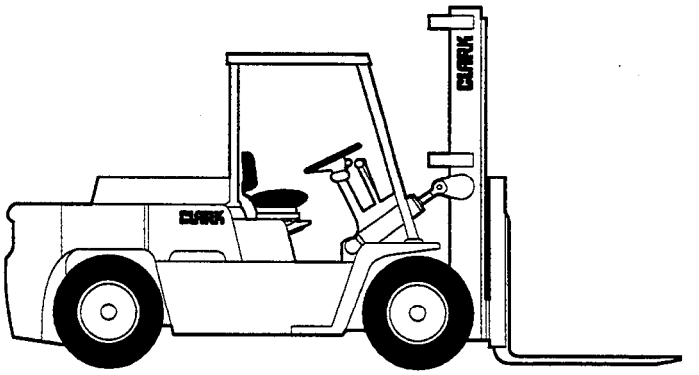
Service Manual

SM 591



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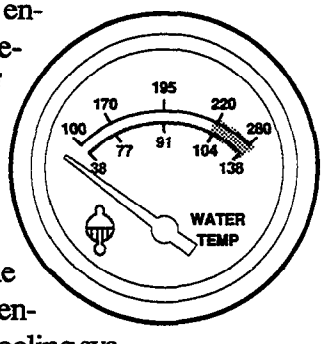
restart" feature requires that the key be returned to the "off" position before it can again be turned to "start." If engine does not start on the first attempt, do not re-engage the starter until engine comes to a complete stop (approximately 5 seconds). After the engine starts, let it warm up until it runs evenly.

Gauges, Meters, and Indicators

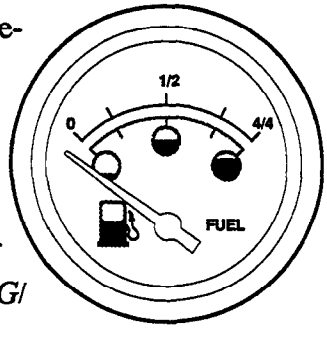
The gauges, hour meter, and indicator light in the instrument panel tell you many important things about the performance of your lift truck. Familiarize yourself with their location and purpose and make it a practice to scan the instrument panel as you start the engine, after it starts, and periodically as you operate the truck.

Water Temperature Gauge



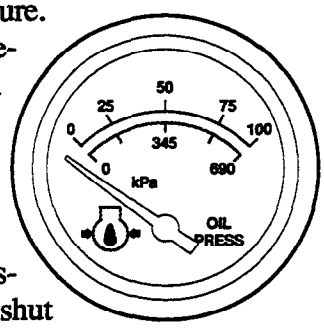
Indicates temperature of engine coolant water in degrees, 100-280°F (38-138°C). Water temperature should be about 180°F (82°C) after 10 minutes of operation. If the indicator registers in the "hot" zone, turn off the engine and troubleshoot the cooling system.

Fuel Gauge



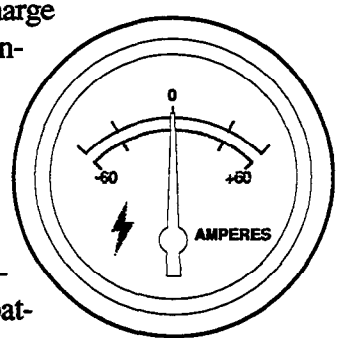
Indicates quantity of fuel remaining in the tank in fractions of the whole. Fuel level should be checked at the beginning of each shift. The tank should be full at the beginning of each shift. *(Not used on LPG/CNG.)*

Oil Pressure Gauge



Indicates engine oil pressure. Oil pressure should be between 30 psi (207 kPa)and 60 psi (414 kPa) at normal engine operating speeds. At idle, pressure should not fall below 20-25 psi (138 kPa). If pressure is low or erratic, shut down the engine and locate the problem.

Ammeter



Indicates rate of battery charge or discharge. With the engine running, the gauge should read slightly to the "+" side of 0. If the ammeter shows a continuous high rate of charge or discharge, or reads erratically, troubleshoot the battery charging system.

Transmission Temperature Light

This light comes on when oil temperature in the torque converter is too high. Shift to a lower range. If light stays on, shut the truck down and troubleshoot the transmission.

Air Restriction Indicator

Located on the seat deck of diesel models, this indicator shows red when it is time to change the air filter element.

NOTICE

The electrically-operated gauges register correctly when the key switch is in the ON position. When the key switch is OFF, the indicator needle will not necessarily return to any given position.

Section 1.

Engine Troubleshooting

NOTE

This troubleshooting chart lists engine problems followed by causes. Each cause is followed by a code indicating whether it pertains to all engines (A) or only to a gasoline (G), diesel (D), LPG (L), or natural gas (N) engine.

Additional troubleshooting information may be found in the engine workshop manual located in Section 2, 3, or 4 of Group 00.

workshop manual for 4.248, 4.236 & 4.212 diesel engines

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This publication is written for world wide use. In territories where legal requirements govern engine smoke emission, noise, safety factors etc., then all instructions, data and dimensions given must be applied in such a way that, after servicing (preventive maintenance) or repairing the engine, it does not contravene the local regulations when in use.

SECTION B
Technical data

Bore (4.248 engine)	3.975 in (100,96 mm)*
Bore (4.236 and 4.212 engines)	3.875 in (98,43 mm)*
Stroke (4.248 and 4.236 engines)	5 in (127 mm)
Stroke (4.212 engine)	4.5 in (114,3 mm)
No. of Cylinders	Four
Cubic Capacity (4.248 engine)	248 in³ (4,06 litres)
Cubic Capacity (4.236 engine)	236 in³ (3,86 litres)
Cubic Capacity (4.212 engine)	212 in³ (3,47 litres)
Compression Ratio (4.248 and 4.236 engines)	16 : 1
Compression Ratio — 4.212 (HC Piston with 3 rings)	17.5 : 1
Compression Ratio — A4.212 (HC Piston with 3 rings)	17.5 : 1
Compression Ratio — A4.212 (LC Piston with 4 rings)	15.5 : 1
Firing Order	1, 3, 4, 2.
Cycle	Four-Stroke
Combustion System	Direct Injection
Lubricating Oil Pressure	30/60 lbf/in² (2,1/4,2 kgf/cm²) or 207/414 kN/m² at max engine speed and normal working temperature.

*Nominal —for actual bore size, see pages B.3 and B.4.

On A4.212 engines, the HC piston with 3 rings was fitted to MF engines from Nos. 212UA87001 to 212UA147672.

Details of Maximum Gross Ratings

4.248 Engines

General Agricultural and Industrial	62 kW (84 bhp) at 2500 rev/min
Maximum Torque	263 Nm (194 lbf ft) at 1400 rev/min
Heavy Duty Agricultural and Industrial	58 kW (78.5 bhp) at 2200 rev/min
Maximum Torque	279 Nm (206 lbf ft) at 1400 rev/min

4.236 Engines

Vehicle	61 kW (82 bhp) at 2800 rev/min
Maximum Torque	256 Nm (194 lbf ft) at 1400 rev/min
General Agricultural and Industrial	60 kW (81 bhp at 2600 rev/min
Maximum Torque	267 Nm (197 lbf ft) at 1350 rev/min
Heavy Duty Agricultural and Industrial	54 kW (72 bhp) at 2200 rev/min
Maximum Torque	272 Nm (201 lbf ft) at 1400 rev/min

4.212 Engines

Agricultural	46 kW (62 bhp) at 2200 rev/min
Maximum Torque	229 Nm (169 lbf ft) at 1350 rev/min

All the above ratings are maximum and can vary according to application.
For details of individual ratings, apply to your nearest Perkins Distributor.

Engine Weights

Typical dry weight	590 lb (269 kg)
Typical installed weight	750/900 lb (340/409 kg)

De-Rating for Altitude

Where engines operate at high altitudes they should be de-rated. The following table is given as a general guide to be applied on a percentage basis, where specific figures for a particular engine rating are not available.

Altitude	Maximum fuel delivery de-rating*
0 — 2,000 feet (600 metre)	No change
2,000 — 4,000 feet (1200 metre)	6%
4,000 — 6,000 feet (1800 metre)	12%
6,000 — 8,000 feet (2400 metre)	18%
8,000 — 10,000 feet (3000 metre)	24%
10,000 — 12,000 feet (3600 metre)	30%

*Measured at setting speed given on Pump Setting Code.

Any necessary adjustments in this respect to the fuel pump should be carried out by the C.A.V. dealer for the territory concerned.

For any further information apply to Perkins Engines Ltd., Peterborough, or to Overseas Companies listed on Page 2.

Water Pump (continued)

Inside Dia. of Impeller Bore	0.6249/0.6257 in (15,87/15,89 mm)
Interference Fit of Impeller on Shaft	0.0005/0.0018 in (0,01/0,05 mm)
Outside Dia. of Impeller	3.094/3.096 in (78,58/78,63 mm)
Impeller Blade to Body Clearance	0.012/0.032 in (0,30/0,81 mm)
Water Pump Seal Type	Synthetic Rubber, Carbon Faced

Balance Unit

Note: Later units have needle roller bearings and all current balance units have reversed weights.

Front Dia. of Shafts (Driving and Driven)	1.2484/1.2490 in (31,71/31,73 mm)
Inside Dia. of Front Balance Frame Bushes	1.2510/1.2526 in (31,78/31,82 mm)
Running Clearance of Shafts in Bushes	0.002/0.0042 in (0,05/0,11 mm)
Rear Dia. of Shafts (Driving and Driven)	0.9987/0.9992 in (25,37/25,38 mm)
Inside Dia. of Rear Balance Frame Bushes	1.001/1.0022 in (25,43/25,46 mm)
Running Clearance of Shafts in Bushes	0.0018/0.0035 in (0,05/0,09 mm)
Shaft Dia. for Balance Weights	1.0622/1.0630 in (26,98/27,00 mm)
Bore Dia. of Balance Weights	1.0625/1.0637 in (26,99/27,02 mm)
Fit of Balance Weights on Shafts	—0.0005/+0.0015 in (—0,01/+0,04 mm)
Spigot Dia. of Earlier Balance Weights	2.499/2.500 in (63,47/63,50 mm)
Recess Dia. in Earlier Balance Weights	2.500/2.501 in (63,50/63,53 mm)
Spigot Dia. for Reversed Balance Weights	1.374/1.375 in (34,90/34,93 mm)
Recess Dia. in Reversed Balance Weight Gears	1.375/1.376 in (34,93/34,95 mm)
Fit of Gear on Balance Weight	—0.000/+0.002 in (—0,00/+0,05 mm)
Dia. of Earlier Shaft for Lub. Oil Pump Gear	0.4215/0.4235 in (10,71/10,76 mm)
Bore Dia. of Earlier Lub. Oil Pump Drive Gear	0.425/0.426 in (10,79/10,82 mm)
Clearance Fit of Earlier Gear on Shaft	0.0015/0.0045 in (0,04/0,11 mm)
Dia. of Shaft for Later Lub. Oil Pump Gear	0.6500/0.6508 in (16,51/16,53 mm)
Bore Dia. of Later Lub. Oil Pump Drive Gear	0.6513/0.6533 in (16,54/16,59 mm)
Clearance Fit of Later Gear on Shaft	0.0005/0.0033 in (0,01/0,08 mm)
Depth of Earlier Lub. Oil Pump Body	0.999/1.002 in (25,38/25,45 mm)
Depth of Later Lub. Oil Pump Body	1.002/1.005 in (25,45/25,53 mm)
Width of Lub. Oil Pump Drive Gears	0.998/1.000 in (25,35/25,40 mm)
End Float of Earlier Oil Pump Gears (with joint)	0.003/0.008 in (0,08/0,20 mm)
End Float of Later Oil Pump Gears	0.002/0.007 in (0,05/0,18 mm)
Shaft Dia. for Lub. Oil Pump Driven Gear	0.4382/0.4386 in (11,13/11,14 mm)
Bore Dia. of Lub. Oil Pump Driven Gear	0.4394/0.4404 in (11,16/11,19 mm)
Running Clearance of Oil Pump Driven Gear	0.0008/0.0022 in (0,02/0,06 mm)
Hub Dia. for Idler Gear	1.4984/1.4990 in (38,06/38,08 mm)
Bore Dia. of Idler Gear Bush	1.500/1.5016 in (38,10/38,14 mm)
Running Clearance of Idler Gear on Hub	0.001/0.0032 in (0,03/0,08 mm)
Idler Gear End Float	0.008/0.014 in (0,20/0,36 mm)

Approved Fuel Oil Specifications

United Kingdom	BS.2869 : 1967 - Class A1 and A2.
United States	A.S.T.M/D.975 - 66T - Nos. 1-D or 2-D. VV - F - 800a : Grades DF-A, DF-1 or DF-2.
Germany	DIN-51601 (1967).
France	(J.O. 14/9/57) Gas Oil or Fuel Domestique.
Italy	CUNA - Gas Oil NC-630-01 (1957).
India	IS : 1460/1968 - Grade Special or Grade A.
Sweden	SIS. 15 54 32 (1969).
Switzerland	Federal Military Specification 9140-335-1404 (1965).

Fuel oils available in territories other than those listed above which are to an equivalent specification may be used.

Fuel Lift Pump

Type of Pump	A.C. Delco. V.P. Series
Method of Drive	Eccentric on Camshaft
Delivery Pressure — Two Bolt Fixing	$2\frac{3}{4}$ to $4\frac{1}{4}$ lbf/in² (0,19/0,30 kgf/cm²) —19 to 29 kN/m²
Delivery Pressure — Four Bolt Fixing	6 to 10 lbf/in² (0,42/0,70 kgf/cm²) —41 to 69 kN/m²
Spring Colour Code — Two Bolt Fixing	Green
Spring Colour Code — Four Bolt Fixing	Red

Valve Seat Inserts

In the majority of applications, valve seat inserts are not fitted to production engines, but may be fitted in service.

However, there are some 4.248 applications in which exhaust valve seat inserts are fitted in production and where it is thought necessary, they may be replaced by new ones.

When fitting inserts to the valve seat, ensure that genuine Perkins Parts are used and proceed as follows: follows:

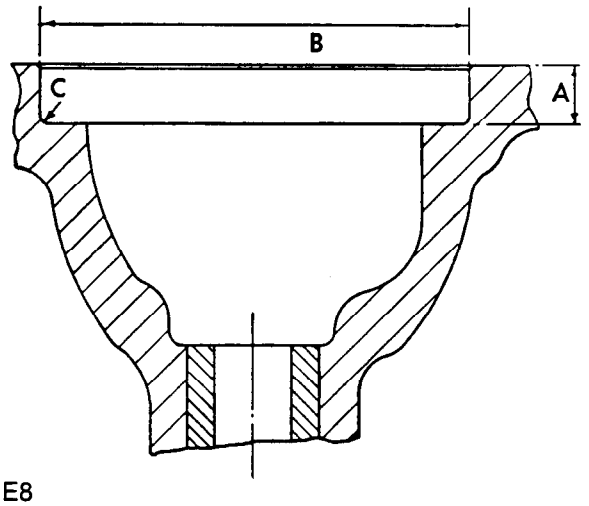
a) For cylinder heads having removable valve guides, press out existing guide and clean the parent bore. Press in new guide.

b) For guideless cylinder heads.
Using the appropriate oversize piloted reamer—0.015 in (0,38 mm) or 0.030 in (0,76 mm) according to the condition of the valve bores in the cylinder head—ream out the valve stem bores.

NOTE: Appropriate oversize stem replacement valves will be needed when this operation has been carried out on guideless cylinder heads.

Proceed as follows for either type cylinder head, with or without valve guides:—

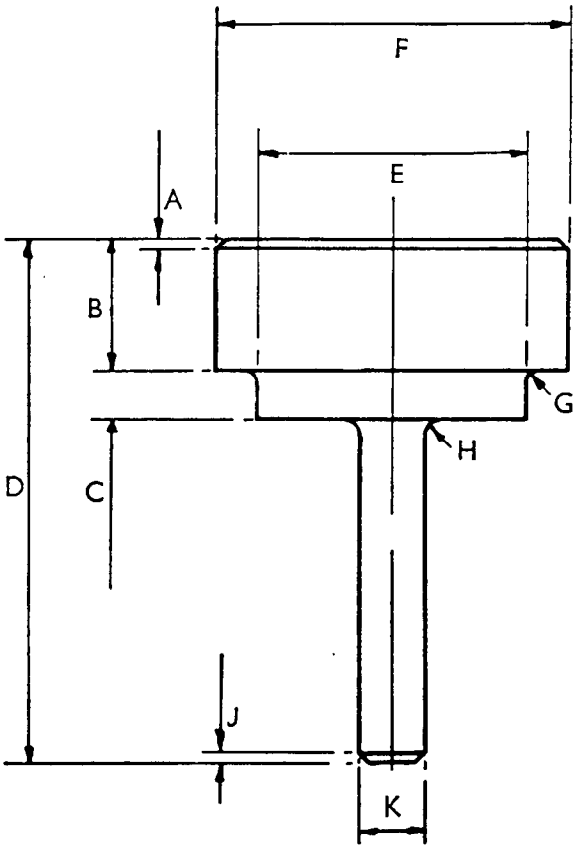
1. Using the new valve bore as a pilot, machine the recess in the cylinder head face to the dimensions in Fig. E.8.
2. Remove all machining swarf and clean the insert recess. Using the valve bore as a pilot, press the insert home using the inserting tool (Fig. E.9). Under no circumstances should the insert be hammered in, neither should lubrication be used during pressing in.
3. Inspect to ensure that the insert has been pressed fully home and is flush with the bottom of the recess.
4. Using the valve bore as a pilot, machine the "flare" to the dimensions in Fig. E.10.



E8

Inlet
A—0.283/0.288 in (7,19/7,31 mm)
B—2.0165/2.0175 in (51,22/51,24 mm)
C—Radius 0.015 in (0,38 mm) max.

Exhaust
A—0.375/0.380 in (9,52/9,65 mm)
B—1.678/1.679 in (42,62/42,64 mm)
C—Radius 0.015 in (0,38 mm) max.



E9

Inlet
A—$\frac{1}{16}$ in (1,59 mm) at 45°
B—$\frac{3}{4}$ in (19,05 mm)
C—0.250 in (6,35 mm)
D—3 in (76,20 mm)
E—1.582/1.583 in (40,18/40,21 mm)
F—2.009/2.019 in (51,03/51,28 mm)
G—1/32 in (0,79 mm) radius
H—$\frac{1}{16}$ in (1,59 mm) radius
J—$\frac{1}{16}$ in (1,59 mm) at 45°
K—0.372/0.373 in (9,45/9,47 mm)

Exhaust
A—1/16 in (1,59 mm) at 45°
B—$\frac{3}{4}$ in (19,05 mm)
C—0.312 in (7,92 mm)
D—3.0 in (76,20 mm)
E—1.248/1.249 in (31,70/31,72 mm)
F—1.670/1.680 in (43,42/43,67 mm)
G—1/32 in (0,79 mm) radius
H—1/16 in (1,59 mm) radius
J—1/16 in (1,59 mm) at 45°
K—0.372/0.373 in (9,45/9,47 mm)

5. Remove all machining swarf and burrs.
6. Re-cut the valve seat at an included angle of 90°, so that the valve head depth below the cylinder head face is within the production limits of 0.042/0.052 in (1,07/1,32 mm) for exhaust valves and 0.035/0.045 in (0,89/1,14 mm) for inlet valves.

Oversize Cylinder Liners

Oversize outside diameter cylinder liners may be fitted to 4.236 factory rebuilt engines and are available for fitment in service where the standard parent bore is enlarged to remove damage.

They are available as follows:—

Oversize	Description
0.005 in (0,13 mm)	Cast Iron Flangless — bore and hone
0.010 in (0,25 mm)	Cast Iron Flangeless — bore and hone
0.010 in (0,25 mm)	Cast Iron Flanged — bore and hone
0.040 in (1,02 mm)	Cast Iron Flanged — hone

Where a parent bore is reclaimed in service, it should be machined to the dimension by adding the appropriate liner oversize to the standard parent bore diameter given on Page B.3. The top of the parent bore must be re-chamfered after machining. The 0.040 in oversize liner has a larger flange diameter than the standard liner and if reclaiming a parent bore with this liner, the flange recess diameter will have to be increased to 4.245/4.250 in (107,82/107,95 mm).

Where 0.005 in and 0.010 in oversize liners are fitted, the liner oversize is stamped on the cylinder block top face between the liner and the edge of the cylinder block. Where 0.040 in oversize liners are used, the number 1849 is stamped on the rear end of the block.

SECTION K
Timing Case and Drive

To Remove the Timing Case Cover

1. Slacken the dynamo or alternator mounting bolts, remove the adjusting arm and drive belt.
2. Where necessary, remove water pump.
3. Remove the crankshaft pulley.
4. Remove the timing case cover taking care not to damage the crankshaft front oil seal which is located in the cover.

To Renew the Crankshaft Front Oil Seal

1. Using a press, remove the oil seal from the timing case cover.
2. Press the new seal into position from the front, until the front face is $\frac{1}{8}$ in (3,17 mm) below the front face of the cover.
   With Massey Ferguson applications, the seal should be pressed in 0.38/0.39 in (0,96/0,99 mm) below the front face of the cover.

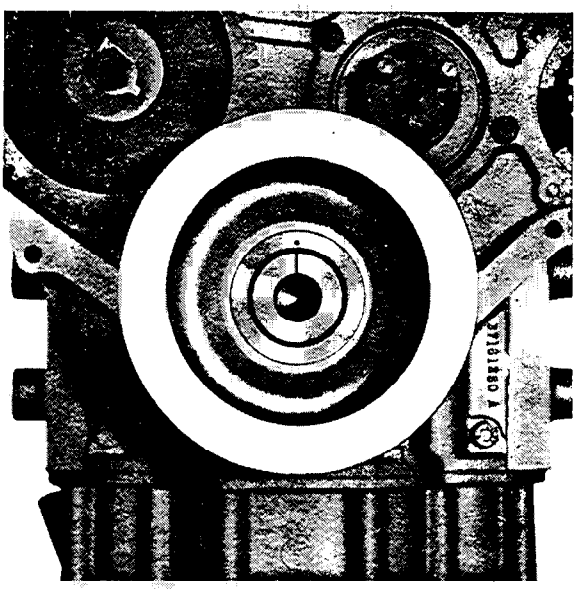
The seal is designed to function correctly with the direction of rotation of the engine and for identification purposes the seal is marked with an arrow.

Earlier engines where fitted with a black nitrile seal and a crankshaft oil thrower.

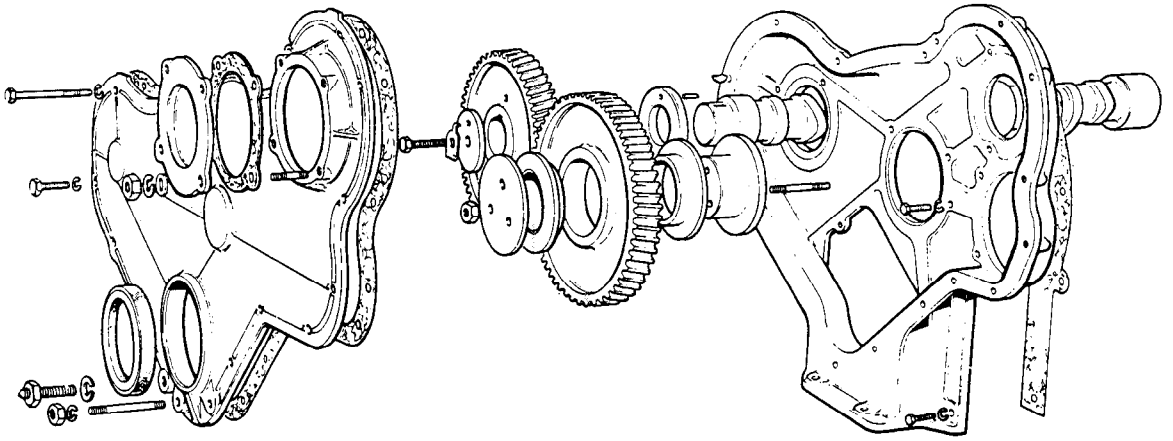
Current engines have a red silicone seal and the oil thrower is replaced with a distance piece. Under no circumstances should the latest red seal be fitted with an oil thrower.

To Refit the Timing Case Cover

1. Position the timing case cover on the timing case by means of two opposite setscrews fitted loosely. Centralise the cover by locating the centralising tool PD.162 on the crankshaft and in the seal housing and tighten the assembly by means of the crankshaft pulley setscrew and washer – do not overtighten.
   Tighten all the timing case cover setscrews and remove the tool. If the centralising tool is not available, the crankshaft pulley can be used to centralise the cover but, as this method utilises the inside diameter of the seal and the latest seal is soft, the cover may not be truly central and leaks may occur.
2. Refit the crankshaft pulley with the centre punch mark on the pulley aligned with the line on the front face of the crankshaft (Fig. K.2). Fit the retaining setscrew and washer and tighten to the torque given on Page B.2.
3. Bolt the dynamo or alternator adjusting arm to the timing case and fit the fan belt.



K2



SECTION L
Lubricating System

The importance of correct and clean lubrication cannot be stressed too highly and all reference to engine oil should be taken to mean lubricating oil which falls within the specification given in the appendix. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated.

Description

The lubrication is of the forced feed type, the oil being circulated by a lobed rotor type oil pump driven through an idler gear by the crankshaft gear or by a gear type oil pump driven from the rear of the balance unit (when fitted). The oil is drawn through a sump strainer to the pump. Oil is then pumped to the relief valve housing and the full flow filter.

Oil passes through the filter to the pressure rail.

From the pressure rail the oil is fed to the main bearings and big ends. A seal prevents oil leaking along the crankshaft at the rear end.

The camshaft bearings are lubricated from numbers one, three and five main bearings.

The camshaft centre bearing supplies a controlled feed of oil to the rocker shaft assembly. This is achieved by allowing oil to be forced to the rocker shaft only when the oilways in the camshaft journal and camshaft centre bearing are in line. Oil from the rocker shaft escapes through a small bleed hole in each rocker lever and lubricates the valves and guides by splash.

The idler gear and hub are pressure lubricated direct from the pressure rail. Oil enters the rear of the hub and passes through drillings to lubricate the idler gear bush and gear retaining plate. Where hydraulically governed pumps are fitted the fuel pump hub is also pressure lubricated from the pressure rail (Fig. N.12). Timing gear teeth are splash lubricated by surplus oil from the front camshaft bearing idler gear hub and fuel pump hub

Pistons, cylinder liners and connecting rod small end bearings are lubricated by splash and oil mist, also the cams and tappets of the valve mechanism.

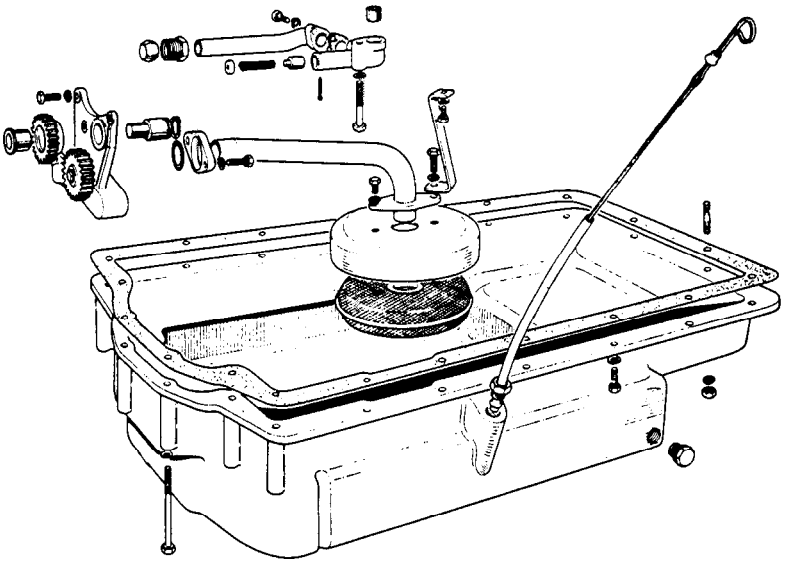
The Oil Pump

The following instructions refer to the lobed rotor type oil pump. Where a balance unit is fitted, then reference should be made to Section J for details of the gear type lubricating oil pump.

