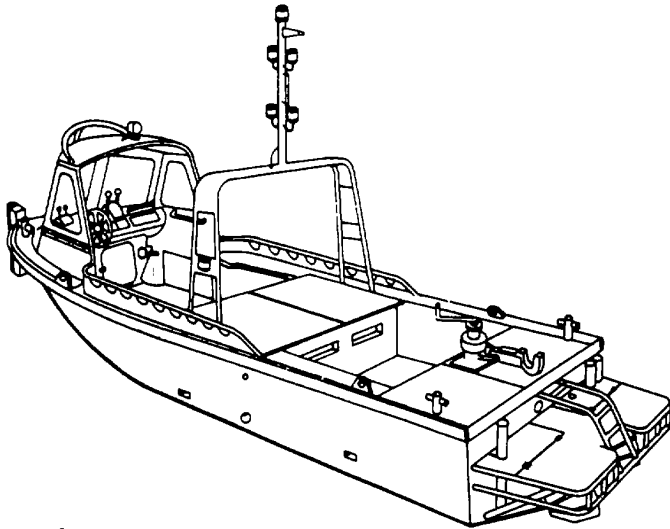


**TECHNICAL MANUAL
DIRECT AND GENERAL SUPPORT
MAINTENANCE MANUAL**



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**BOAT, BRIDGE ERECTION,
TWIN JET, ALUMINUM HULL
MODEL USCSBMK I
(1940-01-105-5728)**

This copy is a reprint which includes current pages from Changes 1 through 4.

HEADQUARTERS, DEPARTMENT OF THE ARMY

10 NOVEMBER 1981

CHANGE
NO. 7

HEADQUARTERS
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WASHINGTON, D.C., 18 JANUARY 1994

Direct and General Support Maintenance Manual

BOAT, BRIDGE ERECTION, TWIN JET, ALUMINUM HULL,
MODELS USCSBMK1 (1940-01-105-5728) AND USCSBMK2 (1940-01-218-9165)

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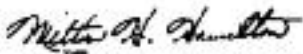
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Direct and General Support Maintenance Manual

**BOAT, BRIDGE ERECTION, TWIN JET, ALUMINUM HULL,
MODELS USCSBMK1 (1940-01-106-6728) AND USCSBMK2 (1940-01-218-9165)**

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Direct and General Support Maintenance Manual

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Direct and General Support Maintenance Manual

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Direct and General Support Maintenance Manual

BOAT, BRIDGE ERECTION, TWIN JET,
ALUMINUM HULL, Model USCSBMK1 (1940-01-105-5728)

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Direct and General Support
Maintenance Manual

BOAT, BRIDGE ERECTION
TWIN JET, ALUMINUM HULL

Model USCSBMK 1
(1940-01-105-5728)

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WARNING**SERIOUS INJURY OR DEATH**

may result if personnel fail to observe the following safety precautions.

Batteries give off explosive hydrogen gas. Be careful making connections. Do not smoke when servicing the battery.

Be sure the master battery switch is off before disconnecting or connecting battery cables.

Always disconnect the ground cable first and connect it last. Make sure the POS (+) and NEG (-) connections are correct.

Do not ground the positive terminal of batteries to boat structure.

Do not operate engines in an enclosed area without adequate ventilation as carbon monoxide, an invisible poisonous gas, is generated. Symptoms of exposure to carbon monoxide are headache, dizziness, drowsiness, loss of muscular control and coma. Severe exposure can cause permanent brain damage.

Wear life preservers (work vest) at all times when aboard the boat.

Do not allow personnel between boats during slave starting.

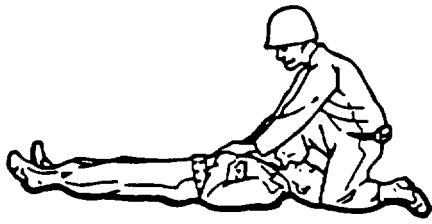
Maintenance procedures for the fuel system must be performed in a well-ventilated area. Do not allow sparks or flame in the vicinity.

Before performing any repair on the electrical system, place master switch OFF and disconnect negative battery cables.

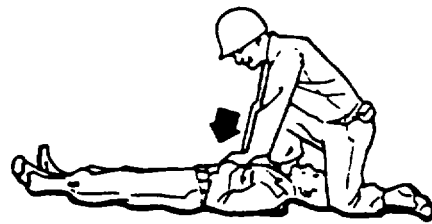
For Artificial Respiration, refer to FM 21-11.

Ear protection (ear plugs) must be worn when operating this boat.

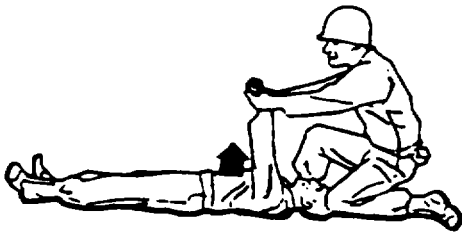
When working near mast assembly, avoid striking head on protruding parts of mast assembly. To avoid injury, be aware of mast assembly position when working below mast.



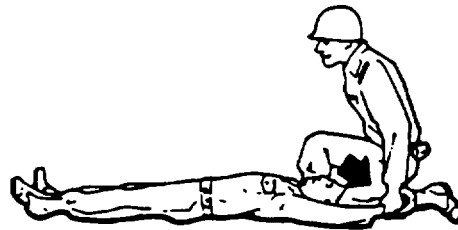
(a) HAND ON LOWER RIBS



(b) STEADY PRESSURE DOWNWARD



(c) ARMS LIFTED UPWARD



(d) ARMS BACKWARD AS FAR AS POSSIBLE

MOUTH--TO--MOUTH RESUSCITATION



NOSE SEALED WITH THUMB AND FINGER



OBSERVE RISE AND FALL
OF SOLDIER'S CHEST

HAND BEHIND HEAD

Figures from FM 21-11

Direct and General Support Maintenance Manual

BOAT, BRIDGE ERECTION, TWIN JET, ALUMINUM HULL,
 MODELS USCSBMK1 (1940-01-105-5728) AND USCSBMK2 (1940-01-218-9165)

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 direct to: Commander, Headquarters, U.S. Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Boulevard, St. Louis MO 63120-1798. A reply will be furnished you.

Marine Corps users shall submit NAVMC Form 10772, Recommended Changes to Technical Publications. Send to: Commanding General, Marine Corps Logistics Base (Code 850), Albany, GA 31704-5000.

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CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

- a. Type of Manual: Direct Support and General Support Maintenance.
 - b. Equipment Name and Model Number: Bridge Erection Boat, Twin Jet, Aluminum Hull. The model numbers assigned to this equipment are USCSBMK-1 and USCSBMK-2.
 - c. Purpose of Equipment: Support bridging and amphibious operations. May also be used as a general purpose workboat in support of diving operations and maritime projects, for inland water patrols, and as safety boat for amphibious river crossings.
 - d. Special Limitations on Equipment: When used to ferry troops or cargo, the safe carrying capacity is limited to a maximum of 12 fully equipped men or 4400 pounds (2000 kilograms).
- 1-2. MAINTENANCE FORMS AND RECORDS. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, The Army Maintenance Management System (TAMMS). Marine Corps personnel will prepare and maintain records and report forms as prescribed by TM 4700-15/1, Equipment Record Procedures.
- 1-3. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS. If your boat needs improvement, let us know. Send us an Equipment Improvement Recommendation (EIR). You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at Commander, Headquarters, U.S. Army Aviation and Troop Command, ATTN: AMSAT-I-MDO, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. U.S. Marine Corps users are encouraged to submit EIRs in accordance with 1650.17, or submit Quality Deficiency Reports in accordance with MCO 4855.10. Mail it to us at Commanding General (P840), Marine Corps Logistics Base, Albany, GA 31704-5000. We'll send you a reply.
- 1-4. WARRANTY INFORMATION. The Bridge Erection Boat, USCSBMK1, is warranted by Fairey Allday Marine Limited for 12 months. The Bridge Erection Boat, USCSBMK2 is warranted by American Development Corporation for 12 months. The warranty starts on the date found in block 23 of DA Form 2408-9 in the logbook. Report all defects in material or workmanship to your supervisor, who will take appropriate action through your organizational maintenance supervisor.

Section II. EQUIPMENT DESCRIPTION

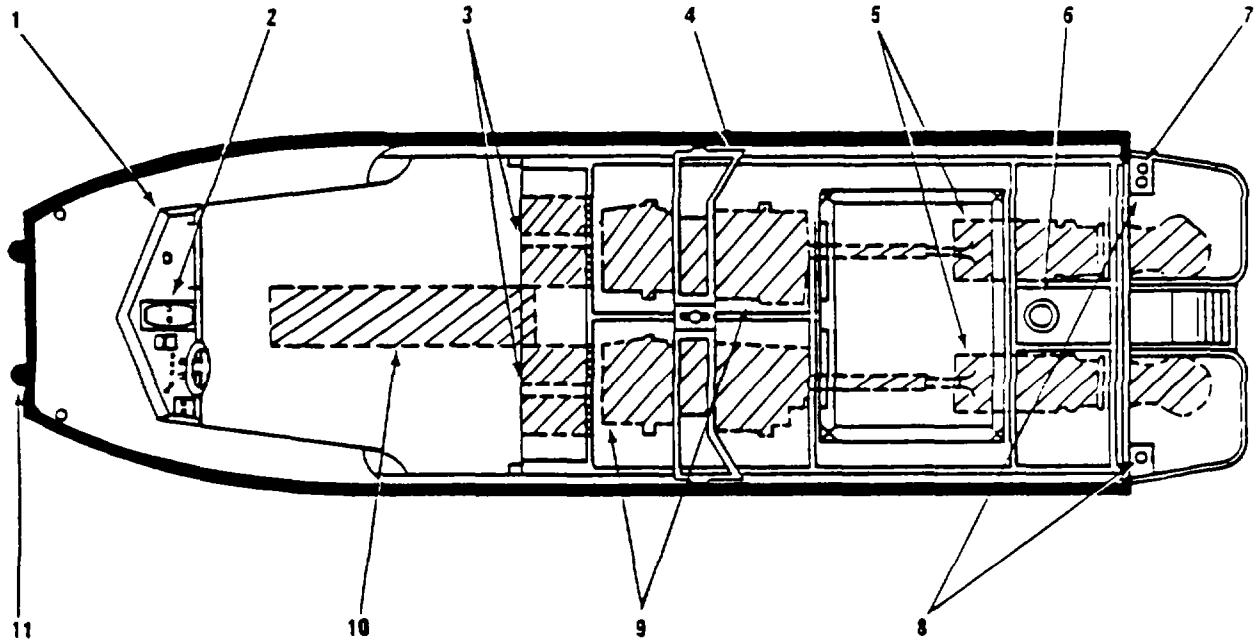
1-5. PURPOSE OF BRIDGE ERECTION BOAT. A transportable, hydrojet propelled, aluminum hull boat designed to maneuver components of floating bridges. The boat can also be used to propel rafts, support diving operations, assist in maritime construction projects, serve as a troop and cargo carrier, and patrol inland waters.

1-6. CAPABILITIES AND FEATURES

- a. Can rotate on its own axis at low engine speeds.
- b. All weather operational.
- c. Transportable by rail, road, and air. (See TB 55-46-1.)
- d. Positive flotation.

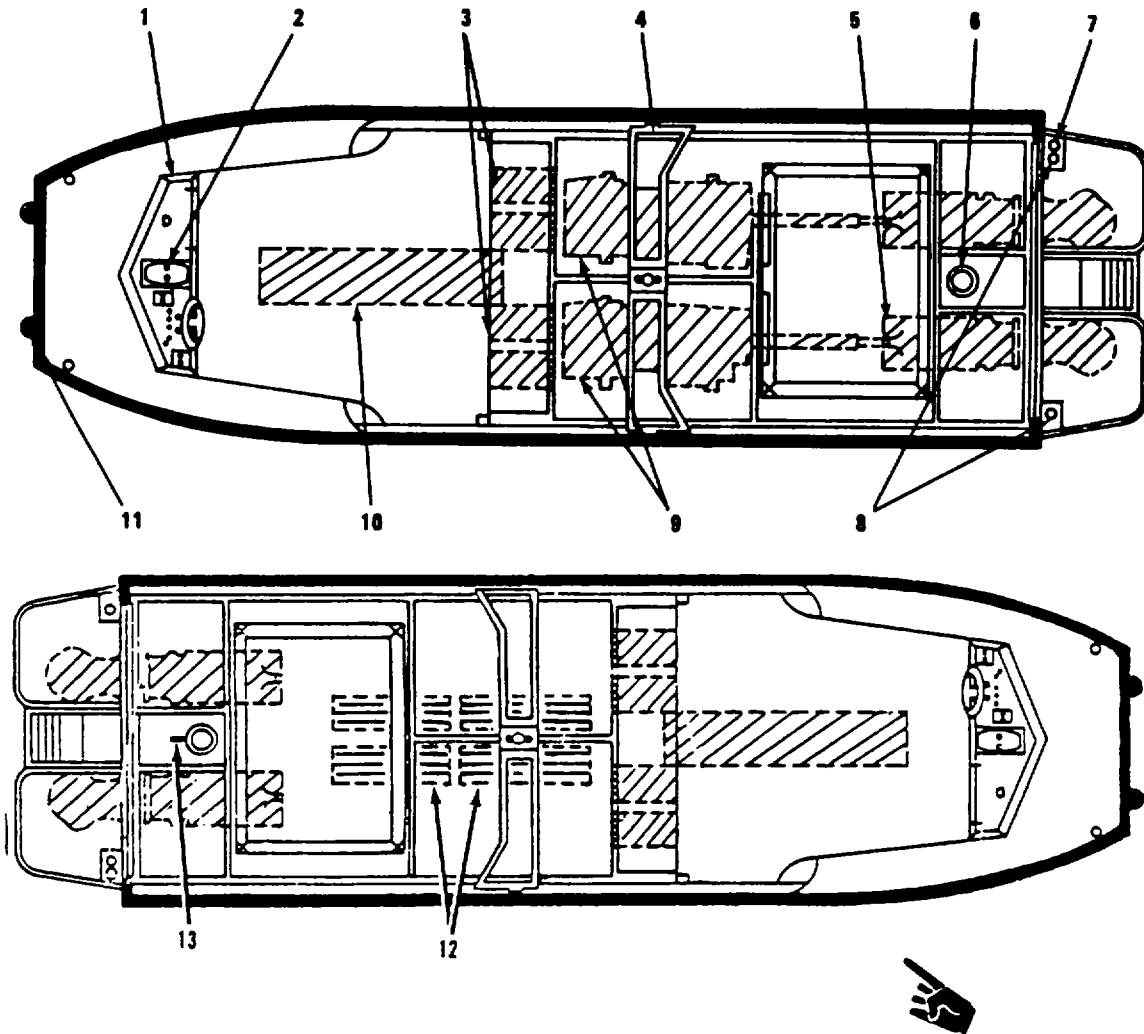
1-7. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

- a. Removable Cab(1). An aluminum frame with windows and aluminum roof that can be attached to the boat to provide protection for the crew during bad weather. The cab is provided with windshield wipers and a place for attaching searchlight.
- b. Control Console (2). Contains all the controls and indicators required for operation of the boat. In addition, it contains a hand-operated bilge pump, a storage compartment for technical manuals, and a storage compartment for life preservers and other gear.



- c. Batteries (3). Provide electrical power for the operation of the boat.
- d. Removable Mast (4). Contains the navigation lights, towing lights, and anchor lights. May be lowered to rest on capstan or removed from the boat when lights are not required.
- e. Hydrojets (5). Consist of diesel engine driven hydrojet propulsion units with directional nozzles and scoops. The propulsion units propel the boat and steer it.
- f. Capstan (6). A two-speed hand-operated winching device used for towing, winching, and other work tasks.

- g. Davit Tube (7) (MK1 only). Allows the attachment of a davit (small crane) to the boat for use in diving operations. Not used in U.S. Army operations.
- h. Beaching Legs (8). Support the boat in an upright position when on a hard surface and not in cradle. The beaching legs are retractable.
- i. Engines (9). Provide power for driving hydrojet units.
- j. Fuel Tank (10). Provides fuel storage capacity for operation of boat.
- k. Pushknees (11). Provides the front of the boat with a flat vertical surface for pushing barges or maneuvering bridge components. The pushknees can be removed.
- l. Keel Coolers (12) (MK2 only). Provide cooling for the engine, transmission, oil, and turbocharged air. Located on the bottom of the boat.
- m. Tow Hook (13). Provides boat with towing capability. Has quick-release mechanism to allow operator to immediately detach boat from object in tow in case of emergency.



EQUIPMENT DATA

WEIGHTS AND DIMENSIONS

Operating

Weight, w/ crew, equipment and fuel	8800 lbs.	(4000 kg)
Length	322.8 in	(820 cm)
Beam	98.0 in	(249 cm)
Height		
w/o cab or mast	77.9 in	(198 cm)
w/ cab	109.8 in	(279 cm)
w/ cab and mast	177.9 in	(452 cm)
Draft		
w/ crew, equipment and fuel	22.0 in	(56 cm)
fully loaded	26.0 in	(66 cm)

Transported

Weight	10800 lbs.	(4909 kg)
Length	326.4 in	(826 cm)
Height w/o cab	96.3 in	(244 cm)
Width	116.3 in	(294 cm)

PERFORMANCE

Speed, w/ crew, equipment and fuel	21.6 knots
Speed, fully loaded	16.2 knots
Maximum load carrying capacity	4400 lbs. (2000 kg)
Towing hook	4400 lbs. (2000 kg)
Turning radius (with scoops at maximum thrust)	
Full speed ahead	2 boat lengths in 15 seconds
Full speed astern	2 boat lengths in 25 seconds
One scoop forward and one scoop in reverse	Standing circle
Fuel consumption (approximate)	
1750 rpm	2.8 gallons/hour (11 liters/hour)
2000 rpm	4.2 gallons/hour (16 liters/hour)
2250 rpm	6.0 gallons/hour (23 liters/hour)
2450 rpm	10.8 gallons/hour (40 liters/hour)
Minimum forward thrust at 2450 rpm	4200 pounds (18.7 kN)
Minimum reverse thrust at 2450 rpm	2200 pounds (9.8 kN)
Maximum safe engine operating speed	
MK1	2800 rpm
MK2	2900 rpm

CAPACITY

Fuel	75 gallons (280 liters)
Oil	
Engine	17-1/2 quarts (16.4 liters)
Transmission	2-1/2 quarts (2.35 liters)
Coolant	
MK1	7-1/5 gallons (27 liters)
MK2	18 gallons (68.1 liters)

ENGINE INSTRUMENT PANEL GAGE READINGS

Tachometer	
Idle speed	650 to 750 rpm
Operating speed	1000 to 2000 rpm
Maximum speed (Under Load)	2500rpm
Engine oil pressure gage	
Idle speed	20 to 30 lb/in ² (1.4 to 2.1 Kp/cm ²)
Operating speed	40 lb/in ² or above (2.8 Kp/cm ²)
Coolant temperature gage (fresh water system)	
Normal	Below 195 ° F (90 ° C)
Overheating	Above 195 ° F (90 ° C)
Battery condition meter (engine not running, no electrical load)	
Battery fully charged	25.4 volts or above
Battery half charged	24.6 to 25.4 volts
Battery fully discharged	23.7 volts or below

NOTE

The above readings are most reliable if the batteries have stood for at least 8 hours without charge or discharge.

Battery condition meter (engine running about 1500 rpm and no electrical load)	
Battery near to fully charged	27.0 to 28.0 volts
Battery partially discharged	24.0 to 27.0 volts
Battery charge low	Below 24.0 volts
Battery condition meter (normal operation)	
Above 24 volts	Alternator output matching or greater than electrical load
Below 24 volts	Load in excess of alternator output
Opening temperature range for thermostat	160 ° - 170 ° F

NOMENCLATURE	
HULL	
Boat, Bridge Erection, Twin Jet, Aluminum Hull	
Manufacturer	Allday Aluminum
MK1	Limited, Gosport Hampshire P012 4DT England
MK2	American Development Corporation (ADCOR) 1930 Hanahan Road North Charleston, SC 29406
Length (overall)	322.8 inches (820 cm)
Width (overall)	98 inches (249 cm)
Height (with cab)	109.8 inches (279 cm)
Height (without cab)	77.9 inches (198 cm)
Weight	8800 lbs. (4000 kg)
Construction	Welded aluminum
ENGINE	
Manufacturer	Sabre Engines Ltd. Ferndown Industrial Estate, Wimborne Dorset, England
Model	212
Maximum rpm (no load)	
MK1	2800 rpm
MK2	2900 rpm
Shaft horsepower	212 @ 2500 rpm ±50 1358 lbs. (with trans- mission) (616 kg)
Weight (dry)	6
No. of cylinders	4.125 inches (105 mm)
Bore	4.524 inches (115 mm)
Stroke	363 cubic inches (5.95 liters)
Total displacement	Counterclockwise (as viewed from fly- wheel)
Firing order	1, 5, 3, 6, 2, 4
Compression ratio	14.7 to 1
Compression pressure (min)	300 psig
Valve clearance (hot)	0.018 inch
No. of main bearings	7
Upper main bearings	Grooved, oil feed holes, steel backed aluminum tin liners
Lower main bearings	Groove in center and rear liners only, steel backed alumi- num tin liners
Oil pump	Sliding vane type camshaft driven

Idle speed	650 to 750 rpm
Fresh water capacity	
MK1	7-1/5 gallons (27 liters)
MK2	18 gallons (68.1 liters)
Lubricating oil capacity	17-1/2 quarts (16.4 liters)
Injection pump timing	21° BTDC
Diesel fuel specification	VV-F-800
Lubrication specification	MIL-M-2104
FUEL INJECTOR	
Manufacturer	CAV Limited, P.O. Box 36 Warple Way, London, England
Model	49053
Nozzle setting pressure	2999 psig (205 atms)
ALTERNATOR	
Manufacturer	CAV Limited, P.O. Box 36 Warple Way, London, England
Model	AC 5
Type	Three-phase, stationary field, revolving armature, self-limiting in current output; current output 17A at 2000 rpm, 22A at 3000 rpm
STARTER MOTOR	
Manufacturer	CAV Limited, P.O. Box 36 Warple Way, London, England
Model	CA45
HYDRAULIC MARINE GEAR (TRANSMISSION)	
Manufacturer	Warner Gear Division Borg Warner Corp. Muncie, Indiana 47302

Model	10-18-002
Type	Hydraulically clutched forward- reverse trans- mission
Rotation	Counterclockwise
Forward-reverse selection	Hydraulic fluid direction to clutches by selec- tor valve inside transmission
Front oil pump	Positive displacement gear type (driven at engine speed)
Oil type	Engine oil
Oil pressure (normal)	110.0 to 150.0 pounds per square inch (7.7 to 10.5 Kp/cm ²)
Oil pressure (maximum)	250.0 pounds per square inch (17.5 Kp/cm ²)
Oil temperature (normal)	155° to 165° Fahrenheit (68.3 to 73.8°C)
Regulator valve spring weight	98 to 108 pounds at 1-1/16 inch height (44.5 to 49.1 Kg at 2.7 cm)

STEERING PROPULSION SYSTEM

Manufacturer	Dowty Hydraulic Units Limited Cheltenham, England
Type	Hydrojet, 12 inch (300 mm) diameter, two stage with scoops for reversing water flow and nozzles that swing through an angle of 40 degrees either side of central position for steering
Steering	Through cable control from helm in front cockpit to steering assembly portion of the hydrojet unit

ELECTRICAL SYSTEM (24 Volts Direct Current)

Batteries

Voltage
Number
Connection

12
4

Two batteries are connected in series to give 24-volt output; one pair is used to provide starting power and the second pair to provide all light and bilge pump operation power

ACCESSORIES

Electric bilge pumps
Manufacturer

Model
Type

Discharge venting

Manual bilge pump (MK1)
Manufacturer

Model
Type

EMPO Pump Co., Inc.
Piqua, Ohio
32-30

Heavy-duty enclosed
motor-driven
impeller

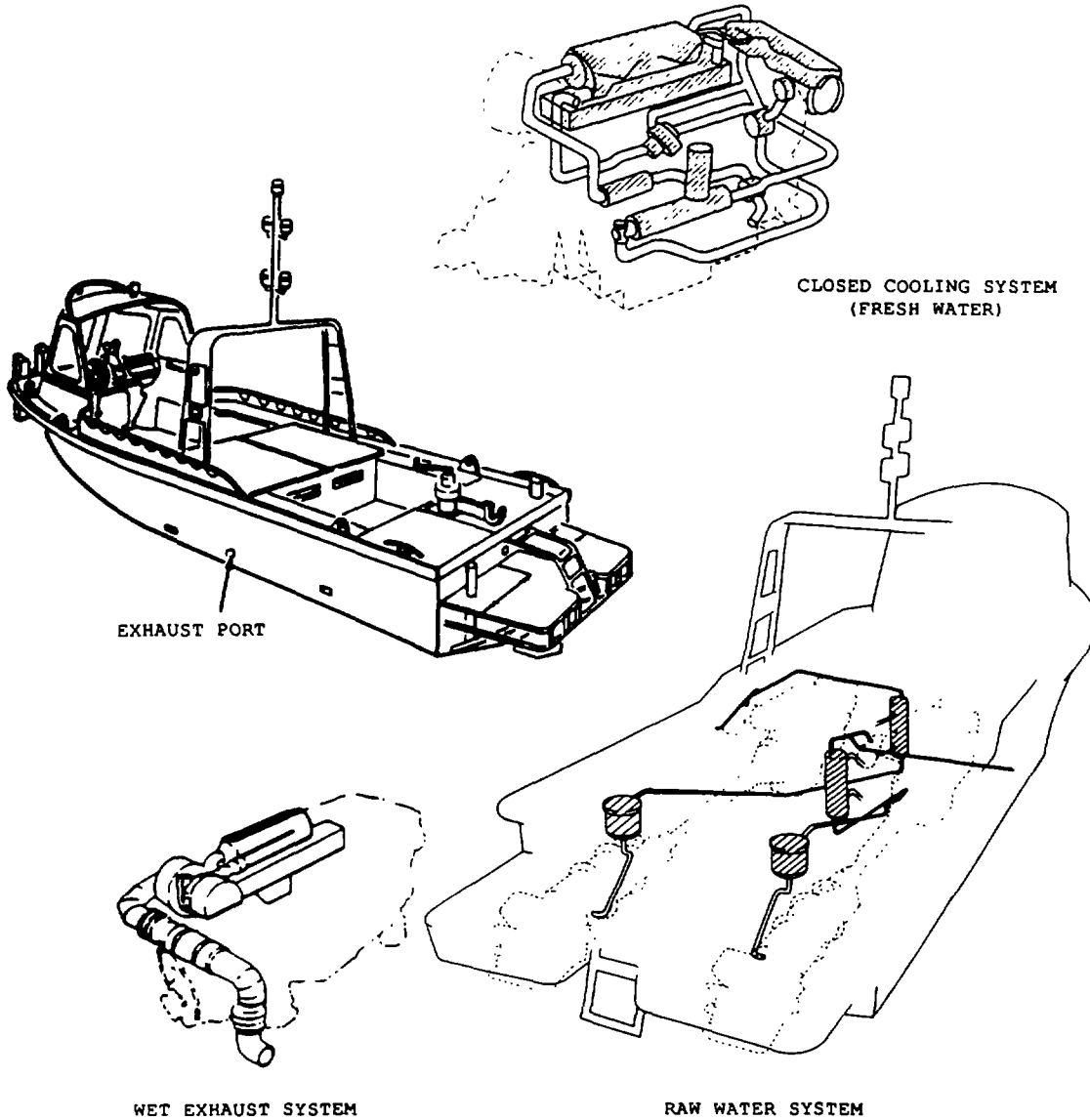
Forward pump discharges through vent in transom onto diver's platform

Henderson Pumps and
Equipment Ltd.
38 Medina Road,
Cowes, Isle of
Wight, PO 31, 7BZ,
England

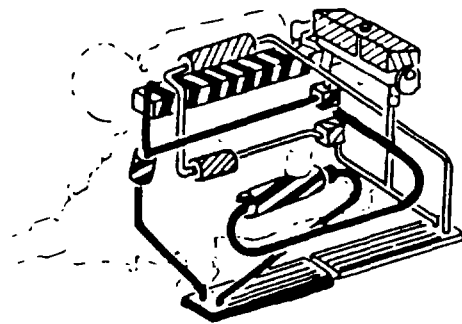
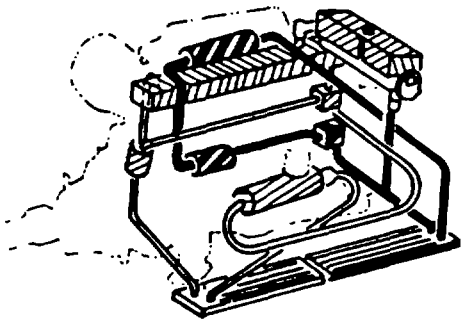
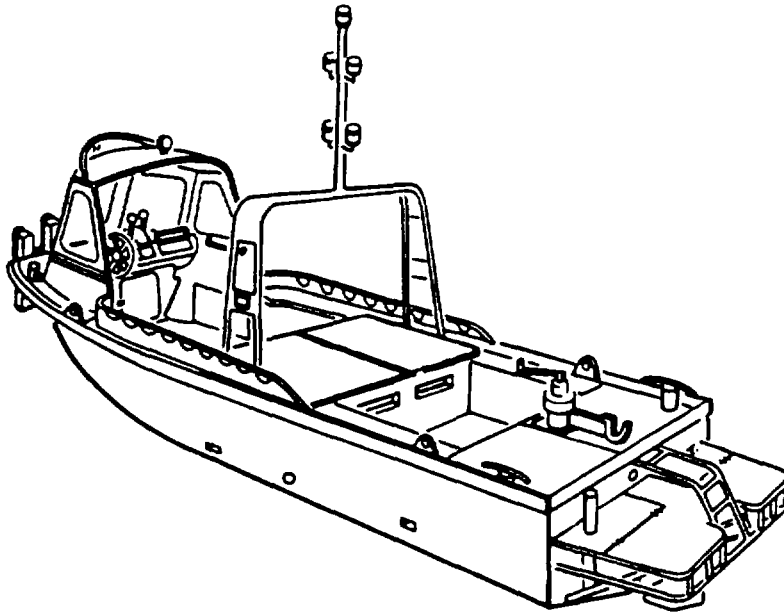
Mk V
Hand-operated
diaphragm pump

1-8.1 DIFFERENCES BETWEEN MODELS. There are two models of the Bridge Erection Boat, the MK1 and the MK2. The two models have different engine cooling systems and air-exhaust systems. The MK2 also has several additional features not on the MK1.

- a. MK2. Each MK2 engine uses two dosed cooling systems which share a common reservoir. The MK2 uses a wet exhaust system similar to the MK1. The hydrojet forces raw water into the exhaust system and out the exhaust port on the side of the boat.



- b. Each MK2 engine uses two dosed cooling systems which share a common reservoir. The MK2 uses a wet exhaust system similar to the MK1. The hydrojet forces raw water into the exhaust system and out the exhaust port on the side of the boat.



**CLOSED COOLING SYSTEMS
(FRESH WATER)**

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CHAPTER 2

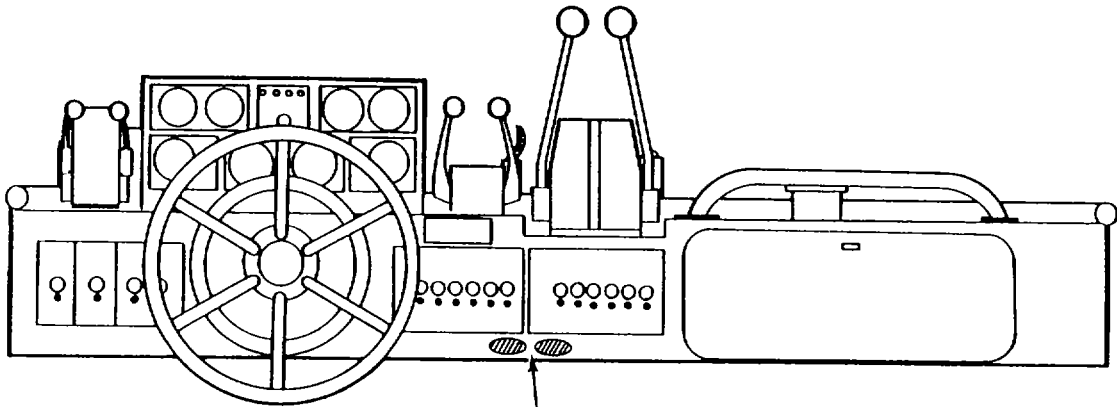
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS**Section I. REPAIR PARTS; SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT**

- 2-1. COMMON TOOLS AND EQUIPMENT. For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (I4TOE) applicable to your unit.
- 2-2. SPECIAL TOOLS; TMDE; AND SUPPORT EQUIPMENT. Special tools and test equipment are required to perform direct and general support maintenance on selected components of the bridge erection boat. The special tools are listed in the Maintenance Allocation Chart (MAC) contained in TM 5-1940-277-20 and in Repair Parts and Special Tools List TM 5-1940-277-34P. Those specially designed tools required for the boat are listed in Appendix C of this publication. These items must be fabricated by the maintenance facility requiring their use. The data required for fabrication are contained in Appendix C of this publication. All specially designed tools required for Direct and General Support Maintenance are applicable to maintenance of the transmission.
- 2-3. REPAIR PARTS. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (TM 5-1940-277-34P) covering the direct and general support maintenance for the bridge erection boat.

Section II. TROUBLESHOOTING PROCEDURES

- 2-4. INTRODUCTION TO TROUBLESHOOTING. This section contains information useful in diagnosing and correcting unsatisfactory operation or failure of the bridge erection boat. Malfunctions which might occur are listed followed by probable causes of the malfunction. The corrective action recommended for the probable cause is described. You should perform the tests, inspections and corrective actions in the order listed. You may be directed to perform appropriate TROUBLESHOOTING TESTS. This will aid you in locating a particular malfunction. This manual cannot list all malfunctions that may occur, nor all tests, inspections or corrective actions possible. If a malfunction is not listed or is not corrected by listed corrective actions consult your supervisor.

TROUBLESHOOTING PROCEDURES (continued)



STOP CONTROL

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

1. SUDDEN LOSS OF POWER WITH NO BLACK SMOKE

Step 1. Check that stop control lever is at full RUN position.

- a. Adjust stop control cable (refer to TM 5-1940-277-20).
- b. If stop lever properly positioned go to step 2.

Step 2. Visually inspect the nylon fuel lines for kinking, sharp bends or some type of internal or external restriction (refer to TM 5-1940-277-20).

- If no fuel line restrictions are found go to step 3.

Step 3. Check for air in fuel line or leaking fuel line connections. (Refer to TM 5-1920-277-20).

- If no air or leak in fuel line go to step 4.

Step 4. Make sure engine stop control is pulled out. Test for fuel lift pump operation (refer to TM 5-1940-277-20).

- If fuel flow satisfactory go to step 4.

Step 5. Check for faulty injectors.

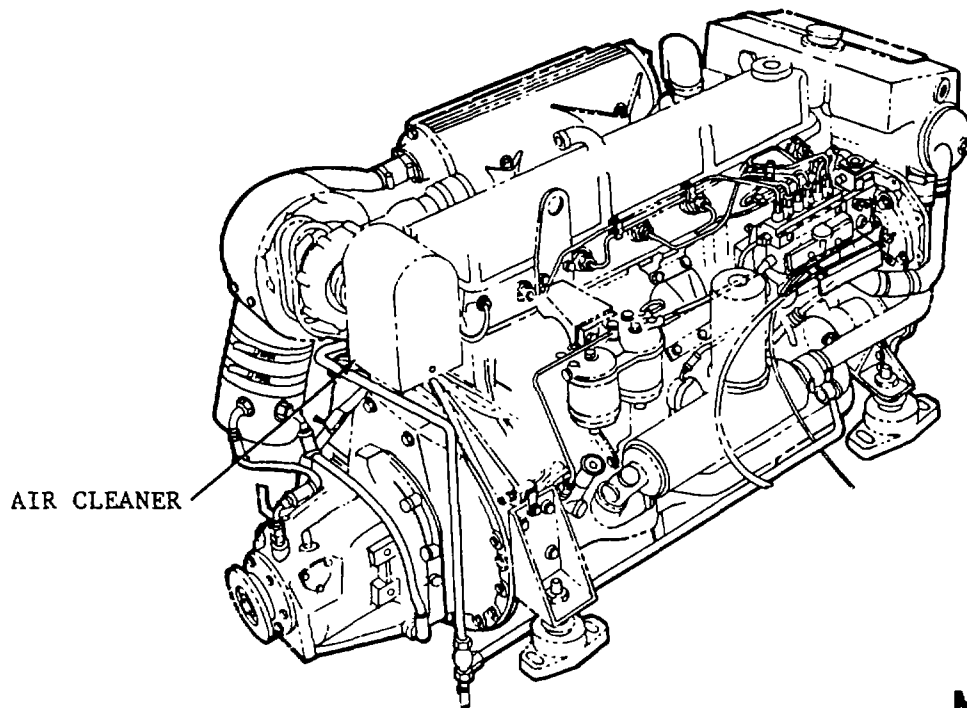
- a. Test injectors (refer to page 2-26).
- b. Repair faulty injectors (refer to page 2-267). If injectors operate properly go to step 6.

Step 6. Make sure engine stop control is pushed in. Test for injector pump operation (refer to TM 5-1940-277-20).

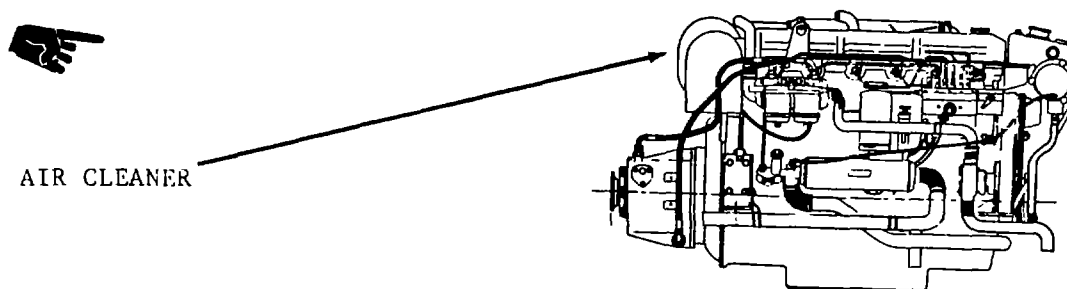
- a. Replace injection pump (refer to page 2-245).
- b. If pump operates correctly contact supervisor.

TROUBLESHOOTING PROCEDURES (Continued)

MK 1



MK 2



TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

2. SUDDEN LOSS OF POWER WITH HEAVY BLACK SMOKE

Step 1. Visually inspect air cleaner for obstruction or clogging. Also inspect air intake slots from aft cockpit to engine compartment (refer to TM 5-1940-277-20).

- a. Clear any obstructions to air flow. Clean dirty air filter (refer to TM 5-1940-277-20).
- b. Test for faulty turbocharger.
 1. Remove air silencer (refer to TM 5-1940-277-20).
 2. Check for free rotation of turbine wheel.
 3. Repair faulty turbocharger (refer to page 5-231).
- c. If no air obstructions go to step 2.

Step 2. Test for faulty injector (refer to page 2-261).

- a. Replace injector (refer to TM 5-1940-277-20).
- b. If injector satisfactory contact supervisor.

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION****3. ENGINE WILL NOT CRANK**

- Step 1. Check battery cells specific gravity (refer to TM 5-1940-277-20).
- Replace battery (refer to TM 5-1940-277-20).
 - If battery check satisfactory go to step 2.
- Step 2. Check-for defective starting switch (refer to TM 5-1940-277-20).
- Replace defective starting switch (refer to TM 5-1940-277-20).
 - If switch operates correctly go to step 3.
- Step 3. Check for faulty wiring and connections (refer to page 2-109).
- Repair faulty wiring (refer to page 2-109).
 - If wiring satisfactory go to step 4.
- Step 4. Test starter (refer to TM 5-1940-277-20).
- If voltage not present replace starter solenoid (refer to TM 5-1940-277-20).
 - If voltage present but starter does not function replace starter (refer to TM 5-1940-277-20).
- Step 5. Check for hydrostatic lock.
- Attempt to hand crank engine.
 - If engine will not turn over by hand, remove injectors one at a time until locked cylinders are freed. (Refer to TM 5-1940-277-20).
 - If engines still will not turn go to step 6.

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

3. ENGINE WILL NOT CRANK (continued)

Step 6. Check for internal engine seizure.

- a. Attempt to hand crank engine.
- b. If engine cannot be rotated through a complete revolution, internal damage is indicated.
- c. Report problem to General Support.

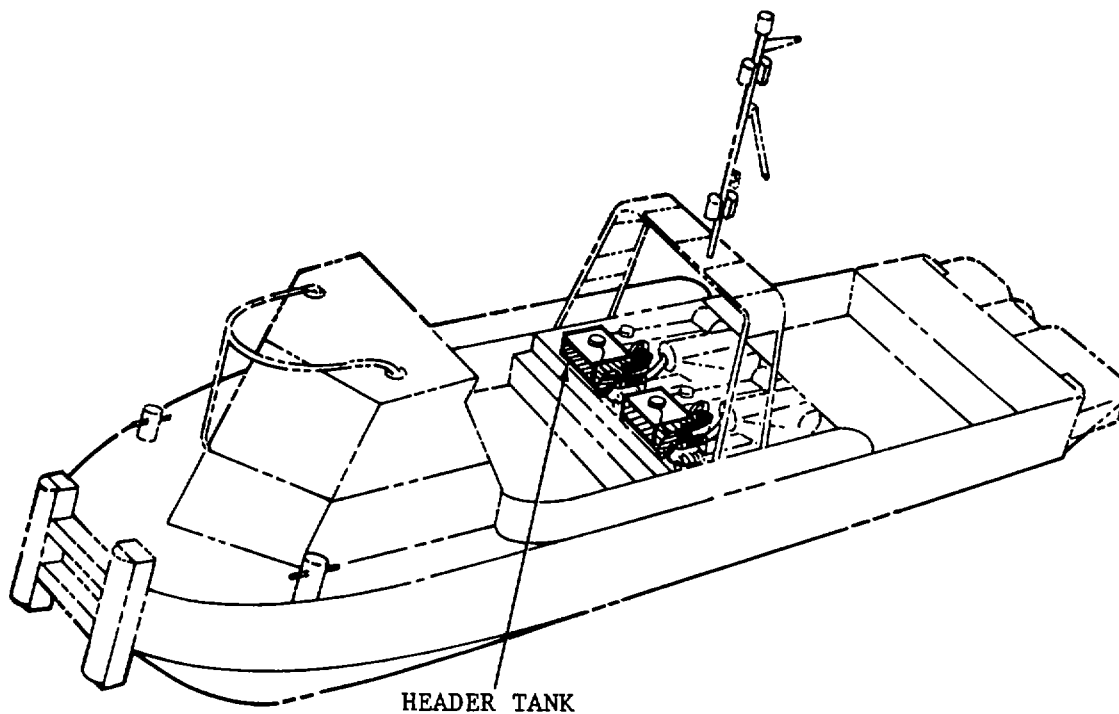
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TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

4. UNEVEN RUNNING OR FREQUENT STALLING

- Step 1. Check for air in fuel line or leaking fuel line connections.
- a. If leaks or air present refer to TM 5-1940-277-20
 - b. If no air or leak in fuel line go to step 2.
- Step 2. Test for defective fuel lift pump (refer to TM 5-1940-277-20).
- a. Replace fuel lift pump (refer to TM 5-1940-277-20).
 - b. If fuel lift pump all right go to step 3.
- Step 3. Test for faulty injector (refer to page 2-261).
- a. Replace injector if defective (refer to TM 5-1940-277-20).
 - b. If symptoms continue go to Step 4.
- Step 4. Perform compression test to determine if valves or piston rings are defective (refer to page 2-173).
- a. If valves are defective replace or repair as required (refer to page 2-277).
 - b. If piston rings are defective report to General Support.
 - c. If compression check is all right contact supervisor.

TROUBLESHOOTING PROCEDURES (Continued)



TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION****5. EXCESSIVE CRANKCASE PRESSURE (OIL COLLECTING IN BREATHER SEDIMENTER BOWL OR BEING BLOWN OVERBOARD)**

Step 1. Check for obstruction in exhaust pipe by using hand and feeling exhaust output for each engine.

a. If exhaust output appears restricted remove the exhaust flexible bellows and check exhaust pipes for obstructions (refer to TM 5-1940-277-20).

b. If no obstruction is evident go to step 2.

Step 2. Remove header tank cap. Start engine and observe water in tank for continual bubbling as evidence of leaking head gasket.

a. Replace head gasket (refer to page 2-291).

b. Change engine oil (refer to TM 5-1940-277-20).

c. If no evidence of head gasket failure found contact supervisor.

WARNING

Cap under pressure when water hot. Remove carefully. Severe burns may result

Step 3. Perform cylinder compression test to determine where blow-by is occurring (refer to page 2-173).

a. Report broken or worn piston rings, piston or sleeve to General Support.

TROUBLESHOOTING PROCEDURES (Continued)

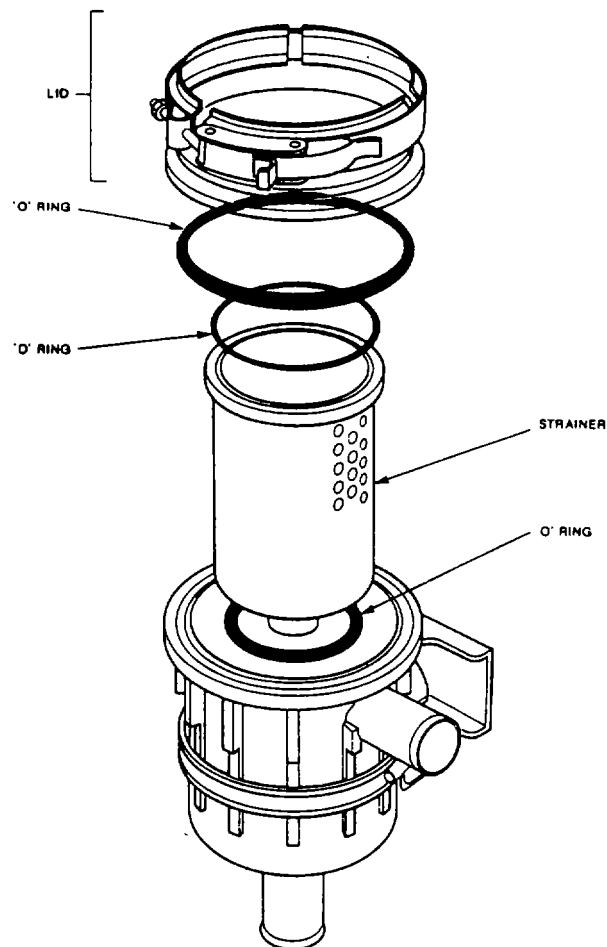
MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES)

a. MK1



Step 1. Stop engine and turn engine circuit switch OFF.

Step 2. Release retaining V damp. Remove lid.

a. Check condition of all O rings. Replace if damaged or worn.

TROUBLESHOOTING PROCEDURES (Continued)

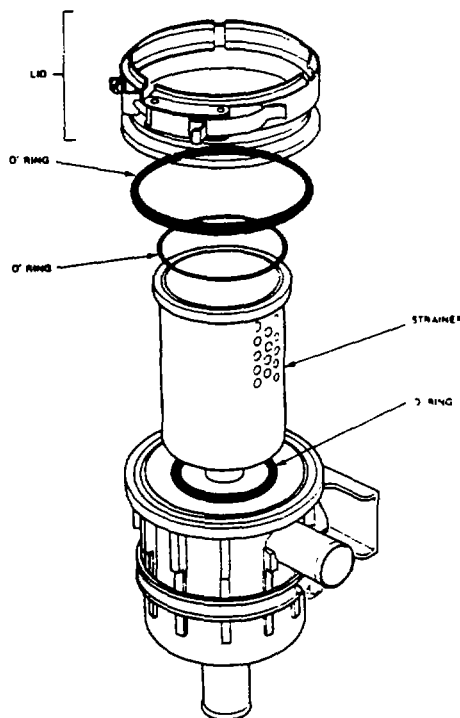
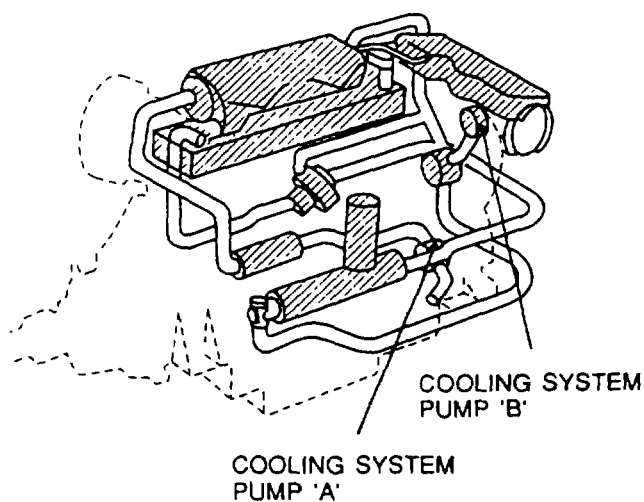
MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES) (Continued)

a. MK-1 (Continued)



Step 3. Check water intake.

- a. Clean strainer and housing.
- b. Replace strainer (refer to TM 5-1940-277-20).

Step 4. Inspect cooling system pump 'A' impeller, cam and end plate (refer to TM 5-1940-277-20).

- a. Replace defective impeller.
- b. Replace defective cam.
- c. Replace end plate.
- d. Replace cooling system pump 'A' (refer to TM 5-1940-277-20).

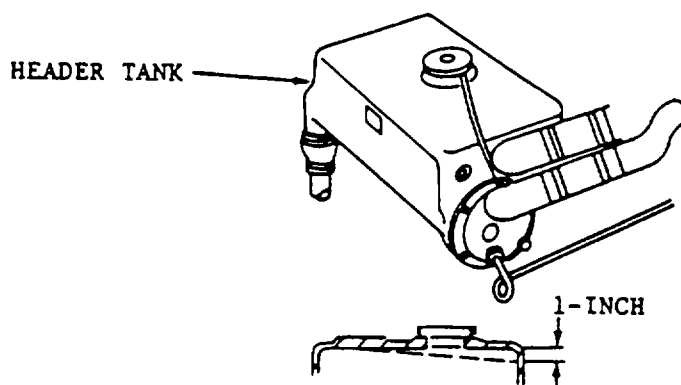
TROUBLESHOOTING PROCEDURES (Continued)

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES) (Continued)
 a. MK-1 (Continued)



- Step 5. Check coolant level in header tank
 a. Fill to 1" below neck
- Step 6. Check for leaks in fresh water system.
 a. Tighten hose dampers.
 b. Replace defective hoses (refer to TM 5-1940-277-20).
 c. Repair header tank (refer to TM 5-1940-277-20).
 d. Replace header tank (refer to TM 5-1940-277-20).
- Step 7. Check raw water hoses and fittings (refer to TM 5-1940-277-20)
 a. Tighten hose dampers.
 b. Replace defective hoses and fittings (refer to TM 5-1940-277-20).

TROUBLESHOOTING PROCEDURES (Continued)

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES) (Continued)

a. MK-1 (Continued)

Step 8. Check V-Belt for looseness, breaks, or fraying.

a. Adjust to correct tension (refer to TM 5-1940-277-20).

b. Replace V-belt (refer to TM 5-1940-277-20).

Step 9. Check thermostat (refer to TM 5-1940-277-20).

a. Replace thermostat (refer to TM 5-1940-277-20). Do not operate engine without thermostat installed.

Step 10. Check cooling system pump "B" for leaks.

a. Replace defective pump (refer to TM 5-1940-277-20).

Step 11. Check intercooler for loose connections or leaks.

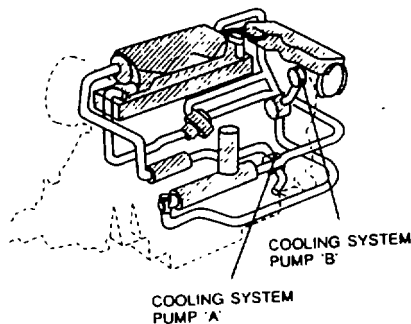
a. Tighten loose raw water hose dampers.

Step 12. Check water temperature sending unit

a. Replace defective water temperature sending unit (refer to TM 5-1940-277-20).

Step 13. Check for dogged remote cooler.

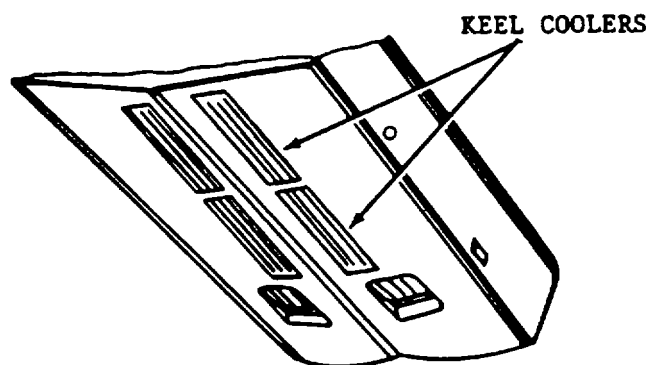
a. Replace defective remote cooler (refer to TM 5-1940-277-20).



MK1

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES) (Continued)
b. MK2



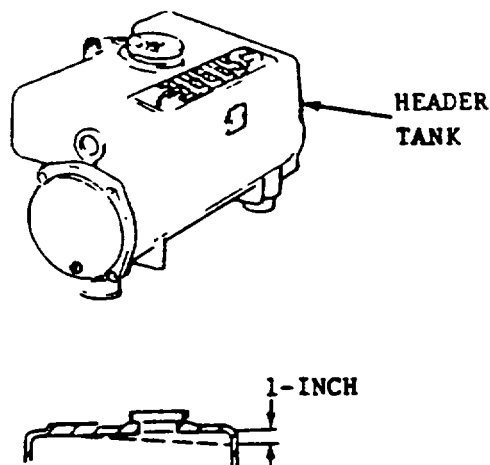
Step 1. Stop engine and turn engine circuit switch OFF.

Step 2. Check keel cooler for marine growth and other foreign matter. Also check for leaks, or any sign of corrosion.

- a. Clean keel coolers with metal brush.
- b. Replace keel cooler (refer to TM 5-1940-277-20).

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES) (Continued)



- Step 3. Check coolant level in header tank
- a. Fill to 1" below neck
- Step 4. Check for leaks in secondary cooling system.
- a. Tighten hose clamps.
 - b. Replace defective hoses (refer to TM 5-1940-277-20).
 - c. Replace header tank (refer to TM 5-1940-277-20).
- Step 5. Inspect secondary water pump impeller, cam, and end plate (refer to TM 5-1940-277-20).
- a. Replace defective impeller.
 - b. Replace defective cam.
 - c. Replace end plate.
 - d. Replace secondary water pump (refer to TM 5-1940-277-20).

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

6. ENGINE OVERHEATS (ENGINE AUDIBLE ALARM ACTIVATES) (Continued)

Step 6. Test water temperature sending unit (refer to TM 5-1940-277-20).

- a. Replace defective water temperature sending unit (refer to TM 5-1940-277-20).

Step 7. Check V-belt for looseness, breaks, or fraying.

- a. Adjust to correct tension (refer to TM 5-1940-277-20).
- b. Replace V-belt (refer to TM 5-1940-277-20).

Step 8. Check primary cooling system for leaks.

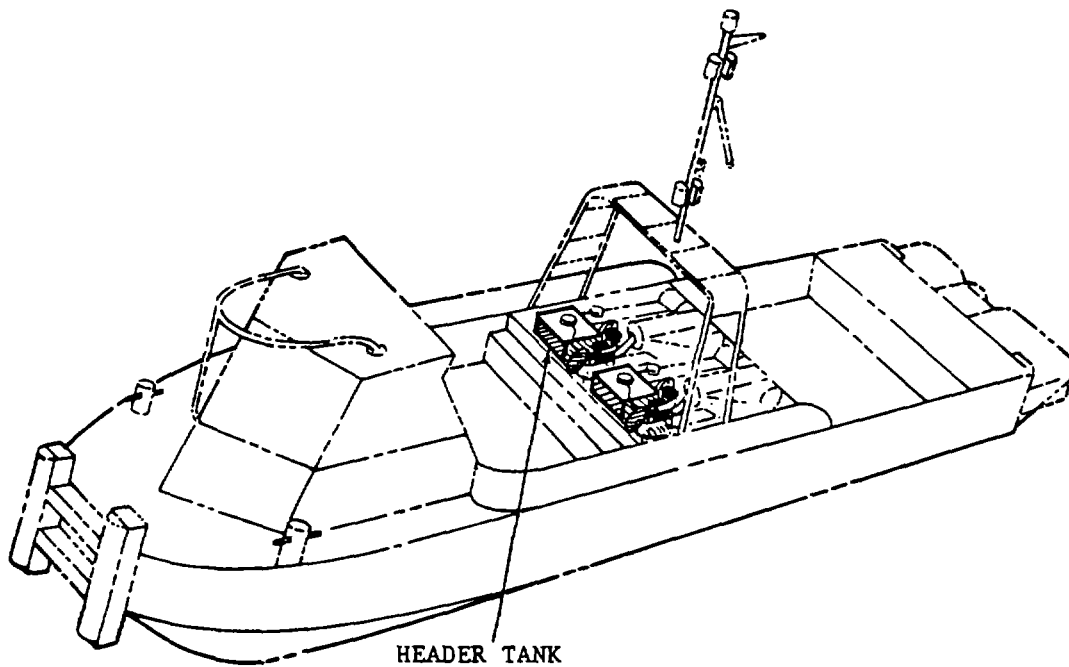
- a. Tighten hose clamps (refer to TM 5-1940-277-20).
- b. Replace defective hoses (refer to TM 5-1940-277-20).

Step 9. Check primary water pump for leaks.

- a. Replace defective primary water pump (refer to TM 5-1940-277-20).
- b. Replace thermostat (refer to TM 5-1940-277-20). Do not operate engine without thermostat installed.

Pages 2-10.7 and 2-10.8 deleted

TROUBLESHOOTING PROCEDURES (Continued)



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TROUBLESHOOTING PROCEDURES (Continued)

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

7. LOSS OF LUBRICATION OIL PRESSURE (SUDDEN DROP OF PRESSURE)

Step 1. Check sending units and gauges (refer to TM 5-1940-277-20).

a. If sending unit and gauges operating go to step 2.

Step 2. Check engine oil level (refer to TM 5-1940-277-10).

- If oil level correct go to step 3. Check sending units and gauges.

WARNING

Cap under pressure when water hot. Remove carefully. Severe burns may result.

Step 3. Remove header tank cap. Check fresh water for oil film contamination. Contamination indicates cracked engine oil cooler tube stack (refer to TM 5-1940-277-20).

a. Replace oil cooler (refer to TM 5-1940-277-20).

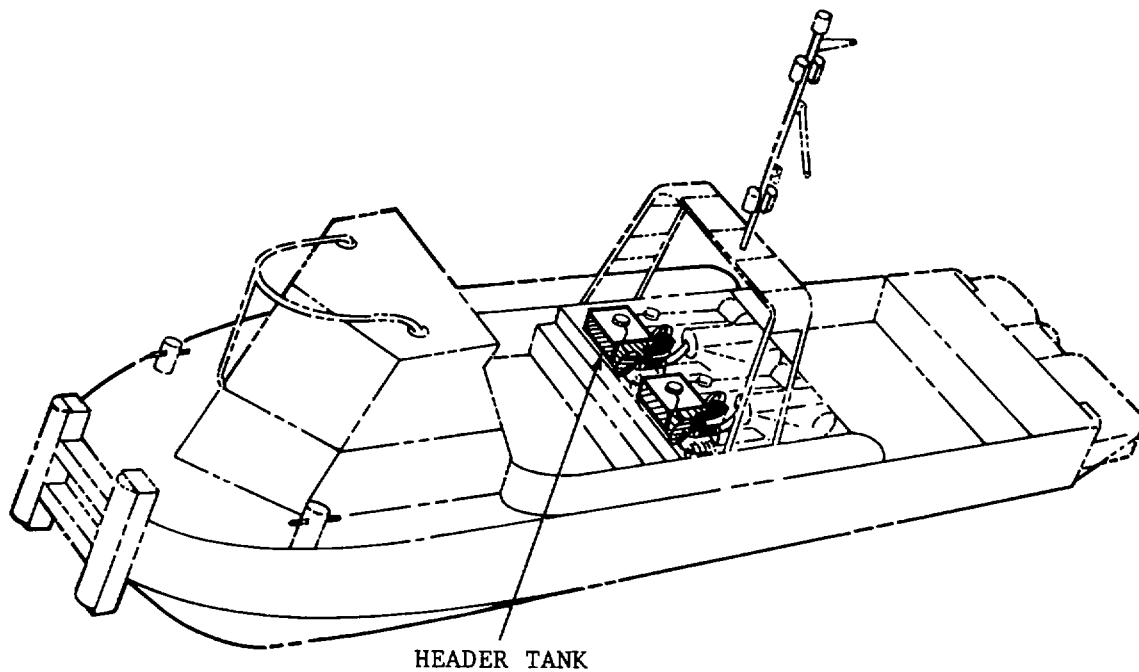
b. If no contamination go to step 4.

Step 4. Check for defective oil pump.

a. Replace defective oil pump (refer to page 3-9).

b. If oil pump all right contact supervisor.

TROUBLESHOOTING PROCEDURES (Continued)



TROUBLESHOOTING PROCEDURES (Continued)

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. HIGH LUBRICATING OIL CONSUMPTION

Step 1. Check for oil in bilge or on engine as evidence of leaking gasket or seal.

- a. Replace gasket or seal found to be source of leak.
- b. If no leak evident go to step 2.

WARNING

Cap under pressure when water hot. Remove carefully. Severe burns may result.

Step 2. Remove cap from header tank. Check fresh water for oil film contamination as evidence of engine oil cooler leaking.

- a. Replace engine oil cooler (refer to TM 5-1940-277-20).
- b. If no evidence of oil cooler leakage go to step 4.

Step 3. Check for excessive crankcase pressure.

- a. Inspect engine breather hose and trap for excessive oil, an indication of excessive crankcase pressure.
- b. Excessive crankcase pressure is evidence of faulty piston rings or head gasket.
 1. Replace faulty cylinder head gasket (refer to page 2-291).
 2. Refer faulty piston rings to General Support.

Step 4. Perform compression tests to determine if valves or piston rings are defective (refer to page 2-173).

- a. Repair or replace valve guides and/or valves as required (refer to page 2-277).
- b. Report defective piston rings to General Support.
- c. If compression satisfactory contact supervisor.

Change 1 2-15

TROUBLESHOOTING PROCEDURES (Continued)

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

9. TRANSMISSION MALFUNCTIONS

CAUTION

Boat must be in water to run engine. For exception during organizational or higher maintenance actions, refer to page 3-326; TM 5-1940-277-20.

Step 1. Start engine and let run for 2 minutes with transmission in neutral. Shut engine off and wait 5 minutes and then check oil level. Must be to mark on dipstick.

- a. Fill with fluid to proper level (refer to TM 5-1940-277-10).
- b. Fluid level all right go to step 2.

Step 2. Check for improperly adjusted control linkage (refer to TM 5-1940-277-20).

- If linkage adjustment is correct go to step 3.

Step 3. Test for low oil pressure with transmission in neutral (refer to page 2-21).

- a. Clean oil strainer (refer to TM 5-1940-277-20).
- b. Clean pressure regulator valve (refer to page 2-327).
- c. Check for weak pressure regulator spring.
- d. Replace defective oil pump (refer to page 2-237).
- e. If pressure all right contact supervisor.

Step 4. Test transmission in forward position.

- Report defective transmission to General Support.

Change 2 2-16

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

10. TRANSMISSION HAS GEAR NOISE IN FORWARD OR REVERSE

- Step 1. Check for inadequate torque on output shaft nut.
- a. Torque nut to 140-150 ft. lbs. If nut will not torque report to General Support.
 - b. If nut properly torqued report to General Support.
- Step 2. Check for loose transmission mounting bolts (refer to page 2-349).
- a. If nut will not torque report to General Support.
 - b. If bolt properly torqued go to step 3.
- Step 3. Check for worn or defective flywheel damper (refer to page 2-317).
- a. Replace defective or worn flywheel damper (refer to page 2-317).
 - b. If flywheel damper is all right report to General Support.

Change 1 2-17

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

11. TRANSMISSION SHIFTS HARD

Step 1. Check transmission shift control linkage for obstructions or improper adjustment (refer to TM 5-1940-277-20).

- a. Check for broken poppet spring or excessively worn (scored) detent ball (refer to step J on page 2-336).
- b. Clean pressure regulator valve (refer to page 2-327).

Step 2. Check for damaged "O" ring on transmission selection valve which pressure regulator is removed.

- a. If pressure regulator and "O" ring are all right contact supervisor.

TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

12. STEERING SYSTEM FEELS LOOSE

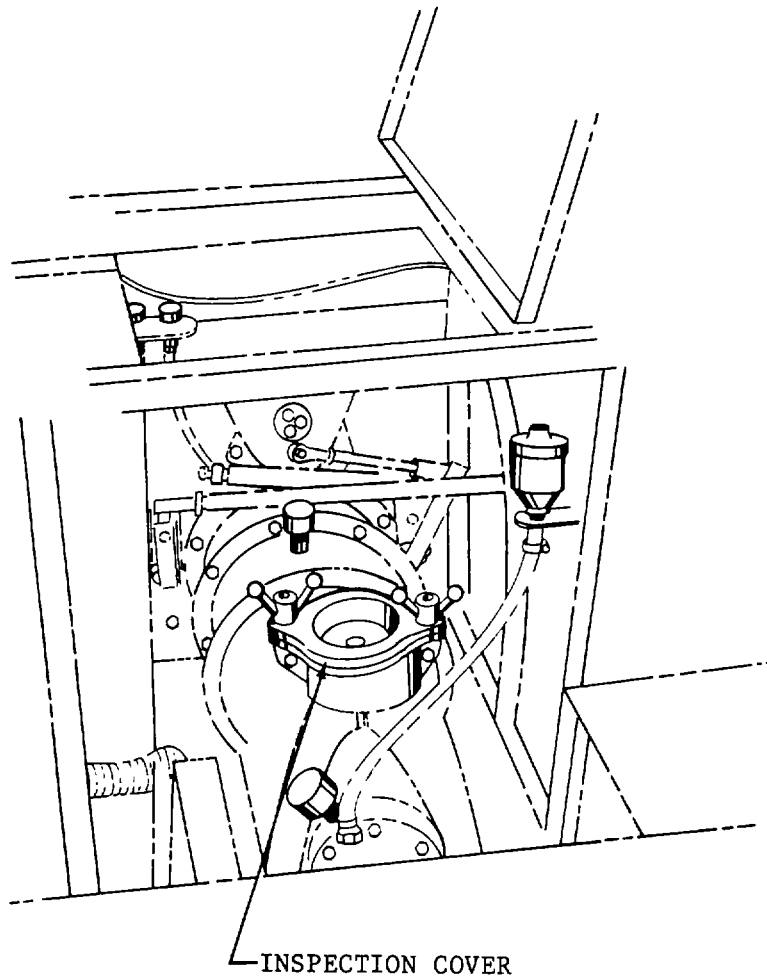
- Step 1. Check for loose or improperly adjusted steering cables and linkage (refer to TM 5-1940-277-20).
- Step 2. Check for worn bushings and bearings (refer to page 2-409).
- Step 3. If bushings or bearings are all right and adjusted correctly contact supervisor.

13. SCOOP CONTROLS ARE HARD TO OPERATE

- Step 1. Check steering assembly brush for wear (refer to TM 5-1940-277-20).
- Step 2. Check control cables for damage (refer to TM 5-1940-277-20).
- Step 3. Check rotary control assembly for defective bearings (refer to page 2-409).
- Step 4. If controls still hard to operate contact supervisor.

Change 1 2-18.1

TROUBLESHOOTING PROCEDURES
(Continued)



TROUBLESHOOTING PROCEDURES (Continued)**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

14. BOAT VIBRATES WHILE UNDER WAY NOTE

NOTE

Boat must be out of water on cradle or on hardstand for test or inspection.

Step 1. One person in boat will open the hydrojet compartment hatch covers and remove the intake case inspection covers. Then reach into the hydrojet unit and feel the front impeller for evidence of deformation or damage. After this inspection a second person using a strong light should look through the jet nozzle at the rear impeller while the first person slowly rotates the unit grasping either the shaft or coupling. Damage will most probably occur to the front impeller.

- a. If damaged impellers report to General Support.
- b. If impellers all right contact supervisor.

Step 2. Check for loose engine mounting bolts (refer to page 2-161).

TROUBLESHOOTING TEST FOR TRANSMISSION

This task covers:

- a. Test

INITIAL SETUP

Test Equipment:

Hydraulic pressure gage (130 psi min.)

3/8 in pipe plug connection

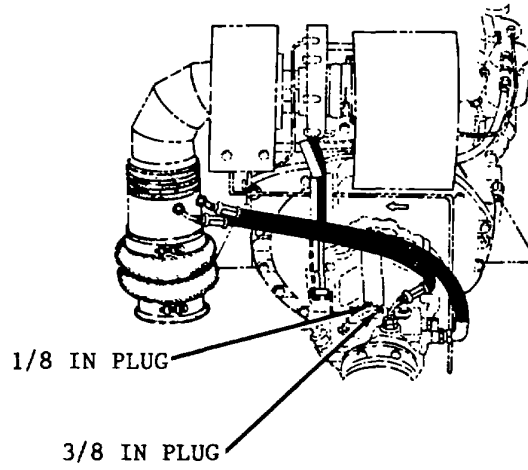
1/8 in pipe plug connection

13/64 in hex key wrench

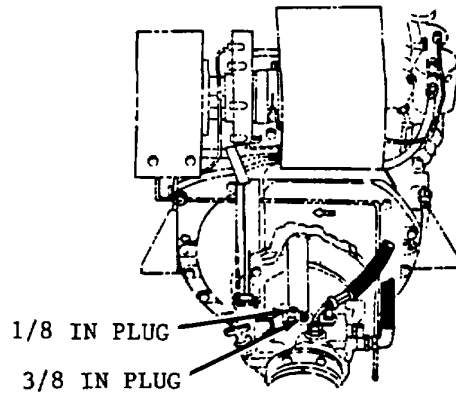
5/16 in hex key wrench

TROUBLESHOOTING TEST FOR TRANSMISSION
(continued)

MK 1



MK 2



TROUBLESHOOTING TEST FOR TRANSMISSION
(continued)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

TEST PROCEDURE

NOTE

Boat must be operated 10 - 15 minutes to allow transmission oil to reach normal temperature before starting test. Then stop engines.

1. Using 5/16 in hex key wrench, remove 3/8 in pipe plug line pressure tap located above regulator valve.
2. Connect hydraulic pressure gage to line pressure tap.

NOTE

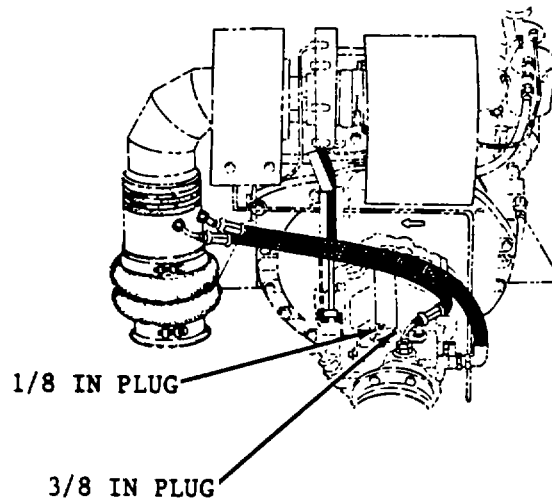
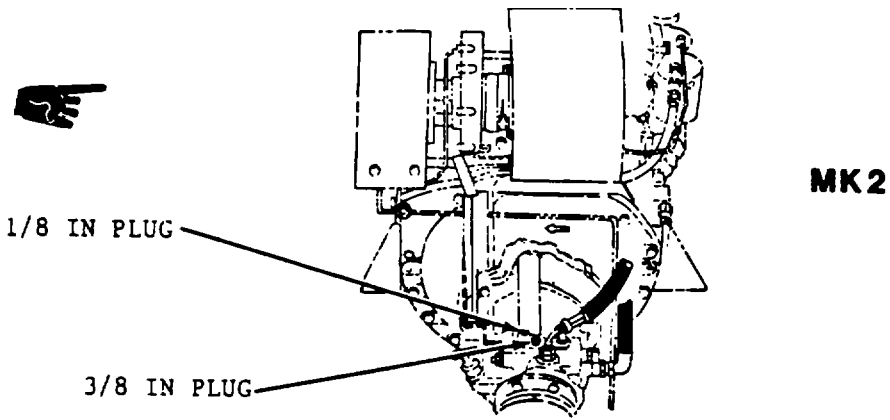
Transmission must be in neutral for first test.

3. Start engine.
4. Follow chart rpm/pressure checks for neutral. If reading is low refer to troubleshooting procedure.

Engine RPM1	Neutral		Forward/Reverse	
	Min	Max	Min	Max
700	90 psi	120 psi	90 psi	120 psi
2000	-	-	100 psi	125 psi

5. While watching pressure gage shift from neutral to forward. If pressure drops and stays low there is leakage in the forward clutch or its circuits.
6. Stop engine.
7. Using 5/16 in hex key wrench, disconnect gage from line pressure tap and install 3/8 in pipe plug.
8. Using 13/64 in hex key wrench, remove 1/8 in reverse clutch pressure plug from adapter tap.
9. Connect hydraulic gage to reverse clutch pressure tap.

TROUBLESHOOTING TEST FOR TRANSMISSION
(continued)



TROUBLESHOOTING TEST FOR TRANSMISSION (Continued)

LOCATION	ITEM	ACTION	REMARKS
<p>NOTE</p> <p>Operate transmission in reverse for only 10 - 15 seconds at a time.</p> <p>10. Start engine.</p> <p>11. Shift transmission to reverse and check pressure readings as per chart. Low pressure readings in reverse indicate same possible problems as neutral low pressure readings.</p> <p>12. High pressure in any range indicate sticking regulator valve, wrong or cold oil.</p> <p>13. Using 13/64 in hex key wrench, disconnect hydraulic pressure gage and install 1/8" pipe plug.</p>			

Section III. DIRECT SUPPORT MAINTENANCE PROCEDURES

GENERAL. This section covers general information for disassembly, cleaning, inspection, repair and assembly for component parts of the bridge erection boat. Specific instructions for individual component maintenance are covered in the appropriate sections.

DISASSEMBLY. Related parts must be kept together, preferably in a tray, to prevent their being lost. For those components which have too many or too large parts to use trays, tag parts with their name as they are disassembled. This will make it easier to identify parts when reassembling the components. Precision matched or mated parts will be marked to insure reassembly in the proper position and place.

CLEANING. All parts except bearings are to be cleaned as specified in TM 9-247. Bearings should be cleaned as specified in TM 9-214.

INSPECTION.

- a. **General.** The importance of carefully inspecting disassembled parts cannot be stressed enough. Reassembly of substandard or defective parts can result in needless troubleshooting, disassembly and inspection. Inspection procedures must be performed by experienced personnel using proper tools and equipment. All measuring and testing equipment must be checked periodically and when required accurately calibrated in accordance with current directives. The recording of complete and accurate inspection records as specified in DA Pam 738-750 is a necessary part of all inspection actions.
- b. **Metallic Parts.** The following procedures should be followed when inspecting metallic parts.
 - (1) Inspect all parts for cracks.
 - (2) Inspect gear teeth, retaining ring grooves and mating surfaces for burrs.
 - (3) Inspect mating and polished surfaces for nicks, scratches and rust. Any nick, scratch, or rust is cause for rejection.
 - (4) Inspect short metal parts for bends, cracks, tears, broken comers or defective welts.
- c. **Non-Metallic Parts.** Non-metallic parts such as seals and gaskets are not subject to inspection. They will be disposed of upon removal and replaced by new items during reassembly.

REPAIR

- a. Hull parts that are cracked may be repaired by welding if it does not distort or impair the strength of the part. Welting procedures will be accomplished as specified in TM 9-237.
- b. A fine file or hone may be used to remove small burrs from gear teeth, retaining ring grooves and mating surfaces. The burrs must be very minor and if on gears only on the engaging edge of the teeth.
- c. Damaged painted surfaces should be repainted as soon as possible to prevent corrosion.

ASSEMBLY. Step-by-step procedures for assembly of the bridge boat components are provided in Chapters 2 and 3. In addition observe the following practices:

- a. Coat the housing contact surface of oil seals with a non-hardening sealer to prevent damage. The lips should be coated with grease (GA).
- b. All pressing operations should be accomplished using a suitable press and adapters unless otherwise specified.
- c. Metallic parts should be lubricated with the lubricant utilized in the component during operation.
- d. Critical torque values are specified in the assembly procedures.
- e. Silicone sealant is used on gaskets and mating surfaces in the engine assembly.

GENERAL DETAILED PROCEDURE APPLICATIONS

- a. Resources required are not listed unless they apply to the procedure.
- b. Personnel required are listed only if the task requires more than one. If PERSONNEL are not listed it means that one person can do the task.
- c. The normal standard equipment condition to start a maintenance task is power (MASTER SWITCH) OFF. EQUIPMENT CONDITION is not listed unless some other condition is required besides the (MASTER SWITCH) being OFF.

CAUTION

When the MK-1 and MK-2 boat engines are operated out of the water, the temperature gages must be monitored at all times to prevent overheating and engine damage.

NOTE

Remember the bridge erection boat has two water cooling systems (refer to FO-1).

- d. The MK1 and MK2 engine WILL NOT be operated out of water for more than 20 minutes at idle speed. Any maintenance task step that requires engine operation MUST BE performed with the boat in water or by following Out of Water Engine Operation procedures (TM 5-1940-277-20).
- e. Standard maintenance procedure requires that upon completion of a maintenance action a component function and performance check be conducted to assure no leakage or malfunction exists. If leakage or malfunction is found repeat the maintenance procedure to correct problem.
- f. Standard maintenance procedure requires that an operational check be performed after completion of repairs if possible. This step is not called out as part of the procedure.

DIRECT SUPPORT MAINTENANCE PROCEDURE INSTRUCTIONS INDEX

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WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS

This task covers:

- a. Disassembly - brush replacement
- b. Cleaning motor
- c. Assemble - brush replacement
- d. Disassemble - drive coupling replacement
- e. Assemble - drive coupling replacement

INITIAL SETUP

Tools:

Description:

- Needle nose pliers
- 3/16 in. open end wrench
- Cross tip screwdriver
- 1/4 in. socket, 1/4 in. drive
- 1/4 in. drive ratchet
- 3/8 in. punch
- Slip joint pliers
- Hammer, ball peen, 8 oz.
- Safety goggles
- Air compressor
- Air blow gun

TM 5-1940-277-20

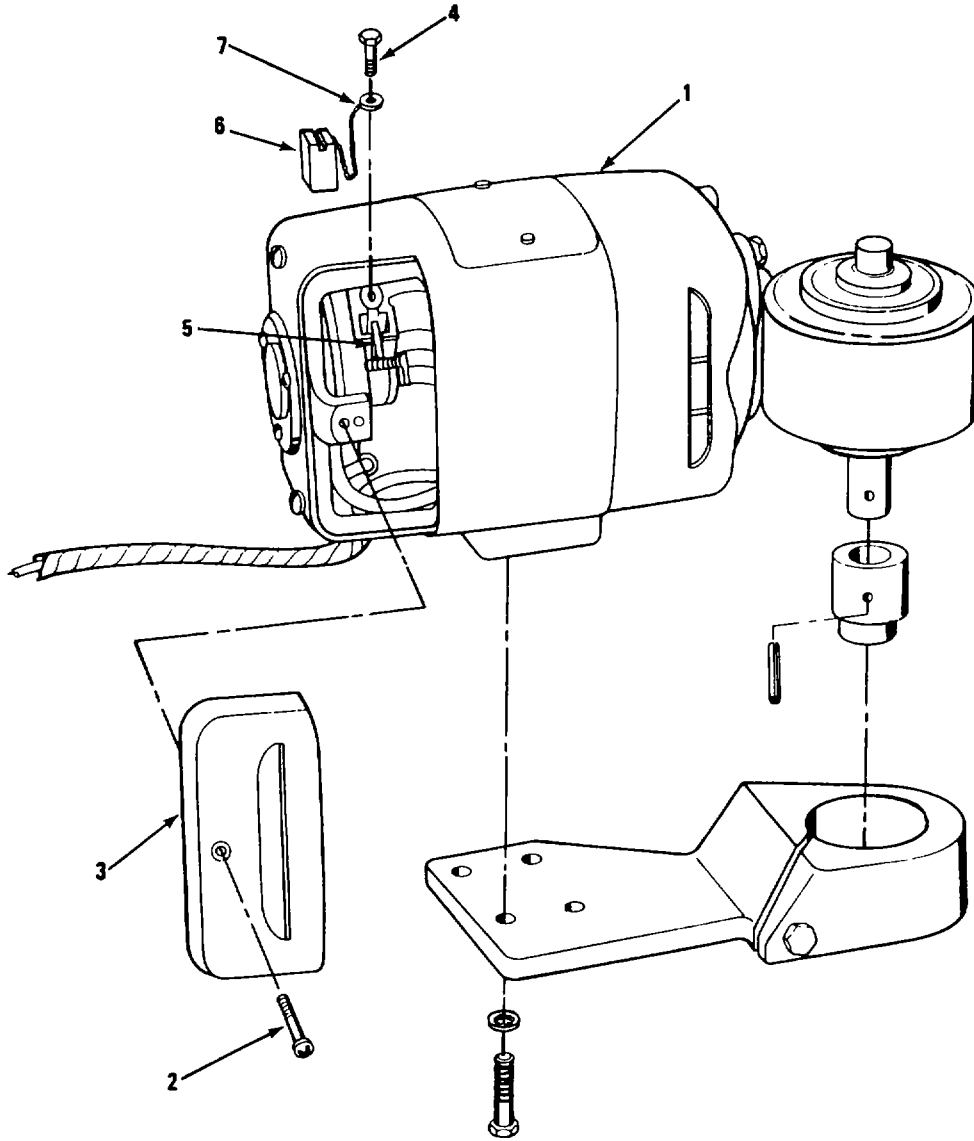
Equipment Condition: Condition

Windshield wiper motor removed from boat.

Materials/Parts:

- Two brushes
- Drive coupling

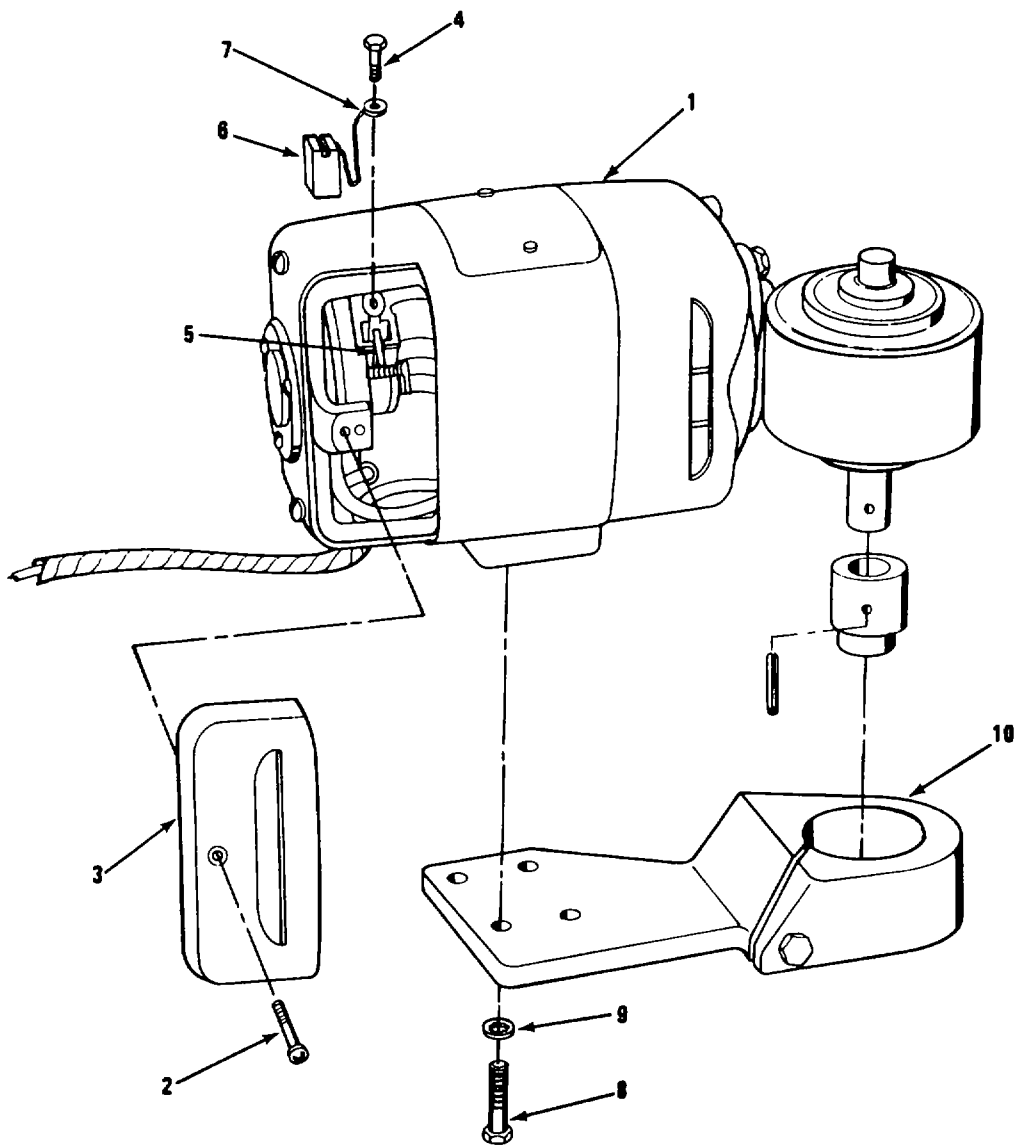
WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS (Continued)



WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>DISASSEMBLE - BRUSH REPLACEMENT</u>			
1. Wiper motor (1)	a. Screw (2)	Unscrew and remove.	Use cross tip screwdriver.
	b. Access cover (3)	Remove.	
	c. Screw (4)	Unscrew and remove, release brush lead.	Use 3/16 in. open end wrench.
	d. Brush spring (5) and brush (6)	Raise spring and lift brush out of holder.	Use needle nose pliers.
WARNING			
Always use safety goggles when using dry compressed air for cleaning. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.			
<u>CLEANING</u>			
2.	Commutator	Clean.	Use dry compressed air.

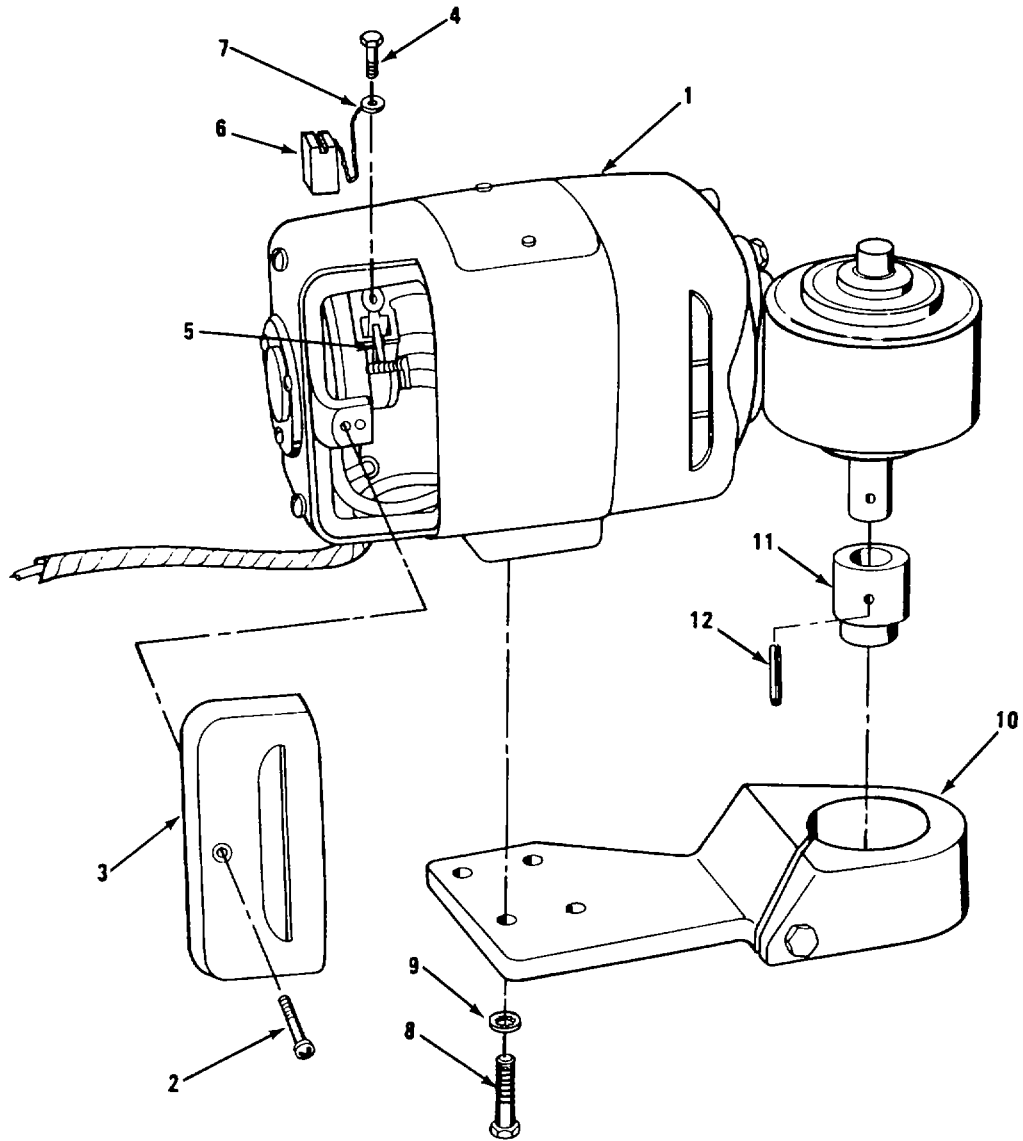
WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS (Continued)



WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>ASSEMBLE - BRUSH REPLACEMENT</u>			
3.	a. Brush spring (5) and brush (6)	a. Raise spring.	Use needle nose pliers.
		b. Insert brush into holder.	Be sure pre-shaped brush is installed correctly for proper contact with commutator.
		c. Release spring.	
	b. Brush lead (7) and screw (4)	Secure lead to motor.	Use 3/16 in. open end wrench.
	c. Access cover (3) and screw (2)	Install and secure.	Use cross tip screwdriver.
<u>DISASSEMBLE - DRIVE COUPLING REPLACEMENT</u>			
1. Wiper motor (1)	a. 4 cap screws (8) and 4 lockwashers (9)	Unscrew and remove. in.	Use 1/4 in. socket and 1/4 drive ratchet.
	b. Bracket (10)	Remove.	

WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS (Continued)



WINDSHIELD WIPER MOTOR REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	c. Retainer pin (12)	Punch out.	a. Use 1/8 in. punch and hammer.
			b. If required extract with pliers.
	d. Drive coupling (11)	Withdraw off shaft.	Use pliers.

ASSEMBLE - DRIVE COUPLING REPLACEMENT

2.	a. Drive coupling (11)	a. Fit onto shaft.	
		b. Aline retainer pin holes.	
	b. Retainer pin (12)	Insert.	Use hammer.
	c. Bracket (10)	Fit in place.	
	d. 4 cap screws (8) and 4 lockwashers (9)	Install and secure bracket.	

FUEL TANK REPLACEMENT INSTRUCTIONS

This task covers:

- a. Removal
- b. Test
- c. Transfer of parts to replacement tank
- d. Installation

INITIAL SETUP

Tools:

Dispensing pump, hand
3/8 in. portable drill
1/4 in. drill bit
1/2 in. open end wrench
5/8 in. open end box wrench
Pipe wrench, 8 in.
1/2 in. box wrench
Flat tip screwdriver, 6 in.
Blind riveter, hand
Air compressor
Air control valve assembly
1/4 in. Punch
Hammer
Safety goggles

Equipment Condition:

TM 5-1940-277-20
TM 5-1940-277-20

Condition Description:

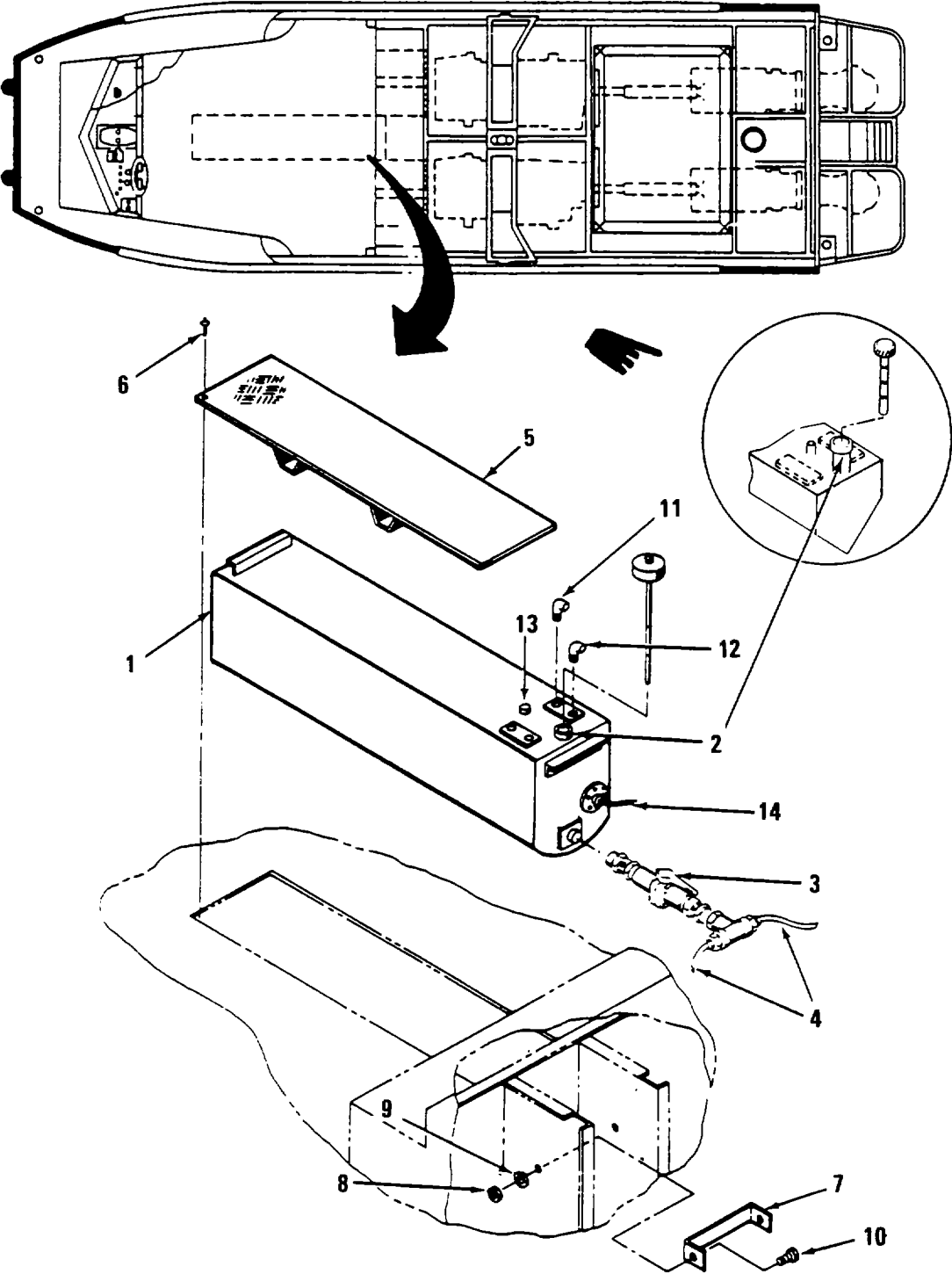
Batteries disconnected.
Battery box lid removed.

