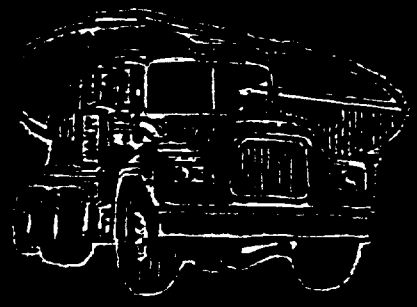
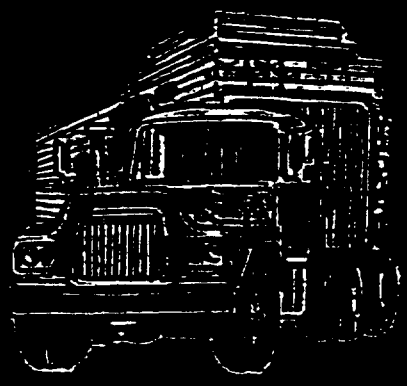
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PLAINTIFF'S EXHIBIT

MAC-13









HIGHWAY VEHICLE SERVICE MANUAL

Mack TRUCKS

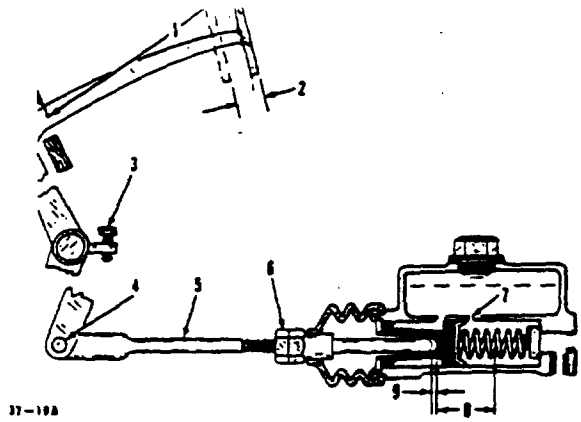


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TS442 10/67 10M
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TS 442



1. Pedal Height
2. Free Pedal
3. Adjusting Capscrew
4. Clevis Pin
5. Rod
6. Locknut
7. Compensating Port
8. Piston Travel
9. Pushrod-Piston Clearance

Figure 13-28. Pedal Adjustment Conventional Cab

System bleeding is performed in the usual way except that bleeder connection is made at the stop light switch tee, located on the pressure side of master cylinder.

1. Make certain that brake fluid reservoir is filled to proper level. Fill if necessary.

2. Remove stop light switch from the tee on pressure side of master cylinder. The master cylinder is located on the firewall inside vehicle cab. Take necessary precautions to protect cab floor mat from damage by brake fluid.

3. Attach pressure ball line into the 1/8 inch female pipe thread where the stop light switch was removed and open pressure ball valve.

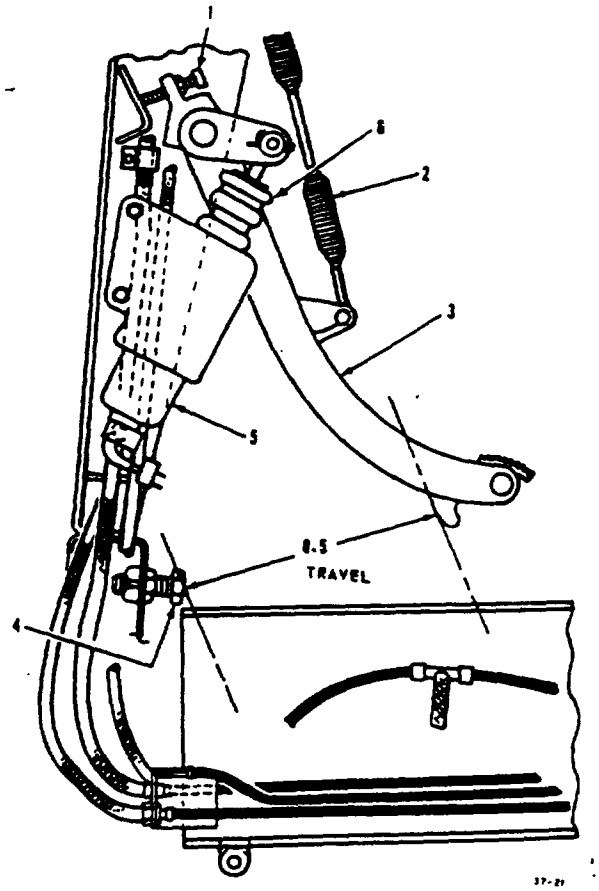
NOTE

To satisfactorily bleed system, the brake pedal must be fully depressed after the pressure ball is attached and valve opened. This closes ports in master cylinder and allows fluid to fill brake lines instead of reservoir only.

4. After bleeding all brake lines, close pressure ball valve and carefully release brake pedal. Remove pressure ball.

5. Reinstall stop light switch.

Pedal adjustment, see Figure 13-29, is controlled by stop bolt (1). Total travel of



1. Stop Bolt
2. Return Spring
3. Pedal
4. Pedal Stop Bolt
5. Master Cylinder
6. Boot

Figure 13-29. Pedal Adjustment Tilt Cab

pedal (3) is nominally 8.5 inches, with stroke limited by pedal stop bolt (4). Adjust stop bolt (1) to provide 0.12 free pedal. At all times ascertain that master cylinder (5) has correct fluid level. Boot (6) is moved upward for this inspection and add, or reservoir fill, is at the piston push rod opening. Spring (2) returns pedal to unapplied position.

Type F Brake

Disassembly and Assembly

1. Remove front wheels and drums.

2. Remove retraction springs and hold-down "C" washers and lift shoes off the backing plate. Do not lose the spring anti-rattle washers, located under each shoe web on the cam stud.

3. To remove wheel cylinders, remove connector tube nuts, anchor bolts and mounting screws. Mark connector tube ports on

each wheel cylinder to avoid errors at assembly. If manifold tubing is installed incorrectly, difficult bleeding may be experienced.

4. Check fit of concentric-ground linings against the fresh drum surface.

NOTE

Every reline should have a fresh drum surface. If drums do not require turning, the preferred method is to take a very light grind on a lathe to remove old lining residue and freshen the surface. The surface can also be renewed by dressing it with fine emery cloth or steel wool.

5. Make sure backing plate and wheel cylinder bolts are tight. Remember that, while upper and lower wheel cylinders are the same, those for right-hand and left-hand brakes have opposite castings and must not be interchanged. The cylinder bore must face in the direction of forward rotation.

6. Install shoes, locating each retraction spring so that its long shank is connected into the heel of the shoe.

7. Install drums and wheels.

8. Check master cylinder for correct fluid level. Add fluid if required.

Adjustment

1. Depress brake pedal several times to center the shoes in drums. See Figure 13-30.

2. As shown in Figure 13-30, place a wrench on cam and shoe guide stud (1) or (2) to adjust one shoe. Rotate wrench in direction of FORWARD wheel rotation to decrease lining-to-drum clearance. Reduce clearance until lining drags on drum.

3. Rotate wrench in opposite direction, to increase clearance, until drag is relieved. Then continue to back off approximately 1/8 turn for running clearance.

4. Place wrench on opposite cam and shoe guide stud (1) or (2) to adjust second shoe. Repeat steps 2 and 3.

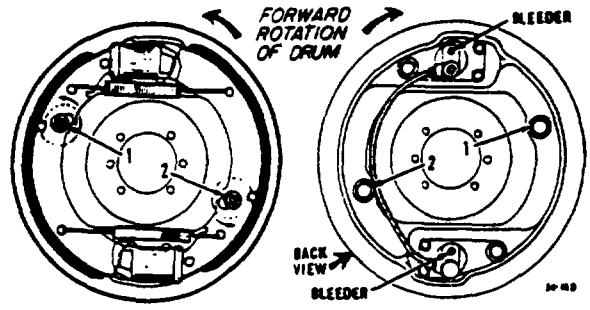


Figure 13-30. Outboard and Inboard Views of Left Front "F" Brake

Type FR-2 Brake

Disassembly and Assembly

1. Remove rear wheels and drums. It may be necessary to back off the adjustment star wheels.

2. Remove retraction springs by sliding looped ends off pins.

3. Remove hold-down lockwires, castellated nuts and plain washers, then lift off shoes.

4. Remove shoe-heel anchor pins; they should pull out of supports easily.

5. Remove star wheel lock springs by removing the attaching screw from each spring.

6. Thread each adjusting screw out from the shoe side of its support. Lift star wheels out of slots.

7. When removing wheel cylinders, mark tube ports on wheel cylinders to avoid an assembly error which might result in difficult bleeding operations.

8. Check fit of the newly lined concentric-ground shoes against the fresh drum surface.

NOTE

Every reline should have a fresh drum surface. If drums did not require turning, the preferred method is to take a very light grind on a lathe to remove old lining residue and freshen the surface. The surface can also be renewed by dressing it with fine emery cloth or steel wool.

9. Make sure backing plate is tight on the axle flange.

10. Insert star wheel in anchor support, thread in adjusting screw and install star wheel lock spring (each anchor support).

11. Install each wheel cylinder so that the longer end, measured from hydraulic port to end of cylinder, faces the shoe toe and adjustment slot.

12. Install each shoe with its toe (identified by cut-away portion of web) positioned next to adjusting screw and star wheel.

13. Install hold-down plain washer and castellated nut at each shoe. Tighten each nut fingertight, then back off 1/4 to 1/3 turn.

14. Install retractor springs.

15. Install drums and wheels.

16. Check master cylinder for correct fluid level. Add fluid if required.

Adjustment. See Figure 13-31

1. Remove adjustment slot covers.

2. Insert clicker wrench or screwdriver into slot (1) or (2), see Figure 13-31, to contact star wheel. Rotate wheel toward axle to decrease clearance until lining drags on drum.

3. Rotate star wheel in the opposite direction until drag is relieved. Operate the brake pedal several times to center the shoes; then check adjustments. Provide running clearance after drag is relieved, by additionally backing off the adjustments five notches for new lining or three notches for worn lining.

4. Repeat steps 2 and 3 on second shoe.

5. Replace adjustment slot covers.

Type FR Brake

Disassembly and Assembly

1. Remove rear wheels and drums. It may be necessary to back off the brake adjustment.

2. Remove retraction springs.

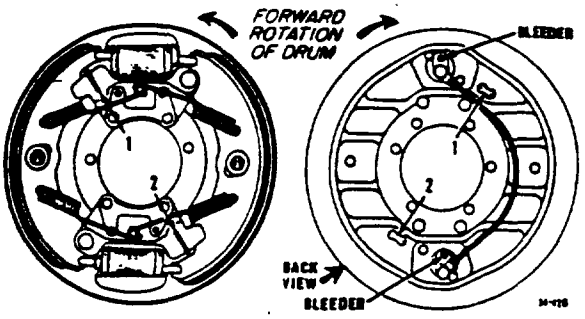


Figure 13-31. Outboard and Inboard Views of Left Rear "FR2" Brake

3. Remove hold-down nut, lockwasher and plain washer at each shoe and remove the shoes.

4. On each shoe, rotate the adjusting worm (forward rotation) until the adjusting screw is threaded free of the worm wheel and shoe. Pry out the worm retainer snap ring to free the remaining parts; that is, the thrust washers, sleeve, worm and worm wheel.

5. To remove a wheel cylinder, disconnect hydraulic tube nut and loosen anchor block nuts. Mark tubing ports on wheel cylinders to avoid an assembly error which might cause difficult bleeding should the manifold tubing be installed in the wrong ports. Take care not to lose spring washers installed on the two locating lugs on each cylinder.

6. Check fit of the new concentric ground lined shoes against the fresh drum surface.

NOTE

Every reline should have a fresh drum surface. If drums did not require turning, the preferred method is to take a very light grind on a lathe to remove old lining residue and freshen the surface. The surface can also be renewed by dressing it with fine emery cloth or steel wool.

7. Make sure each backing plate is tight on the axle flange.

8. If wheel cylinders were removed, make sure that all parts are replaced in correct locations. A spring washer should be installed on each cylinder locating lug, against the cylinder and between it and the cylinder cover straps and anchor block. Each cyl-

inder should be oriented so that the long stroke side (greater length from inlet port to end of casting) faces the adjustment slot in the backing plate and the shoe toe. Assemble the cylinder, cover, and anchor block and mount these parts as a unit.

