), piston cup (D), piston (B), piston stop (P), boot (G) and connecting link (A).

The fluid reservoir or supply tank is cast integral over the master cylinder barrel. A combination filler and breather plug (N) permits atmospheric pressure on the reserve fluid at all times.

Depression of the pedal causes piston (B) and cup (D) to move forward in the cylinder barrel. A very small forward movement of cup (D) closes

compensating port (C) and the pressure stroke commences.

Actual pressure is not built up until the fluid displaced has caused all shoes to go into contact with their drums. Additional pressure on the pedal produces hydraulic pressure within the brake system.

Removal of operator's foot from the brake pedal after each brake application permits the brake pedal and push rod (A) to return independently to their off-position.

The return of piston (B) and cup (D) is accomplished by the piston return spring (I).

The piston for this type of unit is designed to carry a primary cup (D) and a secondary cup (E). The construction of the piston is such that reserve fluid from the tank passes through vent (R) in a recessed area. Thus we have fluid on both sides of the primary cup. The secondary cup (E) is merely a seal to prevent loss of reserve fluid into boot (G).

The combination type master cylinder is also known as a compensating type. Its primary compensating function is to maintain a constant volume of fluid in the system at all times, regardless of expansion (heat) or contraction (cold). The secondary compensating function is the replacement of additional fluid into the system to counterbalance any loss due to gravity seepage.

The return to off-position of piston (B) and cup (D) is much faster in displaced volume than the return of the fluid through fitting (J) into the master cylinder. A momentary vacuum is created in the cylinder barrel and additional fluid is drawn into the system through the drilled holes in piston (B) and past the lip of cup (D). The operating fluid returns more slowly from the wheel cylinders and lines back into the master cylinder barrel. Any excess is by-passed by port (C) into the reservoir. Thus we have a cylinder full of fluid for the next brake application.

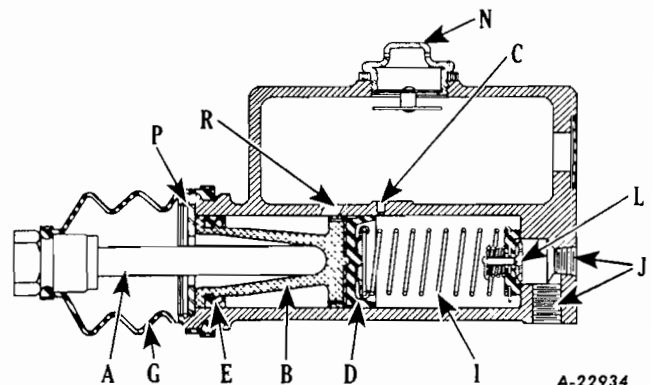


Fig. 1 - Typical Combination Type Master Cylinder.



Check Valve

A double check valve is used in all master cylinders of the compensating type. It is held in the closed end of the master cylinder barrel by the piston cup return spring.

The valve performs two functions:

It acts as a seal to prevent fluid or air being drawn into the system through the bleeder screw during the bleeding operation.

Fluid passed through the valve on the pressure stroke can return into the master cylinder barrel only by raising the entire valve from its seat. The valve is held in place by the cup return spring.

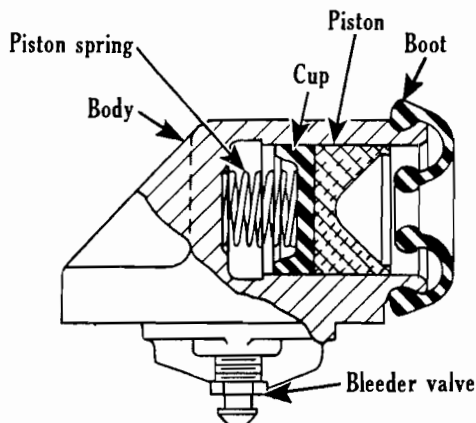
When the pressure on the returning fluid drops below 6 to 8 pounds, the spring closes the valve and the system is under a slight pressure. This pressure will not cause the shoes to drag. It is used to assure a positive seal at the wheel cylinder cup packings.

The valve does not control brake pedal movement. Do not try to remedy this complaint by changing the valve.

NOTE: On vehicles equipped with certain models of Hydrovacs the check valve is located in the Hydrovac slave cylinder tube; and where this is the case, no check valve is used in the master cylinder. (See Hydrovac Specifications.)

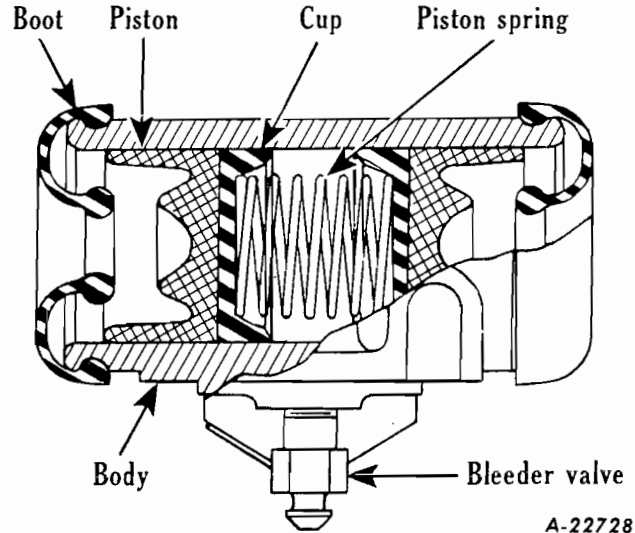
Wheel Cylinders (Fig. 2 and 3)

Two types of wheel cylinders are used in the hydraulic brake system. Different combinations of these two types of cylinders are used on different model trucks. Fig. 2 illustrates a single piston wheel cylinder, and Fig. 3 illustrates a double piston wheel cylinder. The wheel cylinder assembly is the unit that changes the applied hydraulic pressure into mechanical force to actuate the brake shoes.



A-22743

Fig. 2 - Typical Wheel Cylinder (Single-piston type).



A-22728

Fig. 3 - Typical Wheel Cylinder (Double-piston type).

Repairs to Master and Wheel Cylinders

It is possible to rehone the majority of cylinders and place them in good working condition; however, this requires the use of up-to-date honing equipment and plug gauges. A cylinder hone kit is available under number SE-1679, and a set of plug gauges under number SE-1000.

If this equipment is not available, we recommend that the unit be taken to the nearest Wagner Service Branch or Authorized Service Station for repairing.

Cylinders and parts must not be washed in gasoline, kerosene or oil. Use high-grade denatured alcohol.

Care

Keep all lubricant and brake fluid away from brake linings.

Inspect master cylinder at the time of making brake adjustments -- for correct fluid level. Fluid should be within $3/8$ " from bottom of filler neck. Do not fill supply reservoir to top of filler neck. Caution: When removing supply reservoir filler cap, extreme care must be used to prevent dirt or moisture from entering master cylinder.

Brake Pedal Adjustment

When brake control system is in release position, foot brake pedal should have $1/4$ " free travel (Fig. 4) before the pressure stroke starts. This free travel is required to prevent blocking of compensating port in master cylinder. Brakes will drag if compensating port becomes blocked due to pressure building up in the system. Shorten pedal push-rod to allow piston to uncover compensating port, allowing fluid to escape into tank.

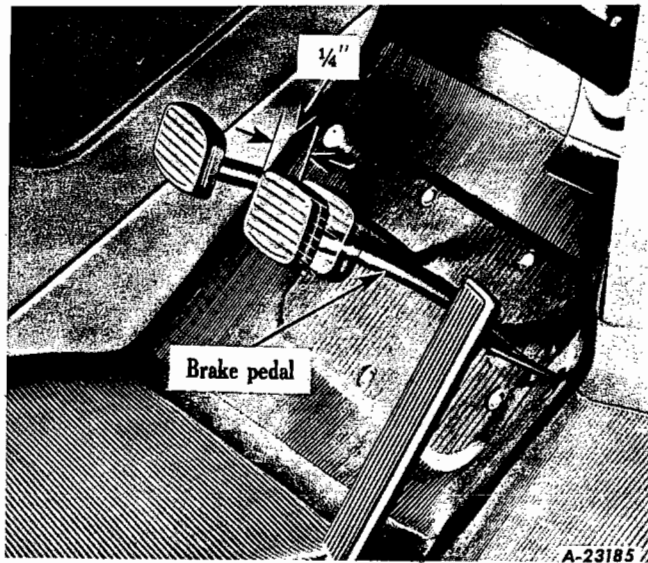


Fig. 4 - Brake Pedal Free Travel.

Bleeding The Lines (Also see Hydrovac Section)

Any air inside the hydraulic system must be removed. Whenever a line has been disconnected at master cylinder, the entire system must be bled at all wheels until all air is completely expelled. When a line has been disconnected at any wheel cylinder, this cylinder together with the cylinder on the opposite wheel must be bled. Air in the system will cause a springy, rubbery action of the brake pedal. Should a sufficient quantity be introduced into the system, the brake pedal will go to toeboard under normal pressure.

Fill master cylinder supply reservoir with genuine Lockheed or any high grade automotive type brake fluid and see that it is kept at least half full during entire bleeding operation.

Use pressure-type brake bleeder where available. Attach bleeder tube to bleeder valve by pushing tube over the end of bleeder valve. Allow tube to hang in a clean container, such as a pint glass jar. Unscrew bleeder valve $3/4$ turn and depress brake pedal by hand, using half strokes, allowing pedal to return slowly. Pumping brake pedal forces fluid out into glass jar, and carries with it any air which might be present in the system. Watch flow of fluid from tube, the end of which should be kept below surface of fluid in pint bottle, and when all air bubbles cease to appear or when stream is a solid fluid mass, close bleeder valve. (See Fig. 5.)

Fluid withdrawn in bleeding operation should not be used again, unless absolutely certain that it does not contain impurities. Fluid of

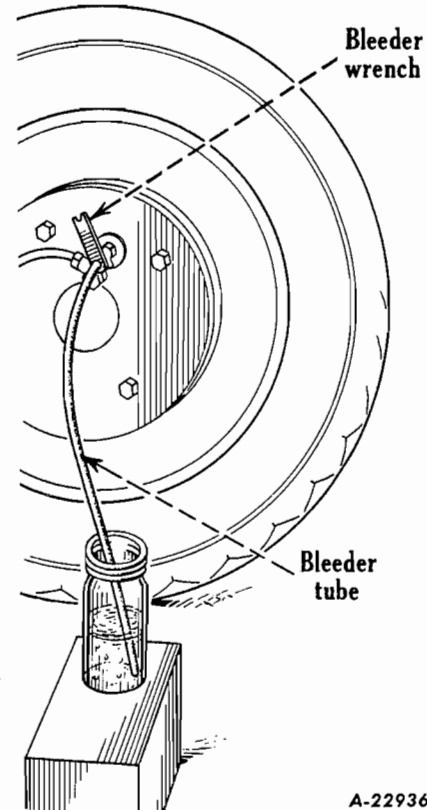


Fig. 5

which the cleanliness is questionable should never be used. Fluid should be replenished in supply reservoir after each cylinder is bled. Should supply reservoir be drained during bleeding operation, air will enter the system and re-bleeding will then be necessary.

Maintenance Hints

1. PEDAL GOES TO FLOOR BOARD:

Cause

- (a) Normal wear of lining.
- (b) Brake shoes not properly adjusted.
- (c) Leak in system.
- (d) Air in system.
- (e) Pedal improperly set.
- (f) No fluid in supply reservoir.

Remedy

- (a) When brake linings become worn it is necessary to set the shoes into closer relation to brake drums. This condition is usually accompanied by the remark that it is necessary to pump the pedal several times before a brake is obtained. Shoes should be set in accordance with instructions on ADJUSTMENTS FOR WEAR. Do not disturb anchor pins when making this adjustment. Adjustment must be made while drums are cool.



(b) In cases where the anchor pins have been disturbed and the relation of the arc of the shoes to drums changed, lining will wear rapidly and the braking efficiency of that particular wheel will be reduced. To overcome this condition, follow instructions as outlined in MAJOR ADJUSTMENTS, brake shoe adjustment sections.

(c) A leak in the system will allow the pedal, under pressure, to go to toe board gradually. If no leaks are found at wheels or joints, remove master cylinder and check bore of barrel for scores or scratches.

(d) Air in the system will cause a springy, rubbery action of the pedal. Should a sufficient quantity be introduced into the system, the pedal will go to toe board under normal pressure. System should be bled.

(e) Brake pedals should be set to give the correct amount of free movement before the pressure stroke starts. Excessive free movement reduces the active travel of the master cylinder piston, which in turn determines the amount of working fluid to be expelled from the master cylinder into the lines or system.

(f) The fluid level in the supply reservoir should be checked at regular intervals. Should the reservoir become empty, air will be introduced into the system, necessitating bleeding.

2. ALL BRAKES DRAG:

Cause

- (a) Mineral oil in system.
- (b) Pedal improperly set.

Remedy

- (a) The introduction of mineral oil, such as engine oil, kerosene, or any fluid with a mineral base, into the system will cause the cups to swell and distort, making it necessary to replace all cups and flush system.
- (b) Directly ahead of the master cylinder piston cup (when in normal release position) is a relief port. It is imperative that this port be open when the brakes are released. Brake pedal should be set to give the proper free movement before pressure stroke begins. Should this port be blocked by piston cup not returning to its proper release position, the pressure in the system will

gradually build up and brakes drag. Shorten pedal push rod to allow piston to uncover compensating port, allowing fluid to return to tank.

3. ONE WHEEL DRAGS:

Cause

- (a) Weak brake shoe return spring.
- (b) Brake shoe set too close to drum.
- (c) Cups distorted.
- (d) Loose wheel bearings.

Remedy

- (a) Springs sometimes lose their contracting power and take a set. Replace spring.
- (b) Readjust shoes to proper clearance. Do not change anchor pin setting unless necessary.
- (c) If in repairing wheel cylinders, kerosene, gasoline and other fluids are used as a cleaner, instead of alcohol, the cups will swell and distort. The return action of the shoes will be retarded and the brake drum will heat. Replace cups and wash unit in alcohol and dip all parts in fluid before reassembling.
- (d) Tighten bearings.

4. TRUCK PULLS TO ONE SIDE:

Cause

- (a) Grease-soaked lining.
- (b) Shoes improperly set.
- (c) Backing plates loose on axle.
- (d) Front spring U-bolts loose.
- (e) Different makes of lining.
- (f) Tires not properly inflated.

Remedy

- (a) Replace with new lining of same make. Grease-soaked linings cannot be salvaged by washing or cleaning.
- (b) Refer to MAJOR ADJUSTMENTS, brake shoe adjustment sections.



- (c) Loose backing plates permit the brake assembly to shift on the locating bolts. This shifting changes the predetermined centers and causes unequal efficiency. Tighten backing plate and readjust shoes with feeler gauge.
- (d) Loose spring U-bolts permit the axle to shift on the springs and run out of line. This is noticed especially when a high braking torque is developed. Tighten U-bolts at their proper location on spring.
- (e) Different makes of linings have different braking efficiency. Two different makes, one with high efficiency and one with low efficiency, would cause truck to pull to one side.
- (f) All tires should be properly inflated.

7. LIGHT PRESSURE ON PEDAL, SEVERE BRAKES:

Cause

- (a) Brake shoes not properly adjusted.
- (b) Loose backing plate on axles.
- (c) Grease-soaked lining.

Remedy

- (a) Consult remedy (b) under No. 4.
- (b) Consult remedy (c) under No. 4.
- (c) Consult remedy (a) under No. 4.

5. SPRINGY, SPONGY PEDAL:

Cause

- (a) Brakes shoes not properly adjusted.
- (b) Air in system.

Remedy

- (a) Consult remedy (b) under No. 1.
- (b) Consult remedy (d) under No. 1.

6. EXCESSIVE PRESSURE ON PEDAL, POOR STOP:

Cause

- (a) Brake shoes not properly adjusted.
- (b) Improper lining.
- (c) Oil in lining.
- (d) Lining making partial contact.

Remedy

- (a) Consult remedy (b) under No. 1.
- (b) Specified linings have been developed to give satisfactory service and no changes should be made in the field to other makes of linings.
- (c) Replace shoes.
- (d) Remove high spots.

HYDROVAC POWER BRAKE SYSTEM

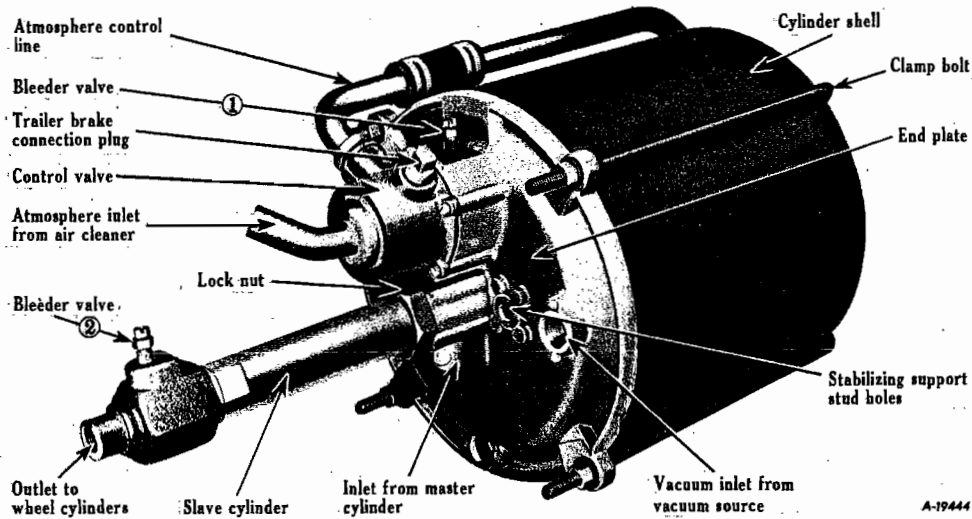


Fig. 1 - Exterior View of Third Series ("C" Series) Single 6-3/4" Diameter Piston Hydrovac No. 474000 (Fig. 2 illustrates the Interior Details of the Above Unit.)

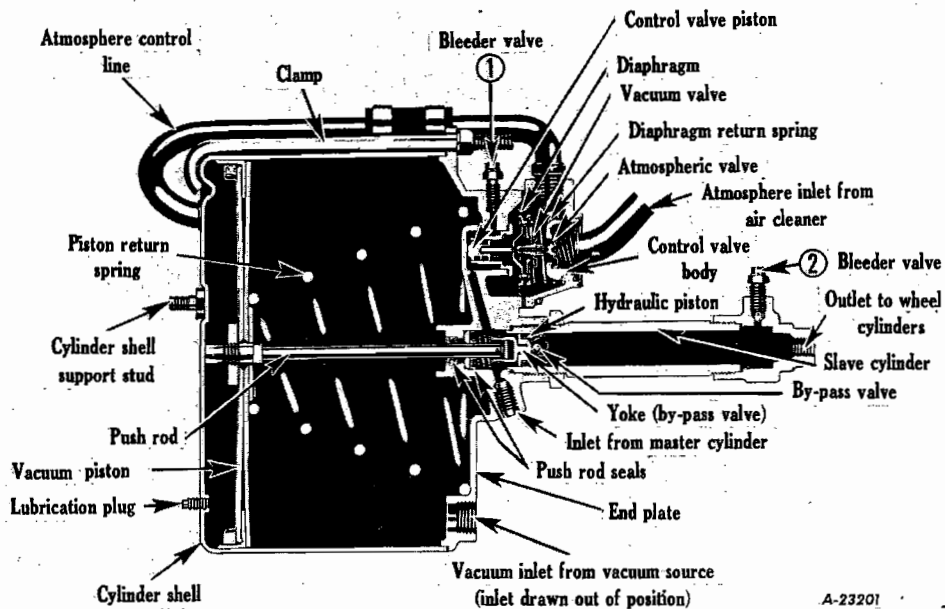
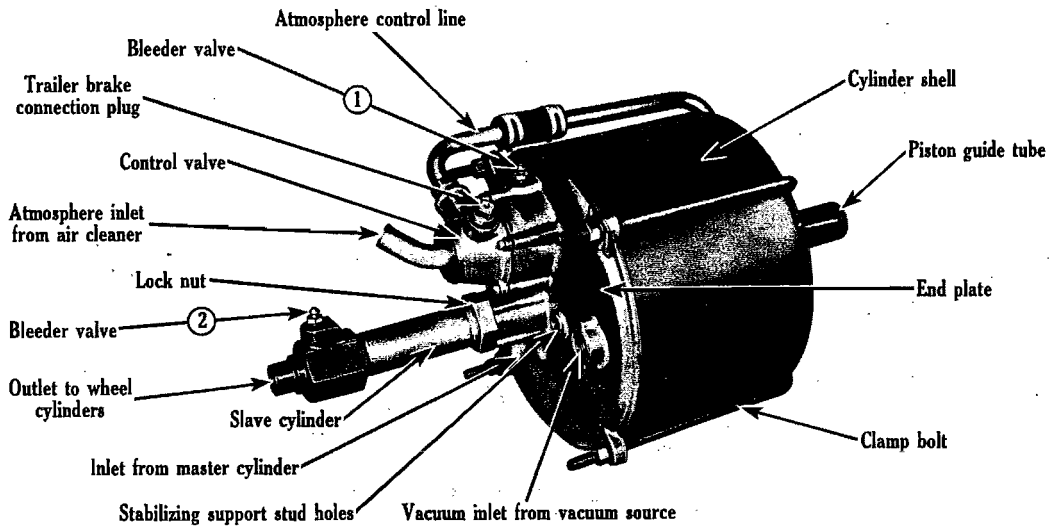
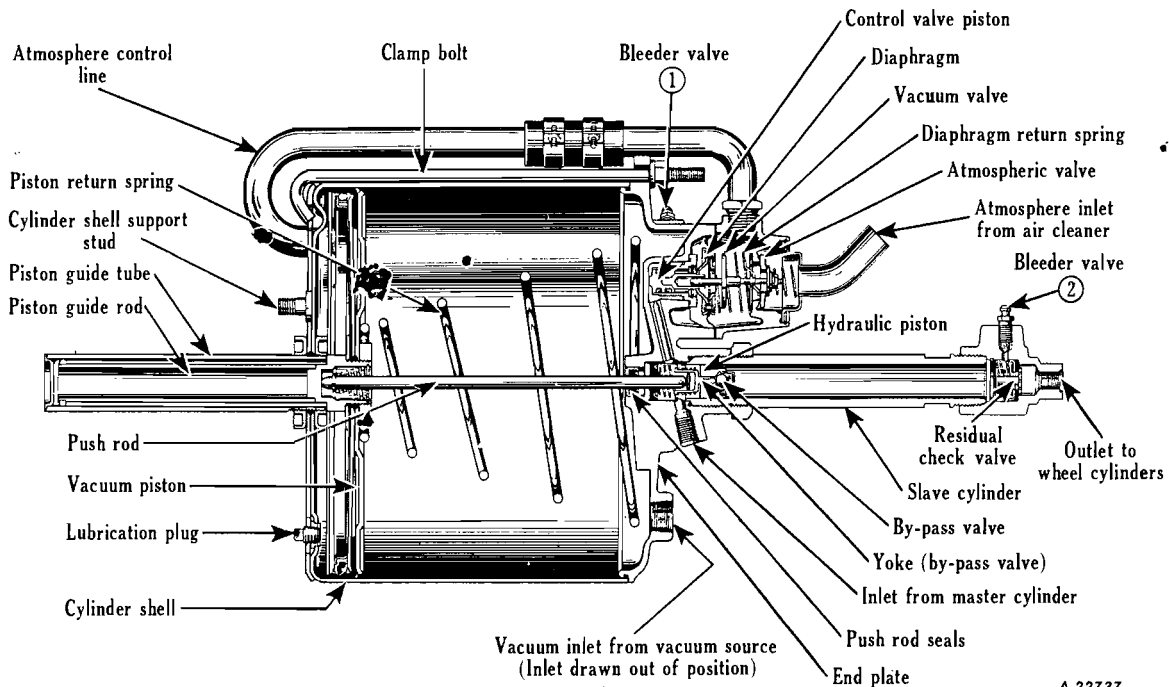


Fig. 2 - Sectional View of Third Series ("C" Series) Single 6-3/4" Diameter Piston Hydrovac No. 374000.



A-22818

Fig. 3 - Exterior View of Third Series ("C" Series) Single 9-1/2" Diameter Guided Piston Hydrovacs No's. 375278 and 375279.



A-22737

Fig. 4 - Sectional View of Third Series ("C" Series) Single 9-1/2" Diameter Guided Piston Hydrovacs No's. 375278 and 375279.

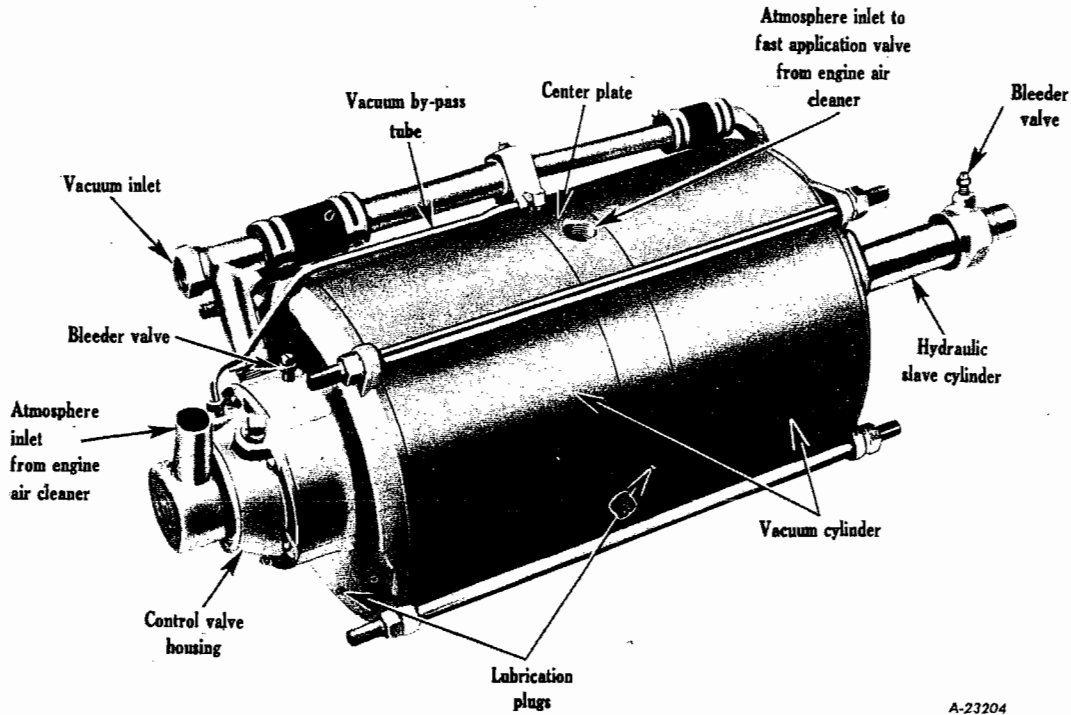


Fig. 5 - Exterior View of Third Series ("C" Series) Tandem 9-1/2" Diameter Cylinder Hydrovacs No's. 374229 and 374230.

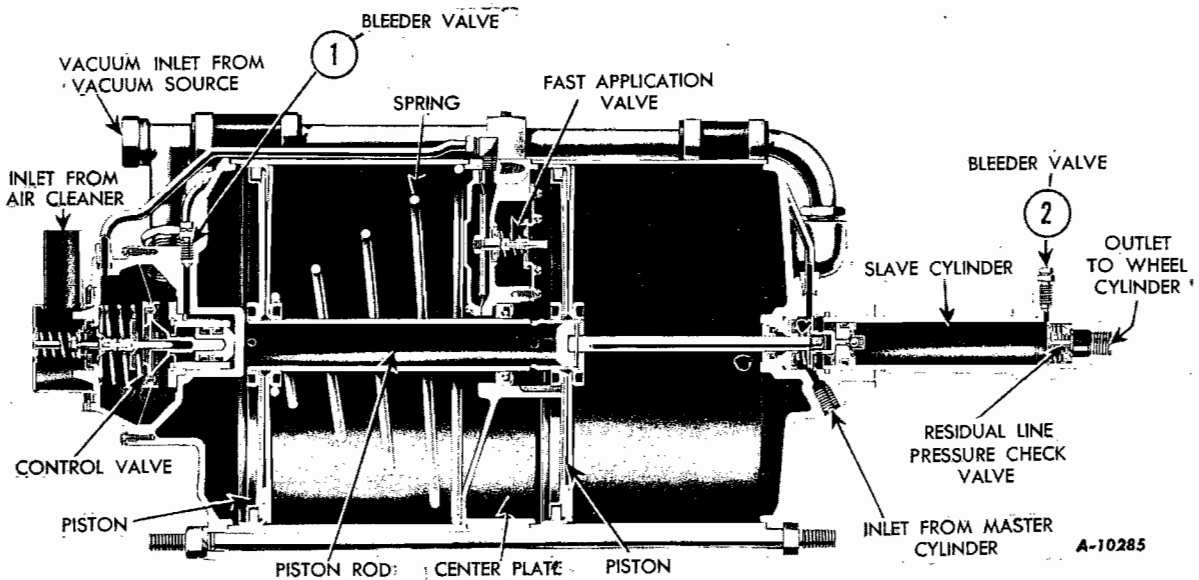


Fig. 6 - Sectional View of Third Series ("C" Series) Tandem 9-1/2" Diameter Cylinder Hydrovacs No's. 374229 and 374230.



HYDROVAC POWER BRAKE SYSTEM (Bendix Hydrovacs Third Series "C" Nos. 374000, 375278, 375279, 374229 and 374230)

Hydrovac Power Brake Units (Figs. 1, 2, 3, 4, 5, 6)

The hydrovac is installed on vehicles having the conventional hydraulic brake system to make available to the operator a greater pressure on the hydraulic brake system than could be exerted by foot pressure alone.

Description

The hydrovac is a hydraulic-vacuum power braking unit which is connected to the truck or bus braking system by a hydraulic line from the vehicle brake master cylinder to the hydrovac and a hydraulic line from the hydrovac to the wheel cylinders of the vehicle brake system. Vacuum for operation of the hydrovac is obtained from the engine intake manifold. The hydrovac is a self-contained unit having no external rods or levers exposed to dirt or moisture to rust and corrode.

Figs. 1 and 2 illustrate the single piston 6-3/4" diameter hydrovac.

Figs. 3 and 4 illustrate the single guided piston 9-1/2" diameter hydrovac.

Figs. 5 and 6 illustrate the tandem piston 9-1/2" diameter hydrovac.

Bleeding Instructions

Bleed the hydrovac and wheel cylinders with the engine stopped, bleeding the hydrovac first at the two bleeder valves (Figs. 2, 4 and 6) in the control valve and in the slave cylinder in the following manner:

1. Attach bleeder tube to bleeder valve No. 1 by pushing the end of tube over the bleeder valve.
2. Insert the end of bleeder tube in a container containing a small amount of brake fluid.
3. Unscrew the bleeder valve 3/4 turn and depress brake pedal by hand. Allow the pedal to return quickly to the "OFF" position.

NOTE: Bleeding instructions for all vehicles having the residual check valve located in the master cylinder recommend allowing the brake pedal to return to the "OFF" position slowly. However, in brake systems where the residual check valve is located in the hydrovac slave cylinder end the brake pedal

must be allowed to snap back "QUICKLY" to be released position. This rapid return of the pedal and master cylinder piston allows the master cylinder barrel to receive brake fluid from the master cylinder reservoir on the return stroke and not just draw fluid back out of the lines when the pedal is released.

Continue bleeding until all of the air is expelled, close bleeder valve. Repeat bleeding operation at bleeder valve No. 2, making sure the master cylinder fluid reservoir is kept full of brake fluid.

4. Bleed the wheel brake cylinders in any convenient order. **NOTE:** Fluid withdrawn in the bleeding operation should not be used again.

Lubrication

It has been definitely established that lubrication is highly important in hydrovac maintenance and that neglect of this service adversely affects performance.

Hydrovacs should be lubricated as follows:

1. Single piston 6-3/4" diameter hydrovacs should be lubricated once a year (preferably before cold weather) or every 20,000 miles, whichever occurs first.
2. Single piston 9-1/2" diameter hydrovacs should be lubricated every six (6) months or every 10,000 miles, whichever occurs first. One of these lubrication periods should occur just prior to the start of cold weather.
3. The tandem piston hydrovacs should be lubricated once a year (preferably before cold weather) or every 20,000 miles, whichever occurs first.

The lubrication service should be performed with the hydrovac mounted on the vehicle, with the engine stopped, and brakes released.

Single piston hydrovacs have one pipe plug in the cylinder shell (Figures 2 and 4), remove pipe plug and fill cylinder with vacuum cylinder oil to the level of the bottom of the hole. Replace pipe plug. Tandem piston hydrovacs have two pipe plugs, one in the end plate below control valve and the other in the center plate between the vacuum cylinders (Fig. 5). Remove pipe plugs and fill cylinder with vacuum cylinder oil to the level of the bottom of the holes. Replace pipe plugs.

NOTE: The quantities of oil required are automatically controlled by the position of pipe plugs. They are located so as to establish the proper oil level.



HYDROVAC OIL CAPACITIES ARE AS FOLLOWS:

HYDROVAC SIZE	APPROXIMATE OIL CAPACITY	
	END CHAMBER	CENTER CHAMBER
6-3/4" Diam. Single Piston	1 ounce	None
9-1/2" Diam. Single Piston	2 ounces	None
9-1/2" Diam. Tandem Piston	2 ounces	4 ounces

Hydrovac Air Inlet Filter (Fig. 7).

On all hydrovac installations, a filter is provided to clean the air entering the power chamber whenever the brakes are applied. This filter is located on the inside of cab below driver's seat. The air cleaner should be inspected every 1000 miles. If air passages are restricted, remove the air cleaner, dismantle and thoroughly clean all parts in a cleaning solvent and allow to drip dry. Then saturate the air cleaning element with a light oil, reassemble and install on vehicle.

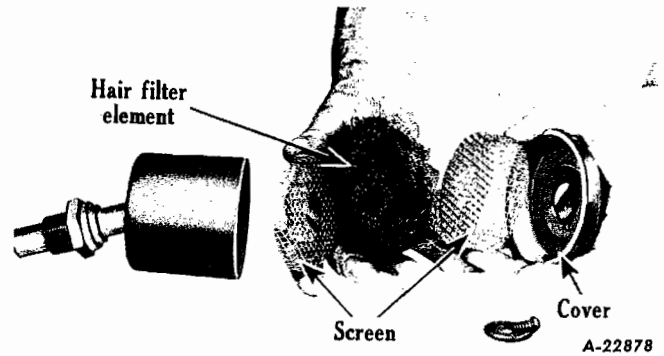


Fig. 7 - Hydrovac Air Inlet Filter.

NOTE: Where the air inlet line is connected to the engine air filter, servicing the air filter as outlined in the Fuel System Maintenance Section will suffice.

CAUTION: All hose connections must be secure and leak-proof.

Vacuum Line Oil Bath Air Cleaner (Fig. 8).

On trucks having a separate air cleaner for the vacuum line, this unit is located on the engine side of cowl at upper right hand corner. The vacuum line air cleaner prevents any dirt or foreign matter being drawn into intake manifold when the brakes are applied. In normal operation, service the cleaner every 5000 miles by removing oil reservoir, cleaning thoroughly in a suitable cleaning solution or kerosene and refilling with clean engine oil to indicated level on side of reservoir (Fig. 8). Use same grade of oil as used in engine crankcase.

CAUTION: Be sure that reservoir seats perfectly against gasket and that clamp is correctly installed after completing service operation. Should a leak occur, the engine performance and hydrovac operation will be seriously affected.

Vacuum Connection Service

Remove the vacuum connection elbow from the intake manifold every 10,000 miles and inspect the elbow and vacuum line for any possible obstruction. Clean the elbow and reinstall.

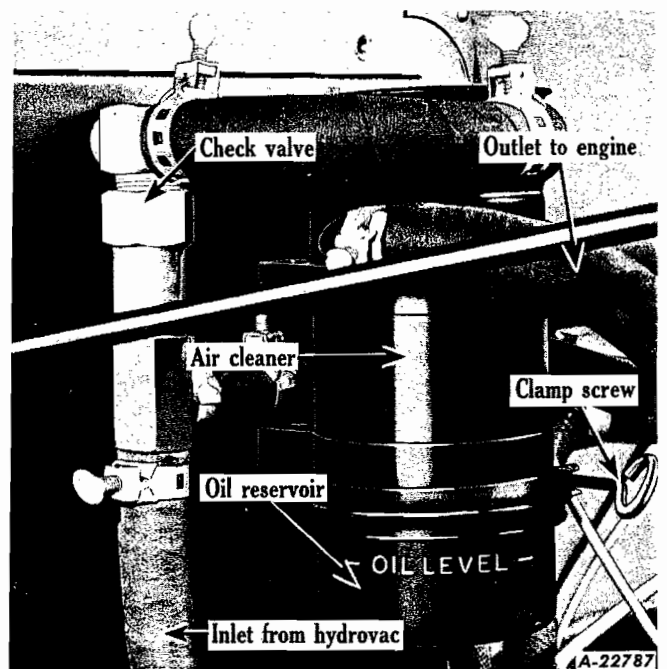


Fig. 8 - Vacuum Line Oil Bath Air Cleaner.



BRAKE TROUBLE CHART FOR VEHICLES EQUIPPED WITH HYDROVAC UNITS

TRUCK BRAKE TROUBLES ARE EASILY DIAGNOSED IF THE COMPLAINT IS UNDERSTOOD.

THEY WILL ALWAYS SHOW UP IN ONE OR MORE OF THE FOUR WAYS LISTED BELOW.

THE DRIVER MAY REPORT OTHER SYMPTOMS, BUT THESE WILL NOT HELP IN YOUR ANALYSIS.

BE SURE TO HAVE THE DRIVER TELL YOU WHICH OF THESE FOUR CONDITIONS HE HAS NOTICED.

IF AT ALL POSSIBLE; DRIVE THE TRUCK AND ACTUALLY FEEL THE CONDITION.

THE "FOUR WAYS" OR CONDITIONS	POSSIBLE SOURCE OF TROUBLE
<p>No. 1 Hard Pedal</p>	<p>1-Vacuum failure due to: (a) Faulty vacuum check valve. (b) Collapsed vacuum hose. (c) Plugged vacuum fittings. 2-Bound-up pedal shaft. 3-Glazed linings. 4-Grease or brake fluid on linings. 5-Hydrovac trouble.</p>
<p>No. 2 "Grabby" Brakes</p>	<p>1-Grease or brake fluid on linings. 2-Scored drums. 3-Anchor pins bound-up. 4-Hydrovac valve trouble.</p>
<p>No. 3 Pedal Goes to Floor or almost to floor</p>	<p>1-Brakes need adjustment. 2-Air in hydraulic system. 3-Hydraulic leak. 4-Master cylinder fluid - reservoir needs replenishing. 5-Cracked drum. 6-Hydrovac leakage.</p>
<p>No. 4 Brakes Fail to Release</p>	<p>1-Master cylinder compensating - post covered or plugged. 2-Anchor pins bound-up. 3-Bound-up brake pedal shaft. 4-Brakes improperly adjusted. 5-Faulty hydraulic check valve - at master cylinder or hydrovac. 6-Hydrovac valve or ball check trouble.</p>



Hydrovac Check

The following data will assist in the checking of brake systems utilizing the Hydrovac Power Unit. The unit should be checked on the vehicle to determine that the trouble is not elsewhere in the brake system. The various units of the brake system should be checked individually for damage or misadjustment before proceeding with the hydrovac check.

A good quick way to check the hydrovac, to determine whether it is operating at all, is as follows:

1. With the vehicle parking brake applied, clutch released, and transmission in neutral position; press the brake pedal to about a medium brake application and hold.
2. Turn the ignition switch to "ON" and start the engine.
3. Shortly after the engine starts, the brake pedal pressure will be felt to relieve itself. This is caused by the Hydrovac picking up the brake application. The relief or movement is quite noticeable when the hydrovac is functioning properly.

If no movement or relief is felt at the brake pedal when making the above check, it is good practice to check the brake system further before centering attention on the hydrovac unit. Check as follows:

1. Master Cylinder Piston Rod Clearance:

Make certain linkage is properly adjusted to permit opening of compensating port with brake pedal in normal full released position. Failure to properly uncover the compensating port may cause sufficient pressure to be maintained in the brake system to hold the hydrovac valve in a partially applied position and thus cause dragging brakes.

2. Restricted Vacuum Lines:

Check for vacuum at the hydrovac by disconnecting the vacuum line at the hydrovac vacuum connection fitting and holding a thumb over the line, with the engine running. If no vacuum exists, or if air flow is slow, check vacuum line to manifold for kinks in tubing and collapsed liners in hoses. Also test the check valve to be sure it opens. Check fitting at engine manifold for restriction.

3. Restricted Air Line and Air Cleaner:

Disconnect the air cleaner line at the hydrovac and blow into the line. If the line is restricted, check for collapsed hose or tubing. Clean or replace air cleaner.

4. Brakes:

Check brake shoe adjustment for proper clearances. Excessive shoe clearance will cause loss of pedal reserve travel. Insufficient shoe clearance may cause dragging brakes.



AIR BRAKES

(For Description and Operation see Shop Talk No. 24)

AIR BRAKE EQUIPMENT

Air brake equipment on trucks and truck-tractors provides a means of controlling the brakes through the medium of compressed air. Air brake equipment consists of a group of devices. Some maintain a supply of compressed air, some direct and control the flow of the compressed air, and others transform the energy of compressed air into the mechanical force and motion necessary to apply the brakes. Different types and sizes of devices are used on different types of vehicles to meet the operating requirements, but they are all fundamentally the same. Following are the devices comprising a typical truck or truck-tractor air brake system, with a brief description of the function of each device.

Compressor

The compressor supplies the compressed air to operate the brakes.

Governor

The governor controls the compression of air by the compressor. Although the compressor runs continuously when the engine is running, the governor, acting in conjunction with the unloading mechanism in the compressor cylinder head, stops and starts the compression of air by the compressor when the desired maximum and minimum air pressures are present in the air brake system.

Brake Valve

The brake valve controls the air pressure being delivered to the brake chambers and in this way controls the operation of the brakes.

Quick Release Valve

The quick release valve speeds the release of air pressure from the front wheel brake chambers.

Relay Valve

The relay valve speeds the application and release of air pressure from the rear wheel brake chambers.

Brake Chambers and Brake Cylinders

Brake chambers and brake cylinders transform the energy of compressed air into the mechanical force and motion necessary to apply the brakes. One brake chamber or one brake cylinder is used to operate the brakes on each wheel.

Slack Adjusters

Slack adjusters provide a quick and easy method of adjusting the brakes to compensate for brake lining wear. One slack adjuster is used for the brakes on each wheel.

Cocks

Cut-out cocks are used in the trailer connection lines to permit these lines to be closed when they are not being used. Reservoir drain cocks are used also, mounted at the bottom of the reservoir. The drain cocks permit draining the oil and water which collects in the reservoir.

Tubing and Tubing Fittings

Tubing and tubing fittings connect the different air brake devices in the air brake system.

Hose, Hose Fittings, Hose Couplings and Dummy Couplings

Flexible hose lines and hose fittings are used where it is necessary to have an air line between two points of the vehicle which change their position in relation to one another. Hose lines also make connections between two vehicles, and in such cases they are provided with hose couplings to permit the connections to be easily connected or disconnected. Dummy couplings seal the hose couplings against the entrance of dirt when the hose couplings are not in use. Dummy couplings on the back of tractor cabs also provide a place for attaching the free ends of connecting hose that is not being used.

Safety Valve

The safety valve protects the air brake system against excessive air pressure.

Reservoirs

Reservoirs store the compressed air until it is needed for brake operation and provide sufficient air pressure to make several brake applications even after the engine has stopped.

Air Gage

The air gage mounted on the instrument panel of the vehicle registers the pressure in the air brake system.



Air Supply Valve

In some cases the air supply valve is included to provide an easy means of obtaining compressed air from the air brake system for such purposes as tire inflation.

Low Pressure Indicator

The low pressure indicator is often provided to warn the driver by sounding a buzzer or by lighting a warning light if for any reason the air pressure in the air brake system falls below a safe operating point.

Stop Light Switch

The air operated stop light switch provides a simple means of controlling the stop lights of the vehicle.

Air Horn

On some vehicles the air horn is included to provide an effective warning signal.

Alcohol Evaporator

On some vehicles the alcohol evaporator is included to prevent moisture freezing in the air brake system.

OPERATION OF THE AIR BRAKE EQUIPMENT

Charging

The reservoirs are charged with air by the compressor. The reservoir air has access to the inlet valve chamber of the brake valve and the inlet valve is then held closed by the tension of its spring and air pressure.

Service Application

When it is desired to apply the brakes, foot pressure is applied to the brake pedal, which action is carried through the brake rod pulling up on the lever of the brake valve. This compresses the spring, deflects the diaphragm downward, and through the medium of the rocker arm closes the exhaust valve and opens the inlet valve. Air is thereby admitted from the reservoir to the brake valve, thence out the two side outlets to the front and rear brake chambers. The power thus exerted against the brake chamber diaphragms or pistons forces the push rods out, rotating the camshafts to apply the brakes.

In flowing to the rear brake chambers the air pressure passes through the quick release valve entering at the top, deflecting the diaphragm and its seat to seal the exhaust opening while the air pressure passes around the diaphragm to the two side connections, each leading to a brake chamber.

In the case of the relay valve (6-wheel models), the connections lead to tee connections and from there to each of the four rear brake chambers.

When the pressure built up in the brake chambers and acting against the brake valve diaphragm is enough to compress the regulating spring, the diaphragm moves upward, allowing the inlet valve to close by action of its spring.

The exhaust valve remains closed by action of the inlet valve spring and tilting of the rocker arm. Further increase of brake chamber pressure is thus prevented. If, however, there should be leakage from the brake chambers or piping, while the brake valve lever remains in this position, the resulting drop in pressure under the brake valve diaphragm will cause the regulating spring to again unseat the inlet valve and restore the lost pressure.

Release

When the foot is removed from the brake pedal, the brake valve lever is moved back toward normal position again, which relieves the tension on the regulating spring so that the diaphragm will be moved upward to its normal position by brake chamber pressure underneath it. This permits the exhaust valve to be unseated by its spring which opens brake chamber line to atmosphere and allows air to exhaust from the brake chambers.

If the brake valve lever is moved all the way back to normal position and left there (foot entirely removed from brake pedal), the brakes will entirely release, but if moved only part way back (foot pressure eased), the brakes will only partially release, i.e., the exhaust valve will remain open until the brake chamber pressure has reduced to such an amount as will no longer hold the diaphragm up, whereupon the regulating spring will move the diaphragm, with rocker arm, downward again and close the exhaust valve.

The brake chamber line to the rear wheels is released only up to the quick release valve or relay valve. This allows the diaphragm to unseat, uncovering the exhaust port through which the rear brake chambers are then exhausted.

OPERATING INSTRUCTIONS

Operating the brakes of an air-braked vehicle differs very little from operating the brakes of a passenger car. Because operation of the brake pedal requires very little physical effort, proper control of the brakes is easily accomplished.



The distance the brake pedal is depressed determines the amount of air pressure delivered to the brake chambers, and the brake chamber pressure determines the braking force. Thus the driver may definitely control the brakes of the vehicle by keeping in mind the fact that he is operating a brake valve capable of giving finely graduated brake control and making full use of this feature.

An air-braked vehicle should not be moved unless the air gage shows at least 60 pounds air pressure in the air brake system, because the brakes are not fully effective at lower pressures. While operating the vehicle, the driver should periodically observe the air pressure registered by the dash gage, to be sure it is being maintained properly. If the air pressure drops to a low point, or if the warning buzzer or light signifies the pressure is low, the vehicle should be stopped and the trouble corrected.

The best stop results when the brake application is as hard at first as the speed, condition of the road, and passenger comfort permits, and then graduated off as the speed decreases. As the stop is completed, there should be only sufficient air pressure in the brake chambers to hold the vehicle stationary. The brakes must never be applied lightly at first and the braking pressure increased as the speed decreases, as this will result in a very rough stop.

The brake pedal should not be "fanned," as this merely wastes compressed air and has no bearing on correct braking results.

The brake pedal should not be fully depressed except in cases of emergency as this causes full braking force to be delivered to the wheels and this should not be necessary in ordinary service.

Normally the engine is used to assist the brakes by not disengaging the clutch until the engine reaches idling speed.

In the event a trailer breaks away from a truck or tractor, the driver must immediately apply the brakes and bring the truck or tractor to a stop. Then the truck or tractor should be held with the handbrake while the cut-out cocks in the emergency and service lines are closed. The truck or tractor air brake system will then be recharged to normal pressure.

When disconnecting trailers from trucks or tractors, the emergency feature of the air brake system on the trailer is often used to lock the trailer brakes. This is approved practice but the air brake system must not be depended upon to hold a vehicle parked. The parking brake must always be applied or the wheels blocked.

COMPRESSOR (TYPE U)

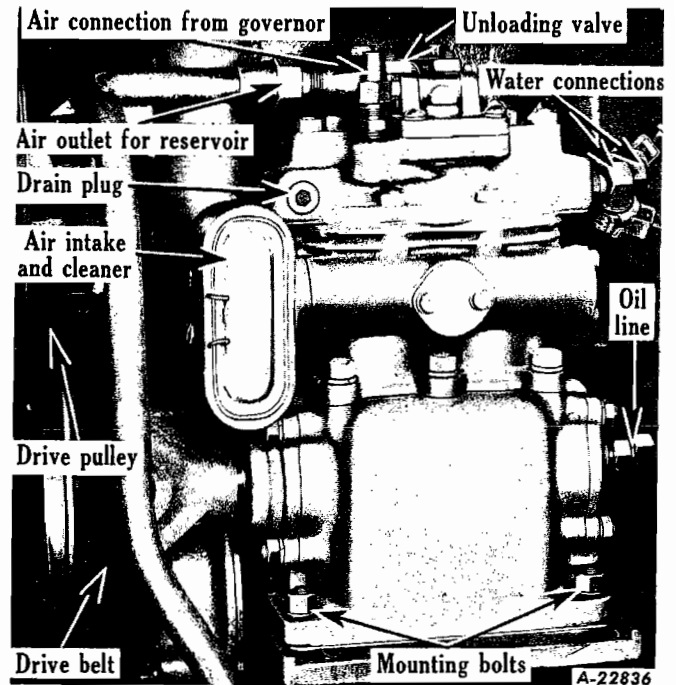


Fig. 1 - Air Compressor Installed.

IDENTIFICATION. All Bendix - Westinghouse compressors are identified by the number stamped on the name plate riveted to the side of the crankcase. Name plates also show the serial number and type of the compressor but compressors cannot be identified by the serial number or the type designation.

The type designation shown on the name plate is in accordance with the following:

Number of Cylinders	Type of Compressor	Lubrication	Rated Capacity	Type of Mounting	Type of Cooling
2 or 3	U	Eng.-E or self-S	4, 6, 7-1/4 or 12	Flange-F Horiz.-H Vertical-V	Air-A Water-W

Thus a 2 UE 7-1/4 VW compressor is a two-cylinder, type U, engine-lubricated compressor with a displacement of 7-1/4 cubic feet per minute at 1250 r.p.m., vertically mounted and water-cooled.

PREVENTIVE MAINTENANCE AND TROUBLE SHOOTING

Daily Service

(a) International trucks are usually equipped with the engine lubricated type air compressor, however, if the compressor is of the self-lubricated type, check the oil level in the compressor crankcase and replenish if necessary.



(b) Should it be necessary to drain the engine cooling system to prevent freezing, always drain the compressor cylinder head (see Fig. 1).

Every Month or After Each 2,000 Miles

(a) Service compressor air strainer. Remove and wash all parts including curled hair in cleaning solvent. Saturate curled hair with clean engine oil and squeeze dry before replacing it in the strainer.

(b) If compressor is the self-lubricated type, drain and flush compressor crankcase and refill with clean engine oil.

(c) Check compressor mounting and drive for alignment, belt tension, etc. Adjust if necessary.

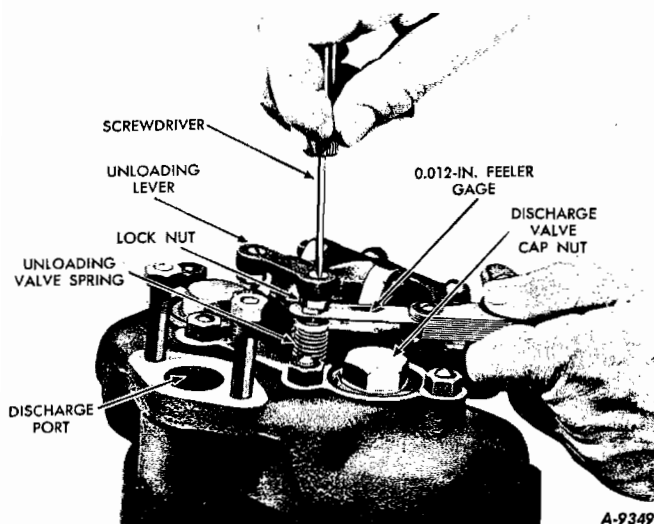


Fig. 2 - Adjusting Compressor Unloading Valve Clearance.

Every Six Months or After Each 10,000 Miles

(a) If the compressor is lubricated from the engine, clean oil supply line to compressor.

(b) Check compressor unloading valve clearance and adjust if necessary (Fig. 2). Clearance must be 0.010 inch minimum to 0.015 inch maximum. To adjust clearance, loosen lock nuts and turn adjusting screws until proper clearance is obtained. Then tighten lock nuts. Clearance can be checked only when governor is cut in (compressor not unloaded). Check unloading valve lever for binding.

(c) If compressor is the self-lubricated type, service crankcase breather. Wash breather in cleaning solvent.

(d) Remove compressor discharge valve cap nuts and check for presence of excessive carbon. If excessive carbon is found, clean the compressor cylinder head; also check compressor discharge line for carbon and clean or replace the discharge line if necessary.

Inspection

1. Be sure compressor air strainer is clean and properly installed. Also be sure blanking covers and gaskets are installed on all strainer openings not being used in the compressor intake manifold.

2. With compressor running, check for noisy operation and oil or water leaks.

3. Check unloader valve clearance.

4. Check compressor drive for alignment, belt tension, etc.

5. Check to be sure compressor mounting bolts are secure.

Operating Tests

Because of the many different types of air brake systems found on different types of vehicles, it is difficult to set up any specific series of tests to determine the serviceability of a compressor on a vehicle. Failure of the compressor to maintain normal air pressure in the air brake system of a vehicle usually denotes loss in efficiency due to wear, provided leakage in the remainder of the system is not excessive. Another sign of wear is excessive oil passing. If either of these conditions develop and inspection shows the remainder of the air brake equipment to be in good condition, the compressor must be repaired or replaced.

Air Leakage Tests

1. Excessive leakage past the discharge valves can be detected by fully charging the air brake system and then with the engine stopped, carefully listening at the compressor for the sound of escaping air. This must be done in a quiet place and if air pressure can be heard escaping inside the compressor, the discharge valve leakage is excessive, and the compressor cylinder head or the complete compressor must be replaced.

2. With the air brake system fully charged (governor cut out) coat the unloading box cover with soapsuds to check for leakage past the unloading diaphragms. Leakage of a one-inch soap bubble in three seconds is permissible. If excessive leakage is found, the compressor cylinder head or complete compressor should be repaired or replaced.

Trouble Shooting

BRAKE VALVE
(See Fig. 3)

Compressor fails to maintain adequate pressure in the air brake system.

- Dirty intake strainer.
- Excessive carbon in compressor cylinder head or discharge line.
- Discharge valves leaking.
- Excessive wear.
- Drive belt slipping.
- No clearance at compressor unloading valves.
- Unloading valves stuck open.
- Excessive leakage of unloading valves.

Compressor passes excessive oil.

- Excessive wear.
- Dirty air strainer.
- Excessive oil pressure.
- Oil return line or passage to engine crankcase plugged.
- Compressor crankcase flooded.
- Back pressure from engine crankcase.
- Oil rings improperly installed.

Noisy operation.

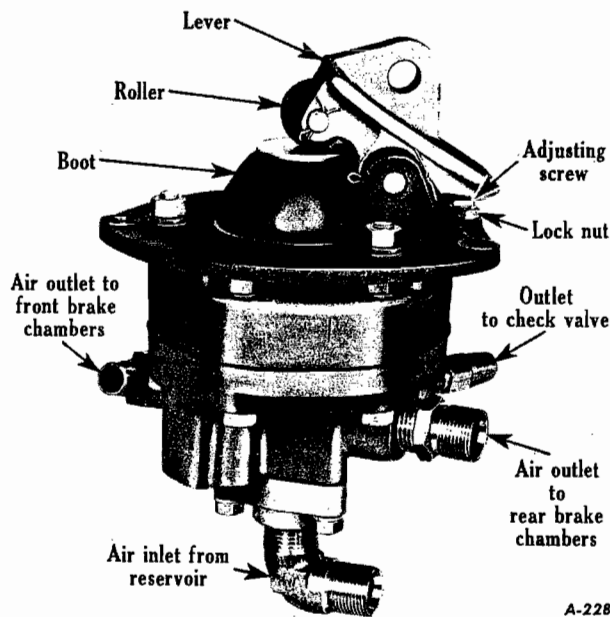
- Back lash in drive coupling or drive gears.
- Loose drive pulley.
- Excessive carbon in cylinder head or discharge line.
- Worn or burnt-out bearings.
- Excessive wear.

Compressor does not unload.

- Defective unloading diaphragms.
- Excessive clearance at unloading valves.
- Unloading cavity plugged with carbon.
- Unloading mechanism binding or stuck.

Description

The brake valve is fitted with a lever suitable for connecting to the brake pedal. The pedal controls the movement of an inlet valve and exhaust valve which in turn controls the air pressure being delivered to or released from the brake chambers on the vehicle. To fully apply the brakes, the brake pedal must be fully depressed; whereas when the pedal is only partially depressed, correspondingly less braking force is developed. In other words,



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Fig. 3 - Brake Valve.

the farther the driver depresses the pedal, the greater the air pressure delivered to the brake chambers and the more effective the brake application. At any time the brakes of the vehicle may be partially released by the driver permitting the brake pedal to partially return towards released position or they may be entirely released by permitting the pedal to return to full released position. In this manner the amount of force being applied to the brakes of the vehicle is always under control of the driver.

Preventive Maintenance

Every Month or After Each 2,000 Miles

(a) Lubricate all linkage between the brake valve and brake pedal; also lubricate the brake valve lever pin.

(b) Check to be sure that no strain is placed on the brake valve lever, because the lower edge of the lever cap strikes the cover when the brake pedal is fully depressed. Adjust



pedal stop or linkage, if necessary, to prevent this interference. After any adjustment, check brake valve delivery pressure.

(c) Be sure the brake valve lever strikes the cover of the valve when the brake pedal is in released position. If necessary, adjust pedal rod length.

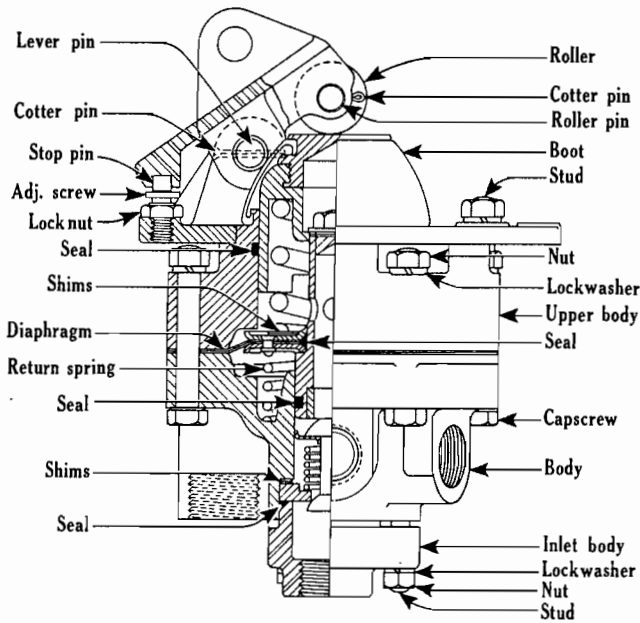


Fig. 4 - Sectional View Of Brake Valve.

Testing For Serviceability
Operating Tests

1. Check the delivery pressure of the brake valve using an accurate air pressure test gage. On vehicles having trailer connections the test gage may be conveniently connected to the service line outlet at the rear of the vehicle. Note that the first movement of the brake pedal towards applied position, after the slack is taken up, causes the brake valve to deliver approximately five pounds air pressure. Note that approximately full reservoir pressure is delivered by the brake valve when the brake pedal is fully depressed. If the brake valve does not deliver approximately full reservoir pressure, when the brake pedal is fully depressed, adjust the pedal stop or linkage so as to increase the travel of the brake valve lever. This should increase the delivered pressure. On some vehicles the pedal stop is so arranged as to prevent the brake valve from delivering full reservoir pressure. This arrangement must not be altered on such vehicles unless a higher delivery pressure is desired in order to increase the effectiveness of the brakes. When making this adjustment, be sure no strain is placed on the valve lever due to the edge of the lever cap striking the cover when the brake pedal is fully depressed. Also be sure the brake valve lever returns to full release position when the brake pedal is released.

2. Hold brake pedal at several different positions between release position and fully depressed position and observe that intermediate delivered pressures between five and seventy pounds are definitely determined by the position in which the brake pedal is held.

Leakage Tests

1. With brakes released, coat the exhaust port with soapsuds.
2. With brakes fully applied, coat the exhaust port with soapsuds.
3. Leakage in excess of a one-inch soap bubble in one second is not permissible in either of these tests. If excessive leakage is found, the brake valve must be repaired or replaced.
4. With brakes applied check for leakage out the top of the brake valve. No leakage is permissible. If leakage is found, the brake valve must be replaced.

BRAKE VALVE
(Hand Operated) Type HP

Description

Type HP brake valves (Fig. 5) are used for controlling the brakes on a trailer independently of the brakes on the towing vehicle. They are usually mounted on the steering column or on the dash and the driver may put the handle in any one of several positions between brakes released and brakes fully applied position so the brakes on the trailer are kept applied until the brake valve handle is returned to release position. The distance the brake valve handle is moved in a clockwise direction toward applied position determines the severity of the brake application. The driver may, therefore, control the brakes on the trailer as the speed, load, and road conditions require.

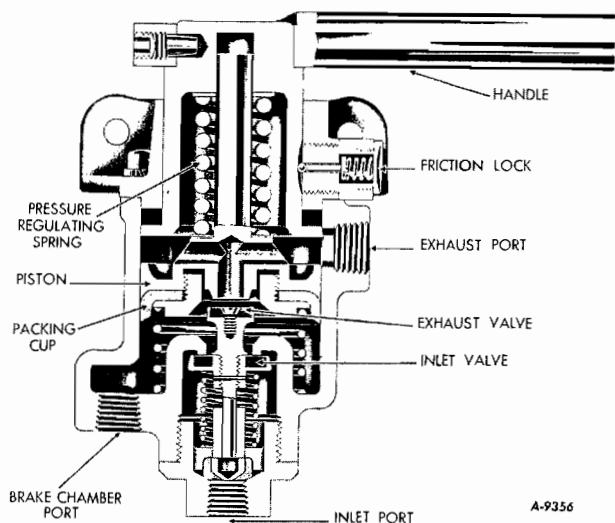


Fig. 5 - Sectional View Of Hand Brake Valve.



Testing for Serviceability (Hand Brake Valve)

Operating Tests

1. Check the delivery pressure of the brake valve using an accurate air pressure test gage. The test gage may be conveniently connected to the service line outlet at the rear of the vehicle. With the brake valve handle moved to its fully applied position, the brake valve must deliver at least sixty pounds pressure.

2. Move the brake valve handle to several different positions between fully applied and fully released positions and observe that the air pressure registered by the test gage varies in accordance with the position to which the handle is moved.

Leakage Tests

1. With brake valve handle in released position, coat the exhaust port with soap suds to check for leakage.

2. With brake valve handle in fully applied position, coat the exhaust port with soap suds to check for leakage.

3. Leakage in excess of a one inch soap bubble in one second is not permissible in either of these tests. If excessive leakage is found it will usually be caused by dirty or worn valves or valve seats and the inlet and exhaust valve assembly or the complete brake valve must be repaired or replaced. Leakage due to dirty valves and valve seats may be corrected by removing the inlet and exhaust valve assembly and cleaning the valves and valve seats. Leakage due to worn valves may be corrected by installing a new inlet and exhaust valve assembly. If the valve seats are pitted or worn excessively or if the installation of a new inlet and exhaust valve assembly does not correct the leakage, the brake valve must be repaired or replaced.

QUICK RELEASE VALVE

Description

The purpose of the quick release valve is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake chambers. It is most commonly used with front wheel brake chambers.

The valve consists of a body containing a spring loaded diaphragm so arranged as to permit air pressure to flow through the valve in one direction; but when the supply pressure is reduced, the air which has passed through the valve is permitted to escape through the exhaust port (Fig. 6).

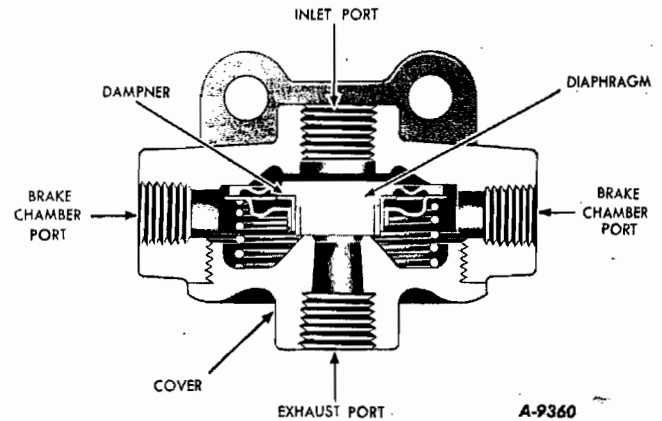


Fig. 6 - Sectional View Of Quick Release Valve.

Operating Tests

Apply the brakes and observe that when the brakes are released, air pressure is quickly exhausted through the exhaust port of the valve. Be sure the exhaust port is not restricted in any way.

The valve must be tested at regular intervals for leakage by applying soapsuds on the exhaust port with the brakes applied. On releasing the brakes see that the valve releases immediately with the corresponding return movement of the foot pedal. Leakage may be caused by dirt in the valve or a defective diaphragm. As a rule the diaphragm should be replaced at least once every year.

The air line from the brake valve to the rear wheel chambers is released back to the quick release valve. This allows the diaphragm in the quick release valve to unseat, uncovering the exhaust port in the valve and permitting the air in the brake chambers to escape quickly at the quick release valve.

On some trucks air is released from the front wheel brake chambers back through the lines to the foot brake valve and exhausted at that point. Where this is the case, the quick release valve housing installed at the front of the vehicle serves merely as a connector and does not contain either a diaphragm or diaphragm spring and the exhaust opening in the quick release valve housing is closed with a plug.

IMPORTANT: DO NOT REMOVE THIS PLUG, TO DO SO WILL RENDER THE FRONT WHEEL BRAKES INOPERATIVE.

Leakage Tests

1. With brakes released, coat the exhaust port with soapsuds to determine leakage.

2. With the brakes fully applied, coat the exhaust port with soapsuds to determine leakage.



3. Leakage in excess of a one-inch soap bubble in one second is not permissible in either of these tests. If excessive leakage is found, the relay valve must be repaired or replaced.

DOUBLE CHECK VALVE

Description

A double check valve is used on the tractor truck at the frame side rail (Fig. 7). It is connected into the air lines from the relay valve to the trailer lines. The purpose of the double check valve is to control the brakes on the trailer or towed load. If the double check valve were not used when one of the brake valves was moved to its applied position, air pressure from the reservoir would escape through the exhaust port of the other brake valve, whose exhaust valve would be open. When the double check valve is used and one of the brake valves is moved to the applied position, the double check valve blocks off the line leading to the other brake valve, in this manner preventing any loss of air pressure through the open exhaust valve of the brake valve not being operated.

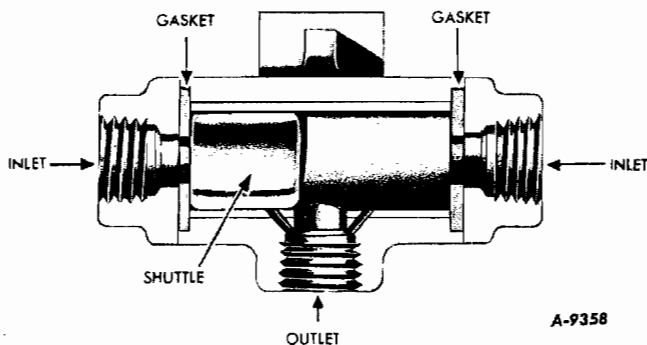


Fig. 7 - Sectional View Of Double Check Valve.

Testing

With the brake system fully charged and both brake valves in released position, move one of the brake valves to applied position, and check with soapsuds for leakage at the exhaust port of the brake valve not being operated. Repeat test with the other brake valve. Leakage in excess of a 3-inch soap bubble in 3 seconds is not permissible. If excessive leakage is found, the defective double check valve must be replaced.

RELAY VALVE

Description

The relay valve (Fig. 8) speeds up the application and release of the rear wheel brakes. It is controlled by the brake valve and keeps the air pressure in the rear brake chambers the same as the pressure being delivered by the brake valve. It reacts to even slight changes

in pressure and raises, lowers, or completely exhausts the air pressure in the rear brake chambers as the brake valve raises, lowers, or completely exhausts air pressure from it.

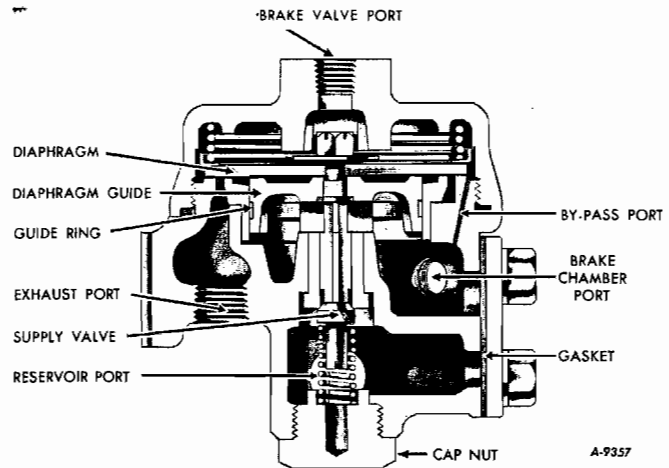


Fig. 8 - Sectional View Of Relay Valve.

Testing for Serviceability

Operating Tests

1. With the air brake system charged, apply brakes and check to be sure the rear wheel brakes controlled by the relay valve apply promptly.
2. Release brakes and check to be sure air pressure is exhausted from the exhaust port of the relay valve promptly.

Leakage Tests

1. With brakes released, coat the exhaust port with soapsuds to determine leakage.
2. With brakes fully applied, coat the exhaust port with soapsuds to determine leakage.
3. Leakage in excess of a one-inch soap bubble in one second is not permissible in either of these tests. If excessive leakage is found, the relay valve must be repaired or replaced.

GOVERNOR (TYPE O-1)

Description

The purpose of the compressor governor is to automatically control the air pressure being maintained in the reservoirs of the air brake system by the compressor, between the maximum pressure desired (100-105 lbs.) and the minimum pressure required for safe brake operation (80-85 lbs.). To understand this function of the governor, it should be remembered that while the compressor may run continuously, actual compression of air is controlled by the governor, which, acting in conjunction with the compressor unloading mechanism, stops or starts compression when these maximum and minimum reservoir pressures are reached.

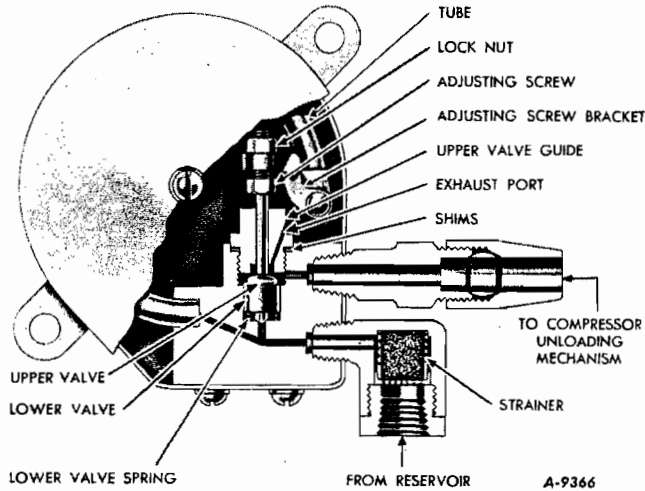


Fig. 9 - Sectional View Of Governor.

The design of the compressor governor is based on the principle of a Bourdon tube which is a flattened metal tube bent to a curve that tends to straighten under internal pressure (Fig. 9). This reaction by the tube, due to changes in the air pressure in the tube, increases or decreases the spring load on the valve mechanism of the governor and makes the valve mechanism assume its "cut-in" or "cut out" positions in accordance with the air pressure in the reservoir. Two types of governor cases will be found in service, one being a die cast case and the other a pressed steel case. Both types of cases are interchangeable with each other and the working parts of the governor used in both types of cases are identical.

Preventive Maintenance

Every Six Months or After Each 10,000 Miles

Remove the governor air strainer and wash all parts in cleaning solvent. Lamb's wool in the air cleaner may be used again if it can be washed thoroughly clean in cleaning solvent, otherwise it must be replaced.

Every Year Or After Each 25,000 Miles

(a) Disassemble governor and clean all parts.

(b) Clean or replace both tubing lines connected to the governor.

Testing for Serviceability and Adjusting

Operating Tests

1. With the engine running, build up air pressure in the air brake system and observe at what pressure registered by the dash gage the governor cuts out stopping further compression. The governor must cut out between 100 and 105 pounds.

2. With engine running, slowly reduce the air pressure in the air brake system by applying and releasing the brakes and observe at what pressure registered by the dash gage the governor cuts in and compression is resumed. The governor must cut in between 80 and 85 pounds.

3. Before condemning or adjusting the pressure settings of the governor, be sure the dash gage is registering accurately. This may be done by using an accurate test gage to check the pressure registered by the dash gage.

4. When necessary, the pressure settings (cut-in and cut-out pressures) may be adjusted after removing the cover. The pressure settings are raised by loosening the adjusting screw lock nut and turning the adjusting screw clockwise viewed from the top (Fig. 9). Pressure settings may be lowered by turning the adjusting screw counterclockwise. The lock nut must be tightened after any adjustment.

5. If the governor cannot be adjusted to cut-in and cut-out at the proper pressure settings, it should be replaced.

6. Adjustment of the range between the cut-in and cut-out pressure is made by removing shims beneath the upper valve guide (Fig. 9) to increase the range or by installing additional shims to decrease the range.

Leakage Tests

1. Remove cover and with the governor in its cut-out position, test for leakage by applying soapsuds to the exhaust port.

2. With the governor in its cut-in position test for leakage by applying soap suds to the exhaust port.

3. Leakage in excess of a one-inch soap bubble in three seconds is not permissible in either of the above tests. If excess leakage is found, the governor must be replaced.

4. Install cover after making tests.

SAFETY VALVE

Description

1. The purpose of the safety valve is to protect the air brake system against excessive air pressure. Should the air pressure in the air brake system rise above the setting of the safety valve at 150 pounds, the valve opens and permits pressure above 150 pounds to be exhausted. It is located on one of the reservoirs.

2. The safety valve consists of a spring-loaded ball check valve which is set to "blow off" at 150 pounds air pressure. (Fig. 10).

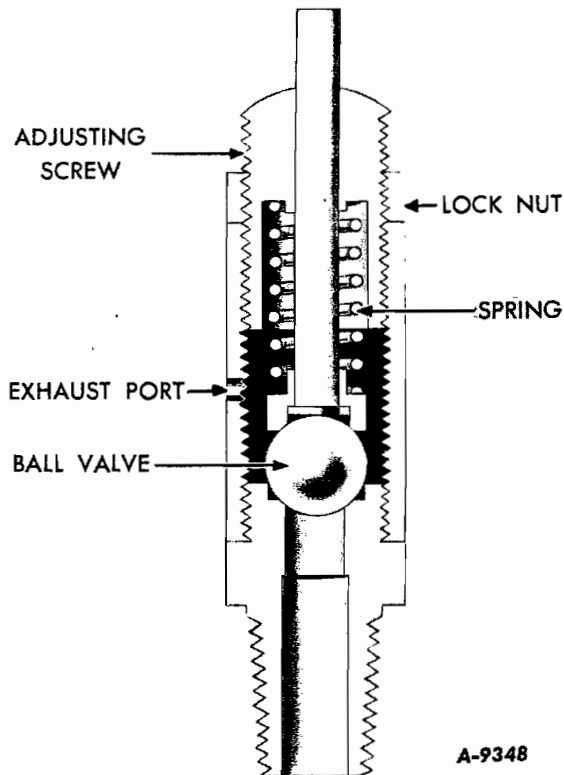


Fig. 10 - Sectional View Of Safety Valve.

Testing

Pressure Setting Tests

1. Connect a test gage known to be accurate into the air brake system so as to register reservoir pressure. A simple way to do this is to connect the air gage to the emergency line at the rear of the tractor truck and open the emergency line cut-out cock. With the motor running, temporarily stop governor operation by turning the air supply valve on the dash panel to its air supply position, and permit the air pressure in the air brake system to rise until the test gage registers 150 pounds. When the test gage reaches 150 pounds, the safety valve must release, or "blow off." If the safety valve does not release, stop the engine immediately, and adjust the pressure setting of the safety valve. Do not permit air pressure in the air brake system to build up higher than 150 pounds, otherwise the compressor may become damaged.

2. To adjust the pressure setting of the safety valve, loosen the lock nut and turn the adjusting screw. Turning the adjusting screw counterclockwise lowers the pressure setting. Turning the screw clockwise raises the pressure setting. Turn the adjusting screw as required until the safety valve releases at 150 pounds pressure registered by the test gage. Then tighten the lock nut to hold the adjusting screw at the proper setting. Reduce air pressure in the air brake system to normal of

approximately 100 pounds by applying and releasing the brakes.

Leakage Tests

With the air brake system fully charged to approximately 100 pounds, coat the safety valve all over with soapsuds to check for leakage. Leakage of a 1-inch soap bubble in 5 seconds is not permissible. Slight leakage may sometimes be corrected by lightly tapping the end of the release pin. If this fails to correct the leakage, replace the safety valve.

SLACK ADJUSTER

Description

One slack adjuster is used at each brake chamber. Slack adjusters consist of a worm and gear enclosed in a body which also serves as an adjustable lever (Fig. 11). They provide a quick and easy means of adjusting the brakes to compensate for brake lining wear. During brake operation, the entire slack adjuster rotates bodily with the brake camshaft. During brake adjustment, the worm moves the gear so as to change the position of the lever arm in relation to the brake camshaft.

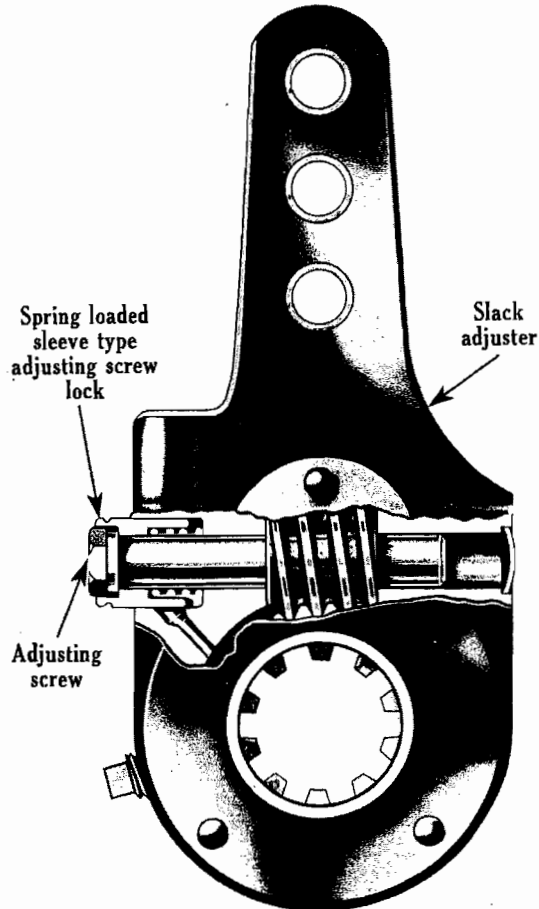
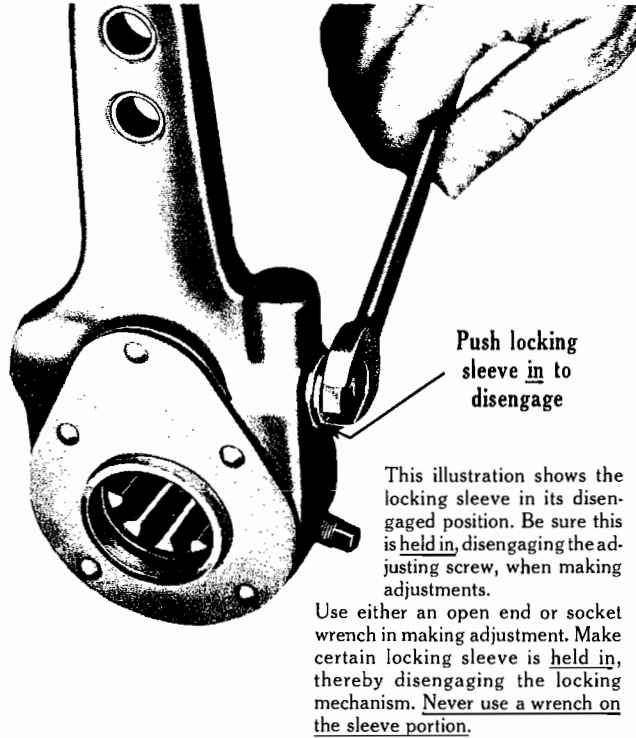


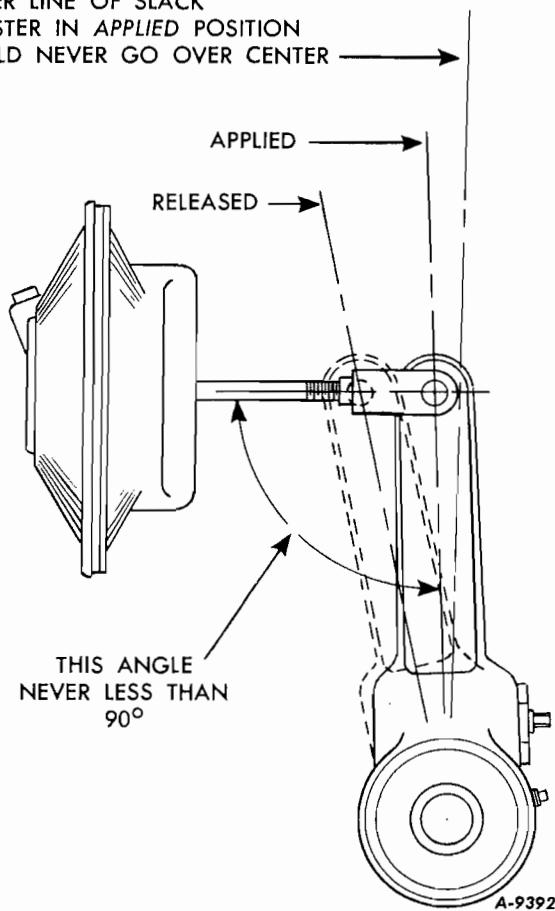
Fig. 11 - Sectional View Of Slack Adjuster.



A-22908

Fig. 12 - Illustrates Locking Sleeve On Adjusting Nut.

CENTER LINE OF SLACK ADJUSTER IN APPLIED POSITION SHOULD NEVER GO OVER CENTER →



Testing

Adjust brakes and note brake chamber push rod travel when brakes are applied. Make several brake applications, and again check push rod travel. Push rod travel must remain the same as it was after adjustment. If the push rod travel increases, or if difficulty is experienced in keeping the brakes adjusted in service, the slack adjuster must be replaced.

When slack adjuster movement does not give the desired brake action, adjustment of the push rod length by altering the location of the yoke may be necessary. With brakes released the angle formed by the push rod and slack adjuster must be greater than 90°, and all slack adjusters should be set at the same angle. With the brakes fully applied, after being adjusted, this angle should still be greater than 90°. In other words, the slack adjuster should not go "over center" when the brakes are applied (Fig. 13). The position of the push rod yoke on the push rod should be adjusted if necessary until these conditions prevail.

Maintenance

The worm gear and worm should be kept well lubricated. This can be done by removing the plug and filling the cavity with a good grade of chassis lubricant every 1,000 miles.

LOW PRESSURE INDICATOR

Description

The low air pressure indicator (Fig. 14) is a safety device designed to give an automatic warning whenever the air pressure in the air brake system is below approximately 60 pounds. Operating as an air-controlled switch of an electrical circuit, the low pressure indicator automatically sounds a buzzer when the air pressure drops too low. On some vehicles a light is used to indicate low pressure, in place of the buzzer.

Testing

1. Drain air brake system, turn on ignition key, and start engine. The low pressure indicator buzzer must sound until the air pressure in the air brake system reaches a point between 54 and 66 pounds when the buzzer must stop sounding.

2. Continue to build up air pressure in the air brake system until the pressure reaches at least 75 pounds, stop engine, and reduce the air pressure in the air brake system by making brake applications. Check to see at what pressure the buzzer again sounds. The buzzer must sound when the pressure in the air brake system reaches a point between 66 and 54 pounds.

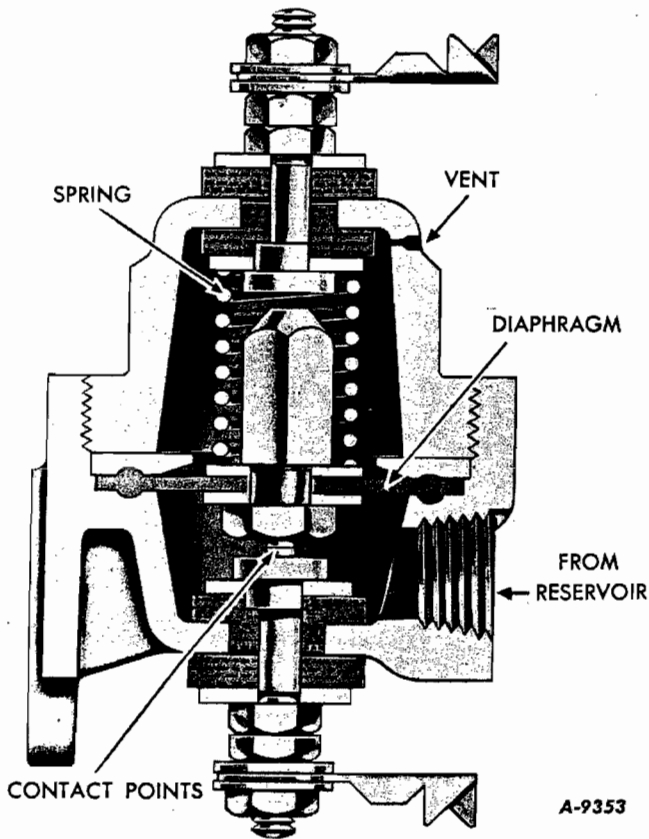


Fig. 14 - Sectional View Of Low Pressure Indicator.

Leakage Test

With the air brake system fully charged, coat the outside of the low pressure indicator with soapsuds to check for leakage. No leakage is permissible. Leakage at the lower diaphragm screw can sometimes be corrected by removing the electrical connection and carefully tightening the terminal screw nut. Leakage through the small vent hole in the cover signifies a leaking diaphragm, and the low pressure indicator must be replaced.

STOP LIGHT SWITCH

Description

The stop light switch is mounted on the left-hand frame side rail. Stop light switches are electro-pneumatic switches which close the stop light electrical circuit when the brakes are applied (see Fig. 15).

Testing

1. With all air pressure exhausted from the air brake system, move the brake valve to applied position, and start the engine. Observe at what pressure registered by the dash gage the stop lights light. Stop lights must light before the dash gage registers 10 pounds pressure.

2. With brakes applied, coat the stop light switch with soapsuds to check for leakage. No leakage is permissible. If leakage is found, the stop light switch must be replaced.

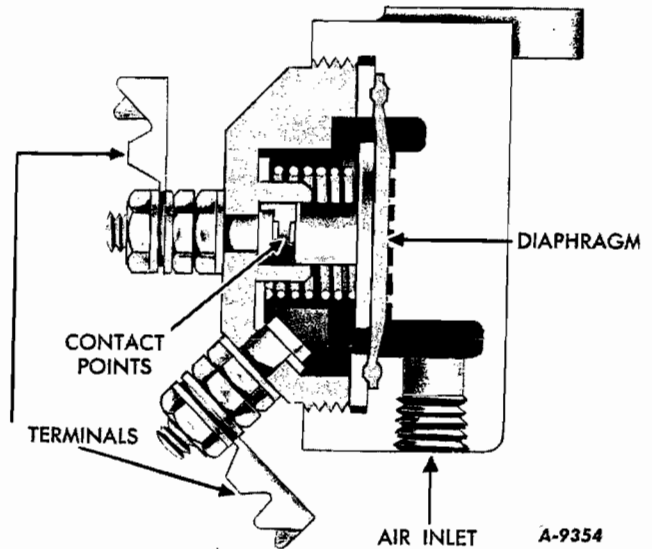


Fig. 15 - Sectional View Of Stop Light Switch.

**BRAKE CHAMBER
(BENDIX-WESTINGHOUSE)**

The Bendix-Westinghouse brake chamber consists of two dished metal plates, namely: the non-pressure plate, and the pressure plate separated by a diaphragm (see Fig. 16).

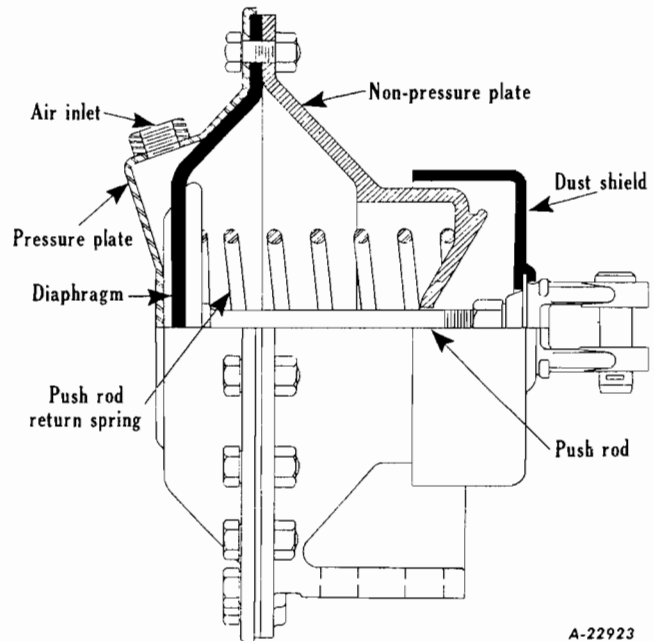


Fig. 16 - Typical Brake Chamber (Diaphragm Type).

In front of the diaphragm are the non-pressure plate, push rod and push rod spring. Behind the diaphragm is the air-tight cavity into which is connected a tubing line from the brake



valve. Due to the extreme sensitivity of the diaphragm, this arrangement permits push rod to respond to the slightest variation of air pressure from the brake valve, thus permitting the driver to apply or release brakes as rapidly or gradually as the various road and operating conditions warrant.

In order to meet requirements for different braking forces, brake chambers are made in several different sizes. All sizes are made for several different types of mountings, such as stud mounting, bracket mounting, and flange mounting.

The following table shows different types of standard brake chambers:

Type	Outside Diameter	Effective Area Square Inches	Normal Working Stroke	Maximum Working Stroke	Maximum Stroke
A	6-15/16"	12	5/8"	1-3/8"	1-3/4"
B	9-3/16"	24	3/4"	1-3/4"	2-1/4"
C	8-1/16"	16	3/4"	1-3/4"	2-1/4"
D	5-1/4"	6	1/2"	1-1/4"	1-5/8"
E	6"	9	5/8"	1-3/8"	1-3/4"
F	11"	36	3/4"	2-1/4"	3"
G	9-7/8"	30	3/4"	1-3/4"	2-1/2"

Preventive Maintenance

Every Month or After Each 2,000 Miles

Check travel of brake chamber push rods and adjust brakes if necessary. Push rod travel should be kept at the minimum without brakes dragging. Excessive travel shortens the service life of brake chamber diaphragms and also results in slow braking response.

Every Year or After Each 50,000 Miles

Disassemble brake chambers and clean all parts. Install new diaphragms. When replacing release springs be sure to use the correct spring, otherwise uneven braking will result.

Leakage Tests

1. With brakes fully applied, coat the brake chamber bolting flanges holding the diaphragm in place with soapsuds to check for leakage. No leakage is permissible. If leakage is found, tighten flange bolts. All flange bolts must be tightened evenly but only sufficiently to prevent leakage, otherwise the diaphragm will be distorted and premature failure will result.

2. With brakes fully applied, check for leakage through the diaphragm by coating the clearance hole around the push rod and the drain hole in the non-pressure plate with soapsuds. No leakage is permissible. If leakage is found, the diaphragm must be replaced.

Testing for Serviceability

Operating Tests

1. Apply brakes and observe that push rods move out promptly without binding.
2. Release brakes and observe that push rods return to release position promptly without binding.
3. Check travel of push rods to be sure it is at the minimum without brakes dragging.

Caution!

Always be sure the correct release spring is used in any brake chamber. Also be sure the brake chamber on the opposite side of the axle of the vehicle has the same release spring; otherwise uneven braking will result.

If a new diaphragm is installed in the brake chamber on one side of the vehicle, a new one also should be installed in the corresponding brake chamber on the other side, otherwise this may also cause uneven braking.

After the brake chamber is installed the brakes must be adjusted and checks made to be sure the linkage does not bind. Adjustment of the push rod length by altering the location of the yoke may be necessary. With brakes released the angle formed by the push rod and slack adjuster must be greater than 90°, and all slack adjusters should be set at the same angle. With the brakes fully applied, after being adjusted, this angle should still be greater than 90°. In other words, the slack adjuster should not go "over center" when the brakes are applied (Fig. 13). The position of the push rod yoke on the push rod should be adjusted if necessary until these conditions prevail.

BRAKE CHAMBER - PISTON TYPE (MIDLAND)

The Midland air cylinder (Fig. 17) requires very little attention, but to insure proper operation, the cylinder should be kept lubricated. At intervals of approximately four months or 15,000 miles, the air connection at the rear of the cylinder should be removed and one quarter pint of lubricant (similar to Elso's (150-LO) graphite type grease with 10% neat's-foot oil), inserted.

At regular truck overhaul periods, the cylinder should be removed, taken apart and thoroughly cleaned. The piston cup should be inspected and free from cracks, scratches and dirt particles. If the piston cup is hard or dry, it should be immersed in neat's foot oil before reassembling in cylinder. If it becomes necessary to replace the piston cup, shellac both



sides of piston stem plug gasket, also shellac threads of piston stem plug and draw up piston stem plug just snugly on ball end of piston stem.

The inside of the air cylinder and complete piston assembly should be thoroughly cleaned and the wall of the cylinder, as well as the entire piston assembly, should be covered with a lubricant as outlined in first paragraph.

Cleanbreather hair in piston stem assembly with cleaning solvent and dip in light lubricating oil before replacing.

Care should be exercised to make sure the rubber boot is in good condition and properly installed to protect the piston shaft from the element.

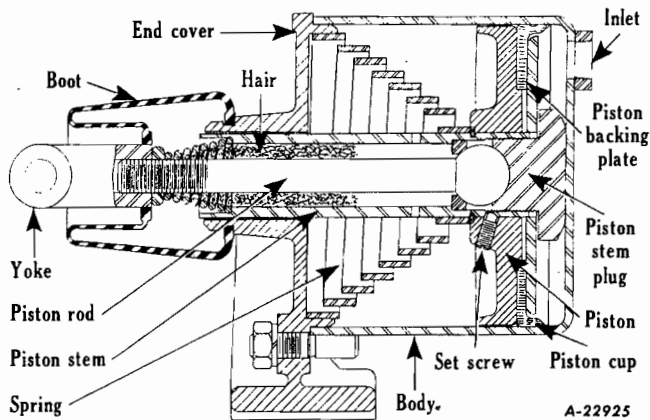


Fig. 17 - Typical Brake Chamber (Piston Type).

AIR PRESSURE GAGE

Description

1. The purpose of the dash-mounted air pressure gage is to register the amount of air pressure in the air brake system. While air pressure gages of this type are commercially accurate, they must never be confused with, or substituted for, test air gages which are intended primarily for accurately checking air pressure in the air brake system.

2. Only test gages known to be accurate are to be used for checking brake valve delivery pressures, governor pressure settings, and other tests. Test gages differ from ordinary dash gages in respect to material and workmanship much as an expensive watch differs from a cheaper one, and due to these differences they are more accurate over their entire range, and maintain their accuracy over longer periods.

Testing

1. Check the dash air gage for accuracy. The simplest way to do this is to compare the

pressures registered by the gage over its normal pressure range with the pressures registered by a test gage known to be accurate.

2. A dash gage which loses its accuracy must be replaced. The continued use of a dash gage showing an error of more than 5 pounds is not recommended.

CUT-OUT COCKS

Description

1. Cut-out cocks have a tapered key ground to the body to prevent leakage. A passage is provided through the key so that when the key is turned to its open position air is permitted to flow through the cock, but when the key is turned to the closed position air is prevented from flowing through the cock. Cut-out cocks are used in the service and emergency lines of the tractor truck to provide a means of closing off these lines when they are not being used.

2. The cut-out cock is open when the handle is at a 90-degree angle with the body of the cock, and closed when the handle is parallel with the body of the cock. Stops are provided so that the handle cannot be turned beyond its normal positions.

3. Always open and close a cut-out cock by hand. Never strike the handle with a hammer, or similar instrument, as the cock would be damaged and leakage would develop.

Testing

1. With brakes applied and cut-out cock closed (hose line disconnected), test with soapsuds for leakage past the key. Also check for leakage through the body by coating the outside of the cut-out cock with soapsuds.

2. With brakes applied and cut-out cock open (hose line connected), check for leakage through the body by coating the outside of the cut-out cock with soapsuds.

3. Leakage in excess of a 3-inch soap bubble in 3 seconds in either of these tests is not permissible.

4. Leakage is caused by a dirty or scored key or body. Leakage due to dirt is corrected by cleaning parts and applying a light coating of cup grease to the key. Leakage due to a scored key or body cannot be repaired, and the cut-out cock must be replaced.

RESERVOIRS

1. Reservoirs are tested against a 200-pound pressure, and treated on the inside with a rust preventive.



2. The purpose of reservoirs is to provide a place to store compressed air so that there will be an ample supply available for immediate use in brake operation. They also provide storage for sufficient compressed air to permit several brake applications after the engine has stopped. Another function of a reservoir is to provide a place where the air, heated during compression, may cool and cause the oil and water vapors to condense.

Testing

1. **LEAKAGE TESTS.** With the air brake system charged, coat the outside of the reservoir with soapsuds to check for leakage. If any leakage is found, replace the reservoir.

2. **INSPECTION.** Inspect inside and outside surfaces for damage or corrosion. A small flashlight is helpful when inspecting the interior. If damage or corrosion is found that would weaken the reservoir, replace the reservoir.

3. Moisture taken in with the air through the compressor inlet valves collects in the reservoirs and necessitates draining the reservoirs daily in cold weather and every week in warm weather by opening the drain cock located on the bottom. Be sure to close the drain cocks after all moisture has been removed.

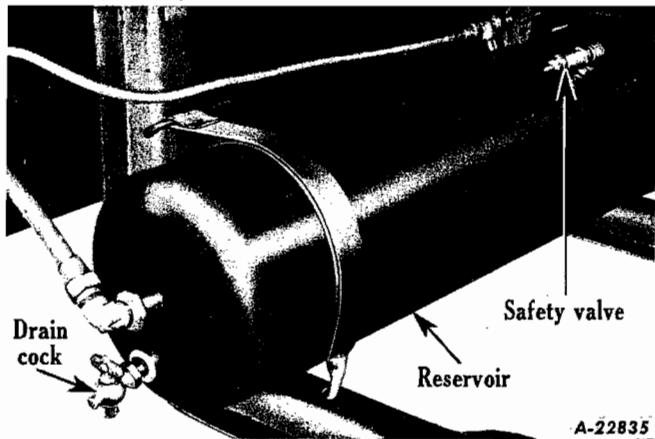


Fig. 18 - Illustrates Reservoir, Safety Valve, and Drain Cock.

DRAIN COCKS

Description

1. Drain cocks have a brass body fitted with a tapered brass key. The drain cock is open when the handle is parallel to the body, and closed when the handle is at right angles to the body. Drain cocks are installed in the bottom of each reservoir in the air brake system to provide a convenient means of draining the condensation which normally collects in the reservoirs.

2. Always open a drain cock by hand. Never strike the handle with a hammer or any other instrument, as the cock would be damaged and leakage would develop.

Testing

1. With the air brake system charged, test with soapsuds for leakage past the key. Also check for leakage through the body by coating the outside of the drain cock with soapsuds. Leakage in excess of a 3-inch soap bubble in 3 seconds is not permissible.

2. Leakage is caused by dirty or scored key or body. Leakage due to dirt is corrected by cleaning parts and applying a thin coating of cupgrease on the key. Leakage due to a scored key or body cannot be repaired, and the drain cock must be replaced.

HOSE, HOSE ASSEMBLIES AND HOSE CONNECTORS

Description

Hose and hose fittings provide a means of making flexible air connections between points on a vehicle which normally change their position in relation to each other, also of making flexible connections between two vehicles. All hose assemblies include detachable-type hose connectors with spring guards. Hose assemblies used to connect the air brake system to another vehicle are fitted with hose couplings. The two hose lines or hose couplings at the rear of the tractor truck are marked by tags identifying them as "SERVICE" or "EMERGENCY."

Testing

1. If any evidence is found indicating that a hose line is restricted, remove and blow air through it in both directions to be sure the passage through the hose is not obstructed in any way.

2. With the brakes applied to be sure that the hose line being tested is under pressure, coat the outside of the hose and connections with soapsuds to check for leakage. No leakage is permissible. Leakage at the connectors is sometimes corrected by tightening the connector nut. If this fails to correct the leakage, replace the connectors, hose, or both.

Replacement

Hose assemblies are easily replaceable by removing the detachable connectors and installing a new piece of hose.

1. Remove connector nuts, and pull hose out of connector body.



2. Do not attempt to remove used sleeve from hose.

3. Cut a piece of new hose to required length, being sure that cut is made at right angles to outside wall of hose, and that end of hose is smooth.

4. Blow out hose with an air line to remove all cuttings.

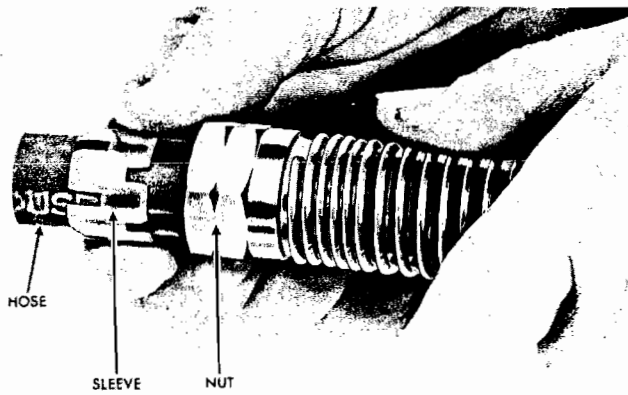


Fig. 19

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5. Place connector nut and sleeve on hose (Fig. 19), being sure that barbs on inside of sleeve point toward end of hose that is being connected.

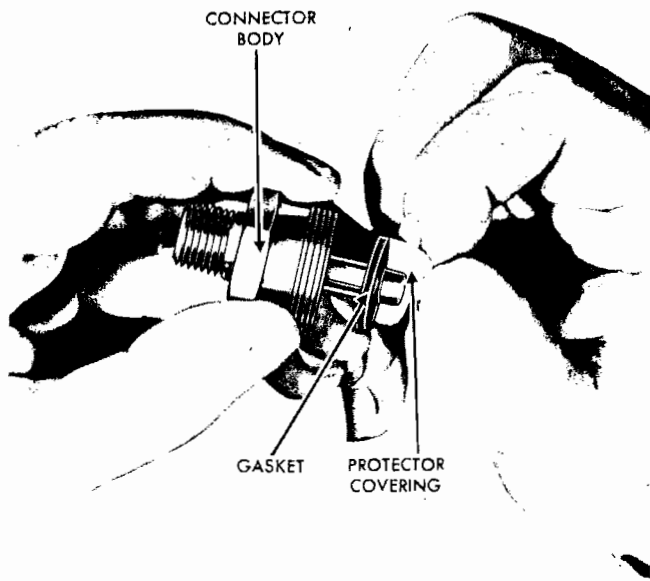


Fig. 20

A-9363

6. Place new gasket over end of guide in connector body so that side with removable protector covering is next to hose. Remove protector covering from gasket (Fig. 20).

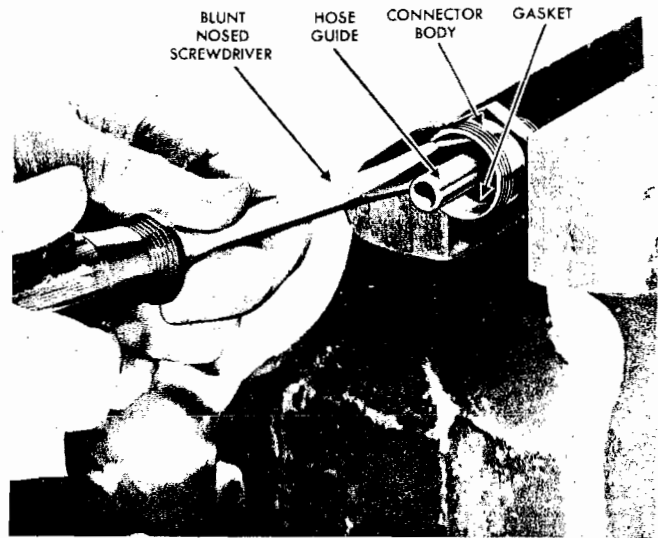


Fig. 21

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7. Push gasket into bottom of recess in connector body (Fig. 21).

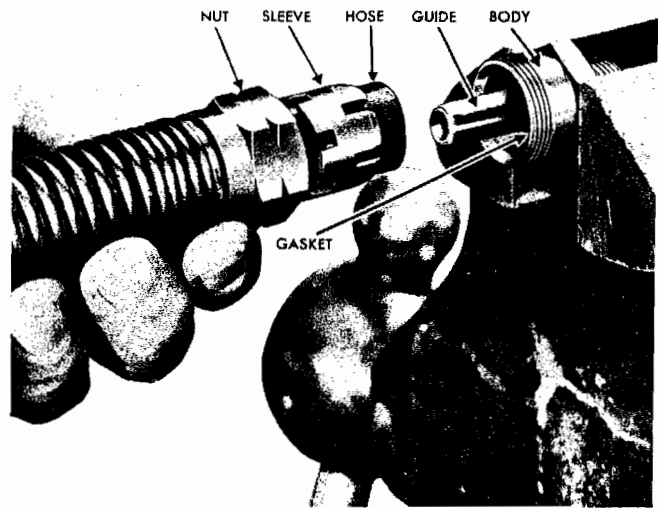


Fig. 22

A-9359

8. Put end of hose in connector body, making sure that end of hose is against gasket at bottom of the recess (Fig. 22).

9. Move sleeve, if necessary, until it is against edge of connector body. Tighten connecting nut. It is only necessary to tighten nut sufficiently to insure an air-tight joint.

10. When installing a hose assembly where both ends are permanently connected, the hose connector at either end is used as a swivel by loosening the nut on one of the connectors. Turn the hose in the loose connector before the connector nut is again tightened. This permits the installation of the hose without kinking or twisting.



HOSE COUPLINGS AND DUMMY COUPLINGS

Description

1. Hose couplings provide an easy and convenient method of connecting and disconnecting air lines between vehicles by hand. The design of the hose couplings is such that when two of them are coupled together pressure is put on two rubber gaskets, making an air-tight seal.

2. Dummy couplings are made in two general designs, some being fitted with brackets to permit them to be rigidly mounted on the vehicle, while others are fitted with a chain attaching them to the vehicle. The bracket type is used where the dummy coupling is to serve as a fastening for holding hose lines when not in use, whereas the chain type is used for blocking off hose couplings rigidly mounted on the vehicle as used on the tractor truck. The purpose of the dummy coupling is to prevent the entrance of dirt or other foreign matter into the air brake lines when the lines are not being used.

Testing

1. With the hose couplings connected and brakes applied, coat the hose couplings all over with soapsuds to check for leakage. There must be no leakage.

2. Leakage is usually caused by worn, damaged, or improperly installed gaskets. To correct leakage, install new gaskets.

3. Remove old gasket by prying out with a screwdriver. Before attempting to install a new gasket, be sure the groove in the coupling in which the gasket fits is thoroughly cleaned. Otherwise it will be impossible to install a new gasket properly.

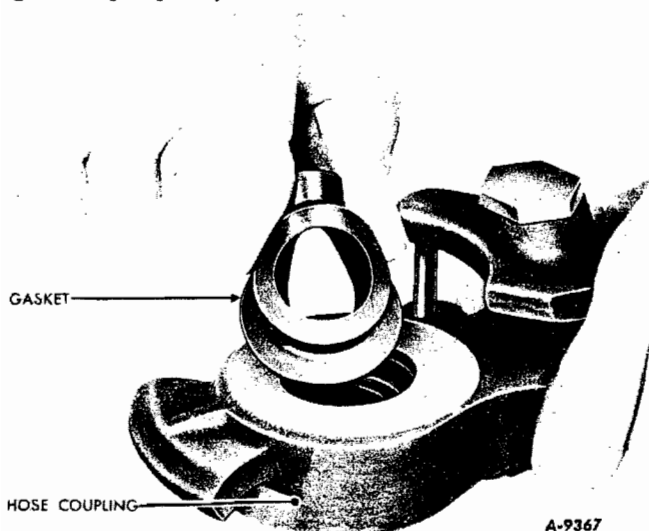


Fig. 23

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4. To install a new gasket, partially collapse it with the fingers (Fig. 23), and enter one side of the gasket flange in the groove in the coupling.

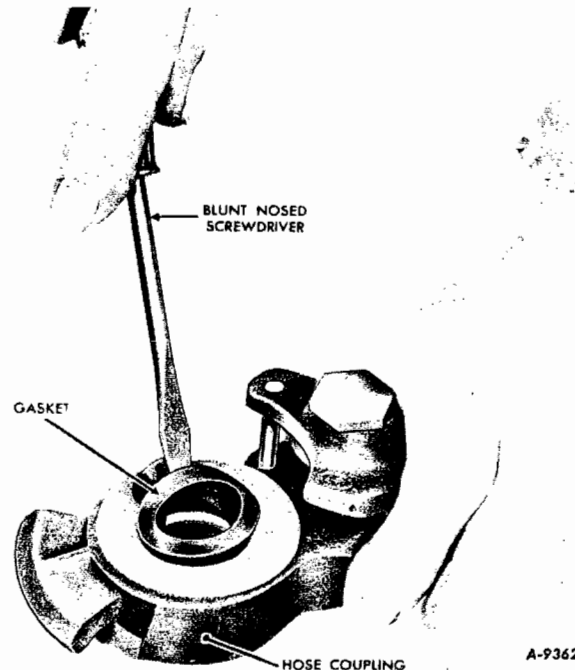


Fig. 24

5. Then use a blunt nosed screwdriver or similar instrument to push the gasket into place (Fig. 24). When properly installed, the exposed face of the gasket will be flat, not twisted or bulged at any point.

TUBING

Operating Tests

If any evidence is found that a tubing line is restricted, remove and blow air through it in both directions to be sure the passage through the tubing is not obstructed in any way. Inspect tubing for partial restrictions such as may be caused by dents or kinks. Damaged tubing must be replaced.

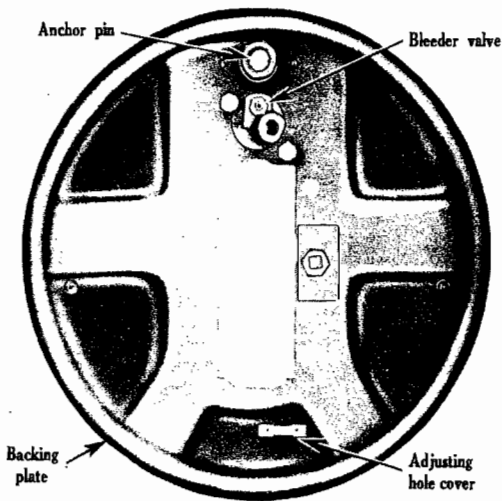
Leakage Tests

With the air brake system fully charged, the governor cut out, and brakes applied, coat all tubing lines and fittings with soapsuds to check for leakage. No leakage is permissible. Leakage at a tubing fitting is sometimes corrected by tightening the tubing fitting nut. If this fails to correct the leakage, replace the tubing fitting, the tubing, or both.

HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

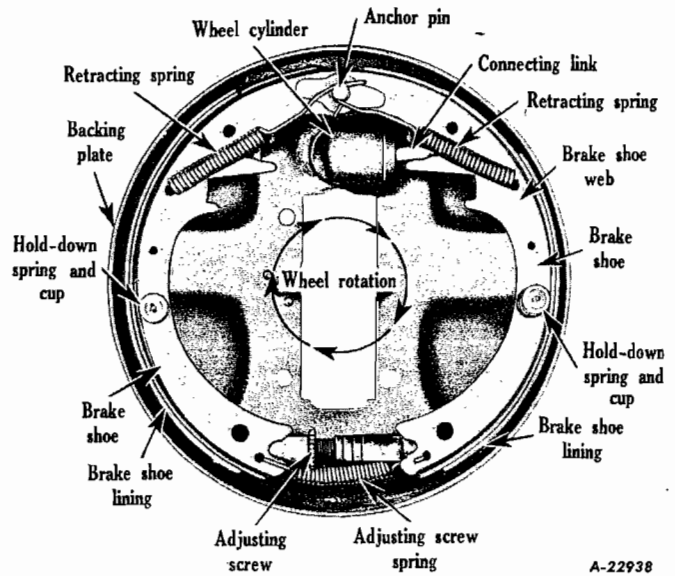
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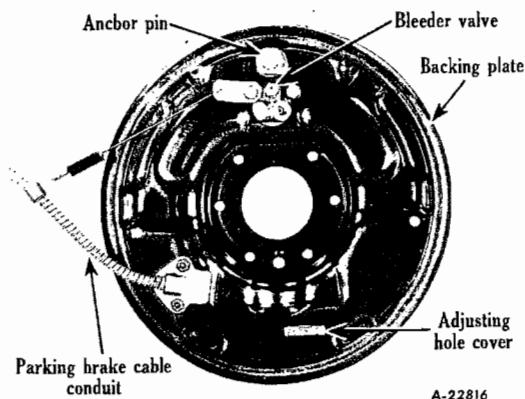
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Fig. 1 - (Front) External View.



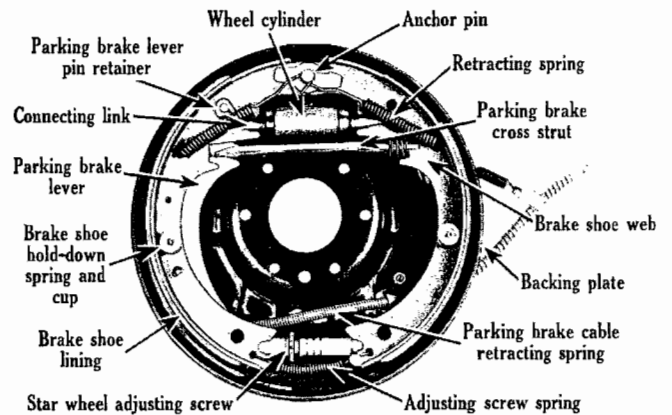
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Fig. 2 - (Front) Internal View.



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Fig. 3 - (Rear) External View.



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Fig. 4 - (Rear) Internal View.

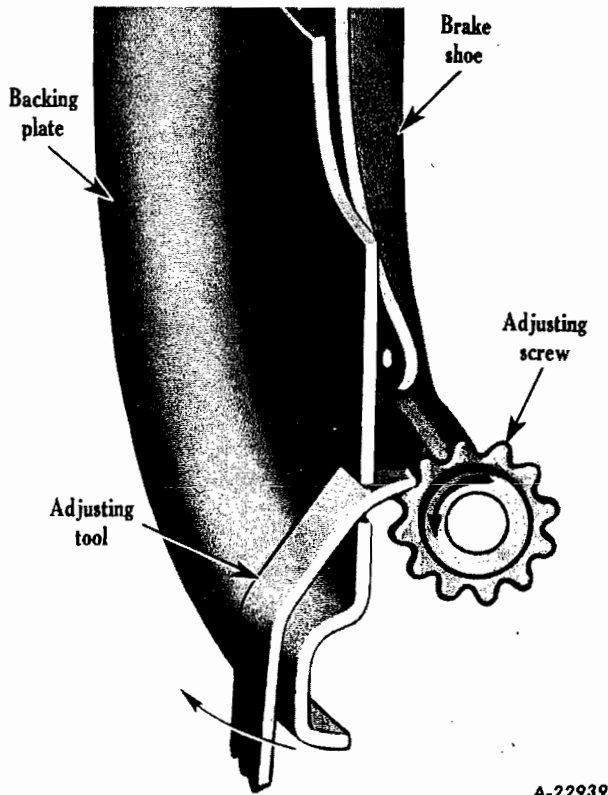


Fig. 5

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BRAKE ADJUSTMENT INSTRUCTIONS

Before attempting to make any brake adjustments - whether minor or major - be sure that wheel bearings are properly adjusted and that brake backing plates are tight.

Adjustment For Wear (Minor) (Figs. 1, 2, 3, 4 and 5)

NOTE: Perform Operations in Sequence Given
(At Both Front and Rear Brakes Unless Other-
wise Noted.):

1. Place parking brake lever in fully released position.
2. Jack up truck until the wheels are free from floor.
3. Remove adjusting hole covers.
4. Insert screwdriver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw (Fig. 5).
5. Move outer end of screwdriver or special tool toward axle, expanding brake shoes to the point where the wheel can just be turned by hand.
6. Rear brakes only. NOTE: Parking brake cable adjustment should be made at this time. With brake shoes still expanded, disconnect the parking brake cable at the intermediate

lever end. With parking brake lever applied approximately 1" from fully released position, pull cables by hand to remove all slack. Adjust cables as required at yoke ends so that clevis pins can be inserted. Insert clevis pins and new cotter pins.

7. Back off star wheel adjusting screw 12 to 14 notches and then check to see that brake drum turns freely. It may be necessary to tap the backing plate lightly to permit the brake shoes to take a central position.
8. Rear brakes only. Pull parking brake lever back until the rear wheel can just be turned by hand. Check rear wheels for even brake drag. If drag is uneven, loosen the tight brake to provide even drag.
9. Replace adjusting hole covers.

Major Adjustments and Servicing (Figs. 1, 2, 3, 4 and 5).

The following adjustments are performed only when adjustments under "Minor Adjustments" fail to give satisfactory results or when installing new shoes or linings.

NOTE: Perform Operations in Sequence Given.
(At both front and rear brakes unless
otherwise noted.)

1. Place parking brake lever in fully released position.
2. Jack up truck until wheels are free from floor.
3. Remove wheels, hubs and drums.
4. Remove adjusting hole covers.
5. Remove brake shoes and inspect linings for excessive wear, grease, loose rivets or other damage. Install new lining if old lining shows excessive wear or is saturated with grease or brake fluid.
6. Inspect brake drums for scores, run-out or cracks. If scores are not too deep or "run-out" does not exceed .010", drums may be machined. If drums are badly scored or cracked, they should be replaced.
7. Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.
8. Clean grease and dirt off backing plate and sand down shoe ledges if rusted or ridged.



9. Disconnect parking brake cables to rear brakes at intermediate lever end. Wipe off dirt and grease from exposed portion of cables and pull cables through conduits as far as possible from the brake end and wipe off old grease.
10. Apply a generous coating of cable lubricant to cables and slide cables back through conduits. Wipe off excessive grease from backing plate.
11. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to shoe ledges and on rear brakes apply to the parking brake lever fulcrum and strut contact points.
12. Thoroughly clean star wheel adjusting screws, pivot nuts, hold down pins, springs and cups. Apply a small amount of suitable lubricant comparable to "Lubriplate" to the threaded end of the adjusting screw and to contact points on the shoe webs.
13. When installing new shoes, lay the shoes out in pairs according to their position on the truck. The rear (secondary) shoe is the shoe with longer lining.
14. Rear brakes only. On rear brake shoes attach parking brake levers to backing plate side of shoe web, using lever pin, spring and retainer. Squeeze ends of retainer lock together after assembly of retainer.
15. Thread the star wheel adjusting screw into the pivot nut to the limit of the thread and assemble star wheel adjusting screw and adjusting screw spring to the adjustment end of the shoes with pivot nut against the right hand shoe. NOTE: Always assemble pivot nut on the right hand shoe regardless of position of shoes on the truck.
16. Guide forked end of shoe links over anchor end of shoe web, and attach shoes to backing plates by means of shoe hold down pins, springs and cups.
17. On rear brakes only, assemble spring on strut against strut shoulder and assemble strut between front (primary) shoe and parking brake lever. The small loop of spring rests against inside of shoe web on right hand brake and on outside of shoe web on left hand brake.
18. On rear brakes only, attach cable to parking brake lever by compressing cable retracting spring and sliding cable into loop at end of lever.
19. Attach retracting springs to shoes and anchor pins. If springs show signs of having been overstressed, they should be replaced.
20. Install brake drums. (For lubrication and adjustment of front wheel bearings see "Wheel Section".)

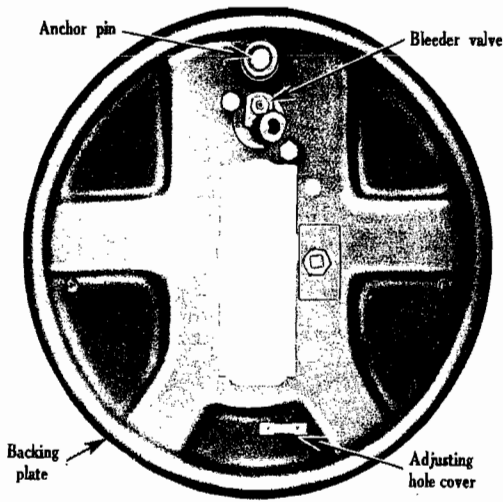
NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING-TO-DRUM CLEARANCE INDICATES A NEED FOR REPOSITIONING OF ANCHORS.
21. Insert a .015" feeler gauge between the lining and drum of the rear (secondary) shoe about 1-1/2" from the star wheel adjusting screw end of the shoe and expand shoe by turning star wheel adjusting screw until feeler gauge cannot be withdrawn. Then turn star wheel adjusting screw in opposite direction until there is but a light drag on the feeler gauge.

Withdraw feeler gauge. NOTE: Expanding shoes until feeler gauge cannot be withdrawn insures that shoes are resting against the anchor pin.
22. Revolve brake drum so that feeler gauge hole is about 1-1/2" from the anchor end of the rear (secondary) shoe lining. There should be a slightly heavier drag on the feeler gauge at this point. If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will be necessary to adjust the anchor pin.
23. To adjust anchor pin, loosen locknut 1/4 to 1/2 of a turn and tap anchor pin either up or down to provide the correct anchor pin position. After positioning the anchor pin to provide the correct rear (secondary) shoe clearance, tighten the anchor pin locknut with a 16" wrench and then recheck anchor and adjusting end clearances.

NOTE: If anchor pin nut is loosened too much, the anchor pin may shift when tightening the locknut.
24. To adjust rear parking brake cables expand shoes at both rear brakes until tight against brake drums. With parking brake lever applied approximately 1" from fully released position, pull cables by hand to remove all slack. Adjust cables as required at yoke ends so that clevis pins can be inserted. Insert clevis pins and new cotter pins.
25. At both rear brakes back off star wheel adjusting screw 12 to 14 notches.
26. To check rear brakes for balance, pull parking brake lever back until rear wheels can just be turned by hand. Check rear wheels for even brake drag. If drag is uneven, loosen the tight brake to provide even drag.
27. Replace adjusting hole covers.

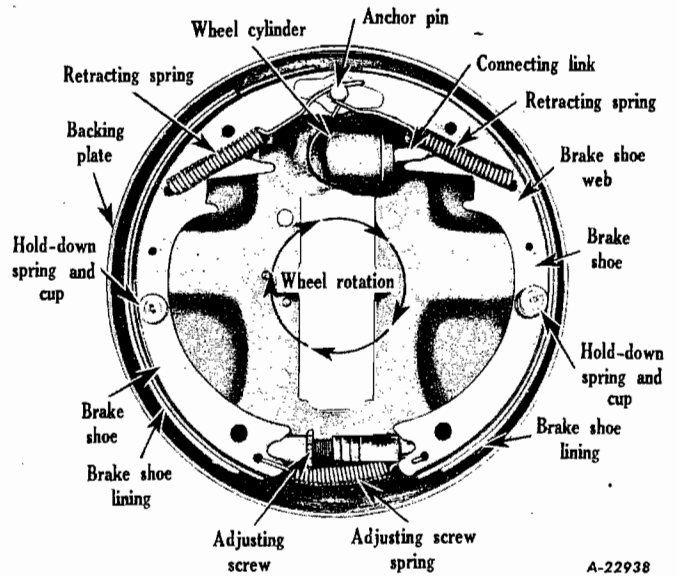
HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

LM-120, LM-121, LM-122 $\left\{ \begin{array}{l} 12 \times 1-3/4'' \text{ FRONT} \\ 12 \times 2'' \text{ REAR} \end{array} \right.$



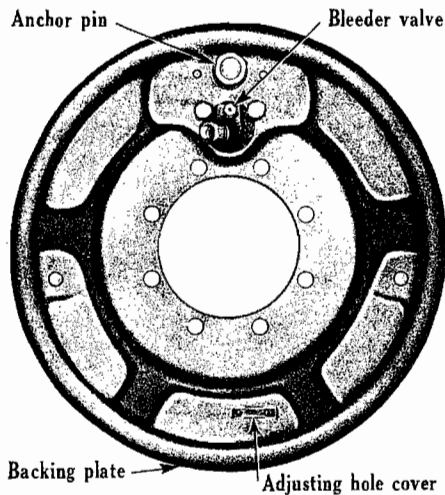
A-22940

Fig. 1 - (Front) External View.



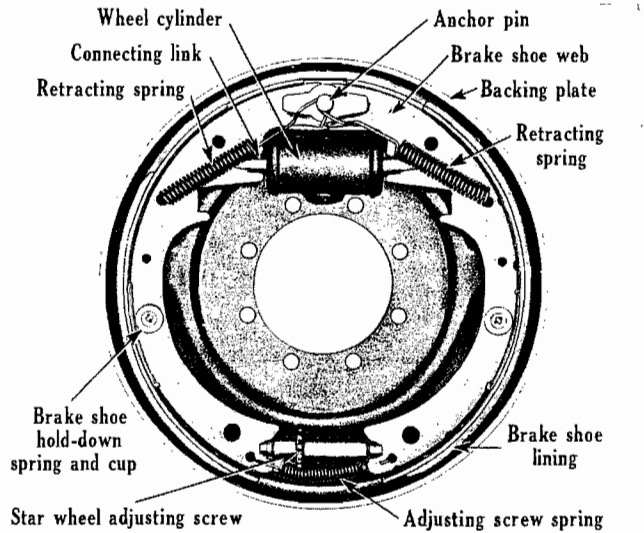
A-22938

Fig. 2 - (Front) Internal View.



A-22926

Fig. 3 - (Rear) External View.



A-22927

Fig. 4 - (Rear) Internal View.

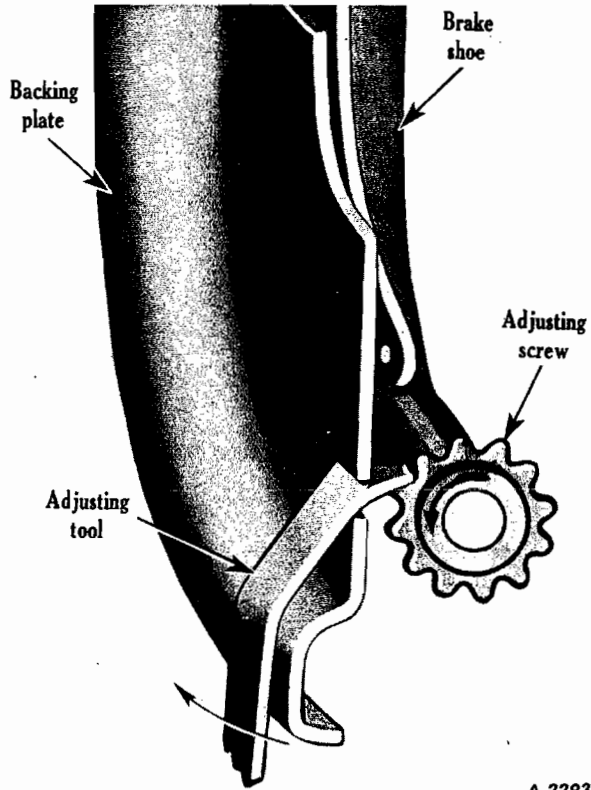


Fig. 5

A-22939

BRAKE ADJUSTMENT INSTRUCTIONS

Before attempting to make any brake adjustments whether minor or major, be sure that wheel bearings are properly adjusted and that brake backing plates are tight.

Adjustment For Wear (Minor)

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED): -

1. Place parking brake lever in fully released position.
2. Jack up truck until the wheels are free from floor.
3. Remove adjusting hole covers.
4. Insert screwdriver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw (Fig. 5).
5. Move outer end of screwdriver or special tool toward axle, expanding brake shoes to the point where the wheel can just be turned by hand.
6. Back off star wheel adjusting screw 12 to 14 notches and then check to see that brake drum turns freely. It may be necessary to tap the backing plate lightly to permit the brake shoes to take a central position.
7. Replace adjusting hole covers.

Major Adjustments and Servicing (Figs. 1, 2, 3, 4 and 5).

The following adjustments are performed only when adjustments under "Minor Adjustments" fail to give satisfactory results or when installing new shoes or linings.

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED): -

1. Place parking brake lever in fully released position.
2. Jack up truck until wheels are free from floor.
3. Remove wheels, hubs and drums.
4. Remove adjusting hole covers.
5. Remove brake shoes and inspect linings for excessive wear, grease, loose rivets or other damage. Install new lining if old lining shows excessive wear or is saturated with grease or brake fluid.
6. Inspect brake drums for scores, run-out or cracks. If scores are not too deep or "run-out" does not exceed .010", drums may be machined. If drums are badly scored or cracked, they should be replaced.
7. Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.
8. Clean grease and dirt off backing plate and sand down shoe ledges if rusted or ridged.
9. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to shoe ledges.
10. Thoroughly clean star wheel adjusting screws, pivot nuts, hold down pins, springs and cups. Apply a small amount of suitable lubricant comparable to "Lubriplate" to the threaded end of the adjusting screw and to contact points on the shoe webs.



11. When installing new shoes, lay the shoes out in pairs according to their position on the truck. The rear (secondary) shoe is the shoe with longer lining.
12. Thread the star wheel adjusting screw into the pivot nut to the limit of the thread and assembly star wheel adjusting screw and adjusting screw spring to the adjustment end of the shoes with pivot nut against the right hand shoe. NOTE: Always assemble pivot nut on the right hand shoe regardless of position of shoes on the truck.
13. Guide forked end of shoe links over anchor end of shoe web, and attach shoes to backing plates by means of shoe hold down pins, springs and cups.
14. Attach retracting springs to shoe and anchor pins. If springs show signs of having been overstressed, they should be replaced.
15. Install brake drums. (For lubrication and adjustment of front wheel bearings see Wheel Section.)

NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING TO DRUM CLEARANCE INDICATES A NEED FOR REPOSITIONING OF ANCHORS.

16. Insert a .015" feeler gauge between the lining and drum of the rear (secondary) shoe about 1-1/2" from the star wheel adjusting screw end of the shoe and expand shoe by turning star wheel adjusting screw until feeler gauge cannot be withdrawn. Then turn star wheel adjusting screw in opposite direction until there is but a light drag on the feeler gauge.

Withdraw feeler gauge. NOTE: Expanding shoes until feeler gauge cannot be withdrawn insures that shoes are resting against the anchor pin.
17. Revolve brake drum so that feeler gauge hole is about 1-1/2" from the anchor end of the rear (secondary) shoe lining. There should be a slightly heavier drag on the feeler gauge at this point. If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will be necessary to adjust the anchor pin.
18. To adjust anchor pin, loosen locknut 1/4 to 1/2 turn and tap anchor pin either up or down to provide the correct anchor pin position. After positioning the anchor pin to provide the correct rear (secondary) shoe clearance, tighten the anchor pin locknut with a 16" wrench and then recheck anchor and adjusting end clearances.

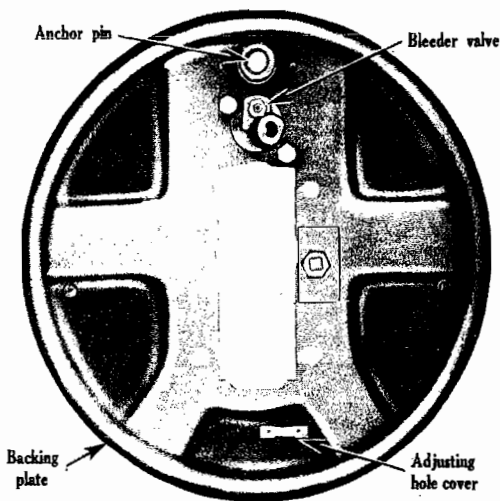
NOTE: If anchor pin nut is loosened too much, the anchor pin may shift when tightening the locknut.

19. Replace adjusting hole covers.



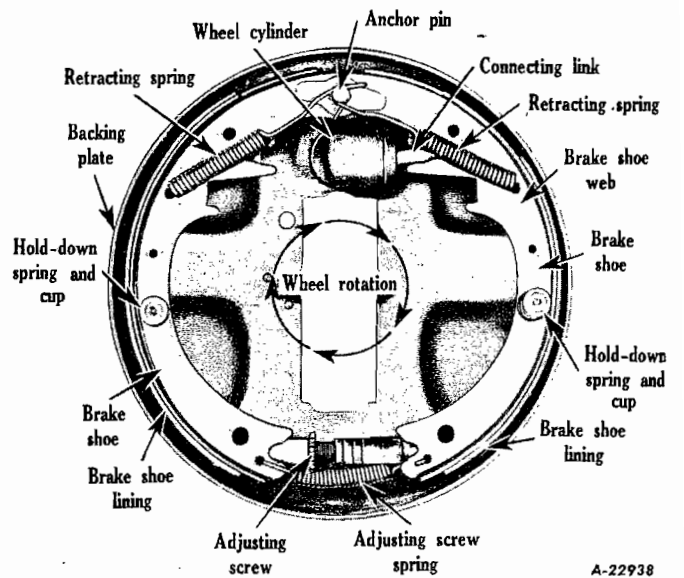
HYDRAULIC BRAKES
BRAKE SHOE ADJUSTMENTS AND SERVICING

L-130, L-131, L-132 { 12 x 1-3/4" FRONT
14 x 2-1/4" REAR



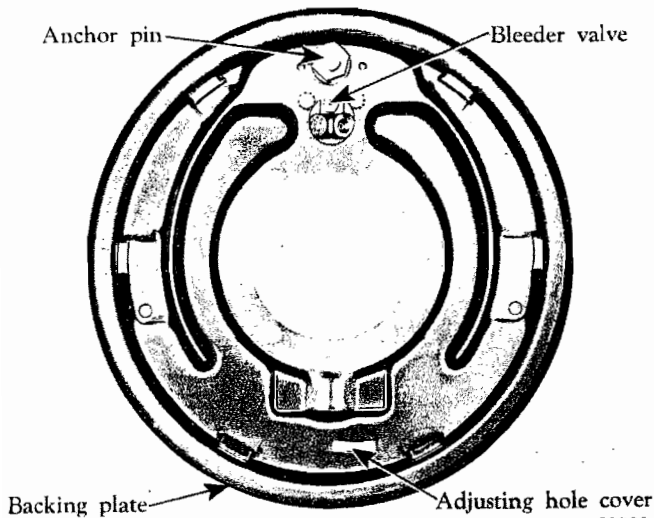
A-22940

Fig. 1 - (Front) External View.



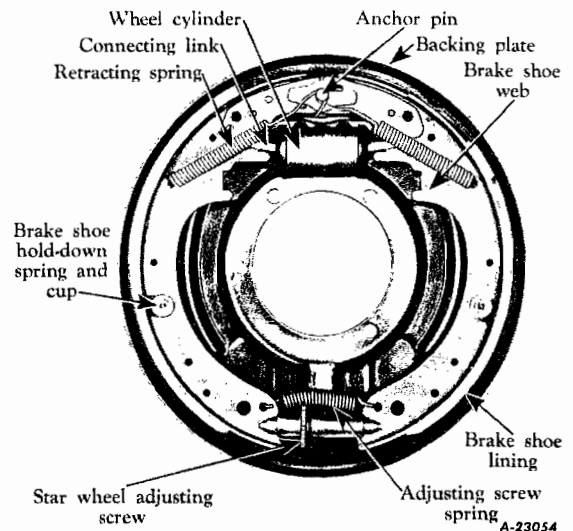
A-22938

Fig. 2 - (Front) Internal View.



A-23055

Fig. 3 - (Rear) External View.



A-23054

Fig. 4 (Rear) Internal View.

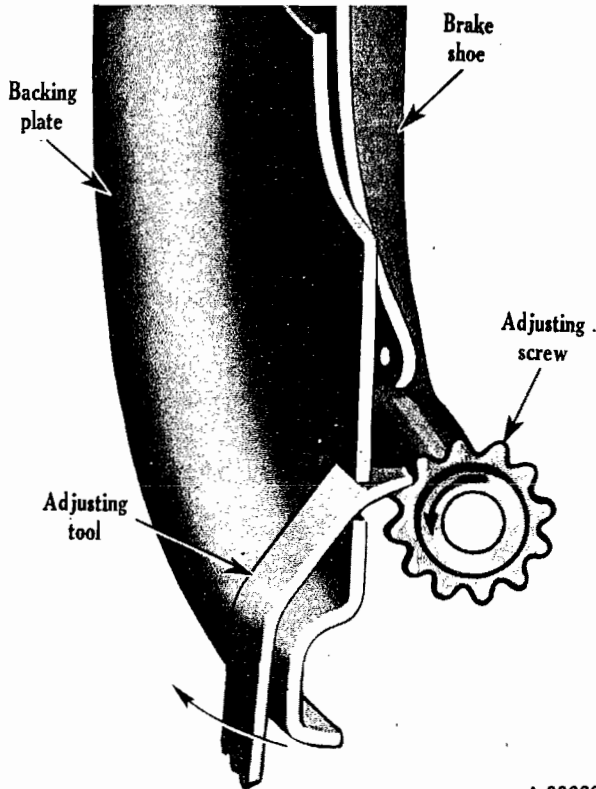


Fig. 5

A-22939

BRAKE ADJUSTMENT INSTRUCTIONS

Before attempting to make any brake adjustments, whether minor or major, be sure that wheel bearings are properly adjusted and that brake backing plates are tight.

Adjustment for Wear (Minor)

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED):

1. Place parking brake lever in fully released position.
2. Jack up truck until the wheels are free from floor.
3. Remove adjusting hole covers.
4. Insert screw driver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw (Fig. 5).
5. Move outer end of screw driver or special tool toward axle, expanding brake shoes to the point where the wheel can just be turned by hand.
6. Back off adjusting screw 12 to 14 notches and then check to see that brake drum turns freely. It may be necessary to tap the backing plate lightly to permit the brake shoes to take a central position.
7. Replace adjusting hole covers.

Major Adjustments and Servicing (Figs. 1, 2, 3, 4, 5).

The following adjustments are performed only when adjustments under "Minor Adjustments." fail to give satisfactory results or when installing new shoes or linings.

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED):

1. Place parking brake lever in fully released position.
2. Jack up truck until wheels are free from floor.
3. Remove wheels, hubs, and drums.
4. Remove adjusting hole covers.
5. Remove brake shoes and inspect linings for excessive wear, grease, loose rivets or other damage. Install new lining if old shows excessive wear or is saturated with grease or brake fluid.
6. Inspect brake drums for scores, run-out or cracks. If scores are not too deep or "run-out" does not exceed .010", drums may be machined. If drums are badly scored or cracked, they should be replaced.
7. Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.
8. Clean grease and dirt off of backing plate and sand down shoe ledges of rusted or ridged.
9. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to shoe ledges.
10. Thoroughly clean star wheel adjusting screws, pivot nuts, hold down pins, springs and cups. Apply a small amount of suitable lubricant comparable to "Lubriplate" to the threaded end of the adjusting screw and to contact points on the shoe webs.
11. When installing new shoes, lay the shoes out in pairs according to their position on the truck. The rear (secondary) shoe is the shoe with longer lining.



L-LINE MOTOR TRUCK SERVICE MANUAL

12. Thread the star wheel adjusting screw into the pivot nut to the limit of the thread and assemble star wheel adjusting screw and adjusting screw spring to the adjustment end of the shoes with pivot nut against the right hand shoe. **NOTE:** Always assemble pivot nut on the right hand shoe regardless of position of shoes on the truck.
13. Guide forked end of shoe links over anchor end of shoe web, and attach shoes to backing plates by means of shoe hold down pins, springs and cups.
14. Attach retracting springs to shoes and anchor pins. If springs show signs of having been overstressed, they should be replaced.
15. Install brake drums. (For lubrication and adjustment of front wheel bearings see Wheel Section.)

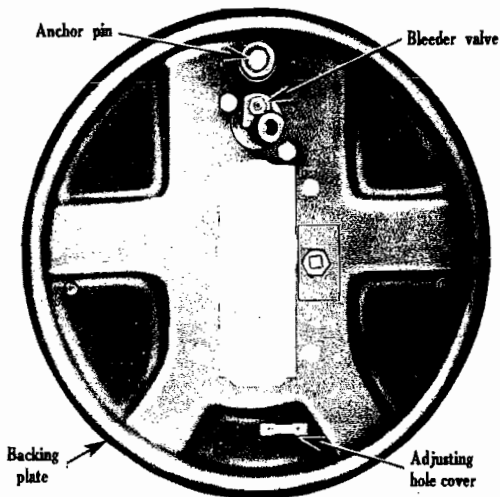
NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING TO DRUM CLEARANCE INDICATES A NEED FOR REPOSITIONING OF ANCHORS.

16. Insert a .015" feeler gauge between the lining and drum of the rear (secondary) shoe about 1-1/2" from the star wheel adjusting screw end of the shoe and expand shoe by turning star wheel adjusting screw until feeler gauge cannot be withdrawn. Then turn star wheel adjusting screw in opposite direction until there is but a light drag on the feeler gauge. Withdraw feeler gauge. **NOTE:** Expanding shoes until feeler gauge cannot be withdrawn insures that shoes are resting against the anchor pin.
17. Revolve brake drum so that feeler gauge hole is about 1-1/2" from the anchor end of the rear (secondary) shoe lining. There should be a slightly heavier drag on the feeler gauge at this point. If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will be necessary to adjust the anchor pin.
18. To adjust anchor pin, loosen locknut 1/4 to 1/2 turn and tap anchor pin either up or down to provide the correct anchor pin position. After positioning the anchor pin to provide the correct rear (secondary) shoe clearance, tighten the anchor pin locknut with a 16" wrench and then recheck anchor and adjusting end clearances. **NOTE:** If anchor pin nut is loosened too much, the anchor pin may shift when tightening the locknut.
19. Replace adjusting hole covers.



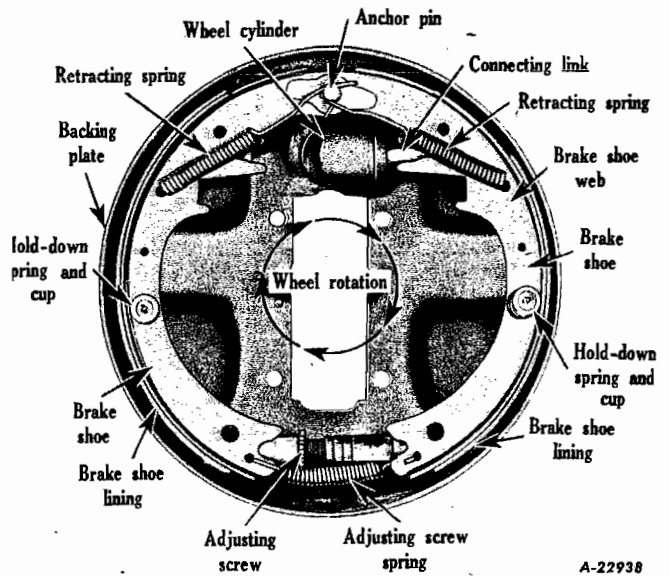
HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

LB-140 { 12 x 1-3/4" FRONT
14 x 2-1/4" REAR



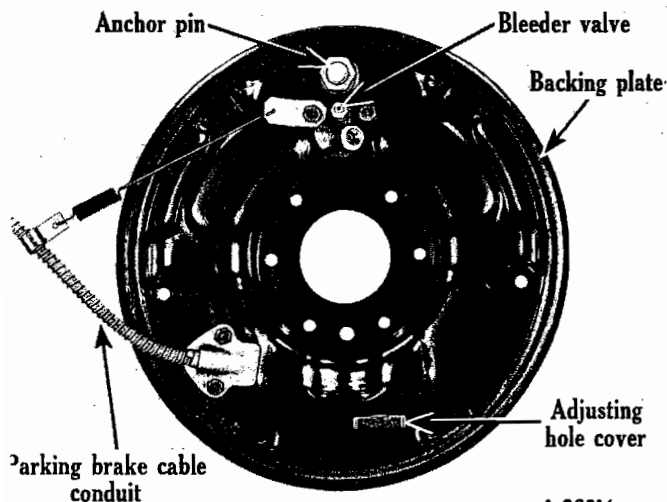
A-22940

Fig. 1 - (Front) External View.



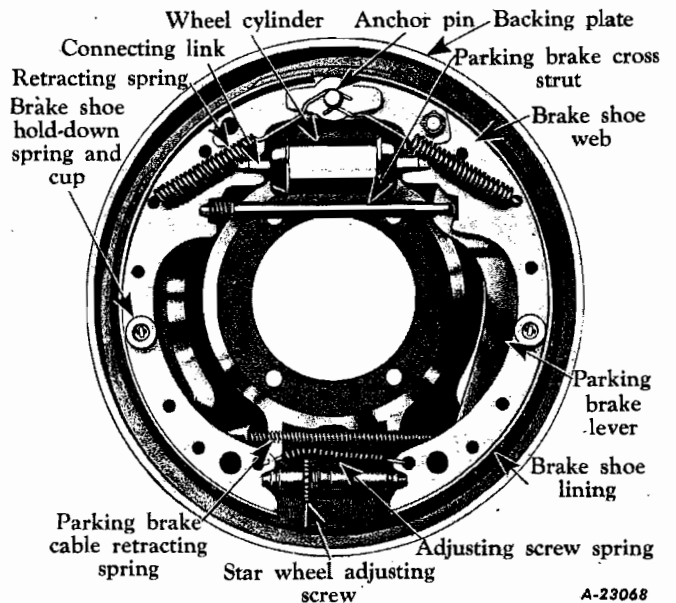
A-22938

Fig. 2 - (Front) Internal View.



A-22816

Fig. 3 - (Rear) External View.



A-23068

Fig. 4 - (Rear) Internal View.

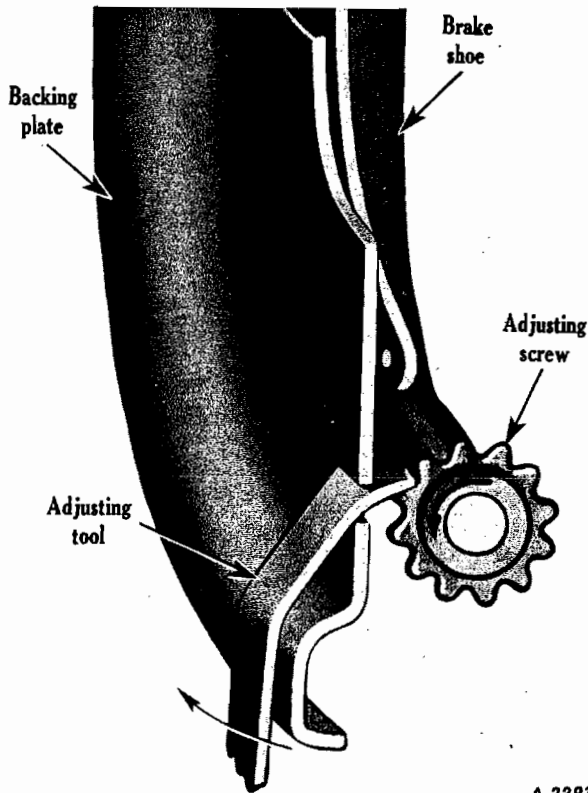


Fig. 5

A-22939

BRAKE ADJUSTMENT INSTRUCTIONS

Before attempting to make any brake adjustments, whether minor or major, be sure that wheel bearings are properly adjusted and that brake backing plates are tight.

Adjustment For Wear (Minor)

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED): -

1. Place parking brake lever in fully released position.
2. Jack up truck until the wheels are free from floor.
3. Remove adjusting hole covers.
4. Insert screwdriver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw (Fig. 5).
5. Move outer end of screwdriver or special tool toward axle, expanding brake shoes to the point where the wheel can just be turned by hand.
6. **REAR BRAKES ONLY.** **NOTE:** Parking brake cable adjustment should be made at this time. With brake shoes still expanded, disconnect the parking brake cable at the

intermediate lever end. With parking brake lever applied approximately 1" from fully released position, pull cables by hand to remove all slack. Adjust cables as required at yoke end so that clevis pins can be inserted. Insert clevis pins and new cotter pins.

7. Back off star wheel adjusting screw 12 to 14 notches and then check to see that brake drum turns freely. It may be necessary to tap the backing plate lightly to permit the brake shoes to take a central position.
8. **REAR BRAKES ONLY.** Pull parking brake lever back until the rear wheel can just be turned by hand. Check rear wheels for even brake drag. If drag is uneven, loosen the tight brake to provide even drag.
9. Replace adjusting hole covers.

Major Adjustments and Servicing

(Fig. 1, 2, 3, 4 and 5).

The following adjustments are performed only when adjustments under "Minor Adjustments" fail to give satisfactory results or when installing new shoes or linings.

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED): -

1. Place parking brake lever in fully released position.
2. Jack up truck until wheels are free from floor.
3. Remove wheels, hubs and drums.
4. Remove adjusting hole covers.
5. Remove brake shoes and inspect linings for excessive wear, grease, loose rivets or other damage. Install new lining if old lining shows excessive wear or is saturated with grease or brake fluid.
6. Inspect brake drums for scores, run-out or cracks. If scores are not too deep or "run-out" does not exceed .010", drums may be machined. If drums are badly scored or cracked, they should be replaced.
7. Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.
8. Clean grease and dirt off of backing plate and sand down shoe ledges if rusted or ridged.
9. Disconnect parking brake cables to rear brakes at intermediate lever end. Wipe off dirt and grease from exposed portion of cables and pull cables through conduits as far as possible from the brake end and wipe off old grease.



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10. Apply a generous coating of cable lubricant to cables and slide cables back through conduits. Wipe off excessive grease from backing plate.
11. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to shoe ledges and on rear brakes apply to the parking brake lever fulcrum and strut contact points.
12. Thoroughly clean star wheel adjusting screws, pivot nuts, hold down pins, springs and cups. Apply a small amount of suitable lubricant comparable to "Lubriplate" to the threaded end of the adjusting screw and to contact points on the shoe webs.
13. When installing new shoes, lay the shoes out in pairs according to their position on the truck. The rear (secondary) shoe is the shoe with longer lining.
14. **REAR BRAKES ONLY.** On rear shoes attach parking brake levers to backing plate side of shoe web. Place spring washer on parking brake lever pin and insert pin through lever and shoe from the backing plate side. Assemble lockwasher and nut. Adjust nut so that parking brake lever is under spring tension, but free of bind.
15. **REAR BRAKES ONLY.** Attach parking brake lever strut to parking brake lever from side opposite backing plate with conical spring, flat washer and cotter pin.
16. Thread the star wheel adjusting screw into the pivot nut to the limit of the thread and assemble star wheel adjusting screw and adjusting screw spring to the adjustment end of the shoes with pivot nut against the right hand shoe. **NOTE:** Always assemble pivot nut on the right hand shoe regardless of position of shoes on the truck.
17. **FRONT BRAKES ONLY.** Guide forked end of shoe links over anchor end of shoe web, and attach shoes to backing plates by means of shoe hold down pins, springs and cups.
18. **REAR BRAKES ONLY.** Place parking brake lever strut spring against shoulder at front (primary) shoe end of strut. Guide forked end of strut and shoe links over anchor end of shoe webs. Attach shoes to backing plate by means of shoe hold down pins, springs and cups.
19. **REAR BRAKES ONLY.** Attach cable to parking brake lever by sliding yoke at brake end of cable over hook end of parking brake lever.
20. Attach retracting springs to shoes and anchor pins. If springs show signs of having been overstressed, they should be replaced.
21. Install brake drums. (For lubrication and adjustment of front wheel bearings see Wheel Section.)
NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING TO DRUM CLEARANCE INDICATES A NEED FOR REPOSITIONING OF ANCHORS.
22. Insert a .015" feeler gauge between the lining and drum of the rear (secondary) shoe about 1-1/2" from the star wheel adjusting screw end of the shoe and expand shoe by turning star wheel adjusting screw until feeler gauge cannot be withdrawn. Then turn star wheel adjusting screw in opposite direction until there is but a light drag on the feeler gauge.

Withdraw feeler gauge. **NOTE:** Expanding shoes until feeler gauge cannot be withdrawn insures that shoes are resting against the anchor pin.
23. Revolve brake drum so that feeler gauge hole is about 1-1/2" from the anchor end of the rear (secondary) shoe lining. There should be a slightly heavier drag on the feeler gauge at this point. If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will be necessary to adjust the anchor pin.
24. To adjust anchor pin, loosen lock nut 1/4 to 1/2 turn and tap anchor pin either up or down to provide the correct anchor pin position. After positioning the anchor pin to provide the correct rear (secondary) shoe clearance, tighten the anchor pin lock nut with a 16" wrench and then recheck anchor and adjusting end clearances. **NOTE:** If anchor pin nut is loosened too much, the anchor pin may shift when tightening the lock nut.
25. To adjust rear parking brake cables expand shoes at both rear brakes until tight against brake drums. With parking brake lever applied approximately 1" from fully released position, pull cables by hand to remove all slack. Adjust cables as required at yoke ends so that clevis pin can be inserted. Insert clevis pins and new cotter pins.
26. At both rear brakes back off star wheel adjusting screw 12 to 14 notches.
27. To check rear brakes for balance, pull parking brake lever back until rear wheel can just be turned by hand. Check rear wheels for even brake drag. If drag is uneven, loosen the tight brake to provide even drag.
28. Replace adjusting hole covers.



HYDRAULIC BRAKES
BRAKE SHOE ADJUSTMENTS AND SERVICING

L-150, LM-150, LM-151 { 12-1/8 x 2" FRONT
14 x 2-1/4" REAR

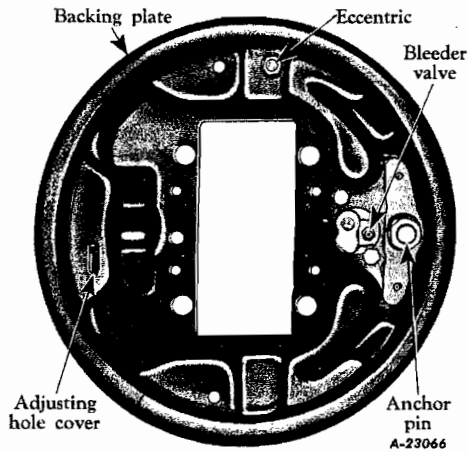


Fig. 1 - (Front) External View.

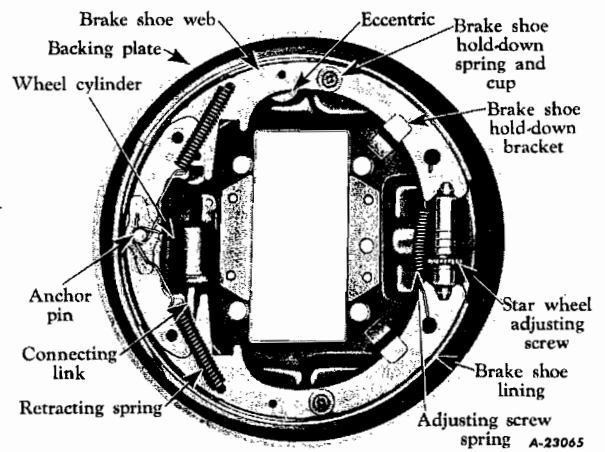


Fig. 2 - (Front) Internal View.

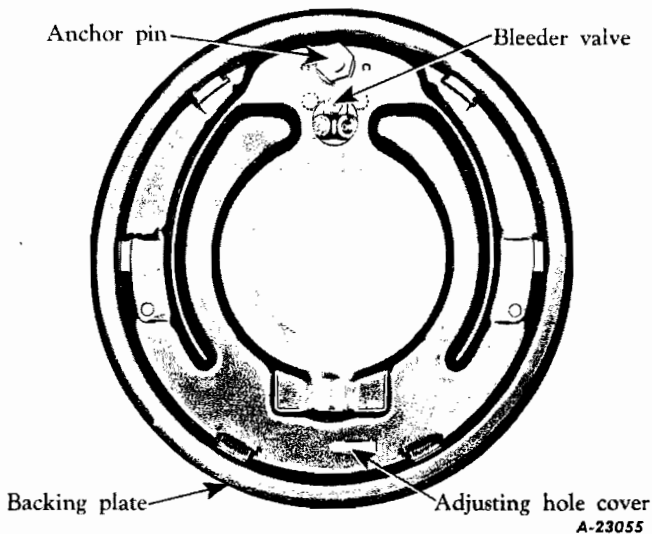


Fig. 3 - (Rear) External View.

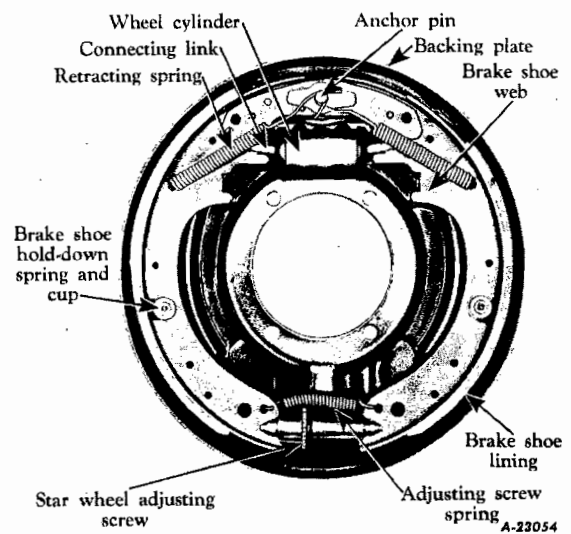


Fig. 4 - (Rear) Internal View.

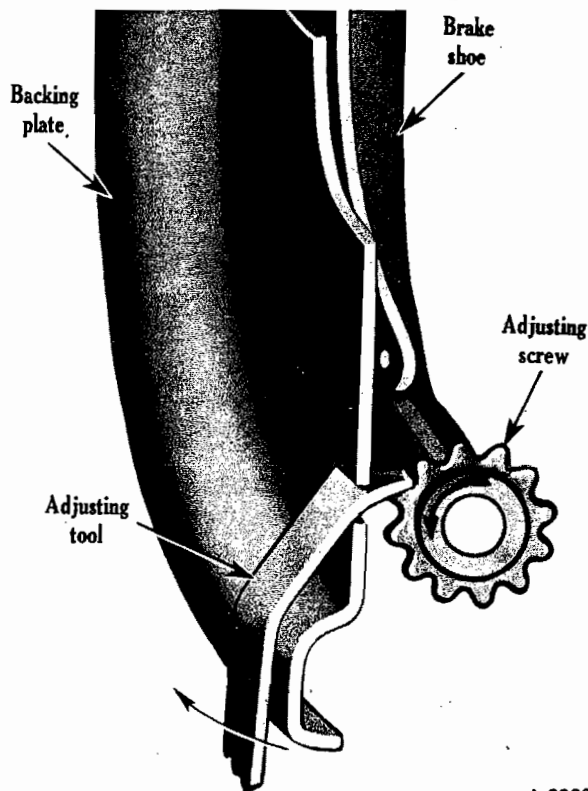


Fig. 5

A-22939

BRAKE ADJUSTMENT INSTRUCTIONS

Before attempting to make any brake adjustments, whether minor or major, be sure that wheel bearings are properly adjusted and that brake backing plates are tight.

Adjustment For Wear (Minor)

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED):-

1. Place parking brake lever in fully released position.
2. Jack up truck until the wheels are free from floor.
3. Remove adjusting hole covers.
4. On front brakes only loosen eccentric locknut and turn eccentric adjustment in the direction of forward wheel rotation until upper (secondary) brake shoe drags. Then turn eccentric in opposite direction until upper (secondary) brake shoe is free of drag. Hold eccentric and tighten eccentric locknut.
5. Insert screwdriver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw (Fig. 5).

6. Move outer end of screwdriver or special tool toward axle, expanding brake shoes to the point where the wheel can just be turned by hand.
7. Back off star wheel adjusting screw 12 to 14 notches and then check to see that brake drum turns freely. On rear brakes it may be necessary to tap the backing plate lightly to permit the brake shoes to take a central position.
8. Replace adjusting hole covers.

Major Adjustments and Servicing
(Figs. 1, 2, 3, 4 and 5).

The following adjustments are performed only when adjustments under "Minor Adjustments" fail to give satisfactory results or when installing new shoes or linings.

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED):-

1. Place parking brake lever in fully released position.
2. Jack up truck until wheels are free from floor.
3. Remove wheels, hubs and drums.
4. Remove adjusting hole covers.
5. Remove brake shoes and inspect linings for excessive wear, grease, loose rivets or other damage. Install new lining if old lining shows excessive wear or is saturated with grease or brake fluid.
6. Inspect brake drums for scores, run-out or cracks. If scores are not too deep or "run-out" does not exceed .010", drums may be machined. If drums are badly scored or cracked, they should be replaced.
7. Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.
8. Clean grease and dirt off of backing plate and sand down shoe ledges if rusted or ridged.
9. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to all shoe ledges.



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10. Thoroughly clean star wheel adjusting screws, pivot nuts, hold down pins, springs and cups. Apply a small amount of suitable lubricant comparable to "Lubriplate" to the threaded end of the adjusting screw and to contact points on the shoe webs.
- NOTE: PERFORM THE FOLLOWING OPERATIONS AT EACH FRONT WHEEL (SEE FIGS. 1 AND 2): -**
11. When installing new brake shoes, lay the shoes out in pairs according to their position on the truck. The upper (secondary) shoe is the shoe with the longer lining.
12. Thread the star wheel adjusting screw into the pivot nut to the limit of the threads and assemble star wheel adjusting screw and spring to the adjustment end of the shoes. **NOTE: Always assemble pivot nut on the right hand shoe as viewed from the adjusting screw end of the shoes regardless of whether the brake shoes are for left or right side of truck.**
13. Assemble shoe links to wheel cylinder and and guide forked end of shoe links over anchor end of shoe webs.
14. Attach brake shoes to backing plates with shoe hold down pins, springs and cups.
15. Attach retracting springs to shoes and anchor pin. If springs show signs of having been overstressed, they should be replaced.
16. Install brake drums. (For lubrication and adjustment of front wheel bearings see wheel section). **NOTE: It may be necessary to change the position of the shoe eccentric when assembling drum over shoes. NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING TO DRUM CLEARANCE INDICATES A NEED FOR REPOSITIONING OF ANCHORS.**
17. Loosen eccentric adjustment locknut and turn eccentric adjustment in the direction of forward wheel rotation until the upper (secondary) shoe begins to drag. Then turn eccentric in opposite direction until brake is just free of drag. Hold eccentric and tighten eccentric locknut.
18. Check lining to drum clearance at both ends of the upper (secondary) shoe. The clearance at both ends of the upper (secondary) shoe should be .010". If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will then be necessary to adjust the anchor pin.
19. To adjust anchor pin loosen locknut 1/4 to 1/2 turn and tap anchor pin toward the front or rear of truck to provide the correct clearance. When the desired lining to drum clearance is obtained, tighten anchor pin nut with a 16" wrench and then recheck (secondary) shoe clearances. **NOTE: If anchor pin nut is loosened too much, the anchor pin may shift when tightening the locknut.**
20. Expand brake shoes by tightening star wheel adjusting screw to the point where wheel can just be turned by hand and then back off star wheel adjusting screw 12 to 14 notches. Replace adjusting hole covers.
- NOTE: PERFORM THE FOLLOWING OPERATIONS AT EACH REAR WHEEL (SEE FIGS. 2 AND 3): -**
21. When installing new shoes, lay the shoes out in pairs according to their position on truck. The rear (secondary) shoe is the shoe with longer lining.
22. Thread the star wheel adjusting screw into the pivot nut to the limit of the thread and assemble star wheel adjusting screw and adjusting screw spring to the adjustment end of the shoes with pivot nut against the right hand shoe. **NOTE: Always assemble pivot nut on the right hand shoe regardless of position of shoes on the truck.**
23. Guide forked end of shoe links over anchor end of shoe web, and attach shoes to backing plates by means of shoe hold down pins, springs and cups.
24. Attach retracting springs to shoes and anchor pin. If springs show signs of having been overstressed, they should be replaced.
25. Install brake drums.
- NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING TO DRUM CLEARANCE INDICATES A NEED FOR REPOSITIONING OF ANCHORS.**
26. Insert a .015" feeler gauge between the lining and drum of the rear (secondary) shoe about 1-1/2" from the star wheel adjusting screw end of the shoe and expand shoe by turning star wheel adjusting screw until feeler gauge cannot be withdrawn. Then turn star wheel adjusting screw in opposite direction until there is but a light drag on the feeler gauge. Withdraw feeler gauge. **NOTE: Expanding shoes until feeler gauge cannot be withdrawn insures that shoes are resting against the anchor pin.**



27. Revolve brake drum so that feeler gauge hole is about 1-1/2" from the anchor end of the rear (secondary) shoe lining. There should be a slightly heavier drag on the feeler gauge at this point. If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will be necessary to adjust the anchor pin.
28. To adjust anchor pin, loosen locknut 1/4 to 1/2 turn and tap anchor pin either up or down to provide the correct anchor pin position. After positioning the anchor pin to provide the correct rear (secondary) shoe clearance, tighten the anchor pin locknut with a 16" wrench and then recheck anchor and adjusting end clearances. **NOTE:** If anchor pin is loosened too much, the anchor pin may shift when tightening the locknut.
29. Replace adjusting hole covers.



HYDRAULIC BRAKES
BRAKE SHOE ADJUSTMENTS AND SERVICING

L-151, L-152, L-153, LM-152 { 12-1/8 x 2" FRONT
14-1/8 x 3" REAR

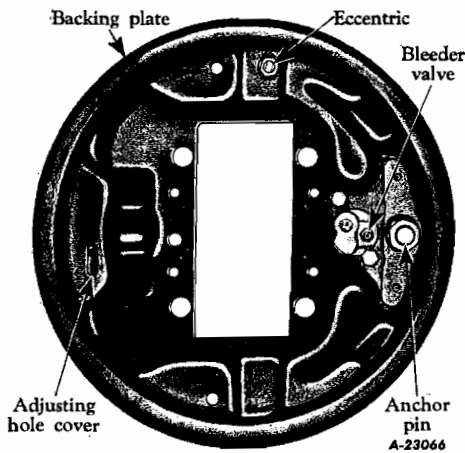


Fig. 1 - (Front) External View.

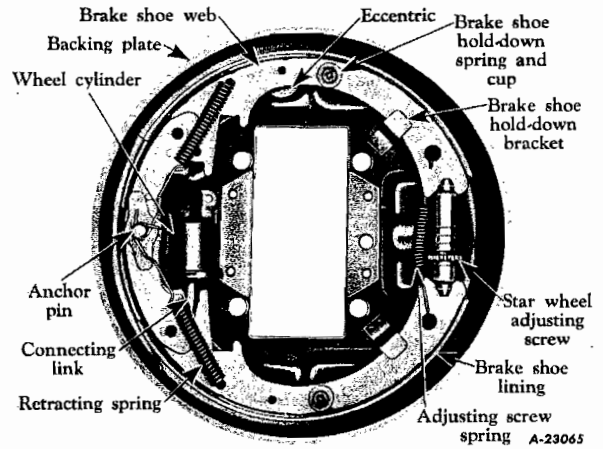


Fig. 2 - (Front) Internal View.

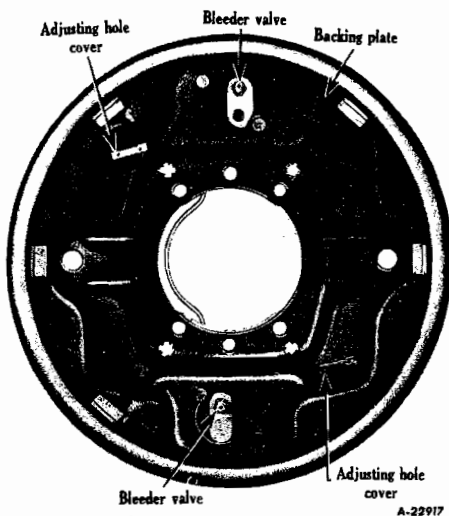


Fig. 3 - (Rear) External View.

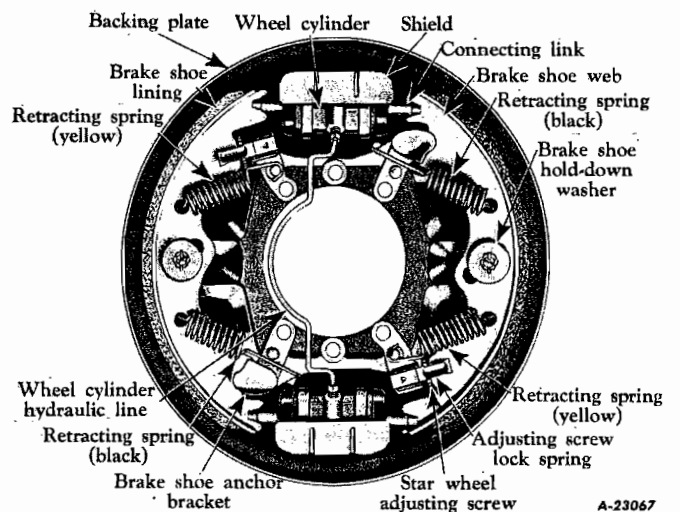


Fig. 4 - (Rear) Internal View.

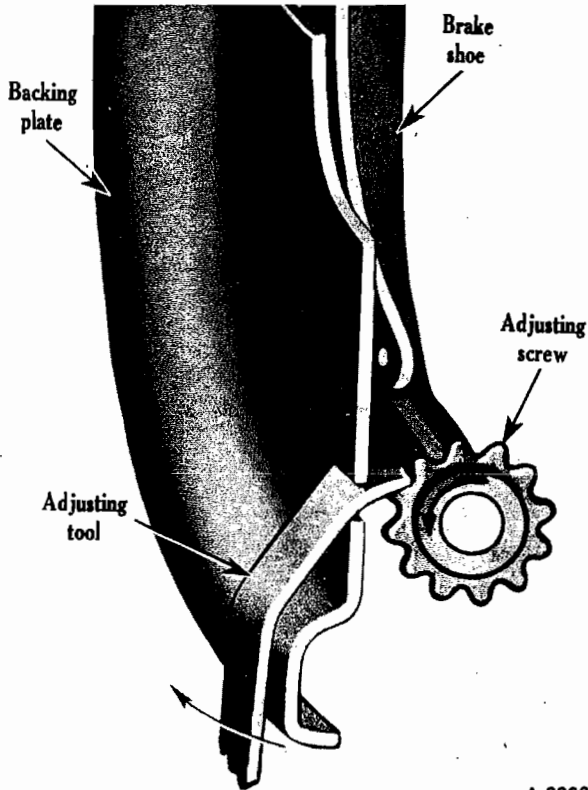


Fig. 5

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BRAKE ADJUSTMENT INSTRUCTIONS

Before attempting to make any brake adjustments, whether minor or major, be sure that wheel bearings are properly adjusted and that brake backing plates are tight.

Adjustments For Wear (Minor)

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED): -

1. Place parking brake lever in fully released position.
2. Jack up truck until the wheels are free from floor.
3. Remove adjusting hole covers.

NOTE: PERFORM THE FOLLOWING AT EACH FRONT WHEEL (SEE FIGS. 1 AND 2): -

4. Loosen eccentric locknut and turn eccentric adjustment in the direction of forward wheel rotation until upper (secondary) brake shoe drags. Then turn eccentric in opposite direction until upper (secondary) brake shoe is free of drag. Hold eccentric and tighten eccentric locknut.

5. Insert screwdriver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw (Fig. 5).
6. Move outer end of screwdriver or special tool toward axle, expanding brake shoes to the point where the wheel can just be turned by hand.
7. Back off star wheel adjusting screw 12 to 14 notches and then check to see that brake drum turns freely.
8. Replace adjusting hole covers.

NOTE: PERFORM THE FOLLOWING AT EACH REAR WHEEL (SEE FIGS. 3 AND 4): -

9. Insert screwdriver or special adjusting tool into upper or front shoe adjusting screw slot of backing plate to engage star wheel adjusting screw (Fig. 5).
10. Move outer end of screwdriver or special adjusting tool toward axle, expanding front brake shoe to the point where the wheel can just be turned by hand.
11. Back off star wheel adjusting screw until brake drum is just free of brake drag, approximately 6 notches.
12. Insert screwdriver or special adjusting tool into lower or rear shoe adjusting screw slot of backing plate and expand rear brake shoe to the point where the wheel can just be turned by hand.
13. Back off star wheel adjusting screw until brake drum is just free of brake drag, approximately 6 notches.
14. Replace adjusting hole covers.

Major Adjustments and Servicing (Figs. 1, 2, 3, 4 and 5).

The following adjustments are performed only when adjustments under "Minor Adjustments" fail to give satisfactory results or when installing new shoes or linings.

NOTE: PERFORM OPERATIONS IN SEQUENCE GIVEN. (AT BOTH FRONT AND REAR BRAKES UNLESS OTHERWISE NOTED): -

1. Place parking brake lever in fully released position.
2. Jack up truck until wheels are free from floor.
3. Remove wheels, hubs and drums.



L-LINE MOTOR TRUCK SERVICE MANUAL

4. Remove adjusting hole covers.
 5. Remove brake shoes and inspect linings for excessive wear, grease, loose rivets or other damage. Install new lining if old lining shows excessive wear or is saturated with grease or brake fluid.
 6. Inspect brake drums for scores, run-out or cracks. If scores are not too deep or "run-out" does not exceed .010", drums may be machined. If drums are badly scored or cracked, they should be replaced.
 7. Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.
 8. Clean grease and dirt off of backing plate and sand down shoe ledges if rusted or ridged.
 9. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to all shoe ledges.
 10. Thoroughly clean star wheel adjusting screws, pivot nuts, hold down pins, springs and cups of front brakes and clean star wheel adjusting screws, locksprings, hold down nuts and washers of rear brakes. Apply a small amount of suitable lubricant comparable to "Lubriplate" to threaded end of the adjusting screws and to points of contact of the shoe webs with the shoe links and anchor buttons.
- NOTE: PERFORM THE FOLLOWING OPERATIONS AT EACH FRONT WHEEL (SEE FIGS. 1 AND 2):-**
11. When installing new brake shoes, lay the shoes out in pairs according to their position on the truck. The upper (secondary) shoe is the shoe with the longer lining.
 12. Thread the star wheel adjusting screw into the pivot nut to the limit of the threads and assemble star wheel adjusting screw and spring to the adjustment end of the shoes. **NOTE:** Always assemble pivot nut on the right hand shoe as viewed from the adjusting screw end of the shoes regardless of whether the brake shoes are for left or right side of truck.
 13. Assemble shoe links to wheel cylinders and guide forked end of shoe links over anchor end of shoe webs.
 14. Attach brake shoes to backing plate with shoe hold down pins, springs and cups.
 15. Attach retracting springs to shoes and anchor pin. If springs show signs of having been overstressed, they should be replaced.
 16. Install brake drums. (For lubrication and adjustment of front wheel bearings see wheel section.) **NOTE:** It may be necessary to change the position of the shoe eccentric when assembling drum over shoes.
- NOTE: DO NOT LOOSEN ANCHOR PINS UNLESS INSPECTION OF LINING TO DRUM CLEARANCES INDICATE A NEED FOR REPOSITIONING OF ANCHORS.**
17. Loosen eccentric adjustment locknut and turn eccentric adjustment in the direction of forward wheel rotation until the upper (secondary) shoe begins to drag. Then turn eccentric in opposite direction until brake is just free of drag. Hold eccentric and tighten eccentric locknut.
 18. Check lining to drum clearance at both ends of the upper (secondary) shoe. The clearance at both ends of the upper (secondary) shoe should be .010". If the clearance at the anchor end of the shoe is greater than the clearance at the adjustment end by .003" or more, it will then be necessary to adjust the anchor pin.
 19. To adjust the anchor pin loosen locknut 1/4 to 1/2 turn and tap anchor pin toward the front or rear of truck to provide the correct clearance. When the desired lining to drum clearance is obtained, tighten anchor pin nut with a 16" wrench and then recheck upper (secondary) shoe clearances. **NOTE:** If anchor pin nut is loosened too much, the anchor pin may shift when tightening the locknut.
 20. Expand brake shoes by tightening star wheel adjusting screw to the point where wheel can just be turned by hand and then back off star wheel adjusting screw 12 to 14 notches. Replace adjusting hole covers.
- NOTE: PERFORM THE FOLLOWING OPERATIONS AT EACH REAR WHEEL (SEE FIGS. 3 AND 4):-**
21. Thread star wheel adjustment screws into anchor brackets to the limit of the thread and assemble locksprings over anchor brackets with long end of lockspring in contact with star wheel.
 22. Assemble shoe links to wheel cylinders.
 23. Hold anchor button in place against cut-out of rear shoe web and guide anchor button into the notch of the anchor bracket. Guide forked end of shoe links over shoe web.



24. Apply a thin coating of suitable lubricant comparable to "Lubriplate" to one side of shoe hold down washer and assemble this side of hold down washer against shoe web. Place a .006" feeler gauge between center shoe ledge and rim of shoe, with shoe in place against the anchor bracket and adjusting screw pad assemble hold down nut and draw down tight against washer, back off one castellation and insert cotter key.
25. Attach retracting springs (black spring) to brake shoe and anchor bracket and (yellow spring) to brake shoe and anchor bracket stud.
26. Assemble front shoe to backing plate in the same manner.
27. Install brake drums.
28. To adjust front shoe insert screwdriver or special brake adjusting tool through slot in backing plate (upper front) and expand front brake shoe to the point where the wheel can just be turned by hand.
29. Back off star wheel adjusting screw 6 notches.
30. To adjust rear shoe insert screwdriver or special brake adjusting tool through slot in backing plate (lower rear) and expand rear brake shoe to the point where the wheel can just be turned by hand.
31. Back off star wheel adjusting screw 6 notches.
32. Replace, adjusting hole covers.



HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

L-160, L-161, L-162, L-163, L-164, L-165, LC-160, LC-161, LC-162, L-170, L-171, L-172, L-173, L-174, L-175, LF-170, LF-171, LF-172	} FRONT BRAKE 12-1/8" x 2-1/4" (TYPE "F")
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L-180, L-181, L-182, L-183, L-184, L-185, LC-180, LC-181, LC-182	} FRONT BRAKE 13" x 2-1/4" (TYPE "F")
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L-190, L-191, L-192, L-193, L-194, L-195, LF-190, LF-191, LF-192, LC-190, LC-191, LC-192, L-200, L-201, L-202, L-204, L-205, LC-200, LC-201, LC-202	} FRONT BRAKE 15" x 2-1/4" (TYPE "F")
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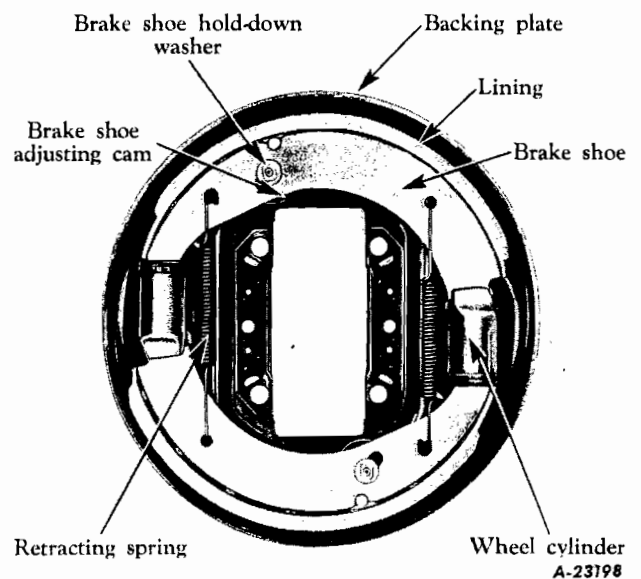
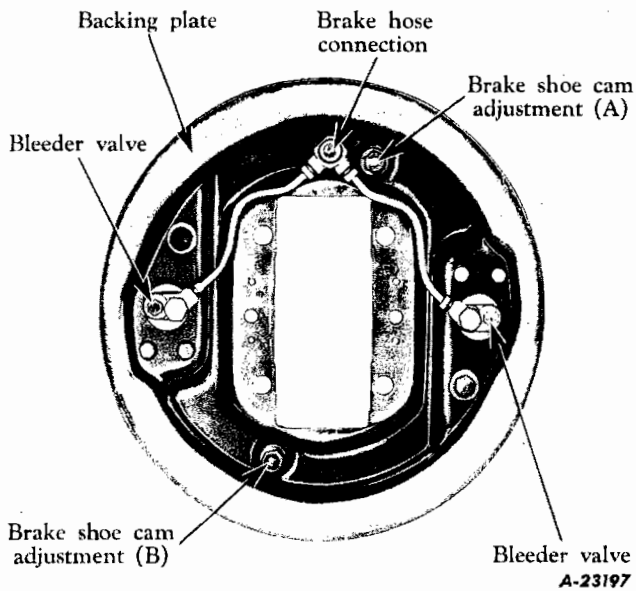
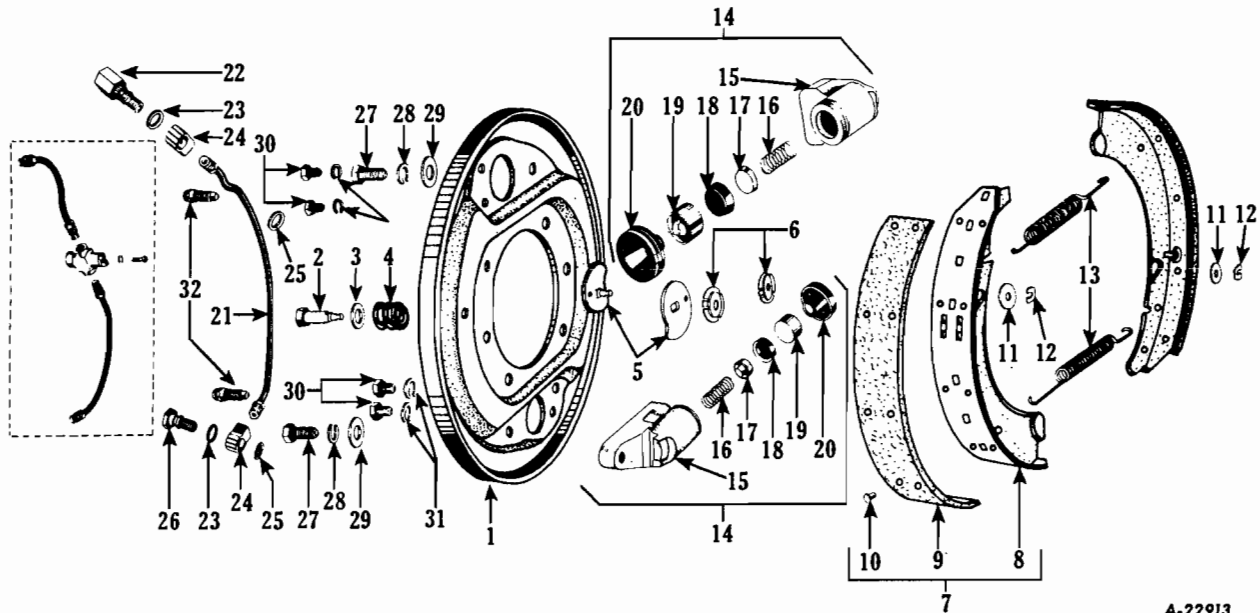


Fig. 1 - Front Brake - External View - Type "F".

Fig. 2 - Front Brake - Internal View - Type "F".



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Fig. 3 - Front Brake - Exploded View - Type "F".

Item No.	DESCRIPTION	Item No.	DESCRIPTION
1	Plate assembly, brake backing.	19	Piston assembly.
2	Stud, adjusting cam & shoe guide.	20	Boot.
3	Washer, plain, cam stud.	21	Tube assembly, connector, wheel cylinder.
4	Spring, adjusting cam.	22	Bolt, fitting, inlet, brake line to cylinder & tube.
5	Cam, shoe adjusting.	23	Gasket, bolt.
6	Washer, spring, anti-rattle, shoe guide.	24	Fitting, inlet, fluid, connector tube.
7	Shoe & lining assembly.	25	Gasket, fitting.
8	Shoe.	26	Bolt, fitting, inlet, connector tube to cylinder.
9	Lining.	27	Screw, anchor, cylinder.
10	Rivet, lining.	28	Lockwasher, cylinder anchor screw.
11	Washer, plain, shoe guide.	29	Washer, plain, cylinder anchor screw.
12	Washer, "C", shoe guide stud.	30	Screw, fastening, wheel cylinder.
13	Spring, retracting, brake shoe.	31	Lockwasher, fastening screw.
14	Wheel cylinder assembly.	32	Valve, bleeder, cylinder.
15	Body, wheel cylinder.		
16	Spring.		
17	Filler, piston cup.		
18	Cup, piston.		

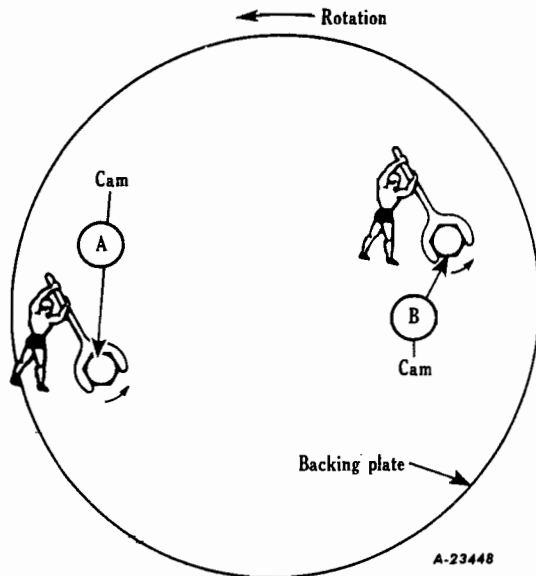


Fig. 4 - Brake Adjustment, Type "F" Brake.

MAINTENANCE AND ADJUSTMENT WAGNER SELF-CENTERING TYPE "F" BRAKES

(See Figs. 1, 2 and 3)

This Wagner self-centering Hi-Tork Brake, Type "F", is a "Floating-Shoe" type which has two identical shoes (7), (Fig. 3) arranged on the backing plate (1) so that their toes are diagonally opposite. Two single-end wheel cylinders (14) are arranged so that one cylinder is mounted between each shoe toe and the opposite shoe heel.

The two-wheel cylinder pistons (19) apply equal amounts of hydraulic force to each shoe toe. Each cylinder body is shaped to provide an anchor block for the opposite shoe heel. Each cylinder anchor block serves as a shoe stop and shoe centering point and provides the fulcrum around which the shoe heel pivots when the brakes are applied.

Each shoe is adjusted by means of an eccentric cam (5) which contacts the underside of the shoe table. Each cam is attached to the backing plate by a cam and shoe guide stud (2) which protrudes through a slot in its shoe web and, in conjunction with washers (11) and "C" washers (12), also serves as a shoe "hold-down". Two retracting springs (13) are connected between the shoes at each toe and heel.

Upon brake application, the wheel cylinder pistons transmit pressure to the toes of the shoes, forcing the shoe linings into contact with the brake drum. If the vehicle is moving forward, the drag of the drum against the shoe lining produces "self-energization" which tends to help rotate the shoes outwardly about their anchor points. This action multiplies the forces

exerted against the drum and produces additional braking effect. Both shoes are forward acting (primary shoes), self-energizing in the forward direction of drum rotation.

If the vehicle is moving backward, the drag of the drum on the linings is in the opposite direction and produces "de-energization" which tends to move the shoe heels away from their anchor blocks. Piston forces at the shoe toes are large enough to overcome this action, but the shoes tend to rotate inwardly about their anchor points and attempt to leave the drum. Both shoes are reverse acting since neither is self-energized in the reverse direction of drum rotation.

Cylinder anchor block sides are aligned on the axle radius. As the shoes roll upon their anchor blocks to contact the drum, the heels may also slide radially upon the anchor block surface. The shoes thus automatically "self-center" in relation to the drum.

The self-energization factor causes this brake to be approximately three times as effective during forward operation as it is during reverse operation; therefore its use is generally confined to the front axle of vehicles in conjunction with a rear axle brake of a type providing effective stopping ability in reverse as well as forward motion.

Disassembly

- Note A. The first disassembly operation is always removal of brake shoe retracting springs (13). With brake spring pliers, pull one hooked end of spring free of shoe web.
- Note B. If wheel cylinder connector tubes (21) are removed, mark wheel cylinder ports to which tubes are attached to avoid error in re-assembly. Difficulty will be encountered in bleeding operation if tubes are assembled in wrong location.

Step-By-Step Procedure (Disassembly)

I. REMOVAL OF SHOE ASSEMBLIES:

1. Remove both brake shoe retracting springs (13). (Refer to Note A).
2. Remove each shoe hold-down "C" washer (12) and washer (11), Shoes easily lift off.

II. REMOVAL OF WHEEL CYLINDERS:

1. Remove brake shoe assemblies (7).
2. Remove connector tubes (21) and wheel cylinder fittings (24). (Refer to Note B.)



3. Remove each cylinder anchor screw (27) (large) and washer (29).
4. Remove cylinder mounting screws (30) (small). Cylinders easily lift off.

III. WHEEL CYLINDER DISASSEMBLY:

1. Pull boot (20) from wheel cylinder. Piston (19) should come with boot. Pull boot from piston.
2. Piston cup (18), cup filler (17), and spring (16) may be pulled from cylinder.

Assembly

Note C. Adjustment cam and shoe guide studs (2) are equipped with friction springs (4). They should easily turn with an 8" wrench, but should not be loose. If frozen, lubricate with kerosene or penetrating oil and work free.

Note D. The two wheel cylinders mounted on one brake are identical; HOWEVER, CYLINDERS FOR LEFT OR RIGHT HAND BRAKES HAVE OPPOSITE CASTINGS (15).

Note E. Clean mating surfaces of cylinders and backing plate before assembly to insure proper alignment.

Note F. When replacing shoe retracting springs (13), place spring end with long hook in heel of shoe and then, with brake spring pliers, stretch spring to secure short hook end in toe of opposite shoe. Use new springs if there is evidence of spring fatigue, (rust, set springs, etc.).

Note G. For best results, new shoe and lining assemblies (7) should have linings (9) of correct thickness, ground (not buffed) to correct radius, concentric with the brake drum. If this is not done, readjustment may be required after linings are "worn-in".

Note H. Do not lubricate brake mechanism except as noted in "C".

Step-By-Step Procedure (Assembly)

IV. WHEEL CYLINDER ASSEMBLY:

1. Do not assemble parts dry. Coat parts and inside of cylinder bore with clean brake fluid.
2. Insert spring (16) cup filler (17), and piston cup (18) into cylinder bore. Cup filler "bumper" and cup lip should face closed end of cylinder.

3. Place boot (20) on piston (19), making sure boot snaps over shoe guide.
4. Install piston and boot. Align piston shoe guide slot to accommodate the shoe toe. Push boot lip into place in groove machined on end of cylinder.

V. REPLACEMENT OF WHEEL CYLINDERS:

1. Place one cylinder in position on backing plate. Install mounting screws (30) and lockwashers (31) (small). (Refer to Notes D and E).
2. Install cylinder anchor screw (27), washer (29), and lockwasher (28) (large).
3. Repeat steps 1 and 2 for second cylinder.
4. Install wheel cylinder fittings (24) and tubes (21). (Refer to Note B under disassembly.)

VI. REPLACEMENT OF SHOE ASSEMBLIES:

1. Install spring anti-rattle washer (6) on cam and shoe guide stud (2), pronged side facing adjusting cam (5).
2. Place shoe assembly on backing plate with cam and shoe guide stud protruding through shoe slot. Locate shoe toe in piston slot and shoe heel in anchor block slot. (Refer to Note G.)
3. Replace hold down washer (11) and "C" washer (12) on cam and shoe guide stud. Crimp "C" washer on stud.
4. Repeat steps 1, 2, and 3 for second shoe.
5. Replace shoe retracting springs (13). (Refer to Note F).

Adjustment

Lining to drum clearance adjustment is required when shoes are relined and, on occasion, to compensate for normal lining wear. Clearance should be sufficient to avoid "brake drag" and yet close to afford a good "pedal reserve".

Manually operated and vacuum-hydraulic actuated brakes require adjustment (or relining) when pedal reserve approximates 2"; that is, when the brake pedal drops to within 2" of floor board on hard application.

Adjustment may be made with the vehicle resting on jacks. On jacks, brake drag is checked by "feel", rotating the drum in the direction of forward rotation as adjustment is made.

Step-By-Step Procedure (Adjustment)

1. Make all adjustments with drums cool.



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2. Make sure wheel bearing is correctly adjusted.
3. Place wrench (5/8") on cam and shoe guide stud (A or B) (Figs. 1 and 4) to adjust one shoe. Rotate wrench in the direction of FORWARD wheel rotation to decrease lining to drum clearance. Reduce clearance until lining drags on drum.
4. Move wrench slightly in opposite direction, to increase clearance, until drag is relieved. Then move wrench slightly (7° to 10°) to increase the working clearance (1" to 1-1/2" movement through arc swung by 8" wrench).
5. Place wrench on opposite cam and shoe guide stude (B or A) to adjust second shoe. Repeat steps 3 and 4.

"Bleeding" The Hydraulic Brake System

Vehicle brake systems using the self-centering hi-tork foundation brake are bled in similar manner to other hydraulic systems.

METHOD A: -

Bleed wheel cylinders in the following order:

1. Cylinder lowest to road.
2. Cylinder highest from road.

METHOD B: -

If brake is mounted so that both cylinder bleeder valves are not at the highest point of their respective cylinder bores, it may be necessary to "surge bleed" the system.

1. Bleed brakes at all wheels in regular manner, using Method A.
2. At each wheel cylinder in turn, open bleeder valve and then kick brake pedal down sharply several times. Close bleeder valve. This action creates turbulence in each cylinder, forcing out any remaining trapped air.

SERVICE SPECIFICATIONS

LINING LENGTH (MEASURED INSIDE ARC) (BOTH LININGS)

12-1/8" Drum Diameter (128°)	12-7/8"
13" Drum Diameter (127°)	13-23/32"
15" Drum Diameter (127°)	15-15/16"

LINING WIDTH

12-1/8" Drum Diameter	2-1/4"
13" Drum Diameter	2-1/4"
15" Drum Diameter	2-1/4"

LINING THICKNESS (STANDARD LINING)

12-1/8", 13", 15" Drum Diameters	5/16"
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LINING RIVET, STANDARD NUMBER

12-1/8", 13" Drum Diameters	7-5
15" Drum Diameter	7-6

WRENCH SIZE

Adjustment cam and shoe guide stud (2) head	5/8"
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LINING TO DRUM CLEARANCE

Freedom from drag plus cam rotation of	7°-10°
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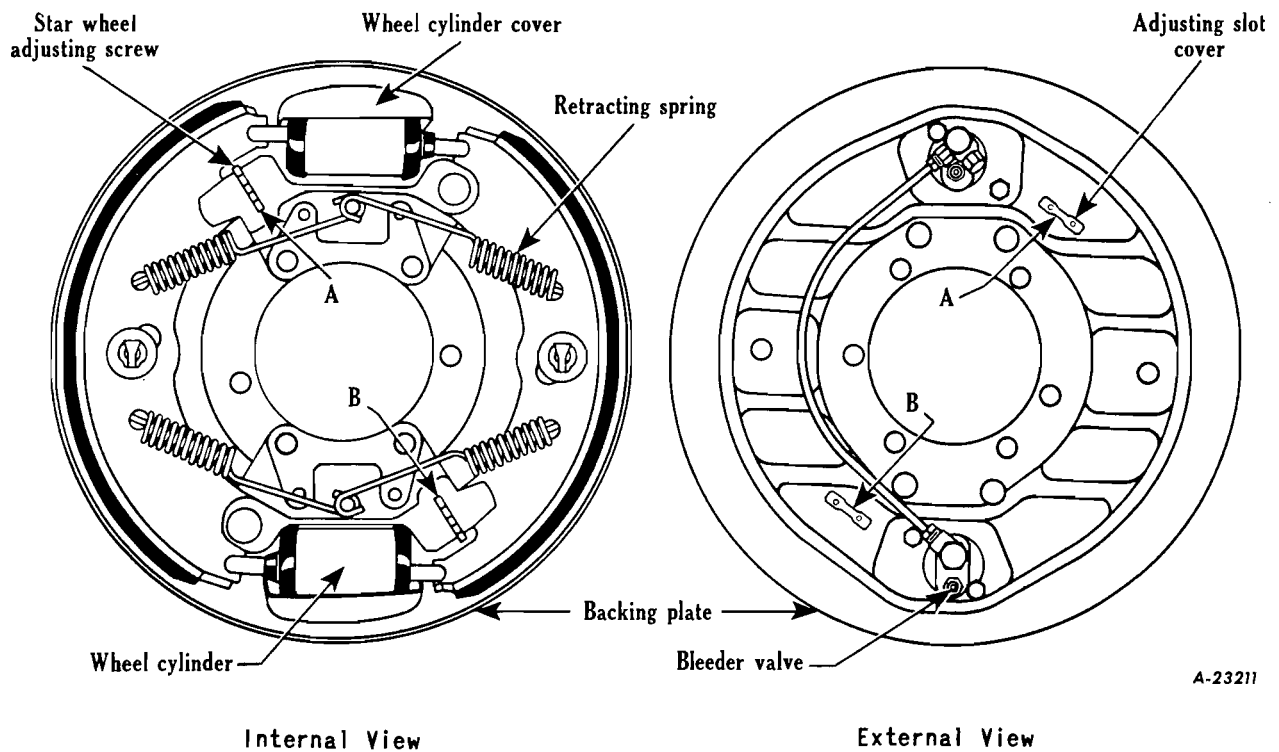


HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

L-160, L-161, L-162, L-163, L-165, LC-160, LC-161, LC-162	} REAR BRAKES 14-1/8" x 3" (TYPE "FR-2") FIGS. 1 and 2
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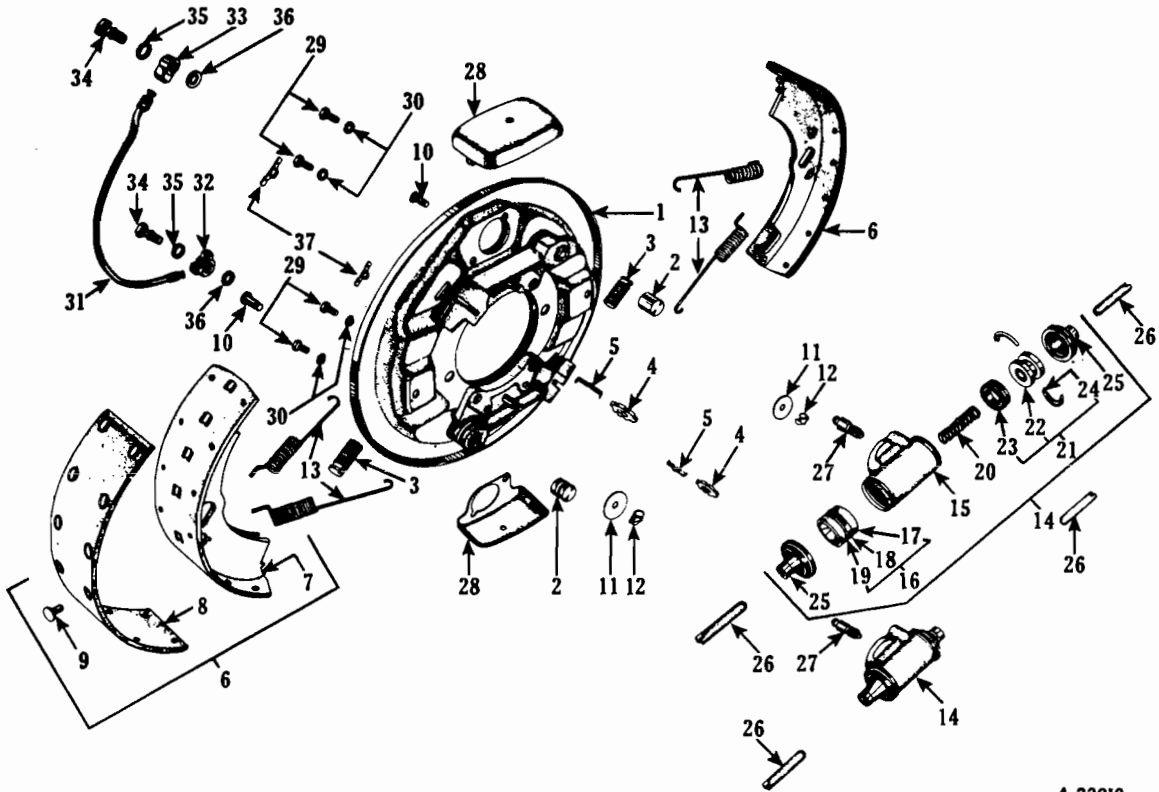
L-164, L-170, L-171, L-172, L-173, L-175, LF-170, LF-171, LF-172	} REAR BRAKES 15" x 3" (TYPE "FR-2") FIGS. 1 and 2
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L-174, L-180, L-181, L-182, L-183, L-185, LC-180, LC-181, LC-182, LF-190, LF-191, LF-192	} REAR BRAKES 15" x 4" (TYPE "FR-2") FIGS. 1 and 2
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A-23211

Fig. 1 - Rear Brake - Type "FR-2".



A-22912

Fig. 2 - Rear Brake, Type "FR-2" - Exploded View.

Item No.	DESCRIPTION	Item No.	DESCRIPTION
1	Plate, brake backing.	20	Spring.
2	Pin, anchor.	21	Piston assembly (short piston).
3	Screw, adjusting.	22	Piston (short).
4	Wheel, star, adjusting.	23	Cup, piston.
5	Lockspring, adjusting.	24	Protector segment, cup, piston.
6	Shoe and lining assembly.	25	Boot assembly.
7	Shoe.	26	Push rod.
8	Lining.	27	Valve, bleeder.
9	Rivet.	28	Cover, wheel cylinder.
10	Pin, shoe guide stud.	29	Bolt, wheel cylinder.
11	Washer, shoe guide.	30	Lockwasher, wheel cylinder bolt.
12	Clip, "C", spring, shoe guide.	31	Tube assembly, connecting.
13	Spring, brake shoe retracting.	32	Fitting, tube, connecting.
14	Wheel cylinder assembly.	33	Fitting, tube, connecting.
15	Body, wheel cylinder.	34	Bolt, fitting, tube, connecting.
16	Piston assembly (long piston).	35	Washer, fitting, bolt.
17	Piston (long).	36	Washer, fitting, bolt.
18	Cup, piston.	37	Cover, adjusting slot.
19	Protector segment, cup, piston.		

HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

L-210, L-211, LF-210, LF-211, LF-212, LF-220, LF-221, LF-222	}	FRONT BRAKES 16-1/2" x 3-1/2" (TYPE "FR-2S") FIGS. 3 and 4
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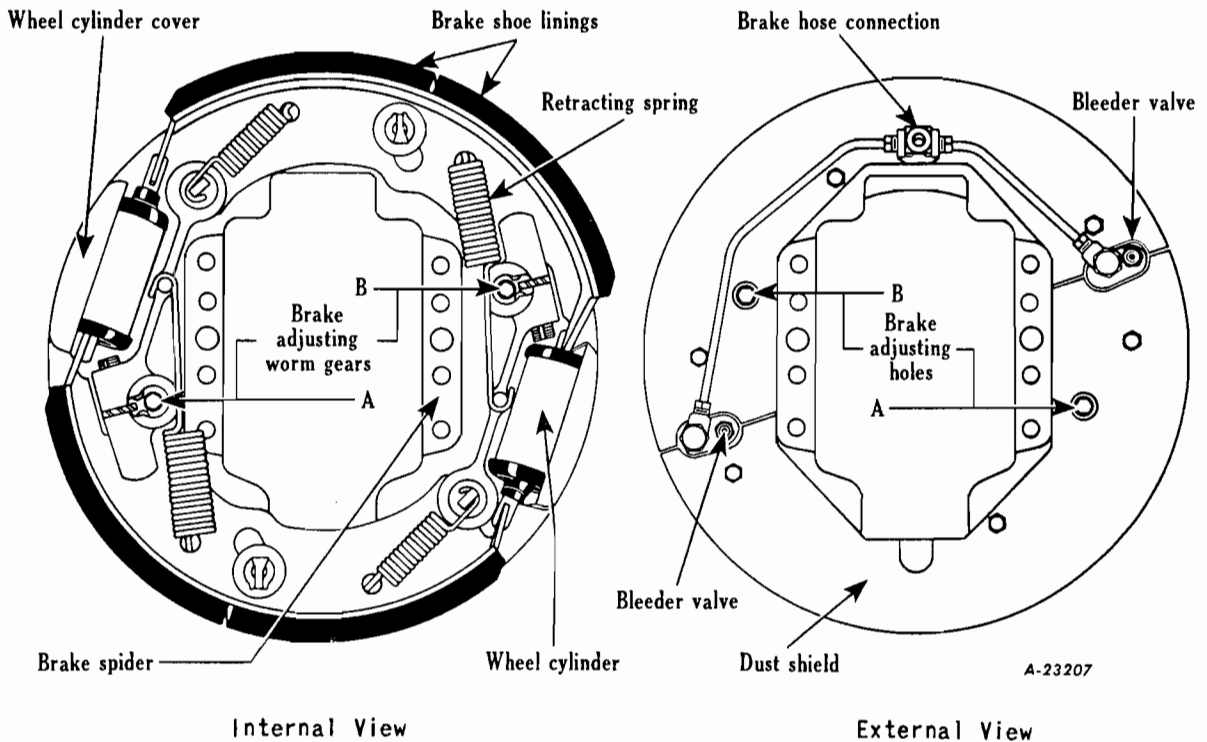
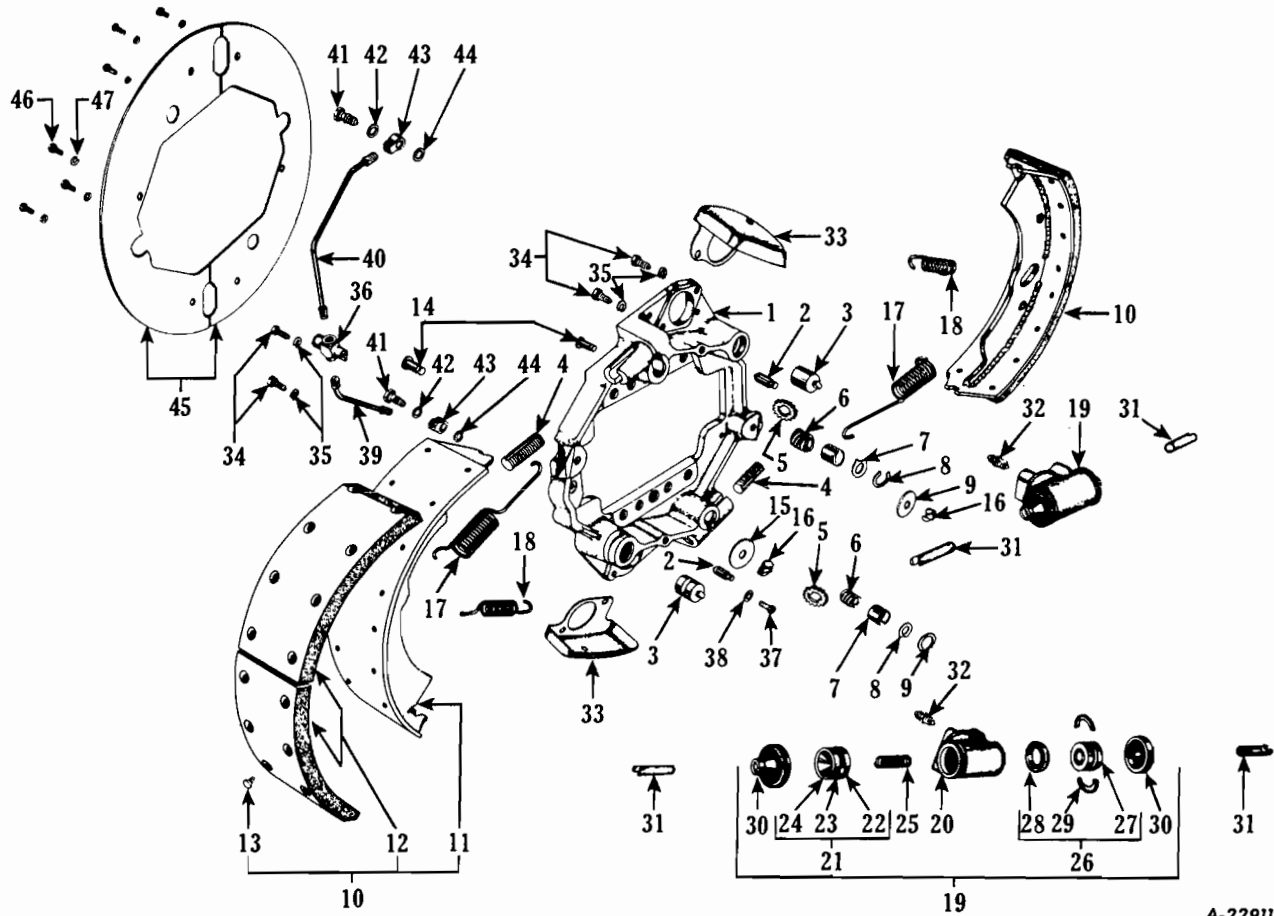


Fig. 3 - Front Brake - Type "FR-2S".