Materials/Parts:

Pipe tape
1/4 in. blind rivets
Fuel tank
Foam strips (packing)
Adhesive, rubber base
Gasket, Rubber

Personnel Required: Three

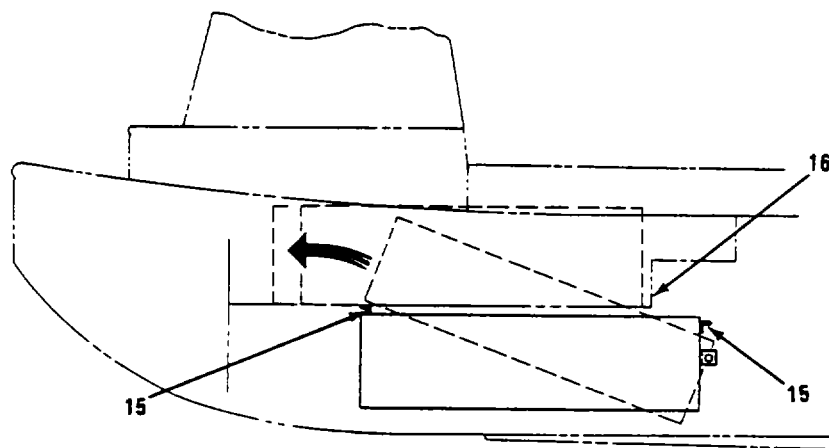
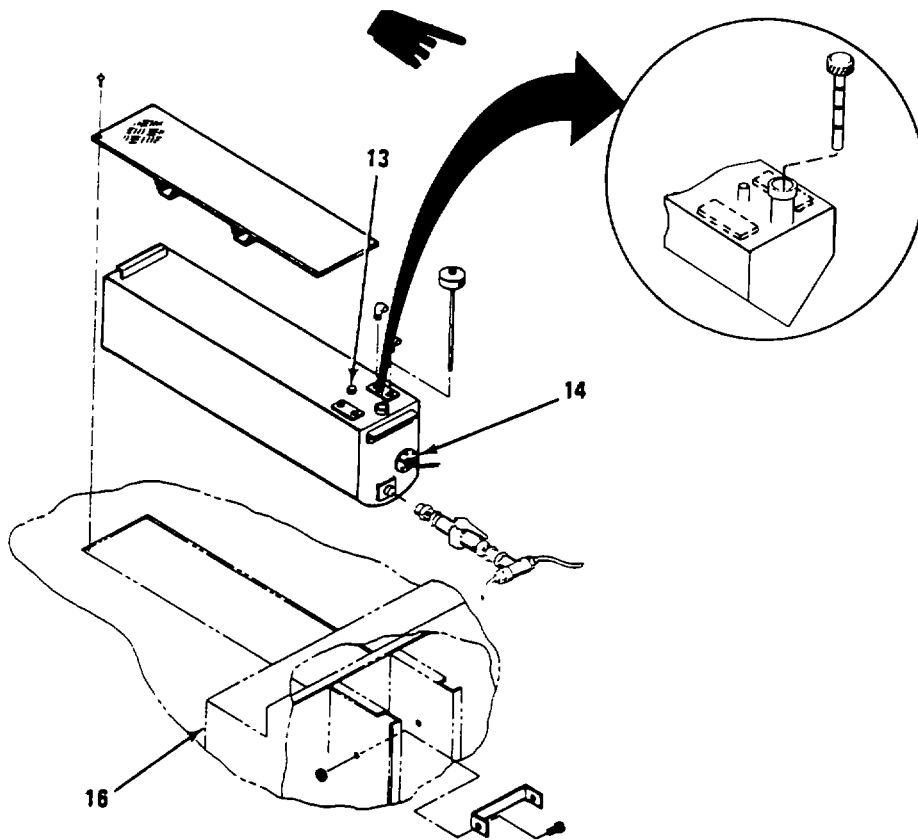
FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)



FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL:</u>			
1. Fuel tank (1)	Fuel tank (1)	Empty by:	Use hand operated dispensing pump or suction pump.
		a. Pumping from filling pipe (2), or	
		b. Isolate at main valve (3), disconnect fuel lines (4) downstream of valve, connect suction hose and pump.	
2. Forward cockpit	a. Center line deck plate (5)	a. Drill 44 ea. rivets (6) until head pops off.	Use 1/4 in drill bit and 3/8 in drill.
		b. Punch rivet through hole.	Use 1/4 in punch and hammer.
		c. Remove.	
	b. Tie bar (7), 2 nuts (8), 2 washers (9), and 2 bolts (10)	Remove.	Use 1/2 in box wrench and 1/2 in open end wrench.
3. Fuel tank (1)	a. 6 ea. fuel lines at connections (11, 12)	Disconnect.	Use 5/8 in open end box wrenches.

FUEL TANK REPLACEMENT INSTRUCTIONS (Continued-)



FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
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CAUTION

Minor fuel leakage will happen when disconnecting fuel lines. Exercise care to prevent fuel from contaminating flotation blocks.

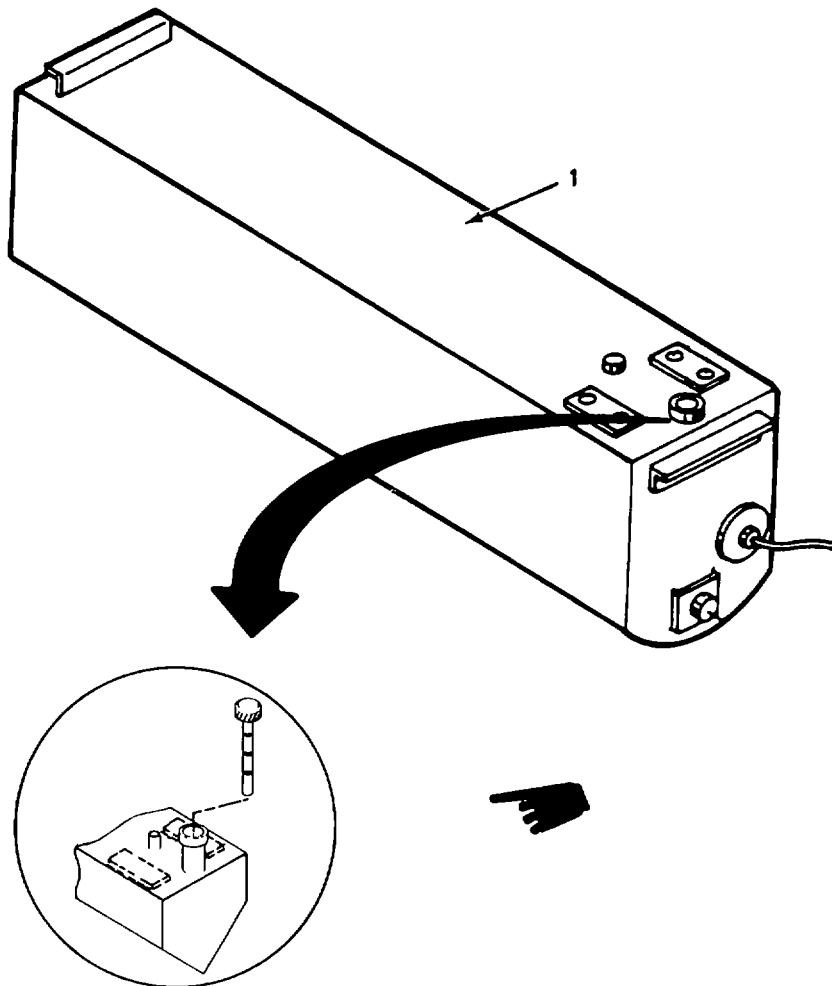
b. Vent hose at vent pipe (13)	Loosen clamp and remove.	Use screwdriver.
c. Fuel level sender lead (14)	Disconnect at first connection away from sender (unplug).	a. Do not disconnect right at sender. b. If there is need to remove sender, see TM 5-1940-277-20 for instructions.

NOTE

Fuel tank is squeeze-fitted into its space using packing. Tank is not secured by any other means.

d. Main fuel valve (3)	Remove valve and tee fitting.	See TM 5-1940-277-20.
e. Fuel tank (1)	Lift tank out of its space by handles (15).	Use at least three persons. Lift forward end and carefully pull tank under battery box (16) up into forward cockpit. Lift the rear end of fuel tank into cockpit as shown in figure.

FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)



FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
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TEST:

WARNING

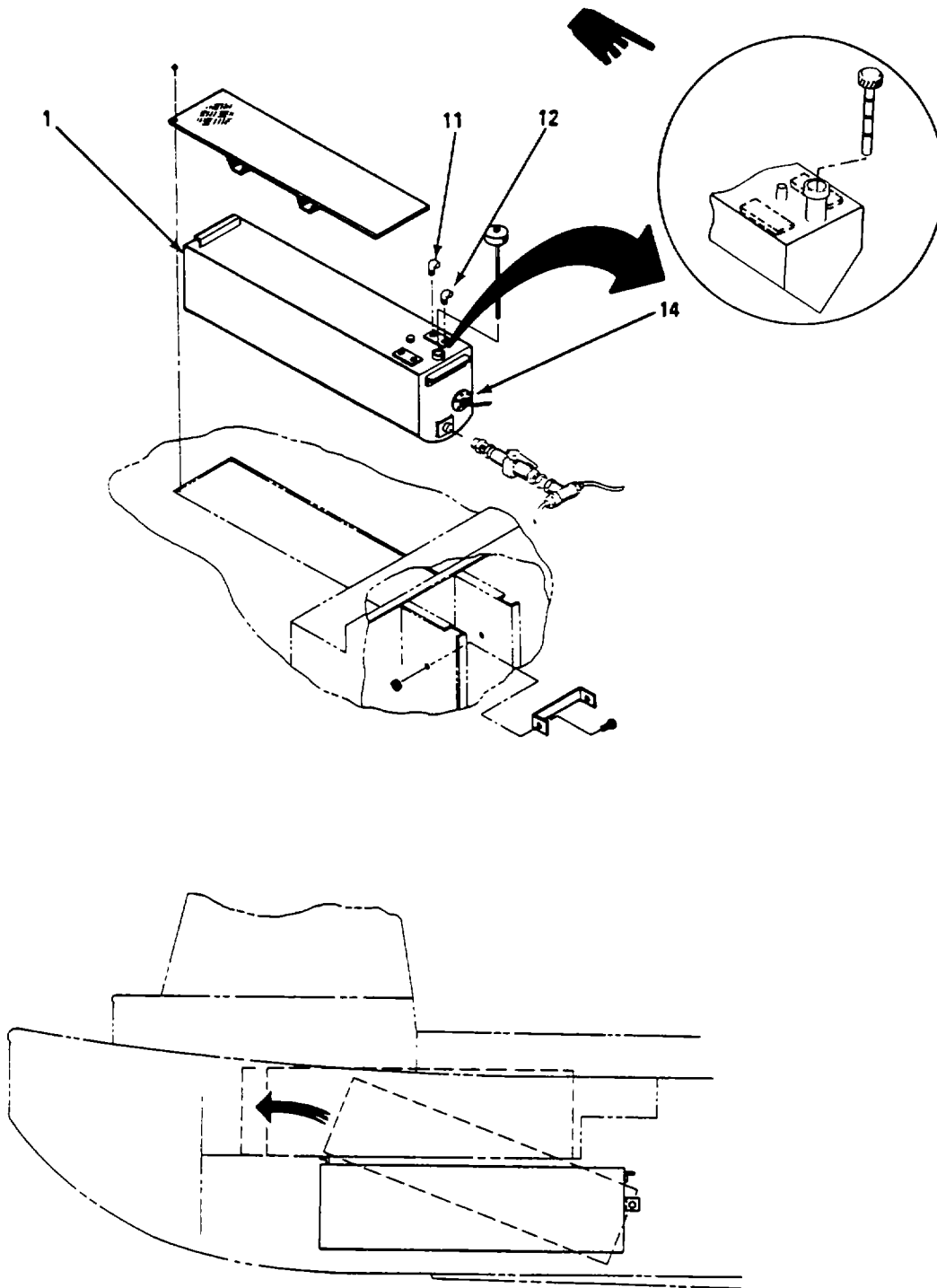
Do not weld used tank. Tank may explode. Severe burns can result.

WARNING

Always use safety goggles when using dry compressed air for cleaning. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.

4. Fuel tank (1)	Fuel tank (1)	Test tank for leaks: a. Close all openings. b. Fit air nozzle. c. Pressurize to 2-1/2 PSI. d. Read pressure after 15 min. If there has been a pressure loss, replace tank. e. If pressure held, release pressure, remove plugs and air nozzle.	Use air compressor and air control valve assembly.
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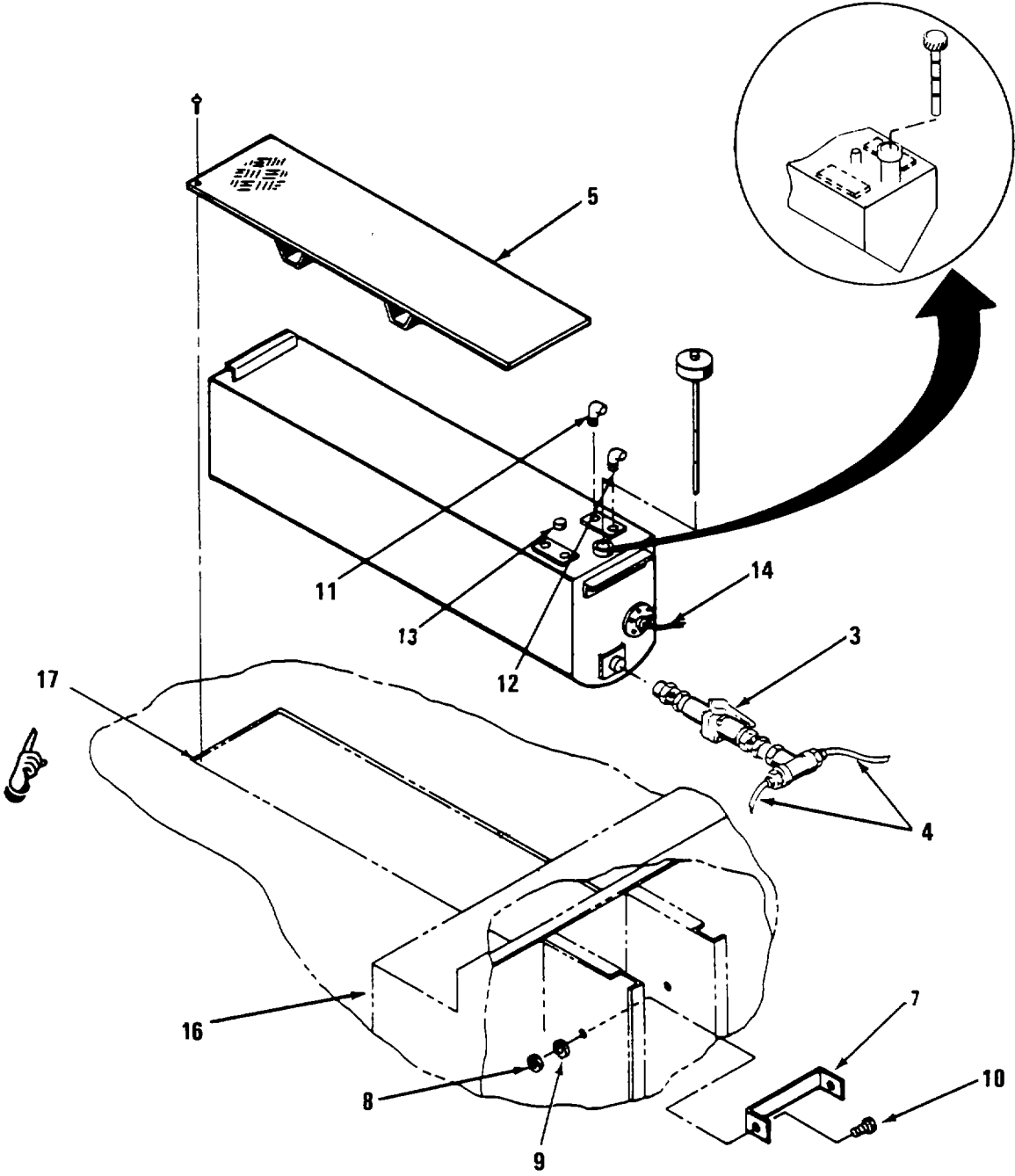
FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)



FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>TRANSFER OF FITTINGS TO REPLACEMENT TANK:</u>			
5. Fuel tank (1)	a. 90° elbows (11, 12) for fuel return lines (4 each)	a. Unscrew.	Use pipe wrench.
		b. Apply pipe tape.	Item 2, App. B
	b. Fuel level sender (14)	Transfer.	See TM 5-1940-277-20.
<u>INSTALLATION:</u>			
6. Fuel tank (1)	a. Fuel tank (1)	a. Install new tank.	Make sure tank is completely seated in cradles and foam strips are preventing any metal-to-metal contact. Foam strip on sides of tank should give tight fit, holding tank in place.
		b. Check bulk-head cradle for foam strips.	
		c. Seat tank.	
	b. Fuel level sender lead (14)	Connect.	

FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)



FUEL TANK REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	c. Vent hose at vent pipe (13)	Connect, tighten hose clamp at vent pipe (13).	Use screwdriver.
	d. Main fuel valve (3)	a. Apply pipe tape. b. Install.	Item 2, APP. B See TM 5-1940-277-20.
	e. 6 ea. fuel lines at connections (11, 12, 4)	Connect.	Use 5/8 in open end box wrench.
7. Battery box (16)	a. Tie bar (7), 2 nuts (8), 2 washers (9), and 2 bolts (10)	Install.	Use 1/2 in box wrench and 1/2 in open end wrench.
	b. Center line deck plate (5)	a. Apply rubber base adhesive and rubber gasket material (17) b. Position deck plate (5) using markings. c. Rivet in place.	Items 12 and 13 APP. B. Use 1/4 in aluminum blind rivets and blind riveter, hand.

NOTE

Be careful to clean up clipped rivet pieces. It is possible that rivet cores are non-compatible metal which will cause corrosion spots if accidentally dropped in bilges.

DRAIN DOWN VALVE REPLACEMENT INSTRUCTIONS (MK1)

This task covers:

- a. Removal
- b. Intallation

INITIAL SETUP

Tools:

- Flat tip screwdriver
- 8 in pipe wrench
- Straight nose pliers
- Multiple tongue and groove slip joint pliers

Materials/Parts:

- Drain down valve
- Compound, pipe fitting

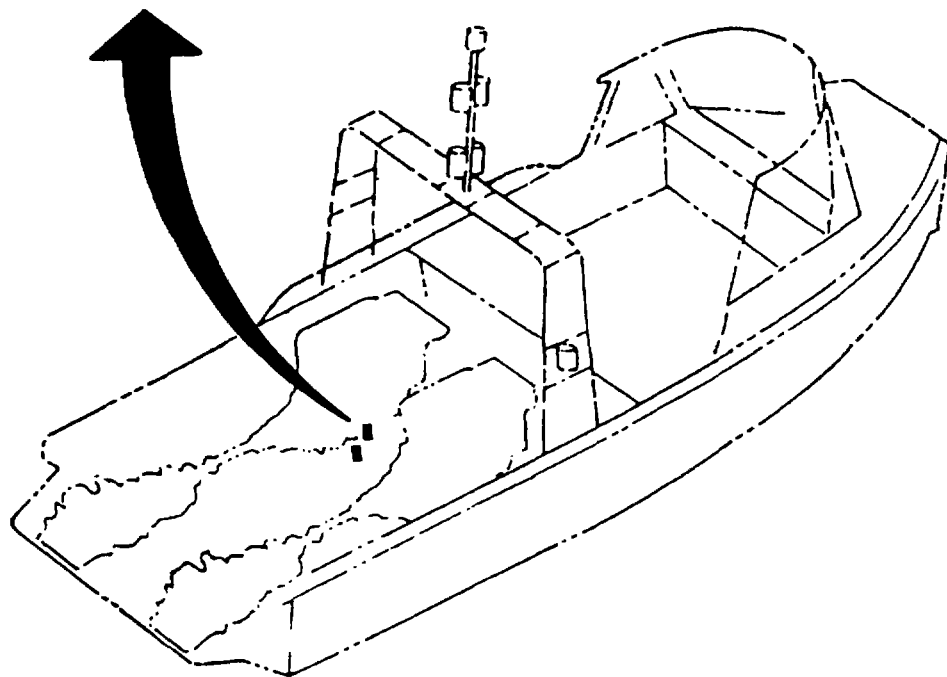
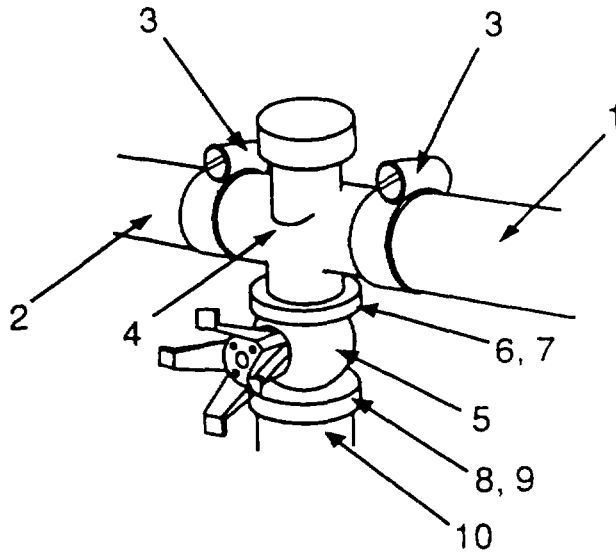
Equipment Condition:

TM 5-1940-277-20

Condition Description:

Engine hatches open.

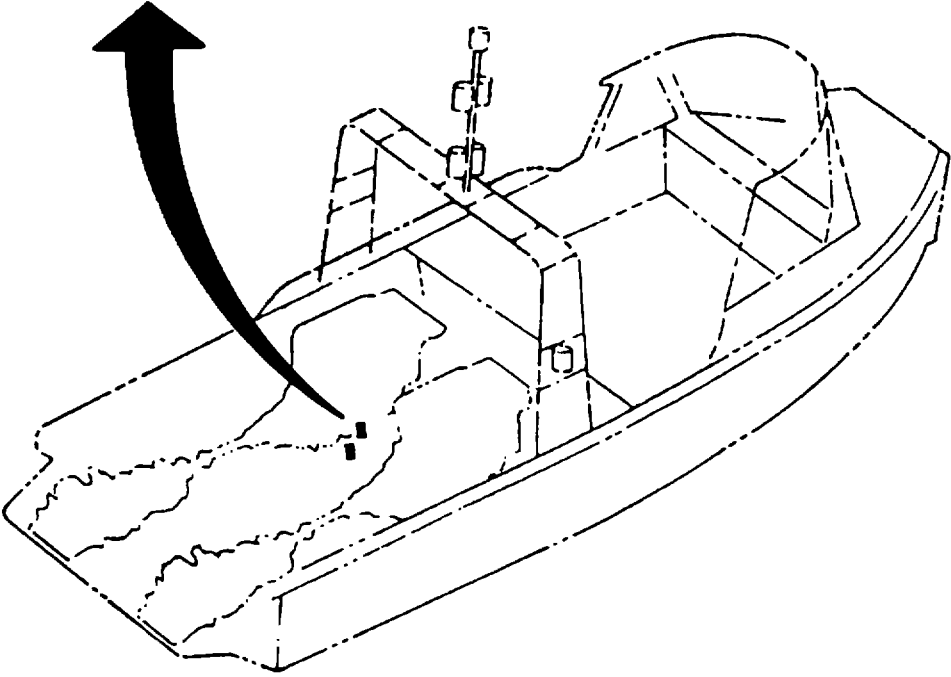
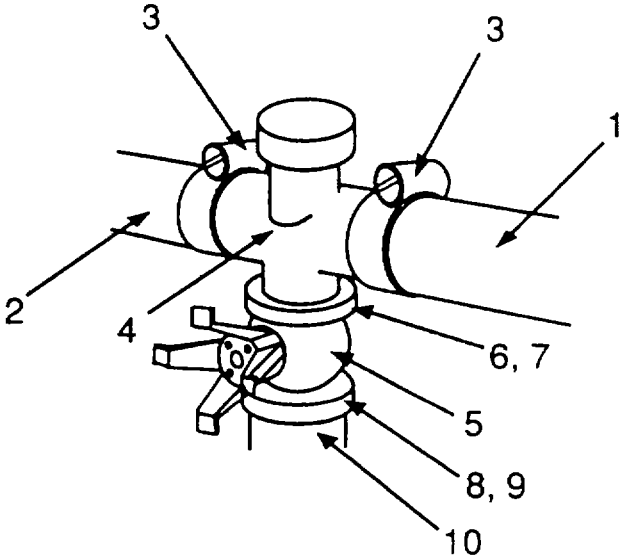
DRAIN DOWN VALVE REPLACEMENT INSTRUCTIONS (MK-I) (Continued)



DRAIN DOWN VALVE REPLACEMENT INSTRUCTIONS (MK-I) (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Engine compartment	a. Hoses (1) and (2)	a. Loosen hose clamps (3). b. Pull hose (1) and (2) off cross drain (4).	Use screwdriver.
	b. Valve (5) fitting (6) with collar (7) from cross drain (4).	a. Unscrew upper b. Unscrew lower fitting (8) with collar (9) from stub pipe (10).C2	Use pipe wrench

DRAIN DOWN VALVE REPLACEMENT INSTRUCTIONS (MK1) (Continued)



DRAIN DOWN VALVE REPLACEMENT INSTRUCTIONS (MK-1) (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>INSTALLATION:</u>			
2. Engine compartment	a. New valve (5)	a. Screw lower fitting (8) with collar (9) onto stub pipe (10) until finger tight.	
	b. Screw upper fitting (6) with collar (7) onto cross drain (4).		
	c. Hose (1) and (2).	Fit hoses (1) and (2) onto cross drain (4) and secure using hose damps (3)	Use screwdriver
Pages 2-56.1 through 2-56.3 deleted			

ALTERNATOR REPAIR INSTRUCTIONS

This task covers:

- | | | |
|-----------------------|--------------------|-------------------------|
| a. Disassembly | d. Testing | g. Bench testing |
| b. Cleaning | e. Repair | |
| c. Inspection | f. Assembly | |

INITIAL SETUP

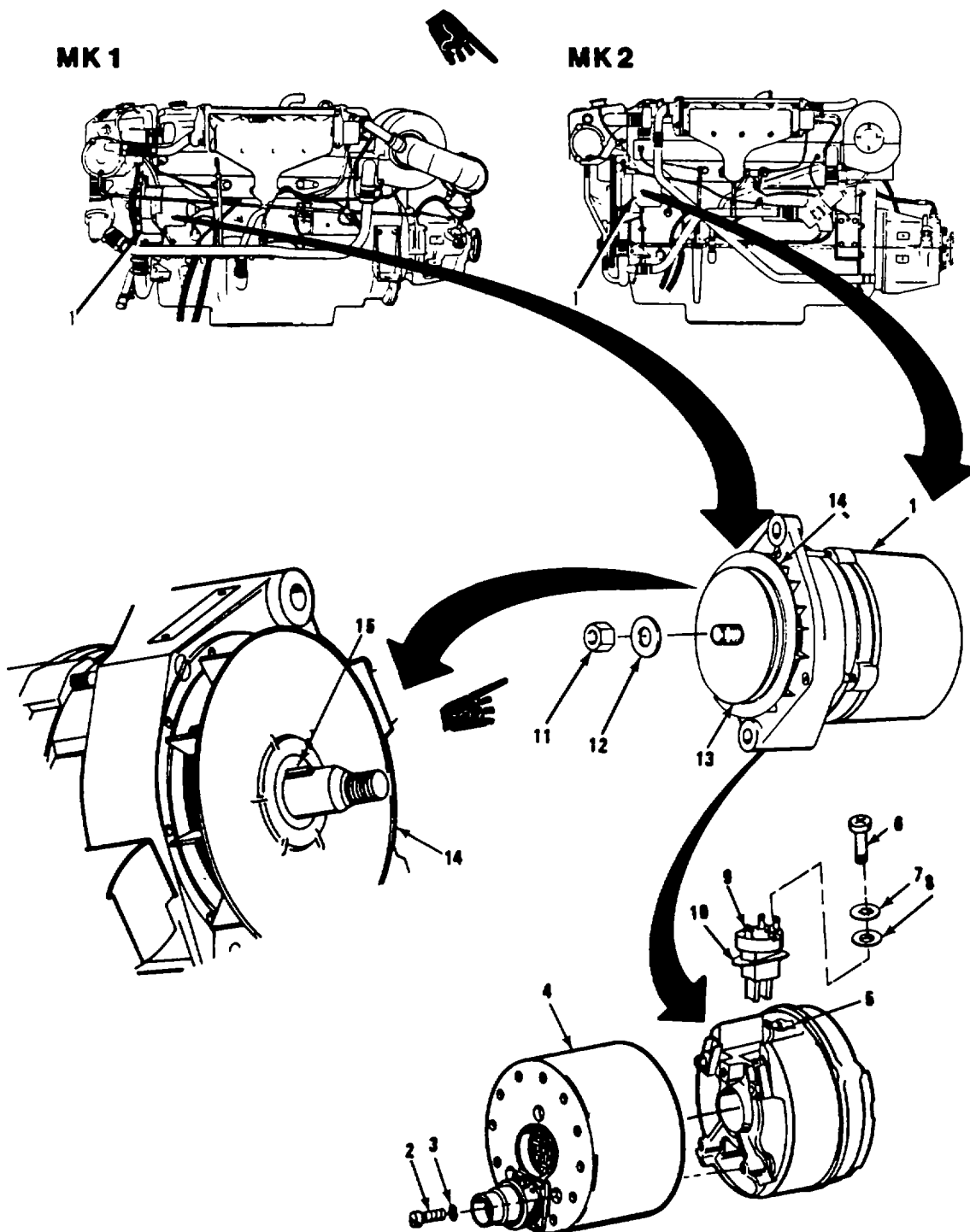
Tools:	Equipment Condition:	Condition Description:
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Vise	TM 5-1940-277-20	Alternator removed from engine.
Vise jaw caps		
Flat tip screwdriver, 6 in		
Cross tip screwdriver, 6 in		
Scribe		
Non-metallic hammer		
15/16 in box wrench		
Soldering iron		
Snap ring pliers		
Air compressor		
Air blow gun		
Multimeter, TS-352B/U		
Torque wrench (0 - 175 ft-lb)		
15/16 in socket, 1/2 in drive		
Generator and starter test stand		
Cylinder support		
Safety goggles		
Press		

Materials/Parts:

Brush box gasket
 O-ring, slip ring end shield
 Solvent
 Brushes
 Loctite
 Lockwashers

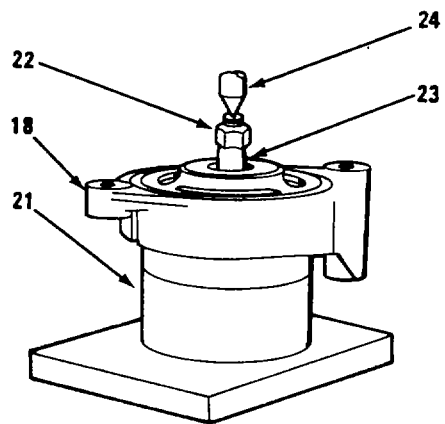
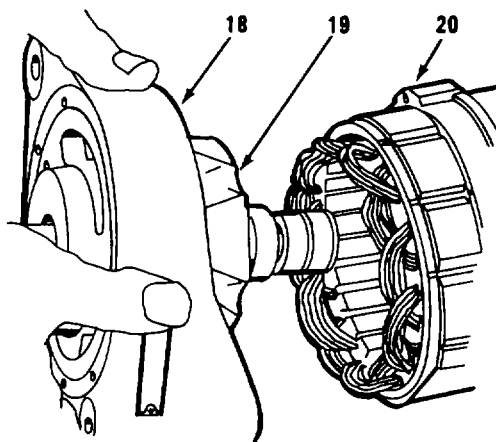
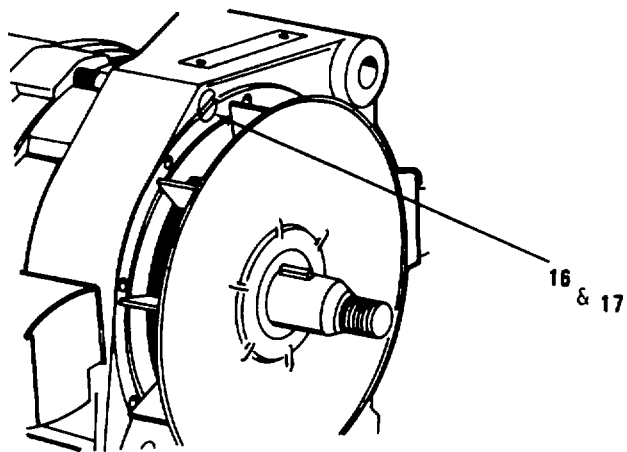
ALTERNATOR REPAIR INSTRUCTIONS (Continued)



ALTERNATOR REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>DISASSEMBLE</u>			
1. Alternator (1)	a. Alternator (1)	a. Remove all surface dirt and grease.	Use solvent.
		b. Lightly clamp in vise.	Use soft jawed vise.
	b. 3 capscrews (2) and 3 lockwashers (3)	Unscrew and remove.	Use flat tip screwdriver.
	c. Cowl (4)	Detach.	
	d. Tag (5)	Disconnect.	
	e. 2 capscrews (6), 2 washers (8) and 2 lock-washers (7)	Unscrew and remove.	Use cross tip screwdriver.
	f. Brush box assembly (9) and gasket (10)	a. Remove. b. Discard gasket.	
	g. Pulley nut (11) and washer (12)	Remove.	Use 15/16 in box wrench.
	h. Pulley (13), fan (14) and woodruff key (15)	Withdraw.	

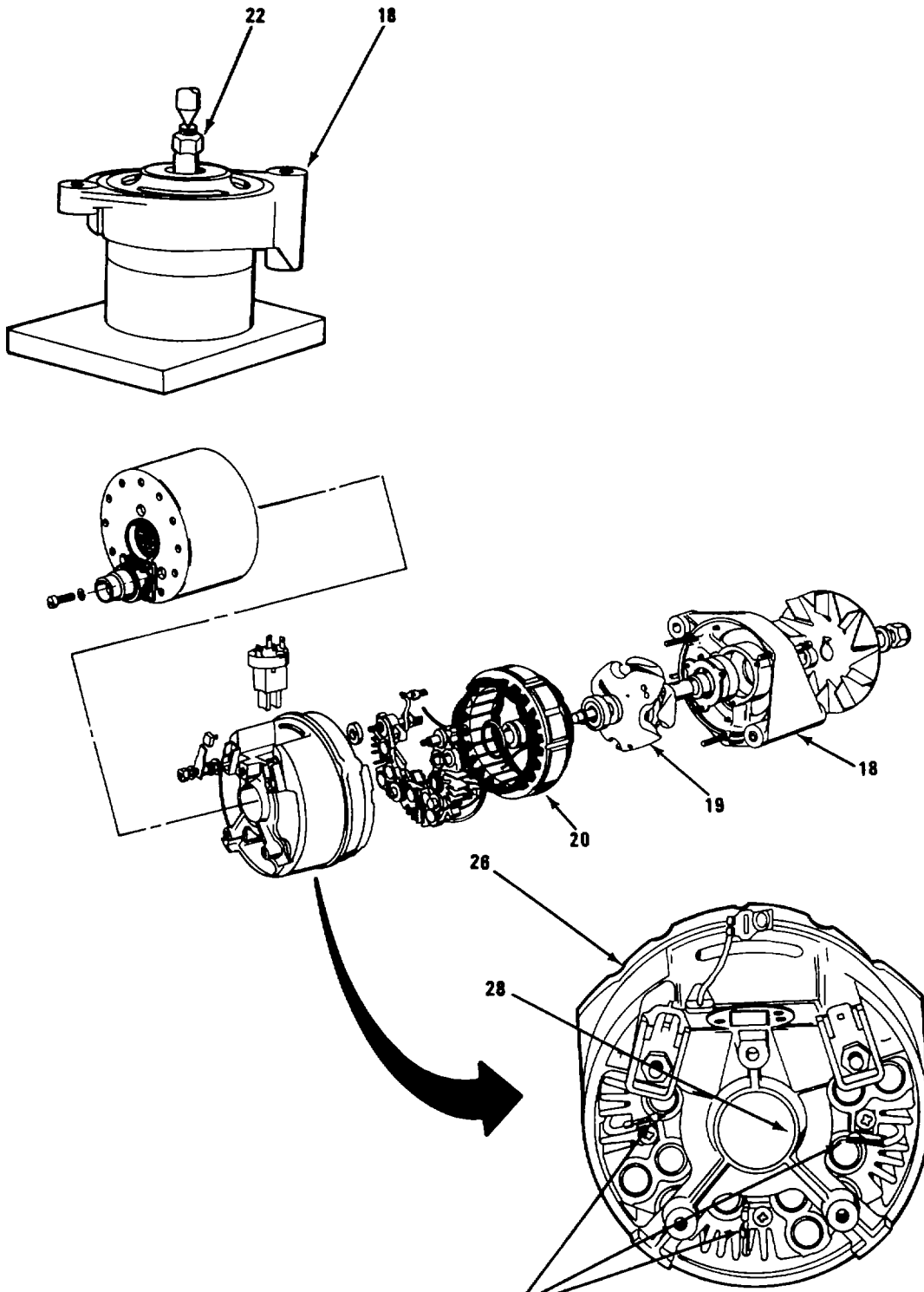
ALTERNATOR REPAIR INSTRUCTIONS (Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	i. 3 through screws (16) and 3 lock-washers (17)	Unscrew and remove.	Use flat tip screwdriver.
	j. Drive end shield (18) with rotor (19)	a. Carefully withdraw from stator (20).	Tap lightly with hammer to separate.
<u>CAUTION</u>			
Do not damage slip rings when placing on table.			
		b. Place over large diameter cylinder support (21).	Cylinder support must be large enough to encase rotor and small enough to slip inside drive end shield (18) and support assembly with three end shield webs seated squarely onto cylinder.
		c. Screw nut (22) onto shaft.	This prevents rotor from dropping onto slip rings during disassembly.
		d. Press rotor shaft (23) from drive end shield (18).	Use press (24).
		e. Remove from cylinder support.	

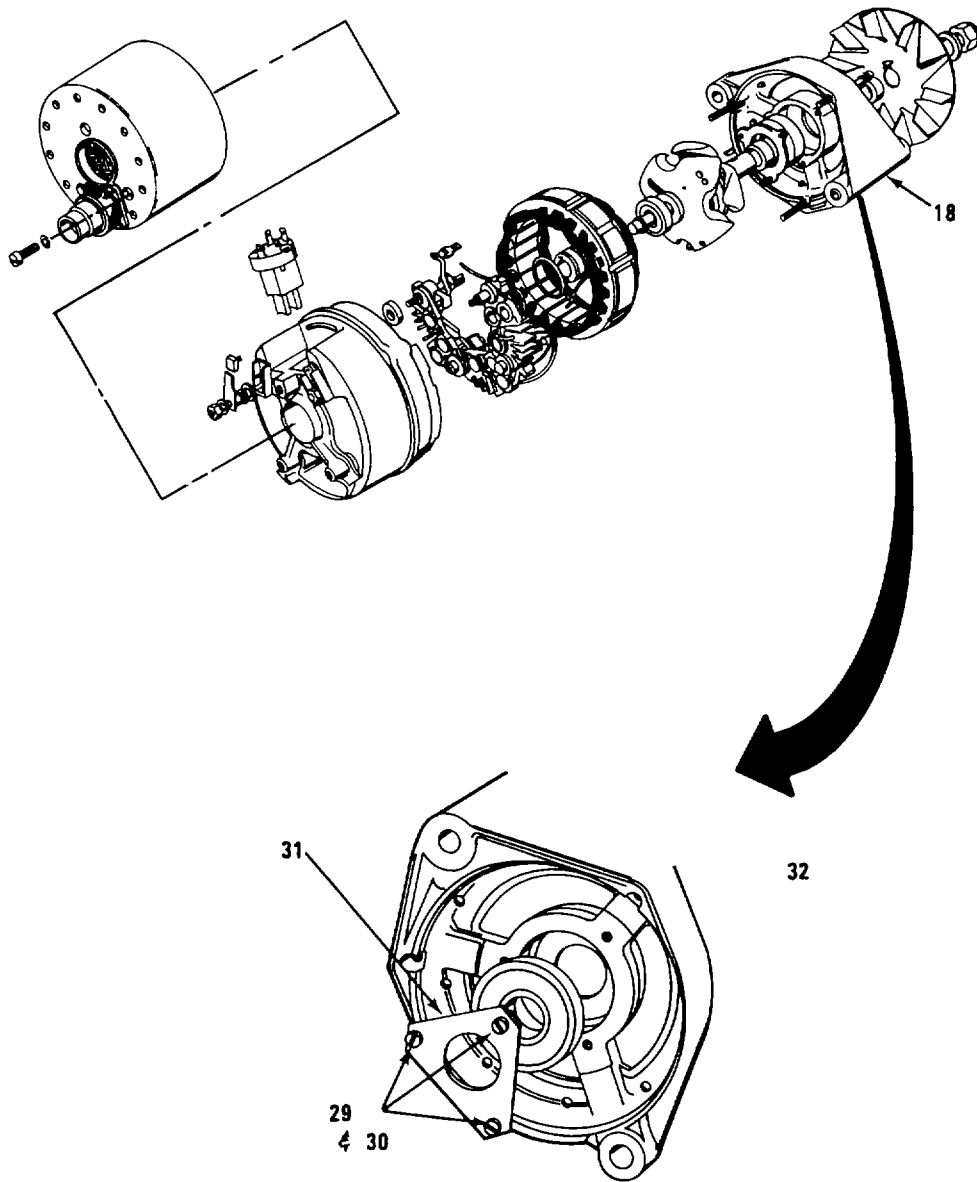
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
2. Stator (20) and slip ring end shield (26)	Stator (20) and slip ring end shield (26)	f. Remove nut (22) from shaft. g. Separate rotor (19) and end shield (18). a. Remove from vise. b. Place on bench, end shield up. c. Unsolder 3 stator leads (27) from heat sink terminal tags.	Take care when lifting that weight of stator is not taken by three stator leads. Use soldering iron.
<u>CAUTION</u> Do not remove tags from heat sinks.			
3. Slip ring end shield (26)	Bearing housing (28)	d. Separate end shield (26) and stator (20). Remove and discard O-ring.	Take care not to damage O-ring groove.

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



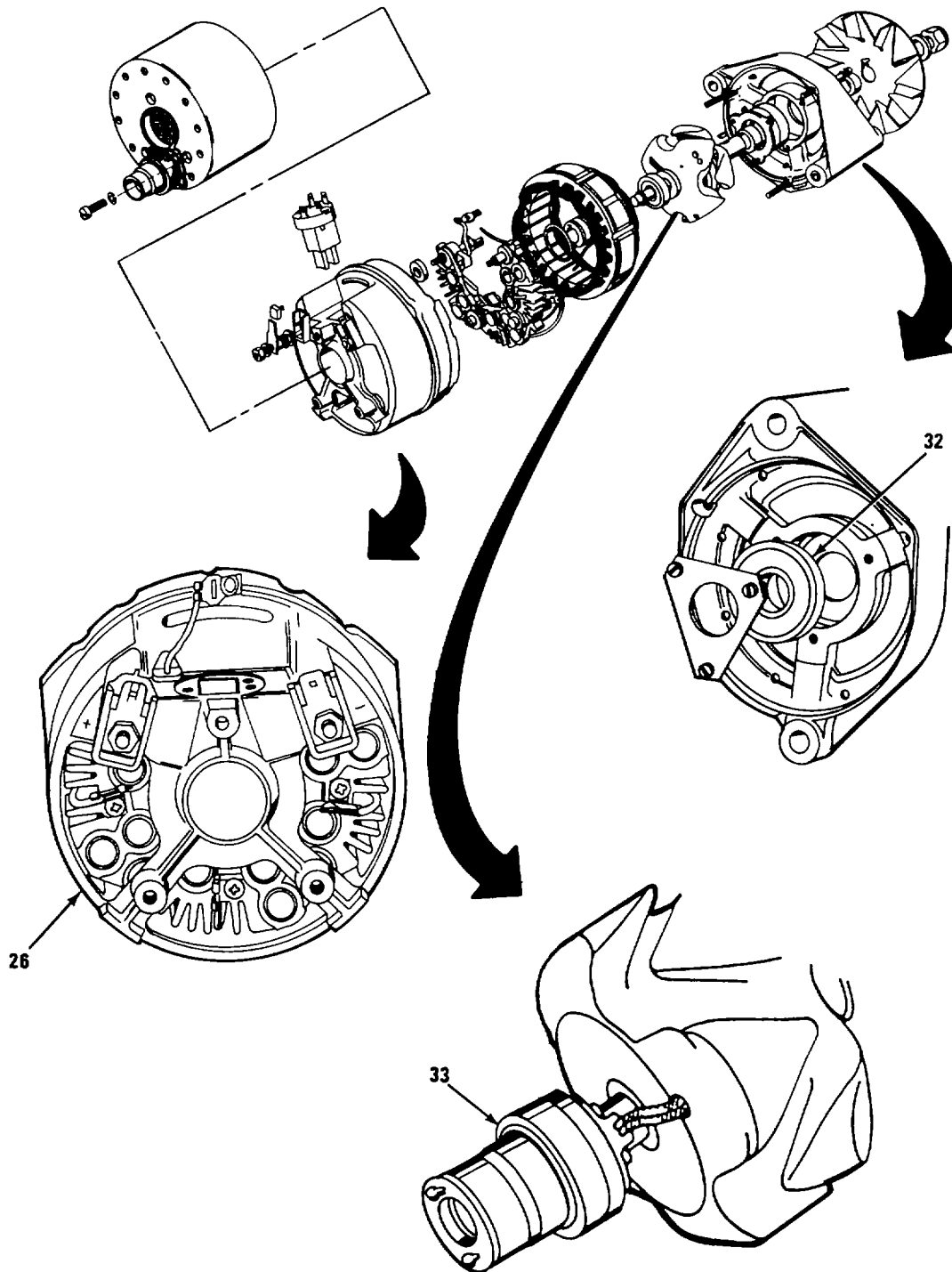
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
4. Drive end shield (18)	a. 3 screws (29), 3 washers (30) and clamping plate (31)	Remove.	Use flat tip screwdriver. Should screws be difficult to remove, heat end shield to 212° F.
	b. Bearing (32)	Extract.	Use suitable drift if required.

CLEANING, INSPECTION, TEST, AND REPAIR

5.	All components	a. Clean thoroughly.	Use dry cleaning solvent.
WARNING			
<p>Always use safety goggles when using dry compressed air. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.</p>			
		b. Remove all traces of carbon dust.	Use low pressure compressed air. DO NOT spin bearings with compressed air.
		c. Inspect visually for Cracks, Corrosion, Local discoloration, and Wear.	

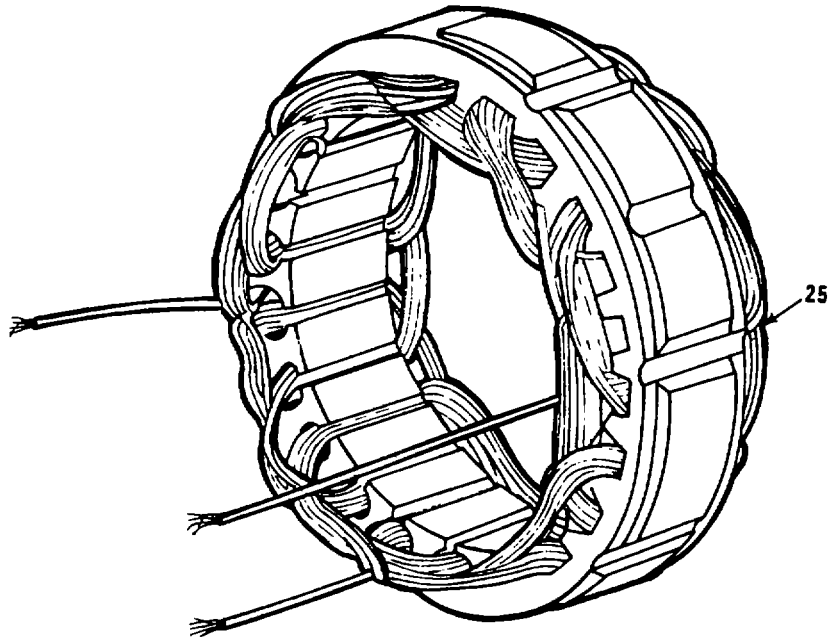
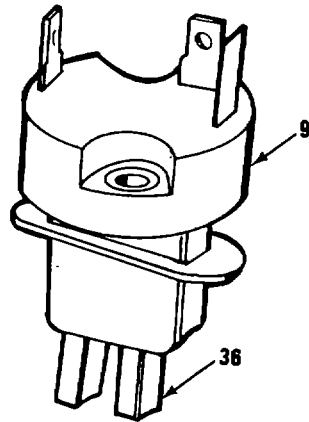
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
6.	Bearings (33 and 32)	<ul style="list-style-type: none"> d. Check all internal and external threads. e. Replace damaged or defective components. a. Examine for excessive play. b. Spin by hand. c. Replace bearing (32) if running dry or too much play. d. If bearing (32) is defective replace rotor assembly. 	<p>Note that self-locking pulley nut (11) can be reused provided nylon insert is in reasonable condition.</p>
7.	Slip ring end shield (26)	<ul style="list-style-type: none"> a. Examine internal bore of bearing housing. b. Replace if signs of wear noted. 	<p>Caused by outer race of bearing revolving.</p>

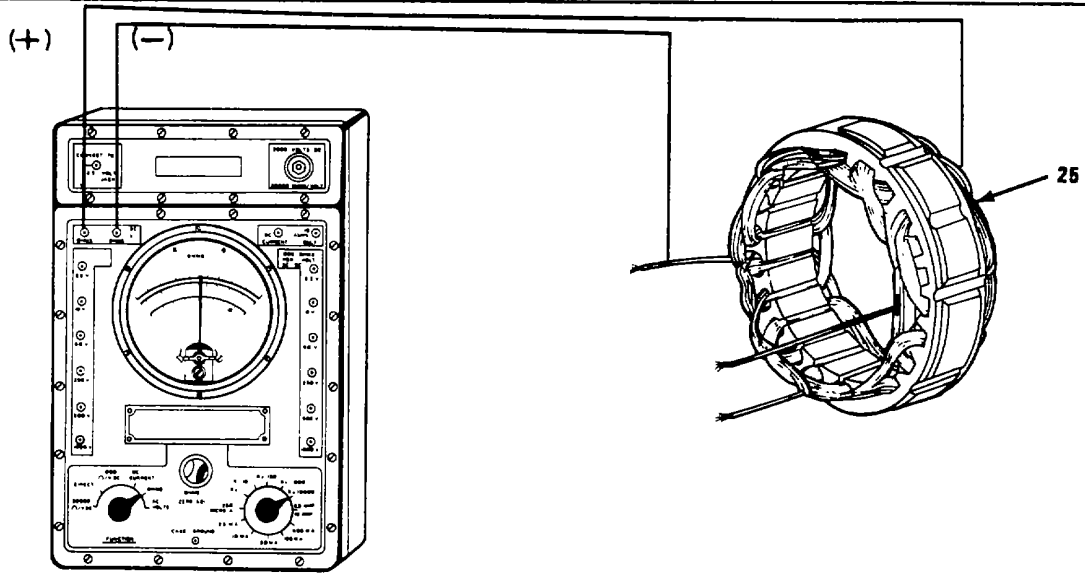
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



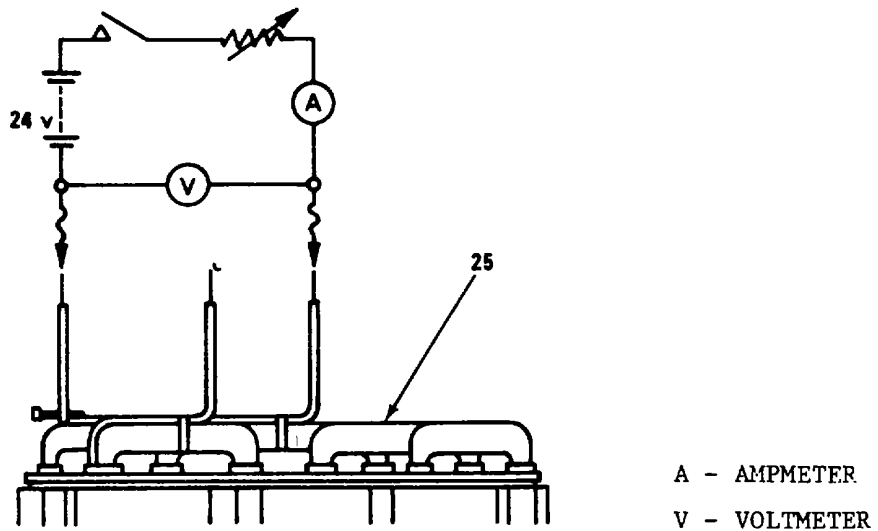
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
8.	Brush box assembly (9)	c. Check fit of bearing (32) into housing.	
		d. If bearing is not tight fit when pressed-in replace end shield.	
		a. Inspect for Cracks, Brushes (36) moving freely in slots, Brush (36) length, min. 0.312 in (8 mm).	
		b. Replace if any defects noted.	
9.	Stator (25)	a. Examine windings visually to ensure they are properly secured and insulation is undamaged.	
		b. Check leads for mechanical soundness and condition of insulation.	

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



STATOR WINDING INSULATION TEST



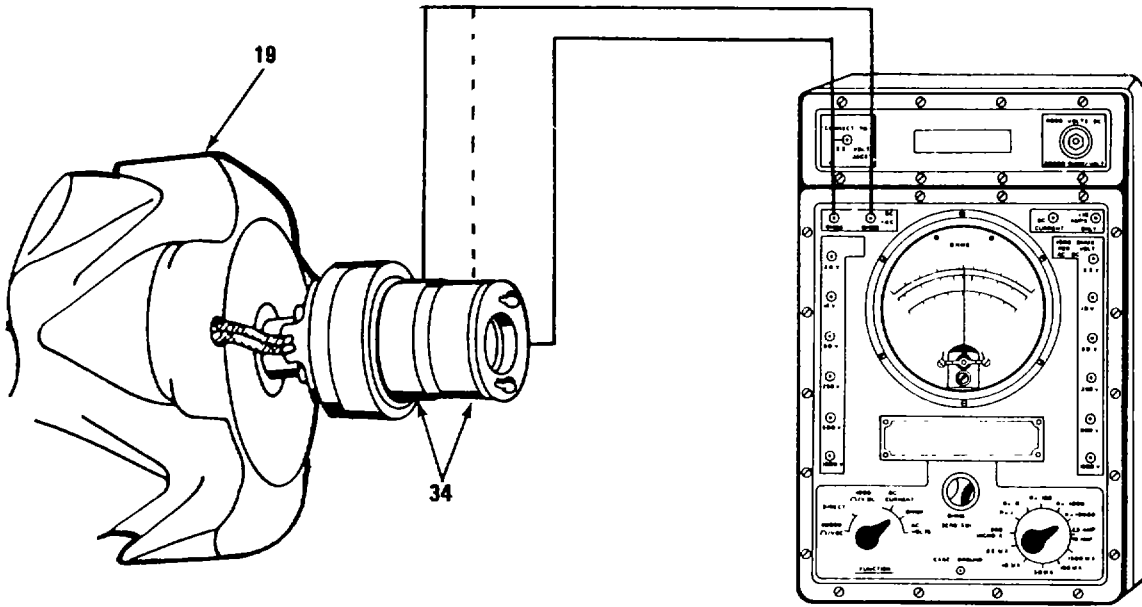
A - AMPMETER
V - VOLTMETER

STATOR COIL TEST CIRCUIT

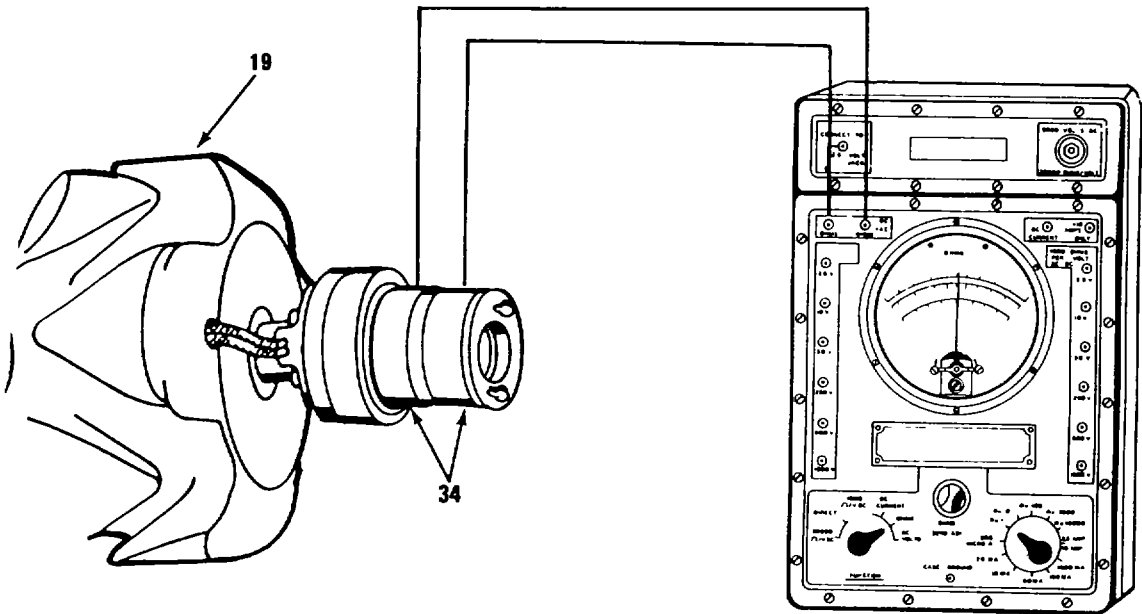
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Test resistance of each lead to frame. Minimum resistance of 10 Megohm.	Use multimeter (see figure).
		d. Test coils <ul style="list-style-type: none"> • Wire test circuit as shown in figure. • Close circuit and adjust variable resistor until current of 20 amperes is indicated. • Note voltage. • Repeat for each pair of leads. • Each voltage reading should show 8 volt drop. 	Use multimeter, ampmeter, variable resistor, 24 V source and a switch or use automotive generator, alternator, and starter test stand, reference TM 9-4910-458-12.
		e. Replace stator if any defects noted.	

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



TEST INSULATION BETWEEN SLIP RINGS AND
ROTOR SHAFT

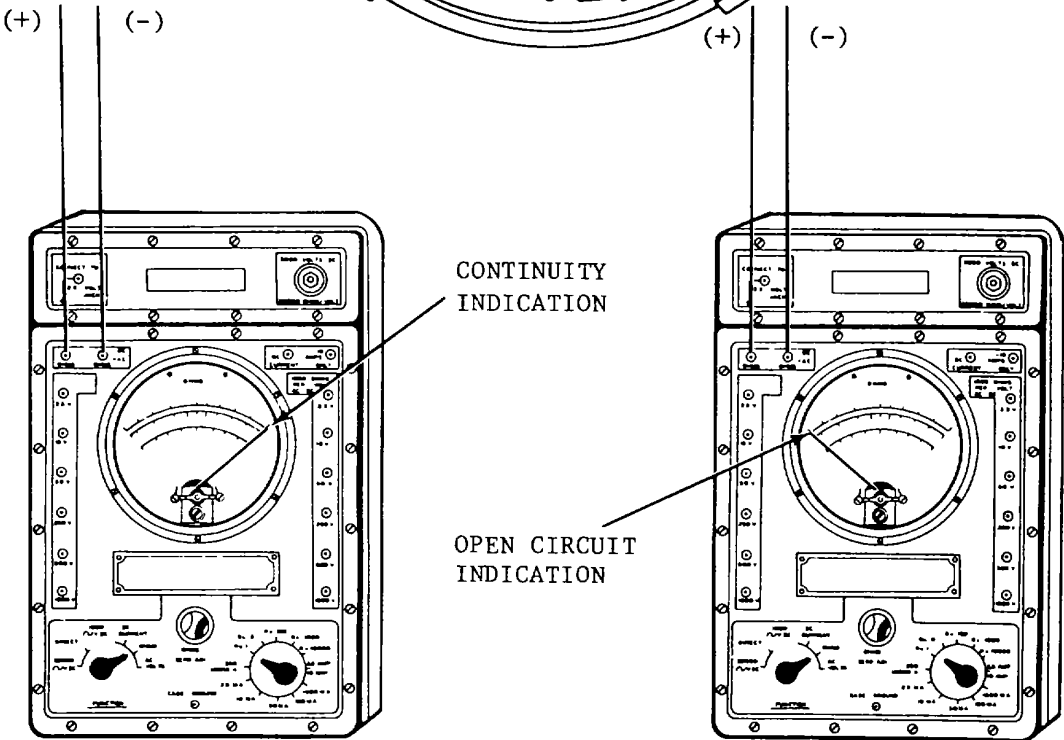
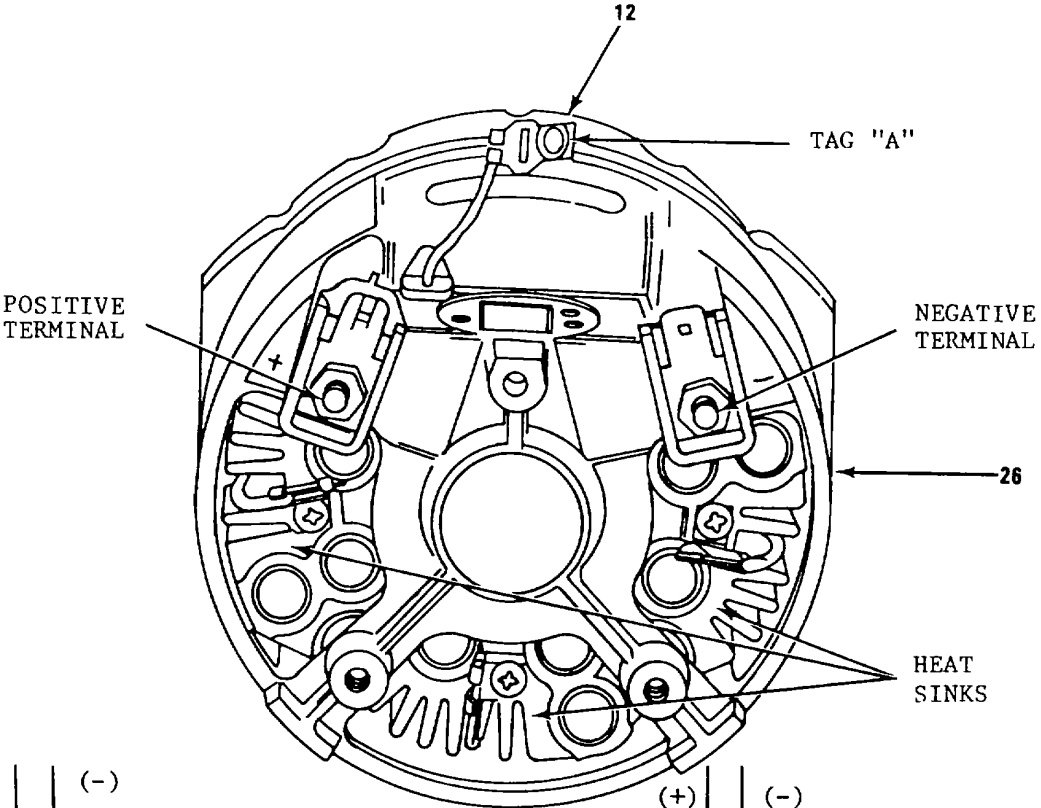


TEST RESISTANCE BETWEEN SLIP RINGS

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
10.	Rotor (19)	<ul style="list-style-type: none"> a. Examine visually for signs of cracking, denting, chipping or rubbing. b. Examine field windings for deterioration of insulation and secured in place. c. Check insulation between each slip ring and rotor shaft. Minimum 10 Megohm. d. Test resistance between two slip rings (9.4 - 9.8 ohm acceptable). e. Replace rotor assembly if it fails to conform to a, b, c or d. 	<p>Use multimeter (see figure).</p> <p>Use multimeter.</p>
11.	Slip ring (34)	<ul style="list-style-type: none"> a. Examine for Pitting and Scoring. b. Replace if defective. 	

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

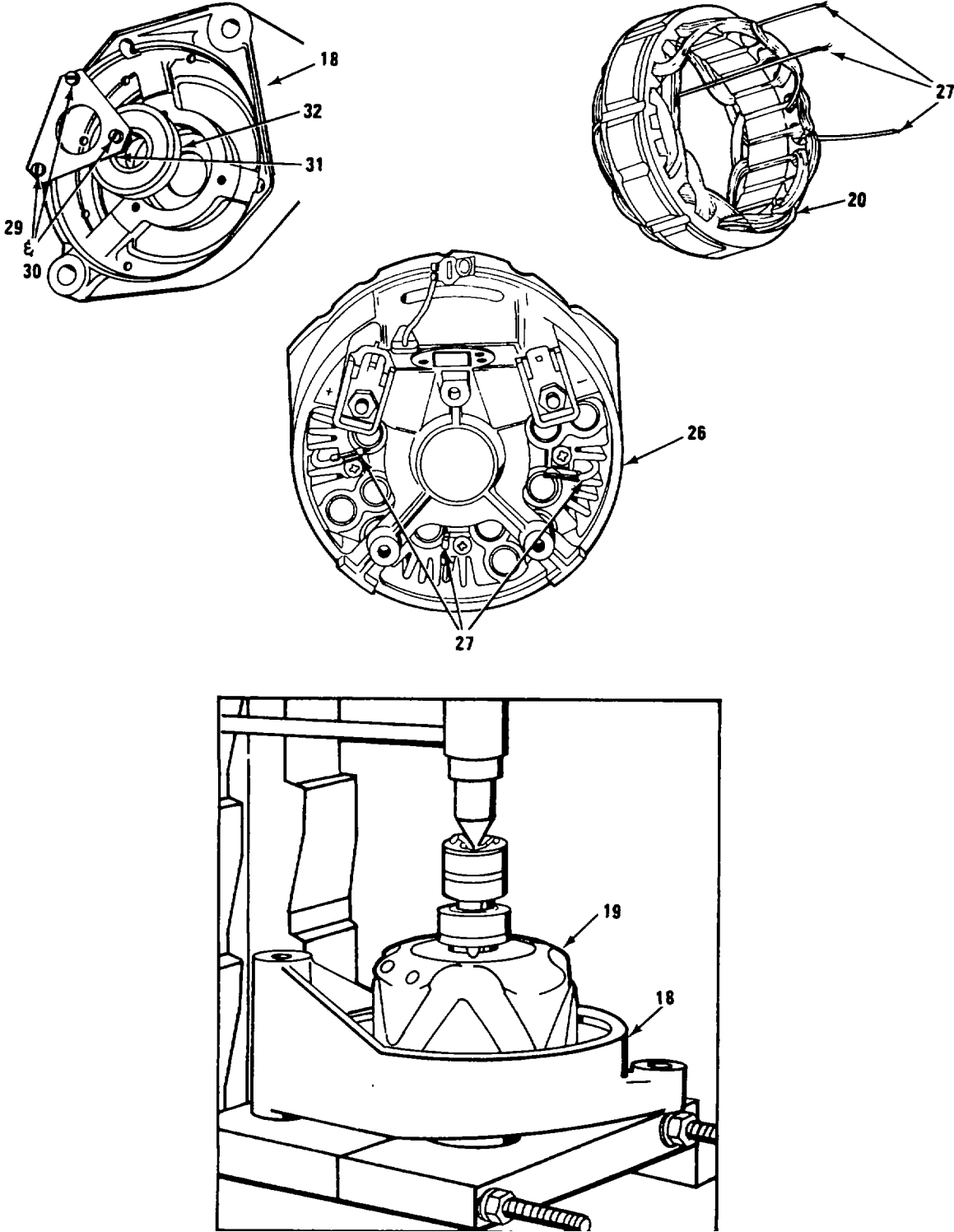
LOCATION	ITEM	ACTION	REMARKS
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12. Slip ring end shield (26)	Diodes	a. Test diodes for serviceability using following table:	Use multimeter TS-352B/U. Diodes can be tested while the three heat sinks are still assembled in the end shield.
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Test	Position of Test Probes		Needle
	Positive Probe	Negative Probe	Indication
1	Each heat sink in turn	Terminal +	To Full Right (Continuity)
2	Terminal + sink in turn	Each heat	No Movement (Open Circuit)
3	Terminal - sink in turn	Each heat	To Full Right (Continuity)
4	Each heat sink in turn	Terminal -	No Movement (Open Circuit)
5	Each heat sink in turn	'A' lead	To Full Right (Continuity)
6	'A' lead	Each heat sink in turn	No Movement (Open Circuit)

b. Replace heat sinks and end shields as a unit if any indication is incorrect.

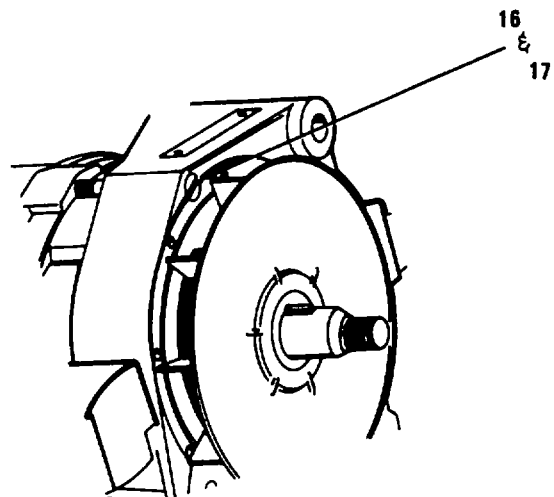
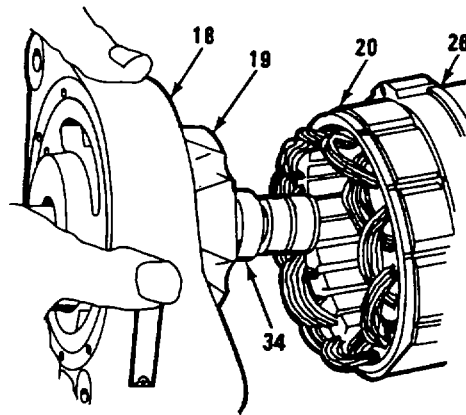
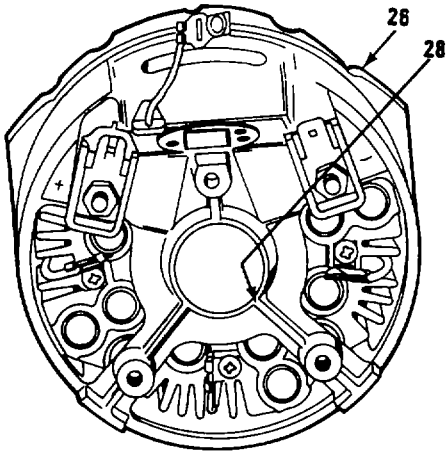
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
13. Drive end	a. Bearing (32) shield (18)	Press into housing.	Make sure bearing is square to housing.
	b. Clamping plate (31)	Position on end shield.	
	c. 3 screws (29) and 3 lock-washers (30)	Screw in and secure plate.	Use flat tip screwdriver.
14. Stator (20)	a. Stator (20)	Place on bench with 3 leads up.	
	b. Slip ring end shield (26)	Lower end shield onto stator.	Make sure three leads pass through three wide gaps in heat sink.
	c. Stator leads (27)	a. Insert end in tag. b. Solder.	Use soldering iron.
15. Drive end shield (18)	a. Drive end shield (18)	Support on suitable surface.	Surface should have hole to admit rotor shaft.
	b. Rotor (19)	a. Fit bearing spacer. b. Press rotor shaft into bearing (32) in drive end shield (18).	Be careful not to damage slip ring, slip ring terminals or field coil leads.

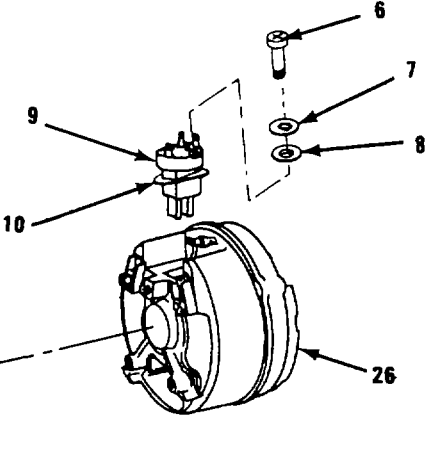
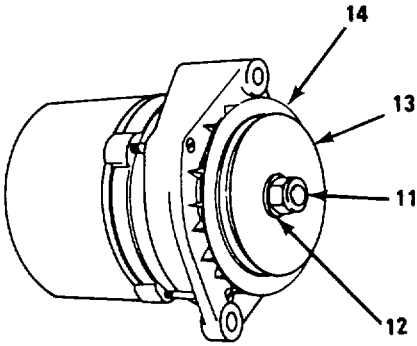
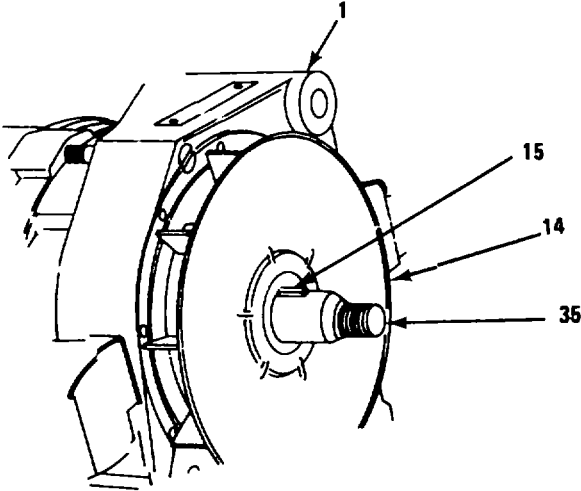
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
16. Slip ring end shield (26) and stator (20) assembly	a. O-ring	a. Fit into inside bearing housing (28).	
		b. Smear light coat of grease on inside of ring.	
	b. Rotor (19) and drive end shield assembly (18)	a. Support as shown on figure and insert rotor shaft through stator into bearing housing (28) so that slip ring bearing (33) enters bearing housing.	Be very careful not to damage slip rings and windings.
		b. Press end shield up to stator as far as possible by hand.	
	c. 3 through-screws (16) and 3 lock-washers (17)	a. Fit lockwashers to each screw.	
		b. Coat screw threads with loctite.	
		c. Insert screws through end shield.	

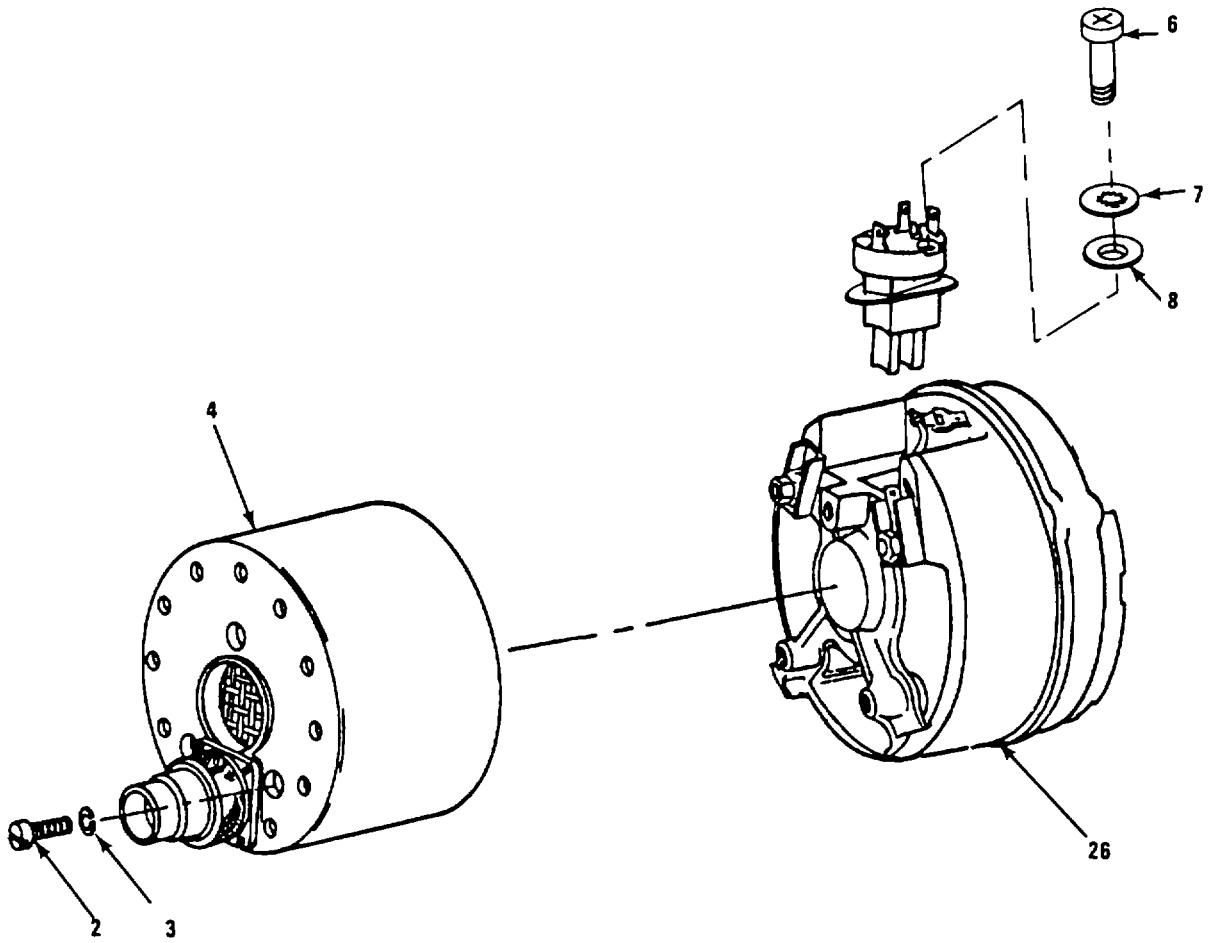
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
		d. Clamp entire assembly lightly in soft jawed vise.	
		e. Tighten each screw progressively in turn while lightly tapping end shield with hammer.	Use flat tip screwdriver and hammer.
17. Alternator (1)	a. Woodruff key (15)	Fit into position.	
	b. Fan (14)	Slide onto shaft.	
	c. Pulley (13)	Slide onto shaft.	
	d. Washer (12)	Slide onto shaft.	
	e. Nut (11)	Screw on, torque to 40 ft-lb (5.3 kg/m).	Use torque wrench, 15/16 in socket.
	f. Shaft (35)	Tap with non-metallic hammer then spin rotor to check for free rotation.	
	g. Brush box assembly (9) and gasket (10)	Assemble to slip ring end shield (26).	

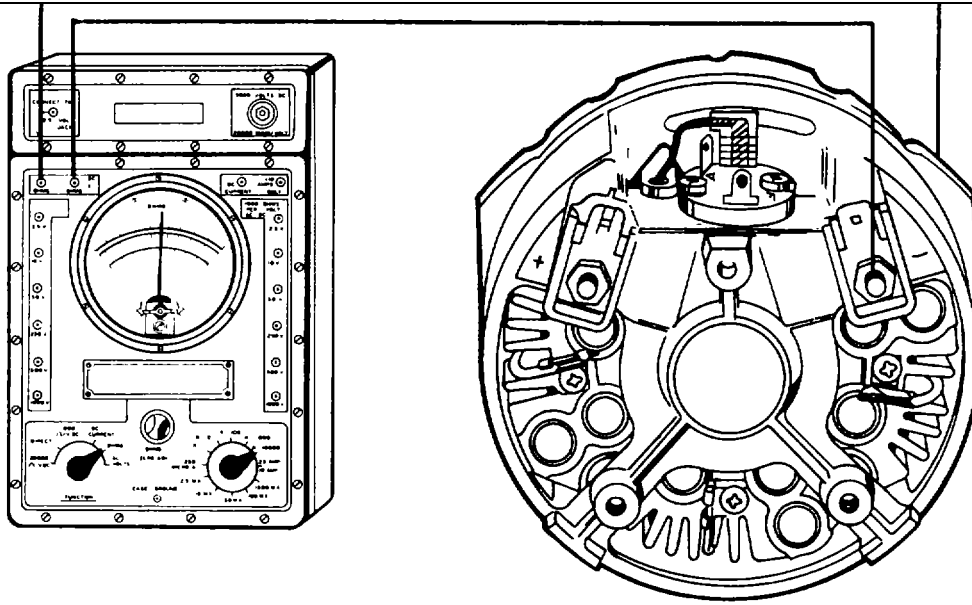
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



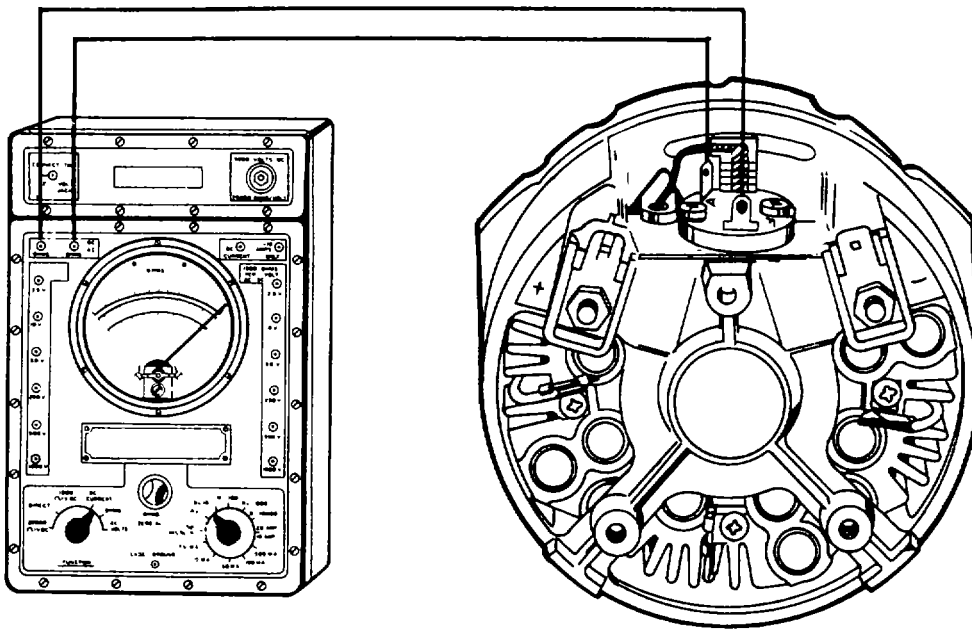
ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	h. 2 screws (6), 2 washers (8) and 2 lock- washers (7)	Screw in to secure brush box.	Use cross tip screwdriver.
	i. Cowl (4)	Position on slip ring end shield (26).	Do not assemble cowl until bench tests are com- pleted.
	j. 3 capscrews (2) and 3 lockwashers (3)	Screw in to secure cowl.	Use flat tip screwdriver.

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)



ALTERNATOR INSULATION TEST



FIELD COIL CIRCUIT CONTINUITY CHECK

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>BENCH TEST</u>			
18. Alternator	a. Insulation (faults)	a. Secure one test lead to housing.	
<u>CAUTION</u>			
Do not apply this test between any two terminals. Serious damage will be caused to the diodes.			
		b. Connect other lead to each terminal in turn. Minimum resistance 10 Megohms.	
	b. Field coil Circuit (continuity)	a. Select lowest resistance range on multimeter.	Use multimeter.
		b. Attach probes to terminals A and F.	A low resistance should be indicated.
		c. Rotate rotor slowly by hand.	a. Low resistance indication should vary slightly.
			b. Large variation usually indicates sticking brushes or dirty slip ring.
		d. Correct any faults noted.	

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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CAUTION

Do not remove any connections while alternator is running. Diodes will be damaged.

NOTE

The following steps apply to Test Stand, Automotive Generator, Alternator and Starter. Refer to TM 9-4910-458-12 for test stand diagrams and instructions.

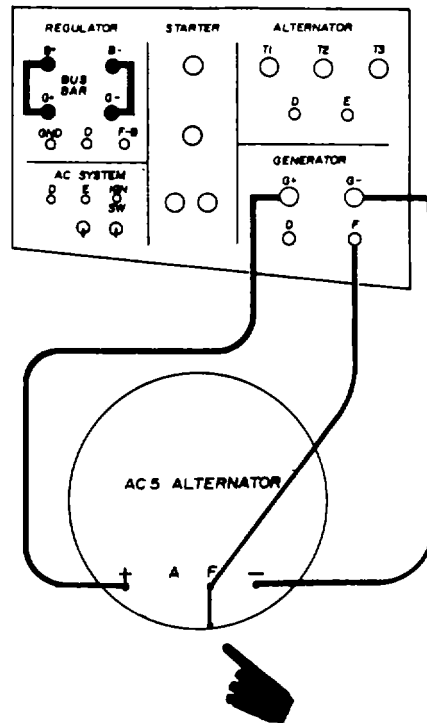
19. Test stand	a. Alternator	Mount alternator on the generator and starter mounting bracket and secure with chain vise.	Make certain that drive belt is over alternator pulley and drive and alternator pulley are aligned.
	b. Control panel settings	Base settings for test stand are as follows:	

Upper Portion of Test Stand

External master power switch.....	Off
Main power switch	Off
DC load ammeter	500 amperes
DC field ammeter.....	30 amperes
Millivolt meter	9 volts and off
DC voltmeter	50 volts and RECT/GEN
Tachometer.....	Direct drive
AC ammeter.....	500 amperes and phase A
AC voltmeter	50 volts and off
400-ampere control box.....	Voltage adjust fully counter-
	clockwise
Equalizer coil test	Off
Ignition switch	Off

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>Lower Portion of Test Stand</u>			
	Power supply switch	Off and rheostat fully counter-clockwise	
	Battery charger switch.....	Off and rheostat fully counter-clockwise	
	External field	Off	
	Field common.....	Negative (-)	
	Field circuit switch.....	Regulator	
	Relay lamp.	Off	
	Regulator load resistor selector.....	Off	
	Current polarity.	Negative (-)	
	Battery selector.....	Off	
	Starter test switch	Off and stator voltage adjusted counterclockwise	
	All load switches	Off	
	Field current rheostat.	Fully counterclockwise	
	Variable load	Fully counterclockwise	



ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	c. Cable connections		Connect alternator + terminal to test stand G+ terminal, alternator - terminal to test stand G-; alternator F terminal to ground. (Alternator Case) alternator A terminal to test stand F terminal.
	d. Switch positions		a. DC load ammeter to 50A (X1). b. DC field ammeter to 30A (X6). c. DC voltmeter to 50 vdc (X5). d. Field circuit switch to MANUAL.
	e. Testing procedure		a. Turn main power ON. b. Press START button. Hold 3 - 5 seconds. c. Adjust vari-drive to 2000 RPM and calibrate to 1882 RPM (4.25 in diameter pulley).

ALTERNATOR REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
		d. Increase drive speed to 3000 RPM. e. Turn battery selector to 24V. <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Do not exceed 28 vdc on the DC voltmeter. Damage to alternator rectifiers will result.</p> f. While watching DC voltmeter slowly turn field current rheostat clockwise until 28 volts are obtained. <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">As test stand batteries are charged, reading on DC voltmeter will rise. Field current rheostat must be turned slightly counterclockwise to maintain 28 volts until battery charging rate has stabilized.</p> g. Turn on master load switch. h. Turn on 50A and 0-25A load switches.	

ALTERNATOR REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
		i. Turn field current rheostat slightly clockwise to maintain 28V on DC voltmeter.	
		j. If load ammeter does not read 25.5A turn variable load rheostat until rated current output is obtained.	
		k. Check the DC field ammeter. Should read 20A.	
		NOTE	
		Record all meter readings.	
		l. Turn field current rheostat fully counterclockwise.	
		m. Turn master load switch OFF.	
		n. Turn battery switch OFF.	
		o. Reduce vari-drive speed to 1000 RPM.	

ALTERNATOR REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
		p. Press STOP button.	
		q. Turn main power OFF.	
		r. Return all switches and controls to base setting.	
		s. Disconnect all cables from alternator and test stand.	
	f. Test results	<p>Evaluate. If alternator output was 24V on DC voltmeter, 23.0 - 25.5 amps on load ammeter and 18 - 20 on field ammeter the alternator is serviceable. If field ammeter reading is low check for open circuits or high resistance in field circuit. If field ammeter reading is high check for grounds or short circuits in field circuit. If voltage output all right but load ammeter reading low check stator windings and rectifier.</p>	

ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**This task covers:**

- a. Removal
- b. Installation

INITIAL SETUP**Tools:**

Flat tip screwdriver (stubby)
 Diagonal cutting pliers
 7/16 in open end wrench
 7/32 in socket, 1/4 in drive
 1/2 in socket, 3/8 in drive
 11 mm socket, 1/4 in drive
 8 mm socket, 1/4 in drive
 7 mm socket, 1/4 in drive
 1/4 in drive ratchet
 3/8 in drive ratchet
 1-5/8 in open end wrench

Equipment Condition:

TM 5-1940-277-20
 TM 5-1940-277-20
 TM 5-1940-277-20
 TM 5-1940-277-20

Condition Description:

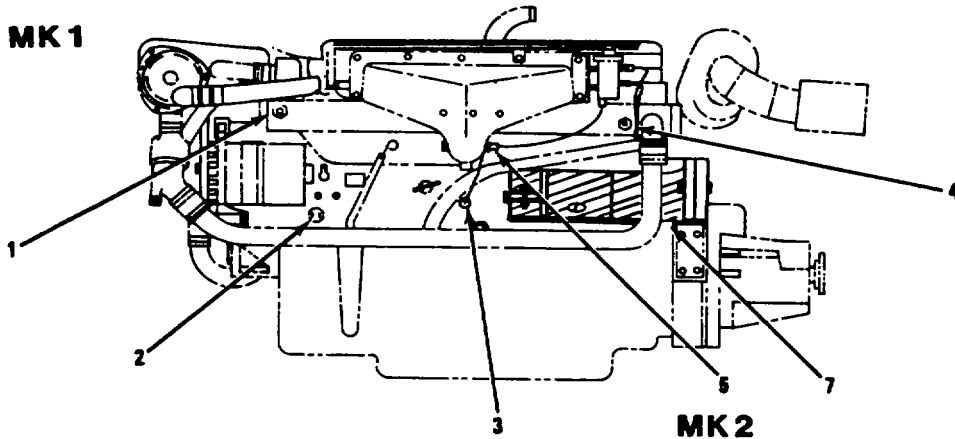
Battery hatch open.
 Batteries disconnected.
 Engine hatches open.
 Control box cover removed.

Materials/Parts:

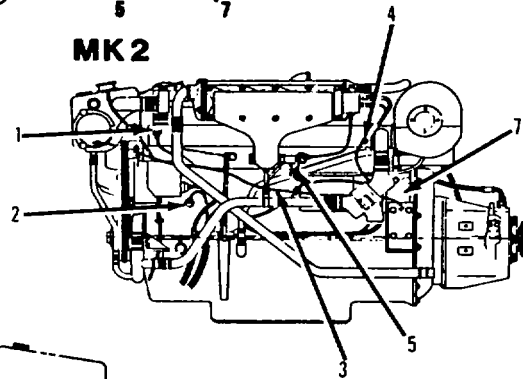
Engine wiring harness
 Tape, electrical, plastic
 Ties, cable, nylon

ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)

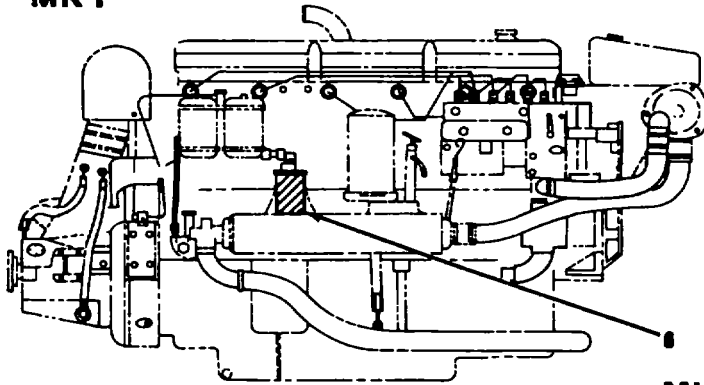
MK 1



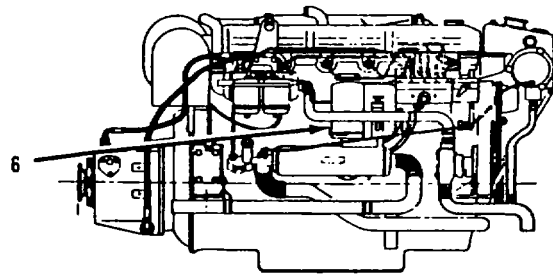
MK 2



MK 1



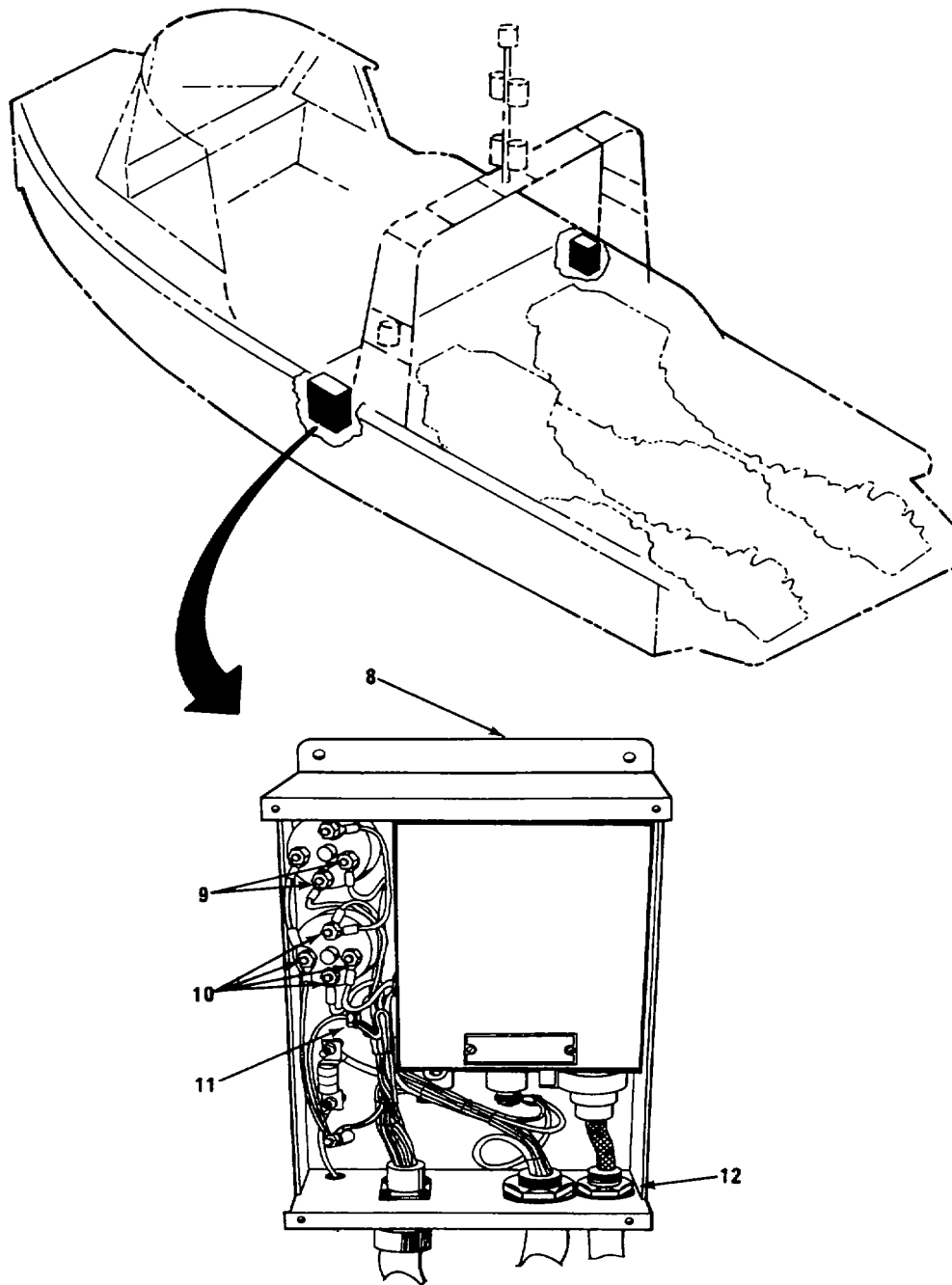
MK 2



ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
NOTE			
Before starting any disconnecting, draw a sketch of wire hookup recording position and color of wire.			
<u>REMOVAL:</u>			
1. Engine	a. Water temperature sending leads (1)	Disconnect.	Unplug.
	b. Oil pressure sending leads (2)	Disconnect.	Use 7 mm socket.
	c. Low oil pressure sending leads (3)	Disconnect.	Unplug.
	d. High temperature sending leads (4)	Disconnect.	Unplug.
	e. Thermostart leads (5)	Disconnect.	Unplug.
	f. Tachometer leads (6, (behind fuel filters)	Disconnect.	Use 7 mm socket.
2. Starter (7)	a. Lead to small S terminal	Disconnect.	Use 8 mm socket.
	b. Two small leads to small R terminal	Disconnect.	Use 8 mm socket.