Torque anchor-block locknuts, as follows:

5/8 x 18 . . . . .105 to 130 lb. ft.
3/4 x 16 . . . . .175 to 220 lb. ft.

9. On each shoe, place adjuster worm in its sleeve and install adjuster parts in the shoe web, one thrust washer at each end of the worm, retainer snap ring on the opposite side of the web from the backing plate. Start the adjuster screw into the worm wheel and rotate the worm wheel (reverse direction) to thread the screw into the shoe web.

10. Install shoes so that adjusting worm in shoe toe is accessible through adjustment slot in backing plate. Install and tighten hold-down bolts, washers, and nuts and connect retraction springs.

11. Install drums and wheels. Lubricate and adjust wheel bearings.

12. Check master cylinder for correct fluid level. Add fluid if required.

Adjustment. See Figure 13-32

1. Remove adjustment slot covers.

2. Insert Allen wrench in adjustment slot (1) or (2), see Figure 13-32, to contact shoe adjusting worm. Rotate wrench in the direction of forward wheel rotation until lining drags on drum.

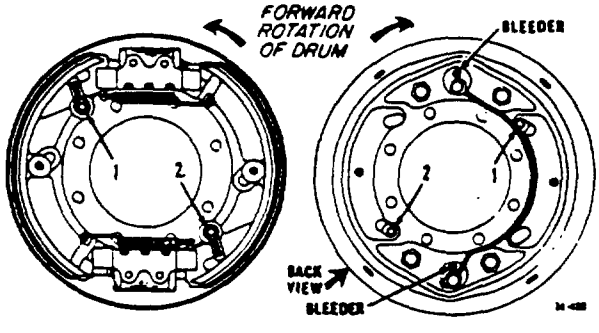


Figure 13-32. Outboard and Inboard Views of Left Rear "FR" Brake

3. Rotate wrench in opposite direction, to increase clearance, until drag is relieved. Then rotate adjustment one additional turn (two turns for new linings) to provide working clearance.

4. Repeat steps 2 and 3 on the second shoe.

5. Replace adjustment slot covers.

WHEEL CYLINDERS

CAUTION

To insure cleanliness, never service wheel cylinders without removing them from the vehicle.

Removal and Installation

1. Clean brake line connection thoroughly.

2. Disconnect brake line and install a clean rubber or wooden plug in end of tubing.

3. Protect brake linings from brake fluid and remove cylinder. If cylinder is scored, replacement by a new cylinder is preferable to honing the old one.

4. Reverse removal procedure to install cylinder.

NOTE

Do not assemble cylinder parts dry. Coat parts and inside of cylinder bore with clean brake fluid before assembly.

5. Bleed cylinder until a solid stream of fluid, free of air bubbles, is obtained.

WEDGE ACTUATED BRAKES

As currently employed, these double-actuated brakes are used in straight air or air over hydraulic systems. Mountings are either spider or backing plate, with air chambers or hydraulic cylinders serving as power units. Auxiliary spring brakes may also be used in conjunction with these assemblies. The assembly shown in Figure 13-33 is a straight air, spider mounted unit, with the auxiliary spring brake sectioned.

Wedge actuated brakes differ from the conventional type in that they do not utilize slack adjusters and brake camshafts for application of linings to brake drums. Air, or hydraulic pressure, forces a wedge between plungers, causing the plungers to spread

2. Replace springs if cracked or defective. Check all springs on a spring tester. Replace all that do not meet specifications.

3. Replace thrust washer if worn, bent or defective.

4. Replace worn release levers, springs and ball seats. Check levers with a straightedge and 11/16 inch ball (17-T-1126), see Figure 5-3, and if bent so that dimension (1) is more than 11/32 inch when measured at a point where distance (2) is 2-1/2 inch, replace the lever.

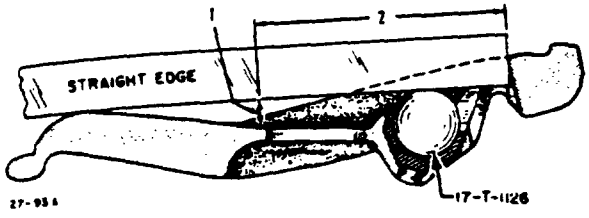


Figure 5-3. Checking Release Lever for Bend

5. If pressure plate is scored, heat checked, or warped more than 0.020 inch, it must be replaced or refaced. Remove only enough metal to obtain a smooth flat surface. Finish with a light cut and polish with emery cloth. When thickness (1) becomes less than the worn limit given in specifications, the plate must be replaced. Measure at outer spring pocket, see Figure 5-4. Measuring at inner pocket is not accurate, if pressure plate is dished. If cleft lugs are worn, cracked or distorted, replace the plate. Replace eyebolts if they are distorted, have worn threads or keyways.

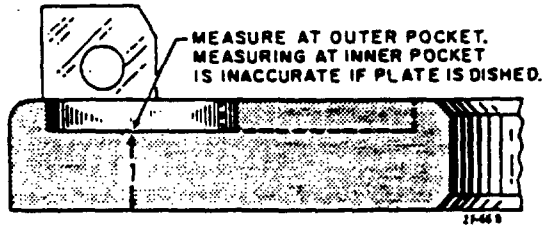


Figure 5-4. Pressure Plate Thickness Dimension

6. If flywheel is warped or heat checked and surface is refinished, maintain the 1.594 inch dimension between disc surface and bolting face for proper release lever adjustment. See Figure 5-5. No more than .070 inch maximum may be removed by grinding.

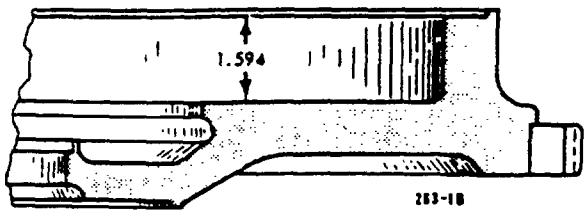


Figure 5-5. Flywheel Rubbing Surface-to-Clutch Cover Bolting Surface Dimension

7. Inspect driven disc assembly for cracks, loose rivets, worn splines, warped or dished condition. If cracked, or hub splines are worn excessively, replace disc assembly. If facings are worn down nearly even with countersunk facing-retaining rivet heads and provided assembly is in otherwise good condition, it may be rebuilt.

8. Pilot bearing should be removed, cleaned and checked each time clutch or engine is removed. Discard bearing if balls or races are chipped or scored. After inspection, hand-pack bearing with recommended clutch pilot bearing grease and install bearing in flywheel. Tap into place with shielded side toward clutch and snap ring seated in counterbore.

NOTE

Old bearings without a snap ring cannot be used in new through-bored flywheels.

After bearing is properly installed, pack the cavity in back of the bearing with recommended clutch pilot grease.

NOTE

To prevent damage to the bearing seal when the transmission is assembled to the engine, the space occupied by the main driving pinion pilot must not be filled with grease. See Figure 5-6.

All current Mack-made engine flywheels have been manufactured by boring the clutch pilot bearing hole straight-through and counterboring a recess to provide proper positioning for the snap ring type pilot bearings now in use.

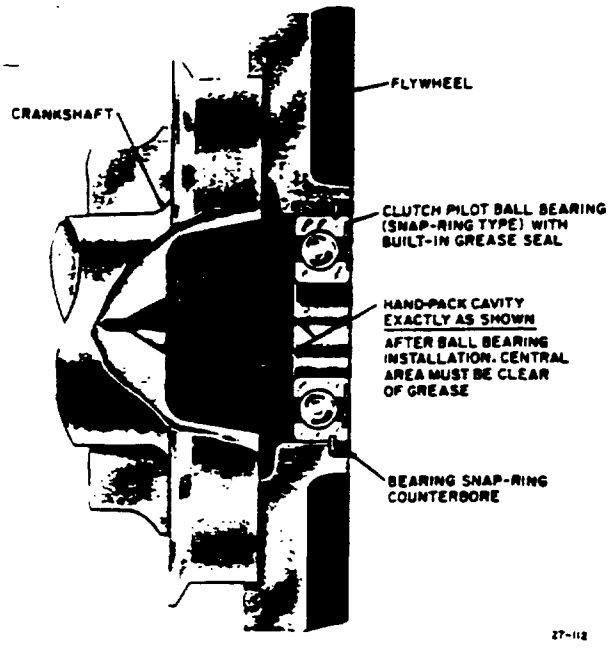


Figure 5-6. Cut-away View of Clutch Pilot Bearing Grease Reservoir Correctly Packed

CAUTION

Do not install a new snap ring bearing in an old flywheel without removing the snap ring and discarding. In old flywheels without the counterbore, the snap ring would position the bearing too far rearward, which would result in early bearing failure and considerable damage to costly components. Use only the recommended snap ring type bearings specified. These bearings will function without premature failure where slight misalignment exists between engine and transmission.

Before assembling the clutch, a positive wear check should be made to insure that it will provide maximum disc wear. This check will uncover any wear conditions that might prevent full release lever travel and allow corrections to be made before the clutch is assembled.

Place the pressure plate assembly and cover (without springs) into position as shown in Figure 5-7, making sure that shims of the correct thickness (.200) are inserted between cover and spacer (17-T-1763). Install each release lever and while pressing firmly on the fulcrum, measure distance (1) inboard end of lever is above cover.

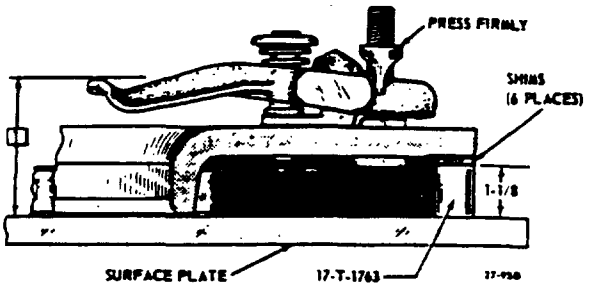


Figure 5-7. Wear Check

Correct height for the CL-28 Series, 3-9/32 inches, for the CL-40 Series, 3 inches.

Reassembly

1. Remove the shims used for the wear check. Lightly lubricate pivot ball bushing, fulcrum groove, eyebolt pin and inboard end of release lever with clutch lever grease.

2. Place the pressure plate on a face plate with the spring pockets of the pressure plate up. Place heat-insulating washers and the springs in the pressure plate spring pockets.

NOTE

If pressure plate was refaced, insert washers into the spring cups of a thickness equal to the metal removed from the pressure plate. Shellac the washers in place to facilitate retention.

3. Place the cover in position, align the springs in the pockets. Bottom the screws of the three spring retention tools into the threaded holes of the pressure plate and bring the tool nuts down snugly against the tool bracket. Tighten the tool nuts alternately, one turn at a time, guiding the pressure plate lugs into the clutch cover holes until the inside face of the cover is 1.125 inch from the face of the pressure plate. Special tool (17-T-1763), is used to facilitate obtaining this dimensions, see Figure 5-8.

4. Place the clutch release levers on the ball fulcrums and eyebolt shanks. Place the lever springs on the spring pins with the small diameter against the release levers.

assembled in their original positions. This is necessary in order not to disturb the dynamic balance of the clutch.

1. Equally space three steel blocks 3/8 inch thick, on bed of arbor or drill press.

2. Place clutch with pressure plate side down, on blocks. (This is done in order to raise clutch to permit disassembly).

3. Place a block of wood, such as a two by four, across cover plate in a position that does not interfere with tips of release levers, as shown in Figure 5-10. Compress clutch assembly slightly, removing lever adjusting screw locknuts.

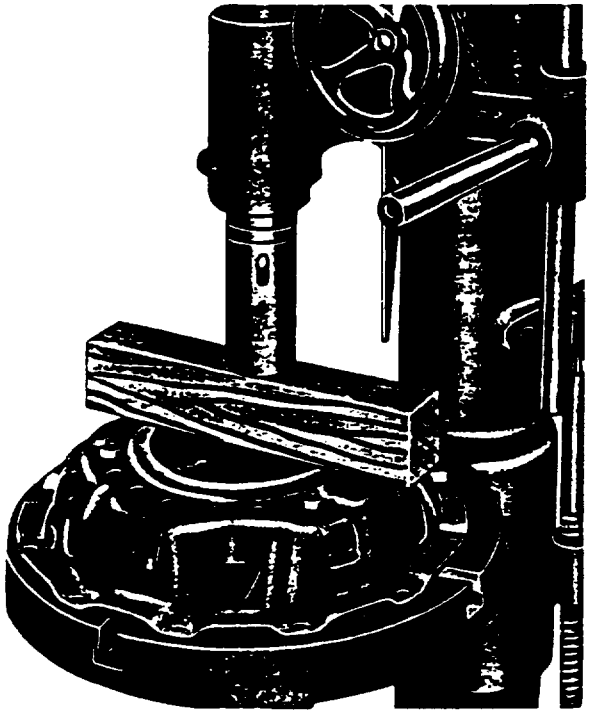


Figure 5-10. Compressing Clutch

4. Turn each lever adjusting screw down (clockwise), a few turns with a screwdriver, releasing spring tension a small amount. Repeat operation until all lever adjusting screws are entirely free of cover plate. Release remaining spring tension, and lift cover plate off pressure springs.