The oil pump is secured to the front main bearing cap by three setscrews.

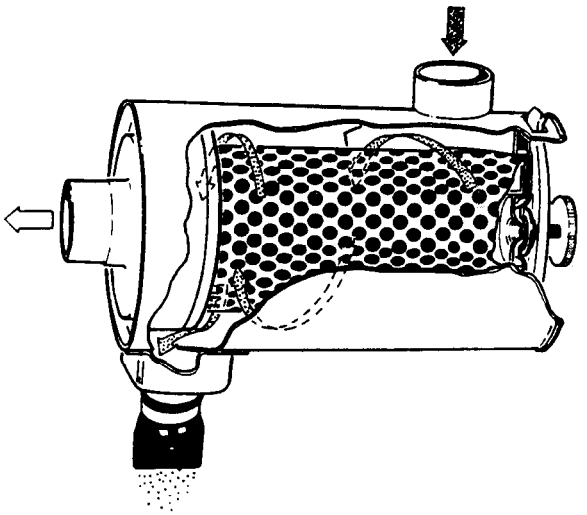
The oil pump gear is driven through a bushed idler gear.

The oil pump drive gear is pressed and keyed on to the pump driven shaft on the other end of which is pressed and pinned a three or four lobed rotor. This rotor meshes with a four or five lobed driven rotor, which is free to rotate in the cast iron pump body.



L2

On later engines, the sump strainer cover is fitted on the upper side of the suction pipe flange (see Fig. L.3).



N2

Inspect cleaned element by placing a bright light inside and looking through element. Any thin spots, pin holes or other damage will render the element unfit for further use.

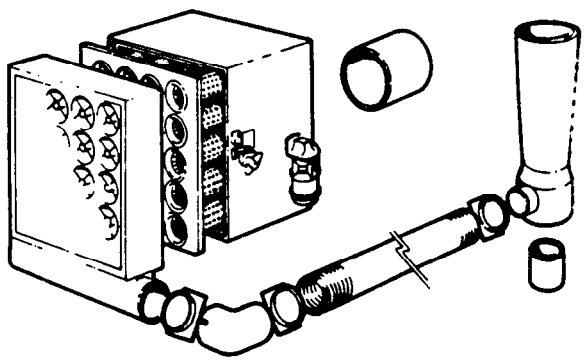
The element should be renewed after six detergent washes or annually, whichever occurs first. Clean the inside of the filter body and dry thoroughly. Inspect joints, hoses and clips and renew where necessary.

Re-assemble filter ensuring that all joints are leak proof.

Extreme Heavy Duty Two Stage, with Multiple Elements "Rotopamic" (Fig. N.3) (Fig. N3)

The "Rotopamic" type air filter may be fitted where the application is designed to work in heavy concentrations of dust and a restriction indicator must be fitted.

The air filter elements are replaceable and no attempt should be made to clean or re-use dirty elements or cartridges.



N3

For cartridge replacement, unclamp and remove the moisture eliminator or pre-cleaner panel, pull out the dirty cartridges and insert the new ones.

Refit the pre-cleaner.

Never use petrol (gasoline) for cleaning any of the air induction system.

Oil Bath Air Filters (Fig. N.4)

To service the oil bath type filter, the lid should be removed and the element lifted out. The oil in the container should be drained out and the dirt and sludge thoroughly cleaned out with a proprietary cleaning fluid or Kerosene. Refill the container with clean new engine lubricating oil to the indicated level. The woven filter element should be cleaned in a bath of Kerosene. Do not use petrol (gasoline) as this highly volatile fuel could cause explosive damage within the engine. The indicated filling mark level should never be exceeded, otherwise oil can be drawn up into the engine which could lead to uncontrolled engine speeds, and excessive engine wear.

The heavy duty oil bath air filters are usually fitted with a centrifugal pre-cleaner mounted on top of the main cleaner, this should be removed and the air inlet vanes in the bottom plate of the assembly, the ejection slots on the side of the cone and the vanes in the outlet tube. cleaned of dust and dirt. The detachable element is accessible by lowering the oil container which may be attached by clips or a pinch screw clamp.

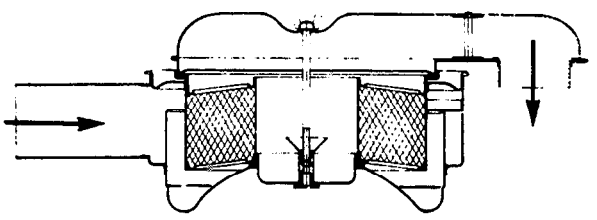
Thoroughly clean the container and refill to the indicated level with new engine lubricating oil. The separate element should be cleaned in a Kerosene bath.

The upper element which is permanently attached inside the body should be periodically cleaned by washing in a Kerosene bath. Drain the element thoroughly before reassembly and do not use petrol (gasoline) for cleaning purposes.

Tractor Type Air Filter (Fig. N.5)

The air filter container should be removed, cleaned and recharged with clean new engine lubricating oil to the level mark every 50 hours. The lower gauze filter should be removed and cleaned. The larger gauze in the main body of the filter should also be cleaned.

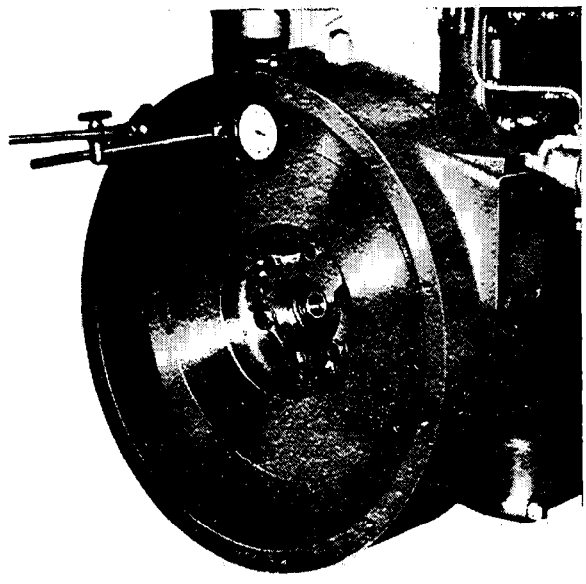
Under extremely dirty conditions attention to the filter should be given more frequently. It is important to note that the filter oil container must never be filled above the indicated level.



N4

SECTION P

Flywheel and Flywheel Housing



P1

To Remove the Flywheel

1. Remove the gearbox and flywheel housing.
2. Remove clutch assembly.
3. Remove the flywheel (see Note). With some applications, the flywheel is secured to the crankshaft with 12 setscrews and washers.
4. Remove the clutch pilot bearing (if fitted).

NOTE. To facilitate safe flywheel removal, remove two diametrically opposed securing setscrews and in their place, fit two suitably sized studs, finger tight only. The remaining setscrews can now be removed and the flywheel withdrawn under control.

To Renew the Flywheel Ring Gear

1. Place the flywheel in a suitable container of clean **cold** water and support it by positioning four metal blocks under the ring gear. Arrange the flywheel assembly so that, when placed in the water the ring gear is uppermost and clear of the water line by approximately $\frac{1}{4}$ in (6,5 mm).
   Heat the ring gear evenly around its circumference, thus expanding it. This will allow the flywheel to drop away from the ring gear.
2. Heat the new ring gear to an approximate temperature of 475°F (246°C). Fit the gear over the flywheel with the lead-in on the teeth facing towards the front of the flywheel and allow the ring to cool.

To Refit the Flywheel

1. Using the method of removal but in reverse, mount the flywheel to the crankshaft flange so that the untapped hole in the flange is in line with the seventh unused smaller hole in the flywheel.
2. Engage the securing setscrews with new locking washers and tighten to a torque of 80 lbf ft (11,0 kgf m) —108 Nm. Where the flywheel is secured with place bolts, without washers, these should be tightened to 90 lbf ft (12,4 kgf m) — 122 Nm. Place bolts can be identified by the 6 slots cut in the head face and the embossed letter 'T'.
3. Set up a clock indicator gauge with the base secured to the flywheel housing or cylinder block and adjust the clock so that the stylus is contacting the flywheel periphery. Turn the crankshaft and check the total reading. The flywheel should run true within 0.012 in (0,30 mm) total indicator reading.
4. Now adjust the clock gauge so that the plunger is at right angles to the crankshaft flange and rests on the vertical machined face of the flywheel, at the outermost point of the face (Fig. P.1).
   Press the crankshaft one way to take up the end float, and turn the flywheel. The run-out on the flywheel face should be within 0.001 in (0.025 mm) per inch (25 mm) of flywheel radius from the crankshaft axis to the clock gauge stylus. If not, remove flywheel and check mating faces for burrs and dirt.
5. Lock the setscrews with the tab washers.
6. Refit the clutch and gearbox, etc.

To Remove the Flywheel Housing

1. Remove the flywheel.
2. Unscrew the nuts or setscrews securing the flywheel housing to the cylinder block and tap the housing clear of the locating dowels.
3. Examine the housing for cracks and damage etc

To Refit the Flywheel Housing

1. Fit the housing to the cylinder block.
2. Refit the securing nuts or setscrews.
3. Check concentricity (Fig. P.2.) The inner bore of of the flywheel housing must be truly central with the crankshaft within the limits listed overleaf.

SECTION S

Alternator, Dynamo & Starter Motor

Alternator

MODELS
Models AC5, 11AC, 15ACR, 17ACR and 18ACR

General

These are driven by the engine in the same manner as a D.C. Generator, namely, belt driven from the crankshaft pulley, but the advantage lies in their ability to provide higher maximum output at lower speeds, to cope with increased electrical load demanded by modern equipment and decreased road speeds owing to increased density of traffic, especially in built up areas. They are also much lighter in weight. output for output.

As opposed to the DC Generator in which the armature windings rotate inside a stationary field system, the alternator has a rotating field system inside a stationary generating winding. When the rotor rotates inside the stator, the output produced is alternating current (AC). This is unsuitable for charging the battery which requires direct current (DC), so it is rectified by means of diodes which converts it to uni-directional flow to the battery.

The alternator voltage output is maintained within close limits by means of a control box which is fully transistorised and functions as fast switches.

Precautions

As previously described the diodes in the alternator function as one-way valves and the transistors in the regulator/control box operate as fast switches. Both are accurate and sensitive.

They do not wear out and seldom require adjustment, but because they are sensitive to voltage changes and high temperature, the precautions are vital to prevent them from being destroyed.

a) DO NOT disconnect the battery whilst the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.

b) DO NOT disconnect a lead without first stopping the engine and turning all electrical switches to the off position.

c) DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors or diodes.

d) DO NOT connect a battery into the system without checking for correct polarity and voltage.

e) DO NOT "flash" connections to check for current flow. No matter how brief the contact the transistors may be ruined.

Maintenance

The alternator charging system will normally require very little attention, but it should be kept free from build-up of dirt, and a check made if it fails to keep the battery charged.

a) Regularly inspect the driving belts for wear and correct tension. It is important to ensure that all belts on a multiple belt drive have equal tension and are each carrying their share of the load. Slack belts will wear rapidly and cause slip which will not drive the alternator at the required speed. Drive belts which are too tight impose severe side thrust on the alternator bearings and shorten their life. Periodically ensure that the alternator is correctly aligned to the drive.

b) Do not replace faulty belts individually in a multi-belt system. A complete matched set of drive belts must always be used.

c) Keep the alternator clean with a cloth moistened in kerosene or cleaning fluids. Ensure that ventilation slots and air spaces are clear and unobstructed.

d) Remove any dirt accumulated on the regulator/control box housing, and ensure that cooling air can pass freely over the casing.

Fault Finding on AC5

The AC 5 alternator is so designed that a flow of current indicated either by the extinguishing of the warning light, or as shown on the ammeter, is sufficient evidence that the system is in proper working order. Therefore, no open circuit, voltage or current output checks should be performed on the installation UNLESS:—

a) The warning light fails to illuminate when the generator is stationary, and the switch is closed OR fails to become extinguished when the alternator is running.

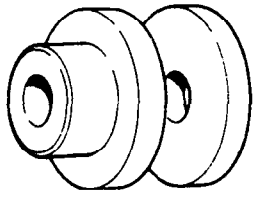
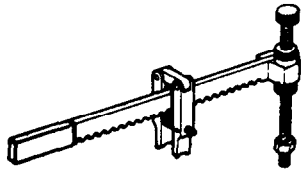
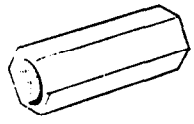
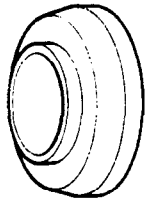
b) No charging current is shown on ammeter.

c) The battery is flat.

d) The battery is "boiling", indicating loss of voltage control.

If any of the above symptoms occur, the procedure indicated below should be followed.

a) Connect a good quality moving coil voltmeter 0—50 volts range across the battery or regulator negative

	Tool No.	Description
	336-102	ARBOR ADAPTOR Used with 335.
	6118B	VALVE SPRING COMPRESSOR
	PD.6118-4	ADAPTOR FOR 6118B
	PD.162	TIMING CASE COVER CENTRALISING TOOL

This publication has been written for gasolene (petrol), natural gas and LPG (liquid petroleum gas) engines. Any information required on LPG engines which is not to be found in this publication, such as, starting procedure, gas pressure reducing equipment, pre-heating and carburation etc., should be obtained from the manufacturer of the machine or his supplier.

Perkins Engines Limited is not responsible for any damage caused to this engine or its component parts by fitting of any LPG or natural gas conversion equipment not approved by the Company or which is incorrectly fitted or adjusted.

DATA

Type	Four cylinder. Four stroke
Bore	3.875 in (98,4 mm) — Nominal
Stroke	5 in (127 mm)
Compression Ratio	7.5 : 1 Gasolene and LPG engines
Compression Ratio	11.5 : 1 (Natural gas engines)
Cubic Capacity	235.9 in³(3,86 litre)
Firing Order	1, 3, 4, 2.
Tappet Clearance	Inlet (cold) 0.012 in (0,30 mm)
	Exhaust (cold) 0.015 in (0,38 mm)
Oil Pressure	30/60 lbf/in²(2,1/4,2 kgf/cm²) at maximum engine speed and normal operating temperature
Lubricating Oil Sump Capacity (less filter)	High Level 14 U.K. pints 16.8 U.S. pints 7,9 litre
Ignition Timing (A.C. Delco Distributor)	2½° B.T.D.C. (Static)
	12° B.T.D.C. at 1250 rev/min (Dynamic)
Ignition Timing (Lucas Distributor)	3° B.T.D.C. (Static)
	15° B.T.D.C. at 1400 rev/min (Dynamic)
Ignition Timing (Lucas Electronic Distributor)	24° B.T.D.C. at 1400 rev/min (Static and Dynamic)
Sparking Plug	Champion N11Y 14 mm
Sparking Plug Gap	0.025 in (0,64 mm)
Sparking Plug Gap (Natural Gas Engines)	Champion N180B 14 mm
Sparking Plug Gap	Not adjustable (Twin electrode)
Contact Breaker Points Gap (A.C. Delco Distributor)	0.019/0.021 in (0,48/0,53 mm)
Contact Breaker Points Gap (Lucas Distributor)	0.014/0.016 in (0,35/0,40 mm)
Reluctor Gap (Lucas Electronic Distributor)	0.006/0.008 in (0,15/0,20 mm)
Fuel Specification (Gasolene Engines)	91 octane
Fuel Specification (Natural Gas Engines)	Methane gas at 15° and 101,3 kPa, 34,82 MJ/m³ nett

Rating Details (Gasolene Engines)

Maximum Gross Output	78 bhp (58 kW) at 2600 rev/min
Maximum Torque	202 lbf ft (273 Nm) at 1250 rev/min

Rating Details (Natural Gas Engines)

Maximum Gross Output	74 bhp (55 kW) at 2000 rev/min
Maximum Torque	206 lbf ft (280 Nm) at 1400 rev/min

Recommended Torque Tensions

Component	Screw Size UNF	lbf ft	kgf m	Nm
Cylinder head nuts and setscrews	½	96	13,2	130
Big end nuts* (Cadmium plated)	½	72	9,9	98
Big end nuts† (Phosphated)	½	92	12,6	125
Main bearing setscrews**	⅝	145	20,0	196
Main bearing setscrews††	⅝	171	23,5	232
Camshaft gear retaining setscrew	½	48	6,6	65
Idler gear hub to block setscrews	⅜	27	3,7	37
Upper idler hear hub nut (Plain)	7/16	37	5,1	50
Upper idler gear hub nut (Cadmium plated)	7/16	42	5,7	57
Crankshaft Pulley Retaining setscrew (Plain)	⅞	287	39,6	390
Crankshaft Pulley retaining setscrews (Cadmium plated)	⅞	230	31,7	312
Crankshaft Pulley retaining setscrews (Phosphated)	⅞	276	38,0	375
Flywheel setscrews	½	77	10,6	105
Governor Drive Gear Retaining Nut	½	24	3,3	32
Lubricating Oil Filter Setscrews	7/16	28	3,8	38
Sparking Plug	14 mm	25	3,4	34

*For engines preceding the following engine number.

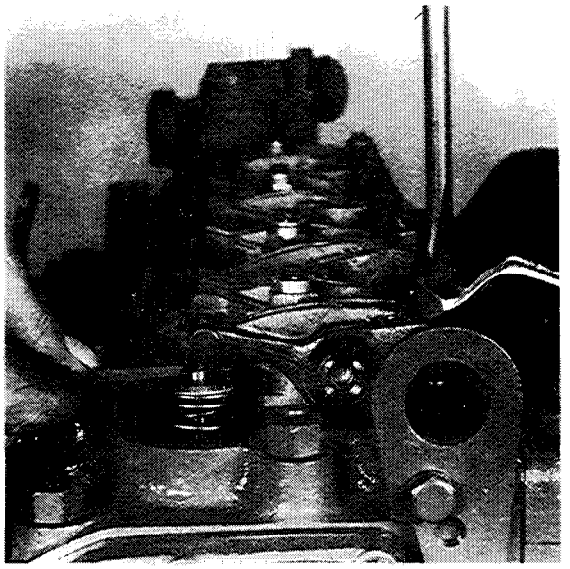
†For engines commencing at the following engine number 236UA1660A

**For engines preceding the following engine number.

††For engines commencing at the following engine number 236U671A.

General

All studs on the cylinder head and top face of the cylinder block should be examined for looseness or damage. The cylinder head nuts and setscrews should also be checked for thread damage.



E4

Re-assembly

Replace valves, washers, rotators, seals, collars, springs and collets. Valves should always be refitted to their original seats and any new valve fitted should be suitably marked to identify its position if removed at a later date. Refer to Fig. E.3 for illustration of valve numbering on assembly of earlier engines. Ensure that the spring damper coils are fitted towards the cylinder head (Fig. E.6).

Fit a new cylinder head gasket DRY. Jointing compound must not be used.

Lower head into position on its studs and torque nuts and setscrews down to the correct value (See 'General Information') and sequence. (Fig. E.7). Fit push rods and refit rocker shaft assembly ensuring that the rocker oil feed pipe rubber olive is fitted in the recess in the head before fitting the rocker shaft assembly. (Fig. E.8).

Adjust valve tip clearance as follows:—

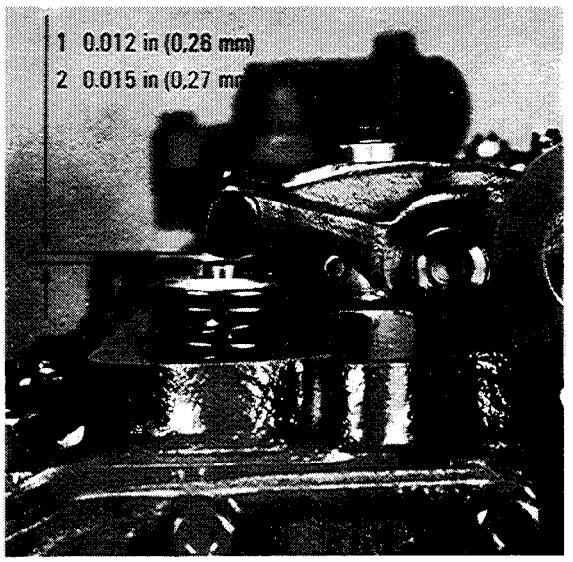
With valves rocking on No. 4 cylinder (i.e. the period between the opening of the inlet valve and the closing of the exhaust valve), set the valve clearances on No. 1 cylinder.

With valves rocking on No. 2 cylinder set the valve clearances on No. 3 cylinder.

With valves rocking on No. 1 cylinder set the valve clearances on No. 4 cylinder.

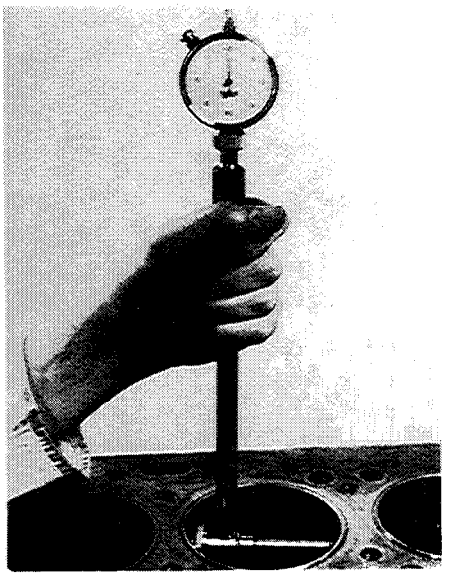
With valves rocking on No. 3 cylinder set the valve clearances on No. 2 cylinder.

Valve tip clearances are (cold) inlet 0.012 in (0,30 mm), exhaust 0.015 in (0,38 mm). Rebuild head in the reverse order to disassembly.



E5 1. Inlet Clearance
2. Exhaust Clearance

G3



G4

Data and Dimensions for Cylinder Block and Liners

Cylinder Block

Total Height of Cylinder Block between Top and bottom faces	17.365/17.377 in (441,07/441,37 mm)
Parent Bore Diameter for Cylinder Liner	4.0615/4.0625 in (103,16/103,19 mm)
Main Bearing Parent Bore Diameter	3.166/3.167 in (80,42/80,44 mm)
Camshaft Bore Dia. No. 1	2.000/2.001 in (50,80/50,82 mm)
Camshaft Bore Dia. No. 2	1.990/1.9918 in (50,55/50,59 mm)
Camshaft Bore Dia. No. 3	1.970/1.9718 in (50,04/50,08 mm)

Cylinder Liners

Type	Dry — Interference Fit
Outside Diameter of Liner	4.0655/4.0665 in (103,26/103,29 mm)
Interference Fit of Liner in Cylinder Block Parent Bore	0.003/0.005 in (0,08/0,13 mm)
Inside Diameter of Finished Liner in Cylinder Block ...	3.877/3.878 in (98,48/98,50 mm)
Liner Height above Cylinder Block Top Face ...	0.030/0.035 in (0,76/0,89 mm)
Overall Length of Liner	9.005/9.015 in (228,73/228,98 mm)

CRANKSHAFT, MAIN BEARINGS AND BALANCER UNIT—H.10

Running-In

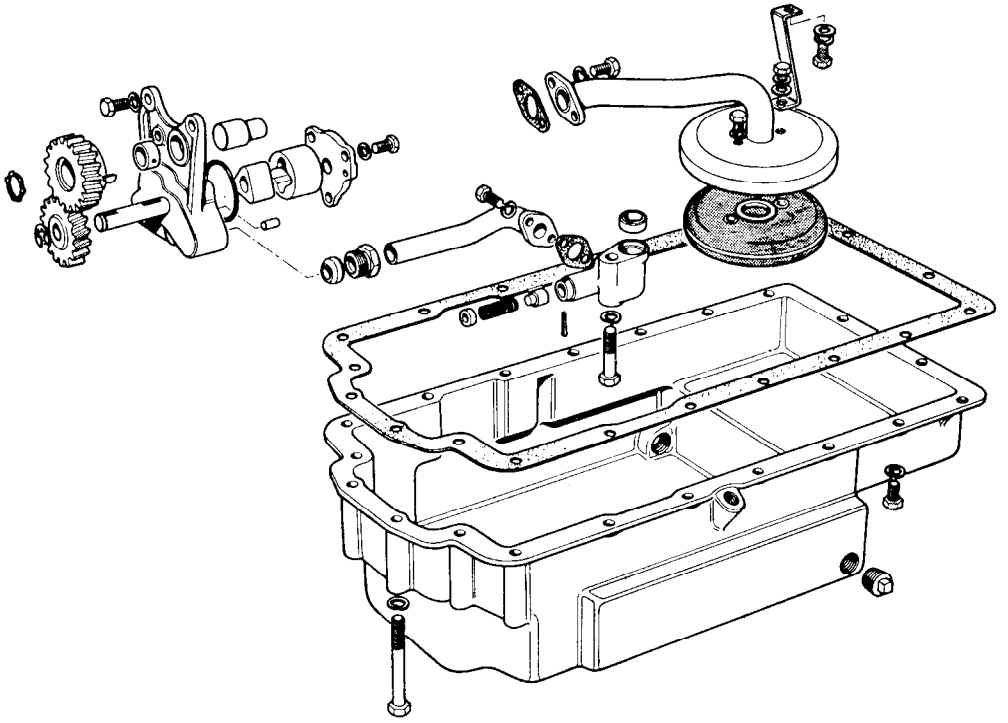
After renewing any parts, the balancer unit must be carefully run-in and this should be effected by firstly running the engine at fast idle for a period of half an hour, followed by a further half hour at 1,000 rev/min.