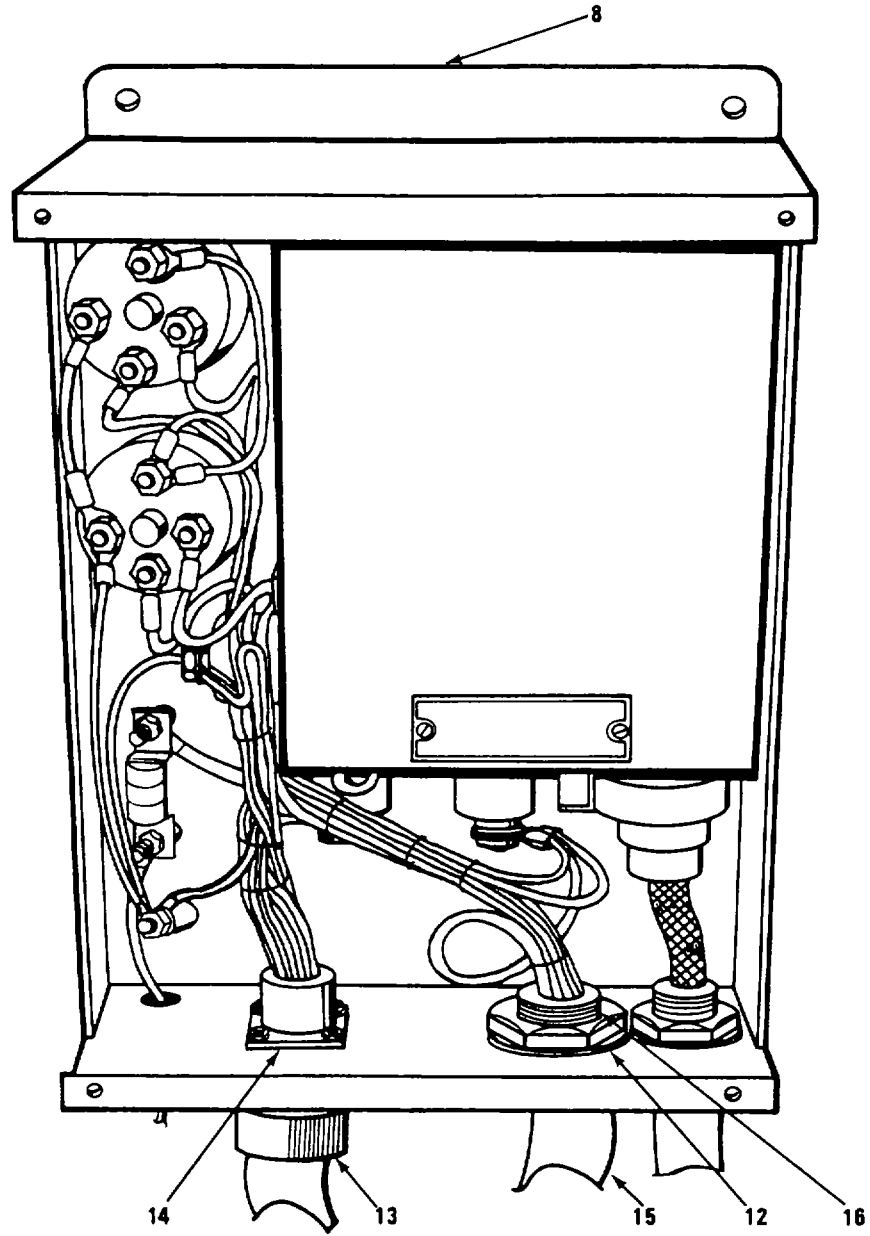
ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	c. Three small leads to R- (negative) terminal	Disconnect.	Use 1/2 in socket. Leave heavy inter-engine battery and battery cables connected.
	d. Two small leads to B+ (positive) terminal	Disconnect.	Use 1/2 in socket. Leave heavy battery cable connected.
3. Control box (8)	a. Starter solenoid leads (9)	Disconnect two leads by removing two nuts and washers.	Use 11 mm socket on one large nut. Use 8 mm socket on smaller nut.
	b. Thermostart solenoid leads (10)	Disconnect leads by removing four nuts and washers.	Use 11 mm socket on two larger nuts. Use 8 mm socket on smaller nuts.
	c. Capacitor leads (11)	Disconnect two places by removing one nut and washer each location.	Use 7/16 in open end wrench. One connection on bottom of regulator box, one on side.
	d. Nut (12)	Unscrew and leave loose on cable.	Use 1-5/8 in wrench.

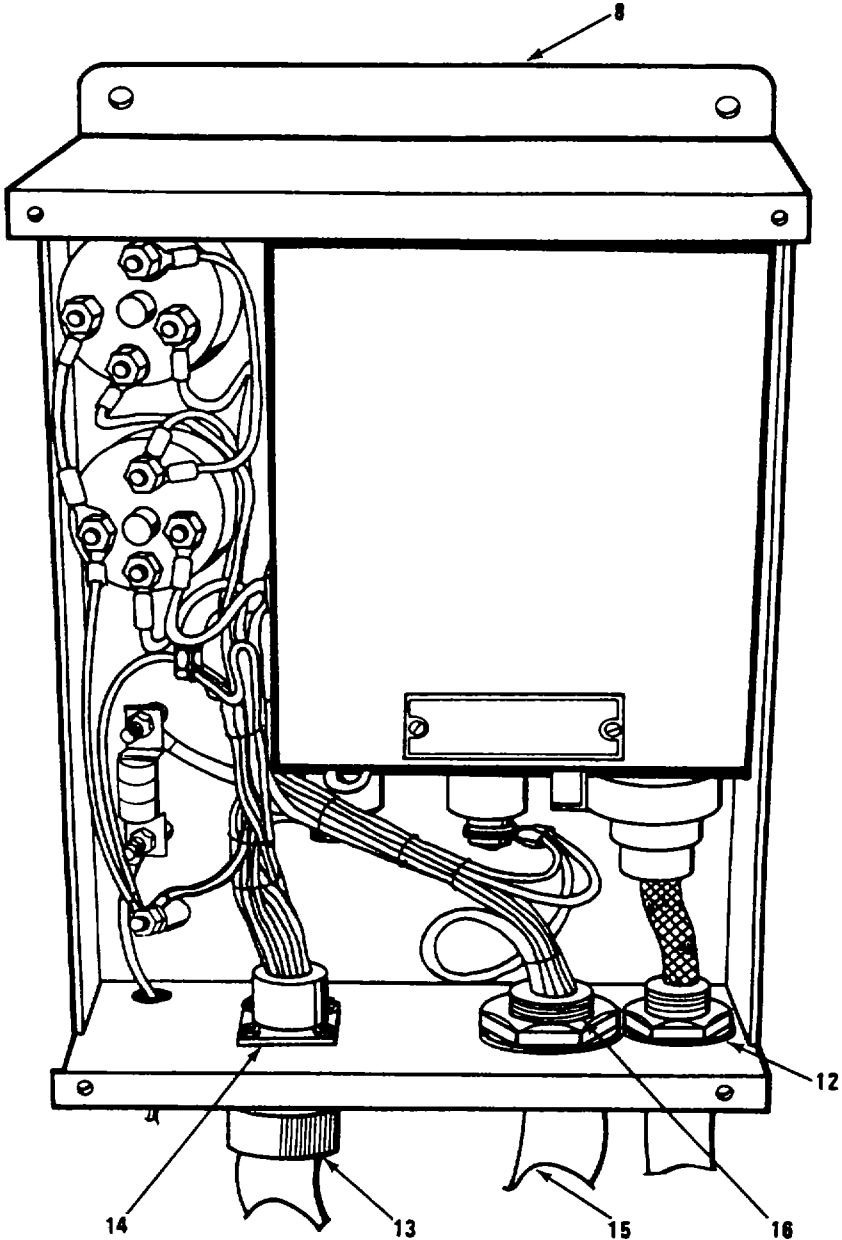
ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	e. Connecting cable (13), control box to console	Disconnect by unscrewing retaining ring on socket and pulling socket away from control box.	Use hands.
	f. Receptacle securing screw (14)	Remove four nuts and screws.	Use 7/32 in socket and screwdriver. This frees receptacle.
NOTE			
Observe cable routing and make notes for use during installation of new cable.			
	g. Wire ties holding wiring harness to other cables	Locate and cut with diagonal cable cutters.	
	h. Wiring harness cable (15)	Pull down until fitting (16) that nut (12) was attached to is clear of box. Slide fitting off cable toward engine.	Retain fitting for installation to new cable.
	i. Wiring Harness cable (15)	Slide back through hole in control box until cable is removed.	Use both hands. Work cable out in short moves.

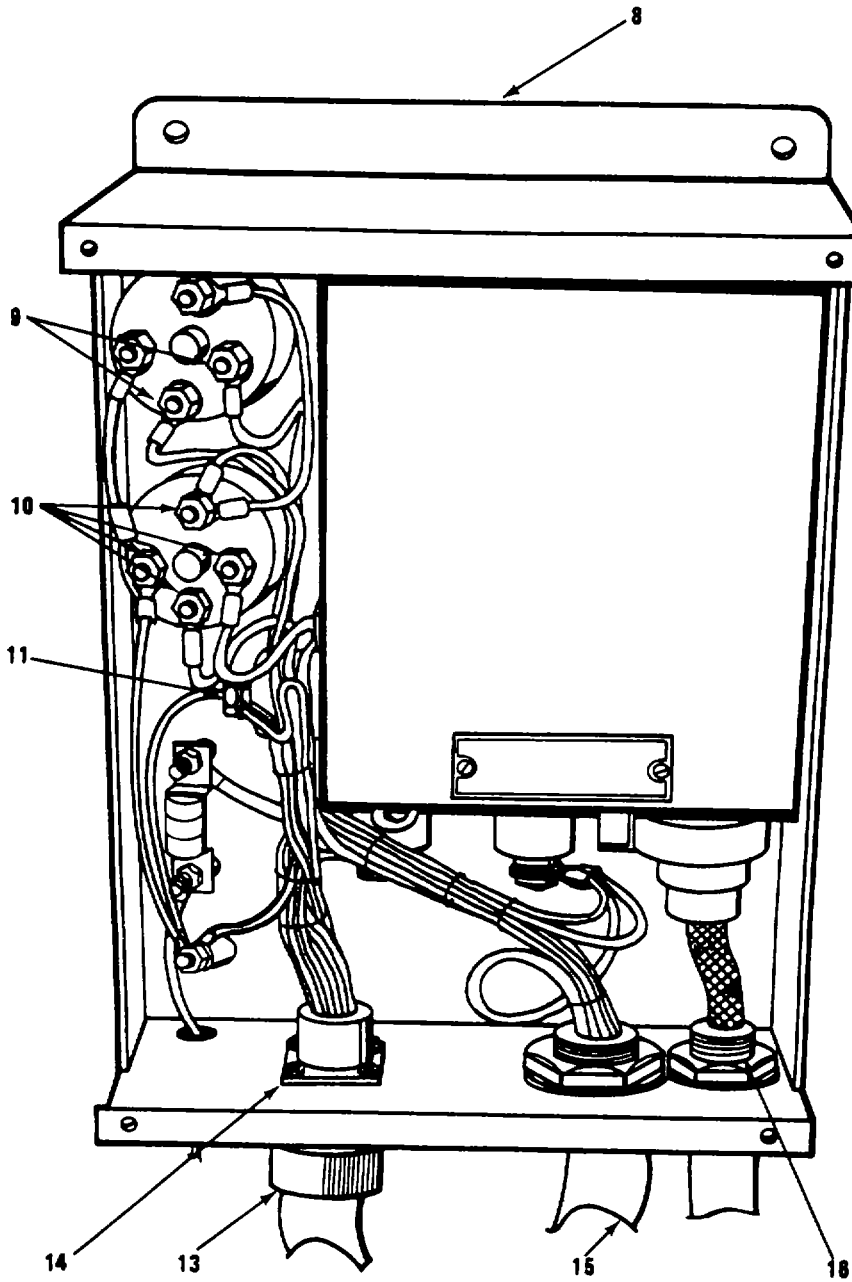
ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
4. Wiring harness cable (15)	Nut (12)	Remove from cable by sliding off toward end that connected to engine.	
<u>INSTALLATION:</u>			
5. Wiring harness cable (15)	Nut (12)	Slide on cable from engine connection end.	Slide on cable all the way to plug end.
6. Control box (8)	a. Wiring Harness cable (15)	Slide end of cable that connects to engine (one without plug) through large hole in bottom of control box. Go from inside control box toward outside.	Use both hands. Work cable in short moves. Slide through until about 1-1/2 inches of heavy rubber cable is left in control box.
	b. Fitting (16) removed in step 3h	Slide fitting, threads first, over cable starting from engine connection end until it seats in hole in control box.	Fit through hole in control box until threads are visible inside box.
	c. Nut (12)	Screw on fitting (16).	Make sure all wires pass through nut.

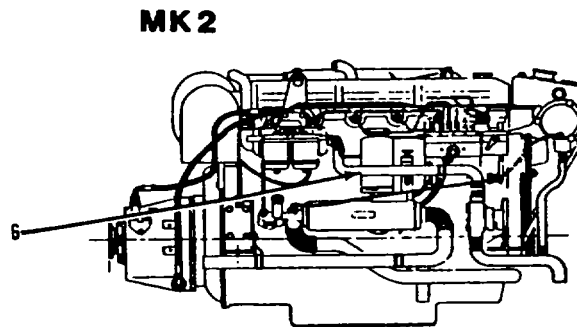
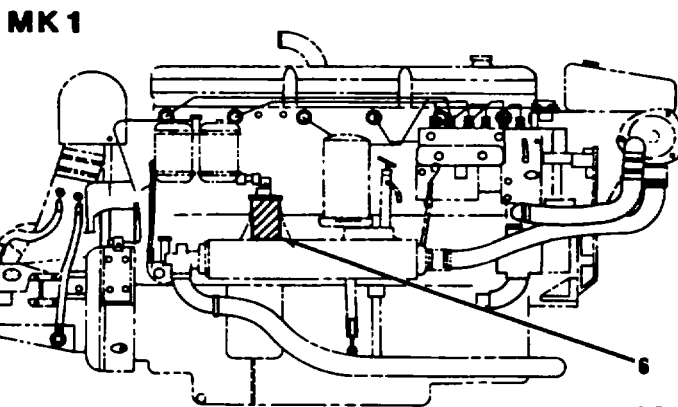
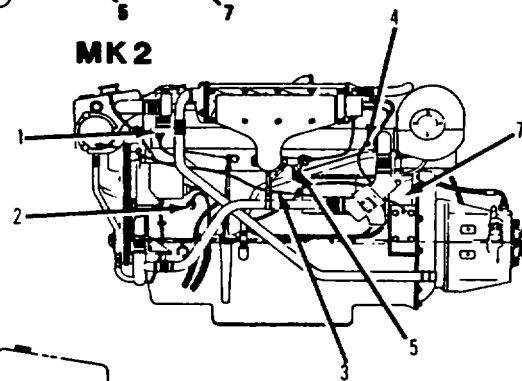
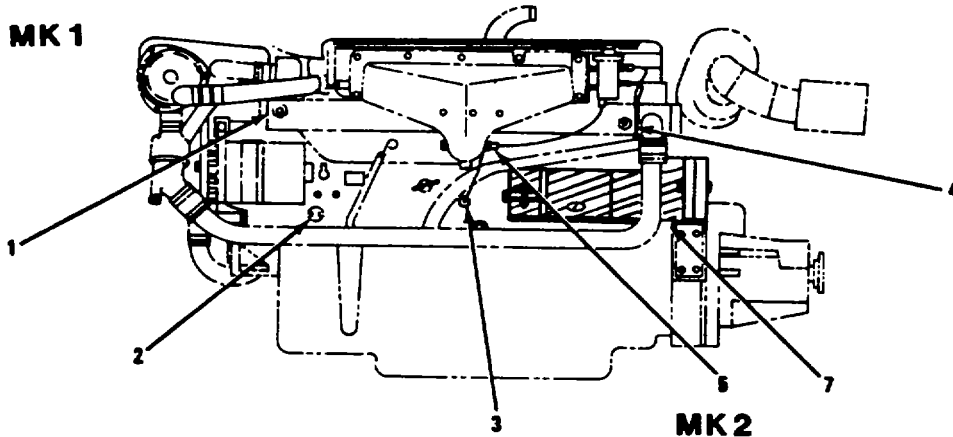
ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
NOTE			
Before starting any connecting, look at the diagrams made when cable was removed. Use wiring diagram and wire reference index. If there is a question check wiring on other engine as guide.			
	d. Capacitor leads (11)	Connect leads and install washer and nut each location.	Make sure all wires pass through nut.
	e. Thermostart solenoid leads (10)	Connect leads and install washer and nut each of four locations.	
	f. Starter solenoid leads (9)	Connect leads and install washer and nut each of two locations.	
	g. Receptacle securing screws (14)	Position receptacle and secure by installing four screws and nuts.	
NOTE			
Refer to notes taken on cable routing before removal. Use as guide to help properly route new cable.			

ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
(Continued)

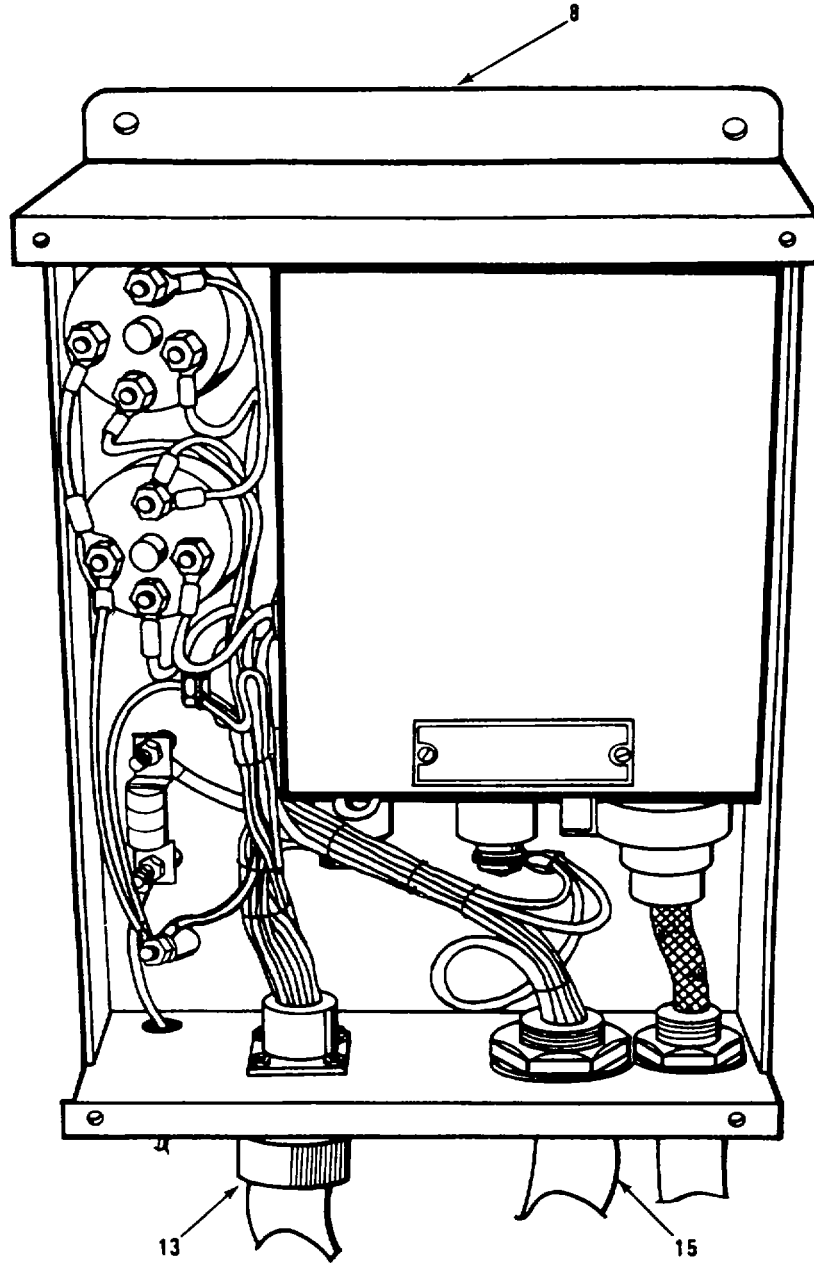


ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
7. Engine	a. Tachometer leads (6)	Connect.	Ring terminals. Use 7 mm socket.
	b. Thermostart leads (5)	Connect.	Push on terminals
	c. High temperature sending leads (4)	Connect.	Push on terminals
	d. Low oil pressure leads (3)	Connect.	Push on terminals
	e. Oil pressure sending leads (2)	Connect.	Ring terminals. Use 7 mm socket.
	f. Water temperature sending leads (1)	Connect.	Push on terminals
8. Starter (7)	a. Three small leads to R- (negative) terminal	Connect.	Use 1/2 in socket.
	b. Two small leads to B+ (positive) terminal	Connect.	Use 1/2 in socket.
	c. Lead to small S terminal	Connect.	Use 8 mm socket.
	d. Two small leads to small R terminal	Connect.	Use 8 mm socket.

ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
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ENGINE WIRING HARNESS REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
9. Control box (8)	Connecting cable (13), control box to console	Connect socket on cable to plug in control box and secure with retaining ring on socket.	Socket and plug are keyed and can fit only in one position.
10. Wiring harness cable (15)	Cable ties	Secure installed cable using ties spaced as required.	

NOTE

FOLLOW ON MAINTENANCE PROCEDURE: Connect batteries and close engine hatches (reference TM 5-1940-277-20).

ENGINE WIRING HARNESS AND INTERCONNECT HARNESS REPAIR INSTRUCTIONS

This task covers:

- a. Inspection**
- b. Repair**

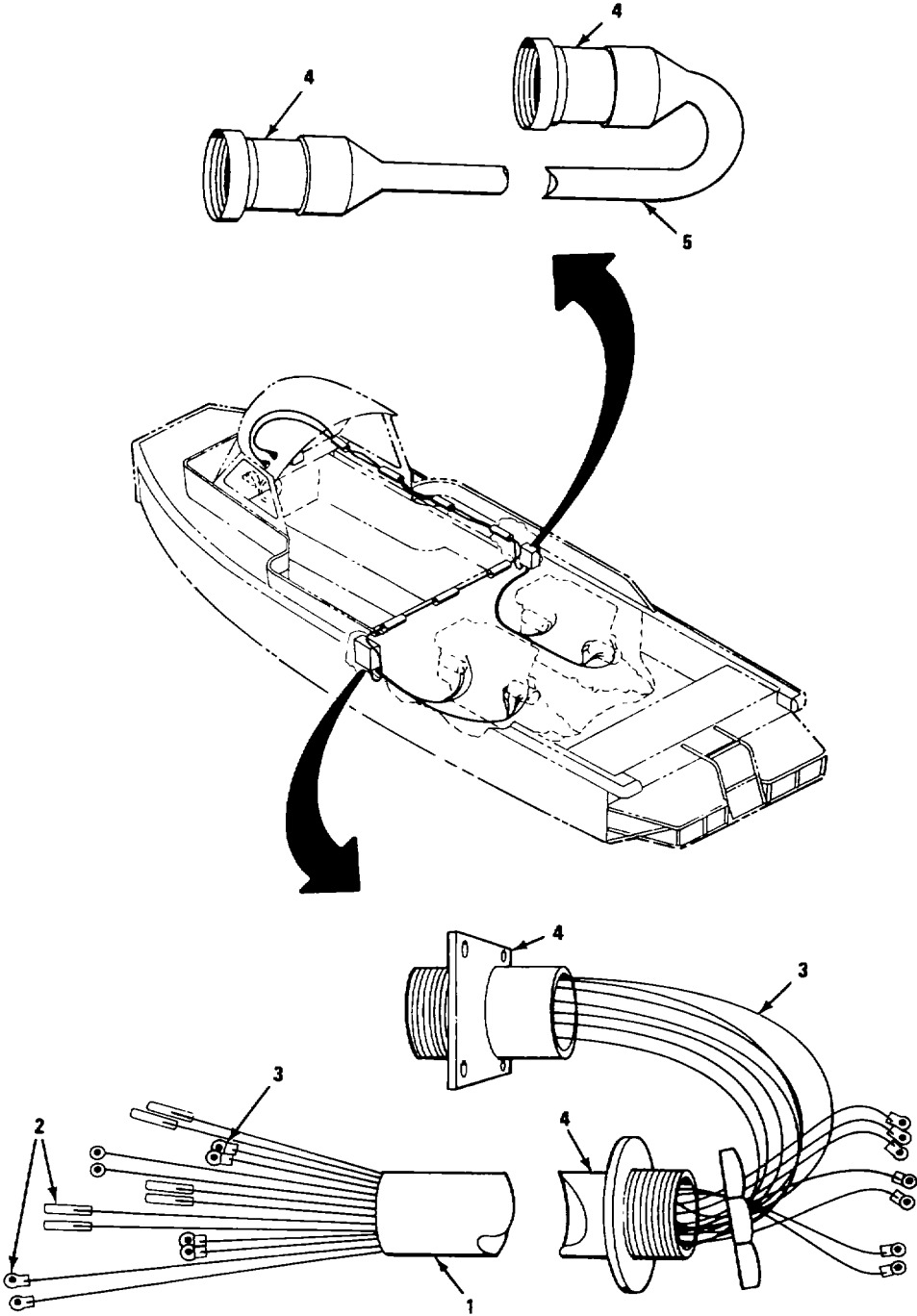
INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Wire stripper	TM 5-1940-277-20	Engine hatches open.
Crimper	TM 5-1940-277-20	Control box cover removed.
Diagonal pliers		Storage compartment open.
Multimeter	TM 5-1940-277-20	
Soldering iron		
Long nose pliers		

Materials/Parts:

- Push on connectors
- Ring terminal connectors
- Butt connectors
- Connector plugs
- Solder, rosin core

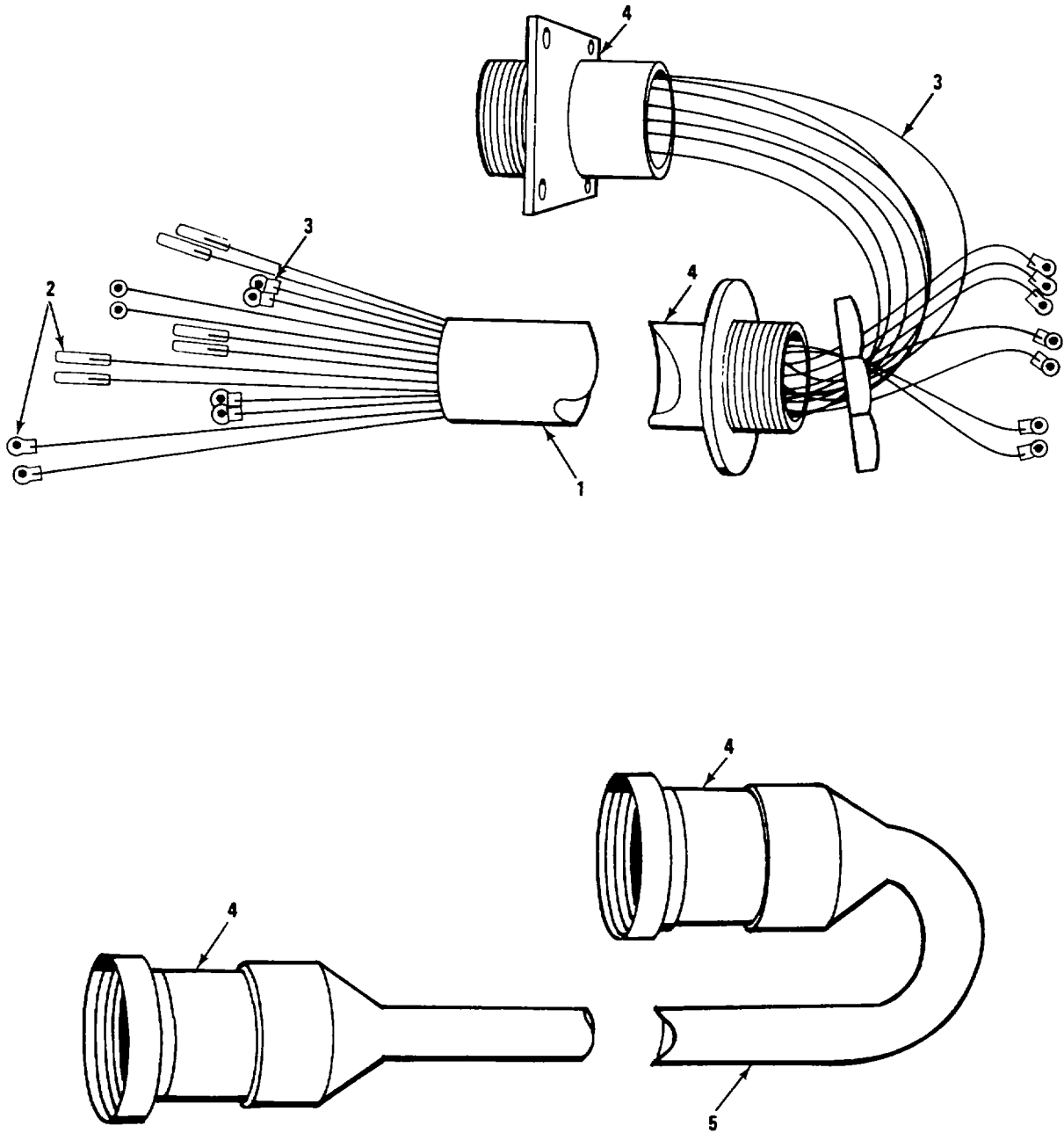
ENGINE WIRING HARNESS AND INTERCONNECT HARNESS REPAIR INSTRUCTIONS
(Continued)



ENGINE WIRING HARNESS AND INTERCONNECT HARNESS REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>INSPECTION</u>			
1.	Engine wiring harness (1) and interconnect harness (5)	Visually inspect wiring harness for broken or damaged connections, broken wires or frayed or cracked insulation.	Use wiring diagram. Repair broken connections and wire. If insulation is damaged replace cable.
<u>REPAIR</u>			
2. Engine wiring harness (1) and interconnect harness (5)	a. Broken connection	Remove old connector (2) by pulling off or removing nut and washer as required. If wire end frayed cut square. Strip about 1/4 in of insulation from wire. Select correct replacement connector (same as one removed) and fit to wire. Crimp connector to wire. Connect wire to terminal.	Use pliers, wire stripper and crimper. Cut only enough wire to square up end.

ENGINE WIRING HARNESS AND INTERCONNECT HARNESS REPAIR INSTRUCTIONS
(Continued)



ENGINE WIRING HARNESS AND INTERCONNECT HARNESS REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	b. Broken wire (3)	If wire is frayed cut ends square. Strip about 1/4 in from each wire end. Fit each stripped wire end into butt connector. Crimp butt connector to each wire end.	Use pliers, wire stripper and crimper. Cut only enough wire to square up ends.
	c. Broken wire, section missing	Replace cable.	
	d. Broken connector plug (4)	Replace cable.	

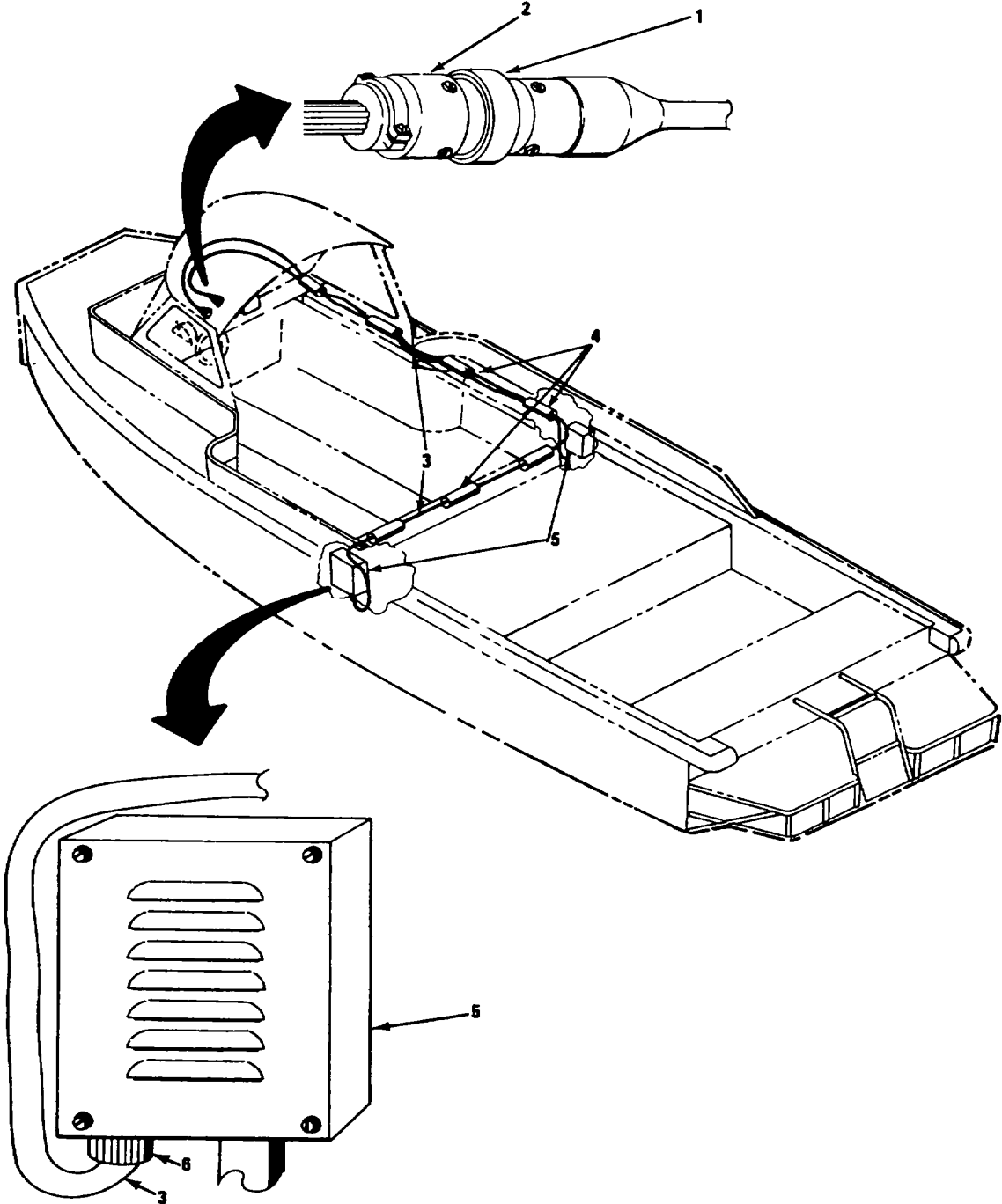
ENGINE WIRING INTERCONNECT HARNESS REPLACEMENT INSTRUCTIONS**This task covers:**

- a. Removal
- b. Installation

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Flat tip screwdriver	TM 5-1940-277-20	Battery disconnected.
Diagonal cutting pliers	TM 5-1940-277-20	Control console access hatch open.
Soldering iron	TM 5-1940-277-20	Storage compartment open.
Materials/Parts:	TM 5-1940-277-20	Wiring diagram for wire identification.
Engine wiring interconnect harness with plug and receptacle		
Tape, electric plastic		
Cord (30 ft.)		

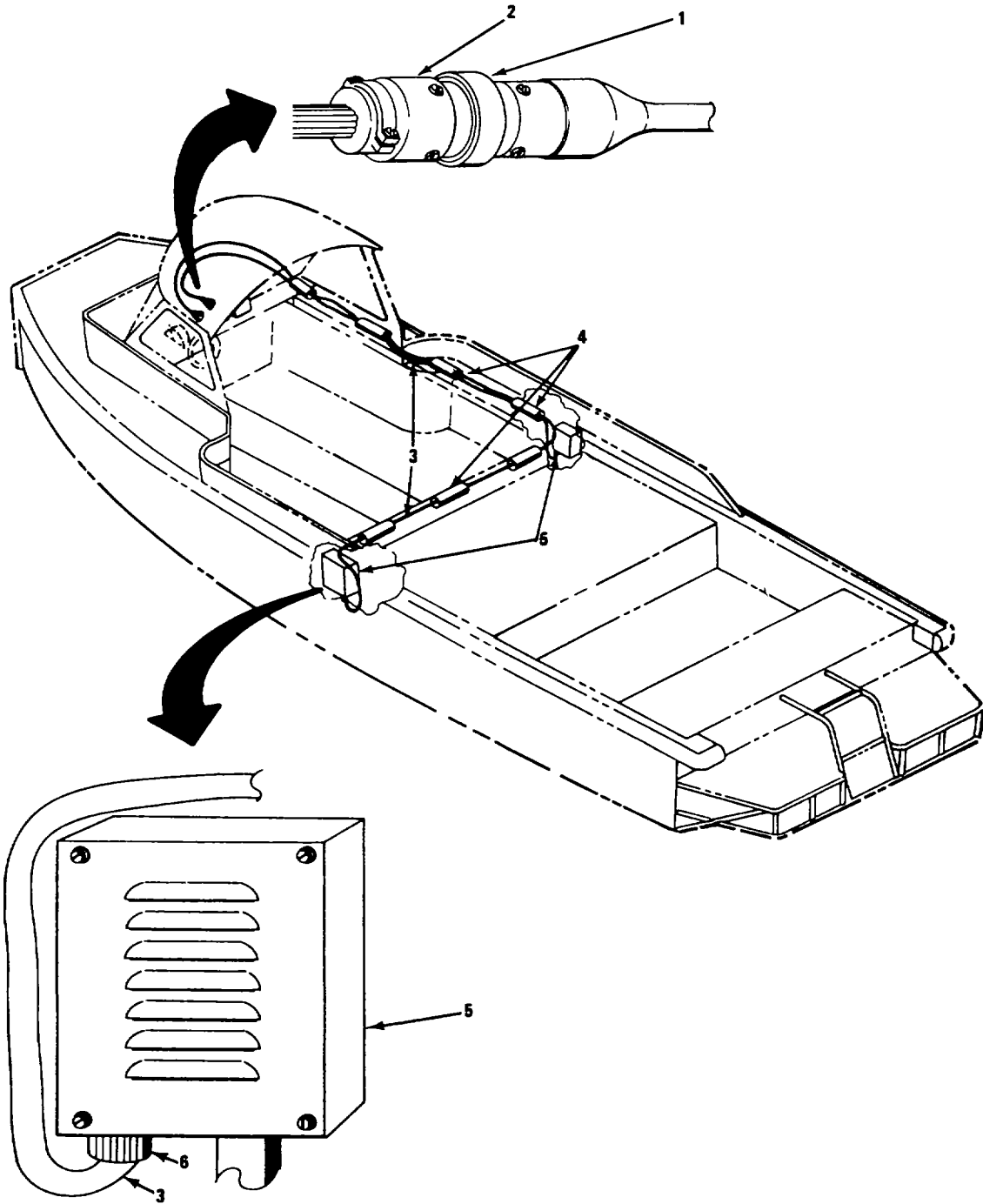
ENGINE WIRING INTERCONNECT HARNESS REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE WIRING INTERCONNECT HARNESS REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Control console	a. Harness connector (1)	a. Disconnect by unscrewing retaining ring on plug (2) and pulling plug from receptacle.	Use hands.
		b. Fasten cord to end of harness.	Tie and tape cord for use in replacing new harness.
NOTE			
Carefully feed cord as harness is being removed.			
2. Battery compartment	Interconnect harness (3)	Pull harness out of support tubes (4) welded on starboard side of boat.	Pull harness by hand aft from starboard side of battery compartment.
3. Control box (5)	Connector plug (6)	Disconnect by unscrewing retaining ring on plug and pulling down on plug.	Use hands.
<u>INSTALLATION</u>			
4. Battery compartment	Harness connector receptacle (1)	a. Fasten cord to harness.	Tie and tape cord to harness.

ENGINE WIRING INTERCONNECT HARNESS REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE WIRING INTERCONNECT HARNESS REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
Carefully feed harness through supports as cord is being pulled.			
5. Control box	Connector plug (6)	b. Route harness from battery compartment along star-board side to control console.	Keep harness straight and feed by hand through support tubes welded on star-board side of boat while pulling at same time on cord.
		Connect plug to receptacle on bottom of control box.	Push plug into receptacle and hand tighten retaining ring on plug.
NOTE			
Wire identification and pin callout are contained on the wiring diagram.			
6. Control console	Harness connector (1)	Connect plug to receptacle on interconnect harness by screwing on retainer ring.	Use hands to turn retainer ring.

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER

This task covers:

- a. Removal**
- b. Installation**

INITIAL SETUP

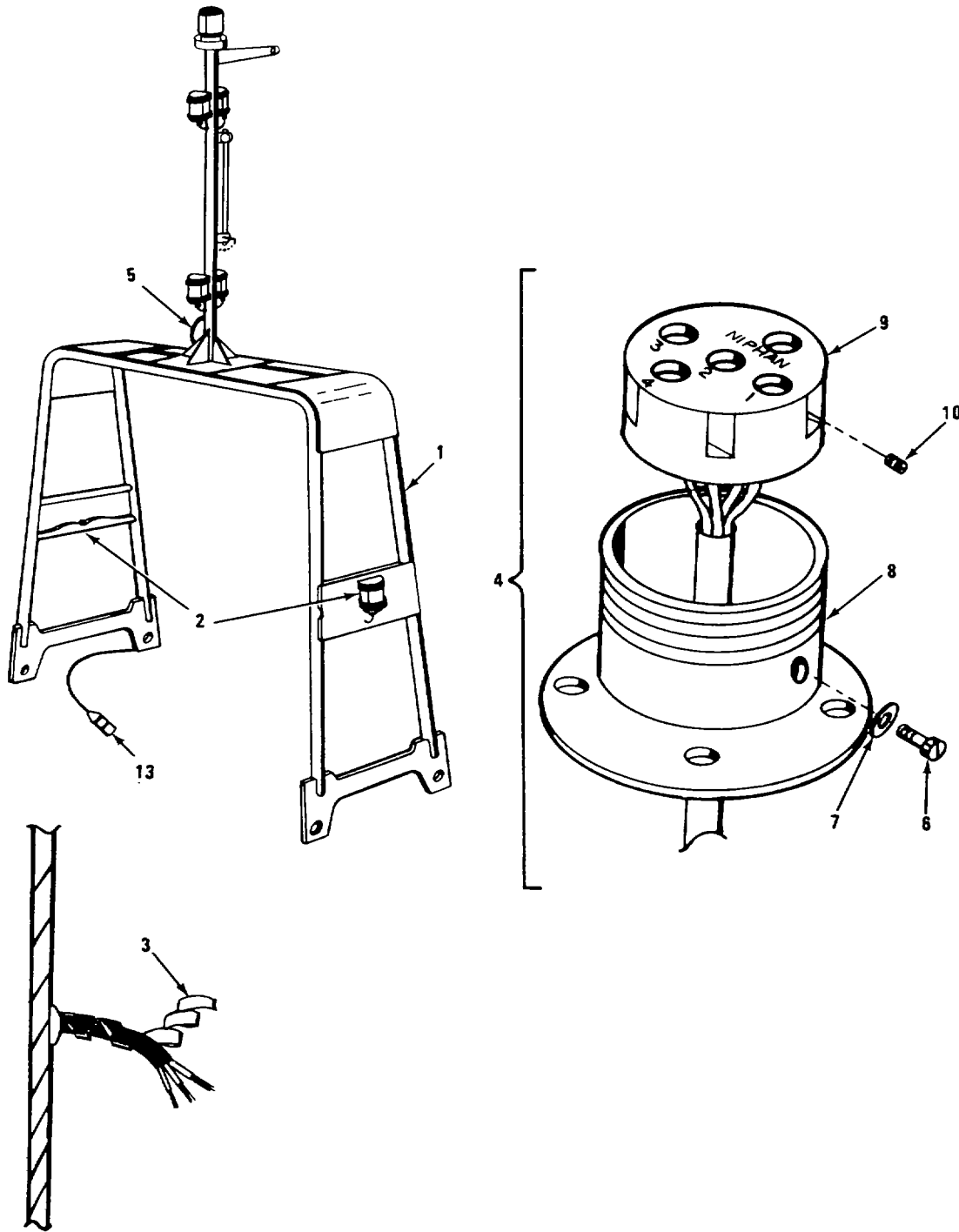
Tools:	Equipment Condition:	Condition Description:
Flat tip screwdriver (small) Knife	TM 5-1940-277-20	Mast removed.

Materials/Parts:

Mast wiring harness with plug
Rubber grommets
Cord (90 feet)

Personnel Required: Three

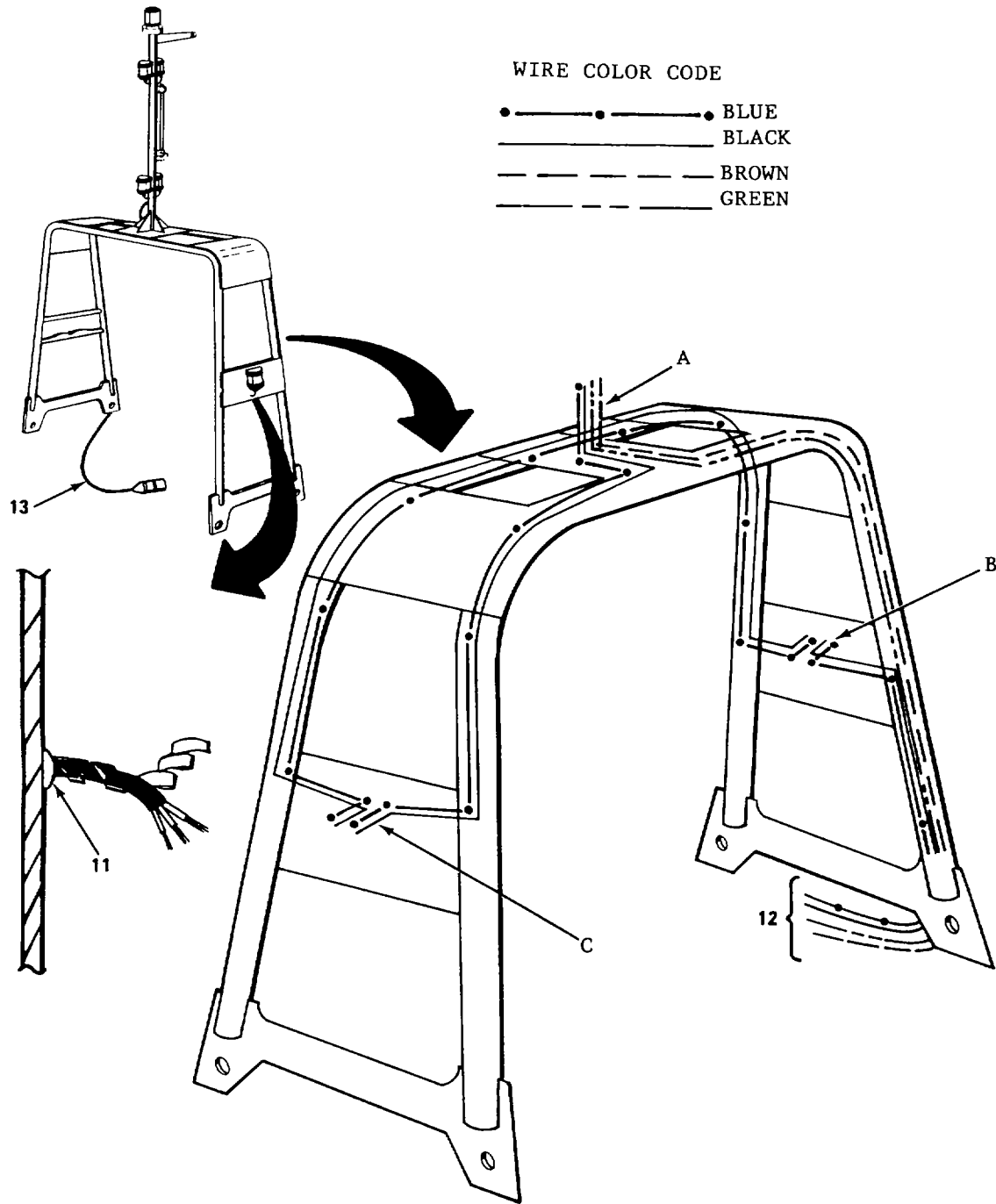
MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER
 (Continued)



MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER
(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Lower mast (1)	a. Light sockets (2) (navigation)	Remove.	Reference TM 5-1940-277-20.
	b. Spiral wrap (3) on wires	Remove all that is exposed.	Wraps around wire. Unwind and retain.
	c. Socket (4) and plug (5)	Unscrew plug from socket.	Disconnects upper mast harness from lower mast harness.
	d. Socket retaining screw (6) and washer (7)	Remove screw from side of socket housing (8).	Use screwdriver. Frees socket to be pulled out of housing.
	e. Socket core (9)	Pull out of socket housing (8).	
NOTE			
Before next step check wire color leading to each pin. Pin numbers are on face of socket and should be: 1 Blue, 2 Black, 3 Brown, 4 - Green. If not, make diagram of connections.			
	f. 4 wire retaining screws (10)	Loosen and pull wires out.	Use screwdriver. Lay core aside for reuse.
NOTE			
Next step applies to point where wires enter mast frame.			

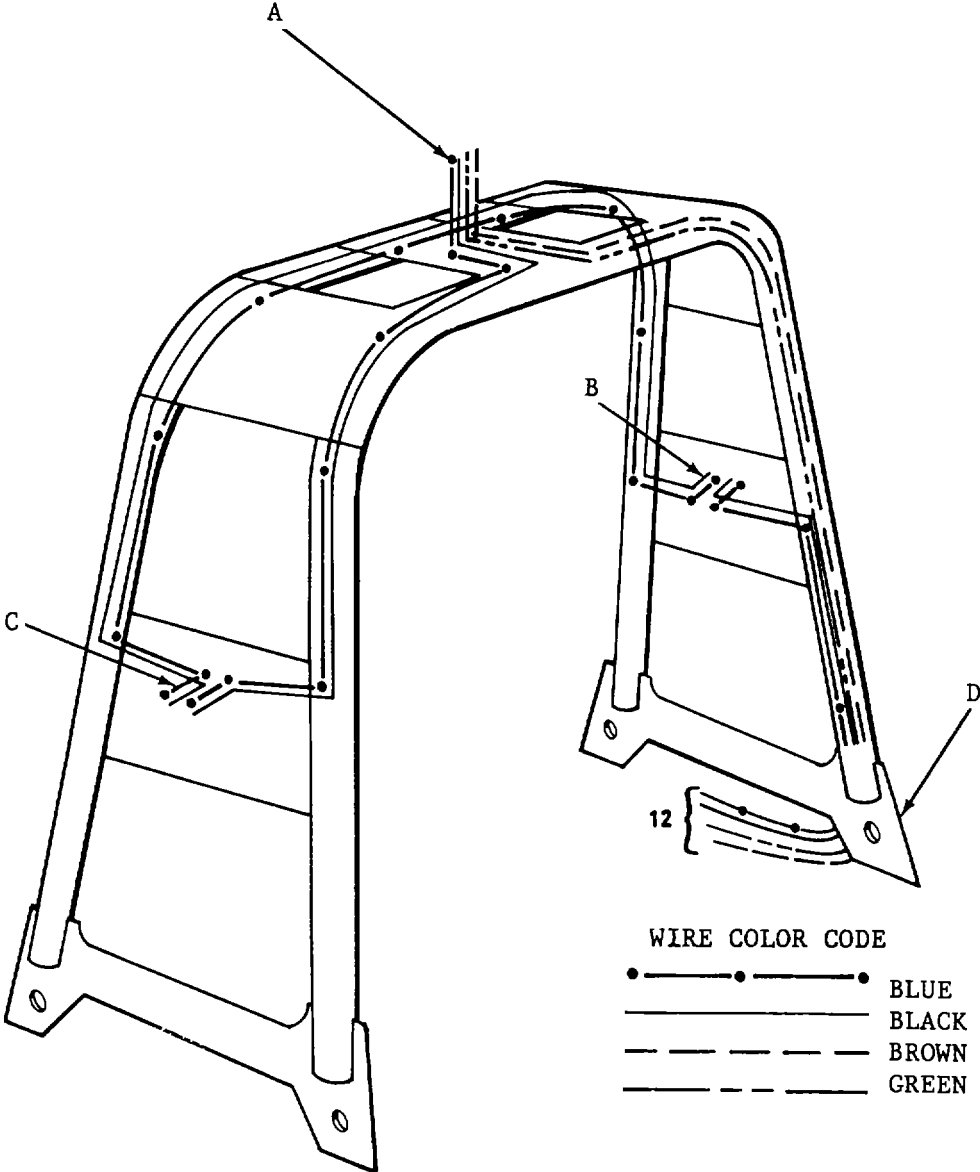
MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER
(Continued)



MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	g. 7 rubber grommets (11)	Pry out of frame, split with knife, remove and discard.	Use screwdriver.
NOTE			
Next step applies to old harness as installed. The wiring harness consists of three separate segments of wires.			
	h. Wiring harness (12) at point A	a. Tie cord to end of brown and green wires.	
		b. Tie a second cord to end of blue and black wires.	
	i. Wiring harness (12) at point B	a. Tie one cord to end of one pair blue and black wires leading to plug (13).	
		b. Tie second cord to second pair of blue and black wires leading to point C.	

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER
(Continued)



MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	j. Wiring harness (12) at point C	Grasp in turn one pair of black and blue wires leading from: removed.	Cord will be pulled through mast as old harness is
		a. Point B	
		b. Point A	
		and pull wiring out of mast frame.	
	k. Wiring harness (12) at point D	Grasp plug and pull wiring out of mast frame at point D.	Cord will be pulled through mast as old harness is removed.
	l. Cord	Tag cords pulled through mast frame by wire colors and points (A or B) to which cord leads.	

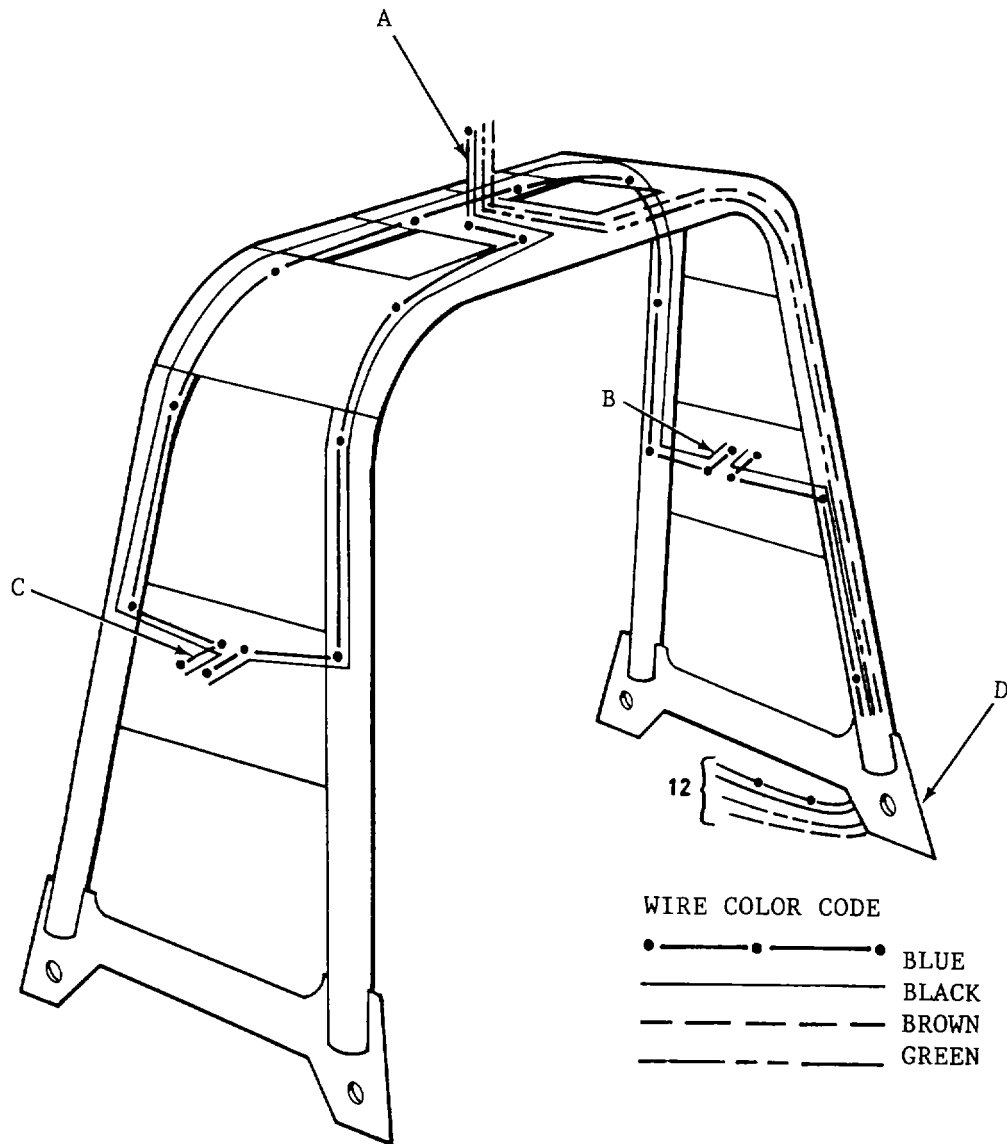
INSTALLATION

NOTE

Before next step lay new harness out and cut individual segments of new harness equal to old harness segments.

m. Wiring harness segments	Tie segments to correct cords (note tags).
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MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER
(Continued)

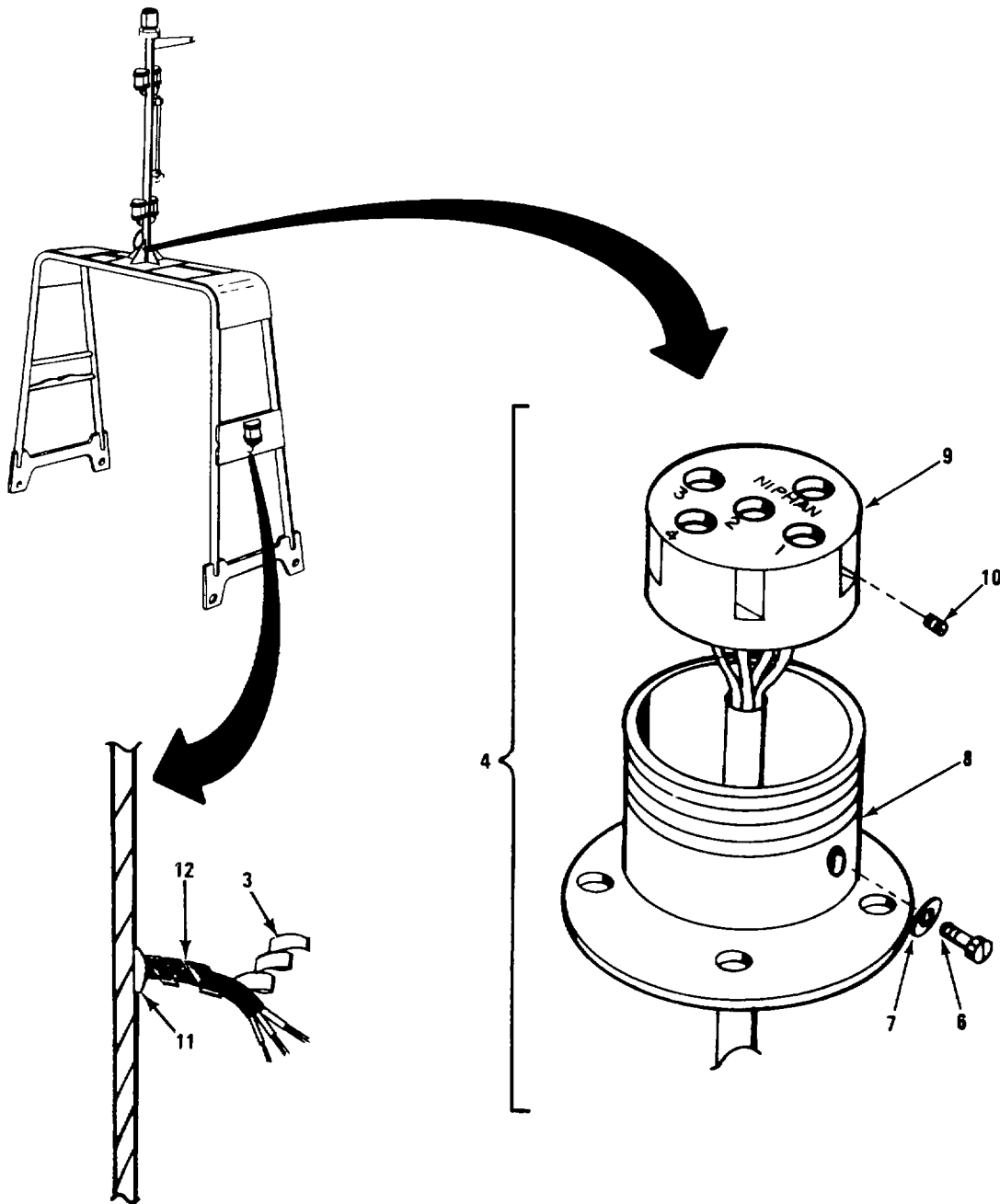


MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	n. Wiring harness (12) attach to plug (13)	a. Feed wires into mast frame at point D.	Requires three persons.
		b. Pull cords attached to wires at points A and B at same time until wire pairs are in position.	
		c. Remove cord when wires in position.	
	o. Wiring harness (12) - blue and black wire pairs at point C	a. Pull on cord at point A and at same time feed wire pair into mast frame at point C until wire is in position.	
		b. Pull on cord at point A and at same time feed second wire pair in mast frame at point C until wires are in position.	
		c. Remove cords when wire pairs in position.	

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER
(Continued)



MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - LOWER

(Continued)

LOCATION	ITEM	ACTION	REMARKS										
	p. Wiring harness (12) at points A, B and C and 7 rubber grommets (11)	a. Feed wires through rubber grommets. b. Install grommets in opening in mast frame.											
	q. Spiral wrap (3)	Install on exposed portions of wires at point A, B and C.											
	r. Socket core (9) and 4 retaining screws (10)	a. Connect 4 wires to correct pin: <table style="margin-left: 20px;"> <tr> <td><u>Pin</u></td> <td><u>Wire</u></td> </tr> <tr> <td>1</td> <td>Blue</td> </tr> <tr> <td>2</td> <td>Black</td> </tr> <tr> <td>3</td> <td>Brown</td> </tr> <tr> <td>4</td> <td>Green</td> </tr> </table> b. Seat in socket housing (8).	<u>Pin</u>	<u>Wire</u>	1	Blue	2	Black	3	Brown	4	Green	
<u>Pin</u>	<u>Wire</u>												
1	Blue												
2	Black												
3	Brown												
4	Green												
	s. Socket retaining screw (6) and washer (7)	Install socket retaining screw in side of housing.											
	t. Lights (2) (navigation)	Install.	Reference TM 5-1940-277-20.										

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER

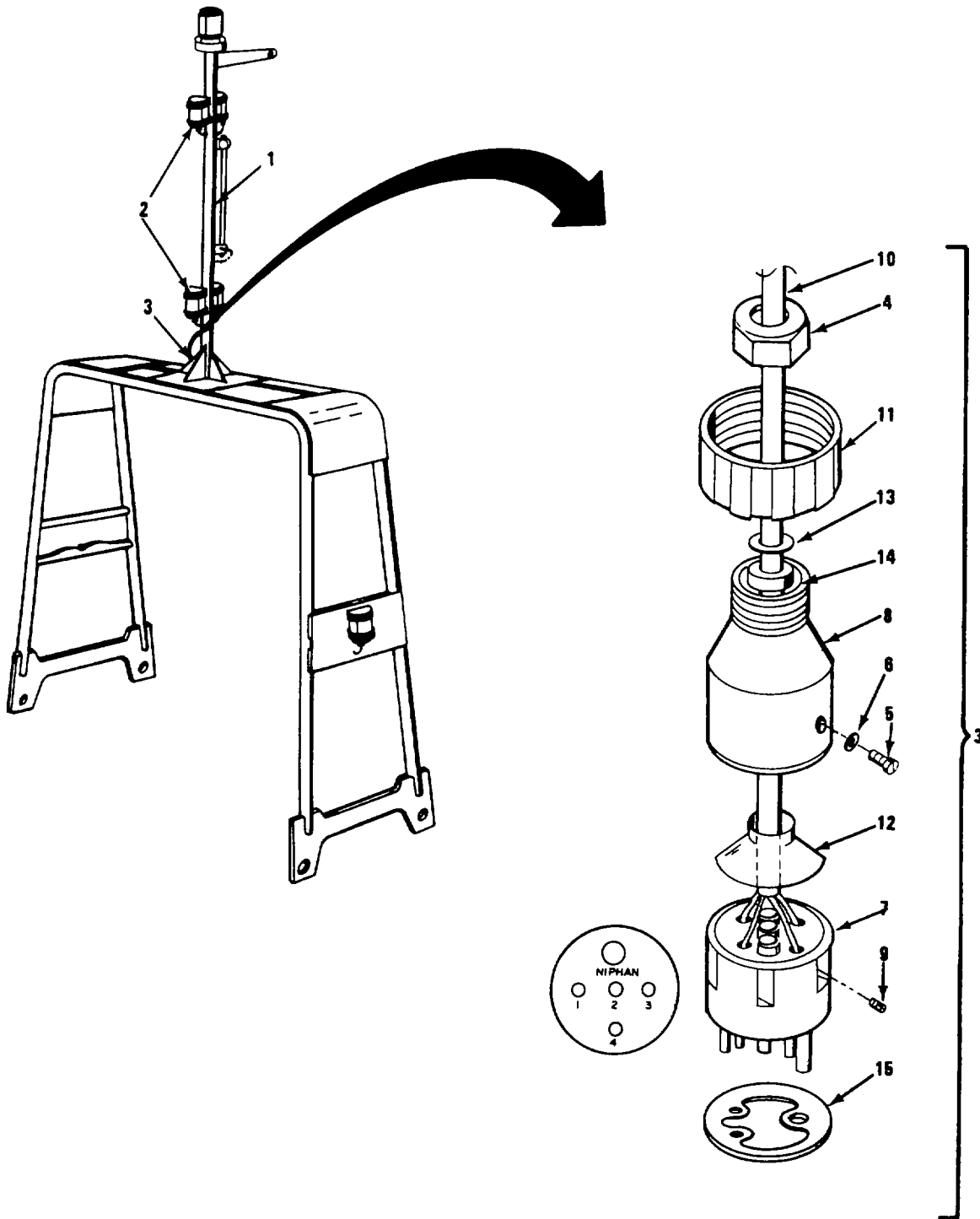
This task covers:

- a. Removal**
- b. Installation**

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Flat tip screwdriver (small) Pliers 7/8 in box/open wrench Wire stripper Knife	TM 5-1940-277-20	Mast removed.
Materials/Parts:		
Wiring harness Cord (50 foot) Waterproof sealing compound		
Personnel Required: Two		

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER
(Continued)

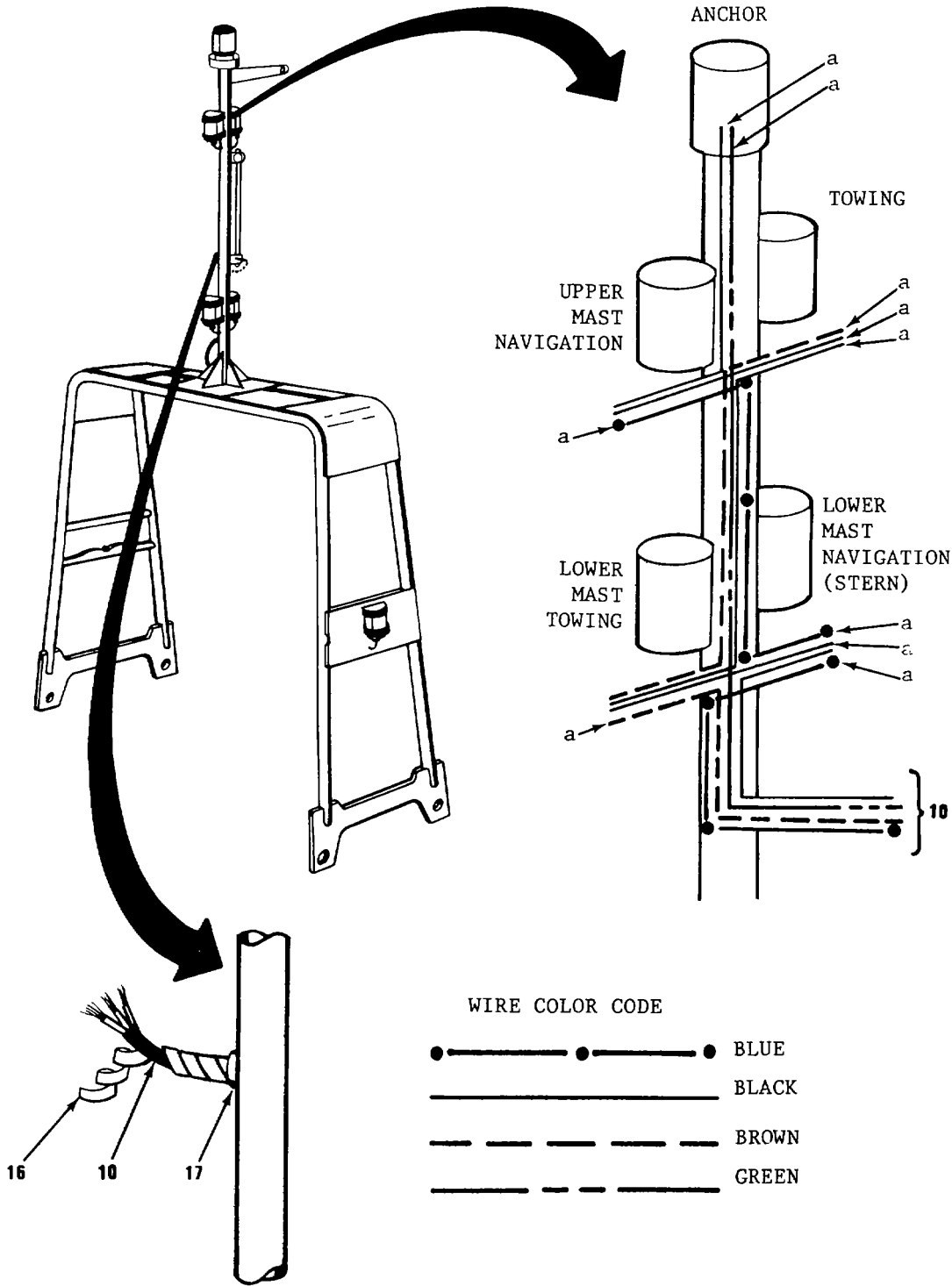


MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER

(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Mast (1) (upper section)	a. Light sockets (2), navigation, anchor)	Remove.	Reference TM 5-1940-277-20.
	b. Plug (3)	Unscrew from socket.	
2. Plug (3)	a. Plug nut (4)	Remove.	Use 7/8 in wrench.
	b. Plug retaining screw (5) and washer (6)	Remove.	Use screwdriver.
	c. Plug core (7)	Pull out of plug case (8).	
NOTE			
Before next step draw diagram of wire color to pin number connections. Pin numbers are on plug face.			
	d. 4 wire retaining screws (9) and wire harness (10)	a. Loosen screws.	Use screwdriver.
		b. Pull wires out of plug core (7).	Retain plug core for installation on new harness.
	e. Plug nut (4), retaining nut (11), plug case (8), plastic shield (12), washer (13), rubber grommet (14) and washer (15)	Remove and retain to be reused.	

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER
(Continued)

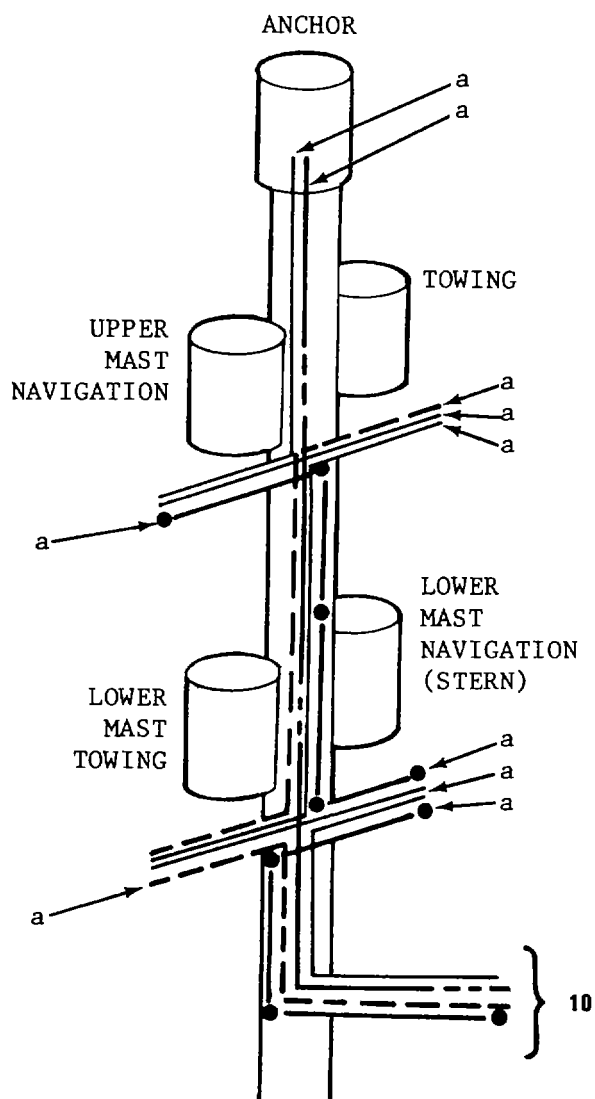


MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	f. Wiring harness (10)	Remove spiral wrap (16) from all exposed sections of harness.	Unwind from wire. Retain for reuse.
NOTE			
Next step involves items located at points wires enter and exit mast section.			
	g. 5 grommets (17)	a. Pry out of mast.	Use screwdriver.
		b. Cut off wires.	Use knife.
		c. Discard.	
	h. Wiring harness (10)	a. Tie a cord to each wire indicated in figure with	
		b. Start with upper navigation light wires and working way down mast to lower light positions, pull each wire without an attached cord out of mast frame with attached cord. Carefully feeding other end of wire being pulled into mast frame.	Stop pulling when each cord has been pulled through mast.

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER

(Continued)



WIRE COLOR CODE

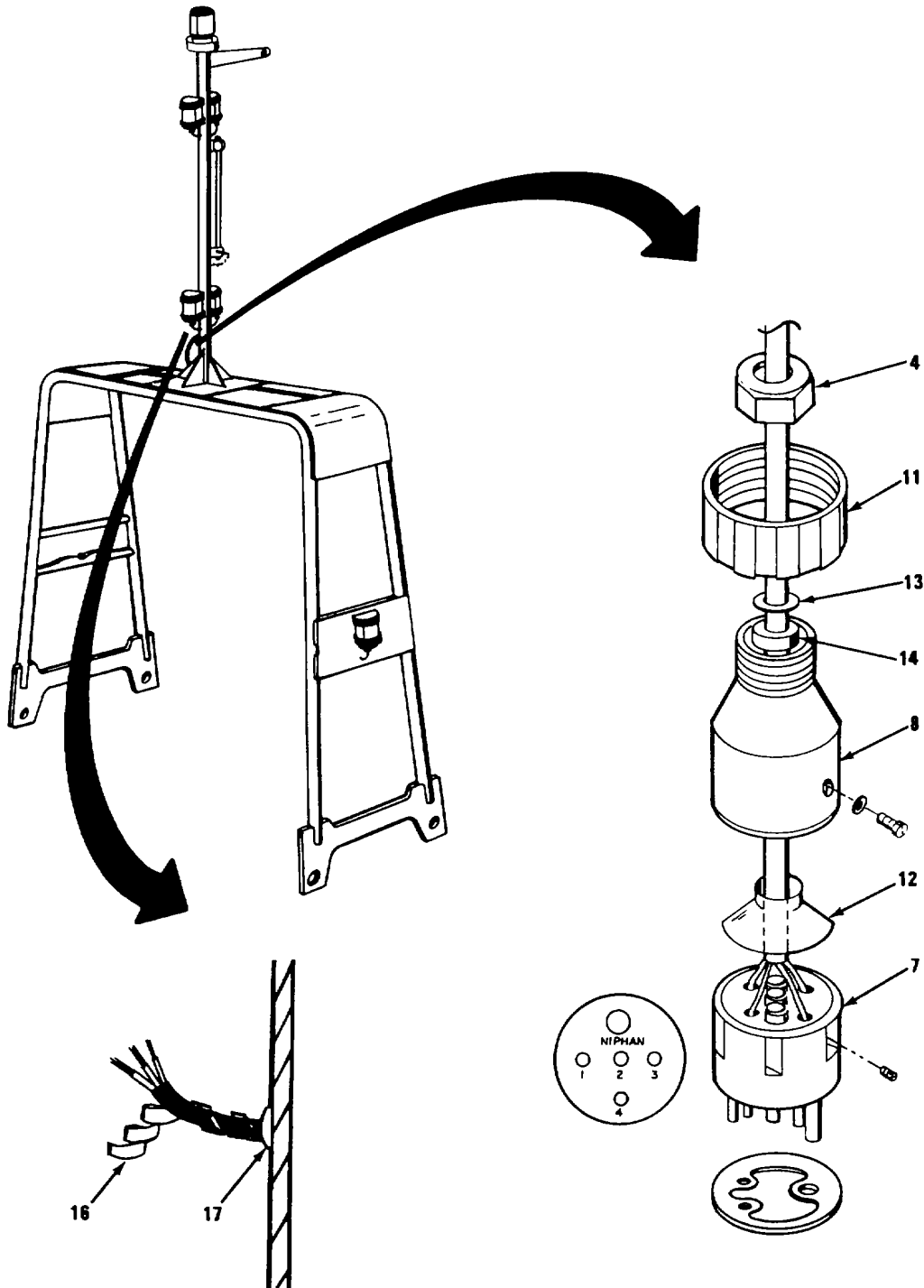
- ——— ● ——— ● BLUE
- BLACK
- - - - - BROWN
- · - · - GREEN

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Tag both ends of each cord by wire color and the positions on mast it passes between.	
		d. Carefully tag each wire segment pulled from frame to note the points of entry and exit from mast frame.	
<u>INSTALLATION</u>			
	i. Wiring harness (10)	a. Cut new wire segments, make sure wires are correct color and length.	Use old wire segments as patterns to cut new segments.
		b. As each new wire segment is cut, transfer tag from old wire to new wire.	

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER
(Continued)

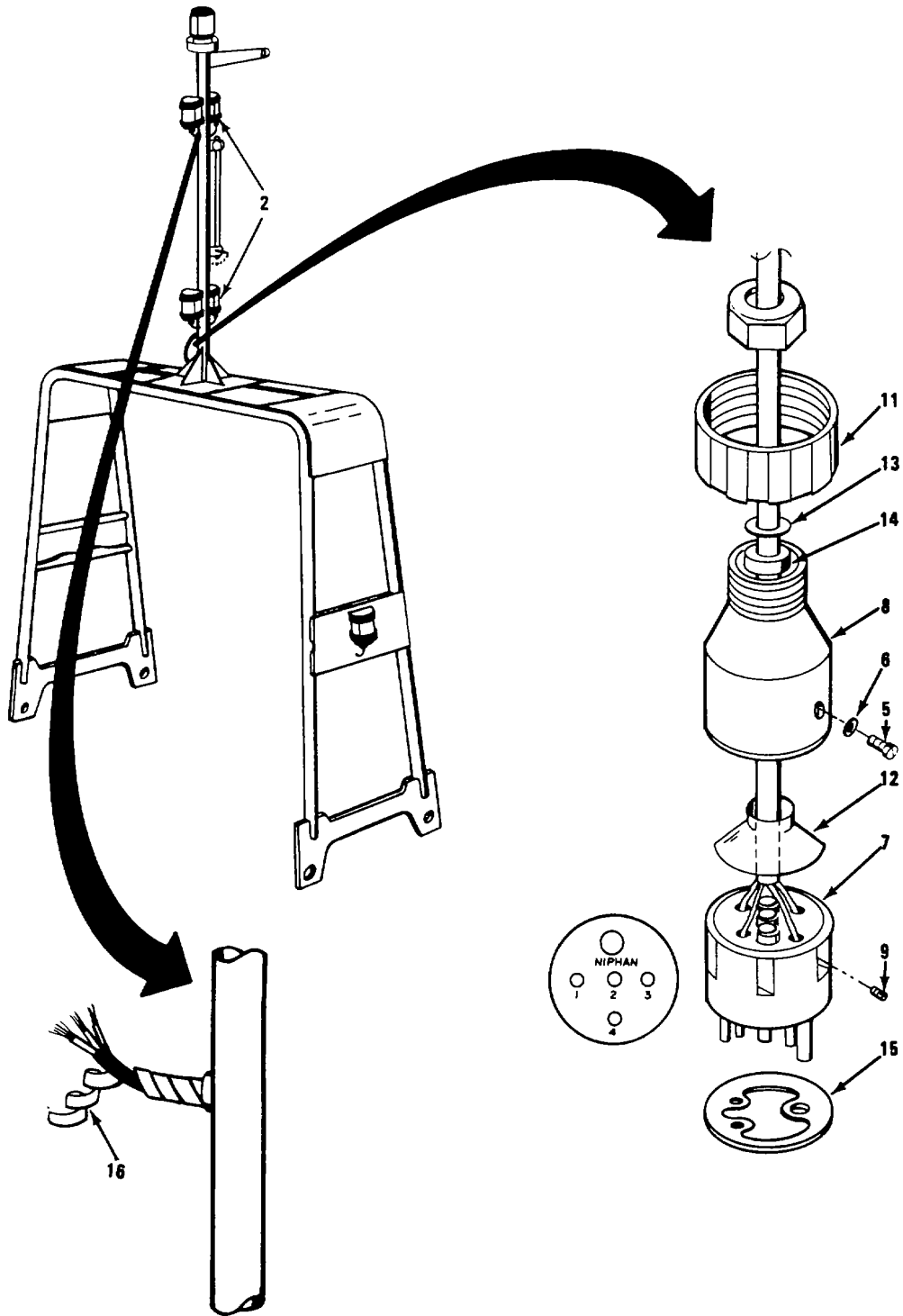


MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Match new wire segments (ID tags) to cords on mast and tie cords to ends of wires.	Test knot to make sure it will not slip off.
		d. Carefully feed wires, one at a time, into mast holes while pulling on cord tied to other end to guide wire into mast frame at same time.	Use two persons, one feeding wire and one pulling on cord.
		e. Remove cords when wire segments have been pulled through mast frame.	
	j. 5 grommets (17)	a. Feed wires at mast holes through grommets.	
		b. Install grommets into mast holes to seal openings.	
	k. Plug nut (4), washer (13), rubber grommet (14), retaining nut (11), plug case (8) and plastic shield (12)	a. Fit in sequence on lower end of wiring harness.	
		b. Strip 1/2 inch insulation from ends of wires.	

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER
(Continued)



MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER
(Continued)

LOCATION	ITEM	ACTION	REMARKS	
	1. Plug core (7)	a. Fit wires into correct pins to match color coding.	<u>Pin</u> 1 2 3 4	<u>Wire</u> Blue Black Brown Green
		b. Install screws (9) securing wires.		
	m. Plastic shield (12)	a. Slide down onto plug core (7).		
		b. Seal throat of shield with sealant.		Use silicone sealant.
	n. Plug case (8)	Slide down over plug core (7).		
	o. Retaining ring (11)	Slide down over plug case (8).		
	p. Plug core retaining crew (5) and washer (6)	Install securing plug core in case.		Retaining ring (11) must be below retaining screw (5) hole in plug case (8) before installing screw.
	q. Washer (13) and rubber grommet (14)	Slide down wires into throat of plug case (8).		
	r. Plug nut (4) case (8).	Screw onto plug case (8).		

MAST WIRING HARNESS REPLACEMENT INSTRUCTIONS - UPPER
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	s. Spiral wrap (16)	Install on exposed wire sections.	
	t. Lights (2) (anchor, navi- gation, towing)	Install.	Reference TM 5-1940-277-20.

CONTROL BOX REPLACEMENT INSTRUCTIONS

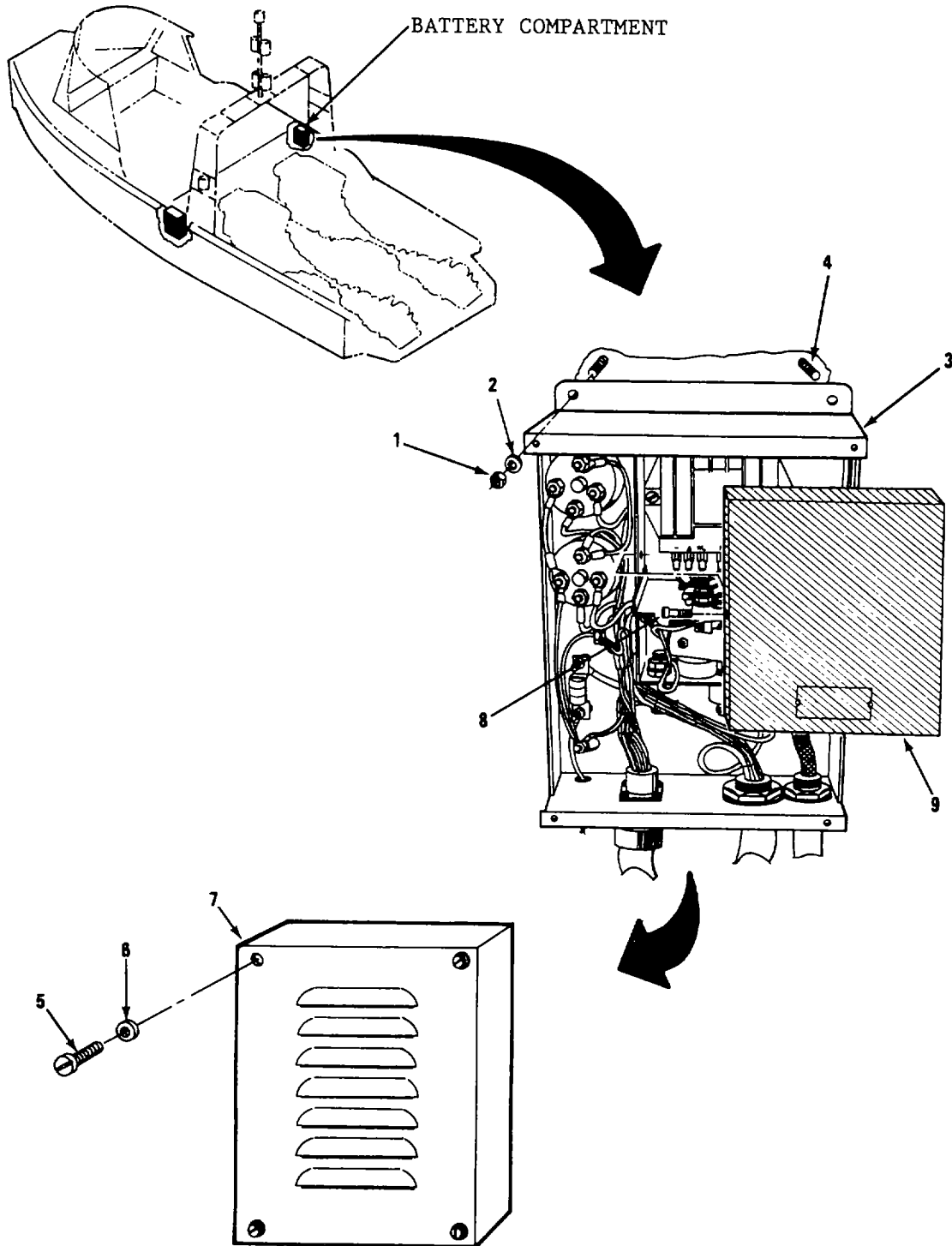
This task covers:

- a. Removal
- b. Replacement

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
10 mm socket Extension Ratchet Flat tip screwdriver	TM 5-1940-277-20 TM 5-1940-277-20 Page 2-93-	Engine compartment hatch open. Battery compartment hatch open. Engine wiring harness disconnected at engine.
Materials/Parts:		
Control box 10 mm open end wrench 13 mm open end wrench Channel lock pliers		

CONTROL BOX REPLACEMENT INSTRUCTIONS
(Continued)

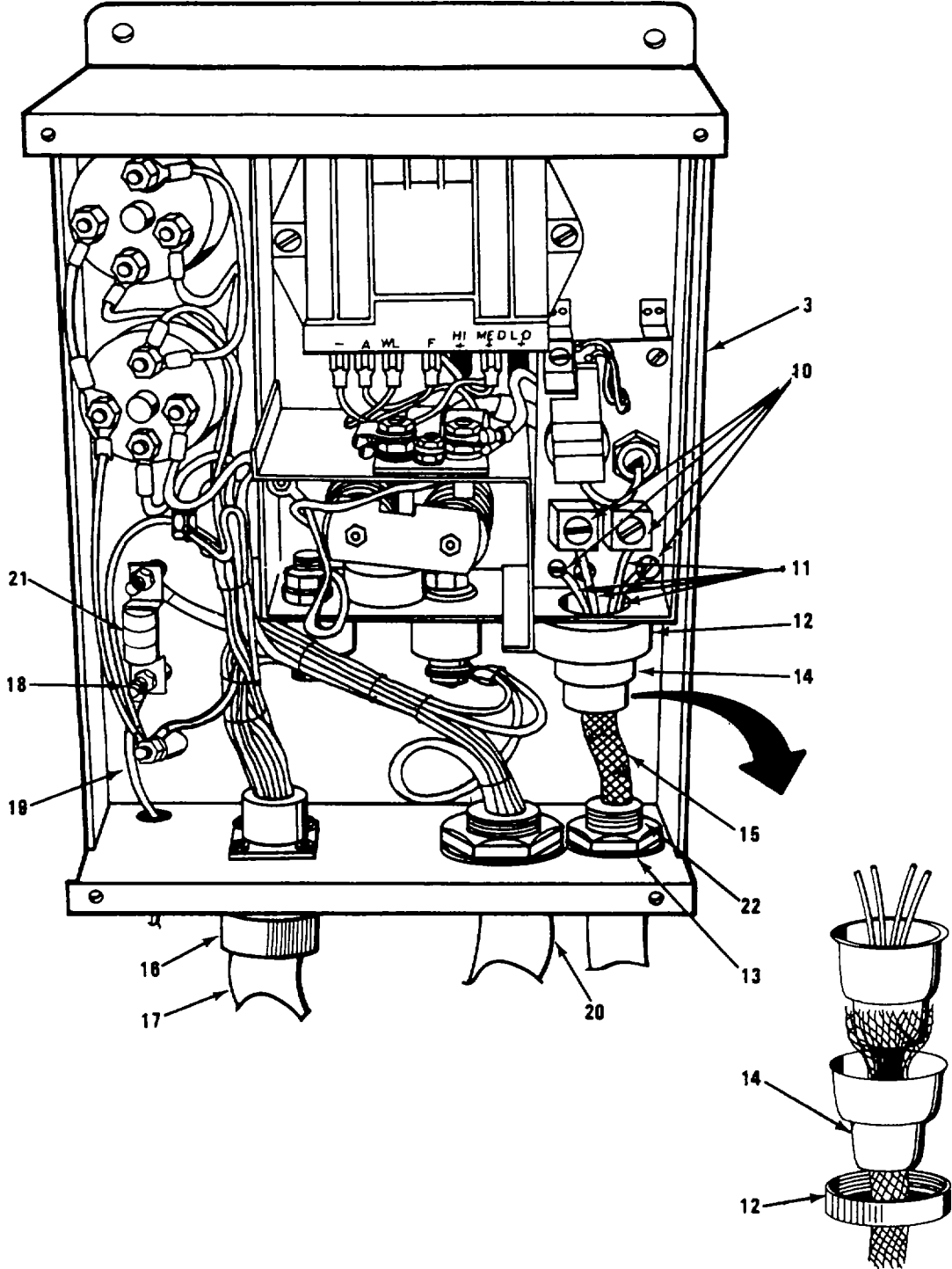


CONTROL BOX REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Battery compartment	Control box (3)	a. Remove four nuts (1) and four washers (2).	Use 10 mm socket with extension. Use 10 mm open end wrench.
		b. Pull control box (3) off four studs (4) and place on top of battery covers.	The control box is easier to work on in this position.
		c. Remove four screws (5), four washers (6) and control box cover (7).	Use flat tip screwdriver.
		d. Remove two screws (8) and voltage regulator box cover (9).	Use flat tip screwdriver.

Change 1 2-147

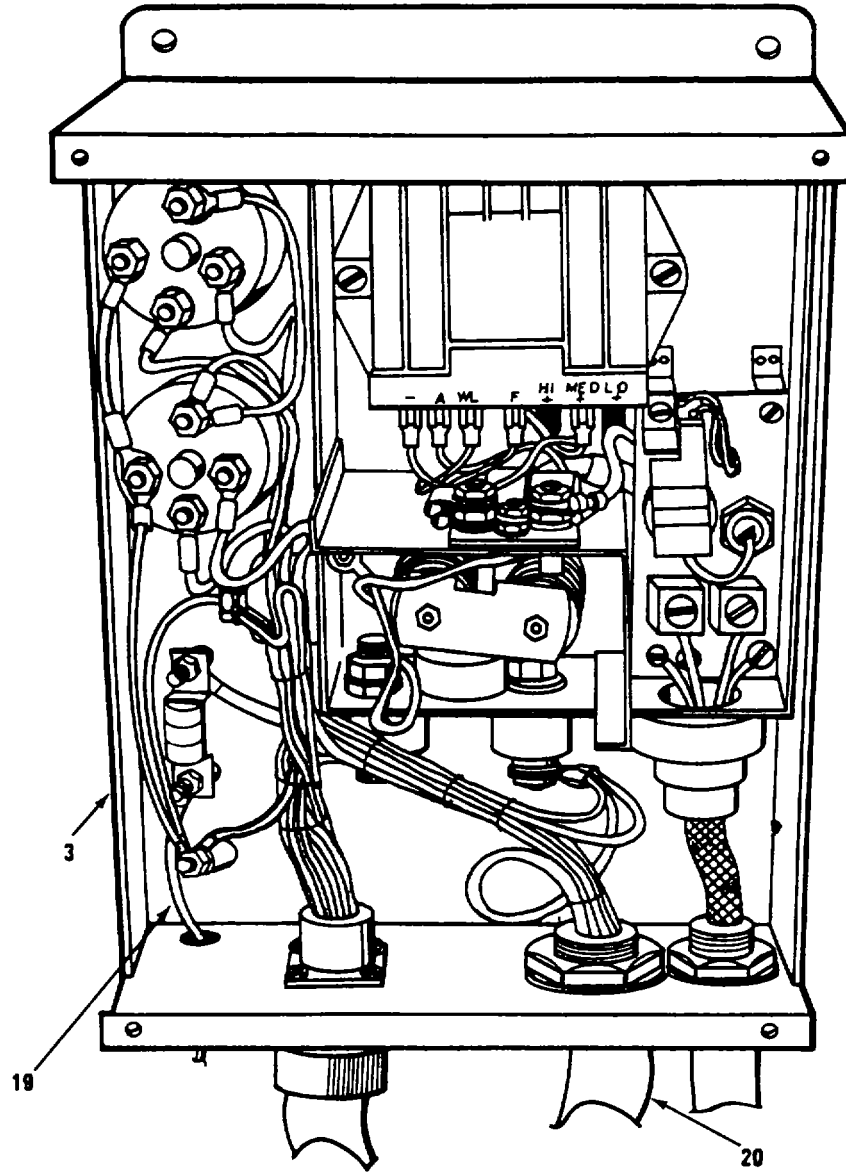
CONTROL BOX REPLACEMENT INSTRUCTIONS
(Continued)



CONTROL BOX REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
		e. Loosen terminal screws (10) and remove alternator wires (11) from terminals. for correct reconnection of wires on replacement control box (3).	a. Use flat tip and/or 13 mm wrench. b. Tag wires and make a location diagram
		f. Unscrew collar (12).	Use channel lock pliers.
		g. Unscrew nut (13).	Use 1-5/8 in wrench.
		h. Separate shielding retainer (14) freeing Shielding.	Use screwdriver.
		i. Pull shielded cable (15) out of control box (3).	Keep nut (13) for reinstallation.
		j. Unscrew collar (16) and disconnect plug (17).	
		k. Loosen nut (18) and remove battery wire (19).	Use 10 mm open end wrench.