A-22911

Fig. 4 - Front Brake, Type "FR-2S" Exploded View.

Item No.	DESCRIPTION	Item No.	DESCRIPTION
1	Spider and pin assembly.	25	Spring.
2	Pin, retracting, spring.	26	Piston assembly (short).
3	Pin, anchor.	27	Piston (short).
4	Wheel, driven, adjusting worm.	28	Cup, piston.
5	Wheel, driven, adjusting worm.	29	Protector segment, cup, piston.
6	Worm, adjusting shoe.	30	Boot assembly.
7	Sleeve, adjusting worm.	31	Push rod.
8	Washer, end thrust, adjusting worm.	32	Valve, bleeder, wheel cylinder.
9	Ring, snap, worm retainer.	33	Cover, wheel cylinder.
10	Shoe and lining assembly.	34	Bolt, mounting, wheel cylinder.
11	Shoe.	35	Lockwasher, cylinder mounting bolt.
12	Lining.	36	Fitting, distributor, fluid.
13	Rivet.	37	Bolt, mounting, distributor fitting.
14	Pin, shoe guide.	38	Lockwasher, distributor fitting bolt.
15	Washer, shoe guide pin.	39	Tube assembly, connecting (short).
16	Clip, "C", spring, shoe guide.	40	Tube assembly, connecting (long).
17	Spring, retracting, shoe toe (long).	41	Bolt, fitting, wheel cylinder.
18	Spring, retracting, shoe heel (short).	42	Gasket, fitting, inlet.
19	Wheel cylinder assembly.	43	Fitting, inlet, fluid.
20	Body, wheel cylinder.	44	Gasket, bolt, fitting.
21	Piston assembly (long).	45	Dust shield.
22	Piston (long).	46	Bolt, mounting, dust shield.
23	Cup, piston.	47	Lockwasher, dust shield mounting bolt.
24	Protector segment, cup, piston.		



HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

L-204, L-210, L-211 { REAR BRAKES
16-1/2" x 7-1/8"
(TYPE FR-2-SD)
FIGS. 5 and 6)

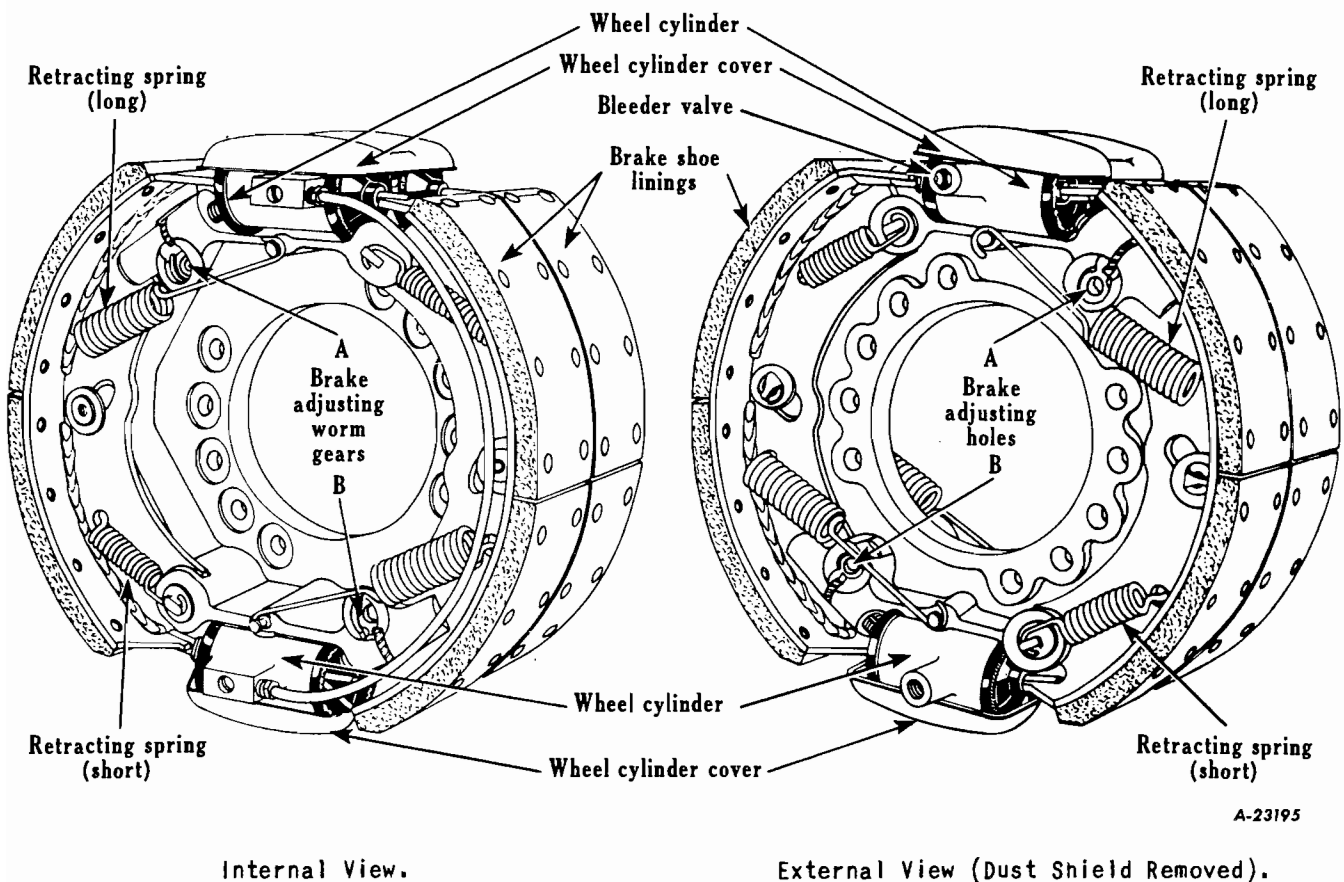
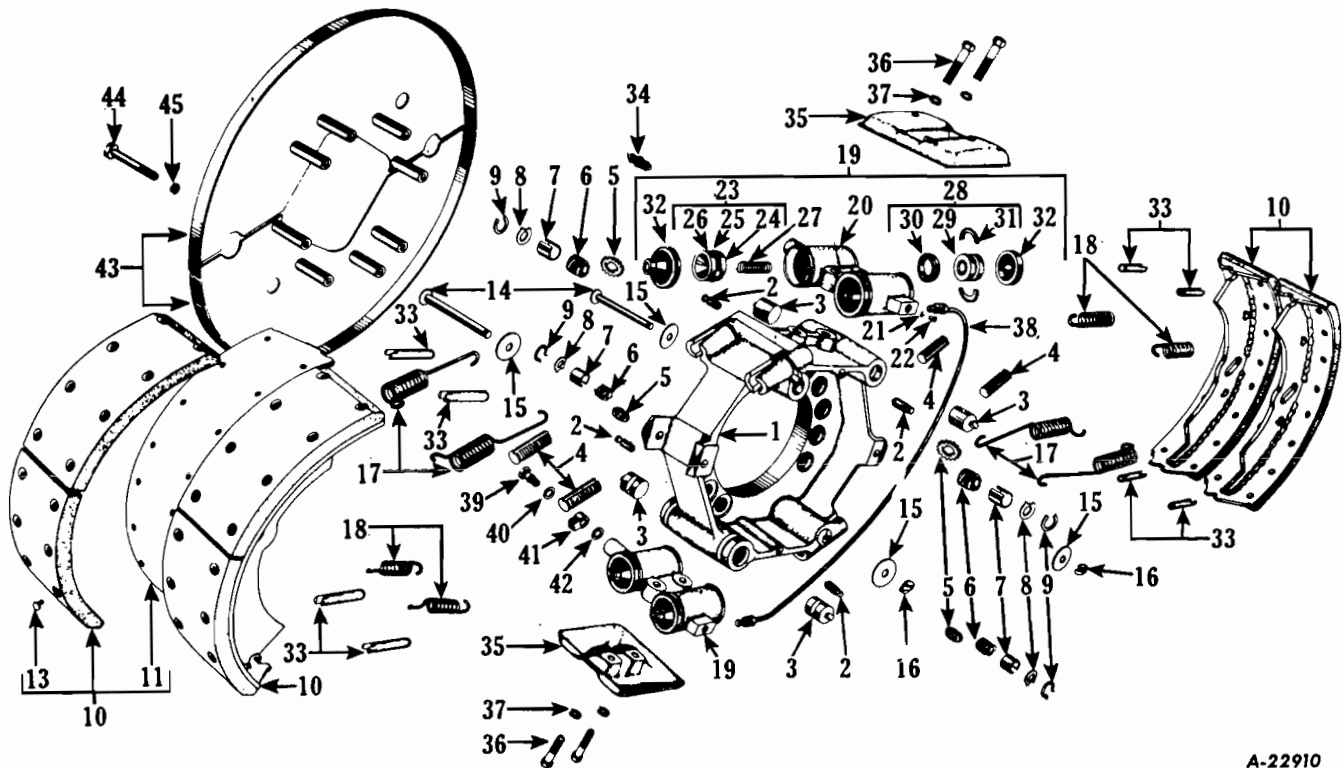


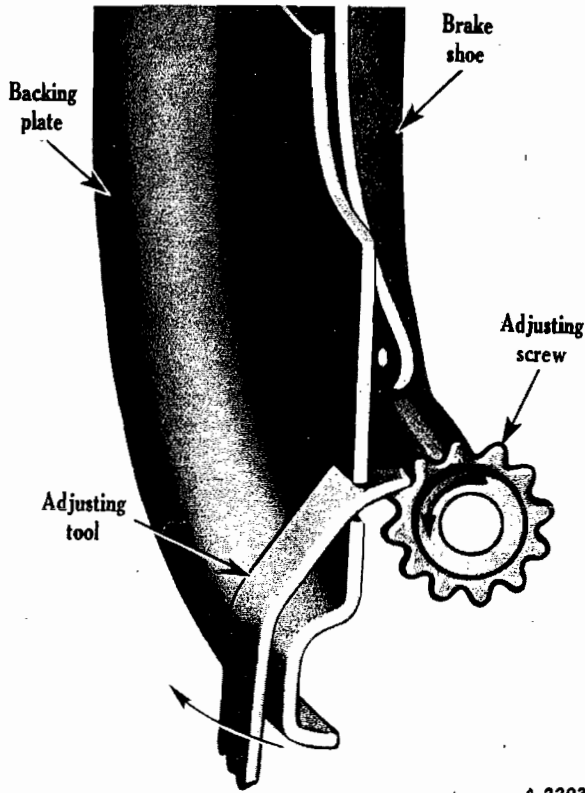
Fig. 5 - Rear Brake - Type "FR-2SD".



A-22910

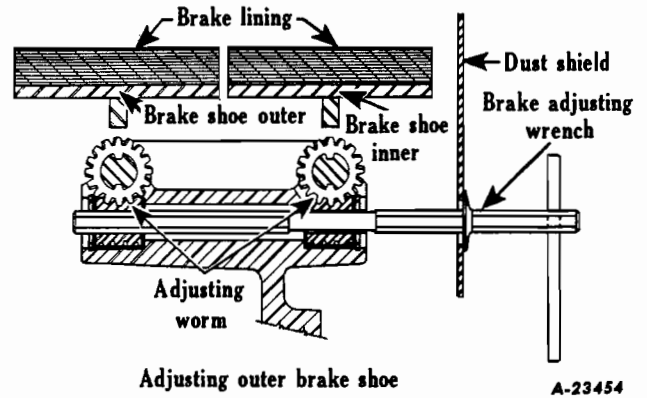
Fig. 6 - Rear Brake - Exploded View - Type "FR-2SD".

Item No.	DESCRIPTION	Item No.	DESCRIPTION
1	Spider and pin assembly.	23	Piston assembly (long).
2	Pin, retracting spring.	24	Piston (long).
3	Pin, anchor.	25	Cup, piston.
4	Screw, adjusting.	26	Protector segment, cup, piston.
5	Wheel, driven, adjusting worm.	27	Spring.
6	Worm, adjusting, shoe.	28	Piston assembly (short).
7	Sleeve, adjusting worm.	29	Piston (short).
8	Washer, end thrust, adjusting worm.	30	Cup, piston.
9	Ring, snap, worm retainer.	31	Protector segment, cup, piston.
10	Shoe and lining assembly.	32	Boot assembly.
11	Shoe.	33	Push rod.
12	Lining.	34	Valve, bleeder, wheel cylinder.
13	Rivet.	35	Cover, wheel cylinder.
14	Pin assembly, shoe guide.	36	Bolt, mounting, wheel cylinder.
15	Washer, shoe guide pin.	37	Lockwasher, cylinder mounting bolt.
16	Clip, "C", spring, shoe guide.	38	Tube, assembly, connecting, wheel cylinder.
17	Spring, retracting, shoe toe (long).	39	Bolt, fitting, inlet.
18	Spring, retracting, shoe heel (short).	40	Gasket, fitting, inlet.
19	Wheel cylinder assembly, upper.	41	Fitting, inlet, fluid.
20	Body, wheel cylinder, upper.	42	Gasket, bolt, fitting.
21	Gasket, port plug.	43	Dust shield, assembly.
22	Screw, port plug.	44	Bolt, mounting, dust shield.
		45	Lockwasher, dust shield mounting bolt.



A-22939

Fig. 7 - Brake Adjustment, Type "FR-2" Brake.



A-23454

Fig. 9 - Brake Adjustment, Type "FR-2SD" Brake.

To adjust outer brake shoe, insert wrench in adjustment slot until flat washer on wrench contacts dust shield (see Fig. 9).

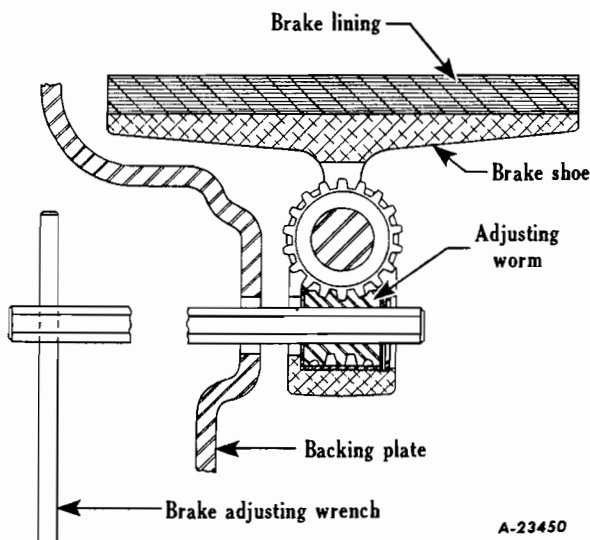
To adjust inner brake shoe, insert wrench in adjustment slot until recessed area on wrench just enters dust shield; this will assure proper engagement of brake tool in inner adjustment worm.

MAINTENANCE AND ADJUSTMENT

WAGNER SELF-CENTERING TYPE FR-2, TYPE FR-2S AND TYPE FR-2SD BRAKES

The development of the Wagner type FR-2 (Figs. 1 & 2), type FR-2S (Figs. 3 & 4), and type FR-2SD (Figs. 5 & 6) brakes has created new vistas of greater braking efficiency in the medium and heavy duty truck field. The type FR-2 brake makes available to medium weight trucks the advantages of full self-energization (shoe wrapping action caused by the drag of the drum on the liners). The type FR-2S and the type FR-2SD bring the advantage of full self-energization to the heavy duty field, and, in addition, make it possible for vehicles of 30,000 to 45,000 lbs. gross weight to utilize the high efficiency of hydraulic braking power to the fullest extent. Heretofore, heavy vehicles have been limited to a very few special applications of hydraulic braking power. The fact that these brakes incorporate the greatest possible use of self-energization in drums of the same or smaller sizes than those now in use is of tremendous importance in solving the braking problems of medium and heavy duty trucks.

The basic design of these brakes is the same. The FR-2 and the FR-2S each incorporate two identical shoes and two identical wheel cylinders. The major difference is that the FR-2 uses a backing plate while the FR-2S is mounted on a spider. The FR-2SD is a dual type brake, equipped with four shoes. Its appearance is comparable to two FR-2S brakes placed back to back, and it employs two Siamese Twin-type



A-23450

Fig. 8 - Brake Adjustment, Type "FR-2S" Brake.



wheel cylinders to actuate the dual shoes. The shoes of all these brakes are arranged with the toes diagonally opposite each other and the double end wheel cylinders are placed between the toe of one shoe and the heel of the other.

An equal amount of hydraulic pressure is thus applied at each end of each shoe. Shoes are always forward acting, independently actuated in the direction of rotation. Shoes anchor at either toe or heel depending upon the rotation of the drum.

The FR-2 brake is constructed for use on the rear axle of medium weight trucks and buses. As previously mentioned, the major difference of this brake from the other two is that the assembly is mounted on a backing plate. Riveted to this backing plate are two anchor and adjusting supports. Into each anchor and adjusting support is placed on anchor pin at one end of the support and a star wheel and adjusting screw at the other end. The adjusting mechanism is assembled as follows: The adjusting screw is threaded into its end of the support, the star wheel is placed in the slot of the support so that the keys inside of the wheel fit into the lengthwise grooves of the adjusting screw, the star wheel being held in the correct adjustment position by a lockspring.

Adjustments are made through a slot in the backing plate opposite the star wheel by placing the special adjusting tool or screwdriver through the slot and turning the star wheel to achieve the desired adjustment.

The FR-2S is constructed for the front axles of vehicles having a gross weight of 30,000 to 45,000 lbs. and is used in conjunction with the FR-2SD rear axle brake. These brakes are mounted on malleable iron spiders, the FR-2S on a single sided spider, and the FR-2SD on a double sided spider. The adjusting and anchor support on these brakes is cast as an integral part of the spider. The principle adjustment difference is that the adjusting screw is operated by a worm and worm wheel instead of a star wheel. The FR-2SD is designed with four shoes, two on each side of the spider. These four shoes offer advantages over two wide shoes in that they provide greater equalization of brake lining pressure on the entire width of the drum surface, more rapid heat dissipation, and longer lining and drum life. Dual shoes also simplify and yet permit greater accuracy of adjustment when compensating for lining wear.

Adjusting mechanisms are similar to the adjustment mechanism on type FR-2. Each adjusting screw is threaded into a worm wheel placed in a slot located in its support. The worm wheel is engaged with a worm which is rotated to effect adjustment. The worm is enclosed in a removable sleeve and worm and sleeve are held in the support by a thrust washer

and a retainer snap ring. Adjustments are made by inserting a 3/8" hex wrench in the worm and turning in the proper direction for the desired adjustment. The worm rotates the worm wheel which, in turn, threads the adjusting screw in the direction which the wrench is turned.

When the brakes are applied the wheel cylinder pistons apply force against the toe and heel of each shoe. As the shoe linings come into contact with the drum, self-energization develops. The rotation of the drum pulls the shoes against the drum surface to multiply the forces exerted on the drum and produce additional braking action. If the vehicle is in forward motion, this self-energization, or wrapping action, pushes the shoe heels against the anchor pins. In backward motion the shoe toes are forced against the adjusting screws which then serve as anchor pins. The anchors are free to rotate within their supports, so that when the brake is applied the pin will turn with the shoe. In addition, the anchors are slotted to allow the shoe heel to slide inwardly or outwardly along the axle radius to center the shoe properly in relation to the drum. Self-centering of shoes when the vehicle is in backward motion is accomplished by rounded shoe toes which pivot on the adjusting screws.

The shoes on these brakes are floating shoes. Each shoe is held in position by a shoe guide pin, washer, shoe guide spring "C" clip and two shoe return springs. On the FR-2 brake the toe and heel shoe return springs are the same. On the FR-2S and the FR-2SD, each shoe heel spring is short, hooked to the anchor end of the shoe and a projection on the anchor pin; each shoe toe spring is long, hooked between the toe end of the shoe and a spring pin centered on the spider.

Disassembly

FR-2 (Fig. 2), FR-2S (Fig. 4) and FR-2SD (Fig. 6) Brakes

- Note A. The first disassembly operation is always removal of the brake shoe retracting springs. With brake spring pliers, slip looped ends off pins or projections on the anchor and adjusting supports.
- Note B. When the wheel cylinder connecting tube is removed, note position of tube and fittings on the brake to avoid error in reassembly. Difficulty may be encountered in the bleeding operation if tube is assembled in the wrong location.
- Note C. Whenever shoes are removed, always dismantle adjusting mechanism and clean dirt, dust and grease from the parts and supports. Care should be taken to distinguish the adjusting



screws as those of the left or right brake. The left brake adjusting screws have a left hand thread, and the right brake screws have a right hand thread. Neither can be assembled to the opposite brake.

Step-By-Step Procedure (Disassembly)

Before beginning the following steps on the FR-2S and FR-2SD, remove the dust shield attaching bolts and lift off the dust shields.

I. TO REMOVE SHOE ASSEMBLIES:

1. Remove brake shoe retracting springs. (Refer to Note A.)
2. Pry off shoe guide spring "C" clip and lift washer off of shoe guide stud. Shoes will slide off easily.
3. The anchor pins should easily pull out of the supports.

II. TO REMOVE WHEEL CYLINDERS WITHOUT DISTURBING SHOES:

1. Remove brake shoe retracting springs. (Refer to Note A.)
2. Remove connecting tube fitting bolts from wheel cylinder.
3. Remove wheel cylinder bolts.
4. Spread shoes away from cylinder until push rods are cleared. Lift out cylinder and cover.

III. TO REMOVE ADJUSTING MECHANISM:

1. Remove shoes from brake.
2. Rotate adjusting screw, backing off adjustment to thread it free of star wheel or worm gear.
3. Push adjusting screw out of support. On FR-2 type, lift star wheel and lock spring from slot. On FR-2S and FR-2SD types, pry worm retainer snap ring from support and remove thrust washer, worm and worm wheel from slot.

IV. TO DISASSEMBLE WHEEL CYLINDERS:

1. Take push rods out of boot assemblies and slip boots off ends of cylinders.
2. Remove pistons and spring by pushing either piston through and out of cylinder.
3. Cups are removed by slipping cup protector segments off and working cups over the end of the pistons.

Assembly

Note D. Each brake utilizes two wheel cylinders which are identical. The piston actuating the toe of each shoe has provision for a longer stroke than the other piston. This is to compensate for adjustments made on the shoe which move the shoe toe away from the wheel cylinder. Thus the long stroke piston is built longer than the short stroke piston, and is also identified by a circular groove machined at the bottom of the push rod socket. The cylinder casting is constructed with the bleeder valve and connecting tube inlets offset toward the short stroke end of the cylinder. **PISTONS MUST BE ASSEMBLED IN THE PROPER ORDER WITHIN THE CYLINDER.** Otherwise, fluid will enter the cylinder chamber improperly and may be forced out past the short stroke piston.

Note E. Do not lubricate shoe adjustment mechanism or other parts of the brake. Lubrication will cause dirt and dust to collect and solidify in the adjustment mechanism.

Note F. When replacing shoes make certain that the toe or cutaway end of each shoe is aligned with the adjusting screw, and the heel of each shoe with the anchor pin -- otherwise, adjustments cannot be made.

Note G. When replacing shoe retracting springs, place the straight ends of the springs in the notched holes in the brake shoes, and, with a brake spring pliers, slip the looped ends over the pin or anchor pin projection as required. The FR-2 type retracting springs are of equal length and loop over a pin mounted in the anchor and adjusting support. Each shoe on the FR-2S and the FR-2SD type brakes has one long toe spring which loops over a pin mounted on a centered location on the spider, and one short heel spring which loops over a projection on the anchor pin.

Step-By-Step Procedure (Assembly)

The brakes are easily assembled in reverse order to disassembly.

V. TO ASSEMBLE WHEEL CYLINDERS:

1. Do not assemble parts dry. Coat parts and inside of cylinder bore with clean brake fluid before assembly.



2. Stretch cups into place on the pistons. Cup lip must face inward toward spring groove side of piston.
3. Slip cup protector segments into place on each piston. Protector segment is placed behind cup with segment lip facing same direction as cup lip.
4. Slide pistons with spring between them into cylinder chamber. Be sure long stroke piston, and short stroke piston are at the correct ends of the cylinder and the push rod socket in each piston faces outward. (Refer to Note D.)
5. Slip boots over ends of cylinder so that the boot edges fit squarely into the grooves on the casting. Place push rods into assembled boots and cylinder.

VI. TO REPLACE ADJUSTING MECHANISM:

1. Do not lubricate parts. (Refer to Note E.)
2. On the FR-2S and FR-2SD types, place worm in sleeve and slip them into hole in adjusting support. Open side of sleeve must face worm wheel slot. Insert thrust washer and snap ring; be sure snap ring fit firmly into groove in wall of worm hole. (Omit this step with the FR-2 type brake.)
3. Hold star wheel (FR-2) or worm wheel (FR-2S, FR-2SD) in slot in adjusting support and slide adjusting screw into the outer end of the support so that the keys machined on the inner circumference of the wheel engage into the keyways on the adjusting screw. Be certain to use the correct adjusting screws for the left and right brakes. (Refer to Note C.)
4. Rotate worm or star wheel to thread adjusting screw into support.

VII. TO REPLACE WHEEL CYLINDER WITHOUT DISTURBING SHOES:

1. Be sure backing plate or spider is clean so that cylinder and cover will fit properly when mounted.
2. Spread shoes as far apart as possible.
3. Place cylinder and cover in proper position on the backing plate or spider and fasten securely with wheel cylinder bolts and lock-washers. Screw in connecting tube fitting bolt. (Refer to Note B.)
4. Engage notched push rod ends into slots provided at each end of the shoes.
5. Replace brake shoe retracting springs. (Refer to Note G.)

VIII. TO REPLACE SHOE ASSEMBLIES:

1. For best results new shoe and lining assemblies should have liners of correct thickness, ground (not buffed) to the correct radius, concentric to the brake drum.
2. Slide anchor pins into supports so that anchor can be engaged by the shoe heel.
3. Replace shoe on backing plate or spider making sure that toe is aligned with the adjusting screw and heel with the slot provided in the anchor pin. Slip shoe guide pin through spider or backing plate guide hole located in shoe web. Install washer and shoe guide spring "C" clip. Repeat step for other shoe or shoes.
4. Replace shoe retracting springs. (Refer to Note G.)

On FR-2S and FR-2SD type brakes, replace the dust shield enclosure after completing assembly of the brake.

Adjustment

Lining to drum clearance adjustment is required when the shoes are relined, and, on occasion, to compensate for normal lining wear. Clearance should be sufficient to avoid "brake drag" and yet close enough to afford a good "pedal reserve".

Manually operated and vacuum-hydraulic actuated brakes require adjustment (or relining) when the pedal reserve approximates 2"; that is, when the pedal drops to within 2" of the floor board on hard application.

Adjustment may be made with the vehicle resting on jacks. On jacks, brake drag is checked by feel, rotating the drum in the direction of forward movement as the adjustment is made.

Step-By-Step Procedure (Adjustment) Type FR-2 Brake (Figs. 1 and 7)

1. Make all adjustments with drum cooled to normal temperature.
2. Make sure wheel bearing is correctly adjusted.
3. Remove adjustment slot covers.
4. Insert special adjusting tool or screwdriver into adjustment slot (A or B) to contact the star wheel. Rotate star wheel toward axles, using outer edge of slot as fulcrum for tool handle, until lining "drags" on the drum.
5. Back lining off drum by rotating star wheel TWO notches away from axle. This will provide sufficient working clearance.
6. Repeat Steps 4 and 5 on Second shoe (B or A).
7. Replace adjustment slot covers.

**Step-By-Step Procedure (Adjustment)****Type FR-2S Brake (Figs. 3 and 8)**

1. Make all adjustments with drum cooled to normal temperature.
2. Make sure wheel bearings are correctly adjusted.
3. Insert brake adjusting wrench (Figs. 3 and 8) through adjusting hole (A or B) in dust shield to fit firmly in adjusting worm. Rotate wrench in direction of forward wheel rotation until lining "drags" on the drum.
4. Rotate wrench in opposite direction to increase clearance until drag is relieved. Then rotate wrench one additional turn to provide working clearance.
5. Repeat Steps 3 and 4 on the other shoe, or shoes (B or A).

Step-By-Step Procedure (Adjustment)**Type FR-2SD Brake (Figs. 5 and 9)**

The rear wheel brakes are adjusted by means of a special 3/8" hex wrench (IH No. SE-1731) which has been designed for the purpose of adjusting either the inner or outer brake shoe but not both shoes at one time.

1. Make all adjustments with drum cooled to normal temperatures.
2. Make sure wheel bearings are correctly adjusted.
3. Insert special wrench (IH No. SE-1731 Figs. 5 and 9) in adjustment slot (A or B) to engage either the inner or outer brake shoe adjusting worm. Rotate wrench in the direction of FORWARD wheel rotation to decrease lining to drum clearance. Reduce clearance until lining "drags" on drum.
4. Rotate wrench in opposite direction, to increase clearance, until "drag" is relieved. Then rotate one (1) additional turn to provide the proper working clearance.

CAUTION: Repeat operation at each shoe (two shoes to be adjusted at each adjustment slot in dust shield).

5. Repeat Steps 3 and 4 at opposite adjustment slot (B or A).

NOTE: For most accurate adjustment it is not advisable to attempt to adjust both brake shoes simultaneously, always proceed as outlined above.

**"BLEEDING" THE HYDRAULIC
BRAKE SYSTEM**

Vehicle brake systems using the Type FR-2, FR-2S, FR-2SD foundation brake are bled in similar manner to other hydraulic systems.

METHOD A:-

Bleed wheel cylinders in the following order:

Type FR-2 and FR-2S only

1. Cylinder nearest to road.
2. Cylinder highest from the road.

Type FR-2SD Dual Brake only

1. Bleeding both cylinders of the FR-2SD brake is accomplished through one bleeder valve located on the high cylinder.

METHOD B: -

If brake is mounted so that both cylinders are almost in a vertical plane, it may be necessary to "surge bleed" the system.

1. Bleed brakes at all wheels in regular manner, using Method A, above.
2. At each wheel cylinder in turn, open bleeder valve and then kick pedal down sharply several times. Close bleeder valve. This action creates turbulence in each cylinder, forcing out any remaining trapped air.



SERVICE SPECIFICATIONS

**LINING LENGTH (Measured Inside Arc)
(Both Linings):**

FR-2 Brake

14-1/8" Drum Diameter 14-1/8"
15" Drum Diameter 15"

FR-2S Brake

16-1/2" Drum Diameter 7-3/4" Block
(Two used per shoe)

FR-2SD Brake

16-1/2" Drum Diameter 7-3/4" Block
(Two used per shoe)

LINING WIDTH:

FR-2 Brake

14-1/8" Drum Diameter 3"
15" Drum Diameter 3"
15" Drum Diameter 4"

FR-2S Brake

16-1/2" Drum Diameter 3-1/2"

FR-2SD Brake

16-1/2" Drum Diameter 3-1/2"

LINING THICKNESS (Standard Lining):

FR-2 Brake

14-1/8" and 15" Drum Diameter 3/8"

FR-2S Brake

16-1/2" Drum Diameter 5/8"

FR-2SD Brake

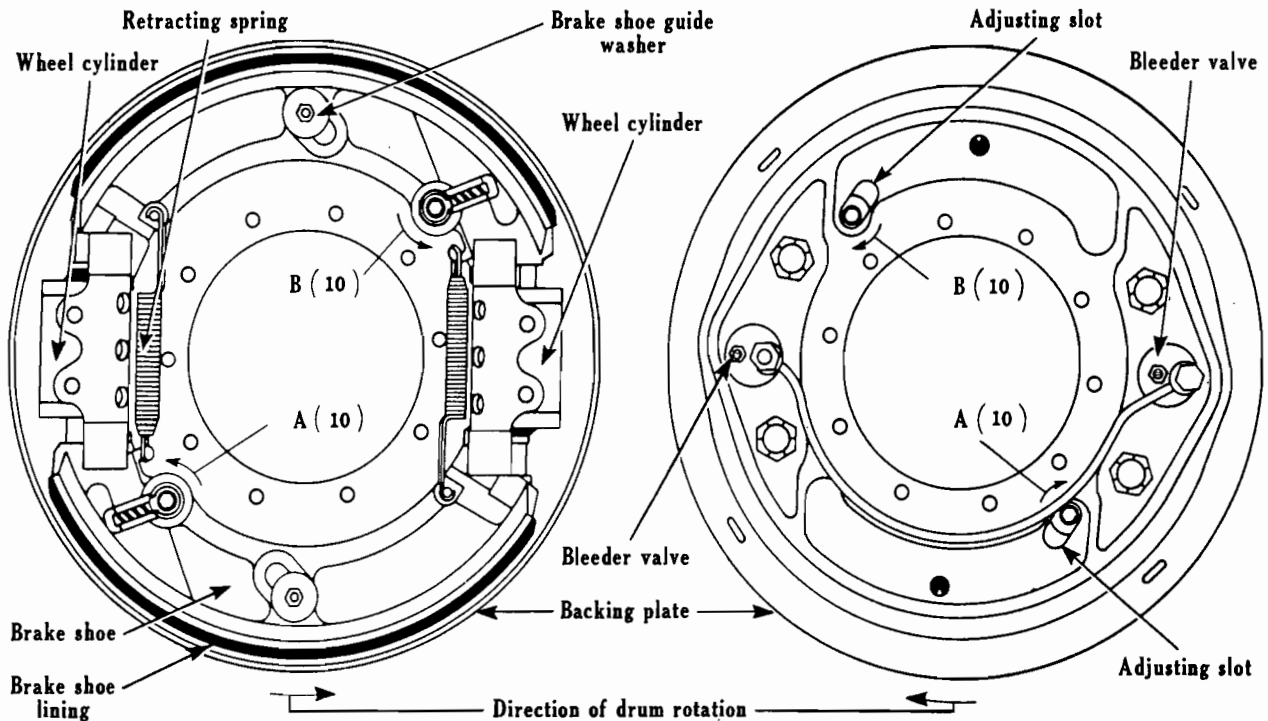
16-1/2" Drum Diameter 5/8"



HYDRAULIC BRAKES BRAKE SHOE ADJUSTMENTS AND SERVICING

L-184, L-190, L-191, L-192, L-193, L-195, LC-190, LC-191, LC-192, LF-210, LF-211, LF-212, LF-220, LF-221, LF-222	} REAR BRAKES 16" x 4" (TYPE "FR")
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L-194, L-200, L-201, L-202, L-205, LC-200, LC-201, LC-202	} REAR BRAKES 16" x 5" (TYPE "FR")
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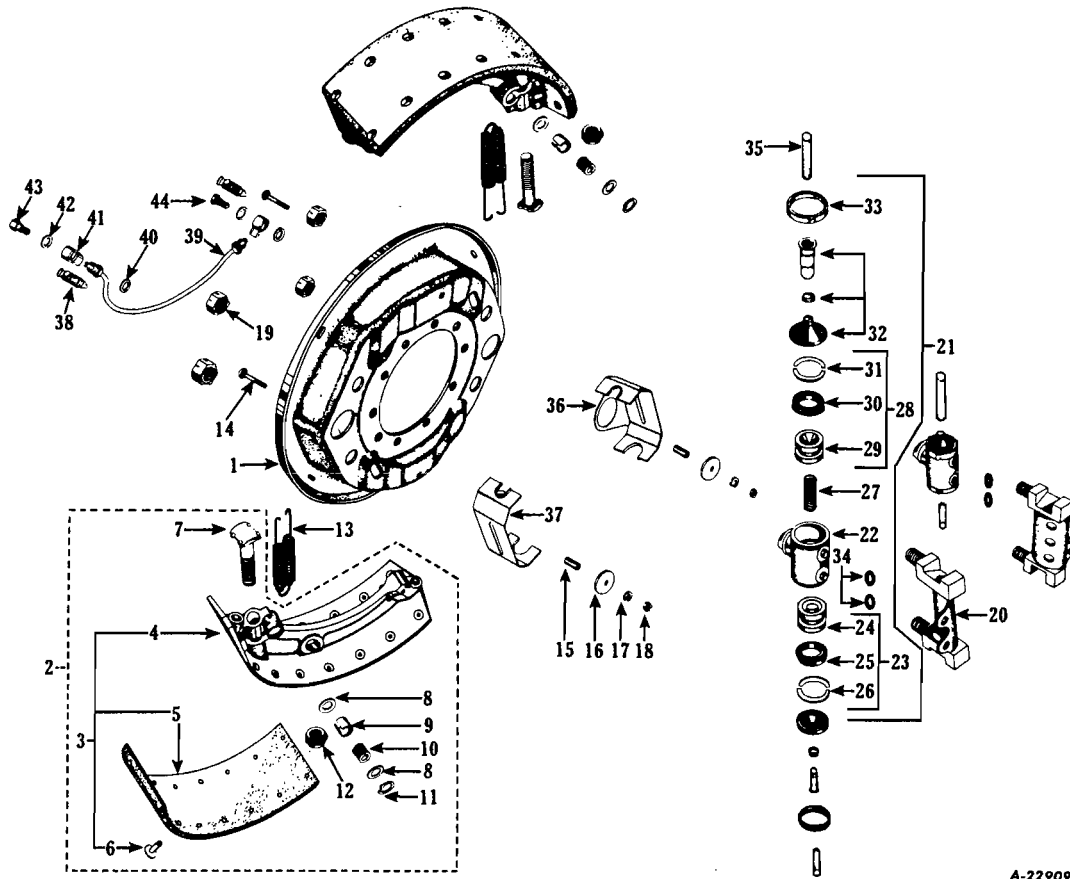


A-23196

Internal View

External View

Fig. 1 - Rear Brake - Type "FR".



A-22909

Fig. 2 - Rear Brake, Type "FR" - Exploded View.

Item No.	DESCRIPTION	Item No.	DESCRIPTION
1	Plate, brake backing.	25	Cup, piston.
2	Shoe, lining & adjuster assembly.	26	Ring segment, back-up, piston cup.
3	Shoe & lining assembly.	27	Spring.
4	Shoe & insert assembly.	28	Piston assembly (short).
5	Lining.	29	Piston (short).
6	Rivet lining.	30	Cup, piston.
7	Screw, adjusting, shoe.	31	Ring segment, back-up, piston cup.
8	Washer, end thrust, adjusting worm.	32	Boot.
9	Sleeve, adjusting worm.	33	Cap, boot retainer.
10	Worm, adjusting, shoe	34	Washer, spring, cylinder mounting.
11	Ring, snap, worm retainer.	35	Link, connecting, piston to shoe.
12	Wheel, driven, adjusting worm.	36	Cover, wheel cylinder.
13	Spring, brake shoe retracting.	37	Cover, wheel cylinder.
14	Bolt, shoe guide.	38	Valve, bleeder, cylinder.
15	Sleeve, shoe guide bolt.	39	Tube, assembly connector, wheel cylinder.
16	Washer, plain, shoe guide bolt.	40	Gasket, fitting.
17	Lockwasher, shoe guide bolt.	41	Fitting, inlet, fluid, connector tube.
18	Nut, shoe guide bolt.	42	Gasket, bolt.
19	Nut, lock, shoe anchor block.	43	Bolt, fitting, inlet, brake pipe to cylinder & tube.
20	Block assembly, shoe anchor.	44	Bolt, fitting, inlet, connector tube to cylinder.
21	Wheel cylinder assembly.		
22	Body, wheel cylinder.		
23	Piston assembly (long).		
24	Piston (long).		

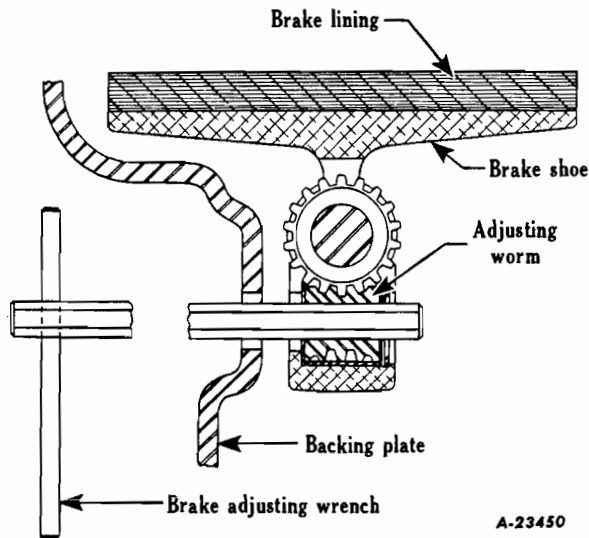


Fig. 3 - Brake Adjustment, Type "FR" Brake.

MAINTENANCE AND ADJUSTMENT WAGNER SELF-CENTERING TYPE "FR" BRAKES (Figs. 1 and 2)

The Wagner self-centering Hi-Tork Brake is a "floating shoe" type which has two identical shoes (2) (Fig. 2) arranged on the backing plate (1) so that their toes are diagonally opposite. Two double-end wheel cylinders (21) are arranged so that one cylinder is mounted between each shoe toe and shoe heel. An equal amount of hydraulic force is thus applied at each end of each shoe. The wheel cylinders are not bolted directly to the backing plate; instead, they are held in position by shoe anchor block (20). The anchor blocks are bolted to the backing plate. Each anchor block serves as a shoe stop and shoe centering point and provides the fulcrum around which the shoe pivots when the brake is applied. Both shoes are always primary shoes (forward-acting), independently actuated in either direction of rotation. Shoes anchor at either toe or heel depending upon the rotation of the brake drum. A pivot pad is placed at both shoes toe and shoe heel. The pad at the shoe toe is an integral part of the shoe adjusting screw (7), a component of the adjusting mechanism, which is placed in the shoe toe on this brake. The adjusting screw is held in the shoe toe by means of worm wheel (12) which threads onto the screw. The worm wheel, in turn, meshes with a worm (10) which is rotated to effect brake adjustment. The worm has a hex bore so that it can easily be turned with a 3/8" hex brake wrench. Adjustment slots (A and B) (Fig. 1) in the brake backing plate, provide access to each of the shoe adjusting worms.

Upon brake application, the wheel cylinder pistons (23 and 28) (Fig. 2) apply force against toe and heel of each shoe. Upon contact of shoe liners (5) with the drum, self-energization (shoe wrapping action caused by drag of the drum on the linings) wraps both shoes into the drum. If the

vehicle is moving forward, the shoe heels are wrapped against their anchor blocks by the drum rotation. If the vehicle is backing, the shoe toes are forced against their anchor blocks. Anchor block sides are aligned on the axle radius. Upon contact with the anchor blocks the shoes pivot and, at the same time, move radially along the anchor block sides until they are centered in relation to the drum.

Self-energization assists brake application equally regardless of the direction of the drum rotation. The brake is thus capable of developing the same maximum torque output for a reverse stop that is used for a forward stop, and it is always automatically self-centering.

Disassembly

Note A. The first disassembly operation is always removal of brake shoe retracting springs (13) (Fig. 2). With brake spring pliers, slip looped end of spring off of the spring hook located at the toe or adjustment end of each shoe.

Note B. If wheel cylinder connecting tube (39) and bleeder valves (38) are removed, mark wheel cylinder ports to which connecting tube is attached to avoid error in reassembly. Difficulty will be encountered in bleeding operation if tube is assembled in wrong location.

Note C. Whenever shoes are removed, always dismantle adjusting mechanism and clean grease, dust, and dirt from parts and from chambers within the shoe.

Step-By-Step Procedure (Disassembly)

I. REMOVAL OF SHOE ASSEMBLIES (2):

1. Remove brake shoe retracting springs (13). (Refer to Note A).
2. Remove shoe guide bolt nut (18), lockwasher (17), and washer (16), holding shoe in place. Shoe (2) easily lifts off.
3. All other parts may then easily be removed. (Refer to Notes B and C).

II. REMOVAL OF WHEEL CYLINDER (21) WITHOUT DISTURBING SHOES:

1. Remove brake shoe retracting springs (13). (Refer to Note A).
2. Disassemble cylinder connecting tube (39) and tube fitting (41). (Refer to Note B).
3. At anchor block (20) of cylinder, loosen anchor block lock nuts (19). It is not necessary to completely remove these nuts.



4. Spread shoes away from cylinder until connecting links (35) are cleared.
5. Push anchor block (20) away from backing plate (1) until clearance is sufficient for cylinder removal.
6. Lift out cylinder, complete with connecting links. Be careful not to misplace spring washers (34).

III. REMOVAL OF SHOE ADJUSTMENT MECHANISM:

1. Remove shoes (2) from brake.
2. Rotate adjusting screw (7), threading it free of worm wheel (12).
3. Pry worm retainer snap ring (11) from shoe.
4. End thrust washers (8), sleeve (9), worm (10), and worm wheel (12) may now easily be removed.

IV. WHEEL CYLINDER (21) DISASSEMBLY:

1. Pry off each boot retainer cap (33). Boot (32) and connecting link (35) will come with the cap.
2. Internal parts may now be forced out of one end of cylinder.
3. Slip cup back up ring segments (26, 31) off of each piston assembly (23, 28).
4. Cups (25, 30) can now be stretched and forced off of each piston. Take care not to mar piston bearing surface or cup groove.
5. In turn, clamp each connecting link (35) in vise. Pry off each boot retainer sleeve. Remove boots (32).

Assembly

Note D. Wheel cylinders are identical. One side of the cylinder has a long stroke, in comparison to the other side, to take care of increased piston travel made necessary when the brake is adjusted to compensate for lining wear. The cylinder inlet and bleeder ports are offset toward the short stroke side. The long stroke piston has greater length than the short stroke piston and is also identified by a circular slot machined at the bottom of the connecting link socket. Pistons must be assembled in proper position within the cylinder. If pistons are reversed, fluid will have difficulty entering the cylinder chamber and it may be forced out of the short stroke side of the cylinder. The long stroke side of

the cylinder (Greatest length from inlet port to end of cylinder) must be assembled to the backing plate so that it faces the: (1) Shoe Toe (adjustment end of shoe), (2) Adjustment slot in backing plate.

Note E. Do not lubricate shoe adjustment mechanism or other parts of the brake. Lubrication will cause dust and dirt to collect and solidify in the adjustment mechanism.

Note F. When replacing shoes, make sure that shoe adjusting worm (10) (Fig. 2) is aligned with adjusting slot (A or B) in backing plate. Shoes (2) can be assembled backward, however, the brake cannot be adjusted.

Note G. When replacing shoe retracting springs (13), place hooked end on shoe pins at shoe heel and then, with brake spring pliers, slip looped end of spring on hook at toe end (adjustment end) of shoe.

Step-By-Step Procedure (Assembly)

The brake is easily assembled in reverse order to disassembly.

V. WHEEL CYLINDER ASSEMBLY:

1. Do not assemble parts dry. Coat parts and inside of cylinder bore with clean brake fluid before assembly.
2. Stretch cups (25 and 30) into place on pistons (24 and 29). Cup lip must face inward toward spring groove side of piston.
3. Slip cup back up ring segments (26 and 31) into place on each piston. Segment must be placed behind the cup lip and segment lip must face in same direction as cup lip.
4. Assemble boots (32) and boot retainer sleeves to connecting links (35). Force sleeves over boots to hold boots in place on links.
5. Place long stroke and short stroke piston assemblies (23 and 28) in correct positions in cylinder with spring (27) between pistons. Piston connecting link sockets must face outward and cup lips face inward. (Refer to Note D).
6. Place assembled boots and links in boot retainer caps (33) and fit on cylinder. Crimp each cap, in at least three places, into grooves machined on ends of cylinder.



L-LINE MOTOR TRUCK SERVICE MANUAL

BRAKES-
ADJUSTMENTS
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VI. REPLACEMENT OF SHOE ADJUSTMENT MECHANISM:

1. Do not lubricate parts. (Refer to Note E).
2. Assemble end thrust washers (8), sleeve (9), worm (10), and worm wheel (12) in place. Sleeve slot must face the worm wheel to allow worm and wheel to mesh.
3. Push worm retainer snap ring (11) in place, making sure it snaps into the groove provided in the shoe.
4. Start adjusting screw (7) into worm wheel (12) thread. Adjust to full off position. Curvature of pad on adjusting screw must be in proper plane to permit it to rock on anchor block when shoe is replaced on backing plate.

VII. REPLACEMENT OF WHEEL CYLINDER WITHOUT DISTURBING SHOES:

1. Make sure that backing plate is clean so that cylinder and anchor block (20) will fit properly when mounted.
2. Make sure spring washers (34) are in position on the two lugs machined on the cylinder casting.
3. Spread shoes as far apart as possible.
4. Holding wheel cylinder so that long stroke side of cylinder faces shoe toe and backing plate adjustment slot, slip mounting lugs into place in the anchor block (20). (Refer to Note D).
5. Slip connecting link ends into sockets provided in the shoes.
6. Tighten anchor block locknuts (19), with a TORQUE WRENCH. Self-locking nuts, to be effective, must not be over tightened.
7. Assemble cylinder connecting tube (39). (Refer to Note B under Disassembly.)
8. Replace brake shoe retracting springs (13). (Refer to Note G).

VIII. REPLACEMENT OF SHOE ASSEMBLIES

- For best results, new shoe and lining assemblies (2) should have liners of correct thickness ground (not buffed) to correct radius, concentric with the brake drum. If this is not done, readjustment may be required after liners are "worn in".
- Replace one shoe on backing plate (1) making sure adjustment worm (10) is aligned with adjustment slot (A or B). (Refer to Note F.)

3. Slip guide sleeve (15) on guide bolt (14). Assemble guide washer (16), lockwasher (17), and lock nut (18). Tighten nut securely.
4. Repeat Steps 2 and 3 for second shoe.
5. Replace shoe retracting springs (13). (Refer to Note G.)

Adjustment

Lining to drum clearance adjustment is required when shoes are relined and, on occasion, to compensate for normal lining wear. Clearance should be sufficient to avoid "brake drag" and yet close to afford a good "pedal reserve".

Manually operated and vacuum-hydraulic actuated brakes require adjustment (or relining) when pedal reserve approximates 2"; that is, when the brake pedal drops to within 2" of the floor board on hard application.

Adjustment may be made with the vehicle resting on jacks. On jacks, brake drag is checked by "feel", rotating the drum in the direction of forward rotation as adjustment is made.

Step-By-Step Procedure (Adjustment)

1. Make all adjustments with drum cooled to normal temperature.
2. Make sure wheel bearing is correctly adjusted.
3. Remove adjustment slot covers.
4. Insert brake adjusting wrench in adjustment slot (A or B) (Figs. 1 and 3) to contact shoe adjusting worm (10). Rotate wrench in the direction of FORWARD wheel rotation to decrease lining to drum clearance. Reduce clearance until lining "drags" on drum.
5. Rotate wrench in opposite direction, to increase clearance, until drag is relieved. Then rotate wrench one additional turn to provide working clearance.
6. Repeat Steps 4 and 5 on the second shoe (Adjustment Slot B or A).
7. Replace adjustment slot covers.



**"BLEEDING" THE HYDRAULIC
BRAKE SYSTEM**

Vehicle brake systems using the self-centering hi-tork foundation brake are bled in similar manner to other hydraulic systems.

METHOD A: -

Bleed wheel cylinders in the following order:

1. Cylinder lowest to road.
2. Cylinder highest from road.

METHOD B: -

If brake is mounted so that both cylinders are almost in a vertical plane it may be necessary to "surge bleed" the system.

1. Bleed brakes at all wheels in regular manner, using Method A.
2. At each wheel cylinder in turn, open bleeder valve and then kick brake pedal down sharply several times. Close bleeder valve. This action creates turbulence in each cylinder, forcing out any remaining trapped air.

SERVICE SPECIFICATIONS

LINING LENGTH (measured inside arc) (Both Linings):

16" Drum Diameter 16-1/8"

LINING WIDTH:

16" Drum Diameter. 4", 5"

LINING THICKNESS (Std. Lining):

16" Drum Diameter 3/8"

TORQUE WRENCH READING, SHOE ANCHOR BLOCK LOCKNUT:

16" Drum Diameter
(3/4"-16 Thrd.) 175-219 lb. ft.



PARKING BRAKE

FOR LM-120, L-130, L-150, LM-150, L-160,
LC-160, L-170, LF-170 SERIES TRUCKS

Parking Brake Adjustments (See Fig. 1)

Note: Perform operations in sequence given:-

1. Place parking brake lever in extreme forward (release) position. NOTE: Brake cam lever must rest squarely on the upper brake band bracket. If necessary readjust linkage.
2. The lining to drum clearance of .020" to .030" is obtained as follows:
 - (a) Adjust anchor screw nut (1) until .020" to .030" clearance is obtained at side of the stop screw.
 - (b) Tighten nuts (4) on adjusting screw bracket bolt (5) to give .020" to .030" clearance between lower half of lining and drum.
 - (c) Adjust lining clearance for upper half of band to .020" to .030" by turning nut (2) on adjusting bolt (3).
 - (d) Lock all adjustments and recheck clearances.

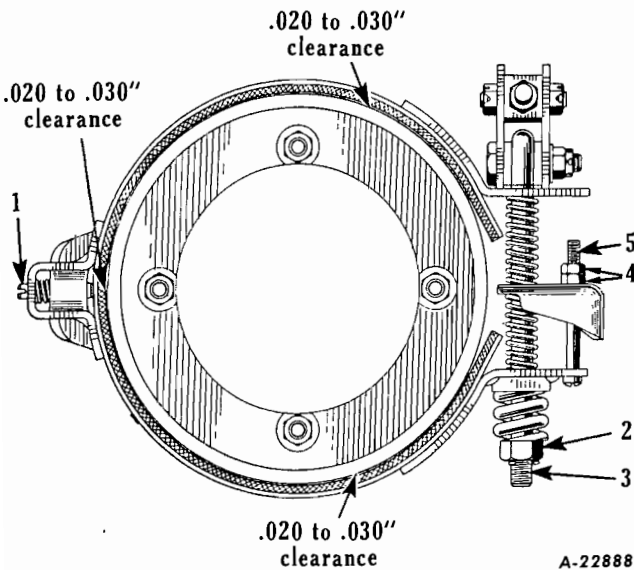


Fig. 1

PARKING BRAKE

FOR L-180, LC-180 SERIES TRUCKS

Parking Brake Adjustments (See Fig. 2)

Note: Perform operations in sequence given:-

1. Place parking brake lever in extreme forward (release) position. NOTE: Brake cam lever must rest squarely on the upper brake band bracket. To correct this position, remove clevis pin and readjust yoke.
2. The lining to drum clearance of .020" to .030" is obtained as follows:
 - (a) Adjust anchor screw nut (1) until .020" to .030" clearance is obtained at side of the stop screw.
 - (b) Tighten nuts (4) on adjusting screw bracket bolt (5) to give .020" to .030" clearance between lower half of lining and drum.
 - (c) Adjust lining clearance for upper half of band to .020" to .030" by turning nut (2) on adjusting bolt (3).
 - (d) Lock all adjustments and recheck clearances.

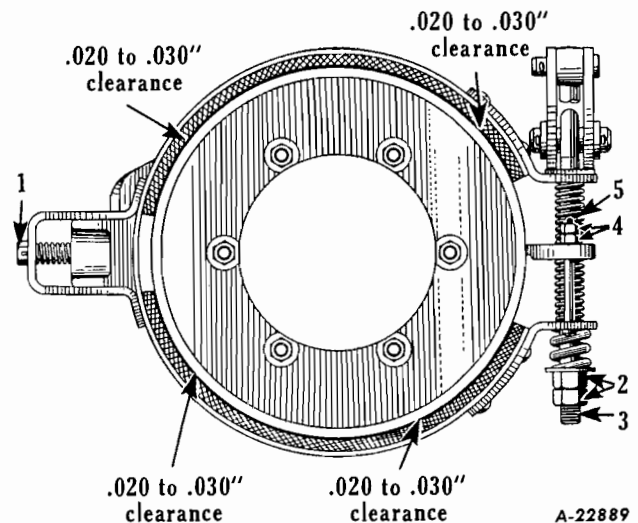


Fig. 2



PARKING BRAKE

FOR L-190 AND LF-190 SERIES TRUCKS,
L-200, L-201, L-202, L-204 TRUCKS

Parking Brake Adjustments (See Fig. 3)

Note: Perform operations in sequence given:-

1. Place parking brake in extreme forward (release) position. NOTE: Brake cam lever must rest squarely on the upper brake band bracket. To correct this position, remove clevis pin and readjust yoke.
2. The lining to drum clearance of .020" to .030" is obtained as follows:
 - (a) Adjust anchor screw nut (1) until .020" to .030" clearance is obtained at side of the stop screw.
 - (b) Tighten nuts (4) on adjusting screw bracket bolt (5) to give .020" to .030" lining clearance to drum for lower half of shoe.
 - (c) Adjust upper half of shoe lining clearance to .020" to .030" by turning nut (2) on adjusting bolt (3).
 - (d) Lock all adjustments and recheck clearances.

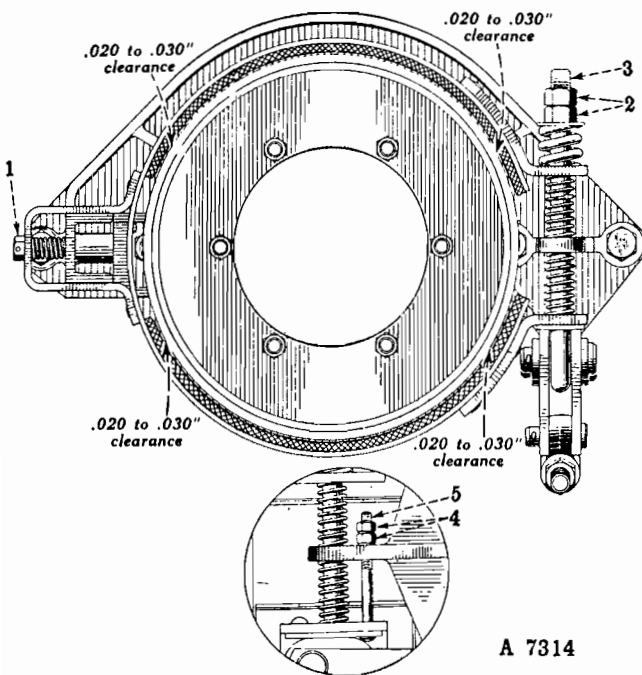


Fig. 3

PARKING BRAKE

FOR L-205, L-210, L-211, L-212, LF-210,
LF-211, LF-212, LF-220, LF-221
LF-222 TRUCKS

Parking Brake Adjustments (See Fig. 4)

Note: Perform operations in sequence given:-

1. Place parking brake lever in extreme forward (release) position. NOTE: Brake cam lever must rest squarely on the upper brake band bracket. To correct this position, remove clevis pin and readjust yoke.
2. The lining to drum clearance of .020" to .030" is obtained as follows:
 - (a) Tighten nuts (3) on bolt (4) to give .020" to .030" clearance between lower half of shoe and drum.
 - (b) Tighten nuts (1) on adjusting bolt (2) to give .020" to .030" clearance between upper half of brake shoe and drum.
 - (c) Tighten nuts (5) on bracket bolt (6) just enough to hold adjustment obtained in paragraph (b).
 - (d) Lock all adjustments.

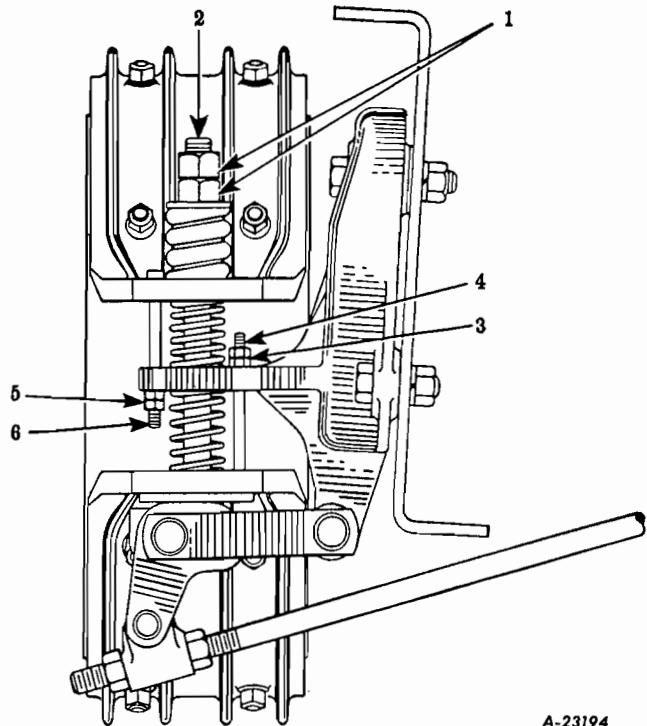


Fig. 4



L-LINE MOTOR TRUCK SERVICE MANUAL

CLUTCH GROUP

Motor truck models and their corresponding clutch models are shown in the following list. Clutch model specifications will be found on specification page 2.

TRUCK MODEL	CLUTCH MODEL	TRUCK MODEL	CLUTCH MODEL
L-110.	RK-10B	L-184	RK-11A-1
L-120.	RK-10B	L-185	RK-11A-1
LM-120	RK-10B	LC-180	RK-12-12
L-130.	RK-10B	L-190	RK-12-15
LB-140. . . . .	.....	L-193	RK-12-15
L-150.	RK-10B	L-194	RK-12-15
L-153.	RK-10B	L-195	R-14-15
LM-150	RK-10B	LC-190 . . . . .	.....
L-160.	R-11A-1	LF-190	R-14-15
L-163.	R-11A-1	L-200	R-14-15
L-164.	R-11A-1	L-204	R-14-15
L-165.	R-11A-1	L-205	R-14-15
LC-160.	R-11A-1	LC-200 . . . . .	.....
L-170.	R-11A-1	L-210	R-14-15
L-173.	R-11A-1	LF-210	R-14-15
L-174.	R-11A-1	L-220	R-15-8
L-175.	R-11A-1	L-225	R-15-8
LF-170.	R-11A-1	LF-220
L-180.	RK-11A-1	L-230
L-183.	RK-11A-1	LF-230

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CLUTCH SPECIFICATIONS

CLUTCH MODELS (IH)	RK-10B	R-11A-1	RK-12-12	RK-12-15	R-14-15	R-15-8
Clutch Model (Manufacturer) . .	10-TT	11-TT	12-TT	12-TT	14-TT	15-TT
Number of plates	1	1	1	1	1	1
Vibration dampener	Coil Spring	Coil Spring	Coil Spring	Coil Spring	Coil Spring	Coil Spring
Pressure Springs;						
Number used	9	12	12	15	15	18
Pounds pressure	145	145	145	145	175	175
at	1-7/16"	1-7/16"	1-7/16"	1-7/16"	1-13/16"	1-13/16"
Clutch Facings;						
Number used	2	2	2	2	2	2
Release Lever Adjustment;						
Flywheel surface to						
levers	1-13/16"	2"	2-1/8"	2-1/8"	2-5/8"	2-3/4"
Clutch Pedal Free Travel. . . .	1 to 1-1/2"	1 to 1-1/2"	1 to 1-1/2"	1 to 1-1/2"	1 to 1-1/2"	1 to 1-1/2"
Capscrew size for						
removal and installation .	3/8-16x1-3/4"	3/8-16x1-3/4"	3/8-16x2"	3/8-16x2"	3/8-16x2-1/4"	3/8-16x2-1/2"





CLUTCH

Clutches on the R-110 through R-190 series chassis (10", 11" and 12" clutches) use a new cushion type driven member, this requires a change in release lever settings to accommodate the new thicker cushion type driven member.

Figure 1 illustrates the 10, 11 and 12 inch clutches and Figure 2 illustrates the 14" clutch used in R-line trucks (see following page). Refer to chart on page 3 for truck models and release lever settings.

The clutch linkage on R-150 and up chassis has two holes in the clutch release lever (see Figures 3 and 4 on page 4) to assure clean clutch release and afford the operator a choice between pedal pressures and travel. The clutch linkage adjustable yoke can be installed in either hole on the release lever to suit operator's choice.

The clutch pedal free travel for all R-line chassis is 2 inches. It is important that clutch pedal free travel be maintained to avoid premature clutch failure. Keep clutch control linkage lubricated.

Clutch release bearing sleeves on all R-line chassis incorporate a lubricator fitting to provide means of lubricating the clutch release bearing, sleeve and fork without their removal from chassis. Lubricate as follows:

Fill release bearing sleeve using hand gun. **Do not over-lubricate.** Lubricate every 15,000 to 20,000 miles. Under unusual "Stop-and-Go" driving conditions lubricate every 10,000 miles. Use lubricant comparable to "Lubriplate No. 110."

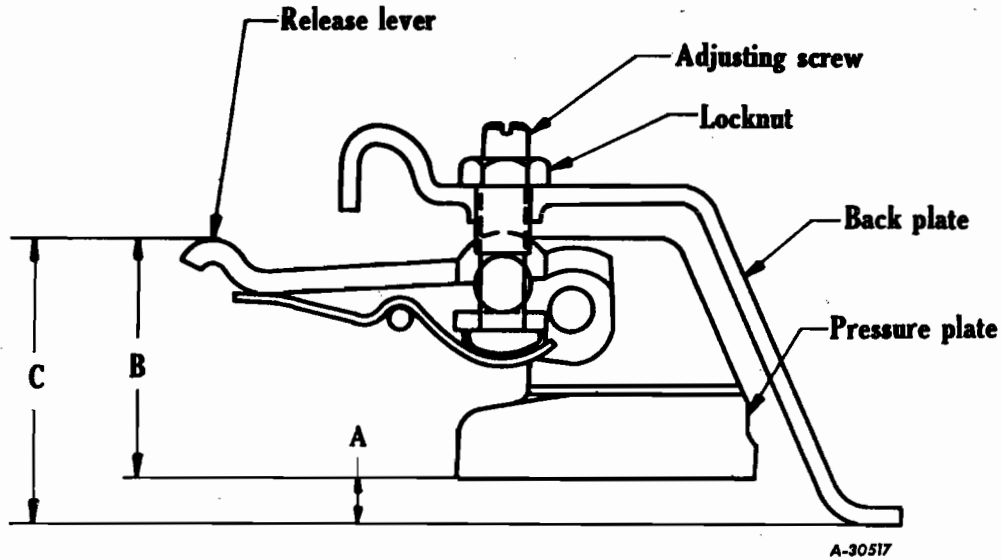


Fig. 1 - Clutch Models RK-10-B, R-11A-1, RR-12-12, RK-12-15 (10", 11" and 12" clutches).
See chart on page 3 for truck models, thickness of pressure plate spacers and release lever settings.

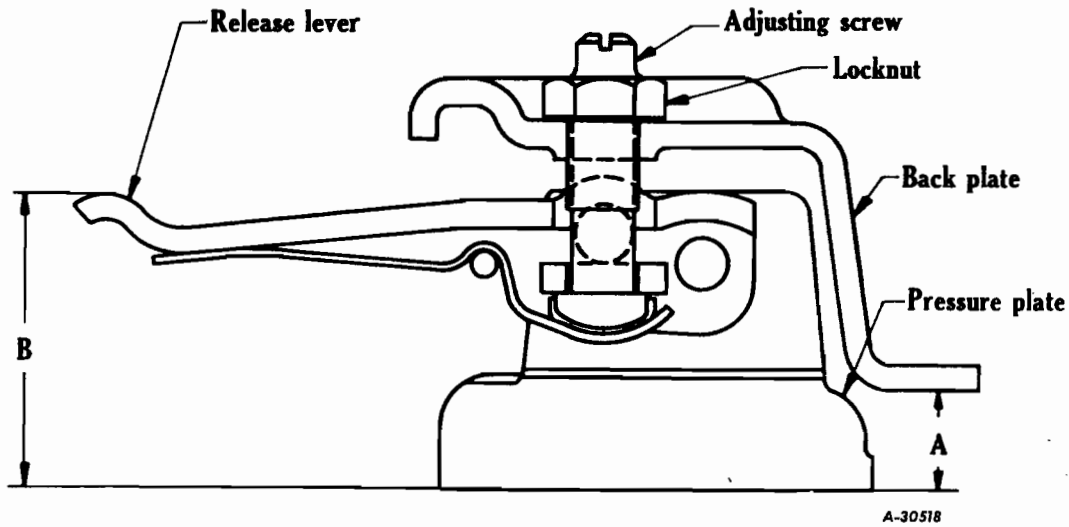


Fig. 2 - Clutch Model RK-14-15 (14" Clutch).
See chart on page 3 for truck models, thickness of back plate spacers and release lever settings.



The following chart shows truck model, clutch model number, type of driven member, thickness and part number of spacer plate, and release lever settings for R-LINE Chassis when using the SE-990 Clutch Overhaul Fixture.

TRUCK MODEL	IH CLUTCH MODEL NUMBER	TYPE OF DRIVEN MEMBER	SPACER THICKNESS AND NUMBER A	LEVER SETTING B	LEVER SETTING C
R-110, R-120, R-130, R-150, RA-120, RA-140, RM-120, RM-150 Series Chassis (10" Rockford Clutch)	RK-10-B	Cushion	5/16" (CR-99)	1-5/8"	1-15/16"
R-110, R-120, R-130, R-150, RA-120, RA-140, RM-120, RM-150 Series Chassis with SD-220 Engine (11" Rockford Clutch with 9 Springs)	R-11A-1	Cushion	5/16" (CR-99)	1-11/16"	2"
R-160, RC-160, R-170 Series Chassis (11" Rockford Clutch with 12 Springs).	R-11A-1	Cushion	5/16" (CR-99)	1-11/16"	2"
R-170, RC-180, RF-170 Series Chassis and R-180, R-181, R-182, R-183, R-184 Chassis (12" Rockford Clutch with 12 Springs)	RR-12-12	Cushion	3/8" (CR-84)	1-53/64"	2-13/64"
R-185, R-1853, R-190, R-191, R-192, R-194 (12" Rockford Clutch with 15 Springs)	RK-12-15	Cushion	3/8" (CR-84)	1-53/64"	2-13/64"
R-190, R-200, R-210, RF-190, RF-210 Series Chassis (14" Rockford Clutch).	RK-14-15	Solid	47/64" (CR-71)	2-5/32"

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R-LINE MOTOR TRUCK SERVICE

CLUTCH SECTION A Page 3

R-LINE MOTOR, TRUCK SERVICE

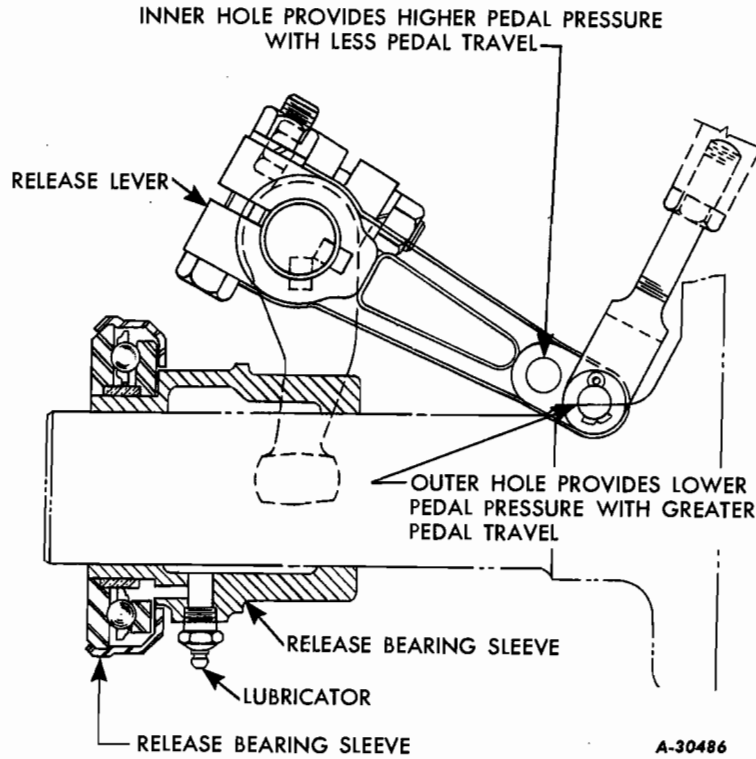


Fig. 3 - Clutch Release Lever, Sleeve and Bearing.
For R-150, R-160, R-170 series trucks, also R-180, R-181, R-182, R-183 and R-184 trucks.

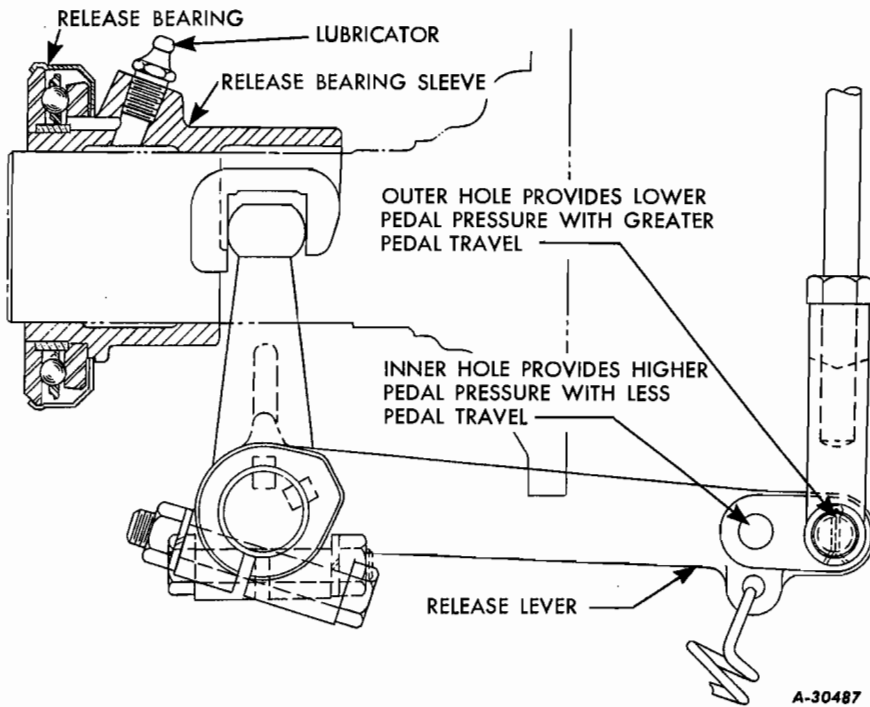


Fig. 4 - Clutch Release Lever, Sleeve and Bearing.
For R-185 to RF-210 trucks.



CLUTCHES

Models RK-10B, R-11A-1, RK-12-12, RK-12-15, R-14-15, R-15-8

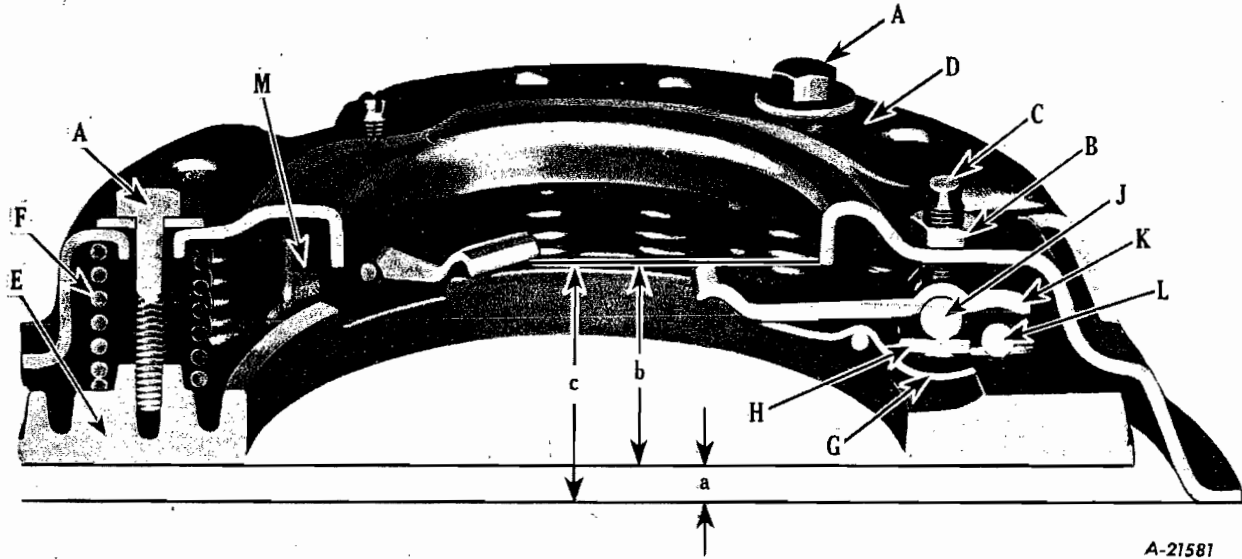


Fig. 1 (RK-10B CLUTCH)

- (a) Pressure plate to flywheel surface 11/32"
- (b) Release lever to pressure plate surface 1-15/32"
- (c) Release lever to flywheel surface 1-13/16"

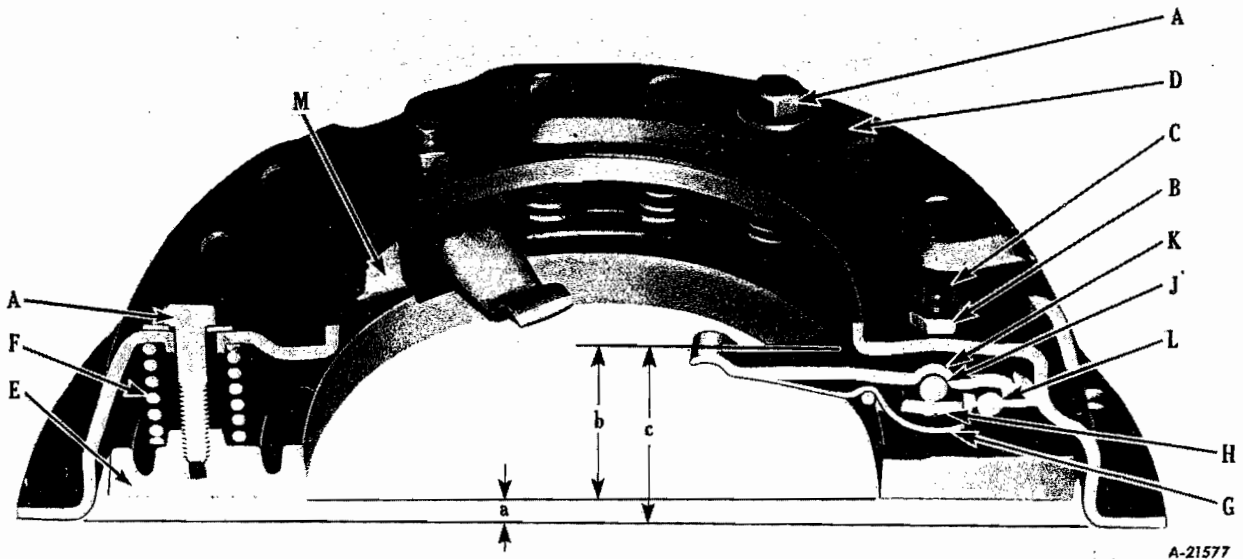


Fig. 2 (R-11A-1 CLUTCH)

- (a) Pressure plate to flywheel surface 11/32"
- (b) Release lever to pressure plate surface 1-21/32"
- (c) Release lever to flywheel surface 2"

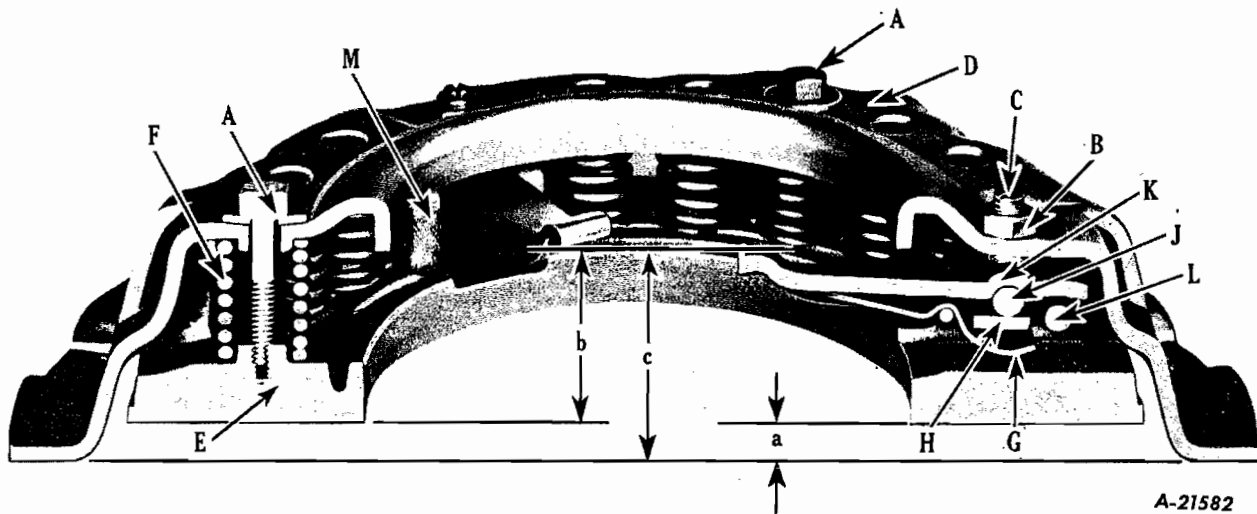


Fig. 3 (RK-12-12, RK-12-15 CLUTCHES)

- (a) Pressure plate to flywheel surface. 3/8"
- (b) Release lever to pressure plate surface 1-3/4"
- (c) Release lever to flywheel surface 2-1/8"

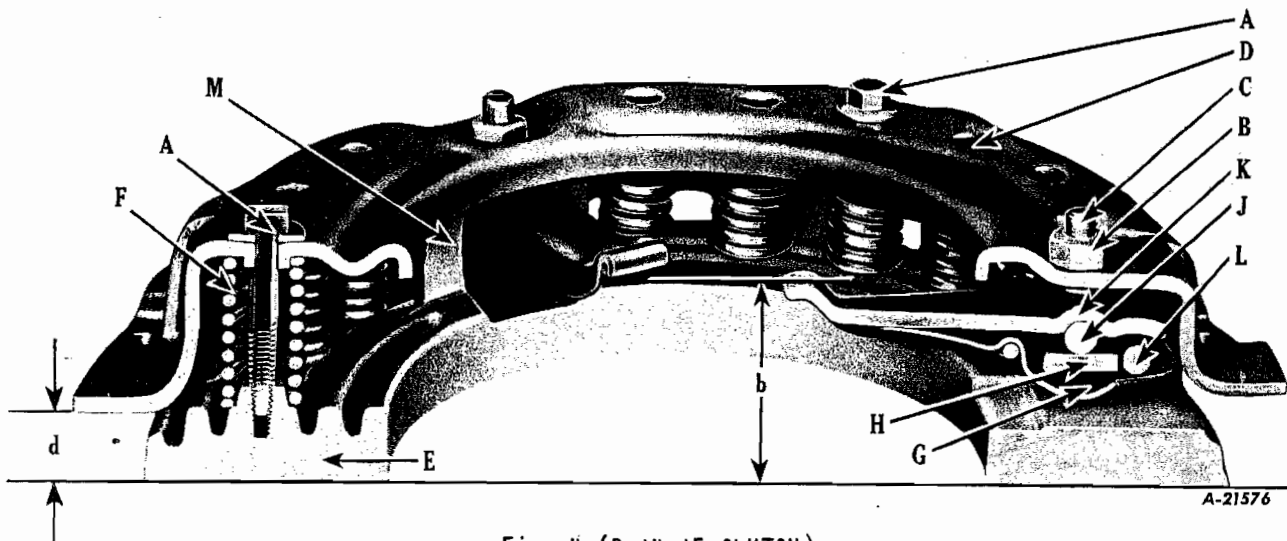


Fig. 4 (R-14-15 CLUTCH)

- * (a) Pressure plate to flywheel surface (not shown). 15/32"
- (b) Release lever to pressure plate surface 2-5/32"
- * (c) Release lever to flywheel surface (not shown) 2-5/8"
- (d) Cover plate mounting surface to pressure plate surface. . . 47/64"

* - Not shown in illustration.

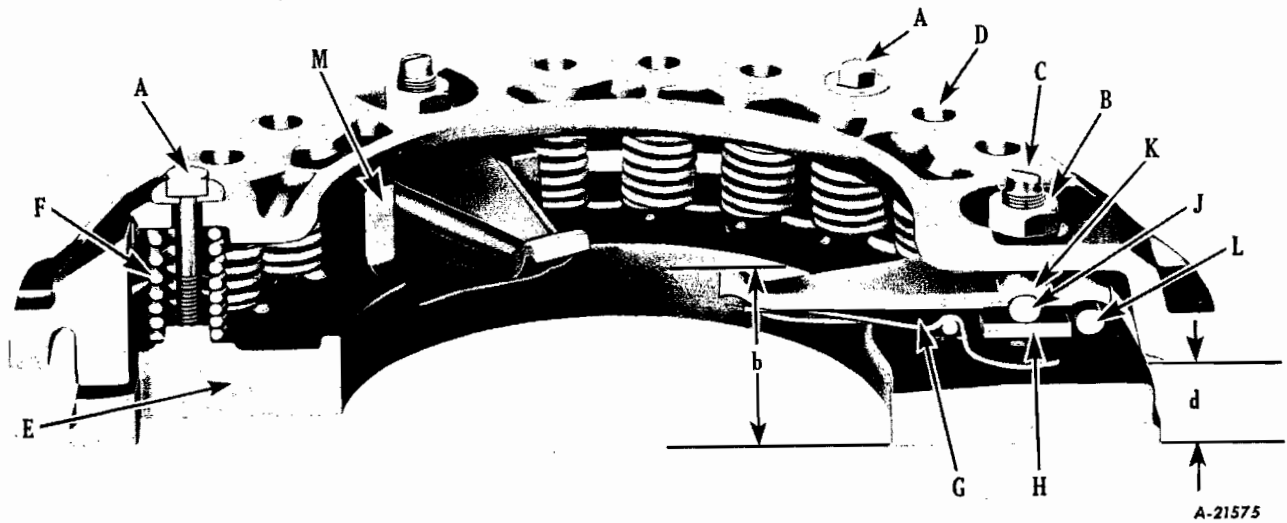


Fig. 5 (R-15-8 CLUTCH)

- * (a) Pressure plate to flywheel surface (not shown). 15/32"
- (b) Release lever to pressure plate surface 2-9/32"
- * (c) Release lever to flywheel surface (not shown) 2-3/4"
- (d) Cover plate mounting surface to pressure plate surface. . . 1-9/32"

* - Not shown in illustration.

LEGEND FOR FIGS. 1 TO 5 INCLUSIVE

- (A) Capscrew (for assembly purposes only)
- (B) Adjusting screw lock nut
- (C) Adjusting screw
- (D) Cover
- (E) Pressure plate
- (F) Pressure spring
- (G) Release lever spring
- (H) Pivot block
- (J) Rollers
- (K) Release lever
- (L) Release lever pin
- (M) Drive lug

NOTE: The above clutch parts are referred to in the following servicing procedure under the designated letter. The servicing procedure, in general, is the same for all clutch assemblies.



CLUTCH

Description

These clutches are of the single dry-plate type, and release lever adjustments should not be required during the normal life of the clutch driven-plate facings. As pedal free-play is reduced by wear of the clutch driven-member facings, the correct amount of pedal free travel should be restored by means of the pedal adjustment, which will also give the proper clearance between clutch release levers and the release bearing. It is extremely important to maintain free travel of the pedal at all times to avoid clutch slippage, and to protect throw-out bearing.

Whenever it is necessary to do any service work on the clutch, advantage should be taken of the opportunity to thoroughly recondition it. This is a comparatively short job and will assure satisfactory operation over a long period of time, whereas failure to do this may necessitate another tear-down within a short time.

Removal

When removing transmission for the purpose of gaining access to the clutch, or for any other reason, extreme care should be taken to support the weight of the transmission until it is completely removed so that the main shaft splines will clear the driven member. Otherwise, there is a possibility of distorting the driven member which will not permit a free release of the clutch.

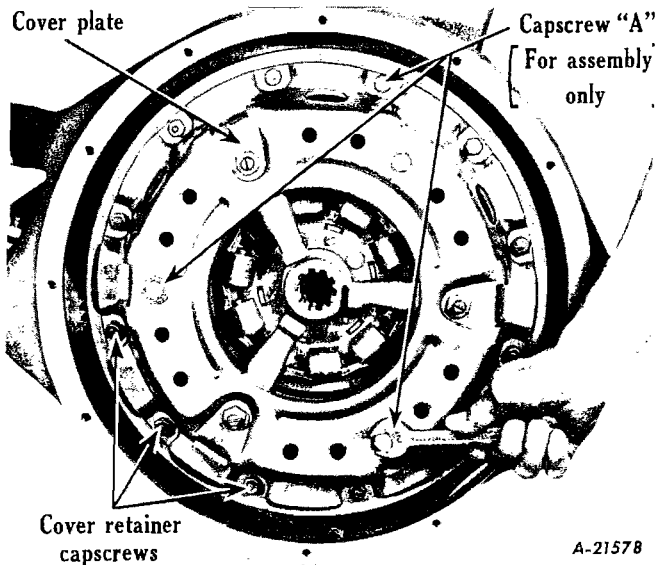


Fig. 6 - Install capscrews "A" before removing clutch assembly.

The clutch pressure plate (E) is drilled and tapped so that three capscrews (A) (see specifications for sizes) with washers may be inserted through the cover plate (D), thereby holding the clutch assembly compressed when it is removed or installed (Fig. 6). With three

capscrews holding the assembly compressed, remove clutch from flywheel by backing out the capscrews which hold it in place. All capscrews should be backed out gradually to avoid damage to the clutch cover or back plate.

Driven Member Assembly

The clutch driven member assembly should be carefully inspected. Facings showing considerable wear, or facings that are rough or oil soaked, should be replaced.

When installing new facings of the continuous ring type, and in cases where two different thicknesses are used on each plate, the thick facing is installed on the pressure plate side. The thin facing is installed on flywheel side.

Installation of clutch facings on the cushion type driven member differs from the other type in that each facing is attached to the discs separately and independently (Fig. 7 and 8).

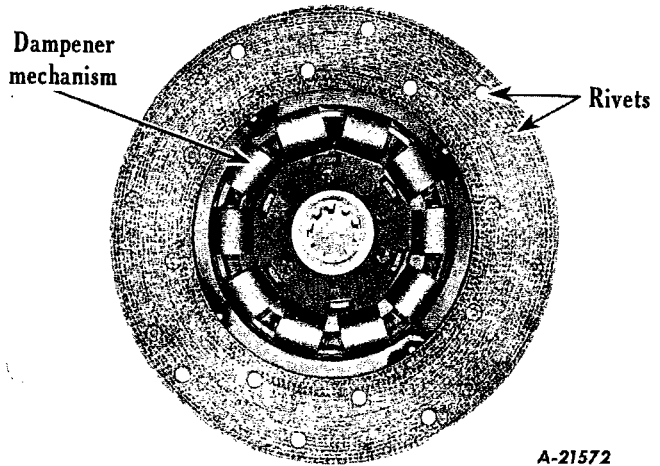


Fig. 7 - Solid type driven member. Each rivet secures both linings to disc.

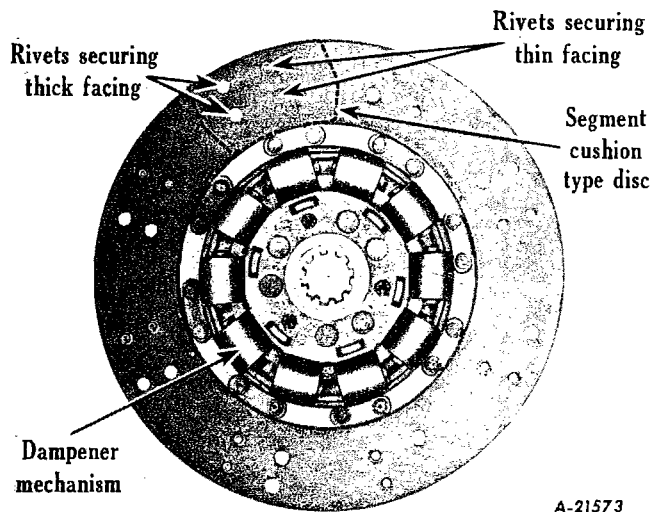


Fig. 8 - Cushion type driven member. Half of the rivets hold thin facing and other half secure thick facing to disc



Clutch Overhauling Fixture

A clutch overhauling fixture is available (Fig. 9) and is adapted to the overhaul and adjustment of clutches used in International Motor Trucks. Complete instructions accompany the machine.

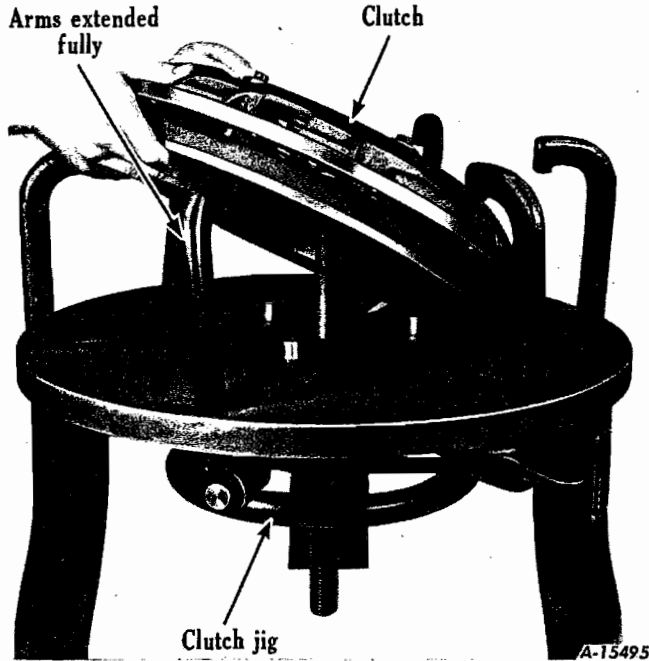


Fig. 9 - Placing clutch in SE-990 fixture.

Servicing the Clutch

NOTE: (Letter references in the text are those shown in Figs. 1 to 5.)

The cover and pressure plate assembly is dismantled by placing specified spacer plate or spacer blocks on clutch overhaul machine

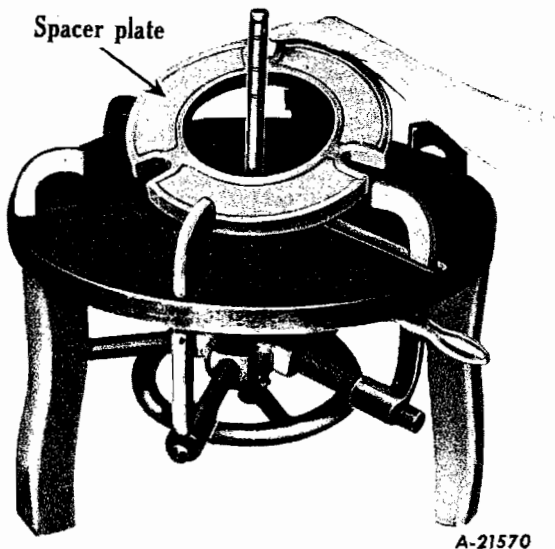


Fig. 10 - Use proper spacer plate, where needed.

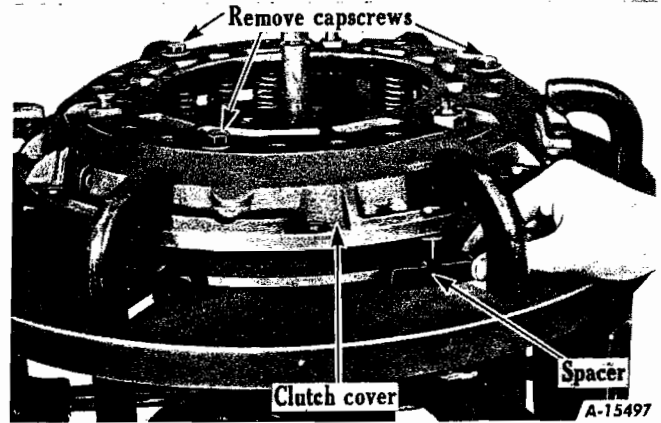


Fig. 11 - Spacer blocks are used when pressure plate extends below clutch cover.

(Figs. 10 and 11). Center clutch assembly over space plate. Draw fixture down to surface plate being sure fixture arms are seated so as not to damage cover (Fig. 12). Compress the assembly lightly.

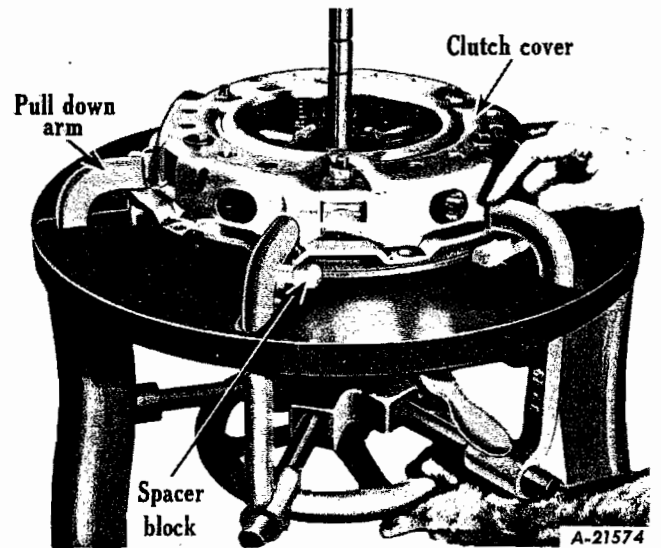


Fig. 12 - Draw clutch down with pulldown arms.

Remove the three capscrews (A) used to hold the assembly while removing it from fly-wheel (Fig. 6).

Loosen and remove lock nuts (B) from adjusting screws (C), Fig. 13. Screw adjusting screws (C) out of cover (D) turning screws clockwise three or four turns at a time while slightly releasing pressure on backing plate. Repeat until pressure from the clutch pressure springs is relieved and adjusting screws (C) are free of cover (D). This procedure of gradually releasing the assembly and backing out of the screws (C) must be followed in order to avoid damage to the lever assemblies (K).

The clutch may then be fully released, after which all parts are readily dismantled for inspection and replacement if necessary. (Fig. 14.)

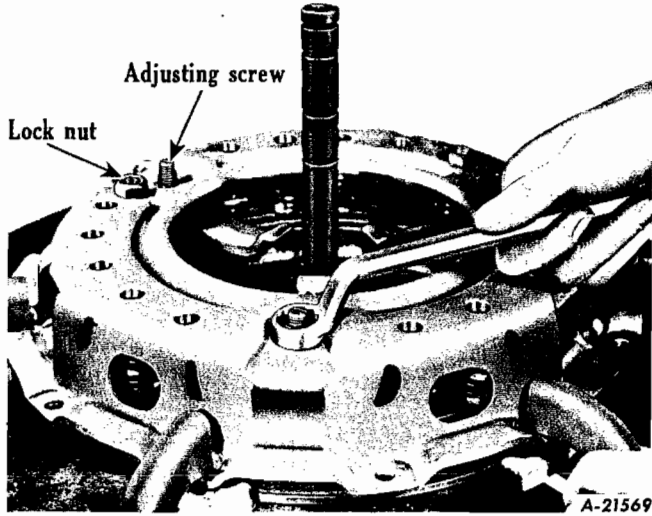


Fig. 13 - Remove adjusting screw lock nuts.

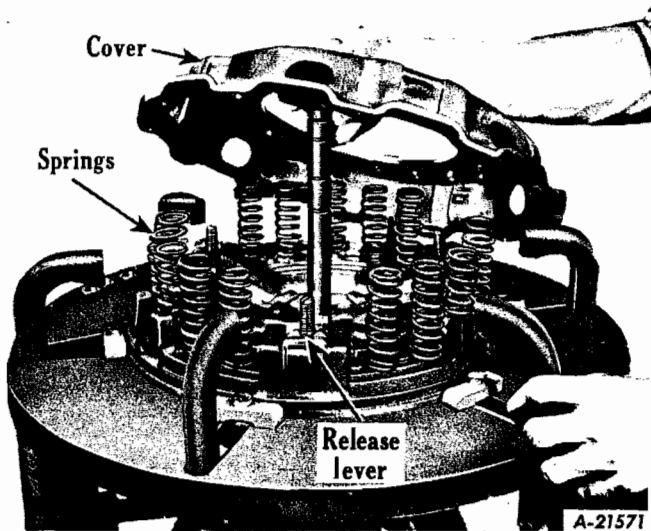


Fig. 14 - Clutch cover removed.

Remove cotter keys from release lever pins (L) and remove pins and levers (K).

A pressure plate (E) that is badly scored, checked or warped should be replaced, as it will not perform satisfactorily, and in addition, will damage the clutch driven member.

If the clutch surface on the flywheel is not smooth, the flywheel should be removed, mounted in a lathe and smoothed with emery cloth using first a coarse cloth, finishing with a fine cloth. Where the surface is extremely rough, a light cut should be taken on the flywheel with a lathe tool, finishing and polishing with emery cloth.

Clutch pressure springs (F) that have had considerable service should be replaced, as it is possible that they may have lost their original tension (see Specifications) and thus permit the clutch to slip under load. Springs that are discolored due to heat should always be replaced.

Clutch spring tester (Fig. 15) or similar unit should be used for testing springs, (F). They may also be tested by comparison with new springs. Discard those not of same length.

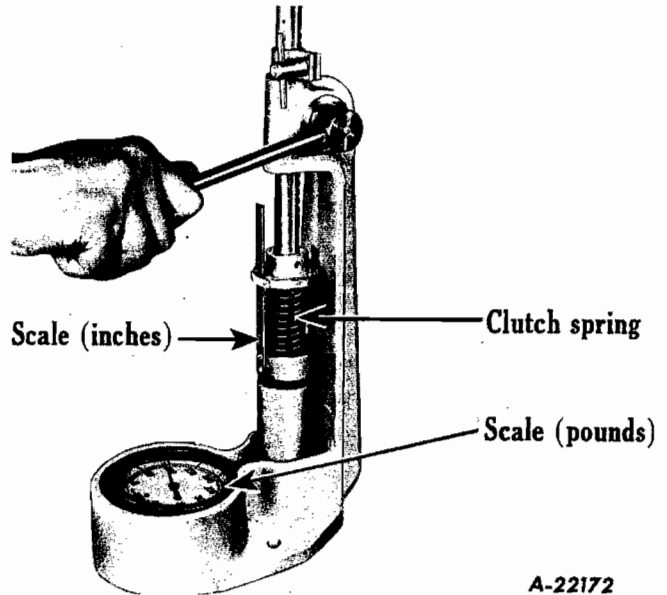


Fig. 15 - Check springs on SE-1565 Spring tester.

Release levers (K) that show considerable wear at the release bearing contact points as well as at the pivot points should be replaced, as should worn lever pins (L). The lever spring (G) should hold the lever adjusting screw (C) and pivot block (H) up firmly against the pivot points on the release levers. If this condition does not exist on the old levers, it is sufficient reason for replacement with new lever assemblies.

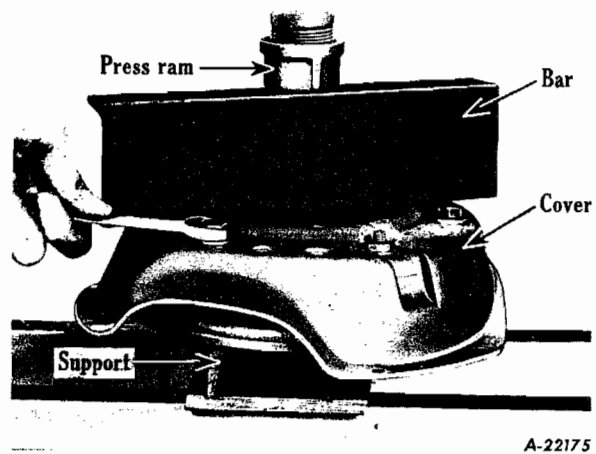


Fig. 16

When overhauling clutch assemblies, where no clutch fixture is available, the following procedure will be found helpful:

The cover and pressure plate assembly is dismantled by placing it on a drill press or arbor press with supporting blocks of

wood or metal under pressure plate. (Fig. 16.) These blocks should not extend out beyond the outside edges of the pressure plate. (E). A bar is then placed across the top of the cover assembly "D" and the drill press or arbor press arm brought down to a point where the assembly is compressed slightly. From this point on, the same procedure can be followed as used with the special type clutch overhaul fixture previously explained.

Clutch Release Levers

Hardened-steel, disc-type rollers (J) are used between the adjusting screw block (H) and lever (K) which reduces operating friction and relieves the stress on the adjusting screws (C).

Assembling The Clutch (Using Clutch Overhaul Fixture)

Place the clutch pressure plate (E) with release levers assembled to plate on top of specified spacer plate (Fig. 10 or Fig. 11). Install pressure springs (F) in position on pressure plate (Fig. 14).

Place clutch cover or back plate (D) over springs, making sure that springs (F) are seated properly both above and below, and that the adjusting screw holes in cover are directly over the clutch lever adjusting screws (C).

Draw fixture down to clutch cover or back plate (D), Fig. 12, being sure fixture arms are seated so as not to damage cover. The assembly can then be compressed slowly until the top unthreaded portion of each adjusting screw (C) can be guided by hand up through the tapped holes in cover plate (D). At this point care should be taken to see that both pressure plate (E) and cover (D) are lined up correctly, so as to permit free entry of the three drive lugs (M).

Turn each adjusting screw (C) up into cover (D) approximately five turns at a time, (turning screw driver counter clockwise) and after each five turns, compress the assembly a small amount.

The release levers (K) may now be adjusted to the correct setting as follows:

Clutch Release Lever Adjustments

The release levers (K) should be set to the dimensions shown in Figs. 1 to 5. Lever adjusting tool as shown in Fig. 17 can be used for accurate adjustment of levers. It is very important that all three levers be set exactly the same height. After levers are set to the correct height, the adjustment lock nuts (B) are installed and tightened securely. Care should be taken not to upset the adjustment when tightening the lock nuts.

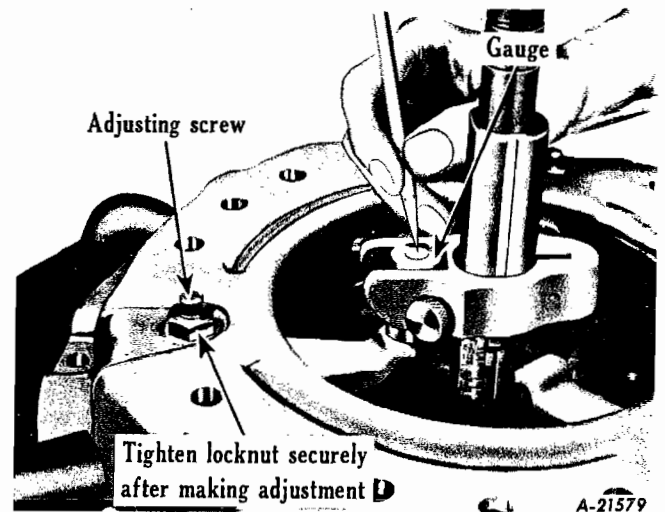


Fig. 17 - Checking lever setting.

FOR SERVICE STATIONS NOT EQUIPPED WITH OVERHAUL FIXTURE, the following procedure may be used:

Place the pressure plate with release levers assembled on supporting blocks on drill or arbor press. From this point on, same procedure as outlined in the above paragraphs may be followed.

The release levers (K) may be adjusted to correct setting as follows:

Adjust the pressure plate in relation to the clutch cover as shown (Fig. 18). Use a straight edge across the cover plate surface and, turning the capscrews a small amount at a time, secure dimension given in specifications. Recheck this operation several times to assure accurate adjustment.

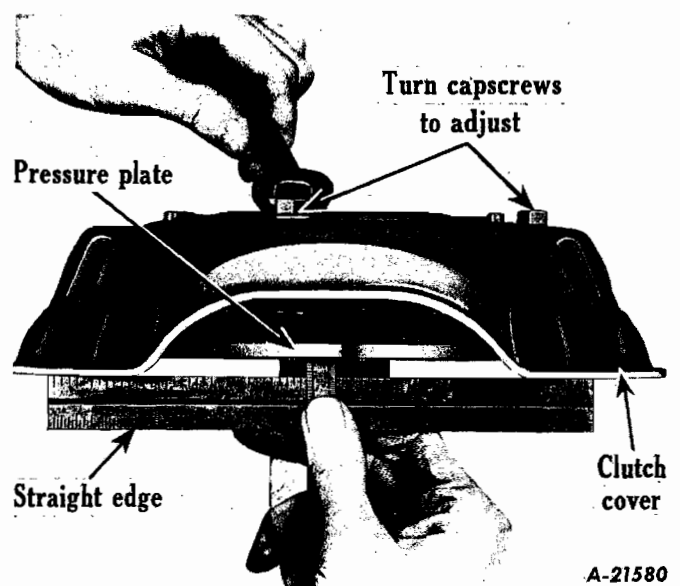


Fig. 18



The release levers are adjusted in a manner similar to that used when the "Clutch Fixture" is available. Place the clutch assembly on a flat surface and, with the adjusting screw lock nuts loose, adjust the levers to secure specified dimensions (Fig. 19). Recheck at each lever to assure accuracy.

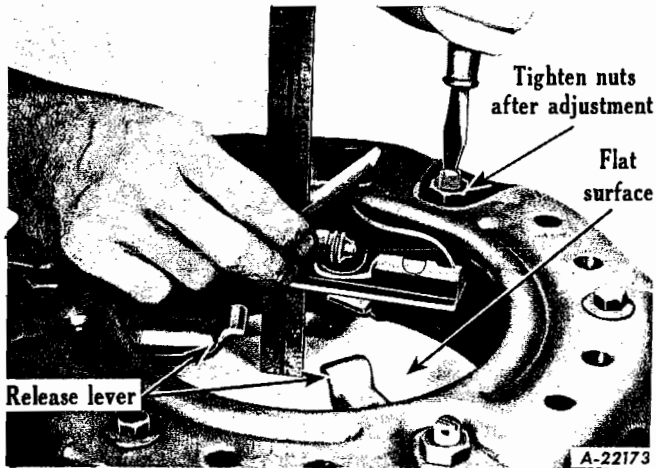


Fig. 19

Installing Clutch

Figs. 21 to 25 inclusive illustrate clutch and control installation.

When installing the clutch on flywheel in truck, care should be taken to see that the clutch driven-member is aligned properly by inserting a transmission stub shaft or aligning bar through the driven member splines and into pilot bearing. Have dampener mechanism of clutch driven member toward the transmission. **IMPORTANT:** An inspection mark or

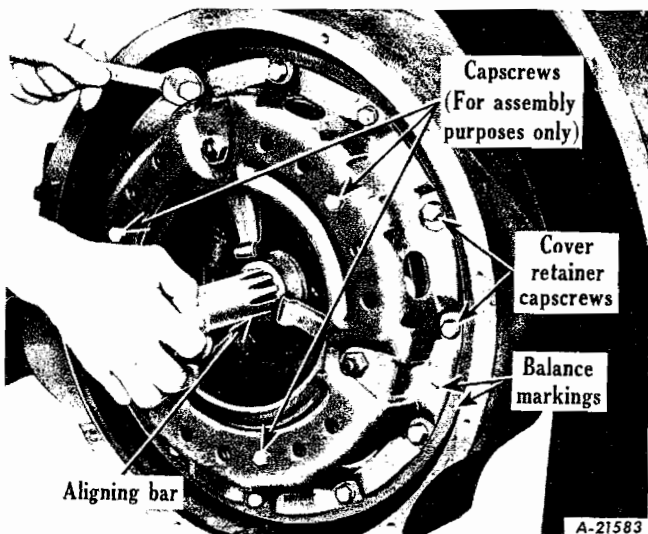


Fig. 20 - Showing use of aligning bar or shaft when assembling clutch to flywheel.

arrow is stamped on the outer flange of the clutch cover which indicates the **HEAVY** side of the clutch assembly. The clutch should be assembled to the flywheel so that this mark is adjacent to the mark "L" stamped on the flywheel which indicates the **LIGHT** side. Fig. 20.

Bolt clutch assembly to flywheel making sure that the marks on the flywheel and outer flange of clutch cover match as nearly as possible. This is important in order to maintain the correct balance of the flywheel and clutch assembly.

Remove the three cap screws (A) holding the assembly compressed. The transmission stub shaft or aligning bar is also removed, as the driven-member assembly will now be held in position by the clutch pressure plate. Care should be exercised when installing the transmission, so as not to permit the transmission to hang by the clutch shaft, which would bend the hub of clutch-driven member, creating misalignment, with resultant clutch "drag".

With transmission installed and floor boards in place, make correct pedal adjustments. Do not adjust the clutch release levers, which were previously set to the correct height and require no further adjustment during the life of the clutch-driven plate facings. Pedal adjustments only are required to maintain the recommended amount of pedal free travel. The specified pedal clearance will assure proper clearance between the clutch release bearing and release levers. (Figs. 21 to 25 incl.)

NOTE: When installing the R-15-8 clutch on the International Continental Engine flywheel, place the white paint marking on the clutch cover as close to the letter "L" (light side) on the flywheel as possible. The white dab of paint on these clutch covers indicates the heavy side of the clutch assembly.

Important

Oil and grease must be kept off the driven member facings. The clutch release bearing is lubricated at assembly and should require no further lubrication during the life of the clutch facings. If this bearing is removed for any reason it should be examined and replaced if it shows signs of lack of lubrication. The bearing and retaining sleeve are available as a unit and neither is furnished separately.



Clutch Control Adjustment

Figs. 21 to 25 inclusive illustrate the assembly of the clutch control mechanism.

The clutch pedal should have a specified amount of free movement before clutch pressure is felt. (See Specifications or Figs. 21 to 25 inclusive). The clutch release bearing will just touch the clutch release levers when the clutch pedal is depressed the above amount. If clutch pedal free movement is 1" or less, adjustment is necessary to provide adequate bearing-to-lever clearance.

As wear of the clutch facing takes place, the clutch release levers move outward, reducing the clearance between the clutch release levers and clutch release bearing. The adjustable yoke on clutch release rod provides means of adjusting the clearance.

Clutch Chatter

Clutch chatter cannot always be attributed to the type of lining being used (molded or woven). It is generally chargeable to grease or oil on the clutch facing, the source of which may be:

1. Failure to remove anti-rust grease from the flywheel and pressure plate.
2. Excessive anti-rust grease in the cover plate assembly.

When dismantling a clutch for service, the flywheel, pressure plate, and cover plate assembly should be thoroughly cleaned. If the clutch facings show evidence of lubricant, they should be replaced. It is impossible to remove oil or grease from clutch facings with solvents or by burning.

THE FOLLOWING PAGES - 10 to 14 inclusive-
ILLUSTRATE CLUTCH INSTALLATIONS

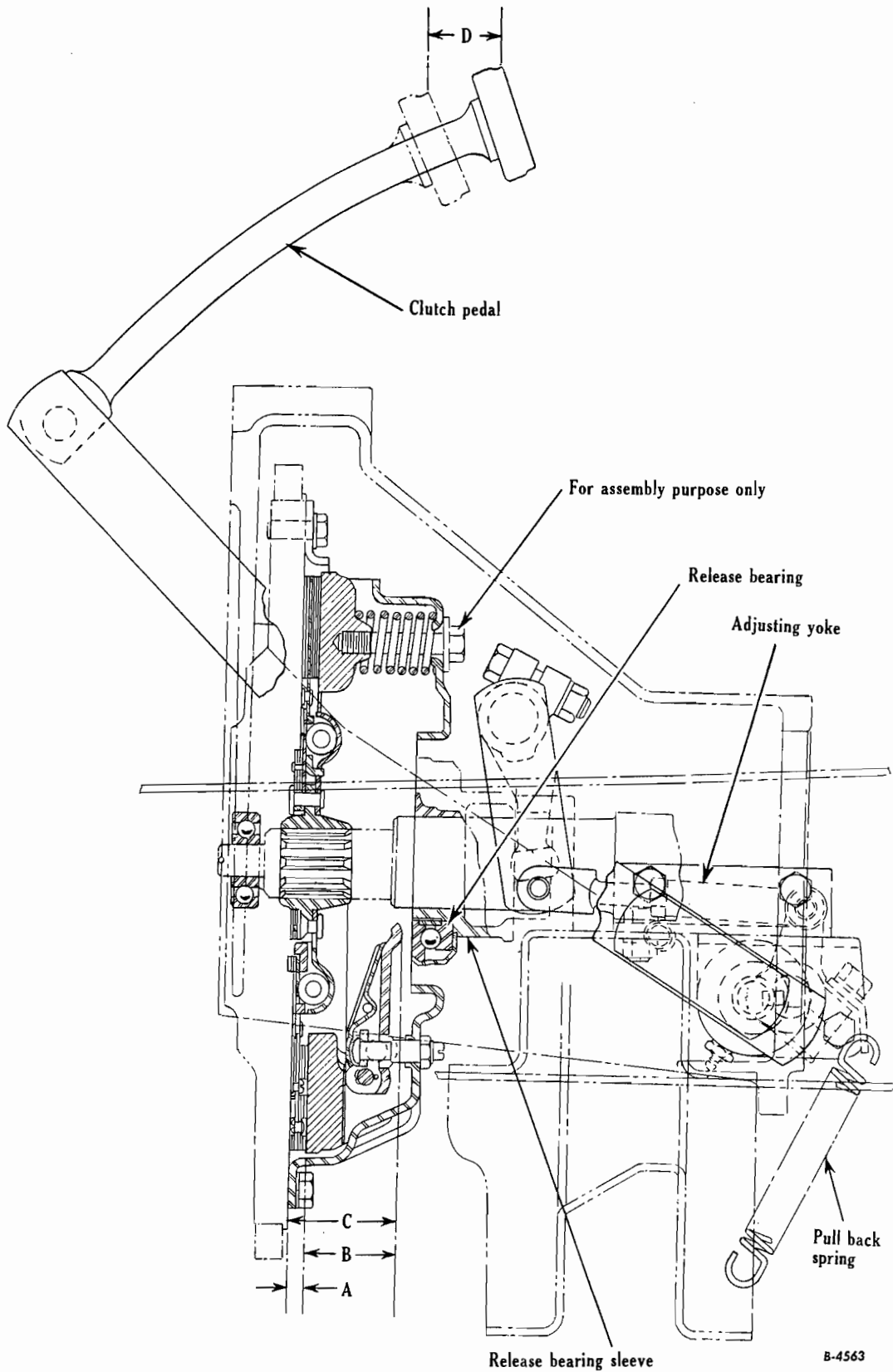
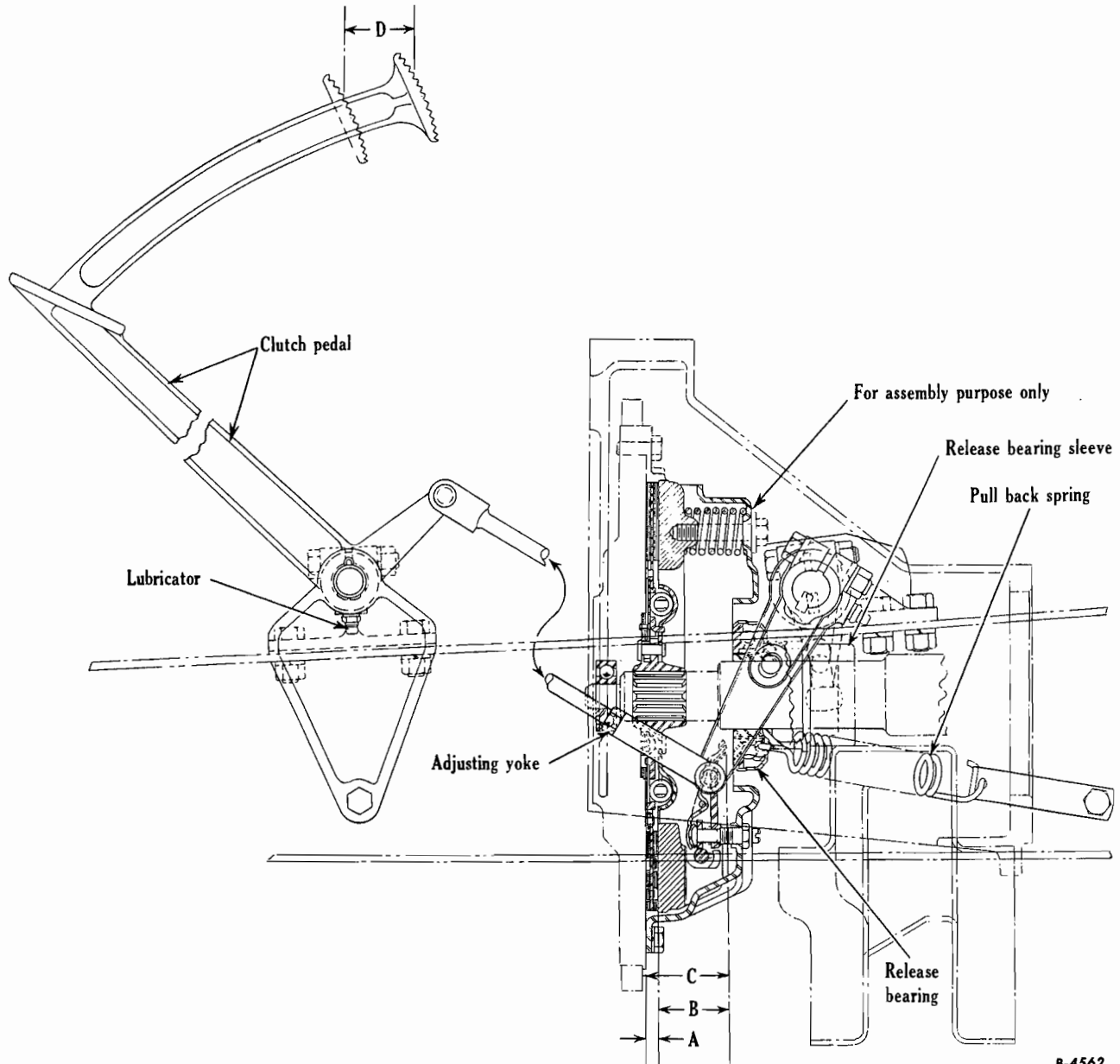


Fig. 21 - Control installation - L-110, L-120, L-130, L-150, L-153 Series.

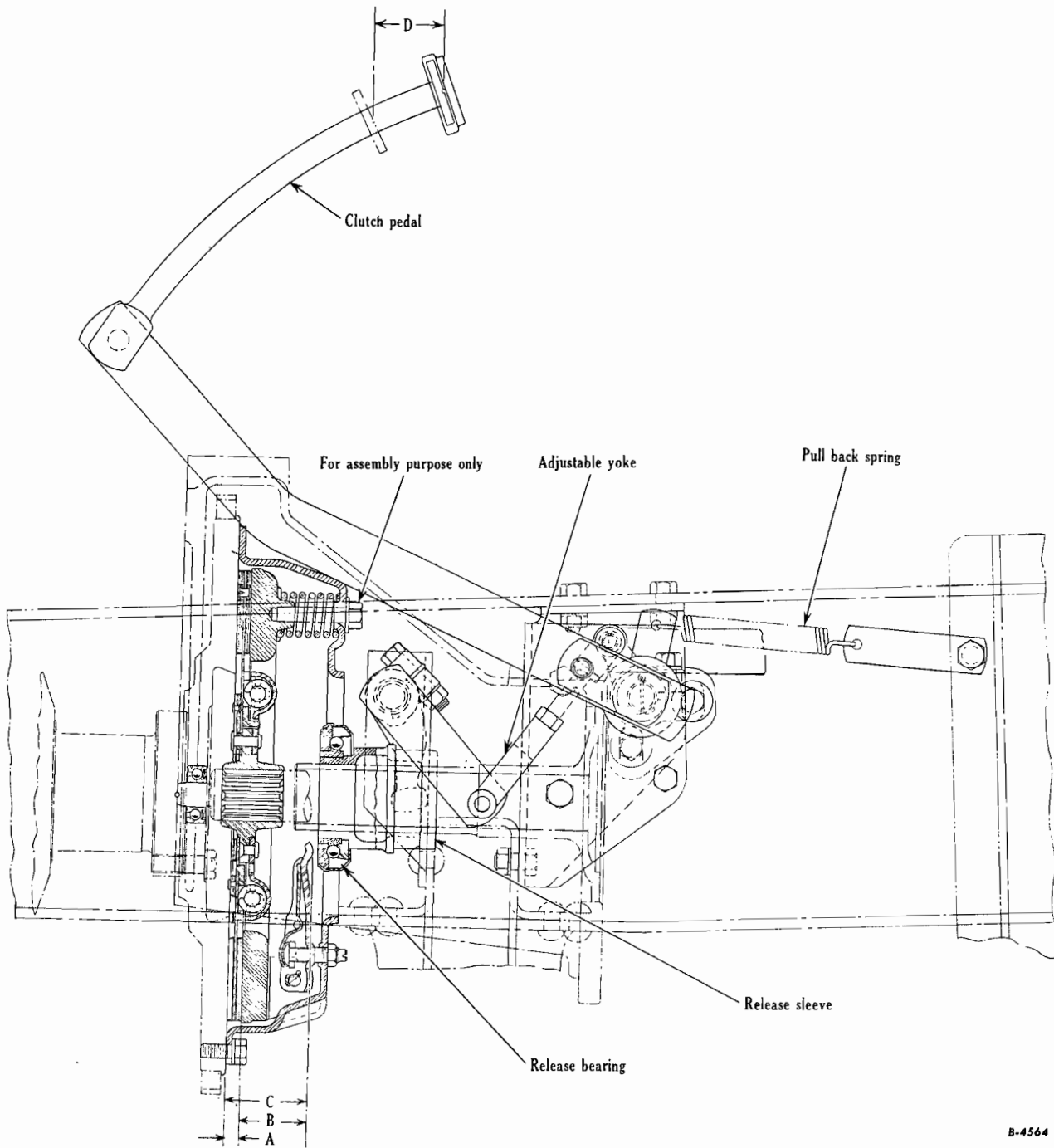
A	B	C	D
11/32"	1-15/32"	1-13/16"	1 To 1-1/2"



B-4562

Fig. 22 - Control Installation - LM-120, LM-150.

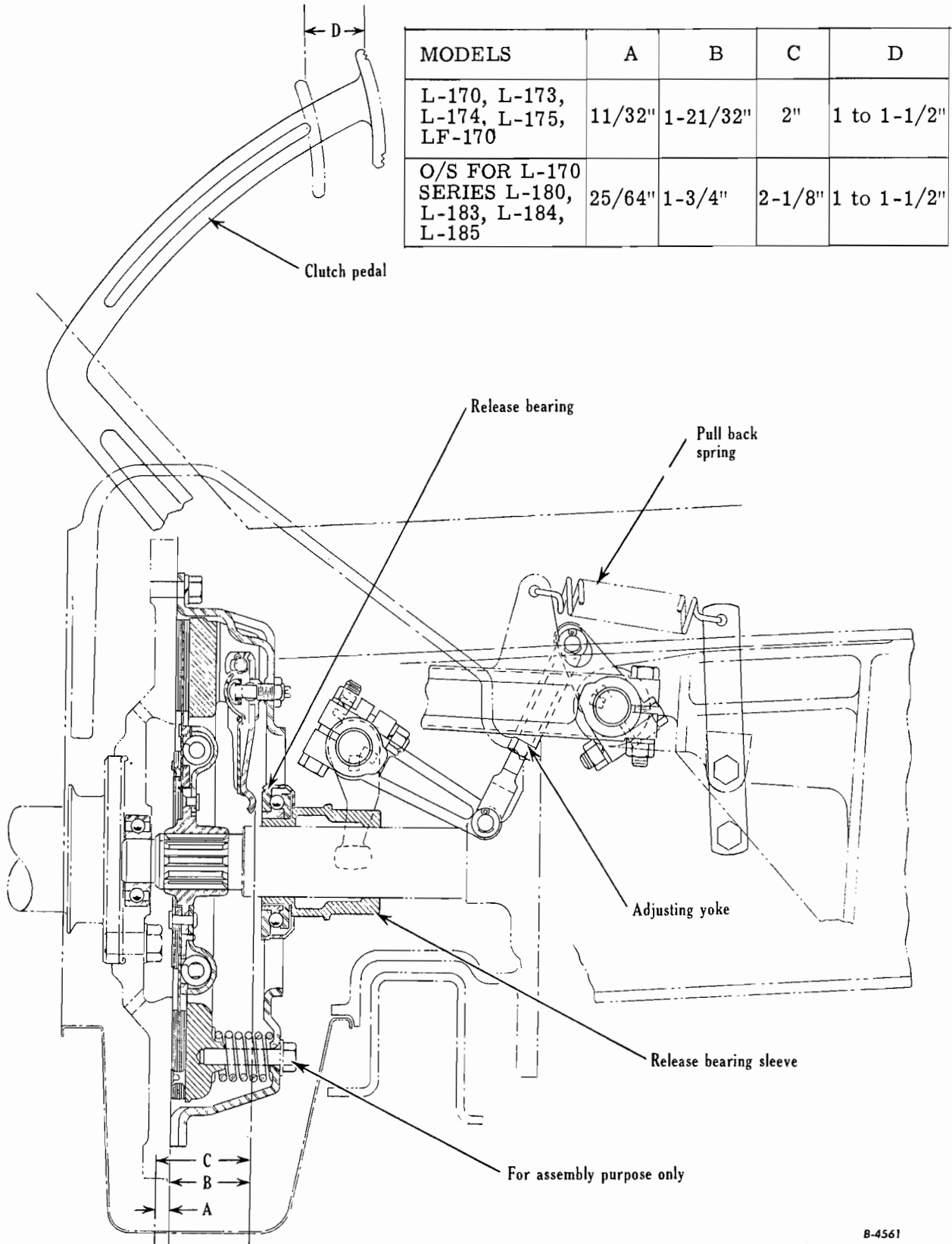
A	B	C	D
11/32"	1-15/32"	1-13/16"	1 To 1-1/2"



B-4564

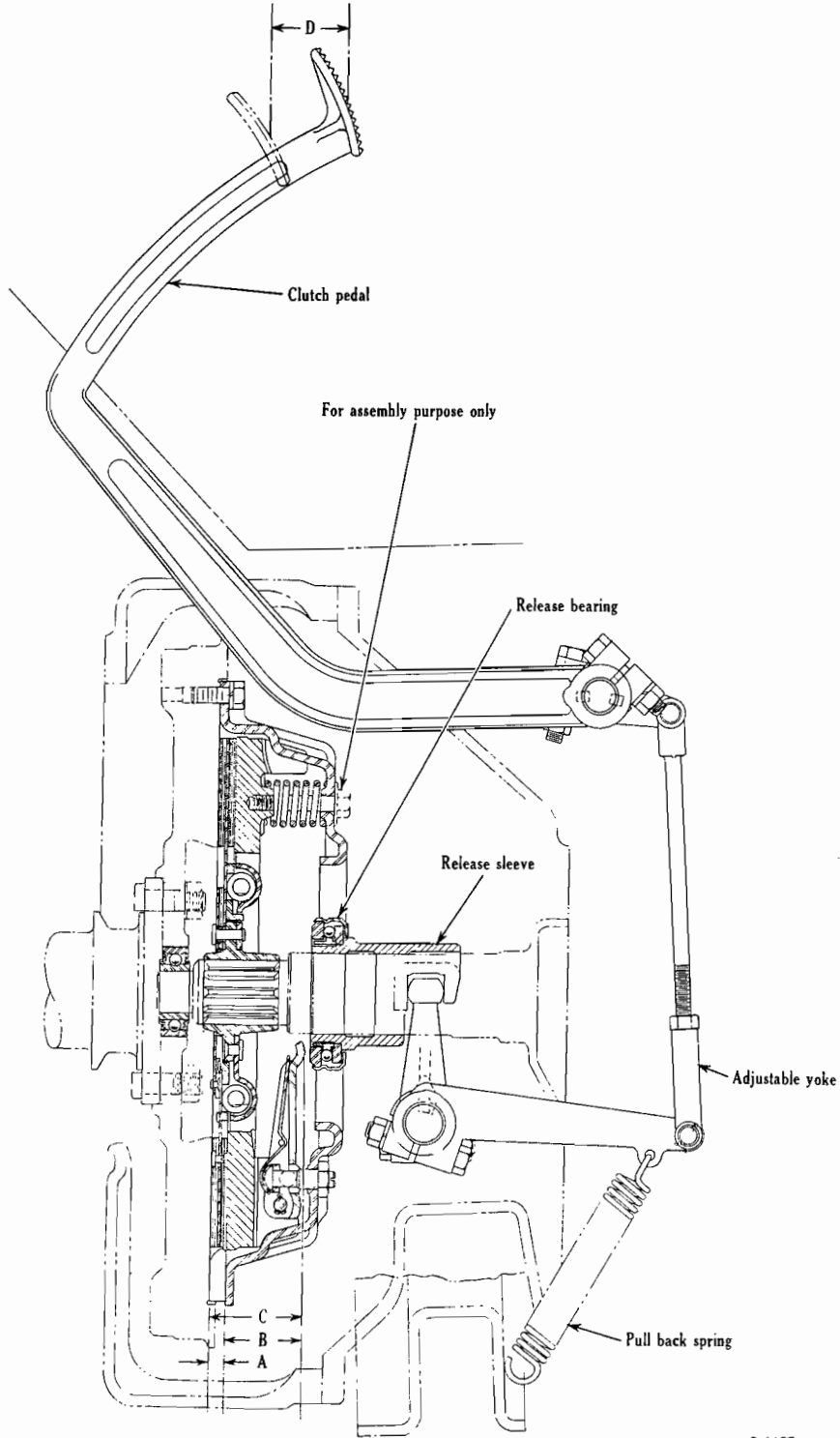
Fig. 23 - Control Installation - L-160, L-163, L-164, L-165, LC-160 Series.

A	B	C	D
11/32"	1-21/32"	2"	1 To 1-1/2"



B-4561

Fig. 24 - Control Installation - L-170, L-173, L-174, L-175, LF-170, L-180, L-183, L-184, L-185 Series.



B-4697

Fig. 25 - Control Installation - L-190, L-193, L-194, L-195, LF-190, L-200, L-204, L-205, L-210, LF-210.

MODELS	A	B	C	D
L-190, L-193, L-194	3/8"	1-3/4"	2-1/8"	1 To 1-1/2"
O/S FOR L-190, L-194 L-195, LF-190, L-200, L-204, L-205, L-210, LF-210	15/32"	2-5/32"	2-5/8"	1 To 1-1/2"



ELECTRICAL SYSTEM GROUP

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**ELECTRICAL SPECIFICATIONS
R-110 THROUGH RF-210
(NOT RA-120, RA-140)**

ENGINE MODELS	SD-220 SD-240	BD-269 BD-282	RD-372 RD-406 RD-450
GENERATOR (Delco-Remy)	DR-1100019	DR-1102785	DR-1102785
Field current (at 6 volts) amperes	1.85-2.03	1.90-2.05	1.90-2.05
Cold output: - Amperes Volts R.P.M.	35 8 2650	45 8 2450	45 8 2450
Hot output: - Amperes { Controlled Volts by current R.P.M. regulator } . . . . .	. . . . .	. . . . .	. . . . .
Regulation.	volt. and current	volt. and current	volt. and current
Brush tension (ounces)	28	28	28
Bearing - commutator end	bronze	bronze	bronze
Bearing - drive end	ball	ball	ball
Rotation (viewed from drive end).	CW	CW	CW
Type of drive.	belt	belt	belt

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R-LINE MOTOR TRUCK SERVICE

ELECTRICAL
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ELECTRICAL SPECIFICATIONS
RA-120, RA-140

ENGINE MODEL	SD-220
GENERATOR (LOW SPEED CUT-IN) (Delco-Remy)	DR-1105876
Field current (at 6 volts) amperes.	1.62-1.82
Cold output: - Amperes Volts	25 8.0
Hot output: - Amperes { Controlled Volts { by current R.p.m. { regulator } . . . . .	. . . . . . . . . . . . . . .
Regulation. . . . .	. . . . .
Brush tension (ounces)	28
Bearing - commutator end.	ball
Bearing - drive end	ball
Rotation (viewed from drive end).	CW
Type of drive.	belt



ELECTRICAL SPECIFICATIONS
R-110 THRU RF-210
(NOT RA-120, RA-140)

ENGINE MODELS	SD-220 SD-240	BD-269 BD-282	RD-372 RD-406 RD-450
VOLTAGE REGULATOR (Delco-Remy)	DR-1118731	DR-1118732	DR-1118732
Amps	35	45	45
Type	vibrating	vibrating	vibrating
Current regulator: - *Current setting-amps. (hot) . . Air gap.	38 .075"	47 .075"	47 .075"
Voltage regulator: - *Voltage setting-volts. (hot) . . . Air gap.	7.4 .075"	7.4 .075"	7.4 .075"
Cutout relay: - *Closing voltage-volts. (hot) . . Air gap. Point opening.	6.4 .020" .020"	6.4 .020" .020"	6.4 .020" .020"

ENGINE MODEL	SD-220 (RA-120; RA-140)
VOLTAGE REGULATOR-25 AMP. LOW SPEED CUT-IN (Delco-Remy)	DR-1118350
Type	vibrating
Current regulator: - *Current setting-amps. (hot) . . Air gap.	25 .075"
Voltage regulator: - *Voltage setting-volts (hot) . . . Air gap.	7.2 .075"
Cutout relay: - *Closing voltage-volts (hot) . . . Air gap. Point opening.	6.4 .020" .020"

* Current and voltage specifications apply only at operating temperature. Operating temperature shall be assumed to exist after not less than 15 minutes of continuous operation with a charge rate of 8-10 amperes.

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RLINE MOTOR TRUCK SERVICE

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ELECTRICAL SPECIFICATIONS
R-170 and RF-170 Series, R-180 thru 184, RC-180, 181, 182

ENGINE MODEL	BD-282
STARTING MOTOR (Delco-Remy)	DR-1108009
Voltage.	6
Number of field coils	4
Bearing - commutator end.	cast iron
Bearing - center	bronze
Bearing - drive end	bronze
Brush tension (ounces)	24-28
No-load test (with Solenoid or Magnetic Switch): -	
Maximum amperes.	70
Volts	5.65
R.p.m. approx	5500
Lock test: -	
Maximum amperes.	570
Volts	3.15
Torque (lb. ft.) (min.)	13.5
Rotation (viewed from drive end).	CW
ENGINE MODEL	BD-282
DISTRIBUTOR (Delco-Remy)	DR-1112359
Initial setting (engine degrees)	6° B.T.C.





ELECTRICAL SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	Cont. R-6602	
COIL (Delco-Remy)	DR-1115327	DR-1115327	DR-1115327	DR-1115327	DR-1115327	DR-1115327	DR-1115251	
DISTRIBUTOR	DR-1112355	DR-1112355	DR-1112359	DR-1112357	DR-1112357	DR-1112357	automatic CCW	
Type	vac. auto	vac. auto	automatic	automatic	automatic	automatic		
Cam angle.	31°-37°	31°-37°	35°	35°	35°	35°		
Initial setting (engine degrees) . .	2° BTC	2° BTC	3° BTC	5° BTC	5° BTC	5° BTC		
Vacuum advance (engine degrees)	15°	15°	none	none	none	none		
Automatic advance (engine degrees)	30°	30°	27°	22°	22°	22°		
Total advance (engine degrees) . .	32°	32°	30°	27°	27°	27°		
Retard (engine degrees)	{ selective 20°	selective 20°	none none	none none	none none	none none		
Contact point setting . . . . .	.022"	.022"	.018-.024	.018-.024	.018-.024	.018-.024	
Contact point pressure (ounces) .	17-21	17-21	17-21	17-21	17-21	17-21		
Rotation (viewed from top)	CCW	CCW	CW	CW	CW	CW		
Firing order	153624	153624	153624	153624	153624	153624		
*DISTRIBUTOR TEST DATA								
Start advance:-								
Engine r.p.m.	500	500	400	500	500	500		
Engine degrees	2°	2°	1.5°	1.5°	1.5°	1.5°		
Intermediate advance:-								
Engine r.p.m.	1800	1800	1800	1400	1400	1400		
Engine degrees	20°	20°	20°	13°	13°	13°		
Maximum advance:-								
Engine r.p.m.	3000	3000	2700	**3200	**3200	**3200		
Engine degrees	30°	30°	27°	22°	22°	22°		
Distributor vacuum control (Delco-Remy)	DR-1116049	DR-1116049	

* Distributor Test Stand figures will be one-half of these specifications.
 ** Test Stand r.p.m. only. For maximum engine r.p.m. see "Engine Section."

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L-LINE MOTOR TRUCK SERVICE MANUAL

ELECTRICAL SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	Cont. R-6602
GENERATOR-50 AMP. (Delco-Remy)	DR-1106757	DR-1106757	DR-1106757	DR-1106757	DR-1106757	DR-1106757	DR-1106822
Field current (at 6 volts) amperes	1.70-1.95	1.70-1.95	1.70-1.95	1.70-1.95	1.70-1.95	1.70-1.95	
Cold output:-							
Amperes	50	50	50	50	50	50	50
Volts	7.5	7.5	7.5	7.5	7.5	7.5	7.5
R.p.m.	1410	1410	1410	1410	1410	1410	
Hot output:-							
Amperes } Controlled { . . . . .	.....	.....	.....	.....	.....	.....	.....
Volts } by current { . . . . .	.....	.....	.....	.....	.....	.....	.....
R.p.m. } regulator { . . . . .	.....	.....	.....	.....	.....	.....	.....
Regulation	{ volt. and current	{ volt. and current	{ volt. and current	{ volt. and current	{ volt. and current	{ volt. and current	{ volt. and current
Brush tension (ounces)	25	25	25	25	25	25	
Bearing - commutator end	ball	ball	ball	ball	ball	ball	
Bearing - drive end	ball	ball	ball	ball	ball	ball	
Rotation (viewed from drive end).	CW	CW	CW	CW	CW	CW	
Type of drive	belt	belt	belt	belt	belt	belt	belt
GENERATOR (LOW SPEED CUT-IN) (Delco-Remy)	DR-1106758	DR-1106758	.....	.....	.....	.....	.....
Field current (at 6 volts) amperes	1.70-1.95	1.70-1.95	.....	.....	.....	.....	.....
Cold output:-							
Amperes	40	40	.....	.....	.....	.....	.....
Volts	7.5	7.5	.....	.....	.....	.....	.....
R.p.m.	1165	1165	.....	.....	.....	.....	.....
Hot output:-							
Amperes } Controlled { . . . . .	.....	.....	.....	.....	.....	.....	.....
Volts } by current { . . . . .	.....	.....	.....	.....	.....	.....	.....
R.p.m. } regulator { . . . . .	.....	.....	.....	.....	.....	.....	.....
Regulation	{ volt. and current	{ volt. and current	.....	.....	.....	.....	.....
Brush tension (ounces)	20	20	.....	.....	.....	.....	.....
Bearing - commutator end	ball	ball	.....	.....	.....	.....	.....
Bearing - drive end	ball	ball	.....	.....	.....	.....	.....
Rotation (viewed from drive end).	CW	CW	.....	.....	.....	.....	.....
Type of drive	belt	belt	.....	.....	.....	.....	.....

ELECTRICAL SYSTEM Specifications Page 2

L-LINE MOTOR TRUCK SERVICE MANUAL





ELECTRICAL SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	Cont. R-6602
GENERATOR-30 AMP. (Delco-Remy)	DR-1102714	DR-1102714	DR-1102714	DR-1102714	DR-1102714	DR-1102714	. . . . .
Field current (at 6 volts) amperes	1.75-1.90	1.75-1.90	1.75-1.90	1.75-1.90	1.75-1.90	1.75-1.90	. . . . .
Cold output:-							
Amperes	30	30	30	30	30	30	. . . . .
Volts	8	8	8	8	8	8	. . . . .
R.p.m.	1750	1750	1750	1750	1750	1750	. . . . .
Hot output:-							
Amperes } Controlled { . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Volts } by current { . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
R.p.m. } regulator { . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Regulation	volt. and current	volt. and current	volt. and current	volt. and current	volt. and current	volt. and current	. . . . .
Brush tension (ounces)	24-28	24-28	24-28	24-28	24-28	24-28	. . . . .
Bearing - commutator end	bronze	bronze	bronze	bronze	bronze	bronze	. . . . .
Bearing - drive end	ball	ball	ball	ball	ball	ball	. . . . .
Rotation (viewed from drive end).	CW	CW	CW	CW	CW	CW
Type of drive	belt	belt	belt	belt	belt	belt

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ELECTRICAL SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	Cont. R-6602
VOLTAGE REGULATOR-30 AMP. (Delco-Remy)	DR-1118303	DR-1118303	DR-1118303	DR-1118303	DR-1118303	DR-1118303	. . . . .
Type	vibrating	vibrating	vibrating	vibrating	vibrating	vibrating	. . . . .
Current regulator:-							
*Current setting-amps. (hot) . .	30	30	30	30	30	30	. . . . .
Air gap. . . . .	.075"	.075"	.075"	.075"	.075"	.075"	. . . . .
Voltage regulator:-							
*Voltage setting-volts (hot) . . .	7.4	7.4	7.4	7.4	7.4	7.4	. . . . .
Air gap. . . . .	.075"	.075"	.075"	.075"	.075"	.075"	. . . . .
Cutout relay:-							
*Closing voltage-volts (hot) . . .	6.4	6.4	6.4	6.4	6.4	6.4	. . . . .
Air gap. . . . .	.020"	.020"	.020"	.020"	.020"	.020"	. . . . .
Point opening. . . . .	.020"	.020"	.020"	.020"	.020"	.020"	. . . . .
VOLTAGE REGULATOR-50 AMP. HIGH OUTPUT (Delco-Remy).	DR-1118333	DR-1118333	DR-1118333	DR-1118333	DR-1118333	DR-1118333	DR-1118368
Type	vibrating	vibrating	vibrating	vibrating	vibrating	vibrating	vibrating
Current regulator:-							
*Current setting-amps. (hot) . .	50	50	50	50	50	50	50
Air gap. . . . .	.082"	.082"	.082"	.082"	.082"	.082"	.075"
Voltage regulator:-							
*Voltage setting-volts (hot) . . .	7.4	7.4	7.4	7.4	7.4	7.4	14.3
Air gap. . . . .	.075"	.075"	.075"	.075"	.075"	.075"	.075"
Cutout relay:-							
*Closing voltage-volts (hot) . . .	6.4	6.4	6.4	6.4	6.4	6.4	12.8
Air gap. . . . .	.020"	.020"	.020"	.020"	.020"	.020"	.020"
Point opening. . . . .	.020"	.020"	.020"	.020"	.020"	.020"	.020"
VOLTAGE REGULATOR-40 AMP. LOW SPEED CUTIN (Delco- Remy)	DR-1118366	DR-1118366	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Type	vibrating	vibrating	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Current regulator:-							
*Current setting-amps. (hot) . .	40	40	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Air gap. . . . .	.075"	.075"	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Voltage regulator:-							
*Voltage setting-volts (hot) . . .	7.4	7.4	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Air gap. . . . .	.075"	.075"	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Cutout relay:-							
*Closing voltage-volts (hot) . . .	6.4	6.4	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Air gap. . . . .	.020"	.020"	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Point opening. . . . .	.020"	.020"	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .

* Current and voltage specifications apply only at operating temperature. Operating temperature shall be assumed to exist after not less than 15 minutes of continuous operation with a charge rate of 8-10 amperes.

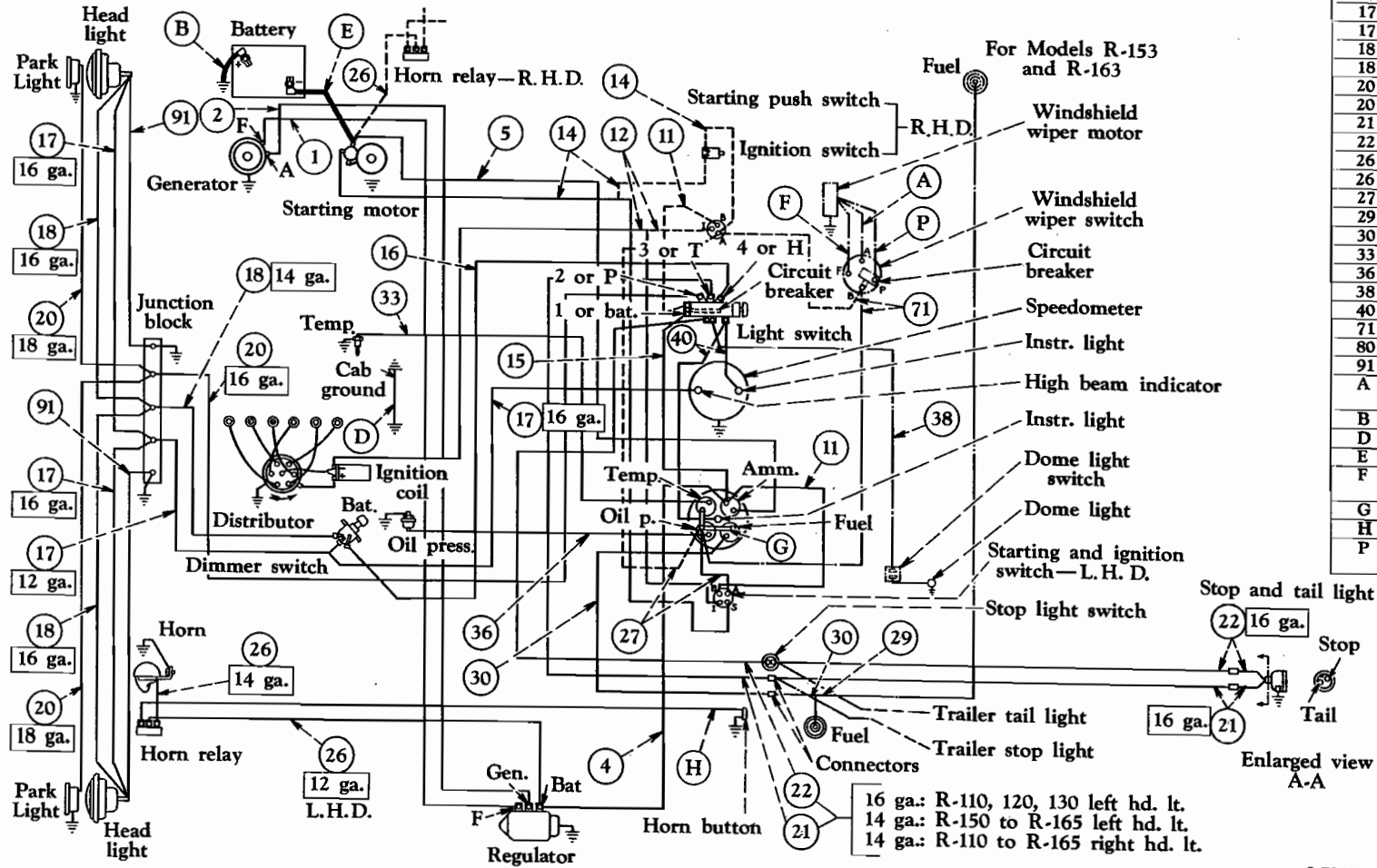


ELECTRICAL SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	Cont. R-6602
SPARK PLUGS							
AC	"standard" { pro-duc- tion ..	44 Com.	44 Com.	45 Com.	43 Com.	43 Com.	82 Com.
Champion		J-7	J-7	J-8	J-6	J-6	5 Com.
Auto-Lite		AN5	AN5	AN7	AN5	AN5	BT4
AC	"hot" { moderate service ..	45 Com.	45 Com.	45 Com.	44 Com.	44 Com.	.....
Champion		J-8	J-8	J-8	J-7	J-7	.....
Auto-Lite		AN7	AN7	AN7	AN7	AN7	.....
AC	"standard" { heavy service ..	44 Com.	44 Com.	45 Com.	43 Com.	43 Com.	82 Com.
Champion		J-7	J-7	J-8	J-6	J-6	5 Com.
Auto-Lite		AN5	AN5	AN7	AN5	AN5	BT4
AC	"cold" { severe service ..	43 Com.	43 Com.	44 Com.	43 Com.	43 Com.	.....
Champion		J-6	J-6	J-7	J-6	J-6	.....
Auto-Lite		AN5	AN5	AN5	AN5	AN5	.....
Spark plug size	14 mm	14 mm	14 mm	14 mm	14 mm	14 mm	18 mm
Spark plug gap	.028-.032	.028-.032	.028-.032	.028-.032	.028-.032	.028-.032	.023-.027
STARTING MOTOR (Delco-Remy)							
Voltage	DR-1107074	DR-1107074	DR-1107967	DR-1108217	DR-1109004	DR-1109004	.....
Number of field coils	6	6	6	6	6	6	12
Bearing - commutator end	2	2	4	4	6	6	6
Bearing - center	cast iron	cast iron	cast iron	cast iron	cast iron	cast iron	bronze
Bearing - drive end	.....	.....	.....	cast iron	cast iron	cast iron	.....
Brush tension (ounces)	bronze	bronze	bronze	bronze	bronze	bronze	bronze
No-load test (with Solenoid or Magnetic Switch):-	24-28	24-28	24-28	24-28	36-40	36-40	36-40
Maximum amperes	75	75	60	70	70	70	65
Volts	5.7	5.7	5.0	5.0	5.7	5.7	11.4
R.p.m. approx.	5000	5000	6000	3500	2200	2200	6000
Lock test:-							
Maximum amperes	525	525	600	600	600	600	725
Volts	3.4	3.4	3.0	3.0	3.0	3.0	5.0
Torque (lb.ft.)(min.)	12	12	15	22	35	35	44
Rotation (viewed from drive end).	CW	CW	CW	CW	CW	CW	CW
MAGNETIC SWITCH (Delco-Remy)							
Current consumption (at 6 volts).	DR-1465	DR-1465	DR-1465	DR-1465	DR-1465	DR-1465
	5.7-7.0	5.7-7.0	5.7-7.0	5.7-7.0	5.7-7.0	5.7-7.0

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Circuit No. or Index Letter	Cable Gauge	Cable Color or Description
1	16	Generator field
2	8	Generator arm.
4	8	Regulator to amm.
5	8	Ammeter feed
11	12	Ignition switch feed
12	16	Ign. sw. to ign. coil
14	16	Starting
15	12	Light switch feed
16	12	Dimmer switch feed
17	12	H. B. feed
17	16	H. B. head lt. leads
17	16	H. B. indicator
18	14	L. B. feed
18	16	L. B. head lt. leads
20	16	Parking feed
20	18	Parking light leads
21	14x16	Tail light
22	14x16	Stop light
26	14	Horn to relay
26	12	Horn relay feed
27	16	Instrument feed
29	18	Fuel gauge
30	18	Fuel gauge
33	18	Temperature gauge
36	18	Oil pressure gauge
38	18	Dome light
40	16	Instrument lights
71	16	Instr. light
80	16	Ignition coil to dist.
91	16	Head light ground
A	16	Nat. with cir. letter "A" or black (wiper)
B	4	Battery ground
D	12	Cab ground
E	1	Battery cable
F	16	Nat. with cir. letter "F" or red (wiper)
G	14	Instrument bus bar
H	16	Horn push button
P	16	Nat. with cir. letter "p" or green (wiper)

Fig. 1 - Wiring circuit diagram. (R-110, R-120, R-130, R-150, R-160 series trucks)

B-7166



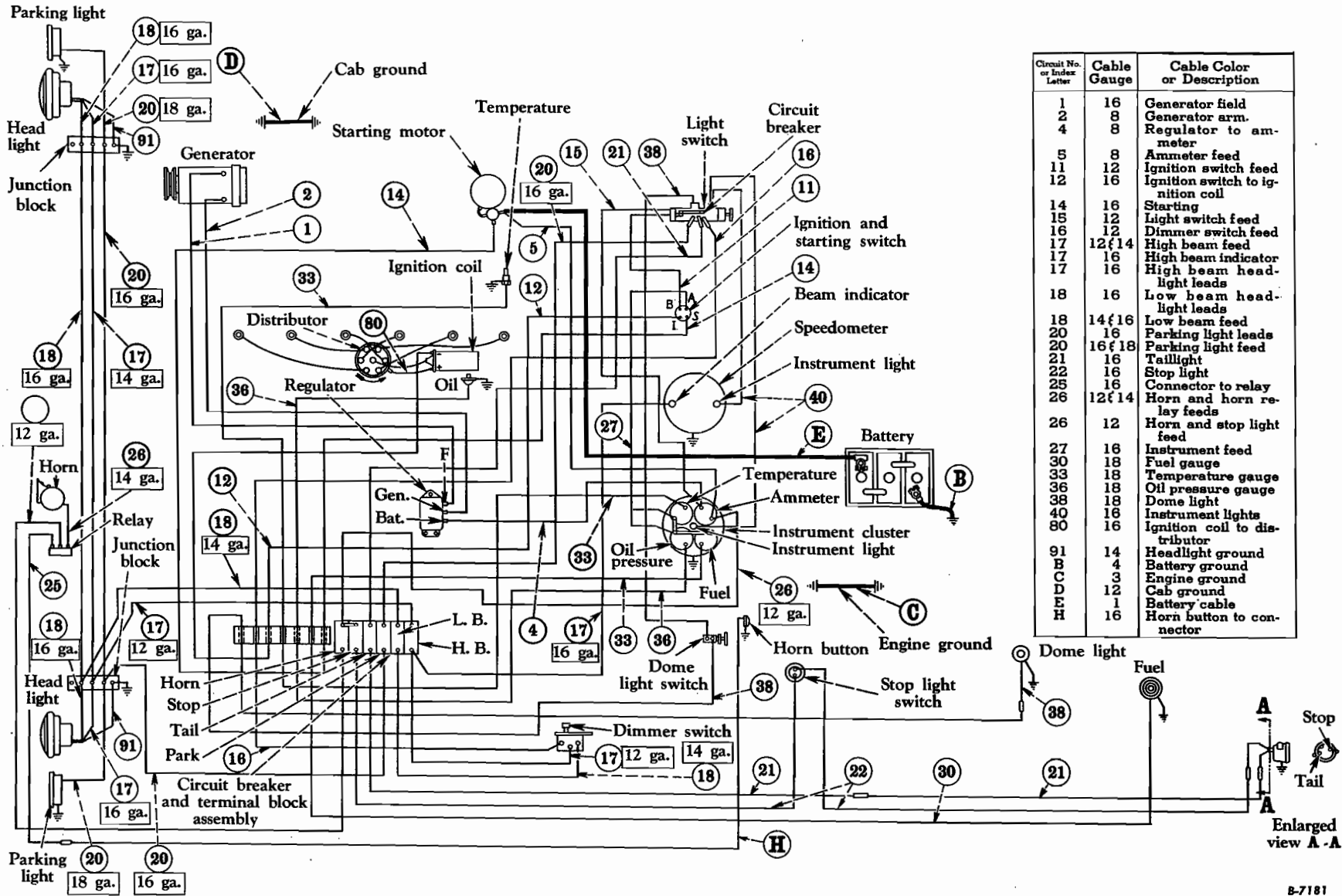
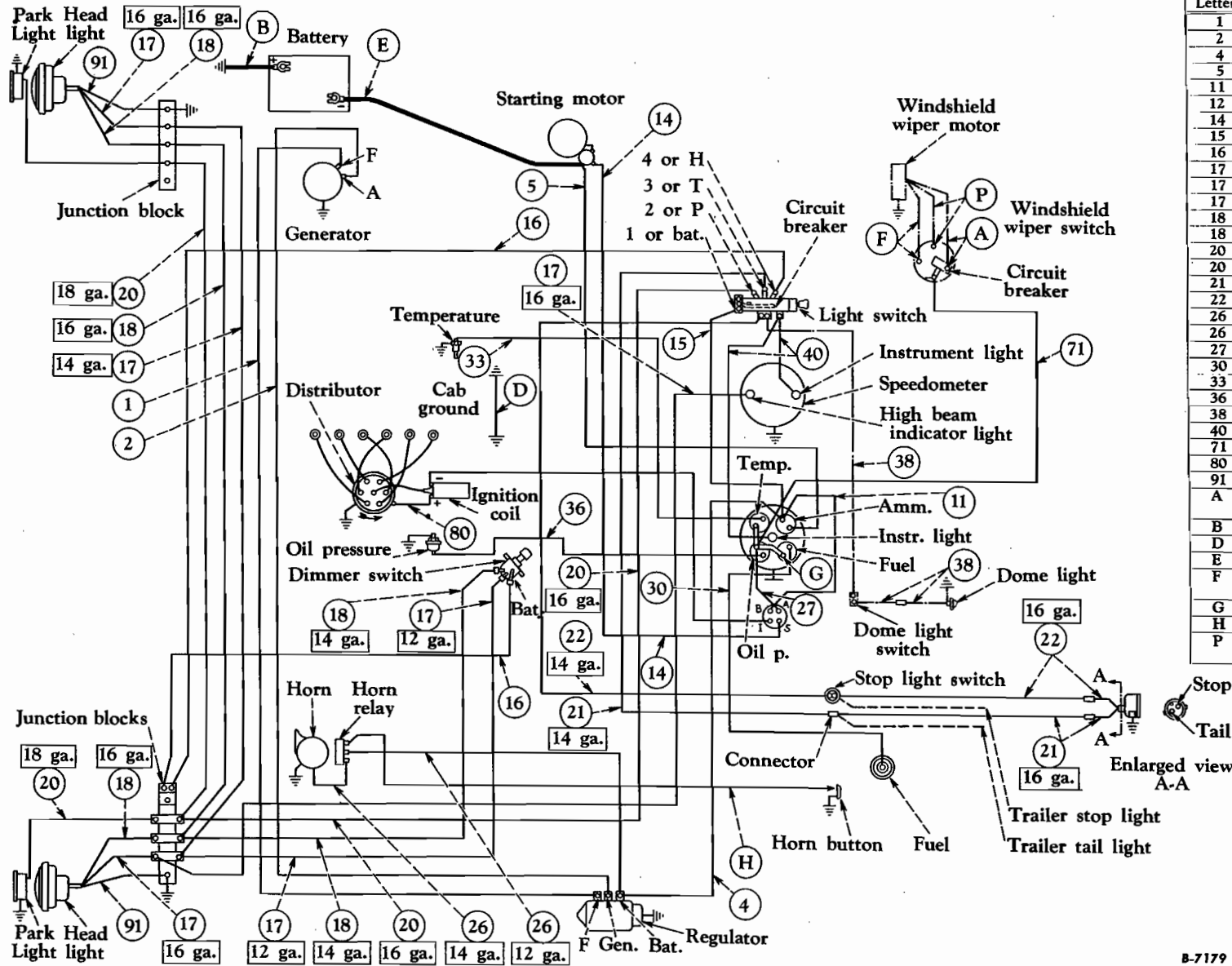


Fig. 2 - Wiring circuit diagram. (RM-120, RM-150 series trucks)

8-7181



CTS-12-MARCH 1953 (Supplemental pages for CTS-11)



Circuit No. or Index Letter	Cable Gauge	Cable Color or Description
1	16	Generator field
2	8	Generator arm.
4	8	Regulator to amm.
5	8	Ammeter feed
11	12	Ignition switch feed
12	16	Ign. sw. to ign. coil
14	16	Starting
15	12	Light switch feed
16	12	Dimmer switch feed
17	12x14	H. B. feed
17	16	H. B. head lt. leads
17	16	H. B. indicator
18	14x16	L. B. feed
18	16	L. B. head lt. leads
20	16x18	Parking feed
20	18	Parking light leads
21	14x16	Tail light
22	14x16	Stop light
26	14	Horn lead
26	12	Horn relay feed
27	16	Instrument feed
30	18	Fuel gauge
33	18	Temperature gauge
36	18	Oil pressure gauge
38	18	Dome light
40	16	Instrument lights
71	16	Wiper switch feed
80	16	Ignition coil to dist.
91	16	Head light ground
A	16	Nat. with cir. letter "A" or black (wiper)
B	4	Battery ground
D	12	Cab ground
E	1	Battery cable
F	16	Nat. with cir. letter "F" or red (wiper)
G	14	Instrument bus bar
H	16	Horn push button
P	16	Nat. with cir. letter "P" or green (wiper)

Fig. 3 - Wiring circuit diagram. (RC-160 series trucks)

B-7179

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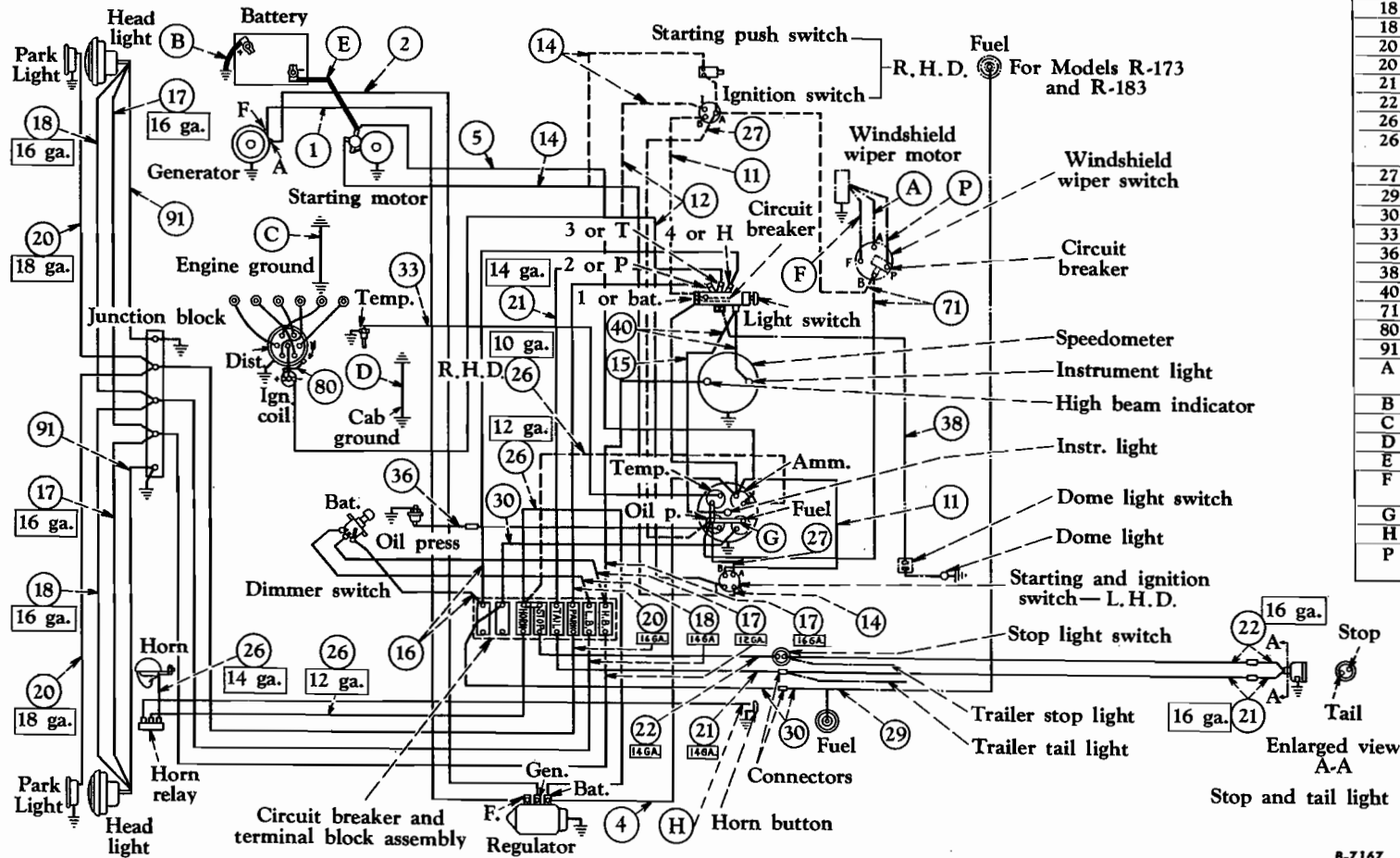
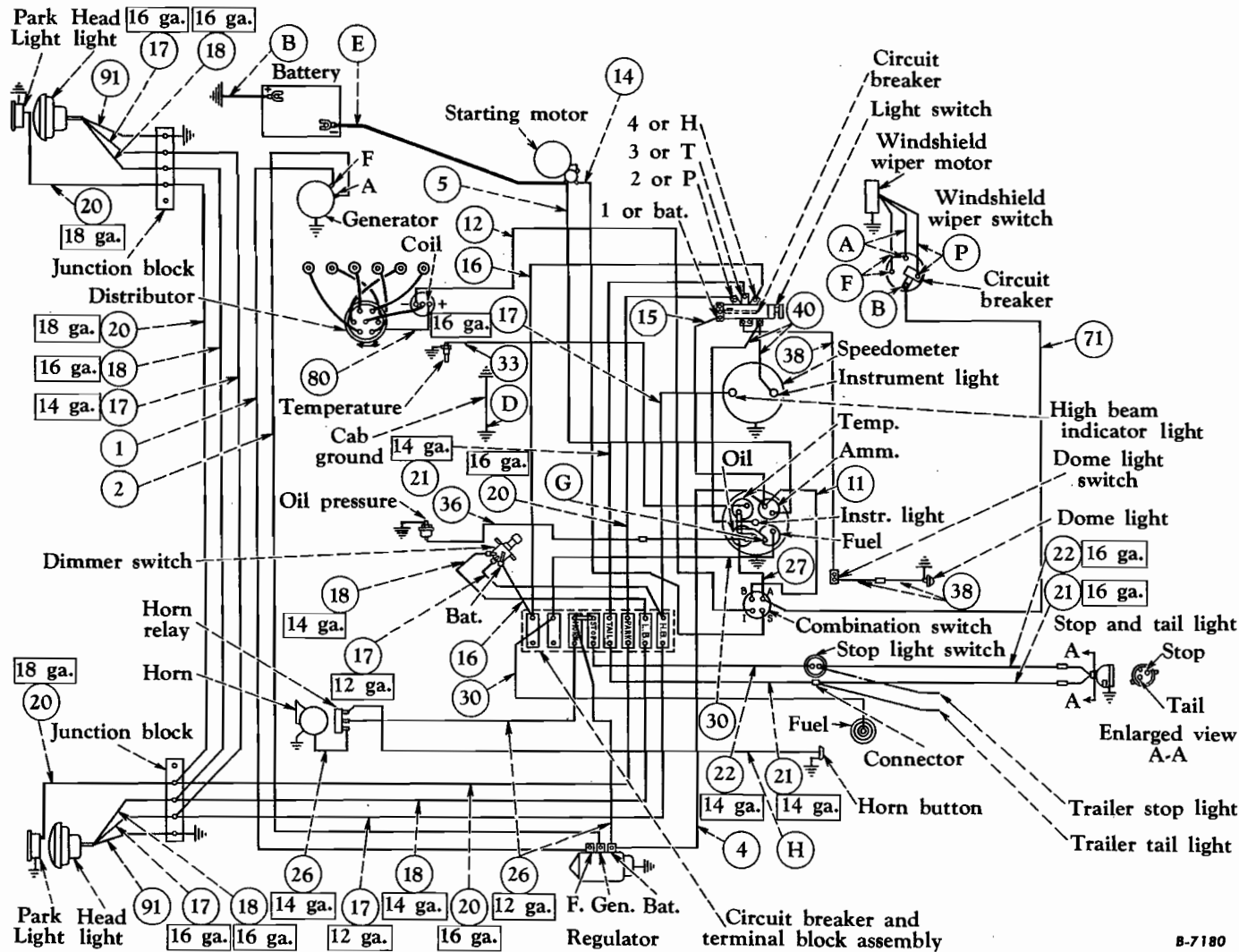


Fig. 4 - Wiring circuit diagram. (R-170, RF-170, R-180 series trucks-not R-185)

B-7167



CTS 12-MARCH 1953 (Supplemental pages for CTS-11).



Circuit No. or Index Letter	Cable Gauge	Cable Color or Description
1	16	Generator field
2	8	Generator arm.
4	8	Regulator to amm.
5	8	Ammeter feed
11	12	Ignition switch feed
12	16	Ign. sw. to ign. coil
14	16	Starting
15	12	Light switch feed
16	12	Dimmer switch feed
17	12x14	H. B. feed
17	16	H. B. head lt. leads
17	16	H. B. indicator
18	14x16	L. B. feed
18	16	L. B. head lt. leads
20	16x18	Parking feed
20	18	Parking light leads
21	14x16	Tail light
22	14x16	Stop light
26	12	Horn & stop lt. feed
26	12x14	Horn and horn relay feeds
27	16	Instrument feed
30	18	Fuel gauge
33	18	Temperature gauge
36	18	Oil pressure gauge
38	18	Dome light
40	16	Instrument lights
71	16	Wiper switch feed
80	16	Ignition coil to dist.
91	16	Head light ground
A	16	Nat. with cir. letter "A" or black (wiper)
B	4	Battery ground
D	12	Cab ground
E	1	Battery cable
F	16	Nat. with cir. letter "F" or red (wiper)
G	14	Instrument bus bar
H	16	Horn push button
P	16	Nat. with cir. letter "P" or green (wiper)

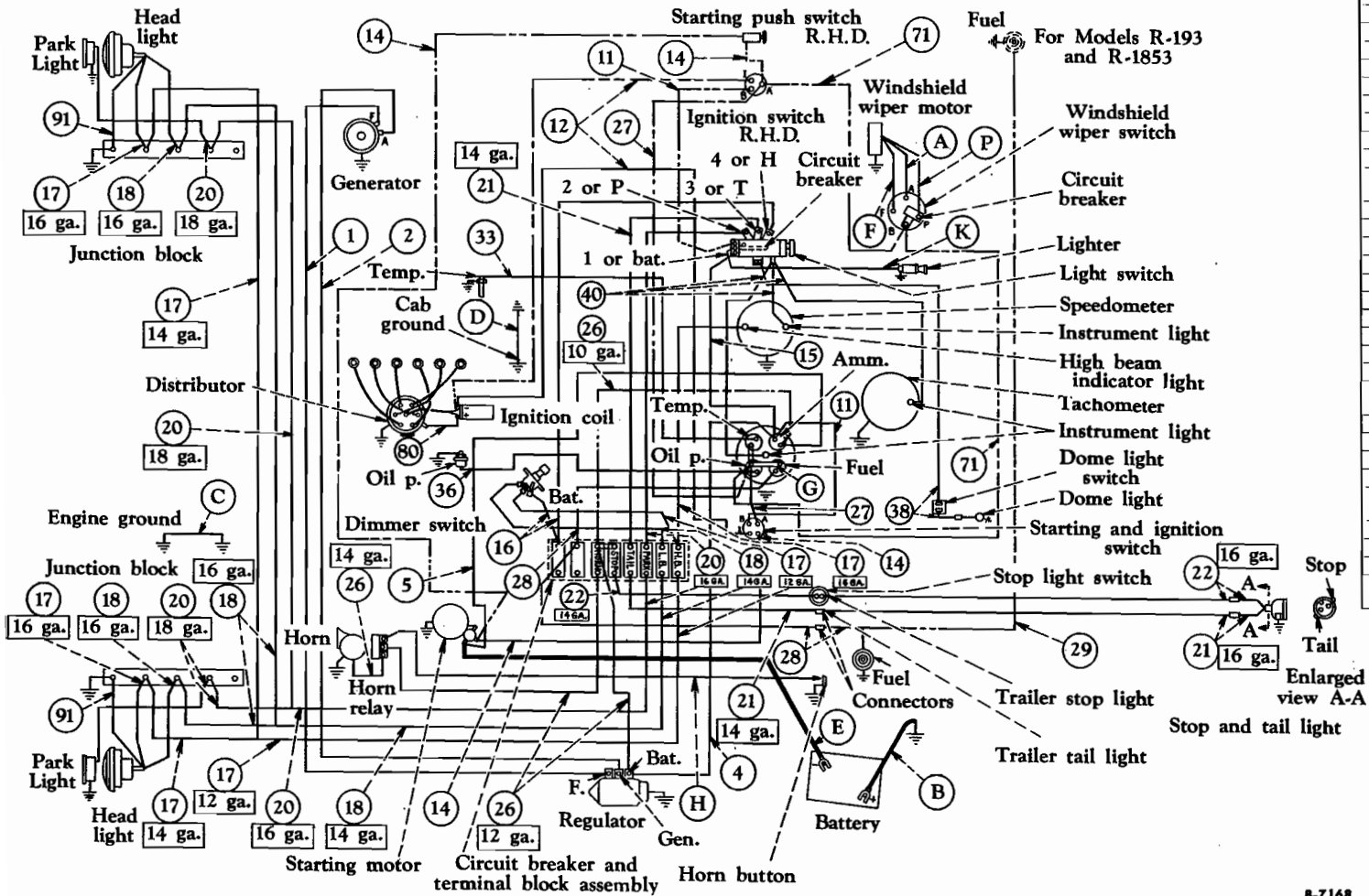
B-7180

Fig. 5 - Wiring circuit diagram. (RC-180 series trucks)

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R-LINE MOTOR TRUCK SERVICE



Circuit No. or Index Letter	Cable Gauge	Cable Color or Description
1	16	Generator field
2	8	Generator arm.
4	8	Regulator to amm.
5	8	Ammeter feed
11	12	Ignition switch feed
12	16	Ign. sw. to ign. coil
14	16	Starting
15	12	Light switch feed
16	12	Dimmer switch feed
17	12x14	H. B. feed
17	16	H. B. head lt. leads
17	16	H. B. indicator
18	14x16	L. B. feed
18	16	L. B. head lt. leads
20	16x18	Parking feed
20	18	Parking light leads
21	14x16	Tail light
22	14x16	Stop light
26	10x12	Horn & stop lt. feed
26	12x14	Horn and horn relay feeds
27	16	Instrument feed
28	18	Fuel gauge
29	18	Fuel gauge
33	18	Temperature gauge
36	18	Oil pressure gauge
38	18	Dome light
40	16	Instrument lights
71	16	Wiper switch feed
80	16	Ignition coil to dist.
91	16	Head light ground
A	16	Nat. with cir. letter "A" or black (wiper)
B	4	Battery ground
C	4	Engine ground
D	12	Cab ground
E	1	Battery cable
F	16	Nat. with cir. letter "F" or red (wiper)
G	14	Instrument bus bar
H	16	Horn push button
K	14	Lighter
P	16	Nat. with cir. letter "P" or green (wiper)

Fig. 6 - Wiring circuit diagram. (R-185 truck and R-190, RF-190, R-200, R-210, RF-210 series trucks)

B-7168





CTS-12-MARCH 1953 (Supplemental pages for CTS-11).

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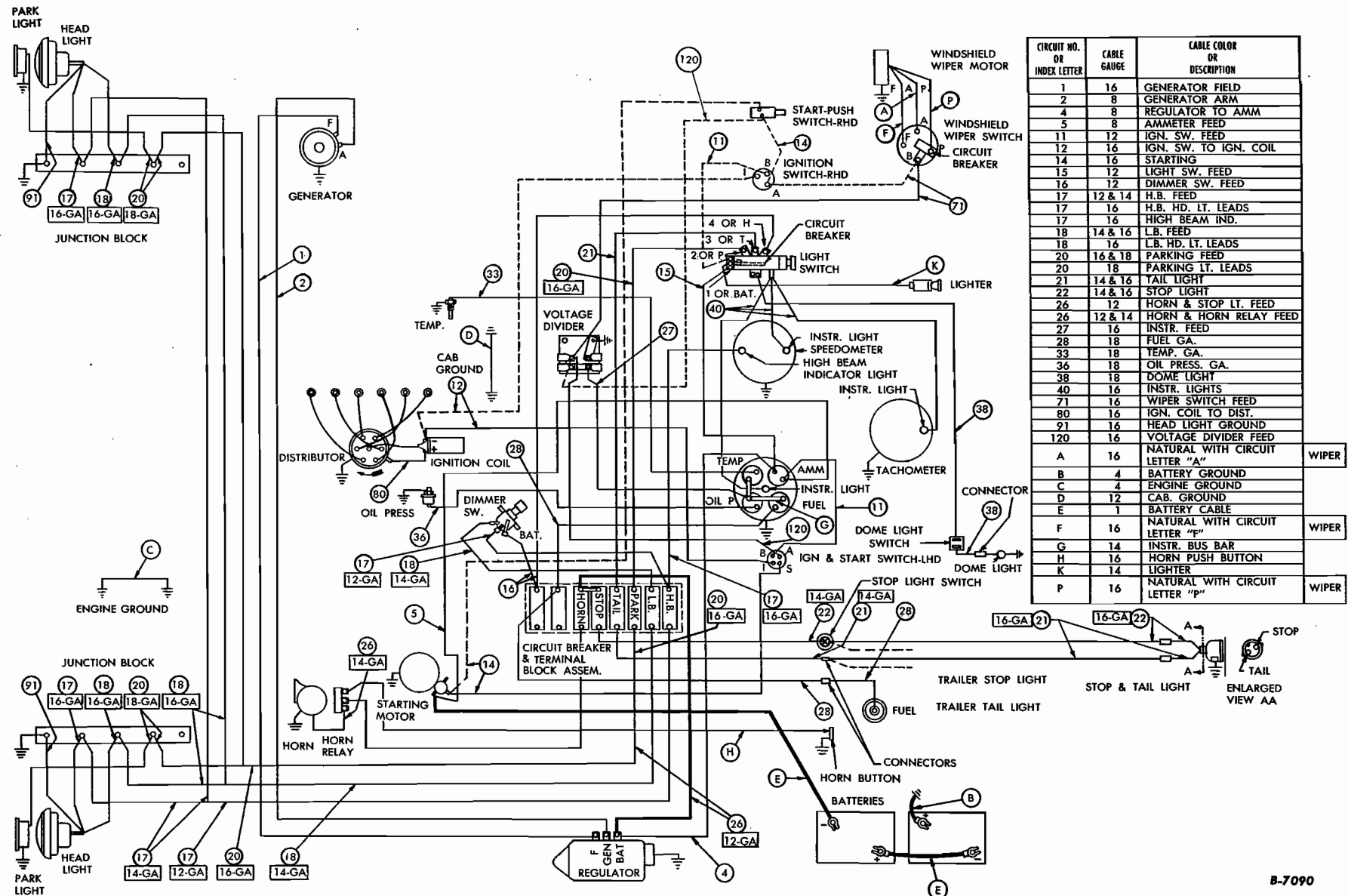


Fig. 7 - Wiring circuit diagram, 12-Volt System. (R-185 to R-210, RF-190 and RF-210 trucks)

B-7090



CIRCUIT DIAGRAMS

Electrical circuits for the various L-Line trucks are illustrated on following pages.

Cables are protected wherever necessary by loom or conduit and by rubber grommets, to prevent chafing where contact is made with the chassis, cab or body. Cables are also securely clipped at important points and connectors are used to facilitate inspection and servicing.

All electrical connections must be kept tight and clean.

Wiring Harness Individual Cable Circuit Identification

Wiring harness cable circuit identification has been established by ("Number Coding") imprinting numerals at regular intervals along the individual cables, except for short cables which are numbered only at the ends. The prime purpose of cable identification is to facilitate wiring harness installation since, in harness, generally only the extreme ends of the individual cables are visible.

The accompanying circuit numbered list (from No. 1 to 124) itemizes circuit numerals used on L-Line. Wherever a particular circuit is used on a vehicle, the identification numeral for that circuit will always be the same. For example, the generator field circuit cable will consistently be Circuit No. 1; the generator armature circuit will always be Circuit No. 2, etc. (see list). In the same manner, if a circuit is not used on a vehicle, the numeral for that circuit will not be used. For example, vehicles not having a 24-volt radio-feed cable will not have a circuit No. 48 in the harness.

Circuit numbers on the list for which no circuit description is given are not presently used by International and these circuits have been reserved for possible future assignment.

Circuit Nos. 28 to 31, inclusive, each pertain to fuel tank-to-receiver unit circuits. Because of the variety of possible combinations for these hook-ups, reference should be made to the illustrations for proper connection of cables. (Fig. 1)

Circuit Diagrams

Wiring circuit diagrams are illustrated in the owner's and driver's manuals and in the service manuals. With each of these illustra-

tions, there is a key to the diagram which contains pertinent information as to circuit number and cable gauge.

Individual Cable Replacement

It is recognized that replacement of one or more individual cables may be necessary and that complete harness replacement may be impractical. For this reason, the chart on each circuit diagram specifies the proper-gauge cable to be used and which can be made up locally from bulk stock.

Circuit Numbers And Circuit Names

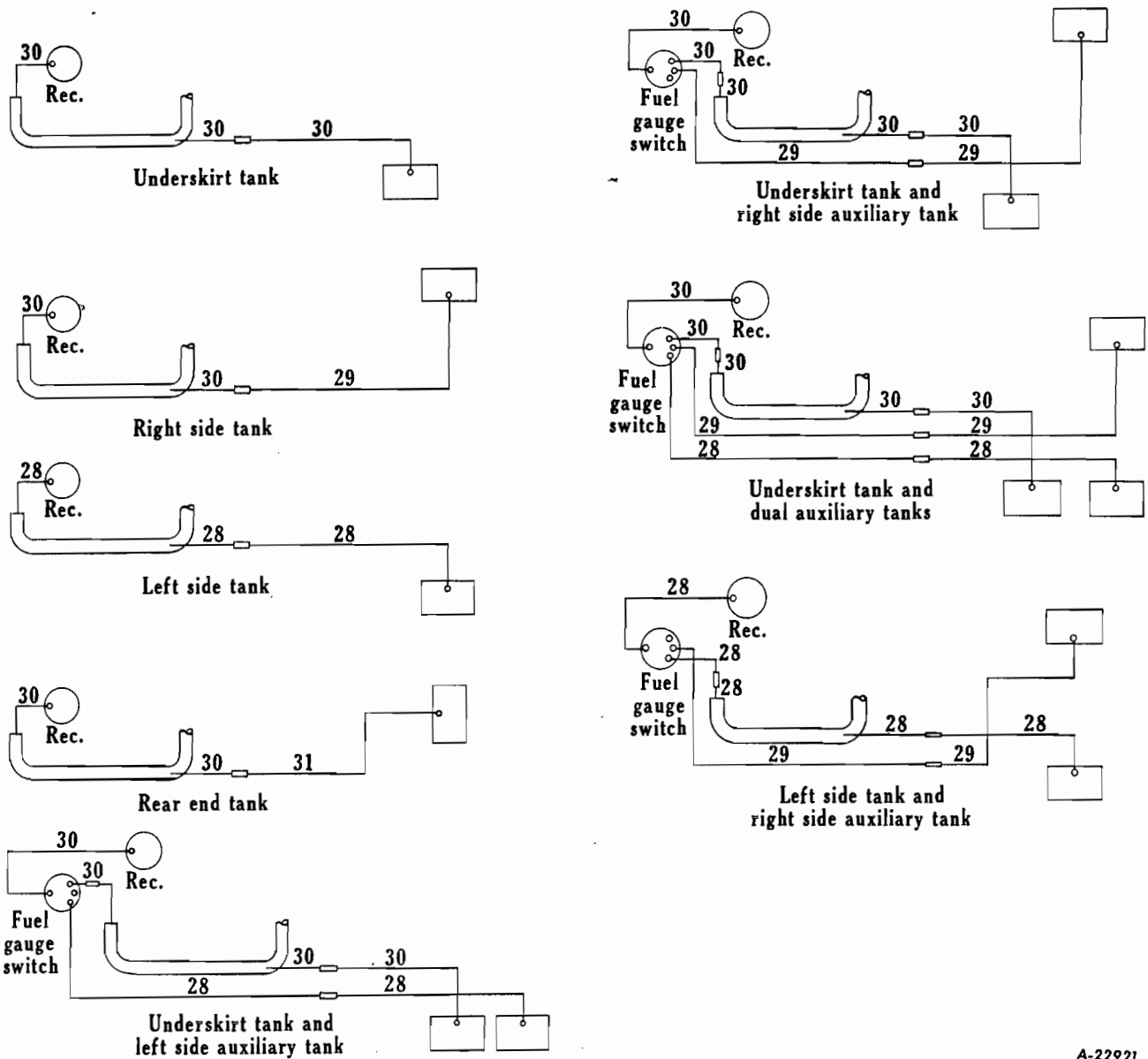
CIRCUIT NO.	CIRCUIT NAME
1.	Generator field circuit.
2.	Generator armature circuit.
3.	Generator ground circuit.
4.	Generator regulator to ammeter or shunt.
5.	Ammeter (or shunt) to starter switch.
6.	Battery to starting motor switch mounted on starting motor.
7.	Battery ground (including master switch, if in this circuit).
8.	Shunt to ammeter positive.
9.	Shunt to ammeter negative.
10.	Circuit breaker, common feed to any point fed from regulator (Bat).
11.	Ignition switch feed (or magneto ground).
12.	Ignition switch to ignition coil (or booster switch to booster coil).
13.	Magneto ground.
14.	Magnetic starting motor switch to push button switch to feed.
15.	Main light switch feed.
16.	Light switch (HT) to service headlight or dimmer switch.
17.	Dimmer switch to upper beam and to beam indicator.
18.	Dimmer switch to lower beam.



- | | |
|---|---|
| <p>19. Light switch (Bod) to blackout driving lamp, including resistor.</p> <p>20. Light switch (BHT) to parking lamps or marker light.</p> <p>21. Light switch (R) or (HT) on blackout switch to service tail light.</p> <p>22. Light switch (H) or (S) on blackout switch to service stop light.</p> <p>23. Light switch (BS) to blackout stop light.</p> <p>24. Light switch (BHT) to blackout tail light.</p> <p>25. Horn switch (including feed) to horn (or horn relay).</p> <p>26. Horn relay feed and horn relay to horn.</p> <p>27. Instruments feed (instruments with polarity).</p> <p>28. }
 29. } Fuel gauge sender to receiver --
 30. } See illustrations Figure 1.
 31. }</p> <p>32. Oil level gauge sender to receiver.</p> <p>33. Water (and oil) temperature gauge sender to receiver.</p> <p>34. Low engine oil pressure warning light circuit (including feed).</p> <p>35. High water temperature warning light circuit (including feed).</p> <p>36. Oil pressure gauge sender to receiver.</p> <p>37. Outlet socket or junction block.</p> <p>38. Dome light circuit (including breaker and switch).</p> <p>39. Map light circuit.</p> <p>40. Instrument light circuit.</p> <p>41. Starting motor to battery (-) (series parallel switch hook-up).</p> <p>42. Series parallel switch (B+) to battery (+).</p> <p>43. Series parallel switch (A-) to battery (-).</p> <p>44. Series parallel switch to ground.</p> <p>45. Series parallel switch (B-) to starting motor.</p> | <p>46. 12 - Volt radio circuit (including radio master switch).</p> <p>47. Slip ring feed.</p> <p>48. 24 Volt radio feed.</p> <p>49. Receptacle, Auxiliary power outlet, positive lead.</p> <p>50. Receptacle, Auxiliary power outlet, negative lead.</p> <p>51. - - - - -</p> <p>52. 6-Volt tap on tail light dropping resistor to tail light.</p> <p>53. Electric brake control circuit.</p> <p>54. Fuel cut-off circuit.</p> <p>55. Flame primer low tension circuit.</p> <p>56. Flame primer high tension circuit.</p> <p>57. Instrument panel ground.</p> <p>58. Compass light circuit.</p> <p>59. Cab (or hull) ventilating fan circuit.</p> <p>60. - - - - -</p> <p>61. Auxiliary generator field.</p> <p>62. Auxiliary generator armature.</p> <p>63. Auxiliary generator ground.</p> <p>64. Auxiliary generator regulator to battery (including heater transfer switch).</p> <p>65. Auxiliary generator starter relay circuit (including switch and feed).</p> <p>66. Auxiliary generator starter to transfer switch (including starter or relay).</p> <p>67. Emergency stop switch ground.</p> <p>68. Battery interconnecting cables.</p> <p>69. Resistor to ground terminal on trailer coupling.</p> <p>70. Regulator ground.</p> <p>71. Windshield wiper circuit.</p> <p>72. Low transmission oil pressure indicator, circuit, with feed.</p> <p>73. Radio terminal box to ground.</p> <p>74. Series parallel switch to solenoid relay.</p> |
|---|---|



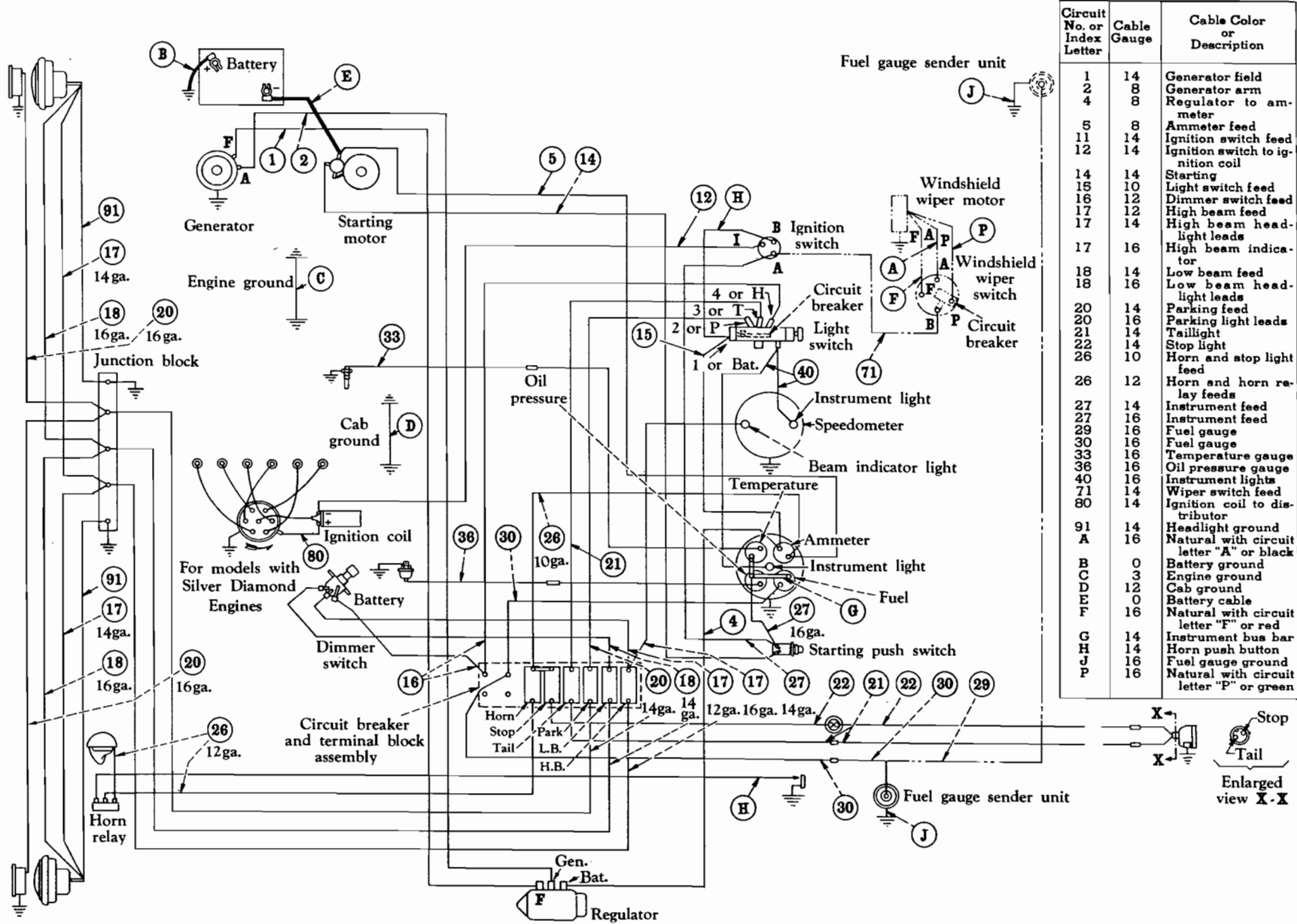
-
- | | |
|--|---|
| 75. Stop switch circuit (SW to SS on blackout SW). | 100. Tachometer transmitter to ground. |
| 76. Fuel pump control feed. | 101. Defroster switch to defroster motor including feed. |
| 77. Fuel pump switch to fuel pump (left side). | 102. Heater switch to heater motor including feed. |
| 78. Fuel pump switch to fuel pump (right side). | 103. Cigar lighter. |
| 79. Fuel gauge sender ground. | 104. Fog light switch to fog light including feed. |
| 80. Ignition coil to distributor. | 105. Tractor light (Back-up). |
| 81. Battery to starting motor switch (or term. block) including master switch. | 106. Carburetor idle fuel shut-off valve. |
| 82. Starting motor switch (or term. block) to starting motor. | 107. Marker or identification light circuit. |
| 83. Blackout light switch (TT) to tail connection on trailer receptacle. | 108. Clearance light circuit. |
| 84. Blackout light switch (SS) to stop light connection on trailer receptacle. | 109. Mico brake lock circuit. |
| 85. Low air pressure indicator buzzer (or light). | 110. Fuel gauge switch (C) to ground (dual safety tanks). |
| 86. Ground on series parallel switch to ammeter (including circuit breaker). | 111. Lockoff solenoid valve to switch (including feed). |
| 87. Spotlight circuit for trucks and wreckers. | 112. Auxiliary ammeter to ground-negative. |
| 88. Winch torque limiter control. | 113. 6-Volt radio circuit (including ratio master switch). |
| 89. Automatic choke. | 114. Direction signal, left turn-front. |
| 90. Trailer receptacle to ground. | 115. Direction signal, left turn-rear. |
| 91. Headlight to ground. | 116. Direction signal, right turn-front. |
| 92. Parking light to ground. | 117. Direction signal, right turn-rear. |
| 93. Starting motor relay to ground. | 118. Direction signal, feed circuit. |
| 94. Starting motor relay auxiliary grounding circuit. | 119. Voltage divider ground. |
| 95. Tail light to ground. | 120. Voltage divider feed or instrument resistor feed. |
| 96. Speedometer sender feed. | 121. Overdrive relay to ignition switch. |
| 97. Tachometer transmitter feed. | 122. Overdrive relay to overdrive governor (including kickdown and overdrive switch). |
| 98. Tachometer transmitter positive (+) to tachometer positive (+). | 123. Overdrive solenoid to ignition coil (including kickdown switch). |
| 99. Tachometer transmitter negative (-) to tachometer negative (-). | 124. Overdrive solenoid to battery (including relay feed). |



A-22921

Fig. 1 - Fuel tank to receiver circuits. Because of the variety of possible combinations for these hook-ups, reference should be made to the above chart for proper connection of cables.

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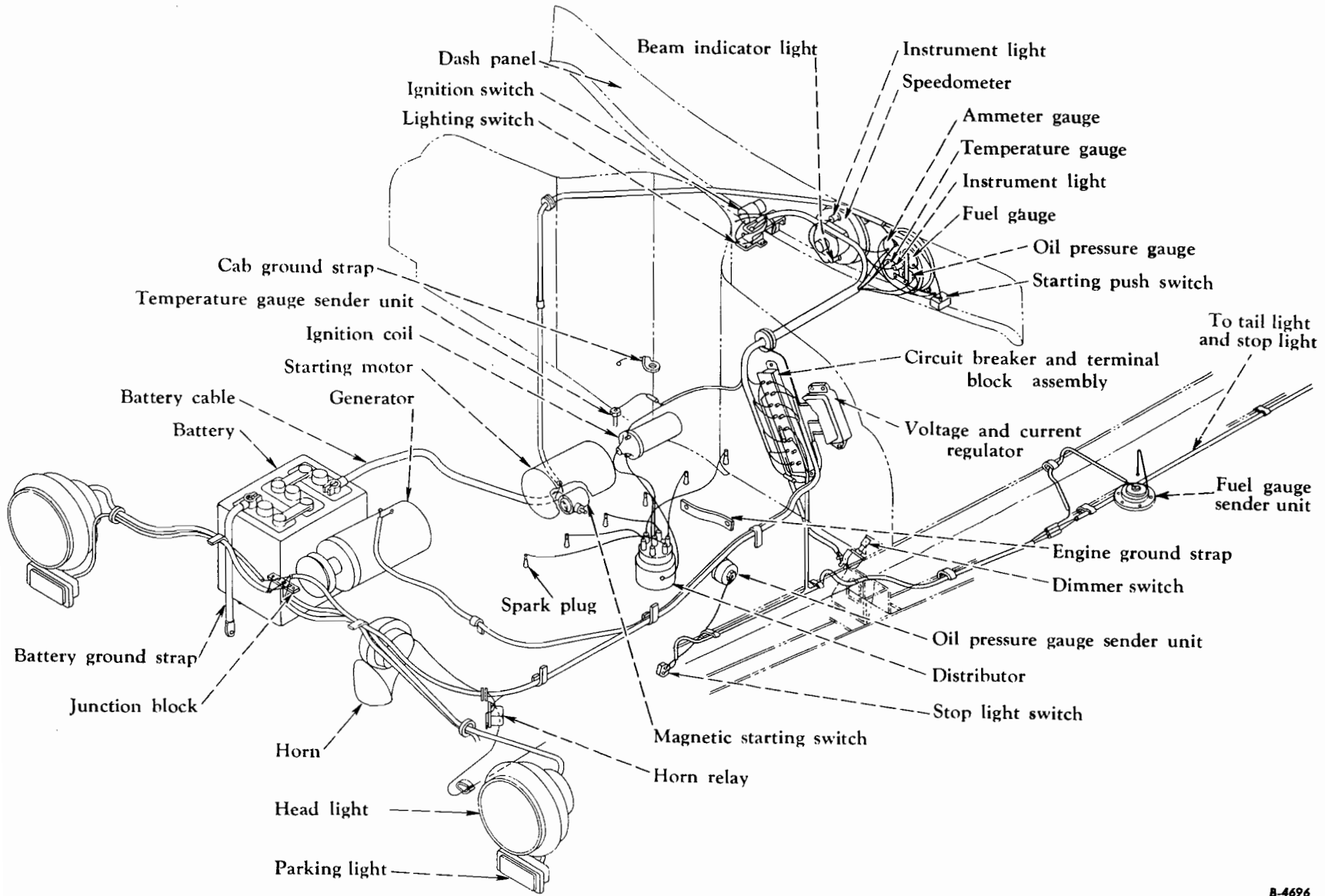
Circuit No. or Index Letter	Cable Gauge	Cable Color or Description
1	14	Generator field
2	8	Generator arm
4	8	Regulator to ammeter
5	8	Ammeter feed
11	14	Ignition switch feed
12	14	Ignition switch to ignition coil
14	14	Starting
15	10	Light switch feed
16	12	Dimmer switch feed
17	12	High beam feed
17	14	High beam headlight leads
17	16	High beam indicator
18	14	Low beam feed
18	16	Low beam headlight leads
20	14	Parking feed
20	16	Parking light leads
21	14	Taillight
22	14	Stop light
26	10	Horn and stop light feed
26	12	Horn and horn relay feeds
27	14	Instrument feed
27	16	Instrument feed
29	16	Fuel gauge
30	16	Fuel gauge
33	16	Temperature gauge
36	16	Oil pressure gauge
40	16	Instrument lights
71	14	Wiper switch feed
80	14	Ignition coil to distributor
91	14	Headlight ground
A	16	Natural with circuit letter "A" or black
B	0	Battery ground
C	3	Engine ground
D	12	Cab ground
E	0	Battery cable
F	16	Natural with circuit letter "F" or red
G	14	Instrument bus bar
H	14	Horn push button
J	16	Fuel gauge ground
P	16	Natural with circuit letter "P" or green



Fig. 2 - Circuit Diagram - L-110 Series to L-180 Series inclusive (Not "Metro")

B-4737





B-4696

Fig. 3 - Diagram showing location of various electrical units. L-110 Series to L-180 Series inclusive (Not "Metro").



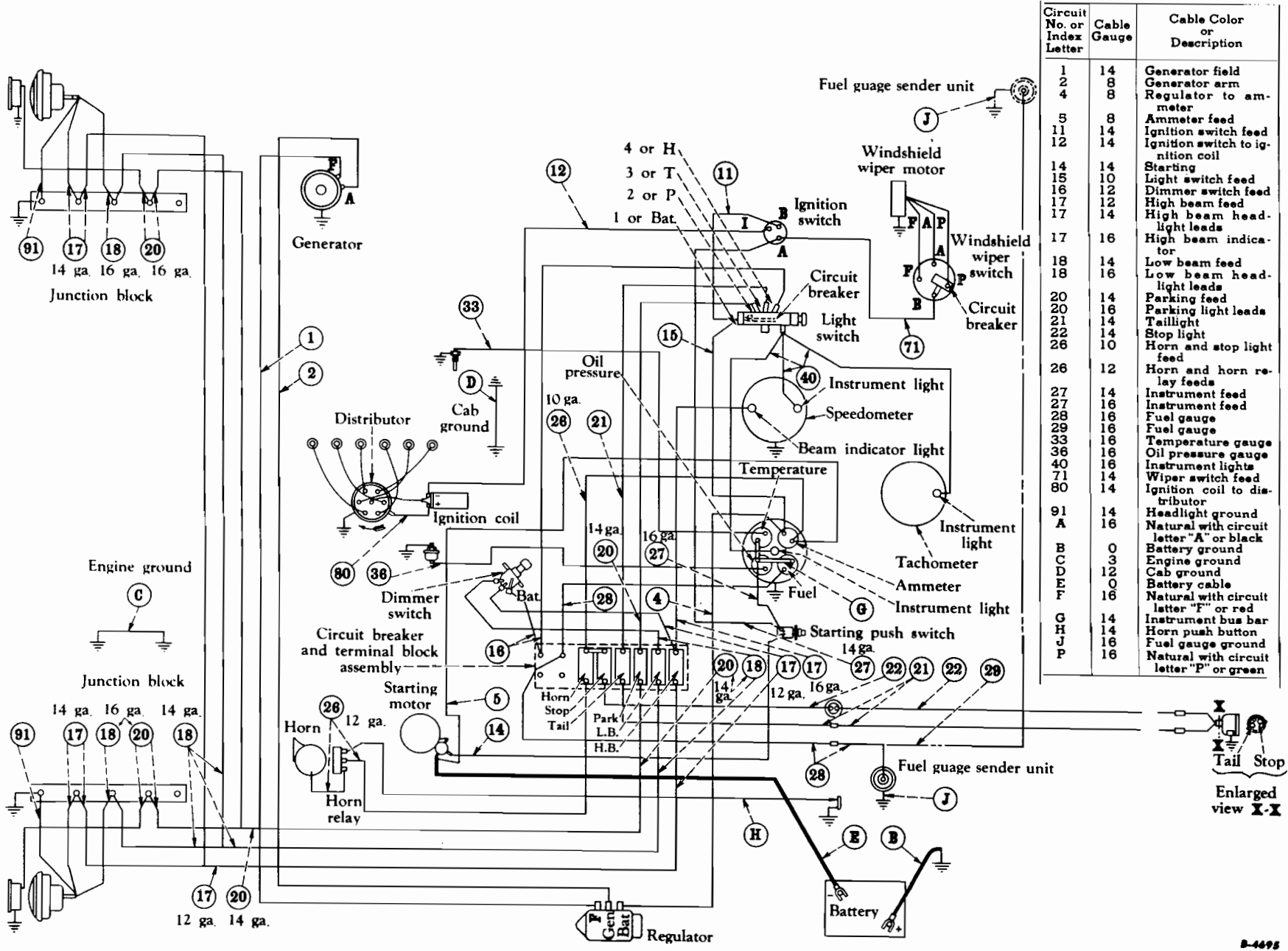


Fig. 4 - Circuit Diagram - L-190 Series And Up.