NOTE

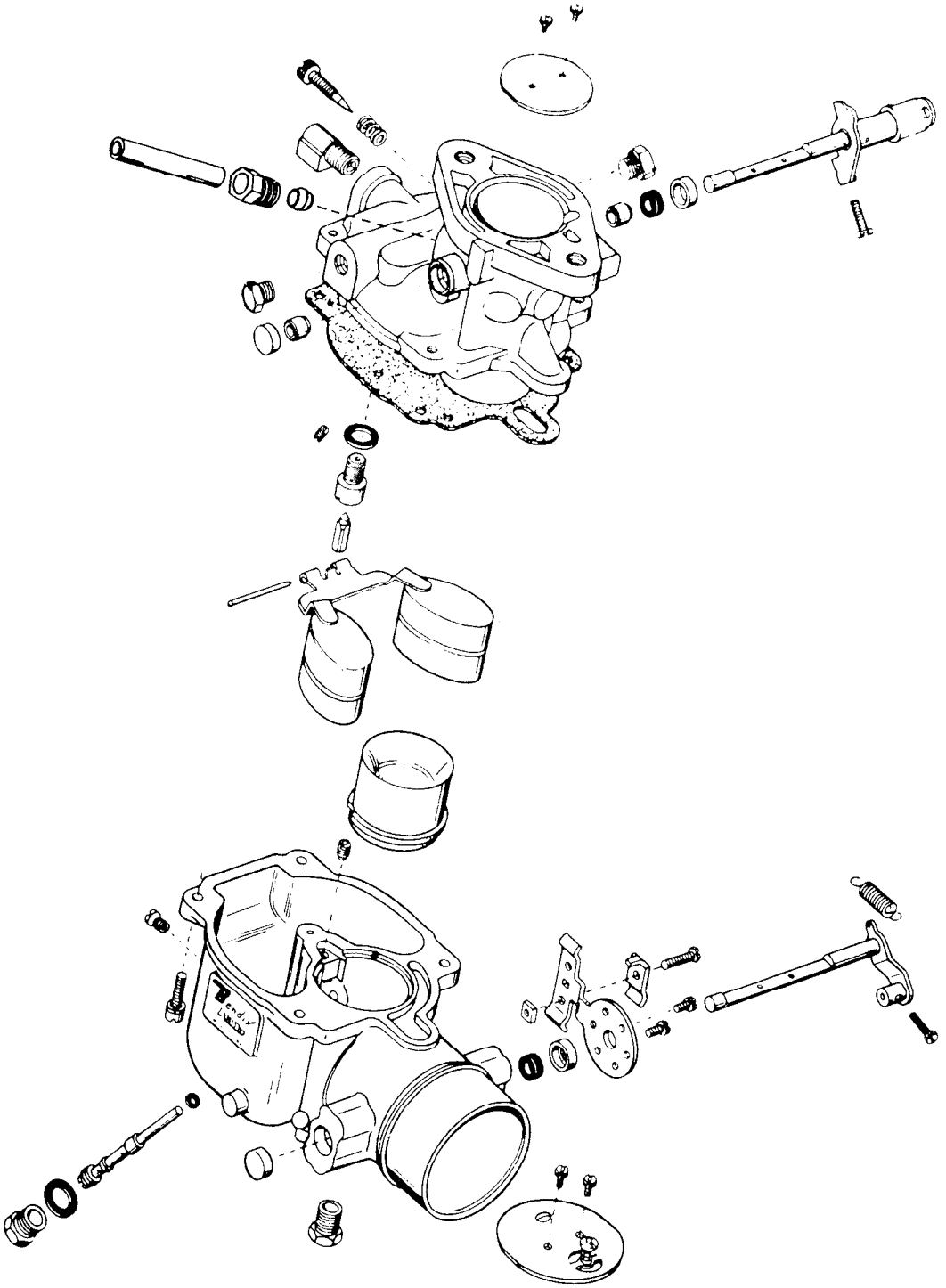
Replacement bushes are not serviced separately for the idler gear. A replacement idler gear, complete with pre-finished bush must be fitted.

The stud which secures the idler gear and hub to the balancer frame is available as a spare part but need not be removed from the balancer frame unless it requires replacing.

SECTION L
Lubrication System



SECTION N
Fuel System



To Remove Flywheel Housing

1. Remove flywheel.
2. Unscrew nuts and setscrews securing flywheel housing to cylinder block and tap the housing clear of the locating dowels.
3. Examine housing for cracks and damage etc.

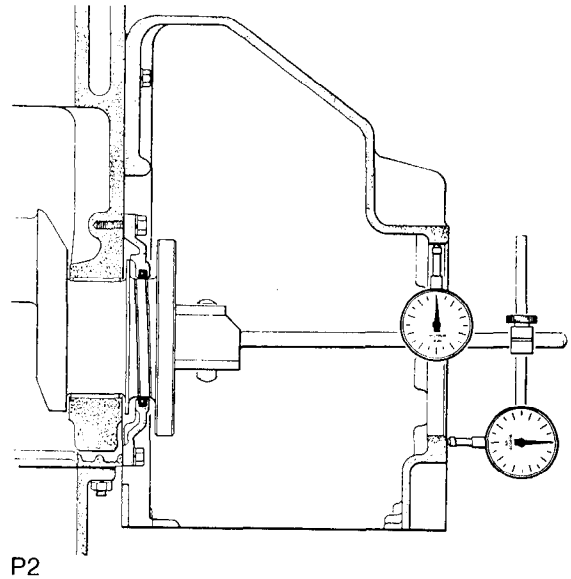
To Refit Flywheel Housing

1. Remove locating dowels and fit housing to cylinder block.
2. Refit securing nuts or setscrews.
3. Check concentricity (Fig. P.2). The inner bore of the flywheel housing must be truly central with the crankshaft within the limits listed below.
4. Check perpendicular alignment (Fig. P.2). This facing should be within the limits listed below.

Diameter of Housing	Allowance
Up to 14¼ in (362 mm)	0.006 in (0,15 mm) T.I.R.
14¼ to 20⅜ in (362 to 511,18 mm)	0.008 in (0,20 mm) T.I.R.
20⅜ to 25½ in (511,18 to 647,70 mm)	0.010 in (0,25 mm) T.I.R.
25½ to 31 in (647,70 to 787,40 mm)	0.012 in (0,30 mm) T.I.R.

(T.I.R. Total Indicator Reading).

5. All adjustments to bring flywheel housing within the above limits must be carried out on the flywheel housing and NOT on the rear face of the cylinder block which must not be interfered with.
6. When housing is properly aligned to the above limits, tighten the securing nuts evenly.
7. Ream dowel holes and fit correct length and size dowels.
8. Refit flywheel.



P2

ALTERNATOR

Models AC5, 11AC, 18ACR and A115/45

1. GENERAL

Alternators are driven by the engine in the same manner as a D.C. Generator, namely, belt driven from the crankshaft pulley, but the advantage lies in their ability to provide higher maximum output at lower speeds, to cope with increased electrical load demanded by modern equipment and decreased road speeds owing to increased density of traffic, especially in built up areas. They are also much lighter in weight, output for output.

As opposed to the DC Generator in which the armature windings rotate inside a stationary field system, the alternator has a rotating field system inside a stationary generating winding. When the rotor rotates inside the stator, the output produced is alternating current (AC). This is unsuitable for charging the battery which requires direct current (DC), so it is rectified by means of diodes which converts it to unidirectional flow to the battery.

The alternator voltage output is maintained within close limits by means of a control box which is fully transistorised and functions as fast switches.

2. PRECAUTIONS

As previously described the diodes in the alternator function as one-way valves and the transistors in the regulator/control box operate as fast switches. Both are accurate and sensitive.

They do not wear out and seldom require adjustment, but because they are sensitive to voltage changes and high temperature, the precautions are vital to prevent them from being destroyed.

a). DO NOT disconnect the battery whilst the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.

b). DO NOT disconnect a lead without first stopping the engine and turning all electrical switches to the off position.

c). DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors or diodes.

d). DO NOT connect a battery into the system without checking for correct polarity and voltage.

e). DO NOT "flash" connections to check for current flow. No matter how brief the contact the transistors may be ruined.

3. MAINTENANCE

The alternator charging system will normally require very little attention, but it should be kept free from build-up of dirt, and a check made if it fails to keep the battery charged.

a). Regularly inspect the driving belts for wear and correct tension. It is important to ensure that all belts on a multiple belt drive have equal tension and are each carrying their share of the load. Slack belts will wear rapidly and cause slip which will not drive the alternator at the required speed. Drive belts which are too tight impose severe side thrust on the alternator bearings and shorten their life. Periodically ensure that the alternator is correctly aligned to the drive.

b). Do not replace faulty belts individually in a multi-belt system. A complete matched set of drive belts must always be used.

c). Keep the alternator clean with a cloth moistened in kerosene or cleaning fluids. Ensure that ventilation slots and air spaces are clear and unobstructed.

d). Remove any dirt accumulated on the regulator/control box housing, and ensure that cooling air can pass freely over the casing.

4. FAULT FINDING ON AC5

The AC 5 alternator is so designed that a flow of current indicated either by the extinguishing of the warning light, or as shown on the ammeter, is sufficient evidence that the system is in proper working order. Therefore, no open circuit, voltage or current output checks should be performed on the installation UNLESS:—

a). The warning light fails to illuminate when the generator is stationary, and the switch is closed OR fails to become extinguished when the alternator is running.

b). No charging current is shown on ammeter.

c). The battery is flat.

d). The battery is "boiling", indicating loss of voltage control.

If any of the above symptoms occur, the procedure indicated below should be followed.

a). Connect a good quality moving coil voltmeter 0-50 volts range across the battery or regulator negative terminal, and one of the three positive terminals marked LO, MED, HI. Disconnect alternator output terminal. Fit a good quality moving coil 0-100 amp. meter in series with the alternator terminal and output lead. **The battery should be in a charged condition.**

MIL-L-2104C OILS

Company	Brand	S.A.E. Designation		
		0°F (-18°C) to 30°F (-1°C)	30°F (-1°C) to 80°F (27°C)	Over 80°F (27°C)
B.P. Ltd.	Vanellus C3	10W	20W/20	30
Castrol Ltd.	Castrol/Deusol CRD	10W	20	30
	Deusol RX Super		20W/40	20W/40
	Agricastrol HDD	10W	20	30
	Agricastrol MP		20W/30	20W/30
	Agricastrol MP		20W/40	20W/40
A. Duckham & Co. Ltd.	Fleetol 3	3/10	3/20	3/30
	Farmadcol 3	3/10	3/20	3/30
	Hypergrade		15W/50	15W/50
	Fleetmaster		15W/40	15W/40
Esso Petroleum Co. Ltd.	Essolube D-3HP	10W	20W	30
	Essolube XD-3	10W	20W	30
	Essolube XD-3		15W/40	15W/40
Mobil Oil Co. Ltd.	Delvac 1300 Series	1310	1320	1330
Shell	Rimula CT	10W	20W/20	30
	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40
Total Oil Co. Ltd.	Total HD3-C (Rubia S)	10W	20W/20	30
	Total HD3-C (Rubia TM)		15W/40	15W/40
	Total Super Universal Tractor Oil (Multagri TM)		20W/30	20W/30

Lubricating oils for use in Perkins engines should have a minimum viscosity index of 80.

The above specifications are subject to alteration without notice.

CSG-649 Gasoline Engine

Part 1 — Basic Engine

CLEANING AND INSPECTION (Continued)

HYDRAULIC VALVE LIFTERS

The valve lifter assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each lifter separately, so as not to intermix the internal parts. **If any part of the lifter assembly needs replacing, replace the entire assembly.**

Cleaning

Thoroughly clean all the parts in cleaning solvent and wipe them with a clean, lint-free cloth.

Inspection

Inspect the parts and discard the entire lifter assembly if any part shows pitting, scoring, galling or evidence of non-rotation. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the lifter assembly and check for freeness of operation by pressing down on the push rod cup. The lifters can also be checked with a hydraulic tester to test the leak-down rate. Follow the instructions of the test unit manufacturer or the procedure in this manual.

TIMING GEARS

Cleaning

Clean the gears in solvent and dry them with compressed air.

Inspection

Inspect the gear teeth for scores, nicks, etc. Note the condition of the teeth contact pattern. If the teeth are scored, replace the gears.

CRANKSHAFT VIBRATION DAMPER

Cleaning

Clean the oil seal contact surface on the crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage the oil seal during installation or cause premature seal wear. **Do not use crocus cloth to the extent that the seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.**

Inspection

Inspect the crankshaft damper or sleeve oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

CAMSHAFT

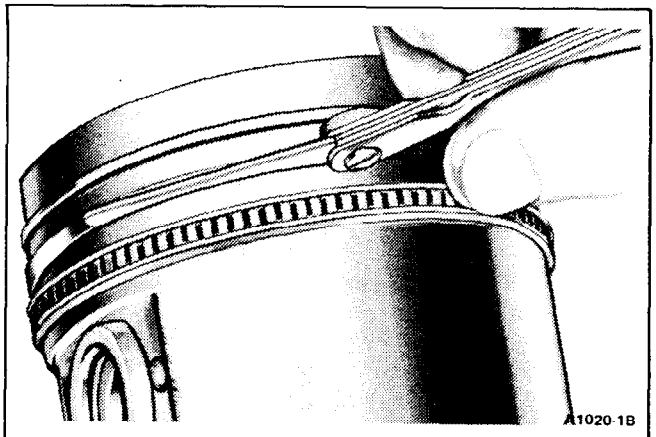
Cleaning and Inspection

Clean the camshaft in solvent and wipe it dry. Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe toe. This pitting is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the camshaft lobe lift loss has exceeded 0.005 inch.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift.

Check the distributor drive gear for broken or chipped teeth.

OVERHAUL (Continued)



FITTING PISTON PINS

The piston pins are selected to give the correct fit in the piston pin bore and bushing in the connecting rod. Pistons are only supplied in service kits complete with the piston pin, to ensure the correct fit. The piston pins should not be interchanged.

VALVE ROCKER ARM

If the pad at the valve end of the rocker arm has a grooved radius, replace the rocker arm. **Do not attempt to true this surface by grinding.**

PUSH RODS

Following the procedures under Push Rod Inspection, check the push rods for straightness.

If the runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**

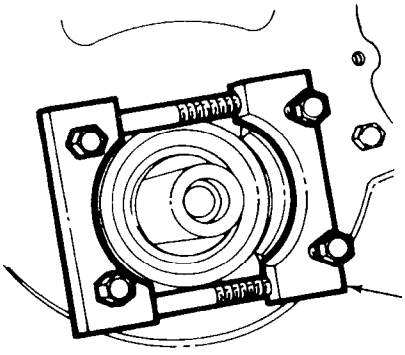
REMOVAL AND INSTALLATION (Continued)

12. Fill and bleed the cooling system. Use the specified antifreeze mix. If foreign material has not entered the crankcase during the service work, it is not necessary to change the engine oil.
13. Operate the engine at fast idle and check for coolant and oil leaks.

FRONT OIL SEAL

Removal

1. Remove the bolts attaching the fan shroud to the radiator.
2. Remove the fan and spacer bolts from the water pump shaft. Remove the fan, spacer and shroud.
3. Loosen the alternator, power steering, Thermactor and air conditioner drive belts, if so equipped. Remove the drive belts.
4. Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.
5. Place the front seal removing tool (Tool T70P-6B070-B) onto the front cover plate over the front seal as shown. Tighten the two through bolts to force the seal puller under the seal flange.
6. Alternately tighten the four puller bolts a half turn at a time as shown to pull the oil seal from the front cover.



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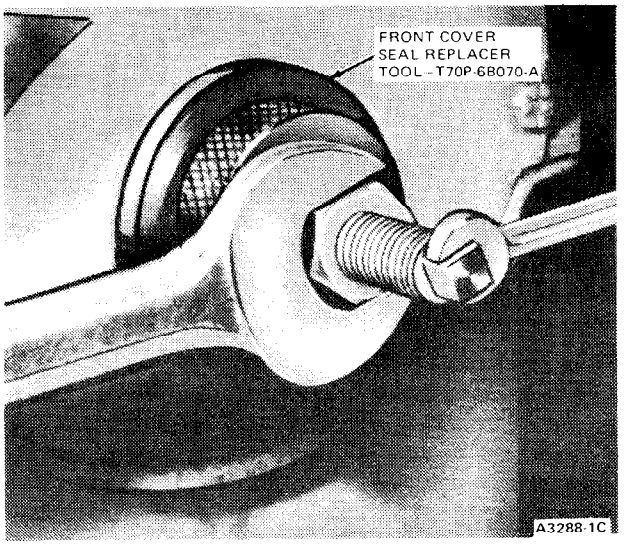
Installation

1. Coat a new front cover plate oil seal with Polyethylene Grease D0AZ-19584-A or equivalent and place it onto the front oil seal alignment and installation sleeve as shown. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.

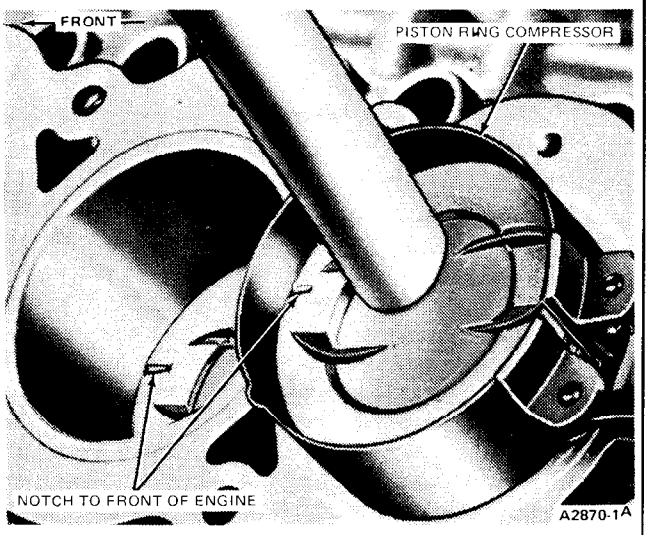


2. Place the installation screw, washer and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.
3. Apply Polyethylene Grease D0AZ-19584-A or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.
4. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft. Install the cap screw and washer. Install the crankshaft pulley.
5. Install the alternator, power steering pump, Thermactor and air conditioner belts, if so equipped.
6. Position the fan shroud over the water pump pulley. Install the fan and spacer. Install the fan shroud attaching screws.
7. Adjust the drive belts to specification.

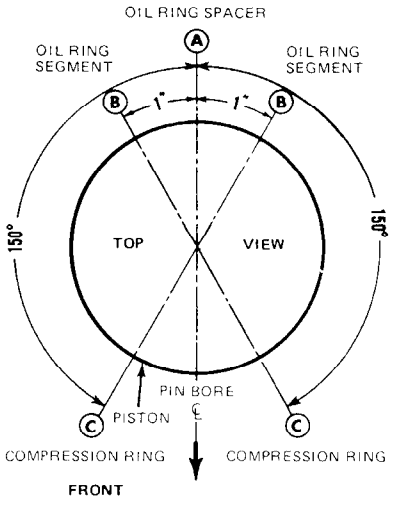
REMOVAL AND INSTALLATION (Continued)

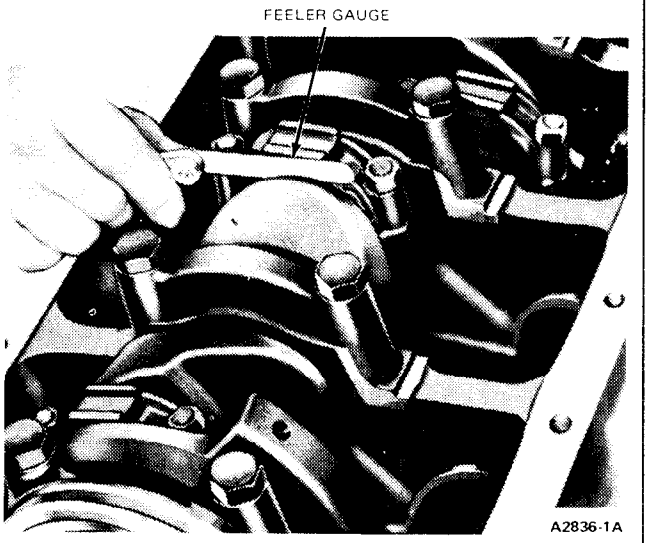
Installation

1. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.
2. Oil the piston rings, pistons and cylinder walls with light engine oil.
3. **Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod sand bearing caps are numbered from 1 to 6 beginning at the front of the engine. The number on the connecting rod and bearing cap must be on the same side when installing in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**
4. Make sure the ring gaps are properly spaced around the circumference of the piston. Oil the rings, then install a piston ring compressor on the piston. Make sure that the indentation in the head of the piston is toward the front, then push the piston into its bore with the handle end of a hammer until it is slightly below the top of the cylinder. Be sure to guide the connecting rods to avoid damaging the crankshaft journals.
5. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.



6. After the bearings have been fitted, apply a light coat of engine oil to the journal and bearings.
7. Turn the crankshaft throw to the bottom of its stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Torque the nuts to specifications.
8. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.
9. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and related parts.





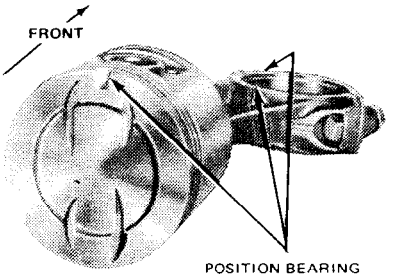
DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

1. Apply a light coat of engine oil to all parts. **Assemble the piston to the connecting rod with the bearing tang side of the connecting rod and the indentation notch in the piston positioned as shown.**
2. Start the piston pin in the piston and connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the connecting rod.
3. Check the end gap of all piston rings (page 1-13). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings.
4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. **If the lower lands have steps, the piston should be replaced.**
5. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts wil distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.



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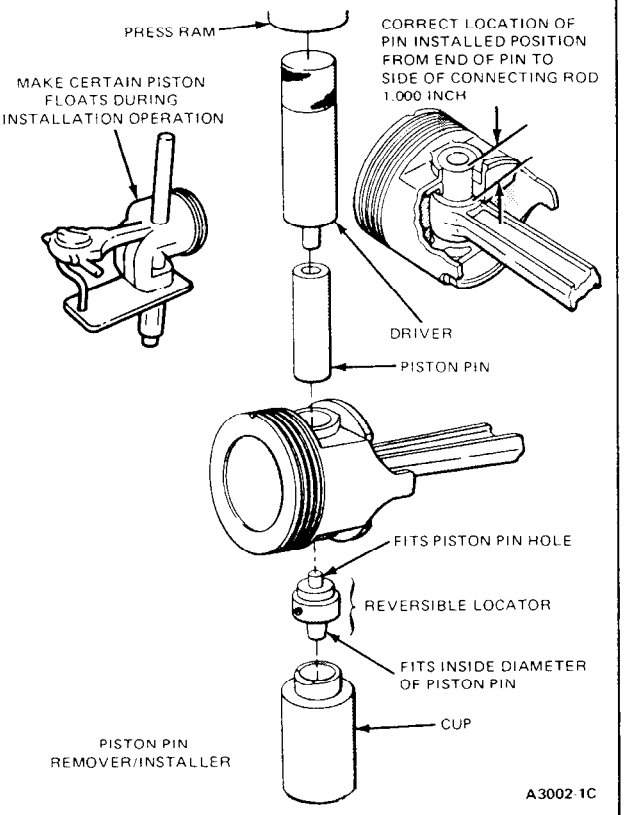

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CYLINDER ASSEMBLY OR BLOCK

Disassembly

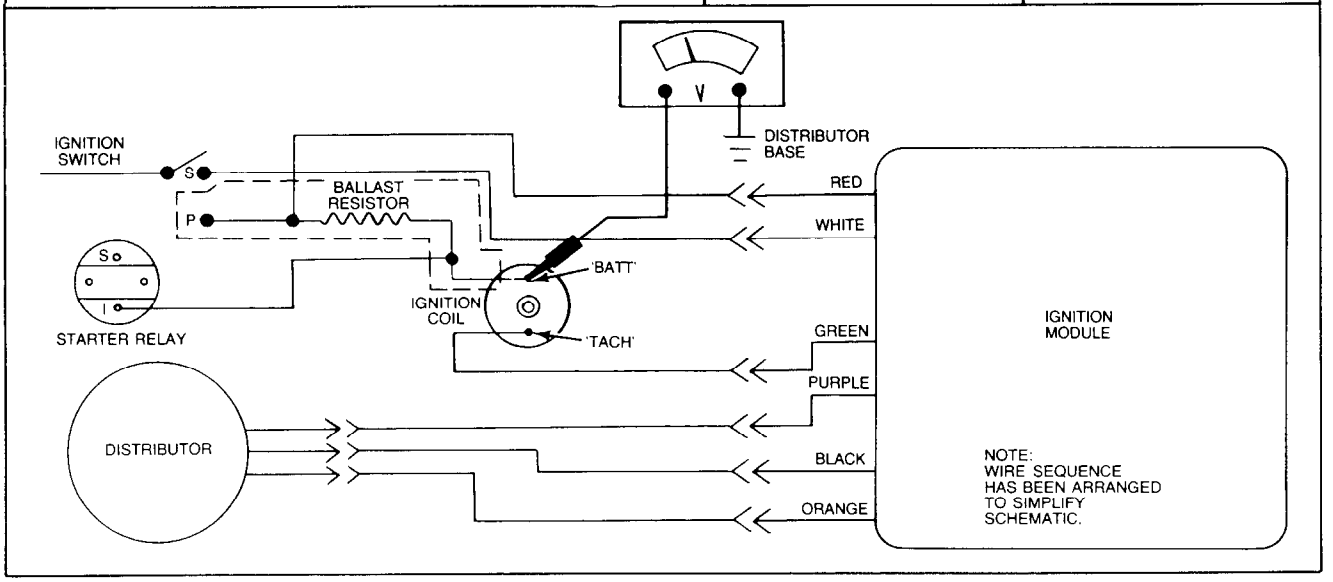
1. Mount the old engine in a work stand and completely disassemble it, removing the cylinder head and manifolds as an assembly. Follow the procedures given in the Removal and Installation Section of this Part.
2. Remove all serviceable parts not furnished with the new cylinder assembly or block, including the cylinder block drain plugs and cylinder head locating dowels.

Assembly

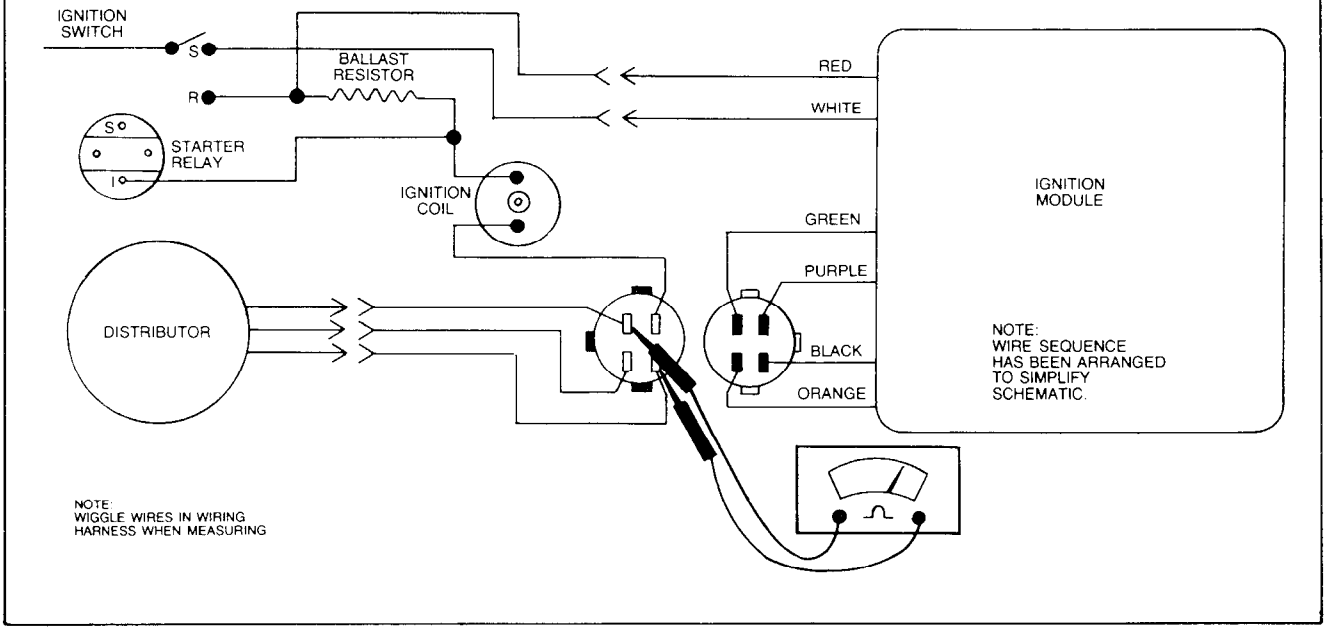
1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly block in the work stand and transfer all serviceable parts removed from the old cylinder engine, following the instructions given in the Removal and Installation Section of this Part.
3. Install the cylinder head locating dowels and block drain plugs.
4. Check all assembly clearances and correct as necessary.

DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
6 IGNITION COIL SUPPLY VOLTAGE 1. Attach negative (−) lead of VOM to distributor base. 2. Turn ignition switch to Run position. 3. Measure voltage at BATT terminal of ignition coil. 4. Turn ignition switch to Off position.	6 to 8 volts	GO to **7**.
	Less than 6 volts or greater than 8 volts	GO to **12**.



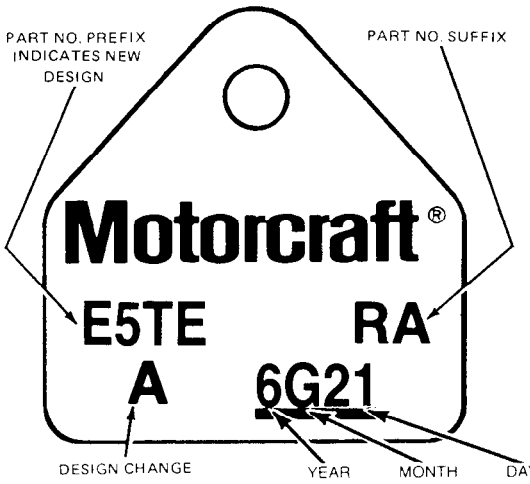
TEST STEP	RESULT	ACTION TO TAKE
7 DISTRIBUTOR STATOR ASSEMBLY AND WIRING HARNESS 1. Separate ignition module four wire connector. Inspect for dirt, corrosion, and damage. 2. Measure stator assembly and wiring harness resistance between wiring harness terminals mating with ORANGE and PURPLE module wires.	400 to 1,300 ohms	Test result OK. GO to **8**.
	Less than 400 or greater than 1,300 ohms	GO to **11**.



Part 3 — Fuel System

IDENTIFICATION

The carburetor identification tag is attached to the upper body of the carburetor. The basic part number for all carburetors is 9510. To procure replacement parts, it is necessary to know the part number prefix and suffix.

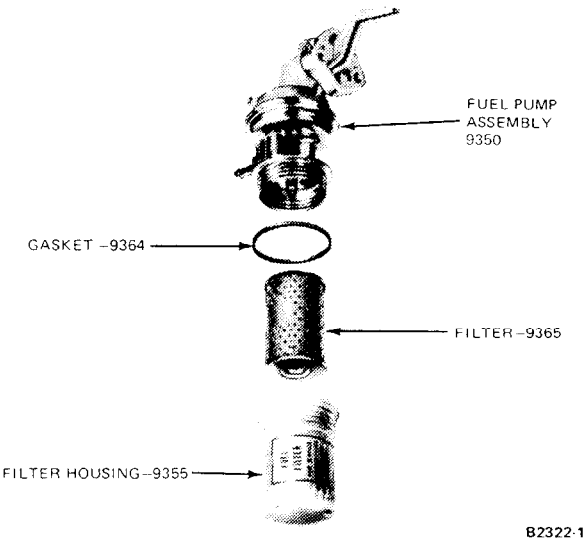


DESCRIPTION

The fuel system includes a mechanical fuel pump. It is mounted on the lower, left-center of the engine cylinder block. The disposable filter is located on the fuel pump body.

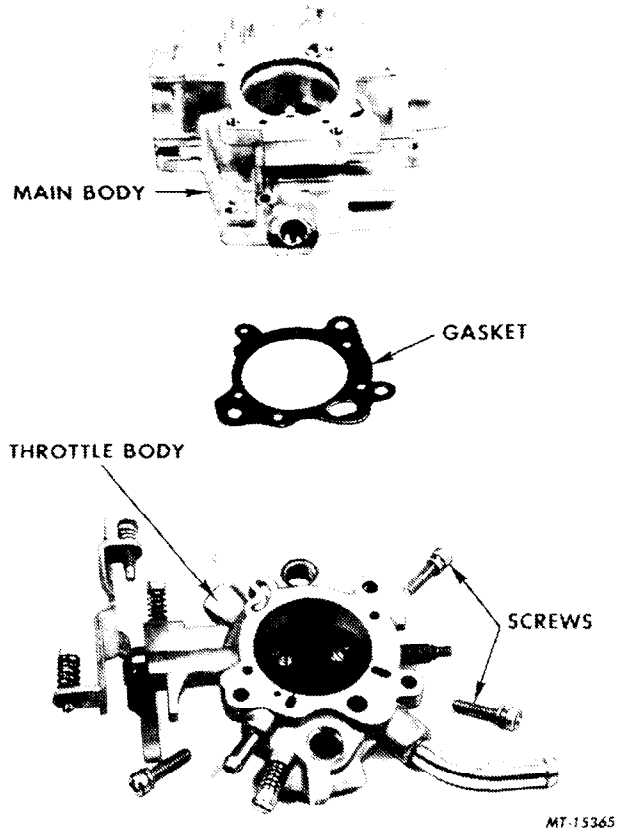
The fuel pumps are mechanically actuated by means of the fuel pump rocker arm and an eccentric on the camshaft.

The Holley 1940 carburetor is covered in detail later in this section.



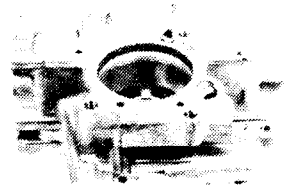
HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

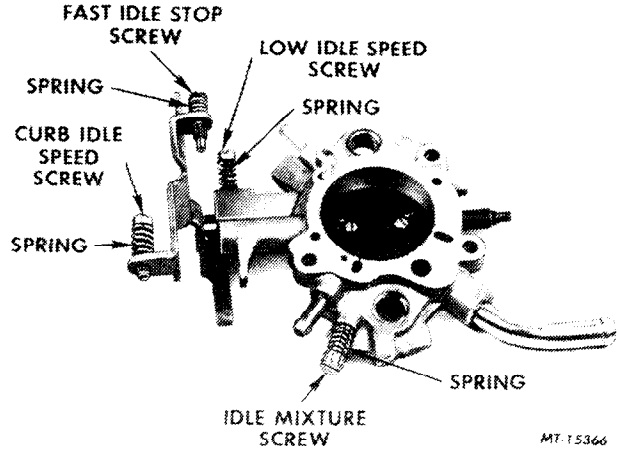
This completes the disassembly of the carburetor body. Remove the three carburetor body-to-throttle body screws. Tap gently and separate the throttle body from the main body.



THROTTLE BODY DISASSEMBLY

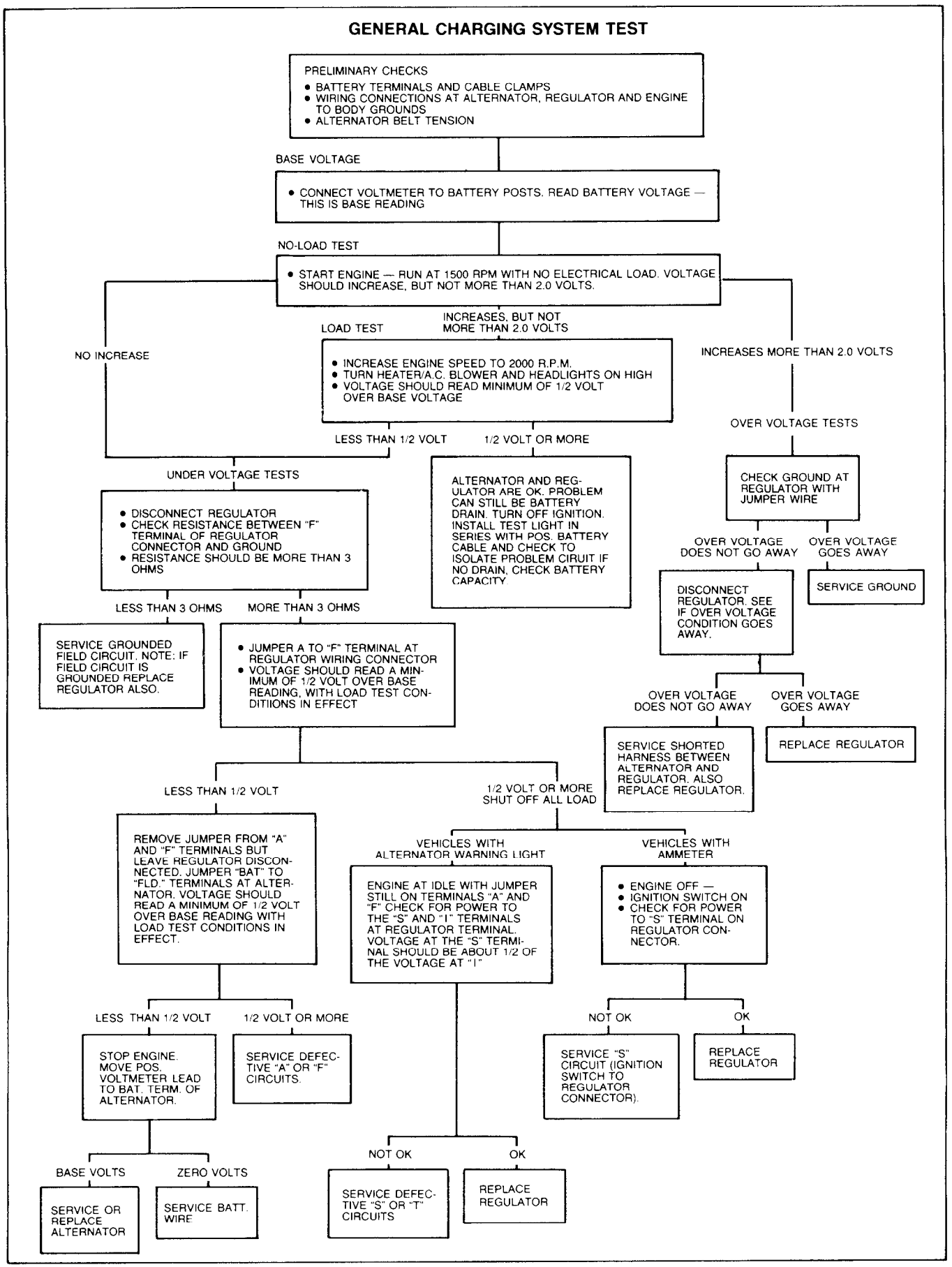
1. Gently turn the idle mixture screw clockwise until it seats. Record the starting position of the slot and the exact number of turns required to seat the screw. This procedure is necessary to reinstall it in the same position after cleaning.
2. Remove the curb idle screw and spring, low idle screw and spring and fast idle screw and spring. Certain applications may not have all of these screws.





3. Carefully inspect the throttle valve for nicks or burrs and the throttle shaft for wear. **Do not remove the throttle valve.** If damage or wear is evident, the throttle body or carburetor must be replaced. If the idle mixture screw is bent or grooved it must also be replaced. Correct idle adjustment cannot be achieved with a grooved or damaged idle mixture needle or screw.

TESTING (Continued)



DISASSEMBLY AND ASSEMBLY (Continued)

17. Align the terminal screws on the rectifier assembly with the holes in the back of the rear housing and install the stator rectifier assembly in the rear housing. Make certain the terminal insulators are seated in their recesses.
18. Install the external insulators, washers and nuts on the terminals. The insulators are color coded as follows:

    Black on the stator (STA) terminal. Tighten nut to 2.8-3.9 N•m (25-35 in-lb).

    Red on the battery (BAT) terminal. Tighten nut to 3.4-6.2 N•m (30-55 in-lb).

    Orange on the field (FLD) terminal. Tighten nut to 2.8-3.9 N•m (25-35 in-lb).
19. Wipe the rear end bearing surface of the rotor shaft with a clean, lint-free rag.
20. Position the rear housing and stator assembly over the rotor and align the scribe marks made during disassembly.
21. Seat the machined portion of the stator core into the stop in both end housings and install the housing through bolts. Tighten the bolts to 4.1-6.7 N•m (35-60 in-lb).
22. Remove the wire holding the brushes.

CAUTION: This step is important so that regulator will not be damaged.

ADJUSTMENTS

DRIVE BELT

The fan drive belt should be properly adjusted at all times. A loose drive belt can cause improper alternator, fan and water pump operation. A belt that is too tight places a severe strain on the water pump and alternator bearings.

A properly tensioned drive belt minimizes noise and also prolongs the service life of the belt. Therefore, it is recommended that a belt tension gauge be used to check and adjust the belt tension. **Any belt that has been operated for a minimum of 10 minutes is considered a used belt, and when adjusted, it must be adjusted to the used belt tension shown in the specifications.**

BELT TENSION

1. Install the belt tension tool on the drive belt and check the tension.
2. If adjustment is necessary, loosen the alternator mounting bolts and move the alternator adjusting arm bolts. Move the alternator toward or away from the engine until the correct tension is obtained. Remove the gauge.
3. Tighten the alternator adjusting arm bolt and the mounting bolts. Install the tension gauge and check the belt tension.

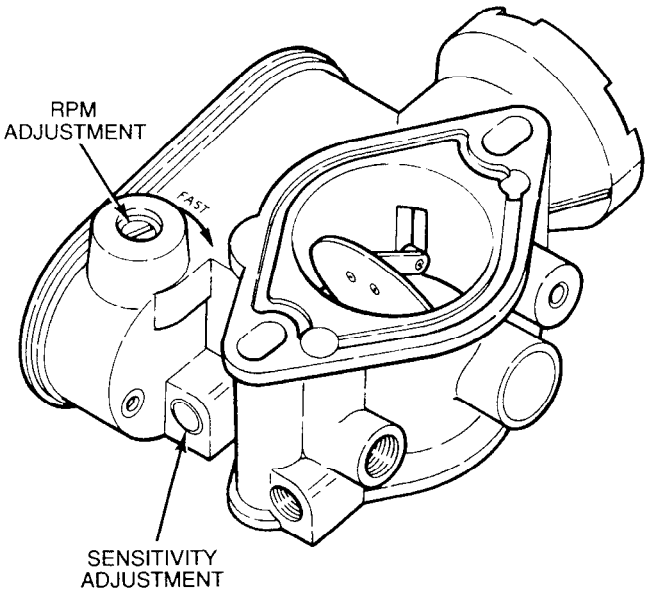
Part 6 — Governors

DESCRIPTION AND OPERATION

The 4.9 liter engine uses either a velocity governor or a belt driven mechanical governor.

VELOCITY GOVERNOR

The velocity governor is a single unit mounted between the carburetor and the intake manifold. There is no provision for repair of this governor. It should be replaced when damaged.



The governor is operated by a combination of manifold vacuum and the air flow past the governor valve. The governor throttle valve is offset in the throttle bore so that the combined force of manifold vacuum and the fuel air flow through the bore has greater effect on the larger, upstream area of the valve. This forces the throttle valve to move toward the closed position restricting fuel-air flow. The closing action of the throttle valve is opposed by the control spring. The control spring is attached to the throttle valve shaft cam. The cam provides a balance between the closing action of the throttle valve and the action of the control spring at all engine speeds.

Under operating conditions, the governor throttle valve does not close, but remains open enough to allow the required quantity of the fuel-air mixture to flow into the manifold to maintain the governed engine speed.

To maintain the proper vacuum to the distributor, the governor has two interconnected vacuum transfer ports and a vacuum transfer plunger. When the carburetor throttle valve controls engine speed, the orifice in the carburetor throat opening controls the spark advance the same as if it were not governor equipped.

However, when the governor controls engine speed vacuum produced below the governor throttle plate pulls the spark transfer valve, permitting an opening from below the governor throttle plate to the diaphragm. At the same time the transfer valve closes off the opening from the carburetor orifice.

SPECIFICATIONS (Continued)

DISTRIBUTOR ADVANCE CHARACTERISTICS

CENTRIFUGAL ADVANCE. Set the test stand to 0° at 250 rpm and 0 inches of vacuum.

rpm (Distributor)	Advance (Degrees)	Vacuum (Inches of Mercury)
600	0-2	0
800	3-5	0
1200	6-8	0
1600	6-8 1/2	0
2000	6-8 3/4	0

VACUUM ADVANCE. Set the test stand to 0° at 1000 rpm and 0 inches of vacuum.

rpm (Distributor)	Advance (Degrees)	Vacuum (Inches of Mercury)
1000	4 1/2-7 1/2	8
1000	6-8 3/4	10
1000	8 3/4-11 1/4	14

FUEL PUMP — MECHANICAL

Static Pressure (psi)* 5-7
Eccentric Total Lift (Inch) ..... .290-.310
Volume Flow — Minimum* .. 1 Pt. in 20 seconds
Inside diameter of smallest passage in test flow circuit must not be less than 0.220 inch.)
*(On engine, with temperatures normalized, and at normal idle speed, in neutral.)

THERMOSTAT

Begins to Open (°F) 157-164
Fully Open (°F) 186

BELT TENSION

Belt Tension — All Except Governor
New 140
Used 110
Governor
New 70
Used 50
A used belt is one that has been in operation for 10 minutes or more.

POSITIVE ENGAGEMENT STARTER

Positive Engagement Starter Motor				Starter Brushes			Through Bolt Torque N•m (in-lbs)	Mounting Bolt Torque N•m (ft-lbs)
Dia. mm (inches)	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed (rpm)	Current Draw No. Load (Amps)	Mfg. Length mm (inches)	Wear Limit mm (inches)	Spring Tension kg (Ounces)		
101.60 (4)	150-200	180-250	70	12.2 (0.50)	6.35 (0.25)	1.134 (40)	6.21-8.47 (55-75)	21-27 (15-20)
114.30 (4.5)	150-180	150-290	80	12.2 (0.50)	6.35 (0.25)	1.134 (40)	6.21-8.47 (55-75)	21-27 (15-20)

Maximum Commutator runout is 0.1270mm (0.005 inch). Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.

ALTERNATOR

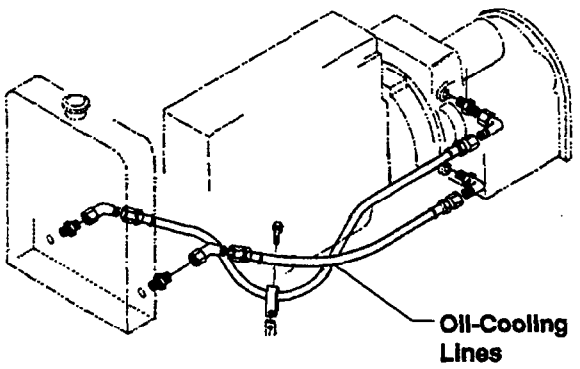
Rating		Field Current* Amps @ 12V	Slip-Ring Turning mm (inches)		Brush Length mm (inches)		Pulley Nut Torque N•m (Ft-Lb)	Belt Tension ①	
Amperes @ 15V	Watts @ 12V		Min. Dia.	Max. Runout	New	Wear Limit		N	(Lb)
40	600	4.25	31 (1.22)	.0127 (0.0005)	12.19 (.480)	6.35 (1/4)	82-135 (60-100)	311-489	(70-110)
60	900	4.25	31 (1.22)	.0127 (0.0005)	12.19 (.480)	6.35 (1/4)	82-135 (60-100)	311-489	(70-110)

①For belt tension specifications, refer to Section 27-06 Accessory Drive Belts in the Engine Shop Manual.
*A field current of 4 amps is used with solid-state regulator.

Section 1.

Cooling System Troubleshooting

7. Remove and cap the transmission oil-cooling lines connected to the radiator oil-cooling chamber.



8. Remove the four radiator bracket-to-frame bolts and lift radiator out of truck. See the illustrations for removing the radiator inlet and outlet hoses.

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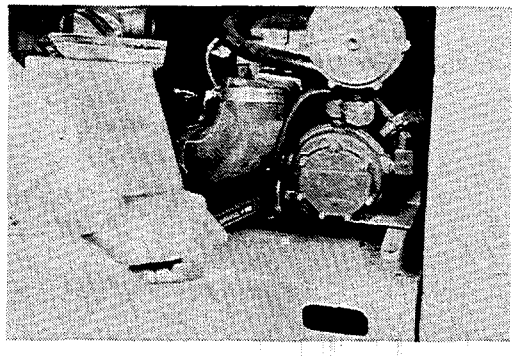
Section 2.

Air Induction System

2. Water hoses between engine and vaporizer-regulator may be either clamp-type or push-on type with reusable fittings. Cut off bad portions of hose and strip from fittings. Push hoses solidly back into position. Do not use cement or clamps on push-on type fittings.



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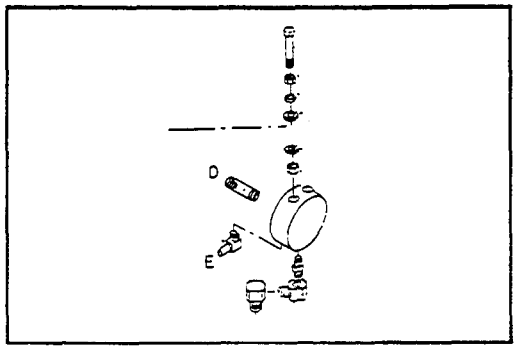
FUEL LOCK-OFF VALVE AND FILTER

OPERATION:

The fuel lock-off valve is vacuum operated. When a slight vacuum is sensed, it opens and allows liquid fuel from tank to flow through an internal fuel filter to vaporizer-regulator. Any time engine stops, whether ignition key is on or off, fuel is shut off automatically. Also, it filters any large particles of solid material, 5 microns and larger, out of fuel before it reaches high pressure side of vaporizer-regulator.



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MAINTENENCE:

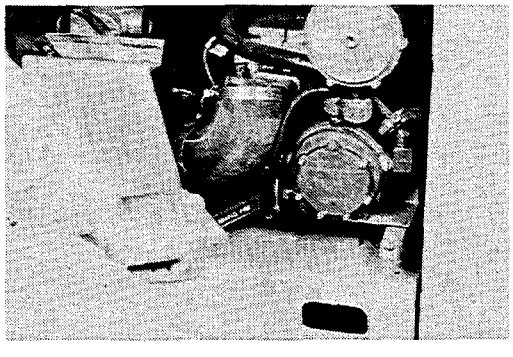
1. The fuel filter element should be checked once a year and replaced if necessary. Foreign matter usually will be collected in filter only when installation is new. Often, a new tank will have scale or rust particles in it which will be caught by filter.

A1580

2. Check hose connections and filter cover (inlet side) for sign of leakage. Look for stains or frost caused by evaporation. Tighten cover screws as required. Disconnect hoses and reseal threads if necessary.

C A U T I O N

OVERLY TIGHT HOSE CONNECTIONS MAY CRACK THE CASTING.



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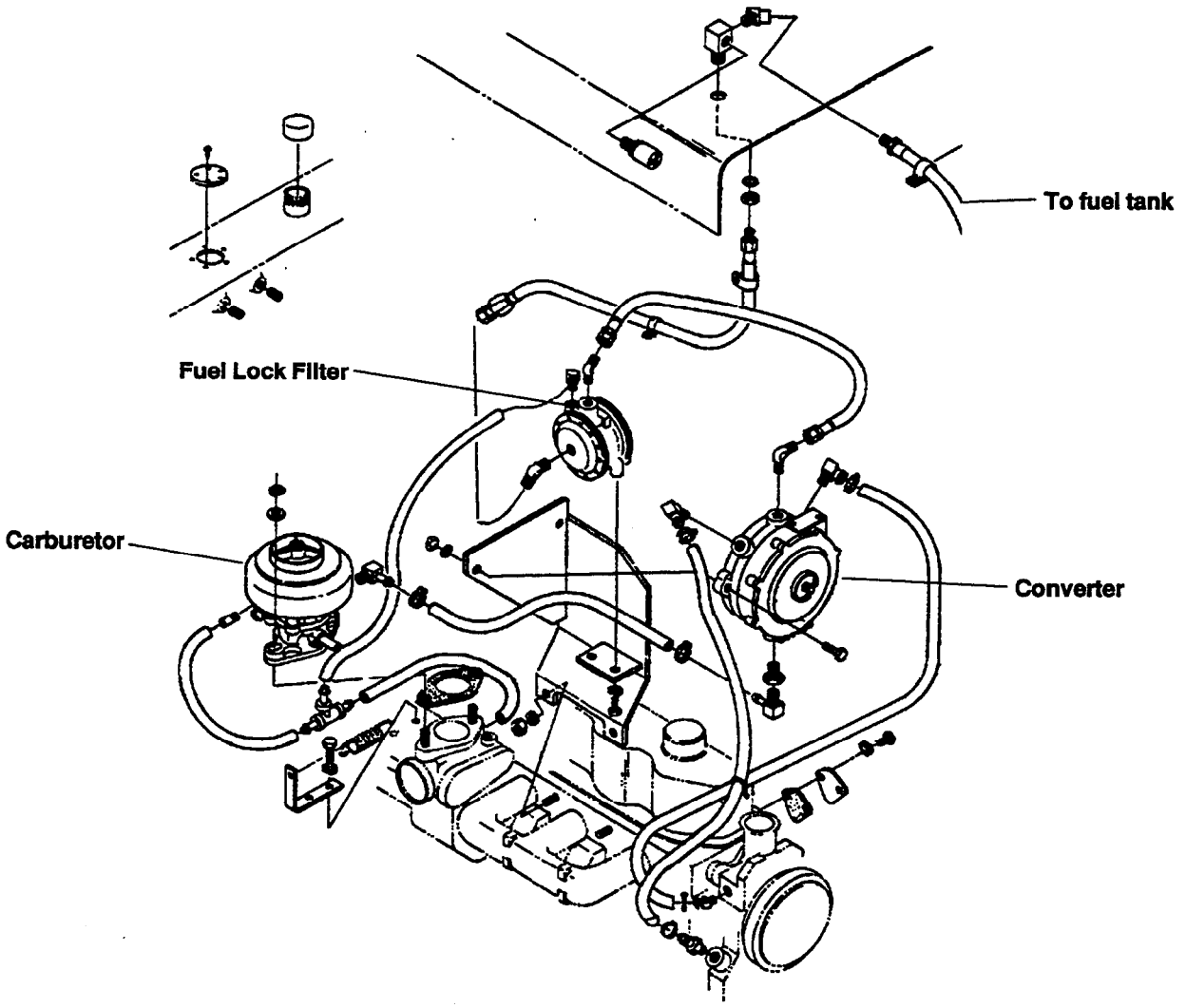
Replacment and overhaul instructions are covered in Supplement OH-373, GROUP 02, Section 5.



