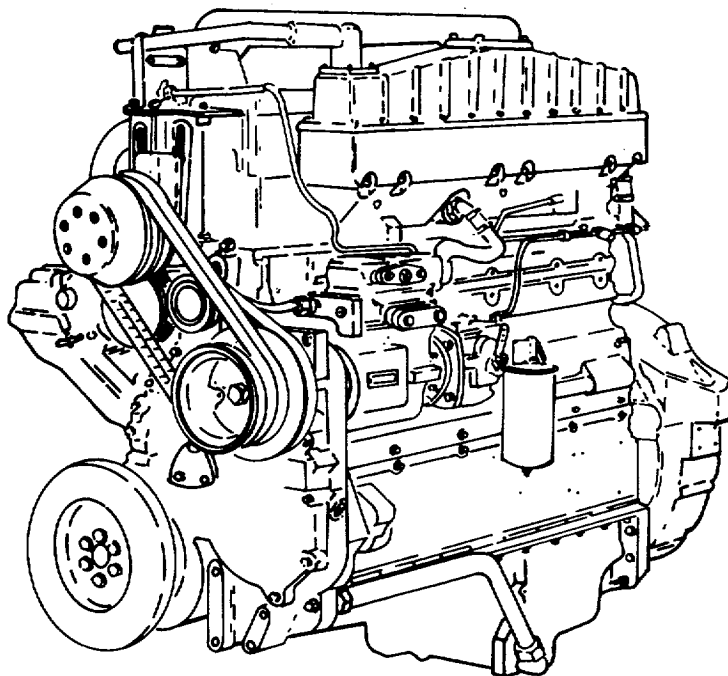


**DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL
FOR**



**ENGINE, DIESEL, 6 CYLINDER
INLINE, TURBOCHARGED,
CUMMINS MODEL NTC-400 BC2
NSN 2815-01-156-6210**

HEADQUARTERS, DEPARTMENT OF THE ARMY

**This copy is a reprint which includes
current pages from Change 1.**

JULY 1985

CHANGE
NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C.
27 MARCH 1987

**Direct Support and General Support
Maintenance Manual**

**ENGINE, DIESEL, 6 CYLINDER
INLINE, TURBOCHARGED
CUMMINS MODEL NTC-400 BC 2**

(2815-01-156-6210)

TM 9-2815-226-34, **SEPTEMBER 1985** is changed as follows:

1. Remove old pages and insert new pages as indicated below.
2. New or changed material is indicated by a vertical bar in the margin of the page.
3. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration identification number.
4. The purpose of Change 1 to this manual is to identify configuration differences between the 1980, 1982, and 1984 models. Model designators can be determined by viewing the data plate on your truck chassis.

Remove Pages	Insert Pages	Remove Pages	Insert Pages
i/(ii blank)	i/(ii blank)	3-381 thru 3-394	3-381 thru 3-394
3-233 and 3-234	3-233 and 3-234	3-401 and 3-402	3-401 and 3-402
3-241 thru 3-244	3-241 thru 3-244	3-407 and 3-408	3-407 and 3-408
3-253 and 3-254	3-253 and 3-254	3-459 thru 3-462	3-459 thru 3-462
3-257 and 3-258	3-257 and 3-258	INDEX-1 thru INDEX-4	INDEX-1 thru INDEX-4
3-263 and 3-264	3-263 and 3-264		
3-267 and 3-268	3-267 and 3-268		
3-287 and 3-288	3-287 and 3-288		
3-357 and 3-358	3-357 and 3-358		
3-373 thru 3-376	3-373 thru 3-376.1/ (3-376.2 blank)		

File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

Official:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

R.L. DILWORTH
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-38, Direct Support and General Support Maintenance requirement for Truck Chassis.

WARNING

EXHAUST FUMES

The following precautions must be observed to ensure the safety of personnel when the engine of any vehicle is operated:

1. **DO NOT** operate personnel heater or engine of vehicle in a closed place unless the place has a lot of moving air.
2. **DO NOT** idle engine for long periods without ventilator blower operation. If tactical situation permits, open hatches.
3. **DO NOT** drive any vehicle with inspection plates, cover plates, or engine compartment doors removed unless necessary for maintenance purposes.
4. **BE ALERT** at all times during vehicle operation for exhaust odors and exposure symptoms. If either are present, **IMMEDIATELY VENTILATE** personnel compartment. If symptoms persist, remove affected crew to fresh air; keep warm; **DO NOT PERMIT PHYSICAL EXERCISE**; if necessary, give artificial respiration and get immediate medical attention.
5. **BE AWARE**; neither the gas particulate filter unit nor the field protection mask for nuclear-biological-chemical protection will protect you from carbon monoxide poisoning.

WARNING

COMPRESSED AIR

Compressed air used for cleaning purposes will not exceed 30 PSI (207 KPA). Use only with effective chip guarding and personal protective equipment (goggles, shield, gloves, etc.).

WARNING

FIRE AND EXPLOSION

Do not use gasoline for cleaning or as fuel.

Do not get battery electrolyte on your skin, clothing, or in your eyes. It is an acid which can cause injury. Keep all sparks and flames away from batteries. The battery gas is explosive.

When disconnecting battery terminals, always disconnect the ground terminal first.

When reconnecting battery terminals, always connect the ground terminal last.

Methyl alcohol is highly flammable and poisonous, and can be absorbed through the skin. Do not drink or breathe it. If you spill any on your skin, wash it off immediately with water. Keep it away from sparks or flames.

Ether quick-start is explosive and poisonous. Do not permit canisters to be subjected to excessive heat. Do not attempt to start vehicle if ether line to engine is broken or disconnected.

When filling fuel tank with diesel fuel, be sure hose nozzle on container contacts filler tube on fuel tank to carry off static electricity. Do not smoke, permit open flame or uncovered battery compartments while you are servicing the diesel fuel system.

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well ventilated area. Avoid contact with skin, eyes, and clothes, and do not breathe vapors. Do not use near open flame or excessive heat.

WARNING

EXHAUST PIPE AND MUFFLER

During normal operation, the exhaust pipe and muffler can become very hot. Do not touch these components with your bare hands.

WARNING

ENGINE COOLANT

Take extreme care when removing engine coolant tank fill cap if temperature gage reads above 195°F (91°C), to prevent burns or serious injury.

WARNING

JACKING UP TRUCK

Hydraulic jack is intended for lifting the truck, not for supporting the vehicle when performing maintenance. To prevent serious injury, do not get under truck unless it is properly supported with blocks or jack stands.

WARNING

COOLING FAN

When working in engine compartment with the engine running, stay clear of the cooling fan. The fan may engage automatically at any time and can cause serious injury.

WARNING

HOISTING TRUCK

Direct personnel to stand clear during hoisting operation. Failure to do this may cause injury to personnel.

**Direct Support And General Support Maintenance Manual
ENGINE, DIESEL, 6 CYLINDER INLINE, TURBOCHARGED
CUMMINS MODEL NTC-400 BC2**

**REPORTING ERRORS AND
RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Tank-Automotive command, ATTN: AMSTA-MBS, Warren, MI 48397-5000. A reply will be furnished to you.

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Section XVII. FLYWHEEL HOUSING REPAIR**3-44. INSPECT FLYWHEEL HOUSING****WARNING**

- **COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).**
- **P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.**

- a. Clean housing with solvent and dry with compressed air.
- b. Visually inspect housing for cracks.
- c. If cracked, replace housing.
- d. Check starter mount pad threads for distortions.
- e. If threads distorted, mark for repair.

3-45. REPAIR FLYWHEEL HOUSING**NOTE**

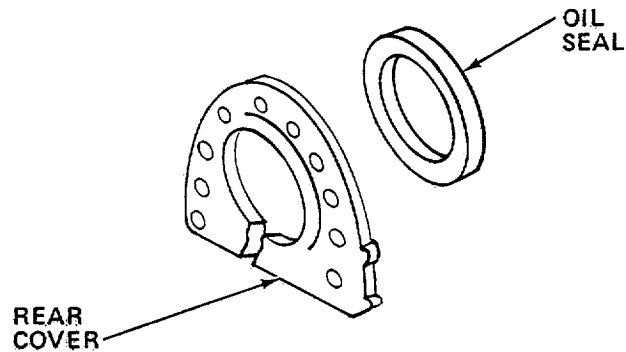
Repair of housing limited to re-threading of starter mount holes.

- a. Determine size of threads.
- b. With used tap, repair damaged thread.

WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- c. Blow out hole with compressed air.
- d. Screw proper size capscrew into housing to check threads.
- e. If distortion does not clear up, replace housing.

Section XVIII. REAR COVER REPAIR**3-46. DISASSEMBLE, INSPECT, AND REPAIR REAR COVER**

TA295399

- a. Place cover on support blocks with rear face down.
- b. Carefully remove oil seal and discard seal.

WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
- P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

- c. Clean cover with solvent and dry thoroughly with compressed air.
- d. Check cover for cracks, nicks, burrs, and distortions. Discard if cracked or distorted.
- e. Remove nicks and burrs with emery cloth.

Section XIX. ROCKER LEVER COVERS REPAIR

3-47. INSPECT ROCKER LEVER COVERS

a. Clean rocker lever cover.

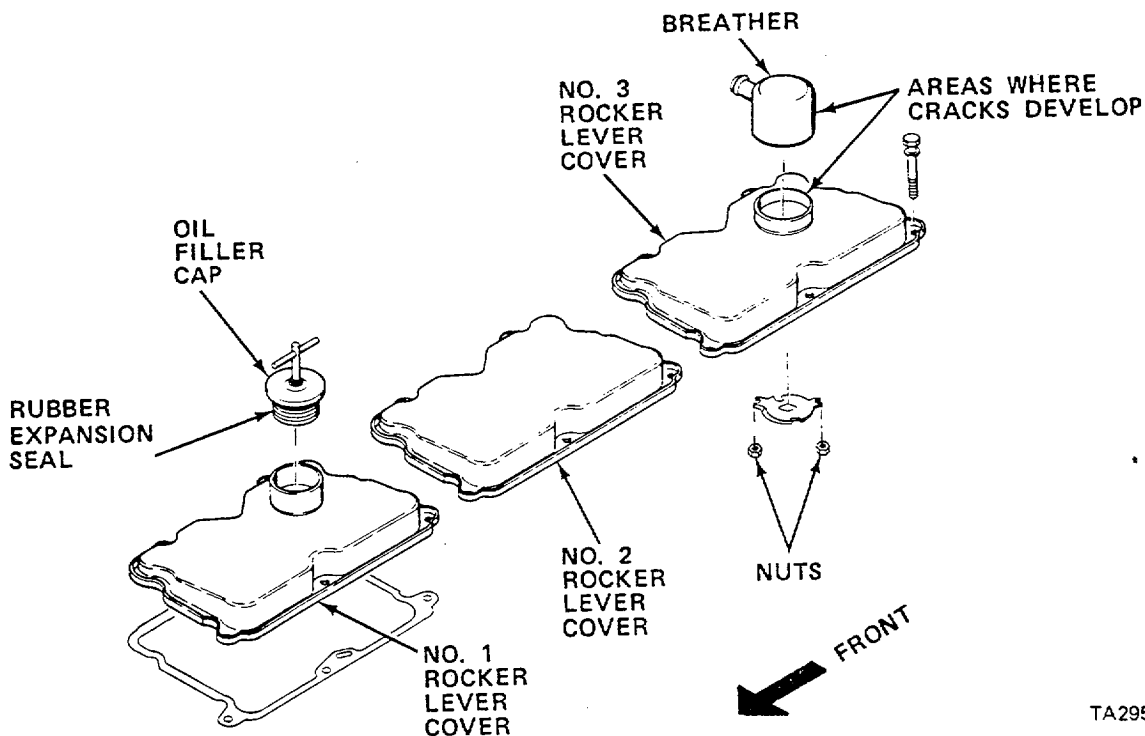
(1) Scrape gasket material from sealing surface.

WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
- P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

(2) Clean cover in solvent and dry with compressed air.

b. Inspect rocker lever cover.



(1) Remove breather baffle retaining nuts and remove baffle on no. 3 cover.

NOTE

Baffle is press-fit over lip on cover breather port.

- (2) Carefully pry breather off cover. Take care not to bend or crack breather or port.
- (3) Check breather for cracks and distortions, especially around press-fit area. Discard if defective.
- (4) Inspect cover for cracks, dents, and distorted sealing surface. Discard if defective.
- (5) Inspect for cracks around capscrew holes and breather port area. Discard if defective.
- (6) Inspect no. 1 cover oil filler cap expansion rubber seal area for tears, deterioration, and security. Discard cap if defective.

3-48. REPAIR ROCKER LEVER COVERS

NOTE

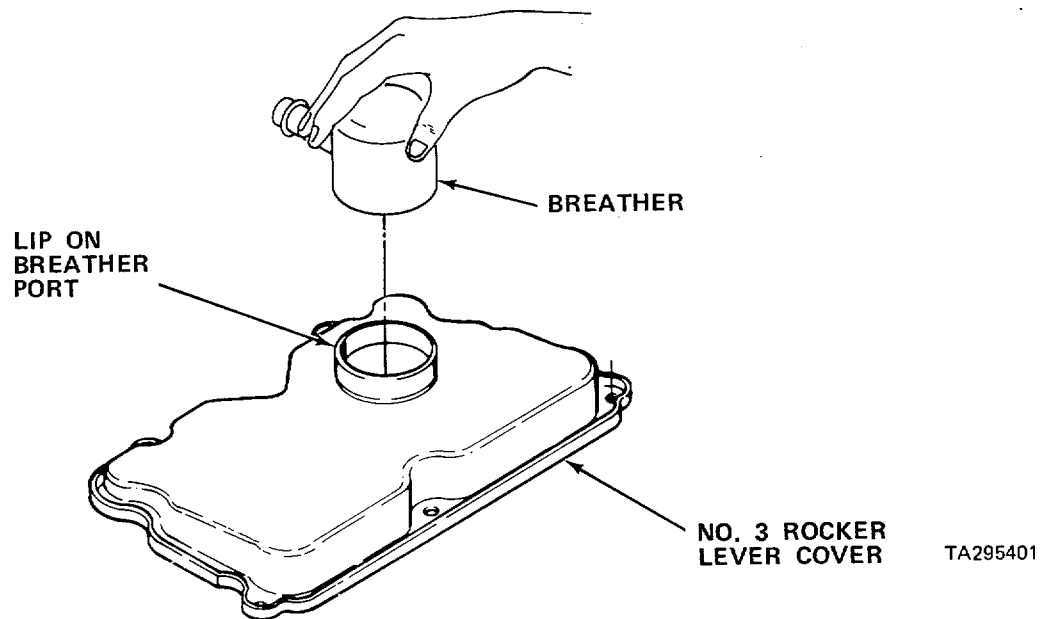
Repair of covers is limited to replacement of breather baffle, breather, and oil filler cap.

- a. Install breather.

CAUTION

PRESS STRAIGHT ON BREATHER TO PREVENT DAMAGE TO BREATHER AND/OR PORT.

- (1) Align breather with no. 3 rocker lever cover breather port.



- (2) With firm hand pressure, snap breather over lip of port.
- (3) Check press-fit area for cracks upon installation.

b. Install breather baffle.

- (1) Position baffle over studs inside no. 3 cover.
- (2) Secure baffle with nuts.

c. Install oil filler cap.

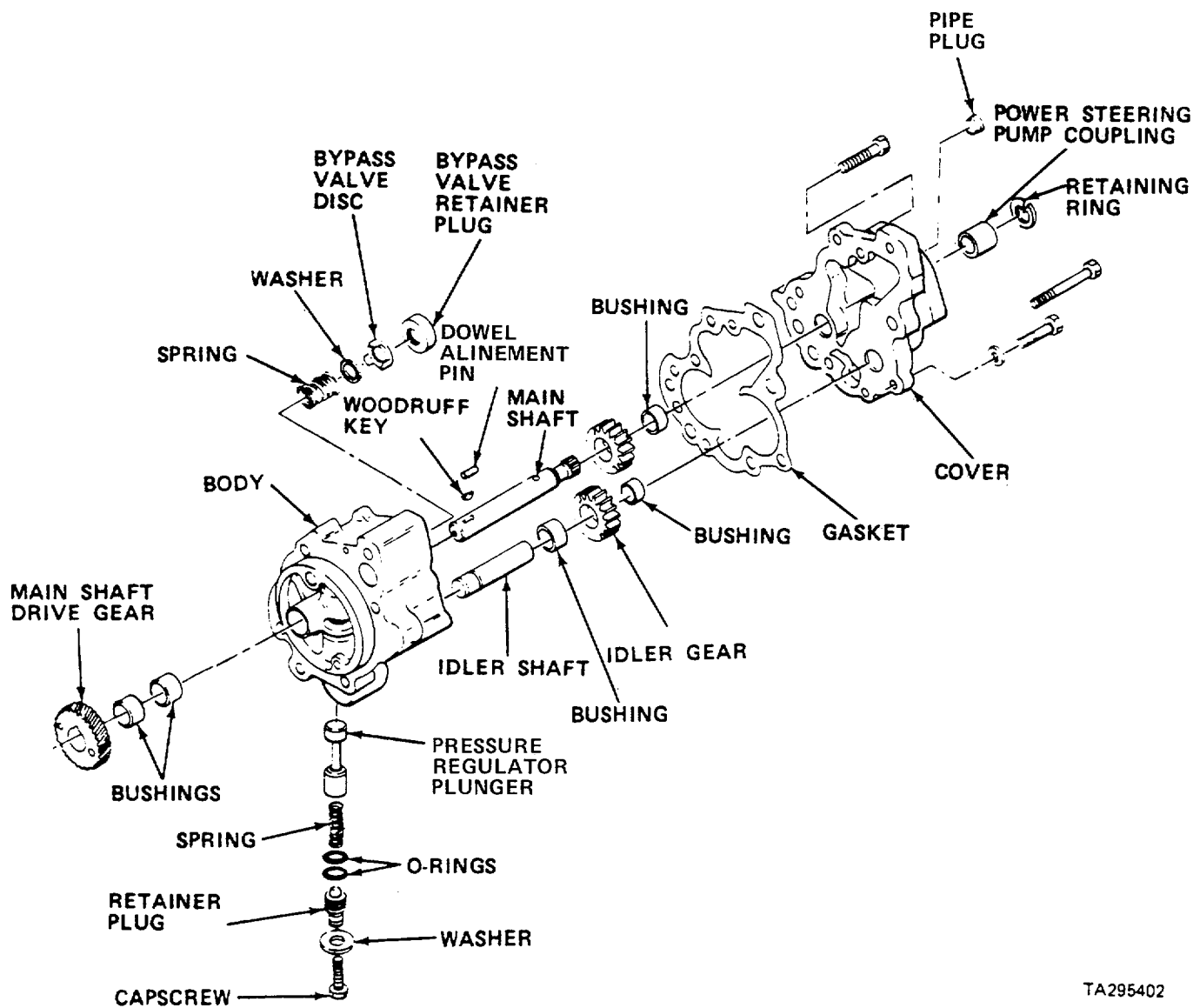
- (1) Insert filler cap into no. 1 rocker lever cover filler port.
- (2) Rotate cap T-handle to expand rubber seal.
- (3) Check cap to ensure it is tightly seated.
- (4) Wipe covers clean.

Section XX. OIL PUMP ASSEMBLY REPAIR

3-49. DISASSEMBLE OIL PUMP ASSEMBLY

CAUTION

TAKE CARE WHEN DISASSEMBLING PUMP TO PROPERLY IDENTIFY PARTS SUCH AS SHAFTS, LENGTHS OF CAPSCREWS, AND THEIR LOCATIONS TO ENSURE CORRECT REASSEMBLY.



TA295402

- a. With a gear puller, remove main shaft drive gear.
- b. Remove woodruff key from shaft.
- c. Remove retaining ring and power steering pump coupling from main drive shaft.

- d. Remove capscrews securing cover to body.
- e. Tap cover lightly with softfaced hammer to loosen cover from dowel alignment pin.
- f. Remove and discard gasket.
- g. Slide main drive shaft and gear out of body.
- h. Press gear off of main drive shaft.
- i. Slide idler gear off of idler shaft.
- j. Remove oil pressure signal tube adapter fitting from cover.
- k. Press idler shaft from body.
- l. Remove capscrew, washer, retainer plug, spring, and pressure regulator plunger from body. Discard plug (with its O-rings) and spring.
- m. Carefully pry high pressure bypass valve retainer plug out of body. Discard plug.
- n. Remove bypass valve disc, washer, and spring. Discard valve and spring.

3-50. INSPECT OIL PUMP ASSEMBLY

WARNING

- **COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).**
- **P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.**

- a. Clean all parts in solvent and dry with compressed air.

CAUTION

DRILLED PASSAGES MUST BE FREE OF ANY FOREIGN MATTER. BLOCKAGE OF PASSAGES CAN RESULT IN REDUCED PRESSURE AND VOLUME OUTPUT OF OIL PUMP. THIS COULD CAUSE TOTAL ENGINE FAILURE AND COSTLY REPAIRS.

- b. Direct compressed air through all passages to remove foreign matter. Ensure all passages are clean.
- c. Remove any gasket material from sealing surfaces.
- d. Inspect gears for worn, or chipped, scored, or broken teeth. Replace if defective.
- e. Inspect body and cover for burrs, pitting, corrosion, nicks, cracks, breaks, and distorted threads. Replace if defective.
- f. Check idler shaft for galling, cracks, and turning in body.
- g. Measure idler shaft outside diameter.
- h. Discard shaft if diameter less than 0.6145 in. (15.603 mm).
- i. Inspect main shaft for galling and cracks.
- j. Measure main drive shaft outside diameter.
- k. Discard shaft if diameter less than 0.6145 in. (15.603 mm).
- l. Measure inside diameters of idler gear bushings.
- m. Mark bushings for replacement if diameters exceeds 0.6184 in. (15.7100 mm).
- n. Inspect dowel alignment pin for damage.
- o. Mark pin for replacement if damaged.
- p. Check pressure regulator plunger in body for binding, sticking, and looseness.
- q. Discard plunger if too loose, binding, or sticking.
- r. Wipe all parts clean.

3-51. REPAIR OIL PUMP ASSEMBLY

- a. With ST-1158 mandrel, remove bushings from body, cover, and idler gear (if damaged or worn).
- b. Clean bores.
- c. Press new bushings in body, cover, or idler gear.
- d. Check that bushings are flush to 0.020 in. (0.508 mm) below surface of bore.
- e. Bore bushings to 0.6165 - 0.6175 in. (15.6591 - 15.6845 mm).
- f. Remove damaged dowel alignment pin with ST-1134 dowel pin extractor.

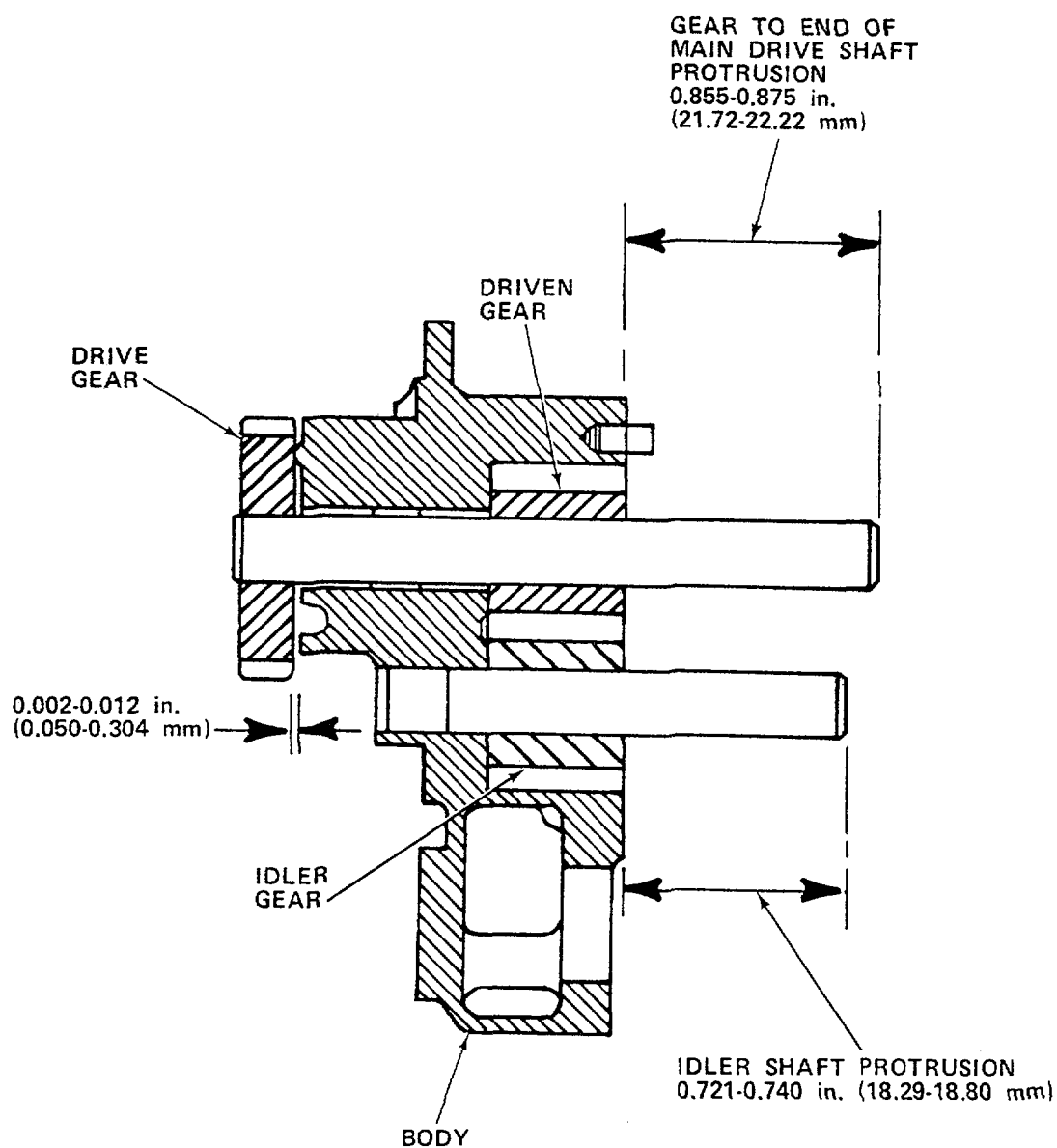
CAUTION

TAKE CARE NOT TO FLATTEN OR BEND PIN. DAMAGE TO COVER MAY RESULT.

- g. Tap new pin into body.

3-52. ASSEMBLE OIL PUMP ASSEMBLY

- a. Press large end of idler shaft in body using deep end of ST-1157 mandrel.



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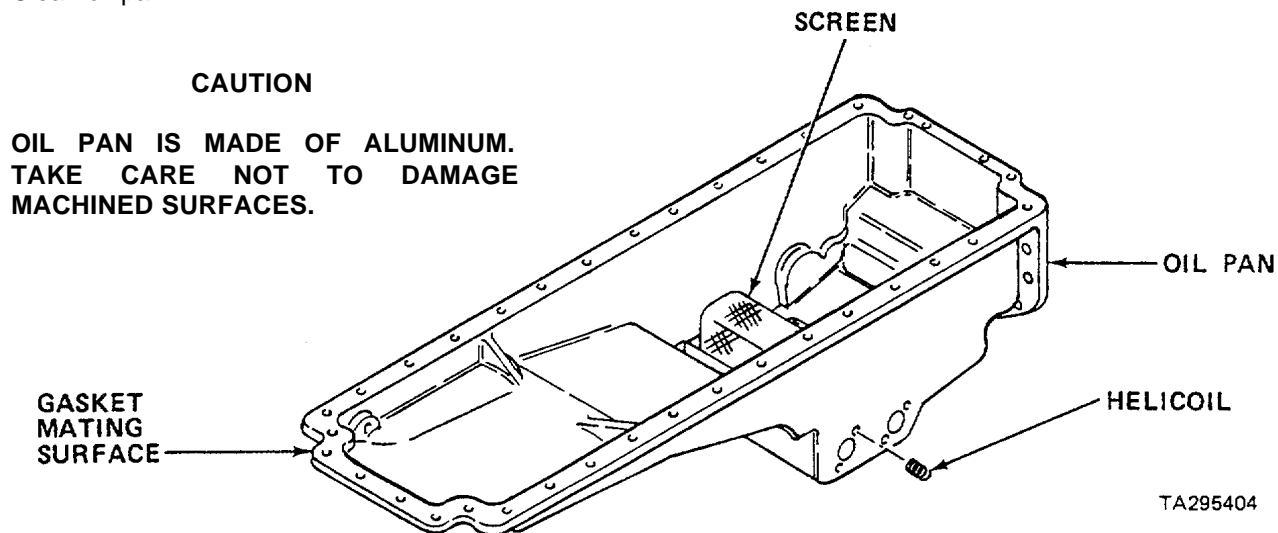
- b. If mandrel not used, press idler shaft into body until shaft protrudes 0.720 - 0.740 in. (18.29 - 18.80 mm) beyond rear face of body.
- c. Press driven gear into main drive shaft with shallow end of ST-1157 mandrel.
- d. If mandrel not used, press gear onto shaft until distance from rear face of gear to end of shaft is 0.855 - 0.875 in. (21.717 - 22.225 mm).

- e. Install new high pressure bypass valve spring, washer, and disc into bore of body.
- f. Press new retainer plug into body with tool no. 3376011 DFC pressure valve fixture.
- g. Lubricate main drive shaft with engine oil and slide shaft with driven gear into body.
- h. Support drive shaft and press drive gear onto shaft. Position gear so that clearance between gear and body is no less than 0.002 in. (0.050 mm) or more than 0.012 in. (0.030 mm).
- i. Lubricate idler shaft and slide idler gear onto shaft.
- j. Lubricate shafts, bushings, and gears in body and cover.
- k. Install new gasket and secure cover to body with seven capscrews.
- l. Install pipe plug in cover.
- m. Install pressure regulator plunger, new spring, new plug retainer (with new O-rings), washer, and capscrew into body.
- n. Rotate main drive shaft with drive gear to check for freedom of rotation. If binding occurs, disassemble pump to investigate cause.
- o. Check drive shaft end play. Should be 0.002 - 0.005 in. (0.050 - 0.127 mm).
- p. Apply thread sealant to oil pressure tube signal line adapter fitting and install fitting into cover. Install dust cap on fitting.
- q. Slide power steering pump coupling onto drive shaft splines.
- r. Secure coupling with retaining ring.
- s. Wipe assembly clean.
- t. Wrap assembly in protective paper.

Section XXI. OIL PAN REPAIR

3-53. INSPECT OIL PAN

- a. Clean oil pan.



- (1) Carefully remove gasket material from pan mating surfaces.

WARNING

WEAR PROTECTIVE CLOTHING AND GOGGLES WHILE STEAM CLEANING TO PREVENT POSSIBLE PERSONAL INJURY.

- (2) Steam clean pan and mounting parts.

WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- (3) Dry with compressed air.

WARNING

P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

- (4) Clean oil screen with solvent and blow dry with compressed air.

- b. Inspect oil pan.
 - (1) Check oil pan for evidence of leaks. If leak suspected, check by using dye penetrant crack detection kit.
 - (a) Spray suspected area with dye penetrant.
 - (b) Allow penetrant to dry for 15 minutes. Do not force dry.
 - (c) Spray area with dye developer.
 - (d) Check for cracks.
 - (2) Check threaded heli-coils and holes for thread damage.
 - (3) Mark holes and heli-coils for repair.
 - (4) Check screen for broken mesh.
 - (5) Mark screen for replacement if damaged.

3-54. REPAIR OIL PAN

- a. Repair oil pan.
 - (1) Determine hole size.

NOTE

Instructions for use of heli-coil kit are contained inside kit cover.

- (2) Using heli-coil kit, extract damaged heli-coil.
 - (3) Condition hole and insert new heli-coil.
 - (4) Bend installation tip of heli-coil toward center then back toward side of hole to break off tip.
- b. Repair oil pan cracks.

CAUTION

DO NOT ATTEMPT TO WELD FINISHED SURFACES.

- (1) Repair small cracks by heli-arc welding.
- (2) Discard pan if cracks are long or are found in finished surfaces.

- c. Repair oil plug drain hole.

NOTE

Two oversize plugs are available to permit rethreading of drain hole at least twice. Plugs come in 1-1/4 in. (31.75 mm) and 1-3/8 in. (34.92 mm) oversizes.

- (1) Install 1-1/4 in. (31.75 mm) oil drain plug.
- (a) Enlarge damaged hole by drilling to 1-11/64 in. (29.77 mm).

CAUTION

USE LUBRICANT WHEN TAPPING TO PREVENT TEARING OF METAL.

- (b) Tap hole with 1-1/4 in. X 12 tap.

WARNING

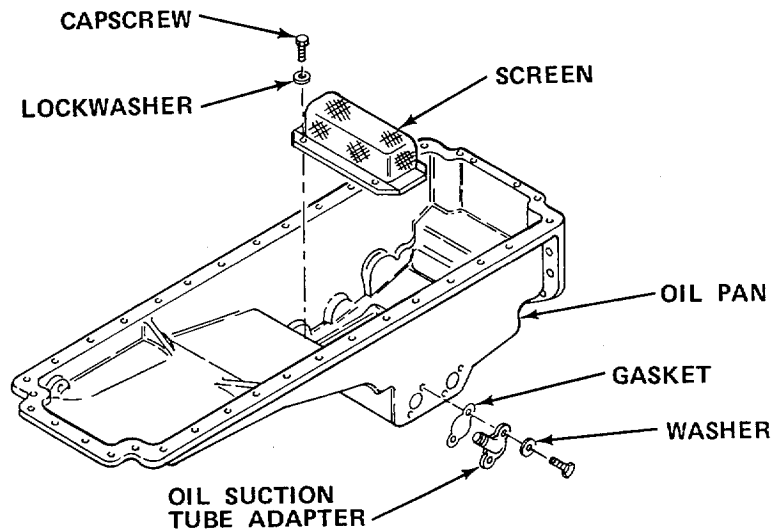
COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- (c) Clean out tapped hole with compressed air.
- (d) Install new drain plug with new copper gasket.
- (e) Torque plug to 60 - 70 ft lbs (81 - 95 N•m).
- (2) Install 1-3/8 in. (34.92 mm) drain plug.
- (a) Enlarge damaged hole by drilling to 1-19/64 in. (32.94 mm).
- (b) Tap hole with 1-3/8 in. X 12 tap.

WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- (c) Clean out tapped hole with compressed air.
 - (d) Install new drain plug with new copper gasket.
 - (e) Torque plug to 60 - 70 ft lbs (81 - 95 N•m).
- (3) Replace screen if defective.

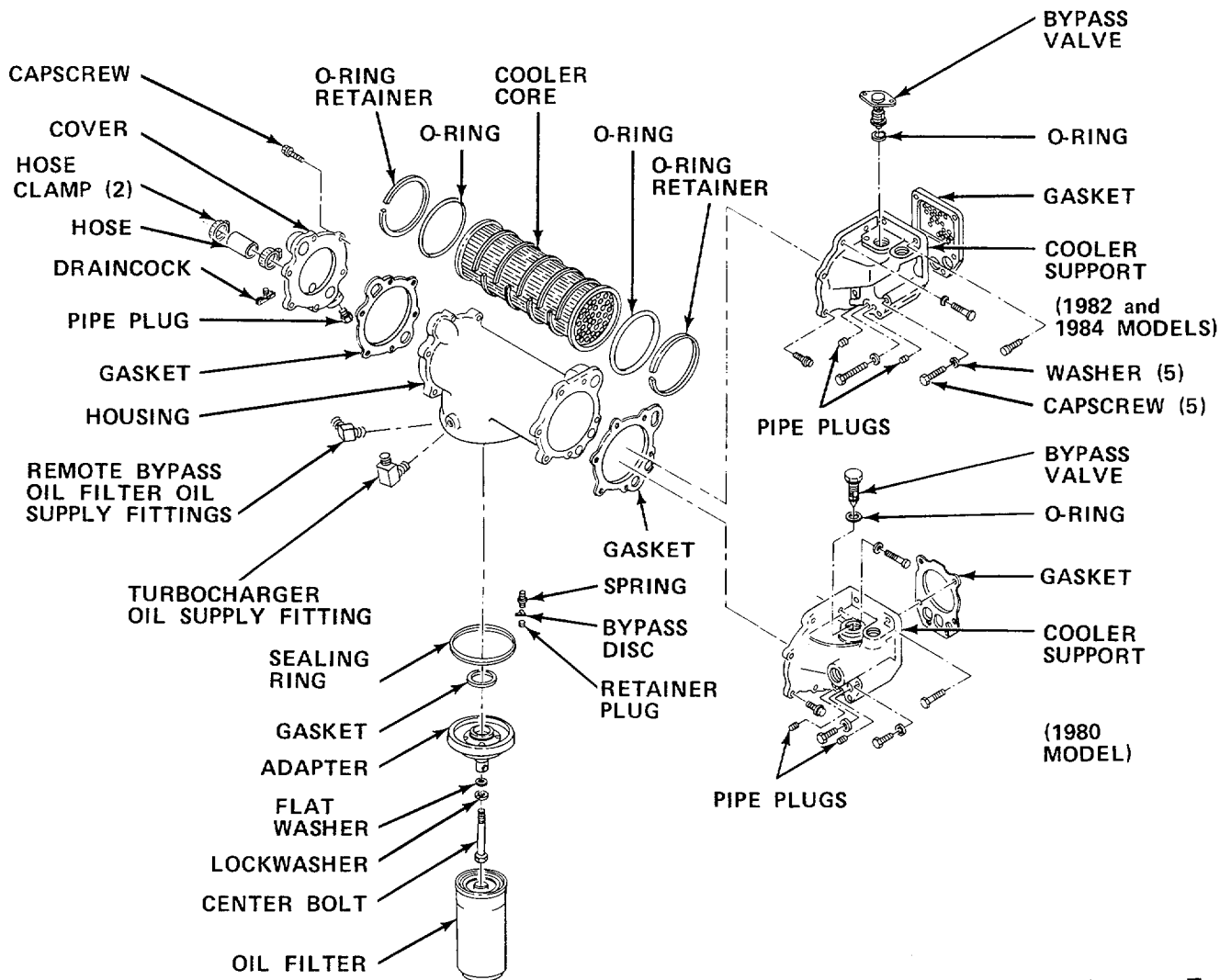


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- (a) Remove capscrews and washers securing oil suction tube adapter to oil pan.
- (b) Remove oil suction tube adapter and discard gasket.
- (c) Remove capscrews and lockwashers securing screen to pan.
- (d) Remove screen.
- (e) Wipe screen mounting surface clean in pan.
- (f) Install new screen.
- (g) Secure with capscrews and lockwashers.
- (h) Using new gasket, secure oil suction tube adapter to oil pan with capscrews and washers.

Section XXII. OIL COOLER ASSEMBLY REPAIR

3-55. DISASSEMBLE OIL COOLER ASSEMBLY



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- a. Remove turbocharger oil supply fitting from housing.
- b. Remove remote bypass oil filter supply fitting from housing.
- c. Remove draincock and pipe plug from cover.

- d. Remove center bolt, lockwasher, flat washer, adapter, gasket, and sealing ring.

NOTE

Bypass valve in support is a temperature sensitive device. When oil temperature is less than 230°F (110°C), approximately half of the oil flow bypasses oil cooler and flows directly to oil filter. When oil temperature exceeds 230°F (110°C), all oil is directed through the cooler which reduces the oil temperature before oil is filtered.

- e. Remove bypass valve and O-ring from cooler support. Discard O-ring.
- f. Remove pipe plugs from cooler support.
- g. Remove capscrews and lockwashers securing cooler support to housing. Discard gasket.
- h. Remove support and gasket from housing. Discard gasket.
- i. Remove capscrews and lockwashers securing cover to housing.
- j. Remove cover and gasket. Discard gasket.
- k. Remove and discard O-ring retainers from both ends of housing.

CAUTION

TAKE CARE WHEN REMOVING O-RING TO PREVENT SCRATCHING OR GROOVING OF HOUSING. DAMAGE TO HOUSING O-RING MATING SURFACE CAN RESULT IN SERIOUS OIL AND COOLING SYSTEM PROBLEMS.

- l. Remove and discard O-rings from both ends of housing.

NOTE

To prevent drying and hardening of foreign substances, clean as soon as possible after removal.

- m. Tilt cooler housing and gently tap end of housing against wooden block until cooler core slips out.

3-56. INSPECT OIL COOLER CORE**WARNING**

P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

- a. Immerse cooler core in cleaning solvent.
- b. Let stand in solvent for one hour.
- c. Force solvent around outside of tubes until clean.
- d. After cleaning, flush cooler core with hot water.
- e. If oil tubes are badly clogged, clean as follows:

WARNING

ADDITIONAL CLEANING WITH CHEMICALS MUST BE DONE IN OPEN AIR OR WELL VENTILATED ROOM. TOXIC EFFECT OF CHEMICALS CAN CAUSE PERSONAL HARM. WEAR PROTECTIVE CLOTHING AND GOGGLES.

- (1) Immerse cooler core in alkaline solution and circulate solution around tubes.
 - (2) After cleaning, flush thoroughly with hot water.
- f. Clean housing and support oil passages by directing solvent through ports in reverse direction of normal flow.

WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- g. Blow compressed air through oil passages to clear of loose foreign matter.

WARNING

MURIATIC ACID (A FORM OF HYDROCHLORIC ACID) IS EXTREMELY HARMFUL TO SKIN. WEAR PROTECTIVE CLOTHING WHEN HANDLING. PROTECT EYES WITH GOGGLES.

- h. Immerse cooler core in solution of 1 part muriatic acid and 9 parts water after adding 1 lb (0.45 kg) of oxalic acid and 0.01 gal. (88 ml) of pyridine to each 5 gal. (19 l) of acid.
- i. Remove cooler core when foaming and bubbling stops. This generally takes 30 to 60 seconds.
- j. Immerse cooler core in 5 percent solution of sodium carbonate. This neutralizes acids.
- k. Remove cooler core when bubbling stops.
- l. Pressure flush all tubes with warm water.
- m. Flush tubes with clean, light oil after cleaning complete.
- n. Steam clean inside of housing, cover, and support.

WARNING

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- **P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.**

- o. Clean all other parts in solvent and dry with compressed air.
- p. Check cooler core tubes for leakage.
 - (1) Secure cooler core to tool no. 3375253 tube bundle tester.
 - (2) Immerse cooler core in water.
 - (3) Apply 30 psi (207 kPa) air pressure to tester end plate.
 - (4) If bubbles are observed, mark cooler core for repair.
 - (5) Cut off air pressure and remove cooler core from fixture.

- q. Check cooler support for cracks and distorted gasket mating flanges. Replace if defective.
- r. Inspect cooler cover for cracks and distorted gasket mating surface. Replace if defective.
- s. Inspect filter adapter for cracks and distortions. Replace if defective.
- t. Inspect housing gasket mating surfaces for cracks and distortions. Replace if defective.

3-57. REPAIR OIL COOLER CORE

NOTE

Repair of cooler is limited to core tube repair.

- a. Repair damaged tubes by inserting a small outside diameter tube inside damaged tube.
- b. Cut and flare ends.

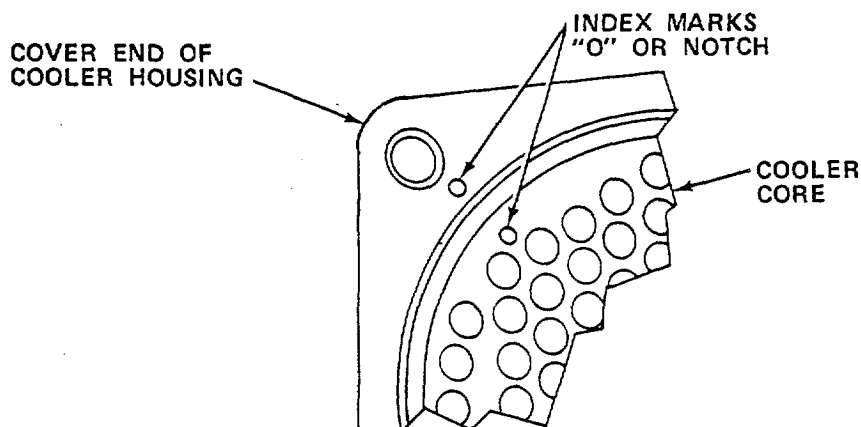
CAUTION

TAKE CARE NOT TO DAMAGE HEADERS OR OTHER TUBES WHILE SOLDERING.

- c. Solder tube securely to headers at both ends.
- d. If more than 5 percent of tubes are defective, discard cooler core.
- e. Test cooler core for leaks (para 3-56p).
- f. Wipe cooler core clean.

3-58. ASSEMBLE OIL COOLER ASSEMBLY

- a. Lubricate new housing O-ring with engine oil.
- b. Place O-ring in groove on cover end of housing. Ensure that O-ring is fully seated and not twisted.

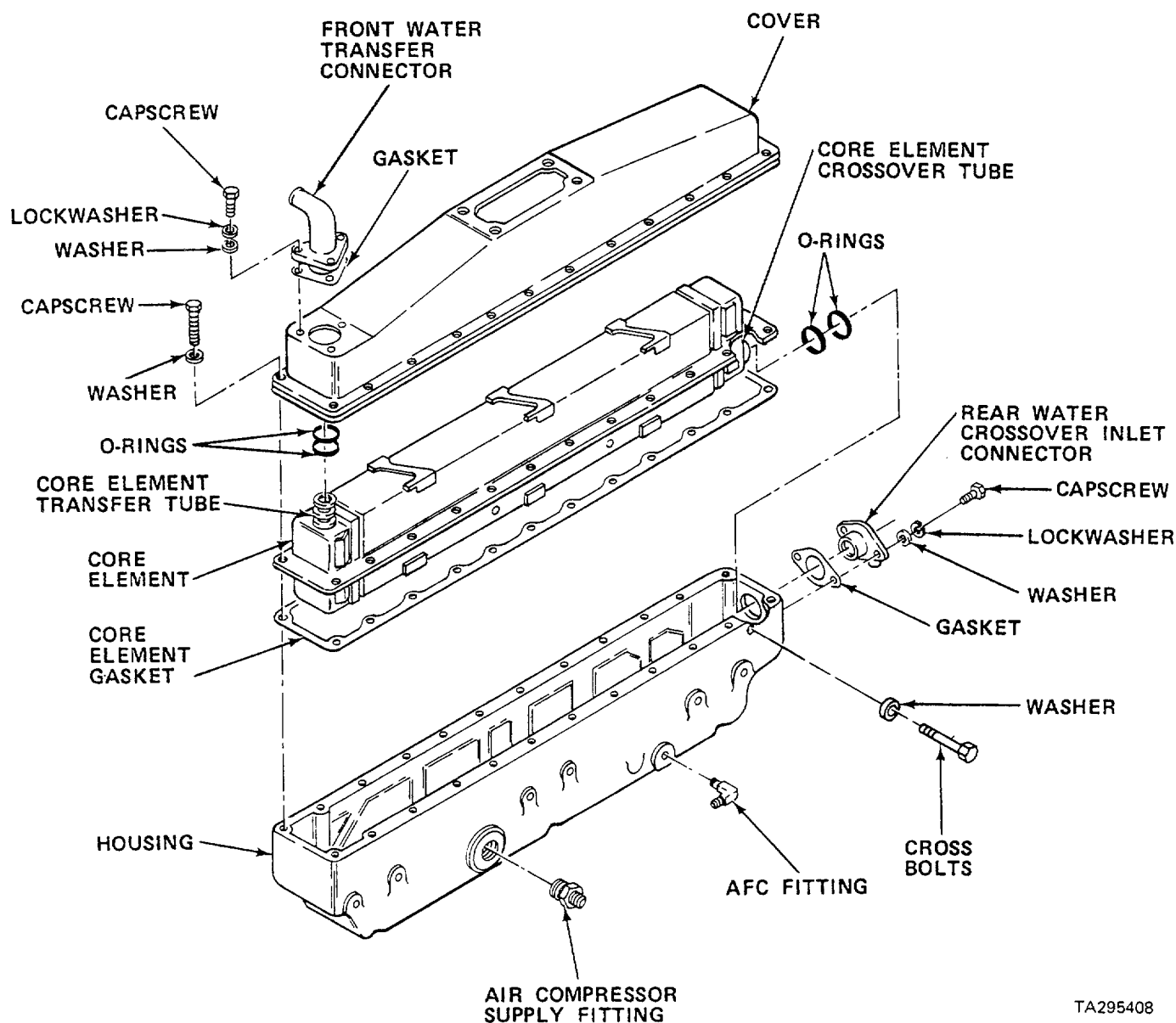


TA295407

- c. Carefully insert cooler core into housing, aligning index mark or notch on cooler core with mark or notch on housing. Do not disturb position of O-ring.
- d. Install new lubricated O-ring in groove at opposite end of housing. Ensure that O-ring is fully seated and not twisted.
- e. Install O-ring retainers in each end of housing.
- f. Install new cover gasket and position cover on housing.
- g. Secure cover with capscrews and lockwashers. Torque screws to 30-35 ft lbs (41-47 N-m).
- h. Install new support gasket and position support on housing.
- i. Secure support with capscrews and lockwashers. Torque screws to 30-35 ft lbs (41-47 Nm).
- j. Apply thread sealant to bypass valve and tightly secure in housing.
- k. Install spring, bypass disc, and plug retainer into housing.
- l. Install new sealing ring, new gasket, adapter, flat washer, lockwasher, and center bolt into housing. Tighten securely.
- m. Apply thread sealant to support and cover pipe plugs and install plugs. Tighten securely.
- n. Apply thread sealant to draincock and install draincock into cover. Tighten securely.
- o. Apply thread sealant to turbocharger oil supply fitting and remote bypass oil filter supply fitting.
- p. Install fittings and tighten securely.
- q. Wipe assembly clean.
- r. Cap fittings and plug all openings.

Section XXIII. AFTERCOOLER REPAIR

3-59. DISASSEMBLE AFTERCOOLER



- Remove capscrews and washers securing rear water crossover inlet connector and remove connector.
- Remove gasket and discard.
- Remove capscrews and washers securing front water transfer connector and remove connector.
- Remove gasket and discard.

- e. Remove capscrews and washer securing aftercooler cover and remove cover.
- f. Remove cross bolts securing core element and lift element out from aftercooler housing.
- g. Remove core element gasket and discard.
- h. Remove O-rings from core element rear water crossover and front water transfer tubes. Discard O-rings.
- i. If necessary, remove AFC fitting and air compressor supply fitting from housing.

3-60. CLEAN COMPONENTS

- a. Clean housing and cover with mild detergent and water. Rinse and dry thoroughly.
- b. Carefully scrape all gasket material from mating surfaces.
- c. Flush core element with water until water draining from core element appears clear.

3-61. INSPECT COMPONENTS

- a. Pressurize core element to 8 - 9 psi (55 62 kPa) and submerge in water tank. Repair by welding as required.
- b. Check O-ring grooves for nicks and burrs. Use crocus cloth to remove any minor defects. Replace core if minor defects cannot be removed.
- c. Inspect housing, cover, and sealing surfaces for breaks or distortions. Replace damaged parts.
- d. Inspect all threads for damage. Chase threads with appropriate size taps to remove defects.
- e. Inspect inner surfaces of water connectors. Replace if scratched or distorted.

3-62. REASSEMBLE AFTERCOOLER

- a. Place gasket on housing-to-core element mating surface.
- b. Lubricate O-rings with engine oil and position in grooves of water connectors of core element.
- c. Carefully place core element in housing and align element and housing cross bolt holes.
- d. Secure core element to housing with washers and cross bolts.
- e. Alternately torque cross bolts initially to 15 ft lbs (21 N•m) then to 25 ft lbs (35 N•m).

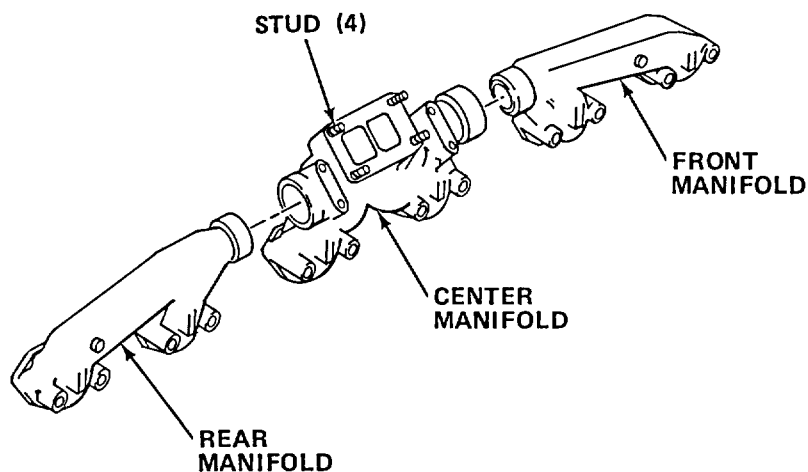
CAUTION

BE CAREFUL NOT TO DAMAGE O-RINGS WHEN INSTALLING WATER CONNECTORS. LEAKAGE CAN RESULT.

- f. Place gasket on rear water crossover connector and insert connector on core element crossover tube.
- g. Secure connector with washers and capscrews finger tight.
- h. Install cover with washers and capscrews. Tighten all capscrews.
- i. Place gasket on front water transfer connector and insert connector on core element tube.
- j. Secure connector with capscrews and washers finger tight.
- k. Torque water crossover connector capscrews to 27 32 ft lbs (37 43 N•m).
- l. Starting at middle of aftercooler and alternating on either side of cover and either side of center, torque cover capscrews to 25 ft lbs (34 N•m).
- m. Torque water transfer connector capscrews to 15 20 ft lbs (21 27 N•m).
- n. Install AFC fitting and air compressor supply fitting.
- o. Plug all openings.
- p. Wipe aftercooler clean.

Section XXIV. EXHAUST MANIFOLD REPAIR

3-63. INSPECT EXHAUST MANIFOLDS



TA295409

- a. Separate manifolds.

WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
- WEAR PROTECTIVE CLOTHING AND GOGGLES WHILE STEAM CLEANING TO PREVENT POSSIBLE PERSONAL INJURY.

- b. Steam clean manifolds and dry with compressed air.
- c. Inspect manifolds for cracks and distortions.
- d. Discard defective parts.
- e. Check center manifold turbocharger mounting studs for corrosion, thread distortion, and bends.
- f. Mark defective studs for replacement.

3-64. REPAIR CENTER EXHAUST MANIFOLD

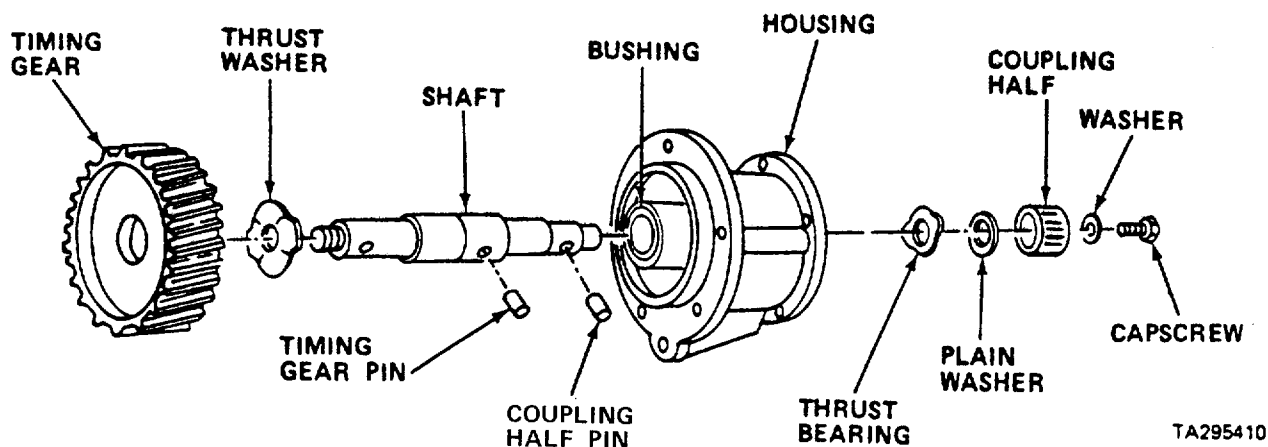
NOTE

Repair of center exhaust manifold is limited to replacement of turbocharger mounting studs.

- a. With vise grips locked onto stud, slowly and carefully remove stud to prevent from breaking.
- b. Run worn tap into threads to remove corrosion and clean distorted threads.
- c. Coat stud threads with antisieze compound.
- d. Install stud.

Section XXV. ACCESSORY DRIVE ASSEMBLY REPAIR

3-65. DISASSEMBLE ACCESSORY DRIVE ASSEMBLY



TA295410

- a. Remove capscrew and washer from end of shaft.
- b. With gear puller, remove coupling half, and pin.
- c. Remove plain washer and thrust bearing from shaft.
- d. Place assembly in press and press shaft and timing gear out of housing.
- e. Press shaft from timing gear.
- f. Remove thrust washer from shaft.
- g. Remove timing gear pin from shaft.

3-66. INSPECT ACCESSORY DRIVE ASSEMBLY

- a. Place parts in wire basket and clean in ultrasonic cleaner.

WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- b. Dry parts with compressed air and direct air through oil port to clear of foreign matter.
- c. Check shaft for wear, distortion, or galling at bushing mating surface.
- d. Measure outside diameter of shaft at bushing mating surface.
- e. Discard shaft if diameter less than 1.310 in. (33.274 mm).
- f. Measure inside diameter of bushing for wear and out-of-round.
- g. Mark bushing for replacement if 0.002 in. (0.050 mm) out-of-round or diameter exceeds 1.321 in. (33.553 mm).
- h. Inspect coupling half and mating splined drive coupling for worn, chipped, or cracked splines.
- i. Replace coupling if defective.
- j. Replace thrust washers if worn or damaged.
- k. Check timing gear for cracked, chipped, worn, or missing teeth.
- l. Replace gear if defective.
- m. Check housing for cracks or distortions. Replace if defective.
- n. Check shaft bushing. If it rotates freely in housing, mark bushing for replacement.

3-67. REPAIR ACCESSORY DRIVE ASSEMBLY**NOTE**

Repair of accessory drive assembly is limited to replacement of housing bushing.

- a. Using mandrel, press bushing from housing.
- b. Wipe bore clean.
- c. Align oil hole in bushing with hole in housing and press new bushing into housing until flush with face of bore.
- d. Check oil hole alignment.
- e. Wipe assembly clean.

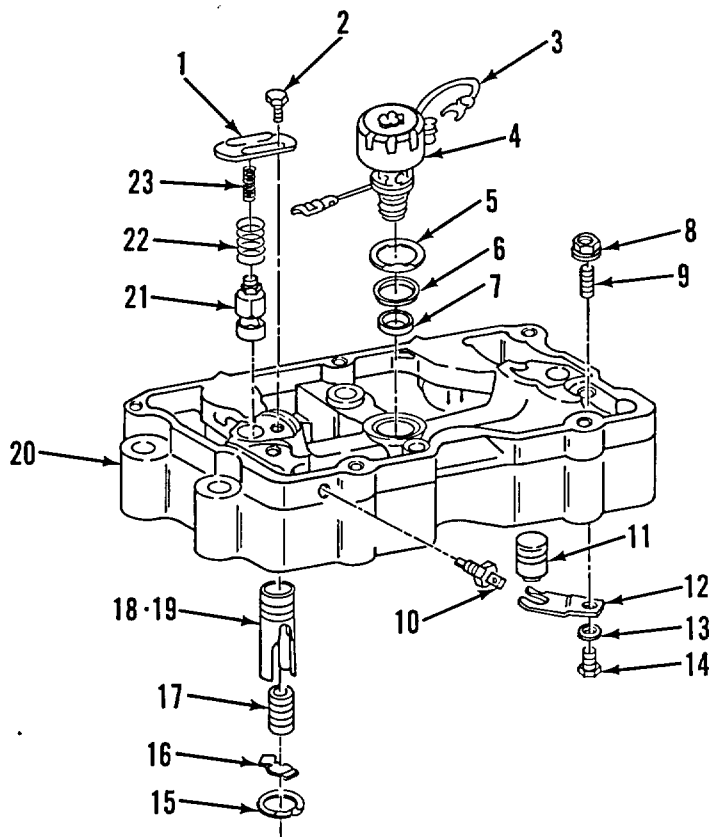
3-68. ASSEMBLE ACCESSORY DRIVE

- a. Lubricate shaft with engine oil and place large thrust washer (grooves facing gear) and timing gear pin on shaft.
- b. Press timing gear on shaft.
- c. Press shaft and timing gear assembly into housing.
- d. Turn assembly over and install small thrust bearing (grooves facing coupling) flat washer, and coupling half pin on shaft.
- e. Lubricate shaft with engine oil and press coupling half on shaft.
- f. Install washer and capscrew and torque to 30 35 ft lbs (41 47 N•m).
- g. With dial indicator pin against end of shaft, measure end (axial) clearance. Disassemble drive and replace thrust washer if end clearance exceeds 0.024 in. (0.609 mm).
- h. Wipe entire assembly clean and wrap in protective paper.

Section XXVI. ENGINE BRAKE ASSEMBLY REPAIR

3-69. DISASSEMBLE ENGINE BRAKE ASSEMBLY

a. Remove valve control assembly.



TA295411

LEGEND:

- | | |
|------------------------------|---|
| 1. CONTROL VALVE COVER (2) | 13. WASHER (2) |
| 2. CAPSCREW (2) | 14. RETAINING SCREW (2) |
| 3. HARNESS | 15. RETAINING RING (2) |
| 4. SOLENOID VALVE ASSEMBLY | 16. SLAVE PISTON RETAINER (2) |
| 5. UPPER SEAL RING | 17. SLAVE PISTON SPRING (2) |
| 6. CENTER SEAL RING | 18. SLAVE PISTON (2) |
| 7. LOWER SEAL RING | 19. SLAVE PISTON (2)
(FOR MILLED CYLINDER HEADS) |
| 8. LOCKNUT (2) | 20. BRAKE HOUSING ASSEMBLY |
| 9. ADJUSTING SETSCREW (2) | 21. CONTROL VALVE (2) |
| 10. TERMINAL | 22. CONTROL VALVE OUTER SPRING (2) |
| 11. MASTER PISTON (2) | 23. CONTROL VALVE INNER SPRING (2) |
| 12. MASTER PISTON SPRING (2) | |

WARNING

COVER IS UNDER LOAD BY CONTROL VALVE SPRING AND MAY EJECT SUDDENLY CAUSING POSSIBLE PERSONAL INJURY.

(1) Apply finger pressure to control valve cover and remove capscrew (2).

- (2) Slowly release pressure on cover (1) to allow stop spring to expand and remove control valve outer spring (22).
 - (3) Remove control valve inner spring (23).
 - (4) Remove control valve (21) with pliers.
 - (5) Matchmark position of spring retainer to control valve, and remove retainer, retainer spring, and ball check valve from control valve.
- b. Remove solenoid valve assembly.
- (1) Detach solenoid electrical harness (3) from brake housing connector terminal (10).
 - (2) Install solenoid wrench no. 011494 and remove solenoid valve assembly (4).
 - (3) Remove upper seal ring (5) and center seal ring (6) from solenoid valve.
 - (4) Remove lower seal ring (7) from brake housing.
- c. Remove slave piston adjusting setscrew (9) and locknut (8).
- d. Turn retarder housing over so that bottom is facing upward.
- e. Remove slave piston.

WARNING

SLAVE PISTON IS RETAINED BY SPRING UNDER HEAVY COMPRESSION. PROGRESSIVE SPRING EXPANSION MUST OCCUR TO PREVENT RAPID DISCHARGE OF SPRING WHICH COULD CAUSE PERSONAL INJURY.

- (1) Using a C-clamp and deep socket, relieve tension on retaining ring (15) by applying force to slave piston retainer (16).
 - (2) Remove retaining ring (15), C-clamp and deep socket.
 - (3) Remove piston retainer (16), spring (17), and slave piston (18) from housing.
- f. Remove master piston.
- (1) Remove master piston retaining screw (14), washer (13), and master piston spring (12).
 - (2) Remove master piston (11).
- g. Remove terminal (10) from brake housing.

3-70. INSPECT COMPONENTS

- a. Clean all parts in ultrasonic cleaner. Dry thoroughly.
- b. Using a micrometer, measure outside diameter of master piston, control valve, and slave piston for uneven wear. Replace defective part(s).
- c. Inspect master piston, control valve, and slave piston for scoring. Replace defective part(s).
- d. Test slave piston spring and control valve outer spring on tester.
- e. Replace springs not meeting following specifications:

Spring Specifications

Slave Piston Spring	Load at 1.625 in. (41.3 mm) 62.5 - 69.5 lbs (278-309 N) Load at 1.478 in. (37.5 mm) 71.5 - 80.5 lbs (318-358 N) Free length 2.58 in. (66 mm) Number of coils - 13 approx.
Control Valve Spring	Load at 0.5 in. (12.7 mm) 4.7 - 5.3 lbs (21-24 N) Load at 0.812 in. (20.6 mm) 0.7 - 1.3 lbs (3-6 N) Free length 0.9 in. (22.9 mm) Number of coils 8 approx.

3-71. ASSEMBLE ENGINE BRAKE ASSEMBLY

- a. Install master piston.

CAUTION

ENSURE THAT ALL BORES IN BRAKE HOUSING ARE CLEAN BEFORE PISTONS AND VALVE ARE INSTALLED.

- (1) Lubricate exterior of master piston (11) with engine oil and insert piston into brake housing (20).
- (2) Position master piston spring (12) with concave part of spring toward piston and spring centered on turned boss on top of piston.
- (3) Secure spring (12) with washer (13) and capscrew (14).

- b. Install slave piston..

- (1) Insert slave piston (18) into its bore. Place spring (17) and piston retainer (16) into slave piston.
- (2) With C-clamp and deep socket acting against piston (18) and piston retainer (16), tighten C-clamp to compress spring and retainer (16) in position.

WARNING

ENSURE THAT RETAINING RING IS PROPERLY SEATED IN BRAKE HOUSING. IMPROPER SEATING COULD CAUSE EJECTION OF SPRING AND POSSIBLE PERSONAL INJURY.

- (3) Position retaining ring (15) in groove of brake housing and remove C-clamp and socket.
- (4) Install slave piston adjusting setscrew (9) and locknut (8).

c. Install solenoid valve assembly.

- (1) Install lower seal ring (7) in housing (20).
- (2) Install upper seal ring (5) and center seal ring (6) on solenoid valve (4).
- (3) Lubricate seal rings with engine oil.
- (4) Carefully screw solenoid valve (4) assembly into brake housing (20).
- (5) Install terminal (10) into housing (20).
- (6) Secure solenoid electrical harness (3) to brake housing connector terminal (10).

d. Install control valve assembly.

- (1) Install ball check valve and spring into control valve and secure with retainer. Screw retainer into valve until match marks align.
- (2) Lubricate exterior of control valve (21) with engine oil and slide valve into brake housing.
- (3) Place inner spring (23) and outer spring (22) onto valve (21).
- (4) Compress spring with cover (1) and secure plate with socket head capscrew (2).

NOTE

Slave piston adjustment is made upon installation of retarder housing.

e. Wipe brake housing clean and wrap in protective paper.

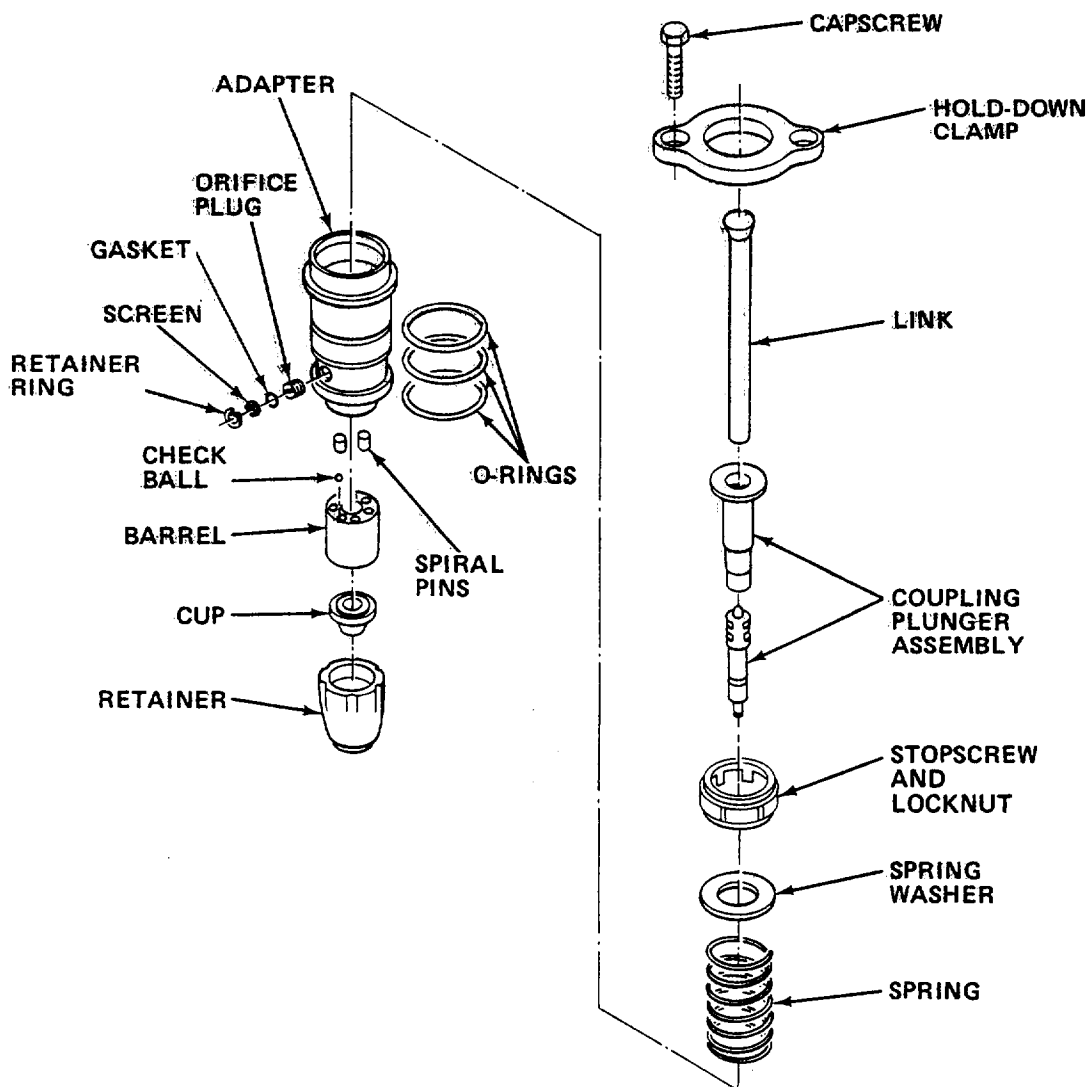
Section XXVII. FUEL INJECTOR REPAIR

3-72. DISASSEMBLE FUEL INJECTOR

CAUTION

ENSURE THAT ALL PARTS AND -WORK AREA ARE MAINTAINED IN A CLEAN CONDITION IN ORDER TO PREVENT INTERNAL CONTAMINATION AND SUBSEQUENT FAILURE OF REPAIRED INJECTOR.

- a. Disassemble fuel injector.



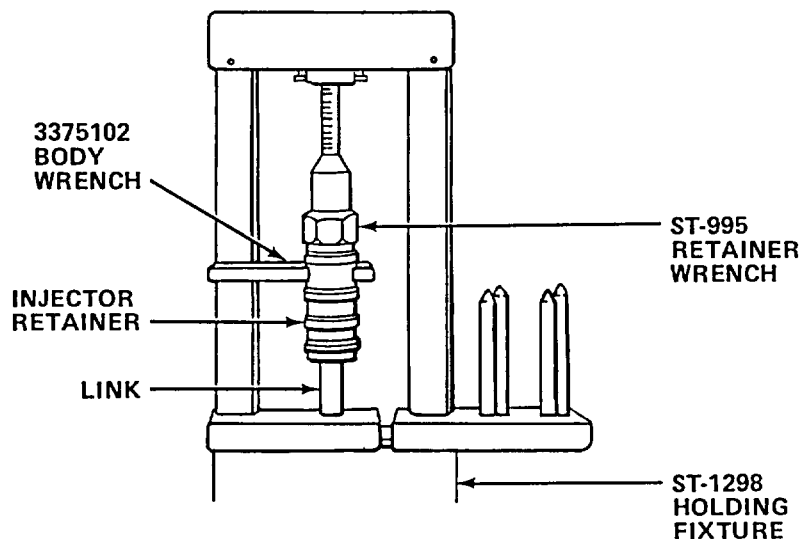
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- (1) Remove coupling/plunger assembly from injector.
- (2) Remove O-rings from injector assembly adapter and discard seals.

NOTE

Do not remove orifice plug from inlet. Plug will be checked during testing.

- (3) Remove screen retainer ring, screen, and gasket. Discard parts.
- (4) Loosen stopscrew and locknut. Slowly unscrew stopscrew and locknut from injector adapter.
- (5) Remove injector spring washer and spring.



NOTE
AIR CYLINDER OMITTED
FOR CLARITY.

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- (6) With injector tip facing upward, slide ST-995 retainer wrench over injector retainer and mount injector on ST-1298 holding fixture.
- (7) Engage 3375102 fixture body wrench over flats on injector adapter to keep injector from rotating.
- (8) Tighten fixture stud to hold injector in place.
- (9) With a 1-1/4 in. wrench engaged with ST-995 retainer wrench, loosen injector retainer.
- (10) Loosen fixture stud and remove injector retainer.

NOTE

Do not lose check ball.

- (11) Screw off injector retainer and remove cup and barrel. Remove check ball spiral pins from top of barrel.

3-73. INSPECT INJECTOR PARTS

a. Clean all injector parts.

- (1) Place parts in basket and clean in ultrasonic cleaner.

WARNING

MINERAL SPIRITS ARE POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

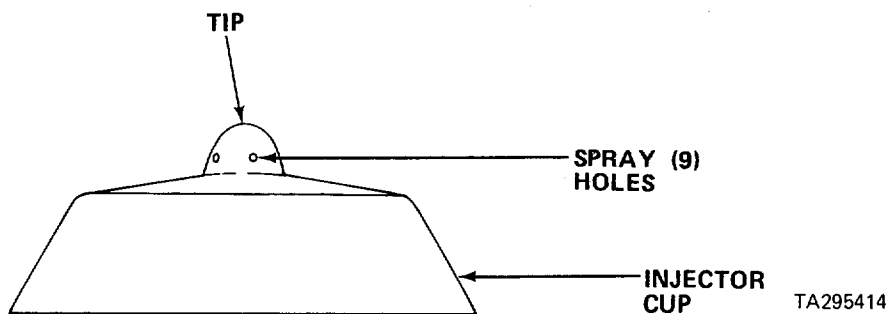
- (2) Neutralize solvent after cleaning by dipping parts in mineral spirits.

WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

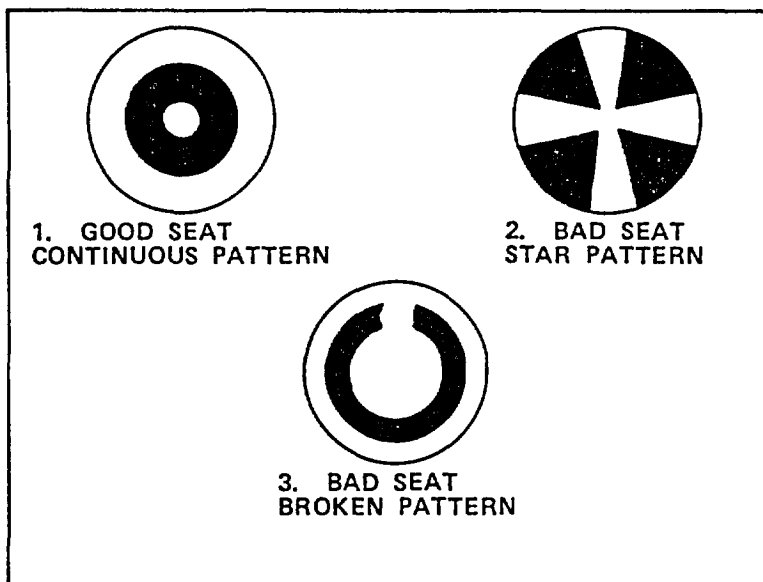
- (3) Dry with compressed air.

b. Inspect injector cup.



- (1) Inspect cup spray holes and tip with an illuminated magnifier. Compare them with new cup. Discard cup if any of following conditions exist:
- (a) Abrasive wear. Wear can begin internally; therefore, inspect both interior and exterior.
 - (b) Corrosion damage and effects of excessive heat.
 - (c) Enlarged or distorted spray holes. This may be caused by cleaning with drills, wire, or brushing with a wire brush or crocus cloth.

- (2) Select a new plunger and coat with Prussian bluing.



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CAUTION

DO NOT ALTER SIZE OF INJECTOR CUP SPRAY HOLES.

- (3) Insert plunger into cup and rotate plunger 90°. If plunger seat covers a 40 percent continuous area around cup cone it is possible to reuse cup if it passes cup-to-plunger leak test. Compare contact patterns to those shown in above illustration.
- (4) Check injector cup to barrel contact surface for distortion and flatness. Use surface plate to check for flatness. Replace cup if any defects noted.

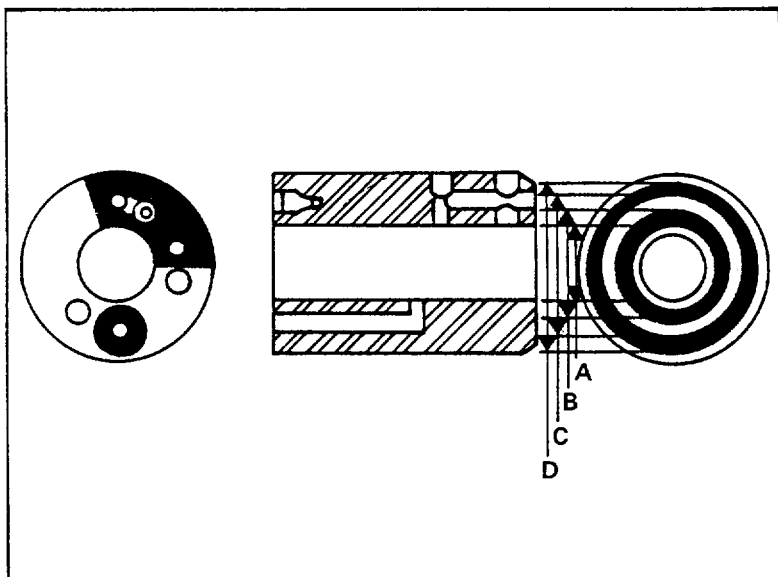
- c. Inspect injector barrel.

CAUTION

BARREL AND PLUNGER ARE MATCHED SETS AND MUST BE REPLACED AS AN ASSEMBLY TO ENSURE PROPER OPERATION OF INJECTOR.

- (1) Inspect barrel plunger bore for scoring. If injector passes leakage test after reassembly, barrel is useable.
- (2) Using illuminated magnifier, check for burrs, carbon, and distorted radii in orifice.

- (3) Check barrel for cracks.



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- (4) Check injector barrel surfaces for mutilation and flatness in black areas as shown:

- (a) Apply Prussian bluing to both ends of barrel.
- (b) Using a surface plate, check surfaces for flatness.
- (c) If mutilation or unevenness are found, lap surfaces with a grade A 280 grit lapping compound to remove mutilation or unevenness.

- d. Inspect cup retainer.

- (1) Inspect threads for damage.
- (2) Check outside cone area for nicks or burrs which could prevent proper seating with sleeve in head.
- (3) Inspect inside of cone area on cup seating ledge for nicks and burrs which could prevent cup seating.

- e. Inspect ball and seat.

- (1) Check ball seat for nicks and burrs. If marred, lap barrel.

CAUTION

CHECK BALL IS MADE OF SPECIAL MATERIAL. DO NOT ATTEMPT TO SUBSTITUTE WITH A COMMERCIAL BALL. SUBSTITUTION OF CHECK BALL WILL RESULT IN PREMATURE FAILURE OF INJECTOR.

- (2) Check ball for wear or distortion. If defective, replace.

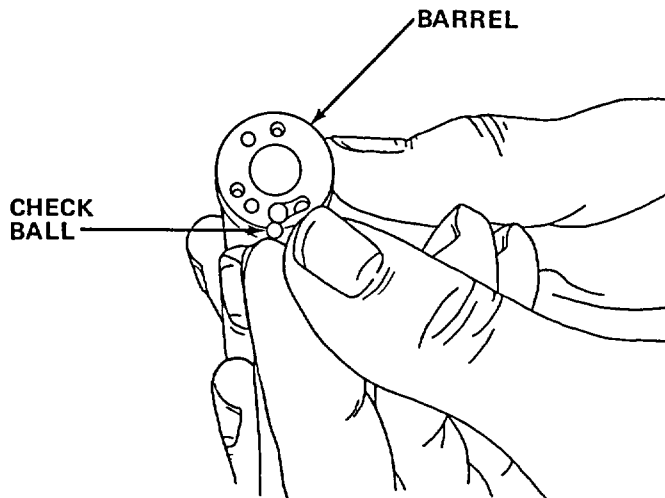
- f. Inspect adapter.
 - (1) Check orifices for burrs or blockage.
 - (2) Check cup retainer threads for damage.
 - (3) Check O-ring grooves for nicks, burrs, or any other defects which could damage O-rings during installation.
 - (4) Inspect barrel mating surface for nicks or burrs. If damaged, lap to repair.