5. Pressure springs may now be removed. After extracting cotter pins and lever pins, remove release levers.

Inspection and Repair

Clean all parts thoroughly with a suitable safe solvent, then inspect carefully for excessive wear, distortion, or cracks as outlined below:

1. Check cover plate for distortion, excessive wear at indentations which register between drive bosses on pressure plate, and for stripped threads in holes accommodating release lever adjusting screws. If the above mentioned conditions are apparent, replacement of cover plate is required.

2. Replace springs if cracked or defective. Check all springs on a spring tester. Replace all that do not meet specifications.

3. Replace release levers that are badly worn on tips (this is an indication of a sticking release bearing), worn threads on lever adjusting screws and nuts, or where binding appears to be present, which retards free back and forth movement.

NOTE

Release levers are serviced as a subassembly only, and consist of lever, adjusting screw, roller, roller block, lever spring and spring retaining pin.

4. If pressure plate shows signs of scoring, excessive wear at lever pin holes, inside of drive bosses, heat checking, or if warped more than .020 inch, plate must be refaced or replaced. (When refacing pressure plate, remove only sufficient metal to obtain a smooth flat surface.)

NOTE

When pressure plate thickness becomes less than 1.141 inch, replacement is necessary.

5. If flywheel is warped or heat checked and surface is refinished, maintain the 1.188 inch dimension between disc surface and bolting face for proper release lever adjustment. No more than .070 inch maximum may be removed by grinding.

6. Inspect driven disc assembly for cracks, loose rivets, worn splines, warped or dished condition. If cracked, or hub splines are worn excessively, replace disc assembly.

If facings are worn down nearly even with countersunk, facing-retaining rivet heads and provided assembly is in otherwise good condition, it may be rebuilt.

7. Pilot bearing should be removed, cleaned and checked each time clutch or engine is removed. Discard bearing if balls or races are chipped or scored. After inspection, hand-pack bearing with clutch pilot bearing grease and install bearing in flywheel. Tap into place with shielded side toward clutch.

After bearing is properly installed, pack the entire cavity in back of the bearing with the same specified clutch pilot grease.

NOTE

To prevent damage to the bearing seal when the transmission is assembled to the engine, the space occupied by the main driving pinion pilot must not be filled with grease. See Figure 5-11.

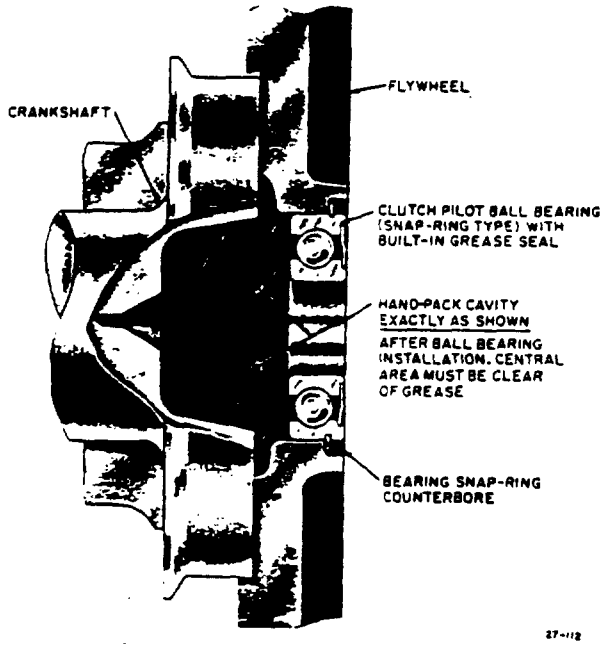


Figure 5-11. Cut-away View of Clutch Pilot Bearing Grease Reservoir Correctly Packed

Use only the recommended pilot bearings specified. These bearings will function without premature failure where slight misalignment exists between engine and transmission.

Reassembly

1. Mount release lever assemblies on pressure plate. Set pressure plate assembly on three equally spaced steel blocks 3/8 inch thick, on bed of arbor or drill press, plate side down.

2. Place pressure springs in position on pressure plate, as shown in Figure 5-12.

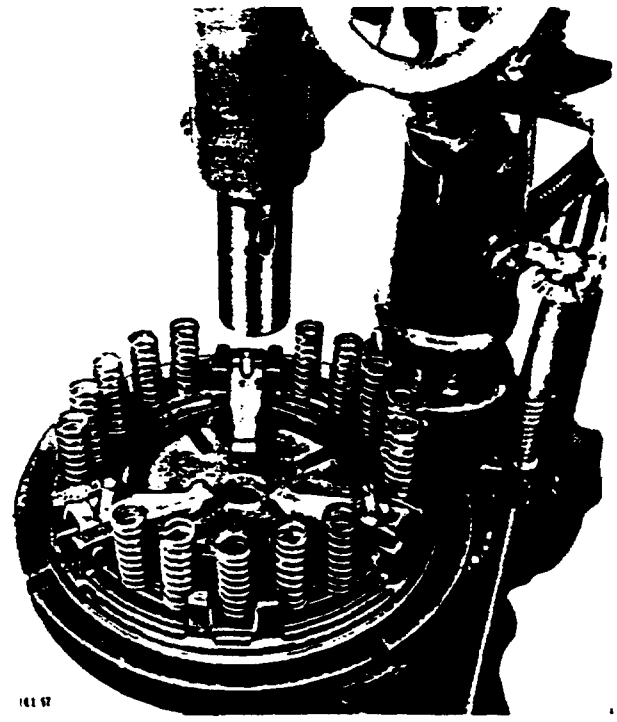


Figure 5-12. Assembling Clutch

3. Lay cover plate over springs, being sure that all springs are seated on bosses of pressure plate, and around indentations on inside of cover.

4. If pressure plate was refaced, it will be necessary at assembly, to add shims under each pressure spring equal to total metal removed.

5. Compress assembly slowly, aligning lever adjusting screws with threaded holes in cover plate. (The indentations inside cover, should enter the spaces between drive bosses on pressure plate freely.) With screwdriver, thread ends of adjusting screws into cover evenly, until screws protrude about 1/2 inch. Hold assembly compressed, while placing locknuts in position, but do not tighten.

6. To facilitate installation on flywheel, place wood blocks approximately 3/8 inch thick, between the tops of release levers and inner rim of cover plate. (Be sure these stay in position as all tension is released).

7. Insert the three spring retention tools (17-T-1766), through cover and bottom in tapped holes in pressure plate (center hole of each five series in cover). With pres-

2. While holding spring retention tool screws, back off tool nuts alternately, making one turn at a time. When spring is entirely relieved, back out the three tool screws.

3. Remove clutch cover and springs. If heat-insulating washers are removed from pressure plate spring pockets, retain them for reassembly. The eyebolts need not be removed, unless inspection reveals distortion or loose fit on pins.

Inspection and Repair

Remove all traces of dirt and oil with a suitable safe solvent. Inspect parts carefully for cracks, distortion or excessive wear as follows:

1. If cover is cracked or distorted, replace. Tack-weld loose spring cups (on covers having this construction) replace worn or loose ball-fulcrums. Replace loose or bent release lever spring pins.

2. Replace springs if cracked or defective. Check all springs on a spring tester. Replace all that do not meet specifications.

3. Replace thrust washer if worn, bent or defective.

4. Replace worn release levers, springs and ball seats. Check levers with a straightedge and 11/16 inch ball (17-T-1126) as illustrated, in Figure 5-14 and if bent so that dimension (1) is more 11/32 inch when measured at a point where distance (2) is 2-1/2 inch, replace the lever.

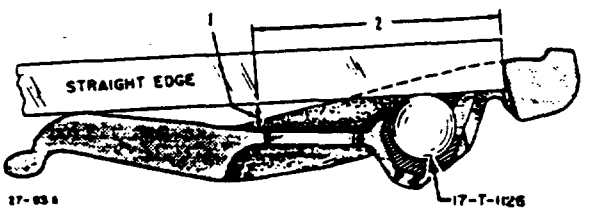


Figure 5-14. Checking Release Lever for Bend

5. If pressure and intermediate plates are scored, heat checked, or warped more than 0.020 inch, they must be replaced or refaced. Remove only enough metal to obtain a smooth flat surface. Finish with a light cut and polish with emery cloth. When thickness (1) becomes less than the worn limit given in specifications, the plate must be replaced. Measure at outer spring pocket as shown in Figure 5-15. Measuring at inner pocket is not accurate if pressure plate is dished. If cleft lugs are worn, cracked or distorted, replace the plate. The intermediate plate features a double set of drive slots for increased service life. At clutch installations after rebuild, it is recommended that the set with less wear be used. Replace eyebolts if they are distorted, have worn threads or keyways.

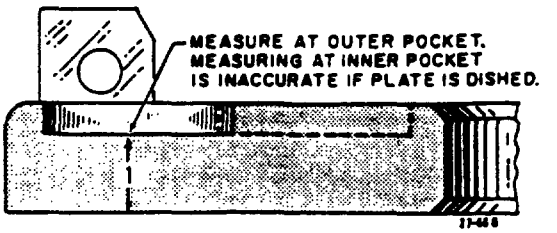


Figure 5-15. Pressure Plate Thickness Dimension

6. If flywheel is warped or heat checked and surface is refinished, maintain the 2.797 inch dimension between disc surface and bolting face for proper release lever adjustment. See Figure 5-16. No more than .070 inch maximum may be removed by grinding.

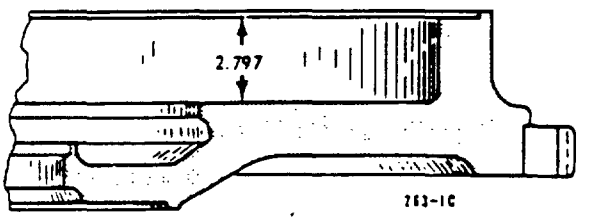


Figure 5-16. Flywheel Rubbing Surface-to-Clutch Cover Bolting Surface Dimension

Intermediate plate drive pins should be inspected for abnormal wear.

When pins have been removed to permit flywheel machining, or require replacement, squareness between flywheel friction and pin drive faces must be maintained at installation. A positioning tool will assist in establishing necessary alignment.

Suitable for this purpose, will be a slotted steel block 4 inches long, 2-1/2 inches wide and 1-1/2 inches thick. One 2-1/2 inches x 4 inches face should be ground for maximum flatness, as it will constitute the major working surface. A 3/16 inch x 45° chamfer along all edges of this face will tend to prevent burrs that would affect accuracy. See Figure 5-17.

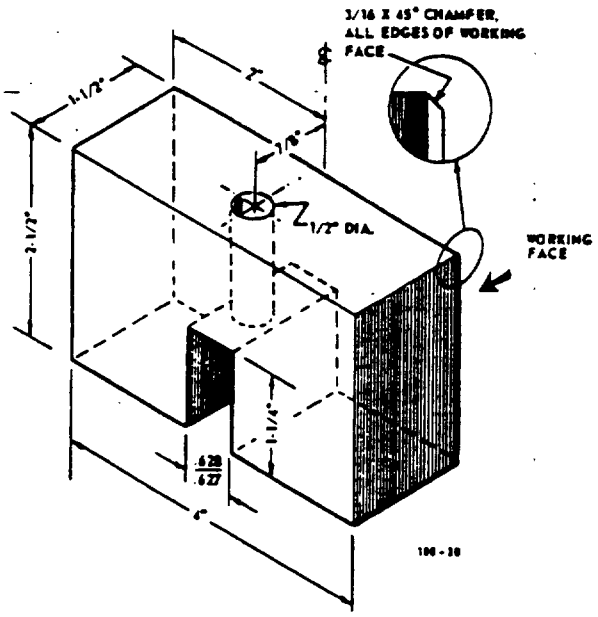


Figure 5-17. Drive Pin Positioning Tool

Midway between ends of the 4 inch length, a .628/.627 inch wide slot 1-1/4 inch deep should be machined through the 1-1/2 inch thickness. The slot must be exactly square with the ground face for it will determine flywheel to drive pin head alignment. A half -inch drift pin clearance hole, drilled from the side opposite, and intersecting with, the slot will complete the tool. Hole centerline should be 7/8 inch from the ground face, so that driving force will be centered over the head. Magnetizing the block will minimize movement during driving and lessen possibility of marring flywheel face.