IMPCO Fuel System

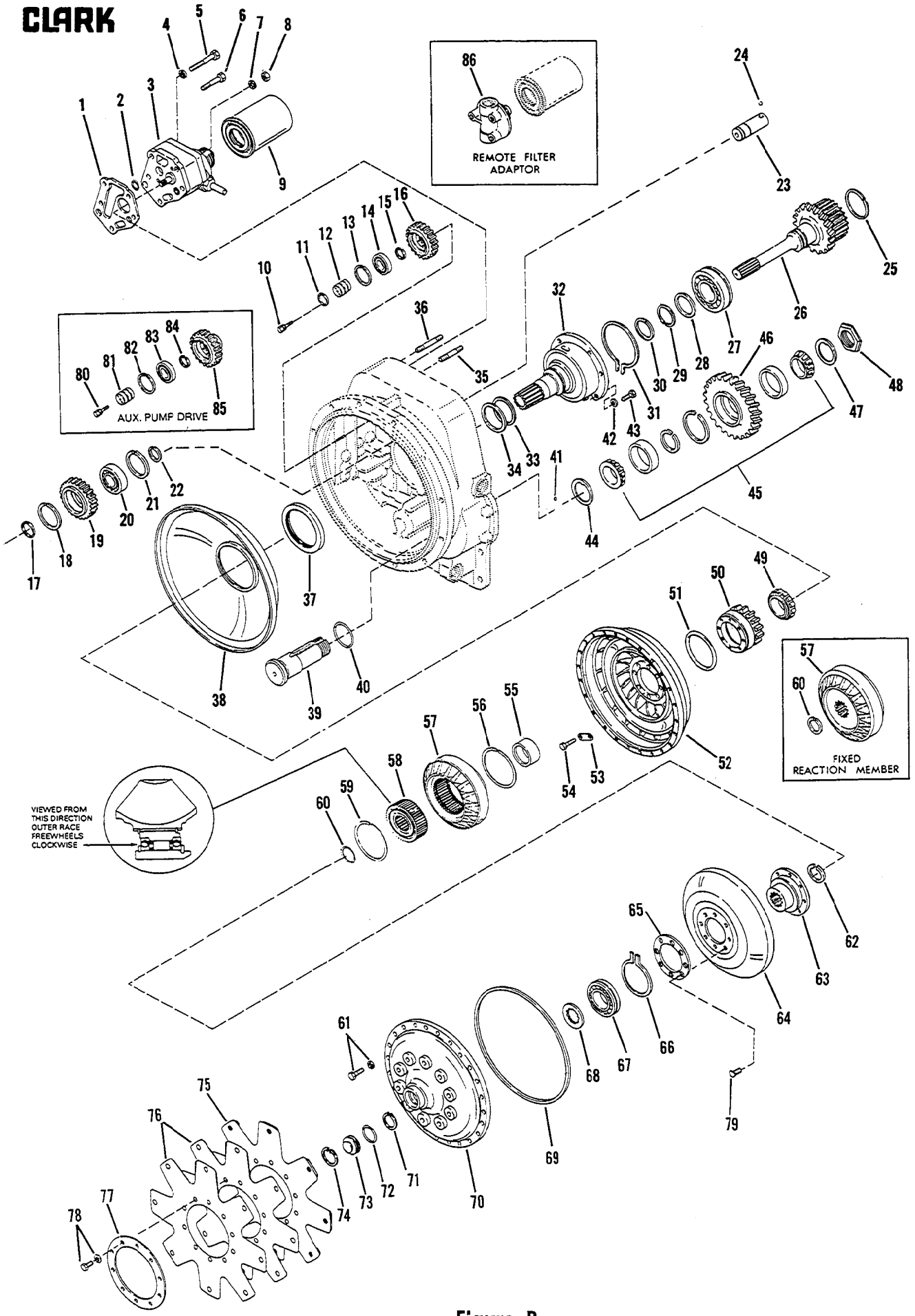
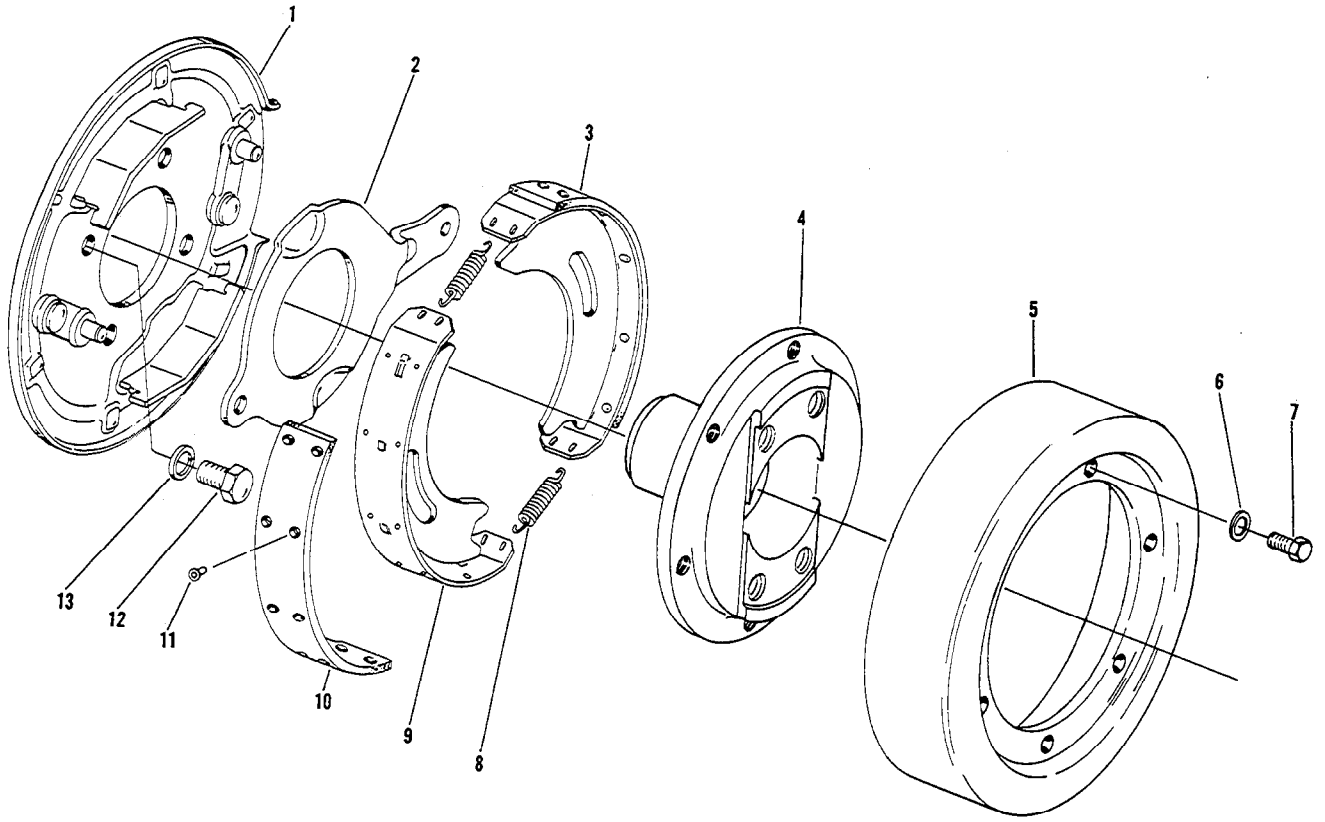

CLARK
REMOTE FILTER ADAPTOR
AUX. PUMP DRIVE
FIXED REACTION MEMBER
VIEWED FROM THIS DIRECTION OUTER RACE FREEWHEELS CLOCKWISE

Figure B

CLARK



PARKING BRAKE GROUP

ITEM	DESCRIPTION	QTY.
1	Backing Plate Assembly	1
2	Actuating Lever	1
3	Brake Shoe and Lining	1
4	Brake Flange	1
5	Brake Drum	1
6	Brake Drum to Flange Screw Lockwasher	6
7	Brake Drum to Flange Screw	6
8	Return Spring	2
9	Brake Shoe, See Item 3	
10	Brake Lining	1
11	Brake Lining Rivet	20
12	Backing Plate Screw	4
13	Backing Plate Screw Lockwasher	4

Figure G

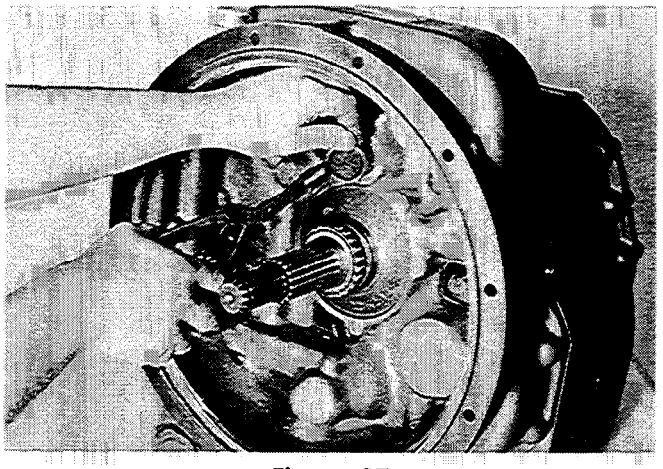


Figure 27
Remove idler stub shaft locating ring.

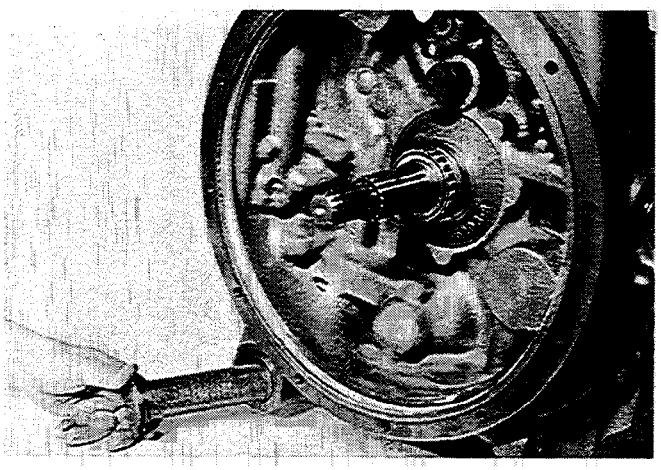


Figure 28
Remove sump screen assembly.

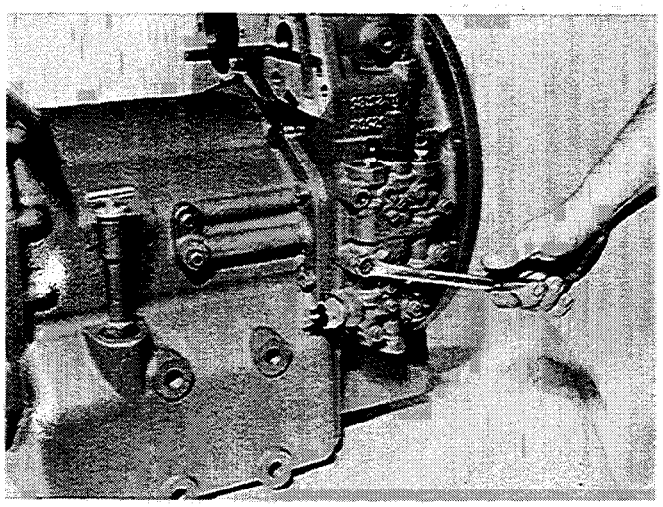


Figure 29
Remove control cover bolts and washers.

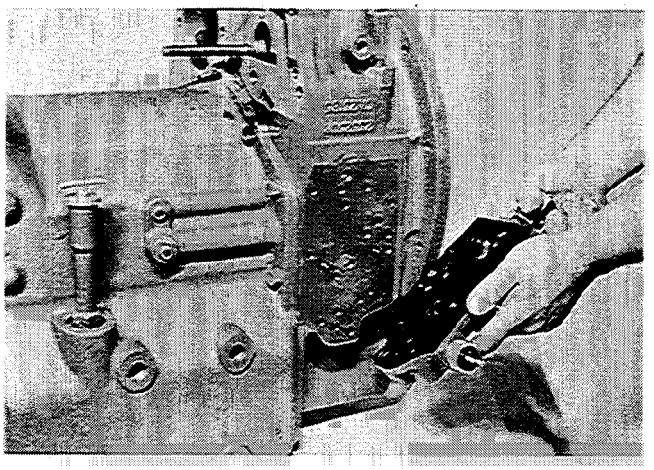


Figure 30
Remove control valve assembly. Use caution as not to lose detent springs and balls.

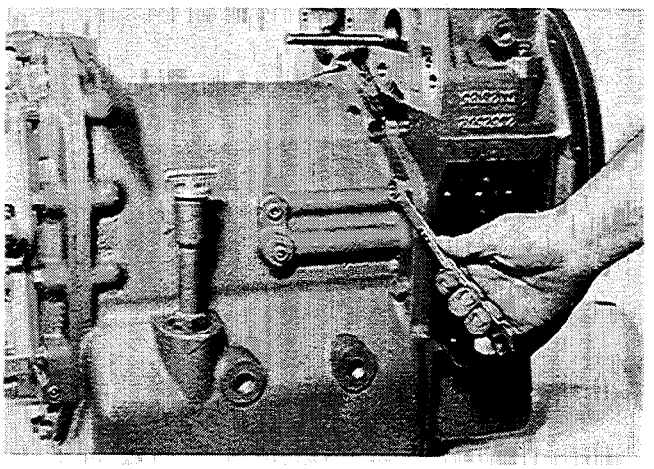


Figure 31
Remove bolts securing transmission case to converter housing.

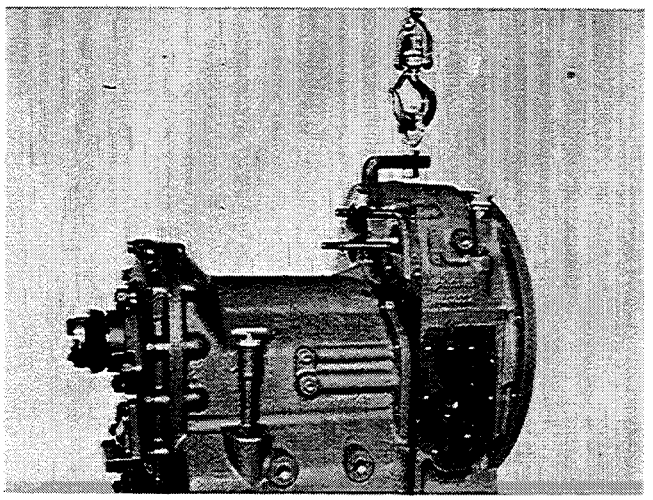


Figure 32
Support converter housing with a chain hoist

REVERSE AND 2nd CLUTCH DISASSEMBLY
(Reverse being disassembled)

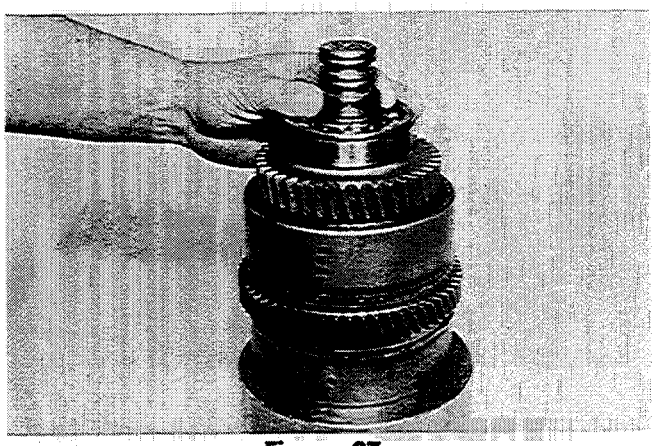


Figure 87
Remove clutch shaft piston rings.

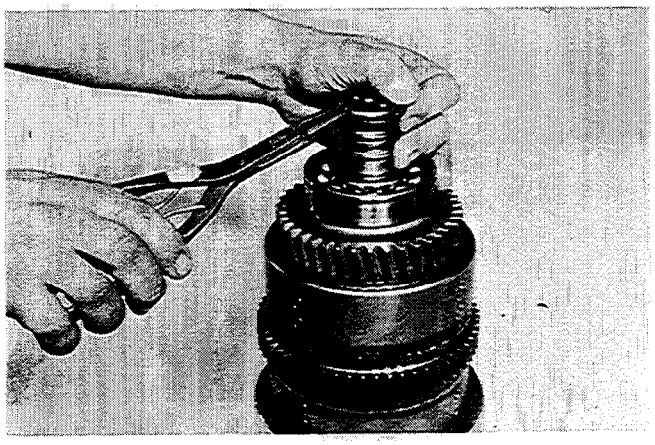


Figure 88
Remove front bearing retainer ring.

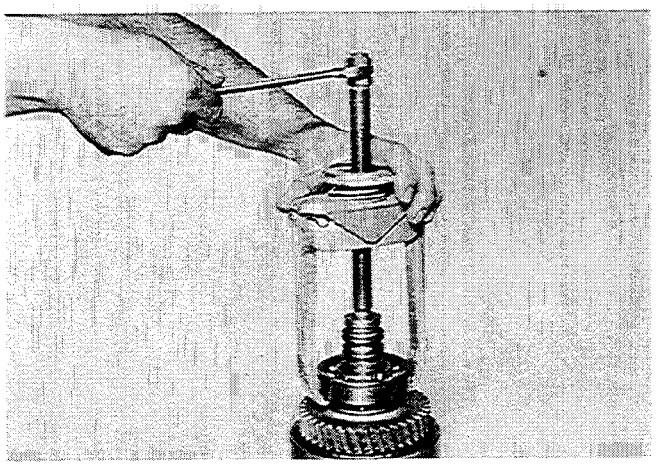


Figure 89
Remove front bearing.

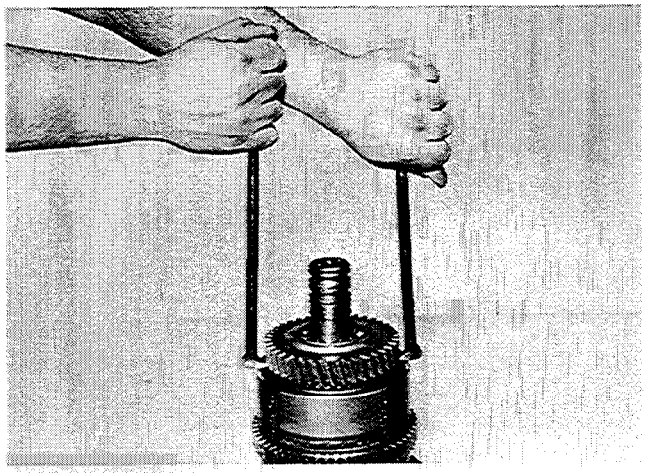


Figure 90
Pry reverse gear from clutch assembly far enough to use a gear puller.

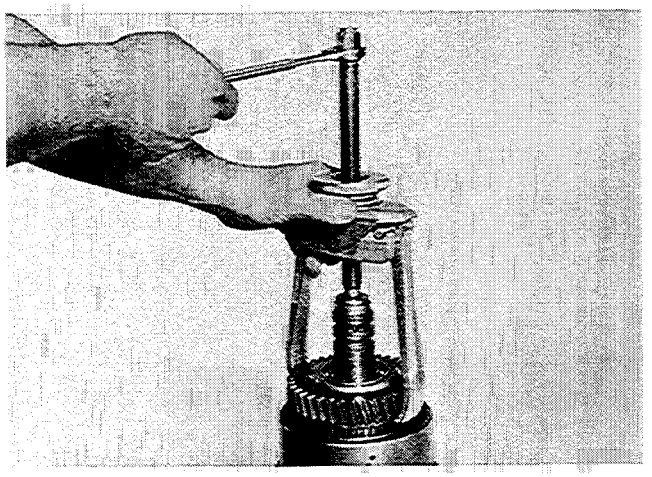


Figure 91
Remove gear as shown.

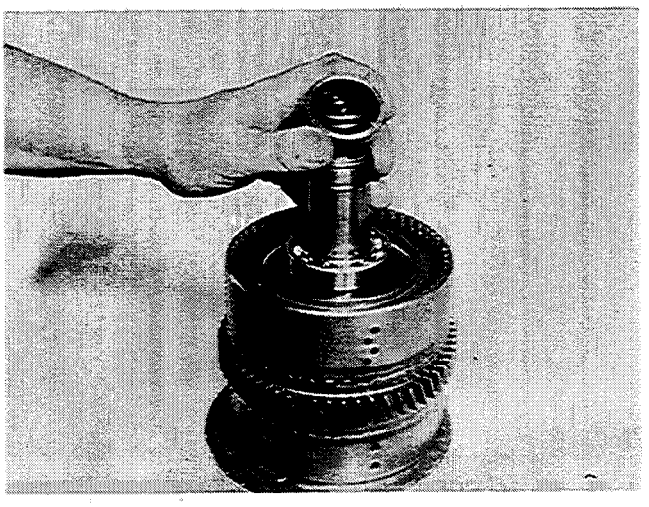


Figure 92
Remove bearing spacer.

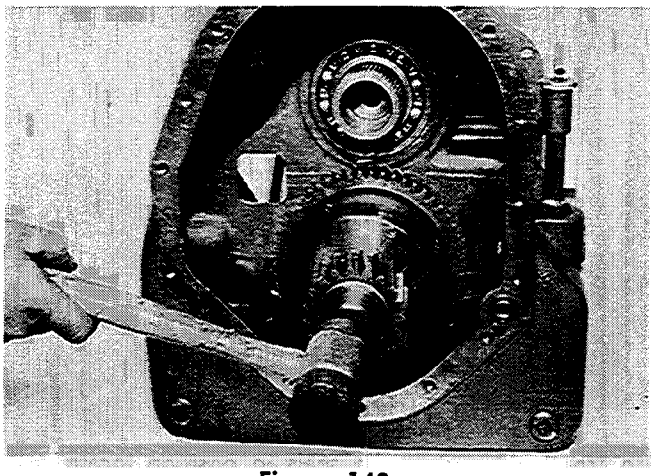


Figure 142

Locate low clutch assembly in housing. Tap into position.

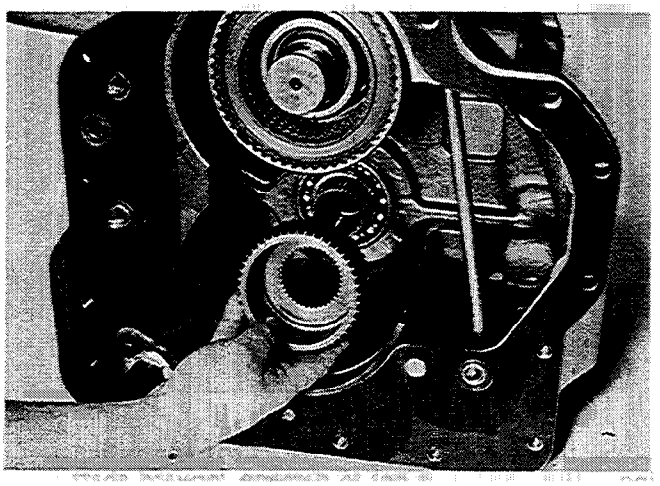


Figure 143

Install the 2nd clutch disc hub.

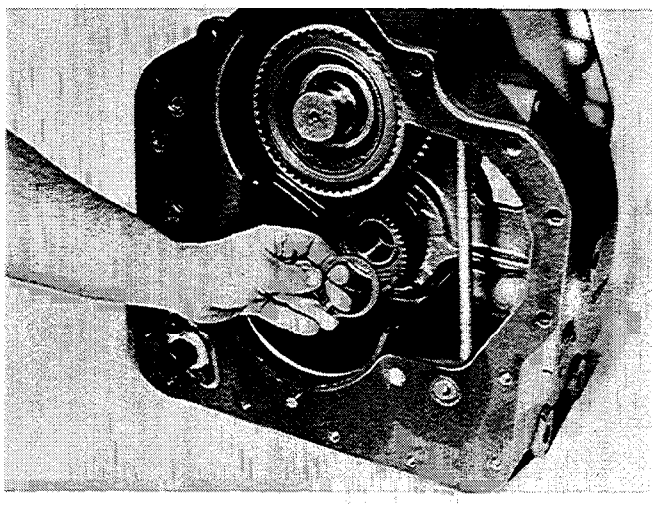


Figure 144

Install disc hub retainer ring.

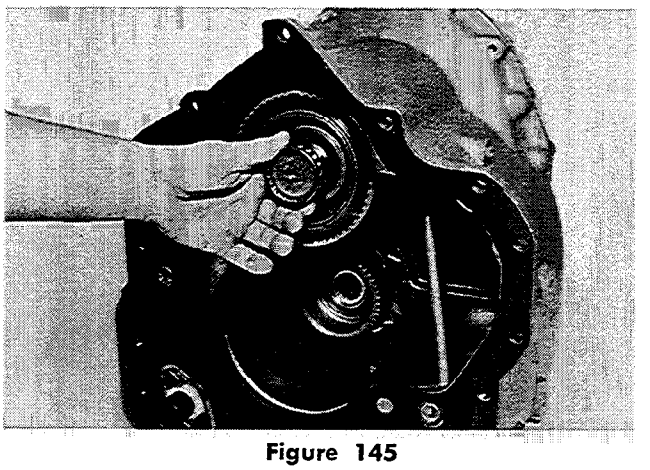


Figure 145

Locate forward shaft pilot bearing.

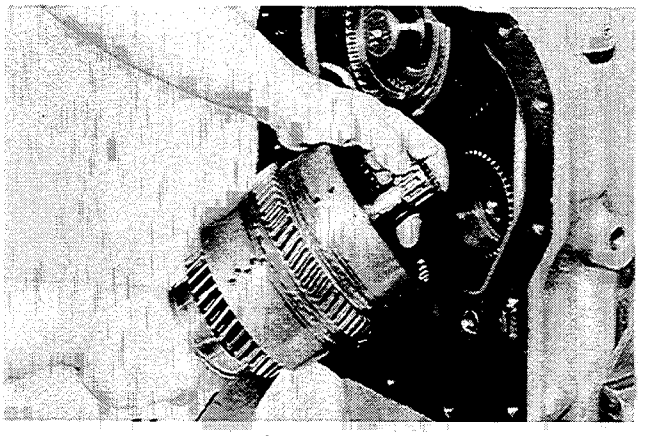


Figure 146

Install 2nd speed clutch shaft rear pilot bearing on shaft.

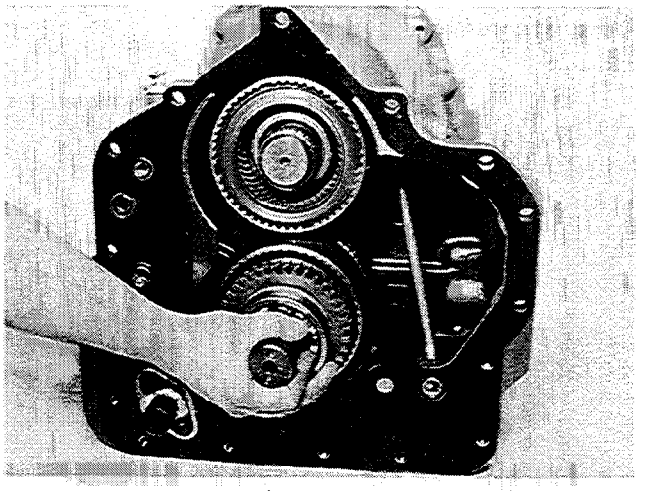


Figure 147

Position reverse and 2nd speed clutch on disc hub aligning splines of disc hub with internal teeth of 2nd speed clutch friction discs. Disc hub must be in full position with friction discs. Do not force this operation.