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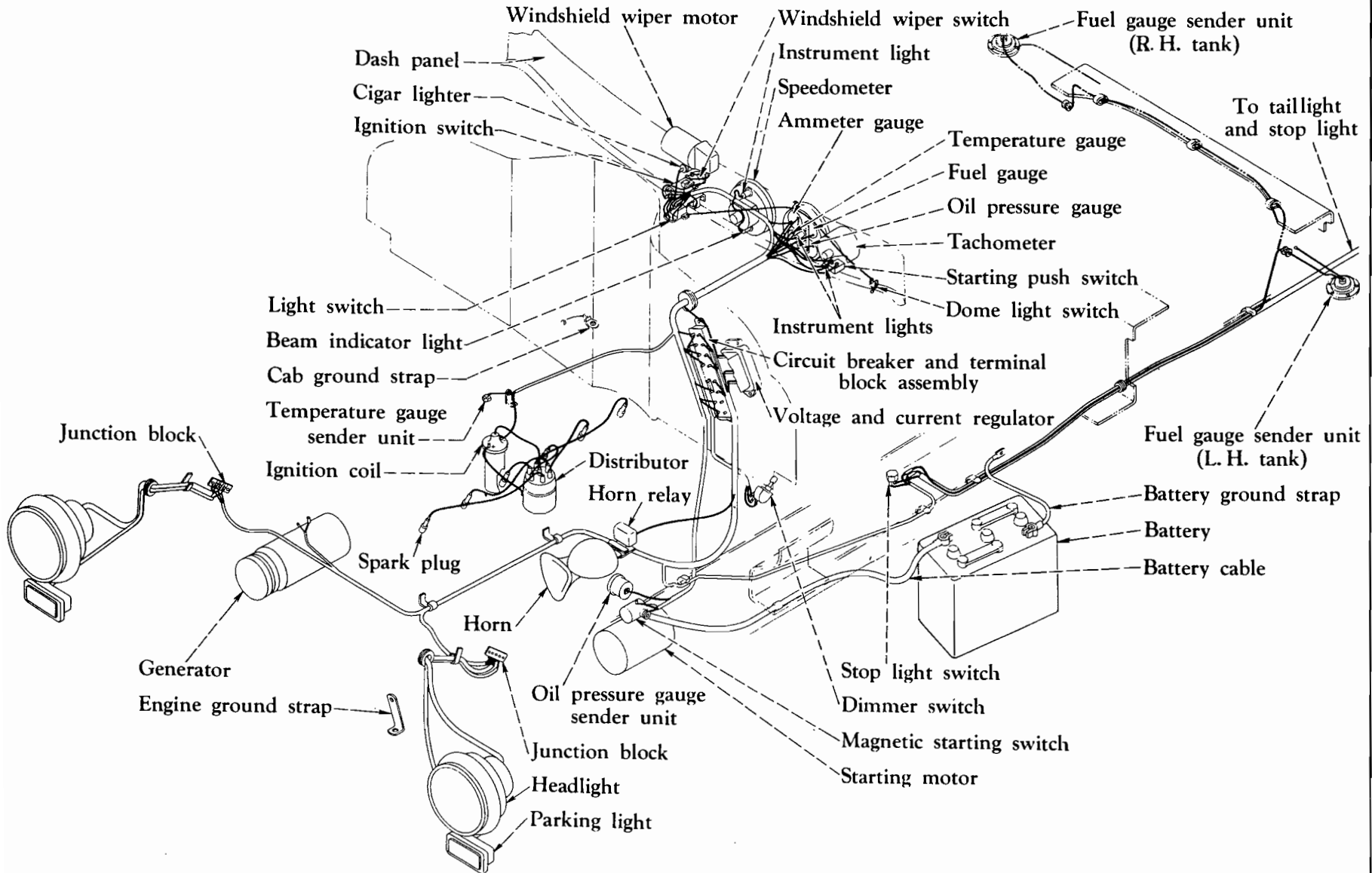


Fig. 5 - Diagram showing location of various electrical units - L-190 And Up.

B-4868





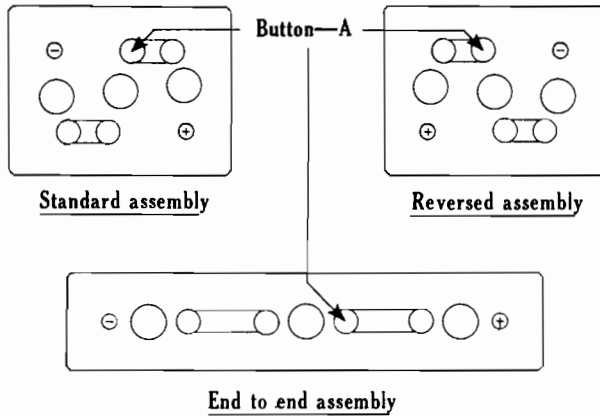
BATTERY

Storage Battery Equipment

Present production trucks are equipped with Auto-Lite batteries.

Code Dating

Each Auto-Lite Battery bears a shipping code stamped on one button of one cell connector of the battery. This button is indicated as "A" in Fig. 1.



Positive button — center cell — 6-volt assembly.

Positive button — cell adjacent to positive terminal cell — 12-volt assembly.

A-14015

Fig. 1

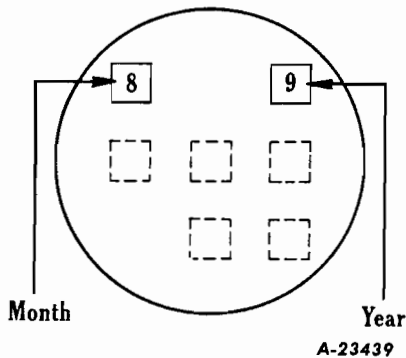


Fig. 2

The code date will be found stamped on the positive connector button on the cell adjacent to the positive terminal cell. See Fig. 2.

In the first row are two symbols: the first is the month, the second is the year of shipment, for example - "8-9" which decodes August - 1949.

In the third row, the second space is used to indicate whether the battery was built "dry" or "wet." If there is no symbol in the space - the battery was built wet. If the space contains a letter "Y" - the unit was built dry. If the letter "Y" is encircled thus - (Y) the battery was built dry and made wet before shipment.

The following chart is the key to the code datings found on Auto-Lite batteries used in International Motor Trucks of later manufacture:

Month	Month Symbol	Year	Year Symbol
January	1		
February	2		
March	3	1949	9
April	4	1950	0
May	5	1951	1
June	6	1952	2
July	7	1953	3
August	8	1954	4
September	9	1955	5
October	10	1956	6
November	11	1957	7
December	12	1958	8

Atmospheric Temperature Affects Battery Capacity

The specific gravity of the electrolyte (distilled water and acid solution) must be maintained at 1.225 to 1.250 and the level of the solution should be at the star level in cell covers. A fully charged battery has a specific gravity of 1.280-1.290 at 80 degrees (F.).

To eliminate the possibility of harmful sulfation of plates, a battery with a specific gravity of 1.225 or less should be recharged to 1.280-1.290 at 80 degrees (F.) battery temperature.

The following chart shows the effect of atmospheric temperature on the capacity of a battery:

State of Charge	Temperature (F.)	Percentage Capacity
Full	80 degrees above 0°	100
Full	60 degrees above 0°	88
Full	40 degrees above 0°	75
Full	20 degrees above 0°	62
Full	Zero degrees	45
Full	20 degrees below 0°	20

Specific Gravity Affects Freezing Point of Electrolyte

Specific gravity of the electrolyte determines the temperature at which a battery will be harmed or damaged by freezing.



The following chart gives the freezing point of battery electrolyte at given specific gravities:

Electrolyte Specific Gravity	Freezing Point (F.)
1.280	90 degrees below 0°
1.220	30 degrees below 0°
1.210	20 degrees below 0°
1.180	10 degrees below 0°
1.160	Zero degrees
1.140	10 degrees above 0°
1.100	20 degrees above 0°
1.000	32 degrees above 0°

Battery Record Card, Form CTS-7

The Form CTS-7 Battery Record Card is the record or history of each battery received and shipped. The card has spaces provided for all necessary information pertaining to the battery. One of these record cards must be maintained for each battery and it should reveal the complete history of the unit while in your possession.

Upon receipt of a shipment of trucks from one of the factories or from another Branch, the batteries must be removed immediately and battery record cards filled out for each battery. THERE MUST BE NO DEVIATION FROM THIS PRACTICE.

The date received, battery type, code marking, truck model, and chassis serial number must be entered on a separate record card for each battery.

The specific gravity of each cell must be recorded on the card under TEST RECORD. The date and the inspector's initials should also be shown in the space provided. Any battery showing a specific gravity reading of less than 1.225 must be placed on the charging line and brought up to 1.280-1.290 at 80 degrees (F.) (battery temperature).

Subsequent inspections of the battery shall be made every thirty days and the specific gravity readings recorded, and distilled water added if necessary. This procedure shall follow during the stay of the battery in your stock.

Upon delivery of battery in a truck, the record card shall be completed by recording

the specific gravity readings of each cell, date of delivery, truck model and chassis serial number, and the name of the purchaser. The card will then be filed in a manner similar to the Customer's Record Card. If the battery is delivered in a truck being transferred in another District, the battery record card shall accompany the battery and shall be continued by the receiving branch.

Battery Maintenance

The Ft. Wayne and Springfield factories are exercising every care in the handling and rotation of batteries to assure the delivery of a fresh and fully charged battery with each and every truck delivered to the territory.

The territory must also follow this practice of rotation, using the oldest batteries first as determined by the code datings stamped on the center cell connector button.

To facilitate truck movement in and around the District or Warehouse, a service battery should be prepared having long cables and clip ends.

Battery Recharging

Suitable and adequate equipment for battery charging is available through the Motor Truck Service Section, Chicago Office.

The general procedure in battery charging is as outlined:

1. With vent plugs in place, wash the top of the battery if necessary, using a solution of water and common baking soda. Rinse with clear water.
2. Remove vent plugs from each cell.
3. Fill the battery cells with pure distilled water to star level in cell covers.
4. Connect battery to the charger unit in series, connecting the positive terminal outlet from the supply line to the positive terminal post of the first battery. Connect the negative terminal of the first battery to the positive terminal of the second battery and so on through the number of batteries being charged. (Do not attempt to exceed the capacity of the battery charging equipment in the number of batteries to be charged at one and the same time.) The last battery must have its negative terminal connected to the negative outlet of the charging unit.
5. Adjust the charging rate in amperes to the lowest normal charge rate of the smallest size battery according to the following chart.



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Batteries should remain on charge for a period of time sufficient to obtain normal voltage and specific gravity readings of each cell. The required length of time will vary from 12 to 48 hours, depending upon the state of discharge of the battery at the time it was placed on the charging line.

Type of Battery	Volts	No. of Plates	Normal Charge Rate
2H-105, 2H-105R	6	15	7 Amperes
2H-120, 2H-120R	6	17	8 Amperes
2H-135R	6	19	9 Amperes
3H-136R	6	17	8 Amperes
4H-152R	6	19	9 Amperes
8T-200	12	25	12 Amperes

Temperature readings should be taken frequently to prevent the electrolyte temperature exceeding 110 degrees (F.) at any time. Should the temperature rise higher than 110 degrees (F.), the charging should be discontinued and the electrolyte allowed to cool. The charging of the battery may then, and only then, be continued.

6. Cell voltage is determined by a normal electrolyte temperature of 80 degrees (F.). Voltage readings are to be taken while the battery is on charge at the normal rate as specified in the foregoing chart.

The cell voltage of a fully charged battery on charge at the normal rate should read as follows:

Temp. 80 degrees (F.) - Voltage between	2.5 and 2.6 volts
Temp. 100 degrees (F.) - Voltage between	2.4 and 2.6 volts
Temp. 110 degrees (F.) - Voltage between	2.35 and 2.55 volts

A battery is fully charged when the cell voltage values are as shown in above table and there is no further rise in voltage over a period of two hours.

7. Add water as necessary, disconnect batteries from the charging line, replace vent plugs, wash the tops of the batteries, and place in attachment room.

Excessive Evaporation of Electrolyte Indicates Overcharging

When excessive evaporation of the electrolyte is experienced, you may be sure that it is an indication that the battery is being overcharged.

Necessity for too frequent battery re-charging may indicate that the battery is being undercharged.

Battery Not to Blame for Failure When Conditions Adverse

It has been shown that temperature plays an important part in affecting the capacity of a battery, and that the colder the temperature - the lower the battery capacity. Bearing this in mind, it will be seen that a fully charged battery is only partially capable at subzero temperatures. This fact, coupled with the condition in which many engines are found, brings about complaints regarding the size, quality, and construction of the standard equipment battery.

There are times when it is necessary to increase the size of the battery or starting motor, but such action should not be considered a "cure-all" for hard starting complaints during winter months. Even when special equipment of this nature is installed, it is still essential to:

1. Use a lubricating oil with the correct body for Winter Service.
2. Maintain distributor points in good condition and properly spaced.
3. Have clean and properly spaced spark plug electrodes.
4. Have good compression in the engine.
5. Maintain all joints and connections between the carburetor, manifolds, and engine in a gas-tight condition.
6. Ascertain that the carburetor choke valve is operating properly.
7. Determine that the engine is well grounded and that the ground straps are securely fastened to clean contacts.

Battery Warranties and Manufacturers' Policy

Storage batteries used in International Motor Trucks are limited to a free repair or replacement warranty of 90 days against defective material and workmanship, beginning on the date the battery is placed in service.

In accordance with this arrangement, service adjustments after 90 days are based on miles of service or months of service - whichever occurs first. Miles of service are mentioned for there are occasions when a customer will attain the limit of miles of service prior to the time limit set forth. In such cases, the adjustment will be made on the miles of service and not on the time limit.

Auto-Lite Batteries, whether installed as factory equipment by the International Harvester Company or sold as replacements to



International Harvester Truck owners, are subject to adjustment as outlined below.

Factory equipment or replacement batteries are adjusted according to the following table:

Service Adjustment Chart

Battery Equipment Type	Mileage Adjustment	Time Adjustment
2H-105, 2H-105R	15,000	7-1/2 Months
2H-120, 2H-120R	18,000	9 Months
2H-135R	21,000	10-1/2 Months
3H-136R	18,000	9 Months
4H-152R	18,000	9 Months
8T-200	24,000	8 Months

Complaints on Battery Performance

Any complaints pertaining to battery performance should be referred to the nearest Auto-Lite Service Station.

Complaints on Service Facilities

Complaints on service facilities of Auto-Lite distributors must be referred to the Sales Department, Motor Truck Service Division, Chicago Office. Accompany complaint with all details concerning the battery and the truck from which it was removed. The matter will be handled with the manufacturer from the Chicago Office and not by the District direct.

Batteries Older Than Four Months at Time of Delivery

Motor Truck Service Bulletin No. 82, 1931, pertained to batteries which were on hand and which were older than four months according to code dating. That bulletin advised that these batteries should be delivered in proper rotation but that they should be properly identified by stamping the letters "IHC" on the center cell connector button. Battery Record Cards, Form CTS-7, were to be notated with this information. Customer Record Cards were to bear a notation to the effect that the battery was past the four months' code dating.

PROPER AND CONSISTENT ROTATION OF BATTERIES IN STOCK MUST BE FOLLOWED, AND THE OLDEST BATTERIES ACCORDING TO CODE DATING DELIVERED FIRST.

Strict Adherence to Instructions Necessary

All persons who have occasion to handle batteries or battery transactions should thoroughly familiarize themselves with the instructions pertaining to maintenance of batteries,

with battery warranties, and the manufacturer's policy. There should be no departure from the instructions as outlined.

It must be remembered that while the manufacturer is under certain obligations in accordance with the warranty policy of the batteries, we too, are not absolved of obligation to the manufacturer to do our part of the arrangement and policy.

It is felt that of all the instructions outlined herein that the following are the most important and no excuse can be accepted for departure from them:

1. REMOVAL OF ALL BATTERIES FROM THE TRUCKS AT THE TIME THEY ARE RECEIVED AT THE BRANCH, AND KEEPING THEM IN THE ATTACHMENT ROOM OR BATTERY ROOM UNTIL THE TIME OF DELIVERY.
2. INSPECTION OF BATTERIES EVERY THIRTY DAYS, AND MAINTAINING THEM AT THE PROPER WATER LEVEL AND AT THE PROPER SPECIFIC GRAVITY READINGS.
3. KEEPING OF FULL AND COMPLETE RECORDS OF THE BATTERY ON THE BATTERY RECORD CARD, FORM CTS-7.
4. PROPER AND CONSISTENT ROTATION OF BATTERIES IN STOCK, DELIVERING THE OLDEST BATTERIES FIRST.
5. INSTRUCTIONS TO THE CUSTOMERS IN THE PROPER CARE OF THE BATTERY AND A CAREFUL STUDY OF THE REQUIREMENTS ON THE BATTERY AND CORRECTIONS FOR SAME IN THE CUSTOMER'S TRUCK.

General Instructions

Do not add anything other than distilled water or drinking water which is colorless, tasteless, and odorless to a storage battery. The use of patent electrolytes or battery "dopes" are injurious and void the guarantee.

Use a strong solution of soda and hot water for removing terminal corrosion and cleaning the battery. To prevent corrosion apply vaseline or cup grease to the terminals.

Moist Uncharged Storage Batteries

To prepare a battery for service which has been shipped dry, all cells should be filled to 3/8" above the tops of the spacers with the electrolyte specific gravity of 1.345.

CAUTION!
NEVER POUR WATER INTO SULPHURIC ACID.



Important Instructions

To prepare 1.345, specific gravity electrolyte from full-strength sulphuric acid stir constantly while adding one volume of 1.835 acid to two volumes of water. THIS MUST BE DONE VERY SLOWLY AS A GREAT DEAL OF HEAT IS GENERATED.

Use only glass or earthenware containers for storing and for mixing the acid.

In some localities acid can be purchased already mixed to 1.345 specific gravity.

Table 1

Cold Climate				Warm or Tropical Climate			
Filling Acid		Final Adjust-ment		Filling Acid		Final Adjust-ment	
Sp. Gr.	Bau-mé	Sp. Gr.	Bau-mé	Sp. Gr.	Bau-mé	Sp. Gr.	Bau-mé
1.345	3.7	1.290	31.5	1.245	28.5	1.225	26.4

A tropical climate is that in which the temperature never falls below the freezing point of water (32° F.) (0° C.).

Place the battery on charge at the ampere rate given below:

Battery Equipment Type	Ampere
2H-105R	7
2H-120R	8
2H-135R	9
3H-136R	8
4H-152R	9
8T-200	12

For converting dry batteries to wet, use a constant rate charger. Do not use a constant potential charger.

The total initial charge must be for 52 hours.

However, should the temperature of the electrolyte while on charge reach 115° F. (46° C.), discontinue the charge and allow the battery to cool. Then resume charging.

The electrolyte at the end of 52 hours' charge with battery temperature at 80° F. (26.7° C.) should be at the value given in Table 1. Make corrections for temperature, when necessary, according to previous direc-

tions. Adjust electrolyte specific gravity by adding distilled water to weaken and 1.400 specific gravity acid to strengthen.

When adjusting electrolyte, charge the battery for one hour before taking a final reading. At the end of 52 hours the cell voltage of the battery while on charge at the proper rate should be between 2.5 and 2.7 volts at 80° F.

Replace vent plugs, wash externally to remove traces of acid, and dry. Battery is now ready for service.

INSTALLATION OF CABLES

When making replacement of original battery cables, starting motor cables or other wires utilizing protective loom or grommets, it is essential that the service cable be equipped with the same type loom or grommet protection as was removed on the replaced cable or wire. Cables that are replaced without proper loom protection create a fire hazard. The wiring circuits on new vehicles are closely checked and approved by Underwriter Companies, therefore, the original circuits should be maintained both as to location and protective devices.

The loom or grommet is placed on cables for the purpose of safeguarding against chafing or cutting through the insulation at points where the cables contact the chassis.

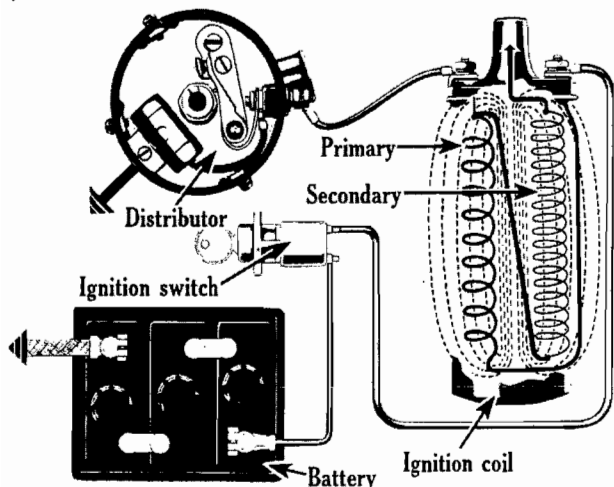
When replacing cables on customers trucks or when making sales of cables, make certain that protective loom or proper grommets are provided where required.

The storage battery can deliver only what the battery cables are able to carry to the electrical system. The battery cannot operate efficiently if it has to overcome the resistance of a worn-out, corroded or undersize cable. Faulty battery performance may indicate cable trouble.

Care should be taken when installing a cable terminal. It should never be hammered into place. To do so may drive some of the active material from the battery plates into the bottom of the battery container or crack the cell cover. Also some metal may be sheared from the post, making it too small for good contact when the next replacement is necessary. The best practice is to pry the jaws of the terminal apart before slipping it over the post.

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IGNITION COILS



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Fig. 1 - Schematic wiring diagram of the primary circuit of an ignition system.

DELCO-REMY MODEL 1115327 IGNITION COIL

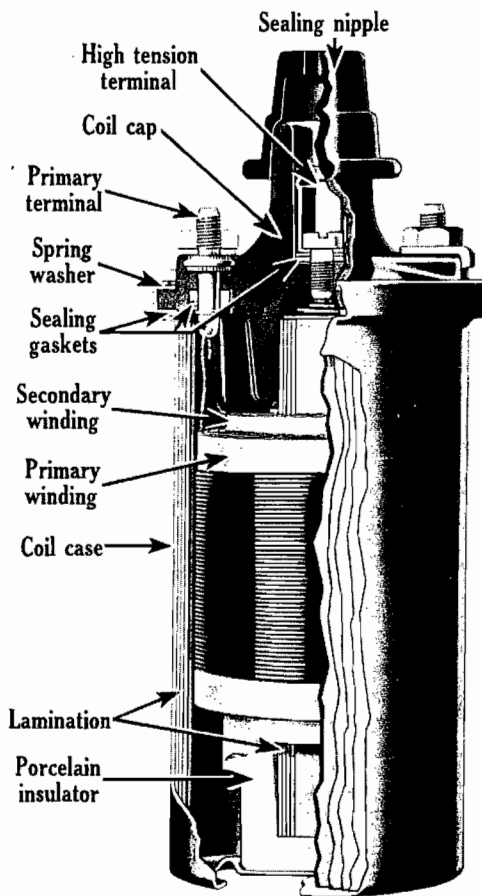
The Delco-Remy (Model 1115327) Ignition Coil is oil-filled and hermetically sealed to prevent the entrance of moisture. The high tension terminal is protected by a bakelite insulator which has high resistance to leakage across its surface and is not damaged by leakage which might occur. The coil should be mounted vertically with the high tension terminal down or horizontally with primary terminals in same horizontal plane. Make sure the coil is mounted so the case is grounded and that the leads are tightly connected to the coil terminals.

If the coil is defective it must be replaced, since the coil can not be repaired. But before a coil is discarded, it should be carefully checked on a good tester to determine that it is actually defective.

Construction and Operation

The ignition coil is a pulse transformer that transforms or steps-up the low battery or generator voltage to the high voltage necessary to jump the gaps at the spark plugs in the engine cylinders. This voltage may reach as much as 20,000 volts.

The ignition coil contains three essential parts; a primary winding consisting of a few hundred turns of relatively heavy wire, a secondary winding consisting of many thousand



A-22552

Fig. 2 - Cutaway view of oil filled coil.

turns of very fine wire, and laminated soft iron which serves to concentrate the magnetic field. The primary winding is assembled around the outside of the secondary winding, and the laminated iron is distributed so that one portion serves as a core for the windings and the remainder as a shell around the entire subassembly. This subassembly is then placed in the coil case and the remaining space nearly filled with insulating compound or oil, and the coil cap assembled into place.

Fig. 3 illustrates a heavy-duty ignition coil used on motor-coach, truck and marine applications. This coil also is hermetically sealed against the entrance of air or moisture and is oil filled for greater insulation protection. The fins cast in the one-piece case plus the oil filling permits improved heat radiation which is a factor in efficient ignition coil performance.

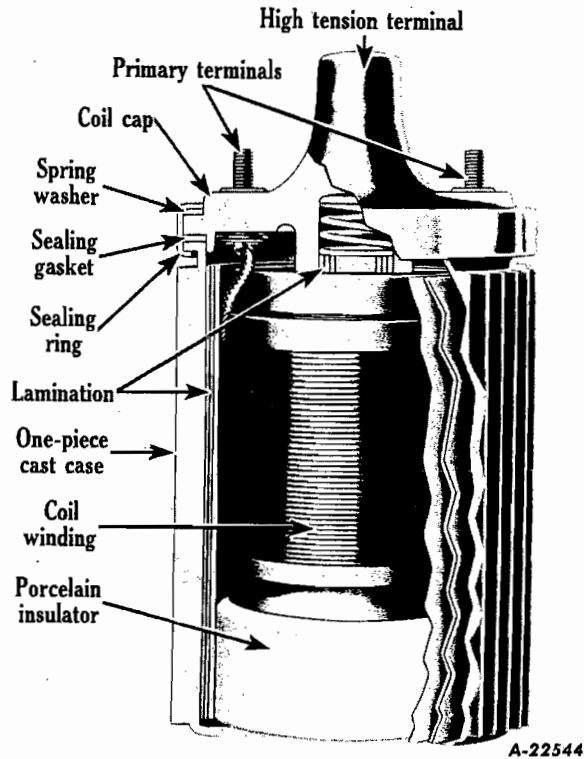


Fig. 3 - Cutaway view of heavy duty oil-filled coil. Coil case utilizes fins to aid in cooling for better ignition coil performance.

Coil Service

Ignition coils do not normally require any service except to keep all terminals and connections clean and tight. In addition, the coil should be kept reasonable clean, but it must not be subjected to steam cleaning or similar cleaning methods which may cause moisture to enter the coil unless it is of the hermetically sealed type. Rubber nipples on the high voltage terminals are valuable in preventing "tracing" or leakage of current across exposed surfaces.

If poor ignition performance is obtained and the coil is suspected of being the cause, the coil may be tested on the truck or it may be removed for the test.

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DISTRIBUTORS

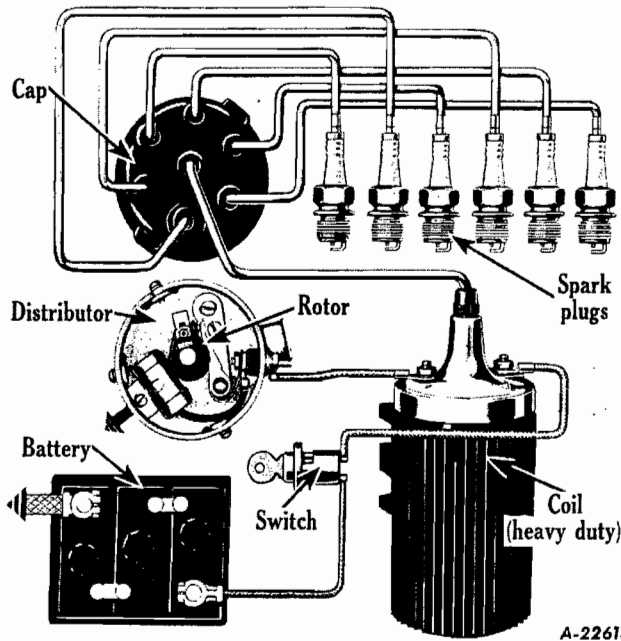


Fig. 1 - Ignition system circuit. Showing relationship of various units.

IGNITION DISTRIBUTORS

The ignition system (Fig. 1) consists of the ignition coil, condenser, ignition distributor, ignition switch, low and high tension wiring, spark plugs, and a source of electrical energy (battery or generator).

The ignition system has the function of producing high voltage surges and directing them to the spark plugs in the engine cylinders. The sparks must be timed to appear at the plugs at the correct instant near the end of the compression stroke with relation to piston position. The spark ignites the fuel-air mixture under compression so that the power stroke follows in the engine.

Function of Distributor

The distributor has three jobs. First, it opens and closes the low tension circuit between the source of electrical energy and the ignition coil so that the primary winding is supplied with intermittent surges of current. Each surge of current builds up a magnetic field in the coil. The distributor then opens its circuit so that the magnetic field will collapse and cause the coil to produce a high voltage surge. The second job that the distributor has is to time these surges with regard to the engine requirements. This is accomplished by the centrifugal and vacuum advance mechanism. Third, the

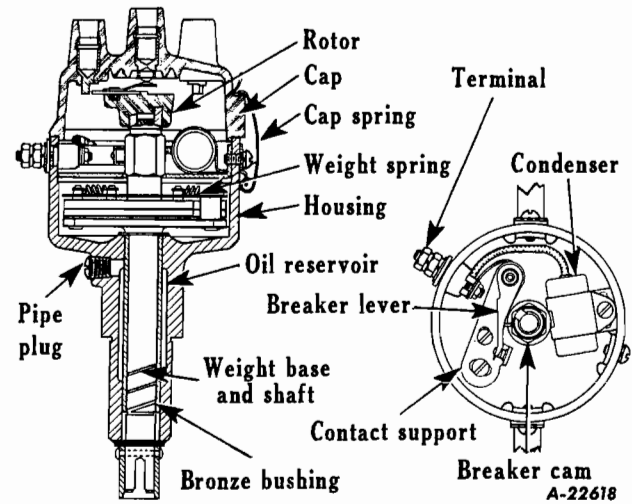


Fig. 2 - Sectional view of distributor.

distributor directs the high voltage surge through the distributor rotor, cap and high tension wiring to the spark plug which is ready to fire.

There are thus two separate circuits through the ignition distributor. One of these is the primary circuit which includes the distributor contact points and condenser. The other is the secondary or high tension circuit which includes the distributor cap and rotor.

DELCO-REMY DISTRIBUTOR

The Delco-Remy Distributors used on BD and RD engines are full automatic units with centrifugal advance mechanism. The SD engine uses a distributor having the vacuum-automatic mechanism.

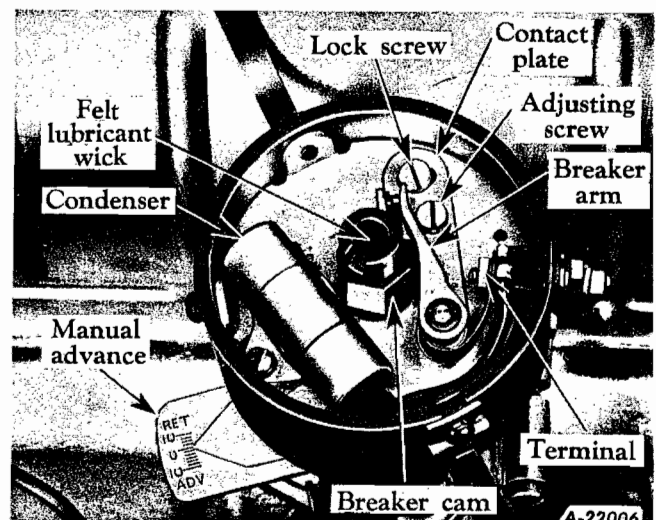


Fig. 3 - Full automatic distributor. Cover removed.

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Distributor Maintenance

LUBRICATION - Do not remove pipe plug in distributor oil reservoir. This reservoir back of the shaft bushing is filled with light engine oil and sealed before the unit is shipped. The supply of oil is sufficient to last for 25,000 miles of operation under normal conditions. Thus the plug need not be removed oftener than every 25,000 miles (or at time of overhaul) for lubrication except when unusual heat or other operating conditions are experienced. Grade SAE #20 oil should be added when needed. Seal the plug with sealing compound that will hold against oil.

A trace of high melting point ball-bearing grease should be placed on the breaker cam every 1000 miles. Every 5000 miles put one drop of light engine oil on the breaker lever pivot and a few drops on the felt wick under the rotor.

Inspection

The cap should be removed at regular intervals and the contact points, rotor, and cap examined. Check the high tension wiring for frayed or damaged insulation and poor connections at the cap or plugs. Replace if necessary. Replace the cap or rotor if they are cracked or show carbonized paths indicating the secondary current is leaking to ground over the surface of the material.

CONTACT POINTS - That are burned or pitted should be replaced or dressed with a clean, fine-cut contact file. The file should not be used on other metals and should not be allowed to become greasy or dirty. **NEVER USE EMERY CLOTH TO CLEAN CONTACT POINTS.** Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily.

OXIDIZED CONTACT POINTS - May be caused by high resistance or loose connections in the condenser circuit, oil or foreign materials on the contact surfaces, or most commonly, high voltages. Check for these conditions where burned contacts are experienced.

THE CONTACT POINT OPENING - Must be set to specification. Points set too closely may tend to burn and pit rapidly. Points with excessive separation tend to cause a weak spark at high speed. The point opening of new points may be checked with a feeler gauge. Use of a feeler gauge on used points is not recommended, since the roughness of used points make it impossible to set the point opening accurately by this method. A dial indicator or a contact angle

meter is recommended to check the point opening of used points. When necessary to check and adjust point opening with a feeler gauge proceed as follows:

Rotate breaker cam until breaker lever rubbing block is on the high point of the cam lobe thus giving the maximum point opening. Loosen the clamp screw holding the contact support and adjust point opening by turning the eccentric screw in the contact support. Tighten clamp screw, check with gauge again after tightening clamp screw. **THE CONTACT POINTS SHOULD BE CLEANED BEFORE ADJUSTING IF THEY HAVE BEEN IN SERVICE.** The cam or contact angle is the angle in degrees of cam rotation through which the points remain closed. This angle increases with decreased point opening. As the rubbing block of a new breaker arm wears in, rounding the corners of the rubbing surface, the contact angle increases.

CONTACT POINT PRESSURE - Must fall within the limits given. Weak tension will cause point chatter and ignition miss at high speed, while excessive tension will cause undue wear of the contact points, cam and rubbing block.

USE OF DISTRIBUTOR TEST FIXTURE - The distributor test fixture accurately checks cam angle, spark advance and synchronization on distributors removed from the car. It will also show excessive distributor shaft eccentricity as indicated by variation in synchronization.

After a distributor has been repaired, the calibration of the centrifugal automatic mechanism should be checked. Proper engine performance cannot be obtained unless the centrifugal curve is within the limits specified for the particular engine.

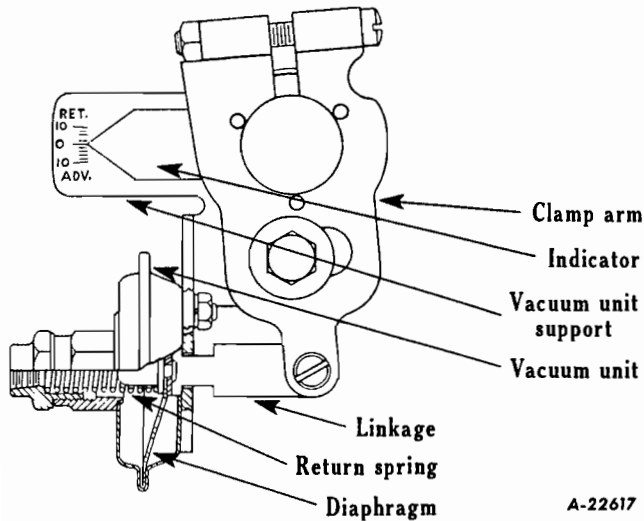
THE CONDENSER - Four factors affect condenser performance and each factor must be considered in making any condenser tests. **BREAKDOWN** is a failure of the insulating material, a direct short between the metallic elements of the condenser. This prevents any condenser action. **LOW INSULATION RESISTANCE** or leakage prevents the condenser from holding a charge. A condenser with low insulation resistance is said to be "weak." All condensers are subject to leakage, which up to a certain limit is not objectionable. When it is considered that the ignition condenser performs its function in approximately 1/12,000 of a second, it can be seen that leakage can be large without detrimental effects. It must be considered, however, in any condenser test. **HIGH SERIES** resistance is excessive resistance in the condenser circuit due to broken strands in



the condenser lead or to defective connections. This will cause burned points and ignition failure upon initial start and at high speeds. CAPACITY is built into the condenser and is determined by the area of the metallic elements and the insulating and impregnating materials. For a complete check of the condenser, it is desirable to use a tester which will check for the above four conditions.

Vacuum Automatic

Vacuum controlled spark is combined with centrifugal-automatic type distributors to obtain greater economy and improved engine performance. The centrifugal-automatic spark mechanism is calibrated to give proper spark advance for the full load, wide-open throttle requirements of the particular engine.



A-22617

Fig. 4 - Details of the vacuum advance mechanism.

The use of the vacuum unit is accomplished by mounting it to the distributor clamp arm assembly. The diaphragm in the unit is linked to the distributor so that advance and retard is obtained by moving the distributor in its mounting. The movement of the diaphragm is actuated by vacuum from the engine manifold and a calibrated return spring.

When the engine is idling the vacuum unit has no action on the distributor. When the throttle is opened slowly the vacuum is high and spark will be given additional advance to that of the centrifugal advance. On full load wide-open throttle when the vacuum is low or at high speed, the vacuum unit will not advance the spark. Under these low vacuum conditions spark advance depends upon the centrifugal mechanism in the distributor.

Full Automatic

There is no manually operated spark advance with this type of spark control, thus making the variation of the spark dependent entirely upon the centrifugal automatic mechanism.

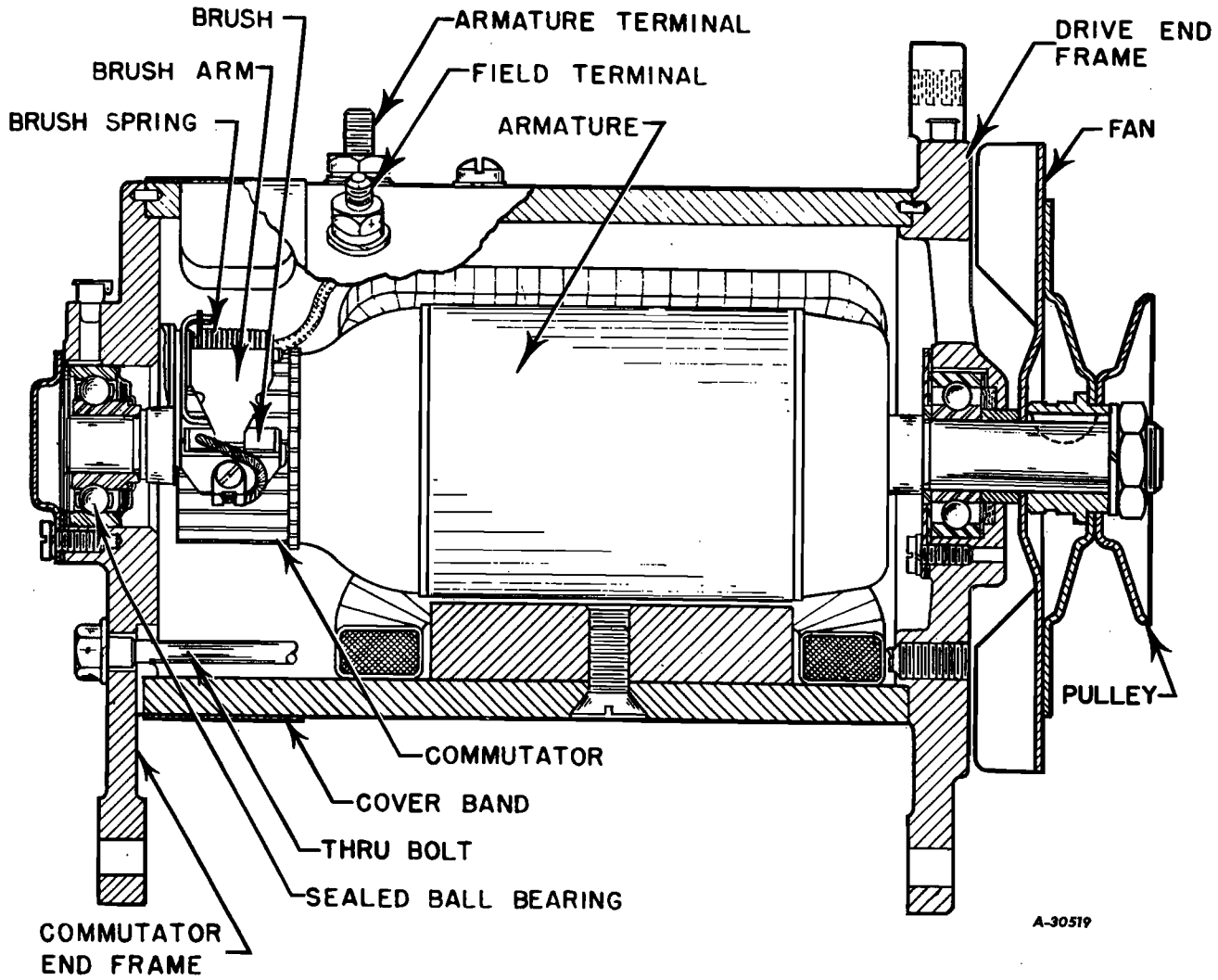
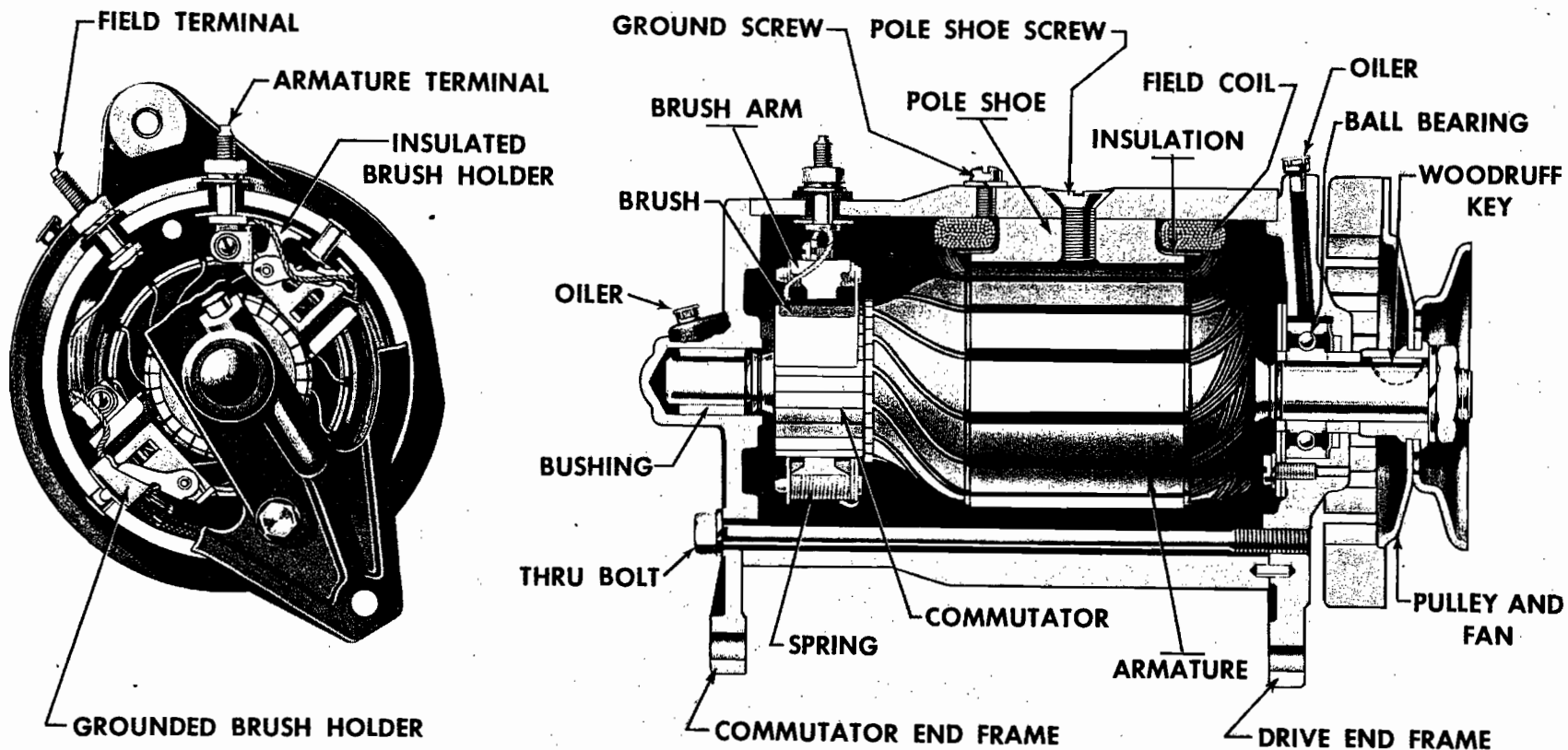


Fig. 1 - Sectional View of Generator (Delco-Remy Model 1100019 and Model 1102785)





A-30520

Fig. 2 - Sectional View of Generator (Delco-Remy Model 1105876)





GENERATORS

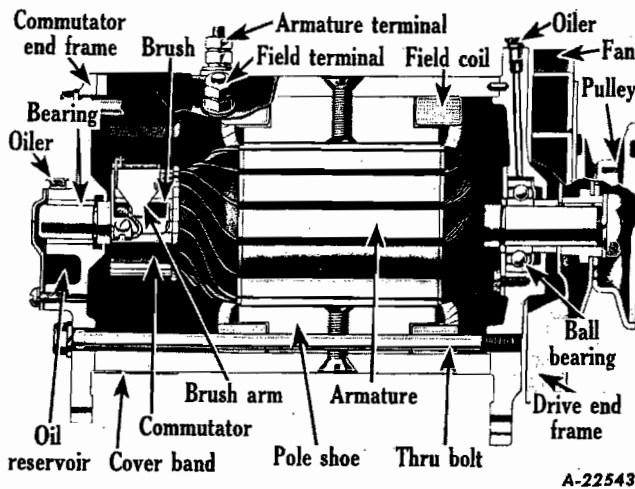


Fig. 1 - Sectional view of generator.

DELCO-REMY GENERATORS
MODELS 1102674 AND 1102714

The Delco-Remy Models 1102674 and 1102714 Generators Fig. 1 are 6 volt, 4-9/16 inch diameter frame size, ventilated, two-brush shunt units, with a ball bearing supporting the armature at the drive end and a bronze bushing in the commutator end. They are force-draft ventilated by means of a fan, mounted back of the drive pulley, which rotates with the armature shaft. The generator output is regulated by the correct settings of the current and voltage regulator.

Generator Maintenance

Generator maintenance may be divided into two sections, normal maintenance required to assure continued operation of generator, and the checking and repair of inoperative units.

Normal Generator Maintenance

LUBRICATION - The two hinge cap oilers should be supplied with 10 to 20 drops of light engine oil every 1000 miles of operation. Do not oil excessively. NEVER OIL COMMUTATOR.

INSPECTION - The cover band should be removed and the commutator and brushes inspected at regular intervals. If the commutator is dirty, it may be cleaned with #00 sandpaper. Blow out all dust after cleaning. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR. If the commutator is rough, out of round, or has high mica, it should be turned down on a lathe and the mica undercut.

Worn brushes should be replaced. They can be seated with a brush seating stone. When held against the revolving commutator, the abrasive material carries under the brushes, seating them in a few seconds. Blow out abrasive particles after seating brushes.

Check brush spring tension, which should be approximately 24-28 ounces.

Generator Disassembly

At regular intervals, the actual mileage or time depending on the type of operation, the generator should be disassembled for a thorough cleaning and inspection of all parts. Never clean the armature or fields in any degreasing tank, or with grease dissolving materials, since these may damage the insulation. The ball bearing should be cleaned and repacked with a good grade of ball bearing grease. The commutator should be trued in a lathe and the mica undercut if necessary. All wiring and connections should be checked. Rosin flux should be used in making all soldered connections. ACID FLUX MUST NEVER BE USED ON ELECTRICAL CONNECTIONS.

Checking Inoperative Generator

Several conditions may require removal of the generator from the engine and further checking of the generator, as follows:

1. NO OUTPUT

Remove cover band and check for sticking or worn brushes and burned commutator bars. Burned bars, with other bars fairly clean, indicate open circuited coils. If brushes are making good contact with commutator, and commutator looks okay, use test leads and light and check as follows:

- a. Raise grounded brush, check with test points from "A" terminal to frame. Light should not light. If it does, the generator is grounded; raise other brush from commutator and check field, commutator and brush holder to locate ground.
- b. If generator is not grounded check field for open circuit.
- c. If the field is not open, check for shorted field. Field draw at 6 volts should be 1.75 to 1.90 amperes. Excessive current draw indicates shorted field.
- d. If trouble has not yet been located, remove armature and check on growler for short circuit.



2. UNSTEADY OR LOW OUTPUT

Check as follows:

- a. Check drive belt tension.
- b. Check brush spring tension and brushes for sticking.
- c. Inspect commutator for roughness, grease and dirt, dirt in slots, high mica, out of round, burned bars. With any of these conditions, the commutator must be turned down in a lathe and the mica undercut.

In addition, with burned bars which indicate open circuit, the open circuit condition must be eliminated or the armature replaced.

3. EXCESSIVE OUTPUT

Excessive output usually results from a grounded generator field - grounded either internally, or in the regulator. Opening the field circuit (disconnecting lead from "F" terminal of regulator or generator) with the generator operating at a medium speed will determine which unit is at fault. If the output drops off, the regulator is causing the condition. If the output remains high, the field is grounded in the generator, either at the pole shoes, leads, or at the "F" terminal.

4. NOISY GENERATOR

Noisy generator may be caused by loose mounting or drive pulley, or worn, dry or dirty bearings, or improperly seated brushes. Brushes may be seated by using brush seating stone, referred to under Normal Generator Maintenance.

Installation Caution

After the generator is reinstalled on the engine, or at any time after leads have been disconnected and then reconnected to the generator, a jumper lead should be connected **MOMENTARILY** between the BATTERY and ARMATURE terminals of the regulator, before starting the engine. This allows a momentary surge of current from the battery to the generator which correctly polarizes the generator with respect to the battery it is to charge.

HEADLIGHTS

Sealed-Beam Headlights

The optical parts are so constructed that the light source, reflector, lens, and gasket are all assembled in one complete, securely sealed unit.

Among the advantages of Sealed-Beam headlights are: (a) relief from glare in "TRAFFIC (LOWER) BEAM" because of better light distribution; (b) maintained lighting efficiency since the optical parts of the unit are permanently sealed against dirt, moisture, and corrosion; (c) longer-lived filaments; (d) replacement of complete optical unit in field assures original lighting efficiency, thereby avoiding poor lighting results through use of improper lens, reflectors, or bulbs.

Sealed-Beam headlights provide two separate and distinct beams and produce considerable more light than former-type headlights. There is a "COUNTRY (UPPER) BEAM" and a "TRAFFIC (LOWER) BEAM".

The "COUNTRY (UPPER) BEAM" is designed to give even road illumination for a considerable distance and is intended for use on the open highway when other vehicles are not approaching.

The "TRAFFIC (LOWER) BEAM" is intended for use in traffic. It is low enough on the left side to avoid glare in the eyes of oncoming drivers, and at the same time the distribution of light on the right side will illuminate the road as far ahead as practical without causing glare on curves.

Changing from "COUNTRY (UPPER) BEAM" to "TRAFFIC (LOWER) BEAM" is accomplished through use of the foot dimmer switch. CAUTION: Always use the "TRAFFIC (LOWER) BEAM" when meeting other vehicles.

Replacements (Sealed-Beam Units)

Should a filament burn out or a lens break, the entire Sealed-Beam unit must be replaced. Maximum lighting efficiency is thus assured. The added cost of the replacement unit will be balanced or offset by the longer-lived filament used in the construction of the sealed unit.

Replacement of a bulb or lens is accomplished only through the replacement of the entire unit. To do this:

1. Loosen door retaining screw on headlight body. Remove door. (See Fig. 1.)



Fig. 1 - Removing headlight door.

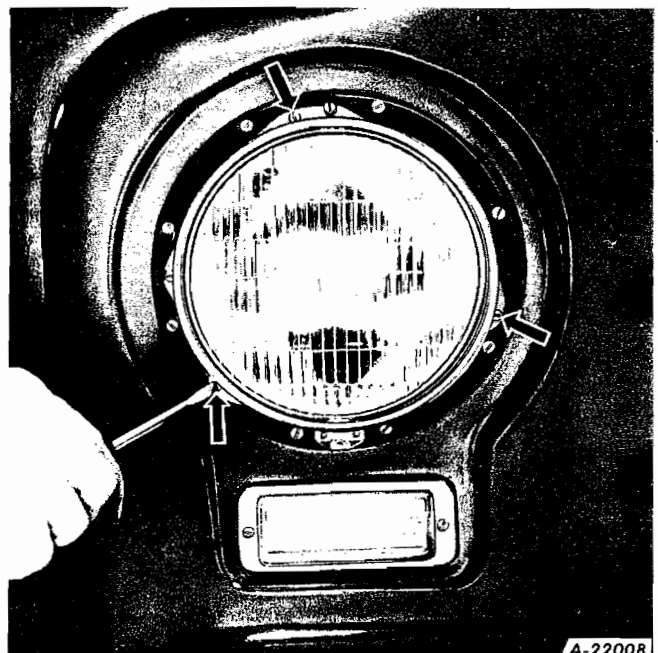


Fig. 2 - Remove retainer ring screws.

2. Remove unit retaining ring by removing three screws. (See Fig. 2.)
3. Remove unit from headlight body and disconnect three-way connector at the rear. (See Fig. 3.)

Reassembly is accomplished by reversing the foregoing procedure.

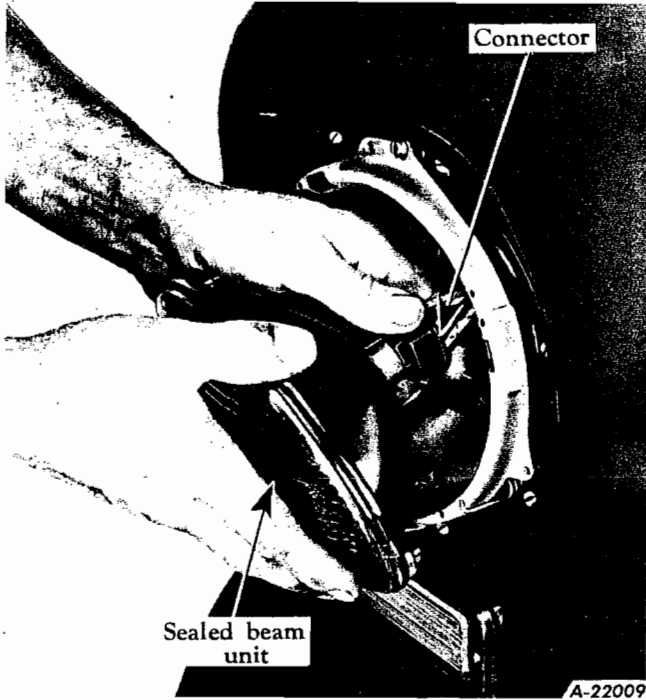


Fig. 3 - Removing sealed-beam unit.

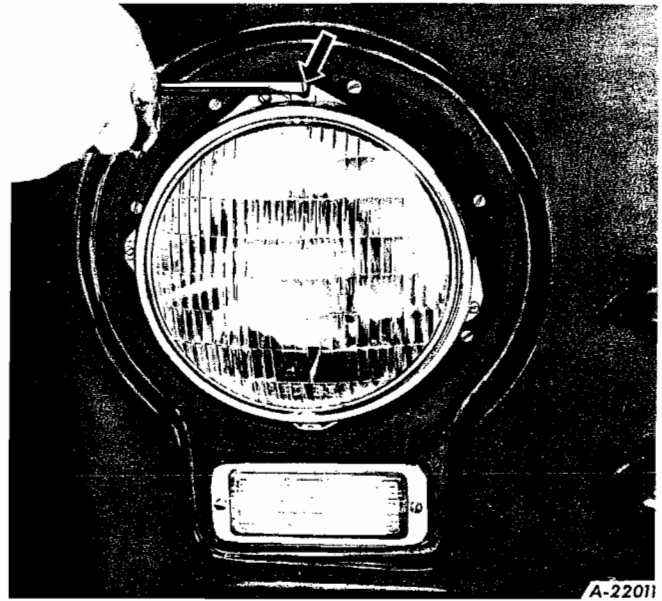


Fig. 5 - Adjusting vertical beam.

Vertical or up-and-down adjustment is accomplished at screw in Fig. 5.

When suitable headlight testing equipment is not available, the following chart will be helpful.

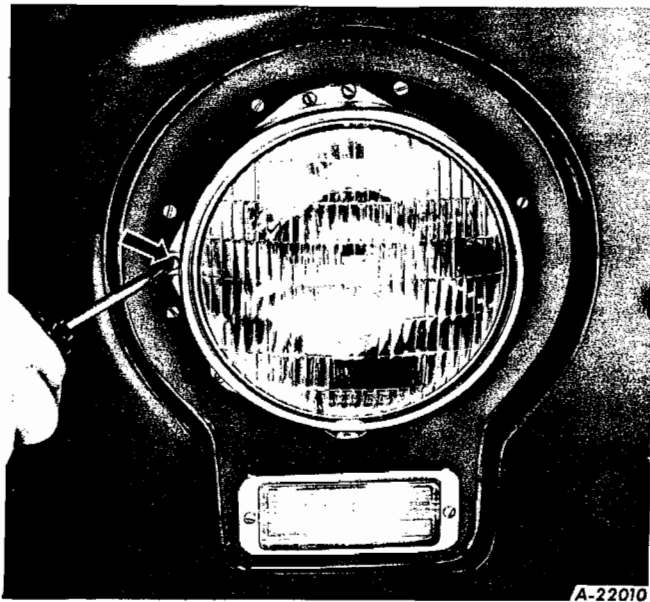


Fig. 4 - Adjusting lateral or side beam.

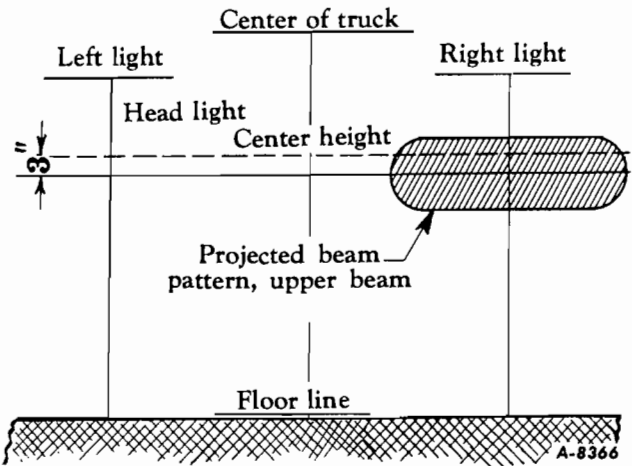


Fig. 6

Adjustment

Headlight adjustment should always be effected on a level floor, otherwise aiming of projected beams will be inaccurate. Truck should be empty.

Lateral or side adjustment is accomplished at screw in Fig. 4.

Aiming of headlights of Sealed-Beam type is effected by projecting the "COUNTRY (UPPER) BEAM" of each individual headlight upon a screen or chart at a distance of twenty-five feet from the headlight. The truck should be squarely lined up with the screen. Vertical lines on the chart mark the distance between the center lines of the headlights and are equally spaced from the center line of the chart.



A horizontal line on the chart shall be placed at a level 3 inches below the height of the headlight centers above the floor. Each headlight must be adjusted so that the hot spot of the beam will be centered over the point of intersection of the vertical and horizontal lines. (In some states this aiming conflicts with existing laws and regulations; wherever such is the case the legal requirements control and these instructions should be modified accordingly.)

Fig. 6 illustrates the beam pattern to be attained.

PARKING LIGHTS

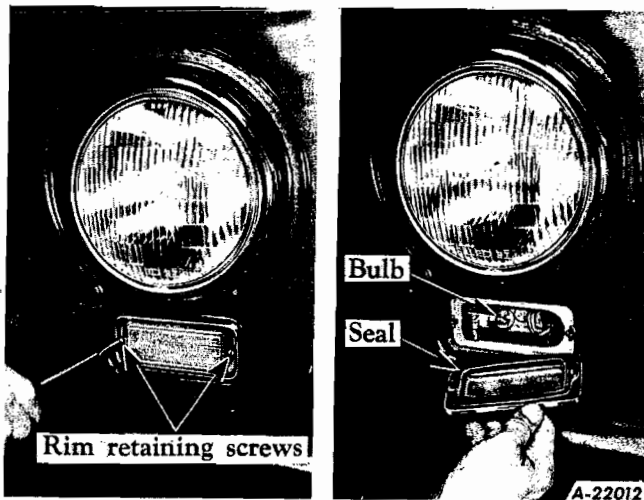


Fig. 7

The parking lights, located just below the headlights, are equipped with ordinary filament bulbs. Should it become necessary to replace either a parking light lens or bulb, remove the rim retaining screws, as shown, replace the necessary parts and reassemble.

CIRCUIT BREAKERS

Independent current circuit breakers are used to protect the headlight high-and-low beam circuits, parking lights, tail lights, stop lights, and horn circuits from possible damage should a short circuit occur.

Each circuit breaker is a sealed non-adjustable unit and consists of a bi-metal plate, contact points, and is connected in series with its respective circuit.

Six (6) circuit breakers and two (2) terminal blocks are included in the assembly as illustrated in Fig. 8, and are located on the vehicle at the engine side of the cab dash panel. The circuit breakers and terminal blocks are similar in outward appearance but different in inward construction and function. Circuit

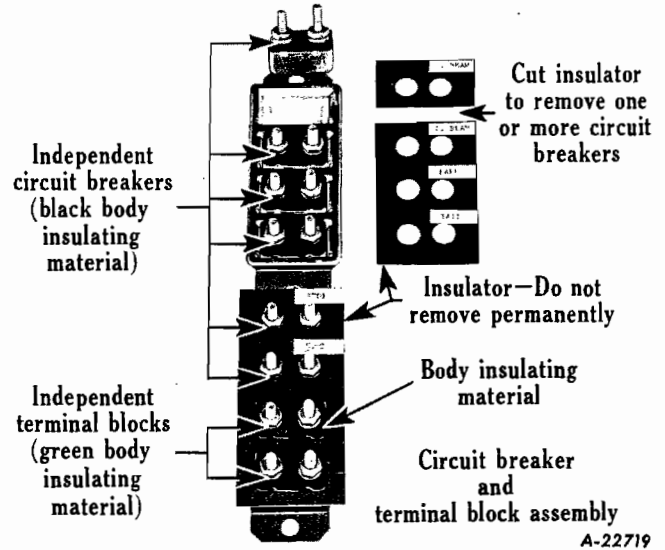


Fig. 8 - Circuit breakers.

breakers can be identified by their "green" color body insulating material, whereas terminal blocks have "black" color body insulating material.

The headlight upper beam circuit and lower beam circuit have independent circuit breakers to eliminate failure of both circuits at the same time should a short occur. For example: Should a short occur in the headlight upper beam circuit, the lower beam circuit would not be affected and could be utilized immediately by depressing the dimmer switch.

Individual replacement of a circuit breaker can be accomplished by disconnecting cables and cutting the insulator between the circuit breakers as shown in Fig. 8. Remove circuit breaker from frame by pulling on terminal screws with pliers. To install, press circuit breaker into frame by hand.

A dead short in a circuit will cause the circuit breaker bi-metal plate to heat sufficiently and pull away from its contact points immediately cutting off the flow of current. A partial short will cause intermittent current flow causing the lights to dim and flicker, this should be taken as a warning and the vehicle brought to a safe stop as soon as possible.

In other units in addition to headlights, a dead short can be detected by the ammeter indicating a heavy discharge momentarily until such time as the circuit breaker opens and the circuit is broken. A partial short can be detected by abnormal fluctuation of the ammeter. The two (2) terminal blocks in the assembly are used to connect circuits for fuel gauge units, dimmer switch feed cable, side mounted fuel tanks, fog lights, directional signals, etc.



Testing The Circuit Breaker

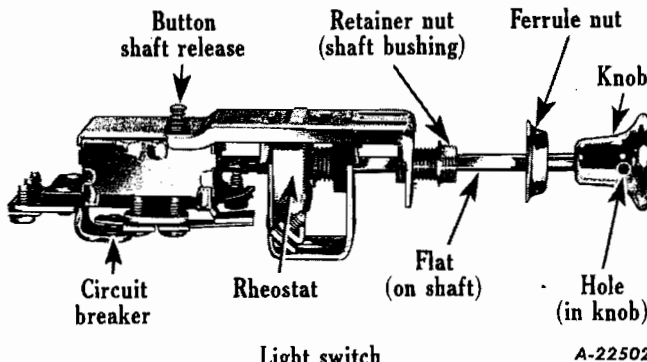
Should current-flow in one of the circuits employing a circuit breaker be interrupted, it is possible that there is a short in the circuit or that the circuit breaker is defective and is holding open. To check for current-flow through the circuit breaker remove the cables from both circuit breaker terminals and connect a hotlead cable to the circuit breaker terminal marked "BAT" and a test light to the remaining terminal marked "AUX". If test light fails to light, the circuit breaker is defective and should be replaced.

LIGHT SWITCH REMOVAL (DELCO-REMY)

1. Pull light switch knob outward to headlight bright position.
2. Depress shaft release button (Fig. 9) on switch body and pull switch knob and shaft out of switch body.
3. Remove ferrule nut by positioning a punch in one of the indentations in nut face, and tap punch lightly turning nut in a counter-clockwise direction.
4. Unscrew switch retainer nut (also shaft bushing) out of switch.
5. Remove various electrical cables from switch.
6. The light switch pull knob can be removed by inserting a thin tool in the small hole in the knob, and pushing the spring lock inside the knob forward (toward knob end of switch). Hold spring lock in forward position and pull knob off of shaft.
7. Installation of the light switch follows:
8. Install electrical cables.
9. Align flat on switch shaft with flat in rheostat assembly in switch (see Fig. 9) and push light switch shaft into its bore in switch body. Install switch retainer nut and ferrule nut. Use same method for installing ferrule nut as prescribed for removal except turn nut clockwise.
10. Align flat on light switch knob with flat on shaft and push knob on shaft by following detailed instructions outlined below:

Instructions for Installing Control Knobs.

Place the control knob in position on the shaft until the end of the shaft just begins to engage the locking hole in the tab portion of



Light switch

Fig. 9

A-22502

the knob retainer spring. (Upon engagement with the retaining spring, the knob cannot be easily pushed into position since the spring, contacting the end of the shaft, prevents further movement).

With the knob in position as shown (Fig. 10) and with the end of the thumb at the top edge of the knob face, press the knob with a combination lifting and pushing motion, performed simultaneously, into position on the shaft.

The lifting motion serves to deflect the knob retainer spring tab, and the pushing motion forces the knob into position.

Installation of the control button on the windshield wiper switch requires that the above instruction be carried out in detail, since unreasonable pressure against the shaft of the windshield wiper switch is apt to damage the switch mechanism. When the control knobs are installed as instructed, no difficulty should be experienced and the operation can be performed with ease.

NOTE: The carburetor hand throttle control knob, the windshield wiper control knob, and the choke wire control knob are removed in the same manner as prescribed for the light switch control knob.

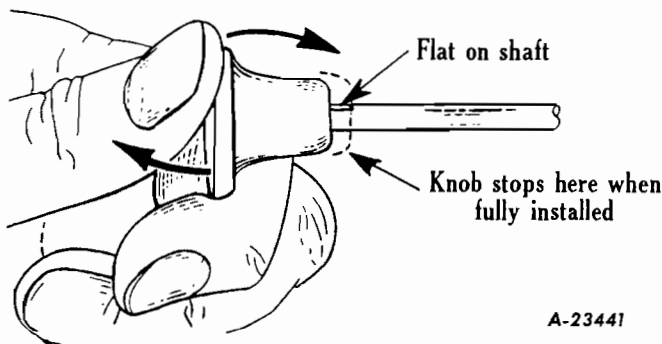
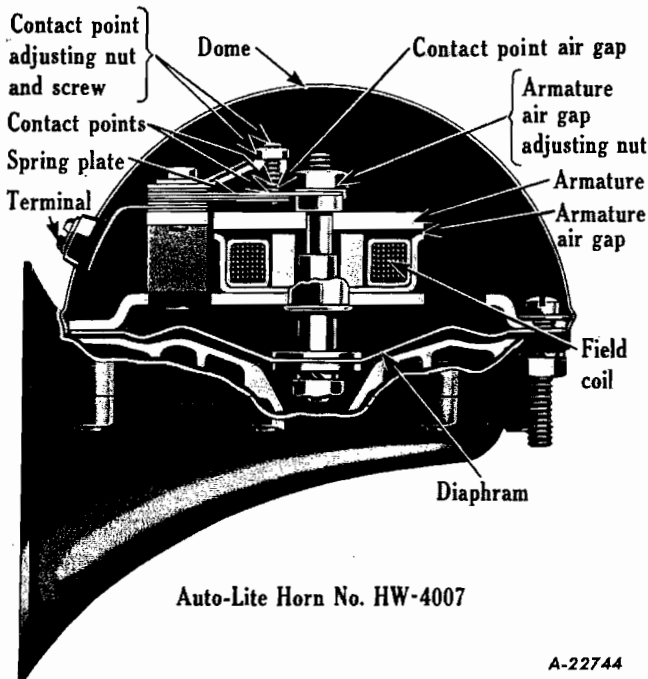


Fig. 10

A-23441



HORN



Auto-Lite Horn No. HW-4007

A-22744

Fig. 1

Electrically Operated Horn

The electrically operated horns are vibrating type units that operate on a magnetic principle to produce the warning signal. Current from the battery flows through the windings within the horn power plant when the circuit is completed at the horn push-button switch. The magnetic attraction of the armature toward the pole causes a tension and slight movement of the diaphragm. This movement opens the contact points in series with the horn windings, breaking the circuit. When the current is interrupted, the armature returns to its original position, relieving the tension of the diaphragm. The slight return movement of the armature and diaphragm allows the contact points to close, completing the circuit. This cycle is repeated a great many times per second, resulting in a rapid vibration of the diaphragm. Each horn is designed to operate at a predetermined number of cycles per second to produce its characteristic warning signal. The pitch of the horns depends upon the number of vibrations per second, the high note horns having the greater frequency.

Conditions Affecting Horn Performance

The following conditions affect the performance of the horns and should be checked before attempting to make any adjustments to the instruments:

Low Horn Voltage

If the horn produces a weak signal, the voltage at the horn should be checked. Connect a voltmeter from the horn terminal to ground when checking horns having one terminal. Connect the voltmeter across the horn terminals when checking horns having two terminals. The voltage readings should not be less than 5.25 volts (six-volt system) or 11 volts (twelve-volt system). A lower reading would indicate either a low battery or a high resistance in the horn circuit.

Low Battery

Check the battery with a voltmeter or hydrometer for condition of charge. If low, the battery should be recharged.

Loose or Corroded Connections in Horn Circuit

Clean and tighten connections wherever necessary. Check for defective wiring by connecting separate test leads from the horn to the battery. A loose connection or poor contact at the horn push-button switch may cause the horn to operate intermittently. Shunt around the horn button to determine whether there is poor contact at the push-button switch.

Loose or Damaged Parts

Horns usually have a rasping sound when vital parts are loose or broken. A loose dome may affect the tone. Tighten all mounting nuts and replace all damaged parts.

Adjustment (For Auto-Lite Horn No. HW-4007)

1. Remove the horn dome. To remove, pry under the edge of the dome with a screwdriver at a point approximately opposite the terminal. On horns using a gasket under the dome, place the screwdriver between the dome bead and the projector and loosen with a twist of the screwdriver.
2. It is important that the horn circuit breaker contact points be kept clean. Rub briskly with crocus cloth, then clean with linen tape and carbon tetrachloride. Remove all residue by drawing a piece of clean tape between the contacts.
3. Tighten all flange bolts.
4. Tighten the two screws holding the circuit breaker, with a socket wrench. Be sure contacts are aligned and that the circuit



breaker spring does not rub against the armature bolt.

5. Check the resistance of the resistor which is connected across the contact points. Its resistance should be 2.5 to 2.8 ohms and is measured by placing a card between the contacts and measuring across the resistor terminals.

6. Check the armature air gap on all sides. Adjust to .0495" by loosening the lock nut and turning the armature. Tighten the lock nut, then recheck the gap making sure the gauge is a snug fit on all sides.

NOTE: Sometimes the armature spring plate sticks to the armature and prevents it from turning. To loosen, tap the armature spring plate lightly with a screwdriver.

7. Connect for tuning test with the ammeter in series with the horn terminal and a 6 volt battery and the horn frame grounded to the other battery terminal. Connect the voltmeter from the horn terminal to a clean spot on the horn frame. Adjust the amperage draw for each horn to 15 amperes at 6.2 volts by loosening the lock nut on the circuit breaker contact and turning the adjusting screw. Retighten the lock nut.

Horn Relay

The horn relay is connected into the horn and battery circuit so as to make a more direct connection between the battery and horns, eliminating the horn button wiring from the horn circuit proper so that higher voltage becomes available at the horns and better horn performance is obtained. The horn relay consists of a winding assembled on a core above which an armature is placed. The armature has a point positioned above a stationary point.

Horn Relay Operation

When the horn button is depressed, the circuit from the battery is completed through the horn relay winding; this causes a magnetic field which pulls the relay armature down so that the circuit between the battery and horns is completed. The horns function and will continue to function as long as the horn button remains in the closed position.

Horn Relay Checks and Adjustments

Three checks and adjustments are required on the horn relay: air gap, point opening and closing voltage. The air gap and contact point opening checks and adjustments should be made with the battery disconnected.

Air Gap

The air gap should not normally require adjustment unless the relay has been misadjusted. Check the air gap with the points barely touching and adjust if necessary by bending the lower point support.

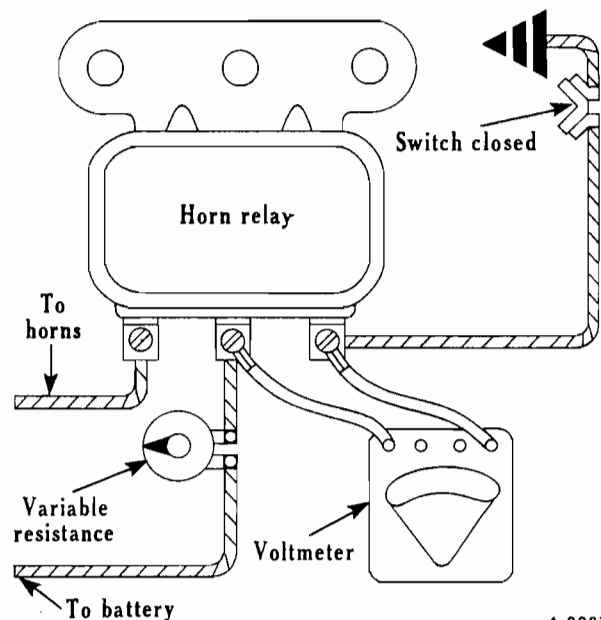
Contact Point Opening

Check the contact point opening and adjust by bending the upper armature stop.

Closing Voltage

To check the relay closing voltage, connect a variable resistance of 10 ohms in series with the relay "B" terminal and connect a voltmeter between the "S" and the "B" terminals as shown in Fig. 2. With the horn button closed, slowly decrease the amount of resistance in order to check the relay closing voltage. Adjust the closing voltage by bending the armature spring post. Bending down to increase the spring tension increases the closing voltage while bending up decreases the closing voltage.

NOTE: Late type horn relay terminals do not carry any markings, but relationship of the terminals is as shown in Fig. 2.



A-22877

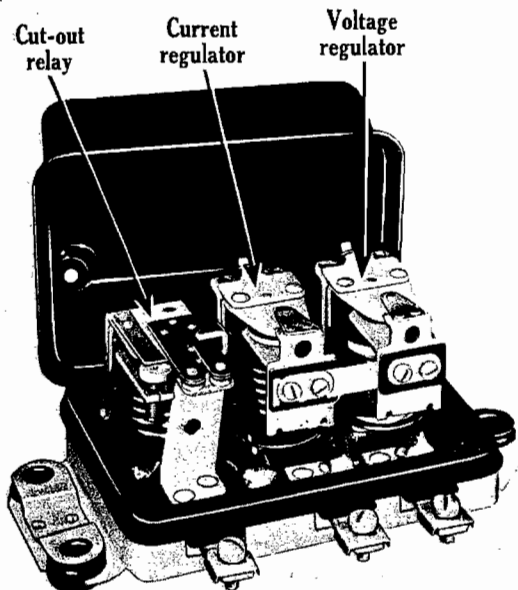
Fig. 2

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REGULATORS

Three-Unit Regulator

The Delco Remy three-unit regulator is designed for use with shunt-type generators with externally grounded field circuits. The regulator contains a cutout relay, a voltage regulator, and a current regulator (Fig. 1.)



A-22609

Fig. 1 - Three-unit regulator. Cover removed to show the Cut-out relay, Current regulator and Voltage regulator.

Cutout Relay

The cutout relay has two windings assembled on one core, a series winding of a few turns of heavy wire and a shunt winding of many turns of fine wire. The shunt winding is shunted across the generator so that generator voltage is impressed upon it at all times. The series winding is connected in series with the charging circuit so that generator output passes through it (Fig. 2.)

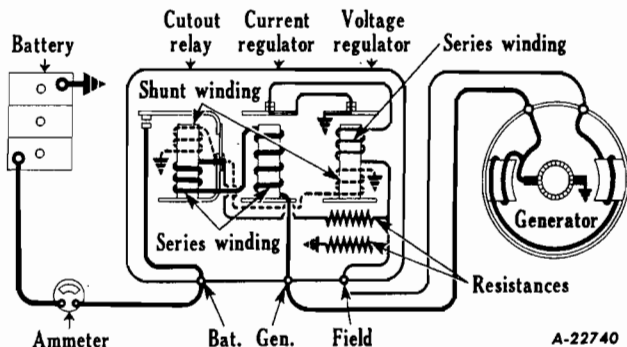


Fig. 2 - Wiring circuit of three-unit regulator.

The relay core and windings are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is centered just above the end of the core. The armature has one or two contact points which are located just above a similar number of stationary contact points. When the generator is not operating the armature contact points are held away from the stationary points by the tension of a flat spring riveted on the side of the armature.

CUTOUT RELAY ACTION--When the generator voltage builds up to a value great enough to charge the battery, the magnetism induced in the relay windings is sufficient to overcome the armature spring tension and pull the armature toward the core so that the contact points close. This completes the circuit between the generator and battery. The current which flows from the generator to the battery passes through the series winding in the proper direction to add to the magnetism holding the armature down and the contact points closed.

When the generator slows down or stops, current begins to flow from the battery to the generator. This reverses the direction that the current flows through the series winding, thus causing a reversal of the series winding magnetic field. The magnetic field of the shunt winding does not reverse. Therefore, instead of helping each other, the two windings now magnetically oppose so that the resultant magnetic field becomes insufficient to hold the armature down. The flat spring pulls the armature away from the core so that the points separate; this opens the circuit between the generator and battery.

VOLTAGE REGULATOR ACTION--When the generator voltage reaches the value for which the voltage regulator is adjusted, the magnetic field produced by the two windings (shunt and series) overcomes the armature spring tension and pulls the armature down so that the contact points separate. This inserts resistance into the generator field circuit so that the generator field current and voltage are reduced. Reduction of the generator voltage reduces the magnetic field of the regulator shunt winding. Also, opening the regulator points opens the regulator series winding circuit so that its magnetic field collapses completely. The consequence is that the magnetic field is reduced sufficiently to allow the spiral spring to pull the armature away from the core so that the contact points again close. This directly



grounds the generator field circuit so that generator voltage and output increase. The above cycle of action again takes place and the cycle continues at a rate of 150 to 250 times a second, regulating the voltage to a constant value. By thus maintaining a constant voltage the generator supplies varying amounts of current to meet the varying states of battery charge and electrical load.

CURRENT REGULATOR ACTION--When the load demands are heavy, as for example, when electrical devices are turned on and the battery is in a discharged condition, the voltage may not increase to a value sufficient to cause the voltage regulator to operate. Consequently, generator output will continue to increase until the generator reaches rated maximum. This is the current value for which the current regulator is set. Therefore, when the generator reaches rated output, this output flowing through the current regulator winding, creates sufficient magnetism to pull the current regulator armature down and open the contact points. With the points open, resistance is inserted into the generator field circuit so that the generator output is reduced.

As soon as the generator output starts to fall off, the magnetic field of the current regulator winding is reduced, the spiral spring tension pulls the armature up, the contact points close and directly connect the generator field to ground. Output increases and the above cycle is repeated. The cycle continues to take place while the current regulator is in operation 150 to 250 times a second, preventing the generator from exceeding its rated maximum.

When the electrical load is reduced (electrical devices turned off or battery comes up to charge), then the voltage increases to that the voltage regulator begins to operate and tapers the generator output down. This prevents the current regulator from operating. Either the voltage regulator or the current regulator operates at any one time - the two do not operate at the same time.

Resistances

The current and voltage regulator circuits use a common resistor (Fig. 2) which is inserted in the field circuit when either the current or voltage regulator operates. A second resistor (Fig. 2) is connected between the regulator field terminal and the cutout relay frame, which places it in parallel with the generator field coils. The sudden reduction in field current occurring when either the current or voltage regulator contact points open, is accompanied by a surge of induced voltage in the field coils as the strength of the magnetic field changes. These surges are partially dissipated by the two resistors, thus preventing excessive arcing at the contact points.

Temperature Compensation

Voltage regulators are compensated for temperature by means of a bi-metal thermostatic hinge on the armature. This causes the regulator to regulate for a higher voltage when cold which partly compensates for the fact that a higher voltage is required to charge a cold battery. Many current regulators also have a bi-metal thermostatic hinge on the armature. This permits a somewhat higher generator output is cold but causes the output to drop off as temperature increases.

Regulator Polarity

Some regulators are designed for use with negative grounded batteries while other regulators are designed for use with positive grounded batteries. Using the wrong polarity regulator on an installation will cause the regulator contact points to pit badly and give very short life. As a safeguard against installation of the wrong polarity regulator, all 1118300 type regulators have the model number and the polarity clearly stamped on the end of the regulator base.

REGULATOR MAINTENANCE

General Instructions

1. Mechanical checks and adjustments (air gaps, point opening) must be made with battery disconnected and regulator preferably off the vehicle.

CAUTION: The cutout relay contact points must never be closed by hand with the battery connected to the regulator. This would cause a high current to flow through the units which would seriously damage them.

2. Electrical checks and adjustments may be made either on or off the vehicle. The regulator must always be operated with the type generator for which it is designed.
3. The regulator must be mounted in the operating position when electrical settings are checked and adjusted and it must be at operating temperature.
4. After any tests or adjustments the generator on the vehicle must be repolarized after leads are connected but before the engine is started, as follows:

Repolarizing Generator

After reconnecting leads, momentarily connect a jumper lead between the "GEN" and "BAT" terminals of the regulator. This allows a momentary surge of current to flow through

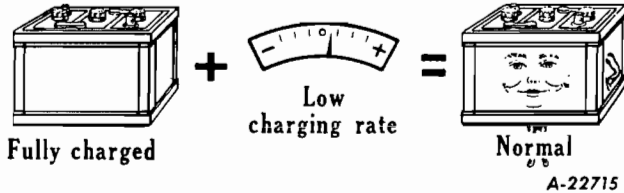


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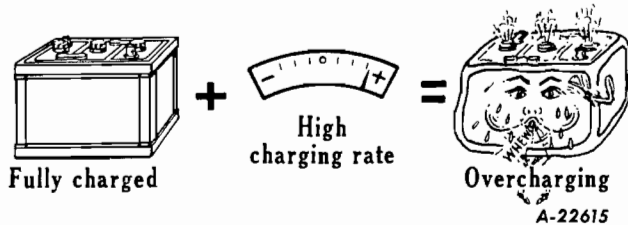
the generator which correctly polarizes it. **CAUTION!** Failure to do this may result in severe damage to the equipment since reversed polarity causes vibration, arcing and burning of the relay contact points.

QUICK CHECKS OF GENERATOR AND REGULATOR

In analyzing complaints of generator-regulator operation, any of several basic conditions may be found.



1. FULLY CHARGED BATTERY AND LOW CHARGING RATE--This indicates normal generator-regulator operation. Regulator settings may be checked as outlined on following pages.



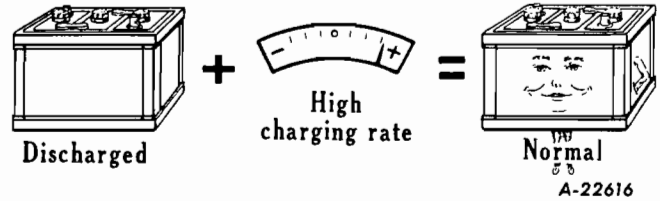
2. FULLY CHARGED BATTERY AND A HIGH CHARGING RATE--This indicates that the voltage regulator is not reducing the generator output as it should. A high charging rate to a fully charged battery will damage the battery and the accompanying high voltage is very injurious to all electrical units.

This operating condition may result from:

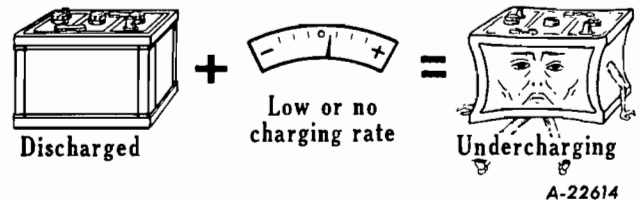
- (a) Improper voltage regulator setting.
- (b) Defective voltage regulator unit.
- (c) Grounded generator field circuit (in either generator, regulator or wiring).
- (d) Poor ground connection at regulator.
- (e) High temperature which reduces the resistance of the battery to charge so that it will accept a high charging rate even though the voltage regulator setting is normal.

If the trouble is not due to high temperature, determine the cause of trouble by disconnecting the lead from the regulator "F" terminal

with the generator operating at medium speed. If the output remains high, the generator field is grounded either in the generator or in the wiring harness. If the output drops off the regulator is at fault and it should be checked for a high voltage setting or grounds.



3. DISCHARGED BATTERY AND HIGH CHARGING RATE--This is normal generator-regulator action. Regulator settings may be checked as outlined in the following section



4. DISCHARGED BATTERY AND LOW OR NO CHARGING RATE--

This condition could be due to:

- (a) Loose connections, frayed or damaged wires.
- (b) Defective battery.
- (c) High circuit resistance.
- (d) Low regulator setting.
- (e) Oxidized regulator contact points.
- (f) Defects within the generator.

If the condition is not caused by loose connections, frayed or damaged wires, proceed as follows to locate cause of trouble.

To determine whether the generator or regulator is at fault, momentarily ground the "F" terminal of the regulator and increase generator speed. If the output does not increase, the generator is probably at fault. If the generator output increases, the trouble is due to:

- (a) A low voltage (or current) regulator setting.
- (b) Oxidized regulator contact points which insert excessive resistance into the generator field circuit so that output remains low.



(c) Generator field circuit open within the regulator at the connections or in the regulator winding.

5. **BURNED RESISTANCES, WINDINGS OR CONTACTS**--These result from open circuit operation, open resistance units, or high resistance in the charging circuit. Where burned resistances, windings or contacts are found, always check car wiring before installing a new regulator. Otherwise, the new regulator may also fail in the same way.
6. **BURNED RELAY CONTACT POINTS**--This may be due to reversed generator polarity. Generator polarity must be corrected as explained on page 2 after any checks of the regulator or generator, or after disconnecting and reconnecting leads.

Cleaning Contact Points

The contact points of a regulator will not operate indefinitely without some attention. It has been found that a great majority of all regulator trouble can be eliminated by a simple cleaning of the contact points, plus some possible readjustment. The flat points should be cleaned with a spoon or riffler file. On negative grounded regulators which have the flat contact point on the regulator armatures, loosen the contact bracket mounting screws so that bracket can be tilted to one side (Fig. 3). On positive grounded regulators, the flat point is in the upper contact bracket so the bracket must be removed for cleaning the points. A flat file cannot be used successfully to clean the flat contact points since it will not touch the center of the flat point where point wear is most apt to occur. NEVER USE EMERY CLOTH OR SANDPAPER TO CLEAN THE CONTACT POINTS.

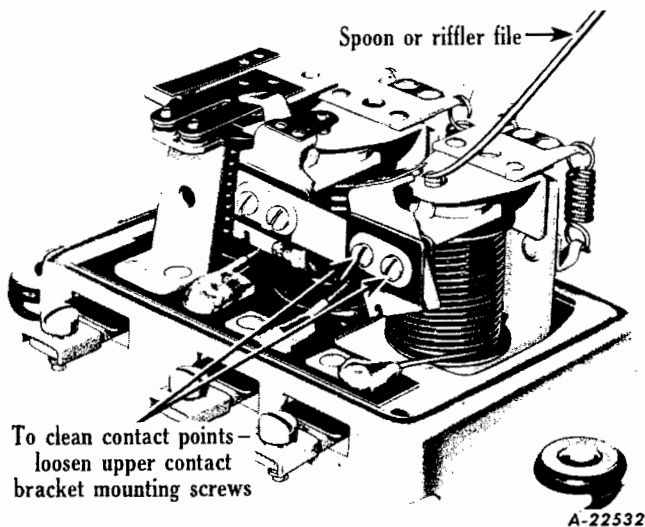
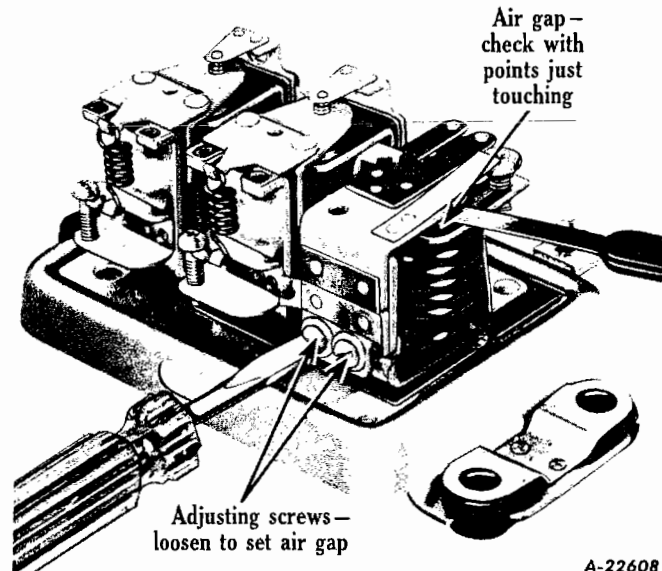


Fig. 3 - Use spoon or riffler file to clean flat contact points in regulator.

THREE-UNIT REGULATOR CHECKS AND ADJUSTMENTS

Cutout Relay

The cutout relay requires three checks and adjustments: air gap, point opening and closing voltage. The air gap and point opening adjustments must be made with the battery disconnected.



A-22608

Fig. 4 - Air gap check and adjustment. Battery must be disconnected when this check is made.

AIR GAP--Place fingers on armature directly above core and move armature down until points just close and then measure air gap between armature and center of core (Fig. 4). On multiple contact point relays, make sure that all points close simultaneously. If they do not, bend spring finger so they do. To adjust air gap, loosen two screws at the back of relay and raise or lower the armature as required. Tighten screws after adjustment.

POINT OPENING--Check point opening and adjust by bending the upper armature stop (Fig. 5).

CLOSING VOLTAGE--To check the closing voltage of the cutout relay, connect the regulator to the proper generator and battery, connect a voltmeter between the regulator "GEN" terminal and regulator base, and connect an ammeter into the charging circuit at the regulator "BAT" terminal as shown in Fig. 6. Slowly increase the generator speed and note relay closing voltage. Decrease generator speed and make sure that cutout relay contact points open. Adjust closing voltage by turning adjusting



screw (Fig. 7). Turn screw clockwise to increase spring tension and closing voltage, and turn screw counterclockwise to decrease closing voltage.

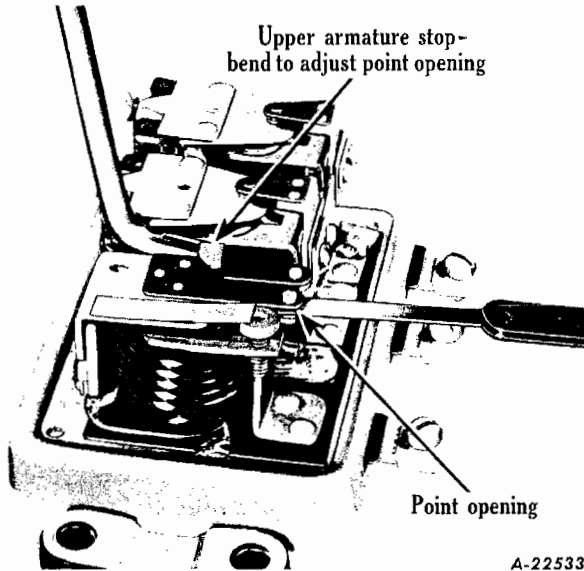


Fig. 5 - Cut-out relay point opening check and adjustment. Battery must be disconnected when this check is made.

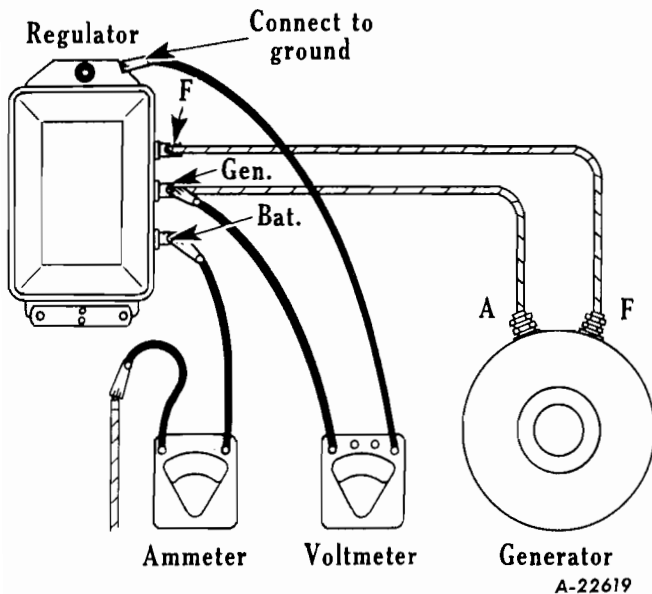


Fig. 6 - Connections to be made when checking relay closing voltage and reverse current to open relay points.

Voltage Regulator

Two checks and adjustments are required on the voltage regulator, air gap and voltage setting.

AIR GAP--To check air gap, push armature down until the contact points are just touching and then measure air gap (Fig. 13). Adjust by loosening the contact mounting screws and raising or lowering the contact bracket as required. Be sure the points are lined up, and tighten screws after adjustment.

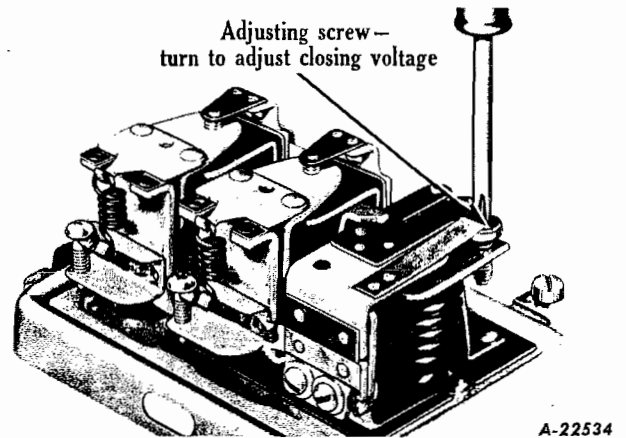


Fig. 7 - Adjusting cutout relay closing voltage.

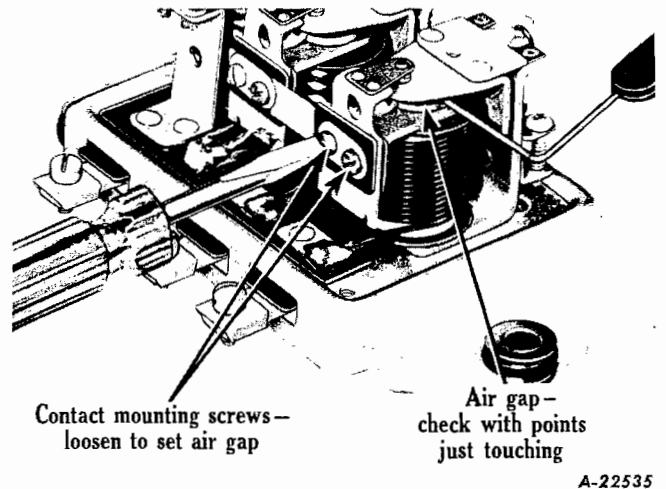


Fig. 8 - Voltage regulator air gap check.

VOLTAGE SETTING--There are two ways to check the voltage setting--the fixed resistance method and the variable resistance method (Figs. 9 and 10).

FIXED RESISTANCE METHOD--With the fixed resistance method, a fixed resistance is substituted for the external charging circuit by disconnecting the battery lead at the regulator and connecting the resistance between the regulator "BAT" terminal and ground. A test voltmeter is connected in parallel with the fixed resistance as shown in Fig. 9. The resistance must be 3/4 ohm* for 6 volt units, 1-1/2 ohms* for 12 volt units, 7 ohms for 24 volt units, and must be capable of carrying 10 amperes without any change of resistance with temperature changes.

* - See note on following page.

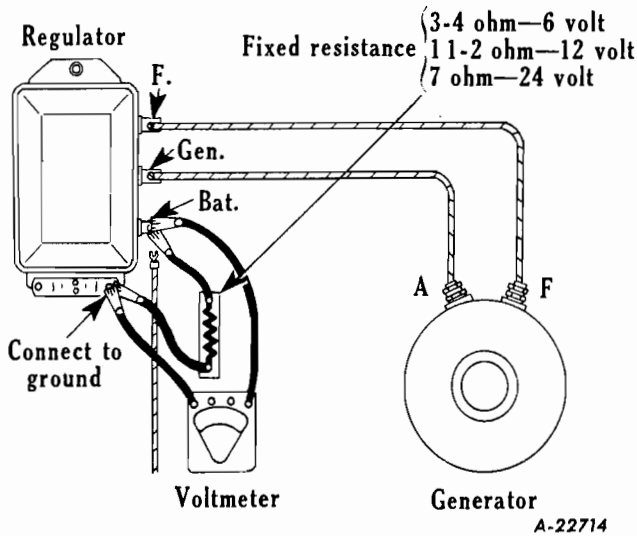


Fig. 9 - Fixed resistance and voltmeter connections to check voltage regulator setting by fixed resistance method. Connections are similar for both two-unit and three unit regulators.

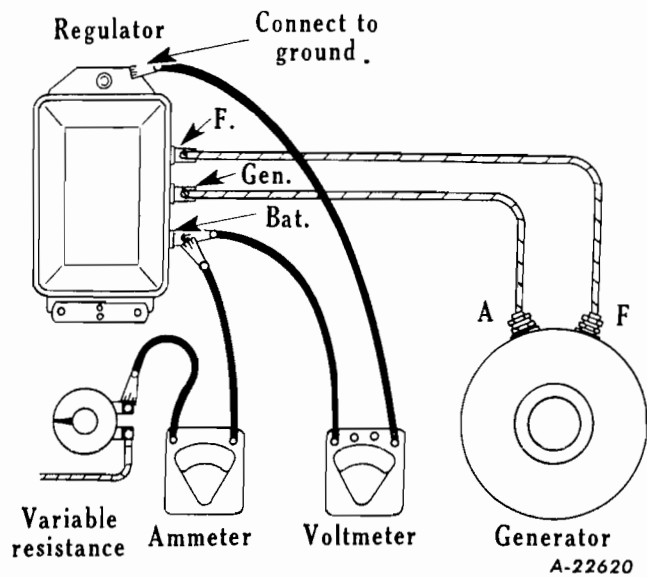


Fig. 10 - Voltmeter ammeter and variable resistance connections for checking voltage regulator setting by the variable resistance method.

*NOTE: With all 6 volt regulators having current ratings less than 15 amperes, it is necessary to use a 1-1/2 ohm fixed resistance to avoid interference from the current regulator. With all 12 volt regulators having current ratings less than 15 amperes, a 2-1/4 ohm fixed resistance (3/4 ohm and 1-1/2 ohm resistors in series) must be used for the same reason.

With generator operating 25 percent above rated output speed and with regulator at operating temperature, note voltage setting. Cover must be in place.

To adjust voltage setting, turn adjusting screw (Fig. 11). Turn screw clockwise to increase voltage setting and counterclockwise to decrease voltage setting.

CAUTION: If adjusting screw is turned down (clockwise) beyond normal adjustment range, spring support may fail to return when pressure is relieved. In such case, turn screw counterclockwise until sufficient clearance develops between screw head and spring support, then bend spring support upward carefully with small pliers until contact is made with screw head. Final setting of the unit should always be approached by increasing spring tension, never by reducing it. If setting is too high, adjust unit below required value, and then raise to exact setting by increasing spring tension.

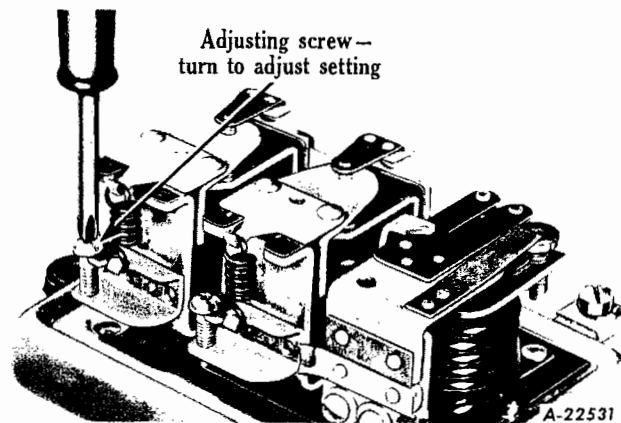


Fig. 11 - Adjusting voltage regulator setting.

If the unit is badly out of adjustment, refer to section headed REGULATOR SPRING REPLACEMENT.

After each adjustment and before taking voltage reading, replace the regulator cover, reduce generator speed until relay points open and then bring the generator back to speed again.

VARIABLE RESISTANCE METHOD--Connect ammeter into charging circuit at "BAT" terminal of regulator with 1/4 ohm variable resistance in series. Connect voltmeter from regulator "BAT" terminal to ground as shown

in Fig. 10. Increase generator speed to 25 per cent above rated output speed. If less than 8 amperes is obtained (or less than 4 amperes on low output 6 and 12 volt generators), turn on lights to permit increased generator output. Cut in resistance until output is reduced to 8-10 amperes (4-6 amperes on 6 and 12 volt generators having current ratings less than 15 amperes). Operate until regulator reaches operating temperature. Retard generator speed until relay points open, then bring generator back to speed and note voltage setting. Voltage readings must be taken with regulator at operating temperature and with 8-10 amperes flowing (4-6 amperes on low output units). Cover must be in place.

NOTE: It is very important that the variable resistance be connected at the "BAT" terminal as shown in Fig. 10 rather than at the "GEN" terminal, even though these terminals are in the same circuit. An examination of the wiring diagram, Fig. 2, will show that the regulation begins at the point where the shunt windings are connected to the series circuit. Any small resistance added to the circuit between the generator and this point will simply be offset by a rise in generator voltage without affecting the output shown at the ammeter.

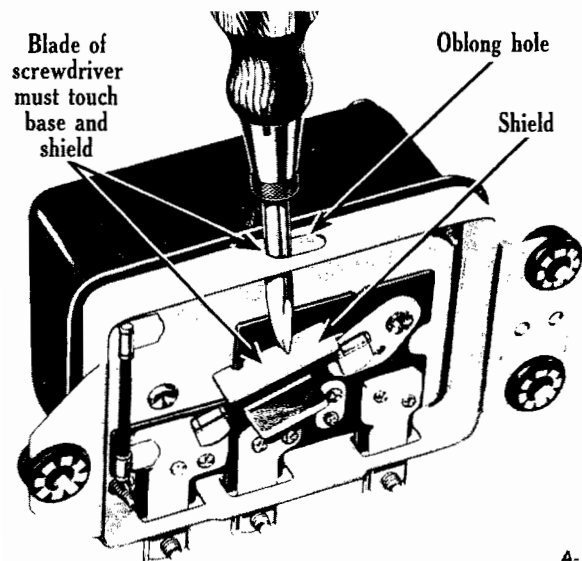


Fig. 12 - Quick method for cutting out voltage regulator in order to check current regulator setting.

Adjust regulator as previously explained. In using the variable resistance method, it is necessary to readjust the variable resistance after each voltage adjustment, and then reduce and increase generator speed before taking the voltage reading.

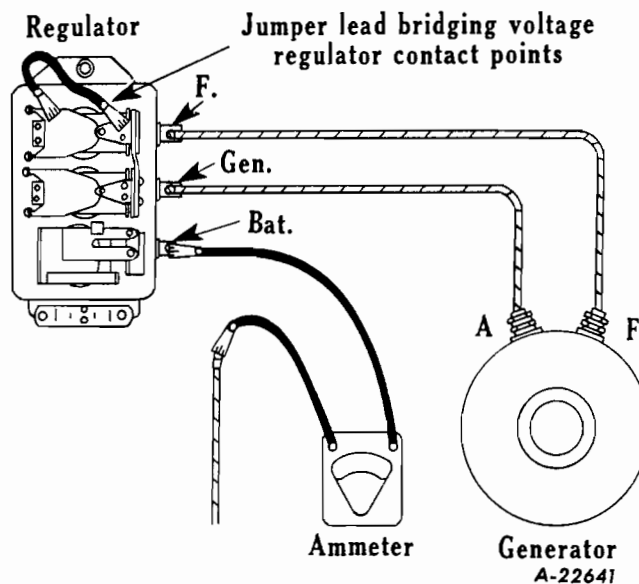


Fig. 13 - Ammeter and jumper lead connections for checking current regulator setting by the jumper lead method.

Current Regulator

Two checks and adjustments are required on the current regulator, air gap and current setting. The air gap on the current regulator is checked and adjusted in exactly the same manner as for the voltage regulator already described.

CURRENT SETTING--To check the current regulator setting, the voltage regulator must be prevented from operating. Four methods of preventing voltage regulator operation are available. Regardless of the method used, an ammeter must be connected into the charging circuit at the regulator "BAT" terminal. The first method should be used for preliminary checks whenever possible since it does not require removal of the regulator cover. The four methods are as follows:

1. QUICK CHECK METHOD--Insert screwdriver blade through oblong hole in base of regulator until contact is made with shield around resistor (Fig. 12). Be sure to keep screwdriver at right angles to base, and hold firmly in place during check so that blade touches regulator base and shield at same time. This temporarily cuts out voltage regulator unit. Turn on lights and accessories to prevent high voltage during the test.



REPAIR SECTION

With ammeter connected as in Fig. 13 and regulator at operating temperature, operate generator at 50 per cent above rated output speed, and note current setting. If necessary to adjust, remove cover and adjust in same manner as voltage regulator unit (Fig. 11) by turning adjusting screw clockwise to increase current setting or counterclockwise to decrease setting. See CAUTION note under Voltage Setting of Voltage Regulator. If unit is badly out of adjustment readjust as explained under REGULATOR SPRING REPLACEMENT.

2. JUMPER LEAD METHOD--Remove the regulator cover and connect a jumper lead across the voltage regulator contact points (Fig. 13). Turn on lights and accessories to prevent high voltage during the test. With generator operating 50 percent above rated output speed and with regulator at operating temperature, note the current setting.
3. BATTERY DISCHARGE METHOD--Partly discharge battery by cranking the engine for 30 seconds with ignition turned off. Never use cranking motor more than 30 seconds continuously since this would overheat and damage it. Immediately after cranking, start engine, turn on lights and accessories and note current setting with engine operating 50 per cent above rated output speed.
4. LOAD METHOD--If a load approximating the current regulator setting is placed across the battery during the time that the current regulator setting is being checked, the voltage will not increase sufficiently to cause the voltage regulator to operate. This load may be provided by a carbon pile or a bank of lights.

Regulator Spring Replacement

If it becomes necessary to replace the spiral spring on either the current or voltage regulator unit, the new spring should first be hooked on the lower spring support and then stretched up until it can be hooked at the upper end. Stretch the spring only by means of a screwdriver blade inserted between the turns (or in a similar manner) - do not pry the spring into place as this is likely to bend the spring supports. After installing a new spring, readjust the unit setting as already described.

Replacing Contact Support Brackets

Voltage or current regulator contact support brackets can be replaced by following the relationship illustrated in Fig. 19. Note particularly that the connector strap is insulated from the voltage regulator contact mounting screws while it is connected to the current regulator contact mounting screws. New bushings should always be used when installing a contact support bracket since the old bushing may be distorted or damaged.

Radio By-Pass Condensers

The installation of radio by-pass condensers on the field terminal of the regulator or generator will cause the regulator contact points to burn and oxidize so that generator output will be reduced and a run-down battery will result. If a condenser is found to have been connected to either of these terminals, disconnect the condenser and clean the regulator contact points as previously explained.

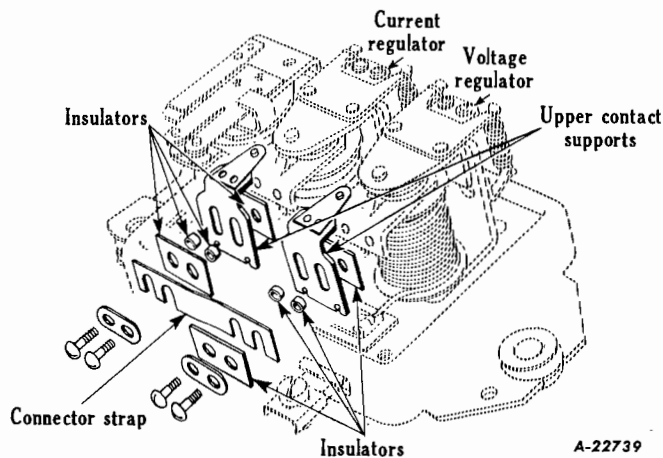


Fig. 14 - Relationship of insulators, connector strap, and upper contact support brackets in three-unit regulator.



L-LINE MOTOR TRUCK SERVICE MANUAL

SPARK PLUGS

The sole purpose of a spark plug is to create a spark between the electrodes to ignite the fuel in the engine. Therefore, if anything is wrong with the spark plug that will prevent its firing, all the other units in the electrical system will have functioned in vain.

From a cold start, a spark plug must operate under extremely high temperatures in just a few seconds, and must withstand repeated terrific explosion pressures. These conditions can be duplicated only in an engine. Therefore the only reliable test of a spark plug is to operate it in an engine under actual operating conditions.

Removal of Spark Plugs

A. Disconnect Ignition Wires:

Detach ignition wires from each spark plug. Most engines carry snap-on type connectors which simply pull off. Some have screw-type terminal connections in which case it is necessary to remove these terminal nuts before lifting off the ignition wires.

B. Select The Proper Size Deep Socket Wrench:

It is highly advisable to use the proper size deep socket type wrench to remove the spark plug from an engine. Improper wrenches are often the cause of spark plug insulator breakage.

C. Loosen Each Spark Plug Two Turns:

Using the proper size deep socket wrench (an extension shaft between wrench and handle is highly desirable), loosen each spark plug two complete turns only. All spark plugs loosen in a counter-clockwise direction.

D. Blow Out The Spark Plug Ports:

The action of loosening each spark plug two turns will also loosen any accumulation of dirt which may be embedded around the base of the spark plug. Use a blast of compressed air to remove this debris and prevent its falling into the cylinder combustion chamber when the spark plug is removed.

E. Remove Spark Plugs:

In most cases it is possible to remove each spark plug from the engine by hand. Place each spark plug and its gasket in a suitable holder in the order of removal from the engine.

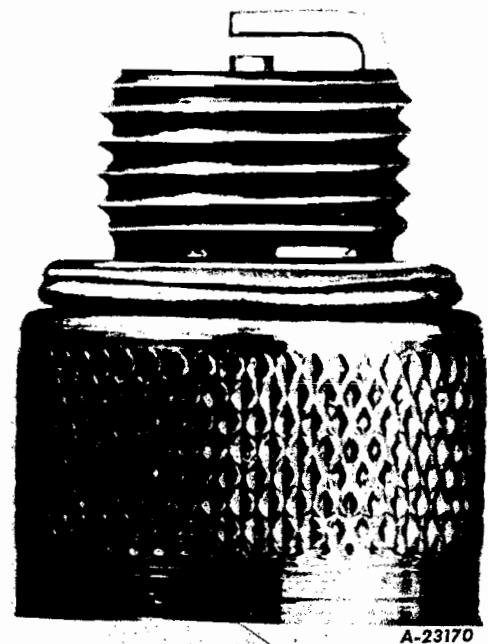


Fig. 1

Visual Inspection

A. Gaskets:

If the gaskets are not flattened (Fig. 1) or compressed it is an indication that the spark plugs have not been properly tightened to prevent blow-by between the spark plug and cylinder head. This condition results in excessive burning of the electrodes and overheats the insulator tip which may cause preignition.

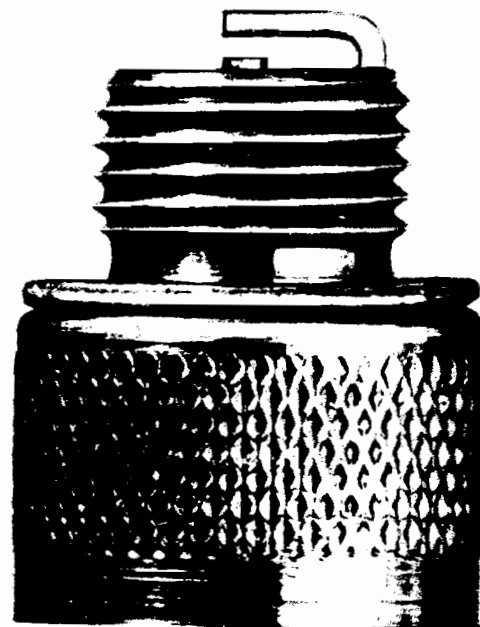


Fig. 2



If the gaskets are flattened or compressed to the point where they have become distorted (out of round) or torn, it is an indication that the spark plugs have been tightened to the extent that damage may have been inflicted on the spark plug itself (Fig. 2).

Excessive torque often causes strains on the steel shell of the spark plug which result in cracked insulators, distortion of metal shell and gap setting, as well as blow-by between the component parts of the spark plug.

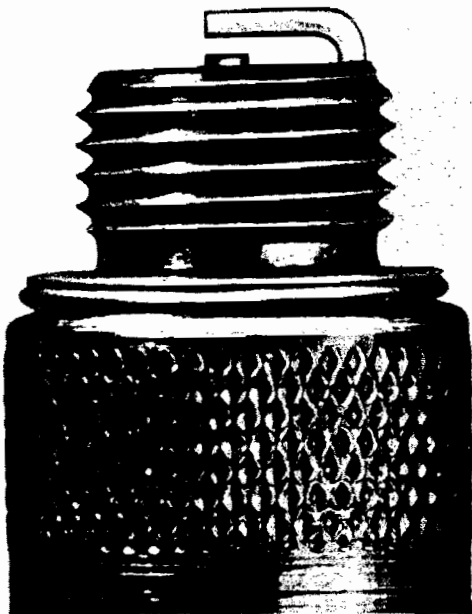


Fig. 3

If the gasket is properly compressed (approximately half of original thickness) showing a flat, clean, even surface, it is an indication that the spark plugs have been properly installed (Fig. 3).

B. Condition of Insulator (Firing End):

(1) OIL FOULING (Fig. 4) is usually identified by the wet, black shiny deposit which results from the following engine and spark plug conditions:

- Worn rings and pistons.
- Worn valve stems or guides.
- Weak battery.
- Faulty ignition wires.
- Distributor trouble.
- Weak coil.
- Too cold a spark plug.

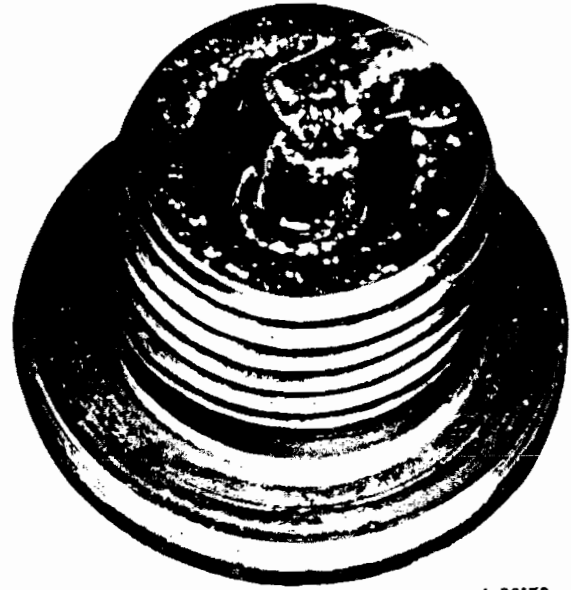


Fig. 4

A-23173

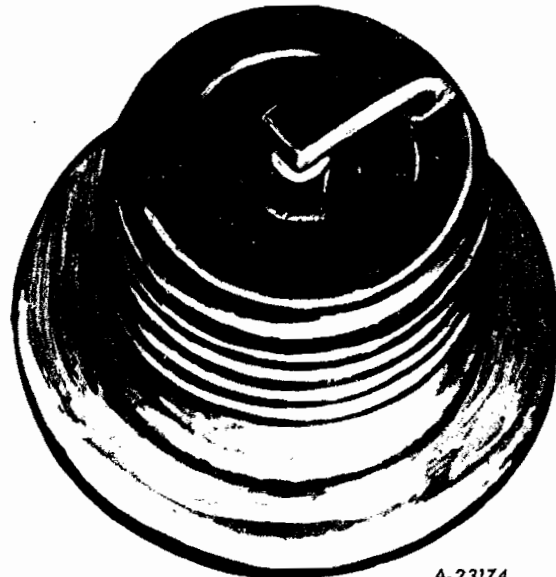


Fig. 5

A-23174

(2) GAS FOULING (Fig. 5) is usually identified by a black, dry fluffy deposit which results from:

- Excessive use of choke.
- Improper adjustment of automatic choke.
- Too rich an air-fuel mixture.
- Prolonged periods of engine idling.
- Too cold a spark plug.

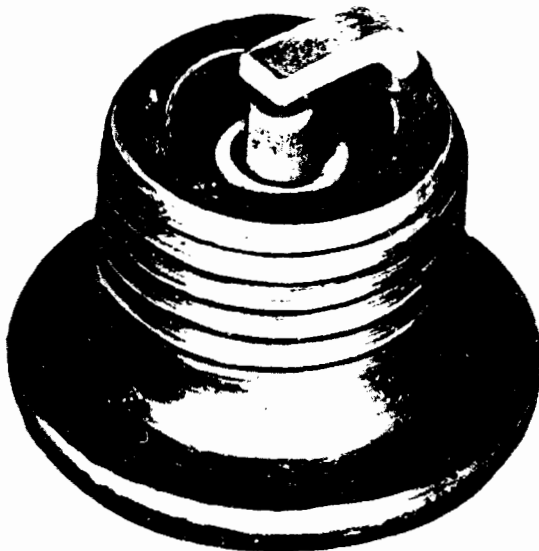


A-23175

Fig. 6

(3) BURNED OR OVERHEATED spark plugs (Fig. 6) are identified usually by dry, shiny, glassy deposits on the insulator, or cracks in the insulator tip itself, which result from:

- Too lean an air-fuel mixture.
- Inefficient engine cooling.
- Poorly seated valves.
- Improper ignition timing.
- Too hot a spark plug for the service.
- Improper installation of spark plugs.
- Compression leakage through spark plug.



A-23176

Fig. 7

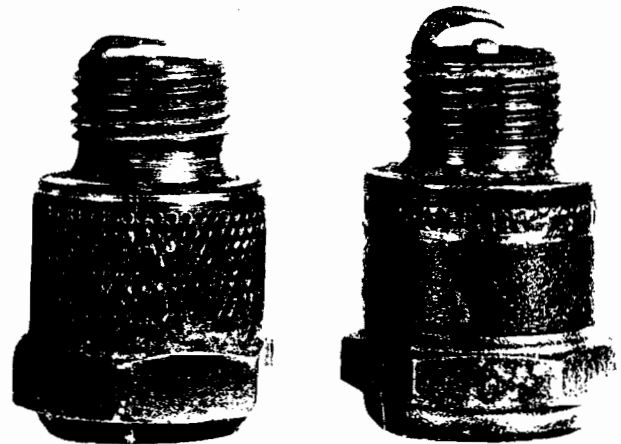
(4) NORMAL CONDITIONS where regular or unleaded gasolines have been used, are identified by a rusty brown to grayish tan powdery deposit, indicating a balanced ignition and combustion condition (Fig. 7).



A-23177

Fig. 8

(5) NORMAL CONDITIONS where highly leaded gasolines have been used, are identified usually by white powdery or yellowish glazed deposits (Fig. 8). Such deposits or "encrustments" do not interfere with spark plug operation and should merely be cleaned off at regular service intervals.



A-23169

Fig. 9

C. Conditions Of Electrodes:

The extent of service and mileage to which a spark plug has been subjected is generally best indicated by the degree of wear of the electrodes. When the center electrode has become worn away, or the ground electrode has become so badly eroded at the sparking area that re-



setting of the gap is either difficult or impossible, the spark plug is not fit for further efficient engine service even if cleaned.

D. Preliminary Examination:

If the spark plug in question exhibits insulator cracks, worn electrodes or other obviously unsatisfactory conditions, the spark plug does not warrant further attention and should be discarded.

Cleaning And Adjusting

A. Remove Gaskets:

Regardless of the condition of the old gaskets, they should be removed from the spark plug before cleaning. If new replacement gaskets are available the old ones should be discarded.

B. Degrease (If Necessary):

Before abrasive cleaning, any spark plugs which have oily deposits on the firing end or the outside of the spark plug should be degreased by brushing with gasoline, naphtha or other suitable solvent which will dry quickly by wiping with a cloth or by air blast. Failure to do this with oil fouled spark plugs will result in packing of the cleaner abrasive inside the firing end of the spark plug.

C. Apply Abrasive Blast:

Place the spark plug in the rubber cleaner adapter of the correct size. Hold the spark plug at the terminal end and while applying the abrasive blast, "wobble" the top of the spark plug in a circle. By this method the abrasive will be able to properly clean the insulator tip and the electrodes. Three seconds time should be sufficient to clean most spark plugs. However, the extent of cleaning time should be limited to only that which is necessary to clean off the

deposits on the insulator nose. Prolonged use of the abrasive blast will wear away the insulator causing irreparable damage to the spark plug. Visual inspection will indicate when the spark plug has been properly cleaned. Loose abrasive remaining inside the firing end should be removed by the use of the "air blast" jet on the cleaner. Do not use picks, screwdrivers, etc. to remove deposits inside the firing end of the spark plug.

D. Clean Threads:

Remove loose abrasive or other foreign material from the spark plug threads by means of a wire brush (a stiff tooth brush is also satisfactory) to complete the job of cleaning.

E. Dress Spark Plug Gaps:

Before actually setting the gap of a cleaned spark plug it is highly desirable to pass a thin point file or nail file between the sparking areas of the center and ground electrodes. This helps to produce flat, parallel surfaces which resist growth better than sharp or uneven areas, and facilitates more accurate gap gauging.

F. Reset Spark Plug Gaps:

Reset all gaps by moving the ground (or side) electrode only. Do not touch the center electrode as insulator tip fracture may result.

Bend the ground electrode towards the center electrode.

Use a good feeler gauge to measure the clearances between the electrodes. Refer to specifications for correct gap settings.

A very slight drag should be felt when the feeler gauge passes between the electrodes.

The spark plug is now ready for testing.

SUITABLE SPARK PLUG CLEANING EQUIPMENT IS AVAILABLE UNDER SE-1634 AND SE-1637. BOTH ITEMS ARE ABRASIVE TYPE CLEANERS.

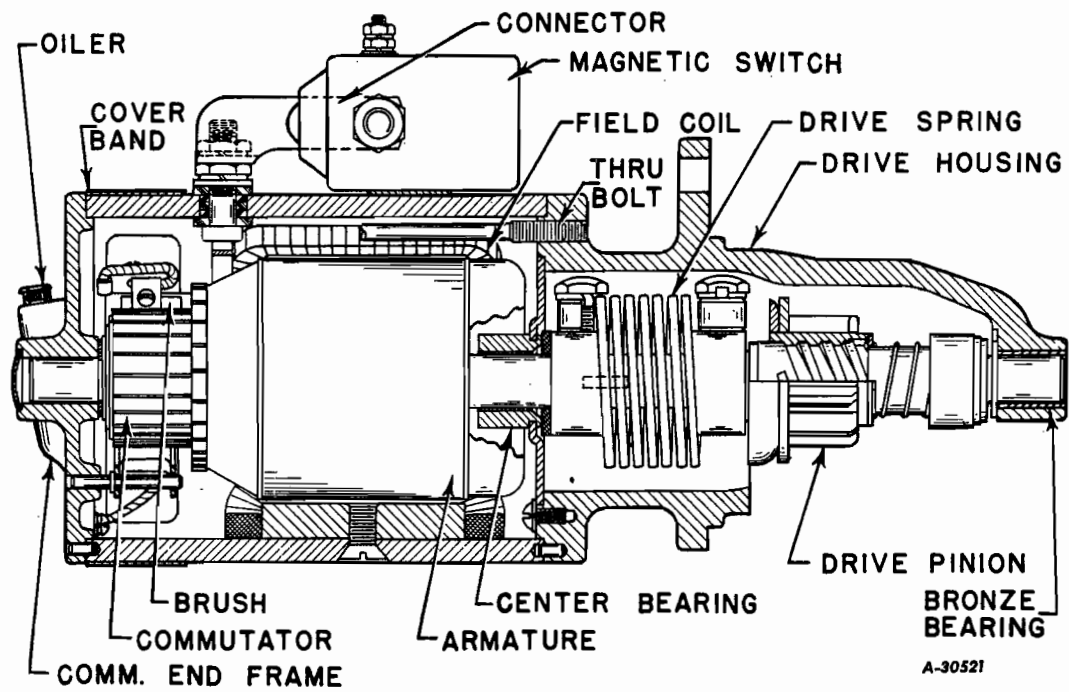
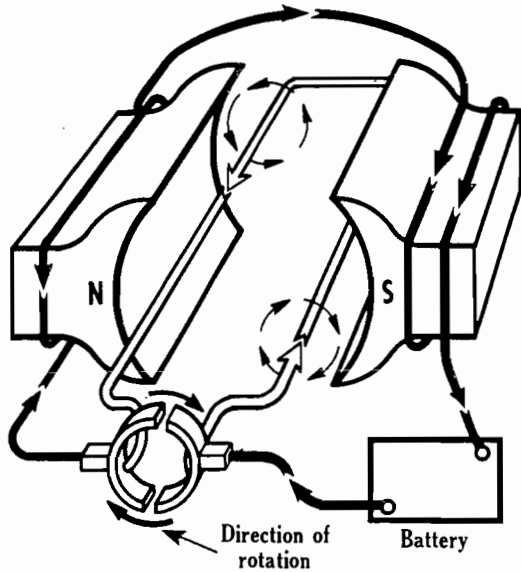


Fig. 1 - Starter (Delco-Remy 1108009)

STARTING MOTORS - (CRANKING MOTORS)



A-22796

Fig. 1 - Wiring diagram of simple electric motor. Showing current flow. The armature windings and field windings are connected in series. Delco-Remy starter motors are all series-wound units.

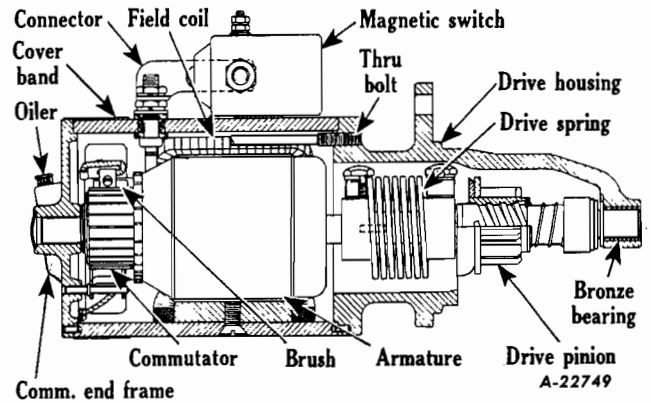


Fig. 3 - Delco-Remy Starter 1107967.

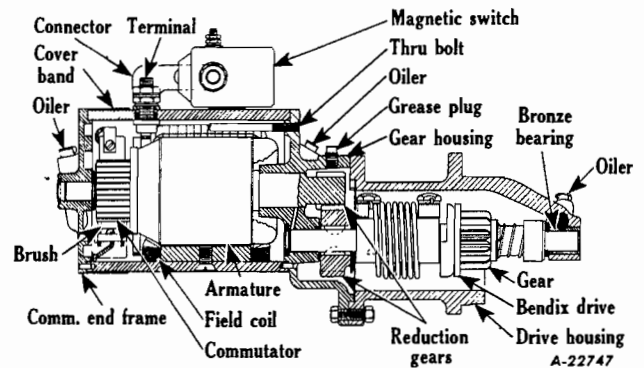


Fig. 4 - Delco-Remy Starter 1108217.

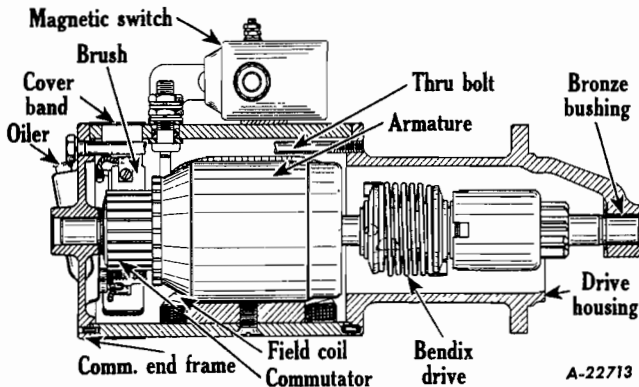


Fig. 2 - Delco-Remy Starter 1107074.

Starting Motors or Cranking Motors

The best assurance of obtaining maximum service from cranking motors with minimum trouble is to follow a regular inspection and maintenance procedure. Periodic lubrication where required, inspection of the brushes, commutator and drive arrangement are essentials in the inspection procedure. In addition, disassembly and thorough overhauling of the cranking motor at periodic intervals are desirable as a safeguard against road failures from accumu-

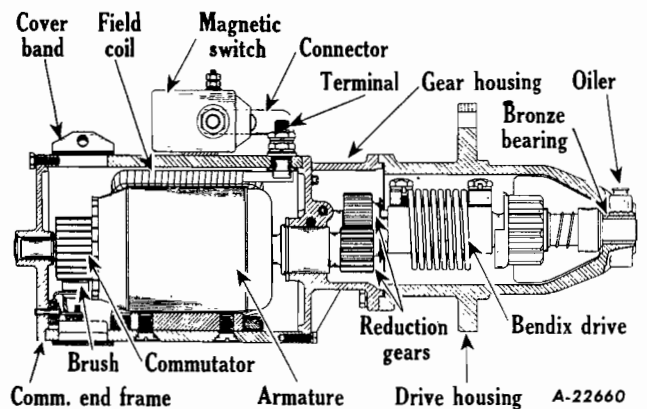


Fig. 5 - Delco-Remy Starter 1109004.

lations of dust and grease and from normal wear of parts. This is particularly desirable on commercial vehicles where maintenance of operating schedules is of especial importance. In addition to the cranking motor itself, the external circuit between the cranking motor and the



battery must be kept in good condition since defective wiring, loose or corroded connections will prevent normal cranking action.

Lubrication

Bearings provided with hinge cap oilers should have 8 to 10 drops of light engine oil every 5,000 miles. Grease cups should be turned down one turn every 5,000 miles and refilled with medium cup grease when required. On tractor, marine, or stationary applications, lubricate every 300 hours of operation as above. Grease plugs on gear reduction cranking motors should be removed every six months so the grease reservoir can be repacked with medium grade graphite grease.

On some models, oil wicks are used to lubricate the center and drive end bushings. The wicks are saturated with oil before assembly, and should be saturated again whenever the cranking motor is taken off the engine or disassembled.

Some cranking motors are equipped with oil-less bushings. These should be supplied with a few drops of light engine oil at any time that the cranking motor is disassembled for repair or service.

Avoid excessive lubrication since this might cause lubricant to be forced out onto the commutator where it would gum and cause poor commutation with a resulting decrease in cranking motor performance.

Lubricating The Bendix Drive Mechanism

Bendix drives should be lubricated with a small amount of light engine oil whenever the cranking motor is removed from the engine for servicing. Heavy oil or grease must not be used as this may retard or prevent normal action of the drive mechanism. The overrunning clutch drive is packed with lubricant during original assembly and requires no additional lubrication.

Never lubricate the commutator and do not attempt to lubricate the cranking motor while it is being operated. Be sure to keep grease or oil clean. Lubricant should be kept in closed containers.

Periodic Inspection

At periodic intervals the cranking motor should be inspected to determine its condition. The frequency with which this should be done will be determined by the type and design of cranking motor as well as the type of service in which it is used. Frequent starts, as in city operation or door-to-door delivery service, excessively long cranking periods caused by a hard-starting engine condition, excessively

dirty or moist operating conditions, heavy vibration, all will make it necessary that the inspection checks be made at more frequent intervals. Generally speaking, passenger car and other standard-duty cranking motors should be inspected at approximately 5,000 mile intervals. Heavy-duty units may not require as frequent inspection. However, where special operating conditions such as outlined above exist, inspection at more frequent intervals may be required.

INSPECTION PROCEDURE:

Cranking motor action is indicative, to some extent, of the cranking motor condition. Thus, a cranking motor that responds normally when the cranking motor switch is closed is usually considered to be in good condition. (Checking a cranking motor that does not operate normally is discussed in a following section.) However, the inspection procedure should include more than a mere check of the cranking motor operation; the following items should also be inspected. The mounting, wiring and connections should be tight and in good condition. The magnetic switch or solenoid (where used) should be firmly mounted and should operate freely and without binding.

Next, remove the cover band so the commutator, brushes and internal connections can be checked. Examine the cover band for thrown solder which results if the cranking motor is subjected to excessively long cranking periods so it overheats. This overheating causes the solder at the commutator riser bars to melt and be thrown out during cranking. Bad connections consequently develop which in turn result in arcing and burning of the commutator bars and ultimate ruination of the armature. If the bars are not too badly burned, the armature can often be saved by resoldering the connections at the riser bars (using rosin, not acid, flux) turning the commutator and undercutting the mica between bars. Some cranking motor armatures are of welded construction, with the armature coil leads welded, not soldered, to the commutator bars. This type of armature should not be repaired by ordinary soldering methods.

NOTE: Regardless of the type of construction, never operate the cranking motor more than 30 seconds at a time without pausing to allow the cranking motor to cool off for at least two minutes. Overheating, caused by excessively long cranking periods, may seriously damage the cranking motor.

When checking the brushes, make sure they are not binding and that they are resting on the commutator with sufficient tension to give good, firm contact. Brush leads and screws should be tight. If the brushes are worn down to one-half their original length, (compare with new brushes) they should be replaced.



Note the condition of the commutator. If it is glazed or dirty, it can be cleaned in a few seconds by holding a strip of number 00 sandpaper against it with a piece of wood while the cranking motor is operated. A brush seating stone can also be used for this purpose. Move the sandpaper or stone back and forth across the commutator while the armature is spinning. Never operate the cranking motor more than 30 seconds at a time without pausing for a few minutes to allow the cranking motor to cool. Blow out all dust after the commutator is cleaned.

If the commutator is rough, out of round, has high mica, or is extremely dirty, it will require turning down in a lathe and undercutting of the mica between the bars.

Quick Checks When in Trouble

When trouble develops in the cranking motor system, and the cranking motor cranks the engine slowly or not at all, several preliminary checks can be made to determine whether the trouble lies in the battery, in the cranking motor, in the wiring circuit between them, or elsewhere. Many conditions besides defects in the cranking motor can result in poor cranking performance.

To make a quick check of the cranking motor system, turn on the headlights. They should burn with normal brilliance. If they do not, the battery may be run down and it should be checked with a hydrometer. If the battery is in a charged condition so the lights burn brightly, operate the cranking motor. Any one of three things will happen to the lights. They will go out, dim considerably, or stay bright without any cranking action taking place.

If the lights go out as the cranking motor switch is closed, it indicates that there is a poor connection between the battery and the cranking motor. This poor connection will most often be found at the battery terminals, and correction is made by removing the cable clamps from the terminals, cleaning the terminals and clamps, replacing the clamps and tightening them securely. A coating of corrosion-inhibitor may be applied to the clamps and terminals to retard formation of corrosion.

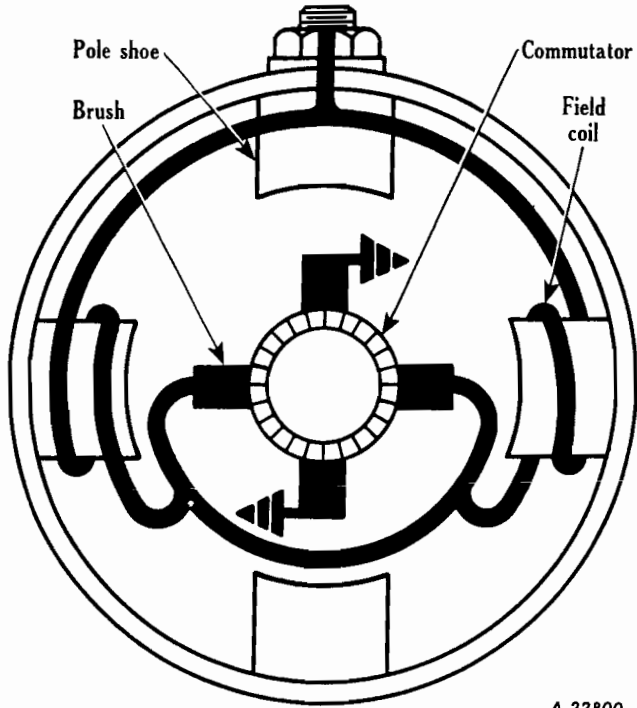
If lights dim considerably as the cranking motor switch is closed and the cranking motor operates slowly or not at all, the battery may be run down. Or, there may be some mechanical condition in the engine or the cranking motor that is throwing a heavy burden on the cranking motor. This imposes a high discharge rate on the battery which causes noticeable dimming of the lights. Check the battery with a hydrometer. If it is charged, the trouble probably lies in either the engine or cranking motor itself. In the engine, tight bearings or pistons, or heavy oil place an added burden on the cranking motor.

Low temperatures also hamper cranking motor performance since it thickens engine oil and makes the engine considerably harder to crank and start. Also, the battery is less efficient at low temperatures. In the cranking motor, a bent armature shaft, loose pole shoe screws or worn bearings, any of which may allow the armature to drag, will reduce cranking performance and increase current draw.

In addition, more serious internal damage is sometimes found. Thrown armature windings or commutator bars, which sometimes occur on overrunning clutch type cranking motors, are usually caused by excessive overrunning after starting. This is a result of such conditions as the driver's keeping his foot on the cranking motor switch too long after the engine has started, the driver's opening the throttle too wide in starting, or improper throttle cracker adjustment. Any of these subject the overrunning clutch to extra strain so it tends to seize, spinning the armature at high speed with resulting armature damage.

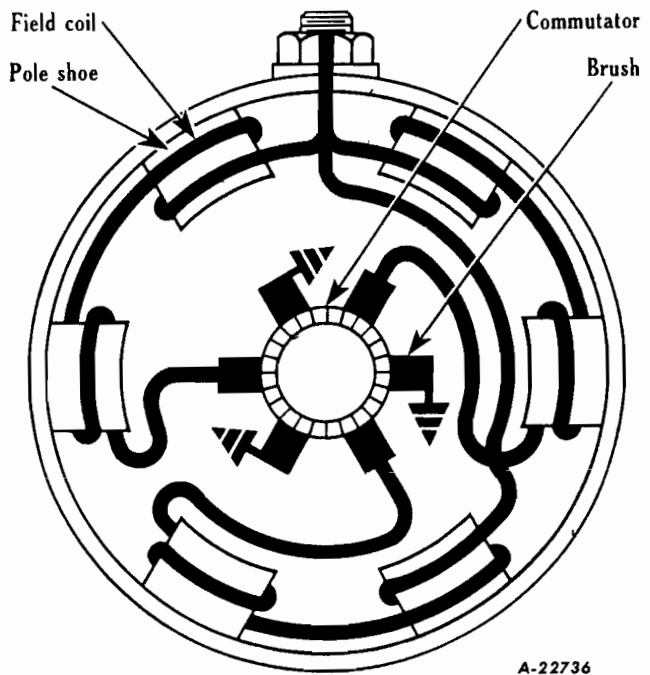
On Bendix drive cranking motors, broken Bendix housings and wrapped-up Bendix springs may result if the driver closes the cranking motor switch during engine rockback after the engine starts and then stops again. Another cause may be engine backfire during cranking which may result, among other things, from ignition timing being too far advanced. To avoid such failures, the driver should pause a few seconds after a false start to make sure the engine has come completely to rest before another start is attempted. In addition, the ignition timing should be reset if engine backfiring has caused the trouble.

The third condition which may be encountered when the cranking motor switch is closed with the lights turned on is that the lights stay bright, but no cranking action takes place. This indicates an open circuit at some point, either in the cranking motor, or in the cranking motor switch or control circuit. Where the application is solenoid-operated, the solenoid control circuit can be eliminated momentarily by placing a heavy jumper lead across the solenoid main terminals to see if the cranking motor will operate. This connects the cranking motor directly to the battery and, if it operates, it indicates that the control circuit is not functioning normally. The wiring and control units must be checked to locate the trouble. If the cranking motor does not operate, it will probably have to be removed from the engine so it can be analyzed in detail.



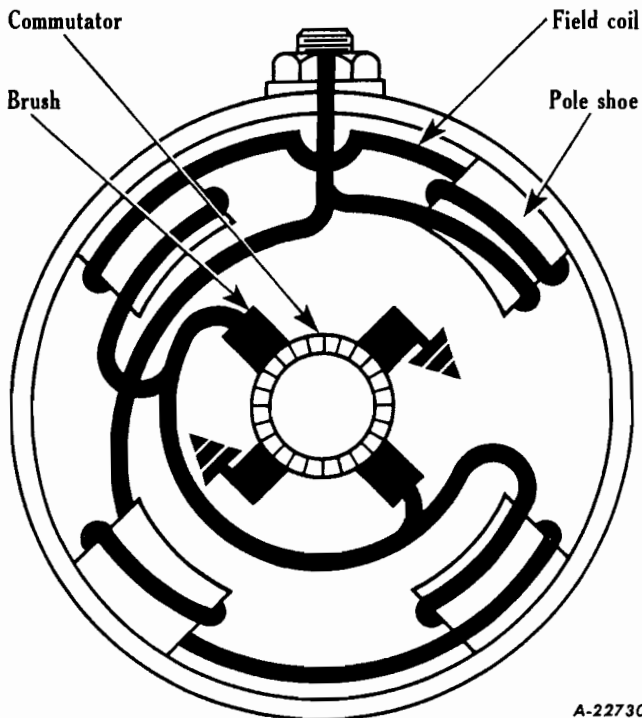
A-22800

Fig. 6 - Schematic wiring diagram of two-pole, four-brush, series-wound cranking motor.



A-22736

Fig. 8 - Schematic wiring diagram of six-pole, six-brush, series-wound cranking motor.



A-22730

Fig. 7 - Schematic wiring diagram of four-pole, four-brush, series-wound cranking motor.



ENGINE GROUP

SPECIFICATIONS

ENGINE SPECIFICATIONS	Page 1-7
WRENCH TORQUE LOAD CHART (Recommended)	8-10

SECTION "A"-SILVER DIAMOND ENGINE

MODELS { L-110, L-120, LM-120, L-130, L-150, L-153, LM-150 (SD-220 Engine)
 { LB-140, L-160, L-163, L-164, L-165, LC-160 (SD-240 Engine)

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REPAIR OF SUB-ASSEMBLIES AND ASSEMBLING	
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Connecting rods and pistons	17-19
Crankshaft, flywheel and camshaft inspection	19, 20
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Camshaft and gear	24
Clutch	24
Connecting rods and pistons	21-24
Crankshaft	21-23
Cylinder head	25
Flywheel and housing	24
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ENGINE GROUP—Continued

SECTION "B"-SUPER BLUE DIAMOND ENGINE

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Camshaft bushings	13
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Cylinder block inspection	12
Cylinder sleeve fits	13
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Cylinder head	20
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ENGINE GROUP—Continued

SECTION "C"-SUPER RED DIAMOND ENGINE

MODELS { L-185, L-190, L-193, L-194, LC-190 (RD-372 Engine)
 L-190, L-194, L-195, LC-190, LF-190, L-200, L-204 (RD-406 Engine)
 L-200, L-204, L-205, LC-200, L-210, LF-210 (RD-450 Engine)

DESCRIPTION	Page 2
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Connecting rods and pistons	10
Cylinder head and valves	4-9
Flywheel and housing	10, 11
Main bearings	10
Manifold	12, 13
Oil pump overhaul	13, 14
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REPAIR OF SUB-ASSEMBLIES AND ASSEMBLING	
Camshaft bushings	15
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Flywheel and housing	21
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Timing	22
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SUPER BLACK DIAMOND 282 SLEEVELESS ENGINE SPECIFICATIONS

Engines used in R-Line chassis are the same as used in L-Line trucks except the new BD-282 Super Black Diamond Sleeveless Engine has been added for the RF-170, R-180, RC-180 as standard equipment. The following chart lists specifications of this new engine.

Engine	Super Black Diamond 282 Sleeveless Engine
Number of cylinders	6
Bore	3-13/16
Stroke	4-1/8
Displacement (cu. in.)	282.546
Rated H.P. (A.M.A.)	34.8
Brake H.P. (maximum)	130.2
At R.P.M.	3400
Brake H.P. (net)	117.5
At R.P.M.	3200
Torque maximum (lbs-ft)	246.3
At R.P.M.	1800
Torque net (lbs-ft)	238.2
At R.P.M.	1600
Maximum recommended speed R.P.M.	3400
Compression ratio	6.5
Firing order	1-5-3-6-2-4
Crankcase refill capacity (qts)	7
Weight (bare) (lbs.)	742
Weight with standard accessories (lbs.)	831

CRANKSHAFT

Main journal diameter	2.701
Crankpin diameter	2-1/8
Bearing clearance . . . . .	.0013-.0043
Crankshaft end play . . . . .	.0055-.0145
Trust taken by	Rear
Hardening method	Through



CAMSHAFT

Camshaft journal diameter:

Front	1.8130-1.8145
Second	1.7248-1.7263
Third	1.7098-1.7113
Fourth	1.5010-1.5025
Camshaft bearing clearance . . . . .	.0010-.0035
Camshaft end play . . . . .	.0020-.0100
Thrust taken by	Thrust flange
Camshaft gear backlash . . . . .	.0015 (desired)

CONNECTING RODS

Connecting rod bearing end clearance . . . . .	.0070-.0130
Connecting rod bearing clearance . . . . .	.0007-.0032

PISTONS

Material	Aluminum alloy
Recommended piston clearance . . . . .	.003

PISTON PINS

Length	3.201
Diameter . . . . .	.9193
Pin fit at room temperature (70°):	
Recommended clearance in rod . . . . .	.0003-.0005
Recommended clearance in piston	{ .0001 tight .0003 loose

FEELER GAUGE RIBBON CHECKING

Width	1/2"
Thickness . . . . .	.003
Tension on scales (lbs.)	6-18
Desired tension (lbs.)	12



PISTON RINGS

Compression rings:

Number used on each piston	3
Size	{ (1) 3/32 (2) 1/8

OIL RINGS

Number used on each piston	1
Size	3/16
Ring diameter	3-13/16

RING GAP

Compression . . . . .	.010-.026
U-flex . . . . .	.0003-.027

FIT IN GROOVE

Compression top . . . . .	.0025-.0040
Second and third . . . . .	.0015-.0030
Oil control fourth . . . . .	.0015-.0035

VALVES

EXHAUST

INTAKE

Stem diameter . . . . .	.372	.372
Angle of face	30°	15°
Tappet clearance (hot) . . . . .	.023	.023
Stem clearance in guide . . . . .	.003	.002
Width of valve seat	5/64-7/64	3/64-5/64
Slo Roto valve cap to stem clearance . . . . .	.001-.005	.....

VALVE TAPPET

Clearance in block0015-.003
------------------------------	------------

VALVE SPRINGS

Free length	2.187
Length valve open	1.468
Pounds pressure - valve open	186-196
Valve Rocker Arm Clearance in Shaft . . . . .	.0015-.004



VALVE TIMING

Intake opens (before T. D. C.)	12°
Intake closes (after T. D. C.)	38°
Exhaust opens (before T. D. C.)	55°
Exhaust closes (after T. D. C.)	15°
Intake valve timing checking clearance. . . . .	.020

OIL PUMP

Body gear end clearance . . . . .	.0025-.0055
Pump body to spiral gear clearance. . . . .	.0048-.0088
Pump shaft diameter. . . . .	.4885-.4890
Pump shaft clearance in bore . . . . .	.005

OIL PRESSURE

Minimum lbs.	15-20
At R. P. M.	Idling
Maximum lbs.	40-45
At R. P. M.	1200 and up

ENGINE SPECIFICATIONS



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ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
Number of cylinders	6	6	6	6	6	6	6
Bore	3-9/16"	3-9/16"	3-9/16"	4-3/8"	4-3/8"	4-3/8"	4-7/8"
Stroke	3-11/16"	4-1/64"	4-1/2"	4-1/8"	4-1/2"	5"	5-3/8"
Displacement (cu. in.) . . .	220.50	240.30	269.10	372.06	405.89	450.99	602.00
Rated h.p. (A.M.A.)	30.4	30.4	30.4	45.9	45.9	45.9	
Brake h.p. (maximum) . . .	100.0	108	100.5	143.8	154.2	162.2	
At r.p.m.	3600	3600	3000	3200	3200	3000	
Brake h.p. (net)	90	93	88.6	128	138	146	
At r.p.m.	3600	3400	2800	2850	2750	2600	
Torque maximum (lbs.ft.) . .	173.5	191.9	222.0	282.5	319.0	358.5	
At r.p.m.	2000	1400	1600	1600	1200	1200	
Torque net (lbs. ft.)	167	186	216.5	280.0	313.5	354.0	
At r.p.m.	1200	1100	1000	1000	1000	1000	
Maximum recommended speed r.p.m.	3600	3400	3000				
Governed speed r.p.m. . . .				2850	2750	2600	
Compression ratio	6.5	6.5	6.3	6.3	6.3	6.2	
Firing order	153624	153624	153624	153624	153624	153624	153624
Crankcase refill capacity (qts.)	7	7	7	9	9	9	16
Weight, bare (lbs.)	607	607	781	937	942	948	1638
Weight, with standard accessories (lbs.)	673	673	874	1047	1076	1082	1863
CRANKSHAFT:							
Main journal diameter	2.748" - 2.749"	2.748" - 2.749"	2.7005" - 2.7015"	3.2495" - 3.2505"	3.2495" - 3.2505"	3.2495" - 3.2505"	3.249" - 3.250"
Crankpin diameter	2.373" - 2.374"	2.373" - 2.374"	2.122" - 2.123"	2.751" - 2.752"	2.751" - 2.752"	2.751" - 2.752"	2.999" - 3.000"
Bearing clearance . . . . .	.0010" - .0040"	.0010" - .0040"	.0013" - .0043"	.0013" - .0043"	.0013" - .0043"	.0013" - .0043"	.0022" - .0046"
Crankshaft end play . . . . .	.005" - .013"	.005" - .013"	.0055" - .0135"	.004" - .012"	.004" - .012"	.004" - .012"	.006" - .008"
Thrust taken by	rear interm.	rear interm.	rear	rear	rear	rear	front
Hardening method	through	through	through	tocco	tocco	tocco	tocco
Main bearing bolt ten- sion (ft. lbs.)	75-85	75-85	100-110	100-110	100-110	100-110	105-115
CAMSHAFT:							
Camshaft journal dia- meter							
Front	2.109" - 2.110"	2.109" - 2.110"	1.811" - 1.812"	2.109" - 2.110"	2.109" - 2.110"	2.109" - 2.110"	2.1220" - 2.1225"
Second	2.089" - 2.090"	2.089" - 2.090"	1.577" - 1.578"	2.089" - 2.090"	2.089" - 2.090"	2.089" - 2.090"	2.1220" - 2.1225"

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
Third	2.069" - 2.070"	2.069" - 2.070"	1.562" - 1.563"	2.069" - 2.070"	2.069" - 2.070"	2.069" - 2.070"	2.1220" - 2.1225"
Fourth	1.4995" - 1.5005"	1.4995" - 1.5005"	1.499" - 1.500"	1.4995" - 1.5005"	1.4995" - 1.5005"	1.4995" - 1.5005"	2.1220" - 2.1225"
Fifth . . . . .	.....	.....	.....	.....	.....	.....	2.1220" - 2.1225"
Camshaft bearing clearance . . . . .	.0010" - .0035"	.0010" - .0035"	.0010" - .0035"	.0010" - .0035"	.0010" - .0035"	.0010" - .0035"	.0015" - .0025"
Camshaft end play . . .	.0020" - .0080"	.0020" - .0080"	.0020" - .0080"	.0020" - .0080"	.0020" - .0080"	.0020" - .0080"	.0050" - .0070"
Thrust taken by	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange
Camshaft gear backlash	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)
CONNECTING RODS:							
Connecting rod bearing end clearance . . . . .	.0070" - .013"	.0070" - .013"	.0070" - .0130"	.0070" - .0130"	.0070" - .0130"	.0070" - .0130"	.0060" - .0100"
Connecting rod bearing clearance . . . . .	.0011" - .0011"	.0011" - .0032"	.0007" - .0032"	.0012" - .0037"	.0012" - .0037"	.0012" - .0037"	.0012" - .0036"
Connecting rod bolt nut tension (ft. lbs.)	45-55	45-55	60-70	75-85	75-85	75-85	100-110
PISTONS:							
Material	aluminum- alloy	aluminum- alloy	aluminum- alloy	aluminum- alloy	aluminum- alloy	aluminum- alloy	aluminum- alloy
Recommended piston clearance:	.003	.003	.003	.003	.003	.003	
PISTON PINS:							
Length	2.950"	2.950"	2.950"	3.796"	3.796"	3.796"	
Diameter . . . . .	.8748" - .8750"	.8748" - .8750"	.9192" - .9194"	1.1089" - 1.1091"	1.1089" - 1.1091"	1.1089" - 1.1091"	1.4998" - 1.5000"
Pin fit (room tempera- ture 70° F.): -							
Recommended clear- ance in rod . . . . .	.0002" - .0004"	.0002" - .0004"	.0003" - .0004"	.0005" - .0006"	.0005" - .0006"	.0005" - .0006"	.0003" - .0007"
Recommended clear- ance in piston . . . . .	.0000" - .0002"	.0000" - .0002"	.0000" - .0002"	.0000" - .0002"	.0000" - .0002"	.0000" - .0002"	.0001" -tight .0001" -loose
FEELER GAUGE RIBBON CHECKING:							
Width	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
Thickness . . . . .	.003"	.003"	.003"	.003"	.003"	.003"	.005"
Tension on scales (lbs.)	6-18	6-18	6-18	6-18	6-18	6-18	5-10
Desired tension (lbs.) .	12	12	12	12	12	12	8





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ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
PISTON RINGS:-							
Compression Rings:-							
Number used on each piston	3	3	3	3	3	3	4
Size	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	
Oil Rings:							
Number used on each piston	1	1	1	1	1	1	1
Size	3/16"	3/16"	3/16"	3/16"	3/16"	3/16"	
Ring diameter	3-9/16"	3-9/16"	3-9/16"	4-3/8"	4-3/8"	4-3/8"	
Ring Gap:-							
Compression . . . . .	.016"-.026"	.016"-.026"	.016"-.026"	.025"-.035"	.025"-.035"	.025"-.035"	.013"-.023"
U-Flex . . . . .	.....	.....	.....	.....	.....	.....	.....
Fit in Groove:-							
Compression - top . . . . .	.0025" - .0040"	.0025" - .0040"	.0025" - .0040"	.0040" - .0055"	.0040" - .0055"	.0040" - .0055"	.0055" - .0070"
- 2nd & 3rd . . . . .	.0015" - .0030"	.0015" - .0030"	.0015" - .0030"	.0020" - .0035"	.0020" - .0035"	.0020" - .0035"	.0025" - .0035"
Oil Control - fourth . . . . .	.0015" - .0035"	.0015" - .0035"	.0015" - .0035"	.0015" - .0035"	.0015" - .0035"	.0015" - .0035"	.0015" - .0035"
Plain - fifth . . . . .	.....	.....	.....	.....	.....	.....	.0015" - .0035"
INTAKE VALVES:-							
Stem diameter . . . . .	.372"	.372"	.342"	.434"	.434"	.434"	.4973"
Angle of face	30°	30°	45°	15°	15°	15°	30°
Tappet clearance (hot) . . . . .	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.020"
Stem clearance in guide . . . . .	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0008"-.0021"
Width of valve seat	1/64"-3/64"	1/64"-3/64"	5/64"-7/64"	5/64"-7/64"	5/64"-7/64"	5/64"-7/64"	1/16"-3/32"
EXHAUST VALVES:							
Stem diameter . . . . .	.370"	.370"	.341"	.434"	.434"	.434"	.494"
Angle of face	30°	30°	45°	45°	45°	45°	45°
Tappet clearance (hot) . . . . .	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.020"
Stem clearance in guide . . . . .	.002"-.004"	.002"-.004"	.002"-.004"	.002"-.004"	.002"-.004"	.002"-.004"	.0035"-.005"
Width of valve seat	3/64"-5/64"	3/64"-5/64"	5/64"-7/64"	3/32"-1/8"	3/32"-1/8"	3/32"-1/8"	5/64"-7/64"
Slo-roto valve cap to stem clearance . . . . .	.....	.....	.....	.002"-.006"	.002"-.006"	.002"-.006"	.002"-.006"
VALVE TAPPET:-							
Clearance in block . . . . .	.0015"-.003"	.0015"-.003"	.0015"-.003"	.001"-.003"	.001"-.003"	.001"-.003"	.0019"-.0002"
VALVE SPRINGS:-							
Free length:							
Inner	2-11-16"	2-11/16"	2-33/64"	2-11/32"	2-11/32"	2-11/32"	2-3/4"
Outer . . . . .	.....	.....	.....	2-9/16"	2-9/16"	2-9/16"	2-13/16"

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
Length - valve open:							
Inner	1.683"	1.683"	1.668"	1.503"	1.503"	1.503"	1.750"
Outer . . . . .	.....	.....	.....	1.706"	1.706"	1.706"	1.750"
Lbs. pressure - valve open:							
Inner	141-149	141-149	103-111	83-88	83-88	83-88	82-88
Outer . . . . .	.....	.....	.....	133-141	133-141	133-141	160-170
VALVE ROCKER ARM CLEARANCE IN SHAFT	.0015"- .004"	.0015"- .004"	.0015"- .004"	.0015"- .004"	.0015"- .004"	.0015"- .004"	.0002"- .0014"
VALVE TIMING:							
Intake opens (before T.D.C.)	10°	10°	5°	8°	8°	8°	12°
Intake closes (after L.D.C.)	46°	46°	45°	52°	52°	52°	62°
Exhaust opens (before L.D.C.)	48°	48°	40°	55°	55°	55°	54°
Exhaust closes (after T.D.C.)	8°	8°	10°	15°	15°	15°	20°
Intake valve timing clecking clearance. .	.023"	.023"	.023"	.023"	.023"	.023"	.020"
OIL PUMP:							
Body gear end clearance . . . . .	.0025"- .0055"	.0025"- .0055"	.0025"- .0055"	.0025"- .0055"	.0025"- .0055"	.0025"- .0055"	.0025"- .0055"
Pump body to spiral gear clearance . . . . .	.....	.....	.03125"	.03125"	.03125"	.03125"	.03125"
Pump shaft diameter. . . . .	.4885"- .4890"	.4885"- .4890"	.4985"- .4992"	.4985"- .4990"	.4985"- .4990"	.4985"- .4990"	.4985"- .4990"
Pump shaft clearance in bore . . . . .	.005"	.005"	.005"	.005"	.005"	.005"	.005"
OIL PRESSURES							
Minimum (lbs.)	15-20	15-20	15-20	15-20	15-20	15-20	15-20
At r.p.m.	idling	idling	idling	idling	idling	idling	idling
Maximum (lbs.)	40-45	40-45	40-45	40-45	40-45	40-45	40-45
At r.p.m.	1200 up	1200 up	1200 up	1500 up	1500 up	1500 up	1500 up
CYLINDER HEAD:							
Cylinder head bolt (ft. lbs.)	85-95	85-95	75-85	100-110	100-110	100-110	100-110





SILVER DIAMOND ENGINE

SIZE AND THREAD	NAME OF ASSEMBLY	RECOMMENDED WRENCH TORQUE LOAD, FT.-LB.
5/16 - 18	Generator strap to generator	14 - 16
5/16 - 18	Water outlet	8 - 10
5/16 - 18	Coil bracket to cylinder head	14 - 16
5/16 - 18	Fuel pump to crankcase	8 - 10
5/16 - 18	Oil pan to crankcase	14 - 16
5/16 - 18	Distributor adapter to crankcase	14 - 16
5/16 - 18	Oil pump cover to body	14 - 16
5/16 - 18	Vibration damper to pulley	16 - 18
5/16 - 18	Oil pump body to crankcase	14 - 16
5/16 - 24	Generator mounting	8 - 10
5/16 - 24	Coil mounting	16 - 18
3/8 - 16	Manifold to cylinder head	25 - 30
3/8 - 16	Engine support bracket to crankcase	25 - 30
3/8 - 16	Generator bracket to crankcase	25 - 30
3/8 - 16	Intake to exhaust manifold	25 - 30
3/8 - 16	Water pump to crankcase	25 - 30
3/8 - 16	Cylinder head cover	25 - 30
3/8 - 16	Gear case cover to crankcase	25 - 30
3/8 - 16	Camshaft thrust flange	25 - 30
3/8 - 24	Connecting rod bolt	45 - 55
3/8 - 24	Carburetor to manifold	23 - 28
3/8 - 24	Intake to exhaust manifold	23 - 28
5/16 - 24	Gear case cover to plate	9 - 11
7/16 - 14	Flywheel housing	50 - 60
7/16 - 14	Oil pressure relief valve	13 - 15
7/16 - 20	Flywheel to crankshaft	55 - 65
1/2 - 13	Starting motor	75 - 85
1/2 - 13	Cylinder head capscrew	85 - 95
1/2 - 13	Crankshaft bearing bolt	75 - 85
1 - 14	Starting crank nut	90 - 100
1 - 20	Camshaft lock nut	110 - 120
7/8 - 18	Spark plug (in cast iron)	32 - 35
14 MM	Spark plug (in cast iron)	25 - 28
14 MM	Spark plug (in aluminum)	21 - 25
18 MM	Spark plug (in cast iron)	28 - 31
18 MM	Spark plug (in aluminum)	25 - 28



SUPER BLUE DIAMOND ENGINE

SIZE AND THREAD	NAME OF ASSEMBLY	RECOMMENDED WRENCH TORQUE LOAD, FT.-LB.
5/16 - 18	Air cleaner to cylinder head.	18 - 22
5/16 - 18	Fuel pump to crankcase.	8 - 10
5/16 - 18	Crankshaft rear oil seal, upper.	14 - 16
5/16 - 18	Distributor bracket to cylinder head	14 - 16
5/16 - 18	Oil pump cover to body	14 - 16
5/16 - 24	Vibration damper to pulley.	16 - 18
5/16 - 24	Gear case cover to plate	8 - 10
5/16 - 24	Generator mounting	8 - 10
3/8 - 16	Manifold to cylinder head.	25 - 30
3/8 - 16	Oil pan to crankcase.	25 - 30
3/8 - 16	Generator bracket to crankcase	25 - 30
3/8 - 16	Oil pump body to crankcase	25 - 30
3/8 - 16	Water pump to cylinder head	25 - 30
3/8 - 16	Crankshaft rear oil seal, lower.	25 - 30
3/8 - 16	Gear case cover to crankcase.	25 - 30
3/8 - 16	Cam shaft thrust flange	25 - 30
3/8 - 16	Starting motor.	25 - 30
3/8 - 24	Carburetor to manifold	23 - 28
3/8 - 24	Gear case cover to plate	9 - 11
7/16 - 14	Oil pressure relief valve.	13 - 15
7/16 - 20	Connecting rod bolt.	60 - 70
7/16 - 20	Intake to exhaust manifold	55 - 65
7/16 - 20	Connecting rod bolt.	60 - 70
1/2 - 13	Flywheel housing	75 - 85
1/2 - 13	Cylinder head cap screw	75 - 85
1/2 - 20	Flywheel to crankshaft	90 - 100
9/16 - 12	Crankshaft bearing capscrew	100 - 110
9/16 - 12	Crankshaft bearing capscrew	100 - 110
1 - 20	Camshaft lock nut.	110 - 120
7/8 - 18	Spark plug (in cast iron)	32 - 35
14 MM	Spark plug (in cast iron)	25 - 28
14 MM	Spark plug (in aluminum).	21 - 25
18 MM	Spark plug (in cast iron)	28 - 31
18 MM	Spark plug (in aluminum).	25 - 28

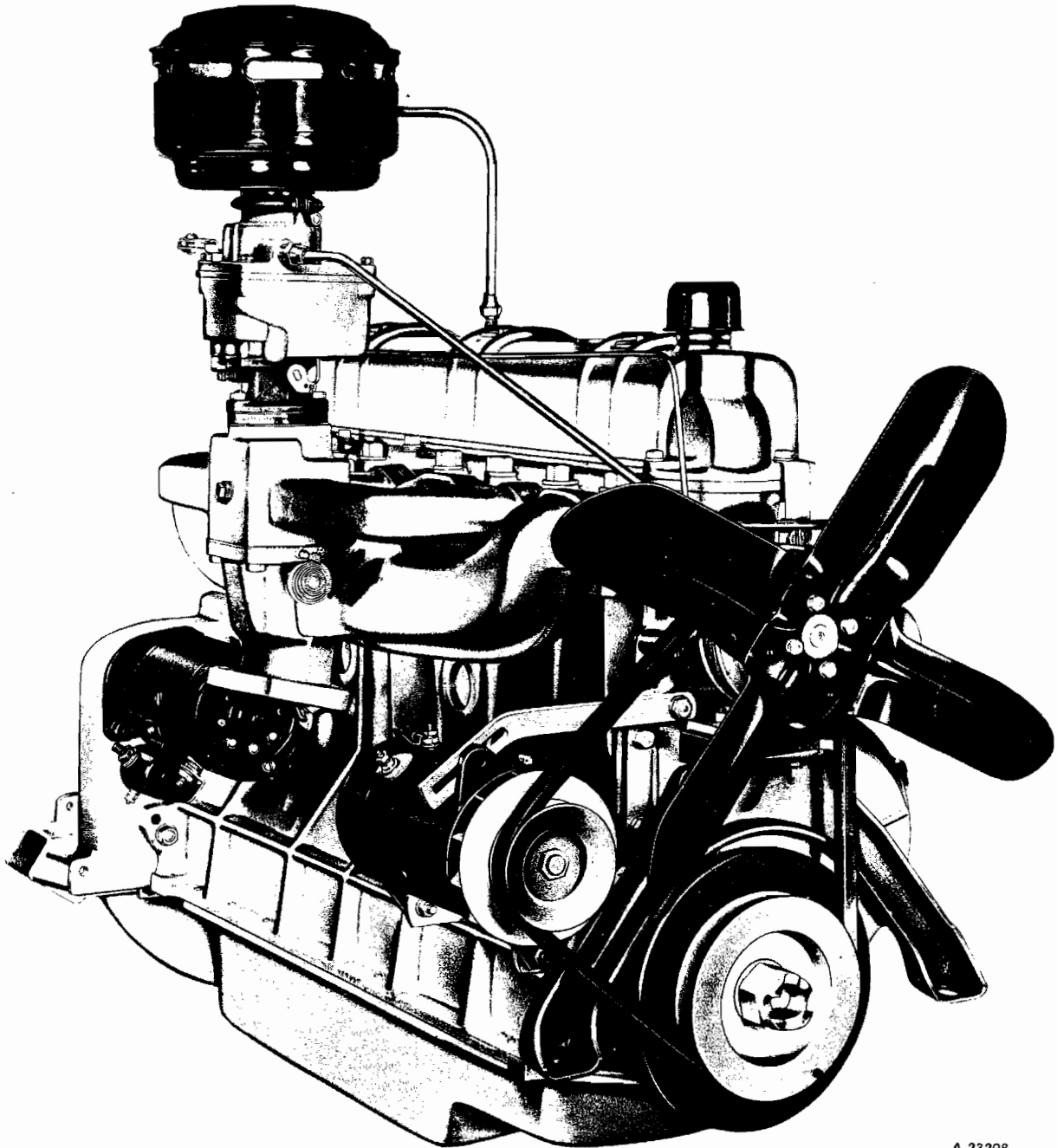


SUPER RED DIAMOND ENGINE

SIZE AND THREAD	NAME OF ASSEMBLY	RECOMMENDED WRENCH TORQUE LOAD, FT.-LB.
5/16 - 18	Distributor bracket to cylinder head	18 - 22
5/16 - 18	Crankshaft rear oil seal, upper.	18 - 22
5/16 - 18	Crankshaft rear oil seal, lower.	18 - 22
5/16 - 24	Generator mounting	20 - 24
5/16 - 24	Carburetor to manifold (Holley)	20 - 24
3/8 - 16	Starting motor mounting	25 - 30
3/8 - 16	Oil pump body to crankcase	25 - 30
3/8 - 16	Camshaft thrust washer.	25 - 30
3/8 - 16	Damper to pulley hub	30 - 35
3/8 - 16	Fuel pump to crankcase.	25 - 30
3/8 - 16	Rocker arm bracket to head.	25 - 30
3/8 - 16	Gear case to crankcase.	25 - 30
3/8 - 16	Generator bracket to case	25 - 30
3/8 - 16	Water pump to cylinder head	25 - 30
3/8 - 16	Oil pan to crankcase.	25 - 30
3/8 - 16	Oil filler.	25 - 30
3/8 - 24	Gear case cover to crankcase plate.	25 - 30
3/8 - 24	Carburetor to manifold (Zenith)	23 - 28
3/8 - 24	Gear case cover.	23 - 28
3/8 - 24	Manifold to cylinder head.	23 - 30
7/16 - 20	Intake to exhaust manifold	55 - 65
7/16 - 20	Intake to exhaust manifold	55 - 65
7/16 - 20	Connecting rod capscrew (place type).	75 - 85
7/16 - 20	Carburetor to manifold	40 - 45
1/2 - 13	Oil filter mounting	75 - 85
1/2 - 13	Cylinder head capscrew, oil.	100 - 110
1/2 - 13	Cylinder head capscrew, long.	100 - 110
1/2 - 13	Cylinder head capscrew, short.	100 - 110
1/2 - 13	Flywheel housing to crankcase	75 - 85
9/16 - 18	Crankshaft to flywheel.	150 - 160
9/16 - 18	Crankshaft to flywheel.	150 - 160
9/16 - 18	Crankshaft bearing cap	100 - 110
9/16 - 18	Crankshaft bearing cap	100 - 110
1 - 20	Camshaft gear nut	110 - 120
7/8 - 18	Spark plug (in cast iron)	32 - 35
14 MM	Spark plug (in cast iron)	25 - 28
14 MM	Spark plug (in aluminum).	21 - 25
18 MM	Spark plug (in cast iron)	28 - 31
18 MM	Spark plug (in aluminum).	25 - 28

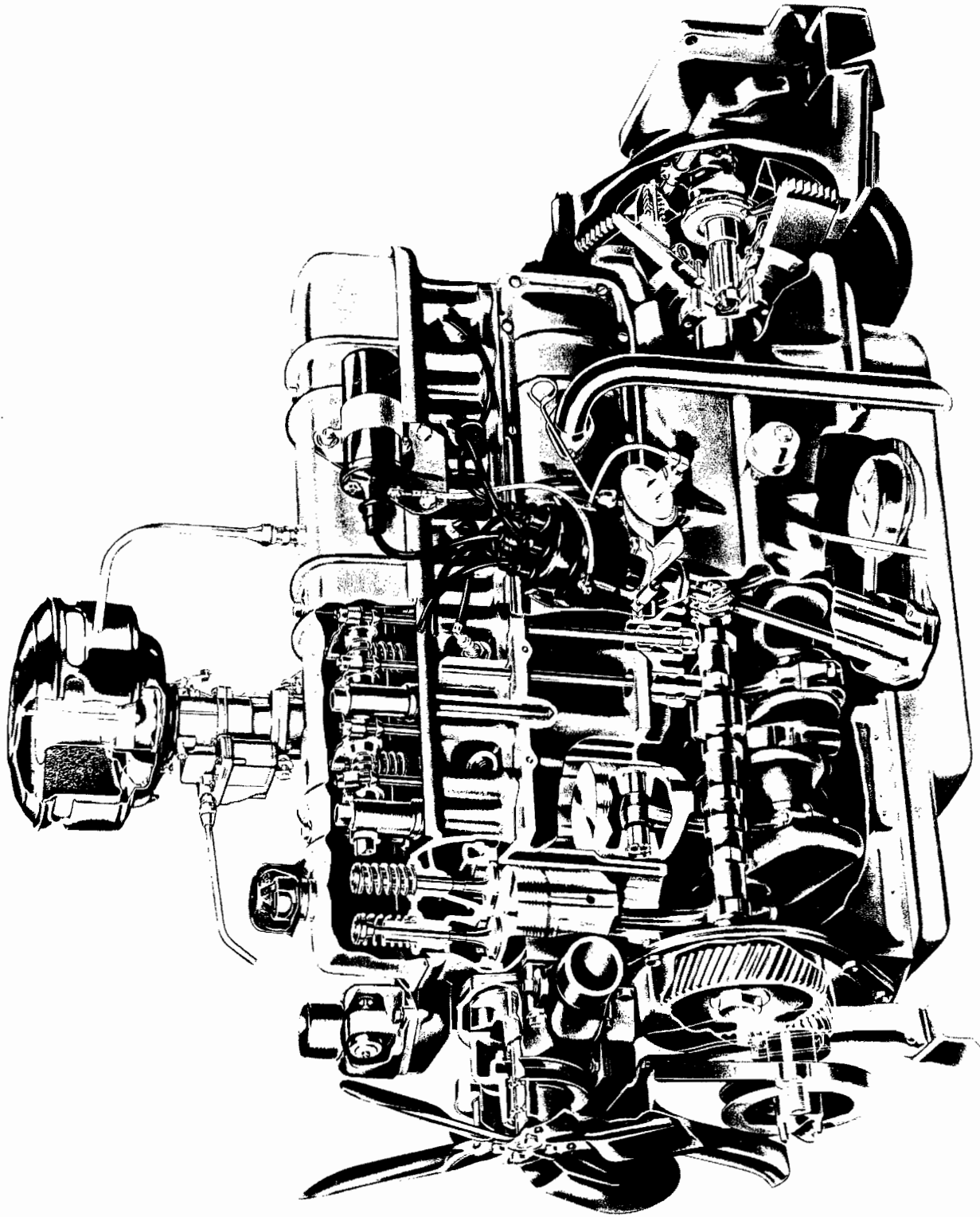


SILVER DIAMOND ENGINE



A-23208

Fig. 1 - Silver Diamond Engine



A-23209

Fig. 2 - Sectional view of Silver Diamond Engine



DESCRIPTION

General

The Model SD engine is a 4-cycle, 6-cylinder-in-line, overhead-valve-type engine (Fig. 1 and Fig. 2). The engine serial number is stamped on a pad at the front on the right side of crankcase just below the cylinder head. The block does not have replaceable liners for the cylinders. The detachable cylinder head contains all valves, valve guides, and springs. The cylinders are numbered from front (fan and timing gear end) to rear. Engine crankshaft rotation is clockwise as viewed from the front end of the vehicle. The intake and exhaust manifolds, carburetor, starter, and generator are located on the right side of engine. The ignition coil, distributor, fuel pump, oil pressure regulator, and breather are located on the left side of engine. The oil filler inlet is located in the valve cover on the top of en-

gine. The bayonet type oil level gauge is located on the left side of engine. The water pump is located at the front of engine.

Construction

1. The generator, fan, and water pump are driven by a V-type belt from a driven pulley mounted on the front end of crankshaft. The distributor, mounted at the left side of engine, is driven by the camshaft through the oil pump.
2. The exhaust and intake manifolds are bolted to each other and to the right side of the engine head. The intake manifold and the exhaust manifold are each cast in one piece.
3. A vibration damper is provided at the front end of the crankshaft on the model SD-240 engine only.

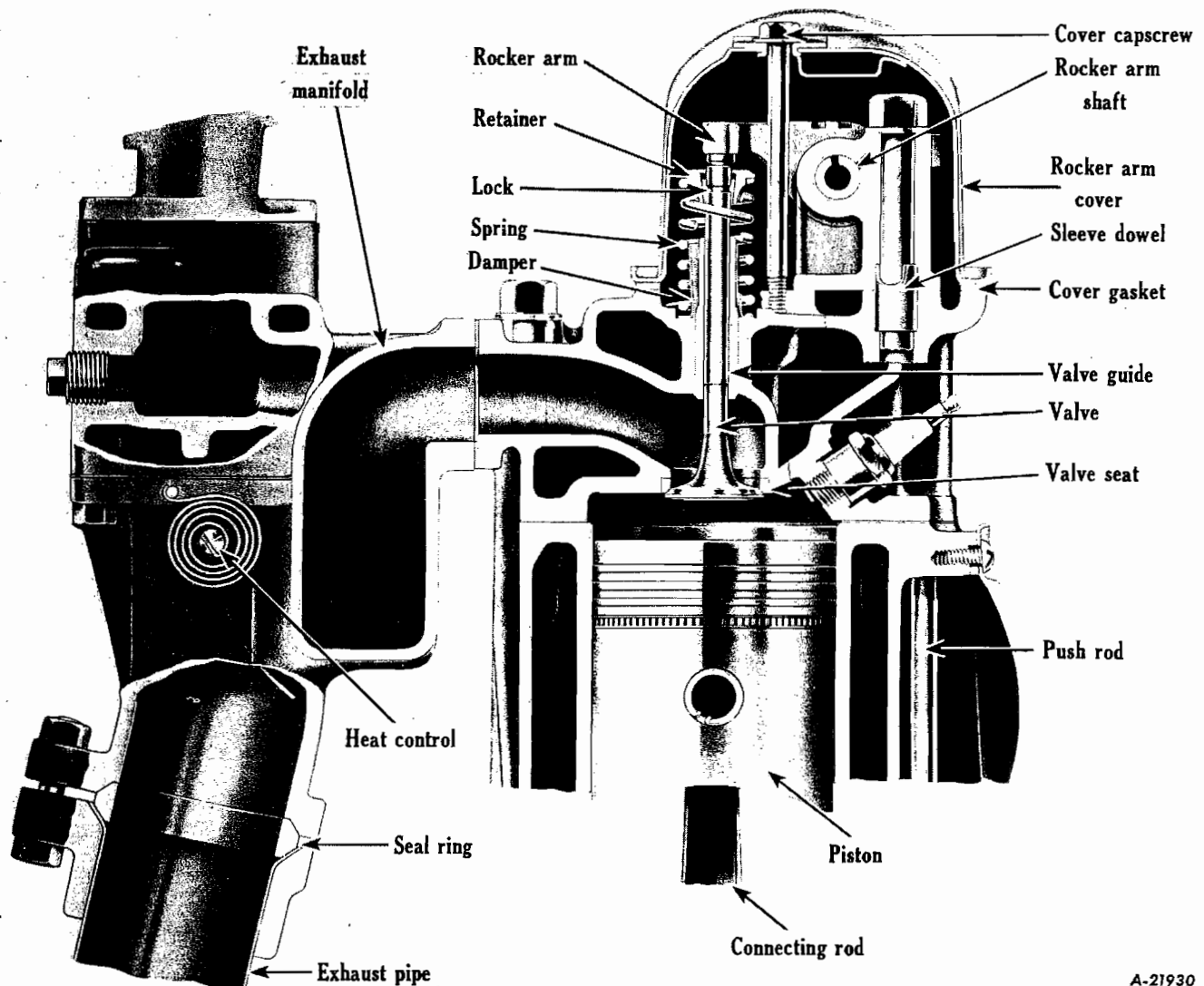


Fig. 3 - Sectional view through engine showing details of valve mechanism.

ENGINES

Silver Diamond

Section A

Page 4

L-LINE MOTOR TRUCK SERVICE MANUAL



4. The cylinder block and crankcase are cast in one piece, and carry the crankshaft main bearings. Water circulation passages completely surround the cylinders in the crankcase, and also provide coolant to the cylinder head.
5. Oil is supplied under pressure by the oil pump to the engine lubrication system. Oil spray from the revolving crankshaft is distributed to the cylinder walls, pistons, and other moving parts inside the engine.
6. Exhaust valve seats are of alloy, and are pressed into place (Fig. 3). These valve seats lengthen the period between valve reconditioning operations. Valves and valve seats are cooled by continuous circulation of water through the cylinder head.
7. The detachable cylinder head is bolted to the crankcase, and a gastight and watertight seal is maintained by means of a gasket.
8. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in four precision-type replaceable shell bearings, the number three bearing taking up the thrust.
9. The pistons are made of an aluminum alloy, are cam ground, and are fitted with three compression rings and one oil control ring. The full-floating type piston pins are held in place in the pistons, at the ends of the pins, by snap rings.
10. The camshaft is machined from a solid drop forging and mounted in four special replaceable bearings.
11. The flywheel is bolted and doweled to the crankshaft flange. The timing mark is located on the flywheel.

ENGINE REMOVAL

The engine, with transmission removed, can be lifted from chassis, without disturbing the fender and grille assembly by using a suitable chain sling and a floor crane (Fig. 4). Disconnect the following electrical circuits, hose connections, and various units as outlined:

1. Drain engine oil pan. Drain all coolant from engine cooling system by opening the drain cock on side of engine as well as the radiator drain cock.

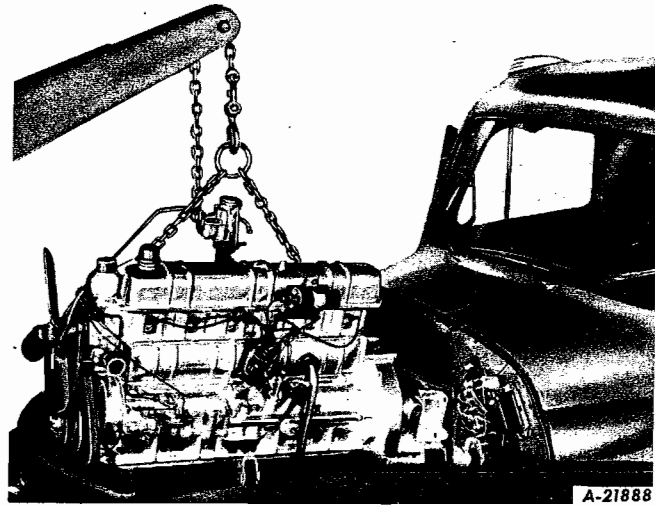


Fig. 4 - Removing Silver Diamond Engine.

2. Disconnect upper and lower radiator hose connections.
3. Disconnect engine circuit wiring. This includes coil wire, starter cable, engine ground strap, and instrument sender unit wires.
4. Disconnect fuel line at fuel pump. Disconnect throttle control linkage at left side of engine and remove choke at carburetor.
5. Disconnect clutch linkage at bell housing.
6. Remove engine rear mounting bolts from both sides of engine support pads.
7. Remove engine front mounting bolts from support bracket; these are the bolts at the front crossmember. NOTE: The engine front support bracket is removed with the engine.
8. Remove radiator mounting bolts, and lift out radiator support and core assembly.
9. Disconnect engine exhaust pipe at manifold.

ENGINE DISASSEMBLY

Install the engine in a suitable rotating engine overhaul stand. NOTE: Many of the disassembly operations can be performed with the engine in the chassis. However, the following disassembly outline is performed with the engine removed from the chassis to clearly illustrate each of the units. Except where indicated, no attempt has been made to prescribe a particular sequence for removing the various units, since some can be readily removed with the engine in the chassis. The extent of the service required on a particular unit will govern the necessity for its removal.

Removing Rocker Arms

The following steps are to be followed when removing the rocker-arm cover and rocker-arm assembly. (Carburetor and air cleaner previously removed):

1. Remove three capscrews from rocker-arm cover. Remove air cleaner line and remove cover (Fig. 5).

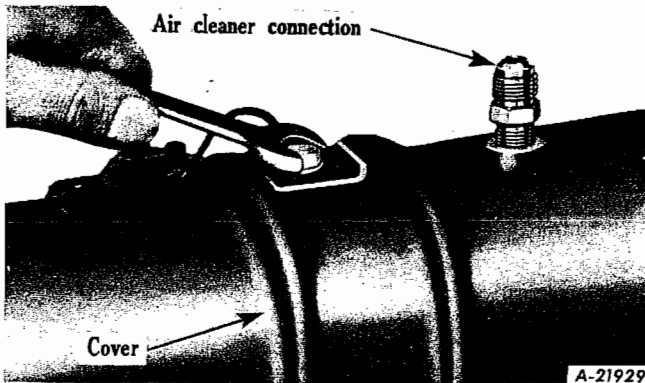


Fig. 5

2. Remove capscrews from shaft brackets (Fig. 6).

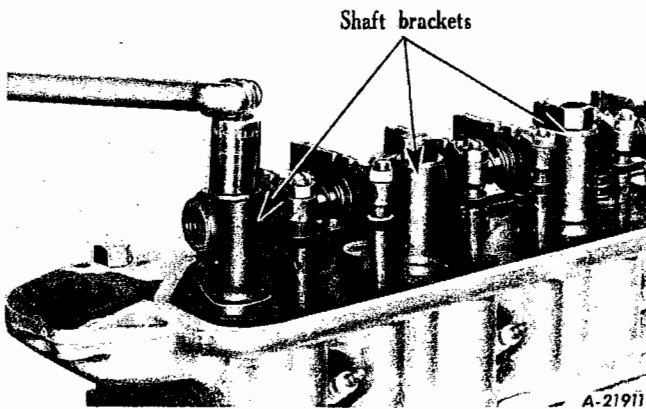


Fig. 6

3. Remove rocker-arm assembly as a unit (Fig. 7).

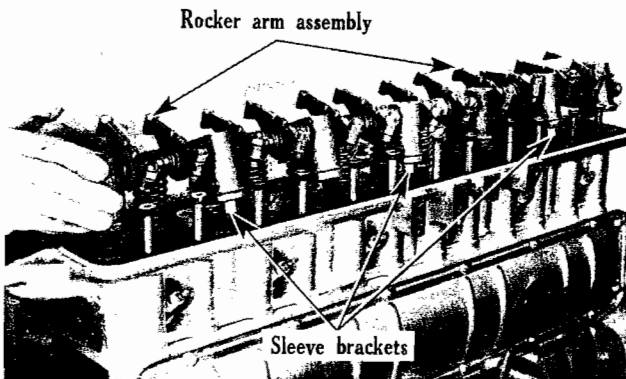


Fig. 7

Rocker-Arm and Valve Mechanism Disassembly

1. The rocker-arm assembly is composed of front and rear shafts joined at the center, on which are mounted twelve rocker arms and six tension springs (Fig. 8). The shafts are mounted in seven brackets, and are prevented from turning at the two end brackets by slots in the shaft into which the cylinder-head bolts fit.

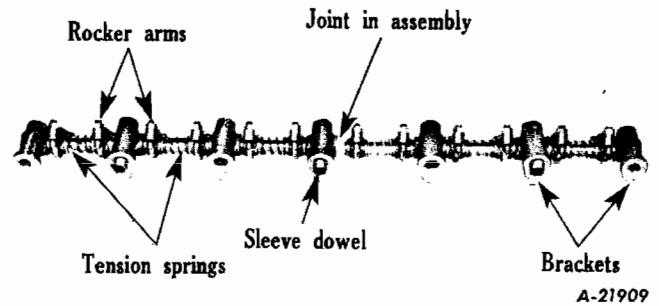


Fig. 8

2. Number two, four and six rocker-arm brackets have sleeve dowels which keep the rocker-arm assembly aligned.
3. These sleeve dowels measure approximately 5/8" in diameter, 1" long, and 1/32" wall.
4. The three hold-down brackets are reamed, from the bottom side (Fig. 9) so that the sleeve dowels will fit .0005"-.0035" tight in brackets. About one-half inch of dowel is in the bracket. The remaining half of dowel is fitted .0025"-.0055" loose in the head. When removing rocker-arm assembly the dowels will remain in hold-down brackets.

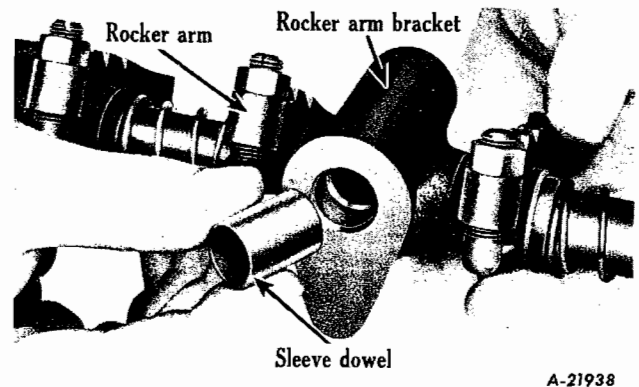


Fig. 9 - Details of sleeve dowel located in bracket.

5. Separate the shafts and slide rocker arms, springs, and brackets from shafts.
6. Clean all parts in a solvent cleaning fluid, being careful to clean all accumulated sludge and carbon deposits from oil holes and slots.



Rocker Arm Inspection

Carefully inspect all parts for defects and wear:

1. Inspect rocker-arm shaft expansion plugs. Check on a surface plate for signs of bending, check for wear from rocker arms. If a shaft is bent or shows perceptible wear, it must be replaced.
2. Inspect rocker-arm adjusting screws for wear at contact surface and for thread wear. Replace worn screws. Check rocker-arm bushings for wear. If clearance on shaft exceeds .004", replace bushings. Inspect valve stem contact pad surface of rocker arms, and resurface if wear is perceptible.
3. Inspect tension springs for breakage or loss of tension. Replace defective springs. Remove valve lifter rods.

Re-bushing Rocker Arms

With properly fitting adapter, press old rocker-arm bushing from rocker arm (Fig. 10). Place new rocker-arm bushing in position. Align oil hole in bushing with oil hole in rocker arm, which is located 23° from top of rocker arm toward rocker-arm adjusting nut. Use an installing tool and press new bushing into rocker arm (Fig. 11). Burnish bushing into place in the rocker arm (Fig. 12), then ream rocker-arm bushing to provide .0015"-.004" clearance.

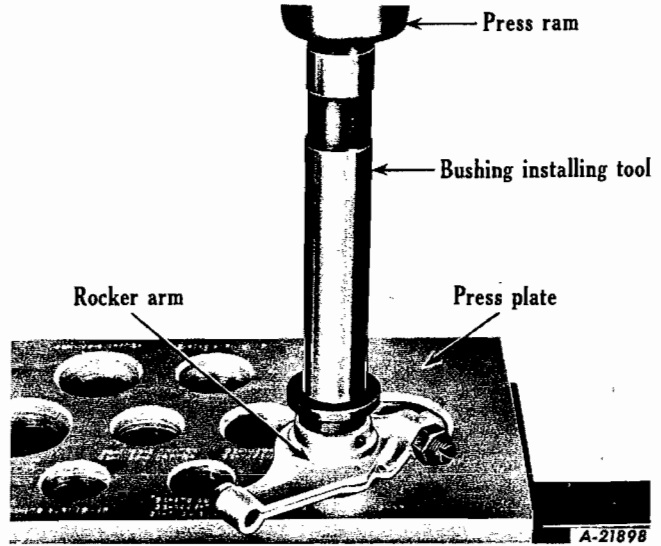


Fig. 11 - Installing new rocker arm bushing.

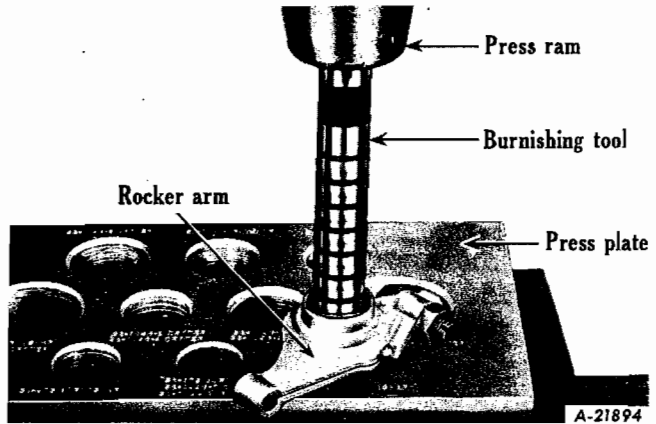


Fig. 12 - Use SE-931 Burnishing bar.

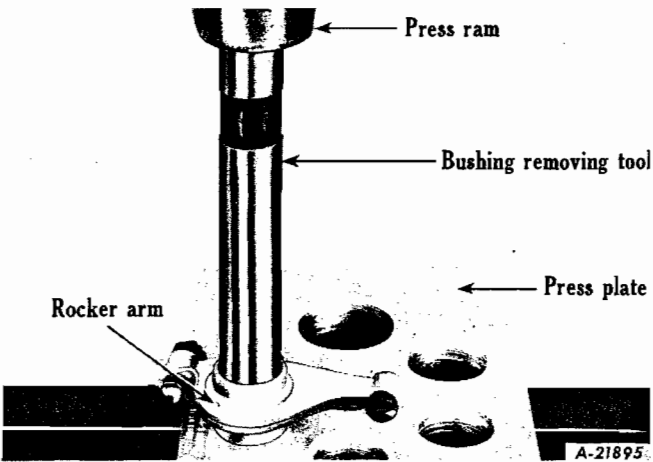


Fig. 10 - Use SE-1036-1 Bushing Removing Tool when removing the rocker arm bushing. Support the rocker arm on the SE-1033 support block. Select a hole in the support block to properly support the rocker arm at the same time permit the bushing to clear the support block when being removed. Use the support block when installing and burnishing the new bushing.

Cylinder Head and Valves

The following instructions are to be followed when reconditioning cylinder head and gasket. Remove push rods, remove cylinder-head bolts and lift off cylinder head and gasket (Fig. 13). Place cylinder head on bench.

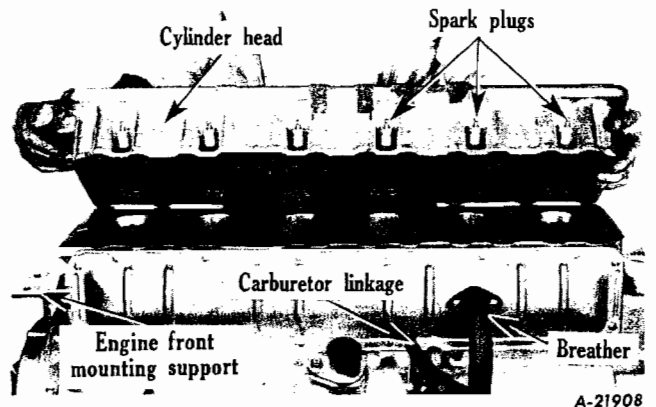


Fig. 13



1. Compress valve spring with a valve compressor and remove valve spring retainer locks (Fig. 14). Remove retainer. Remove valve spring and damper and separate valve spring damper from valve spring. Note that valve springs can be installed with either end toward the cylinder head. Remove all valve springs as outlined, and remove valve spring damper from each spring (Fig. 15).

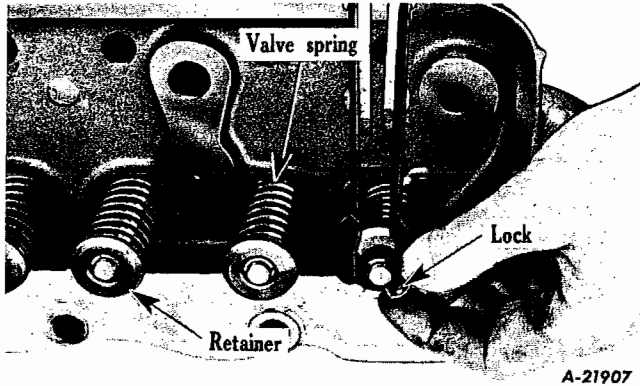


Fig. 14

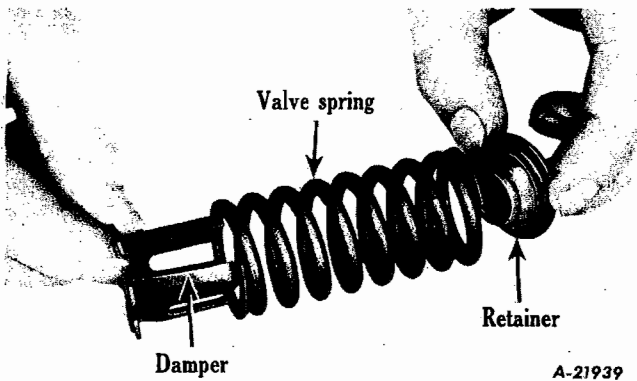


Fig. 15 - Dampers are used at all the valves. Assemble damper, spring and retainer as shown.

2. Invert cylinder head. Remove all valves from their valve guides and from the head.
3. Scrape all carbon from cylinder-head combustion chamber, and clean any gasket material from surface of head. Clean the head using steam cleaning or other suitable cleaning equipment
4. Clean all carbon deposits from valve heads and valve stems with a wire brush. Wash all valve springs and retainers in cleaning solvent.

Inspection of Cylinder Head

1. Inspect cylinder head visually for signs of cracks or sand holes. If found defective, weld or replace head.

2. Inspect exhaust valve seat rings for looseness and inspect for excessive width of valve seat surface. If rings are loose, replace. If a seat has been previously ground to such extent that it cannot be narrowed from top to bring to proper position near center of valve face, the ring must be replaced.

Inspection of Valve Guides, Valve Springs, and Valves

1. Clean valve guides with a suitable cleaning tool. Check each valve guide with a "Go and No-Go" gauge, if available; otherwise, use a new valve to check fit. If "No-Go" portion of gauge enters, the guide must be replaced. Recommended valve stem to valve guide clearance is from .0015" to .0035" for intake valves, and from .002" to .004" for exhaust valves. Clearance in excess of .006" for intake valves or .008" for exhaust valves, require guide replacement. Valve guides are reamed to .3743"-.3758" after assembly in cylinder head.
2. Test valve springs with damper in position. Test tension of each valve spring at valve open length with a valve-spring tester (Fig. 16). Check valve springs at 1-11/16" length, and replace if pressure is less than 149 lbs.

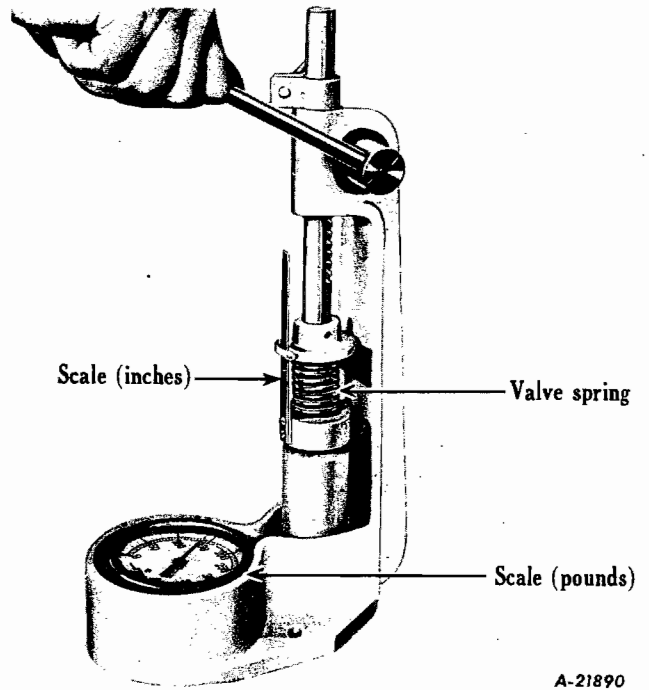


Fig. 16 - Use SE-1565 Valve spring testing tool or similar tool to check spring tension.

3. Inspect each valve for warpage, for severely burned condition, and for excessive grinding on the valve head. Inspect valve stem for scuff marks or perceptible wear.



Inspect valve stem end for wear at contact surface with valve rocker arm. If valve is warped, excessively burned, or has been previously ground to extent that valve head is thin at edge, replace valve; otherwise, valve can be reconditioned and reinstalled.

Repair of Cylinder Head

1. If cylinder head has to be resurfaced, remove only enough material to true-up surface.
2. If any valve guide shows excess clearance or out-of-round condition, press guide from cylinder head with a special removing tool (Fig. 17). Install new guide, and press into cylinder head until approximately 1-1/4" remains above the top surface of cylinder head (Fig. 18). Check valve guides after installation to .3758" to .3743" with "Go and No-Go" gauge. Ream valve guides to .3743"-.3758" after assembly in cylinder head.
3. If an inspection has indicated the necessity, replace the valve seat.
4. Grind the valve seats in cylinder head to 30° on exhaust and 30° on intake.

Reconditioning Valves and Seats

One of the principal difficulties experienced in reconditioning valves is obtaining nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.

The grinding stones on both the valve-refacing machine and valve-seat grinder should

be dressed before starting a reconditioning job. You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for true-ness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the valve head.

The location of the valve seat on the valve face and its width controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperatures and poor heat dissipation also produce excessive valve stem temperatures and hasten the accumulation of carbon on the stem, causing them to stick in the guides.

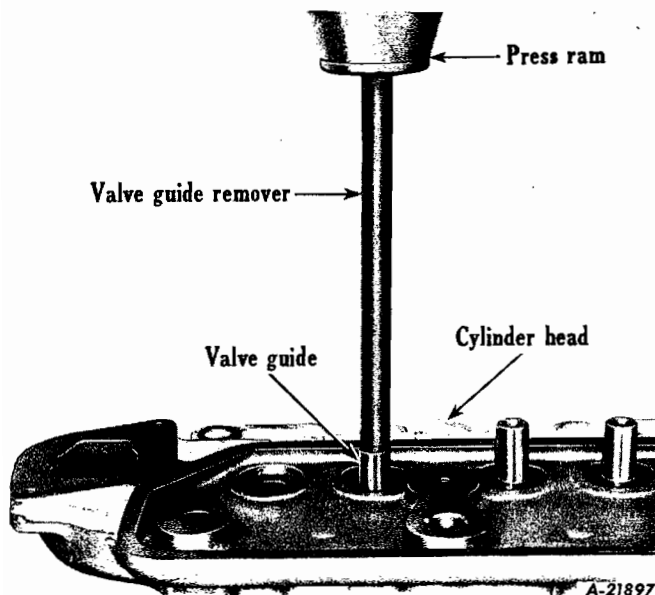


Fig. 17 - Use SE-1722 Valve stem guide tool.

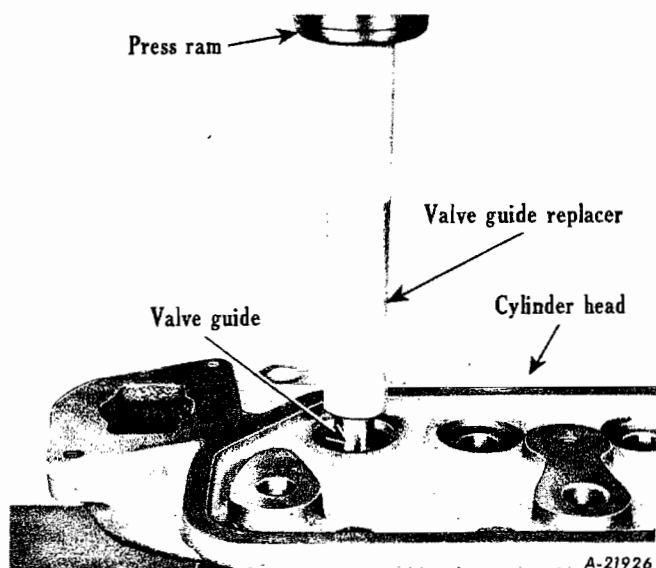


Fig. 18 - Using SE-1723 Guide replacer. Push guide down until tool bottoms on head.



Valve Seat Widths

In general, the width of exhaust seat should range between the average and maximum specifications and the intake seats between the minimum and average specifications. The intake seats may be narrower than the exhaust because they are usually larger in diameter, thus providing a total seat area approximately equal to smaller exhaust valve with the wider seat. Also the less severe heat conditions do not require as large a seat area for heat dissipation purposes.

There are also objections to an excessively wide seat, a few of which are as follows:

1. In city or light delivery service a wide seat collects carbon and particles of dirt that will produce variations or loss of compression, resulting in poor idle and possibly a loss of general performance and economy.
2. A wide seat in severe service operating in the presence of dirt or an excess of carbon will produce a badly pitted seat which may be just as detrimental to valve life as a too narrow seat. Under these conditions a seat width to the minimum limit would possibly be better; however, the source of trouble (which is the dirt and excessive carbon) should be eliminated, making it possible to retain the wider seat.

Valve Seat Inserts

Necessity for replacing valve seat inserts should be very rare; however, if a replacement is made it is important that new inserts be peened securely in place, using either insert peening tool or a dull-pointed chisel, 1/4" wide, topeen cylinder head metal over outer edge of valve seat insert.

Valve seat insert installing tools are available.

Valve seat inserts supplied for service are standard size and .030" oversize which permits a tight fit in cylinder head.

Repair of Valves

1. True-up the ends of valve stem against face of grinder. Remove only enough material to true the surface.
2. Reface exhaust valves to 30°. The valve face and valve seat angle must be identical.
3. Reface intake valves to 30° with valve seat being the same.
4. Place valves in cylinder head. Place a thin coat of Prussian blue on each valve

face, and tap valve lightly to its seat. NOTE: This is merely for test and proof of results of refacing and reseating operations. A poor grinding job cannot be corrected by valve lapping.

5. Inspect each valve coated with blue for seat position. The seat should be at the approximate center of valve face, 3/64"-5/64" wide for exhaust, and 1/64"-3/64" wide for intake (Fig. 19).

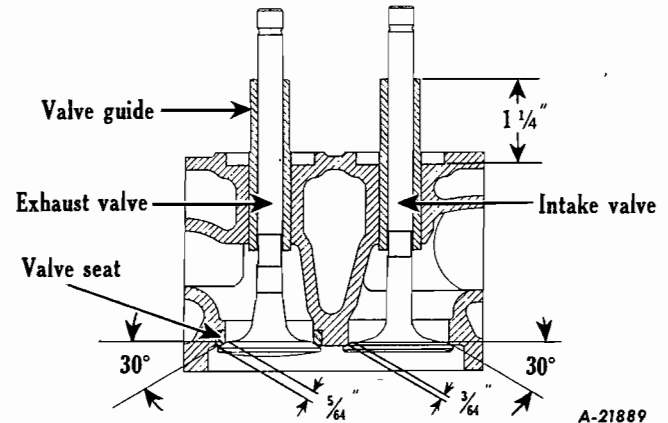


Fig. 19 - Diagram showing valve installation.

Valve Assembly

1. Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat valve stems and valve faces with oil, and install valves in same seats to which they were checked.
2. Install valve springs with dampers. Compress valve springs with a valve spring compressor, and install valve spring retainers and retainer locks. Be sure that retainers and locks are correctly seated.

When overhauling engine with head and pan removed, the following procedures are recommended:

1. Remove front motor to frame bracket by removing two nuts on top side (Fig. 20). Remove fan drive pulley nut and washer from end of crankshaft. Install puller and remove crankshaft fan drive pulley from crankshaft (Fig. 21). Remove 4 capscrews holding motor mounting bracket to block (Fig. 22).
2. Remove nuts and capscrews from engine gear case cover, remove gear case cover and gasket. Remove crankshaft oil slinger from end of shaft (Fig. 23).
3. Remove two self-locking capscrews from camshaft retainer thrust flange plate, working through two holes in camshaft gear (Fig. 24). Pull camshaft and gear assembly from cylinder block. Remove



two capscrews holding the gear case cover plate to block; remove plate and gasket (Fig. 25). Remove crankshaft timing gear, using a special gear puller (Fig. 26). (NOTE: Lubricate puller screw to prevent damage to screw threads).

Turn engine in the overhaul stand and proceed with disassembly as follows:

- Each connecting rod is numbered as to its position in the engine and these numbers are located on the camshaft side of the engine. Remove self-locking capscrews from connecting-rod cap and remove cap. Push connecting-rod and piston assembly

toward top of block, but first remove ridge from top of cylinder wall, if any. Lift piston and connecting-rod assembly from top of cylinder block (Fig. 27). Replace cap on connecting rod. Remove the remaining pistons, following the same procedure.

Note that the connecting-rod caps are aligned with the rods by means of tongue and groove construction (Fig. 28).

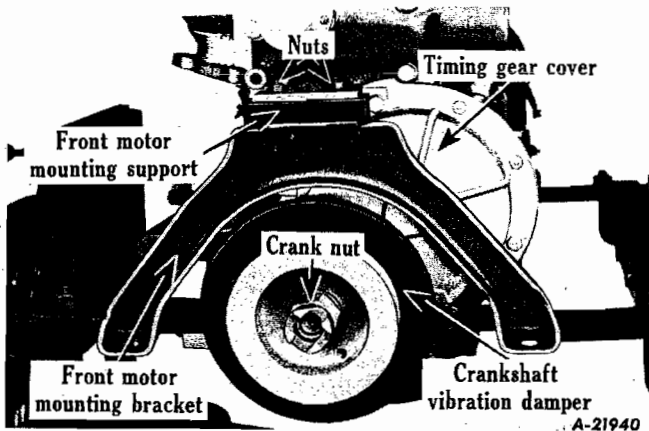


Fig. 20

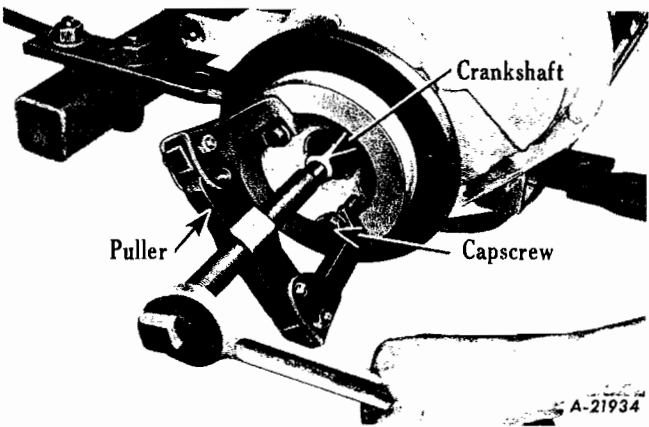


Fig. 21

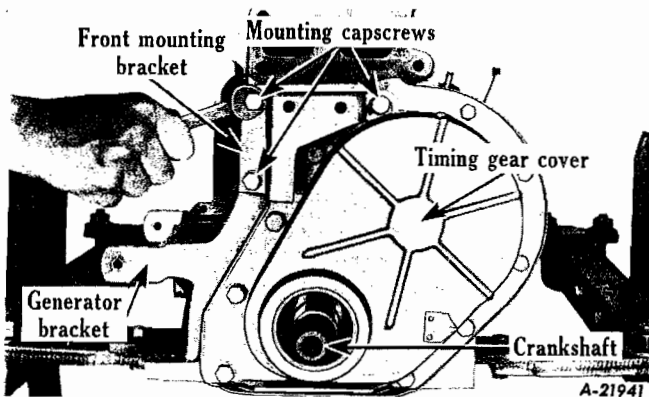


Fig. 22

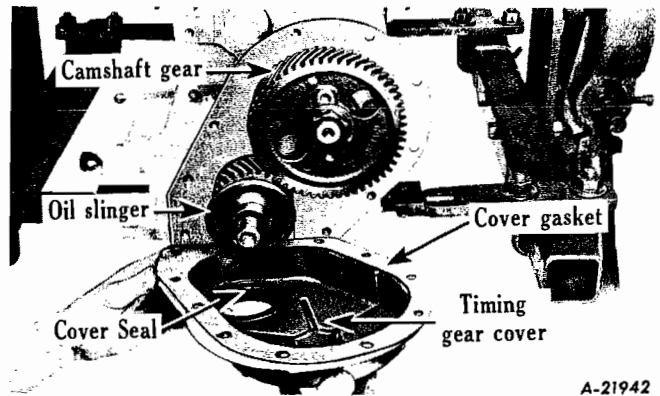


Fig. 23 - Gear case cover removed showing timing gear details.