CONTROL BOX REPLACEMENT INSTRUCTIONS
(Continued)

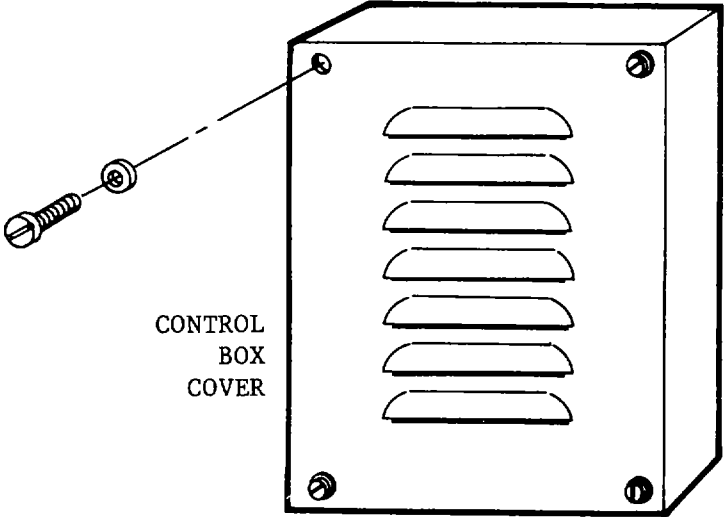
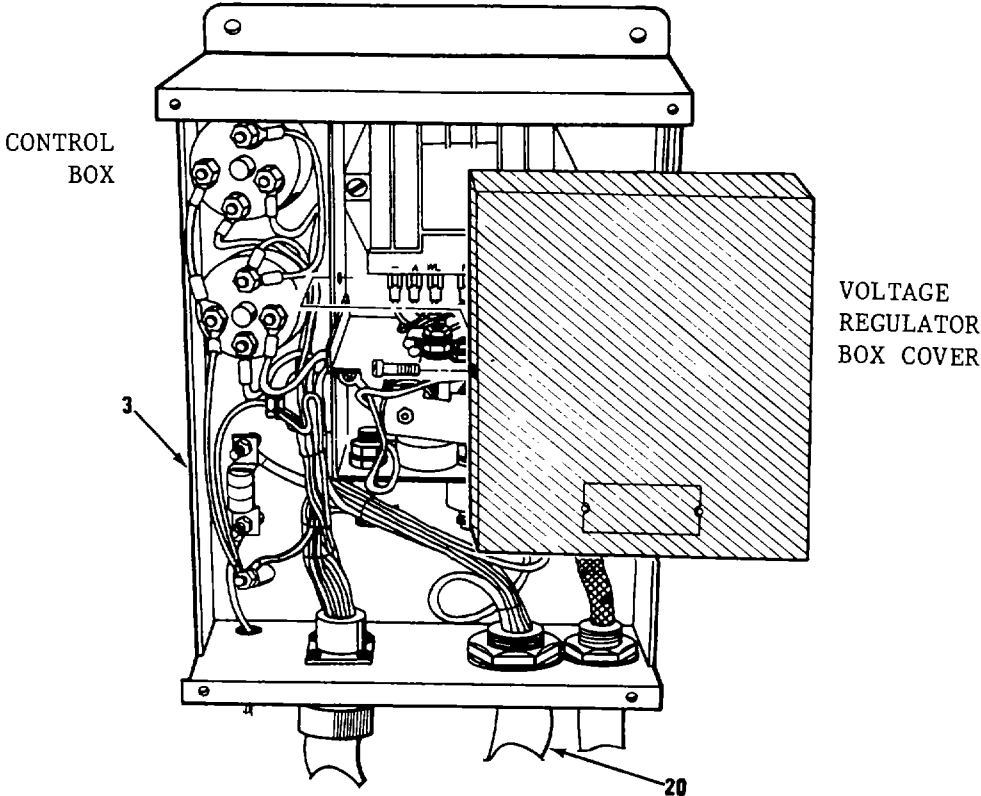


CONTROL BOX REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
2. Work area	<ul style="list-style-type: none"> <li>i. Pull battery wire (19) out of control box (3). <li>m. Remove control box (3) with its connected engine wiring harness (20) from battery compartment to suitable work area. 	<p>Disconnect engine wiring harness leads internal to the control box and remove engine wiring harness (20).</p>	<p>See page "Engine Wiring Harness Replacement Instructions" for procedures to remove engine wiring harness.</p>

CONTROL BOX REPLACEMENT INSTRUCTIONS
(Continued)

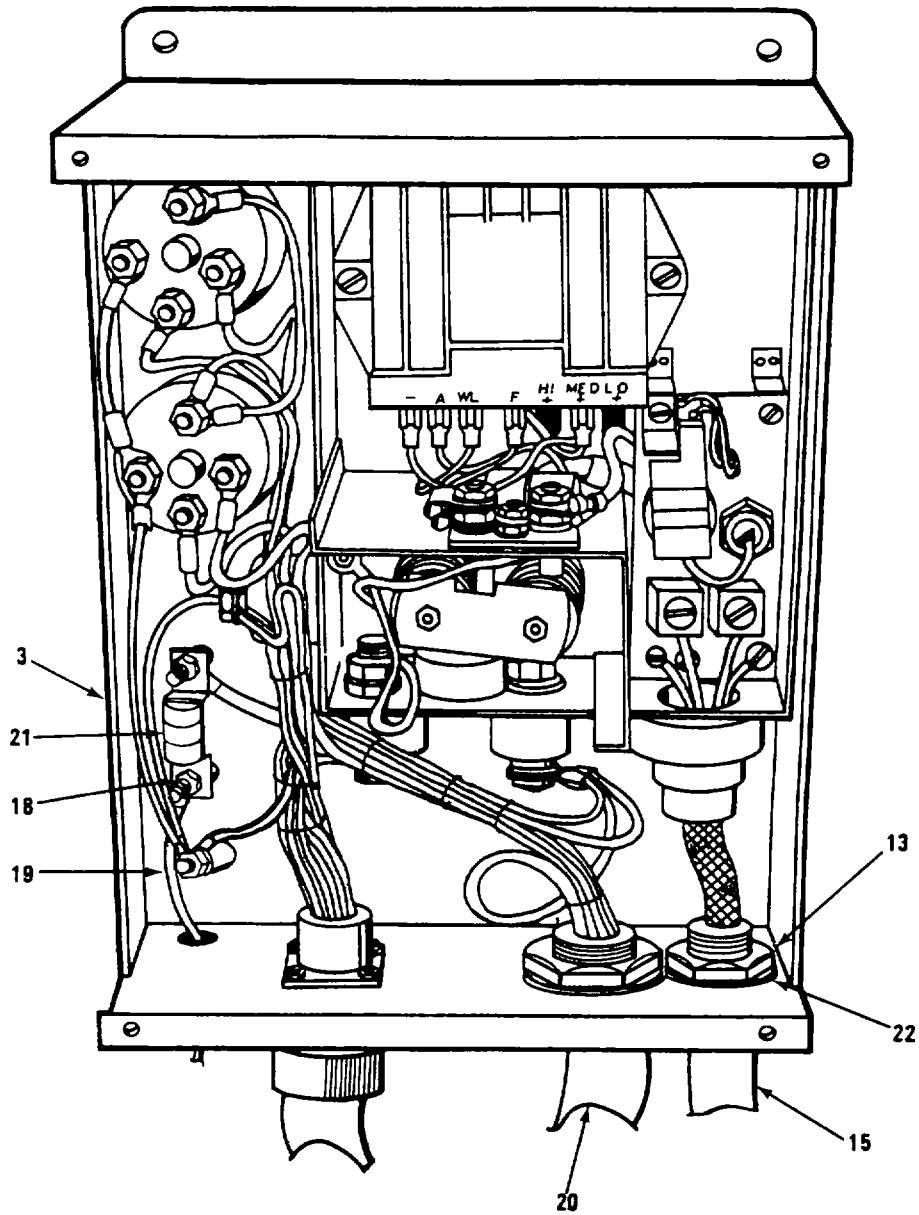


CONTROL BOX REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
<p>Before exchanging or discarding used control box check replacement control box for interconnector wires between components. Transfer needed cables from used control box to replacement box.</p>			
<u>INSTALLATION:</u>			
3. Work area	Control box (3)	<p>a. Remove four screws (5), four washers (6) and control box cover (7).</p> <p>b. Remove two screws (8) and voltage regulator box cover (9).</p> <p>c. Inspect new control box (3) for interconnect wires between components.</p> <p>d. Transfer any needed interconnect wires from used control box to new control box.</p> <p>e. Install engine wiring harness (20) in control box (3).</p>	<p>Use screwdriver.</p> <p>Use screwdriver.</p> <p>Replacement control box may not have interconnect wires installed by supplier.</p> <p>See page "Engine Wiring Harness Replacement Instructions" for procedures.</p>

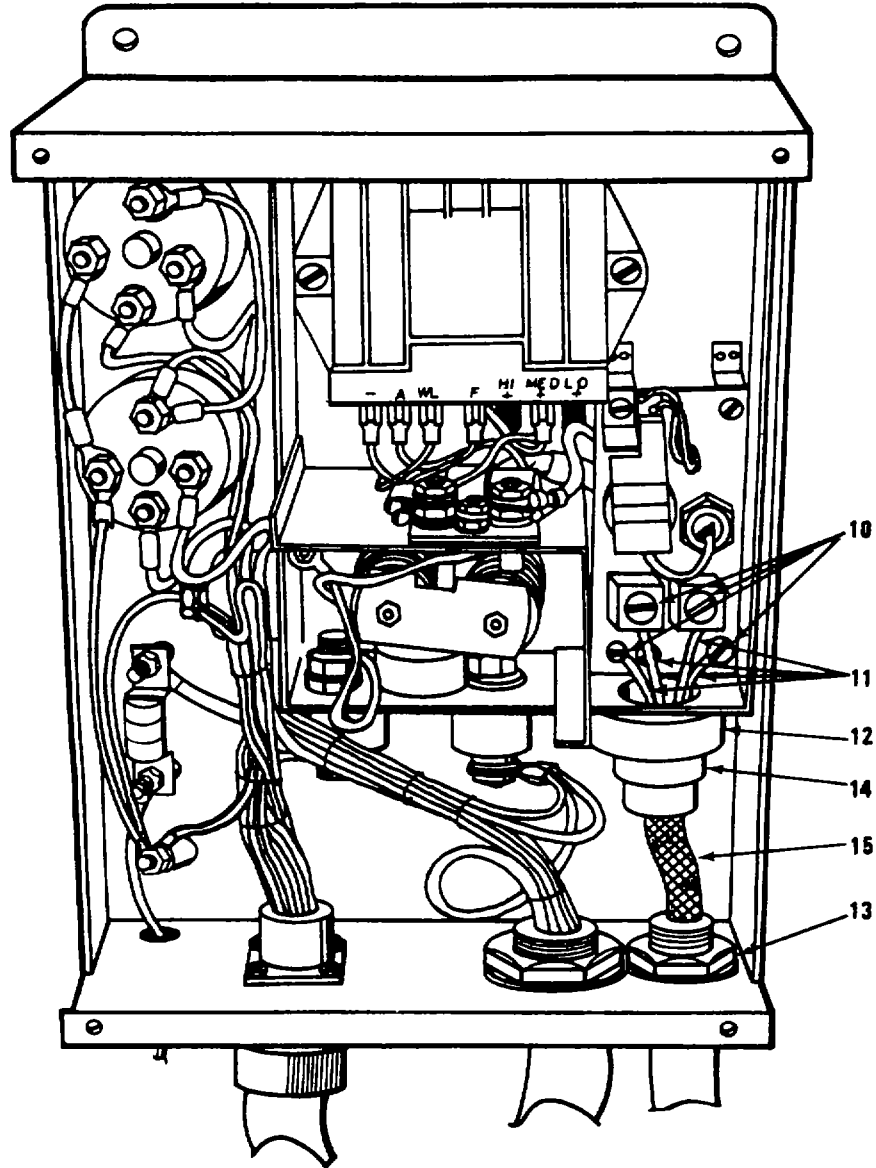
CONTROL BOX REPLACEMENT INSTRUCTIONS
(Continued)



CONTROL BOX REPLACEMENT INSTRUCTIONS**(Continued)**

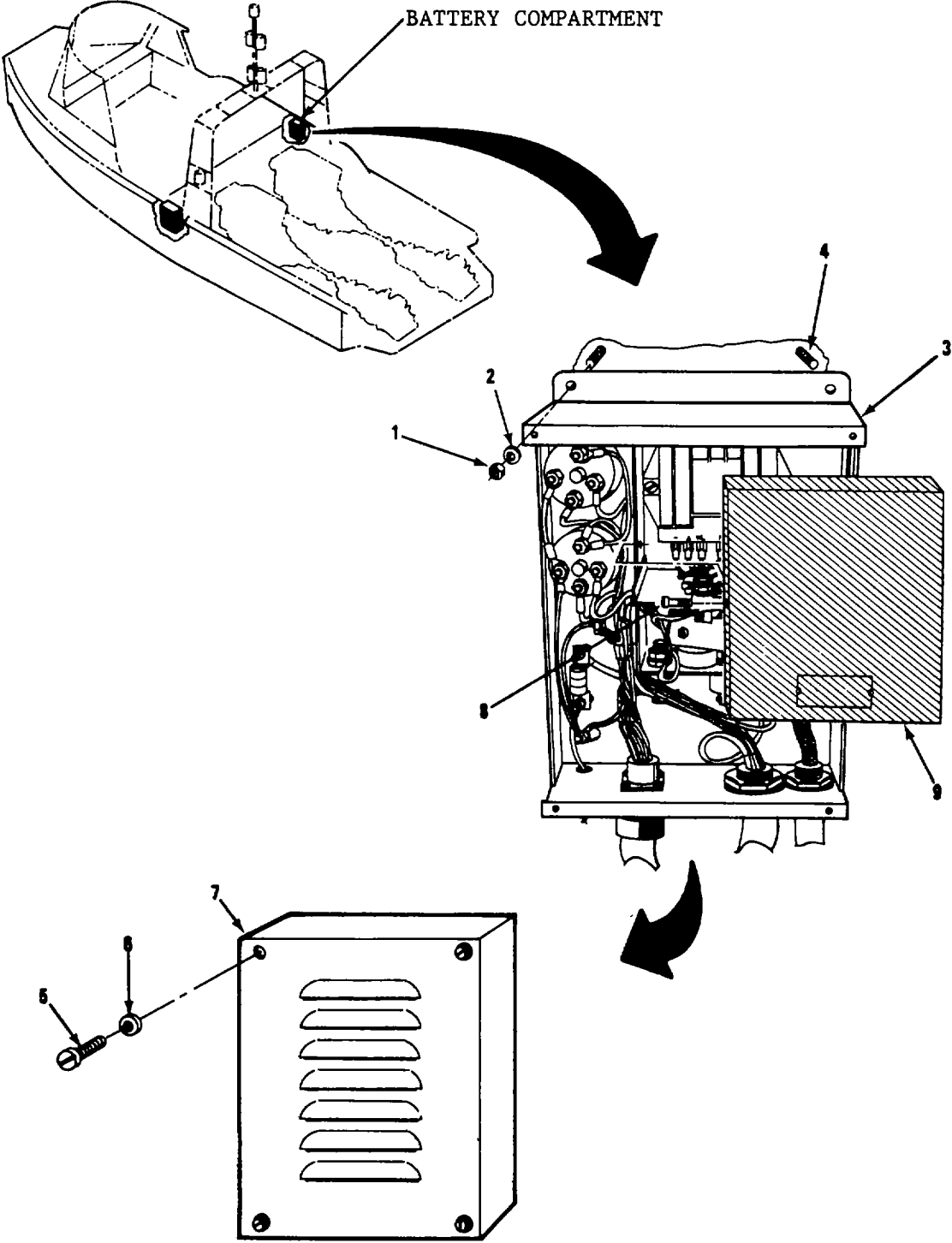
LOCATION	ITEM	ACTION	REMARKS
4. Battery compartment	Control box	<ul style="list-style-type: none"> <li>a. Place control box (3) with install engine wiring harness (20) on battery covers. <li>b. Feed engine wiring harness (20) into engine compartment . <li>c. Feed battery wire (19) into control box (3). <li>d. Secure battery wire (19) to fast fuse (21) using nut (18). <li>e. Feed shielded alternator cable (15) into control box (3). <li>f. Place nut (13) over alternator cable (13) and screw onto fitting (22) Securing cable to control box. 	Use 10 mm open end wrench.

CONTROL BOX REPLACEMENT INSTRUCTIONS
(Continued)



CONTROL BOX REPLACEMENT INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
		g. Slide collar (12) over end of alternator cable (15) and install wire shielding retainer (14) to end of cable.	
		h. Feed wires (11) into regulator box. Install collar (12) securing cable (15) to the regulator box.	
		i. Connect wire (11) to terminals and tighten terminal screws (10) to secure.	Use flat tip screwdriver.

CONTROL BOX REPLACEMENT INSTRUCTIONS (Continued)



CONTROL BOX REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		j. Reinstall regulator box cover (9) and secure using two screws (8).	Use flat tip screwdriver.
		k. Reinstall control box cover (7) and secure using four screws (5) and four washers (6).	Use flat tip screwdriver.
		l. Install control box (3) on four studs (4) and secure to side of boat using four nuts (1) and four washers (2).	Use 10 mm socket with extension.
		m. Connect plug (17) and secure by tightening collar (16).	
		n. Reinstall engine wiring harness on engine.	See page "Engine Wiring Harness Replacement Instructions" for installation procedures.

ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS**This task covers:**

- a. Removal
- b. Installation

INITIAL SETUP**Tools:**

Ratchet, 1/4 in drive
 6 in extension, 1/4 in drive
 10 mm socket, 1/4 in drive
 10 m box wrench
 Portable electric drill
 1/4 in drill bit
 Ratchet, 1/2 in drive
 6 in extension, 1/2 in drive
 1-1/16 in socket, 1/2 in drive
 5/8 in socket, 1/2 in drive
 3/4 in socket, 1/2 in drive
 1/2 in socket, 1/2 in drive
 11/16 in open end wrench
 Torque wrench,
 0-175 ft-lb capacity, 1/2 in drive
 Blind rivet gun
 Lifting sling
 Hoist

Equipment Condition:

TM 5-1940-277-20
 TM 5-1940-277-20
 TM 5-1940-277-20
 TM 5-1940-277-20

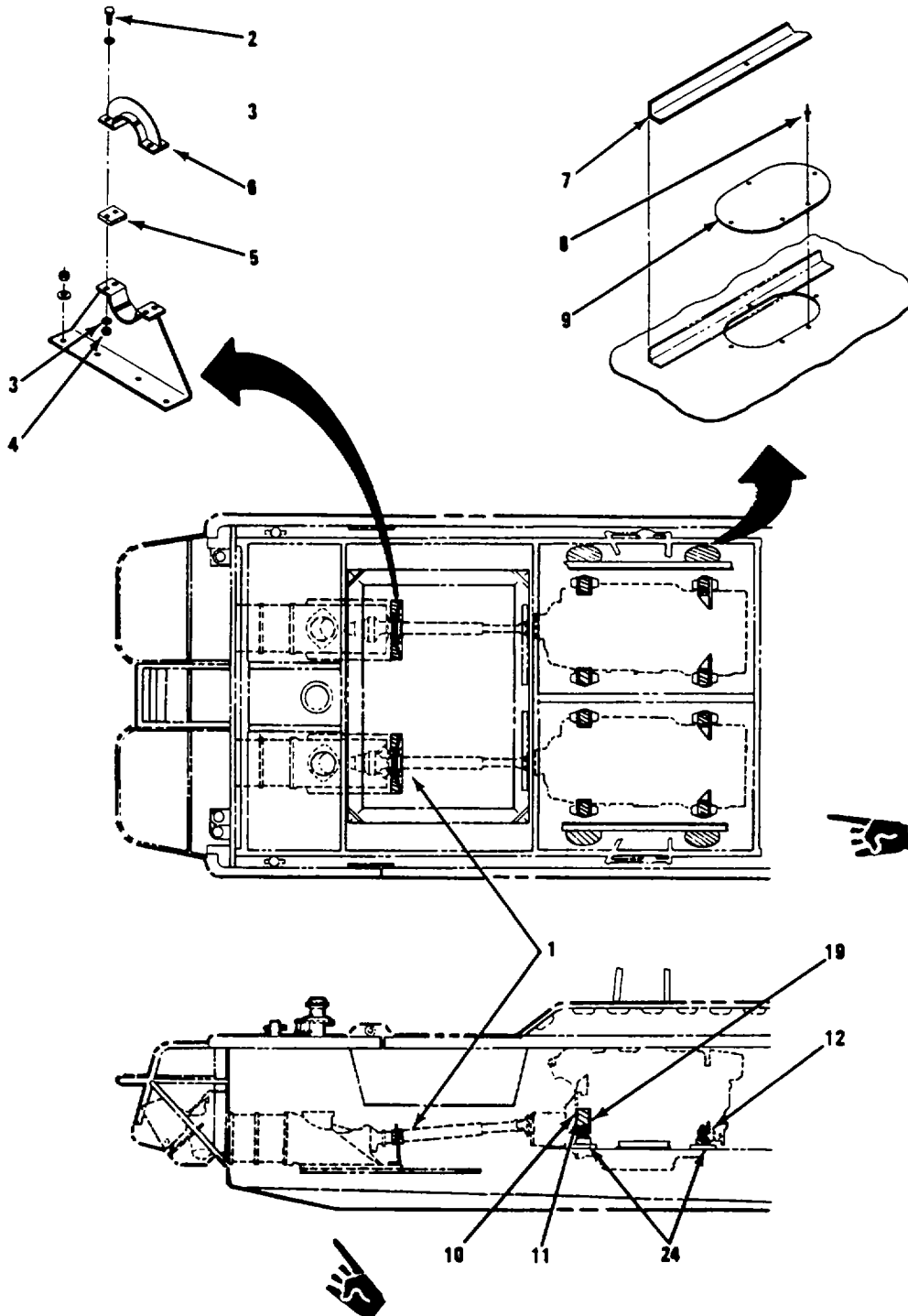
Condition Description:

Aft cockpit removed.
 Engine hatches open and secured.
 Batteries disconnected.
 Buoyancy flotation material removed (as required).

Materials/Parts:

Lockwashers, 7/16 in
 Flexible engine mount
 Aluminum rivets, 1/4 in

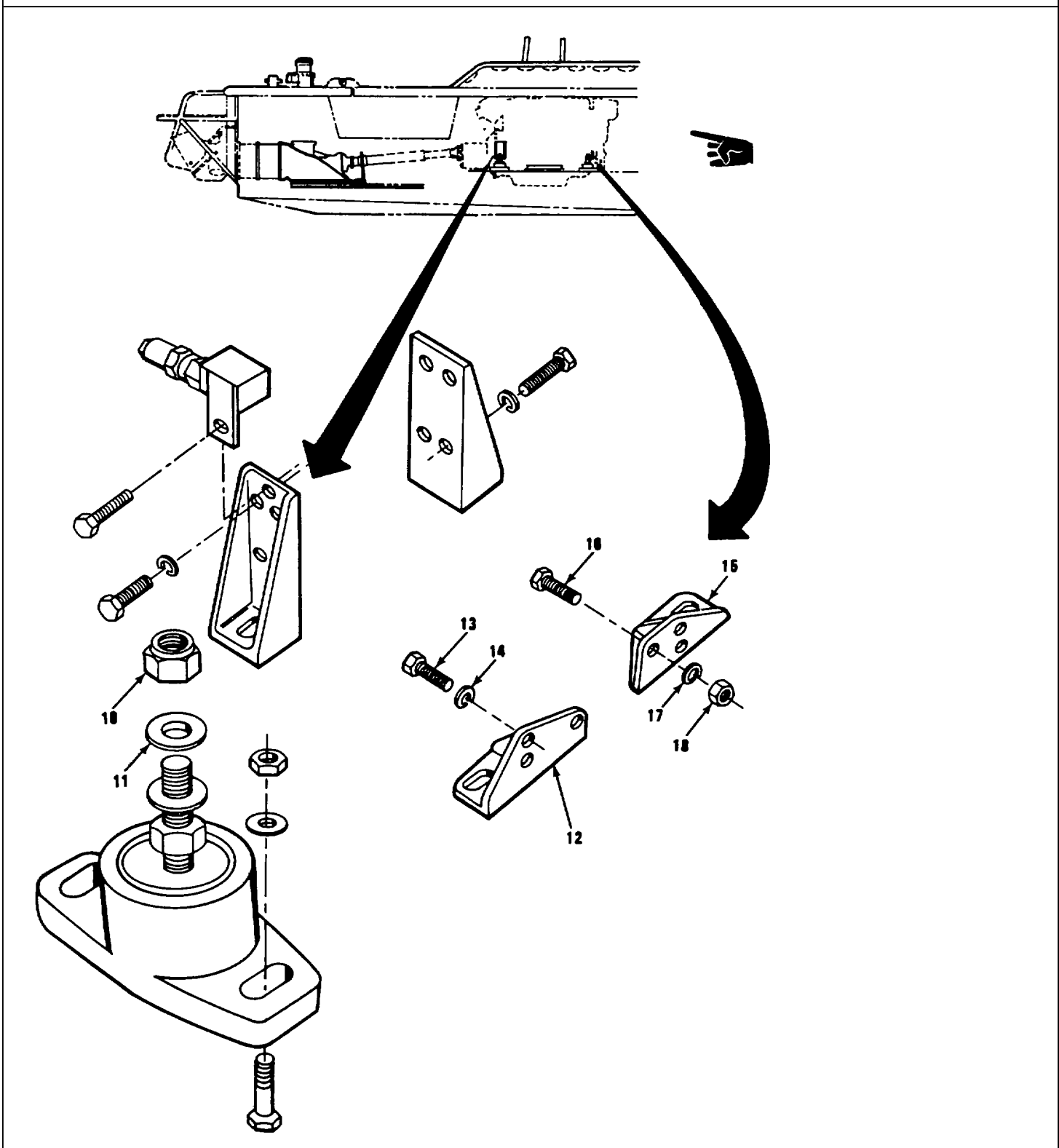
ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)



ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)

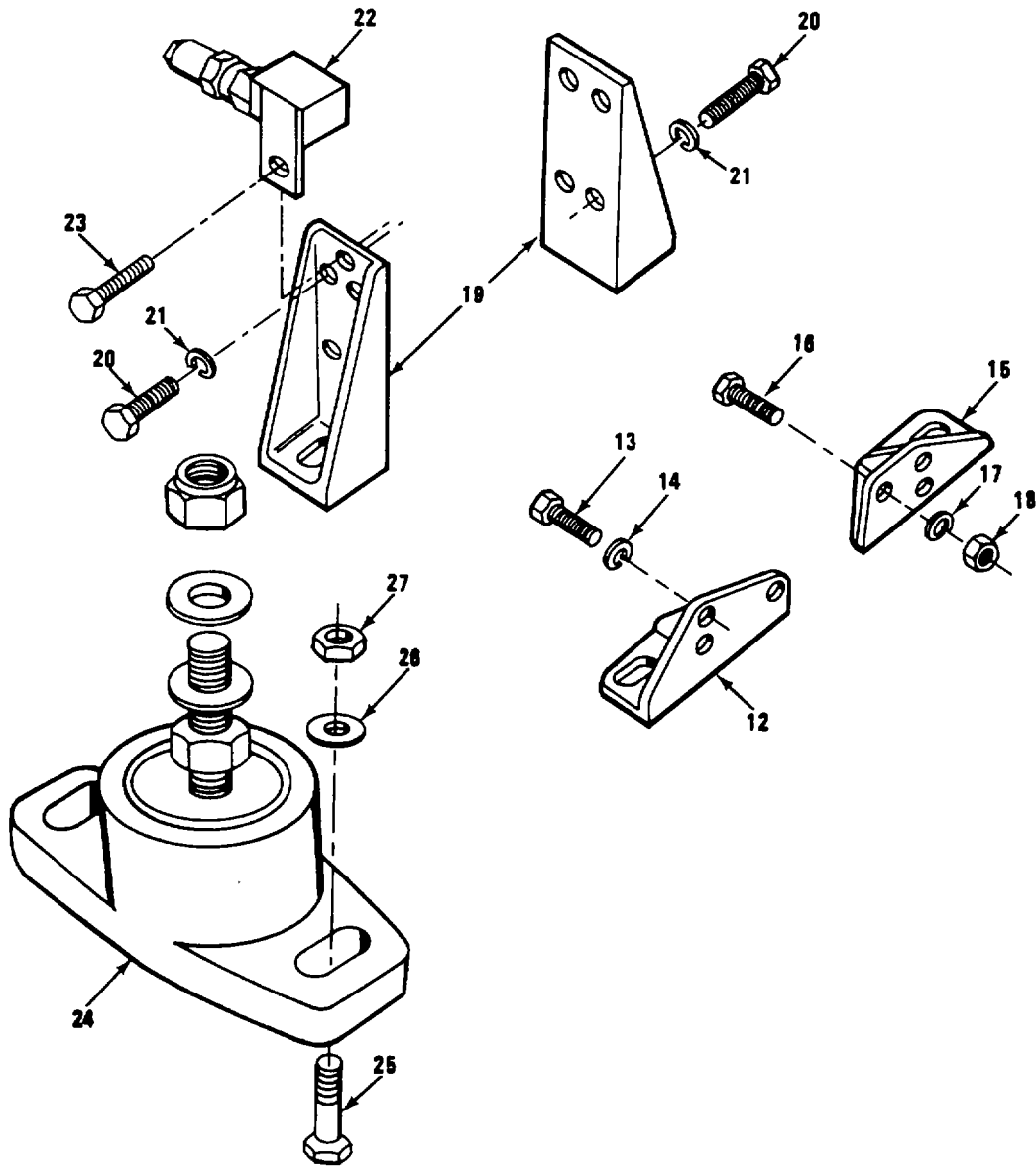
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Drive shaft (1)	4 bolts (2), 8 washers (3), 4 nuts (4), 2 spacers (5) and drive shaft guard top plate (6)	Remove if replacing engine mount. drive, ratchet.	Use 10 mm socket, 6 in extension with 1/4 in and 10 mm box wrench.
2. Engine compartment	9 rivets (8) securing access cover (9) and flotation blocking bracket (7)	a. Drill out rivets. b. Remove cover and bracket.	Use portable electric drill with 1/4 in bit (only required for replacement of outboard mount).
3. Engine assembly	a. 4 nuts (10) and 4 washers (11)	a. Remove for engine mount replacement. b. Loosen for bracket replacement.	Use 1-1/16 in socket, 6 in extension, 1/2 in drive ratchet.

ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)



ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
	b. Engine assembly	a. Attach lifting sling to lifting eyes. b. Raise only as high as necessary. <ul style="list-style-type: none"> • For bracket, replacement, take weight off bracket. • For mount replacement, clear mounting bolt (approx. 1-1/2 in). 	
<p>NOTE</p> <p>Remove and replace only defective bracket or mount.</p>			
	c. Starboard front bracket (12), 3 cap screws (13), lockwashers (14)	a. Remove. b. Discard lockwashers.	Use 5/8 in socket, 1/2 in drive ratchet.
	d. Port front bracket (15), 3 bolts (16), 3 lockwashers (17), 3 nuts (18)	a. Remove. b. Discard lockwashers.	Use 5/8 in socket, 1/2 in drive ratchet and 11/16 in box wrench.

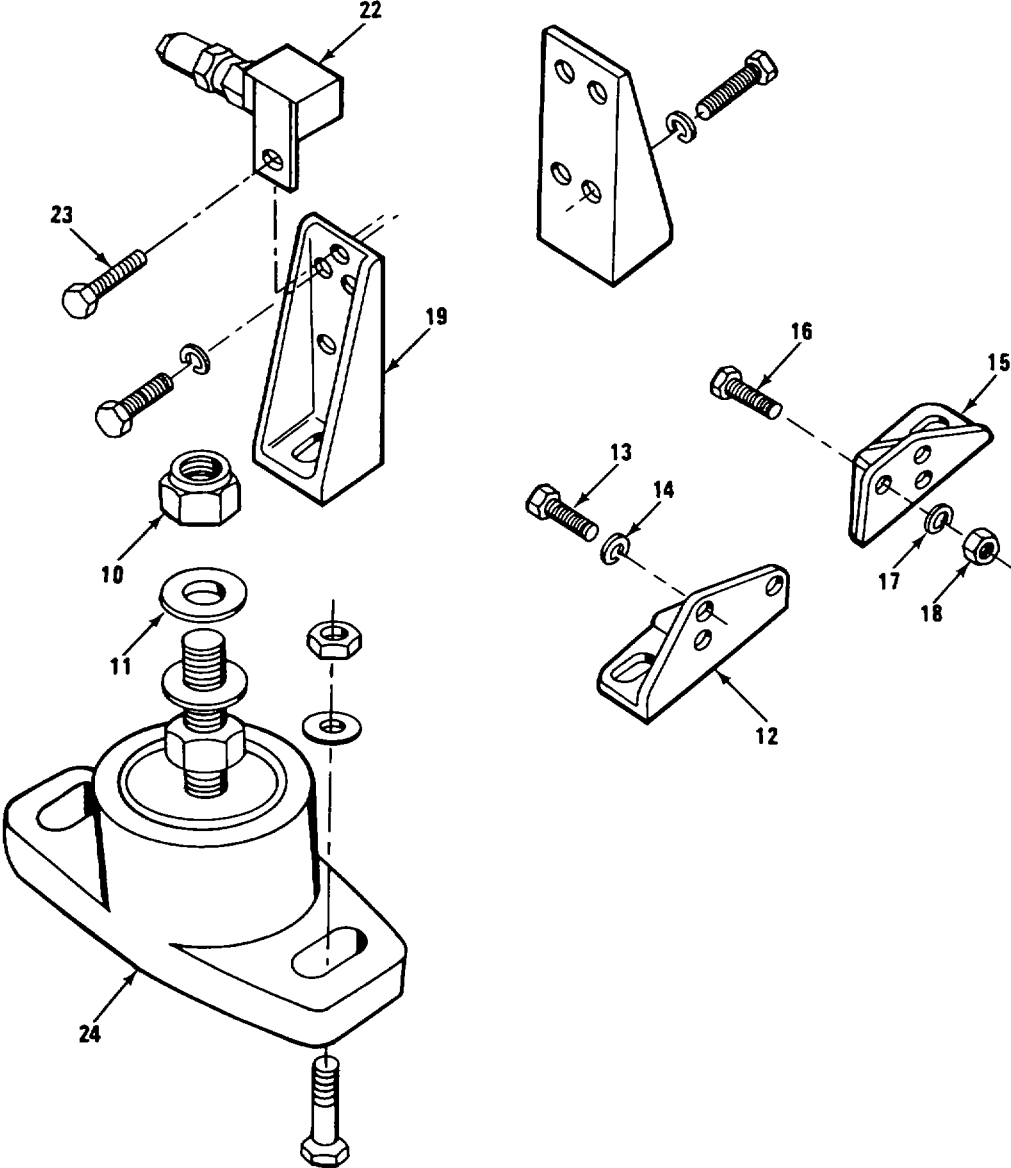
ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)



ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	e. Rear bracket (19), 0 bolts (20) and 4 lock-washers (21)	a. Remove.	Use 5/8 in socket, 1/2 in drive ratchet and 6 in extension.
		b. Discard lockwashers.	
	f. Fuel return line bracket (22) at star-board rear bracket (19) and setscrew (23)	Remove.	Use 1/2 in socket with 1/2 in drive ratchet.
	g. Engine mount (24), 2 bolts (25), 2 washers and 2 nuts	Remove.	Use 3/4 in socket, 1/2 in drive ratchet (26) and 3/4 in (27) box wrench.
INSTALLATION			
4.	a. Engine mount (24), 2 bolts (25), 2 washers (26) and 2 nuts (27)	Install securing mount to boat frame.	Use 3/4 in socket, 1/2 in drive ratchet and 3/4 in box wrench.
	b. Engine assembly	Clean face where new bracket is to be fitted.	
	c. Rear bracket (19), 4 bolts (20) and 4 lock-washers (21) extension.	Install securing bracket to cylinder block.	Use 5/8 in socket, 1/2 in drive ratchet and 6 in

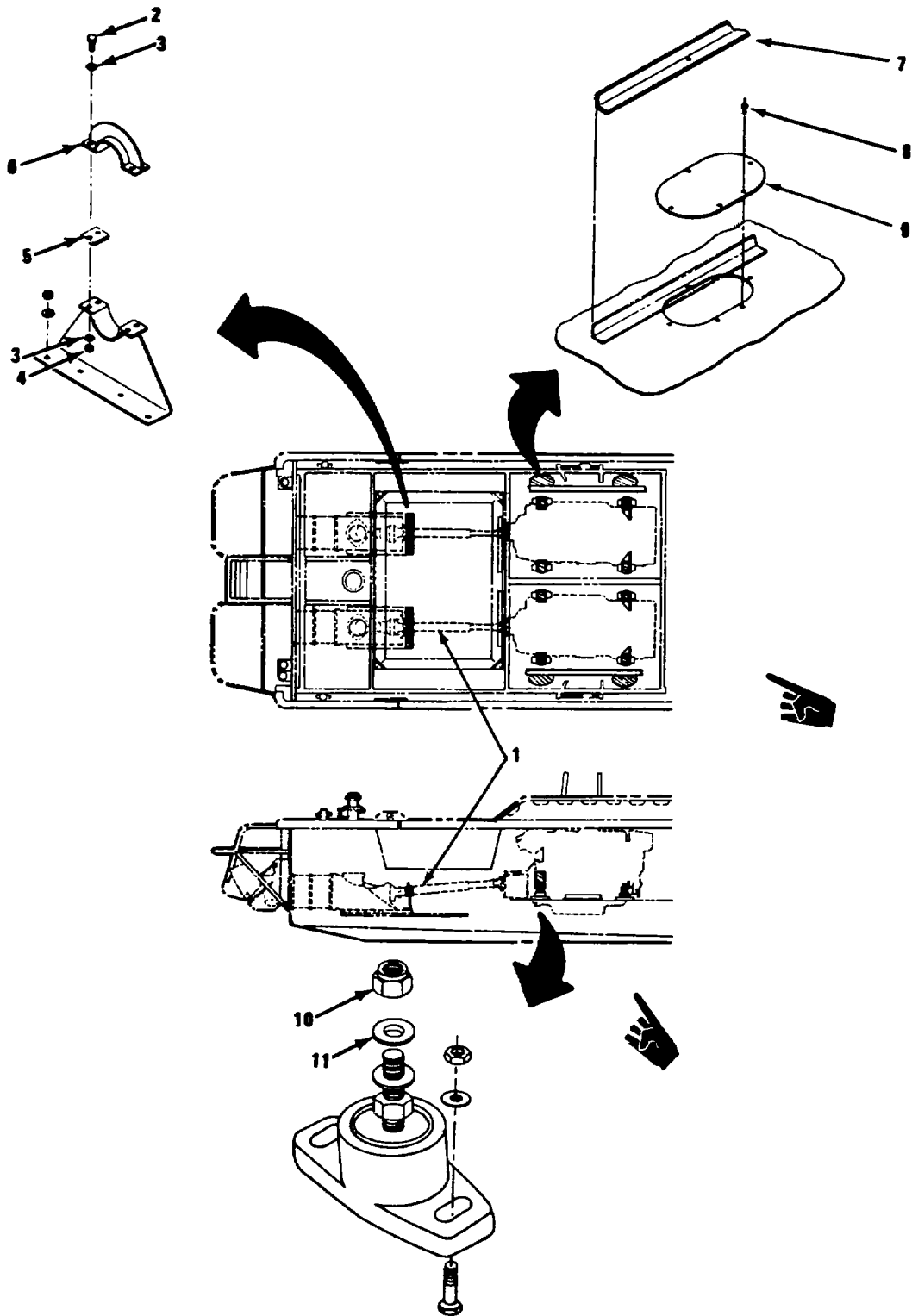
ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)



ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Fuel return line bracket (22) and cap screw (23)	Install on starboard rear bracket (19).	Use 1/2 in socket with 1/2 in drive ratchet.
	e. Port front bracket (15), 3 bolts (16), 3 lockwashers (17), and 3 nuts (18)	Install securing bracket to front support brackets.	Use 5/8 in socket, 1/2 in drive ratchet and 11/16 in open end wrench.
	f. Starboard front bracket (12), 4 bolts (13) and 4 lockwashers (14)	Install securing bracket to cylinder block. ratchet.	Use 5/8 in socket and 1/2 in drive
	g. Engine assembly	Lower onto mounts (24).	If necessary, loosen bracket and reposition slightly for correct seating on mount. Retighten bracket.
	h. 4 nuts (10) and 4 washers (11)	Install, securing engine to mount. Torque 30 - 35 ft-lb (4.15 to 4.84 kgfm).	Use 3/4 in socket and torque wrench, 0 - 175 ft-lb capacity.
	i. Engine assembly	Remove lifting sling.	

ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)



ENGINE MOUNTS AND BRACKETS REPLACEMENT INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
5. Engine compartment	Access cover (9) and flotation blocking bracket (7)	Rivet in place.	Use 1/4 in blind aluminum rivets and rivet gun.
6. Drive shaft (1)	Drive shaft guard top plate (6), 4 bolts (2), 8 washers (3), 4 nuts (4) and 2 spacers (5)	Install.	Use 10 mm socket, ratchet, and 10 mm box wrench.

ENGINE ASSEMBLY TEST INSTRUCTIONS

This task covers:

- a. Engine compression test

INITIAL SETUP

Tools:

1/2 in socket
 Extension
 Torque wrench

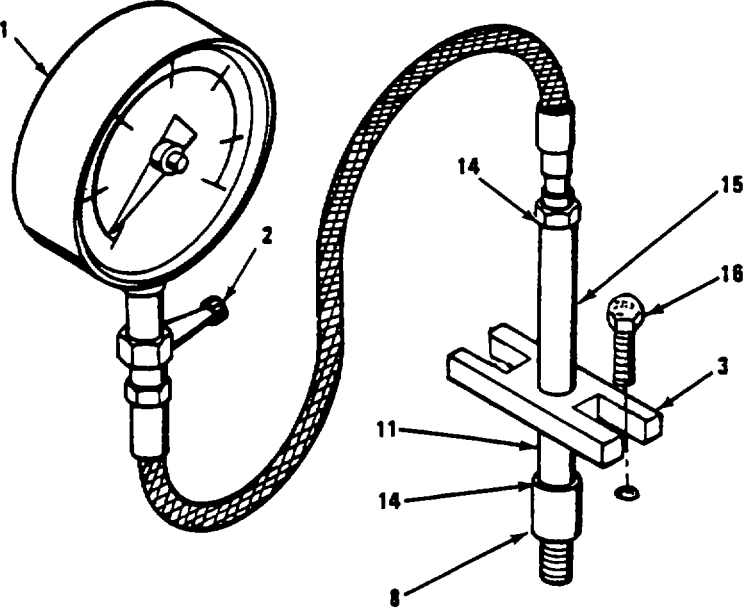
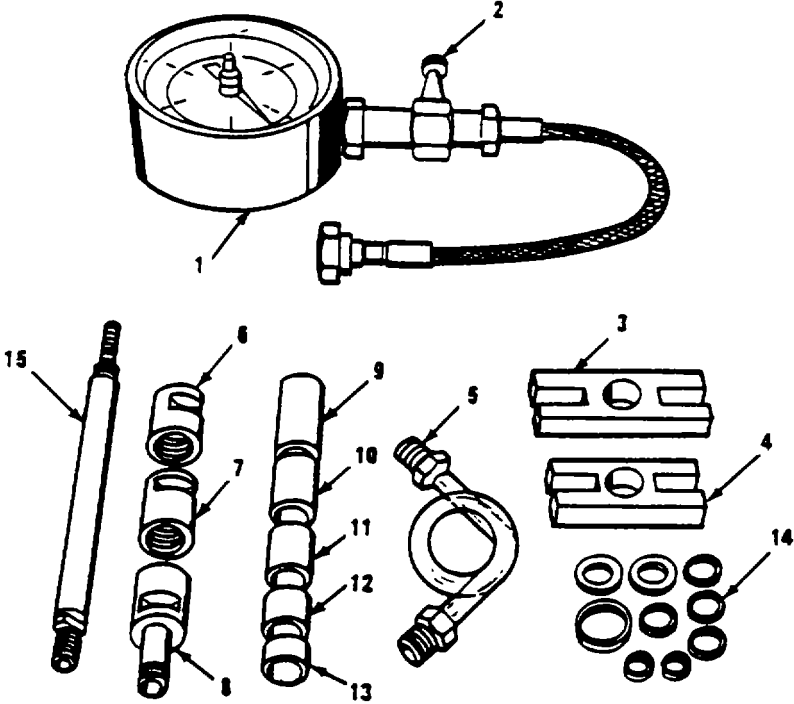
Equipment Condition:

TM 5-1940-277-20

Condition Description:

Injector removed.

ENGINE ASSEMBLY TEST INSTRUCTIONS (Continued)



ENGINE ASSEMBLY TEST INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
1. Cylinder head	Compression gage (1)	<ul style="list-style-type: none"> a. Install injector seal washer (14). b. Position gage in injector mounting hole. 	
NOTE			
Compression gage crosshead must be positioned so that gage does not bottom out when fit in mounting hole.			
2. Compression gage (1)	Injector mounting bolt (16)	<ul style="list-style-type: none"> a. Install two bolts through gage crosshead (3). Tighten bolts finger tight. b. Screw gage into crosshead until gage stem bottoms against injector seat. c. Torque injector mounting bolts (16) to 14 to 16 ft-lbs (19.0 to 31.7 Nm). d. Turn gage pressure release screw (2) clockwise until closed. 	Use fingers.

ENGINE ASSEMBLY TEST INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
3. Control console	Engine stop handle	Pull out.	
4. Engine compartment	Engine	Using starter turn engine over 5 - 6 revolutions. Read compression on gage (1). A reading of over 300 psi is satisfactory.	
5. Compression gage (1)	Pressure release screw (5)	Turn counter-clockwise to release pressure until gage reads zero.	Use fingers.

NOTE

Repeat process for each cylinder. A pressure differential between cylinders of greater than 125 psi is unsatisfactory. Report to supervisor.

ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS

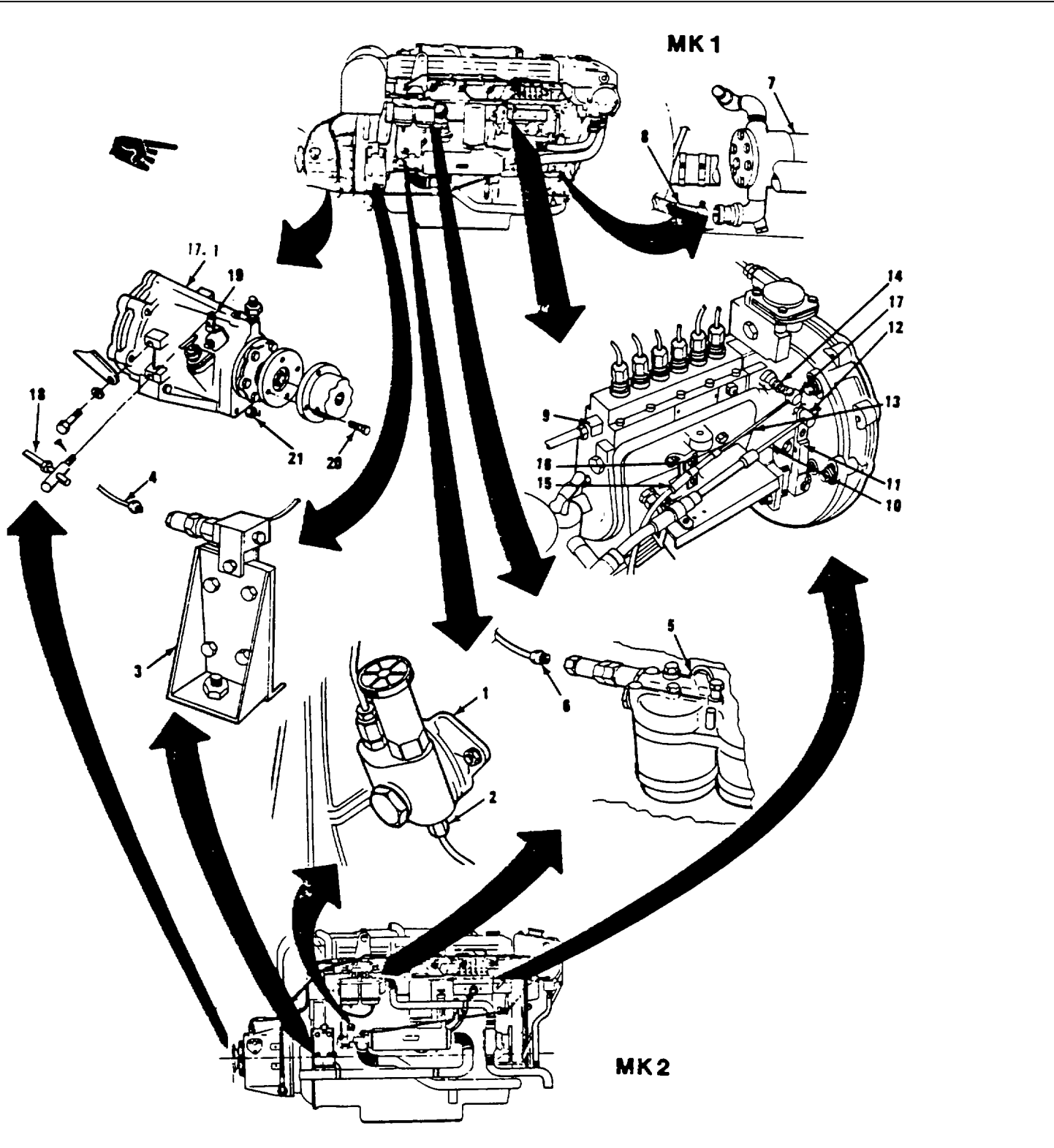
This task covers:

- a. Removal
- b. Transfer of components to replacement engine
- c. Installation

INITIAL SETUP

<p>Tools:</p> <p>Ratchet with 1/2 in drive 15/16 in socket 1 in socket 6 in extension Ratchet with 3/8 in drive 1/2 in socket 8 mm open end wrench 11/16 in open end wrench 5/8 in open end box wrench 7/16 in box wrench 1/2 in box wrench Flat tip screwdriver, 6 in Lifting sling Lifting device Drain pan Wooden blocking Torque wrench (0-175 ft-lb), 1/2 in drive Pliers 11/16 in box wrench 1-1/8 in socket 1/2 in open end wrench 11/16 in open end box wrench 1 in open end box wrench</p>	<p>Equipment Condition:</p> <p>TM 5-2090-202-12&P TM 5-1940-277-20 TM 5-1940-277-20 TM 5-1940-277-20</p>	<p>Condition Description:</p> <p>Boat out of water on grounded cradle. Engine compartment hatches open and secured. Master switch off. Buoyancy flotation material removed.</p>
	<p>Materials/Parts:</p> <p>Replacement engine Engine oil Anti-freeze Cotter pin Gasket</p>	
	<p>Personnel Required: Two</p>	

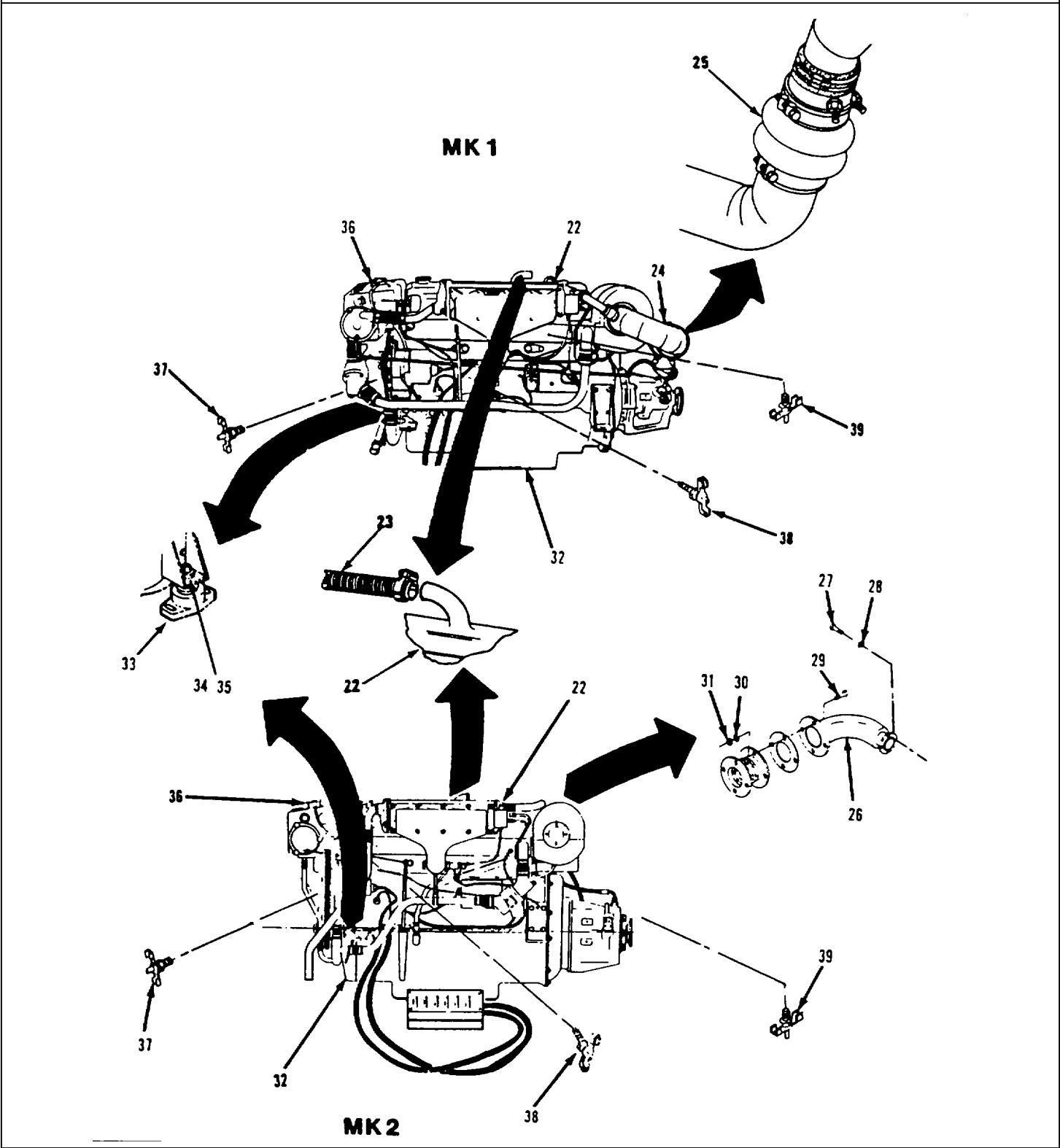
ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

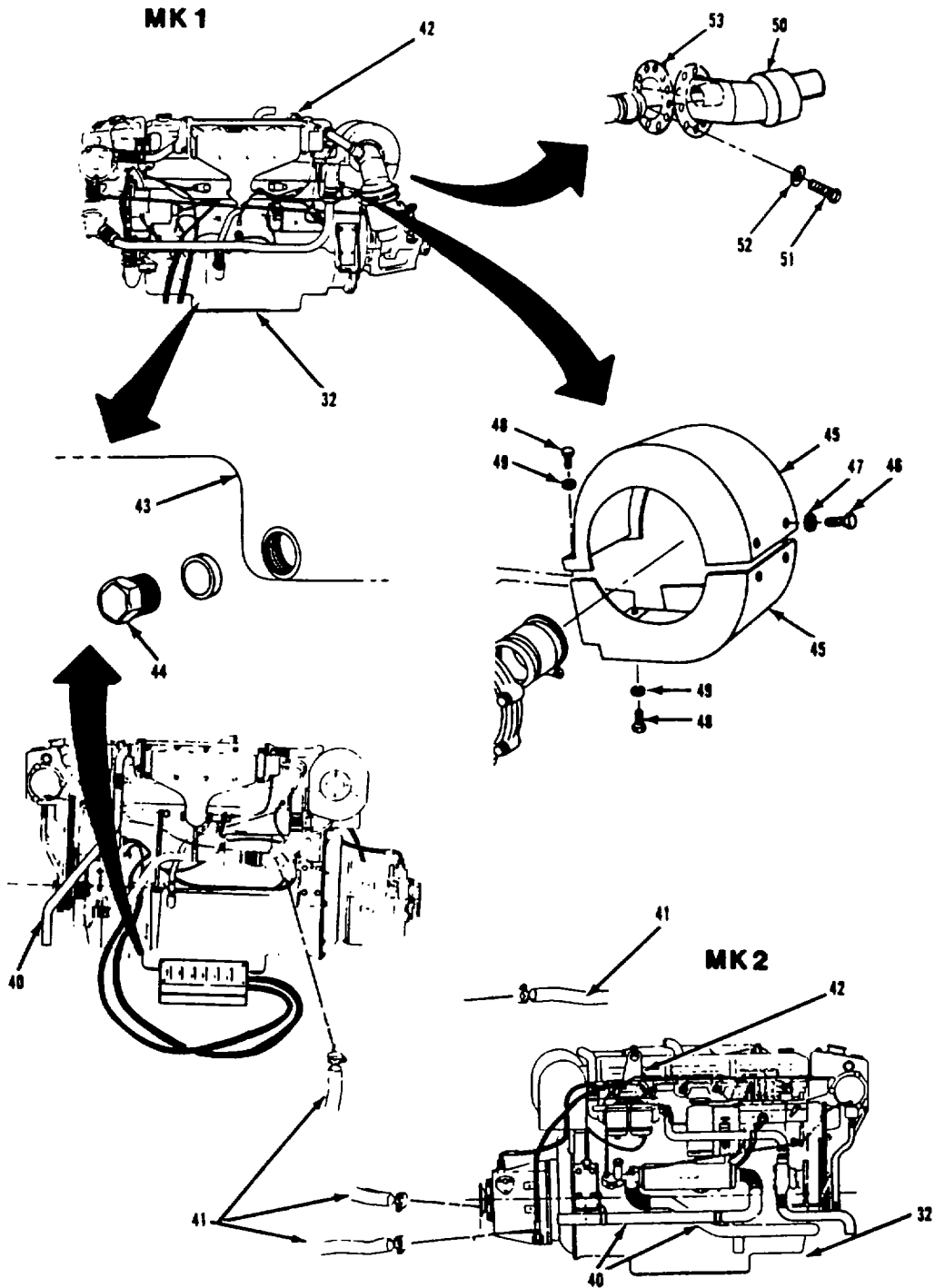
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Fuel lift pump (1)	Fuel feed line (2)	Disconnect.	Use 13/16 in open end box wrench.
2. Starboard rear engine mounting bracket (3)	Fuel return line (4)	Disconnect.	Use 5/8 in open end box wrench.
3. Fuel filters (5)	Fuel return line (6)	Disconnect.	Use 5/8 in open end box wrench.
4. Secondary Water pump(7) (MK-2) Cooling System Pump(7) (MK-1)	Intake hose (8)	Loosen damp and disconnect	Use screwdriver.
5. Injection pump (9)	a. Cable (10) to speed selector lever (11)	Remove cotter pin (12) and withdraw bracket	Use pliers and screwdriver.
	b. Cable (13) to engine stop lever (14), bracket (15) and 2 screws (16)	Loosen setscrew (17), remove bracket (15) and withdraw cable (13).	Use 8 mm open end wrench and screwdriver.
6. Transmission (17.1)	a. Cable (18) to selection lever (19)	Remove cotter pin and withdraw bracket.	Use pliers and screwdriver.
	b. 4 bolts (20) and 4 nuts (21) securing transmission to drive shaft	Remove end wrench and	Use 11/16 in open 11/16 in box wrench.

ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
7. Rocker arm cover (22)	Breather hose (23)	Loosen damp and disconnect.	Use screwdriver.
8. Exhaust pipe (24) (MK1)	Exhaust bellows (25)	Loosen damp and disconnect.	Use 1/2 in box wrench.
9. Exhaust return pipe (26) (MK2)	a. 4 bolts (27) and washers (28) securing exhaust return pipe to turbo-charger	Remove.	Use 1/2 in socket and 3/8 in ratchet.
	b. 4 bolts (29), washers (30), and nuts (31) securing exhaust return pipe to flexible connection	Remove and withdraw exhaust return pipe.	Use 1 in socket, 112 in ratchet, and 12 in open end box wrench.
10. Engine assembly (32)	Wiring looms to engine and screened alternator loom	Disconnect from all points on engine assembly.	See page 2-93 for instructions and figure.
11. Engine mounts (33)	4 nuts (34) and 4 washers (35)	Remove.	Use 1-1/8 in socket, 6 in extension, 1/2 in ratchet.
12. Engine assembly (32)	a. Fresh water filler cap (36)	Remove.	
	b. 3 petcocks (37, 38, and 39)	a. Open, drain cooling system into suitable container. b. Close when system drained.	
	c. Fresh water filler cap (36)	Reinstall.	

ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



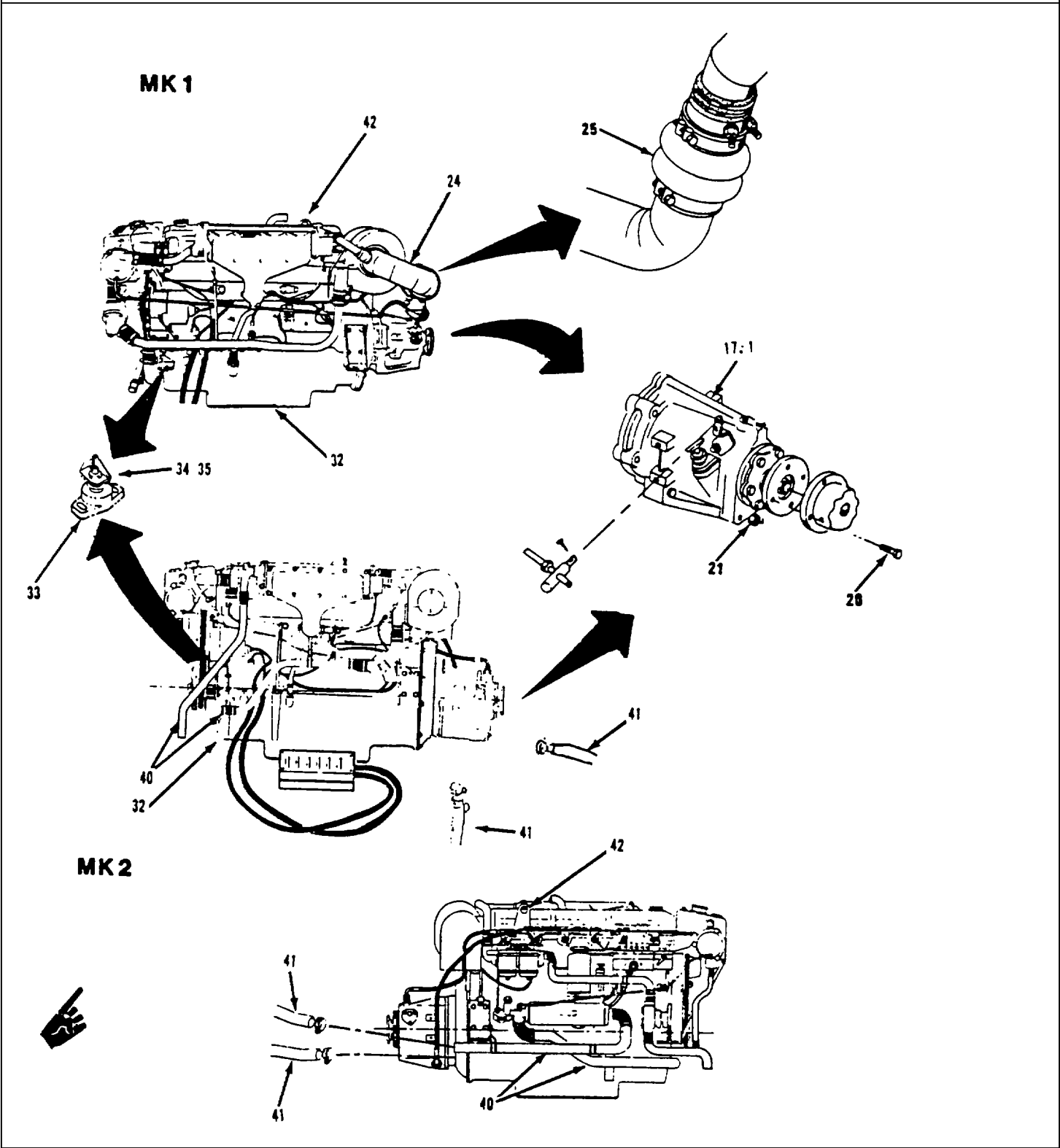
ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
13. Coolant inlet and outlet pipes (40) (MK2)	Keel cooler hoses (41)	Loosen dampers and disconnect.	Use screwdriver.
14. Engine assembly (32)	Engine assembly (32)	a. Attach lifting sling to lifting eyes (42). b. Raise engine of boat. c. Mount engine on blocks.	Use lifting out device. Use blocks.
15. Oil sump (43)	Drain plug (44)	a. Remove plug, drain engine oil.	Use drain pan. Use 15/16 in socket and 112 in ratchet.

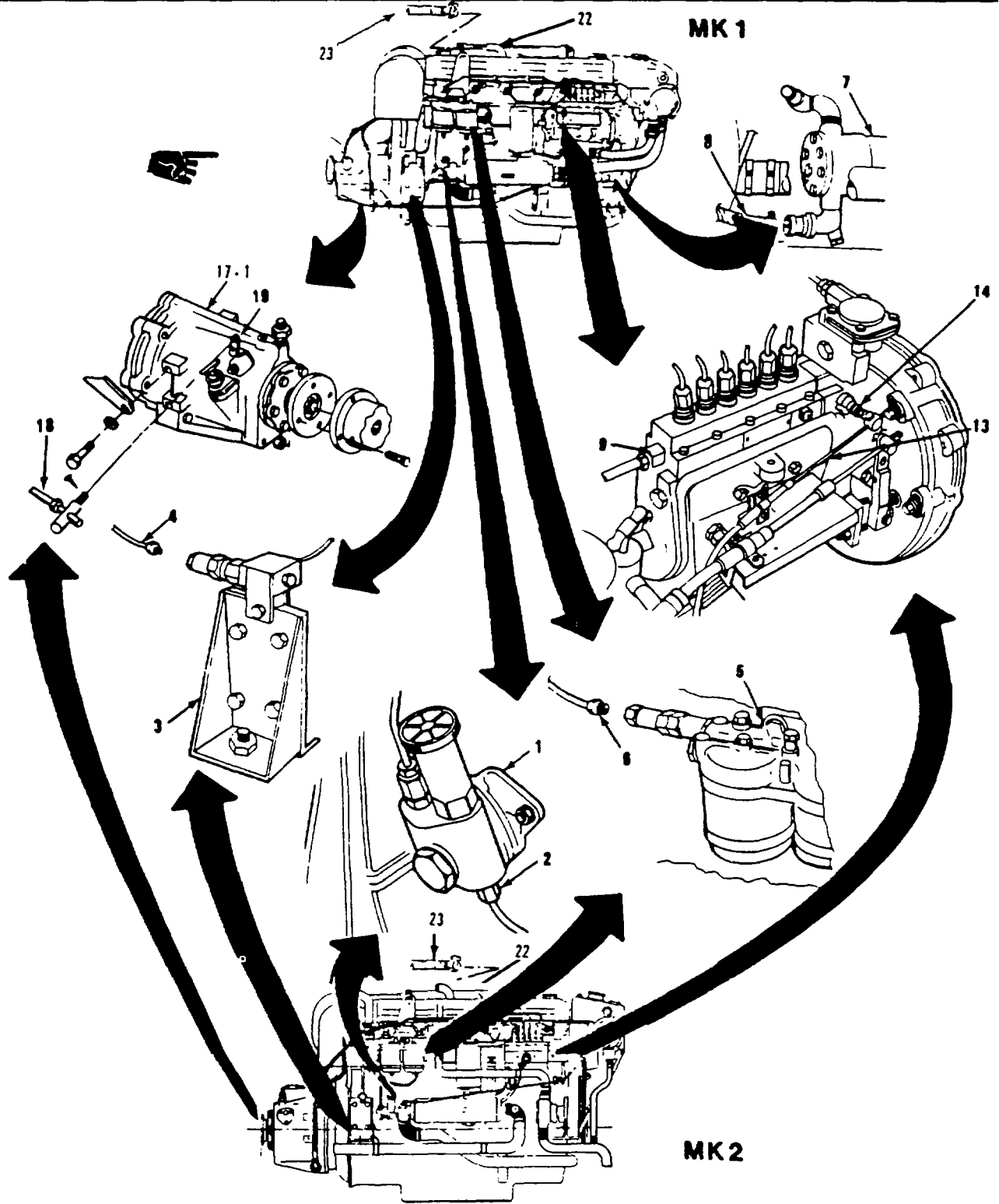
TRANSFER OF COMPONENTS TO REPLACEMENT ENGINE

16. Engine assembly (32)	a. Heat shield (45), bolt (46), washer (47), 2 bolts (48) and 2 washers (49) (MK1)	Remove both used and replacement engine assemblies.	Use 1/2 in socket with ratchet.
	b. Exhaust elbow (50), 4 bolts (51), 4 washers (52) and gasket (53) (with any attached exhaust pipe) (MK1)	Transfer to replacement engine. Discard gasket and replace with new gasket.	Use 1/2 in socket with 3/8 in ratchet and 1/2 in open end wrench.
	c. Heat shield (45), bolt (46), washer (47), 2 bolts (48) and 2 washers (49) (MK1)	Reinstall on used and replacement engine assemblies.	Use 1/2 in socket with ratchet.

ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

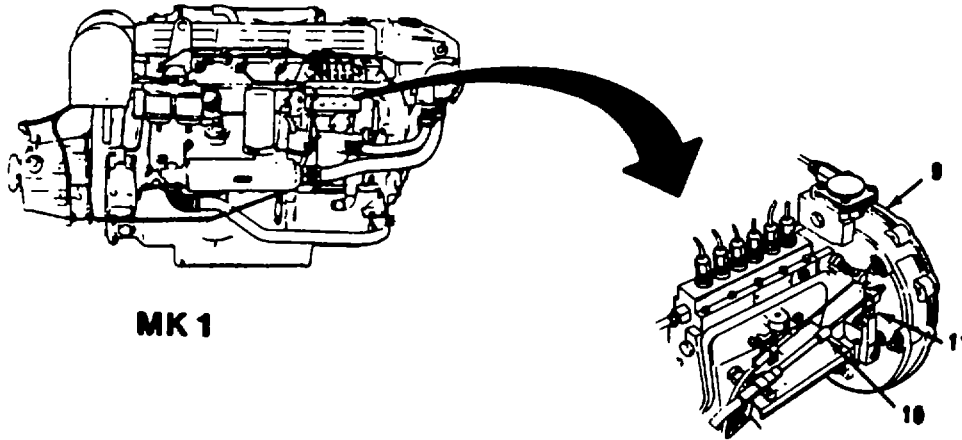


ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

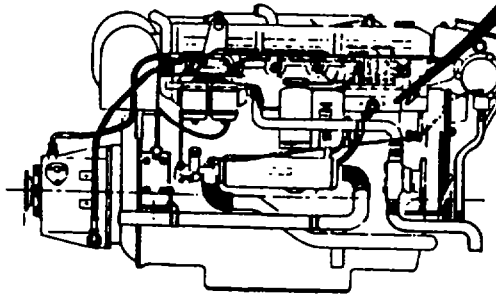
LOCATION	ITEM	ACTION	REMARKS
	g. Breather hose (23)	Connect to rocker arm cover (22) and tighten hose damp.	Use screwdriver.
	h. Water intake hose (8) (MK1)	Connect to pump (7) and tighten hose damp.	Use screwdriver. Modified).
	i. Fuel line, return (4)	Connect to fitting at starboard rear engine bracket (3).	Use 5/8 in open end box wrench.
	j. Fuel line, return (6)	Connect to fuel filter (5).	Use 5/8 in open end box wrench.
	k. Fuel line, feeder (2)	a. Connect to fuel lift pump (1). b. Bleed fuel lines.	Use 5/8 in open end box wrench. See TM 5-1940-277-20.
	l. Cable (18) to selection lever (19) on transmission (17.1)	Install and adjust.	See TM 5-1940-277-20.
	m. Cable (13) to engine stop lever (14) on injector pump (9)	Install and adjust.	See TM 5-1940-277-20.
	n. Cable (10) to speed selector lever (11) on injector pump (9)	Install and adjust.	See TM 5-1940-277-20.
NOTE			
Service engine in accordance with TM 5-1940-277-20 and LO 5-1940-277-12/L1 1940-12.			

ENGINE ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
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MK 1



MK 2

2-190. 1 deleted

STARTER MOTOR REPAIR INSTRUCTIONS

This task covers:

- | | | |
|-----------------------|----------------------|----------------|
| a. Disassembly | b. Inspection | c. Test |
| d. Repair | e. Assembly | |

INITIAL SETUP

Tools:

Blind riveter
 Hammer, ball peen
 Drift pin
 Punch
 Ratchet
 5/16 in socket
 13/16 in socket
 Flat tip screwdriver, 6 in
 1-1/8 in box wrench
 Snap ring pliers
 Non-metallic hammer
 Long nose pliers
 Vise
 Vise Jaw caps
 13/16 in box wrench
 1/2 in open end wrench
 Honing stone
 Cross tip screwdriver
 Armature test set
 Multimeter
 Generator, alternator and
 starter test stand
 Feeler gage
 Press
 Micrometer calipers, inside
 Bottle brush
 Lathe
 Air compressor
 Air blow gun
 Spring tester, resiliency
 Torque wrench (0 - 175 ft-lb)
 Safety goggles

Equipment Condition:

TM 5-1940-277-20

Condition Description:

Starter motor removed
 from engine.

Materials/Parts:

Lubricator core plugs, drive end
 shield (1 each small, 2 each large)
 Snap ring
 Blind rivet
 Solvent
 Engine oil
 Lapping paste
 Fine sandpaper
 Parafin
 Brushes (set)
 Grease
 Crocus cloth

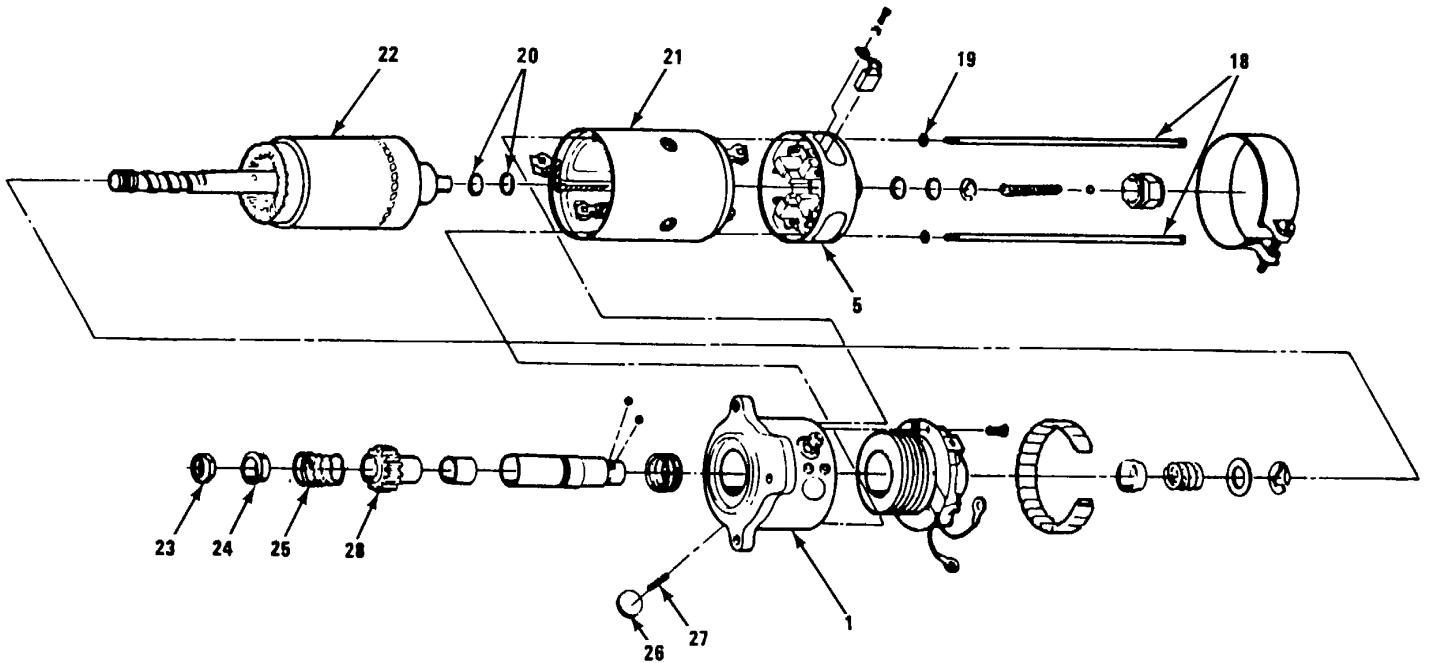
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS	
<u>DISASSEMBLY</u>				
1. Drive end shield (1)	a. 2 core plugs (2)	Remove and discard.	Use punch and ball peen hammer. Use new plugs when reassembling.	
	b. 2 screws (3) and 2 lock-washers (4)	Unscrew and remove, releasing field terminal leads.	Use 5/16 in socket and ratchet.	
2. Commutator end shield (5)	a. Commutator cover (6)	Loosen fixing screw (7) and remove.	Use flat tip screwdriver.	
	b. 4 brush lead screws (8) and 4 lock-washers (9)	Remove, freeing brush lead.	Use flat tip screwdriver.	
	c. 4 brushes (10)	a. Raise springs (11) and remove.		
		b. Discard.		
	d. End cap (12) and steel ball (13)	Remove.	Use 1-1/8 in box wrench. Be careful of steel ball (11) which is under spring pressure.	
e. Spring (14), snap ring (15), thrust washer (16), shim washers (17)	Remove.	Use snap ring pliers.		

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



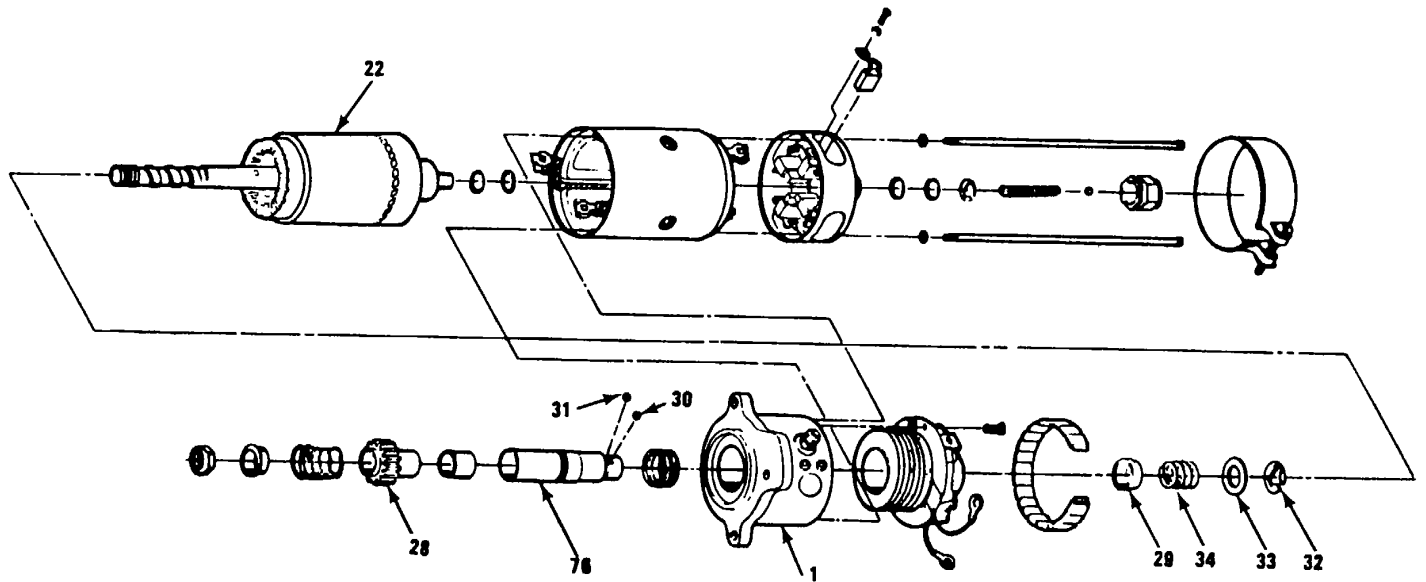
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	f. 2 through screws (18) and 2 washers (19)	Unscrew and remove.	Use flat tip screwdriver.
	g. Commutator end shield (5) and shim washers (20)	Tap lightly with non-metallic hammer and remove from end of armature shaft.	Keep shims (20) to simplify end float adjustment upon reassembly.
3. Drive end shield (1)	a. Drive end shield (1) with armature (22)	Tap, lightly, away from yoke (21) and withdraw.	Use non-metallic hammer.
	b. Armature (22)	Mount in soft jawed vise.	
	c. Pinion stop nut (23), thrust washer (24) and pinion spring (25)	Remove.	Use 13/16 in box wrench.
	d. Lubricator core plug (26) and spring (27)	a. Remove.	Use punch and ball peen hammer.
		b. Discard plug.	Use new plug when reassembling.
	e. Pinion (28) and drive end shield (1)	a. Push end shield toward armature to release locking mechanism.	

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



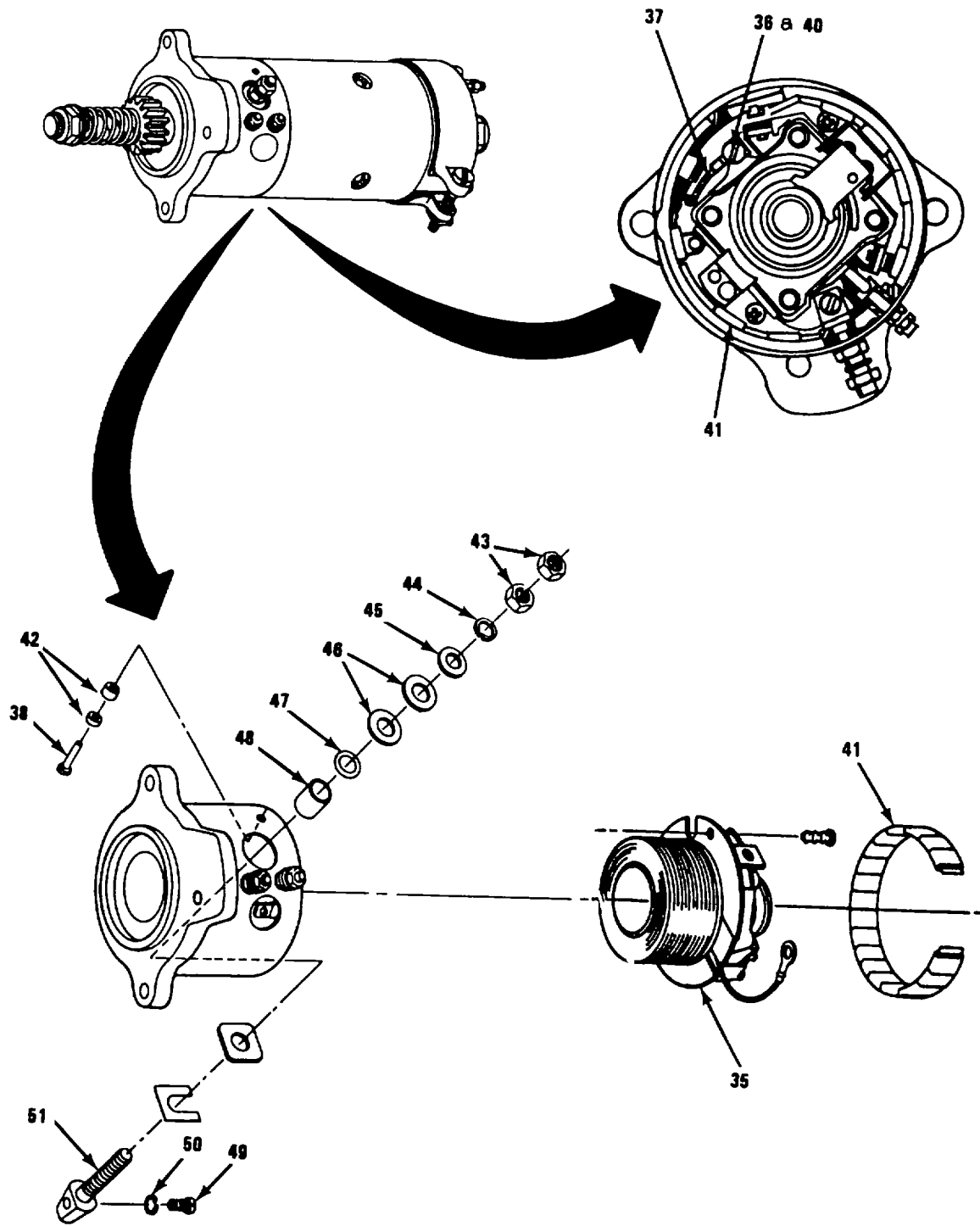
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Hold lock collar (29) in this position.	
		c. Unscrew pinion until helix disengages.	
		d. Slide pinion and end shield off shaft.	
		e. Collect 6 lock balls (30) and 4 overspeed balls (31).	
4.	Armature (22)	Remove from vise.	
5.	Pinion (28)	a. Snap ring (32), trip collar (33), lock collar spring (34), and lock collar (29)	Remove from end of pinion sleeve (76). Use snap ring pliers.
	b. Snap ring (32)	Discard.	
	c. Pinion (28)	a. Carefully remove any burrs on pinion.	Use honing stone.
	b. Withdraw from drive end shield (1).		

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



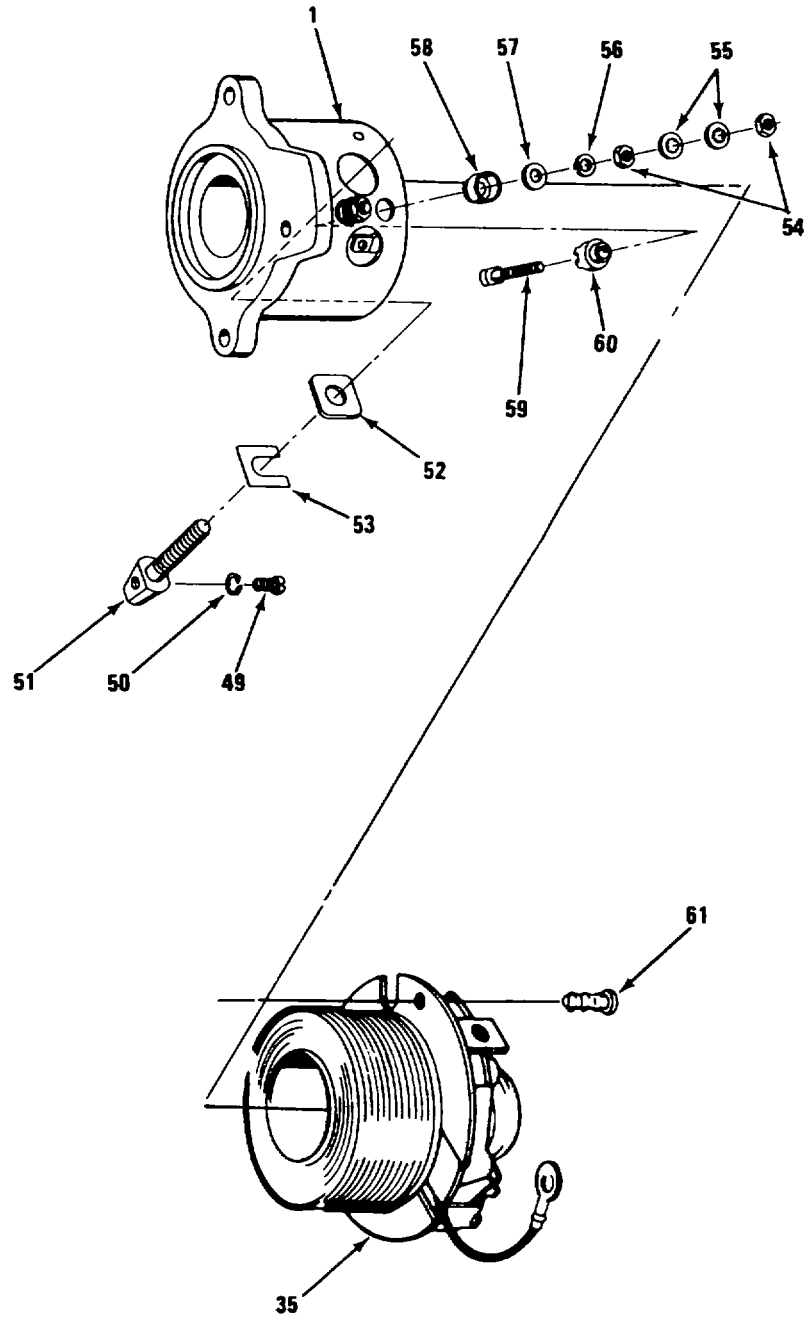
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
6. Solenoid (35)	Screw (36)	Remove and release resistor flexible lead (37).	Use flat tip screwdriver.
7. Drive end shield (1)	a. Rivet (38)	Punch out.	Use punch and ball peen hammer.
	b. Resistor flexible lead (37)	Remove screw (36) and washer (40). Detach from solenoid.	Use flat tip screwdriver.
	c. Resistor (41) and 2 nylon bushings (42)	Remove.	
	d. 2 nuts (43), lockwasher (44), plain washer (45), 2 insulating washers (46), rubber ring washer (47), and insulating bushing (48)	Remove.	Use 1/2 in wrench.
	e. Screw (49) and lockwasher (50)	Remove from inside drive end shield.	Use flat tip screwdriver.
	f. Main terminal (51)	Push in and remove from inside drive end shield.	To make easier rotate terminal 180°.

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



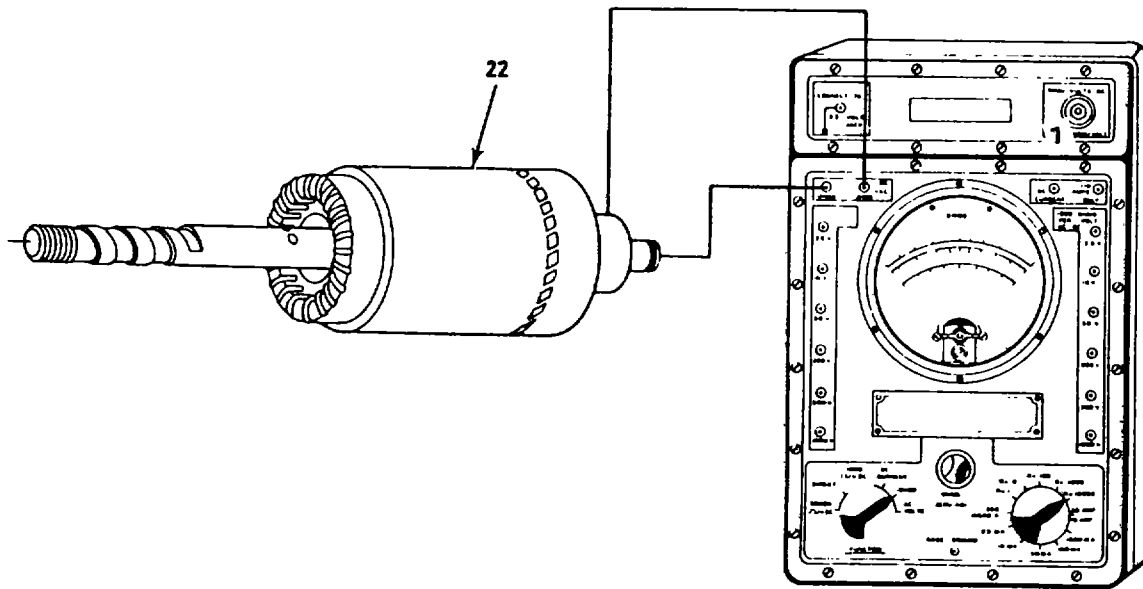
STARTER MOTOR REPAIR INSTRUCTIONS

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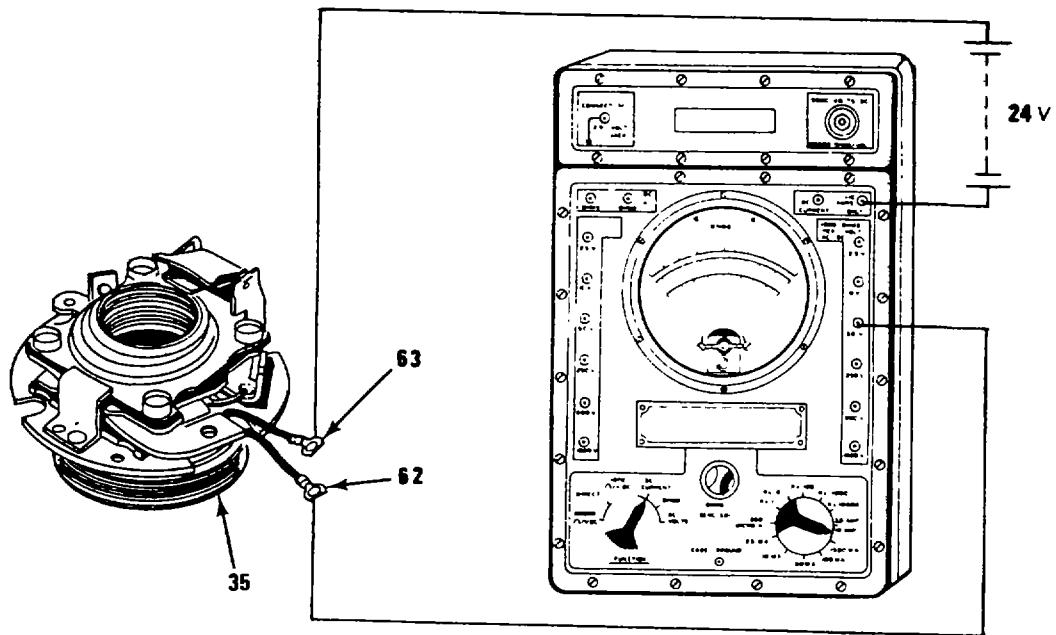
LOCATION	ITEM	ACTION	REMARKS
	g. Insulator (52) and anodized strip (53)	Remove off main terminal (51).	
	h. 4 nuts (54), 4 lockwashers (55), 2 lockwashers (56), 2 plain washers (57), and 2 insulating bushings (58)	Remove from solenoid terminals.	Use 5/16 in open end wrench.
	i. 2 solenoid terminals (59)	Push well into and remove from inside drive end shield.	
	j. Shaped insulating bushing (60)	Remove from solenoid terminal.	
8. Solenoid (35)	a. 2 screws (61)	Remove.	Use cross tip screwdriver.
	b. Solenoid (35)	Withdraw from drive end shield.	

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



ARMATURE INSULATION TEST



SOLENOID TEST

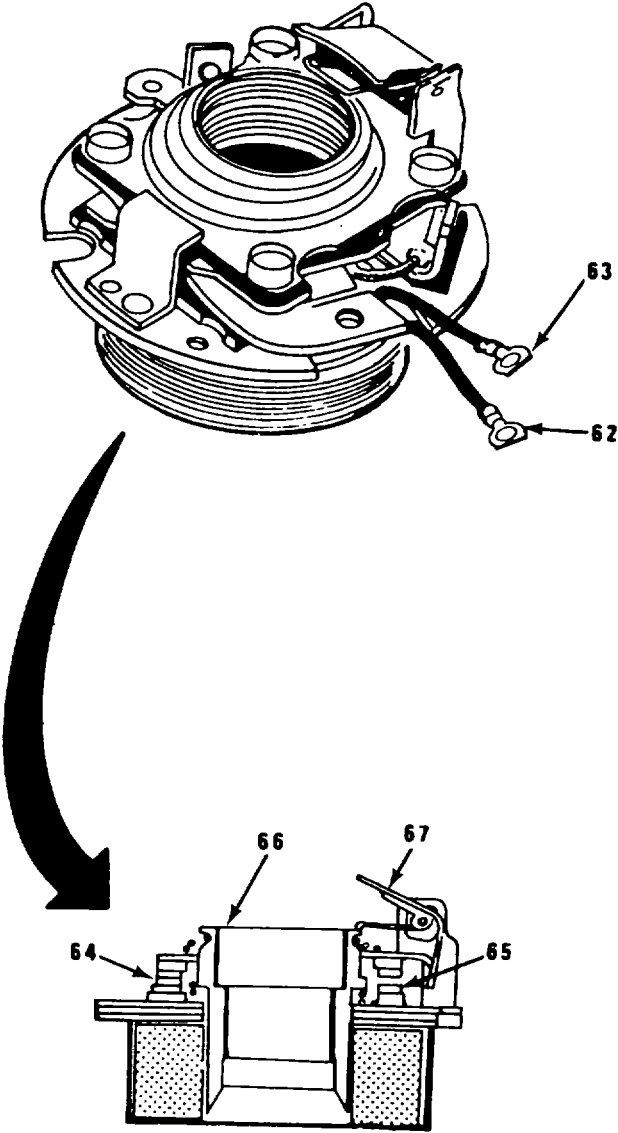
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>INSPECTION AND REPAIR</u>			
9. Armature (22)	Armature (22)	a. Test windings for continuity and shorts.	Use armature test set.
		b. Check insulation between commutator segments (70) and shaft. Minimum resistance 1 megohm.	Use multimeter.
		c. Replace if defective.	
10. Solenoid (35)	Solenoid (35)	a. Test coils for short or open circuit by applying 24V to black (62) and yellow (63) leads. Current consumption should be approx. 19 amp.	See figure for circuit. Some starters will have green leads instead of yellow.