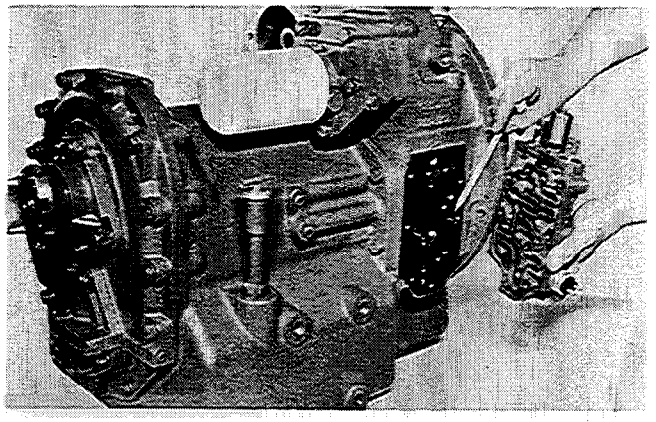


Figure 200

Position new gasket and detent springs on converter housing. Install control cover and cover to housing capscrews and washers.

If the turbine or turbine hub was replaced or disassembled, this procedure must be used for reassembly.

TURBINE HUB ASSEMBLY WITH BACKING RING AND SPECIAL SELF LOCKING SCREWS

1. Clean hub mounting surface and tapped holes with solvent. Dry thoroughly being certain tapped holes are dry and clean.

2. Install backing ring and special screws to approximately .06 [1,5] of seated position. With a calibrated torque wrench, tighten screws 37 to 41 lbs. ft. torque [50,2 - 55,6 N·m]. **NOTE:** Assembly of turbine hub must be completed within a fifteen minute period from start of screw installation. The screws are prepared with a coating which begins to harden after installation in the hub holes. If not tightened to proper torque within the fifteen minute period, insufficient screw clamping tension will result. The special screw is to be used for one installation only. If the screw is removed for any reason it must be replaced. The compound left in the hub holes must be removed with the proper tap and cleaned with solvent. Dry hole thoroughly and use a new screw for reinstallation.

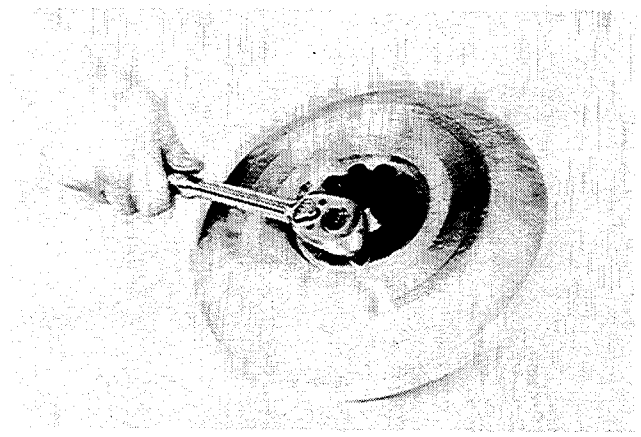


Figure A

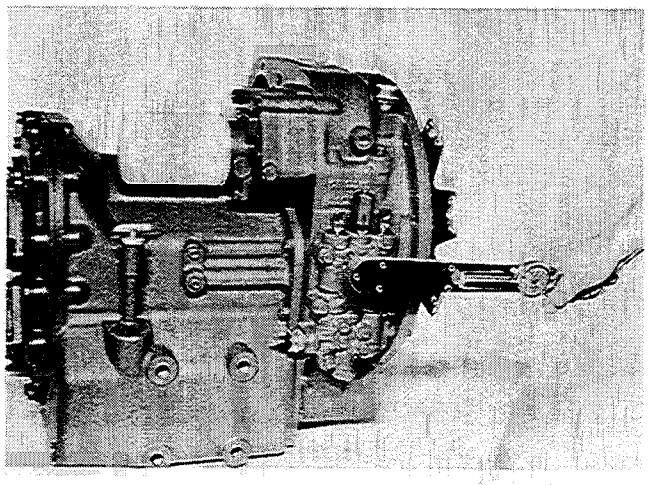


Figure 201

Tighten capscrews 23 to 25 ft. lbs. torque [31,2 - 33.8 N·m].

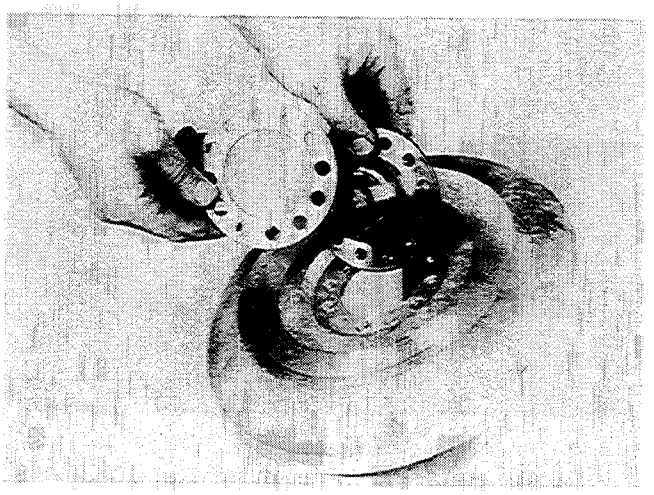


Figure B

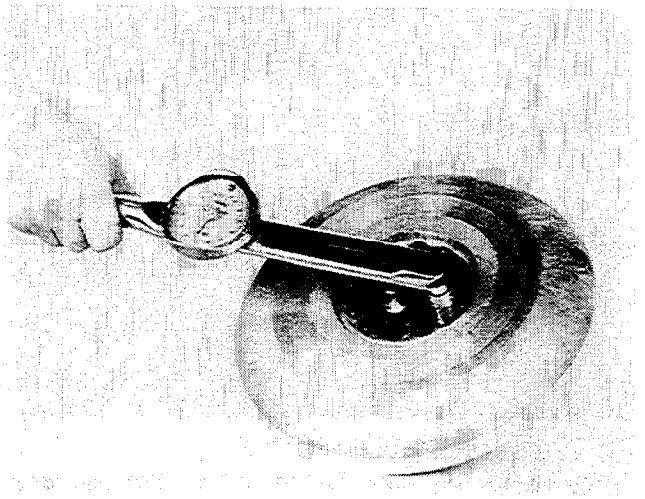


Figure C

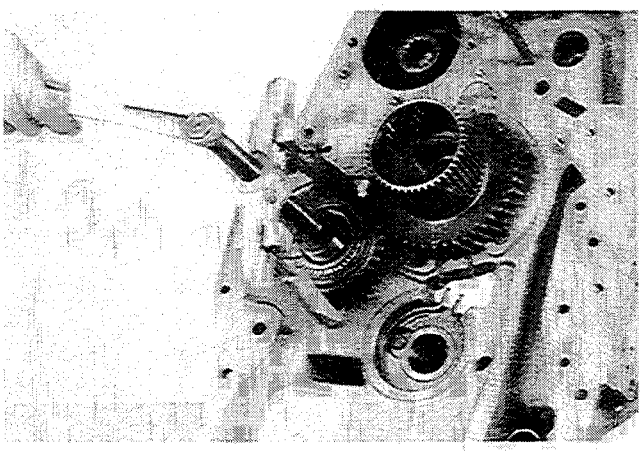


Figure 204
Remove idler gear and outer taper bearing from idler shaft.

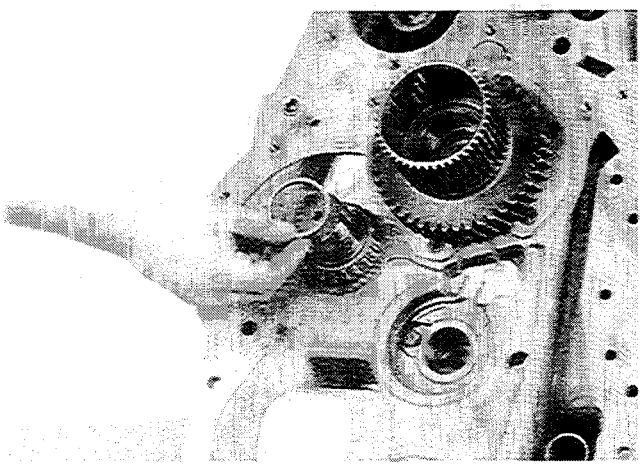


Figure 205
Remove bearing spacer.

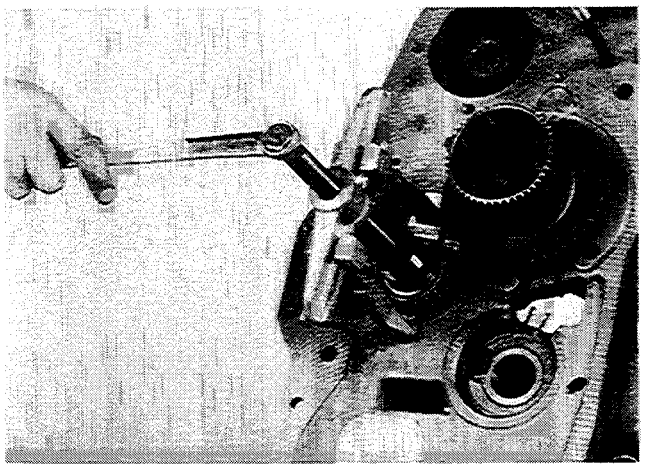


Figure 206
Remove inner taper bearing.

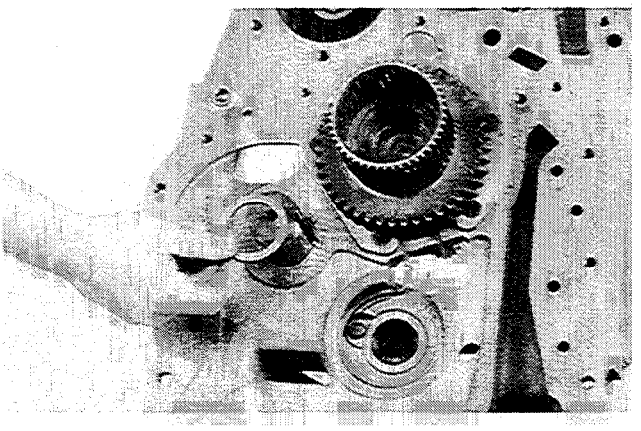


Figure 207
Remove bearing spacer.

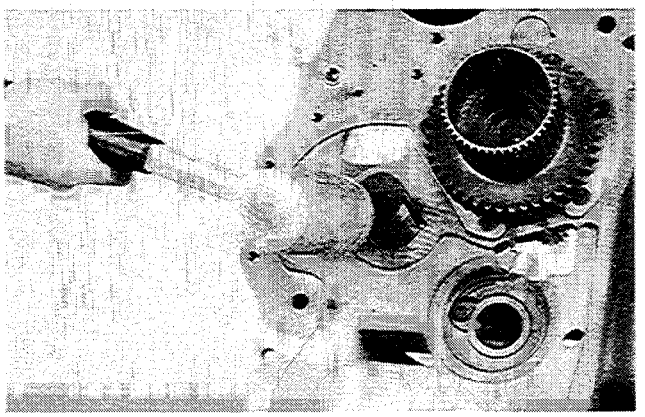


Figure 208
Remove idler shaft, use caution as not to lose shaft lock ball. Refer to page 21 for further disassembly.

REASSEMBLY OF LOCKNUT TYPE IDLER SHAFT

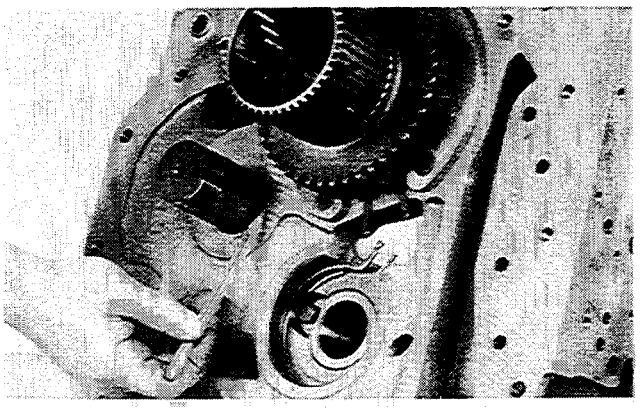


Figure 209
With new "O" ring on shaft, position idler shaft and lock ball in converter housing. Tap shaft into position. Note lock ball.

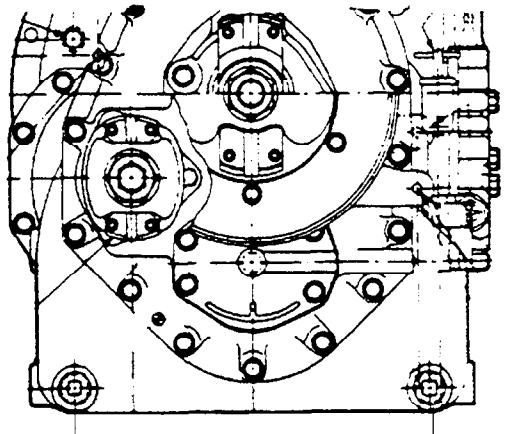
Transmission Drain and Refill

1. Drain and refill transmission fluid every 1000 hours or every six months.

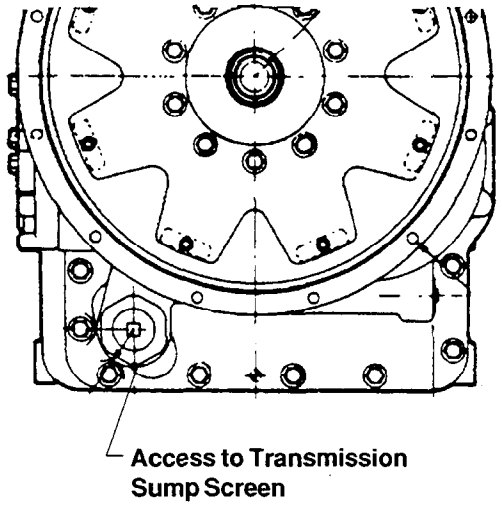
NOTE

Transmission should be drained with truck at NORMAL OPERATING TEMPERATURE.

2. Remove both drain plugs and allow fluid to drain completely. Clean plugs of all debris.

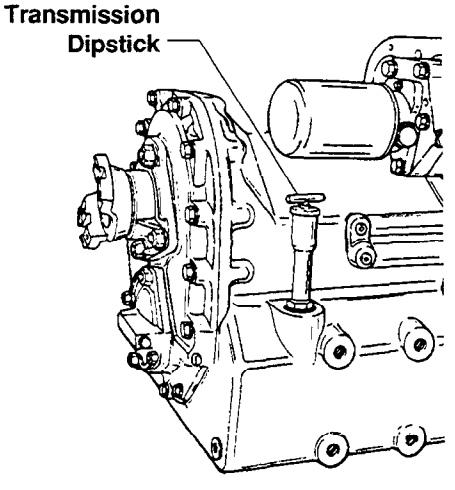


3. Remove and clean transmission sump screen.



- Check O-rings for damage and scratches; replace if damaged.
- Use a Stoddard-type cleaning solvent to clean the screen.
- Blow the screen dry with compressed air blowing from inside out through the screen.

4. Install the sump screen.
5. Install the drain plugs.
6. Fill the transmission through the dipstick opening with Amoco 1000 automatic transmission fluid.



7. With the directional control lever in the neutral position, run the engine at fast idle to allow the engine to reach normal operating temperature and fill the system with clean fluid.
8. Run the engine at normal idle and check the fluid level on the dipstick. Add fluid as needed to bring the level to the full mark on the dipstick.

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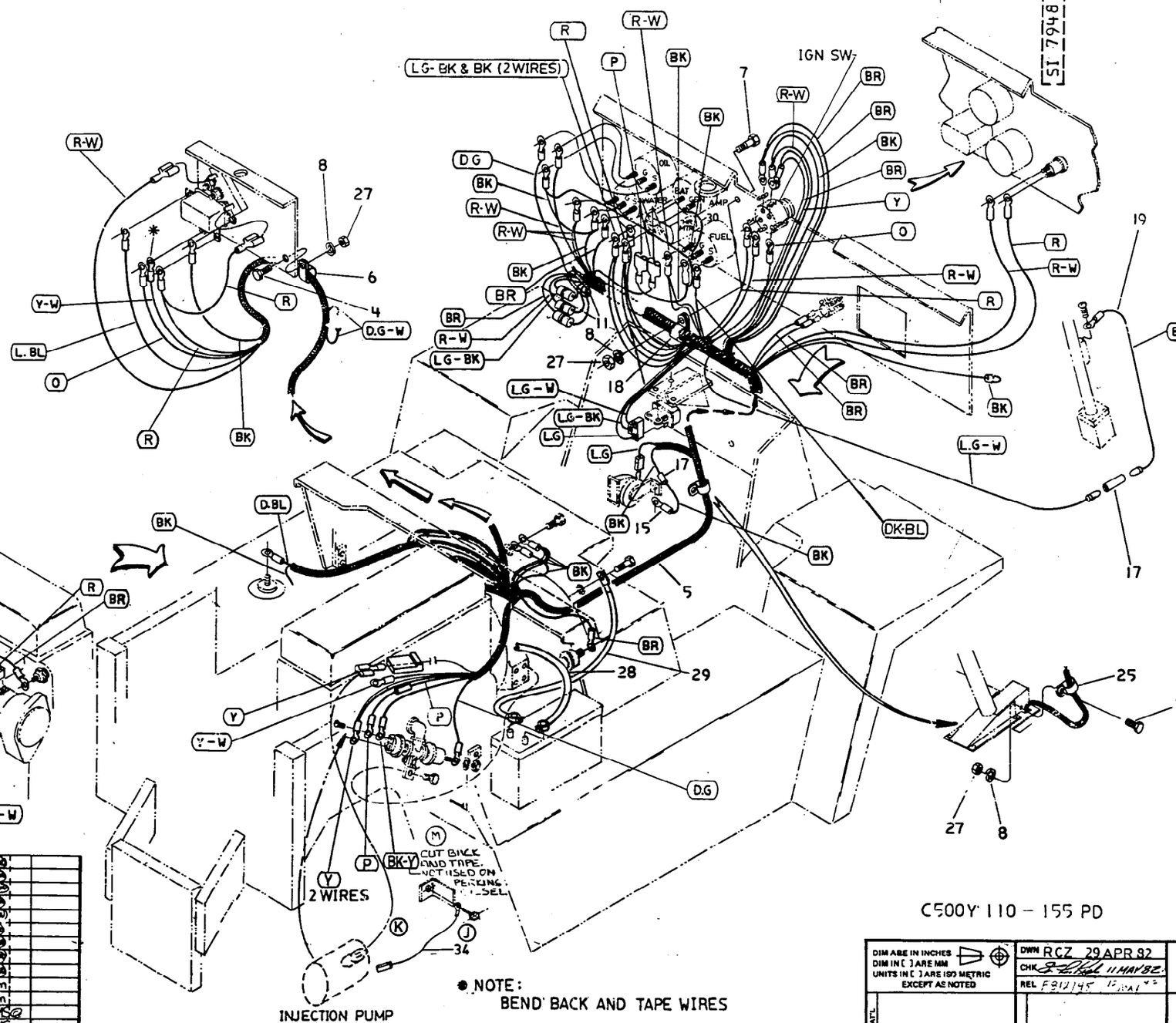
ALL FUSES ARE 14 AMPERE

BK	BLACK
BL	BLUE
BR	BROWN
G	GREEN
O	ORANGE
R	RED
W	WHITE
Y	YELLOW
GY	GRAY
V	VIOLET
P	PINK
PU	PURPLE

FIRST COLOR SYMBOL IS WIRE COLOR, SECOND IS WIRE TRACER I.E., (R-W) RED WITH WHITE TRACER.



● NOTE:
BEND BACK AND TAPE WIRES

ITEM	P/N	REF DWG	QTY
(N) 1	33EM50		
(N) 2	33DM50		
(N) 3	33DM100		
4	1C-408H		1
(F) 5	2384032		1
6	30H 33		1
7	1C 412H		3
8	4E 04H		4
9			
10	30H 36		1
(P) 11	1715312		1
(Z) 12			
13	2C 608H		1
(S) 14	6E6CR		1
15	1319599	645335	1
(AA) 16			
(W) 17	602355		2
18	30H 54		1
(L) 19	672886		1
20			
21			
(R) 22	31H 33		1
23			
24			
25	30H 56		1
26			
27	61D 04H		4
28			
29			
(Y) 30	1323157		1
31			
32			
(K) 33			
34	1304032		1
35			
36			
37			
38			
39			

REV	DESCRIPTION	CHG NOTICE	DATE	APPROVAL
Z	REMOVE 30H20	F900511	20-JULY-90	
Y	ADD 1323157	F900511	20-JULY-90	
W	WAS QTY 3	F900511	20-JULY-90	
V	SEE SHEET 2	F900511	20-JULY-90	
U	SEE SHEET 2	F900511	20-JULY-90	
T	SEE SHEET 2	F900511	20-JULY-90	
S	WAS 10E06 (2)	F900511	20-JULY-90	
R	WAS QTY (2)	F900511	20-JULY-90	
P	WAS 1715311	F900511	20-JULY-90	
N	ADDED	F810211	10OCT89	
M	ADDED NOTE	F890211	10OCT89	
L	WAS 1312748	F891166	27 JUL 89	
K	2378804 REMOVED	F840220	26 MAR 84	
J	GROUND RELOCATED	F840506	3 MAR 84	
H	SEE SHEET 2	F830653	5 JAN 83	
G	REVISED WIRING	F830653	5 JAN 83	
F	WAS 2362500	↓	↓	↓

AD	SEE SHEET 2	F905134	25JAN91	
AC	SEE SHEET 2	F900511	20-JULY-90	
AB	SEE SHEET 2	F900511	20-JULY-90	
AA	REMOVE 672886	F900511	20-JULY-90	

DIM ARE IN INCHES
DIM IN [ ] ARE MM
UNITS IN [ ] ARE ISO METRIC
EXCEPT AS NOTED

DWN RCZ 29APR 92
CHK 11MAY92
REL F911145 17MAY92

MAT'L
TREAT
HARD

INSTL - WIRING HARNESS (PERKINS)

CLARK EQUIPMENT
DWG NO SI 7948
D WT SHEET 1 OF 2

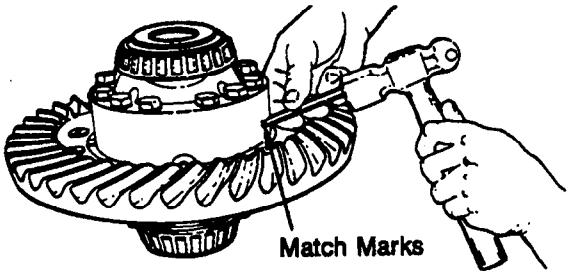
(M) (N) (N) (K) (M) (J) (S) (L) (F) (K) (P) (R) (S) (W) (Y) (Z) (AA)

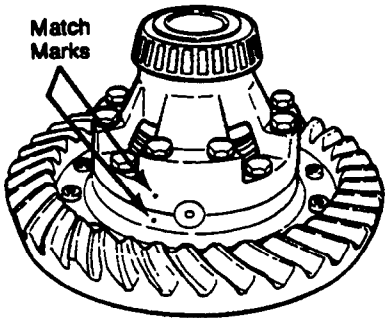
Section 1.

Drive Axle Description

Disassembling the Differential and Ring Gear Assembly

1. If the matching marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. The purpose of the marks is to match the plain half and flange half correctly when you assemble the carrier.





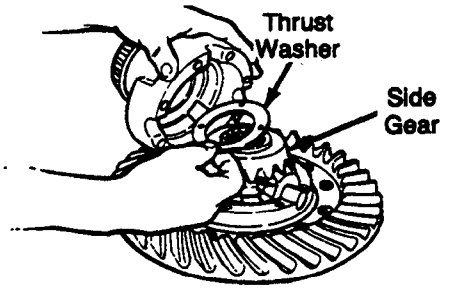
2. Remove either the lock wire, capscrews, and washers or bolts, nuts and washers that hold the case halves together, depending on which design is used.

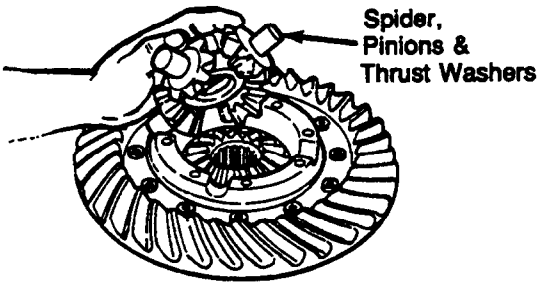
⚠ WARNING

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

3. Separate the case halves. If necessary, use a brass, plastic, or leather mallet to loosen the parts.

4. Remove the differential spider (cross), four pinion gears, two side gears, and six thrust washers from inside the case halves.



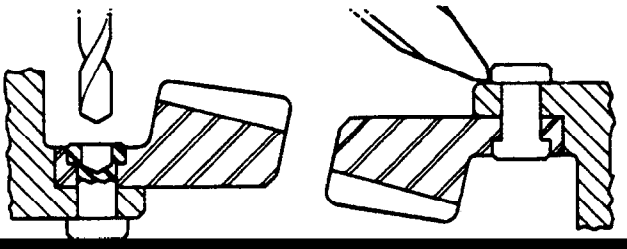


5. If the ring gear needs to be replaced, remove it. If bolts, nuts, and washers hold the gear to the flange case half, remove them.

   If rivets hold the ring gear to the flange case half, remove the rivets as follows:

   a. Carefully center punch each rivet head in the center, on the ring gear side of the assembly.

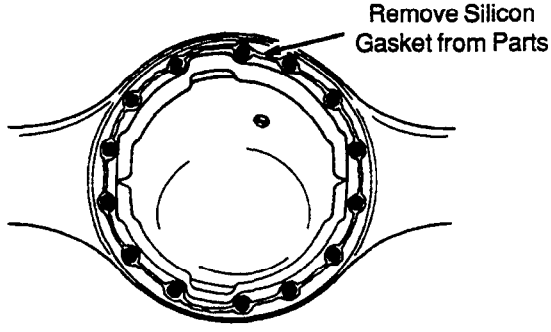
   b. Drill each rivet head on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 1/32 of an inch smaller than the body diameter of the rivets.



Repairing or Replacing Worn or Damaged Parts

Replace worn or damaged parts of an axle assembly. The following are some examples to check for, repair or replace:

1. Replace any fastener if corners of the head are worn.
2. Replace washers if damaged.
3. Replace gaskets, oil seals, or grease seals at the time of axle or carrier repair.
4. Clean parts and apply new silicone gasket material where required when axle or carrier is assembled.



5. Remove nicks, mars and burrs from parts having machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.
6. Clean and repairs threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

CAUTION

Threads must be without damage and clean so that accurate adjustments and correct torque values can be applied to fasteners and parts.

7. Tighten all fasteners to the correct torque values. See Group 20, Section 4 for torque values of fasteners.
8. DO NOT repair rear axle housings by bending or straightening.

WARNING

Repair of the axle housings by bending or straightening will cause poor or unsafe operation of the axle and early failure.

Bending, Straightening, or Welding Drive Axle Housings

No attempt should be made to correct or modify drive axle housings by bending or straightening. All damaged drive axle housings should be replaced.

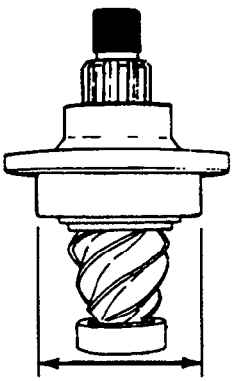
Replace any housing assemblies where cracks have worked into the parent metal. Also, any housings that have seam weld or cover weld cracks, due to known overloading of the axle, should not be repair welded.