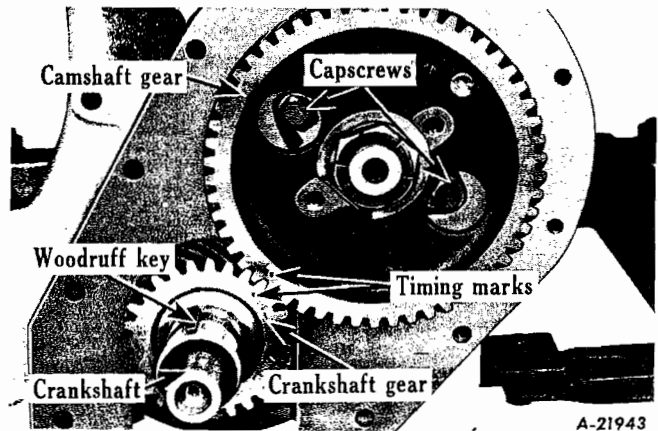


Fig. 24 - Timing gear timing marks and camshaft thrust plate details.

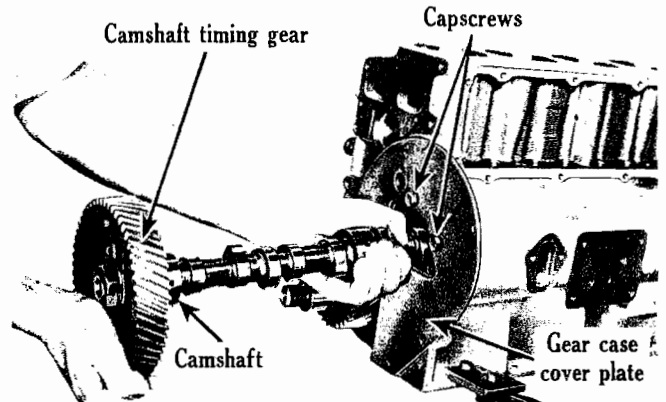


Fig. 25 - Camshaft and cover plate removal.

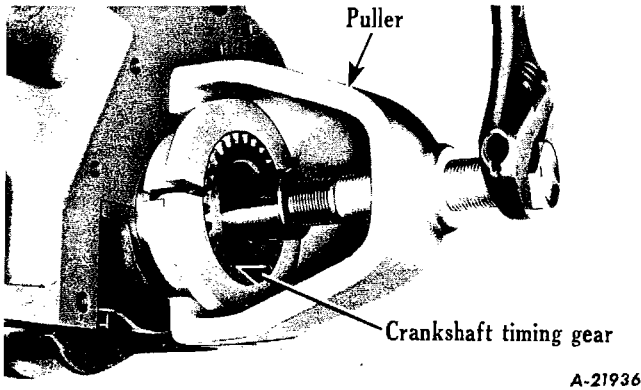


Fig. 26 - Crankshaft gear puller SE-1715 is installed with puller plates in position shown. Lubricate puller screw thoroughly.

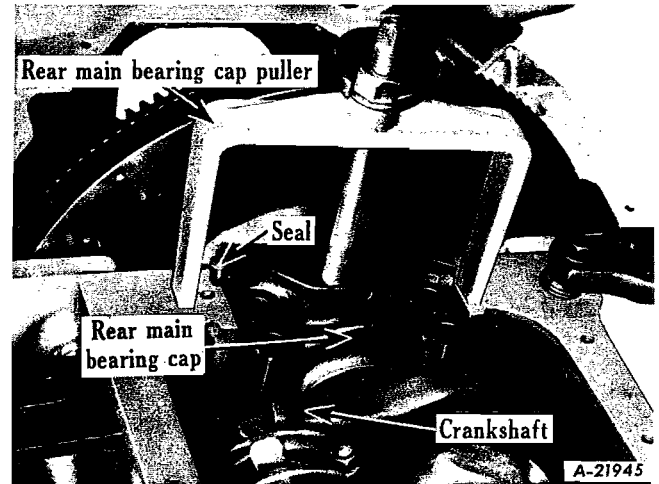


Fig. 29 - Use SE-1719 Bearing cap puller to remove rear main bearing cap.

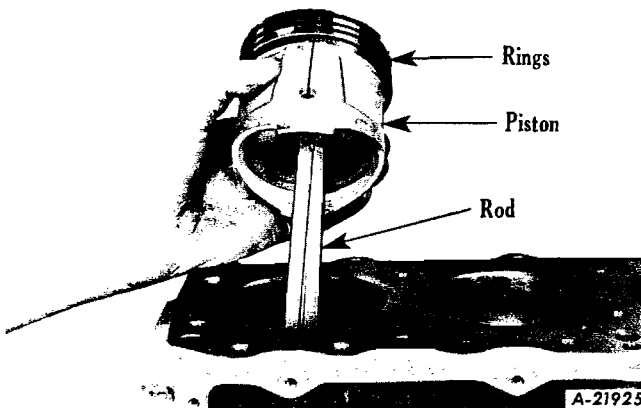


Fig. 27 - Remove piston and rod from top of cylinder block.

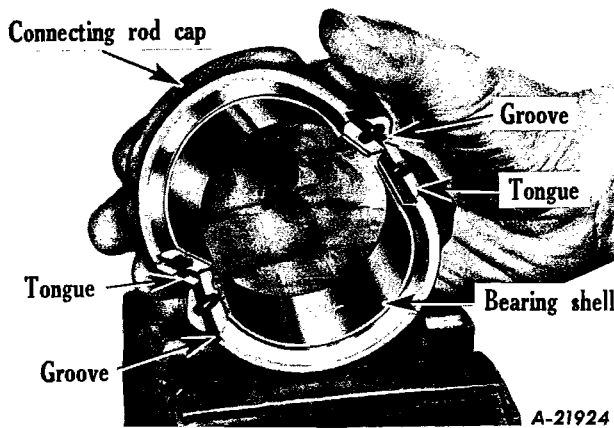


Fig. 28 - Connecting rod caps are aligned by means of tongue and groove construction.

- The crankshaft bearing caps are numbered to identify their position and they must be reinstalled in their respective positions. Remove self-locking capscrews from each bearing cap. Remove all crankshaft main bearing caps. NOTE: To remove the rear, or No. 4, main bearing cap, a puller is required (Fig. 29). After all caps have been removed, lift crankshaft straight up and out of cylinder block, and place in a vise equipped with soft jaws.

- With crankshaft securely clamped in vise, remove the six self-locking capscrews holding flywheel to crankshaft (Fig. 30). Tap flywheel with a soft hammer to loosen it from crankshaft; remove flywheel with ring gear assembly.

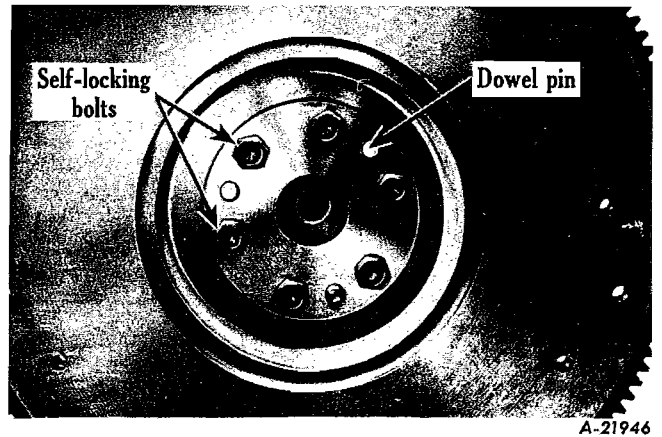


Fig. 30 - Remove self locking capscrews to remove flywheel.

- Remove six capscrews and lockwashers from engine flywheel housing. Drive out the two engine block dowels, remove flywheel housing.
- Remove fuel pump, starter, oil pressure regulator valve assembly, distributor, generator, oil gauge, coil, and all "freeze plugs" in block. (NOTE: Removal of the "freeze plugs" or core hole plugs is only necessary when it is determined that the condition of the water passages in the block warrant a thorough cleaning, or the plugs appear to be leaking.) Clean inside and outside of block with a solvent cleaner or steam. Install core plugs using SE-1725 Adapter and SE-1581-1B Handle.



Water Pump Removal and Overhaul

The water pump is of the centrifugal packless type (Fig. 31). It is bolted to the front end of the engine and is driven by the fan pulley. It requires no external adjustment. The bearing is of the sealed lubricated type and does not require added lubrication at any time. The water pump is driven by a V-belt on the fan pulley. The pump, by means of centrifugal force developed by the impeller rotation, draws water up from the lower part of the radiator into the water passages in the cylinder block and cylinder head. The water circulates through the cylinder block and then out through the thermostat housing into the radiator upper tank.

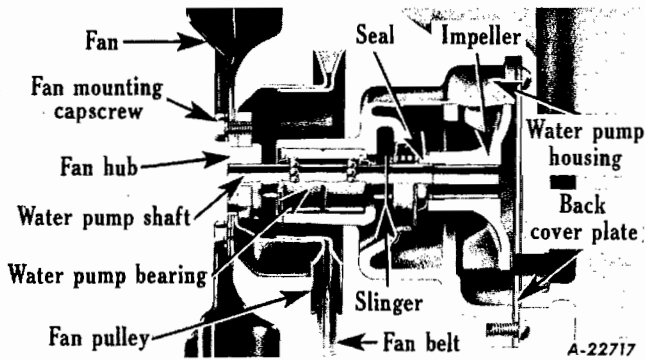


Fig. 31 - Sectional view of water pump.

Water Pump Disassembly

1. Remove four capscrews and lockwashers holding fan to hub. Remove fan blade assembly from hub.
2. Remove four mounting capscrews from water pump (Fig. 32). Remove water pump from front end of cylinder head.

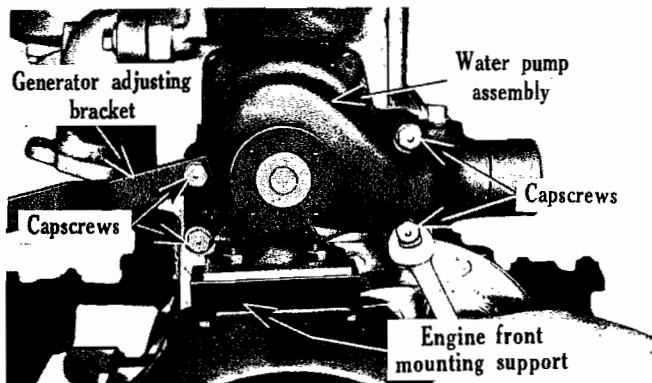


Fig. 32

3. Remove three screws from back cover plate. Remove plate and gasket from pump body (Fig. 33).

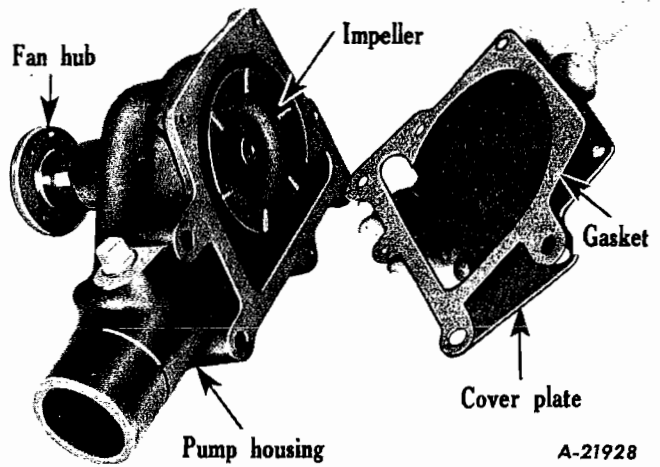


Fig. 33

4. Remove snap ring from front of water pump shaft bearing (Fig. 34). Support the water pump on an arbor press and push shaft and bearing out, as one assembly (Fig. 35).

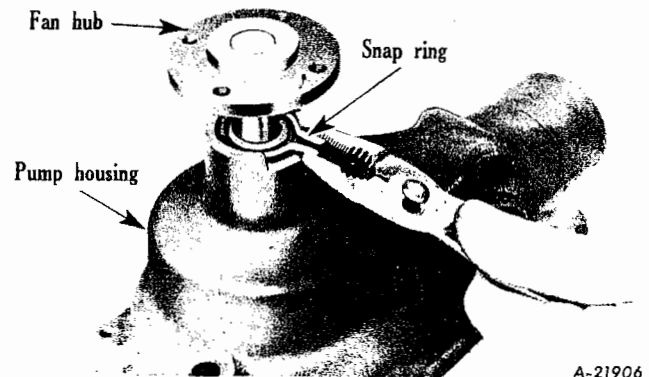


Fig. 34

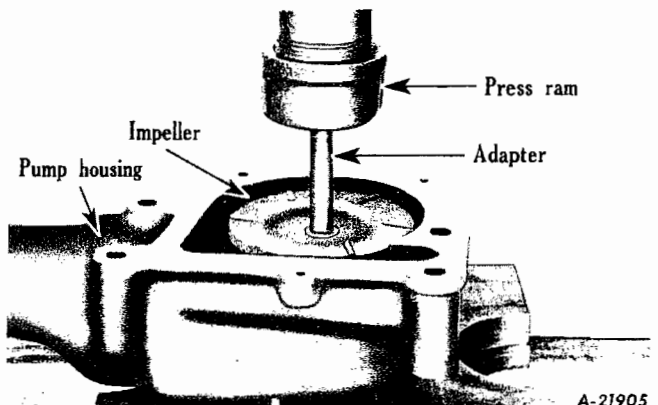


Fig. 35



- Place shaft assembly in press and press fan hub from shaft (Fig. 36). Do not attempt to remove bearing or slinger, as they are factory installed on the shaft in the proper location.
- Remove seal from housing through back side of pump. Use a drift, and carefully drive seal from the pump body.

Water Pump Cleaning and Inspection

Before reassembling water pump, the following should be checked:

- Clean all parts by steam or cleaning solvent.
- Examine seal for wear or damage and replace parts as necessary. Use special tool when installing seal. Use a new seal when rebuilding the pump since the old seal may have been damaged upon removal.
- Examine pump impeller seat seal surface, if face of pump is scored, it must be resurfaced or replaced to prevent leakage.

- Inspect pump shaft bearing for wear. If worn, replace bearing.
- Examine shaft for wear and replace if needed.

Water Pump Assembly

- Press fan hub on shaft with the smaller diameter of the hub to the front (Fig. 37).
- Install shaft in housing from front end by pressing shaft, bearing, slinger, and fan hub in as one unit (Fig. 38).
- Install snap ring in place behind fan hub (Fig. 39).
- Mount assembly in press. Press impeller on rear end of shaft. Place a straight edge across the back of the water pump housing and check the clearance between the straight edge and impeller. There should be about .025" clearance (Fig. 40).

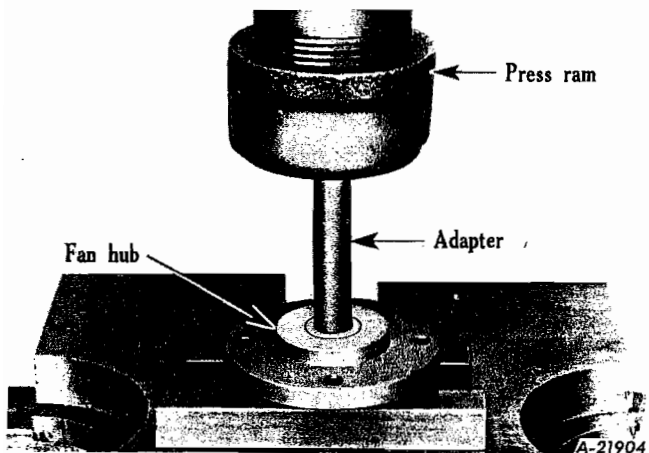


Fig. 36

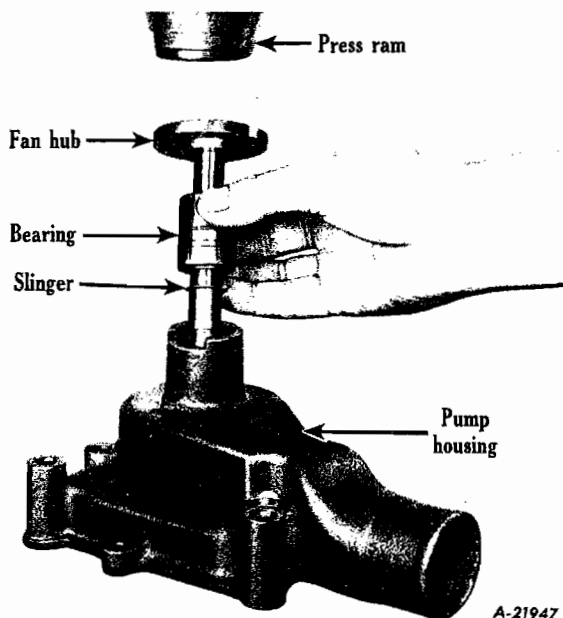


Fig. 38

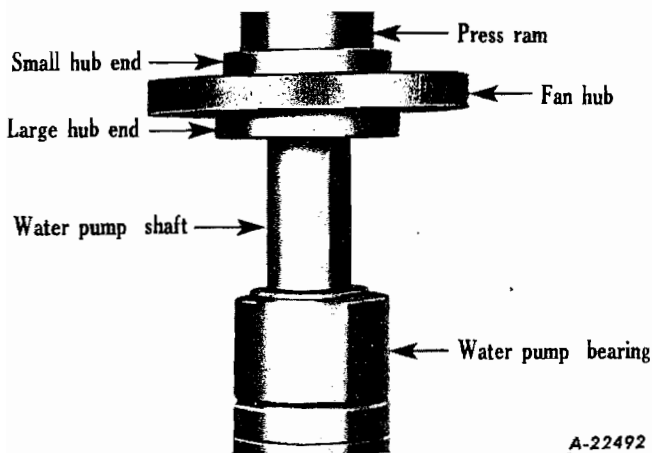


Fig. 37

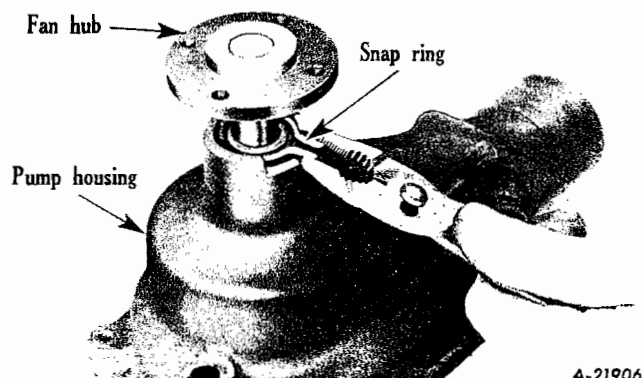


Fig. 39

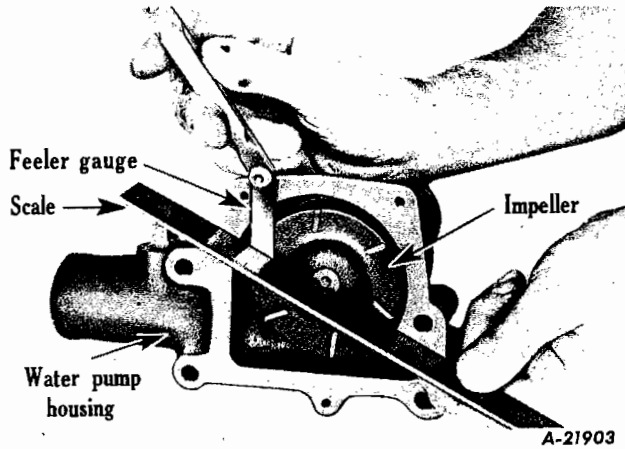


Fig. 40

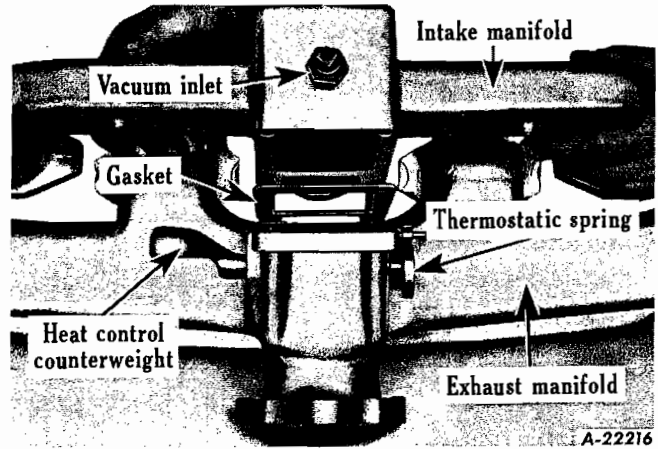


Fig. 42

5. Install cover plate with new gasket, and mount fan blades.

Intake and Exhaust Manifolds

When disassembling and assembling the manifolds, the following procedures are used:

1. After removing the eight capscrews from head and three bolts from exhaust flange, remove both intake and exhaust manifolds as a unit (Fig. 41). NOTE: Let manifolds cool before starting above operations.
2. To separate the two manifolds, remove the two outside capscrews and two inside nuts from the center of manifolds (Fig. 42).
3. The intake and exhaust manifolds are each of one piece construction, requiring no disassembly after separation.

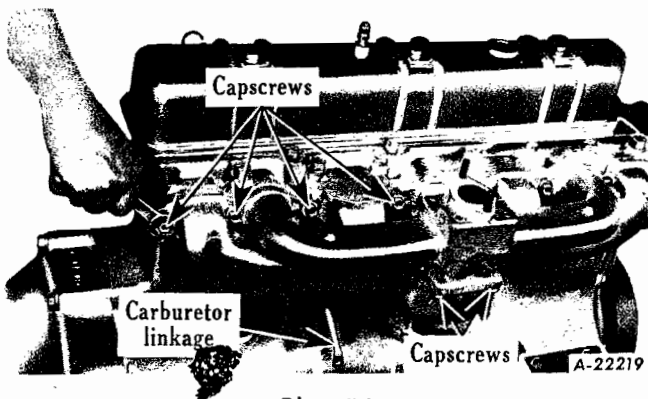


Fig. 41

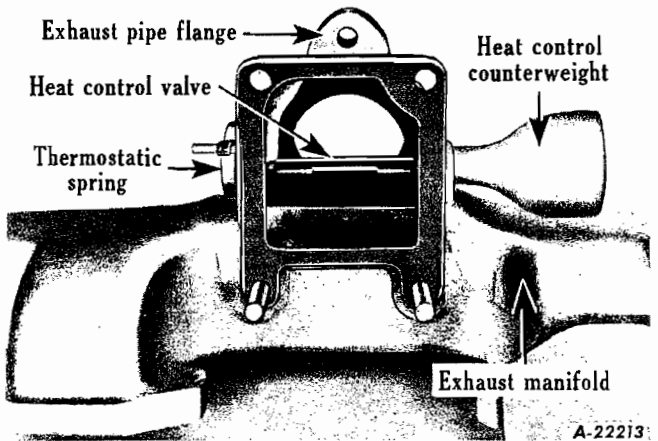


Fig. 43

2. If vacuum is needed to operate any unit within the truck, a threaded inlet is provided in the manifold for such purposes.

Exhaust Manifold

1. The exhaust manifold consists of four outlets. The two end outlets remove burned gases from the No. 1 and No. 6 cylinders, while the two center outlets remove burned gases from Nos. 2, 3, 4 and 5 cylinders.
2. Located in the exhaust manifold, in the center, is the manifold heat control unit (Fig. 43).

Intake Manifold

1. The intake manifold consists of three outlets, each supplying fuel to two cylinders. Two studs are located on the top for carburetor mounting.

3. The purpose of the heat control unit is to keep the intake manifold warm enough to vaporize the fuel mixture as completely as possible. The heat control is automatic in operation, being controlled by a coiled thermostatic spring. A counterweight, under spring tension, is mounted on the heat control valve shaft and this counterweight operates with the spring to close and operate the heat control valve.

4. Should the valve hold too much heat, the engine is likely to detonate or "ping" when engine is accelerated. If valve opens too early, not enough heat is retained in the manifold, resulting in a slow warm-up. If the thermostatic spring becomes disconnected, the whole heat control system will be upset.
5. Should the shaft of the heat control become stuck, tapping it with a hammer and working the valve back and forth by hand usually frees it. An application of penetrating oil will help the process of freeing a sticking heat valve.

Manifold Inspection

Inspect intake and exhaust manifolds visually for cracks or breakage. Place manifolds on surface plate and check for warpage. If cracked or broken, replace or weld. If slightly warped, true-up on surface grinder but replace if warpage is extreme.

Manifold Assembly

Place new gasket between the intake and exhaust manifolds and install two capscrews and two nuts. Mount manifolds together loosely before installing on engine. This will assure proper alignment of the units with each other and with the engine cylinder head.

Oil Pump Removal and Overhaul

After oil pump has been removed, the following steps are to be used for disassembly:

1. Remove cotter pin holding float to oil pump (Fig. 44). Remove float from pump. Remove two capscrews holding pump in block. Remove oil pump.

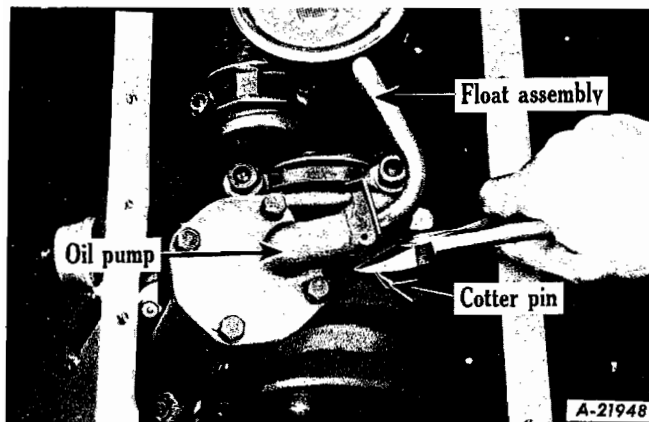


Fig. 44

2. Remove four capscrews and lockwashers from oil pump cover plate. Then lift cover and gasket from oil pump body (Fig. 45).
3. Lift out oil pump idler gear from idler gear shaft (Fig. 46).

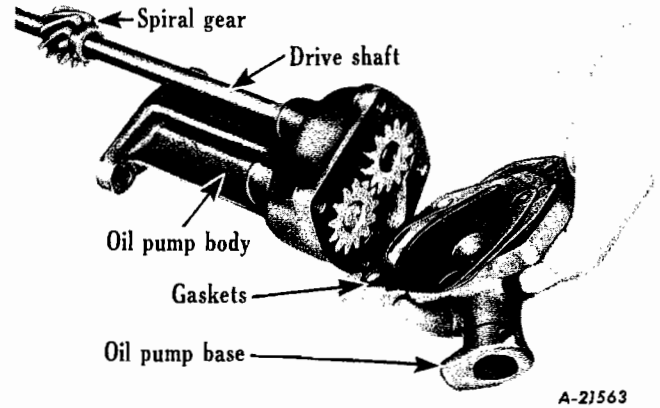


Fig. 45

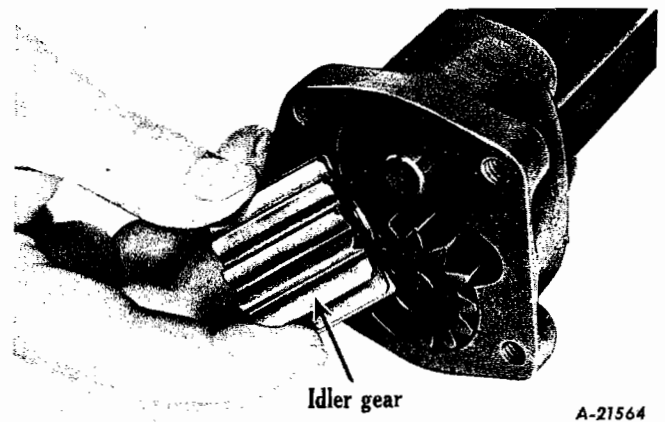


Fig. 46

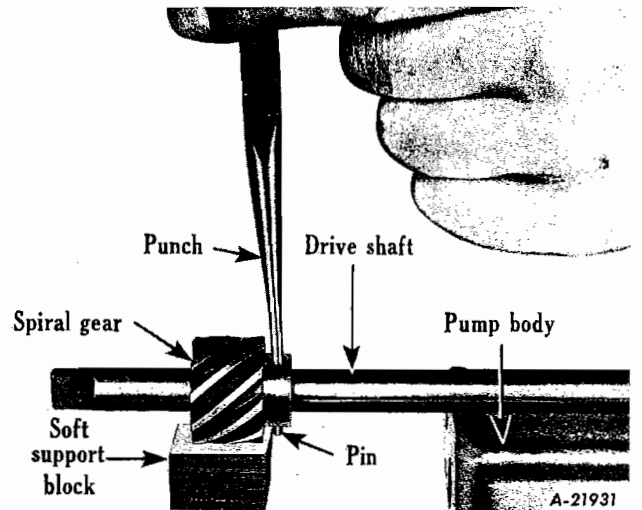


Fig. 47

4. Support oil pump shaft to prevent bending shaft, and using a small punch, drive out spiral gear pin from oil pump spiral gear (Fig. 47).
5. Place two support plates under spiral gear in press, and press oil pump drive shaft out of pump spiral gear (Fig. 48). Remove Woodruff key.

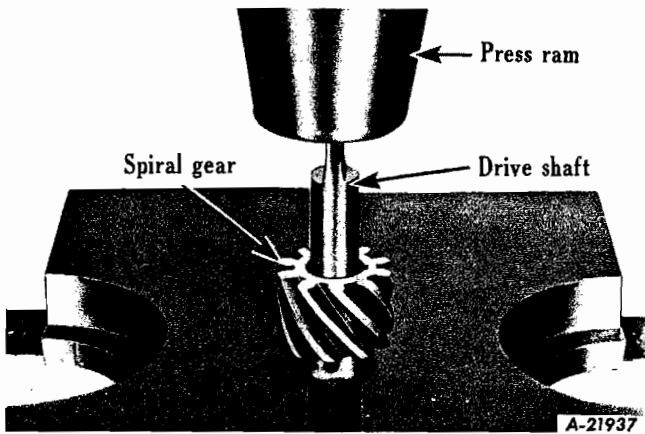


Fig. 48 - Use SE-1499 Oil pump support plate or other suitable support when pressing shaft from gear.

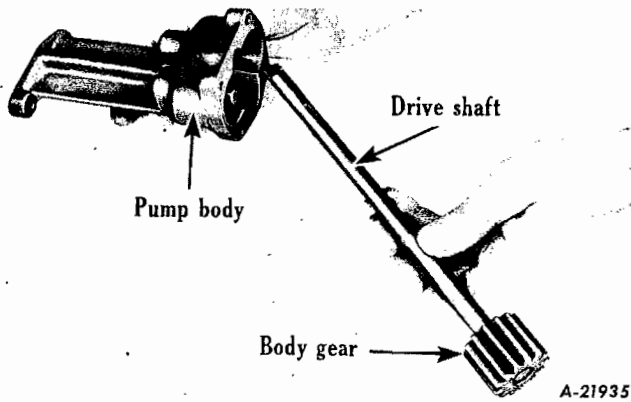


Fig. 49

6. Remove body gear and drive shaft from oil pump body (Fig. 49).
7. Press pump body gear from shaft and remove Woodruff key.

8. Wash all parts in a cleaning solvent.

Oil Pump Inspection

Check the following parts carefully:

1. Check oil pump drive shaft for wear at points of contact with body. If shaft is worn or bent, it should be replaced.
2. The standard measurement of oil pump shaft is .4885"-.4890". The shaft should be concentric and straight through its entire length within .004" indicator reading.
3. Check oil pump body for warpage, damage, and wear. Replace if body is warped or cracked, or if shaft bore is worn so that clearance between shaft and bore is in excess of .005". The oil pump body shaft bore measures .490".
4. Inspect oil pump gears, and replace if wear is perceptible.

Oil Pump Assembly

The following instructions are to be followed for reassembly:

1. Install new Woodruff key on body end of drive shaft.
2. Place in press and press body gear on drive shaft. The end of the shaft can be from flush to .030" below the level of gear face.
3. Insert oil pump drive shaft and body gear into oil pump body.
4. Install new Woodruff key in spiral gear end of drive shaft and press on spiral drive gear. Make sure that spiral gear hub is down. Install new spiral gear pin in place.
5. Install idler gear on idler gear shaft. Install gaskets, oil pump body cover, four capscrews, and lockwashers.
6. Check oil pump body gear end clearance by using a dial indicator (Fig. 50). If end clearance is less than .0025" add one gasket that measures not more than .003" in thickness. If end clearance is in excess of .0055" remove one gasket of not more than .003" in thickness. Body gear end clearance should measure between .0025" and .0055".
7. Insert oil pump float in oil pump, line up cotter pin holes, install new cotter pin, and fasten securely.

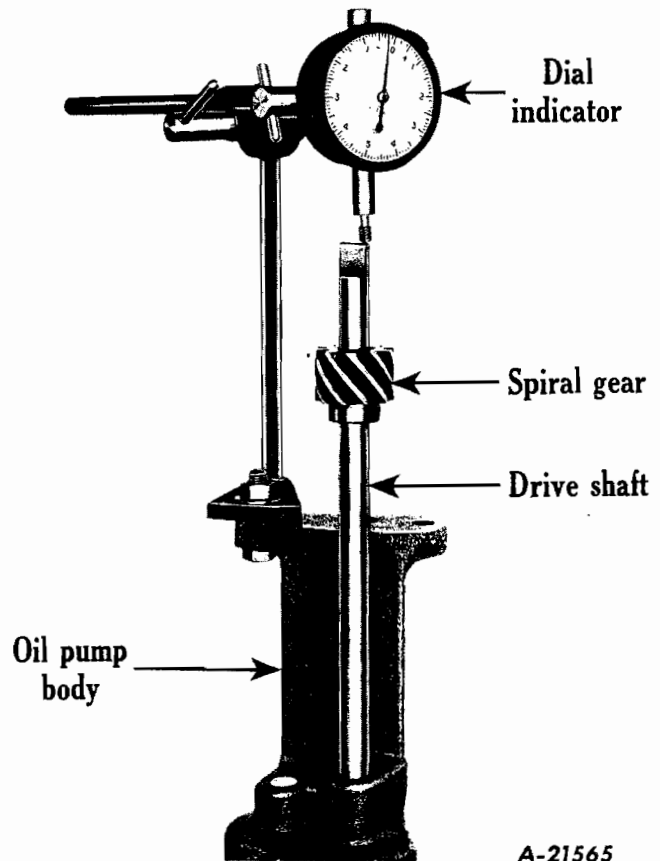


Fig. 50 - Checking end clearance of pump shaft and body gear.



DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

Cleaning the Cylinder Block

1. Remove all old gasket material from block. Clean both inside and outside of block with steam or cleaning solvent. Remove all dirty oil, sludge, scale, and carbon from cylinder block. Check core plugs for indication of leakage. Remove and replace plugs that show signs of leaking, or rusting through. Use installing tool for core plug replacement (Fig. 51).

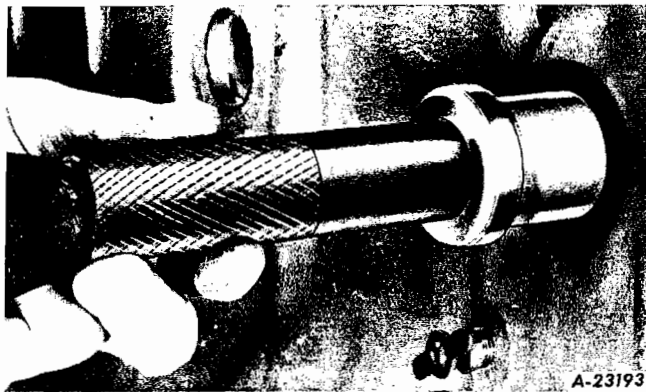


Fig. 51 - Installing core plug using SE-1725 installing tool with SE-1581-B handle.

Cylinder Block Inspection

1. Inspect cylinder walls for cracks. Weld the cracks or replace block if necessary.
2. Check top surface for trueness with a straight-edge. Test by attempting to insert a .012" feeler gauge ribbon between the straight-edge and the cylinder block. If this is possible, either surface or replace the cylinder block.
3. Inspect camshaft bearings for damaged or scored condition, and inspect for wear. Replace if damaged or if worn beyond clearance limit of .006".
4. Measure cylinder walls with an inside reading micrometer to determine taper, out-of-round, or worn condition. The measurements must be made not only at top of the cylinder bore, just below ring groove, but at several places around the inside circumference of the bore. Bore should be checked at the bottom, below ring wear surface, to determine the amount of taper. Rebore if worn beyond .008" clearance.

Replacing Camshaft Bushings

1. If camshaft bearing replacement is necessary, remove and install new bushings with special camshaft bearing installation tool (Fig. 52). No reaming is required.

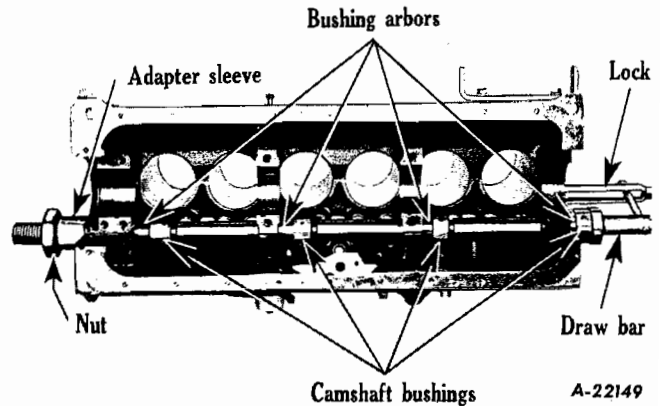


Fig. 52 - SE-1724 Camshaft bushing installation. Showing tool in position.

Connecting-Rod and Piston

1. Remove piston-pin retainers from each piston, and remove piston rings from piston ring grooves.
2. Heat piston in boiling water or piston heater. Place piston in piston vise, and using pin-driving tool, drive piston pin from piston and connecting rod (Fig. 53). After piston pin is removed, lift piston from connecting rod.

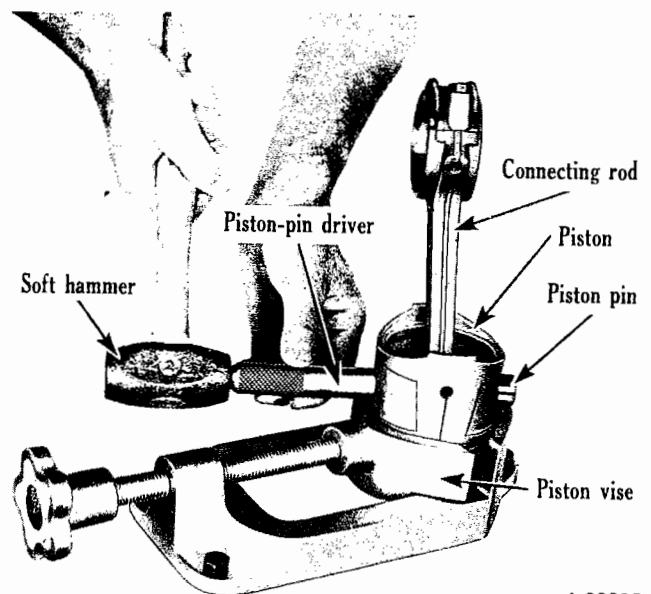


Fig. 53 - Use suitable piston vise to hold piston and drive piston pin out using SE-1263. Use soft (bronze or brass) hammer when driving to prevent damage to tools.



3. Wash all parts in a cleaning solvent. **CAUTION:** Do not use a caustic solution for aluminum pistons. Clean the carbon from piston ring grooves with a broken ring or ring groove cleaner.
4. Inspect connecting rods, caps, and bearing shells. All connecting-rod bearings and piston-pin bushings should be replaced at every major overhaul. Test rods for alignment. Rods only slightly mis-aligned can be straightened with proper equipment. Badly twisted or bent connecting rods must be replaced.
5. Inspect pistons for cracks, breakage, or scores. Check piston ring grooves and ring lands for wear, using a new piston ring and feeler gauge. If clearance between ring and ring land exceeds .005", (total clearance) replace piston (see specifications for data covering piston fit in cylinder block).
6. Inspect piston pins for wear, and if wear is perceptible, replace pins. Replace piston pins which show signs of corrosion or etching.
7. With properly fitting adapter, press old piston-pin bushing from connecting rod (Fig. 54). Place new piston-pin bushing in position, align oil hole in bushing with oil hole in connecting rod, install bushing with a .0055" to .0035" press fit (Fig. 55). Burnish bushing into place in the connecting rod (Fig. 56).
8. With reamer, ream piston-pin bosses in piston to provide a tight fit of from .0000" to .0002" with piston pin. **NOTE:** When fitting piston pins, the pins should be at room temperature (70° F.) and the pistons should be heated to approximately 200° F. in boiling water or piston heater. The pin should be a "palm-push" fit under these conditions.

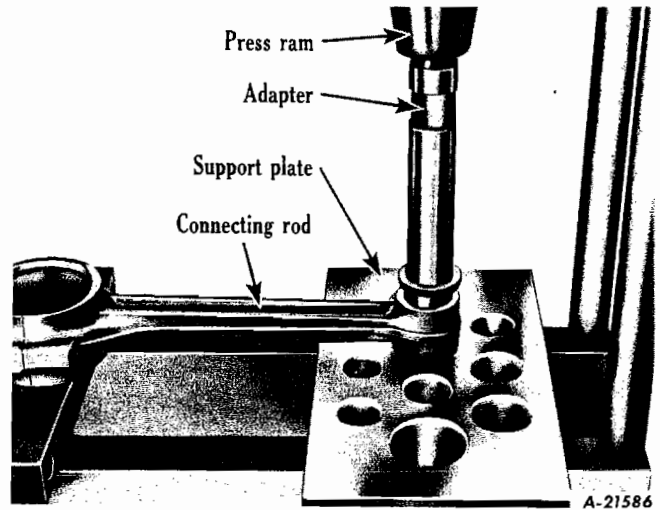


Fig. 55 - Installing new bushing in rod.

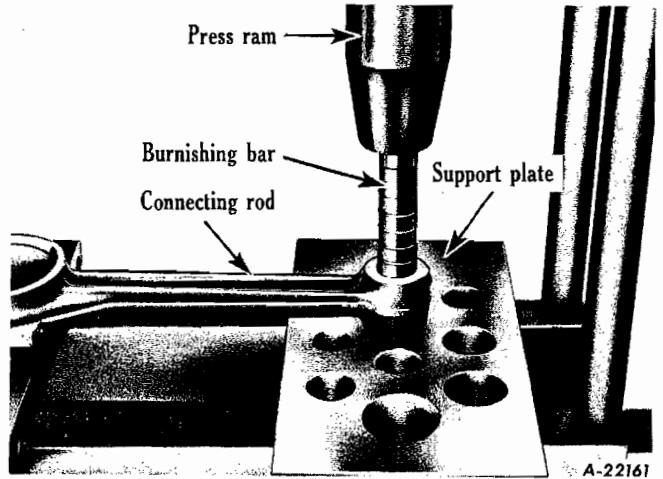


Fig. 56 - Use SE-879 Burnishing tool.
Connecting-Rod and Piston Assembly

1. With piston heated to approximately 200° F., support connecting rod in vise, push piston pin into piston bosses while piston is hot (Fig. 57). When assembling piston on rod, the slot in the piston skirt must be toward the camshaft side of the engine, which is the numbered side of the connecting rod. Install piston-pin retainer in piston at each end of pin, making sure that

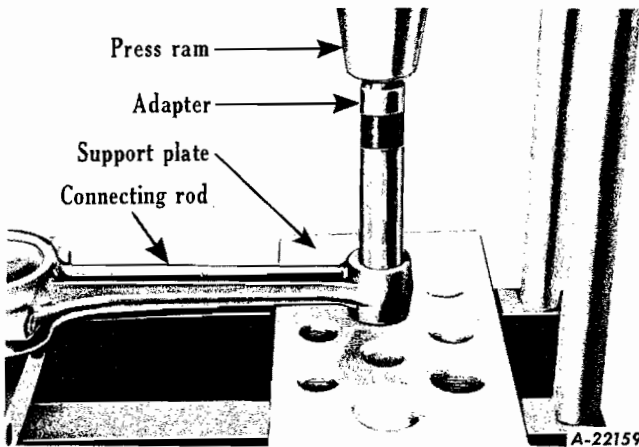


Fig. 54 - Press bushing from rod using SE-1036-4 Bushing adapter and SE-1033 support plate.

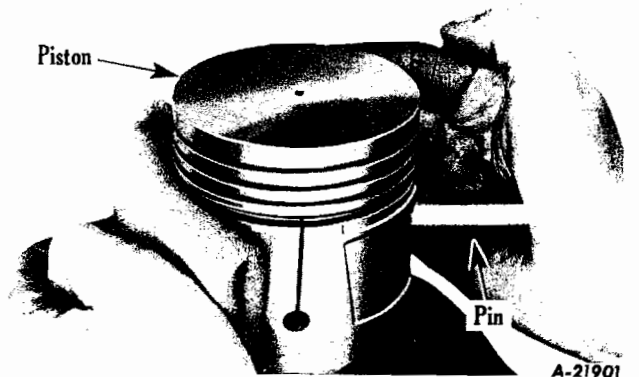


Fig. 57

retainers seat fully and with tension in grooves. Test connecting-rod and piston assembly on a connecting-rod aliner, and correct any misalignment.

- Place piston and connecting rod in vise. Test each piston ring for proper gap by placing in cylinder and measuring gap with feeler gauge. Gap should be .016" to .026" (Fig. 58).

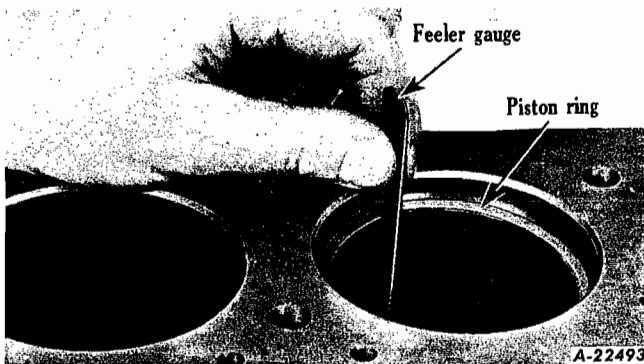


Fig. 58 - Checking ring gap.

- When installing piston rings in piston grooves, be careful not to distort rings. If possible use a suitable piston-ring expander tool (Fig. 59). Also check new piston rings in piston ring grooves for clearance between ring and ring lands. The correct ring clearance is shown in specifications.

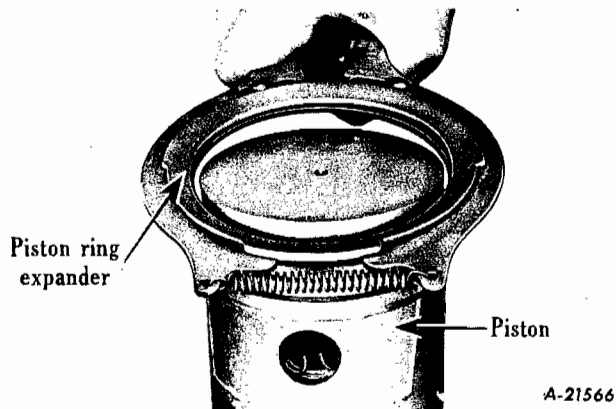


Fig. 59 - Installing piston ring using SE-1149-8 piston ring installing tool.

Crankshaft Cleaning and Inspection

- Wash and clean crankshaft with cleaning solvent or steam.
- Inspect main bearing and connecting-rod journals for wear. If journals show wear, or out-of-round in excess of .003", the shaft should be either reground and under-size bearings installed, or replaced. Use micrometers for checking.

- Check crankshaft and flywheel dowels for damage and fit, and replace if worn or damaged.
- Examine crankshaft timing gear teeth, and replace gear if teeth are worn or damaged.
- Install Woodruff key in groove in crankshaft. Heat crankshaft gear in boiling water or piston heater. This will expand the gear enough to let it be tapped on the crankshaft without the danger of damaging the gear. Use gear driver to insure alignment when starting gear (Fig. 60).

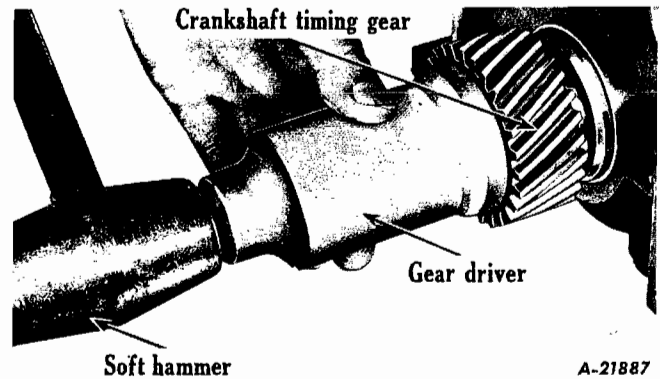


Fig. 60 - Installing crankshaft timing gear using SE-1716 Installing tool.

Flywheel and Ring Gear Inspection

- Clean flywheel and ring gear with a cleaning solvent, remove all traces of oil and grease.
- Inspect the flywheel ring gear. If any teeth are damaged, or if ring gear is loose on flywheel, the ring gear must be replaced.
- Check the flywheel dowel holes and mounting bolt holes for wear, also check for flywheel having been loose.
- To replace flywheel ring gear, heat gear with torch, and remove from flywheel with a hammer and drift. Heat new ring gear with torch, heating evenly all the way around. While the ring gear is hot, install gear on flywheel and allow it to cool.
- Check pilot bearing in flywheel for wear or damage and replace if needed.
- Install flywheel on crankshaft. Install six self-locking capscrews, drive dowel pins through flywheel to crankshaft.

Camshaft Cleaning and Inspection

- Remove nut from front of camshaft gear. Attach gear puller, and remove camshaft gear from camshaft, and remove camshaft thrust flange. Remove Woodruff key.



2. Wash parts in cleaning solvent, brushing to facilitate removal of all sludge or carbon deposits.
3. Inspect camshaft journals for signs of wear or out-of-round.
4. Inspect oil pump drive gear in center of shaft. If teeth are worn or damaged, the camshaft must be replaced, as the gear is integral with shaft.
5. Inspect camshaft lobes. If worn, chipped, or scored, replace the camshaft.
6. Inspect camshaft gear, and replace if wear is evident or gear teeth are nicked or otherwise damaged.
7. To reassemble, install thrust flange over end of camshaft. Install Woodruff key in slot in shaft. Place camshaft gear in boiling water or piston heater, and install over Woodruff key. Install camshaft nut and tighten to approximately 120 foot-pounds tension.
5. Inspect crankshaft vibration damper for evidence of rubber coming loose from steel plates (SD-240 engines only) and inspect for wear. Replace damper if either condition is encountered. Do not submerge vibration damper assembly in hot cleaning solvents.
6. Inspect crankshaft fan drive pulley for wear in hub bore. If inner diameter of bore is worn, scored, or Woodruff keyway damaged, replace pulley.
7. Inspect engine gear case cover, and replace if cracked or broken. Remove old cover seal (Fig. 62) and with special driver install new seal (Fig. 63).

Cleaning and Inspecting Miscellaneous Parts

1. Cleaning miscellaneous engine parts includes brackets, oil pan, engine case cover, flywheel housing, and other parts that were removed during disassembly of engine and were not covered by procedure. Wash in cleaning solvent or steam clean preliminary to inspection.
2. Check all twelve valve lifter or push rods for straightness by rolling on flat surface. Replace any that are bent or have loose ends (Fig. 61).

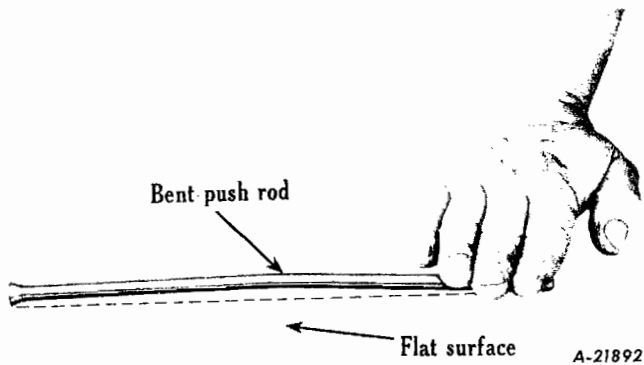


Fig. 61

3. Inspect oil pan for cracks or deep bends, and straighten or weld.
4. Inspect oil pan drain plug and drain plug boss for fit and thread wear. If plug is loose or threads are damaged, replace plug. If threads in oil pan boss are worn or damaged, repair threads or replace oil pan.

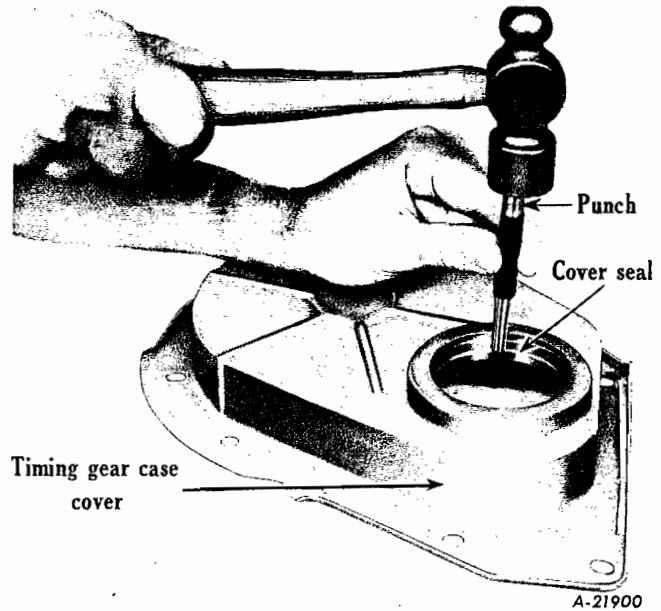


Fig. 62

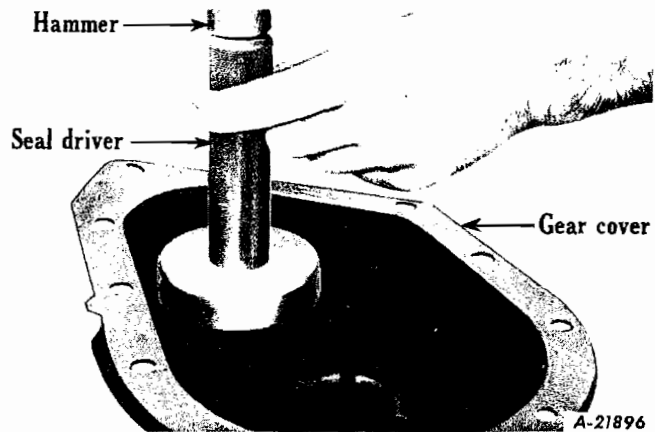


Fig. 63 - Use SE-1718 Seal Installing tool with the SE-1581-B Handle.

8. Check each of 12 engine valve tappets for irregular wear, chipping, cracking, or scores. Replace defective tappets.

9. Inspect engine flywheel housing for cracks or breakage and replace if damaged. Inspect flywheel housing to crankcase pilot dowel holes for wear. If wear is evident, drill or ream the holes and install oversize dowels. Also inspect dowels for wear and replace if wear is evident.
10. Inspect all capscrews and nuts for thread wear or breakage, and replace as necessary. Use new lockwashers when reassembling engine.
11. All gaskets and oil seals must be replaced at each overhaul or major repair.

ASSEMBLY OF ENGINE

When all parts have been cleaned, inspected, and repaired, and necessary replacement parts have been procured, install engine cylinder block in engine overhaul stand for reassembly.

Main Bearing and Connecting-Rod Bearing Installation

BEARING CRUSH. Undersize precision-type bearing shells should be installed when, because of wear, bearing-to-crankshaft running clearances are to be reduced. Bearing caps must not be filed, lapped, or in any other manner reworked.

Premature bearing failure will result from attempts to reduce journal-to-bearing running clearance by reworking of either bearing caps, bearings, or both, because such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush".

When installing precision-type connecting-rod or main bearings, it is important that the bearing shells fit tightly in the rod or case bore. To accomplish this, the bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled. When the assembly is drawn up tight, the bearing is compressed, assuring a good contact between the bearing back and the bore. This increased diameter is referred to as bearing "crush" (Fig. 64).

To obtain proper bearing assembly with the correct "crush", care must be taken when tightening the clamping bolts to make sure they are drawn down alternately and evenly, using a tension wrench and tightening as specified.

As a result of excessive bearing crush due to reworking the caps, the rod or main bearing bore will possibly become distorted, because

more force is required to draw the cap and housing together.

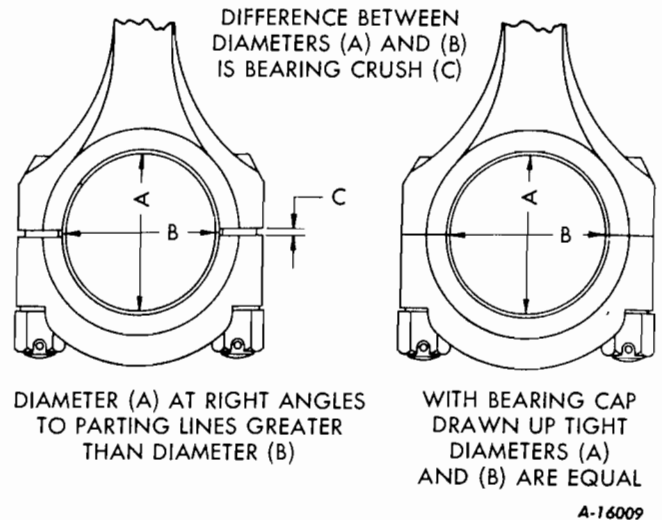


Fig. 64

Rods, caps, or blocks must not be filed, lapped, or in any other manner reworked in order to reduce clearance. While such practice will make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion. New bearing shells will have to be installed eventually and that is when additional trouble starts.

In general, a visual inspection of the parting faces of the rod or caps under a magnifying glass will provide sufficient proof of any attempt at reworking. Under the glass, the parting line surface of standard parts will show the manufacturing cutter tool marks and will not have a polished or extremely smooth appearance. On the other hand, reworked parts will have a polished surface and, if a file was used, will show the even pattern of the file teeth. Seriousness of this condition is in direct proportion to the amount of reworking.

BEARING SPREAD. Main and connecting-rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting-rod bore into which they are assembled, (Fig. 65). For example, the width across the open ends of the Silver Diamond engine connecting-rod bearing, not in place, is approximately .025" more than when the bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat.

Rough handling in shipment, storage, or normal results of use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread

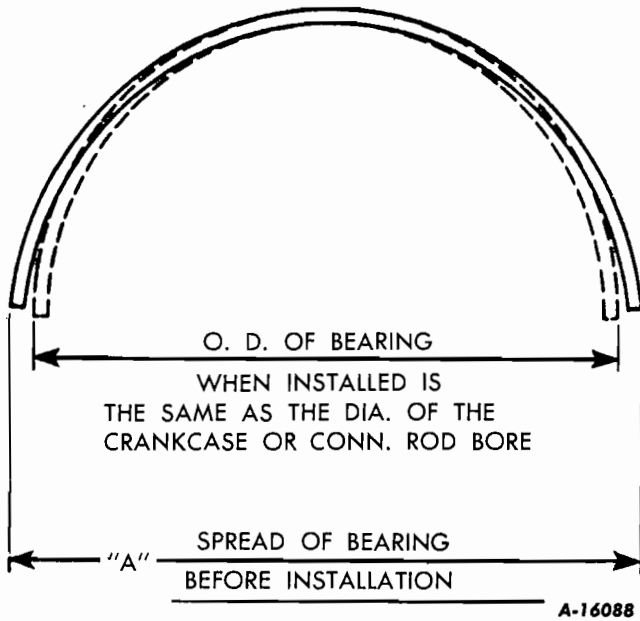


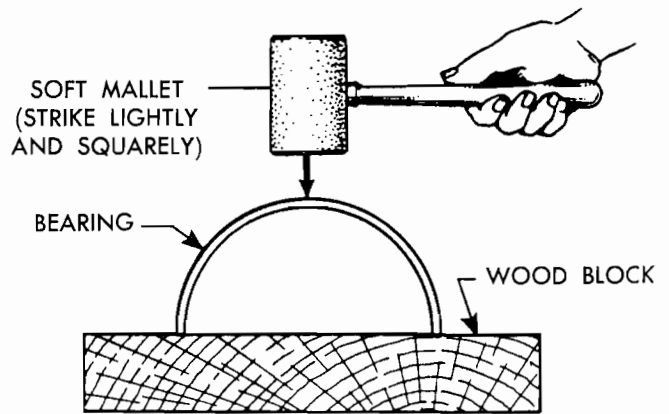
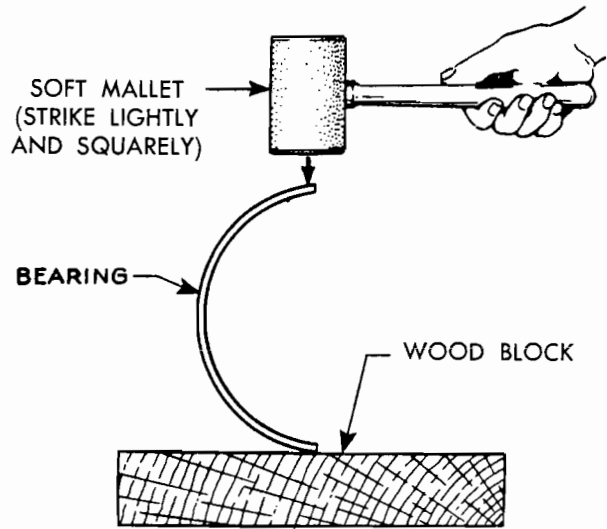
Fig. 65

should, therefore, be carefully measured and corrected as necessary before installation in an engine.

Bearing spread can be safely adjusted as follows, although care and judgment should be exercised in the process:

1. Excessive spread. If measurement of spread (Fig. 65) indicates that distance "A" is excessive (see chart for specifications), place bearing on a wood block (Fig. 66) and strike the side lightly and squarely with a soft mallet. Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.
2. Insufficient spread. If measurement of spread indicates insufficient spread, place bearing on wood block (Fig. 66) and strike the back of the bearing lightly and squarely with a soft mallet. Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

moved. Place bearing shell halves in position in bore in cylinder block, making sure that bearing shells are fully seated, that oil holes in bearing shells line up with



A-16095

Fig. 66

oil holes in cylinder block, and that locking tongs on bearings fit into recesses. Follow same procedure, place bearing shell cap halves in bearing caps. Place a film of engine oil on shell surfaces and lift crankshaft to align itself in the bearings, and also provide lubrication. Place bearing caps and bearing lower halves over crankshaft journals. Be sure bearing caps are properly installed with numbers to camshaft.

2. In order that an accurate measurement can be made to check all bearing clearances, "plastigage" can be used.
3. Use the following instructions when using "plastigage":-
 - (a) Remove oil from bearing cap insert and exposed half of crankshaft journal.
 - (b) Place a piece of "plastigage" the full width of the bearing insert.

Chart of Bearing Spread Dimensions.
Silver Diamond Engine (Minimum)

"A"	Connecting-Rod Bearing	2.500" + .025"
	Main Bearing	2.942" + .025"

1. **INSTALL CRANKSHAFT AND BEARINGS.** Clean all surfaces of crankshaft bearing journals and wipe clean the bearing bores in the cylinder block. Remove bearing cap self-locking capscrews and bearing cap. Wipe backs of cylinder block half of bearings, making sure that dirt and oil are re-

- (c) Reinstall the bearing cap. Tighten the self-locking capscrews to approximately 80 foot-pounds.
- (d) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell or the crankshaft.
- (e) To determine the bearing clearance, compare the width of the flattened plastigage at its widest point with the graduations on the envelope (Fig. 67). The number within the graduation on the envelope indicates the clearance in thousandths of an inch. NOTE: Do not turn crankshaft during the above procedure.

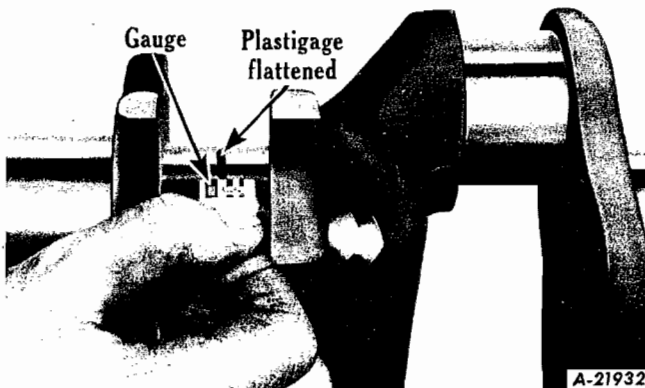


Fig. 67

4. If clearance is not within .001" to .004", either use undersize bearing, regrind shaft or replace shaft. Check crankshaft for end-play which is taken up by number three main bearing. End clearance should be from .0055" to .0135".

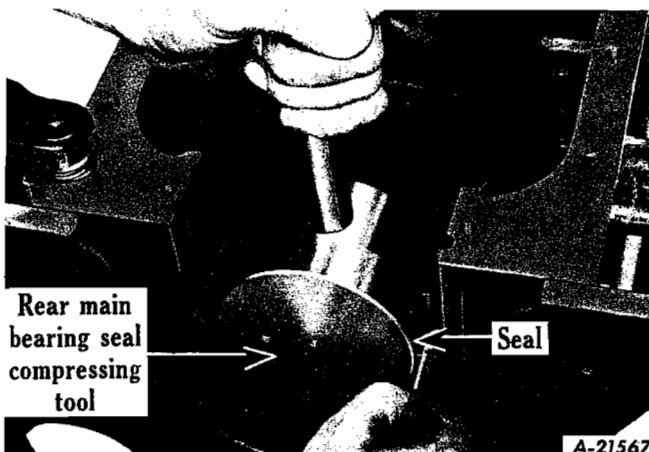


Fig. 68 - Installing upper oil seal in crankcase using SE-1720 Rear Main Bearing Oil seal compressor.

5. Before installing rear main bearing cap (after all bearing clearances have been checked) install upper seal in block. Use special tool to press or roll seal in place (Fig. 68). After seal has been seated in

block, trim ends of seal that project above cap surface level. Repeat the same operation with main bearing cap. Install wicking on each side of rear main bearing cap (Fig. 69). Tighten all main bearing cap bolts to 80 foot-pounds.

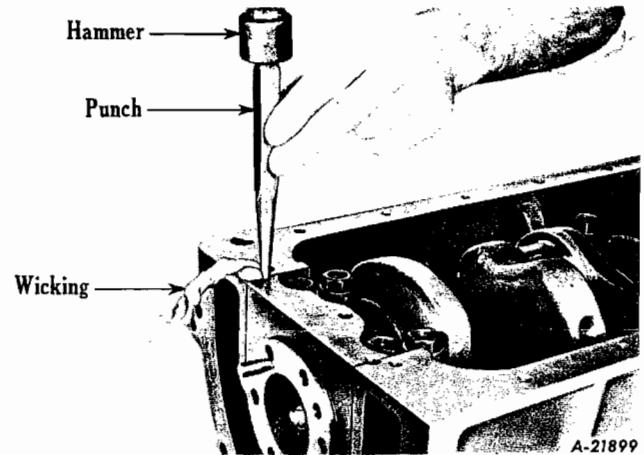


Fig. 69 - Pack wicking securely using punch to work wicking into holes provided.

6. INSTALL FLYWHEEL HOUSING. Place flywheel housing in position over two flywheel-housing-to-cylinder-block dowels, and tap into place with soft hammer. Install six capscrews and lockwashers in flywheel housing. If either block or flywheel housing is replaced, the flywheel housing will have to be aligned with a dial indicator. When correctly aligned, run-out of bore should not exceed .005".
7. INSTALL ENGINE FLYWHEEL. Place engine flywheel and ring gear into position on dowels in crankshaft flange. Install six self-locking capscrews in flywheel and crankshaft flange, and tighten to a tension of approximately 60 foot-pounds, using a tension wrench.
8. INSTALL GEAR CASE COVER PLATE. Place plate and gasket at front end of engine cylinder block. Install two capscrews and lockwashers.
9. INSTALL CAMSHAFT AND GEAR. Coat camshaft with engine oil. Insert camshaft into front end of engine block, being careful not to damage camshaft bearings. Before completely entering camshaft rotate shaft until marked teeth on crankshaft gear and camshaft gear index (Fig. 70). Install two capscrews and lockwashers in camshaft thrust flange, working through large holes in camshaft gear. Rotate crankshaft and camshaft to establish that gears do not bind or interfere. Backlash must be from .000" to .007" (.0015" preferred).
10. INSTALL GEAR COVER CASE. Place gasket in position on case cover. Place

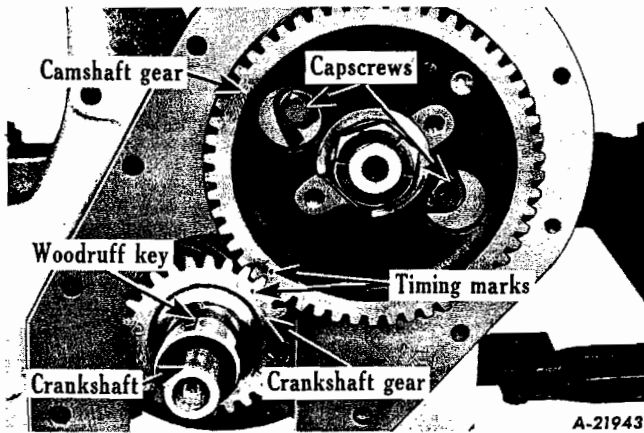


Fig. 70

crankshaft oil slinger over end of crankshaft and install Woodruff key for fan drive pulley in crankshaft. Place gear case cover in position and install gear case cover aligning tool (Fig. 71). Install capscrews, new lockwashers, and nuts. Remove aligning tool.

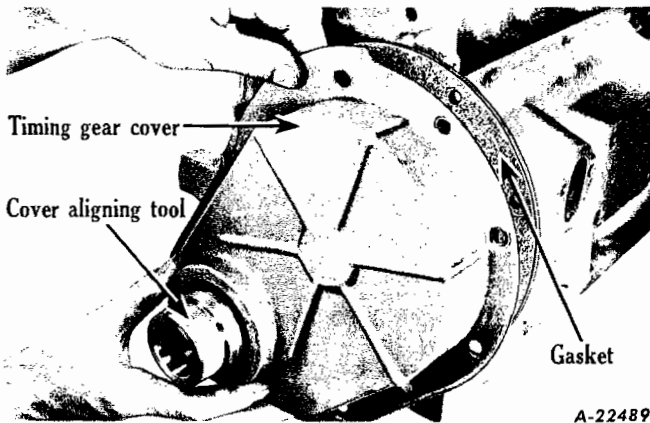


Fig. 71 - Aligning timing gear cover using SE-1717 Aligning tool.

11. **INSTALL FAN DRIVE PULLEY AND VIBRATION DAMPER.** Heat crankshaft fan drive pulley and vibration damper assembly in boiling water. When heated, quickly install assembly on crankshaft and install washer and fan drive pulley nut. Tighten nut with wrench of about 36" leverage. Vibration damper is used on the model SD-240 engine only.

Installing Connecting Rods and Pistons

1. Install one connecting-rod and piston assembly down through top of cylinder block having slot in piston towards camshaft side of engine. Pistons are also marked with an arrow indicating front of engine. Use a piston ring compressor sleeve to compress piston rings and thus avoid possible ring damage (Fig. 72).
2. Wipe base of connecting rod free of oil and dirt. Place bearing shell upper half in

connecting rod base, being sure that oil hole aligns with oil hole in connecting rod and that locking tangs of bearing shell fit into recess. Clean connecting-rod cap bearing bore and clean back of bearing. Place bearing shell lower half in connecting rod cap, making sure that tang of bear-

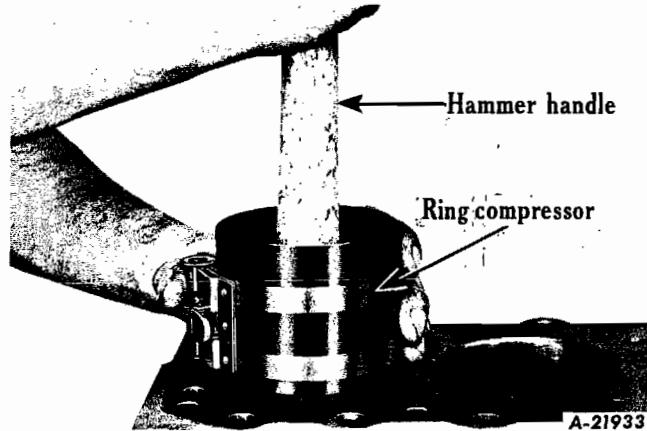


Fig. 72

ing fits into recess in cap. (NOTE: See instructions under "Main Bearing and Connecting-Rod Bearing Installation".)

3. Coat bearing surfaces with oil. Pull connecting rod into position on crankshaft journal and install connecting-rod cap and bearing. NOTE: Bearing cap can only be installed on connecting rod one way, because of the construction of rod and cap. Install two self-locking capscrews and tighten to 50 foot-pounds, using tension wrench.
4. To check connecting-rod bearing to crankshaft clearance, follow procedure given for "plastigage" test. Specified connecting-rod bearing to crankshaft clearance is from .001" to .0035". Do not attempt to file connecting rod or bearing caps.
5. Follow the foregoing procedure for installing remaining connecting rods and pistons.
6. **INSTALL OIL PUMP.** Place crankshaft and piston in position for firing on No. 1 piston. Insert oil pump assembly into opening in cylinder block, rotate pump drive shaft so that tang in top of shaft is parallel to engine block. This position will assure the oil pump drive shaft being in proper position for distributor installation. Install and tighten two capscrews. Place one-piece oil pan gasket in place and install 25 capscrews around oil pan flange.
7. **INSTALL CLUTCH.** Install clutch driven disc against flywheel so that the long portion of the hub is toward the rear. Place clutch in position on flywheel over clutch driven disc. Locate clutch so that arrow

on flange of clutch backing plate or cone is as near as possible to the letter "L" on the flywheel, and install two or three mounting capscrews and lockwashers loosely. Insert a clutch aligning arbor, if available, or a transmission main drive gear shaft, through clutch driven disc hub spline and into clutch pilot bearings. Hold clutch driven disc in position while completing installation of six mounting capscrews and lockwashers in flange of clutch backing plate or cover. Tighten all six capscrews securely. Remove three retaining capscrews and flat washers which were installed to hold clutch compressed. NOTE: Clutch will not operate properly unless these retaining capscrews are removed.

8. **INSTALL VALVE TAPPETS.** Coat each of 12 valve tappets with heavy engine oil and drop each, flat side down, through recess in side of cylinder block into sockets in block (Fig. 73).

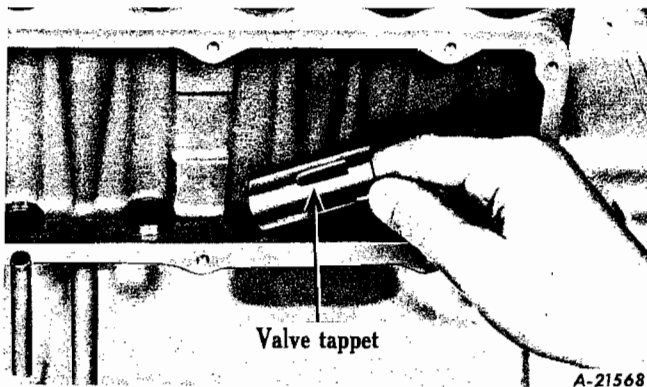


Fig. 73

9. **INSTALL VALVE LIFTER ROD COVER.** Install new gasket over opening at left-hand side of engine block. Install valve lifter rod covers and slotted screws.

Install Cylinder Head

1. **INSTALL HEAD.** Place gasket on cylinder block and align bolt holes. Place cylinder head on crankcase, being careful not to damage of shift gasket position. Loosely install all cylinder-head bolts and flat washers, omitting bolts in holes for rocker-arm assembly.
2. **INSTALL VALVE ROCKER-ARM ASSEMBLY.** Insert 12 valve lifter rods in cylinder head, make sure they enter the valve tappet. Lift the valve rocker-arm assembly into position on cylinder head with the drilled oil bracket placed third from front. Make sure number 2, 4, and 6 bracket sleeve dowels are in place (Fig. 74). Install the remainder of cylinder-head bolts and tighten alternately and evenly in sequence to 90 foot-pounds.

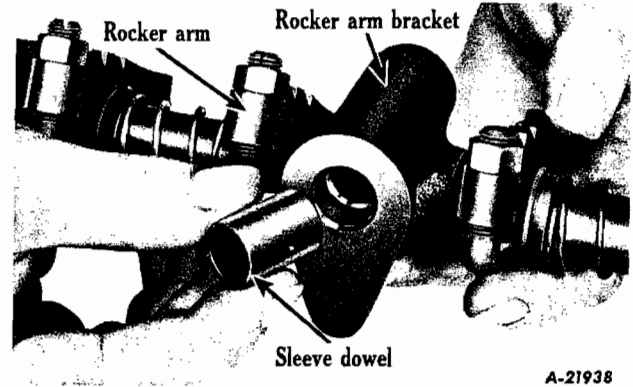


Fig. 74

3. **ADJUSTING VALVES.** To adjust valve stem to valve rocker arm clearance correctly, each cylinder must be on top-dead-center on its compression stroke at the time of adjustment of valves for that cylinder. To determine the correct position, turn the engine crankshaft until No. 1 piston is at top-dead-center on compression stroke and the ignition timing dot on the flywheel is in line with the pointer on the flywheel housing (Fig. 75). Adjust clearance on each valve of No. 1 cylinder to .018" to .020" by using a feeler gauge between valve stem and valve rocker arm and turn rocker-arm adjusting screw out of rocker arm until clearance is obtained. Tighten adjusting screw lock nut and recheck clearance. (NOTE: Valve clearance should be rechecked with engine at normal operating temperature.)

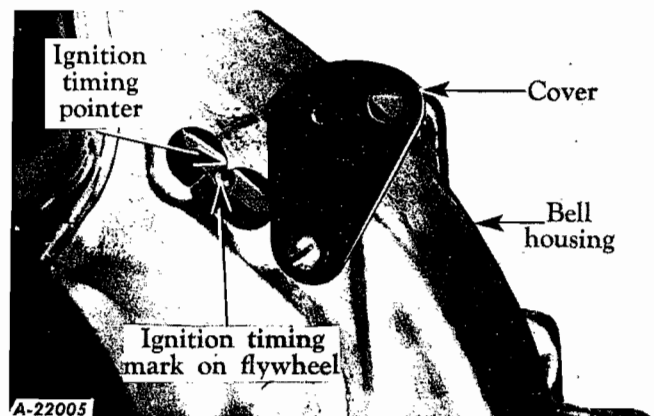


Fig. 75

4. Turn crankshaft one-third revolution and adjust clearance on No. 5 valves. Working in firing order sequence, continue to set valves of each of the remaining cylinders, turning crankshaft one-third turn after each valve adjustment.
5. **INSTALL INTAKE AND EXHAUST MANIFOLDS.** To facilitate installing the manifolds, after manifold gaskets and pilot rings are installed, start capscrews at each end of intake manifold. This will permit the



manifold to slide straight up between the engine head and capscrews and flat washers. When manifold is lined up with pilot rings and gasket, tilt bottom of manifold toward engine block. This will force manifold out at top enough to bind against the two capscrews and hold manifold in position until the front and rear capscrews can be installed (Fig. 76).

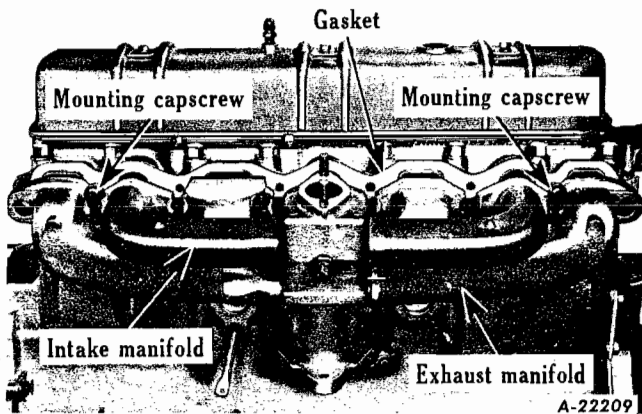


Fig. 76

6. **INSTALL WATER PUMP.** Place water pump gasket in position, at water pump opening in front of cylinder head. Install water pump and fan and install four capscrews and lockwashers in pump and cylinder block.
7. **INSTALL OIL FILTER.** Place oil filter and new gasket in place on cylinder block. Install four capscrews and lockwashers in oil filter base. (NOTE: Be sure filter assembly is thoroughly cleaned and a new cartridge is installed before replacement on engine.) Tighten center tube nut using wrench SE-1728.
8. **INSTALL ACCESSORIES.** Install carburetor, generator, distributor and connecting wires, starter, fuel pump, ignition coil, oil gauge, and thermostat.
9. **FILL ENGINE WITH OIL.** After making certain that oil drain plug is securely installed, fill crankcase with oil. After engine has been installed and placed in operation, again recheck oil level and if necessary add sufficient oil to bring level up to full mark on gauge.
10. **INSTALL CYLINDER-HEAD COVER.** If engine is not to be installed at this time, install new cylinder-head cover gasket and install cylinder-head cover. Install three flat copper washers and three capscrews on cover.

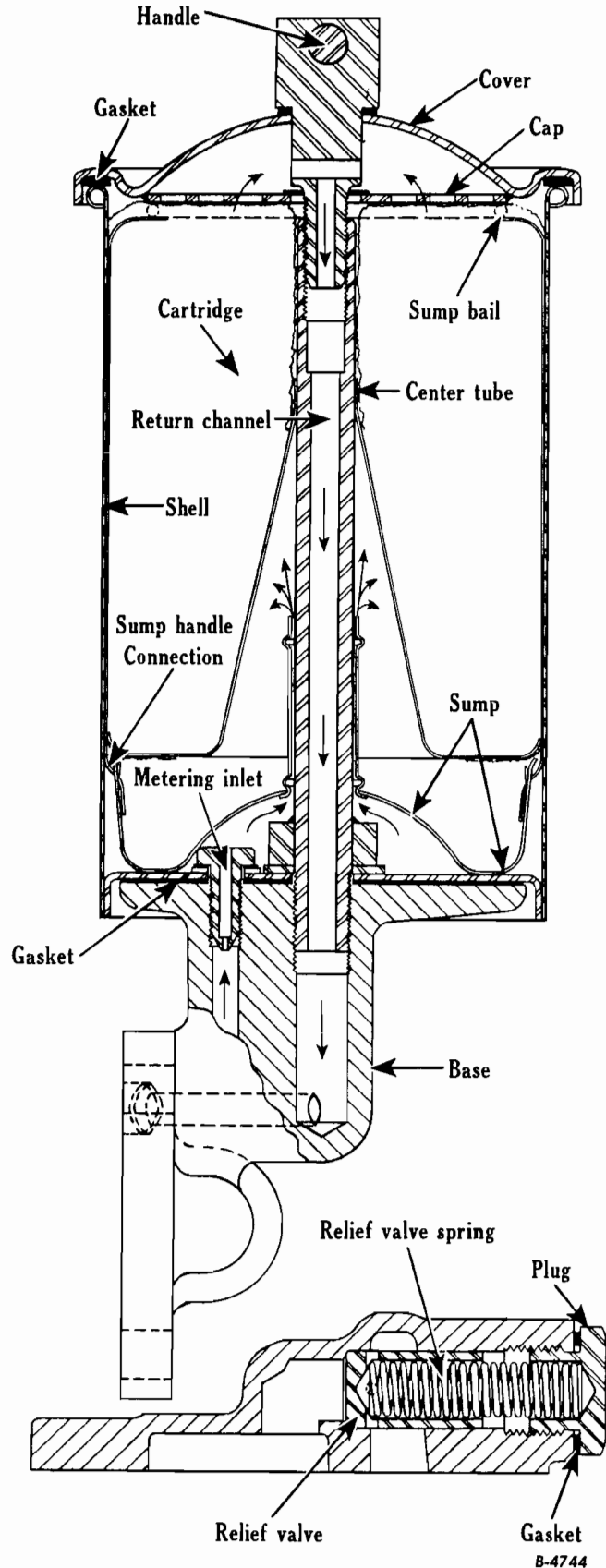
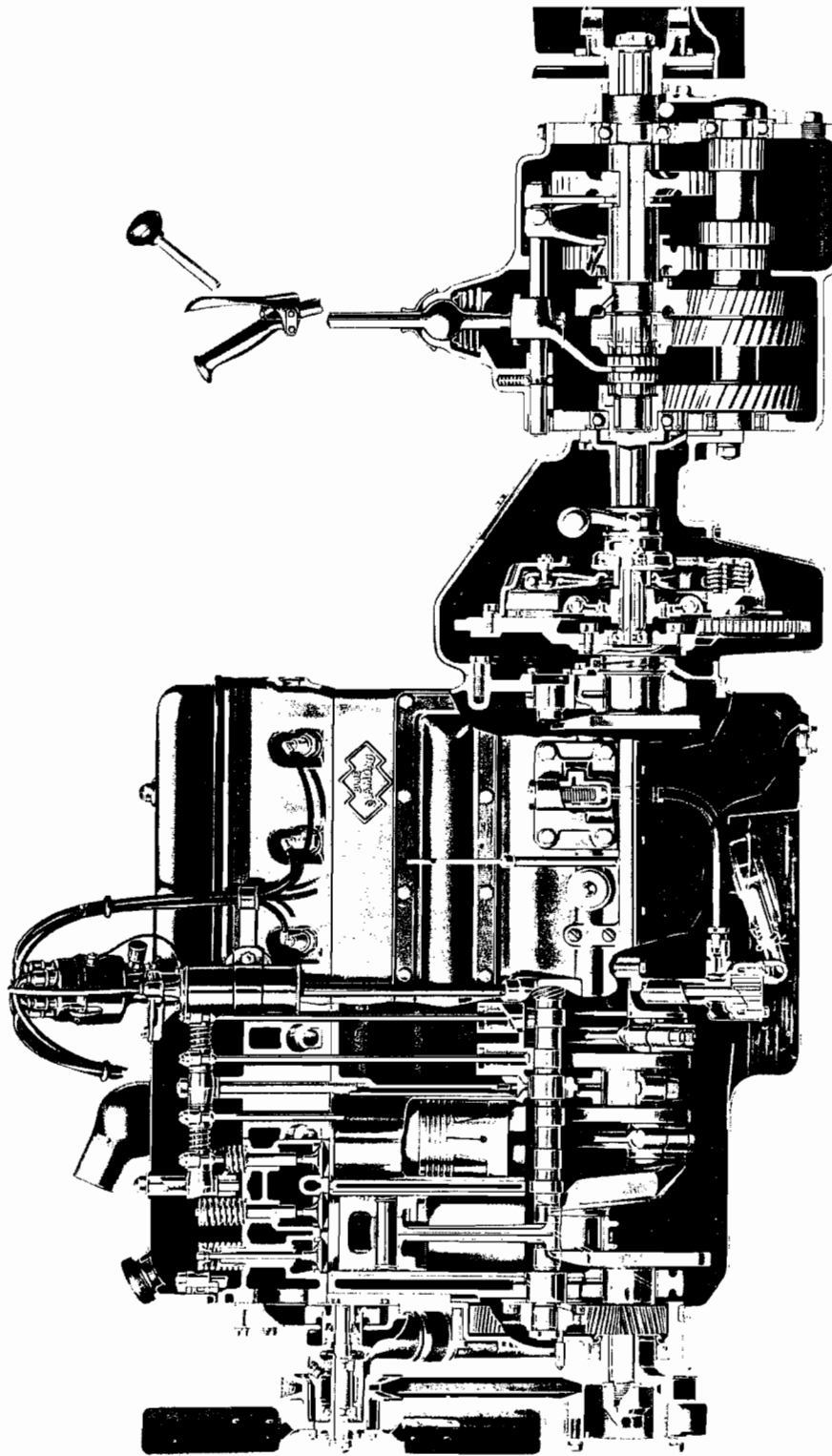


Fig. 77 - Details of Deluxe Oil Filter.



SUPER BLUE DIAMOND ENGINE



A-23212

Fig. 1 - Sectional view of Super Blue Diamond Engine.



DESCRIPTION

General

The Model BD, Super Blue Diamond engine is a 4-cycle, 6-cylinder-in-line, overhead-valve-type engine (Fig. 1). The engine serial number is stamped on a pad at the front on the left side of the crankcase just below the cylinder head. The block has dry-type replaceable liners for the cylinders. The detachable cylinder head contains all valves, valve guides, and springs. The cylinders are numbered from front (fan and timing gear end) to rear. Engine crankshaft rotation is clockwise as viewed from the front end of the vehicle. The intake and exhaust manifolds, carburetor, starter, and generator are located on the right side of the engine. The distributor, fuel pump, and oil filter are located on the left side. The oil filler inlet is located in the valve cover on the top of engine. The bayonet type oil level gauge is located on the left side. The water pump is located at the front of engine.

Construction

1. The generator, fan, and water pump are driven by a V-type belt from a driven pulley mounted on the front end of the crankshaft. The distributor, mounted at the left side of the engine, is driven by the camshaft through the oil pump.
2. The exhaust and intake manifolds are bolted to each other and to the right side of the engine head. The intake manifold and the exhaust manifold are each cast in one piece.
3. A vibration damper is provided at the front end of the crankshaft.
4. The cylinder block and crankcase are cast in one piece, and carry the crankshaft main bearings. Water circulation passages completely surround the cylinders in the crankcase and also provide coolant to the cylinder head.
5. Oil is supplied under pressure by the oil pump to the engine lubrication system. Oil spray from the revolving crankshaft is distributed to the cylinder walls, pistons, and other moving parts inside the engine.
6. Exhaust valve seats are of alloy and are pressed into place. These valve seats lengthen the period between valve reconditioning operations. Valves and valve seats are cooled by continuous circulation of water through the cylinder head.
7. The detachable cylinder head is bolted to the crankcase, and a gastight and watertight seal is maintained by means of a gasket.

8. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in four precision-type replaceable shell bearings, the number four (rear) bearing taking up the thrust.
9. The pistons are made of an aluminum alloy, are cam ground, and are fitted with three compression rings and one oil control ring. The full-floating type piston pins are held in place in the pistons, at the ends of the pins, by snap rings.
10. The camshaft is machined from a solid drop forging and mounted in four special replaceable bearings.
11. The flywheel is bolted and doweled to the crankshaft flange. The timing mark is located on the front crankshaft pulley.

ENGINE REMOVAL

The engine, with transmission removed, can be lifted from chassis without disturbing the fender and grille assembly, by using a suitable chain sling and a floor crane.

Disconnect the following electrical circuits, hose connections, and various units as outlined (Fig. 2 and Fig. 3):

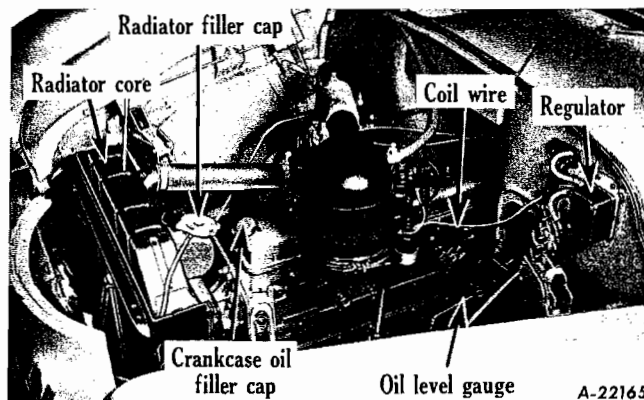


Fig. 2

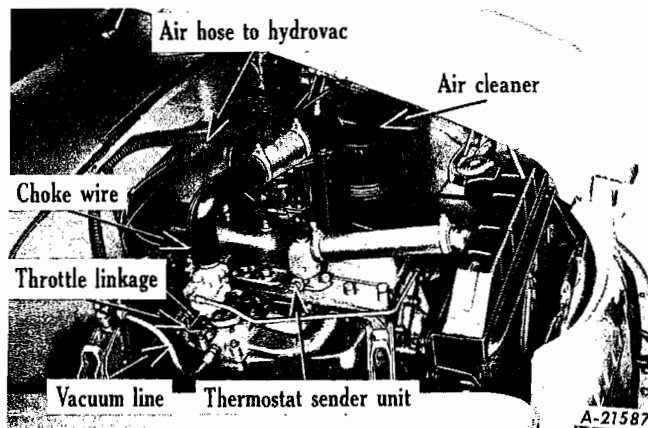


Fig. 3

1. Drain engine oil pan. Drain all coolant from engine cooling system by opening the drain cock on side of engine as well as the radiator drain cock. Remove radiator filter cap when draining cooling system.
2. Disconnect upper and lower radiator hose connections. Disconnect engine air cleaner and remove air cleaner. Disconnect vacuum line at manifold.
3. Disconnect engine circuit wiring. This includes coil wire, starter cable, engine ground strap and instrument sender unit wires.
4. Disconnect fuel line at fuel pump. Disconnect throttle control linkage and remove choke at carburetor.
5. Disconnect clutch linkage at bell housing.
6. Remove engine rear mounting bolts from both sides of engine support pads.
7. Remove engine front mounting bolts from support bracket; these are the bolts at the front crossmember.
8. Remove radiator mounting bolts and lift out radiator support and core assembly.
9. Disconnect engine exhaust pipe at manifold.
10. Attach engine sling to front and rear right side cylinder head bolts and remove engine (Fig. 4).

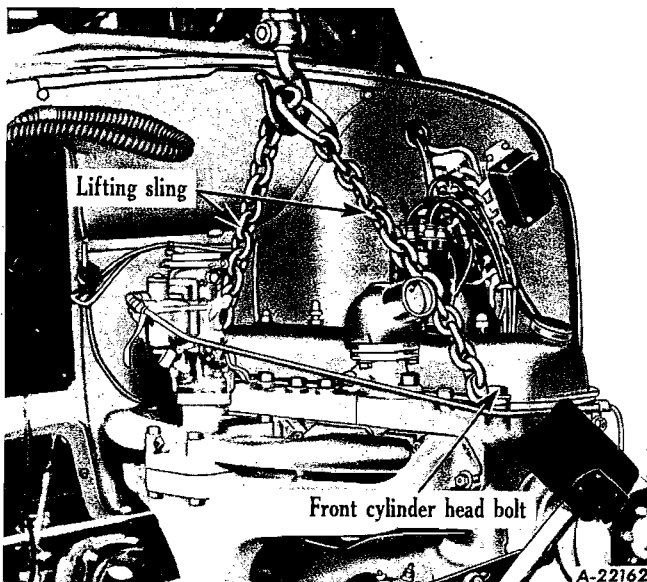


Fig. 4 - Removing engine from chassis. Chain sling attached to front and rear right side cylinder head bolts.

ENGINE DISASSEMBLY

Install the engine in a suitable rotating engine overhaul stand. NOTE: Many of the disassembly operations can be performed with the engine in the chassis. However, the following disassembly outline is performed with the engine removed from the chassis to clearly illustrate each of the units. Except where indicated, no attempt has been made to prescribe a particular sequence for removing the various units, since some can be readily removed with the engine in the chassis. The extent of the service required on a particular unit will govern the necessity for its removal.

Removing Rocker Arms

The following steps are to be followed when removing the rocker-arm cover and rocker-arm assembly. (Carburetor and air cleaner previously removed.):

1. Remove three nuts from rocker-arm cover. Remove air cleaner line and remove cover.
2. Remove bolts from shaft brackets (Fig. 5.)
NOTE: Left front head bolt supplies oil to rocker arms.

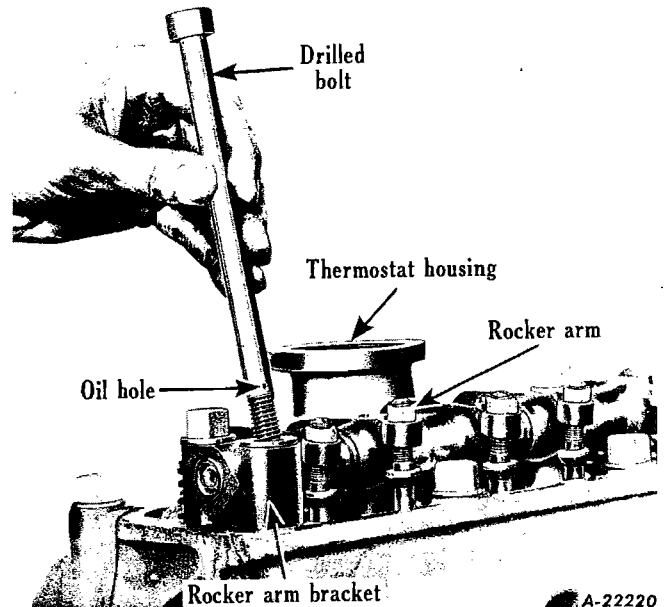


Fig. 5

3. Remove rocker-arm assembly as a unit.

Rocker-Arm and Valve Mechanism Disassembly

1. The rocker-arm assembly is composed of front and rear shafts joined at the center, on which are mounted twelve rocker arms and six tension springs. The shafts are mounted in seven brackets, and are prevented from turning at the two end brackets, by slots in the shaft into which the cylinder-head bolts fit (Fig. 6).

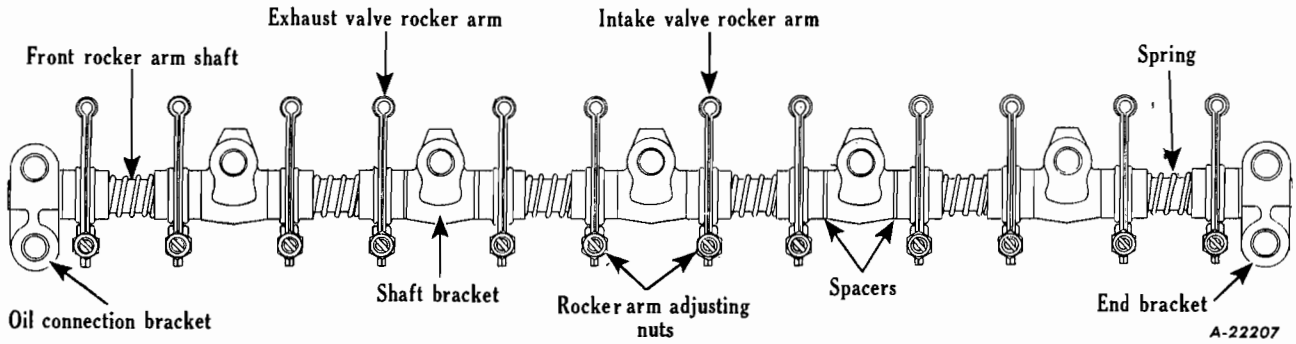


Fig. 6 - Details of rocker-arm assembly.

2. Separate the shafts and slide rocker arms, springs, and brackets from shafts.
3. Clean all parts in a solvent cleaning fluid, being careful to clean all accumulated sludge and carbon deposits from oil holes and slots.

Rocker Arm Inspection

Carefully inspect all parts for defects and wear.

1. Inspect rocker-arm shaft expansion plugs. Check on a surface plate for signs of bending, check for wear from rocker arms. If a shaft is bent or shows perceptible wear, it must be replaced.
2. Inspect rocker-arm adjusting screws for wear at contact surface and for thread wear. Replace worn screws. Check rocker-arm bushings. Inspect valve stem contact pad

surface of rocker arm, and resurface if wear is perceptible. Do not remove more than .010" of material when resurfacing rocker-arm pads.

3. Inspect tension springs for breakage or loss of tension. Replace defective springs. Remove valve lifter rods from engine.

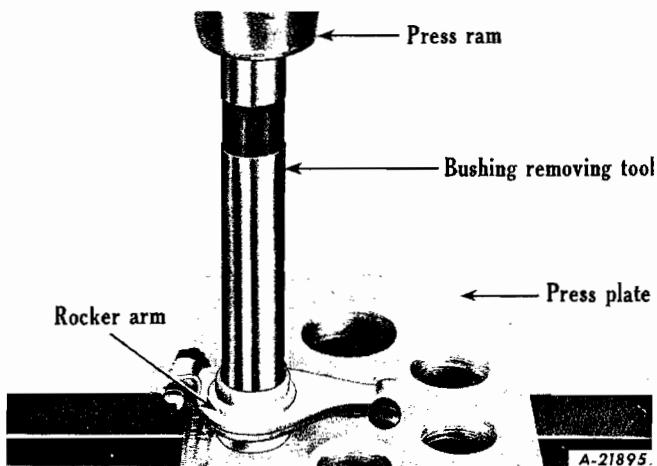


Fig. 7 - Use SE-1036-1 Bushing Removing Tool when removing the rocker arm bushing. Support the rocker arm on the SE-1033 support block. Select a hole in the support block to properly support the rocker arm at the same time permit the bushing to clear the support block when being removed. Use the support block when installing and burnishing the new bushing.

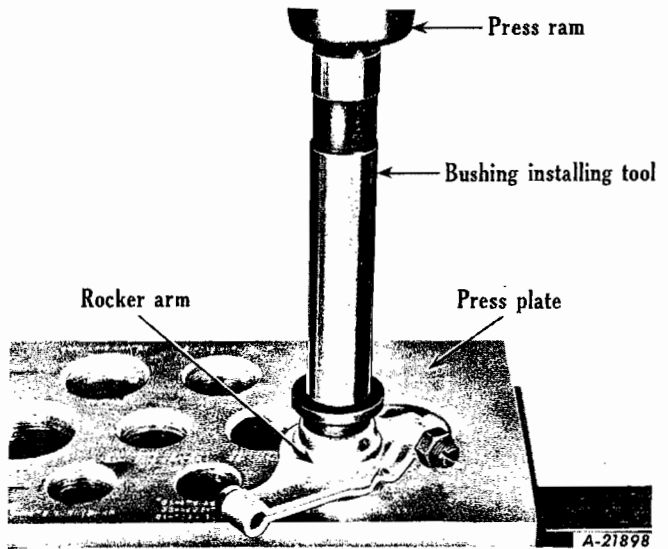


Fig. 8 - Showing method of installing new rocker arm bushing.

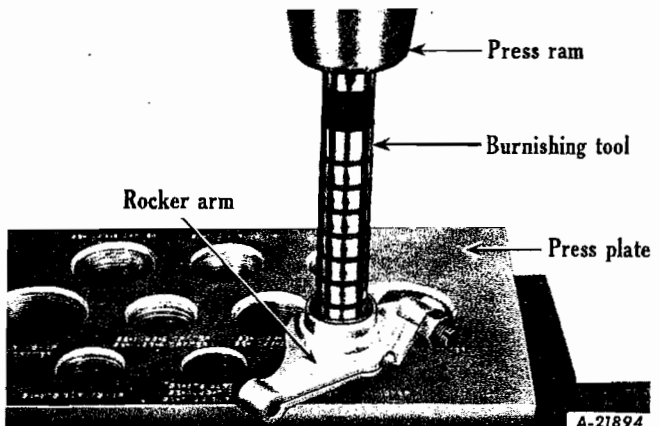


Fig. 9 - Burnishing rocker arm bushing. Use SE-931 Burnishing Tool.

Re-bushing Rocker Arms

With properly fitting adapter or special tool equipment provided (Figs. 7, 8 and 9), press old rocker-arm bushing from rocker arm. Place new rocker-arm bushing in position. Align oil hole in bushing with oil hole in rocker arm, which is located 30° from top of rocker arm toward rocker-arm adjusting nut. Using installing tool, press new bushing into rocker arm. Burnish bushing into place in the rocker arm, then ream rocker-arm bushing to provide .0015" to .004" clearance. Ream dimension is .7505" - .7520".

Cylinder Head and Valves

The following instructions are to be followed when reconditioning cylinder head and valves. Remove push rods, remove cylinder-head bolts and lift off cylinder head and gasket. Place cylinder head on bench.

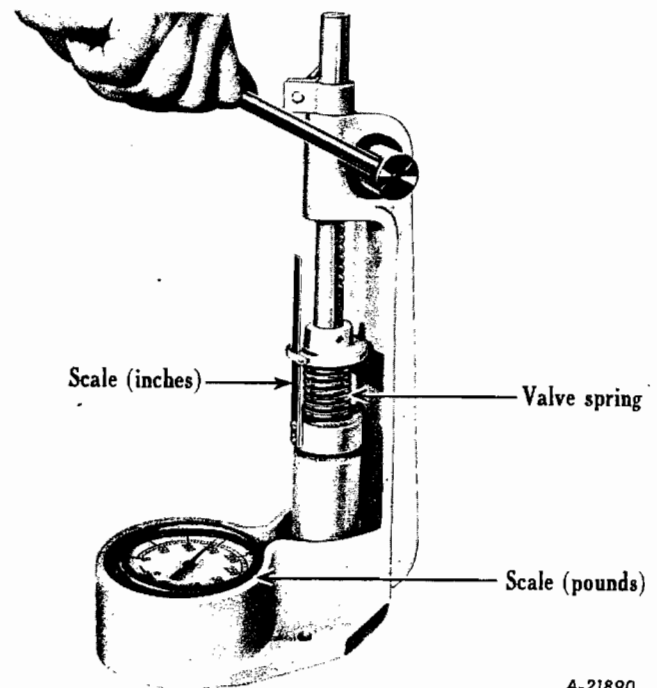
1. Compress valve spring with a valve compressor and remove valve spring retainer locks. Remove retainer. Remove valve spring and damper and separate valve spring damper from valve spring. Remove all valve springs as outlined, and remove valve spring damper from each spring.
2. Invert cylinder head. Remove all valves from their valve guides and from the head, keeping each valve in a suitable rack which will assure replacement of the valves in their original location.
3. Scrape all carbon from cylinder-head combustion chamber, and clean any gasket material from surface of head. Clean the head using steam cleaning or other suitable cleaning equipment.
4. Clean all carbon deposits from valve heads and valve stems with wire brush. Wash all valve springs and retainers in cleaning solvent.

Inspection of Cylinder Head

1. Inspect cylinder head visually for signs of cracks or sand holes and if found defective, weld or replace head.
2. Inspect exhaust valve seat rings for looseness and inspect for excessive width of valve seat surface. If insert rings are loose, replace. If a seat has been previously ground to such extent that it cannot be narrowed from top to bring to proper position near center of valve face, the ring must be replaced.

Inspection of Valve Guides, Valve Springs and Valves

1. Clean valve guides with a suitable cleaning tool. Check each valve guide with a "Go and No-Go" gauge, if available; otherwise, use a new valve to check fit. If "No-Go" portion of gauge enters, the guide must be replaced. Recommended valve stem to valve guide clearance is from .002" to .004" for exhaust valves, and from .0015" to .0035" for intake valves. Clearance in excess of .006" for intake valves or .008" for exhaust valves, require guide replacement. Ream guides to .3435"-.3455" after assembly in cylinder head.
2. Test valve springs with damper in position. Test tension of each valve spring at valve open length with a valve-spring tester (Fig. 10). Check valve springs at 1-43/64" length, and replace if pressure is less than 111 lbs.



A-21890

Fig. 10 - Test valve springs in SE-1565 Valve spring testing tool.

3. Inspect each valve for warpage, for severely burned condition, and for excessive grinding on the valve head. Inspect valve stem for scuff marks or perceptible wear. Inspect valve stem end for wear at contact surface with valve rocker arm. If valve is warped, excessively burned, or has been previously ground to extent that valve head is thin at edge, replace valve; otherwise, valve can be reconditioned and reinstalled.



Repair of Cylinder Head

1. If cylinder head has to be resurfaced, remove only enough material to true-up surface.
2. If any valve guide shows excessive clearance or out-of-round condition, press guide from head with special removing tool. Install new guide, and press into head until approximately 1-1/16" remains above the top surface of the head. Check valve guides after installation to .002" to .004" for exhaust and .0015" to .0035" on intake with "Go and No-Go" gauge. Ream valve guides to .3435"-.3455" after assembly in cylinder head.
3. If inspection indicates necessity, replace valve seat.
4. Grind valve seats in cylinder head to 45° on both exhaust and intake.

Reconditioning Valves and Seats

One of the principal difficulties experienced in reconditioning valves is obtaining nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.

The grinding stones on both the valve-refacing machine and valve seat grinder should be dressed before starting a reconditioning job. You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for trueness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to

prevent burning of the seat and warping of the valve head.

The location of the valve seat on the valve face and its width controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperature and poor heat dissipation also produce excessive valve stem temperatures and hasten the accumulation of carbon on the stem, causing them to stick in the guides.

Valve Seat Widths

In general, the width of exhaust seat should range between the average and maximum specifications and the intake seats between the

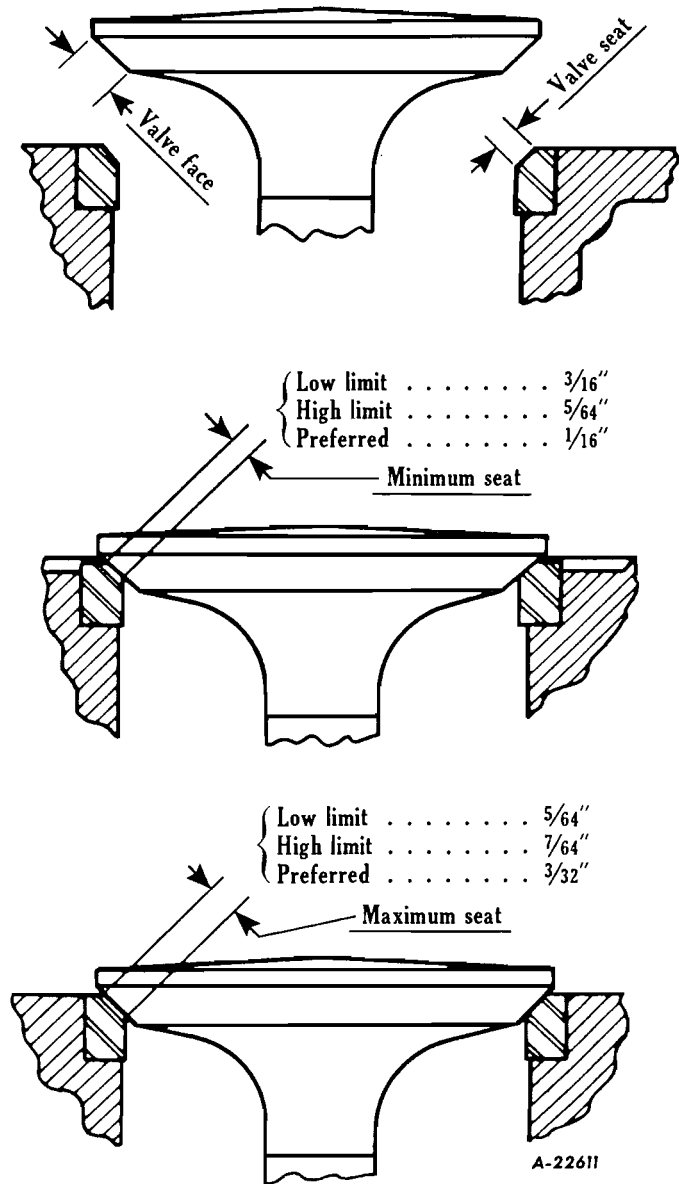


Fig. 11 - Valve seat widths.



minimum and average specifications. The intake seats may be narrower than the exhaust because they are usually larger in diameter, thus providing a total seat area approximately equal to smaller exhaust valve with the wider seat. Also the less severe heat conditions do not require as large a seat area for heat dissipation purposes. Fig. 11 illustrates recommended valve seats to be obtained.

There are also objections to an excessively wide seat, a few of which are as follows:

1. In city or light delivery service, a wide seat collects carbon and particles of dirt that will produce variations or loss of compression, resulting in poor idle and possible a loss of general performance and economy.
2. A wide seat in severe service operating in the presence of dirt or an excess of carbon will produce a badly pitted seat which may be just as detrimental to valve life as a too narrow seat. Under these conditions, a seat width to the minimum limit would possibly be better; however, the source of trouble (which is the dirt and excessive carbon) should be eliminated, making it possible to retain the wider seat.

Valve Seat Inserts

Necessity for replacing valve seat inserts should be very rare; however, if a replacement is made it is important that new inserts be peened securely in place, using either insert peening tool or a dull-pointed chisel, 1/4" wide, topeen cylinder head metal over outer edge of valve seat insert.

Valve seat insert installing tools are available.

Valve seat inserts supplied for service are standard size and .030" oversize which permits a tight fit in cylinder head.

Repair of Valves

1. True-up the ends of valve stem against face of grinder. Remove only enough material to true the surface.
2. Reface exhaust valves to 45°. The valve face and valve seat angle must be identical.
3. Reface intake valves to 45° with valve seat being the same.
4. Place valves in cylinder head. Place a thin coat of Prussian blue on each valve face, and tap valve lightly to its seat. NOTE: This is merely for test and proof of results of refacing and reseating operations. A poor grinding job cannot be corrected by valve lapping.

5. Inspect each valve coated with blue for seat position. The seat should be at the approximate center of valve face, 7/64"-5/64" wide for exhaust, and 5/64"-7/64" wide for intake.

Valve Assembly

1. Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat valve stems and valve faces with oil, and install valves in same seats to which they were checked.
2. Install valve springs with dampers. Compress valve springs with a valve spring compressor, and install valve spring retainers and retainer locks. Be sure that retainers and locks are correctly seated.

Engine Disassembly - Continued

When overhauling engine with head and pan removed, the following procedures are recommended:

1. Remove fan drive pulley nut and washer from end of crankshaft. Install puller and remove crankshaft fan drive pulley and damper assembly from crankshaft.
2. Remove nuts and capscrews from engine gear case cover (Fig. 12), remove gear case cover (Fig. 13). Remove crankshaft oil slinger from end of shaft (Fig. 14). Remove side cover plate and remove valve tappets (Fig. 15). Remove nut from end of camshaft and remove camshaft gear with puller (Fig. 16). NOTE: Camshaft may be removed without removing timing gear, by removing thrust plate retainer screws.

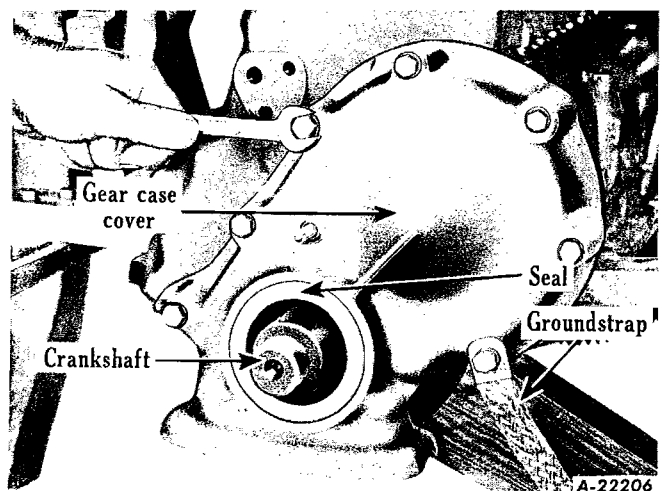


Fig. 12 - Removing timing gear case cover.

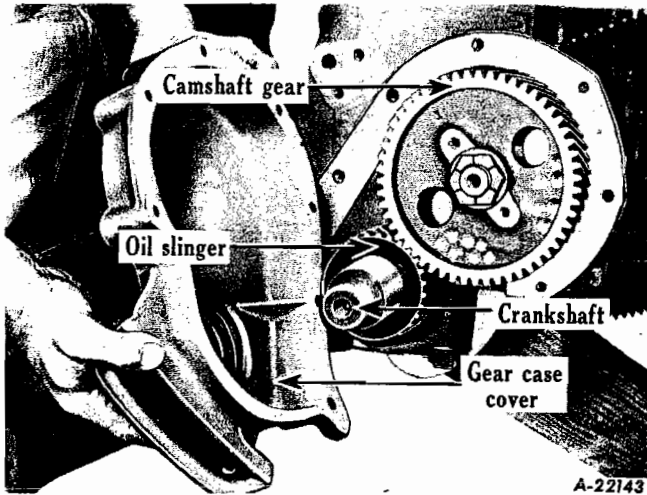


Fig. 13 - Showing details of timing gears. Cover removed.

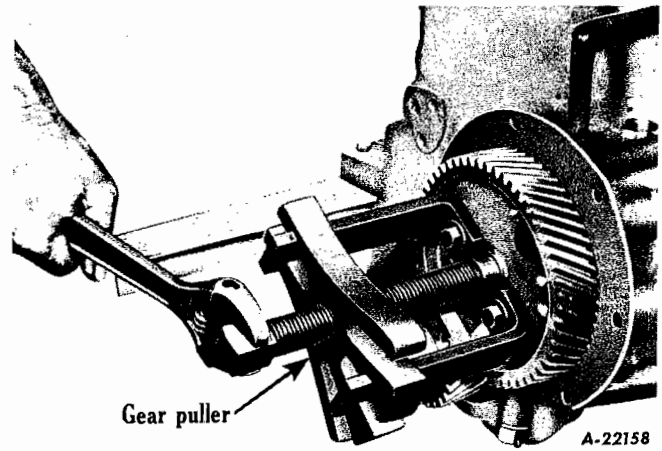


Fig. 16 - Pulling camshaft gear.

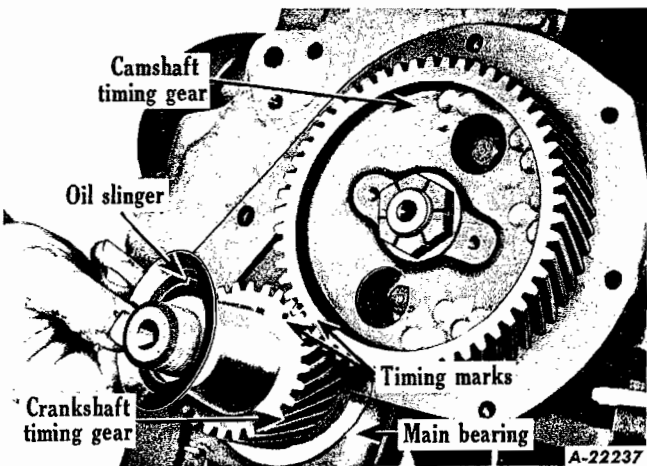


Fig. 14 - Removal of oil slinger. Note that flange of slinger is bent outward.

3. Remove capscrews from camshaft retainer thrustflange plate (Fig. 17). Remove camshaft (Fig. 18). Remove capscrew holding the gear case cover plate to block; remove plate and gasket. Remove crankshaft timing gear, using a gear puller (Fig. 19). (NOTE: Lubricate puller screw to prevent damage to screw threads.)

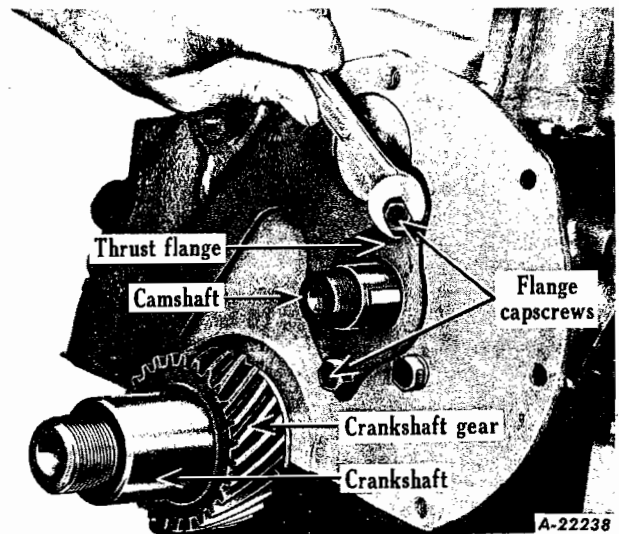


Fig. 17 - Removing camshaft with gear removed. Camshaft may be removed with gear attached.

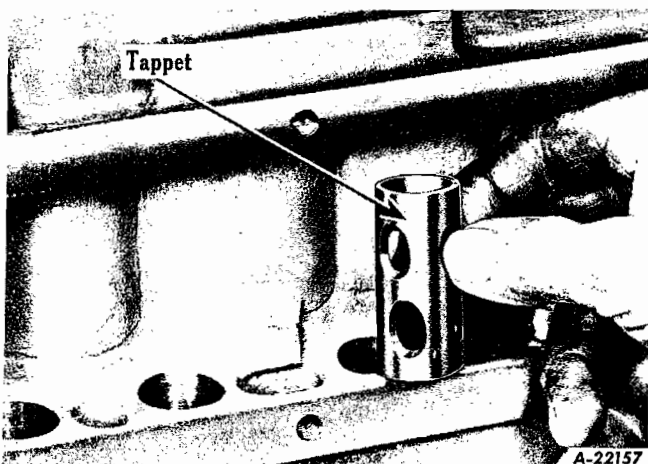


Fig. 15 - Tappets are removed to permit removal of camshaft.

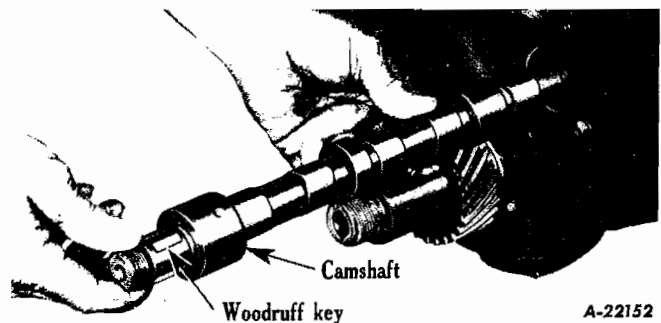
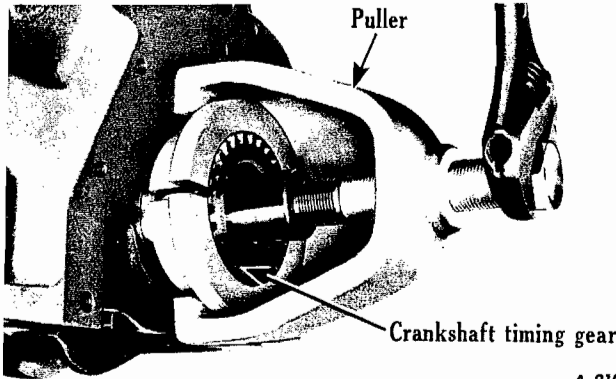


Fig. 18 - Removing camshaft.

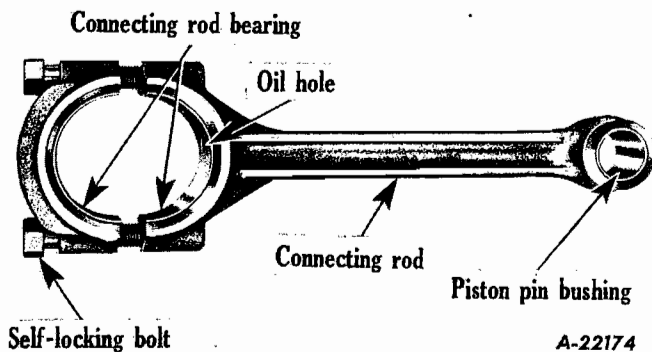


A-21936

Fig. 19 - Pull crankshaft gear, using SE-1715 Gear puller. Lubricate threads of puller to prevent damage to puller threads.

Turn engine in overhaul stand and proceed with disassembly as follows:

- Each connecting rod is numbered as to its position in the engine and these numbers are located on the camshaft side of the engine (Fig. 20). Remove self-locking capscrews from connecting-rod cap and remove cap. Push connecting-rod and piston assembly toward top of block, but first remove ridge from top of cylinder wall, if any. Lift piston and connecting-rod assembly from top of cylinder block. Replace cap on connecting rod. Remove the remaining pistons, following the same procedure.

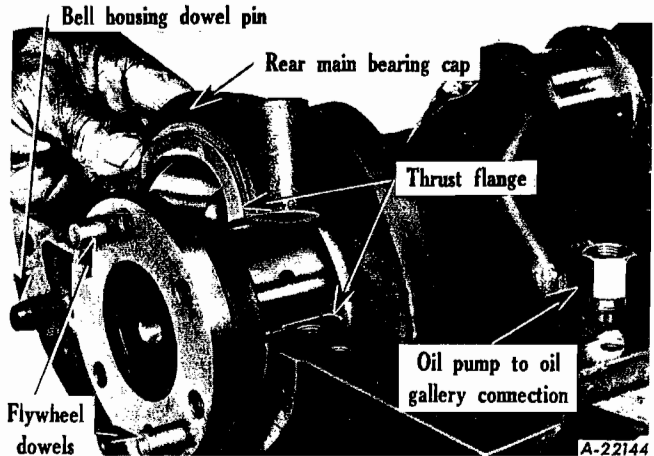


A-22174

Fig. 20

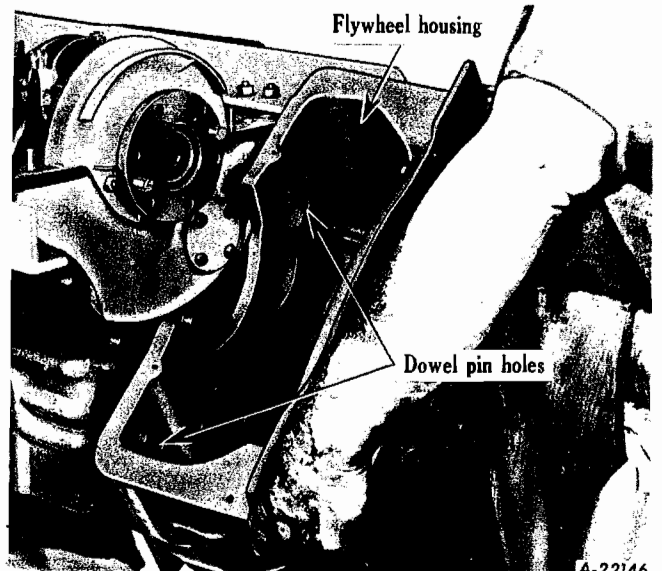
- The crankshaft bearing caps are numbered to identify their position and they must be reinstalled in their respective positions. Remove self-locking capscrews from each bearing cap. Remove all crankshaft main bearing caps (Fig. 21). After all caps have been removed, lift crankshaft straight up and out of cylinder block, and place in a vise equipped with soft jaws.
- With crankshaft securely clamped in vise, remove the six self-locking capscrews holding flywheel to crankshaft. Tap flywheel with a soft hammer to loosen it from

- crankshaft; remove flywheel with ring gear assembly.
- Remove capscrews and lockwashers from engine flywheel housing. Drive out the two engine block dowels, remove flywheel housing (Fig. 22).
- Remove fuel pump, starter, oil pressure regulator valve assembly, distributor, generator, oil gauge and coil.



A-22144

Fig. 21



A-22146

Fig. 22

Water Pump Removal and Overhaul

See sectional view of BD Engine water pump (Fig. 23). The water pump assembly is composed of a body and cover plate which house a ball-bearing mounted pump shaft and impeller. The rear and front bearings are pressed onto the shaft and are separated by a spacer. A slinger is held in place by two half-lock rings. The shaft assembly with its two bearings is held in place in the housing by a retaining snap ring. The fan pulley is pressed onto the shaft (press fit .0007" to .0018") and held in place by a nut and plain washer.

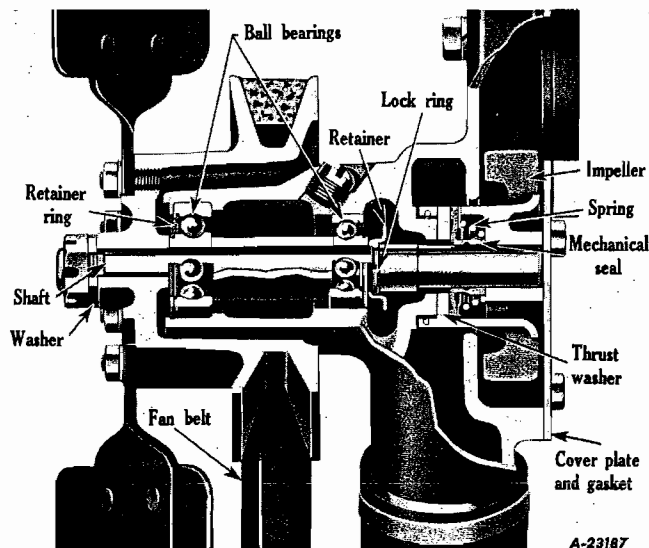


Fig. 23

The impeller seal assembly consists of a seal spring, seal clamp ring, flexible seal, seal spring guide, and a seal carbon washer. The parts are held in place in the impeller by a snap ring. The impeller and seal assembly is pressed onto the pump shaft (press fit of .002" to .0035").

Water Pump Disassembly

(Complete illustrated procedure for water pump servicing is given in Shop Talk No. 14)

1. Remove six capscrews and lockwashers holding fan to pulley. Remove fan blade assembly from pulley. Remove water pump from front end of cylinder head.
2. Remove nut and flat washer holding pulley to water pump shaft. Remove pulley from water pump shaft with puller.
3. Remove four capscrews from cover plate. Remove plate and gasket from pump body.
4. Remove snap ring from front of the water pump shaft front bearing. Supporting water pump on arbor press, push shaft and bearing as an assembly out of impeller from the rear.
5. Support the shaft and bearing assembly on an arbor press, force shaft out of bearing, spacer, and slinger, pressing shaft toward rear bearing. Be careful not to lose the two halfmoon lock rings from under the slinger.
6. Remove snap ring from groove in the front of impeller, and lift out the seal parts from the impeller.

Water Pump Cleaning and Inspection

1. Following disassembly, wash all except rubber parts in cleaning solvent.

2. Examine seal parts for wear, corrosion, or damage, and replace with new parts as necessary. Examine the pump body seal seat surface. If face of surface is scored, it must be resurfaced to prevent leakage. Inspect pump shaft bearing for wear or corrosion. If worn or corroded, replace bearings. Examine shaft for wear at ends, or for damaged threads at front end.

Water Pump Repair

If water pump body seal seat is scored, pitted, or rough, it must be resurfaced. Use special water pump housing seat finishing tool and adapter.

Water Pump Assembly

1. Install rear bearing, spacer, and front bearing onto water pump shaft. Place slinger in position behind rear bearing. Place two half-moon lock rings in groove in shaft, and press shaft into bearing and spacer from rear until rear bearing rests firmly against slinger and ring locks.
2. Place seal clamp ring, seal spring, seal spring guide, flexible seal and retainer, and carbon seal thrust washer into position in impeller. Hold them in position while installing snap ring in impeller groove.
3. Install water pump shaft and bearing assembly into body and hold in place by inserting snap ring in groove in front of front bearing.
4. Support water pump shaft at front end, press impeller and seal assembly onto rear end of water pump shaft. Press impeller only flush with end of shaft.
5. Place new gasket in position on water pump body and install cover plate and four capscrews.
6. Place fan assembly in position on front of pulley, and install six capscrews and lockwashers. Fill pump housing with wheel bearing grease. Use low pressure gun.

Intake and Exhaust Manifolds

When disassembling and assembling the manifolds, the following procedures are used:

1. After removing the eight capscrews from head and three bolts from exhaust flange, remove both intake and exhaust manifolds as a unit (Fig. 24). Remove three manifold pilot rings (Fig. 25). NOTE: Let manifolds cool before starting above operations; this will help to prevent manifold warpage.

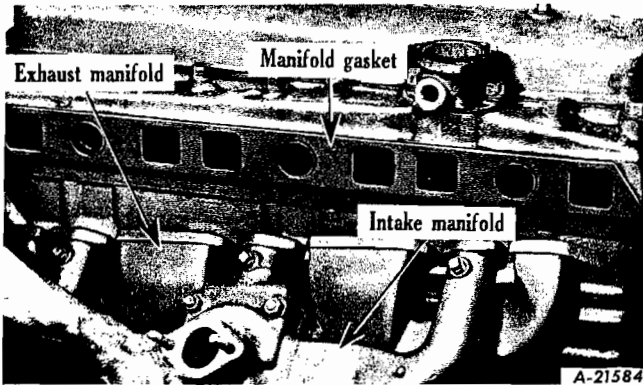


Fig. 24 - Removing intake and exhaust manifold.

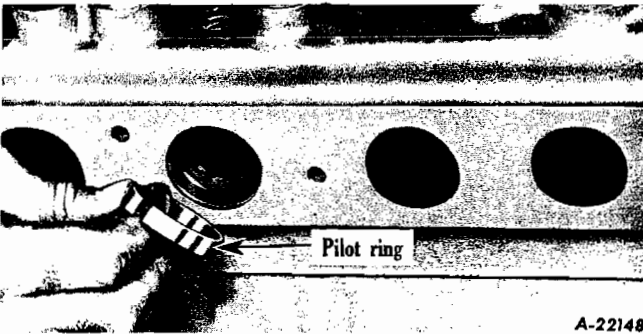


Fig. 25 - Pilot rings are used to hold the intake manifold in alignment and should always be reinstalled.

2. To separate the two manifolds, remove the two outside bolts and nuts and two inside bolts and nuts from the center of manifolds.
3. The intake and exhaust manifolds are each of one piece construction, requiring no disassembly after separation.

Intake Manifold

1. The intake manifold consists of three outlets, each supplying fuel to two cylinders. Two studs are located on the top for carburetor mounting.
2. If vacuum is needed to operate any unit within the truck, a threaded inlet is provided in the manifold for such purposes.

Exhaust Manifold

The exhaust manifold consists of four outlets. The two end outlets remove burned gases from the No. 1 and No. 6 cylinders, while the two center outlets remove burned gases from Nos. 2, 3, 4 and 5 cylinders.

Manifold Inspection

Inspect intake and exhaust manifolds visually for cracks or breakage. Place manifolds on surface plate and check for warpage. If

cracked or broken, replace or weld. If slightly warped, true-up on surface grinder but replace if warpage is extreme.

Manifold Assembly

Place new gasket between the intake and exhaust manifolds and install two capscrews and two nuts. Mount manifolds together loosely before installing on engine. This will assure proper alignment of the units with each other and with the engine cylinder head. NOTE: Do not eliminate the intake manifold aligning pilot rings.

Oil Pump Overhaul

(Complete illustrated procedure for oil pump overhaul is given in Shop Talk No. 28)

Special tool equipment is available for oil pump overhaul under SE-1499. Use of these tools will speed up the job and assure accurate work.

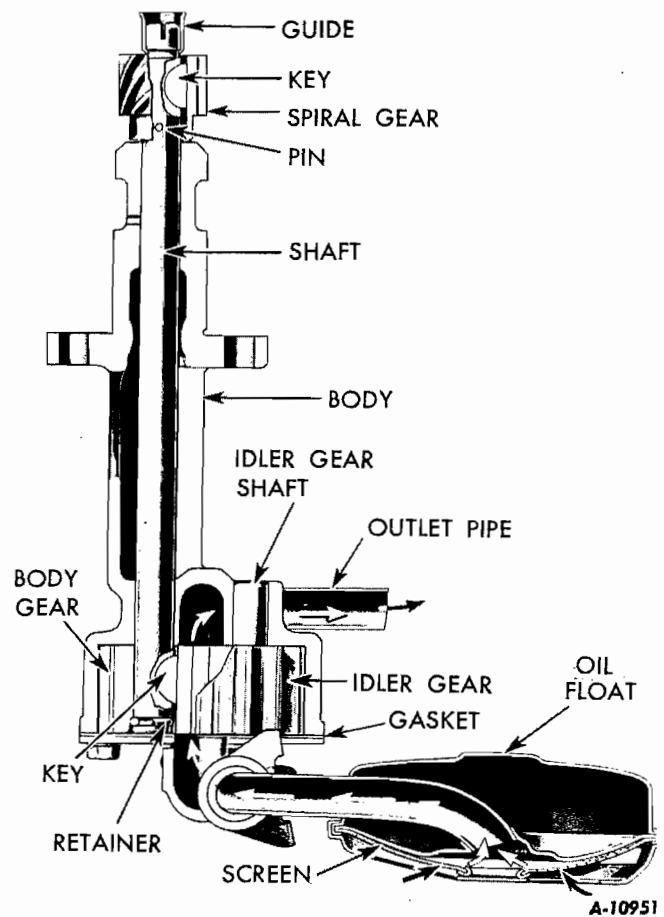


Fig. 26

Oil Pump Disassembly

See sectional view of the model BD engine oil pump (Fig. 26).

1. Remove cotter pin holding float to oil pump.

ENGINES

Super Blue Diamond

Section B

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L-LINE MOTOR TRUCK SERVICE MANUAL



- Remove float from pump. Loosen oil outlet coupling and remove oil line from pump.
- Remove four capscrews and lockwashers from oil pump body cover and lift cover and gaskets from oil pump body.
 - Lift out oil pump idler gear from idler gear shaft. After removing oil pump drive gear shaft guide from top of shaft, use small punch to drive out spiral gear pin from oil pump spiral gear. Using an adapter collar which fits underneath the spiral gear, and an adapter with a tang which will fit down into the slot of the oil pump drive shaft so as to apply pressure of press at bottom of slot, press oil pump drive shaft out of oil pump spiral gear. Remove Woodruff key from shaft. Remove oil pump body gear and oil pump drive shaft from oil pump body.
 - Press oil pump gear onto oil pump drive shaft far enough to reveal retainer ring. Remove ring from oil pump shaft. Press oil pump body gear from shaft and remove Woodruff key from shaft. Wash all parts in cleaning solvent.
- Using hole in spiral gear as guide, drill .1255" hole in shaft. Drive new spiral gear pin into place. Install a new guide on the end of the pump shaft, use guide installing tool.
- Install idler gear on idler gear shaft. Install gasket and oil pump body cover, and install four capscrews and lockwashers. Test oil pump body gear end play to cover by using a feeler gauge between oil pump spiral gear hub and oil pump body. End play must be from .0025" - .0055". If clearance is in excess of .0055", remove one gasket from cover. If clearance is less than .0025", add one gasket between cover and body. Recheck end play after making any alterations. Insert oil pump into cylinder block so that slot in top of shaft is at right angles to the side of the engine with the number one piston in firing order.
 - Connect oil pump outlet to pump and tighten coupling. Insert oil pump float in oil pump body, line up cotter pin holes, install new cotter pin, and fasten securely.

Oil Pump Inspection

Check the following parts carefully:

- Check the oil pump drive shaft for wear at points of contact with body. If wear is perceptible, the shaft must be replaced. Diameter of shaft is from .4985 to .4992 inches.
- Check the oil pump body for warpage, damage and wear. Replace if body is warped or cracked, or if shaft bore is worn so that clearance between shaft and bore is in excess of .005". Inspect all oil pump gears, and replace if wear is perceptible.

Oil Pump Assembly

- Press body gear onto oil pump drive shaft after placing new Woodruff key in slot of shaft. Press gear onto shaft far enough to permit installation of retainer ring in groove in oil pump. Press oil pump body gear down against ring.
- Insert oil pump drive shaft and body gear into oil pump body. Install new Woodruff key in slot at top end of shaft. Install oil pump spiral gear, with gear hub down, onto drive shaft. Press spiral gear down onto shaft until 1/32" clearance remains between gear hub and pump body when oil pump body gear is up against pump body.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR AND ASSEMBLY OF SUB-ASSEMBLIES

Cleaning the Cylinder Block

Remove all old gasket material from block, clean both inside and outside of block with steam or cleaning solvent. Remove all dirty oil, sludge, scale, and carbon from cylinder block.

Cylinder Block Inspection

- Inspect cylinder walls for cracks. Weld cracks or replace block, if necessary.
- Check top surface for trueness with a straight-edge. Test by attempting to insert a .012" feeler gauge ribbon between the straight-edge and the cylinder block. If this is possible, either surface grind or replace the cylinder block.
- Inspect camshaft bearings for damaged or scored condition, and inspect for wear. Replace if damaged or if worn beyond clearance limit of .0035".
- Measure cylinder walls with an inside reading micrometer to determine taper, out-of-round or worn condition. The measurements must be made not only at top of the cylinder bore, just below ring groove, but at several places around the inside circumference of the bore. Bore should be checked at the bottom, below ring wear surface, to determine the amount of taper. Re-sleeve if worn beyond .008" clearance.



Cylinder Sleeve Fits

The fit of the cylinder sleeve in the crankcase should be 100 to 200 lbs. hand push fit or approximately .0005" to .001" loose fit. This fit can be obtained by honing the cylinder bore sufficiently in the crankcase until the cylinder sleeve can be pushed all the way in by hand.

Before installation of cylinder sleeve, the crankcase bores should be cleaned of all carbon and foreign matter.

Installation of cylinder sleeves in the foregoing manner will preclude to a large extent the necessity of excessive honing when fitting pistons to the cylinder sleeves.

NOTE: If cylinder water jacket shows an excessive amount of lime deposits, the cooling system cannot provide effective heat dissipation.

Whenever the top of the sleeve flange goes below the top of the crankcase, a thin tag wire should be placed under the sleeve flange to raise it flush with the crankcase, or not to exceed .006" above the crankcase face.

Cylinder wall surface finish is of utmost importance in piston and piston ring life and in oil consumption control. The best type surface is one having characteristics midway between "smooth" and "highly polished". The resulting surface of a boring or honing operation consists of numerous microscopic scratches or grooves which act as oil reservoirs or retainers of oil while the surface between the grooves provides a load-bearing surface. If the scratches are too deep and too close together, the surface is referred to as "rough" and will not provide adequate ring and piston contact area which results in fast wear. Should the finish be highly polished or too "smooth", the scratches or grooves are shallow and will have insufficient oil-retaining capacity to provide adequate lubrication for the adjacent contact or load-bearing area and will result in scuffing or scoring. It is therefore advantageous to strike a "happy medium" by removing only the sharp peaks of these microscopic ridges and in this way still reap the benefits of the oil-retaining grooves. This type of cylinder wall surface is obtained through exercise of care in finishing operation and through proper use of equipment.

The following procedure will produce the best results when fitting pistons to sleeves:

1. Using 150-grit hone stones and having both sleeve and stones coated with one of the vegetable shortenings (Crisco, Spry, Dexo, or equivalent), work hone up and down in cylinder approximately 20 strokes. This should bring the bore diameter to within .0003" of the desired size. (Hone should

be moved up and down at a speed rate of approximately one stroke per second.)

2. Using 280-grit hone stones and having both sleeve and stones coated with vegetable shortening, work hone up and down in the cylinder bore approximately 20 strokes. This operation should bring the bore to the desired size.
3. Still using 280-grit hone stones, but having lubricant only on the stones, pass the hone up and down in the bore about 5 times. This operation will not increase the bore diameter but will merely serve to remove the sharp ridges and leave the desired type of surface finish.

NOTE: In steps 1 and 2, the hone should be quite snug in the bore. In step 3, the tension should be a little less.

CAUTION: Extreme care must be taken to assure that no abrasive remains in the engine.

4. After engine has been reassembled, it should be allowed to run-in for two or three hours at a fast idle (approximately 1200 r.p.m.).

Replacing Camshaft Bushings

If camshaft bearing replacement is necessary, remove and install new bushings with special camshaft bearing installation tool. No reaming is required. Fig. 27 illustrates the use of camshaft bearing installing tool.

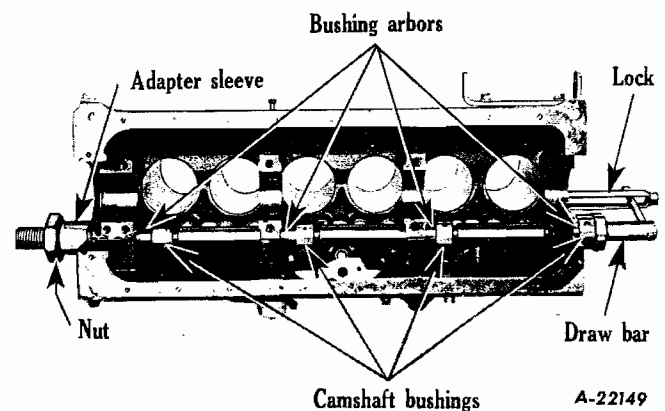


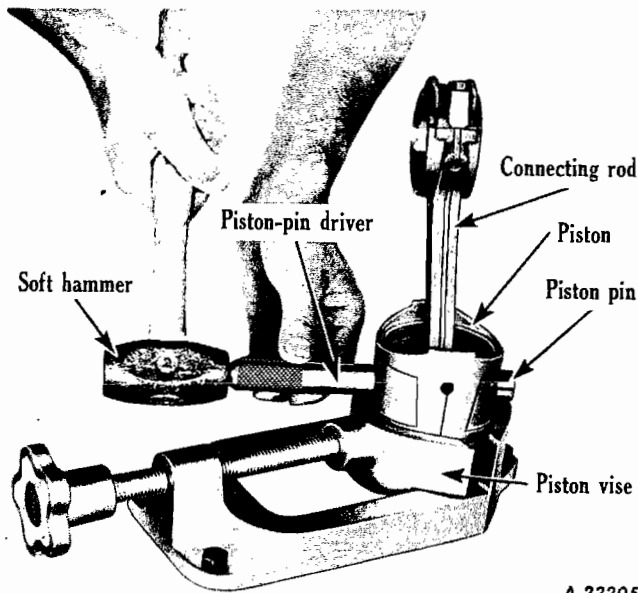
Fig. 27 - Using the SE-1724 Camshaft Bushing installing tool.

Connecting Rod and Piston Disassembly

1. Remove piston-pin retainers from each piston, and remove piston rings from piston ring grooves.
2. Heat piston in boiling water or piston heater. Place piston in piston vise, and using pin-driving tool, drive piston pin from



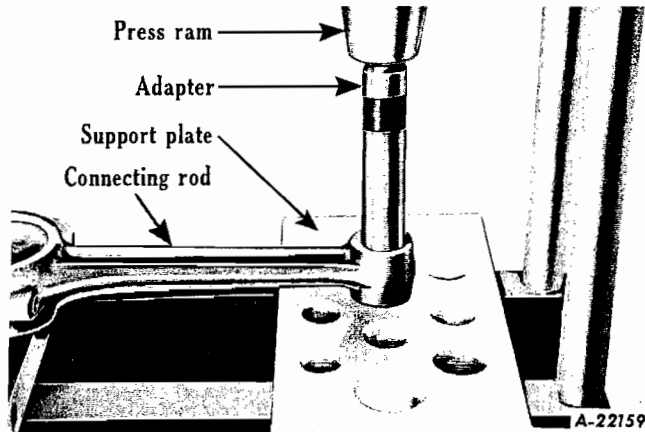
piston and connecting rod (Fig. 28). After piston pin is removed, lift piston from connecting rod.



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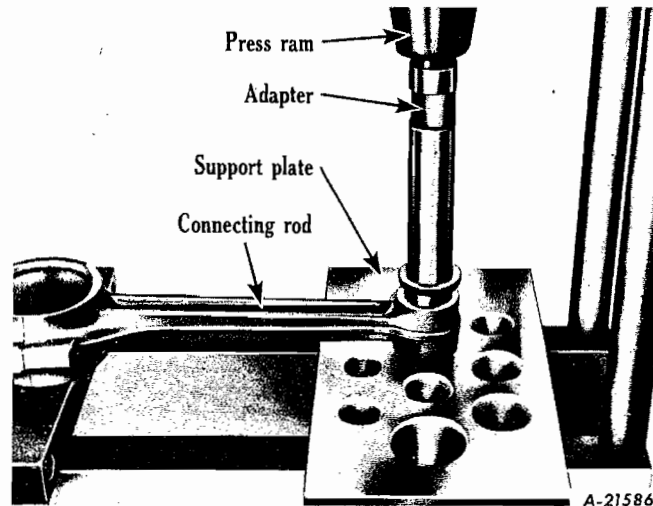
Fig. 28 - Use suitable piston vise to hold piston and drive pin out with SE-1263 Piston Pin Driver. Use soft hammer.

3. Wash all parts in a cleaning solvent. CAUTION: Do not use a caustic solution for aluminum pistons. Clean the carbon from piston ring grooves with a broken ring or ring groove cleaner.
4. Inspect connecting rods, caps, and bearing shells. All connecting-rod bearings and piston-pin bushings should be replaced at every major overhaul. Test rods for alignment. Rods only slightly misaligned can be straightened with proper equipment. Badly twisted or bent connecting rods must be replaced.
5. Inspect pistons for cracks, breakage, or scores. Check piston ring grooves and ring lands for wear, using a new piston ring and feeler gauge. If clearance between ring and ring land exceeds .005", (total clearance) replace piston (see specifications). Pistons which are scored or damaged, must be replaced.
6. Inspect piston pins for wear, and if wear is perceptible, replace pins. Replace piston pins which show signs of corrosion or etching.
7. With properly fitting adapter, press old piston-pin bushing from connecting rod (Fig. 29). Place new piston-pin bushing in position, align oil hole in bushing with oil hole in connecting rod, (Fig. 30), install bushing with a .0035" to .0055" press fit. Burnish bushing into place in the connecting rod (Fig. 31), then ream pin bushing to provide a hand-push fit.
8. With reamer, ream piston pin bosses in piston to provide a tight fit of from .0000"



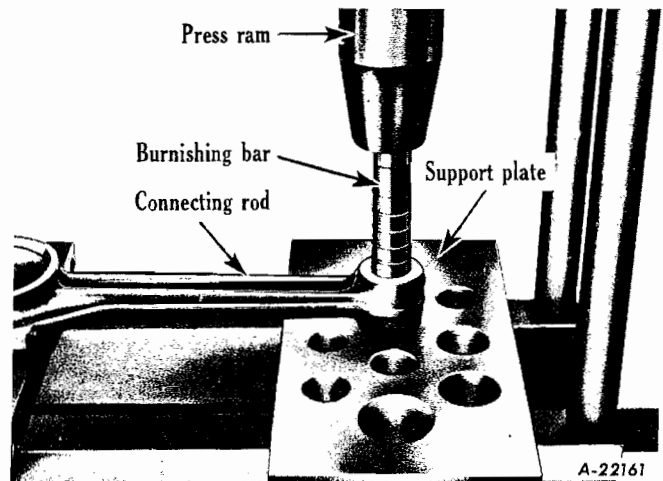
A-22159

Fig. 29 - Use SE-1036-4 to remove bushing. Select proper hole in SE-1033 Support plate to permit clearance for bushing.



A-21586

Fig. 30 - Installing new bushing in rod.



A-22161

Fig. 31 - Burnish bushing using SE-879.

to .0002" with piston pin. NOTE: When fitting piston pins, the pins should be at room temperature (70° F) and the pistons should be heated to approximately 200° F

in boiling water or piston heater. The pin should be a "palm-push" fit under these conditions.

Piston Fitting

When fitting pistons in the cylinder sleeves, use a .003" feeler ribbon 1/2" wide between the piston and cylinder 90° from the piston pin hole and in line with the thrust face of the piston (Fig. 32). Apply a tension pull on scale to the feeler ribbon, and check clearance to specifications as outlined in the chart.

Feeler Gauge Ribbon Checking	
Width	1/2"
Thickness . . . . .	.003"
Tension on Scale (Lb.)	6-18
Desired Tension (Lb.)	12

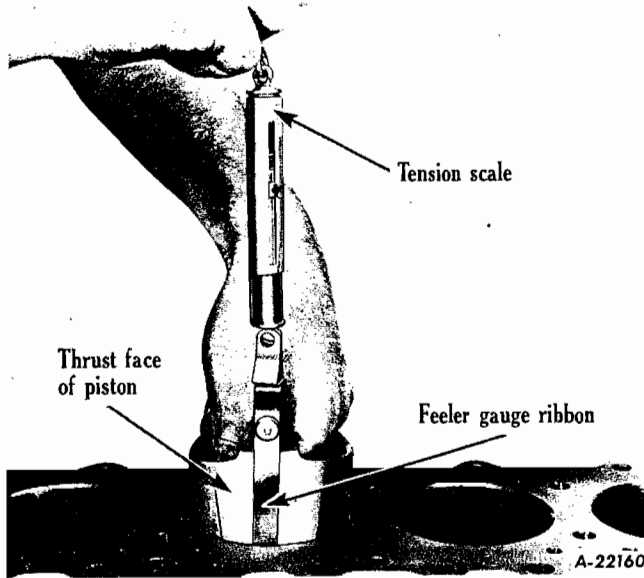


Fig. 32 - Checking piston fit using feeler gauge ribbon. SE-1007 Gauge Set is available for this operation.

Connecting-Rod and Piston Assembly

1. With piston heated to approximately 200° F., support connecting rod in vise, push piston pin into piston bosses while piston is hot. When assembling piston on rod, the slot in the piston skirt must be toward the camshaft side of the engine, which is the numbered side of the connecting rod. Install piston-pin retainer in piston at each end of pin, making sure that retainers seat fully and with tension in grooves. Test connecting-rod and piston assembly on a connecting-rod aligner, and correct any misalignment.
2. Place piston and connecting rod in vise. Test each piston ring for proper gap by placing in cylinder and measuring gap with feeler gauge. Gap should be .016" to .026" (Fig. 33).

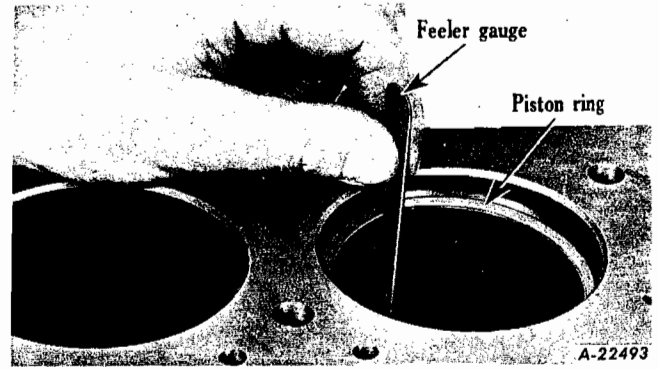


Fig. 33 - Checking ring gap.

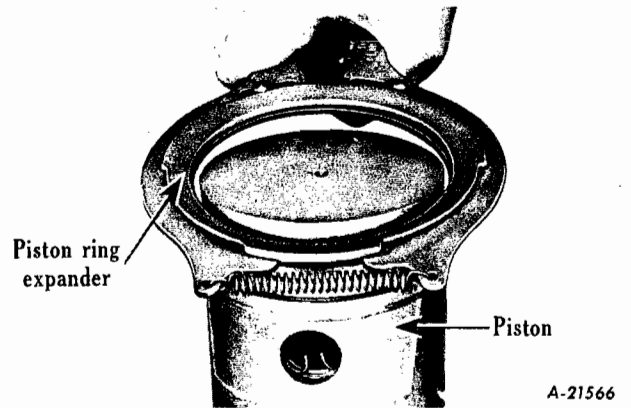


Fig. 34 - Installing pistonring using SE-1149-8 Ring installing tool.

3. When installing piston rings in piston grooves, be careful not to distort rings. If possible, use a suitable piston ring expander tool (Fig. 34). Also check new piston rings in piston ring grooves for clearance between ring and ring lands. The correct ring clearance is shown in specifications.

Crankshaft Cleaning and Inspection

1. Wash and clean crankshaft with cleaning solvent or steam.
2. Inspect main-bearing and connecting-rod journals for wear. If journals show wear or out-of-round in excess of .003", the shaft should be either reground and under-size bearings installed, or replaced. Use micrometers for checking.
3. Check crankshaft and flywheel dowels for damage and fit, and replace if worn or damaged.
4. Examine crankshaft timing gear teeth, and replace gear if teeth are worn or damaged.
5. Install Woodruff key in groove in crankshaft. Heat crankshaft gear in boiling water

ENGINES

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or piston heater. This will expand the gear enough to allow it to be tapped onto the crankshaft without the danger of damaging the gear. A special crankshaft gear installing tool is available under SE-1088.

Flywheel and Ring Gear Inspection

1. Clean flywheel and ring gear with a cleaning solvent, remove all traces of oil and grease.
2. Inspect the flywheel ring gear. If any teeth are damaged, or if ring gear is loose on flywheel, the ring gear must be replaced.
3. Check the flywheel dowel holes and mounting bolt holes for wear, also check for flywheel having been loose.
4. To replace flywheel ring gear, heat gear with torch, and remove from flywheel with a hammer and drift. Heat new ring gear with torch, heating evenly all the way around. While the ring gear is hot, install gear on flywheel and allow it to cool.
5. Check pilot bearing in flywheel for wear or damage and replace if needed.
6. Install flywheel on crankshaft. Install six self-locking capscrews, drive dowel pins through flywheel to crankshaft.

Camshaft Cleaning and Inspection

1. Wash camshaft in cleaning solvent, brushing to facilitate removal of all sludge or carbon deposits.
2. Inspect camshaft journals for signs of wear or out-of-round.
3. Inspect oil pump drive gear in center of shaft. If teeth are worn or damaged, the camshaft must be replaced, as the gear is integral with shaft.
4. Inspect camshaft lobes. If worn, chipped, or scored, replace the camshaft.
5. Inspect camshaft gear, and replace if wear is evident or gear teeth are nicked or otherwise damaged.
6. To reassemble, install thrust flange over end of camshaft. Install Woodruff key in slot in shaft. Place camshaft gear in boiling water or piston heater, and install over Woodruff key. Install camshaft nut and tighten to approximately 120 foot-pounds tension.

Cleaning and Inspecting Miscellaneous Parts

1. Cleaning miscellaneous engine parts. This includes brackets, oil pan, engine case

cover, flywheel housing, and other parts that were removed during disassembly of engine and were not covered by procedure. Wash in cleaning solvent or steam clean preliminary to inspection.

2. Check all twelve valve lifter or push rods for straightness by rolling on flat surface. Replace any that are bent or have loose ends.
3. Inspect oil pan for cracks or deep bends, and straighten or weld.
4. Inspect oil pan drain plug and drain plug boss for fit and thread wear. If plug is loose or threads are damaged, repair threads or replace oil pan.
5. Inspect crankshaft pulley and vibration damper assembly for evidence of rubber coming loose from pulley, and inspect for wear. Replace damper assembly if either condition is encountered. Do not submerge vibration damper assembly in hot cleaning solvents. Inspect crankshaft fan drive pulley for wear in hub bore. If inner diameter of bore is worn, scored, or Woodruff key way damaged, replace pulley.
6. Inspect engine gear case cover, and replace if cracked or broken. Remove old cover seal and install new seal.
7. Check each of twelve engine valve tappets for irregular wear, chipping, cracking or scores. Replace defective tappets.
8. Inspect engine flywheel housing for cracks or breakage and replace if damaged. Inspect flywheel housing to crankcase pilot dowel holes for wear. If wear is evident, drill or ream the holes and install over-size dowels. Also inspect dowels for wear and replace if wear is evident.
9. Inspect all capscrews and nuts for thread wear or breakage, and replace as necessary. Use new lockwashers when reassembling engine.
10. All gaskets and oil seals must be replaced at each overhaul or major repair.

ASSEMBLY OF ENGINE

When all parts have been cleaned, inspected and repaired, and necessary replacement parts have been procured, install engine cylinder block in engine overhaul stand for reassembly.

Main-Bearing and Connecting-Rod Bearing Installation

It is essential that main bearings be in alignment with the crankshaft journals. The



model BD engines do not have the bearing caps piloted in the crankcase. When no means of piloting the bearing caps has been provided, misalignment is possible due to a slight shifting of the bearing caps when the bearing cap bolts are tightened. If a bearing cap bolt is not straight or if the threads are not concentric with the body of the bolt, this condition will be aggravated; therefore, all bolts should be carefully examined before installation, to avoid such a condition.

The following method has proved successful in holding the caps and bearings in alignment with the crankshaft. After bearings have been fitted to specified clearances, remove the caps and apply a coating of petrolatum or white vaseline, or heavy engine oil to the bearing surfaces, then reassemble the caps and tighten the bolts.

It will be noted that a small quantity of the petrolatum or vaseline may be squeezed out when the bearing caps are tightened; however a sufficient quantity will remain which will serve as a cushion or filler between the bearings and crankshaft journals, thereby reducing the tendency of the cap and bearing to shift.

The petrolatum or vaseline will also serve as a lubricant when the engine is first started and will dissolve and mix with the regular engine lubricating oil after a few revolutions.

Under no circumstances should anything other than petrolatum or vaseline or heavy engine oil be used due to the possibility of chemical reactions which would cause damage to the bearing material.

BEARING CRUSH. Undersize precision-type bearing shells should be installed when, because of wear, bearing-to-crankshaft running clearances are to be reduced. Bearing caps must not be filed, lapped, or in any other manner reworked.

Premature bearing failure will result from attempts to reduce journal-to-bearing running clearance by reworking of either bearing caps, bearings, or both, because such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush".

When installing precision type connecting rod or main bearings, it is important that the bearing shells fit tightly in the rod or case bore. To accomplish this, the bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled. When the assembly is drawn up tight, the bearing is compressed, assuring a good contact

between the bearing back and the bore. This increased diameter is referred to as bearing "crush" (Fig. 35).

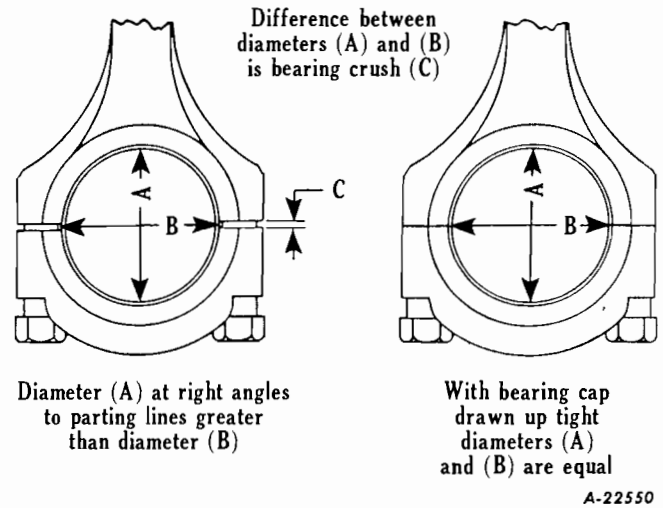


Fig. 35

To obtain proper bearing assembly with the correct "crush", care must be taken when tightening the clamping bolts to make sure they are drawn down alternately and evenly, using a tension wrench and tightening as specified.

As a result of excessive bearing crush, due to reworking the caps, the rod or main bearing bore will possible become distorted because more force is required to draw the cap and housing together.

Rods, caps, or blocks must not be filed, lapped, or in any other manner reworked in order to reduce clearance. While such practice will make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion. New bearing shells will have to be installed eventually and that is when additional trouble starts.

In general, a visual inspection of the parting faces of the rod or caps under a magnifying glass will provide sufficient proof of any attempt at reworking. Under the glass, the parting line surface of standard parts will show the manufacturing cutter tool marks and will not have a polished or extremely smooth appearance. On the other hand, reworked parts will have a polished surface and, if a file was used, will show the even pattern of the file teeth. Seriousness of this condition is in direct proportion to the amount of reworking.

BEARING SPREAD. Main and connecting-rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting-rod bore into which they are assembled. For example, the width across the open ends of the BD engine connecting-rod bearing not in



place is approximately .025" more than when the bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat (Fig. 36).

Rough handling in shipment, storage, or normal results of use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread should, therefore, be carefully measured and corrected as necessary before installation in an engine.

Bearing spread can be safely adjusted as follows, although care and judgment should be exercised in the process:

1. Excessive spread. If measurement of spread indicates that distance "A" is excessive (see chart for specifications), place bearing on a wood block and strike the side lightly and squarely with a soft mallet (Fig. 37). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.
2. Insufficient spread. If measurement of spread indicates insufficient spread, place bearing on wood block and strike the back of the bearing lightly and squarely with a soft mallet (Fig. 37). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

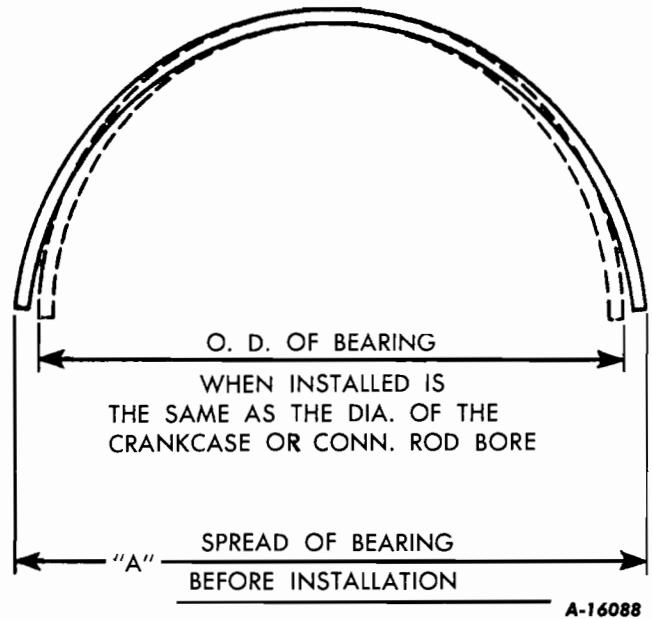
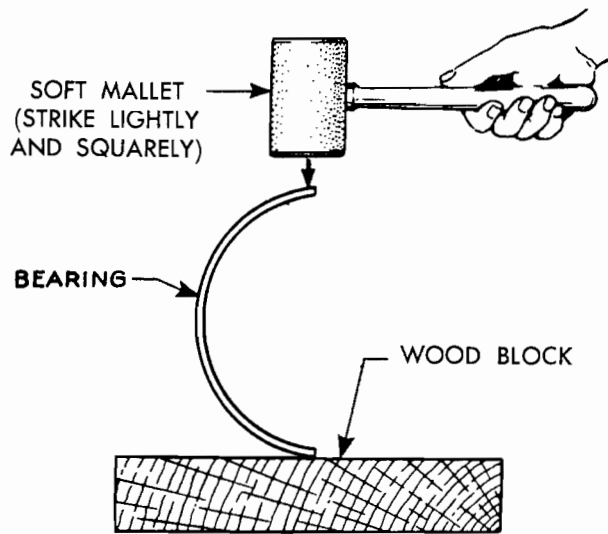


Fig. 36

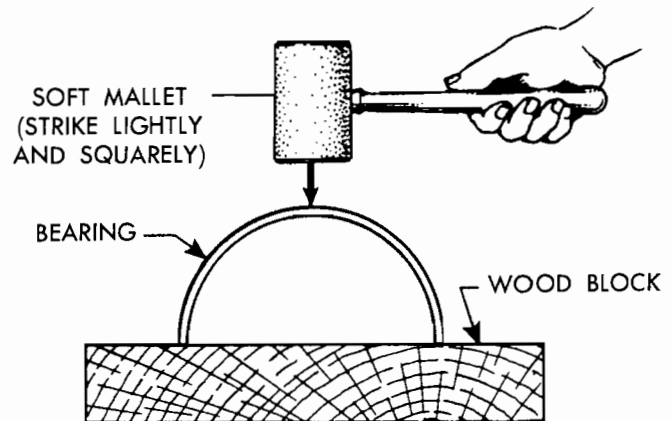
Chart of Bearing Spread Dimensions.
BD Engine (Minimum)

"A"	Connecting-Rod Bearing	2.237" + .025"
	Main Bearing	2.875" + .025"

1. **INSTALL CRANKSHAFT AND MAIN BEARINGS.** Clean all surfaces of crankshaft bearing journals and wipe clean the bearing bores in the cylinder block. Remove bearing cap self-locking capscrews and bearing cap. Wipe backs of cylinder block half of bearings, making sure that dirt and oil is removed. Place bearing shell halves in position in bore in cylinder block, making sure that bearing shells are fully seated, that oil holes in bearing shells line up with oil holes in cylinder block, and that locking tongs on bearings fit into recesses. Follow same procedure, place bearing shell cap halves in bearing caps. Place a film of engine oil on bearing shell surfaces and lift crankshaft to align itself in the bearings, and also provide lubrication. Place bearing caps and bearing lower halves over crankshaft journals. Be sure bearing caps are properly installed with numbers to camshaft.



DECREASING SPREAD



INCREASING SPREAD

Fig. 37

A-16095



2. In order that an accurate measurement can be made to check all bearing clearances, a material similar to "plastigage" or "virgin lead" can be used.
3. Use the following instructions when using "plastigage".
 - (A) Remove oil from bearing cap insert and exposed half of crankshaft journal.
 - (B) Place a piece of "plastigage" the full width of the bearing insert.
 - (C) Reinstall the bearing cap. Tighten the self-locking capscrews to approximately 105 foot-pounds.
 - (D) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell or the crankshaft.
 - (E) To determine the bearing clearance, compare the width of the flattened plastigage at its widest point with the graduations on the envelope (Fig. 38). The number within the graduation on the envelope indicates the clearance in thousandths of an inch. NOTE: Do not turn crankshaft during the above procedure.
- (d) Rock the crankshaft back and forth two or three times. Further tighten bolts to 60 to 70 foot-pounds and again rock the crankshaft two or three times. Tighten bolts to 105 foot-pounds and remove bearing cap.
- (e) The virgin lead will now be compressed exactly in accordance with the amount of bearing to crankshaft clearance. Peel off flattened piece of virgin lead wire and measure with micrometer. Thickness of flattened piece of wire is exact amount of bearing clearance present. Repeat above operations on all bearings.
5. If clearance is not within .0013" - .0043", either use undersize bearing, regrind shaft, or replace shaft. Check crankshaft for end-play which is taken up by number four main bearing. End clearance should be from .013" to .005".
6. **INSTALL FLYWHEEL HOUSING.** Place flywheel housing in position over two flywheel housing to cylinder block dowels and tap into place with soft hammer. Install six capscrews and lockwashers in flywheel housing. If either block or flywheel housing is replaced, the flywheel housing will have to be aligned with a dial indicator. When correctly aligned, run-out of bore should not exceed .005" (Fig. 39). NOTE: If possible align flywheel housing while engine is in overhaul stand and with engine in vertical position (flywheel housing up).

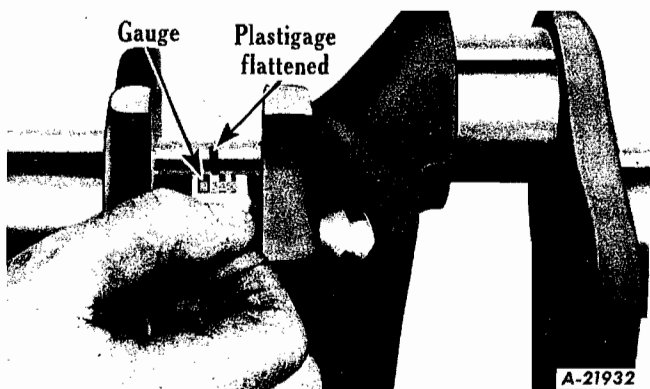


Fig. 38 - Checking bearing clearance.

4. When using the "virgin lead method" use the following procedure:
 - (a) Virgin lead wire of approximately .010" thickness should be used. If wire of .010" thickness is not available and thicker wire must be used, it must be rolled to approximately .010" thickness.
 - (b) Remove one bearing cap. Place 1/2" piece of virgin lead length wise on top of crankshaft bearing journal.
 - (c) Install cap and bearing shell half. Install bearing cap bolts and tighten to 30 to 40 foot-pounds tension.

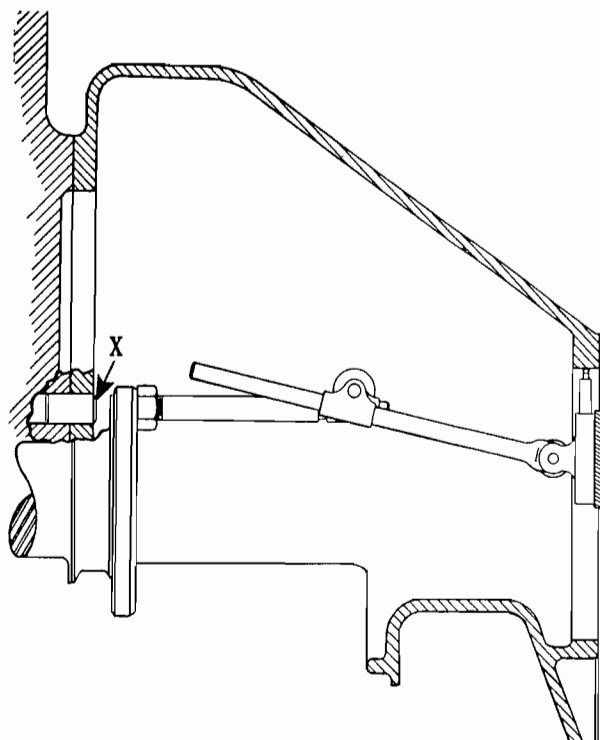


Fig. 39



7. **INSTALL ENGINE FLYWHEEL.** Place engine flywheel and ring gear into position on dowels in crankshaft flange. Install six self-locking capscrews in flywheel and crankshaft flange, and tighten to a tension of approximately 100 foot-pounds, using a tension wrench.
 8. **INSTALL GEAR CASE COVER PLATE.** Place plate and gasket at front end of engine cylinder block. Install one capscrew and lockwasher.
 9. **INSTALL CAMSHAFT AND GEAR.** Coat camshaft with engine oil. Insert camshaft into front end of engine block, being careful not to damage camshaft bearings. Before completely entering camshaft rotate shaft until marked teeth on crankshaft gear and camshaft gear index (Fig. 14). Install two capscrews and lockwashers in camshaft thrust flange, working through large holes in camshaft gear. Rotate crankshaft and camshaft to determine that gears do not bind or interfere. Back-lash must be from .000" to .002" (.0015" preferred).
 10. **INSTALL GEAR COVER CASE.** Place gasket in position on case cover. Place crankshaft oil slinger over end of crankshaft and install Woodruff key for fan drive pulley in crankshaft. Place gear case cover in position. Install capscrews, new lockwashers and nuts.
 11. **INSTALL FAN DRIVE PULLEY AND VIBRATION DAMPER.** Heat crankshaft fan drive pulley and vibration damper assembly in boiling water. When heated, quickly install assembly on crankshaft and install washer and fan drive pulley nut. Tighten nut with wrench of about 36" leverage.
- into recess in cap. (NOTE: See instructions under "Main Bearing and Connecting-Rod Bearing Installation".)
 3. Coat bearing surfaces with oil. Pull connecting rod into position on crankshaft journal and install connecting-rod cap and bearing. NOTE: Bearing cap must only be installed on connecting rod one way, with both connecting rod number and bearing cap number to camshaft side. Install two self-locking capscrews and tighten to 65 foot-pounds, use tension wrench.
 4. To check connecting-rod bearing to crankshaft clearance, follow procedure given for "plastigage" on "virgin lead" test. Specified connecting-rod bearing to crankshaft clearance is from .0007"-.0032". Do not attempt to file connecting rods or bearing caps.
 5. Follow procedure outlined in steps above for remaining connecting rods and pistons.
 6. **INSTALL CLUTCH** Install clutch driven disc against flywheel so that the long portion of the hub is toward the rear. Place clutch in position on flywheel over clutch driven disc. Locate clutch so that arrow or inspection mark (usually a dab of white paint) on flange of clutch backing plate or cover is as near as possible to the letter "L" on the flywheel, and install two or three mounting capscrews and lockwashers loosely. Insert a clutch aligning arbor, if available, or a transmission main drive gear shaft, through clutch driven disc hub spline and into clutch pilot bearings. Hold clutch driven disc in position while completing installation of six mounting capscrews and lockwashers in flange of clutch backing plate or cover. Tighten all six capscrews securely. Remove three retaining capscrews and flat washers which were installed to hold clutch compressed. NOTE: clutch will not operate properly unless these retaining capscrews are removed.

Installing Connecting Rods and Pistons

1. Install one connecting-rod and piston assembly down through top of cylinder block having slot in piston towards camshaft side of engine. Pistons are also marked with an arrow indicating front of engine. Use a piston ring compressor sleeve to compress piston rings and thus avoid possible ring damage.
2. Wipe bore of connecting rod free of oil and dirt. Place bearing shell upper half in connecting rod bore, being sure that oil hole aligns with oil hole in connecting rod and that locking tangs of bearing shall fit into recess. Clean connecting-rod cap bearing bore and clean back of bearing. Place bearing shell lower half in connecting rod cap, making sure that tang of bearing fits
7. **INSTALL VALVE TAPPETS.** Coat each of twelve valve tappets with heavy engine oil and drop each, flat side down, through recess in side of cylinder block into sockets in block.
8. **INSTALL VALVE LIFTER ROD COVER.** Install new gasket over opening at left-hand side of engine block. Install valve lifter rod covers and slotted screws.

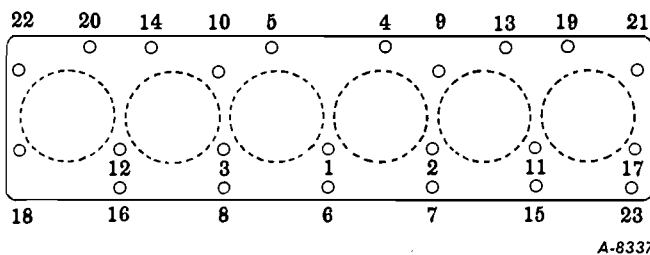
Install Cylinder Head

1. **INSTALL HEAD.** Place gasket on cylinder block and align bolt holes. Place cylinder head on crankcase, being careful not to damage or shift gasket position. Loosely



install all cylinder-head bolts and flat washers, omitting bolts in holes for rocker arm assembly.

2. **INSTALL VALVE ROCKER ARM ASSEMBLY.** Insert twelve valve lifter rods in cylinder head, make sure they enter the valve tappet. Lift the valve rocker-arm assembly into position on cylinder head with the drilled oil bracket on the front end. Install the remainder of cylinder-head bolts and tighten alternately and evenly in sequence to 80 foot-pounds (Fig. 40). Be sure to place stud with oil hole in the left front cylinder-head bolt hole. Retighten cylinder head after engine has been operated for a short period.



A-8337

Fig. 40

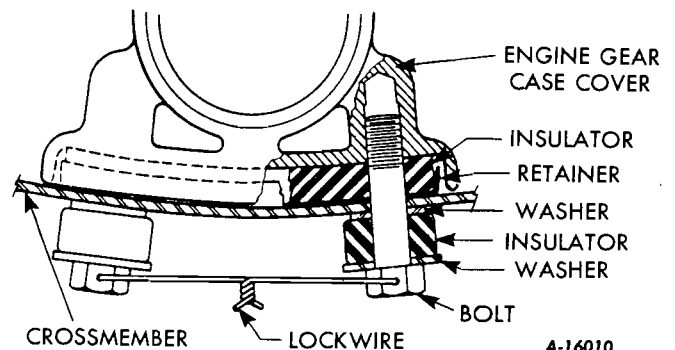
3. **ADJUSTING VALVES.** To adjust valve stem to valve rocker arm clearance correctly, each cylinder must be on top dead center on its compression stroke at the time of adjustment of valves for that cylinder. To determine the correct position, turn the engine crankshaft until No. 1 piston is at top dead center on compression stroke and the ignition timing mark on the crankshaft pulley in line with the pointer on the timing gear case. Adjust clearance on each valve of No. 1 cylinder to .018" to .020" by using a feeler gauge between valve stem and valve rocker arm and turn rocker arm adjusting screw out of rocker arm until clearance is obtained. Tighten adjusting screw lock nut and recheck clearance. (NOTE: Valve clearance should be rechecked with engine at normal operating temperature.)
4. Turn crankshaft one-third revolution and adjust clearance on No. 5 valves. Working in firing order sequence, continue to set valves of each of the remaining cylinders, turning crankshaft one-third turn after each valve adjustment.
5. **INSTALL INTAKE AND EXHAUST MANIFOLDS.** To facilitate installing the manifolds, after manifold gaskets and pilot rings are installed, start capscrews at end of intake manifold. This will permit the manifold to slide straight up between the engine head and capscrews and flat washers. When manifold is lined up with

pilot rings and gasket, tilt bottom of manifold toward engine block. This will force manifold out at top enough to bind against the two capscrews and hold manifold in position until the front and rear capscrews can be installed.

6. **INSTALL WATER PUMP** Place water pump gasket in position, at water pump opening in front of cylinder head. Install water pump and fan and install three capscrews and lockwashers in pump and cylinder block.
7. **INSTALL OIL FILTER.** Place oil filter and new gasket in place on cylinder block. Install four capscrews and lockwashers in oil filter base. (NOTE: Be sure filter assembly is thoroughly cleaned and a new cartridge is installed before replacement on engine.)
8. **INSTALL ACCESSORIES.** Install carburetor, generator, distributor and connecting wires, starter, fuel pump, ignition coil, gauge, and thermostat. Tighten fan belt sufficiently to secure 1/2" depression on belt midway between generator pulley and fan pulley.
9. **FILL ENGINE WITH OIL.** After making certain that oil drain plug is securely installed, fill crankcase with oil. After engine has been installed and placed in operation, again recheck oil level and add as necessary to bring oil level to full mark.
10. **INSTALL CYLINDER HEAD COVER** If engine is not to be installed at this time, install new cylinder-head cover gasket and install cylinder-head cover. Install three flat washers and three nuts on cover.

ENGINE MOUNTINGS

Fig. 41 and 42 illustrate engine front and rear mountings.



A-16010

Fig. 41 - Front mounting.

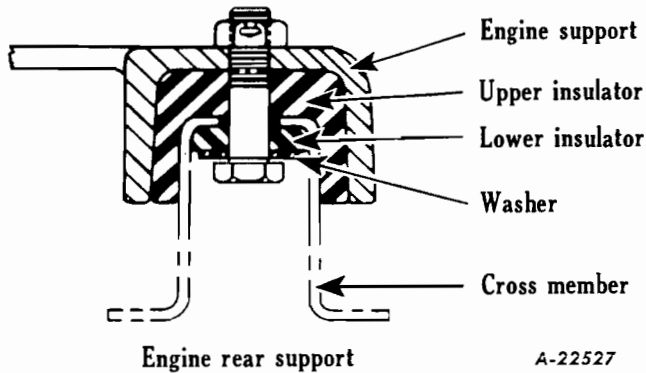


Fig. 42

OIL FILTER

1. The DeLuxe oil filter is used on the BD engines and incorporates a removable sump (Fig. 43).
2. Water, grit, metal particles, sludge and other contaminants that settle out of the oil are held in the sump away from the cartridge. When the cartridge is changed the cartridge and sump quickly and easily lift out as a single unit. Change filter cartridge and clean sump at regularly established periods; according to operating conditions.
3. When reassembling filter unit after complete disassembly: tighten center tube nut securely using wrench SE-1728.

CRANKCASE VENTILATION

The BD engine has a crankcase ventilator metering valve installed at the rear left side of engine on the tappet cover. To remove valve, disconnect the vacuum line and unscrew unit from tappet cover plate. To service, separate the two halves of the unit and remove weight. Clean all parts thoroughly. When reinstalling the valve, make sure the arrow on the housing is pointed up. (Fig. 44).

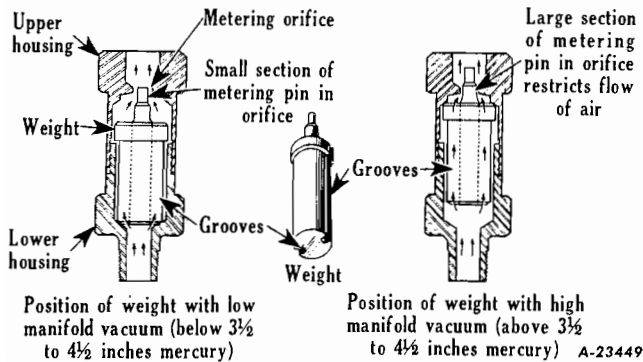


Fig. 44

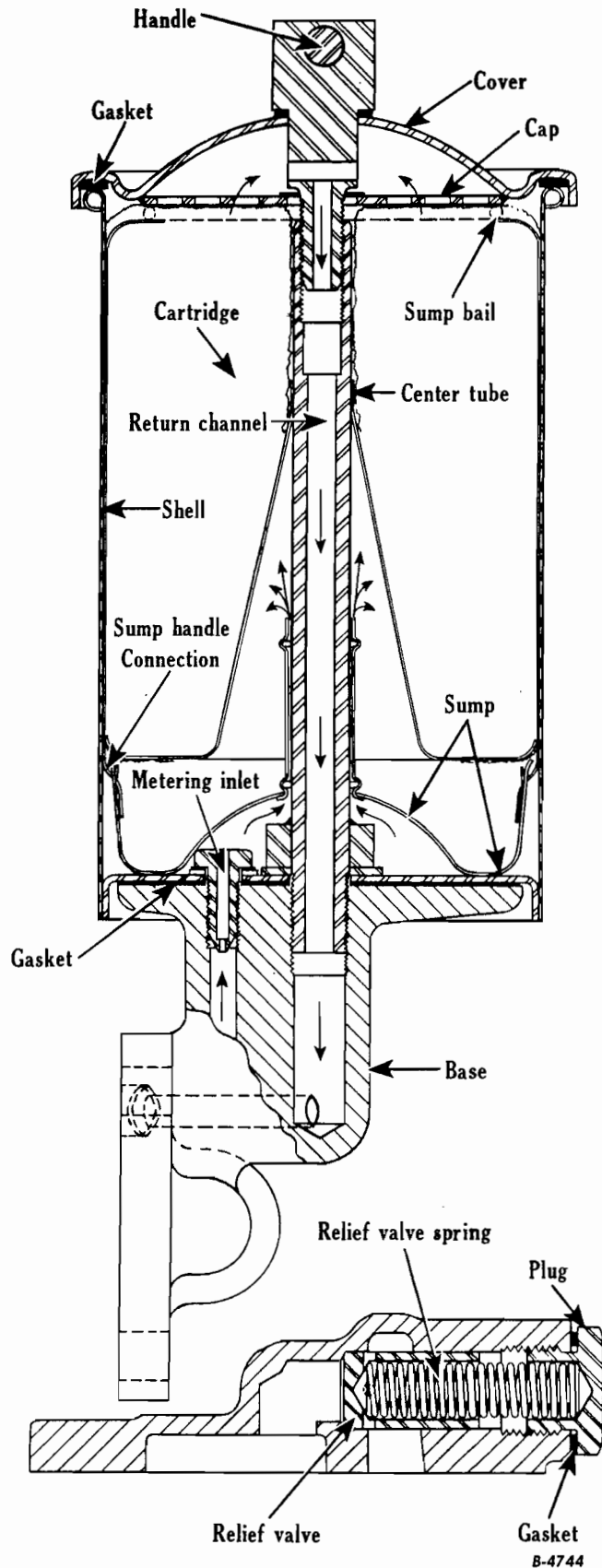
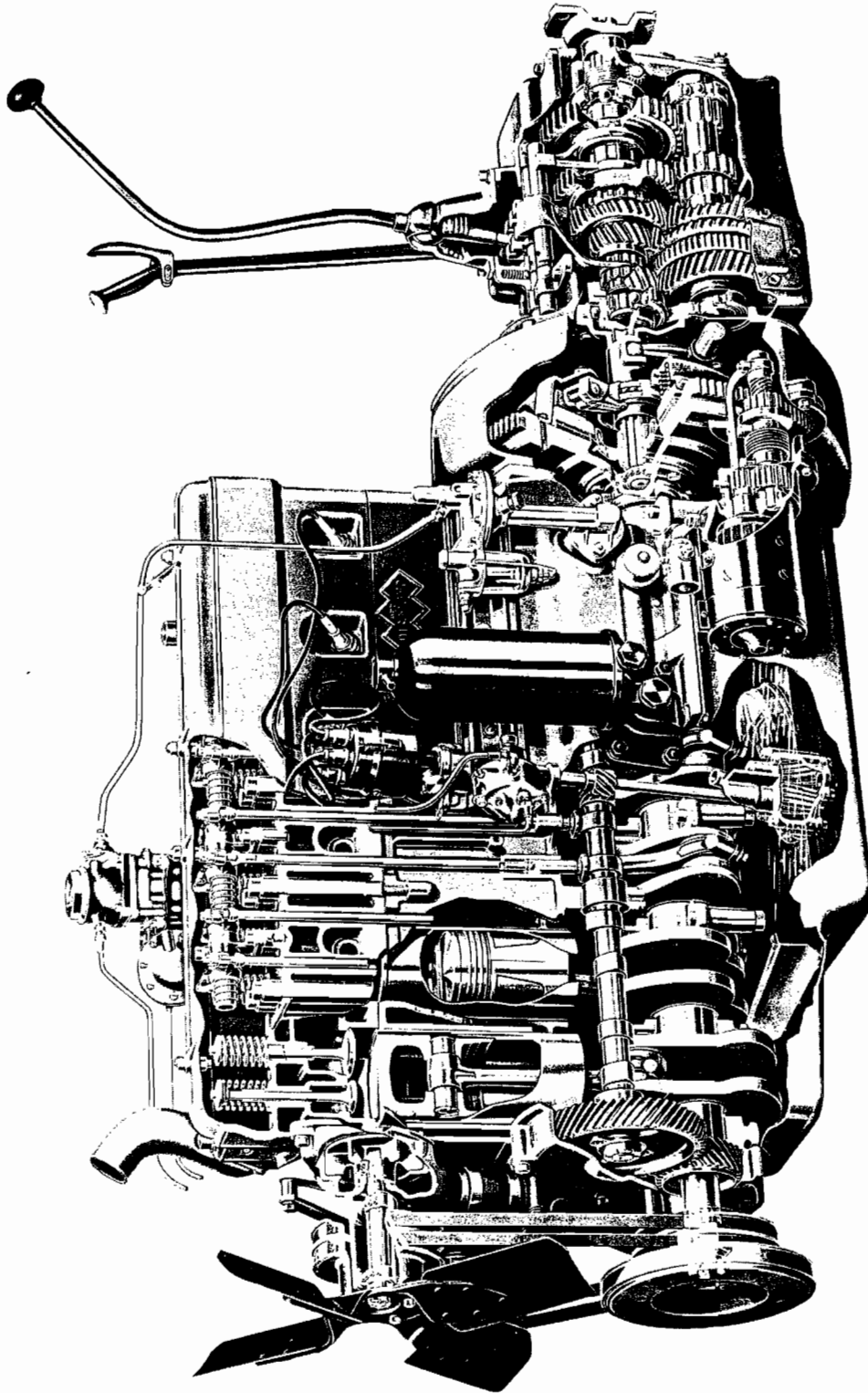


Fig. 43

B-4744



SUPER RED DIAMOND ENGINE



A-23188

Fig. 1 - Sectional view of Super Red Diamond Engine



DESCRIPTION

General

The Model RD, Super Red Diamond engine is a 4-cycle, 6-cylinder-in-line, overhead valve type engine (Fig. 1). The engine serial number is stamped on a pad at the front on the left side of the crankcase just below the cylinder head. The block has dry-type replaceable liners for the cylinder. The detachable cylinder head contains all valves, valve guides, and springs. The cylinders are numbered from front (fan and timing gear end) to rear. Engine crankshaft rotation is clockwise, as viewed from the front end of the vehicle. The intake and exhaust manifold, carburetor, and generator are located on the right side of the engine. The distributor, starter, fuel pump, and oil filter are located on the left side. The oil filler inlet is located on the left side of engine at the front. The bayonet type oil level gauge is located on the left side. The water pump is located at the front of engine.

Construction

1. The generator, fan, and water pump are driven by V-type belts from a driven pulley mounted on the front end of the crankshaft. The distributor, mounted at the left side of the engine, is driven by the camshaft through the oil pump.
2. The exhaust and intake manifolds are bolted to each other and to the right side of the engine head. The intake manifold is cast in one piece. The exhaust manifold is made of three parts which are held together by expansion clamps and seal.
3. A vibration damper is provided at the front end of the crankshaft.
4. The cylinder block and crankcase are cast in one piece, and carry the crankshaft main bearings. Water circulation passages completely surround the cylinders in the crankcase and also provide coolant to the cylinder head.
5. Oil is supplied under pressure by the oil pump to the engine lubrication system. Oil spray from the revolving crankshaft is distributed to the cylinder walls, pistons, and other moving parts inside the engine.
6. Exhaust valve seats are of alloy and are pressed into place. These valve seats lengthen the period between valve reconditioning operations. Valves and valve seats are cooled by continuous circulation of water through the cylinder head.

7. The detachable cylinder head is bolted to the crankcase, and a gas-tight and water-tight seal is maintained by means of a gasket.
8. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in seven precision-type replaceable shell bearings, the number seven (rear) bearing taking up the thrust. The rear main bearing is made up of two shell halves together with four thrust flanges. The two lower thrust flanges are held in position by dowels in the main bearing cap.
9. The pistons are made of an aluminum alloy, are cam ground, and are fitted with three compression rings and one oil control ring. The full-floating type piston pins are held in place in the pistons, at the ends of the pins, by snap rings.
10. The camshaft is machined from a solid drop forging and mounted in four special replaceable bearings.
11. The flywheel is bolted and doweled to the crankshaft flange. The timing mark is located on the front crankshaft pulley.

ENGINE REMOVAL

Disconnect the following electrical circuits, hose connections, and various units as outlined:

1. Drain engine oil pan. Drain all coolant from engine cooling system by opening the drain cock on side of engine as well as the radiator drain cock. Remove radiator filler cap when draining cooling system.
2. Disconnect upper and lower radiator hose connections. Disconnect engine air cleaner and remove air cleaner. Disconnect vacuum line at manifold. (Air line at compressor when vehicle is equipped with air brakes.)
3. Disconnect engine circuit wiring. This includes coil wire, starter cable, engine ground strap and instrument sender unit wires.
4. Disconnect fuel line at fuel pump. Disconnect throttle control linkage and remove choke wire at carburetor.
5. Remove hood and floor boards. Remove fenders and radiator grille as a unit.
6. Remove radiator mounting bolts and lift out radiator support and core assembly.



- Remove ending front mounting bolts from support bracket. These are the bolts at the front crossmember.
- Support transmission using floor jack or suitable blocking. Remove capscrews from around bell housing.
- Disconnect engine exhaust pipe at manifold.
- Attach engine sling to front and rear right side cylinder head bolts and remove engine.

- Remove rocker-arm assembly as a unit (Fig. 3).

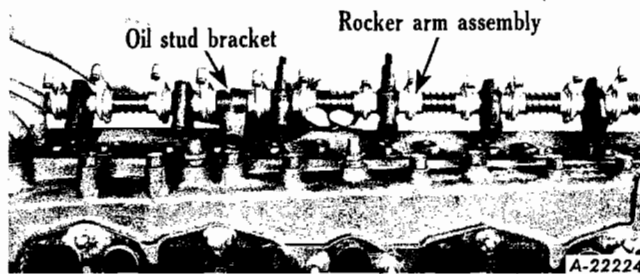


Fig. 3 - Removing Rocker Arm Assembly

ENGINE DISASSEMBLY

Install the engine in a suitable rotating engine overhaul stand. NOTE: Many of the disassembly operations can be performed with the engine in the chassis. However, the following disassembly outline is performed with the engine removed from the chassis to clearly illustrate each of the units. Except where indicated, no attempt has been made to prescribe a particular sequence for removing the various units, since some can be readily removed with the engine in the chassis. The extent of the service required on a particular unit will govern the necessity for its removal.

Removing Rocker Arms

The following steps are to be followed when removing the rocker-arm cover and rocker-arm assembly. (Carburetor and air cleaner previously removed):

- Remove four nuts from rocker-arm cover. Remove air cleaner line and remove cover.
- Remove nuts, capscrews and oil bolts from shaft brackets. NOTE: Third bolt from the rear on the left side of the cylinder head supplies oil to rocker arms (Fig. 2).

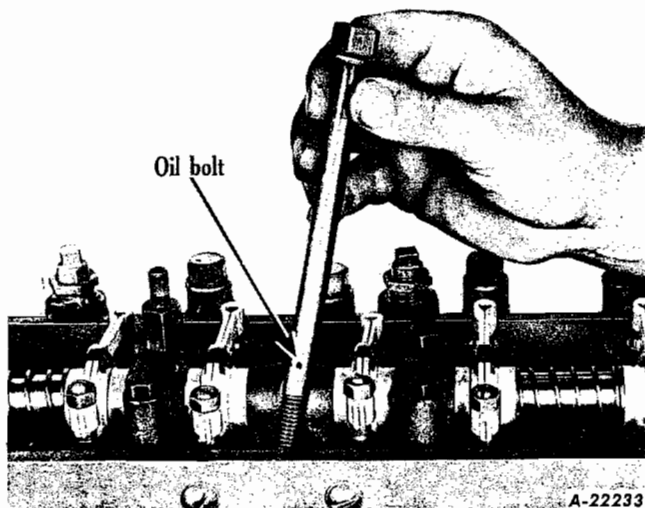


Fig. 2

Rocker-Arm and Valve Mechanism Disassembly

- The rocker-arm assembly is composed of front and rear shafts joined at the center, on which are mounted twelve rocker arms and four tension springs. The shafts are mounted in seven brackets, and are prevented from turning at the two center brackets which contain locking washers fitting into slots in the shaft. Remove locking washers from two center brackets (Fig. 4).

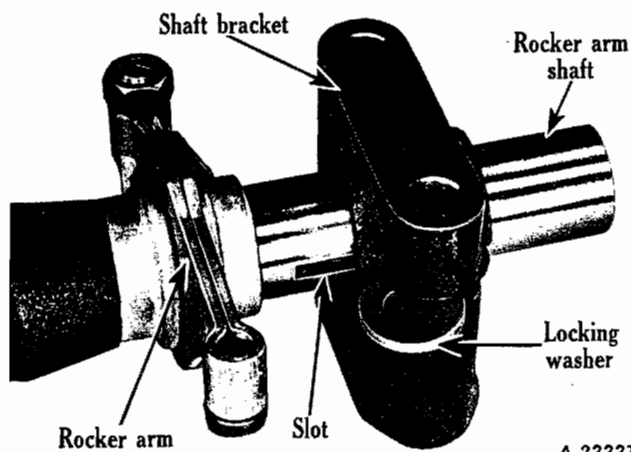


Fig. 4

- Separate the shafts, and slide rocker arms, springs, and brackets from shafts.
- Clean all parts in a solvent cleaning fluid, being careful to clean all accumulated sludge and carbon deposits from oil holes and slots.

Rocker Arm Inspection

Carefully inspect all parts for defects and wear.

- Inspect rocker-arm shaft and expansion plugs. Check on a surface plate for signs of bending, check for wear from rocker arms. If a shaft is bent or shows perceptible wear, it must be replaced.



2. Inspect rocker-arm adjusting screws for wear at contact surface and for thread wear. Replace worn screws. Check rocker-arm bushings. Inspect valve stem contact pad surface of rocker arm, and resurface if wear is perceptible. Do not remove more than .010" of material when resurfacing rocker-arm pads.
3. Inspect tension springs for breakage or loss of tension. Replace defective springs.

Re-Bushing Rocker Arms

With properly fitting adapter of special tool equipment provided (Figs. 5, 6 and 7), press old rocker-arm bushing from rocker arm. Place new rocker-arm bushing in position. Align oil hole in bushing with oil hole in rocker arm, which is located approximately 30° from top of rocker arm toward rocker-arm adjusting nut. Using installing tool, press new bushing into rocker arm. Burnish bushing into place in the rocker arm, then ream rocker-arm bushing to provide .0015" to .004" clearance. Ream dimension is .8745" - .8760".

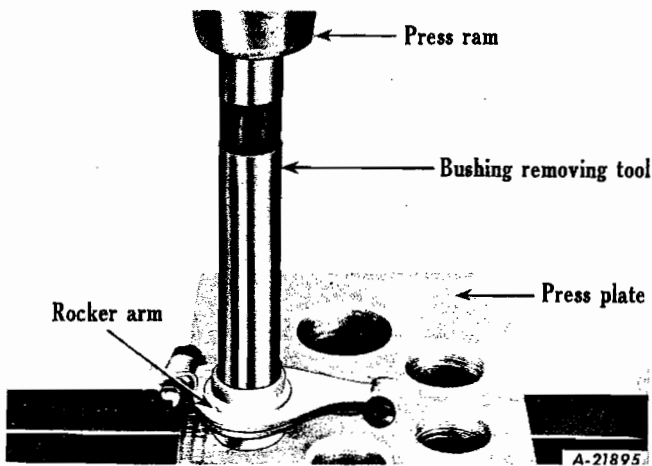


Fig. 5 - Use SE-1036-2 Bushing Removing Tool when removing the rocker arm bushing. Support the rocker arm on the SE-1033 support block. Select a hole in the support block to properly support the rocker arm at the same time permit the bushing to clear the support block when being removed. Use the support block when installing and burnishing the new bushing.

Cylinder Head and Valves

The following instructions are to be observed when reconditioning cylinder head and valves: Remove push rods (Fig. 8). Remove caps from end of exhaust valve stems, remove cylinder-head bolts and lift off cylinder head and gasket. Place cylinder head on bench.

1. Compress valve spring with a valve compressor and remove valve spring retainer locks. Remove retainer. Remove outer spring and inner spring. Remove valve

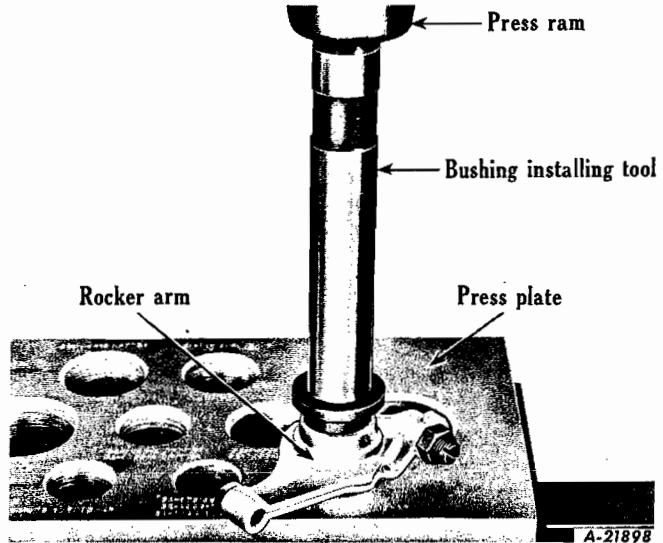


Fig. 6 - Showing method of installing new Rocker Arm Bushing.

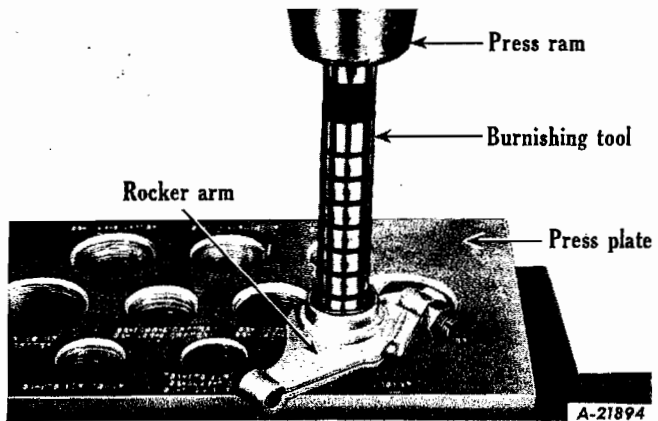


Fig. 7 - Burnishing Rocker Arm Bushing. Use SE-879 Burnishing Tool.

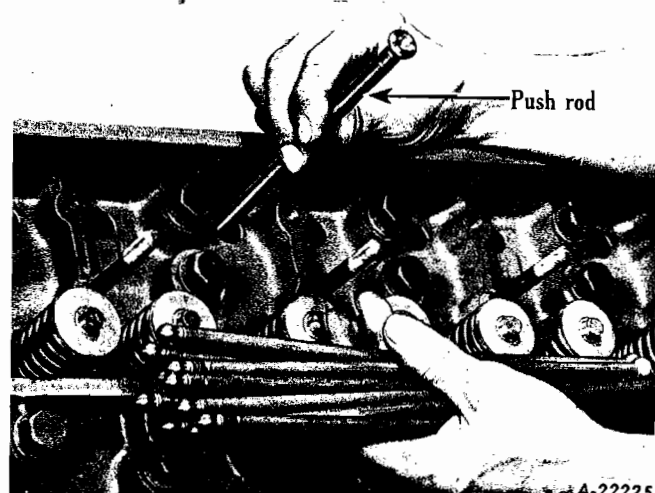


Fig. 8

spring spacer. NOTE: Valve springs are installed with close-coiled ends toward the cylinder head. Remove all valve springs as outlined.

2. Invert cylinder head. Remove all valves from their valve guides and from the head, keeping each valve in a suitable rack which will assure replacement of the valves in their original location.
3. Scrape all carbon from cylinder head combustion chamber, and clean any gasket material from surface of head. Clean the head using steam cleaning or other suitable cleaning equipment.
4. Clean all carbon deposits from valve heads and valve stems with wire brush. Wash all valve springs and retainers in cleaning solvent.

Inspection of Cylinder Head

1. Inspect cylinder head visually for signs of

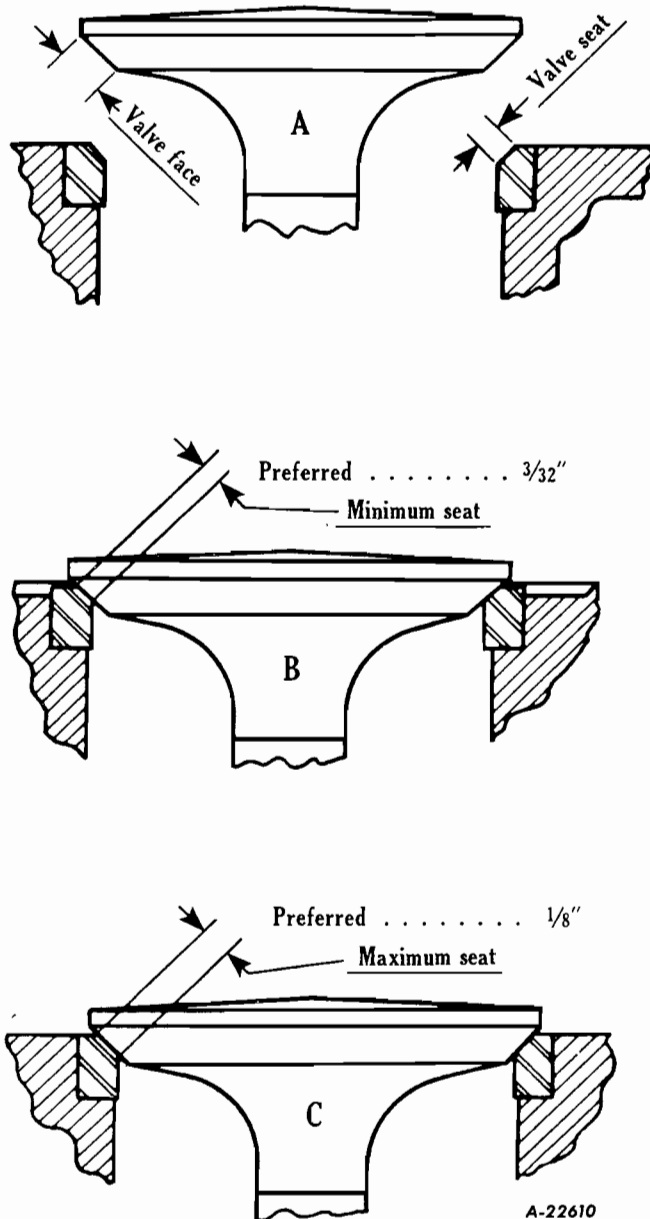


Fig. 9 - Valve Seat Widths, Exhaust.

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cracks or sand holes and if found defective, weld or replace head.

2. Inspect exhaust valve seat rings for looseness and inspect for excessive width of valve seat surface (Fig. 9). If insert rings are loose, replace. If a seat has been previously ground to such extent that it cannot be narrowed from top to bring to proper position near center of valve face, the ring must be replaced.