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



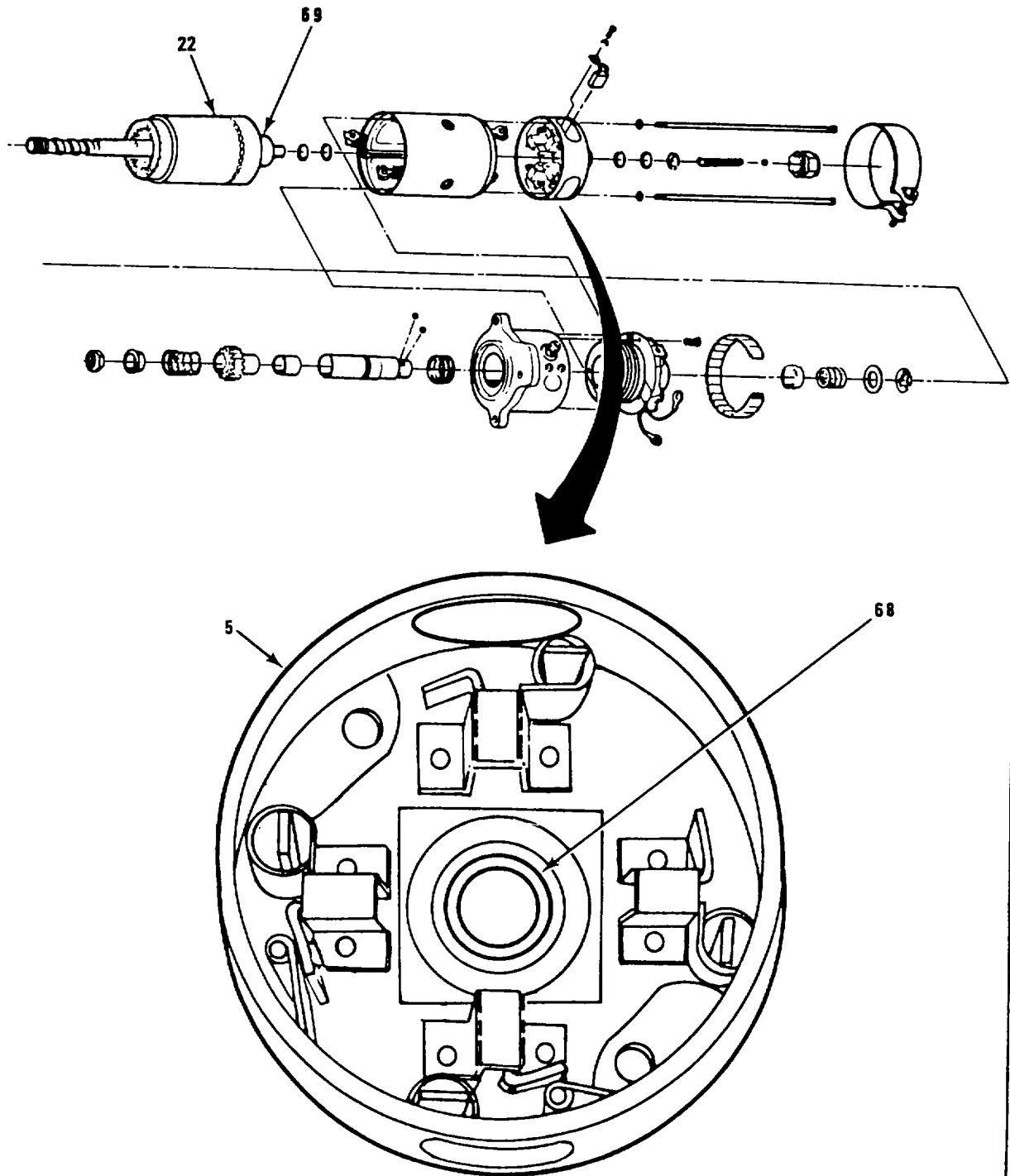
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Check contacts (64) and (65) for: Cleanliness, Burnt spots, Overheated coil, Gap - 1st stage contact (56) (0.076 - 0.098 in.) (0.193 - 0.249 mm).	Use feeler gage.
		c. Press down plunger (66) and check that 2nd stage contact (65) meets only after trigger (67) is tripped.	
		d. Clean dirty contacts.	Use dry cleaning solvent and fine sandpaper.
		e. Replace complete solenoid if any defect is noted.	

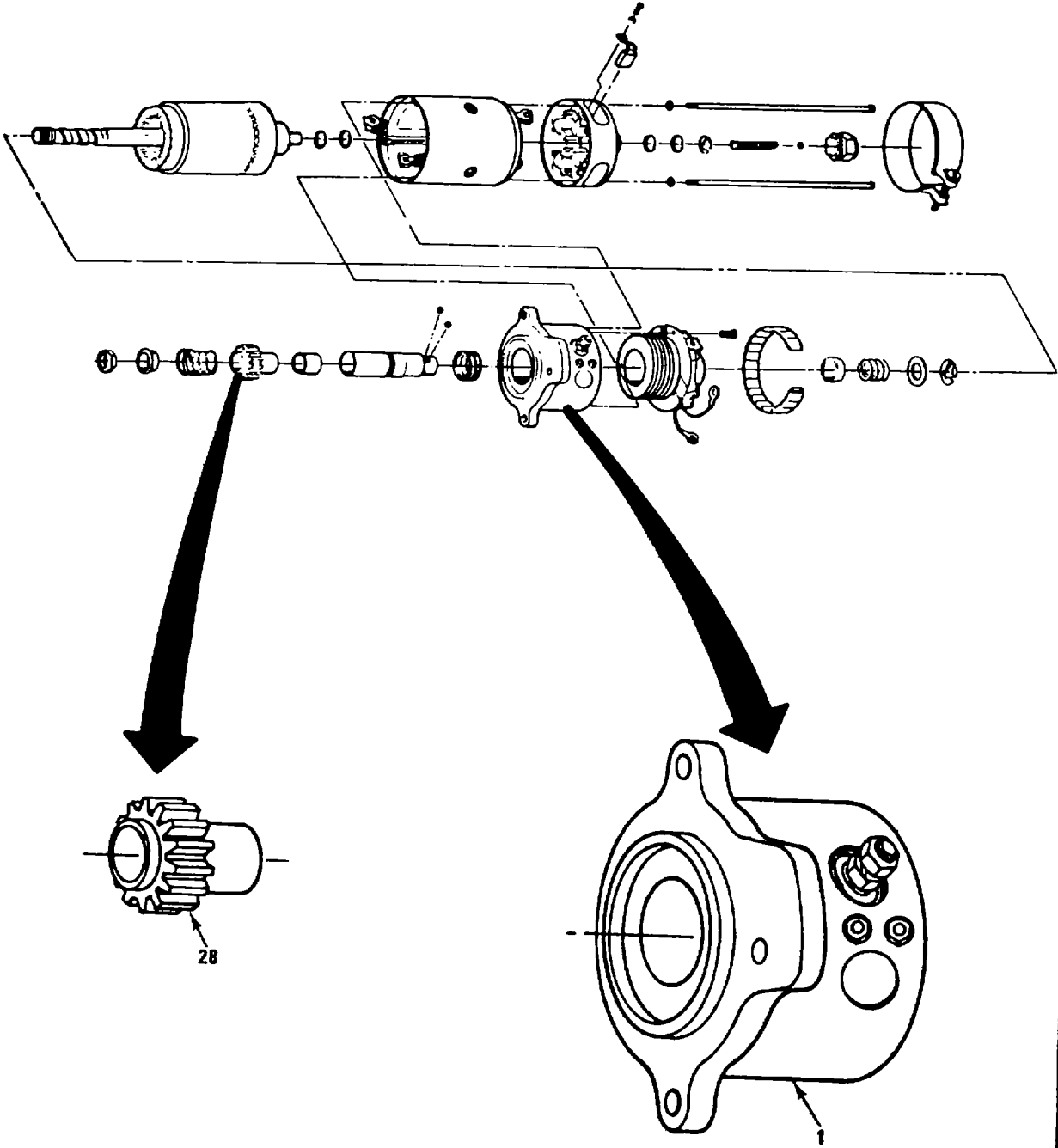
STARTER MOTOR REPAIR INSTRUCTIONS

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STARTER MOTOR REPAIR INSTRUCTIONS

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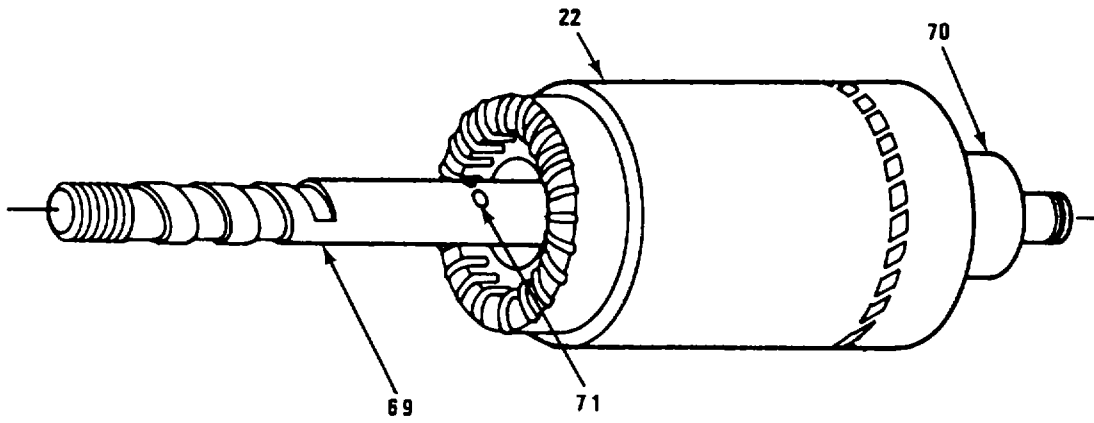
STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
12. Drive end shield (1)	Drive end shield bearing	a. Measure internal diameter: tolerance 1.127 -0 +0.0007 in. b. Replace with new drive end shield assembly if bearing worn.	Use micrometer calipers, inside.
13. Pinion (28)	Pinion (28)	a. Replace if teeth badly worn or chipped. b. Check that pinion slides freely on armature shaft. c. If necessary for fit, lightly lap the pinion and shaft. d. Remove all traces of lapping paste.	Make sure new pinion has same number teeth as old pinion. Use fine lapping paste. Use a bottle brush to ensure absolute cleanliness.

STARTER MOTOR REPAIR INSTRUCTIONS

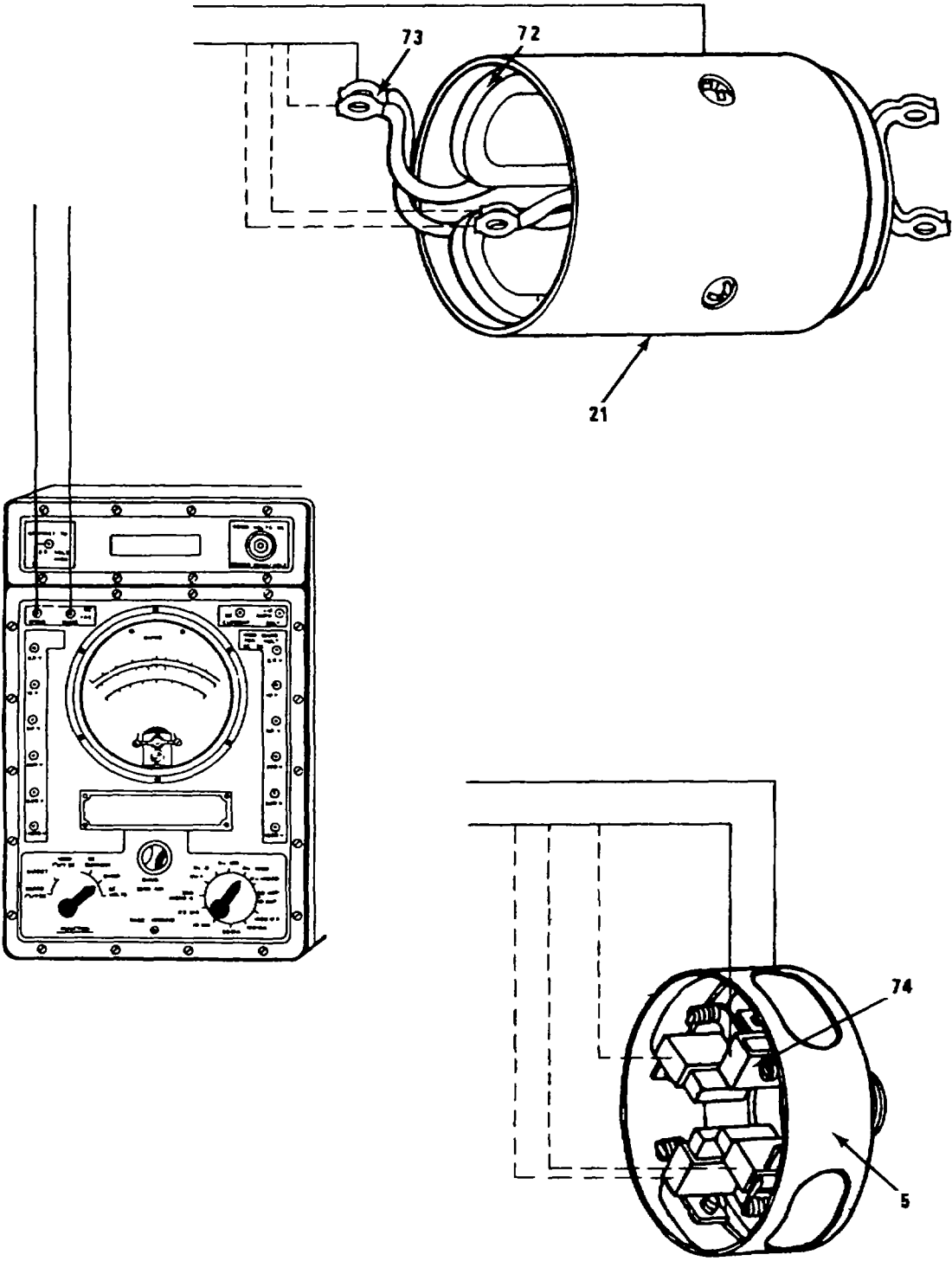
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STARTER MOTOR REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
14.	Springs (see chart below)	a. Check for bending or breaking. b. Test for tension strengths as follows: c. Replace if outside limits.	Use spring resiliency tester.
	SPRING	COMPRESSED LENGTH	TENSION
	Lock spring (34)	0.375 in (9.53 mm)	1.69 to 1.94 lb (0.765 to 6.878 kg)
	Recoil spring (14)	1.313 in (33.35 mm)	26.5 to 29.5 lb (12.0 to 13.39 kg)
	Pinion spring (25) (oil sealed starter)	1.469 in (37.3 mm)	9.81 to 10.19 lb (4.4 to 4.6 kg)
	Brush spring (11)	Raise to height of installed brush.	6.0 to 7.5 lb (2.7 to 3.4 Kg)
15. Armature (22)	Commutator (70)	a. Clean dirty or discolored surface. b. If badly pitted or grooved replace armature.	Use crocus cloth.
16. Armature (22)	Armature (69) Shaft	a. Remove burrs in lock ball recesses (71) if necessary.	Use honing stone.

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
17. Yoke (21)	Field windings (72)	b. Remove burrs on helices if necessary.	Use honing stone.
		c. Clean helices	Use parafin.
		d. Smear helices with small quantity of grease.	
		e. Replace if helices chipped.	
		a. Test insulation between poles (leads) (73) and yoke (21). Min. resistance 1 megohm.	Use multimeter.
18. Commutator end shield (5)	Brush gear	b. Try new stator if shorts in coils are suspected.	Resistance of coils is very low making it hard to test for shorts.
		c. Replace stator if shorts are detected.	
		a. Test insulation between brush holders (74) and frame of commutator end shield (5). Min. resistance 1 megohm.	Use multimeter.

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

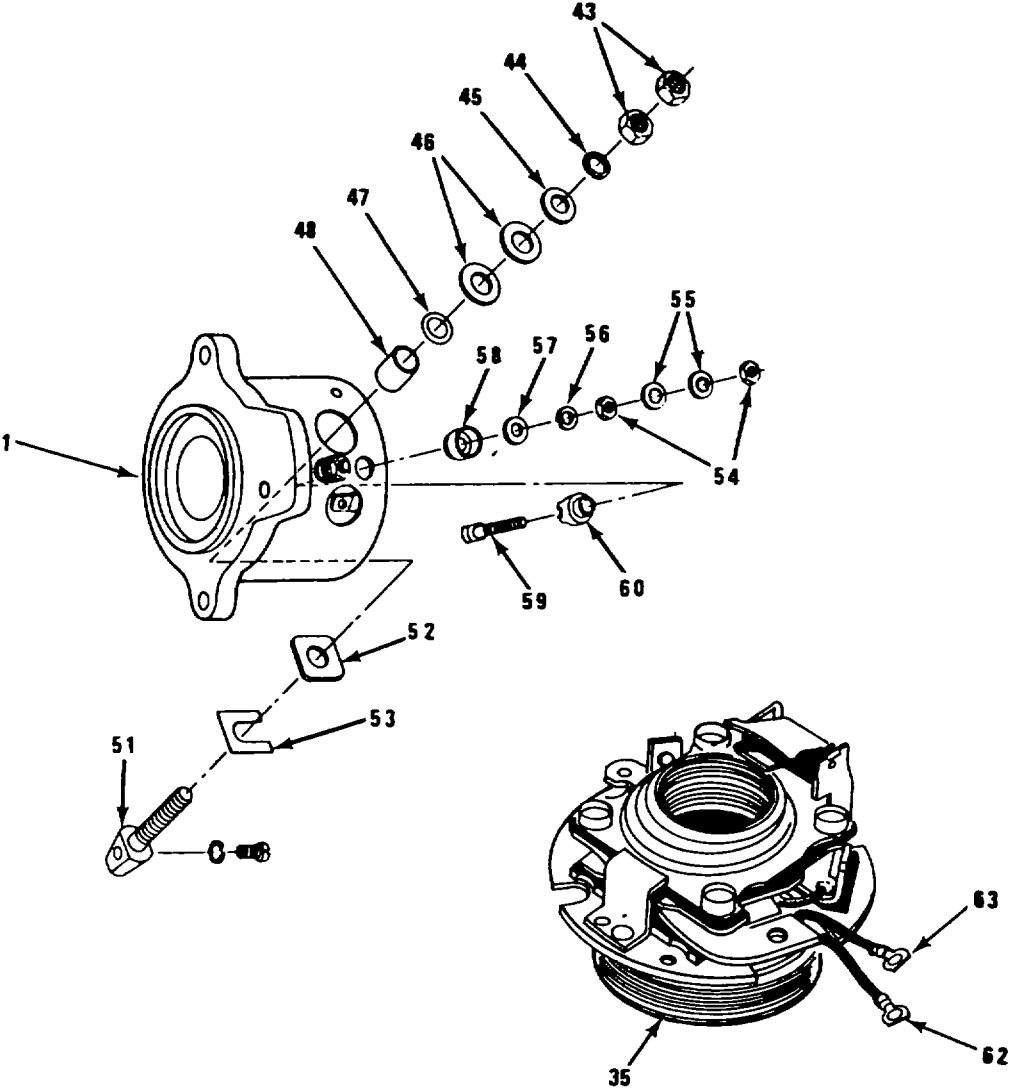
LOCATION	ITEM	ACTION	REMARKS

STARTER MOTOR REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
19. Commutator end shield (5)	Brushes (10)	<p>b. Replace commutator end shield if defective.</p> <p>Replace as a set to give maximum serviceable life after repair.</p>	
ASSEMBLY			
20. Drive end shield (1)	a. Drive end shield (1)	<p>a. On new end shield remove leatheroid retaining pad from oil way.</p> <p>b. Check that felt pad (75) is free to move under influence of spring.</p> <p>c. Remove lubricator core plug (26) and spring (27) being fitted.</p>	<p>Important - new end shields come with leatheroid retaining pad fitted in oil way. If pad is not removed bearing will be oil starved.</p> <p>Spring pressure on felt pad (75) will prevent pinion sleeve</p>
	b. Solenoid (35)	Insert in drive end shield.	
	c. Two screws (61)	Install to secure solenoid.	Use cross tip screwdriver.

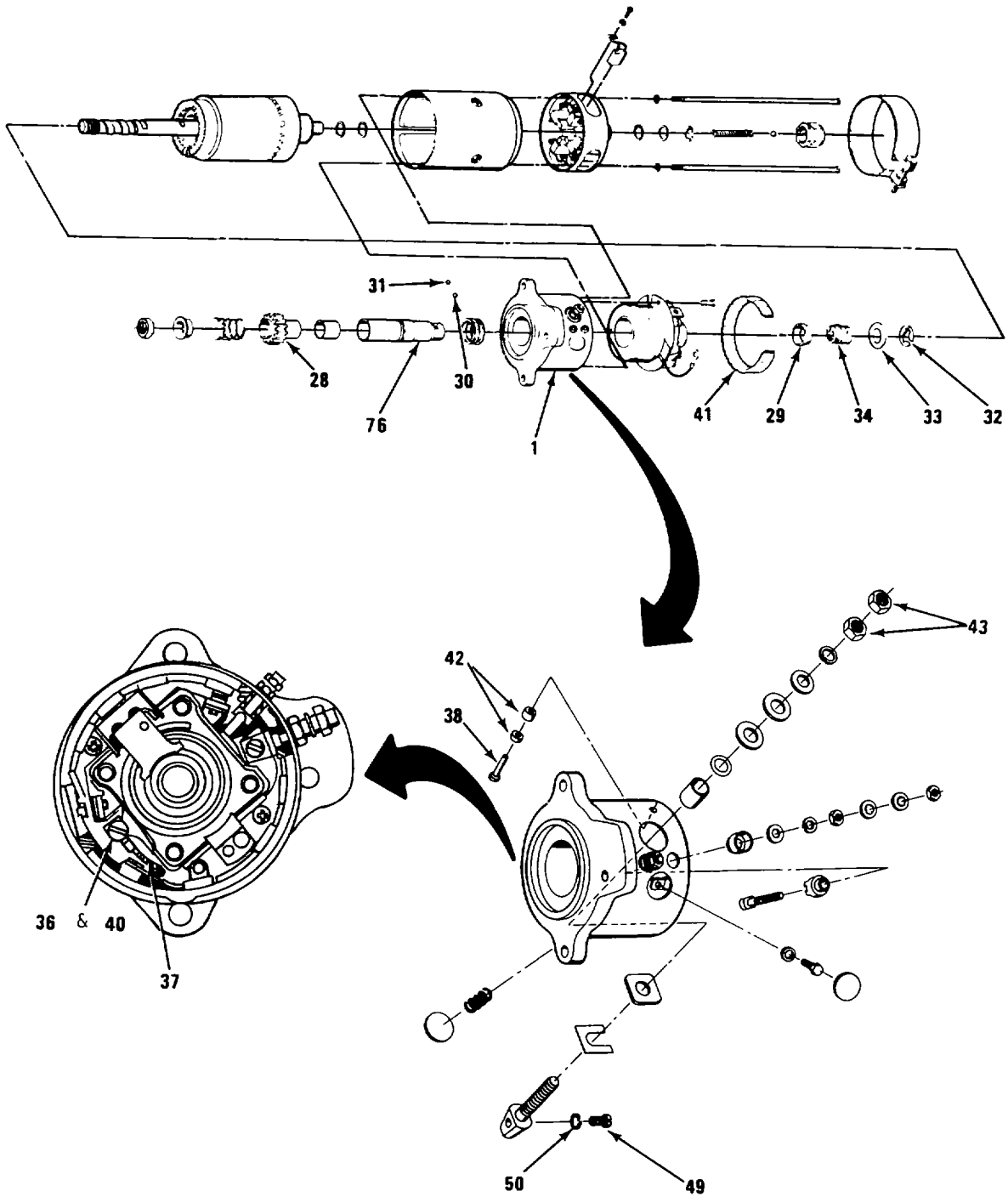
STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	d. Anodized metal strip (53)	Drop in place on inside face of main terminal insulator (52).	
21. Solenoid terminals (59)	a. 2 shaped insulator (60) and terminal tag	Place over bushings terminal screw.	Yellow lead goes on terminal closest to open end of drive end shield.
	b. 2 terminals (59)	Push through hole in end shield.	
	c. 2 round insulating bushings (58), 2 washers (57), 2 lockwashers (56), 4 nuts (54) and 4 lockwashers (55)	Fit on terminal screw.	Use 5/16 in wrench.
22. Drive end shield (1)	Main terminal (51)	Insert into position from inside housing through anodized metal strip (53) and insulator (52).	Depress solenoid plunger for room to insert terminal.
23. Main terminal (51)	a. Insulating bushing (48), rubber ring (47), 2 insulating washers, (46), plain washer (45), lockwasher (44), and 2 nuts (43)	a. Fit on terminal. b. Screw nut on finger tight.	

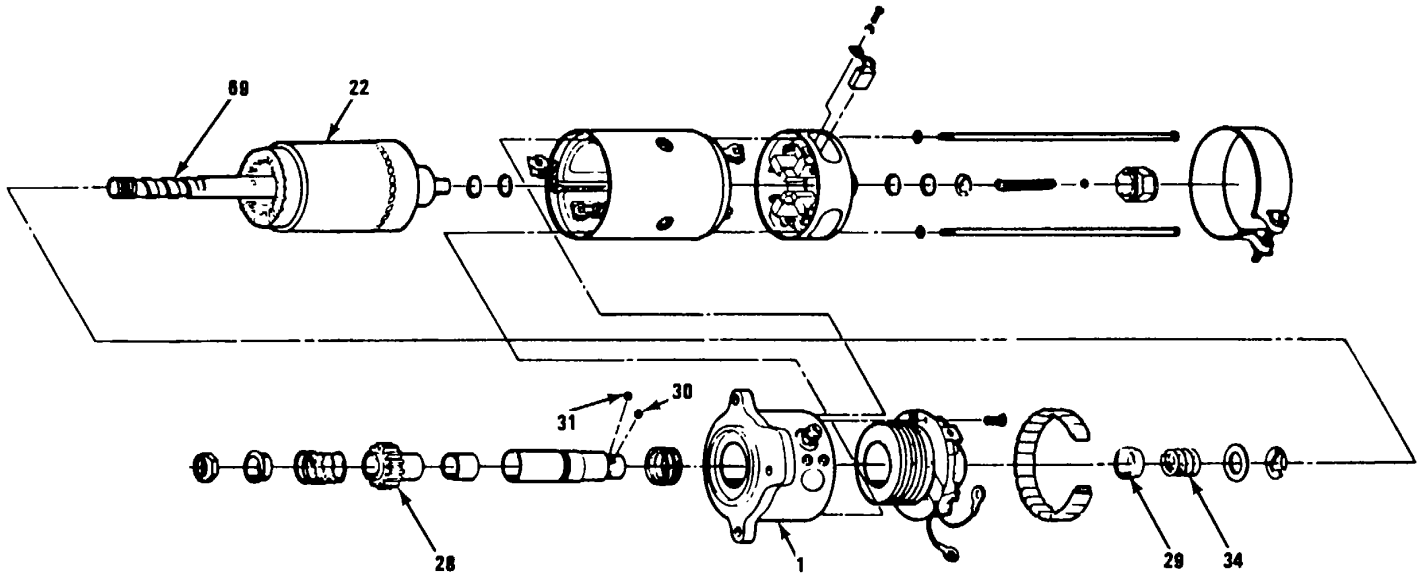
STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	b. Screw (49) and lock-washer (50)	Install and tighten.	Use flat tip screwdriver.
	c. Nut (43)	Tighten.	Use 1/2 in open end wrench.
24. Pinion (28)	a. Lock collar (29)	Fit to pinion sleeve.	Make sure 45° chamfer, inside collar, faces solenoid.
	b. Spring (34), trip collar (33), new snap ring (32)	Fit to sleeve.	Make sure snap ring seats squarely in locking groove.
25. Drive end shield (1)	a. Resistor (41), bushing spacers (42), rivet (38)	Insert in recess in shield. Secure resistor and bushing spacers with rivet.	Use blind riveter.
	b. Resistor lead (37), washer (40) and screw (36)	Secure lead to lug on solenoid moving contact using washer and screw.	Use flat tip screwdriver.
26. Pinion sleeve (76)	6 lock balls (30) and 4 over-speed balls (31)	Insert balls into pinion sleeve holes.	Use small screwdriver with spot of grease to feed in balls. Hold in place with smear grease.

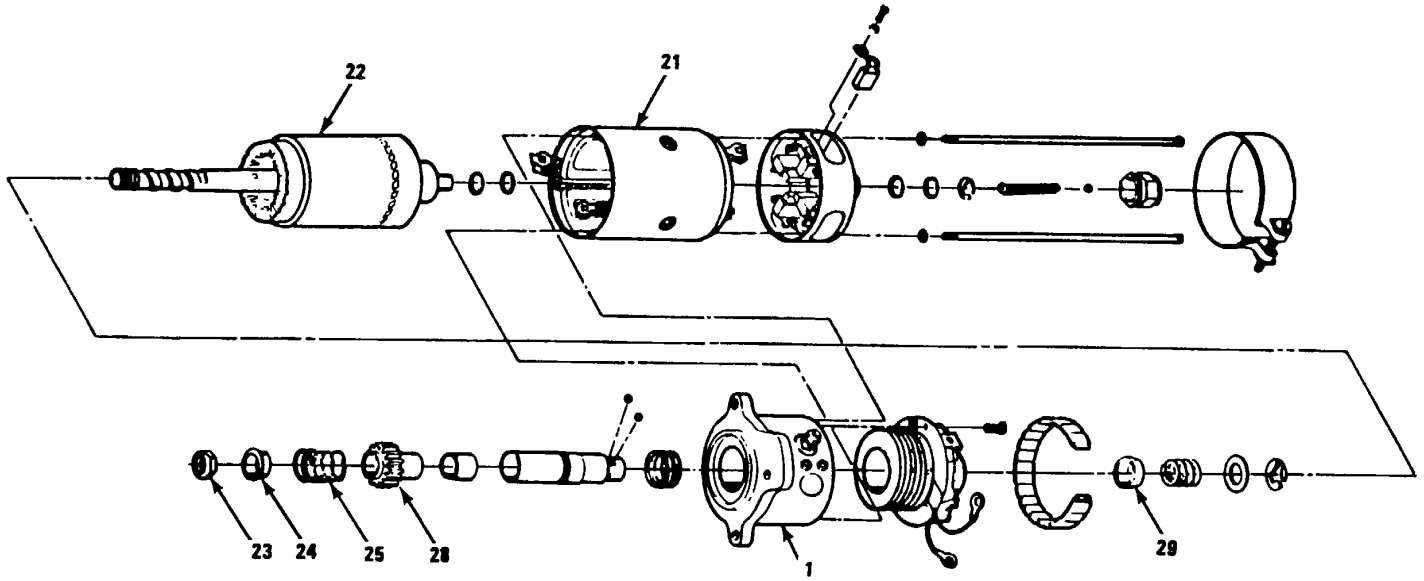
STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
27. Armature (22)	Pinion (28), drive end shield (1) and armature (22)	Assemble pinion and drive end shield to the armature as follows:	
	a. Pinion (28) and drive end shield (1)	a. Pull pinion out drive end shield until lock collar (29) is pressed against spring (34) by solenoid plunger.	
		b. Hold in this position until helix is engaged (step 27d below).	
	b. Lock balls (30) and overspeed balls (31)	Press fully in holes.	
	c. Pinion (28) and drive end shield (1)	Slide pinion and drive end shield onto armature shaft (69).	Take care not to displace balls.
	d. Pinion (28)	a. Engage helix.	
		b. Release pull on pinion (28).	
		c. Screw pinion onto helix.	

STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)

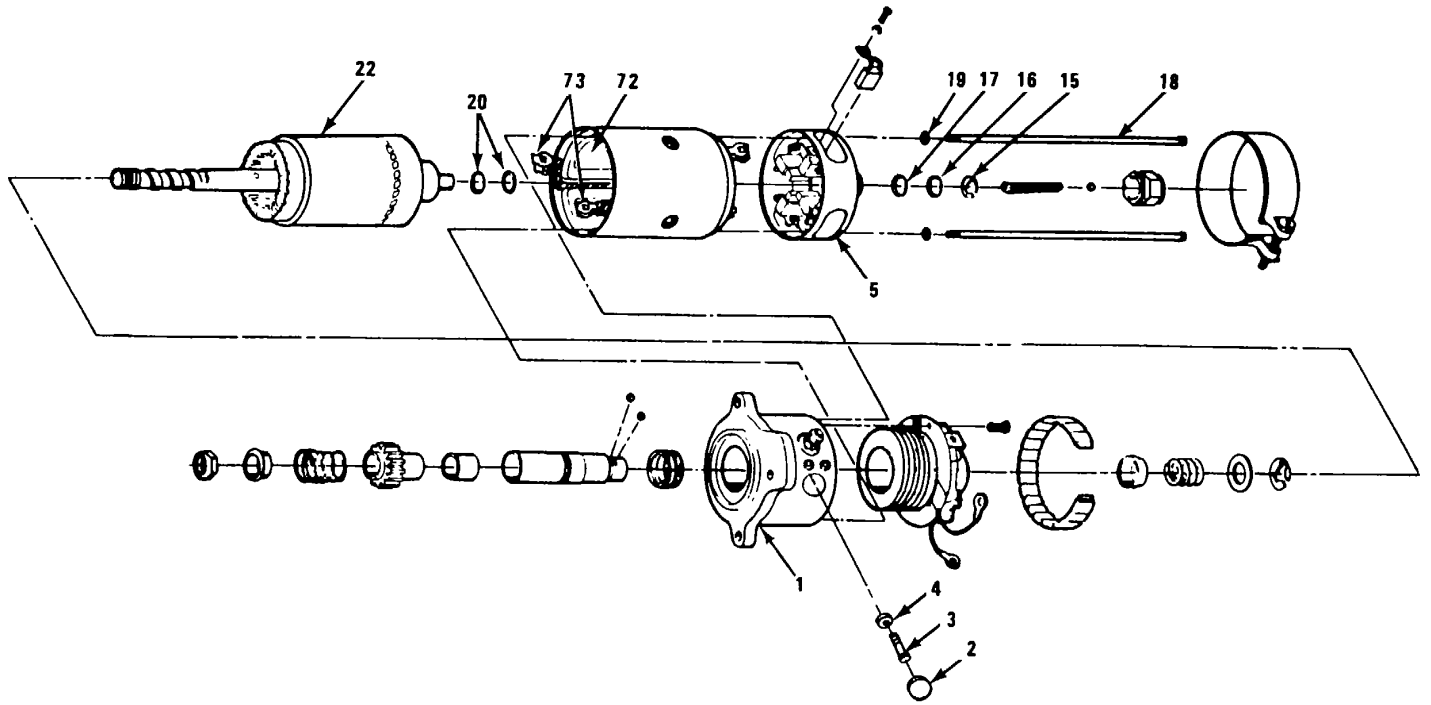


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STARTER MOTOR REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
		d. Check that pinion locking mechanism engages.	
28. Pinion (28)	a. Locking collar (29)	Release locking mechanism, pull collar back against spring.	
	b. Pinion (28)	Check that it is free on shaft, support end shield and rotate pinion both directions.	
29. Armature (22)	a. Armature (22)	Mount in soft jawed vise.	
	b. Pinion return spring (25) and thrust washer (24)	Assemble onto pinion shaft.	
	c. Pinion stop nut (23)	a. Screw onto shaft.	Use 13/16 in socket and torque wrench.
		b. Torque to 40 to 50 ft-lb (5.6 to 6.9 kg-m).	
30. Yoke (21)	Armature (22) and drive end shield assembly (1)	a. Assemble to yoke (21).	Make sure yoke dowel locates in shield slot.

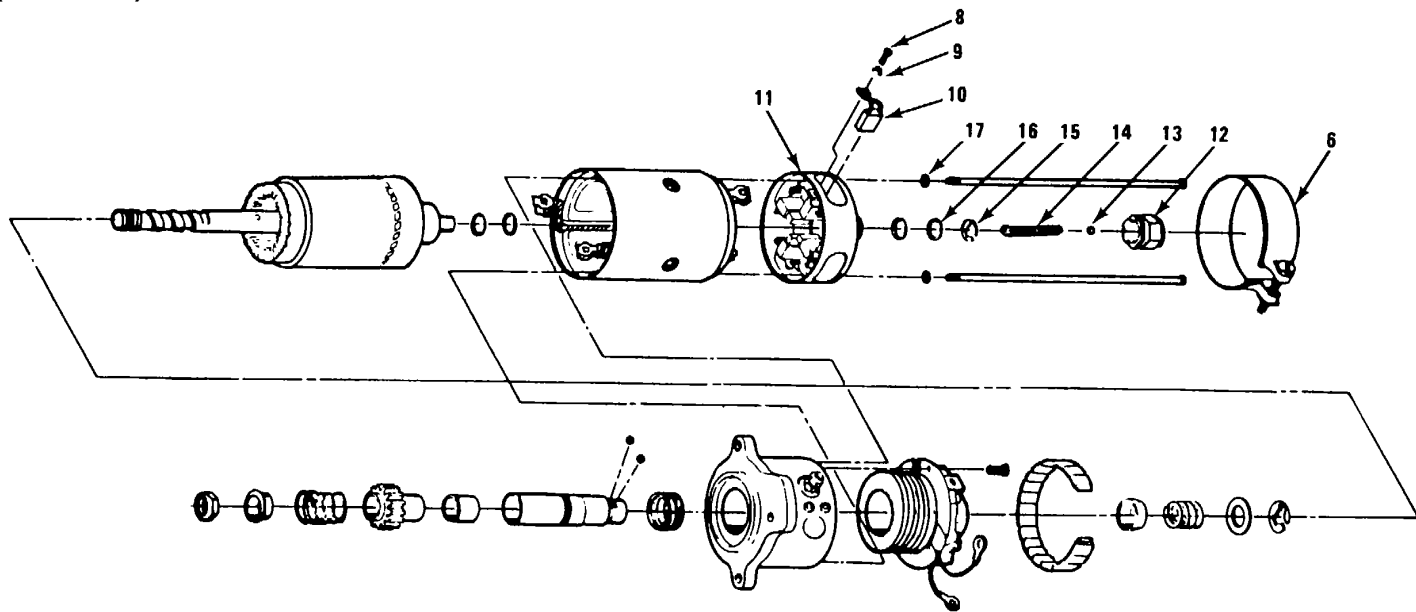
STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
31. Armature (22) and drive end shield assembly (1)	a. 2 screws (3), 2 lockwashers (4) and 2 (new) core plugs (2)	a. Install washers and screws securing tags (73) from field windings (72).	Use 5/16 in socket and ratchet.
	b. Shim washers (20)	Fit original washers on armature shaft.	Use drift pin and ball peen hammer.
	c. Commutator end shield (5)	Fit onto shaft.	Use flat tip screwdriver.
	d. 2 through screws (18) and washers (19)	Insert and tighten.	
32. Starter	a. Starter	Hold vertically with commutator end shield up.	
	b. Shim washers (17)	Fit original washers onto shaft.	
	c. Thrust washers (16)	Fit onto shaft.	

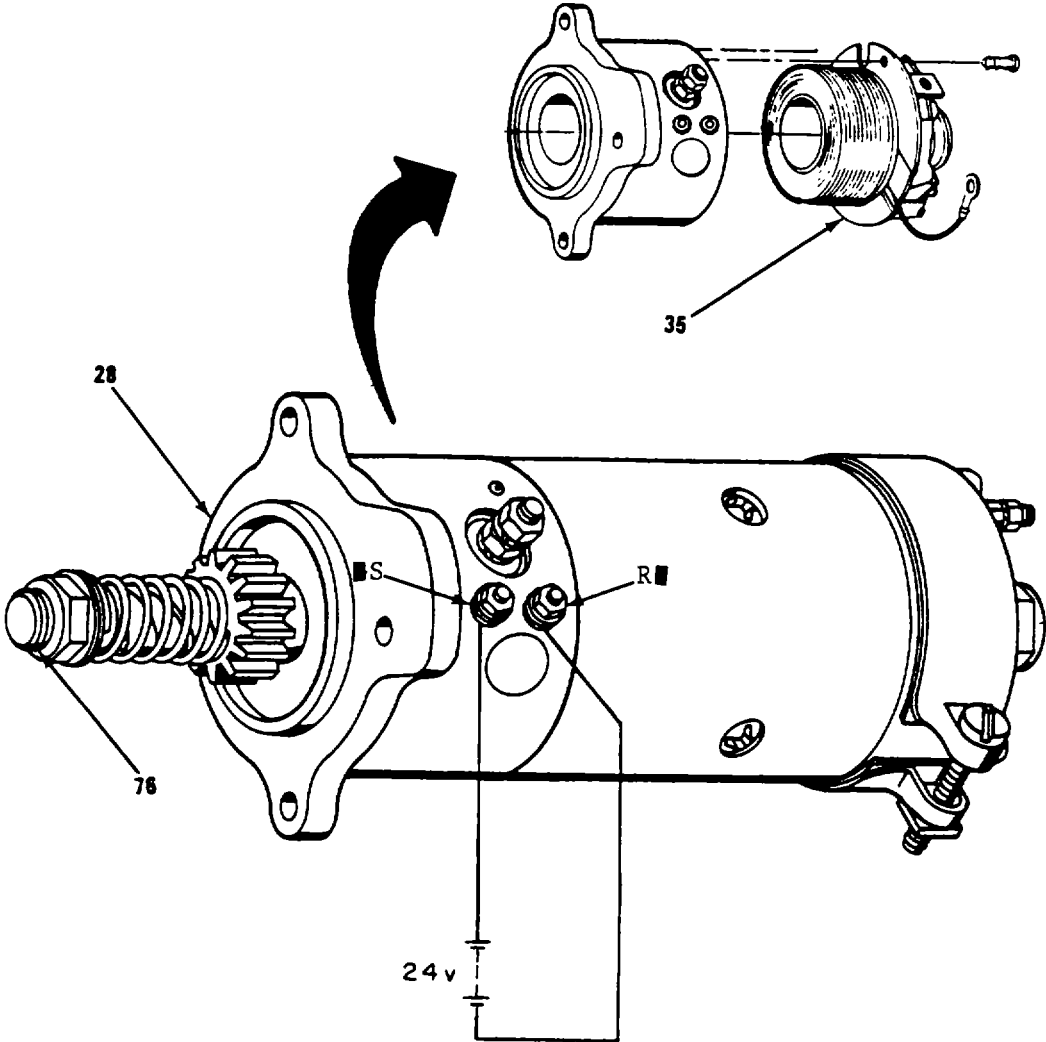
STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Snap ring (15)	Fit onto shaft.	Use snap ring pliers.
	e. Spring (14) and ball (13)	a. Smear with grease. b. Insert in bore in armature shaft.	
	f. End cap (12)	Screw onto end of armature shaft.	Use 1-1/8 in box wrench.
	g. 4 new brushes (10)	Raise spring (11) and install.	Use screwdriver.
	h. 4 brush lead screws (8) and 4 lock-washers (9)	Install securing brush leads.	Use flat tip screwdriver.
	i. Commutator end shield cover (6)	Install and tighten.	Use flat tip screwdriver.

STARTER MOTOR REPAIR INSTRUCTIONS
(Continued)



STARTER MOTOR REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>BENCH TEST</u>			
NOTE			
Use automotive generator, alternator and starter test stand, reference TM 9-4910-458-12.			
	Solenoid (35)	a. Pull pinion (28) forward by hand (approx. 0.0625 in.). b. Release. c. Apply battery voltage of 24 volts between "S" and "R" terminals d. With solenoid energized (c above) draw pinion forward by hand, rotating clockwise. e. Disconnect battery. Pinion (28) must return to disengaged position in one sharp movement.	Pinion should return to original position. a. Battery should be well charged. b. Pinion (28) should move forward 0.25 in. (6.3 mm). Pinion locking mechanism should lock pinion in forward position.

STARTER MOTOR REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
		f. Apply compression spring tester force to drive end of shaft (76).	Shaft should not move backward until 30-38 lb. (13.6 to 17.2 kg) force applied (check recoil spring).

TURBOCHARGER REPAIR INSTRUCTIONS**This task covers:****a. Disassembly****b. Inspection and Repair****c. Assembly****INITIAL SETUP**

Tools:

Ratchet

7/16 in socket

Scribe

1-1/4 in box wrench

1/2 in box wrench

Two 7/16 in open end wrenches, 6 in

Two flat tip screwdrivers

Snap ring pliers

Air compressor with air gun

Safety goggles

Bristle brush

Wire brush

Putty knife

Equipment Condition:

TM 5-1940-277-20

Condition Description:

Turbocharger removed
from engine.

Materials/Parts:

Overhaul kit:

O-ring

Thrust ring

Thrust plate

Thrust washer

Bearing

Piston ring (2 each)

Lockwashers

Snap ring

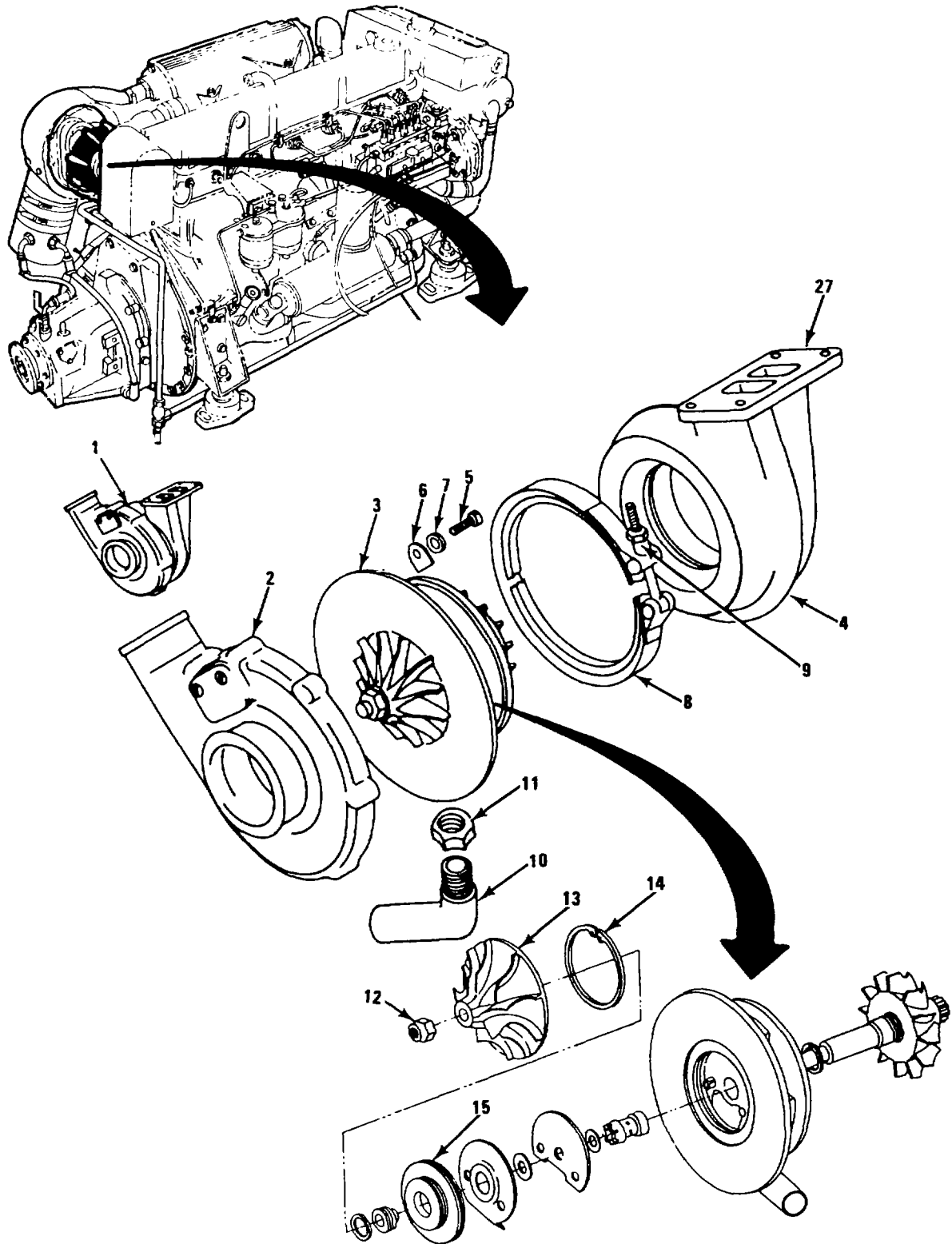
Solvent

Engine oil

Plastic scraper

Crocus cloth

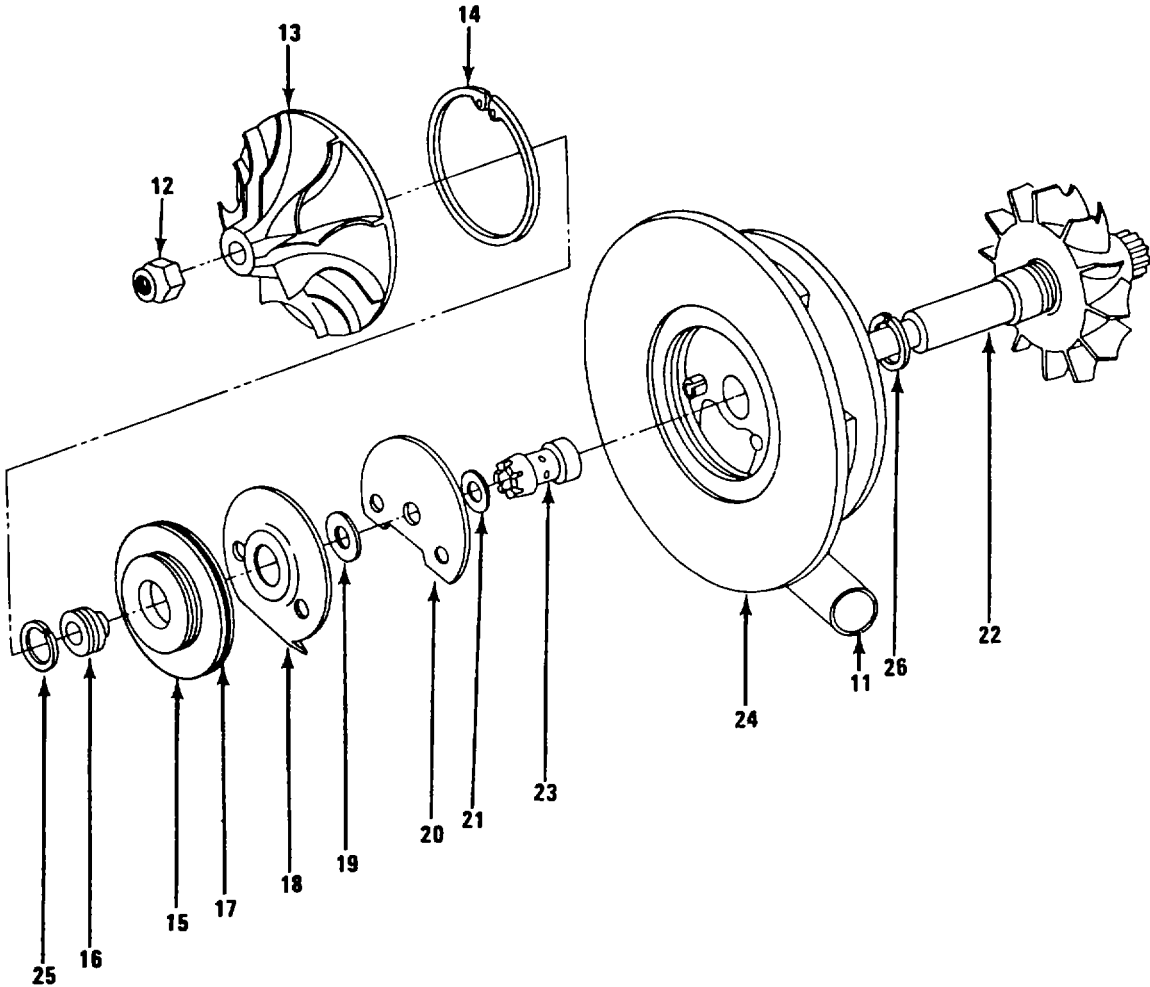
TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)



TURBOCHARGER REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>DISASSEMBLE</u>			
1. Turbocharger (1)	a. Turbocharger (1)	Clamp in vise on turbine inlet flange (27).	
	b. Compressor housing (2), core assembly (3), turbine housing (4)	Scribe (mark) for correct alignment on reassembly.	
	c. 8 capscrews (5), 8 washers (6), 8 lock-washers (7) and compressor housing (2)	Remove.	Use 7/16 in socket with ratchet.
	d. "V" clamp (8) and core assembly (3)	Loosen lock nut (9) and remove.	Use 7/16 in open end wrench.
	e. Oil drain tube (10) and nut (11)	Remove.	Use 1-1/4 in box wrench.
2. Center core assembly (3)	a. Nut (12) and compressor wheel (13)	Remove.	Use 1/2 in box wrench.
	b. Snap ring (14)	Remove.	Use snap ring pliers.
	c. Insert (15)	Remove.	Use two screw-drivers as levers

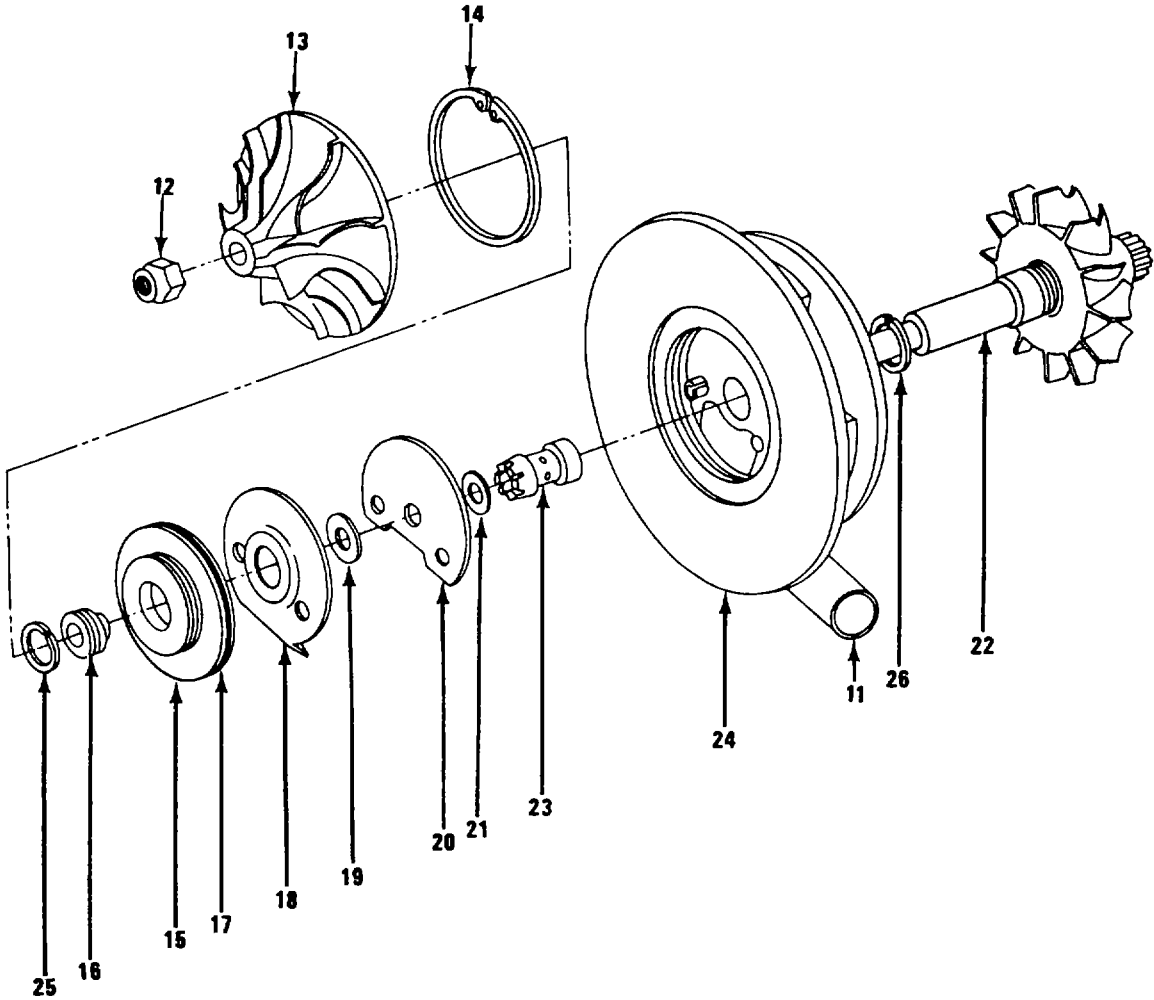
TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)



TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
3. Insert (15).	a. Spacer sleeve (16)	Push out through insert.	
	b. O-ring (17) from insert (15)	Remove and discard.	
4. Bearing housing (24)	a. Oil deflector (18)	Remove.	
	b. Thrust ring (19)	Remove and discard.	
	c. Thrust plate (20)	Remove and discard.	
	d. Thrust washer (21)	Remove and discard.	
	e. Turbine wheel and shaft (22)	Remove.	
	f. Bearing (23)	Remove and discard.	
5. Spacer sleeve (16)	Piston ring (25)	Remove and discard.	
6. Turbine wheel and shaft (22)	Piston ring (26)	Remove and discard.	
<u>CLEAN</u>			
7.	a. All components	Soak in solvent.	

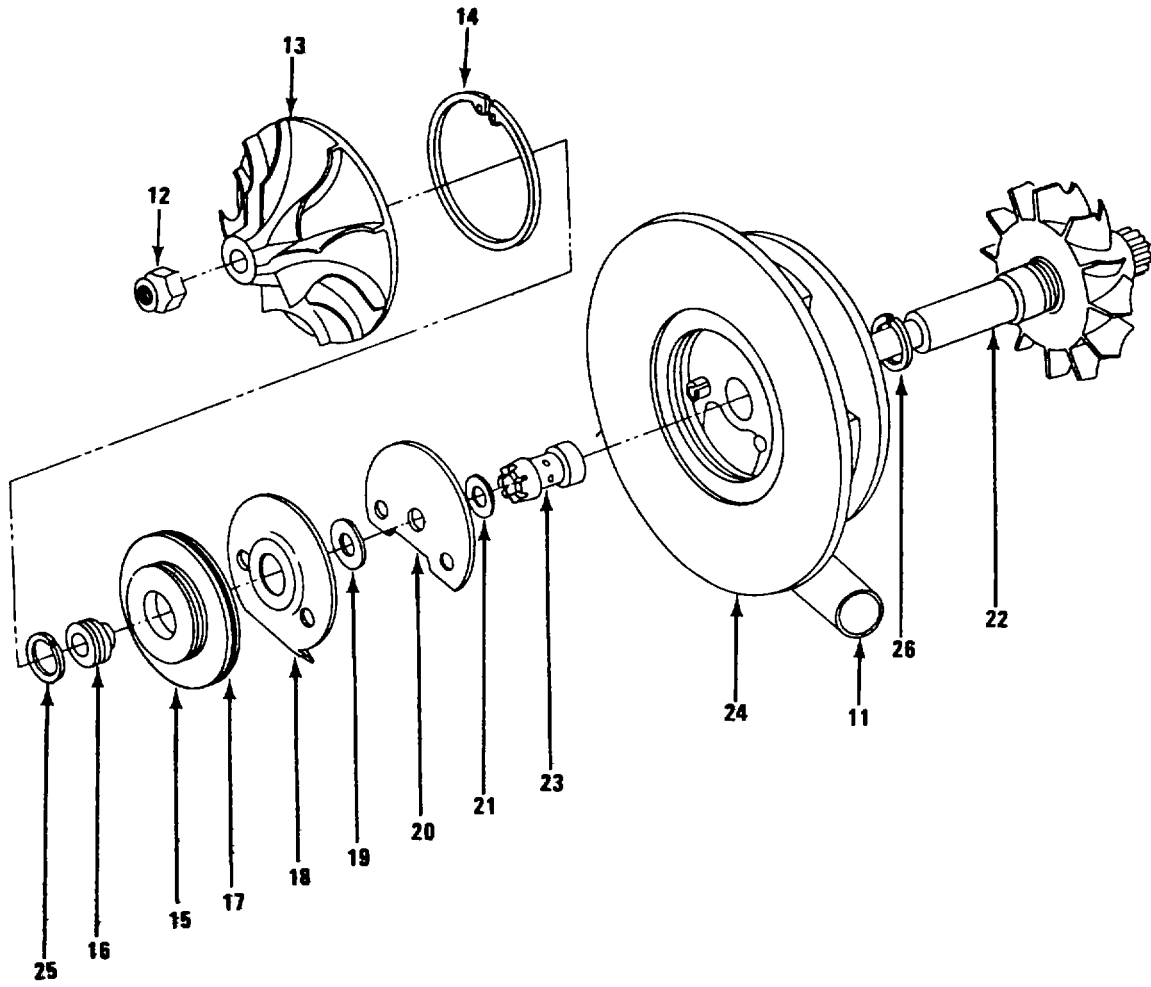
TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)



TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Aluminum components	Remove remaining deposits.	Use plastic scraper or bristle brush.
WARNING			
<p>Always use safety goggles when using dry compressed air for cleaning. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.</p>			
	c. Drilled passages	Clean out.	Use air compressed with air blow gun. Use low air pressure.
<u>INSPECT AND REPAIR</u>			
8. Turbine wheel and shaft (22)	a. Bearing journal and piston groove wall	a. Inspect for: Scratching, Galling, and Wear.	
		b. Minor scratches acceptable if they can be polished out with crocus cloth; otherwise replace.	Use crocus cloth.

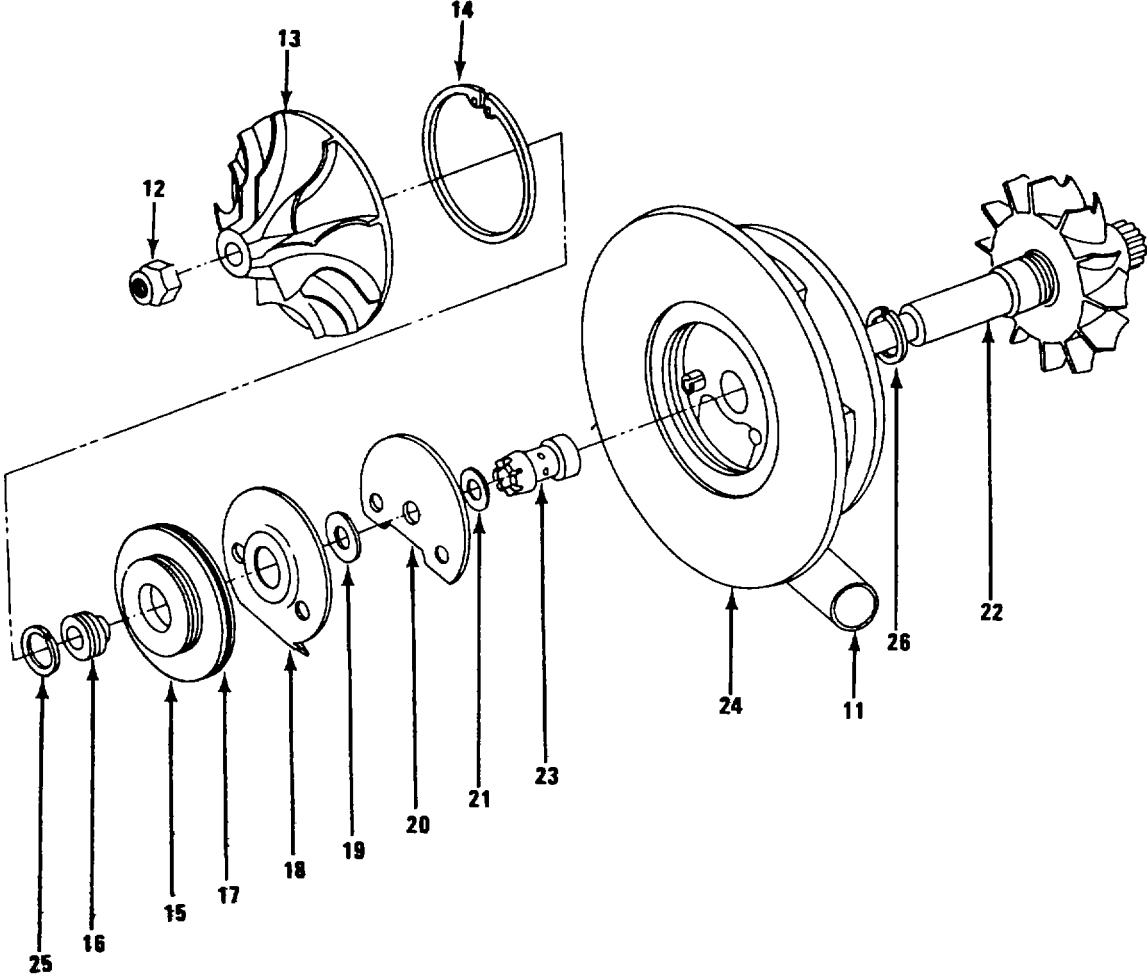
TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)



TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
CAUTION			
DO NOT ATTEMPT TO STRAIGHTEN BLADES.			
9. Bearing housing (24)	Bearing and piston ring bores	<ul style="list-style-type: none"> a. Inspect for: Cracks, Bends, Chipped blades. b. Replace if any of above defects noted. 	
		<ul style="list-style-type: none"> a. Inspect for: Scratches, Wear. b. Replace housing if unable to polish out with crocus cloth. 	Use crocus cloth.
10. Spacer sleeve (16)	Spacer and piston ring groove	<ul style="list-style-type: none"> a. Inspect for Cracks or Knicks. b. Replace if cracked or knicked. 	
11. Compressor wheel (13)	Blades	<ul style="list-style-type: none"> a. Inspect for: Cracks, Bends, Chips. b. Replace if defect noted. 	

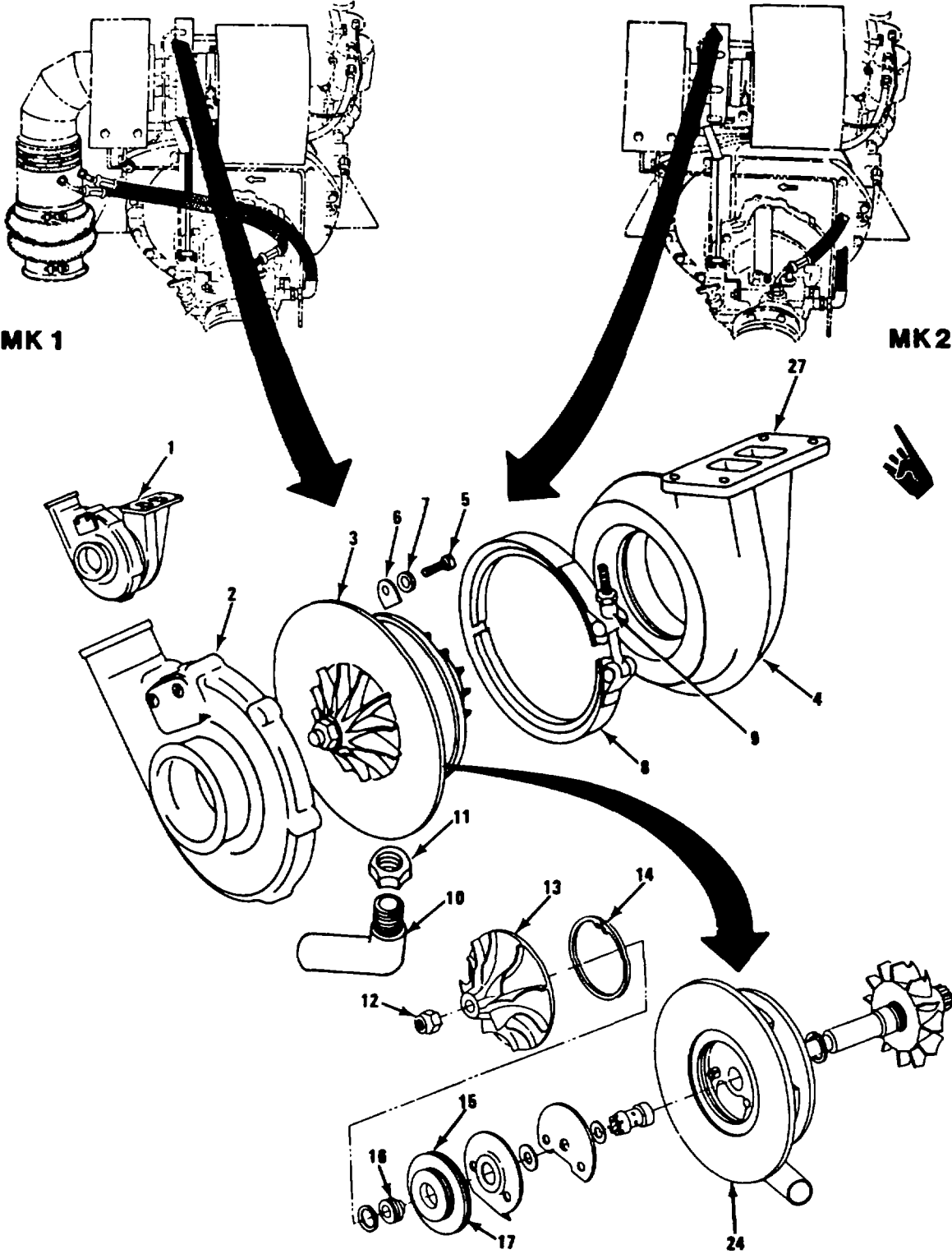
TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)



TURBOCHARGER REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>ASSEMBLE</u>			
Before assembly lubricate all parts with light coat of oil.			
12. Turbine wheel and shaft (22)	Piston ring (26)	Fit on shaft.	
13. Spacer sleeve (16)	Piston ring (25)	Fit on sleeve.	
14. Bearing housing (24)	a. Bearing (23)	Insert in housing.	
	b. Turbine wheel and shaft (22)	Assemble to housing.	Do not force piston ring into housing.
	c. Thrust washer (21)	Install.	
	d. Thrust plate (20)	Install.	Make sure holes in plate locate over spring pin (26) in housing.
	e. Thrust ring (19)	Install.	
	f. Oil deflector (18)	Install.	Make sure holes locate over spring pin (26) in housing with crank in plate toward oil gallery.

TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)



TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
15. Insert (15)	a. O-ring (17)	Fit on insert.	
	b. Spacer sleeve (16)	Push into insert from housing side.	
16. Bearing housing (24)	Insert (15)	Insert into housing.	Do not disturb O-ring (17).
17. Turbine wheel and shaft (22)	a. Snap ring (14)	Install.	Use snap ring pliers.
	b. Compressor wheel (13)	Mount on shaft, secure with nut (12).	Use 1/2" box wrench.
18. Center core assembly (3)	Oil drain tube (10) and nut (11)	Install.	Use 1-1/4" box wrench.
19. Turbine housing (4)	a. Inlet flange (27)	Clean gasket face.	Use wire brush or putty knife.
	b. "V" clamp (8)	Aline with housing using scribe marks.	
	c. Center core assembly (3)	Aline with housing using scribe marks.	
	d. "V" clamp (8)	Tighten lock nut (9) to secure core to housing.	Use 7/16" open end wrench.
20. Center core assembly (3)	a. Compressor housing (2)	Aline scribe marks.	

TURBOCHARGER REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. 8 capscrews (5), 8 washers (6) and 8 new lock-washers (7)	Install and tighten.	Use 7/16 in socket and ratchet.
	c. Spin turbine shaft	Check for free rotation.	NOTE: When cold, large free play can be expected but it is normal.

INJECTION PUMP REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Tools:

3/4 in open end wrench

5/8 in open box/end wrench

1/2 in box/open end wrench

9/16 in socket

Ratchet

6 in extension

3/8 in hex key wrench (Allen)

Equipment Condition:

TM 5-1940-277-20

Condition Description:

Engine hatch covers raised.

NOTE

Modify hex key wrench if required. Refer to Appendix C, Figure C-4.

Flat tip screwdriver, 6 inch

15/16 in socket

Inspection mirror

Hinge handle

Long nose pliers

11/32 in box/open end wrench

1/8 in drill bit

NOTE

A piece of 1/8 in brass rod may be used. Refer to Appendix C, Figure C-5.

Flashlight

Materials/Parts:

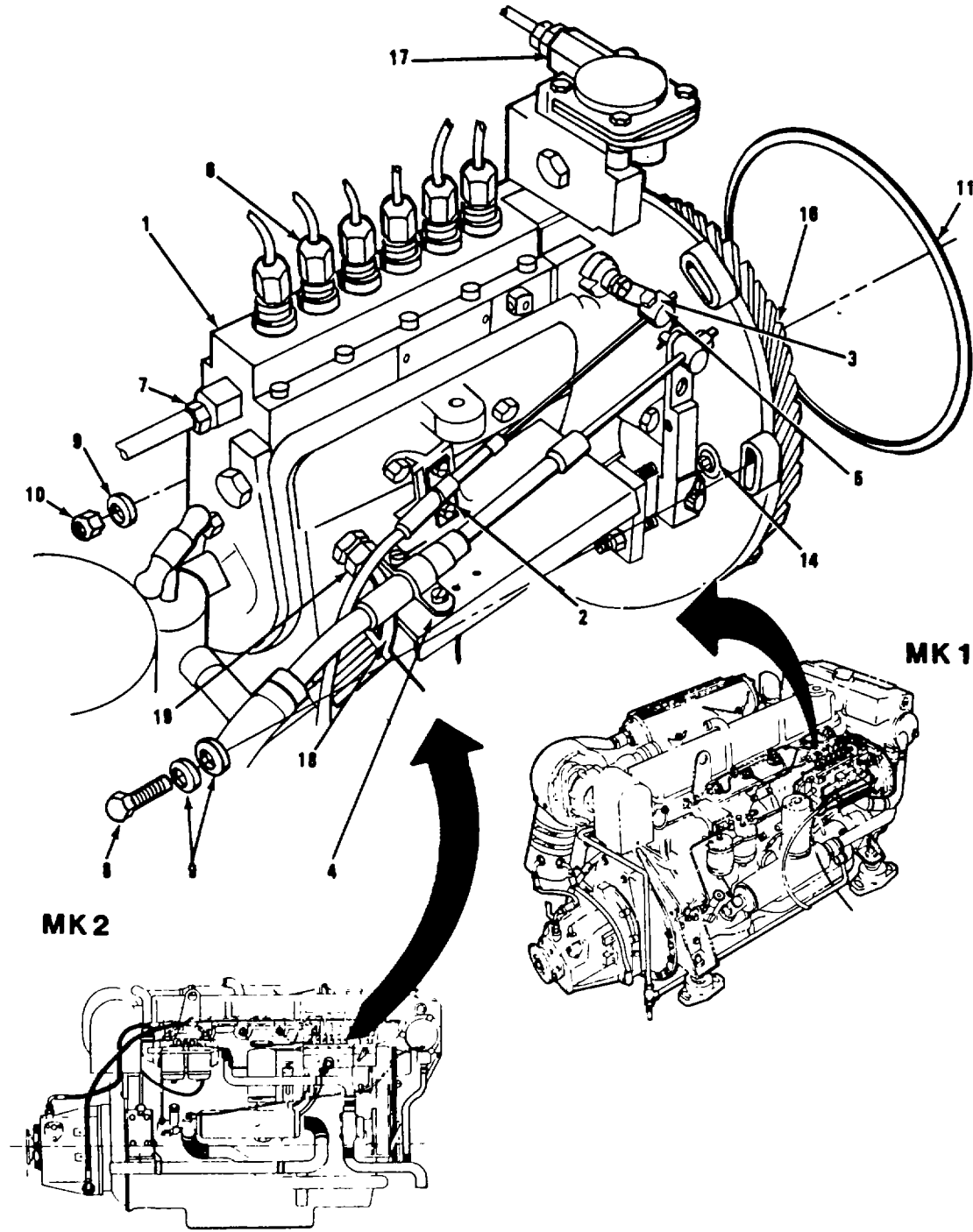
Injection pump

O-ring

Engine oil

Personnel Required: Two

INJECTION PUMP REPLACEMENT INSTRUCTIONS
(Continued)

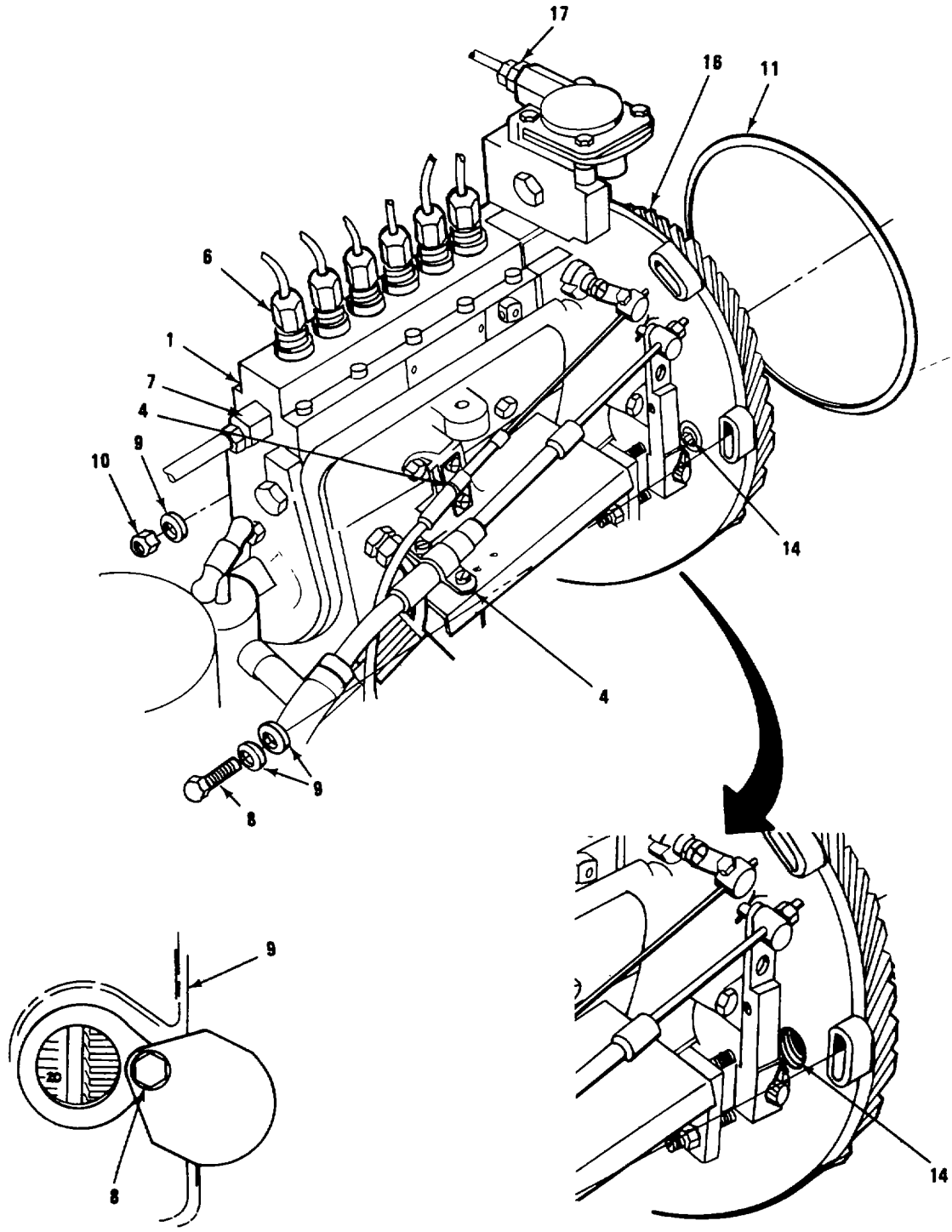


INJECTION PUMP REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
1. Injection pump (1)	a. Stop control cable clamp (2)	Remove two screws and clamp.	Use screwdriver.
	b. Stop control cable holding screw (3)	Loosen screw and pull stop control cable free.	Use 11/32 in wrench.
	c. Throttle cable retaining clamp (4)	Remove two screws and bracket.	Use screwdriver.
	d. Throttle cable cotter pin (5)	Pull out pin and move cable aside.	Use long nose pliers.
	e. 6 injector pipe union nuts (6)	Unscrew.	Use 5/8 in open end wrench.
	f. Fuel line union nut (7)	Unscrew one nut at injection pump end and one nut at fuel filter end of line.	Use 1/2 in open end wrench. Remove line.
	g. Governor vacuum line nut (17)	Unscrew one nut at governor and loosen one nut on intake manifold end.	Use 1/2 in open end wrench.
	h. Oil line (18)	Loosen nut (19) and disconnect oil line(18).	Use 3/4 in wrench

INJECTION PUMP REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
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INJECTION PUMP REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	i. 4 mounting bolts (8), 5 washers (9) and nut (10)	Remove bolts and washers and one nut and washer.	Use 9/16 in socket, ratchet and 6 in extension.
	j. Injection pump (1)	Remove.	Work pump out of housing and free of injector lines while moving lines as little as possible.
	k. O-ring (11)	Remove and discard.	

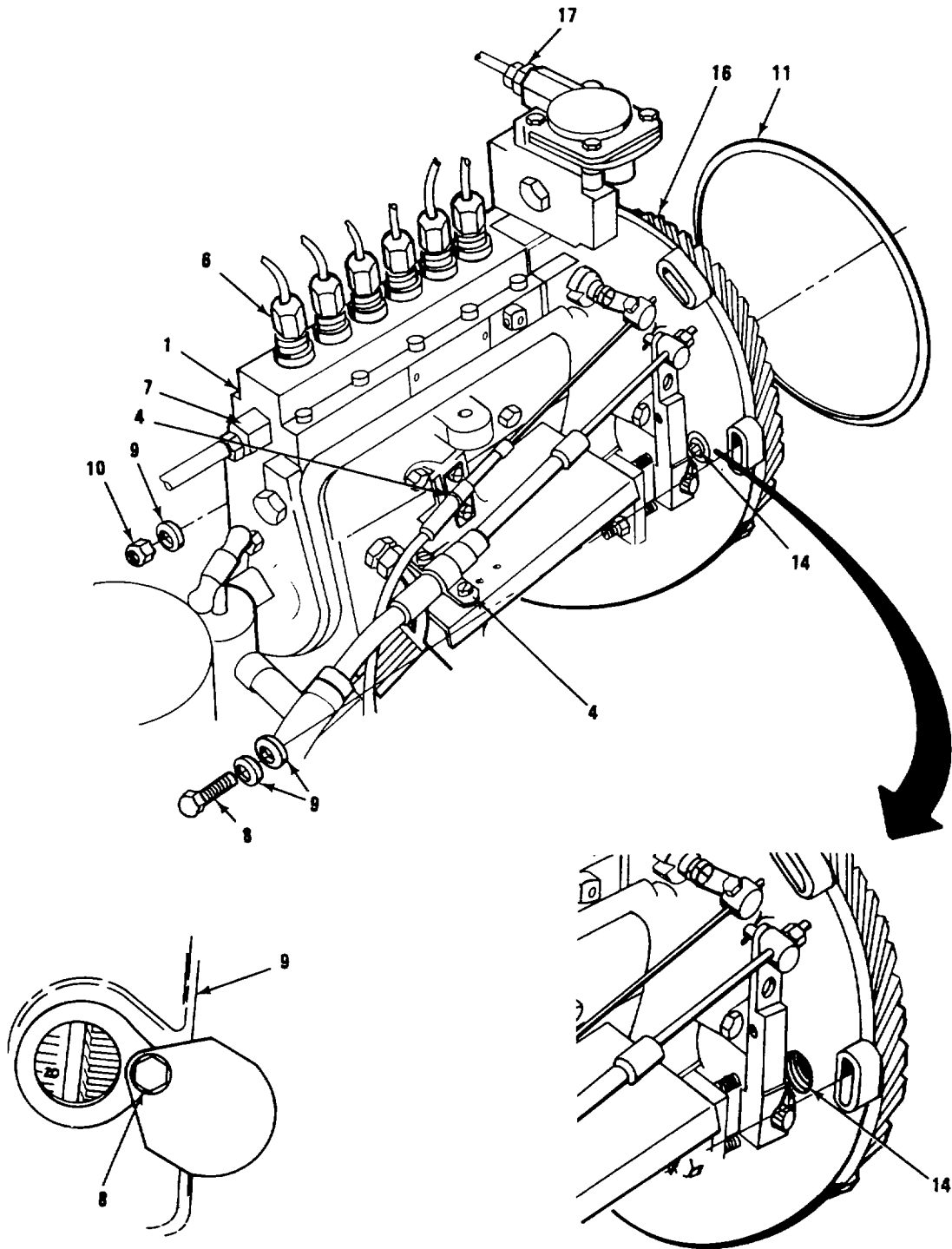
INSTALLATION**NOTE**

Before pump installation the engine cylinders must be properly positioned. This is done through coordinated positioning of two marks. One on the flywheel diameter and the other on the back face of the camshaft gear as seen through the opening where the pump was removed. To view the flywheel mark you must open a viewing port located on the starboard lower quarter of the flywheel housing edge. (Below rear starboard engine mount bracket)

2. Flywheel housing (12)	Viewing port nut (13)	Loosen and swing port cover open.	Use 1/2 in wrench.
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INJECTION PUMP REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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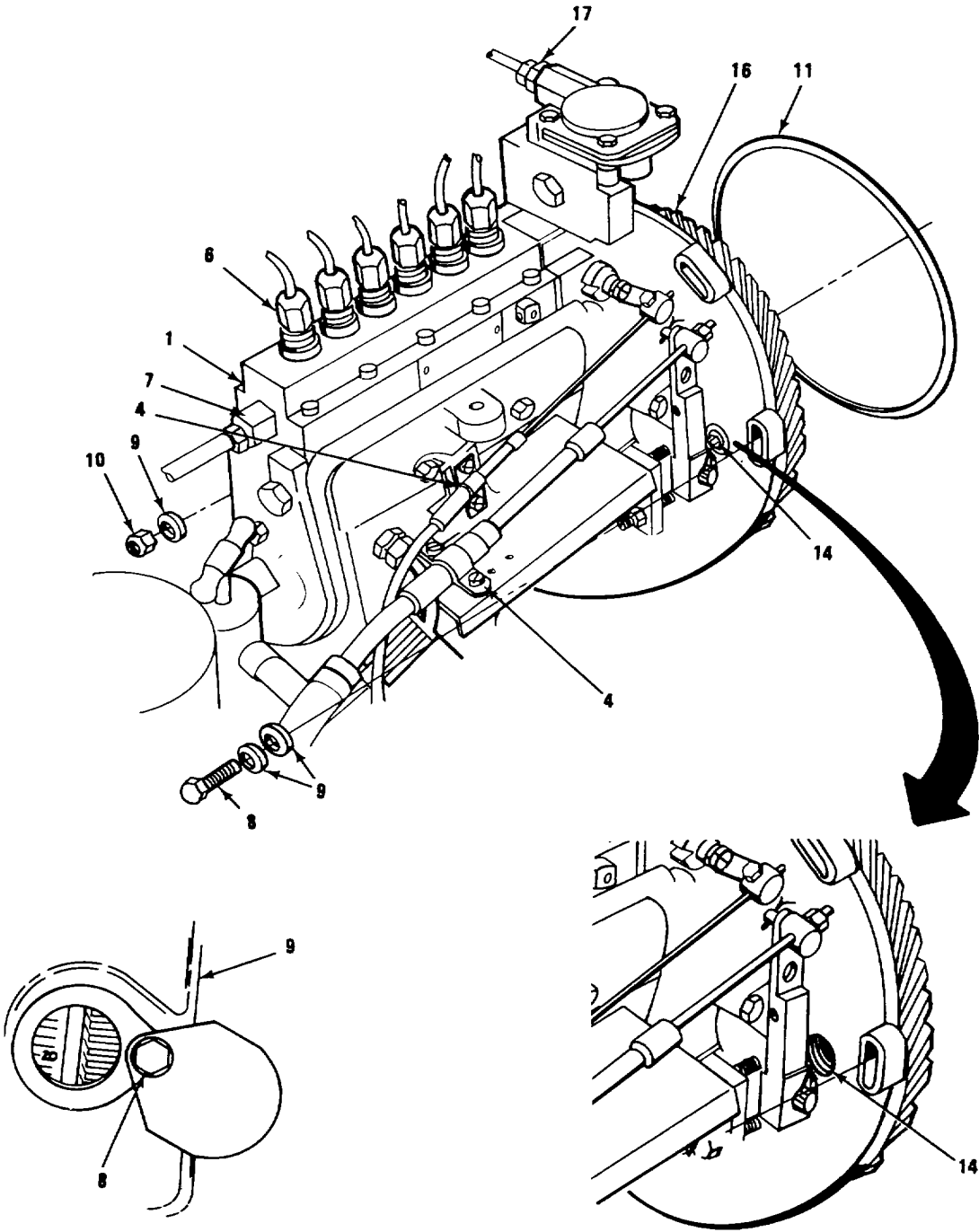


INJECTION PUMP REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
3. Fly wheel and camshaft gear rear face	21 degree mark on flywheel and straight mark on camshaft gear rear face	Line 21 degree mark up with timing mark that appears on edge of viewing port opposite the securing bolt. At the same time this engine is lined up, the mark on the rear face of the camshaft gear must be visible. Rotate engine until both conditions are satisfied.	One person will use 15/16 in socket and hinge handle on nut for crankshaft pulley at the front of At engine to rotate At the same time a second person using an inspection mirror must observe the flywheel port to line up the 21 degree mark on the flywheel and the pointer on the flywheel housing and check the rear face of the camshaft gear to see that the mark is visible in the opening left by removal of the injection pump. BOTH CONDITIONS MUST BE SATISFIED. This puts engine piston in proper position relative to injection pump positioning.
4. Injection pump (1)	a. Timing hole plug (14)	Unscrew from pump mounting flange.	Use 3/8 in hex key wrench (Allen). NOTE Modify hex key wrench if required. Refer to Appendix C, Figure C-4.

INJECTION PUMP REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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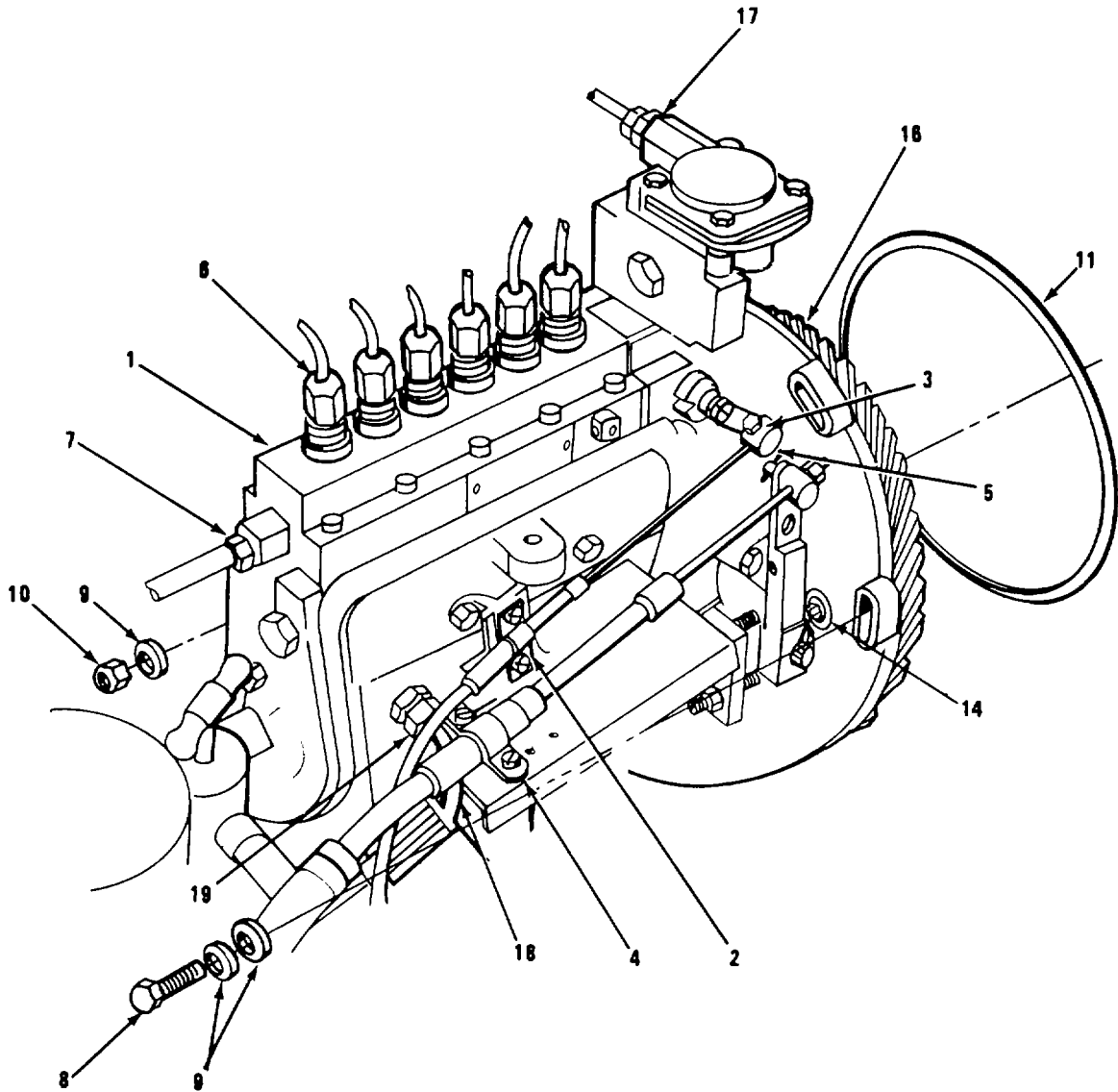


INJECTION PUMP REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Gear (16)	Turn until small indent mark in rear face of gear is visible through hole.	Use flashlight to see indent.
	c. Gear (16)	Fit 1/8 in drill bit through timing bit hole and seat in indent. Move gear until drill bit is centered in hole. Remove bit when centered.	Use 1/8 in drill NOTE A piece of 1/8 in brass rod may be used. Refer to Appendix C, Figure C-5.
	d. O-ring (11)	Lightly coat with clean engine oil and position on shoulder on front face of pump mounting flange.	
5. Engine	e. Injection pump (1)	Fit pump to engine keeping the stud in center of slotted mounting hole as much as possible.	Pump may have to be rotated slightly to engage pump gear teeth to camshaft gear teeth.

INJECTION PUMP REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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INJECTION PUMP REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
6. Injection pump (1)	a. 5 mounting washers (9), 4 bolts (8) and nut (10)	Install washers and bolts and one washer and nut to protruding stud.	Use 9/16 in socket, ratchet and 6 in extension.
	b. Timing hole plug (14)	Screw into hole in pump flange and tighten.	Use 3/8 in hex key wrench (Allen).
	c. 6 injector pipe union nuts (6)	Position and tighten.	Use 5/8 in open end wrench.
	d. Governor vacuum line nut ()	Connect nut to governor and tighten at governor and at intake manifold.	Use 1/2 in wrench.
NOTE			
Prior to connecting oil line, fill injector pump at oil line opening with 1/3 pint of engine oil.			
	e. Oil Line (18)	Connect nut (19) to injector pump and tighten.	Use 3/4 in wrench.
	f. Throttle cable cotter pin (5)	Connect cable to throttle lever and install cotter pin.	Connect cable to middle hole in lever.
	g. Throttle cable retaining clamp (4)	Position clamp and secure with two screws.	Use screwdriver.

INJECTION PUMP REPLACEMENT INSTRUCTIONS
(Continued)

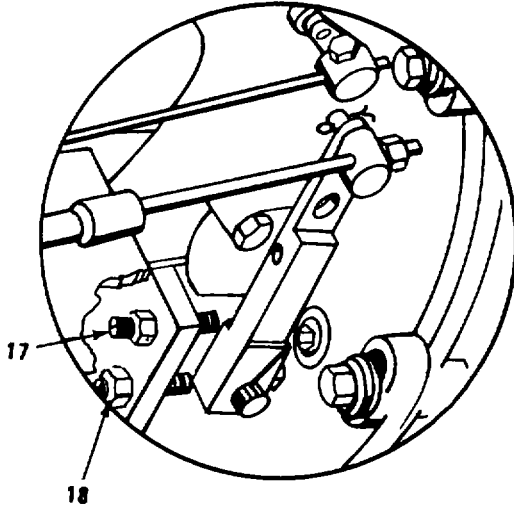
LOCATION	ITEM	ACTION	REMARKS
	h. Stop control cable holding screw (3)	Run end of stop cable through inner hole in stop lever and tighten securing screw.	Use 11/32 in wrench. Make sure stop control on dashboard pushed in and stop lever on pump is all the way forward before tightening screw.
	i. Stop control cable clamp (2)	Position and secure with two screws.	Use screwdriver.
	j. Fuel line union nut (7)	Install fuel line between pump and fuel filters. Connect and tighten union nut at pump end of line and at fuel filter end.	Use 1/2 in open end wrench. If line does not appear to position properly when attempting installation check to see if it fits better by turning it around.