3-74. ASSEMBLE INJECTOR

CAUTION

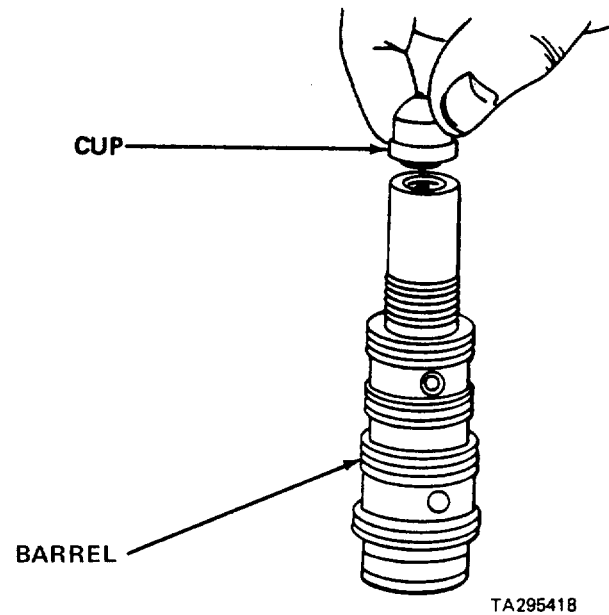
ENSURE THAT ALL MATING SURFACE ARE CLEAN BEFORE ASSEMBLING.

- a. Install check ball into top of barrel.



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- b. Hold barrel with check ball up and place new adapter spiral pins into barrel.
- c. Mate barrel to adapter engaging spiral pins. Be sure not to drop check ball.



- d. Turn assembly with barrel up and place cup on barrel.
- e. Lubricate cup retainer threads and cup flange contact area with engine oil and screw retainer onto adapter finger tight. Loosen 1/4 turn.
- f. Coat plunger with clean injector test oil and install in adapter.
- g. Install three O-rings on adapter.
- h. Turn injector with cup side up and slide ST-995 retainer wrench over retainer and mount injector in ST-1298 holding fixture.
- i. Engage 3375102 fixture body wrench over flats on injector adapter to keep injector from rotating.
- j. Lubricate holding fixture stud threads with general purpose oil and tighten stud to 75 in. lbs (8.5 N•m) to ensure cup-to-plunger alinement.
- k. With 1-1/4 in. wrench engaged with ST-995 retainer wrench, torque retainer to 50 ft lbs (68 N•m).

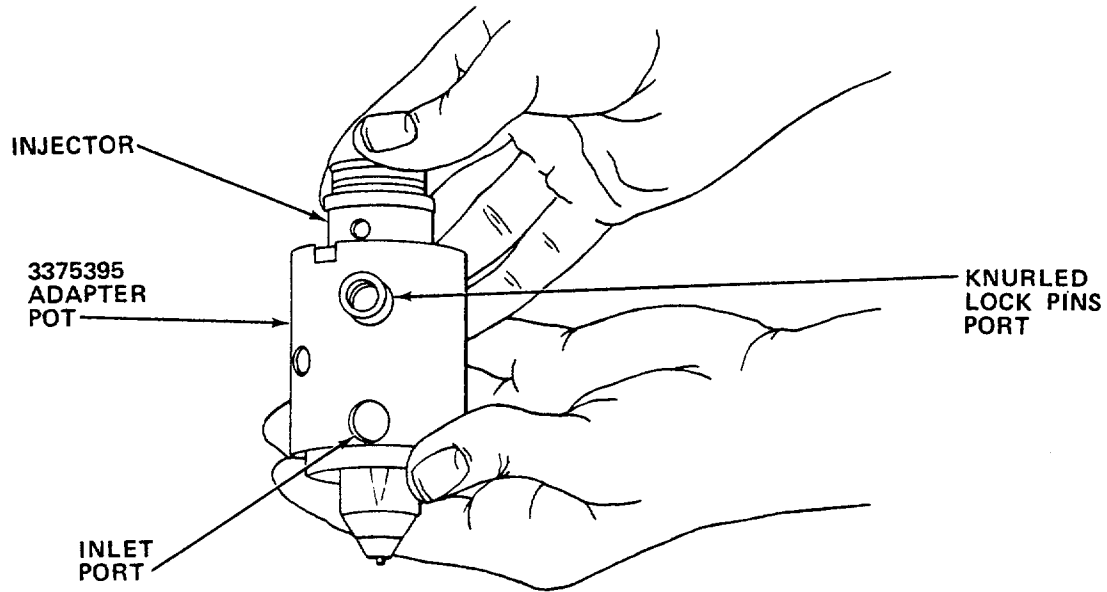
CAUTION

DO NOT HIT CUP ON STUD WHEN REMOVING INJECTOR FROM HOLDING FIXTURE. MAY DAMAGE TIP.

- l. Loosen fixture stud enough to allow for unobstructed removal of injector and remove injector.
- m. To check cup to plunger alignment, remove plunger and coat with clean fuel oil or test oil.
- n. Hold injector in vertical position (cup down) and allow plunger to drip a few drops of oil into cup.
- o. Insert plunger approximately 1/2 in. (12.7 mm) into barrel and install a suitable plunger extension tool into plunger.
- p. With palm of hand, jam plunger into cup and rotate injector 90 while holding plunger firmly against cup seat.
- q. Hold injector with cup up; plunger should slide out when injector is lifted quickly.
- r. If plunger does not slide out, remove plunger, coat tip with oil and repeat alignment test.
- s. If plunger still sticking, remount injector in holding fixture, loosen and repeat alignment test.
- t. If plunger still sticking, remount injector in holding fixture, loosen cup retainer, rotate cup 1/4 turn, and retorque retainer. Repeat as necessary.
- u. Install new gasket, new screen, and new retainer in injector fuel inlet port.
- v. Insert link into adapter.
- w. After assembly, wrap injector in protective paper until ready for testing.

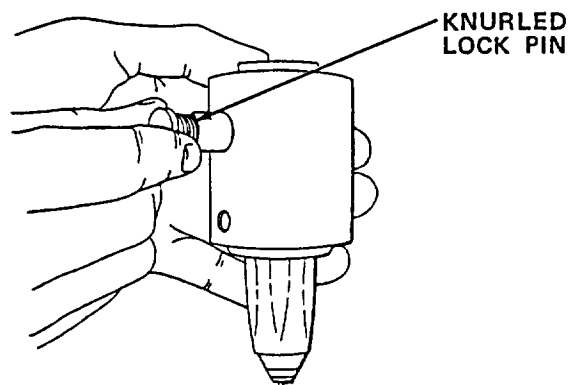
3-75. TEST INJECTOR

- a. Prepare injector for plunger-to-barrel leakage test, check ball leakage test, and plunger-to-cup tip leakage check using 3375375 leakage tester:
 - (1) Remove injector inlet retainer and screen.
 - (2) Remove injector stopscrew, locknut, washer, and spring if installed.



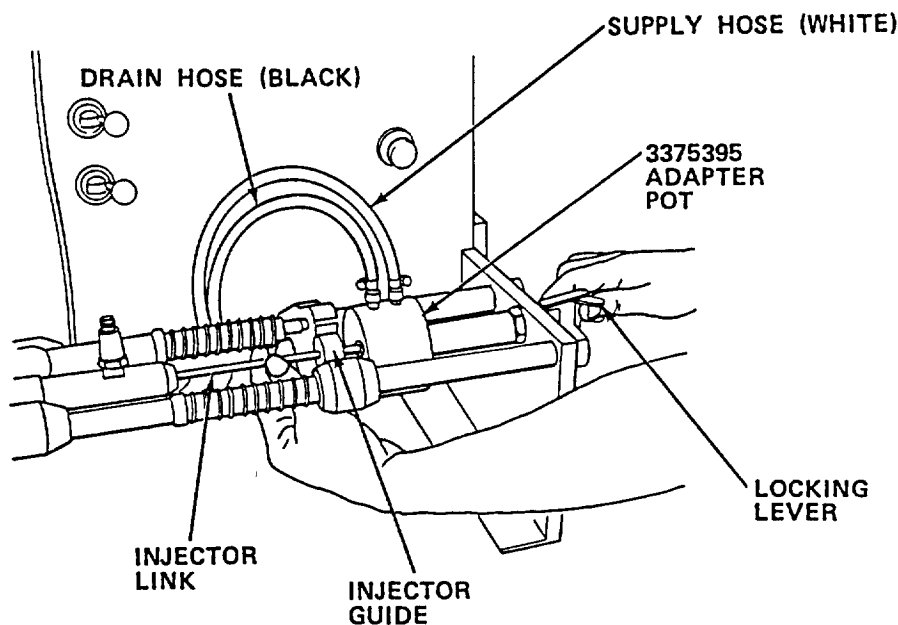
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- (3) Lubricate O-rings on exterior of injector and insert injector into 3375395 adapter pot.



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- (4) Tighten knurled lock pin to lock injector in place.
- (5) Install 3375397 injector plunger extension in top of injector plunger and tighten knurled knob to lock in place.
- (6) Insert 3375396 link into plunger extension.



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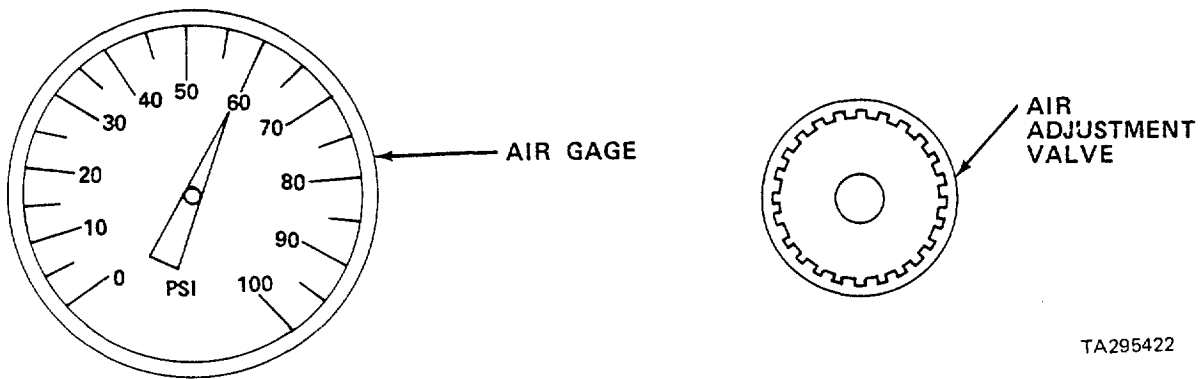
- (7) Install entire assembly into injector guide, link end first. Secure in place with locking lever.

NOTE

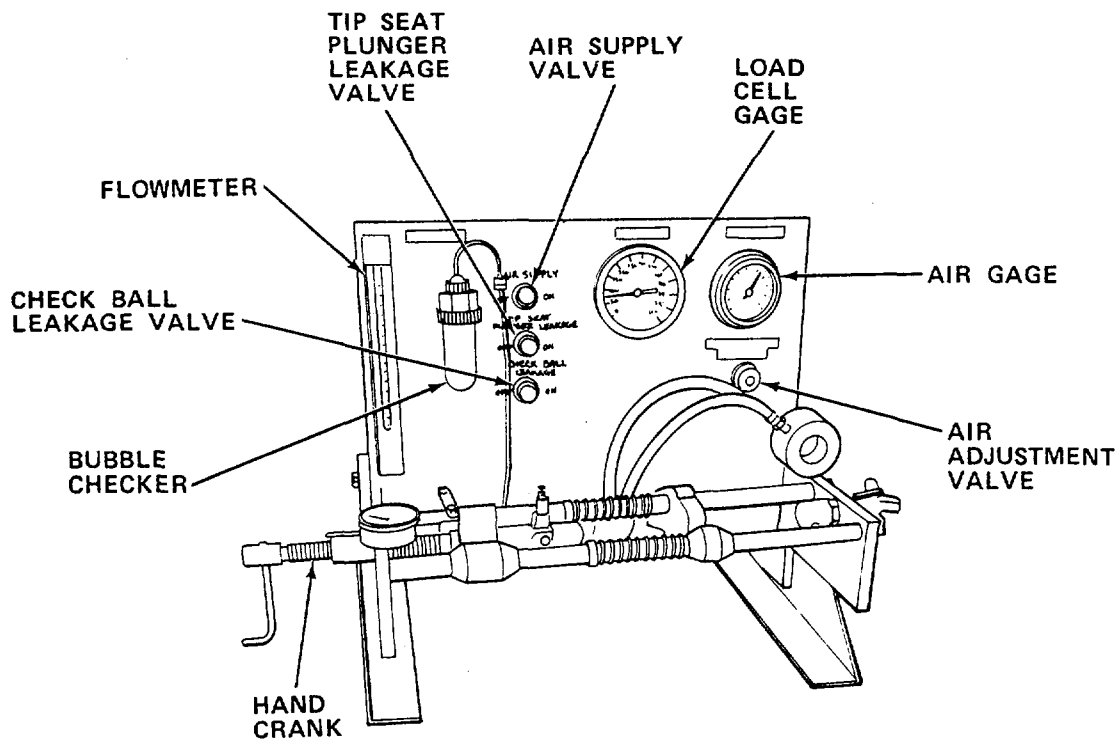
Supply (white) hose attaches to fitting located nearest the injector cup.

- (8) Install supply and drain hoses to fittings on adapter pot.

b. Perform plunger-to-cup tip leakage test.



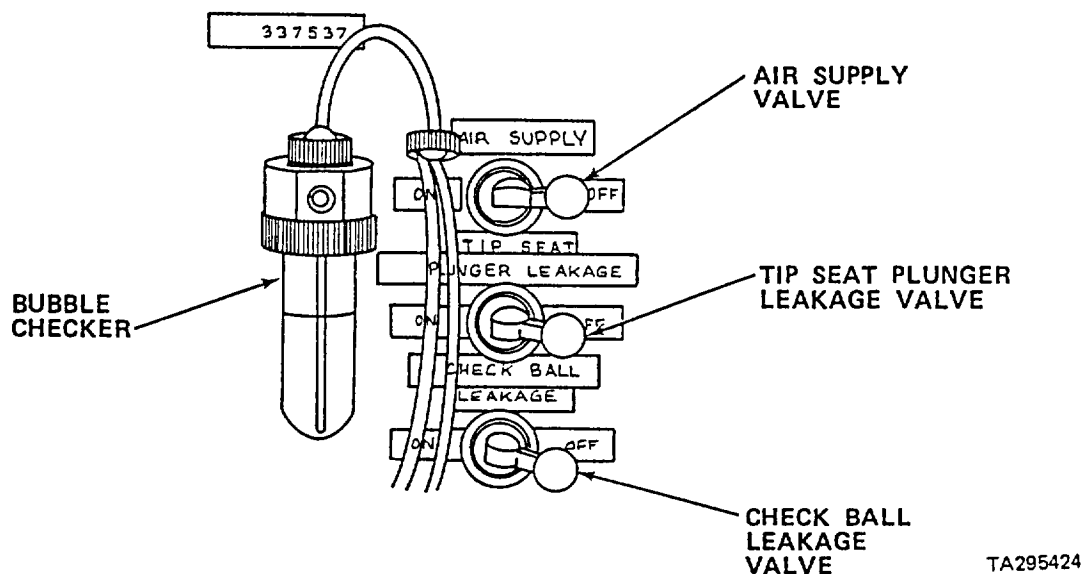
(1) Adjust air pressure to 60 psi (414 kPa) with air adjustment valve.



CAUTION

DO NOT OVERLOAD CELL GAGE. DAMAGE TO GAGE MAY OCCUR.

(2) Adjust hand crank to show 200 lbs on load cell gage.



- (3) Place AIR SUPPLY valve OFF.

NOTE

The AIR SUPPLY valve must be OFF whenever other valves are switched either ON or OFF. The rush of air may blow oil from bubble checker.

- (4) Turn TIP SEAT PLUNGER Leakage valve ON and turn AIR SUPPLY valve ON and look for bubbles in bubble checker. If no bubbles appear within 10 seconds, or if time between bubbles is more than 5 seconds, cup-to-plunger seating is acceptable. If unacceptable, remove injector and retorque cup retainer.

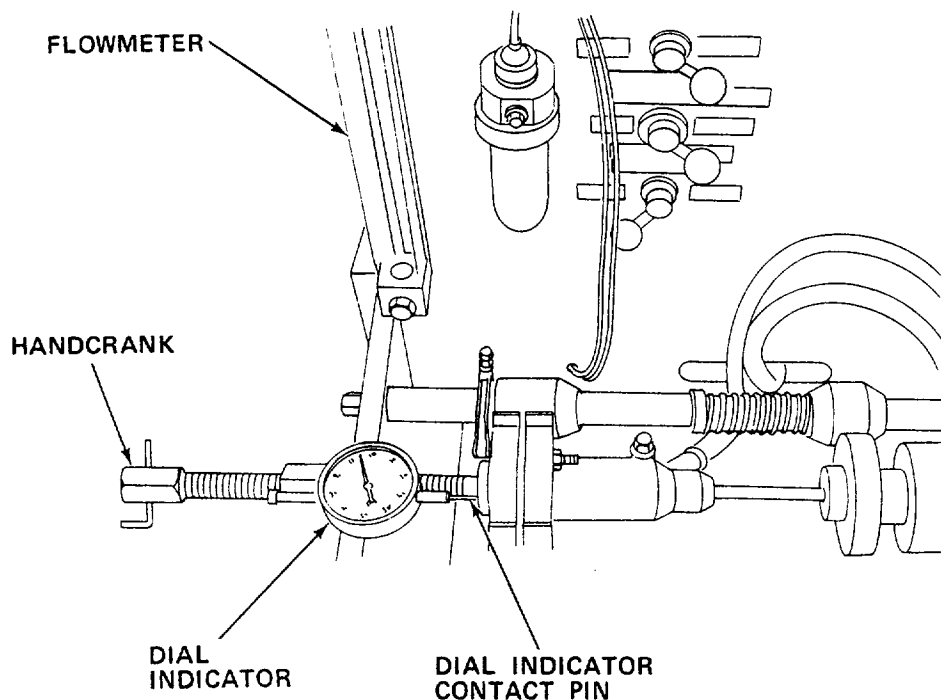
c. Perform plunger-to-barrel leakage test.

- (1) Adjust air pressure to 60 psi (414 kPa).

CAUTION

DO NOT OVERLOAD CELL GAGE. DAMAGE TO GAGE MAY OCCUR.

- (2) Adjust hand crank to show 200 lbs on load cell gage.



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- (3) Zero dial indicator.
- (4) Back out hand crank 0.047 in. (1.193 mm) as measure on dial indicator.
- (5) With AIR SUPPLY VALVE OFF, turn TIP SEAT PLUNGER LEAKAGE valve ON.
- (6) Turn AIR SUPPLY valve ON.
- (7) Gently rotate injector plunger in small increments, and watch flowmeter for highest reading.

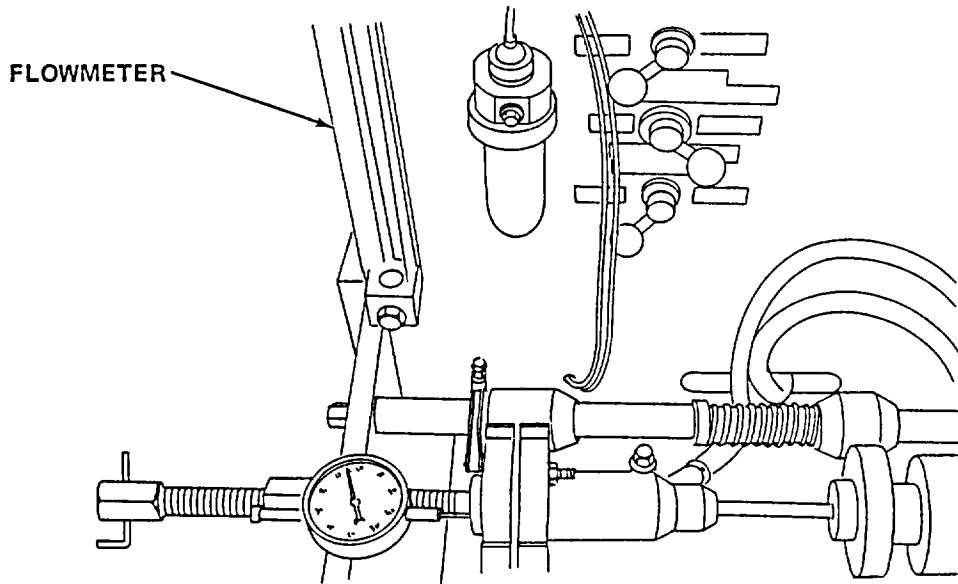
NOTE

A zero reading on flowmeter indicates no leakage.

- (8) If leakage exceeds flowmeter reading of 4.5 units on used or overhauled injector replace plunger and barrel.
- (9) If leakage exceeds reading of 2.5 units for 3/3 in. (9.52 mm) barrel or 2.2 for 5/16 in. (7.93 mm) on new injector, replace plunger and barrel.

d. Perform check ball leakage test.

- (1) With plunger still in retracted position (0.047 in [1.193 mm] on dial indicator), and TIP SEAT PLUNGER Leakage and AIR SUPPLY valves OFF, turn CHECK BALL LEAKAGE valve ON.
- (2) Turn AIR SUPPLY valve ON and adjust air pressure to 80 psi.



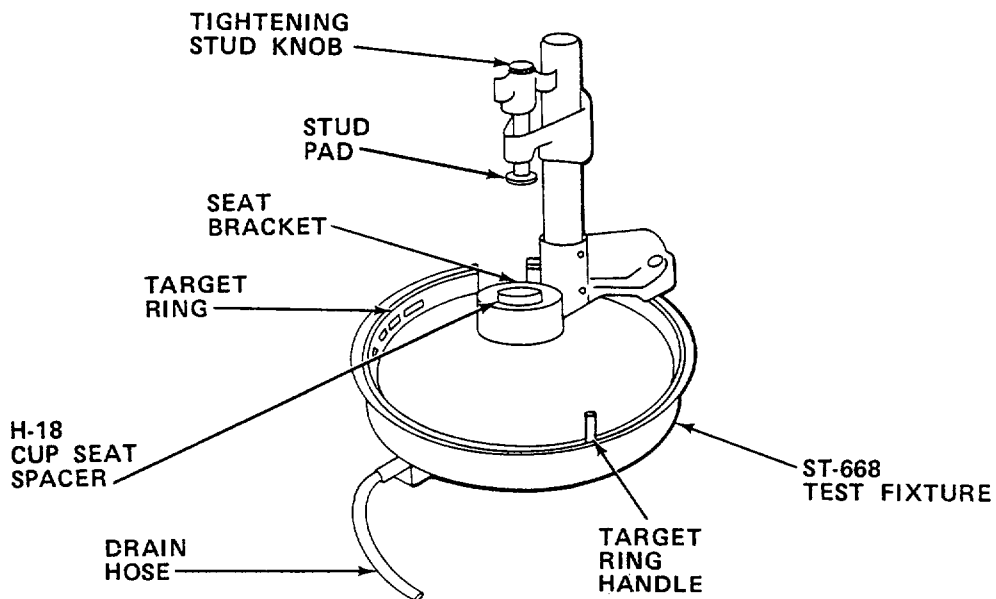
TA295426

NOTE

If lowest reading on flowmeter is 1 or 10, both equal one unit.

- (3) Observe flowmeter. If reading exceeds 6 units of leakage, inspect check ball seat for condition and replace check ball.
- (4) Turn AIR SUPPLY valve OFF and CHECK BALL LEAKAGE valve OFF.
- (5) Remove injector from tester.

- e. Perform injector spray pattern check.



TA295427

- (1) Place ST-668 injector spray pattern test fixture near ST-790 injector flow test stand or other source of 22 psi (152 kPa) constant fuel pressure. Use injector test oil or fuel oil to perform test. Place drain hose of ST-668 into drain pan of ST-790.
- (2) Secure H-18 cup seat spacer to fixture seat bracket bore.
- (3) Place nine hole target ring (marked on handle of ring) in base of ST-668.
- (4) Lubricate inside of 3375395 adapter pot with test oil so injector O-rings will slide smoothly into body.
- (5) Slide injector into 3375395 adapter pot so that injector fuel inlet port lines up with pot inlet hole.
- (6) Insert and tighten locating lock pin which seats in hole of injector.
- (7) With injector plunger removed from injector, insert ST-668-5012 plug into plunger bore.
- (8) Screw knurled plug into injector drain opening on adapter pot.
- (9) Place injector in test fixture seat and adjust hold-down bracket into position where tightening stud pad just makes contact with plunger bore plug.
- (10) Turn tightening stud knob against plunger bore plug until plug is firmly seated.
- (11) Screw fuel inlet line from ST-79 test stand into injector adapter pot inlet port.

- (12) Start ST-790 test stand and set fuel pressure at 22 psi (152 kPa).

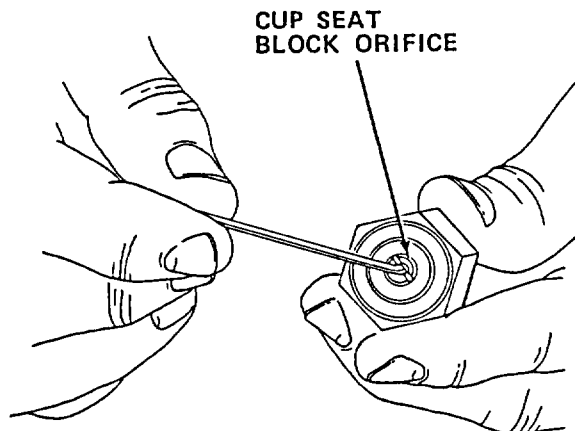
NOTE

No. 1 window is tallest and nearest the target ring handle.

- (13) Shift target ring in base of test fixture so that one spray stream hits center of No. 1 (index) window.
- (14) Check that all other streams hit a window within +2 tolerance. If any one stream is not within tolerance, disassemble injector to clean injector cup holes and retest for proper spray pattern.
- (15) If defect still exists, replace cup and retest.
- (16) Shut off ST-790 fuel supply and remove injector from test fixture.
- f. Perform flow test of injector on ST-790 test stand.

NOTE

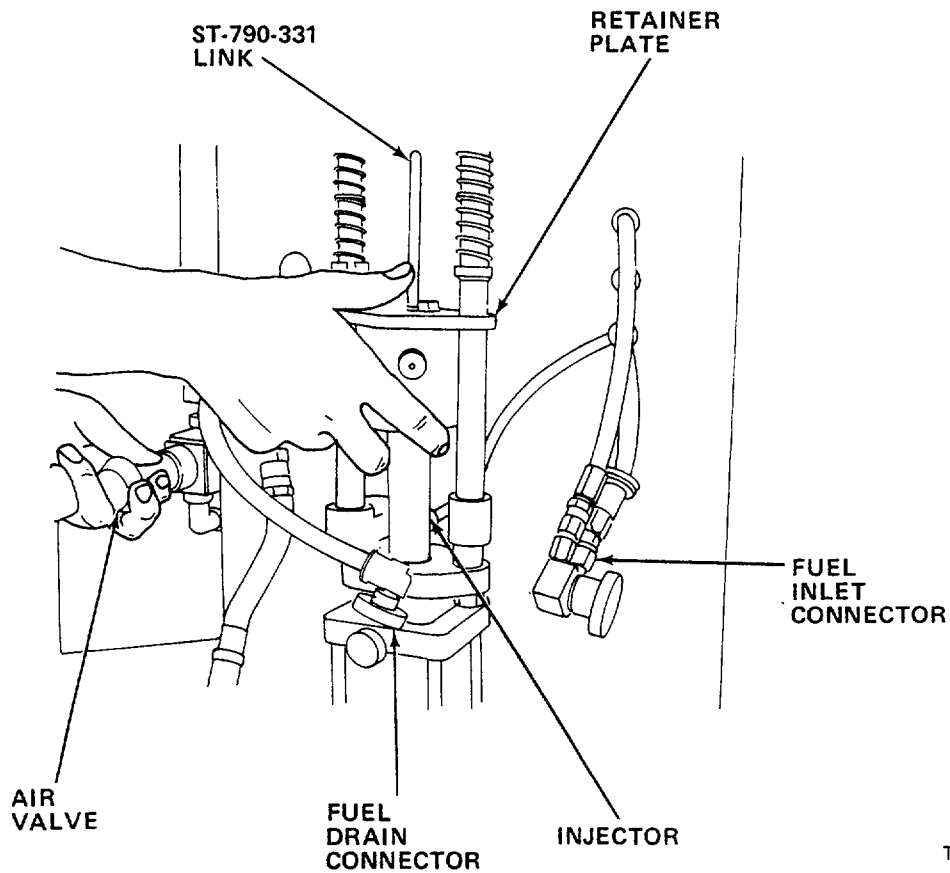
ST-790 test stand counts injection strokes and supplies fuel at a specified pressure to closely simulate actual operating conditions.



TA295428

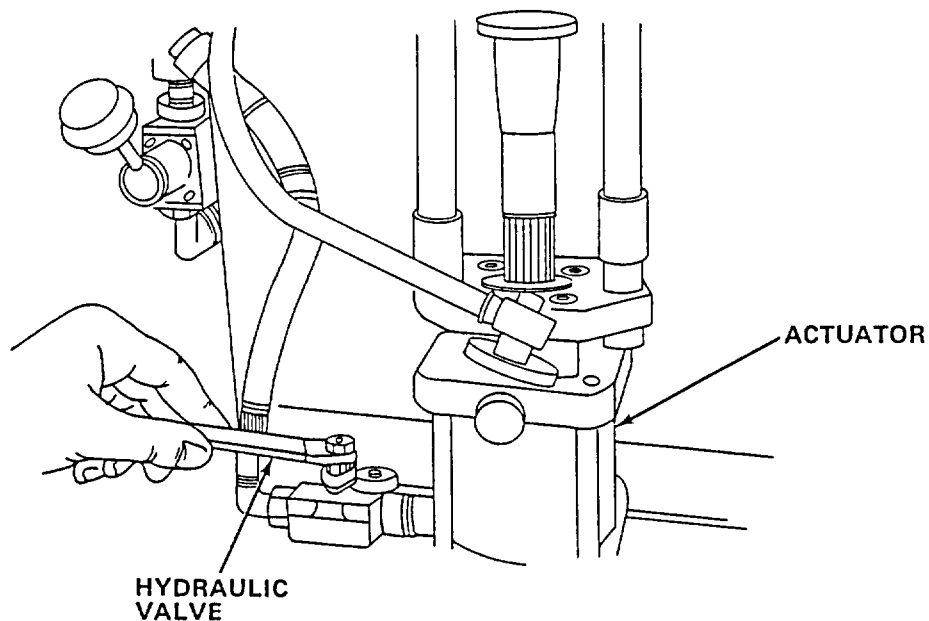
- (1) Install 0.026 in. (0.66 mm) orifice (has one notch in face) into test stand cup seat block. Tighten to 6 in. lbs (0.7 N•m).
- (2) Lubricate inside of 3375086 adapter pot with test oil so injector O-rings will slide smoothly into pot.
- (3) Slide injector into adapter pot so that injector fuel inlet hole lines up with pot inlet hole.

- (4) Tighten locating lock pin which seats in hole of injector.
- (5) Install injector spring, washer, and plunger.

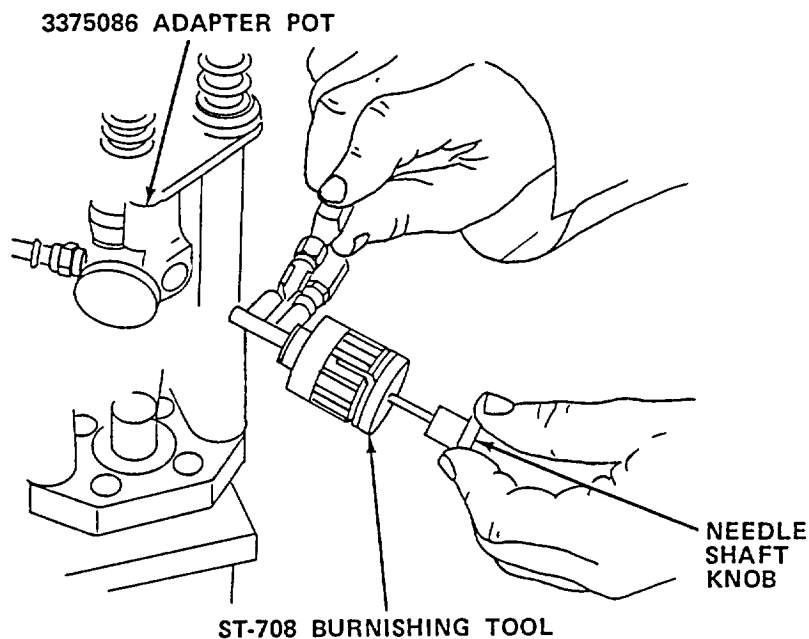


TA295429

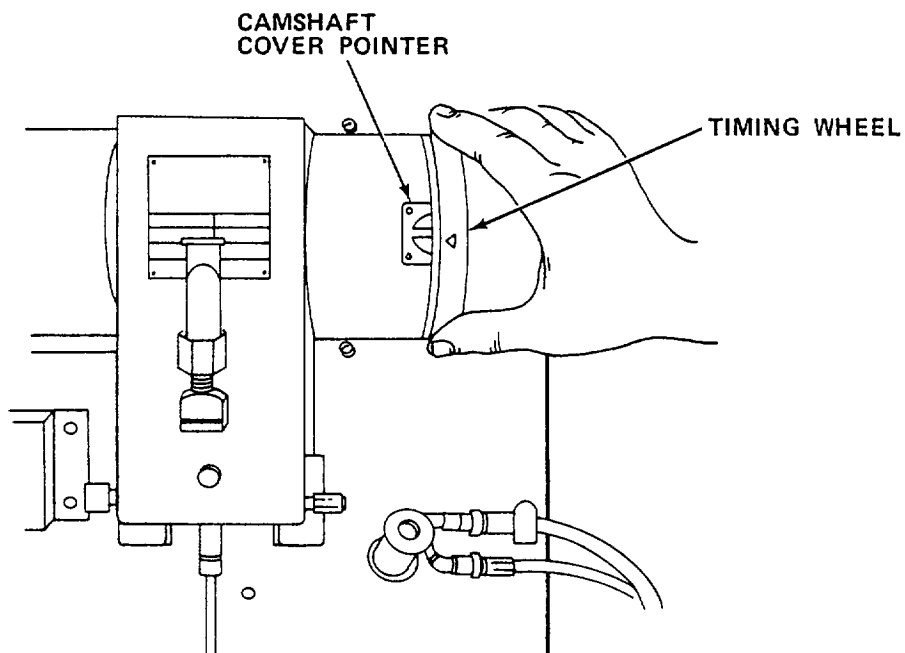
- (6) Position injector and pot on test stand cup seat block with injector cup facing downward.
- (7) Engage grooves at top of adapter pot with retainer plate pins.
- (8) Insert ST-790-331 link into top of injector and align link with machine push rod.
- (9) Open air valve (lift up knob). This pressurizes hydraulic reservoir/ system.



- (10) While holding injector plunger link, open hydraulic valve to raise hydraulic actuator raising injector to clamped position.
- (11) Close hydraulic valve to lock injector in clamped position.

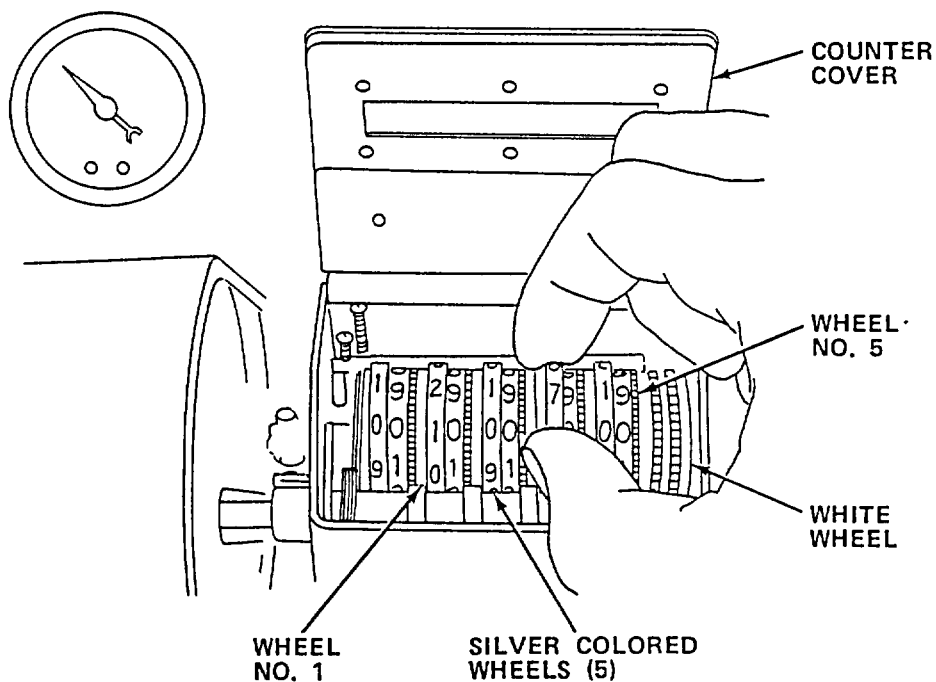


- (12) Remove standard knurled knob from test stand inlet connector and install ST-708 burnishing tool through connector and into injector adapter pot inlet port. Retract burnishing needle by pulling out small needle shaft knob.
- (13) Secure drain connection (clear line) to injector adapter pot.



TA295432

- (14) Aline mark on timing wheel with pointer on camshaft cover.
- (15) Place test stand start-stop switch to START.
- (16) Check test oil temperature gage for minimum of 90°F (32°C) before any test readings are taken.
- (17) Adjust fuel pressure with regulator valve until fuel pressure gage indicates 120 psi (828 kPa). This pressure must be maintained during testing.



TA295433

NOTE

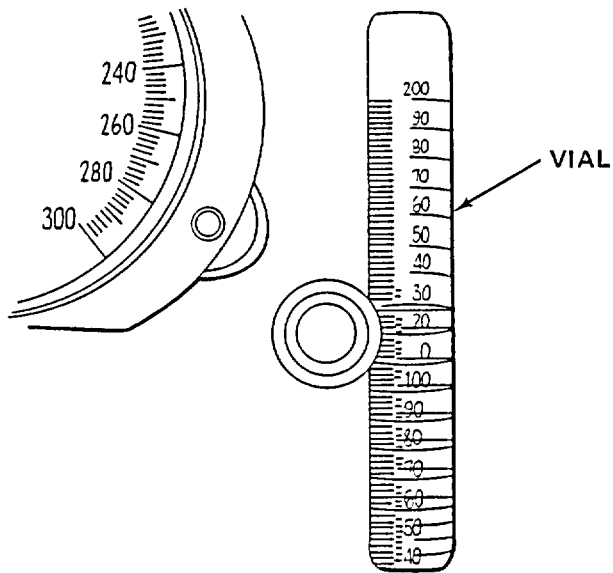
Silver-colored wheels must be set at 600 strokes.

(18) Lift cover on counter and set each silver-colored wheel to following positions:

- No. 1 wheel - 0
- No. 2 wheel - 0
- No. 3 wheel - Shift to right and rotate to 6 then release wheel.
- No. 4 wheel - 0
- No. 5 wheel - 0

(19) Set white wheels to zero by rotating thumbscrew on end of counter one full turn to right.

(20) Depress red flow start switch and release.



TA295434

- (21) After 600 injection strokes are completed and flow stops from injectors, check amount collected in vial.

NOTE

Delivery rate is stamped on injector adapter.

- (22) If delivery is less than 173 cc with fuel inlet pressure at 120 psi (828 KPA) turn burnishing tool indicator knob until it is spaced 3/8 in. (9.5 mm) from large knob.

CAUTION

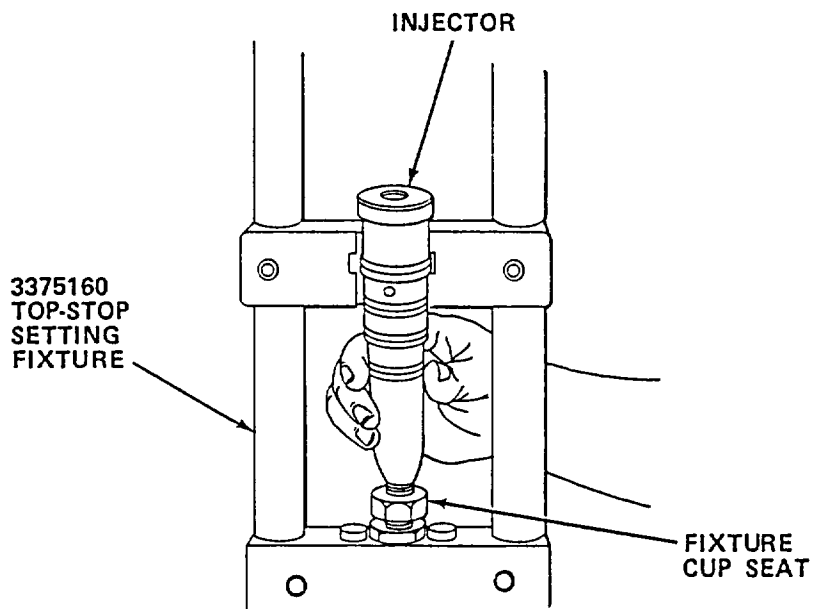
ST-708 BURNISHING TOOL MUST BE USED WITH EXTREME CAUTION WHEN SIZING INJECTOR ORIFICE PLUGS. DO NOT DAMAGE INJECTOR BODY UNDER ORIFICE PLUG.

- (23) Slowly push needle shaft knob in until needle is felt entering orifice plug.
- (24) Turn needle shaft knob to left to lock needle shaft to indicator knob.
- (25) Turn indicator knob to right until needle contacts orifice plug.
- (26) Index indicator with mark on largest knob and turn indicator knob one mark to right.-

- (27) Turn indicator knob to left until 3/8 in. (9.5 mm) from largest knob.
- (28) Turn needle shaft knob to right to unlock from indicator knob and retract needle.
- (29) Reset counter and recheck delivery flow.
- (30) If delivery more than 177 cc, unclamp injector and remove from test stand.
- (31) Remove old orifice plug and gasket and discard.
- (32) With new gasket, screw new orifice into injector inlet port. Torque to 8 -10 in. lbs (0.9 1.1 Nm) with tool no. 3376177 torque wrench.
- (33) Reclamp injector on test stand and perform delivery flow test.
- (34) Unclamp injector, shut down test stand with start-stop switch and remove injector.
- (35) Withdraw injector from injector adapter pot.

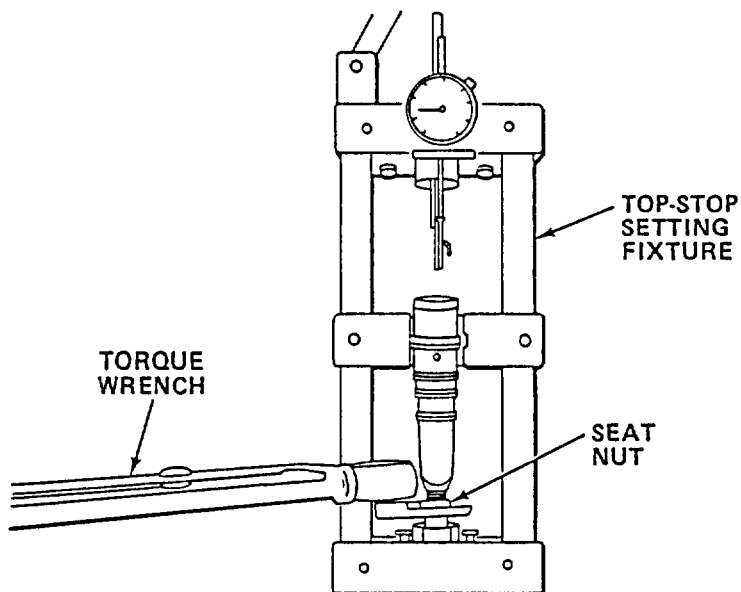
3-76. FINAL ASSEMBLY OF INJECTOR

- a. With new gasket, install screen and retainer ring in injector inlet port.
- b. With injector spring and washer installed in top of injector, screw top-stop screw with locknut into injector until two of top threads of stop protrude above locknut.



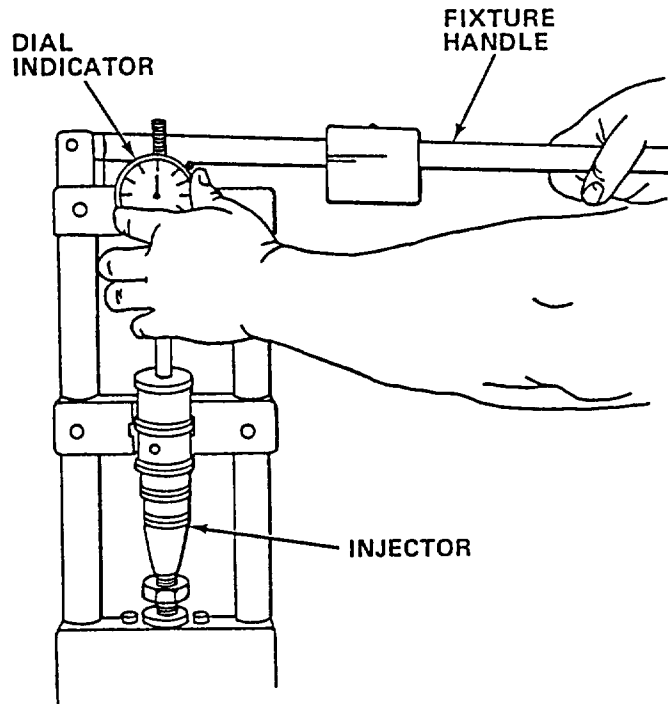
TA295435

- c. Install injector into 3375160 top-stop setting fixture with cup centered over cup seat of fixture.



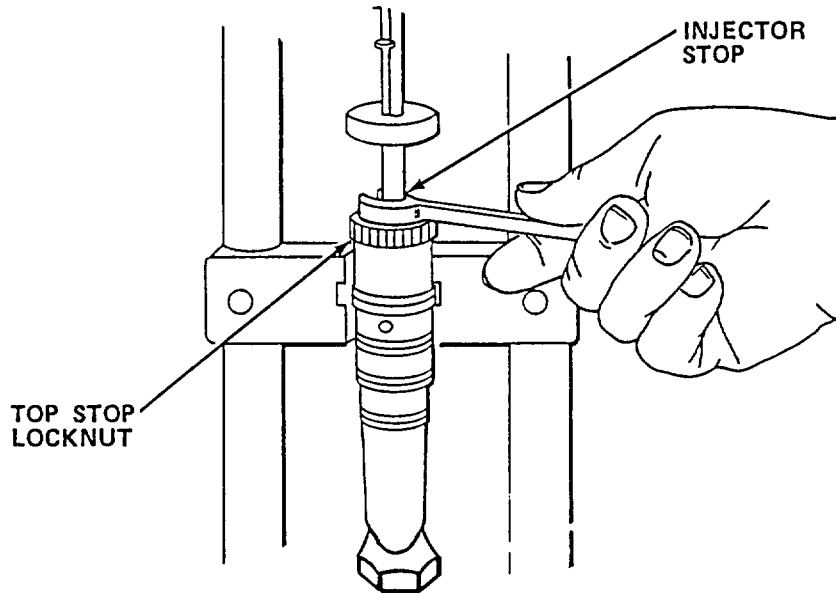
TA295436

- d. Adjust cup seat upward and torque seat nut to 100 - 115 in. lbs (11 - 13 Nm).



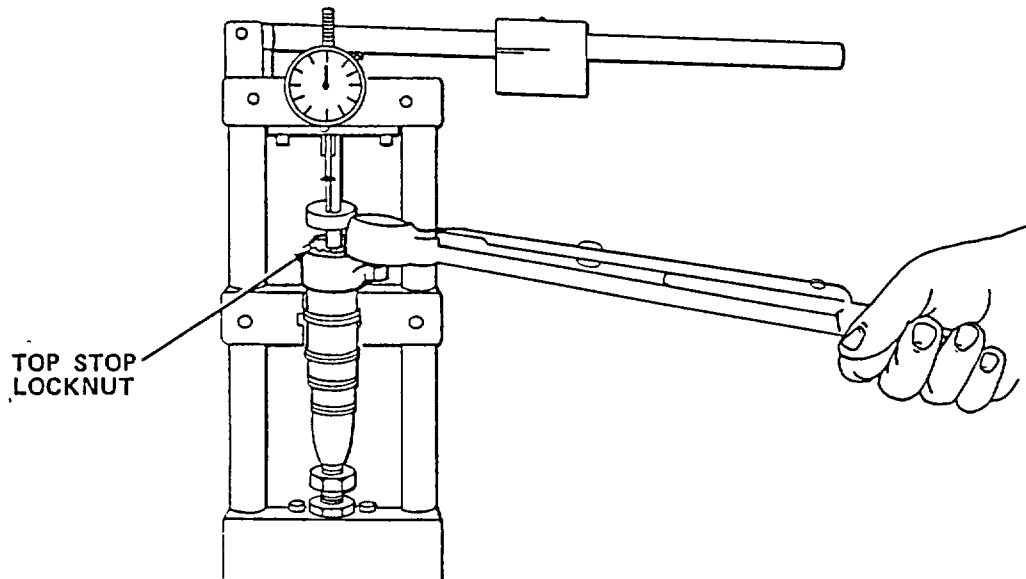
TA295437

- e. Pull fixture handle down to bottom plunger in its cup and set dial indicator (extension in contact with surface of plunger coupling) to zero.
- f. Release plunger slowly and observe travel required until plunger spring washer contacts injector top-stop.



TA295438

- g. Bottom plunger again and adjust stop up or down until travel equals 0.222 in. (5.639 mm) +0.005 in. (0.127 mm).



TA295439

- h. Torque top-stop locknut-to 55 ft lbs (75 N•m).
 i. Recheck travel to ensure of no change due to torquing of locknut.
 j. Wipe assembly clean and wrap in protective paper.

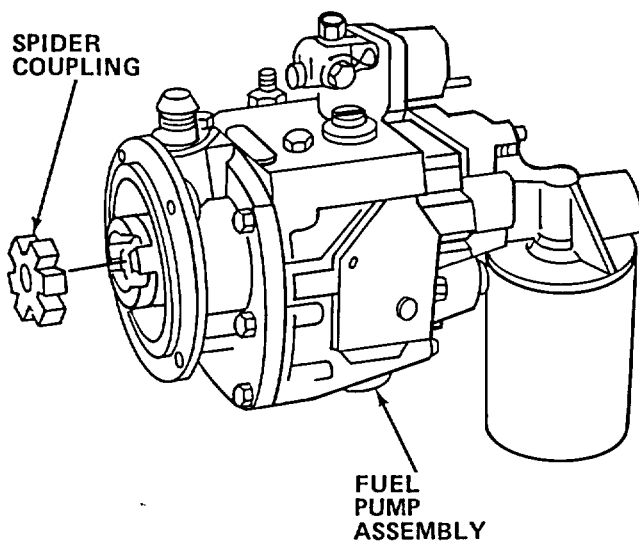
Section XXVIII. FUEL PUMP REPAIR

3-77. FUEL PUMP REPAIR

- a. Clean fuel pump.

WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
- P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.



TA295440

- (1) Clean fuel pump-to-compressor spider coupling with cleaning solvent and blow dry with compressed air.

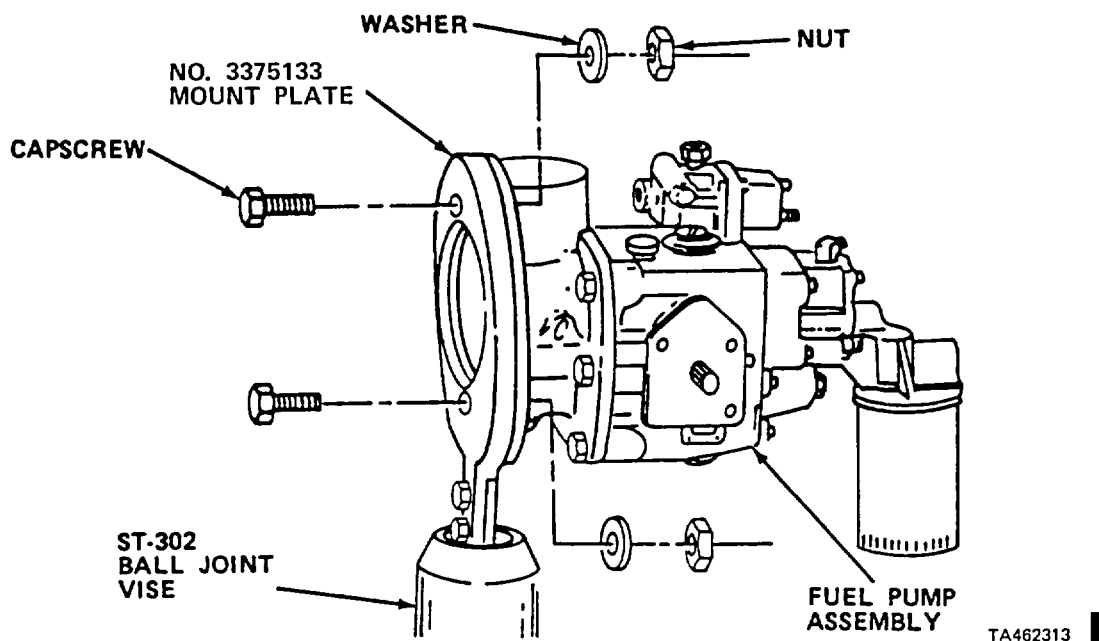
CAUTION

CLEANING SOLVENT CAN CAUSE DAMAGE IF IT GETS INSIDE FUEL PUMP. MAKE SURE ALL FUEL PUMP PORT PLUGS AND CAPS ARE SECURE TO PREVENT ENTRY OF SOLVENT INTO PUMP.

- (2) Clean exterior of fuel pump and front drive cover assembly with cleaning solvent and blow dry with compressed air.

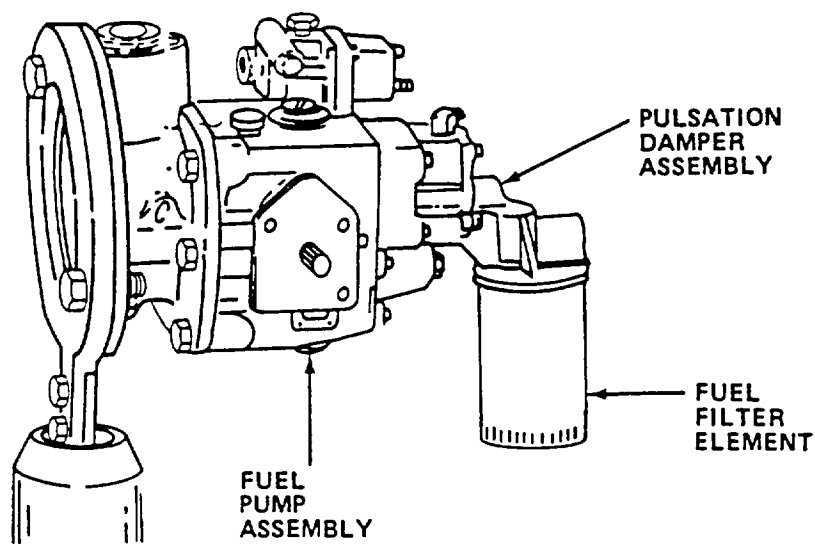
b. Inspect fuel pump.

- (1) Inspect fuel pump-to-spider coupling for cracks, breaks, bending, or other damage. Discard if damaged.

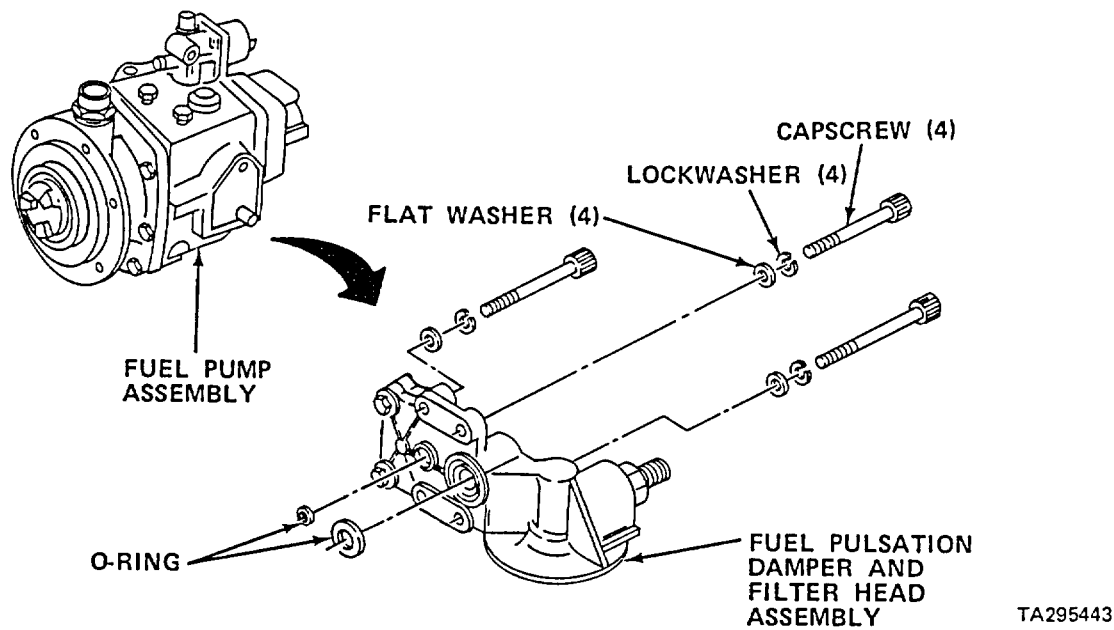


- (2) Mount and secure fuel pump to mount plate of ST-302 ball joint vise.
- (3) Inspect fuel pump for cracks, breaks, bending, corrosion, or other damage. Repair/replace defective parts.

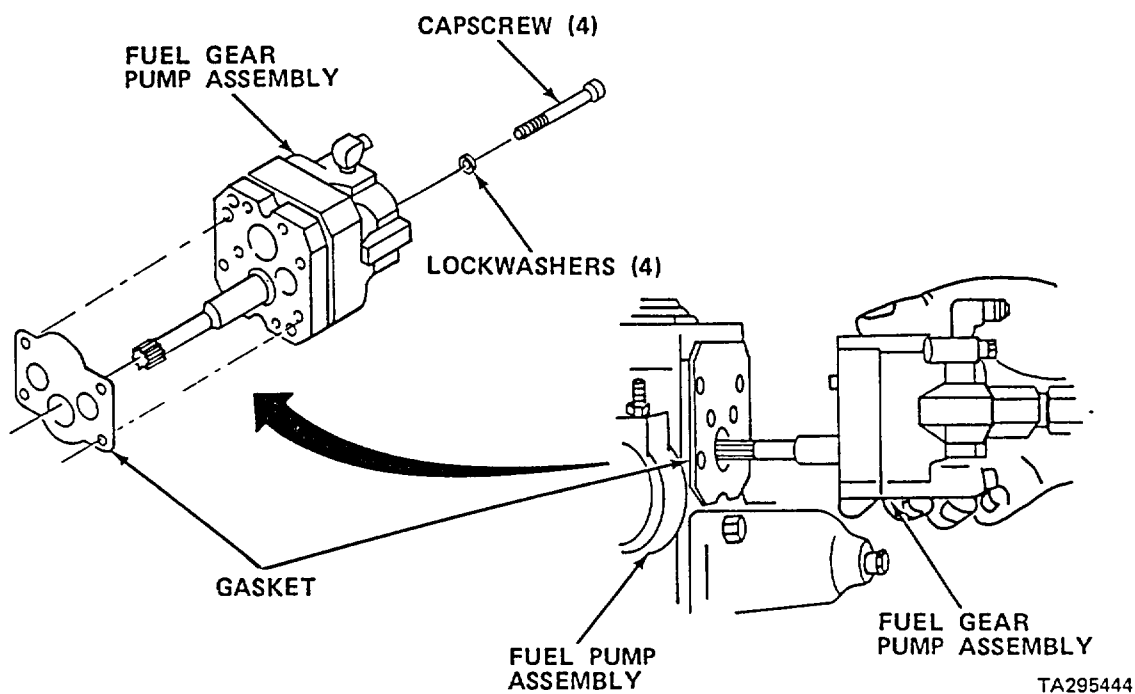
c. Remove exterior components from fuel pump.



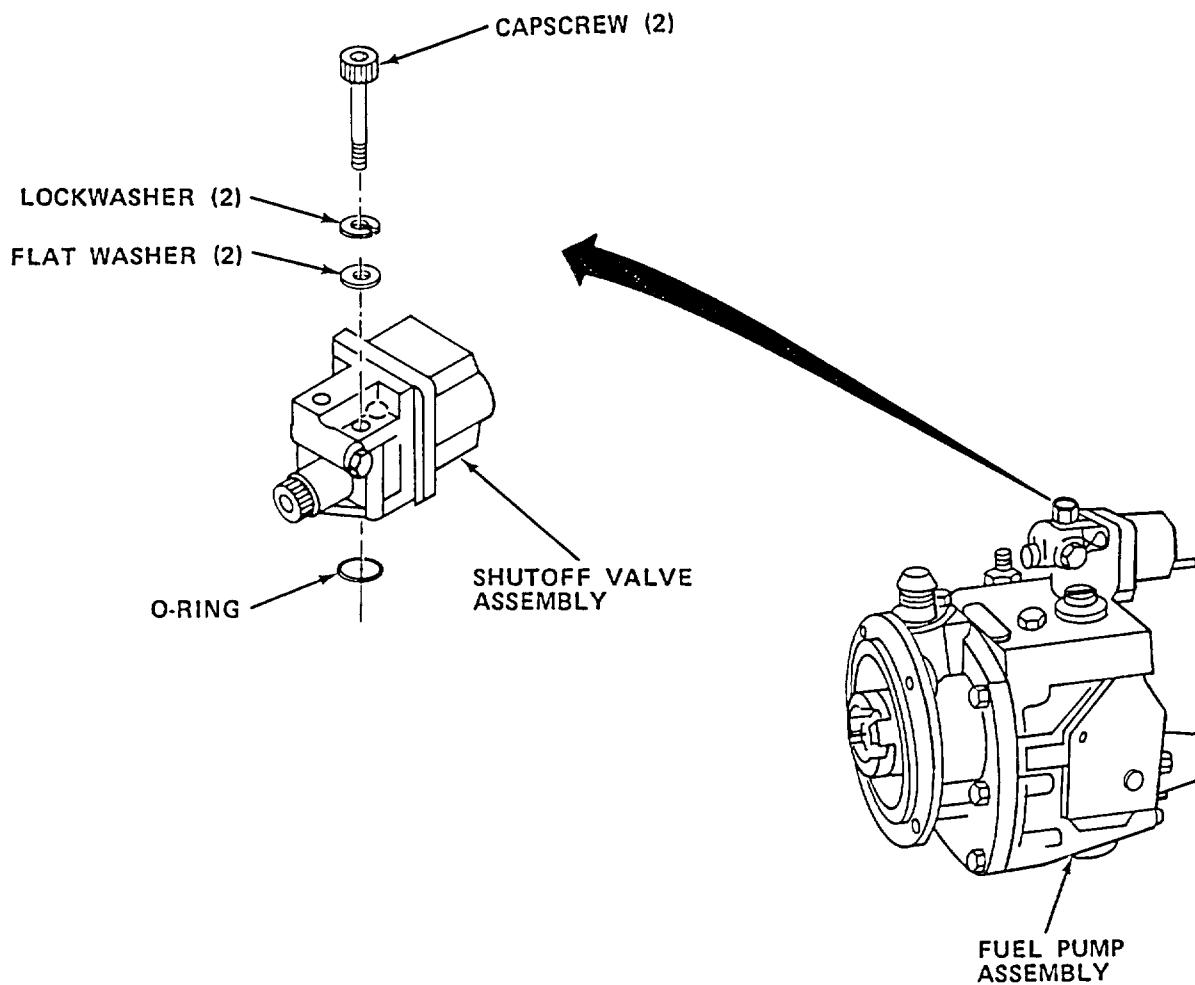
- (1) Remove fuel filter element from fuel pump pulsation damper and filter head assembly (if not previously removed).



- (2) Remove socket head capscrews, lockwashers, flat washers, pulsation damper and filter head assembly, and O-rings from fuel pump. Discard O-rings.
- (3) Remove inlet fitting from pulsation damper assembly.

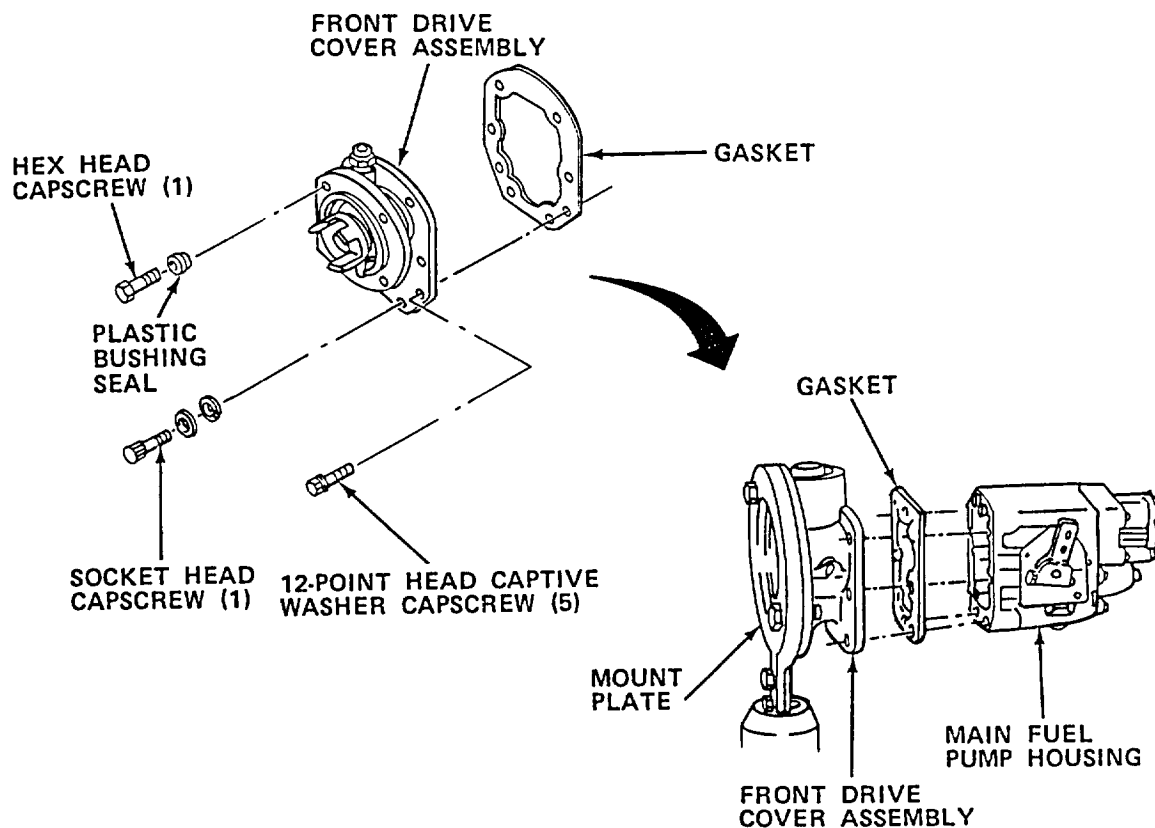


- (4) Remove capscrews, lockwashers, gear pump, and mount gasket from fuel pump. Discard gasket.



TA295445

- (5) Remove socket head capscrews, lockwashers, flat washers, shutoff valve assembly, and O-ring from fuel pump. Discard O-ring.

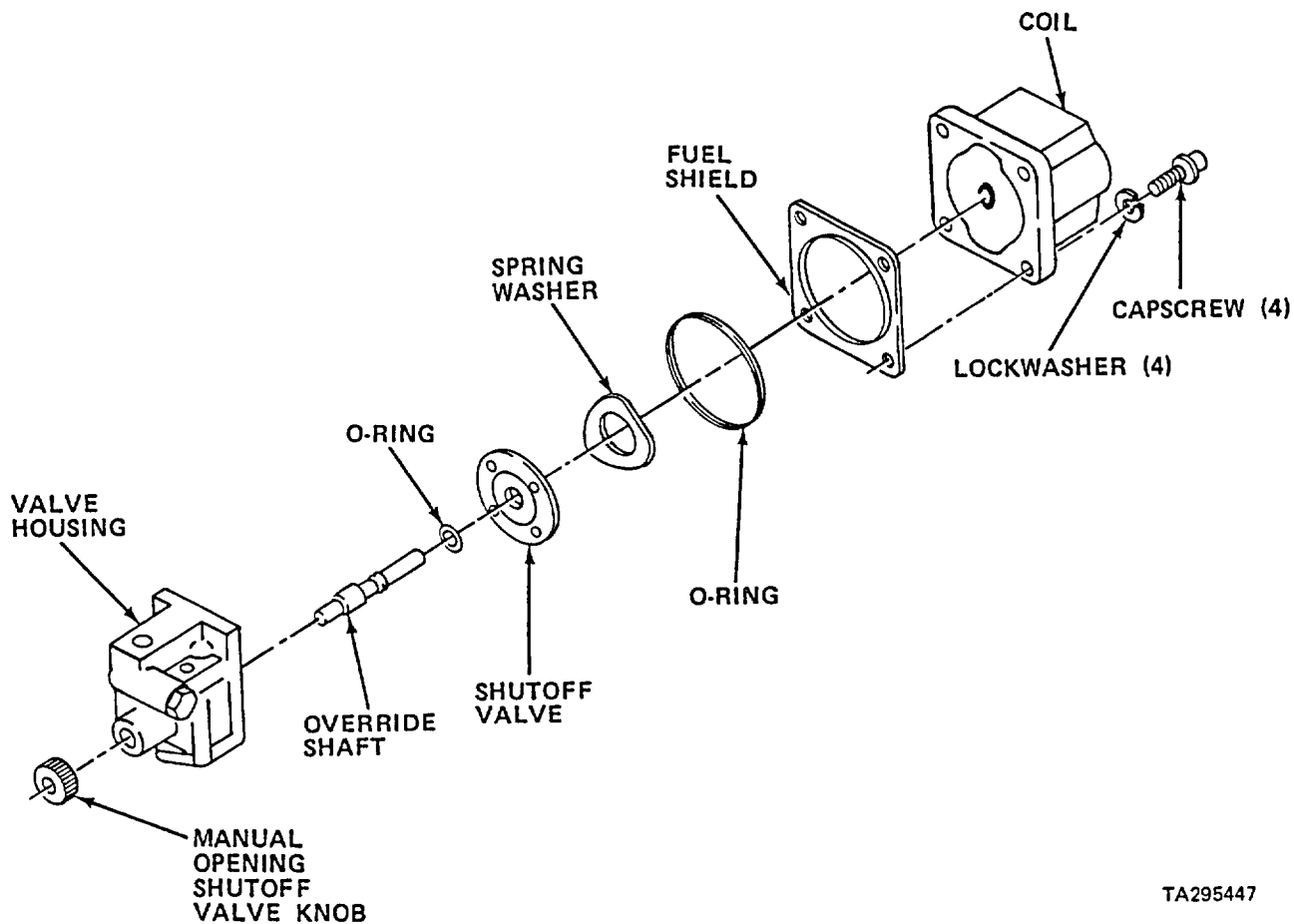


TA295446

- (6) Unscrew hex head capscrew and remove plastic bushing seal. Discard bushing.
- (7) Remove socket head capscrew, flat washer and lockwasher.
- (8) Remove five 12-point head captive washer capscrews.
- (9) Tap fuel pump housing with softface hammer to loosen housing from front cover assembly and separate housing from cover assembly. Discard gasket.

3-78. SHUTOFF VALVE ASSEMBLY REPAIR

- a. Disassemble shutoff valve assembly



TA295447

- (1) Remove coil mounting screws, lockwashers, coil, fuel shield, O-ring, spring washer, and shutoff valve from valve housing. Discard O-ring and washer.

NOTE

Knob is pressed on shaft.

- (2) Remove manual opening shutoff valve knob from override shaft by turning knob on shaft to the right.
- (3) Unscrew override shaft and O-ring from valve housing. Discard shaft and O-ring.

b. Clean shutoff valve assembly components.

- (1) Clean coil with clean, dry, lint-free cloth.
- (2) Polish coil face with 200 grit emery cloth on a flat surface.

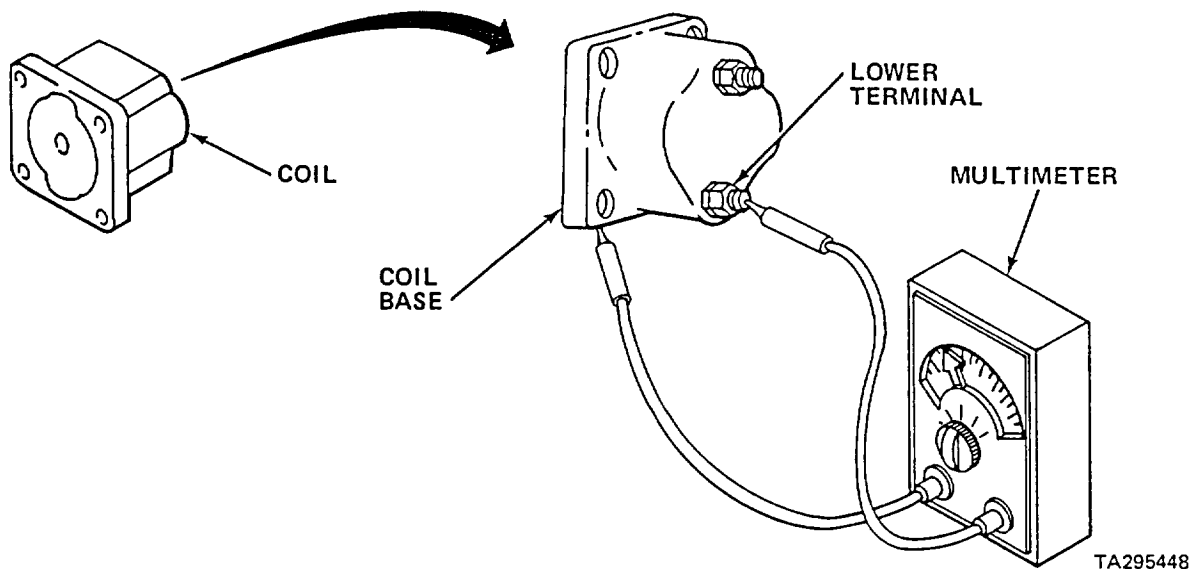
WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
- P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

- (3) Clean remaining parts with cleaning solvent. Blow dry with compressed air.

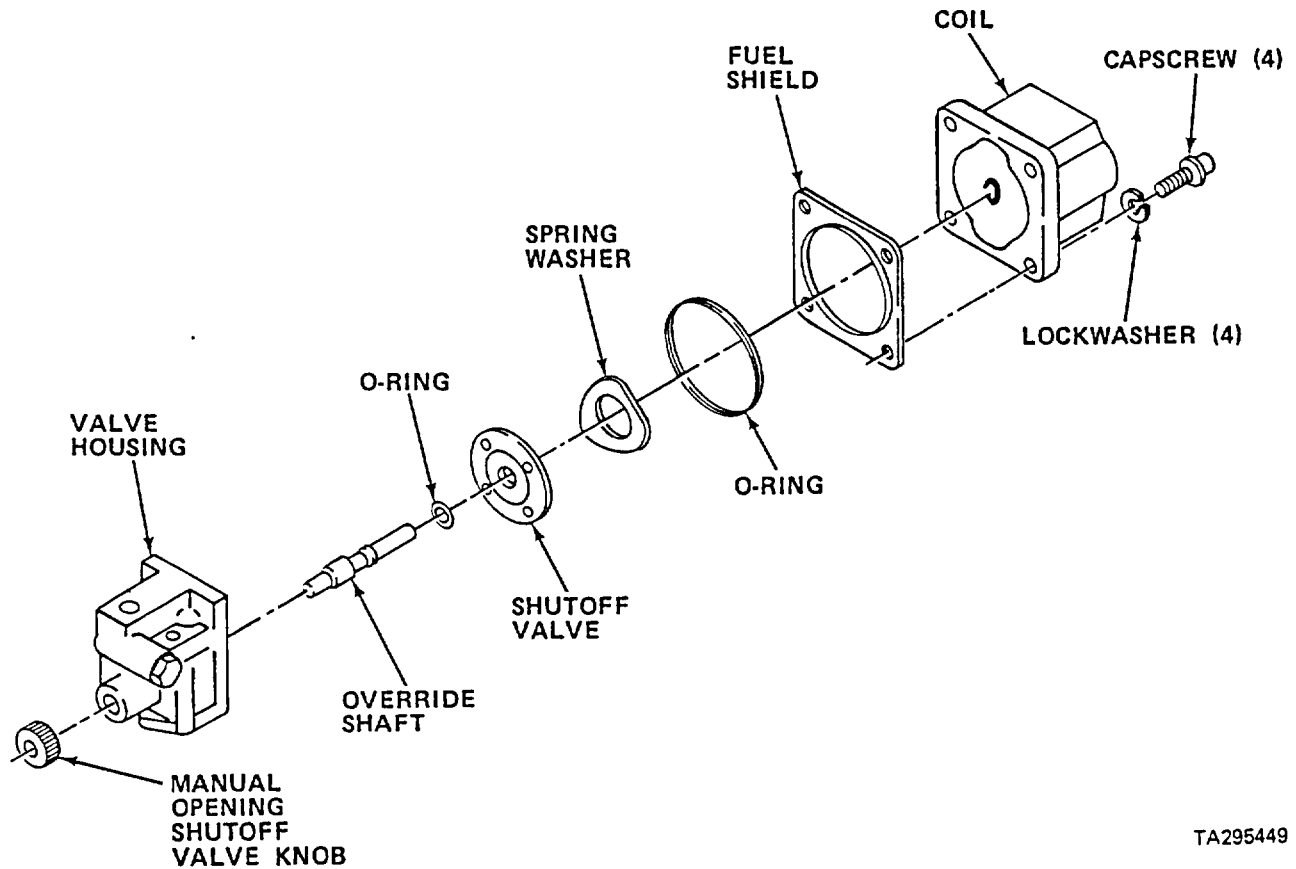
c. Inspect shutoff valve assembly components.

- (1) Check shutoff valve for wear, corrosion, or bonding separation. Replace valve if defective.
- (2) Measure valve seat width in valve housing with micrometer. Replace valve housing if seat width is less than 0.015 in. (0.38 mm).



- (3) With multimeter, check resistance between lower terminal of coil and base of coil. Discard coil if resistance not within 7 to 8 ohms.

d. Assemble shutoff valve assembly.



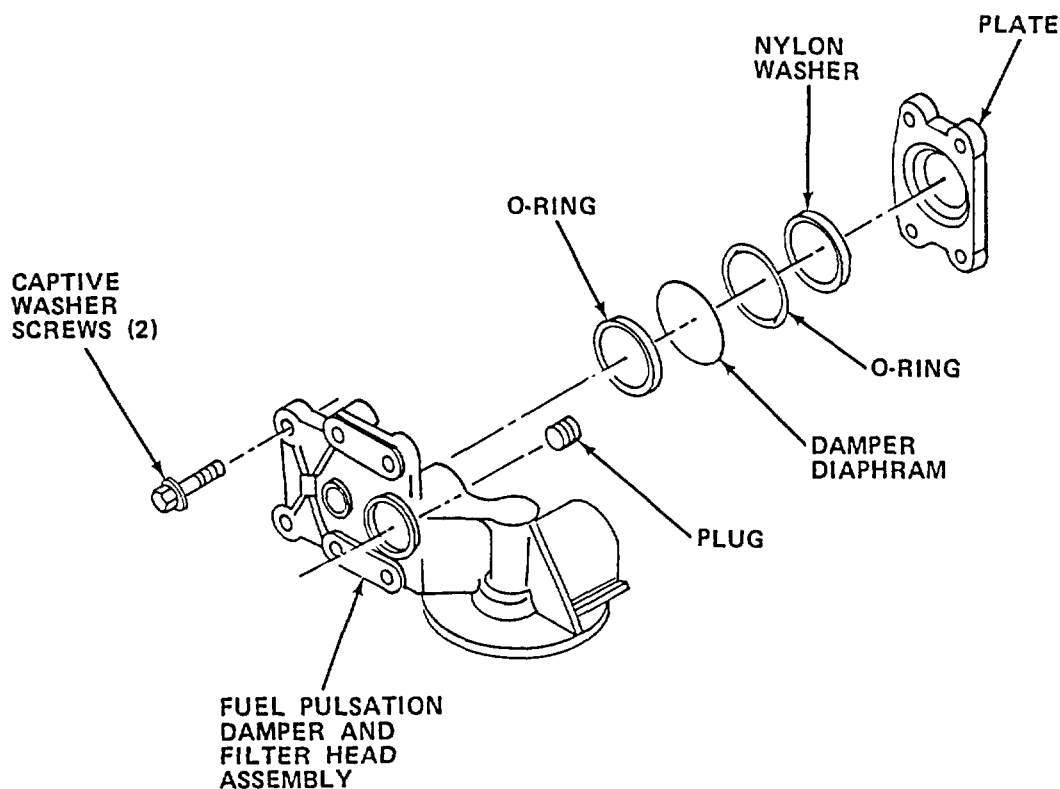
TA295449

- (1) Install new O-ring on override shaft and apply a light coat of lubricating oil on O-ring.
- (2) Screw override shaft into valve housing until valve bottoms in bore.
- (3) Using depth micrometer set at 0.118 in. (2.997 mm), check distance from face of valve housing to tip of override shaft.
- (4) If necessary, screw shaft out until it is 0.118 in. (2.997 mm) below face of valve housing.