Inspection of Valve Guides, Valve Springs, and Valves

1. Clean valve guides with a suitable cleaning tool (Fig. 10). Check each valve guide with a "Go and No Go" gauge (Fig. 11), if available; otherwise, use a new valve to check fit. If "No-Go" portion of gauge enters, the guide must be replaced. Recommended valve stem to valve guide clearance is

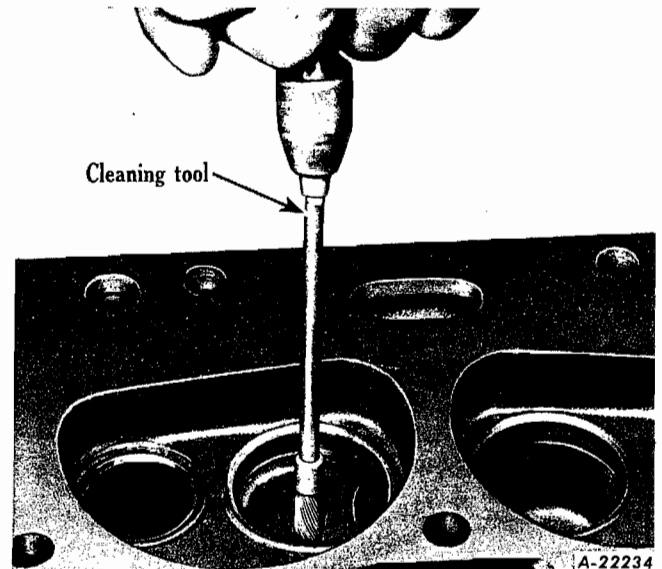


Fig. 10

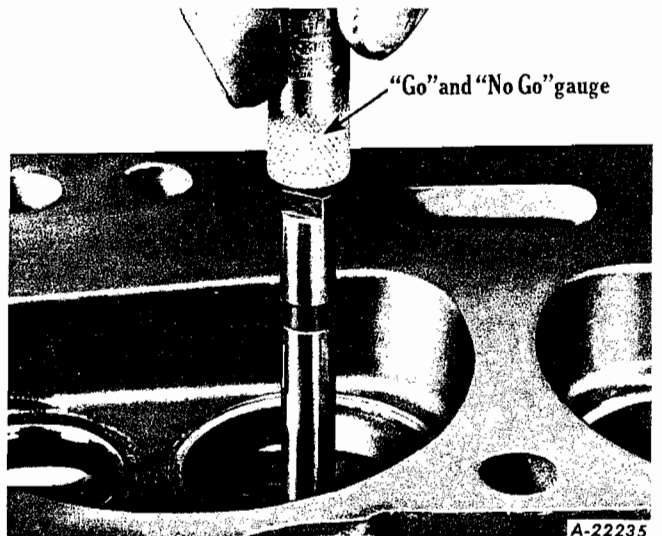


Fig. 11 - Use SE-1145 "Go and No-Go" set.



from .002" to .004" for exhaust valves, and from .0015" to .0035" for intake valves. Clearance in excess of .006" for intake valves or .008" for exhaust valves, requires guide replacement. Valve guides are reamed to .437" after assembly (Fig. 12).

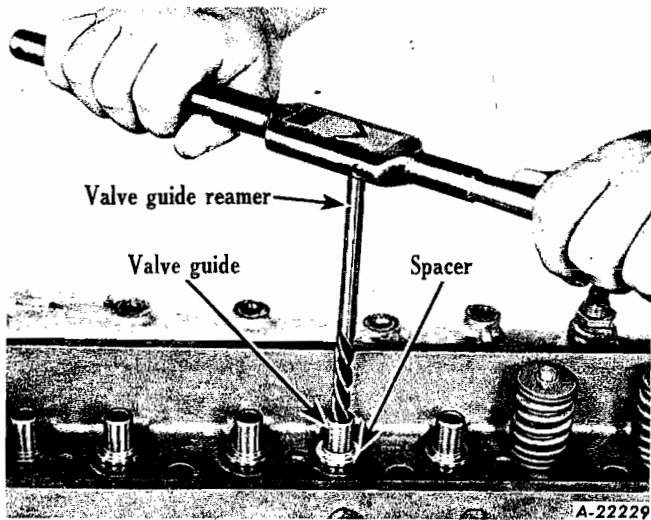


Fig. 12

2. Test valve springs (Fig. 13). Test tension of each valve spring at valve open length with a valve spring tester. Check inner valve springs at 1-1/2" length, replace if pressure is less than 86 pounds. Test outer spring at 1-45/64" length, and replace if pressure is less than 136 pounds.

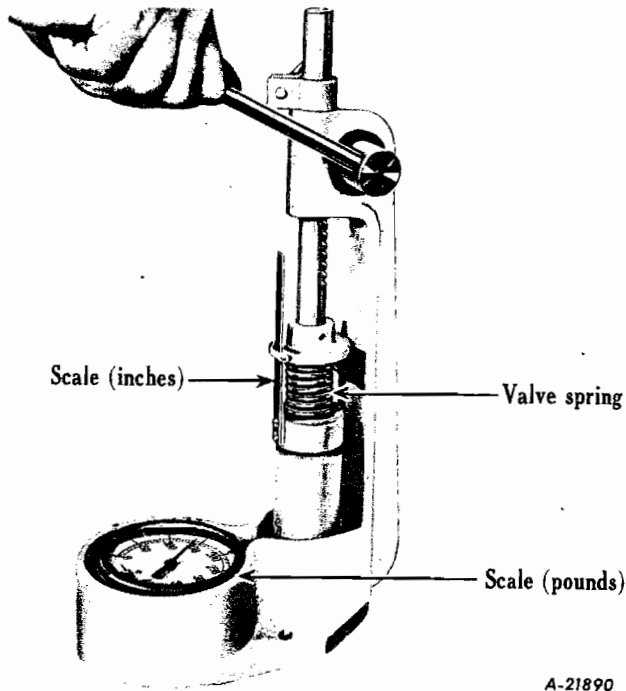


Fig. 13 - Testing valve springs in SE-1565 Valve Spring Testing Tool.

3. Inspect each valve for warpage, for severely burned condition, and for excessive grinding on the valve head. Inspect valve stem end for wear at contact surface with valve rocker arm. If valve is warped, excessively burned, or has been previously ground to extent that valve head is thin at edge, replace valve; otherwise, valve can be reconditioned and reinstalled.

Rotating Exhaust Valve Mechanism ("Slo-Roto Valves")

Valve burning is commonly caused by deposits accumulating on valve seat, thus holding valves open to be burned to escaping exhaust gases. Carbon deposits collecting under valve head hold valves open, further causing blow-by. With the valve slowly rotating, these accumulations are kept from forming to a great degree, thus improving valve life. All rotator parts are interchangeable, but should be checked after assembly to insure proper clearance required for rotation. Care should be taken not to damage or nick valve stem ends or tips as this will alter the clearance.

The parts involved in the rotating valve mechanism are: special spring seat retainer, a pair of flat half-moon keys, a close fitting cap located on the valve stem, and a specially constructed valve stem.

In order to accommodate valve expansion, the tappet lash (valve tappet clearance) must be maintained. When camshaft rotation causes this lash or tappet clearance to be taken up, the cap on the valve stem causes the valve keys to lower the spring retainer, removing the load of the valve springs from the valve before the valve is raised from its seat. A clearance of .002" to .006" should be maintained between the end face of the valve stem and cap (Fig. 14).

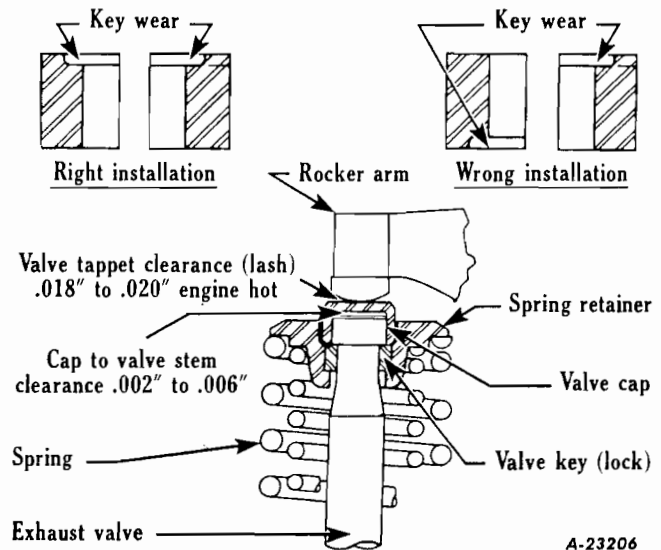


Fig. 14



This is the distance the spring retainer is lowered before the valve is moved. The slow valve rotating motion is caused by vibration of the valve, the flowing of exhaust gases around the valve head, and a slight rotating motion imparted to the valve by the valve spring.

Checking Clearance Between Valve Stem and Cap

Operation of the rotating valve feature required that clearance between the valve stem face and valve cap be maintained at all times.

If no clearance exists after assembly, remove cap, wash and wipe clean, then recheck clearance. Examine the keys to see if they are resting against the shoulder of the valve stem properly. If they are in proper position, replace the cap and check again. If clearance still does not exist, remove all parts and adjust clearance by grinding valve stem tip. If clearance is too great, remove enough stock from lower face or skirt of the cap to reduce clearance to the proper limits. NOTE: Because of manufacturing tolerances, in both valve stem ends and the valve cap, it is possible to select a new cap and valve combination with the required clearance.

Maximum service lift and efficiency is largely dependent upon cap-clearance which should be set at the time of installation at, or very near, the low limit of .002" to provide for the wear factor. Cap-clearance normally increases in service due to wear caused by impact of the half-moon keys against the shoulder on the valve stem. As the cap-clearance increases, the rate of wear increases due to longer key travel, which increases the impact.

When rotating mechanism parts have been fitted, the same combination or group of parts should be maintained once the engine is placed in service. After the valves have been in operation over an extended period, the keys may show signs of wear at the point of contact with the valve stem. As long as the .002" to .006" clearance is maintained, this wear is not harmful; however, when reinstalling keys make sure that both parts of the key set are in the same position, with the wear facing in the same direction (Fig. 14). This will eliminate cocking of the spring retainer. The valve keys can be reversed (turned worn side down) to utilize the unworn face of the keys, thus reestablishing the specified cap-clearance. However, when this practice is resorted to, it is important that an accurate check be made to assure that desired cap-clearance is present.

Check the rotating valve cap-clearance using the special clearance gauge as follows:

Remove cap from exhaust valve. (The rotating feature is used on the exhaust valves only) (Fig. 15). Make sure end of valve stem

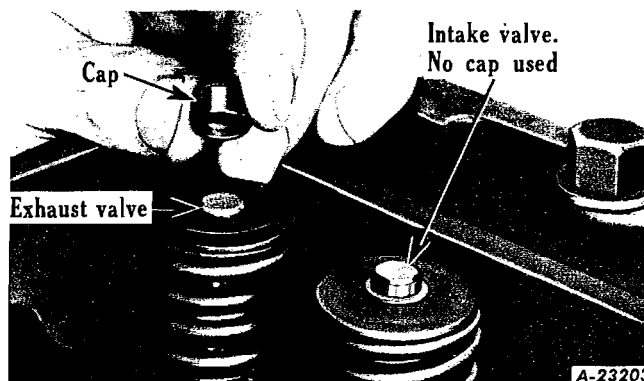


Fig. 15

and gauge plunger pin are clean. Place Clearance Gauge on end of exhaust valve with gauge set at "0" marking. Press the plunger pin of the gauge firmly against the valve stem and tighten clamp screw (Fig. 16). Remove gauge

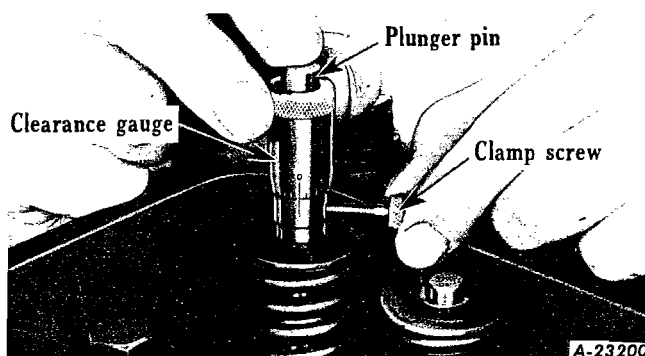


Fig. 16 - Showing use of SE-1726 Gauge.

from stem and place valve cap on plunger pin of gauge. The clearance (or lack of clearance) that existed between the valve stem and cap are now transferred to the end of the gauge plunger pin and valve cap and shows in thousandths of an inch on the spindle barrel (Fig. 17). Press

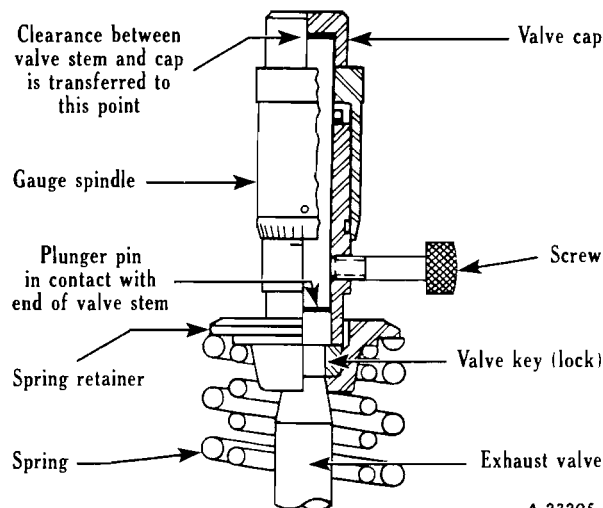


Fig. 17



the cap firmly against the gauge. Turn spindle of gauge to right or left until cap bottoms on gauge pin, and rim of cap just contacts top of gauge. Read gauge. Readings to right of Zero indicate positive clearance (see "B" in Fig. 18) and readings to left indicate negative clearance

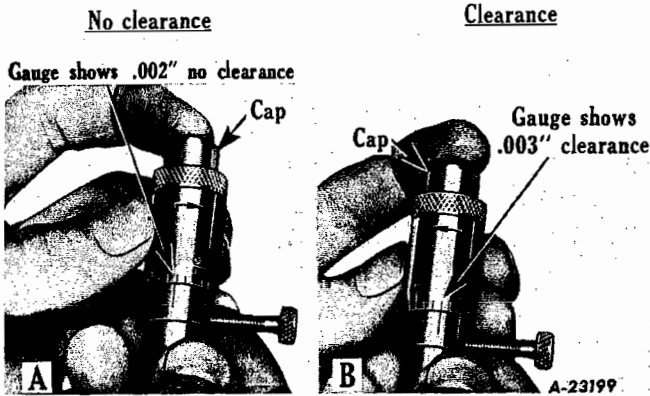


Fig. 18

(see "A" in Fig. 18). To check cap clearance with valve removed from engine, install keys and valve spring retainer under shoulder of valve stem. Position clearance gauge on valve stem. Place cap on plunger pin pressing down firmly. Turn spindle of gauge and check reading as outlined in foregoing (Fig. 19).

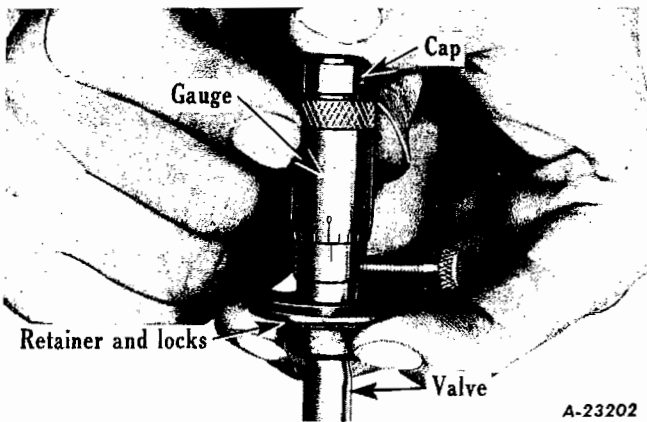


Fig. 19 - Checking cap clearance with valve removed.

Repair of Cylinder Head

1. If cylinder head has to be resurfaced, remove only enough material to true-up surface.
2. If any valve guide shows excessive clearance or out-of-round-condition, press guide from head. Install new guide, and press into head until approximately 1-1/16" remains above the top surface of the head. Check valve guides after installation to .002" to .004" for exhaust and .0015" to .0035" on intake with "Go and No-Go" gauge. Ream valve guides to .437" after assembly in cylinder head (Fig. 12).
3. If inspection indicates necessity, replace valve seat.

4. Grind valve seats in cylinder head to 45° for exhaust and 15° for intakes.

Reconditioning Valves and Seats

One of the principal difficulties experienced in reconditioning valves is obtaining nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.

The grinding stones on both the valve re-facing machine and valve seat grinder should be dressed before starting a reconditioning job. You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for true-ness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the head.

The location of the valve seat on the valve face and its width controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperatures and poor heat dissipation also produce excessive valve stem temperatures and hasten the accumulation of carbon on the stem, causing them to stick in the guides.

Valve Seat Widths

In general, the width of exhaust seat should range between the average and maximum specifications and the intake seats between the minimum and average specifications. The intake seats may be narrower than the exhaust



because they are usually larger in diameter, thus providing a total seat area approximately equal to smaller exhaust valve with the wider seat. Also the less severe heat conditions do not require as large a seat area for heat dissipation purposes. Figure 9 illustrates recommended valve seats to be obtained.

There are also objections to an excessively wide seat, a few of which are as follows:

1. In city or light delivery service, a wide seat collects carbon and particles of dirt that will produce variations or loss of compression, resulting in poor idle and possible loss of general performance and economy.
2. A wide seat in severe service operating in the presence of dirt or an excess of carbon will produce a badly pitted seat which may be just as detrimental to valve life as a too narrow seat. Under these conditions, a seat width to the minimum limit would possibly be better; however, the source of trouble which is the dirt and excessive carbon should be eliminated, making it possible to retain the wider seat.

Valve Seat Inserts

Necessity for replacing valve seat inserts should be very rare; however, if a replacement is made it is important that new inserts be peened securely in place, using either insert peening tool or a dull-pointed chisel, 1/4" wide, topeen cylinder head metal over outer edge of valve seat insert.

Valve seat insert installing tools are available.

Valve seat inserts supplied for service are standard size and .030" oversize which permits a tight fit in cylinder head.

Repair of Valves

1. True-up the ends of valve stem against face of grinder. NOTE: This refacing operation applies to the intake valves, however, in the case of the exhaust valves, where slow rotating valve mechanism is used, refacing of valve stems is not necessary except when clearance adjustment is made. See under "ROTATING EXHAUST VALVE MECHANISM". Remove only enough material to true the surface.
2. Reface exhaust valves to 45°. The valve face and valve seat angle must be identical.
3. Reface intake valves to 15° with valve seat being the same.

4. Place valves in cylinder head. Place a thin coat of Prussian blue on each valve face, and tap valve lightly to its seat.

NOTE: This is merely for test and proof of results of refacing and reseating operations. A poor grinding job cannot be corrected by valve lapping.

5. Inspect each valve coated with blue for seat position. The seat should be at the approximate center of the valve face. 3/32"-1/8" (exhaust) with the widest seat preferable. Intake seat should be 5/64"-7/64".

Valve Assembly

1. Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat valve stems and valve faces with oil, and install valves in same seats to which they were checked. NOTE: Check exhaust valve rotating mechanism to assure proper clearance between valve stem and cap before installing valves.
2. Install inner and outer valve springs. Install retainers. Compress valve springs with a valve spring compressor, and install valve spring retainer locks. Be sure that retainers and locks are correctly seated. Recheck exhaust valve cap clearance.

Engine Disassembly - Continued

When overhauling engine with head and pan removed, the following procedures are recommended:

1. Remove fan drive pulley nut and washer from end of crankshaft. Install puller and remove crankshaft fan drive pulley and damper assembly from crankshaft.
2. Remove nuts and capscrews from engine gear case cover, remove gear case cover. Remove crankshaft oil slinger from end of shaft. Push twelve tappets up into retaining clips to permit camshaft removal. Remove nut from end of camshaft and remove camshaft gear with puller. NOTE: Camshaft may be removed without removing timing gear, by removing thrust plate retainer screws.
3. Remove capscrews from camshaft retainer thrust flange plate. Remove camshaft. Remove two capscrews holding the gear case cover plate to block; remove plate and gasket. Remove crankshaft timing gear, using a gear puller. (NOTE: Lubricate puller screw to prevent damage to screw threads.)



Turn engine in the overhaul stand and proceed with disassembly as follows: (Fig. 20).

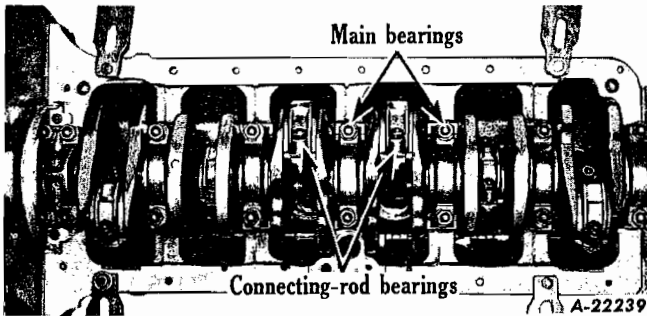


Fig. 20

4. Each connecting rod is numbered as to its position in the engine and these numbers are located on the camshaft side of the engine. Remove self-locking capscrews from connecting-rod cap and remove cap (Fig. 21). Push connecting-rod and piston assembly toward top of block. Lift piston and connecting-rod assembly from top of cylinder block. Replace cap on connecting rod. Remove the remaining pistons, following the same procedure.

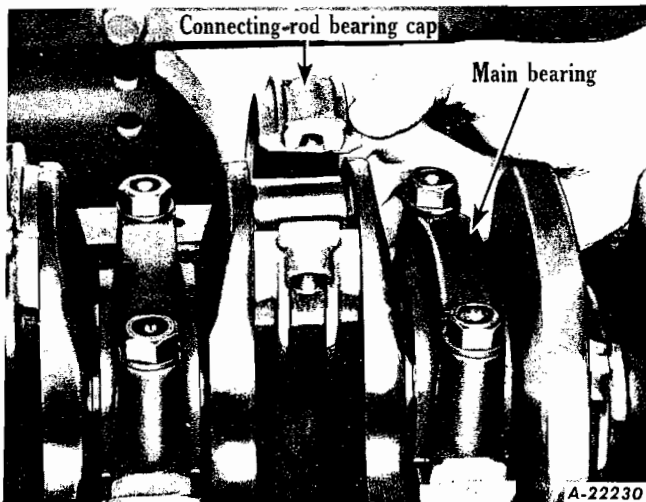


Fig. 21

5. The crankshaft bearing caps are numbered to identify their position and they must be reinstalled in their respective positions. Remove rear oil seal retainer (Fig. 22). Remove all crankshaft main bearing caps (Fig. 23). Remove twelve capscrews from clutch and remove clutch. Remove six self-locking bolts from flywheel. Install two 1/2" N.C. bolts, 2" long, in threaded holes in flywheel and force flywheel from crankshaft flange dowels (Fig. 24). Remove flywheel from housing. Remove six bolts from engine flywheel housing (Fig. 25). Tap housing with a soft hammer to knock it from dowels. Remove housing from crankcase. Lift crankshaft straight up and out of cylinder block and place in vise with

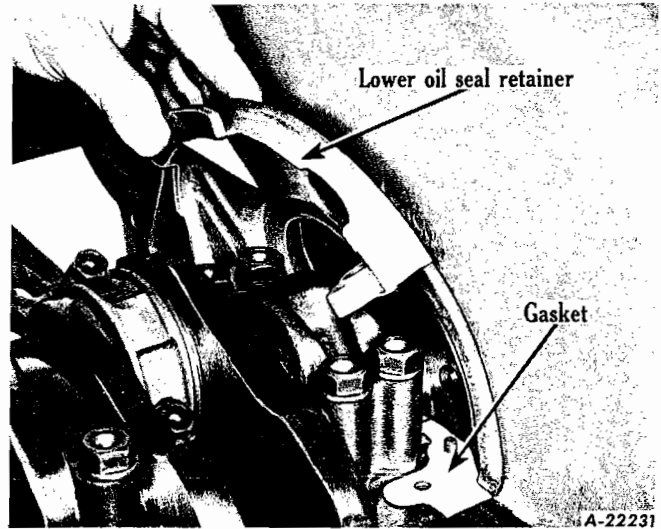


Fig. 22

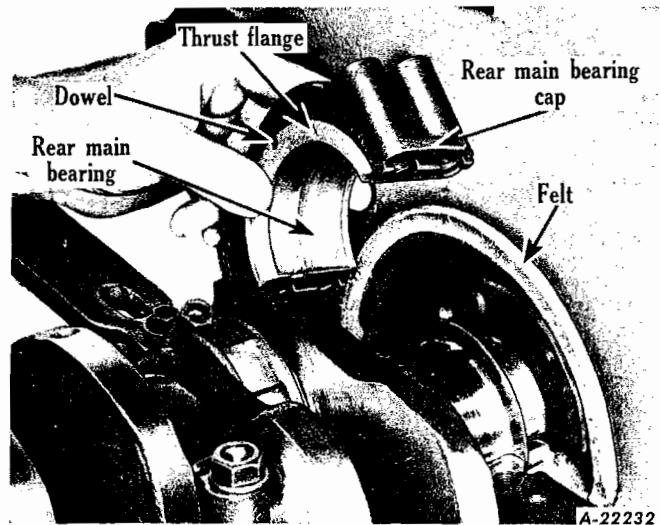


Fig. 23

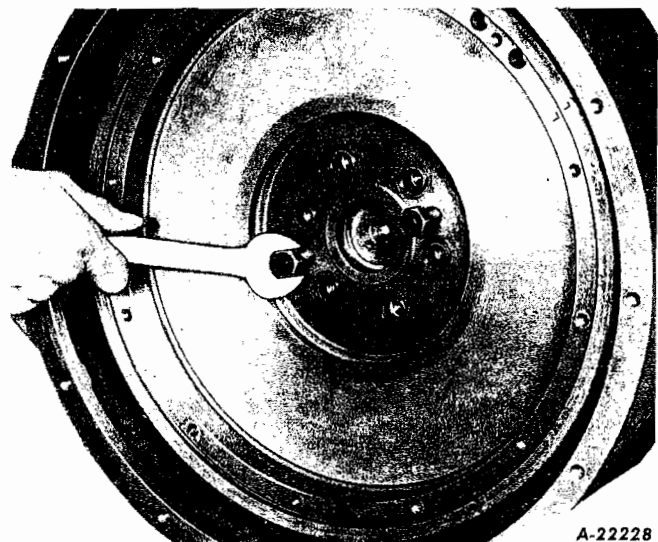
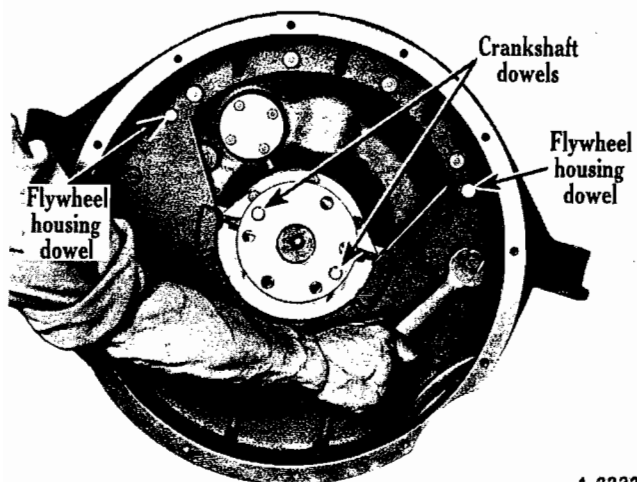


Fig. 24



A-22226

Fig. 25

soft jaws. NOTE: Self-locking bolts may be used instead of bolts requiring locking wires. The self-locking bolts, identifiable by the depression in their heads, require no locking wires.

- Remove fuel pump, starter, oil pressure regulator valve assembly, distributor, generator, oil gauge, and ignition coil.

Water Pump Removal and Overhaul

See sectional view of RD Engine water pump (Fig. 26). The water pump assembly is composed of a body and cover plate which house a ball-bearing mounted pump shaft and impeller. The rear and front bearings are pressed onto the shaft and are separated by a spacer. A slinger is held in place by two half lock rings. The shaft assembly with its two bearings is held in place in the housing by a retaining snap ring. The fan pulley is pressed onto the shaft (press fit .0007" to .0018") and held in place by a nut and plain washer.

The impeller seal assembly consists of a seal spring, seal clamp ring, flexible seal, seal

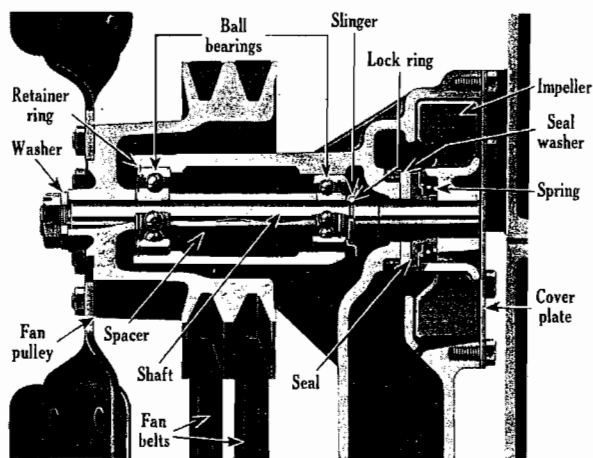


Fig. 26.

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spring guide, and a seal carbon washer. The parts are held in place in the impeller by a snap ring. The impeller and seal assembly is pressed onto the pump shaft (press fit of .002" to .0035").

Water Pump Disassembly

(Complete illustrated procedure for Water Pump Servicing is given in Shop Talk No. 14)

- Remove four capscrews and lockwashers holding fan to pulley. Remove fan blade assembly from pulley. Remove water pump from front end of cylinder head.
- Remove nut and flat washer holding pulley to water pump shaft. Remove pulley from water pump shaft with puller.
- Remove five capscrews from cover plate. Remove plate and gasket from pump body.
- Remove snap ring from in front of the water pump shaft front bearing. Supporting water pump on arbor press, push shaft and bearing as an assembly out of impeller from the rear.
- Support the shaft and bearing, assembly on an arbor press, force shaft out of bearing, spacer, and slinger, pressing shaft toward rear bearing. Be careful not to lose the two half-moon lock rings from under the slinger.
- Remove snap ring from groove in the front of impeller, and lift out the seal parts from the impeller.

Water Pump Cleaning and Inspection

- Following disassembly, wash all except rubber parts in cleaning solvent.
- Examine seal parts for wear, corrosion, or damage, and replace with new parts as necessary. Examine the pump body seal seat surface. If face of surface is scored, it must be resurfaced to prevent leakage. Inspect pump shaft bearing for wear or corrosion. If worn or corroded, replace bearings. Examine shaft for wear at ends, or for damaged threads at front end.

Water Pump Repair

If water pump body seal seat is scored, pitted, or rough, it must be resurfaced. Use special water pump housing seat finishing tool and adapter.

Water Pump Assembly

- Install rear bearing, spacer, and front bearing onto water pump shaft. Place



slinger in position behind rear bearing. Place two half-moon lock rings in groove in shaft, and press shaft into bearing and spacer from rear until rear bearing rests firmly against slinger and ring locks.

2. Place seal clamp ring, seal spring, seal spring guide, flexible seal and retainer, and carbon seal thrust washer into position in impeller. Hold them in position while installing snap ring in impeller groove.
3. Install water pump shaft and bearing assembly into body and hold in place by inserting snap ring in groove in front of front bearing.
4. Support water pump shaft at front end, press impeller and seal assembly onto rear end of water pump shaft. Press impeller only flush with end of shaft.
5. Place new gasket in position on water pump body and install cover plate and four capscrews.
6. Place fan assembly in position on front of pulley, and install six capscrews and lockwashers.

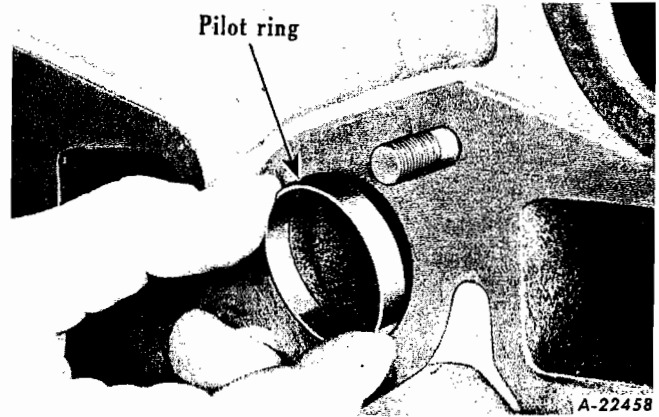


Fig. 28

2. To separate the two manifolds, remove the two outside bolts and nuts and two inside bolts and nuts from the center of manifolds.
3. The intake manifold is of one piece construction. The exhaust manifold is of three piece construction (Fig 29).

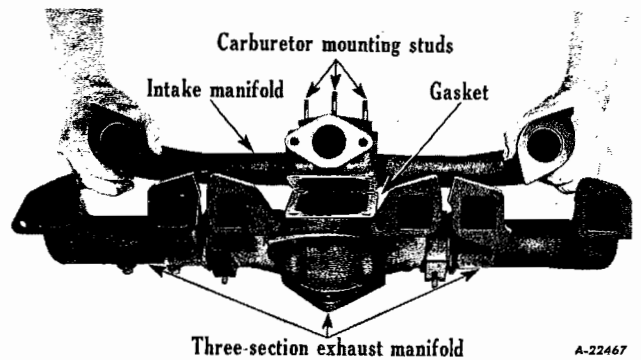


Fig. 29

Intake and Exhaust Manifolds

When disassembling and assembling the manifolds the following procedures are used:

1. After removing eight nuts, eight flat washers, four capscrews and three bolts from exhaust flange, remove both intake and exhaust manifolds as a unit (Fig. 27). Remove two manifold pilot rings (Fig.28). NOTE: Let manifolds cool before starting above operations; this will help to prevent manifold warpage.

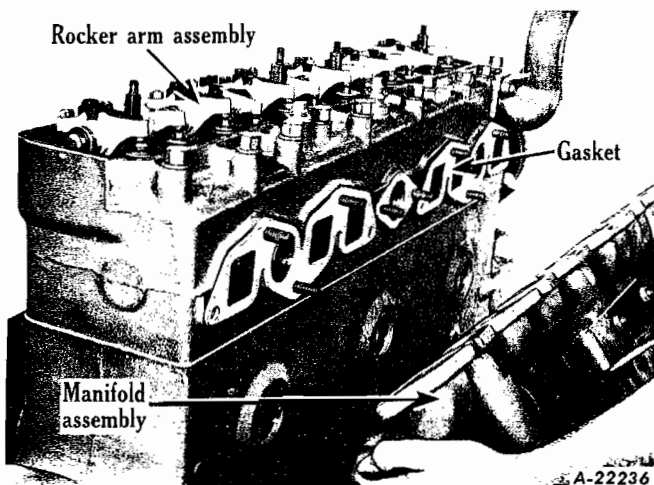


Fig. 27

Intake Manifold

1. The intake manifold consists of three outlets, each supplying fuel to two cylinders. Two studs are located on the top for carburetor mounting.
2. If vacuum is needed to operate any unit within the truck, a threaded inlet is provided in the manifold for such purposes.

Exhaust Manifold

The exhaust manifold consists of three parts and four outlets. The two end outlets remove burned gases from the No. 1 and No. 6 cylinders, while the two center outlets remove burned gases from Nos. 2, 3, 4, and 5 cylinders.

Manifold Inspection

Inspect intake and exhaust manifolds visually for cracks or breakage. Place manifolds

on surface plate and check for warpage. If cracked or broken, replace or weld. If slightly warped, true-up on surface grinder but replace if warpage is extreme.

Manifold Assembly

Place new gasket between the intake and exhaust manifolds and install four bolts and four nuts. Mount manifolds together loosely before installing on engine. This will assure proper alignment of the units with each other and with the engine cylinder head. NOTE: Do not eliminate the intake manifold aligning pilot rings. Tighten both manifolds to head. Tighten exhaust manifold expansion clamp bolts (Fig. 30), and replace with new seals if needed, and tighten intake to exhaust manifold bolts.

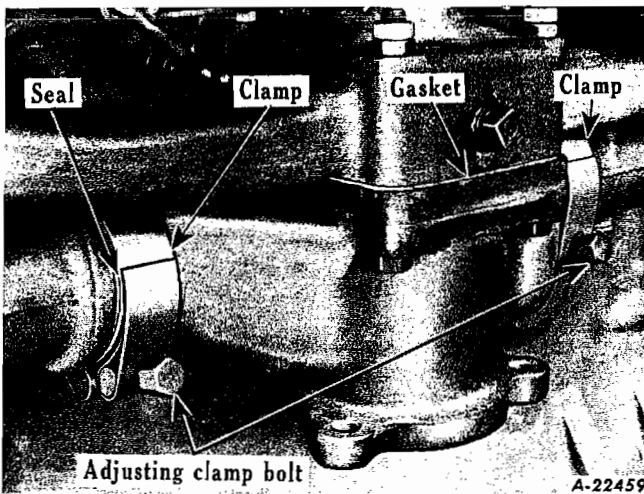


Fig. 30

Oil Pump Overhaul

(Complete illustrated procedure for Oil Pump Overhaul is given in Shop Talk No. 28)

Special tool equipment is available for oil pump overhaul under SE-1499. Use of these tools will speed up the job and assure accurate work.

Oil Pump Disassembly

See Sectional view of model RD engine oil pump (Fig. 31).

1. Remove cotter pin holding float to oil pump. Remove float from pump.
2. Remove six capscrews and lockwashers from oil pump body cover and lift cover and gaskets from oil pump body.
3. Lift out oil pump idler gear from idler gear shaft. After removing oil pump drive gear shaft guide from top of shaft, use small punch to drive out spiral gear pin from oil pump spiral gear. Using an adapter collar which fits underneath the spiral gear, and an adapter with a tang which will fit down into the slot of the oil pump drive

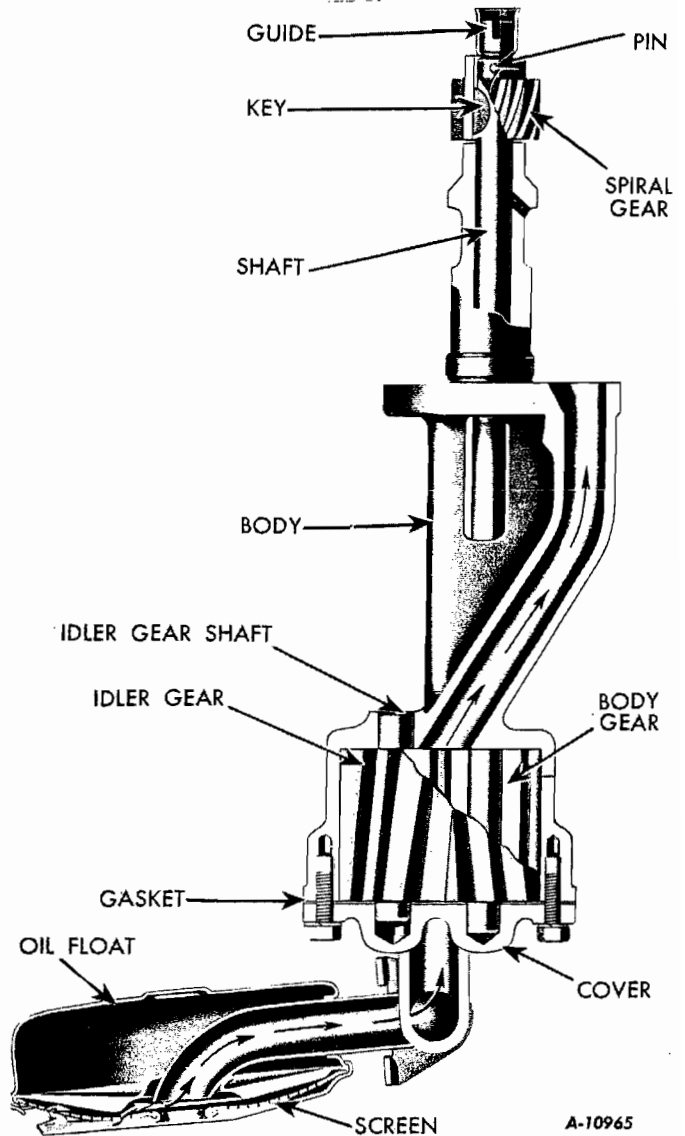


Fig. 31

shaft so as to apply pressure of press at bottom of slot, press oil pump drive shaft out of oil pump spiral gear. Remove Woodruff key from shaft. Remove oil pump body gear and oil pump drive shaft from oil pump body.

4. Press oil pump gear onto oil pump drive shaft far enough to reveal retainer ring. Remove ring from oil pump shaft. Press oil pump body gear from shaft and remove Woodruff key from shaft. Wash all parts in cleaning solvent.

Oil Pump Inspection

Check the following parts carefully:

1. Check the oil pump drive shaft for wear at points of contact with body. If wear is perceptible, the shaft must be replaced. Diameter of shaft is from .4985 to .4990 inches.



2. Check the oil pump body for warpage, damage and wear. Replace if body is warped or cracked, or if shaft bore is worn so that clearance between shaft and bore is in excess of .005". Inspect all oil pump gears, and replace if wear is perceptible.

Oil Pump Assembly

1. Press body gear onto oil pump drive shaft after placing new Woodruff key in slot of shaft. Press gear onto shaft far enough to permit installation of retainer ring in groove in oil pump. Press oil pump body gear down against ring.
2. Insert oil pump drive shaft and body gear into oil pump body. Install new Woodruff key in slot at top end of shaft. Install oil pump spiral gear, with gear hub down, onto drive shaft. Press spiral gear down onto shaft until 1/32" clearance remains between gear hub and pump body when oil pump body gear is up against pump body. Using hole in spiral gear as guide, drill .1255" hole in shaft. Drive new spiral gear pin into place. Install a new guide on the end of the pump shaft, use guide installing tool.
3. Install idler gear on idler gear shaft. Install gasket and oil pump body cover, and install four capscrews and lockwashers. Test oil pump body gear and play to cover by using a feeler gauge between oil pump spiral gear hub and oil pump body. End play must be from .0025"-.0055". If clearance is in excess of .0055", remove one gasket from cover. If clearance is less than .002", add one gasket between cover and body. Recheck end play after making any alterations. Insert oil pump into cylinder block so that slot in top of shaft is 30° angle to the side of the engine with the No. 1 piston in firing order (Fig. 32).

4. Insert oil pump float in oil pump body, line up cotter pin holes, install new cotter pin, and fasten securely.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR AND ASSEMBLY OF SUB-ASSEMBLIES

Cleaning the Cylinder Block

Remove all old gasket material from block, clean both inside and outside of block with steam or cleaning solvent. Remove all dirty oil, sludge, scale, and carbon from cylinder block.

Cylinder Block Inspection

1. Inspect cylinder walls for cracks. Weld cracks or replace block, if necessary.
2. Check top surface for trueness with a straight-edge. Test by attempting to insert a .012" feeler gauge ribbon between the straight-edge and the cylinder block. If this is possible, either surface grind or replace the cylinder block.
3. Inspect camshaft bearings for damaged or scored condition, and inspect for wear. Replace if damaged or if worn beyond clearance limit of .0035". End play should be from .001" to .0035". Special tool equipment is available for installation of the prereamed camshaft bearings (Fig. 33).
4. Measure cylinder walls with an inside reading micrometer to determine taper, out-of-round or worn condition. The measurements must be made not only at top of the cylinder bore, just below ring groove, but at several places around the inside circumference of the bore. Bore should be checked at the bottom, below ring wear surface, to determine the amount of taper. Re-sleeve if worn beyond .008" clearance.

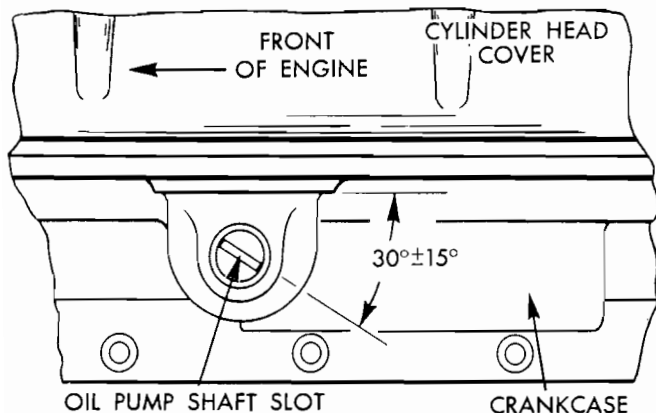


Fig. 32

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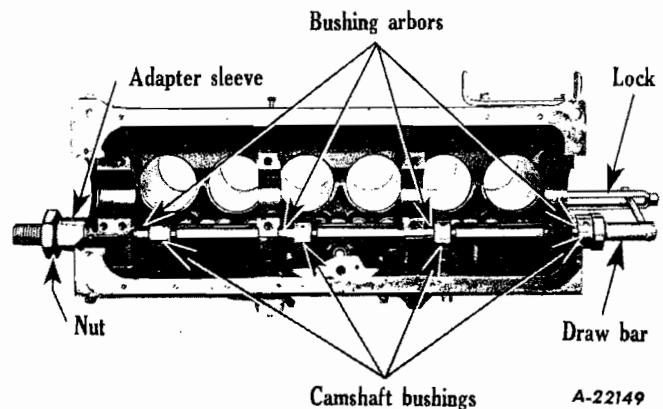


Fig. 33

A-22149

Cylinder Sleeve Fits

The fit of the cylinder sleeve in the crankcase should be 100 to 200 lbs. hand push fit or approximately .0005" to .001" loose fit. This fit can be obtained by honing the cylinder bore sufficiently in the crankcase until the cylinder sleeve can be pushed all the way in by hand.

Before installation of cylinder sleeve, the crankcase bores should be cleaned of all carbon and foreign matter.

Installation of cylinder sleeves in the foregoing manner will preclude to a large extent the necessity of excessive honing when fitting pistons to the cylinder sleeves. NOTE: New cylinder sleeves are rough honed and must be finish honed to size in the crankcase.

NOTE: If cylinder water jacket shows an excessive amount of lime deposits, the cooling system cannot provide effective heat dissipation.

Whenever the top of the sleeve flange goes below the top of the crankcase, a thin tag wire should be placed under the sleeve flange to raise it flush with the crankcase, or not to exceed .006" above the crankcase face.

Cylinder wall surface finish is of utmost importance in piston and piston ring life and in oil consumption control. The best type surface is one having characteristics midway between "smooth" and "highly polished". The resulting surface of a boring or honing operation consists of numerous microscopic scratches or grooves which act as oil reservoirs or retainers of oil while the surface between the grooves provides a load-bearing surface. If the scratches are too deep and too close together, the surface is referred to as "rough" and will not provide adequate ring and piston contact area which results in fast wear. Should the finish be highly polished or too "smooth", the scratches or grooves are shallow and will have insufficient oil-retaining capacity to provide adequate lubrication for the adjacent contact or load-bearing area and will result in scuffing or scoring. It is therefore advantageous to strike a "happy medium" by removing only the sharp peaks of these microscopic ridges and in this way still reap the benefits of the oil-retaining grooves. This type of cylinder wall surface is obtained through exercise of care in finishing operation and through proper use of equipment.

CAUTION: Extreme care must be taken to assure that no abrasive remains in the engine after the finish honing operation.

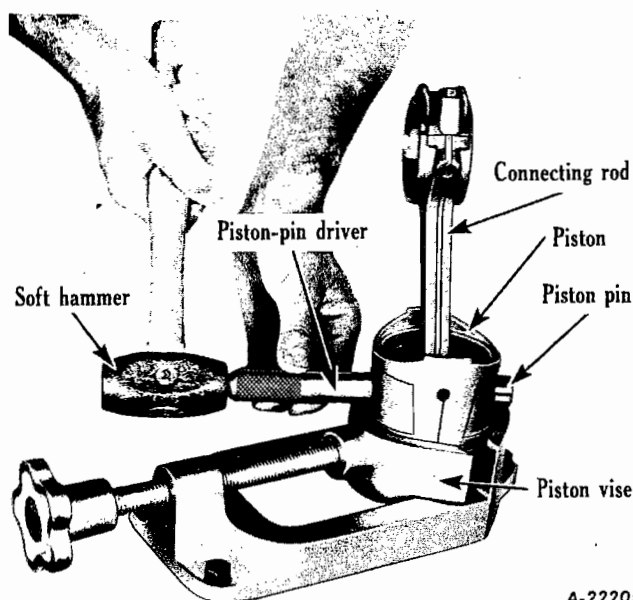
After engine has been reassembled, it should be allowed to run-in for two or three hours at a fast idle (approximately 1200 r.p.m.).

Replacing Camshaft Bushings

If camshaft bearing replacement is necessary, remove and install new bushings with special camshaft bearing installation tool. No reaming is required. Fig. 33 illustrates the use of camshaft bearing installing tool.

Connecting Rod and Piston Disassembly

1. Remove piston-pin retainers from each piston, and remove piston rings from piston ring grooves.
2. Heat piston in boiling water or piston heater. Place piston in piston vise, and using pin-driving tool, drive piston pin from piston and connecting rod (Fig. 34). After piston pin is removed, lift piston from connecting rod.



A-22205

Fig. 34 - Use suitable piston vise to hold piston and drive pin out with SE-1264 Piston Pin Driver. Use soft hammer.

3. Wash all parts in a cleaning solvent. CAUTION: Do not use a caustic solution for aluminum pistons. Clean the carbon from piston ring grooves with a broken ring or ring groove cleaner.
4. Inspect connecting rods, caps, and bearing shells. All connecting-rod bearings and piston-pin bushings should be replaced at every major overhaul. Test rods for alignment. Rods only slightly misaligned can be straightened with proper equipment. Badly twisted or bent connecting rods must be replaced.
5. Inspect pistons for cracks, breakage, or scores. Check piston ring grooves and ring lands for wear, using a new piston ring and feeler gauge. If clearance between ring and ring land exceeds .005",



(total clearance) replace piston (see specifications). Pistons which are scored or damaged, must be replaced.

6. Inspect piston pins for wear, and if wear is perceptible, replace pins. Replace piston pins which show signs of corrosion or etching.
7. With properly fitting adapter (Fig. 35), press old piston-pin bushing from connecting rod. Place new piston-pin bushing in position, align oil hole in bushing with oil hole in connecting rod, (Fig. 36), install bushing with a .0035" to .0055" press fit. Burnish bushing into place in the connecting rod (Fig. 37), then ream pin bushing to provide a hand-push fit.

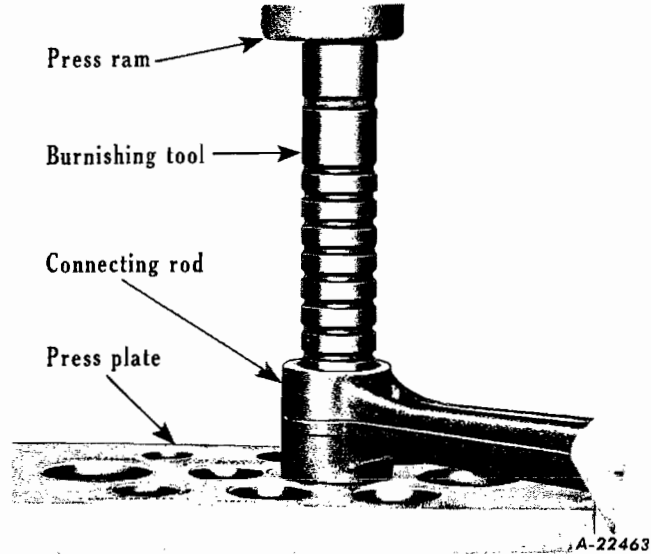


Fig. 37 - Burnish Bushing using SE-789.

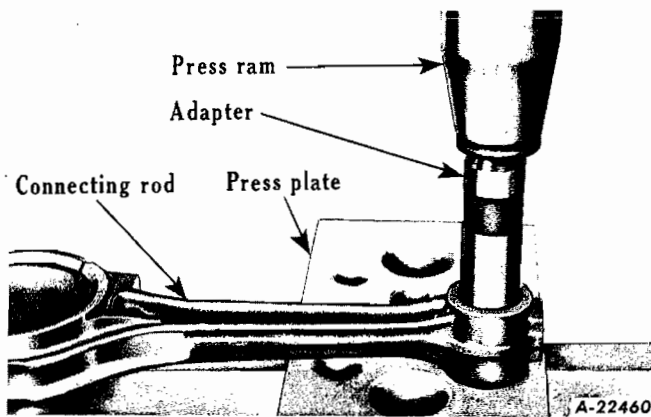


Fig. 35 - Use SE-1036-6 to remove bushing. Select proper hole in SE-1033 Support Plate.

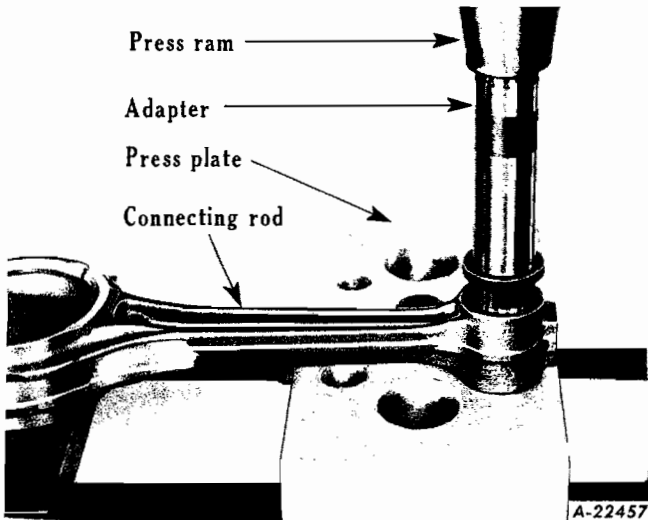


Fig. 36 - Installing new bushing in rod.

8. With reamer, ream piston pin bosses in piston to provide a tight fit of from .0000" to .0002" with piston pin.

Piston Fitting

When fitting pistons in the cylinder sleeves, use a .003" feeler ribbon 1/2" wide between the piston and cylinder, 90° from the piston pin hole and in line with the thrust face of the piston

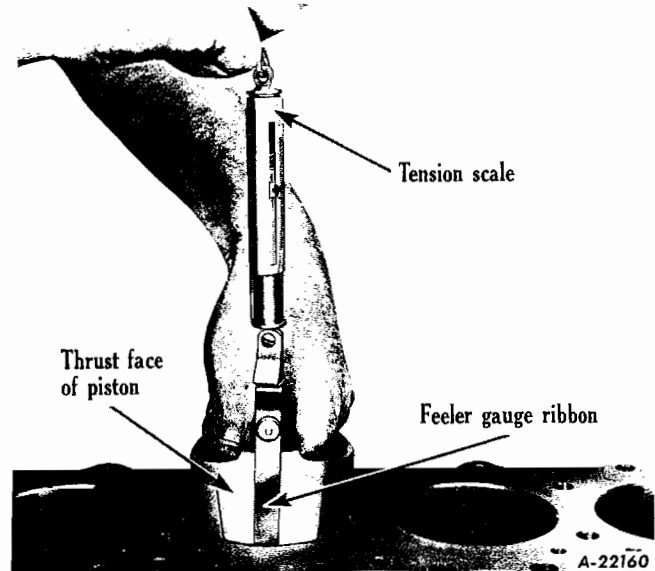


Fig. 38 - Checking piston fit using feeler gauge ribbon. SE-1007 gauge set is available.

(Fig. 35). Apply a tension pull on scale to the feeler ribbon and check clearance to specifications as outlined in the chart below.

Feeler Gauge Ribbon Checking	
Width	1/2"
Thickness . . . . .	.003"
Tension on Scale (lb.)	6-18
Desired Tension (lb.)	12

Connecting-Rod and Piston Assembly

1. With piston heated to approximately 200° F., support connecting rod in vise, push piston pin into piston bosses while piston is hot (Fig. 36). When assembling piston on rod, the slot in the piston skirt must be toward the camshaft side of the engine, which is the numbered side of the connecting rod. Install piston pin retainer in piston at each

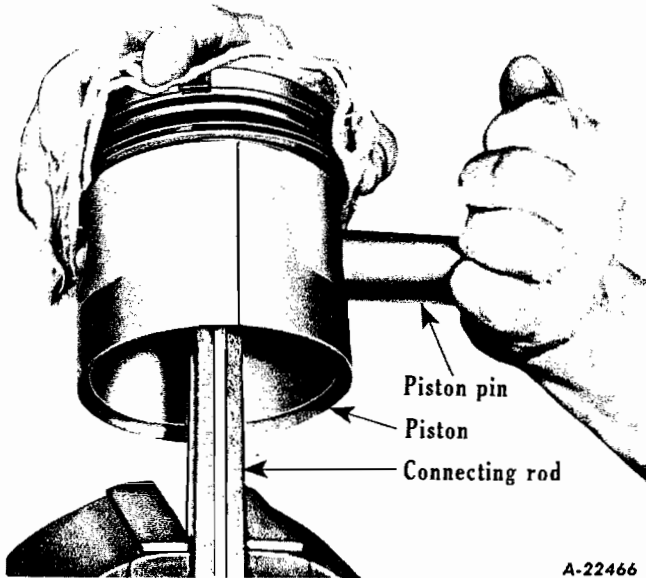


Fig. 39

end of pin, making sure that retainers seat fully and with tension in grooves. Test connecting-rod and piston assembly on a connecting-rod aligner, and correct any mis-alignment.

- Place piston and connecting rod in vise. Test each piston ring for proper gap by placing in cylinder and measuring gap with feeler gauge. Gap should be .016" to .026" (Fig. 40).

Piston Ring Installation

- Before installing rings in glazed cylinder bores, a surface-hone should be passed through the bores to remove the glaze and minor irregularities. This should only be done provided a thorough job of cleaning the grit and abrasives from the engine is performed after the honing operation. **IMPORTANT** -- if the engine is not thoroughly cleaned after surface-honing, the benefits are more than offset by damage caused by the remaining grit and abrasives.
- When installing piston rings in piston grooves, be careful not to distort rings. If possible, use a suitable piston ring expander tool (Fig. 41). Also check new piston rings in piston ring grooves for clearance between ring and ring lands. The correct ring clearance is shown in specifications.

Crankshaft Cleaning and Inspection

- Wash and clean crankshaft with cleaning solvent or steam.
- Inspect main-bearing and connecting-rod journals for wear. If journals show wear or out-of-round in excess of .003", the shaft should be either reground and under-size bearings installed, or replaced. Use micrometers for checking.

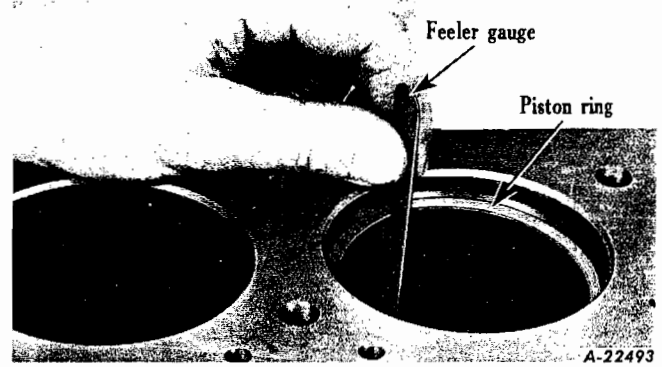


Fig. 40 - Checking ring gap.

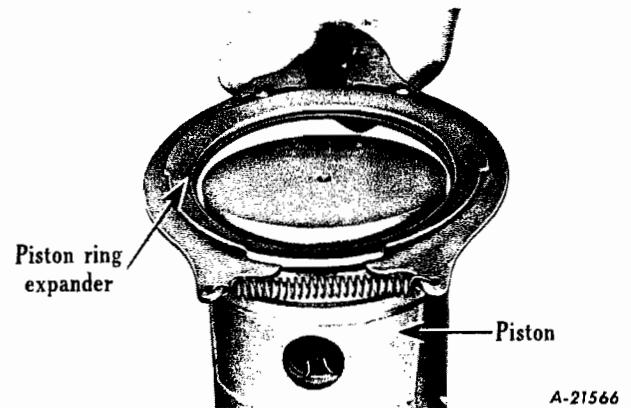


Fig. 41 - Installing piston ring using SE-1149-6 Ring Installing Tool.

- Check crankshaft and flywheel dowels for damage and fit, and replace if worn or damaged.
- Examine crankshaft timing gear teeth, and replace gear if teeth are worn or damaged. **NOTE:** Replace timing gear on camshaft when replacing crankshaft gear. These gears are provided in matched sets.
- Install Woodruff key in groove in crankshaft. Heat crankshaft gear in boiling water or piston heater. This will expand the gear enough to allow it to be tapped onto the crankshaft without the danger of damaging the gear. A special crankshaft gear installing tool is available.

Flywheel and Ring Gear Inspection

- Clean flywheel and ring gear with a cleaning solvent, remove all traces of oil and grease.
- Inspect the flywheel ring gear. If any teeth are damaged, or if ring gear is loose on flywheel, the ring gear must be replaced.
- Check the flywheel dowel holes and mounting bolt holes for wear, also check for flywheel having been loose.



4. To replace flywheel ring gear, heat gear with torch, and remove from flywheel with a hammer and drift. Heat new ring gear with torch, heating evenly all the way around. While the ring gear is hot, install gear on flywheel and allow it to cool.
5. Check pilot bearing in flywheel for wear or damage and replace if needed.
6. Install flywheel on crankshaft. Install six self-locking capscrews, drive dowel pins through flywheel to crankshaft. Tighten to 155 foot-pounds.

Camshaft Cleaning and Inspection

1. Wash camshaft in cleaning solvent, brushing to facilitate removal of all sludge or carbon deposits.
2. Inspect camshaft journals for signs of wear or out-of-round.
3. Inspect oil pump drive gear in center of shaft. If teeth are worn or damaged, the camshaft must be replaced, as the gear is integral with shaft.
4. Inspect camshaft lobes. If worn, chipped, or scored, replace the camshaft.
5. Inspect camshaft gear, and replace if wear is evident or gear teeth are nicked or otherwise damaged. NOTE: Timing gears are factory matched and are furnished in sets. The gears should be replaced in sets.
6. To reassemble, install thrust flange over end of camshaft. Install Woodruff key in slot in shaft. Place camshaft gear in boiling water or piston heater, and install over Woodruff key. Install camshaft nut and tighten to approximately 120 foot-pounds tension.

Cleaning and Inspecting Miscellaneous Parts

1. Cleaning miscellaneous engine parts. This includes brackets, oil pan, engine case cover, flywheel housing, and other parts that were removed during disassembly of engine and were not covered by procedure. Wash in cleaning solvent or steam clean preliminary to inspection.
2. Check all twelve valve lifter or push rods for straightness by rolling on flat surface. Replace any that are bent or have loose ends.
3. Inspect oil pan for cracks or deep bends, and straighten or weld.
4. Inspect oil pan drain plug and drain plug

boss for fit and thread wear. If plug is loose or threads are damaged, repair threads or replace oil pan.

5. Inspect crankshaft pulley and vibration damper assembly for evidence of rubber coming loose from pulley flange plate, and inspect for wear. Replace damper assembly if either condition is encountered. Do not submerge vibration damper assembly in hot cleaning solvents. Inspect crankshaft fan drive pulley for wear in hub bore. If inner diameter of bore is worn, scored, or Woodruff key way damaged, replace pulley.
6. Inspect engine gear case cover, and replace if cracked or broken. Remove old cover seal and install new seal.
7. Check each of twelve engine valve tappets for irregular wear, chipping, cracking or scores. Replace defective tappets.
8. Inspect engine flywheel housing for cracks or breakage and replace if damaged. Inspect flywheel housing to crankcase pilot dowel holes for wear. If wear is evident, drill or ream the holes and install oversize dowels. Also inspect dowels for wear and replace if wear is evident.
9. Inspect all capscrews and nuts for thread wear or breakage, and replace as necessary. Use new lockwashers when reassembling engine.
10. All gaskets and oil seals must be replaced at each overhaul or major repair.

ASSEMBLY OF ENGINE

When all parts have been cleaned, inspected, and repaired, and necessary replacement parts have been procured, install engine cylinder block in engine overhaul stand for re-assembly.

Main-Bearing and Connecting-Rod Bearing Installation

It is essential that main bearings be in alignment with the crankshaft journals. The model RD engines have the main bearing caps piloted in the crankcase (Fig. 42). All bolts should be carefully examined before installation.

BEARING CRUSH. Undersize precision type bearing shells should be installed when, because of wear, bearing-to-crankshaft running clearances are to be reduced. Bearing caps must not be filed, lapped, or in any other manner reworked.

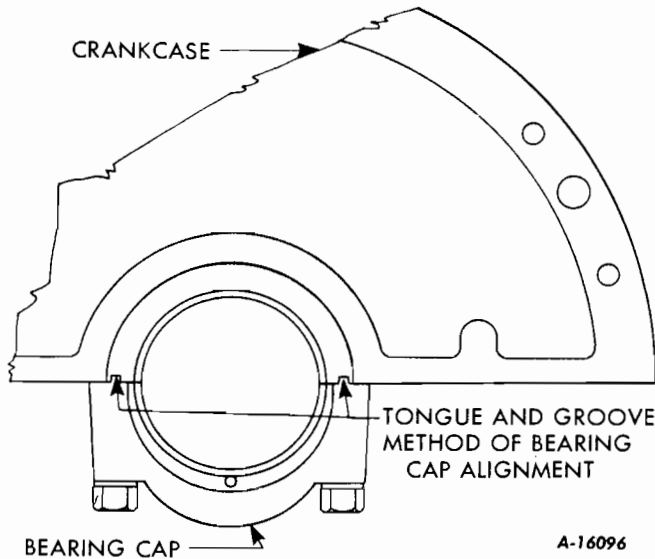


Fig. 42 illustrates tongue and groove method of Bearing Cap Alignment with crankcase.

Premature bearing failure will result from attempts to reduce journal-to-bearing running clearance by reworking of either bearing caps, bearings, or both, because such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush".

When installing precision type connecting rod or main bearings, it is important that the bearing shells fit tightly in the rod or case bore. To accomplish this, the bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled. When the assembly is drawn up tight, the bearing is compressed, assuring a good contact between the bearing back and the bore. This increased diameter is referred to as bearing "crush" (Fig. 43).

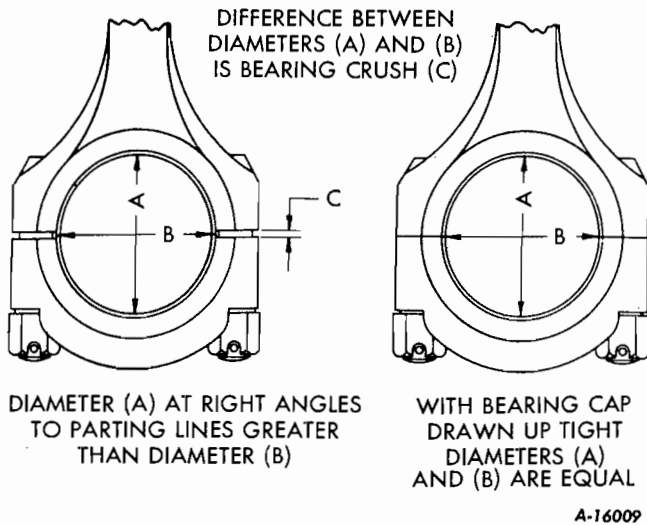


Fig. 43

To obtain proper bearing assembly with the correct "crush", care must be taken when tightening the clamping bolts to make sure they are drawn down alternately and evenly, using a tension wrench and tightening as specified.

As a result of excessive bearing crush, due to reworking the caps, the rod or main bearing bore will possibly become distorted because more force is required to draw the cap and housing together.

Rods, caps, or blocks must not be filed, lapped, or in any other manner reworked in order to reduce clearance. While such practice will make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion. New bearing shells will have to be installed eventually and that is when additional trouble starts.

In general, a visual inspection of the parting faces of the rod or caps under a magnifying glass will provide sufficient proof of any attempt at reworking. Under the glass, the parting surface of standard parts will show the manufacturing cutter tool marks and will not have a polished or extremely smooth appearance. On the other hand, reworked parts will have a polished surface and, if a file was used, will show the even pattern of the file teeth. Seriousness of this condition is in direct proportion to the amount of reworking.

BEARING SPREAD. Main and connecting-rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting rod bore into which they are assembled. For example, the width across the open ends of the engine connecting rod bearing not in place is approximately .025" more than when the

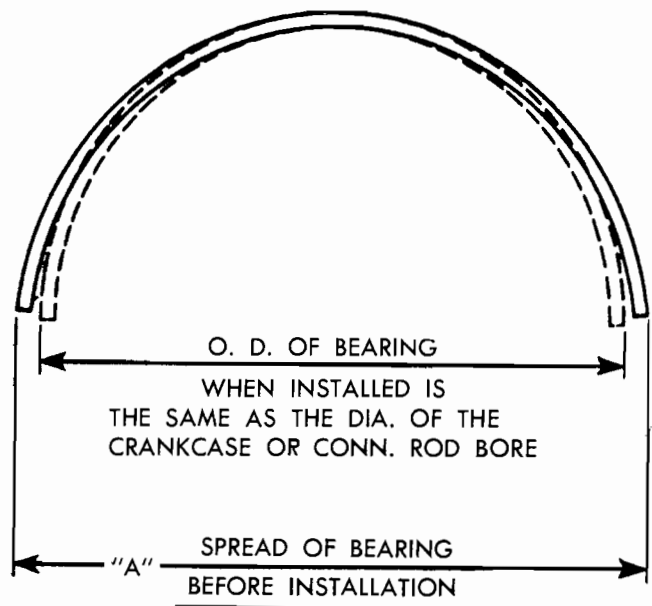


Fig. 44

ENGINES

Super Red Diamond

Section C

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bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat (Fig. 44).

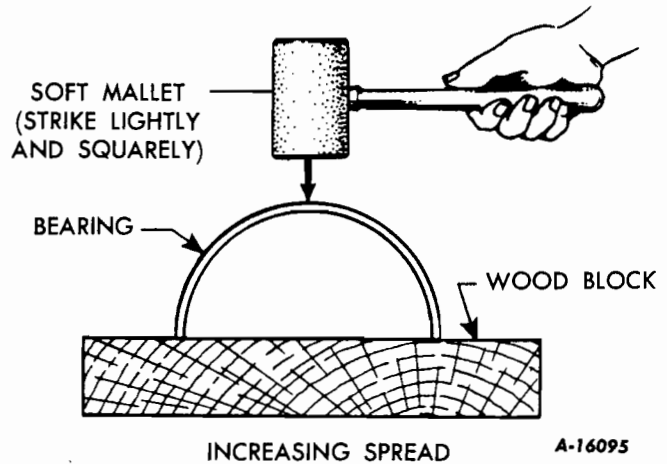
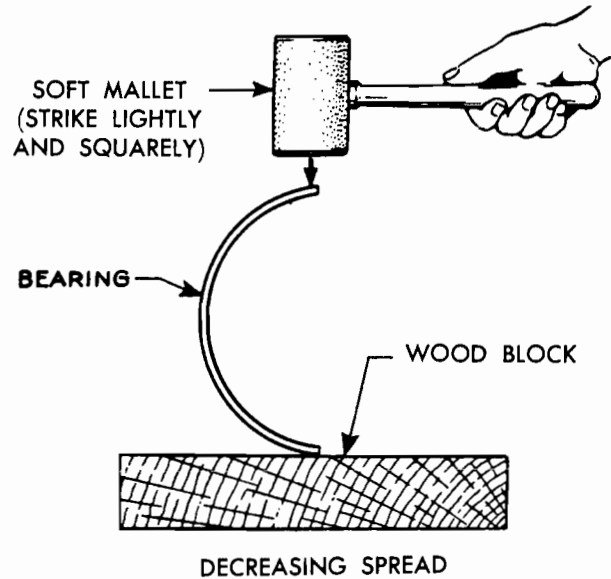
Rough handling in shipment, storage, or normal results of use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread should, therefore, be carefully measured and corrected as necessary before installation in an engine.

Bearing spread can be safely adjusted as follows, although care and judgment should be exercised in the process:

1. **Excessive spread.** If measurement of spread indicates that distance "A" is excessive (see chart for specifications), place bearing on a wood block and strike the side lightly and squarely with a soft mallet (Fig. 45). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.
2. **Insufficient spread.** If measurement of spread indicates insufficient spread, place bearing on wood block and strike the back of the bearing lightly and squarely with a soft mallet (Fig. 45). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

Chart of Bearing Spread Dimensions. RD Engine (Minimum)		
"A"	Connecting-Rod Bearing	2.8985" + .025"
	Main Bearing	3.424" + .025"

1. **INSTALL CRANKSHAFT AND MAIN BEARINGS.** Clean all surfaces of crankshaft bearing journals and wipe clean the bearing bores in the cylinder block. Remove main bearing cap self-locking capscrews and main bearing cap. Wipe backs of cylinder block half of bearings, making sure that dirt and oil is removed. Place bearing shell halves in position in bore in cylinder block, making sure that bearing shells are fully seated, that oil holes in bearing shells line up with oil holes in cylinder block, and that locking tangs on bearings fit into recesses. Follow same procedure, place bearing shell cap halves in bearing caps. Place a film of engine oil on bearing shell surfaces and lift crankshaft to align itself in the bearings, and also provide lubrication. Place bearing caps and bearing lower halves over crankshaft journals. Be sure bearing caps are properly installed with numbers to camshaft.



A-16095

Fig. 45

2. In order that an accurate measurement can be made to check all bearing clearances, a material similar to "plastigage" or "virgin lead" can be used.
3. Use the following instructions when using "plastigage":
 - (a) Remove oil from bearing cap insert and exposed half of crankshaft journal.
 - (b) Place a piece of "plastigage" the full width of the bearing insert.
 - (c) Reinstall the bearing cap. Tighten the self-locking capscrews to approximately 105 foot-pounds.
 - (d) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell or the crankshaft.

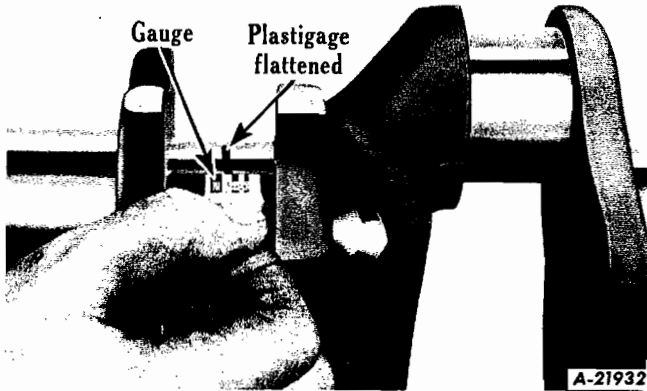


Fig. 46 - Checking Bearing Clearance

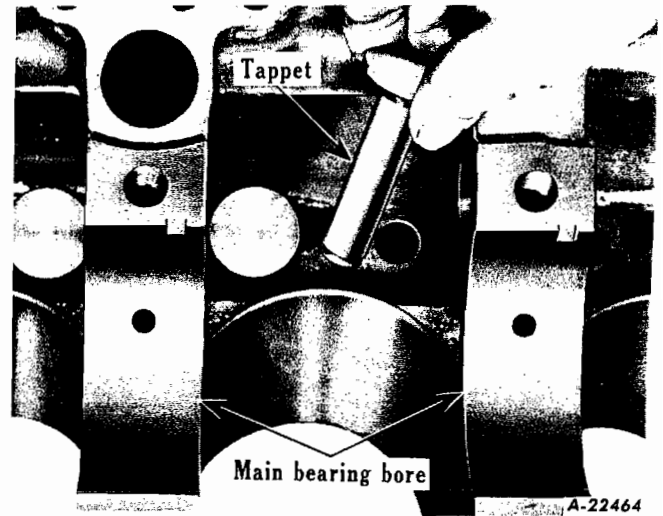


Fig. 47

- (e) To determine the bearing clearance, compare the width of the flattened plastigage at its widest point with the graduations on the envelope (Fig. 46). The number within the graduation on the envelope indicates the clearance in thousandths of an inch. NOTE: Do not turn crankshaft during the above procedure.
4. When using the "virgin lead method" use the following procedure:
- Virgin lead wire of approximately .010" thickness should be used. If wire of .010" thickness is not available and thicker wire must be used, it must be rolled to approximately .010" thickness.
 - Remove one bearing cap. Place 1/2" piece of virgin lead lengthwise on top of crankshaft bearing journal.
 - Install cap and bearing shell half. Install bearing cap bolts and tighten to 30 to 40 foot-pounds tension.
 - Rock the crankshaft back and forth two or three times. Further tighten bolts to 60 to 70 foot-pounds and again rock the crankshaft two or three times. Tighten bolts to 105 foot-pounds and remove bearing cap.
 - The virgin lead will now be compressed exactly in accordance with the amount of bearing to crankshaft clearance. Peel off flattened piece of virgin lead wire and measure with micrometer. Thickness of flattened piece of wire is exact amount of bearing clearance present. Repeat above operations on all bearings.
5. If clearance is not within .0013" to .0043", either use undersize bearing, regrind shaft or replace shaft. Check crankshaft for end-play which is taken up by No. 4 main bearing. End clearance should be from .004" to .012".
- INSTALL FLYWHEEL HOUSING. Place flywheel housing in position over two flywheel housing to cylinder block dowels and tap into place with soft hammer. Install six capscrews and lockwashers in flywheel housing. If either block or flywheel housing is replaced, the flywheel housing will have to be aligned with a dial indicator. When correctly aligned, run-out of bore should not exceed .005". NOTE: If possible, align flywheel housing while engine is in overhaul stand and with engine in vertical position (flywheel housing up).
 - INSTALL ENGINE FLYWHEEL. Place engine flywheel and ring gear into position on dowels in crankshaft flange. Install six self-locking capscrews in flywheel and crankshaft flange, and tighten to a tension of approximately 155 foot-pounds, using a tension wrench.
 - INSTALL VALVE TAPPETS. Coat each of twelve valve tappets with heavy engine oil and install from crankcase side of engine (Fig. 47).
 - INSTALL GEAR CASE COVER PLATE. Place plate and gasket at front end of engine cylinder block. Install two capscrews and lockwashers. NOTE: To be sure that cover plate is in line with the gear case mounting bolts, which go through the cover plate, install or start three or four gear case bolts before tightening the two cover plate capscrews. Remove gear case bolts after tightening operation.
 - INSTALL CAMSHAFT AND GEAR. Coat camshaft with engine oil. Insert camshaft into front end of engine block, being careful not to damage camshaft bearings. Before completely entering camshaft, rotate

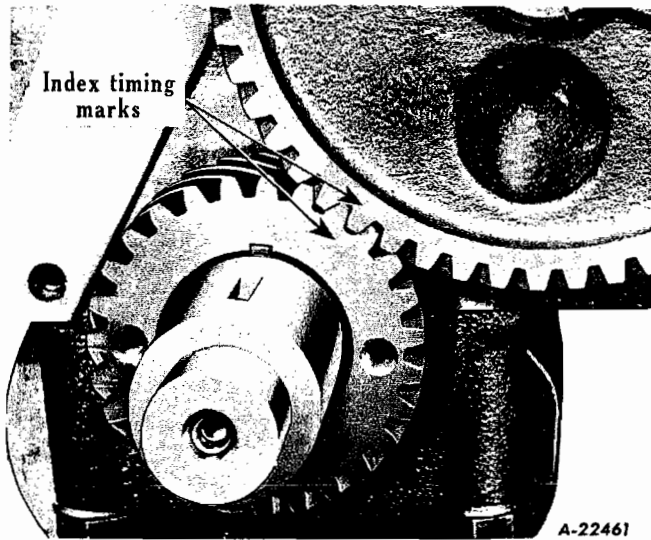


Fig. 48

shaft until marked teeth on crankshaft gear and camshaft gear index (Fig. 48). Install two capscrews and lockwashers in camshaft thrust flange, working through large holes in camshaft gear. Rotate crankshaft and camshaft to determine that gears do not bind or interfere. Back-lash must be from .000" to .002" (.0015" preferred).

11. **INSTALL GEAR COVER CASE.** Place gasket in position on case cover. Place crankshaft oil slinger over end of crankshaft and install Woodruff key for fan drive pulley in crankshaft. Place gear case cover in position. Install capscrews, new lockwashers, and nuts. **NOTE:** Do not tighten gear case capscrews and bolts at this point.
12. **INSTALL FAN DRIVE PULLEY AND VIBRATION DAMPER.** Heat crankshaft fan drive pulley and vibration damper assembly in boiling water. When heated, quickly install assembly on crankshaft and install washer and fan drive pulley nut. Tighten nut with wrench of about 36" leverage. Tighten gear case capscrews and bolts. By tightening the gear case cover to the engine block after the drive pulley had been installed, the pulley has served to align the gear case cover.

Installing Connecting Rods and Pistons

1. Install one connecting-rod and piston assembly down through top of cylinder block having slot in piston towards camshaft side of engine. Pistons are also marked with an arrow indicating front of engine. Use a piston ring compressor sleeve to compress piston rings and thus avoid possible ring damage (Fig. 49).
2. Wipe bore of connecting rod free of oil and dirt. Place bearing shell upper half in con-

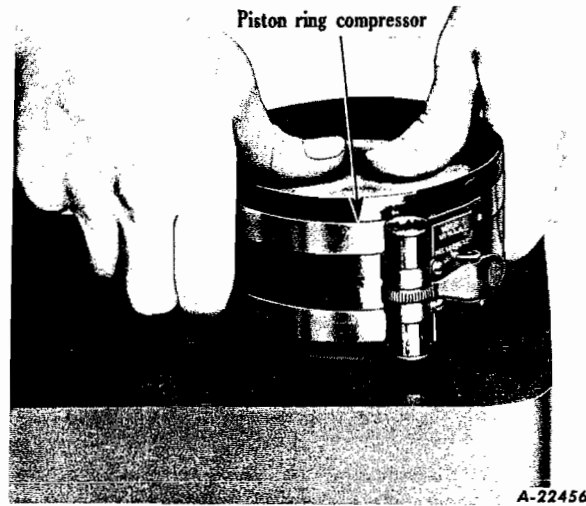


Fig. 49

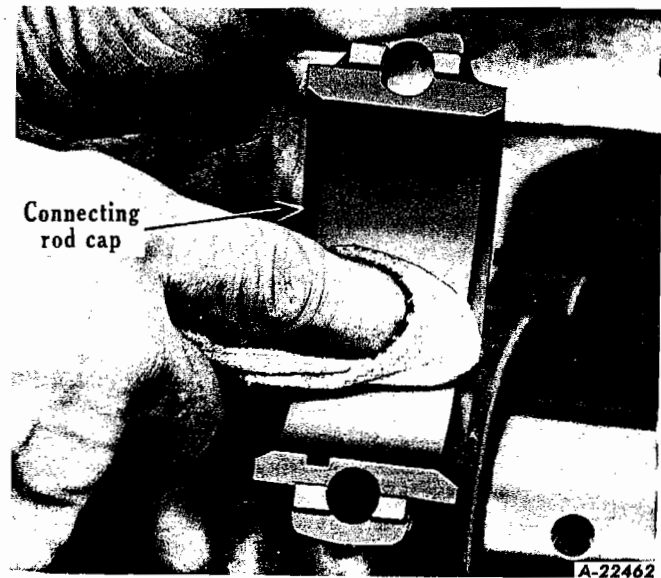


Fig. 50

necting rod bore, being sure that oil hole aligns with oil hole in connecting rod and that locking tangs of bearing shell fit into recess. Clean connecting rod cap bearing bore and clean back of bearing (Fig. 50). Place bearing shell lower half in connecting rod cap (Fig. 51), making sure that tang of bearing fits into recess in cap. (**NOTE:** See instructions under "Main Bearing and Connecting-Rod Bearing Installation.")

3. Coat bearing surfaces with oil. Pull connecting rod into position on crankshaft journal and install connecting-rod cap and bearing.

NOTE: Bearing cap must only be installed on connecting rod one way, with both connecting rod number and bearing cap number to camshaft side. Install two self-locking capscrews and tighten to 80 foot-pounds, use tension wrench.

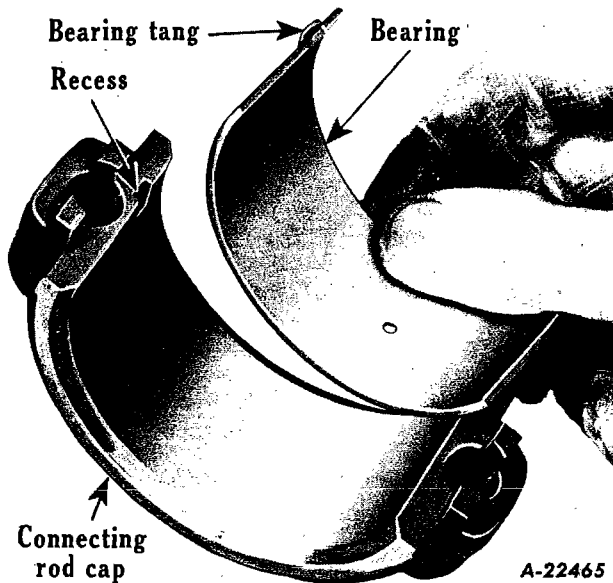


Fig. 51

4. To check connecting-rod bearing to crankshaft clearance, follow procedure given for "plastigage" or "virgin lead" test. Specified connecting rod bearing to crankshaft clearance is from .0012" to .0037". Do not attempt to file connecting rods or bearing caps.
5. Follow procedure outlined in steps above for remaining connecting rods and pistons.
6. **INSTALL CLUTCH.** Install clutch driven disc against flywheel so that the long portion of the hub is toward the rear. Place clutch in position on flywheel over clutch driven disc. Locate clutch so that arrow or inspection mark (usually a dab of white paint) on flange of clutch backing plate or cover is as near as possible to the letter "L" on the flywheel, and install two or three mounting capscrews and lockwashers loosely. Insert a clutch aligning arbor, if available, or a transmission main drive gear shaft, through clutch driven disc hub spline and into clutch pilot bearings. Hold clutch driven disc in position while completing installation of twelve mounting capscrews and lockwashers in flange of clutch backing plate or cover. Tighten all twelve capscrews alternately, evenly and securely. Remove three retaining capscrews and flat washers which were installed to hold clutch compressed (Fig. 52). **NOTE:** Clutch will not operate properly unless these retaining capscrews are removed.
7. **INSTALL VALVE LIFTER ROD COVER.** Install new gasket over opening at left-hand side of engine block. Install valve lifter rod cover and six capscrews and copper washers.

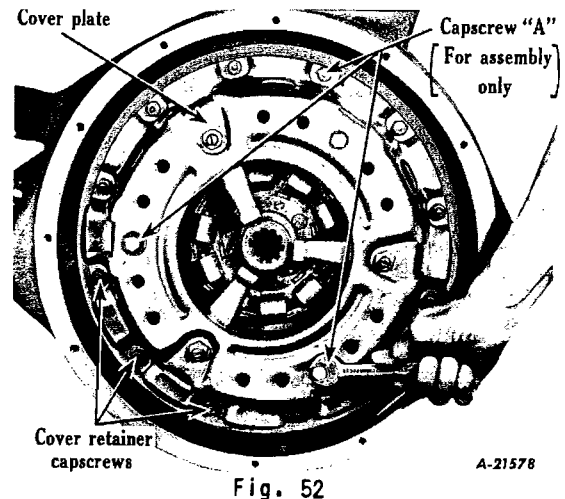


Fig. 52

Install Cylinder Head

1. **INSTALL HEAD.** Place gasket on cylinder block and align bolt holes. Place cylinder head on crankcase, being careful not to damage or shift gasket position. Loosely install all cylinder-head bolts and flat washers, omitting rocker arm oil feeding bolt. Tighten alternately and evenly in sequence to 105 foot-pounds.
2. **INSTALL VALVE ROCKER ARM ASSEMBLY.** Insert twelve valve lifter rods in cylinder head, make sure they enter the valve tappet. Lift the valve rocker-arm assembly into position on cylinder head. Install rocker-arm oil feeding bolt six 3/8" SAE nuts on hole-down bracket studs, and six hold-down bracket capscrews. Be sure to place stud with the oil hole, in the left third from rear, cylinder-head bolt hole and tighten to 105 foot-pounds. Retighten cylinder head after engine has been operated for a short period. Install oil pan making sure all gasket joints are leak-proof. See Fig. 53).



Fig. 53



3. **ADJUSTING VALVES.** To adjust valve stem to valve rocker arm clearance correctly, each cylinder must be on top dead center on its compression stroke at the time of adjustment of valves for that cylinder. To determine the correct position, turn the engine crankshaft until No. 1 piston is at top dead center on compression stroke and the ignition timing mark on the crankshaft pulley in line with the pointer on the timing gear case. Adjust clearance on each valve of No. 1 cylinder to .018" to .020" by using a feeler gauge between valve stem and valve rocker arm and turn rocker arm adjusting screw out of rocker arm until clearance is obtained. Tighten adjusting screw lock nut and recheck clearance. (NOTE: Valve clearance should be rechecked with engine at normal operating temperature.)
4. Turn crankshaft one-third revolution and adjust clearance on No. 5 valves. Working in firing order sequence, continue to set valves of each of the remaining cylinders, turning crankshaft one-third turn after each valve adjustment.
5. **INSTALL WATER PUMP.** Place water pump gasket in position, at water pump opening in front of cylinder head (Fig. 54). Install water pump and fan and install three capscrews and lockwashers in pump and cylinder block.

oil gauge, and thermostat. Tighten fan belt sufficiently to secure 1/2" depression on belt midway between generator pulley and fan pulley. Install oil pan making sure that gaskets are in place when tightening the pan.

8. **FILL ENGINE WITH OIL.** After making certain that oil drain plug is securely installed, fill crankcase with oil. After engine has been installed and placed in operation, again recheck oil level and add as necessary to bring oil level to full mark.
9. **INSTALL CYLINDER HEAD COVER.** If engine is not to be installed at this time, install new cylinder-head cover gasket and install cylinder-head cover. Install four flat washers and four nuts on cover.

ENGINE MOUNTINGS

Figs. 55 and 56 illustrate engine front and rear mountings.

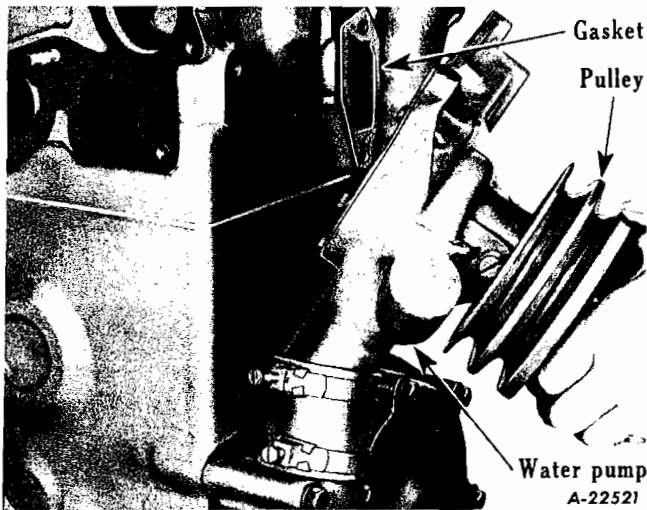


Fig. 54 - Installing Water Pump

6. **INSTALL OIL FILTER.** Place oil filter and new gasket in place on cylinder block. Install four capscrews and lockwashers in oil filter base. (NOTE: Be sure filter assembly is thoroughly cleaned and a new cartridge is installed before replacement on engine.)
7. **INSTALL ACCESSORIES.** Install carburetor, generator, distributor and connecting wires, starter, fuel pump, ignition coil,

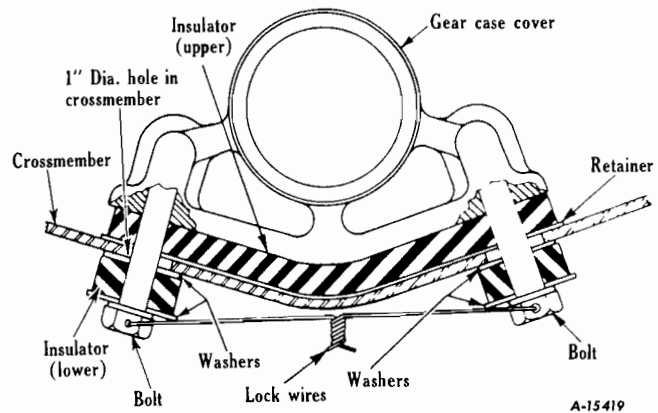


Fig. 55

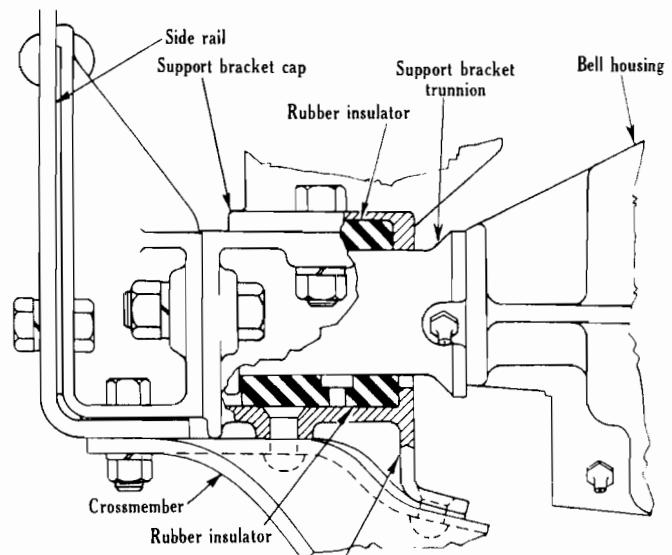


Fig. 56

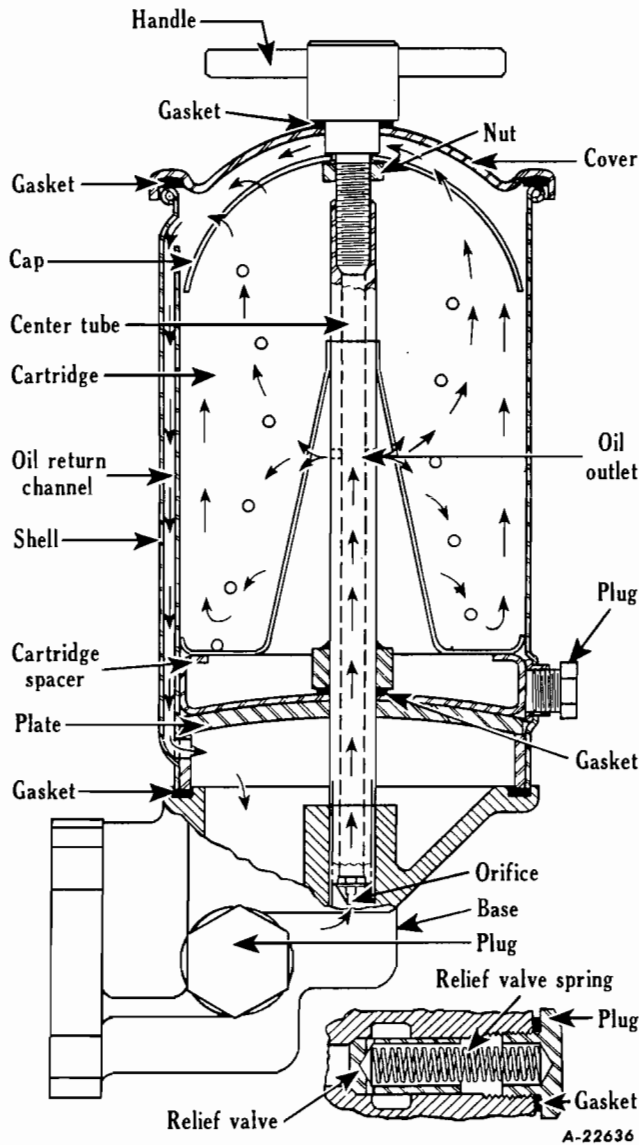


Fig. 57 - DeLuxe Oil Filter

OIL FILTER (DELUXE)

1. The DeLuxe oil filter is used on the RD engines and incorporates a removable sump (Fig. 57).
2. Water, grit, metal particles, sludge and other contaminants that settle out of the oil are held in the sump away from the cartridge. When the cartridge is changed the cartridge and sump quickly and easily lift out as a single unit. Change filter cartridge and clean sump at regularly established periods; according to operating conditions.

OIL FILTER (MICHIANA)

1. The Michiana oil filter is used on the RD engines (Fig. 58). Oil from the engine is delivered by the oil pump into the filter

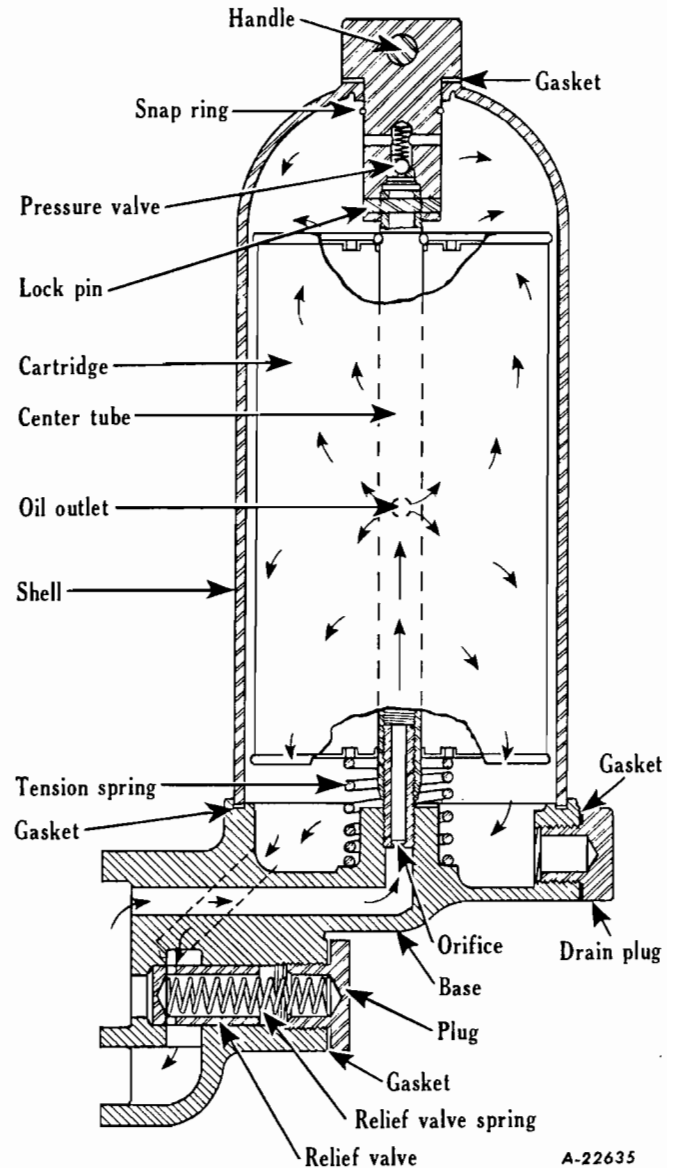


Fig. 58 - Michiana Oil Filter

center tube through the oil filter base. Pressure at which the oil is discharged into the filter element is controlled by the pressure valve at the top of the center tube. The orifice at the bottom of the center tube contains a 7/64" hole.

2. Oil leaves the tube at the center of the filter element and flows through the element toward the ends. The filtered oil returns to the engine oil pan through the oil filter base.
3. The filter element or cartridge should be replaced when the oil appears smoky or black. The element is replaced by unscrewing handle at the top of filter and lifting off cover. The old filter element can then be removed and a new one installed.



4. Do not attempt to wash out the old filter element. Replace with a new one.
5. Remove drain plug in filter sump whenever a new element is installed and drain sump.
6. If new engine oil discolors too rapidly after the filter element has been replaced it may indicate that the pressure valve in the center tube is not functioning and the oil is not going through the element. Remove the complete filter unit from the engine and wash the parts with cleaning solvent.
7. Avoid using a wrench on the filter cover handle. If the cover cannot be drawn down by hand tight enough to prevent oil leakage it is necessary to replace the gasket.

CRANKSHAFT PULLEY TIMING MARKS

The ignition timing mark and the timing pointer is located on the front of the engine at the crankshaft pulley. To assure efficient operation of the engine, the timing should be checked with a timing light, and the timing mark and pointer should be in register as indicated for the best engine performance. Two marks are located on the crankshaft pulley. One marked with an "O" indicates top dead center (T.D.C.) and the other mark shows 5° before top dead center (T.D.C.)

CRANKCASE VENTILATION

1. The RD engine has a crankcase ventilator metering valve installed at the oil filler pipe. The purpose of the crankcase ventilator metering valve, which is connected to the intake manifold by a vacuum line, is to control the amount of fumes and vapors drawn from the crankcase by the intake manifold vacuum. The operation of the crankcase ventilation system consists of drawing cleaned air into the engine and withdrawing the fumes from the crankcase.
2. **CRANKCASE VENTILATOR METERING VALVE.** To remove the ventilator metering valve disconnect the vacuum line leading to the intake manifold. Unscrew the ventilator metering valve unit from the oil filler pipe. To service, separate the two halves of the valve unit, and remove the weight. Clean all parts. When installing the ventilator metering valve on filler pipe, point arrow up. Screw unit into filler pipe. Connect vacuum line leading to the intake manifold (Fig. 59).

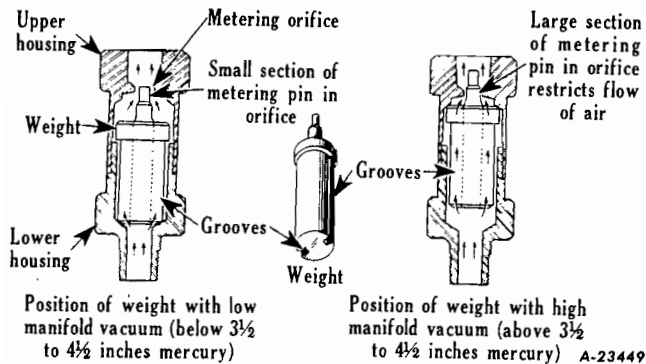


Fig. 59

A-23449



FRAME GROUP

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FRAMES

Frame Alignment

Any vehicle that has been in an accident which might result in a bent or sprung frame should have the frame and axle alignment carefully checked.

Checking Frame Alignment

A satisfactory method of checking the frame and axle alignment, particularly when a body and cab is on a chassis, is to mark on a level floor all points at which measurements are to be taken. Tack or cement pieces of paper to the floor directly under each point of measurement on the chassis as indicated by the letter "K" in the various figures. The points of measurement must be accurately marked in relation to the frame in order to obtain a satisfactory alignment check.

After each measurement point has been carefully marked on the floor, proceed as follows:

1. Locate center line of chassis by measuring front and rear end widths, using marks on floor. If frame widths check, draw center line on floor, full length of chassis. If frame widths do not check, lay out center line as follows:
2. Center line can be drawn through the intersection of any one pair of equal diagonals (A-A, B-B, C-C, D-D) and center point of one end of frame or through points of intersection of any two pairs of equal diagonals.

3. Measure distance from center line to opposite points marked over entire length of frame. Measurements should not vary more than 1/8" at any point.
4. Measuring diagonals, A-A, B-B, C-C, D-D will indicate point where misalignment occurs. If diagonals in each pair check with 1/8", that part of frame included between points of measurement may be considered in satisfactory alignment. These diagonals should intersect within 1/8" of center line.

Axle Alignment with Frame

After determining that frame is properly aligned, the axle alignment with the frame should be checked by comparing diagonals.

Dimensions for side elevation of frame should be checked at the points indicated and should not vary more than 1/8".

Cutting, Reinforcing, Riveting and Welding

Whenever it is necessary to cut the frame, the side rail should be cut at an angle of 45 degrees. This method distributes the cut and weld over a greater area than a cut made at right angles with the rail.

Reinforcements can be made with flat, channel, or angle stock. Because of difficulties encountered when inserting channel reinforcements into frame side rails, the use of angle reinforcements is acceptable. Wherever possible the reinforcement should extend from the

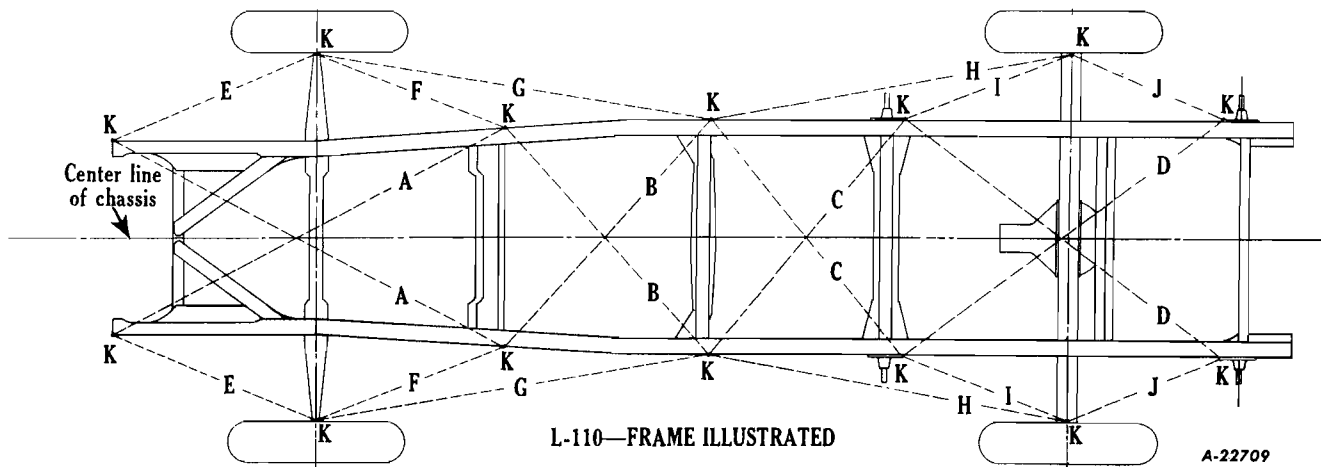


Fig. 1 - Frame and Axle Alignment Checking Diagram.

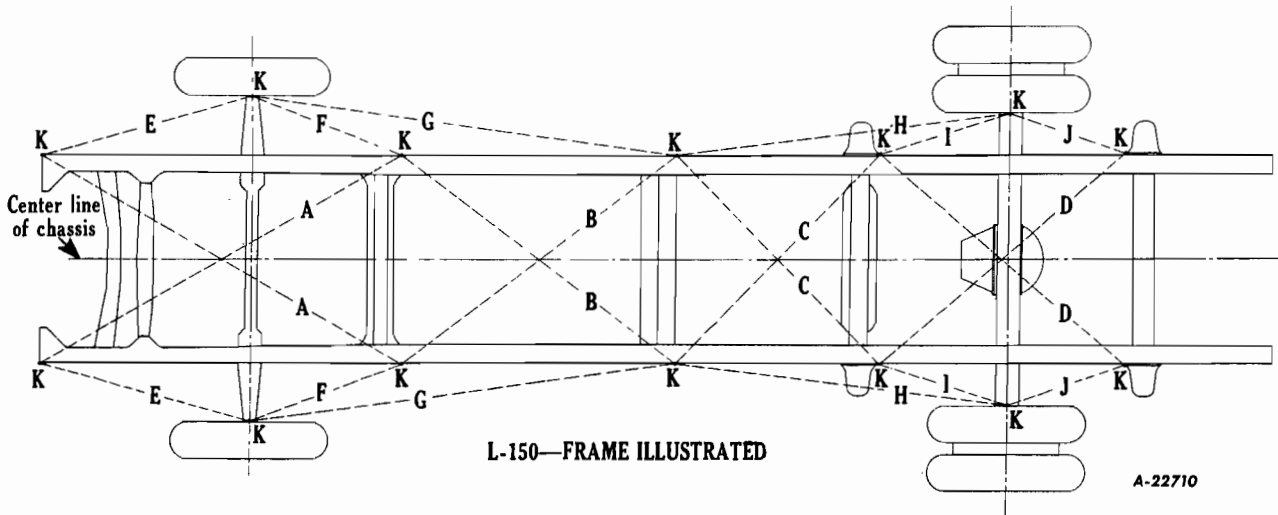


Fig. 2 - Frame and Axle Alignment Checking Diagram.

front axle to slightly beyond the rear spring front mounting bracket as shown in illustration below. This procedure, of course, may be impractical in some instances because of the position of attached units and existing cross-members. The reinforcement thickness should not exceed that of the side rail to be reinforced.

Wherever possible, parts should be securely riveted together. Hot rivets are acceptable, as they can be more easily driven with hand tools. Cold rivets should only be used where tools of sufficient power to properly set the rivets are provided.

Electric arc-welding is recommended for all frame welding. The heat of the weld is localized and burning of material is minimized when this method is used.

In addition to thoroughly welding the cut in the side rail, the outside edges of the reinforce-

ments should be welded to the frame after the reinforcements are riveted. All unused holes should be filled with welding material. Welding rod should be substantially the same material as that used in the frame.

The diameter of the reinforcement rivets depends upon spacing and the number of rivets used. Generally, rivets should be from 50% to 100% as heavy in diameter as the total thickness of the plates to be riveted.

Frame Straightening

Use of heat is not recommended when straightening frames. Heat weakens structural characteristics of frame members and all straightening should be done cold. Frame members which are bent or buckled sufficiently to show cracks or weakness after straightening, should be replaced, or reinforced.

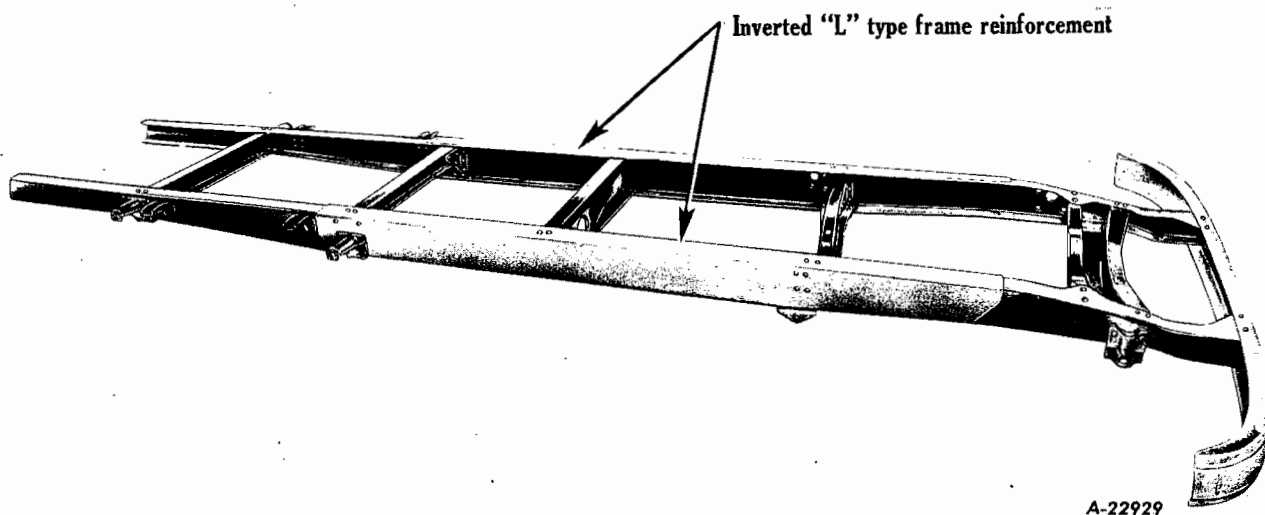


Fig. 3



FUEL SYSTEM GROUP

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SPECIFICATIONS COVERING HOLLEY CARBURETOR MODEL 1904-FS USED ON SD-220,240 AND BD-269 ENGINES

FUEL SYSTEM SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269
CARBURETOR (HOLLEY) MODEL NUMBER	1904FS	1904FS	1904FS
Float Level	Use gauge (SE-1772-9-MC-145)	Use gauge (SE-1772-9-MC-145)	Use gauge (SE-1772-9-MC-145)
Venturi	1-5/16"	1-5/16"	1-5/16"
Main Jet	#69 (Std. Alt.) #73 (High Alt.)	#70 (Std. Alt.) #73 (High Alt.)	#70 (Std. Alt.) #73 (High Alt.)
Power Jet . . . . .	.052-#55 DR.	.043-#57 DR.	.0595-#53 DR.
High Speed Bleed . . . . .	.031-#68 DR.	.031-#68 DR.	.028-#70 DR.
Main Well Bleed-Upper. . . . .	.025-#72 DR.	.025-#72 DR.	.025-#72 DR.
Main Well Bleed-Lower. . . . .	.025-#72 DR.	.025-#72 DR.	.025-#72 DR.
Idle Well Restriction. . . . .	.028-#70 DR.	.028-#70 DR.	.032-#67 DR.
Idle Air Bleed . . . . .	.055-#54 DR.	.055-#54 DR.	.0595-#53 DR.
Idle Transfer Hole . . . . .	.0465-#56 DR.	.0465-#56 DR.	.0465-#56 DR.
Idle Adjusting Screw	Adjust Screw to Obtain 350 to 400 R.P.M.	Adjust Screw to Obtain 350 to 400 R.P.M.	Adjust Screw to Obtain 350 to 400 R.P.M.
Accelerator Pump Spring.	38R-452 (.035 Wire)	38R-452 (Wire)	38R-452 (Wire)
Accelerator Pump Link	33R-207	33R-207	33R-207
Accelerator Jet . . . . .	.0293-#69 DR.	.0293-#69 DR.	.0293-#69 DR.
Fuel Seat . . . . .	.082	.082	.082
Used With Governor	Yes	Yes	Yes

SPECIFICATIONS COVERING HOLLEY CARBURETOR MODEL 1904-H USED ON BD-282 ENGINE

FUEL SYSTEM SPECIFICATIONS

ENGINE MODELS	BD-282 (Not RC-Trucks)
CARBURETOR (HOLLEY) MODEL NUMBER	1904H
Float Level	Use Gauge (SE-1772-9-MC-145)
Venturi	1-3/8"
Main Jet	#72 (Std. Alt.) #73 (High Alt.)
Power Jet . . . . .	.050"
High Speed Bleed . . . . .	.035-#65 DR.
Main Well Bleed - Upper . . . . .	.025-#72 DR.
Main Well Bleed - Lower . . . . .	.025-#72 DR.
Idle Well Restriction . . . . .	.031-#68 DR.
Idle Air Bleed . . . . .	.055-#54 DR.
Idle Transfer Hole . . . . .	.0465-#56 DR.
Idle Discharge Hole . . . . .	.0465-#56 DR.
Idle Adjusting Screw	Adjust Screw to Obtain 350 to 400 R.P.M.
Accelerator Pump Spring	38R-452 (.035 Wire)
Accelerator Pump Link	33R-207
Accelerator Jet . . . . .	.033"
Fuel Seat . . . . .	.082"
Used With Governor	Yes



**SPECIFICATIONS COVERING HOLLEY CARBURETOR MODEL 885 FFG USED ON RD-406 AND RD-450 ENGINES
FUEL SYSTEM SPECIFICATIONS**

ENGINE MODELS	RD-406	RD-450
CARBURETOR (HOLLEY) MODEL NUMBER	885 FFG	885 FFG
Float Level	1/2" Below Top of Fuel Bowl	1/2" Below Top of Fuel Bowl
Venturi	1-7/32"	1-1/4"
Main Jets	#60 (Std. Alt.) #58 (High Alt.)	#61 (Std. Alt.) #59 (High Alt.)
Idle Tubes	54 C.C. Per Min. (.025")	54 C.C. Per Min. (.025")
Fuel Inlet Needle Seat . . . . .	.098"	.098"
Accelerator Pump Plunger Stroke	Adjustable	Adjustable
Power Jet Economizer Valve	*No. 25R-80A-43	*No. 25R-80A-58
Flange	1-1/4 SAE (Dual)	1-1/4 SAE (Dual)
Idle Adjusting Screws	3/4 to 1-1/4 Turn Open	3/4 to 1-1/4 Turn Open
Main Well Bleed . . . . .	.025"	.031"
Aspirating Hole . . . . .	.043"	.067"
Accelerating Jet . . . . .	.033"	.033"
Idle Air Bleed . . . . .	.0465"	.0465"
Well Tubes	3/32" O.D. 4 Holes .028"	3/32" O.D. 6 Holes .040"
Idle Progression Hole	#56 DR. - .0465"	#56 DR. - .0465"
Idle Adjusting Hole	#56 DR. - .0465"	#56 DR. - .0465"
Accelerator Pump Spring . . . . .	.040" Wire	.040" Wire
Secondary Venturi	3/8" I.D.	3/8" I.D.
Bowl Cover Plate Vent Holes	2 #18 DR. - .1695"	2 #18 DR. - .1695

* Only last two digits of number appear on power jet.

(Continued)

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R-LINE MOTOR TRUCK SERVICE

FUEL SYSTEM
Specifications
Page 3

SPECIFICATIONS COVERING HOLLEY CARBURETOR MODEL 885 FFG USED ON RD-406 AND RD-450 ENGINES

FUEL SYSTEM SPECIFICATIONS - Continued

ENGINE MODELS	RD-406	RD-450
GOVERNOR (HOLLEY)	885 FFG	885 FFG
Governor Spring Color Marking	Yellow	Plain
Governor Spring Position in Housing . .	#3 Perch Position	#3 Perch Position
Governor By-Pass Jet (Hole "A") . . . . .	.028"	.028"
Governor By-Pass Jet (Hole "B") . . . . .	.052"	.052"
Maximum No-Load Speed.	2950 R.P.M.	2800 R.P.M.
Governor Rotor Valve and Housing Assembly - IH Part Number.	114510-R91	114510-R91

Air Cleaner Oil Capacity Specifications covering the "Hat" type air cleaner used in conjunction with the Holley 1904 Carburetor.

SD-220 ENGINE	SD-240 ENGINE	BD-269 ENGINE	BD-282 ENGINE
2 pints	2 pints	2 pints	2 pints





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FUEL SYSTEM SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	Cont. R-6602
FUEL PUMP (AC)							
Model number	1539537	1539537	1539501	1539513	1539513	1539513	1538259
Type	AF	AF	AT	. . . . .	. . . . .	. . . . .	. . . . .
Operating pressure.	3 to 4-1/2 lbs. at 3500 engine r.p.m.	3 to 4-1/2 lbs. at 3500 engine r.p.m.	3 to 4-1/2 lbs. at 3500 engine r.p.m.	4 to 5-1/4 lbs. at 3600 engine r.p.m.	4 to 5-1/4 lbs. at 3600 engine r.p.m.	4 to 5-1/4 lbs. at 3600 engine r.p.m.	4 to 5-1/4 lbs. at 3600 engine r.p.m.
FUEL PUMP (CARTER)							
Model number	M-737S	M-737S	EX112-78	. . . . .	. . . . .	. . . . .	. . . . .
Operating pressure.	3 to 4-1/2 lbs. at 3500 engine r.p.m.	3 to 4-1/2 lbs. at 3500 engine r.p.m.	3 to 4-1/2 lbs. at 3500 engine r.p.m.	. . . . .	. . . . .	. . . . .	. . . . .



FUEL SYSTEM SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240
CARBURETOR (CARTER)		
Model number	YF-735-S	YS-736-S
Float level	25/64" ($\pm 1/64"$)	7/16" ($\pm 1/64"$)
Flange	1-1/4 SAE	1-1/4 SAE
Venturi.	1-5/16"	1-5/16"
Main jet . . . . .	.104	.1015
Idle jet. . . . .	.0276	.0292
Accelerating jet. . . . .	.025	.025
Main air bleed. . . . .	.034	.034
Fuel valve seat . . . . .	.076	.081
Metering rod.	No. 75-693	No. 75-688
Idle adjustment	3/4 to 1-3/4 turns open	3/4 to 1-3/4 turns open
Used with governor.	yes	yes

FUEL SYSTEM SPECIFICATIONS

ENGINE MODEL	BD-269
CARBURETOR (CARTER)	
Model number	BBR1-617SA
Float level	5/64" ($\pm 1/64"$)
Flange	1-1/4 SAE
Venturi.	1-5/16"
Main jet	298 C.C.
Idle tube . . . . .	.031
Accelerating pump jet. . . . .	.0315
Step-up jet . . . . .	.0374
Fuel valve seat . . . . .	.086
Idle adjustment	1/2 to 1-1/2 turns open
Used with governor.	yes



FUEL SYSTEM SPECIFICATIONS

ENGINE MODELS	RD-372	RD-406	RD-450
CARBURETOR (HOLLEY)			
Model number	AA-1G	852FFG	852FFG
Float level	1-1/4"	1-1/4"	1-1/4"
Venturi	1-1/16"	1-3/16"	1-3/16"
Main jets . . . . .	.059	.063	.061
Idle tubes	88 C.C. per min.	64 C.C. per min.	64 C.C. per min.
Bleeder plug or button (in nozzle bar) . . . . .	.175	.234	.234
Fuel inlet needle seat . . . . .	.098	.098	.098
Accelerator pump plunger stroke	adjustable	adjustable	adjustable
Power jet economizer valve	No. 25R-67A	*No. 25R-72A-49	*No. 25R-72A-66
Flange	1-1/4 SAE	1-1/4 SAE (dual)	1-1/4 SAE (dual)
Idle adjusting screws	3/4 to 1 turn open	3/4 to 1 turn open	3/4 to 1 turn open
GOVERNOR (HOLLEY)			
Governor spring color marking	brown	. . . . .	. . . . .
Governor spring position in housing . . . . .	. . . . .	. . . . .	. . . . .
Governor by-pass jet (hole "A") . . . . .	.025	. . . . .	. . . . .
Governor by-pass jet (hole "B") . . . . .	.047	. . . . .	. . . . .
Maximum no-load speed	2950 r.p.m.	2925 r.p.m.	2750 r.p.m.
Governor rotor valve and housing assembly-IH part number	54 784-R91	54 784-R91	54 784-R91

* Only last two digits of number appear on power jet.

FUEL SYSTEM—GENERAL

VAPOR LOCK

The Service Parts Department has available an electric fuel pump for use on trucks which have given trouble with vapor lock, but they cannot furnish material other than shown in Fig. 1, because the installation will have to conform to individual requirements.

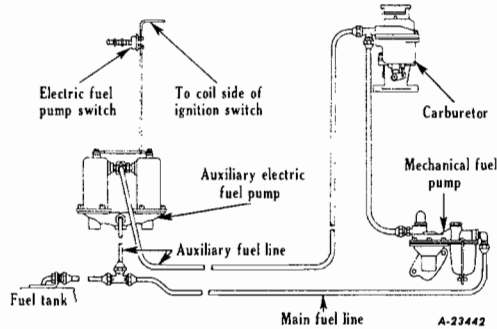


Fig. 1

INSTALLATION - ELECTRIC FUEL PUMP

Fig. 1 illustrates a hook-up that is adaptable to any type of fuel system.

The location of the fuel line from the electric pump should be on the outside of the frame rail opposite the exhaust system and if necessary carried across the front cross member to the carburetor.

Considerable freedom can be exercised in locating the lines, always keeping in mind that they should be away from the exhaust system and not exposed to hazards that will result in their being damaged. The use of loom is recommended where protection from radiated heat is required.

Should the electric pump be located where it may be damaged from stones, etc., a simple shield can be readily installed to supply the necessary protection.

The following discussion on vapor lock is for the purpose of providing necessary information to diagnose and get a solution to the problem:-

WHAT IS VAPOR LOCK?

When a section of the fuel system becomes filled with gasoline vapor causing either partial or total disruption of fuel service to the carburetor, it is said to be vapor-locked.

PRINCIPAL SOURCES OF HEAT - VAPOR LOCK

The fuel pump is generally the part of the fuel system where the greatest rise in fuel temperature occurs because of heat derived from the following sources:

- (a) Heat conducted from crankcase and camshaft.
- (b) Heat received from hot oil splashed into pump body for lubricating purposes.
- (c) Radiated heat from exhaust manifold.
- (d) Heat received from under hood air.

It is for these reasons that the electric fuel pump is mounted on the outside of the frame rail.

The fuel line from the fuel tank to the regular mechanical pump is under a depression or more commonly known as suction which lowers the vaporizing or boiling point of a liquid. This makes it particularly bad to have it located close to the exhaust system. By locating the electric fuel pump close to the fuel tank a greater percentage of the system is under pressure, which increases the vaporizing or boiling temperature of the gasoline.

WHEN AND WHY OF VAPOR LOCK

Vapor lock occurs in hot weather with a hot engine when the fuel requirements are at minimum, such as idling after a hard run. When the maximum amount of fuel is again required, the fuel pump must first expell the vapor during which time the following cycle is being established:

- (a) Reduced engine speed because of lack of fuel.
- (b) Reduced fuel pump speed with proportional loss of pumping ability.
- (c) Increased fuel temperatures and resultant increase in vapor formation resulting in reduced fuel delivery and further reduction of engine speed.

The continuation of the cycle will ultimately result in the complete cessation of gasoline delivery.

TYPE OF FUEL - VAPOR LOCK

The use of a highly volatile gasoline such as furnished in "Winter" weather will produce vapor lock under conditions where a less volatile or "Summer" gasoline would be satisfactory.

HOW TO DIAGNOSE VAPOR LOCK

A vapor lock in the system permits the gasoline level in the float bowl to become low or even dry, causing a lean mixture, which is evidenced by the following operating characteristics:

- (a) Lack of power on full throttle or softness and flat spots on part throttle operation.
- (b) Stalling on idle when engine is hot.
- (c) Inability to start a hot engine.



PROPER USE OF ELECTRIC FUEL PUMP FOR VAPOR LOCK

When the first indications of vapor lock are observed, the electric pump should be brought into operation and upon regaining the lost engine speed, should be shut off, thus giving the standard mechanical pump an opportunity to rid the regular fuel system of vapor. This method of operation may have to be repeated several times before the mechanical pump will supply sufficient fuel, after which the use of the electric pump is not required; however, in stubborn cases continuous operation may be necessary. It should be noted that "shut off" valves are not shown on the sketch as it is desired to make the auxiliary system as flexible as possible to accommodate either continuous or intermittent operation, making it unnecessary to stop the engine.

NOTE: If the electric pump is not required regularly, it should be operated every few days to prevent the stagnant gasoline from forming gum.

TRUCK STORAGE - PREPARATION OF FUEL SYSTEM

When placing trucks in storage remove all fuel from the fuel system. If fuel is not entirely removed, a gumlike substance will be deposited on all parts contacted by the fuel, and will seriously affect operation of the carburetor and fuel pump.

All standard grades of gasoline have a small gum content, which is not sufficient to cause any trouble under ordinary conditions. However, when allowed to stand for a period of two or more weeks, the gum will increase to a point where a deposit is formed on the surfaces which it contacts. This deposit, when dry, has a hard, varnishlike appearance.

Gum deposits may completely alter calibration of the carburetor for it will partially or completely plug the jets or cause the power jet valve and the accelerating pump to stick. Gum deposits in the fuel pump will cause the fuel filter to become clogged or the check valves to stick.

IMPORTANT: It is well to emphasize the possibilities that can develop because of gum film in carburetor jets. A thin film of gum (assume .002" thick) is transparent and would escape casual inspection; but this thickness of film represents a .004" reduction in orifice size, and should one or all jets be affected there would be a lean-mixture ratio that would be detrimental to the engine as well as performance - for it would contribute to sticking and burning of valves because of gum accumulation on the stems. The condition would also be a contributing cause of premature spark plug failures. Gum is not soluble in gasoline, therefore any reduction in the capacity of the jets will be perpetuated almost indefinitely.

The best known means of preventing gum formation in trucks that are to be placed in storage or allowed to stand idle for a period of two or more weeks is to thoroughly condition the fuel system as follows:

1. Completely drain the fuel tank.
2. Run engine until all fuel is consumed in carburetor.
3. Remove plug from carburetor under main jet assembly to complete draining.
4. Empty sediment bowl at fuel pump.

The possible affected parts in the fuel pump are the check valves and the filtering screen or filtering element. To determine the condition of the check valves, remove the caps from over the valves and test for freedom of action.

The filtering screen, if in a gummed condition, should be replaced and the sediment bowl cleaned.

If there is doubt as to the condition of the carburetor, it is suggested that a one-quart mixture of 50-50 CP acetone and gasoline be burned through the carburetor at fast idle from a closed container attached direct to the carburetor - not through the fuel pump because of the detrimental effect of acetone on fuel pump diaphragms. This will serve to remove a large amount of the gum providing that it has not become hard and varnishlike. If the results are not satisfactory the carburetor must be removed and all jets and carburetor valves replaced.

FUEL PUMPS

DESCRIPTION

The fuel pump is installed on the engine between the fuel tank and the carburetor. The suction side of the pump is connected to the fuel tank and the discharge side to the carburetor by tubing designed to carry the fuel. The purpose of the pump is to suck fuel from the supply tank and push it into the carburetor float bowl as it is required by the engine.

OPERATION

The pumping operation is accomplished through a rockerarm on the pump, contacting an eccentric on the engine camshaft.

The link is hinged to the rockerarm so that it can be moved down, but cannot be raised by the rockerarm. The only function of the rockerarm spring is to make the rockerarm follow the cam. The link and diaphragm are moved by the diaphragm spring. The pump, therefore, delivers fuel to the carburetor only when the fuel pressure in the outletline is less than the pressure maintained by the diaphragm spring. This condition arises when the float needle valve is not seated and the fuel passage from the pump into the carburetor float chamber is open. When the needle valve in the carburetor float chamber is closed, and held in place by the pressure of the fuel on the float, the pump builds up pressure until it overcomes the diaphragm spring. This pressure results in almost a complete stoppage of diaphragm movement until further fuel is needed.



HOW TO DIAGNOSE FUEL PUMP TROUBLE

Fuel pump trouble is of only two kinds. Either the pump is supplying too little gas - or, in rare cases, too much.

If the pump is supplying too little gas, the engine either will not run at all, or will cough and falter.

If the pump is supplying too much gas, you will be able to see gasoline dripping from the carburetor; or the engine will not run smoothly when idling. Engines are hard to start when getting too much gas.

LOCATING FUEL PUMP TROUBLE

ALWAYS CHECK WHILE THE PUMP IS INSTALLED ON THE ENGINE. DON'T TAKE IT OFF TO CHECK IT.

ENGINE NOT GETTING ENOUGH GAS:

If the engine is getting too little gas, the trouble may be in the pump, the fuel line; or the gas tank.

First, be sure that there is gas in the tank.

Disconnect the outlet line from the pump, or the carburetor, whichever is easier to reach. Then, turn the engine over a few times, using the starting motor. It is best to turn off the ignition switch.

If gas spurts from the pump or the outline line, the pump, gas line, and tank are OK.

If no gas flows at all, or if only a little gas flows, do the following:

1. Look for a leaky bowl gasket seat. Install a new gasket if you are not sure.
2. Remove and clean the gas strainer which is inside the pump bowl.
3. Look for loose line connections. Check all the way back to the gas tank. Tighten all connections.
4. Look for a clogged fuel line. Blow out with compressed air.
5. Make sure that all cover screws on the pump are tight. Make sure that the external plugs over pump valves are tight.
6. Inspect the flexible fuel line for breaks or porous condition.

If correction of the above six items does not place the pump in operating condition, it should be removed for replacement or overhaul.

ENGINE GETTING TOO MUCH GAS:

More often than not, an oversupply of gasoline is caused by trouble somewhere else - not in the pump. So, first check the following:

1. Defective automatic choke.
2. Excessive use of hand choke.
3. Punctured carburetor float.
4. Defective carburetor needle valve.
5. Loosely connected fuel line, or loose carburetor assembly screws.
6. Improper carburetor adjustment.

NOTE: If none of these is the cause of flooding or poor gasoline mileage, then the pump needs overhauling.

FINAL CHECK:

After overhauling, a simple check of the suction and pressure should be made before installing the pump on the engine. This can be done by holding the fingers over the inlet and outlet openings of the pump and manipulating the rockerarm by hand. The pump may then be reinstalled on the engine and tested. (See installation instructions below). It should prime itself, that is, fill the filter bowl, in about 30 seconds with the starter button depressed. If it fails to provide sufficient pressure, the diaphragm has been incorrectly installed, preventing the full stroke of the push rod, or the springs do not have sufficient tension; and it will be necessary to disassemble the pump to reinstall the diaphragm correctly or to replace the linkage springs if this has not been done.

INSTALLATION OF FUEL PUMP

Use a new gasket between fuel pump mounting flange and pad on crankcase and tighten cap screws securely.

Connect fuel lines, first making sure that there is no dirt on the fittings which might be drawn into the system.

If carburetor has not been removed there will usually be sufficient fuel in it to run the engine long enough to fill the fuel pump filter bowl. If there is an air leak between filter bowl and gasket, the pump cannot draw fuel into the bowl. To remedy this, install a new gasket and see that bowl seats squarely. Tighten clamp screw securely with the fingers only.

If fuel pump bowl still does not fill, the trouble may be due to an air-bound condition. In this case the bowl should be loosened slightly so that air can escape and, by blowing in the gasoline tank filler neck, fuel will be forced into the pump. Then tighten bowl securely and start engine.

CARTER MODEL-YF CARBURETOR

Description

The Carter carburetor model YF for the 220 and 240 Silver Diamond engines is essentially the same as conventional carburetors in that it has a high-speed fuel circuit, low-speed circuit, and accelerating pump circuit.

There is, however, a departure in the method of controlling the fuel flow on part-throttle, wide-open-throttle and through the accelerating pump circuit as compared to carburetors previously used. A calibrated metering rod (Fig. 4) fits into the main jet. It becomes effective at low-part-throttle speeds and automatically positions itself according to the throttle opening thus producing proper fuel flow throughout part-throttle and wide-open-throttle.

The heart of the carburetor is the diaphragm (Fig. 4) which actuates the accelerating pump and the step-up action for wide-open-throttle fuel mixtures.

The underside of the diaphragm is subjected to manifold vacuum by means of a channel down to the carburetor flange. This channel is restricted by a bushing in the flange in order to obtain consistent and smooth performance and to promote extra long diaphragm life.

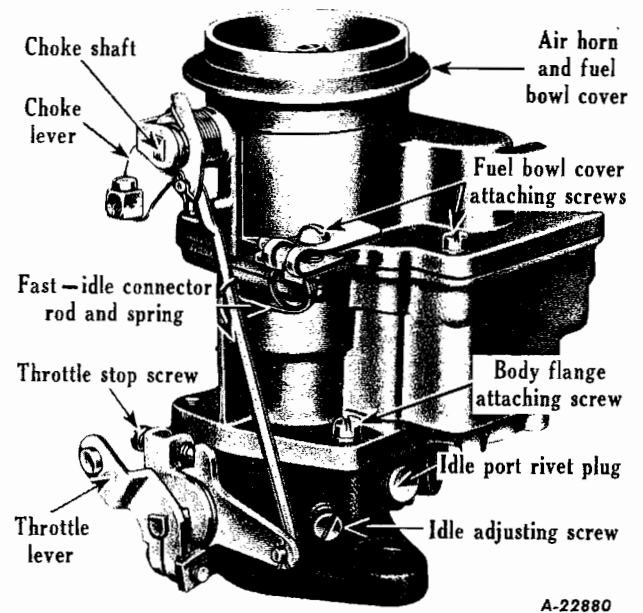
Any movement of the diaphragm results in a corresponding movement of the metering rod. When the throttle is wide open the manifold vacuum drops sufficiently to allow the diaphragm to move upward thus shifting the metering rod to the wide open throttle step.

A chamber above the top of the diaphragm supplies fuel for the accelerating pump circuit. The diaphragm acts as a pump and the quantity of fuel discharged by the pump is controlled by the size of the pump jet or nozzle calibration (Fig. 2) and also the size of the fuel inlet hole to the chamber. There is no check valve on the inlet. There is a check valve in the outlet channel near the pump jet to allow fuel to pass in an outward direction only and also to prevent air from being sucked back into the chamber under certain conditions. The pump jet is free to flow at all times generally starting at a part-throttle engine speed of 1500 r.p.m. and continuing throughout wide-open-throttle.

This carburetor has a unique feature in that no change in setting is required when it is used in conjunction with a sandwich type governor, regardless of whether or not a vacuum by-pass is used around the governor.

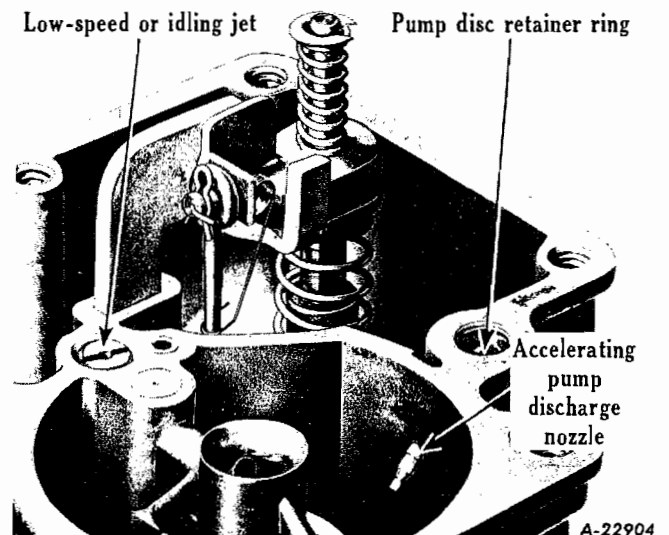
Illustrations (Figs. 1 to 8) show the location of the various parts, and will aid in correctly

identifying the various assemblies when dismantling the YF model carburetor for complete reconditioning, as outlined in the following step-by-step instructions.



A-22880

Fig. 1 - Carter (Model YF) Carburetor



A-22904

Fig. 2

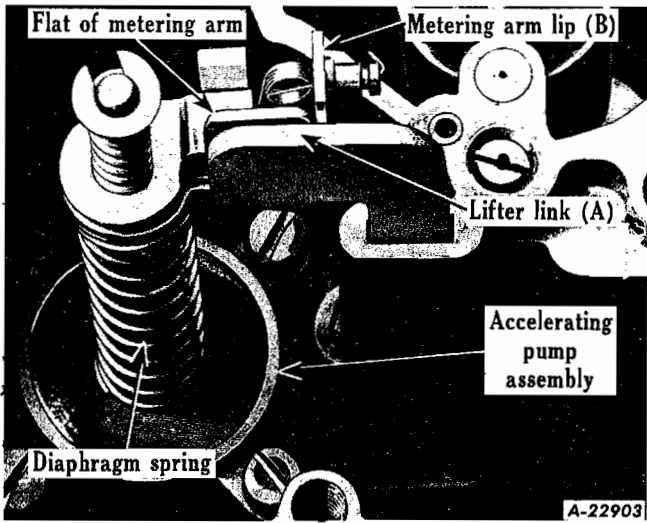


Fig. 3

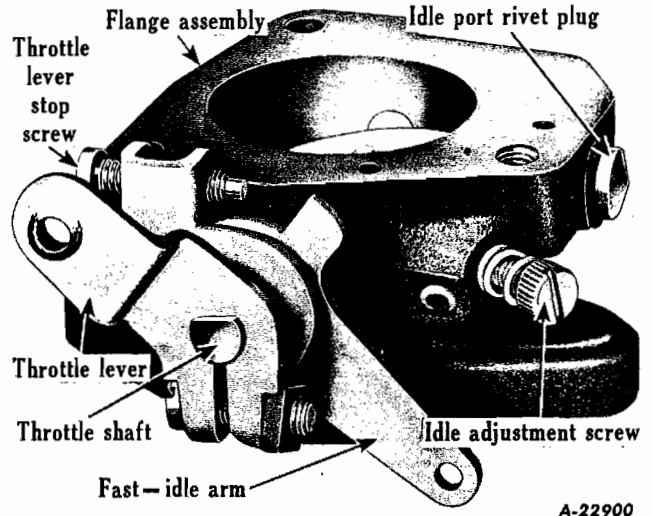


Fig. 6

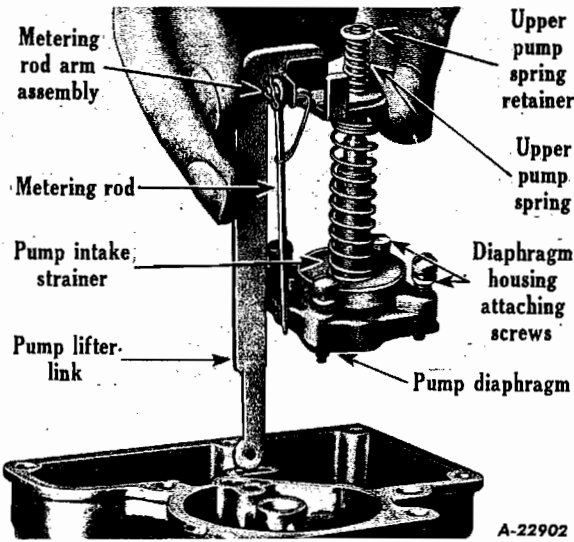


Fig. 4

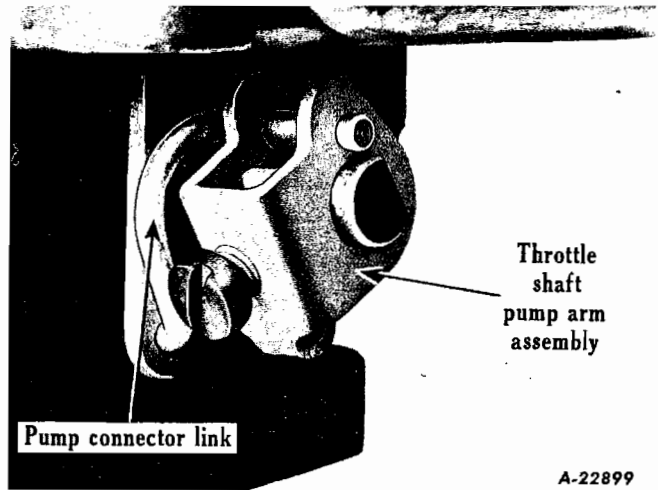


Fig. 7

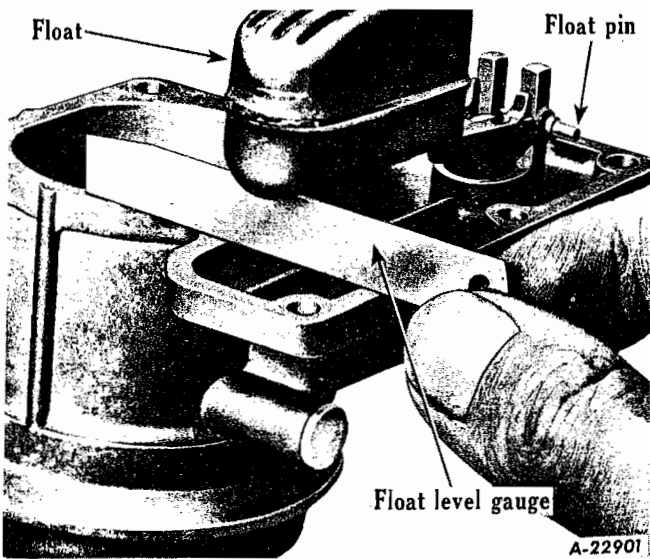


Fig. 5

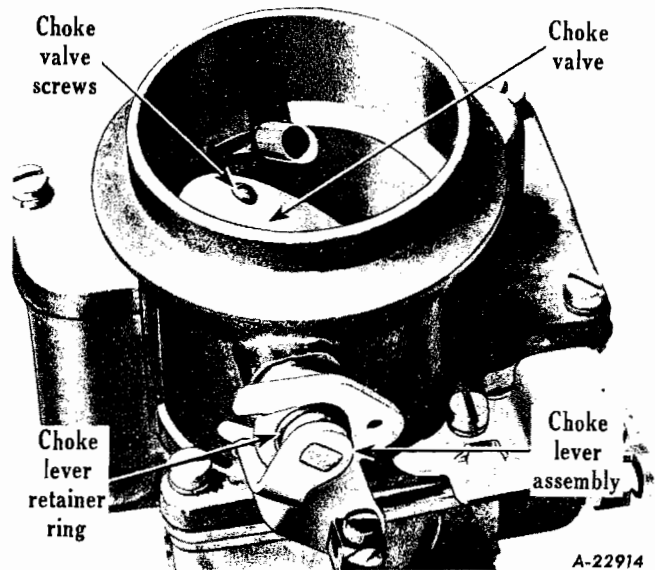


Fig. 8



MODEL YF - SERVICE PROCEDURE

To Disassemble

1. Remove pin springs, fast idle connector rod spring, and rod (Fig. 1).
2. Remove air horn and bowl cover attaching screws (7), and choke tube clamp assembly (Fig. 1).
3. Remove air horn assembly, and gasket.
4. Remove pump disc retainer ring (using knife tip), retainer, and pump check disc (Fig. 2).
5. Remove throttle shaft arm assembly, pump connector link, shaft seal spring, dust seal washer, and felt dust seal (Fig. 7).
6. Loosen diaphragm housing attaching screw, and washer assemblies (4) and lift out entire pump and metering rod assembly (Figs. 3 and 4).
7. Remove diaphragm housing attaching screws, pin spring, metering rod upper pump spring retainer, upper pump spring, metering rod arm assembly, and pump lifter link (Fig. 4).
8. Remove diaphragm spring retainer, spring, and pump diaphragm assembly (Fig. 4).
9. Carefully remove pump intake strainer from housing, using tip of knife blade.
10. Remove metering rod jet.
11. Remove low-speed (idle) jet assembly. Do not remove pressed in parts such as nozzle, pump jet or anti-percolator air bleed. (Fig. 2).
12. Remove body flange attaching screw (3), body flange assembly, and gasket (Fig. 1).
13. Remove idle adjustment screw, spring, idle port rivet plug, throttle lever assembly, washer, fast-idle arm, valve attaching screws (2), and throttle shaft. Then remove throttle shaft seal by prying out seal retainer. Do not remove vacuum passage orifice (pressed in).
14. Remove float pin, float, and needle and seat assembly from air horn casting (Fig. 5).
15. Remove choke valve screws and choke valve. Unhook choke spring and slide shaft from housing. Do not remove balance vent tube. NOTE: In normal service, choke lever assembly will not require replacing. However, if it has been bent or otherwise damaged requiring replacement, proceed as follows: Pry off choke lever retainer ring and remove lever assembly (Fig. 8).

16. Wash all parts in carburetor cleaning solution and blow out passages with compressed air. Do not immerse diaphragm assembly, pump check disc or seals in cleaning solution. Inspect all parts for wear or damage and replace if necessary. Always use new gaskets.

To Reassemble

17. Group all parts, controlling the float circuit: float, float pin, needle and seat assembly, air horn gasket.
18. Group all parts, controlling the low-speed circuit: throttle shaft seals (2), and retainers (2), throttle shaft, throttle valve and screws, fast-idle arm, throttle shaft washer, throttle lever, idle port rivet plug, idle adjusting screw and spring, gasket, attaching screws (3), low-speed jet, throttle shaft seal spring.
19. Group all parts, controlling the high-speed circuit: Metering rod, metering rod jet, pin spring.
20. Group all parts, controlling the pump circuit: pump lifter link, pump connector link, throttle shaft arm assembly, metering rod arm assembly, pump diaphragm housing, pump diaphragm assembly, pump diaphragm spring, diaphragm spring retainer, pump intake strainer, upper pump spring, upper pump spring retainer, pump disc check, pump disc retainer, pump disc retainer ring, diaphragm housing screw and washer assembly (4).
21. Group all parts, controlling the choke circuit: choke valve and screws (2), choke shaft and lever assembly, fast-idle connector rod and spring, choke tube clamp assembly, air horn attaching screw and washer assembly (7), pin spring (2).
22. Install throttle shaft seal and retainer in flange casting.
23. Install fast-idle arm, washer and lever assembly on throttle shaft; slide shaft into place and install throttle valve. Carter trademark should go toward the idle port when viewed from manifold side of flange. Tap valve and hold in place with finger before tightening screws.
24. Install idle port rivet plug and idle adjusting screw and spring.
25. Attach flange assembly to body casting. Use new gasket.
26. Install low-speed jet assembly.



27. Install pump intake strainer in pump diaphragm housing and carefully press into recess. CAUTION: If strainer is even slightly damaged, a new one must be used.
28. Install pump diaphragm assembly in diaphragm housing, then install pump diaphragm spring (lower) and retainer.
29. Install pump lifter link, metering rod arm, upper pump spring and retainer.
30. Install metering rod jet; no gasket is used with this jet.
31. Install diaphragm housing attaching screws (4) in the diaphragm housing, making sure the edges of diaphragm are not wrinkled. Lower into place and tighten screws evenly and securely.
32. Install throttle shaft seal, dust seal washer, and shaft seal spring.
33. Install pump connector link in the throttle shaft arm assembly. Install throttle shaft arm assembly on throttle shaft, guiding connector link into pump lifter link hole. CAUTION: Linkage must not bind in any throttle position. If binding occurs, loosen clamp screw in throttle arm, adjust slightly and retighten screw.
34. Install pump check disc, disc retainer, and lock ring.
35. Install metering rod, and pin spring. Connect metering rod spring.
36. Metering Rod Adjustment: Be sure flat of metering rod arm is parallel to flat of pump connector link before proceeding with metering rod adjustment. With throttle valve seated, press down on upper end of diaphragm shaft. Metering rod should be seated in casting and metering rod arm (Fig. 3) flat against pump lifter link (A). If metering rod does not seat in body casting (check by pressing downward on metering rod) or seats before the metering rod arm makes flat contact with pump lifter link, raise or lower by bending lip (B) on metering rod arm. Adjust float level as shown in Fig. 3. Width of gauge is 25/64" for YF-735S carburetor and 7/16" for YF-736S carburetor. A tolerance of plus or minus 1/64" is permissible in each float level setting.
37. Install needle seat and gasket assembly, needle, float and float pin. NOTE: Stop shoulder on float pin must be on side away from bore of carburetor.
38. Set float level to catalog page specifications. Measure from machined surface of casting (gasket removed). Adjust by bending lip which contacts needle.
39. Install air horn gasket and air horn assembly. Install attaching screws and lock washers (7) and choke tube clamp assembly. (Tighten center screws first.)
40. Slide choke shaft and lever assembly into place and connect choke lever spring. Install choke valve. Center valves by tapping lightly and hold in place with fingers when tightening screws.
41. Install fast-idle connector rod with offset portion of the rod to top of pin spring to the outside. Install fast-idle connecting rod spring.

CARTER MODEL BBR-1 CARBURETOR

(FOR DETAILED DISASSEMBLY INSTRUCTIONS SEE SHOP TALK NO. 35)

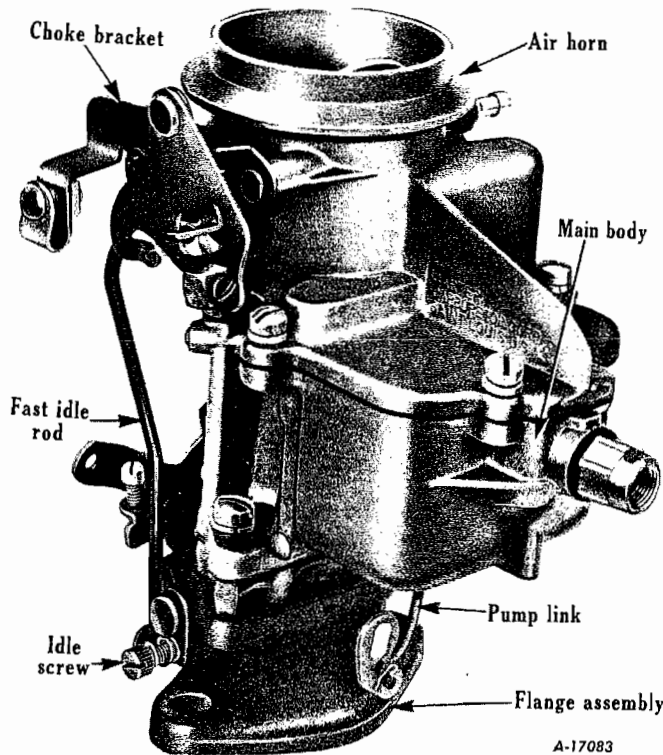


Fig. 1

Description

The Carter Model BBR-1-6175A carburetor (Fig. 1) is a downdraft carburetor, divided into five circuits which consist of the following:

FLOAT CIRCUIT

The float circuit controls the height of the gasoline level in the bowl (Fig. 2). A gasoline level too high or too low may cause trouble in other circuits, and make complaints hard to trace.

The float circuit consists of a needle valve, seat and gasket, float, float bowl, float bowl cover, float lever, pin retainer, float pin, gasket and vent hole.

LOW-SPEED CIRCUIT

The idle or low-speed circuit controls the supply of gasoline to the engine during idle and no-load up to a speed of approximately 15 to 20 m.p.h. and it partially controls the supply of fuel for no-load or light loads at higher speeds (Fig. 3).

The low-speed circuit consists of the idle

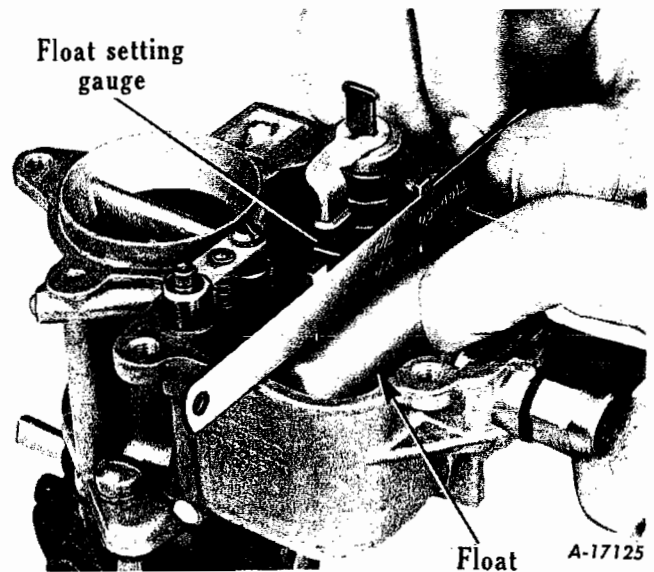


Fig. 2 - Before adjusting float level, be sure float lever pin is firmly seated and that the float pin retainer is in position. Reset float level by bending lip of float lever away from needle to raise level, or toward needle to lower float level. Bend vertical lip of float only. Use float gauge (SE-1639-10) and check level as shown. Setting is $5/64$ " plus $1/64$ " below top surface of carburetor body casting and without the body gasket.

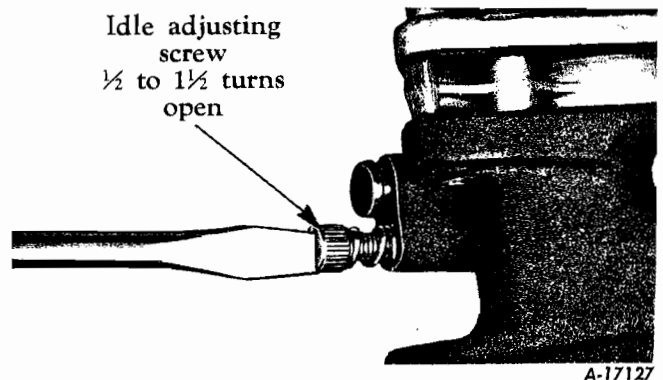


Fig. 3 - Idle adjustment is $1/2$ to $1\frac{1}{2}$ turns open. For richer mixture, turn the idle screw out.

orifice tube and plug assembly, air bleed, idle port, idle mixture adjusting screw, throttle valve, carburetor bore, and economizer.

HIGH-SPEED CIRCUIT

The intermediate and high-speed circuit consists of the step-up jet, step-up piston and rod assembly, main metering jet, main vent tube, diffuser holes, and air passage.

PUMP CIRCUIT

The acceleration circuit consists of the



accelerating pump spring, pump plunger and rod assembly, pump leather, inlet valve, outlet valve, pump jet air bleed, and pump jet.

The accelerating pump is provided with an adjustable stroke setting. Set the accelerator link in the inner hole in the throttle shaft lever for summer operation. For winter setting, use the outer hole.

CHOKE CIRCUIT

This circuit is used only in starting and warming a motor, its purpose being to supply a rich mixture temporarily. It consists of a choke shaft and lever assembly, a choke valve, choke breather valve and spring, and a means of controlling the position of the valve. It incorporates a fast idle cam connected to the choke shaft by a rod. When the choke is closed the throttle valve is forced open slightly by the cam to make starting easier and prevent stalling.

The choke breather valve allows sufficient air to enter so that the motor will start and not flood even though the choke valve is fully closed.

Carburetor Overhaul

(See Shop Talk No. 35 for complete instructions and details).

When disassembling the carburetor keep the various groups of circuit parts together so that each group can be inspected and replaced completely before proceeding to the next group. Use a sectionalized pan or muffin tin to separate each group of parts.

Reassembly of the carburetor is practically the reverse of disassembly. A complete set of servicing tools is provided to facilitate overhauling of the Carter carburetors. These tools are available under SE-1639, and are shown in Fig. 4.

Proper selection of carburetor flange gasket is necessary when installing the carburetor on the manifold, see Fig. 5. If the carburetor is used in conjunction with a sandwich governor (governor mounted between carburetor flange and manifold), the gasket having four small holes is used. Where no governor is used the slotted gasket is used. The slots in the gasket provide leads to the vacuum passage leading to the step-up piston cylinder. Either gasket can be used between the governor and manifold.

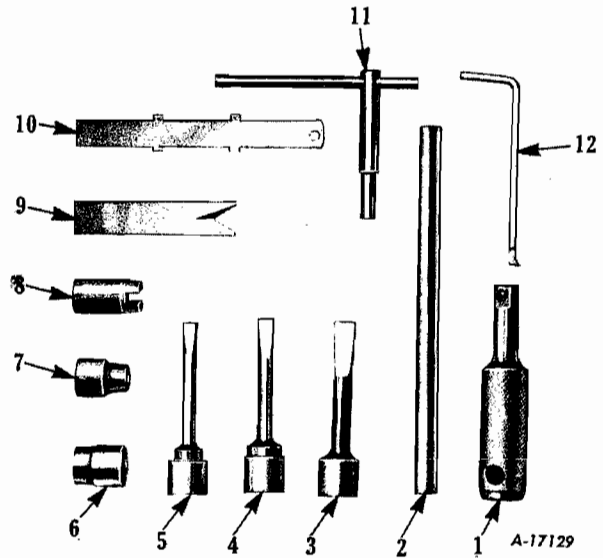


Fig. 4 - Service Tools (See list below)

Service Tools

A special set of tools is provided to facilitate overhauling of the Carter carburetors, (see Fig. 4). These tools are as follows:

- SE-1639 Carter Carburetor Service Tools.
Set consists of SE-1639-1 to 1639-13 inclusive:-
- SE-1639-1 Grip handle for sockets (No. T 109-51)
 - SE-1639-2 Handle bar for grip handle (No. T109-53)
 - SE-1639-3 Screw driver bit 5/16" (No. T 109-57)
 - SE-1639-4 Screw driver bit 1/4" (No. T109-58)
 - SE-1639-5 Screw driver bit 3/16" (No. T 109-59)
 - SE-1639-6 Socket, double hex, 9/16" (No. T109-69)
 - SE-1639-7 Socket, double hex, 5/16" (No. T109-64)
 - SE-1639-8 Ball retaining ring inserter tool (No. T109-75)
 - SE-1639-9 Rivet extractor tool (No. T109-43)
 - SE-1639-10 Float level gauge (No. T109-50)
 - SE-1639-11 Main vent tube tool (No. T109-195)
 - SE-1639-12 Ball retaining ring removing tool (No. T109-56)
 - SE-1639-13 Metal box for SE-1639 tools.

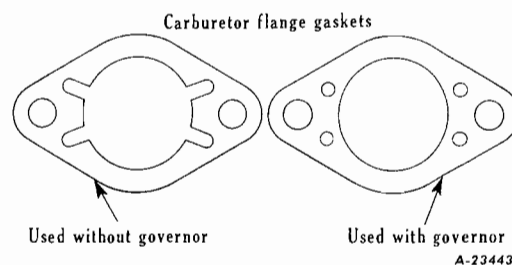


Fig. 5

HOLLY MODEL 852-FFG CARBURETOR

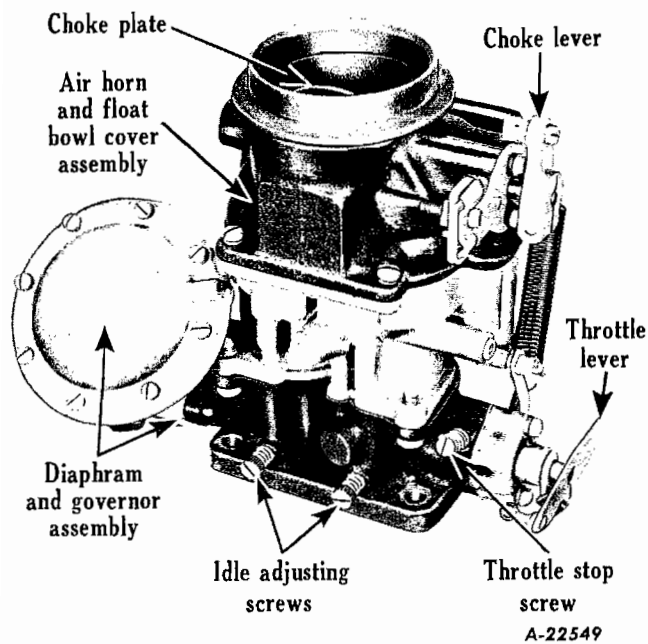


Fig. 1

Description

The Holley Model 852-FFG carburetor is a dual downdraft carburetor of the plain tube type, designed for use on engines of approximately 260 to 390 cubic inch displacement. All of the metering jets and passages are located in the center of the main body, which provides for correct metering of fuel and air at all practical operating angles. The carburetor fuel system is fully balanced and sealed, the air for all vents and bleeds being taken from the main air entrance of the carburetor, thus, only air which has passed through the air cleaner is admitted to the carburetor.

The governor actuated throttle mechanism is an integral part of the carburetor, designed to provide the needed power required for moving the throttle to governing speeds and is controlled by a separately driven governor rotor. The combination of these two units has been engineered to give instant response and accurate governing.

A power valve provides additional fuel for high power operation, and a throttle actuated accelerating pump provides the necessary fuel for fast engine pick-up.

A throttle lever which is self-locking and self-positioning is incorporated in this carburetor.

This dual carburetor can be considered as two carburetors built into one unit. There are separate venturi tubes, idle tubes and throttle

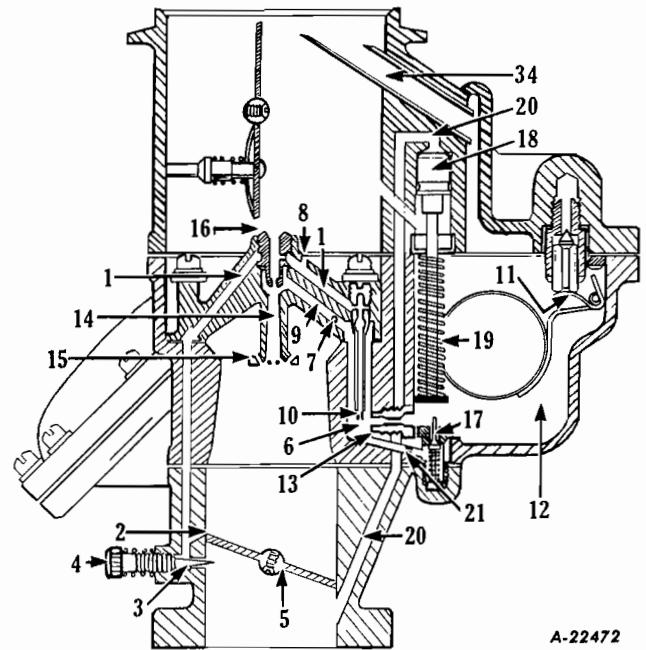


Fig. 2

plates and a separate main metering system and idle system, one for each side.

NOTE: In the following explanations, one side is generally referred to, unless mentioned otherwise.

Idle Fuel System

The fuel from the carburetor bowl (12) passes through the main metering jet (13) into the idle tube (10) as shown in Fig. 2. Air is introduced into the fuel stream by idle air bleed (8). This fuel and air mixture then travels through the idle passage (1) through the chamber around the bleeder plug (16) and to the continuation of passage (1) then discharges at idle transfer hole (2) and idle discharge hole (3).

When the engine is set to idle at a speed of approximately 350 r.p.m. the mixture is discharged out of the lower hole (3) only. As the throttle plate (5) is opened and the engine speed and air flow increases, the upper idle transfer hole (2) starts discharging in addition to the lower hole at about 450 r.p.m. The action and timing are such that the discharge from the upper hole reaches a maximum at approximately 750 r.p.m. and then gradually becomes less effective as the main nozzle (15) begins to flow.

The lower discharge hole (3) is provided with an idle adjusting needle (4). Turning this needle out (to the left) gives a richer mixture and turning in (to the right) a leaner mixture. The idle adjustment should be set with a vacuum gauge for the highest and steadiest vacuum reading or

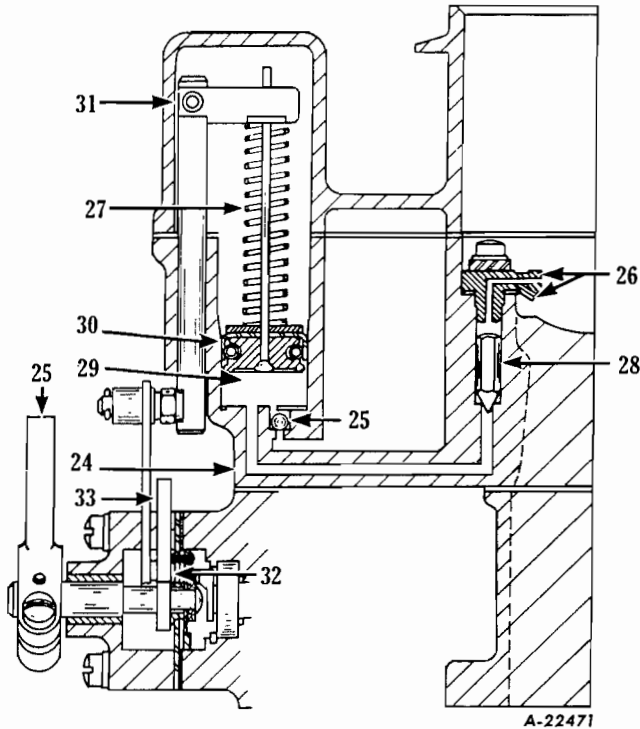


Fig. 3

the smoothest running and maximum idle r.p.m. When seating the idle adjustment needle (4), excessive force should never be used as this may cause a groove to form on the needle point. If this occurs, the adjusting needle will have to be replaced in order to obtain a satisfactory idle adjustment.

Main Fuel System

As the throttle is opened and the idle system becomes less effective, the main discharge nozzle (15) in Fig. 2 starts to deliver fuel.

This occurs at approximately 900 r.p.m. road load. Between 900 and 1200 r.p.m., there is a definite blending of the idle and main fuel system. In the above range all the fuel passes through the main jet (13) up through the main well (6) to angle channel (9). Here the fuel is atomized by the high speed bleed (7), and an additional supply of air is introduced to this mixture by the bleeder plug (16) before being discharged through the vertical passage (14) into the venturi.

The float bowl (12), Fig. 2, is vented to the atmosphere through a balance tube (34). This system, besides correcting float chamber air pressure for atmospheric changes, keeps dirt out of the fuel system and reduces air cleaner clogging effects to a minimum.

POWER MIXTURE SUPPLY

The power valve vacuum piston (18) and the spring (19) shown in Fig. 2 are actuated by the vacuum below the throttle plate (5) which communicates with the top of the piston (18) through passage (20).

At idle the vacuum is the highest, and it decreases as the load of the engine increases. The piston (18) (actuated by vacuum) and the spring (19) are held in the "up" position which allows the valve (17) to remain closed until the vacuum drops to approximately 7.5 to 6.5 inches of mercury. Below this vacuum the piston force is not great enough to resist the compressed load of the spring (19) and thus opens the power valve (17).

Under load, as in climbing hills, etc., the vacuum drops because it becomes necessary to open the throttle wider in order to maintain speed. When the vacuum drops below 7.5 inches of mercury, the power valve is opened by the piston stem. The fuel then flows into the power valve chamber and through the restriction (21) into the main well (6), and is discharged together with fuel from the main metering system. This gives the additional fuel required for high speeds for heavy loads and low speeds at full throttle.

Accelerating Pump

The accelerating pump shown in Fig. 3 is connected to the throttle shaft by means of link (33) and operating lever (32). The function of the accelerating assembly is to temporarily enrich the mixture for rapid acceleration. The fuel is drawn into the pump chamber (29) through pump inlet check valve (25) on the upward stroke of pump piston (30) when closing the throttle. When the throttle is opened, the pump piston (30) moves downward, closing the pump check valve (25) and forcing the displaced fuel through passage (24) to raise the pump discharge valve (28). The accelerating fuel charge then goes around the valve and out the pump discharge nozzle (26).

A slot in the pump piston stem allows the pump operating rod (31) to overrun the pump piston (30) when the throttle is opened suddenly. This overrun causes the pump piston to be subjected to the pressure of the spring (27), thereby giving a prolonged discharge of the accelerating fuel.

The accelerating pump is provided with an adjustment for varying the quantity of the accelerating charge. This adjustment is made by changing the position of the pump link (30) in the holes of the operating lever (32). The position farthest away from the pivot point is the cold weather setting since it gives the greatest discharge. The middle position is the average setting, and the position nearest the pivot is used under conditions of very hot weather.

ADJUSTMENTS AND SERVICE HINTS

TOOLS REQUIRED - This carburetor can be cleaned or repaired without the use of special tools.

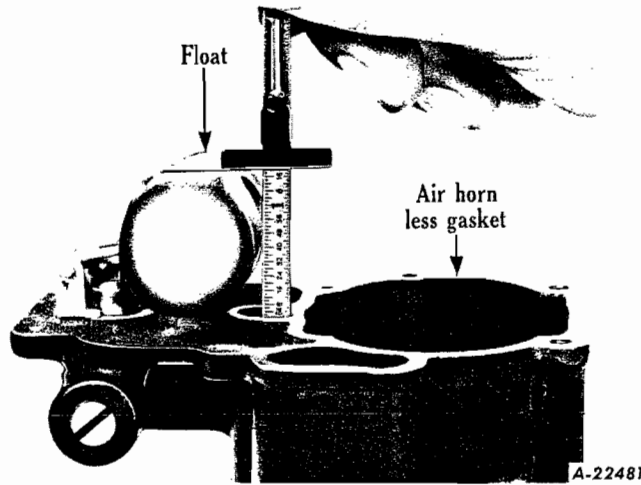


Fig. 4

Before making any adjustments to the carburetor, it is important that the breaker points and spark plugs be properly spaced, the ignition timing correct and valve tappets set to proper clearance. Check all carburetor assembly screws and manifold flange bolts, see that they are thoroughly tightened and that there are no leaks at gaskets.

FLOAT LEVEL - Proper carburetor performance is dependent on maintaining the correct fuel level in the bowl. The float level can be set accurately, when the air horn is off, by gauging the distance between the bottom of the float and the flange surface of the air horn. Holding the air horn upside down, less gasket, and with the float in the closed position, measure the distance from the flange surface of the air horn to what would normally be the bottom side of the float, not the soldered seam (Fig. 4). The correct distance that it should measure is 1-11/32". To correct the float setting, the float lever arm (11), Fig. 2, should be bent up or down to bring the float within the established limits and thus correct the fuel level for best operation. Pushing the float toward the float chamber

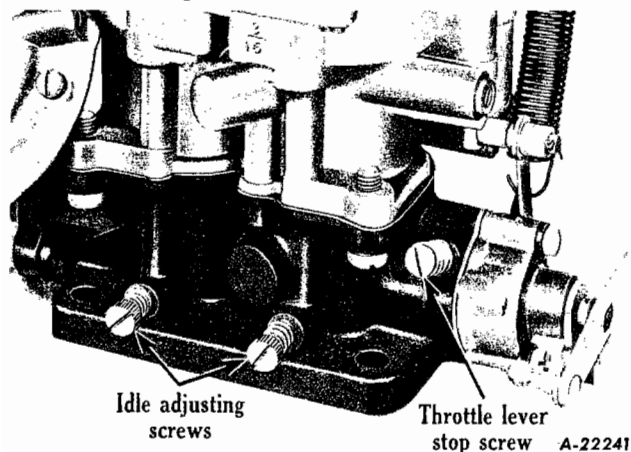


Fig. 5

cover raises the level; pushing it away from the cover lowers the level.

NOTE: The fuel inlet valve, valve seat, and gasket are serviced as an assembly and should be used as supplied in factory matched sets. When replacing the valve seat, be sure to use a screwdriver with a blade wide and heavy enough to fill the slots in the valve seat.

IDLING SPEED ADJUSTMENT - First set the idling speed by adjusting the throttle stop screw, (Fig. 5).

The idle mixture is controlled by the idle adjusting screws (Fig. 5).

NOTE: These screws regulate fuel flow and are not air bleed needles. Turning these screws in (or to the right) makes the mixture leaner, and turning them out (or to the left) makes the mixture richer. Screws should be turned in until they just touch the seat, then backed off one full turn. Care should be taken not to jam the screws against the seat tight enough to groove the points. If this occurs, the needles will have to be replaced before a satisfactory adjustment can be made. The screws should be adjusted with the fingers to avoid damage.

When the engine has warmed up, turn both idle screws in until the engine starts to slow down, then turn both idle screws out until the engine starts to slow down. A point half way between these two will be very close to the correct idle mixture.

After arriving at the correct mixture, it may be necessary to reset the throttle stop screw to obtain the correct idle speed. Changing the speed may make a slight change in the idling mixture. In the event this occurs, re-adjust the screws as outlined above.

NOTE: When adjusting the idle mixture it is important that both idle screws be set at approximately the same number of turns open, otherwise, the off idle performance may be erratic.

FAILURE TO IDLE PROPERLY AFTER ADJUSTING - Be sure motor is tuned to specifications. Check for air leaks in intake manifold gaskets, carburetor body, bowl and flange gaskets.

If the idle is erratic and not sensitive to adjustment, check the float level in the float bowl. Check the idle tubes (10). They must be tight on seat in nozzle bar casting (15), Fig. 2.

ACCELERATING PUMP ADJUSTMENT - When the engine does not accelerate properly, check the accelerating pump system for dirt. If the pump inlet check valve (25), Fig. 3, does not seat, fuel will return to the float bowl instead



of discharging through the pump discharge passages (26). This can be checked by removing the main body cover and operating the pump with a small amount of fuel in the bowl. If the check ball is leaking, air or fuel will bubble back into the float bowl through the inlet hole. After cleaning this seat, extreme care should be taken when reinstalling the pump piston to be sure the piston leather is not damaged and that it contacts the cylinder wall. If the leather is not a snug fit against the cylinder wall, fuel will leak by the piston on acceleration, causing a weak discharge.

To clean the accelerating pump system, remove piston assembly and check ball retainer and check ball from bottom of cylinder. Remove pump discharge nozzle, and valve (28) Fig. 3. Remove pump discharge needle valve. All channels can then be cleaned of all foreign matter by flowing out with compressed air. The small holes or restrictions in the discharge nozzle should deliver a fine, solid and round stream. When the system is in good condition, a quick steady stream will flow from the discharge outlet the instant the throttle is opened.

MAIN FUEL SYSTEM - To check for trouble at intermediate speeds, be sure all gaskets are tight. Remove main jets (13) Fig. 2, and check size in accordance with specifications. Clean main jets, main jet passages and main discharge nozzle with compressed air.

NOTE: Never attempt to clean any of the small holes or restrictions by forcing any object through them. This is apt to enlarge the hole or distort the shape and change the calibration.

HIGH SPEED COMPLAINTS - For high speed complaints, check the power valve (17), Fig. 2, as well as the main jets (13) in accordance with the above instructions. Clean all passages with compressed air. Check the fuel pump pressure to be sure it is sufficient to maintain fuel level in the bowl. Check float travel to insure full opening of the inlet valve.

ALTITUDE OPERATION - In some cases in high altitudes, it may be necessary to use leaner metered main jets. Usually a 5% or 10% leaner jet will compensate for any variation in altitude. The metering jets are marked in thousandths of an inch of hole diameter; thus, the smaller the hole, the smaller the number on the jet.

The main jets can be removed and installed without disassembling or removing the carburetor from the engine in the following manner:

1. Remove the two main jet passage plugs and gaskets from the carburetor main body. Removal of these plugs will drain the fuel bowl. See Fig. 38.

2. Remove the main jets using a screw driver having a screw starter blade. See Fig. 39.

NOTE: If the jet fails to stick to the end of the removing tool, but falls off into the fuel bowl, it may be necessary to remove the air horn assembly.

3. Install the main jets in the reverse of the removal operation. No gaskets are used with the main jets.

NOTE: Do not try to change the size of the power valve restriction (21) Fig. 2, or the pump discharge nozzles (26) Fig. 3, as this will cause erratic performance.

ECONOMY COMPLAINTS - Changing jets rarely increases economy more than slightly and often ruins performance. Make a thorough check on the condition of the motor with a compression gauge and make sure valves are in good condition. In a vehicle, check for dragging brakes or extra friction. Do not merely take a customer's word on mileage; run a gas test with a scientific mileage tester. Check float level in carburetor bowl and make sure the fuel pump pressure is not excessive. Then, if there is still cause for complaint, the various points as outlined above should be carefully checked over.

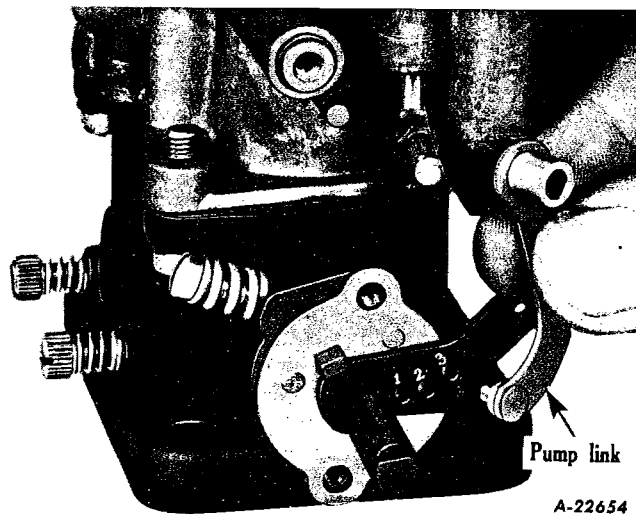
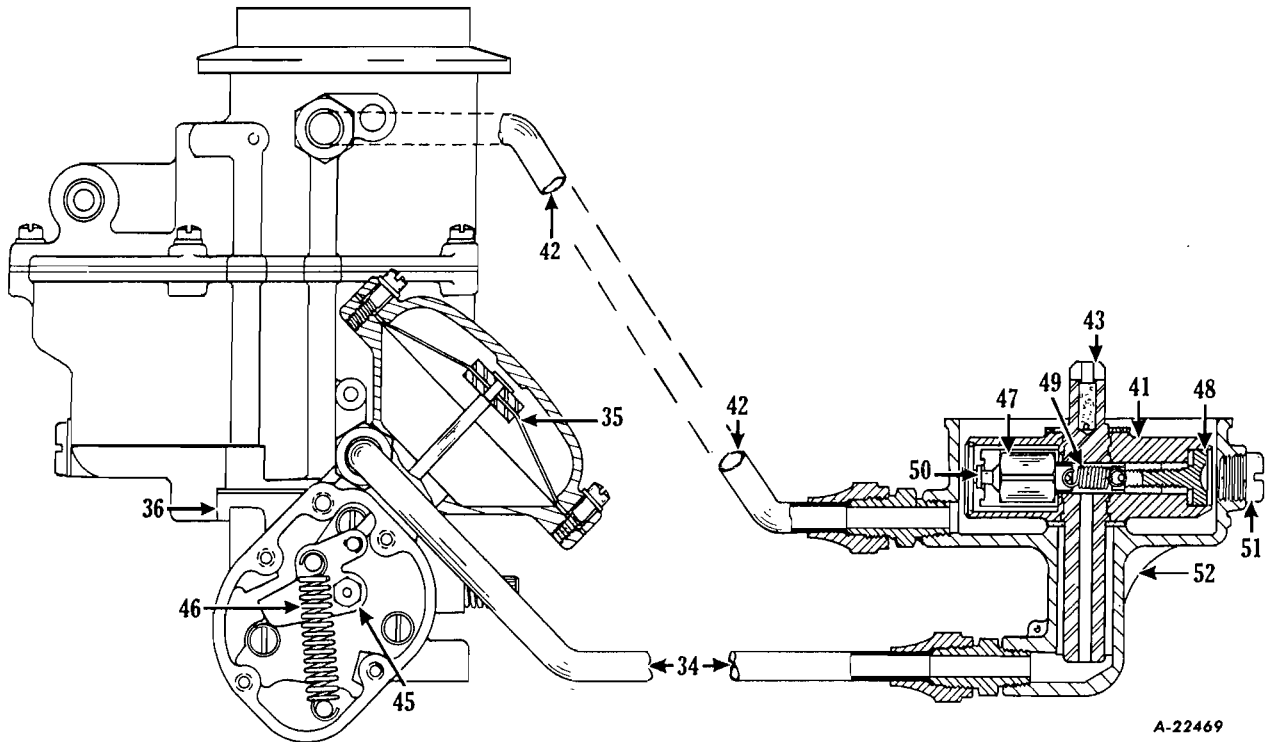


Fig. 6 - Showing adjustment provided for accelerating pump stroke. No. 1 hole shortens pump stroke. No. 2 length-increases pump stroke. The No. 2 hole is the intermediate and recommended position.

GOVERNOR - MODEL 1174

This engine speed governor has been designed and engineered as an integral part of the Holley Carburetor. The governor is a vacuum controlled device featuring all the advantages of a



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Fig. 7 - Details of governor. Spinner or rotor housing is located at distributor.

mechanical governor without resorting to lengthy and complicated linkage. The governor can be cleaned and serviced without the use of special tools.

The governor is made up of two units (see Fig. 7). The control at the engine end of the governor consists of a governor valve (47), an adjusting screw (48) and a spring (49) assembled in a rotor (41) which revolves at one half the engine speed, in a housing (52), attached to an engine driven shaft (43). The controls at the carburetor end of the governor unit consist of a diaphragm (35) which is connected to the governor lever (45) by a short rod and a tension spring (46) which is also attached to the governor lever (45) and tends to hold the throttle open.

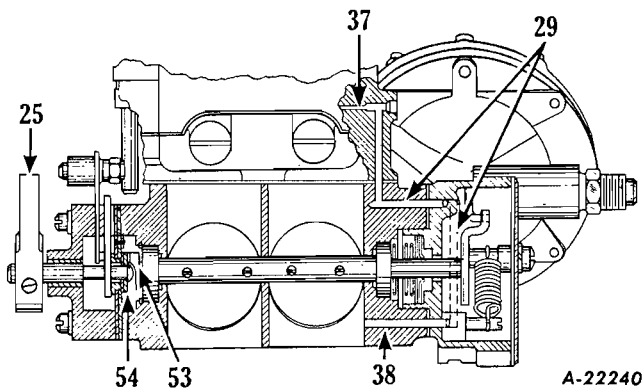
The diaphragm chamber (33) in Fig. 9 is connected to the governor valve air bleed orifice (50) in Fig. 7 by means of a conventional pipe line (34). The air bleed supply enters the rotor housing (52), Fig. 7, from a pipe line (42) attached to the engine air cleaner or carburetor as shown in Fig. 7.

Vacuum to the diaphragm (33), Fig. 7, is supplied by means of the two channels (37) and (38) as shown in Fig. 8. Channel (37) opens into the carburetor above the throttle plate and channel (38) below the throttle plate. These two openings are connected by channel (29), Fig. 8, which in turn is directly connected to channel (36) as shown in Fig. 9. The vacuum is controlled by the governor by-pass channel jets (39) instead of the variable restriction formerly used.

A detailed description and the operation of the above mentioned features follows:

Governor Operation

When the engine is running at idling speed, the throttle is controlled by the external lever (2), Fig. 8, and the pin (54) which is held against the internal lever (53) on the throttle shaft by the accelerator spring, as shown in Fig. 8. At idling speed, the governor valve (50) in Fig. 7 is held away from the air bleed orifice (50) by the spring (49) which is fastened to the governor adjusting screw (48). As the accelerator is



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Fig. 8

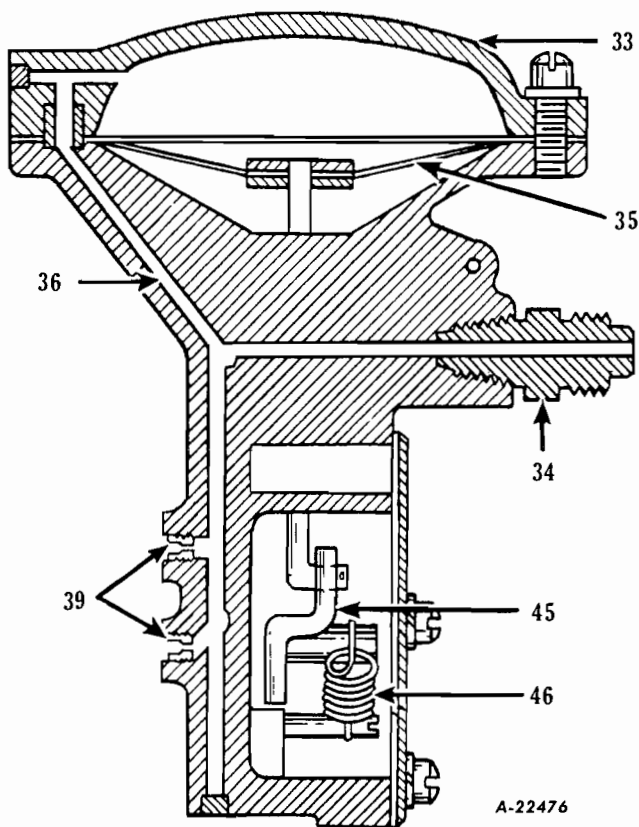


Fig. 9

moved to and held in the full open position to increase the engine speed, the governor spring (46) in Fig. 7, pulls the throttles to the wide open position to remain there until the engine r.p.m. has reached the predetermined governor cut-off speed. At this point, the governor mechanism which has kept pace with the engine speed is ready to go into action and take over control of the throttle, causing the accelerator system to become ineffective for further engine speed increase. The action of the mechanism is, that when the engine speed increases, the governor valve (50) in Fig. 7, stretches the spring (49) and moves toward the air bleed orifice (50) thus restricting the bleed to the diaphragm (35). As the air bleed to the diaphragm is reduced it permits the suction supplied by the orifices (37) and (38) in Fig. 8, to operate the diaphragm. As this suction increases, the diaphragm power overcomes the tension of the governor spring (46) in Fig. 7, and takes over full control of the throttles. The engine governed is then held constant by the valve (47) being balanced between the pull of centrifugal force actuated by the rotation of the shaft (43) and the tension of the spring (49) in Fig. 7.

Any slight change in speed or engine load will cause the governor valve (47) to act immediately either to increase or decrease the amount of air bleed through orifice (50), which in turn causes an instant response from the diaphragm to increase or decrease the throttle opening.

When the accelerator is released the control is taken away from the governor by the external throttle lever, and the governor connecting spring (40) then closes the throttle to bring the engine to any desired lower speed.

NOTE: The governor adjustments have been set at the factory to operate the engine at the proper recommended speed. It is not likely that the adjustments will change once they are set.

Governor Adjustments and Service Hints

To adjust the governor cut-off speed, proceed as follows:

1. Remove the seal from the screw (51) that will be found on the side of the governor housing (52) in Fig. 7.
2. Remove the screw from the housing.
3. Rotate the engine until the end of the governor rotor (41) in Fig. 7, which carries the adjusting screw (48) is in line with the hole from which the screw (51) was removed.
4. With a suitable screw driver turn the adjusting screw to the RIGHT to INCREASE the engine governed speed or to the LEFT to DECREASE the speed.

NOTE: Where the governor has been disassembled and serviced, after reassembling turn the adjusting screw (48) to the right until it stops then turn the screw to the left three full turns. Final adjustment is then made after the governor has been assembled to the engine as outlined above in operation 4.

HOLLEY CARBURETOR AND GOVERNOR OVERHAUL

The carburetor and governor can be overhauled with ordinary tools.

Clean all loose dirt from carburetor assembly before proceeding with the following instructions:

CAUTION: Do not immerse the carburetor assembly in cleaning solvent as the solution may cause damage to leather seals and governor diaphragm. Do not direct compressed air stream into air vent tubes in air horn as air pressure will damage float.

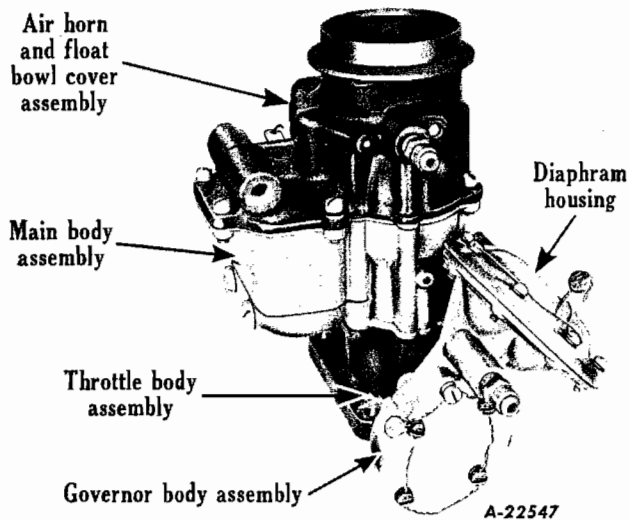


Fig. 10

Fig. 10 - The carburetor is in reality an assembly of four major sub-assemblies. These assemblies are identified above and should be disassembled and kept together in their respective groups.

Disassembly

Disassembly of the carburetor is as follows:

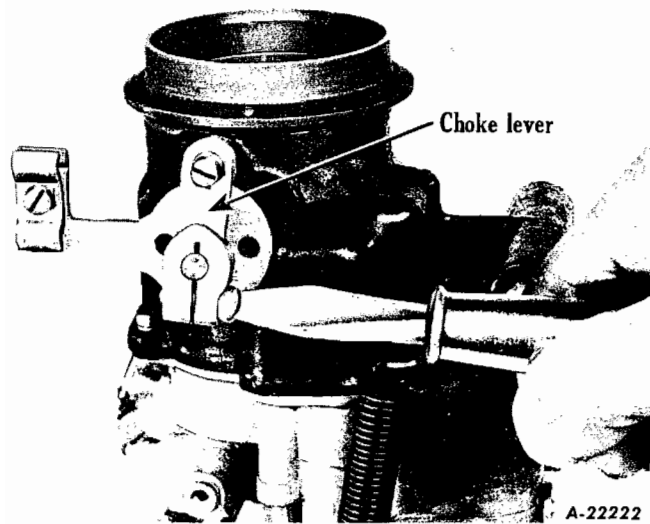


Fig. 11

Fig. 11 - Loosen screw in choke lever clamp and remove lever.

Fig. 12 - Remove two choke wire bracket retaining screws and lockwashers and remove the choke wire bracket.

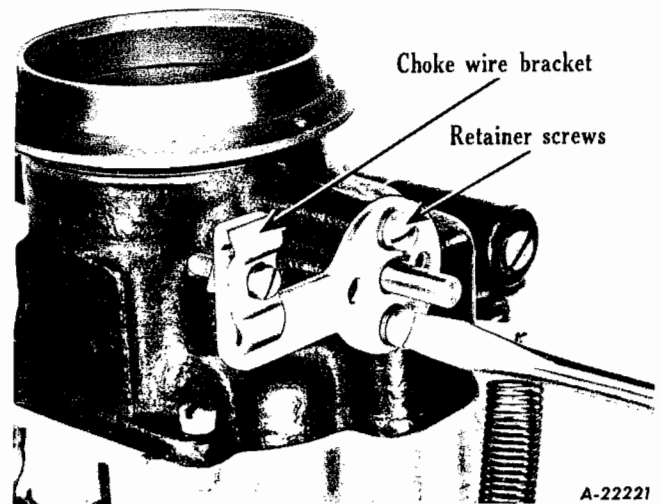


Fig. 12

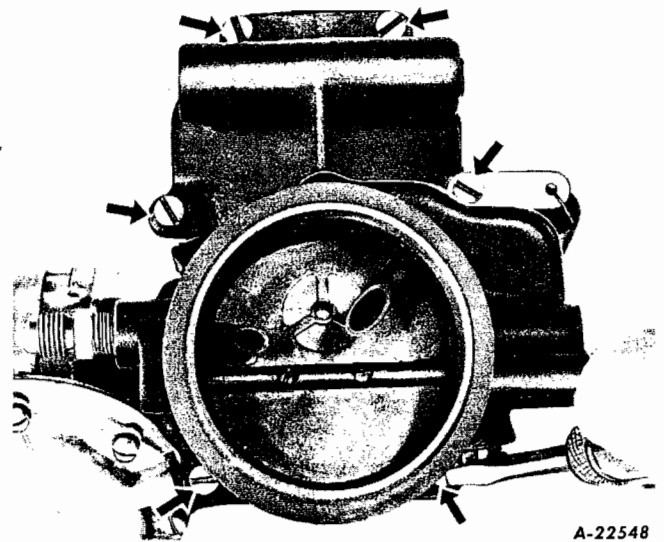


Fig. 13

Fig. 13 - Remove six air horn assembly screws and lockwashers.

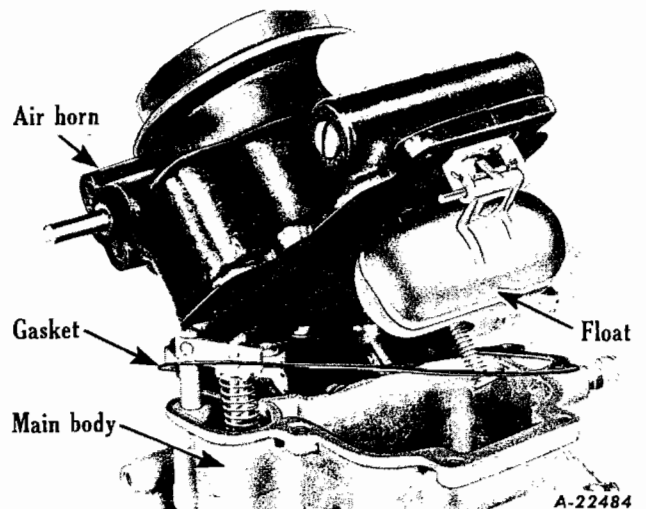


Fig. 14



Fig. 14 - Separate air horn from main body assembly and remove gasket. Be careful not to damage float.

Fig. 15 - Remove float shaft and float.

Fig. 16 - Remove fuel valve needle. Note: The fuel inlet valve, seat and gasket are serviced as an assembly and should be used in matched sets as supplied.

Fig. 17 - Remove fuel valve needle seat and gasket using a large screw driver that fits the slot properly or SE-1190-14 wrench.

Fig. 18 - Remove economizer piston and stem assembly. Use special wrench to fit piston retainer.

Fig. 19 - In removing the choke plate note that the two choke plate screws are upset and must be filed flat before removing to prevent breakage or stripping of threads in shaft.

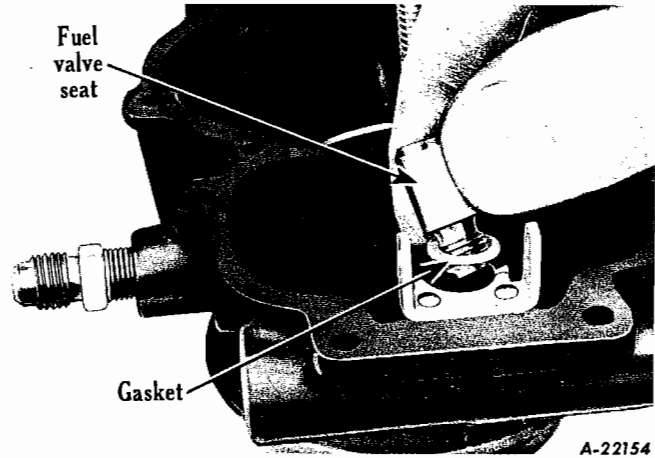


Fig. 17

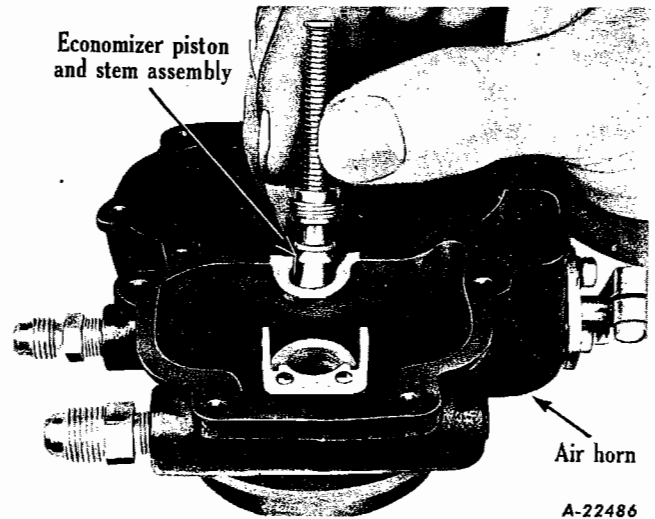


Fig. 18

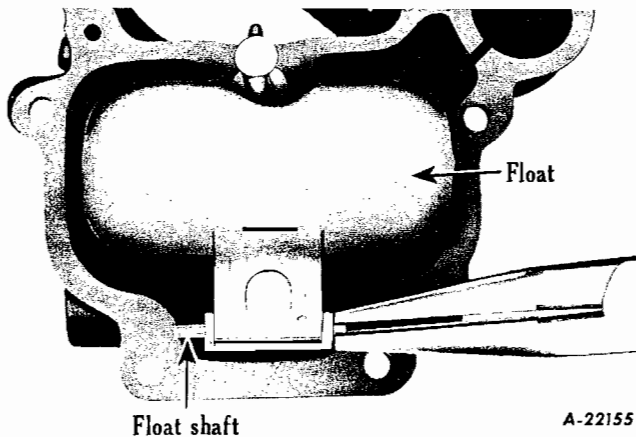


Fig. 15

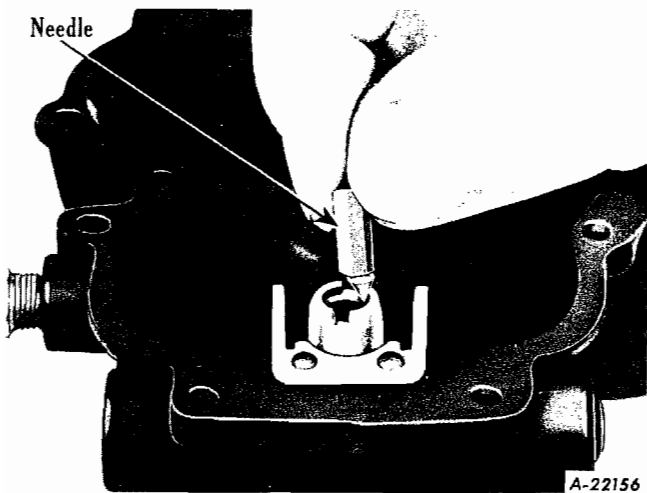


Fig. 16

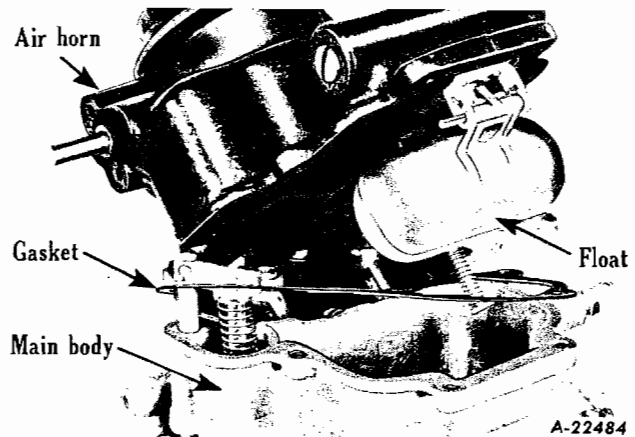


Fig. 19

Fig. 20 - Remove the two choke plate screws.

Fig. 21 - Remove choke plate, shaft and felt packing. Do not attempt to remove vent tubes. Do not remove plug from end of choke shaft bars. All removable parts have been stripped from air horn and float bowl cover assembly and should be kept together as a group ready for cleaning and inspection preparatory to reassembling.

Fig. 22 - Remove cotter pin holding accelerating pump link in place.

Fig. 23 - Remove the two throttle operator shaft housing assembly retainer screws and remove housing assembly.

Fig. 24 - Remove accelerating pump link. Note: It is not necessary to remove the throttle operator shaft housing assembly when changing pump link to secure better engine performance or to adjust carburetor for climatic changes. It was removed here to show the pump link lever more clearly.

Fig. 25 - Remove the throttle operator shaft assembly.

Fig. 26 - Remove the pump operating rod stud.

Fig. 27 - Remove the accelerating pump operator rod and piston assembly.

Fig. 28 - Disassemble the pump rod and piston by compressing the spring and removing the pump rod from the piston slot.

Fig. 29 - Remove accelerating pump operator rod seal. Use narrow blade screw driver and pry out felt retainer and remove felt.

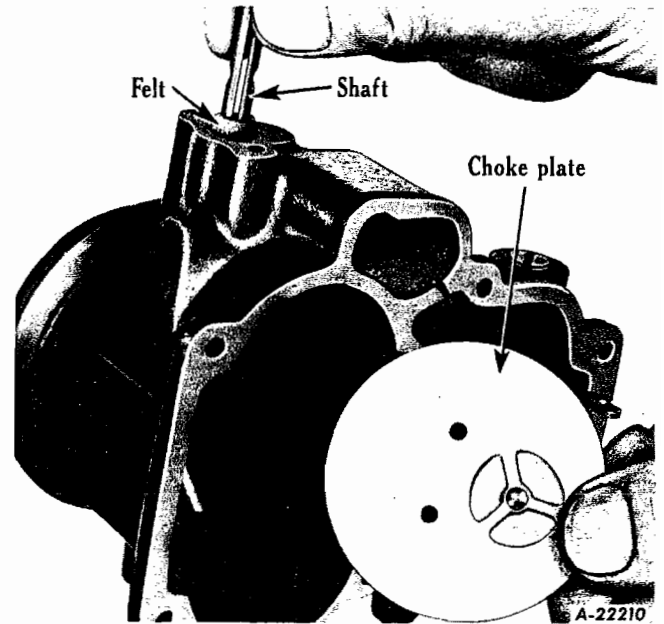


Fig. 21

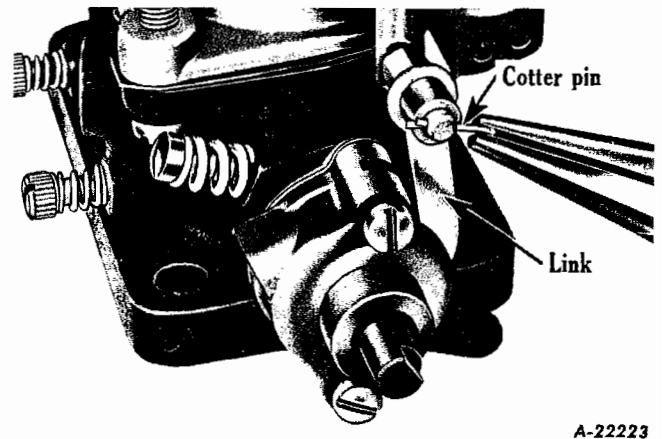


Fig. 22

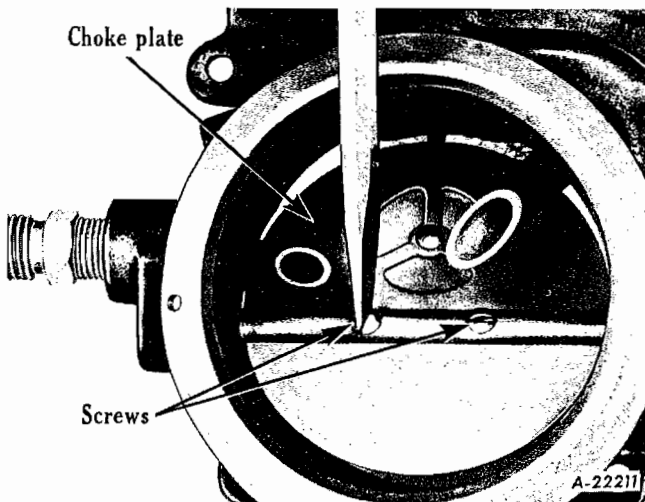


Fig. 20

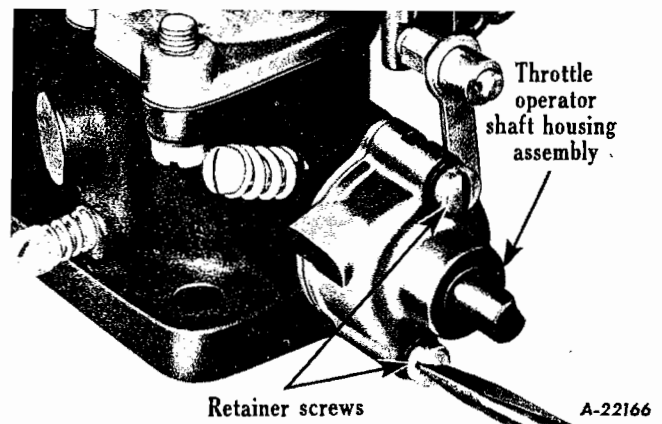
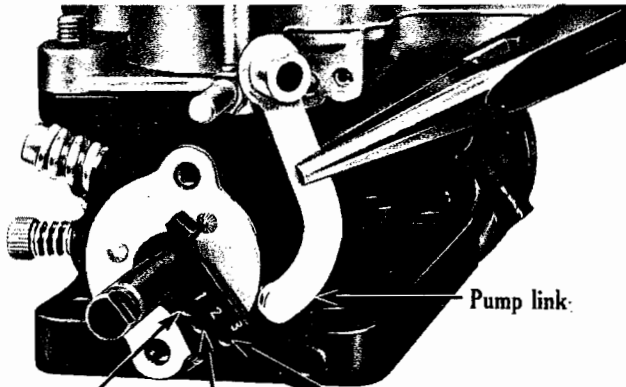


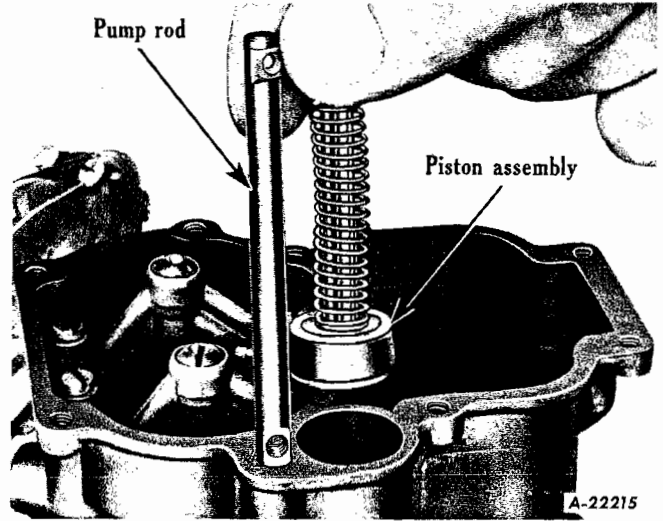
Fig. 23



1 Less fuel 2 Average 3 More fuel

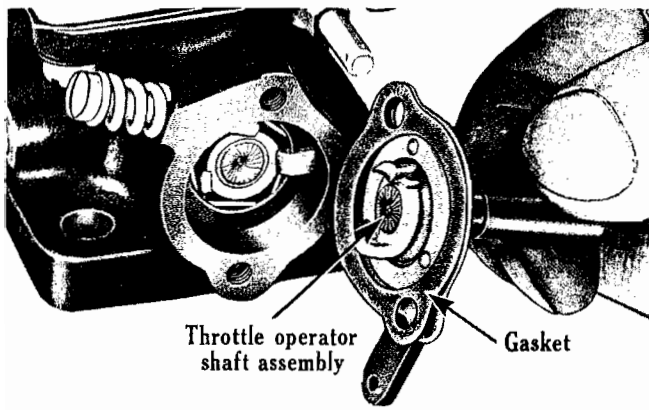
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Fig. 24



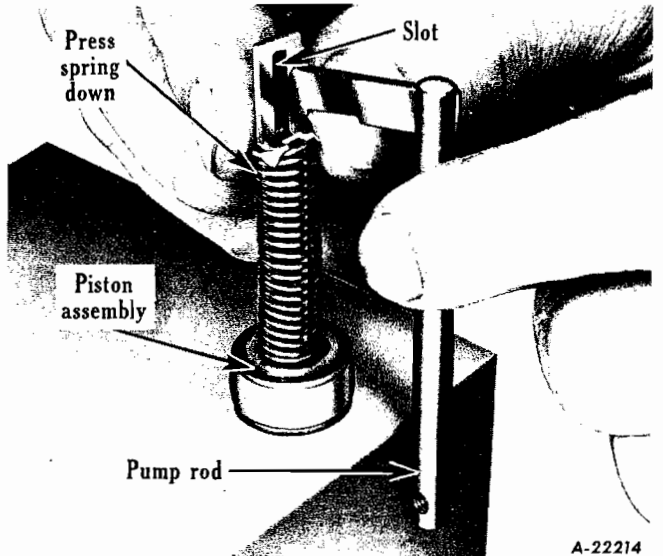
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Fig. 27



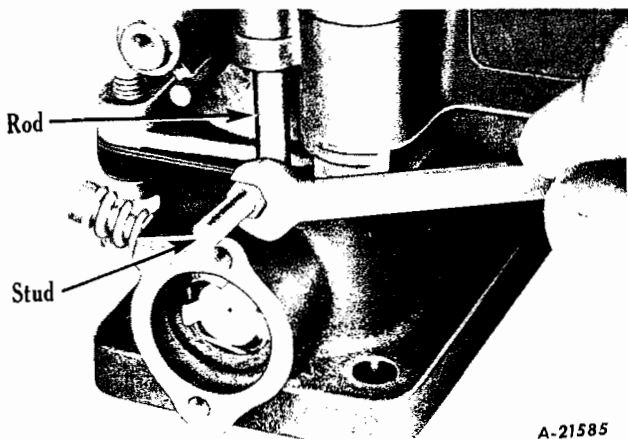
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Fig. 25



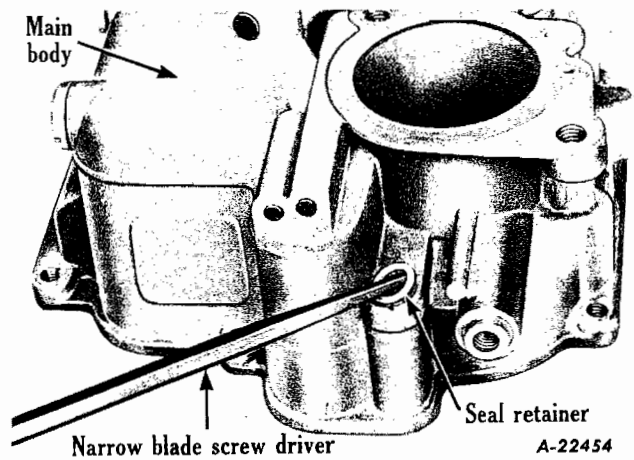
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Fig. 28



A-21585

Fig. 26



A-22454

Fig. 29

Fig. 30 - Remove the two brass air bleed plugs and gaskets located at the top of the main discharge nozzle bars.