3. Apply and hold the correct amount pressure to the pinion bearings. (See Chart 1 below). As pressure is applied, rotate the bearing cage several times so that bearings make normal contact.
4. While pressure is held against the assembly, wind a cord around the bearing cage several times.
5. Attach a spring scale to the end of the cord.
6. Pull the cord with scale on a horizontal line. As the bearing cage rotates, read the value indicated on scale. Make a note of reading.

NOTE

Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give a false reading.

7. Measure the diameter of bearing cage where the cord was wound. Measure in inches or centimeters.
8. Divide the dimension in half to get the radius. Make a note of radius dimension.



Measure Diameter of Cage

9. Use the following procedure to calculate the bearing preload (torque):

   Pounds pulled x Radius (inches) = lb-in preload x 0.113 = N•m preload

   OR

   Kilograms pulled x Radius (centimeters) = kg-cm preload x 0.098 = N•m preload

   Examples:

   Reading from spring scale = 7.5 pounds (3.4 kg)

   Diameter of bearing cage = 6.62 inches (16.8 cm)

   Radius of bearing cage = 3.31 inches (8.4 cm)

   7.5 lb x 3.31 in= 24.8 in-lb preload x 0.113 = 2.8 N•m preload

   OR

   3.4 kg x 8.4 cm = 28.6 kg-cm preload x 0.098 = 2.8 N•m preload

10. If the preload (torque) of pinion bearings is not within specifications, do the following procedure then repeat steps 1 to 9.

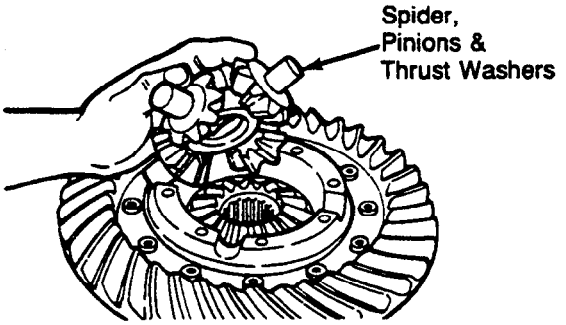
    To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

11. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust preload of pinion bearings, yoke or flange method.

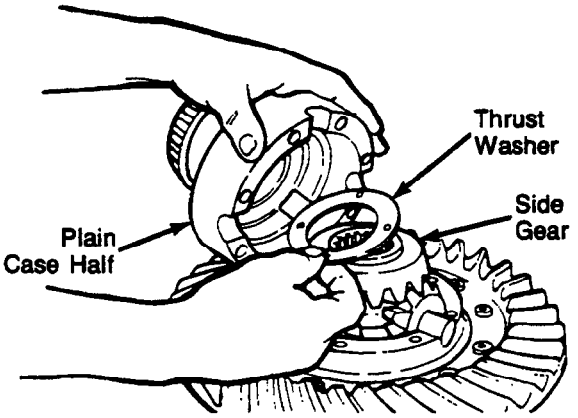
Chart 1

Thread Size of Pinion Shaft	Press Pressure Needed on Bearings of Correct Preload *lbs / tons*	*(kg / metric tons)*	Torque Value Needed on Pinion Nut for Correct Bearing Preload *lb-ft*	*(N•m)*
7/8"-20	22,000 / 11	(9979 / 10)	200-275	(271- 373)
1"-20	30,000 / 15	(13608 / 13.6)	300-400	(407- 542)
1 1/4"-12	54,000 / 27	(24494 / 24.5)	700-900	(949-1220)
1 1/4"-18	54,000 / 27	(24494 / 24.5)	700-900	(949-1220)
1 1/2"-12	54,000 / 27	(24494 / 24.5)	800-1100	(1085-1491)
1 1/2"-18	54,000 / 27	(24494 / 24.5)	800-1100	(1085-1491)
1 3/4"-12	50,000 / 25	(24680 / 22.7)	900-1200	(1220-1627)
2"-12	50,000 / 25	(24680 / 22.7)	1200-1500	(1627 -2034)

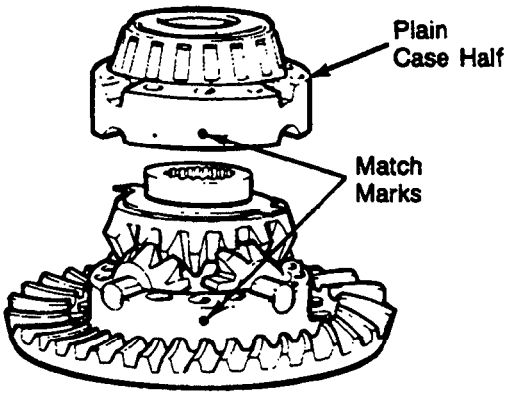
12. Install the spider (cross), differential pinions and thrust washers into the flange case half.



13. Install the second side gear and thrust washer over spider and differential pinions.

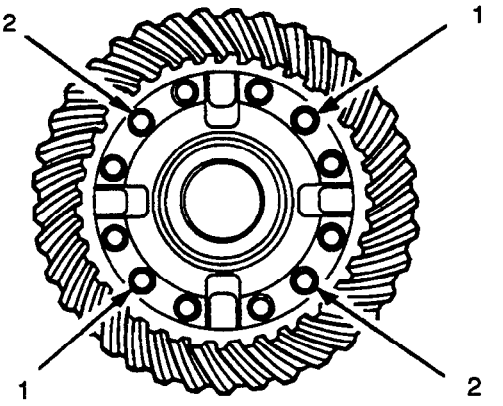


14. Put the plain half of the differential case over the flange half and gears. Rotate the plain half as needed to align the match marks.



15. Install Dri-Loc fasteners into the case halves. See "General Procedures" earlier in this Section and follow steps a and b below.

    a. Install (as used) four capscrews and washers or bolts, nuts and washers into the case halves. The distance between the fasteners MUST be equal. Tighten the fasteners to the correct torque value in a pattern opposite each other. See torque chart Section 4.



    b. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value (See the torque chart in Section 4.)

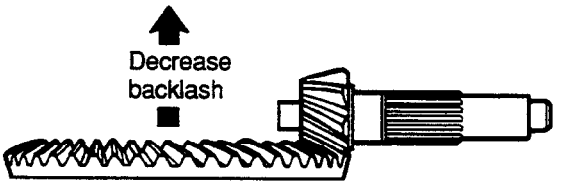
16. Check the rotating resistance of the differential gears. Use the following procedure.

c. Install the drive pinion, bearing cage and shims into the carrier. See the procedure given previously in "Pinion Cage Shim Pack Adjustment."

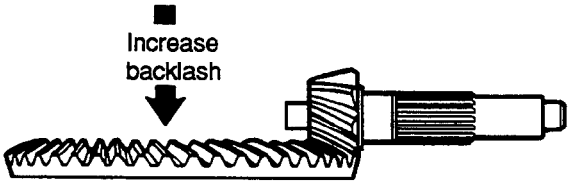
d. Repeat steps 2 to 5 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust backlash of the ring gear within specification range to move the contact patterns to the correct location in the length of the gear teeth. See the procedure given previously in "Ring Gear Backlash Adjustment."

a. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth.



b. Increase backlash to move the contact patterns toward the heel of the ring gear teeth.



c. Repeat steps 2 to 4 and 6 until the contact patterns are in the correct location in the length of the gear teeth.

7. Install (as used) cotter keys, pins, or lock plates that hold the two bearing adjusting rings in position. Use the following procedures.

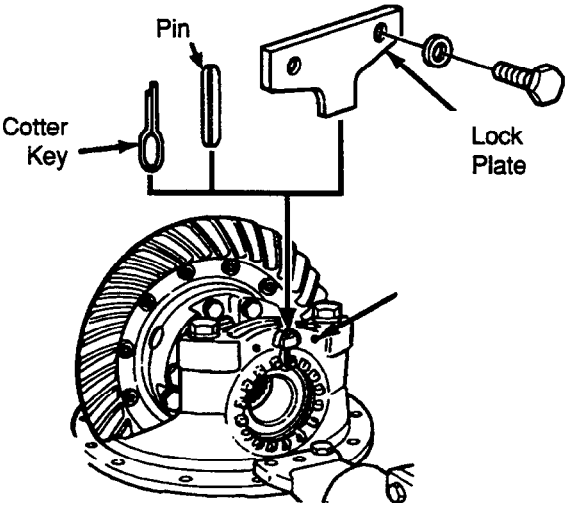
⚠ CAUTION

If your carrier uses cotter keys, lock the adjusting rings only with cotter keys. If your carrier uses roll pins, reuse the roll pins or lock the adjusting rings with cotter keys. Do not force a roll pin into a cotter key hole.

a. Cotter keys (if used)—Install cotter keys between lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss.

b. Pins (if used)—Install pin through boss of the bearing cap until the pin is between lugs of the adjusting ring. Use a drift and hammer to install the pin.

c. Lock Plates (if used)—Install lock plate on bearing cap so that the tab is between lugs of the adjusting ring. Install the two capscrews that hold the lock plate to the bearing cap. Tighten the capscrews to correct torque value. (See the torque chart in Section 4.)



Axle End Disassembly

1. Safely raise and properly block the front of the truck as described in Group 22, Section 2, "Jacking, Blocking, and Towing."
2. Remove the outer and inner wheels as described in Group 22, Section 3, "Wheel Mounting."

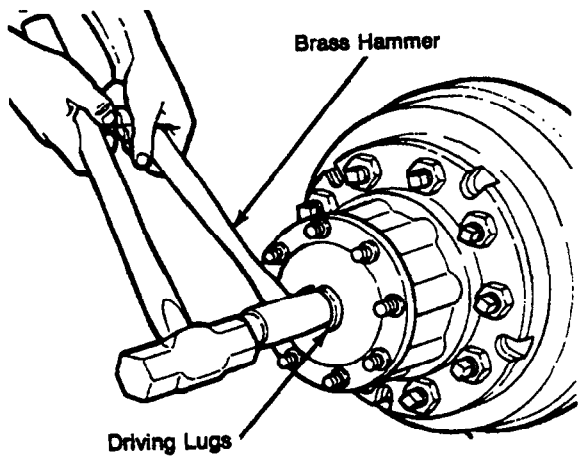
The following procedures refer to the **illustration on the next page.**

3. Remove brake drum (A).
4. Remove the stud nuts (B) from the flanges of both axle shafts.
5. Loosen the tapered dowels (B) in the flanges of both axle shafts as follows:

WARNING

Wear safety eye protection. Do not hit the round driving lugs on the head of axle shafts. Lugs can break and cause injury.

a. Hold a 1-1/2 inch diameter brass drift against the center of the axle shaft, inside round driving lugs.



NOTE

A 1-1/2 inch diameter brass hammer can be used as a drift.

b. Hit the end of the drift with a large hammer (five to six pounds) and the axle shaft and tapered dowels will loosen.

CAUTION

Do not use a chisel or wedge to loosen the axle shafts and dowels. The chisel or wedge can damage the hub, axle shafts and, if used, oil seals.

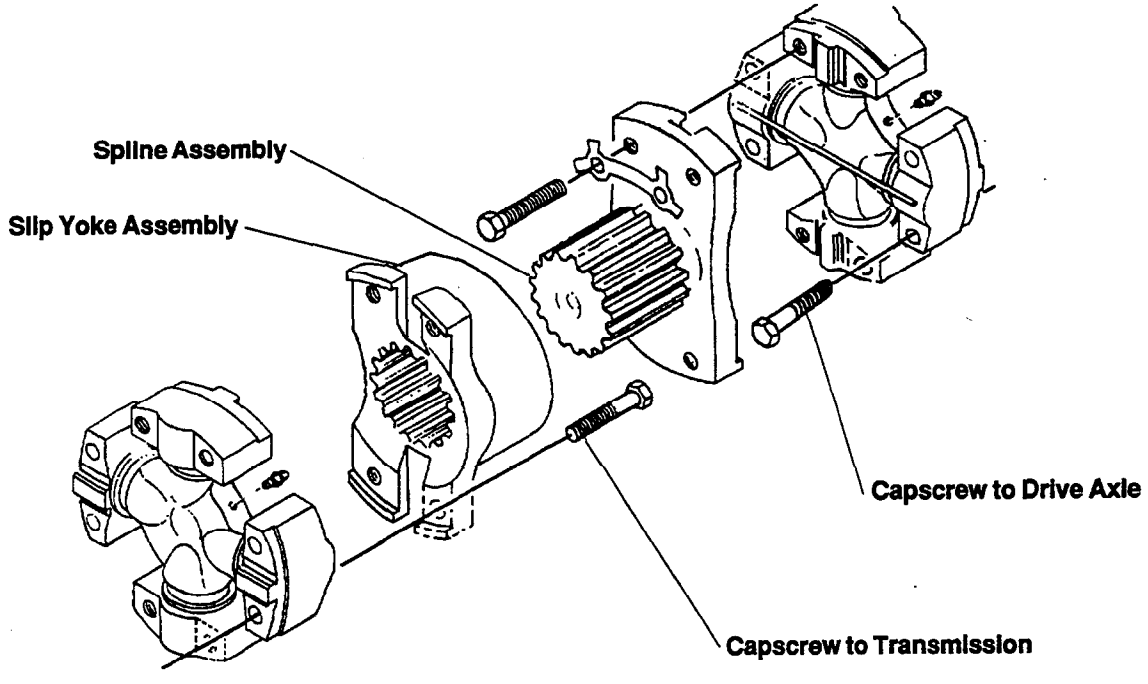
6. Pull axle shaft (C) out of axle housing.
7. Remove gasket (D) from hub.
8. Remove jam nut (E) from spindle.
9. Remove lock ring (F) from spindle.
10. Remove lock nut (G) from spindle. Note dowel on lock nut.
11. Remove outer cone bearing (H) from spindle.
12. Remove hub assembly (I) from spindle.
13. Remove inner cone (J) bearing.
14. Remove brake assembly (K) by unbolting it from mounting flange on axle housing.

Axle End Assembly

1. Install brake assembly (K) using 7 bolts, cones, and nuts per wheel. Torque to 75-115 ft-lb (102-156 N•m).
2. Lube inner cone bearing (J) with gear lube and install bearing on spindle.
3. Install hub (I) assembly.
4. Add gear lube to hub well for start-up lubrication.
5. Install outer cone bearing (H).
6. Install locknut with dowel (G) facing you.

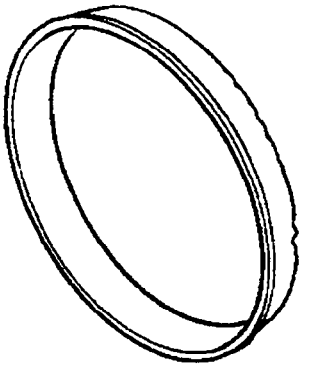
Prop Shaft Removal

1. Park truck on level surface and set parking brake.
2. Remove the driver's compartment floor plate.
3. Remove capscrews and disconnect prop shaft assembly from companion flange of transmission.
4. Remove capscrews and disconnect prop shaft assembly from companion flange of drive axle.
5. Compress the spline assembly into the slip yoke assembly to remove prop shaft assembly from truck.



Prop Shaft Assembly

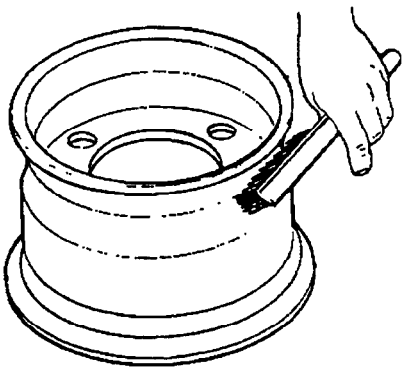
11. Check wedge ring for wear or damage.



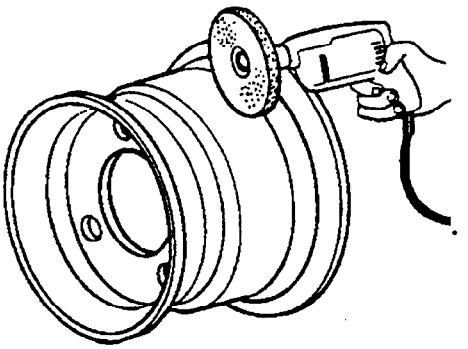
WARNING

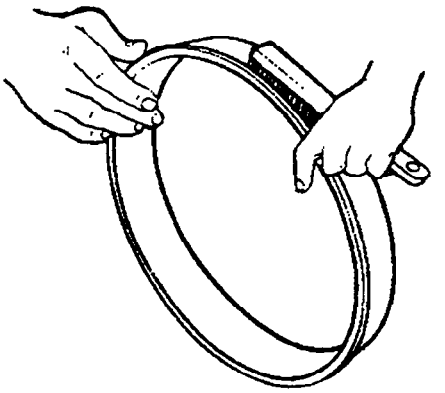
Too much corrosion will cause wear and damage to the wheel wedge ring.

12. Clean the wheels. Remove rust and dirt.

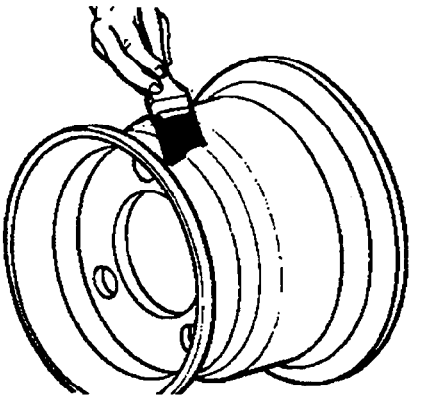


13. Clean the tire bead seat area. Remove all rust and rubber





14. Clean wedge and lock rings. Make sure the seating surface and bead seat areas are clean



15. Apply paint to the tire rim with a brush or use an aerosol can of metal primer.

The parts must be clean and dry before you apply the paint. Make sure to apply paint to the outside or tire side of the rim. This is important because air is on the metal surface of the tire side of the rim.

After the paint has thoroughly dried, apply lubricant on the tire side of the rim base. Do not use a lubricant that has water or solvent which will cause damage to the rubber.

NOTE

Your Clark dealer can supply the correct lubricant, which contains a rust inhibitor.

4. Check that the counterweight bolts on both trucks are in place and properly torqued. These bolts are made of special, high-tensile steel and are not commercially available. When necessary, replace these bolts only with a genuine Clark replacement part.
5. Use an approved, solid metal tow bar with towing couplers that connect to the towing pins in the counterweights.

NOTICE

Optional towing equipment is available from your Clark dealer.

6. Set the direction control on the disabled truck in neutral and release the parking brake.
7. Because the tow bar is secured to the towing pins between the towing and disabled trucks, the disabled truck is towed backwards. An operator must be on the disabled truck to steer along the path the towing truck is taking.

CAUTION

The power steering will not operate on the disabled truck when the engine is not running. The steering handwheel will be difficult to turn.

8. Tow the truck slowly. Careful towing is necessary to prevent an injury to personnel or damage to the disabled truck. The truck should only be towed 300 yards or less at less than 5 mph (8 kph, or a moderate walking speed) with a driver in place and steering the disabled truck.

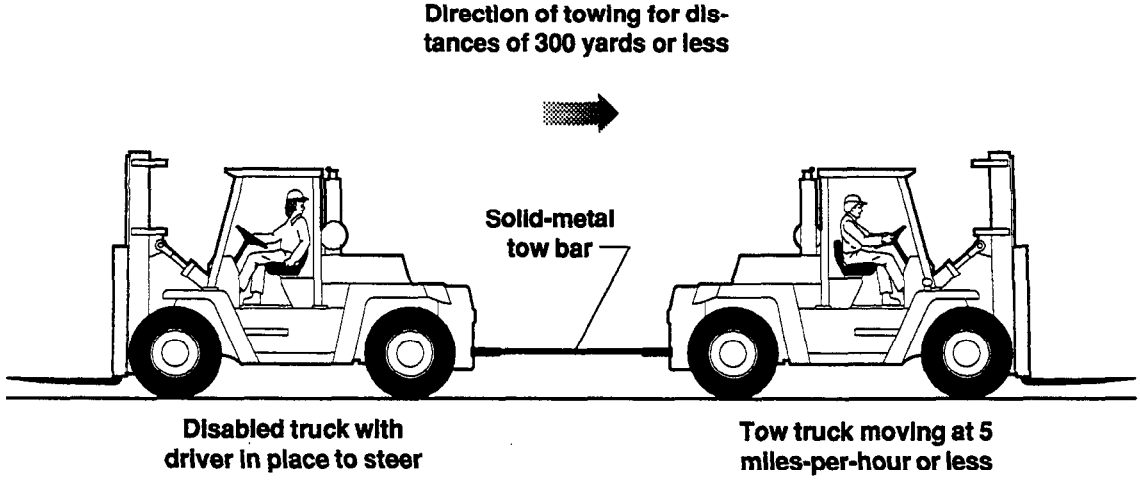
IMPORTANT

Do not lift the disabled truck or any wheels off the floor while the truck is being towed.

9. Park the disabled truck in authorized areas only. Fully lower the forks on the floor, leave the directional control in neutral, turn the ignition switch to OFF, and engage the parking brake. Remove the ignition key and, when necessary, block the wheels to prevent the truck from rolling.

WARNING

Always engage the parking brake when parking a lift truck. The truck can roll and cause injury or death to personnel near it.



Section 3.

Brake and Inching System Bleeding

Brake/Inching Bleeding: Precautions

- Do not mix different types and brands of brake fluid.
- Do not use brake fluid that is contaminated in any way.
- Do not use brake fluid that is cloudy, opaque, an emulsion, separated into layers, or that contains any moisture.
- Store brake fluid in original container and keep air tight.
- Clean off brake fluid containers before opening.
- Do not reuse brake fluid containers for any other purpose.
- Never reuse brake fluid once it has entered any brake system.
- Use only new brake fluid for bleeding and cleaning of brake/inching system parts.
- Clean off the reservoir before removing cap.
- Do not open the reservoirs in a dusty area or where snow, rain, etc., can enter the fluid.
- Clean off bleeder screws before bleeding brakes.
- Before bleeding, make all necessary repairs on lines, hoses, cylinders, etc.
- Flush the entire brake system if the fluid in the master cylinders looks dirty, cloudy, or emulsified, separated into layers, or if it contains any foreign liquid.

CAUTION

Do all brake/inching bleeding with the ENGINE OFF.

Before installing a replacement master cylinder on a power brake unit, inspect the piston socket. Sometimes a replacement cylinder, furnished for both manual and power brakes, contains a rubber bumper or grommet in the socket that must be fished out when the cylinder is used in conjunction with power brakes.

If the length of an adjustable push rod must be altered and a gauge is not available, turn the threaded rod tip in or out, in short increments, until the cylinder just seats against its mount without rod interference. The objective is to secure minimum clearance, less than 0.010 inch (0.25 mm), between push rod and piston in released position.

After installation, check to make sure the master cylinder by-pass is not blocked.

CONDITION	POSSIBLE CAUSE	SUGGESTED CORRECTION
No steering.	1. Hydraulic fluid level very low. 2. Hose broken. 3. Power steering pump defective. 4. Air in hydraulic oil.	1. Check fluid level. Fill as required. 2. Replace hose. 3. Repair or replace power steering pump. 4. Fix air leak in hydraulic system.
Hard steering.	1. Hydraulic fluid level very low. 2. Power steering pump defective. 3. Steering gear box defective. 4. Air in hydraulic oil.	1. Check fluid level. Fill as necessary. 2. Repair or replace power steering pump. 3. Repair or replace steering gear box. 4. Fix air leak in hydraulic system.
Wheels turn but requires effort.	1. Hydraulic fluid level low. 2. System leaking. 3. Incorrect tire pressure. 4. Lack of lubrication. 5. Air in hydraulic oil. 6. Malfunctioning, damaged, or worn priority demand valve (flow control valve).	1. Check fluid level. Fill as required. 2. Check for leaks. Repair as necessary. 3. Correct tire pressure. 4. Lubricate. 5. Fix air leak in hydraulic system. 6. Inspect, overhaul, or replace priority demand valve (flow control valve).

DISASSEMBLY PROCEDURE

Plug the four port holes and clean the exterior of the unit thoroughly. Then remove the plugs.

1. Remove Dirt Seal (2) and discard.

2. To prevent possible distortion of damage to unit if placed directly in vise, the following procedure should be used. Insert "o" ring tube fitting, with tube nut or fitting cap attached, into one of the four threaded ports in the housing. Clamp the fitting in a vise in a manner which will locate the seven end cover bolts in an upright position. (See figure HGA-7).

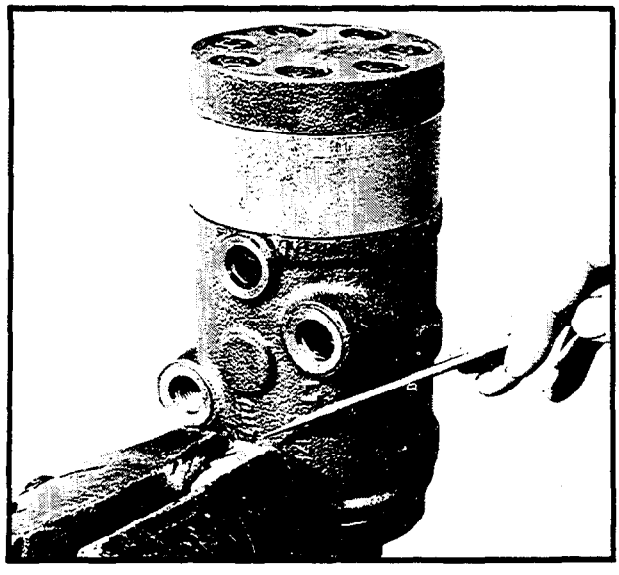


Figure HGA-7

3. Unscrew the seven special bolts (39) from the end cover (38). Note: Special care should be used in the following steps to insure protection of the ground and lapped faces of the components. Avoid scratching or nicking of finished surfaces.

4. Remove end cover (38) by bumping it sideways with a soft hammer to loosen it from the rotor seal (36) and seal retainer (35), and lift from unit. Caution: The washer (37) and commutator (34) may adhere to the end cover, and may be removed with the end cover. Do not attempt to remove pin because pin is press fit in the plate and is non-serviceable. (See Figure HGA-8).

5. Remove the rotor seal (36) and seal retainer (35) by bumping the retainer sideways with a soft hammer to loosen it from the valve body and lift off the rotor seal and seal retainer. Discard rotor seal.

6. If the wear washer (37) and commutator (34) were not removed with the end cover (38), remove these parts from the HGA unit.

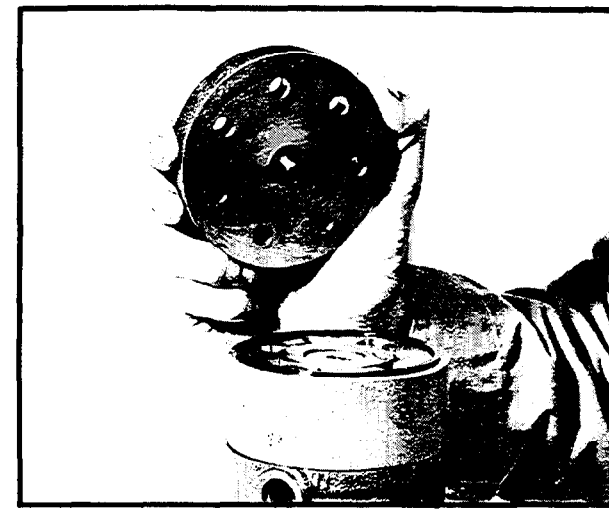


Figure HGA-8

7. Remove the commutator ring (33) from the manifold (32), by a sliding and lifting motion. Care should be used in the handling of this fragile component.