In use, the threaded portion of the pin is inserted in the flywheel hole. The positioning tool slot is placed over the drive head, with the ground surface held flat against the flywheel friction face. The pin is then driven until fully seated.

7. Inspect driven disc assembly for cracks, loose rivets, worn splines, warped or dished condition. If cracked, or hub splines are worn excessively, replace disc assembly. If facings are worn down nearly even with countersunk facing-retaining rivet heads and assembly is in otherwise good condition, it may be rebuilt.

8. Pilot bearing should be removed, cleaned and checked each time clutch or engine is removed. Discard bearing if balls or races are chipped or scored. After inspection, hand-pack bearing with clutch pilot bearing grease and install bearing in flywheel. Tap into place with shielded side toward clutch and snap ring seated in counterbore. Old bearings without a snap ring cannot be used in new through-bored flywheels.

After bearing is properly installed, pack the entire cavity in back of the bearing with the same specified clutch pilot grease.

NOTE

To prevent damage to the bearing seal when the transmission is assembled to the engine, the space occupied by the main driving pinion pilot must not be filled with grease. See Figure 5-18.

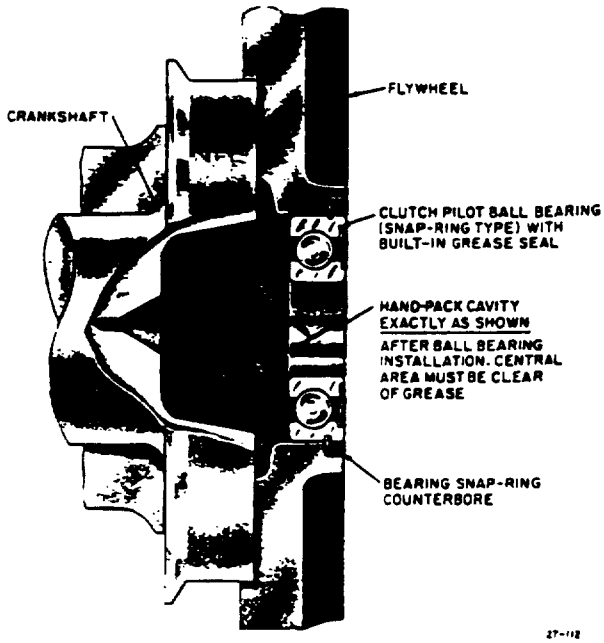


Figure 5-18. Cut-away View of Clutch Pilot Bearing Grease Reservoir Correctly Packed

All current Mack-made engine flywheels have been manufactured by boring the clutch pilot bearing hole straight-through and counterboring a recess to provide proper positioning for the snap ring type pilot bearings now in use.

CAUTION

Do not install a new snap ring bearing in an old flywheel without removing the snap ring and discarding. In old flywheels without the counterbore, the snap ring would position the bearing too far rearward, which would result in

early bearing failure and considerable damage to costly components. Use only the recommended snap ring type bearings specified. These bearings will function without premature failure where slight misalignment exists between engine and transmission.

Before assembling the clutch, a positive wear check should be made to insure that it will provide maximum disc wear. This check will uncover any interference that might prevent full release lever travel and allow corrections to be made before the clutch is assembled.

Place the pressure plate assembly and cover (without springs) into position as shown in Figure 5-19, making sure that shims of the correct thickness (.250) are inserted between cover and spacer (17-T-1763). Install each release lever and while pressing firmly on the fulcrum, measure distance (1) inboard end of lever is raised above cover. Correct height is 3-11/32 inches. Remove any interference that prevents obtaining this dimension.

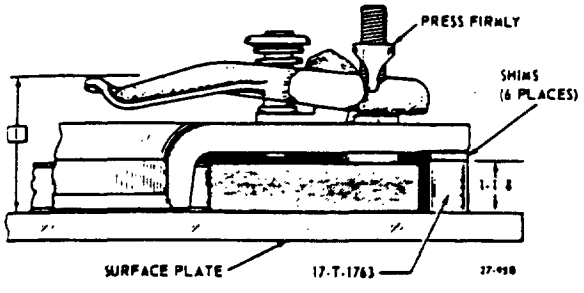


Figure 5-19. Wear Check

Reassembly

1. Remove the shims used for the wear check. Lightly lubricate pivot ball bushing, fulcrum groove, eyebolt pin and inboard end of release lever with clutch lever grease.

2. Place the pressure plate on a surface plate with the spring pockets of the pressure plate up. Place heat-insulating washers and the springs in the pressure plate spring pockets.

NOTE

If pressure plate and intermediate plate were refaced, insert washers into the spring cups of a thickness equal to the metal removed from the pressure plate and intermediate plate. Shellac the washers in place to facilitate retention.

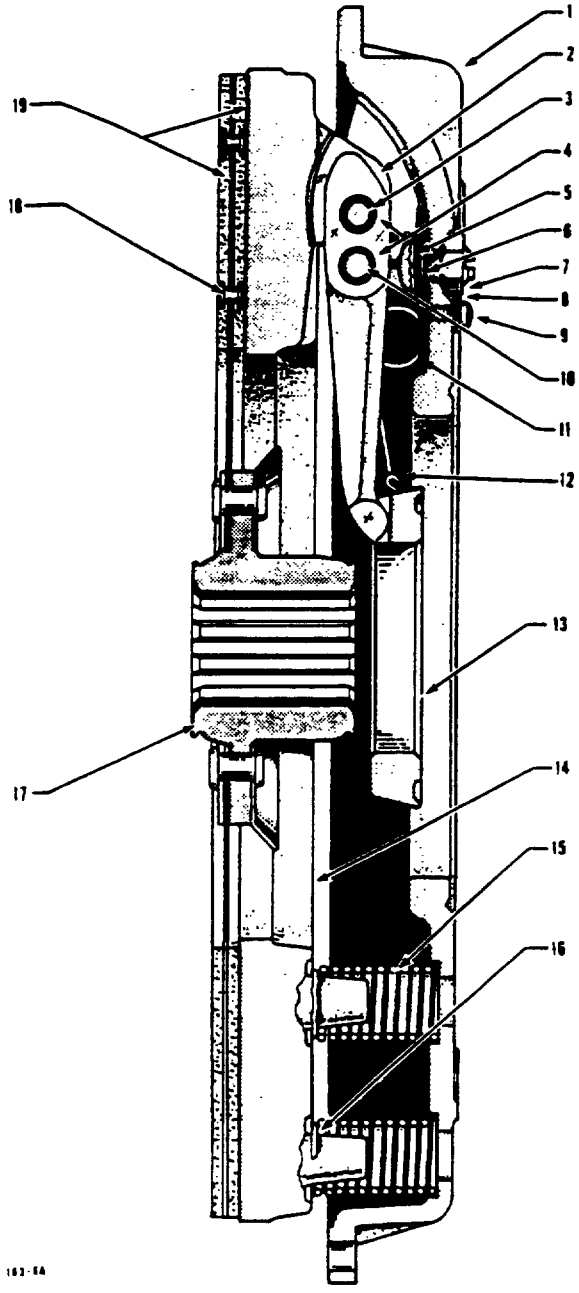
3. Place the cover in position, align the springs in the pockets. Bottom the screws of the three spring retention tools into the threaded holes of the pressure plate and bring the tool nuts down snugly against the tool bracket. Tighten the tool nuts alternately, one turn at a time, guiding the pressure plate lugs into the clutch cover holes until the inside face of the cover is 1.1875 inch from the face of the pressure plate. Special tool (17-T-1763) and a 1/16 inch spacer (17-T-11337), is used to facilitate obtaining this dimension. See Figure 5-20.

NOTE

If the intermediate driving plate is worn or has been machined, the consequent reduction in thickness will produce the same effect as worn clutch discs when the clutch assembly is installed in a vehicle. In an extreme case, one-half the available release collar wear travel may be used up before the vehicle is put back into service.

To compensate for this condition, shims of appropriate thickness must be inserted between cover and spacers (17-T-1763) while the clutch is adjusted. Measure thickness of the intermediate driving plate which will be used with clutch being adjusted and compare with new thickness as shown in specifications. If plate is .010 inch or more below new thickness, secure shims equal in thickness to amount of metal removed and insert them between clutch cover and spacers (17-T-1763) at equally spaced intervals. See Figure 5-20.

4. Place the clutch release levers on the ball fulcrums and eyebolt shanks. Place the lever springs on the spring pins with the small diameter against the release levers. Place the spring washers in position, com-



1. Clutch Cover
2. Release Cover
3. Release Lever Pin
4. Needle Bearings
5. Release Lever Yoke
6. Yoke Leaf Spring
7. Lever Adjusting Nut
8. Adjusting Nut Lock Plate
9. Lock Plate Lock Screw
10. Yoke Clevis Pin
11. Double Torsion Anti-Rattle Spring
12. Thrust Washer Clamp
13. Lever Thrust Washer Ring
14. Pressure Plate
15. Helical, Main Spring
16. Heat Insulator Ring
17. Driven Disc Assembly
18. Facing Rivet
19. Driven Disc Facings

Figure 5-21. Sectional View of CL-58 Series Clutch

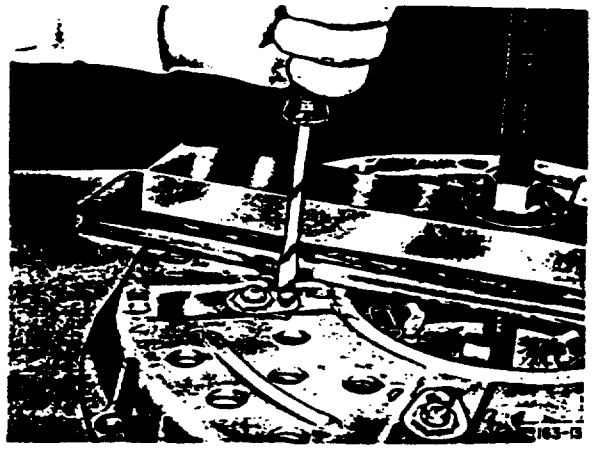


Figure 5-22. Removing Lever Adjusting Nut Lock Plates

main spring insulator washers from pressure plate bosses.

NOTE

Do not remove the six lever anti-rattle springs from the cover unless replacement is necessary.

4. Lay pressure plate on bench and with a soft metal drift, drive hardened lever pins out of pressure plate drive lugs to free release levers. With a pair of pliers, remove cotter pin from each lever yoke clevis pin and then press out each yoke clevis pin by hand.

NOTE

When removing levers from pressure plate drive lugs and lever yoke, be very careful not to lose any of the small uncaged needle rollers.

Inspection and Repair

Remove all traces of dirt and oil with a suitable safe solvent. Inspect parts carefully for cracks, distortion or excessive wear as follows:

1. Replace springs if cracked or defective. Check all springs on a spring tester. Replace all that do not meet specifications.

2. If pressure plate is scored, heat checked, or warped more than .025 inch, it must be replaced or refaced. Remove only enough metal to obtain a smooth flat surface. No more than .070 inch maximum may be removed by grinding.

3. Inspect clutch release lever tips and clevis pin holes for excessive wear. Make sure levers are not bent. Replace where necessary.

4. Inspect release lever yokes for condition of threads. Slight thread damage may be cleaned up with a three-cornered Swiss file. Replace lever yokes if clevis pin holes are elongated.

5. Check clevis pins and lever pins for wear. Replace if wear is excessive. Check lever slotted thrust washer ring for excessive wear. Replace if slots are excessively worn.

6. Check lever needle roller bearings for wear. If flats are such that rollers slide rather than roll, replace rollers.

7. Inspect driven disc assembly for cracks, loose rivets, worn splines, warped or dished condition. . If cracked, or hub splines are worn excessively, replace disc assembly.

If facings are worn down nearly even with countersunk facing-retaining rivet heads and provided assembly is in otherwise good condition, it may be rebuilt.