Fig. 31 - Remove the two nozzle bar clamp screws and lockwashers located nearest the fuel reservoir and remove clamp.

Fig. 32 - Remove the accelerating pump discharge nozzle and gasket.

Fig. 33 - Turn the casting upside-down and catch the coiled spring and ball resting in the pump discharge nozzle well.

Fig. 34 - Remove the two idle tubes from the main discharge nozzle bars, using a screw driver.

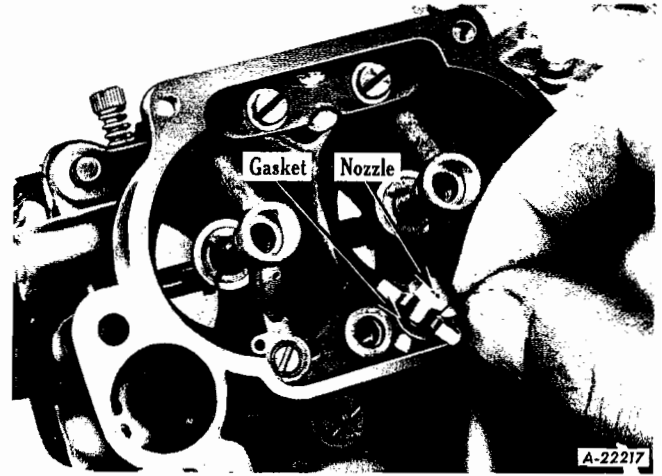


Fig. 32

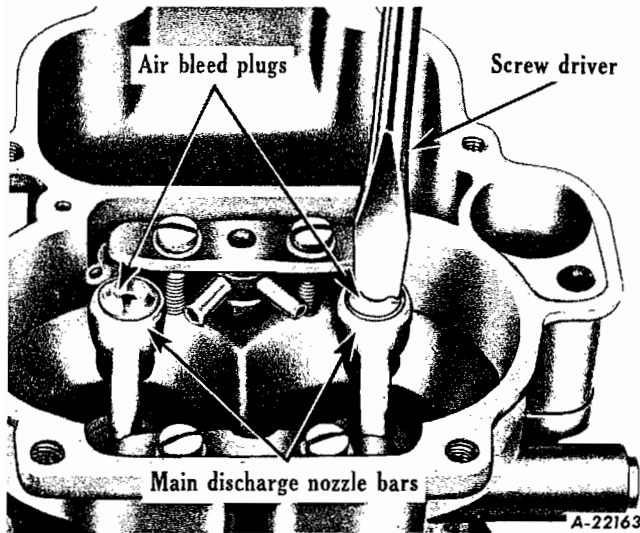


Fig. 30

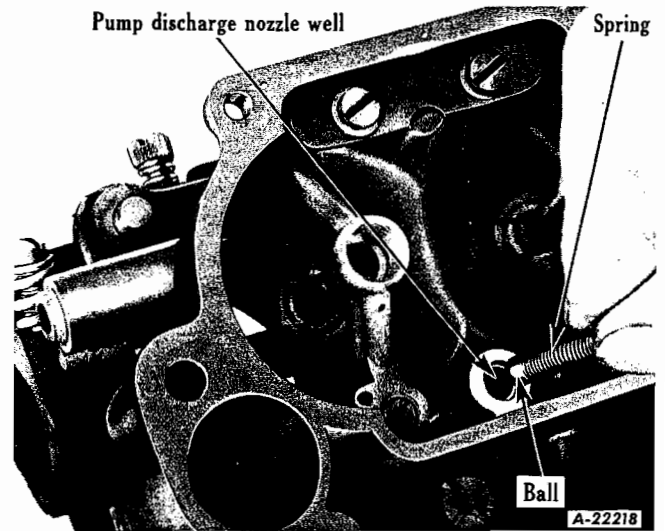


Fig. 33

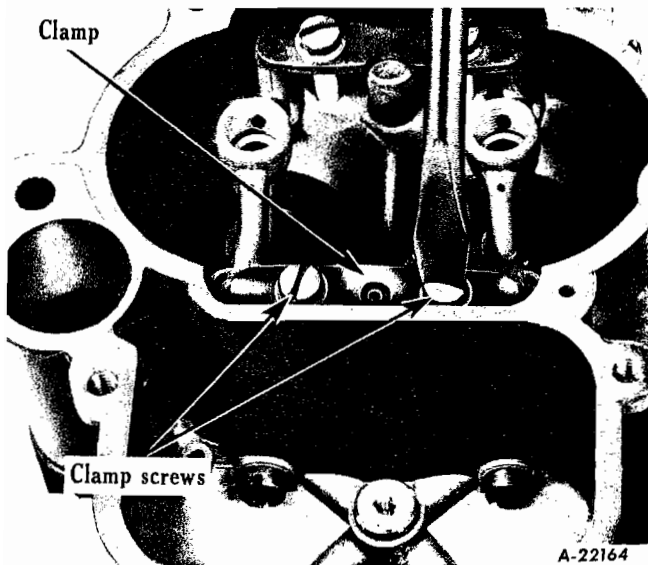


Fig. 31

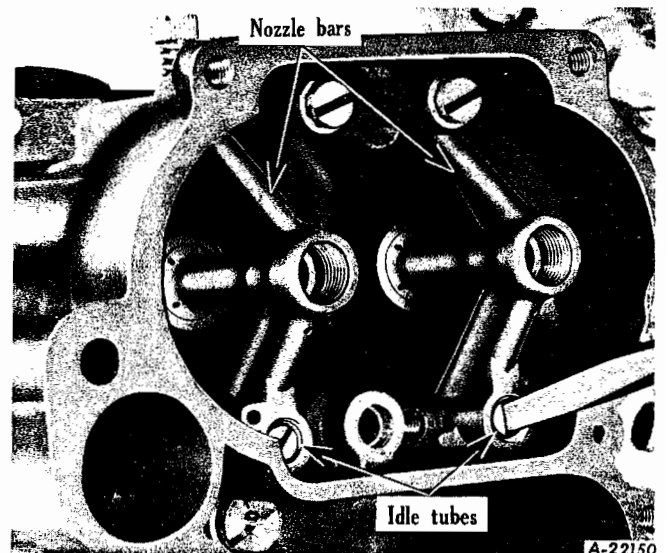


Fig. 34



Fig. 35 - Remove the remaining two nozzle bar clamp screws and remove clamp.

Fig. 36 - Remove the two nozzle bars and gaskets.

Fig. 37 - Use a wire having a short hook bent at 90° and remove the accelerating pump inlet ball check retainer spring from the bottom of the pump chamber. Turn the casting upside down and catch the inlet ball check.

Fig. 38 - Remove the two main jet passage plugs and gaskets.

Fig. 39 - Remove the two main jets using a screw driver or SE-1190-2 jet wrench.

Fig. 40 - Remove economizer valve and gasket in bottom of fuel bowl using a screw driver with a wide blade.

Fig. 41 - Lay casting on its side and remove two throttle body to main body assembly screws. Pass screw driver through the carburetor mounting stud holes in base.

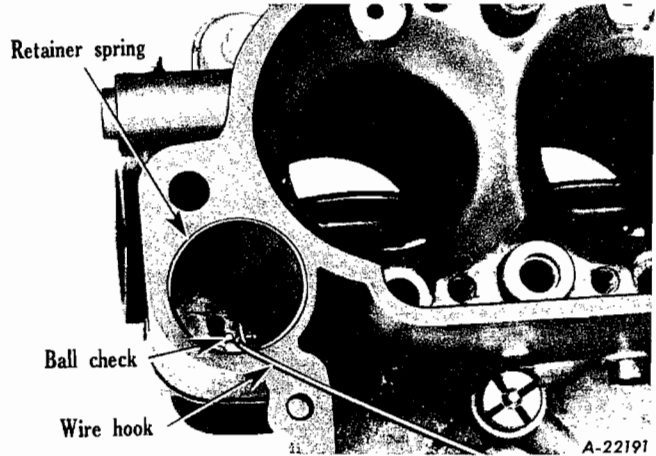


Fig. 37

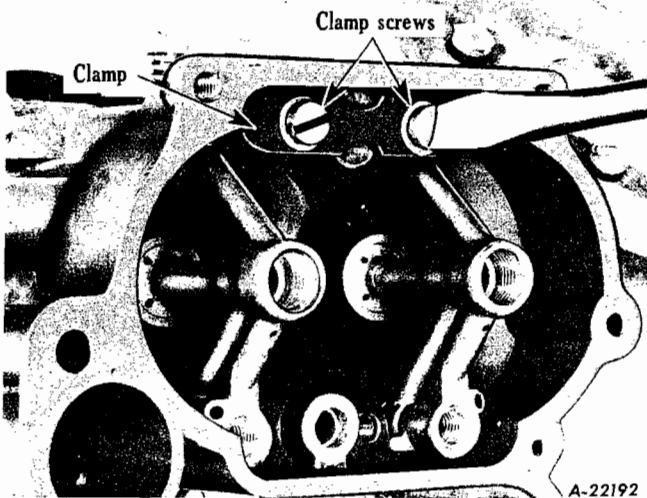


Fig. 35

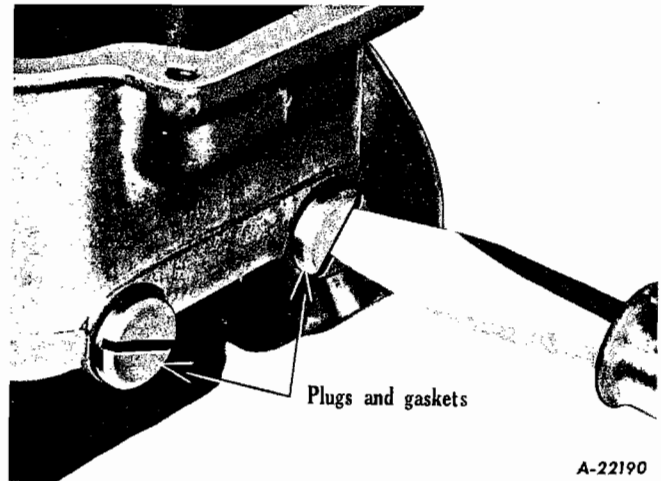


Fig. 38

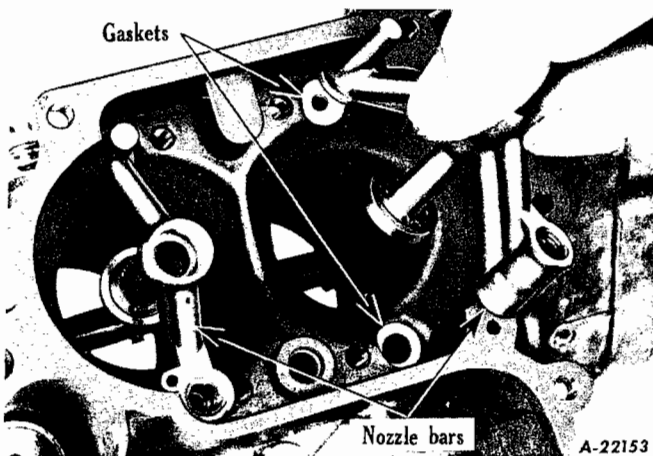


Fig. 36

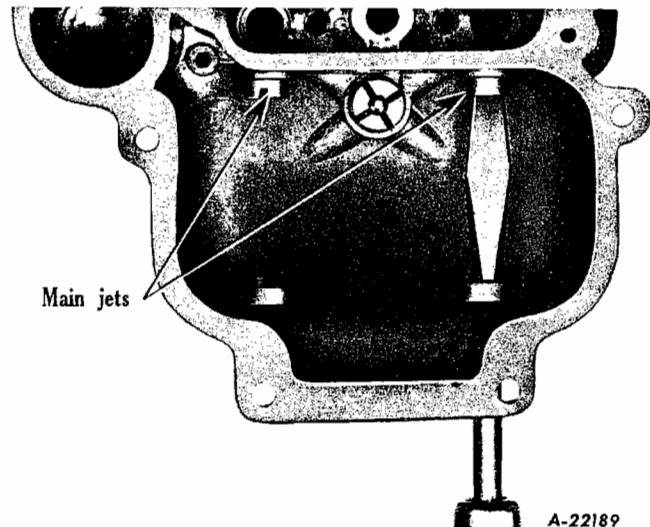


Fig. 39

Fig. 42 - Turn casting over and remove the third throttle body to main body assembly screw. Access to this screw is by means of a hole in carburetor mounting flange face.

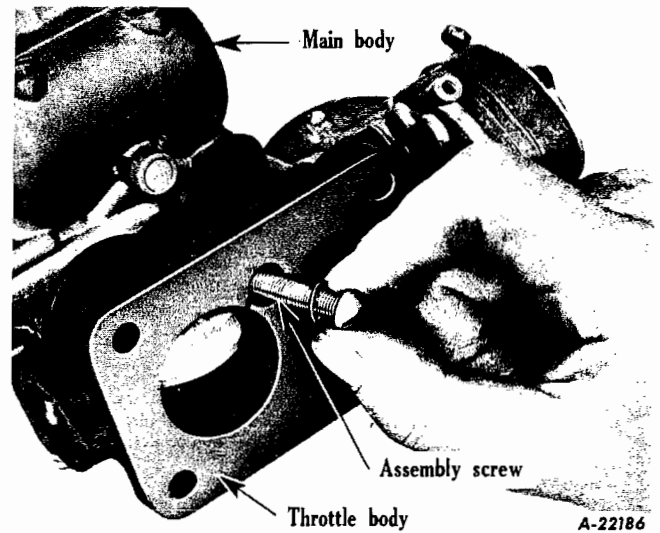


Fig. 42

Fig. 43 - Separate the main body from the throttle body assembly and remove gasket. Retain all parts removed from main body assembly as a group for cleaning and inspection.

Fig. 44 - Remove seal and wire from governor body cover plate screws.

Fig. 45 - Remove cover plate screws and lock-washers. Note: Plug screw located in cover plate. This screw serves to plug blind hole in governor housing and has no effect on carburetor operation.

Fig. 46 - Remove governor body cover plate and gasket.

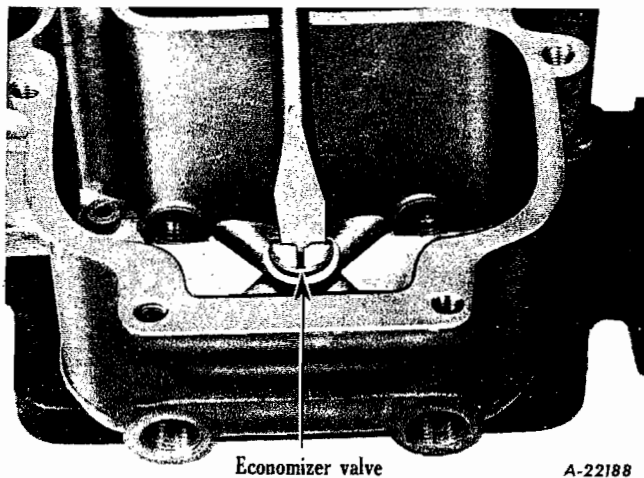


Fig. 40

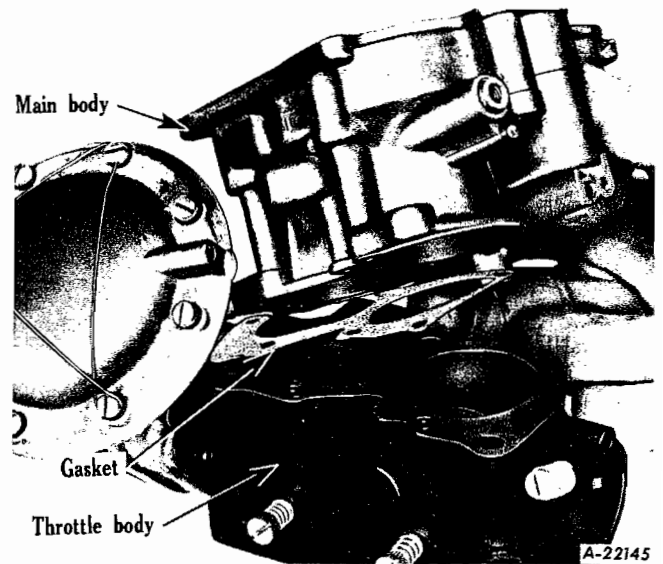


Fig. 43

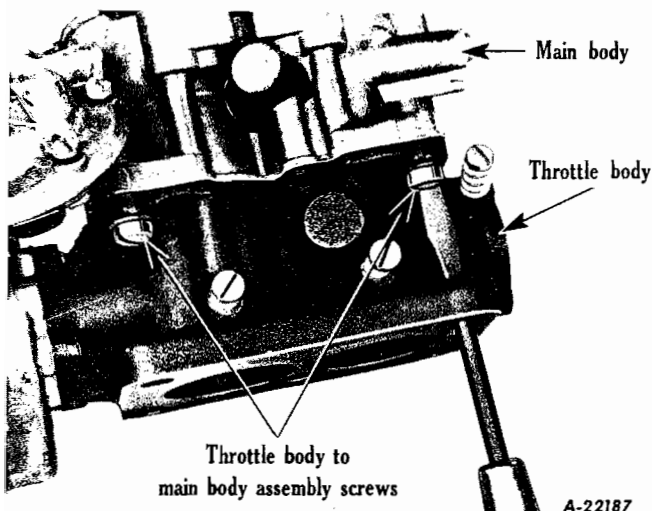


Fig. 41

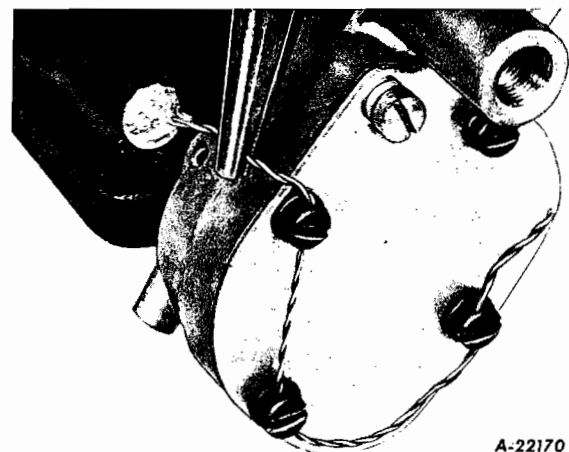


Fig. 44



Fig. 47 - Remove the governor spring with the fingers. Be sure to hold throttle open while removing spring.

Fig. 48 - Remove cotter pin holding diaphragm rod to governor lever.

Fig. 49 - Remove governor lever retainer nut and lockwasher. SE-1190-9 wrench fits this nut.

Fig. 50 - Remove governor lever from throttle shaft.

Fig. 51 - Remove the three screws and lockwashers that hold governor housing to throttle body.

Fig. 52 - Remove the governor housing from the throttle body and remove gasket. Note: The throttle shaft leather seal and washer will usually adhere to governor body, but were placed on shaft to show correct assembly.

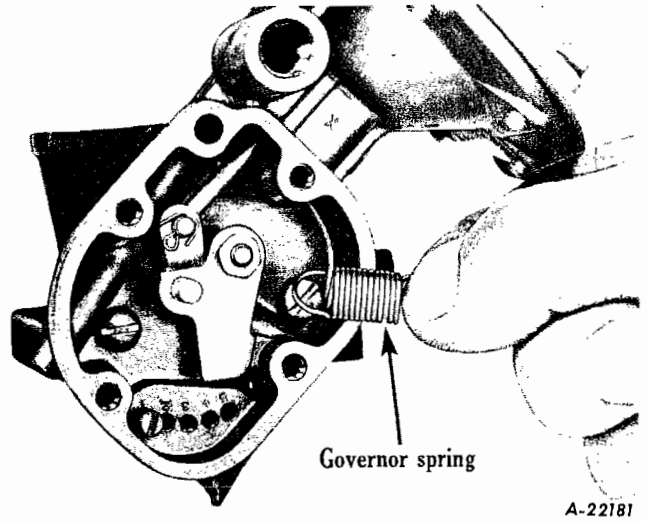


Fig. 47

A-22181

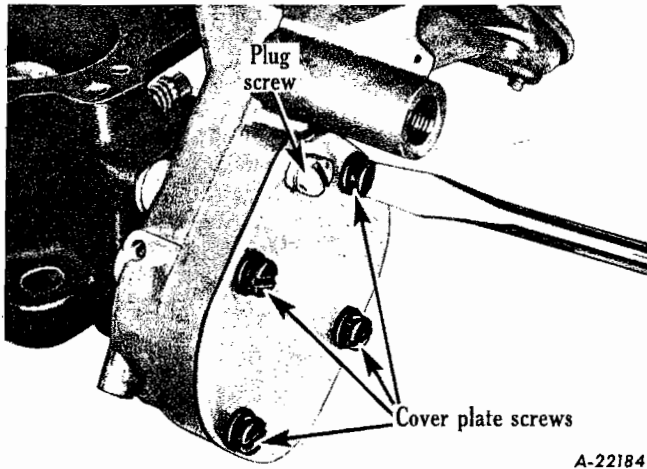


Fig. 45

A-22184

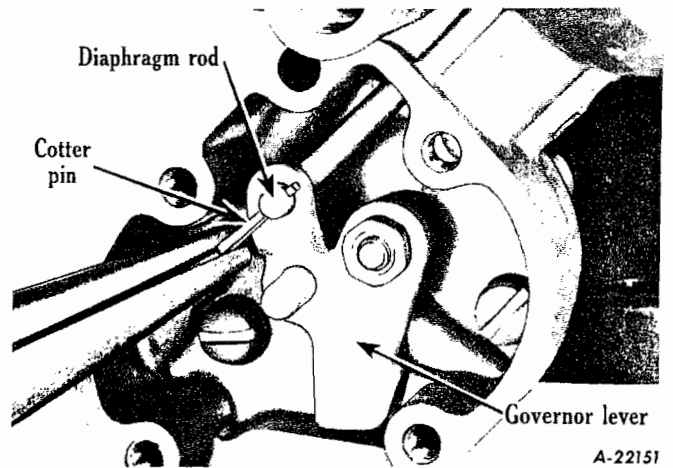


Fig. 48

A-22151

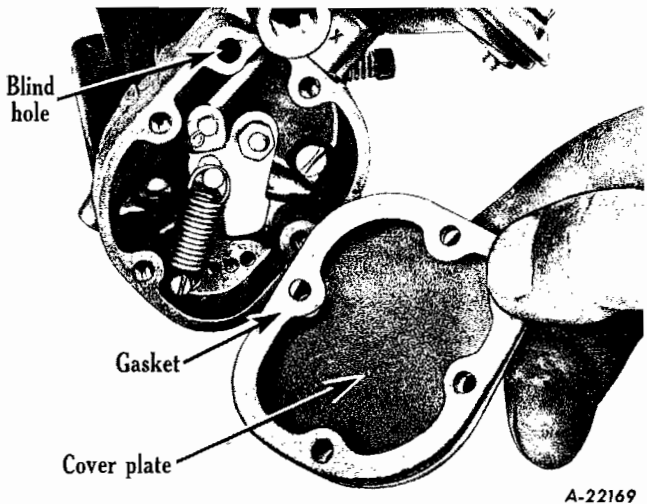


Fig. 46

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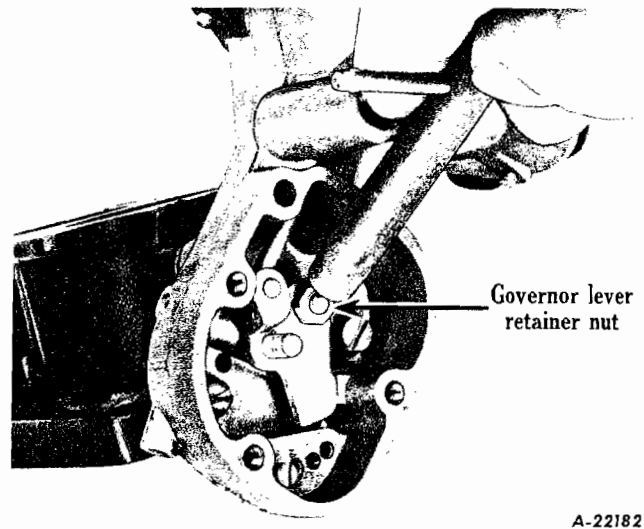


Fig. 49

A-22182

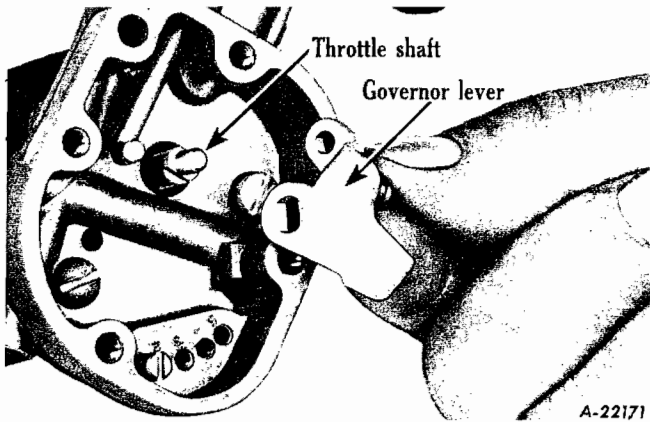


Fig. 50

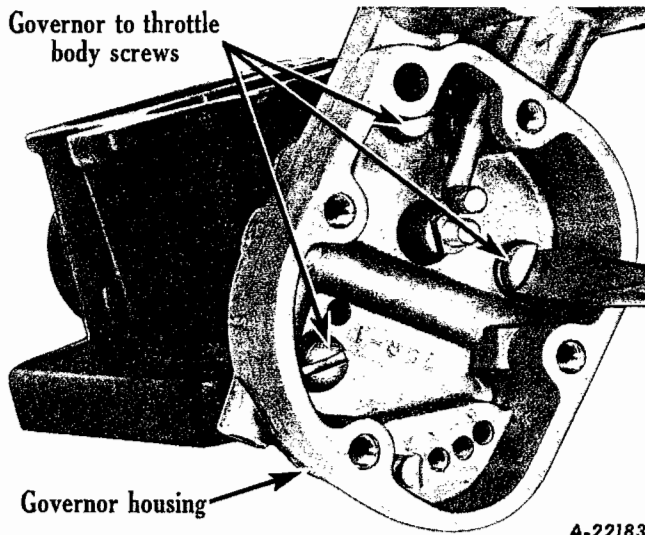


Fig. 51

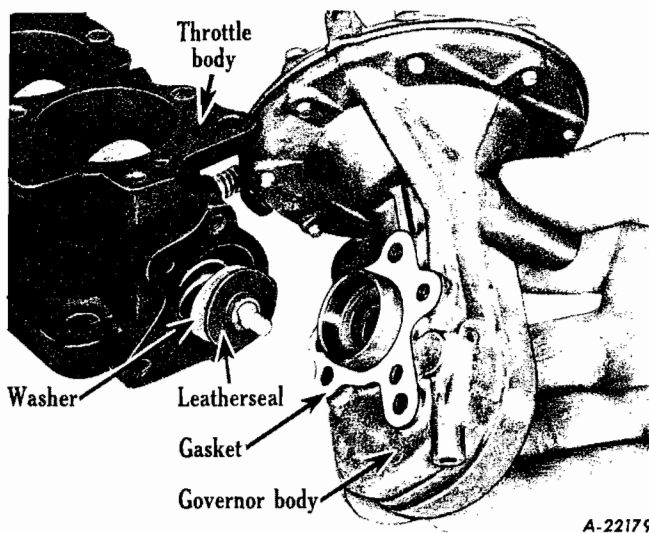


Fig. 52

Fig. 53 - Remove coiled seal retainer spring from throttle body.

Fig. 54 - Remove two idle adjusting screws and springs.

Fig. 55 - Mark the throttle plates "1" and "2" and also mark the same number on the casting flange as shown. Scribe lines across the full width of the plates against the shaft. This will assure installation in their proper barrels and in correct position when reassembling.

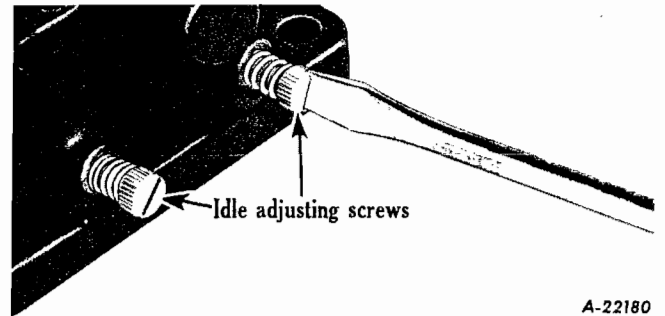


Fig. 53

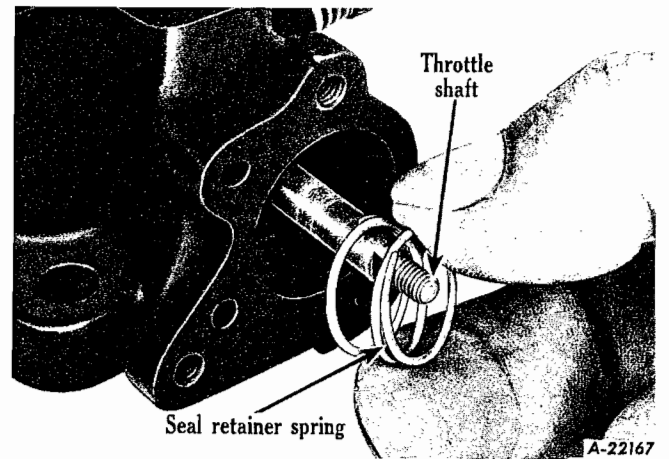


Fig. 54

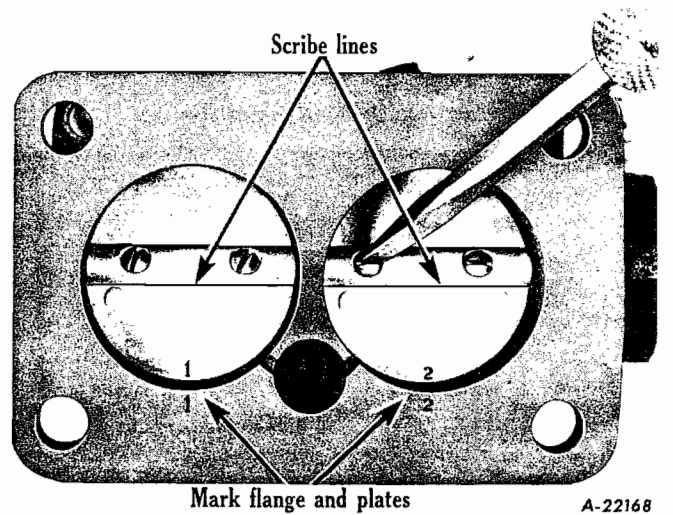


Fig. 55



The four throttle plate screws have been upset and must be filed flat before removing to avoid breakage or stripping of threads in shaft. Remove four throttle plate screws.

Fig. 56 - Remove the throttle plates.

Fig. 57 - Remove the throttle stop screw and spring.

Fig. 58 - Remove the retainer spring holding the throttle shaft and bearing assembly in place.

Fig. 59 - Remove the throttle shaft and bearing assembly by tapping threaded end of shaft lightly with a soft hammer. Note: Do not attempt to remove the bearing on end of shaft as this bearing is pressed and staked in place.

Fig. 60 - Insert a 9/32" brass rod through shaft hole, at throttle lever end, and remove throttle shaft bearing by tapping lightly on the brass rod.

The foregoing completes removal of all parts from the throttle body; parts should be kept together in a group ready for cleaning and inspection before reassembly.

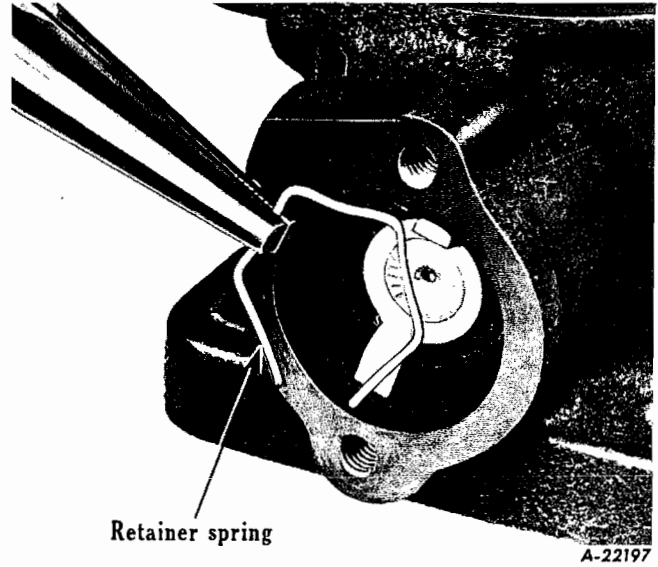


Fig. 58

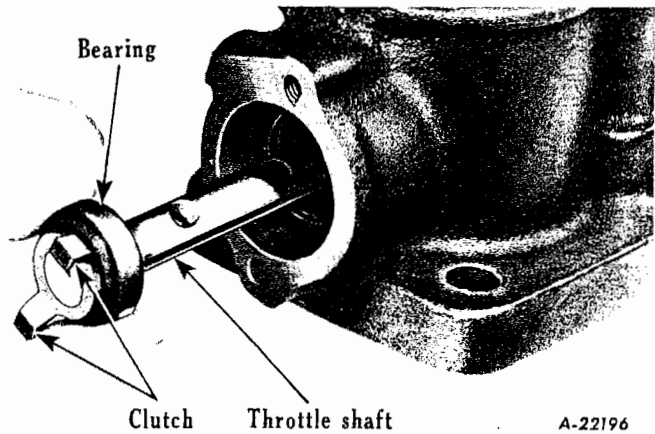


Fig. 59

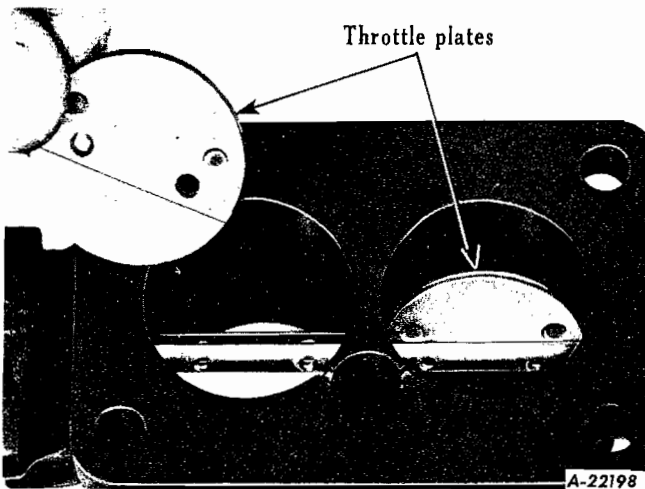


Fig. 56

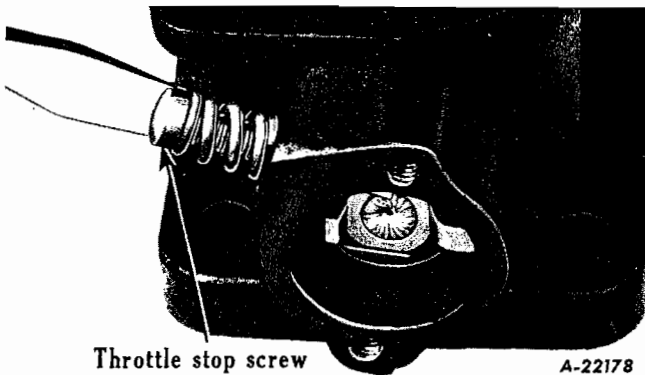


Fig. 57

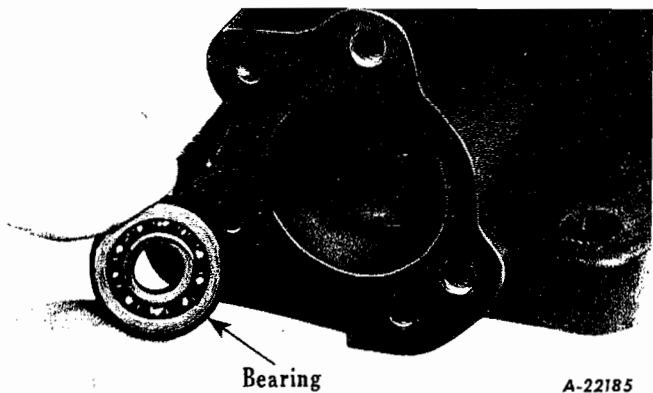


Fig. 60

- Fig. 61 - Remove the washer and leather seal from governor body.
- Fig. 62 - Remove the governor housing by-pass jets. The assembly of governor by-pass passage jets is shown above. The outside diameters of the "A" jet and "B" jet are not identical, hence it is impossible to assemble them incorrectly.
- Fig. 63 - Remove the seal and wire from the three governor diaphragm cover retaining screws.
- Fig. 64 - Remove the eight governor diaphragm cover retaining screws.
- Fig. 65 - Remove diaphragm cover. Use a soft hammer and tap lightly around the edge of the cover until cover breaks loose. **DO NOT PRY COVER OFF.** Remove the diaphragm and rod assembly. If diaphragm sticks to the body flange, carefully work it loose with the fingers.

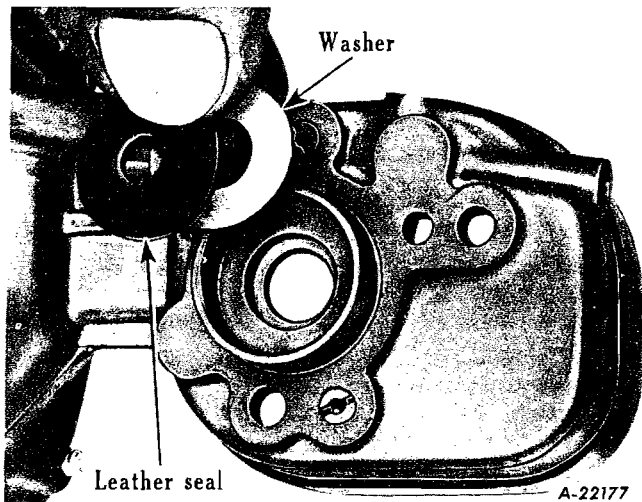


Fig. 61

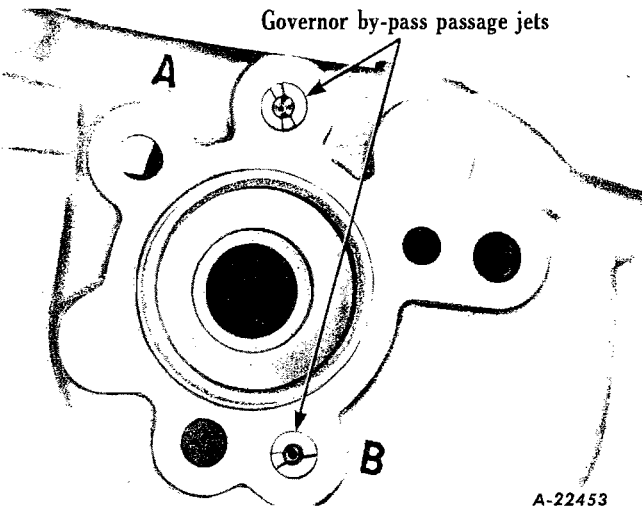


Fig. 62

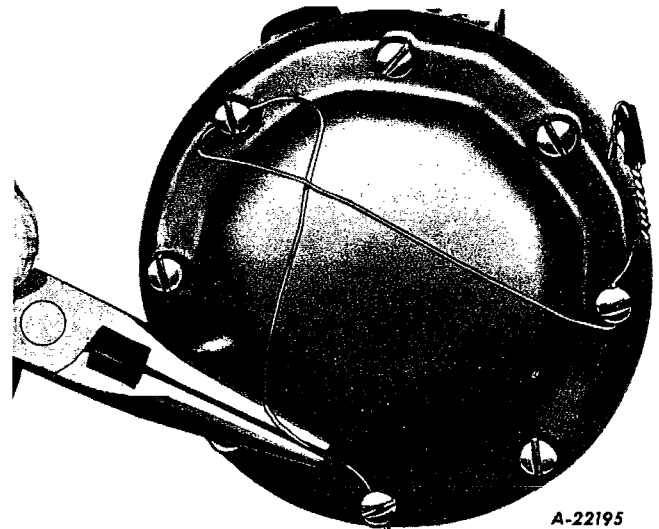


Fig. 63

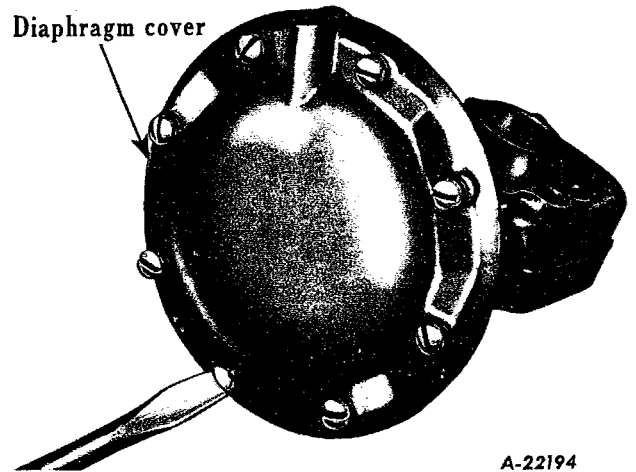


Fig. 64

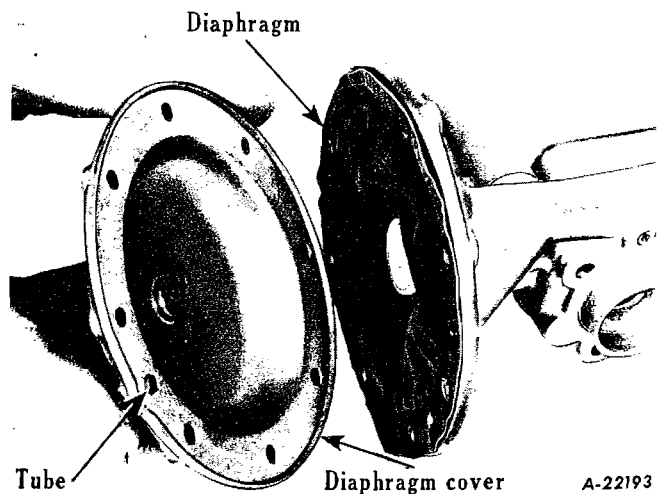


Fig. 65

NOTE: The foregoing instructions completely strip the governor; keep all the component parts together for cleaning and inspection, in preparation for reassembly.



Cleaning

1. The disassembled carburetor should be segregated into the four major groups. Clean the castings and parts in each individual group. Wash castings thoroughly in cleaning solvent and blow out all passages with compressed air. **CAUTION:** Do not wash **LEATHER** parts or governor **DIA-PHRAGM** in cleaning solvent. If these parts are dirty wipe them with a soft cloth.
2. Wash metal parts in a cleaning solution and rinse them in a solvent solution. Dry all parts thoroughly.
3. Remove all carbon deposits from throttle body bores and throttle plates. **CAUTION:** A wire or drill used to clean metered jets or discharge holes will destroy the accurate calibration and defeat the purpose of the overhaul. Do not use a wire brush to clean parts.

Inspection and Assembly

Inspect and assemble castings and parts by groups. **NOTE:** Inspect all parts thoroughly, check closely for any possible defect. Replace any doubtful parts. Never use old gaskets when reassembling the carburetor.

Air Horn and Float Bowl Cover

Replace all defective parts and assemble as follows:

1. **CASTING.** Examine for cracks or breaks. Be sure sealing surfaces of casting are smooth and clean. Float lever bracket must not be twisted or bent.
2. Install new choke shaft felt in choke shaft hole counterbore.
3. Assemble choke wire clamp bracket to casting with the two mounting screws. Mount bracket with the clamp end to the left when holding casting with air filter side facing up.
4. **CHOKE SHAFT.** If shaft is bent or indicates excessive wear, use a new shaft. Install choke shaft.
5. **CHOKE PLATE.** Replace the plate if poppet valve assembly is damaged. To facilitate installation of the choke plate, rotate the choke shaft until the countersunk holes face the vent tubes. Hold the shaft in this position and insert the choke plate from the float side of casting and with the poppet valve stem pointing away from vent tubes. Center the plate in the bore and assemble to shaft using new screws. The screws must be upset to lock them firmly in place. Use a

blunt center punch for this operation, also support opposite side of shaft to prevent bending the shaft.

6. **CHOKE LEVER.** Install on shaft with choke wire lock screw in swivel nut facing away from air horn casting and with outer edge of lever flush with end of shaft. Hold choke plate in open position and tighten lever clamp screw.
7. **FUEL INLET VALVE SEAT ASSEMBLY AND GASKET.** Whenever a carburetor has been in continual service for 10,000 miles or more, and when carburetor is being overhauled for any reason whatsoever, always replace original fuel inlet valve assembly with a complete new unit. Install a new fuel inlet needle, seat and gasket. Wipe taper of needle valve with a soft clean cloth before inserting in valve seat.
8. **FLOAT.** Replace float if it is corroded or damaged in any way. If the lip on the float lever is rough, polish with a small piece of No. 320 wet or dry abrasive paper. Place float in position in hinge bracket. Be sure float balancer spring is in position.
9. **FLOAT LEVER SHAFT.** Replace shaft if bent or shows excessive wear at bearing ends. Assemble shaft and float to bracket. There should be at least .005" clearance on each side of float lever and assembly bracket. If end play is insufficient, remove the float and spread the bracket.
10. **FLOAT LEVEL SETTING.** Hold air horn assembly at eye level (float side up) and gauge float. Gauge must just slide over top of float when float is in closed position. If float is too high, press it down gently with the fingers and regauge. If float is too low, remove it and insert a narrow screw driver between the float bracket and lip. Twist the screw driver enough to raise the lip. Install float and regauge. (See Float Level Adjustment.)
11. **ECONOMIZER PISTON AND STEM ASSEMBLY.** Examine assembly closely. Replace if piston is worn, stem is bent or spring is damaged. Install economizer piston and stem assembly.
12. After completing installation of economizer piston and stem assembly place casting to one side until ready to assemble to main body.

Main Body

1. **CASTING.** All gasket surfaces must be smooth and clean. If any sealing surface is damaged to the extent that a perfect seal is impossible, the casting must be replaced.

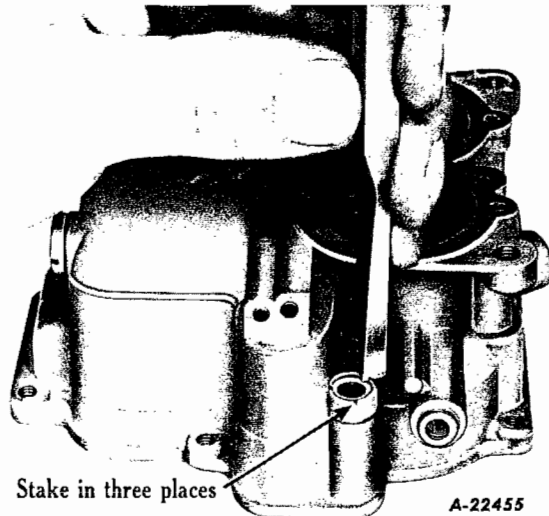


Fig. 66

2. Pump the operator rod and seal. Install a new felt seal and retainer washer and stake as shown in Fig. 66.
3. JETS. Replace jets if screwdriver slot, orifice or threads have been damaged or otherwise mutilated.
4. Install jets in casting.
5. ACCELERATING PUMP INLET BALL CHECK. Replace ball check if it is corroded or nicked. Drop ball into pump chamber and work into seat housing. (Ball seat is located in cut-away portion of chamber floor, in which the bent end of the retainer fits.)
6. RETAINER SPRING. Replace spring if bent or twisted (spring must lay flat). Install spring in pump chamber keeping bent end of spring in line with ball check. Then with a 5/8" diameter dowel pin of wood or fiber, press the retainer in the groove at bottom of chamber. Be sure bent end of spring is directly over the ball when in place
7. PUMP DISCHARGE BALL CHECK AND SPRING. Replace ball check if corroded or nicked. Replace coiled spring if corroded or distorted. Install ball check in pump discharge well. Install coiled spring over ball check.
8. PUMP DISCHARGE NOZZLE AND GASKET. Replace if damaged in any way. Discharge holes must be clean (blow out with compressed air). Place a new gasket in position on nozzle and hold assembly until ready to install bar clamp after main discharge nozzle bars have been placed in position.

9. DISCHARGE NOZZLE BARS. Replace nozzle bars if damaged in any way. All drillings and channels must be free from dirt (blow out thoroughly with compressed air).

10. Install four new neoprene nozzle bar gaskets in place. Note: In all cases where nozzle bars have been removed from casting for any reason use new gaskets when reassembling. To install gaskets, place a gasket on the blade of a narrow screw driver and put blade at edge of gasket seat. Then elevate handle of screwdriver until gasket slides into place.
11. Install nozzle bars in place, being careful not to dislodge gaskets.

Note: Nozzle bars are marked with the letter "R" or "L" meaning right or left on the outer wall of the idle tube housing. (See Fig. 36). Place nozzle bar marked "R" next to accelerating pump chamber.

12. Place nozzle bar clamp in position on opposite side of fuel bowl. Insert short clamp screws and star washers through clamp and tighten screws just enough to hold nozzle bars in place.
13. IDLE TUBES. Replace idle tubes if bent or otherwise damaged blow out idle tubes with compressed air and install in place. Fig. 34. Idle tubes must be tight on seats.
14. Install the remaining nozzle bar clamp, first being sure to install the fuel pump discharge nozzle and gasket. Also make sure fuel pump discharge ball check and spring are still in place. Tighten both clamps.
15. Install new bleeder plug gaskets in top of nozzle bars. Install bleeder plugs in place and tighten.
16. ECONOMIZER VALVE. Replace valve if spring is weak or if the valve stem is bent. Place a new gasket on valve body and assemble valve in place. (Fig. 40).
17. ACCELERATING PUMP. Examine pump piston, operator rod, operating spring, leather cup and cup expander spring. Replace any worn, bent or distorted parts.
18. Assemble pump rod, spring and retainer to piston and install the pump assembly in the pump chamber of the main body casting. Be careful not to damage the leather as it is entered into the pump chamber.
19. PUMP OPERATING ROD STUD. Replace stud if bent or badly worn. Using a small accurate fitting open end wrench (1/4") tighten stud to rod.



20. Assemble main jet plugs and gaskets to casting. Blow out casting thoroughly with compressed air.
21. Assemble air horn to main body. Recheck the float setting using gauge. Holding assembly gasket in place assemble air horn to main body and tighten all screws tight. Be sure throttle lever spring bracket is installed in correct position at accelerating pump chamber. See Fig. 67. Place assembly to one side being careful not to damage accelerating pump operating rod.

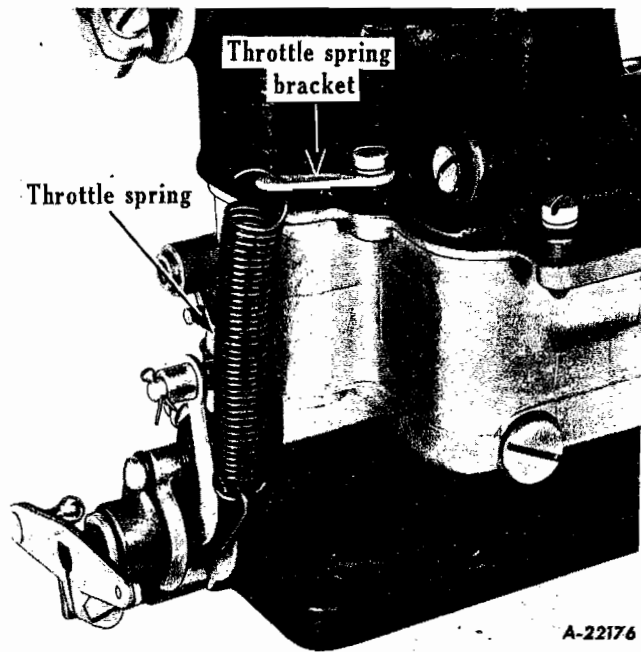


Fig. 67

Throttle Body

Inspect and assemble throttle body as follows:

1. **THROTTLE SHAFT BEARING.** Replace bearing if worn, corroded or damaged in any way. Bearing must rotate freely and be free of gum and grit. Install the bearing in the throttle body bearing boss on the governor side and with a brass rod lightly tap bearing in place.

Note: Bearing must be installed with lettering on race visible after installation.

2. **THROTTLE SHAFT AND BEARING.** Replace the assembly if the shaft is bent or if threads are stripped. Replace the assembly if the bearing is corroded, damaged or worn or if throttle clutch is loose. Bearing must be free from gum or grit. Install throttle shaft and bearing. Install throttle shaft bearing retainer.

3. **THROTTLE PLATES.** Replace throttle plates if they are nicked or otherwise damaged. To install plates, place throttle body on bench with the manifold mounting flange up and the threaded end of the throttle shaft to the left. Rotate the shaft until the countersunk holes in shaft are facing the idle adjusting screw bosses.

Note: During the disassembly operation, the plates and barrels were marked No. 1 and No. 2. Place No. 1 plate in No. 1 barrel. Install the throttle plate with the bevel edge down and facing the countersunk side of shaft. Close the plate, and using the previously scribed lines as a guide, center the plate in the bore and assemble plate to shaft with new screws. Before drawing screws tight, be sure the plate is properly centered. Repeat same procedure to install the other throttle plate. Then check the four assembly screws to be sure they are tight.

4. Upset the threaded ends of the screws with a blunt center punch and a light hammer. Be sure to support opposite side of shaft to prevent bending. After upsetting screws, check the shaft to make sure it oscillates freely. If shaft binds or drags, tap screw heads lightly with a brass rod until shaft operates freely.
5. Rest throttle body on bench with threaded end of shaft up.

Governor Body

1. Check all sealing surfaces for cracks, nicks, or imperfections. Replace casting if defective. Using compressed air, blow out all governor channels. Replace governor body, etc.
2. **LEATHER BEARING SEAL AND STEEL WASHER.** Replace leather seal if worn or otherwise damaged. Replace the steel washer if it is damaged.
3. Install leather seal in governor body so that the flat side of the seal is up. Install steel washer over leather seal.
4. Install coiled retainer spring against bearing in throttle body.
5. Assemble governor body to throttle body. Be sure gasket is correctly lined up before inserting the three assembly screws and lockwashers. Draw assembly down tight.
6. **GOVERNOR DIAPHRAGM AND ROD ASSEMBLY.** Replace assembly if diaphragm is burned, torn or otherwise damaged. Replace the assembly if the rod is bent or twisted.



Note: Sealing surfaces of diaphragm housing and cover must be clean and free from nicks or burrs.

7. Install diaphragm assembly to housing with the bent end of the rod parallel with the throttle shaft and pointing away from the throttle body. (See Fig. 48). Line up the holes and place diaphragm cover in position.

Note: Be sure that suction connector tube (Fig. 65) in cover fits into suction channel in the body properly.

8. Assemble cover to body with eight screws and lockwashers. Thread all screws in until both flange surfaces nearly come together. Then with the thumb or fingers pull the diaphragm rod as far back (toward the throttle shaft) as possible, hold it there and tighten every other cover assembly screw tight. Then release the rod and tighten the remaining screws.

Note: When inserting the cover screws, observe the three screws that are drilled for the seal wire. Space drilled screws as shown in Fig. 63. Install the seal wire and seal.

9. GOVERNOR LEVER. Replace the lever if the pin is loose or if rod is worn. Start lever onto throttle shaft and work end of diaphragm rod into hole in lever. Press lever into position and assemble to shaft with hex, nut and lockwasher. Be sure that nut is started correctly. Use a 5/16" socket wrench.

CAUTION: Excessive tension will strip the threads on the shaft.

DO NOT DRAW THE NUT DOWN TOO TIGHT.

10. Push end of diaphragm rod through lever by placing a thin blade screw driver or similar tool under the rod. Lock rod to the lever with a cotter pin. Insert the cotter pin so that open ends point towards the diaphragm. Spread the ends of the cotter pins around the rod.
11. GOVERNOR OPERATING SPRING. Replace the spring if corroded or distorted. Install operating spring with the fingers by hooking the loops over pins. Be sure the loops drop into the grooves in the pins.
12. GOVERNOR BY-PASS PASSAGE JETS. Replace jets if worn or damaged. Install the by-pass jets in "A" and "B" channel (Figure 62).

Note: The by-pass jets have different outside diameters to aid in making correct installation.

13. GOVERNOR COVER AND GASKET. Install a new gasket and install cover to governor body. Install seal wire in cover screws and seal.

Throttle Body Idle Screws and Shaft Assembly

1. IDLE ADJUSTING SCREWS AND SPRINGS. Replace screws if the tapered points are badly scored or bent. Replace the springs if they are corroded or distorted. Install adjusting screws and springs.

Note: Turn screws in with the fingers until they are seated. (Do not use a screw driver.) Then back screws off seats one full turn.

2. THROTTLE LEVER AND THROTTLE OPERATOR SHAFT ASSEMBLY. Replace lever if bent or if ball stud is worn. Replace shaft if worn, or accelerating pump lever if loose or if clutch assembly is loose.

Replace housing if shaft bearing is down or if housing is damaged.

Install throttle operator shaft in housing and place throttle lever in position (ball stud facing toward carburetor) and tighten lever clamp screw.

3. Install the two throttle operator lever shaft housing mounting screws and place gasket in position. Hold the assembly with throttle lever ball stud up and assemble to throttle body as shown in Fig. 23. Tighten housing mounting screws.

Note: Check the assembly; if correct, the throttles will close when lever is turned counter-clockwise. Releasing lever should permit governor operating spring to pull throttle into full open position.

4. THROTTLE LEVER STOP SCREW. Place spring over stop screw and install assembly in throttle body. Holding throttle plates closed, turn the throttle stop screw in until throttles open enough to allow a .003" feeler to pass freely between edge of plate and wall of bore.

Main Body and Throttle Body Assembly

1. Install new main body to throttle body gasket.
2. Place main body in position on throttle body and assemble with the three mounting screws. (This operation is accomplished by reversing the procedure outlined in Fig. 41 and Fig. 42.) Tighten the three mounting screws.



3. Recheck all visible assembly screws; make sure all are tight. **DO NOT DISTURB INITIAL SETTING OF IDLE ADJUSTING NEEDLES AND THROTTLE STOP ADJUSTING SCREW.**
4. **PUMP OPERATING LINK.** Replace the link if bent, twisted or worn. Install link over pump operator shaft stud first, then start pin end of link into No. 2 hole on the throttle lever (for normal operation). Push link all the way onto stud.
5. Install cotter key holding pump link to stud, bend open ends of cotter key around stud.

Note: The recommended position for the pump link is in the No. 2 hole. Placing the link in the No. 3 hole increases the pump stroke and hence increases the accelerating fuel charge to maximum. Placing the link in No. 1 hole shortens the pump stroke and decreases the accelerating fuel charge to minimum.

6. **THROTTLE LEVER SPRING.** Install spring, being sure loops are securely hooked at spring bracket and throttle lever.

CARBURETOR FINAL ADJUSTMENT

All adjustments made during assembly procedures were preliminary. Final and accurate adjustments can only be made after carburetor is mounted on engine.

ADJUSTING GOVERNOR - MODEL 1174

Connect tachometer and adjust governor to cut off within the engine no-load cut-off range (see Specifications) as follows:

1. Turn off ignition switch. The engine must be completely stopped to adjust this governor.
2. Remove the adjusting hole plug seal located at the side of the governor housing. (Do not break the pipe connection seal). Remove the adjusting hole plug. (Figs. 68, 69).
3. Turn engine over with hand crank (ignition switch OFF) until the adjusting screw in the end of the enclosed rotor appears at the plug hole.
4. Insert a screwdriver through the opening from which the hole plug was removed and turn the screw clockwise to increase speed or counter-clockwise to decrease engine governed speed (Fig. 70). One turn of the screw will affect the governed speed approximately 150 engine r.p.m.

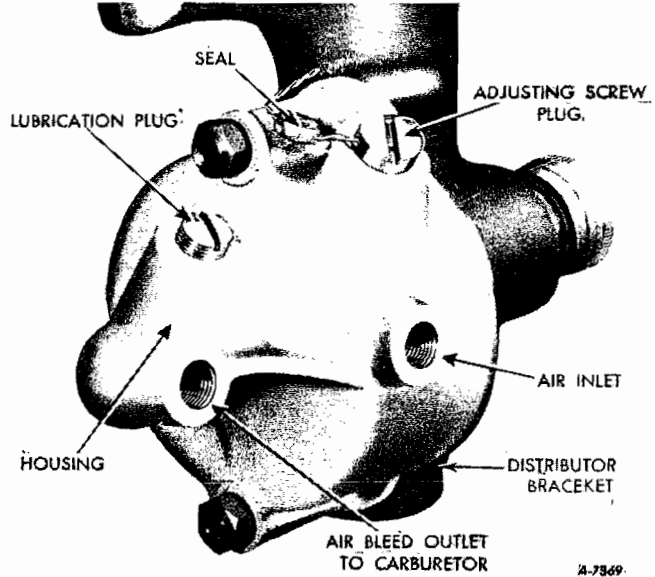


Fig. 68



Fig. 69

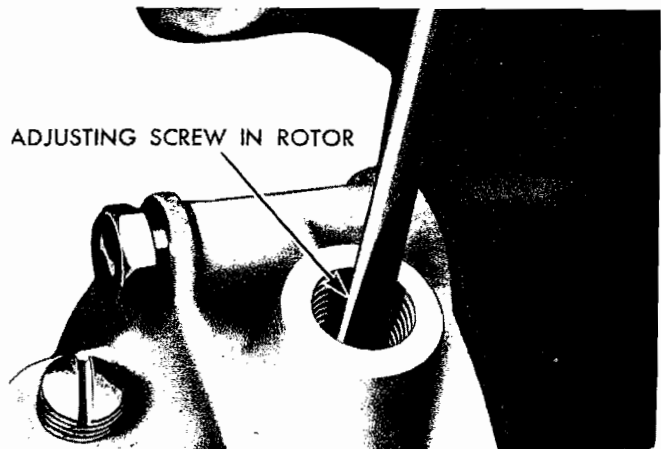


Fig. 70

CAUTION: Excessive engine speeds cause undue strains and rapid wear on engine parts, therefore, the governor must not be adjusted to allow the engine to exceed the maximum recommended r.p.m.

AIR CLEANERS

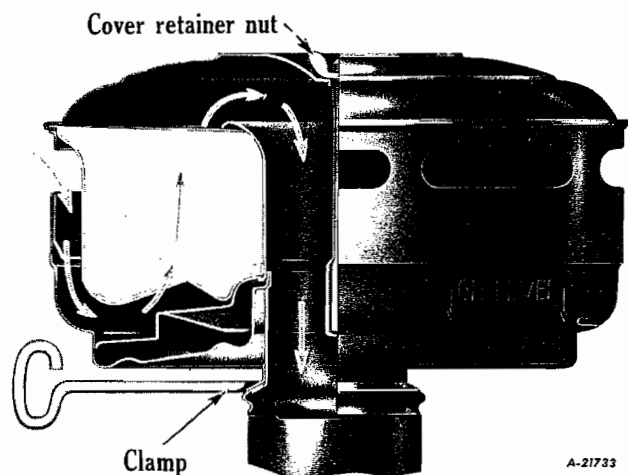


Fig. 1 - Air Cleaner (Bonnet type mounting).

Description

The construction of the oil-type air cleaner (Figs. 1 and 2) is such that uncleaned air is drawn into the upper portion of the unit and then drawn downward at high velocity. Just above the oil reservoir the direction of air travel is suddenly reversed, and this reversal of air flow causes the larger particles of dirt to fall into the oil. The partially cleaned air then travels upward through an oil moistened filtering element where any remaining dirt and dust particles are removed. The cleaned and purified air then leaves the air cleaner and enters the carburetor.

The air cleaner on Super Red Diamond Engines is located in the conventional "under the hood" position. However, the air taken into the air cleaner is drawn through a special hood opening (Fig. 3).

The purpose of this outside intake is to draw in cooler outside air during hot-weather operations, when high under-hood temperatures would otherwise make available to the engine only expanded air with low oxygen content.

By drawing in cooler air, with greater oxygen volume per cubic foot, volumetric efficiency is increased and the engine produces the greater horsepower for which it is designed.

In cold weather, when under-hood air temperature is more desirable for efficient engine operation, air intake is easily changed to draw air from under the hood.

Servicing Air Cleaners

The necessity for cleaning and servicing of oil type air cleaners depends entirely upon operating conditions as to dust, dirt, etc.

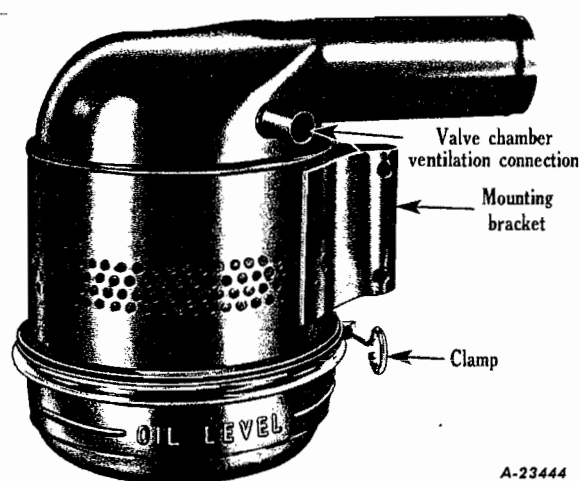


Fig. 2 - Air Cleaner (Bracket type mounting).

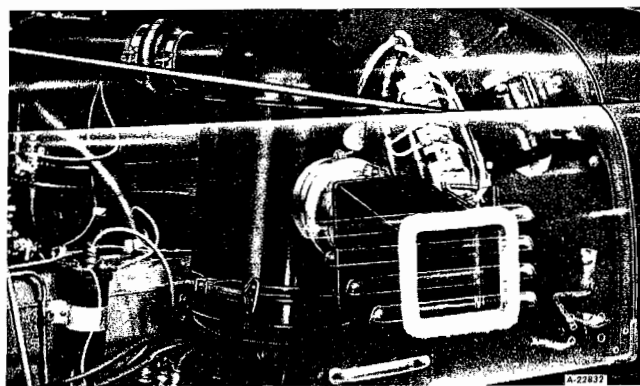


Fig. 3

Under normal conditions, oil type air cleaners should be removed and serviced every 5000 miles. The operation should be performed at earlier intervals under dusty operation - even daily, under severe conditions.

When servicing the oil type air cleaner, remove, the oil cup, or reservoir, and clean free of old oil and dirt. Wash the filtering mesh, or element, in kerosene then dip in clean oil and allow the excess oil to drain from the element.

Air cleaners should be serviced with same grade oil as used in the crankcase, and the oil cup filled to the level indicating beads in the cup. (See chart below for approximate capacities).

Air cleaner connections must be maintained in a tight and leak-proof condition. Otherwise, uncleaned air will be allowed to enter the engine.

OIL CAPACITY (PINTS)

SD 220-240	BD 269	RD 372-406 450	Cont. R-6602
1	2-1/2	3	3-1/4



INSTRUMENT GROUP

SECTION "A"

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Method of checking gauges	3,4
Oil pressure gauge operation	2
Service instructions	1
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INSTRUMENTS

COMBINATION STARTING AND IGNITION SWITCH

R-110 to RF-210 (Delo-Remy No. 1116501)

When the switch key is turned to the left, all accessories and gauges are "ON" except the ignition which is "OFF". When the switch key is turned half way to the right, the accessories and ignition are both "ON". Turning the ignition switch key to the extreme right will engage the starting switch and complete the electrical circuit between the battery and the starting motor so that the pinion engages the flywheel ring gear and cranks the engine.

INSTRUMENTS

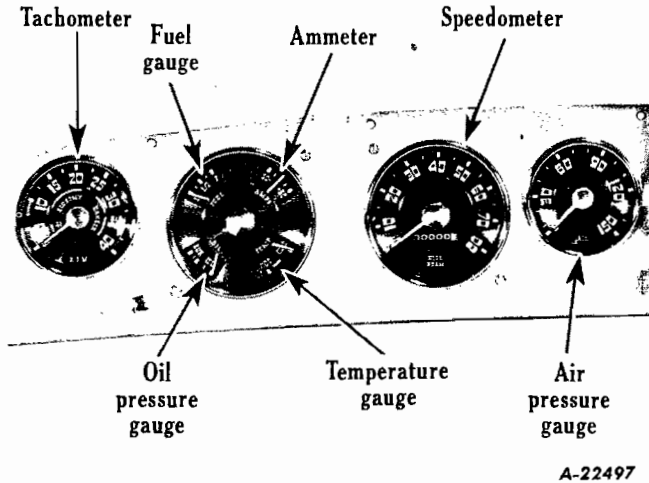


Fig. 1

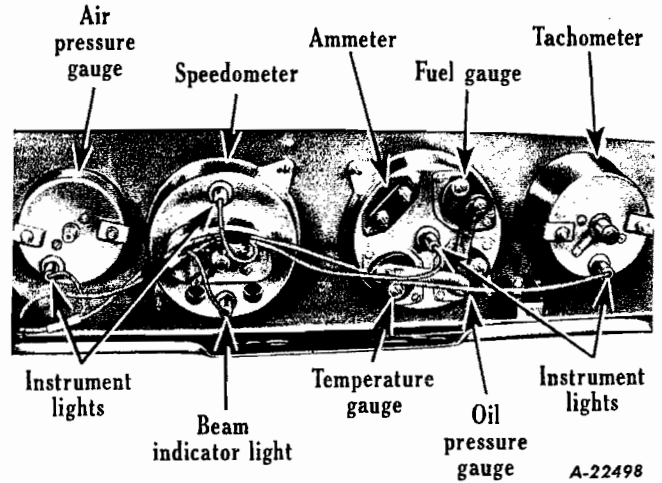


Fig. 2

General Description

Fig. 1 illustrates location of instruments on dash panel. Fig. 2 illustrates the rear view of the same instruments and panel assembly as in Fig. 1.

The fuel gauge, oil pressure gauge, and water temperature gauge are electrically operated and consist of a sender and receiver (dash) unit.

Diagrams (Figs. 3 to 9 inclusive) illustrate the major parts of each unit and the principle of operation. An optional source of supply of instruments is established at the factory and the new truck may be equipped with instruments that come to rest in the upper range when the switch is turned to "OFF" position. In these instances, the details of operation of the unit are similar. The illustrations will apply in either case except for direction of travel after switch is turned to "OFF" position.

Service Instructions.

The following units require no adjustment or maintenance other than keeping the electrical connections tight. Due to the intricate construction no attempt should be made to repair or calibrate these units. IF UNIT FAILURE OCCURS, REPLACE WITH A NEW UNIT. However, no unit should be removed until a thorough check has been made of wiring, sender units, condenser, etc. for a short, otherwise, a new unit will also burn out.

- Coil
- Ammeter
- Starter switch
- Ignition switch
- Circuit breaker
- Stop light switch

- Electrical tachometer
- Magnetic starting switch
- Headlight sealed beam unit
- Headlight dimmer switch
- Fuel gauge and fuel tank sender unit
- Oil pressure gauge and engine sender unit
- Water temperature gauge and engine sender unit

CAUTION: Always have ignition switch in "OFF" position when changing or working on instruments to avoid the possibility of a short circuit, which will damage instruments. Both sender and receiver units must be of same type. Do not use a sender unit of one manufacturer with a receiver unit of another, or vice versa.

Fuel Gauge Operation (King-Seeley)

When fuel tank is empty (Fig. 3) the two contacts in fuel tank sender unit are just touching. With the ignition switch on, current flows through the circuit, warming up the heater wires which causes the bi-metals to bend, and

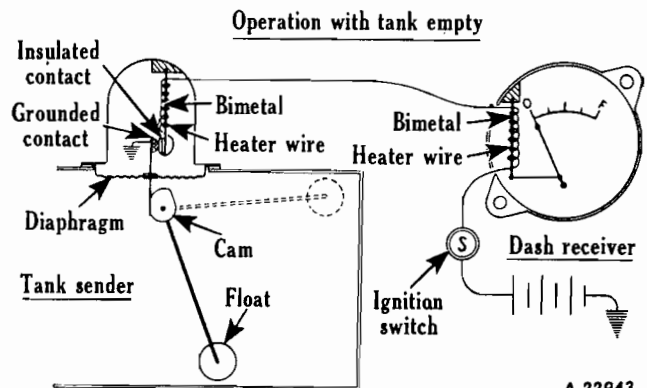


Fig. 3 - Gas Gauge - Tank Empty.



bending of bi-metal in tank sender unit opens the contacts and circuit is broken--the heater wire then cools and the bi-metal returns to its former position. Contact is then again made and the procedure is repeated at the rate of approximately once per second.

Since both heater wires are in the same circuit, a similar slight bending of the bi-metal in the dash receiver unit occurs, which is just sufficient to make the needle register zero.

When tank is filled with gasoline (Fig. 4) the action of the float and cam pushes the grounded contact against the insulated bi-metal contact, bending the bi-metal in the tank sender unit.

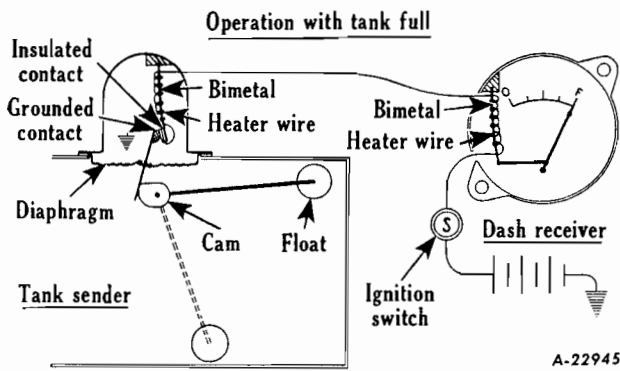


Fig. 4 - Gas Gauge - Tank Full.

Now if the ignition switch is on, the action described in the preceding paragraphs occurs but because the bi-metal is already under strain a much greater amount of current is required to bend the bi-metal sufficiently to break contact in this position. A similar greater bending of the bi-metal in the dash receiver unit occurs and this action pulls the needle over to the full point.

The movement of the needle in any position caused by the make-and-break of the circuit is so minute that it can not be detected.

Oil Pressure Gauge Operation (King-Seeley)

The operation of the oil pressure gauge sender unit is similar to the fuel gauge sender unit except that instead of a cam, a diaphragm is used as a means of moving the grounded contact. The dash receiver units operate exactly the same. NOTE: Should the oil pressure gauge indicate pressure lower than normal, the engine sender unit and dash unit should be checked prior to looking further for the trouble (Fig. 5).

In some instance low oil pressure reading on the gauge can be corrected by changing the position of the engine unit. This unit is normally assembled with the small depression in the cover at the top.

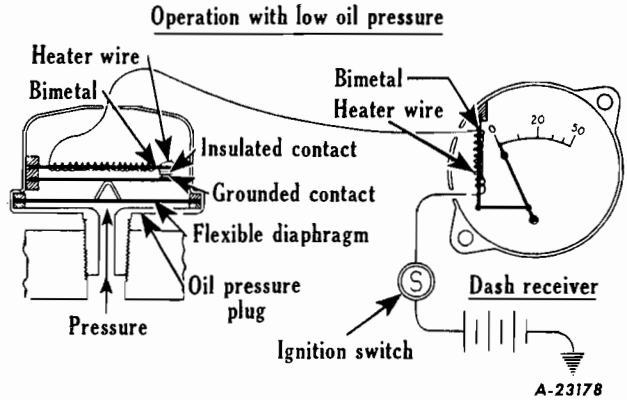


Fig. 5 - Oil Pressure Gauge - No Pressure.

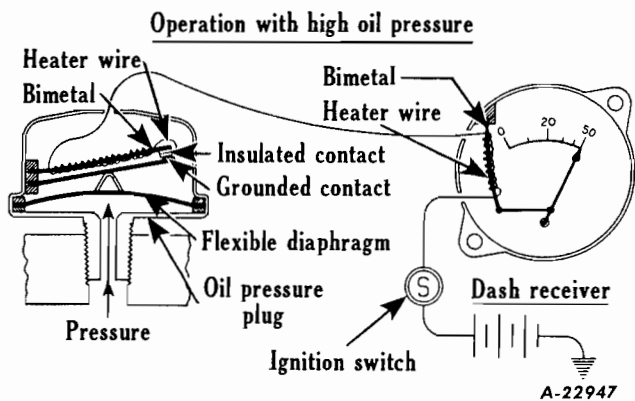


Fig. 6 - Oil Pressure Gauge - With Pressure.

Note in Fig. 6 that the deflection of the diaphragm pushed the grounded contact against the insulated bi-metal contact, bending the bi-metal in the sender unit.

Water Temperature Gauge Operation (King-Seeley)

The engine sender unit consists of a fixed grounded contact, so positioned that the bi-metal against which it presses is bent mechanically. At low temperatures (Fig. 7) considerable heat is required to make this bi-metal bend away from the grounded contact. With the temperature of the engine-cooling water

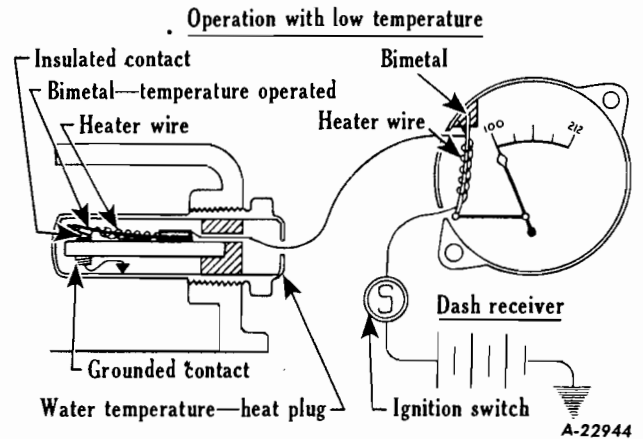


Fig. 7 - Water Temperature Gauge - Cold.

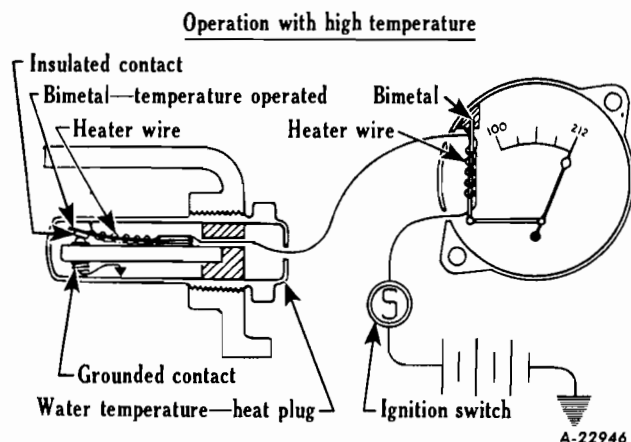


Fig. 8 - Water Temperature Gauge - Hot.

low, all this heat must be generated electrically, and this same current flowing through the heater wire of the dash receiver creates an equal amount of heat there and a resultant bending of the dash receiver bi-metal, causing the pointer to show a low temperature reading.

As the water temperature rises, its heat aids in bending the sender bi-metal--less heat is generated electrically, the resultant bending of the bi-metal in the receiver is less, resulting in higher temperature readings (Fig. 8).

The following service instructions apply to fuel level, oil pressure or water temperature gauges.

IMPORTANT: Do not disconnect instruments with ignition switch "ON" as there is danger of causing a short circuit which will damage instruments. Always turn ignition switch "OFF" before changing or working on instruments.

NOTE: If it is necessary to replace the receiver unit, because it has been burned out, then check wiring, sender unit, and condenser, if any, for a short, and correct this condition, otherwise, new receiver unit will also burn out. A short in the gauge circuit is easily recognizable because it will cause receiver unit to over-read and in most cases beyond full scale.

Equipment Necessary for Checking Gauges

1. One new fuel tank unit. If there is any question about the new tank unit being correct, then hook it up in series with a receiver unit known to be satisfactory, and apply 6 volts of current. Operate tank unit by hand and see if receiver unit reads zero with tank unit float in bottom position and full with tank unit float in top position.
2. Two ten-foot lengths of insulated wire equipped with clip terminals at each end.

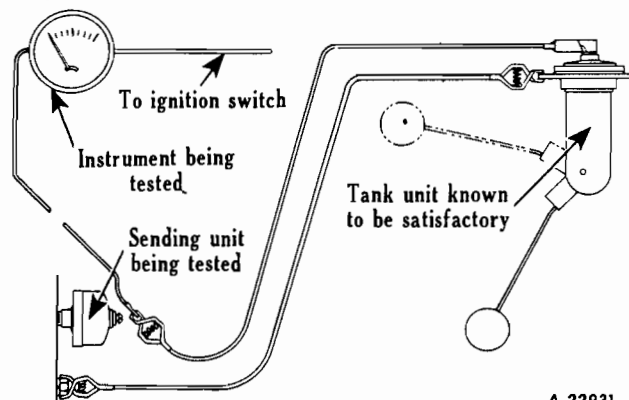


Fig. 9 - Method of checking gauges.

These long lengths will in practically all instances permit individual making check to sit in seat of truck and observe gauge being checked.

Method of Checking Gauges

(IMPORTANT: No units should be removed from truck until check has been completed which shows such units to be damaged or defective.)

1. Disconnect sender unit being checked and hook in tank unit as shown in Fig. 9. Turn on ignition switch and operate float rod of tank unit by hand. With float of tank unit at bottom position, receiver unit being checked should register at bottom mark on dial. Next, move float rod up to top position, then receiver unit being checked should move to top mark on dial (allow one minute for receiver to come to rest).

NOTE: Exceptions to this are the oil pressure and water temperature gauges. The oil pressure gauge should register at the RUN mark with the float rod at top position. This is the mark just below the top mark on this gauge. The water temperature gauge should register at the HOT mark.

2. If receiver unit operates correctly, then check sender unit on truck to see if it is properly grounded. Also (a) if truck is radio-equipped check condenser on sender unit. If condenser is shorted, it will cause receiver unit to overread. When replacing condenser, it is preferable to use one of .10 or .20 micro-farad capacity, but up to .50 can be used if necessary to cut out radio interference. (b) If ground and condenser are satisfactory, then replace sender unit and check to see if this has corrected the difficulty.
3. If receiver does not operate or fails to operate correctly then check wire lead to receiver unit. Do this by attaching one end



of a ten-foot length of wire to the terminal of the receiver unit to which sender unit wire was attached. Ground the other end of the ten-foot lead and turn on the ignition switch. If the gauge operates now and did not operate with the regular wire connection, the wiring is at fault and must be replaced.

If wiring is satisfactory then replace receiver unit and check again with tank unit.

Do not attempt the repair or calibration of any receiver or sending unit in the field as this is not practical. Replacement with a new unit is the only practical means of servicing these gauges.

Speedometer

The speedometers used on L-Line trucks are of the magnetic-type.

A speedometer is used on a vehicle to indicate speed in miles per hour as shown by the pointer on face dial, and to record distance traveled by means of an odometer. The speedometer is driven through a flexible shaft connected to a set of gears in the vehicle transmission. These gears are designed for the particular vehicle model and take into consideration the tire size and rear axle ratio. The flexible shaft, which connects the transmission driven gear to the speedometer, consists of an outer casing and inner core.

The odometer usually records up to 99,999 miles before it automatically returns to zero. The extra wheel on the right side of the odometer is known as the tenth dial, replacing the old type trip odometer, and records every tenth of a mile.

There are occasions when, due to change in axle ratios or tire sizes, it is necessary to make compensating corrections in the speedometer drive gear. For method of speedometer adapter calculations, see following Section "B", Instruments.

Tachometer

A tachometer is installed on a vehicle to record engine r.p.m. speeds and enables the driver to keep engine within efficient operating range.

The magnetic type tachometer is installed at the factory on all Super Red Diamond Engines. It is driven by a flexible shaft connected to the vehicle distributor shaft by means of a drive joint or adapter and records the r.p.m. from the distributor shaft onto the face dial through a magnetic field within the unit.

There are two additional types of tachometers available, namely, centrifugal, with a maximum r.p.m. hand, and electrical.

The centrifugal tachometer works on the weight-type governor principle and is driven from the distributor shaft in the same manner as the magnetic type. The centrifugal type also has a maximum r.p.m. hand on the tachometer head to record maximum speed of engine.

The electric tachometer is a two-unit combination consisting of transmitter and tachometer head. The head is mounted on the instrument panel and the transmitter on engine side of dash. The transmitter name plate provides a cover for an easily replaceable standard flash-light battery which supplies a fixed voltage to guarantee 2% overall accuracy. The current requirement is so small that the battery will give a normal service of approximately six months. The electric tachometer receives electrical impulses from the distributor through the transmitter and records the r.p.m. in this manner.

Tachometer Flexible Shaft

A complete flexible shaft consists of two major assemblies. A flexible outer casing with nuts and ferrules at both ends and a wire-wound flexible inner coil assembly with squared ends or crimped-on tips. The core diameter and end connections vary for different applications.

One end of the flexible shaft is attached to the instrument (speedometer or tachometer) and the other end is attached to the transmission or power take-off point. The flexible inner core transmits the power from the take-off, while the outer casing is held rigidly in place at each end by the ferrules and nuts.

Repairing Tachometer Flexible Shaft

Disconnect both ends of the shaft and remove from vehicle. Pull the core out of the casing and check for kinks by rolling on a flat surface. If a flat surface is not available, take an end in each hand and roll core between fingers. In either case a core kink will show up as a "hop" at the kinked point. Never reuse a kinked core, because it will cause fluctuation of the speedometer or tachometer point. Also check for frayed spots by running it loosely through your finger. Do not reuse a frayed core. Kinked or frayed core usually indicates a casing with very sharp bend. CAUTION: Under no circumstances should a casing have less than a six-inch radius bend.

Lubricating Tachometer Flexible Shaft

Thoroughly clean the core and casing. Apply a thin coat of graphite impregnated non-hardening grease evenly over the core ONLY. Hold the casing with one hand and feed the core with lubricant into casing. CAUTION: Never fill or pack the casing with grease. Periodical lubrication of the flexible shaft is recommended to avoid premature failure.



METHOD OF SPEEDOMETER ADAPTER CALCULATION

There are occasions when, due to changes in axle ratios, or tire size, it is necessary to make compensating corrections in the speedometer drive.

Parts catalogs list available speedometer adapters and the one chosen should most closely coincide with the calculated results.

The following formulae are based on new tire radii when correctly inflated and properly loaded, and should prove helpful in selecting speedometer adapter equipment.

Problem	Formulae	Problem	Formulae
(A) Error in speedometer indication	$\frac{\text{Actual distance traveled}}{\text{Speedometer reading}} \times \text{*Present adapter ratio} = \text{Required adapter ratio.}$ <p>*NOTE: If no adapter in present hook-up - disregard in calculations.</p> <p>EXAMPLE: Actual distance traveled: 5 miles Speedometer reading: 6 miles *Present adapter ratio: 1.200 Formula is then: $\frac{5}{6} \times *1.200 = .9996$</p>	(D) Tire size has been changed.	$\frac{\text{Old tire rev. per mile}}{\text{New tire rev. per mile}} \times \text{*Present adapter ratio} = \text{Required adapter ratio.}$ <p>NOTE: If no adapter in present hook-up - disregard in calculations. EXAMPLE: Old tire rev. per mile (7.00-20): 573 New tire rev. per mile (9.00-20): 525 *Present adapter ratio: 1.155 Formula is then: $\frac{573}{525} \times *1.155 = 1.260$</p>
(B) Axle ratio has been changed.	$\frac{\text{Old axle ratio}}{\text{New axle ratio}} \times \text{*Present adapter ratio} = \text{Required adapter ratio.}$ <p>*NOTE: If no adapter in present hook-up - disregard in calculations.</p> <p>EXAMPLE: Old axle ratio: 5.285-1 New axle ratio: 6.16-1 *Present adapter ratio: 1.155 Formula is then: $\frac{5.285}{6.16} \times *1.155 = .9909$</p>	(E) Tire size and axle ratio both changed.	$\frac{\text{*Present adapter ratio} \times \text{old tire rev. per mile} \times \text{Old axle ratio}}{\text{New tire rev. per mile} \times \text{new axle ratio}} = \text{Required adapter ratio.}$ <p>NOTE: If no adapter in present hook-up - disregard in calculations. EXAMPLE: *Present adapter ratio: 1.155 Old tire rev. per mile (7.00-20): 573 Old axle ratio: 5.285 New tire rev. per mile (9.00-20): 525 New axle ratio: 6.16-1 Formula is then: $\frac{*1.155 \times 573 \times 5.285}{525 \times 6.16} = 1.081$</p>
(C) To find tire revolutions per mile.	$\frac{10084}{\text{Loaded tire radius in inches}} = \text{*Tire rev. per mile.}$ <p>*Deduct 1% for high pressure tires, or 1-1/2% for balloon tires.</p> <p>NOTE: See CT-350 for tire radius specifications.</p> <p>EXAMPLE: Constant figure: 10084 Loaded tire radius of 7.50-20 tire: Formula is then: $\frac{10084}{17.3} = 582$ 582 - 1-1/2% = 573</p>	(F) To check adapter if tire diameter, axle ratio, and speedometer drive and driven gears are known.	$\frac{\text{Loaded tire radius} \times 0.1 \times \text{number teeth in driven gear}}{\text{Axle ratio} \times \text{number teeth in drive gear}} = \text{Adapter ratio.}$ <p>NOTE: See CT-350 for tire radius specifications. EXAMPLE: Loaded tire radius (9.00-20): 18.9 Constant figure: 0.1 Number of teeth in speed driven gear: 14 Axle ratio: 6.16-1 Number of teeth in speed drive gear: 4 Formula is then: $\frac{18.9 \times 0.1 \times 14}{6.16 \times 4} = 1.073$</p>



LUBRICATION GROUP

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LUBRICATION

NEW SERVICE CLASSIFICATIONS AND DESIGNATIONS FOR LUBRICATING OILS FOR AUTOMOTIVE TYPE GASOLINE AND DIESEL ENGINES

In the period just prior to World War II, developments in the design of both gasoline and high speed diesel engines and in the services to which they were subjected, resulted in the introduction of new types of crankcase oils. To enable the automotive manufacturers to recommend these new oils, the American Petroleum Institute was asked to define them. This was done and the API definitions of oil types designated "Regular," "Premium" and "Heavy Duty" were published in 1945.

Recently, the automotive and petroleum industries have recognized that the definitions just mentioned had limitations. While satisfactory when established in 1945, the definitions did not provide for the many new developments since the war in engines or in crankcase oils.

To correct this situation, two industry committees worked together; one, the Lubrication Committee of the American Petroleum Institute representing both large and small refiners and marketers, the other from the American Society of Testing Materials on which the major manufacturers of gasoline engines and high speed diesel engines were represented. By this joint effort, a new system of Service Classifications and Designations for Motor Oils for Automotive Type Engines has been developed as a basis for selecting and recommending oils for these engines.

The SAE Viscosity Numbering System is in no way affected by the new API Service Classification System and will be used as before to indicate the proper viscosity grades of oils for any service.

The definitions of service, approved by the API and the supplementary explanations are presented for the information of those who are interested.

BASIS OF THE NEW SERVICE CLASSIFICATIONS

In devising the new Service Classification System, it was recognized that the satisfactory operation of automotive gasoline and high speed

diesel engines is based primarily on the suitable combination of these five factors:

1. Engine Design and Construction
2. Fuel
3. Motor Oil
4. Maintenance Practices
5. Operating Conditions

To begin with, the design and construction of different engines and consequently their lubrication needs vary widely since individual engine manufacturers place emphasis on different engine features. Fuels also vary widely, depending upon the crude oil and refining methods used. Motor oil characteristics and performance depend not only upon crude source and refining methods, but on the special ingredients which may be added to oils in their manufacture. As for the maintenance of engines, naturally it varies from good to poor.

The service conditions under which engines operate are extremely wide and have a major influence upon the character of oil required to give the best performance for any particular combination of engine design and kind of fuel.

To provide a workable guide for the selection of oils suited to various engine designs, service conditions had to be divided into broad classes, based on the most up-to-date knowledge and experience. Obviously, it was impossible to define and include all possible service conditions and it was actually unnecessary because an engine may be operated in a variety of services in any given period.

In the new system, the various classes of service for gasoline and diesel engines are defined and explained. Quite important is the fact that some types of service commonly thought of in the past as being very light are actually quite severe from the lubrication standpoint. This applies especially to passenger cars and light trucks.

Each service class is designated by letters. This provides a convenient means whereby oil companies may indicate what class or classes of service each of their several brands of oil are suitable for. The engine manufacturer may similarly use these letter designations to indicate the service and lubrication requirements of his various engine designs.



DEFINITIONS AND EXPLANATION OF SERVICE CLASSIFICATIONS

The new Service Classification System includes five types of service, three for gasoline engines, two for diesel engines. Each service type is defined and explained below and the corresponding letter designations shown.

GASOLINE AUTOMOTIVE TYPE ENGINES

Service MS

Service typical of gasoline or other spark ignition engines operating under unfavorable or severe types of service conditions, and where there are special lubrication requirements for deposit or bearing corrosion control, due to operating conditions or to fuel or to engine design characteristics.

Service MS normally represents the most severe service conditions encountered in the operation of gasoline and other spark ignition engines. It includes two different types of severe or adverse operating conditions which are as follows:

Start and stop service promotes condensation in engine cylinders and crankcases of water from fuel combustion and also dilution of the oil with unburned fuel; it can promote corrosive wear of cylinders, pistons and rings, also oil ring plugging, varnish deposits and low temperature emulsion type sludge. In passenger cars and other units the severity of this service increases in wintertime as atmospheric temperatures drop, although it is often a year-round problem in taxicabs, delivery trucks and similar operations. The nature of the fuel can influence these troubles. The design of the cooling system and the effectiveness of crankcase ventilation can increase or decrease their severity.

High temperature, severe service promotes oxidation of the lubricating oil. This type of service may cause high temperature varnish and sludge deposits, stuck rings, and scuffing of rings in all types of engines. It may also cause corrosion of some types of bearings. This condition is aggravated by driving long distances at high speed, particularly in hot weather. Under these conditions, the crankcase oil is subjected to relatively high temperatures. The nature of the fuel may have some influence on the severity of this condition, but its relative influence is less under these high engine temperatures than under start and stop conditions. Engine design, especially adequate cooling of oil as well as of pistons, valve guides, and seats, can minimize the effect on the oil.

Service MM

Service typical of gasoline and other spark ignition engines operating under moderate to severe service conditions, but presenting problems of deposit or bearing corrosion control when crankcase oil temperatures are high.

This is a more moderate service condition than Service MS. Vehicles powered by engines which are relatively insensitive to deposit formation when operated at high speeds and under heavy loads are included in this service, particularly when operated with fuels of suitable characteristics. It does not include extensive operation under the severe type of low engine temperature service such as start and stop driving or prolonged idling described under Service MS.

Service ML

Service typical of gasoline and other spark ignition engines operating under light and favorable service conditions, the engines having no special lubrication requirements and having no design characteristics sensitive to deposit formation.

This is the least severe service condition. This type of service includes moderate speed driving most of the time, with no severe low or high engine temperature operation. It also includes operation of vehicles with engines insensitive to sludge, deposit formation or fuel characteristics.

DIESEL AUTOMOTIVE TYPE ENGINES

The severity of diesel engine service with respect to wear and deposit formation depends upon a combination of several factors. First is the power requirement. High continuous power output or overload at high atmospheric temperatures or intermittent power demands at low temperatures represent severe service. By contrast, rated load, continuous or intermittent operation at normal temperatures can be considered normal diesel engine service.

From the standpoint of design, diesel engine speeds are usually lower than gasoline engine speeds but higher temperatures within the engine and greater bearing loads may be expected. The design of the engine and its cooling system, also its installation in any equipment all affect service severity.

In the diesel engine, harmful products of combustion causing wear and deposits on pistons and in the crankcase can be formed from incomplete combustion of any fuel and from some specific fuel components such as



sulphur. The effects of these combustion products and consequently the severity of the service requirements are greatly magnified by low temperature operation and are influenced in varying degree by engine design characteristics.

Service DG

Service typical of diesel engines in any operation where there are no exceptionally severe requirements for wear or deposit control due to fuel or to engine design characteristics.

Rated load, continuous output or intermittent operation under normal temperature conditions can be considered as normal service requirements for service DG. Depending upon individual engine design characteristics, most diesel engine builders have designated maximum fuel sulphur limits for this service classification.

Service DS

Service typical of Diesel engines operating under extremely severe conditions or having design characteristics or using fuel tending to produce abnormal wear or deposits.

The service conditions in this classification are the most severe encountered in the operation of diesel engines. High load operation at high temperatures, design factors or engine installation details causing high temperatures within the engine, constitute severe service, as does intermittent operation at low temperatures since both promote wear and deposit formation. Cooling system design and maintenance practices can aggravate or minimize the severity in either case. The use of high sulphur content fuels increases service severity with respect to wear and deposits in varying degree, depending upon design, maintenance and operating conditions, especially low temperatures. Hence, frequently their use is considered to constitute severe service.

USE OF LETTER DESIGNATIONS

When the letter designations are used to indicate services for which oils may be suitable, it is the intent that they be preceded by the words, "For Service." To illustrate, an oil suitable for moderate service conditions in gasoline engines would be referred to as "For Service MM." If oils are suitable for more than one service, it is appropriate that these oils be referred to with the marks associated with such services. For example, "For Services MS--DG or MS--MM," etc.

CLUTCH RELEASE SLEEVE AND BEARING · LUBRICATION

Clutch release bearing sleeves on all R-line chassis incorporate a lubricator fitting to provide means of lubricating the clutch release bearing, sleeve and fork without their removal from chassis.

R-110 through R-184 chassis have the clutch release sleeve and bearing lubricator fitting located at the bottom of the release bearing sleeve, as illustrated in figure 1. Access to this fitting is gained by removal of the flywheel housing bottom cover.

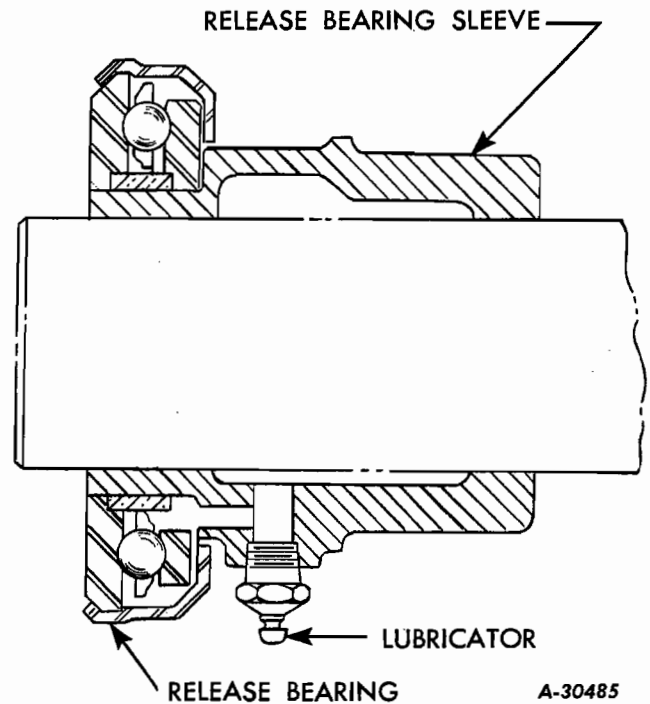


Fig. 1 - Release Bearing, Sleeve and Lubricator

R-185 through RF-210 chassis have the clutch release sleeve and bearing lubricator fitting on the top of the release bearing sleeve (not illustrated). Access to this fitting is gained by removal of the cab floor mat, cab floor transmission cover plate and clutch bell housing inspection plate.

To lubricate, use a low-pressure hand operated grease gun filled with a suitable lubricant comparable to "Lubriplate No. 110", fill lubricant cavity in release sleeve and bearing. **DO NOT OVER-LUBRICATE.** Lubricate every 15,000 to 20,000 miles under normal operating conditions. Under unusual "Stop-and-Go" driving conditions, lubricate every 10,000 miles.



LUBRICATION

GENERAL INSTRUCTIONS

Thorough lubrication at definite intervals with a good lubricant will aid greatly in prolonging the life of the truck and in the reduction of operating expense. The interval between lubrication periods depends entirely upon operating conditions. The loads carried, speed, road and weather conditions all have a bearing on the frequency of lubrication periods.

In the lubrication charts, the mileage recommendations are approximate, being based on average conditions. For some types of operations it will be necessary to figure the lubrication periods upon an hourly basis, and where operating conditions are extremely severe, the truck should be lubricated after every twenty-four hours of operation.

Only lubricants of the best quality, having proper body or viscosity, manufactured by a reputable concern, should be used.

We do not attempt to specify any particular manufacturer's products. High-grade lubricants can be secured from any reputable oil company.

The viscosity numbers used are those adopted by the Society of Automotive Engineers to classify lubricants according to body or thickness and do not cover any other properties.

When changing engine oil, clean and refill air cleaner, also clean oil filter if used.

ENGINE OIL SELECTION

Selection of proper engine lubricating oil demands consideration of two important factors--namely, easy starting during very cold weather, and adequate engine lubrication after the engine is placed in service.

Lighter viscosity oils facilitate cold-weather starting and also provide better immediate lubrication as the engine starts. CAUTION: They do not, however, provide adequate lubrication under sustained higher engine speeds or severe service. Increased oil consumption can also be expected when using lighter viscosity oils. Frequent oil level check must be made when using lighter viscosity oils.

Consideration must therefore be accorded to the cold weather housing facilities for the idle truck, the service in which the truck is engaged, and the selection of higher viscosity oils which have better free-pouring characteristics at low temperatures.

In consideration of the foregoing, the following general recommendations are made:

MODERATE SERVICE--trucks operating in multi-stop or other service where sustained higher engine speeds will not be encountered:

ENGINE	TEMPERATURES			
	90° (F.) and up*	32° (F.) to 90° (F.)	+10° (F.) to 32° (F.)	+10° (F.) to -10° (F.)
SD	SAE-30	SAE-30	SAE-20W	SAE-10W
BD	SAE-40	SAE-40	SAE-20W	SAE-10W
RD	SAE-40	SAE-40	SAE-20W	SAE-10W
R-6602	SAE-40	SAE-40	SAE-20W	SAE-10W
* See Hot Climate - High Speed instructions below.				

For temperatures lower than minus 10° (F.), use SAE-10W and kerosene. (SAE-10W may be safely diluted with colorless kerosene up to 30%). Mix kerosene thoroughly with the oil before adding to the engine. NOTE: Kerosene will evaporate rapidly under crankcase operating temperatures. Because of this fact, more frequent checking of the oil level must be made to avoid operating the engine with low oil level.

Hot Climate - High Speed

For trucks operating on highway, or other services demanding sustained higher engine speeds, use engine lubricating oils having a viscosity of as near SAE-50 as possible (SAE-40 for SD Engines) in keeping with the starting ability. NOTE: High viscosity oils are available which also have very good cold pour characteristics.

ENGINE OIL TYPES

Engine oils are available either as "straight" mineral oil (having nothing added during its manufacture other than possibly a pour-point depressor), or as "additive" oils which have had certain chemicals added during manufacture for the purpose of providing qualities or properties not available in the original oil, either before or after refining.



Under operating conditions, oils tend to undergo chemical changes due to oxidation and form such nonlubricating products as varnish, lacquer, and carbon. Where formation of these undesirable products is excessive when using untreated oils, use of an additive oil may prove beneficial since, through the additive chemicals, formation of those deposits may be minimized or retarded.

"Additive" engine oils are those to which chemicals have been added to alter or modify the characteristics of the oil and are generally referred to as "inhibited" oils or as "detergent" oils. An "inhibited" oil is not necessarily a "detergent" oil. Additive oils having both inhibiting and detergent qualities are classed as "Heavy-Duty Oils." The matching of chemical additives to a base oil is carried out in extensive laboratory engine tests. (Note: The refiners' choice of the base stock to be treated with modern additives is very important. An inferior base oil cannot be transformed into an acceptable oil merely by the use of additives. Not all base oils are equally susceptible to improvement with a given additive, and not all additives are equally effective in the same base oil.)

Additives to engine oils generally serve as (1) corrosion inhibitors or anti-oxidants, (2) as detergents, (3) as pour-point depressants. More fully, these agents are described as follows:

- (1) **CORROSION INHIBITORS OR ANTI-OXIDANTS;** Some of the products of oil or fuel oxidation are corrosive in nature and attack certain of the engine metals such as hard alloy bearings, causing pitting or etching. Engine deposits such as sludge and lacquer result in part from oil oxidation products. Anti-oxidants impart in great degree resistance to corrosion and sludge formation by controlling oil oxidation.
- (2) **DETERGENTS (DISPERSANTS).** Chemicals are added which serve as mild cleaning agents and, as such, tend to clean or wash away lacquer and sludge deposits from pistons, side walls, bearing surfaces, and other interior working surfaces of an engine. The detergent action is the result of the ability of the oil to keep insoluble particles--the products of fuel combustion and oil decomposition--in a finely divided state so that they can be kept in suspension in the oil. Unless these particles are carried in suspension or filtered out, they tend to deposit in piston ring grooves and on other engine interior parts. The detergent dispersive action is not effective with particles of metal, other abrasives, or coarse carbonaceous material.

- (3) **POUR-POINT DEPRESSANTS;** Because mineral oils thicken or congeal at low temperatures, certain chemicals are added to "additive" oils to serve as pour-point depressants or, in other words, to lower or depress the pour point a few degrees. The result is an oil having better flow characteristics at low temperatures which will provide better immediate lubrication upon starting during cold weather because of the fluid state of the oil. The use of the proper engine oil is of utmost importance in obtaining maximum performance and satisfaction. The selection of the proper brand of oil should be based on the reputation of the refiner or marketer.

The American Petroleum Institute and the automotive manufacturers have agreed that engine oils shall now be marketed under three classifications or categories, namely, "Regular Oil," "Premium Oil," and "Heavy-Duty Oil." These are more fully defined as follows:

REGULAR MOTOR OIL: This term shall be used to designate a straight mineral oil. Oils of this type are generally suitable for use in internal-combustion engines under moderate operating conditions. (These oils may and often do contain pour-point depressants.)

PREMIUM MOTOR OIL: This term shall be used to designate an oil having oxidation stability and bearing corrosion preventive properties. Oils of this type are generally suitable for use in internal-combustion engines where operating conditions are such that regular oils do not give satisfactory service.

HEAVY-DUTY MOTOR OIL: This term shall designate an oil having proved oxidation stability, bearing corrosion preventive properties, and detergent-dispersant characteristics. Oils of this type are generally suitable for use in both high-speed Diesel and gasoline engines under heavy-duty service conditions.

Heavy-Duty Oil, if installed in an engine where other-type oils have been used, requires that precautionary measures be taken to prevent loosened particles from clogging oil passages. The following measures represent good, practical advice when changing from any brand of oil to another:

1. Drain and flush engine crankcase.
2. Install new oil filter cartridge and thoroughly clean oil filter sump. (Note: Only absorbent type or edge type (filter disc) filter packs should be used with detergent type oils. Clay or chemically treated filters should not be used as they will remove some of the beneficial additives used in the manufacture of the oil.)



L-LINE MOTOR TRUCK SERVICE MANUAL

- It is very important that engine operating temperatures be maintained at an efficient level of 160-180° F. to reduce the possibility of excessive sludge formation.

Certain precautionary measures must also be observed after the detergent type oil is placed in service:

- THE ORIGINAL FILL should be drained after 300-500 miles operation, and the oil filter should be serviced. In new or reconditioned engines this is necessary in order to remove possible abrasives. In other engines, where other-type oils have previously been used, the washing or detergent action of the heavy-duty type oil tends to loosen deposits which, if not removed by draining, may clog the oil pump screen and oil channels.
- THE SECOND FILL should not be used in excess of 1000 miles operation and the oil filter again should be serviced. (Note: If necessary, as judged by the condition of the oil, change at an earlier period.)
- THE THIRD FILL will generally serve for the regularly established drain period. (Note: Color can not be the basis on which oil changes are made; rather, the oil should be changed at periods previously established or as recommended by the oil manufacturer.
- If an engine previously operated on either Regular or Premium-type oils (not Heavy-Duty) had a bad varnish condition, the use of Heavy-Duty Oil, because of its detergent quality, may dissolve some of the varnish and increase running clearances, resulting in an increase in engine noise and a lowering or loss of oil pressure. Should this occur, the cause should be determined and the necessary corrections made to restore the oil pressure.

TRANSMISSIONS

When possible, always drain transmission when truck has come in from a run. With the oil warm a more thorough draining job can be done, especially in cold weather. To drain, unscrew plug at bottom of case and allow sufficient time for all the old oil to run out. Before refilling, flush with light engine oil or light flushing oil, followed by complete draining; this will remove thickened material within the case. Use SCL, EP gear oil or multi-purpose gear lubricant.

CHASSIS

When greasing the chassis, it is good practice to force lubricant into the bearings until all old lubricant is forced out and the new appears. This will flush out any loose dirt or abrasives that may have accumulated and will also assure thorough greasing.

A high-grade viscous chassis lubricant will, except in extreme cases, be satisfactory for year-around use. If gear oil is used to lubricate chassis, SAE-140 is the proper viscosity.

WATER PUMPS

SD engine water pumps are lubricated at assembly and no further lubrication is necessary.

BD and RD engine water pumps should be packed with medium short fiber wheel bearing grease at time of overhaul. Pumps should be periodically (10,000 miles) lubricated. Remove lubricant plug, fill housing using a low-pressure lubricant gun.

WHEEL BEARINGS

Wheel bearings should be carefully lubricated. If too much grease is used there will be the possibility of brake linings becoming soaked.

Rear axle shaft bearings and the cavity in which they are assembled in the L-110 Series trucks are properly lubricated at time of assembly. Pipe plugs are installed in the lubricant fitting holes. It is intended that at 10,000 miles these plugs should be removed, lubricant fittings installed, the bearings lubricated, and the plugs again installed.

Lubricant fittings should not be allowed to remain in place for they may prove an invitation to overlubricate the bearings. The cavity containing the bearing holds approximately one ounce or two cubic inches of lubricant.

NOTE: Excess lubrication will result in damaged oil seals and grease accumulating on brake linings.

CLUTCH RELEASE BEARINGS

The clutch release bearing used in International Motor Trucks, is of prelubricated type and should require no further attention.



PROPELLER SHAFT CENTER BEARINGS (NOT PRE-LUBRICATED TYPE)

Propeller shaft center bearing should not be lubricated with gear oil or chassis lubricant.

Use a medium, short-fibre wheel bearing grease, the technical specifications of which are--cold-milled sodium soap--not calcium--content with a work penetration consistency of 250 that will not break down below 300.

AIR CLEANERS (OIL-TYPE)

The cleaning and servicing of oil type air cleaners depends upon operating conditions as to dust, dirt, etc. Under normal conditions, oil type air cleaners should be removed and serviced every 5000 miles and at earlier intervals under dusty operations--even daily, under severe conditions.

When servicing, remove the oil cup, or reservoir, and clean out old oil and dirt. Wash the filtering mesh, or element, in kerosene then dip in clean oil and allow the excess oil to drain from the element. Use same grade oil as used in the crankcase, and fill cup to the "oil level" indicating beads in the cup.

Air cleaner connections must be maintained in a tight and leak-proof condition; otherwise, uncleaned air will get into the engine.

SINGLE-SPEED HYPOID AXLES (NOT EATON)

Hypoid gearing in these axles requires the use of lubricants with properties enabling them to withstand the higher unit pressures and sliding action characteristic of this type gearing.

The mileage figures, relative to the frequency of lubrication changes, are based upon average vehicle operating conditions, and are not applicable in all cases. The actual conditions under which the vehicle is operated should be the determining factor in establishing lubrication requirements.

Changes to the correct grade of lubricant for Winter or Summer operations are dependent upon climatic conditions and should be made as required regardless of mileage. For average operation, check the lubricant level every 1,000 miles and drain and refill to level of tapped filler hole every 10,000 miles.

To further assure complete lubrication after overhaul, and before the vehicle is placed into heavy slow-speed operation, jack up both rear wheels and run the axle for a short period at speeds equivalent to 25 to 30 m.p.h. Do not allow the wheel on one side to race faster than the wheel on the opposite side.

IMPORTANT: NEVER ADD LUBRICANT TO SINGLE-SPEED HYPOID AXLES, UNLESS IT IS THE SAME MAKE AND GRADE AS THAT WHICH IS ALREADY IN THE AXLES. IF THE SAME MAKE AND GRADE LUBRICANT IS NOT AVAILABLE, DRAIN, FLUSH, AND REFILL WITH LUBRICANT AS PER FOLLOWING INSTRUCTIONS:-

Draining should preferably be done when truck has come in from a run in order that the oil may be well agitated and warmed up. This is particularly desirable in cold weather.

To drain, unscrew plug at bottom of housing and allow sufficient time for all the old oil to run out. Before refilling, we suggest thorough flushing with light engine oil or light flushing oil, followed by complete draining. This will insure removal of any thickened material within the housing.

NOTE: Use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles and supplied by a reputable refinery. Use SAE-90 for cold climate and SAE-140 for warm climate.

SINGLE-SPEED HYPOID AXLES (EATON ONLY)

Hypoid gear lubricants have been developed primarily for the differential gear case. The lubricant is intended to provide protection against heavy loads and the sliding action characteristic of hypoid ring and pinion gears. Use a hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent. A number of hypoid lubricants are prepared by reputable companies which contain Elco additive concentrates. Viscosity of the hypoid lubricant should be SAE-90. When high atmospheric temperatures (above 100° F.) prevail, SAE-140 may be used.

Check Lubricant Level

Every 1,000 miles, remove filler plug in housing cover and add sufficient lubricant to bring level to filler opening. Install and tighten plug.

Drain and Refill

Every 10,000 miles (see following note) remove housing cover lower screw or plug at bottom of housing and drain lubricant. Drain when unit is hot, preferably immediately after operation. Fill until lubricant level is up to filler opening. Install and tighten plug.

NOTE: The service intervals between lubricant drain periods must always be based upon type of service in which the unit is operated. Rough and unimproved highway operations as well as heavy loads and off-highway operations require more frequent lubricant changes. Sustained high speed and high temperatures



also cause rapid deterioration of the lubricant. Regularly established lubricant change periods should be observed, based upon operation conditions.

TWO-SPEED HYPOID AXLES (EATON)

Hypoid gearing in these axles requires the use of lubricants with properties enabling them to withstand the higher unit pressures and sliding action characteristic of this type gearing.

The mileage figures, relative to the frequency of lubrication changes, are based upon average vehicle operating conditions, and are not applicable in all cases. The actual conditions under which the vehicle is operated should be the determining factor in establishing lubrication requirements.

Changes to the correct grade of lubricant for Winter or Summer operations are dependent upon climatic conditions and should be made as required regardless of mileage. For average operation, check the lubricant level every 1,000 miles and drain and refill to level of tapped filler hole every 10,000 miles.

To further assure complete lubrication after overhaul and before the vehicle is placed into heavy slow speed operation; jack up both rear wheels and run the axle for a short period at speeds equivalent to 25 to 30 m.p.h. Do not allow the wheel on one side to race faster than the wheel on the opposite side.

IMPORTANT:-NEVER ADD LUBRICANT TO TWO-SPEED HYPOID AXLES UNLESS IT IS THE SAME MAKE AND GRADE AS THAT WHICH IS ALREADY IN THE AXLES. IF THE SAME MAKE AND GRADE LUBRICANT IS NOT AVAILABLE, DRAIN, FLUSH, AND REFILL WITH LUBRICANT AS PER FOLLOWING INSTRUCTIONS:-

Fill axle through back filler plug until oil flows from overflow plug. Insert plug. Then add one additional pint of oil using filler hole at top of carrier. This will supply the extra oil required to fill differential and planetary unit. At 1,000 mile intervals, check level of oil in housing.

NOTE: Use a hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent. A number of hypoid lubricants are prepared by reputable companies which contain Elco additive concentrates. Viscosity of the hypoid lubricant should be SAE-90. When high atmospheric temperatures (above 100° F.) prevail, SAE-140 should be used.

DOUBLE-REDUCTION HYPOID AXLES (EATON)

Hypoid gearing in these axles requires the use of lubricants with properties enabling them to withstand the higher unit pressures and sliding action characteristic of this type gearing.

The mileage figures, relative to the frequency of lubrication changes, are based upon average vehicle operating conditions, and are not applicable in all cases. The actual conditions under which the vehicle is operated should be the determining factor in establishing lubrication requirements.

Changes to the correct grade of lubricant for Winter or Summer operations are dependent upon climatic conditions and should be made as required regardless of mileage. For average operation, check the lubricant level every 1,000 miles and drain and refill to level of tapped filler hole every 10,000 miles.

To further assure complete lubrication after overhaul and before the vehicle is placed into heavy slow speed operations: jack up both rear wheels and run the axle for a short period at speeds equivalent to 25 to 30 m.p.h. Do not allow the wheel on one side to race faster than the wheel on the opposite side.

IMPORTANT: NEVER ADD LUBRICANT TO DOUBLE-REDUCTION HYPOID AXLES UNLESS IT IS THE SAME MAKE AND GRADE AS THAT WHICH IS ALREADY IN THE AXLES. IF THE SAME MAKE AND GRADE LUBRICANT IS NOT AVAILABLE, DRAIN, FLUSH, AND REFILL WITH LUBRICANT AS PER FOLLOWING INSTRUCTIONS:-

Fill axle through back filler plug until oil flows from overflow plug. Insert plug. Then add one additional pint of oil using filler hole in pinion cage. This will supply the extra oil required to fill differential and planetary unit. At 1,000 mile intervals, check level of oil in housing and add make-up if needed.

NOTE: Use a hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent. A number of hypoid lubricants are prepared by reputable companies which contain Elco additive concentrates. Viscosity of the hypoid lubricant should be SAE-90. When high atmospheric temperatures (above 100° F.) prevail, SAE-140 should be used.



TIMKEN (S-200, U-200, S-300, U-300) AXLES

Hypoid gearing in these axles requires the use of lubricants with properties enabling them to withstand the higher unit pressures and sliding action characteristic of this type gearing.

The mileage figures, relative to the frequency of lubrication changes, are based upon average vehicle operating conditions, and are not applicable in all cases. The actual conditions, under which the vehicle is operated should be the determining factor in establishing lubrication requirements.

Changes to the correct grade of lubricant for Winter or Summer operations are dependent upon climatic conditions and should be made as required regardless of mileage. For average operation, check the lubricant level every 1,000 miles and drain and refill to level of tapped filler hole every 10,000 miles.

Where an axle has been out of use for a long period, or has been overhauled the lubricant plug on the top of the Hypoid pinion cage should be removed and one pint of lubricant inserted. This provides immediate lubrication for the pinion before oil is thrown up from the axle housing bowl. To further assure complete lubrication after overhaul and before the vehicle is placed into heavy slow speed operation: jack up both rear wheels and run the axle for a short period at speeds equivalent to 25 to 30 m.p.h. Do not allow the wheel on one side to race faster than the wheel on the opposite side.

IMPORTANT: NEVER ADD LUBRICANT TO TIMKEN HYPOID AXLES UNLESS IT IS THE SAME MAKE AND GRADE AS THAT WHICH IS ALREADY IN THE AXLES. IF THE SAME MAKE AND GRADE LUBRICANT IS NOT AVAILABLE, DRAIN, FLUSH, AND REFILL WITH LUBRICANT AS FOLLOWS:-

NOTE: Use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles and supplied by a reputable refinery. Use SAE-90 for cold climate and SAE-140 for warm climate.



L-LINE MOTOR TRUCK SERVICE MANUAL

REAR AXLE LUBRICATION CAPACITIES

IH MODEL	CODE NUMBER	AXLE TYPE	CAPACITY (PINTS)
R-1060	1401	Single-Reduction	4 Pts.
R-1070	1402	Single-Reduction	4 Pts.
R-1165	1433	Single-Reduction	4 Pts.
R-1170	1403	Single-Reduction	3 Pts.
R-1440	1404	Single-Reduction	8 Pts.
RF-1475	1428	Single-Reduction	Each Axle 8 Pts.
R-1470	1405	Single-Reduction	8 Pts.
R-1530	1406	Single-Reduction	11 Pts.
R-1540	1415	Double-Reduction - Eaton	19 Pts.
R-1555	1407	Single-Reduction	20 Pts.
RF-1575	1429	Single-Reduction	Each Axle 11 Pts.
R-1630	1408	Single-Reduction	18 Pts.
R-1640	1416	Double-Reduction	19 Pts.
RF-1670	1430	Single-Reduction . . . . .	. . . . .
R-1731	1419	Double-Reduction - S-200	38 Pts.
R-1741	1409	Single-Reduction . . . . .	. . . . .
R-1810	1420	Double-Reduction - U-200	38 Pts.
R-2465	1410	Two-Speed	13 Pts.
R-2466	1411	Two-Speed	13 Pts.
R-2470	1425	Two-Speed with Timken Diff. . . . .	. . . . .
R-2475	1426	Two-Speed with Timken Diff. . . . .	. . . . .
R-2580	1413	Two-Speed	22 Pts.
R-2585	1412	Two-Speed	20 Pts.
R-2590	1427	Two-Speed with Timken Diff. . . . .	. . . . .
R-2600	1414	Two-Speed	22 Pts.
R-2741	1422	Two-Speed - S-300	37 Pts.
R-2800	1423	Two-Speed - U-300	37 Pts.

TRANSMISSION LUBRICATION CAPACITIES

IH MODEL	CODE NUMBER	TRANSMISSION TYPE	CAPACITY (PINTS)
HDS	1301	3-Speed	3 Pts.
H-41-B	1320	4-Speed	5 Pts.
T-87-D	1302	3-Speed	6 Pts.
T-98	1303	4-Speed	8 Pts.
T-98	1304	4-Speed	8 Pts.
F-51	1307	5-Speed - O.D.Transmission	12 Pts.
F-51-C	1308	5-Speed - Direct-in-Fifth	12 Pts.
F-52	1309	5-Speed - O.D.Transmission	19 Pts.
F-52-C	1310	5-Speed - Direct-in-Fifth	19 Pts.
F-54	1311	5-Speed - O.D.Transmission	24 Pts.
F-54-B	1312	5-Speed - Direct-in-Fifth	24 Pts.
F-55	1313	5-Speed - O.D.Transmission	26 Pts.
F-55-B	1314	5-Speed - Direct-in-Fifth	26 Pts.

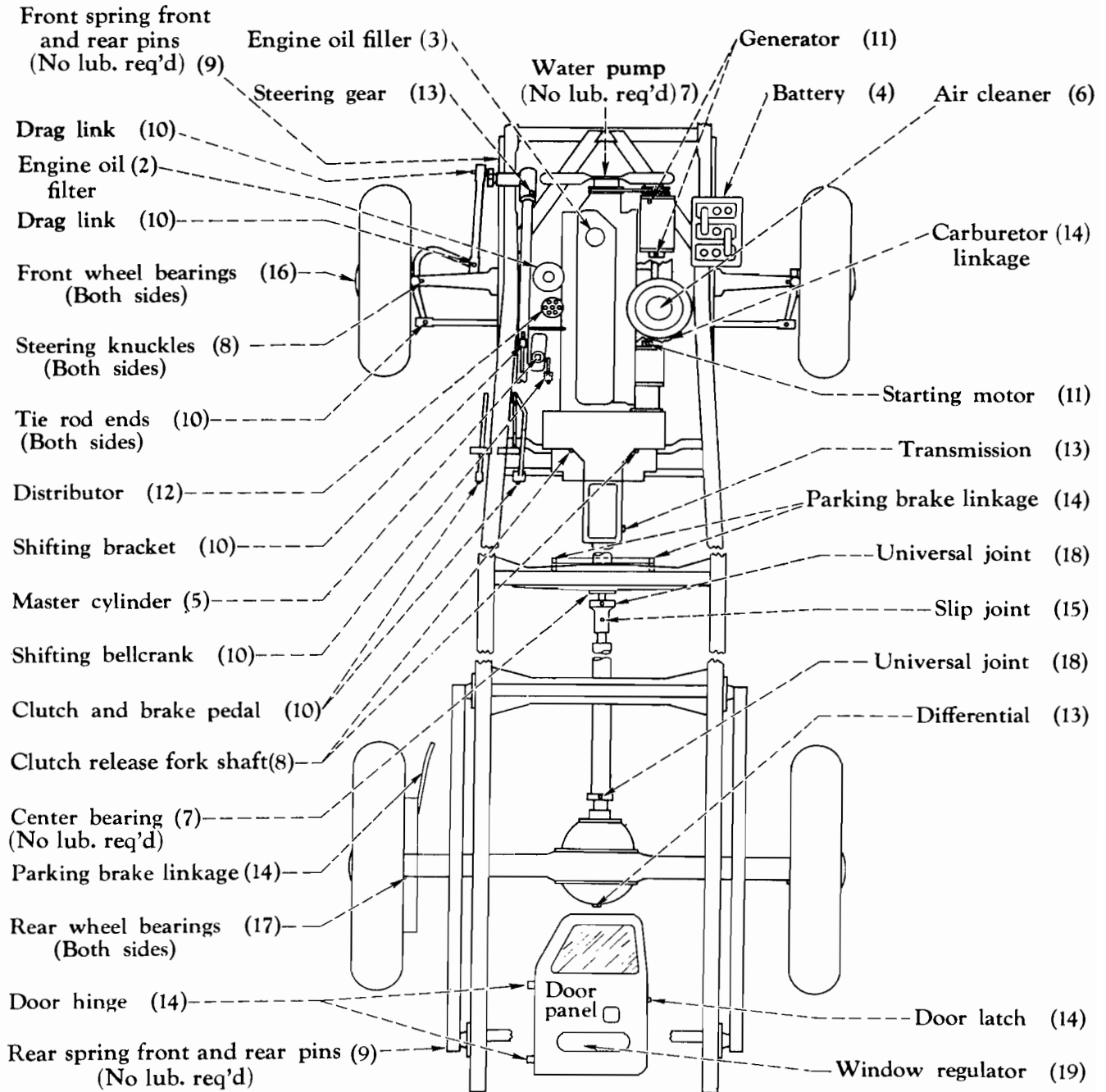
Code numbers are shown on vehicle specification card L-160 trucks and up.



LUBRICATION CHART

L-110 SERIES TRUCKS

(SEE PAGE 2 FOR INSTRUCTIONS)



A-23656

Lubrication periods provide an excellent opportunity to inspect and check for maintenance service that may be needed. Early attention to minor service needs at this inspection will usually prevent serious breakdown later.



LUBRICATION CHART INSTRUCTIONS
L-110 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.)	SAE-40	Minus 10° (F.) to	
(* See Hot Climate - High Speed instruction following)		10° (F.) above zero.	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.
Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

PERIODICALLY

2. Engine oil filter: {Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Engine oil filler: Remove filler cap, clean element, and dip in engine oil - then drain and replace.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: {Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Air cleaner: {Remove filter element and wash in kerosene. Clean oil sump and refill to indicated level with clean engine oil, same grade used in crankcase.
7. Water pump:
Propeller shaft center bearing: } Lubricated at factory. Further lubrication not required.

500 TO 1,000 MILES

8. Steering knuckles:
Clutch release fork shaft: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate - too much oil will cause failure of brake and clutch lining.
9. Spring pins: Pins are rubber mounted; lubrication not required.
10. Drag link; tie rod ends:
Shifting bracket:
Shifting bellcrank:
Clutch and brake pedals: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt, and water are expelled.
11. Generator:
Starting motor: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
12. Distributor: {Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to distributor cam and contact arm fiber rubbing block. Note: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug.
13. Differential:
Transmission:
Steering gear: } Inspect oil level every 1,000 miles and keep oil up to filler plug, using same make and grade oil as in unit; if same grade oil is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For differential (4 pints), use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles as supplied by a reputable refinery. Keep breather fittings clean. For transmission (3 pints) and steering gear (1 pint), use SCL, EP gear oil or multi-purpose gear oil, supplied by a reputable refinery.
14. Parking brake linkage:
Carburetor linkage:
Door hinges, door latches: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door latches.

3,000 TO 5,000 MILES

15. Propeller shaft slip joint: Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.

10,000 MILES

16. Front wheel bearings: {Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.
17. Rear wheel bearings: {Remove grease plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force about one oz. into bearing cavity. Note: Too much lubricant will damage brake lining. Remove fitting and replace plug.

15,000 TO 20,000 MILES

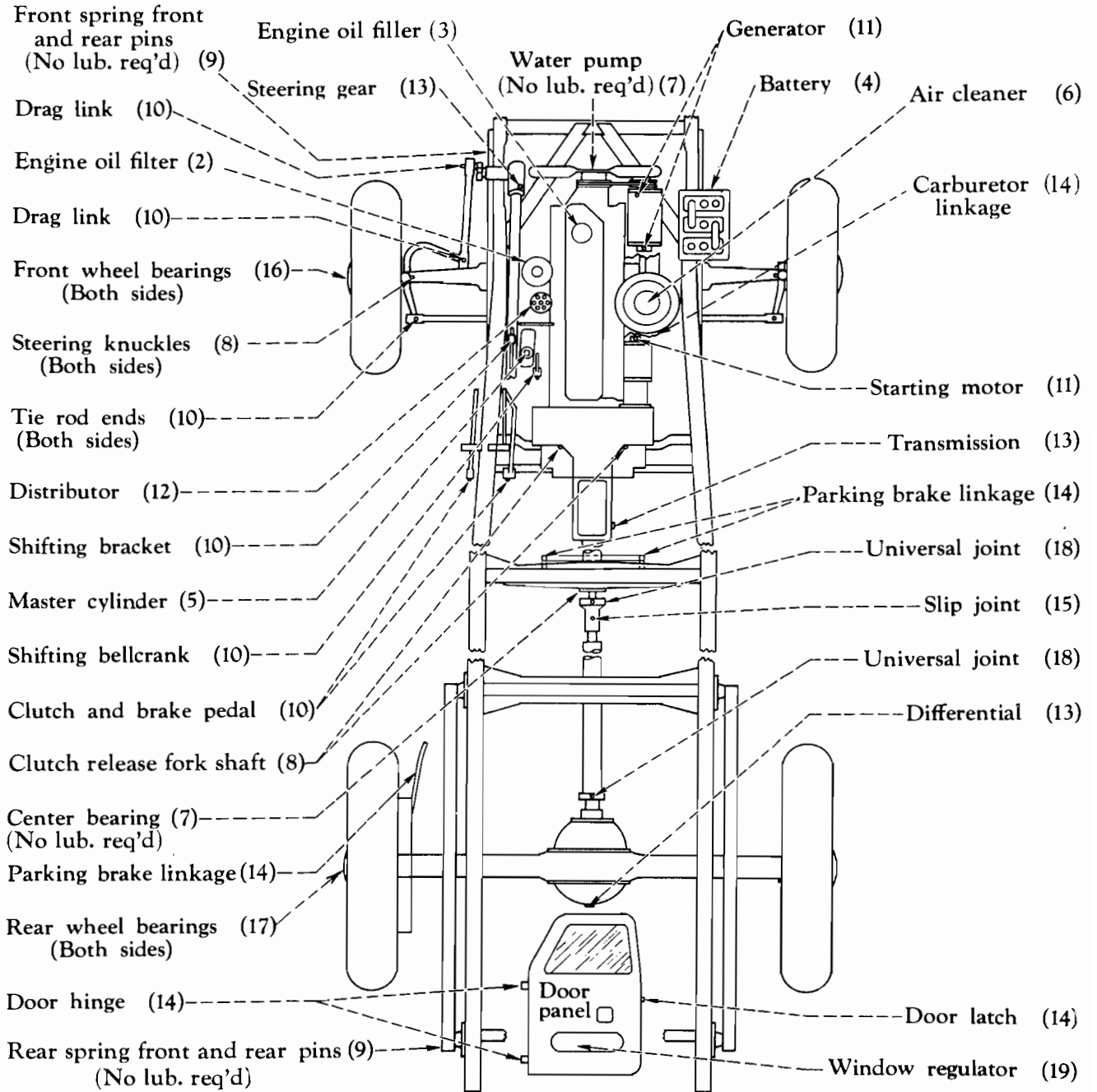
18. Propeller shaft universal joints: {Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
19. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



LUBRICATION CHART

L-120 SERIES TRUCKS

(SEE PAGE 4 FOR INSTRUCTIONS)



A-23655

Lubrication periods provide an excellent opportunity to inspect and check for maintenance service that may be needed. Early attention to minor service needs at this inspection will usually prevent serious breakdown later.



LUBRICATION CHART INSTRUCTIONS
L-120 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES		OIL GRADE	TEMPERATURES		OIL GRADE
* 90° (F.) and up	.....	SAE-40	10° (F.) to 32° (F.) (above zero)	.....	SAE-20W
32° (F.) to 90° (F.)	.....	SAE-40	Minus 10° (F.) to		
(* See Hot Climate - High Speed instruction following)			10° (F.) above zero.	.....	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.
Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

PERIODICALLY

2. Engine oil filter: {Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Engine oil filler: Remove filler cap, clean element, and dip in engine oil - then drain and replace.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: {Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Air cleaner: {Remove filter element and wash in kerosene. Clean oil sump and refill to indicated level with clean engine oil, same grade used in crankcase.
7. Water pump:
Propeller shaft center bearing: } Lubricated at factory. Further lubrication not required.

500 TO 1,000 MILES

8. Steering knuckles:
Clutch release fork shaft: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate - too much oil will cause failure of brake and clutch lining.
9. Spring pins: Pins are rubber mounted; lubrication not required.
10. Drag link; rod ends:
Shifting bracket:
Shifting bellcrank:
Clutch and brake pedals: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt, and water are expelled.
11. Generator:
Starting motor: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
12. Distributor: {Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to distributor cam and contact arm fiber rubbing block. Note: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug.
13. Differential:
Transmission:
Steering gear: } Inspect oil level every 1,000 miles and keep oil up to filler plug, using same make and grade oil as in unit; if same grade oil is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For differential (4 pints), use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles as supplied by a reputable refinery. Keep breather fittings clean. For transmission (3 pints) and steering gear (1 pint), use SCL, EP gear oil or multi-purpose gear oil, supplied by a reputable refinery.
14. Parking brake linkage:
Carburetor linkage:
Door hinges, door latches: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door latches.

3,000 TO 5,000 MILES

15. Propeller shaft slip joint: {Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.

10,000 MILES

16. Front wheel bearings: } Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.
17. Rear wheel bearings: }

15,000 TO 20,000 MILES

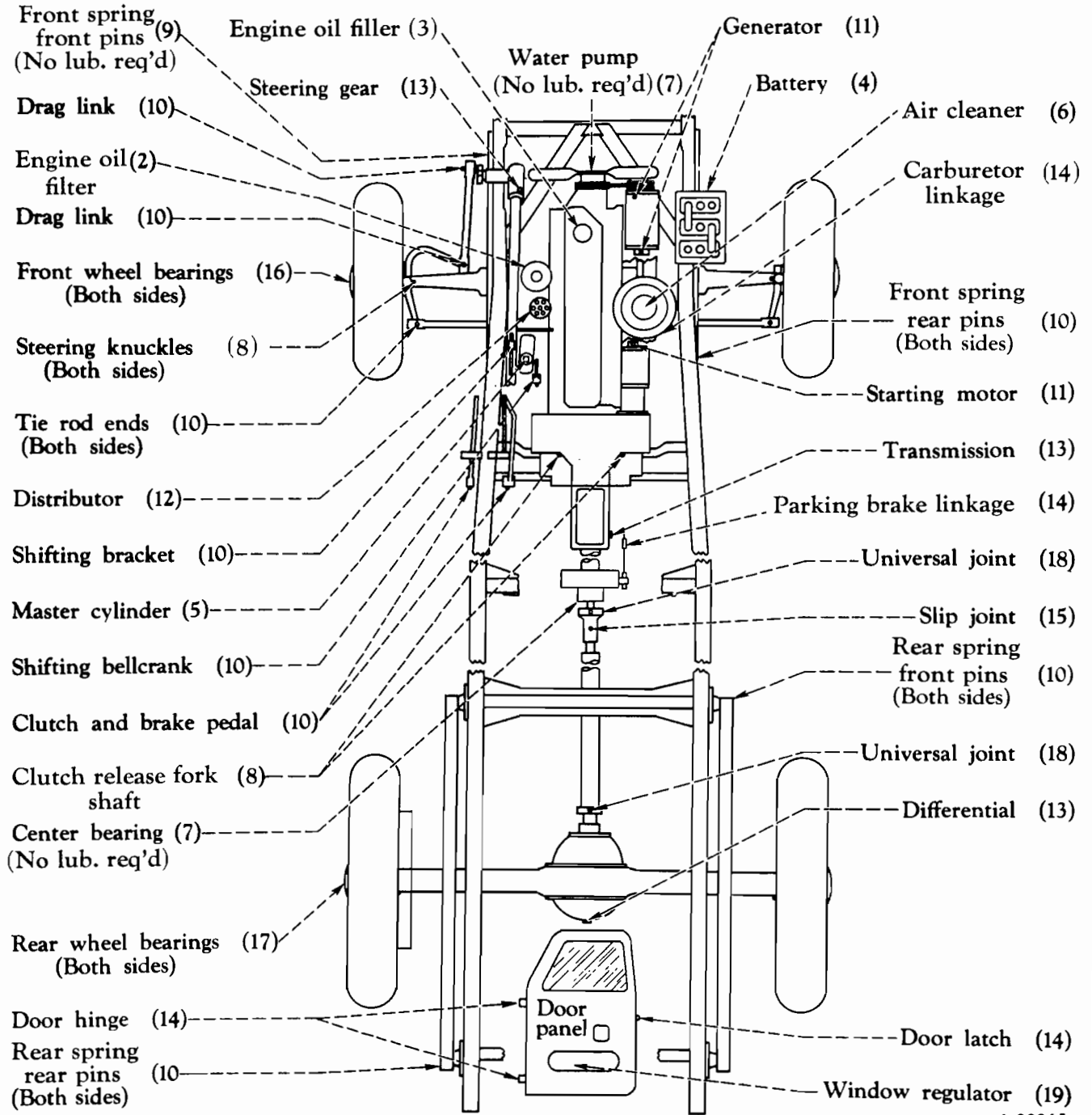
18. Propeller shaft universal joints: {Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
19. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



LUBRICATION CHART

L-130 SERIES TRUCKS

(SEE PAGE 6 FOR INSTRUCTIONS)



A-22865



LUBRICATION CHART INSTRUCTIONS

L-130 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.)	SAE-40	Minus 10° (F.) to	
(* See Hot Climate - High Speed instruction following)		10° (F.) above zero.	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

PERIODICALLY

2. Engine oil filter: { Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Engine oil filler: Remove filler cap, clean element, and dip in engine oil - then drain and replace.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: { Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Air cleaner: { Remove filter element and wash in kerosene. Clean oil sump and refill to indicated level with clean engine oil, same grade used in crankcase.
7. Water pump:
Propeller shaft center bearing: } Lubricated at factory. Further lubrication not required.

500 TO 1,000 MILES

8. Steering knuckles:
Clutch release fork shaft: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate - too much oil will cause failure of brake and clutch lining.
9. Front spring front pins: Are rubber mounted; lubrication not required.
10. Front spring rear pins: }
Rear spring - all pins:
Drag link; tie rod ends: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt, and water are expelled.
Shifting bracket:
Shifting bellcrank:
Clutch and brake pedals: }
11. Generator:
Starting motor: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
12. Distributor: { Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to distributor cam and contact arm fiber rubbing block. Note: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug.
13. Differential:
Transmission:
Steering gear: } Inspect oil level every 1,000 miles and keep oil up to filler plug, using same make and grade oil as in unit; if same grade oil is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For differential (4 pints), use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles as supplied by a reputable refinery. Keep breather fittings clean. For 3-speed transmission (6 pints), for 4-speed transmission (5 pints), and steering gear (1 pint), use SCL, EP gear oil or multi-purpose gear oil, supplied by a reputable refinery.
14. Parking brake linkage:
Carburetor linkage:
Door hinges, door latches: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door latches.

3,000 TO 5,000 MILES

15. Propeller shaft slip joint: { Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.

10,000 MILES

16. Front wheel bearings: } Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.
17. Rear wheel bearings: }

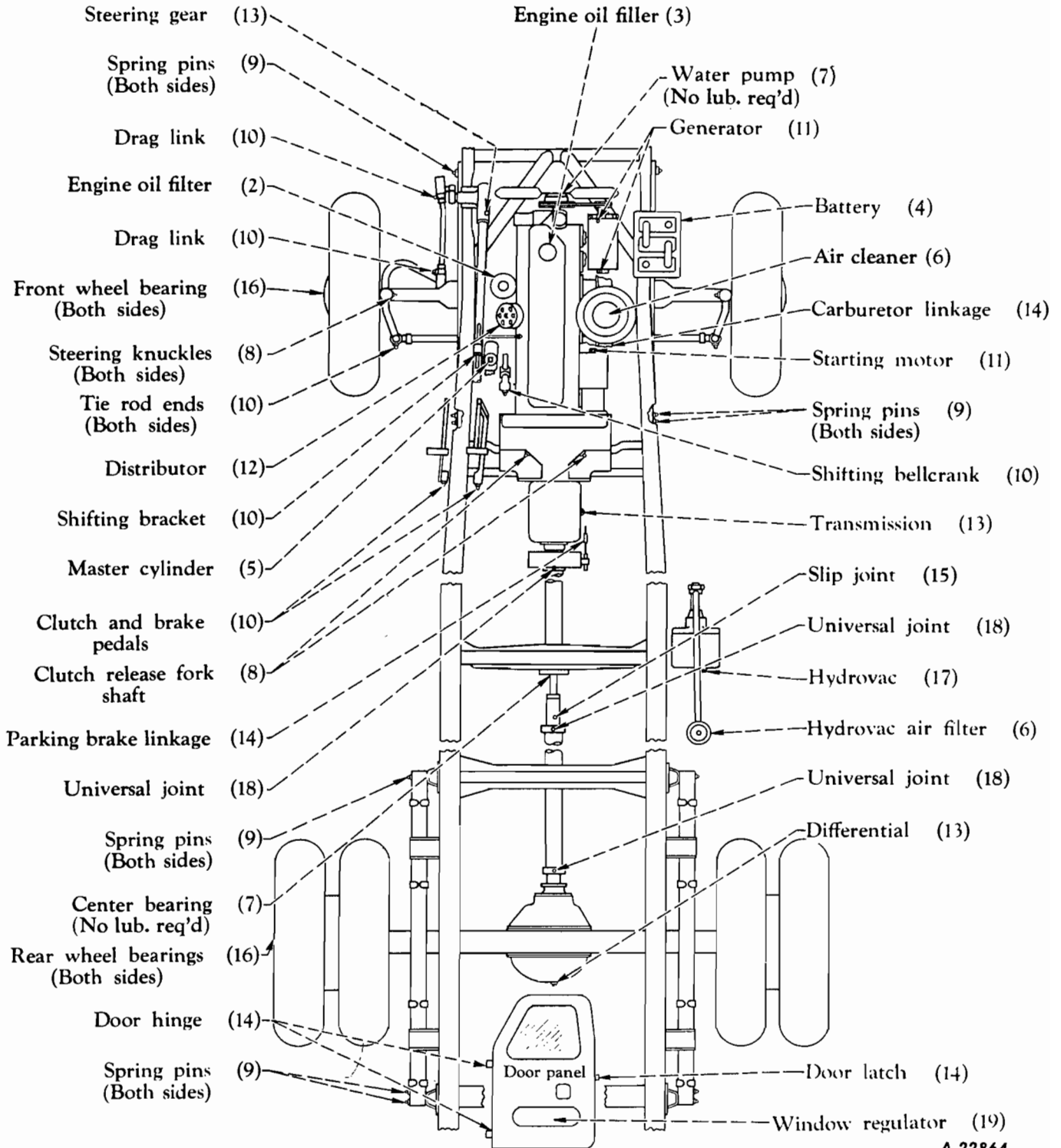
15,000 TO 20,000 MILES

18. Propeller shaft universal joints: { Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
19. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



L-LINE MOTOR TRUCK SERVICE MANUAL

LUBRICATION CHART L-150 SERIES TRUCKS



A-22864



LUBRICATION CHART INSTRUCTIONS

L-150 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.)	SAE-40	Minus 10° (F.) to	
(* See Hot Climate - High Speed instruction following)		10° (F.) above zero.	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

PERIODICALLY

2. Engine oil filter: { Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Engine oil filler: Remove filler cap, clean element, and dip in engine oil - then drain and replace.
4. Battery: Check wafer level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: { Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Engine air cleaner: { For engine air cleaner - remove filter element and wash in kerosene; clean the oil sump and refill to indicated level with clean engine oil, same grade used in crankcase. For hydrovac air cleaner - remove cleaner, dismantle and clean parts in a cleaning solvent and allow to dry; saturate element with a light oil and replace parts.
7. Water pump: } Lubricated at factory. Further lubrication not required.
- Propeller shaft center bearing: }

500 TO 1,000 MILES

8. Steering knuckles: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate - too much oil will cause failure of brake and clutch lining.
- Clutch release fork shaft: }
9. Spring pins: }
10. Drag link; tie rod ends: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt, and water are expelled.
- Shifting bracket: }
- Shifting bellcrank: }
- Clutch and brake pedals: }
11. Generator: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
- Starting motor: }
12. Distributor: { Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to distributor cam and contact arm fiber rubbing block. Note: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug.
13. Differential: { Inspect oil level every 1,000 miles and keep oil up to filler plug, using same make and grade oil as in unit; if same grade oil is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For differential (3 pints), use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles as supplied by a reputable refinery. Keep breather fittings clean. For 4-speed heavy-duty transmission (5 pints), 4-speed synchro-mesh transmission (8 pints) and steering gear (1 pint), use SCL, EP gear oil or multi-purpose gear oil, supplied by a reputable refinery.
- Transmission: }
- Steering gear: }
14. Parking brake linkage: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door latches.
- Carburetor linkage: }
- Door hinges, door latches: }

3,000 TO 5,000 MILES

15. Propeller shaft slip joint: { Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.

10,000 MILES

16. Front wheel bearings: } Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.
- Rear wheel bearings: }

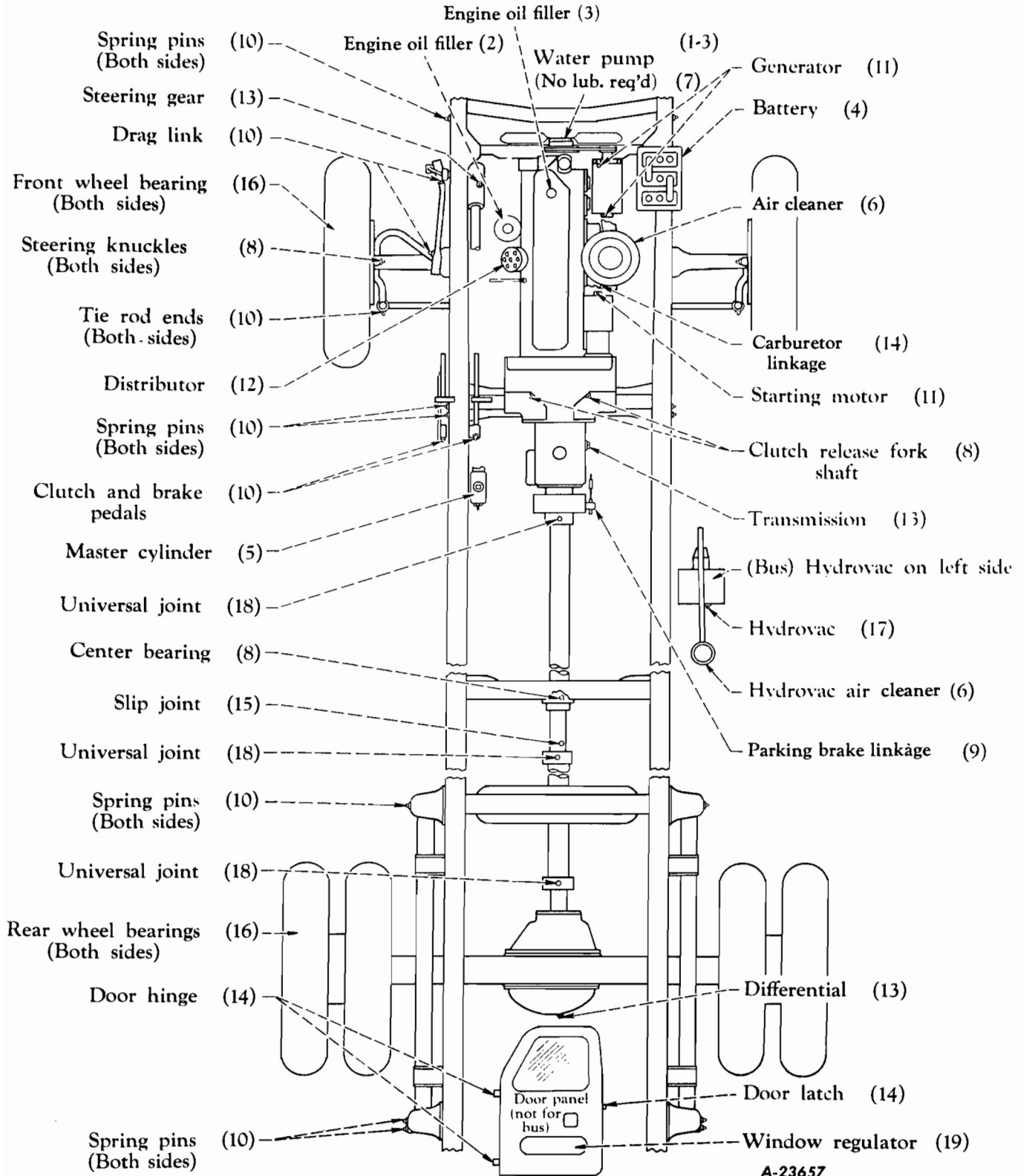
15,000 TO 20,000 MILES

17. Hydrovac: { Must be lubricated every 20,000 miles or once a year, before cold weather sets in. Remove pipe plug (located in air inlet end of cylinder). Use vacuum cylinder oil and add to top level of plug hole. Replace plug.
18. Propeller shaft universal joints: { Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
19. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



LUBRICATION CHART

L-160 SERIES TRUCKS



A-23657



LUBRICATION CHART INSTRUCTIONS L-160 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.)	SAE-40	Minus 10° (F.) to 10° (F.) above zero	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

PERIODICALLY

2. Engine oil filter: { Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Engine oil filler: Remove filler cap, clean element, and dip in engine oil - then drain and replace.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: { Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Hydrovac air cleaner: { For engine air cleaner - remove filter element and wash in kerosene; clean oil sump and refill to indicated level with clean engine oil, same grade used in crankcase. For hydrovac air cleaner - remove cleaner, disassemble and clean parts in a cleaning solvent and allow to dry; saturate element with a light oil and replace parts.
7. Water pump: Lubricated at factory Further lubrication not required.

500 TO 1,000 MILES

8. Steering knuckles: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate. Too much oil on
Clutch release fork shaft: } knuckles, and on clutch shaft cause failure of brake and clutch lining.
Propeller shaft center bearing: }
9. Parking brake linkage: Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil.
10. Spring pins: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt and water are
Drag link; tie rod ends: } expelled.
Clutch and brake pedals: }
11. Generator: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
Starting motor: }
12. Distributor: { Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to distributor cam and contact arm fiber rubbing block. Note: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug.
13. Differential: { Inspect oil level every 1,000 miles and keep oil up to filler plug, using same make and grade oil as in unit; if same
Transmission: } grade oil is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For single reduction axle (8 pints), and
Steering gear: } for two-speed axle (13 pints). Use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles as supplied by a reputable refinery (not Eaton Axles). For Eaton Axles, use hypoid gear lubricant available as Elco Gear
Electric shift: } Safety "28" or its equivalent (see instructions, section "A"). Keep breather fittings clean. For 4-speed syncro-mesh transmission (8 pints) and steering gear (1 pint), use SCL, EP gear oil or multi-purpose gear oil, supplied by a reputable refinery. For electric shift, inspect oil level every 10,000 miles and keep filled to plug level with SAE-10 oil.
14. Carburetor linkage: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on
Door hinges, door latches: } door latches.

3,000 TO 5,000 MILES

15. Propeller shaft slip joint: { Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.

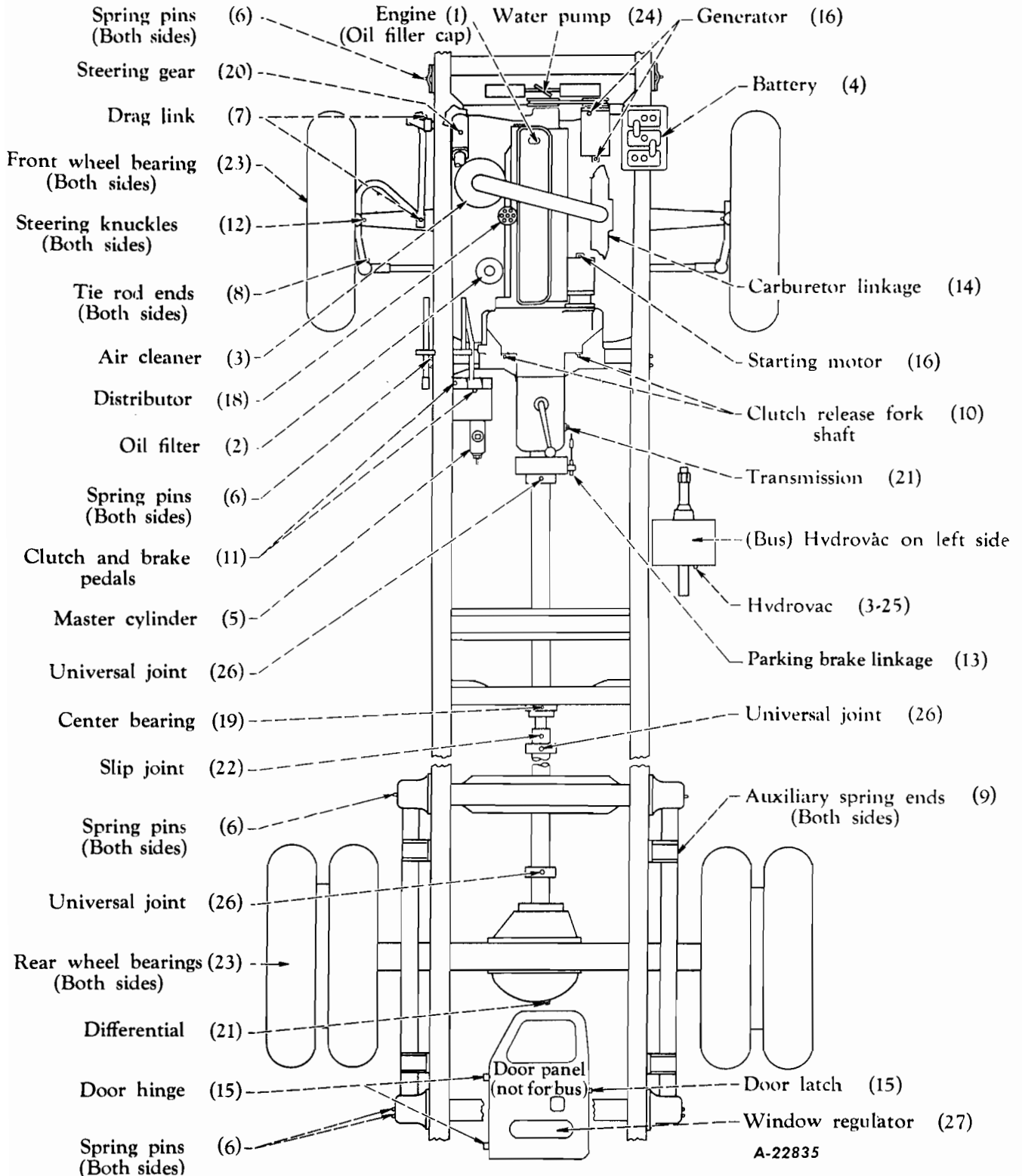
10,000 MILES

16. Front wheel bearings: } Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel
Rear wheel bearings: } bearing grease. Replace wheels and adjust bearings.

15,000 TO 20,000 MILES

17. Hydrovac: { Must be lubricated every 20,000 miles or once a year, before cold weather sets in. Remove pipe plug (located in air inlet end of cylinder). Use vacuum cylinder oil and add to top level of plug hole. Replace plug.
18. Propeller shaft universal joints: { Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil.
Remove fitting and replace plug.
19. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.

LUBRICATION CHART L-170 SERIES TRUCKS



A-22835



LUBRICATION CHART INSTRUCTIONS L-170 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather required frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.)	SAE-40	Minus 10° (F.) to 10° (F.) above zero	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-50 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

500 TO 1,000 MILES

2. Oil filter: { Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Air cleaners: { For engine air cleaner remove reservoir and dispose dirty oil; clean filter and reservoir and refill to oil level mark with clean engine oil, same grade used in crankcase. For hydrovac air cleaner - remove cleaner, dismantle and clean parts in a cleaning solvent and allow to dry; saturate element with a light engine oil and replace parts.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: { Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Spring pins: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt, and water are expelled.
7. Drag links: }
8. Tie rods: }
9. Auxiliary spring ends: }
10. Clutch release fork shaft: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate. Too much oil on knuckles, and on clutch shaft will cause failure of brake and clutch lining.
11. Clutch and brake pedal: }
12. Steering knuckles: }
13. Parking brake linkage: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door hinges, door latches.
14. Carburetor linkage: }
15. Door hinges, door latches: }
16. Generator: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
17. Starting motor: }
18. Distributor: { Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to the distributor cam and contact arm fiber rubbing block. NOTE: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug. For distributor with grease cup: Fill cup with SAE-140 gear oil, as required, and turn one turn every 1,000 miles.
19. Propeller shaft center bearing: Use a medium short-fiber wheel bearing grease (sodium-soap type).
20. Steering gear: Remove pipe plug and inspect oil level every 1,000 miles. Use SAE-140 gear oil. Keep housing full of oil.
21. Transmission Refill:

Code No. 1304 - Capacity 8 Pts.	} Inspect oil level every 1,000 miles and keep oil level up to filler plug, using same make and grade oil as in unit; if same grade is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For transmission use SLC, EP gear oil or multi-purpose gear oil supplied by a reputable refinery. For rear axles (not Eaton) use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles supplied by a reputable refinery. For Eaton axles, use hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent (see instructions, section "A"). *For Electric Shift, inspect oil level every 10,000 miles and keep filled to plug level with SAE-10 oil.
Code No. 1307 - Capacity 12 Pts.	
Code No. 1308 - Capacity 12 Pts.	
Code No. 1405 - Capacity 8 Pts.	
Code No. 1406 - Capacity 11 Pts.	
*Code No. 1411 - Capacity 13 Pts.	
*Code No. 1412 - Capacity 20 Pts.	

3,000 TO 5,000 MILES

22. Propeller shaft slip joint: { Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.
23. Wheel bearings: { Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.

10,000 MILES

24. Water pump: { Remove plug and install a pressure gun fitting. Use a short-fiber wheel bearing grease and fill housing (under low pressure).
25. Hydrovac: Inject two ounces vacuum cylinder oil twice yearly or every 10,000 miles, preferably in the spring and fall.

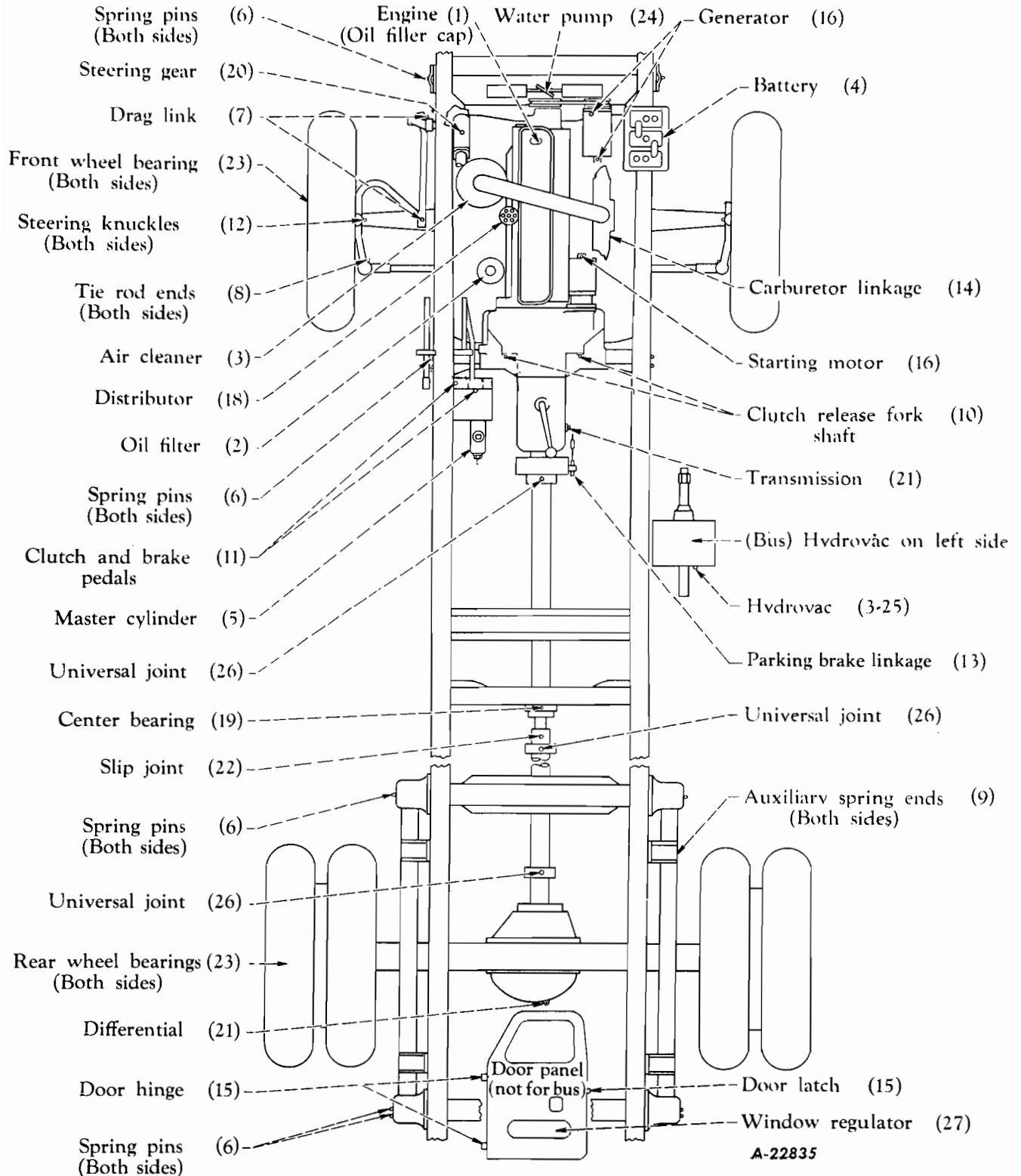
15,000 TO 20,000 MILES

26. Propeller shaft universal joints: { Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
27. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



LUBRICATION CHART

L-180, L-181, L-182, L-183, L-184 TRUCKS





LUBRICATION CHART INSTRUCTIONS

L-180, L-181, L-182, L-183, L-184 TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Col weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.):	SAE-40	Minus 10° (F.) to	
(* See Hot Climate - High Speed instruction following)		10° (F.) above zero.	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

500 TO 1,000 MILES

2. Oil filter: { Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge
Run engine for a few minutes and check filter for leaks.
3. Air cleaners: { For engine air cleaner remove reservoir and dispose dirty oil; clean filter and reservoir and refill to oil level mark
with clean engine oil, same grade used in crankcase. For hydrovac air cleaner - remove cleaner, dismantle and clean parts in a cleaning solvent and allow to dry; saturate element with a light engine oil and replace parts.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: { Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Spring pins: } Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt, and water are expelled.
7. Drag links: }
8. Tie rods: }
9. Auxiliary spring ends: }
10. Clutch release fork shaft: }
11. Clutch and brake pedal: }
12. Steering knuckles: } Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate. Too much oil on knuckles and on clutch shaft will cause failure of brake and clutch lining.
13. Parking brake linkage: }
14. Carburetor linkage: }
15. Door hinges, door latches: } Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door latches.
16. Generator: }
17. Starting motor: } Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
18. Distributor: { Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to the distributor cam and contact arm fiber rubbing block. NOTE: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug. For distributor with grease cup: fill cup with SAE-140 gear oil, as required, and turn one turn every 1,000 miles.
19. Propeller shaft center bearing: Use a medium short-fiber wheel bearing grease (sodium-soap type).
20. Steering gear: Remove pipe plug and inspect oil level every 1,000 miles. Use SAE-140 gear oil. Keep housing full of oil.
21. Transmission Refill: } Inspect oil level every 1,000 miles and keep oil level up to filler plug, using same make and grade oil as in unit; if same grade is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For transmission use SLC, EP gear oil or multi-purpose gear oil supplied by a reputable refinery. For rear axles (not Eaton) use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles supplied by a reputable refinery. For Eaton axles, use hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent (see instructions, section "A"). *For Electric Shift, inspect oil level every 10,000 miles and keep filled to plug level with SAE-10 oil.

3,000 TO 5,000 MILES

22. Propeller shaft slip joint: { Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.
23. Wheel bearings: { Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.

10,000 MILES

24. Water pump: { Remove plug and install a pressure gun fitting. Use a short-fiber wheel bearing grease and fill housing (under low pressure).
25. Hydrovac: Inject two ounces vacuum cylinder oil twice yearly or every 10,000 miles, preferably in the spring and fall.

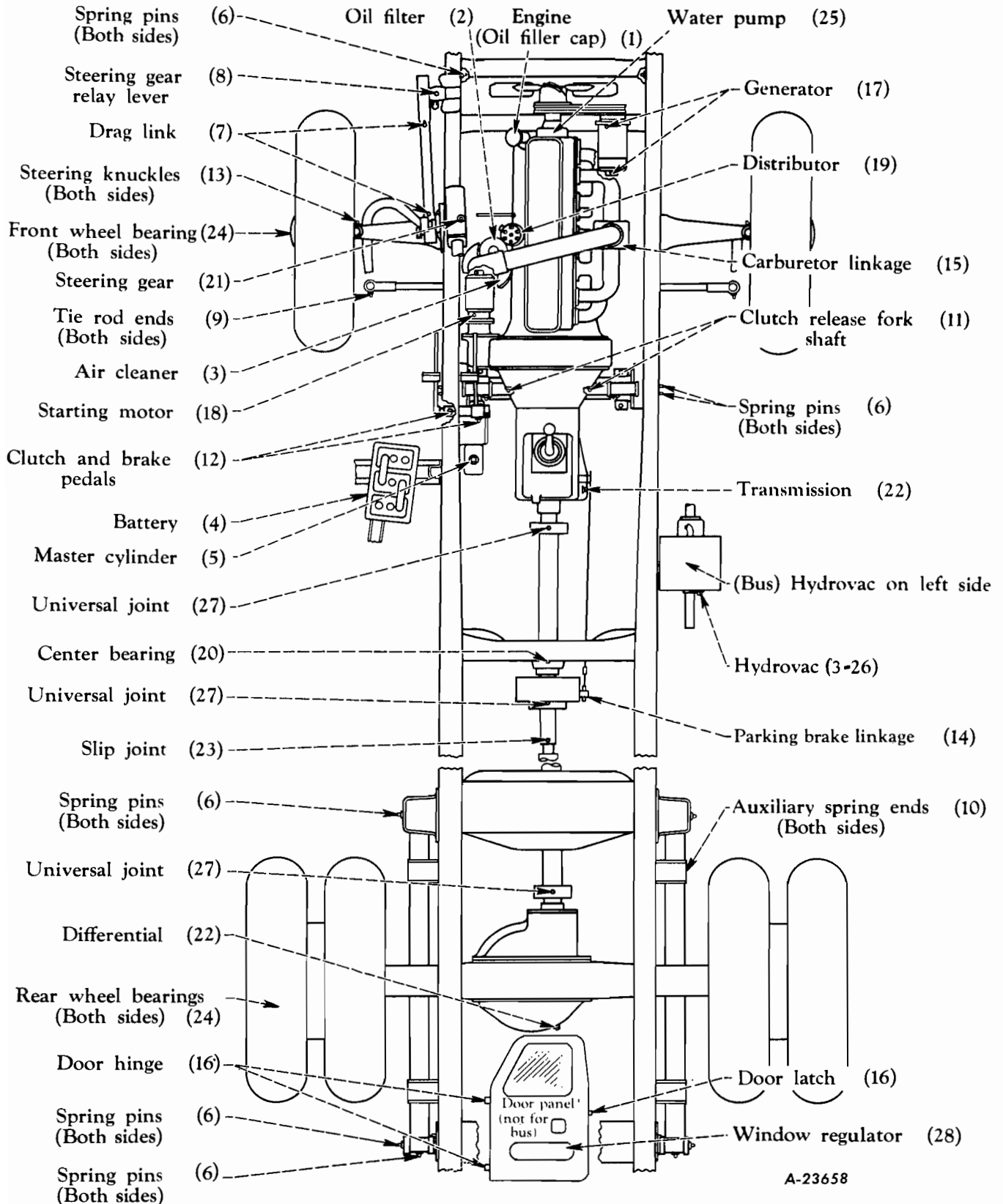
15,000 TO 20,000 MILES

26. Propeller shaft universal joints: { Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil
Remove fitting and replace plug.
27. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



L-LINE MOTOR TRUCK SERVICE MANUAL

LUBRICATION CHART L-190 SERIES TRUCKS



A-23658



LUBRICATION CHART INSTRUCTIONS

L-190 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES	OIL GRADE	TEMPERATURES	OIL GRADE
* 90° (F.) and up	SAE-40	10° (F.) to 32° (F.) (above zero)	SAE-20W
32° (F.) to 90° (F.)	SAE-40	Minus 10° (F.) to	
(* See Hot Climate - High Speed instruction following)		10° (F.) above zero.	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

500 TO 1,000 MILES

2. Oil filter: { Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Air cleaners: { For engine air cleaner remove reservoir and dispose dirty oil; clean filter and reservoir and refill to oil level mark with clean engine oil, same grade used in crankcase. For hydrovac air cleaner - remove cleaner, dismantle and clean parts in a cleaning solvent and allow to dry; saturate element with a light engine oil and replace parts.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: { Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Steering gear relay arm: }
7. Spring pins: }
8. Drag links: }
9. Tie rods: }
10. Auxiliary spring ends: }
11. Clutch release fork shaft: }
12. Clutch and brake pedal: }
13. Steering knuckles: }
14. Parking brake linkage: }
15. Carburetor linkage: }
16. Door hinges, door latches: }
17. Generator: }
18. Starting motor: }
19. Distributor: { Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to the distributor cam and contact arm fiber rubbing block. NOTE: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug. For distributor with grease cup: fill cup with SAE-140 gear oil, as required, and turn one turn every 1,000 miles. Put one or two drops of engine oil on governor rotor.
20. Propeller shaft center bearing: Use a medium short-fiber wheel bearing grease (sodium-soap type).
21. Steering gear: Remove pipe plug and inspect oil level every 1,000 miles. Use SAE-140 gear oil. Keep housing full of oil.
22. Transmission Refill: Code No. 1309 - Capacity 19 Pts.
Code No. 1310 - Capacity 19 Pts.
Differential Refill: Code No. 1407 - Capacity 20 Pts.
Code No. 1408 - Capacity 18 Pts.
*Code No. 1413 - Capacity 22 Pts.
*Code No. 1414 - Capacity 22 Pts.
Code No. 1415 - Capacity 19 Pts.
Code No. 1416 - Capacity 19 Pts. } Inspect oil level every 1,000 miles and keep oil level up to filler plug, using same make and grade oil as in unit; if same grade is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For transmission use SCL, EP gear oil or multi-purpose gear oil supplied by a reputable refinery. For rear axles (not Eaton) use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles supplied by a reputable refinery. For Eaton axles, use hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent (see instructions, section "A"). *For Electric Shift, inspect oil level every 10,000 miles and keep filled to plug level with SAE-10 oil.

3,000 TO 5,000 MILES

23. Propeller shaft slip joint: { Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.
24. Wheel bearings: { Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.

10,000 MILES

25. Water pump: { Remove plug and install a pressure gun fitting. Use a short-fiber wheel bearing grease and fill housing (under low pressure)
26. Hydrovac: Inject two ounces vacuum cylinder oil twice yearly or every 10,000 miles, preferably in the spring and fall.

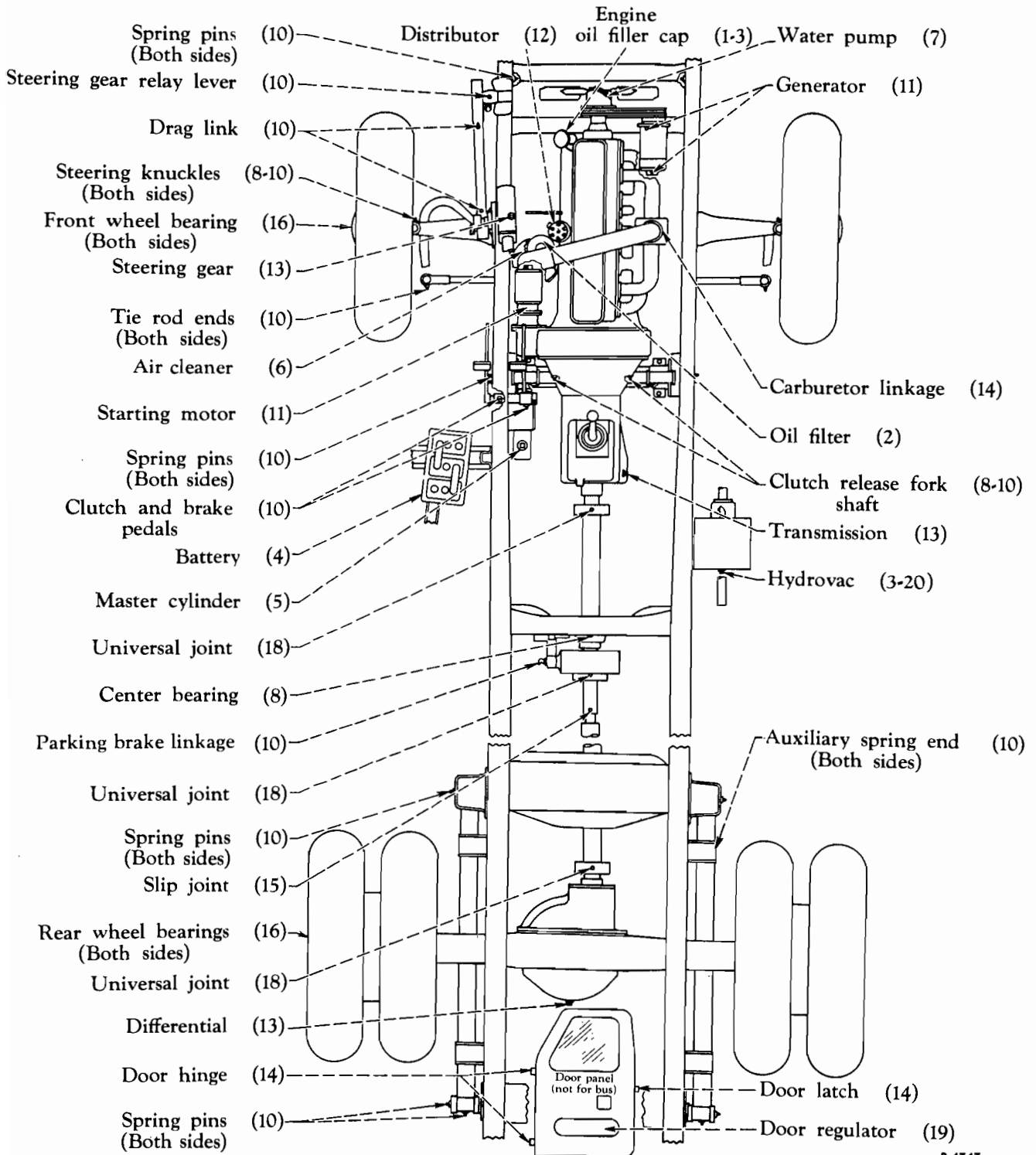
15,000 TO 20,000 MILES

27. Propeller shaft universal joints: { Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
28. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



LUBRICATION CHART

L-200 SERIES TRUCKS





LUBRICATION CHART INSTRUCTIONS
L-200 SERIES TRUCKS

DAILY

1. Engine: Keep crankcase filled to correct level with high-grade engine oil. Changing oil regularly will remove accumulated dirt. Cold weather requires frequent oil change because of increased use of choke, also condensation of moisture. Refill capacity, 7 quarts; add 1 quart for oil filter. For trucks in multi-stop, or other services where sustained high engine speeds are not encountered, select oil grade as follows:

TEMPERATURES		OIL GRADE	TEMPERATURES		OIL GRADE
* 90° (F.) and up	.....	SAE-40	10° (F.) to 32° (F.) (above zero)	.....	SAE-20W
32° (F.) to 90° (F.)	.....	SAE-40	Minus 10° (F.) to		
(* See Hot Climate - High Speed instruction following)			10° (F.) above zero	.....	SAE-10W

Temperatures lower than minus 10° (F.) below zero, use SAE-10W plus kerosene. SAE-10W may be safely diluted with colorless kerosene up to 30 percent; mix thoroughly before adding to engine, and check oil level OFTEN - because kerosene evaporates rapidly at crankcase temperature.

Hot Climate - High Speed: For trucks operating on highway, or other service demanding sustained high engine speeds, use engine oil having a viscosity as near SAE-40 as possible and as starting ability will permit. Note: High viscosity oils are available which also have very good cold-pour characteristics.

500 TO 1,000 MILES

2. Oil filter: {Change cartridge when oil has darkened. Remove filter cover and cartridge, clean inside of filter - install new cartridge. Run engine for a few minutes and check filter for leaks.
3. Air cleaners: {For engine air cleaner remove reservoir and dispose dirty oil; clean filter and reservoir and refill to oil level mark with clean engine oil, same grade used in crankcase. For hydrovac air cleaner - remove cleaner, dismantle and clean parts in a cleaning solvent and allow to dry; saturate element with a light engine oil and replace parts.
4. Battery: Check water level. If necessary, add pure distilled water to 3/8 inch above plates. Do not overfill.
5. Brake master cylinder: {Check fluid level. Do not allow dirt to enter. If necessary, fill to 3/4 inch from top with a high grade automotive type brake fluid. Do not overfill.
6. Steering gear relay arm: {
7. Spring pins: {
8. Drag links: {Force a viscous chassis lubricant or SAE-140 gear oil into fittings until old lubricant, dirt and water are expelled.
9. Tie rods: {
10. Auxiliary spring ends: {
11. Clutch release fork shaft: {
12. Clutch and brake pedal: {Use a viscous chassis lubricant or SAE-140 gear oil. Do not over-lubricate. Too much oil on knuckles, and on clutch shaft will cause failure of brake and clutch lining.
13. Steering knuckles: {
14. Parking brake linkage: {
15. Carburetor linkage: {Lubricate linkage, clevis pins, pivot pins, and sliding surfaces with engine oil. Put suitable lubricant on door latches.
16. Door hinges, door latches: {
17. Generator: {
18. Starting motor: {Put 10 to 20 drops light engine oil in each cup. Do not over-lubricate.
19. Distributor: {Put one drop of light oil on movable contact arm pivot pin. Remove rotor and put two or three drops of light engine oil on felt wick. Apply a light coat of vaseline to the distributor cam and contact arm fiber rubbing block. NOTE: Lubricate distributor shaft at overhaul or at 25,000-mile intervals. Use SAE-20 engine oil. Use sealing compound when replacing lubricant plug. For distributor with grease cup: fill cup with SAE-140 gear oil, as required, and turn one turn every 1,000 miles. Put one or two drops of engine oil on governor rotor.
20. Propeller shaft center bearing: Use a medium short-fiber wheel bearing grease (sodium-soap type).
21. Steering gear: Remove pipe plug and inspect oil level every 1,000 miles. Use SAE-140 gear oil. Keep housing full of oil.
22. Transmission Refill: {

Code No. 1309 - Capacity 19 Pts.	Inspect oil level every 1,000 miles and keep oil level up to filler plug, using same make and grade oil as in unit; if same grade is not available, drain, flush and use new oil. (Drain and flush twice yearly or every 10,000 miles, preferably in the spring and fall.) SAE-90 cold climate. SAE-140 warm climate. For transmission use SCL, EP gear oil or multi-purpose gear oil supplied by a reputable refinery. For rear axles (not Eaton) use SCL, EP gear oil or multi-purpose gear lubricant suitable for hypoid axles supplied by a reputable refinery. For Eaton axles, use hypoid gear lubricant available as Elco Gear Safety "28" or its equivalent (see instructions, section "A"). *For Electric Shift, inspect oil level every 10,000 miles and keep filled to plug level with SAE-10 oil.
Code No. 1310 - Capacity 19 Pts.	
Code No. 1311 - Capacity 24 Pts.	
Code No. 1312 - Capacity 24 Pts.	
Differential Refill:	
Code No. 1408 - Capacity 18 Pts.	
Code No. 1416 - Capacity 19 Pts.	
Code No. 1419 - Capacity 38 Pts.	
*Code No. 1414 - Capacity 22 Pts.	
*Code No. 1422 - Capacity 37 Pts.	

3,000 TO 5,000 MILES

23. Propeller shaft slip joint: {Remove plug and install a pressure-gun fitting. Use a viscous chassis lubricant. Force a small amount into joint. Note: Too much pressure will damage oil seal and retainer. Remove fitting and replace plug.
24. Wheel bearings: {Remove wheels, clean and inspect bearings, races and wheel hubs. Repack bearings, using a short fiber wheel bearing grease. Replace wheels and adjust bearings.

10,000 MILES

25. Water pump: {Remove plug and install a pressure gun fitting. Use a short-fiber wheel bearing grease and fill housing (under low pressure).
26. Hydrovac: Inject two ounces vacuum cylinder oil twice yearly or every 10,000 miles, preferably in the spring and fall.

15,000 TO 20,000 MILES

27. Propeller shaft universal joints: {Remove plug, install a pressure-gun fitting and fill (under low pressure). Use SAE-140 gear oil. Remove fitting and replace plug.
28. Window regulator: Remove door panel and lubricate regulator slide. Use a viscous chassis lubricant.



PROPELLER SHAFT GROUP

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PROPELLER SHAFT

PROPELLER SHAFTS AND UNIVERSAL JOINTS

The propeller shafts are of tubular construction, having splined slip yokes and universal joints with steel roller bearings. Front propeller shafts have fixed joints while rear propeller shafts have the slip yoke which allows for variations in distance between rear axle and transmission or center bearing.

Universal joints used on L-Line trucks are of several types and sizes, and are illustrated below.

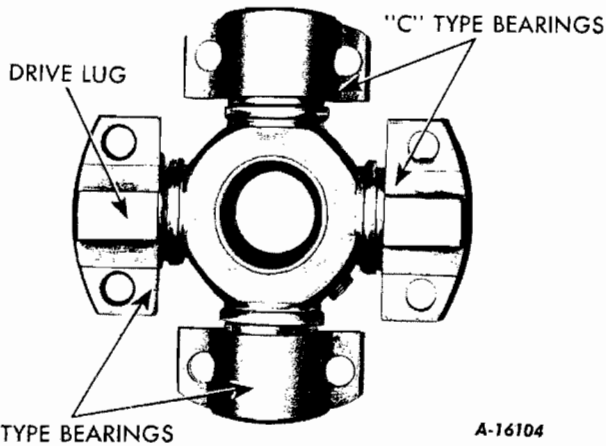


Fig. 1 -- Illustration shows details of the "C" type universal joint. With this type joint the four bearings on the journal or cross are alike.

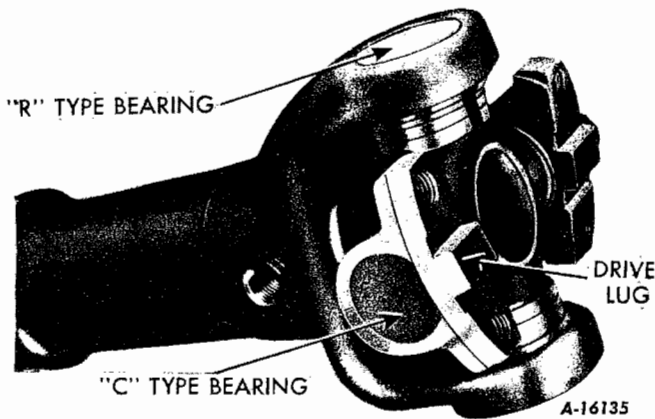


Fig. 2 -- Showing details of the "CR" type joint. In this type joint one pair of bearings is of the "C" type while the opposite pair of bearings is of the "R" type.

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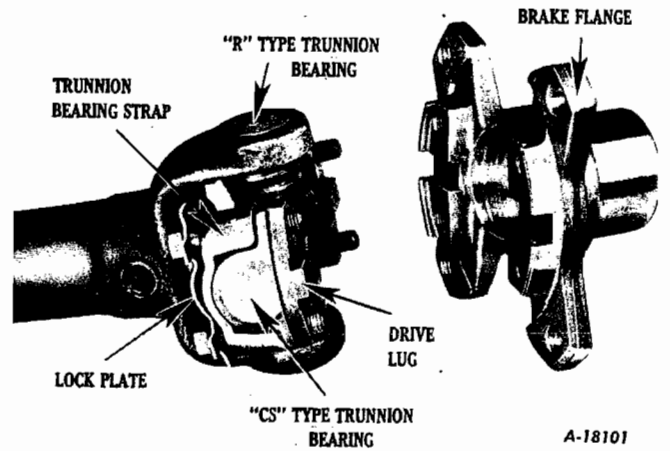


Fig. 3 -- Showing details of the "CS" type joint. On this type joint the "C" type bearings are secured by means of straps or lock plates.

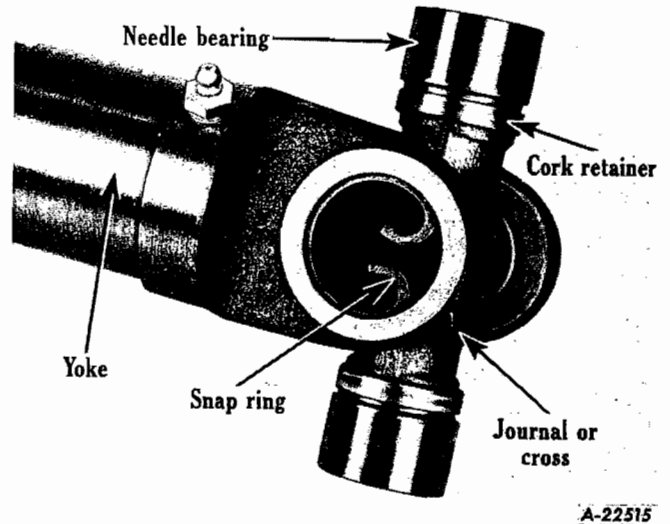


Fig. 4 -- Spicer propeller shaft joint.

Disassembling (Type C) Joint

To take a joint and shaft assembly out of a chassis, it is necessary only to remove eight capscrews; the four screws that hold the two bearings to the transmission fitting, whether it be fitting yoke or brake flange fitting, or the center joint fitting on a long wheelbase chassis and the four screws that hold the two bearings to the pinion shaft fitting (Fig. 5). To disengage the bearings from the end fittings, compress the slip joint.

Care must be taken to prevent the bearings from falling off the journals of the spider when they have been disengaged from the fitting yokes. It is a good idea to tie the bearings together in place on the spider while the other bearings are

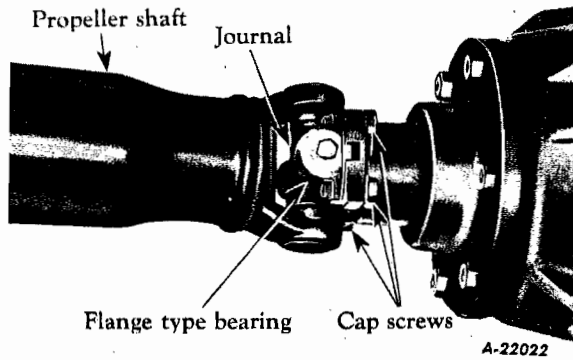


Fig. 5

being disengaged from the slip yoke and propeller shaft yoke. This precaution should be taken to eliminate the possibility of dirt or other foreign matter from entering the bearings, provided they are to be used again. It requires but very little dirt or other foreign matter in a bearing to cause considerable damage to a joint.

Unless the propeller shaft or the slip yoke is to be replaced, it is best not to disassemble these two parts. They are balanced in the position in which they are found, and should remain in that position.

When a bearing is removed from the spider, the cork packing washer usually comes off with, and remains in, the bearing. If the joint has given considerable service, the cork packing washers should be removed from the bearing and replaced.

Reassembling (Type C) Joint

All parts should be thoroughly cleaned before they are reassembled, and each bearing should be packed with a small amount of clean lubricant. (Use a high-grade lightweight semi-fluid chassis lubricant.)

Before assembling the bearings to the spider, be sure the four dust shields are in place on the shoulders of the journals of the spider. Place a new cork packing washer on each journal and push it up to the shoulder. Then place the bearing on the journal.

Because new cork packing washers are used, and also because a possible air-lock is in the bearings, it is necessary to compress the bearings in order to get them in the proper location for assembling to the yokes and fittings. After opposite bearings have been compressed as much as possible, a tie wire is to be used to keep them in the compressed position. When all four bearings have been compressed tightly in place on each of the two spiders, these spider and bearing assemblies are then ready for attaching to the propeller shaft yoke and slip yoke.

Sometimes, due to the air-lock in the bearings not having been entirely eliminated by compressing the bearings, it is necessary to tap the ends of the bearings lightly with a hammer. This will relieve the air-lock and permit the assembly of the bearings to the yoke without further difficulty.

When the key or lug (Fig. 1) of a bearing is seated properly in the keyway of the yoke, the entire face of the bearing will be flat on the face of the yoke. Be sure the entire face of each bearing is flush with the face of the yoke before inserting the capscrews.

A single lock plate is used for locking each set of two screws. The screws are to be assembled in the holes of the lock plates before they are inserted in the yoke screw holes. After the screws have been drawn up as tightly as possible, one of the two projecting lips at each end of the lock plate is to be turned up tightly against a flat side of the lock head. It is very important that each screw be securely locked.

It is necessary to have perfect alignment of the front and rear joints. Therefore, if either the slip yoke or propeller shaft has been replaced, be sure when assembling these two items that the bearing keyway of the slip yoke is in alignment with the bearing keyway of the propeller shaft yoke.

Due to the design and construction of the drive shaft and universal joint assembly, the replacement of any part or parts can be accomplished without special tools or garage equipment. Replacements can be made without removing the propeller shaft assembly from the chassis.

If a failure occurs in the rear joints, the bearing capscrews can be removed, and the propeller shaft pushed forward in the slip yoke, thereby disengaging the bearings from both the propeller shaft yoke and the pinion shaft yoke. The reassembling of the joint is no more difficult than disassembling. Less difficulty will be experienced in the reassembly if the bearings are assembled to the propeller shaft yoke first.

The same procedure is to be followed in disassembling, replacing parts and reassembling the front slip joint, the only difference being that the slip yoke is pushed back on the propeller shaft. The best results will be obtained in the reassembly of this joint if the bearings are first assembled to the slip yoke.

If the slip yoke or propeller shaft has been damaged and must be replaced, these two parts can be disassembled merely by removing the slip yoke grease retainer or cap. In such instances it is necessary to be very careful when reassembling the shaft and slip yoke that the bearing drive lugs of the slip yoke are directly in line with the bearing drive lugs of the propeller shaft yoke. Arrows stamped on the pro-

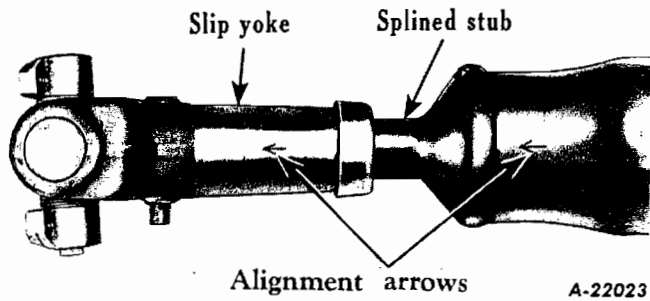


Fig. 6

propeller shaft and slip yoke indicate the correct position for assembly. **THESE ARROWS MUST MATCH** (Fig. 6).

Disassembling (Type CR, CRS) Joints

Disassemble propeller shaft joint using following procedure:

Remove the propeller shaft from the truck by taking out four capscrews at each end holding the flange type bearings to the fitting yokes, being careful not to let the flanged bearings fall off and permit foreign matter to enter the rollers. Clamp the propeller shaft in a vise and remove the flange bearings (two at each end). The remaining bearings are cylindrical in shape and fit into bore in the yoke arms.

There are snap rings fitting in grooves of the bearings which locate them on the inside of the yoke arms. These snap rings can be removed, as shown in Fig. 7, by means of a punch placed against an end of the snap ring loop and then tapping the end of the punch with a hammer, until the ring comes off the bearing. After all of the snap rings have been removed, the assembly can be placed on parallels, or in a vise, as shown in Fig. 8, with the trunnions of the cross resting on parallels and the yoke members suspended. By striking the suspended yoke, as shown, the yoke member will be driven down until it comes in contact with the cross. This will leave the bearing protruding, as shown.

After one of the bearings has been driven out in this way, the complete assembly should be turned over, and the same operation repeated, to drive the opposite bearing out part way. This leaves both bearings protruding from the yoke.

The next operation is to clamp the end of a protruding bearing in a vise, as shown in Fig. 9, and then proceed to strike the yoke member until the bearing is completely released from its snug fit in the yoke. Turn the assembly around, clamp the other bearing in the vise in the same manner as before, and drive yoke member from

the bearing. The cross member then can be removed from the yoke without any difficulty.

Should any of the working parts be worn, they should be renewed with a new cross and four complete bearing assemblies. In handling these parts, be sure that the trunnions of the cross are clean and that no dirt gets into the bearings before they are assembled into the joint.

It is always advisable to replace the old cork sealing washers on each of the trunnions, which serve to prevent the ingress of dirt and retain the lubricant in the bearing units.

Reassembling (Type CR, CRS) Joints

Before assembling the bearings, be sure that there is lubricant in each one, then proceed as follows:

Rest one of the yoke forks on a flat piece of iron, leaving the other fork member freely suspended below, then drive one of the bearings in, so that

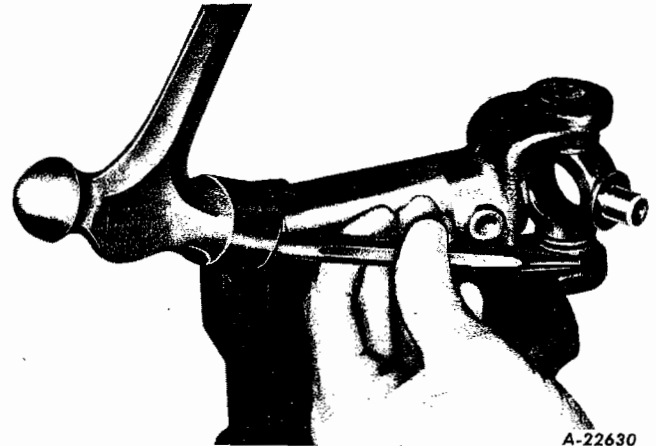


Fig. 7

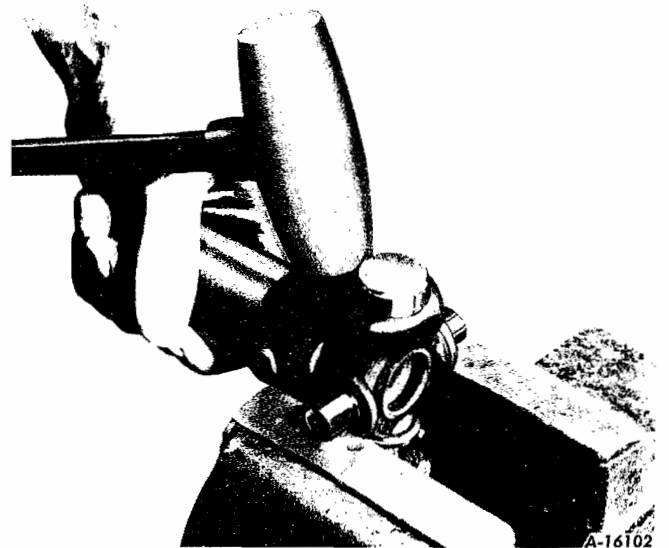


Fig. 8



Fig. 9

the open end comes flush with the inside of the yoke fork. Insert the cross through the opposite hole without the bearings, and swing in place and down into the partially assembled bearings. Turn the assembly over, resting the above partially assembled bearing on the flat surface, and drive in the other bearing (Fig. 10).

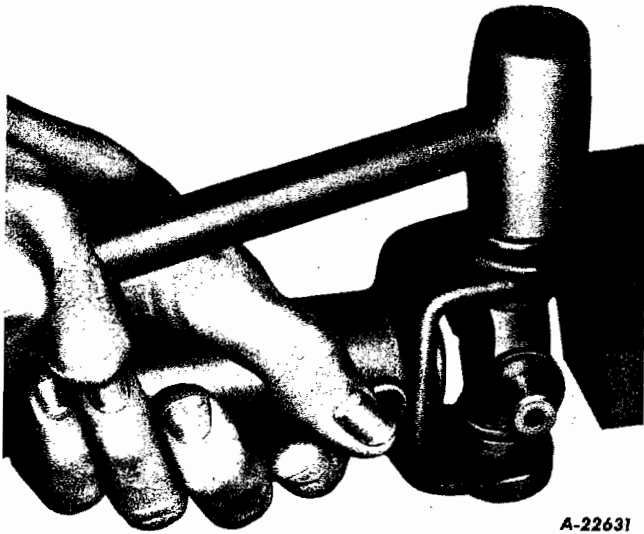


Fig. 10

By continuing to tap the bearings, they will both find their seats against the ends of the trunnions and will come approximately flush with the outside of the yoke.

After this is done, it is possible that there will be some off-center condition between the cross and the yoke. This is an advantage, because it permits driving in the snap ring on the side that gives the most clearance. This is shown in Fig. 11.

After the first snap ring is in place, the assembly should be turned over, as shown in Fig. 12, having the one assembled snap ring at the bottom and resting the yoke on the flat iron surface, then striking the bearing on the top, driving the upper bearing down, which carries the lower bearing with it, until the snap ring rests securely against the milled surface of the yoke fork. After this is done, put in the opposite snap ring, and the joint is ready for service.



Fig. 11

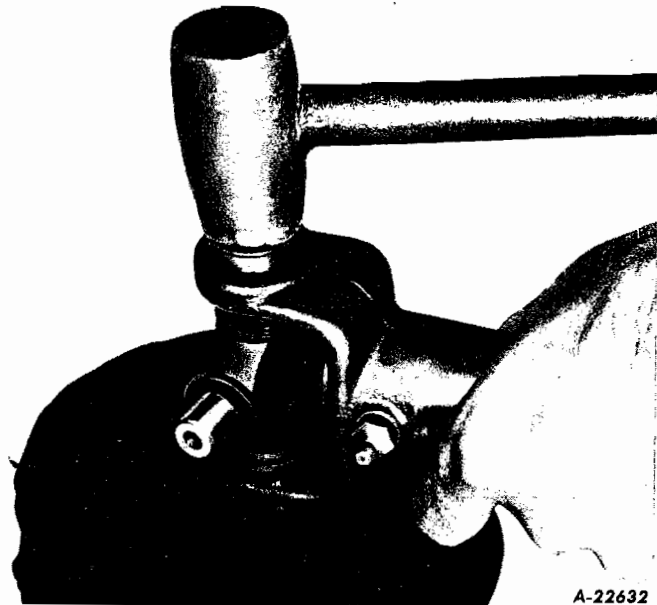


Fig. 12



Disassembling (Type 1410 Spicer) Joint

- a. Remove oil seal retainer from end of slip joint and remove slip joint assembly from shaft. When replacing slip joint, make certain that arrows on shaft and joint are in line (Fig. 13).
- b. Place joint assembly in vise using soft jaws to protect the joint threads. Remove needle bearing assembly from journal or cross (Fig. 14).
- c. Using a small punch, tap end of needle bearing assembly to loosen snap ring. Move needle bearing only enough to break bearing assembly away from snap ring (Fig. 15).
- d. Remove snap ring from slip joint or yoke. Turn joint over and remove opposite snap ring (Fig. 16).
- e. Tap needle bearing until opposite needle bearing is free of yoke; using a soft round drift (brass) with flat face about 1/32" smaller than the diameter of the hole in the yoke to prevent damage to the bearing (Fig. 17).

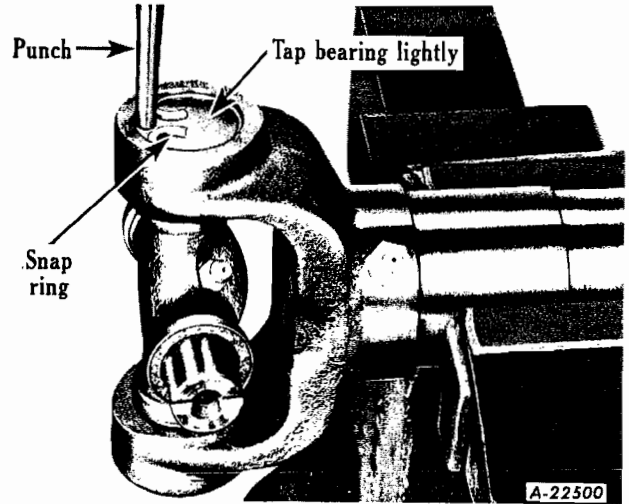


Fig. 15

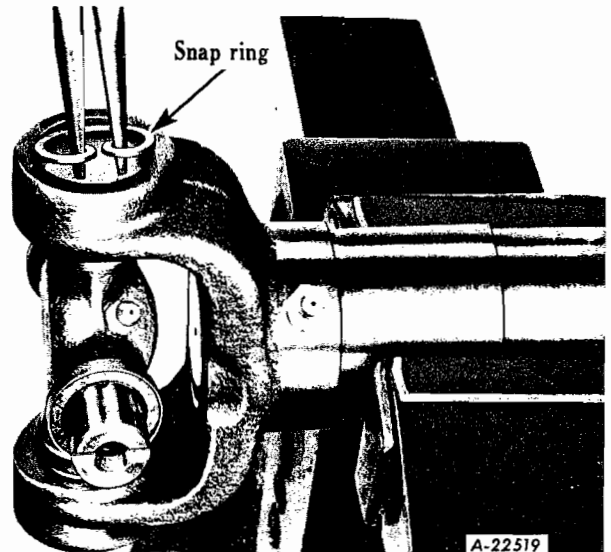
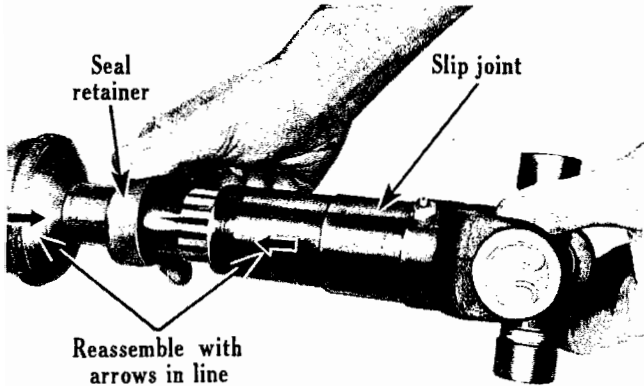


Fig. 16



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Fig. 13

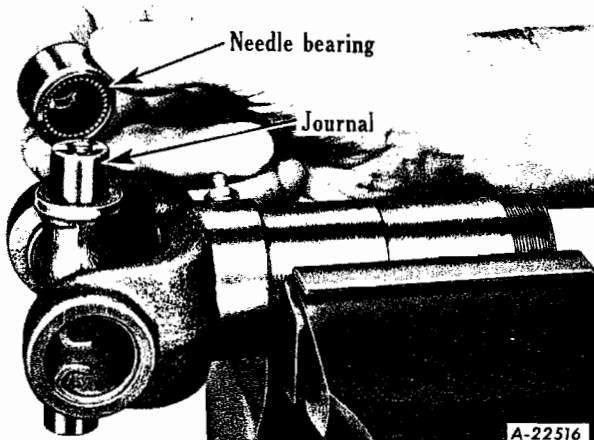


Fig. 14

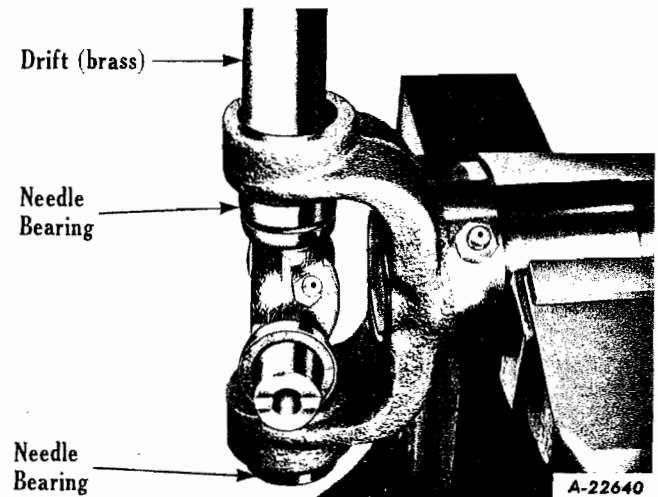


Fig. 17



- f. Turn yoke or joint over and tap on exposed end of journal or cross end to remove remaining needle bearing (Fig. 18).
- g. Remove journal cross from yoke. Tip cross as shown in Fig. 19, and lift out of yoke.

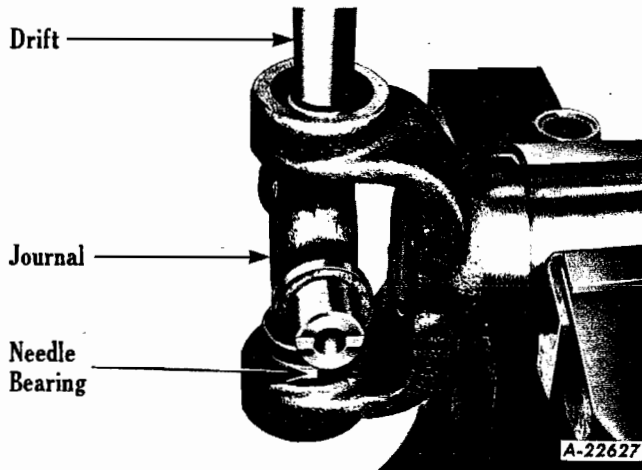


Fig. 18

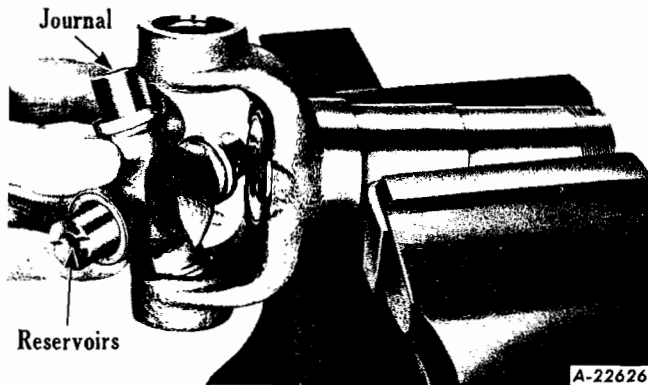


Fig. 19

Reassembling (Type 1410 Spicer) Joint

Reassembling is merely a reversal of the foregoing disassembling operations. On joints without a lubrication fitting, repack reservoirs in the journal cross ends with a good grade of semi-fluid lubricant (140 S.A.E.). Make sure the reservoirs in each trunnion are filled. With the rollers in the race, fill the race about 1/3 full.

Lubrication (Slip Yokes and Joints)

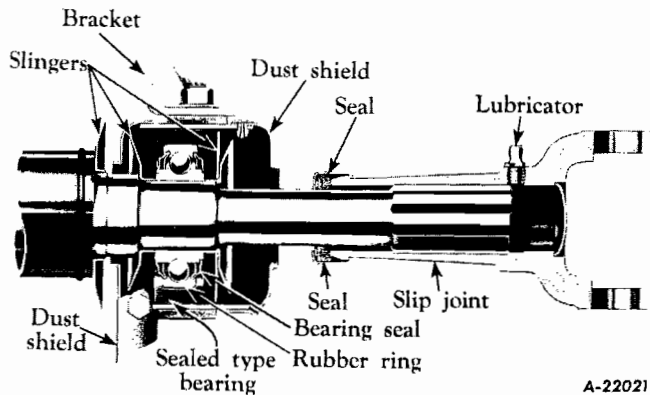
Propeller shaft slip yokes are to be lubricated every 3,000 to 5,000 miles. Use viscous chassis lubricant or SAE-140 gear oil. Remove the pipe plug and inject lubricant. Replace the pipe plug.

The universal joints are lubricated every 15,000 to 20,000 miles using a viscous lubricant or SAE-140 gear oil. Remove pipe plug and inject lubricant using a low pressure grease gun. Replace pipe plug.