NOTE**Knob acts as stop for override shaft.**

- (5) Without moving override shaft, press manual opening knob onto override shaft.
 - (6) Place valve in valve housing with rubber side towards housing.
 - (7) Coat new O-ring with lubricating oil and place O-ring in groove of valve housing.
 - (8) Place spring washer on valve with concave side up.
 - (9) Place fuel shield on coil and mate coil to valve housing.
 - (10) Secure coil with capscrews and lockwashers. Torque capscrews to 25 30 in. lbs (2.8 3.4 N•m).
- e. Install shutoff valve assembly.
- (1) Apply light coat of lubricating oil to O-ring and install O-ring in groove in bottom of shutoff valve assembly.
 - (2) Place shutoff valve assembly on fuel pump and secure valve with socket head capscrews, new lockwashers, and flat washers.
 - (3) Torque capscrews to 9 - 11 ft lbs (12 - 15 N•m).

3-79. FUEL PULSATION DAMPER AND FILTER HEAD ASSEMBLY REPAIR



TA295450

- a. Remove captive washer screws securing plate to filter head and remove plate, nylon washer, O-ring, damper diaphragm, and O-ring from filter head. Discard nylon washer and O-ring.
- b. Remove plug from filter head.

WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
 - P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.
- c. Clean all fuel pulsation damper components with cleaning solvent. Blow dry with compressed air.

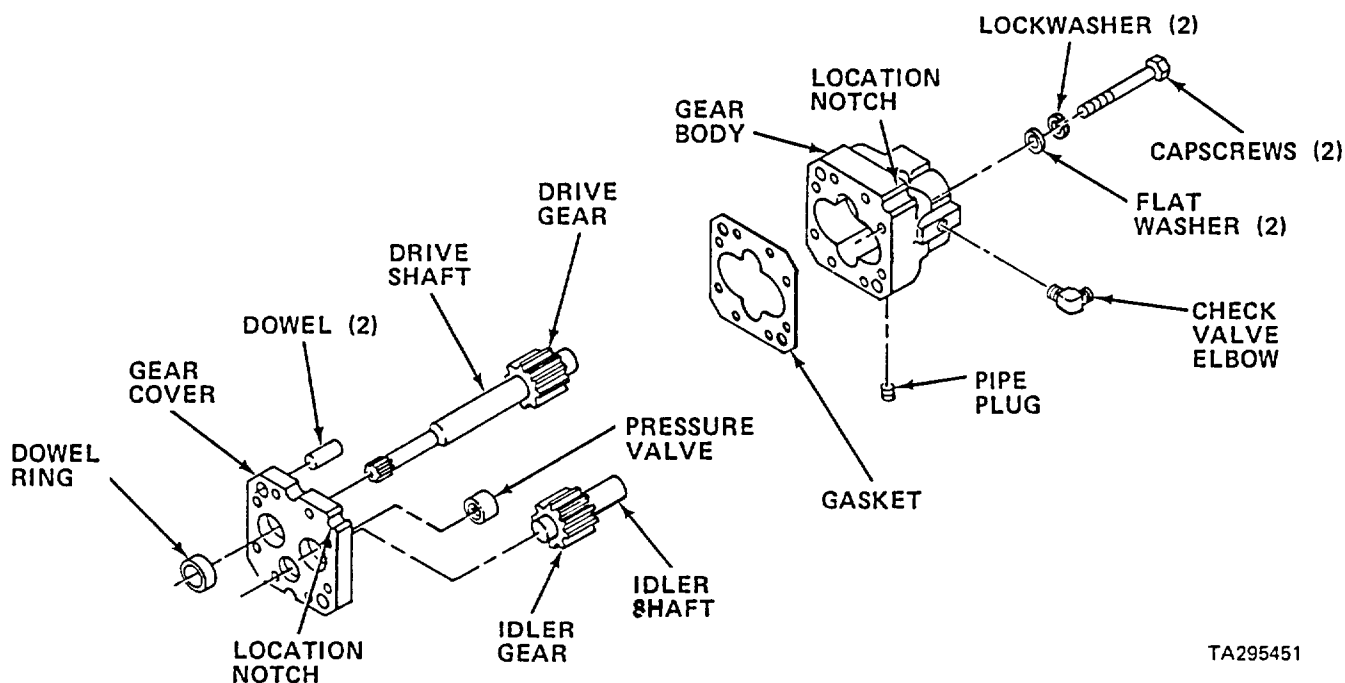
- d. Inspect fuel pulsation damper and filter head assembly components.
 - (1) Check damper diaphragm, body, and filter head for corrosion, excessive wear, and cracks. Discard damaged or worn parts.
 - (2) Check damper diaphragm for hidden cracks by dropping it on a hard surface. Diaphragm should have a clear ring. Discard if it has a flat sound.
- e. Assemble fuel pulsation damper and filter head assembly.
 - (1) Screw plug into filter head.
 - (2) Install new O-ring into filter head groove and new O-ring into body groove.

NOTE
Be sure diaphragm is clean.

- (3) Coat damper diaphragm with lubricating oil and place against filter head O-ring.
- (4) Place new nylon washer against diaphragm and mate plate to filter head.
- (5) Secure plate to filter head with captive washer screws. Torque screws to 11 13 ft lbs (15 - 18 Nm).

3-80. FUEL GEAR PUMP ASSEMBLY REPAIR

- a. Disassemble fuel gear pump assembly.



- (1) Remove two capscrews, flat washers, and lockwashers securing gear body to gear cover.
- (2) Remove check valve elbow from pump gear body.
- (3) Install two screws into holes in gear body.
- (4) With softface hammer, tap on screws to separate gear body from gear cover. Discard gasket.
- (5) Remove idler shaft with gear and drive shaft with gear from gear body. Do not separate gears from shafts at this time.
- (6) Remove pressure valve from gear cover.
- (7) Remove pipe plug from gear body.

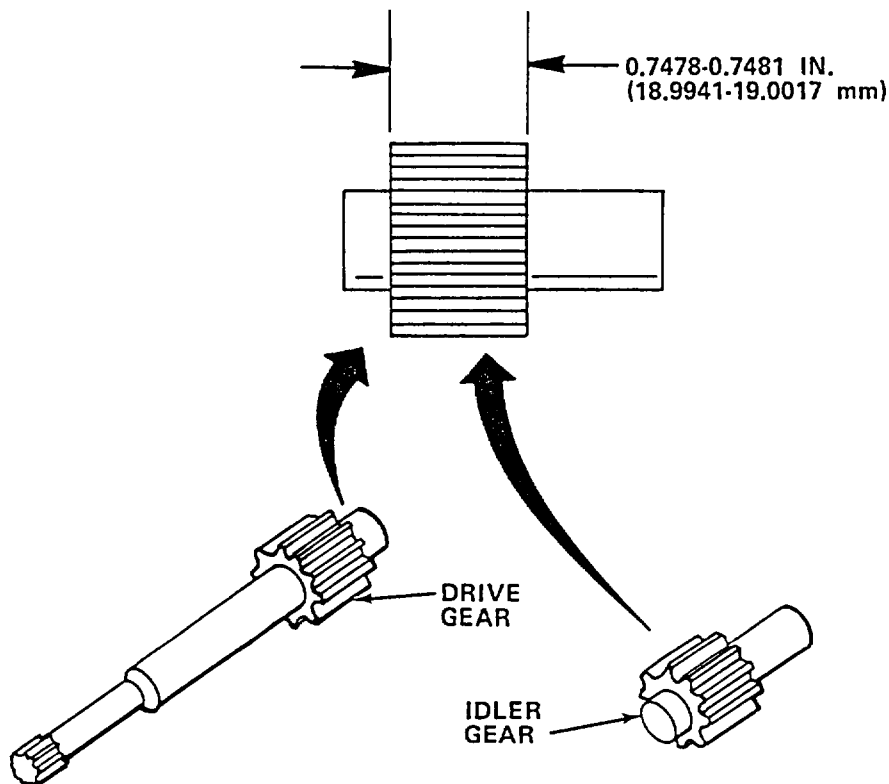
WARNING

- **COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).**
- **P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.**

- b. Clean fuel gear pump assembly components with cleaning solvent. Blow dry with compressed air.

c. Inspect fuel gear pump assembly components.

- (1) Check dowel ring for damage or looseness. Replace if defective.
- (2) Inspect idler shaft and drive shaft for scoring, wear, and other damage. Remove gear(s) and discard shaft(s) if defective.
- (3) Using micrometer, measure outside diameter of idler shaft and drive shaft. Remove gear(s) and discard shaft(s) if diameter less than 0.4998 in. (12.6949 mm).
- (4) Inspect idler and drive gears for scoring, wear, and other damage. Remove gear(s) and discard if defective.



TA295452

- (5) Using micrometer, measure width of idler and drive gears. Remove gear(s) and discard if width not within 0.7478 and 0.7481 in. (18.9941 and 19.0017 mm).
- (6) Inspect gear cover and gear body for scoring, wear, and other damage. Discard fuel gear pump assembly if defective.
- (7) Using micrometer, measure gear pocket depth in gear body. Discard fuel gear pump assembly if depth not within 0.7478 and 0.7481 in. (18.9941 and 19.0017 mm).
- (8) Using micrometer, measure idler shaft bore in gear cover and gear body. Discard fuel gear pump assembly if bore not within 0.5011 and 0.5016 in. (12.7279 and 12.7406 mm).

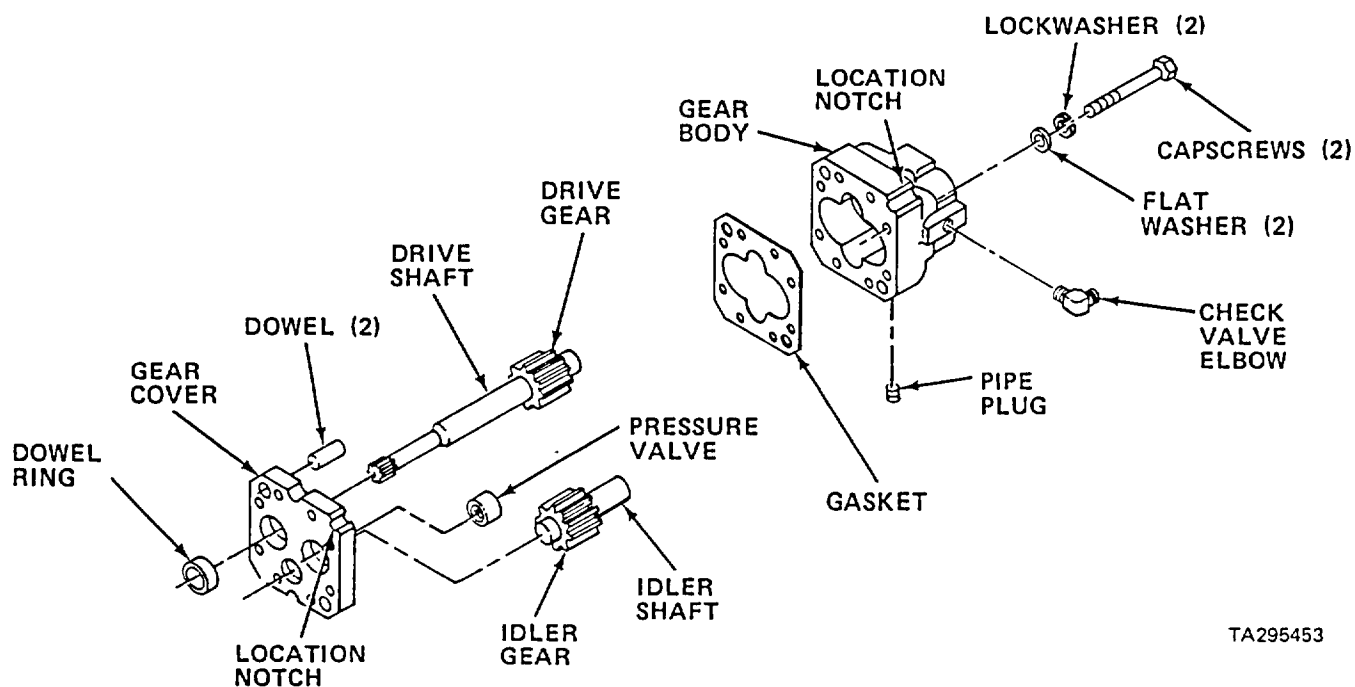
- (9) Using micrometer, measure drive shaft bore in dowel ring. Discard dowel ring if bore not within 0.5011 and 0.5016 in. (12.7279 and 12.7406 mm).

WARNING

P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

- (10) Check lubrication holes in gear cover and gear body for cleanliness. Clean in cleaning solvent as necessary.
- (11) Inspect all other parts for cracks, breaks, and other damage. Discard if defective.

d. Assemble fuel gear pump assembly.



TA295453

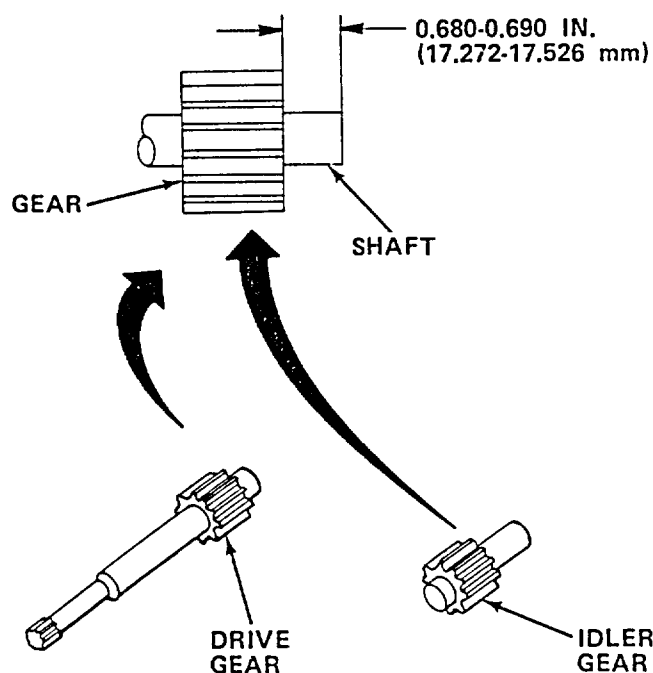
- (1) Screw pipe plug into gear body. Torque plug to 10 - 13 ft lbs (14 - 18 N•m).
- (2) With 3375959 driver, install pressure valve in gear cover. Valve must be even to 0.015 in. (0.381 mm) below cover face.

CAUTION

BE CAREFUL NOT TO DAMAGE VALVE WHEN INSTALLING. IF DAMAGED THE LEAST BIT, REPLACE VALVE.

NOTE

Proceed to next step (3) only if idler gear and/or drive gear was removed from its shaft. If gears not removed, proceed to step (4).



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- (3) Press idler gear and/or drive gear onto its shaft 0.680 - 0.690 in. (17.272 - 17.526 mm) away from gear body end of shaft.

NOTE

Be sure all parts are clean.

- (4) Lubricate and install idler shaft in gear body pocket nearest locating notch on body.
 (5) Lubricate and install drive shaft in gear body pocket.
 (6) Install new gasket on gear cover.

- (7) Aline locating notch on gear cover with locating notch on gear body and mate cover and body.
 - (8) Secure body to cover with two socket head capscrews, lockwashers, and flat washers. Torque capscrews to 11 - 13 ft lbs (15 18 N•m).
 - (9) With dial indicator, check drive shaft end clearance. End clearance must not be less than 0.0009 in. (0.0228 mm) or more than 0.0015 in. (0.0381 mm). Gaskets are available in 0.0020 in. (0.0508 mm) and 0.0015 in. (0.0381 mm).
 - (10) With micrometer, check drive shaft protrusion from gear cover. Shaft must protrude 2.370 2.412 in. (60.198 61.265 mm).
 - (11) With dial indicator, check gear backlash. Backlash must be within 0.006 0.010 in. (0.152 0.254 mm).
 - (12) If pump binds or has excessive backlash, check for errors in assembly to prevent early pump failure.
- e. Install fuel gear pump assembly.
- (1) Install check valve elbow into pump gear body. Be sure elbow faces toward rear of fuel gear pump assembly.

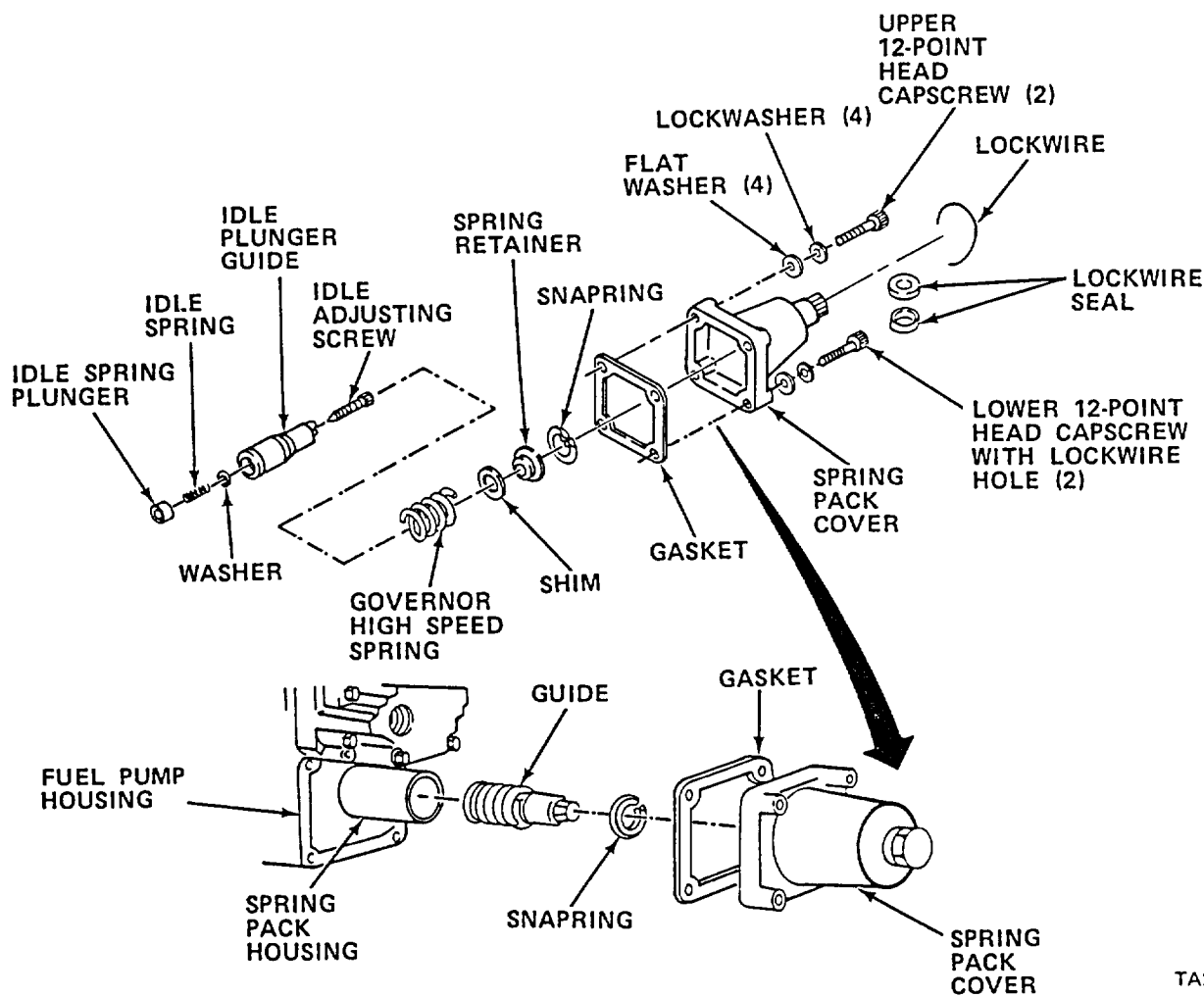
CAUTION

USE CORRECT GASKET IN STEP (2) AND BE SURE GASKET IS CORRECTLY POSITIONED. BE SURE PUMP MAIN HOUSING FUEL HOLES MATCH GEAR PUMP ASSEMBLY HOLES. IMPROPER GASKET CAN CAUSE ENGINE FAILURE.

- (2) Install new gear pump assembly mount gasket on fuel gear pump assembly and mate gear pump assembly with fuel pump main housing.
- (3) Secure gear pump assembly with socket head capscrews and new lockwashers. Torque capscrews to 11 13 ft lbs (15 -18 N•m).
- (4) Check that gear pump drive shaft rotates freely.

3-81. FUEL PUMP GOVERNOR SPRING PACK REPAIR

a. Remove fuel pump governor spring pack.



TA295455

NOTE

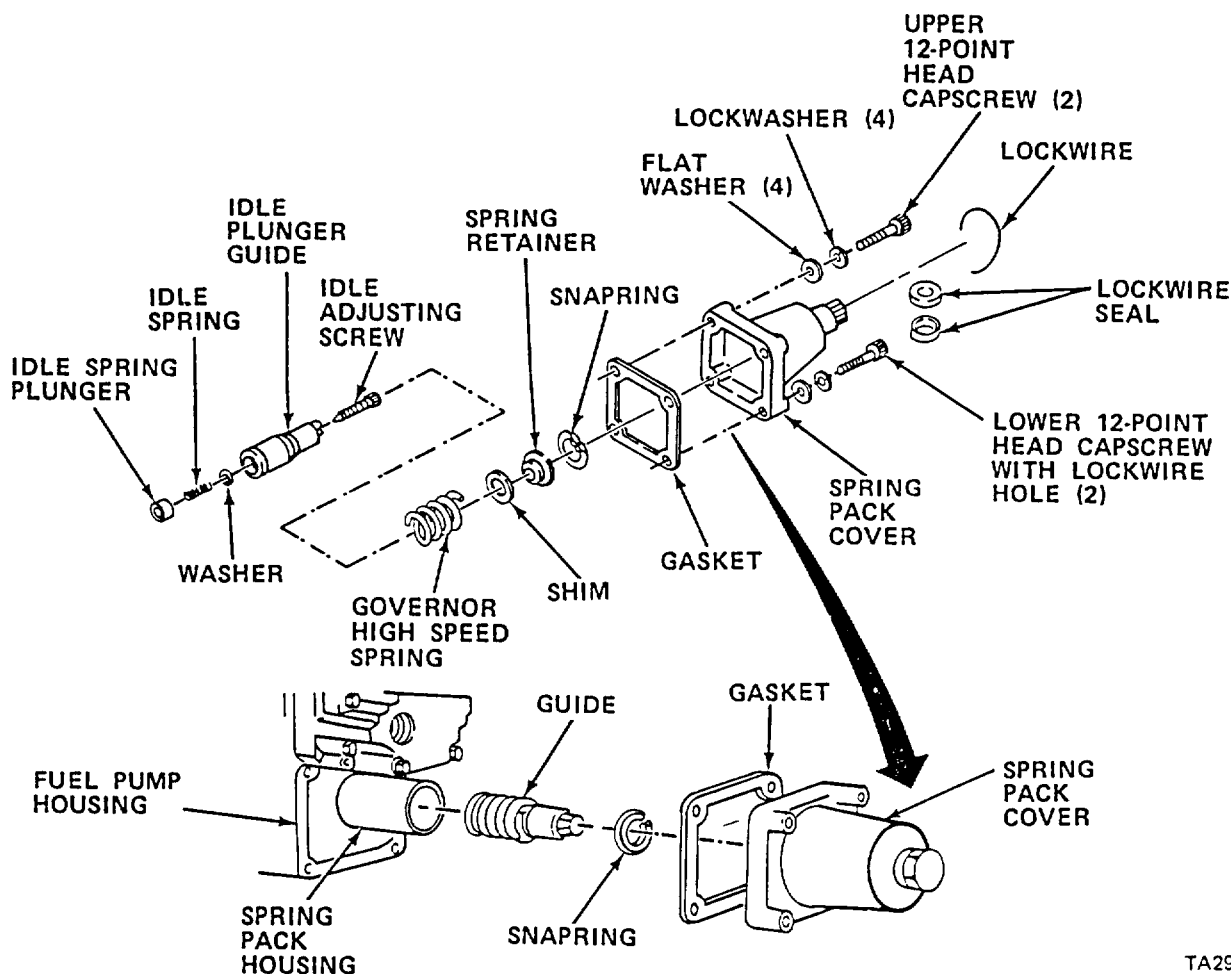
Lockwire and lockwire seal prohibit access to governor adjusting screw which is inside the governor spring pack cover.

- (1) Cut lockwire and remove lockwire and seal.
- (2) Remove 12-point head cap screws, lockwashers, and flat washers securing spring pack cover, and remove cover and gasket. Discard gasket.
- (3) Remove and discard snapping.
- (4) Remove spring retainer, shim, and governor high-speed compression spring.
- (5) Remove idle plunger guide.
- (6) Remove idle adjusting screw, idle spring plunger, idle spring, and adjusting screw washer from idle plunger guide. Discard idle spring.

WARNING

- COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).
- P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.

- b. Clean fuel pump governor spring pack components in cleaning solvent. Blow dry with compressed air.
- c. Inspect fuel pump governor spring pack components.
 - (1) Inspect all parts for cracks, breaks, and other damage. Discard defective parts.
 - (2) Inspect all threaded parts for cross-threading, stripped threads, and other damage. Discard defective parts.
- d. Install fuel pump governor spring pack.



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- (1) Screw idle adjusting screw into idle plunger guide.
- (2) Place adjusting screw washer over end of adjusting screw in guide.
- (3) Slide idle spring (Part No. 3018767) into plunger guide over idle adjusting screw.
- (4) Place idle spring plunger (Part No. 140923) into plunger guide against idle spring.
- (5) Slide governor high-speed compression spring (Part No. 143252), shim, and spring retainer onto guide.
- (6) Install guide and attached parts into spring pack housing in fuel pump.
- (7) Secure with snapping.

NOTE

Final idle adjustment will be made during fuel pump calibration.

- (8) Turn idle adjusting screw to right until contact made with seat.

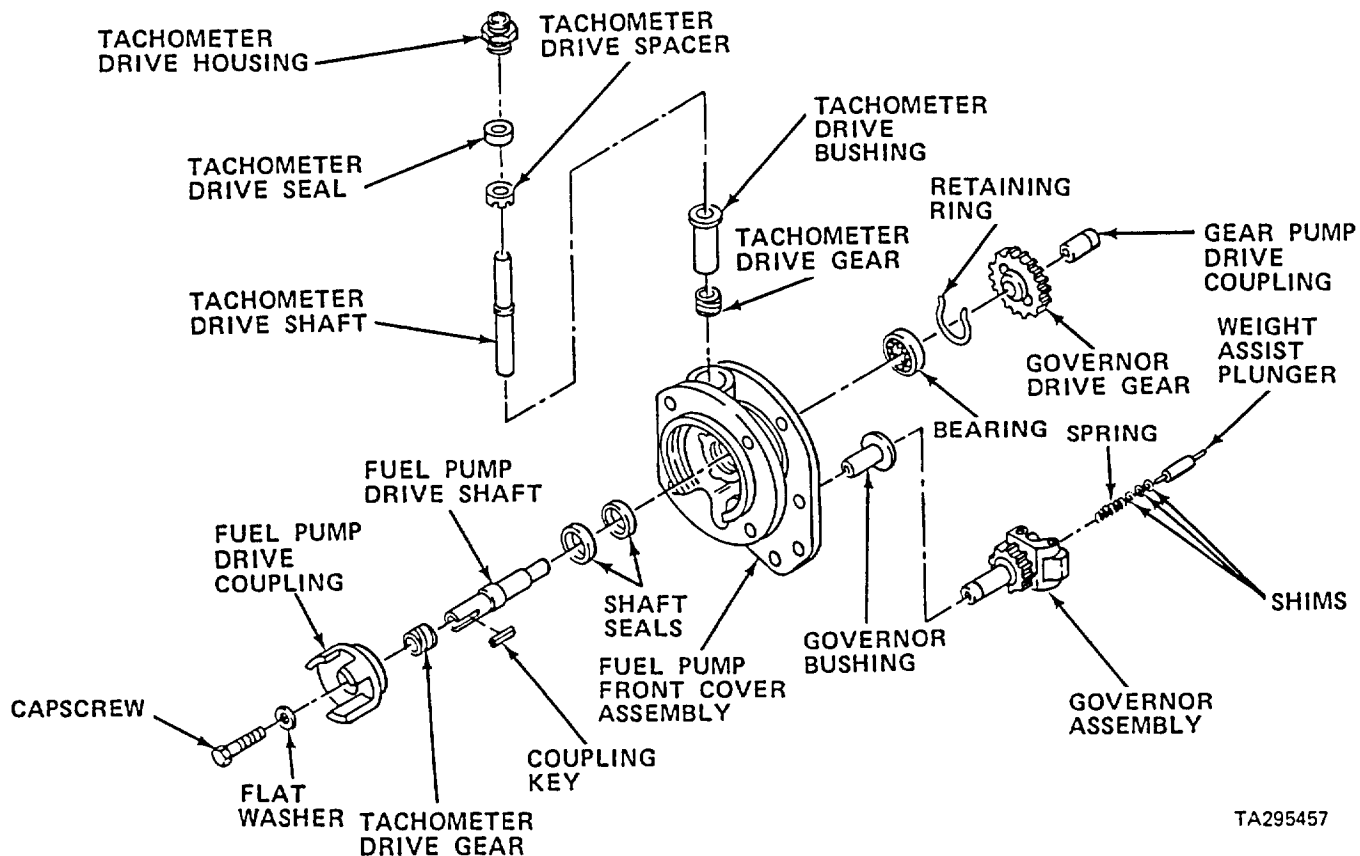
NOTE

Screws with lockwire holes are installed in lower right and left corners. Lockwire is not installed until fuel pump has been calibrated.

- (9) Secure spring pack cover and gasket to fuel pump with 12-point head capscrews., flat washers, and lockwashers. Torque capscrews to 9 - 11 ft lbs (12 - 15 N•m).

3-82. FUEL PUMP FRONT COVER ASSEMBLY AND GOVERNOR REPAIR

- a. Remove front cover assembly (para. 3-77).
- b. Disassemble fuel pump front cover assembly and governor.



TA295457

CAUTION

BE VERY CAREFUL WHEN REMOVING WEIGHT ASSIST PLUNGER. A SLIGHT NICK CAN CAUSE EXTENSIVE DAMAGE. AFTER REMOVING, PLACE PLUNGER WHERE IT WILL NOT BE DAMAGED.

- (1) Check governor assembly shaft for excessive wear before removing from front cover assembly. Shaft has excessive wear if it can be moved from side to side in its bushing. Discard governor assembly and bushing if worn excessively.
- (2) Check gear backlash between governor assembly gear and fuel pump drive gear. Normal backlash is 0.005 0.009 in. (0.127 0.228 mm). Discard governor assembly and fuel pump drive gear if backlash is more than 0.009 in. (0.228 mm).

- (3) Remove weight assist plunger, shims, and spring from governor assembly.
- (4) Using ST-709 puller, remove governor assembly from governor bushing in front cover assembly.

NOTE

Take care not to lose weight assist spring and shims during removal of weight assist plunger. Keep plunger, shims, and spring together.

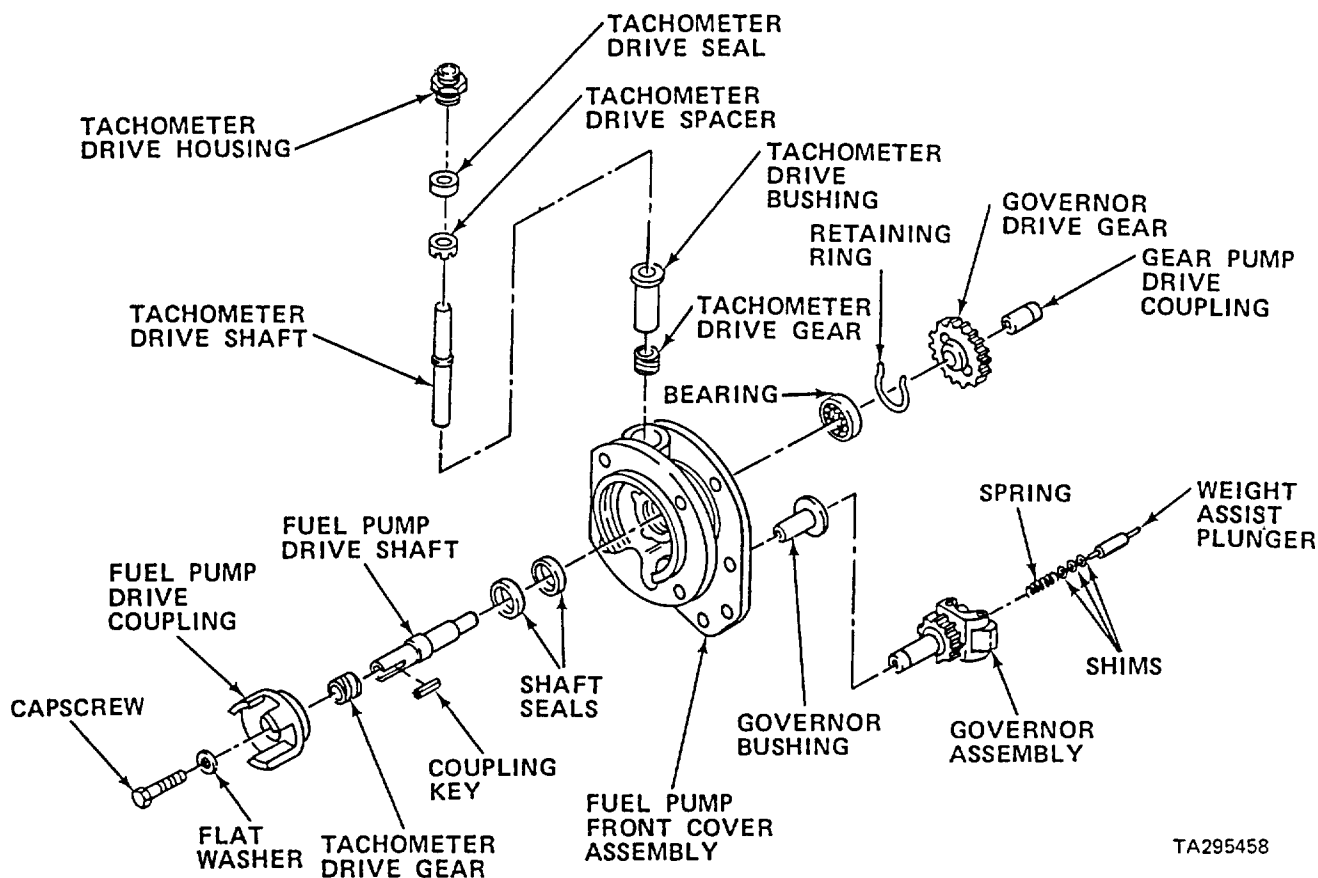
- (5) Remove capscrew and flat washer from fuel pump drive coupling.
- (6) Using ST-709 puller, remove drive coupling from drive shaft.
- (7) Remove tachometer drive gear and coupling key.
- (8) Remove retaining ring from rear or front cover assembly.
- (9) Press out fuel pump drive shaft, bearing, governor drive gear and gear pump drive coupling as an assembly from front cover assembly.
- (10) Press out two shaft seals from front cover assembly. Discard seals.
- (11) Press gear pump drive coupling and governor drive gear from fuel pump drive shaft. Leave bearing on shaft at this time.
- (12) Unscrew tachometer drive housing from front cover assembly.
- (13) Using brass punch, remove tachometer drive shaft, seal, spacer, bushing, and driven gear from front cover assembly.
- (14) Remove tachometer driven gear and bushing from tachometer drive shaft.

WARNING

- **COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).**
- **P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.**

- c. Clean fuel pump front cover assembly and governor with cleaning solvent. Blow dry with compressed air.
- d. Inspect fuel pump front cover assembly and governor.
 - (1) Inspect all parts for cracks, breaks, and other damage. Discard defective parts.
 - (2) Using micrometer, measure inside diameter of governor bushing. Discard bushing if diameter exceeds 0.504 in. (12.801 mm).
 - (3) Inspect fuel pump drive shaft for scoring, wear grooves, and other damage. Remove bearing (step 4) and discard shaft if defective.
 - (4) Inspect bearing for roughness and ease of rotation. If bearing defective, press from shaft and discard bearing.
 - (5) Using micrometer, measure outside diameter of tachometer drive shaft. Replace shaft if diameter is less than 0.3950 in. (10.0330 mm).
 - (6) Using micrometer, measure inside diameter of tachometer drive shaft bushing. Replace bushing if diameter is greater than 0.397 in. (10.084 mm).
 - (7) Check tachometer drive shaft drive and driven gears for chipped, broken, missing, or worn teeth. Replace if defective.

e. Assemble fuel pump front cover assembly and governor.



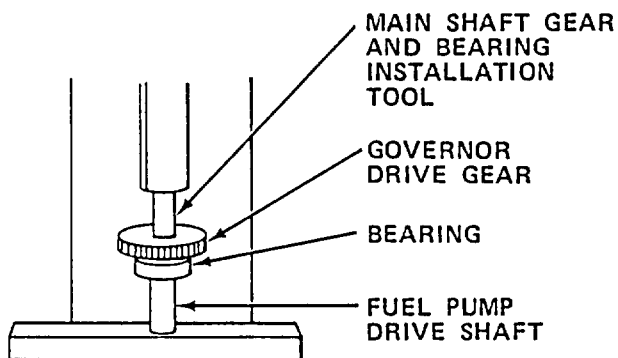
TA295458

- (1) Lubricate fuel pump drive shaft with clear calibration fluid and press bearing onto shaft with bearing installation tool. Tool is part of 3375175 front cover and main shaft assembly tool kit.
- (2) Install tachometer drive shaft bushing onto tachometer drive shaft.
- (3) Put a 0.004 in. (0.101 mm) feeler gage on top of bushing.
- (4) Press gear onto tachometer drive shaft until there is clearance of 0.002 0.005 in. (0.050 0.127 mm) between gear and bushing.
- (5) Line up oil groove in top of bushing with fuel pump drive shaft and press tachometer drive shaft, bushing, and drive gear as an assembly in front cover assembly until bushing bottoms.

NOTE
Spacer must bottom on bushing.

- (6) Install tachometer drive spacer on top of bushing with spacer slotted edge down.

- (7) Using tachometer drive seal driver from front cover and main shaft assembly tool kit, install tachometer drive seal with spring side down.

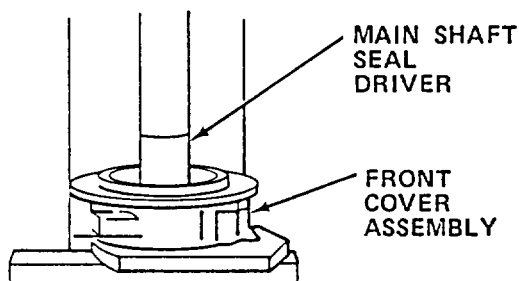


TA295459

NOTE

Flat side of gear should face away from bearing.

- (8) Using main shaft gear and bearing installation tool, press governor drive gear onto drive shaft until seated against bearing.
- (9) Lubricate fuel pump drive shaft and bore of gear pump drive coupling.
- (10) Press gear pump drive coupling onto drive shaft until coupling seats against governor drive gear.



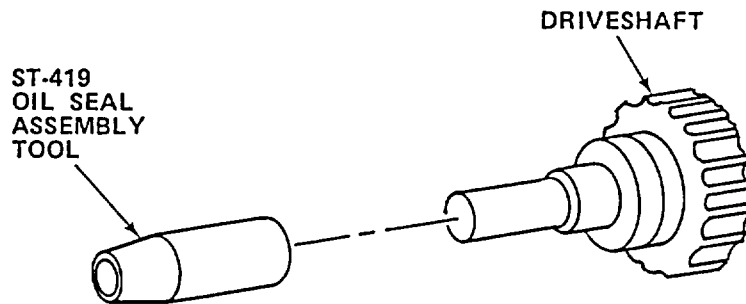
TA295460

- (11) Using main shaft seal driver from front cover and main shaft assembly tool kit, press first shaft seal into front cover assembly with lip of seal facing rear of cover assembly.

NOTE

Shaft seals must be spaced so weep hole is not covered.

- (12) Using main shaft seal driver, press second seal into front cover assembly with lip of seal facing front of cover assembly.



TA295461

NOTE

ST-419 oil seal assembly tool protects oil seals from damage when drive shaft is installed.

- (13) Lubricate ST-419 oil seal assembly tool and slip tool over drive shaft (fuel pump drive coupling end).

CAUTION

TAKE CARE NOT TO MOVE OIL SEALS WHEN INSTALLING DRIVE SHAFT. SHAFT OIL SEAL LEAKAGE COULD RESULT.

- (14) Carefully press pump drive shaft and attached parts into front cover assembly until bearing seats in cover bore.

NOTE

Look through holes in gear to check that retaining ring is fully engaged in groove.

- (15) Install retaining ring into groove of front cover assembly behind bearing.

CAUTION

DO NOT OVERTIGHTEN HOUSING. EXCESS PRESSURE ON SPACER CAN FLATTEN SPACER WHICH WILL DESTROY ITS EFFECTIVENESS.

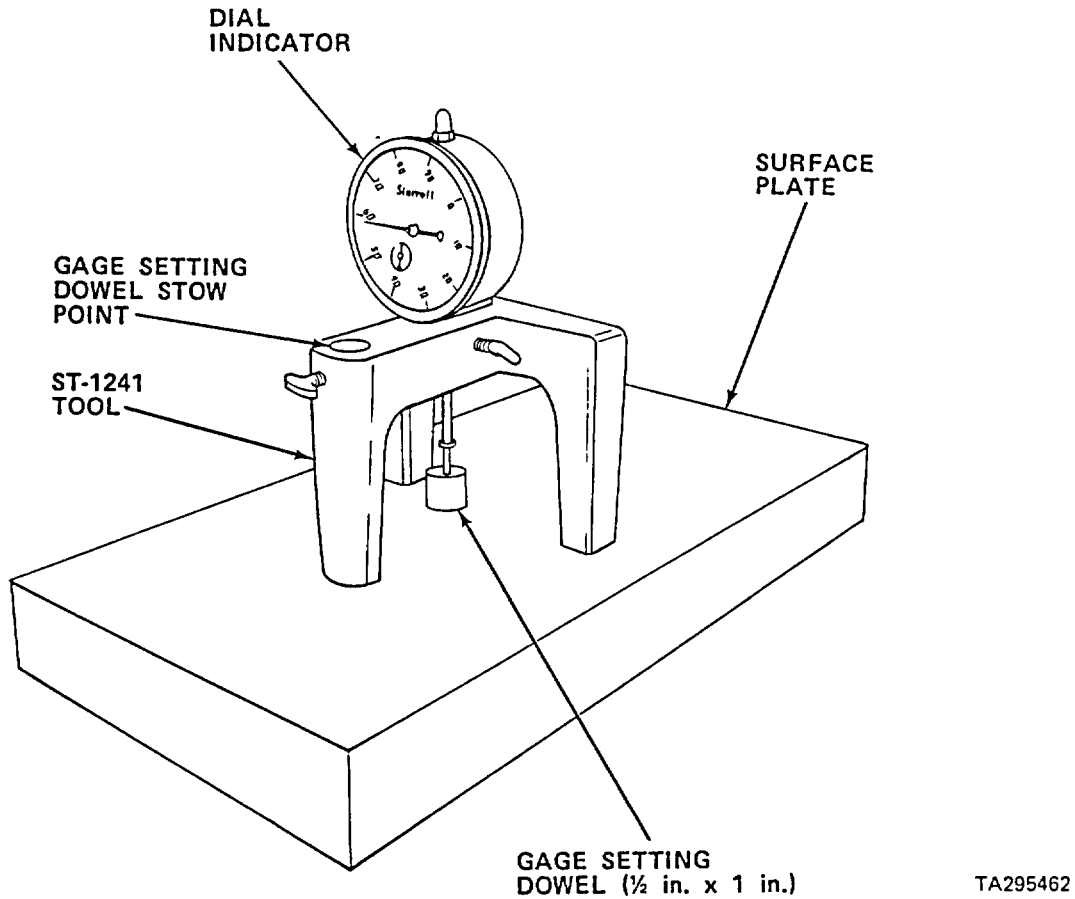
- (16) Screw tachometer drive housing into front cover assembly and torque housing to 35 - 45 ft lbs (47 - 61 N•m).
- (17) Install coupling key on fuel pump drive shaft.
- (18) Position tachometer drive gear on fuel pump drive shaft. Make sure drive gear teeth mate with driven gear teeth.
- (19) Position pump drive coupling behind tachometer drive gear and align with coupling key.
- (20) Carefully press coupling onto fuel pump drive shaft.
- (21) Secure fuel pump drive coupling with flat washer and capscrew.
- (22) Secure coupling in copper-jawed vise and torque capscrew to 5 ft lbs (7 N•m).
- (23) Coat governor bushing with high pressure lubricant and press bushing into front cover assembly. Be sure bushing is fully seated.
- (24) Slide governor assembly into governor bushing.
- (25) Rotate governor with weights open to be sure governor turns freely in bushing.

NOTE

Use enough shims between weight assist plunger and spring to make plunger tip protrude above gasket surface of front cover assembly.

- (26) Install weight assist plunger, shims, and new spring (part no. 143847) between governor weights and into bore of governor assembly. Be sure weight assist plunger is installed with smallest end facing governor weights.

- (27) Check protrusion of weight assist plunger as follows:

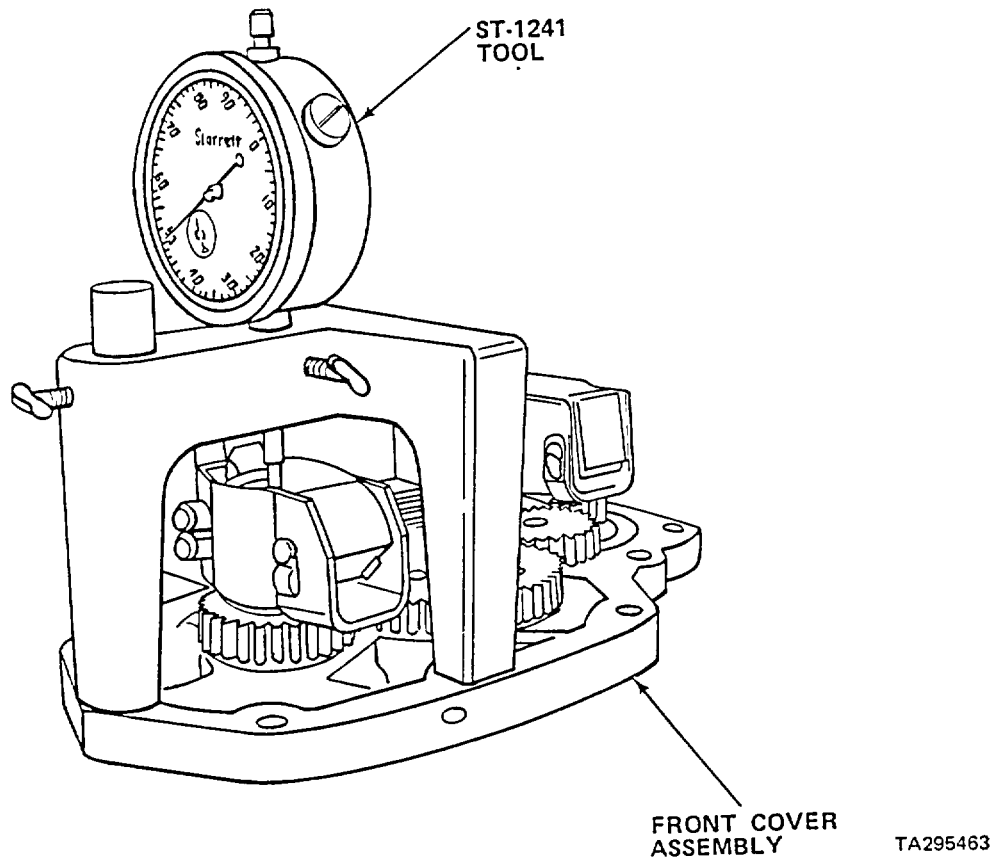


- (a) Place ST-1241 plunger protrusion checking tool on a surface plate.

NOTE

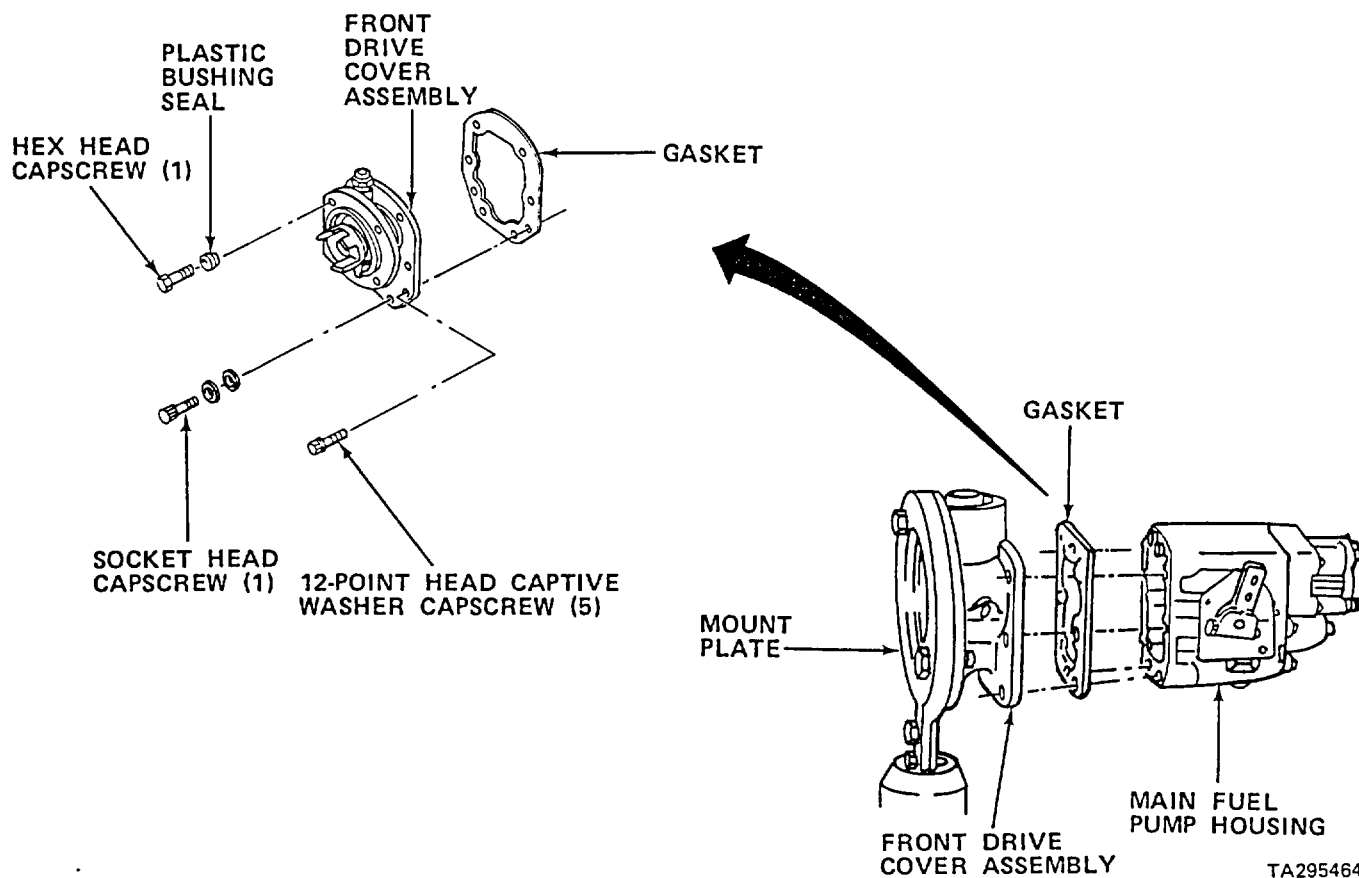
Gage setting dowel is used to establish zero start point on gage.

- (b) Remove gage setting dowel from tool and place under dial indicator contact pin.
 (c) Zero checking tool dial indicator.
 (d) Remove gage setting dowel and stow dowel on tool.



- (e) Place protrusion checking tool on front cover assembly so that dial indicator contact pin comes in contact with tip of weight assist plunger.
- (f) Read protrusion on dial indicator.
- (g) If protrusion is less than 0.840 in. (21.336 mm), add shims between plunger and spring until 0.840 in. is indicated. Remove shims if indication is greater than 0.840 in.
- (h) If protrusion cannot be gotten with no shims installed and indication is greater than specified, grind small end (tip) of plunger to meet specification.

f. Install fuel pump front cover assembly and governor.



- (1) Place new mount gasket on dowel pins of fuel pump main housing.
- (2) Position governor assembly weight carrier horizontally and hold weights in.
- (3) Mate fuel pump main housing to front cover assembly while checking that governor weights are properly engaged with tang on governor plunger.

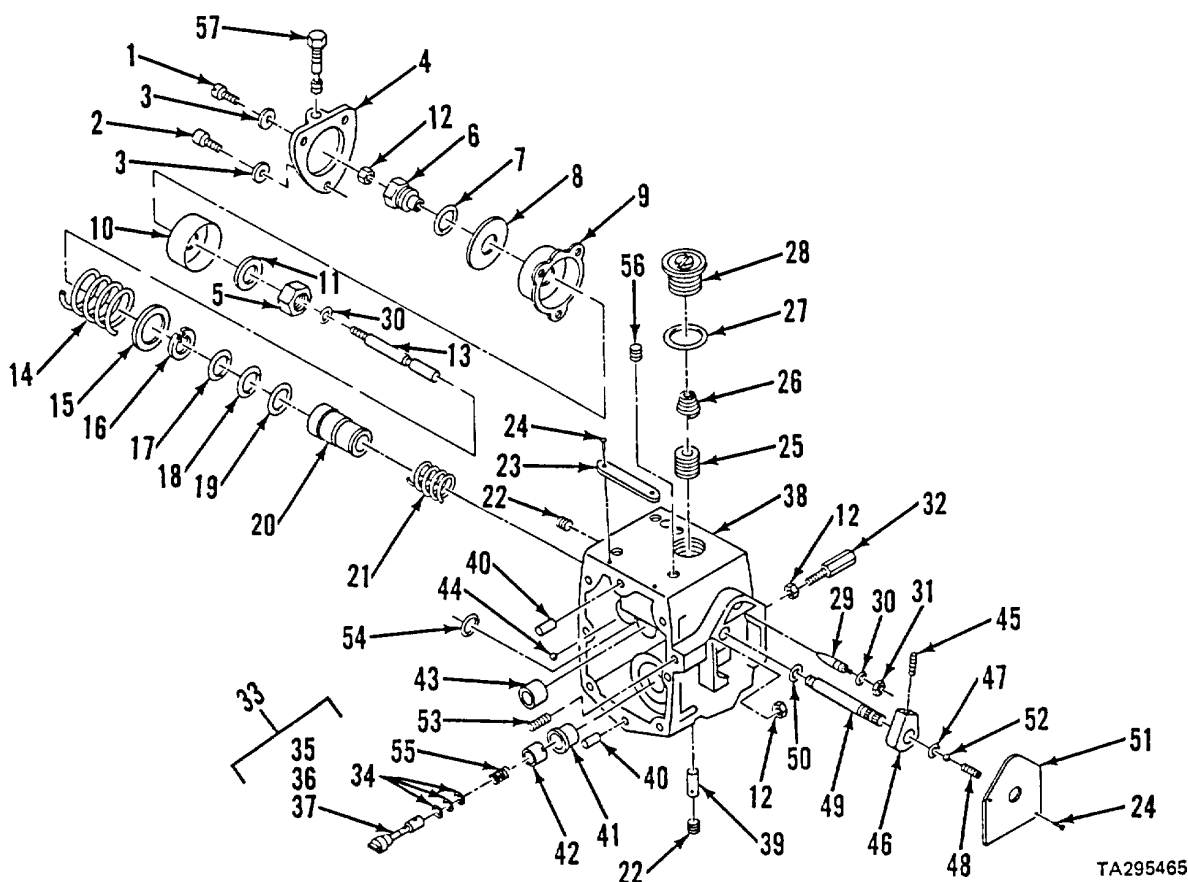
NOTE

Do not use washer with hex head capscrew which retains plastic bushing seal.

- (4) Secure front cover assembly to fuel pump main housing with new plastic bushing seal and its hex head capscrew, one 12-point head screw, and its lockwasher and flat washer, and remaining captive washer screws.
 - (5) Torque all screws to 9 - 11 ft lbs (12 - 15 N•m).
 - (6) Remove fuel pump front cover assembly and fuel pump from ball joint vise mounting plate.
- g. Perform fuel pump testing and calibration (para. 3-84).

3-83. FUEL PUMP MAIN HOUSING REPAIR

a. Disassemble fuel pump main housing



TA295465

LEGEND:

- | | | |
|-----------------------------------|-----------------------------|------------------------------|
| 1. FILISTER HEAD SCREW (2) | 20. BARREL | 39. ROLL PIN |
| 2. DRILLED FILISTER HEAD SCREW | 21. BARREL SPRING | 40. DOWEL (2) |
| 3. FLAT WASHER (3) | 22. PIPE PLUG (4) | 41. SPRING PACK HOUSING |
| 4. FUEL CONTROL COVER | 23. NAME PLATE | 42. GOVERNOR BARREL |
| 5. NUT | 24. DRIVE SCREW (4) | 43. TACHOMETER DRIVE BUSHING |
| 6. AIR FUEL CONTROL PISTON INSERT | 25. FUEL FILTER SCREEN | 44. AC PLUG BALL (2) |
| 7. GASKET WASHER | 26. FILTER SPRING | 45. SETSCREW |
| 8. RETAINER WASHER | 27. CAP SEAL RING | 46. STOP |
| 9. BELLOWS | 28. FILTER SCREEN CAP | 47. O-RING |
| 10. AFC PISTON | 29. AFC NEEDLE VALVE | 48. FUEL ADJUSTING SCREW |
| 11. PISTON SPACER | 30. O-RING | 49. THROTTLE SHAFT |
| 12. HEXAGON JAM NUT (2) | 31. NUT | 50. O-RING |
| 13. THROTTLE PLUNGER | 32. THREADED STUD | 51. THROTTLE SHAFT |
| 14. SPRING | 33. GOVERNOR SPACER | 52. THROTTLE SHAFT BALL |
| 15. AFC SHIM | 34. SHIMS | 53. TAPERED STUD |
| 16. RETAINING RING | 35. GOVERNOR SPACER | 54. RETAINING RING |
| 17. O-RING | 36. GOVERNOR PLUNGER | 55. TORQUE SPRING |
| 18. O-RING (2) | 37. GOVERNOR PLUNGER DRIVER | 56. PIPE PLUG |
| 19. O-RING | 38. HOUSING | 57. FLOW VALVE |

- (1) Remove drive screws (24) from throttle shaft cover (51). Discard screws.
- (2) Remove throttle shaft cover (51) from housing (38).
- (3) Remove retaining ring (54) securing throttle shaft (49) to housing (38). Discard retaining ring.
- (4) Remove throttle shaft (49) from housing (38).
- (5) Remove and discard O-ring (50) from shaft (49).

CAUTION

BE CAREFUL NOT TO DAMAGE THROTTLE SHAFT WHEN DRILLING OUT THROTTLE SHAFT BALL.

- (6) Carefully drill out throttle shaft ball (52) from throttle shaft (49).
- (7) Unscrew and remove fuel adjusting screw (48) from inside of throttle shaft (49).
- (8) Remove and discard O-ring (47) on fuel adjusting screw (48).
- (9) Remove setscrew (45) from stop (46) and remove stop from throttle shaft (49).
- (10) Loosen nut (31) on AFC needle valve (29) and remove valve from housing (38).
- (11) Remove nut (31) and O-ring (30) from AFC needle valve (29). Discard O-ring.
- (12) Loosen jam nut (12) on threaded stud (32).
- (13) Remove threaded stud (32) from housing (38) and remove jam nut (12) from stud.
- (14) Remove jam nut (12) from tapered stud (53) and remove stud from housing (38).
- (15) Remove screen cap (28), cap seal ring (27), filter spring (26), and fuel filter screen (25), from housing (38).
- (16) Remove flow valve (57) from fuel control cover (4).
- (17) Remove two screws (1), one screw with lockwire hole (2), and three flat washers (3) which secure fuel control cover (4) to housing (38).

- (18) Remove fuel control cover (4).
- (19) Carefully remove bellows (9) with attaching parts from housing (38).
- (20) Remove spring (14) and AFC shim (15) from housing (38).
- (21) Remove and discard retaining ring (16) from housing (38).
- (22) Using 3375599 puller, remove AFC barrel (20) from housing (38).
- (23) Remove and discard O-rings (17, 18, and 19) from AFC barrel (20).
- (24) Remove barrel spring (21) from housing (38).
- (25) Remove jam nut (12) from AFC plunger (13).
- (26) Unscrew and remove AFC plunger (13) from air fuel control piston insert (6).
- (27) Remove and discard O-ring (30) from AFC plunger (13).
- (28) Remove nut (5) and piston spacer (11) from air fuel control piston insert (6).
- (29) Remove AFC piston (10), bellows (9), retainer washer (8), and gasket washer (7) from air fuel control piston insert (6). Discard gasket, washer, and bellows.
- (30) Remove governor plunger (33), shims (34), and torque spring (55) as an assembly from housing (38).

CAUTION

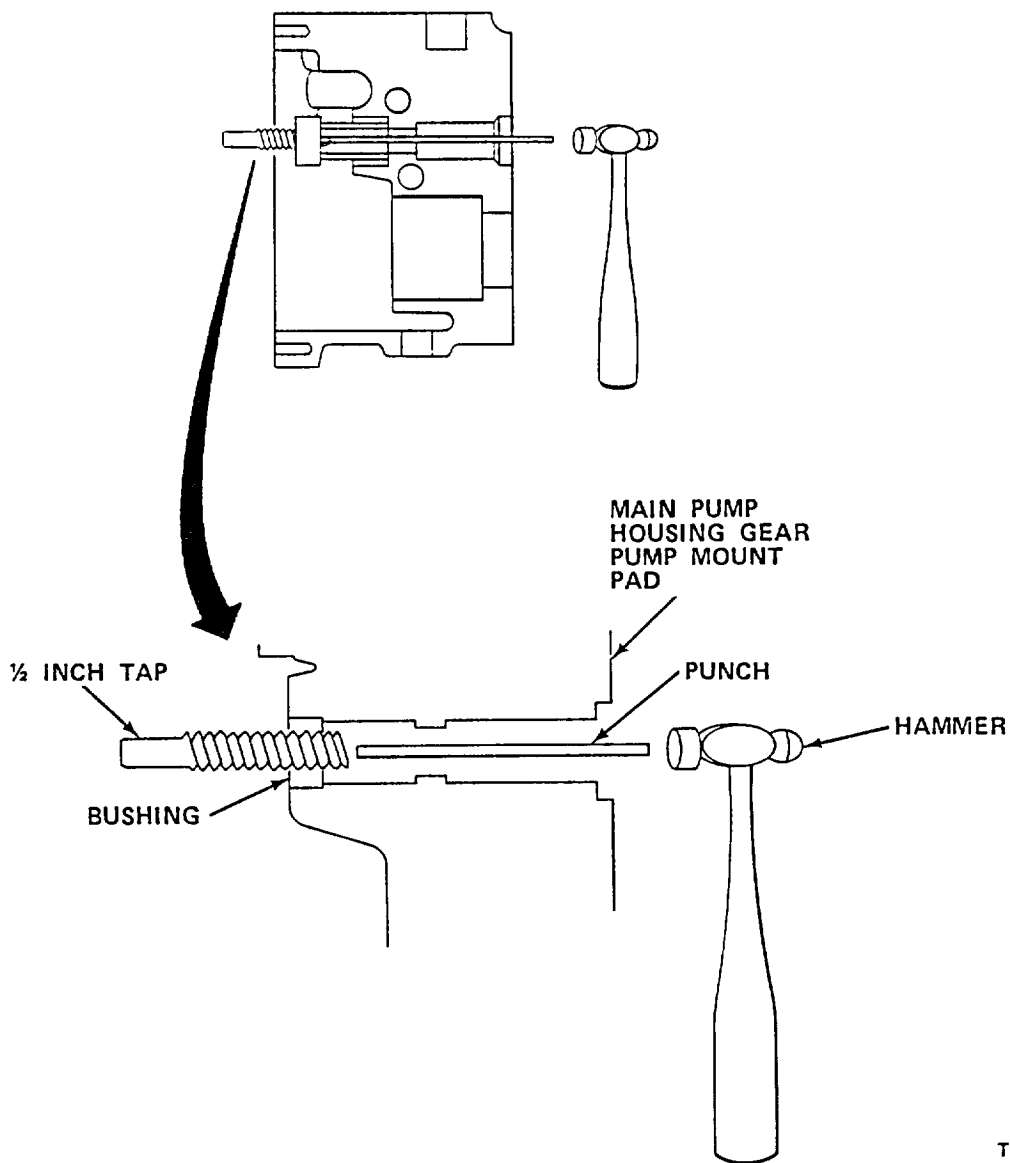
DO NOT PULL TORQUE SPRING (56) TO REMOVE FROM GOVERNOR PLUNGER. PULLING SPRING WILL EXPAND IT BEYOND ITS ELASTIC LIMIT AND PERMANENTLY DAMAGE SPRING. USE TWISTING MOTION WHEN REMOVING TORQUE SPRING.

- (31) Twist torque spring (55) and carefully remove from governor plunger (33).
- (32) Remove shims (34).
- (33) Remove pipe plugs (22 and 56) from housing (38).

WARNING

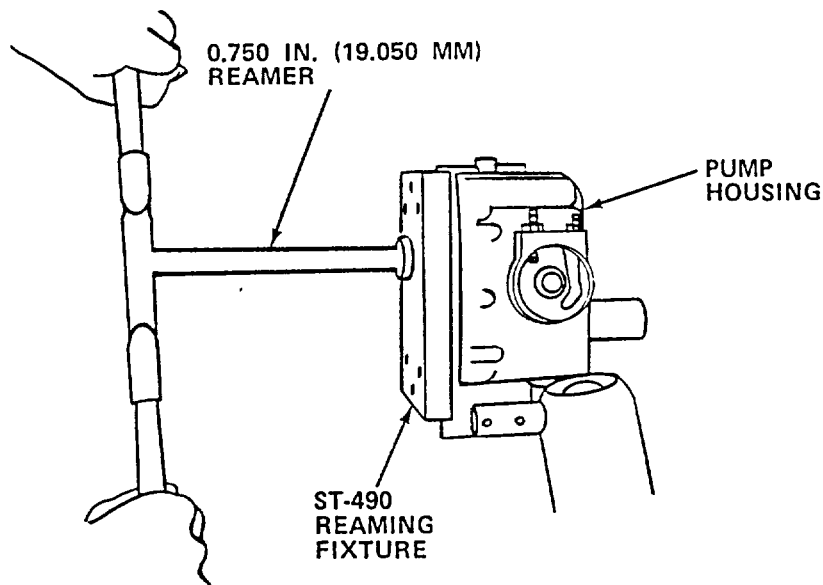
- **COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC).**
 - **P-D-680 SOLVENT IS POTENTIALLY DANGEROUS. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP AWAY FROM FLAME OR EXCESSIVE HEAT.**
- b. Clean fuel pump main housing components with cleaning solvent. Blow dry with compressed air.
- c. Inspect and repair fuel pump main housing components.
- (1) Inspect tachometer drive bushing (43) for scoring, burrs, and other damage. Replace bushing if defective (step c (3) below).
 - (2) Using suitable micrometer, measure inside diameter of tachometer drive bushing (43). Replace bushing if inside diameter is greater than 0.7525 in. (19.1135 mm) (step c (3) below).

(3) Replace tachometer drive bushing as follows:



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- (a) With a 0.50 in. (12.70 mm) pipe tap, cut a thread in bushing. Leave tap in bushing.
- (b) Insert punch through rear of housing (38) (gear pump mount pad) and drive out bushing.
- (c) Apply coat of high pressure lubricant to new bushing.
- (d) Press bushing into housing flush with housing bore.



TA295467

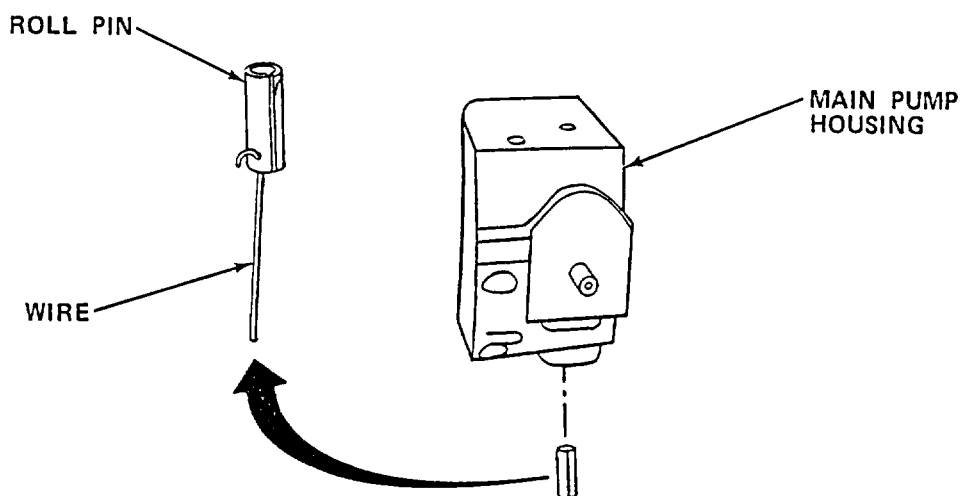
- (e) Secure ST-490 reaming fixture to pump housing.
- (f) Using a well-oiled 0.750 in. (19.050 mm) reamer, line ream bushing to 0.7495 - 0.7505 in. (19.0373 - 19.0627 mm).
- (g) Clean all metal filing from housing.
- (h) Check bushing inside diameter after reaming. Diameter must be less than 0.7525 in. (19.1135 mm).

NOTE

If governor barrel (42) shows signs of wear or damage or governor plunger (33) is damaged, barrel and plunger must be replaced. If plunger is just worn and not damaged, e.g., scored, the barrel does not have to be replaced.

- (4) Inspect governor barrel (42) for wear and other damage.

- (5) If governor barrel is defective, replace as follows:
- (a) Locate pipe plug hole on bottom of housing (38) directly below governor barrel (42).



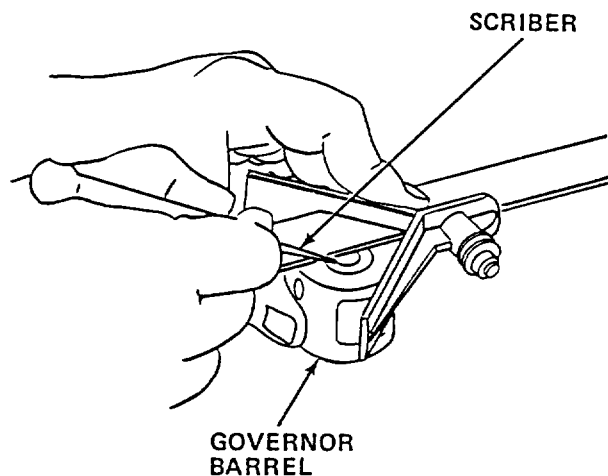
TA295468

- (b) With a piece of wire bent to form a hook, insert wire through pipe plug hole and engage hook in hole of roll pin (39).
- (c) Pull roll pin (39) out of housing (38) and discard roll pin.
- (d) Heat housing (38) in oven to 300°F (149°C).

WARNING

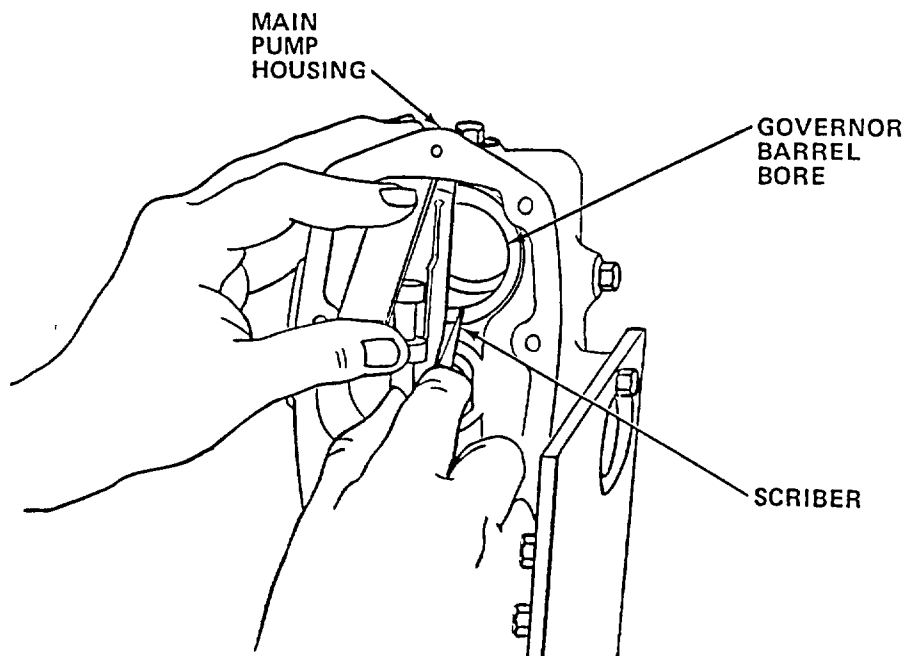
TAKE PRECAUTIONS AGAINST BURNS FROM DIRECT SKIN CONTACT WITH HOT HOUSING. WEAR PROTECTIVE GLOVES.

- (e) Press governor barrel (42) out of housing (38) by pushing against spring pack housing (41).
- (f) Using micrometer, measure barrel bore in housing (38) and outside diameter of new governor barrel.
- (g) Discard housing (38) if barrel in housing bore is not at least 0.002 in. (0.050 mm) smaller than barrel outside diameter.
- (h) Check barrel bore of housing for score marks. Remove slight score marks with crocus cloth. Discard housing (38) if deeply scored.



TA295469

- (i) Scribe a centering line on face of governor barrel in line with roll pin hole in bottom of barrel.



TA295470

- (j) Scribe a centering line on face of barrel in governor housing bore in line with roll pin hole in bottom of bore.
- (k) Heat housing (38) in oven to 300°F (149°C).
- (l) Coat new governor barrel with high pressure lubricant.

WARNING

TAKE PRECAUTIONS AGAINST BURNS FROM DIRECT SKIN CONTACT WITH HOT HOUSING. WEAR PROTECTIVE GLOVES.

- (m) Remove pump housing from oven and drop spring pack housing (41) in place through governor barrel bore in housing.
- (n) Place governor barrel (chamfered end first) in housing bore alining scribe mark on barrel face with scribe mark on housing.
- (o) Press governor barrel into housing until barrel bottoms against spring pack housing (41).
- (p) Check that roll pin holes in barrel and housing are alined.
- (q) With slot in roll pin (39) facing front of housing, install new roll pin through bottom of housing using 3376136 driver.
- (r) Select a new governor plunger to fit new barrel using following table:

Code	Red	Blue	Green	Yellow	Orange	Black	Gray	Purple
Size/ Class	0	1	2	3	4	5	6	7
Part. No.	3009380	3009381	3009382	3009383	3009384	3009385	3009386	3009387

- (s) Select a new size/class 2 green (Part No. 3009382) governor plunger and try to fit it into governor barrel.
- (t) If plunger enters, try a size/class 3 yellow (part no. 3009383) plunger.
- (u) Keep trying larger sizes/classes until one will not enter barrel; then select a plunger two sizes/classes smaller than last plunger that did enter.
- (v) Check plunger fit by making sure that it drops into barrel with no help.
- (w) Etch governor barrel face with the size/class of plunger in use.
- (x) If only plunger to be replaced, check size/class etched on barrel face and replace with same size/class plunger.

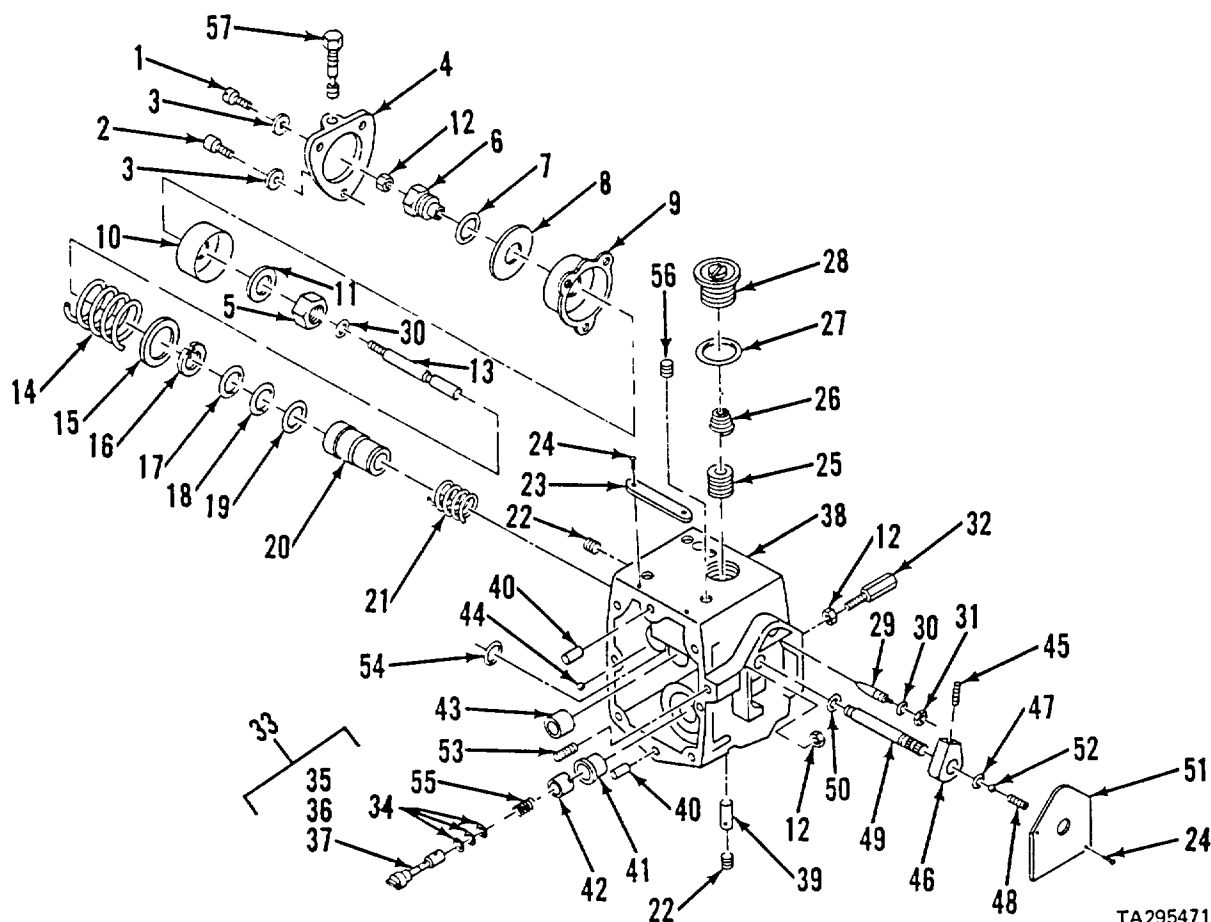
- (6) Inspect throttle shaft sleeve in housing (38) for damage. Discard housing if throttle shaft sleeve is damaged.
- (7) Check fuel pump name plate (23) for damage. Replace if damaged as follows:
 - (a) Remove drive screws (24) and remove name plate (23).
 - (b) Install new name plate and secure with drive screws.
 - (c) Transfer information from damaged name plate to new name plate.
 - (d) Discard damaged name plate.
- (8) Inspect throttle shaft (49) for wear, scoring, and other damage. Replace if defective with same color code shaft.
- (9) Check dowels (40) for damage. Replace if damaged.
- (10) Check fuel filter screen (25) for mesh damage or imbedded metal particles. Replace if defective.
- (11) Inspect AFC plunger (13) and AFC barrel (20) for wear, scoring, burrs, and other damage. Replace defective part(s).
- (12) Inspect all other parts for cracks, breaks, and other damage. Discard damaged parts.

NOTE

Do not remove AFC plug balls (44).

- (13) Check AFC plug balls (44) for damage. If balls damaged, discard housing (38).

d. Assemble fuel pump main housing.