8. If flywheel is warped or heat checked and surface is refinished, maintain dimensions shown in Figure 5-23 between disc surface and bolting face for proper release lever adjustment. No more than .070 inch maximum may be removed by grinding.

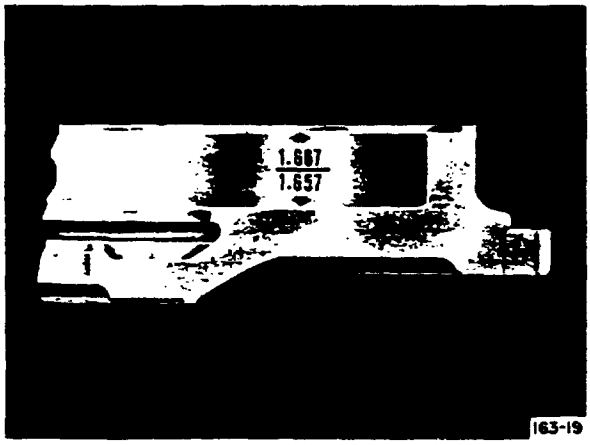


Figure 5-23. Flywheel Rubbing Surface-to-Clutch Cover Bolting Surface Dimension

9. Pilot bearing should be removed, cleaned and checked each time clutch or engine is removed. Discard bearing if balls or races are chipped or scored. After inspection, hand-pack bearing with clutch pilot bearing grease specified and install bearing in flywheel. Tap into place with shielded side toward clutch and snap ring seated in counterbore.

After bearing is properly installed, pack the entire cavity in back of the bearing with the same specified clutch pilot grease.

NOTE

To prevent damage to the bearing seal when the transmission is assembled to the engine, the space occupied by the main driving pinion pilot must not be filled with grease. See Figure 5-24.

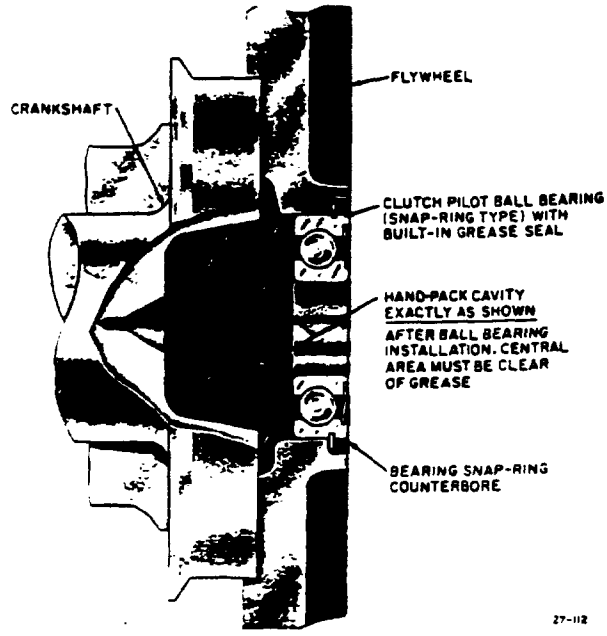


Figure 5-24. Cut-away View of Clutch Pilot Bearing Grease Reservoir Correctly Packed

Use only the recommended snap ring type bearings. These bearings will function without premature failure where slight misalignment exists between engine and transmission.

Reassembly

1. Apply a light coat of clutch lever grease on the loose needle bearings and install rollers in each pin hole of levers. When bearings are installed, apply additional grease to each assembled bearing group.

2. Spread a thin coat of lever grease on the two rubbing flats of each lever and on all yoke rubbing surfaces. Center lever

yoke clevis pin holes over lever inner bearing-lined pin holes and carefully insert clevis pin through the aligned holes. Lock pin in position with cotter pin.

3. Apply a thin even coat of lever grease on all pressure plate drive lug rubbing surfaces. Carefully position lever assembly between drive lugs. Align pin holes in drive lugs with assembled needle rollers and push pin through lugs and bearing opening.

NOTE

Remove all excess grease.

4. Position clutch pressure plate and lever assembly in clutch overhaul machine, arbor press, drill press or whatever clamping arrangement being used. After centering thereon, install heat insulator washers on the spring heat grids, then main springs in their correct specified positions.

NOTE

Except as specified below, install BLACK or COLORLESS main springs on all locating bosses remaining without springs.

CL-58, install an all RED spring on each No. 1 and No. 3 spring boss. CL-581, install an all WHITE spring on each No. 4 and 5 spring boss.

CL-582, install an all WHITE spring on each No. 6 spring locating boss. See Figure 5-25. Install inverted yoke springs on yoke stems.

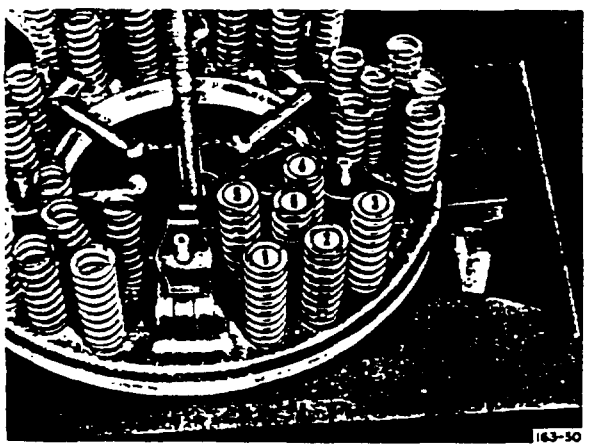


Figure 5-25. Main Spring Arrangement In One of the Six Identical Pressure Plate Segments

NOTE

Make sure leaf springs are inverted on yoke stems and parallel to levers so that their upturned ends will bear against under side of cover when assembled, thus spring-loading each yoke.

5. Position yokes vertically. Position clutch cover over assembly. After centering all main springs in their counterbored seats in cover, set up clamping arrangement and compress springs slowly. Make sure ALL yoke stems are in alignment, then continue to compress springs until all six stems are sticking out of their cover holes.

6. Apply a very thin coat of clutch lever grease to adjusting nut spherical seats in cover. Then install adjusting nuts. Clamping pressure on clutch cover may now be relieved.

7. Lay engine flywheel on bench. Make up four spacers exactly .402 inch thick each and arrange them on flywheel rubbing surface. The spacer thickness of .402 inch corresponds to the mean driven disc assembly thickness under load. See Figure 5-26. Then without disturbing the .402 inch spacer arrangement, position clutch in flywheel counterbore. Install clutch in flywheel counterbore. Install clutch cover-to-flywheel capscrews with their lock washers. Tighten capscrews a turn or two at a time, in rotation, so cover will not be cocked and forced into flywheel pilot by the tightening of the screws.

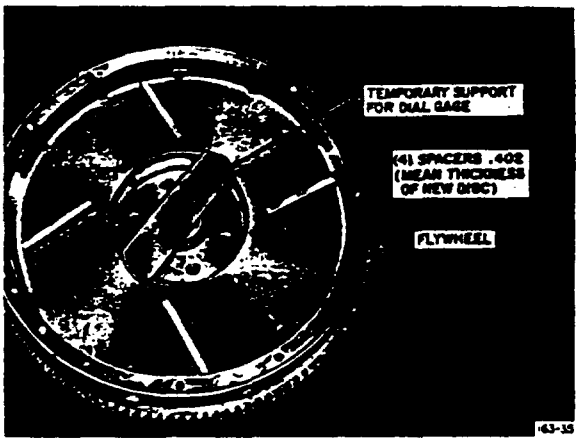


Figure 5-26. Clutch Lever Adjustment Spacer Arrangement in Flywheel

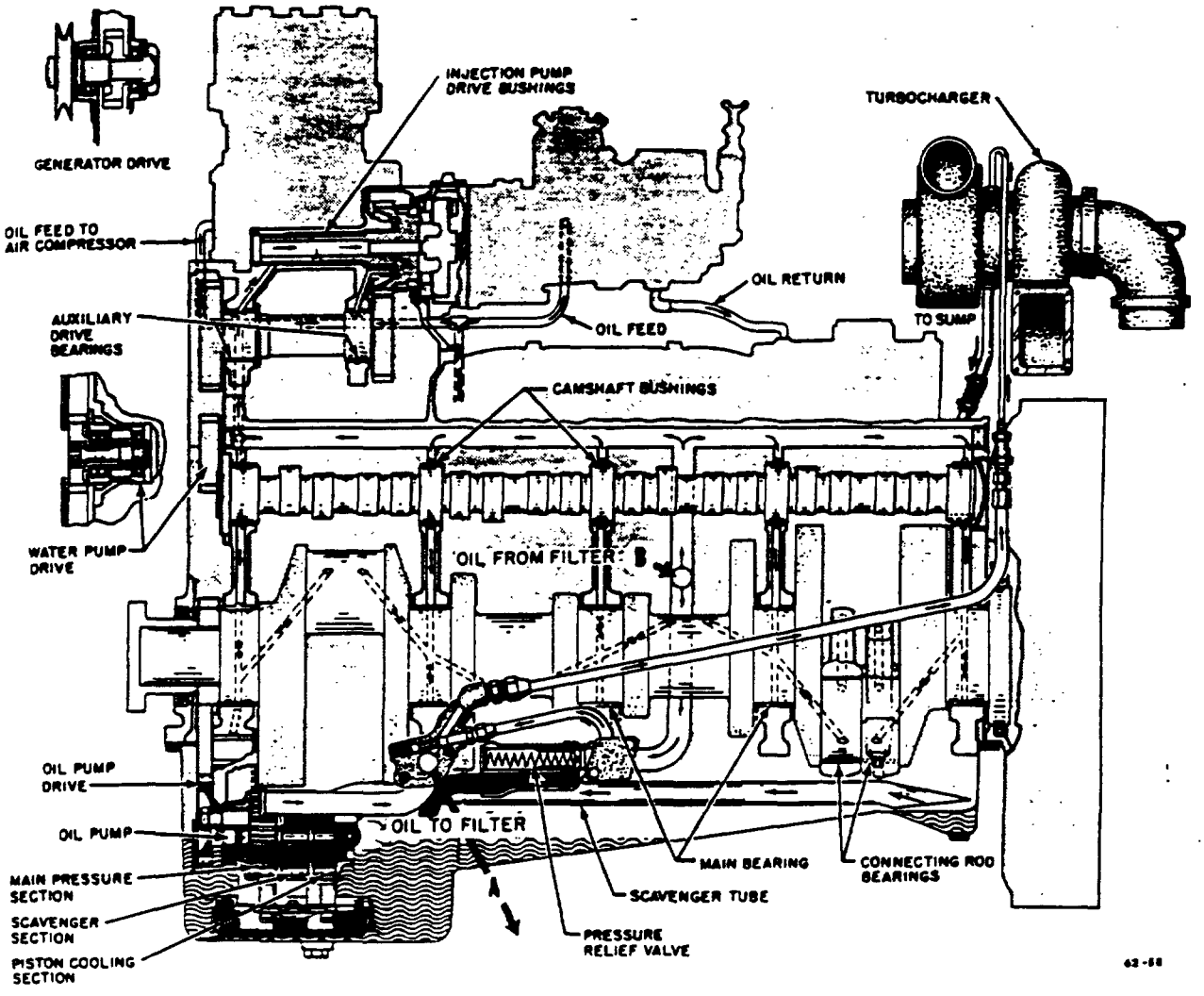


Figure 3-184. Lubrication System END T864 Series

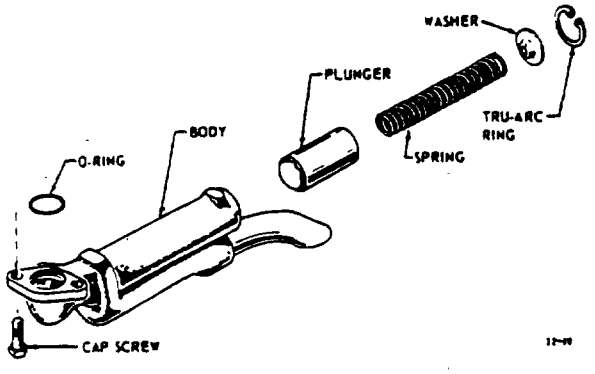


Figure 3-185. Pressure Relief Valve Assembly END864 Series

Installation

Position a new O-ring on the oil pressure relief valve housing flange and install housing onto cylinder block. See Figure 3-186. Position discharge spout away from center of cylinder block then torque capscrews. This will provide sufficient clearance between connecting rod and oil pressure relief valve housing assembly.