8. Remove the manifold (32) from the rotor set (31) by sliding and lifting motion.

9. Remove the rotor set (31), spacer (29) and drive link (30) as an assembly by grasping the spacer and removing the assembly with a sliding and lifting motion. (See figure HGA-9).

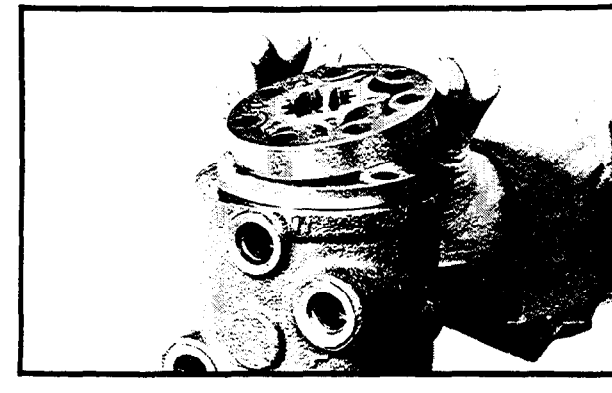


Figure HGA-9

10. Separate drive link (30) by sliding the rotor set (31) on the spacer (29), allowing the drive link teeth to clear the spacer hole. Remove drive link and separate rotor set from spacer. Use extreme caution to keep vanes (31D) and springs (31C) from falling out .When handling the rotor set, pressure should be applied to the rotor (31B) by gripping the rotor set between the fingers and urging the rotor into contact with the stator (31A). (See figure HGA-10)

    Carefully protect against damage to side faces. Note: The rotor (31B) and the stator (31A) must be kept in a matched set.

Section 1.

Steering System Checks and Adjustments

NOTE

Steering system troubleshooting is provided in Group 25, Section 1.

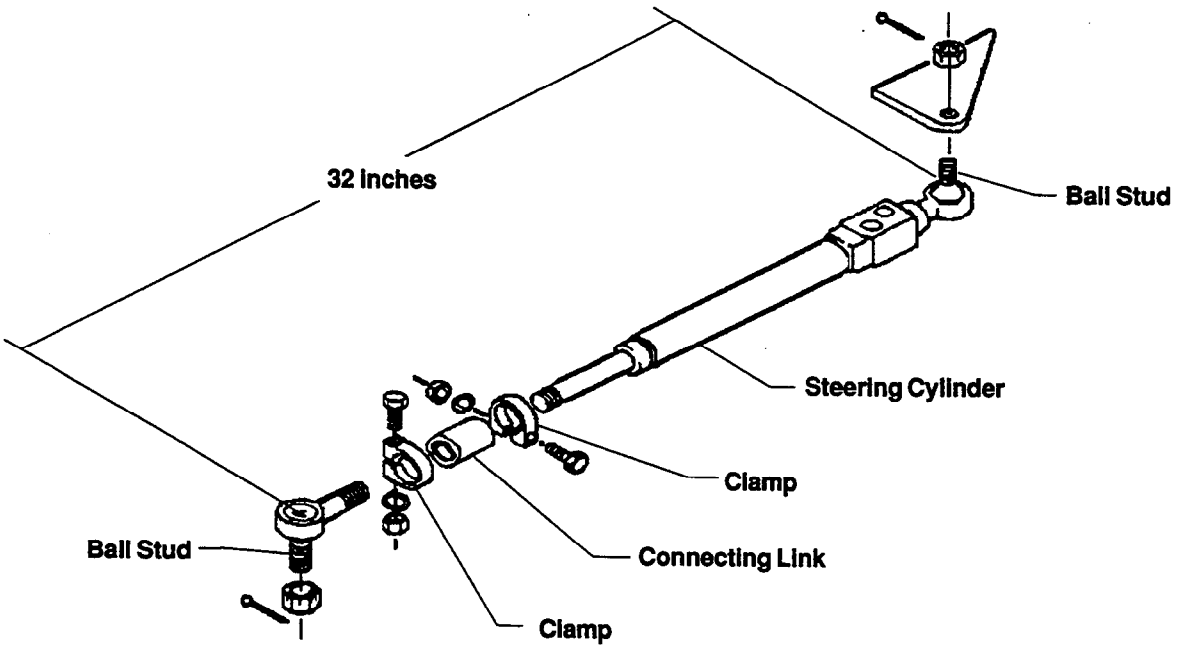
General Checks and Adjustments

Check all hydraulic lines to make sure connections and clamps are tight with no leakage. Make sure hoses are in good condition with no evidence of drying or cracking. Check the entire power steering system as shown in the illustration on page 2.

Referring to the illustration below:

1. Loosen clamp bolts and adjust connecting link to set the steering cylinder to 32 inches (812.8 mm) from the center of one ball stud to the center of the other with the cylinder in the closed position.
2. Adjust the steering cylinder for a minimum of 0.30 inch (7.6 mm) overtravel at the end of each stroke.
3. Torque the cylinder clamp bolts to 30-40 ft-lb (40.5-54 N•m).
4. Torque the nuts on the ball studs to 110-125 ft-lb (148-168 N•m). Advance the bolt to the next slot and insert a new cotter pin.

Then adjust the tie rods so that they are equal and so that there is zero degree toe-in. Also, adjust axle stops for proper turning radius, as specified in "General Specifications" in Group 40.



Section 5.

Steer Cylinder Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the corrrect repair parts, seals, and gasket sets are available.

5. Remove the drive and driven gears. Keep the gears together because they are a matched set. Examine and replace if necessary.

   Take care not to damage the machined surfaces of gears.

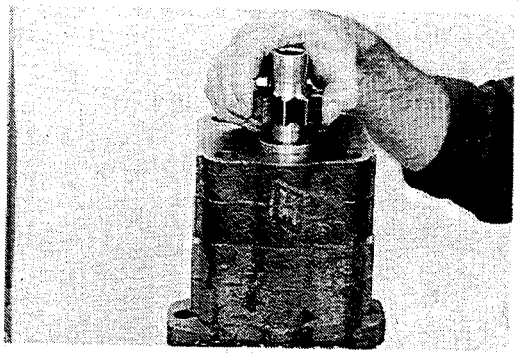


Fig. 17021

6. Lift or pry off the bearing carrier. Take care not to damage the machined surfaces.

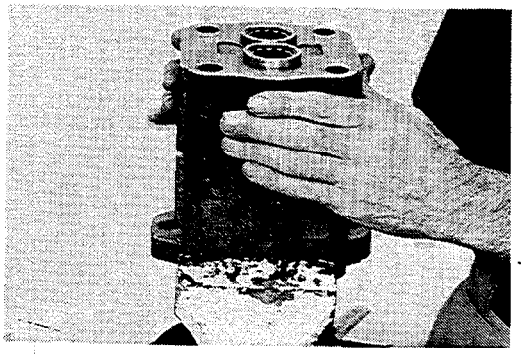


Fig. 17022

7. Lift or pry off the first section gear housing. Be careful not to damage machined surfaces. Remove thrust plate.

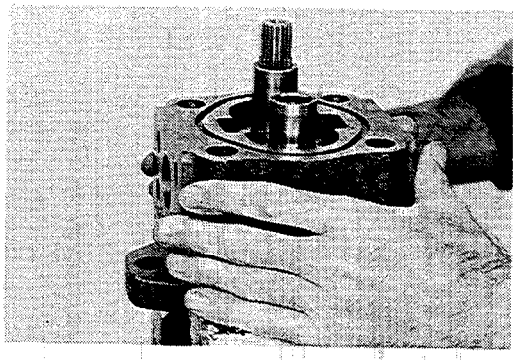


Fig. 17023

8. Remove the drive gear with shaft and the driven gear. Keep these together as they are a matched set. Examine and replace if necessary.

   Take care not to damage the machined surfaces of gears.

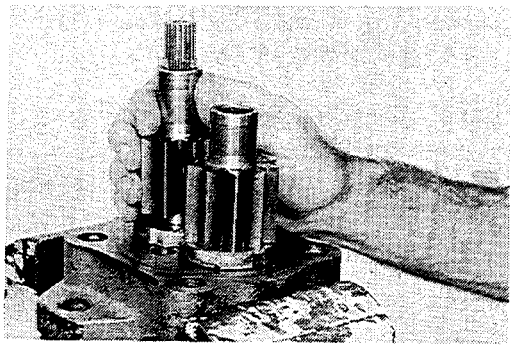
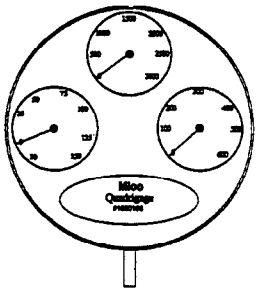


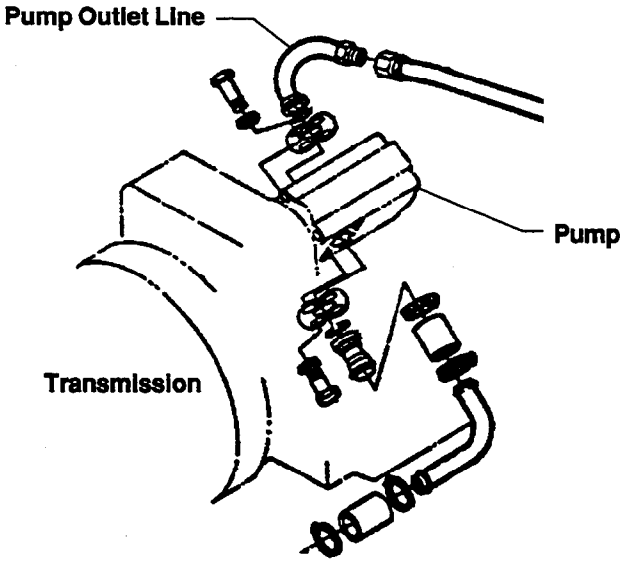
Fig. 17024

Hydraulic System Pressure Check

The hydraulic relief valve, which is in the main hydraulic control valve assembly, may be checked using a Mico Quadrigage (Clark Part Number 1800106) or by installing a conventional pressure gauge with a 0-4000 psi (0-28000 kPa) scale.



1. A test port (not shown) is fitted into the elbow that connects to the main hydraulic pump outlet. Remove the plug and connect the gauge to the test port.



NOTE

The main hydraulic pump and power steering pump are integrated into one housing. The main hydraulic pump outlet line goes directly to the main hydraulic control valve.

2. Put on the parking brake. Start the engine and operate at governed rpm.
3. Hold tilt lever back until the pressure builds up and moves the pressure relief valve off the seat. Do not hold the tilt lever longer than is necessary to check the pressure reading on the gauge. Take the reading and then release the accelerator and tilt lever. The pressure reading should be 2500 psi (17,237 kPa).

WARNING

When checking hydraulic fluid pressure, do not use your hands to check for leakage. Fluid under pressure can penetrate your skin and cause serious injury.

4. Reconnect the hydraulic line connection by hand tightening and then using a wrench to complete 1 1/2 to 3 full turns on the fitting.

6. Install the plain hex headed relief cap. Put grease on a new O-ring seal and tighten the cap to [61 N˙m] 45 lb. ft. of torque.

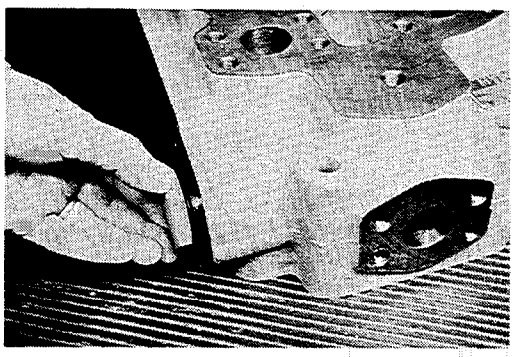


Fig. 21234

7. Install each spool in the same valve bore following the marks made during disassembly. Install each spool the same distance from each side of the valve body. The spool wrench flats must be on the operating side of the valve.

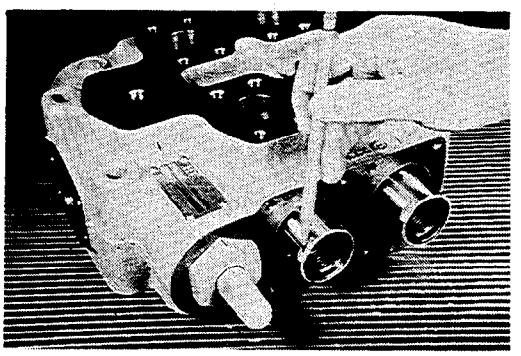


Fig. 21235

8. Apply grease to a new spool seal and install it on the spool with the marked side out. Seals that do not have marks are earlier types and must be replaced with the newer seals.

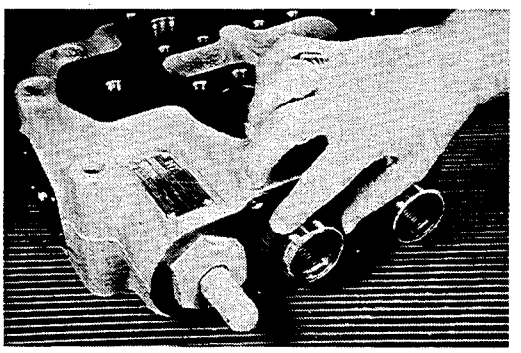


Fig. 21236

9. Using a seal installing tool, set the spool seal at the bottom of the seal bore.

IMPORTANT
DO NOT DAMAGE OR CAUSE DISTORTION TO THE SEAL.

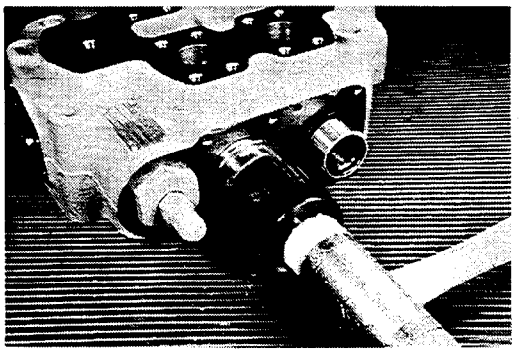
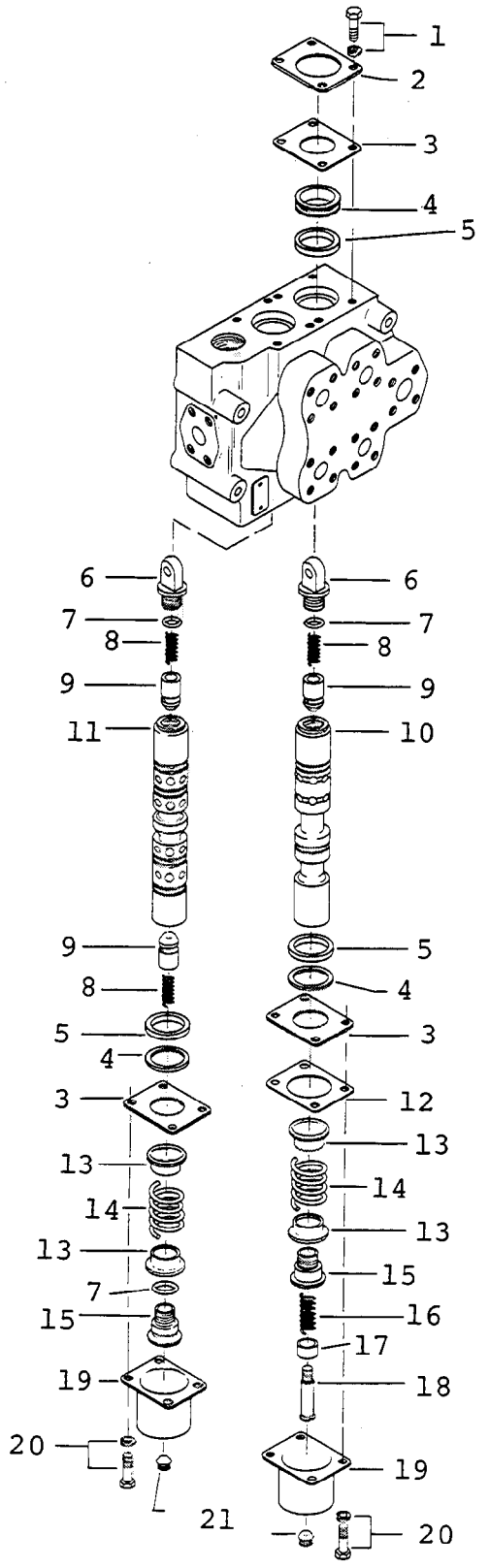


Fig. 21237



TYPICAL HYDRAULIC VALVE

1. Retainer Bolt
2. Wiper Retainer Plate
3. Seal Retainer Plate
4. Spool Wiper
5. Oil Seal
6. Spool Eye
7. O-Ring Seal
8. Poppet Spring
9. Poppet
10. Lift Spool
11. Tilt Spool
12. Cover Spacer
13. Spring Guide
14. Centering Spring
15. Spool Cap
16. Detent Spring
17. Spring Guide
18. Guide Bolt
19. Spring Cover
20. Cover Bolt
21. Plug

Section 2.

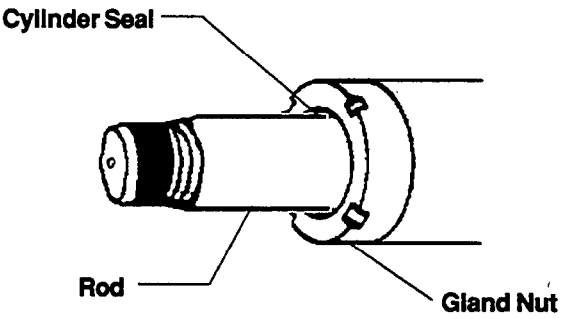
Tilt Cylinder Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the corrrect repair parts, seals, and gasket sets are available.

5. Lift and Tilt Cylinders: Cylinder seals should be checked for leakage. Cylinder rods should be free of grit, nicks, and chemical residues or paint. Keep the cylinder heads clean; rods should be in the retracted position when not in use. Performance checks are described under Section 2, "Operational Checks."

A shim inspection should be conducted whenever carriage and rail play becomes unacceptable for your operation. This involves checking rail-to-roller clearance for all roller mounts on the carriage and upright rails. The procedures for checking shims and clearances are included under the Sections 3 and 4 dealing with carriages and uprights.



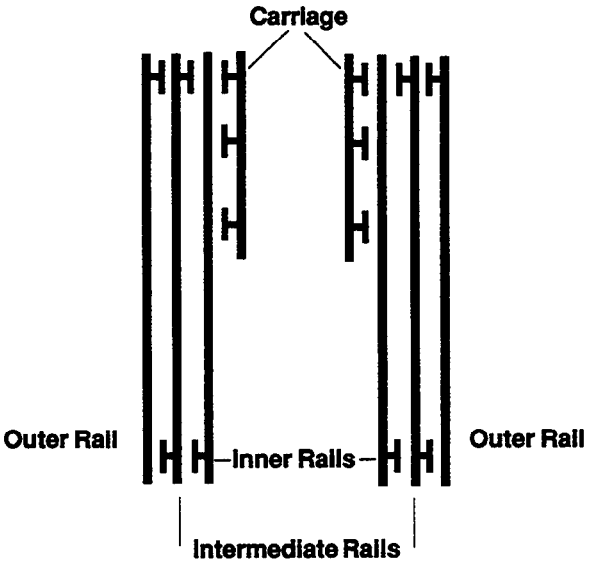
Typical Rod and Cylinder Seal Assembly

Whenever the upright components do not perform smoothly, appropriate diagnostic tests should be performed. See Section 2, "Operational Checks," and the sections dealing with the component for tests to determine the cause and extent of the problems. The sections include procedures for correcting the problems.

Carriage Roller Check

Carriage rollers, like upright rail rollers, must be checked periodically for wear. This wear may be indicated by the load test and/or roll pattern checks. You make adjustments by adding shims to the rollers to compensate for over-tolerance clearances between carriage and rail rollers and the nested rails.

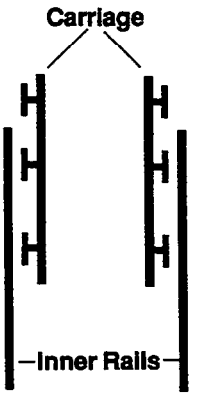
Evaluation of shim requirements generally dictates that a specific roller is acceptable until a clearance of 1/16" (1.5 mm) is measured. Shims are each 1/32" (.75 mm), therefore two shims would be required for adjustment. It is recommended that the shims are split evenly with one shim on each side. When an odd number of shims are required, always keep the same number to the same side of the upright, two shims on the right-side rollers and one shim on the left-side rollers, for example.



Carriage Roller Check Set-Up

To check the carriage roller clearance:

1. Position carriage as shown in the figure.
2. Use a "C" clamp to force the rollers to one side.
   a. Use a shim block under the "C" clamp on the inside of the channel rail.
   b. Torque on the "C" clamp should not exceed 20 ft-lb.
   c. If the carriage has a fork-bar thrust roller, the roller must be removed from the side opposite the "C" clamp.
3. Measure the rail-to-roller clearance using feeler gauges.
4. Top and bottom carriage roller clearances should be checked at the top, middle, and bottom of the inner rail. Check shimming of center roller on six-roller carriage by raising upright until the carriage top rollers come out the top of the inner rails.



Checking the Center Carriage Rollers

Upright Reassembly

The following steps detail the procedures for reassembling the upright.

Again, read the entire procedure before beginning. Make sure to read each step, including all warnings and service notes, before proceeding.

1. Raise the intermediate rail enough to remove the block between the lower tie bars of the inner and intermediate rails.
2. Lower the intermediate rail to the floor. You may need to use a prybar to guide the inner rail onto the intermediate rail rollers.

WARNING

Never attempt to move or align the rails with your hands. Use a pry bar.

3. Reattach the lifting strap around the upper tie bars of both the inner and intermediate rails.
4. Raise both rails carefully guiding both top and bottom rail bearings into position.

WARNING

Never attempt to move or align the rails with your hands, use a pry bar.

5. Continue to raise both rails until a 4-foot (1.3 m) block can be placed under the base of both the intermediate and inner rails. Before proceeding with this step, read the following warning.

WARNING

The block supporting the intermediate and inner rail must be large enough to cover the lower edge surfaces of both rails. Be sure to insert the block securely into the channel of the outer rail so that it cannot be knocked out of place.

6. Lower the rails onto the block checking to be sure both rails are being held securely in place. Using the 3/8" (9 mm) safety chain, securely chain the lower tie bars of the intermediate rail to the top tie bar of the outer rail.

WARNING

The chain and block supports are back up safety points. You must use both of them.

You may need to raise the inner rail slightly to install the rail stop. When the stop has been installed be sure to lower the rail.

7. Reinstall the inner rail to intermediate rail stop block to the inner rail lower tie bar.
8. Reinstall the final lift cylinders. Be sure the welded hydraulic fitting is pointing toward the inside of the upright.
9. Reinstall final lift cylinder locks.
10. Reinstall final lift cylinder hydraulic lines.

NOTE

Make sure ORS "O" rings are reinstalled properly to seal the connection.

11. Reinstall the hydraulic line and bracket to the base of the primary lift cylinder.

    Where used, reinstall the lower internal hose bracket and hoses. When internal hoses are used you will need to reinstall the primary cylinder hose bracket and the internal hose bracket together.

12. Using the lifting strap and overhead hoist, raise the inner and intermediate rails and remove the 4-foot (1.3 m) block.

Section 1.

Counterweight Removal and Replacement

Capacities

Models	At 24-inch Load Center	At 500 mm Load Center
GPH/DPH 50	11,500 lb	5000 kg
GPH/DPH 60	13,500 lb	6000 kg
GPH/DPH 70	15,500 lb	7000 kg
GPH/DPH 75	16,500 lb	7500 kg

Service Weights

Approximate weights without load, with preferred uprlghts, less any attachment (optional).
Note: Refer to the Truck Data Plate for exact Service and Axle Weights.

	Standard Upright (mfh=137 in [3480 mm])
GPH 50	16,135 lb (7319 kg)
DPH 50	16,235 lb (7364 kg)
GPH 60	18,170 lb (8242 kg)
DPH 60	18,440 lb (8366 kg)
GPH 70	19,635 lb (8906 kg)
DPH 70	19,735 lb (8952 kg)
GPH 75	20,680 lb (9380 kg)
DPH 75	20,780 lb (9426 kg)

Axle Weights

With standard upright (mfh=137 in [3480 mm]), less any attachment (optional).

		Weight without load
GPH 50	Drive Axle	6445 lb (2923 kg)
	Steer Axle	9690 lb (3488 kg)
DPH 50	Drive Axle	6485 lb (2942 kg)
	Steer Axle	9750 lb (4423 kg)
GPH 60	Drive Axle	7255 lb (3291 kg)
	Steer Axle	10,915 lb (4951 kg)
DPH 60	Drive Axle	7365 lb (3942 kg)
	Steer Axle	11,075 lb (5024 kg)
GPH 70	Drive Axle	7840 lb (3556 kg)
	Steer Axle	11,795 lb (5350 kg)
DPH 70	Drive Axle	7880 lb (3574 kg)
	Steer Axle	11,855 lb (5377 kg)
GPH 75	Drive Axle	8260 lb (3747 kg)
	Steer Axle	12,420 lb (5634 kg)
DPH 75	Drive Axle	8300 lb (3765 kg)
	Steer Axle	12,480 lb (5661 kg)

Section 3.

PM and Driver's Daily Inspection Forms

Part Number	Description
1803260	**Spray Adhesive** Dries clear with superior bonding strength. For permanent or repositionable applications. Resists water, humidity, and heat. Used for attaching cloth, carpeting, sound insulation, and floor coverings.
1803261	**Steel And Aluminum Epoxy** Grey epoxy adhesives for metals, concrete, and many plastics. When cured, can be drilled, sanded, threaded, or filed. Resistant to fuels and solvents. Fills gaps and bonds trim. Use on casting cracks and holes, auto trim, and ornaments.
1803262	**Loctite Weld - An Alternative To Welding** A 15-minute, 2-part adhesive and filler system that eliminates the need for welding or brazing. Once cured, it can be drilled, sanded, filed, or painted. Use on aluminum, steel, brass, bronze, casings, stampings, etc. Over 3000 psi shear strength.
1803263	**Loctite Weld Stix** Similar to Loctite Weld only in pre-measured ribbons. Sets in 5 minutes and cures fully in 1 hour. Fills gaps to 2" (50 mm) and is ideal for under water applications. Use on aluminum, steel, iron, wood, glass, masonry, ceramic, gas tanks, oil pans, and most plastics.

Cleaners

886397	**Penetrating Oil** An easy-to-use penetrating oil that cuts rust, paint, and grease and is effective on hot surfaces. Saves time, labor, and broken parts; contains Moly.
1800330	**Degreaser** This easy-to-use degreaser is water soluble, safe for paint, and does not rust.
1802522	**Brake Cleaner** This brake cleaner provides fast, complete cleaning, removing oil, dirt, and grease, leaving no film. It is non-flammable and can be used on brake parts, and electrical and ignition accessories. An effective, thorough, safe, and economical parts cleaner.
1803264 - 4 oz.; 1803265 - 24 oz.; 1803266 - gal.	**Natural Blue™ Cleaner/Degreaser** General purpose, biodegradable, cleaner for removing grease, grime, oil, and mildew, food or other stains from any washable or metal surface. Non-toxic, non-corrosive, U.S.D.A.-authorized, contains no butyl. Dilutes with water. Great for pressure washers and steam cleaners. Also cleans engine parts, floors, porcelain and more.

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