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LEGEND:

- | | | |
|-----------------------------------|-----------------------------|------------------------------|
| 1. FILISTER HEAD SCREW (2) | 20. BARREL | 40. DOWEL (2) |
| 2. DRILLED FILISTER HEAD SCREW | 21. BARREL SPRING | 41. SPRING PACK HOUSING |
| 3. FLAT WASHER (3) | 22. PIPE PLUG (4) | 42. GOVERNOR BARREL |
| 4. FUEL CONTROL COVER | 23. NAME PLATE | 43. TACHOMETER DRIVE BUSHING |
| 5. NUT | 24. DRIVE SCREW (4) | 44. AC PLUG BALL (2) |
| 6. AIR FUEL CONTROL PISTON INSERT | 25. FUEL FILTER SCREEN | 45. SETSCREW |
| 7. GASKET WASHER | 26. FILTER SPRING | 46. STOP |
| 8. RETAINER WASHER | 27. CAP SEAL RING | 47. O-RING |
| 9. BELLOWS | 28. FILTER SCREEN CAP | 48. FUEL ADJUSTING SCREW |
| 10. AFC PISTON | 29. AFC NEEDLE VALVE | 49. THROTTLE SHAFT |
| 11. PISTON SPACER | 30. O-RING (2) | 50. O-RING |
| 12. HEXAGON JAM NUT (3) | 31. NUT | 51. THROTTLE SHAFT COVER |
| 13. THROTTLE PLUNGER | 32. THREADED STUD | 52. THROTTLE SHAFT BALL |
| 14. SPRING | 33. GOVERNOR PLUNGER | 53. TAPERED STUD |
| 15. AFC SHIM | 34. SHIMS | 54. RETAINING RING |
| 16. RETAINING RING | 35. GOVERNOR SPACER | 55. TORQUE SPRING |
| 17. O-RING | 36. GOVERNOR PLUNGER | 56. PIPE PLUG |
| 18. O-RING (2) | 37. GOVERNOR PLUNGER DRIVER | 57. FLOW VALVE |
| 19. O-RING | 38. HOUSING | |
| | 39. ROLL PIN | |

- (1) Install pipe plugs (22 and 56), in housing (38). Torque plugs to 5 - 8 ft lbs (7 - 11 N•m).
- (2) Install shims (34) on governor plunger (33).
- (3) Install torque spring (55), part no. 138781, by placing small diameter end of spring on governor plunger (33) and twisting spring until fully seated.
- (4) Install governor plunger assembly (33), into governor barrel (42) in housing (38).
- (5) Place new gasket washer (7) and retaining washer (8) under head of air fuel control piston insert (6).

NOTE

If bellows (9) has part number, number must face toward piston (10).

- (6) Install new bellows (9), AFC piston (10), and piston spacer (11) on air fuel control piston insert (6).
- (7) Secure all components to air fuel control piston insert (6) with nut (5). Torque nut to 30 - 40 in. lbs (3.4 - 4.5 N•m).
- (8) Apply light coat of lubricant to new plunger O-ring (30) in AFC plunger groove just below threads.
 - (9) Screw AFC plunger (13) into fuel control piston insert (6) until threaded end of AFC plunger is flush with outer edge of piston insert.
 - (10) Screw jam nut (12) onto AFC plunger (13) finger tight. Nut will be tightened when pump is tested and calibrated.
 - (11) Install barrel spring (21) in housing (38).
 - (12) Lubricate new O-rings (17, 18, and 19) and install in grooves of barrel (20).
 - (13) Press barrel (20) into housing (38) and secure with new retaining ring (16).
 - (14) Check spring (14) for proper load as follows:
 - (a) Measure free length of spring. Length must be 1.140 - 1.260 in. (28.956 - 32.004 mm). Replace spring if it does not meet free length specification.
 - (b) Place spring in spring tester and apply 7.00 lbs (31.13 N) load to spring. Note length of spring while under this load.

- (c) Compress spring 0.300 in. (7.620 mm) more than length noted in (b) above, and check spring load.
 - (d) If load is not 26.3 - 29.7 lbs (116.9 - 132.1 N), replace spring.
- (15) Install AFC shim (15) and spring (14) into housing (38).

CAUTION

INSERT PLUNGER VERY CAREFULLY TO PREVENT PLUNGER DAMAGE AND SUBSEQUENT FAILURE OF FUEL PUMP.

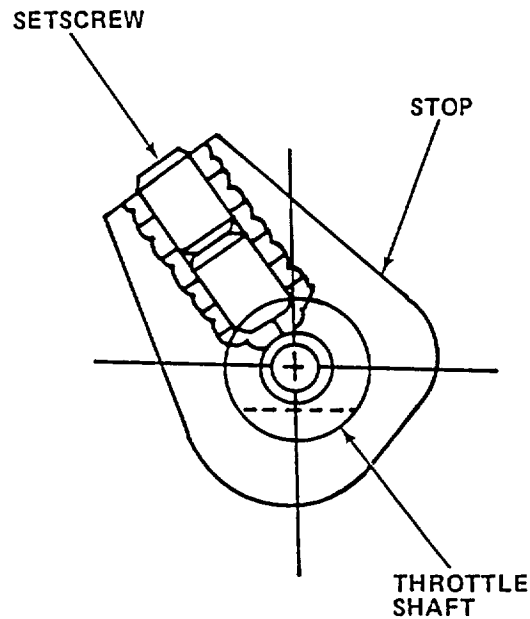
- (16) Carefully install AFC plunger (13) with attached parts into barrel (20) in housing (38).
- (17) Aline holes in AFC bellows (9) with holes in housing (38) and install fuel control cover (4).
- (18) Install two screws (1), two flat washers (3), and screw with lockwire hole (2) and flat washer (3) securing fuel control cover (4) to housing (38). Leave screws finger tight. Cover will be removed during fuel pump testing and calibration and reinstalled after testing and calibration.
- (19) Check that flow valve (57) ball is loose and hole near bottom of valve is not plugged.
- (20) Screw flow valve (57) into fuel control cover (4). Torque flow valve to 5 - 8 ft lbs (7 - 11 N•m).
- (21) With hole in fuel filter screen (25) facing down, install screen into top of housing (38).
- (22) Install filter spring (26) in housing (38).
- (23) Place new cap seal ring (27) on filter screen cap (28) and install cap in housing (38). Torque cap to 8 - 12 ft lbs (11 -16 N•m).
- (24) Screw tapered stud (53) into housing (38).
- (25) Screw jam nut (12) onto tapered stud (53).
- (26) Screw jam nut (12) onto threaded stud (32) and screw threaded stud into housing (38).
- (27) Lubricate O-ring (30) and using 3375148 O-ring installation tool, install new O-ring on AFC needle valve (29).
- (28) Screw AFC needle valve (29) into housing (38) until valve bottoms out.

- (29) Screw nut (31) onto AFC needle valve finger tight. Nut will be tightened after pump is tested and calibrated.

NOTE

If new throttle shaft being installed, be sure that new throttle shaft color code is same as old shaft.

- (30) Slide stop (46) onto throttle shaft (49).
- (31) Install setscrew (45) into stop (46) and torque setscrew to 70 - 90 in. lbs (8 - 10 N•m).
- (32) Lubricate O-ring (47) and install in groove of fuel adjusting screw (48).
- (33) Screw fuel adjusting screw (48) into throttle shaft (49) approximately six turns.
- (34) Check that throttle shaft fuel hole is open.
- (35) Lubricate new O-ring (50) and install in groove of throttle shaft (49).



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- (36) Insert throttle shaft (49) into housing (38) with stop pointing upward and fuel port in shaft facing down.
- (37) Secure throttle shaft (49) to housing (38) with new retaining ring (54). Ring is installed through front opening of housing.

NOTE

Throttle shaft ball (52), throttle shaft cover (51), and two cover drive screws (24) will be installed after fuel pump has been tested and calibrated.

- (38) Install fuel pump front cover assembly and governor (para. 3-82).
- (39) Install fuel pump governor spring pack (para. 3-81).
- (40) Install fuel gear pump assembly (para. 3-80).
- (41) Install shutoff valve assembly (para. 3-78).
- (42) Perform fuel pump testing and calibration (para. 3-84).

3-84. FUEL PUMP TESTING AND CALIBRATION

- a. Calibration data. Test and calibrate fuel pump on MIL-STD 110-20-200 fuel injection pump tester using the data found in the following calibration values table.

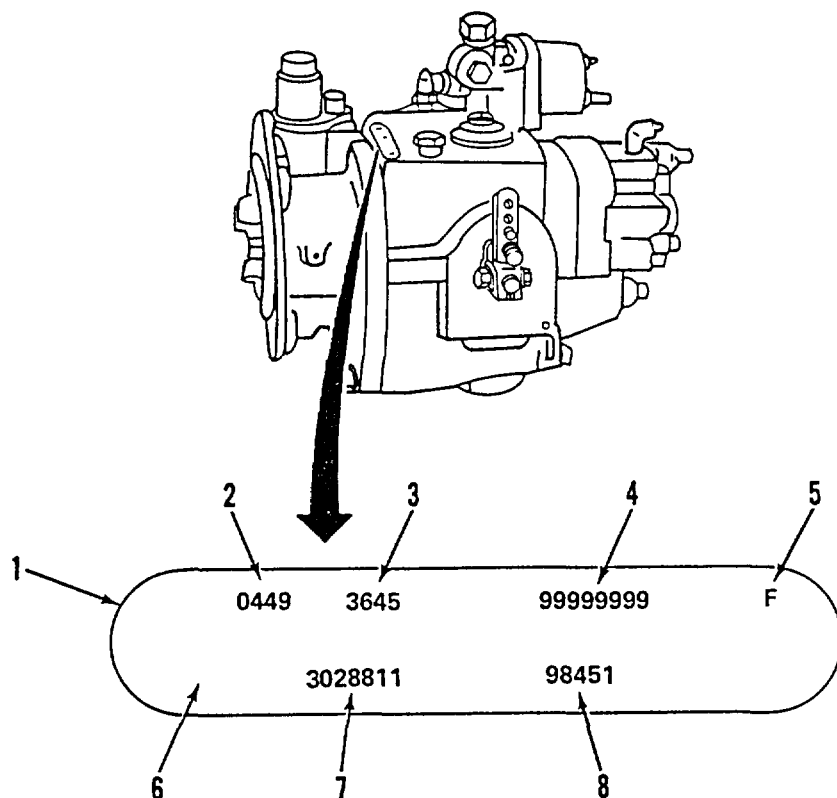
Table 3-4. CALIBRATION VALUES: PT (TYPE G) - AFC FUEL PUMP

Pump Code	3645-F
Date	November 1982
Control Parts List	0449
Nominal HP @ Rated RPM	392 - 408 @ 2100
Engine Fuel Rail psi	146 - 162
Fuel Rate lb/hr	141 - 147
Torque Rise %	15
Auto Governor Cutoff rpm	2130 - 2150
Throttle Leakage cc/minute	110
Service Idle Speed psi @ rpm	23 @ 500
Service No Air Snap Rail psi	50
Intake Manifold Press. in. Hg	37 - 45
Calibration psi @ lb/hr @ rpm	157 @ 495 @ 2100
Check Point 1	
psi @ rpm	112 - 118 @ 1500
Flow Rate lb/hr	410
Check Point 2	
psi @ rpm	63 - 71 @ 1000
Flow Rate lb/hr	280

Table 3-4. CALIBRATION VALUES: PT (TYPE G) - AFC FUEL PUMP (Cont)

AFC Plunger Setting	
rpm	1600
in. Hg	6
psi	69 Fuel psi 69
Flow Rate lb/hr	300
AFC No-Air Setting	
rpm	1600
psi	42
Flow Rate lb/hr	230
Weight Assist Protrusion Setting	0.840 in. (21.336 mm)
Weight Assist Spring Part No.	143847
Idle Plunger Spring Part No.	140923
AFC Spring Part No.	179820
Idle Spring Part No.	3018767
Torque Spring Part No.	138781
Governor Weight Part No.	146437.
Governor Spring Part No.	143252
Governor Plunger Part No.	3009380
Gear Pump Size	0.750 in. (19.050 mm)

- b. Check that fuel pump nameplate properly describes fuel pump to be calibrated. Nameplate is stamped as follows:



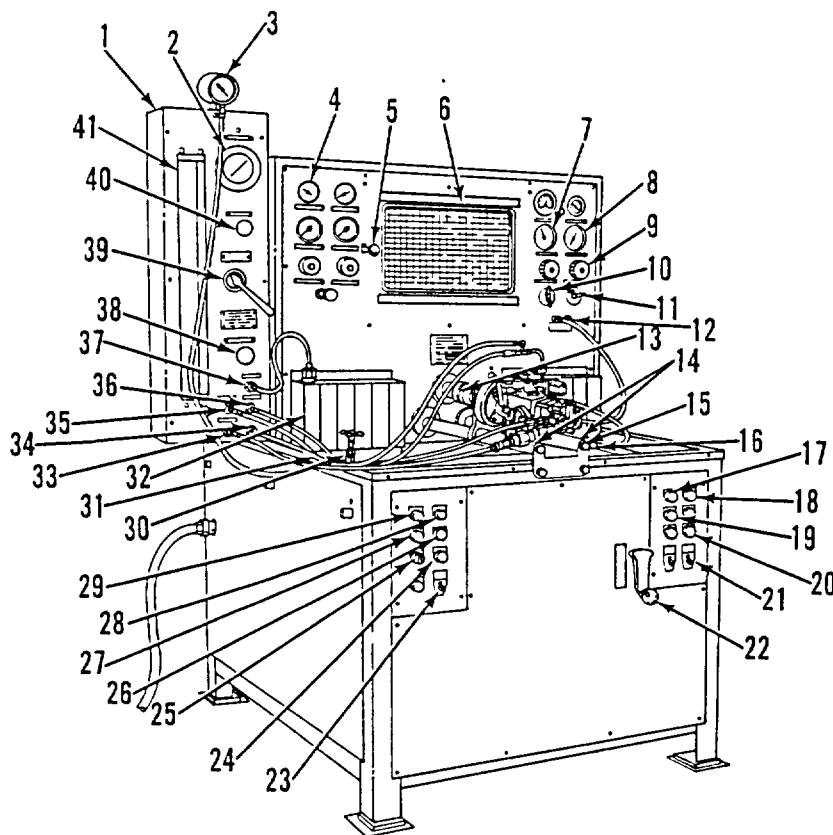
TA295473

LEGEND:

- | | |
|----------------------------|-----------------------------------|
| 1. FUEL PUMP NAMEPLATE | 5. LATEST FUEL PUMP REVISION CODE |
| 2. CONTROL PARTS LIST | 6. FUEL PUMP ROTATION |
| 3. FUEL PUMP CODE | 7. FUEL PUMP ASSEMBLY NUMBER |
| 4. FUEL PUMP SERIAL NUMBER | 8. ENGINE SHOP ORDER NUMBER |

- (1) First set of four digits on top line provides pump control parts list.
- (2) Next four spaces on top line provide base fuel pump code.
- (3) Next eight spaces on top line provide fuel pump serial number.
- (4) Last space on top line provides latest fuel pump revision code.
- (5) First space on bottom line provides fuel pump direction of rotation. Right hand rotation pumps are not marked and this space will be blank if pump has right hand rotation. Use REVERSE position on fuel pump test stand to drive fuel pump clockwise for right rotation.
- (6) Next seven spaces on bottom line provide fuel pump assembly number.
- (7) Last five spaces on bottom line provide engine shop order number.

c. Mount fuel pump on test stand.

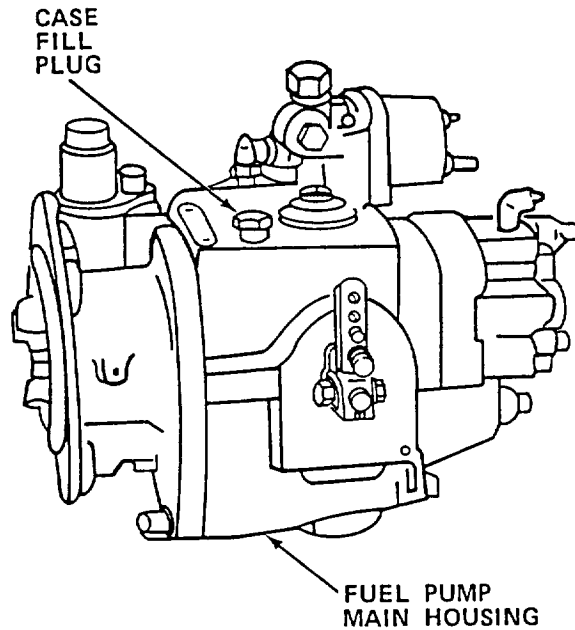


TA295474

LEGEND:

- | | | |
|---|--------------------------------|----------------------------------|
| 1. TEST STAND | 15. LUBE OIL RETURN | 30. LUBE OIL PRESSURE OUTLET |
| 2. FUEL PRESSURE GAGE | 16. FUEL RETURN | 31. PRIMER PRESSURE OUTLET |
| 3. NO. 2 VACUUM GAGE | 17. START COUNT BUTTON | 31. PRIMER PRESSURE OUTLET |
| 4. FUEL TEMPERATURE GAGE | 18. COUNTING LIGHT | 32. NO. 1 ACCUMULATOR |
| 5. DUMPING LEVER | 19. 500-1000-OFF COUNT SWITCH | 33. FUEL INPUT CONNECTOR |
| 6. BURETTES | 20. FUEL HEAT LIGHT | 34. FUEL OUTLET CONNECTOR |
| 7. TACHOMETER | 21. FUEL HEAT SWITCH | 35. FUEL PRESSURE GAGE CONNECTOR |
| 8. MANIFOLD VACUUM PRESSURE GAGE | 22. SPEED CONTROL ROD ASSEMBLY | 36. AUXILIARY FUEL RETURN |
| 9. PRESSURE REGULATOR | 23. AUXILIARY MOTOR SWITCH | 37. LEAK TEST CONNECTOR |
| 10. VACUUM-PRESSURE SELECTOR VALVE | 24. POWER ON LIGHT | 38. BYPASS VALVE |
| 11. MANIFOLD PRESSURE-CAPSULE PRESSURE SELECTOR VALVE | 25. FORWARD-OFF-REVERSE SWITCH | 39. SELECTOR VALVE |
| 12. MANIFOLD-SUPERCHARGER INLETS | 26. SLOW BUTTON | 40. FLOW CONTROL VALVE |
| 13. DRIVE SHAFT COUPLING | 27. STOP BUTTON | 41. FLOWMETER GLASS TUBE |
| 14. MOUNTING RAILS | 28. FAST BUTTON | |
| | 29. START BUTTON | |

- (1) Fill fuel pump test stand with calibration fluid. If calibration fluid not available, use diesel fuel.
- (2) Remove fuel filter element (if installed) and install 3375014 fuel filter adapter testing plate and 3375015 gasket on fuel filter head.

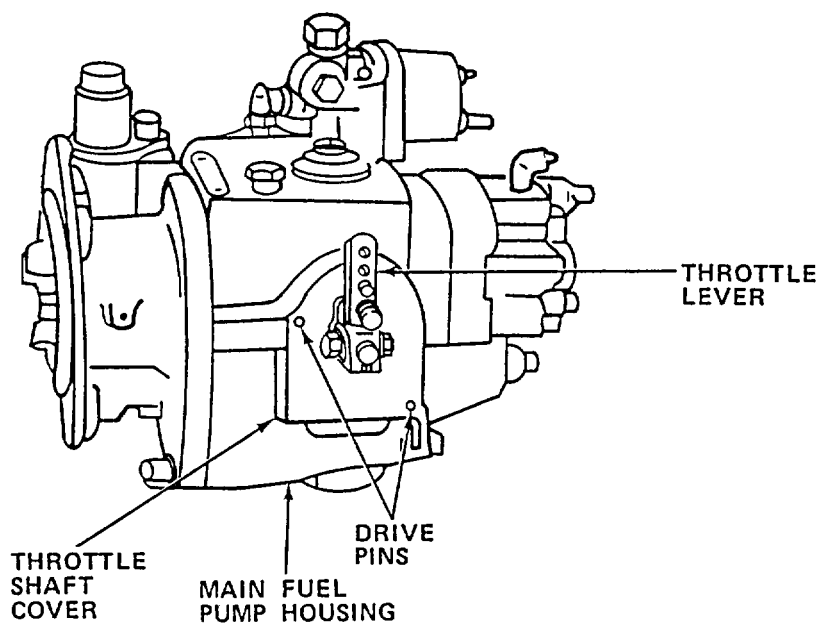


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- (3) Remove case fill plug from pump main housing.
- (4) Fill fuel pump main housing with clean calibration fluid.
- (5) Reinstall case fill plug and tighten enough to make sure no leakage will occur during air test.

NOTE

If the throttle shaft cover has not already been removed, its removal will be necessary to gain access to the no-air adjustment screw. Adjustment of the no-air adjustment screw is necessary for proper calibration of the fuel pump. Perform steps (6) through (10) to remove the throttle shaft cover.

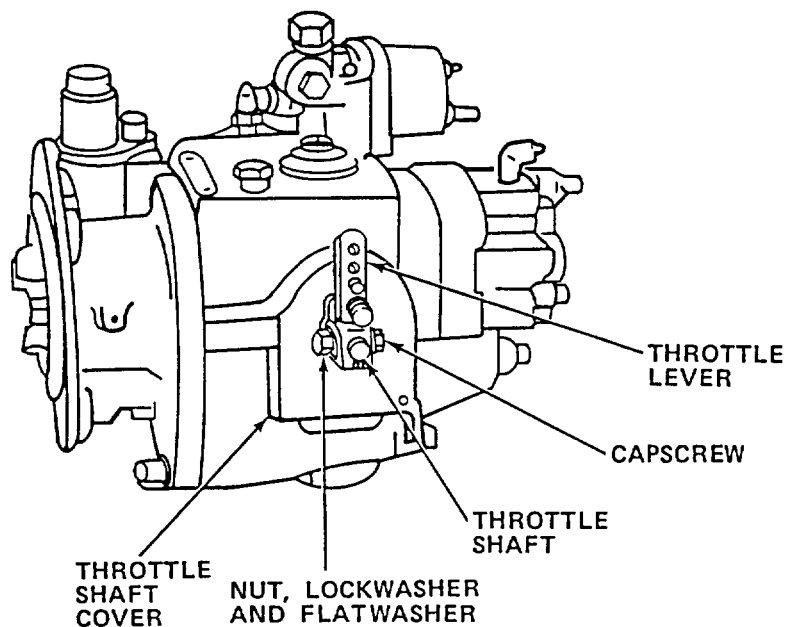


TA295476

CAUTION

BE CAREFUL NOT TO DAMAGE MAIN HOUSING WHEN REMOVING DRIVE PINS.

- (6) Using channel lock pliers or chisel, carefully remove drive pins from throttle shaft cover.

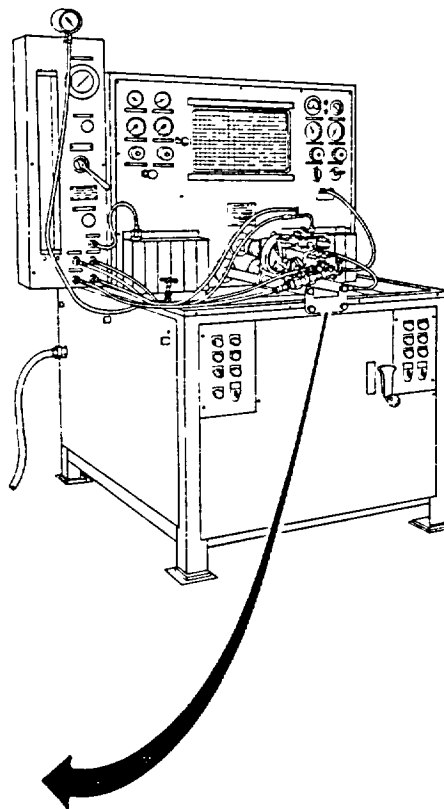
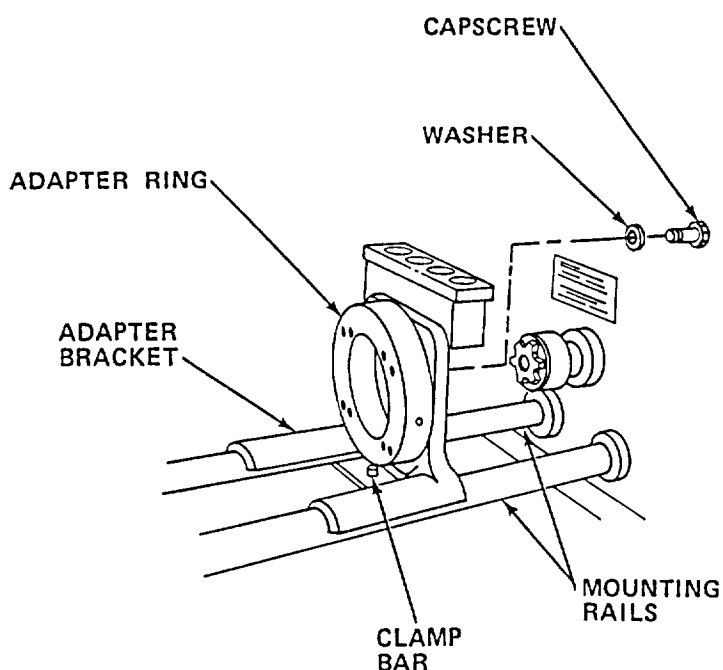


TA295477

NOTE

Match mark throttle shaft to throttle lever before removing.

- (7) Remove nut, lockwasher, flat washer and capscrew from throttle lever.
- (8) Remove throttle lever from throttle shaft.
- (9) Remove throttle shaft cover from fuel pump main housing.
- (10) Reinstall throttle lever alining match marks on lever with throttle shaft. Secure with capscrew, flatwasher, lockwasher, and nut.



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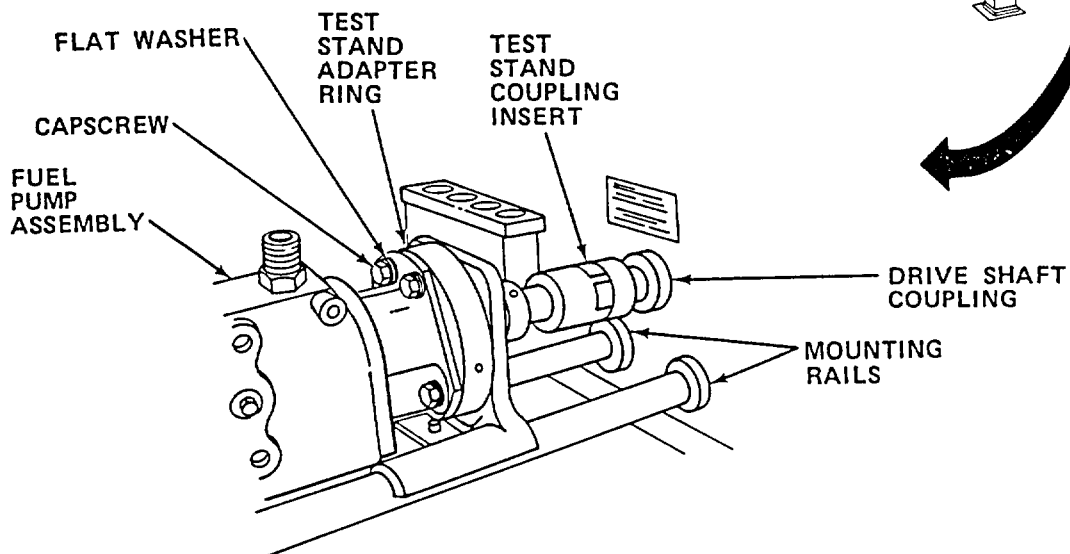
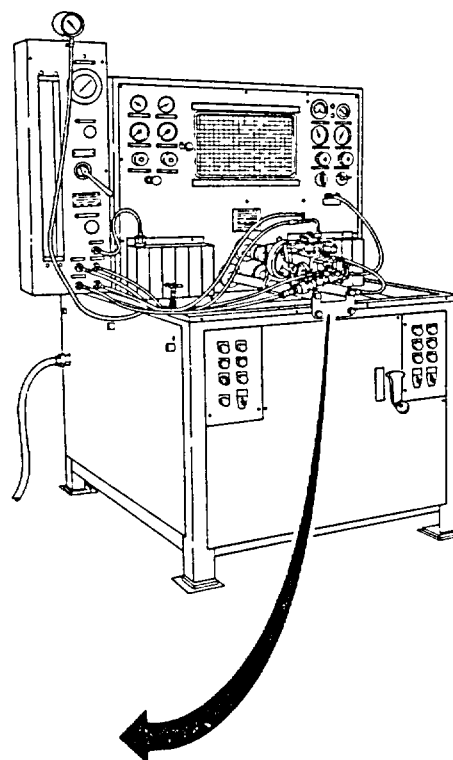
NOTE

Word "TOP" (or adapter ring or part no.) must be visible on top side of ring when assembled.

- (11) Install test stand adapter ring on adapter bracket and secure with capscrews and flat washers.
- (12) Install test stand adapter ring and test stand adapter bracket as an assembly on test stand mounting rails.
- (13) Secure test stand adapter bracket to test stand mounting rails with clamp bar. Tighten clamp bar finger tight at this time.

NOTE

Lubricate tachometer drive gears in fuel pump front cover to protect gears from excessive wear during calibration.



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- (14) Position fuel pump assembly on test stand adapter ring and secure with capscrews and flat washers.
- (15) Rotate main shaft so that one lug on drive flange is located at 12 o'clock position.

NOTE

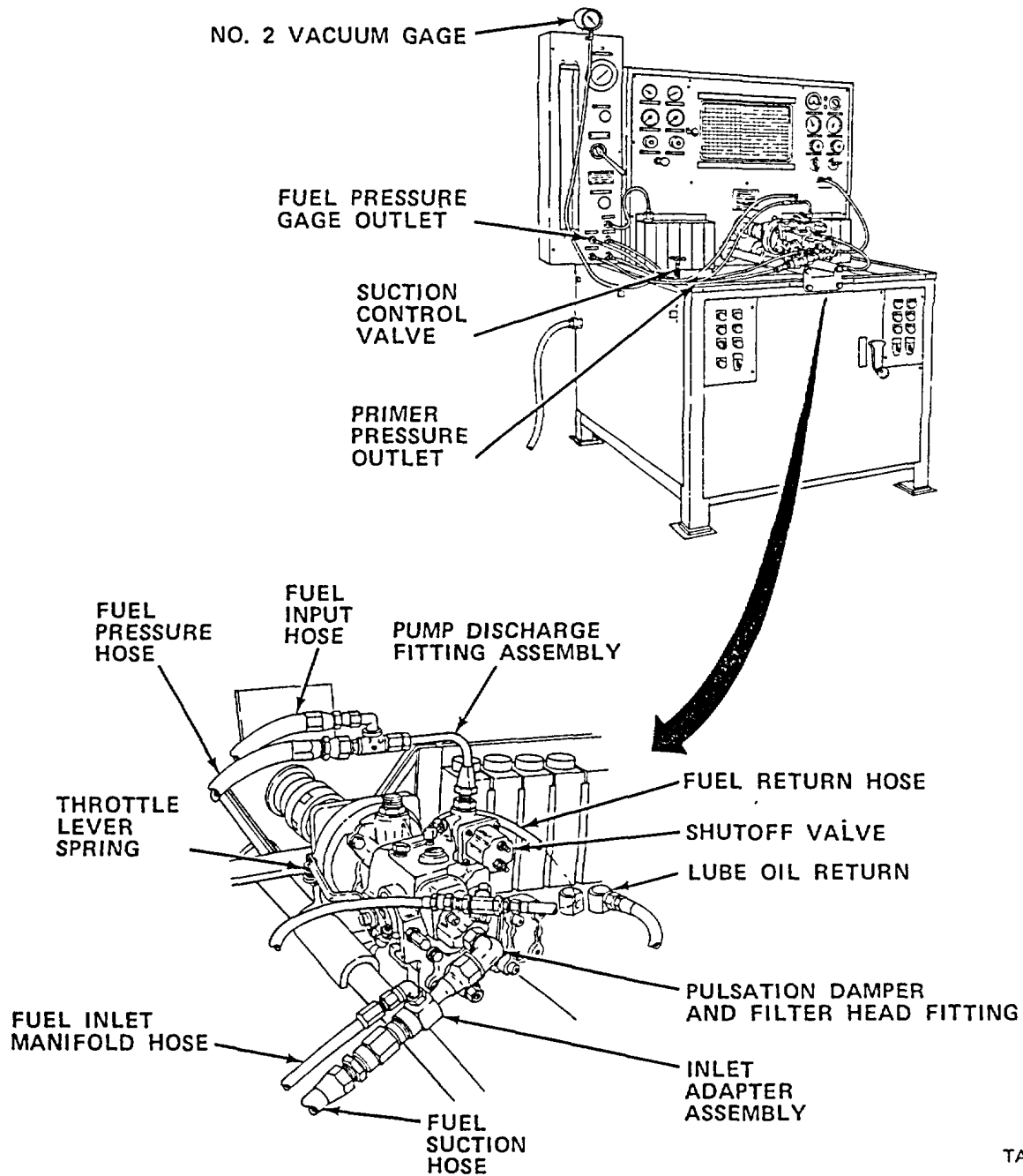
It may be necessary to hand rotate drive shaft coupling to attain proper positioning of coupling insert lugs. This is to ensure easy engagement of fuel pump drive coupling lugs into test stand coupling insert.

- (16) Place test stand coupling insert into test stand drive shaft coupling so that one lug of insert is at 11 o'clock position and another lug at 1 o'clock position.

NOTE

Allow 0.0625 in. (1.5875 mm) clearance between drive coupling on fuel pump assembly and coupling insert on test stand.

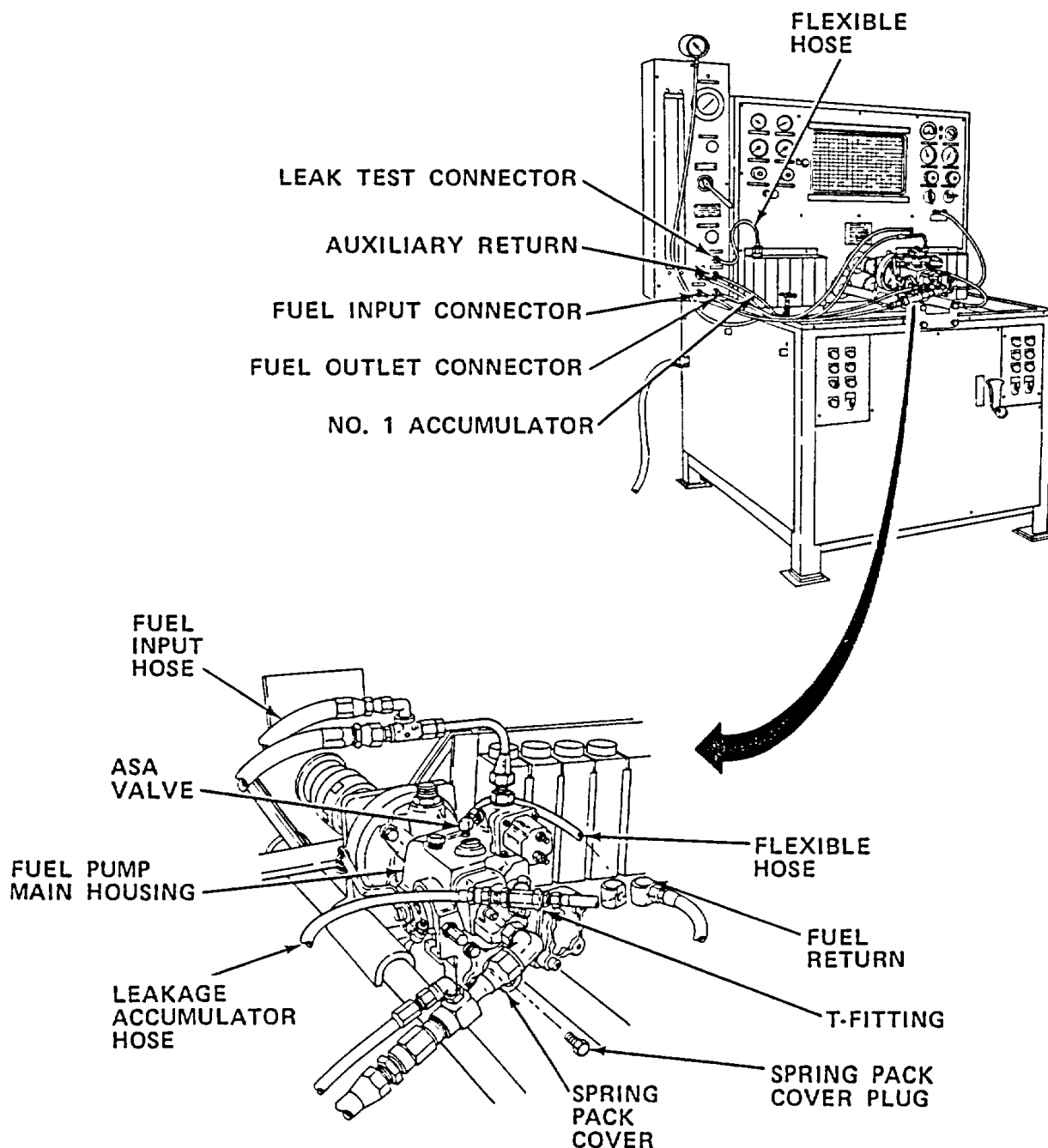
- (17) Loosen clamp bar and slide fuel pump assembly, test stand adapter ring, and test stand adapter bracket on mounting rails until fuel pump assembly coupling engages with test stand coupling insert. Check for proper clearance.
- (18) Tighten clamp bar when fuel pump assembly is properly engaged.



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- (19) Rotate throttle lever toward test stand (to wide open position) and retain with a spring between throttle lever and adapter ring.
- (20) Secure inlet adapter assembly to pulsation damper and filter head fitting.
- (21) Attach fuel suction hose from suction control valve to inlet adapter assembly.
- (22) Plug primer pressure outlet with pipe plug.

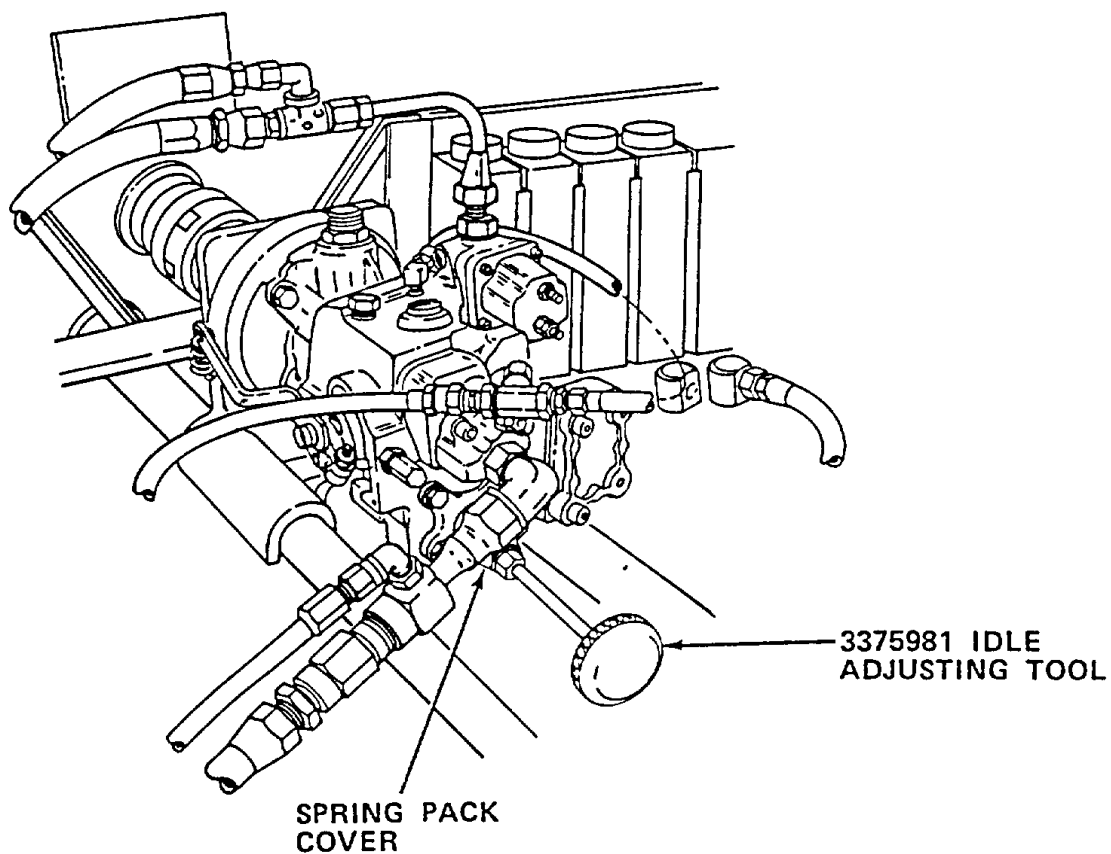
- (23) Connect fuel return hose from lube oil pressure outlet to lube oil return.
- (24) Connect fuel inlet manifold hose from no. 2 vacuum gage to side connection of inlet adapter assembly.
- (25) Install pump discharge fitting assembly in top of shutoff valve.
- (26) Connect fuel pressure hose from fuel pressure gage outlet to pump discharge fitting assembly.
- (27) Connect fuel input hose from fuel input connector to pump discharge fitting assembly.



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- (28) Connect fuel hose from fuel outlet connector to fuel return.

- (29) Connect flexible hose from leak test connector to no. 1 accumulator.
- (30) Install T-fitting into gear pump bleed drain fitting.
- (31) Connect leakage accumulator hose from auxiliary return to T-fitting.
- (32) Install hydraulic air signal attenuator (ASA) valve into top of fuel pump main housing.
- (33) Connect flexible hose from ASA valve to T-fitting.
- (34) Remove governor spring pack cover plug.

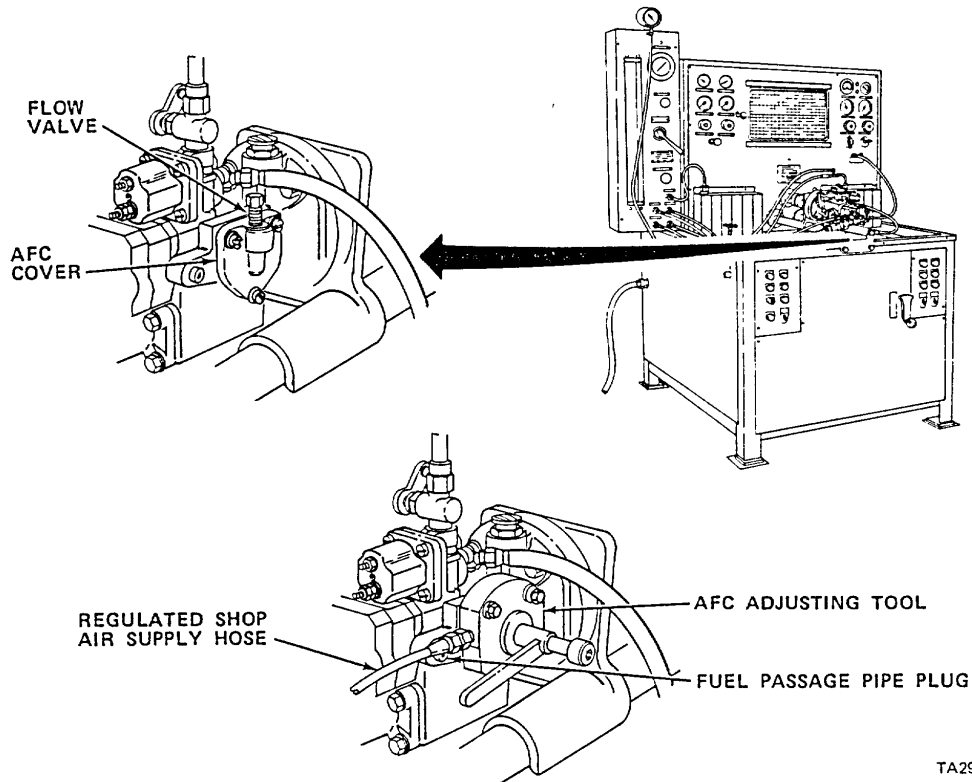


- (35) Install 3375981 fuel pump idle adjusting tool in governor spring pack housing.

TA295482

NOTE

AFC adjusting tool is part of 3375189 AFC fuel pump adjusting tool kit. Pull out knob on tool to disengage sockets. Relief cuts on tool must face toward rear of pump to allow clearance for AFC fuel passage pipe plug.



TA295483

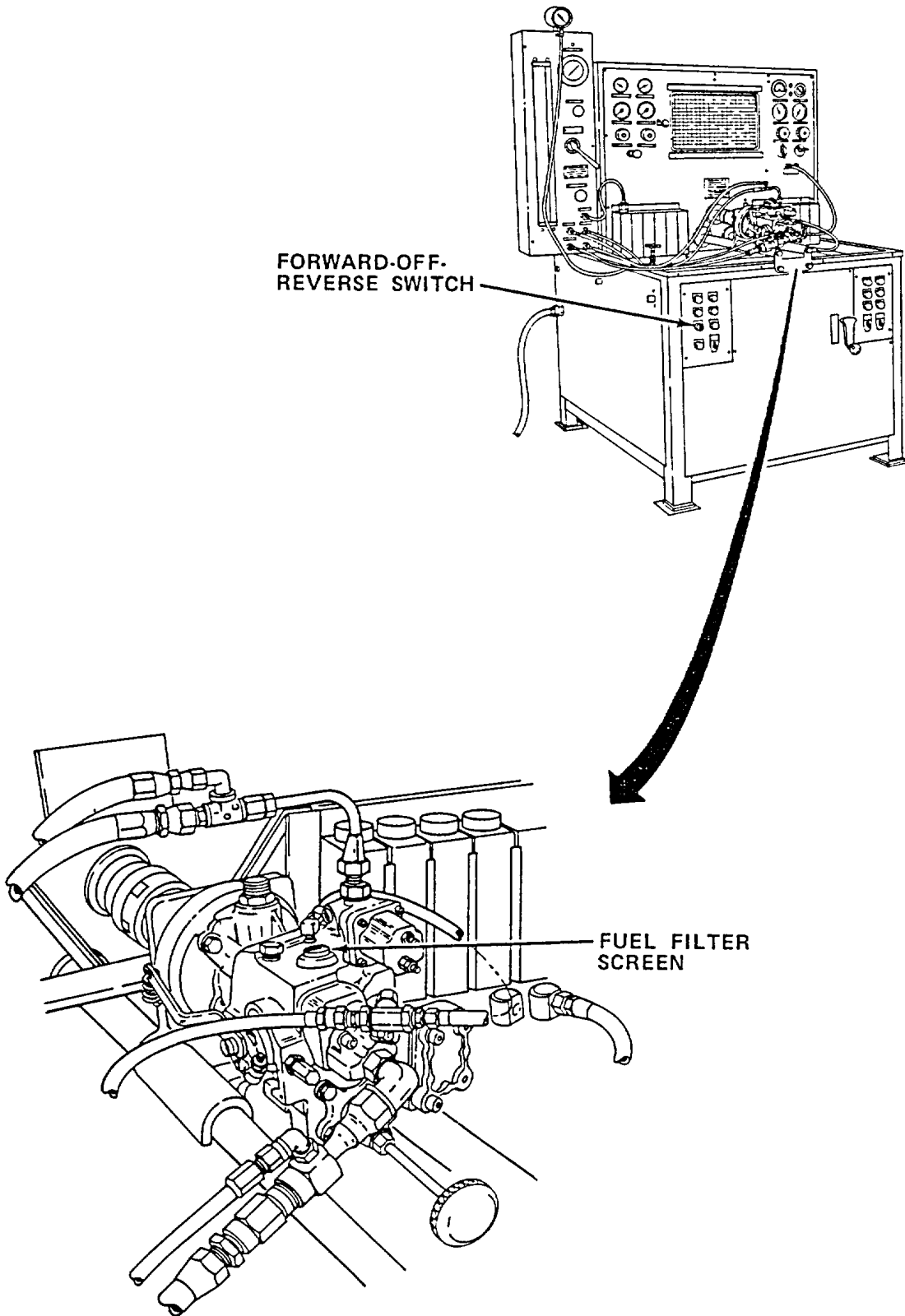
- (36) Remove AFC cover and flow valve from pump main housing.

NOTE

Pull out knobs on tool to disengage sockets. Relief cuts on tool must face towards rear of pump to allow clearance for AFC fuel passage pipe plug.

- (37) Install AFC adjusting tool in pump main housing.
 (38) Connect regulated shop air supply to AFC adjusting tool.

d. Perform fuel pump run-in.



TA295484

CAUTION

THE TEST STAND DIRECTIONAL CONTROL IS CALLED THE FORWARD-OFF-REVERSE SWITCH. FOR ALL TESTING OF THIS PUMP, THE TEST STAND FORWARD-OFF-REVERSE SWITCH MUST BE SET TO REVERSE. THIS POSITION CORRESPONDS TO THE RIGHT HAND DRIVE ROTATION REQUIREMENTS FOR THIS PUMP. IF THE FORWARD-OFF-REVERSE SWITCH IS IN THE INCORRECT POSITION, THE PUMP WILL RUN DRY AND COULD BE DAMAGED.

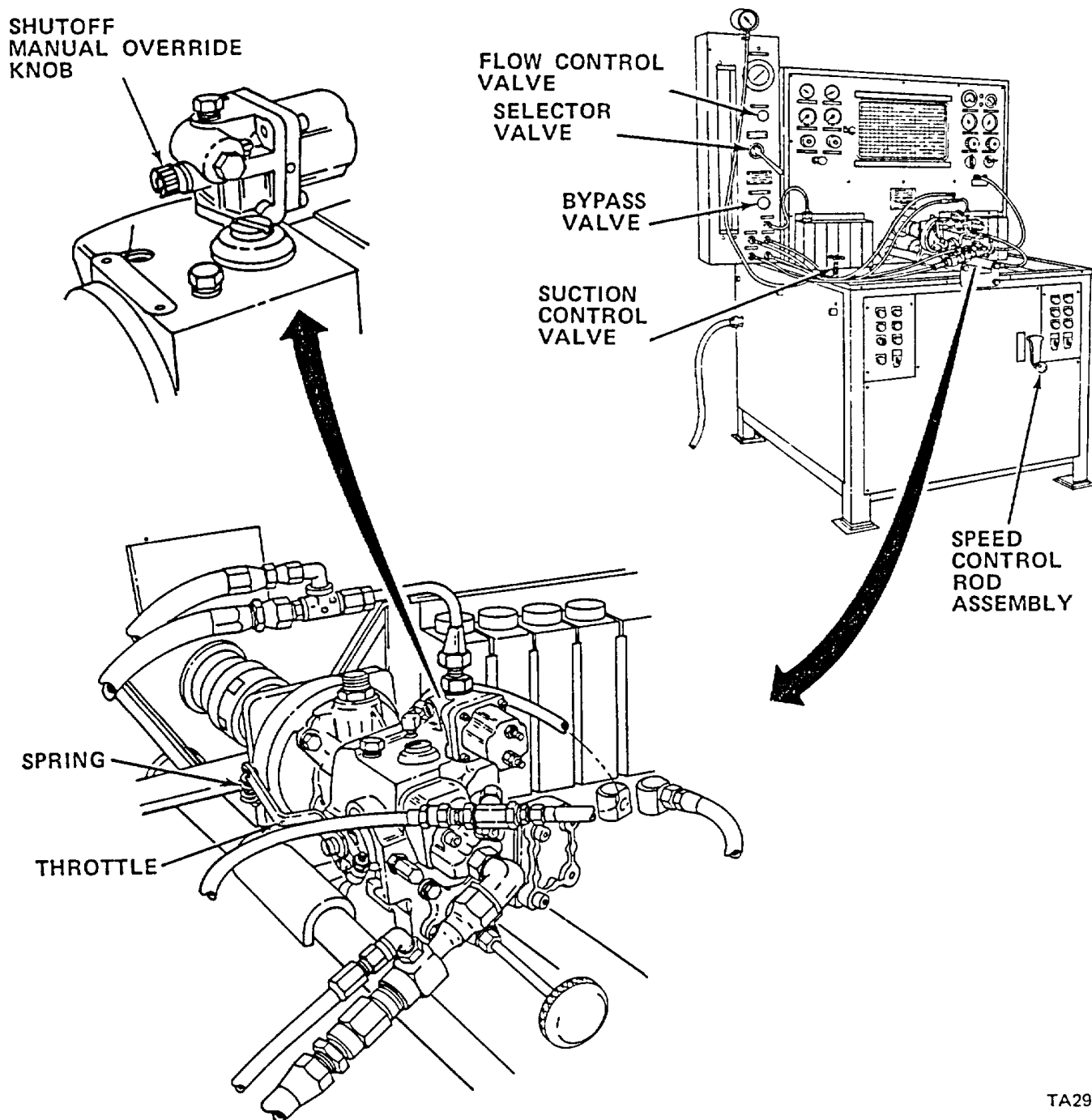
BE CERTAIN THE FUEL FILTER SCREEN IS CLEAN AND CORRECTLY INSTALLED. FOREIGN MATERIAL IN THE PUMP COULD DAMAGE SEALS, GEARS, AND SHAFTS, AND PLUG FUEL PASSAGES. CHECK TO SEE THAT THE FILTER SCREEN IS INSTALLED WITH THE HOLE IN THE SCREEN AT THE BOTTOM. IF THE FUEL FILTER SCREEN IS INSTALLED UPSIDE DOWN, IT WILL CUT OFF FUEL FLOW TO THE PUMP. THE PUMP WOULD THEN RUN DRY AND COULD BE DAMAGED.

NOTE

For a complete description of the test stand controls and indicators, refer to TM 9-4910-387-14&P, Tester, Fuel Injection, Single End Drive, 150 to 3000 RPM.

NOTE

This step is needed to cancel out the normal electrical shut down through the shutoff valve and allows fuel flow for testing purposes.



TA295485

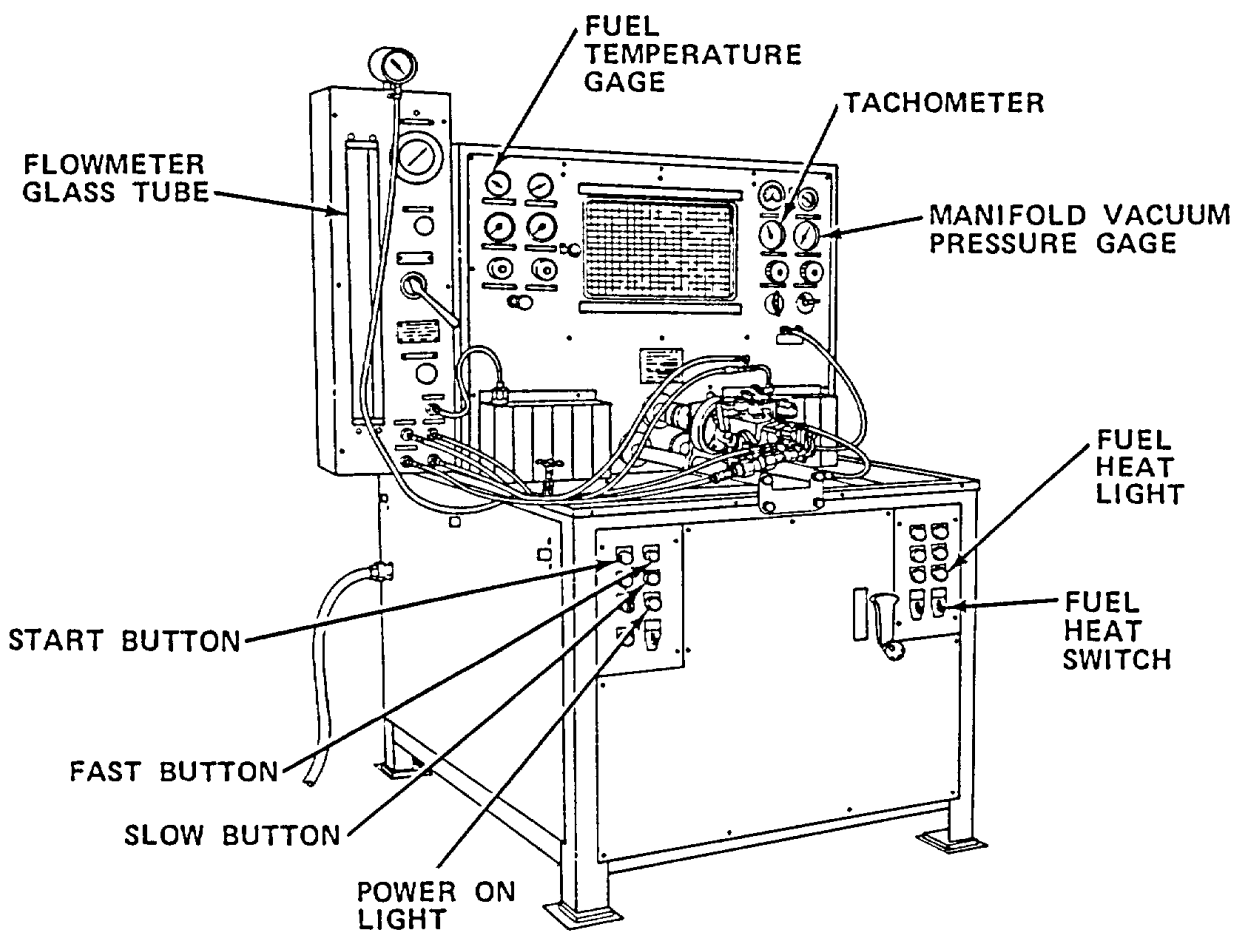
- (1) Open shutoff valve manual override knob by turning fully clockwise.

- (2) Open test stand bypass valve, suction control valve, and flow control valve.
- (3) Back seat all other valves on test stand to prevent leakage.

NOTE

After setting speed control rod assembly to HIGH range, turn crank to left approximately one turn so that hand load is neutralized.

- (4) Set speed control rod assembly at HIGH range.
- (5) Check that throttle lever is wide open and secured in that position with spring.
- (6) Turn selector valve to ROTAMETER position.



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- (7) Turn wall mounted power switch to ON position. Check that power ON light comes on.

NOTE

Paper operating temperature for calibration fluid is 90°F 100°F (32°C 57°C). The test stand built-in thermometer automatically maintains that temperature once the fluid has circulated.

- (8) Turn fuel heat switch to ON position. Check that fuel heat light comes on. Monitor fuel temperature on fuel temperature gage throughout testing and calibration of fuel pump.
- (9) Adjust shop air pressure regulator until reading of 25 psi (50 in. Hg) is established in shop air supply line secured to AFC adjusting tool.
- (10) Depress test stand start button.
- (11) Depress and release the fast or slow button as required until exactly 500 rpm is indicated on tachometer.
- (12) Check flowmeter glass tube for air in the fuel.

NOTE

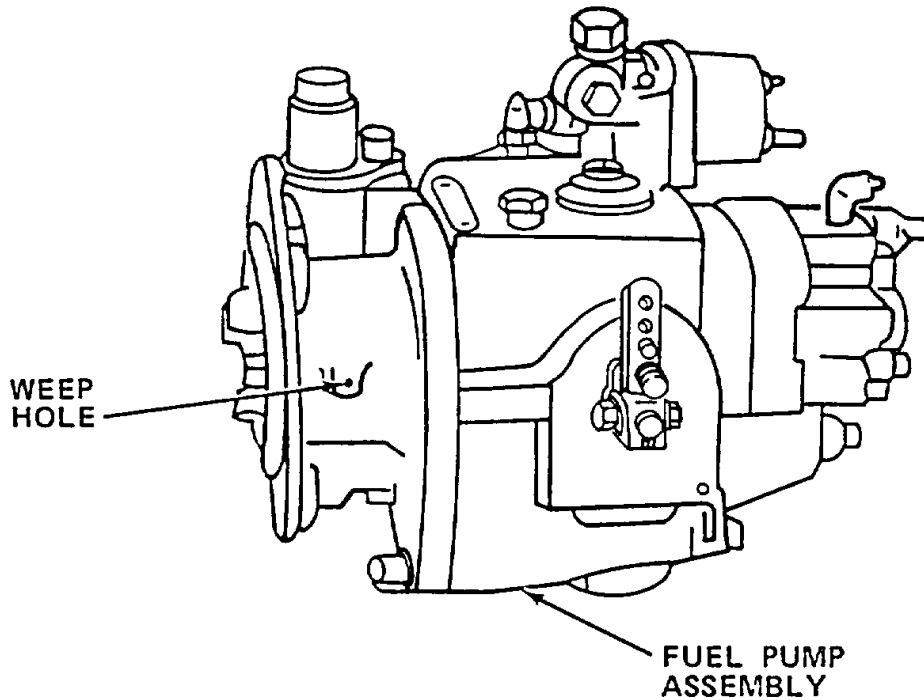
Step (13) is accomplished to purge all air from the system. The gear pump must be able to pick up fluid at 500 rpm without the aid of priming. If no fluid pickup is indicated in the flowmeter glass tube, check the fuel filter screen for proper installation; check that test stand FORWARD or REVERSE switch is in the REVERSE position; check that the test stand suction control valve is open; and check all hose connections and gear pump for condition.

If air bubbles persist, it is an indication of an air leak in the system. Turn the test stand off and check all line connections between the test stand and fuel pump for security, rating of gear pump to main housing and that test stand reservoir is full of fluid.

- (13) Work throttle lever from full open to idle several times to relieve any trapped air in pump.

e. Perform fuel pump vacuum and seal test.

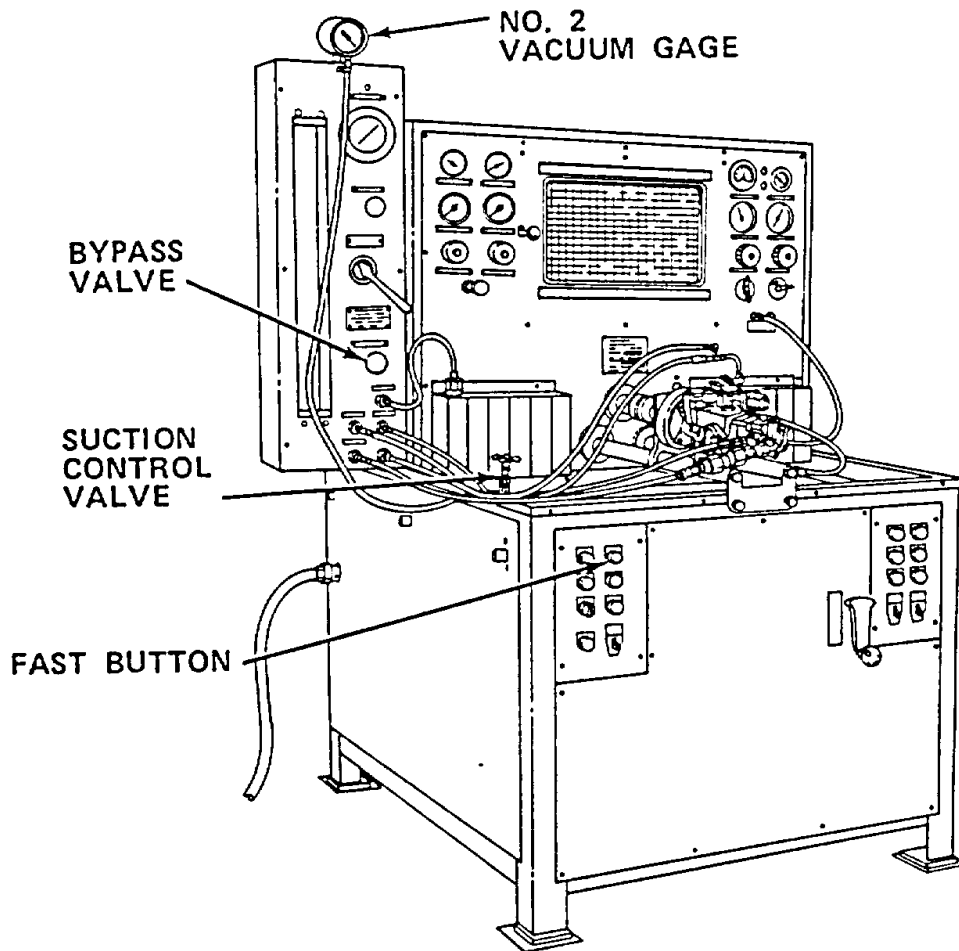
- (1) Remove case fill plug from fuel pump main housing.
- (2) Look into fuel pump main housing to ensure fuel is present.
- (3) Reinstall case fill plug.



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- (4) Check mating surfaces and weep hole on fuel pump assembly for leaks.
- (5) If leakage detected, replace front cover seals as required (para 3-82).

f. Perform fuel pump vacuum adjustment.



TA295488

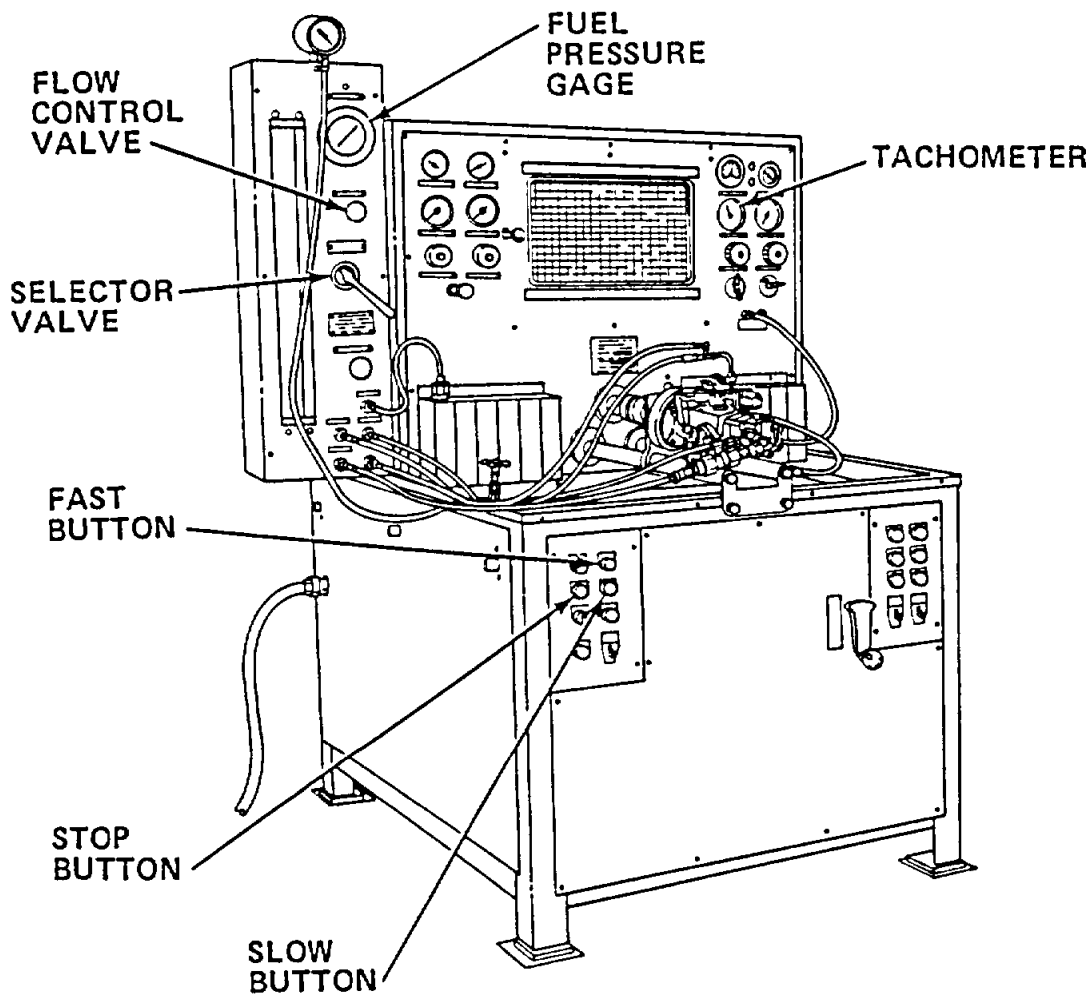
- (1) Close stand bypass valve.
- (2) Completely open stand suction control valve.
- (3) Depress stand FAST button until fuel pump speed is 2000 rpm.

NOTE

When the suction control valve setting is reached, the valve setting must not be changed during later calibration procedures.

- (4) Adjust suction control valve to obtain 8.0 in. Hg (4 psi) reading on no. 2 vacuum gage.

g. Perform governor cutoff rpm check.



TA295489

NOTE

Be sure flow control valve is open and selector valve is in the ROTAMETER position.

- (1) Depress FAST button until fuel pump speed is 2100 rpm.

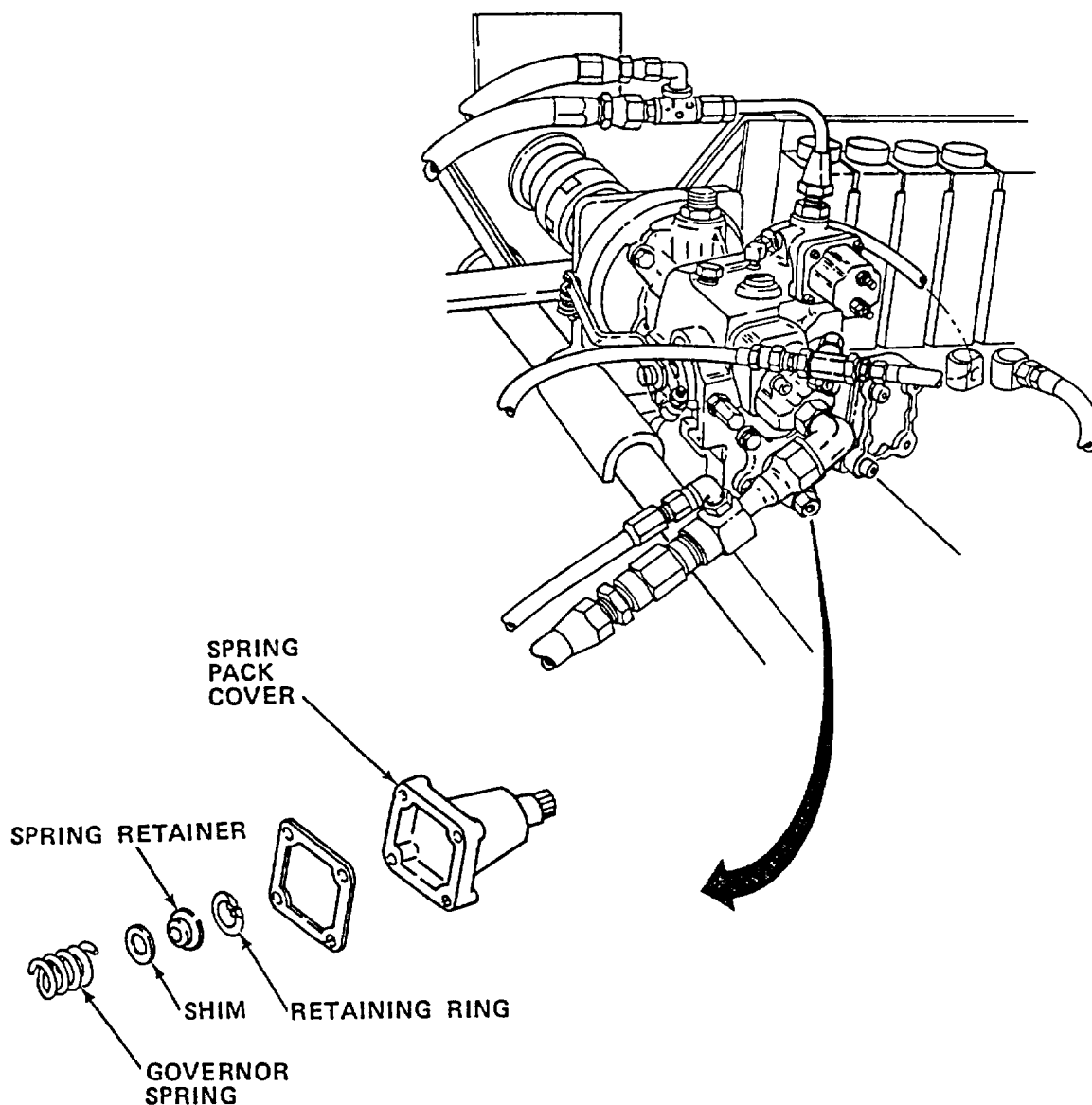
NOTE

Be sure fuel pump throttle lever remains in wide open position as retained by a spring.

- (2) Adjust flow control valve to setting of 495 pph.
- (3) While observing fuel pressure gage, gradually increase pump speed until fuel pressure drops slightly instead of increasing.

(4) Check reading on tachometer at the fuel pressure drop point. If pump speed is between 2130 and 2150 rpm, governor cutoff rpm is correct. If rpm is less than 2130 or more than 2150 rpm, governor will require adjustment as follows:

- (a) Depress stand SLOW button until stand minimum speed is attained.
- (b) Depress stand STOP button.



TA295490

- (c) Remove governor spring pack cover.
- (d) Remove retaining ring.

NOTE

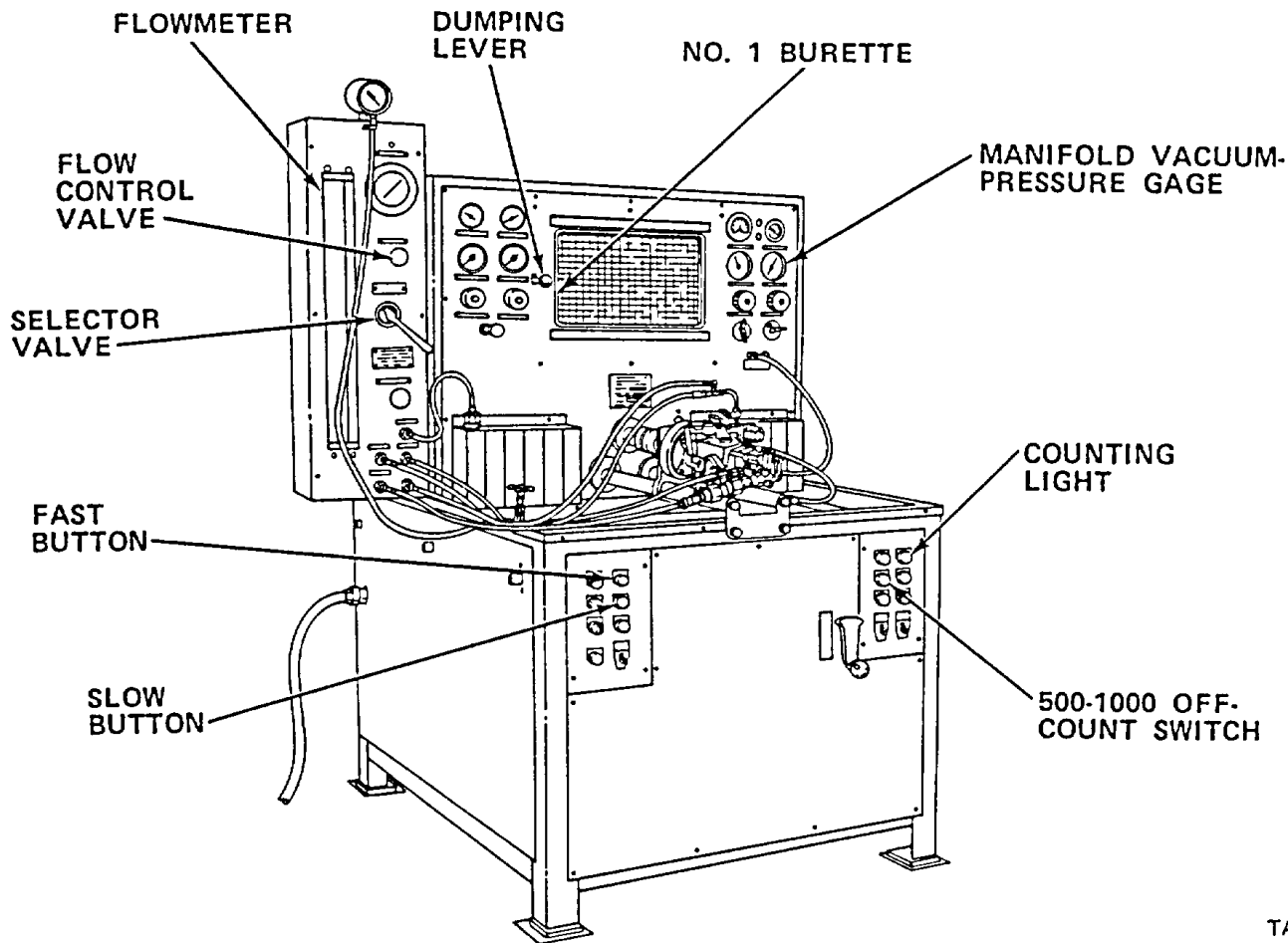
To decrease governor cutoff rpm, shims are removed from governor spring pack. To increase rpm, shims are added. Each 0.001 in. thickness of shim will change the governor cutoff speed approximately 2 rpm. Shims are available in 0.005, 0.010, and 0.020 in. (0.127, 0.254, and 0.508 mm) thicknesses. If over 0.150 in. (3.81 mm) of shim thickness is required to be added, replace governor spring. Shims are to be placed between governor spring and spring retainer.

- (e) Remove spring retainer and remove or install (as required) shims.
 - (f) Reinstall spring retainer and secure with retaining ring.
 - (g) Reinstall governor spring pack cover.
- (5) Purge fuel pump of air as initially done during pump run-in.
- (6) Recheck governor cutoff rpm.

h. Perform throttle leakage check.

NOTE

This setting is important since it controls the deceleration time of the engine.



TA295491

- (1) Set pump speed at 2100 rpm.
- (2) Check that fuel flow is exactly 495 pph as indicated on flowmeter.

NOTE

Be sure selector valve is in ROTAMETER position.

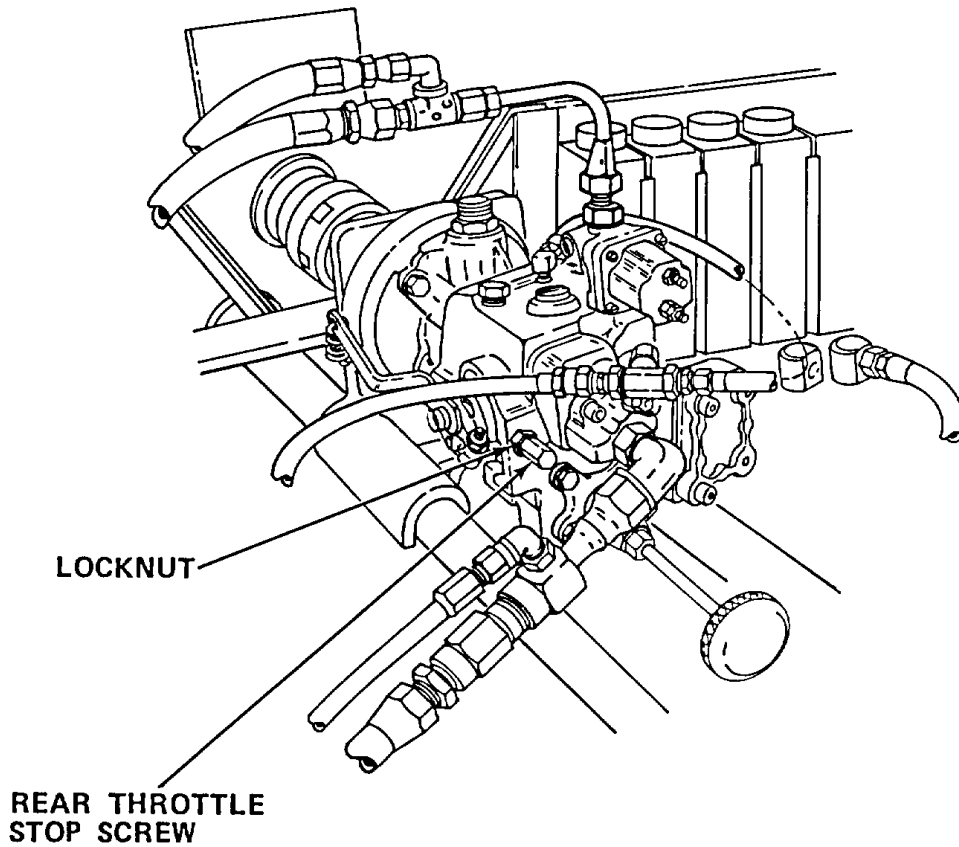
- (3) If fuel flow is more or less than 495 pph, readjust flow control valve to establish proper setting.
- (4) Rotate selector valve to LEAKAGE TEST position.
- (5) Place 500-1000-OFF count switch to 1000 position.

- (6) Pull out dumping lever so that fuel will be retained in no. 1 burette.
- (7) Move throttle lever to idle position and hold in that position.
- (8) Observe vacuum gage.
- (9) When vacuum reading stabilizes, depress and release START COUNT button. Counting light will come on.
- (10) When count cycle ends and counting light goes out release throttle lever.

NOTE

The burette scale is graduated in cubic centimeters (CC's).

- (11) Observe amount of throttle leakage in cc's on burette scale. Leakage specification is 110 cc's/min. Repeat check at least three times to be sure of accuracy.



TA295492

(12) If leakage not as specified, adjust rear throttle stop screw as follows:

NOTE

Just loosening and retightening of locknut may be enough to gain specified fuel flow.