OIL PAN EXCEPT END475 SERIES

Inspection

Inspect oil pan for dents, cracks and condition of flange, bolt holes for elongation and baffle for security. Inspect drain hole for condition of threads.

Installation

Position gasket on oil pan and position oil pan on cylinder block. Install and tighten oil pan retaining capscrews evenly to prevent oil leakage.

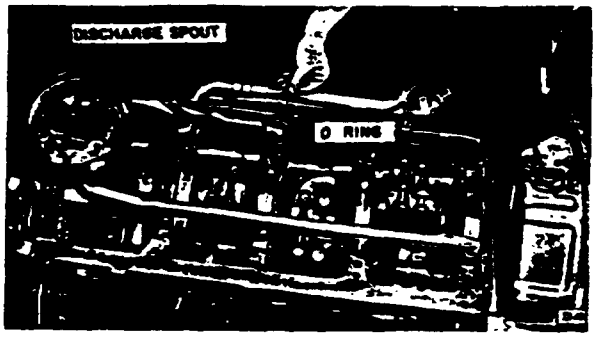


Figure 3-186. Oil Pressure Relief Valve Installed END864 Series

OIL PAN END475 SERIES

Description

Oil pan is a machined casting and is provided with a sheet metal cylindrical oil screen. The oil screen has a crimped section for proper positioning in the oil pan.

Inspection

Inspect oil pan for dents, cracks, condition of flanges, bolt holes for elongation and condition of threads. Check oil pressure relief valve mounting pad for flatness and condition of threaded holes. Check oil passages to ensure they are not obstructed. Check oil screen assembly for holes, cracks and condition of welds. Check screen cover section to ensure pick up oil tube hole is not damaged and mounting surface is clean.

Installation

Position spacer on stud in center of oil pan. Install screen assembly over stud and locate crimped section of screen on lug to properly position cover for oil pick up tube. Install lockwasher and nut to secure screen assembly. Position oil baffle in pan and secure in place with capscrews and lockwashers. Position new gasket on oil pan flange and new O-ring on pressure relief valve tube. Install new felt washer on oil pick up tube. Position oil pan on crankcase and secure with capscrews. Torque capscrews evenly to prevent oil leakage.

CYLINDER HEAD STUDS

Inspection

Check cylinder head studs for condition of threads, and straightness of shank.

Installation

Apply a light coat of lubricating oil to the threads of the studs and install them in the cylinder block finger tight.

NOTE

END475 cylinder studs are installed with the shoulder fully seated.

Locate the longer studs at the corners on the push rod hole side of the cylinder block.

NOTE

On END864 the longer studs are positioned at the rocker arm shaft bracket locations.

CYLINDER HEAD INSTALLATION

Place cylinder head gasket over studs on cylinder block. Ensure that all passages are open and not blocked by gasket. Ensure O-rings are properly positioned. Cylinder gaskets are precoated, no soaking, coating or sealants are required. Use gaskets as received.

NOTE

If desired, apply a light coating of Permatex to the entire outer edge of the gasket to seal the corbestos layer which may be affected by lube oil or fuel.

Position cylinder head over studs and onto cylinder block. See Figure 3-187. Ensure no foreign material is in cylinder.

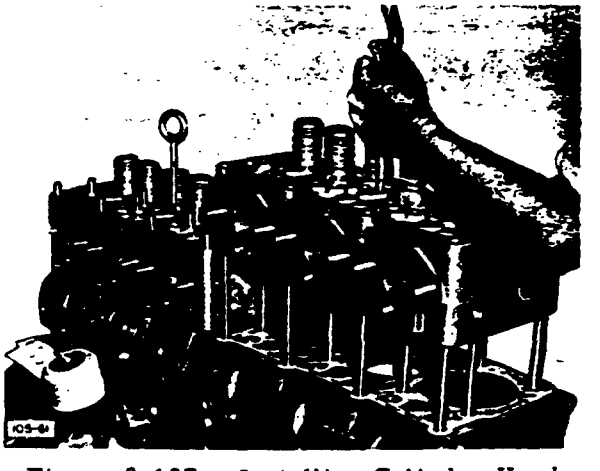


Figure 3-187. Installing Cylinder Head

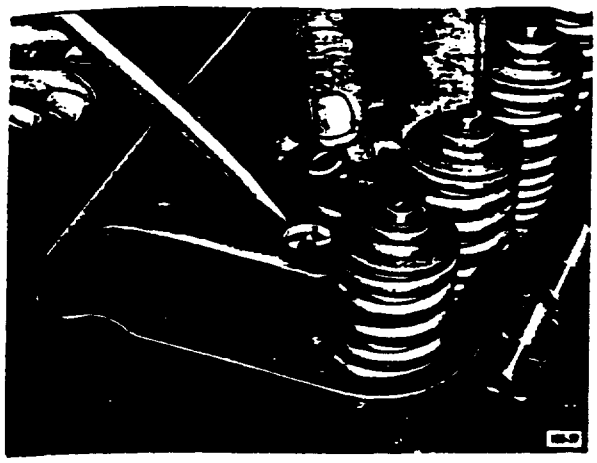


Figure 3-197. Installing Rocker Arm Bracket O-ring END465, 673, T, and 711 Series

NOTE

The END475 uses a paper type gasket between the rocker arm shaft bracket and the cylinder head.

Installation

Install rocker arm assembly to cylinder head ensuring rocker arm bracket with oil hole is over the O-ring oil seal.

Install rocker arm bracket capscrews and tighten to proper torque.

NOTE

On END475 install hollow oil transfer bolts at the rocker arm bracket locations, also be sure valve stem wear caps are installed.

To set the rocker arm static (cold) clearance, position No. 1 cylinder piston on TDC of the compression stroke. Timing indicator on flywheel must indicate TDC.

Adjust inlet and exhaust valve clearance in firing order. Each adjustment from No. 1 piston TDC setting is 1/3 of a turn on the crankshaft from one adjustment to the next. Two complete revolutions of the crankshaft are required to make all valve clearance adjustments.

NOTE

On END, T, 864 each adjustment from No. 1 piston setting is 1/4 of a turn on the crankshaft from one adjustment to the next.

WATER OUTLET MANIFOLD

Inspection

Inspect water outlet manifold for restrictions. Check mounting flanges for cracks and straightness.

On END, T, 864 check the thermostat seal in the water outlet fitting for looseness and erosion.

Installation

Place new hose and clamps between front half and rear half of the water outlet manifold or tube and O-ring, if applicable. Place new gaskets between water manifold and cylinder head. Install and tighten attaching capscrews to the proper torque. Position hoses and hose clamps as applicable.

Install thermostat and by-pass fitting and thermostat housing cover and seal as applicable. See Figures 3-198, 3-199, and 3-200.

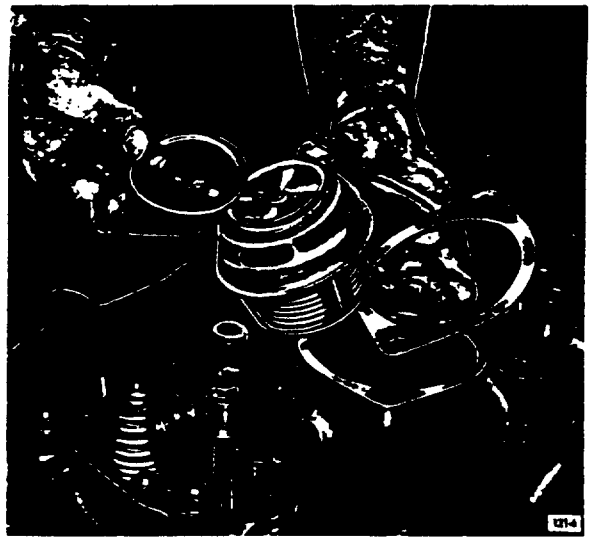


Figure 3-198. Installing Thermostat END465 Series

On END, T, 864 install new thermostat seal if old one was found unserviceable. See Figure 3-201.

INJECTION PUMP INSTALLATION (PSJ-PSM) END465, 673, T, 711 SERIES

1. Bar engine in normal direction of rotation until No. 1 cylinder is on compression stroke and flywheel timing mark indicates correct number of degrees BTC. recommended on pump data plate.

Installation

Place new gaskets between intake manifold and cylinder head. Install and tighten attaching capscrews to the proper torque. On END864 position O-rings and install inlet manifold cross-over tubes and hose. See Figure 3-209.

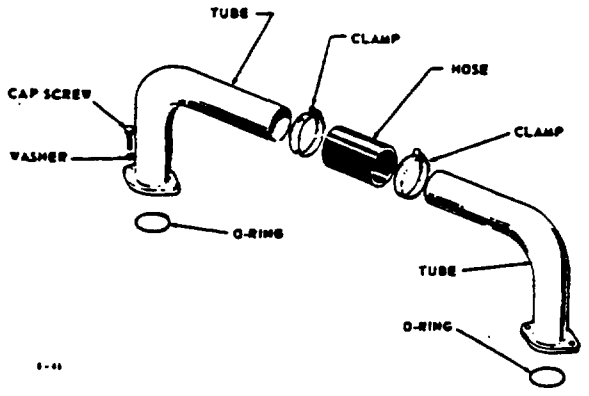


Figure 3-209. Intake Manifold Cross Over Tube END864

EXHAUST MANIFOLD

Inspection

Inspect the exhaust manifold for restrictions. Check mounting flanges for erosion, cracks and straightness.

Installation

Place new gaskets between exhaust manifold and cylinder head. Install and tighten the attaching washers and nuts or capscrews, as applicable, to the proper torque.

ROCKER ARM COVERS

Inspection

Inspect rocker arm covers for cleanliness, dents and straightness of flange. Check breather in cover, if applicable, to be sure it is not plugged.

Installation

Cement new gasket to mounting flange of rocker arm cover.

Position cover over rocker arms, install and torque cover retaining capscrews or nuts as applicable.

ENGINE BREAK-IN PROCEDURE AFTER OVERHAUL OR REBUILD

Comparative tests and careful review of engine break-in methods have proven that a short run under full-load is substantially more effective than the light or no-load slow speed increase type of break-in. Compatibility between the critical components (pistons, rings and bores) is greatly improved by raising engine speed and applying full-load immediately after warm-up.

Use the recommended type and grade engine oil and fuel as required for usual operation of the vehicle.

Immediately prior to initial starting of the engine, oil galleries and filters are to be primed preferably by means of a pressure tank.

Check the air intake system to ensure all joints are tight and the filter element and system are clean.

After break-in procedure is complete, recheck cylinder head stud nut torque and valve clearance adjustment.

NOTE

Torque cylinder head studs while engine is at operating temperature. Back each nut off individually and then tighten to the recommended torque.

When the vehicle is put into service, treat the engine as though it were new and follow the "Breaking in a New Vehicle" instructions listed in the Operation Manual.

Where a dynamometer is available, the break-in schedule is as follows:

Minutes	RPM	LOAD
15	1000	Warm-up (no more than 1/4 load)
30	1400	Full
30	2100	Full
15		Check out

CAUTION

When using chassis dynamometer, provide fans for cooling rear tires at roller contact area.

NOTE

Current production auxiliary drive gears do not have timing marks and do not have to be timed.

Oil Pump Drive and Compressor Drive Coupling Gear

Oil pump drive and compressor drive coupling gear is designed with the coupling gear on one end and the oil pump drive gear on the other.

Inspect gears for wear pattern and cracked, chipped or broken teeth. See Figure 22. Install locating key in keyway of auxiliary shaft. Align slot in oil pump drive gear end of coupling and install gear on shaft. Install coupling washer and nut. Torque nut. Install compressor oil transfer tube in end of auxiliary driveshaft.

Tachometer Drive Assembly

Inspect tachometer shaft for wear and gear for chipped, cracked or broken gear teeth. Check housing bore for wear and flange for straightness and condition of holes.