Cleaning and Inspection

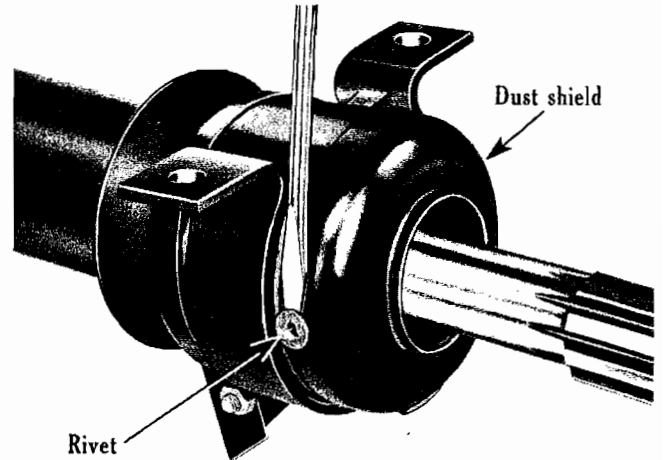
1. **CLEAN ALL PARTS**--Use a suitable cleaning fluid. Allow the parts to remain in the cleaner for some time to loosen up any particles of grease or foreign matter. Remove any burrs or rough spots from any machined surfaces.
2. **NEEDLE BEARING**--Do not disassemble. Clean with short stiff brush and blow out with compressed air. Work a small quantity of lubricant (140 S.A.E. Oil) into each needle bearing and turn the needle bearing on the trunnion to check wear. Replace if worn.
3. **JOURNAL CROSS**--Because worn needle bearings used with a new journal cross, or new needle bearings used with a worn journal cross, will wear more rapidly (making another replacement necessary in a short time) always replace the journal cross and four needle bearings as a unit.
4. **JOURNAL AND BEARING KIT**--To facilitate the replacement of journals and bearings, a journal and bearing kit is available. The use of the kit insures having the correct individual parts when required, and saves valuable time.

PROPELLER SHAFT CENTER BEARINGS



A-22021

Fig. 20 -- Pre-lubricated center bearing.



A-22499

Fig. 21

Construction (Pre-Lubricated Type Bearing)

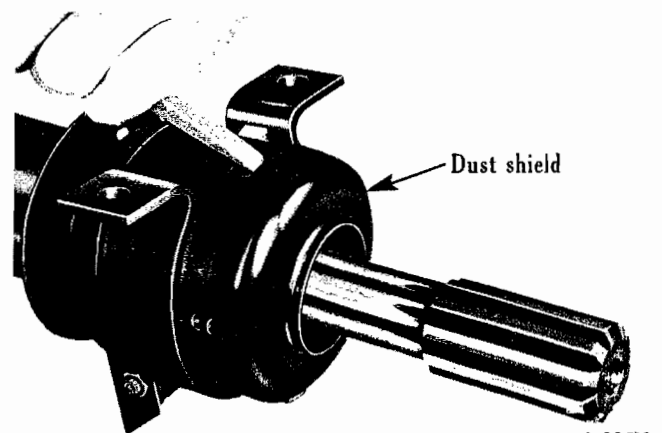
The center bearing used on the L-110 to L-150 trucks is the pre-lubricated, single-row ball-bearing type. The bearing is permanently sealed against water or dirt entering into bearing to cause rapid wear. The center bearing is still further protected from dirt and water by three slingers and a dust shield, forming an integral part of the center bearing assembly.

The flexibility of the mounting protects the bearing from all misaligning forces caused by unevenness of the road and results in the lowest possible bearing resistance, a minimum loss of power, and a distinct reduction in drive-line noises.

Disassembling (Pre-Lubricated Type Bearing)

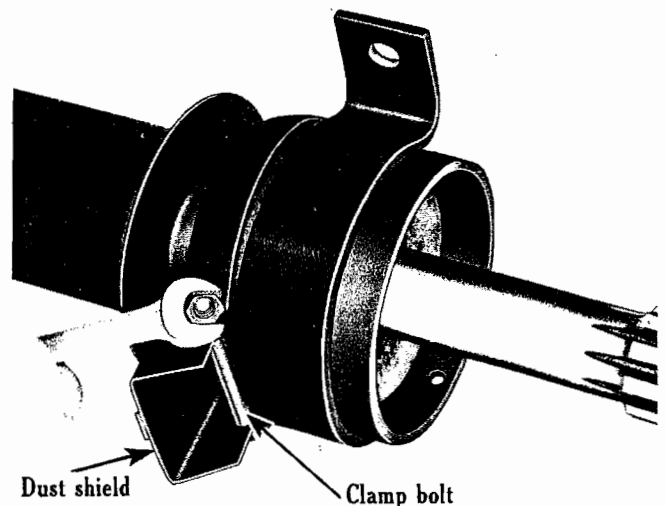
The prelubricated type center bearing can be serviced without removing the propeller shaft from the truck although a much more satisfactory job can be performed by removing the shaft and center bearing assembly from the vehicle. The following illustrations show servicing procedure with the shaft removed. Disassemble the bearing as follows:

- a. Remove retainer rivets from each side of rear dust shield (Fig. 21).
- b. Use a broad nose chisel to remove rear dust shield (Fig. 22).
- c. Remove clamp bolt from rear dust shield assembly (Fig. 23).
- d. Carefully bend (open) rear dust shield assembly only enough to remove from the housing and shaft (Fig. 24).
- e. Apply puller to strap or bracket edge of bearing housing, pull housing and bracket assembly from rubber ring (Fig. 25).



A-22518

Fig. 22



A-22501

Fig. 23

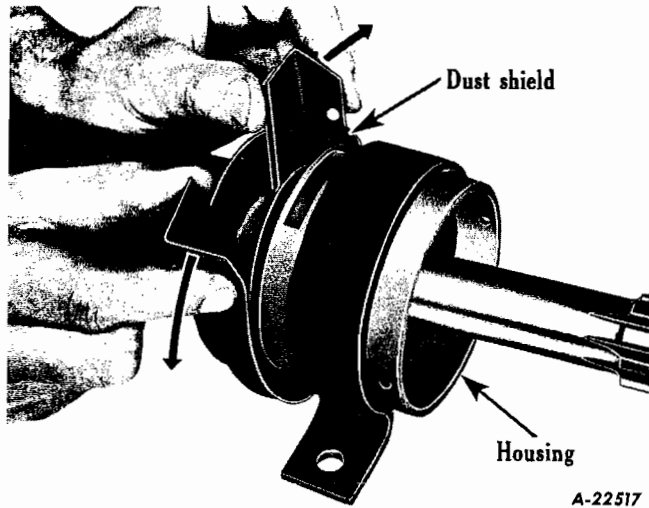


Fig. 24

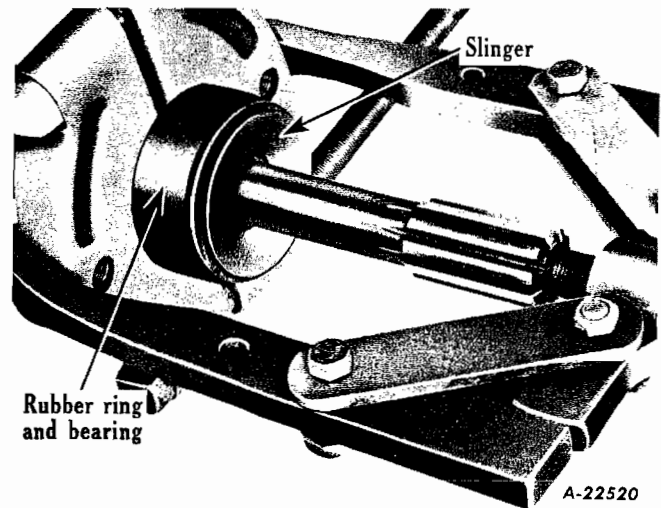


Fig. 26

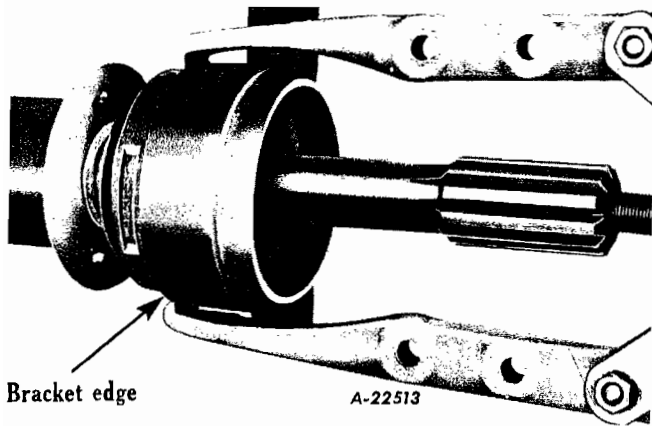


Fig. 25

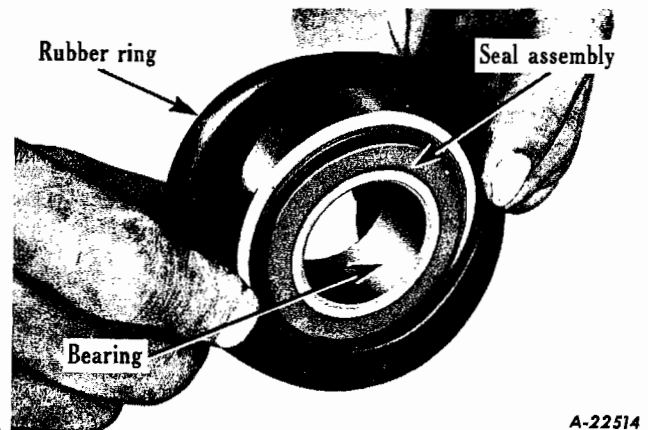


Fig. 27

- f. Place puller plates between slinger and rear of bearing and pull bearing with rubber ring and rear slinger from end of shaft (Fig. 26). NOTE: Make certain that the pulling pressure is exerted on the bearing inner race, or cone, if the bearing is to be reused. The bearing is prelubricated (lubricated at factory) and no further lubrication is necessary. If the sealing parts (Fig. 27) are damaged during the removal or replacing operation, the bearing is apt to fail because of loss of lubricant.
- g. Remove rubber ring from bearing (Fig. 27). When replacing bearing and rubber ring in housing, apply thin coating of soap solution to ring to permit easy entry of rubber ring into housing. The bearing is a press fit on the shaft. Use a short length of tube or pipe slightly larger on its ID than the propeller shaft spline diameter for pressing on the slinger, bearing and rubber ring assembly and outer slinger.

Reassembling (Pre-Lubricated Type Bearing)

Reassembling procedure is the reverse of the foregoing disassembling operations.

Construction (Not Pre-Lubricated Type) Bearing

Figs. 28, 29, and 30 illustrate the construction details of the center bearing assembly as used on L-160 trucks and up.

The center bearing is constructed having a double-row tapered roller bearing operating in a special housing in which lubricant channels have been incorporated to assure a continuous flow of lubricant to the bearing.

The assembly is amply provided with shields and slingers to prevent the entrance of dirt and water, and the entire assembly is mounted in a rubber ring to provide insulation from the frame.

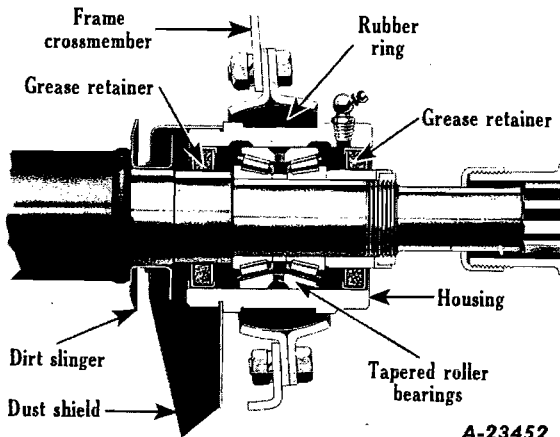


Fig. 28 -- Center bearing used on L-160 Series.

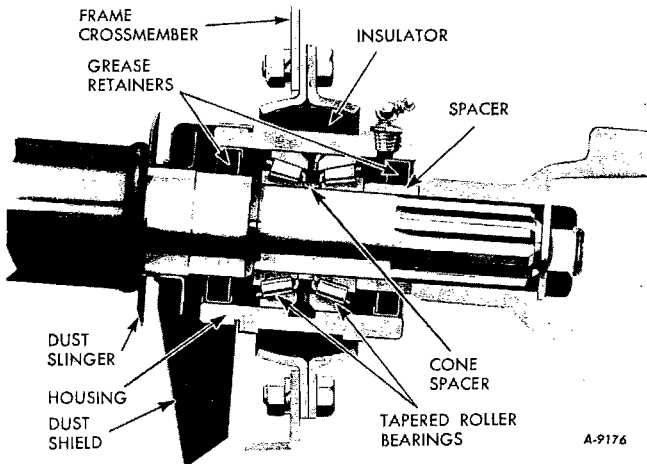


Fig. 29 -- Center bearing used on L-170, L-180 Series.

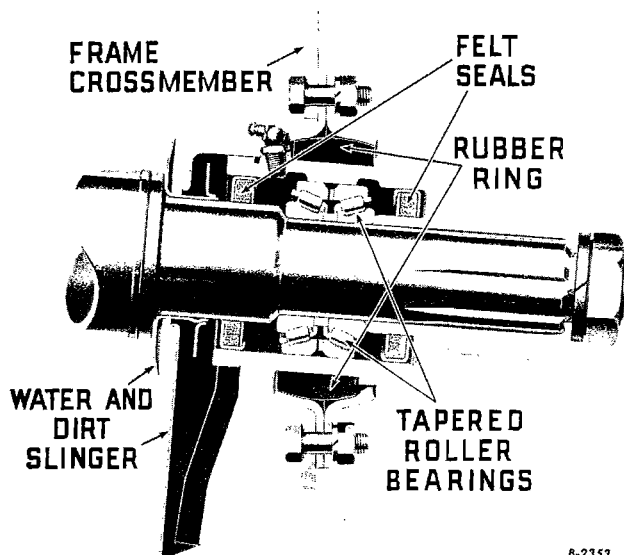


Fig. 30 -- Center bearing used on L-190, L-200 Series.

Installation (Not Pre-Lubricated Type Bearing)

Because of accuracy in manufacture, this bearing has the proper roller contact and specified end clearance. Always install a complete bearing, rather than separate parts. The Service Parts department will supply only the complete bearing.

Make a bench assembly of the bearing, housing, and seals, then install this assembly as a unit. Note that the bearing must be a sliding fit in the housing, and that the seals are installed with the rolled edge of the seal to the inside of the housing.

Install housing and bearing assembly, having all nuts hand tight. Permit the engine to drive the propeller shaft at a low idle speed to permit the bearing housing and rubber ring to center themselves in the carrier. Tighten all mounting nuts.

Adjustment (Not Pre-Lubricated Type Bearing)

Prior to reinstalling a roller bearing of this type, it should be checked for wear or end play.

- a. Place the bearing assembly in a vise and mount an indicator as shown in Fig. 31. First, spin the bearing in order to center the races and then immediately check for end play by moving cup toward the indicator as shown. Two or three checks should be made to definitely establish amount of end play present. End play should be from .005" to .008" and corrections should be made if amount is in excess of .008".

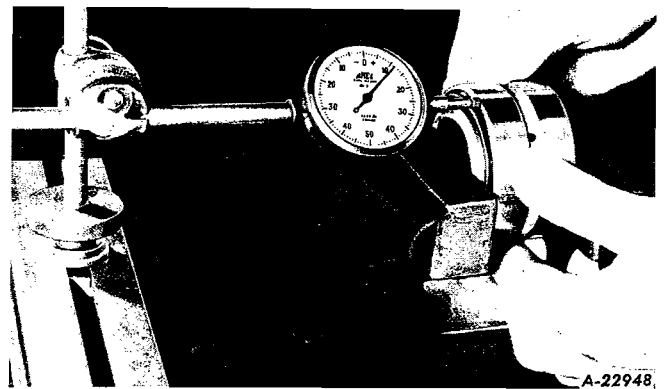


Fig. 31

- b. Where indicator shows end play to exceed .008", the bearing should be disassembled, thoroughly cleaned, and the cone spacer measured with a micrometer as shown in Fig. 32.
- c. Reduce the cone spacer thickness the required amount (indicator reading less .005") through the use of emery cloth on a smooth surface, moving the spacer in a circular motion. See Fig. 33.
- d. Reassemble bearing and recheck results. See Fig. 34.

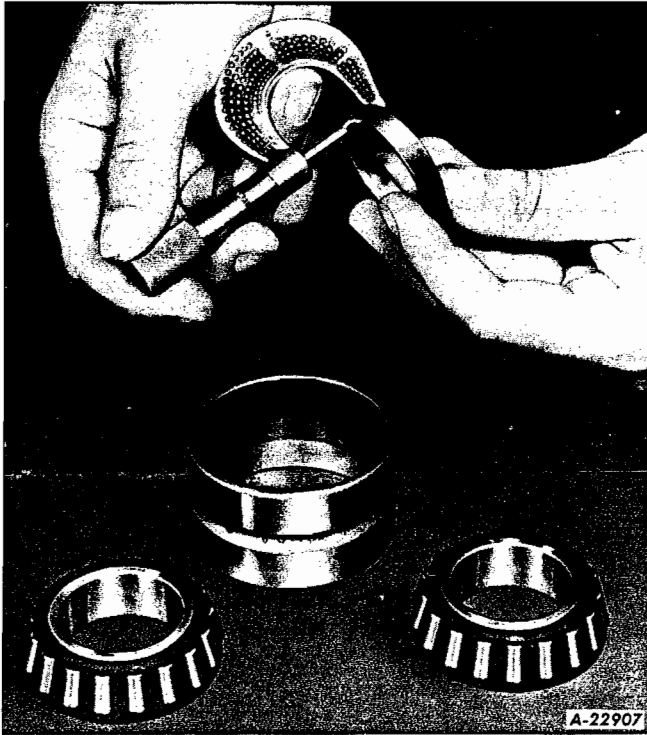


Fig. 32



Fig. 33

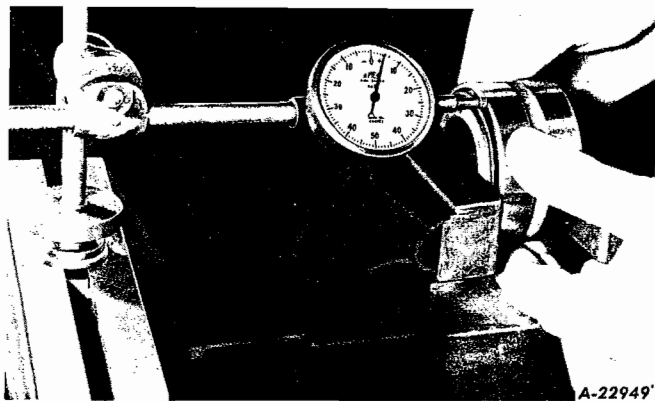


Fig. 34

Center Bearing Lubrication

The lubricant recommended for the center bearing is a medium, short-fibre, wheel bearing grease, the technical specifications of which are a cold-milled sodium-soap type -- not calcium -- having a work penetration consistency of 250 maximum and which will not work down below 300.

The center bearing should be lubricated every 500 to 1000 miles.

Center Bearing Replacement on Shaft

Motor Truck Service Bulletin No. 25, 1941, describes in detail the advisability of testing center bearing installation for interference between the bearing and the fillet on the propeller shaft. Interference at this point will cause early failure of the bearing.

Center Bearing Housing Assembly Felt Seal Replacement

When replacing felt seals in the center bearing housing assembly, they should be tested for fit on the propeller shaft as shown in Fig. 35. A break-away tension of from two to eight pounds is considered satisfactory for a dry seal and shaft (not oiled).

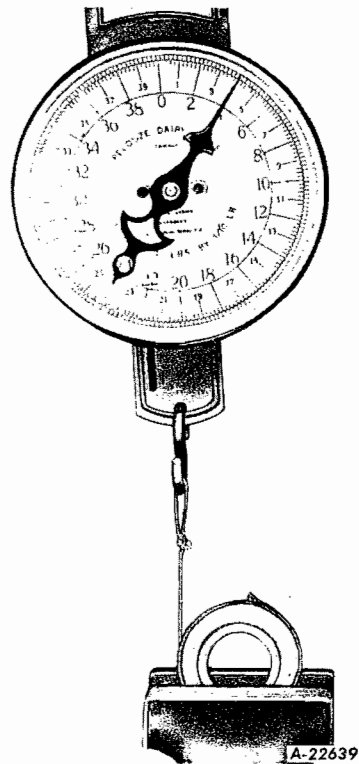


Fig. 35

PROPELLER SHAFT (OR DRIVE LINE) VIBRATION

Where drive line vibration is experienced, it will be necessary to inspect the following units as outlined below, before any attempt is made to balance the propeller shafts as described under the heading "Step-by-Step Procedure for Checking Drive Line Vibration".

COMPANION FLANGES--The companion flange mounting nuts, and the bolts that attach the shaft to the flange, must be tight to assure drive line balance. The least degree of looseness in the flange mounting nuts, or the shaft attaching bolts, is enough to cause excessive (out-of-balance) vibration at high propeller shaft speeds. Where the flange also maintains the adjustment on the rear axle pinion bearings or propeller shaft center bearings, this adjustment is destroyed because of lack of torque on the nut. When a companion flange is removed from a transmission, center bearing or rear axle, the flange and shaft should be marked so that the flange can be reinstalled in the same position on the shaft. Care should be exercised in the removal or replacement of companion flanges as rough handling such as hammering on the trunnion mounting may bend or distort flange.

CORRECT ALIGNMENT--Correct alignment of the universal joints is imperative to efficient torque transmission at high speeds. To assure parallel alignment of the universal joints, arrows are stamped on the shaft end and on the slip yoke. These arrows must be lined up; see Fig. 6.

LUBRICATION--When a propeller shaft has been removed from a chassis, proper lubrication is an important part in the re-installation operation. Be sure to work a small quantity of lubricant (SAE-140 Gear Oil) into the roller assemblies and make certain that the slip joint splines are also properly lubricated.

CENTER BEARING--Tighten propeller shaft center bearing mounting bolts. Should the center bearing insulator be deteriorated or oil soaked, it should be replaced. Loose mounting bolts or an oil soaked or deteriorated insulator can cause excessive vibration.

ENGINE MOUNTINGS--Tighten the engine mounting bolts. Should the engine mountings be oil soaked or deteriorated, they should be replaced. Loose mounting bolts, or oil soaked or deteriorated mountings, can cause excessive vibration.

CLUTCH AND FLYWHEEL--The light side of the flywheel is stamped with a letter "L" and should be lined up with the arrow or inspection mark (usually a white dab or paint) stamped on the heavy side of clutch. (If no arrow is stamped on clutch, it can be assembled to the flywheel in any position.) If these markings are not lined up, excessive vibration can result.

Step-By-Step Procedure For Checking Drive Line Vibration

Start engine, and with clutch disengaged and transmission in gear to keep the clutch disc from spinning, bring engine speed up slowly to governed speed to determine if vibration is in engine itself or due to an out-of-balance clutch pressure plate assembly. If only normal vibration is evident, disconnect the front propeller shaft at the transmission companion flange and with transmission in direct drive and clutch engaged, slowly bring engine speed to governed speed to determine if vibration is caused by an out-of-balance clutch disc or out-of-balance transmission gears.

If both the above checks show only normal vibration, connect the front propeller shaft and use the following step-by-step procedure in balancing the drive line assembly.

Drive line vibration can be checked by road testing truck, spinning the drive line with truck up on jacks or by pulling the rear axle shafts and spinning the drive line.

Before any balance weights are added to brake drum or propeller shafts, disconnect the rear propeller shaft at center bearing and rotate shaft 180° in relation to companion flange (truck without center bearing rotate shaft at transmission) reconnect shaft then road test truck or spin drive line and check for vibration.

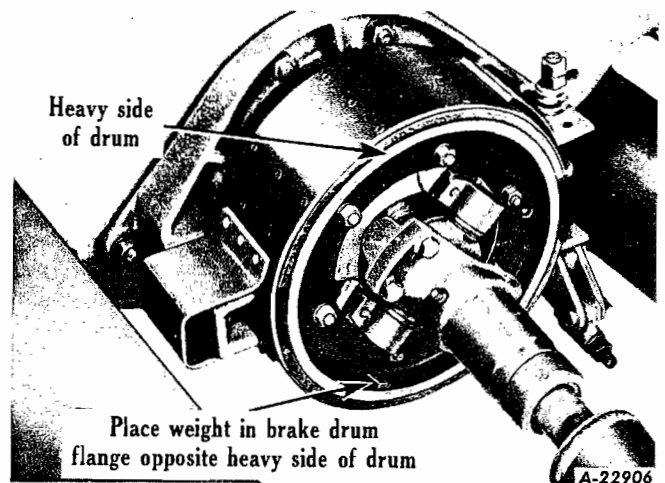


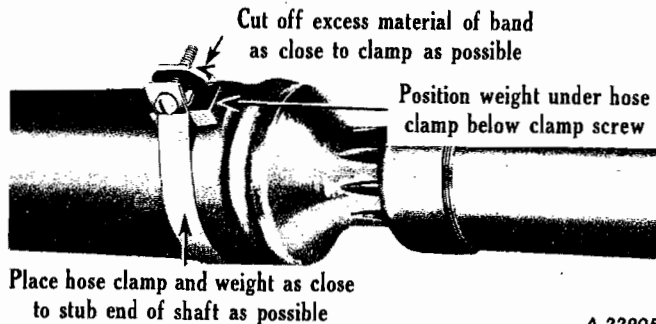
Fig. 36

If vibration is still present after above changes, on truck with brake drum at center bearing, place a lump of glazer's putty weighing approximately one-half ounce at brake drum flanges (See Fig. 36). (A small magnet can be used in brake drum flange in place of the putty, 1/2 ounce magnet can be obtained by removing the magnet from a magnetic drain plug), then road



test truck or spin drive line and by changing location of the weight, find the point of least vibration. Then increase or decrease this weight at that point to obtain as nearly as perfect a balance as possible. Weigh the glazer's putty (or magnetic weight) and install a piece of steel of the same weight in the same location by tack-welding weight to inside of brake flange. Hold weld material to a minimum.

For truck without a brake drum at the center bearing, use an adjustable hose clamp and a small metal weight (approximately 1/2 ounce). Clamp the weight to the rear shaft near the center bearing and cut off excess material of band as close to clamp as possible (See Fig. 37). Then road test truck or spin drive line; then by moving the weight to various locations on the shaft, find the point of least vibration. Then increase or decrease the weight at this point to obtain as perfect a balance as possible. Mark location of weight on shaft; remove hose clamp and weight. Weigh the weight and add 3/8 of an ounce for clamp screw and nut. Select a piece of steel of this total weight and tack-weld to propeller shaft at locating mark. Hold weld material to a minimum.



A-22905

Fig. 37

For trucks with a single propeller shaft, use an adjustable hose clamp, and a small weight (approximately 1/2 ounce), clamp the weight to the front end of the shaft and cut off excess material of band as close to clamp as possible (See Fig. 37). Then road test the truck or spin the drive line; then by moving the weight to various locations on the shaft, find the point of least vibration. Then increase or decrease the weight at this point to obtain as perfect a balance as possible. Mark location of weight on shaft; remove hose clamp and weight. Weigh the weight and add 3/8 of an ounce for clamp screw and nut. Select a piece of steel of this total weight and tack-weld to propeller shaft at locating mark. Hold weld material to a minimum.

CAUTION: When attaching loose weights to propeller shaft with hose clamps (when checking for vibration,) make sure that weights are clamped securely to shaft to avoid hazard of weights flying off.



COOLING SYSTEM AND RADIATOR GROUP

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COOLING SYSTEM SPECIFICATIONS

MODEL:	LB-140	LM-120 LM-250	LM-120 LM-150	L-170-3-4 L-180-3-4 LF-170 LF-180	L-170-3-4 L-180-3-4 LF-170 LC-180	L-175	L-185 L-190 L-193 L-194	L-185 L-190 L-193 L-194
ENGINE:	SD-220	SD-220	BD-269	BD-269	BD-269	BD-269	RD-372	RD-372
TYPE OF COOLING:	STD. & INCR.	STD.	INCR.	STD.	INCR.	STD. & INCR.	STD.	INCR.
COOLING SYSTEM: Capacity (qts.)	.....	17	18	21	21	21	28	28
FAN BELT: Type	V	V	V	V	V	V	V	V
Number used	1	1	1	1	1	1	1	1
RADIATOR HOSE: Inlet (upper)	2x8-7/8	2x8-7/8	2x8-7/8	2x13-1/4	2x13-1/4	2x13-1/4	2x11-1/2	2x11-1/2
Outlet (lower)	2x11-13/32	2x11-13/32	2x11-13/32	2x10-13/32	2x10-13/32	2x10-13/32	2-1/8x13-1/16	2-1/8x13-1/16
I.H.:								8103-1-1
Core number								3
Thickness	3	1-25/32	2-1/4	2-1/4	3	3	3	3
Fins per inch	9	7	8	7	9	9	8	10
Shroud dia.	20	18-1/2	18-1/2	18-3/4	18-3/4	18-3/4	22-1/2	22-1/2
Fan	18-1/2x30°	17x30°	17x30°	17-3/4x35°	17-3/4x35°	17-3/4x35°	20x30°	20x30°
Pulley	1.21-1	1.21-1	1.21-1	1.11-1	1.11-1	1.11-1	1.13-1	1.3-1
MODINE:								
Core number								3
Thickness	3	1-25/32	2-1/4	2-9/32	3	3	3	3
Fins per inch	9	7	8	7	9	9	8	10
Shroud dia.	20	18-1/2	18-1/2	18-3/4	18-3/4	18-3/4	22-1/2	22-1/2
Fan	18-1/2x30°	17x30°	17x30°	17-3/4x35°	17-3/4x35°	17-3/4x35°	20x30°	20x30°
Pulley	1.21-1	1.21-1	1.21-1	1.11-1	1.11-1	1.11-1	1.13-1	1.3-1
McCord:								
Core number								3
Thickness	3	1-3/4	2-1/4	2-1/4	3	3	3	3
Fins per inch	9	7	8	7	9	9	8	10
Shroud dia.	20	18-1/2	18-1/2	18-3/4	18-3/4	18-3/4	22-1/2	22-1/2
Fan	18-1/2x30°	17x30°	17x30°	17-3/4x35°	17-3/4x35°	17-3/4x35°	20x30°	20x30°
Pulley	1.21-1	1.21-1	1.21-1	1.11-1	1.11-1	1.11-1	1.13-1	1.3-1



COOLING SYSTEM SPECIFICATIONS

MODEL:	L-190 L-194 L-195 LF-190 L-200 L-204	L-190 L-194 L-195 LF-190 L-200 L-204	L-200 L-210	L-200 L-210	L-220 L-225	LD-230	LD-230
ENGINE:	RD-406	RD-406	RD-450	RD-450	R-6602	HRBB-600	NHB-600
TYPE OF COOLING:	STD.	INCR.	STD.	INCR.	STD. & INCR.	STD. & INCR.	STD. & INCR.
COOLING SYSTEM: Capacity (qts.)	28	28	28	28			
FAN BELT: Type	V	V	V	V			
Number used	2	2	2	2			
RADIATOR HOSE: Inlet (upper)	2x11-1/2	2x11-1/2	2x11-1/2	2x11-1/2			
Outlet (lower)	2-1/8x13-1/16	2-1/8x13-1/16	2-1/8x13-1/16	2-1/8x13-1/16			
I.H.:							
Core number	8103-3-1	8103-1-1	8103-1-1	8103-1-1			
Thickness	3	3	3	3	3	3	3
Fins per inch	8	10	10	10			
Shroud dia.	22-1/2	22-1/2	22-1/2	22-1/2			
Fan	20x30 ^o	20x30 ^o	30x30 ^o	21x30 ^o			
Pulley	1.13-1	1.3-1	1.13-1	1.3-1			
MODINE:							
Core number							
Thickness	3	3	3	3	3	3	3
Fins per inch	8	10	10	10			
Shroud dia.	22-1/2	22-1/2	22-1/2	22-1/2			
Fan	20x30 ^o	20x30 ^o	20x30 ^o	21x30 ^o			
Pulley	1.13-1	1.3-1	1.13-1	1.3-1			
McCord:							
Core number							
Thickness	3	3	3	3	3	3	3
Fins per inch	8	10	10	10			
Shroud dia.	22-1/2	22-1/2	22-1/2	22-1/2			
Fan	20x30 ^o	20x30 ^o	20x30 ^o	21x30 ^o			
Pulley	1.13-1	1.3-1	1.13-1	1.3-1			

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L-LINE MOTOR TRUCK SERVICE MANUAL

COOLING SYSTEM AND RADIATORS

COOLING SYSTEM AND RADIATORS

Rust Prevention

(Also see "Cooling System Servicing" paragraphs.)

One of the common causes of engine overheating is a rust-clogged cooling system. Rust is the result of water action on steel and iron when air is present. Scales originate from impurities in the water used in cooling system. Rust and scales interferes with circulation and cooling, causing overheating.

Rust and corrosion formation can be prevented by maintaining full strength corrosion protection at all times.

For rust protection during the winter months, a fresh filling of an anti-freeze containing an effective corrosion preventive should be installed in the fall. In the spring, drain and discard the old anti-freeze solution because the cooling liquid may have become contaminated by corrosive impurities during use, and the rust preventives or "inhibitors" in the anti-freeze solution may have become weakened and exhausted in continual driving.

During the summer, a rust preventive should be added to the cooling system to protect the system against corrosion during warm weather operation. This inhibitor solution should be drained in the fall and a fresh filling of chemically treated anti-freeze solution again installed.

Cleaning The Cooling System

(Also see "Cooling System Servicing" paragraphs.)

Approximately twice a year, or oftener, depending upon kind of cooling water used, the cooling system should be drained and thoroughly flushed out. This is particularly important before using an anti-freeze solution.

Unless the cooling water is treated with a corrosion preventive, rust and scale will eventually clog up passages in radiator and water jackets. This condition is aggravated in some localities by the formation of insoluble salts from the water used.

Cleaning solutions are available which have proven very successful in removing the accumulation of rust, scale, sludge and grease. These solutions should be used according to the manufacturer's recommendation.

If no commercial cleaning solution is available, dissolve about 4 pounds of ordinary washing soda in sufficient water to fill the complete cooling system. Leave radiator filler cap off and run engine for about 1/2 hour or until engine gets hot. Then drain and flush thoroughly with clean water.

When draining the cleaning solution, disconnect the radiator outlet hose, as large particles of sediment will not pass through the drain cock.

If radiator is clogged with insoluble salt formations it should be taken to a reputable concern specializing in the removal of such formations. Reliable radiator service stations are familiar with local conditions and are equipped to apply the proper treatment.

Draining Cooling System

(Also see "Cooling System Servicing" paragraphs.)

During freezing weather, if anti-freeze solutions are not used, the entire cooling system should be drained when truck is not in use. On the Silver Diamond and Blue Diamond Series engines, it is necessary to remove the pipe or drain cock located on the right side of the crankcase between the generator and starter. On the Red Diamond and R-6602 engines this plug is located on the right rear of crankcase.

Opening the radiator drain cock on these engines will only drain the water that is in the radiator and cylinder head, leaving the water jackets in the cylinder block, full, and if freezing occurs, damage to the block will result. Be sure to replace plug (or close drain cock) before refilling system. Engines should be level when drained in order that all water in the system can flow out. **BE SURE TO REFILL COOLING SYSTEM BEFORE STARTING ENGINE.**

Anti-Freeze Solutions

IMPORTANT: Do not under any circumstances use Honey -- Salt -- Kerosene -- Glucose or Sugar, in the cooling water as an anti-freeze.

These at the best are poor substitutes and will cause trouble due to corrosion, clogging of the system, and deterioration of the rubber hose connections. Use only anti-freeze solutions manufactured by a reputable concern.

Before installing any anti-freeze solution the following items should be checked:



1. Tighten all water connections. Hose connections should be in good condition inside and out.
2. Inspect water pump for leaks. A leaking water pump indicates need of water pump over-haul since no packing nut or adjusting seal is provided.
3. Adjust fan belt to proper tension. Replace if necessary.
4. Drain and clean cooling system.

Radiator Mountings

For detailed information on radiator mountings and installations, see illustrations (Fig. 2 to 6 inclusive) covering all L-line trucks. Mounting insulators are required to provide a specific amount of flexibility in radiator mounting, otherwise premature failure will result.

Radiator Cap (Pressure Type)

Radiator caps of pressure-sealing type, as shown in Fig. 1, are used to hold the cooling

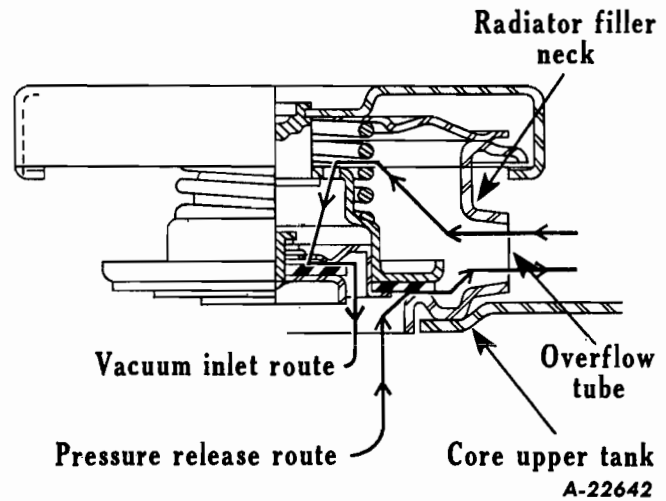
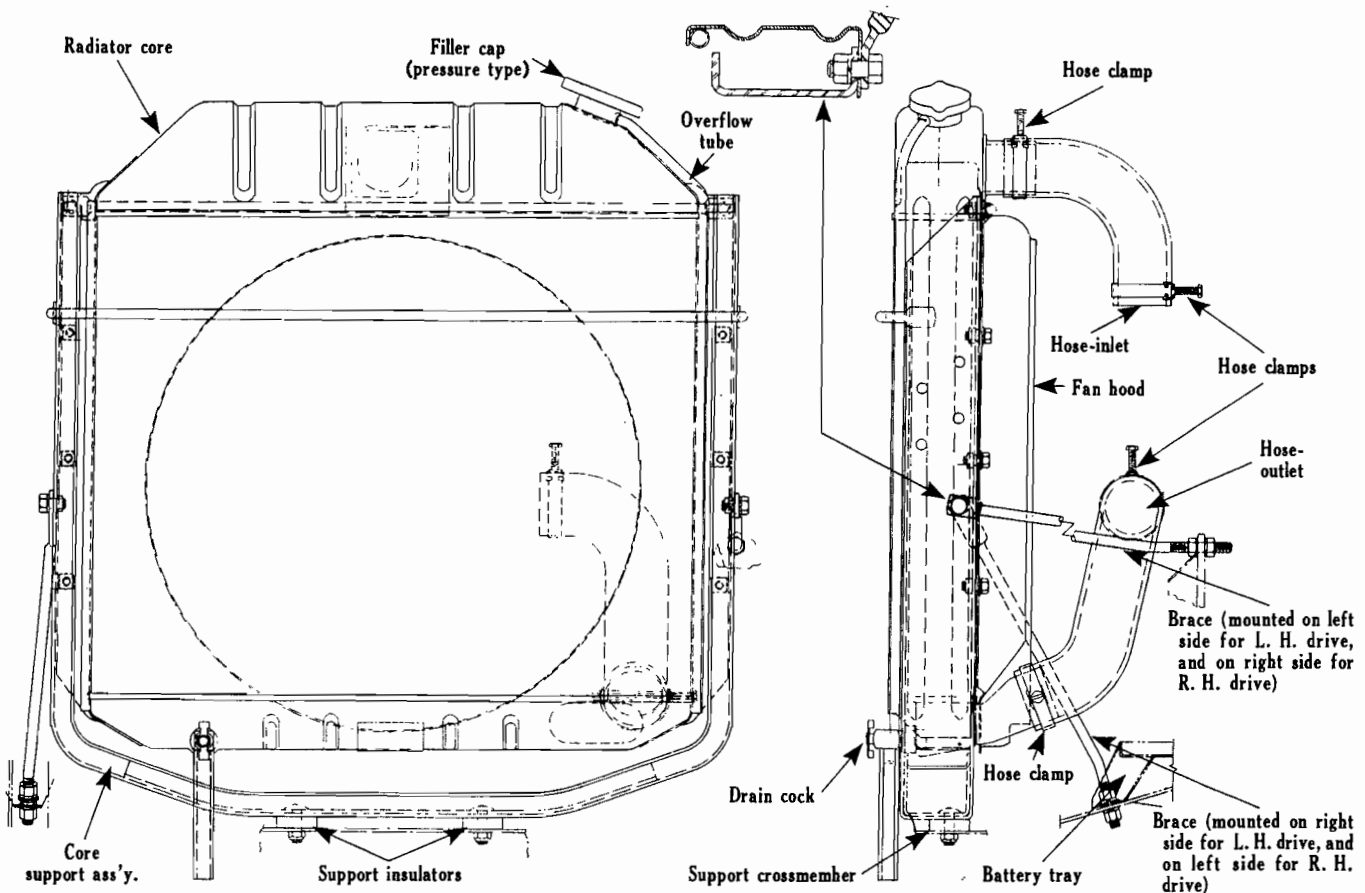


Fig. 1 - Radiator Cap (Pressure Type).



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Fig. 2 - Radiator Mounting, L-110, L-120, L-130, LB-140.

L-LINE MOTOR TRUCK SERVICE MANUAL

system under a slight pressure, increasing the boiling point of the cooling solution, and preventing loss of the solution due to evaporation and overflow.

The cap has a spring-loaded valve, the seat of which is below the over-flow tube in the filler neck. This prevents the escape of air or liquid while the cap is in position. When the cooling system pressure reaches a predetermined point, the cap valve opens and will again close when the pressure drops to the predetermined point.

This cap is also equipped with spring-loaded valve, to release the vacuum during the cooling period while engine is not in use. The vacuum valve releases at approximately 5/8 pounds per square inch.

When removing the pressure-type cap from the radiator, perform the operation in two steps. Loosening the cap to its first notch raises the valve from the gasket and releases the pressure through the over-flow pipe. In the first

stage position of the cap, it should be possible to depress the cap approximately 1/8 inch. The prongs on the cap can be bent to adjust this condition. Care must be taken that the cap is not too loose, as this would prevent proper sealing.

In removing the cap loosen it slowly, and then pause a moment. This will avoid possible burning by hot water or steam. Then continue to turn the cap to the left until you can remove it.

NOTE: REMOVE CAP WHEN DRAINING COOLING SYSTEM TO ASSURE PROPER DRAINING.

Cooling System Servicing

1. CLEANING:

- (a) Coolant shut-off cocks to heaters and other accessories should be open to allow complete circulation during cleaning, flushing, and draining. Run

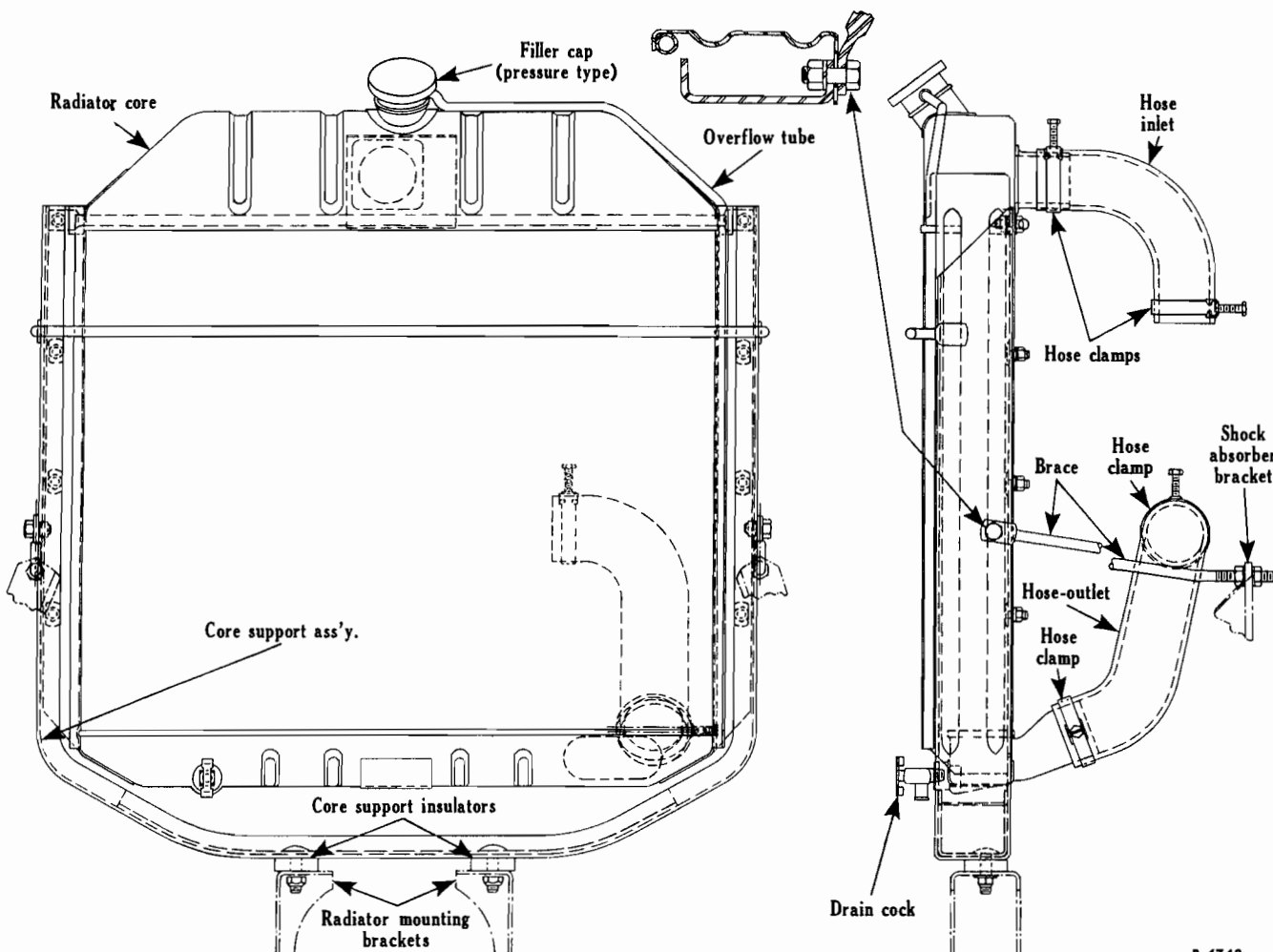


Fig. 3 - Radiator Mounting, LM-120, LM-150.



the engine, with radiator covered if necessary, until temperature is up to operating range (160° F to 180° F). Stop engine, remove radiator cap, and drain system by opening drain cocks in radiator and cylinder block.

- (b) Allow engine to cool, close drain cocks, and pour cleaning compound into radiator according to directions. Fill system with water.
- (c) Place a clean drain pan to catch overflow, and use to maintain level in radiator. Do not spill solution on vehicle paint.
- (d) Replace radiator cap, and run engine at moderate speed, covering radiator if necessary, so that radiator core reaches a temperature of 180° F or above, but does not reach boiling point. Allow the engine to run at least two hours at 180° F so that cleaning solution may take effect. Do not drive vehicle or allow liquid level in radiator to drop low enough to interfere with circulation.
- (e) Stop engine as often as necessary to prevent boiling.
- (f) With the engine stopped, feel the radi-

ator core with bare hands to check for cold spots, and watch temperature gauge. When there is no change in temperature for some time, drain the cleaning solution.

- (g) If clogging of core is relieved but not fully corrected, allow the engine to cool, pressure-flush the system (step 3 below), and repeat cleaning operation.
- (h) If clogging of core, indicated by low temperature spots on core, is not relieved, radiator core must be removed for mechanical cleaning. Mechanical cleaning requires removal of upper and lower tanks and rodding out the accumulated rust and scale from the water passages of the core.

2. NEUTRALIZING:

- (a) Allow engine to cool, close drain cocks, and pour neutralizer compound into radiator. Use as directed. Fill system with water.
- (b) Run engine, with radiator covered if necessary, until radiator reaches operating temperature (160° F to 180° F).

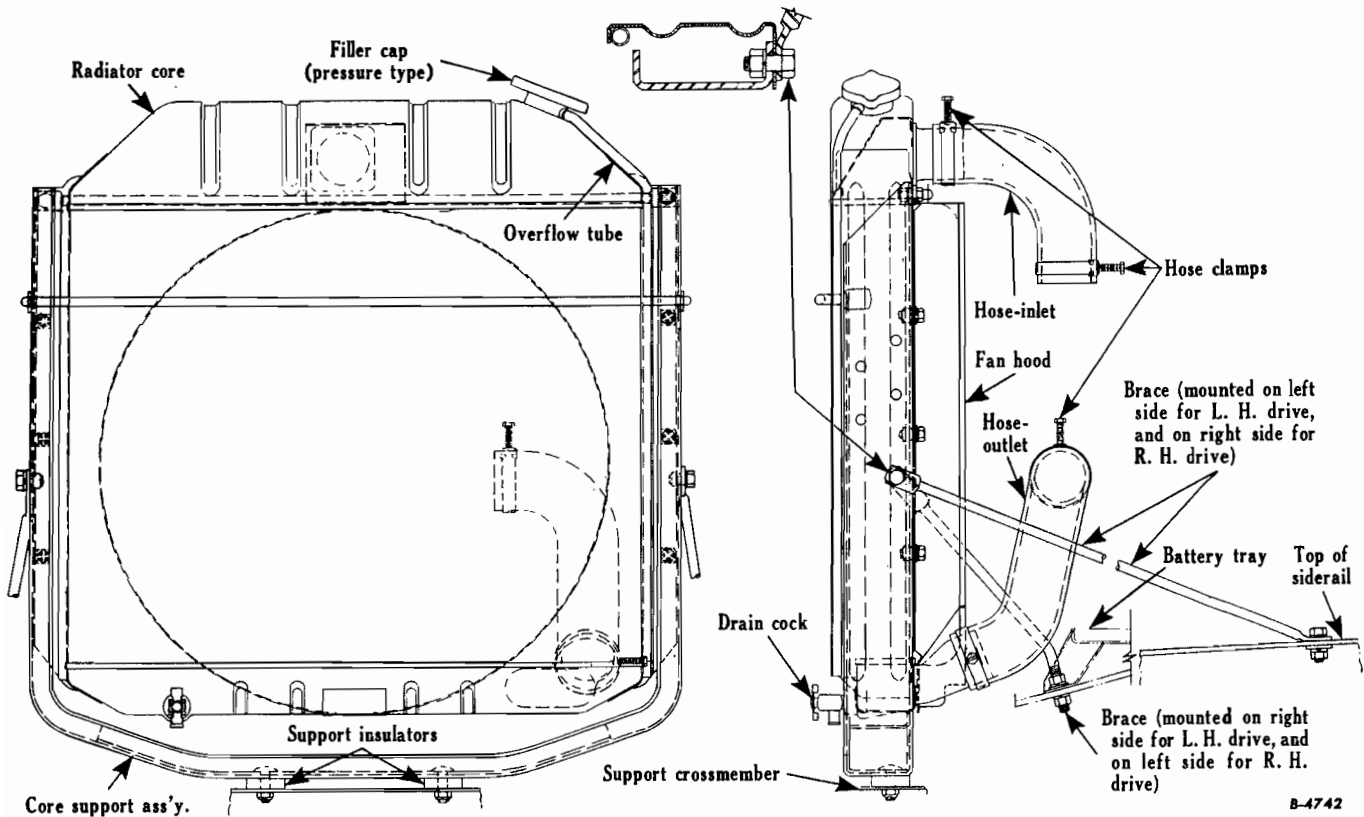


Fig. 4 - Radiator Mounting, L-150, L-153, L-160, L-163, L-164, L-165, LC-160.



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- (c) Drain the system by removing radiator cap and opening drain cocks.

3. PRESSURE FLUSHING:

- (a) Disconnect the upper radiator hose which connects radiator core to engine water outlet and remove thermostat from engine water outlet.
- (b) Clamp a convenient length of hose to radiator core outlet opening, and attach another suitable length of hose to the radiator inlet opening to carry away the flushing stream.
- (c) Connect flushing gun to compressed air and water pressure, and clamp the gun nozzle to the hose attached to the radiator outlet opening.
- (d) With radiator cap on tight, fill core with water. Turn on air pressure in short blasts to prevent core damage.

- (e) Continue filling radiator with water and applying air pressure as above until the water comes out clear.

- (f) Clamp the flushing gun nozzle firmly to a hose attached securely to the engine water outlet opening. Fill engine block with water, partly covering water inlet opening to facilitate complete filling.

- (g) Turn on compressed air to blow out water and loose sediment. Continue filling with water and blowing out with air until flushing stream comes out clear.

- (h) For badly clogged engine water jackets that do not respond to regular pressure flushing, remove engine cylinder head and core hole plugs and, with a suitable length of small copper tubing attached to the flushing gun nozzle, flush water jackets through openings.

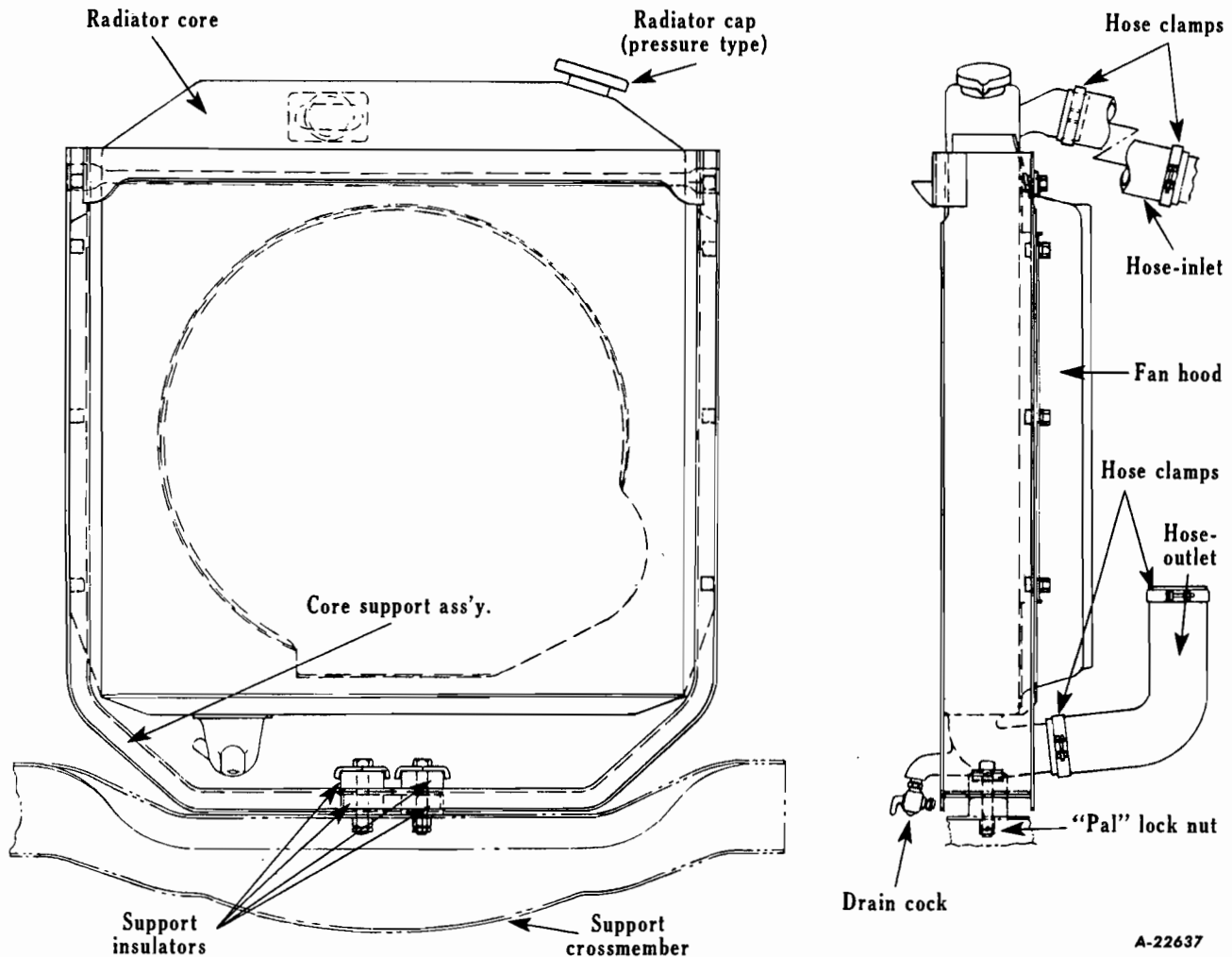


Fig. 5 - Radiator Mounting
L-170, L-173, L-174, L-175, LF-170, L-180, L-183, L-184, L-185.



- (i) When vehicle is equipped with a heater connected to the cooling system, flush the heater, following same procedure as for radiator core.
- (j) After completing the flushing operation, clean out radiator overflow pipe, inspect the water pump, clean the thermostat, and radiator cap control valves. Check thermostat for proper operation before installation. (See "Engine" Section.)
- (k) Blow insects and dirt from radiator core air passages, using water, if necessary, to soften obstructions.

4. LEAKS:

- (a) Before pouring coolant into the cooling system a check should be made for leaks to avoid loss of solution, foaming and corrosion. Check tightness of cylinder head bolts, using tension wrench and tightening to specific number of foot-pounds with engine hot.

NOTE: After tightening cylinder head on valve-in-head engines it will be necessary to recheck valve stem clearance. Adjust, if necessary.

5. COOLANT SERVICE:

- (a) When servicing for summer, fill system with clean water and add rust inhibitor compound. Use as directed.
- (b) When servicing for winter, refill system with clean water and sufficient antifreeze solution for protection to lowest temperature likely to be encountered.

6. GENERAL INFORMATION:

- (a) Never mix cleaning solution with inhibitor or antifreeze compounds.
- (b) Before dismantling an engine preliminary to grinding valves, removing carbon, or rebuilding, always clean the cooling system first.

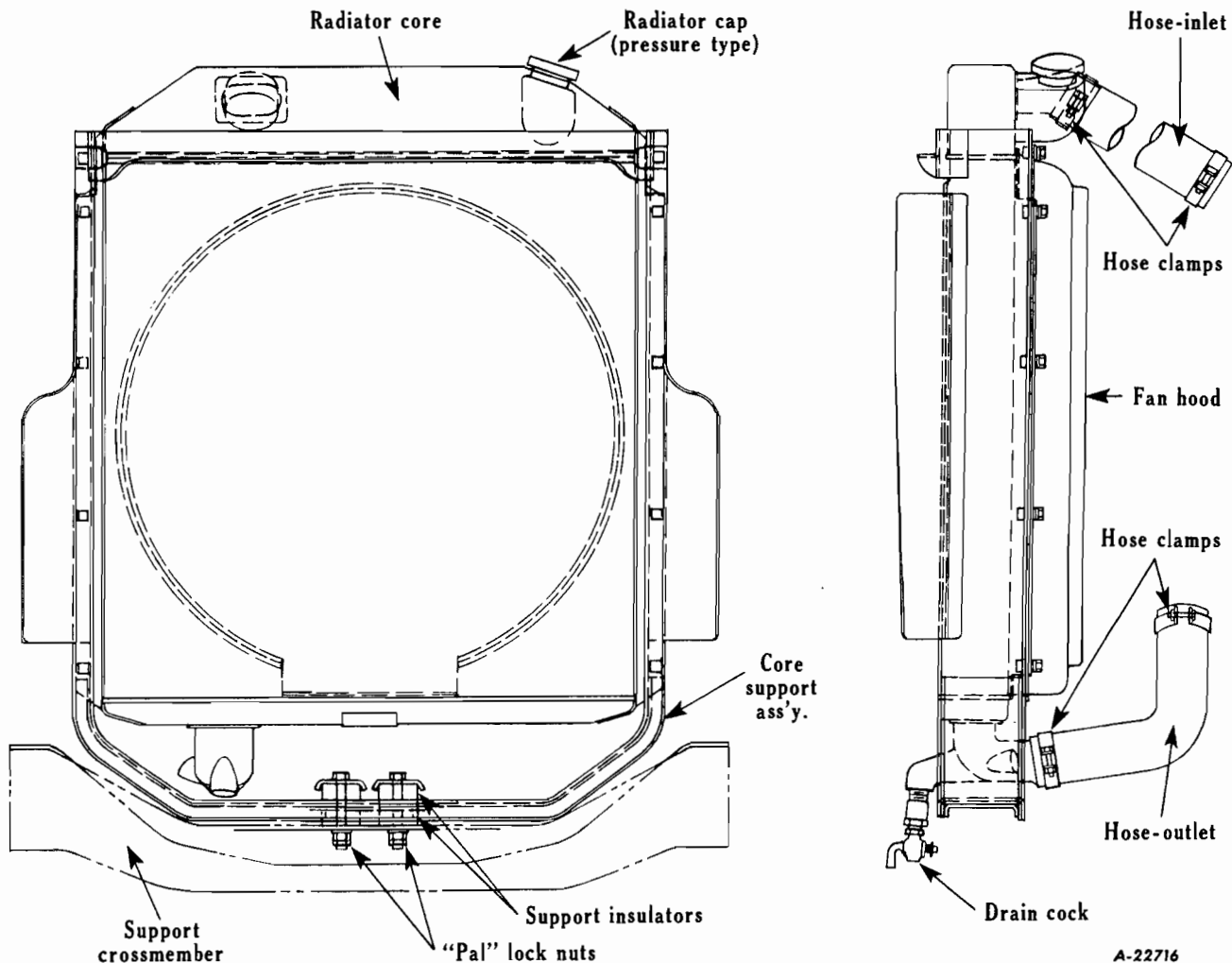


Fig. 6 - Radiator Mounting
L-190, LF-190, L-193, L-194, L-195, L-200, L-204, L-205, L-210, LF-210.

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SPRING GROUP

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SPRING SPECIFICATIONS

MODELS	L-110	L-120	LM-120	L-130	LB-140	L-150	L-153	LM-150
FRONT SPRINGS:								
No. of leaves	7	9	9	8	8	8	8	10
Length (flat)	42"	42"	42"	42"	42"	46"	46"	42"
Width	1-3/4"	1-3/4"	1-3/4"	1-3/4"	1-3/4"	2"	2"	1-3/4"
Thickness (per leaf)	.262"	.262"	.291"	.291"	.291"	.323"	.323"	.291"
Load to bump	4-3/16"	4"	4-3/8"	4"	3-16/16"	4"	4"	3-7/8"
REAR SPRINGS:								
No. of leaves	8	10	10	8	10	8	10	10
Length (flat)	52"	52"	52"	52"	52"	50"	52"	52"
Width	1-3/4"	1-3/4"	1-3/4"	2-1/4"	2-1/4"	2-1/2"	2-1/2"	2-1/4"
Thickness (per leaf)	.291"	.323"	.323"	.360"	.360"	.401"	.401"	.360"
Load to bump	4-3/8"	4-13/16"	4-13/16"	4-3/8"	3-9/16"	4-1/8"	4-1/8"	4"
AUXILIARY SPRINGS:								
Standard								
Optional	optional	optional	optional	optional	optional	optional	optional	optional
No. of leaves	5	5	5	6	6	8	.....	6
Length (flat)	33"	33"	33"	34"	32-7/8"	33"	.....	32-7/8"
Width	1-3/4"	1-3/4"	1-3/4"	2-1/4"	2-1/4"	2-1/2"	.....	2-1/4"
Thickness (per leaf)	.262"	.262"	.262"	.262"	.262"	.262"262"
Load to bump	3"	3"	3"	3"	3-3/8"	4-1/8"	3-3/8"

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SPRING SPECIFICATIONS

MODELS	L-160	L-163	L-164	L-165	LC-160	L-170	L-173	L-174
FRONT SPRINGS:								
No. of leaves	8	8	9	9	10	9	9	10
Length (flat)	46"	46"	46"	46"	46"	46"	46"	46"
Width	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"
Thickness (per leaf)	.323"	.323"	.323"	.291"	.323"	.323"	.323"	.323"
Load to bump	4"	4-5/16"	3-7/8"	3-3/4"	3-5/16"	3-7/16"	3-1/4"	3-3/8"
REAR SPRINGS:								
No. of leaves	8	12	10	8	8	10	14	12
Length (flat)	52"	52"	52"	52"	52"	52"	52"	52"
Width	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Thickness (per leaf)	.401"	.401"	.401"	.401"	.401"	.401"	.401"	.401"
Load to bump	4"	5-1/2"	4-1/2"	3-7/8"	4-1/8"	4-9/16"	6"	5-1/16"
AUXILIARY SPRINGS:								
Standard	standard		standard	standard	standard	standard		standard
Optional								
No. of leaves	6		6	6	6	8		9
Length (flat)	37"		37"	37"	37"	38"		38"
Width	2-1/2"		2-1/2"	2-1/2"	2-1/2"	2-1/2"		2-1/2"
Thickness (per leaf)	.323"		.323"	.323"	.323"	.291"		.201"
Load to bump	4"		4"	3-7/8"	4-1/8"	4-9/16"		5-1/16"



SPRING SPECIFICATIONS

MODELS	L-175	LF-170	L-180	L-183	L-184	L-185	LC-180	L-190
FRONT SPRINGS:								
No. of leaves	8	12	10	10	11	9	12	9
Length (flat)	46"	46"	46"	46"	46"	46"	46"	52"
Width	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"	2-1/4"	3"
Thickness (per leaf)	.323"	.323"	.323"	.323"	.323"	.323"	.323"	.360"
Load to bump	3-9/16"	3-5/16"	3-5/16"	3-5/16"	3-5/16"	3-1/2"	3-1/4"	3-5/8"
REAR SPRINGS:								
No. of leaves	10	10	11	13	14	11	11	12
Length (flat)	52"	32-1/4"	54"	54"	54"	54"	54"	54"
Width	2-1/2"	3"	3"	3"	3"	3"	3"	3"
Thickness (per leaf)	.401"	8-.447" 2-.401"	8-.401" 3-.360"	3-.447" 10-.401"	6-.401" 8-.360"	8-.401" 3-.360"	8-.401" 3-.360"	.401"
Load to bump	4-9/16"		3-11/16"	4-1/4"	3-1/8"	3-11/16"	3-11/16"	3-3/8"
AUXILIARY SPRINGS:								
Standard	standard		standard		standard	standard	standard	standard
Optional								
No. of leaves	8		7		9	7	7	7
Length (flat)	38"		39"		39"	39"	39"	41"
Width	2-1/2"		3"		3"	3"	3"	3"
Thickness (per leaf)	.291"		.323" 6-.291"		3-.323"	.323"	.323"	.323"
Load to bump	4-9/16"		3-11/16"		3-1/8"	3-11/16"	3-11/16"	3-3/8"

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SPRING SPECIFICATIONS

MODELS	L-193	L-194	L-195	LF-190	LC-190	L-200	L-204	L-205
FRONT SPRINGS:								
No. of leaves	9	9	8	9	.....	9	10	9
Length (flat)	52"	52"	52"	52"	.....	52"	52"	52"
Width	3"	3"	3"	3"	.....	3"	3"	3"
Thickness (per leaf)	.401"	.401"	.360"	.401"	.....	.401"	.401"	.360"
Load to bump	3-3/4"	3-7/16"	3-7/8"	3-9/16"	.....	3-5/16"	3-5/8"	3-5/8"
REAR SPRINGS:								
No. of leaves	12	13	12	12	.....	13	16	13
Length (flat)	56"	54"	54"	37-3/4"	.....	54"	56"	54"
Width	3"	3"	3"	4"	.....	3"	3"	3"
Thickness (per leaf)	7-.447" 5-.401"	.447"	.401"	9-.447" 3-.401"	.....	.447"	.447"	.447"
Load to bump	3-7/8"	3-1/4"	4-3/8"		.....	3-1/2"	4-7/16"	3-3/4"
AUXILIARY SPRINGS:								
Standard		standard	standard			standard	standard	standard
Optional					.....		
No. of leaves		8	7		.....	8	10	8
Length (flat)		41"	41"		.....	41"	41"	41"
Width		3"	3"		.....	3"	3"	3"
Thickness (per leaf)		.323"	.323"		.....	.323"	.323"	.323"
Load to bump		3-1/4"	4-3/8"		.....	3-1/2"	4-7/16"	3-3/4"



SPRING SPECIFICATIONS

MODELS	LC-200	L-210	LF-210	L-220	LF-220	L-225	L-230	LF-230
FRONT SPRINGS:								
No. of leaves		10	10			10		
Length (flat)		52"	52"			52"		
Width		3"	3"			3"		
Thickness (per leaf)		9-.447" 1-.401"	9-.447" 1-.401"			.401"		
Load to bump		3-3/4"	3-3/4"			3-1/2"		
REAR SPRINGS:								
No. of leaves		15	12					
Length (flat)		56"	37-3/4"					
Width		3"	3"					
Thickness (per leaf)		.499"	10-.500" 2-.375"					
Load to bump		4-3/16"						
AUXILIARY SPRINGS:								
Standard		standard						
Optional								
No. of leaves		9						
Length (flat)		41"						
Width		3"						
Thickness (per leaf)		3-.401" 6-.360"						
Load to bump		4-3/16"						

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SPRINGS

Front Spring Mounting

Front springs are mounted at the front with brackets and at the rear by shackles.

Rear Spring Mounting

Rear springs are mounted at the front with brackets and at the rear with shackles.

Auxiliary Spring Mounting

Auxiliary springs are mounted on top of the main rear spring and under load the auxiliary spring ends will contact the brackets attached to the side rails.

Rubber Bushed Spring Mounting (Rear Only)

On trucks equipped with rubber bushed spring mountings, it is necessary to remove the complete spring assembly to replace the rubber bushings. These rubber bushings are made up of two parts on each pin. To install new bushings, the following instructions are to be used:

1. Remove nuts and washers from bracket pins at front and rear.
2. Remove U-bolts and slide spring off of both front and rear bracket pins.
3. Place spring in vise and remove shackle pin nut and washer.
4. The rubber bushings are separated at the center of each pin, making it possible to remove a half of a bushing from each side of the spring and shackle eye.
5. Install new bushings by reversing the above operation.
6. Application of soap solution to the bushing will facilitate installation of the bushings.
7. When installing nuts on the shackle and bracket pins, the knurled side of the nut must face toward the outside. Tighten spring and bracket pin nuts securely (approximately 35 ft. lbs.).

Spring Maintenance

Spring leaf failures at the spring eye are generally a result of improper spring pin adjustment. If the pin is drawn up too tightly in the bracket or shackle, a bind will result.

Spring failures at the center section, or near the center bolt hole, are generally caused by loose U-bolts. These bolts must be kept tight and checked frequently. The best results will be obtained by having the vehicle fully loaded at the time of tightening the U-bolts,

since this assures the spring leaves being compressed.

Spring pins on the L-line trucks are of three types:

1. Spring pins that are threaded into shackles or brackets.
2. Spring pins that are driven into shackles or brackets.
3. Spring pins that are welded or pressed in brackets.

Spring pins which are threaded into the bracket require that the pin be tightened into the bracket and then backed out one-half turn. The locknut should then be tightened securely and the cotter pin installed.

NOTE: Do not back off nut to permit installation of cotter pin since this would permit pin to turn in the bracket, and cause excessive wear. If necessary, turn pin out of bracket a slight amount to permit installation of cotter pin when the locknut is tight.

Spring pins which are to be driven into the shackle or bracket, require that the pin be aligned so as to be able to install lock bolt through bracket or shackle with pin in place.

Spring pins that are welded or pressed into bracket or shackle require that spring pin nut be tightened securely with knurled side out. This is a self-lock type nut.

When installing threaded spring pins in threaded spring shackles, the lubricant hole in the spring pin should be located in an area approximately 90° on either side of top center of the spring eye or away from the loaded side of the spring pin (See Fig. 1).

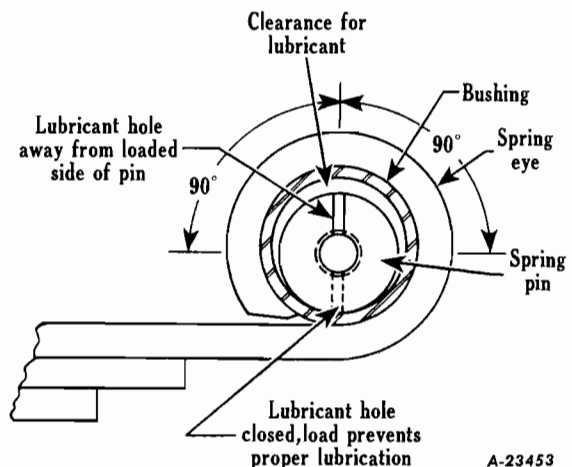


Fig. 1 - Spring Pin Installation (Diagrammatic). With the pin in this position, adequate lubrication is assured.



Rubber Bushed Spring (Front Spring Only)

To remove rubber bushing from front springs, the following instructions are to be used:

(FRONT END)

1. Remove the self-locking nut from spring bracket.
2. To remove the front spring pin, remove the two bolts and nuts that hold the inside half of the pin bracket to the frame channel. This will allow the spring pin to be removed with the inside half of the spring bracket.
3. Unless replacement of the spring pin is necessary, do not attempt to drive spring pin out of bracket. This will damage and loosen the pin in the inner bracket eye.

(REAR END)

To remove the rubber bushings from the rear end of front spring, use the following procedure:

1. Remove nuts from both rear spring pins.
2. Remove retainer from pins.
3. This will let the inside shackle be removed with both shackle pins attached.

Disassembly of Springs

The disassembly of front or rear springs is identical in procedure. Disassemble springs as follows:

1. Place spring in vise, clamping assembly near center of spring.
2. Remove nuts from four spring clip bolts, and remove bolts from clips.
3. Remove nut from spring center bolt.
4. Release vise to permit leaves to separate. Remove spring from vise. Separate and remove leaves from center bolt.

Auxiliary Springs

Disassembly of the auxiliary springs differ only slightly from that of the front or rear springs:

1. Place auxiliary spring in vise, and clamp leaves together.
2. Straighten tabs of two spring clips, being careful not to break them off. Heating clips with a torch will help avoid breakage.
3. Remove nut from center bolt, and release vise to permit leaves to separate. Remove spring from vise.
4. Remove spring leaves from center bolt.

Cleaning and Inspection of Springs

Wash or scrub all parts in cleaning solvent or clean all parts with steam cleaning equipment. Brushing of spring leaves with a wire brush will facilitate scale removal. (NOTE: Do not immerse rubber spring bushings in cleaning solvent.)

1. Inspect all spring leaves for breakage and cracks. Replace defective leaves. Inspect all leaves for arch by comparison with new leaves. If leaves are flattened out, either re-arch or replace.
2. Examine spring pins for wear. If wear is apparent, or if pins are corroded or cracked, replace with new pins.
3. Inspect spring eye bushing, and rear spring shackle bushings for wear, and replace if defective.
4. Inspect spring bracket for breakage and for wear in mounting bolt, or rivet holes, and replace if worn or broken.
5. Replace center bolts at each overhaul.

Assembly of Front and Rear Springs

1. Lightly coat spring leaves with graphite grease. Replace spring leaves in proper order, lining up the center bolt holes.
2. Partially compress spring leaves, and insert center bolt and nut.
3. Place spring assembly in vise, and compress spring leaves fully.
4. Install four spring clip bolts in spring clips, and install nuts on bolts. Tighten center bolt nut.
5. Run over end of clip bolts and center bolt enough to prevent loosening of nut.

Auxiliary Spring Assembly

1. Coat spring leaves lightly with graphite grease. Place leaves one on top of another in accordance with length.
2. Compress spring leaves and install center bolt and nut.
3. Place spring in vise and compress leaves fully. Tighten center bolt nut. Bend down ends of spring clips, being careful not to break them. Heating the clips with a torch will facilitate operation.

FRONT SPRING MOUNTINGS

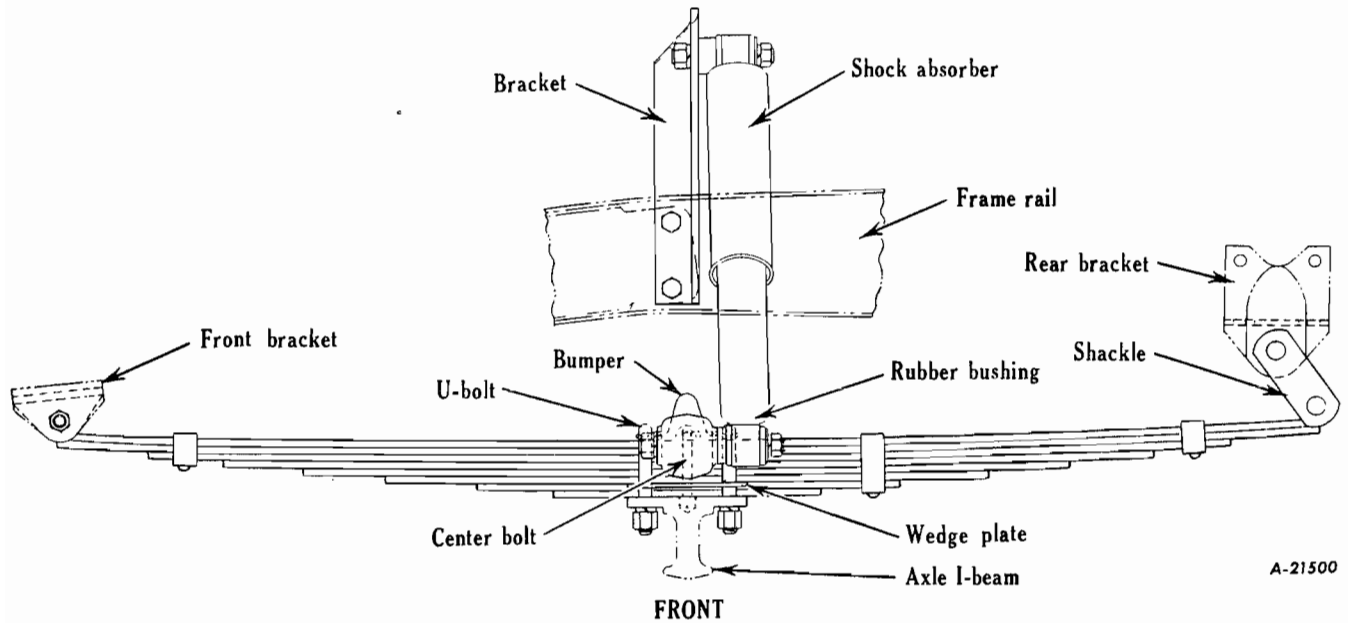


Fig. 1 - Models L-110, L-120, LM-120, L-130, LB-140, LM-150.

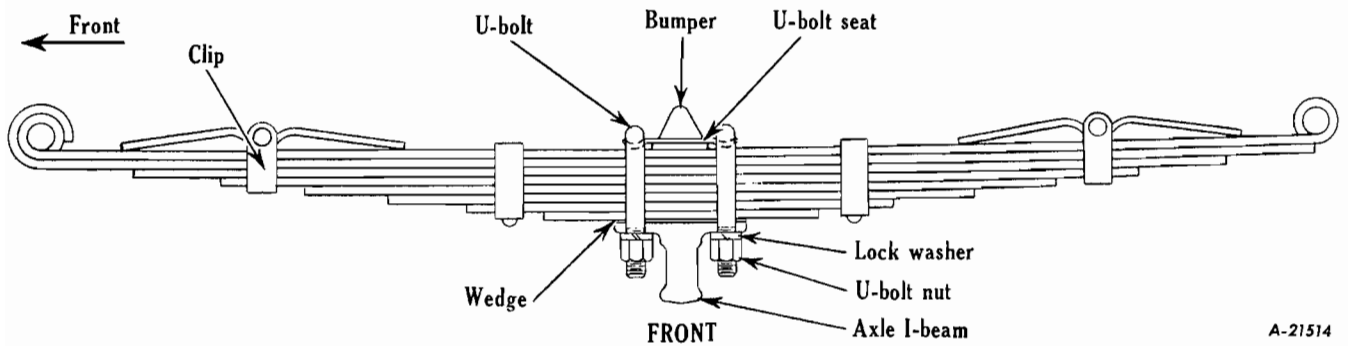


Fig. 2 - L-150, L-153, L-160, L-163, L-164, L-165, LC-160.

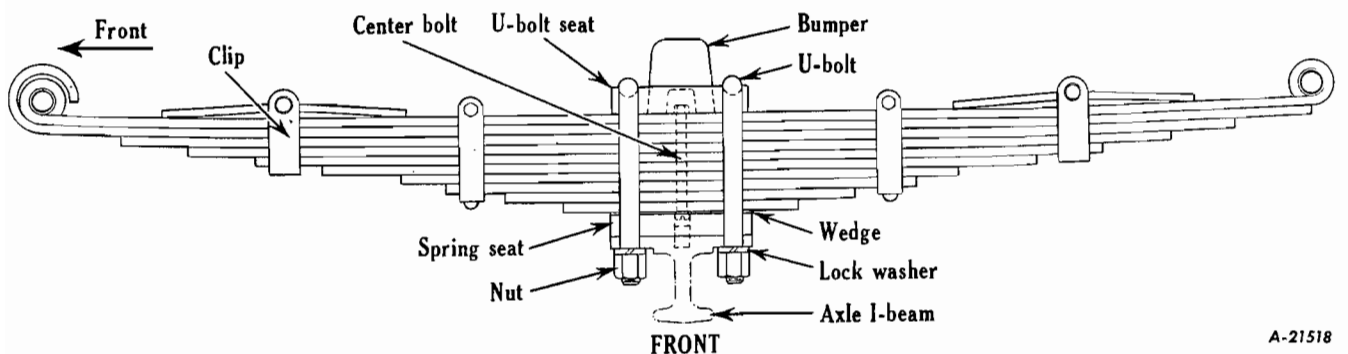


Fig. 3 - Models L-170, L-173, L-174, L-175, LF-170, L-180, L-183, L-184, L-185, LC-180.

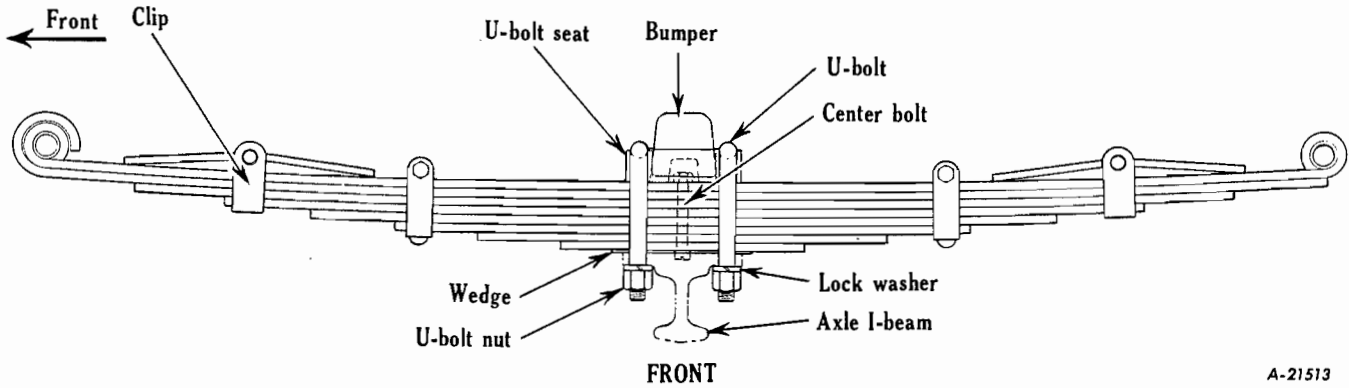


Fig. 4 - Models L-190, L-193, L-194, L-195, LF-190, L-200, L-204, L-205, L-210, LF-210.

REAR SPRING MOUNTINGS

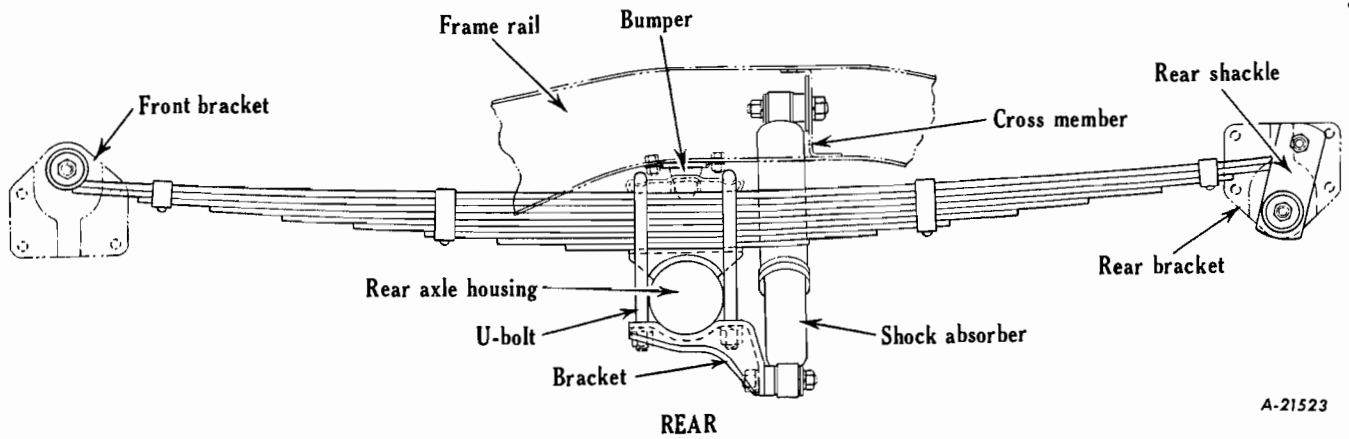


Fig. 5 - Models L-110, L-120, LM-120 (Shock Absorbers-Standard) L-130, LB-140, LM-150 (Shock Absorbers-Optional).

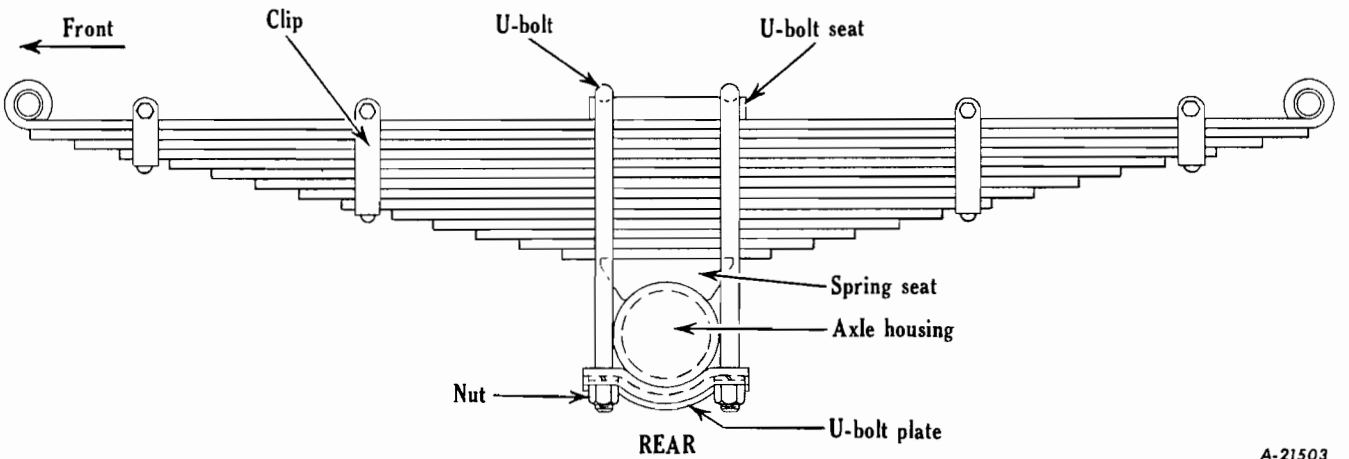
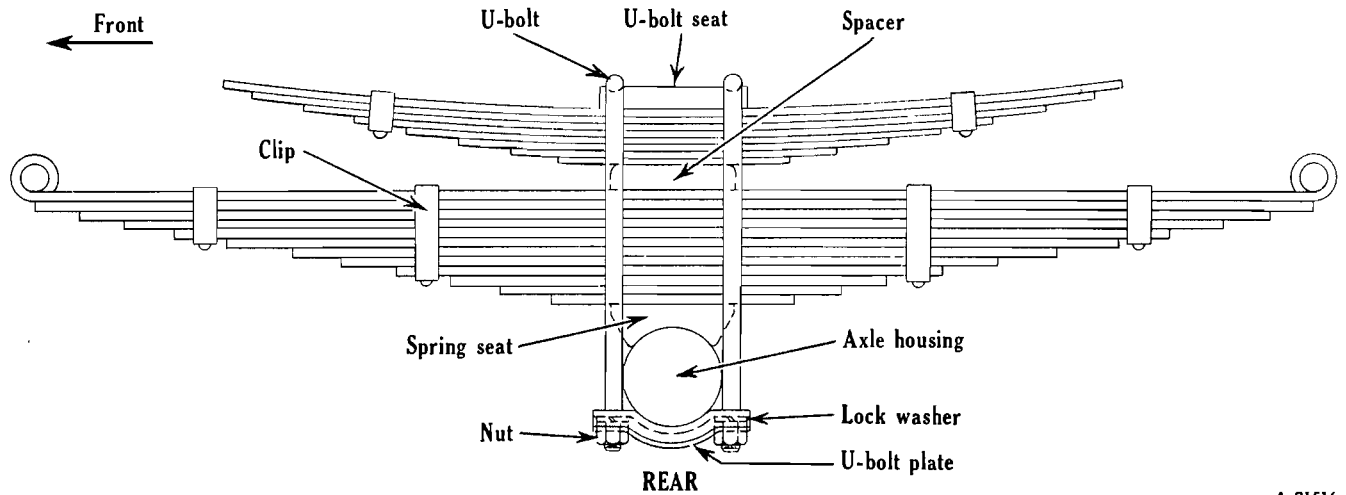
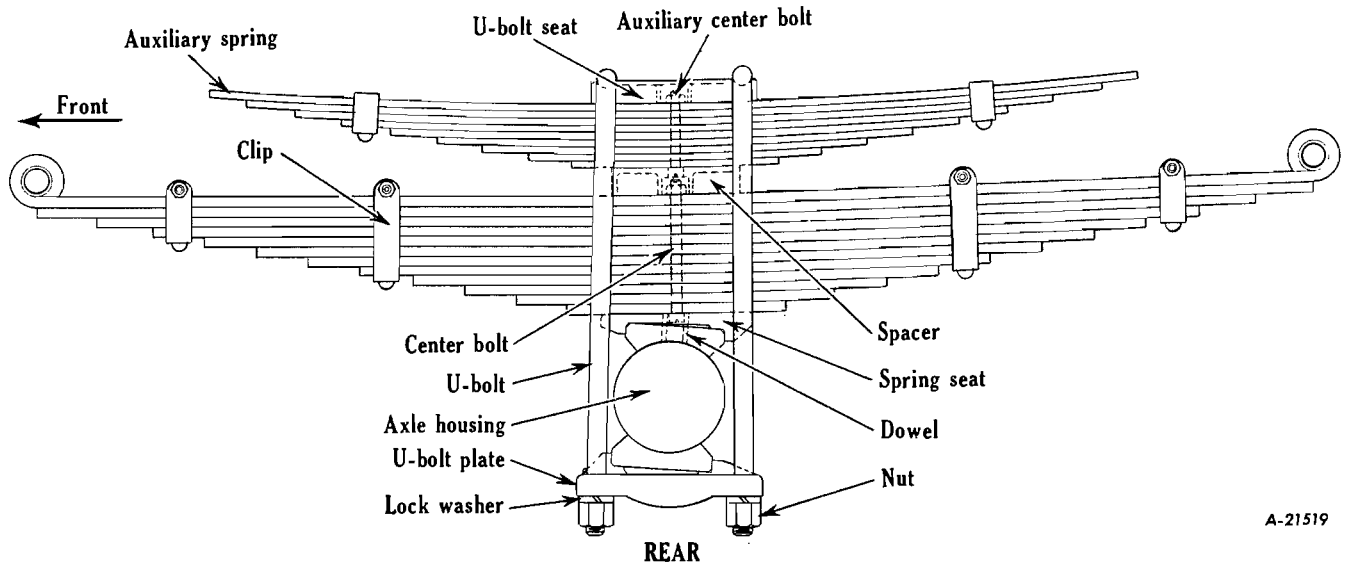


Fig. 6 - Models L-150, L-153, L-163.



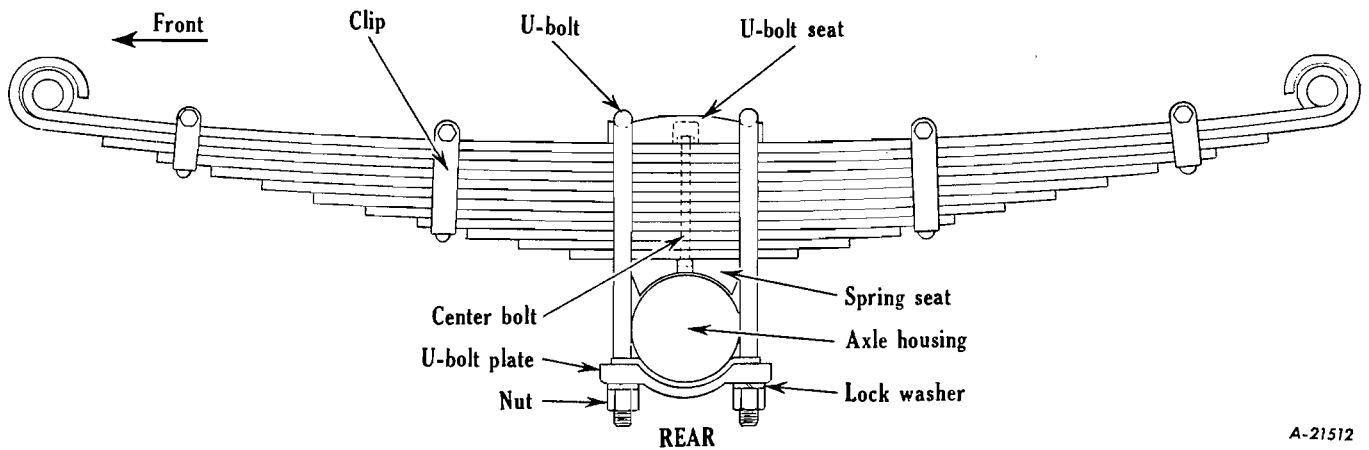
A-21516

Fig. 7 - Models L-160, L-164, L-165, LC-160, L-170, L-175.



A-21519

Fig. 8 - Models L-174.



A-21512

Fig. 9 - Models L-173, L-183.

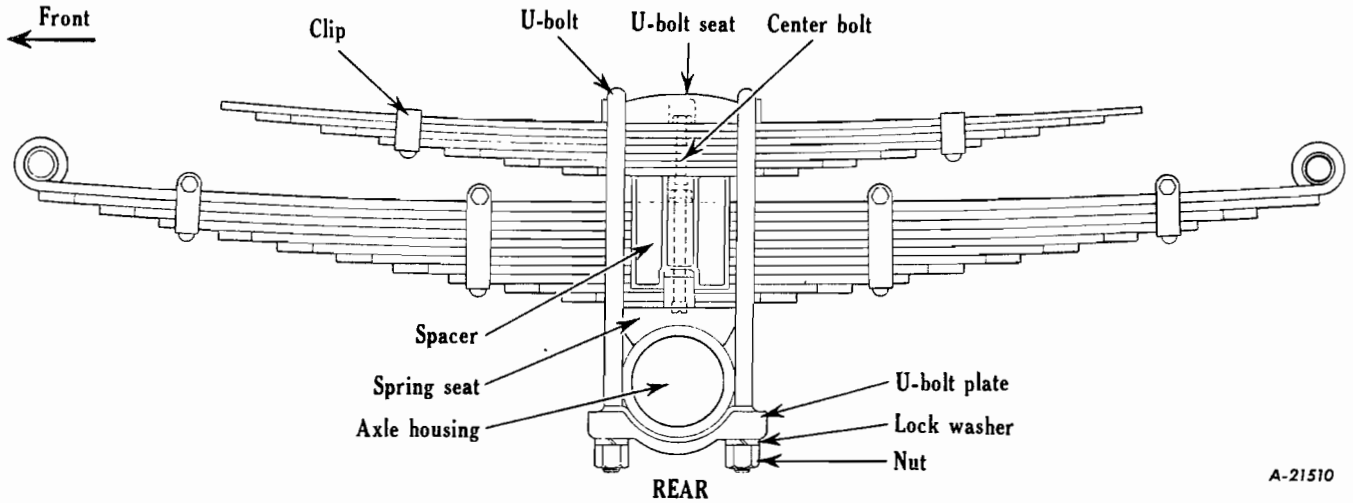


Fig. 10 - Models L-180, L-185, LC-180.

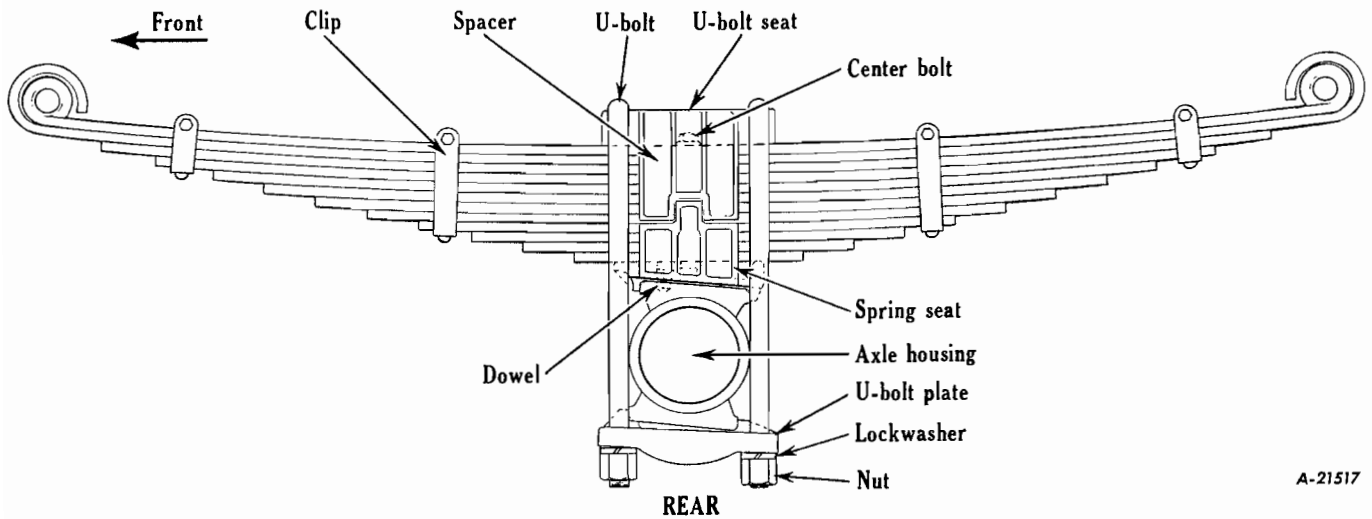


Fig. 11 - Models L-193.

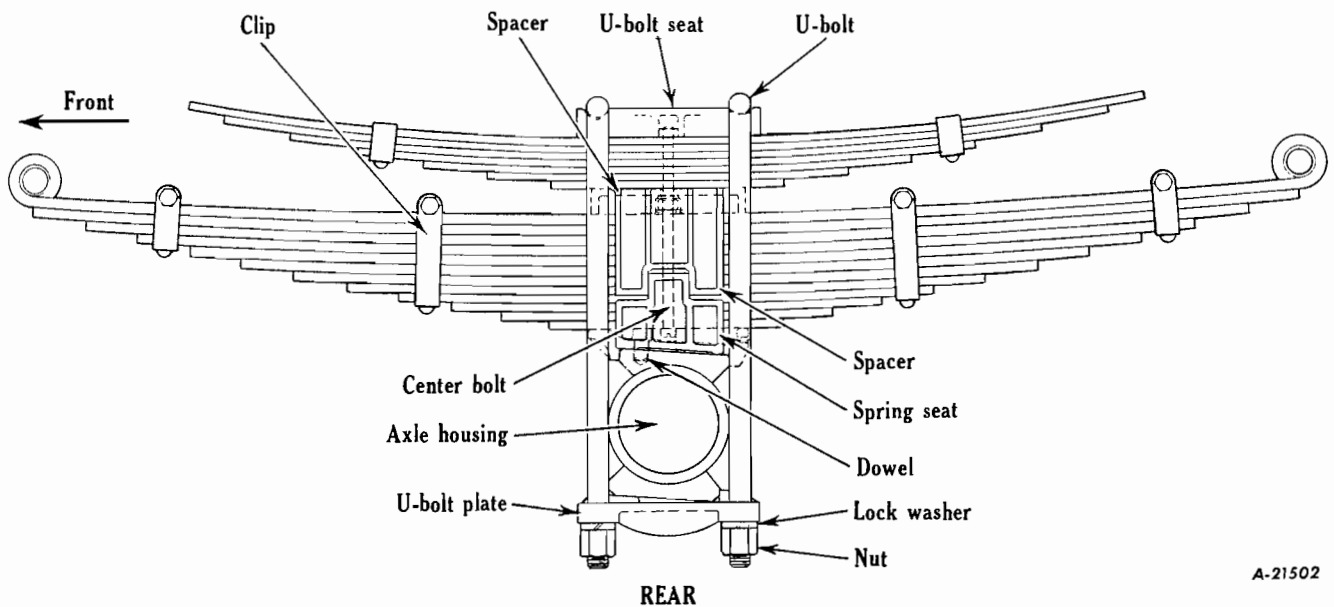
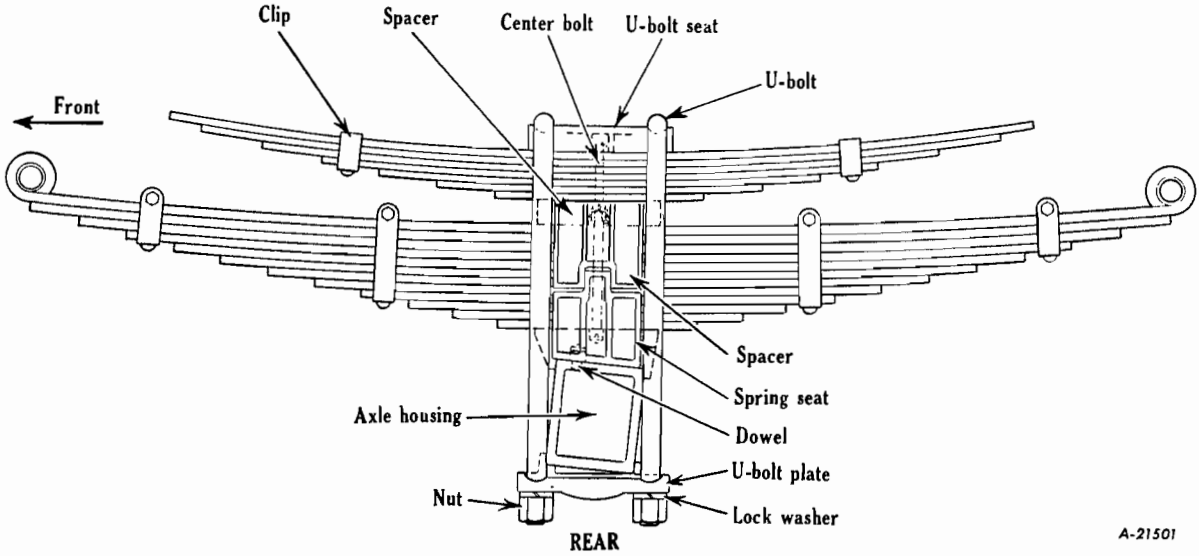
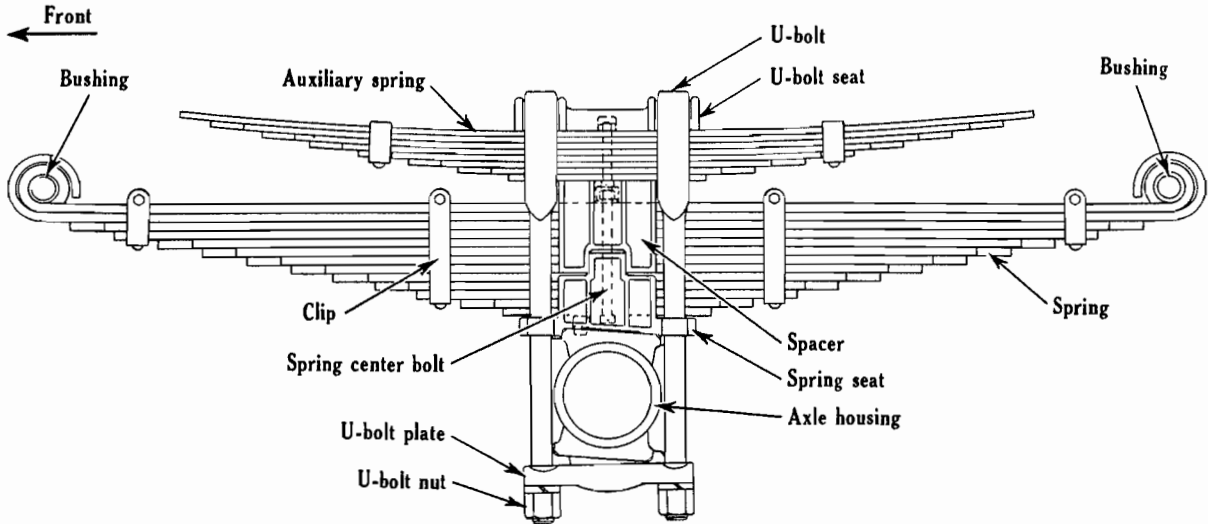


Fig. 12 - L-184, L-190, L-195.



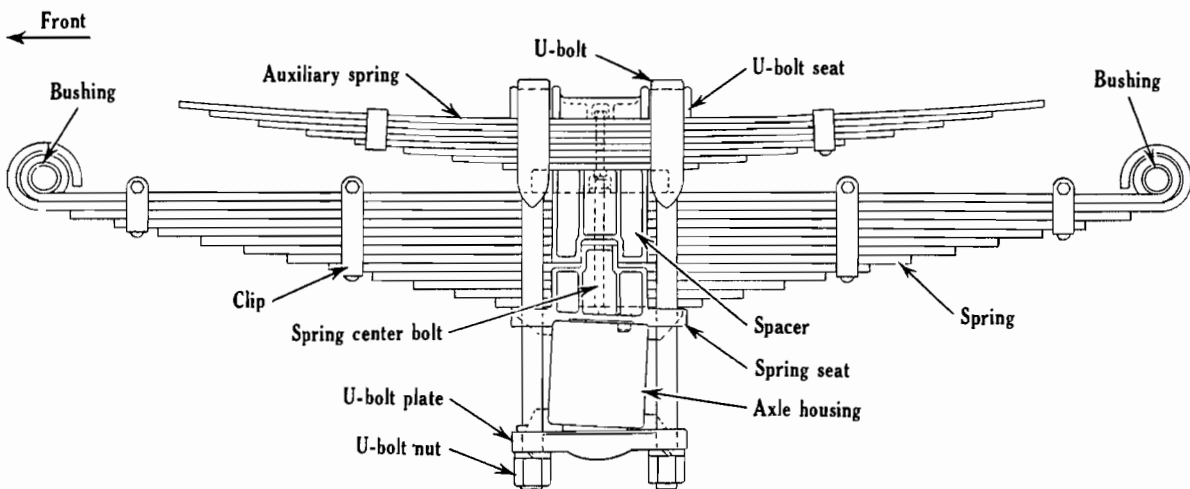
A-21501

Fig. 13 - Models L-195.



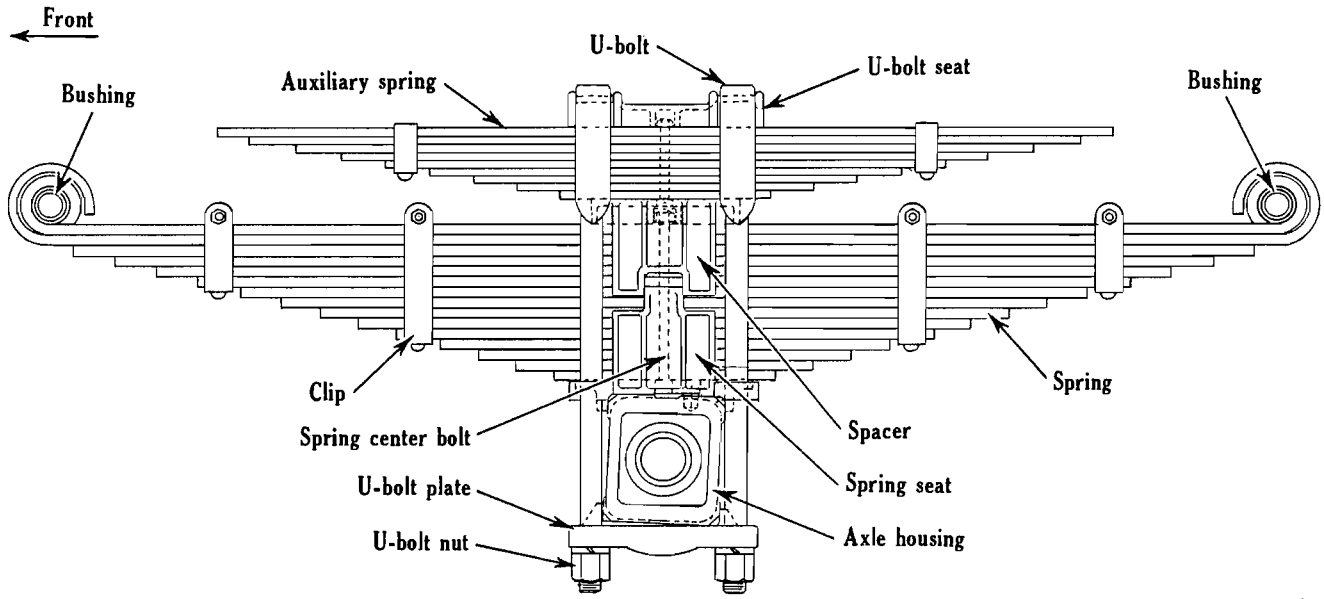
A-21742

Fig. 14 - Models L-194, L-200, L-205.



A-21741

Fig. 15 - Models L-204.



A-21743

Fig. 16 - Models L-210.

SPRING SHACKLES AND BRAKES

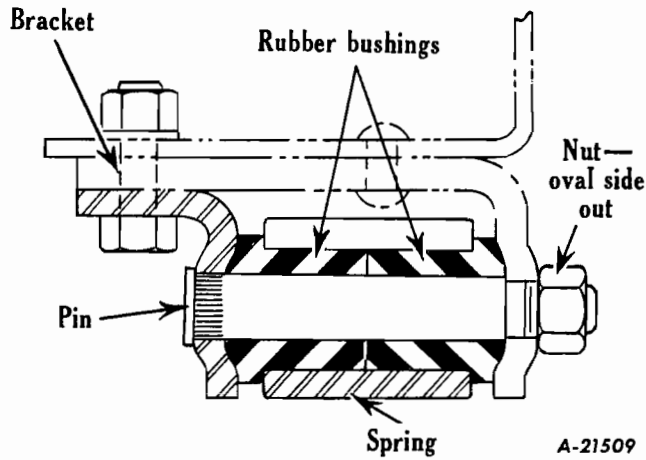


Fig. 1 - Front Spring Front Bracket For Models L-110, L-120, LM-120.

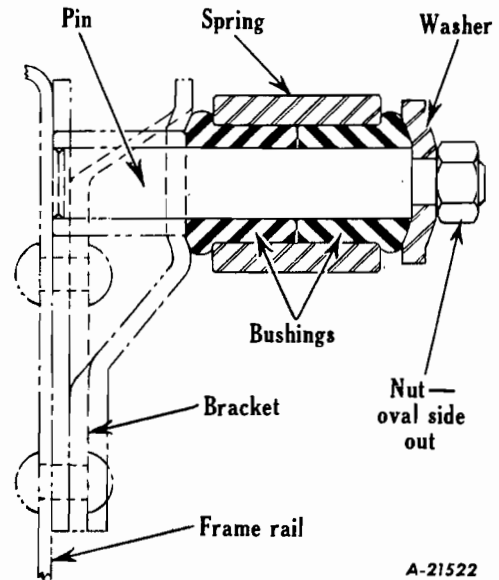


Fig. 3 - Rear Spring Front Bracket For Models L-110, L-120, LM-120.

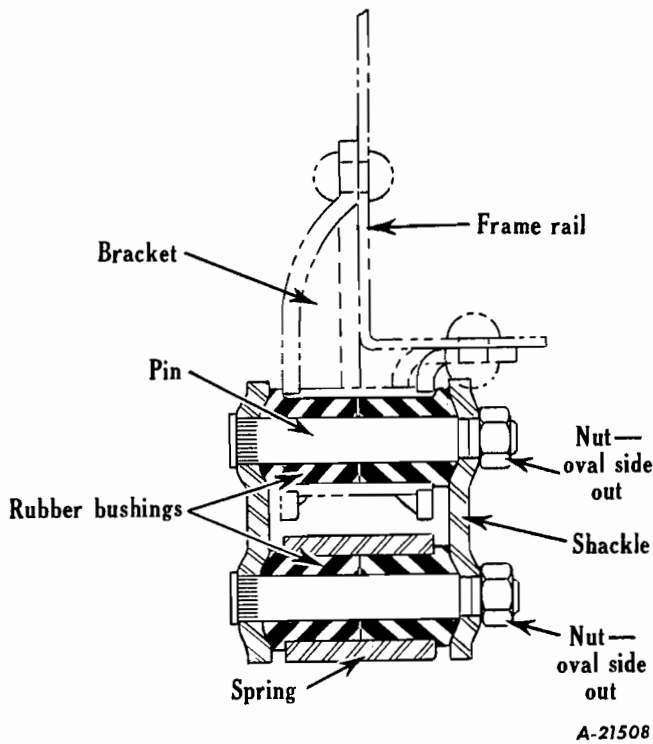


Fig. 2 - Front Spring Rear Shackle For Models L-110, L-120, LM-120.

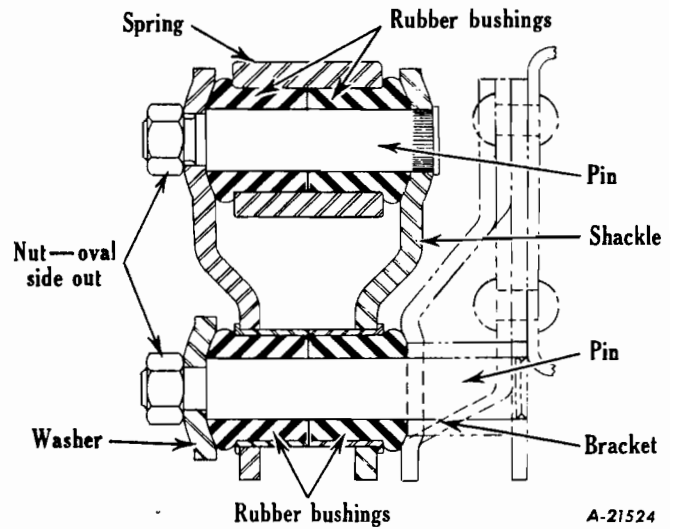


Fig. 4 - Rear Spring Rear Shackle For Models L-110, L-120, LM-120.

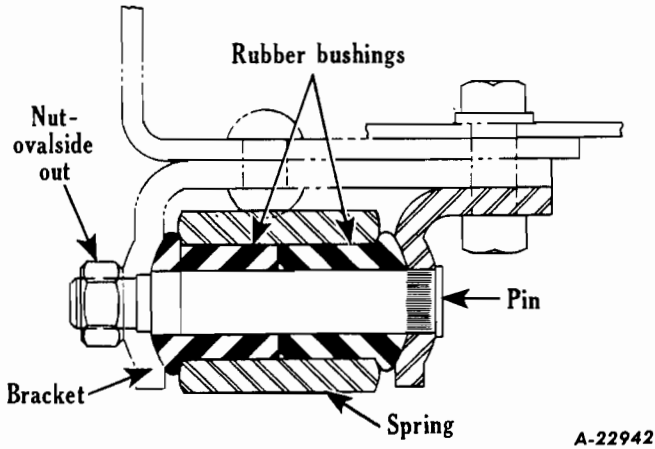


Fig. 5 - Front Spring Front Bracket For Models L-130, LB-140, LM-150.

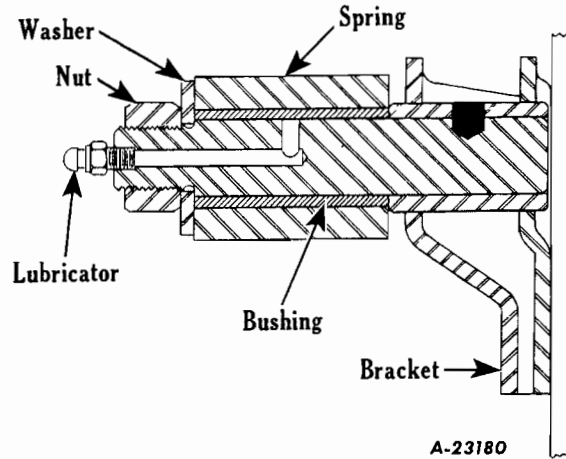


Fig. 7 - Rear Spring Front Bracket For Models L-130, LB-140, LM-150.

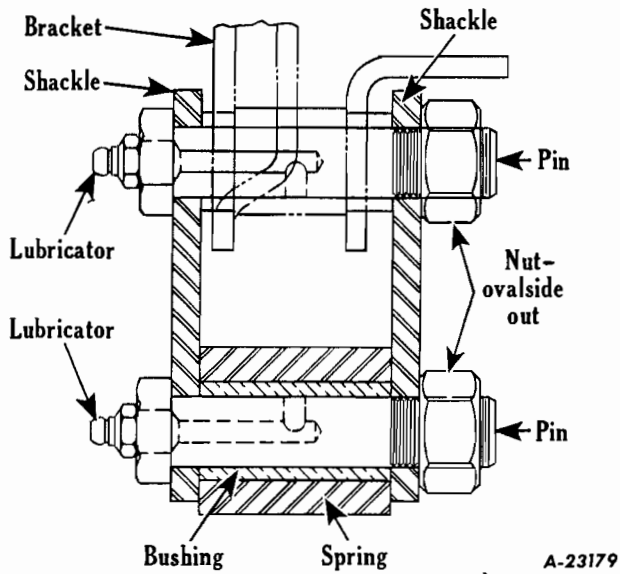


Fig. 6 - Front Spring Rear Shackle For Models L-130, LB-140, LM-150.

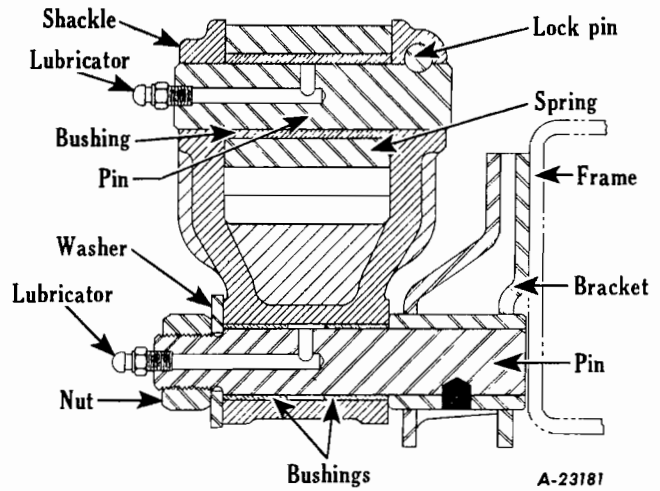


Fig. 8 - Rear Spring Rear Shackle For Models L-130, LB-140, LM-150.

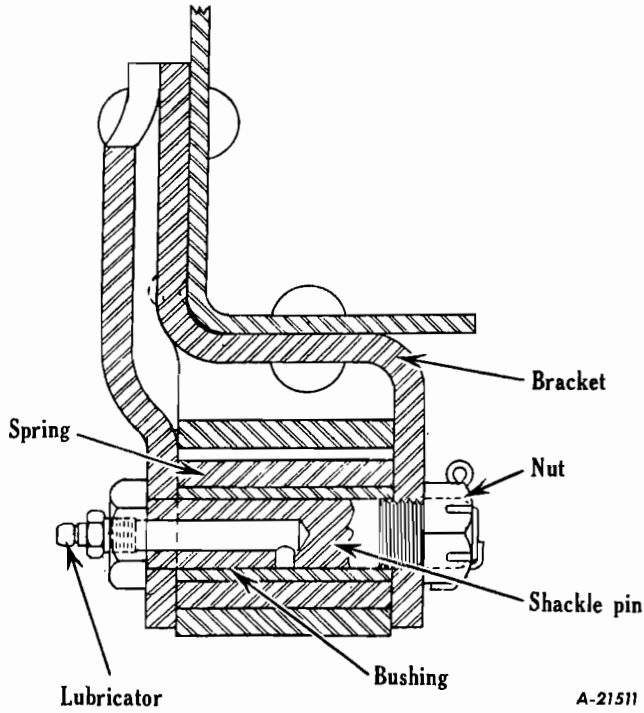


Fig. 9 - Front Spring Front Bracket For Models L-150, L-153, L-160, L-163, L-164, L-165, LC-160, L-170, L-173, L-174, L-175, LF-170, L-180, L-183, L-184, L-185, LC-180.

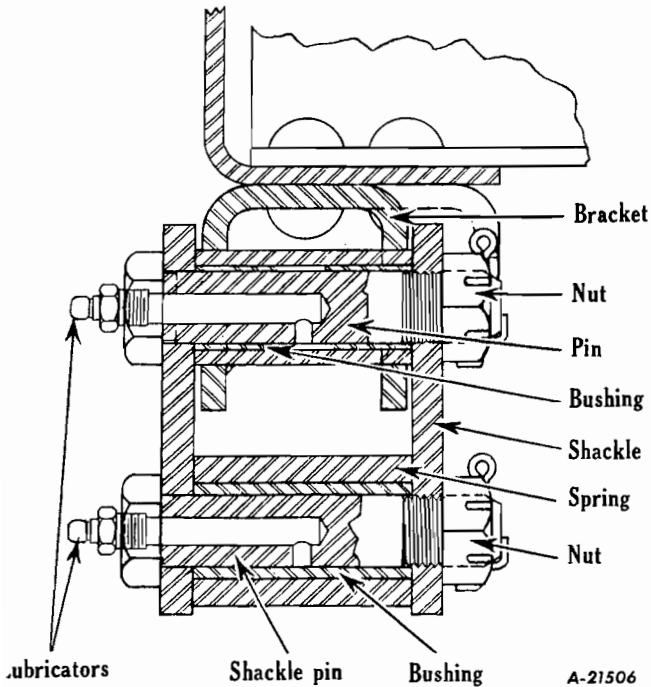


Fig. 10 - Front Spring Rear Shackle For Models L-150, L-153, L-160, L-163, L-164, L-165, LC-160, L-170, L-173, L-174, L-175, LF-170, L-180, L-183, L-184, L-185, LC-180.

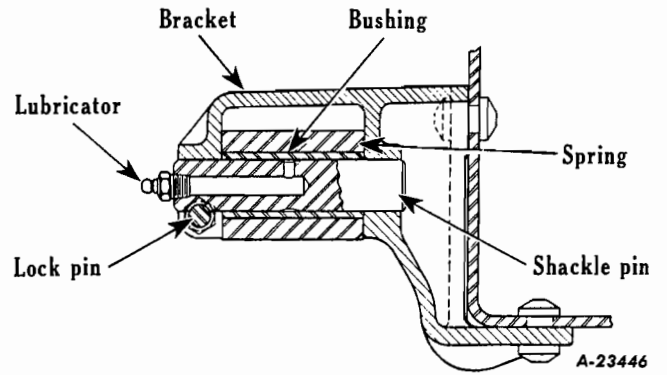


Fig. 11 - Rear Spring Front Bracket For Models L-150, L-153.

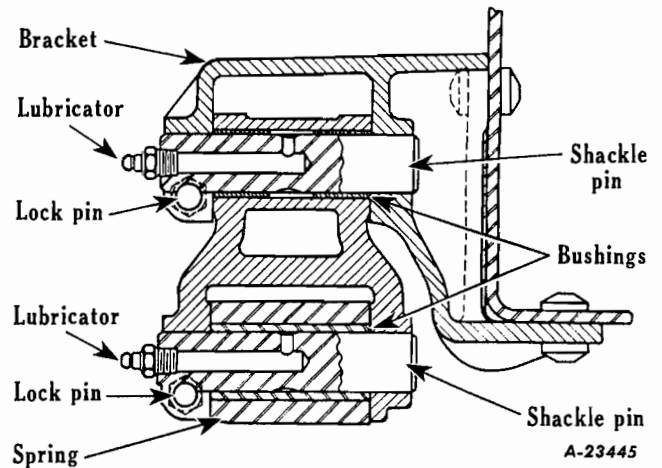


Fig. 12 - Rear Spring Rear Shackle For Models L-150, L-153.

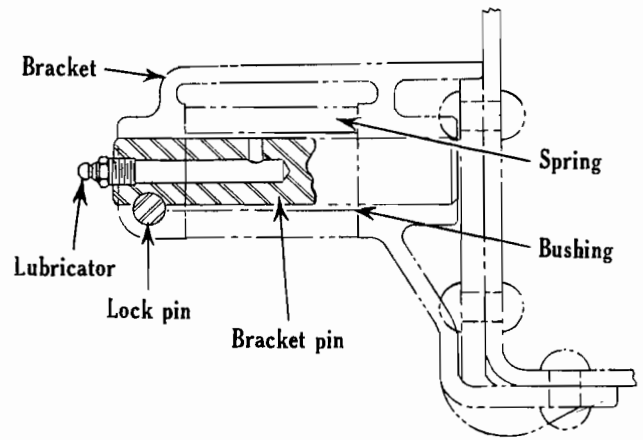


Fig. 13 - Rear Spring Front Bracket For Models L-160, L-163, L-164, L-165, LC-160, L-170, L-173, L-174, L-175.

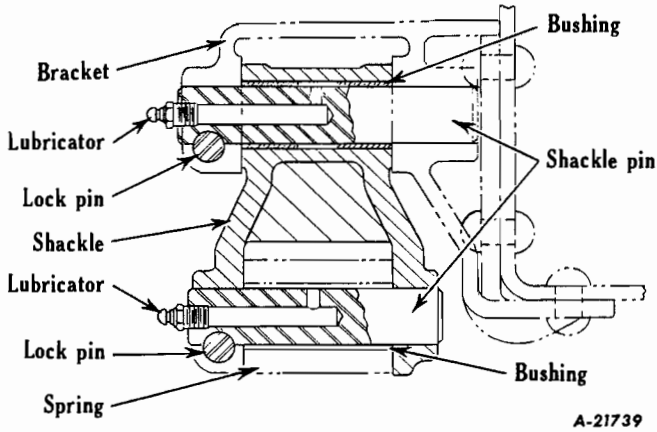


Fig. 14 - Rear Spring Rear Shackle For Models L-160, L-163, L-164, L-165, LC-160, L-170, L-173, L-174, L-175.

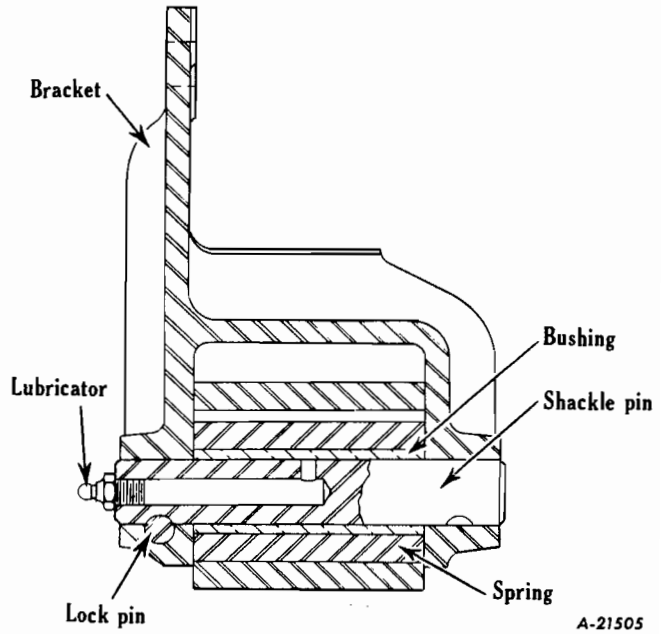


Fig. 17 - Front Spring Front Bracket For Models L-190, L-193, L-194, L-195, LF-190, L-200, L-204, L-205, L-210, LF-210.

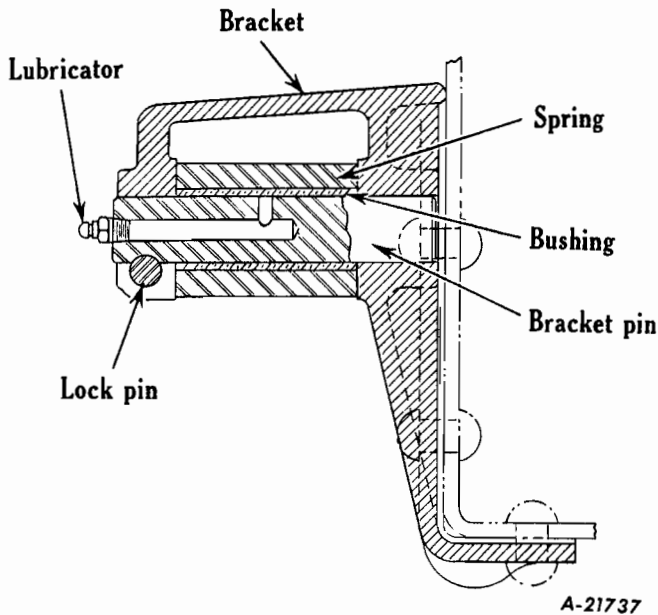


Fig. 15 - Rear Spring Front Bracket For Models L-180, L-183, L-184, L-185, LC-180, L-190, L-193, L-195.

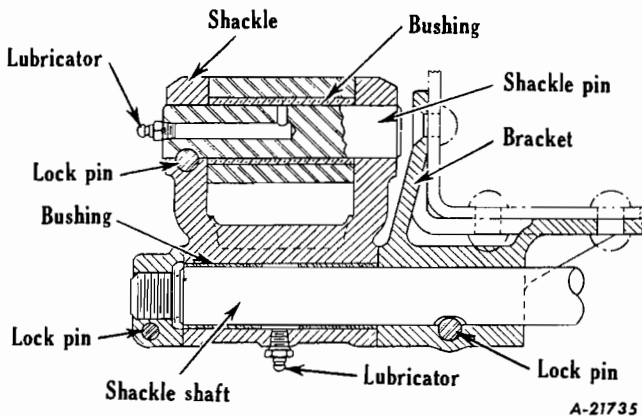


Fig. 16 - Rear Spring Rear Shackle For Models L-180, L-183, L-184, L-185, LC-180, L-190, L-193, L-195.

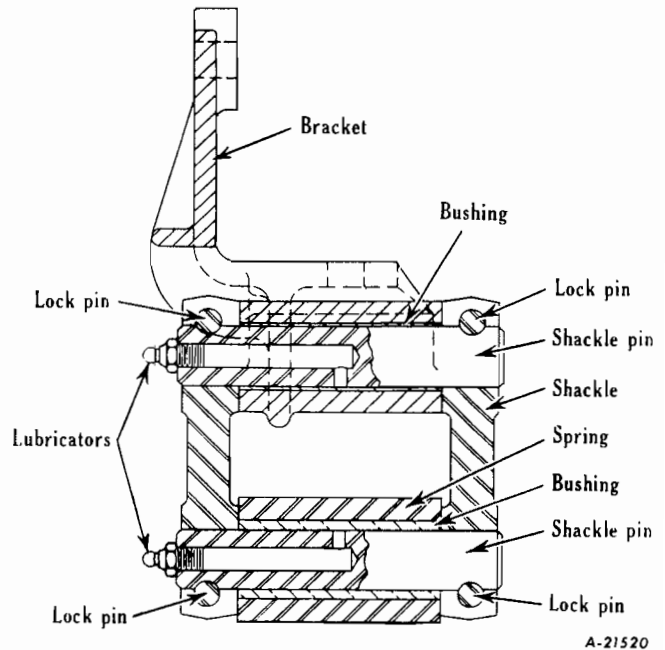


Fig. 18 - Front Spring Rear Shackle For Models L-190, L-193, L-194, L-195, LF-190, L-200, L-204, L-205, L-210, LF-210.



L-LINE MOTOR TRUCK SERVICE MANUAL

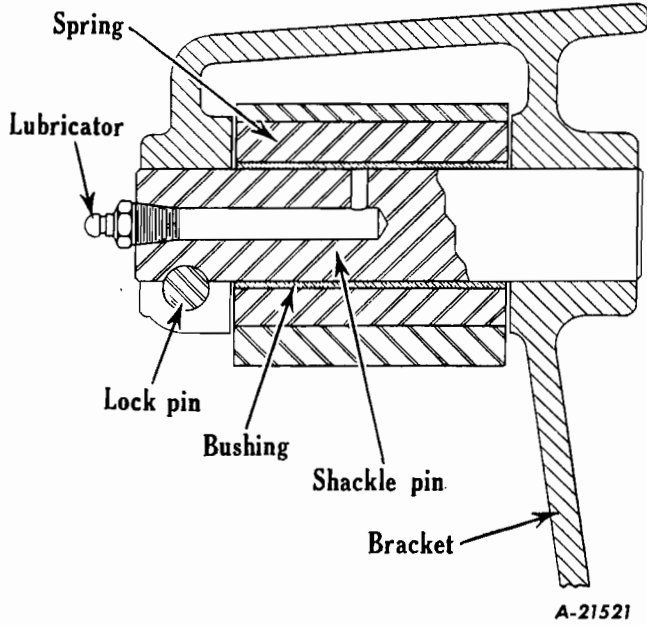


Fig. 19 - Rear Spring Front Bracket for Models L-194, L-200, L-204, L-205, L-210.

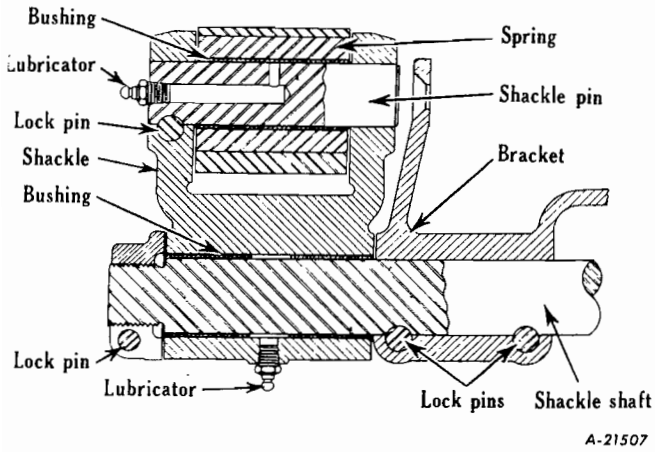


Fig. 20 - Rear Spring Rear Shackle For Models L-194, L-200, L-204, L-205, L-210.



STEERING GROUP

The following list shows the L-line truck models and their corresponding steering gear models. Specifications of the individual steering gear models will be found on specifications page 1.

TRUCK MODELS	STEERING GEAR MODELS	TRUCK MODELS	STEERING GEAR MODELS
L-110	TA-12	L-184	TA-61
L-120	TA-12	L-185	TA-61
LM-120	TA-14	LC-180	TA-61
L-130	T-14	L-190	T-66
LB-140	T-14	L-193	T-66
L-150	TA-14	L-194	T-66
L-153	TA-14	L-195	T-66
LM-150	TA-14	LC-190	
L-160	TA-54	LF-190	TA-66
L-163	TA-54	L-200	TA-66
L-164	TA-54	L-204	TA-66
L-165	TA-54	L-205	TA-66
LC-160	TA-54	LC-200	
L-170	TA-54	L-210	TA-70
L-173	TA-54	LF-210	TA-70
L-174	TA-61	L-220	
L-175	TA-54	LF-220	
LF-170	TA-61	L-225	TA-70
L-180	TA-61	L-230	
L-183	TA-61	LF-230	

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STEERING GEAR SPECIFICATIONS

STEERING GEAR MODELS	TA-12	T-14	TA-14	TA-54	TA-61	T-66	TA-66	TA-70
Steering Gears:								
Make	Ross	Ross	Ross	Ross	Ross	Ross	Ross	Ross
Ratio	15.4:13.5:15.4	17:15:17	20:18:20	20:18:20	22:18:22	19:17:19	23.4:19.5:23.4	23.4:19.5:23.4
Lever Shaft Diameter . . . . .	.9360	.9980	1.1230	1.1230	1.248	1.3730	1.3730	1.4975
Pitman Travel:								
Available	120°	116°	116°	116°	112°	104°	112°	106°
Steering Post Diameter	7/8"	7/8"	7/8"	7/8"	1"	1"	1"	1"
Steering Jacket Diameter	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-3/4"	1-3/4"	1-3/4"	1-3/4"



STEERING GEARS

TA-12, T-14, TA-14, TA-54, TA-61, T-66, TA-66, TA-70

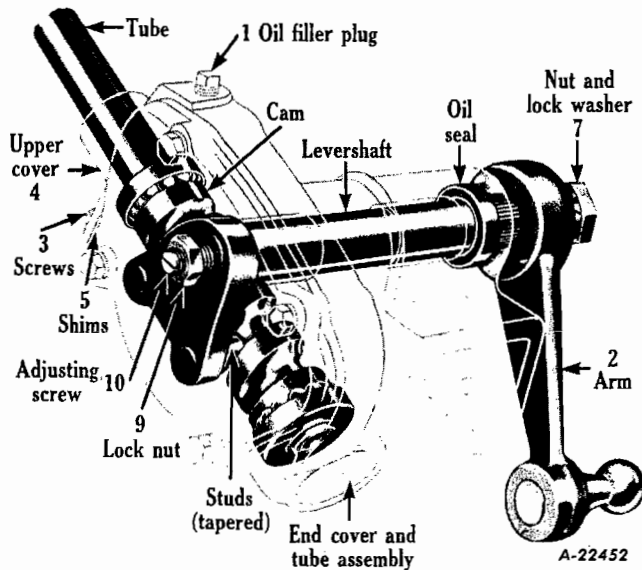


Fig. 1 - Models TA-12, T-14, TA-14.

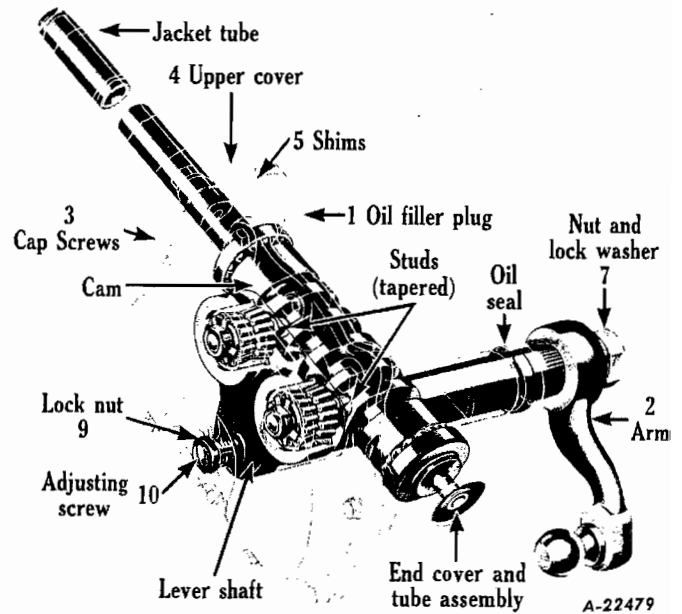


Fig. 2 - Models TA-54, TA-61, T-66, TA-66, TA-70.

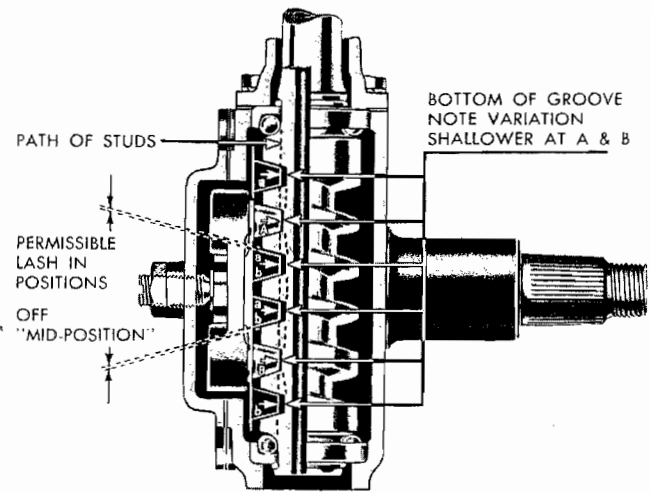
Construction (See Figs. 1, 2, 3)

L-Line Trucks are equipped with (Ross) semi-reversible cam and twin-lever steering gears. The twin-lever construction is shown in Figs. 1 and 2.

There are two types of twin-lever gears used: -

1. Twin-lever with sliding studs -- the studs are riveted in the lever so that the studs have a sliding contact with the cam (Fig. 1).
2. Twin-lever with rolling studs -- the studs are mounted in the lever with tapered roller bearings so that the studs have a rolling contact on the cam (Fig. 2).

Both studs of the twin-lever gear engage the cam for normal straight-ahead driving. As the steering action moves away from the normal driving position into the parking range, one of the studs disengages the cam. The effective leverage of this single stud increases so rapidly, however, that in full parking the leverage is 45 percent greater than with a single-lever type steering gear. This is due largely to the fact that because of the twin levers the steering arm is shorter and, therefore, has a full 100 degrees of travel compared to 76 degrees in a single-lever unit. Actually, the driver has at his disposal a dual-ratio gear which automatically changes from one ratio to another to suit the requirements of steering stability at high speeds, and easy wheel turn for sharp



GEAR (Studs A & B) SHOWN AT MID-POSITION OF TRAVEL
a shows VARIOUS POSITIONS OF STUD A ON TURNS
b shows VARIOUS POSITIONS OF STUD B ON TURNS
IMPORTANT - ADJUST THRU THE MID-POSITION A-23440

Fig. 3

turns in parking. A valuable safety factor is a lessening of the tendency to over-steer on curves and when passing other vehicles at high speed (See Fig. 3).

Adjustments

NOTE: The basic design of the steering gears used in these trucks is similar and the method of servicing applies generally to all units used. For illustrative purposes, assemblies of the more common type are used.



Except for position of the lever shaft in the housing, the steering gear details are similar and are serviced in the same manner.

When making adjustments, free the steering gear of all load, preferably by disconnecting the drag link from the steering arm, and loosen instrument panel bracket clamp on steering gear jacket tube.

If the ball thrust bearings on the cam must be adjusted, make adjustment (1) before making side adjustment to lever shaft studs in cam groove (2).

1. ADJUSTMENT OF BALL THRUST BEARINGS ON CAM.

- (a) Before making this adjustment loosen the housing side cover adjusting screw (9, 10) to free the studs in the cam groove (Fig. 4).
- (b) Adjustment should be made so there is a very slight drag but not so much that steering wheel cannot be turned from extreme to extreme by lightly gripping rim with thumb and forefinger.
- (c) Unscrew the four screws (3) and raise the housing upper cover (4) to permit removal of shims (5). (Shims are of .002", .003" and .010" thickness) (Fig. 5).
- (d) Clip and remove a thin shim or more as required, and draw cover down tight against shims.
- (e) Test as outlined in paragraph (b) and if necessary remove or replace shims until adjustment is correct.

2. ADJUST LEVER SHAFT STUDS IN CAM GROOVE FOR BACKLASH.

- (a) Backlash at this point shows up as end play of lever shaft, also as backlash at steering wheel and at ball on steering arm.
- (b) The groove is purposely cut deeper in ends of cam than in mid-position. This produces a high range through mid-position and makes grooves narrower through this range. This permits take-up of backlash in mid-position, after normal wear of groove, without causing a bind in ends (Fig. 3).
- (c) Adjust to this mid-position high range. Do not adjust in end positions. Play in end position is not objectionable.
- (d) Tighten side cover adjusting screw (10) until a very light drag is felt through the mid-position high range when turning steering wheel slowly

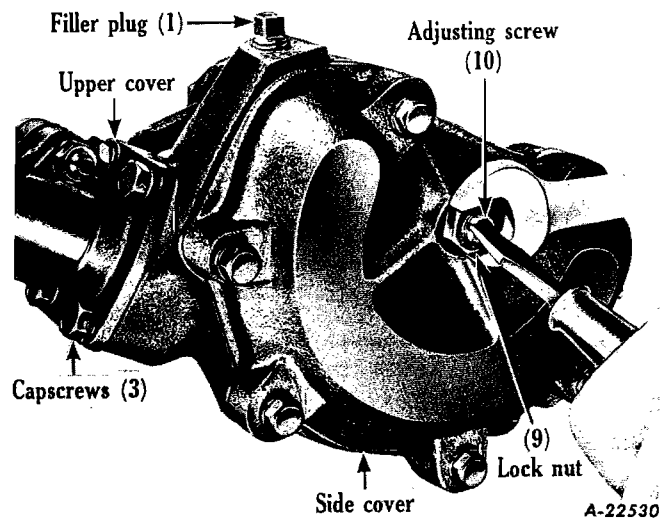


Fig. 4 - Illustrates location of adjusting screw and locknut

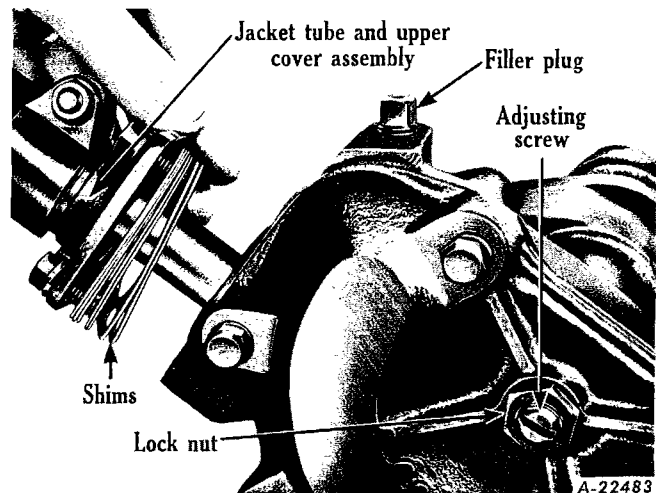


Fig. 5 - Showing location of shims under upper housing cover used to adjust end-play on cam. (Shims are of .002", .003", and .010" thickness)

from extreme to extreme position (Fig. 4).

- (e) **IMPORTANT:** Steering gear must not bind any position. Only a very slight drag should be felt. A closer adjustment will not correct steering looseness caused by wear in other steering gear members, but will damage parts and impair operation.
- (f) When proper adjustment has been made, tighten lock nut (9) and then give gear a final test.
- (g) Make sure steering gear arm is tight on splined lever shaft and that lock-washer and nut are tight also.

3. STEERING COLUMN ALIGNMENT.

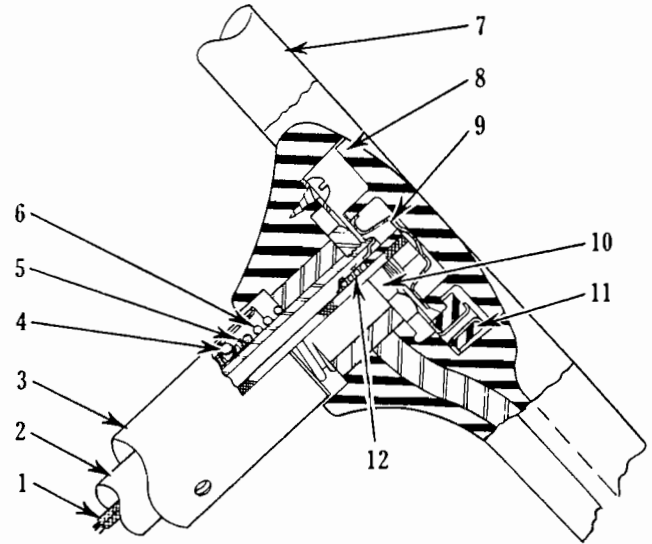
(a) After adjustments have been made and lock screw tightened, turn steering wheel to see if any stiffness exists. If so, steering gear has been adjusted too tight or steering column is out of alignment. Misalignment of the column places a bend in the column, consequently, the wheel tube must undergo reverse bending stresses during each revolution. This is a serious condition and must be avoided. THE STEERING COLUMN MUST NOT BE SPRUNG IN ANY DIRECTION.

4. STEERING GEAR CONNECTION WITH FRONT WHEELS.

(a) The steering gear should be connected to the front wheels so as to obtain as nearly as possible the specified turning radius on both left and right turns. This is accomplished by turning the steering wheel as far to the right as possible, then rotate the wheel in the opposite direction as far as possible and note the total number of turns. Turn the wheel back just one-half of this total movement, thus placing the gear in the mid-position. With the front wheels in position for straight-ahead driving, it should then be possible to connect the drag link to the ball on the end of the steering gear arm without moving the gear to any appreciable extent. If this cannot be done, remove the arm from the steering gear, using a suitable puller, and place it on the splined shaft in the proper position. Otherwise it will not permit the front wheels to swing equally to the left and right. Check steering knuckle stop on front axle to make sure that there is proper clearance for the tire when turning at maximum angle. Axle stops should also be set out sufficiently to prevent steering gear from "bottoming", that is, to stop the gear short of its absolute limit of travel. If the gear is permitted to bottom, damage to internal parts will occur. Check to see if axle stops are set to do this on both left and right turns. See that steering gear housing is filled with lubricant as recommended in "Lubrication Section".

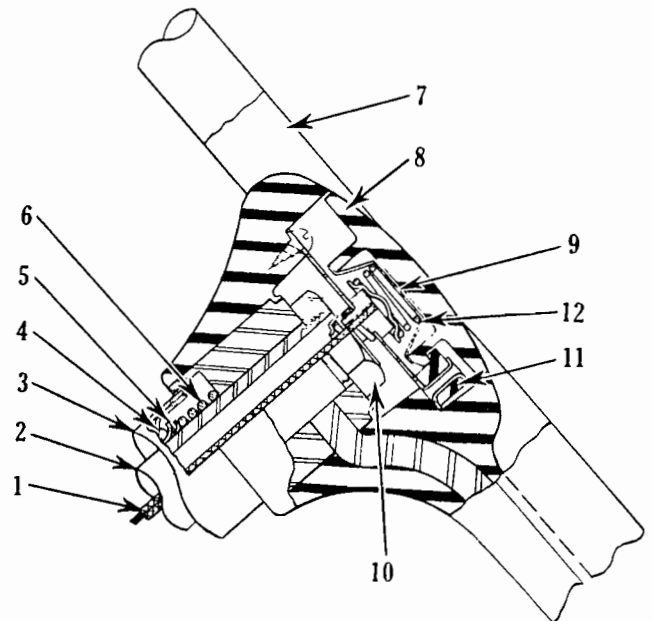
5. TO REMOVE STEERING WHEEL (Figs. 6 and 7).

- (a) Disconnect horn wire at bottom of steering gear.
- (b) Remove horn button (8) by pressing down and turning to right or left with



A-21734

Fig. 6, Models TA-12, T-14, TA-14, TA-54



A-21736

Fig. 7, Models TA-61, T-66, TA-66, TA-70

LEGEND for Figs. 6 and 7.

- | | |
|------------------------|-------------------------|
| 1. Horn cable assembly | 7. Steering wheel |
| 2. Steering tube | 8. Horn button |
| 3. Jacket tube | 9. Horn contact cap |
| 4. Bearing assembly | 10. Steering wheel nut |
| 5. Spring seat | 11. Base plate assembly |
| 6. Spring | 12. Horn button spring |



palm of hand or vacuum cup, holding steering wheel stationary.

- (c) Remove contact cap and spring.
- (d) Remove the three screws holding the horn button retainer base plate (11) and remove this plate and horn wire.
- (e) Remove steering wheel nut (10) and take off steering wheel using a suitable puller.

6. TO INSTALL STEERING WHEEL.

- (a) Place in correct position on shaft. Wheel should be installed so that spokes are in shape of a "Y" when seated in driver's seat and with front wheels straight ahead. This will permit driver to read instruments through the top of steering wheel.
- (b) Install steering wheel nut (10) and tighten securely.
- (c) Insert horn wire and thread through hole in cover plate at bottom of steering gear housing. Attach horn button retainer base plate (11) with three screws.
- (d) Install contact plates, spring and horn button. Horn button should be pressed down and turned until it locks in the rubber retainers on retainer base plate, using vacuum cups or palm of hand.

- (e) Connect horn wire at bottom of steering gear.

7. DISASSEMBLING STEERING GEAR.

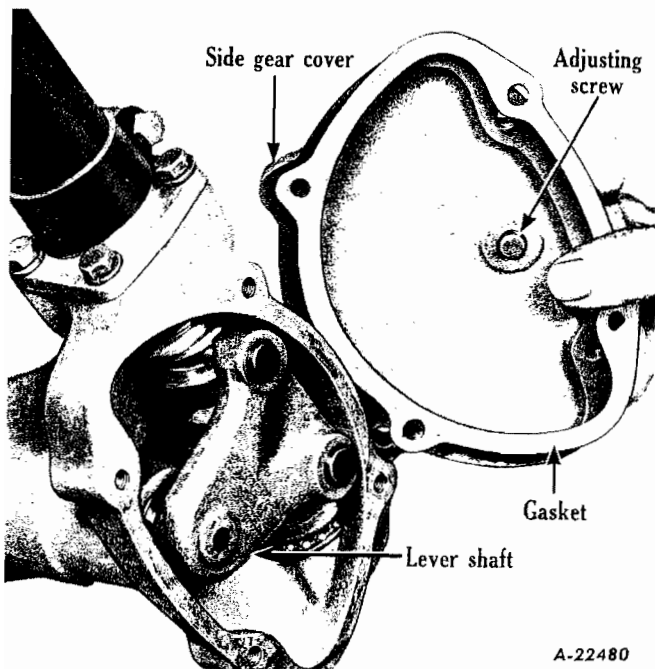
- (a) Remove horn button, cable and steering wheel.
- (b) Remove housing side gear cover and pull out lever shaft (Fig. 8).
- (c) Loosen clamp collar and remove jacket tube and housing upper cover (Fig. 9).
- (d) Remove cam and tube assembly, complete with bearings, from the housing (Fig. 10).
- (e) Remove lever shaft oil seal and clean the counterbore in the gear housing.

8. REASSEMBLING STEERING GEAR.

- (a) Install new lever shaft oil seal (Fig. 11).

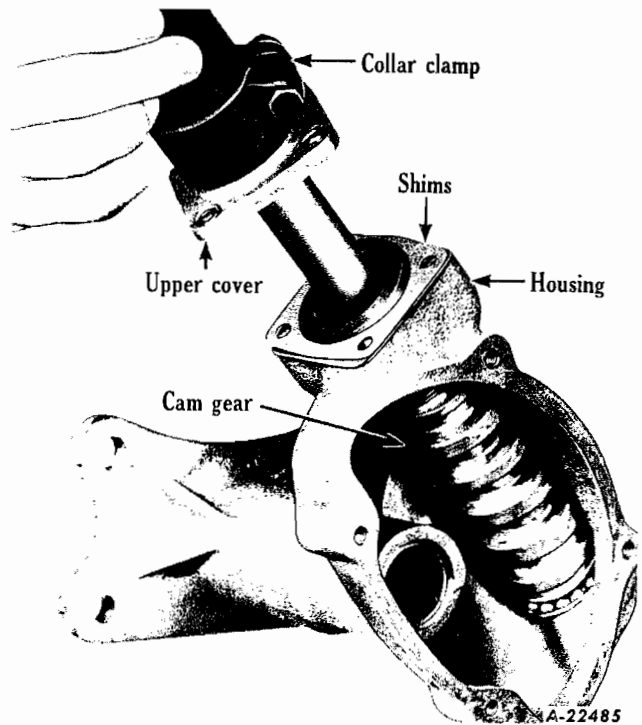
Position oil seal in housing with side stamped "Fluid Side" toward bottom of counterbore. Using a hammer, tap lightly on the end of a socket wrench or adapter (cold rolled stock) having a slightly smaller outside diameter than the oil seal. It is important that the seal bottoms in the counterbore of housing.

- (b) Place cam and tube assembly with bearings in the housing (Fig. 10).



A-22480

Fig. 8 - Removal of housing side gear cover revealing lever shaft



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Fig. 9 - Removal of jacket tube and upper housing cover assembly

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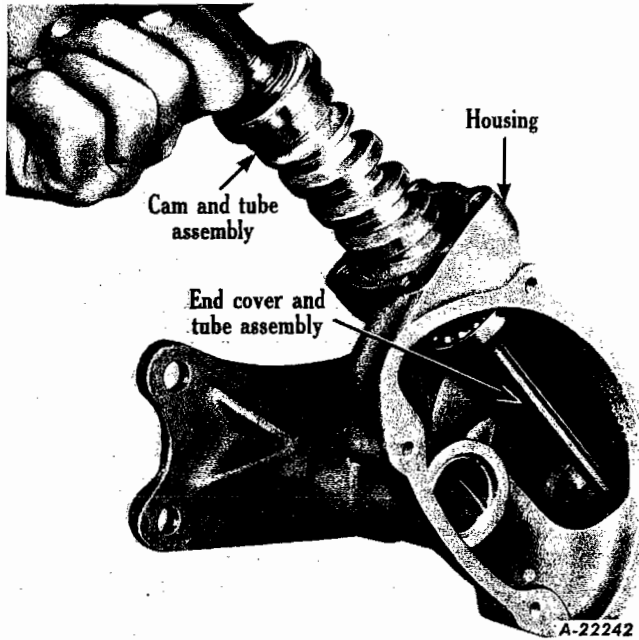


Fig. 10 - Removing cam and tube assembly with bearings

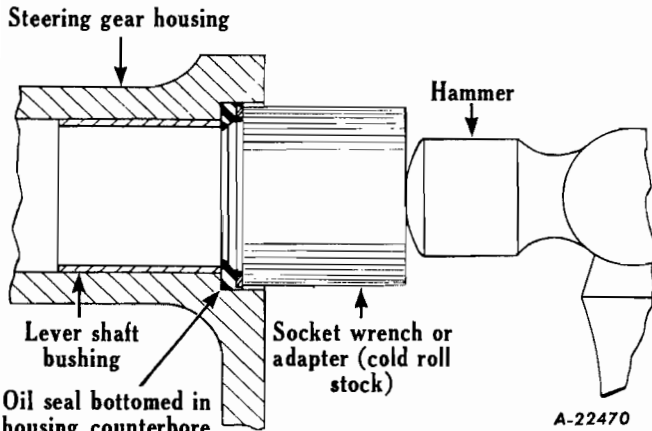


Fig. 11 - Location and installation of lever shaft oil seal

- (c) Assemble housing upper cover with shims and make proper bearing adjustments.
- (d) Install lever shaft in housing and assembly housing side cover, first loosening the adjusting screw (Fig. 8).
Draw side cover screws tight.
- (e) Adjust lever shaft stud in cam groove for backlash and lock adjustment with lock nut.
- (f) Assemble jacket tube with clamp collar and tighten clamp.
- (g) Install steering wheel, horn cable and button.

Drag Link (Figs. 12, 13, 14)

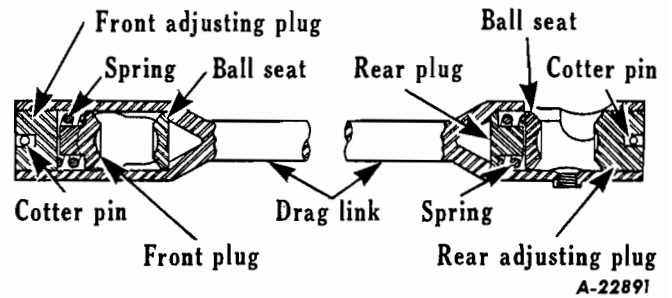


Fig. 12

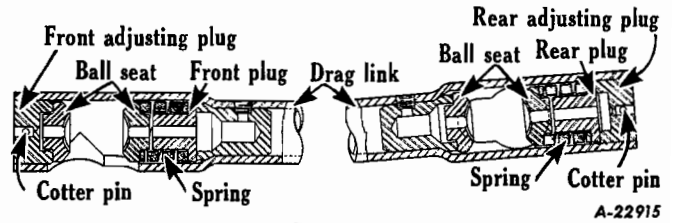


Fig. 13

This type of drag link requires very little care other than periodical lubrication and occasional inspection to make sure that it is properly adjusted. (Figs. 12 and 13).

Adjustment is made by removing cotter pin and turning adjusting plug in the desired direction. To adjust for wear, turn adjusting plug in until it is tight, then back off to first cotter pin hole. Insert a new cotter pin of the correct size and bend ends over securely. Drag link should not be adjusted too tight, otherwise steering will be affected.

The spring is merely to accommodate wear and is not intended to act as a cushion against shock. Fig. 14 shows details of steering gear, relay link and drag link used on L-190 series trucks and up.

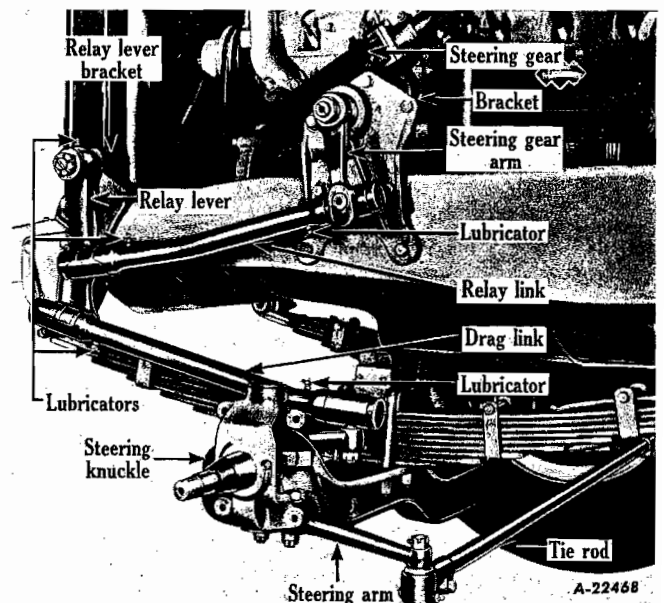


Fig. 14 - Steering gear linkage to front axle for models L-190 series and up



Steering Jacket Tube Bearing

A ball-type steering jacket bearing is used, improving steering gear performance and ease of handling. Fig. 15 illustrates this construction.

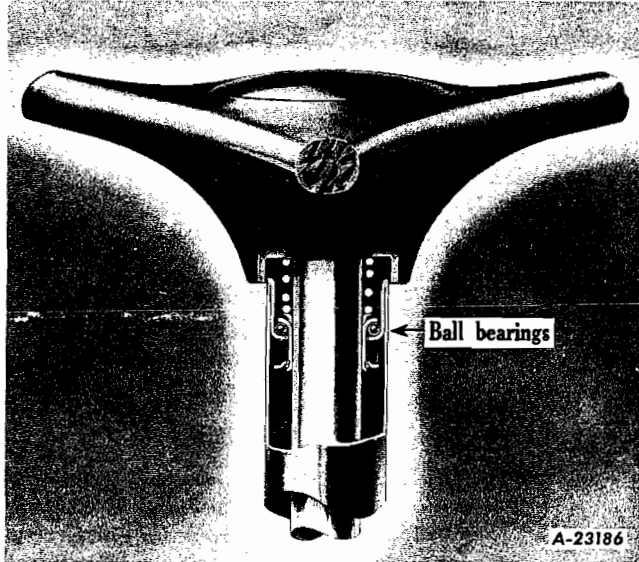
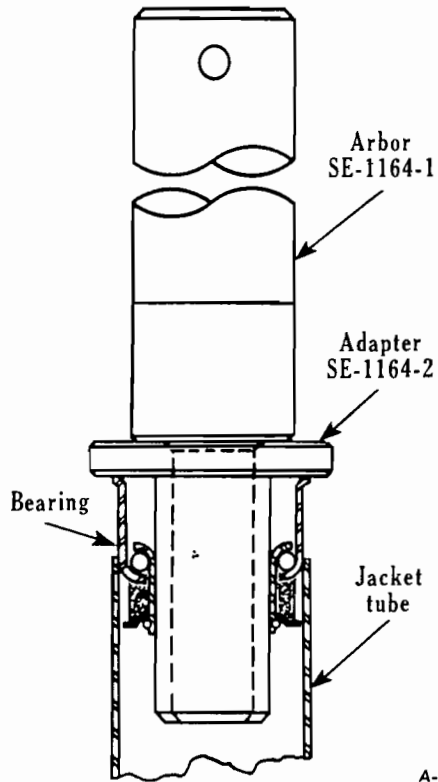


Fig. 15 - Showing location of jacket tube bearing

Special service tools (SE-1164) are available for this bearing, and are to be used for installation of a new bearing (see Fig. 16).



A-22890

Fig. 16 - Installation of steering gear jacket tube bearing



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TRANSMISSION SPECIFICATIONS

TRANSMISSION MODELS (IH)	HDS	T-87-D	H-41-B	T-98	F-51	F-51-C	F-52	F-52-C	F-54	F-54-B
Transmission (make)	IH	Warner	Warner	Warner	Fuller	Fuller	Fuller	Fuller	Fuller	Fuller
Manufacturer's model	-----	AS-4-T-87D	AS-74-T-9	ASA T-98	5-A-330	5-A-33	5-A-430	5-A-43	5-A-620	5-A-62
Type	Synchro- mesh	Synchro- mesh	Direct in 4th	Synchro- mesh	O.D. in 5th	Direct in 5th	O.D. in 5th	Direct in 5th	O.D. in 5th	Direct in 5th
Overdrive	No	No	No	No	Yes	No	Yes	No	Yes	No
Number of forward speeds	1	1	1	1	1	1	1	1	1	2
Reductions:										
First (low)	3.058-1	3.714-1	6.40-1	6.398-1	6.36-1	7.35-1	6.98-1	8.03-1	7.07-1	8.08-1
Second	1.481-1	1.871-1	3.09-1	3.092-1	3.725-1	4.30-1	3.57-1	4.61-1	3.50-1	4.67-1
Third	1.000-1	1.000-1	1.69-1	1.686-1	1.92-1	2.52-1	1.89-1	2.46-1	1.72-1	2.62-1
Fourth	-----	-----	1.00-1	1.00-1	1.000-1	1.42-1	1.00-1	1.41-1	1.00-1	1.38-1
Fifth	-----	-----	-----	-----	.823-1	1.000-1	.825-1	1.000-1	.776-1	1.00-1
High reverse	-----	-----	-----	-----	-----	-----	-----	-----	-----	8.12-1
Low reverse	3.707-1	4.588-1	7.82-1	7.820-1	6.39-1	7.20-1	6.95-1	8.00-1	7.11-1	4.74-1
Number of P. T. O. opening	None	None	1	1	2	2	2	2	2	2
Lubricant capacity (pints)	3	6	5	8	12	12	19	19	24	24

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AUXILIARY TRANSMISSION SPECIFICATIONS

MODEL	2-A-45	5531	6231	6231-A	8031-C	8031-G
Make	Fuller	Brown-Lipe	Brown-Lipe	Brown-Lipe	Brown-Lipe	Brown-Lipe
Number of speeds	2	3	3	3	3	3
Number of bearings	7	6	7	7	6	6
Type of bearings	6-Ball, 1-Roller	2-Ball, 4-Roller	1-Ball, 6-Roller	1-Ball, 6-Roller	3-Ball, 3-Roller	3-Ball, 3-Roller
Ratios:						
Direct	1.00 to 1	1.00 - 1	1.00 - 1	1.00 - 1	1.00 - 1	1.00 - 1
Underdrive	1.30 - 1	2.00 - 1	2.14 - 1	1.24 - 1	2.59 - 1	1.29 - 1
Overdrive	-----	.72 - 1	.69 - 1	.86 - 1	.75 - 1	.84 - 1
Lubricant capacity:						
Summer (pints)	10	6	8	8	12	12
Winter (pints)	10	6	8	8	12	12





TRANSMISSIONS

Driving Downhill

A safety rule to follow by all good drivers is to use the same or next lower transmission gear when going downhill as would be used in climbing the same hill. If necessary, the vehicle speed can then be easily controlled to the maximum road speeds for that particular gear by "snubbing down" with the brakes. This practice will not only prevent damage to the engine, but will also effect a saving on the brakes.

CAUTION: Do not coast down hill, even for a very short distance, with the clutch disengaged. If the clutch is engaged while the truck is coasting, the sudden acceleration of the engine's speed will result in a shock to the gears, an excessive strain and ultimate failure of the driving parts.

Overdrive

Some transmissions have an over-drive speed. This gearing is for maintaining increased road speed with reduced engine speed. Overdrive should be used only when conditions are favorable to high road speeds. Overdrive should never be used at low road speeds or for lugging. Usually, for overland hauling, the minimum road speed for overdrive is 30 m.p.h.

Overload

The transmissions installed in International trucks are engineered to the rated capacity of the trucks. An ample safety factor well above normal requirements has been provided, but neither the transmission nor any other part of the truck will give maximum performance and long wear if continued to load it beyond its rated capacity.

Shifting

Probably one of the most distinguishing characteristics of a good driver is his ability to shift gears from a high to a lower transmission speed.

A knowledge of the maximum obtainable road speeds in the various gears is helpful in determining the maximum road speed at which a shift from a high to a lower gear can be made.

For example, in shifting fourth speed to third speed, the maximum road speed at which this change can be made is at approximately

thirty-three miles per hour since that is the maximum available road speed for this truck in third gear.

Gear changes from a higher to lower gear speeds should be made as follows:

1. Ease off on accelerator and disengage clutch.
2. Move gear shift lever to neutral position and engage clutch. At same time, accelerate engine to governed speed.
3. Disengage clutch, ease off on accelerator, and move gear shift lever to next lower transmission gear position.
4. Engage clutch and depress accelerator sufficiently to pick up load.

The above procedure, known as "double-clutching," is necessary to bring about an equalization or synchronization of engine speed and transmission gear speed, and thereby prevent clashing of gears.

When the truck is equipped with a governor the maximum engine speed is controlled. If, however, it is desired to shift at lower road speeds than those shown, the shifts should be made at correspondingly lower engine speeds. Since the governor does not operate at the lower engine speeds, determination of the proper lower engine speed at which to shift is a matter of judgment that comes with practice.

When the operator becomes accustomed to the sound of the engine at various engine speeds and has become experienced at "double-clutching" he should be able to shift from a high to a lower gear very rapidly--and without clashing the gears. **CAUTION:** When shifting, avoid injury to the gear teeth by making it a practice to shift gears with as little clashing as possible.

Starting

When starting a new unit or one which has been exposed to cold weather, allow sufficient time for the lubricant to circulate and coat all contacting surfaces. Do not stay in any one gear for any length of time. The metal-to-metal contact between some of the working parts, due to insufficient lubrication, will result in damage which may not appear immediately but will eventually develop into serious trouble.



TRANSMISSION (HDS)

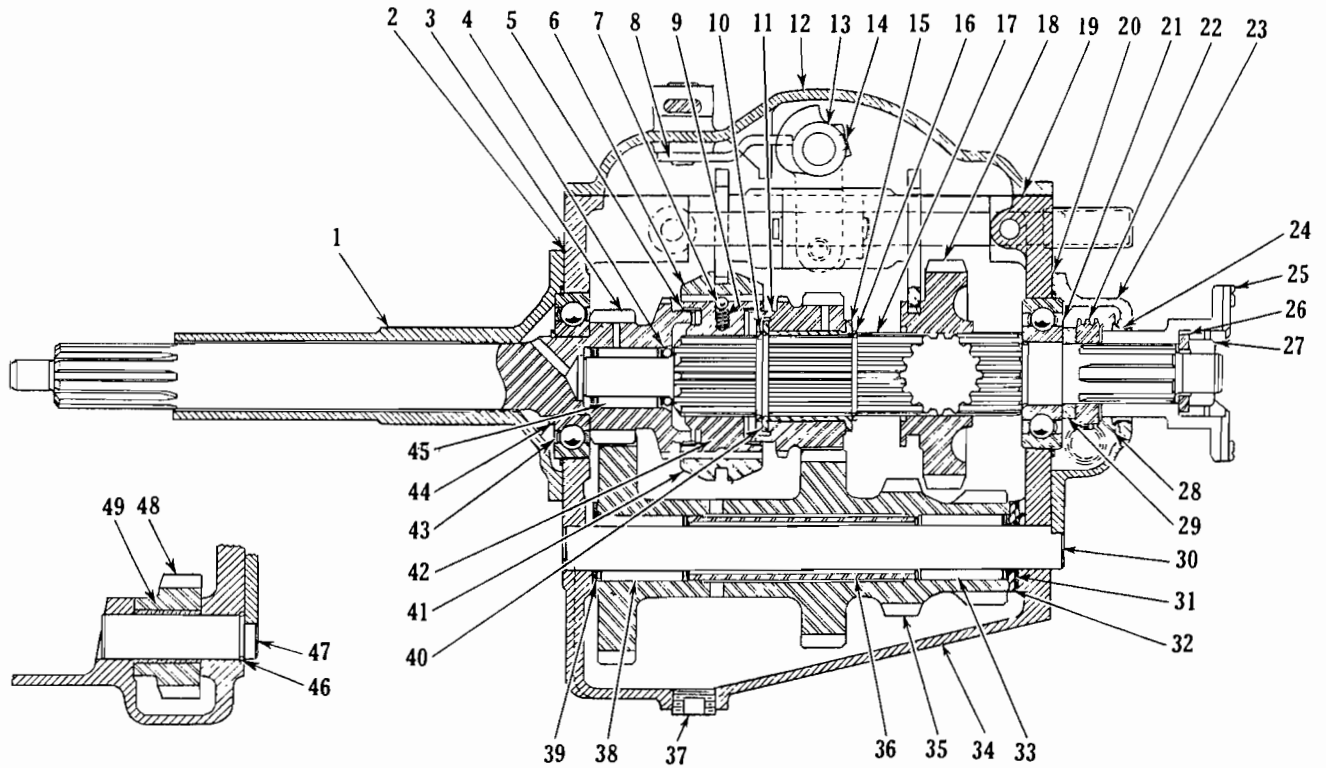


Fig. 1 - (HDS)

A-21744

No.	Description	No.	Description
1.	Main drive gear bearing retainer.	25.	Flange.
2.	Retainer gasket.	26.	Lockwasher.
3.	Main drive gear.	27.	Nut.
4.	Mainshaft pilot bearing spacer.	28.	Oil slinger.
5.	Sliding clutch synchronizer ring.	29.	Speedometer gear spacer.
6.	Mainshaft clutch sleeve.	30.	Countershaft.
7.	Clutch poppet ball.	31.	Countershaft thrust washer (bronze).
8.	Selector lever assembly.	32.	Countershaft thrust washer (steel).
9.	Clutch poppet spring.	33.	Countershaft roller bearing.
10.	Second speed gear lock ring.	34.	Transmission case.
11.	Second speed gear.	35.	Countershaft gear cluster.
12.	Transmission cover.	36.	Countershaft bearing spacer.
13.	Shift lever assembly.	37.	Drain plug.
14.	Shift lever setscrew.	38.	Countershaft roller bearing.
15.	Mainshaft adapter.	39.	Countershaft thrust washer.
16.	Second speed gear lock ring.	40.	Second speed gear thrust washer.
17.	Mainshaft.	41.	Clutch sleeve (second and high).
18.	Mainshaft sliding gear (low and reverse).	42.	Clutch hub (second and high).
19.	Transmission cover gasket.	43.	Main drive gear ball bearing.
20.	Rear bearing retainer gasket.	44.	Bearing lock ring.
21.	Mainshaft rear bearing.	45.	Mainshaft pilot bearing.
22.	Speedometer drive gear.	46.	Idler shaft snap ring.
23.	Mainshaft rear bearing retainer.	47.	Reverse idler shaft.
24.	Oil seal.	48.	Reverse idler gear.
		49.	Reverse idler gear bushing.



TRANSMISSION (MODEL HDS)

The Model HDS transmission is of synchromesh type with remote control having three speeds forward and one reverse. Fig. 2 illustrates the shift diagram.

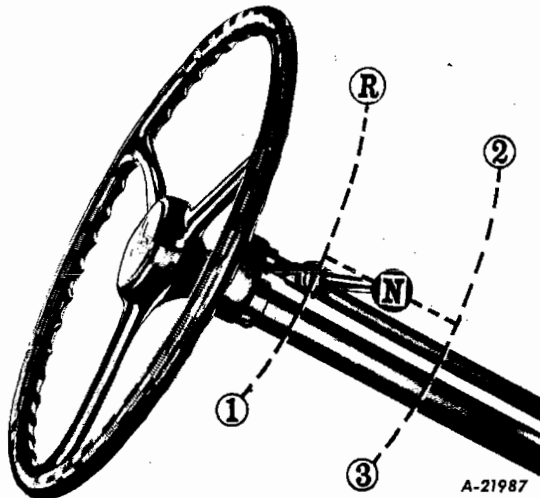


Fig. 2 - Shifting Diagram (HDS)

DISASSEMBLING AND REASSEMBLING

With a few minor exceptions, the assembly is simply the reverse of disassembling. Therefore the following disassembly instructions will also serve as reference for assembling.

Fig. 1 illustrates construction details of this transmission and figure numbers in parentheses throughout this section will refer to this illustration.

1. Clean outside of transmission, particularly around the control and bearing covers (1, 12, 23).
2. Shift selector lever (8) and shift lever (13) to neutral position. Remove cotter pin and breather cap from hold-down bolt. Remove four capscrews and lockwashers from control cover (12) and lift off control cover assembly.
3. To disassemble the control cover assembly:
 - (a) Remove outer selector lever setscrew releasing both outer and inner levers (8).
 - (b) Remove shift lever setscrew (14) and this will release the shaft, spring and shift lever (13).
4. Disassembling shift forks and shafts:
 - (a) Remove poppet ball and spring retainer plugs releasing balls and springs.
 - (b) Remove setscrews from shift forks and slide shift bar toward rear of case.

Use shift bar to tap out bar thimbles (dust plugs). With the removal of shift bar, the shift fork is lifted out through top of case.

- (c) Remove interlock plunger retainer capscrew to release interlock plunger from case.

CAUTION: In reassembling transmission, be sure to insert interlock plunger, poppet springs and balls.

- (d) Remove low and reverse shift bar and fork, in the same manner as described in paragraph (b).

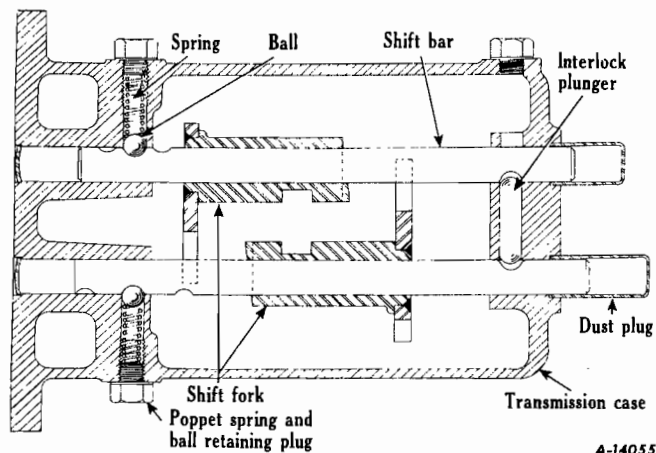


Fig. 3 - Sectional View of Shifting Bars, Poppet Springs and Balls and Shifting Forks.

5. Removing main drive gear assembly:
 - (a) Lock transmission and remove companion flange (25). Remove capscrews - three in number - from mainshaft rear bearing retainer (23). Lift off retainer and gasket (20) revealing oil deflector (28), speedometer drive gear (22) and spacer (29).
 - (b) Drive out countershaft (30) toward rear of case permitting countershaft gear cluster (35) to drop down in case, allowing clearance for removal of main drive gear.
 - (c) Remove capscrews - four in number - from the main drive gear bearing retainer (1). Remove retainer (1) revealing main bearing (43) and retaining ring (44).

NOTE: When reassembling, see that oil drain in retainer (1) is located at bottom.

 - (d) Main drive gear (3) and bearing (43) can now be removed from case (34) by driving toward front of case. **CAUTION:** Exercise care not to damage bearing (43) when driving from case.

6. Removal of mainshaft assembly:

- (a) With companion flange (25) and mainshaft bearing retainer (23) removed, slip off oil deflector (28) speedometer drive gear (22) and spacer (29) from mainshaft assembly.
- (b) Remove mainshaft rear bearing (21). **CAUTION:** Exercise care in driving off bearing to prevent its being damaged.
- (c) Mainshaft assembly can then be lifted out through top of case.

NOTE: Main drive gear assembly (3) must be removed first as outlined in paragraph 5.

7. Removal of countershaft cluster gear:

- (a) As countershaft (30) has already been removed for disassembly of main drive gear (3), the countershaft gear cluster (35) is merely lifted out through top of case. Be sure to remove the bronze washer (39) at front and bronze washer (31) and steel thrust washer (32) at rear in bottom of case.
- (b) Countershaft bearings (38) and spacer (36) can also be removed from gear cluster.

8. Removal of reverse idler gear and shaft:

- (a) Reverse idler shaft (47) can now be removed by driving shaft toward rear of case and this will permit lifting idler gear (48) out through top of case. **NOTE:** When reassembling, be sure to position shaft so that recess will take rear bearing retainer properly.

9. Disassembly of mainshaft clutch assembly:

- (a) Mainshaft clutch and sleeve are held together by poppet springs (9) and balls (7). Mainshaft clutch can be removed from sleeve by supporting outer diameter of sleeve and pressing on clutch. Use care when disassembling as poppet balls are under spring tension and may fly out when sleeve is removed. It is suggested that a cloth be wrapped around the assembly to guard against this.

A special tool, SE-920, is available which if used, will facilitate disassembly and reassembly. If you do not have this tool on hand, follow instructions outlined in paragraph (b).

- (b) To reassemble, insert clutch partially in sleeve and install springs and balls. Then insert cotter pins (1/8 x 2") having the ends spread slightly as shown in Fig. 4. The cotter pins, when pressed between the splines, force the balls into the clutch and after clutch is pressed into sleeve, cotter pins can be removed.

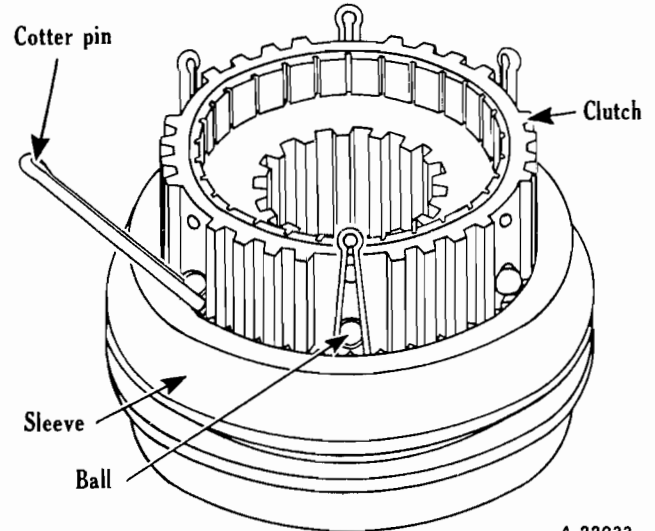


Fig. 4

TRANSMISSION (T-87-D)

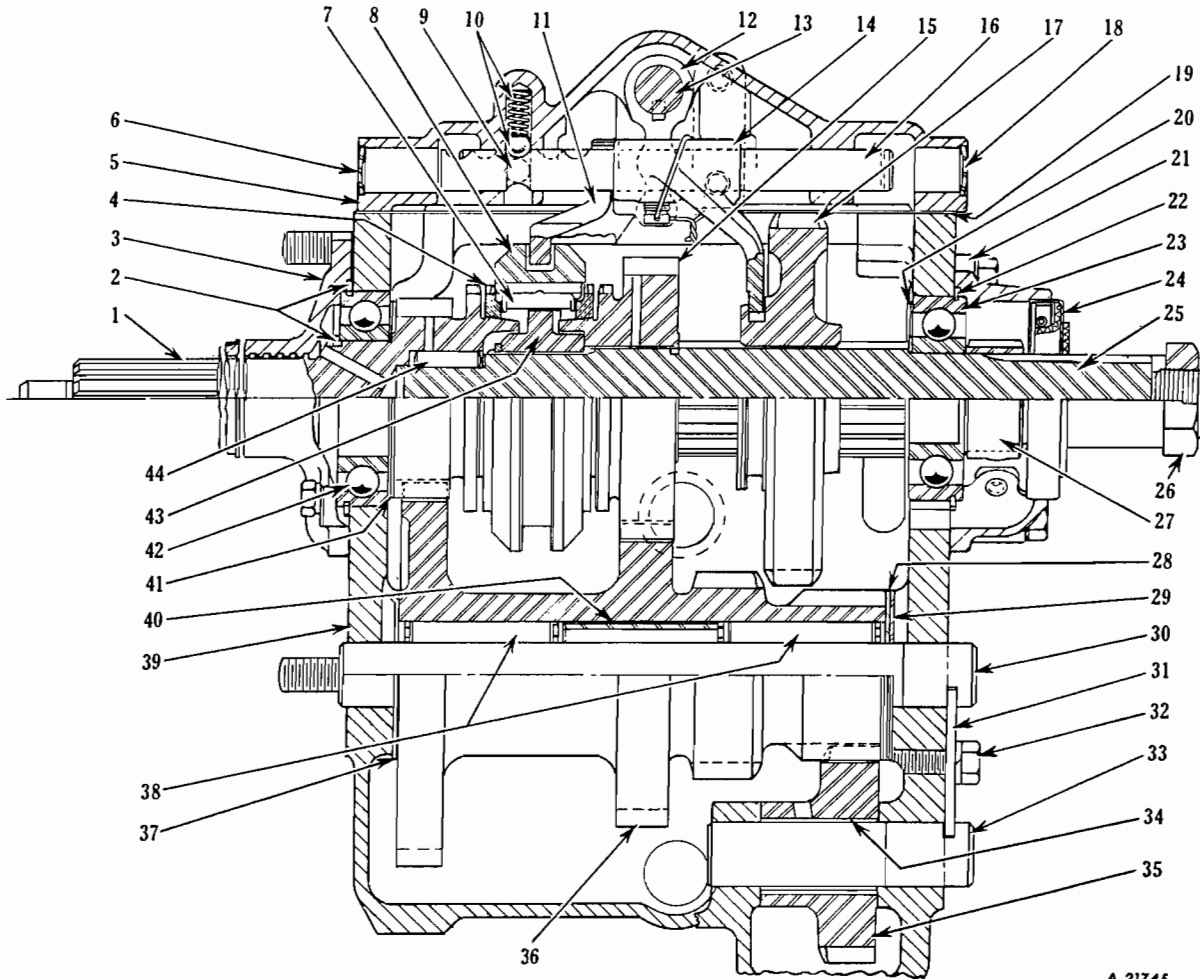


Fig. 1 - (T-87-D)

A-21745

No.	Description	No.	Description
1.	Main drive gear.	23.	Mainshaft rear bearing.
2.	Bearing snap rings.	24.	Oil seal.
3.	Main drive gear bearing retainer.	25.	Mainshaft.
4.	Synchronizer blocking ring.	26.	Mainshaft flange nut.
5.	Transmission cover.	27.	Speedometer drive gear.
6.	Expansion plug.	28.	Countershaft thrust washer (inner).
7.	Shifting plate.	29.	Countershaft thrust washer (outer).
8.	Clutch sleeve (second and direct).	30.	Countershaft.
9.	Interlock plunger.	31.	Lock plate.
10.	Poppet ball and spring.	32.	Lock plate capscrew.
11.	Shift fork (second and third).	33.	Reverse idler shaft.
12.	Shift lever.	34.	Reverse idler gear bushing.
13.	Shifting shaft.	35.	Reverse idler gear.
14.	Shift fork (low and reverse).	36.	Countershaft gear cluster.
15.	Mainshaft second speed gear.	37.	Countershaft thrust washer (front).
16.	Shift rail.	38.	Countershaft roller bearing.
17.	Mainshaft low and reverse gear.	39.	Transmission case.
18.	Expansion plug.	40.	Countershaft bearing spacer.
19.	Transmission cover gasket.	41.	Oil retainer washer.
20.	Oil retainer washer.	42.	Main drive gear bearing.
21.	Mainshaft rear bearing retainer.	43.	Clutch hub (second and direct).
22.	Mainshaft bearing snap ring.	44.	Mainshaft pilot bearing.



TRANSMISSIONS (MODEL T-87-D)

The Model T-87-D transmission is of synchro-mesh type, with remote controls, having three speeds forward and one reverse. Fig. 2 illustrates the shift diagram.

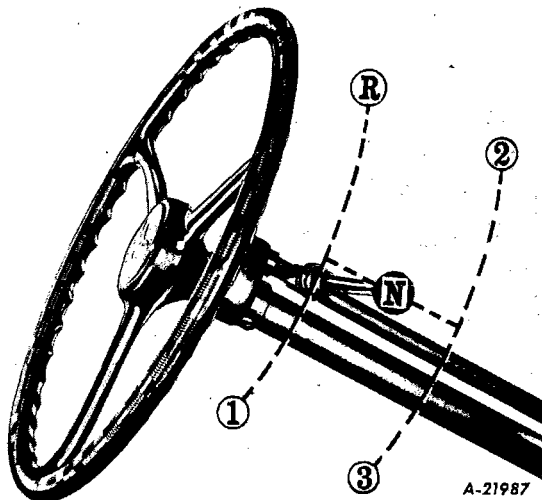


Fig. 2 - Shifting Diagram (T-87-D)

DISASSEMBLING AND REASSEMBLING

The assembly is simply the reverse of disassembling with the exception of a few minor details. Therefore the following disassembly instructions will also serve as reference for assembling.

Figure numbers in parantheses throughout this section will refer to Fig. 1 which illustrates construction details of this transmission.

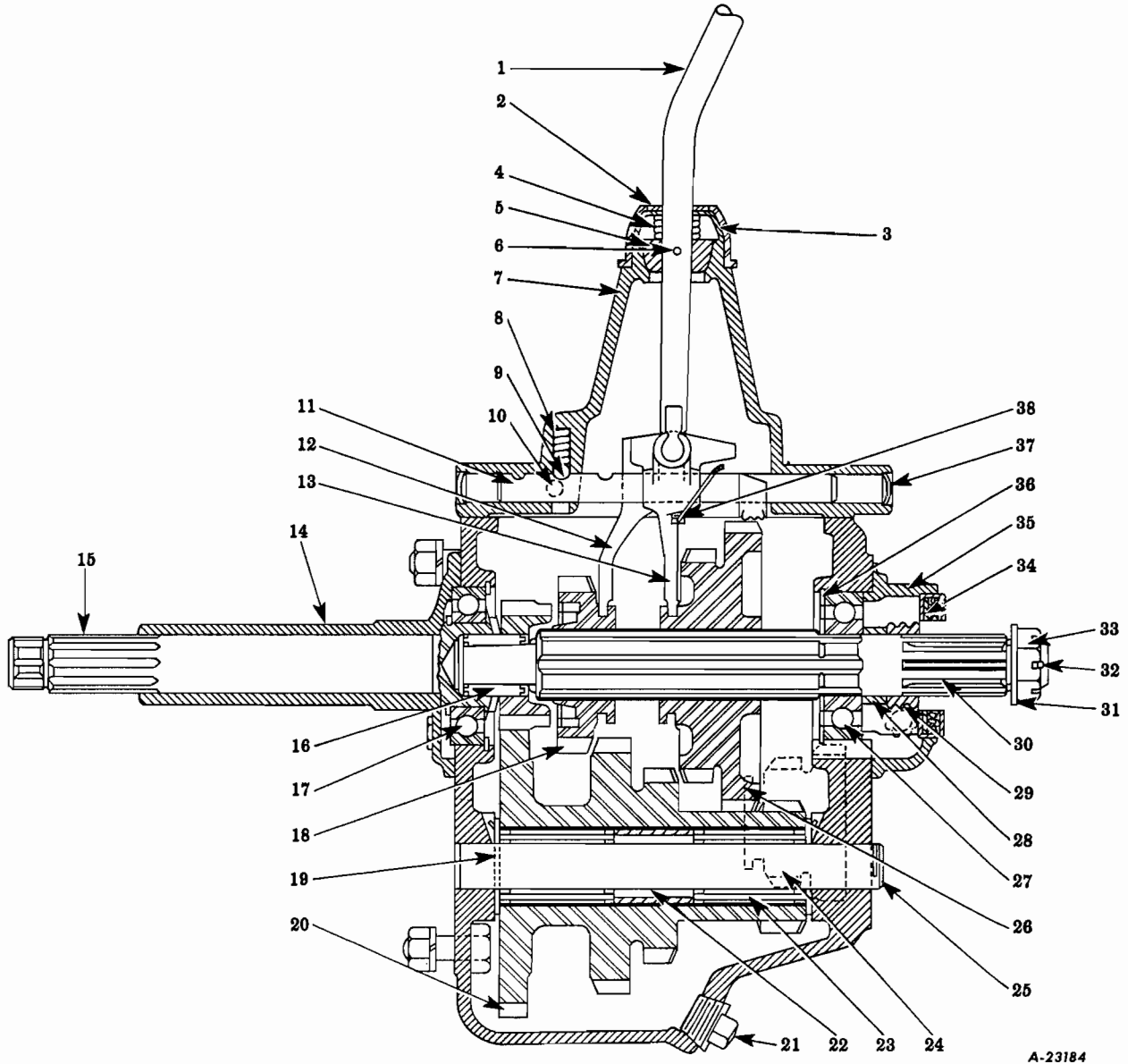
1. Clean outside of transmission especially around the control and bearing covers (3; 5, 21).
 2. Shift selector lever (12) into neutral position. Remove capscrews and lockwashers holding cover assembly (5) to case (39) and lift off the cover assembly.
 3. To disassemble the control cover assembly:
 - (a) Clip lockwire and remove lockscrew from low and reverse speed shift fork (14). Tap shift rail (16) toward rear of cover driving out expansion plug (18). Pull out shift rail (16) releasing poppet spring and ball (10) and shift fork (14). CAUTION: Do not lose poppet springs and balls.
 - (b) To remove second and third speed shift fork (11), rail, expansion plug, poppet spring and balls (10), follow the same procedure as in step (a).
 - (c) Remove snap rings from shifting shaft (13) located on each side of shift lever (12) thus releasing shaft assembly (13), spring, shift lever (12) and key.
 - (d) Interlock plunger (9) may be removed by pulling 3/8" tapered plug located on left side transmission cover (5) directly below poppet spring and ball.
- NOTE: When reassembling the top cover assembly (5) to case, make sure that shift forks (11, 14) are not sprung and engaged properly with sliding gears.
4. To disassemble the mainshaft assembly.
 - (a) Lock transmission and remove companion flange nut (26). Remove capscrews - four in number - holding main drive gear bearing retainer (3) to case (39) and five capscrews holding mainshaft assembly rear bearing retainer (21).
 - (b) Lift off main drive gear retainer (3) revealing snap rings (2) and bearing (42). Remove mainshaft rear retainer (21) revealing speedometer drive gear (27) snap ring (22) and bearing (23). NOTE: When reassembling the front bearing retainer (3) see that oil drain in retainer is located at bottom.
 - (c) With the mainshaft rear bearing retainer (21) removed, slip speedometer drive gear (27) from mainshaft (25). Remove mainshaft rear bearing (23) and oil retainer washer (20). CAUTION: Exercise care in driving off bearing to prevent damage.
 - (d) Pull main drive gear (1) and bearing (42) out through front of case until drive gear contacts countershaft gear. Slide mainshaft assembly through rear bore of case as far as necessary to clear main drive gear (1) and lift out through top of case. CAUTION: Be sure to catch pilot needle bearings (14) - sixteen in number - when removing mainshaft assembly. A helpful suggestion in reassembling pilot needle bearing (44), use a rubber band to hold the sixteen needle bearings in place until the assembly is started in the main drive gear and then the rubber band is removed before completing the assembly.
 - (e) To disassemble mainshaft assembly, remove retainer snap ring and use sliding gear (17) to tap synchronizer assembly and bushed gear (15) from mainshaft.



5. To disassemble main drive gear:
 - (a) Remove snap ring (2) holding bearing (42) on main drive gear (1). Push the drive gear and bearing assembly back into case until outside snap ring seats snugly against case. Using a soft hammer, tap the mainshaft gently toward inside of case until bearing is freed and the mainshaft can then be lifted out through top of case. CAUTION: Do not damage bearing during this operation.
6. To disassemble countershaft assembly:
 - (a) Remove capscrew (32) and lock plate (31) releasing countershaft (30) and reverse idler shaft (33). Drive countershaft (30) out through rear of case using a brass drift. With the countershaft removed, the gear cluster (36) can be lifted out through top of case. Be sure to pick up the bronze thrust washer (37) at front and bronze washer (28) and steel washer (29) at rear in bottom of case.
 - (b) Countershaft bearings (38) and spacer (40) can also be removed from gear cluster.
7. Removal of reverse idler gear and shaft:
 - (a) Reverse idler shaft (33) can be removed by driving out through rear of case. May also be removed by placing a pinch bar in lock plate slot and pulling out shaft. With the idler shaft (33) removed, the idler gear (35) can be lifted out of case. NOTE: When reassembling, be sure to position properly slots in countershaft (30) and idler shaft (33) to take lock plate (31).
8. To disassemble mainshaft clutch assembly:
 - (a) The mainshaft clutch hub and sleeve are held together by two retaining springs located on each side of clutch hub. The clutch sleeve (8) can be removed from clutch hub (43) by removing the retaining springs and supporting the outside diameter of sleeve (8) and pressing on hub (43). Use care when disassembling not to lose the three shifting plates (7). The blocker rings (4) are supported by the main drive gear hub and second speed gear hub and are disassembled with the removal of the mainshaft assembly.

CAUTION: In reassembling the clutch, be sure to place end of each retaining spring in the same shifting plate with the loose ends located in same position on both sides to equalize the tension on all three shifting plates (7). Also index etched marking on hub and sleeve.

TRANSMISSION (H-41-B)



A-23184

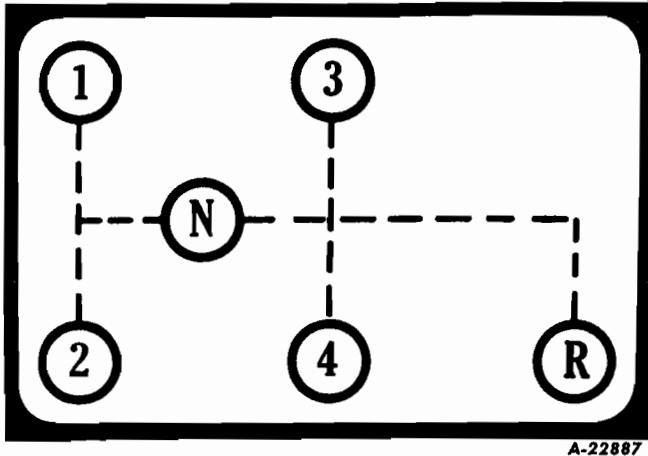
Fig. 1 - (H-41-B)

No.	Description	No.	Description	No.	Description
1.	Shift lever.	15.	Main drive gear.	26.	Mainshaft gear (low and second).
2.	Retainer.	16.	Main drive gear.	27.	Mainshaft rear bearing.
3.	Retainer washer.	17.	Main drive gear bearing.	28.	Spacer.
4.	Spring.	18.	Mainshaft gear (3rd and direct).	29.	Speedometer drive gear.
5.	Fulcrum ball.	19.	Countershaft thrust washer.	30.	Mainshaft.
6.	Pin.	20.	Countershaft gear cluster.	31.	Washer.
7.	Control cover.	21.	Drain plug.	32.	Cotter pin.
8.	Poppet spring.	22.	Bearing spacer.	33.	Nut.
9.	Poppet ball.	23.	Countershaft bearing.	34.	Grease seal.
10.	Interlock pin.	24.	Reverse idle gear.	35.	Rear bearing retainer.
11.	Shifter shaft.	25.	Countershaft.	36.	Grease slinger.
12.	Shift fork (3rd and direct).			37.	Expansion plug.
13.	Shift fork (1st and 2nd).			38.	Shifter fork lock screw.
14.	M. drive gear brg. retainer.				



TRANSMISSIONS (MODEL H-41B)

The Model H-41-B transmission is of sliding gear type, having four speeds forward and one reverse. Fig. 2 illustrates the shift diagram.



A-22887

Fig. 2 - Shifting Diagram (H-41-B)

DISASSEMBLING AND REASSEMBLING

With a few minor exceptions, the assembling is simply the reverse of disassembling. Therefore the following disassembly instructions will also serve as reference for assembling.

Fig. 2 illustrates construction details of this transmission and figure numbers in parentheses throughout this section will refer to this illustration.

1. Clean the outside of the transmission, particularly around the control and bearing covers (7, 14, 35).
2. Place shift lever (1) in neutral position. Remove the six holding capscrews and lift off the control assembly (7).
CAUTION: Do not force the control cover off the transmission. Forcing may spring the yokes of alignment and cause partial engagement or gear interference. If binding occurs, a slight manipulation will free it.

3. To disassemble the control cover assembly:

- (a) Remove control lever retainer (2) from top of cover (7). Lift out control lever (1), retainer (2), washer (3), and spring (4) and fulcrum ball (5). Fulcrum ball (5) can be removed from control lever (1) by driving out pin (6) with a suitable punch.
- (b) Clip lockwire from first and second speed shift fork (38) and remove lock-screw (38). Drive shift rail (11) toward rear of cover driving out expansion plug (37). With the expansion plug removed, pull shift rail (11) out and lift shift fork (13) out of cover.
CAUTION: Do not lose poppet spring (8) and ball (9).
- (c) Continue disassembly operation removing third and direct shift fork (12), reverse shift block, stop pin, spring, rails, poppet balls and springs and interlock pins and stops. CAUTION: In reassembling the control cover, care should be exercised to see that all parts are replaced in their correct positions and none of the small interlocking parts are lost or omitted.

4. To remove mainshaft assembly:

- (a) Lock transmission by engaging two speeds and remove flange nut (32).
- (b) Remove five capscrews holding mainshaft rear bearing retainer (35) to case. Lift bearing retainer off mainshaft revealing gasket, speedometer drive gear (29), spacer (28), and mainshaft rear bearing (27).
- (c) Hold mainshaft sliding gears (18, 26) in position. Mainshaft (30) and bearing (27) can now be removed through rear of case. If necessary, use a brass drift against washer (31) and nut (32).
- (d) Lift out mainshaft third and direct gear (18) and low and second gear (26) through top of case.

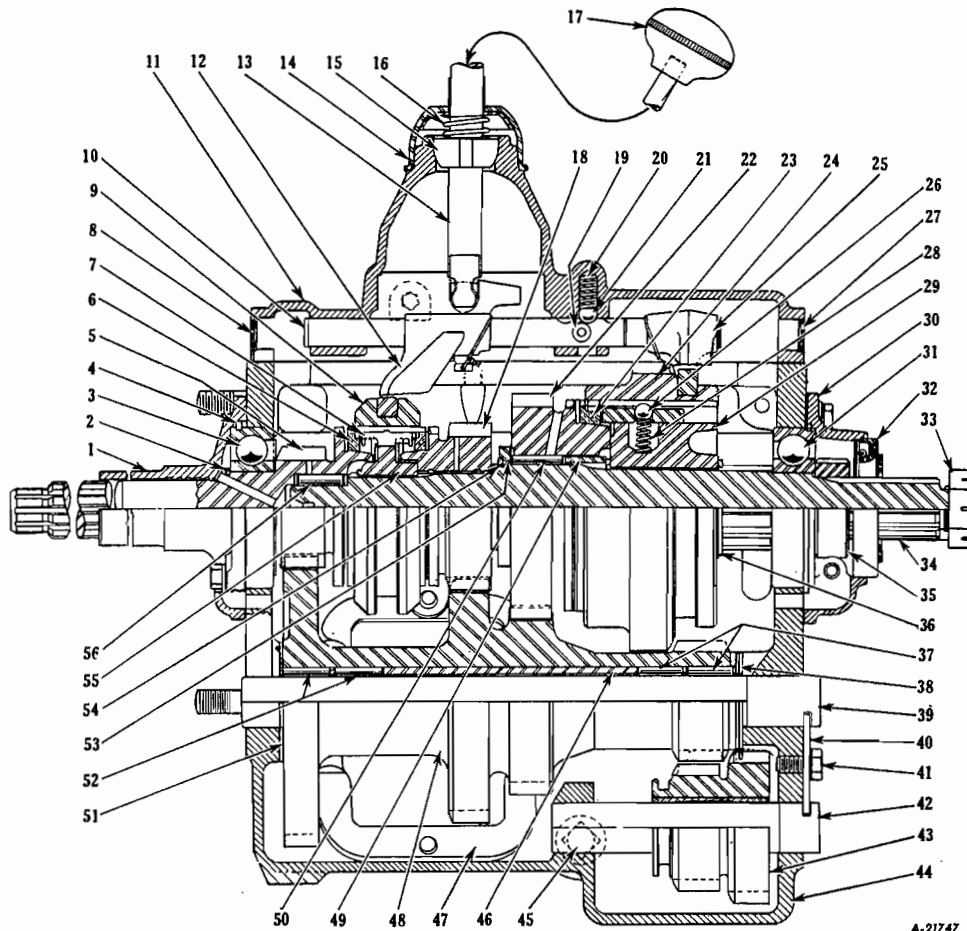


L-LINE MOTOR TRUCK SERVICE MANUAL

5. To disassemble the mainshaft:
 - (a) Remove nut (32), companion flange, then remove rear bearing retainer (35), speedometer drive gear (29), spacer (28), and bearing (27).
 - (b) Remove cotter pin from reverse idler gear shifter fork shaft. Drive shaft toward rear of case with a brass drift and remove idler shifter fork.
 - (c) Lift countershaft gear cluster (20) with bearings (23) and spacer (22), through top opening of case. Tilt gear cluster slightly through rear bore in case to facilitate removal.
 - (d) Remove roller bearings (23) and spacer (22) from cluster (20). Be sure to pick up countershaft thrust washers, one each end, from bottom of case.
6. Remove main drive gear:
 - (a) Remove four capscrews holding main drive gear bearing retainer (14) to case.
 - (b) Remove retainer (14) revealing gasket and bearing (17). NOTE: When re-assembling, be sure to locate oil drain at bottom.
 - (c) Main drive gear (15) and bearing (17) can now be removed from front of case. If necessary, use babbit or rawhide hammer to tap main drive gear (15).
7. Removing the countershaft assembly:
 - (a) Remove countershaft and reverse idler shaft lock screw and plate. Drive out countershaft (25) toward rear of case, using a brass drift.
8. Removing the reverse idler gear and shaft assembly:
 - (a) Insert screwdriver or pinch bar in lock plate groove and pry out shaft. Reverse idler gear can then be lifted out through top of case. NOTE: When reassembling, be sure to position slot in shaft properly to take lock plate.
9. When reassembling the top cover assembly, make sure that the shifter forks are not sprung, and engaged properly with sliding gears.



TRANSMISSION (T-98)



A-21747

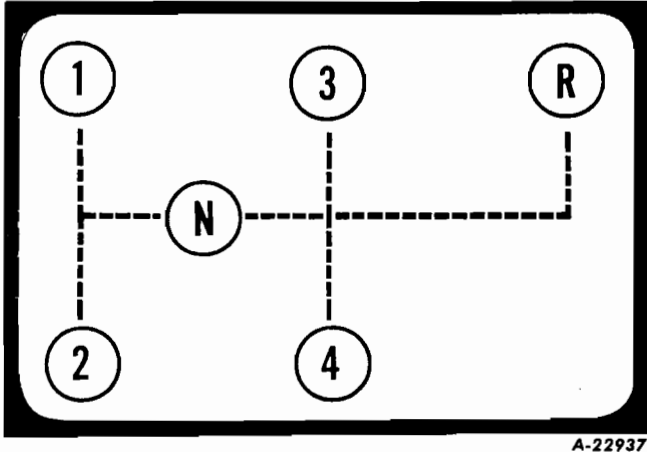
Fig. 1 - (T-98)

No.	Description	No.	Description	No.	Description
1.	Main drive gear bearing retainer.	23.	Synchronizer blocking ring.	40.	Lock plate.
2.	Snap ring.	24.	Mainshaft 1st and 2nd speed gear.	41.	Lock plate capscrew.
3.	Main drive gear bearing.	25.	Shift fork, 1st and 2nd speed.	42.	Reverse idler shaft.
4.	Snap ring.	26.	Poppet ball.	43.	Reverse idler gear.
5.	Main drive gear.	27.	Expansion plug.	44.	Transmission case.
6.	Synchronizer blocking ring.	28.	Poppet spring.	45.	Drain plug.
7.	Shifting plate.	29.	Clutch hub, 1st and 2nd speed.	46.	Countershaft bearing spacer.
8.	Expansion plug.	30.	Mainshaft rear bearing retainer.	47.	P.T.O. opening.
9.	Sleeve (3rd and direct).	31.	Mainshaft rear bearing.	48.	Countershaft gear cluster.
10.	Shift rail.	32.	Rear bearing retainer seal.	49.	2nd speed gear bearing spacer.
11.	Transmission cover.	33.	Mainshaft flange nut.	50.	2nd speed gear roller bearing.
12.	Shift fork, (3rd and direct).	34.	Mainshaft.	51.	Countershaft thrust washer, front.
13.	Control lever.	35.	Speedometer drive gear.	52.	Countershaft roller bearing.
14.	Control housing cap.	36.	Snap ring.	53.	2nd speed gear thrust washer.
15.	Fulcrum ball.	37.	Countershaft roller bearing.	54.	Snap ring.
16.	Control lever spring.	38.	Countershaft thrust washer, rear.	55.	Clutch hub, 3rd and direct.
17.	Control lever ball.	39.	Countershaft.	56.	Mainshaft pilot bearing.
18.	Mainshaft 3rd speed gear.				
19.	Interlock plunger.				
20.	Poppet spring.				
21.	Poppet ball.				
22.	Mainshaft 2nd speed gear.				