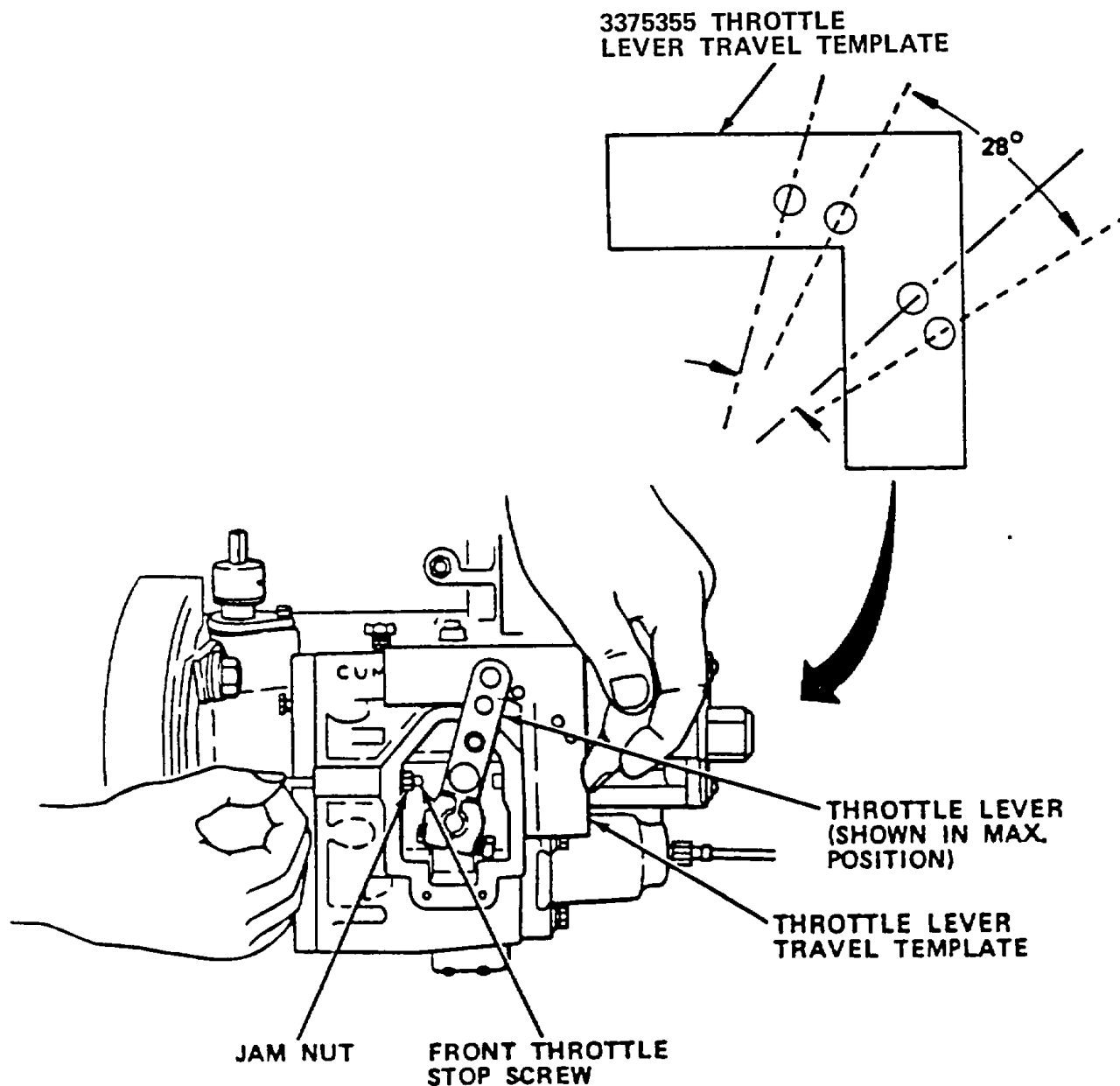
- (a) Loosen throttle stop screw locknut.
- (b) Turn screw in to increase fuel flow or out to decrease flow.
- (c) Tighten locknut.

i. Perform throttle lever travel adjustment.

(1) Decrease pump speed to 500 rpm.

NOTE

The throttle lever travel template, tool no 3375355, has two sets of matched holes for lever alinement. Either set (first and third, or second and fourth) may be used to adjust throttle lever travel, but do not use the first and fourth holes in combination or the second and third holes. Either of these combinations will result in an inaccurate reading. Correct travel is 27 29 degrees.



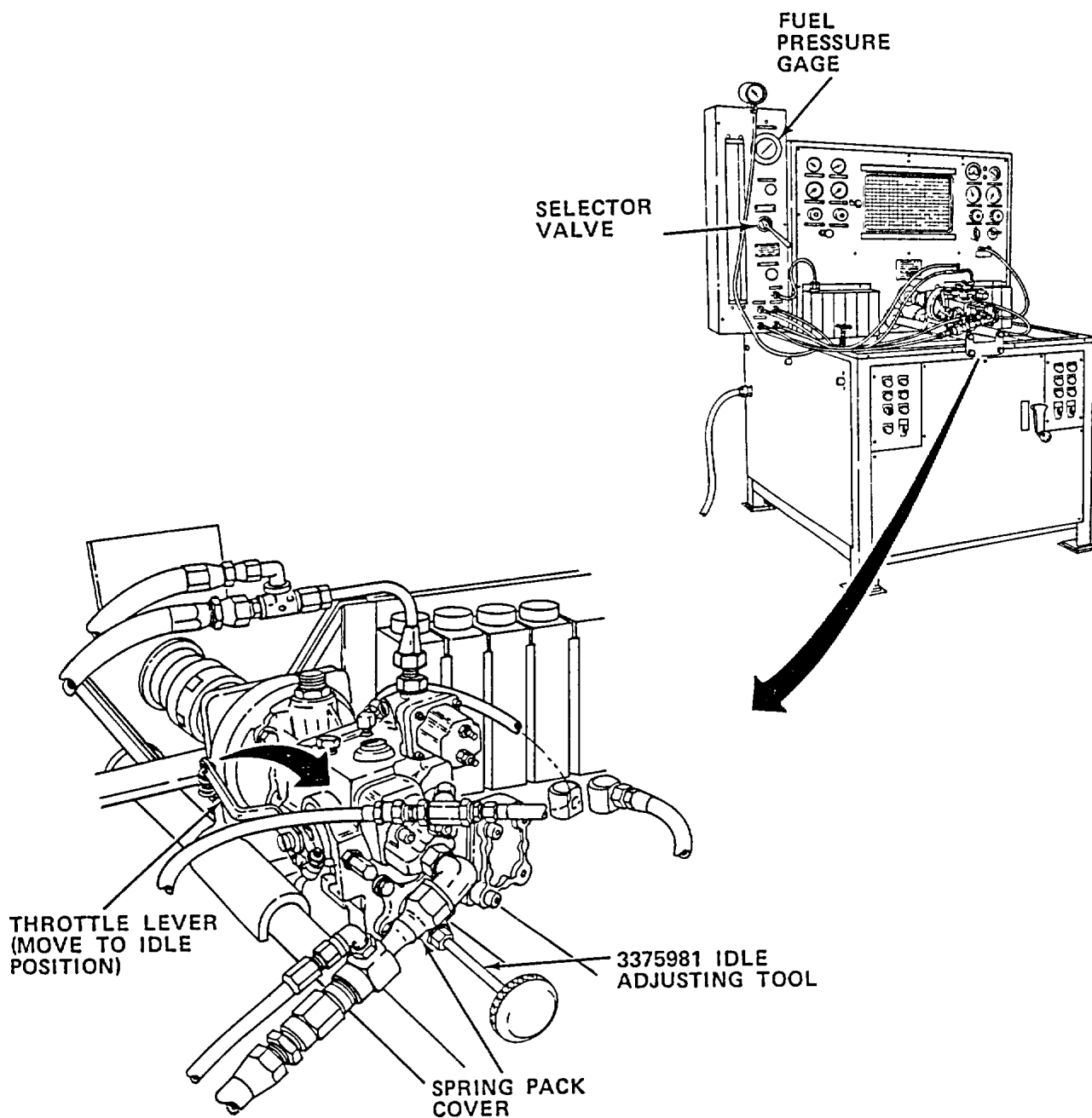
(2) Position throttle lever template on fuel pump main housing.

NOTE

Do not disturb the rear throttle stop screw adjustment. This adjustment was made to establish the throttle leakage and must not be tampered with. Any change to the rear throttle stop screw adjustment at this point in the testing/calibration process would require readjustment of the throttle leakage.

- (3) Move throttle lever to idle position and line up hole in throttle lever with idle hole in throttle lever travel template.
- (4) If throttle lever hole does not line up with idle hole in template, reposition lever on throttle shaft.
- (5) Move throttle lever to full throttle position and line up hole in throttle lever with appropriate MAX hole in throttle lever travel template.
- (6) If throttle lever hole does not line up with template MAX hole, loosen jam nut and adjust front throttle stop screw until holes line up. Tighten jam nut.

j. Perform fuel pump idle speed check.

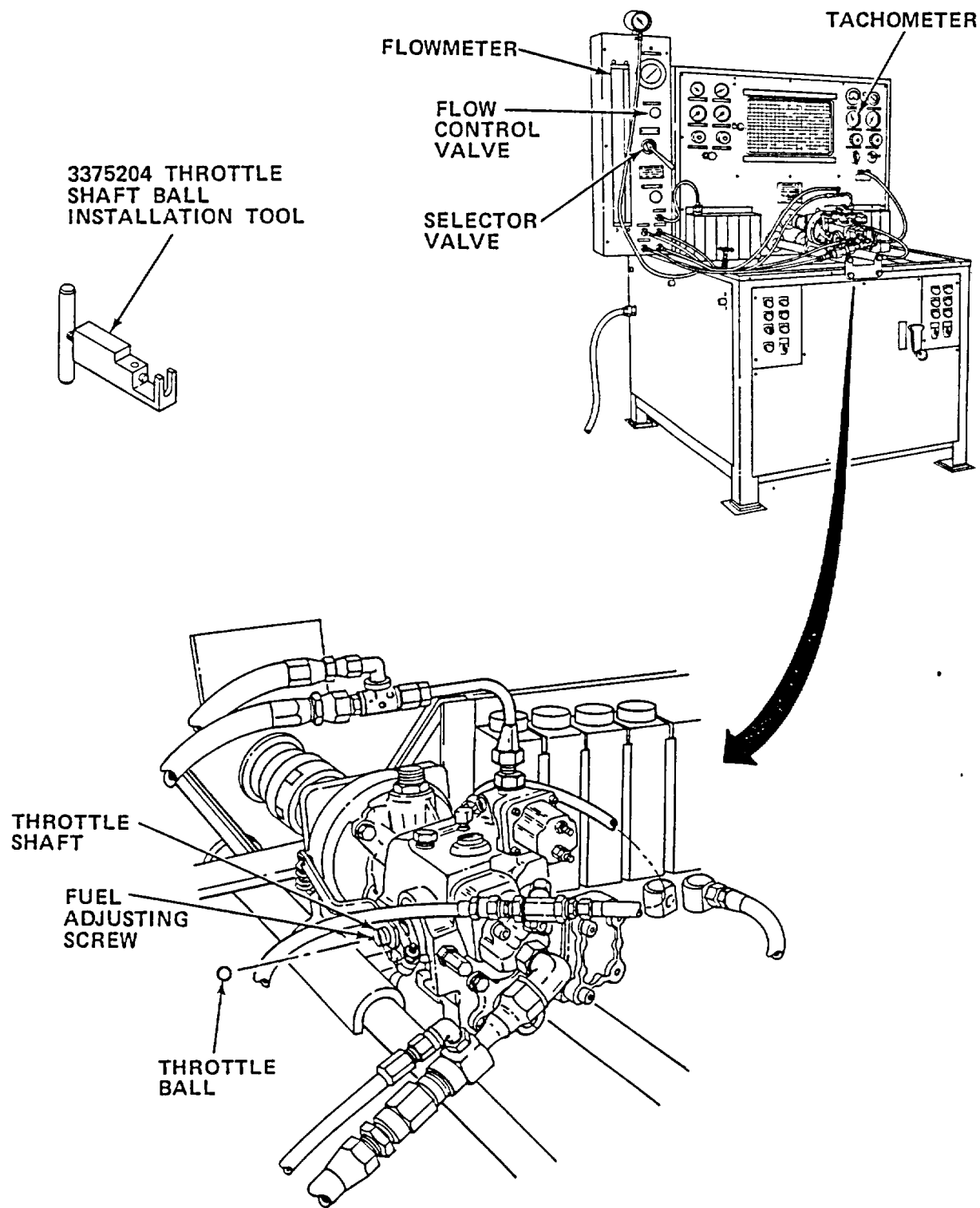


TA295494

- (1) Turn selector valve to IDLE position.
- (2) Set pump speed at 500 rpm.
- (3) Hold throttle lever in idle position and observe pressure on fuel pressure gage. Pressure should be 23 psi (158.7 kPa).

- (4) If fuel pressure is incorrect, turn idle adjusting tool (in governor spring pack cover) clockwise to increase pressure and counterclockwise to decrease pressure.
 - (5) If adjusting screw bottoms out, stop test stand, remove governor spring pack cover, and add washers to spring end of screw. Reinstall cover.
 - (6) Reset idle speed and shut down stand.
 - (7) Remove idle adjusting tool from governor spring pack housing.
 - (8) Install plug in governor spring pack housing.
- k. Perform fuel pump main pressure adjustment.
- (1) Turn selector valve to ROTAMETER position.
 - (2) Start stand and set pump speed at 2100 rpm.
 - (3) Adjust flow control valve until exactly 470 pph is indicated on the flowmeter.
 - (4) Check for 157 psi (1083.3 kPa) indication on fuel pressure gage.

(5) If fuel pressure is incorrect, proceed as follows:



(a) Center punch throttle ball located in end of throttle shaft.

CAUTION

TAKE CARE NOT TO DAMAGE BORE OF THROTTLE SHAFT WHEN DRILLING.

- (b) With 1/4 in. (635 mm) drill bit drill out ball from throttle shaft.
 - (c) To increase fuel pressure, rotate throttle shaft internal adjusting screw clockwise; to decrease, counterclockwise.
 - (d) If torque required to rotate internal adjusting screw is less than 1-1/2 in. lbs, a new screw must be installed.
 - (e) Install new throttle ball with tool no. 3375204 throttle shaft ball installation tool.
- I. Perform calibration check point checks.

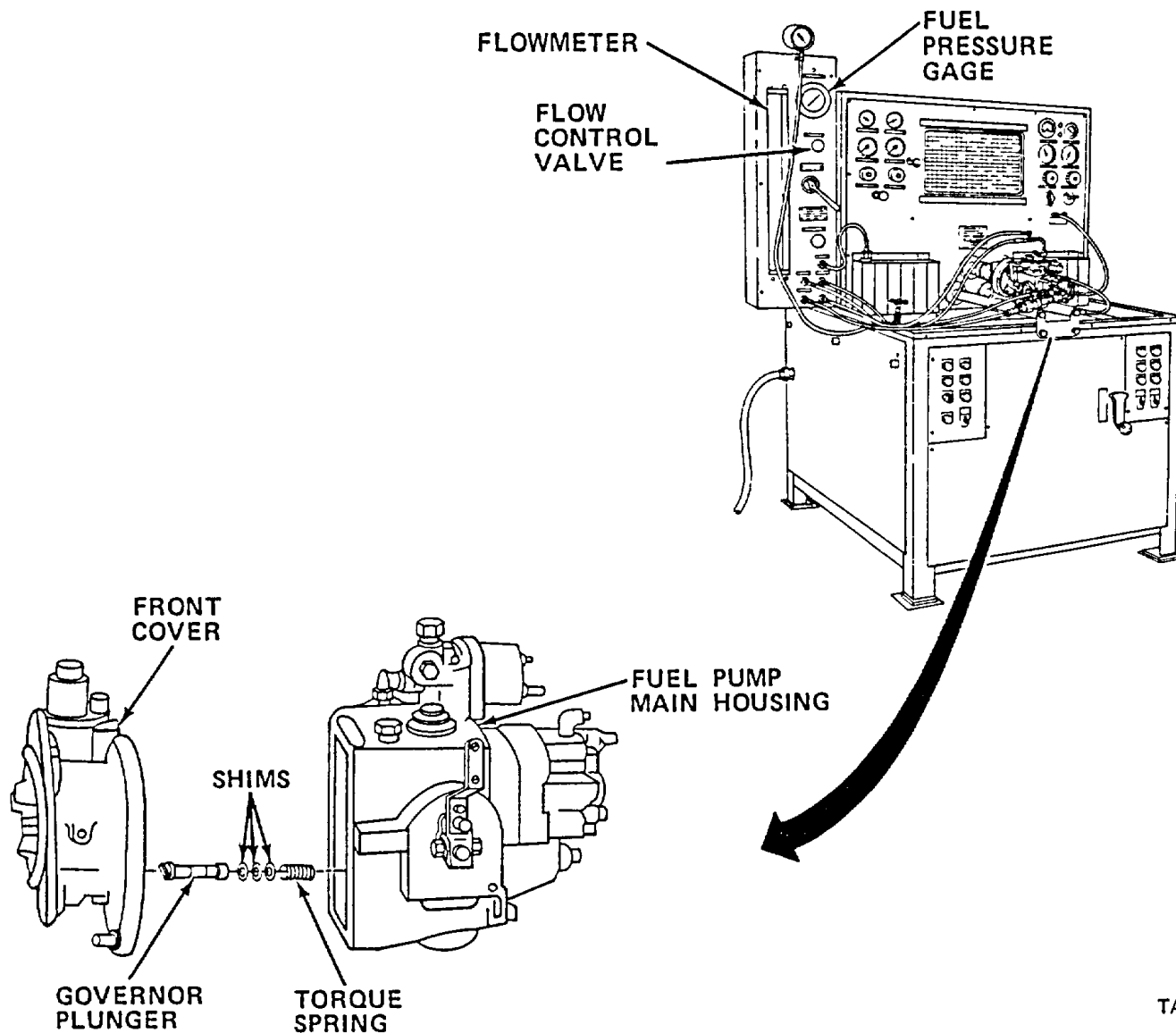
NOTE

There are two calibration check points. The first checks the condition of the torque spring and the second checks the condition of the weight assist plunger.

- (1) Check Point 1.

NOTE

Be sure throttle lever is in full throttle position.



TA295496

- (a) Set fuel pump speed at 1500 rpm.
- (b) Adjust flow control valve until 410 pph flow is indicated on flowmeter.
- (c) Check fuel pressure gage for indication of 112 - 118 psi (772.8 - 814.2 kPa).
- (d) If pressure above or below desired range, stop test stand.
- (e) Separate front cover from fuel pump main housing (para 3-77).

NOTE

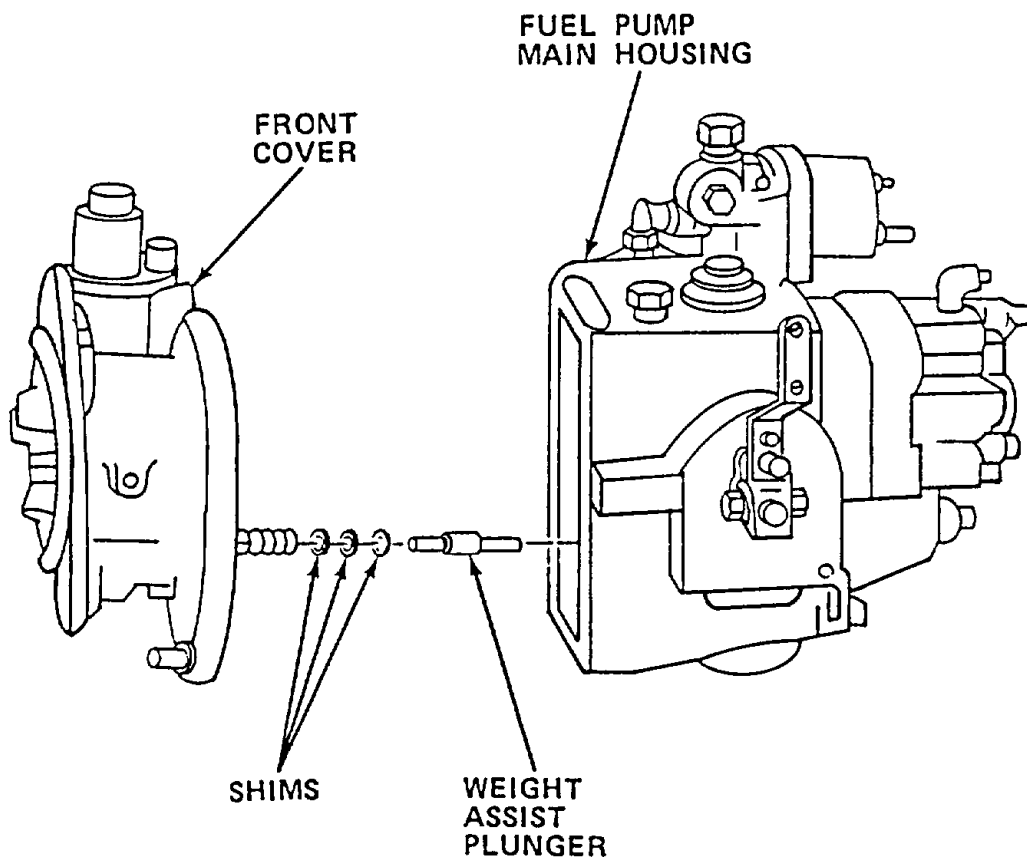
Incorrect spring may be installed or spring may be improperly seated or shimmed. Install correct spring, part number 138781, and shims as needed. Torque spring shims are available in 0.005, 0.010, and 0.020 in. (0.127, 0.254, and 0.508 mm) thicknesses. If new torque spring or shims are installed, pump must be recalibrated.

- (f) Remove governor plunger and check torque spring and shims. Replace as necessary.
 - (g) Reinstall front cover (para 3-82).
 - (h) Reaccomplish check point 1 until proper pressure reading is attained.
- (2) Check Point 2.

NOTE

Be sure throttle lever is in full throttle position.

- (a) Set pump speed at 1000 rpm.
- (b) Adjust flow control valve until 280 pph flow is indicated on flowmeter.
- (c) Check fuel pressure gage for indication of 63 - 71 psi (434.7 - 489.9 kPa).
- (d) If pressure above or below desired range, stop test stand.
- (e) Separate front cover from fuel pump main housing (para 3-77).



TA295497

NOTE

Add shims to increase pressure and remove shims to decrease pressure. Shims are available in 0.007 in. and 0.015 in. (0.177 mm and 0.381 mm) thicknesses.

- (f) Remove weight assist plunger and add or remove shims until correct fuel pressure reading is attained.
- (g) Install weight assist plunger and front cover (para 3-82).
- (h) Repeat calibration steps starting with Fuel Pump Main Pressure Adjustment para k above.

m. Perform AFC plunger setting.

NOTE

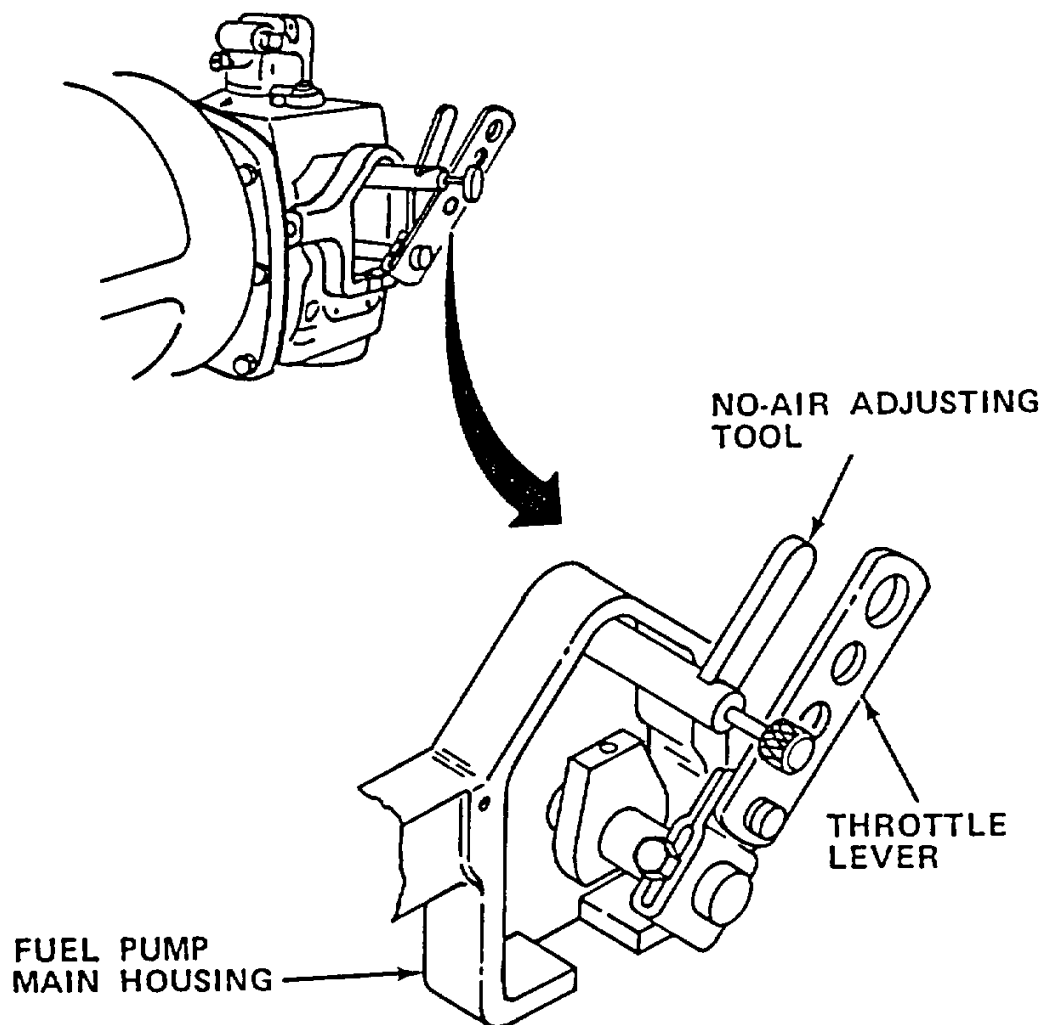
Be sure throttle lever is in full throttle position.

- (1) Check that selector valve is in ROTAMETER position.

NOTE

All adjustments to the AFC plunger setting must be made when no-air adjusting screw is bottomed in the pump main housing.

No-air adjusting tool 3375140 is part of the AFC fuel pump adjusting tool kit tool no. 3375189.



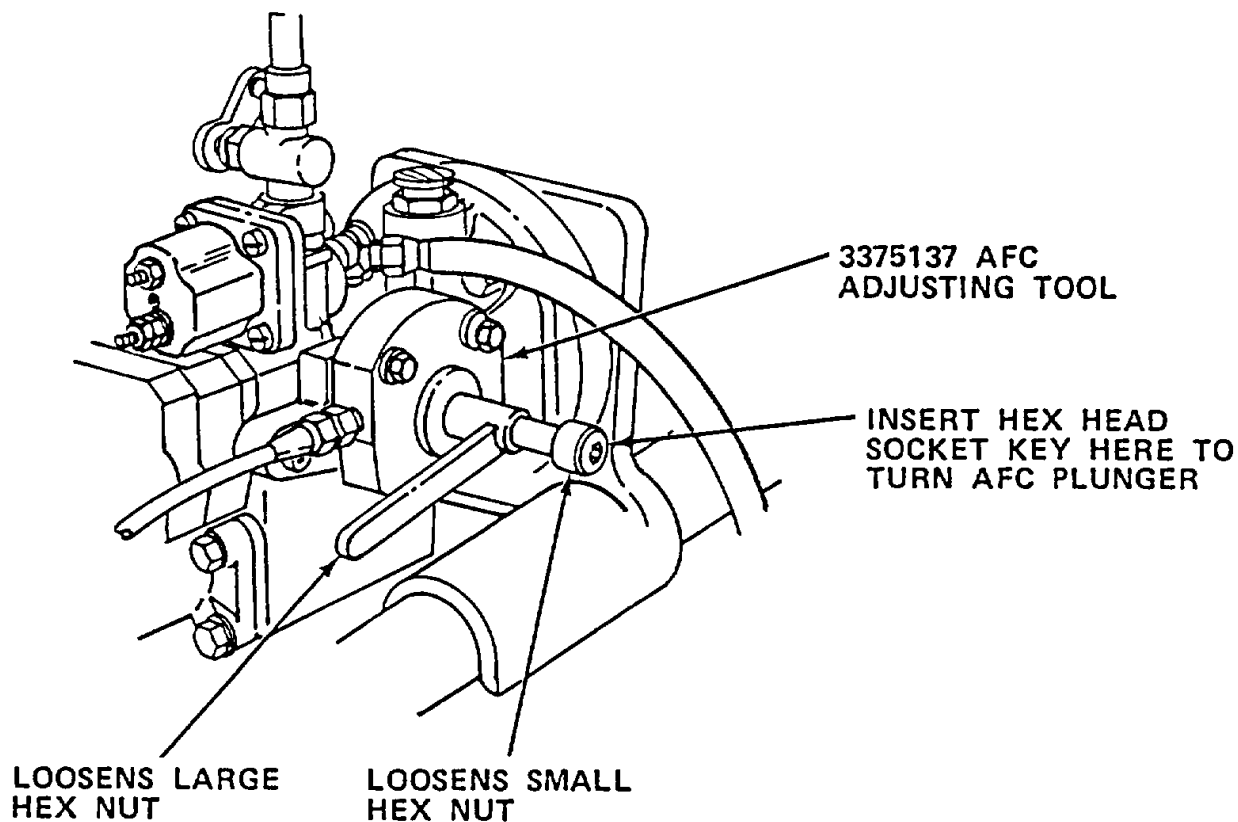
TA295498

- (2) With no-air adjusting tool, loosen locknut and turn adjusting screw clockwise until it bottoms in pump main housing.
- (3) Set pump speed at 1600 rpm.
- (4) Reduce regulated shop air pressure to 0 psi (2.2 in. Hg).
- (5) Check that fuel level in flowmeter stabilizes at or near zero.

NOTE

Air pressure during AFC plunger setting procedure must always be reached while increasing air pressure on the AFC bellows. If specified pressure reading is over shot, reduce air pressure to 0 psi and wait until fuel flow stabilizes at or near zero in flowmeter before increasing or decreasing the setting.

- (6) Increase air pressure reading to 3 psi (6 in. Hg).
- (7) Adjust flow control valve until 300 pph is indicated on flowmeter.



TA295499

CAUTION

THE AFC ADJUSTING TOOL 3375137 MUST BE USED WITH CARE. THE LARGE MOVEABLE CENTER HEX SOCKET ENGAGES THE NUT THAT RETAINS THE AFC BELLOWS TO THE PLUNGER. THE SOCKET HEAD KEY MOVES THE PLUNGER IN AND OUT TO ATTAIN THE PROPER ADJUSTMENT.

IF THE LARGE HEX SOCKET IS NOT PROPERLY ENGAGED, THE AFC BELLOWS CAN BE DAMAGED. THE PROPER SEQUENCE OF TOOL USE IS TO FIRST ENGAGE THE LARGE HEX SOCKET, THEN THE SMALL HEX SOCKET, FOLLOWED BY HEX HEAD SOCKET KEY.

NOTE

During this adjustment, it may be necessary to adjust the flow control valve to maintain a flow rate of 300 pph. This flow rate must be maintained during adjustment.

- (8) Using AFC adjusting tool and hex socket key, adjust fuel pressure reading on test stand fuel pressure gage to read 69 psi (476.1 kPa).

CAUTION

AFC PLUNGER CAN BE VERY EASILY BROKEN WHEN TIGHTENING JAM NUT. USE EXTREME CARE WHEN TIGHTENING JAM NUT TO 25-35 IN. LBS (2.83-3.96 N m) TORQUE. THE LARGE AND SMALL HEX SOCKETS MUST BE FULLY RETRACTED AFTER LOOSENING THE PLUNGER JAM NUT TO AVOID INTERFERING WITH THE AFC PISTON TRAVEL. IF THE AFC PISTON IS DISTURBED WHILE ADJUSTING THE PLUNGER, REPEAT THE ENTIRE AFC PLUNGER SETTING PROCEDURE.

- (9) Tighten AFC plunger jam nut with adjustment tool after correct fuel pressure is attained.
- (10) Recheck for fuel pressure gage indication of 69 psi (476.1 kPa) and flowmeter indication of 300 pph to ensure accuracy of adjustment.

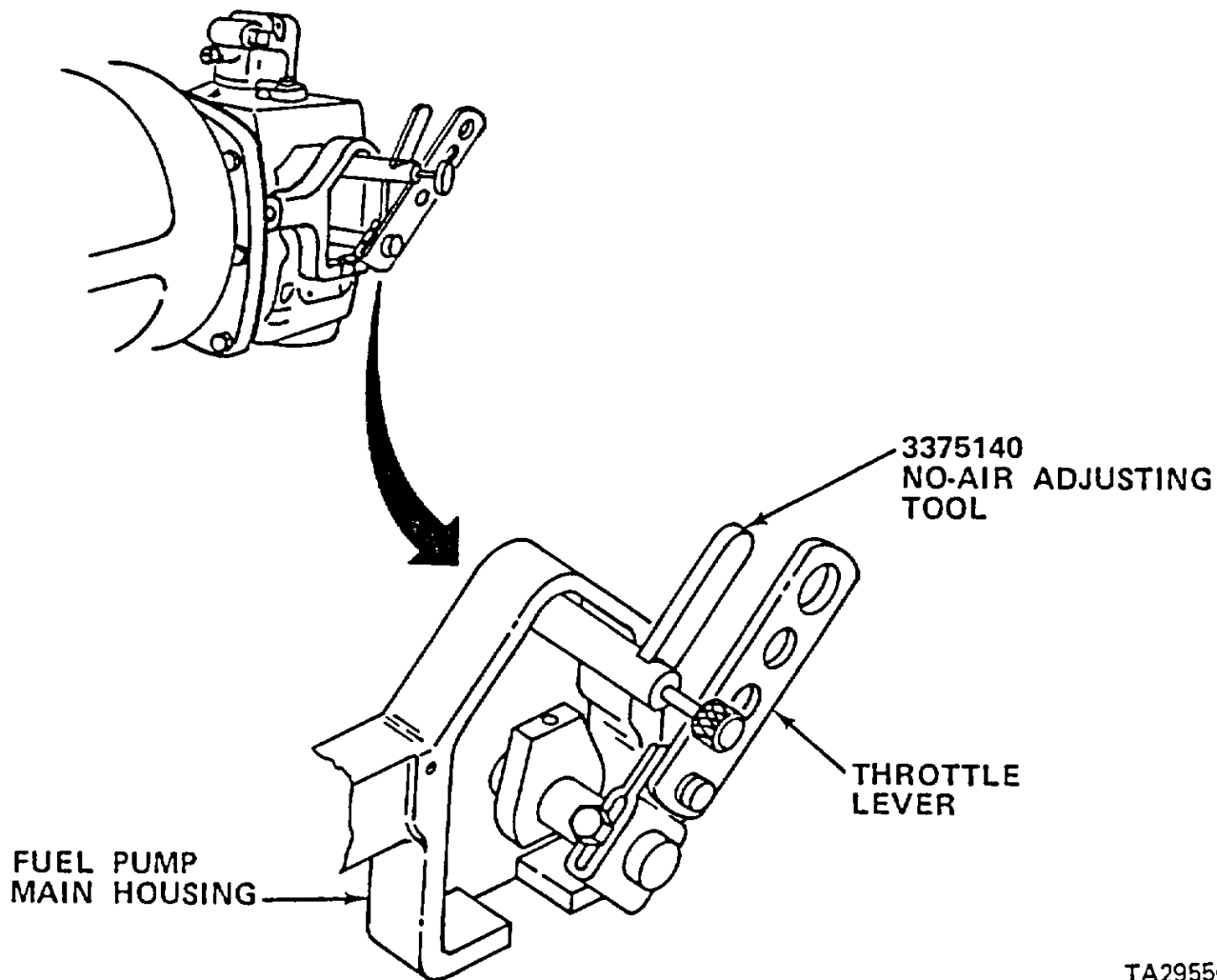
n. Perform no-air screw adjustment.

- (1) Set fuel pump speed at 1600 rpm.

NOTE

Be sure throttle lever is in full throttle position and manifold vacuum-pressure gage indicates 0 in. Hg.

- (2) Check that selector valve is in ROTAMETER position.



TA295500

- (3) Loosen locknut on no-air adjustment screw.

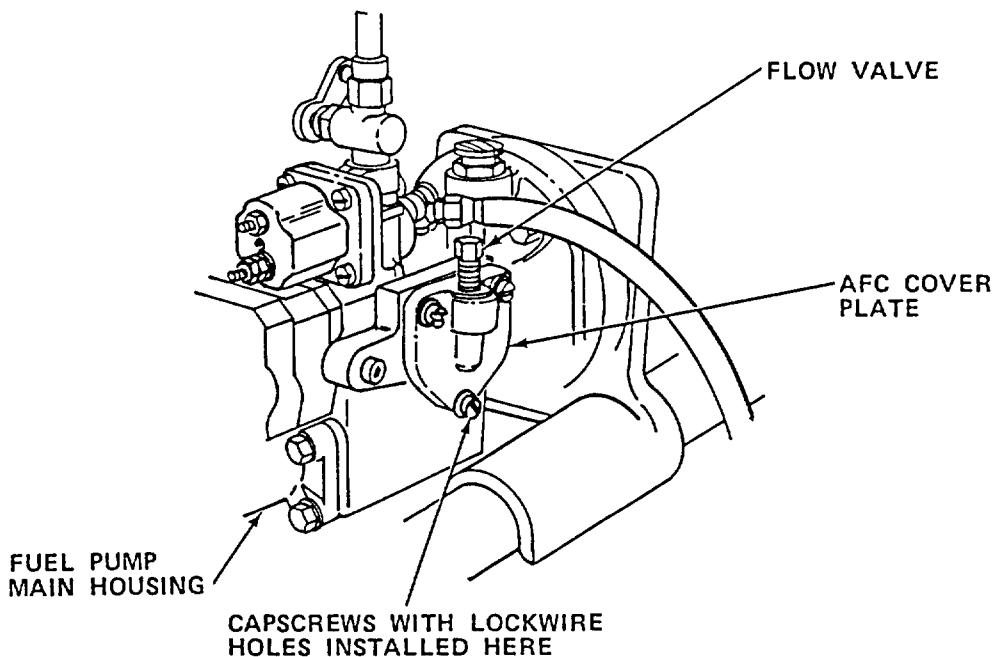
NOTE

Check that fuel flow on flowmeter indicates 230 pph during this adjustment. If necessary adjust fuel flow to maintain that flow rate.

- (4) Using no-air adjustment tool, adjust screw until 42 psi (289.8 kPa) fuel pressure is indicated on fuel pressure gage.

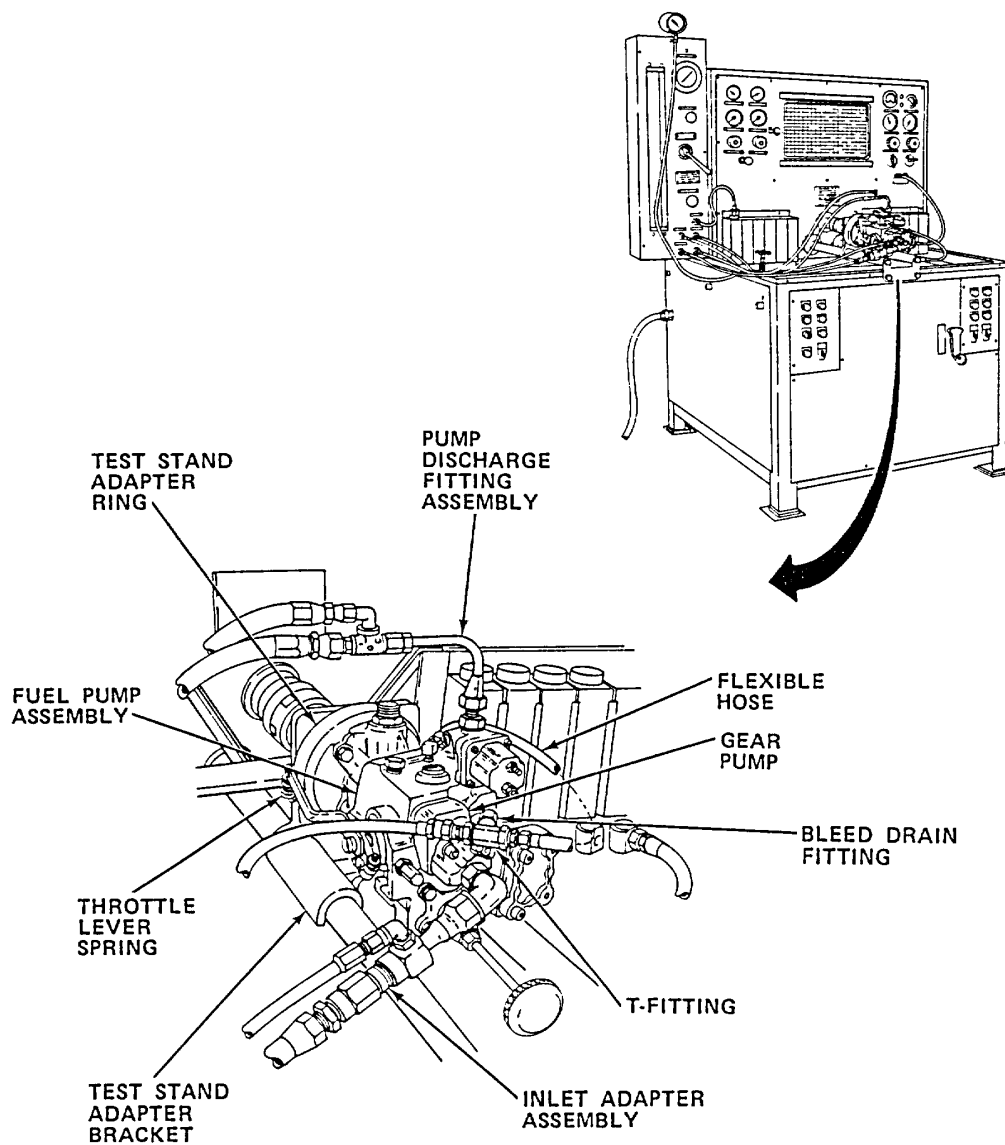
- (5) When proper fuel pressure is reached, tighten adjustment screw locknut.
 - (6) When all calibration checks have been completed, slow down test stand to minimum rpm, then actuate stand STOP button.
- o. Remove fuel pump from test stand.
- (1) Remove AFC adjusting tool from pump.
 - (2) Install AFC cover plate, with its flow valve installed, on fuel pump main housing.

NOTE
Bottom capscrew should have a lockwire hole drilled through its head.



TA295501

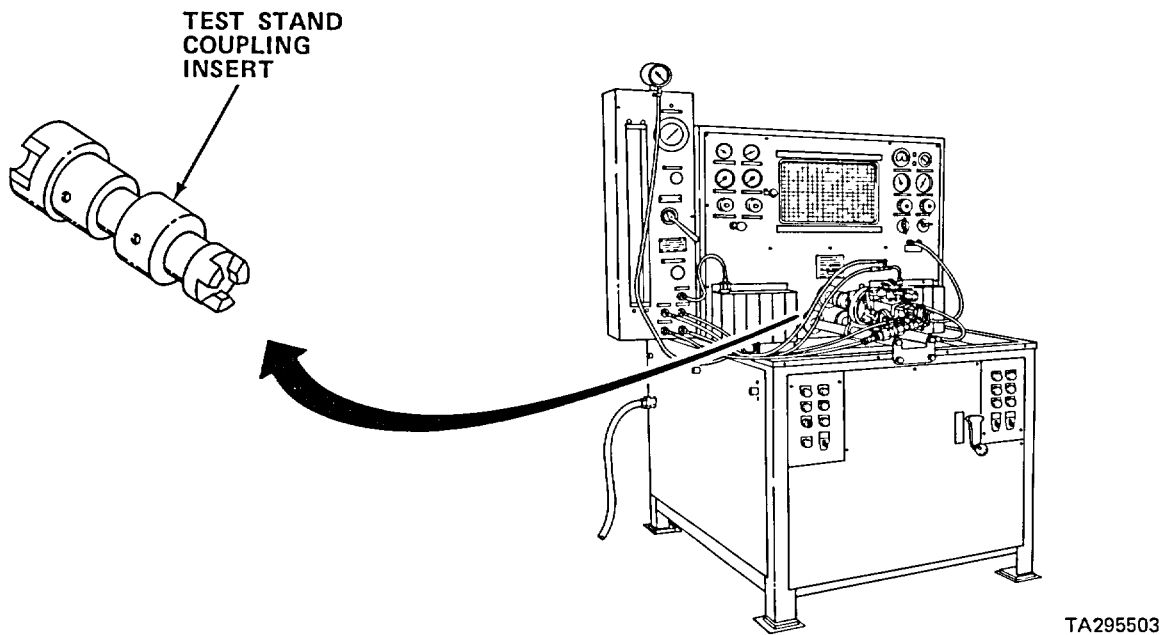
- (3) Secure cover plate with capscrews.
- (4) Torque capscrews to 30 - 45 in. lbs (3.39 - 5.09 N•m).
- (5) Disconnect all hoses from fuel pump assembly and test stand.



TA295502

- (6) Remove T-fitting from bleed drain fitting on gear pump.
- (7) Remove pump discharge fitting assembly from fuel pump shutoff valve.
- (8) Remove inlet adapter assembly from gear pump inlet fitting.
- (9) Disengage spring from throttle lever and test stand adapter ring.

- (10) Remove fuel pump assembly, test stand adapter ring, and test stand adapter bracket from test stand.
- (11) Separate pump assembly from test stand adapter ring.



TA295503

- (12) Remove test stand coupling insert from test stand.

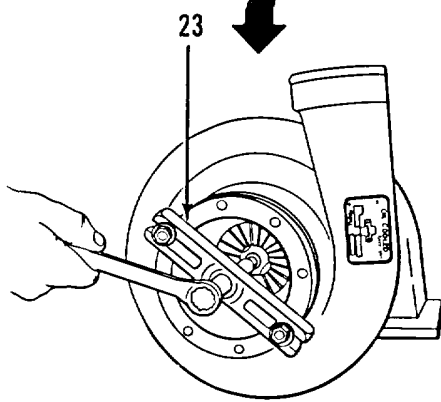
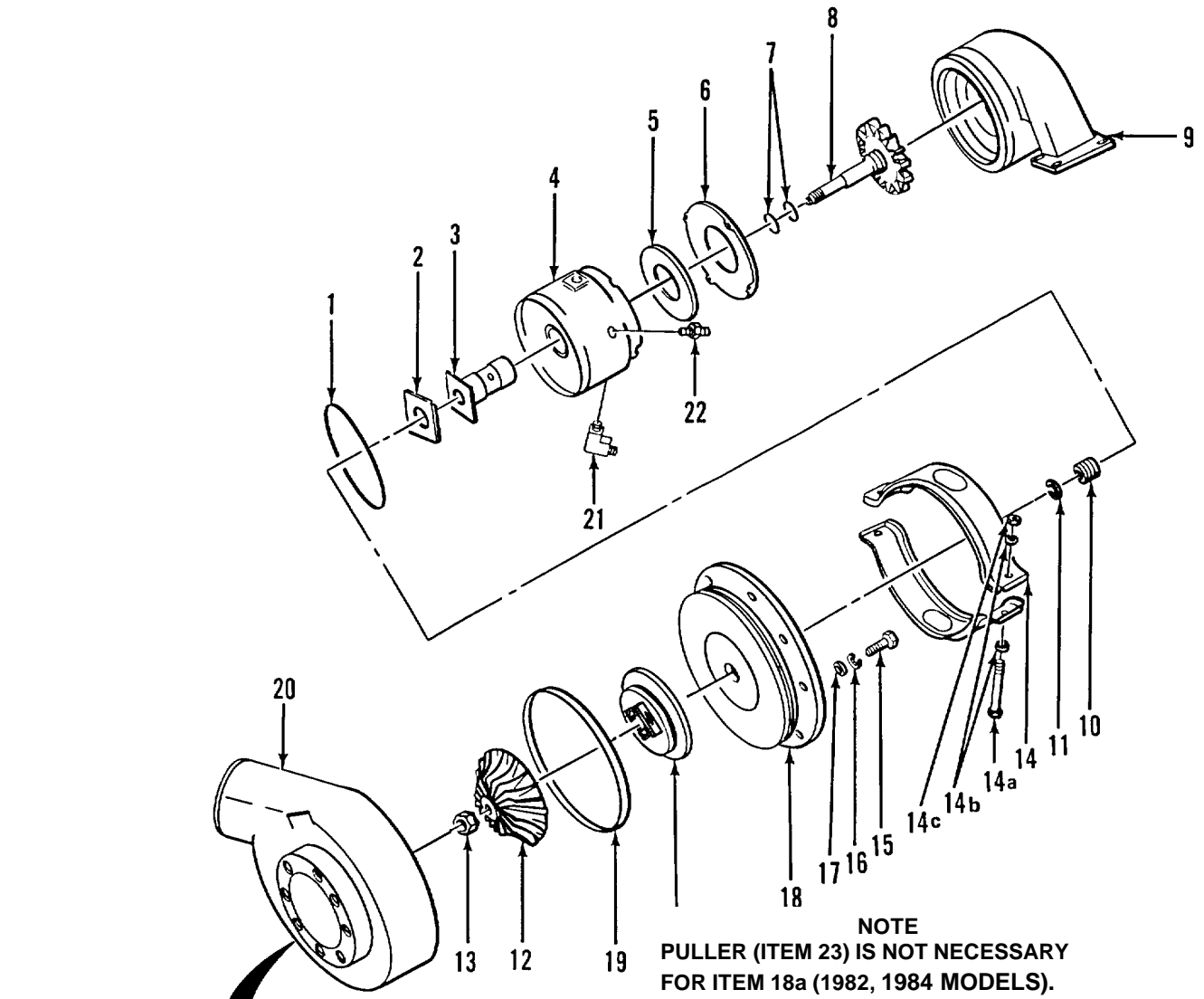
NOTE

Throttle shaft cover must be left off pump in order to perform on-engine fuel pump adjustment. Cover will be installed after the on-engine fuel adjustment has been made.

- (13) Cover all openings with protective paper to prevent entry of foreign matter.

Section XXIX. TURBOCHARGER REPAIR

3-85. DISASSEMBLE TURBOCHARGER



LEGEND:

- | | |
|----------------------------|---|
| 1. O-RING | 14a. BOLT |
| 2. BEARING INSERT | 14b. WASHERS |
| 3. BEARING | 14c. LOCKNUT |
| 4. BEARING HOUSING | 15. DIFFUSER CAPSCREW |
| 5. INSULATION PAD | 16. LOCKWASHER |
| 6. HEAT SHIELD | 17. FLAT WASHER |
| 7. OIL SEALING RINGS | 18. DIFFUSER PLATE |
| 8. TURBINE WHEEL AND SHAFT | 18a. DIFFUSER PLATE (1982, 1984 MODELS) |
| 9. TURBINE HOUSING | 19. O-RING |
| 10. OIL SEAL SLEEVE | 20. COMPRESSOR HOUSING |
| 11. OIL CONTROL RING | 21. DRAIN FITTING |
| 12. COMPRESSOR WHEEL | 22. OIL SUPPLY FITTING |
| 13. ROTOR LOCKNUT | 23. PULLER |
| 14. V-BAND CLAMPS | |

- a. Matchmark compressor housing (20), bearing housing (4), V-band clamp (14) and turbine housing (9) to facilitate realinement during assembly.
- b. Remove oil supply fitting (22) and drain fitting (21).
- c. Remove compressor wheel rotor locknut (13) while keeping turbine end of rotor shaft from turning.
- d. Remove V-band clamps (14). Discard bolts (14a), washers (14b), and locknuts (14c). For 1982 and 1984 models, go to step j.1.
- e. Secure puller (23) to compressor housing (20) with end of puller bolt in contact with turbine wheel and shaft (8).
- f. Pull compressor housing (20), diffuser plate (18), and compressor wheel (12) from bearing housing (4).
- g. Remove capscrews (15), lockwashers (16), and flat washers (17) from diffuser plate (18) and compressor housing (20).
- h. Remove diffuser plate (18) from compressor housing (20) and lift out compressor wheel (12).
- i. Remove and discard O-ring seal (19) on diffuser plate (18).
- j. With finger pressure, push oil seal sleeve (10) out of center of diffuser plate (18).
- j.1. Remove compressor housing (20). While rotating opposite end of shaft with socket wrench, remove compressor wheel (12).
- k. Tap end of turbine wheel and shaft (8) to loosen. Remove oil seal sleeve (10) and diffuser plate (18a).
- l. Remove oil control ring (11) from oil seal sleeve (10) and discard ring.

NOTE

Closely examine the manner in which the bearing insert fits the diffuser plate to ensure proper reassembly.

- m. Remove bearing insert (2) from diffuser plate (18a).
- n. Remove bearing (3) from bearing housing (4).
- o. Remove O-ring (1) from diffuser plate (18a). Discard O-ring.

CAUTION

To prevent damage to parts, place rags beneath turbo charger to cushion rotor and bearing assembly housings as they drop out of turbine housing.

NOTE

Turbine wheel and shaft, and bearing housing is removed as an assembly.

- p. Remove turbine wheel and shaft (8) and bearing housing (4) from turbine housing (9).
- q. Remove turbine wheel and shaft (8) from bearing housing (4).
- r. Remove heat shield (6) and insulation pad (5) from bearing housing (4).
- s. Remove oil seal rings (7) from grooves in turbine shaft (8), and discard rings.

3-86. CLEAN TURBOCHARGER

WARNING

- WEAR PROTECTIVE CLOTHING AND GOGGLES WHILE STEAM CLEANING TO PREVENT PERSONAL INJURY.
- WHEN USING PAINT THINNER, MINERAL SPIRITS, AND SIMILAR SOLVENTS, AVOID SKIN CONTACT, INHALATIONS, OR CONDITIONS THAT MAY CAUSE FIRE HAZARDS.

- a. Steam clean compressor housing, bearing housing, diffuser plate and turbine housing.
- b. Place remaining parts in wire basket and submerge into ultrasonic cleaner for 24 hours. Hot water and soap or mineral spirits can also be used to clean parts.

CAUTION

DO NOT USE WIRE BRUSH OR ANY OTHER STIFF BRISTLE BRUSH TO CLEAN PARTS.

- c. Use soft bristle brush to assist in removing carbon deposits from parts.

- d. Flush oil passages with ultrasonic cleaning solvent.
- e. Drain and steam clean parts after soaking.

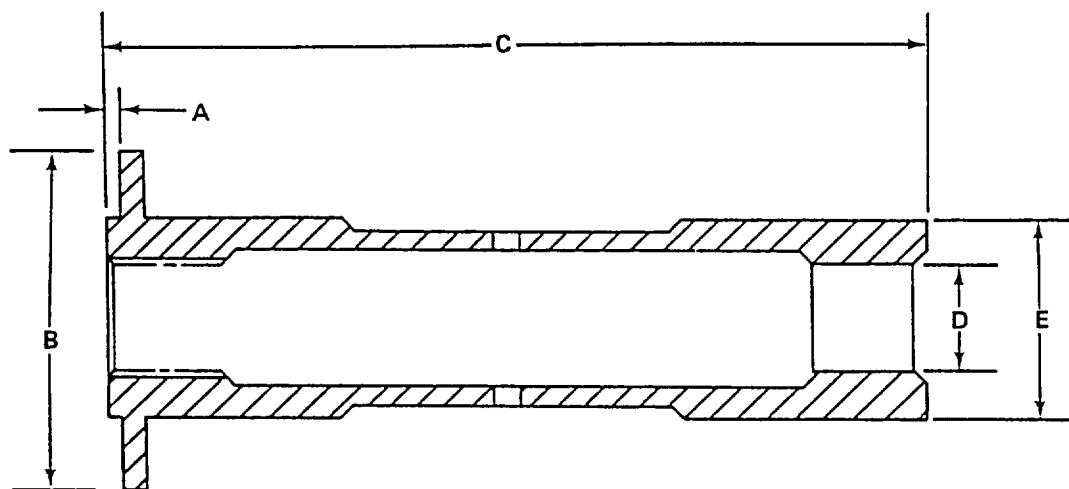
WARNING

COMPRESSED AIR USED FOR CLEANING PURPOSES WILL NOT EXCEED 30 PSI (207 KPA). USE ONLY WITH EFFECTIVE CHIP GUARDING AND PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, SHIELD, GLOVES, ETC.).

- f. Dry all parts with clean compressed air.

3-87. INSPECT TURBOCHARGER

a. Inspect bearing, referring to following specifications:

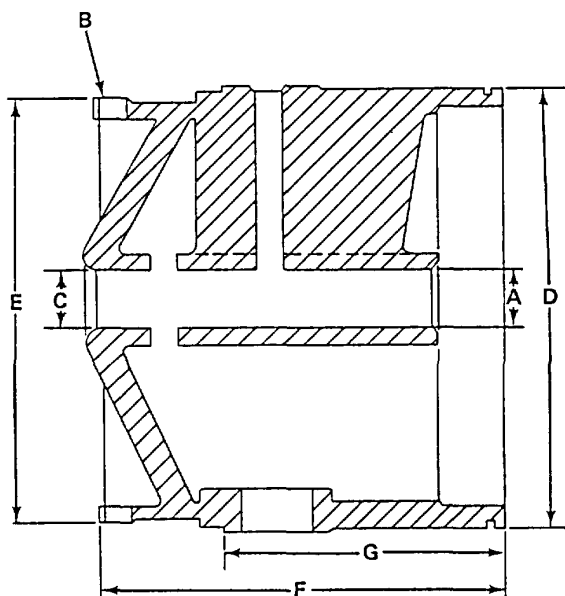


TA295505

Reference Letter	Part or Location	New Part Limit	Wear Limit
A	Flange Thickness	0.136 in. (3.454 mm)	0.143 in. (3.632 mm)
B	Flange Width	1.850 in. (46.990 mm)	1.960 in. (49.784 mm)
C	Length	3.077 in. (78.155 mm)	3.075 in. (78.105 mm)
D	inside Diameter	0.752 in. (19.100 mm)	0.7525 in. (19.1135 mm)
E	Outside Diameter	1.272 in. (32.308 mm)	1.274 in. (32.359 mm)

b. Replace bearing if wear limits exceeded or bearing scratched, nicked or dented.

c. Inspect bearing housing referring to following specifications:

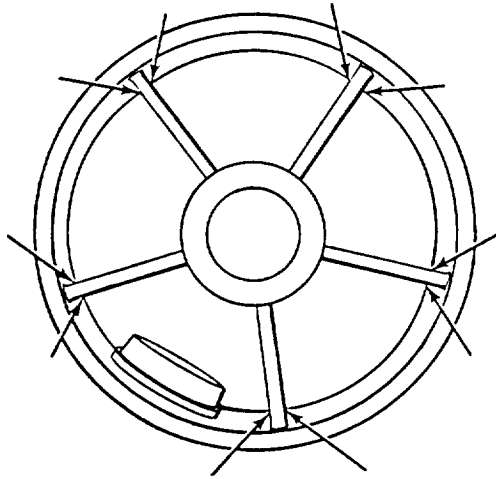


TA295506

Reference Letter	Part or Location	New Part Limit	Wear Limit
A	Sealing Ring Bore	1.275 in. (32.385 mm)	1.276 in. (32.416 mm)
B	Hot Shield Slots Width	0.460 in. (11.684 mm)	0.750 in. (19.050 mm)
C	Bearing Bore	1.275 in. (32.385 mm)	1.276 in. (32.410 mm)
D	Compressor End Outside Diameter	5.3965 in. (137.0711 mm)	5.4025 in. (137.2235 mm)
E	Turbine End Outside Diameter	5.049 in. (128.244 mm)	5.055 in. (128.39 mm)
F	Overall Housing Length	3.990 in. (101.346 mm)	4.012 in. (101.904 mm)
*G	Compressor Stop To Turbine Stop Length	2.986 in. (75.844 mm)	2.994 in. (76.047 mm)

* Measured at four equal locations Discard if any one measurement is more than wear limit.

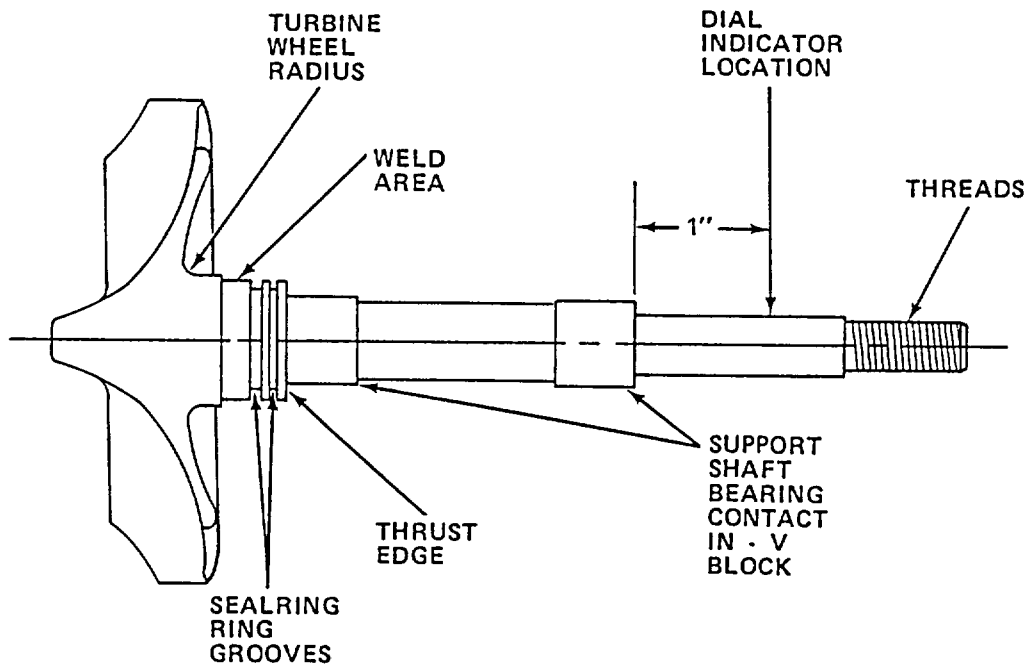
- d. Visually inspect bearing housing for cracks in area of supply and drain fittings. Replace if cracked.



TA295507

- e. Check for cracks in areas indicated by arrows. Replace if cracked.
- f. Check for notches in dome area at heat shield end of housing. Replace if notched.

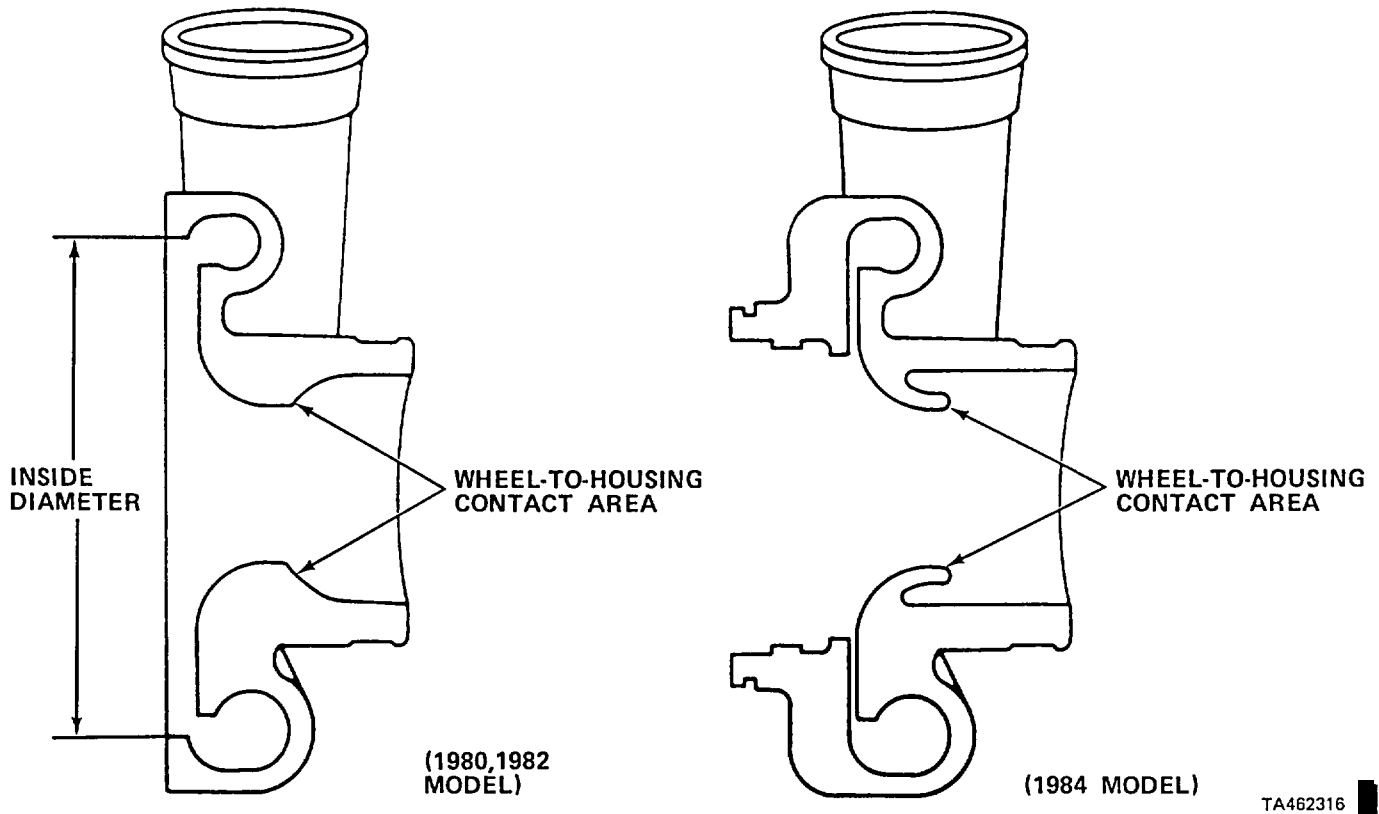
- g. Inspect turbine wheel and shaft.



TA295508

- (1) Perform magnetic particle inspection of weld area and wheel radius.
- (2) Replace turbine wheel and shaft if more than three cracks found in weld area or any one crack exceeds 0.0625 in. (1.5875 mm) in length. Distance between any two cracks cannot be less than 0.250 in. (6.350 mm).
- (3) Holes with maximum diameter of 0.015 in. (0.381 mm) are acceptable in weld area.
- (4) No defects are permitted in turbine wheel radius area.
- (5) Cracks are not permitted in other areas of shaft.
- (6) Perform dye penetrant inspection of turbine wheel. Replace assembly if any one sealing ring groove width exceeds 0.132 in. (3.352 mm). New groove width is 0.126 in. (3.200 mm).
- (7) Check thrust edge for scratches. Smooth with crocus cloth.
- (8) Measure bearing contact journals on shaft. Replace shaft if outside diameter is less than 0.7495 in. (19.0373 mm). New part limit is 0.750 in. (19.050 mm).
- (9) Check shaft for damaged threads. Discard shaft if damaged.
- (10) With shaft in V-blocks, rotate shaft and measure total dial indicator reading for maximum of 0.0005 in. (0.0127 mm). Replace if limit exceeded.

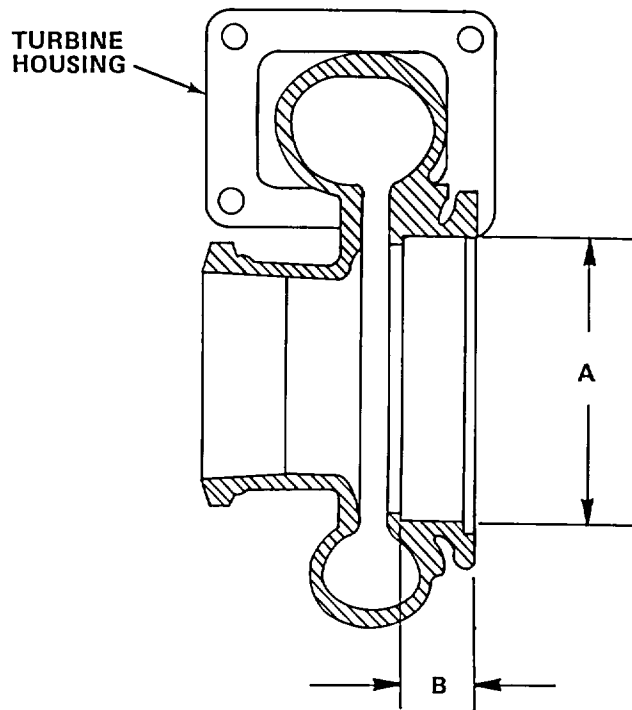
h. Inspect compressor housing.



TA462316

- (1) Check compressor housing-to-bearing housing inside diameter. Old part limit is 5.400 in. (137.160 mm). Replace housing if diameter exceeds 5.406 in. (137.312 mm). (1984 models, disregard this step.)
- (2) Check housing for compressor wheel-to-housing contact. Small chips or scratches can be blended with crocus cloth.
- (3) Check housing for cracks or distortions. Replace if cracked or distorted.

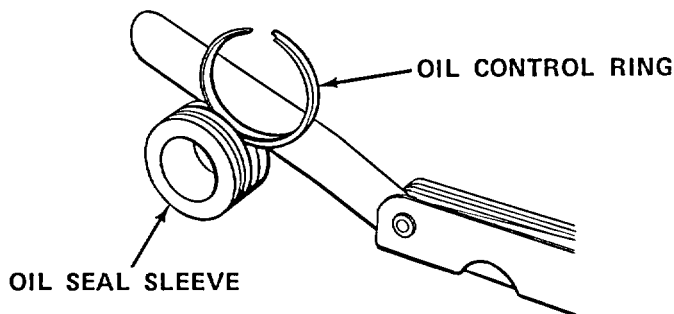
- i. Inspect turbine housing.



TA295510

- (1) Measure mount flange inside diameter (A). New part limit is 5.0543 in. (128.379 mm). Replace casing if diameter exceeds 5.058 in. (128.473 mm).
- (2) Measure casing depth (B). New part limit is 1.1935 in. (30.3149 mm). Replace housing if depth exceeds 1.202 in. (30.530 mm).
- (3) Replace casing if turbine wheel contact marks are found.
- (4) Check for cracks in mounting flange or exhaust pipe attachment flange. Replace if cracked.

j. Inspect oil seal sleeve.

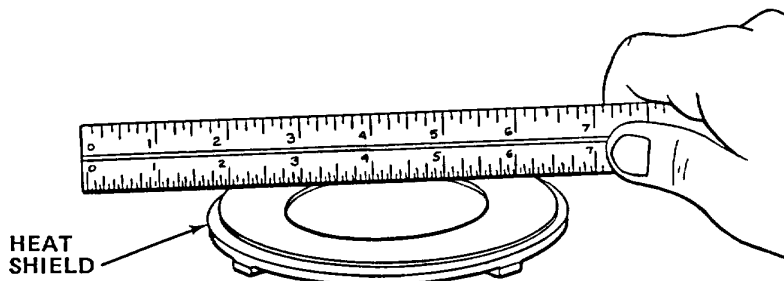


TA295511

- (1) Insert new oil control ring into groove of oil seal sleeve as shown. If clearance between ring and groove exceeds 0.009 in. (0.228 mm), replace sleeve.
- (2) Measure width of groove. New part limit is 0.125 in. (3.175 mm). Replace sleeve if width exceeds 0.131 in. (3.327 mm).
- (3) Measure width of oil control ring. New part limit is 0.122 in. (3.109 mm). Replace if width exceeds 0.124 in. (3.149 mm).

k. Inspect heat shield.

- (1) Inspect for cracks. Replace if cracked.



TA295512

- (2) With straightedge, check for distortions. Replace if distorted.

l. Inspect compressor wheel.

NOTE

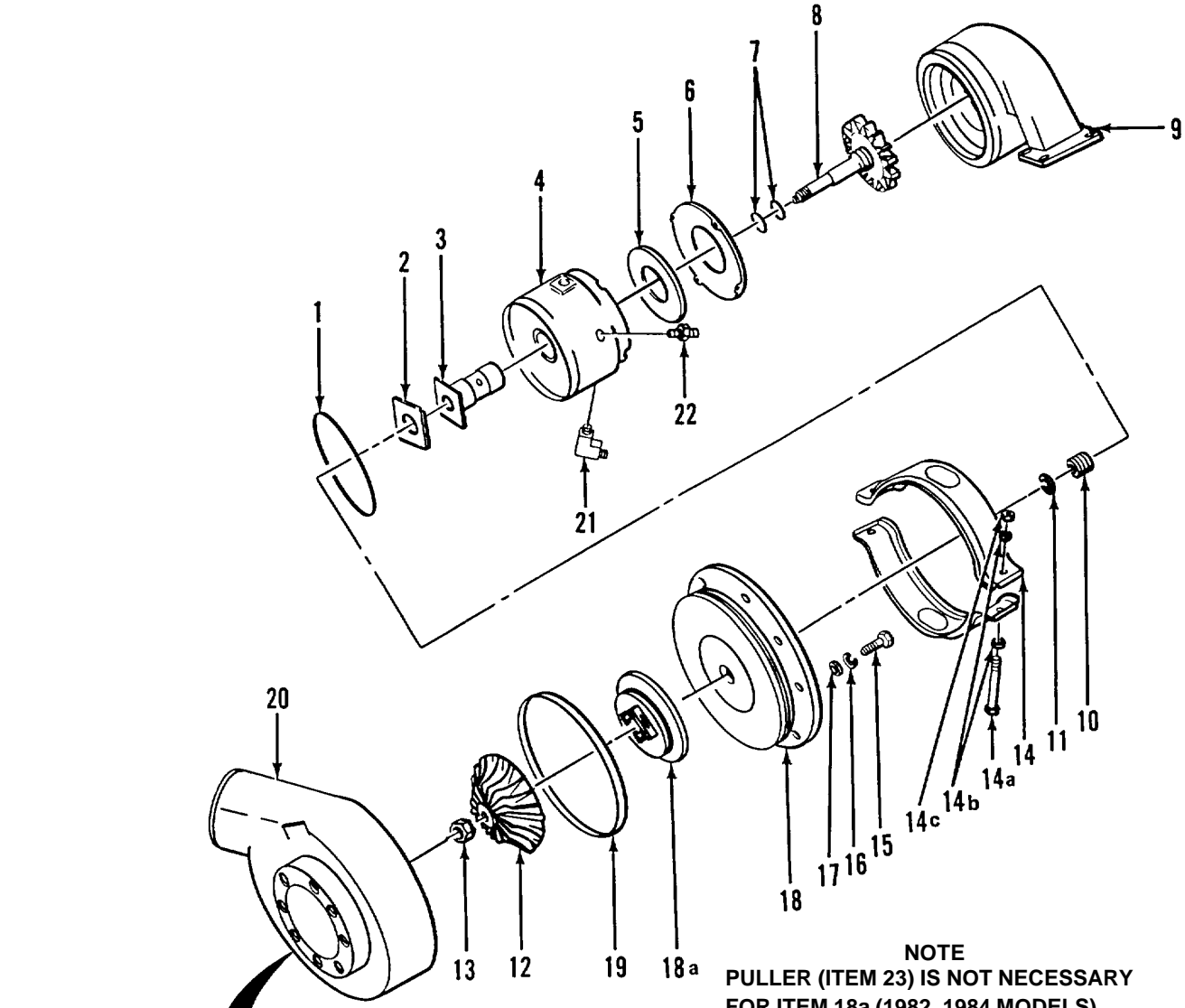
Compressor wheel must be replaced if vanes are cracked, broken, or have touched compressor housing.

- (1) Perform crack inspection using dye penetrant method. Replace if vanes cracked.
- (2) Check for vane damage due to contact with compressor housing. Replace if damaged.

3-88. REASSEMBLE TURBOCHARGER

CAUTION

ALL PARTS AND WORK AREA MUST BE FREE OF GREASE, OIL, AND DIRT TO KEEP ABRASIVES OUT OF TURBOCHARGER DURING ASSEMBLY.

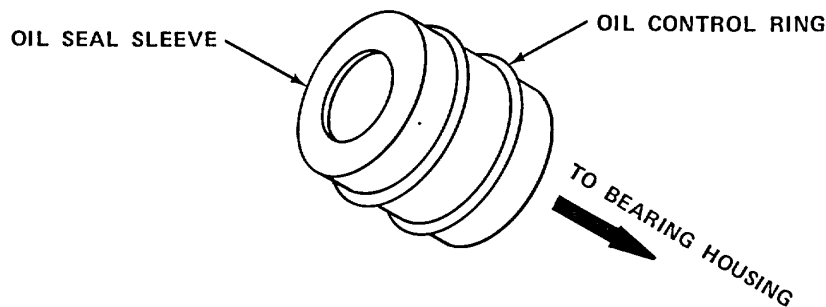


NOTE
 PULLER (ITEM 23) IS NOT NECESSARY FOR ITEM 18a (1982, 1984 MODELS).

LEGEND:

- | | |
|------------------------------|---|
| 1. O-RING | 14a. BOLT |
| 2. BEARING INSERT | 14b. WASHERS |
| 3. BEARING | 14c. LOCKNUT |
| 4. BEARING HOUSING | 15. DIFFUSER CAPSCREW |
| 5. INSULATION PAD | 16. LOCKWASHER |
| 6. HEAT SHIELD | 17. FLAT WASHER |
| 7. OIL SEALING RINGS | 18. DIFFUSER PLATE |
| 8. TURBINE WHEEL AND SHAFT | 18a. DIFFUSER PLATE (1982, 1984 MODELS) |
| 9. TURBINE HOUSING | 19. O-RING |
| 10. OIL SEAL SLEEVE | 20. COMPRESSOR |
| 11. OIL CONTROL RING HOUSING | 21. DRAIN FITTING |
| 12. COMPRESSOR WHEEL | 22. OIL SUPPLY FITTING |
| 13. ROTOR LOCKNUT | 23. PULLER |
| 14. V-BAND CLAMPS | |

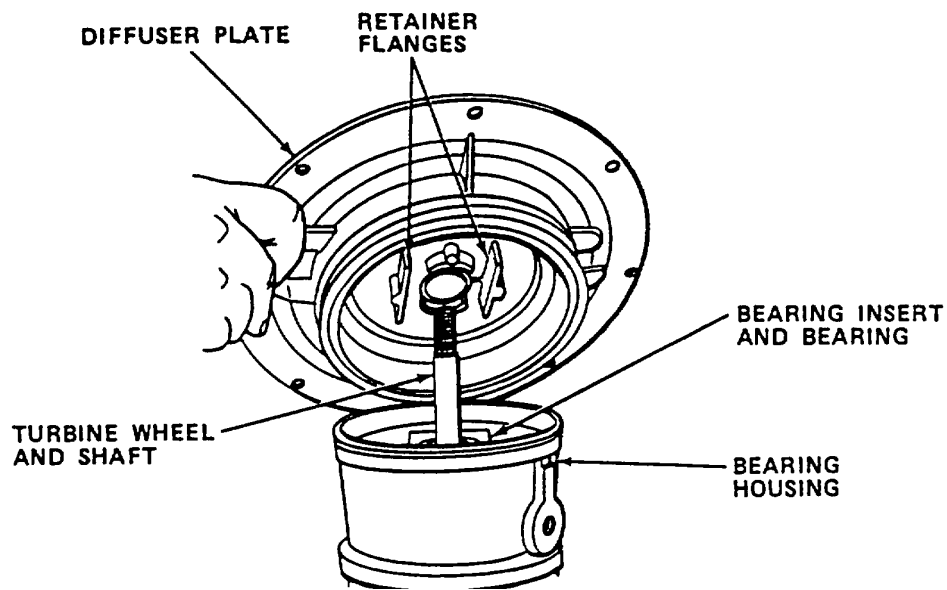
- a. Position oil sealing rings (7) in grooves on turbine wheel and shaft (8).
- b. Ensure that ring gaps are 180 degrees apart.
- c. Position new insulation pad (5) on turbine end of bearing housing (4).
- d. Install heat shield (6) on bearing housing (4).
- e. Lubricate bore of bearing housing (4).
- f. Carefully insert turbine wheel and shaft (8) into turbine end of bearing housing (4), compressing oil sealing rings (7) in the process.
- g. Lubricate turbine wheel and shaft (8) and bearing (3).
- h. Position bearing insert (2) over flange of bearing (3). Insert bearing and bearing insert into back of diffuser plate (18a) (1982 and 1984 models).
- i. Lubricate groove in oil seal sleeve (10) and new oil control ring (11). Slide oil control ring over sleeve, into groove.



NOTE
Oil control ring end of sleeve must face bearing housing.

TA462807

- j. Lubricate bore of diffuser plate (18a), and insert oil seal sleeve (10) into diffuser plate (18a), keeping oil control ring compressed until sleeve is started into bore.
- k. Lubricate new O-ring (1) and insert in groove of diffuser plate (18a) (1982 and 1984 models).
- l. Slide bearing (3) into bearing housing (4) with diffuser plate (18a) attached. Tap edges of diffuser plate to seat diffuser plate in bearing housing (4) (1982 and 1984 models).