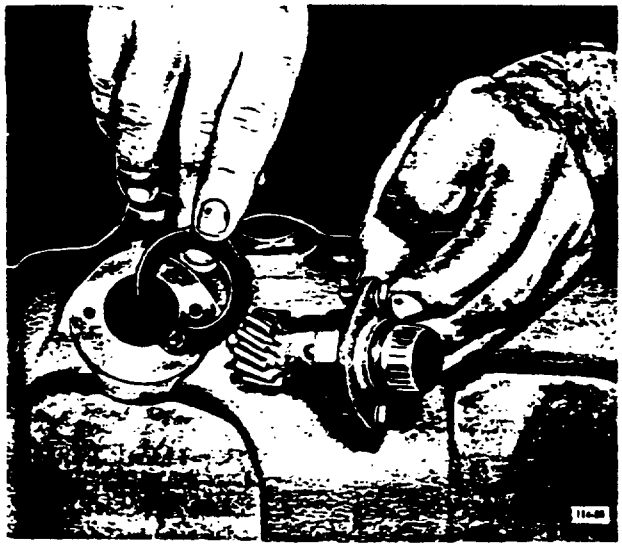


Figure 23. Installing Tachometer Drive Assembly

Lubricate tachometer shaft and gear and position in tachometer housing.

Install tachometer drive assembly and gasket on auxiliary drive housing. See Figure 23.

Injection Pump Drive Assembly

NOTE

Current production turbocharged engines use an aluminum injection pump drive housing and does not use ball bearings or bushings.

Injection pump drive assembly consists of a shaft with integral flange and tangs, a front and rear ball bearing positioned by a spacer and retained in the housing by a nut and cotter key. See Figure 24.

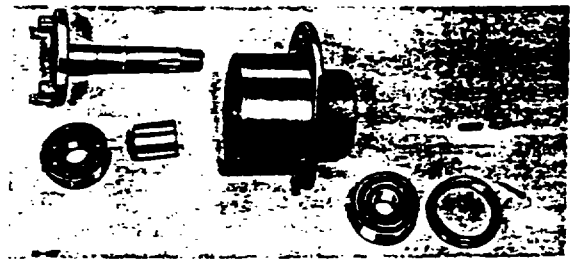


Figure 24. Injection Pump Drive Assembly

Inspect shaft for condition of flange and tangs. Check bearing locations for wear and galling. Check keyway slot and threads for condition. Inspect bearings for condition and free rotation. Check housing for straightness of flange, condition of bearing locations, holes and threads.

Position housing on bench with small end up. Coat bearing O.D. and recess lightly with Loctite grade B. Do not allow Loctite to enter bearing races. Install front bearing in housing with closed side up and tap into position with a suitable drift. Install bearing retaining nut; torque and lock in position with a cotter key. Allow Loctite to harden at least 72 hours at 72° F. Moderate heat may be used to accelerate hardening.

Installation

Position crankshaft pulley and vibration damper on crankshaft hub and secure with hardened washers and capscrews. Where separate pulley and damper parts are used, torque capscrews.

OIL PRESSURE CONTROL VALVE ASSEMBLY (Anti-lag valve not used with Airesearch turbocharger)

Description

Oil pressure control valve is a machined casting containing oil passages and spring-loaded valves for oil pressure control and direction. See Figure 55.

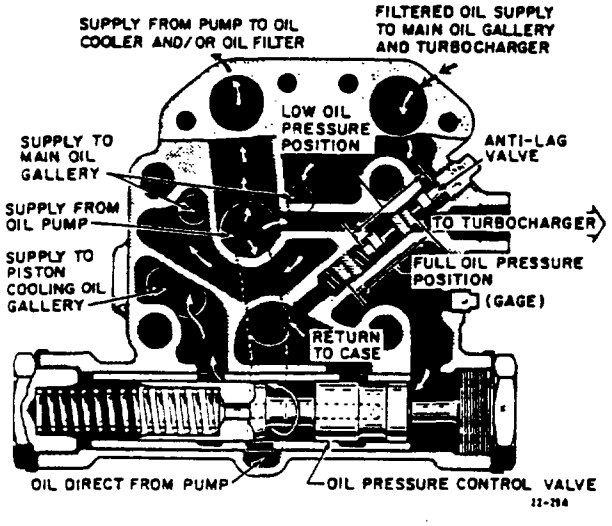


Figure 55. Oil Pressure Control Valve

The assembly is mounted externally on the cylinder block and aligns with the oil passage directly from the oil pump.

A portion of this oil is directed to the turbocharger to insure immediate and positive lubrication when starting the engine. After the engine is running, however, the passage is closed off by the anti-lag valve and filtered oil is channeled to the turbocharger.

The oil is transferred by an external line from the pressure regulator to the oil cooler. After passing through the oil cooler, an external line transfers the oil to the oil filter and the oil filter outlet is connected by an external line to the oil pressure regulator.

The cooled and filtered oil entering the regulator is directed to the engine oil gallery for engine lubrication and also acts upon the two valves located in the housing. The oil acts upon the anti-lag valve and closes the passage which had admitted oil to the turbocharger from the oil pump and now directs filtered oil to the turbocharger. An anti-drainback valve is in the turbocharger lubricating oil line to prevent oil drainback during layovers.

The oil also acts upon the pressure regulator valve and allows oil, directly from the oil pump, for piston cooling and permits excess oil to drain back to the crankcase.

Oil for piston cooling system is direct from the oil pump and is only effective at engine rpm above idle.

Inspection

Inspect the oil pressure control valve housing for flatness. Be sure all oil passages are clean and not obstructed. Check anti-lag valve and pressure control valve springs for wear and proper compression pressure. Check anti-lag valve for wear, condition, and for freedom of movement in housing.

Check pressure control valve for wear, condition and freedom of movement in housing bushing. Be sure oil passages are clean and not obstructed.

Check pressure control valve bushing in housing to be sure notch on bushing and housing are lined up indicating oil slots are in proper position.

Assembly

Install the anti-lag valve spring in the housing. Lubricate and install anti-lag valve. Be sure pilot on valve enters hole in spring. Apply a light coat of sealant to the threads of the pipe plug and install in housing to retain anti-lag valve.

Position washer on oil pressure control valve retainer cap. Install cap into housing and bend tab to lock cap. Lubricate and install pressure control valve and pressure control valve spring.

Position washer on oil pressure control valve spring retainer cap and install cap into housing. Torque cap and bend tab to lock cap.

Apply a light coat of sealant to the threads of the two pipe plugs and install in housing.

Install protective covers on oil IN and OUT fittings.

Installation

Position a new gasket on the cylinder block and install the oil pressure control valve

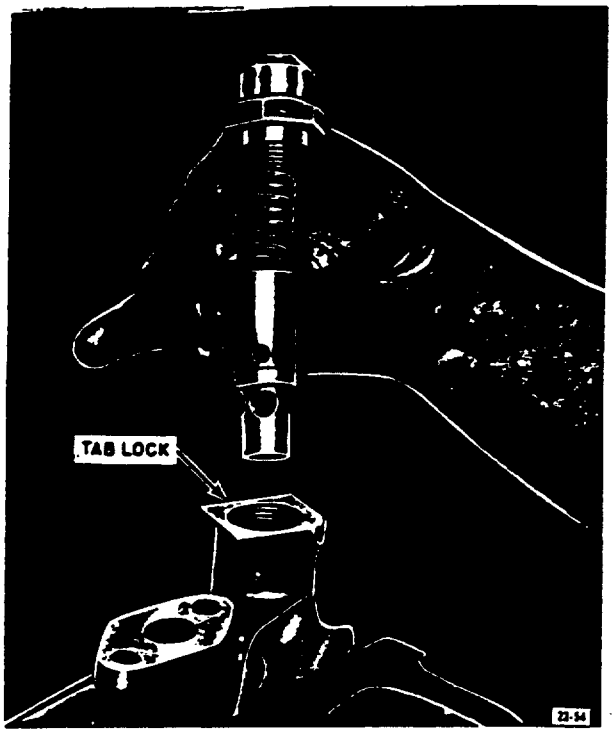


Figure 59. Installing Oil Pump Pressure Relief Valve Plunger

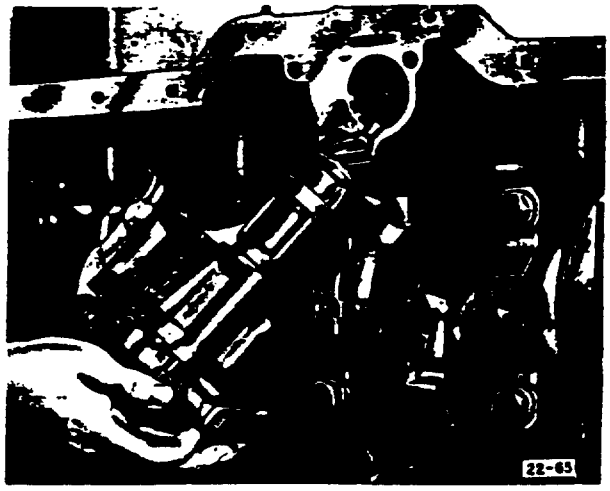


Figure 60. Installing Oil Pump

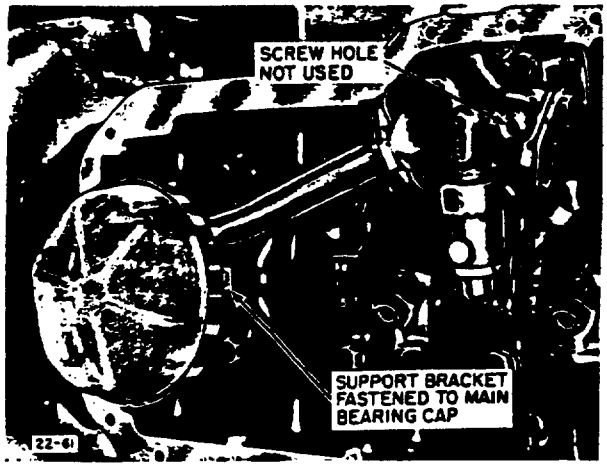


Figure 61. Oil Pump Pick-up Pipe Installation

Check oil pick-up pipe and shield assembly for cleanliness and lack of obstruction. Place a gasket on pump flange and install oil pick-up line. Torque screws and lockwire together. Install oil screen, support and inlet pipe. See Figure 61. See Figures 62, 63 and 64 for lubrication system.

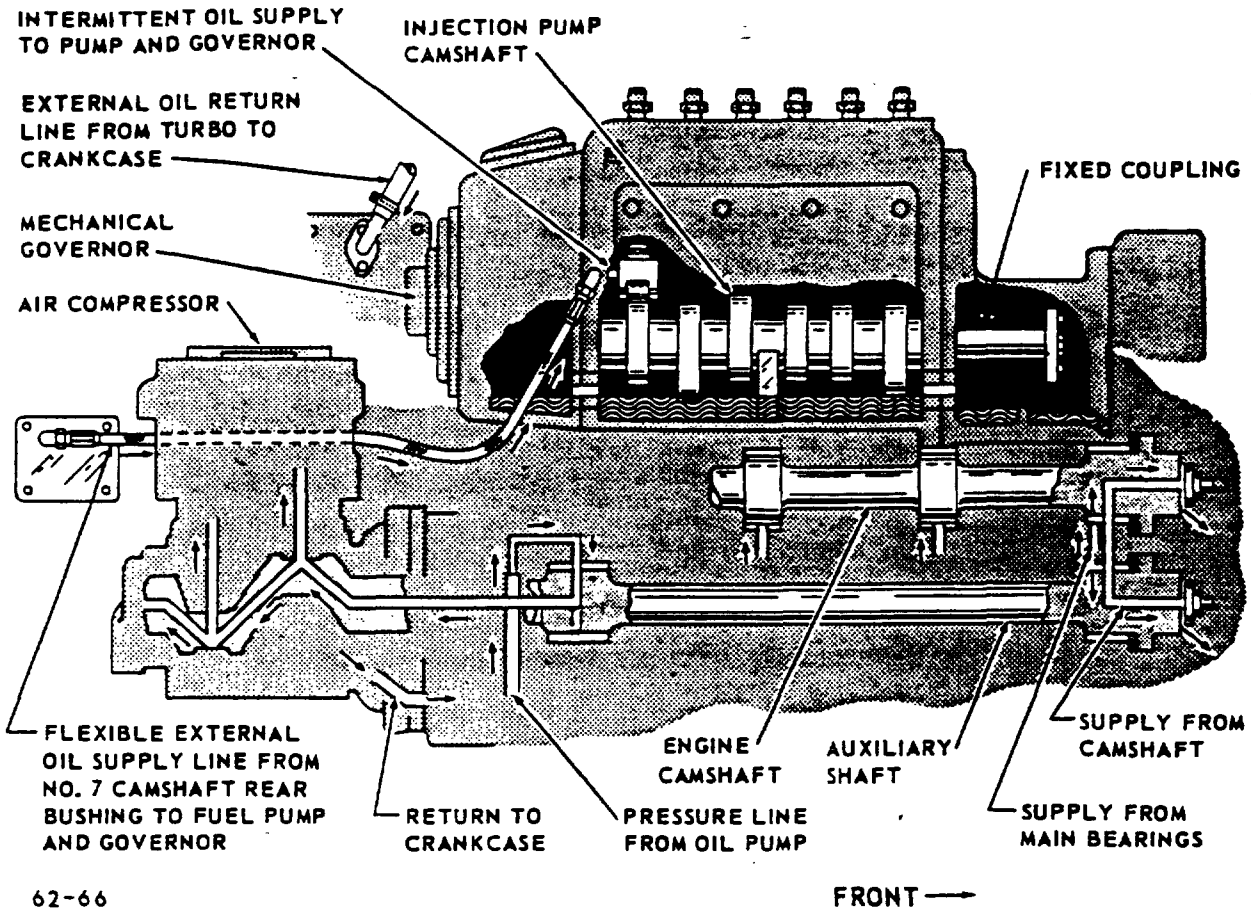


Figure 64. Auxiliary Drive and Injection Pump Lubrication

OIL PAN

Inspection

Inspect oil pan for dents, cracks and condition of flange, bolt holes for elongation and baffle for security. Inspect drain hole for condition of threads.