TRANSMISSION (MODEL T-98)

The Model T-98 transmission is of synchromesh type having four speeds forward and one reverse. Fig. 2 illustrates the shift diagram.



A-22937

Fig. 2 - Shifting Diagram (T-98)

DISASSEMBLING AND REASSEMBLING

With a few minor exceptions, the assembling is simply the reverse of disassembling. Therefore the following disassembly instructions will also serve as reference for assembling.

Fig. 1 illustrates construction details of this transmission and figure numbers in parentheses throughout this section will refer to this illustration.

1. Clean outside of transmission particularly around the control and bearing covers (1, 11, 30).
2. Place control lever (13) into neutral position. Remove capscrews and lockwashers holding cover (11) to case (44) and lift control cover assembly off transmission.

CAUTION: Do not force the control cover assembly off the transmission. Forcing may spring the yokes and cause partial engagement or gear interference. A slight manipulation will free the cover.

3. To disassemble the control cover assembly:
 - (a) Cut lock wire on reverse shift block and remove shift block lockscrew. Drive shift rail (10) out toward rear of cover driving out expansion plug (27) and remove shift block.
 - (b) Pull tapered plug located on left outside of cover directly below poppet spring and ball and remove interlock plunger (19) and third and direct speed shift rail interlock pin.

- (c) Continue disassembly operation in the same manner as described in paragraph (a), removing third and direct speed shift fork (12) and first and second speed shift fork (25), rails, expansion plugs, poppet springs, balls and interlock plunger.

CAUTION: In reassembling the control cover assembly, care should be exercised to see that all parts are replaced in their correct positions and none of the small interlocking parts are lost or omitted.

- (d) To remove control lever (13) from cover (11), turn off the housing cap (14) releasing retainer washer, spring (16) and fulcrum ball (15). With the fulcrum ball and control lever assembly removed, the control lever pivot pin can be removed from cover.

4. To remove the mainshaft assembly:

- (a) Lock transmission by engaging two speeds and remove flange nut (33).
- (b) Remove capscrews, five in number, and lift off mainshaft rear bearing retainer (30) revealing speedometer gear (35), bearing (31), and snap rings. Slide speedometer gear (35) off of mainshaft (34). Disassemble main drive gear bearing retainer (1) by removing capscrews and lockwashers, revealing main drive gear bearing (3) and snap rings (2) and (4).
- (c) Remove main drive gear bearing snap ring (2) and pull main drive gear (5) and bearing (3) out through front of case sufficiently to expose bearing snap ring (4). Apply bearing puller and remove bearing (3) from main drive gear (5). Tap mainshaft assembly toward rear of case and pull mainshaft rear bearing (31). Push mainshaft assembly through rear bore in case to clear main drive gear (5) and tilt front end upward and lift out through top of case.

CAUTION: Be sure to catch pilot needle bearing, sixteen in number, when removing mainshaft assembly. When reassembling front bearing retainer (1), be sure to locate oil drain hole at bottom.

5. To disassemble main drive gear:
 - (a) With the main drive gear bearing (3) removed from drive gear (5), it is lifted out through top of case.



6. To disassemble the mainshaft assembly:
- Remove snap ring holding third and direct speed clutch assembly and mainshaft third speed gear (18) and slide clutch assembly and bushed gear from mainshaft.
 - Remove first and second speed hub retainer snap ring (36) and slide off synchronizer assembly.
 - Remove mainshaft second speed gear snap ring (54) releasing thrust washer (53) needle bearing (50), thirty-four in number, second speed gear (22) and spacer (49).
7. To disassemble the countershaft assembly:
- Remove capscrew (41) and lock plate (40) locking countershaft (39) and reverse idler shaft (42).
 - Using a brass drift, drive countershaft out through rear of case and lift the gear cluster (48) out through top of case. NOTE: The countershaft gear cluster turns on four sets of roller bearings (37, 52) which are loose in the bore of the countershaft gear. There are twenty-two rollers in each bearing set, totaling eighty-eight bearings, separated by spacer washers and spacer (46). These rollers will probably intermingle with the main drive gear pilot bearing rollers (56) in bottom of case when the countershaft gear is removed. Countershaft rollers (37, 52) are slightly smaller than pilot bearing rollers (56). Be sure to pick up front thrust washer (51), rear thrust washer (38) and spacing washer from bottom of case.
8. To disassemble the reverse idler gear assembly:
- Remove reverse shifting arm and drive reverse idler shaft (42) out through rear of case and lift idler gear (43) out through top of case. NOTE: When reassembling, be sure to position slot in shaft properly to take lock plate.
9. To disassemble the third and direct speed clutch assembly:
- The mainshaft clutch hub and sleeve are held together by two retaining springs located on each side of clutch hub. The clutch sleeve can be removed from clutch hub by removing the retaining springs and supporting the outside diameter of sleeve and pressing on hub. Use care when disassembling not to loose the three shifting plates (7). The blocker rings are supported by the main drive gear hub and third speed gear hub and are disassembled with the removal of the mainshaft assembly.
- CAUTION: In reassembling the clutch assembly, be sure to place end of each retaining spring in the same shifting plate (7) with the loose ends located in same position on both sides to equalize the tension on all three shifting plates (7), and also index etched marking on hub and sleeve.
10. To disassemble first and second speed synchronizer unit:
- The mainshaft first and second speed clutch hub (29) and sleeve gear (24) are held together by poppet springs (28) and balls (26). The clutch hub (29) can be removed from sleeve (24) by supporting the outside diameter and pressing on the hub. Use care when disassembling as poppet springs and balls are under spring tension and may fly out when sleeve is removed. It is suggested that a cloth be wrapped around the assembly to guard against this.
- ### TRANSMISSION REMOVAL (L-160 SERIES)
- When it becomes necessary to remove the transmission on the above series trucks, it is necessary to disconnect and move to one side the front propeller shaft. This will permit removal of the transmission. Proceed as follows.
- Remove the bolts from the front end of the front propeller shaft at the joint flange (Spicer joints used.)
 - Remove the brake drum retainer bolts and slide the brake drum out of the brake band onto the propeller shaft. (This will provide maximum clearance for the end of the propeller shaft to permit its being moved to one side.)
 - Carefully pry the shaft end towards the rear and over the transmission mainshaft flange and nut to permit the shaft to clear the flange.
 - Securely wire the shaft to one side to keep it out of the way while proceeding with transmission removal.



TRANSMISSIONS (F-51 AND F-51-C)

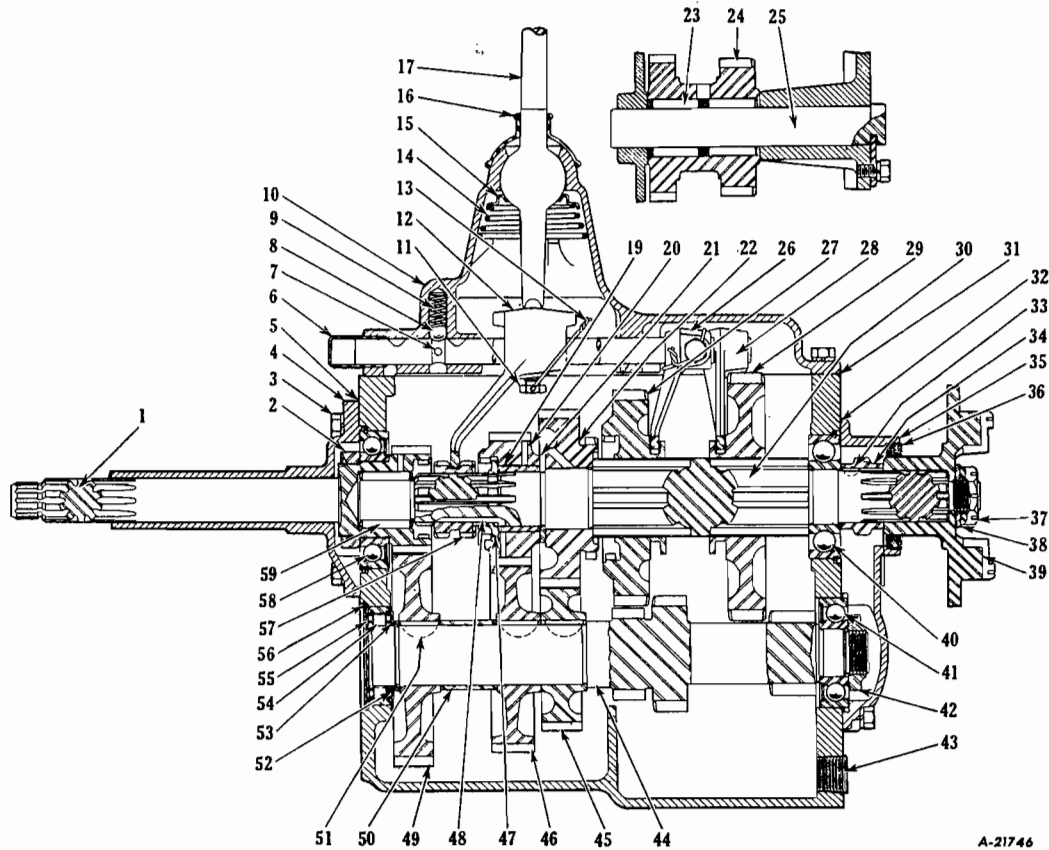


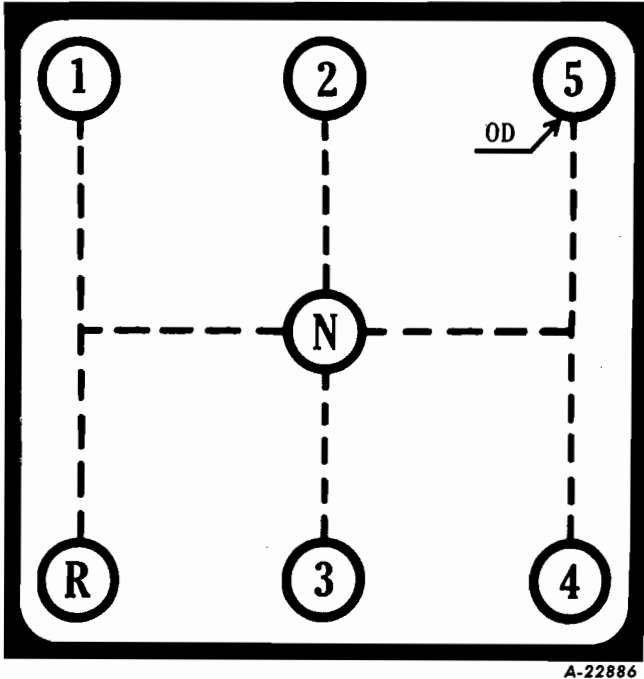
Fig. 1 - (F-51 and F-51-C)

No.	Description	No.	Description	No.	Description
1.	Main drive gear.	23.	Reverse idler roller bearing.	42.	Countershaft rear bearing lock nut.
2.	Drive gear bearing nut.	24.	Reverse idler gear.	43.	Drain plug.
3.	Front bearing retainer capscrew.	25.	Reverse idler shaft.	44.	Countershaft gear, 1st, 2nd & reverse.
4.	Main drive gear bearing retainer.	26.	Shifter fork, 2nd & 3rd speed.	45.	Countershaft 3rd speed gear.
5.	Retainer gasket.	27.	Mainshaft 2nd & 3rd speed gear.	46.	Countershaft 5th speed gear.
6.	Shift rail thimble.	28.	Shifter fork (low & reverse).	47.	Mainshaft 5th gear washer.
7.	Interlock pin.	29.	Mainshaft low & reverse gear.	48.	Mainshaft 5th speed gear key.
8.	Poppet ball.	30.	Mainshaft.	49.	Countershaft drive gear.
9.	Poppet spring.	31.	Control cover gasket.	50.	Spacer.
10.	Control cover.	32.	Rear bearing cover gasket.	51.	Key.
11.	Shifter fork lockscrew.	33.	Speedometer drive gear key.	52.	Countershaft snap ring.
12.	Shifter fork, 4th & 5th speed.	34.	Speedometer drive gear.	53.	Countershaft front bearing washer.
13.	Shifter fork lockwire.	35.	Rear bearing retainer.	54.	Countershaft front bearing.
14.	Spring.	36.	Mainshaft rear bearing grease seal.	55.	Countershaft front bearing retainer.
15.	Retainer.	37.	Flange nut.	56.	Expansion plug snap ring.
16.	Dust cover.	38.	Flange lockwasher.	57.	Mainshaft sliding clutch.
17.	Shift lever, and ball.	39.	Flange.	58.	Main drive gear bearing.
19.	Mainshaft sleeve, 5th gear.	40.	Mainshaft rear bearing.	59.	Mainshaft pilot bearing.
20.	Mainshaft 5th gear.	41.	Countershaft rear bearing.		
21.	Mainshaft 3rd speed washer.				
22.	3rd speed constant mesh gear.				



TRANSMISSIONS (MODELS F-51 and F-51C)

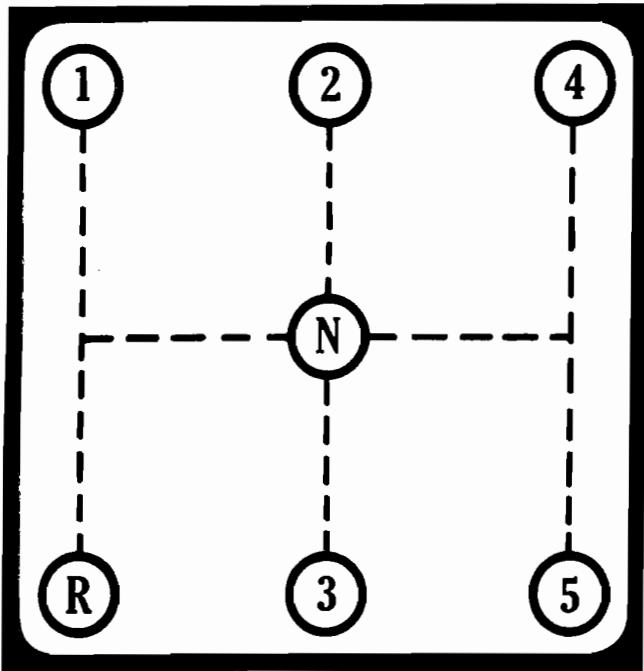
The Model F-51 transmission (5-A-330) has five speeds forward and one reverse. Fifth speed is overdrive. Fig. 2 illustrates the shift diagram.



A-22886

Fig. 2 - Shifting Diagram (F-51)

The Model F-51-C transmission (5-A-33) is constructed having five forward speeds and one reverse speed. Fifth speed is direct. Fig. 3 illustrates the shift diagram.



A-22882

Fig. 3 - Shifting Diagram (F-51-C)

Fig. 1 illustrates construction details of the F-51 and F-51-C transmissions and figure numbers in parentheses throughout this section will refer to this illustration. Item (20) on Fig. 1 will be referred to as Mainshaft Fifth Speed Gear although due to change in diameter on F-51-C, direct in fifth transmission, it is used as fourth speed gear.

DISASSEMBLING AND REASSEMBLING

With a few exceptions, the assembling is simply the reverse of disassembling. Therefore the following disassembly instructions will also serve as reference for assembling.

1. Clean the outside of the transmission, particularly around the control and bearing covers (4, 10, 35).
2. Place shift lever (17) to neutral position. Remove nine capscrews and lockwashers from control cover (10) and lift cover assembly and gasket (31) from top of case.
3. To disassemble the control cover assembly:
 - (a) Cut lockwire (13) at fourth and fifth speed shift fork (12) and remove shift fork lockscrew (11). Drive shift rail out toward front of cover driving out shift rail thimble (6) and remove shift fork (12). Do not lose poppet ball (8) and spring (9).
 - (b) Remove interlock ball and pin retainer plug located on left outside of cover directly below the poppet spring and ball housing, releasing interlock ball and pin (7).
 - (c) Continue disassembly operation removing low and reverse and second and third speed shift forks (26, 28), shift block, step pin, spring and rails. Do not lose shift rail poppet balls (8) and springs (9) or interlock pin (7) and balls.
 - (d) Remove shift lever ball (18) from shift lever (17). Remove lever dust cover (16) and also nut and lockwasher from control lever pivot pin. Place cover (10) in a vise, grasp lower end of control lever spring (14) with a large pliers and twist it from its retaining lugs. Spring may also be removed by use of a pinch bar and forcing spring over the retaining lugs. The shift lever (17) may now be lowered through the control cover (10). Control lever pivot pin can also be removed from cover. **CAUTION:** In reassembling the controls, care should be exercised that all parts are replaced in their respective positions.



4. Disassembling main drive gear and mainshaft assembly:

- (a) Lock transmission and disassemble flange nut (37), washer (38) and flange (39). Remove six capscrews and lockwashers from mainshaft rear bearing retainer (35). Lift retainer and gasket (32) from case. Slide speedometer drive gear (34) from mainshaft (30) and remove speedometer gear drive key (33).
- (b) Drive mainshaft assembly toward rear of case sufficiently to expose rear bearing (40) snap ring. Install suitable puller and pull bearing (40) from mainshaft (30).
- (c) Remove six capscrews (3) and lockwashers from main drive gear bearing retainer (4) and lift off retainer (4) and gasket (5). Remove main drive gear (1) and bearing (58) and also mainshaft pilot bearing (59) out through front of case.
- (d) Lift mainshaft (30) and gears out through top of case, tilting front end upward and leaving low and reverse speed gear (29) in case. With the mainshaft assembly removed, lift out low and reverse speed gear (29) out of case.

5. To disassemble mainshaft assembly:

- (a) Slide mainshaft second and third speed gear (27) from mainshaft and also the mainshaft sliding clutch (57) from opposite end of mainshaft.

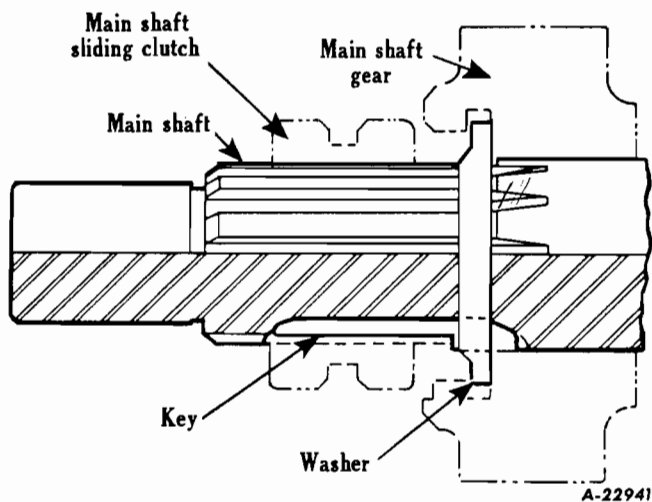


Fig. 4

- (b) Remove fifth speed gear key (48) from groove in mainshaft (30). Rotate fifth

speed gear washer (47) on mainshaft to index lugs with splines of shaft and then remove (Figure 4). Slide mainshaft fifth speed gear (20) sleeve (19) and washer (21) from shaft.

6. To disassemble main drive gear:

- (a) Remove peened over material from slots in main drive gear and turn off drive gear bearing nut (2). NOTE: Nut is left-hand threaded. Press bearing (58) from main drive gear (1).

7. To disassemble countershaft and reverse idler gear:

- (a) Remove peened over material from slots and remove countershaft rear bearing nut (42) from countershaft (44).
- (b) Remove capscrew and lockwasher from reverse idler shaft lock plate and remove from slot in idler shaft (25). Drive idler shaft (25) toward rear of case and lift idler gear (24) and roller bearings (23) from case.
- (c) Drive countershaft assembly (44) toward rear of case sufficiently to expose rear bearing (41), attach puller, and remove rear bearing from countershaft. Lift countershaft assembly through top of case, lifting front end upward and tilting assembly. Also remove front bearing thrust (53). The countershaft front bearing is disassembled by removing snap ring (56) from groove and drive retainer (55) from case. The countershaft front bearing (54) may now be removed from case.
- (d) To disassemble the countershaft assembly, remove snap ring (52) from countershaft. Using adapter plates, press countershaft drive gear (49) spacer (50) fifth speed gear (46) and third speed gear (45) from countershaft (44) and remove gear keys (51).

CAUTION: In reassembling, NEW snap rings should be used throughout the unit.



TRANSMISSIONS (F-52 AND F-52-C)

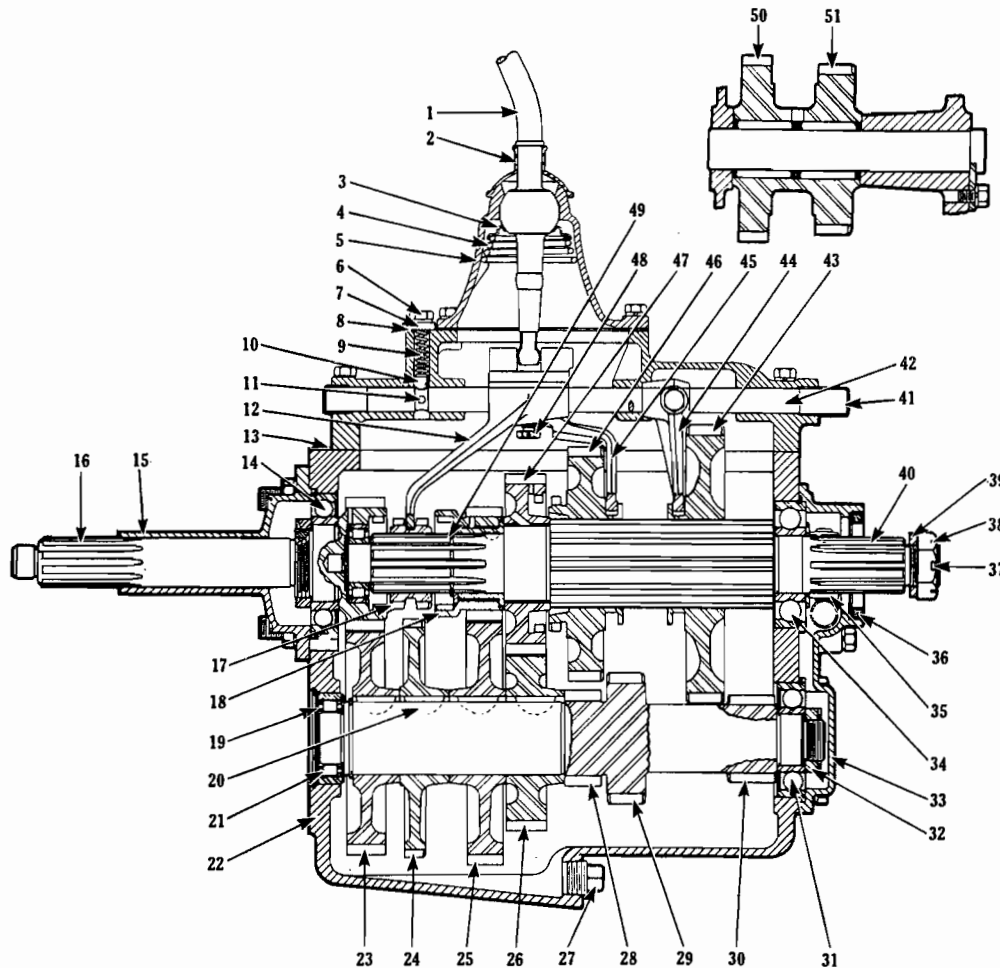


Fig. 1 - (F-52 and F-52C)

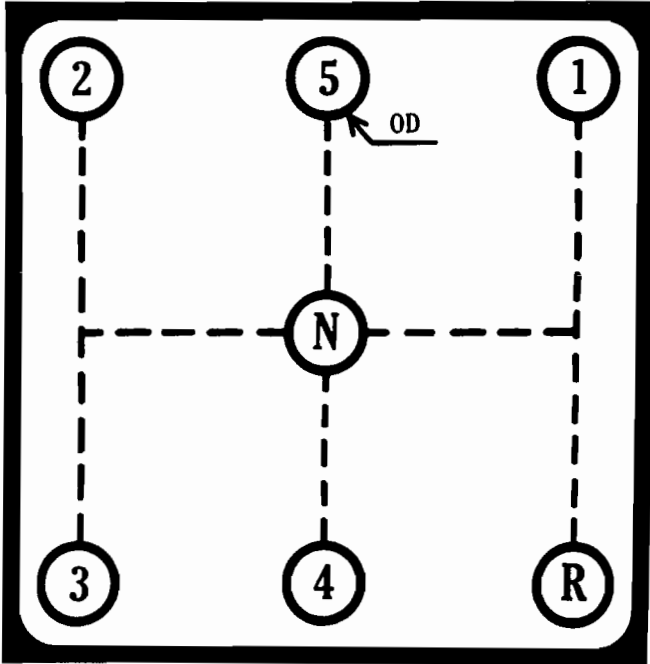
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No.	Description	No.	Description	No.	Description
1.	Shift lever.	20.	Countershaft gear key.	36.	Mainshaft rear grease seal.
2.	Dust cover.	21.	Countershaft front bearing.	37.	Cotter pin.
3.	Spring retainer.	22.	Transmission case.	38.	Nut.
4.	Spring.	23.	Countershaft drive gear.	39.	Washer.
5.	Shift lever cover.	24.	Power take-off drive gear (right side).	40.	Mainshaft.
6.	Capscrew.	25.	Countershaft overdrive gear.	41.	Shifter shaft rear cover.
7.	Poppet spring cover.	26.	Countershaft 3rd speed drive gear.	42.	Shifter shafts.
8.	Control cover.	27.	Drain plug.	43.	Mainshaft low and reverse sliding gear.
9.	Poppet spring.	28.	Reverse drive gear.	44.	Shifter fork (low and reverse).
10.	Poppet ball.	29.	Countershaft 2nd speed drive gear.	45.	Shifter fork (2nd and 3rd speed).
11.	Interlock pin.	30.	Countershaft low speed drive gear.	46.	Mainshaft 2nd and 3rd speed sliding gear.
12.	Shifter fork (direct and overdrive).	31.	Countershaft rear bearing.	47.	Mainshaft 3rd speed constant mesh gear.
13.	Retainer gasket.	32.	Countershaft rear bearing lock nut.	48.	Shifter shaft lock screw.
14.	Main drive gear bearing.	33.	Rear bearing retainer.	49.	Mainshaft gear lock washer.
15.	Main drive gear bearing retainer.	34.	Mainshaft rear bearing.	50.	Constant mesh reverse idle gear.
16.	Main drive gear.	35.	Speedometer drive gear.	51.	Reverse drive gear.



TRANSMISSIONS (MODELS F-52 and F-52-C)

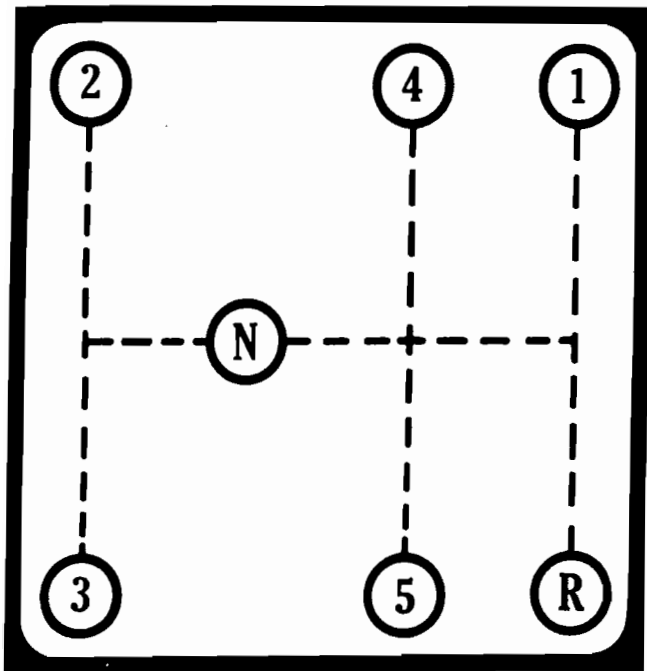
The Model F-52 transmission (S-A-430) is constructed having five forward speeds and one reverse. Fifth speed is overdrive. Fig. 3 illustrates the shift diagram.



A-22881

Fig. 2 - Shifting Diagram (F-52)

The Model F-52-C transmission (5-A-43) is constructed having five speeds forward and one reverse. Fifth speed is direct. Fig. 4 illustrates the shift diagram.



A-22883

Fig. 3 - Shifting Diagram (F-52-C)

Fig. 1 illustrates construction details of the F-52 and F-52-C transmissions and figure numbers in parentheses throughout this section will refer to this illustration. Item (18) on Fig. 1 will be referred to as mainshaft fifth speed gear although due to change in diameter on F-52-C, direct in fifth transmission, it is used as fourth speed gear.

DISASSEMBLING AND REASSEMBLING

With a few exceptions, the assembly is simply the reverse of disassembly. Therefore, the following disassembly instructions will also serve as reference for assembly.

1. Clean the outside of transmission, particularly around the control and bearing covers (15, 8, 5, 33).
2. Place shift lever (1) to neutral position, then remove the holding capscrews and lift off the control cover assembly. CAUTION: Do not try to force the cover off, as it may spring the shifting yokes and cause gear interference. A slight manipulation will free it.
3. Disassembling the control cover assembly:
 - (a) Remove four capscrews and lift shift lever cover assembly (5) from control cover assembly (8).
 - (b) Remove shift lever ball from shift lever (1) and also dust cover (2). Remove nut and lockwasher from pivot pin. Place cover in vise, grasp lower end of control lever spring (4) with a large pliers and twist it from its lugs. Spring may also be removed by use of a pinch bar and forcing spring over the retaining lugs. With the spring removed, releasing spring retainer (3), the lever (1) can be lowered through shift lever cover (5).
 - (c) Remove capscrews (6) and poppet spring and ball cover plate (7) releasing poppet springs (9) and balls (10). Cut lockwire at reverse shift block and remove lockscrew. Drive shift rail (42) toward rear of cover driving out shift rail cover (41). Pull shift rail out releasing reverse shift block on inside of cover. CAUTION: Do not lose poppet spring (9) and ball (10).
 - (d) Remove interlock ball retainer cap located on left outside of cover directly below poppet spring and ball housing, releasing the interlock ball and pin (11).

- (e) Continue disassembly operation in the same manner as described in paragraph (c) removing the balance of shift rails (42), covers (41), shift forks (12, 44), poppet springs and balls and interlock ball.

CAUTION: In reassembling the control cover assembly, care must be exercised to see that all parts are replaced in their correct positions and none of the small interlocking parts are lost or omitted.

4. Disassemble mainshaft assembly:

- (a) After locking gears by engaging two speeds, the countershaft rear bearing nut (32) is removed from end of countershaft. Remove rear bearing retainer (33). Slide off speedometer gear (35) and remove key.
- (b) Drive mainshaft assembly toward rear of case sufficiently to expose rear bearing (34) snap ring. Install suitable puller and pull bearing (34) from mainshaft (40). By tilting the mainshaft assembly front end upward, the entire unit comes out easily leaving sliding gears (46, 43) inside case. After shaft assembly is removed, the sliding gears may then be lifted out of case.
- (c) To disassemble the mainshaft, slide the sliding clutch (17) from front end of shaft. Remove gear retaining washer key (Fig. 5).

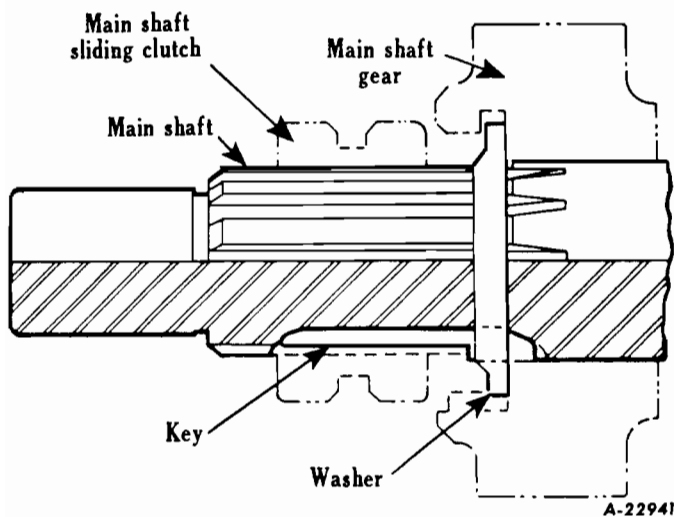


Fig. 4

After removing key, rotate gear retainer washer until its inside lugs line up with grooves in the shaft and then

remove. The bushed gears (18) (47) and sleeve are removed by using rear gear (47) to start the sleeve. Also remove the sleeve key from shaft.

5. To disassemble main drive gear:

- (a) Remove four capscrews from main drive gear bearing retainer (15). The main drive gear (16), bearing (14) and lock nut assembly can then be withdrawn through front of case.
- (b) Remove peened over material from slots in drive gear shaft (16) and turn off drive gear bearing lock nut. **NOTE** Nut is left-hand threaded. Press bearing (14) from main drive gear (16).

6. To disassemble countershaft and reverse idler gear:

- (a) To disassemble reverse idler gear, remove capscrew and lock plate from groove in idler. A simple method of pulling idler shaft, use a short piece of pipe, a long bolt having threads the same size as those tapped in end of shaft. Using a flat piece of steel with a hole in the center sufficiently large to permit passage of bolt. The nut is turned on the bolt close up to the head. The bolt is then passed through plate and pipe in order named and screwed into idler shaft. The nut is then tightened against the plate with the result that the pulling action is exerted against the shaft with the case acting as a base through the pipe and plate. After withdrawing reverse idler shaft, the gears (50, 51) are lifted from case and bearings removed from idler gear.
- (b) With the countershaft rear bearing lock nut (32) removed, drive countershaft assembly toward rear of case sufficiently to install suitable puller to remove rear bearing (31). By tilting the front end upward, the countershaft assembly is easily removed through top of case. Also remove front bearing thrust washer.
- (c) To disassemble countershaft, remove retaining snap ring from countershaft. Countershaft gears (23, 24, 25, 26) should be pressed off, one at a time, and keys (20) removed from shaft.

CAUTION: In reassembling, new snap rings should be used throughout the unit. When reassembling mainshaft assembly, always replace lock key and washer and make sure the gears are neither tight nor loose after they are assembled. Make sure that all gears in the unit are replaced in their proper position.



TRANSMISSIONS (F-54 AND F-54-B)

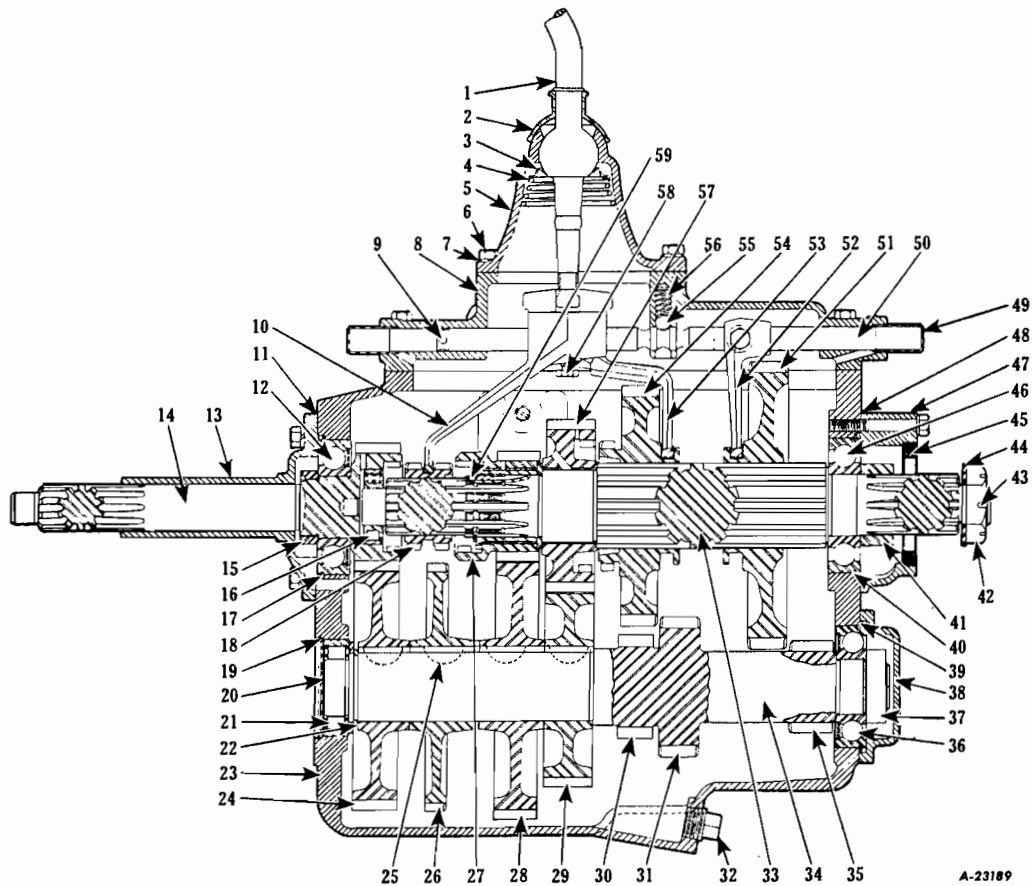


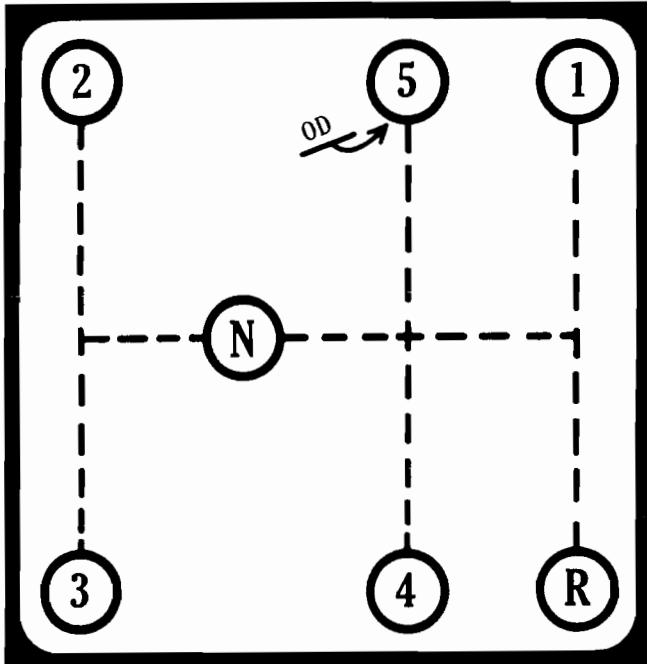
Fig. 1 - (F-54 and F-54-B)

No.	Description	No.	Description	No.	Description
1.	Shift lever.	23.	Transmission case.	42.	Nut
2.	Dust cover.	24.	Countershaft drive gear.	43.	Cotter pin.
3.	Spring retainer.	25.	Key.	44.	Washer.
4.	Spring.	26.	Power take-off drive gear.	45.	Mainshaft rear grease seal.
5.	Shift lever cover.	27.	Mainshaft overdrive gear.	46.	Mainshaft rear bearing.
6.	Capscrew.	28.	Countershaft overdrive gear.	47.	Rear bearing cover and speedometer housing.
7.	Lockwasher.	29.	Countershaft 3rd speed drive gear.	48.	Gasket.
8.	Control cover.	30.	Reverse drive gear.	49.	Shifter shaft rear cover.
9.	Interlock pin.	31.	Countershaft 2nd speed drive gear.	50.	Shifter shafts.
10.	Shifter fork (direct and overdrive).	32.	Drain plug.	51.	Mainshaft low and reverse sliding gear.
11.	Retainer gasket.	33.	Mainshaft.	52.	Shifter fork (low and reverse).
12.	Main drive gear bearing.	34.	Countershaft.	53.	Shifter fork (2nd and 3rd speed).
13.	Main drive gear bearing retainer.	35.	Countershaft low speed drive gear.	54.	Mainshaft 2nd and 3rd speed sliding gear.
14.	Main drive gear.	36.	Countershaft rear bearing.	55.	Poppet ball.
15.	Main drive gear bearing retaining nut.	37.	Countershaft rear bearing lock nut.	56.	Poppet spring.
16.	Mainshaft front bearing.	38.	Countershaft rear bearing retainer.	57.	Mainshaft 3rd speed constant mesh gear.
17.	Snap ring.	39.	Snap ring.	58.	Shifter shaft lock screw.
18.	Mainshaft sliding clutch.	40.	Snap ring.	59.	Mainshaft gear lock key.
19.	Snap ring.	41.	Speedometer drive gear.		
20.	Expansion plug.				
21.	Countershaft front bearing.				
22.	Spacer.				



TRANSMISSION (MODELS F-54 and F-54-B)

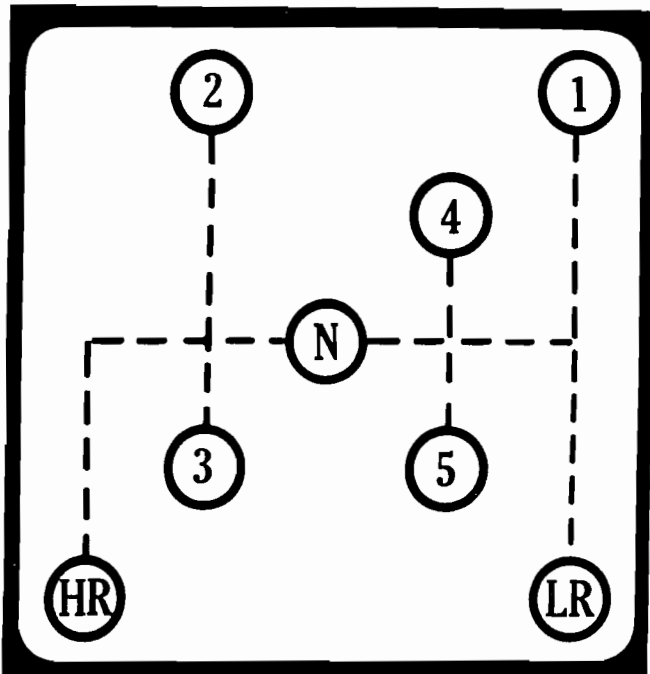
The Model F-54 transmission (5-A-620) is constructed having five forward speeds and one reverse. Fifth speed is overdrive. Fig. 2 illustrates the shift diagram.



A-22884

Fig. 2 - Shifting Diagram (F-54)

The Model F-54-B transmission (5-A-62) is constructed having five speeds forward and two reverse. Fifth speed is direct. Fig. 3 illustrates the shift diagram.



A-22885

Fig. 3 - Shifting Diagram (F-54-B)

Fig. 1 illustrates construction details of the F-54 and F-54-B transmissions and figure numbers in parentheses throughout this section will refer to this illustration. Item (27) on Fig. 1 will be referred to as mainshaft fifth speed gear although due to change in diameter on F-54-B, direct in fifth transmission, it is used as fourth speed gear.

DISASSEMBLING AND REASSEMBLING

With a few minor exceptions, the assembling is simply the reverse of disassembling. Therefore, the following disassembling instructions will also serve as reference for assembling.

1. Clean the outside of transmission, particularly around the control and bearing covers (5, 13, 8, 47, 38).
2. Place shift lever to neutral position and remove the holding capscrews and lift off control cover assembly (8). **CAUTION:** Do not try to force the cover off, as you may spring the shifting yoke and cause gear interference.
3. To disassemble control cover assembly:
 - (a) Remove four capscrews (6) and lift shift lever assembly (5) from control cover assembly (8).
 - (b) Remove shift lever ball from shift lever (1) and also dust cover (2). Remove nut and lockwasher from pivot pin. Place cover in a vise, grasp lower end of control lever spring (4) with a large pliers and twist it from its lugs. Spring may also be removed by use of a pinch bar and forcing over the retainer lugs. With the spring removed, releasing spring retainer (3), the lever (1) can be lowered through shift lever cover (5).
 - (c) Cut lockwire and remove shift fork lockscrew (58), starting with upper shift rail (50). Drive shift rail (50) out toward rear of cover driving out shift rail cover (thimble) (49). Shift fork can be lifted out of cover. **CAUTION:** Do not loose poppet springs (56) and balls (55).
 - (d) Continue disassembly operation removing the balance of shift rails (50) interlock pin (9) shifter forks (52, 53, 10) interlock balls, shift blocks and stop pins.

CAUTION: In reassembling the control cover, care should be exercised to see that all parts are replaced in their correct positions and none of the small interlocking parts are lost or omitted.



4. To remove mainshaft assembly:
- Remove mainshaft rear bearing retainer (47) and countershaft rear bearing (38). Slide off speedometer drive gear (41) and remove key. After locking gears by engaging two speeds, the countershaft rear bearing lock nut (37) is removed from end of countershaft.
 - Drive mainshaft assembly toward rear of case sufficiently to expose rear bearing snap ring (40). Install suitable puller and remove bearing (46) from mainshaft (33). By tilting the mainshaft assembly, front end upward, the entire unit comes out easily leaving sliding gears (51, 54) inside case. After shaft assembly is removed, the sliding gears may then be lifted out of case.
 - To disassemble the mainshaft, remove the pilot bearing (16) and sliding clutch (18) using the latter part to free the bearing. After removing key (59) (Fig. 4) rotate gear retainer washer until its inside lugs line up with grooves in shaft and then remove.
- (b) Remove peened over material from slot in drive gear shaft (14) and turn off drive gear bearing lock nut (17). NOTE: Nut is left hand threaded. Press bearing (12) from main drive gear (14).
6. To disassemble countershaft and reverse idler gears:
- To disassemble reverse idler gear or gears, remove capscrews and lock plates from groove in idler shafts. A simple method of pulling shaft, or shafts, use a short piece of pipe, a long bolt having threads the same size as those tapped in end of shaft. Using a flat steel plate with a hole in the center sufficiently large to permit passage of bolt. The nut is turned on the bolt close up to the head. The bolt is then passed through plate and pipe in order named and screwed into idler shaft. The nut is then tightened against the plate with the result that the pulling action is exerted against the shaft with the case acting as a base through pipe and plate. After withdrawing the idler shaft or shafts from case, the idler gears are lifted out through top of case and bearings removed from idler gears.

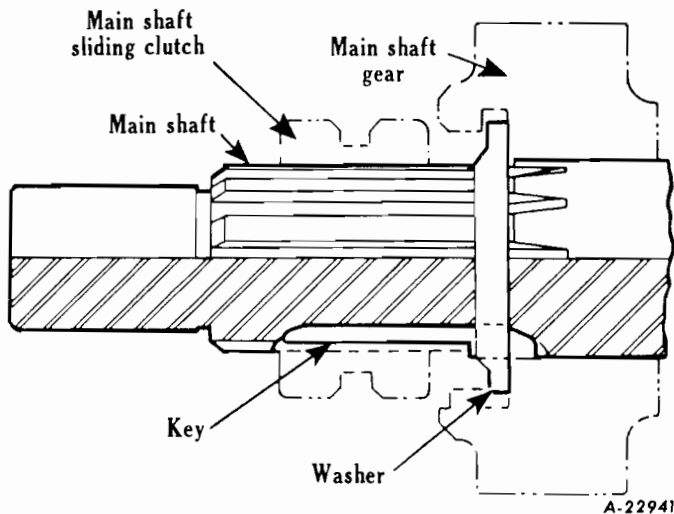


Fig. 4

The bushed gears (27) (57) and sleeve are removed by using rear gear (57) to start the sleeve. Also remove sleeve key from shaft.

5. To disassemble main drive gear:

- Remove four capscrews from main drive gear retainer (13), and lift off retainer. The main drive gear (14), bearing (12) and lock nut (15) can then be withdrawn through front of case.

- With the countershaft rear bearing lock nut (37) removed, drive countershaft assembly toward rear of case sufficiently to install suitable puller to remove rear bearing (36). By tilting the front end upward, the countershaft assembly is easily removed through top of case. Also remove front bearing thrust washer (22).
- To disassemble countershaft, remove retaining snap ring from countershaft. Gears (24) (26) (28) (29) should be pressed off, one at a time and keys (25) removed from shaft.

CAUTION: In reassembling, NEW snap rings should be used throughout the unit. When reassembling mainshaft assembly, always replace lock key and washer and make sure the gears are neither tight nor loose after they are assembled. Make sure that all gears in the unit are replaced in their proper position.



FULLER AUXILIARY TRANSMISSION — MODEL 2-A-45

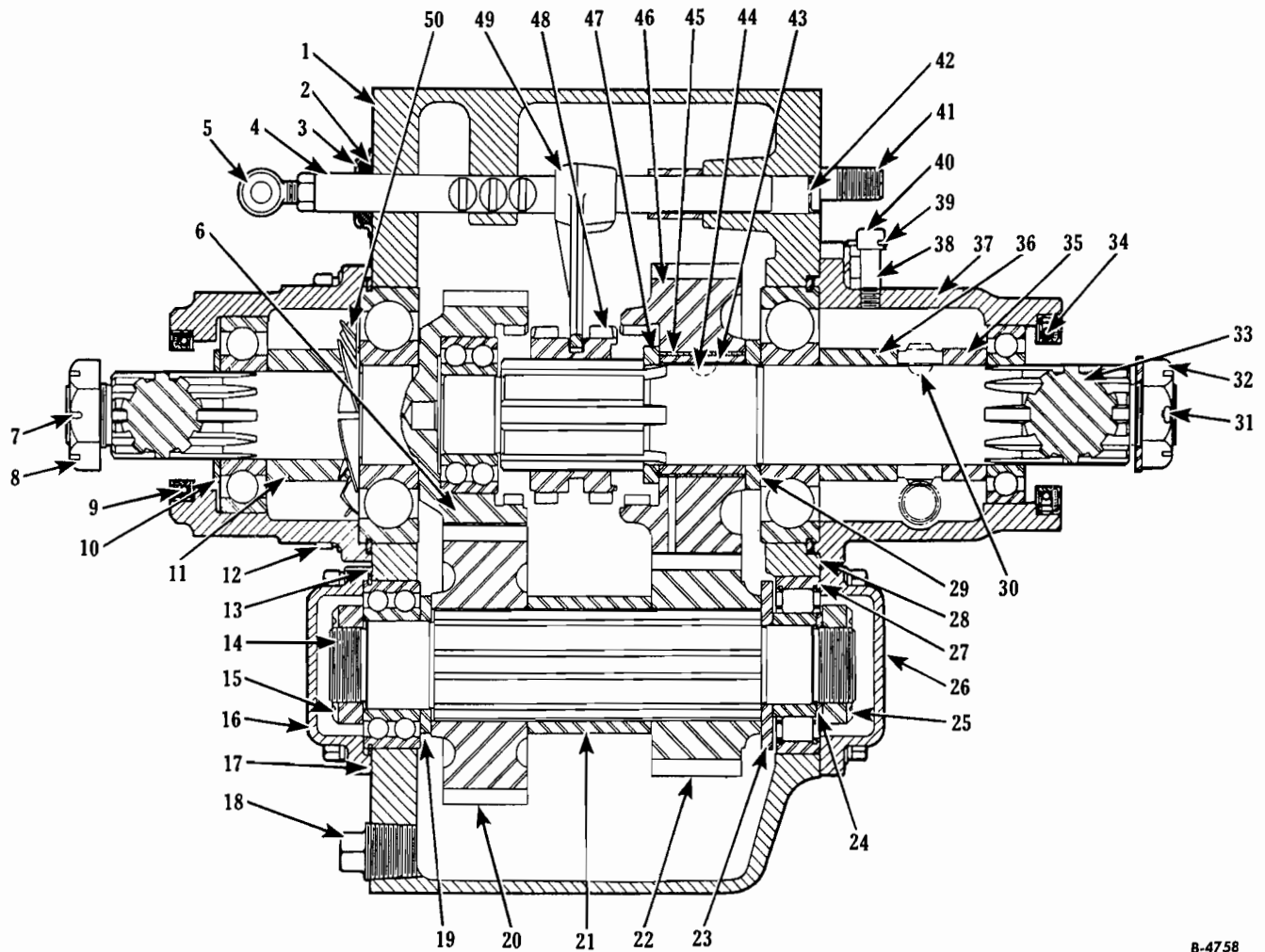


Fig. 1

B-4758

No.	Description	No.	Description	No.	Description
1.	Transmission case.	20.	washer.	35.	Mainshaft.
2.	Cork seal.	21.	Countershaft drive gear.	36.	Speedometer gear spacer.
3.	Cork seal retainer.	22.	Countershaft low-speed gear.	37.	Rear bearing cover and speedometer housing.
4.	Shifting bar.	23.	Countershaft rear bearing spacer.	38.	Breather pipe.
5.	Shifting bar eyebolt.	24.	Countershaft rear bearing washer.	39.	Cotter pin.
6.	Main drive gear.	25.	Countershaft bearing nut.	40.	Breather pipe cap.
7.	Cotter pin.	26.	Countershaft rear bearing cover.	41.	Rear support stud.
8.	Nut.	27.	Gasket.	42.	Oil retainer thimble.
9.	Oil seal.	28.	Gasket.	43.	Mainshaft low-speed gear sleeve.
10.	Mainshaft bearing washer.	29.	Mainshaft washer.	44.	Key.
11.	Front bearing spacer.	30.	Key.	45.	Mainshaft low-speed gear bushing.
12.	Front bearing cover.	31.	Cotter pin.	46.	Mainshaft low-speed gear.
13.	Gasket.	32.	Nut.	47.	Mainshaft low-speed gear washer.
14.	Countershaft.	33.	Mainshaft.	48.	Shifting yoke.
15.	Countershaft bearing nut.	34.	Oil seal.	49.	Shifting yoke.
16.	Countershaft front bearing cover.			50.	Oil deflector.
17.	Gasket.				
18.	Drain plug.				
19.	Countershaft front bearing				



POWER TAKE-OFF FOR FULLER MODEL 2-A-45 TRANSMISSION

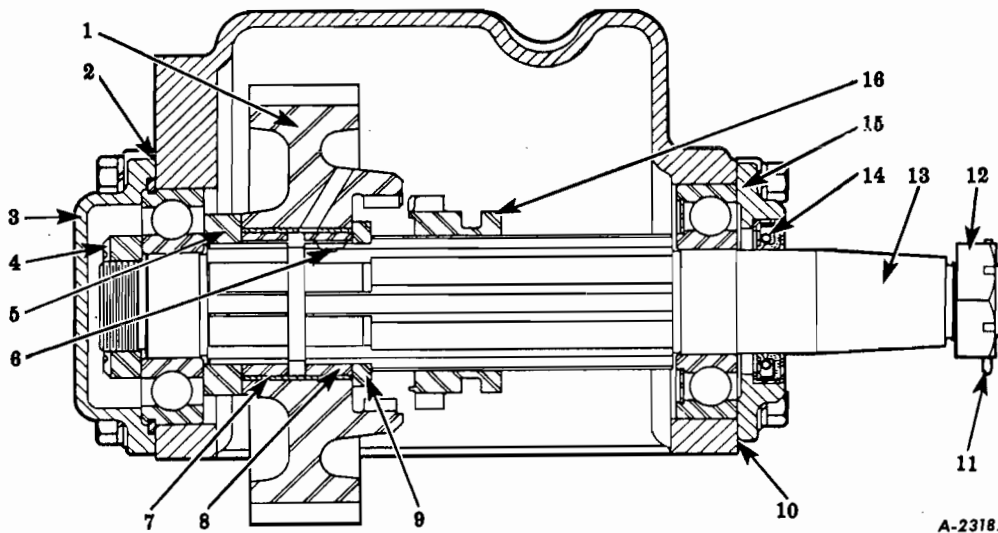


Fig. 2

No.	Description
1.	Gear.
2.	Gasket.
3.	Front bearing cover.
4.	Countershaft bearing nut.
5.	Bearing spacer.
6.	Key.
7.	Bushing.
8.	Gear sleeve.
9.	Gear washer.
10.	Gasket.
11.	Cotter pin.
12.	Nut.
13.	Mainshaft.
14.	Oil seal.
15.	Rear bearing cover.
16.	Mainshaft sliding clutch.



The Fuller Model 2-A-45 Auxiliary Transmission is designed to be used in conjunction with regular transmissions.

The gear ratios of the two-speed Model 2-A-45 Auxiliary Transmission are as follows:

Direct-----1.00 to 1
Underdrive----1.3 to 1

The following procedure will be found helpful in servicing the unit:

(A) Dismantle Transmission

1. Remove capscrews holding side cover or power take-off.
2. Remove cover or power take-off, and gasket.
3. Remove poppet spring retainer screw.
4. Remove shifter fork lock screw.
5. Withdraw shifter bar.
CAUTION: Do not lose poppet spring and ball as shifter bar emerges.
6. Remove shifter fork.
7. Remove capscrews from countershaft front bearing cover.
8. Remove countershaft front bearing cover and gasket.
9. Remove countershaft rear bearing cover capscrews.
10. Remove countershaft rear bearing cover and gasket.
11. Lock transmission gears.
12. Remove countershaft front bearing lock nut.
13. Remove capscrews from main drive gear cover.
14. Remove main drive gear, bearings, and cover as a unit.
15. Press main drive gear from cover and bearing assembly.
16. Remove capscrews from main shaft rear bearing cover.
17. Remove rear bearing cover and gasket.
18. Remove main shaft rear bearing.
19. Remove rear bearing spacer.

20. Remove speedometer gear and key.
21. Remove inner bearing spacer.
22. Force main shaft out of rear bearing through main drive gear bearing bore in front of case, removing main shaft underdrive bushed gear and washer as shaft emerges.
23. Remove main shaft pilot bearing from shaft.
24. Remove main shaft sliding clutch gear.
25. Remove main shaft underdrive gear sleeve washer from shaft.
26. Remove main shaft underdrive gear sleeve and key from shaft.
27. Force countershaft toward rear and out of case, removing countershaft front bearing spacer washer, countershaft drive gear, gear spacer, and countershaft underdrive gear as shaft emerges.
28. Remove countershaft rear bearing lock nut and washer.
29. Press off countershaft rear bearing.
30. Remove countershaft rear bearing washer.
31. Remove countershaft front bearing from case.

(B) Assemble Transmission

1. Install countershaft front bearing in case.
2. Install countershaft rear bearing washer on shaft.
3. Press on countershaft rear bearing.
4. Install countershaft rear bearing lock nut and washer.
5. Install countershaft in position by inserting through rear bore in case.
6. Install countershaft underdrive gear, gear spacer, countershaft drive gear, and front bearing spacer washer as shaft progresses.
7. Install main shaft underdrive gear sleeve and key on shaft.
8. Install main shaft underdrive gear sleeve washer on shaft.

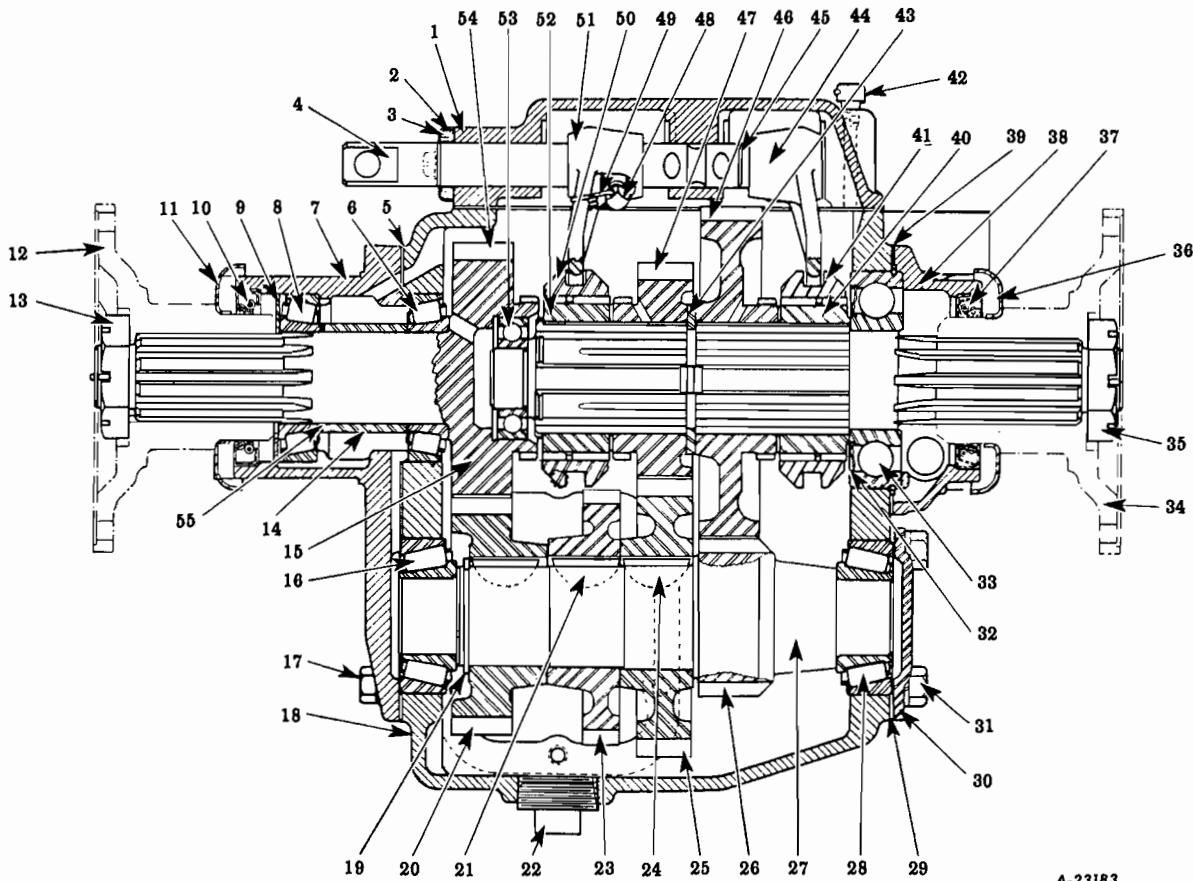
L-LINE MOTOR TRUCK SERVICE MANUAL



9. Install main shaft sliding clutch gear in position.
10. Press main shaft pilot bearing into position on shaft.
11. Install main shaft rear bearing in position in rear bore in case.
12. Insert main shaft assembly, previously prepared, through front bore in case and move toward the rear. Install rear bearing washer and main shaft underdrive bushed gear as shaft progresses.
13. Install main drive gear bearing in position on main drive gear.
14. Install main drive gear bearing spacer.
15. Install main drive gear outer bearing.
16. Install main drive gear and bearing assembly in position in case.
17. Install main drive gear and bearing cover and gasket.
18. Install capscrews in main drive gear bearing cover.
19. Install main shaft rear bearing spacer.
20. Install speedometer drive gear and key.
21. Install main shaft rear bearing spacer.
22. Install main shaft rear bearing.
23. Install rear bearing cover and gasket.
24. Install rear cover capscrews.
25. Install shifter bar through shifter fork, hub of shifter fork toward the rear.
26. Insert poppet spring and ball in position.
27. Push shifter fork into position.
28. Install poppet spring retainer screw.
29. Install shifter fork lock screw.
30. Install side cover or power take-off and gasket.
31. Install capscrews holding cover or power take-off.
32. Fill transmission with lubricant (10 pints).



BROWN-LIPE AUXILIARY TRANSMISSION — MODEL 5531



A-23183

Fig. 1

No.	Description	No.	Description	No.	Description
1.	Shifter housing.	20.	Countershaft drive gear.	37.	Mainshaft rear oil seal.
2.	Shifter rod gland cover.	21.	Woodruff key.	38.	Mainshaft rear bearing retainer.
3.	Shifter rod packing gland.	22.	Drain plug.	39.	Mainshaft rear bearing retainer gasket.
4.	Shifter rail - direct and overdrive.	23.	Power take-off gear.	40.	Mainshaft clutch gear.
5.	Mainshaft front bearing cap gasket.	24.	Woodruff key.	41.	Mainshaft clutch collar.
6.	Mainshaft inner bearing.	25.	Countershaft overdrive gear.	42.	Breather assembly.
7.	Mainshaft front bearing cap.	26.	Countershaft underdrive gear.	43.	Overdrive and underdrive gear spacer.
8.	Mainshaft outer bearing.	27.	Countershaft.	44.	Underdrive shifter fork.
9.	Drive gear front bearing oil slinger.	28.	Countershaft rear bearing.	45.	Underdrive shifting rod.
10.	Drive gear front bearing oil seal.	29.	Countershaft rear bearing shims.	46.	Mainshaft underdrive gear.
11.	Drive gear oil seal cover.	30.	Countershaft rear bearing cap.	47.	Mainshaft overdrive gear.
12.	Companion flange.	31.	Countershaft rear bearing retainer capscrew.	48.	Shifter fork lock screw.
13.	Mainshaft nut.	32.	Mainshaft rear bearing spacer washer.	49.	Shifter fork lock screw lockwire.
14.	Drive gear bearing spacer.	33.	Mainshaft rear bearing.	50.	Mainshaft clutch collar.
15.	Mainshaft drive gear.	34.	Companion flange.	51.	Overdrive shifter fork.
16.	Countershaft front bearing.	35.	Mainshaft nut.	52.	Mainshaft clutch gear.
17.	Countershaft front bearing retainer cap.	36.	Mainshaft rear oil seal cover.	53.	Mainshaft pocket bearing.
18.	Transmission housing.			54.	Main gears.
19.	Countershaft gear snapping.			55.	Main gear front bearing spacer shims.



The Brown - Lipe Model No. 5531 Auxiliary Transmission is constructed with three speeds forward, with Direct Drive on second speed and Overdrive on third speed. There are no speeds in Reverse.

As an Auxiliary Transmission it is designed to be used in conjunction with standard four or five-speed transmissions.

The Gear Ratios of the Brown-Lipe No. 5531 Auxiliary Transmission are:

Direct----- 1.00 to 1.00
Overdrive----- .72 to 1.00
Underdrive----- 2.00 to 1.00

The following instructions will be found helpful in servicing the unit; and it will be noted that the procedure is best handled in sections.

(A) Dismantle Transmission

1. Drain transmission.
2. Remove shifter housing capscrews and housing.
3. Remove companion flange nut -- front.
4. Remove companion flange nut -- rear.
5. Remove companion flange -- front.
6. Remove companion flange -- rear.
7. Remove power take-off covers and gaskets.
8. Remove countershaft rear bearing cover and shims.
9. Remove countershaft front bearing cover and shims.
10. Drive countershaft toward rear of housing, forcing rear bearing cup from position.
11. Drop countershaft assembly to bottom of case.
12. Remove main shaft rear bearing cover.
13. Force main shaft assembly toward rear of case.
14. Remove main shaft rear bearing.
15. Tilt main shaft assembly and lift out through top of case.
16. Remove drive gear and bearing from top of case.
17. Remove countershaft assembly.

(B) Dismantle Countershaft Assembly

1. Remove countershaft front bearing cone.
2. Remove countershaft rear bearing cone.
3. Remove snap ring from front of countershaft.
4. Press off countershaft drive gear and remove key.
5. Press off countershaft overdrive gear and remove key.
6. Press off countershaft power take-off gear and remove key.

(C) Dismantle Main Shaft Assembly

1. Remove underdrive clutch gear collar.
2. Remove underdrive clutch gear.
3. Remove main shaft underdrive gear.
4. Remove direct and overdrive clutch gear collar.
5. Remove direct and overdrive clutch gear.
6. Remove direct and overdrive gear.
7. Remove main shaft snap-ring.

(D) Dismantle Shifter Housing Assembly

1. Remove lockwires from shifter rail setscrews.
2. Remove shifter rail setscrews.
3. Remove poppet retaining plugs and springs.
4. Remove overdrive shifter rail, poppets and springs, and shifter fork.
5. Remove underdrive shifter rail, poppets and springs, and shifter fork.
6. Remove shifter rail packing glands and covers.

(E) Dismantle Main Drive Gear Assembly

1. Remove pocket bearing.
2. Press off main drive gear bearing.

**(F) Dismantle Main Shaft Front Bearing Cover Assembly**

1. Remove front bearing oil seal.
2. Remove front bearing oil slinger.
3. Remove inner bearing race.

(G) Assemble Countershaft Assembly

1. Press countershaft power take-off gear into place after installing holding key.
2. Press countershaft overdrive gear and key into place.
3. Press countershaft drive gear and key into place.
4. Install countershaft gear lock-ring.
5. Install countershaft front bearing cone.
6. Install countershaft rear bearing cone.

(H) Assemble Main Shaft Assembly

1. Install main shaft snap-ring in place on shaft.
2. Install main shaft underdrive gear with clutch gear to rear of shaft.
3. Install main shaft underdrive clutch gear with flat face toward rear of shaft.
4. Install main shaft underdrive clutch gear collar with hub toward rear of shaft.
5. Install main shaft direct and overdrive gear with clutch gear to front of shaft.
6. Install main shaft direct and overdrive clutch gear with flat face toward front of shaft.
7. Install main shaft direct and overdrive gear clutch gear collar with clutch teeth toward the front.

(I) Assemble Transmission Shifter Housing Assembly

1. Install direct and overdrive shifter rail shifter fork, poppet ball and spring in place in housing cover. (Shifter fork must be installed with hub toward the rear.)
2. Install shifter rail interlock.
3. Install underdrive shifter rail, shifter fork, poppet ball, and spring in place in housing. (Shifter fork must be in-

stalled with hub toward the front.)

4. Lock underdrive shifter fork in place with setscrew.
5. Lock direct and overdrive shifter fork in place with setscrew.
6. Install lockwires through shifter fork setscrews.
7. Install poppet spring retaining plugs.
8. Install packing glands and covers for shifter rails.

(J) Assemble Transmission

1. Install countershaft front bearing cup in position in front of case.
2. Install countershaft front bearing cap and gasket.
3. Place countershaft and gear assembly in position in case.
4. Install countershaft rear bearing cup in place in bore of case.
5. Install countershaft rear bearing cap, gasket and shims.
6. There should be no perceptible bind or end play in the countershaft assembly. Make this assembly in such manner that there is a distinct drag felt and then add one .003" shim.
7. Remove front countershaft bearing cap.
8. Remove countershaft rear bearing cap gasket and shims.
9. Drive countershaft assembly toward rear of case, forcing rear bearing cup from position in bore of case.
10. Allow countershaft to lay in bottom of case.
11. Press bearing cone against shoulder of main drive gear.
12. Place front bearing cover over main drive gear shaft.
13. Install drive gear bearing spacer over shaft.
14. Install shims over spacer.
15. Install front bearing cone in cover.
16. Install companion flange.

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17. Install companion flange nut.
18. There should be no perceptible bind or end play in the main shaft assembly. Make this assembly in such manner that there is a distinct drag felt and then add one .003" shim.
19. Remove companion flange nut.
20. Remove companion flange.
21. Remove front cover, front bearing, and bearing spacer with shims.
22. Bolt front main shaft bearing cover in place to housing.
23. Install main drive gear and inner bearing in position through top of case.
24. Assemble drive gear bearing spacer, shims, and outer bearing as previously prepared.
25. Install oil slinger, oil seal, and dirt shield.
26. Install companion flange.
27. Install companion flange nut and cotter key.
28. Install main drive gear pocket bearing in hole in main drive gear.
29. Tilt main shaft gear assembly, previously prepared, and place in position in housing with pilot of shaft inside pocket bearing in main drive gear.
30. Using bar through power take-off opening, raise countershaft assembly into place.
31. Install countershaft rear bearing cup.
32. Bolt countershaft rear bearing cap, shims, and gasket into place.
33. Bolt countershaft front cover and gasket into place.
34. Using bar through power take-off opening, raise main shaft and gear assembly into place.
35. Install main shaft rear bearing.
36. Bolt main shaft rear bearing cap and gasket into place.
37. Install main shaft rear bearing oil slinger, oil seal, and dirt slinger in place.
38. Install companion flange.
39. Install companion flange nut and cotter key.
40. Install shifter housing and fork assembly in place with shifter forks in proper position.
41. Install shifter housing cover capscrews.
42. Install power take-off cover and gasket.
43. Fill with lubricant. (6 pints).

BROWN-LIPE AUXILIARY TRANSMISSION MODELS 6231 AND 6231-A

(FOR TEAR-DOWN ILLUSTRATIONS SEE SHOP TALK No. 38)

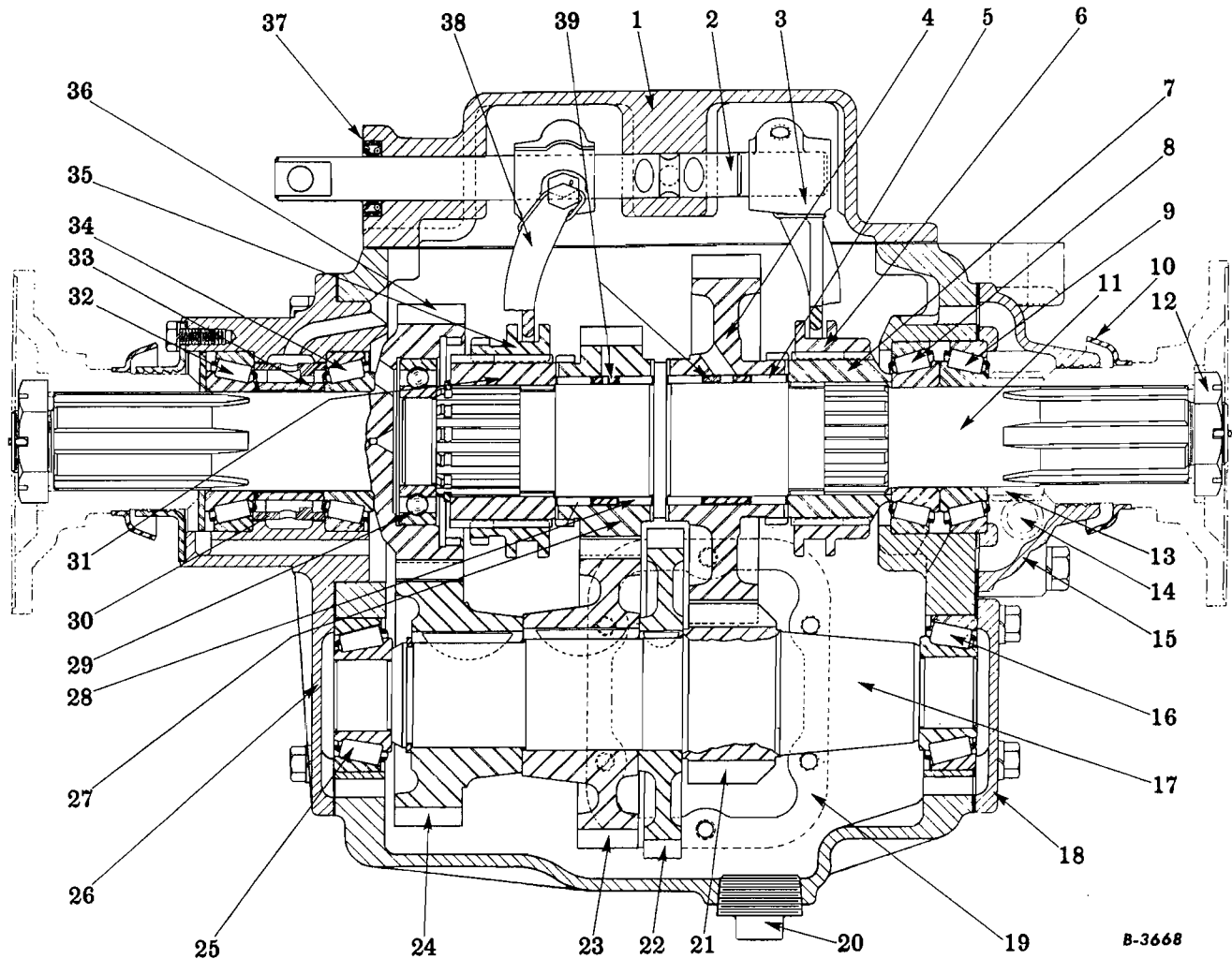


Fig. 1

No.	Description	No.	Description	No.	Description
1.	Cover.			27.	Mainshaft overdrive gear.
2.	Shift bar.	16.	Countershaft rear bearing.	28.	Needle bearings (47).
3.	Shift fork.	17.	Countershaft.	29.	Mainshaft pilot bearing.
4.	Underdrive gear.	18.	Countershaft rear bearing retainer.	30.	Sleeve (oil dam).
5.	Needle bearings (47).	19.	Power take-off opening.	31.	Clutch gear.
6.	Clutch collar.	20.	Drain plug.	32.	Mainshaft outer bearing (front).
7.	Clutch gear.	21.	Countershaft underdrive gear.	33.	Sleeve.
8.	Inner bearing (rear).	22.	Power take-off gear.	34.	Mainshaft inner bearing (front).
9.	Outer bearing (rear).	23.	Countershaft overdrive gear.	35.	Clutch collar.
10.	Slinger.	24.	Countershaft drive gear.	36.	Mainshaft drive gear.
11.	Mainshaft.	25.	Countershaft bearing front.	37.	Seal.
12.	Mainshaft flange nut.	26.	Bearing retainer (front).	38.	Shift fork.
13.	Speedometer drive gear.			39.	Spacers.
14.	Speedometer driven gear.				
15.	Mainshaft rear bearing re-				



The Brown-Lipe Models No. 6231 and 6231-A auxiliary transmissions are constructed having three speeds forward. There are no speeds in reverse.

As an auxiliary transmission it is designed to be used in conjunction with a standard transmission.

The gear ratios of the Brown-Lipe No. 6231 auxiliary transmission are:

Direct	1.00 to 1
Overdrive	.69 to 1
Underdrive	2.14 to 1

The gear ratios of the Brown-Lipe No. 6231-A auxiliary transmission are:

Direct	1.00 to 1
Overdrive	.86 to 1
Underdrive	1.24 to 1

The following instructions will be found helpful in servicing the unit:

(A) Dismantle transmission:

1. Drain transmission.
2. Remove six cover retaining capscrews and lift off cover assembly and gasket.
3. Remove companion flange nut and flange - front.
4. Remove companion flange nut and flange - rear.
5. Remove power take-off covers and gaskets.
6. Remove countershaft rear bearing cover and shims.
7. Remove mainshaft rear bearing retainers, shims, gasket and speedometer drive gear.
8. Remove seven main drive gear and bearing retainer assembly capscrews and lockwashers.
9. Lift off main drive gear and retainer assembly, leaving pilot bearing in the drive gear.
10. Remove clutch collar from front of mainshaft.
11. Support mainshaft underdrive gear on blocks inside of front face of transmission case. Press mainshaft out of rear bearings, underdrive clutch gear,

collar and underdrive gear. NOTE: Do not lose any of the loose needle bearings located in the underdrive gear. There are 47 rollers in each row of bearings.

12. The mainshaft assembly can then be removed out through front of case and underdrive gear lifted out through top of case.
13. Press out mainshaft rear, outer bearing cup and use a brass drift and carefully drive out mainshaft front bearing cup.
14. Tap forward end of countershaft with soft hammer to drive out countershaft rear bearing cup.
15. Lift countershaft assembly out through top of case and then remove countershaft front bearing cup.

(B) Dismantle countershaft assembly:

1. Remove countershaft rear and front bearing cones.
2. Remove snap-ring from front end of countershaft.
3. Press off countershaft drive gear and remove key.
4. Press off countershaft overdrive gear and remove key.
5. Press off countershaft power take-off gear and remove key.

(C) Dismantle the mainshaft assembly:

1. Remove underdrive clutch gear and collar.
2. Remove mainshaft underdrive gear.
3. Remove snap ring from front end of mainshaft.
4. Remove direct and overdrive clutch gear and collar.
5. Remove overdrive gear and roller bearings. NOTE: There are 47 needle bearings in each of the two rows used, with a spacer sleeve between the rows.

(D) Dismantle shifter housing assembly:

1. Cut lockwires and remove shift fork lock screws.
2. Remove poppet retaining plugs releasing balls and springs.



3. Pull overdrive shift rail out through front of cover and remove shift fork.
4. Pull underdrive shift out through front of cover and remove shift fork.
5. Remove shift rails interlock pin and seals.

(E) Dismantle main drive gear assembly:

1. Remove four oil retainer capscrews and lockwashers and lift off oil retainer and gasket.
2. Lift out spacing washer.
3. Press on end of main drive gear shaft to remove shaft, spacer sleeve, shims and inner bearing cone from retainer. NOTE: Keep shim pack together.
4. Press inner and outer bearing cups out of retainer together with oil sleeve.
5. Remove pilot bearing from main drive gear.

(F) Assemble the main drive gear assembly:

1. Install inner bearing race in the retainer, then place the oil sleeve (or lubricant-dam sleeve) in the retainer with the ridge of the oil sleeve toward inside of the retainer casting. Be sure to locate oil sleeve holes in proper location. The sleeve permits building up a reservoir of oil to assure front bearing lubrication.
2. Press in outer bearing cup.
3. Press inner bearing cone on the main drive gear and install spacer and shims.
4. Slide main drive gear shaft through retainer assembly and install outer cone.
5. Place suitable tubing over end of main drive gear shaft and against outer bearing cone. Press against tubing to seat the bearings and shims. Approximately 30 tons pressure against sleeve will suffice to firmly seat the bearings. Bearing adjustment must be .000" to .002" tight.
6. Install spacing washer and oil retainer on outer end of drive gear shaft retainer.
7. Install companion flange and nut draw down tight.
8. Install mainshaft pilot bearing in main drive gear.

(G) Assemble countershaft assembly:

1. Press countershaft power take-off gear into place after installing holding key.
2. Press countershaft overdrive gear into place after installing holding key.
3. Press countershaft drive gear into place after installing holding key.
4. Install countershaft gear snap ring.
5. Install countershaft front and rear bearing cones.

(H) Assemble mainshaft assembly:

1. Place mainshaft underdrive gear on flat surface and insert a little non-soap, viscous type, low melting point grease in the bore of the gear. Insert one row of roller bearings (47 rollers), and turn gear over and insert spacer.
2. Insert second row of bearings (47 rollers). Note that when all bearings are in place there is a space wide enough for another roller. Do not place another roller in the bearing row. The space is left to provide rolling clearance for all the rollers in that particular row.
3. Repeat roller installation as outlined in paragraphs (1 & 2) with the mainshaft overdrive gear.
4. Slide overdrive gear on shaft being careful not to disturb the rollers.
5. Place clutch gear on mainshaft with flat face of gear toward front of shaft and install gear retaining snap ring.
6. Carefully place mainshaft underdrive gear, with bearings, on shaft with clutch teeth on gear toward rear and install clutch collar.

(I) Assemble transmission shifter housing assembly:

1. Install direct and overdrive shift rail, shift fork, poppet ball and spring, in place in housing cover. (Shift fork must be installed with hub toward rear.)
2. Install shift rail interlock pin.
3. Install underdrive shift rail, shift fork, poppet ball and spring in place in housing. (Shift fork must be installed with hub toward front.)



4. Lock shift forks in place with setscrews and install lockwires through setscrews.
 5. Install poppet springs, balls and retainer plugs.
 6. Install shift rail seals.
- (J) Assemble transmission:
1. Install countershaft front bearing cup in position in front of case.
 2. Install front bearing retainer and gasket.
 3. Place countershaft and gear assembly in position in case and tap toward front of case until gear contacts inside face of case.
 4. Install countershaft rear bearing cup in place in bore of case.
 5. Install rear bearing cap, gasket and shims.

Add or remove shims at rear bearing retainer to provide an adjustment of .000" to .003" loose. Such an adjustment will allow the countershaft to revolve freely and with no perceptible end play or drag.
 6. Remove front bearing retainer and proceed with the assembly.
 7. Holding the mainshaft and gear assembly together, with fingers in clutch collar groove, tilt the shaft, and install in case, being careful to hold underdrive gear and clutch collar in position.
 8. With the mainshaft gears resting on the countershaft, slide the underdrive clutch gear through rear bore onto the mainshaft and into the underdrive clutch collar. NOTE: Beveled end of gear toward rear of case.
 9. Place overdrive clutch collar on direct and overdrive clutch gear with clutch collar teeth toward front.
 10. Install main drive gear and retainer assembly previously assembled.
 11. Install rear bearing cups, cones, speedometer drive gear, and bearing retainer with shims.
 12. Adjust mainshaft assembly to obtain .000" to .003" loose bearing adjustment.
 13. Install companion flange, nut and cotter key - tighten securely.
 14. Install transmission cover assembly, being sure that the shifting forks engage clutch collars and tighten all capscrews securely.
 15. Fill with specified lubricant per lubrication section - (Capacity 8 pints).



WHEELS AND RIMS GROUP

SECTION "A"

General	Page 1
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Rear wheel bearing adjustment	1, 2
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Oil seals - rear wheels (Timken axles)	3, 4
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TIRES

SECTION "B"

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WHEELS

General

Tapered roller bearings carry the wheels and are adjustable. Satisfactory operation and life depends upon correct adjustment and proper lubrication. Every 3,000 to 5,000 miles remove the wheels, clean and inspect the bearings, races and wheel hubs. Then repack the bearings, replace the wheels and adjust the bearings. Use a short fibre wheel bearing grease.

Illustrations used in this section may vary due to the availability of Stamped, Cast and Budd wheels on various models, but the arrangement of bearings, grease seals and retainers are similar. Therefore, use illustrations for wheel mounting on the axle ONLY and disregard the design of wheel and brake.

Front Wheel Bearing Adjustment

Use an 8" wrench and apply steady pressure with one hand, pulling up the adjusting nut until a definite drag is felt on the wheel. Rotate wheel at the same time nut is being tightened to be sure that all parts are correctly seated. Back-off nut to first castellation and install new cotter pin.

Front wheel bearings should never be given a loose adjustment for such will not permit the rollers and races to be in proper contact and bearing failure will result.

Rear Wheel Bearing Adjustment

Rotate wheel and tighten inner adjusting nut until a drag or bind is felt, then back off nut about 1/6" turn. Install lockwasher and outer nut, and after tightening securely, check the adjustment. There should be a very slight shake in the wheel (with axle shaft removed) if the adjustment is correct.

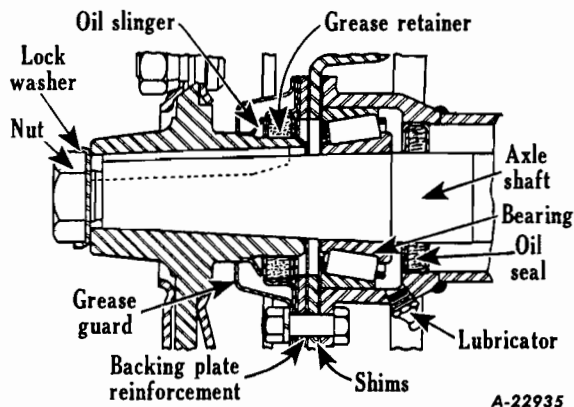


Fig. 1

A-22935

NOTE: R-1060 series axle (Semi-floating) rear wheel bearings are adjusted by shims located between backing plate and end of axle housing. (See Fig. 1.)

Remove plug and install lubricator fitting as shown in Fig. 1 to lubricate bearing, re-install plug.

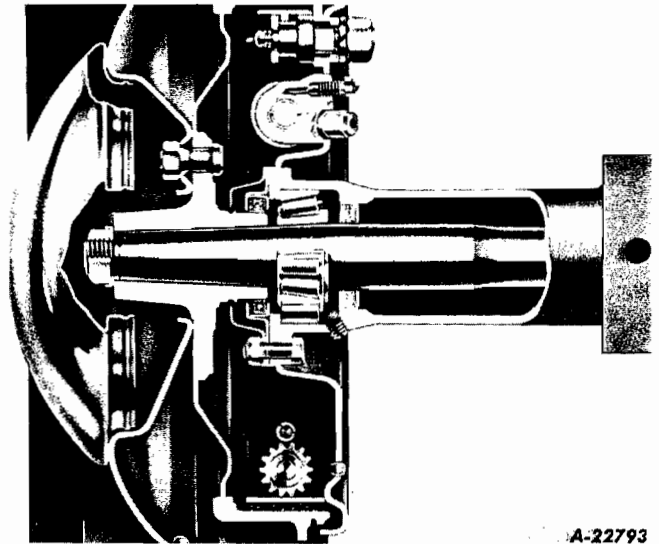


Fig. 2

Fig. 2 illustrates construction details of rear wheel assembly on axles R-1060 series.

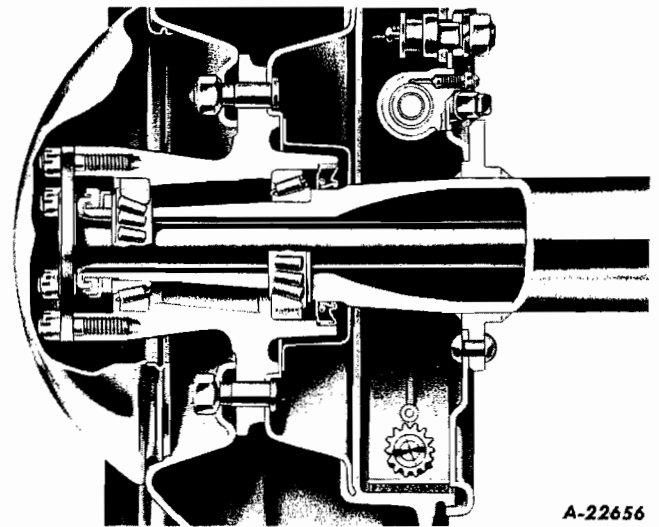


Fig. 3

Fig. 3 illustrates construction details at rear wheel assembly on axles R-1070 series.

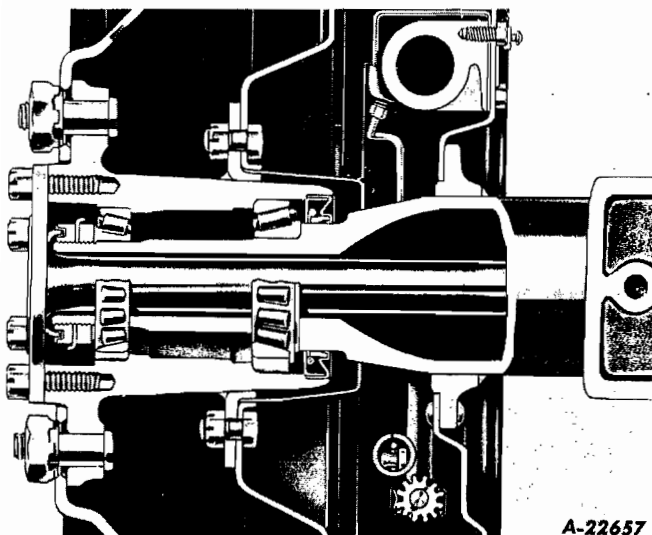


Fig. 4

Fig. 4 illustrates construction details at rear wheel assembly on axles R-1165 and R-1170 series.

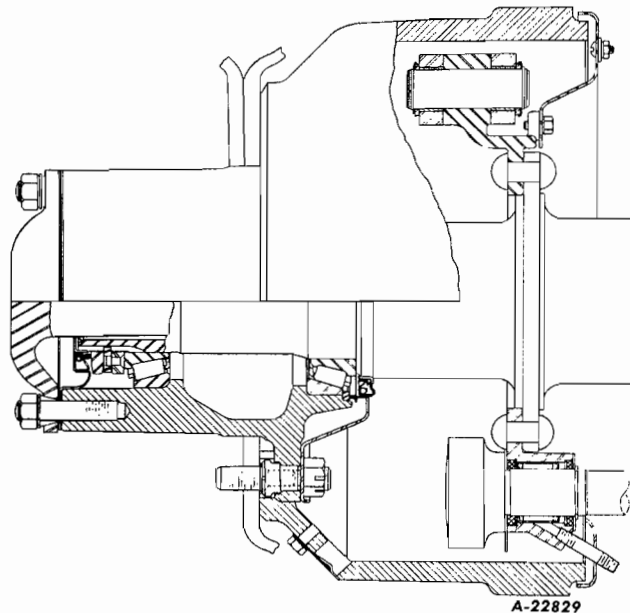


Fig. 6

Fig. 6 illustrates construction details at rear wheel assembly on axles of R-1741 series.

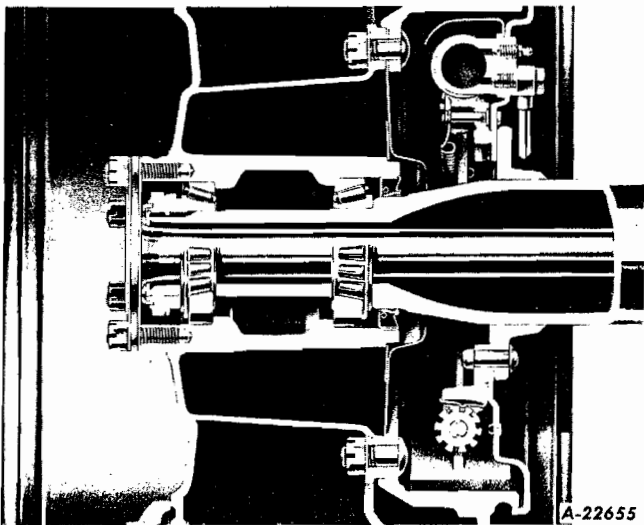


Fig. 5

Fig. 5 illustrates construction details at rear wheel assembly on axles of R-1440, R-1470, R-1530, R-2470, R-2475, R-2490, R-1555, R-1630, R-2580, R-2600, R-1540, R-1640, RF-1455, RF-1575, RF-1670, R-2465, R-2466 and R-2585 series.

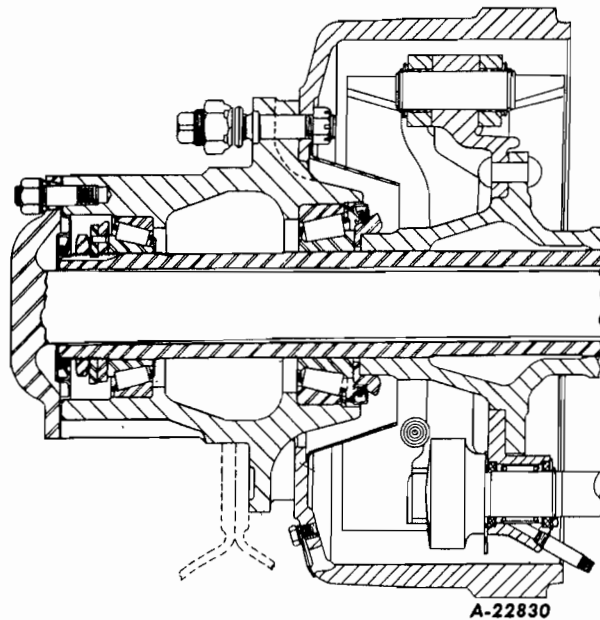


Fig. 7

Fig. 7 illustrates construction details at rear wheel assembly on axles of R-1731, R-1810, R-2741 and R-2800 series.



L-LINE MOTOR TRUCK SERVICE MANUAL

Oil Seals - Front Wheels

The front wheel oil seal should be inspected when hub or wheel is removed and replaced if necessary. When installing new seal, dip in light oil first and make sure it is properly installed in the hub to assure satisfactory service. The machined surface of the steering knuckle must be clean and free of nicks and burrs so that sealing element can seat properly on the surface provided.

Oil Seals - Rear Wheels

Place inner seal assembly in hub and drive carefully into place being sure that the seal bottoms and is aligned square with the hub. The outer seal is assembled into the bearing lock nut and is self adjusted on the axle shaft when the axle shaft is tightened against the hub. Machined surfaces of the axle housing and shaft must be clean and free of nicks and burrs to assure satisfactory service of the seals.

Oil Seals - Rear Wheels (Timken Axles)

The inner and outer wheel hub oil seals must be properly installed to assure satisfactory service. Machined surfaces of component parts and sealing surfaces of wiper rings must be clean and free of nicks or burrs. The sealing elements must seat evenly on the wiper rings.

Special tools (SE-1581) have been provided for proper installation of oil seals and wiper rings. The following illustrations show these tools in use for their specific application.

Lubricate inner seat with wheel bearing grease and place on end of axle housing. Using inner seal adapter and driving sleeve, drive the seal carefully onto the end of the axle housing until it is seated firmly against shoulder on the housing (Fig. 8).

Using a square as shown in Fig. 9, check from the end of the axle housing to the face of the sealing element at 90° intervals. The sealing element should not be in excess of .010" off parallel with the end of the housing.

Install inner seal wiper ring in wheel hub as shown in Fig. 10. The ring has one face ground and one face polished. Position the polished face outward to contact the sealing element, and the ground face seated firmly against inner bearing cup.

Following installation of the wiper ring, check installation using a .002" feeler gauge (Fig. 11) between the ring and bearing race. If the ring is in excess of .002" off parallel with the bearing cup, remove ring, check for dirt or other obstruction and reinstall.

Install inner wheel bearing. (Bearing must be properly lubricated before installation.) Install wheel hub assembly and outer wheel bearing. Turn inner nut until it is tight against the outer bearing cone and at the same time revolve the wheel to seat the tapered bearings and oil seal. Continue to tighten the nut, while revolving the wheel until a definite drag is felt, and then back off about one-sixth of a turn. Place the locking washer on the axle with the lug in the groove. Place the washer against the nut so that the pin in the nut enters one of the holes in the washer, using either side of the locking washer to accomplish this. If it is necessary to turn the inner nut to bring the pin into line with one of the holes, install washer so that the least movement of the nut is necessary. Install outer nut and tighten securely.

Install the outer oil seal wiper ring and gasket (Fig. 12).

Place gasket inside cup of wiper ring and over end of axle housing end. Use adapter driver and drive the outer wiper ring carefully onto the end of the axle housing until it seats firmly against the gasket.

Place gasket against wheel hub as shown in Fig. 13.

Install outer seal assembly and place outer gasket over hub studs. Install axle shaft, tapered dowels, lock washers and stud nuts, and tighten securely.

Wheels and Rims

Wheel stud nuts should be inspected and tightened at regular intervals. Rim clamp nuts should be kept tight and the rim and tire alignment in relation to the wheel should be checked to make sure tire is running true.

Where left- and right-hand thread studs and nuts are used, the left-hand thread nuts can be identified by a small groove machined around the flats and the studs, by letter "L" stamped on the head. Use left-hand nuts (stamped "L") on the left side of truck.

Wheel Bolt Nut Tensions (Disc Wheels)

KELSEY-HAYES WHEELS -- When tightening wheel bolt nuts on Kelsey-Hayes disc wheels, do not use excessive leverage. Use a wrench of the same length as that furnished with the tool kit.

BUDD WHEELS -- When tightening wheel bolt nuts on Budd disc wheels, use wrench which will provide sufficient leverage to tighten as follows: (see next page)



9/16" Bolt -- tighten to 250 foot-pounds.
(100 pounds pressure on a 2-1/2 foot wrench.)
3/4" Bolt -- tighten to 350 foot-pounds.
(140 pounds pressure on a 2-1/2 foot wrench.)

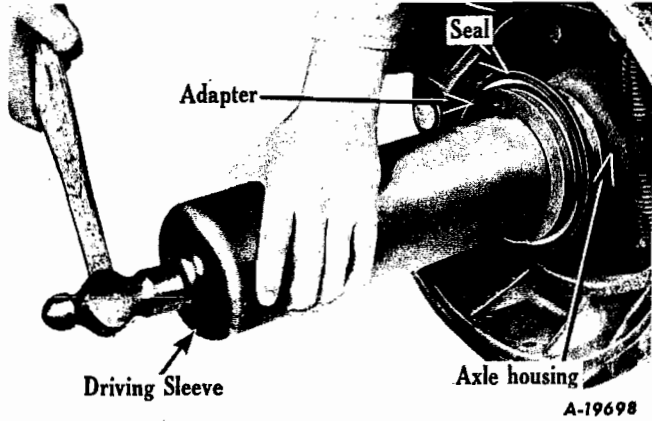


Fig. 8 - Installing inner oil seal on axle housing.

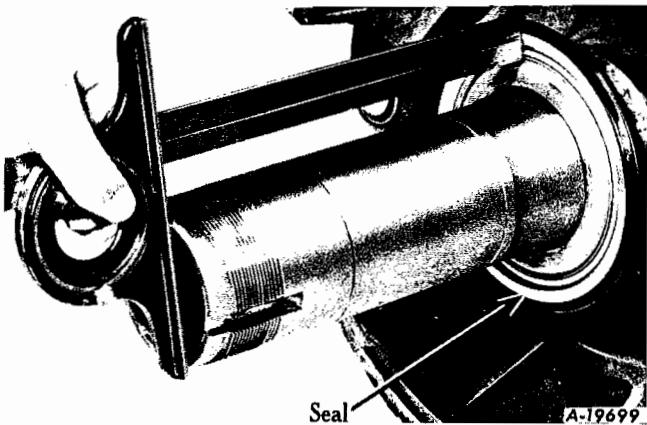


Fig. 9 - Checking alignment of inner seal assembly.

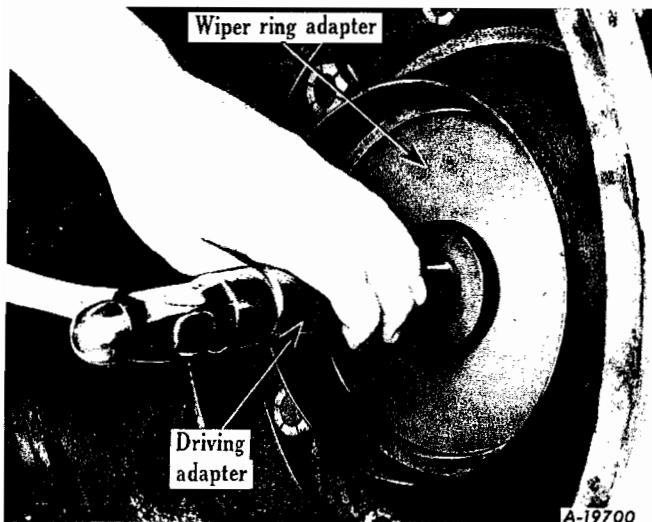


Fig. 10 - Installing inner wiper ring in wheel hub.

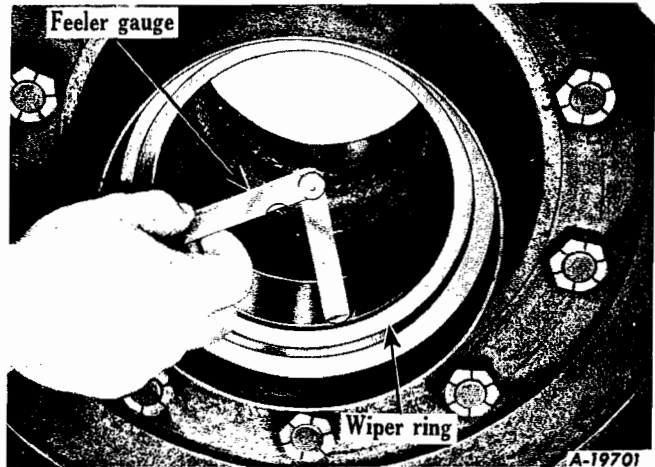


Fig. 11 - Checking wiper ring alignment.

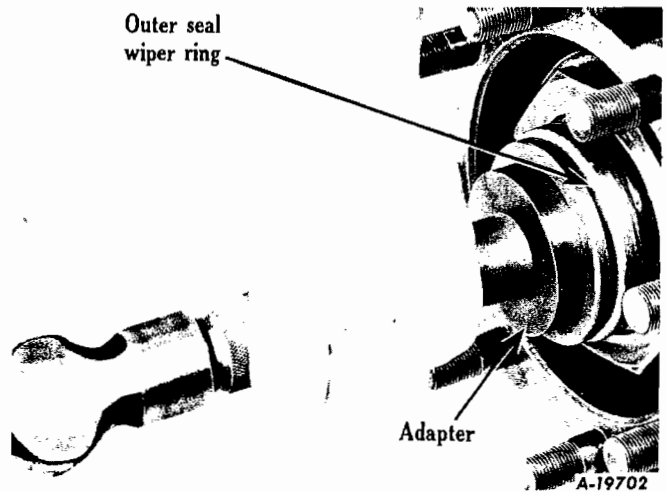


Fig. 12 - Installing outer wiper seal ring.

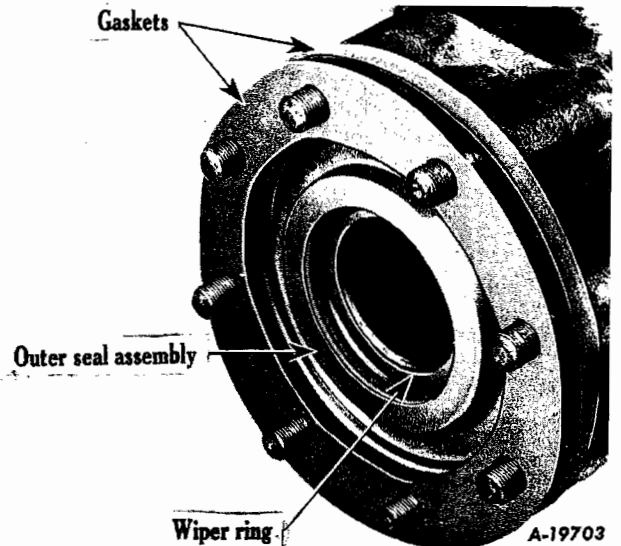


Fig. 13 - Outer seal and gaskets installed.

TIRES

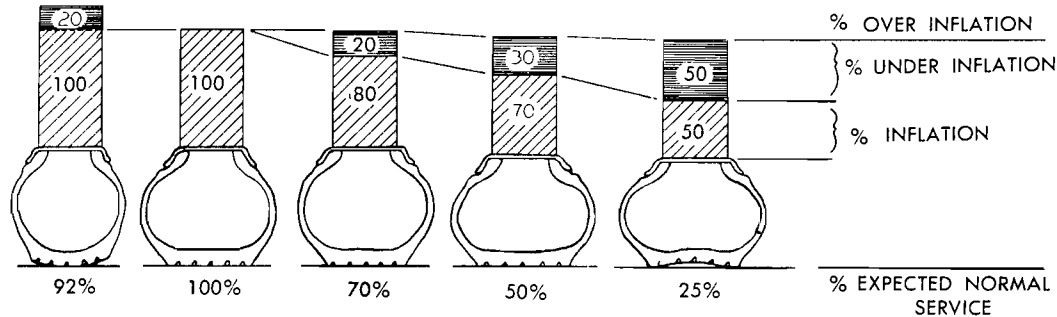
Tire Inflation

Proper tire inflation, tire loads, and road speeds are important determining factors governing tire mileage, and also affect steering ease and maneuverability. Inflation pressures should be checked at regular and frequent intervals and the pressures maintained to specifications. Use an accurate tire pressure gauge.

Inflation

Inflation pressures should be checked when tires are cool. Never bleed a hot tire.

The chart (Fig. 7) illustrates the loss in tire mileage caused by under inflation. It will be noted that a tire under-inflated only 20% will produce only 70% normal mileage.



A-16013

Fig. 1 - Inflation vs. Mileage.

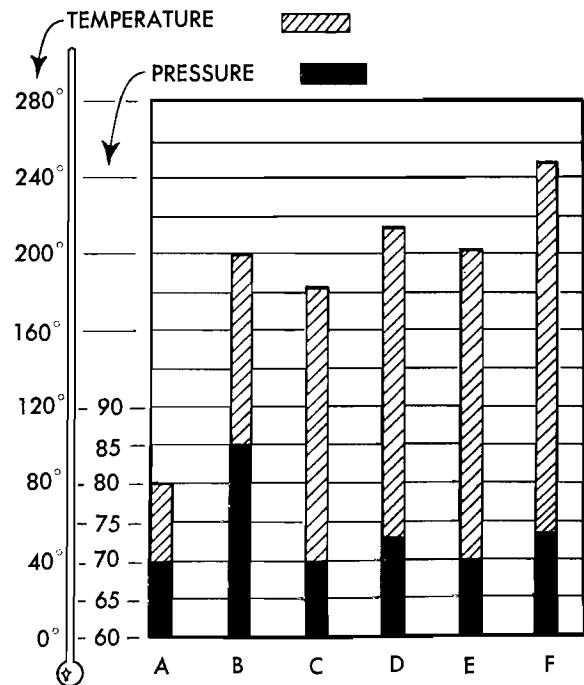
Over-inflation is also costly for a tire which is 20% over-inflated will produce only 92% normal tire mileage.

"Bleeding" of air from hot tires should never be practiced. The pressure will be reduced but an increase in temperature will result as soon as the driving continues.

The chart (Fig. 2) illustrates a condition where a tire was started cool with a pressure of 70 pounds, and at a temperature of 80°:

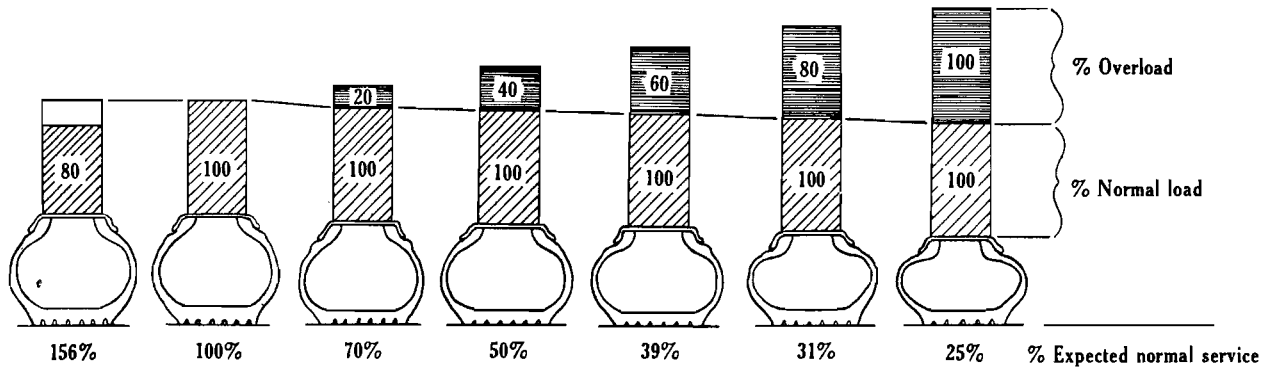
- (A) Initial conditions.
- (B) After 140 miles of driving the pressure had increased to 85 pounds and temperature to 200°.
- (C) The pressure was then "bled" to 70 pounds and an additional drive made of 140 miles. Note the temperature.
- (D) The pressure had now increased to 73 pounds but the temperature increase was approximately 220°.
- (E) Again "bleeding" was resorted to. Note the temperature.
- (F) After 200 miles the tire failed from a temperature of over 250°.

- A—INITIAL CONDITIONS
- B—AFTER 140 MILES
- C—PRESSURE "BLED"
- D—140 MILES AFTER "BLEEDING"
- E—PRESSURE "BLED"
- F—AFTER 200 MILES—TIRE FAILED



A-16011

Fig. 2 - Effects of "Bleeding".



A-16012

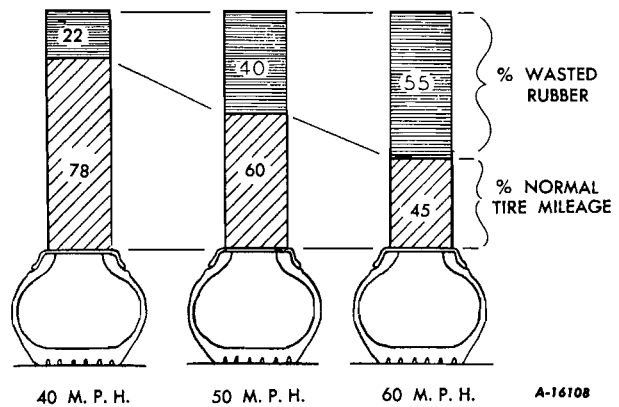
Fig. 3 - Overload vs. Mileage.

Overloading

Loading tires beyond their rated capacity is expensive, because tire mileages are rapidly decreased with overloads. The above chart (Fig. 3) illustrates how an overload of only 20% will result in tire mileage being only 70% of normal.

Speeds

Excessive speed is definitely one of the most important factors in loss of tire mileage. The chart (Fig. 4) illustrates how an increase in speed from 40 to 50 m.p.h. results in an 18% loss in mileage. An increase of speed from 40 to 60 m.p.h. results in a 33% mileage loss.



A-16108

Fig. 4 - Speed vs. Mileage.



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SERVICE LOAD AND INFLATION TABLE

TIRE SIZE	PLY RATING	LOADS AT VARIOUS INFLATION PRESSURES										
		32	36	40	45	50	55	60	65	70	75	80
6.00x16	6	990	1065	<u>1130</u>								
6.00x20	6	1040		1225	1325	<u>1400</u>						
6.00x20	8					<u>1400</u>	1475	1550	1625	<u>1700</u>		
6.50x16	6	1135	1215	<u>1290</u>								
6.50x17	6			<u>1300</u>	1400	<u>1500</u>						
6.50x20	6			1500	1600	<u>1700</u>						
6.50x20	8					<u>1700</u>	1775	1850	<u>1950</u>			
7.00x16	6		1395	<u>1485</u>								
7.00x17	6			<u>1475</u>	1575							
7.00x17	8			1475	<u>1575</u>	1675	<u>1775</u>					
7.00x18	8			1525	1650	1750	<u>1850</u>					
7.00x20	8			1650	1775	1900	<u>2000</u>					
7.00x20	10						<u>2000</u>	2075	2150	<u>2250</u>		
7.00x24	10						2300	2375	2475	<u>2575</u>		
7.50x16	6	1455	<u>1560</u>									
7.50x16	8		<u>1560</u>	1650	1760	<u>1850</u>						
7.50x17	8			1650	1775	<u>1900</u>	2000	<u>2100</u>				
7.50x18	8			1750	1875	2000	2100	<u>2200</u>				
7.50x20	8			1875	2000	2125	2250	<u>2375</u>				
7.50x20	10						2250	2375	2500	2600	<u>2700</u>	
7.50x24	10						2550	2700	2850	2975	<u>3100</u>	
8.25x17	10			1950	2080	2200	2330	2470	<u>2585</u>			
8.25x18	10			2000	2150	2300	2425	2550	<u>2675</u>			
8.25x20	10			2175	2325	2475	2600	2750	<u>2900</u>			
8.25x20	12							2750	2900	3025	<u>3150</u>	
9.00x18	10				2600	2775	2925	3075	<u>3225</u>			
9.00x18	12								<u>3225</u>	3350	3475	<u>3600</u>
9.00x20	10				2775	2950	3125	3300	<u>3450</u>			
9.00x20	12								<u>3450</u>	3600	3725	<u>3850</u>
9.00x22	10				2950	3150	3325	3500	<u>3675</u>			
9.00x24	10				3175	3375	3575	3750	<u>3925</u>			
9.00x24	12								<u>3925</u>	4100	4250	<u>4375</u>
10.00x18	12					3100	3275	3450	3600	<u>3775</u>		
10.00x20	12					3275	3475	3650	3825	<u>4000</u>		
10.00x20	14									<u>4000</u>	4175	<u>4350</u>
10.00x22	12					3500	3700	3900	4100	<u>4275</u>		
10.00x24	12					3725	3950	4150	4250	<u>4550</u>		
11.00x20	12					3700	3900	4100	4300	<u>4500</u>		
11.00x20	14								4300	<u>4500</u>	4675	<u>4850</u>
11.00x22	12					3900	4125	4350	4550	<u>4750</u>		
11.00x24	12					4100	4350	4575	4800	<u>5000</u>		
11.00x24	14									<u>5000</u>	5200	<u>5400</u>
12.00x20	14							4625	4850	5075	<u>5275</u>	
12.00x22	14							4900	5150	5375	<u>5600</u>	
12.00x24	14							5200	5450	5700	<u>5925</u>	
13.00x20	16								5775	6025	<u>6275</u>	
13.00x24	16								6475	6750	<u>7025</u>	
14.00x20	18									7075	7350	<u>7650</u>
14.00x24	18									7900	8225	<u>8525</u>

Underscoring denotes maximum recommended loads.
Duals will carry twice the load of corresponding singles.

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WHEEL, RIM, AND HUB BOLT TENSION APPLICATION CHART

TRUCK MODEL SERIES	PART	BOLT & STUD PART NO.	BOLT & STUD SIZE	NUT PART NO.	TYPE BOLT	WHERE USED	TYPE WHEEL	APPLI-CATION TENSION FT.-LBS.
L-110	Bolt	69956-H	1/2-20NF	69958-H		Hub to Wheel	F & R	80-90
	Bolt	69955-H	1/2-20NF	69957-H		Hub to Wheel	Kelsey-Hayes	80-90
L-120	Stud	96914-H	9/16-18NF	96916-H		Hub to Wheel	Rear	175-200
	Stud	96915-H	9/16-18NF	96917-H		Hub to Wheel	Budd	175-200
LM-120	Stud	96914-H	9/16-18NF	96916-H		Hub to Wheel	Front	175-200
	Stud	96915-H	9/16-18NF	96917-H		Hub to Wheel	Budd	175-200
L-120	Stud	81362-H	9/16-18N	81364-H		Hub to Wheel	Rear Budd	175-200
	Stud	81363-H	9/16-18N	81365-H		Hub to Wheel	Dual	175-200
L-120	Stud	96914-H	9/16-18NF	96916-H		Hub to Wheel	Rear	175-200
	Stud	96915-H	9/16-18NF	96917-H		Hub to Wheel	Budd	175-200
L-120	Stud	81368-H	9/16-18N	81364-H		Hub to Wheel	Rear	175-200
	Stud	81369-H	9/16-18N	81365-H		Hub to Wheel	Budd - Dual	175-200
L-150	Bolt	119343-H	5/8-18NF	12261-H	4	Wheel to Drum	Rear	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
L-150	Bolt	70647-R1	1/2-20NF	12260-R1	4	Wheel to Drum	Front	80-90
	Bolt	78193-R1	3/4-16N	84712-H		Hub to Wheel	Budd	300-350
	Bolt	78194-R1	3/4-16N	84711-H		Hub to Wheel		300-350
L-150	Bolt	70647-R1	1/2-20NF	12260-R1	4	Wheel to Drum	Rear	80-90
	Bolt	78193-R1	3/4-16N	84711-R1		Hub to Wheel	Budd	300-350
	Bolt	78194-R1	3/4-16N	84712-R1		Hub to Wheel		300-350
L-150	Bolt	78193-R1	3/4-16N	83155-R1		Wheel to Hub	Rear	300-350
		78194-R1	3/4-16N	83156-R1		Wheel to Hub	Budd	300-350
	Bolt		3/4-16N	41419-V		Wheel to Hub	Dual	300-350
			3/4-16N	41420-V		Wheel to Hub		300-350
L-150	Bolt	82115-R1	1/2-20NF	12260-R1	4	Wheel to Drum	Front	80-90
	Bolt	61883-R1	1/2-13NC	22230-V	2	Wheel to Rim	Cast	70-80
L-150	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Rear	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
L-160	Bolt	82115-R1	1/2-20NF	12260-R1	4	Wheel to Drum	Front	80-90
	Bolt	61883-R1	1/2-13NC	22230-V	2	Lug to Rim	Cast	70-80
L-160	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Rear	150-180
	Bolt	61883-R1	1/2-13NC	22230-V	2	Lug to Rim	Cast - Single	70-80
L-160	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Rear	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4	Lug to Rim	Cast - Single	150-160
L-160	Stud	80339-R1	3/4-16N	84711-H		Hub to Wheel	Front	300-350
	Stud	80340-R1	3/4-16N	84712-H		Hub to Wheel	Budd	300-350
L-160	Stud	69327-R2	3/4-16N	41419-V		Hub to Wheels	Rear	300-350
		69328-R2	3/4-16N	41420-V		Hub to Wheels	Budd	300-350
	Stud		1-1/8-16N	83155-H		Hub to Wheels	Dual	250-300
			1-1/8-16N	83156-H		Hub to Wheels		250-300



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TRUCK MODEL SERIES	PART	BOLT & STUD PART NO.	BOLT & STUD SIZE	NUT PART NO.	TYPE BOLT	WHERE USED	TYPE WHEEL	APPLI-CATION TENSION FT.-LBS.
L-160	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear - Dual Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
LF-170	Bolt	78167-R1	5/8-18NF	12261-R1	4	Hub to Drum Lug to Wheel	Rear Dual	150-180
	Bolt	77602-R1	5/8-11NC	21814-H	4			150-160
LF-170	Stud	80339-R1	3/4-16N	41419-V		Hub & Drum to Wheel Hub & Drum to Wheel Hub & Drum to Wheel Hub & Drum to Wheel	Rear Budd Dual	300-350
		80340-R1	3/4-16N	41420-V				300-350
	Stud	1-1/8-16N	83155-H	250-300				
		1-1/8-16N	83155-H	250-300				
LF-170	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
L-170 & L-180	Bolt	82115-R1	1/2-20NF	12260-R1	4	Wheel to Drum Lug to Rim	Front Cast	80-90
	Bolt	61883-R1	1/2-13NC	22230-V	2			70-80
L-180	Bolt	78167-R1	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear Dual	150-180
	Bolt	77602-R1	5/8-11NC	21814-H	4			150-160
L-170 & L-180	Bolt	X-4725-173	3/8-24NF	12259-R1		Hub to Drum Lug to Rim	Front Steel	40-50
	Bolt	X-4725-172	5/8-11NC	21814-H				150-160
L-180	Bolt	119343-H	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
L-170	Bolt	78167-R1	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear Steel	150-180
	Bolt	77602-R1	5/8-11NC	21814-H	4			150-160
L-170	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
L-170 & L-180	Stud	144235-H	1/2-20NF	12260-R1	4	Hub to Drum Hub to Wheel Hub to Wheel	Front Budd	80-90
		55539-R1	3/4-16N	84711-H				300-350
		55540-R1	3/4-16N	84712-H				300-350
L-190	Stud	91862-HA	1/2-20NF	12260-R1	4	Hub to Drum Lug to Rim	Front Cast	80-90
		91872-H	5/8-11USS	21814-H	4			150-160
L-190	Bolt	61830-HA	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear Cast	150-180
		75887-H	5/8-11NC	21814-H	4			150-160
L-190	Stud	137991-H	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear Cast	150-180
		54494-R1	3/4-10USS	54495-R1	SAE-3135			180-200
L-190	Stud	69354-R1	3/4-16N	131258		Drum to Wheel Drum to Wheel Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub	Rear Budd Dual	200-230
		69355-R1	3/4-16N	131258				200-230
			3/4-16N	41419-V				300-350
			3/4-16N	41420-V				300-350
			1-1/8-16N	83155-H				250-300
			1-1/8-16N	83156-H				250-300
L-190	Stud	55575-H	3/4-16N	131258		Drum to Hub Drum to Hub Wheel to Hub Wheel to Hub	Rear Budd Dual	200-230
		55576-H	3/4-16N	131258				200-230
			3/4-16N	41419-V				300-350
			3/4-16N	41420-V				300-350
L-190			1-1/8-16N	83155-H		Wheel to Hub Wheel to Hub	Rear Budd Dual	250-300
			1-1/8-16N	83156-H				250-300
L-190	Stud	119343-H	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear - Dual Cast	150-180
		75887-H	5/8-11NC	21814-H	4			150-160

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TRUCK MODEL SERIES	PART	BOLT & STUD PART NO.	BOLT & STUD SIZE	NUT PART NO.	TYPE BOLT	WHERE USED	TYPE WHEEL	APPLI-CATION TENSION FT.-LBS.
L-190	Stud	119343-H	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear - Cast Dual	150-180
	Stud	75887-H	5/8-11NC	21814-H	4			150-160
L-190	Stud	55575-H	3/4-16N	131258		Drum to Hub Drum to Hub Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub	Rear - Dual Budd	200-230
	Stud	55576-H	3/4-16N	131258				200-230
			3/4-16N	41419-V				300-350
			3/4-16N	41420-V				300-350
			1-1/8-16N	83155-H				250-300
			1-1/8-16N	83156-H				250-300
L-190	Bolt	55505-H	1/2-20NF	12260-R1	4	Hub to Drum Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub	Front Budd	80-90
	Stud	136339-H	3/4-16N	131258	300-350			
	Stud	136340	3/4-16N	131258	300-350			
			3/4-16N	84711-H	300-350			
			3/4-16N	84712-H	300-350			
L-190	Bolt	119344-H	1/2-20NF	12260-H	4	Wheel to Drum Lug to Rim	Front Cast	80-90
	Bolt	68333-H	5/8-11NC	21814-H	4			150-160
LF-190	Bolt	78167-R1	5/8-18NF	12261-R1	4	Hub to Drum Lug to Rim	Rear Steel	150-180
	Bolt	77602-R1	5/8-11NC	21814-H	4			150-160
LF-190	Bolt	78193-R1	3/4-16N	41419-V		Hub & Drum to Wheel Hub & Drum to Wheel Hub & Drum to Wheel Hub & Drum to Wheel	Rear Budd Dual	300-350
	Bolt	78194-R1	3/4-16N	41420-V				300-350
			1-1/8-16N	83155-H				250-300
			1-1/8-16N	83156-H				250-300
LF-190	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
L-204 & L-225	Stud	48796-H	3/4-16NAT	131258		Drum & Wheel to Hub Drum & Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub	Rear Budd Dual	300-350
	Stud	48797-H	3/4-16NAT	131258				300-350
			3/4-16N	41419-V				300-350
			3/4-16N	41420-V				300-350
			1-1/8-16N	83155-H				250-300
			1-1/8-16N	83156-H				250-300
L-205 & L-225	Bolt	61830-HA	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
L-204 & L-225	Bolt	61830-HA	5/8-18NF	12261-R1	4	Wheel to Drum Lug to Rim	Rear Cast	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4			150-160
L-205 & L-225	Stud	69354-R1	3/4-16N	131258		Hub to Drum Hub to Drum Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub	Rear Budd Dual	200-230
	Stud	69355-R1	3/4-16N	131258				200-230
			3/4-16N	41419-V				300-350
			3/4-16N	41420-V				300-350
			1-1/8-16N	83155-H				250-300
			1-1/8-16N	83156-H				250-300
L-205 & L-225	Bolt	71541-R1	5/8-18NF	12261-R1	2	Hub to Drum Lug to Rim	Rear Cast	150-180
	Stud	54494-R1	3/4-10USS	54495-R1	SAE-3135			180-200
L-204 & L-225	Bolt	71541-R1	5/8-18NF	12261-R1	2	Hub to Drum Lug to Rim	Rear Cast	150-180
	Stud	54494-R1	3/4-10USS	54495-R1	SAE-3135			180-200
L-200	Stud	61565-R1	3/4-16N	131258		Hub to Drum Hub to Drum Wheel to Hub Wheel to Hub Wheel to Hub Wheel to Hub	Rear Budd	200-230
	Stud	61566-R1	3/4-16N	131258				200-230
			3/4-16N	41419-V				300-350
			3/4-16N	41420-V				300-350
			1-1/8-16N	83155-H				250-300
			1-1/8-16N	83156-H				250-300



L-LINE MOTOR TRUCK SERVICE MANUAL

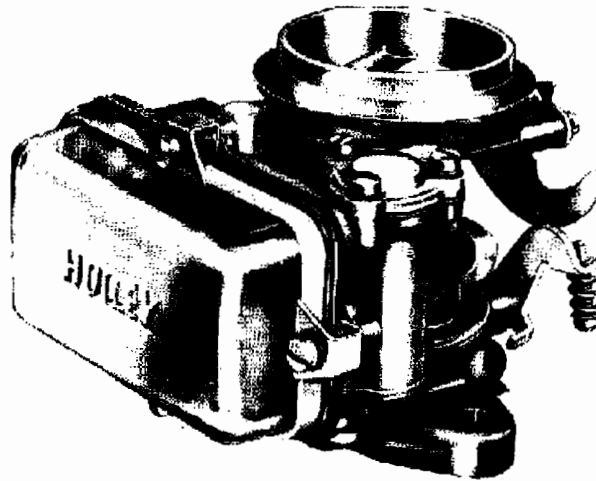
TRUCK MODEL SERIES	PART	BOLT & STUD PART NO.	BOLT & STUD SIZE	NUT PART NO.	TYPE BOLT	WHERE USED	TYPE WHEEL	APPLI-CATION TENSION FT.-LBS.
L-200	Stud	182820	5/8-18NF	12261-R1	2	Hub to Drum	Front	150-180
	Stud	31714-V	3/4-16AM.N	131258		Wheel to Hub	Budd	300-350
	Stud	31715-V	3/4-16AM.N	131258		Wheel to Hub		300-350
			3/4-16AM.N	84711-H		Wheel to Hub		300-350
			3/4-16AM.N	84712-H		Wheel to Hub		300-350
L-200	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Front	150-180
	Bolt	68333-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
L-200	Bolt	61830-HA	5/8-18NF	12261-R1	4	Wheel to Drum	Rear	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
L-210	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Front	150-180
	Bolt	100568-H	3/4-16N	131258		Wheel to Hub	Budd	300-350
	Bolt	100569-H	3/4-16N	131258		Wheel to Hub		300-350
			1-1/8-16N	83156-H		Wheel to Hub		250-300
		1-1/8-16N	83155-H	Wheel to Hub		250-300		
L-210	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Front	150-180
	Bolt	68333-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
L-210	Bolt	115380-H	5/8-18NF	12261-R1	4	Wheel to Drum	Front	150-180
	Stud	91872-H	5/8-11USS	21814-H	4	Lug to Rim	Cast	150-160
L-210	Bolt	119343-H	5/8-18NF	12261-R1	4	Wheel to Drum	Front	150-180
	Bolt	68333-H	5/8-11NC	21814-H		Lug to Rim	Cast	150-160
L-210	Stud	48796-H	3/4-16N	131258		Hub to Drum	Rear	200-230
	Stud	48797-H	3/4-16N	131258		Hub to Drum	Budd	200-230
			3/4-16N	41419-V		Wheel to Hub		300-350
			3/4-16N	41420-V		Wheel to Hub		300-350
			1-1/8-16N	83155-H		Wheel to Hub		250-300
			1-1/8-16N	83156-H		Wheel to Hub		250-300
L-210	Stud	48796-H	3/4-16N	131258		Hub to Drum	Rear	200-230
	Stud	48797-H	3/4-16N	131258		Hub to Drum	Budd	200-230
			3/4-16N	41419-V		Wheel to Hub		300-350
			3/4-16N	41420-V		Wheel to Hub		300-350
			1-1/8-16N	83155-H		Wheel to Hub		250-300
			1-1/8-16N	83156-H		Wheel to Hub		250-300
L-210	Bolt	119343-H	5/8-18NF	12261-R1	4	Hub to Drum	Front	150-180
	Stud	54477-R1	3/4-16N	131258		Wheel to Hub	Budd	300-350
	Stud	54478-R1	3/4-16N	131258		Wheel to Hub		300-350
	Stud	54477-R1	1-1/8-16N	83156-H		Wheel to Hub		250-300
	Stud	54478-R1	1-1/8-16N	83155-H		Wheel to Hub		250-300
L-210	Stud	71541-R1	5/8-18NF	12261-R1	2	Wheel to Drum	Rear	150-180
	Stud	54494-R1	3/4-10USS	54495-R1		SAE-3135	Lug to Rim	Cast	180-200
L-210	Bolt	61830-HA	5/8-18NF	12261-R1	4	Wheel to Drum	Rear	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
LF-210	Bolt	61830-HA	5/8-18NF	12261-R1	4	Wheel to Drum	Rear	150-180
	Bolt	75887-H	5/8-11NC	21814-H	4	Lug to Rim	Cast	150-160
LF-210	Stud	61229-H	3/4-16N	131258		Drum to Hub	Rear	200-230
	Stud	61228-H	3/4-16N	131258		Drum to Hub	Budd	200-230
			3/4-16N	41419-V		Wheel to Hub		300-350
			3/4-16N	41420-V		Wheel to Hub		300-350
			1-1/8-16N	83156-H		Wheel to Hub		250-300
			1-1/8-16N	83155-H		Wheel to Hub		250-300

MEMORANDA

MEMORANDA

CARBURETOR

MODEL NO. 1704
FOR
INTERNATIONAL
HARVESTER CO.



DOWNDRAFT CARBURETOR

AUGUST 1953



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SERVICE MANUAL

VAN DYKE, MICHIGAN U.S.A. . . . PUBLICATIONS DEPARTMENT



CARBURETOR MODEL 1904

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INTRODUCTION

The Holley Carburetor Model 1904 is a notable advance in carburetion engineering. It combines the time-proved Holley characteristics of efficiency, dependability, and effective performance in a compact unit of outstanding simplicity.

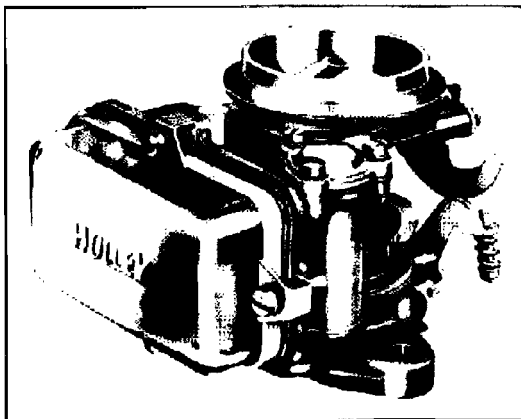
The elimination of the conventional air horn has resulted in a carburetor less than two thirds the height, but having a capacity comparable to units of standard design. By locating the choke plate in the venturi, the elimination of the air horn has been accomplished with no loss in efficiency or performance. In addition, the arrangement of the mixture discharging components in relation to the choke plate when open, aids in the distribution and vaporization of the fuel discharged into the airstream passing through the venturi.

In line with the advanced engineering conception of this carburetor is the transparent fuel bowl of most versions of this carburetor model. This transparent fuel bowl greatly simplifies trouble shooting and carburetor servicing. Overhaul procedure also has been simplified by combining most of the fuel metering elements of the carburetor in a single, easily replaceable assembly.

Close attention to design details has resulted in the improvement of various other parts. A spring arrangement is incorporated in the fuel inlet needle to cushion float movement and act as a vibration dampener to stabilize the fuel level on rough roads. The conventional economizer piston and accelerating pump piston have been replaced by neoprene diaphragms to insure more positive action and increased service life.

This manual includes a full factory-approved overhaul procedure together with much valuable information on the description, operation, and adjustment of the Carburetor Model 1904. Careful adherence to the procedures given in overhauling this carburetor will insure the retention of the high standard of economical, efficient, and dependable performance, characteristic of all Holley products, which is delivered by this carburetor.

DESCRIPTION



HOLLEY CARBURETOR MODEL
1904 STANDARD ENGINE

1. DESIGN

The Holley Carburetor Model 1904 is a single-barrel downdraft unit of advanced design. This carburetor is a model of noteworthy compactness and simplicity with its many new features assuring

ing lasting, effective, and dependable service.

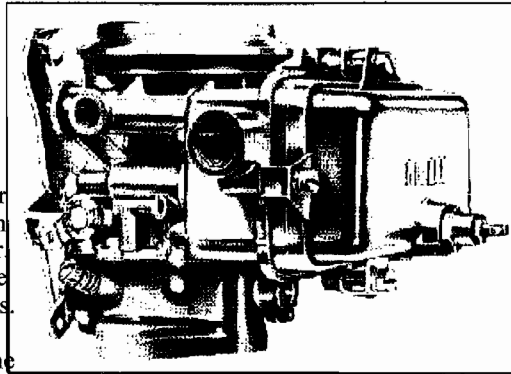
Most versions of this carburetor model contain a tempered glass fuel bowl which permits visual inspection of the float chamber. The action of the float and of the economizer stem during operation can be readily observed. Fuel level is clearly visible and the presence of water or sediment in the float chamber is readily detected.

Fuel from the carburetor fuel inlet discharges below the fuel level in the float chamber to prevent foaming or splashing, assuring a constant, uninterrupted fuel flow to the metering components of the carburetor. Fuel in the float chamber circulates completely around the easily removable main well and economizer body which contains most of the fuel metering elements and passages. This circulation has a cooling effect on the fuel being metered through the passages in the main well and economizer body. In addition to that factor, the high-lift design of the carburetor main well gives this carburetor excellent hot operation and anti-percolation qualities.

Improved control of the power enrichment

system is assured by a unique diaphragm-type economizer. This type of economizer, which may be removed without disassembling the remainder of the carburetor, insures accurate response to variations in engine load conditions.

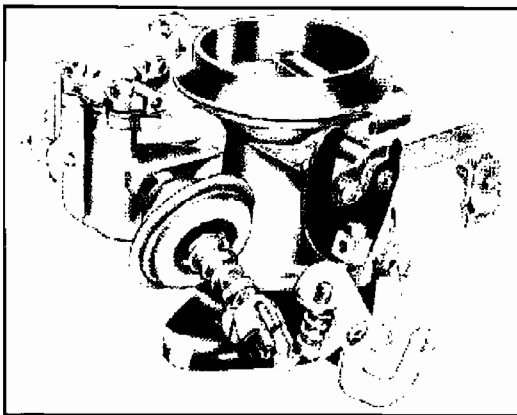
These new features have been incorporated in this carburetor in conjunction with many of the time-proved engineering refinements found in other Holley carburetor models. The carburetor is fully sealed and balanced, with all air bleeds and vents being open only to the air cleaner. This filtered air supply gives added protection against the accumulation of foreign matter in the carburetor passages. The main jet and other fuel metering components are individually flow tested to insure proper calibration of the carburetor. Smoother acceleration is assured by the prolonged discharge of fuel provided by the spring overriding feature of the diaphragm type accelerating pump. The fully-automatic vacuum-actuated power enrichment system of improved design provides the enriched mixture required for high power operation.



HOLLEY CARBURETOR MODEL 1904
WITH ALTITUDE ADJUSTMENT

NOTE

Carburetor part numbers and other information applicable to specific I.H.C. vehicles may be obtained from the current Holley Carburetor Parts Catalog Sheets for these carburetors.



HOLLEY CARBURETOR MODEL 1904 FOR
AUTOMATIC TRANSMISSION ENGINE

2. APPLICATION

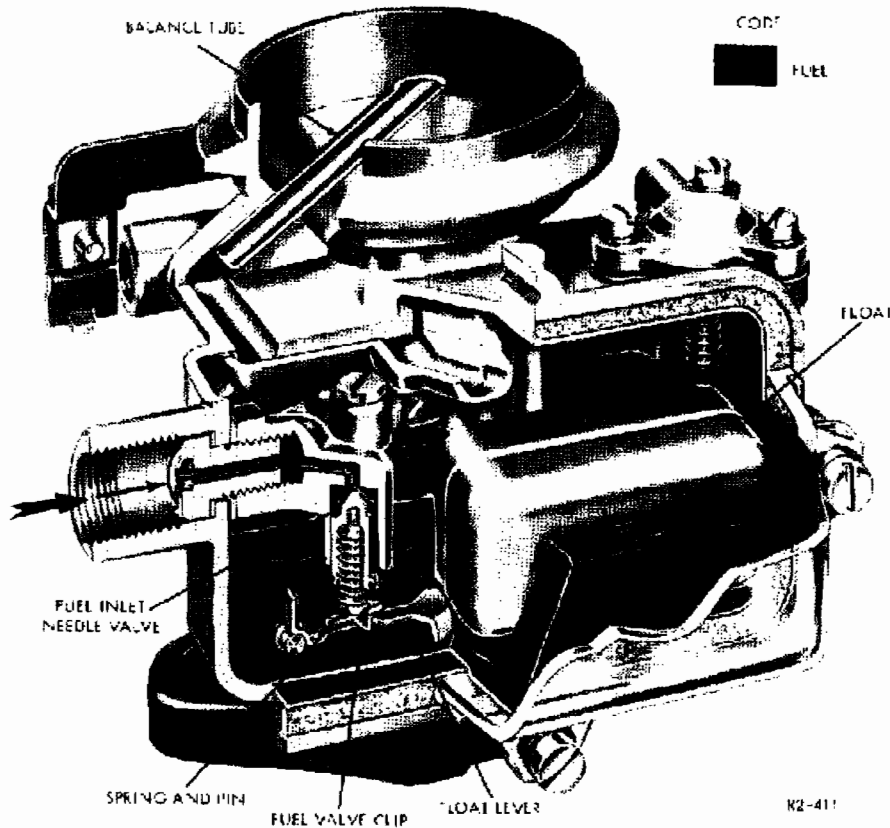
This carburetor model is used on the International Harvester Company 220 SD, 240 SD, 269 BD, 282 BD (C. O. E.), and 282 BD truck engines.

On the carburetor used with automatic transmission engines, the dashpot assembly is mounted on a boss on the side of the main body.

OPERATION

The fuel-air requirements of an automotive engine vary considerably throughout its range of operation. To assure effective carburetion, the

carburetor must supply an efficient but economical mixture for normal cruising conditions, a richer mixture when a high power output is desired,



FUEL INLET SYSTEM

and a still richer mixture for a smooth idle and low speed performance. In order to supply the correct mixture to the engine under all operating conditions, the Holley Carburetor Model 1904 has four basic fuel metering systems. These are the main metering system, the idle system, the power enrichment system, and the accelerating pump system. In addition, there is a fuel inlet system which provides the four basic fuel metering systems with a constant supply of fuel, and the choke system which provides a means of temporarily enriching the mixture to aid in starting and running a cold engine.

1. FUEL INLET SYSTEM

The fuel inlet system provides the four basic fuel metering systems and the choke system of the carburetor with a constant supply of fuel. This fuel, under pressure from the engine's fuel pump,

enters the carburetor through the fuel inlet needle valve and seat assembly and flows into the float chamber. The float, rising and falling with the fuel level in the float chamber, moves the fuel inlet needle in relation to its seat to regulate the amount of fuel entering the carburetor. When the fuel in the float chamber reaches a specified level, the float moves the needle valve to a position to restrict the flow of fuel. Only enough fuel to replace that being used will then be admitted. Any slight change in the fuel level causes a corresponding movement of the float, opening or closing the fuel inlet needle valve to immediately restore the proper fuel level. The fuel inlet system must constantly maintain this specified level of fuel because the basic fuel metering systems are calibrated to deliver the proper mixtures when the fuel is at the specified level only.

A spring and pin inside the hollow fuel inlet

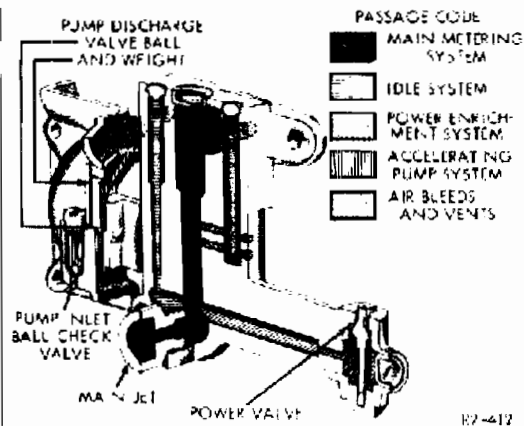


needle valve cushion the needle valve for protection against road shocks and vibration. A fuel valve clip, attached to the bottom of the needle valve, fits under the tab of the float lever to insure proper response of the needle when the float drops.

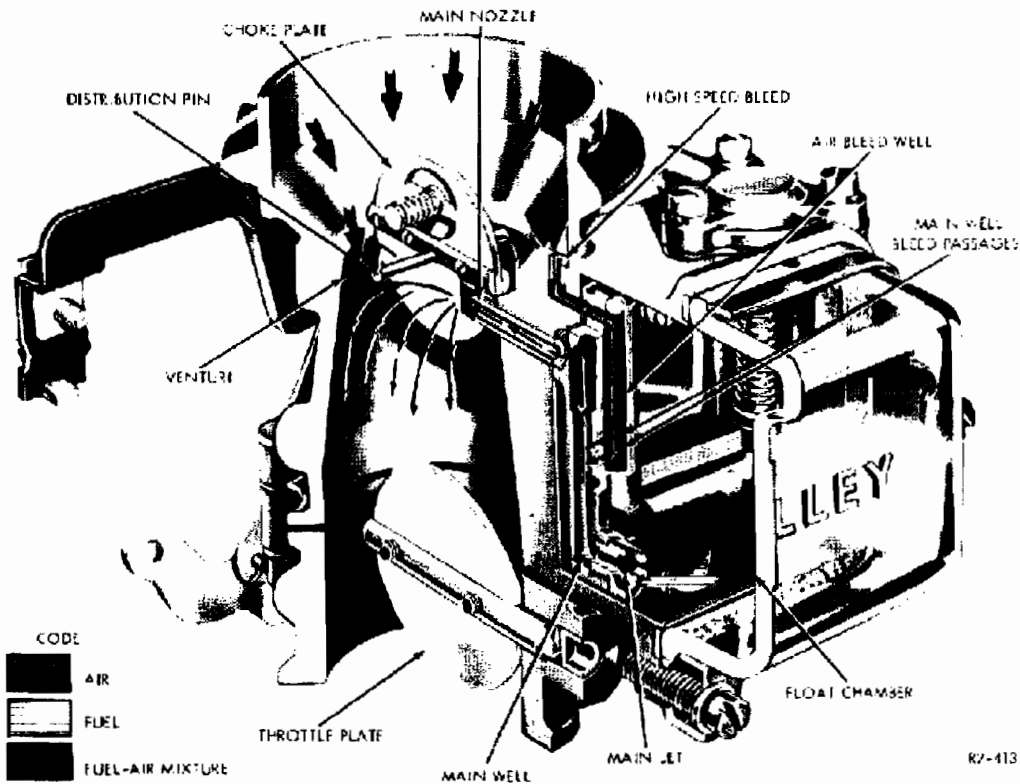
A balance tube in the air inlet of the carburetor bore vents the float chamber to maintain balanced air pressures in that chamber, assuring proper fuel metering in all phases of engine operation.

2. MAIN WELL AND ECONOMIZER BODY

Fuel in the float chamber is distributed to the fuel passages of the four basic fuel metering systems through the main well and economizer body. A study of the passages in this assembly will insure a clearer understanding of the explanation of the operation of the four fuel metering systems.



MAIN WELL AND ECONOMIZER



MAIN METERING SYSTEM

3. MAIN METERING SYSTEM

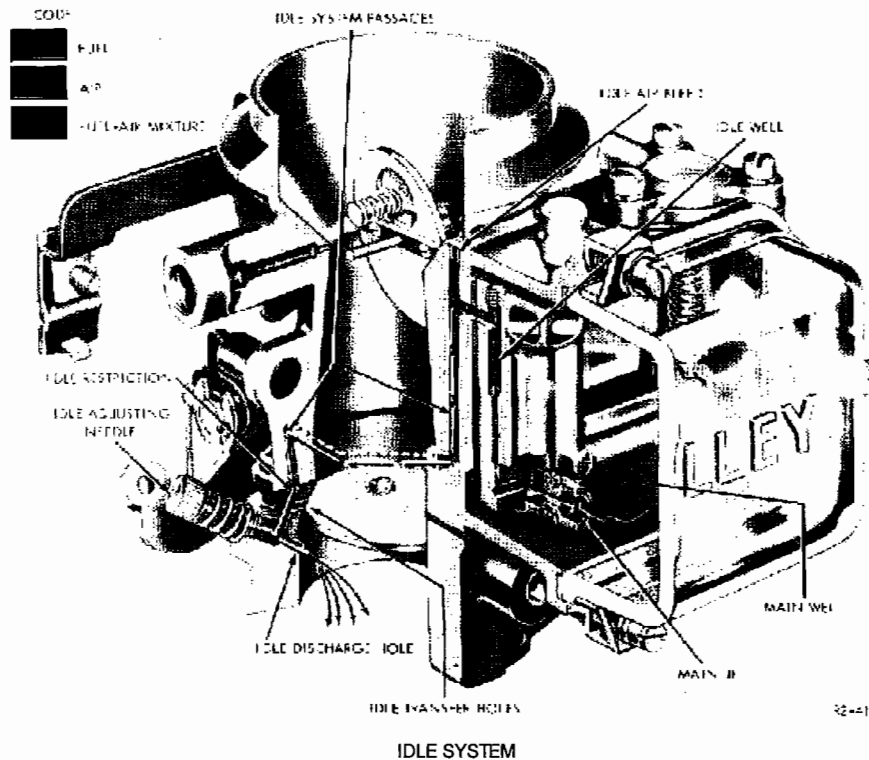
When the engine is running, the intake stroke of each piston draws air through the carburetor. As this air passes through the venturi of the carburetor, the drop in pressure in the venturi creates what is commonly called a vacuum. The strength of that vacuum varies in proportion to the velocity of the air flow through the venturi. This, in turn, is governed by the speed and power output of the engine.

At normal cruising speeds, the difference between the normal, atmospheric air pressure in the float chamber and the vacuum in the venturi is used to operate the main metering system. This pressure differential draws a metered flow of fuel from the float chamber through the main metering system and out the main nozzle into the air stream in the venturi. When the fuel passes out of the float chamber, it is metered (or measured) by the main jet as it flows into the bottom of the main well.

The fuel moves up the main well past the two narrow air bleed passages and enters the main nozzle. Filtered air from the carburetor air inlet enters the air

speed bleed and passing out the two narrow air bleed passages is mixed with the fuel flow in the main well. The high speed bleed meters a properly increasing amount of air into the fuel as speeds increase, stabilizing the fuel discharge and maintaining the required mixture ratios. This emulsion of fuel and air, being lighter than the raw fuel, has a more instantaneous response to any change in venturi vacuum and is more readily vaporized than raw fuel upon being discharged into the air stream. The fuel flows through the main nozzle and is sprayed onto the open choke plate in the venturi. Airstream turbulence over the distribution pin and choke plate distributes the fuel over the lower portion of the choke plate where it is vaporized and mixed with the air flowing through the carburetor.

The throttle plate controls the amount of fuel-air mixture admitted to the intake manifold, regulating the engine speed and power output in accordance with accelerator pedal movement. The distribution pin extending perpendicularly from both sides of the choke plate creates a turbulence as an aid to the proper distribution of the mixture to all cylinders of



At the idle and low speeds, the velocity of the air flowing through the carburetor is reduced and the vacuum created in the venturi will not be strong enough to operate the main metering system. Because of the restriction of the air flow through the carburetor due to the nearly closed throttle plate, intake manifold vacuum will be high. This high manifold vacuum provides a pressure differential which is used to operate the idle system.

At the idle, fuel flows through the main jet into the bottom of the main well. The high manifold vacuum acting on this fuel through the idle system passages draws the fuel from the main well through a short horizontal passage into the idle well. A calibrated restriction in the lower portion of the idle well meters the flow of fuel entering the idle system. The fuel passes out the top of the idle well and into the idle system passages in the main body. A metered flow of air from the idle air bleed is admitted to the fuel as it enters the idle passage in the main body. The idle air bleed also serves to vent the idle system to prevent any siphoning effect at higher speeds or when the engine is stopped. This mixture of fuel and air continues down, flowing through the idle restriction and, passing the two idle transfer holes in the throttle body, is discharged through the idle discharge hole into the strong manifold vacuum existing below the throttle plate. The two idle transfer holes act as additional air bleeds at the idle. An idle adjusting needle, which seats in the idle discharge hole, controls the discharge of fuel at the idle and provides a means for adjusting the idle mixture of the engine. Turning the idle adjusting needle in moves the pointed tip of the needle closer to its seat, restricting the fuel flow out of the idle discharge hole. This results in a leaner idle mixture. Conversely, turning the needle out allows more fuel to flow out the idle discharge hole to provide a richer idle mixture.

During off-idle operation, which occurs when the throttle plate is moved open slightly past the two idle transfer holes, each hole begins discharging fuel as it is exposed to manifold vacuum. As the throttle plate is opened still wider and engine speed increases, the velocity of the air flow through the carburetor is also increased. This creates a vacuum in the venturi strong enough to bring the main metering system into operation. The flow from the idle system tapers off as the main metering system begins discharging fuel. The two systems are engineered to provide a

smooth, even transition from idle to cruising speeds.

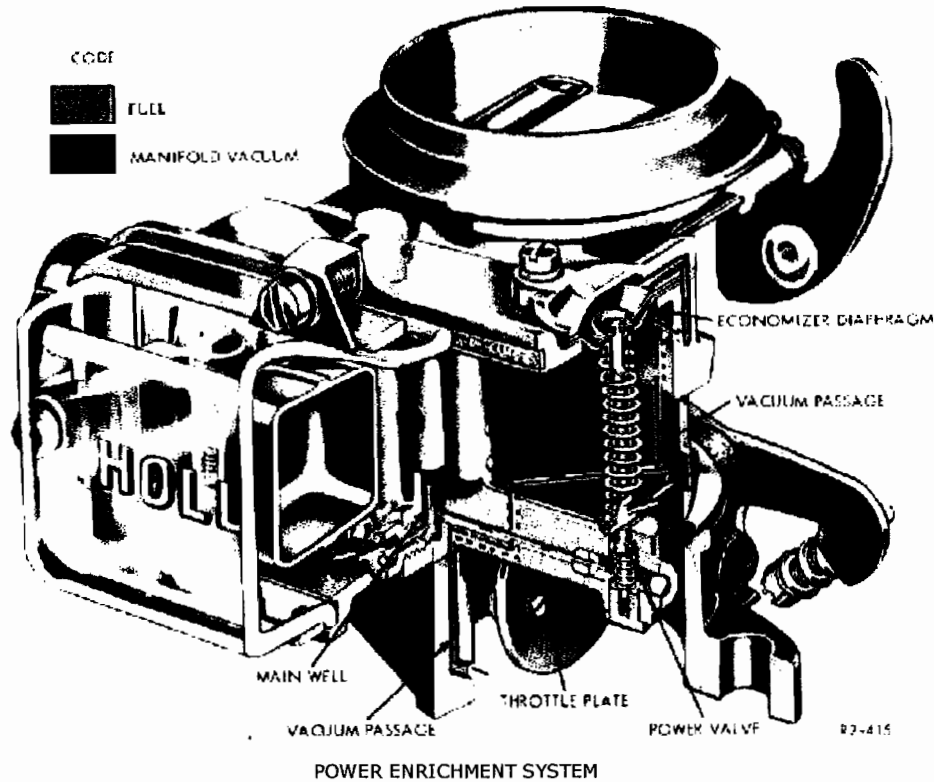
S. POWER ENRICHMENT SYSTEM

When high power output is required, a richer mixture must be provided than is required for normal cruising when no great load is placed on the engine. The carburetor provides the added fuel for high power operation by means of the power enrichment system, sometimes called the economizer system.

The power enrichment system is actuated by manifold vacuum. Manifold vacuum, which is strongest at the idle when there is no load on the engine, is reduced in proportion to the increase in engine loading. This is due to the fact that, as the load on the engine is increased, the throttle plate must be opened wider to maintain any given speed. Manifold vacuum will be reduced because the restriction offered to the air flow entering the intake manifold by the throttle plate will be lessened as the plate is opened. The strength of the manifold vacuum is thus an accurate indicator of the power demands placed on the engine..

Manifold vacuum acting on the economizer diaphragm actuates the power enrichment system. This vacuum from the lower portion of the throttle bore below the throttle plate is transmitted through the vacuum passage to the vacuum chamber on top of the economizer diaphragm. At idle and normal cruising speeds, the vacuum acting on the economizer diaphragm is strong enough to hold the diaphragm up against the tension of the diaphragm spring. This raises the economizer diaphragm stem clear of the power valve and the power valve will be held in the closed position by the tension of its spring. The power enrichment system will thus be inoperative in conditions of high manifold vacuum.

When high power demands place a greater load on the engine, manifold vacuum is reduced. When the vacuum is reduced below a predetermined point, the diaphragm can no longer overcome the tension of the diaphragm spring and the stem will be forced down. This depresses the pin in the center of the power valve, opening the valve. Fuel from the float chamber will flow into the valve and, passing through a horizontal passage, enter the main well. There it is added to the fuel flow of the main metering system, enriching the mixture for full power. The drilled plug in the passage between the power valve and the main well is a calibrated restriction which meters the flow of fuel through the power enrichment system.



POWER ENRICHMENT SYSTEM

6. ACCELERATING PUMP SYSTEM

The air flowing through the carburetor responds almost immediately to any increase in throttle opening. There is, however, a brief interval before the relatively heavier fuel-air mixture in the narrow carburetor passages can gain speed and maintain the desired balance of fuel and air. The accelerating pump system operates during this interval, supplying fuel until the other systems can provide the proper mixture.

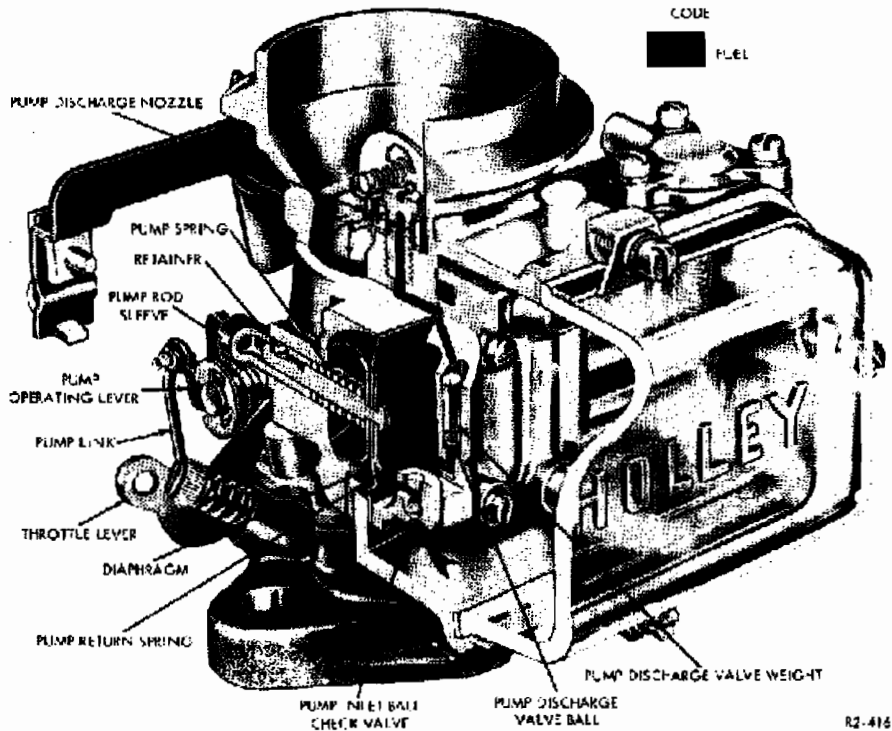
When the throttle is closed, the pump return spring forces the pump diaphragm toward the back of the pump chamber, drawing fuel into the chamber through the pump inlet. The pump inlet contains a ball check valve which opens to admit fuel from the float chamber into the pump chamber, and closes when the pump is operated to prevent a reverse flow of fuel.

When the throttle is opened, the movement is transmitted by the pump link to the pump operating lever. That lever presses the pump rod sleeve inward, compressing the pump spring. The pump spring, in turn, presses on the diaphragm, forcing the fuel from the pump chamber into the pump discharge passage. The "overriding" feature

provided by the pump spring assures an even, prolonged discharge of fuel regardless of how suddenly the throttle is opened and cushions the action of the pump to prevent damage to the pump linkage due to those sudden throttle movements.

The fuel, under pressure from the diaphragm, flows through the pump discharge passage and, forcing the pump discharge ball check valve and weight up, passes into the pump discharge nozzle screw. The pump discharge ball check valve seals the passage when the pump is not discharging fuel. The hexagonal weight holds the ball check valve on its seat to prevent a loss of fuel from the pump chamber due to the siphoning effect of the airstream at high engine speeds.

Flowing up the hollow pump discharge nozzle screw, the fuel passes out holes in the head of the screw into the pump discharge nozzle and is sprayed into the airstream in the venturi. A slot cut into the pump discharge nozzle vents the system to prevent the pump discharge ball check valve and weight from being lifted and fuel drawn from the pump chamber by the siphoning tendencies of the airstream at high engine speeds.



ACCELERATING PUMP SYSTEM

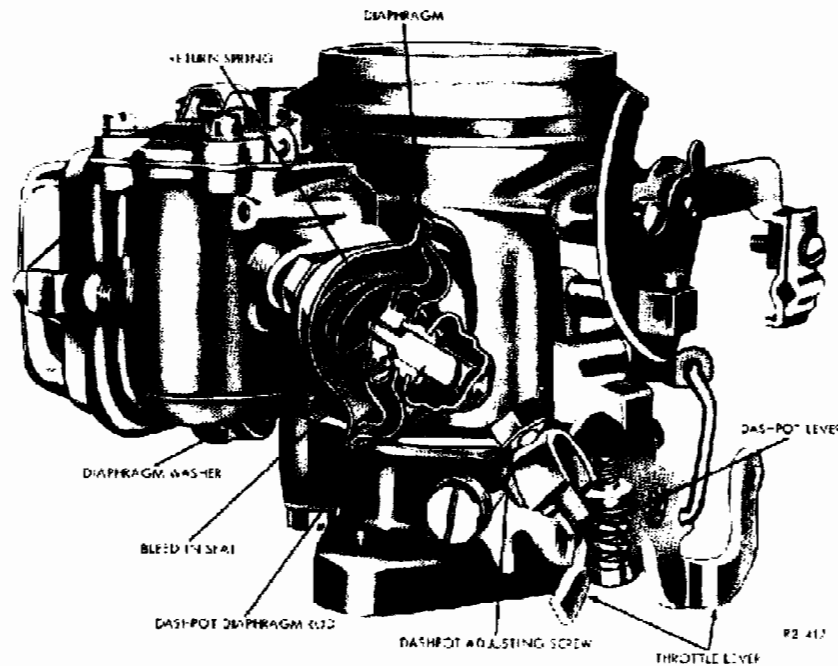
7. CHOKE SYSTEM

In a cold engine, much of the vaporized fuel from the carburetor condenses to a liquid on contact with the low-pressure area and cold surfaces of the intake manifold. This results in an inefficient distribution of fuel to the cylinders, causing hard starting, rough running, stalling, and loss of power. The choke plate is the means used to provide an enriched flow of fuel to aid in starting and warming-up a cold engine. Closing the choke plate which is located in the venturi, confines manifold vacuum within the carburetor and draws a rich flow of fuel from the idle and main metering systems. When the engine starts, enough air is drawn through the spring-loaded poppet valve in the choke plate to enable the engine to run and to prevent flooding. The throttle plate opening is increased by the fast idle cam during chocking to allow the engine to operate at a fast idle to prevent stalling. The fast idle cam, which is a curved extension of the choke lever, contacts the throttle stop screw and prevents the throttle plate from closing completely when the engine is choked.

8. DASH POT

Engines equipped with automatic transmissions require an anti-stall device as protection against loading the engine when the accelerator pedal is suddenly depressed and released. This protection is provided by the dashpot. The dashpot retards the closing rate of the throttle plate as it approaches the idle position, allowing the engine to dissipate the raw fuel discharged into the intake manifold by the accelerating pump.

The dashpot slows the final phases of throttle plate closing by means of a spring-loaded diaphragm. When the accelerator pedal is released, the throttle return spring in the throttle linkage closes the throttle plate simultaneously with the release of the pedal. As the throttle plate approaches the idle position, a tab on the throttle lever contacts the lower edge of the dashpot lever. This rotates the dashpot lever, causing the head of the dashpot adjusting screw of the dashpot lever



DASHPOT-(AUTOMATIC TRANSMISSION)

to impinge on the dashpot diaphragm rod. As the rod is moved into the dashpot, the tapered step of the rod engages the diaphragm washer. Continued movement of the rod will cause a corresponding movement of the diaphragm, compressing the air in the diaphragm chamber above the diaphragm. The compressed air bleeds out of the diaphragm chamber through a groove in the seat of the diaphragm washer, retarding the closing speed of the throttle plate. This allows the engine to properly use the charge of accelerating fuel, preventing

stalling from an over-rich condition in the manifold.

When the throttle is again opened, the pressure is released from the dashpot diaphragm rod and the dashpot return spring moves the rod off its seat in the diaphragm washer. This allows air to flow back into the diaphragm chamber. After moving the rod off its seat, the spring returns the rod and diaphragm to their original position.

OVERHAUL

1. INTRODUCTION

The proper overhaul of the carburetor requires that it is completely disassembled and each part is thoroughly cleaned. Each clean part should then be examined for signs of wear, damage, or deterioration. Defective parts should be

replaced with genuine Holley replacement parts and the carburetor should be carefully rebuilt. Care in rebuilding and accuracy in adjusting the carburetor will insure the continuation of the characteristics of power, economy, and performance engineered into every Holley carburetor.

2. SPECIAL TOOLS AND IMPROVISED TOOLS

This carburetor may be overhauled using ordinary tools if a reasonable amount of care is exercised. Overhaul will be facilitated, however, and damage to parts avoided if factory-approved tools are used. The special tools recommended for use in the overhaul of this carburetor are listed below.

TOOL	SNAP-ON TOOL NO.	HOLLEY TOOL
Main Jet Wrench	TMC-36	82R-49
Power Valve Wrench (Used for fuel inlet seat retainer screw)	MC-128	82R-34
Float Gauge	MC-164	82R-53

In addition to the special tools listed above, a simple tool for removing or installing the distribution pin may be improvised. Obtain a section of brass tubing at least three inches long with an inside diameter of 1/8 inch (or slightly larger if that size is not obtainable), a length of 1/8 inch or larger drill rod (or a flat-tip punch having an end diameter of at least 1/8 inch), and a length of No. 52 or 1/16 inch diameter drill rod. *These improvised tools are to be used as described in the overhaul procedure that follows.

REFER TO FIGURE NO.	IMPROVISED PARTIAL	PART NAME
2	1	Pump Link Cotter Pin
3	2	Throttle Body Screws and Lockwashers (2)
	3	Throttle Body Gasket

3. MASTER REPAIR KITS

The Master Repair Kits contain Holley replacements for parts which are subject to wear or may be damaged in disassembly. The disassembly procedure includes instructions to discard all parts for which replacements are provided in the Master Repair Kit. The proper kit for this carburetor is listed in the current Holley Carburetor Parts Catalog Sheets for these carburetors.

4. DISASSEMBLY

A. PREPARATION

During disassembly, use separate containers for the component parts of both major subassemblies; the main body assembly, and the throttle body assembly. Cleaning, inspection, and reassembly will be facilitated by use of separate containers.

B. DISASSEMBLY-MAIN BODY ASSEMBLY FROM THROTTLE BODY ASSEMBLY

The following list contains all parts removed in separating the main body assembly from the throttle body assembly. Parts to be discarded and replaced from a Master Repair Kit are marked with an asterisk (*).

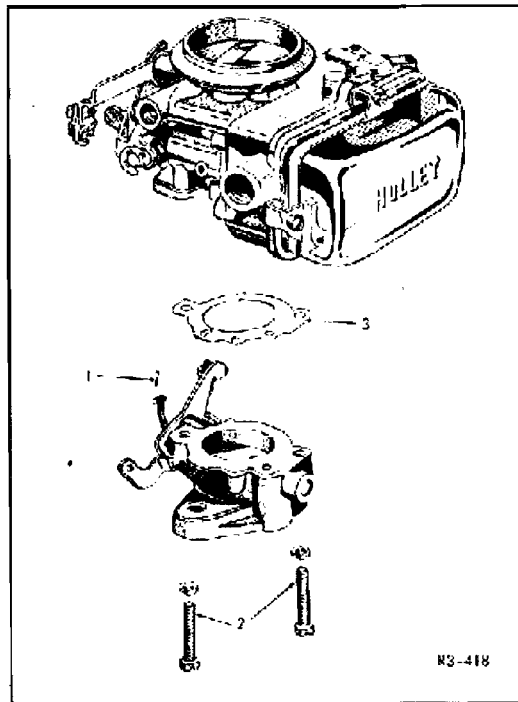


Figure I. Disassembly - Two Major Subassemblies

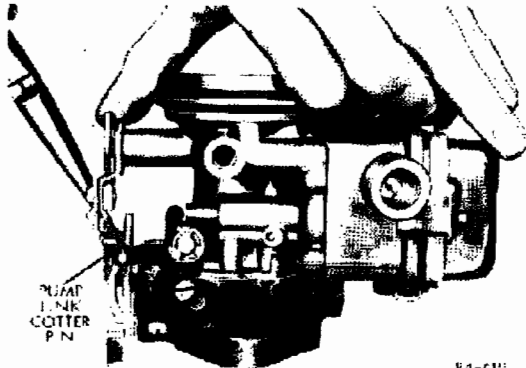


Figure 2. Removing Pump Link Cotter Pin

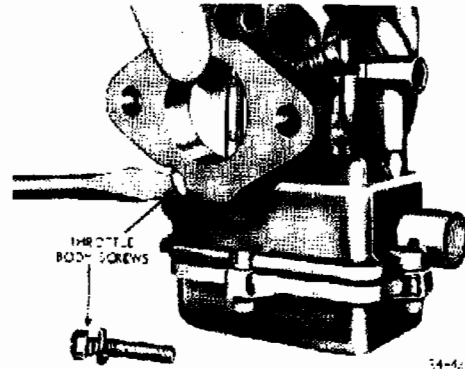


Figure 3. Removing Throttle Body Screws

(1) Remove and discard the upper pump link cotter pin. Disengage the upper end of the pump link from the pump operating lever.

(2) Remove the two throttle body screws and lockwashers. Separate the throttle body and main body and discard the throttle body gasket.

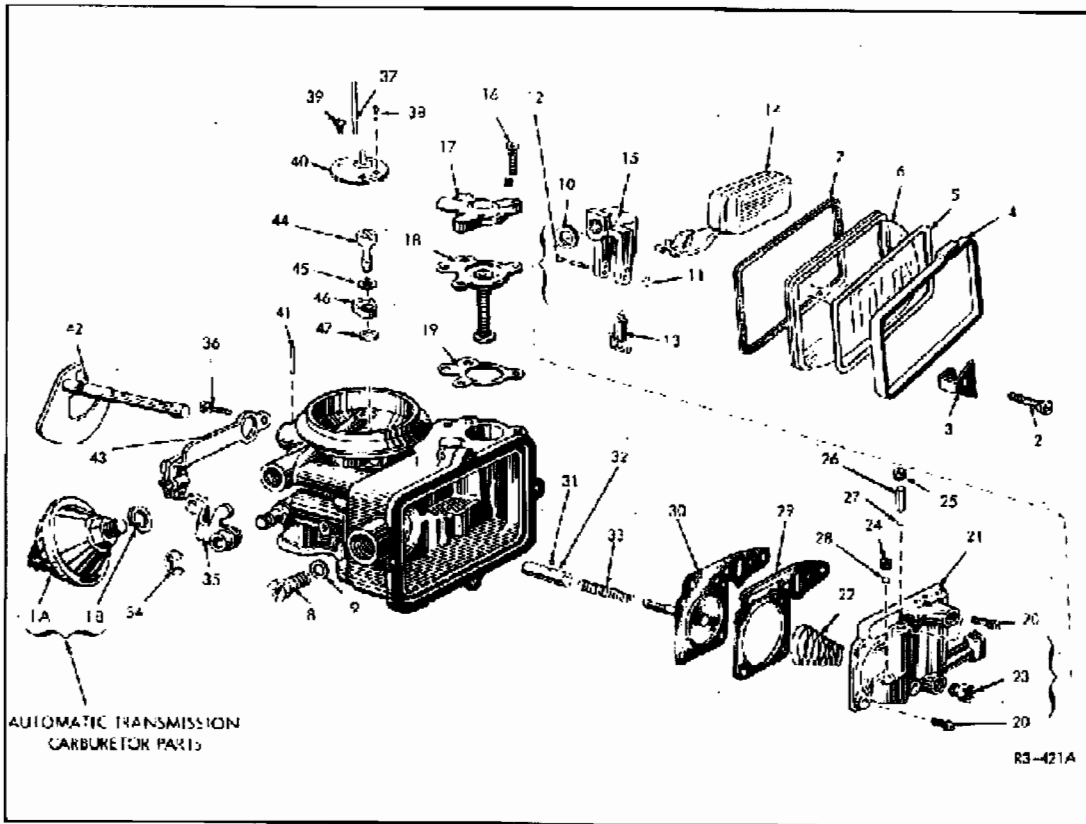


FIGURE 4. DISASSEMBLY - MAIN BODY ASSEMBLY



C. DISASSEMBLY-MAIN BODY

in disassembling the main body assembly. Parts to be discarded and replaced from a Master Repair Kit are marked with an asterisk (*).

PARTS TO BE REMOVED		PART NAME	PARTS TO BE REMOVED		PART NAME
5	1A	Dashpot Assembly	15	24	Pump Inlet Check Valve Retainer
5	1B	Dashpot Lockwasher	15	25	Pump Discharge Valve Retainer
6	2	Clamp Ring Retainer Screw and Lockwasher (4)	16	26	Pump Discharge Valve Weight
6	3	Clamp (4)	16	27	Pump Discharge Valve Ball
6	4	Clamp Ring	16	28	Pump Inlet Valve Ball
6	5	Clamp Ring Gasket *	17	29	Spacer Gasket
6	6	Fuel Bowl	17	30	Pump Diaphragm and Rod Assembly *
6	7	Fuel Bowl Gasket *	18	31	Pump Rod Sleeve Retainer Ball
7	8	Fuel Inlet Seat Retainer Screw *	18	32	Pump Rod Sleeve
9	9	Fuel Inlet Seat Retainer Screw Gasket *	18	33	Pump Spring
9	10	Fuel Inlet Seat Gasket *	19	34	Pump Operating Lever Retainer
9	11	Float Shaft Retainer *	20	35	Pump Operating Lever
9	12	Float Shaft *	21	36	Choke Bracket Screw and Lockwasher
9	13	Fuel Inlet Needle Assembly *	22	37	Distribution Pin
9	14	Float and Lever Assembly	23	38	Choke Plate Screw
9	15	Fuel Inlet Valve Seat *	23	39	Choke Plate Screw and Lockwasher
10	16	Economizer Body Cover Screw and Lockwasher (4)	23	40	Choke Plate
11	17	Economizer Body Cover	24	41	Choke Shaft Retainer Pin
11	18	Economizer Diaphragm and Stem Assembly *	25	42	Choke Shaft and Lever Assembly
11	19	Economizer Body Cover Gasket *	25	43	Choke Bracket
12	20	Main Well and Economizer Body Screw and Lockwasher (5)	26	44	Pump Discharge Nozzle Screw
14	21	Main Well and Economizer Body	45	45	Pump Discharge Nozzle Screw Gasket
13	22	Pump Return Spring	26	46	Pump Discharge Nozzle
14	23	Main Jet	47	47	Pump Discharge Nozzle Gasket

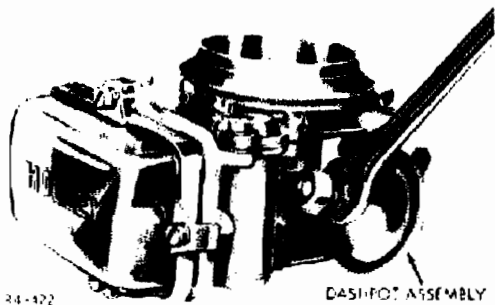


Figure 5. Removing Dashpot Assembly

(1) If the carburetor being disassembled is for an automatic transmission engine, remove dashpot assembly and dashpot lockwasher.



Figure 6. Removing Clamp Ring Retainer Screws

(2) Remove the fuel bowl by removing the four clamp ring retainer screws and lockwashers, and clamps. Lift the clamp ring off the fuel bowl. Remove and discard the fuel bowl gasket and the paper clamp ring gasket.

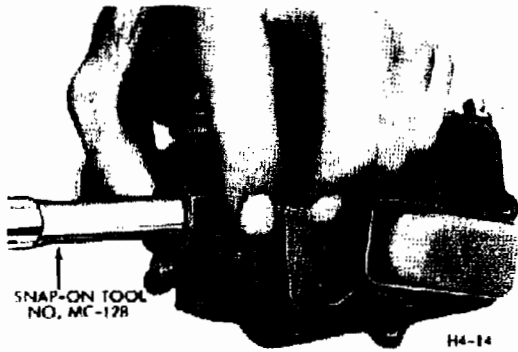


Figure 7. Removing Fuel Inlet Seat Retainer Screw

(3) Using Snap-On Tool No. MC-128, remove the fuel inlet seat retainer screw. Discard the retainer screw and gasket.

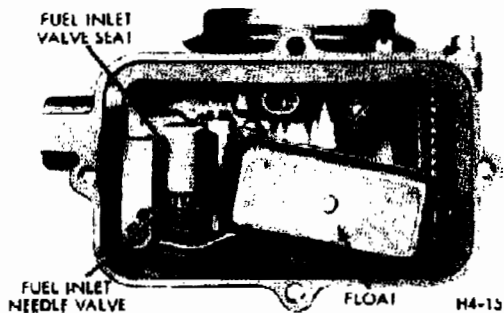


Figure 8. Float and Fuel Inlet Valve Assembly

(4) Lift out the float and fuel inlet assembly and discard the gasket.

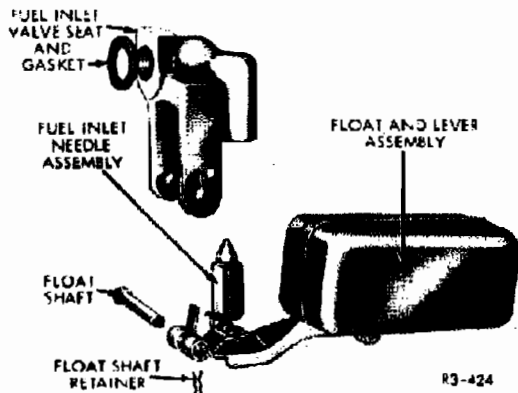


Figure 9. Float and Fuel Inlet Valve Separated

(5) Remove the float shaft retainer and separate the float and lever assembly from the fuel valve assembly by sliding out the float shaft. Discard all parts except the float and lever assembly.

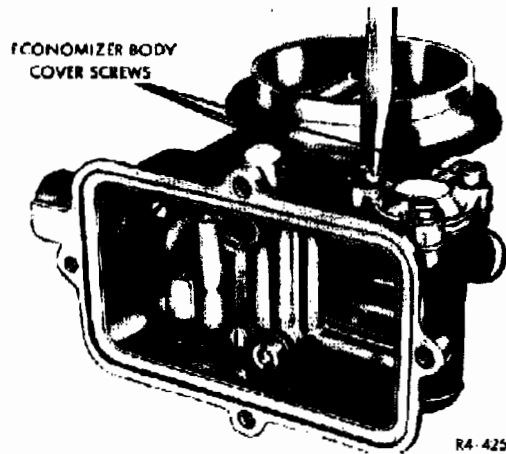


Figure 10. Removing Economizer Body Cover

(6) Remove the three economizer body cover screws and lockwashers.

(7) Lift the economizer assembly out of the main body and discard the gasket.

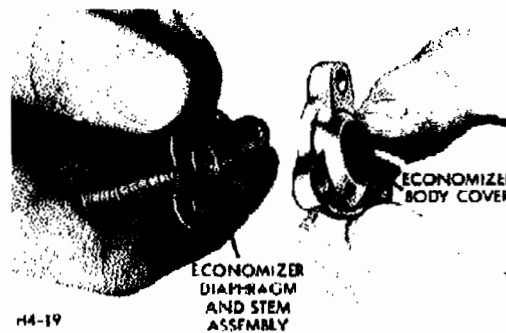


Figure 11. Removing Economizer Body

(8) Separate the economizer body cover from the economizer diaphragm and stem assembly. Discard the economizer diaphragm and stem assembly.

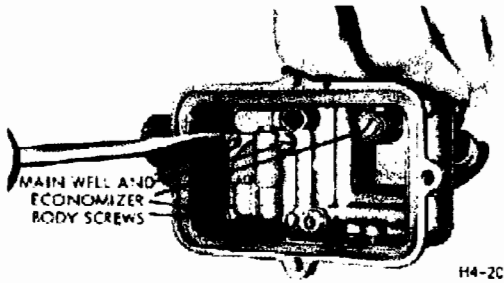


Figure 12. Removing Main Well and Economizer Body Screws

(9) Remove the five main well and economizer body screws and lockwashers. (Place a thumb against the main well and economizer body to retain it in position until those screws and lockwashers have been removed.) Lift out the main well and economizer body.

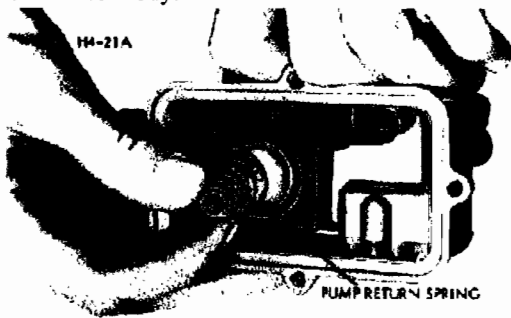


Figure 13. Removing Pump Return

(10) Remove the pump return spring which bears against the metal disk of the accelerating pump piston.

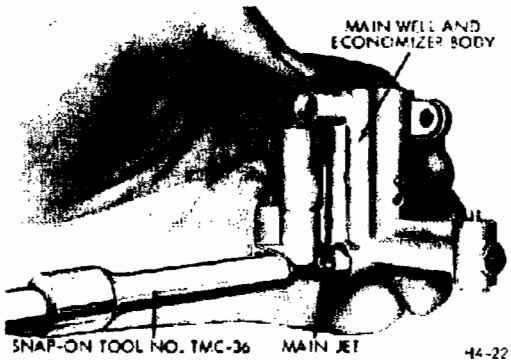


Figure 14. Removing Main Jet

(11) Using Snap-On Tool No. TMC-36, remove the main jet from the main well and economizer body. Discard the main jet.

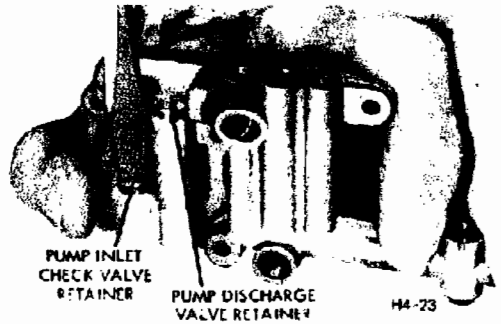


Figure 15. Removing Pump Valve Retainers

(12) Remove the pump inlet check valve retainer and the pump discharge valve retainer.

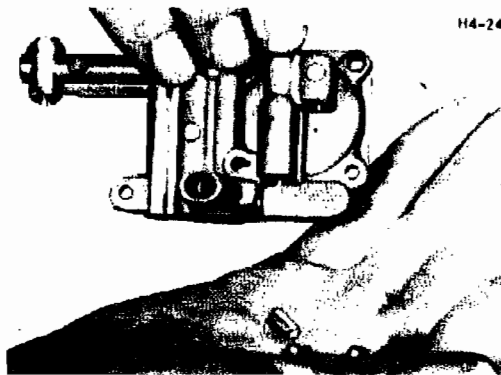


Figure 16. Removing Pump Inlet and Discharge Valve Balls and Weight

(13) Invert the main well and economizer body and allow the pump inlet check valve ball, pump discharge valve weight, and pump discharge valve ball to drop out. Discard the two steel balls.

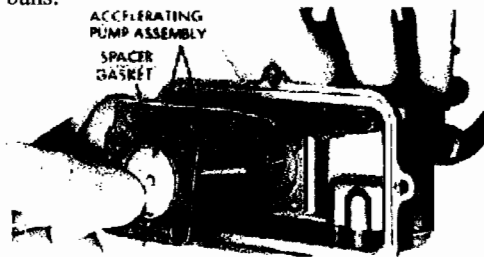


Figure 17. Removing Accelerating Pump Assembly

(14) Slide the accelerating pump assembly out of the main body. Remove and discard the spacer gasket.

CAUTION

Care must be taken when removing the accelerating pump assembly as the pump rod sleeve is under considerable spring tension. The assembly must be pulled straight out and not rotated during removal.



Figure 18. Removing Pump Rod Sleeve Retainer Ball

(15) Press the pump rod sleeve toward the pump diaphragm, compressing the pump spring; and allow the pump rod sleeve retainer ball to drop out (rotate the sleeve if the ball sticks in place). Discard the ball.

(16) Slide the pump rod sleeve and pump spring off the pump diaphragm rod. Discard the pump diaphragm and rod assembly.

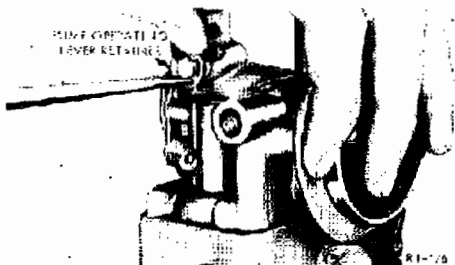


Figure 19. Removing Pump Operating Lever Retainer

(17) Using the thin-bladed screwdriver, pry the pump operating lever retainer off the pump operating lever stud. Discard the retainer.

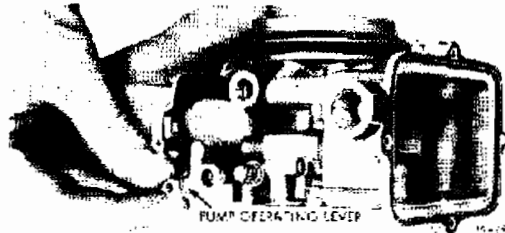


Figure 20. Removing Pump Operating Lever

(18) Slide the pump operating lever off the stud.



Figure 21. Removing Choke Bracket Screw

(19) Remove the choke bracket screw and lockwasher.

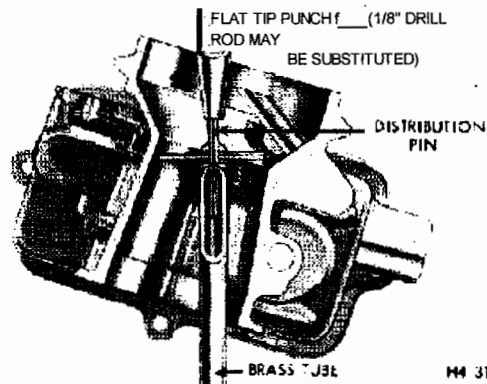


Figure 22. Removing Distribution Pin

(20) Rotate the choke plate past the full open position until it is nearly inverted. Place the distribution pin in a section of brass tubing with the end of the tube bearing against the choke shaft. Using a flat tip punch or a piece of 1/8 inch drill rod, drive the pin flush with the choke shaft. Then, using a smaller diameter punch or drill rod, drive the pin out of the choke shaft. Refer to "Special Tools and Improved Tools" on page 10 for complete information on the improvised tools.

NOT

In the illustration (Figure 22), a section of the upper portion of the brass tubing is shown cutaway for the purpose of clarity. Do not cut out this section of tubing.

CAUTION

Care is to be taken when removing the distribution pin to prevent damaging the choke shaft and poppet valve.

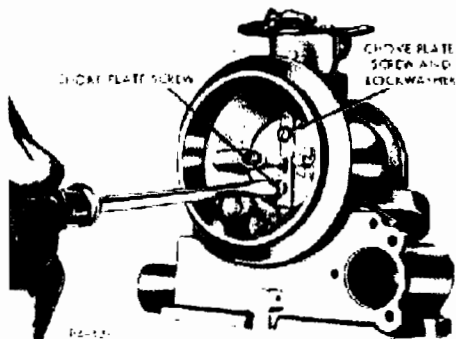


Figure 23. Removing Choke Plate

(21) Remove and discard the choke plate screws and lockwasher and slide the choke plate out of the choke shaft.

NOT

If the tip of the choke plate screw has been flared out excessively by staking, it is advisable to file off the flared-out portion to avoid damaging the threads in the choke when removing the screw. Care is to be taken while filing the screw tip to avoid damaging the carburetor bore, choke shaft, or other components.

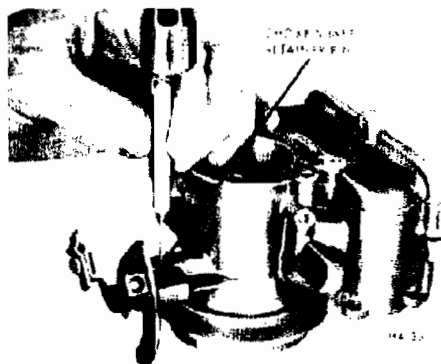


Figure 24. Removing Choke Shaft Retainer Pin

(22) Using a small flat-tip punch, drive the choke shaft retainer pin out of the main body.

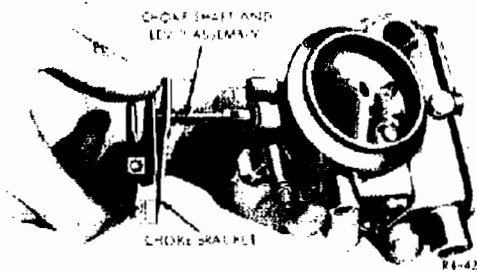


Figure 25. Removing Choke Shaft

(23) Remove the choke shaft and lever assembly and the choke bracket.

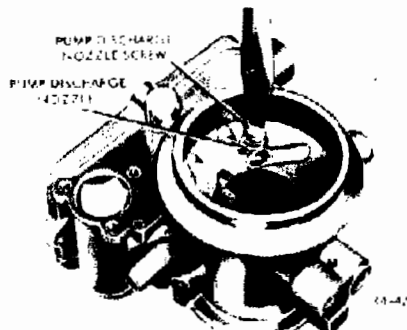


Figure 26. Removing Pump Discharge Nozzle Screw

(24) Remove the pump discharge nozzle screw and lift out the pump discharge nozzle. Discard the two gaskets.

NOT

In some versions of this carburetor model the fuel bowl contains an externally adjusted needle for regulating fuel flow through the main jet. Replacements for this main adjusting needle assembly will be found in the Master Repair Kit.



Figure 27. Disassembly - Throttle Body Assembly

This completes the disassembly of the main body assembly. Do not attempt to remove any of the pressed-in passage plugs, air bleed plugs, or the main nozzle in the main body,

D. DISASSEMBLY-THROTTLE BODY ASSEMBLY

The following list contains all parts removed in disassembling the throttle body assembly. Parts to be discarded and replacement made from a Master Repair Kit are marked with an asterisk (*).

REFER TO FIG. NO.	ORDER OF REMOVAL	PART NAME
28	1	Idle Adjusting Needle*
28	2	Idle Adjusting Needle Spring
29	3	Pump Link Cotter Pin*
29	4	Pump Link*
30	5	Throttle Plate Screw and Lockwasher (2)*
30	6	Throttle Plate
30	7	Throttle Shaft
31	8	Dashpot Lever Screw
31	9	Dashpot Lever Spring
31	10	Dashpot Lever

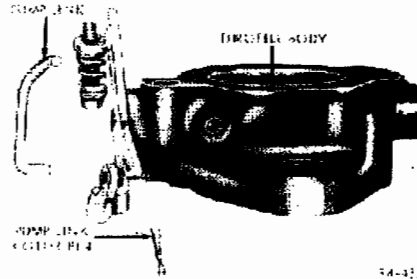


Figure 29. Pump Link and Cotter Pin

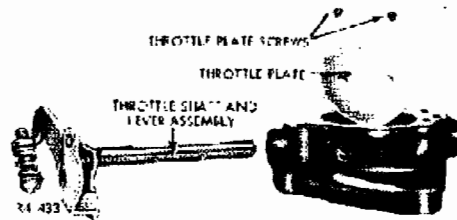


Figure 30. Throttle Shaft and Plate Removed

(4) Slide the throttle shaft and lever assembly out of the throttle body.

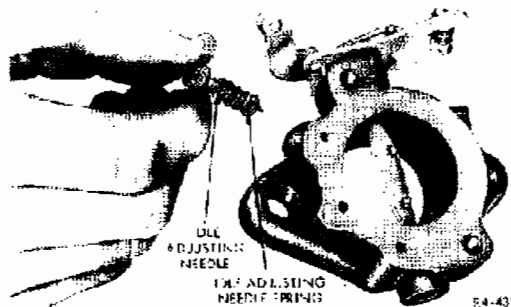


Figure 28. Removing Idle Adjusting Needle

(1) Remove the idle adjusting needle and spring. Discard the needle.

(2) Remove and discard the pump link cotter pin and pump link.

(3) Scribe the throttle plate along one side of the throttle shaft to facilitate proper alignment during reassembly. Remove and discard the two throttle plate screws and lockwashers. Lift out the throttle plate.

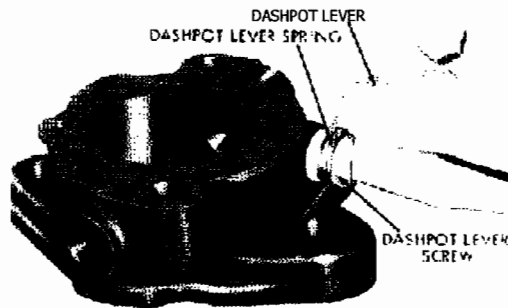


Figure 31. Removing Dashpot Lever Screw

(5) On carburetors for the automatic transmission engine, remove the dashpot lever screw, spring, and lever.

This concludes the disassembly of the Carburetor Model 1904.

5. CLEANING AND INSPECTION

A. CLEANING

(1) All castings and metal parts except the dashpot assembly are to be soaked in a cleaning



solution to loosen the accumulated foreign matter. Laquer thinner or denatured alcohol may be used if a commercial carburetor cleaning solvent is not available. Place the parts to be cleaned in a wire basket suspended in the solution. After the parts have soaked sufficiently to loosen the foreign deposits, they should be rinsed in hot water to remove all traces of the cleaning solution. All remaining foreign deposits should be scrubbed away with a stiff bristle brush while the parts are being rinsed.

(2) Soak each casting and part briefly in clean gasoline and dry them with compressed air. Direct the compressed air through all passages in the castings and through all openings, jets, and tubes. As the neoprene diaphragm of the dashpot assembly is deteriorated by most cleaning solvents, the exterior of the dashpot assembly should be wiped clean with a rag moistened with gasoline. Do not use compressed air on this assembly as the diaphragm and the synthetic rubber bellows seal may be distorted or ruptured.

CAUTION

Attempts to clean passages with a wire, drill, or similar object may distort those passages and adversely affect carburetor performance. Use of a buffing wheel, wire brush, or other abrasive means to remove surface deposits may damage the part and also remove the protective plating, exposing the part to corrosion.

NOTE

As gaskets, neoprene diaphragms, and felt seals are deteriorated by most solvents, those items should never be exposed to cleaning fluids. Never re-use old gaskets neoprene diaphragms, or felt seals when rebuilding the carburetor.

B. INSPECTION

(1) MAJOR CASTINGS

All major castings are to be examined for cracks, stripped threads, or damaged gasket mating surfaces and discarded if damage is found. Check the venturi bore in the main body casting for signs of nicks, scratches, or other imperfections. Calibration of the carburetor may be affected by even a slight irregularity in the venturi. Examine the main discharge nozzle in the venturi and other passages in the castings for signs of damage or obstruction. The check for obstruc

tion may be made by directing compressed air through the passages. (Refer to the "Operation" section, beginning on page 2, for locations of passages in the castings).

(2) CHOKE SHAFT AND THROTTLE SHAFT

Check the shafts for distortion, stripped threads, or loose levers. If irregularities are found, the shaft should be discarded. Also examine the swivel assembly on the choke lever for stripped threads. If damage is found or the swivel is no longer securely riveted, the choke shaft and lever assembly must be replaced.

(3) FUEL BOWL

The fuel bowl must be replaced if the edges are chipped or if cracks are found anywhere in the bowl. In the plastic fuel bowls containing the adjustable jet, the adjusting needle body must be checked for signs of leaking or for other evidence of damage or distortion.

(4) FLOAT AND LEVER ASSEMBLY

Replace the float and lever assembly if the float leaks, or if the assembly is corroded or damaged. Shake the float to determine if fuel has leaked into it.

(5) THROTTLE AND CHOKE PLATES

Discard the plates if distortion, nicked edges, corrosion, or damage to the protective plating is found. Check to insure that the poppet valve in the choke plate IS clean and operates properly.

(6) SPRINGS AND RETAINERS

Distorted or damaged springs and retainers must be replaced.

(7) SCREWS, LOCKWASHERS, AND

Screws, lockwashers, and nuts must be replaced if stripped threads, distortion or other damage is found.

6. REASSEMBLY

A. REASSEMBLY-THROTTLE BODY

(1) Slide the throttle shaft and lever assembly into position in the throttle body. Referring the marks scribed on the plate during disassembly, set the plate in place on the throttle shaft. and hold the throttle body up to the light. If no excessive amount of light shows between the edge

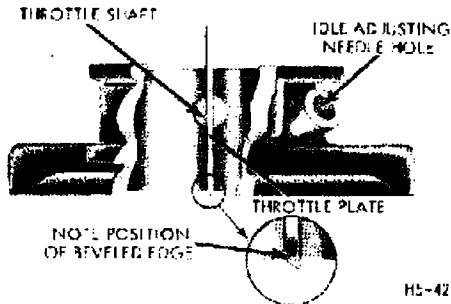


Figure 32. Installing Throttle Plate

of the throttle plate and the throttle bore, and if the throttle plate moves freely throughout its range of travel, throttle plate alignment is satisfactory. Hold the throttle plate in the closed position and tighten the throttle plate screws.

(2) Install the new pump link in the throttle lever with the double bend of the link uppermost. Secure the pump link in place with one of the new pump link cotter pins. (The two holes in the throttle permit adjustments to compensate for climatic conditions; place the pump link in the hole nearest the throttle shaft for normal climatic conditions, or use the outer hole for continuous extreme cold weather operation.)

(3) Install the new idle adjusting needle with its spring. Turn the needle down gently with the fingers until it seats, then back it off one full turn. Take care not to force the needle down on its seat. This will groove the tip of the needle and make it impossible to accurately adjust the idle mixture.

(4) On carburetor for automatic transmission engines, install the dashpot lever, spring, and screw.

B. REASSEMBLY-MAIN BODY

(1) Place a new gasket on both sides of the pump discharge nozzle, then insert the pump discharge nozzle screw into the channeled side of the nozzle. (The pump discharge nozzle screw may be identified by the hole drilled vertically from its tip to a point shortly below the head of the screw, where it joins a short horizontal drilled passage terminating in a groove in the side of the screw.) Install the pump discharge nozzle in the recess at the top of the venturi in the main body. Allow the pump discharge nozzle to rotate to the limits of its travel in a clockwise direction as the nozzle screw is tightened. The nozzle will stop

against the edge of its recess in its proper operating position after a small amount of rotation.

NOTE

In the List No. 763 and 831 Carburetors, however, the pump discharge nozzle should be held in a counter-clockwise position against the limits of its rotational travel as the nozzle screw is tightened.

(2) Position the choke bracket on the boss on the main body. Slide the choke shaft and lever assembly into the main body and secure it in place by driving the choke shaft retainer pin into the small vertical hole in the top of the choke shaft boss.

(3) Rotate the choke lever until the choke lever swivel is below the choke shaft. Insert the choke plate into the slot in choke shaft with the stem and spring of the poppet valve extending upward.

CAUTION

Take care not to damage the tip of the main nozzle while installing the choke plate.

(4) Center the choke plate to avoid damaging the venturi then close the choke plate by rotating the choke lever in a counter-clockwise direction. Install the choke plate screws, fitting the screw with the attached lockwasher in the hole nearest the choke lever. Turn the screws down snugly but not tightly. Rotate the choke lever until the choke plate is nearly inverted and the poppet valve stem and spring extend downward. Align the distribution pin hole in the choke shaft with the corresponding hole in the choke plate. Brace the choke shaft from beneath and drive the distribution pin into position. Install the distribution pin so the clearance between the tip of the pin and the venturi wall is equal on both sides

NOTE

The List No. 763 and 831 Carburetors use a hex-head screw on the side of the choke shaft nearest the fuel bowl and pump discharge nozzle. A stem extends above the hex-head of the screw to facilitate proper fuel distribution in C.O.E. installations. A shakeproof external tooth lockwasher is used to retain the screw. The regular choke plate screw continues in use as the other plate screw.

(5) Check the choke plate for binding by moving the choke lever through the extent of its travel. If it moves freely, tighten the choke plate screws while holding the choke plate in the fully closed position. Stake the screws (on carburetor models having choke plate screws without lockwashers) using any approved staking tool. If an impact type staking tool, such as a punch, is used, each screw head should be braced with a solid object to prevent bending the choke shaft. Take care not to nick or mar the venturi or choke plate with the staking tool.

(6) Install the choke bracket screw and lock-washer.

(7) Place the pump operating lever on the stud in the main body and secure it by fitting the new pump operating lever retainer in the groove at the end of the shaft.

(8) Place the pump spring on the rod of the new pump diaphragm and rod assembly. Position the pump rod sleeve on the pump diaphragm rod with the small hole in the sleeve aligned with the center of the flat cutaway portion of the rod. Press the sleeve on the rod, compressing the pump spring, and drop the new pump rod sleeve retainer ball into the small hole in the pump rod sleeve. Insert the assembly into position in the main body.

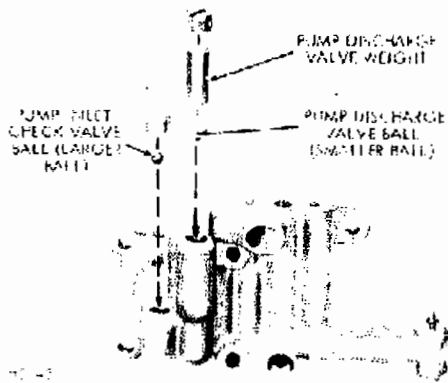


Figure 33. Installing Pump Inlet and Discharge Valve Balls

(9) Install the pump inlet check valve ball and the pump discharge valve ball in the main well and economizer body. (The pump inlet check valve ball is the larger of the two balls.) The new steel balls are to be seated by placing a thin brass rod on the top of each ball and tapping the rod **very lightly** three or four times with a fiber mallet, Shake the casting to insure that the balls move

freely in their chambers, then install the pump discharge valve weight and the two retainers.

NOTE

It is extremely important that these parts are correctly installed or carburetor performance will be adversely affected.

(10) Using Snap-On Tool No. TMC-36, install the new main jet in the main well and economizer body.

(11) Place the new main well and economizer body spacer gasket in position over the accelerating pump diaphragm.

(12) Install the pump return spring, seating the larger end of the spring in the metal disk of the accelerating pump piston.

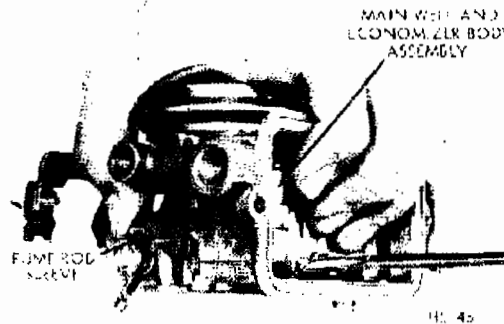


Figure 34. Installing Main Well and Economizer Body

(13) Align all holes in the main well and economizer spacer gasket with the corresponding holes in the accelerating pump diaphragm and the main body. Insert the five main well and economizer body screws and lockwashers in the main well and economizer body with the two long screws placed in the center top and bottom holes. Set the power valve situated at the extreme right end of the main well and economizer body into its position in the main body, then press the main well and economizer body into place against the accelerating pump diaphragm using the following procedure. Grasp the main body in the left hand, holding the thumb over the protruding end of the pump rod sleeve and the fingers over the main well and economizer body. Apply pressure with thumb and fingers to compress the pump spring and pump return spring. This pressure must be applied evenly to prevent the tension of the pump return spring from disturbing the alignment of the holes in the diaphragm, spacer gasket, and the main body. After the main well and economizer body

is pressed into position, maintain the pressure until the five main well and economizer body screws have been started in their holes and a check is made on the alignment of the diaphragm and spacer gasket. Do not tighten the screws, but turn them in as far as possible without compressing the lockwashers. Release the pump rod sleeve. This will allow the pump return spring to expand, stretching the accelerating pump diaphragm to insure full travel when the accelerating pump is operated. Then tighten the five main well and economizer body screws.

(14) Insert the three economizer body cover screws and lockwashers in the economizer body cover. Place the new economizer diaphragm and stem assembly and the economizer body gasket over the screws. Insert the assembly into its position in the main body, taking care the alignment of the vacuum passage hole is not disturbed, then tighten the screws.

(15) If the fuel inlet needle assembly has been received unassembled, it is to be assembled as follows.

Fit the new fuel inlet needle spring over the fuel inlet needle pin and insert those parts into the new fuel inlet needle. Install the new wire fuel valve clip in the groove in the fuel inlet needle.

(16) Set the fuel inlet needle on the float lever tab, placing the fuel valve clip under the tab to hold the needle in place. Guide the fuel inlet needle into the new fuel inlet needle seat, positioning the pivot of the float lever between the float lever bracket arms on the fuel inlet needle seat. Install the new float shaft and new float shaft retainer.

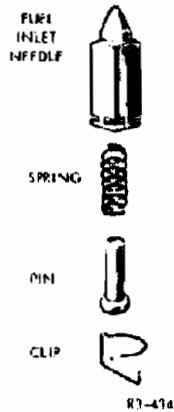


Figure 35. Fuel Inlet Needle Assembly

CAUTION

Fuel inlet needles and seats are matched assemblies, factory tested to insure proper operation, and their component parts are not interchangeable.

(17) Place the new fuel inlet seat retainer screw gasket on the new fuel inlet seat retainer screw and insert the screw in the fuel inlet fitting boss on the main body. Place the new fuel inlet seat gasket on the end of the fuel inlet seat retain

er screw which protrudes into the fuel bowl. Ease the float and fuel inlet valve assembly into position and secure it in place by tightening the fuel inlet seat retainer screw, using Snap-On Tool No. MC12_8.

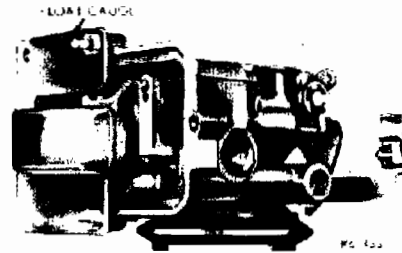


Figure 36. Setting Float

(18) At this point the float setting should be checked and necessary adjustments made. Invert the main body assembly, allowing the float to drop to the closed position. Using Snap-On Tool No. MC-164, gauge the float, checking the setting on both the "touch" and "no touch" legs of the gauge. The level of the float may be adjusted by bending the small tab in the float lever which contacts the head of the fuel inlet needle pin. Use needle-nosed pliers for this correction and recheck the float setting after adjustments have been made.

(19) Fit the new fuel bowl gasket into the recess in the rim of the fuel bowl in the main body. Place the new clamp ring gasket and clamp ring on the fuel bowl and set the fuel bowl in position on the main body. Install the four clamp ring retainers, screws, and lockwashers. Tighten the screws alternately, a half a turn at a time, until the lockwashers are compressed. The screws must be tightened alternately and not drawn too tightly to prevent setting up stresses that may result in a cracked fuel bowl.

NOT

The procedure for installing the plastic fuel bowls containing the adjustable jet is the same as described above except the main body is to be held in the inverted position so the float is in its fully closed position and clear of the main jet. Install the fuel bowl with the adjusting needle backed out to the open position, taking care not to damage the tip of the needle when the bowl is set in place.

(20) Install the dashpot assembly on carburetors so equipped.

C. REASSEMBLY-MAIN BODY TO THROTTLE BODY ASSEMBLY

(1) Insert the two throttle body screws and lockwashers into the throttle body. Settle the new throttle body to main body gasket in place over the throttle body screws and check to insure the proper alignment of the holes in the gasket with the corresponding holes in the throttle body. Set the main body in position on the throttle body,

invert the carburetor and tighten the two screws. Tighten the screws alternately, a little at a time, to compress the gasket evenly and eliminate the possibility of an air leak.

(2) Insert the upper end of the pump link in the pump operating lever and secure it in place with the new pump link cotter pin.

This completes the reassembly of the Carburetor Model 1904. It is now ready for installation on the engine.

INSTALLATION

1. INSTALLATION ON THE ENGINE

Check the carburetor mating surface on the intake manifold for signs of rust or dirt. If it is clean, fit a new carburetor flange gasket on the manifold and install the carburetor. Turn the two carburetor mounting nuts down hand tight and connect and tighten the fuel line and the distributor vacuum line. Then draw the mounting nuts down evenly, tightening them alternately a little at a time until the flange gasket has been compressed and the nuts are tight. This method of tightening the mounting nuts will eliminate the possibility of an air leak past the flange gasket. Connect the throttle and choke linkage, checking the choke plate in the carburetor venturi to insure it opens fully when the choke control knob is pushed in. Clean and install the air cleaner.

CAUTION

The moving parts of the dashpot assembly are not to be lubricated. Any attempt to lubricate the diaphragm rod will eventually result in the formation of sludge in the dashpot, preventing the proper functioning of the unit.

2. CARBURETOR ADJUSTMENTS A. ADJUSTING THE IDLE

(1) All carburetor adjustments to be accurate must be made with the vehicle standing on a level surface. Start and warm up the engine. When the engine has reached its normal operating temperature, after first checking to insure that the choke plate is fully open, adjust the throttle stop screw to idle the engine at the rpm specified in the current Holley Carburetor Company Specifications Catalogue.

(2) Set the idle adjusting needle to give the highest steady manifold vacuum or, if a vacuum gauge is not available, the smoothest maximum

idle speed. Clockwise rotation of the idle adjusting needle will give a leaner mixture, counterclockwise rotation a richer mixture. An effective setting may be obtained by turning the idle adjust needle in until a drop in engine speed results and then backing the needle off over the "high-spot" until the engine again slows down. Setting the idle adjusting needle between these two points result in a satisfactory idle mixture setting. Should this adjustment result in an excessive increase in the idle rpm, reset the throttle stop screw to obtain the specified rpm and again adjust the idle mixture setting.

NOTE

The accelerating pump stroke can be adjusted to compensate for seasonal or climatic changes by changing the position of the link in the throttle lever. The hole in the lever nearest the throttle shaft is the normal setting and should be satisfactory for nearly all operating conditions. Should a richer accelerating pump discharge be required for extreme cold weather operation, the pump link is to be placed in the outer hole in the throttle lever.

B. ADJUSTING THE DASHPOT

(1) The dashpot on carburetors for engines equipped with automatic transmissions is to be adjusted after the idle speed and mixture settings have been completed. Close the throttle lever to the idle position. Set the dashpot adjusting screw so the clearance specified in the current Holley Carburetor Company Specifications Catalog is obtained between the dashpot adjusting screw and the diaphragm rod with the rod in the fully compressed position. To assure an accurate adjustment, check the choke plate to insure it remains fully opened while setting the dashpot adjusting screw.