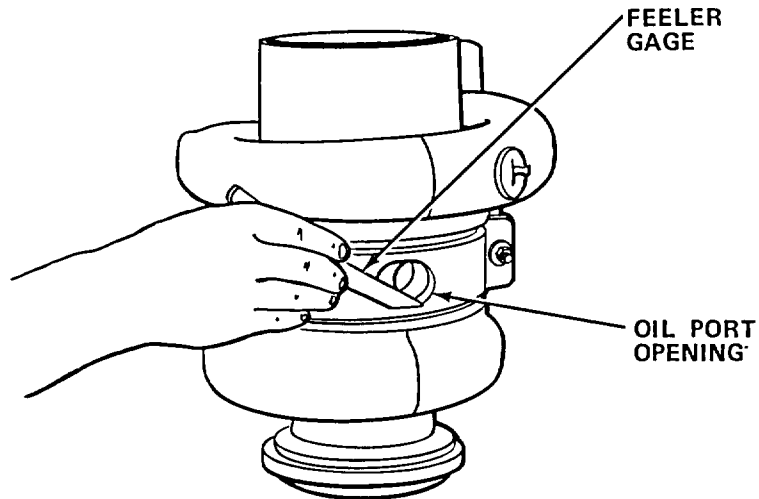
TA462808

1980 MODEL

- l.1. Position diffuser plate so that retainer flanges of diffuser plate align with bearing insert and bearing (1980 model).
- m. Lubricate turbine housing (9) bore with MIL-C-47121 antiseize compound.
- n. Press bearing housing (4) and turbine wheel and shaft (8) into turbine housing (9), ensuring that alignment marks match.
- o. Lubricate turbine shaft (8). Press compressor wheel (12) onto shaft.
- p. Install new rotor nut (13) on turbine shaft (8). Torque nut to 24 ft lbs (27-33 N•m).
- q. Install compressor housing (20). Position V-band clamps (14) around bearing housing (4), centering openings of clamps over oil supply and drain ports.
- r. Secure diffuser plate (18) to compressor housing (20) with lockwashers (16), flat washers (17) and capscrews (15). Torque capscrews to 5 - 7 ft lbs (7 -9 N•m).

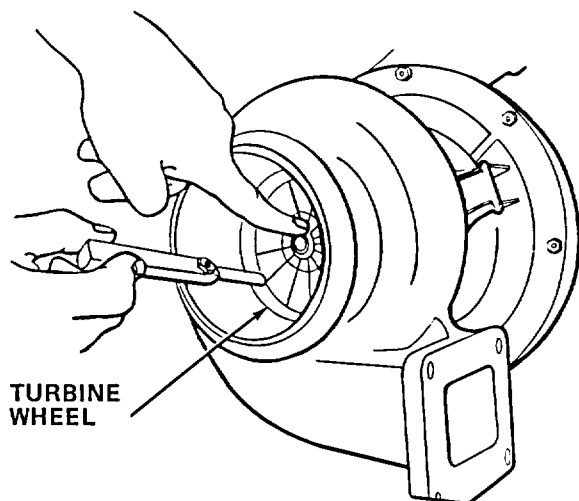
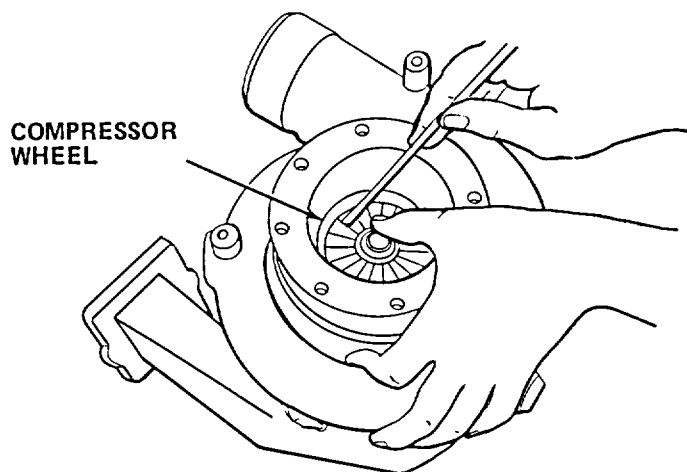
CAUTION**DO NOT OVERTORQUE CLAMP NUTS. THIS CAUSES CLAMP DISTORTION.**

- s. Install new bolts and nuts securing clamp halves (14) in position and torque nuts to 31 - 36 in. lbs (3.6 - 4.1 Nm). Ensure that clamps are seated correctly and equal gap exists at clamp closing points. ■



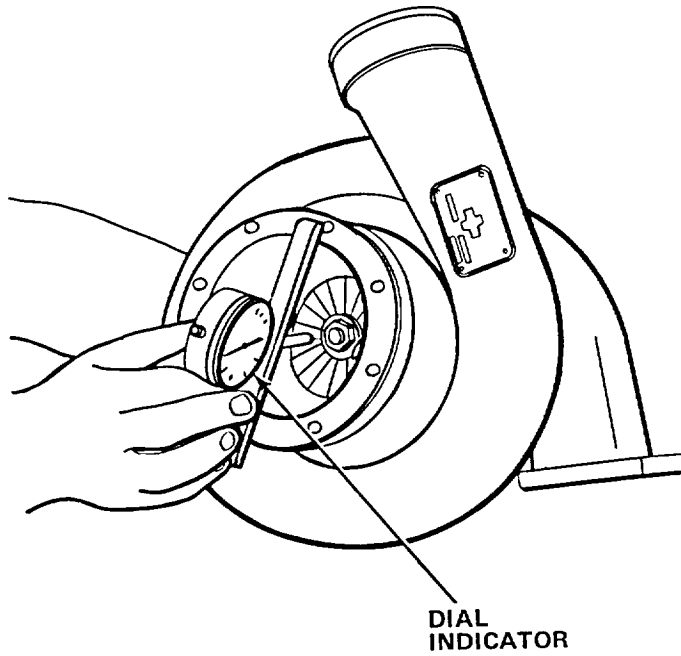
TA295515

- t. Measure clearance between V-band clamp and turbine housing at oil port openings in clamp. There must be no less than 0.035 in. (0.889 mm) clearance. If less than 0.035 in. (0.889 mm), change clamp. ■
- u. Check radial clearance at turbine wheel and compressor wheel. ■



TA295516

- (1) Push shaft towards side of bore.
- (2) Check clearance between tip of wheel vanes and bore. Clearance must be 0.006 - 0.028 in. (0.152 - 0.711 mm) at compressor end and 0.008 - 0.043 in. (0.023 - 1.092 mm) at turbine end. If unable to meet clearance(s) disassemble turbocharger and remeasure housing bores.

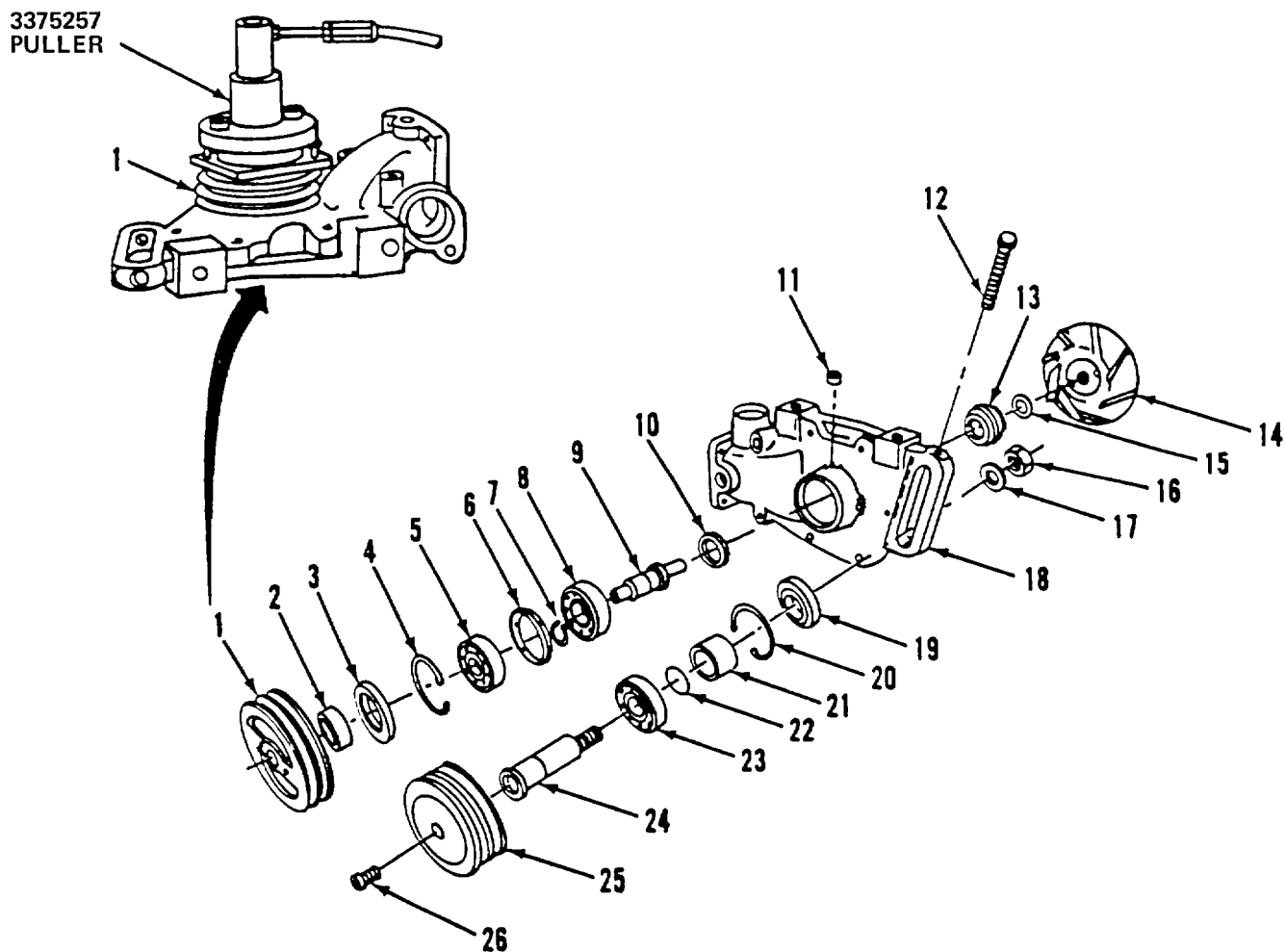


TA295517

- z. With a dial indicator, measure total end clearance. Clearance must be within 0.006 - 0.018 in. (0.15 - 0.46 mm). If end clearance is incorrect, disassemble turbocharger and check bearing for defects.
- aa. Apply thread sealant to oil inlet fitting and install fitting. Torque fitting to 20 - 25 ft lbs. (27 - 34 N•m).
- ab. Apply thread sealant to oil drain fitting and install fitting. Torque fitting to 50 ft lbs (68 N•m).
- ac. Tape all openings to prevent entry of dirt and abrasives.

Section XXX. WATER PUMP AND IDLER PULLEY ASSEMBLY REPAIR

3-89. DISASSEMBLE WATER PUMP



LEGEND:

- | | |
|---------------------------|------------------------|
| 1. Pulley, Water Pump- | 14. Impeller |
| 2. Sleeve | 15. Cup seat |
| 3. Grease Seal (Front) | 16. Locknut |
| 4. Retaining Ring - Large | 17. Washer |
| 5. Outer Bearing | 18. Water Pump Housing |
| 6. Spacer | 19. Grease Seal |
| 7. Retaining Ring - Small | 20. Retaining Ring |
| 8. Inner Bearing | 21. Spacer |
| 9. Water Pump Shaft | 22. O-ring |
| 10. Grease Seal (Rear) | 23. Bearing |
| 11. Pump Cavity Pipe Plug | 24. Idler Shaft |
| 12. Adjustment Screw | 25. Idler Pulley |
| 13. Face Seal | 26. Plug |

- a. Remove adjustment screw (12) from idler shaft (24) and water pump housing (18).
- b. Remove nut (16) and washer (17) securing idler shaft (24) to water pump housing (18) and remove idler pulley assembly.
- c. Using tool no. 3375257 hydraulic puller, remove pulley (1) and impeller (14) from water pump shaft (9).
- d. Remove front grease seal (3) from front of water pump housing (18). Discard seal.
- e. Remove large retaining ring (4) securing bearings (5 and 8) and water pump shaft (9) to water pump housing (18).
- f. Support water pump housing (18) at pulley end and press bearings (5 and 8) and shaft (9) out from water pump housing (18) by applying pressure to impeller end of shaft.
- g. Remove rear grease seal (10), cup seat (15), and face seal (13).
- h. Using ST-1114 bearing separator, press water pump shaft (9) from outer bearing (5) and spacer (6).
- i. Remove small retaining ring (7) securing inner bearing (8) and press water pump shaft (9) from bearing.

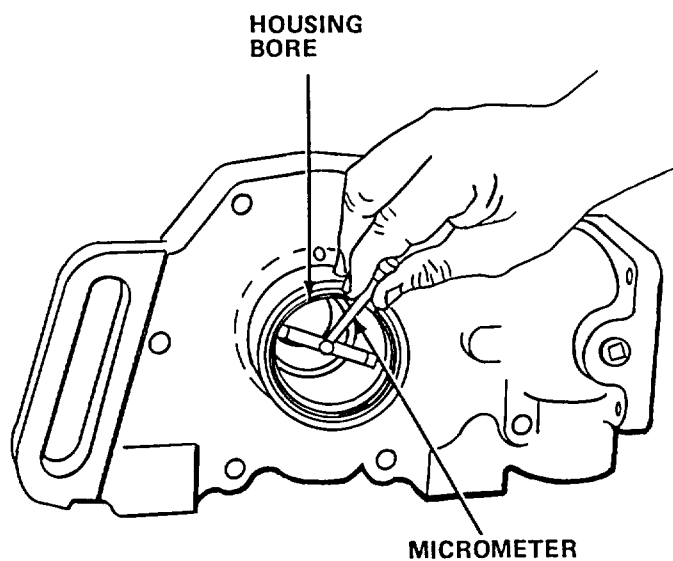
3-90. DISASSEMBLE IDLER PULLEY

- a. Clamp spacer (21) in vise and tap shaft and pulley assembly out of spacer.
- b. Remove grease seal (19) from pulley (25). Discard seal.
- c. Remove retaining ring (20).
- d. Remove O-ring (22) from groove in shaft (24) and discard O-ring.
- e. Remove plug (26) from pulley (25).
- f. Insert flat-end punch through hole in pulley and tap bearing (23) and idler shaft (24) from pulley.
- g. Press idler shaft (24) from bearing (23).

3-91. INSPECT WATER PUMP AND IDLER PULLEY COMPONENTS

- a. Inspect bearing for rough or worn races Discard bearing if defective.
- b. Check impeller for cracks of erosion. Replace if defective.
- c. Measure impeller bore for maximum diameter of 0.625 in. (15.875 mm). Replace if diameter greater than specified.
- d. Measure shaft diameter at impeller end. Replace shaft if diameter less than 0.6262 in. (15.9054 mm).
- e. Compare impeller inside diameter to shaft outside diameter. There must be a minimum of 0.001 in. (0.025 mm) press fit between impeller and shaft. Replace components necessary to gain required fit.
- f. Measure water pump pulley inside diameter and shaft outside diameter at pulley end. There must be a minimum of 0.001 in. (0.025 mm) press fit between impeller and shaft. Replace components necessary to gain required fit.
- g. Inspect shaft for straightness and galling at bearing surfaces. Replace if bent or galled.
- h. Inspect pulley grooves for wear, chips or cracks. Check belts' seating with new belt. Belts should not bottom in grooves and not protrude more than 1/8 in. (3.175 mm) above grooves.
- i. Measure idler puller bore and idler shaft outside diameter. There must be minimum of 0.001 in. (0.025 mm) press fit between shaft and pulley. Replace components necessary to gain required fit.
- j. Inspect wear sleeve on pulley. If grooves found, replace sleeve:
 - (1) Grind 15 angle on end of 3/16 in. (4.762 mm) straight shaft punch.
 - (2) Secure pulley in vise with front face up.
 - (3) Drive wear sleeve from pulley hub by placing punch through puller holes in pulley. Discard sleeve.
 - (4) Press new wear sleeve on until it is flush with end of hub.

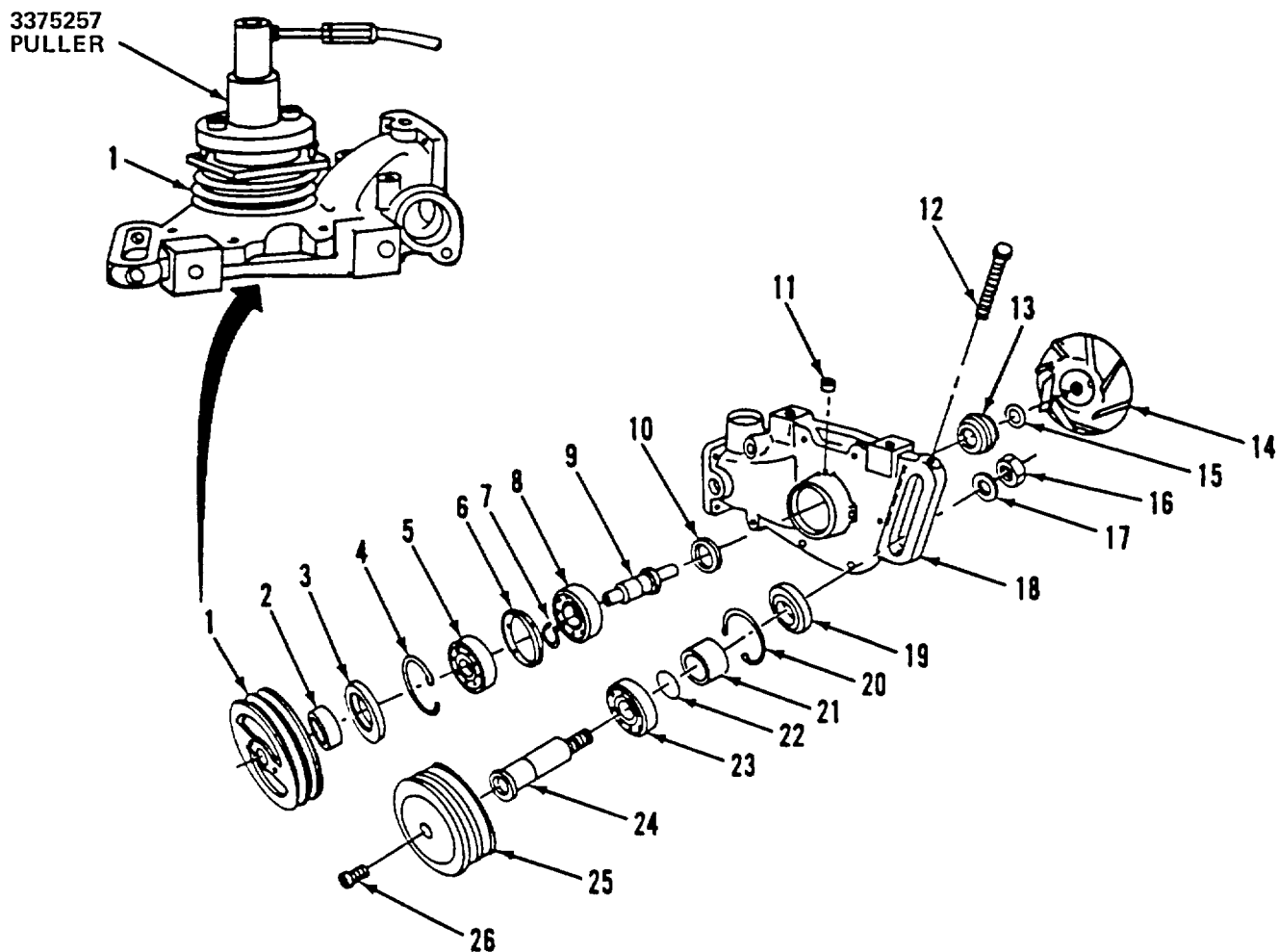
- k. Inspect water pump housing for cracks and damage from possible bearing spinning.



TA295519

- l. Measure housing bore. If larger than 2.4494 in. (62.2147 mm), replace housing.

3-92. REASSEMBLE IDLER PULLEY



LEGEND:

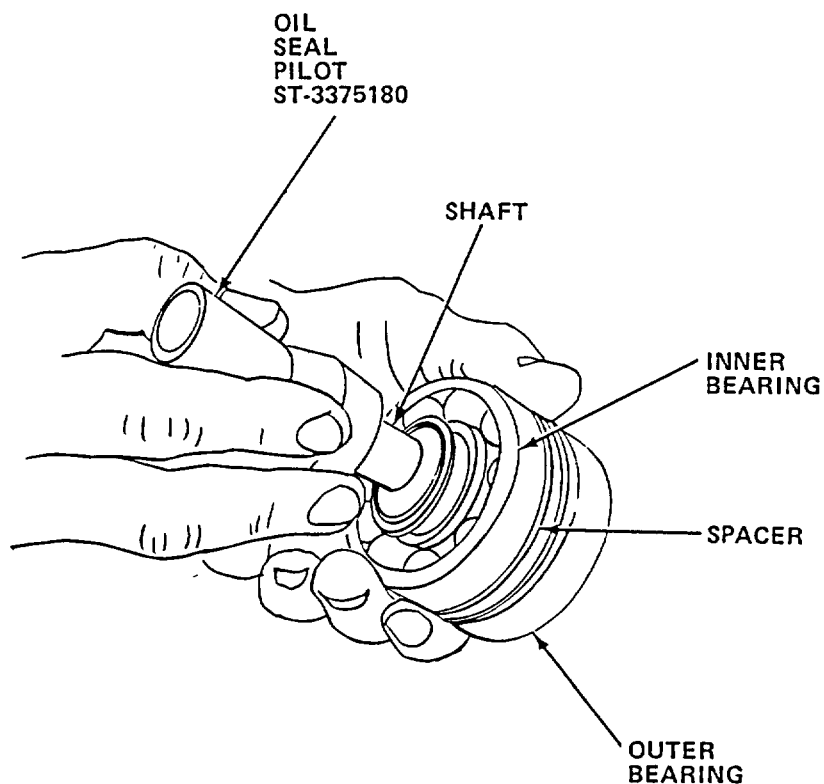
- | | |
|---------------------------|------------------------|
| 1. Pulley, Water Pump | 14. Impeller |
| 2. Sleeve | 15. Cup seat |
| 3. Grease Seal (Front) | 16. Locknut |
| 4. Retaining Ring - Large | 17. Washer |
| 5. Outer Bearing | 18. Water Pump Housing |
| 6. Spacer | 19. Grease Seal |
| 7. Retaining Ring - Small | 20. Retaining Ring |
| 8. Inner Bearing | 21. Spacer |
| 9. Water Pump Shaft | 22. O-ring |
| 10. Grease Seal (Rear) | 23. Bearing |
| 11. Pump Cavity Pipe Plug | 24. Idler Shaft |
| 12. Adjustment Screw | 25. Idler Pulley |
| 13. Face Seal | 26. Plug |

- a. Lubricate idler shaft (24) bearing surface and press shaft into new bearing (23).
- b. Apply thin coat of sealant to bearing (23) outer race.

- c. Press shaft and bearing-assembly into pulley (25) until bearing (23) bottoms in bore.
- d. Install retaining ring (20) (beveled side up) into groove in pulley (25).
- e. Install grease fitting into hole in face of pulley.
- f. Pump in grease, MIL-G-3545, until grease appears through bearing.
- g. Remove grease fitting and install plug (26).
- h. With lip side down, press new grease seal (19) into pulley bore until flush with top of pulley.
- i. Lubricate new O-ring (22) and install O-ring (22) into groove on idler shaft (24).
- j. Place spacer (21) over shaft (24) and slide over O-ring (22) until spacer bottoms on bearing (23).

3-93. REASSEMBLE WATER PUMP

- a. Using ST-1191 seal driver, with seal lip towards driver, press rear grease seal (10) into water pump housing bore until seated. Seal is inserted through front bore of housing.
- b. Lubricate water pump shaft (9) bearing surface.
- c. Using ST-658 bearing mandrel, press pulley end of shaft (9) through inner bearing (8) until shaft shoulder seats tight against bearing race.
- d. Install small retaining ring (7) on shaft (9) securing inner bearing (8).
- e. Support outer bearing (5) on ST-658 bearing mandrel.
- f. Place bearing spacer (6) on shaft (9).
- g. Press shaft assembly through outer bearing (5) until spacer (6) seats firmly against bearings. Ensure that both bearings turn freely.



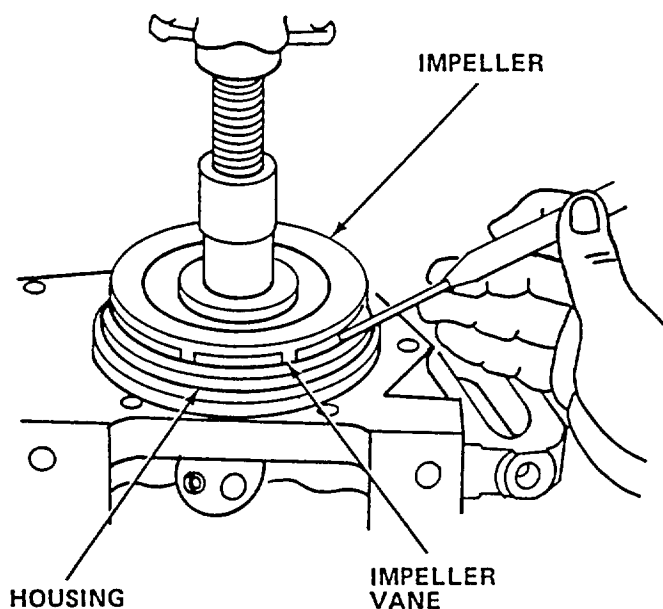
TA295521

- h. Slide tool no. 3375180 oil seal pilot onto impeller end of shaft.
- i. Apply thin coat of sealant to outer races of bearings (5 and 8).
- j. With ST-658 bearing mandrel, insert bearings and shaft assembly into water pump housing bore and press into housing until seated.
- k. Remove oil seal pilot from impeller end of shaft.
- l. Install large retaining ring (4) (with beveled side up) inside housing groove against bearing.
- m. Remove pipe plug (11) from pump housing (18) and install grease fitting.

CAUTION
DO NOT OVERFILL CAVITY. BEARING OVERHEATING AND FAILURE MAY RESULT.

- n. Pump grease MIL-G-3545 into cavity until it first appears at outer bearing.
- o. Using ST-1191 seal driver, press front grease seal (3), with seal lip toward bearing into pump housing (18) until flush with face of bore.
- p. Turn housing over.

- q. Apply sealant to outside diameter of brass case of face seal (13).
- r. Using 375448 mandrel, press seal (13) into housing (18) until seal bottoms out.
- s. Using no. 3375448 mandrel, press new cup seat (15) into place on shaft (9).
- t. Apply thin coat of sealant in pulley bore and place pulley (1) face down on press.
- u. Center pump assembly shaft in pulley bore and press shaft in-to pulley until end of shaft is flush with pulley face.



TA295522

- v. Apply thin coat of sealant in impeller (14) bore and press impeller on shaft (9) maintaining clearance between impeller vane and housing of 0.020 - 0.040 in. (0.508 - 1.076 mm).
- w. Insert idler pulley assembly shaft into pump housing slot and install adjustment screw (12), washer (17), and nut (16). Leave nut loose.
- x. Remove grease fitting from pump housing bearing cavity and reinstall pipe plug (11).
- y. Wipe exterior clean and plug all openings.

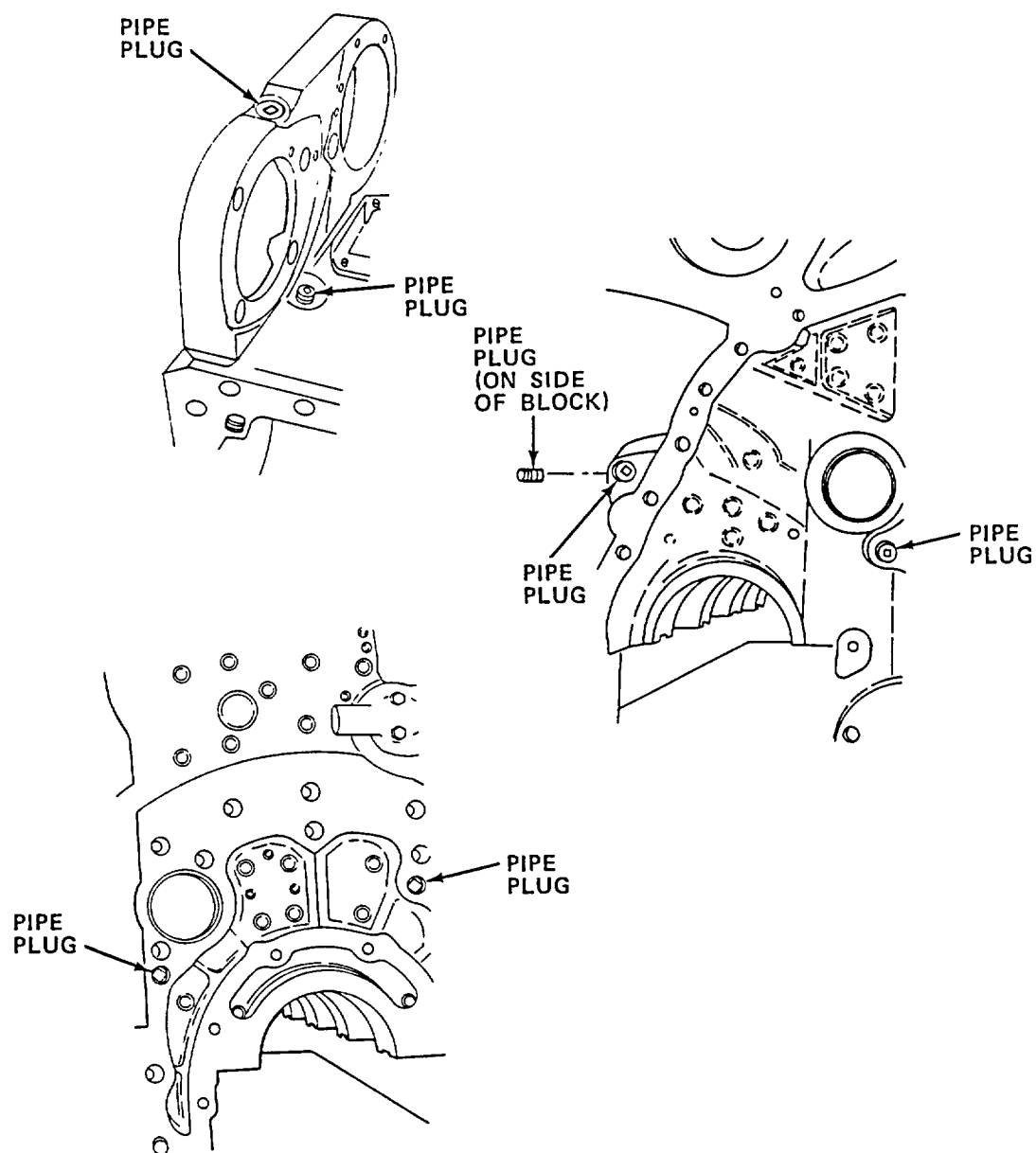
Section XXXI. ENGINE REASSEMBLY**3-94. ASSEMBLY CYLINDER BLOCK****NOTE**

During assembly, carefully inspect all components to ensure nothing has been overlooked during inspection and repair. Plugs should be checked for tightness, parts kept clean, openings covered to prevent foreign object entry, and machined surfaces protected.

Deviations from certain procedures as set forth in this section, may be necessary for convenience. If so, just locate particular assembly paragraph and follow directions given. For example, some shops may prefer to install crankshaft before cylinder liners.

- a. Secure cylinder block to engine stand.

b. Install pipe plugs.



TA295523

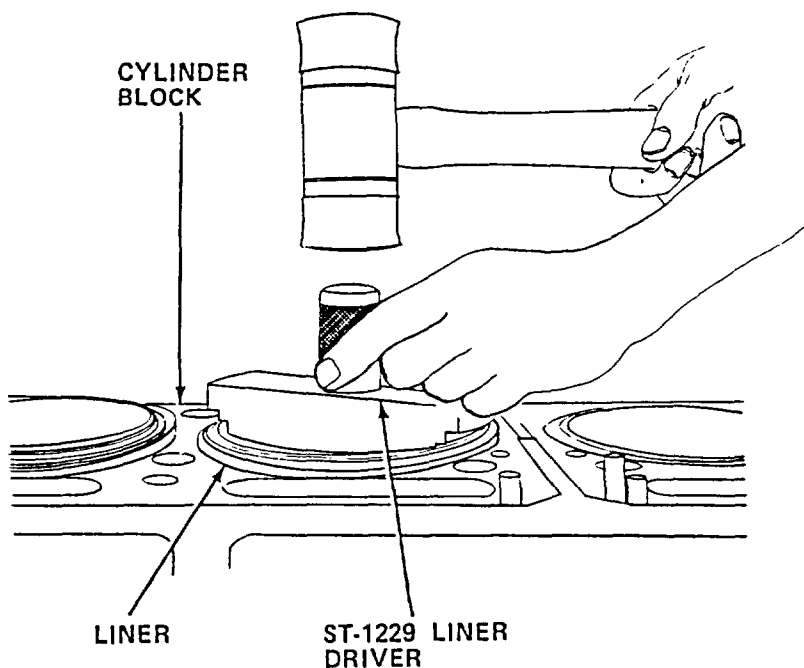
- (1) Apply no. 3375066 thread sealant to cylinder block pipe plugs.
- (2) Install plugs and torque to 60 - 70 ft lbs (81 - 95 N•m).

- c. Install cylinder liners.

CAUTION

TO PREVENT SWELLING OF O-RINGS AND POSSIBLE DISLODGING UPON LINER INSTALLATION APPLY COAT OF HIGH TEMPERATURE GREASE TO RINGS JUST BEFORE THEIR INSTALLATION.

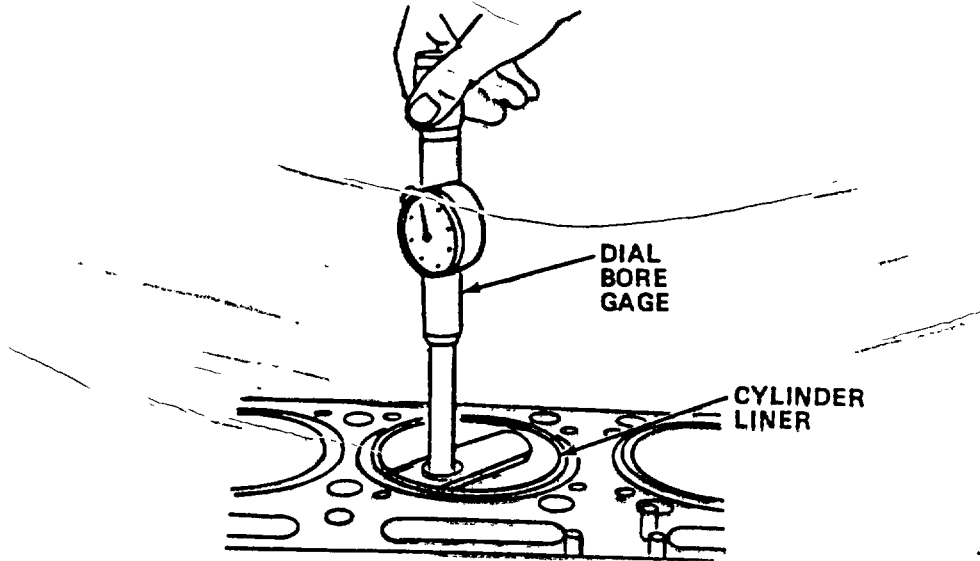
- (1) Lightly lubricate crevice and O-rings with engine oil.
- (2) Carefully slide crevice seal into top groove of liner.
- (3) Carefully roll black O-ring with yellow stripe into center groove.
- (4) Carefully roll red O-ring with two blue stripes into bottom groove.
- (5) Remove any twists from crevice seal and O-rings.
- (6) Wipe upper and lower cylinder block counterbores clean.
- (7) Lubricate cylinder block-to-liner mating surfaces in block with high temperature grease.
- (8) Place liner with shim(s) (if used) in block by hand being careful not to dislodge O-rings and crevice seal.



TA295524

- (9) Place ST-1229 liner driver squarely in liner and seat liner with swift solid blow with softface hammer. Liner will snap into place.

- (10) Using ST-1184 clamps and tool no. 3376220 gage block, recheck liner protrusion.



TA295525

- (11) With dial bore gage, measure inside diameter at several points of liner within range of piston travel to determine if out-of-round.
- (12) If liner is more than 0.002 in. (0.050 mm) out-of-round in crevice seal/ O-ring area, remove liner and check for causes of distortion.
- (13) If liner is more than 0.003 in. (0.076 mm) out-of-round at top one inch (25.4 mm) of liner, remove liner and check for causes of distortion.

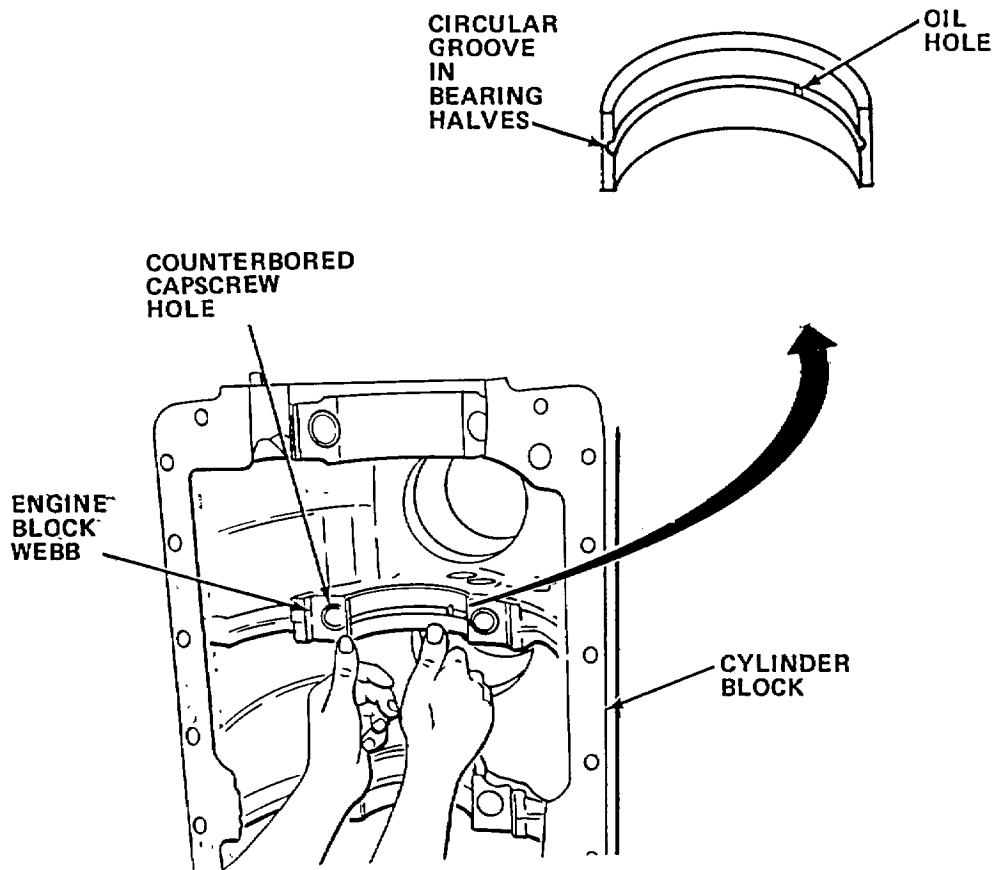
d. Install crankshaft and main-bearings.

- (1) Turn cylinder block upside down.
- (2) Wipe main bearing bores, caps, and bearing halves clean.

NOTE

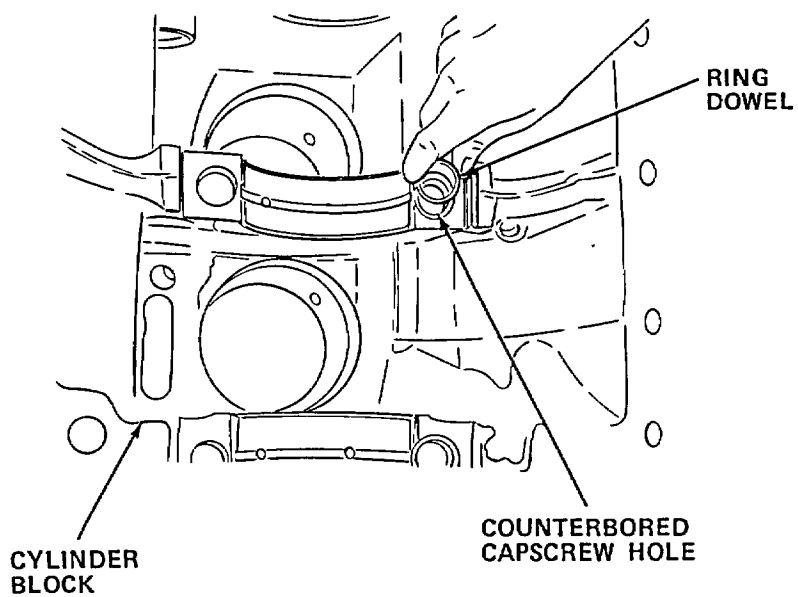
- **Main bearing caps on 1980 and 1982 models have 1 in. diameter bolts with a lockplate; 1984 models have 3/4 in. bolts with washers. (Refer to paragraph 3-6.m for torque requirements.)**
- **Upper main bearing halves are grooved and drilled to provide oil flow into halves. Bearing halves numbers 1, 3, and 5 are alike and numbers 2, 4, and 6 are alike. Number 7 has oil groove and hole off-center. That bearing is installed with its wide portion toward flywheel end of block.**

- (3) Thoroughly coat upper main bearing halves with engine oil.



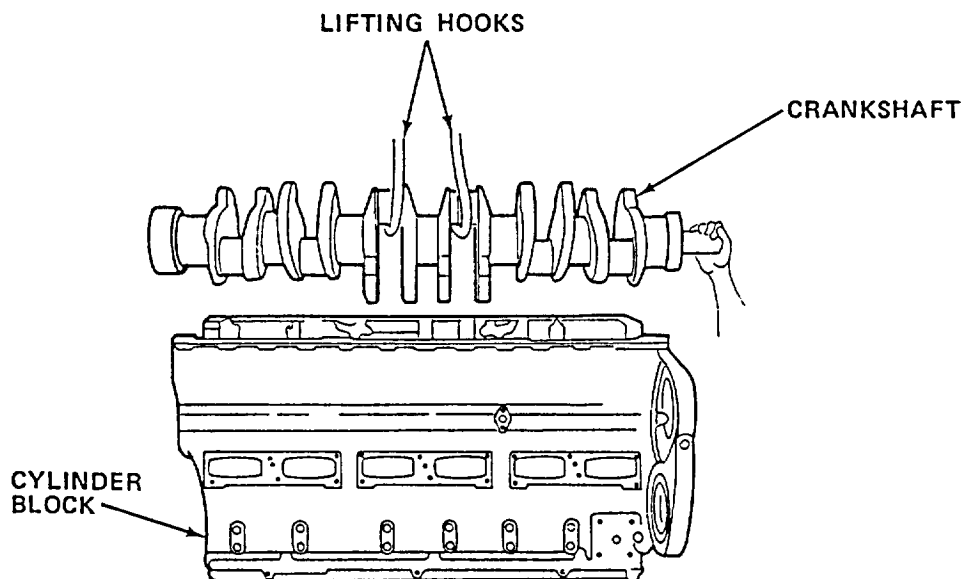
TA295526

- (4) Install upper main bearing half into cylinder block webb and ensure that oil holes are properly aligned.



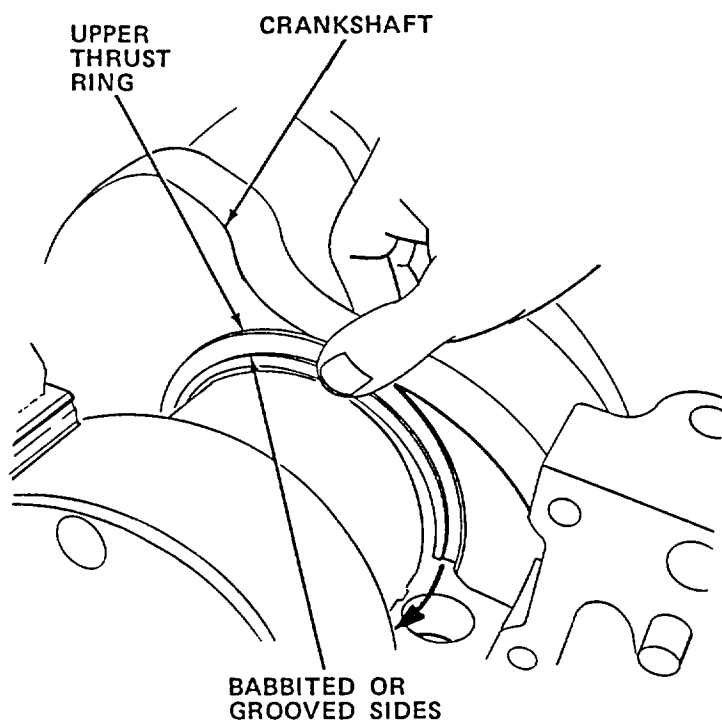
TA295600

- (5) Install new ring dowels in counterbored capscREW holes.



TA295527

- (6) Lift crankshaft in position using hooks protected with rubber hose or a rope sling at two crank throws.
- (7) Carefully lower crankshaft in position and remove lifting device.
- (8) Check rear counterweight of crankshaft to see if oversize thrust rings are to be used and where installed; front or rear. Counterweight is stamped to provide that information.



TA295599

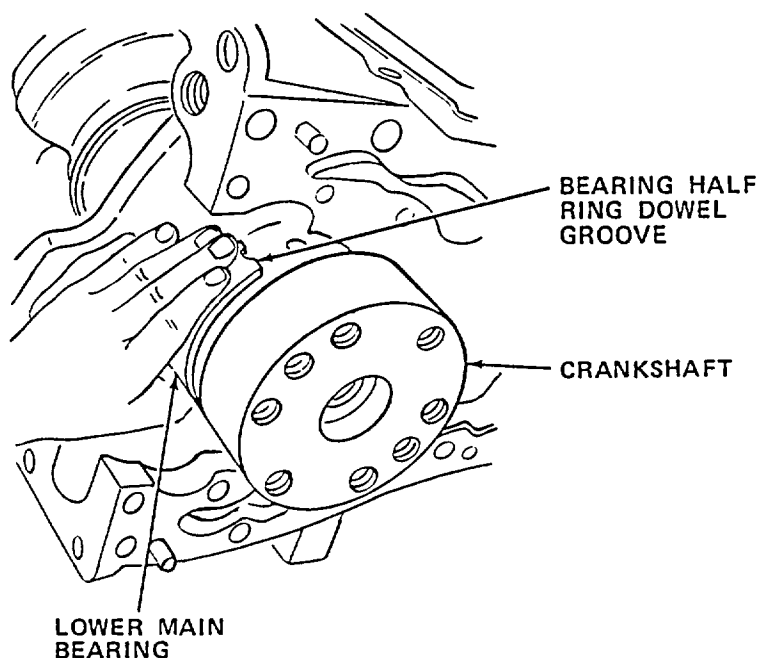
- (9) Coat upper thrust rings with engine oil.

- (10) With babbitted or grooved sides of upper thrust rings next to crankshaft flange, slide rings into position. Upper rings are not dowel pinned to block.

NOTE

Lower main bearing halves are plain with no grooves or oil holes.

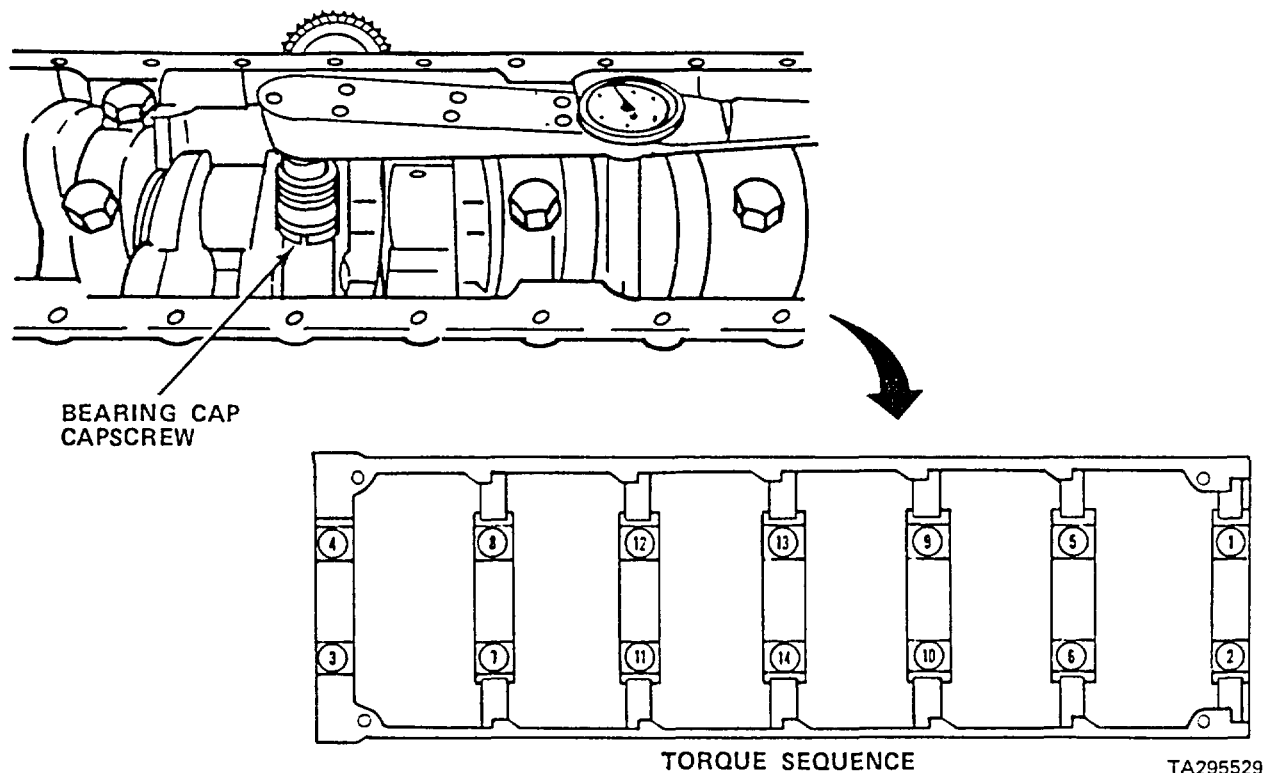
- (11) Coat lower main bearing halves and crankshaft journal with engine oil.



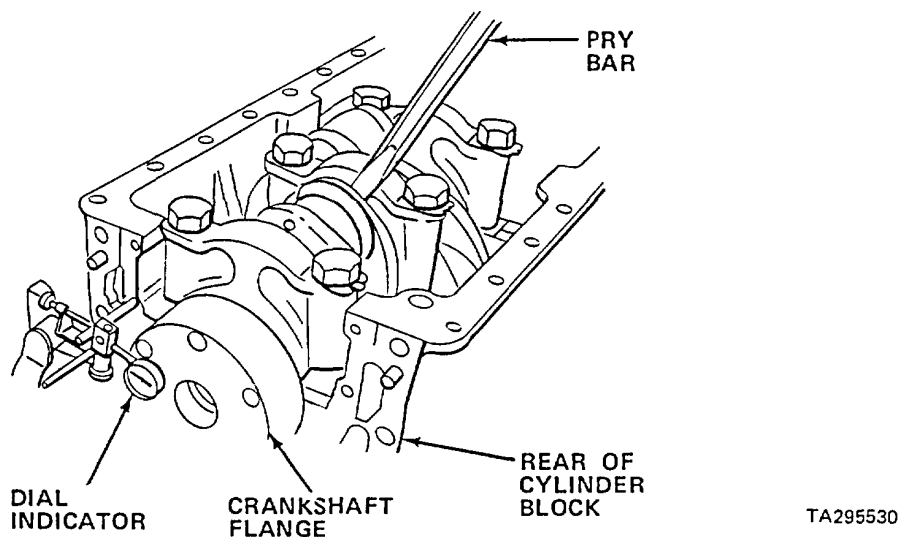
TA295528

- (12) Aline bearing halves with ring dowel and snap in opposite side.
- (13) Check threads in cylinder block bearing webs for foreign matter and excess oil. Excess oil must be removed to prevent hydraulic lock.
- (14) Install lower thrust rings over dowels of no. 7 main bearing cap.
- (15) Install main bearing caps with numbers corresponding to those stamped on camshaft side of block. Use rubber mallet to seat caps.
- (16) Install lockplates and bearing cap capscrews.

(17) Tighten capscrews alternately, slowly, and evenly to properly seat and secure caps in position. Torque capscrews as follows:

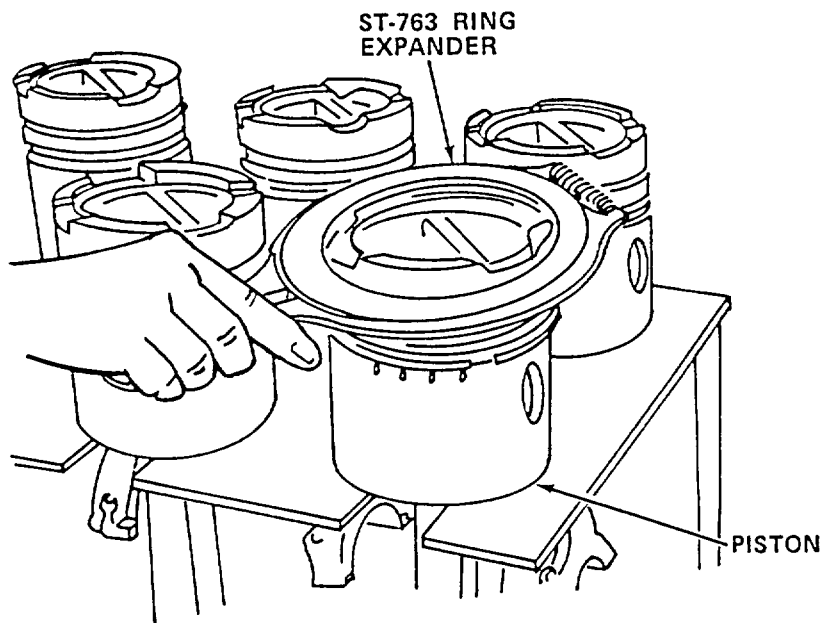


- (a) Torque each capscrew in sequence as shown, 85 ft lbs (115 N•m), at a time until each capscrew is torqued to 300-310 ft lbs (407 - 420 N•m).
- (b) Loosen each capscrew a minimum of 3 turns and repeat step 17 (a).



(18) Secure dial indicator to rear of cylinder block with indicator contact point acting against end face of crankshaft flange.

- (19) With pry bar, carefully pry crankshaft towards front of engine.
 - (20) Remove pry bar.
 - (21) Set dial indicator at 0.
 - (22) Pry crankshaft toward rear of engine.
 - (23) Observe indicator reading. Total reading should be 0.07 0.0017 in. (0.177 0.431 mm) with new crankshaft and thrust rings.
 - (24) If reading is less than 0.007 in. (0.177 mm):
 - (a) Loosen all bearing cap capscrews slightly
 - (b) Shift crankshaft first toward front then toward rear of engine
 - (c) Retorque capscrews as described in step (17) above.
 - (d) Recheck crankshaft end play clearance.
 - (25) If reading more than 0.022 in. (0.558 mm), crankshaft must be reworked or oversize thrust rings must be used.
 - (26) Bend lockplate tabs over capscrews and bearing caps.
- e. Install connecting rods and pistons.

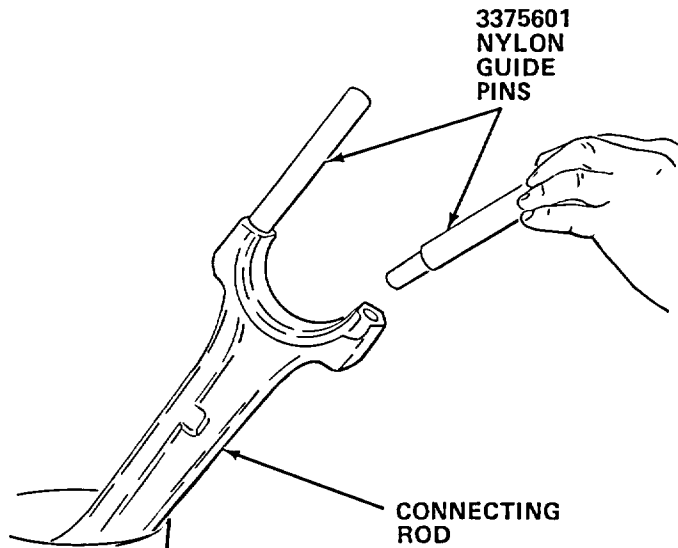


TA295531

CAUTION

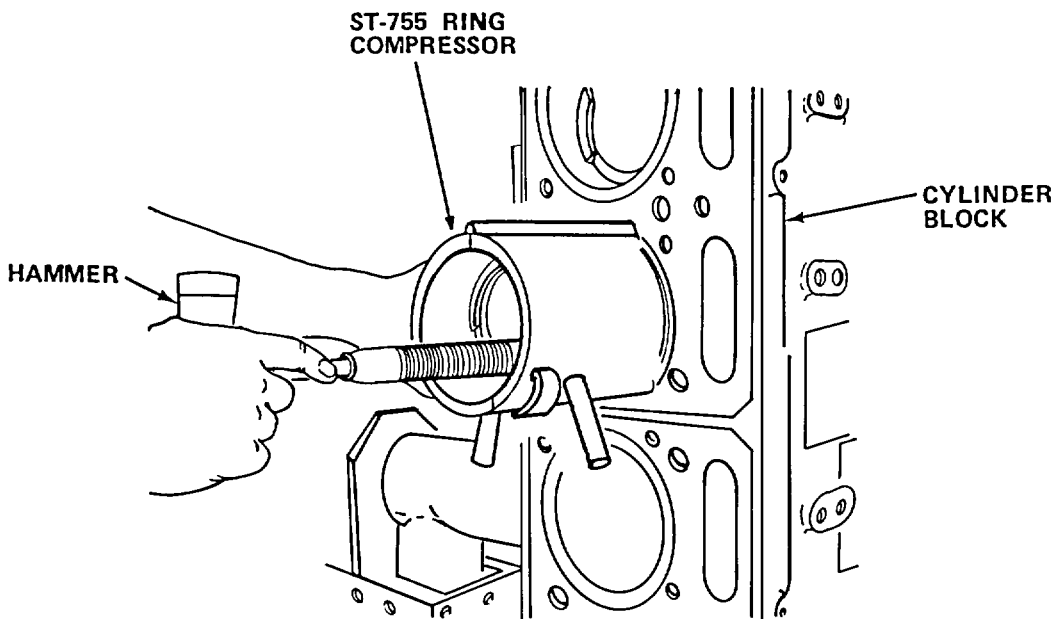
OVER-EXPANDING A PISTON RING CAN CAUSE DISTORTIONS WHICH COULD LEAD TO RING FAILURE AND ENGINE DAMAGE.

- (1) With word "TOP" on oil control ring facing upward, set new ring in ST-763 ring expander.
- (2) Expand ring only enough to slide over piston into lower groove.
- (3) Slide ring in position. Be sure ring face is flush with ring land.
- (4) Remove ring expander and install remaining new rings.
- (5) Stagger ring gap so they are not in line with each other or with piston pin.
- (6) Rotate cylinder block to vertical position.
- (7) Rotate crankshaft so that crankshaft throw for connecting rod and piston being inserted is at bottom center position.
- (8) Remove connecting rod cap. Keep cap with its mated connecting rod.
- (9) Lubricate liner with engine oil.
- (10) Dip piston and ring assembly in engine oil.
- (11) Slide 3375162 piston ring compressor over rings and compress rings.
- (12) Coat connecting rod bearing upper half with engine oil.
- (13) Install rod bearing upper half on connecting rod assembly.
- (14) Lubricate and install lower rod bearing half into rod cap.



TA295532

- (15) Install tool no. 3375601 nylon guide pins into connecting rods.
- (16) With bearing tang facing camshaft side of block, insert piston and rod assembly into cylinder.



TA295533

CAUTION

ENSURE THAT LOWER BAND OF RING COMPRESSION TOOL DOES NOT SLIP DOWN AND BIND PISTON. RINGS MAY BREAK.

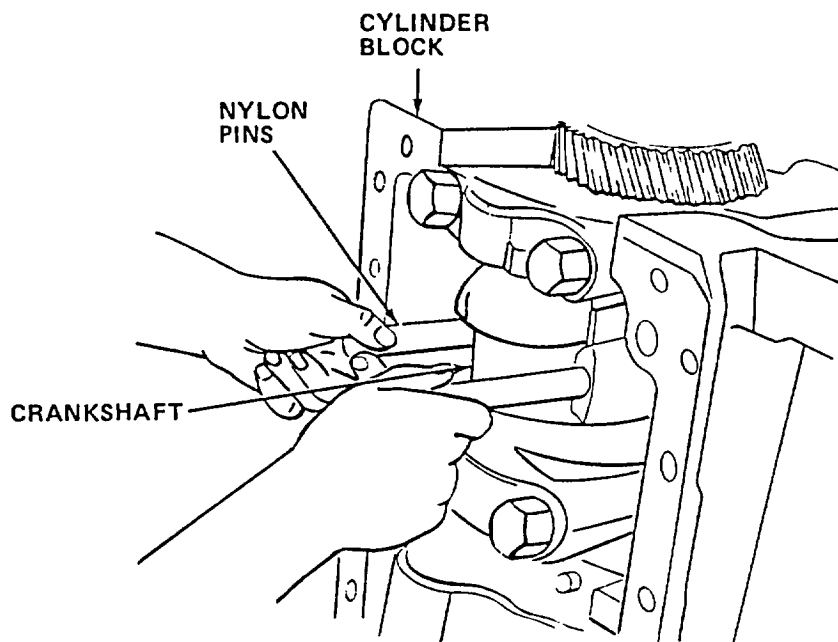
NOTE

Two persons should be used for the following step.

- (17) Carefully push piston and rod assembly through ring compressor until rings are in liner. Guide nylon guide pins around crankshaft journal as piston is pushed into liner.
- (18) Remove compression tool.

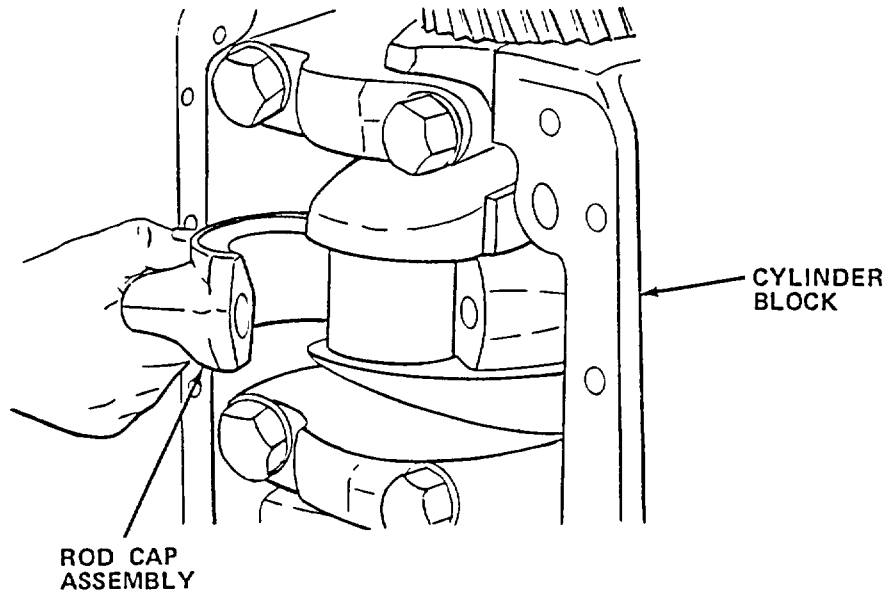
CAUTION

DO NOT FORCE PISTON ASSEMBLY INTO LINER. IF PISTON DOES NOT INSTALL FREELY INTO LINER, REMOVE ASSEMBLY AND CHECK FOR BROKEN RINGS.

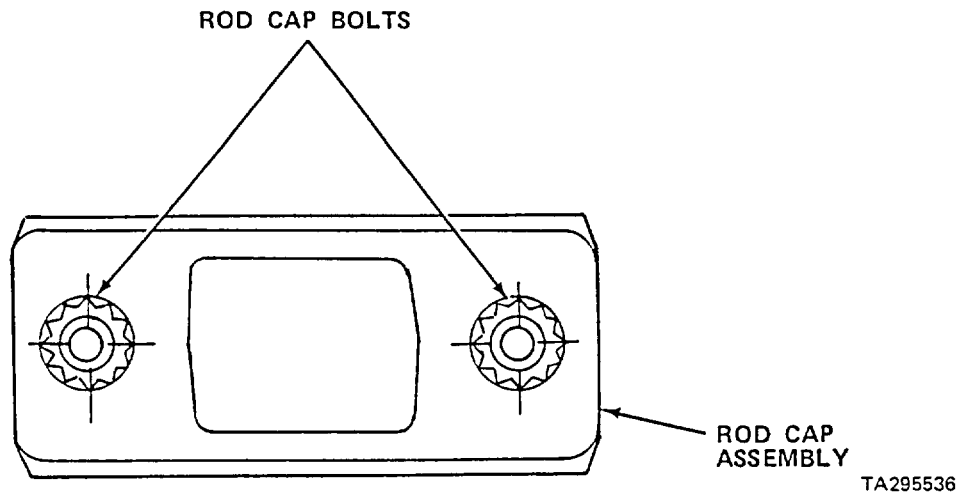


TA295534

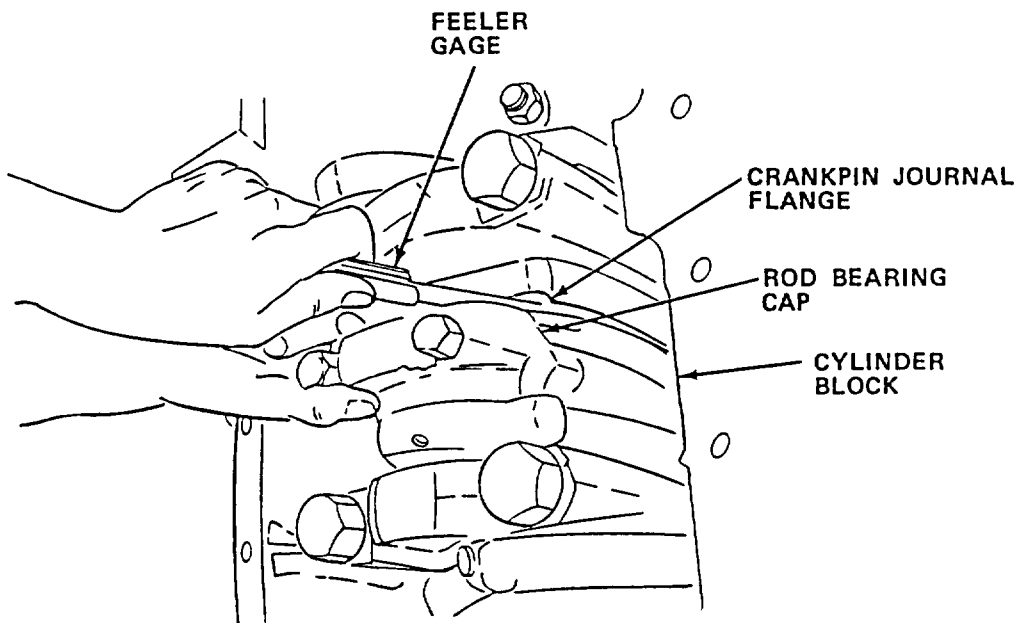
- (19) Continue pushing piston into liner until rod bearing seats on crankshaft journal. Seat by pulling on nylon pins.
- (20) Remove guide pins.



- (21) Install rod cap assembly with tang side of cap matching tang side of rod.
- (22) Lightly lubricate rod cap retaining bolts with SAE 30 oil.



- (23) Torque bolts alternately in sequence and evenly to pull cap to rod as follows:
- (a) Torque to 70 - 75 ft lbs (95 - 102 N•m)
 - (b) Advance to 140 - 150 ft lbs (190 - 203 N•m)
 - (c) Loosen all completely
 - (d) Torque to 25 - 30 ft lbs (34 - 41 N•m)
 - (e) Advance to 70 - 75 ft lbs (95 - 102 N•m)
 - (f) Advance to 140 - 150 ft lbs (190 - 203 N•m)
- (24) Move rod sideways on journal with hand pressure.
- (25) If rod is not free, remove cap and check for improper bearing size (as stamped on forward counterweight), burrs, dirt, etc.



TA295537

- (26) With feeler gage, check connecting rod side clearance. Clearance must be no less than 0.0045 in. (0.1143 mm) or more than 0.013 in. (0.323 mm).
- (27) If clearance incorrect, remove affected piston and rod assembly and investigate for cause.
- (28) Rotate engine to upright position.

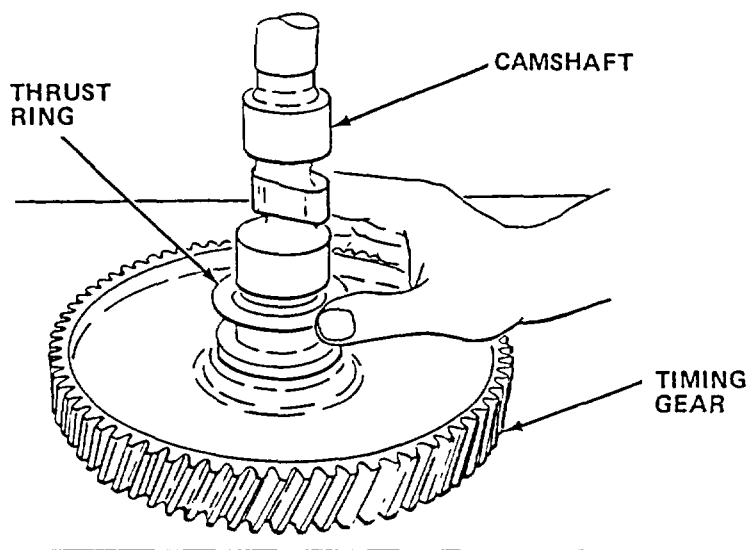
f. Install camshaft and year.

- (1) Coat cup plug with sealant no. 375068.

CAUTION

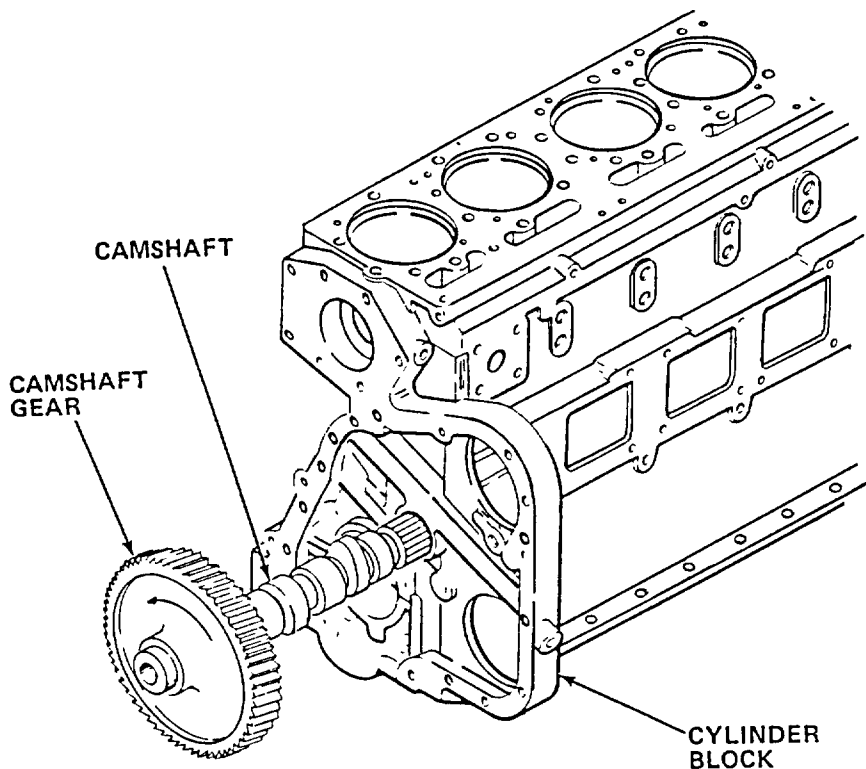
DO NOT USE SOCKET AS DRIVER. CUP MAY BE DRIVEN TOO DEEP, BLOCKING OFF OIL DRAIN HOLE. ENGINE FAILURE MAY RESULT.

- (2) Using tool no. 3375708 cup plug driver, install new cup plug in cam bore at rear face of cylinder block. Flange on driver prevents driver from pushing cup plug too deeply into cylinder block.



TA295538

- (3) Coat both sides of thrust ring with high-pressure lubricant.
- (4) With oil grooved face of thrust ring (washer) facing toward camshaft timing gear, install ring on camshaft.
- (5) Lubricate camshaft with retaining compound.

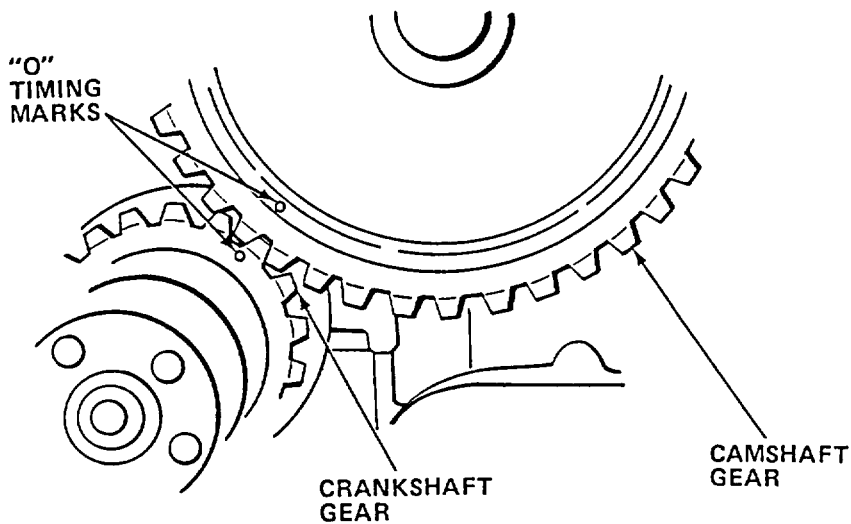


TA295539

NOTE

An assistant is needed to perform following step.

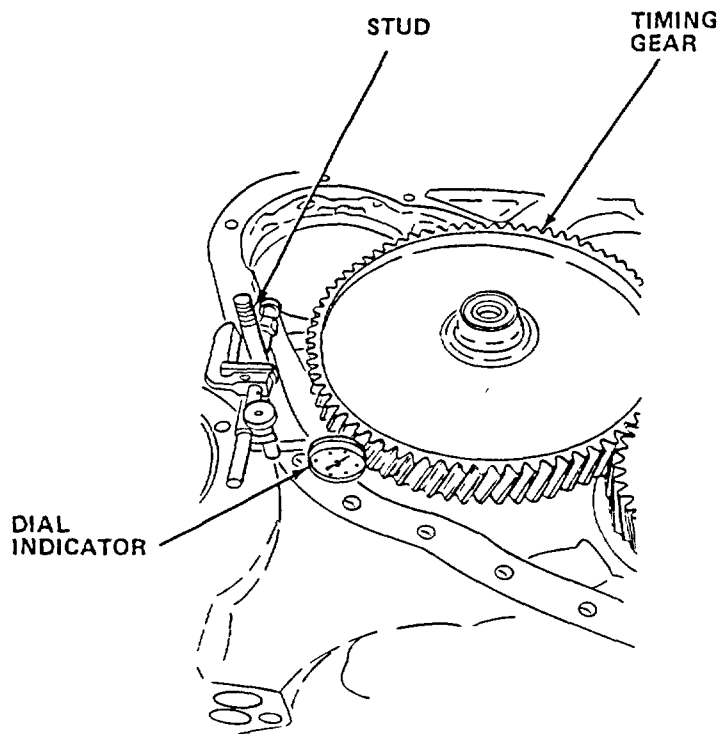
- (6) Carefully insert camshaft into cylinder block, slowly rotating shaft as it slides into block.



TA295540

- (7) Rotate crankshaft so that "0" timing mark on crankshaft gear aline with "0" timing mark on camshaft gear.

- g. Measure crankshaft gear to camshaft gear backlash.



TA295541

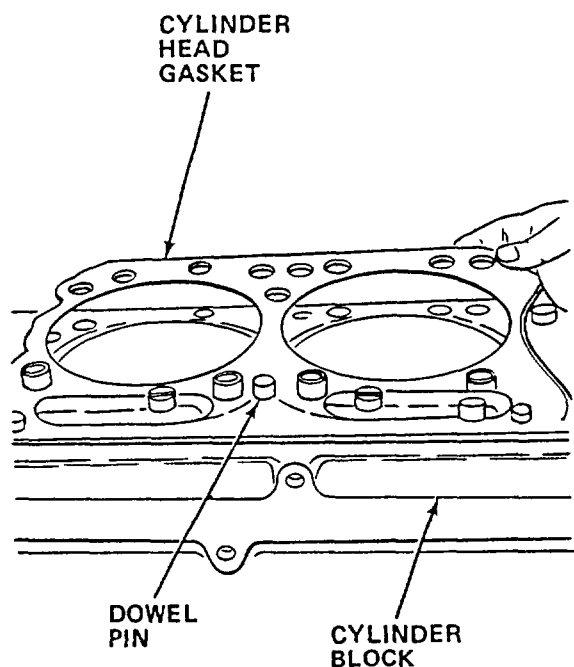
- (1) Screw stud into tapped hole above camshaft timing gear.
- (2) Secure dial indicator to stud. Position indicator pin against face of tooth on gear.
- (3) Rotate camshaft gear as far as it will move to the right.
- (4) While holding gear in place, zero dial indicator.
- (5) Rotate gear in opposite direction until it stops.
- (6) Read indication. Normal backlash is 0.0045 to 0.0105 in. (0.1143 to 0.2667 mm) on a new gear. Minimum backlash is 0.002 in. (0.05 mm).
- (7) Gears will rattle if backlash exceeds 0.010 in. (0.254 mm). If noise is not objectionable, continue gears in service.
- (8) If backlash exceeds 0.020 in. (0.508 mm), replace both gears.

h. Install cylinder heads.

- (1) Wipe head gasket mating surfaces clean.

NOTE

Use gasket with standard white grommets, 0.097 0.103 in. (2.463 2.616 mm) thick, if water holes are free of erosion. Use black grommets, 0.107 0.113 in. (2.717 2.870 mm) thick, if there is evidence of erosion. No special grommet retainers are used.



TA295542

- (2) Install new head gasket over dowel pins so word "TOP" on gasket is visible.

CAUTION

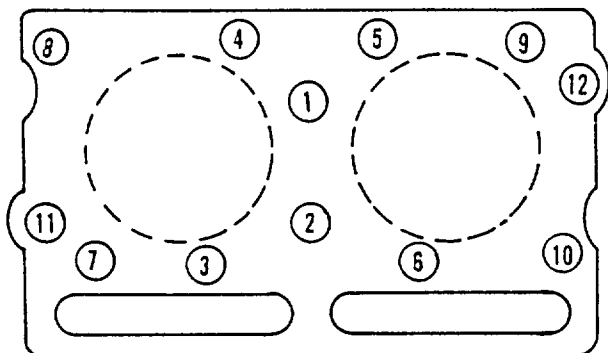
CYLINDER HEAD BOLTS MUST HAVE LETTERS "NT" FORGED ON THEIR HEADS. DO NOT USE ANY SUBSTITUTE BOLTS WHICH MAY BREAK UNDER HIGH HEAT LOAD.

- (3) Lubricate entire cylinder head bolt with rust preventive lubricant. Make sure to allow excess lubricant to drip from bolt.
- (4) Install two guide studs in block.

(5) Slide cylinder head over guide studs and seat head on gasket.

(6) Remove guide studs.