Installation

Position gasket on oil pan and position oil pan on cylinder block. Install and tighten oil pan retaining capscrews evenly to prevent oil leakage.

CYLINDER HEAD STUDS

Inspection

Check cylinder head studs for condition of threads, and straightness of shank.

Installation

Apply a light coat of lubricating oil to threads of studs and install them in cylinder block finger-tight, then back off 1/3 turn.

CYLINDER HEAD INSTALLATION

CAUTION

New cylinder head gaskets and fire rings must be installed each time cylinder heads are removed.

Place cylinder head gasket over studs on cylinder block. Be sure that all passages are open and not blocked by gasket. Make sure fire rings are properly positioned. Cylinder gaskets are precoated; no soaking, coating or sealants are required. Use gaskets as received.

Position cylinder head over studs and gently onto cylinder block. See Figure 65. Be sure no foreign material is in cylinder.

Install cylinder head stud washers and nuts. Torque cylinder stud nuts in progressive steps of 50 lb. ft. using proper tightening sequence. See Figure 66.

To set the rocker arm static (cold) clearance, position No. 1 cylinder piston on TDC of the compression stroke. Timing indicator on flywheel must indicate TDC.

Adjust inlet and exhaust valve clearance in firing order. Each adjustment from No. 1 piston TDC setting is 1/3 of a turn on the crankshaft from one adjustment to the next. Two complete revolutions of the crankshaft are required to make all valve clearance adjustments.

WATER OUTLET MANIFOLD

Inspection

Inspect water outlet manifold for restrictions. Check mounting flanges for cracks and straightness.

Installation

Place new hose and clamps between front half and rear half of the water outlet manifold. Place new gaskets between water manifold and cylinder head. Install and tighten attaching capscrews to the proper torque. Position hoses and hose clamps as applicable.

Install thermostat and by-pass fitting and thermostat housing cover and seal as applicable. See Figure 69.

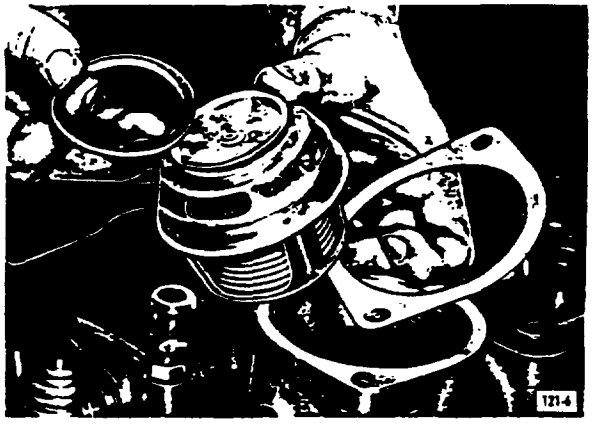


Figure 69. Installing Thermostat

WATER PUMP

Description

The water pump is a centrifugal-rotor type, V-belt driven from the crankshaft. The pump cover contains the grease cavity and provisions for two, single row, ball bearings which support the shaft. The bearings are sealed on one side to retain grease. A vent fitting replaces the usual grease fitting because the initial pack of grease, 1/3 full, should suffice for the life of the pump. A cartridge-type water seal with synthetic rubber bellows and carbon ring form an effective water-tight seal.

The housing, which comprises the volute (rotor casing) and water outlet to the engine is also the pump mounting.

It is usually more economical to obtain a rebuilt exchange water pump than to overhaul the old one. Contact your Mack Branch or Distributor for rebuilt exchange water pumps.

INJECTION PUMP INSTALLATION

1. Bar engine in normal direction of rotation until No. 1 cylinder is on compression stroke and flywheel timing mark indicates correct number of degrees BTC recommended on valve cover escutcheon plate. The injection pump driveshaft flange lugs should now be in a horizontal plane and indexing pin hole at 4 o'clock position, looking at face of shaft flange.

2. Grease front (non-counterbored) face of coupling and mount on pump driveshaft flange with long end of offset indexing pin pointing rearward and center the coupling ring laterally.

3. Remove pump adapter inspection hole cover.

4. Rotate pump coupling driven flange until lugs are in a vertical plane and indexing hole is at 7 o'clock position, looking from drive end of pump. See Figure 70.

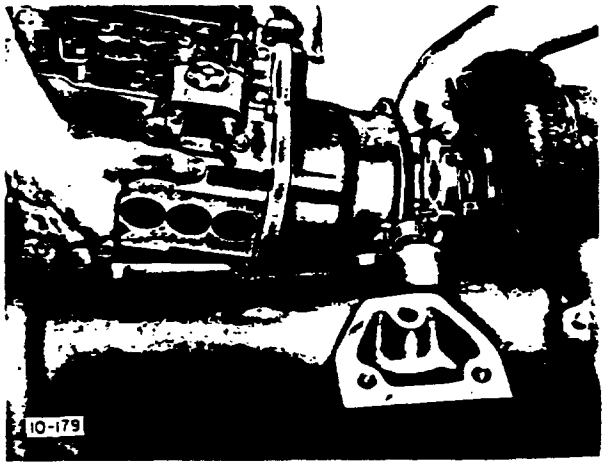


Figure 70. Installing Injection Pump

AIR COMPRESSOR

Inspection

Inspect air compressor flange for cracks, straightness and condition of holes. Check coupling teeth and insure shaft nut is tight and tab is bent to lock nut.

Installation - See Figure 72

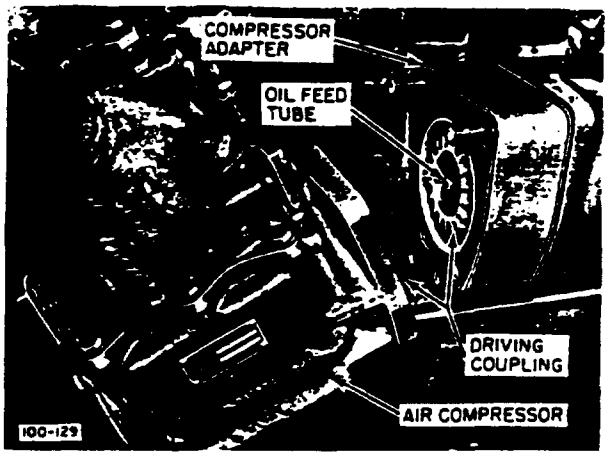


Figure 72. Installing Air Compressor

The air compressor is "phased" or "timed" to the engine. A tooth in the bore of the fiber coupling is shaved down to clear a pin in the drive coupling. The compressor can be installed only one way. If difficulty is experienced, recheck to insure coupling and drive are in proper mesh.

Current production engines do not require phasing or timing. The pin has been omitted from the drive coupling.

Be sure oil transfer tube is tight in end of auxiliary driveshaft.

Position air compressor adapter ring, if used, into auxiliary housing counterbore. Place gasket on air compressor and position on auxiliary housing. Install and torque air compressor retaining capscrews or nuts.

WARNING

Recheck auxiliary shaft end float after installing air compressor or vacuum pump.

FUEL INJECTION LINES, HIGH PRESSURE

Description

Fuel injection lines are seamless cold-drawn high tensile steel. All lines on one engine are of identical length and inside diameter.

Inspection

Inspect fuel injection line for chafing, dents, nicks or sharp bends. Check fittings, seat and threads for condition. Check lines to be sure they are not restricted.

Installation

Install fuel injection nozzles. Install fuel injection lines and be sure brackets are properly positioned to prevent lines from chafing.

The lines should fit without difficulty if they have not been changed around. NEVER BEND THE LINES TO MAKE THEM FIT.

Torque fuel injection lines at injection nozzles and pump locations. Torque injection line brackets.

INLET MANIFOLD

Inspection

Inspect inlet manifold for restrictions. Check mounting flanges for erosion, cracks and straightness.

Installation

Place new gaskets between inlet manifold and cylinder head. Install and tighten attaching capscrews to the proper torque.

EXHAUST MANIFOLD

Inspection

Inspect the exhaust manifold for restrictions. Check mounting flanges for erosion, cracks and straightness.

Installation

Place new gaskets between exhaust manifold and cylinder head. Install and tighten the attaching washers and nuts to the proper torque.

ROCKER ARM COVERS

Inspection

Inspect rocker arm covers for cleanliness, dents and straightness of flange. Check breather in cover, if applicable, to be sure it is not plugged.

Installation

Cement new gasket to mounting flange of rocker arm cover.

Position cover over rocker arms; install and torque cover retaining capscrews or nuts as applicable.

TURBOCHARGER (Refer to Page 3-23 for turbocharger information)

TURBOCHARGER TROUBLE SHOOTING

Frequently turbochargers are removed and returned for repair exchange unnecessarily as factory inspection reveals they are still serviceable and repair is not necessary. If turbocharger malfunction is suspected, follow these inspections and refer to trouble shooting chart at end of bulletin.

CAUTION

Do not place hands or fingers near turbocharger inlet while engine is running. Vacuum can be created which could draw fingers into compressor blading causing injury.

PROCEDURE

I. NOISE CHECK

Start engine and check for unusual noise or vibration from turbocharger. This will indicate out of balance, rubbing or damage to compressor or turbine wheels. If rubbing noise is evident, shut down engine immediately.

NOTE

Remove compressor housing and/or turbine housing. If any sign of turbine wheel or compressor wheel rub is evident, the turbocharger will have to be removed, cleaned, repaired or exchanged, as necessary.

II. LEAKAGE CHECKS

If no noise is evident, perform the following inspections:

With Engine Running:

1. Check for leaks in air inlet system from air cleaner to inlet manifold. Use light oil squirted from oil can or soap suds on joints to detect suction or pressure leaks. Soap suds can be used to detect porous hose or light application of starting fluid spray which causes engine speed to rise when applied against porous or leaking hose or connections. Check all hoses and tubing for chafing, holes or sliding out of place.

2. Check exhaust manifold for cracks, leaks and missing, loose or blown gaskets.

3. Check turbocharger lubricating oil inlet and outlet lines and fittings for chafing, pinching or leaking.

Shut Engine Down and Perform the following:

1. Be sure all bolts, clamps and connections are tight and intake manifold gaskets are in proper location and tight.

2. Check to be sure exhaust manifold and turbocharger mountings are tight.

3. Perform the following checks if the turbocharger compressor shows evidence of oil leakage.

a) Wet Inlet: Check air cleaner and/or air compressor inlet line if compressor inlet is tied into engine air inlet system.

b) Wet Outlet: Check back of compressor wheel and in crossover tube to intake manifold.

If oil wetting is found, clean compressor, compressor wheel and crossover tube. Run again under operating conditions, inspect, if no leakage is evidenced, check air compressor for oil passing or engine oil difficulties other than the turbocharger.

III. PRESSURE CHECKS

Install an oil pressure gage in the turbocharger oil inlet line and a pressure gage in the inlet manifold and perform the following checks. See Figure 1 for typical gage locations. Start engine.

1. Check turbocharger oil inlet pressure for minimum of 10 psi with engine at idle rpm.

2. Recheck items 1, 2, 3 and 4 as in Section II with the engine running.