CYLINDER HEAD BOLTS TORQUE SEQUENCE

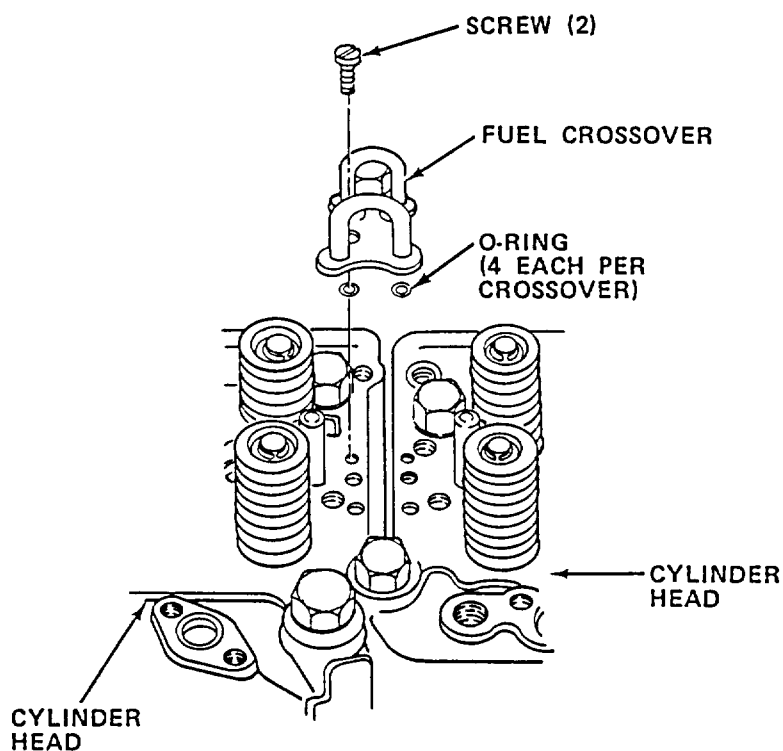


STEP	TORQUE (FT LBS) (N.M)
1	25 (34)
2	50-100 (68-136)
3	180-200 (244-271)
4	280-300 (380-407)

TA295543

(7) Install washers and head bolts. Torque head bolts in sequence as shown.

(8) Install remaining cylinder heads.



TA295544

(9) Install new O-rings on cylinder heads and position fuel crossovers O-rings.

- (10) Secure crossovers with slotted-head screws.
- (11) With screwdriver adapter, torque screws to 34 - 38 in. lbs (3.8 - 4.3 N•m).

i. Install cam follower housing assemblies.

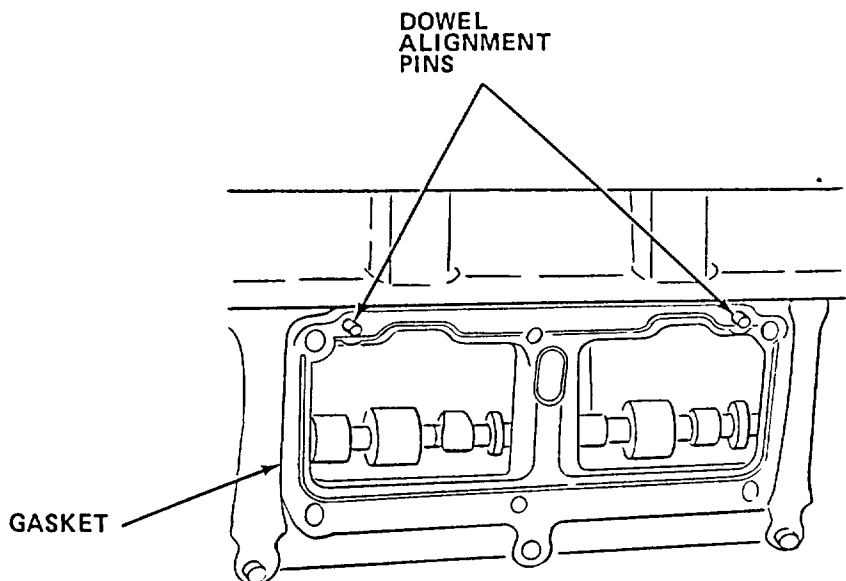
NOTE

It may be necessary to add or remove gaskets to obtain correct injector timing.

- (1) Assemble number of new gaskets to equal thickness of old gasket(s) removed. That thickness should have been recorded during engine disassembly.

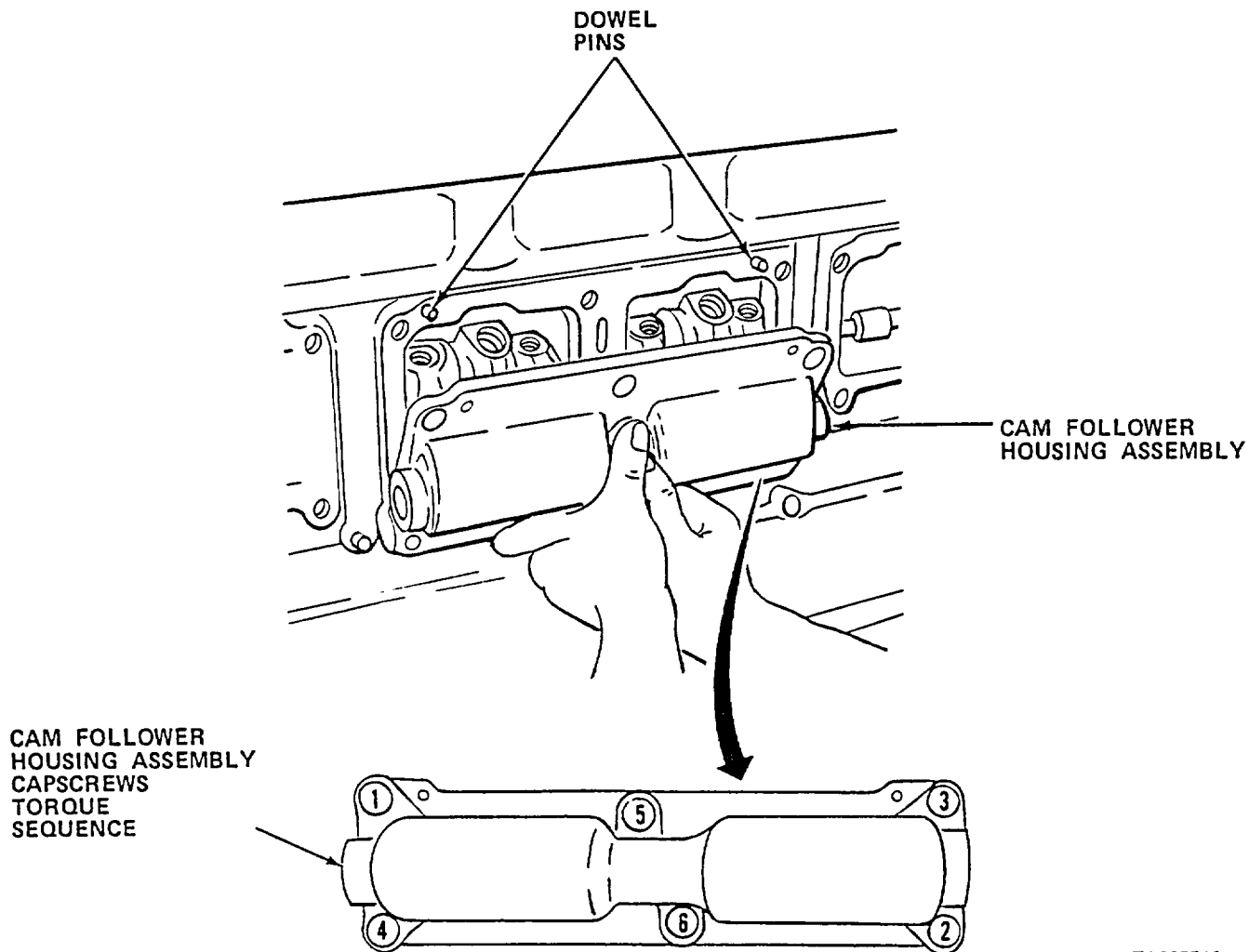
NOTE

Ensure that raised portion of print-o-gasket seal faces toward follower housing.



TA295545

- (2) Install new gasket(s) over dowel alignment pins. Raised sealing portion of gasket must face out.



- (3) Install cam follower housing assembly in position on block over dowel alignment pins.
- (4) Torque cap screws in sequence shown in increments of 15 ft lbs (10 N•m) to final torque of 30 - 35 ft lbs (41 - 47 N•m).

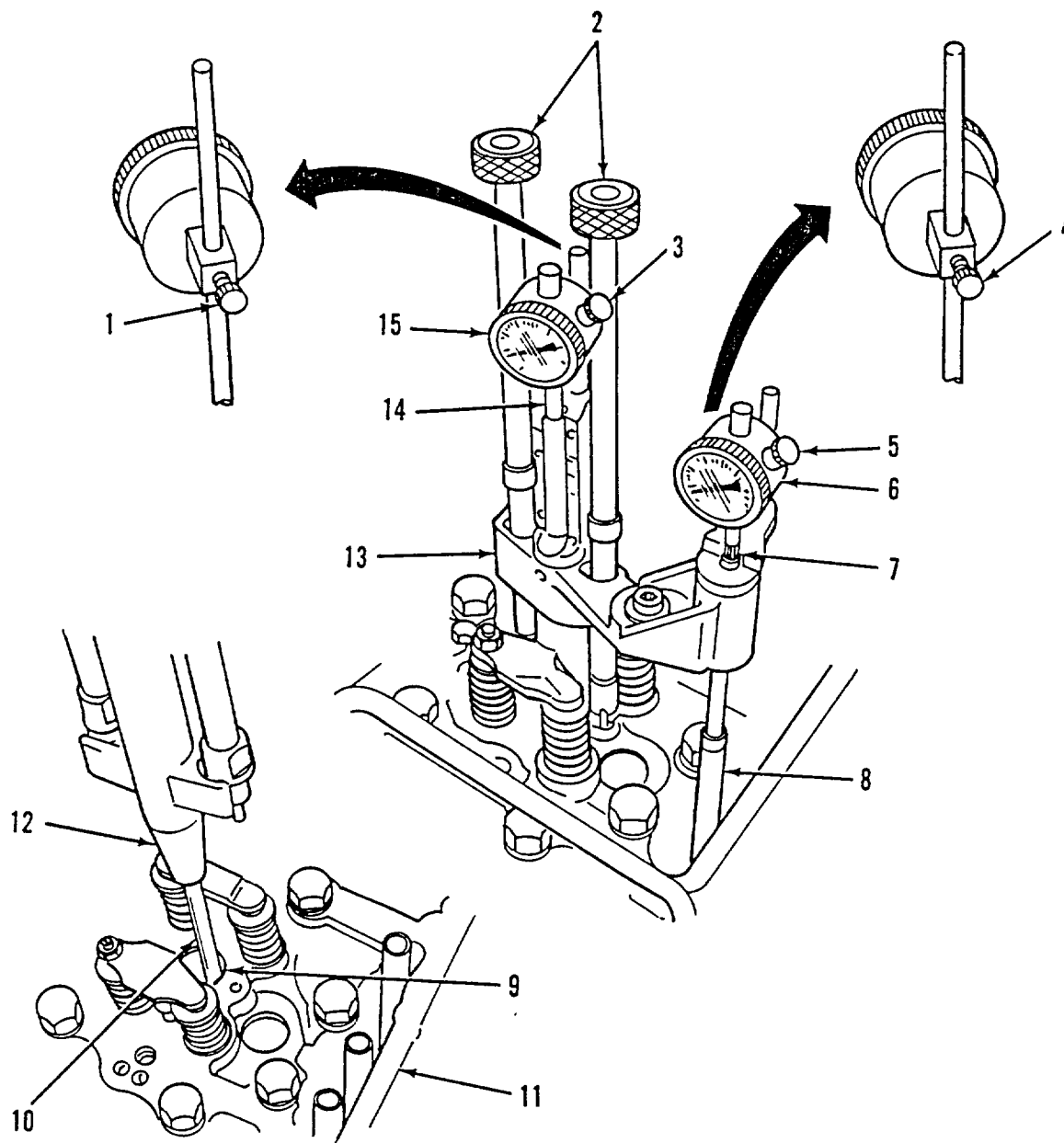
NOTE

Injector push tube is largest and fits in middle socket. Intake and exhaust tubes are identical.

- (5) Install all push tubes.

j. Time no. 1 cylinder injector

(1) Install timing fixture tool no. 3375522.



TA295547

LEGEND:

- | | |
|---------------------------------------|--------------------------------|
| 1. PISTON DIAL INDICATOR SETSCREW | 9. INJECTOR SLEEVE |
| 2. KNURLED HOLDDOWN (2) | 10. PISTON FOLLOWER ROD |
| 3. PISTON DIAL INDICATOR THUMBSCREW | 11. CYLINDER HEAD |
| 4. PUSH ROD DIAL INDICATOR SETSCREW | 12. TIMING FIXTURE SLEEVE |
| 5. PUSH ROD DIAL INDICATOR THUMBSCREW | 13. INJECTION TIMING FIXTURE |
| 6. PUSH ROD DIAL INDICATOR | 14. PISTON DIAL INDICATOR STEM |
| 7. PUSH ROD DIAL INDICATOR STEM | 15. PISTON DIAL INDICATOR |
| 8. INJECTOR PUSH ROD | |

(a) Position timing fixture sleeve (12) in injector sleeve (9) of no. 1 cylinder.

NOTE

BE SURE INJECTION TIMING FIXTURE (13) IS MOUNTED STRAIGHT ON CYLINDER HEAD (11).

- (b) Secure fixture to top threaded holes with two knurled hold downs (2).
- (c) Loosen setscrews (1) and (4) of piston dial indicator and push tube dial indicator.

CAUTION

INDICATORS MUST BE RAISED TO HIGHEST LEVEL TO PREVENT THEIR DAMAGE WHEN ATTEMPTING TO LOCATE TOP DEAD CENTER.

- (d) Slide both indicators (6) and (15) to their upper most position and tighten setscrews (1) and (4).
- (2) Perform timing procedure.

CAUTION

INJECTION TIMING FOR NO. 1 CYLINDER REQUIRES THAT NO. 1 PISTON BE SET AT TOP DEAD CENTER. TOP DEAD CENTER WILL OCCUR DURING THE COMPRESSION STROKE AND THE EXHAUST STROKE. INJECTION TIMING IS TO BE PERFORMED WHEN PISTON IS AT TOP DEAD CENTER OF COMPRESSION STROKE.

NOTE

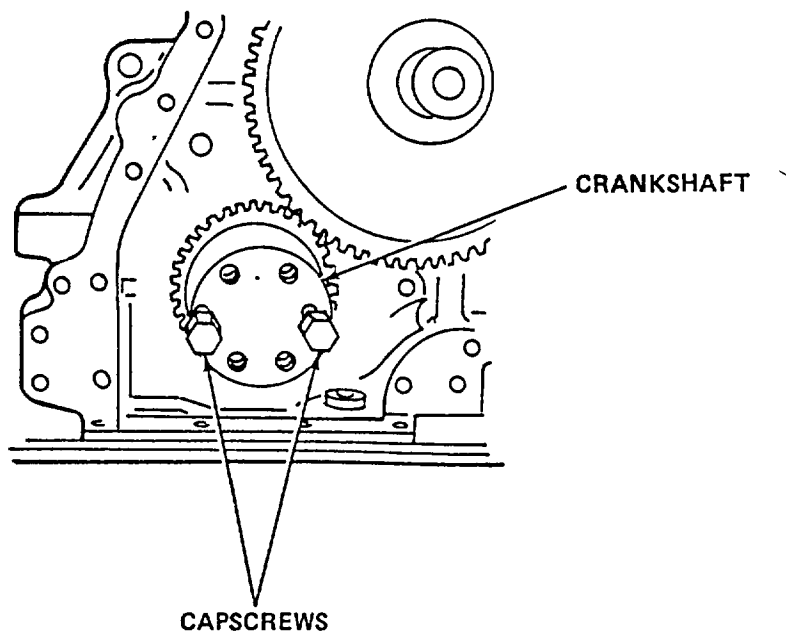
Adjustments to injection timing are made by altering the thickness of cam follower gaskets.

The injection timing may be advanced or retarded by adding or removing cam follower gaskets.

Use cylinders no. 1, 5, and 3 to check injection timing.

Dial indicators used in injection timing must have a total travel of at least 0.250 in. (6.35 mm).

Be sure to push camshaft in every time crankshaft is rotated.

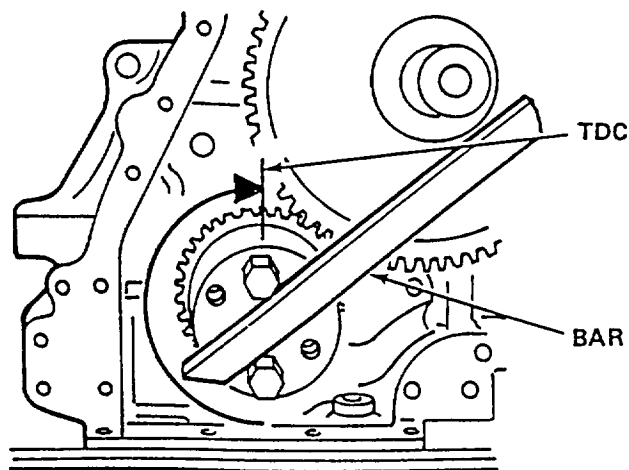


TA295548

- (a) Install two hex head capscrews into front of crankshaft. These capscrews will be used to rotate crankshaft.

NOTE

Top Dead Center (TDC) can be determined when both the injection push rod (8) and piston follower rod (10) start moving upward. Continue rotating until the piston follower rod reaches its upper most travel position.



TA295549

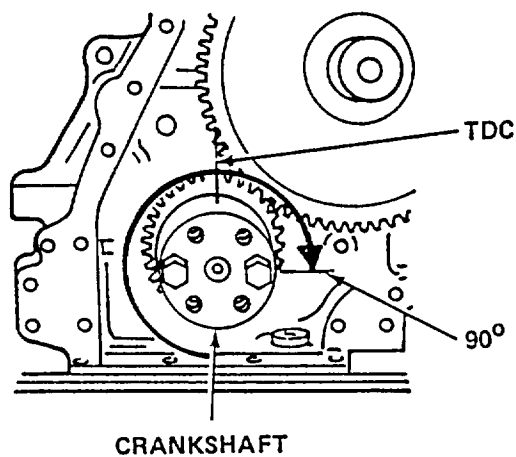
- (b) Rotate crankshaft to TDC of compression stroke using a bar between capscrews as shown.

- (c) With piston at TDC, remove previously installed capscrews and reinstall them at the 12 and 6 o'clock positions of crankshaft.
- (d) Loosen piston dial indicator setscrew (1) and push rod dial indicator setscrew (4) and move both indicators (15 and 6) downward to their fully compressed positions.
- (e) Raise both dial indicators (15 and 6) approximately 0.020 in. (0.508 mm).
- (f) Lock indicators in place with setscrews (1 and 4).

NOTE

Both dial indicators will move in the same, direction when piston is on the compression stroke.

- (g) Slowly rotate crankshaft several degrees clockwise and counter clockwise to make certain piston is at TDC.
- (h) Zero piston dial indicator (15).

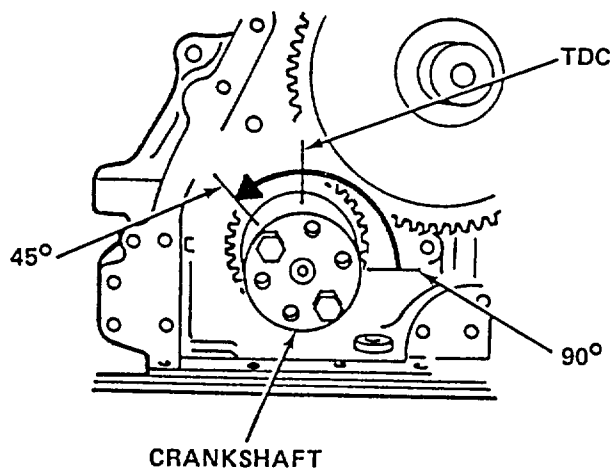


TA295550

- (i) Rotate crankshaft 90 degrees after TDC. Piston follower rod (10) will be near bottom of its travel.
- (j) Zero push rod dial indicator (6).

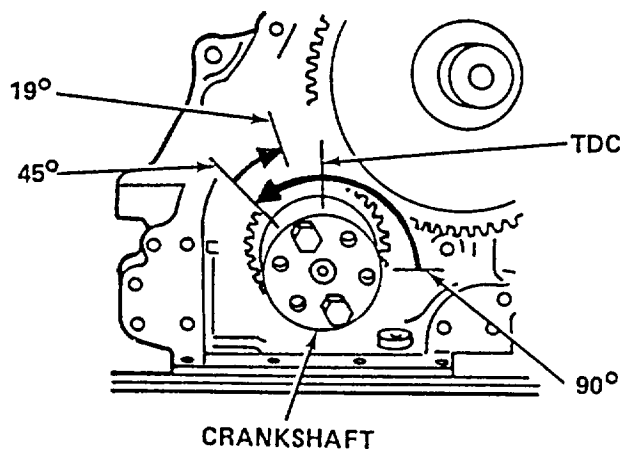
NOTE

Next step is necessary to remove gear train backlash and provide more accurate indicator readings for step (1).



TA295551

- (k) Rotate crankshaft counterclockwise past TDC to 45 degrees before TDC.



TA295552

- (1) Slowly rotate crankshaft clockwise to 19 degrees before TDC. Piston follower rod (10) will be almost in contact with piston dial indicator stem (14).

NOTE

The reading of 0.0032 in. (0.0813 mm) is actually 0.2032 in. (5.161 mm) before zero since the piston dial indicator will have reached over 0.200 in. (5.080 mm) as the crankshaft moved to 45 degrees before TDC. Each complete revolution of the dial indicator hand represents 0.100 in. (2.54 mm).

- (m) Gently rotate crankshaft clockwise until piston dial indicator (15) reads 0.0032 in. (0.0813 mm) before zero.

NOTE

Each graduation on the push rod dial indicator represents 0.001 in. (0.035 mm).

- (n) Read total travel of pointer on push rod dial indicator (6). Reading on push rod indicator should be between 0.069 in. (1.753 mm) and 0.071 in. (1.803 mm).

- (3) Changing injection timing.

CAUTION

NEVER CHANGE CAM FOLLOWER GASKETS TO CORRECT INJECTION TIMING UNTIL CHECKING THE FOLLOWING:

- THAT THE TIMING TOOL IS CORRECTLY INSTALLED.
- THAT THE GAGES ARE CORRECTLY ADJUSTED.
- THAT THE CRANKSHAFT HAS BEEN ROTATED IN THE CORRECT POSITION.
- THAT THE CAPSCREWS SECURING THE CAM FOLLOWER HOUSINGS ARE TORQUED TO 30 35 FT LBS (51 47 N·m).

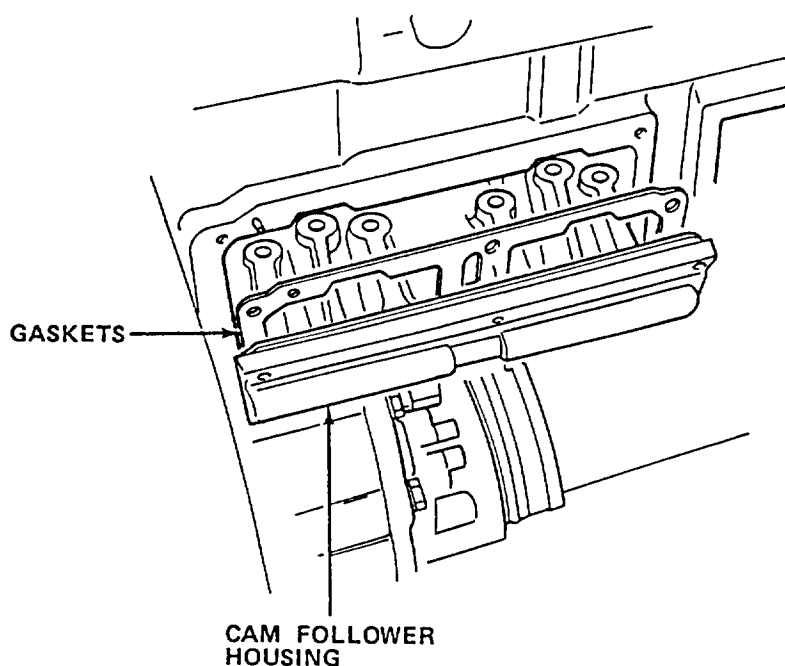
NOTE

Do not increase the total gasket thickness to more than 0.080 in. (20.32 mm). The minimum total thickness must not be less than 0.014 in. (0.356 mm).

- (a) Advance or retard injector timing as follows:

NOTE

Cam follower housing gaskets are available in four thickness; 0.006 0.008 in. (0.152-0.203 mm); 0.014 0.020 in. (0.355-0.508 mm); 0.002 0.024 in. (0.050-0.609 mm); 0.027 0.037 in. (0.685-0.939 mm). Refer to para 3-6 for cam follower gasket removal and para 3-94j for gasket installation.



TA295553

- (b) Advance timing by increasing thickness of cam follower housing gaskets.
- (c) Retard timing by decreasing thickness of cam follower housing gaskets.

- (4) Time no.'s 3 and 5 cylinder injectors.

NOTE

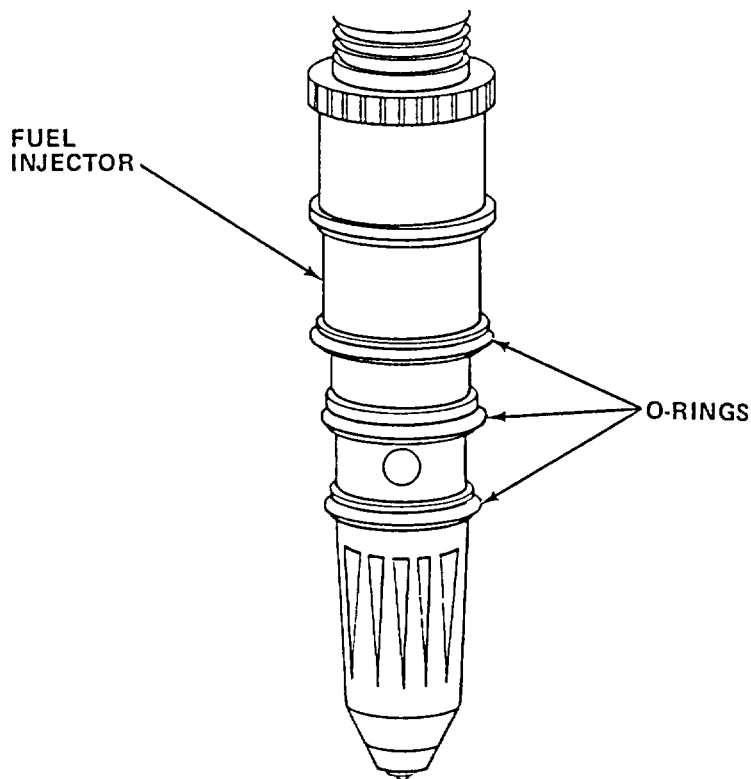
The injection timing procedures for cylinders no.'s 3 and 5 are similar to no. 1 cylinder. When those cylinders are involved, the timing fixture is moved to the applicable cylinder and that cylinder is used to determine its piston's TDC position.

- (5) If injector push tube travel is greater than specified, timing is fast.
- (6) If travel is less than specified, timing is slow.
- (7) Before adding or removing cam follower housing gaskets to change timing, perform following:
- (a) Ensure that cam follower housing capscrews are torqued to 30 35 ft lbs (41 47 Nm).
 - (b) Recheck indicator positioning. Ensure they are not binding or bottoming out.
 - (c) Carefully recheck TDC position. Ensure that each timing step is carefully and accurately performed.
- (8) To retard timing, remove gasket(s) from cam housing and follower assembly mount pad.
- (9) To advance timing, add gasket(s).
- (10) Recheck timing after gaskets are removed or added.
- (11) Remove timing fixture and perform timing check on one cylinder of each remaining cylinder head.

- k. Install fuel injector assembly.

CAUTION

HANDLE INJECTORS WITH CARE. TURNING INJECTOR UPSIDE DOWN WILL ALLOW PLUNGER TO DROP OUT. DAMAGED PLUNGER WILL CAUSE ENGINE FAILURE.



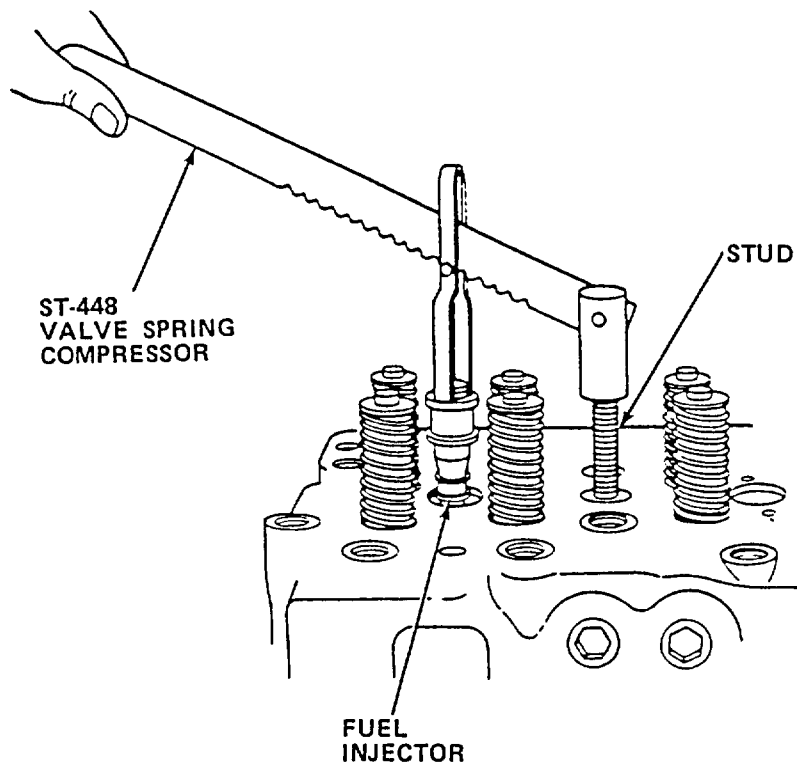
TA295554

- (1) Install new O-rings in grooves on injector.
- (2) Lubricate O-rings with engine oil.

CAUTION

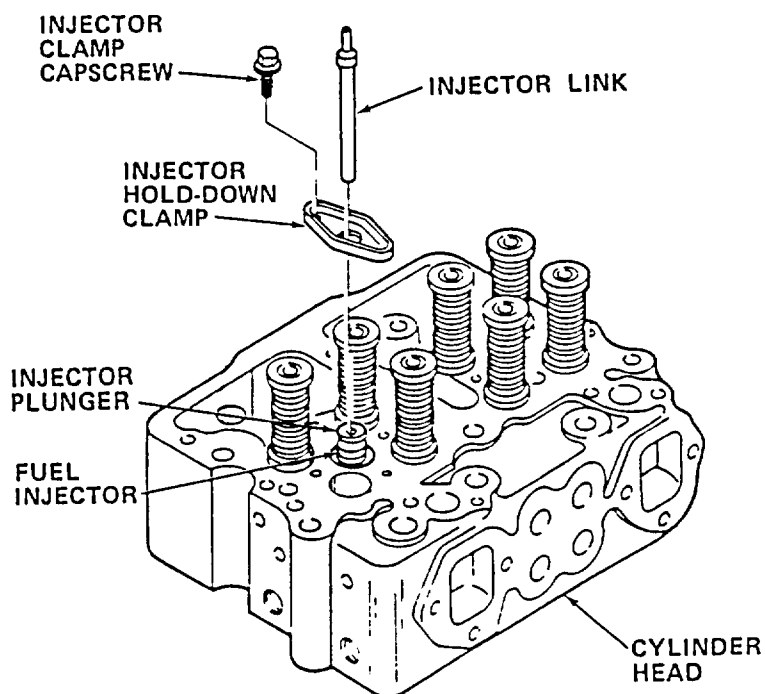
DO NOT USE WOODEN HAMMER HANDLE OR SIMILAR TOOL TO INSTALL INJECTOR. DIRT OR SPLINTER MAY DROP INTO PLUNGER LINK SEAT CAUSING EARLY FAILURE OF ENGINE.

- (3) Start injector into bore. Guide it by hand until aligned in bore and ensure that it is not bound.



TA295555

- (4) Secure ST-448 valve spring compression tool to cylinder head.
- (5) Seat injector by giving it a quick hard push. A snap should be heard and felt as injector seats in its sleeve.



TA295556

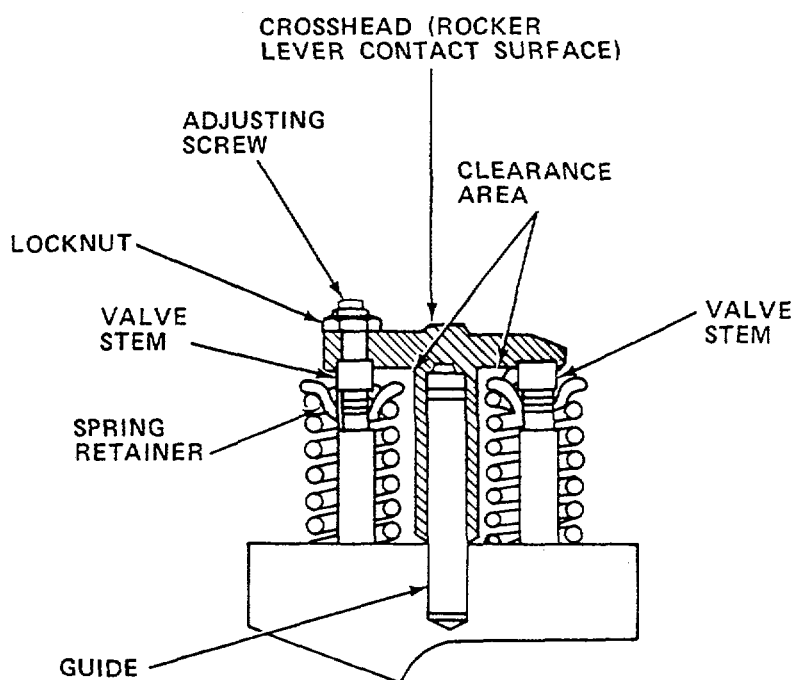
- (6) Place hold-down clamp (with counterbore up) over injector body and secure with capscrews.

- (7) Torque capscrews in 5 ft lbs (7 N•m) increments until torqued to 12 ft lbs (16 N•m).
- (8) Lift, then release plunger to check if it is binding.

NOTE

Injector plunger must move freely.

- (9) If plunger is not free to move, loosen and retorqued capscrews.
 - (10) Install injector link.
- l. Install fuel fittings.
- (1) Apply thread sealant to fuel supply and return fittings.
 - (2) Install fuel supply fitting in top port at rear of No. 3 cylinder head. Temporarily cap fitting.
 - (3) Install fuel return fitting in lower port at rear of No. 3 cylinder head. Temporarily cap fitting.
- m. Adjust valve crossheads.



TA295557

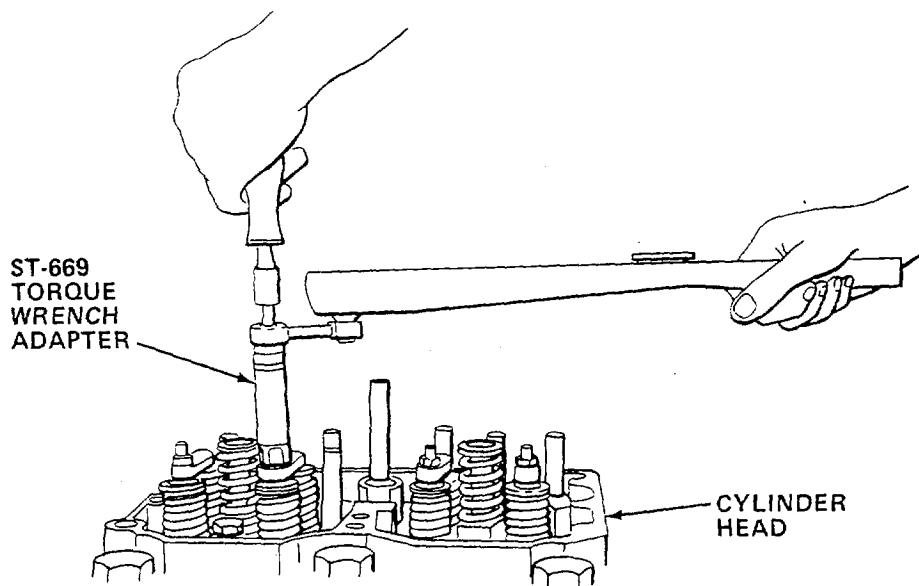
- (1) Place crossheads on guides with adjusting screws toward exhaust side of head.
- (2) Loosen adjusting screw locknut and back out adjusting screw one turn.

- (3) Apply light finger pressure on rocker lever contact surface to hold crosshead in contact with valve stem nearest the push tube.

NOTE

If crossheads and guides are new, advance adjusting screw 1/3 of one hex to straighten stem on guide. If crossheads and guides are worn, it may be necessary to advance screw as much as 1/2 of one hex to straighten stem.

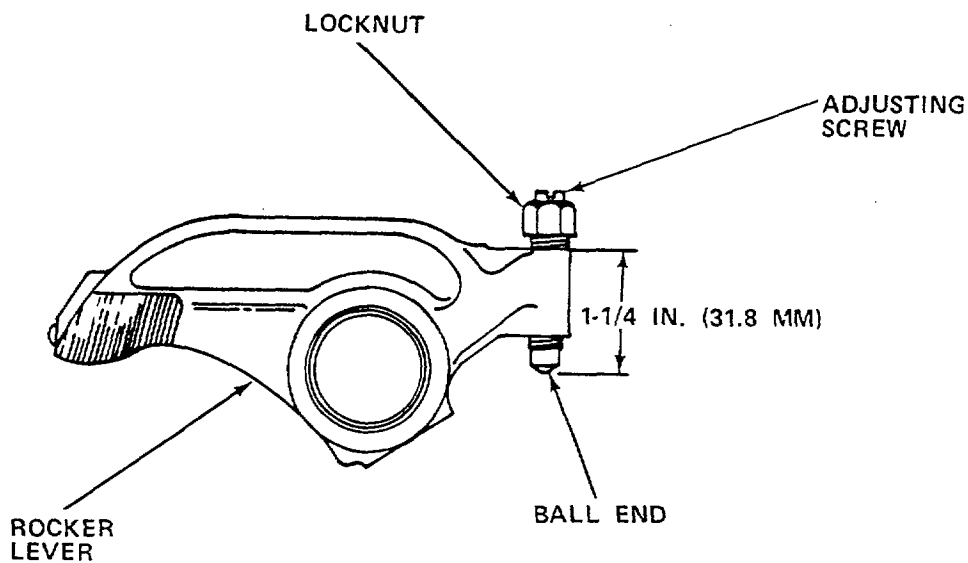
- (4) Turn adjusting screw down until it contacts mating valve stem. Advance screw depending on whether components are worn or new as noted above.



TA295558

- (5) Using ST-669 torque wrench adapter, hold adjusting screw in position and torque locknut to 22 - 26 ft lbs (30 - 35 N•m).
- (6) If ST-669 is not available, hold screw with screwdriver and torque locknut to 25 - 30 ft lbs (34 - 41 N•m).
- (7) Check clearance between crosshead and valve spring retainer with wire gage. Must be minimum of 0.025 in. (0.64 mm) clearance.

- n. Install rocker lever housing.
- (1) Position new rocker lever housing gasket on cylinder head.

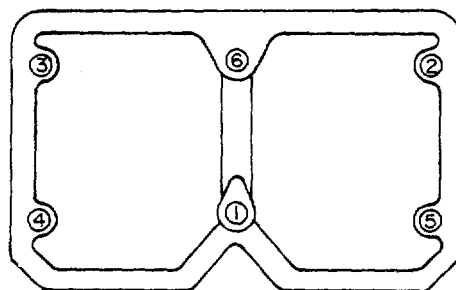


TA295559

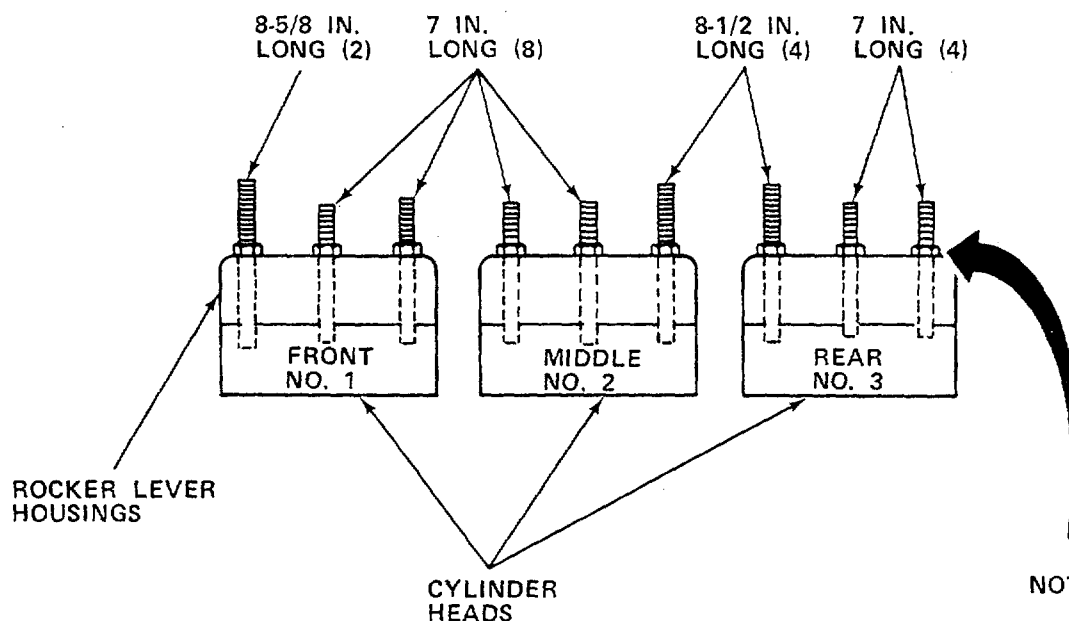
CAUTION

IF ADJUSTING SCREW PROTRUDES BEYOND DIMENSION GIVEN, PUSH TUBES MAY BEND OR HOUSING MAY CRACK WHEN HOUSING IS TORQUED TO HEAD. ENGINE FAILURE WILL RESULT.

- (2) Loosen locknuts and back off rocker lever adjusting screws so there is a maximum of 1-1/4 in. (31.8 mm) between machined surface at top of rocker lever and tip of ball on adjusting screw.
- (3) Holding rocker levers in place, position housing on heads with ball end of levers fitting into their respective push tube sockets.



TORQUING SEQUENCE



NOTE

USE SPECIAL WASHER UNDER STUD HEXES IF ALUMINUM ROCKER LEVER HOUSINGS USED

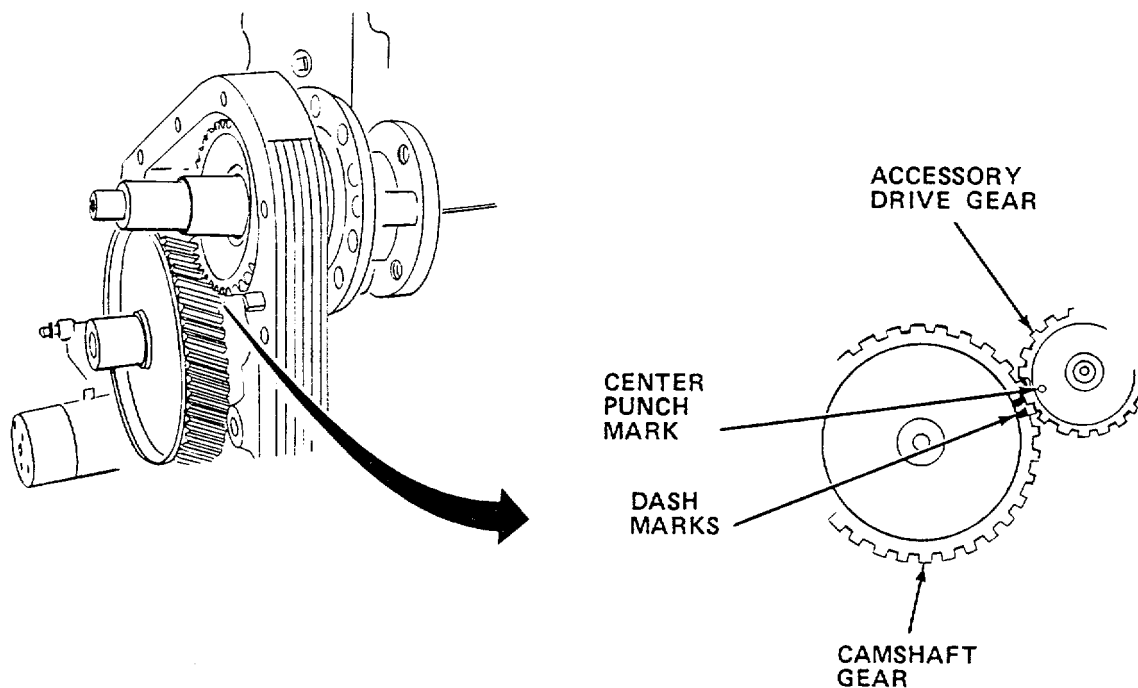
TA295560

NOTE

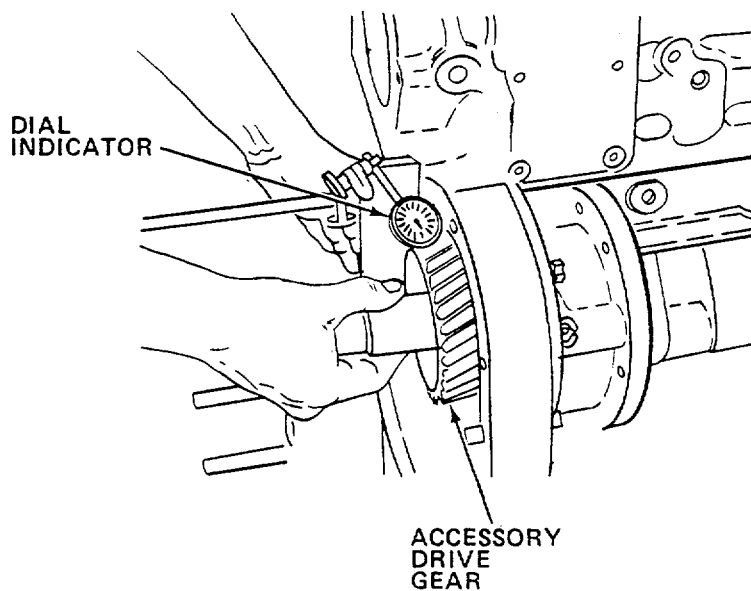
Rocker lever housings can be made of aluminum or cast iron. If aluminum housing is used, hold-down studs must have special washers installed. If cast iron, washers are not used.

- (4) Install studs with washers (if aluminum housing) noting length and locations and torque in sequence to 65 - 75 ft lbs (88 - 102 N•m).
- o. Install accessory drive housing assembly.
- (1) Rotate crankshaft in direction of engine rotation and place no. 1 piston at TDC on compression stroke.

- (2) Continue rotating to 90 degrees ATDC. In this position, two dash marks on camshaft gear are in position to align with accessory drive gear center-punch mark when drive is installed.
- (3) Place new gasket on cylinder block accessory drive mounting pad.



- (4) Install accessory drive, aligning center-punch mark on accessory drive gear with camshaft timing dash marks.
- (5) Secure drive with lockwashers and capscrews.



- (6) Screw stud into threaded hole in block above accessory drive gear.

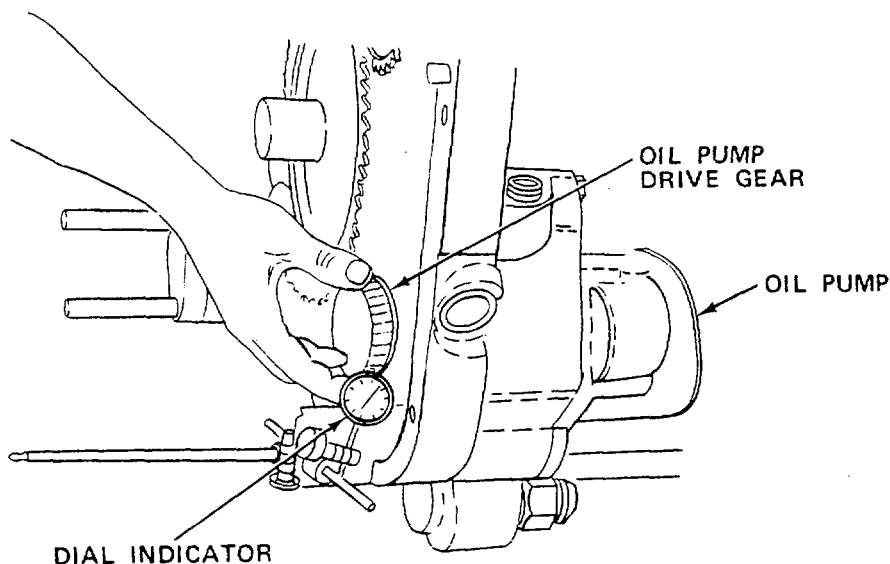
- (7) Secure dial indicator to stud and place indicator pin against accessory drive gear tooth.
- (8) Rotate gear to right as far as it will move to take up backlash. Hold gear in that position.
- (9) Zero indicator.
- (10) Rotate gear to left as far as it will move.
- (11) Read backlash on indicator.
- (12) Replace accessory drive gear if backlash less than 0.0045 in. (0.1143 mm) or more than 0.0105 in. (0.2667 mm).

p. Install oil pump.

CAUTION

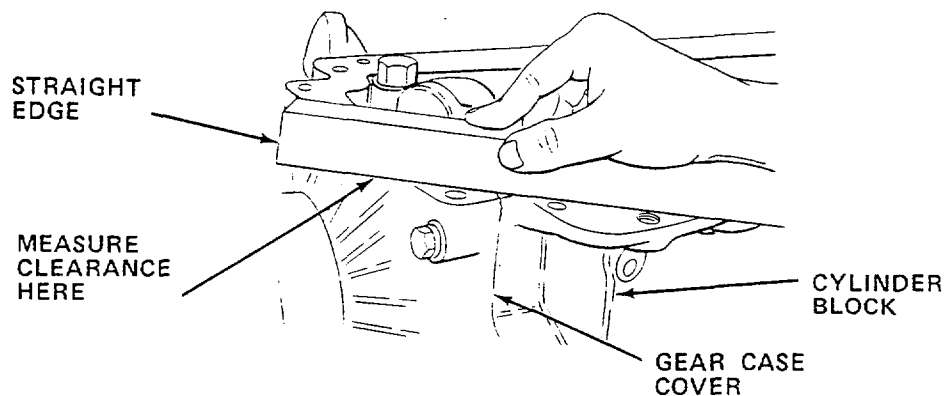
ENSURE OIL PASSAGES IN PUMP AND CYLINDER BLOCK MOUNT PAD ARE OPEN. BLOCKED PASSAGE WILL RESULT IN RAPID ENGINE FAILURE.

- (1) Install new mount gasket on oil pump.
- (2) Install pump, meshing its drive gear with accessory drive gear.
- (3) Secure oil pump with capscrews.



TA295563

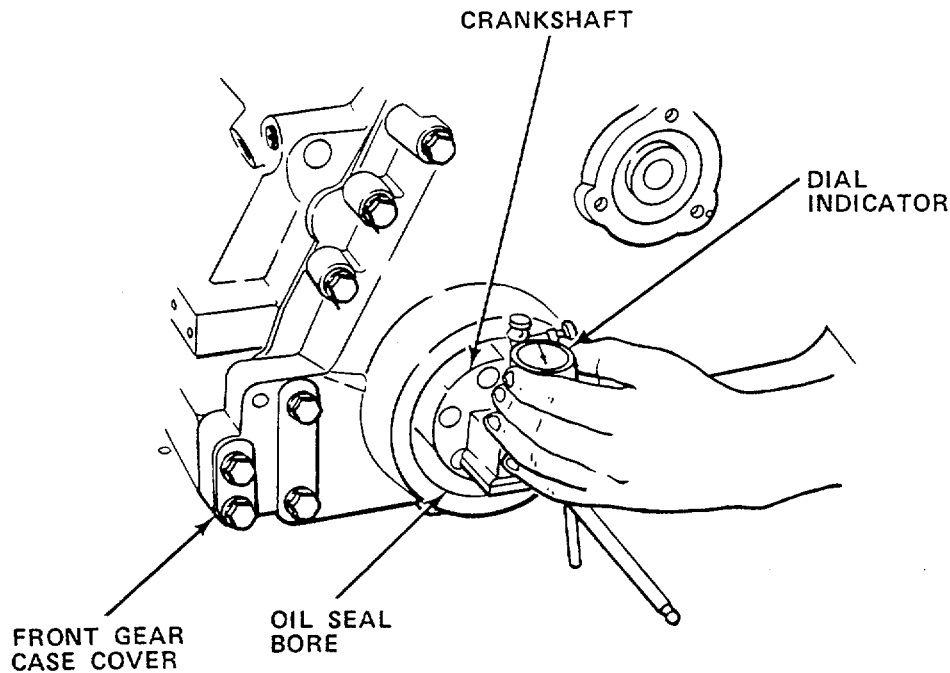
- (4) Secure dial indicator to stud installed in block next to oil pump drive gear.
 - (5) Position indicator pin against pump drive gear tooth.
 - (6) Rotate gear to right as far as it will move to take up backlash. Hold gear in that position.
 - (7) Zero indicator.
 - (8) Rotate gear to left as far as it will move.
 - (9) Read backlash on indicator.
 - (10) Replace oil pump drive gear if backlash less than 0.0045 in. (0.1143 mm) or more than 0.105 in. (0.266 mm).
 - (11) Apply thread sealant to oil pressure signal tube 90 degrees elbow and install elbow in side of cylinder block.
 - (12) Apply thread sealant to oil pressure signal fitting on oil pump and elbow in block.
 - (13) Secure oil pressure signal line to pump fitting and elbow on cylinder block.
- q. Install front gear case cover.
- (1) Apply gasket sealant to gear case cover mounting flange and cylinder block mating surface.
 - (2) Place new gasket on gear case cover and place case cover in position over alignment dowel pin.
 - (3) Secure case cover with capscrews and washers. Torque capscrews to 45 - 50 ft lbs (61 - 68 N•m).
 - (4) Trim off excess gasket material at pan flange mounting area.



TA295564

- (5) With feeler gage and steel straight edge, measure distance between oil pan surface of block and bottom surface of case cover.

- (6) If distance is within +0.004 in. (+0.101 mm) of being flush with pan surface of block, case cover is properly positioned.
- (7) If out of limits, loosen attaching capscrews and carefully tap case cover with soft-face hammer to reposition.
- (8) Remeasure distance.



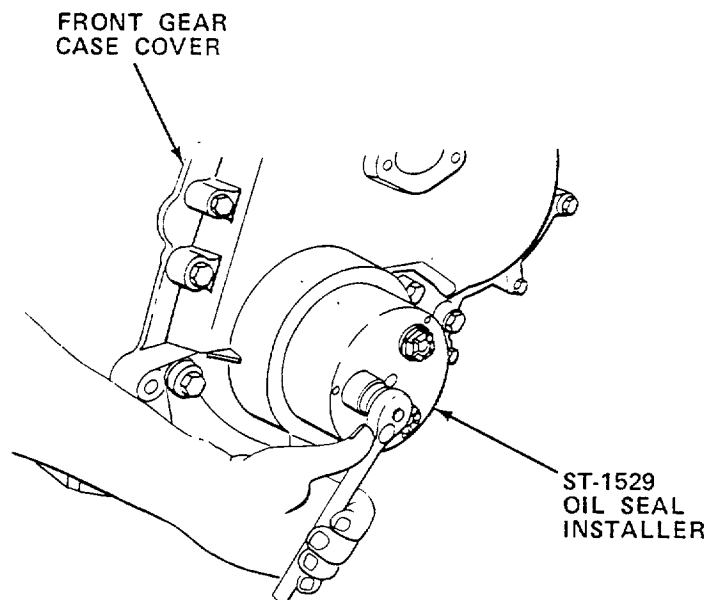
TA295565

- (9) Check concentricity of oil seal bore in relation to crankshaft.
- (10) If total indicated reading exceeds 0.010 in. (0.254 mm) remove, clean and relocate gear case cover.

CAUTION

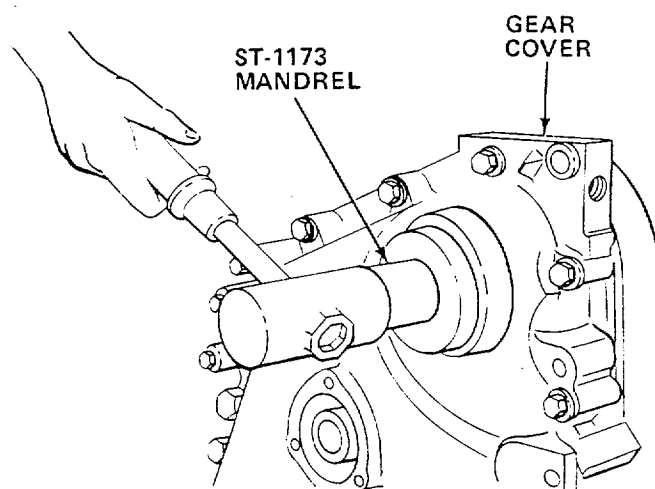
CRANKSHAFT AND ACCESSORY DRIVE OIL SEALS MUST BE INSTALLED WITH SEAL LIP AND OUTSIDE DIAMETER OF SHAFTS CLEAN AND DRY TO PREVENT PREMATURE LEAKAGE. DO NOT LUBRICATE SHAFTS OR SEAL LIPS.

- (11) Ensure new crankshaft oil seal sealing lip and crankshaft seal mating surfaces are clean and dry.



TA295566

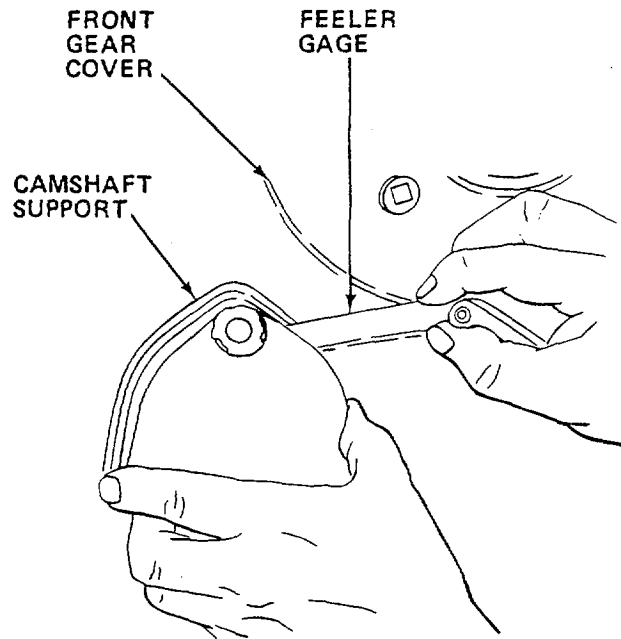
- (12) Coat outside diameter of seal with thin film of engine oil.
- (13) With ST-1259 oil seal installer, press crankshaft oil seal into position.
- (14) Check seal to ensure that it's front face is square with crankshaft axis within 0.010 in. (0.254 mm).
- (15) Ensure that new accessory drive oil seal, sealing lip, and accessory drive shaft are clean and dry.
- (16) Coat outside diameter of new seal with thin film of engine oil.



TA295567

- (17) With ST-1173 mandrel and softface hammer, tap accessory drive seal into cover bore. Mandrel seats seal to required depth.
- (18) Push camshaft to rear as far as it will move.

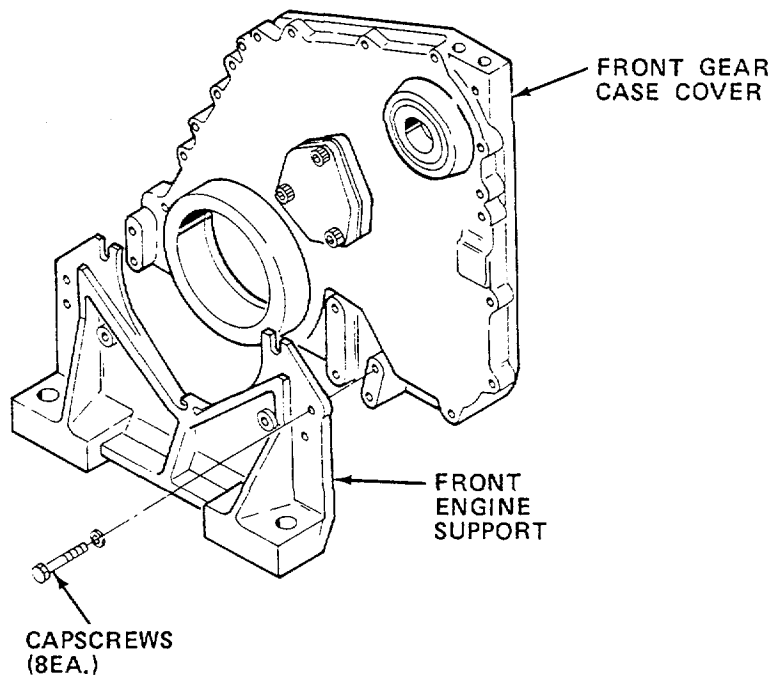
- (19) Remove O-rings (if installed) and shims from camshaft support.



TA295568

- (20) Insert support into cover bore. Support will not fully enter bore.
- (21) With feeler gages, measure distance between support and gear cover.
- (22) Add 0.008 - 0.013 in. (0.203 - 0.330 mm) to that distance. This establishes correct end clearance between camshaft and support.
- (23) Using micrometer, select appropriate size and number of shims to establish correct end clearance.
- (24) Install shims on camshaft support.
- (25) Lubricate and install new O-rings on support.
- (26) Secure support to gear case cover with capscrews, flat washers, and lockwashers.
- r. Install accessory drive pulley (TM 9-2320-281-34).

s. Install front engine support.



- (1) Place front engine support in position on front gear case cover.

NOTE

Two top bolts which fit in support slots have flat and lockwashers.

- (2) Secure support with cap screws and lockwashers. Torque cap screws to 55 ft lbs (75 N•m).

t. Install vibration damper and pulley.

- (1) Wipe vibration damper and pulley clean and secure damper to pulley with cap screws and lockwashers. Torque cap screws to 85 ft lbs (115 N•m).

CAUTION

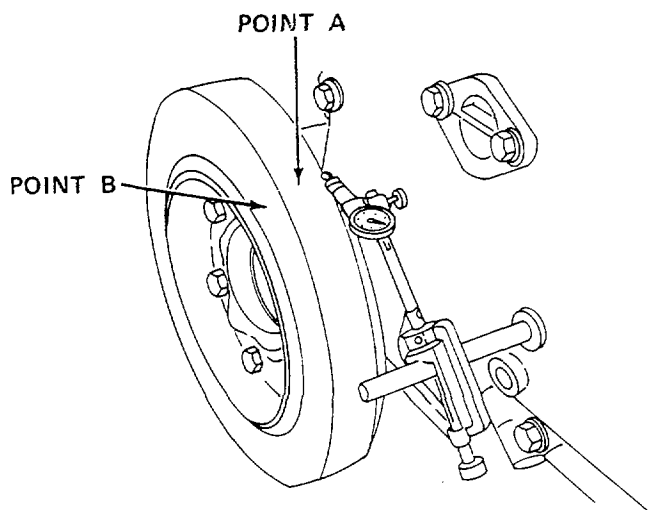
DO NOT USE LUBRICANT ON PULLEY OR CRANKSHAFT MATING SURFACES.

- (2) Wipe mating surfaces with clean dry cloth.
- (3) Aline cap screw holes and tap vibration damper assembly into position with softface hammer.

NOTE

If 1/2 in. (12.7 mm) Grade 8 capscrews are used, torque capscrews to 115-125 ft lbs (156-170 N·m). If 5/8 in. (15.88 mm) Grade 8 capscrews are used, torque capscrews to 180-200 ft lbs (244-271 N·m). If 5/8 in. (15.88 mm) Grade 5 capscrews are used, torque to 150 - 170 ft lbs (203 - 231 N·m).

- (4) Coat capscrews with oil and secure damper assembly to crankshaft. Torque capscrews to specifications as noted above.



TA295570

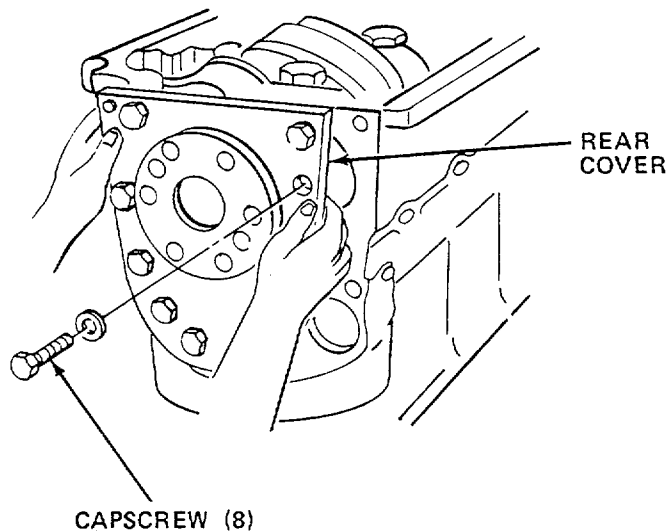
- (5) Position dial indicator contact pin against outside surface of vibration damper (Point A). Zero indicator.

NOTE

Use accessory drive pulley nut to rotate engine.

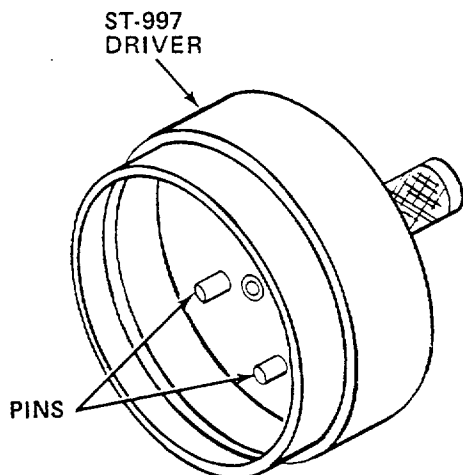
- (6) Rotate crankshaft so that indicator measures run-out of 1 in. (25.4 mm) distance.
- (7) Run-out must not exceed 0.0025 in. (0.0635 mm).
- (8) If run-out exceeds specification, replace damper.
- (9) Relocate indicator so that its contact pin acts against front face of damper (Point B).
- (10) Rotate crankshaft so that indicator measures amount of damper wobble over a 1 in. (25.4 mm) distance.

- (11) If wobble exceeds specification, remove damper assembly and inspect pulley and crankshaft mating surfaces for nicks, burrs, distortions and foreign matter.
 - (12) Remove minor defects with emery cloth. Replace distorted pulley.
 - (13) If no defects found, separate damper and pulley and check their mating surfaces for nicks, burrs, distortions and foreign matter.
 - (14) Remove minor defects with emery cloth. Replace distorted parts.
 - (15) Reassemble pulley and damper.
 - (16) Install assembly and remeasure out-of-round and wobble.
- u. Install water pump and idler assembly (TM 9-2320-281-20).
 - v. Install water pumps and idler assembly drive belt (TM 9-2320-281-20).
 - w. Install fan bracket (TM 9-2320-281-20).
 - x. Install rear cover and oil seal.
- (1) Rotate engine upside down.



TA295571

- (2) Position new rear cover gasket and cover on cylinder block.
- (3) Install capscrews and lockwashers. Tighten capscrews finger tight.



NOTE

WHEN USING TOOL AS PILOT FOR CENTERING OF REAR COVER, REMOVE PINS.

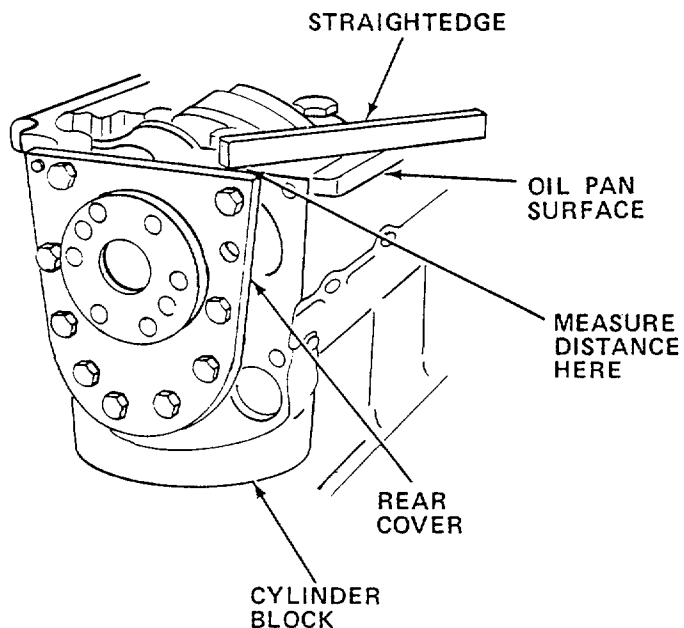
REINSTALL PINS WHEN DRIVING OIL SEAL INTO REAR COVER.

TA295572

NOTE

ST-997 crankshaft rear oil seal driver is used as both a cover alignment tool and seal driver. With pin removed, tool is used as alignment device. With pins installed, tool is a driver.

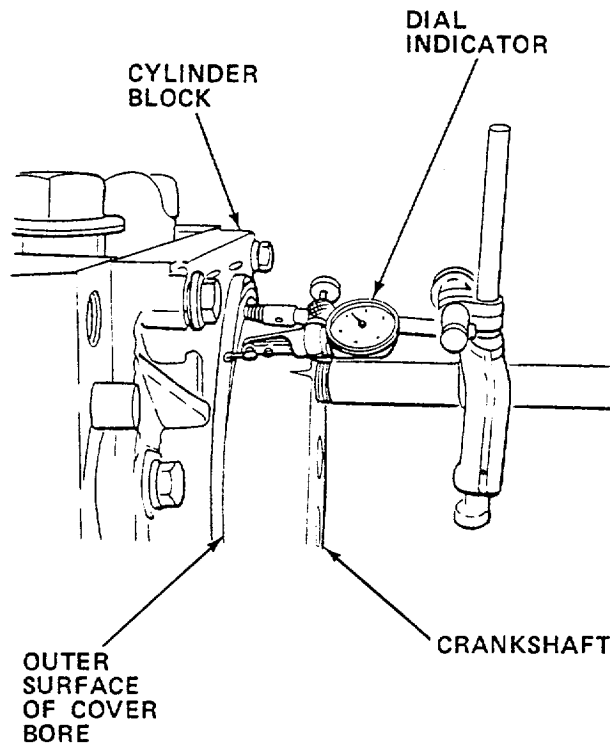
- (4) Remove pins from ST-997 driver.
- (5) Slide driver into bore of rear cover and over end of crank shaft. Rear cover will pilot over tool.
- (6) Snug capscrews so cover can be shifted.



TA295573

- (7) With feeler gage and steel straightedge, measure distance between oil pan surface of block and bottom surface of cover.

- (8) If distance from cover is within +0.004 in. (+0.101 mm) of being flush with pan surface of block, cover is properly positioned.
- (9) To position cover within specifications, gently bump it to shift its position.



TA295574

- (10) Mount dial indicator as shown.
- (11) Adjust indicator contact pin so that it rides on outside surface of cover bore. Zero indicator.
- (12) Turn crankshaft one full turn while observing indicator reading.
- (13) If total indicated run-out exceeds 0.005 in. (0.127 mm) gently bump cover to reposition as required to meet specification.
- (14) Recheck dimension between oil pan surface of block and bottom surface of cover.
- (15) Position cover as required to satisfy bottom clearance and run-out specifications.
- (16) Torque cover capscrews to 24 - 29 ft lbs (33 - 39 N•m).
- (17) Trim off excess gasket material.

CAUTION

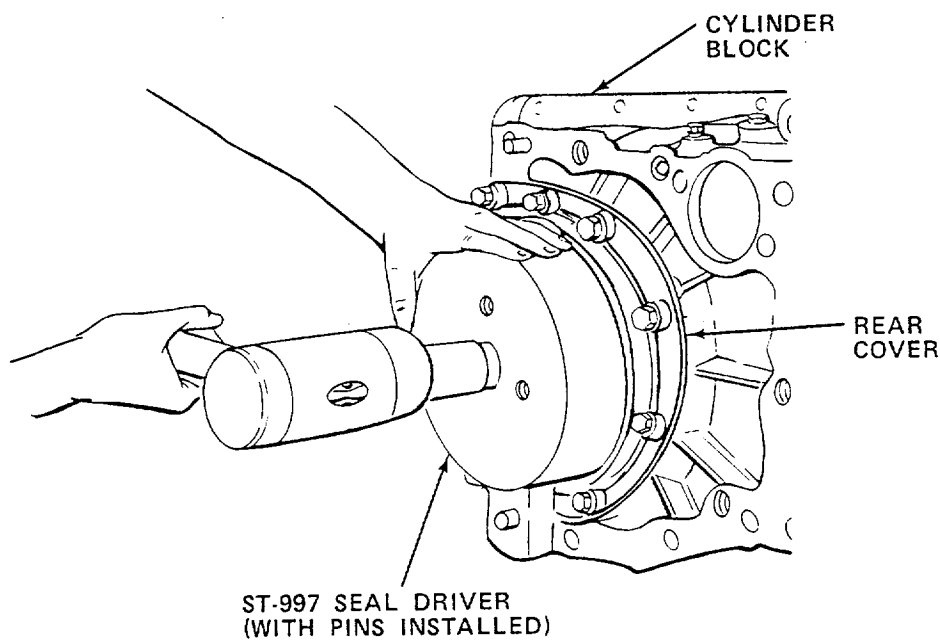
OIL SEAL MUST BE INSTALLED WITH SEAL LIP AND CRANKSHAFT OUTSIDE DIAMETER CLEAN AND DRY. USE OF LUBRICANT OF ANY KIND MAY CAUSE PREMATURE LEAKAGE.

- (18) Clean crankshaft oil seal mating surface with crocus cloth and wipe clean.

NOTE

A new rear oil seal is shipped from manufacturer with sleeve installed in the seal lip. Sleeve protects lip during shipment and is used as an installation tool.

- (19) Place larger inside diameter portion of shipping/installation sleeve over end of crankshaft.
- (20) Carefully push seal off sleeve onto crankshaft. Remove sleeve and discard.
- (21) Reinstall pins in ST-997 rear oil seal driver.



- (22) Place driver behind oil seal and carefully drive seal into cover with softfaced hammer.
- (23) Wipe assembly clean.

y. Install flywheel housing.

- (1) Rotate engine right side up.
- (2) Clean mating surfaces of cylinder block and flywheel housing.

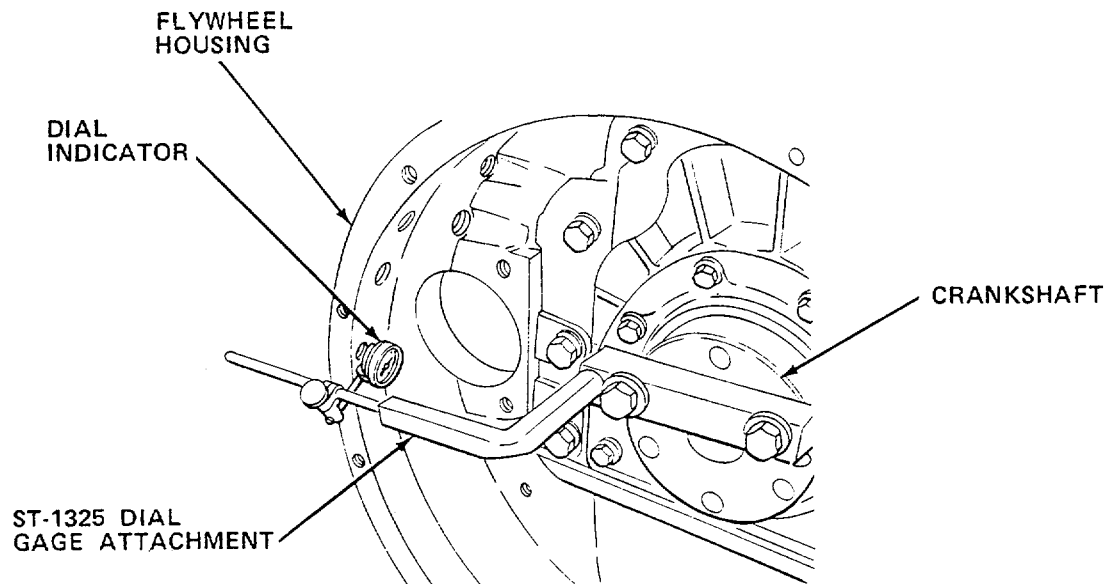
NOTE

If same flywheel housing is installed that was removed, and same block is used, no special checks are required upon installation of housing. If new flywheel housing is installed, new block is used, or dowel alignment pins are worn, sheared, or loose requiring installation of oversized dowels, housing to crankshaft concentricity must be checked. After concentricity is established, housing alignment pin holes and cylinder block alignment pin bores may have to be reamed to a larger size to accept oversize alignment pins.

- (3) Remove alignment pin dowel (if defective) from cylinder block with ST-1134 dowel pin extractor.
- (4) Carefully tap new standard size, 0.4995 in. (12.6873 mm), dowel into block bore. Take care not to flatten or bend pin.
- (5) Remove and discard new pin if loose. Bore will have to be reamed (after housing installed) to accept next oversize, 0.5615 in. (14.2621 mm), pin.
- (6) Install old flywheel housing on old block.
 - (a) Position housing over block alignment pins.
 - (b) Secure housing with nine flat washers and capscrews.
 - (c) Progressively torque capscrews, alternating from side to side and top.
 - (d) Apply torque in increments of 50 ft lbs (68 Nm) until final torque of 150 ft lbs (203 Nm) is reached.
 - (e) Wipe interior of housing clean.
- (7) Install old flywheel housing on new block or new flywheel housing on old block.
 - (a) Place flywheel housing on block alignment pins.
 - (b) Install capscrews and washers. Tighten but do not torque capscrews.

CAUTION

SQUARENESS OF THE FACE OF THE FLYWHEEL HOUSING AND ITS RELATIVE POSITION (CONCENTRICITY) TO CENTERLINE OF CRANKSHAFT MUST BE WITHIN SPECIFICATIONS TO ENSURE PROLONGED ENGINE LIFE.



TA295576

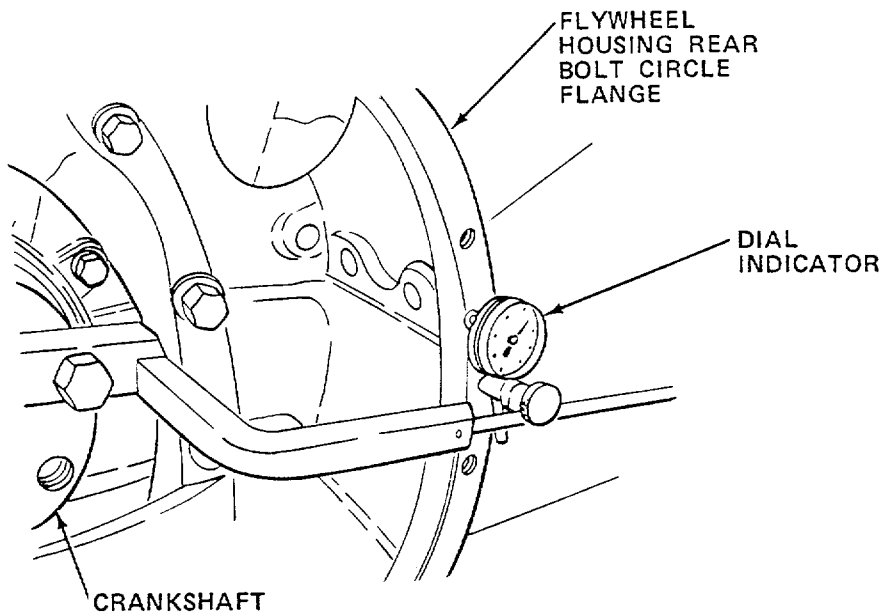
- (c) Secure ST-1325 dial gage attachment to end of crankshaft.
- (d) Slide dial indicator on attachment and position indicator contact pin against inside surface of flywheel housing at 9 o'clock position. Secure and zero indicator.
- (e) Draw chalk lines at 3, 6, 9, and 12 o'clock positions on rear bolt circle flange of housing.
- (f) Rotate crankshaft and observe run-out at 3 and 9 o'clock positions. Record reading.
- (g) Observe run-out at 6 and 12 o'clock positions. Record readings.

NOTE

Dowel pins are removed so that block can be redoweled once concentricity is established.

- (h) If 0.006 in. (0.152 mm) run-out is exceeded in either recorded position, remove housing and dowel alignment pins in block.
- (i) Reinstall housing and recheck run-out.

- (j) Bump housing in direction necessary to bring run-out within specification.
- (k) With housing correctly positioned, progressively torque capscrews alternately from side to side and top.
- (l) Apply torque in increments of 50 ft lbs (68 N•m) until final torque of 150 ft lbs (203 N•m) is reached.

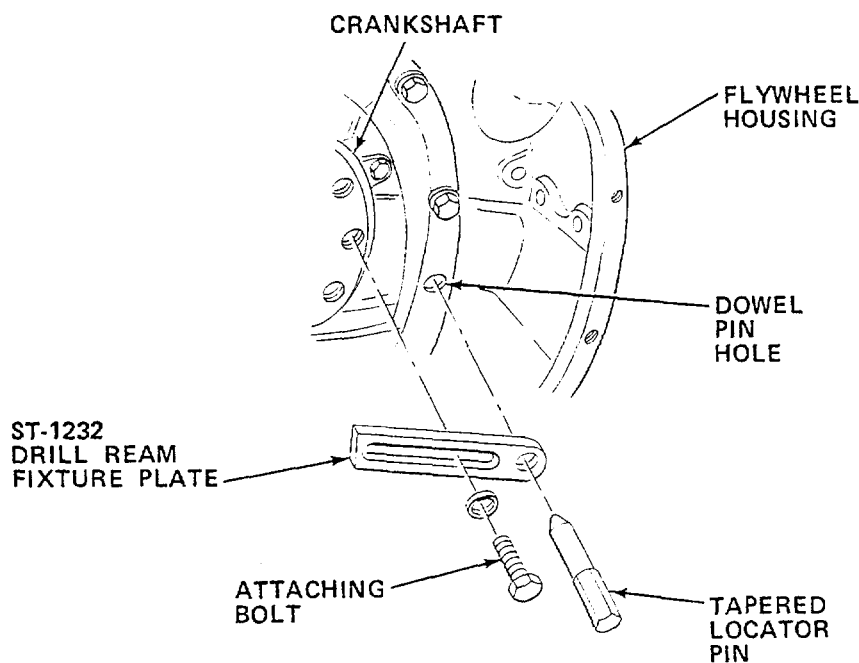


TA295577

- (m) Reposition dial indicator so that its contact pin rides against rear bolt circle flange of housing.
- (n) Push crankshaft full forward to take up end clearance.
- (o) With crankshaft kept forward, rotate shaft one full turn while observing indicator reading.
- (p) If total indicated run-out exceeds 0.006 in. (0.152 mm), remove housing and inspect cylinder block and housing mating surfaces.
- (q) Remove any nicks or burrs with fine file and emery cloth. Ensure that surfaces are clean.
- (r) Reinstall housing and reestablish concentricity.
- (s) Remeasure rear flange run-out.
- (t) If run-out is still not correct and crankshaft was kept full forward when rotated, replace housing.
- (u) If both concentricity and rear flange run-out are within limits with dowel pin removed, dowel holes in housing and bores in cylinder block must be reamed to accept oversize pins.

CAUTION

ENSURE THAT ALL ATTACHING CAPSCREWS ARE PROPERLY TORQUED.



TA295578

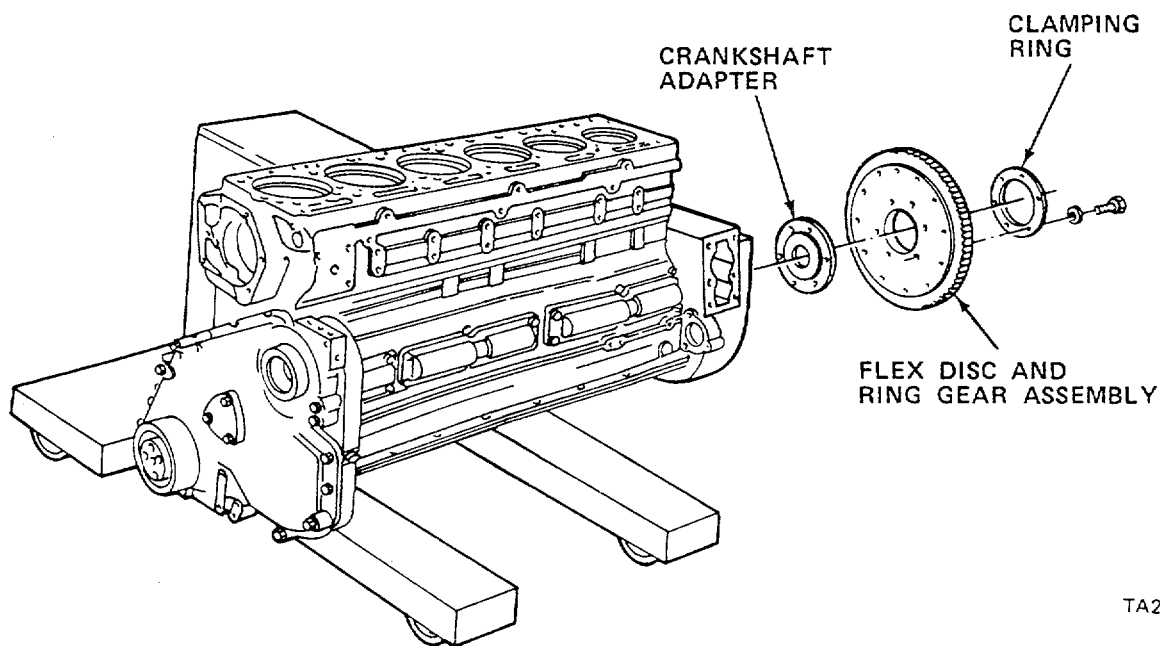
- (v) Attach ST-1232 drill ream fixture plate to crankshaft flange with attaching bolt. Do not tighten attaching bolt.
- (w) Place tapered locating pin through hole in plate into former dowel pin hole.
- (x) Tighten attaching bolt.
- (y) Remove locating pin.
- (z) Determine size of next oversize dowel pin to be used.
- (aa) Select required size bushing from ST-1233, ST-1234, ST-1235, or ST-1236 drill/ream bushing set.
- (ab) Insert bushing into ream fixture plate. Bushing acts as guide for reamer.

CAUTION

COVER CRANKSHAFT AREA TO PREVENT ENTRY OF METAL SHAVINGS. OIL SEAL FAILURE MAY OCCUR. KEEP REAMER STRAIGHT TO PREVENT DIFFICULTY IN HOUSING REMOVAL AT NEXT ENGINE REBUILD.

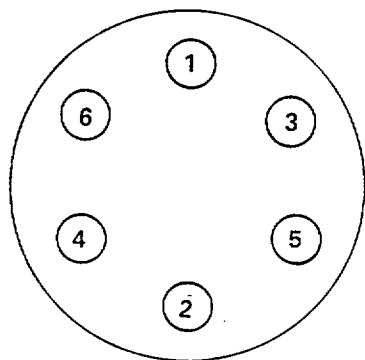
- (ac) With hand drill and required size reamer, insert reamer through bushing and carefully ream hole in housing and bore in block.

- (ad) Perform reaming operation on remaining dowel pin.
 - (ae) Install new oversize dowel pins. Take care not to flatten pin.
 - (af) Wipe interior of housing clean.
- z. Install flex disk and ring gear assembly.



TA295579

- (1) Apply thin coat of lubricating oil to threads of capscrews and washers before installing.
- (2) Position crankshaft adapter, flex disc and ring gear assembly, and clamping ring against crankshaft and secure with flat washers and capscrews.

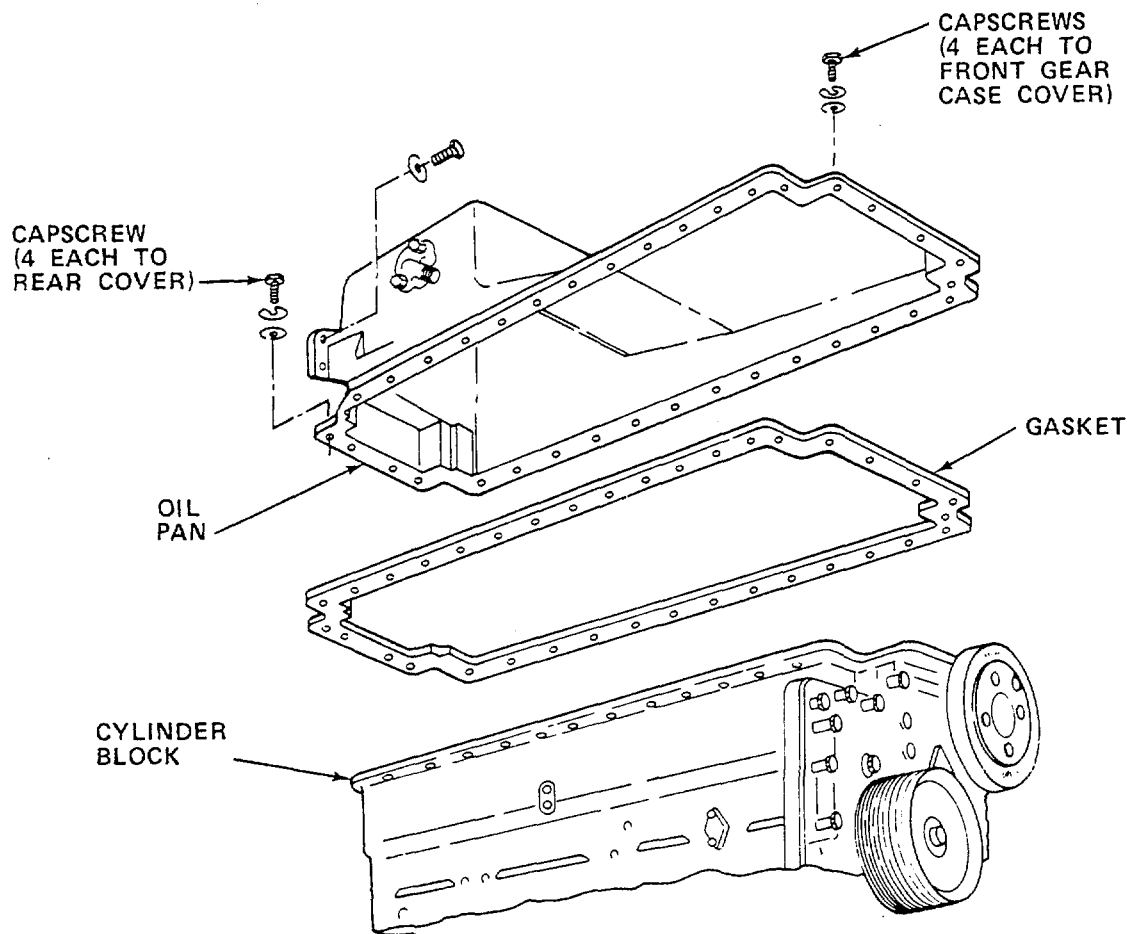


TA295580

- (3) Torque capscrews in sequence shown to 200 - 220 ft lbs (271-298 N•m).

aa. Install oil pan.

- (1) Rotate engine to upside down position.
- (2) Install two guide studs in oil pan flange of block, one on each side.

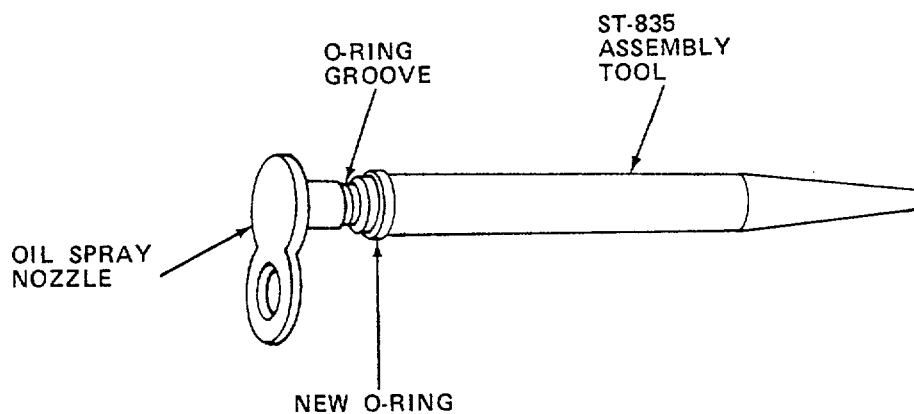


TA295581

- (3) Apply gasket sealant to block flange and place gasket on flange.
- (4) Check pan screen to ensure proper assembly and security of screws.
- (5) Position oil pan over guide studs and start 28 capscrews, flat washers, and lockwashers by hand.
- (6) Install four capscrews, flat washers, and lockwashers through rear flange at both sides of pan. These screws pull pan tight and square against flywheel housing.
- (7) Lock pan in position by tightening two center capscrews on each side of block.

- (8) Remove four capscrews and washers previously installed in rear flange at both sides of pan. Screws must be removed to provide socket clearance to corner capscrews.
 - (9) Tighten two corner pan to block flange capscrews. This draws pan flange to block flange to ensure pan is firmly seated into corner of flywheel housing and block.
 - (10) Remove guide studs.
 - (11) Reinstall four rear flange capscrews and washers.
 - (12) Install four pan to front gear cover capscrews, flat washers, and lockwashers.
 - (13) Install four pan to rear cover capscrews, flat washers, and lockwashers. Torque capscrews to 15 - 20 ft lbs (20 - 27 N•m).
 - (14) Torque all other capscrews to 28 - 40 ft lbs (38 - 54 N•m).
- ab. Install oil suction tube.
- (1) Position new gasket and oil suction flange on left side of pan.
 - (2) Secure flange with capscrews and lockwashers. Do not tighten capscrews.
 - (3) Push tube and sleeve of flex hose into lube oil pump until tube bottoms. Tighten nut 1-1/4 turn from finger tight.
 - (4) Secure other end of hose to oil suction flange finger tight.
 - (5) Torque suction flange capscrews to 30 - 35 ft lbs (41 - 47 N•m).
 - (6) Tighten flex hose tube nut against stop on suction flange.
 - (7) Remove oil pan capscrew and washers located approximately midway the length of oil suction hose.
 - (8) Position suction line support bracket on pan flange and secure with oil pan retaining capscrew and lockwasher.
 - (9) Torque capscrew to 30 - 35 ft lbs (41 - 47 N•m).
 - (10) Place clamp around oil suction hose.
 - (11) With spacer placed between clamp and bracket insert capscrew with flat washer through clamp, spacer, and bracket.
 - (12) Secure capscrew with lockwasher and nut.
 - (13) Secure dust cap to remote bypass oil filter 90 degrees return fitting on right rear side of pan.
- ac. Install air compressor (TM 9-2320-281-34).

- ad. Install air governor (TM 9-2320-281-20).
- ae. Install fuel pump (TM 9-2320-281-34).
- af. Install water manifold and thermostat housing (TM 9-2320-281-34).
- ag. Install water filter and mount bracket (TM 9-2320-281-20).
- ah. Install piston cooling oil spray nozzles.



TA295582

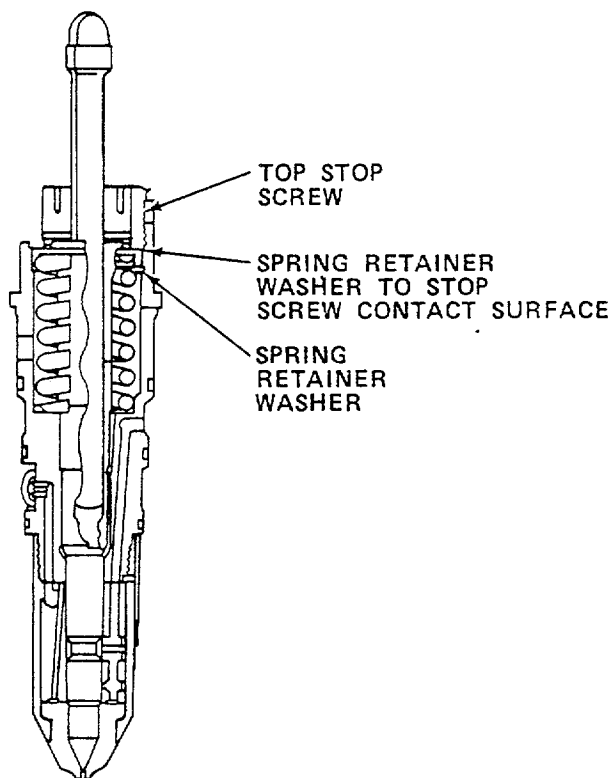
NOTE

New nozzles are furnished with O-rings installed.

- (1) Lightly lubricate new O-ring and slip it on ST-835 O-ring assembly tool.
- (2) Insert oil spray nozzle into tool so that O-ring groove on nozzle is aligned with end of tool.
- (3) Carefully slide O-ring off tool and into O-ring groove. Ensure that O-ring is not twisted in groove.
- (4) Perform same procedures with remaining five nozzles.
- (5) Carefully insert nozzles into block and secure with capscrews.
- (6) Torque capscrews to 10 ft lbs (14 Nm).

ai. Adjust injectors and valves.

- (1) Rotate engine until "A" mark on accessory drive pulley is aligned with pointer on front gear cover. In this position, both valves for cylinder no. 5 must be closed and their rocker levers must be free to move. No. 3 cylinder injector plunger link must be at top of its travel.
- (2) If rocker levers not free and plunger link not at top of travel, rotate engine one complete turn (360°) and realine pulley "A" mark with gear cover pointer.
- (3) Turn no. 3 cylinder injector rocker lever adjusting screw down until all lash is removed from injector train.
- (4) Tighten adjusting screw one additional turn to properly seat injector link and to squeeze oil from socket surface.

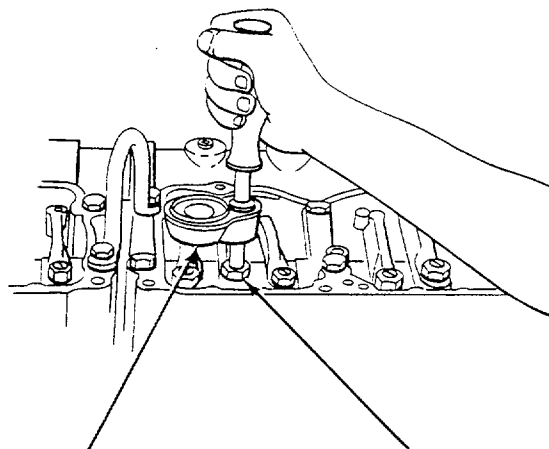


TA295583

- (5) Back adjusting screw off until spring retainer washer in fuel injector contacts top stop screw.

NOTE

Injector link to rocker lever housing is a zero clearance adjustment.



TOOL NUMBER 3375232
TORQUE WRENCH

ADJUSTING
SCREW

TA295584

- (6) With tool no. 3375232 inch-pound torque wrench and socket, tighten adjusting screw to 5 - 6 in. lbs (0.56 - 0.68 N•m).

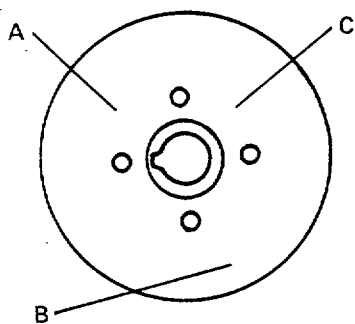
NOTE

If torque wrench not available, zero clearance can be set at point where link is slightly loaded, but free enough to be rotated by thumb and forefinger.

- (7) With ST-669 torque wrench adapter and socket, hold adjusting screw and torque locknut to 30 - 35 ft lbs (41 - 47 N•m).
- (8) If ST-669 not used, hold adjusting screw with box end wrench and torque locknut to 40 - 45 ft lbs (54 - 61 N•m).

Table 3-5. Timing

Bar in Direction	Pulley Position	Cyl. Firing	Injector	Set Cylinder	Valve
Start	A	1	3		5
Advance to	B	5	6		3
Advance to	C	3	2		6
Advance to	A	6	4		2
Advance to	B	2	1		4
Advance to	C	4	5		1



TIMING MARK RELATIVE POSITIONS ON PULLEY ACCESSORY DRIVE

TA295585

NOTE

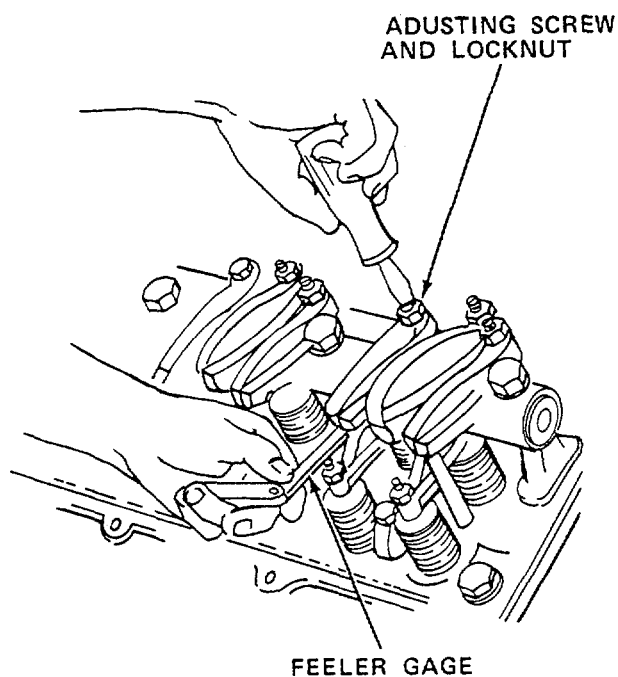
Note that in Timing Table 3-5, the same engine position (A, B, or C) mark on pulley used to adjust injector is also used for setting intake and exhaust valves. However, valves to be adjusted are not the same cylinders as injectors. In the present position ("A" mark on pulley and no. 5 valves closed), since no. 3 injector has been adjusted, no. 5 cylinder valves are ready for adjustment. Always adjust valves after injector adjustment. Move progressively down the table until all injectors and valves are adjusted.

- (9) Loosen valve rocker lever adjusting screw locknut and back-off adjusting screw.

Table 3-6. Valve Setting Specifications

OIL TEMPERATURE	Intake Inch (mm)	Exhaust Inch (mm)
COLD	0.011 (0.28)	0.023 (0.58)
HOT	0.008 (0.20)	0.023 (0.58)

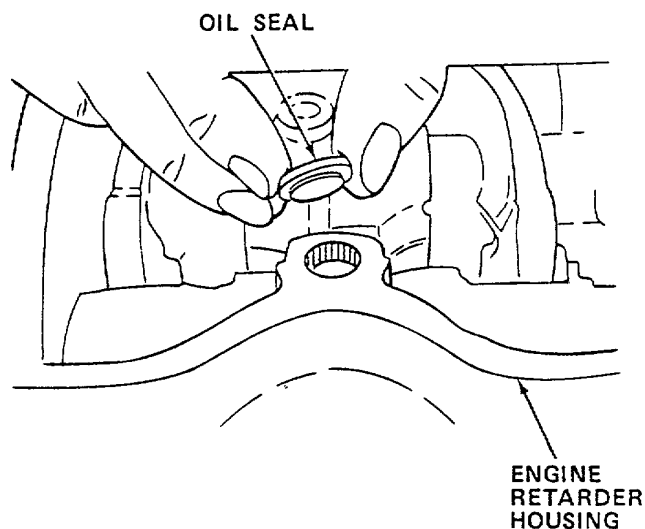
- (10) Determine whether valve is intake or exhaust. Exhaust valve crossheads are wider at rocker lever contact point.



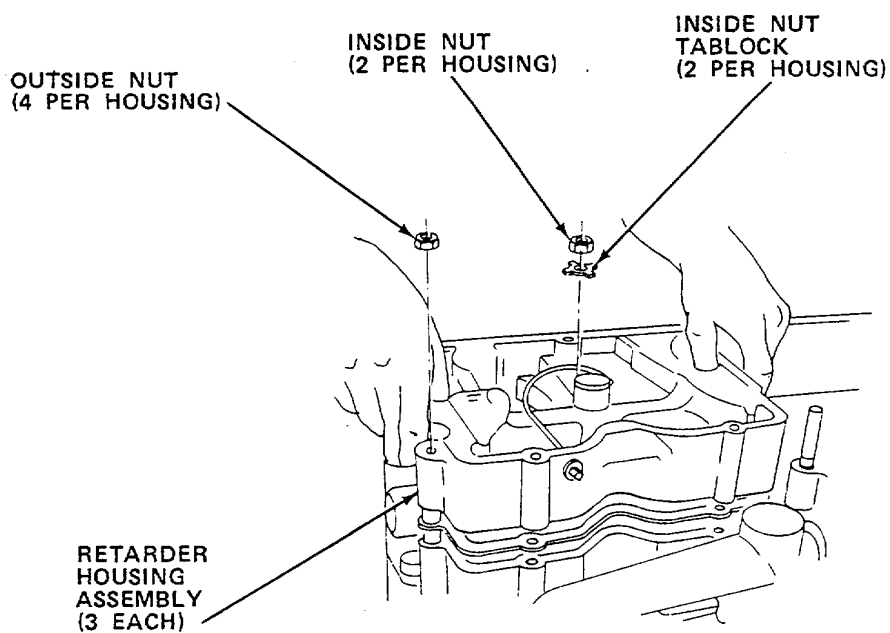
TA295586

- (11) Insert appropriate thickness feeler gage (Table 3-6) between rocker lever and crosshead.
- (12) Turn adjusting screw down until lever just touches gage.
- (13) Using ST-669 torque wrench adapter with screwdriver bit and deep socket, hold adjusting screw and torque locknut to 35 - 40 ft lbs (47 - 54 N•m).
- (14) If ST-669 not used, hold adjusting screw with screwdriver and torque locknut to 40 - 45 ft lbs (54 - 61 N•m).
- (15) Adjust adjacent valve referring to Table 3-6 for proper valve clearance.
- (16) Rotate engine to next pulley position (Table 3-5) and so on until all injectors and valves are adjusted.

- aj. Install engine retarder assemblies.
- (1) Clean mating surfaces of retarder housings and rocker lever housings.
 - (2) Turn retarder housings upside down.
 - (3) Apply petrolatum to outer area of oil seals.



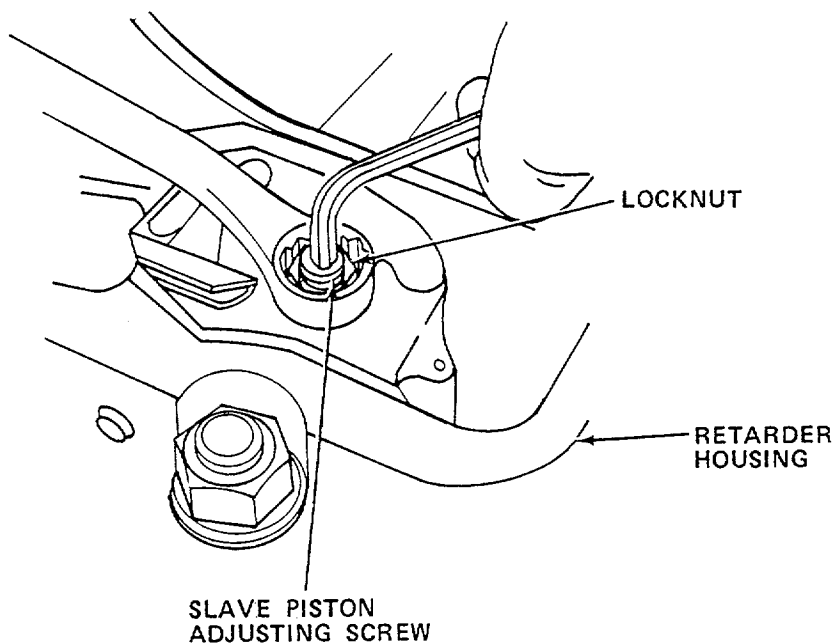
- (4) Insert seals (flat surface down) into hole located in center of web of each housing.
- (5) Place new gaskets on rocker arm housings.



TA295588

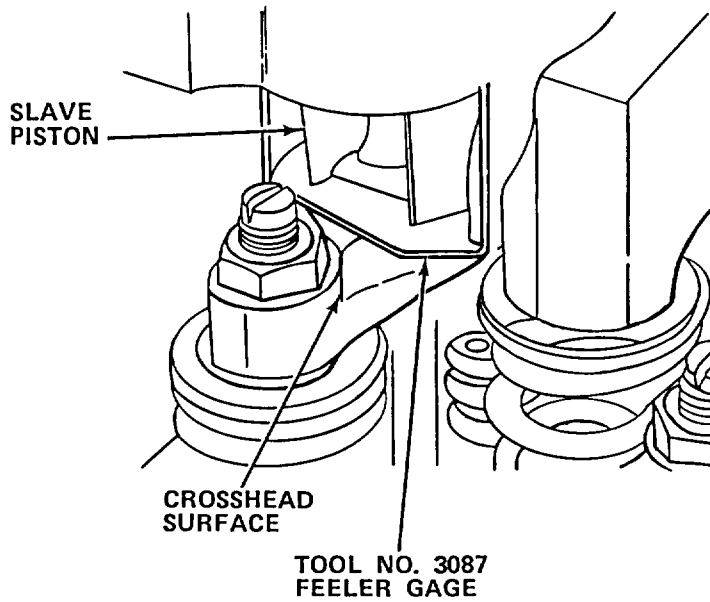
- (6) Carefully place retarder housings on studs and seat in position.

- (7) Place special tablock on two studs located in center web area of each housing.
- (8) Install hold-down nuts on all studs.
- (9) Torque nuts to 50 - 60 ft lbs (68 - 81 N•m) in same sequence as rocker lever housing retaining stud bolts.
- (10) Bend long tab of each tab lock down over housing surface and bend short tabs over hex flats of nuts.
- (11) Adjust retarder housing slave piston.



TA295589

- (a) Loosen slave piston adjusting screw locknut and backout screw until slave piston seats in its bore.
- (b) Rotate engine in direction of normal rotation until "A" mark on accessory drive pulley aligns with timing mark on front gear cover. Exhaust valves in cylinder 1 or 6 are closed.



TA295590

- (c) Insert a 0.018 in. (0.457 mm) feeler gage (tool no. 3087) between closed exhaust valve crosshead and slave piston.
- (d) Turn slave piston adjusting screw in until slight drag is felt on feeler gage.
- (e) Tighten locknut.

NOTE

Engine firing order (front to rear) is 1-5-3-6-2-4.

- (f) Continue rotating engine and setting remaining slave piston clearances in firing order.
 - (g) Check that brake solenoid electrical leads are securely attached to solenoids and brake housing terminals.
- ak. Install fan support brace, forward lift bracket, and power steering cooler mount bracket (TM 9-2320-281-20).
 - al. Install engine rear lift bracket (TM 9-2320-281-20).
 - am. Install air intake tube center support bracket (TM 9-2320-281-20).

- an. Install rocker housing cover (TM 9-2320-281-20).
- ao. Install aftercooler (TM 9-2320-281-34).
- ap. Remove engine from maintenance stand.
 - (1) Secure lifting fixture to forward and rear engine lift brackets.

WARNING

**DIRECT PERSONNEL TO STAND CLEAR DURING HOISTING OPERATION.
FAILURE TO DO THIS MAY CAUSE INJURY TO PERSONNEL.**

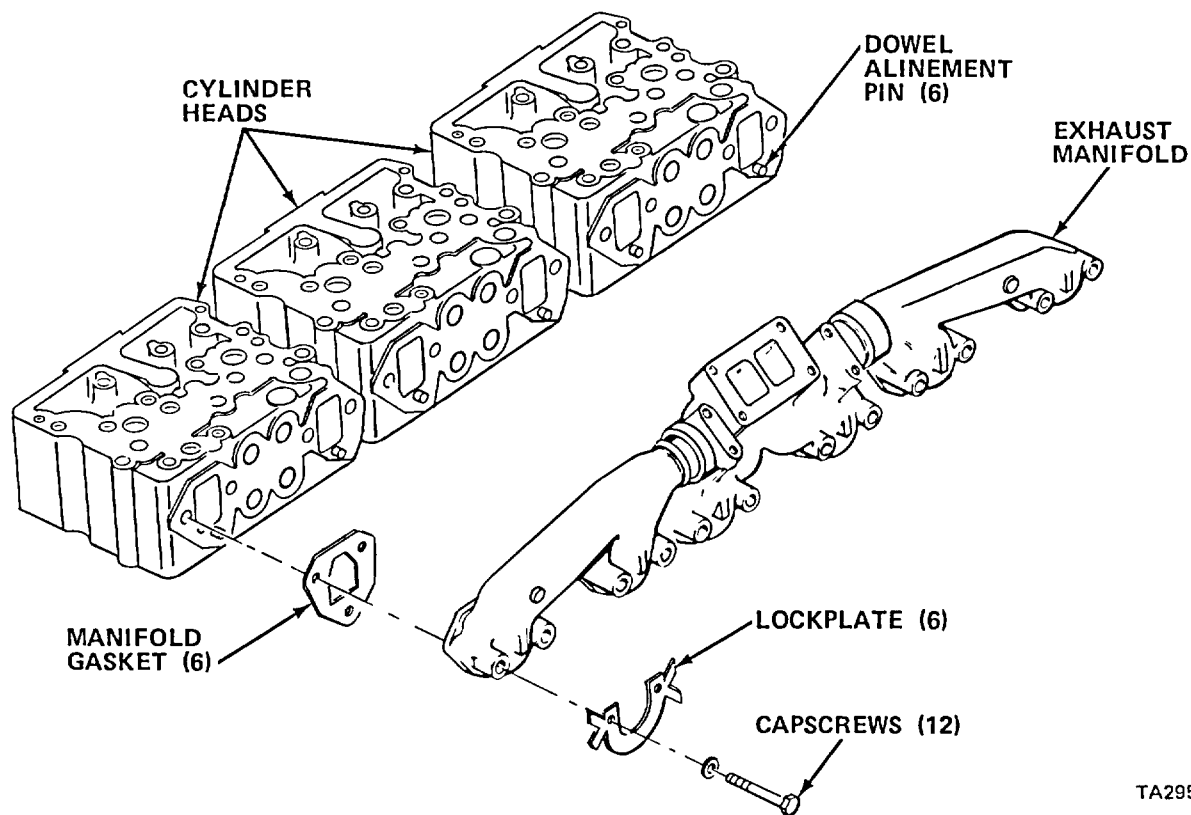
- (2) With weight of engine on hoist and fixture, remove capscrews and washers securing adapter plate to maintenance stand.
- (3) Roll stand away and position supports under engine.

CAUTION

DO NOT REST ENGINE ON OIL PAN. DAMAGE MAY RESULT TO PAN.

- (4) Slowly lower engine on supports. Engine oil pan-to-block mating flange will rest on support.
- (5) Remove lifting fixture.
- (6) Remove adapter plate capscrews and washers. Remove plate.
- (7) Remove rear water header cover adapter plate, capscrews and washers. Remove plate.
- aq. Install forward water header cover.
 - (1) Clean gasket mating surfaces of cylinder block and water header cover.
 - (2) Position new gasket on forward water header port.
 - (3) Secure cover to port with capscrews and lockwashers.
- ar. Install water inlet assembly (TM 9-2320-281-20).
- as. Install oil cooler and water header connection (TM 9-2320-281-34).

at. Install exhaust manifold.



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- (1) Place new steel exhaust manifold gasket over lower dowel alinement pins. Side marked "OUT" must face outward.
- (2) Assemble front, center, and rear manifolds.
- (3) Coat capscrew threads with antiseize compound.
- (4) Position manifolds and lockplates.
- (5) Secure plates and manifolds with capscrews and washers.
- (6) Torque capscrews to 25 ft lbs (34 Nm).
- (7) Bend lockplate tangs over capscrew heads.

au. Install air crossover connection (TM 9-2320-281-20).

av. Install turbocharger (TM 9-2320-281-20).

aw. Install oil dipstick and filler tube bracket (TM 9-2320-281-20).

ax. Install breather tube (TM 9-2320-281-20).

- ay. Install alcohol evaporator (TM 9-2320-281-20).
- az. Install alternator (TM 9-2320-281-20).
- ba. Install starter (TM 9-2320-281-20).
- bb. Install fan clutch assembly and drive belts (TM 9-2320-281-20).
- bc. Install power steering cooler (TM 9-2320-281-20).
- bd. Install starter relay mount bracket (TM 9-2320-281-20).

CAUTION

DO NOT INSTALL POWER STEERING PUMP IF ENGINE IS TO BE TESTED ON DYNAMOMETER. PUMP FAILURE WILL OCCUR IF PUMP OPERATED WITHOUT HYDRAULIC FLUID.

- be. Install cover plate on engine oil pump (if power steering pump not to be installed).
- bf. Install power steering pump if engine not to be tested on dynamometer (TM 9-2320-281-20).

Section XXXII. ENGINE TESTING

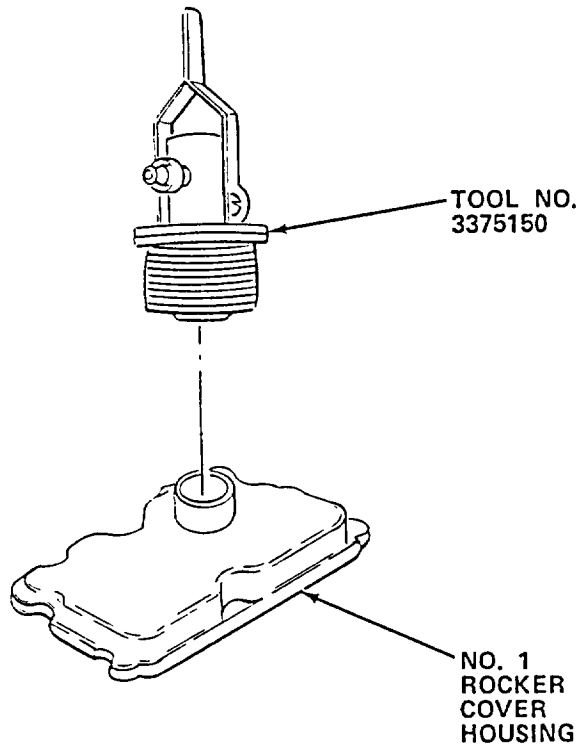
3-95. TEST ENGINE ASSEMBLY

NOTE

Break-in and testing are accomplished simultaneously. Break-in of new or rebuilt engine is necessary because it provides an operating period during which moving parts acquire their final finish and mating surfaces reach a full seat. Engine testing helps detect possible assembly errors, need for adjustments as engine "breaks-in," and establishes a period for final adjustments for best engine performance.

- a. Install engine on dynamometer.
 - (1) Place engine on dynamometer test stand.
 - (2) Secure engine mount pads to engine support risers.
 - (3) Position dynamometer drive shaft flange to engine flywheel. Check for proper alinement as per manufacturer's instructions.

- (4) Secure water supply and return hoses to water cooling arrangement.
- (5) Attach ST-1190 fuel consumption measuring device to engine.
- (6) Connect throttle linkage instruments, exhaust piping and air intake piping to engine.
- (7) Remove oil filler cap on no. 1 rocker housing cover.

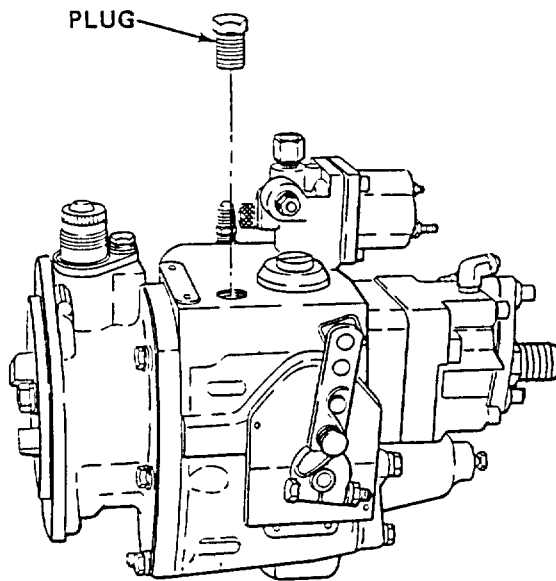


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- (8) Insert tool no. 3375150 blow-by checking tool in filler cap opening and secure in place.
- (9) Fill water manometer to 0 mark at middle of scale and secure to blow-by checking tool.

b. Prime fuel system.

- (1) Fill fuel tank and filter(s) with clean diesel fuel.



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- (2) Remove plug on top of fuel pump next to tachometer drive.
- (3) Fill pump housing with clean fuel.
- (4) Reinstall plug.
- (5) Ensure that injectors and valves have been properly adjusted.

c. Prime lubrication system.

- (1) Disconnect oil supply line to turbocharger.
- (2) Squirt 2 to 3 oz. (59 to 89 ml) of engine oil into housing.
- (3) Reconnect line.

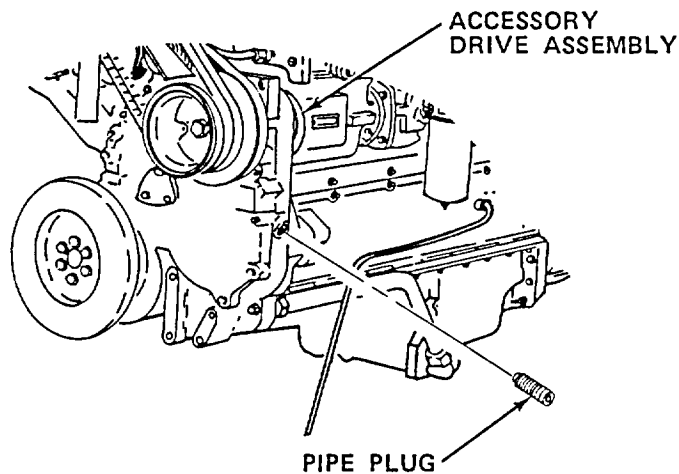
NOTE

Lube system capacity is 28 qts (26.6 l).

- (4) Fill crankcase to "L" (low) mark on dipstick.

CAUTION

DO NOT PRIME LUBE SYSTEM FROM REMOTE BYPASS FILTER CONNECTOR ON OIL COOLER ABOVE FILTER. IMPROPER PRIMING MAY RESULT, ACCELERATING ENGINE MOVING PARTS WEAR AND FAILURE.



TA295594

- (5) Remove pipe plug from left side of cylinder block.
- (6) Connect a hand or motor-driven priming pump line from source of clean lubricating oil to plug port in housing.
- (7) Prime until a 30 psi (207 kPa) maximum pressure is obtained.
- (8) Manually close fuel pump shut-off valve to prevent engine start.

CAUTION

DO NOT CRANK ENGINE CONTINUOUSLY FOR MORE THAN 30 SECONDS. EXCESSIVE CRANKING CAN OVERHEAT STARTER CAUSING POSSIBLE INTERNAL DAMAGE.

- (9) Crank engine for minimum of 15 seconds while maintaining external oil pressure at minimum of 15 psi (103 kPa).
- (10) Stop cranking.
- (11) Remove external priming line.

- (12) Reinstall pipe plug and torque to 60 - 70 ft lbs (81 - 95 N•m).
 - (13) Fill crankcase to "H" (high) mark on dipstick.
 - (14) Check engine for any water, fuel, or oil leaks. Correct any deficiencies.
- d. Pre-run start-up.
- (1) Open manual fuel shut-off valve at fuel pump.
 - (2) Disconnect turbocharger oil drain line at cylinder block.
 - (3) Start engine and maintain low idle speed (580 - 620 rpm).
 - (4) Observe turbocharger oil drain. Oil should flow in 10 to 15 seconds after start.
 - (5) If no oil flows in 30 seconds, shut down engine and correct fault.
 - (6) Reconnect oil drain line when flow established.
- e. Start engine.
- (1) Set throttle for low idle speed (580 - 620 rpm).

CAUTION

DO NOT CRANK ENGINE CONTINUOUSLY FOR MORE THAN 30 SECONDS. EXCESSIVE CRANKING CAN OVERHEAT STARTER CAUSING POSSIBLE INTERNAL DAMAGE.

- (2) Actuate start switch and release upon engine start.
- (3) Start water to dynamometer as per manufacturer's instructions.

- f. Perform break-in and test procedures.

NOTE

Maximum horsepower rating is 400 hp at 2100 rpm. Maximum performance would be delivered at sea level, 60°F (16°C) intake air temperature and 29.92 in. Hg (760.0 mm Hg) barometric pressure.

If deaeration is necessary because of extremely high altitude operation (above 12,000 ft [3658 m]), deaerate at 4 percent for each 1000 ft (305 m) additional altitude and 1 percent for each 10°F air temperature rise above 60°F (16°C).

New or newly rebuilt engines during dynamometer testing are not required to deliver more than 96 percent of maximum horsepower at power checks.

- (1) Set engine speed at 800 rpm at no load for five to ten minutes.

CAUTION

ABNORMALLY HIGH OIL PRESSURE MAY INDICATE BLOCKED LUBE PASSAGES OR LINES. ABNORMALLY LOW PRESSURE MAY INDICATE INSUFFICIENT SUPPLY OF LUBE OIL FROM PUMP DUE TO PUMP WEAR, EXTERNAL LEAKAGE, OR INCREASED CLEARANCES DUE TO BEARING FAILURE.

- (2) Check oil pressure for 10 - 32 psi (69.0 - 220.8 kPa). Shut down engine if pressure not within specifications.
- (3) Check for proper water circulation, fuel, oil, and air leaks.

(4) At each phase:

Table 3-7. Dynamometer Test Chart

Engine	HP@ RPM	Rated HP@RPM 500 Ft-Alt	Fuel Rate LB/HR	Air Manifold Pressure IN/HG	Rating @ Altitude Maximum FT.	Crankcase Pressure With Turbo IN/H ₂ O	Phase 1 To Temp HP@ RPM	Phase 2 15 Min. HP@ RPM	Phase 3 15 Min. HP@ RPM	Phase 4 15 Min. HP@ RPM	Power Check 5 Min. HP@ RPM	Torque Ft/Lb Sea Level	Torque Ft/Lb 500 Ft Alt.
NTC-400 BC2	400@ 2100	400@ 2100	158	41/49	12,000	12	200@ 1575	300@ 2100	340@ 2100	360@ 2100	380@ 2100	1000	1000

NOTE

NTC400BC2 engine does not require fuel deaerating below altitude shown in column entitled "Rating Altitude Maximum." Above maximum altitude, deaerate at each 1,000 ft (304.8 m) additional altitude by 4 percent. Crankcase pressure is given in inches of water. Percent of HP @ RPM ratings for break-in phases are established as follows

- Phase 1 - 50% HP @ 75% RPM
- Phase 2 - 75% HP @ 100% RPM
- Phase 3 - 85% HP @ 100I RPM
- Phase 4 - 90% HP @ 100% RPM
- Power Check - 96% HP @ 100% RPM

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(a) Apply dynamometer load to +10% horsepower at +5% speed as shown.

NOTE

Crankcase pressure (blow-by) manometer readings not exceeding 0.30 in. H₂O (7.62 mm H₂O) surge are normal.

- (b) Make frequent checks of crankcase pressure (blow-by) at any given stabilized speed. If pressure surge exceeds 0.30 in H₂O (7.62 mm H₂O), reduce speed for 30 to 45 minutes, and then accelerate back to original setting.
- (c) If blow-by continues to drop at any given speed, cut run-in time in half; otherwise, run engine for specified time period.

Table 3-8. Oil Pressure Specifications

PSI	Speed
35-45	Rated
30	Torque Peak (Minimum)
10-32	Idle

NOTE

Specifications are for pressures at operating oil and water temperatures.

- (d) Check oil pressure. Pressure should remain at or near constant at speeds and loads specified.

CAUTION

ALLOW ENGINE TO IDLE 3 TO 5 MINUTES BEFORE SHUTTING DOWN TO PREVENT TURBOCHARGE BEARINGS SEIZURE AND ENGINE COOLANT FROM BOILING.

- (e) If oil pressure not within specifications, cool and shutdown engine. Investigate and correct as necessary.
- (f) After every phase during run-in, shut down engine and service oil to "H" mark on dipstick. New oil filter will absorb some oil.
- (g) Check oil temperature. If temperature rises sharply above 250°F (121°C), cool and shut down engine. Investigate and correct as necessary.
- (h) After engine started, add coolant as necessary to completely fill cooling system and remove entrapped air.
- (i) Check coolant temperature. Coolant should not exceed 200°F (93°C) or drop below 160°F (71°C) during engine operation.

- (5) At Phase 1.
 - (a) Run engine until normal oil operating temperature is obtained.
 - (b) Run at speed and horsepower indicated.
 - (c) Check for proper blow-by, oil pressure, oil temperature, and coolant temperature indications.
 - (d) Check for fuel, oil, coolant, and air leaks.
 - (e) Cool and shut down engine.
 - (f) Service oil system as required.
- (6) At Phase 2.
 - (a) Run engine at speed and horsepower indicated.
 - (b) Perform all checks listed in Phase 1.
 - (c) Set engine idle speed and governed speed.
 - (d) Service oil system as required.
- (7) At Phase 3.
 - (a) Run engine at speed and horsepower indicated.
 - (b) Perform all checks listed in Phase 1.
 - (c) Cool and shut down engine.
 - (d) Service oil system as required.
- (8) At Phase 4.
 - (a) Run engine at speed and horsepower indicated.
 - (b) Check closely for leaks and tighten all accessible capscrews.
 - (c) Perform power check below (para g).
 - (d) Cool and shut down engine.
 - (e) Check injector and valve adjustment clearances.

NOTE

Readjustment after one hour of operation is necessary to assure lowest smoke potential and to avoid excessive injector train load.

- 1 Set valves to "HOT" setting in accordance with Table 3-7.
- 2 Use tool no. 3375096 adjustment kit to adjust valves with engine brake housings installed.

g. Perform power check.

- (1) Run engine at speed and horsepower indicated on Table 3-7.
- (2) Check fuel flow standard rate for 158 lb/hr at rated speed and power. Engine should develop 96 percent (384 hp) of rated (400 hp) horsepower at standard fuel flow rate.
- (3) Operate engine an additional 30 minutes at 96 - 100 percent rated load (384 - 400 hp) and rpm (2016 - 2100 rpm).

NOTE

Surges of up to 0.30 in. H₂O (7.62 mm H₂O) are acceptable.

- (4) Check blow-by pressure. If there is no rapid change in excess of 2 in. H₂O (50.8 mm H₂O) of water and reading does not exceed 12 in. H₂O (304.8 mm H₂O), blow-by is acceptable.
- (5) If blow-by exceeds surge limit of 0.3 in. H₂O (7.62 mm H₂O) or 12 in. H₂O (304.8 mm H₂O) or changes in excess of 2 in. H₂O(50.8 mm H₂O), investigate cause.
- (6) Cool and shut down engine.
- (7) Perform on-engine fuel pump adjustment if pump was removed for calibration and reinstalled (TM 9-2320-281-34).

Section XXXIII. PREPARATION FOR STORAGE OR SHIPMENT

3-96. GENERAL. An engine not in service is subject to rust and corrosion, particularly its unpainted machined surfaces. The rate of corrosion varies with climatic conditions. An engine stored in a climate with high humidity will corrode more rapidly than an engine stored in a dry climate.

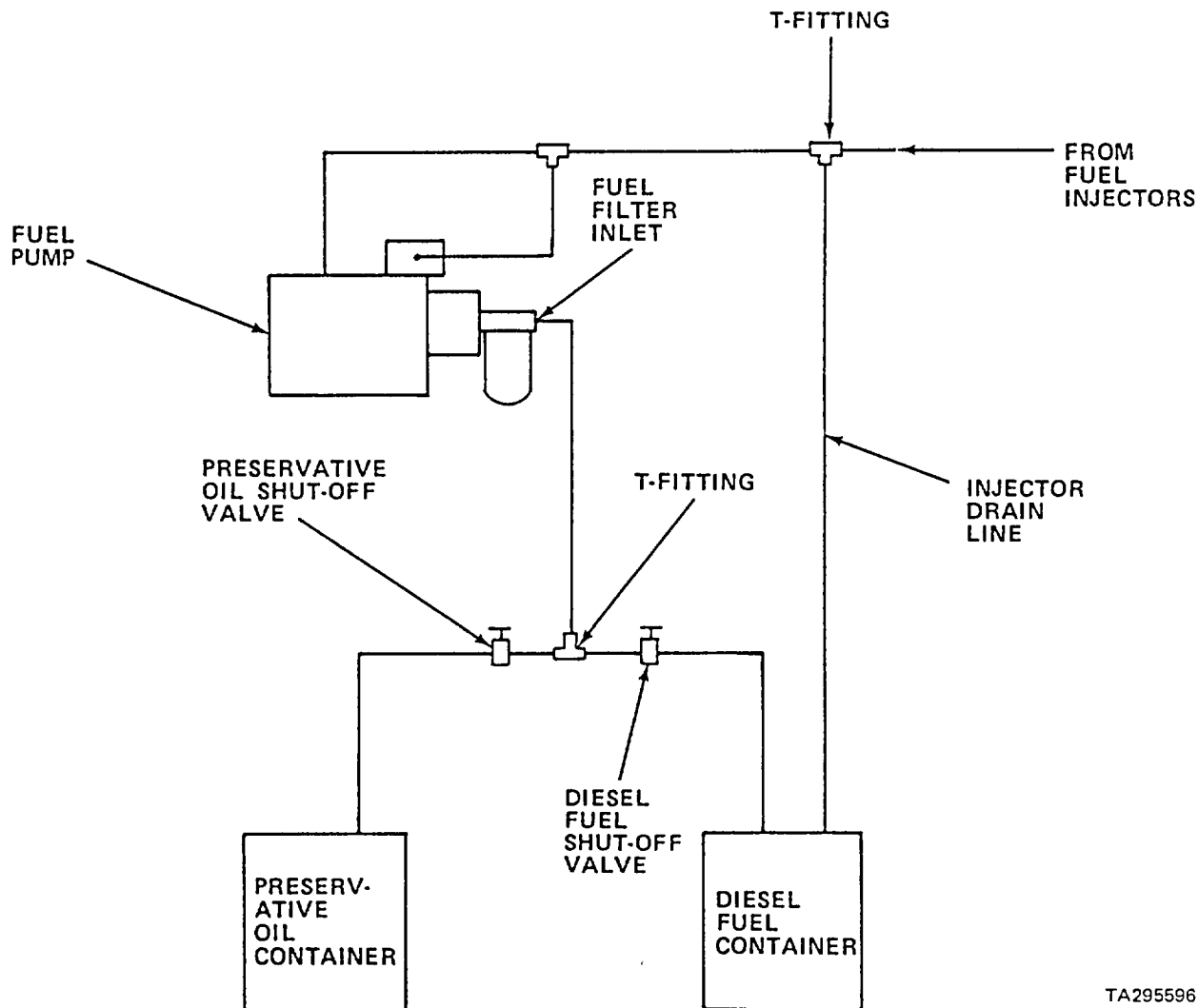
- a. Preparation for temporary storage.

NOTE

If an engine remains out of service for less than six months, special precautions should be taken to prevent rust. The following procedures are required to minimize or prevent damage to temporarily stored engines.

- (1) Install engine on test stand and operate until thoroughly warm, then shut down.
- (2) Disconnect fuel supply line from engine fuel filter and injector drain line from drain line T-fitting (TM 9-2320-281-20).

- (3) Fill two five-gallon containers, one with diesel fuel and the other with MIL-L-644, Type P-9 preservative oil.



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- (4) Assemble a shut-off valve and T-fitting to a line from the preservative oil container.
- (5) Assemble a second shut-off valve to a line from the diesel fuel container.
- (6) Connect line from diesel fuel shut-off valve to preservative oil shut-off valve T-fitting.
- (7) Attach a fuel line to the T-fitting and secure other end to engine fuel pump fuel filter inlet.
- (8) Open diesel fuel shut-off valve and close preservative oil shut-off valve.

- (9) Attach injector drain line to diesel fuel container to collect drainage while running engine.
- (10) Start engine and run until smoothly operating.
- (11) Slowly open preservative oil shut-off valve while closing diesel fuel shut-off valve.
- (12) Operate engine for 5 to 10 minutes at 1500 rpm on preservative oil only (preservative oil shut-off valve fully open; diesel fuel shut-off valve fully closed).
- (13) Shut down engine.
- (14) Disconnect engine fuel pump fuel filter inlet line and install cap on filter inlet fitting.
- (15) Disconnect injector drain line from engine T-fitting and install cap on T-fitting.
- (16) Drain engine crankcase. Crankcase may remain empty until engine is ready for use.
- (17) Disconnect electrical lead from fuel pump shut-off valve and manually turn shut-off valve knob fully to the left.
- (18) Slowly crank engine and atomize spray one ounce of MIL-L-46002, Grade 1 or MIL-L-23310, Grade 1 oil into air crossover and one ounce into turbocharger air inlet.
- (19) Tag engine stating, "ENGINE PRESERVED. DO NOT CRANK UNTIL ISSUED TO USER. CRANKCASE MUST BE SERVICED WITH ENGINE OIL PRIOR TO OPERATION".
- (20) Store engine in dry and uniform temperature area.
- (21) Rotate engine crankshaft two or three revolutions every three to four weeks.
- (22) Atomize spray all surfaces inside of engine flywheel housing with thin film of MIL-C-16173, Grade 4 preservative.
- (23) Seal off engine flywheel housing with PPP-T-60, Class 1 tape.
- (24) Seal off turbocharger inlet and outlet ports, water transfer tube inlet port, thermostat housing outlet port, starter mount pad (if starter removed), breather tube outlet, and oil filler and dipstick tube mount ports (if cover not installed) with MIL-B-131, AP-104-00 barrier paper and/or PPP-T-60, class 1 tape.
- (25) Cap or plug all open lines and fittings.

- b. Preparation for permanent storage

NOTE

If engine is to be stored for six months or more, its lubrication system, cooling system, fuel system, combustion system, and external parts must be protected against rust and corrosion.

Preserve lubrication system before preserving fuel, combustion, and cooling systems.

Engine lubrication system has 28 qt (26.6 l) capacity.

- (1) Remove oil pan drain plug and drain crankcase. Reinstall drain plug.
- (2) Fill crankcase to full mark on oil dipstick with MIL-L-21260, Type 1, Grade 30 preservative oil.
- (3) Attach a tag to crankcase filling location. Mark tag to read "THIS CRANKCASE IS FILLED TO THE OPERATING LEVEL WITH PRESERVATIVE LUBRICATING OIL GOOD FOR OPERATION UNTIL THE FIRST REQUIRED LUBRICANT CHANGE - DO NOT DRAIN - CHECK OIL LEVEL - IF LOW, FILL TO THE OPERATING LEVEL WITH MIL-L-45199, GRADE 30 OPERATING OIL".
- (4) Disconnect fuel supply line from engine fuel pump filter and injector drain line from drain line T-fitting.
- (5) Fill two five-gallon containers, one with diesel fuel, the other with MIL-L-644, Type P-9 preservative oil.
- (6) Assemble a shut-off valve and T-fitting to a line from the preservation container.
- (7) Assemble a second shut-off valve to a line from the diesel fuel container.
- (8) Connect line from diesel fuel shut-off valve to preservative oil T-fitting.
- (9) Attach a fuel line to the T-fitting and secure either end of line to engine fuel pump filter inlet.
- (10) Open diesel fuel shut-off valve and close preservative oil shut-off valve.
- (11) Attach injector drain line to diesel fuel container to collect drainage while running engine.
- (12) Remove air compressor inlet and discharge air lines.

- (13) Start engine and run until smoothly operating.
- (14) Slowly open preservative oil shut-off valve while closing diesel fuel shut-off valve.
- (15) Operate engine for 5 to 10 minutes at 1500 rpm on preservative oil only (preservative oil shut-off valve fully open; diesel fuel shut-off valve fully closed).
- (16) Spray MIL-L-21260, Type 1, Grade 10 preservative oil into air compressor inlet port until oil appears at outlet port.
- (17) Shut down engine.
- (18) Reconnect air compressor lines to compressor.
- (19) Disconnect engine fuel pump filter inlet line and install cap on fuel inlet fitting.
- (20) Disconnect injector drain line from engine T-fitting and install cap on T-fitting.
- (21) Allow cylinder head temperature to cool to 100°F (38°C). It is permissible to accelerate cooling process with fans or other appropriate cooling methods.
- (22) Remove aftercooler (TM 9-2320-281-34), turbocharger (TM 9-2320-281-20), and exhaust manifold (para 3-6 f).
- (23) Remove rocker arm covers (TM 9-2320-281-20).
- (24) Manually depress each intake valve and while each valve is open, atomize spray 1/2 ounce of MIL-L-21260, Type 1, Grade 10 oil into each intake port.
- (25) Manually depress each exhaust valve and while each valve is open, atomize spray 1/2 ounce of MIL-L-21260, Type 1, Grade 10 oil into each exhaust port.

WARNING

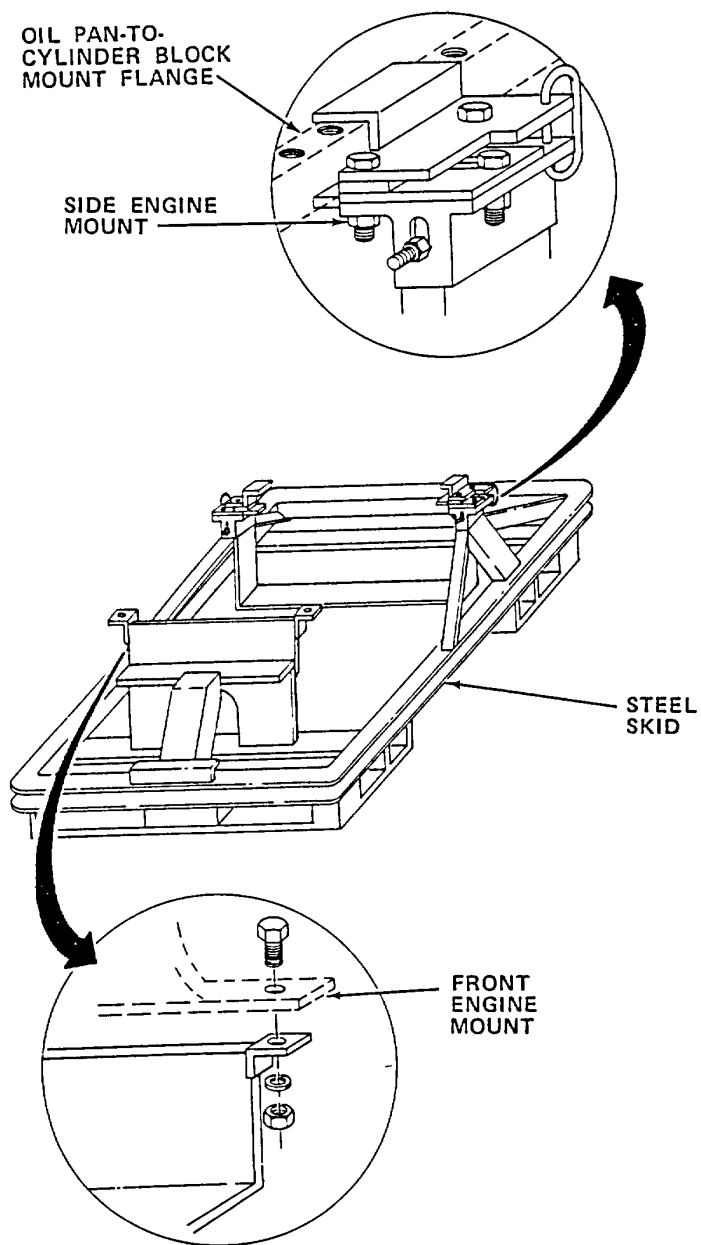
ENGINE CAN FIRE AND RUN ON PRESERVATIVE OIL IN THE FUEL LINES.

- (26) Rotate crankshaft at least two complete revolutions.
- (27) Repeat steps (23) and (24) above.
- (28) Check aftercooler and exhaust manifold mount gaskets for deterioration and damage. Replace if defective.

- (29) Reinstall aftercooler (TM 9-2320-281-34) and turbocharger (TM 9-2320-281-20) and exhaust manifold (para 3-6). Leave turbocharger air cross-over connection disconnected from turbocharger air discharge port.
- (30) Atomize spray one ounce of MIL-L-46002, Grade 1 or MIL-L-23310, Grade 1 oil into air crossover connection towards the aftercooler and one ounce of same oil into turbocharger air inlet.
- (31) Secure air crossover connection to turbocharger with T-bolt clamp. Tap outer circumference of clamp with soft-headmallet while tightening clamp.
- (32) Spray all inner surfaces of engine brake housings and engine rocker lever housings, rocker levers, valve stems, valve springs, valve guides, push rods, and inside surface of each rocker arm cover with MIL-L-21260, Type 1, Grade 10 preservative oil.
- (33) Check rocker arm covers gaskets for breaks, deterioration, or damage. Replace if defective (TM 9-2320-281-20).
- (34) Reinstall rocker arm covers (TM 9-2320-281-20).
- (35) Release tension on water pump and idler assembly drive belt (TM 9-2320-281-20).
- (36) Release tension on alternator drive belts (if alternator installed) (TM 9-2320-281-20).
- (37) Release tension on fan clutch actuator drive belts (if fan clutch actuator installed) (TM 9-2320-281-20).
- (38) Coat unpainted pulley grooved surfaces with MIL-P-46093 primer.
- (39) Securely attach a warning tag in a conspicuous place. Mark tag to read, "BELT TENSION RELEASED; ADJUST BEFORE STARTING ENGINE".
- (40) Atomize spray all surfaces inside of engine flywheel housing with thin film of MIL-C-16173, Grade 4 preservative.
- (41) Seal off engine flywheel housing with PPP-T-60, Cass 1 tape.
- (42) Seal off turbocharger inlet and outlet ports, water transfer tube inlet port, thermostat housing outlet port, starter mount pad (if starter removed), breather tube outlet, and oil filler and dipstick tube mount ports (if cover not installed), with MIL-B-131, AP-104-11 barrier paper and/or PPP-T-60, Class 1 tape.
- (43) Cap or plug all open lines and fittings.

c. Preparation for shipment

- (1) Preserve engine for permanent storage (para b above).
- (2) Wipe engine clean.
- (3) Lift engine and place on steel shipping skid.

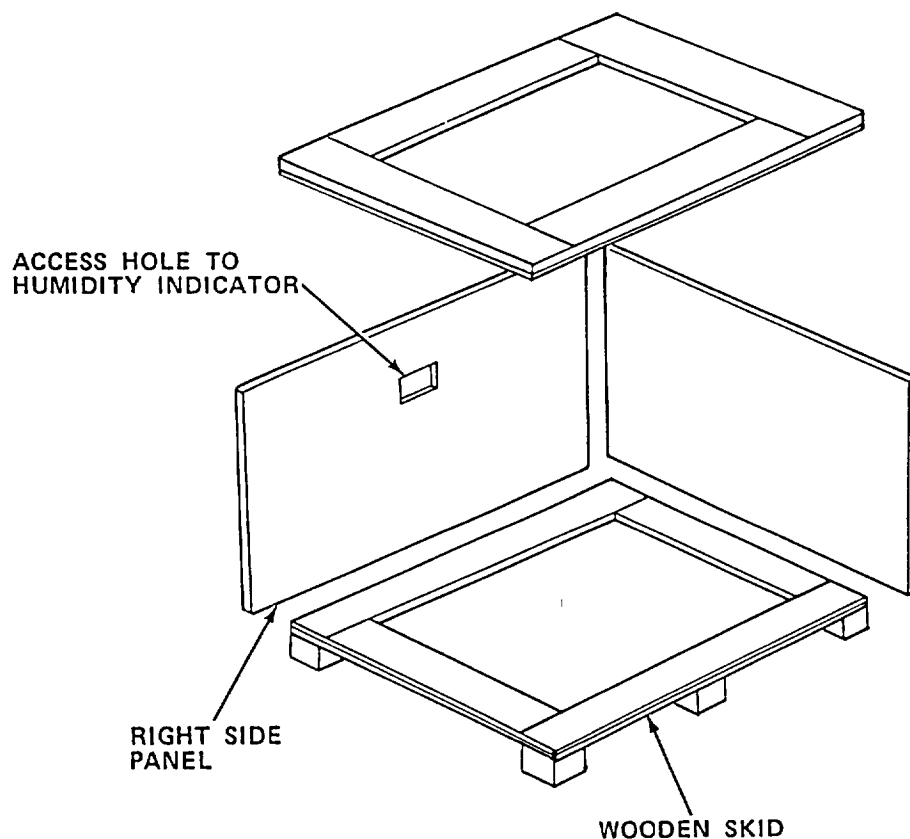


- (4) Secure front engine mount to skid with capscrews, nuts, and washers.

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- (5) Secure skid left and right side mounts to engine oil pan-to-cylinder block mount flange.
- (6) Place wooden skid under hoist assembly.
- (7) Lay one layer of 1 in. (25.4 mm) thick cushioning material on top surface of wooden skid.
- (8) Cut a piece of MIL-B-131, AP-104-00 barrier paper large enough to act as a bag, completely covering the entire engine.
- (9) Lay another layer of the 1 in. (25.4 mm) cushioning material (same size as the first) over barrier paper on skid.
- (10) Lay another layer of the 1 in. (25.4 mm) cushioning material (same size as the first) over barrier paper on skid.
- (11) Lift engine and steel skid with engine lifting fixture and lower engine into wooden skid. Steel skid will be held captive by wooden skid and weight of engine; therefore, no bolts are required to attach skids together.
- (12) Remove engine lifting fixture.
- (13) Carefully pull barrier paper over engine forming a bag.
- (14) While holding bag together, cut a 6 in. (152.4 mm) by 4 in. (101.6 mm) window in right side of bag.
- (15) Tape a humidity indicator in position over window with PPP-T-60, class 1 tape.
- (16) Place 16 bags of 240 units desiccant in bag.
- (17) Seal off bag with PPP-T-60, Class 1 tape leaving a small opening for air evacuation.
- (18) Using a medium duty industrial vacuum cleaner, insert vacuum cleaner hose into opening in bag.
- (19) Turn on cleaner and evacuate air from bag.

- (20) With cleaner running, quickly withdraw hose from bag and seal off opening with tape.



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- (21) Select wooden box side panel which will enclose right side of engine and temporarily nail panel to wooden skid.
- (22) Mark relative position of bag humidity indicator on inside surface of side panel.
- (23) Remove side panel and cut a hole 6 in. (152.4 mm) by 4 in. (101.6 mm) where marked.
- (24) Assemble side panels, end panels and top, and nail in position.
- (25) Mark box and affix label as required.

APPENDIX A

REFERENCES

A-1. PUBLICATION INDEXES

Indexes should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to material covered in this publication.

a. Military Publication Indexes.

Consolidated Index of Army Publications and Blank Forms.....	DA PAM 310-1
Index of Army Motion Pictures and Related Audiovisual Aids	DA PAM 108-1
U.S. Army Equipment Index of Modification Work Orders	DA PAM 750-10

b. General References.

Catalog of Abbreviations and Brevity Codes	AR 310-50
First Aid for Soldiers	FM 21-11
How to Prepare and Conduct Military Training	FM 21-6
Military Symbols	FM 21-30

A-2. FORMS

Refer to DA PAM 738-750, The Army Maintenance Management System (TAMMS), for instructions on the use of maintenance forms pertaining to the materials.

A-3. ARMY REGULATION, FIELD MANUALS, LUBRICATION ORDER, TECHNICAL BULLETINS, AND TECHNICAL MANUALS

The following publications contain information pertinent to the major item of materiel and associated equipment.

a. Vehicle.

Lubrication Order Truck Chassis for Direct Support Section Topographic Support System (TSS).....	LO 9-2320-281-12
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A-3. ARMY REGULATION, FIELD MANUALS, LUBRICATION ORDER, TECHNICAL BULLETINS, AND TECHNICAL MANUALS (Continued)

a. Vehicle (Continued)

Operator's Manual Truck Chassis for Direct Support Section Topographic Support System (TSS)..... TM 9-2320-281-10

Hand Receipt Covering Contents of Components of End Item (COEI), Basic Issue Items (BII), and Additional Authorization List (AAL) for Truck Chassis: for Direct Support Section, Topographic Support System (TSS)..... TM 9-2320-281-10-HR

Organizational Maintenance Manual Truck Chassis: for Direct Support Section, Topographic Support System (TSS)..... TM 9-2320-281-20

Organizational Maintenance Repair Parts and Special Tools List for Truck Chassis: for Direct Support Section, Topographic Support System (TSS)..... TM 9-2320-281-20P

Direct Support and General Support Maintenance Manual Truck Chassis: for Direct Support Section, Topographic Support System (TSS)..... TM 9-2320-281-34

Direct Support and General Support Maintenance Repair Parts and Special Tools List for Truck Chassis: for Direct Support Section, Topographic Support System (TSS)..... TM 9-2320-281-34P

Direct Support and General Support Maintenance Repair Parts and Special Tools List for Engine, Diesel, 6 Cylinder Inline, Turbocharged, Model NTC-400 BC2 TM 9-2815-226-34P

b. Camouflage.

Camouflage..... FM 5-20

c. Decontamination.

Chemical, Biological, and Radiological (CBR) Decontamination.....TM 3-220

NBC (Nuclear, Biological, and Chemical) DefenseFM 21-40

Nuclear, Biological, and Chemical (NBC) Reconnaissance and Decontamination Operations (How to Fight).....FM 3-87(HTF)

A-3. ARMY REGULATION, FIELD MANUALS, LUBRICATION ORDER, TECHNICAL BULLETINS, AND TECHNICAL MANUALS (Continued)

d. General.

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Manual for the Wheeled Vehicle Driver.....FM 21-305

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Prevention of Motor Vehicle AccidentsAR 385-55

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Procedures for Destruction of Tank-Automotive Equipment to
Prevent Enemy Use..... TM 750-244-6

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e. Maintenance and Repair.

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Description, Use, Bonding Techniques, and Properties of Adhesives..... TM ORD 1032

Inspection, Care, and Maintenance of Antifriction BearingsTM 9-214

Materials Used for Cleaning, Preserving, Abrading and Cementing Ordnance
Materiel and Related Materials Including Chemicals.....TM 9-247

Operator's, Organizational, Direct Support and General Support Maintenance
Manual of Lead-Acid Storage Batteries..... TM 9-6140-200-14

Operator's Manual for Welding Theory and Application.....TM 9-237

Painting Instructions for Field Use..... TM 43-0139

Use of Antifreeze Solutions and Cleaning Compounds in Engine
Cooling Systems..... TB 750-651

f. Administrative Storage.

Administrative Storage of Equipment..... TM 740-90-1

APPENDIX B**EXPENDABLE SUPPLIES AND MATERIALS LIST**

Section I. INTRODUCTION**1. SCOPE**

This appendix lists expendable supplies and material you will need to operate and maintain the NTC-400 BC2 Diesel Engine. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

2. EXPLANATION OF COLUMNS

a. Column (1) - Item number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, Item 5, App. "B").

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed item.

- C - Operator/Crew
- O - Organizational Maintenance
- F - Direct Support Maintenance
- H - General Support Maintenance

c. Column (3) - National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parenthesis followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	O		ANTIFREEZE, PERMANENT ETHYLENE GLYCOL (60 F) INHIBITED, O-A-548, TYPE 1 MIL-A-46153 1-GAL CONTAINER	GAL
2	F	8135-00-282-0565	BARRIER MATERIAL, WATER-VAPOR PROOFED, MIL-B-131	RO
3	F	5350-00-221-0872	CLOTH, CROCUS, P-C-458	SH
4	F	5350-00-584-4654	CLOTH, EMERY, 290, GRIT, A-A-1049	SH
5	C	7920-00-292-9204	CLOTH, LINT-FREE, CCC-C-46	LB
6	F		COMPOUND, ANTISIEZE, MIL-A-907	LB
7	F	8030-00-753-4953	COMPOUND, ANTISIEZE MIL-A-13881	LB
8	F	5350-00-224-6692	COMPOUND, LAPPING 280 GRIT, SSL-1682, 1-PT CAN	PT
9	F	6850-00-664-9067	COMPOUND, PRUSSIAN BLUE, MIL-L-83795	
10	F	8030-00-181-7529	COMPOUND, RETAINING MIL-R-46082	BT
11	F	8030-00-244-1297	CORROSION-PREVENTIVE COMPOUND, STORAGE, MIL-C-16173	
12	F	6850-00-782-2717	DEVELOPER, SPOTCHECK, SKD-NF	
13	F	9150-00-698-2382	FLUID, AUTOMATIC TRANSMISSION TYPE A, AQATF1562A 1-QT CAN	QT

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS LIST (CONTINUED)

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
14	F		FLUID, CALIBRATION, INJECTOR TEST STAND, 45A 1-PT CAN	PT
15	C		FUEL OIL, DIESEL, DF-2, VV-F-800	
		9140-00-286-5294	BULK	GAL
		9140-00-286-5295	5-GAL CAN	GAL
		9140-00-286-5296	55-GAL DRUM, 16-GAGE	GAL
		9140-00-286-5297	55-GAL DRUM, 18-GAGE	GAL
16	C		GREASE, AUTOMOTIVE AND ARTILLERY, GAA, MIL-G-10924C	
		9150-00-065-0029	2-1/2 OZ TUBE	OZ
		9150-00-935-1017	14-OZ CARTRIDGE	OZ
		9150-00-190-0904	1-LB CAN	LB
		9150-00-190-0905	5-LB CAN	LB
		9150-00-190-0907	35-LB CAN	LB
			120-LB DRUM	LB
17	F	6850-00-753-4967	INHIBITOR, CORROSION, MIL-L-23310	CN
18	F	6850-00-826-0981	INSPECTION PENETRANT KIT	KT
19	F	8030-00-081-2330	LOCTITE, MIL-S-2274 (GRADE CV)	PT
20	F	9150-00-458-0075	LUBRICANT, HIGH PRESSURE, BRAYCO300	PT
21	O		LUBRICATING OIL, GEAR, MULTIPURPOSE, GO-80/140, MIL-L-2105C	
		9150-01-035-5390	1-QT CAN	QT
		9150-00-001-9395	5-GAL CAN	GAL
		9150-01-035-5396	55-GAL DRUM	GAL

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS LIST (CONTINUED)

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
22	C	9150-00-183-7807 9150-00-189-6727	LUBRICATING OIL, OE/HDO 10, MIL-L-2104C BULK 1-QT CAN 5-GAL DRUM	GAL QT GAL
		9150-00-191-2772	55-GAL DRUM, 16-GAGE 55-GAL DRUM, 18 GAGE	GAL GAL
23	C	9150-00-186-6681 9150-00-188-9858 9150-00-189-6729	LUBRICATING OIL, OE/HDO 30, MIL-L-2104C BULK 1-QT CAN 5-GAL DRUM 55-GAL DRUM, 16-GAGE 55-GAL DRUM, 18-GAGE	GAL QT GAL GAL GAL
24	F	9150-00-111-0209 9150-00-111-0210	LUBRICATING OIL, PRESERVATIVE AND BREAK-IN, MIL-L-21260 5-GAL CAN 55-GAL DRUM	GAL GAL
25	F	9150-00-889-3523 9150-00-985-7293	LUBRICATING OIL, PRESERVATIVE, MIL-L-46002, CORROSION INHIBITED 1-QT CAN 5-GAL CAN 55-GAL DRUM	QT GAL GAL
26	F	8010-00-837-7969	MINERAL SPIRITS, TT-T-291	GAL
27	F	6810-00-222-9641	MURIATIC ACID, TECHNICAL 30%	PT
28	F		OIL, CUTTING, TOLEDO BLACK	GAL
29	F	6810-00-132-4020	OXALIC ACID, CRYSTAL	PT
30	F	5350-00-543-3600	PAPER, ALUMINUM OXIDE, 240 GRIT, ALOY GRIT 80	EA
31	F	9150-00-231-2361 9150-00-231-2356	PRESERVATIVE OIL, MEDIUM, MIL-L-3150 1-QT CAN 5-GAL CAN 55-GAL DRUM	QT GAL GAL

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS LIST (CONTINUED)

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
32	F	9150-00-407-0973	PRESERVATIVE OIL, MIL-P-46002 1-QT CAN 55-GAL CAN	QT GAL
33	F	8010-00-943-6694	PRIMER COATING, METAL, MIL-P-46093	QT
34	F	6810-00-227-0407	PYRIDENE, LIQUID	PT
35	F	8030-00-247-2524	SEALANT, CUP PLUG, MIL-S-45180	OZ
36	F	8030-00-246-0933	SEALANT, PIPE, MIL-S-15204	OZ
37	F	8030-00-543-4384	SEALANT, THREAD AND GASKET MIL-S-7916	OZ
38	F	6810-00-233-1715	SODIUM CARBONATE, (5% SOLUTION)	PT
39	C	7930-01-055-6121	SOLUTION, SOAP	GL
40	O	6850-00-664-5685 6850-00-281-1985 6850-00-274-5421 6850-00-285-8012 6850-00-285-8011	SOLVENT, DRY CLEANING, SD-2, FED SPEC P-D-680, TYPE II 1-QT CAN 1-GAL CAN 5-GAL CAN 55-GAL DRUM, 16-GAGE 55-GAL DRUM, 18-GAGE	QT GAL GAL GAL GAL
41	F	7510-00-074-4952 5970-00-944-5014	TAPE, PRESSURE SENSITIVE, PACKAGING, PPP-T-60, 2-IN. GUIDE 50-FT ROLL, 1/4-INCH WIDE 50-FT ROLL, 1/2-INCH WIDE	RO FT FT
42		8040-00-902-3871 8040-00-865-8991	TEFLON LIQUID, MIL-A-46106 3 -OZ TUBE 12-OZ CAN	OZ OZ

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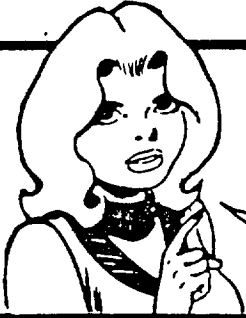
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TEAR ALONG PERFORATED LINE

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
 1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
 1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
 1 Kilogram = 1000 Grams = 2.2 Lb
 1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
 1 Liter = 1000 Milliliters = 33.82 Fluid Ounces
 320 Fahrenheit is equivalent to 0° Celsius

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
 1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
 1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
 1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu. Feet

TEMPERATURE

$5/9 (^{\circ}\text{F} - 32) = ^{\circ}\text{C}$
 212° Fahrenheit is equivalent to 100° Celsius
 90° Fahrenheit is equivalent to 32.2° Celsius
 $9/5 (^{\circ}\text{C} + 32) = ^{\circ}\text{F}$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.45
Short Tons	Metric Tons	0.0907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.195
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters Fluid	Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621