NOTE

Boat must be in water. Do fuel system bleed procedure per TM 5-1940-277-20. Start engine and check for leaks. Tighten any leaking connections. Proceed to next step with engine still running at idle speed.

INJECTION PUMP REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
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INJECTION PUMP REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	j. Idle speed adjusting screw (17)	Loosen lock nut and back screw off. Set operators throttle control so engine is idling at 650 rpm. Run screw up to contact with speed selector lever, hold and tighten lock nut.	Screw located on engine side of pump. Use 1/2 in wrench and screwdriver.
	k. Maximum speed adjusting screw (18)	Loosen lock nut and back screw off. Adjust operator throttle control for 2800 rpm. Run screw up against speed selector lever, hold and tighten lock nut.	Screw located immediately below idle adjusting screw. Use 1/2 in wrench and screwdriver.

NOTE

Bring engine speed to idle for one minute and stop engine.

INJECTOR TEST AND REPAIR INSTRUCTIONS

This task covers:

- | | | |
|--------------------|-----------------------|----------------------|
| a. Testing | b. Disassembly | c. Inspection |
| d. Cleaning | e. Repair | f. Assembly |

INITIAL SETUP

Tools:

1 in box/open wrench
 3/4 in box/open wrench
 Torque wrench
 Flat tip screwdriver
 1 in socket
 Soft brass wire brush

Equipment Condition:

TM 5-1940-277-20

Condition Description:

Injector removed from engine.

Special Tools:

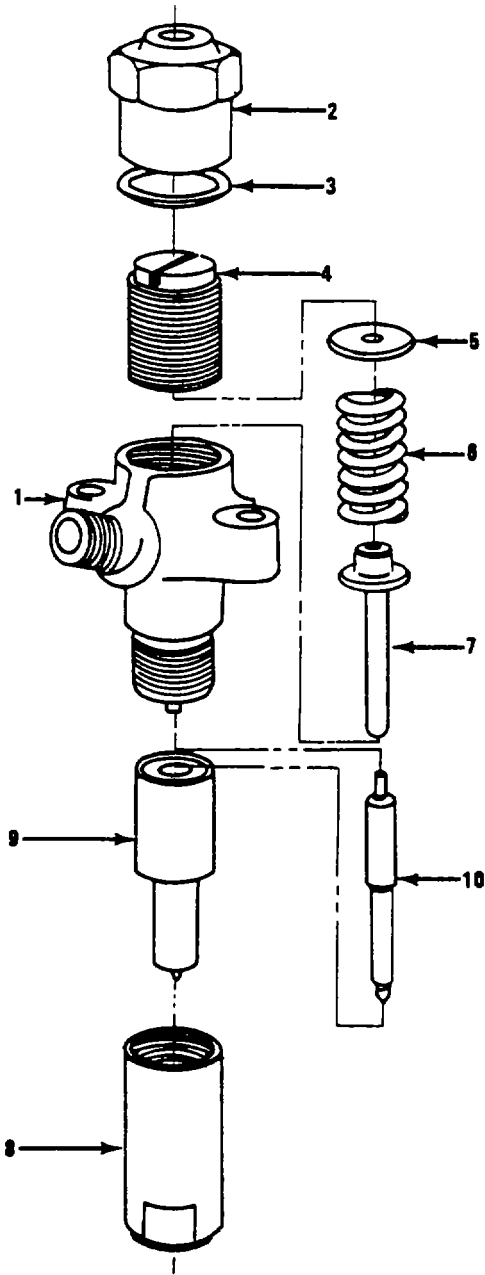
Nozzle nut socket
 Injector tester

Materials/Parts:

Copper washer
 Diesel fuel

INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)

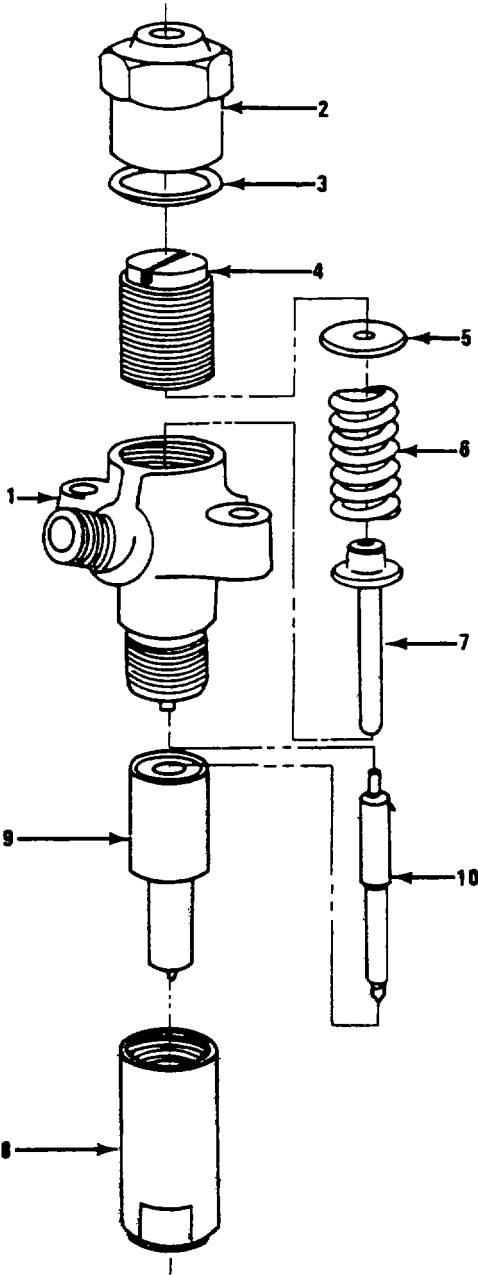
LOCATION	ITEM	ACTION	REMARKS
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INJECTOR TEST AND REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
1. Injector tester	a. Nozzle holder (1)	Connect to testing machine.	Use testing machine.
	b. Injector cap nut (2)	Loosen.	Use 1 in wrench.
	c. Spring adjusting screw (4)	a. Pump tester up to pressure of 2,705 psig (184.1 atm). b. Rotate spring adjusting screw counter-clockwise until nozzle sprays. c. Hold spring adjusting screw and tighten injector cap nut (2) securely.	Adjust by placing screwdriver down through leak-off drilling in cap nut (2). Open valve on tester one-half turn from closed position. Pump tester as necessary to maintain constant pressure
	d. Needle valve (10)	Back Leakage Test: o Pump tester to 2,190 psig (149 atm) o Fully open tester valve.	

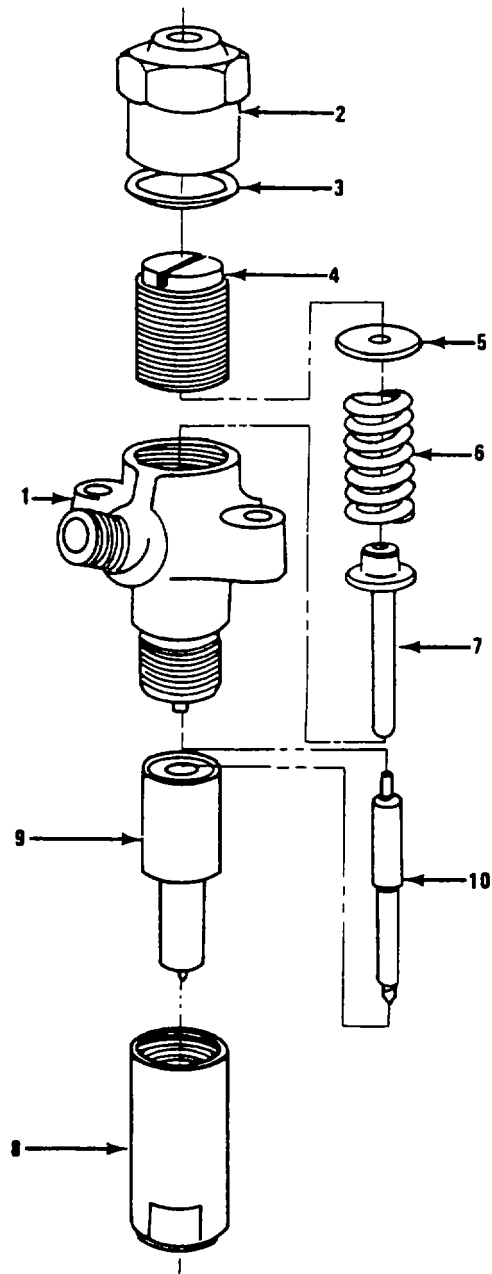
INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)



INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
		<ul style="list-style-type: none"> • Check time it takes to fall to 1,455 psig (99 atm). The time should be 10 seconds for new injectors, 6 seconds for reconditioned. 	<p>Less time indicates damaged or dirty injector. Disassemble, inspect and repair.</p>
	e. Needle valve (10)	<p>Seat Leakage Test:</p> <ul style="list-style-type: none"> • Wipe injector tip dry. • Pump tester to 2,962 psig (201.6 atm). • Hold pressure 10 seconds. • Repair if test failed. 	<p>Nozzle tip dampness is permissible but drop must not be visible.</p>
	f. Injector	<p>Atomization Test:</p> <ul style="list-style-type: none"> • Close valve on tester. • Pump tester until pressure between 2,962 and 3,036 psig (202 and 207 atm) is reached. • Examine four sprays. 	<p>Maintain pressure.</p> <p>Each spray should have no visible streaks or distortion. Spray should spread about 2 inches before hitting sides of containers. Injector should break with hard note (pop).</p>

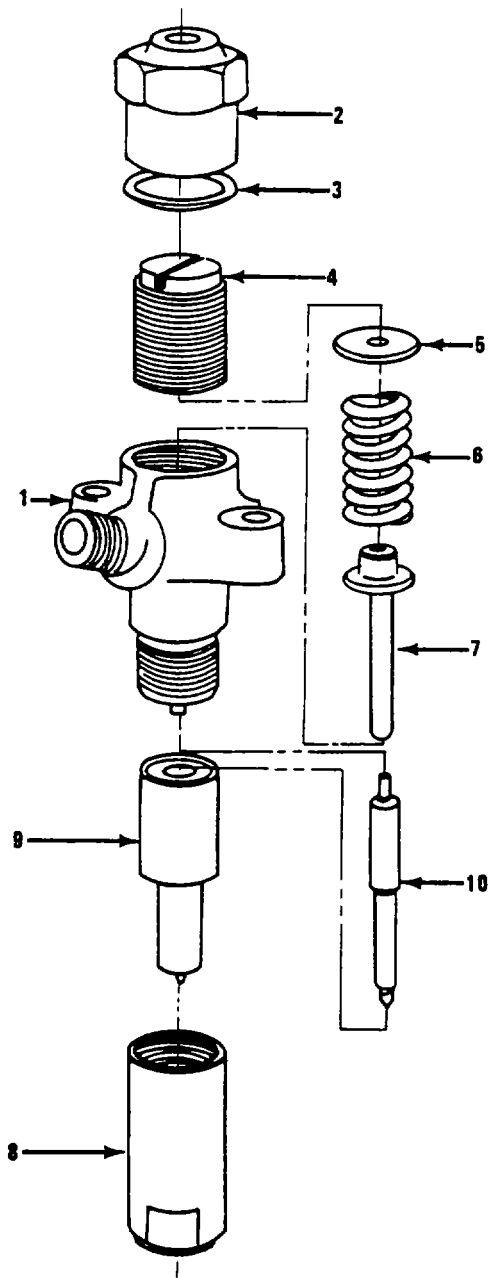
INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)



INJECTOR TEST AND REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
NOTE			
If all tests are satisfied, no further action is required. Injector is ready for use.			
NOTE			
Do not handle injector parts with dry fingers. Always moisten fingers with clean diesel fuel before handling parts.			
<u>DISASSEMBLY</u>			
2. Nozzle holder (1)	a. Injector cap nut (2)	Remove.	Use 1 in wrench. Injector must be held securely.
	b. Copper washer (3)	Remove and discard.	
	c. Spring Adjusting screw (4)	Unscrew and remove.	Use screwdriver.
	d. Spring seat (5)	Remove.	
	e. Spring (6)	Remove.	
	f. Spindle (7)	Remove.	

INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)



INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	g. Nozzle nut (8)	Unscrew and remove.	Use 3/4 in wrench. Do not turn injector upside down to perform this step. The nozzle assembly and needle valve come off with nozzle nut.
	h. Nozzle assembly (9)	Lift out of nozzle nut.	Nozzle and needle valve are lapped and must be kept as a pair.
NOTE			
Do not interchange needle valves.			
3. Nozzle assembly (9)	Needle valve (10)	Lift out of assembly.	

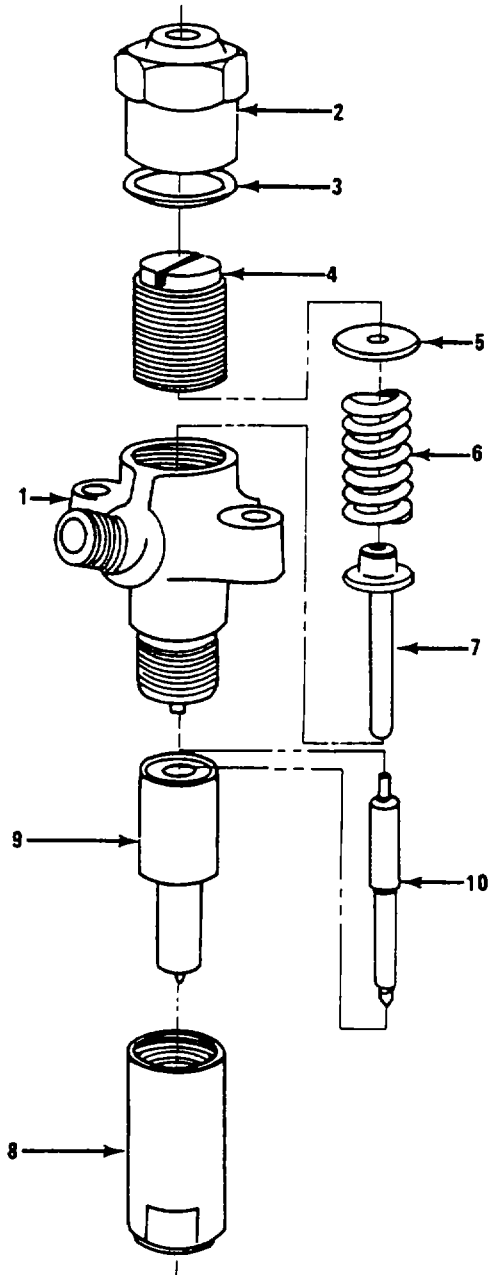
INSPECTION, CLEANING AND REPAIR

NOTE

Wash all injector parts in clean diesel fuel.

4.	Nozzle assembly (9)	a. Clean off all carbon with soft brass wire brush. b. Inspect needle valve tip for bluing and seat for scouring.	
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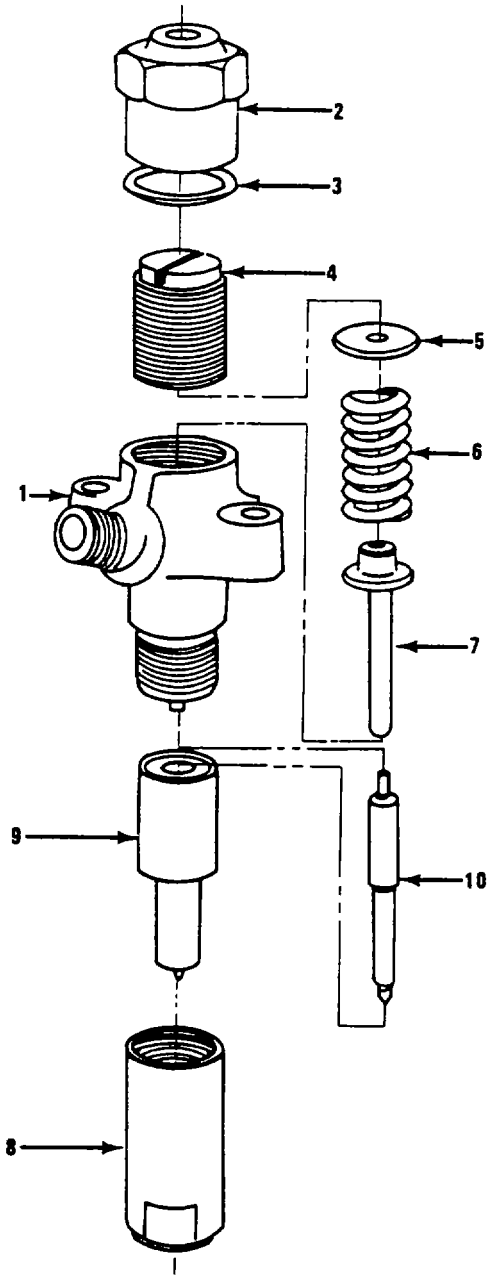
INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)



INJECTOR TEST AND REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
5.	Nozzle assembly (9)	c. Replace nozzle and valve if blued or scoured. a. Look at spray holes. b. If filled with carbon replace nozzle assembly.	They should not be filled with carbon.
6.	Spring (6)	a. Check for breaks, rust and square ends. b. Replace if defective.	
7.	Spindle (7)	a. Examine surface in bore at bottom end of spindle. b. Replace if damaged.	Should not be seriously flattened.
8.	Nozzle holder (1) and nozzle nut (8)	a. Inspect joint faces for scratches. b. Replace if scratched.	
9.	Nozzle assembly (9) and needle valve (10)	a. Wet all surfaces with clean diesel fuel.	

INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)

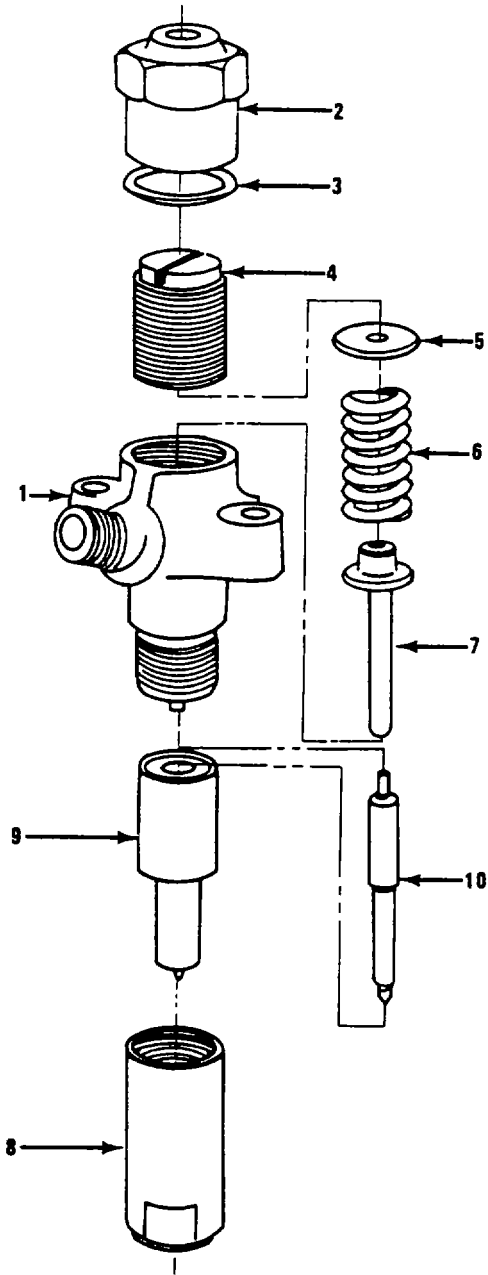


INJECTOR TEST AND REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Fit valve into nozzle.	Valve should drop in under own weight and fall out when nozzle is inverted.
		c. If valve fails test, replace both nozzle and needle valve.	
<u>ASSEMBLY</u>			
10. Nozzle assembly (9)	Needle valve (10)	Fit needle valve into assembly.	
11. Nozzle nut (8)	Nozzle assembly (9)	Fit into nut.	
12. Nozzle holder (1)	a. Nozzle nut (8) and nozzle assembly (9)	Locate carefully on dowels on holder and screw on. Torque to 45 - 50 ft-lb.	Use nozzle nut socket and torque wrench.
	b. Spindle (7)	Fit into top of holder.	
	c. Spring (6)	Fit over spindle into holder.	
	d. Spring seat (5)	Fit on top of spring.	

INJECTOR TEST AND REPAIR INSTRUCTIONS
(Continued)



INJECTOR TEST AND REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	e. Spring adjusting screw (4)	Screw into top of holder until pressure on spring is felt.	
	f. Copper washer (3)	Fit over top of adjusting screw.	
	g. Injector cap nut (2)	Screw on spring adjusting screw. Do not tighten.	Make sure copper washer (3) remains positioned.
13. Injector tester	a. Nozzle holder (1)	Connect to tester. Pump tester pressure and rotate spring adjusting screw clockwise at same time. Adjust until injector opens (sprays) at 2,999 psig (205 atm).	Use screwdriver.
	b. Injector cap nut (2)	Torque to 37 - 43 ft-lb.	Use 1 in socket and torque wrench.
14. Injector tester	Nozzle holder (1)	Retest needle valve back leakage, needle seat leakage and atomization.	Steps 1d, 1e, 1f. If injector fails test replace injector.

CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS

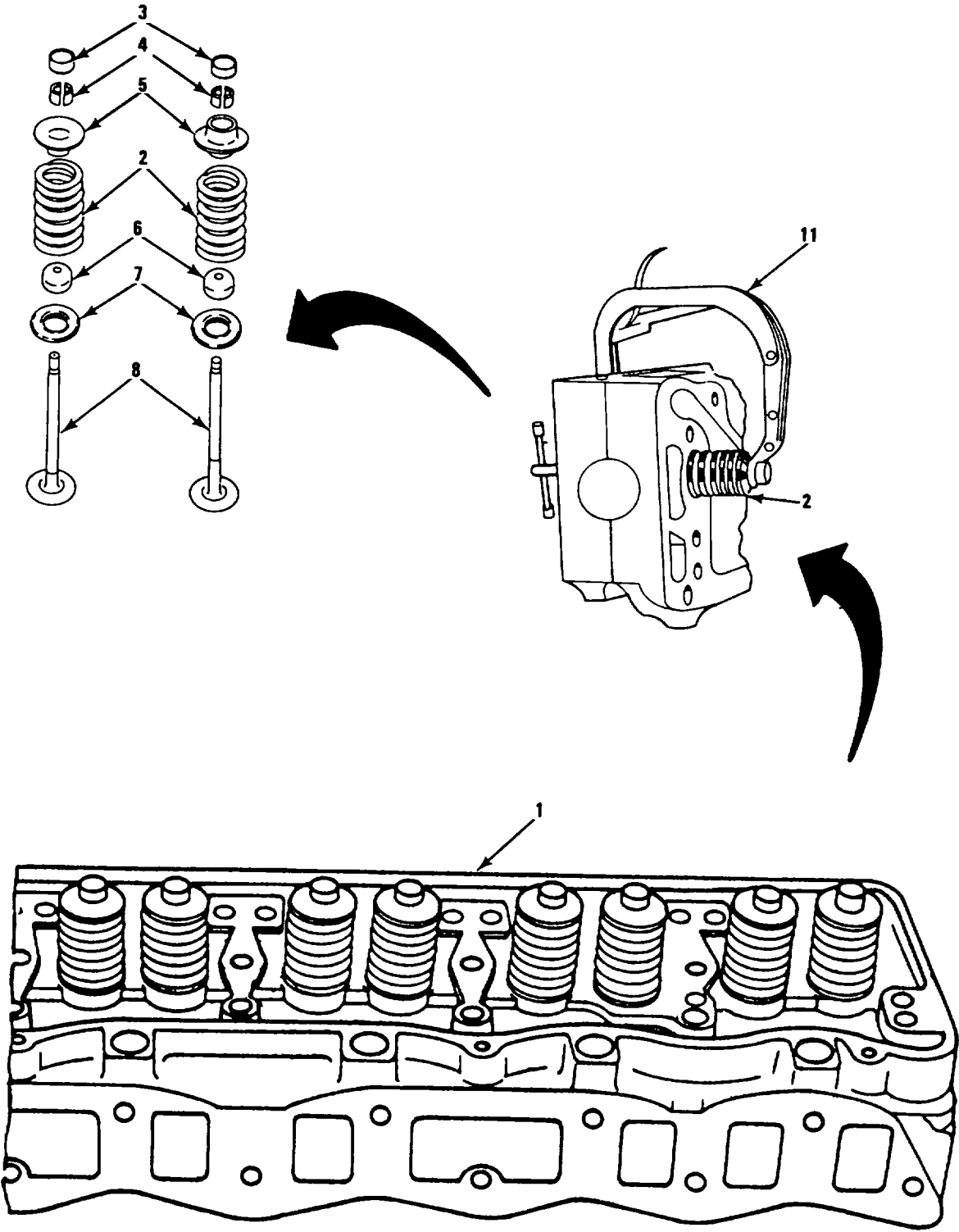
This task covers:

- a. Disassembly b. Inspection and Repair c. Assembly**

INITIAL SETUP

<p>Tools:</p> <p>Valve spring compressor Valve guide remover Hammer, ball peen Valve seat remover Micrometer caliper, inside Micrometer caliper, outside Valve seat grinding kit Lathe Spring tester Straightedge Valve guide installer Valve seat installer Air compressor Air blow gun Feeler gage Safety goggles</p> <p>Materials/Parts:</p> <p>Oil seals, valve stem Engine oil</p>	<p>Equipment Condition:</p> <p>Page 2-291</p>	<p>Condition Description:</p> <p>Cylinder head assembly removed.</p>
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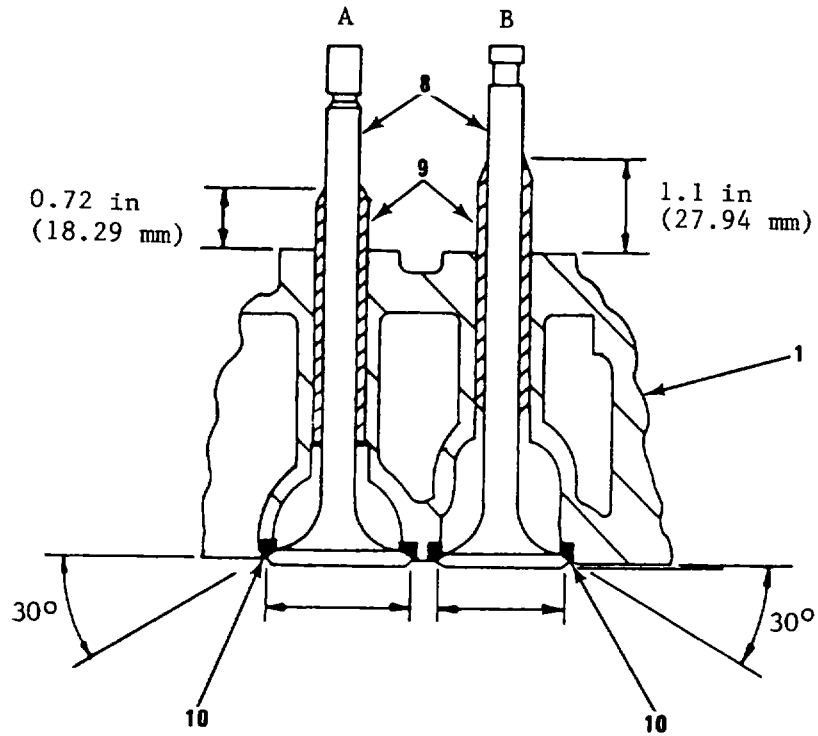
CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)



CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
<p>When disassembling valves be-sure to maintain component identification by valve number. Valves are numbered front to rear, one through twelve. Reused components must be reassembled to their original positions.</p>			
<u>DISASSEMBLE:</u>			
1. Cylinder head assembly (1)	a. Cylinder head (1)	Turn onto side.	
	b. Valve springs (2)	Compress.	Use valve spring compressor (11).
	c. Valve stem cap (3)	Remove.	
	d. Split collets (4)	Extract.	
	e. Valve springs (2)	Release compression.	
	f. Spring retainers (5)	Remove.	
	g. Valve springs (2)	Remove.	
	h. Oil seals (6)	Remove and discard.	
	i. Spring seats (7)	Remove	

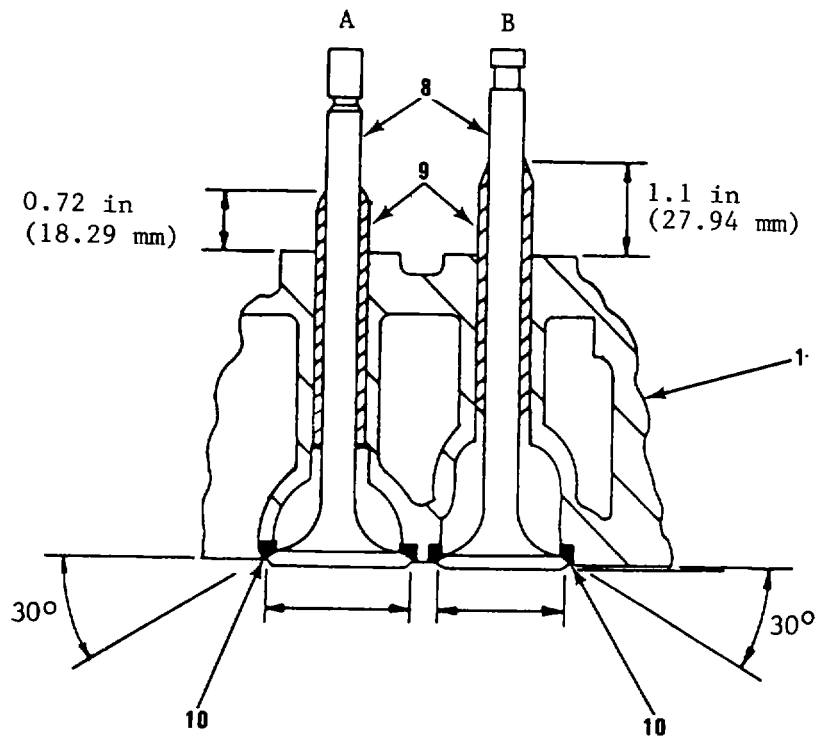
CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)



A - INLET VALVE
B - EXHAUST VALVE

CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)

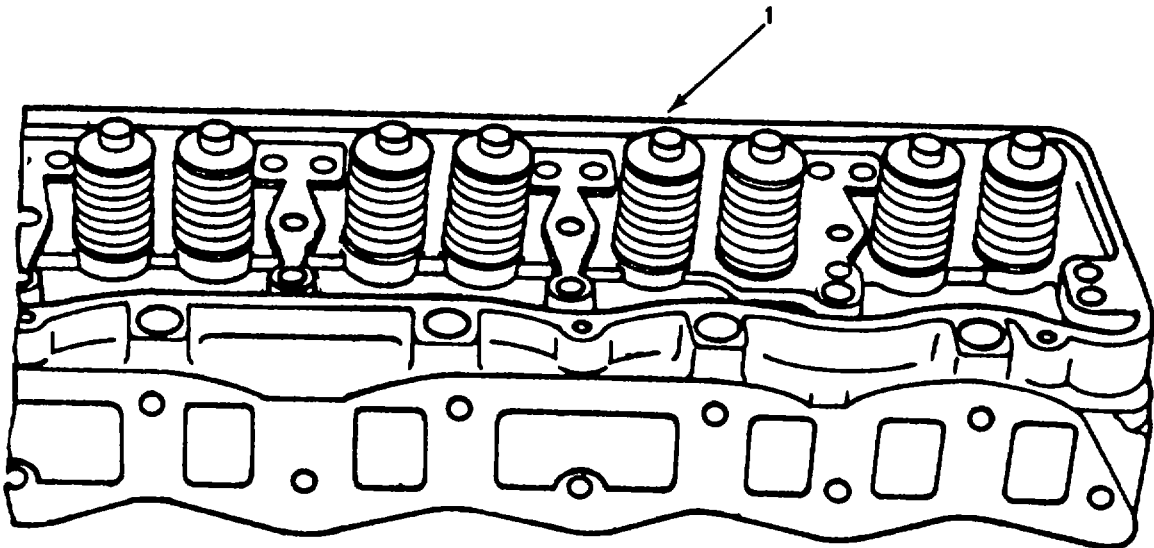
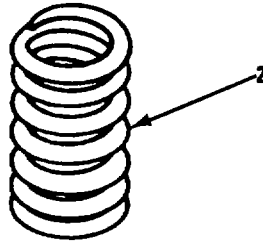
LOCATION	ITEM	ACTION	REMARKS
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A - INLET VALVE
 B - EXHAUST VALVE

CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
		c. Replace guide if worn.	See removal step 1k.
	b. Valve seat inserts (10)	a. Inspect for: Excessive carbon build-up, Pitting, Cracks, Seat angle greater than 30°, and Looseness.	
		b. Recut seats which are pitted or burned.	Use valve seat grinding kit.
		c. Replace defective insert.	See removal step 1k.
3. Valve (8)	Valve (8)	a. Inspect face for: Pitting, Distortion (warpage), Ridging, Cracks, and Excessive carbon build-up.	
		b. Inspect stem for Scuffing, Scratches.	

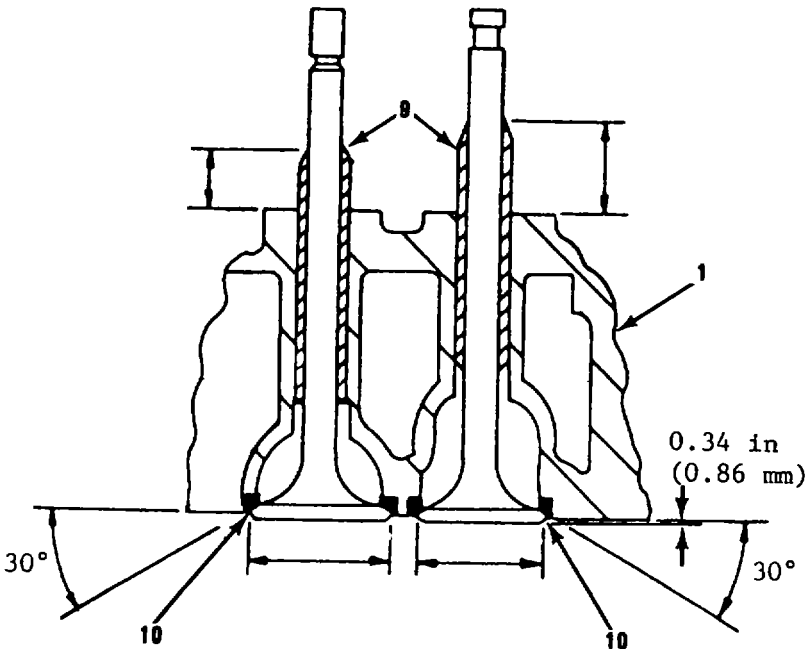
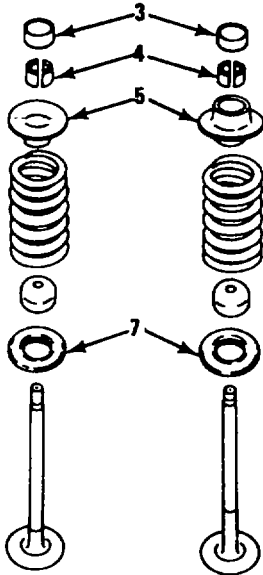
CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)



CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Regrind face if not unduly pitted or distorted. Minimum edge thickness 0.008 in. (0.79 mm).	Use lathe.
4. Valve spring (2)	Valve spring (2)	d. Replace valve guide if valve stem scuffed or scratched. a. Inspect for Distortion, Broken ends.	
		b. Test for resiliency. Limits: Valve open - 163 lb. (73.94 kg) Valve closed - 65 lb. (29.48 kg).	Use spring tester.
		c. Replace spring if defect noted or not within resiliency.	
5. Cylinder head (1)	Cylinder head (1)	a. Inspect for warpage.	Use accurate straightedge and feeler gage.
		b. Inspect for cracks.	Seal cooling passages, pressurize and place head in heated water.

CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)



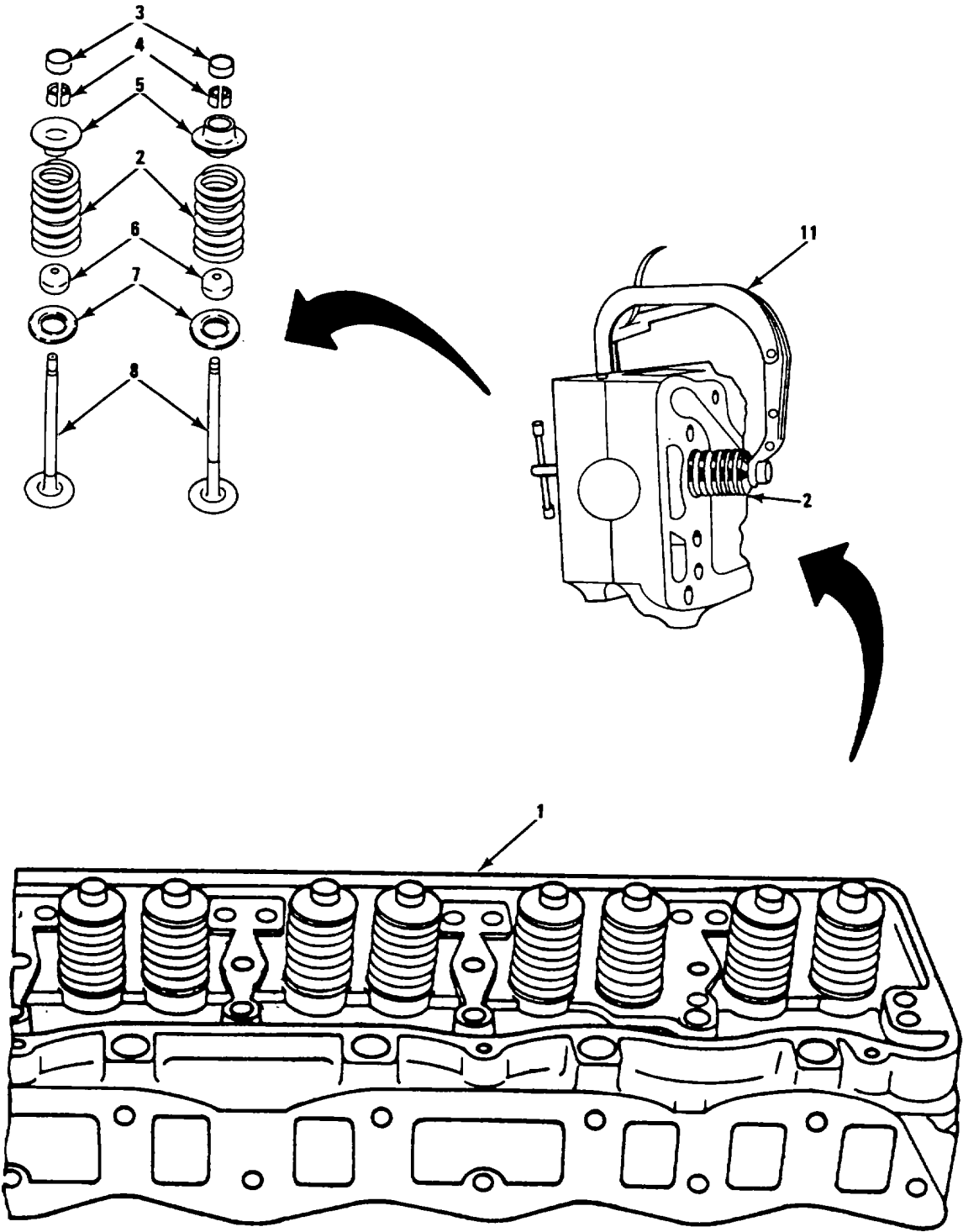
CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
6.	All other components: spring seat (7), spring retainer (5), split collets (4), and valve stem cap (3)	<p>c. Replace cylinder head if warped or cracked.</p> <p>Replace if worn or damaged.</p>	

ASSEMBLE:

7. Cylinder head (1)	a. Valve guide (9)	Install to correct depth and protrusion in head (see figure).	Use valve guide installer. See figure protrusion for dimensions.
	b. Valve seat (10)	a. Press into head.	Use valve seat installer. Install with chamfer (beveled) edge away from combustion chamber.
		b. Cut seat (30°) to give maximum valve protrusion 0.034 in. (0.86 mm) above head.	Use valve seat grinding kit.

CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)



CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Recut old seat if valve guide replaced to ensure concentricity.	Use valve seat grinding kit.
	c. Cylinder head (1)	a. Place on side. b. Clean valve guide bores.	
	d. Valve (8)	a. Lubricate stem with clean engine oil. b. Insert in correct position, valve head against seat.	If reusing original valves make sure they are installed in their original bores.
	e. Valve spring seat (7)	Install on valve stem.	
	f. Oil seal (6)	Install on valve stem.	
	g. Valve spring (2)	Place over stem and oil seal (6).	
	h. Spring retainer (5)	Place on spring.	
	i. Valve spring (2)	Compress.	Use valve spring compressor.

CYLINDER HEAD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	j. Split collets (4)	Place in valve stem collet grooves.	
	k. Valve spring (2)	Release compres- sion engaging collets with spring retainers.	
	1. Valve stem cap (3)	Fit on valve stem.	

CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS

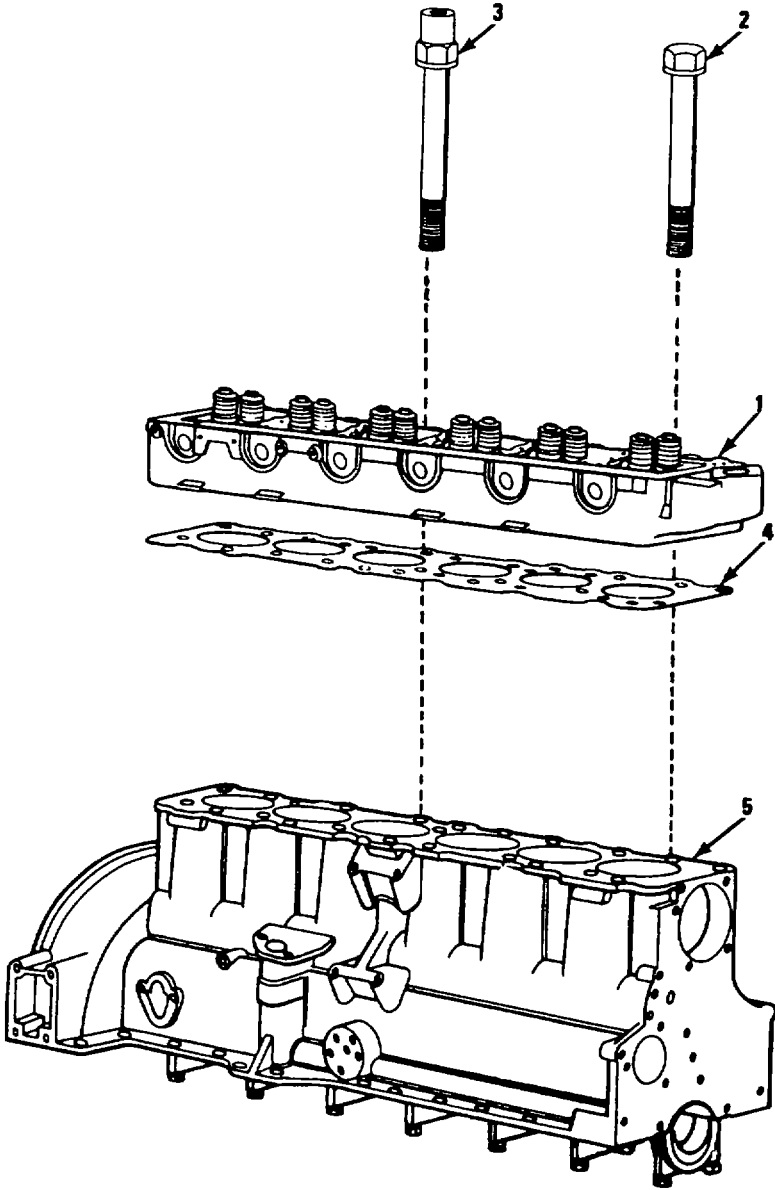
This task covers:

- a. Removal
- b. Installation

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Ratchet with 1/2 in drive 6 in extension 3/4 in socket Torque wrench (O - 175 ft-lb) Air compressor Air blow gun Putty knife Safety goggles	TM 5-1940-277-20 TM 5-1940-277-20 TM 5-1940-277-20 TM 5-1940-277-20 TM 5-1940-277-20 TM 5-1940-277-20 TM 5-1940-277-20	Cooling system drained. Air cleaner removed. Turbocharger removed. Header tank/heat exchanger removed. Intercooler removed. Manifolds removed. Fuel filter assembly and transmission oil cooler with bracket removed. Rocker arm shaft assembly and push rods removed. Injectors removed.
Materials/Parts:		
Engine oil Cylinder head gasket	TM 5-1940-277-20 TM 5-1940-277-20	
Personnel Required: Two		

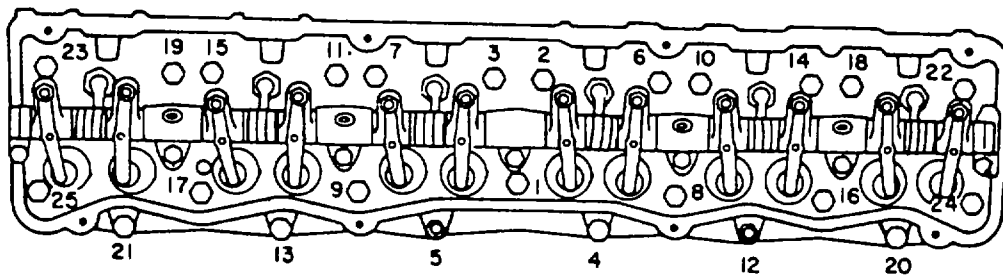
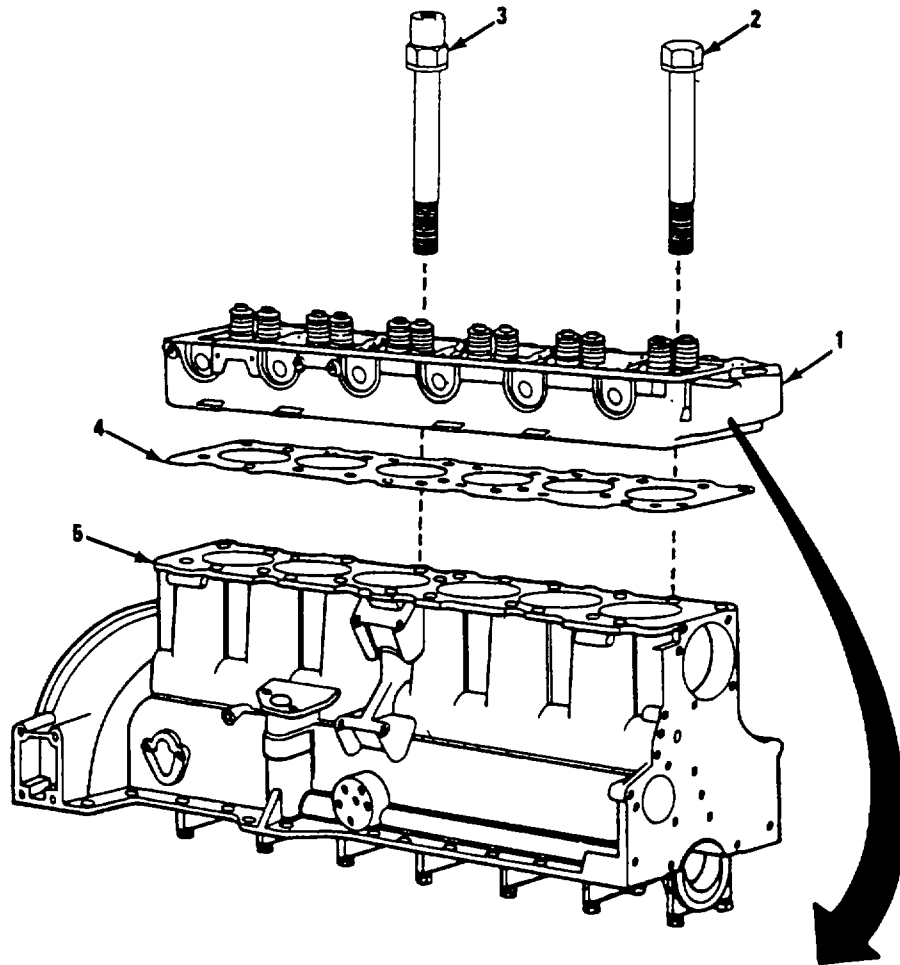
CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVE:</u>			
1. Cylinder head assembly (1)	a. 23 bolts (2) and 2 bolts (3)	Remove.	Use 3/4 in socket with extension and ratchet.
	b. Cylinder head assembly (1)	Remove from cylinder block (2).	Use two persons or lifting device.
	c. Head gasket (4)	Remove and discard.	
<u>INSTALL:</u>			
2. Cylinder head assembly (1)	Cylinder head assembly (1)	Clean all mating surfaces.	Use putty knife. Make sure surfaces free of carbon buildup, gasket material or other substance.
<u>WARNING</u>			
Always use safety goggles when using dry compressed air for cleaning. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.			
3. Cylinder block (5)	a. Cylinder block (5)	Check, clean and dry all cylinder head bolt holes.	Use low air pressure, be careful not to blow any foreign material into cylinders.

CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

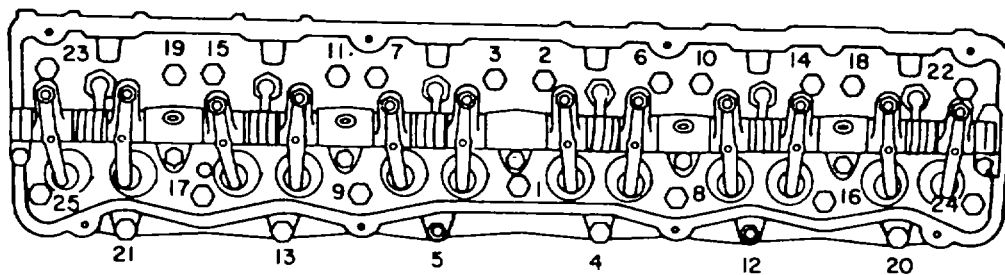
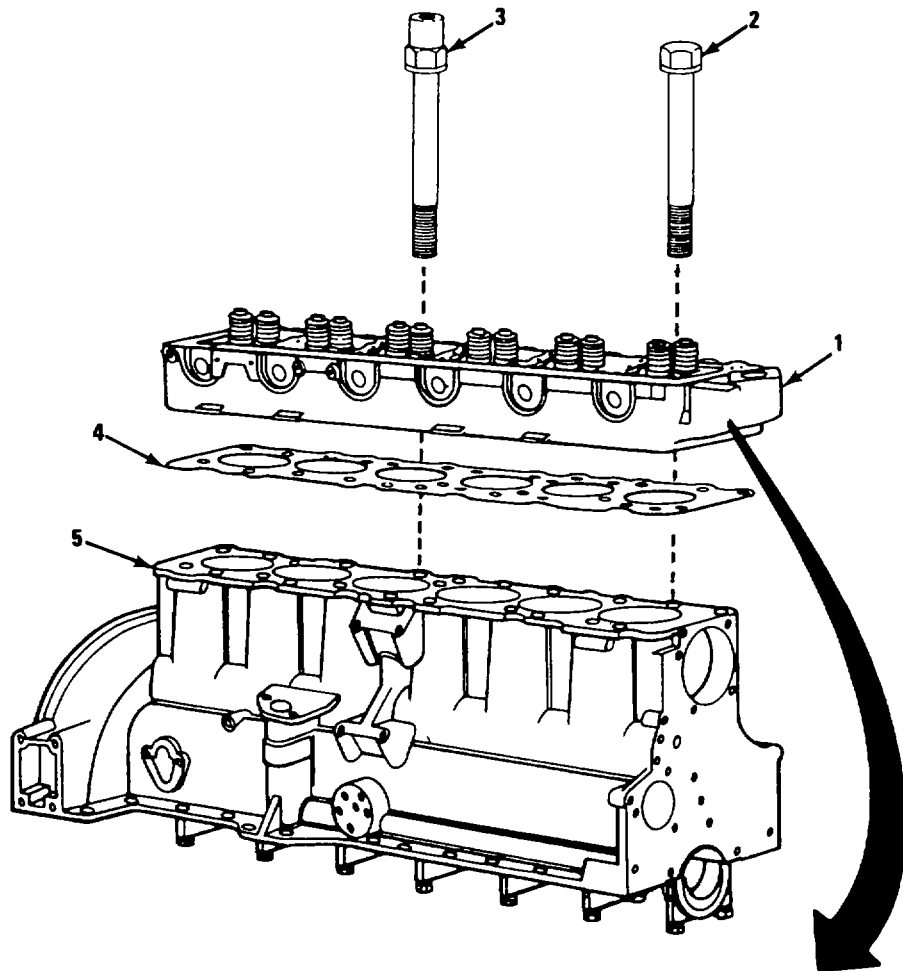


CYLINDER HEAD BOLT TIGHTENING SEQUENCE

CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Head gasket (4)	a. Apply thin smear of clean grease on both sides of gasket. b. Position on block over thimble dowels.	
	c. Cylinder head assembly (1)	Place in position on block.	Use two persons or lifting device. Do not damage gasket.
4. Cylinder head assembly (1)	23 bolts (2) and 2 bolts (3)	a. Smear threads and underside of bolts liberally with clean engine oil.	
		b. Install finger tight.	Make sure two extension bolts (5) for mounting intercooler are in numbers 5 and 12 positions.
<u>CAUTION</u>			
<p>Under no circumstance torque bolts more than specified. Severe metal fatigue may result.</p>			
		c. Torque bolts evenly in sequence to 50 ft-lb then to 95 ft-lb.	Use 3/4 in socket and torque wrench. Turn each bolt in sequence 1/2 turn at a time until specified torque reached.

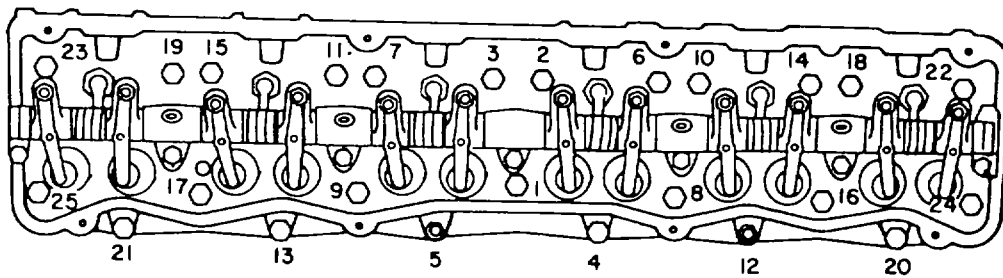
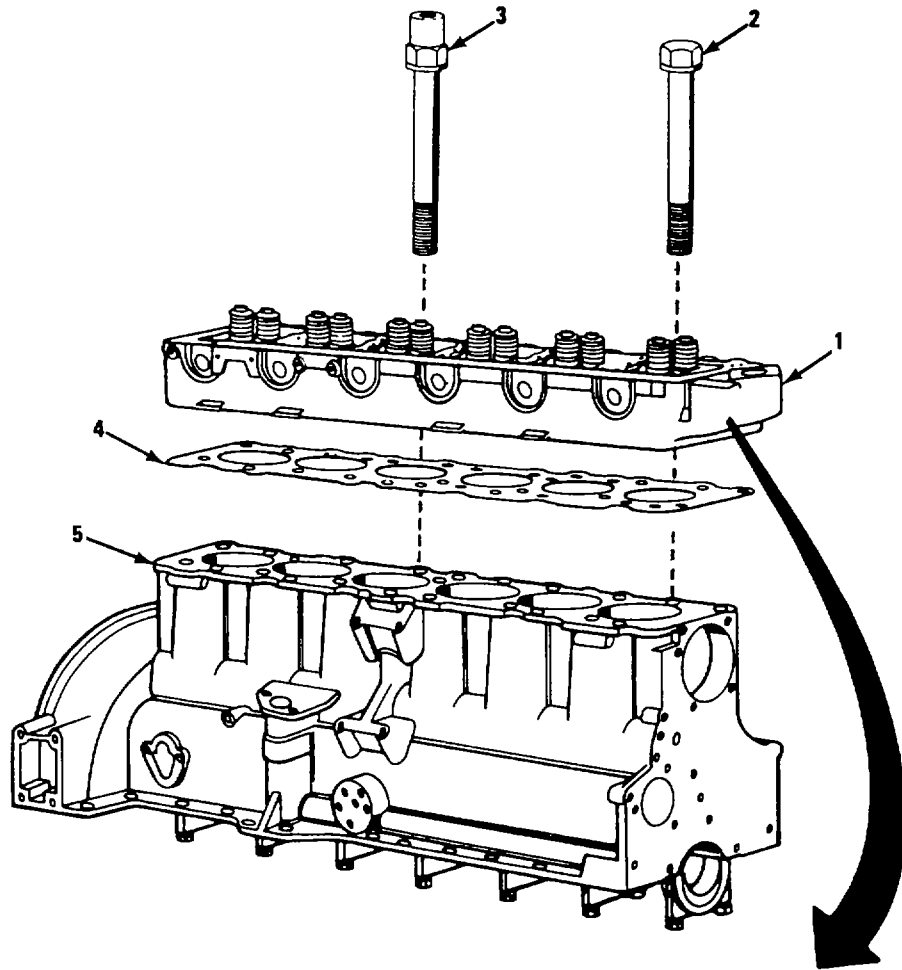
CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



CYLINDER HEAD BOLT TIGHTENING SEQUENCE

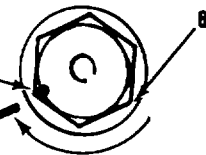
CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
		d. Reassemble engine in accordance with instructions.	See equipment Conditions References. (See page 2-269)
<u>CAUTION</u>			
Do not start or operate engines with boat out of water. Severe engine damage will result.			
5. Engine assembly	Engine assembly	a. Start and operate engine until water temperature reaches 60-70°C.	See TM 5-1940-277-10 for starting procedures.
<u>NOTE</u>			
Perform the following task while the engine is still hot.			
		b. Remove inter-cooler.	See TM 5-1940-277-20.
		c. Remove rocker arm cover.	See TM 5-1940-277-20.
		d. Remove rocker arm assembly.	See TM 5-1940-277-20.
6. Cylinder head assembly (1)	Each cylinder head bolts in turn using numbering sequence shown.	a. Loosen bolt (2) and (3).	
		b. Re-torque	Use 3/4 in.

CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)



CYLINDER HEAD BOLT TIGHTENING SEQUENCE

Mark bolt head corner and adjacent surface



Turn until this corner reaches mark.

CYLINDER HEAD ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		bolt to 50 ft-lb.	socket and torque wrench.
	c.	Wipe the area of cylinder head around bolt free of oil.	
	d.	Mark one corner of bolt and adjacent cylinder head surface.	See illustration.
	e.	Tighten bolt until next corner (6) but one reaches the mark.	See illustration.
	f.	Reinstall rocker arm assembly.	See TM 5-1940-277-20.
	g.	Adjust valve.	See TM 5-1940-277-20.
	h.	Reinstall rocker arm cover.	See TM 5-1940-277-20.
	i.	Reinstall intercooler.	See TM 5-1940-277-20.

CYLINDER HEAD ASSEMBLY - VALVE SPRING REPLACEMENT INSTRUCTIONS

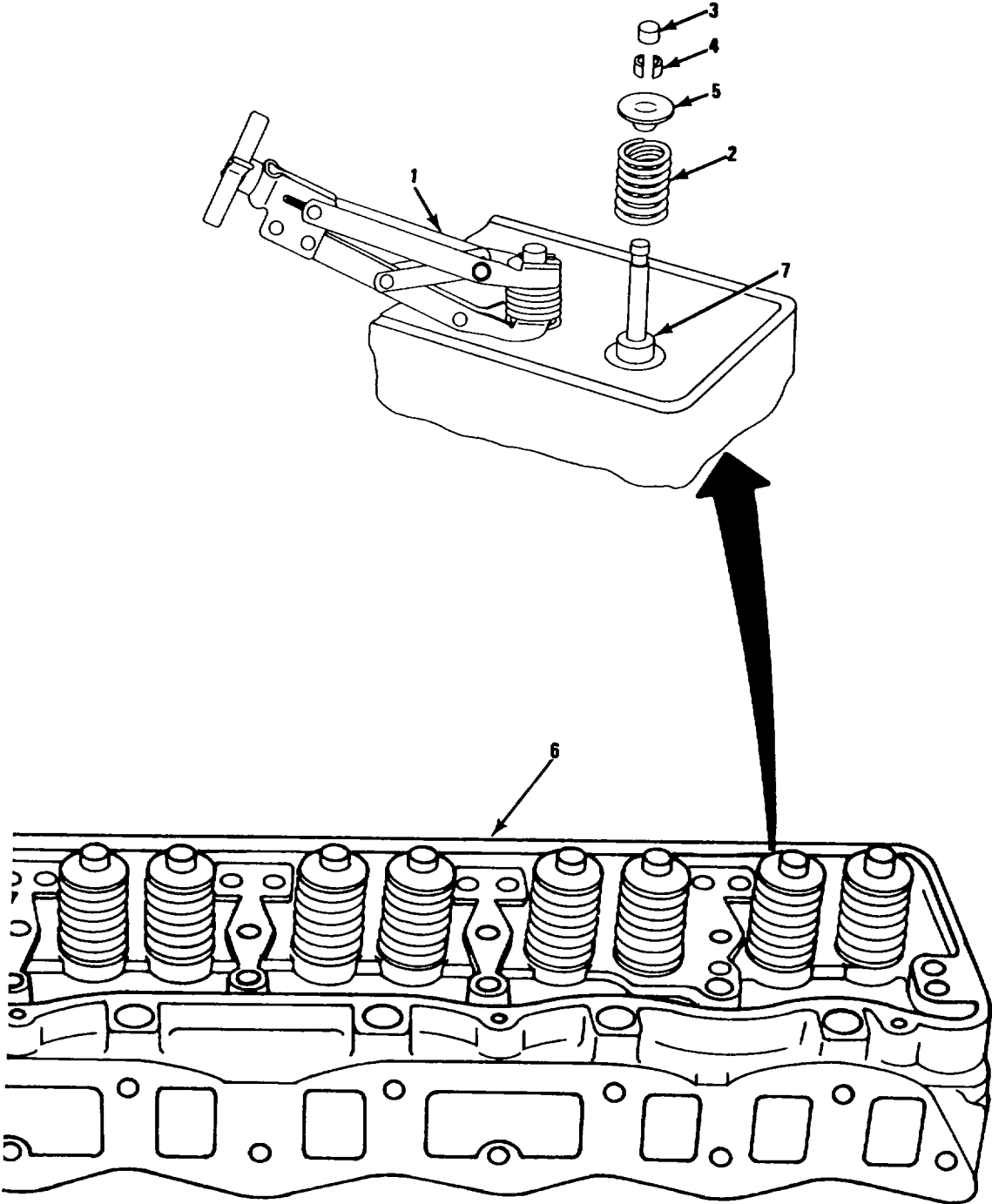
This task covers:

- a. Removal (Cylinder head not removed from engine)
- b. Installation (Cylinder head not removed from engine)

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Valve spring lifter	TM 5-1940-277-20	Intercooler removed.
Materials/Parts:	TM 5-1940-277-20	Rocker arm shaft assembly removed.
Valve springs		

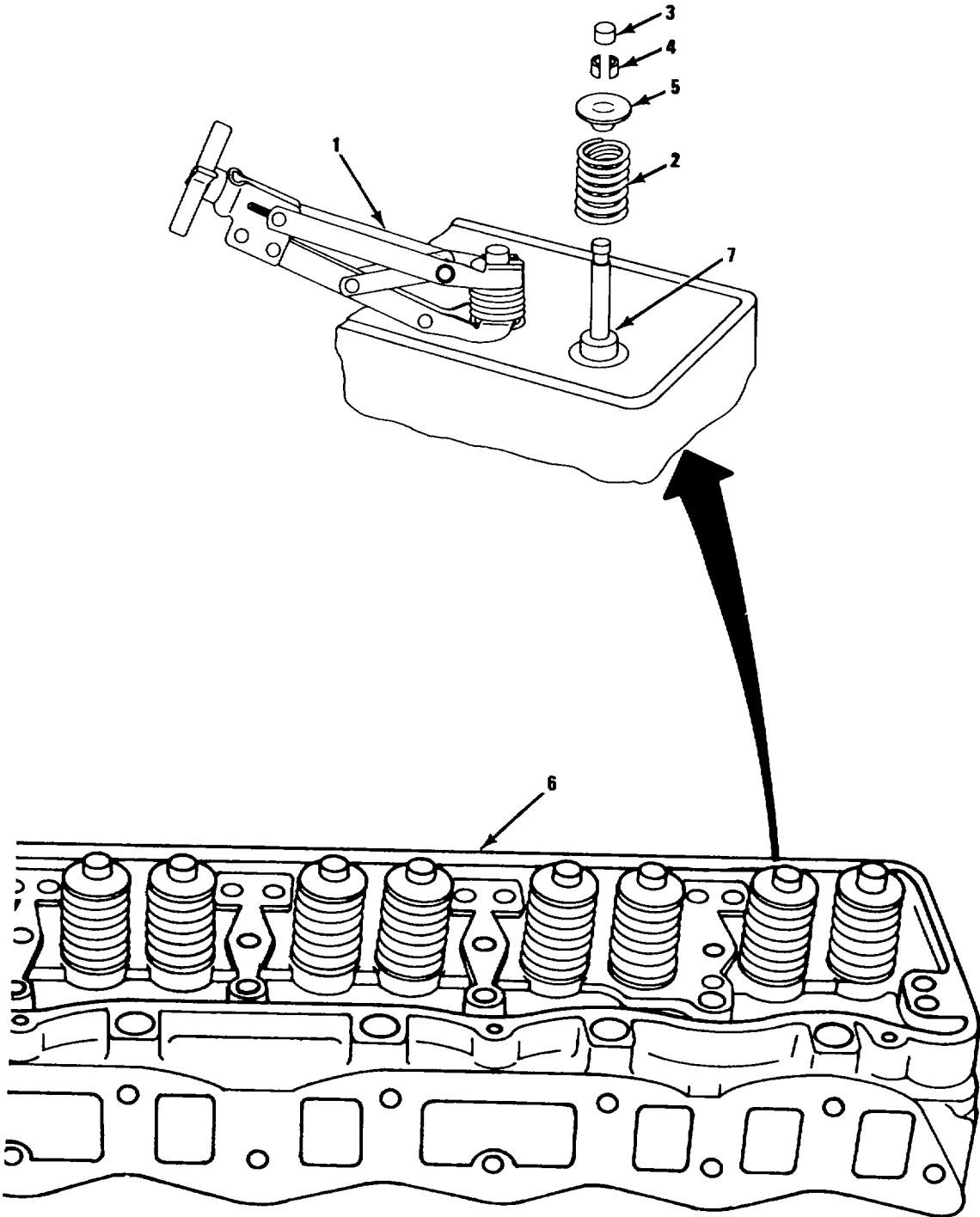
CYLINDER HEAD ASSEMBLY - VALVE SPRING REPLACEMENT INSTRUCTIONS (Continued)



CYLINDER HEAD ASSEMBLY - VALVE SPRING REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
Piston at which valve spring is to be replaced must be at top dead center (refer to Timing Procedures, TM 5-1940-277-20).			
<u>REMOVAL:</u>			
1. Cylinder head assembly (6)	a. Valve spring (2)	Compress	Use valve spring lifter (1).
	b. Valve stem cap (3)	Remove.	
	c. Split collets (4)	Extract.	
	d. Valve spring (2)	Release compression.	
	e. Spring retainer (5)	Remove.	
	f. Valve spring (2)	Remove.	
<u>INSTALLATION:</u>			
2. Cylinder head assembly (6)	a. New valve spring (2)	Place over stem and oil seal (7).	
	b. Spring retainer (5)	Place on spring.	
	c. Valve spring (2)	Compress.	Use valve spring lifter (1).

CYLINDER HEAD ASSEMBLY - VALVE SPRING REPLACEMENT INSTRUCTIONS (Continued)



CYLINDER HEAD ASSEMBLY - VALVE SPRING REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Split collets (4)	Place in valve stem collet grooves.	
	e. Valve spring (2)	Release compression engaging collets with spring retainer.	
	f. Valve stem cap (3)	Fit on valve stem.	

OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS

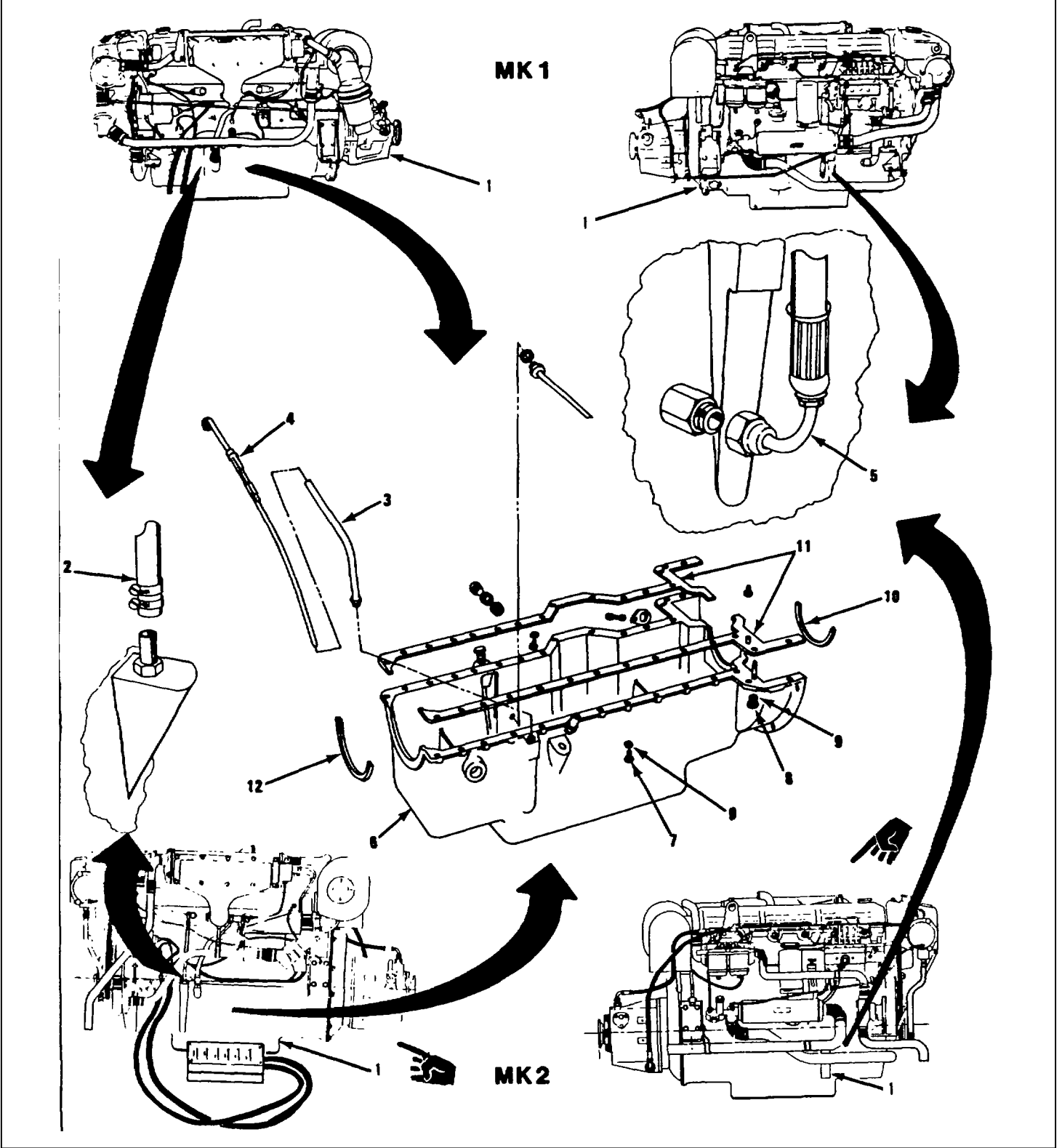
This task covers:

- a. Removal
- b. Inspection
- c. Transfer of parts to replacement sump
- d. Installation

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Ratchet	Page 2-179	Engine assembly removed from boat and mounted on engine maintenance stand or laid on side on top of work bench.
6 in extension		Transmission removed.
9/16 in socket		Engine oil drained.
3/4 in open end wrench	Page 2-345	Cooling system drained.
7/8 in open end wrench	TM 5-1940-277-20	Flywheel housing cover removed.
1-1/8 in open end wrench	TM 5-1940-277-20	
15/16 in box wrench	Page 2-317	
Flat tip screwdriver		
1/2 in box wrench		
3/8 in universal joint		
 Materials/Parts:		
Oil sump		
Oil sump gasket set		
Lockwasher		
O-ring, sump pump suction type		
Engine oil		
Silicone sealant		

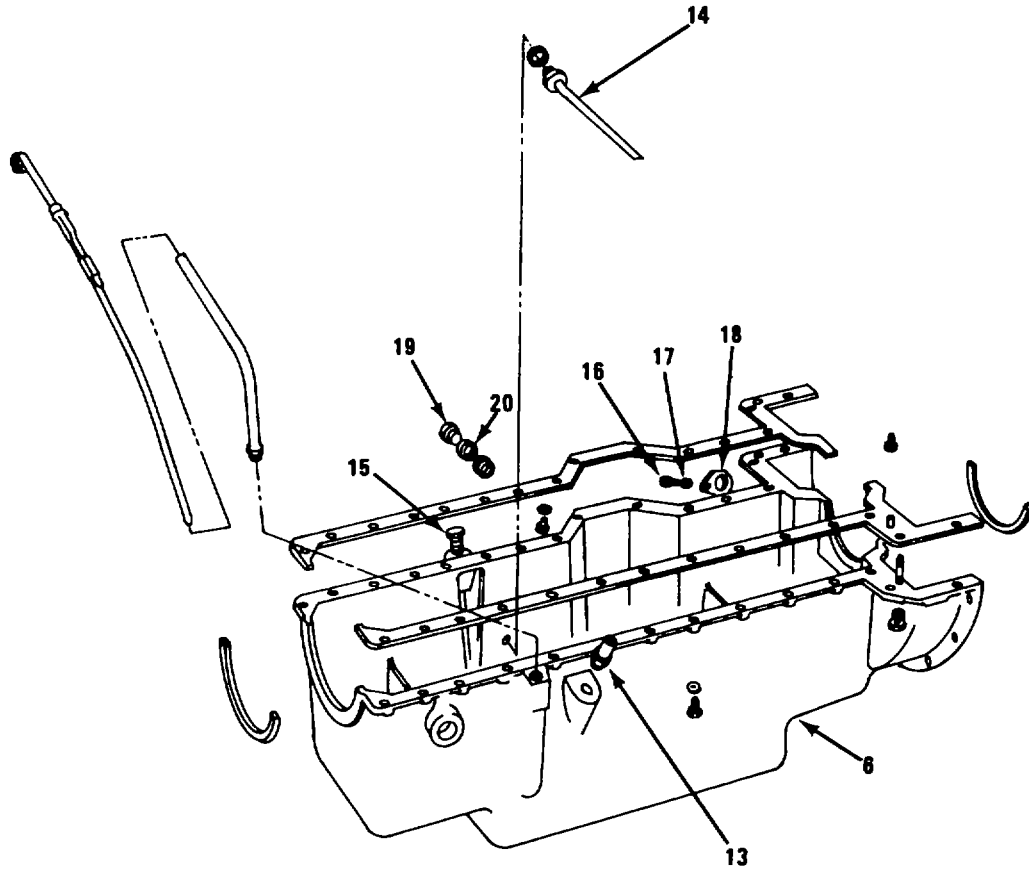
OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL:</u>			
. Engine assembly (1)	a. Turbocharger oil drain pipe (2)	Loosen clamp and disconnect.	Use screwdriver.
	b. Dipstick tube (3) and dipstick (4)	Remove.	Use 3/4 in open end wrench.
	c. Sump pump hose and end fittings assembly (5)	Disconnect at oil sump end.	Use 7/8 in open end wrench.
	d. Engine assembly (1)	Invert on maintenance stand or laid on side on top of work bench.	
2. Oil sump (6)	a. 25 capscrews (7), 4 nuts (8) and 29 washers (9)	Remove.	Use 9/16 in socket, 6 in extension, ratchet and universal joint.
	b. Oil sump (6)	Remove and set aside.	
	c. Gaskets (11) and seals (10 and 12)	Remove and discard.	
<u>INSPECTION:</u>			
3.	Oil sump (6)	a. Visually inspect for cracks, distortions.	

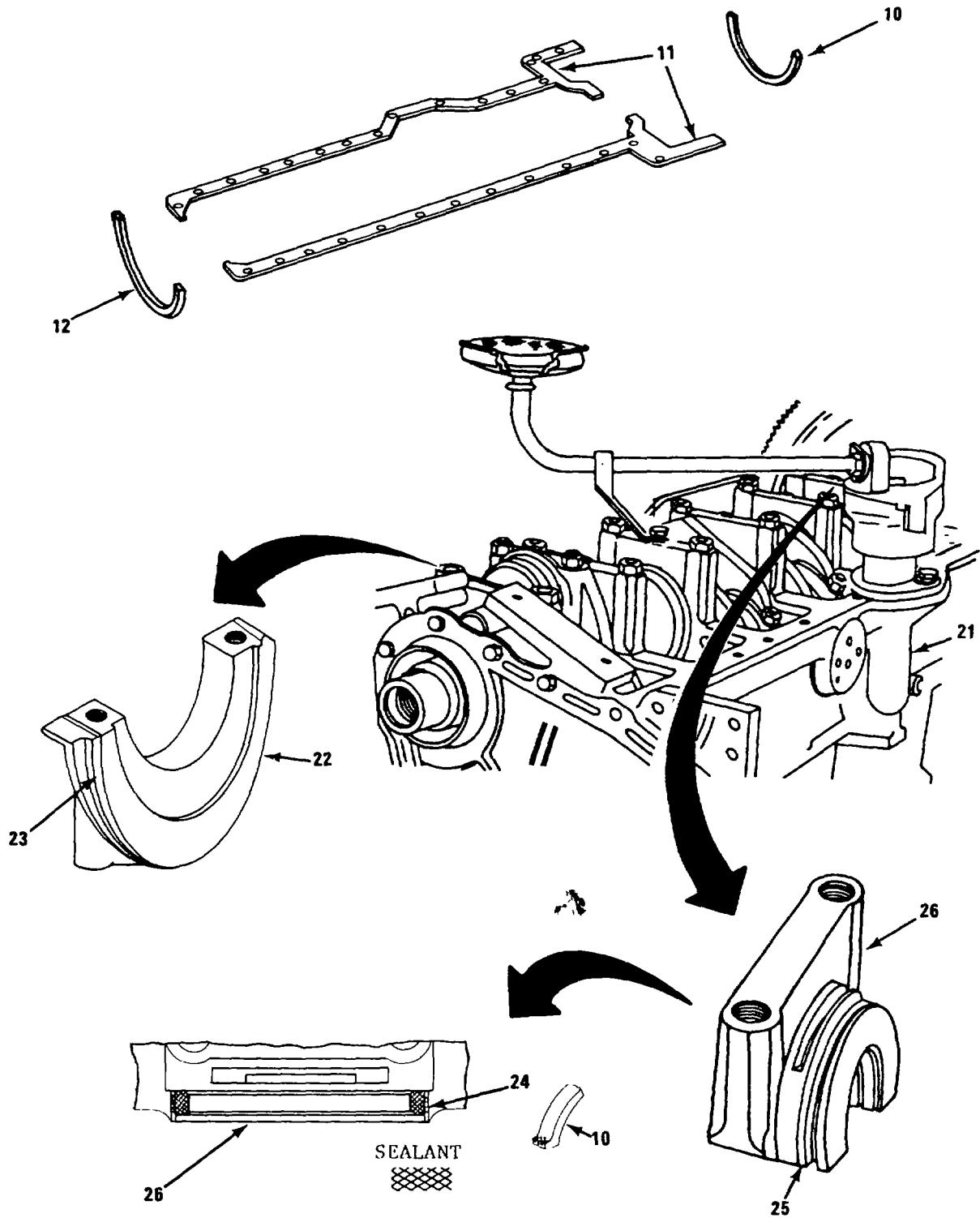
OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Replace sump if any defects noted.	
<u>TRANSFER OF PARTS TO REPLACEMENT SUMP:</u>			
4. Oil sump (6)	a. Turbocharger oil drain adapter (13)	Transfer (remove from old sump and install on new sump).	Use 1-1/8 in open end wrench.
	b. Sump pump adapter, male, and suction pipe (14)	Transfer, replace O-ring.	Use 7/8 in open end wrench.
	c. Dipstick blanking plug (15)	Transfer.	Use 3/4 in open end wrench.
	d. Setscrew (16), lock-washer (17) and timing hole cover (18)	Transfer.	Use 1/2 in box wrench.
	e. Drain plug (19) and washer (20)	Transfer.	Use 15/16 in box wrench.

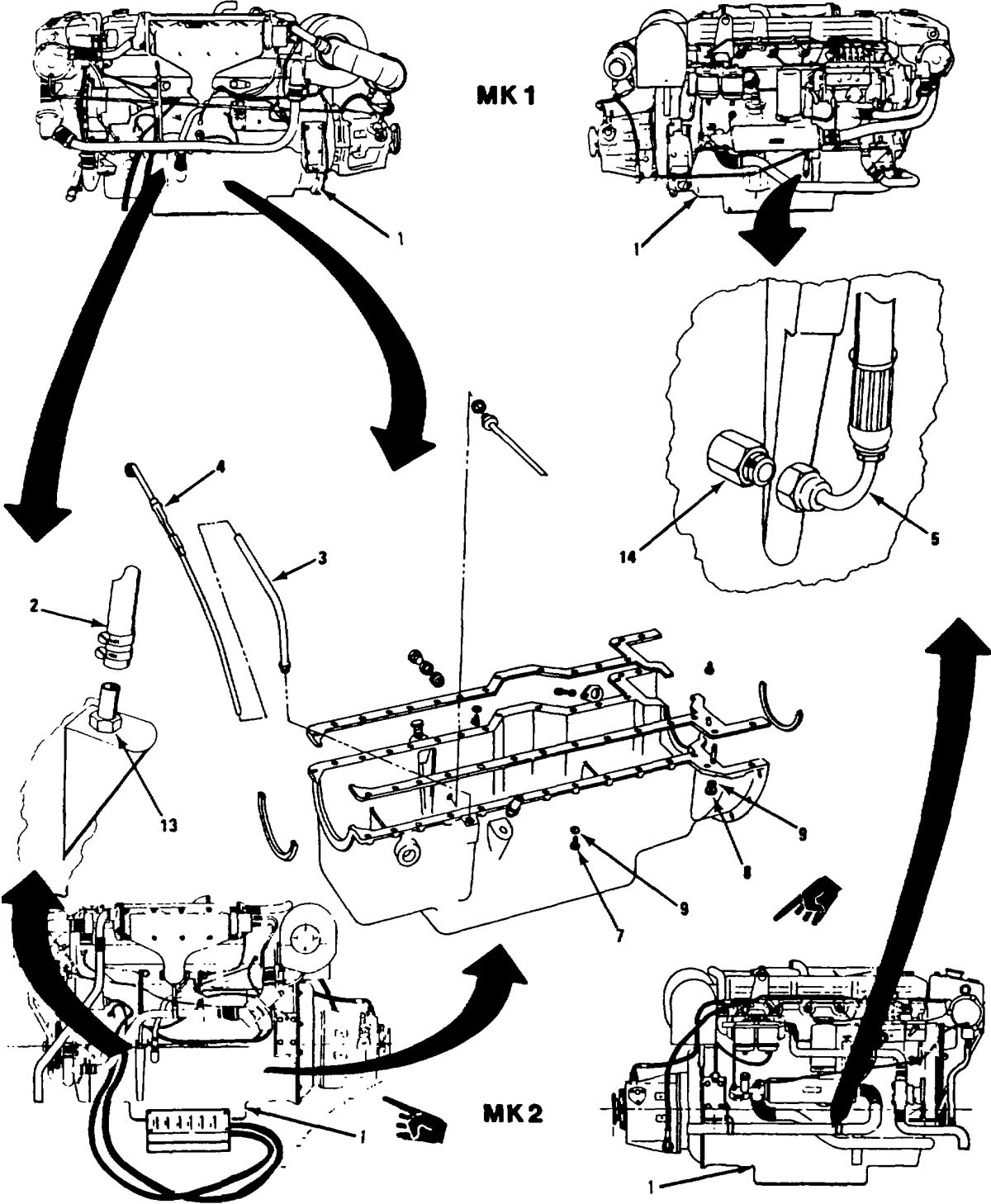
OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
5. Cylinder block (21)	a. Oil sump gasket (11)	a. Apply sealant to both sides of gasket.	Use silicone sealant.
		b. Fit gasket to face of block using dowels for positioning.	
		c. Apply sealant in space for gasket in front oil seal groove (23) around front main bearing cap (22).	
	b. Front oil seal (12)	Fit in groove in front main bearing cap (23)	Take care not to trap timing gear housing gasket.
c. Rear oil seal (10)	a. Make sure area (24) under seal feet is free of sealant.	b. Apply thin coat of sealant as shown.	c. Fit in groove (25) in rear main bearing cap (26).
	d. Oil sump (6)	Position on block.	

OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



OIL SUMP (PAN) INSPECTION AND REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
6. Engine assembly (1)	e. 25 capscrews (7), 4 nuts (8) and 29 washers (9)	Install and tighten.	Use 9/16 in socket, 6 in extension, ratchet and universal joint.
	a. Engine assembly (1)	Return to upright position, either in engine maintenance stand or on blocks.	
	b. Dipstick (4) and dipstick tube (3)	Install.	Use 3/4 in open end wrench.
	c. Sump pump hose and end fittings assembly (5)	Connect to adapter (14) on sump.	Use 7/8 in open end wrench.
	d. Turbocharger oil-drain pipe (2)	Fit on adapter (13) and tighten clamp.	Use screwdriver.

FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS**This task covers:****a. Removal****b. Installation****INITIAL SETUP****Tools:**

9/16 in socket, 1/2 in drive
 5/8 in box wrench
 3/8 in drive ratchet
 5/8 in socket, 3/8 in drive
 1/2 in socket, 3/8 in drive
 1/2 in drive ratchet
 3/4 in socket, 1/2 in drive
 Torque wrench, (O - 150 lb-ft),
 1/2 in drive
 Slip joint pliers
 Runout indicator dial
 Honing stone
 Cross tip screwdriver
 Hammer
 Chisel

Equipment Condition:

Page 2-179

Page 2-345

TM 5-1940-277-20

Condition Description:

Engine removed from
 boat and mounted on
 blocks.
 Transmission removed.
 Air cleaner removed.

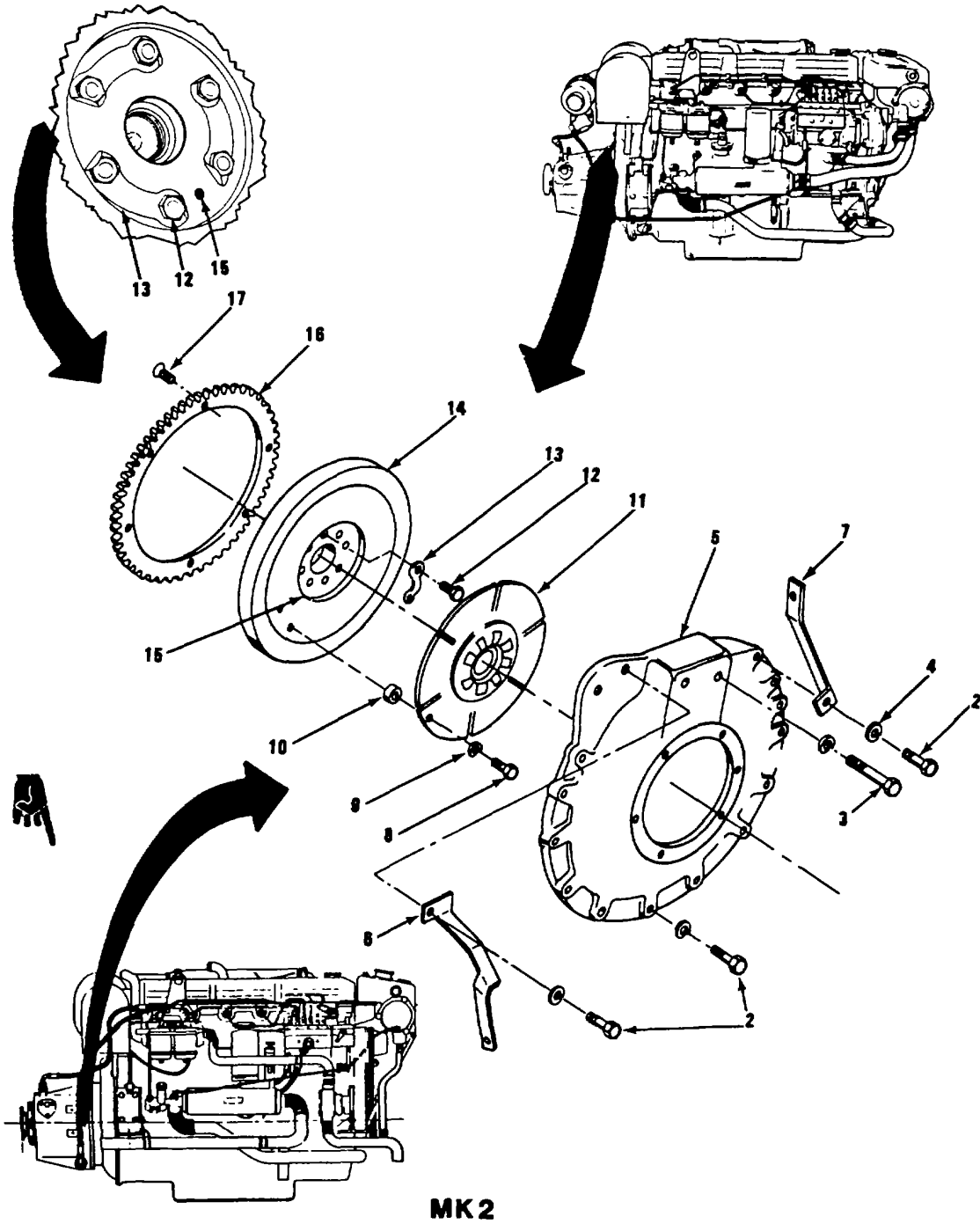
Materials/Parts:

Lockwashers
 Locktabs
 Slocks

Personnel Required: Two

FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS
(Continued)

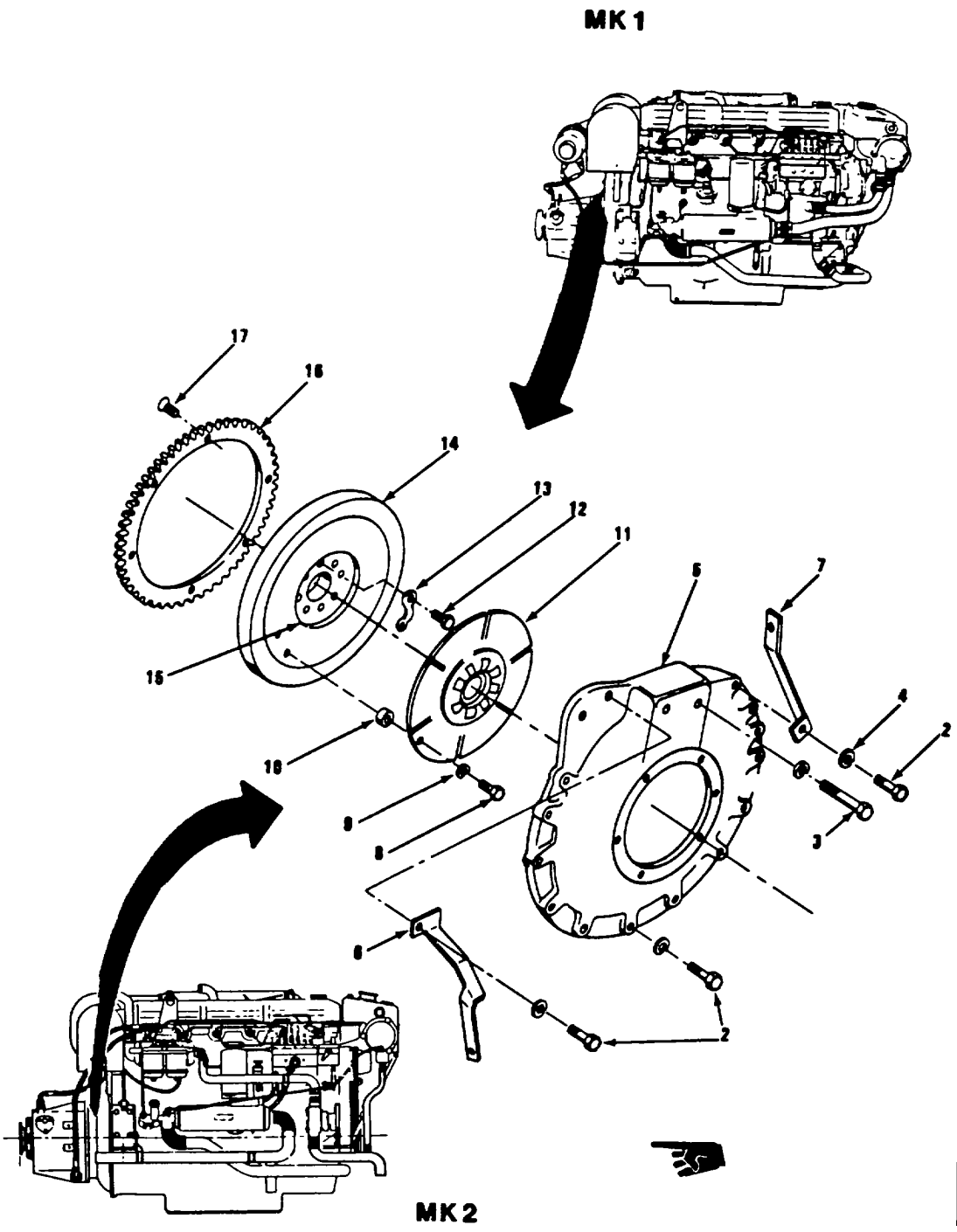
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FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Flywheel and housing assembly (1)	a. 13 setscrews (2), 2 bolts (3), 15 lockwashers (4), flywheel housing cover (5), gear box control cable bracket (6) and air cleaner housing bracket (7)	a. Unscrew bolts and remove parts secured by bolts. b. Discard lockwashers.	Use 5/8 in box wrench, 5/8 in socket and 3/8 in drive ratchet.
	b. 6 dowel bolts (8), 6 lockwashers (9), 6 washers (10) and damper drive plate (11)	Remove.	Use 1/2 in socket and 3/8 in drive ratchet.
	c. 6 flywheel bolts (12), 3 locktabs (13)	a. Bend back tabs. b. Remove bolts and tabs.	Use hammer and chisel. Use 3/4 in socket and 1/2 in drive ratchet.
	d. Flywheel (14)	a. Screw two 3/8-16 UNC bolts into tapped holes (15).	

FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS
(Continued)

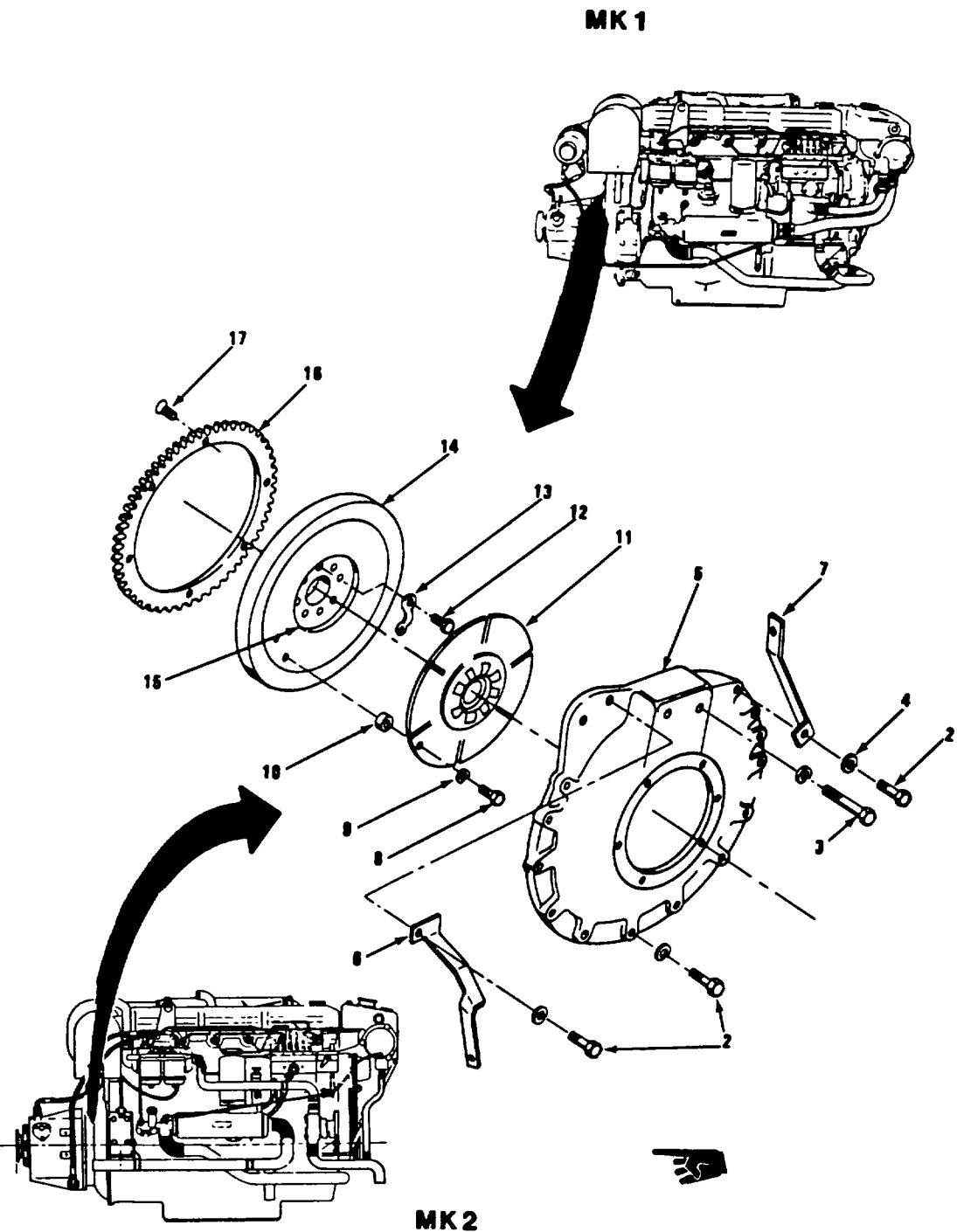


FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>WARNING</u>			
Flywheel weighs 87 lbs. Use two men to lift it. Injury to personnel may result.			
		b. Jack flywheel off crankshaft by tightening bolts evenly.	Use 9/16 in socket and 1/2 in drive ratchet.
	e. Ring gear (16) and 6 screws (17)	Remove. screwdriver.	Use cross tip
<u>INSTALLATION</u>			
2. Flywheel (14)	Ring gear (16) and 6 screws (17)	Mount gear on flywheel.	Use cross tip screwdriver.
3. Engine assembly	a. Crankshaft	Clean crankshaft flange, remove any burrs.	Use honing stone.
	b. Flywheel (14) and ring gear (16)	a. Clean mounting face, remove any burrs.	Use honing stone.
		b. Fit to crankshaft, press into place.	Do not hammer.

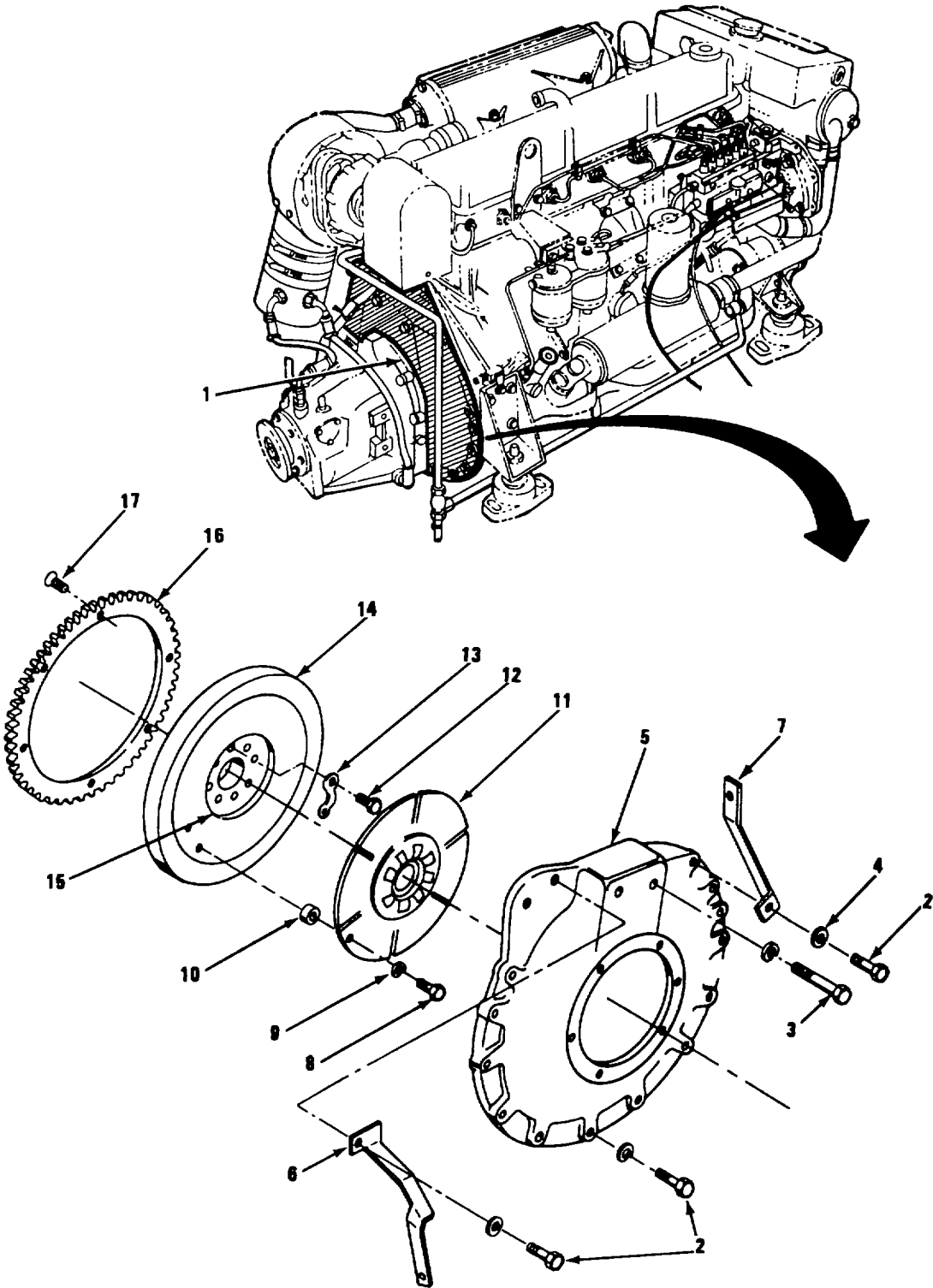
FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS
(Continued)



FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	c. 6 flywheel bolts (12) and 3 locktabs (13)	a. Install. b. Torque bolts evenly to 80 - 90 ft-lb (11.06 to 12.43 kg/m).	Use 3/4 in socket, 1/2 in drive ratchet and torque wrench, 0 - 175 ft-lb.
		c. Bend locktabs up.	Use hammer and chisel.
	d. Flywheel (14)	a. Check runout at 5.5 inches (13.97 mm) radius. Runout not to exceed 0.007 inches (0.178 mm).	Use indicator dial.
		b. If runout not within limits remove flywheel and recheck crankshaft flange and flywheel mounting face.	
		c. If runout within limits bend locktabs (13) up securing bolts (12).	Use chisel and hammer.

FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS
(Continued)



FLYWHEEL AND HOUSING REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	e. 6 dowel bolts (8), 6 lock-washers (9), 6 washers (10) and damper drive plate (11)	Install.	Use 9/16 in socket and 3/8 in drive ratchet.
	f. 13 setscrews (2), 2 bolts (3), 15 lock-washers (4), flywheel housing cover (5), transmission control cable bracket (6) and air cleaner housing bracket (7)	Install.	Use 5/8 in box wrench, 5/8 in socket and 3/8 in drive ratchet.

VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Tools:

7/16 in open/box wrench
 1/2 in open/box wrench
 Hammer, non-metallic

Equipment Condition:

TM 5-1940-277-20

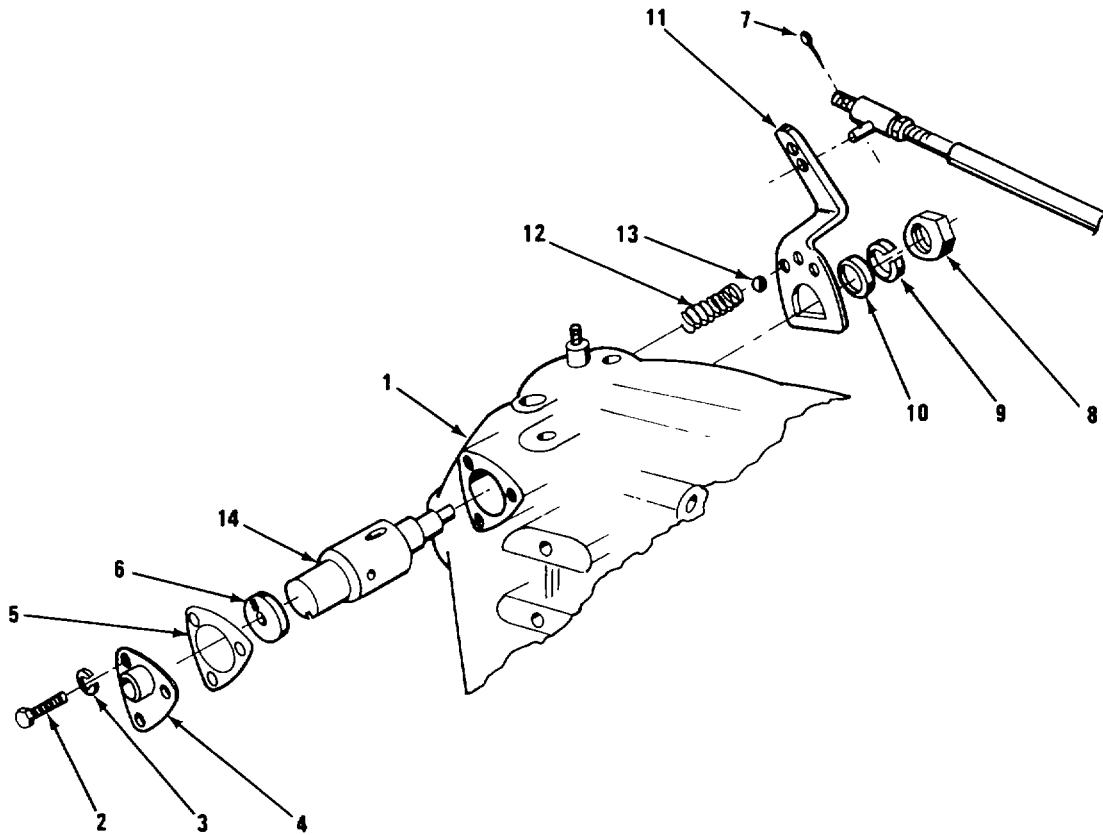
Condition Description:

Engine hatch covers
 open.

Materials/Parts:

Gaskets
 Oil
 Valve and spring assembly
 Silicone sealant

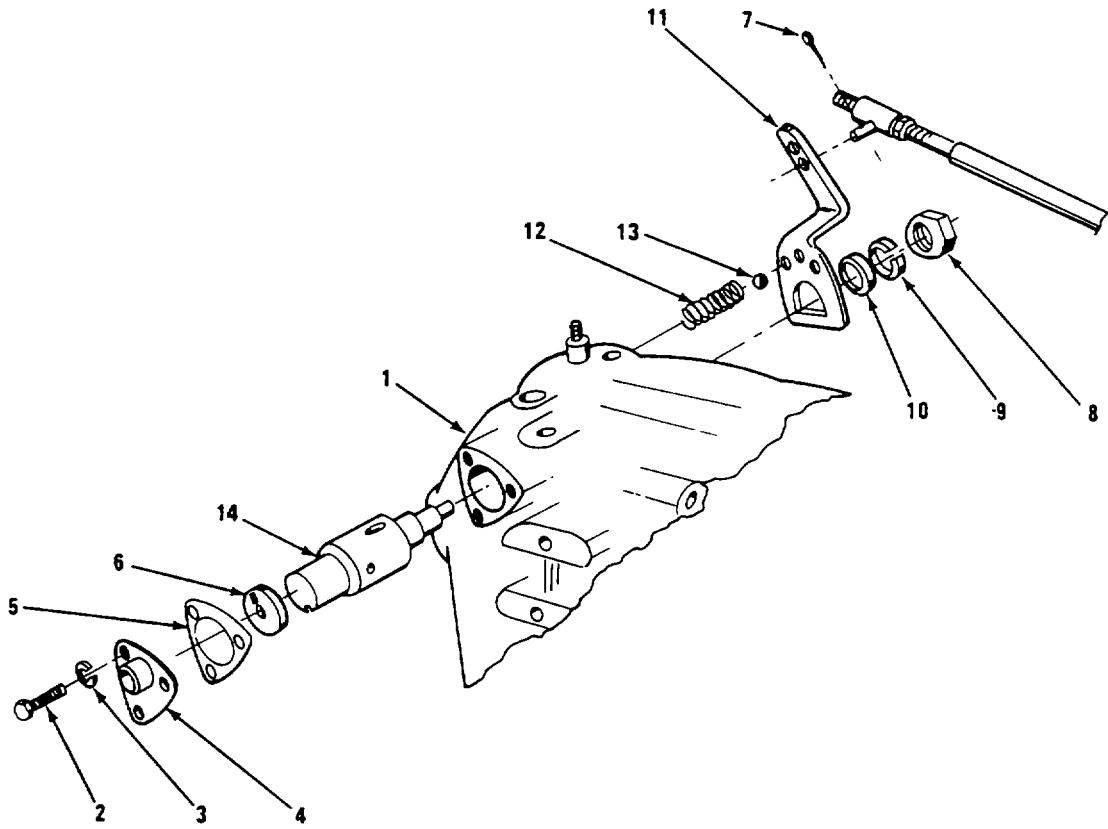
VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Transmission (1)	a. 3 valve cover cap screws (2) and 3 washers (3)	Remove.	Use 7/16 in wrench.
	b. Valve cover (4)	Remove.	
	c. Valve cover gasket (5)	Discard.	
	d. Switch cam (6)	Remove.	
	e. Control linkage cotter pin (7)	a. Remove. b. Disconnect control linkage.	Use long nose pliers.
	f. Shift lever retaining nut (8), lockwasher (9), and control lever washer (10)	Remove.	Use 1/2 in wrench. The poppet spring behind shift lever may push lever off as nut is removed.
	g. Shift lever (11)	Remove.	Do not let poppet and steel ball fly out.
	h. Poppet spring (12), ball (13)	Remove.	

VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



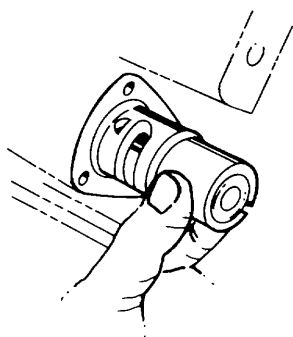
VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	i. Valve and spring assembly (14)	Tap threaded shaft that held shift lever and pull valve out of case through valve cover opening.	Use non-metallic hammer.

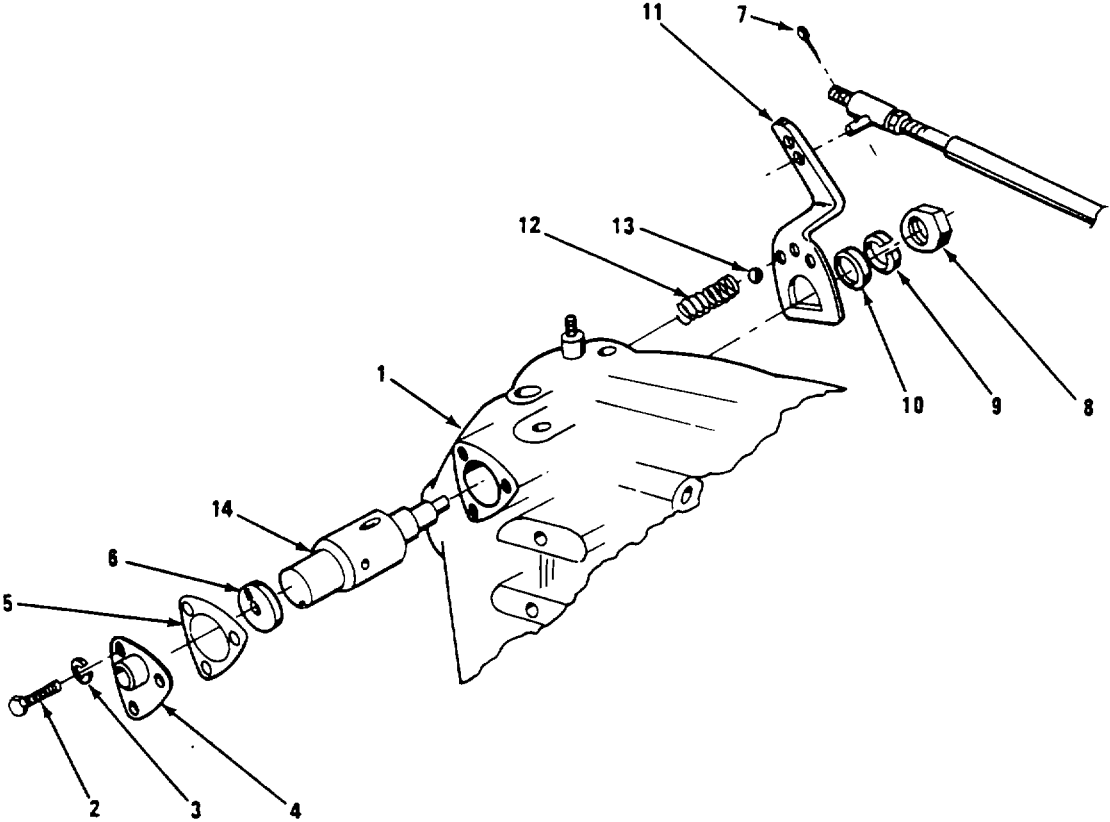
INSTALLATION

2. Transmission (1)	a. Valve and spring assembly (14)	With threaded end first place valve assembly into hole on right rear of transmission. Push valve in until it "bottoms" against the shoulder in case bore.	Valve should only require hand pressure to fit into case.
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b. Valve and spring assembly (14)	Align the slot in control valve with the bottom bolt hole for the valve cover.
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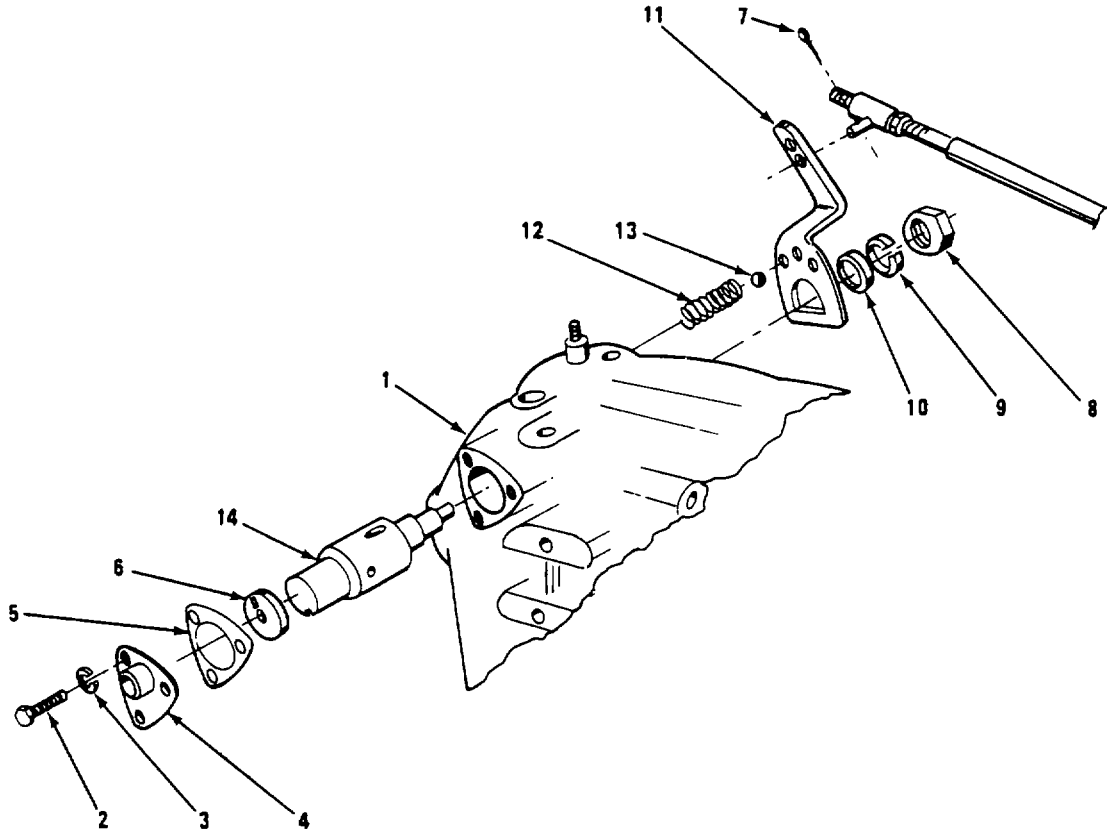
VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	c. Valve cover gasket (5)	a. Coat lightly with sealant.	Use silicone sealant.
		b. Position to transmission case.	Use new gasket.
	d. Switch cam (6)	Position.	Place slot outward and at top.
	e. Valve cover (4)	Position to transmission case.	Tang in cam fits slot in bottom edge of control valve.
	f. Valve cover washer (3) and cap screw (2)	Install and tighten.	
	g. Poppet spring (12) and ball (13)	Install.	Spring goes in hole next to control valve end. Ball goes in end of spring.

VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



VALVE AND SPRING ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	h. Shift lever (11)	Position on control valve.	Poppet spring and ball will compress behind shift lever in neutral position.
	i. Control lever washer (10), lockwasher (9) and nut (8)	Install and tighten.	
	j. Valve and spring assembly (14)	Check action by rotating shift lever through forward, neutral and reverse positions.	Valve action should require only fingertip pressure. If valve binds remove and inspect.
	k. Control linkage cotter pin (7)	a. Connect linkage and install.	
		b. Adjust control linkage.	Reference TM 5-1940-277-20.

TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Tools:

1/2 in socket
Ratchet
Seal puller
Arbor press
Screwdriver

Equipment Condition:

Page 2-345

Condition Description:

Transmission removed.

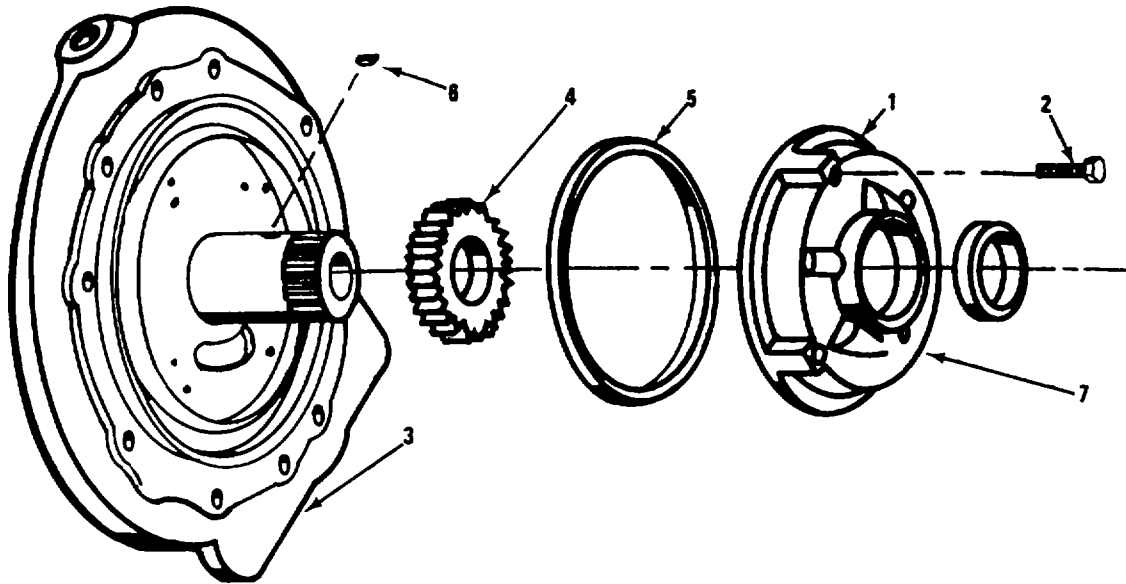
Special Tools:

Oil pump seal sleeve
Torque wrench (0 - 175 ft-lb)

Materials/Parts:

Seal
Gasket
Silicone sealant
Oil, OE 30

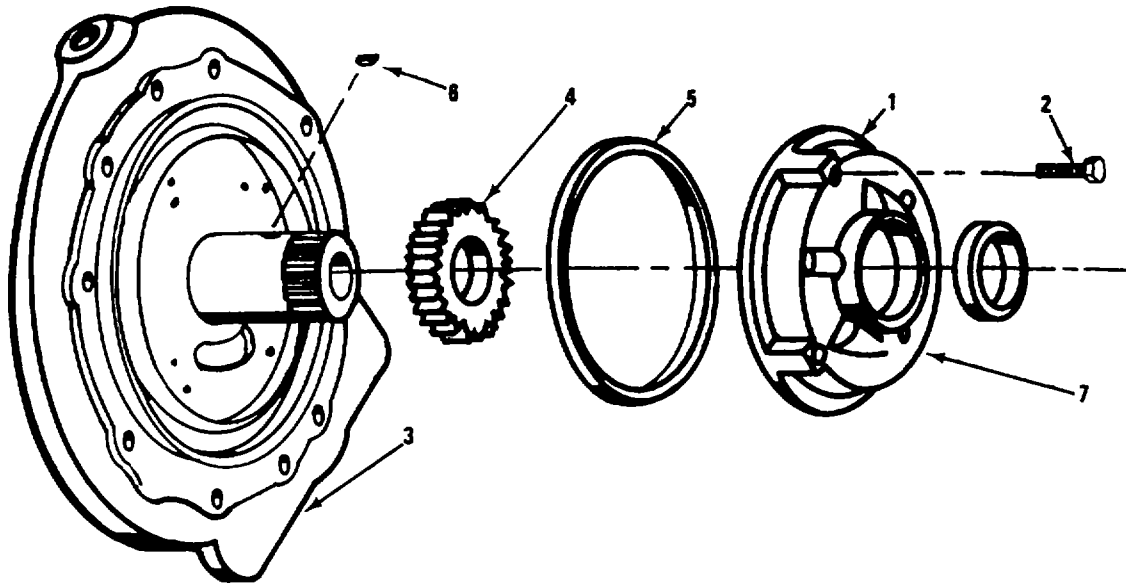
TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS
(Continued)



TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Front pump housing (1)	4 attaching bolts (2)	Remove.	Use 1/2 in socket with ratchet.
2. Transmission (3)	Front pump housing (1)	Slide pump assembly squarely off shaft.	Drive gear will stay on shaft.
3. Transmission (3)	a. Drive gear (4)	Pull gear off shaft.	Use hands.
	b. Front pump gasket (5)	Remove and discard.	Use hands.
	c. Woodruff key (6)	Remove from slot in shaft and retain for use in installation.	Use screwdriver.
<u>ASSEMBLY</u>			
NOTE			
A new oil pump will come complete with oil seal. If the pump has been removed for a reason other than to replace the pump, the oil seal should be replaced before installing the pump. Steps 9a and 9b do not apply for new pump installation.			
4. Front pump housing (1)	a. Oil seal (7)	Remove and discard.	Use seal puller.

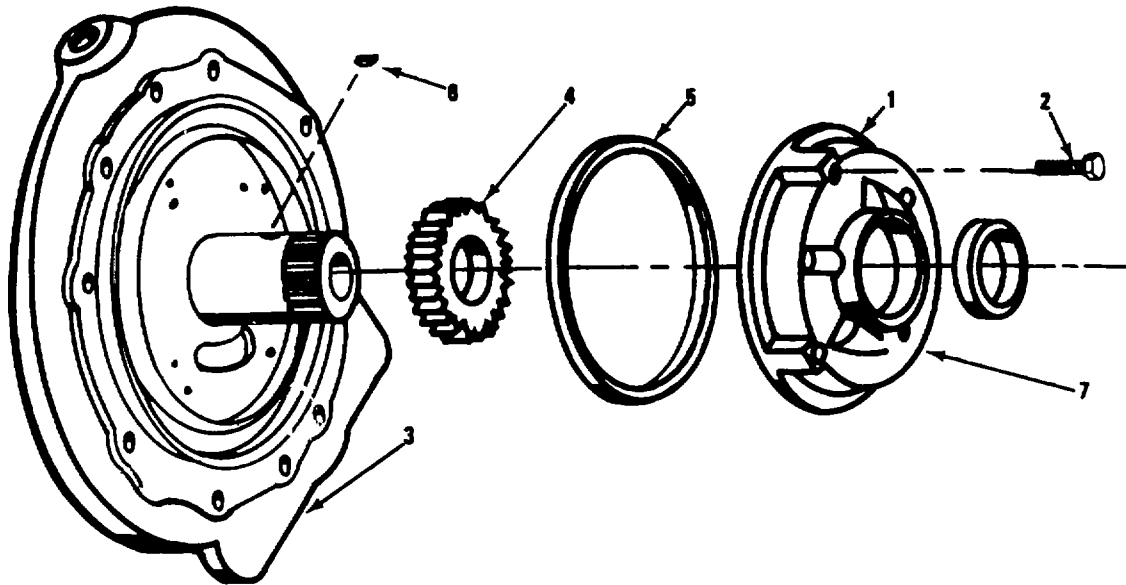
TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS
(Continued)



TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Oil seal (7)	Apply sealant to outside diameter of seal. Install with seal lip toward inside of housing. Press seal into housing until front face of seal is flush with front face of pump housing.	Seal must be pressed into housing squarely using arbor press and suitable tool. Keep any sealant off sealing element and wipe off any excess sealant after seal is installed
NOTE			
Before next step lubricate all parts with transmission fluid.			
5. Transmission (3)	a. Front pump gasket (5)	Apply sealant and install.	
	b. Woodruff key (6)	Install.	
	c. Drive gear (4)	Install with one of the key slots in gear mating with key on shaft and match marks alined.	

TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS
(Continued)



TRANSMISSION OIL PUMP REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>INSTALLATION</u>			
CAUTION			
Once pump is positioned, it must be oriented to correspond with the direction of engine rotation. For this application the portion of the pump housing marked with an arrow pointing to the right should be at top of transmission. Otherwise pump will not function when engine is started.			
NOTE			
Cover splined portion of input shaft to protect rubber lip of pump oil seal during assembly. Use pump oil seal sleeve.			
6. Transmission	Front pump housing (1)	Install squarely on shaft insuring that seal is not damaged or deformed.	A slight rotation of pump will allow gear teeth to engage and pump to seat.
7. Front pump housing (1)	4 attaching bolts (2)	Install and torque to 17 - 20 ft-lb.	Use 1/2 in socket and torque wrench.

TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Tools:

5/8 in socket
Ratchet
6 in extension
11/16 in box/open wrench
7/8 in box/open wrench
Long nose pliers
5/8 in box/open wrench

Equipment Condition:

TM 5-1940-277-20
TM 5-1940-277-20
TM 5-1940-277-20
TM 5-1940-277-20

Condition Description:

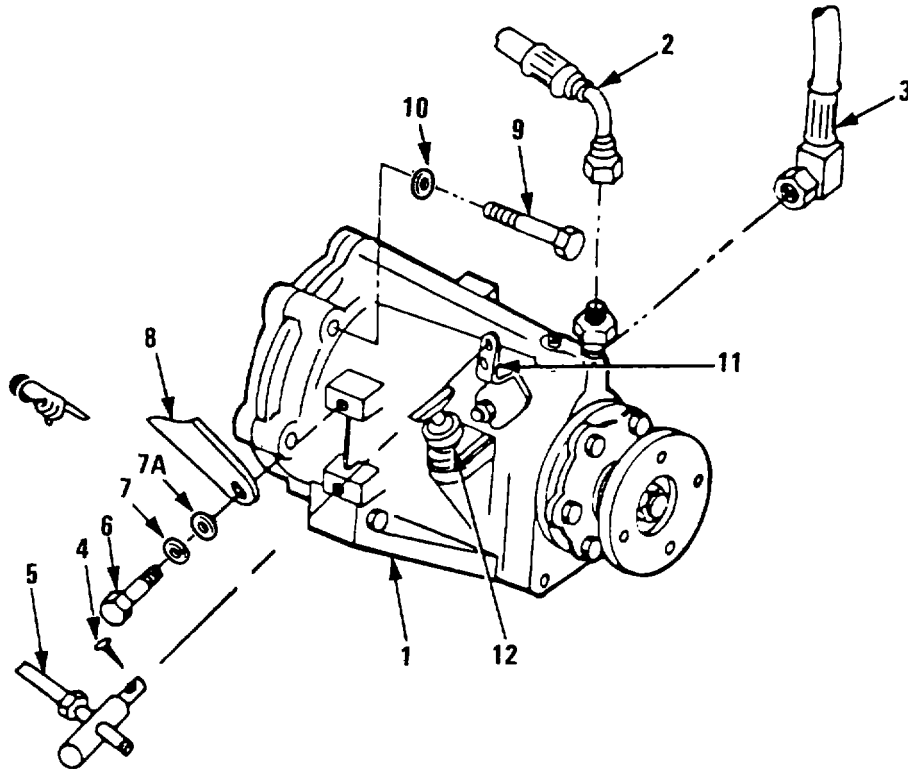
Engine hatch covers
open.
Aft cockpit removed.
Drive shaft removed.
Buoyancy blocks
removed.

Materials/Parts:

Transmission
Engine oil
Container (6 qt.)
Silicone rubber sealant

Personnel Required: Two

TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

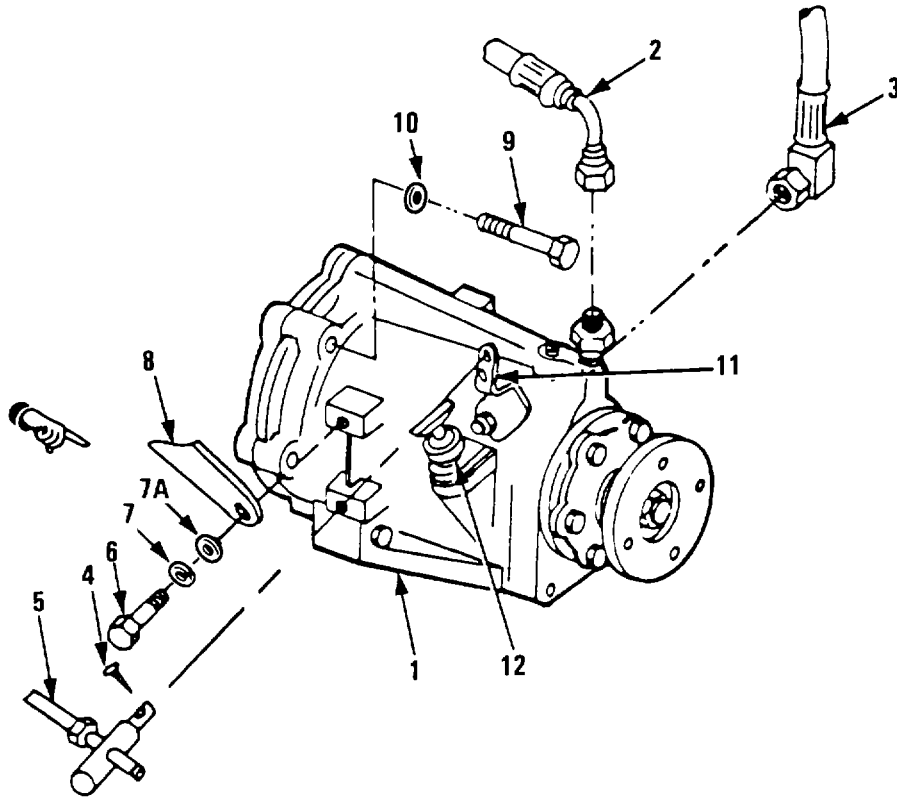


TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Transmission (1)	a. Oil outflow line (2)	Disconnect.	Use 7/8 in wrench.
	b. Oil return line (3)	Disconnect.	Use 7/8 in wrench. Place container under connection to catch old oil.
	c. Shift control cable cotter pin (4)	Disconnect by pulling cotter pin and moving cable (5) aside.	Use pliers.
	d. Brace cap screw (6) and lock washer (7) and flat washer (7A)	Remove.	Use 5/8 in wrench. Loosen cap screw on brace connection to adapter housing so brace (8) may be moved aside.
	e. 6 mounting cap screws (9) and 6 washers (10)	While supporting the rear of transmission remove.	Use 5/8 in socket with extension and ratchet.
	f. Transmission (1)	Carefully move transmission approximately 3 in toward rear to disengage shaft. Remove transmission from boat.	Use 2 persons. Transmission weighs 109 pounds.

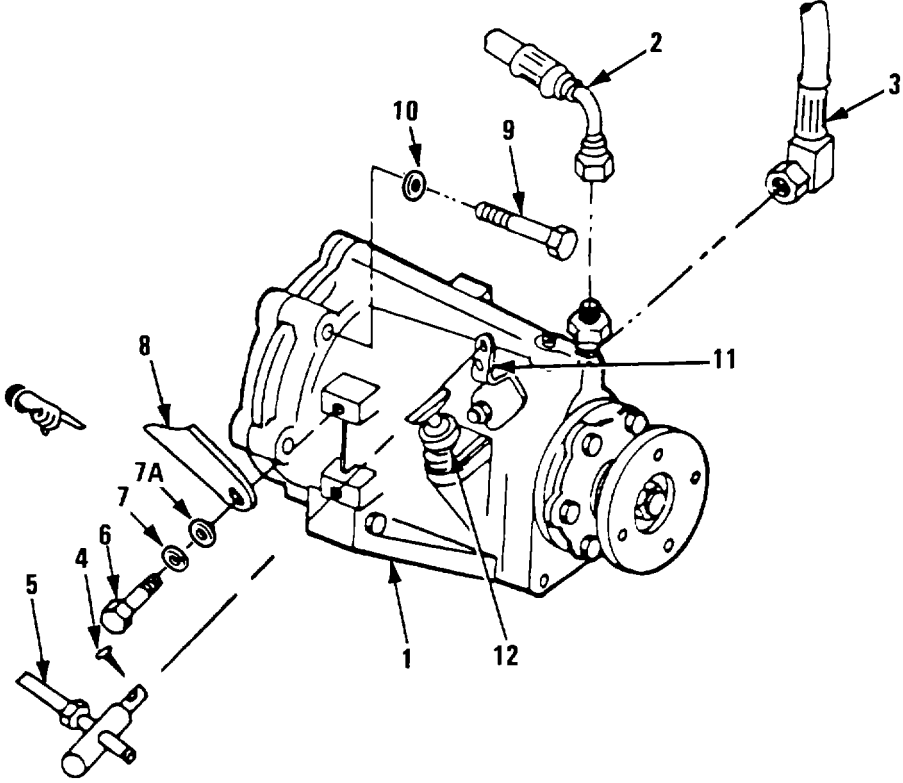
TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
<u>INSTALLATION</u>			
2. Engine compartment	Transmission (1)	a. Coat mating surface with sealant. b. Carefully lift transmission into position at rear of engine. c. Making certain transmission is level, fit transmission spline into damper spline. d. Support transmission.	Use silicone rubber sealant. Use 2 persons. Transmission must go forward until seated against adapter housing.
3. Transmission (1)	a. 6 mounting washers (10) and 6 cap screws (9) b. Brace flat washer (7A), lock washer (7) and cap screw (6) c. Shift control cable cotter pin (4)	Install. Install. Connect.	Support transmission at rear. Transmission shift lever (11) may be moved to a forward, neutral, or reverse position as required.

TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



TRANSMISSION ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Oil return line (3)	Connect.	
	e. Oil outflow line (2)	Connect.	
5. Transmission (1)	Dipstick (12)	a. Check oil level.	
		b. Fill to mark on dipstick.	

HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP

Tools:

1/2 in combination wrench
19 mm open end wrench
11/16 in open end wrench
5/8 in open end wrench
Ratchet
6 in extension
18 in extension
10 mm open end wrench
19 mm socket
10 mm socket
Flat tip screwdriver, 6 inch
Sling
Wrecker
3/8 in hex key wrench (Allen)
Hammer, ball peen
Drift pin

Equipment Condition:

Page 2-367

TM 5-1940-277-20

TM 5-1940-277-20

TM 5-1940-277-20

Condition Description:

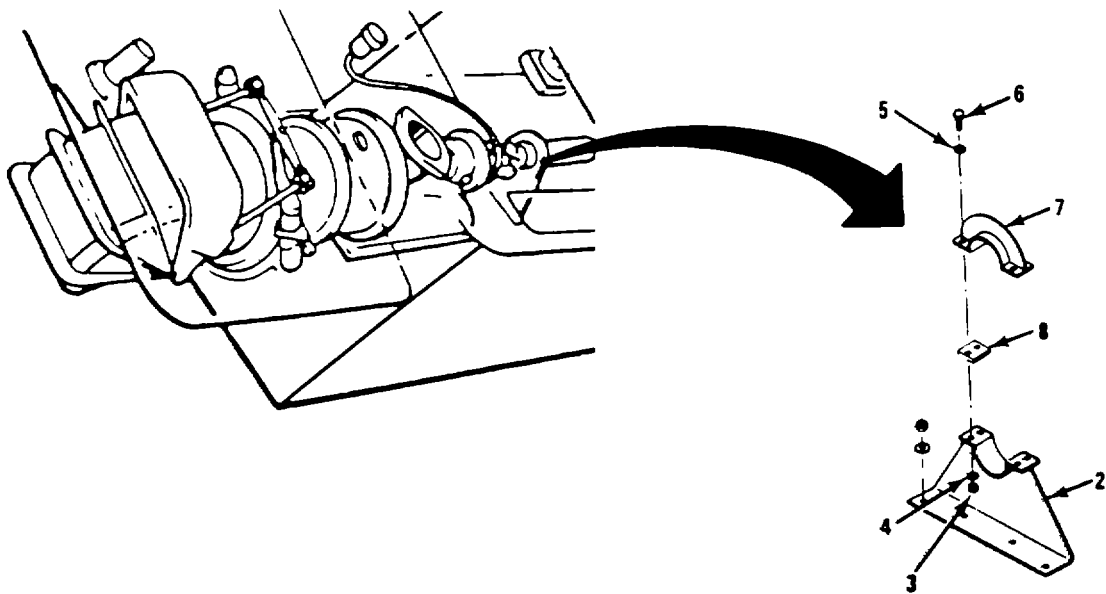
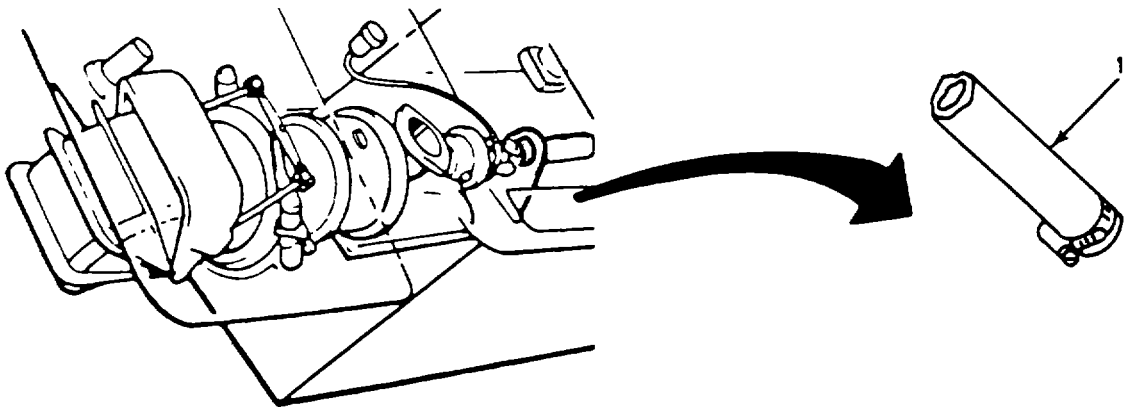
Boat out of water on grounded cradle.
Steering assembly removed.
Aft cockpit removed.
Access hatches open and secure.
Drive shaft removed.

Materials/Parts:

Oil
Grease
Intake gasket
Adhesive, rubber base
Small container

Personnel Required: Three; wrecker operator will only operate wrecker

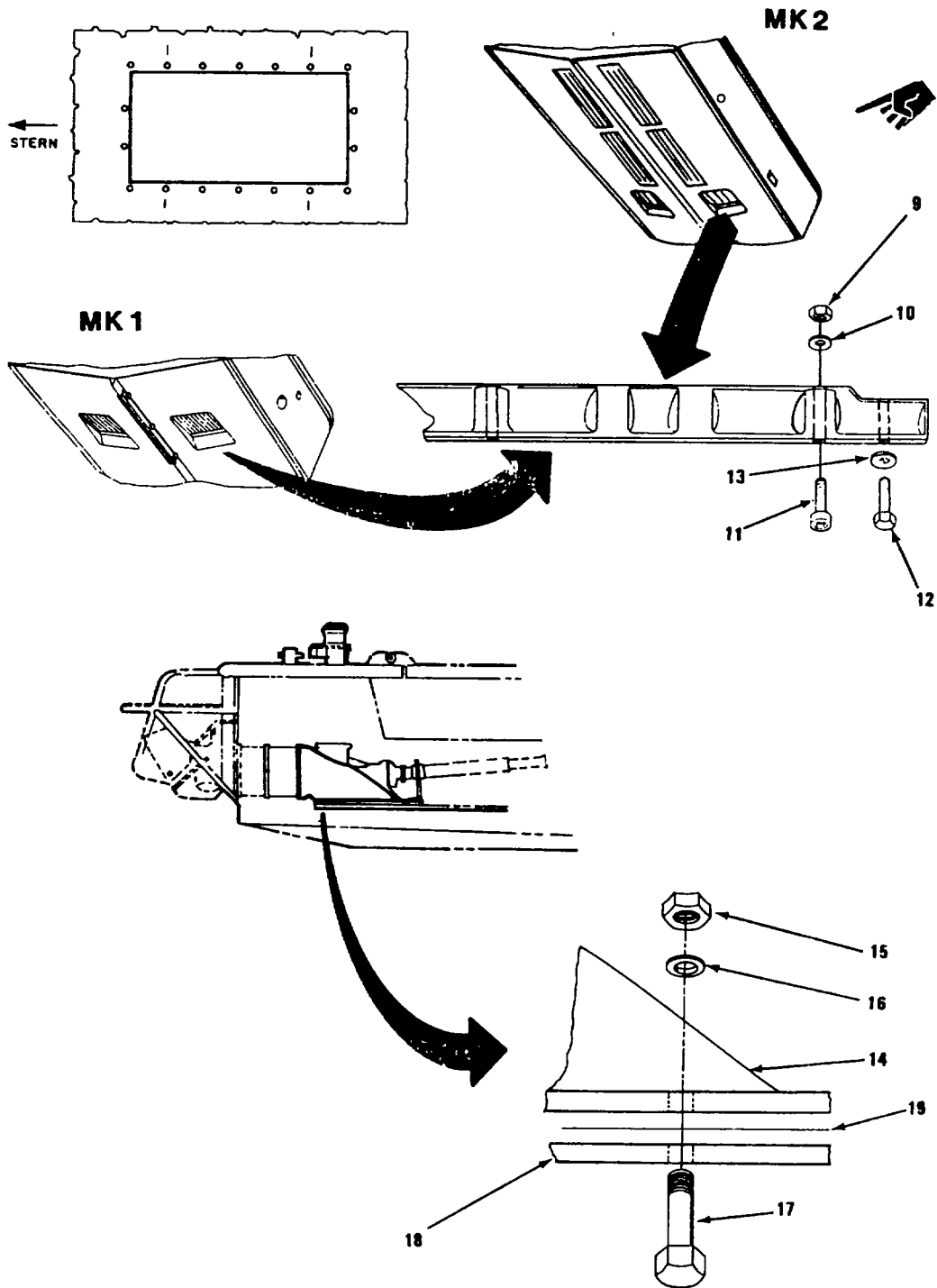
HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
NOTE			
Before performing next step get a small container to hold oil in reservoir.			
1. Hydrojet compartment	Oil pipe (1)	Loosen clamp. Disconnect hose and drain oil.	Use screwdriver. Drain oil into container.
2. Drive shaft guard (2)	4 nuts (3), 4 washers (4), 4 bolts (5), cap (7) and 2 spacers (8)	Remove bolts, nuts, washers and cap and set aside.	Use 10 mm wrench and 10 mm socket with ratchet.

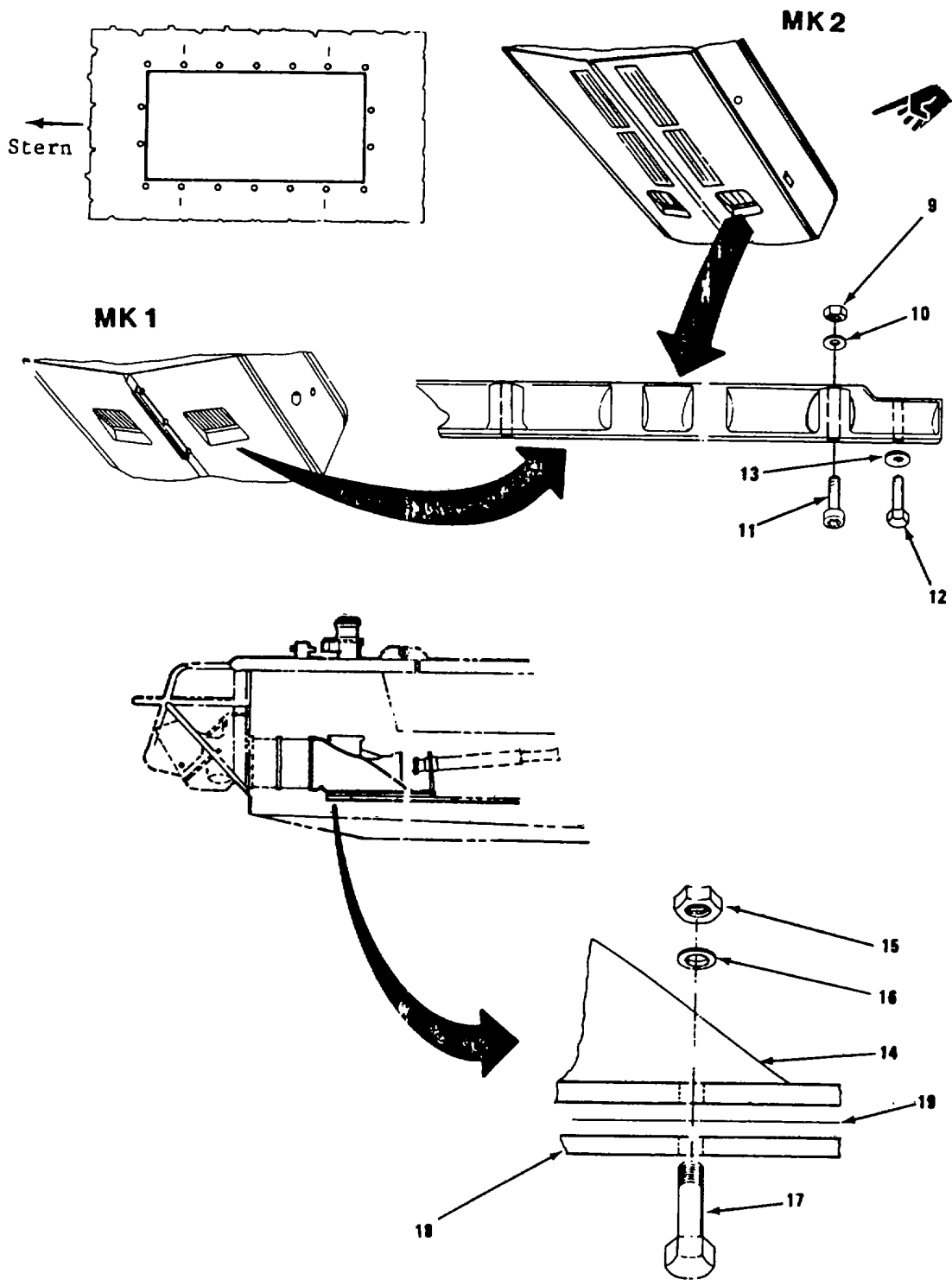
HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
WARNING			
Exercise care in removing intake grille. It weighs 30 pounds and retainer may separate from grille when mounting bolts are removed. Injury to personnel will result.			
NOTE			
Before next step, check bolt installation diagram for four unmarked bolts. These are bolts removed in next step.			
3. Hull, aft underside	4 nuts (9), 4 washers (10), and 4 socket head bolts (11) securing intake grille	Remove nuts, washers and bolts. When last bolt is removed grille will drop free.	Three persons required, one inboard, two outboard. Use 3/8 in hex key wrench (Allen) outboard and 14 mm socket, ratchet and extension in- board.
4. Hydrojet intake case (14)	a. 2 cap screws (12) and 2 washers (13) securing aft end of intake case	Remove from underneath boat.	Use 19 mm socket and ratchet.

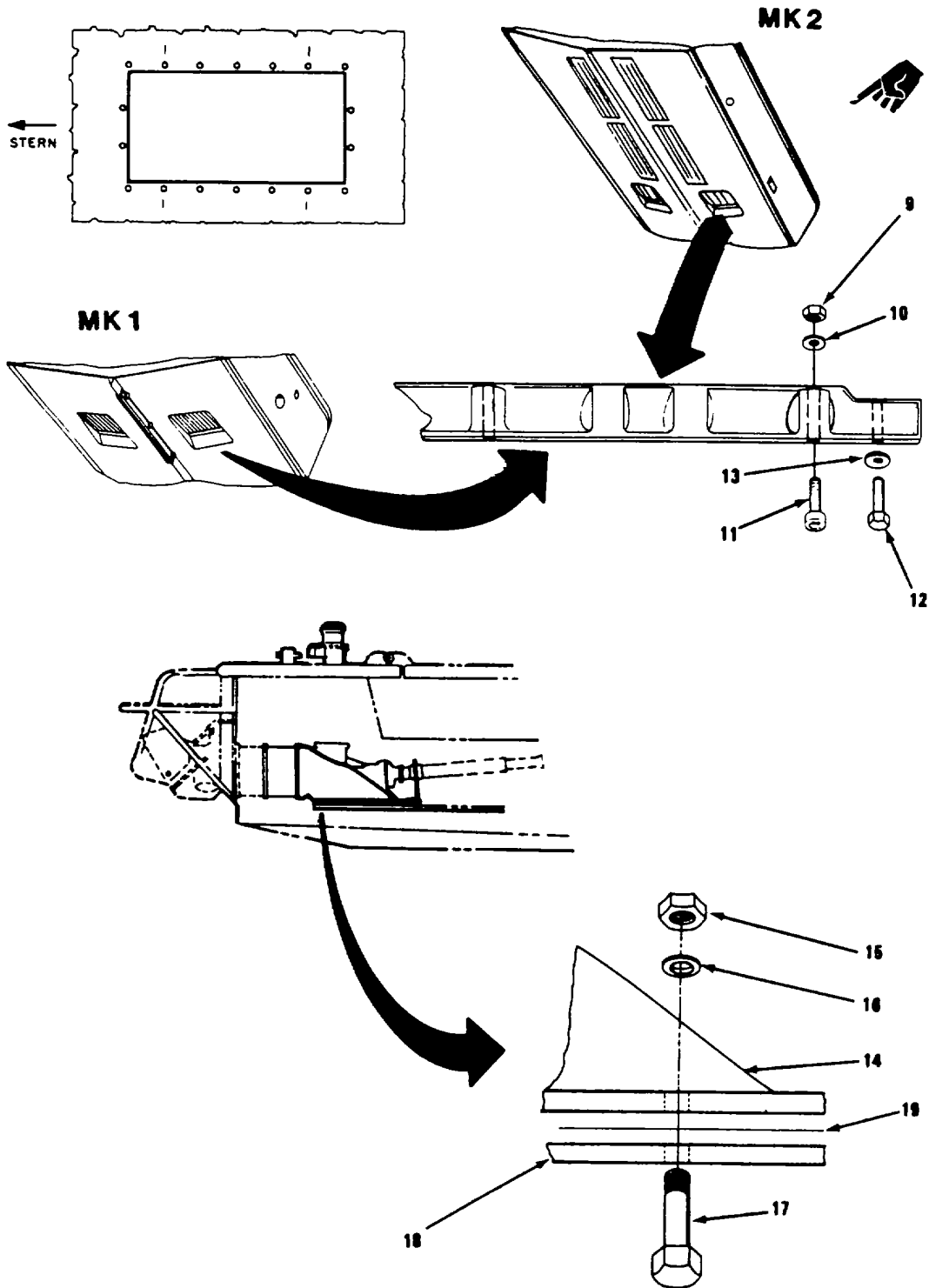
HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	b. 12 nuts (15), 12 washers (16), and 12 bolts (17) retaining intake case	Remove nuts, washers and bolts which pass through hull (18); this frees intake case.	Two persons needed. Use 19 mm wrench out- board and 19 mm socket, ratchet and 18 in exten- sion inboard. This also frees drive shaft guard bottom section (2) which must be set aside. It may be necessary to tap bolts through hull; use hammer and drift.
	c. Sling	Attach to hydro- jet unit and to lifting device. Attach sling to intake case only.	
5. Hydrojet compartment	a. Hydrojet assembly	Carefully lift assembly out of compartment. Position as required.	Guide unit out of compartment carefully to prevent damage.
	b. Intake gasket (19)	Remove and discard.	

HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)



HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
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INSTALLATION

NOTE

If assembly has rear reaction case attached, it must be removed. To remove case, remove eight cap screws, nuts and washers and then remove case. Case may be attached to steering assembly. Refer to steering assembly removal procedure.

6. Hydrojet Compartment	Intake gasket (19)	Coat one side of gasket with rubber base adhesive and stick into posi- tion on hull interior.	Item 12, APP. B. Make sure bolt holes are alined.
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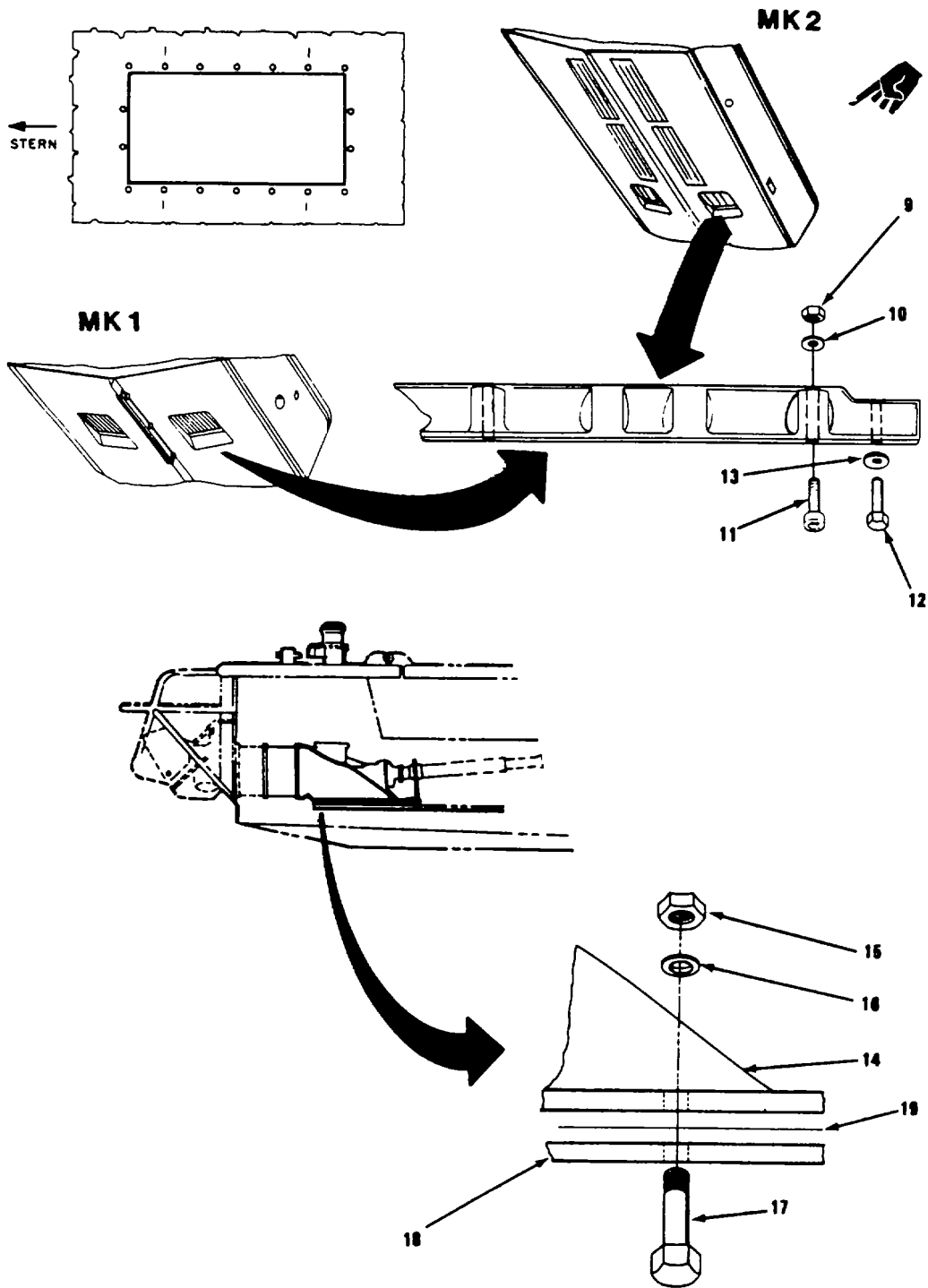
7. Hydrojet assembly	Sling	Attach to intake case and to lifting device.	
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8. Hydrojet compartment	Hydrojet assembly	Carefully lift assembly and position into compartment, alining bolt holes.	Use drift pins through corner bolt holes to assist in aline- ment. Be careful not to displace the intake gasket (19) and to aline bolt holes as unit is posi- tioned.
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NOTE

Before going to next step look at diagram. Note order in which mounting bolts are installed.

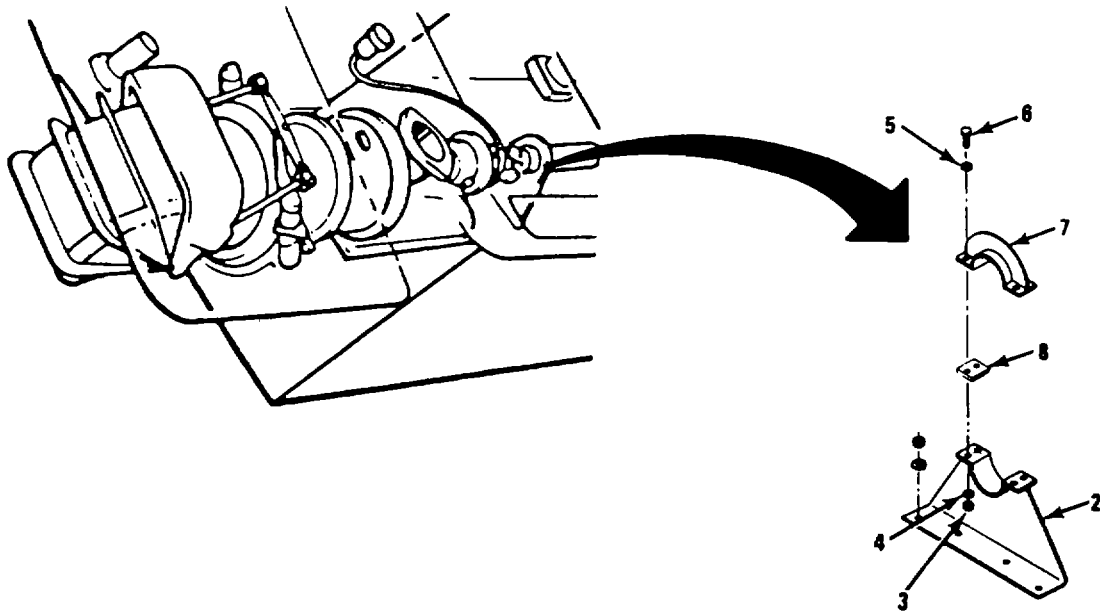
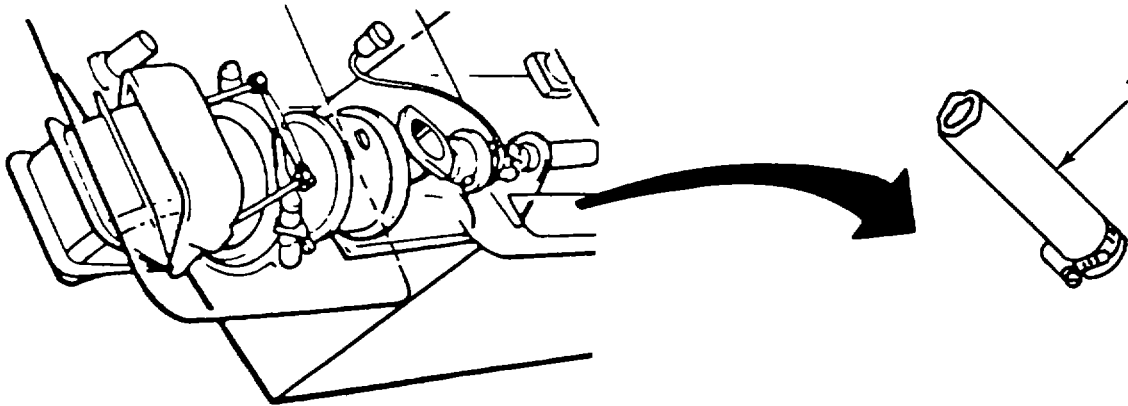
HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
9. Hydrojet intake case (14)	a. Drive shaft guard bottom section (2)	Position across forward edge of intake case.	Check the positioning of guard on other intake case to double check for correct positioning.
	b. 2 cap washers (13) and 2 cap screws (12)	Install cap screws and washers in positions noted as 2 on the installation diagram.	Use 19 mm socket and ratchet.
	c. 12 mounting bolts (17), 12 washers (16) and 12 nuts (15)	Install bolts, nuts and washers noted as 1 on the installation diagram.	Two persons needed. Use 19 mm wrench outboard and 19 mm socket, ratchet and 18 in extension inboard.
NOTE			
Before proceeding to next step, make sure intake grille and retainer are assembled properly and mounting bolts are handy. Two persons outboard are required.			
10. Hull aft underside	Intake grille, 4 socket head bolts (11), 4 washers (10), and 4 nuts (9)	a. Position grille into hull opening with scoop portion of retainer toward bow of boat.	One person must be inboard during installation.
		b. Secure with bolts, washers and nuts.	

HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



HYDROJET ASSEMBLY REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
11. Drive shaft guard (2)	Drive shaft guard spacers (8), cap (7), 4 washers (4), 2 bolts (5), and 2 nuts (3)	Install cap and secure.	Use 10 mm wrench and 10 mm socket with ratchet.
12. Hydrojet Compartment	a. Oil pipe (1)	Connect and tighten clamp.	Use screwdriver.
	b. Oil reservoir	Fill with oil.	See LO 5-1940-277-12.
NOTE			
FOLLOW ON MAINTENANCE PROCEDURE: Do steering assembly installation procedure (page 2-367).			

STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS**This task covers:**

- a. Removal
- b. Installation

INITIAL SETUP

Tools:

19 mm open end wrench
19 mm socket
17 mm box/open wrench
Ratchet
6 in extension
17 mm socket, 3/8 in drive
14 mm box/open wrench (2 each)
8 mm hex key wrench (Allen)
17 mm box/open wrench
Pinch, bar
Transmission Jack

Equipment Condition:

Condition Description:

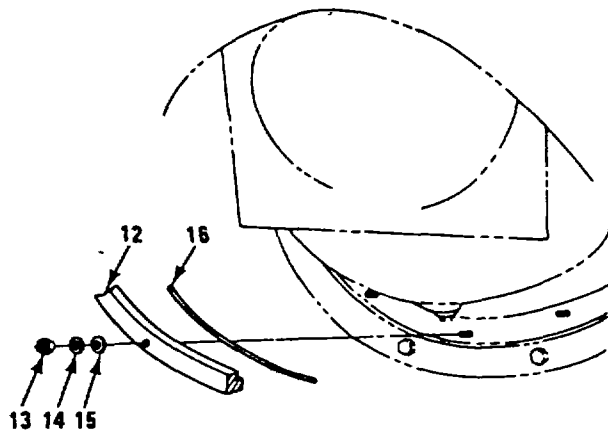
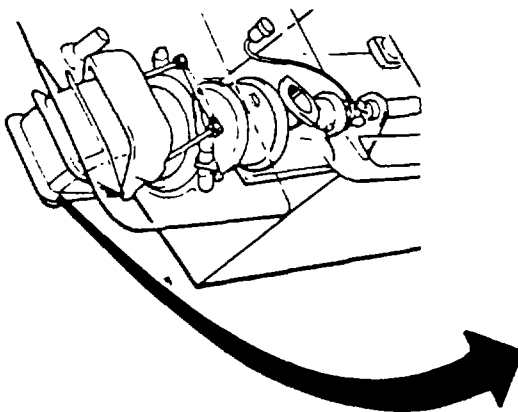
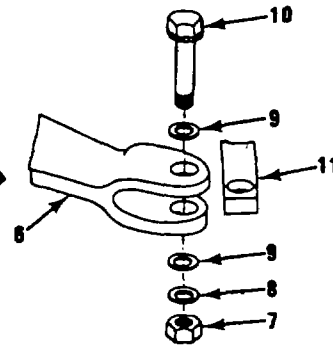
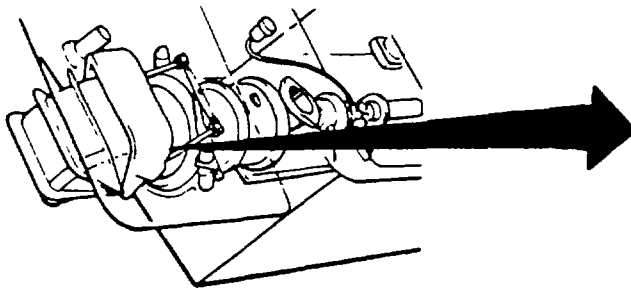
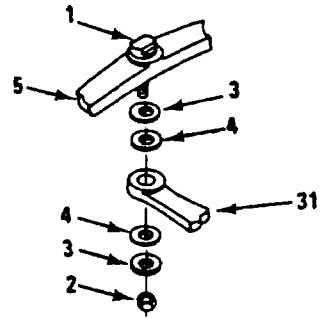
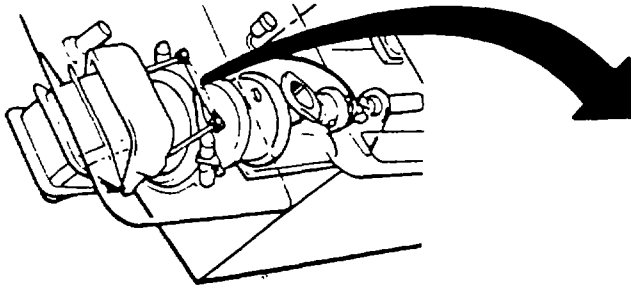
Boat out of water on
grounded cradle.

Materials/Parts:

Reaction case gasket
Grease (GAA)
Cord, 10 foot
Rubber seal ring
Rope

Personnel Required: Three

STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

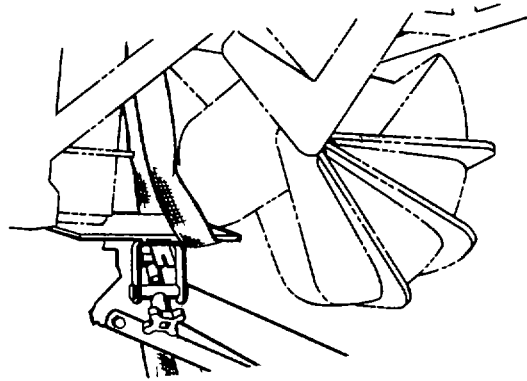


STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS

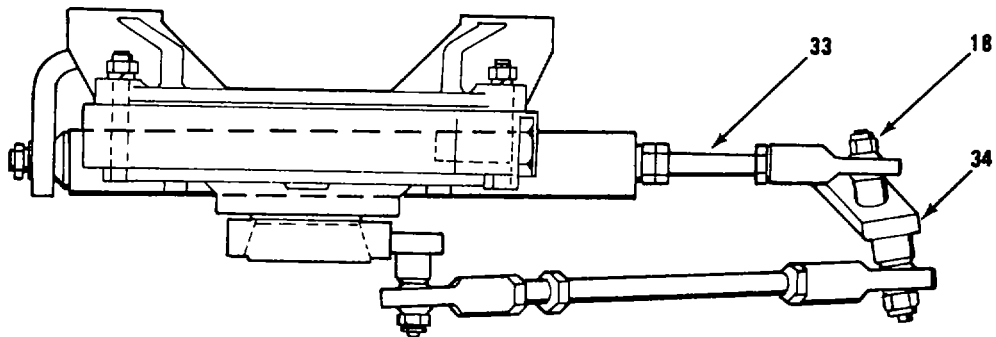
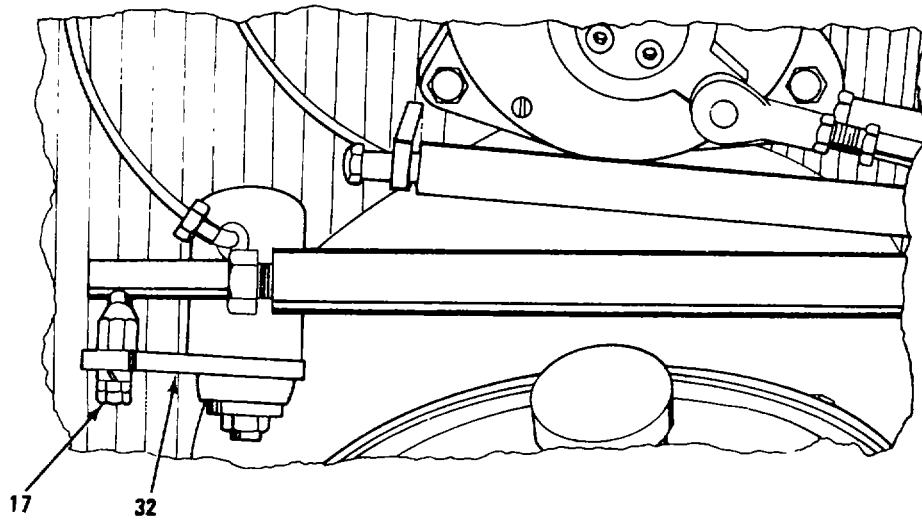
(Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
Before doing first step tie scoop in place by passing light cord around scoop fin and in between scoop fin and cover and tying off.			
<u>REMOVAL</u>			
1. Reverse control pivot (1)	a. Nut (2), steel washer (3), tufnol washer (4)	Remove.	Use 19 mm open end wrench and 19 mm socket with ratchet.
	b. Reverse balance lever (5)	Disconnect from outboard reverse lever (31).	Retain two washers that separate reverse balance lever (5) from reverse lever (31).
2. Outboard steer lever (6)	Nut (7), steel washer (8), tufnol washer (9), bolt (10), and steering link (11)	Remove nut, washers, and bolt and move link aside.	Use 17 mm wrench and 17 mm socket with ratchet.
3. Transom sealing flange (12)	a. 12 nuts (13), 12 steel washers (14), 12 tufnol washers (15)	Remove. Move flange out of position.	Use 14 mm wrench.
	b. Transom rubber seal ring (16)	Ease out of position.	Use hands.
NOTE			
Before going to next step position transmission jack under steering assembly and raise jack until it is in contact with the lower pivot bracket. Secure steering assembly to jack using rope.			

STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



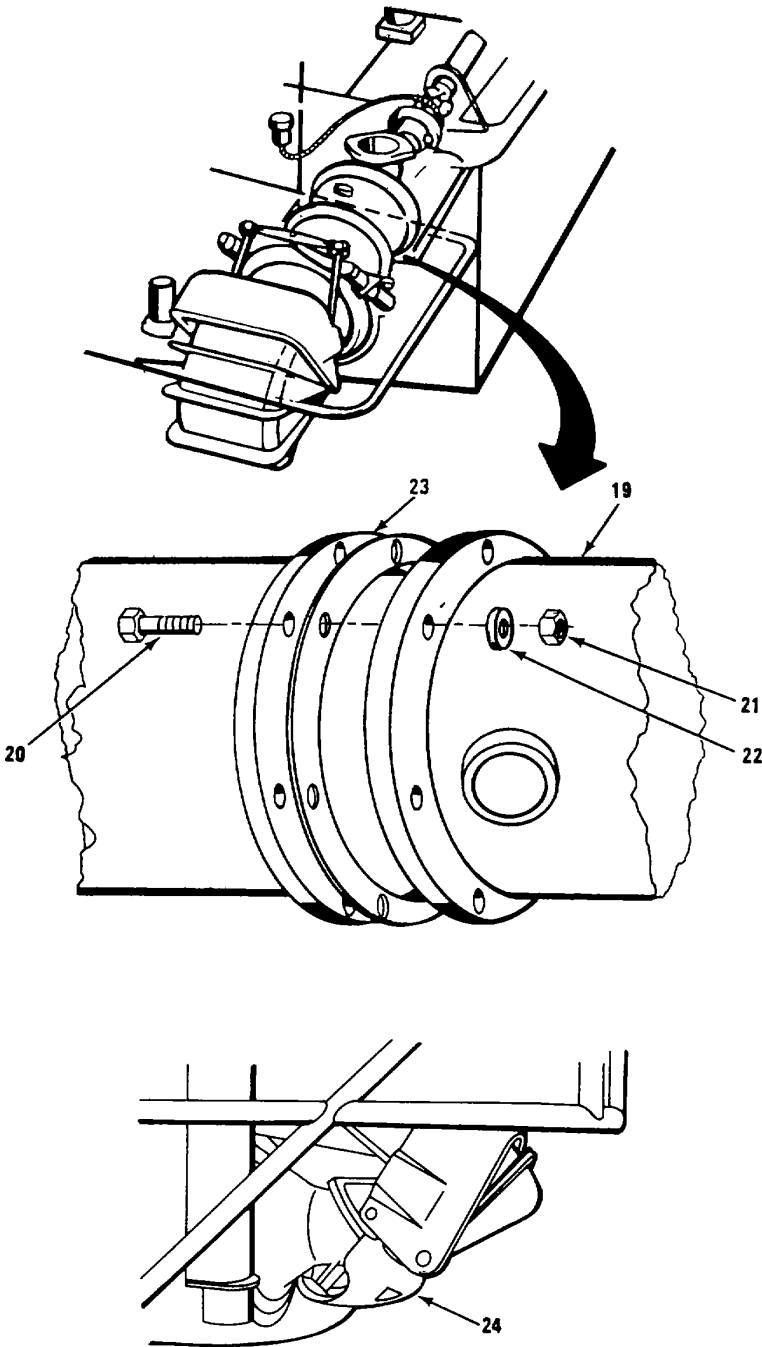
JACK PLACEMENT



STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
Perform step 4 if removing starboard steering assembly and step 5 if removing port steering assembly. Scoop control in full reverse.			
4. Starboard hydrojet compartment	Tie bar securing nut (17)	Remove nut and lift tie bar up from inboard steering lever (32).	Use two 14 mm wrenches.
5. Port hydrojet Compartment	Guide tube rod securing nut (18)	Remove nut. Lift guide tube rod (33) off connecting stud on inboard scoop control lever (34).	Use 14 mm wrench. Rod is under spring pressure and may have to be pulled toward center of boat to ease off stud. Once disconnected let rod out slowly. Assembly may now be removed by pulling out.

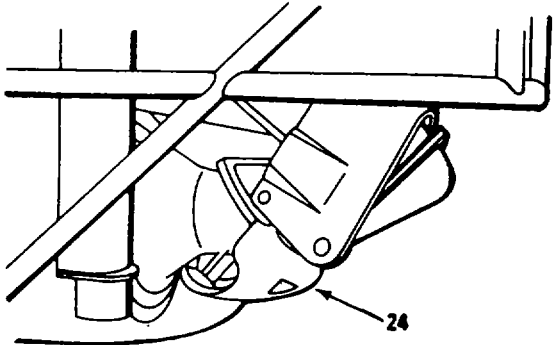
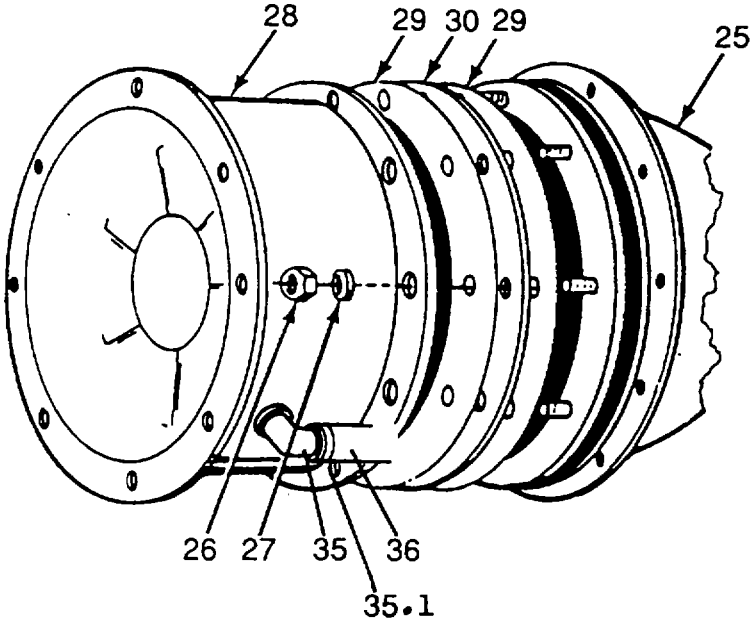
STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
6. Front reaction case (19)	8 front to rear reaction case connecting bolts (20), 8 nuts (21), 8 washers (22)	Remove.	Use 8 mm hex key wrench (Allen) and 14 mm wrench.
<p>NOTE During the next step keep steering assembly level as it is withdrawn to avoid damage to the rear impeller.</p>			
7. Boat stern	Steering assembly (24)	Pull transmission jack and steering assembly carefully away from the stem of boat until clear of divers platform. When clear of platform it can be picked up and carried to work area.	Two persons required outboard, one inboard. Keep unit level to dear opening.
8. Front reaction case (19)	Gasket (23)	Remove and discard.	

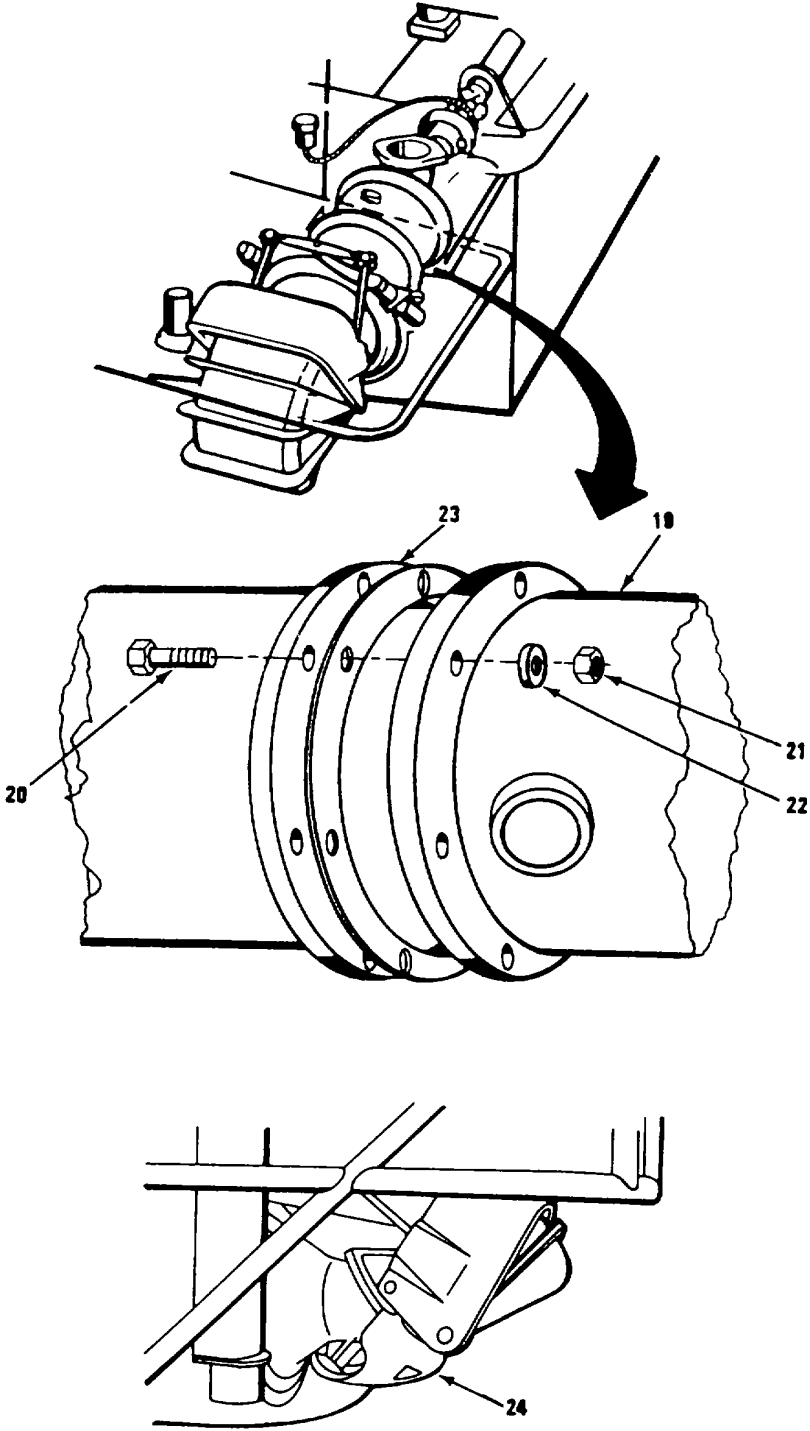
STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
9. Tail pipe (25)	a. 8 rear reaction case connecting nuts (26) and 8 washers (27)	Remove.	Use 14 mm wrench.
	b. Rear reaction case (28), damp (35.1), hose (36), and elbow (35).	Remove	
	c. Rear reaction case (28)	Remove and set aside.	
	d. Gasket (29), Insulating ring (30), gasket (29)	a. Remove.	
		b. Discard gasket.	
		c. Retain insulating ring.	
<u>INSTALLATION</u>			
10. Tail pipe (25)	a. Reaction case gaskets (29), insulating ring (30)	Smear gaskets with grease, place on each side of ring and fit on tail pipe studs.	
	b. Rear reaction case (28)	Fit to tail pipe.	
	c. 8 washers (27) and 8 nuts (26)	Install and tighten.	Use 14 mm wrench.
	d. Rear reaction case (28) elbow (35) hose (36), and damp (35.1).	Install and tighten.	

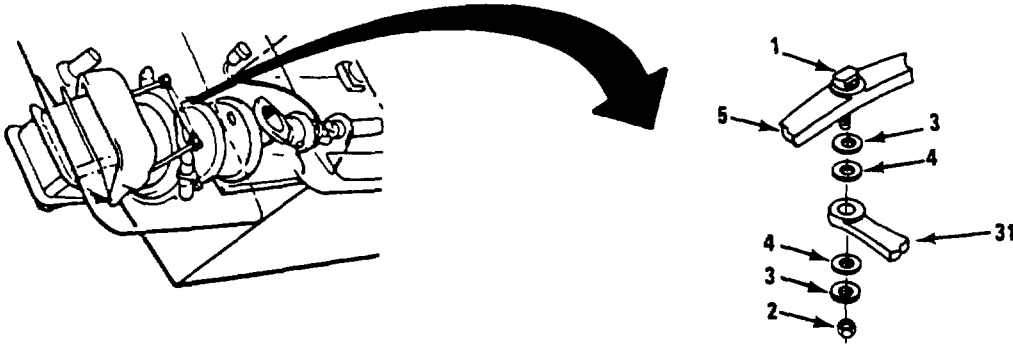
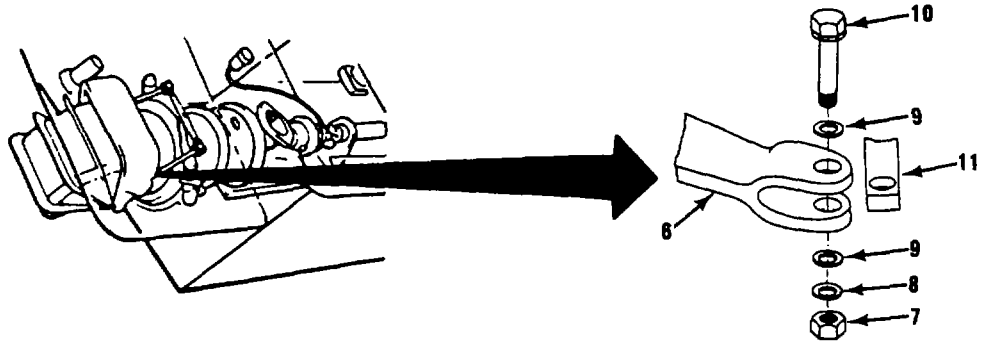
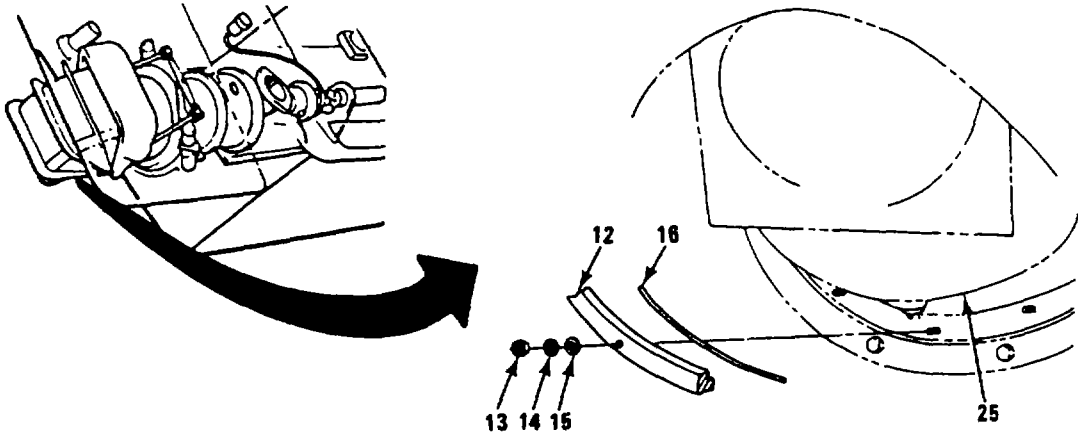
STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS (Continued)



STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
11. Boat stern	Steering assembly (24)	Position on transmission jack and move into location under divers platform. When in position elevate jack until level with hole in transom.	Secure the steering assembly to jack with rope as in disassembly.
12. Front reaction case (19)	Reaction case gasket (23)	a. Remove any portion of old gasket left. b. Smear new gasket with grease and stick to front reaction case.	Use putty knife. Make sure all bolt holes are aligned.
13. Boat stern	Steering assembly(24)	Move assembly, on jack, carefully into position with rear reaction case fitting through transom hole and mating to front reaction case.	Make certain case does not bind over rear impeller.
14. Front reaction case (19)	8 reaction case connecting bolts (20), 8 washers (22) and 8 nuts (21)	Install and tighten.	Use 8 mm hex key wrench (Allen) and 14 mm wrench.

STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

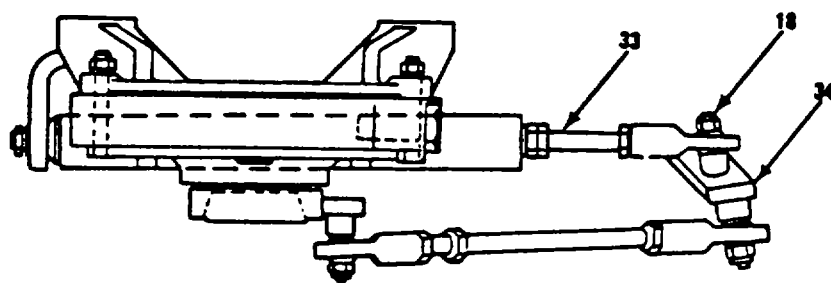
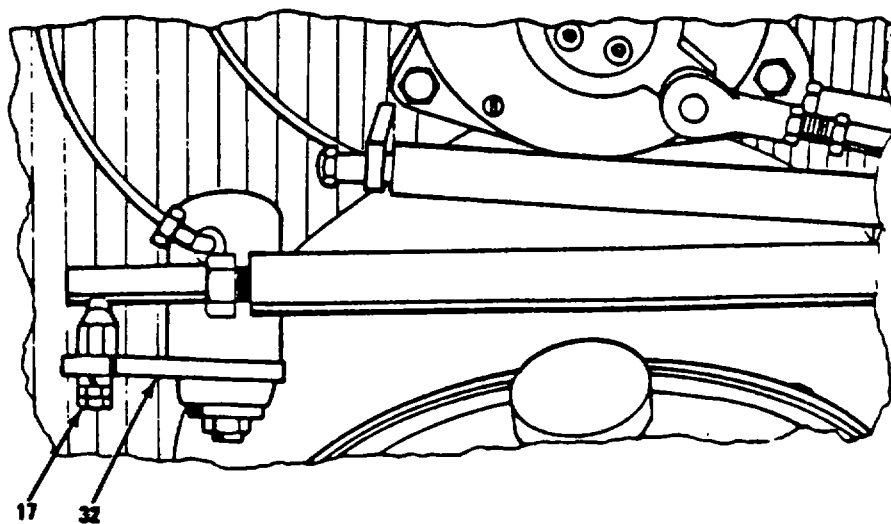


STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
15. Tail pipe (25)	a. Transom rubber seal ring (16)	Smear with grease and gently press into position.	Use hands. Jack may be removed for better accessibility.
	CAUTION Do not over tighten nuts to avoid stripping threads.		
	b. Transom sealing ring (12), 12 tuf-nol washers (15), 12 steel washers (14), 12 nuts (13)	Place ring into position and install washers and nuts.	Use IN9 14 mm wrench, torque nuts (13) to 12 lb-ft + 5 lb ft (16-27N-M + 6.8N-M).
NOTE It may be necessary to loosen pump bolts to align transom seal "O" ring.			
16. Outboard steering lever (6)	a. Pivot bolt (10), washer (9), steering link (11), tufnol washer (9), steel washer (8), nut (7)	Install bolt with washer on to connect outboard steering lever (6) and steering link. Install washers and nut and tighten.	Use 17 mm wrench and 17 mm socket with ratchet.
	b. Reverse balance lever (5)	Position on top of outboard reverse lever (31) making certain one steel (3) and one tufnol (4) washer are between the levers.	
	c. Reverse control pivot (1)	Install tufnol washer (4), steel washer (3) and nut (2).	Use 19 mm open end wrench and 19 mm socket with ratchet.

STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS

(Continued)



STEERING ASSEMBLY REPLACEMENT INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
<p>Perform step 17 if starboard steering assembly was removed and step 18 if port steering assembly was removed. Scoop control should be in full reverse.</p>			
17. Starboard hydrojet compartment	Tie bar securing nut (17)	Fit tie bar to inboard steering lever and install securing nut (17).	Use two 14 mm wrenches.
18. Port hydrojet compartment	Guide tube rod securing nut (18)	Seat end of guide tube in hole on rotary control. Pry pivot end of rod toward boat center until connection can be made to stud on inboard scoop control lever. Install nut when rod seated on stud.	Use 14 mm wrench and pinch bar to pry tube guide rod into position.
NOTE			
<p>FOLLOW ON MAINTENANCE PROCEDURE: Do scoop and steering adjustment (TM 5-1940-277-20)</p>			

STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP

Tools:

- 19 mm box/open wrench (2)
- 17 mm box/open wrench
- 13 mm box/open wrench
- Pliers
- Punch
- Hammer
- Vise

Equipment Condition:

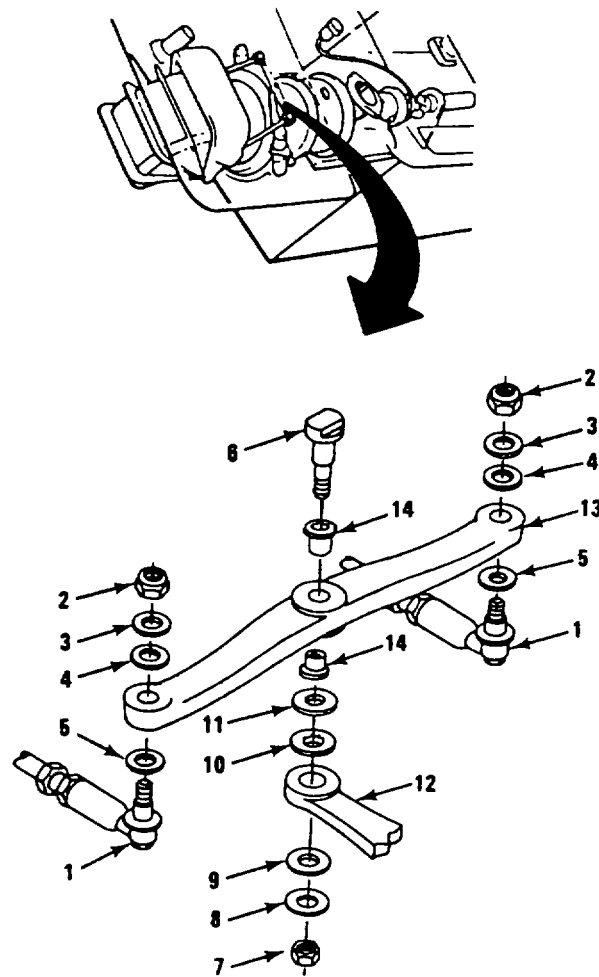
Condition Description:

Boat out of water on grounded cradle.

Materials/Parts:

Reverse balance lever

STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
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REMOVAL

NOTE

If the reverse balance lever is broken the scoop will be secured in some manner or will be hanging free. In either case movement of scoop will not occur when anything is disconnected. If the lever is not broken but only cracked the first step below will free scoop to drop to lowest point. No damage will occur but you should be prepared for this to happen.

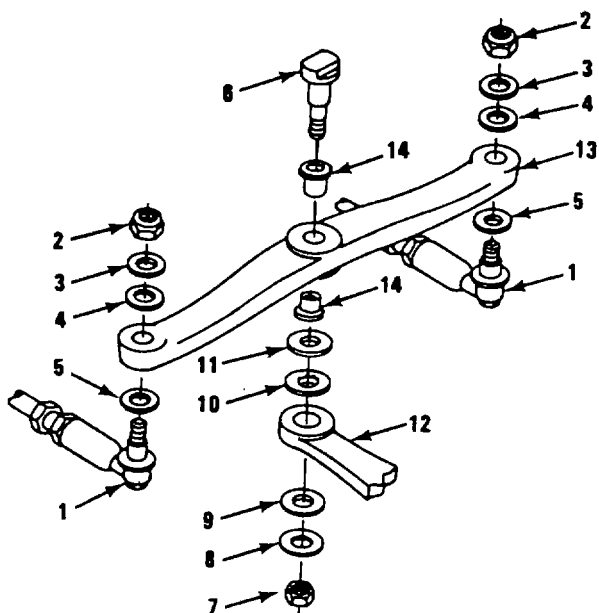
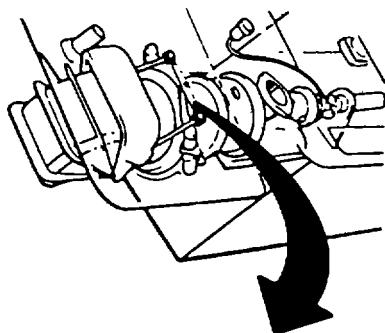
1. Ball joint pivot (1)	Nut (2), steel washer (3) and tufnol washer (4)	Remove larger of two nuts and washers on each pivot and separate pivot from reverse balance lever (13). (Scoop control rod stays attached to pivot.)	Use 17 mm and 13 mm wrenches. There are two pivots, one each end of reverse balance lever (13). There will be a tufnol washer (5) on pivot when it separates. Do not lose it.
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NOTE

Next step is subject to equipment condition. If reverse balance lever is broken the reverse control pivot will be attached only to outboard reverse balance lever. Before removing nut check for all components [pivot (6), two flanged bushings (14), two steel washers (11, 8), two tufnol washers (10, 9), and nut (7)].

2. Reverse control pivot (6)	a. Nut (7), steel washer (8) and tufnol washer (9)	Remove.	Use two 19 mm wrenches.
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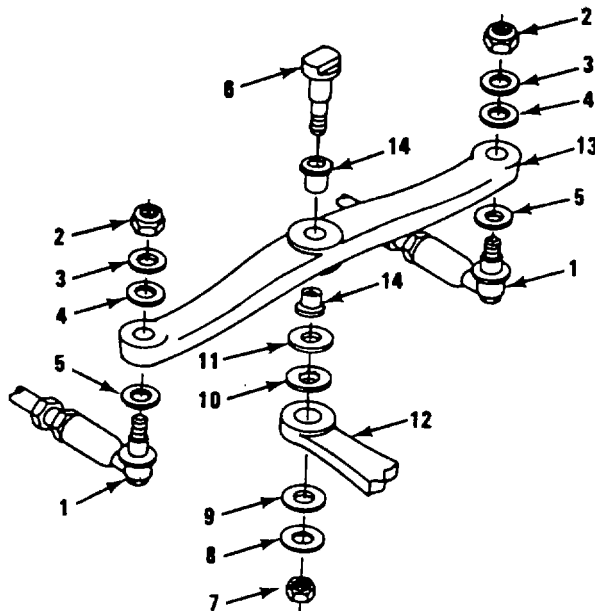
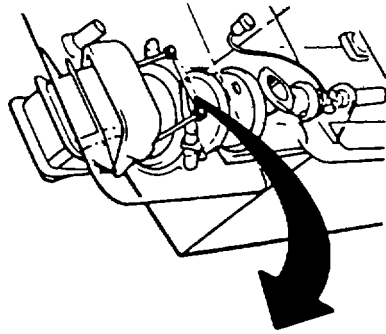
STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Reverse control pivot (6)	Withdraw from outboard reverse lever (13). As pivot clears outboard reverse balance lever one steel washer (10) and one tufnol washer (11) placed between the reverse balance lever (13) and outboard lever (12) will be freed. Do not lose them.	Pliers may be required to get pivot out.
3. Reverse balance lever (13)	a. Reverse control pivot (6)	Remove.	
	b. 2 flanged bushings (14)	Remove and retain.	Use punch and hammer as required. Be careful not to damage bushing.
<u>INSTALLATION</u>			
4. Reverse balance lever (13)	a. 2 flanged bushings (14)	Install one each side of center hole.	Use vise to squeeze bushing into position.
	b. 2 ball joint pivots (1) and 2 tufnol washers (5)	Install one each end of reverse balance lever.	
5. Ball joint pivot (1)	Tufnol washer (4), steel washer (3) and nut (2)	Install and tighten.	Use 17 mm and 13 mm wrenches.

STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - REVERSE BALANCE LEVER REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
6. Reverse balance lever (13)	Reverse control pivot (6)	Install pivot. Then fit one steel and one tufnol washer onto pivot and hold in position while connecting reverse balance lever/pivot assembly to out-board reverse balance lever (13).	
7. Reverse control pivot (6)	Tufnol washer (9), steel washer (8) and nut (7) washer (8), nut (7)	Install and tighten.	Use two 19 mm wrenches. After tightening, operate scoop control on operator's console. If movement is hard loosen nut on reverse control pivot (6) slightly and see if this eases operation of scoop control.

NOTE

FOLLOW ON MAINTENANCE PROCEDURE: Do scoop adjustment check and adjustment procedure as required (TM 5-1940-277-20).

STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP CONTROL ROD REPLACEMENT

This task covers:

- a. Removal
- b. Installation

CAUTION

This assembly contains left and right hand threads. Threads can be damaged if over stressed.

INITIAL SETUP

Tools:

- 17 mm open end wrench
- 13 mm open end wrench

Equipment Condition:

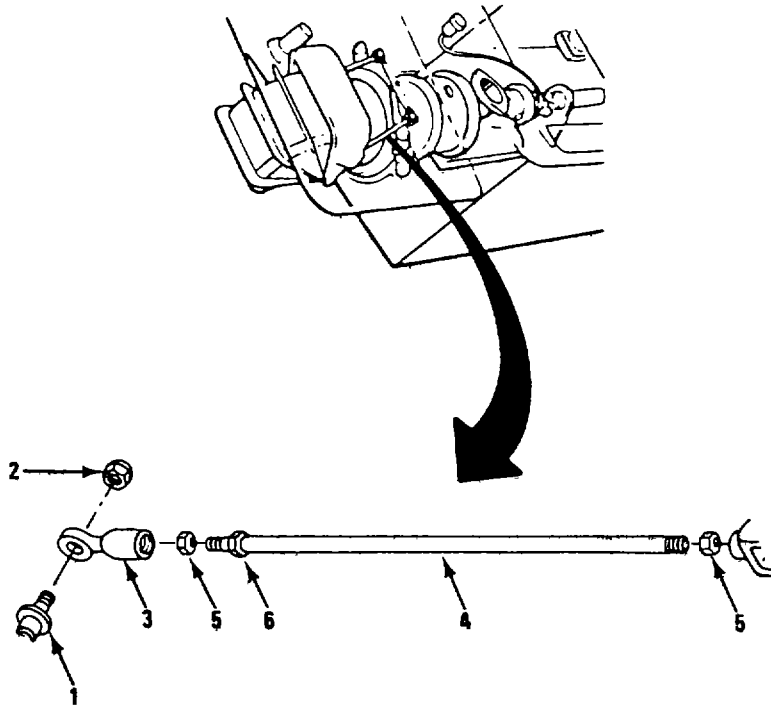
Condition Description:

Boat out of water.

Materials/Parts:

Scoop control rod

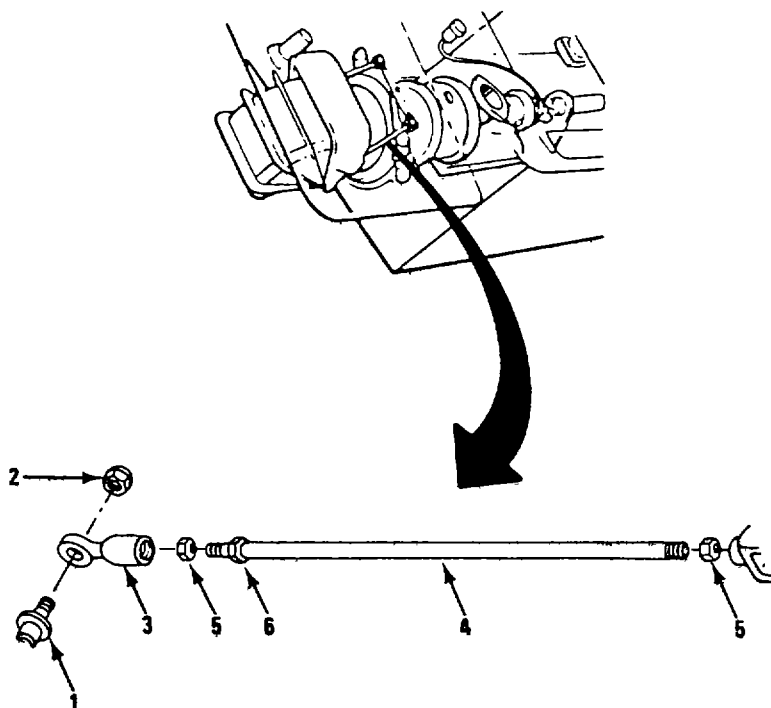
STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP CONTROL ROD REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP CONTROL ROD REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Ball joint pivot (1)	a. Nut (2)	Remove the smaller nut on pivot. It is on ball end.	Use 13 mm and 17 mm wrenches.
	b. Ball joint (3)	Slip joint off pivot.	
2. Scoop control rod (4)	a. 2 lock nuts (5)	Loosen nuts on both ends of rod.	Use 17 mm wrench. Nut on end next to fixed nut has left hand threads.
	b. Fixed nut (6)	Use to unscrew rod from fork.	
	c. Ball joint (3)	Unscrew from rod.	Has left hand thread.
	d. Lock nut (5)	Remove from rod.	
<u>INSTALLATION</u>			
3. Scoop control rod (4)	a. 2 lock nuts (5)	Screw nuts on both ends of rod.	One nut has left hand thread. If it does not fit easily on one end try other.
	b. Ball joint (3)	Screw on rod.	Put on end with fixed nut.
	c. Scoop control rod (4)	Screw rod into fork end.	Use 17 mm wrench.

STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP CONTROL ROD REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP CONTROL ROD REPLACEMENT
(Continued)

LOCATION	ITEM	ACTION	REMARKS
4. Ball joint pivot (1)	a. Ball joint (3)	Fit joint over pivot.	
	b. Nut (2)	Install and tighten.	Use 13 mm and 17 mm wrenches.

STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP

Tools:

19 mm open/box wrench
 19 mm socket
 Ratchet
 17 mm open/box wrench
 17 mm socket
 Hammer
 Punch
 Torque wrench
 Vise

Equipment Condition:

Condition Description:

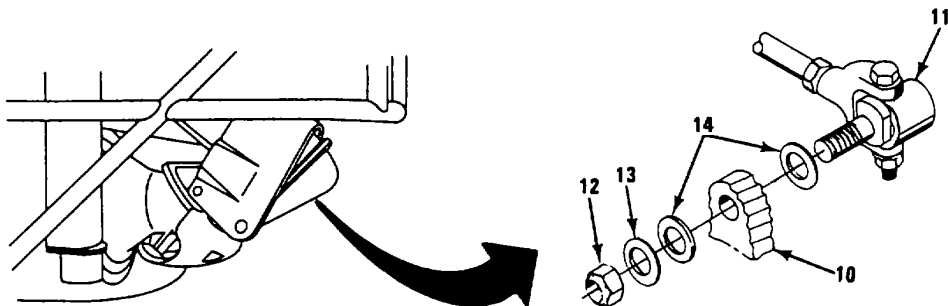
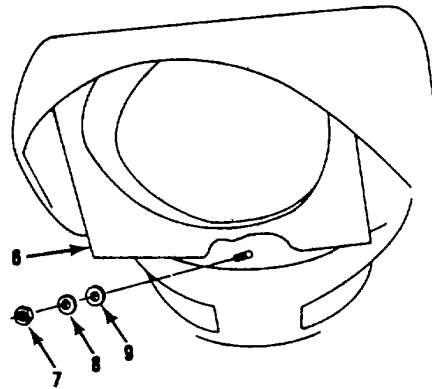
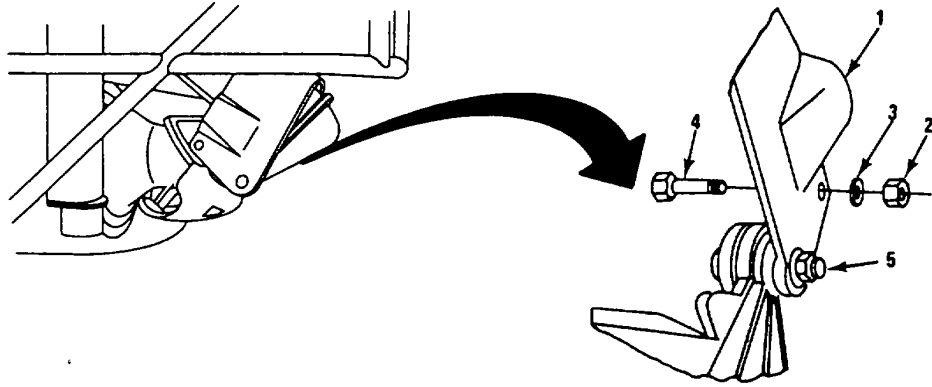
Boat out of water on grounded cradle.

Materials/Parts:

Scoop

Personnel Required: Two

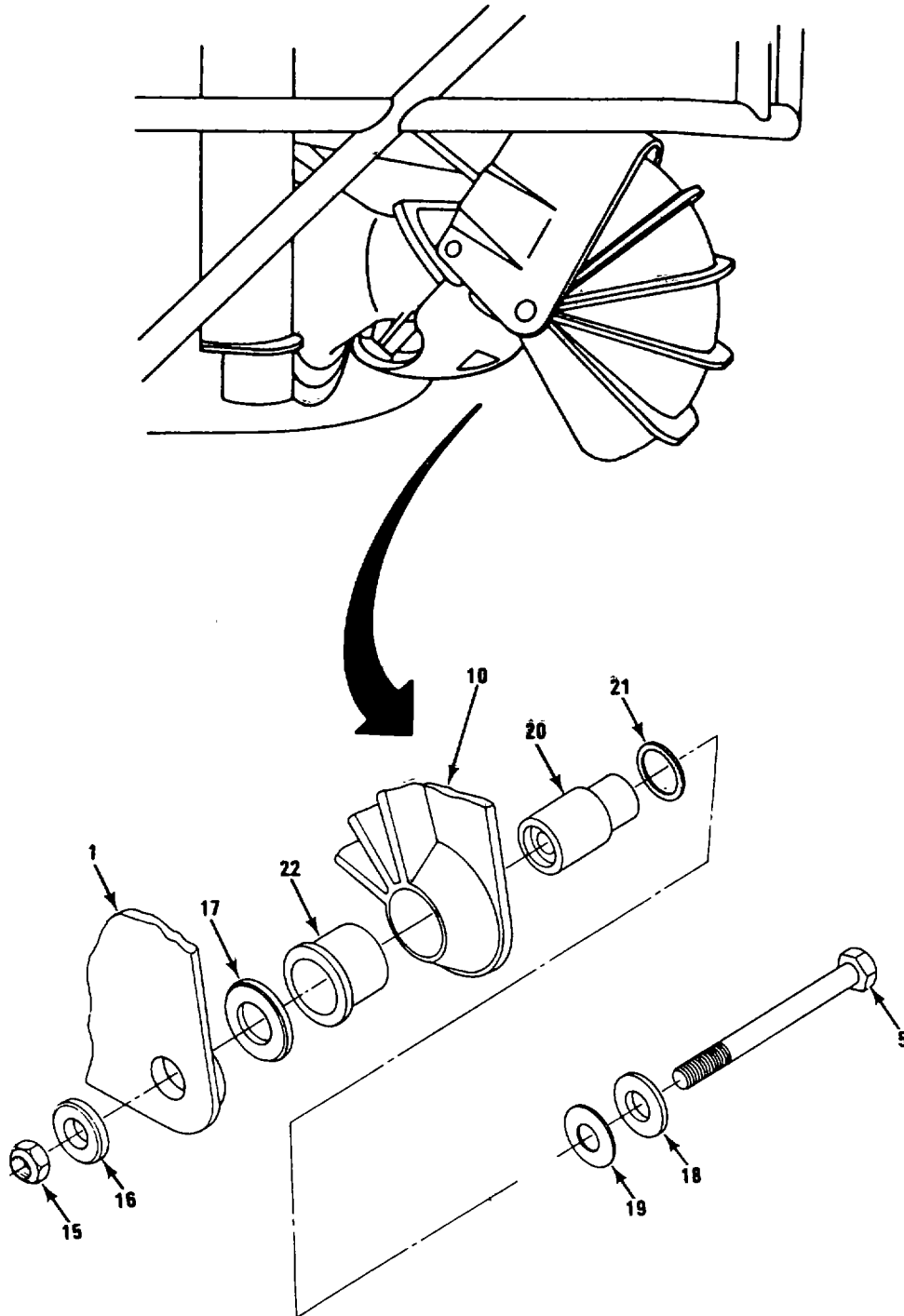
STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Cover (1)	a. Upper mounting nut (2), washer (3) and bolt (4)	Remove.	Use 17 mm wrench and 17 mm socket with ratchet.
	b. Scoop retaining and lower mounting bolt (5)	Loosen and swing cover rearward to gain access to top of tail pipe.	Use 19 mm wrench and 19 mm socket with ratchet.
NOTE			
Scoop control in full reverse for next step.			
2. Jet nozzle (6)	a. 3 nuts (7), 3 steel washers (8) and 3 tufnol washers (9)	Remove one on bottom and one each side with access from top.	Use 17 mm wrench.
	b. Jet nozzle (6)	Pull free from tail pipe.	Use hammer to free nozzle.
3. Scoop (10)	Control pivot (11), nut (12), steel washers (13) and tufnol washer (14)	Remove nut and washer and withdraw pivot from scoop (one each side).	Use 19 mm wrench and 19 mm socket with ratchet. This will free scoop to rotate around its mounting bolt. No damage will result.

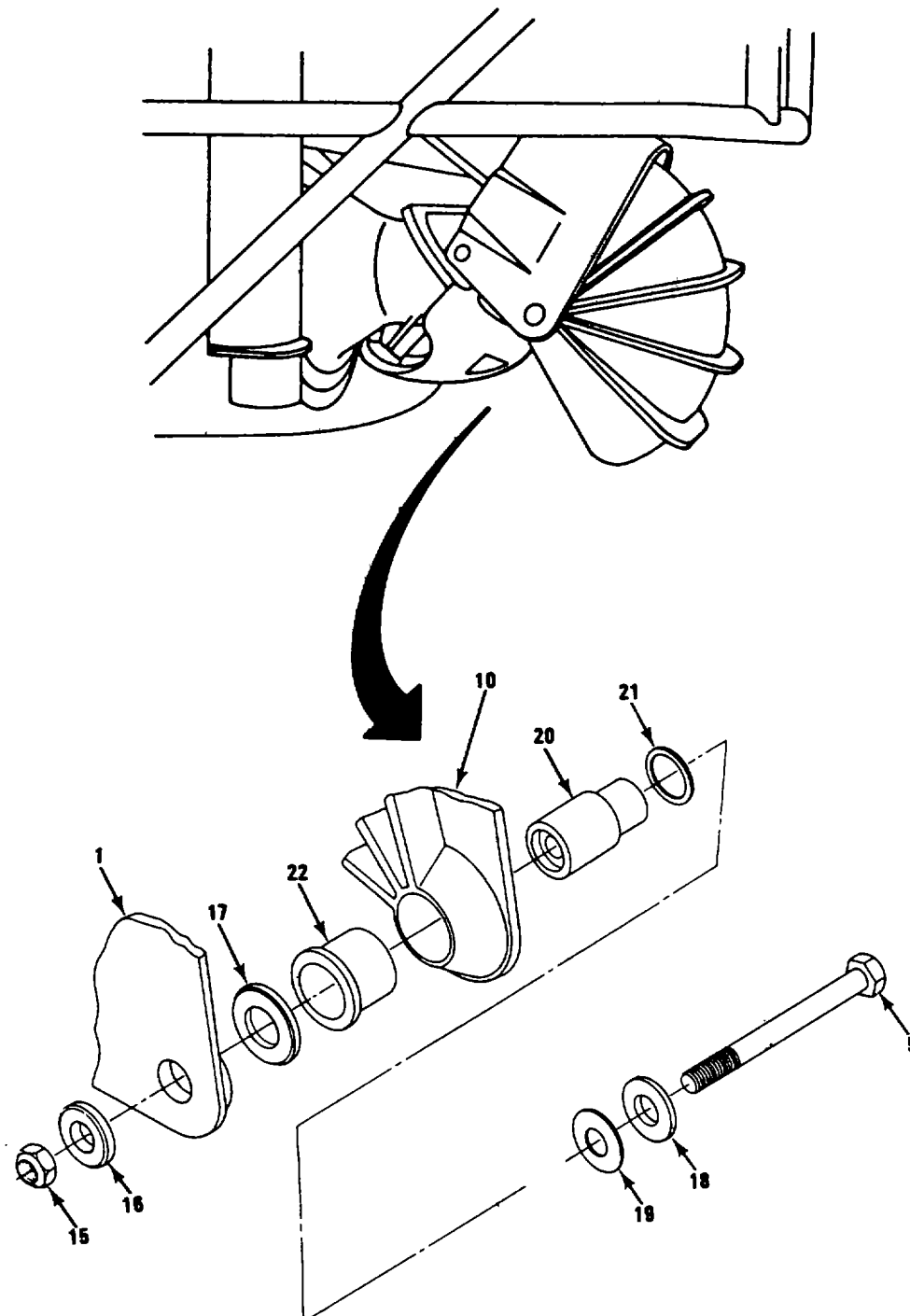
STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
4. Cover (1)	a. Scoop retaining and lower mounting bolt (5)	Remove nut (15) and washer (16). Drive bolt back until it clears cover mounting sleeve.	Use 19 mm wrench, 19 mm socket, and ratchet. Use hammer and punch as required. Use one person each side to prevent binding and damage.
	b. Cover (1)	Remove and lay aside.	
5. Scoop (10)	a. Scoop retaining and lower cover mounting bolt (5)	Remove bolt.	This will free a large plain washer (17), small plain washer (18) and small insulating washer (19).
	b. Trunion (20)	Push from inside of tail pipe mounting toward outside of scoop to free scoop. The large insulating washer (21) will be freed and drop out as trunion is pushed back through scoop. Do not lose it.	There is one each side. When second trunion is pushed clear of tail pipe mounting the scoop will be free for removal. Use one person each side to prevent binding and damage.
	c. Scoop (10)	Remove.	
CAUTION			
Do not damage surface of the trunion.			

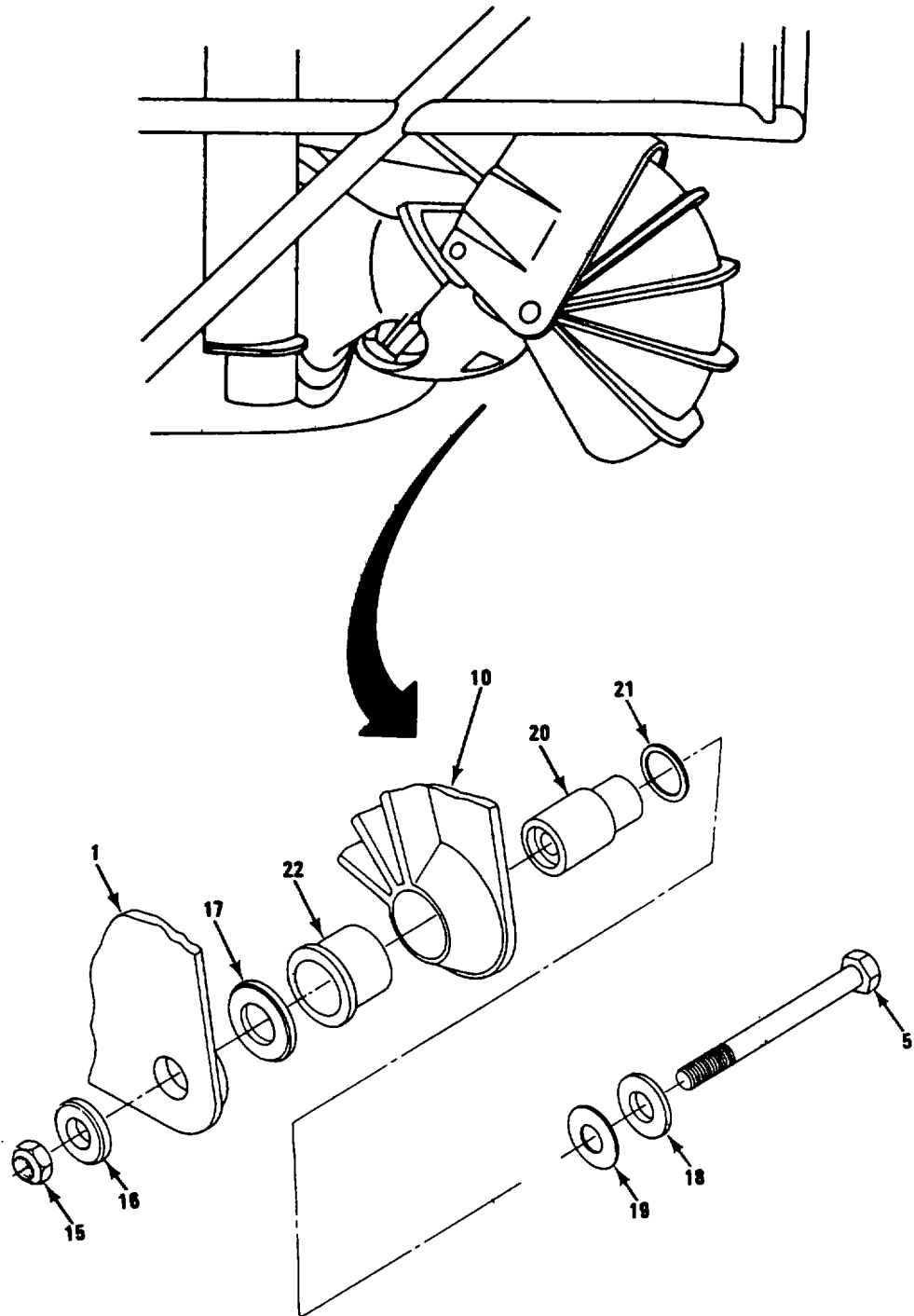
STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Trunion (20)	Pull out of scoop.	
<p><u>CAUTION</u></p> <p>Do not damage inner bore of bushing.</p>			
	e. Long flanged bushing (22)	Remove from scoop and retain.	Use hammer and punch if required.
<p><u>INSTALLATION</u></p>			
6. Scoop (10)	a. Long flanged bushing (22)	Install in scoop.	Use vise to press in if necessary.
	b. Trunion (20)	Install in bushing and push in until just clear of scoop inside surface.	
	c. Large insulating washer (21)	Fit over the part of trunion sticking through scoop inside surface.	
	d. Scoop (10)	Fit into mounting position.	Use one person each side to control and prevent damage.

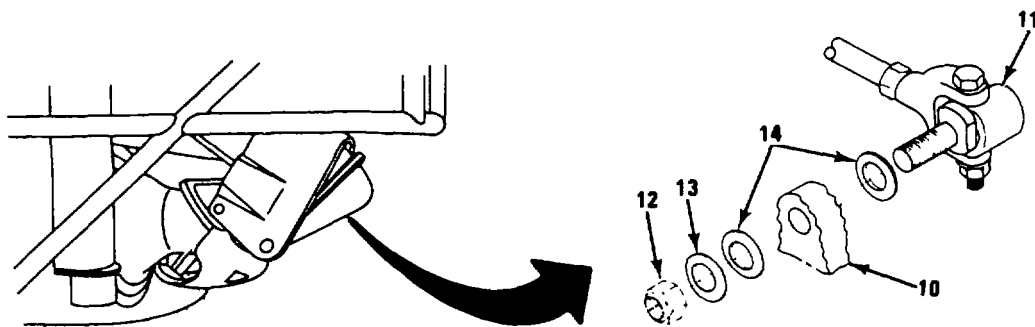
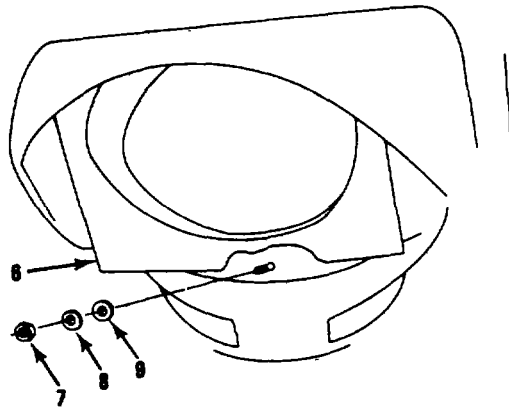
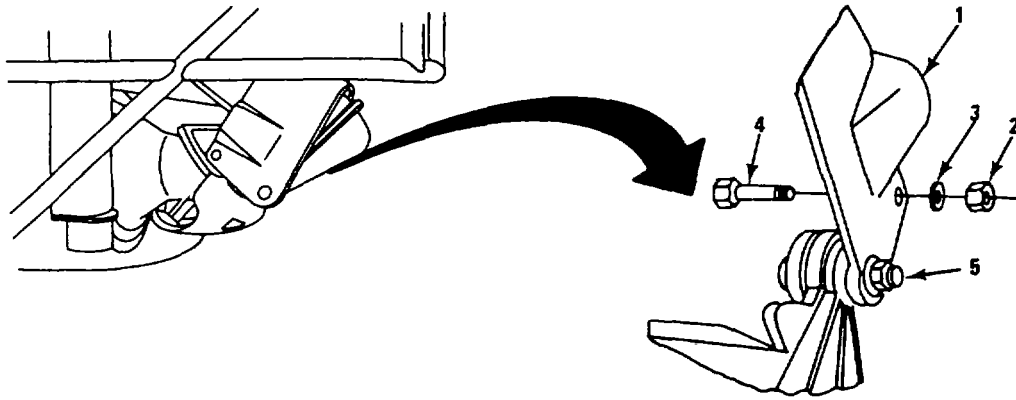
STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	e. Trunion (20)	Push in until seated. Smaller portion of trunion fits into mounting hole in tail pipe casting.	This secures scoop to tail pipe but the scoop can still swing freely.
	f. Scoop retaining and lower cover mounting bolts (5)	Partially install bolt with small plain washer (18) and small insulating washer (19) on bolt. Install from inside through trunion. Push through until 2 - 3 threads are exposed outside face of trunion.	
	g. Large plain washer (17)	Place on exposed threads of bolt.	
7. Cover (1)	a. Cover (1)	Position and push mounting bolt through sleeve.	Use one person each side. Make sure large plain washer stays in place.
	b. Scoop retaining and cover lower mounting bolt (5)	Install small plain washer (16) and nut (15).	Tighten finger tight. This will hold assembly together until final positioning is completed.

STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - SCOOP REPLACEMENT
(Continued)

LOCATION	ITEM	ACTION	REMARKS
8. Tail pipe	Jet nozzle (6)	Fit into position on tail pipe.	
9. Jet nozzle (6)	Tufnol washer (9), steel washer (8) and nut (7)	Install three locations and tighten.	Use 17 mm wrench.
10. Scoop (10)	Control pivot (11), tufnol washer (14), steel washer (13), nut (12)	Install pivot through scoop, secure with washer and nut and tighten.	Use 19 mm wrench, 19 mm socket and ratchet.
11. Cover (1)	a. Upper mounting bolt (2), washer (4) and nut (3)	Rotate cover into position, install bolt, secure with washer and nut and tighten.	Use 19 mm wrench, 19 mm socket and ratchet.

NOTE

Before next step move scoop control to full forward.

b. Scoop retaining and cover lower mounting bolt (5)	Torque to 40 ft-lb.	Use torque wrench.
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NOTE

FOLLOW ON MAINTENANCE PROCEDURE: Check scoop adjustment (TM 5-1940-277-20).

STEERING ASSEMBLY REPAIR INSTRUCTIONS - ROTARY CONTROL ASSEMBLY

This task covers:

- a. Removal
- b. Installation
- c. Repair
- d. Assembly

INITIAL SETUP

Tools:

7/32 in hex key wrench
(Allen)
17 mm open/box wrench
17 mm open end wrench
13 mm open/box wrench
13 mm socket
Ratchet
Flat tip screwdriver, 6 inch

Equipment Condition:

TM 5-1940-277-20
TM 5-1940-277-20

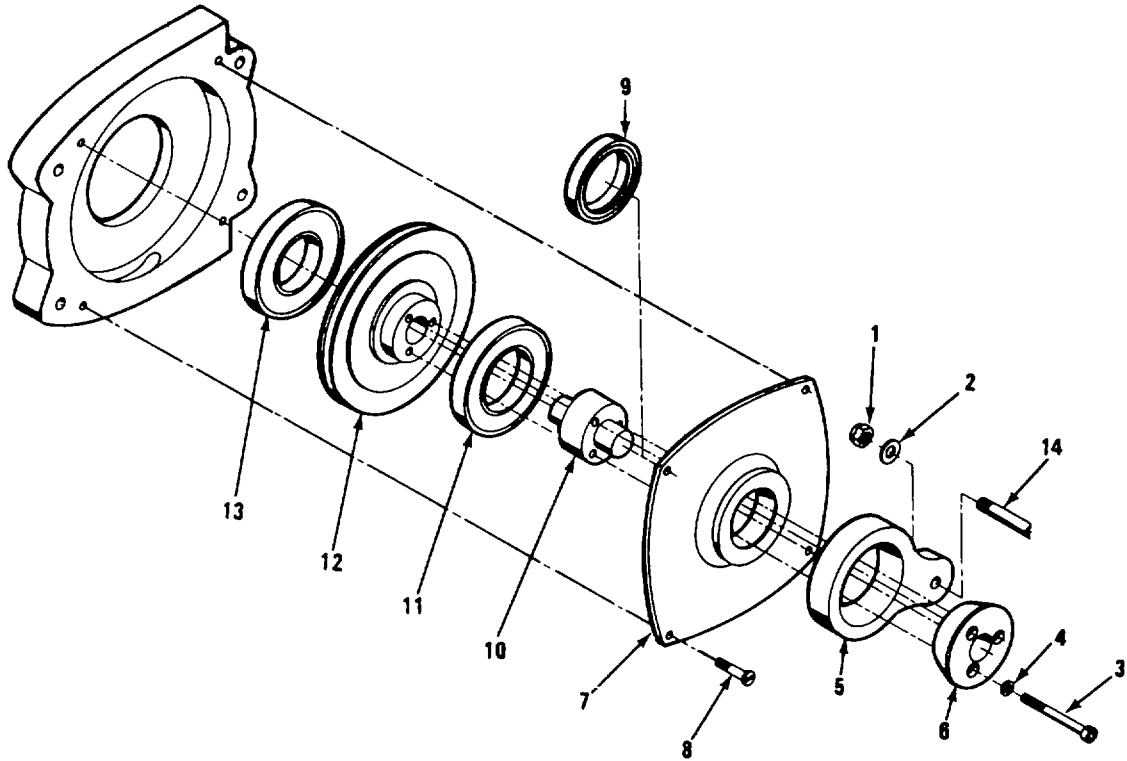
Condition Description:

Hydrojet hatches
opened and secured.
Steering cable removed.

Materials/Parts:

Shaft seal
Bearings
Seal sleeve
Grease

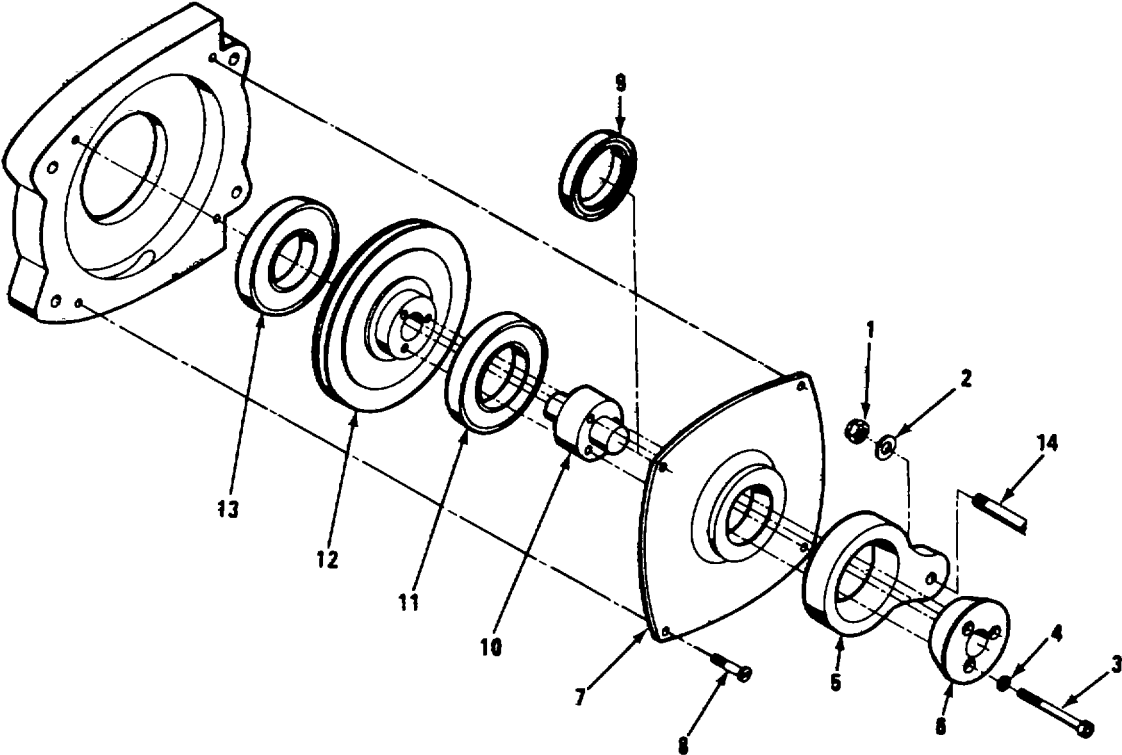
STEERING ASSEMBLY REPAIR - ROTARY CONTROL ASSEMBLY-MAINTENANCE INSTRUCTIONS
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - ROTARY CONTROL ASSEMBLY
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>			
1. Rotary control assembly	a. Ball joint pivot nut (1) and washer (2)	Remove. Take pivot (14) out of crank (5).	Use two 17 mm wrenches.
	b. 3 socket head screws (3) and 3 washers (4)	Remove and retain.	Use 7/32 in hex key wrench (Allen).
	c. Crank (5)	Remove crank and cone (6) as unit.	Use hands.
	d. Cover (7)	Remove four screws (8) and put cover aside.	Use screwdriver.
	e. Seal (9)	Pull out of cover and discard.	Use seal puller.
	f. Seal sleeve (10)	Pull out and retain.	Make sure bearing (11) does not pull out with sleeve.
	g. Front bearing (11)	Remove and retain.	
	h. Cable wheel (12)	Remove and retain.	Cable wheel is packed in grease. Rear bearing may stick to wheel.
	i. Rear bearing (13)	Remove.	

STEERING ASSEMBLY REPAIR - ROTARY CONTROL ASSEMBLY - MAINTENANCE INSTRUCTIONS (Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - ROTARY CONTROL ASSEMBLY
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
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INSPECTION

NOTE

Clean all components before inspecting.

2.	Bearings (11 and 13)	a. Check for Chips, Cracks or Discoloration. b. Replace defective or discolored bearings.	
3.	Cone (6), crank (5), cable wheel (12) and seal sleeve (10)	a. Inspect all components for Cracks or Breaks. b. Replace defective parts.	

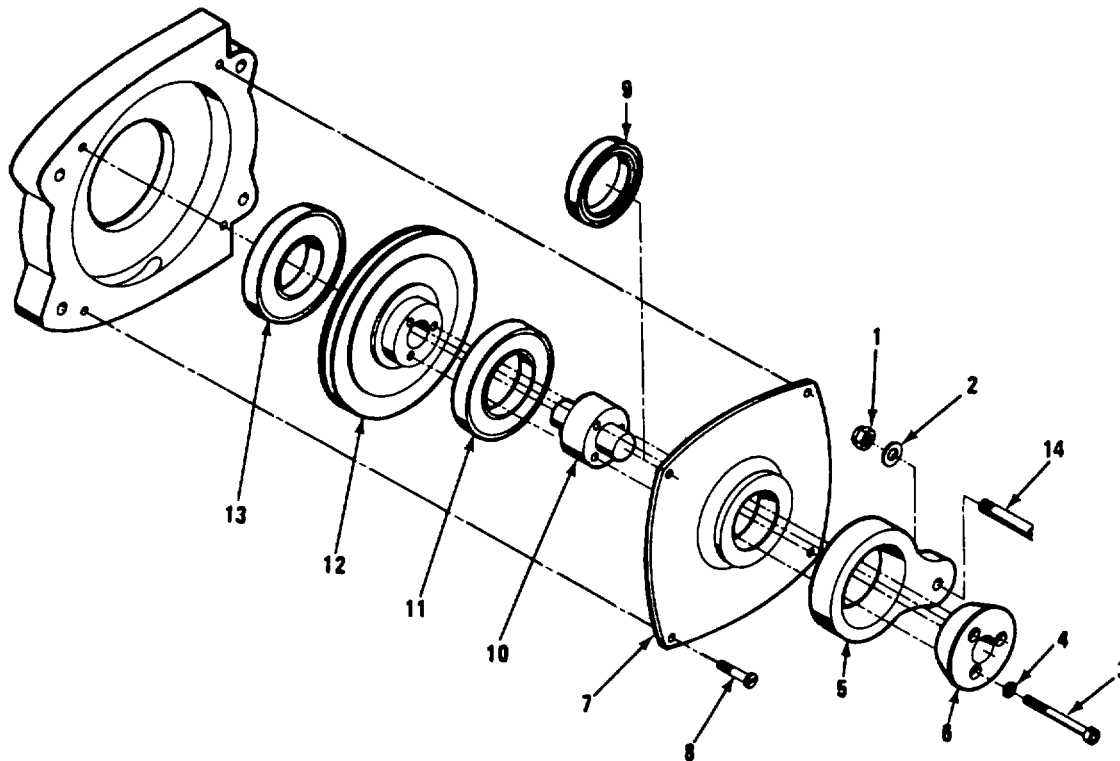
ASSEMBLY

NOTE

Smear all parts with grease before assembly.

4.	Rotary control assembly	a. Rear bearing (13) b. Cable wheel (12)	Fit to rear side of cable wheel (12). Fit cable wheel and bearing (13) into body. Rear bearing to remain in position while wheel fitted.
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STEERING ASSEMBLY REPAIR - ROTARY CONTROL ASSEMBLY - MAINTENANCE INSTRUCTIONS
(Continued)

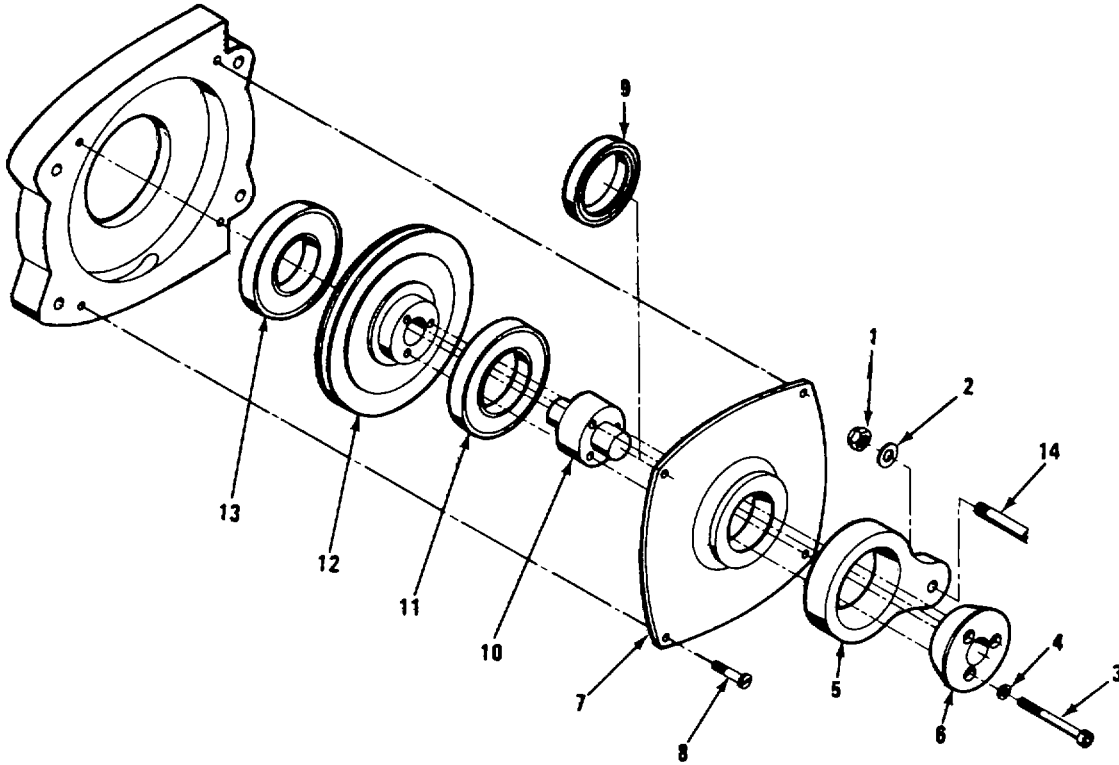


STEERING ASSEMBLY REPAIR INSTRUCTIONS - ROTARY CONTROL ASSEMBLY

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	c. Front bearing (11)	Fit into position on front of cable wheel (12).	
	d. Seal sleeve (10)	Fit into position with bolt holes alined with those in cable wheel.	
	e. Seal (9)	Fit into front cover.	
	f. Cover (7)	Carefully slide cover over seal sleeves and bearings. Move assembly into position and secure cover with four screws (8).	Use screwdriver. The cover positions the assembly components. Care should be taken to see that cover is properly positioned and fitted.
	g. Crank (5) and cone (6)	Fit crank over cone and position this subassembly, alining bolt holes in cone with those in seal sleeve (10).	
	h. 3 socket head screws (3) with washers (4)	Install.	Tighten finger tight.
	i. Ball joint washer (2) and nut (1)	Fit pivot (14) to crank (5) and install washer and nut.	Use 17 mm wrench.

STEERING ASSEMBLY REPAIR - ROTARY CONTROL ASSEMBLY - MAINTENANCE INSTRUCTIONS
(Continued)



STEERING ASSEMBLY REPAIR INSTRUCTIONS - ROTARY CONTROL ASSEMBLY

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	j. 3 socket head screws (3)	Tighten evenly.	Use 7/32 in hex key wrench (Allen). Three socket head screws secure assembly together
NOTE			
FOLLOW ON MAINTENANCE PROCEDURE: Do scoop adjustment check (reference TM 5-1940-277-20).			

ROTARY CONTROL ASSEMBLY REPLACEMENT INSTRUCTIONS

This task covers:

- a. Removal
- b. Installation

INITIAL SETUP

Tools:

17 mm open/box wrench
 17 mm open end wrench
 1/2 in open/box wrench
 1/2 in socket
 Ratchet

Equipment Condition:

TM 5-1940-277-20
 TM 5-1940-277-20

Condition Description:

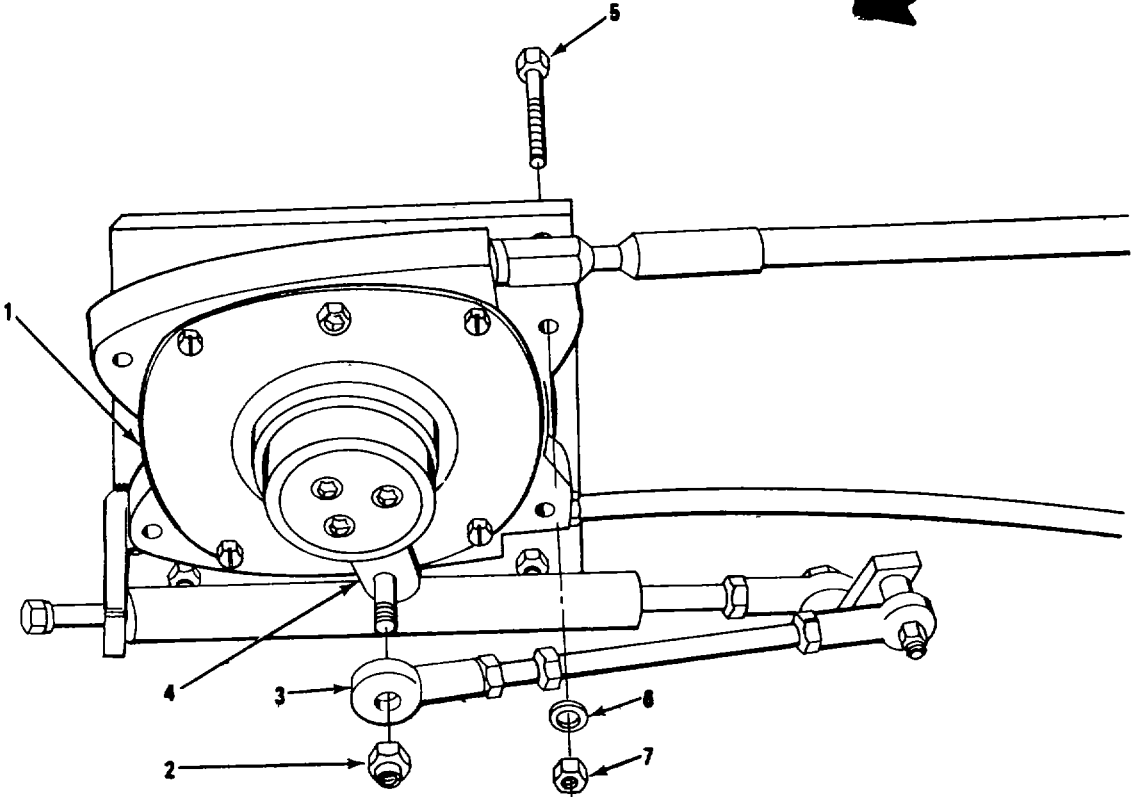
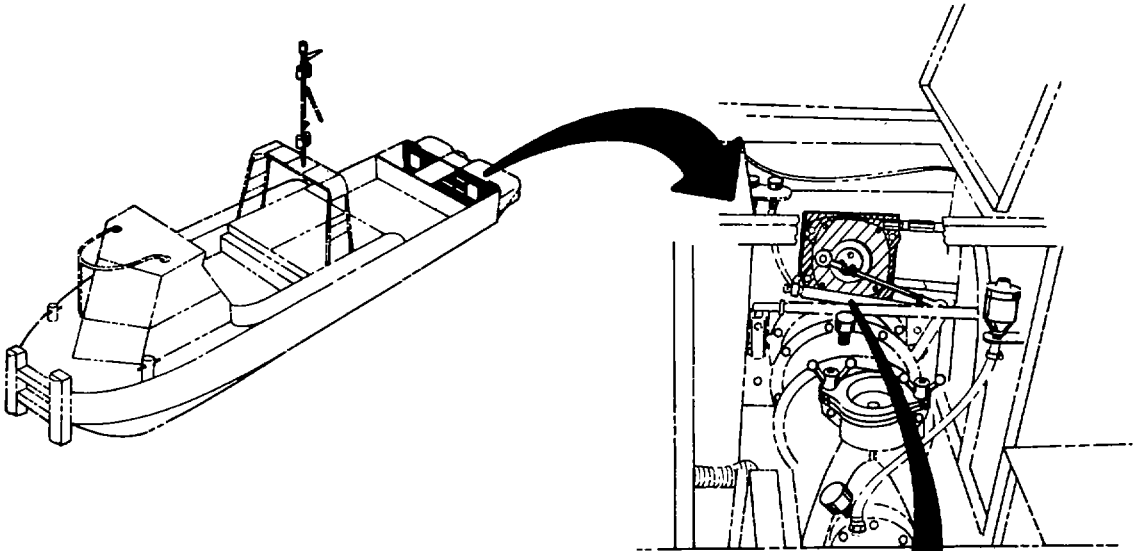
Hydrojet hatches
 opened and secured.
 Steering cable removed.

Materials/Parts:

Rotary control assembly

ROTARY CONTROL ASSEMBLY REPLACEMENT INSTRUCTIONS

(Continued)



ROTARY CONTROL ASSEMBLY REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Rotary control assembly (1)	a. Control rod (3)	a. Remove pivot nut (2).	Use two 17 mm wrenches.
		b. Remove control rod (3) from crank (4).	
	b. Rotary control assembly (1)	a. Remove and retain 4 nuts (5), washers (6) and bolts (7).	Use 1/2 in socket and 1/2 in open end wrench.
		b. Remove rotary control assembly (1).	Use hands.
<u>INSTALLATION</u>			
2. Rotary control assembly (1)	a. Rotary control assembly (1)	a. Position assembly (1).	
		b. Install and tighten 4 bolts (7), washers (6) and nuts (5).	Use 1/2 in socket and 1/2 in open end wrench.
	b. Control rod (3)	a. Install onto crank (4).	Use two 17 mm wrenches.
		b. Install and tighten pivot nut (2).	Use two 17 mm wrenches.

ROTARY CONTROL ASSEMBLY REPLACEMENT INSTRUCTIONS			
(Continued)			
LOCATION	ITEM	ACTION	REMARKS
<p>NOTE</p> <p>FOLLOW ON MAINTENANCE PROCEDURE: Do scoop adjustment check (reference TM 5-1940-277-20).</p>			

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS

This task covers:

- a. Repair
- b. Cleaning
- c. Painting

INITIAL SETUP

Tools:

Equipment Condition:

Condition Description:

Arc welding set, insert gas
 Non-metallic hammer
 Electric disc sander
 Electric drill
 Twist drill set
 Temperature-indicating crayon
 Hammer
 Metal saw

TM 5-2090-202-12
 TM 5-1940-277-20

Boat on grounded
 cradle.
 Batteries disconnected.

Materials/Parts:

Aluminum plate
 Rivets
 Paint, epoxide undercoat
 Paint, polyurethane top coat
 Sealant, waterproof
 Solvent

HULL ASSEMBLY REPAIR INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

NOTE

The exact procedure to be followed in hull repair varies with the location of the damaged or broken section. In the areas above the engine mounting surface and running from the back of battery compartment to the transom there are buoyancy foam blocks that can be removed. In the bow section buoyancy foam is placed and the deck riveted or welded in place. Below engine mount level the space is filled with buoyancy balls. Buoyancy balls are plastic spheres of two sizes which are 25/32 in (20mm) and 1-49/64 in (45mm) in diameter. For those two areas any welding or heating done on the exterior surface must be done carefully to prevent excessive damage to the buoyancy material. Refer to FO-4 for general arrangement of buoyancy materials.

WARNING

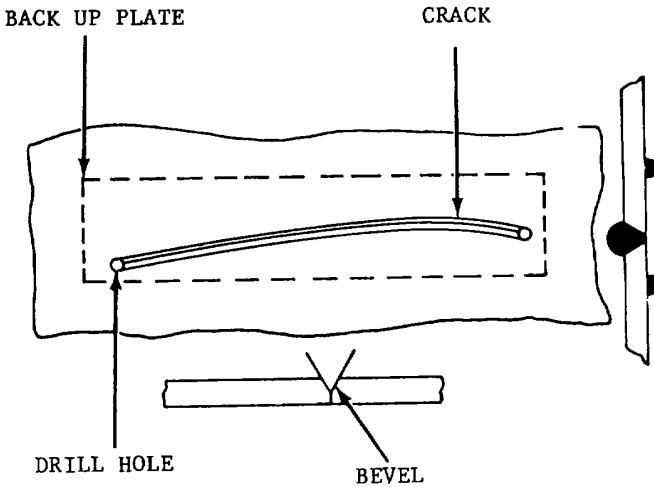
Application of flame to buoyancy foam produces an acrid smoke. Inhalation of this smoke may be harmful to personnel. Flame should not be allowed to come in contact with buoyancy foam. Care in heating metal in contact with buoyancy foam must be exercised.

REPAIR:

- 1. Dents
 - a. Minor Dents
 - Use rubber-headed mallet with back-up mallet on opposite side of the plate. Hammer carefully, first around outer periphery and then work in a spiral to center where dent is greatest.
 - b. Deep Dents
 - 1. Deep dents may require careful application of heat to aid in reforming metal.
 - 2. Use temperature-indicating crayon:
 - (a) Mark central area of dent with 500°F (260°C) crayon.
 - (b) Mark rings around central area with 400°F (260°C) crayon.
 - 3. Apply heat until crayon marks begin to melt.
 - 4. Withdraw heat and immediately start hammering.

HULL ASSEMBLY REPAIR INSTRUCTIONS

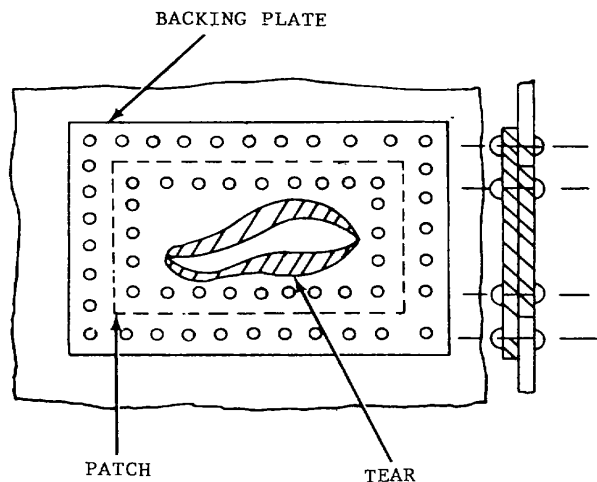
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	5.	Continued applications of heat may be required.	
	6.	Cool area with a light water spray.	
	7.	Cold-hammer remaining minor dents or buckled areas.	
	c.	Deep, Small Area Dent	
	1.	Occasionally, a deep small-area dent will not respond to above methods of repair. Drill a small hole in the center of the dent. This provides room for metal displacement during hammering.	
	2.	Repair with one of above methods as required.	
	3.	Close hole by welding.	
			 <p>The diagram illustrates a repair technique for a crack in a metal plate. A horizontal crack is shown in a rectangular plate. A dashed rectangular area is drawn around the crack, representing the area to be repaired. A 'BACK UP PLATE' is shown on the right side of the crack, held against the opposite face. A 'DRILL HOLE' is shown at each end of the crack. A 'BEVEL' is shown at the ends of the crack, indicating the preparation of the metal for welding. The labels 'BACK UP PLATE', 'CRACK', 'DRILL HOLE', and 'BEVEL' are connected to their respective parts in the diagram by arrows.</p>
2.	Cracks	a.	Reshape metal using one of methods in 1. above.
		b.	Drill a hole at each end of the crack.
		c.	Hold aluminum back-up plate against opposite face.

HULL ASSEMBLY REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Bevel groove using router, chisel, saw or disc sander.		
	e. Bolt or tack weld, temporarily, back-up plate in position.		
	f. Weld crack.		
	g. After welding is underway remove bolts if used.		
	h. Weld edges of back-up plate to opposite face of hull plate.		



3. Tears

NOTE

Tears may be welded if the metal can be hammered back into position so that the damage may be treated as a crack. Normal crack repair procedure may then be followed. The alternative is riveting.

- a. Remove the section of hull plate to be replaced by sawing a rectangular hole. Cut hole large enough to remove all damaged metal.

HULL ASSEMBLY REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
----------	------	--------	---------

- b. Deburr the edges.
- c. Cut a patch of the same material as the hull and size as the hole.
- d. Cut another rectangular plate whose length and width exceed that of patch plate by at least 4 in.
- e. Center the patch plate on the larger plate.
- f. Drill a row of holes (size depends on rivet diameter) approximately 1 in from the edge of the patch plate and through both plates (spacing must be not less than 3 times the rivet diameter or more than 24 times the thickness of both plates).
- g. Rivet the two plates together.
- h. Position the prepared patch in the hole in the hull with the oversize plate on the inside of the hull.
- i. Drill a row of holes approximately 1 in in from the edge of the backing (oversize) plate through the backing plate and hull plate (spacing as in step f).
- j. Remove the prepared patch and coat the area of the backing plate that contacts the hull plate with a waterproof sealant.
- k. Position the patch and rivet in place.

NOTE

If there is a question about the fit of the patch the seam could be closed by a light weld.

CLEANING, PAINTING

1.

NOTE

The surface must be prepared before painting can be undertaken. The primary preparation consists of a thorough cleaning. Degreasing is not sufficient.

HULL ASSEMBLY REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		<ul style="list-style-type: none"> a. Be sure all welds have been ground down and area is ready to be painted. b. Clean the area to be painted with solvent, detergent, or non-etch alkaline cleaner. 	
		<p>NOTE</p> <p>Do not use brushes or sanding discs that have been used before. Use only new material.</p>	
		<ul style="list-style-type: none"> c. Rough the surface to be painted using stainless steel wire wool or brush, a disc sander or orbital sander. d. When surface is clean and dry, apply one coat of epoxide primer. e. Apply a coat of epoxide undercoat and a polyurethane top coat. f. Apply camouflage paint in accordance with local requirements. 	
		<p>NOTE</p> <p>Painting is needed for antifouling only. The aluminum will not corrode where paint has been removed, nor will attack occur between the paint and aluminum to cause adjacent paint to peel off.</p>	

CHAPTER 3**GENERAL SUPPORT MAINTENANCE INSTRUCTIONS**

- 3-1. **GENERAL.** This section covers general information for disassembly, cleaning, inspection, repair and assembly for component parts of the bridge erection boat. Specific instructions for individual component maintenance are covered in the appropriate sections.
- 3-2. **DISASSEMBLY.** It is recommended that groups of related parts be kept together, preferably in a tray, to prevent their being lost. For those components which have too many or too large parts to use trays it is recommended that the parts be tagged with their name as they are disassembled. This will make it easier to identify parts when assembling the components. Precision matched or mated parts will be marked to insure reassembly in the proper position and place.
- 3-3. **CLEANING** All parts except bearings are to be cleaned as specified in TM 9-247. Bearings should be cleaned as specified in TM 9-214.
- 3-4. **INSPECTION.**
- a. **General.** The importance of carefully inspecting disassembled parts cannot be stressed enough. Reassembly of substandard or defective parts can result in needless troubleshooting, disassembly and inspection. Inspection procedures must be performed by experienced personnel using proper tools and equipment. All measuring and testing equipment must be checked periodically and when required accurately calibrated in accordance with current directives. The compilation of complete and accurate inspection records as specified in DA Pam 738750 is a necessary part of all inspection actions.
 - b. **Metallic Parts.** The following procedures should be followed when inspecting metallic parts.
 - (1) All parts should be inspected for cracks.
 - (2) Inspect gear teeth retaining ring grooves and mating surfaces for burrs.
 - (3) Mating and polished surfaces should be inspected for nicks, scratches and rust. Any nick, scratch, or rust is cause for rejection.
 - (4) Short Metal parts should be inspected for bends, cracks, tears, broken corners or defective welds.
 - c. **Non-Metallic Parts.** Non-metallic parts such as seals and gaskets are not subject to inspection. They will be disposed of upon removal and replaced by new items during assembly.
- 3-5. **REPAIR**
- a. Hull parts that are cracked may be repaired by welding if it does not distort or impair the strength of the part. Welding procedures will be accomplished as specified in TM 9-237.

- b. A smooth file or hone may be used to remove small burrs from gear teeth, retaining ring grooves and mating surfaces. The burrs must be very minor and if on gears only on the engaging edge of the teeth.
- c. Damaged painted surfaces should be repainted as soon as possible to prevent corrosion.

3-6. ASSEMBLY. Step-by-step procedures for assembly of the bridge boat components are provided in Chapter 3. In addition the following practices should be observed.

- a. The housing contact surface of oil seals should be coated with a nonhardening sealer to prevent leaks. The lips should be coated with grease (GAA).
- b. All pressing operations should be accomplished using a suitable press and adapters unless otherwise specified.
- c. Metallic parts should be lubricated with the lubricant utilized in the component during operation.
- d. Critical torque values are specified in the assembly procedures.
- e. Silicone rubber sealant is used on gaskets and mating surfaces in the engine assembly.

3-7. GENERAL DETAILED PROCEDURE APPLICATIONS

- a. Resources required are not listed unless they apply to the procedure.
- b. Personnel required are listed only if the task requires more than one. If PERSONNEL are not listed it means that one person can do the task.
- c. The normal standard equipment condition to start a maintenance task is power (MASTER SWITCH) OFF. EQUIPMENT CONDITION is not listed unless some other condition is required besides the (MASTER SWITCH) being OFF.

NOTE

Remember the bridge erection boat has two water cooling systems (refer to FO-3).

- d. The MK1 engine WILL NOT be operated without a supply of water to circulate through the raw water system. At full speed the system requires 27 gallons of water per minute. The MK2 engine WILL NOT be operated out of water for more than 20 minutes at idle speed. Any maintenance task step that requires engine operation MUST BE performed with the boat in water or by following Out of Water Engine Operation procedures (TM 5-1940-277-20).
- e. Standard maintenance procedure requires that an operational check be performed after completion of repairs if possible. This step is not called out as part of the procedure.

GENERAL SUPPORT MAINTENANCE PROCEDURE INSTRUCTIONS INDEX

Procedure	Page
ENGINE	
Cam Follower Inspection	3-5
Cam Follower Replacement	3-5
Oil Pump Replacement	3-9
Piston and Connecting Rod Assembly Inspection	3-15
Piston and Connecting Rod Assembly Repair	3-15
Piston and Connecting Rod Assembly Replacement	3-29
Cylinder Liner Inspection	3-37
Cylinder Liner Replacement	3-37
Main Bearing Inspection	3-47
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Engine Block Inspection	3-87
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TRANSMISSION	
Transmission Repair	3-99
HYDROJET UNIT	
Hydrojet Assembly, Two Stage Repair (Impeller Section)	3-165
Hydrojet Assembly, Two Stage Repair (Drive Section)	3-183

CAM FOLLOWER INSPECTION AND REPLACEMENT INSTRUCTIONS

This task covers:

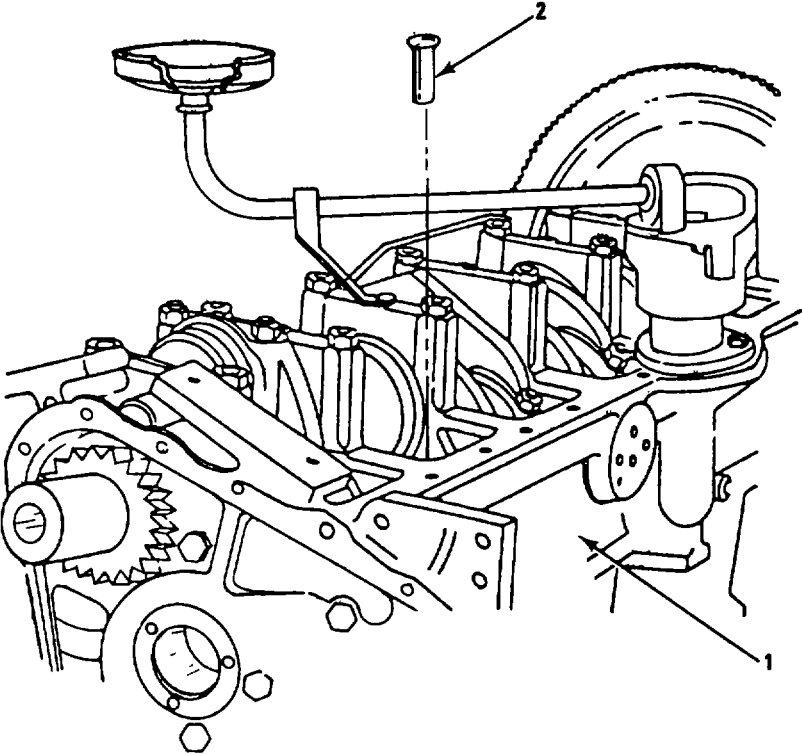
- a. Removal
- b. Inspection
- c. Installation

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Engine maintenance stand from boat and mounted	Page 2-179	Engine assembly removed
Materials/Parts:		on engine maintenance stand or laid on side on top of work bench.
Set of cam followers	Page 2-345 Page 2-317 Page 2-307 Page 3-75	Transmission removed. Flywheel and housing removed. Oil sump removed. Camshaft removed.

CAM FOLLOWER INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)



CAM FOLLOWER INSPECTION AND REPLACEMENT INSTRUCTIONS			
(Continued)			
LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Cylinder block (1)	Cam followers (2)	Lift out of cylinder block.	Keep in order for correct reassem- bly if original cam followers are reusable. Rotate crankshaft as needed to get to cam followers.
<u>INSPECTION</u>			
2.	Cam followers (2)	a. Inspect for: Cracks, wear. b. Replace if defective.	
<u>INSTALLATION</u>			
3. Cylinder block (1)	Cam followers (2)	Install into bores in cylinder block.	Make sure rein- stalled followers are returned to original posi- tions.

OIL PUMP REPLACEMENT INSTRUCTIONS

This task-covers:

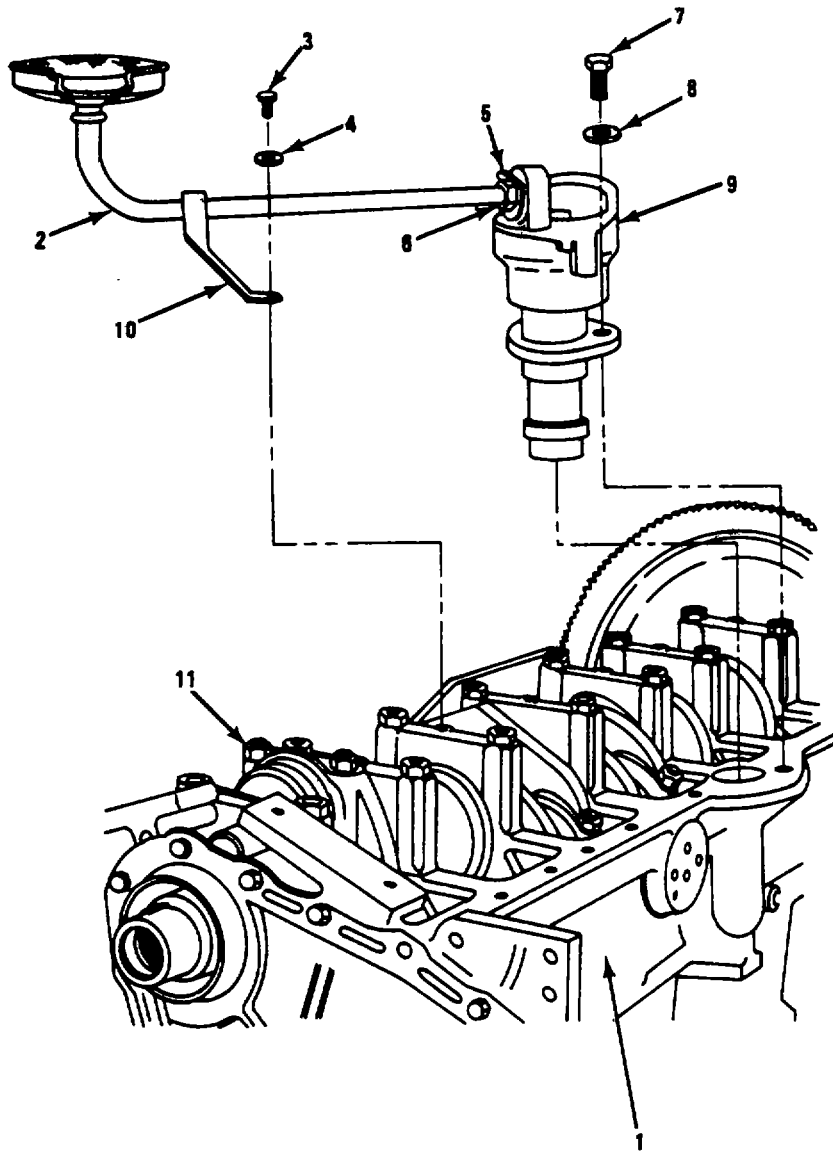
- a. Removal
- b. Installation

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Ratchet 1/2 in socket 7/8 in open end wrench 1/2 in box wrench Engine maintenance stand	Page 2-179 TM 5-1940-277-20	Engine assembly removed from boat and mounted on engine maintenance stand or laid on side on top of work bench. Coolant system drained. Transmission removed. Flywheel housing cover removed. Oil sump removed.
Materials/Parts: Oil pump	Page 2-345 Page 2-317 Page 2-307	

OIL PUMP REPLACEMENT INSTRUCTIONS

(Continued)



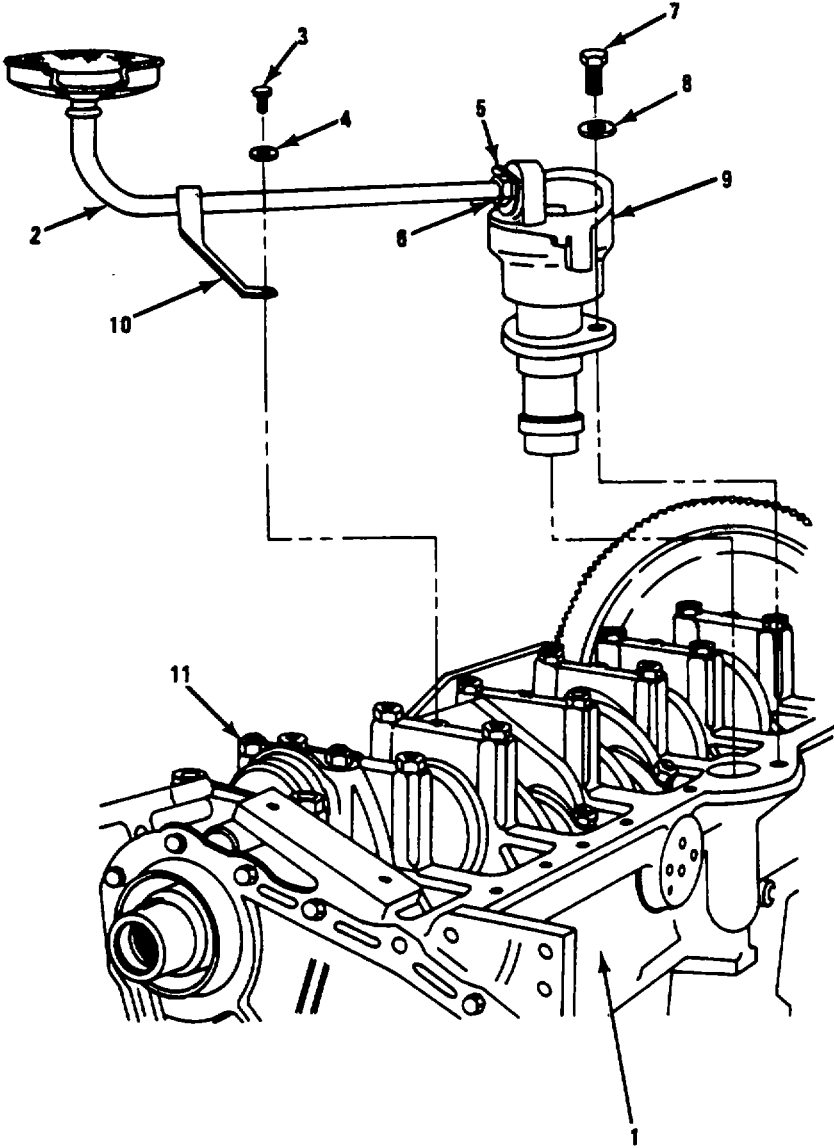
OIL PUMP REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL:			
1. Cylinder block (1)	a. Oil pump inlet pipe (2)	a. Unscrew and remove cap screw (3) and washer (4).	Use 1/2 in socket and ratchet.
		b. Bend back lockwasher tab (5) and unscrew pipe union (6).	Use 7/8 in open end wrench.
		c. Remove.	
	b. 2 cap screws (7) and 2 washers (8)	Remove.	Use 1/2 in box wrench.
	c. Oil pump (9)	Withdraw from cylinder block (1).	
INSTALLATION:			
2. Cylinder block (1)	a. Oil pump (9)	Insert into cylinder block (1).	
	b. 2 cap screws (7) and 2 washers (8)	Install and tighten to secure pump.	Use 1/2 in box wrench.
3. Oil pump (9)	a. Oil pump inlet pipe (2)	a. Insert pipe into pump connection.	

OIL PUMP REPLACEMENT INSTRUCTIONS

(Continued)



OIL PUMP REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Screw in union (6), bend down lock tab (5).	Use 7/8 in open end wrench.
		c. Secure pipe bracket (10) to main bearing cap (11) using cap screw (3) and washer (4).	Use 1/2 in socket and ratchet.

3-13 (3-14 Blank)

PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS

This task covers:

- a. Disassembly
- b. Inspection
- c. Repair
- d. Assembly

INITIAL SETUP

Tools:

- Snap ring pliers
- Drift pin
- Hammer
- Piston ring assembly tool
- Grinding machine
- Feeler gage
- Drilling machine
- Scale

Equipment Condition:

Page 3-29

Condition Description:

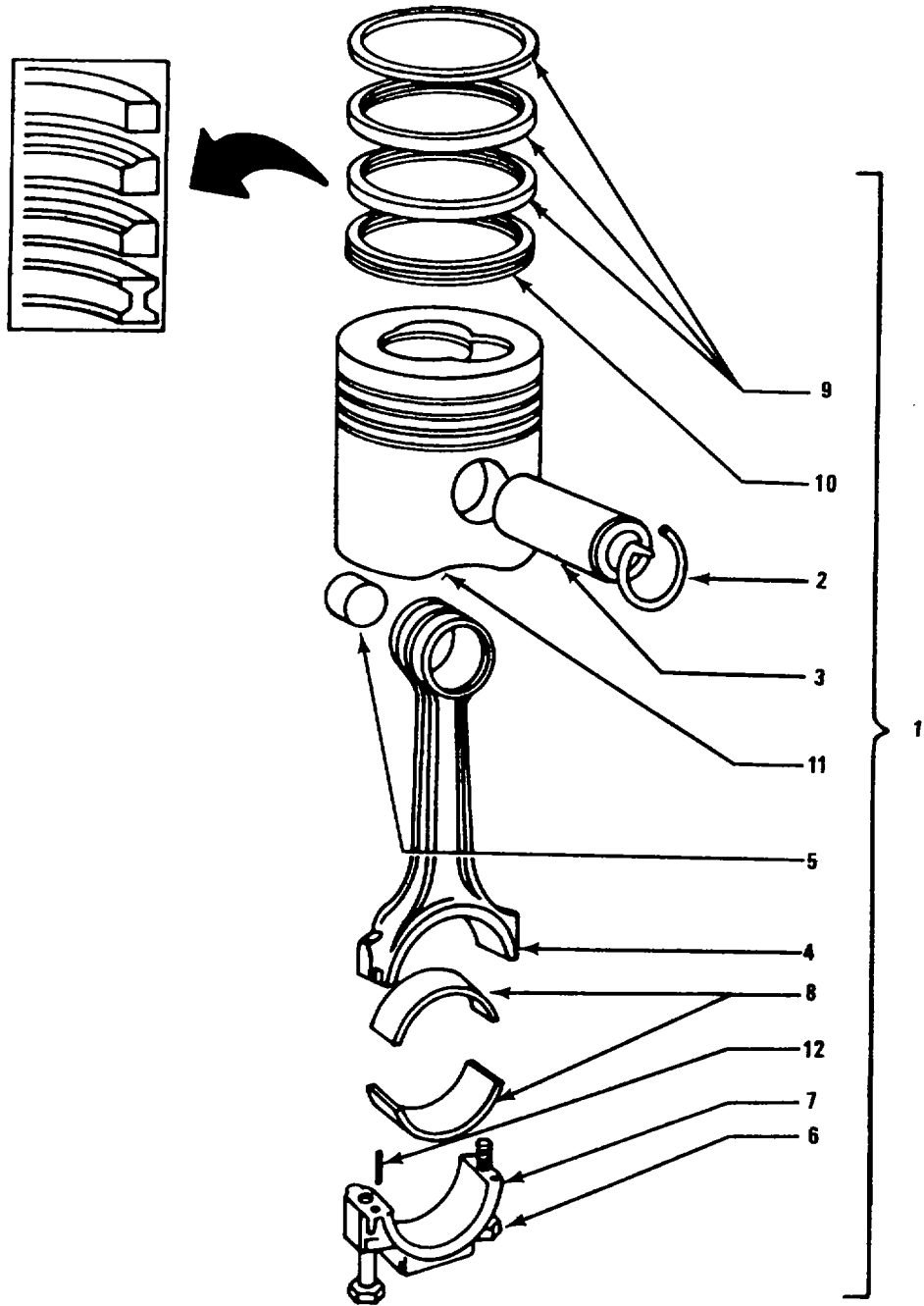
Piston removed from cylinder block.

Materials/Parts:

- Snap rings
- Crocus cloth
- Solvent
- Set of piston rings

PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS

(Continued)

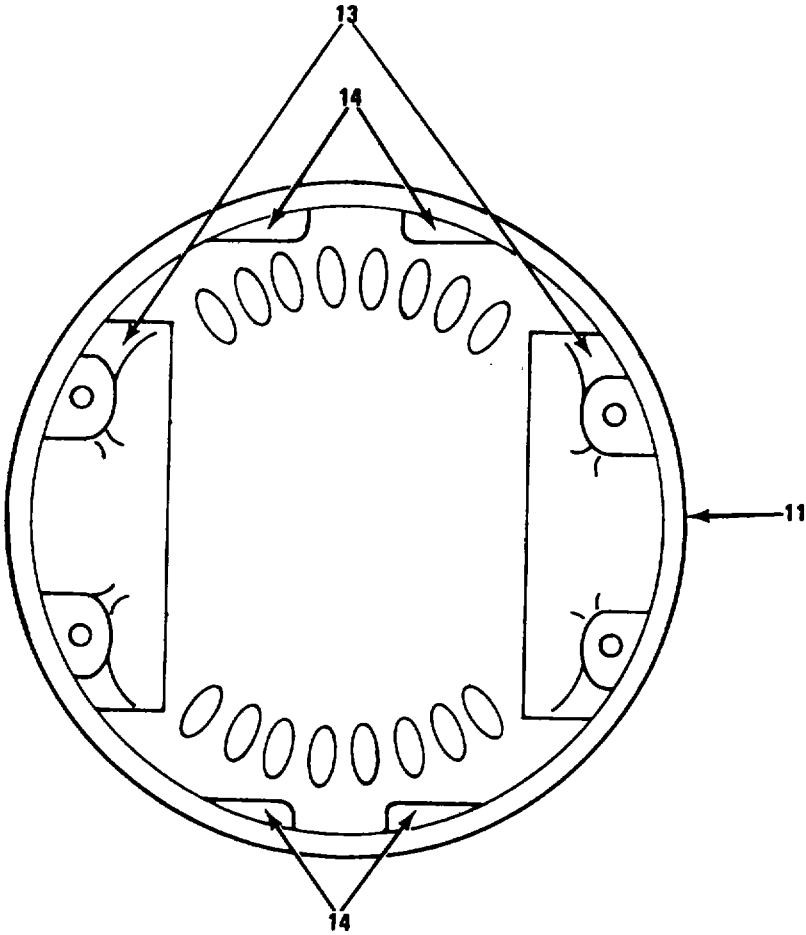


PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
When disassembling be sure to maintain component identification by piston number. Reinstalled components must be reassembled and installed in original positions.			
<u>DISASSEMBLE:</u>			
1. Piston and connecting rod assembly (1)	a. 2 snap rings (2)	Remove.	Use pliers.
	b. Piston pin (3)	Extract.	
	c. Connecting rod (4)	Separate from piston.	
	d. Small end bushing (5)	Drive out of connecting rod.	Use drift pin and hammer.
	e. 2 bearing cap bolts (6), bearing cap (7) and bearing liners (8)	Remove.	Use hand.
	f. 4 piston rings (9) and (10)	Remove.	Use piston ring, assembly tool.

PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)

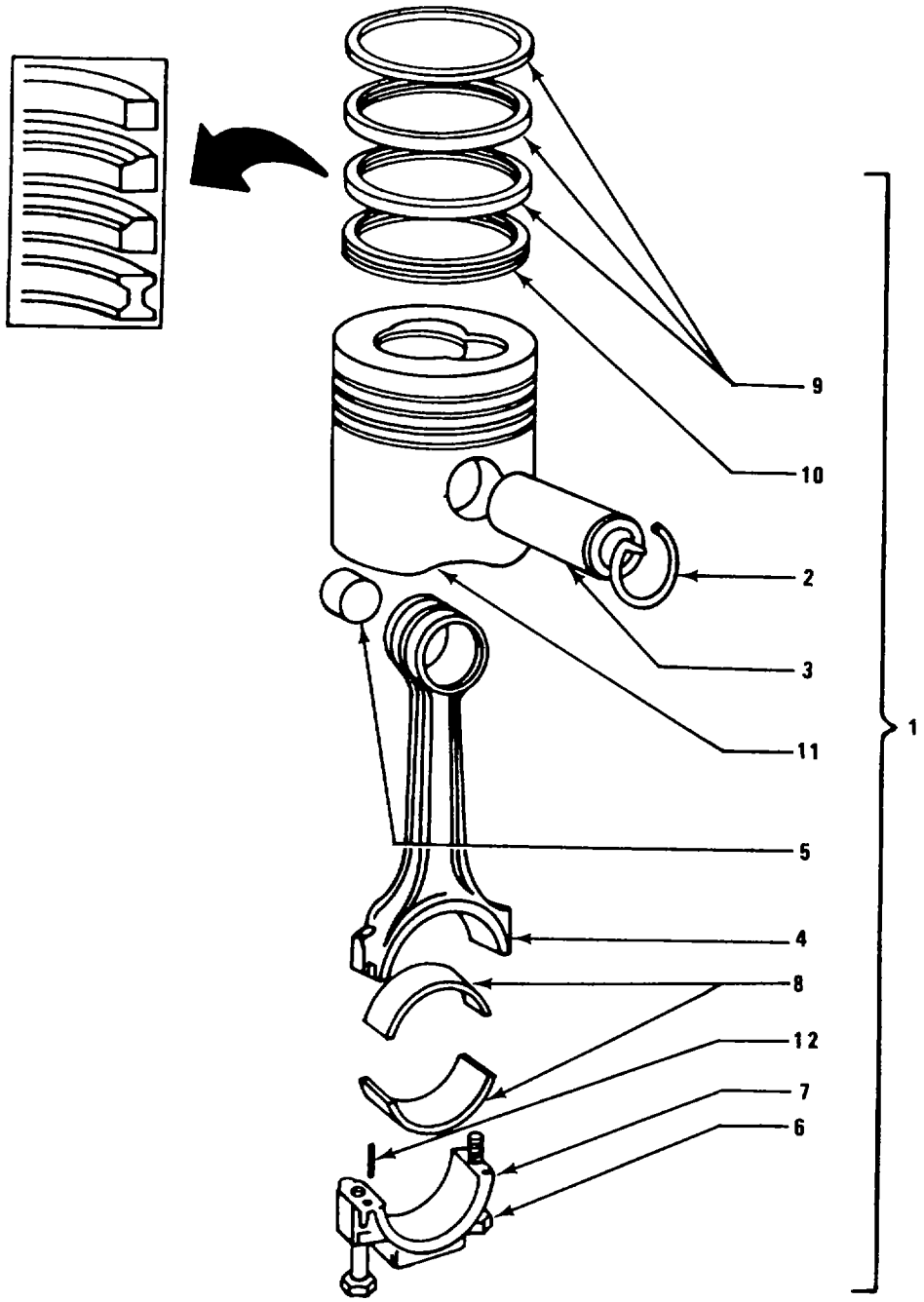


PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
2.	Piston (11)	<ul style="list-style-type: none"> <li>a. Inspect walls for Scoring or Scuffing. <li>b. Inspect inside and outside for cracks at piston pin bosses (13), piston balance strut (14), piston crown and struts between crown and pin bosses. <li>c. Hone piston if lightly scored. <li>d. Replace piston if any cracks, scoring, or scuffing noted. <li>e. Replace piston if piston seized. 	<p>If heavy scuffing above pin on one side and below pin on other side is noted, inspect for possible bent connecting rod (4).</p> <p>Use grinding machine and crocus cloth.</p> <p>If replacing a heavily scored piston, cylinder liner also must be replaced.</p> <p>Cylinder liner must also be replaced.</p>

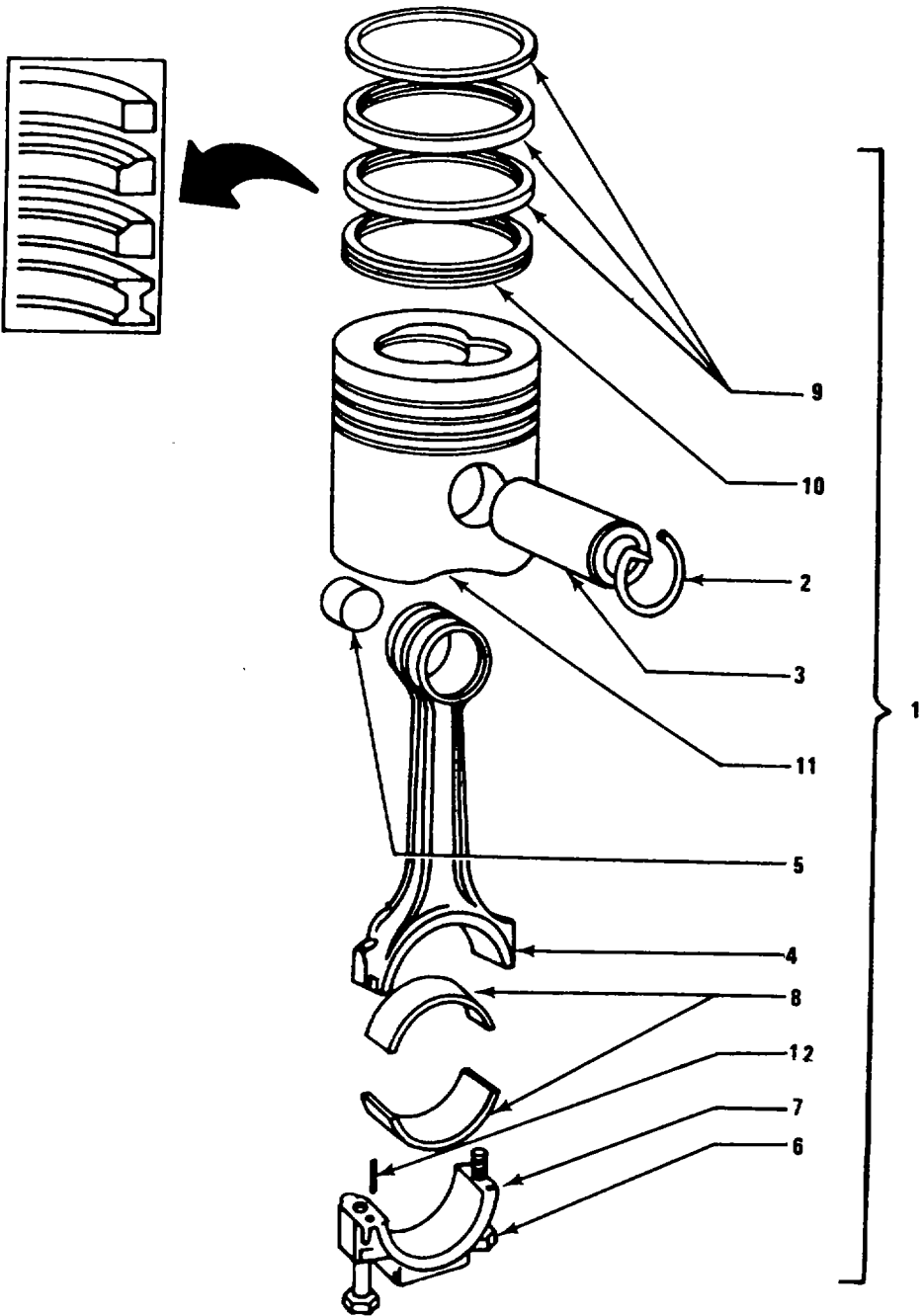
PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)



PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)

		f. Check clearance in cylinder bore.	See page 3-33 for procedures. If out of tolerance cylinder liner requires replacement.
		g. Clean carbon deposit from crown and ring grooves if reusing pistons.	Use solvent.
3.	Connecting rod (4)	a. Inspect for cracking, bending.	
		b. Replace if defect is noted.	
4.	Piston pin (2)	a. Inspect for cracks.	
		b. Replace if cracked.	
5.	Small end bushing (5) and bearing liners (8)	a. Inspect for scoring, wear, scratching.	
		b. Replace if any of above is evident.	

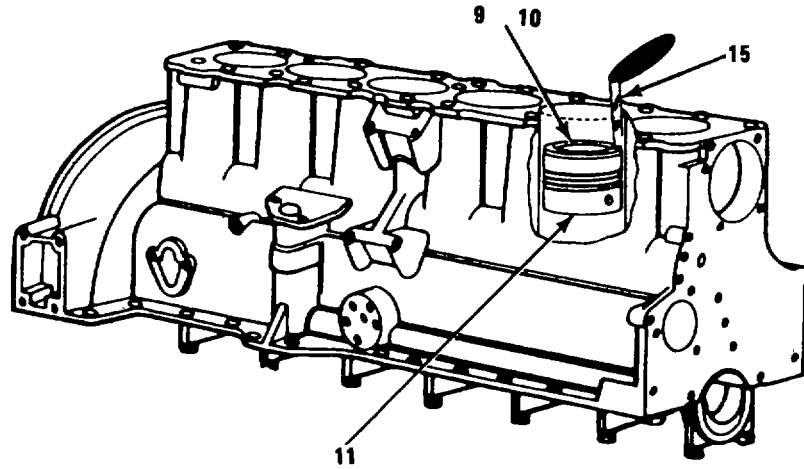
PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)



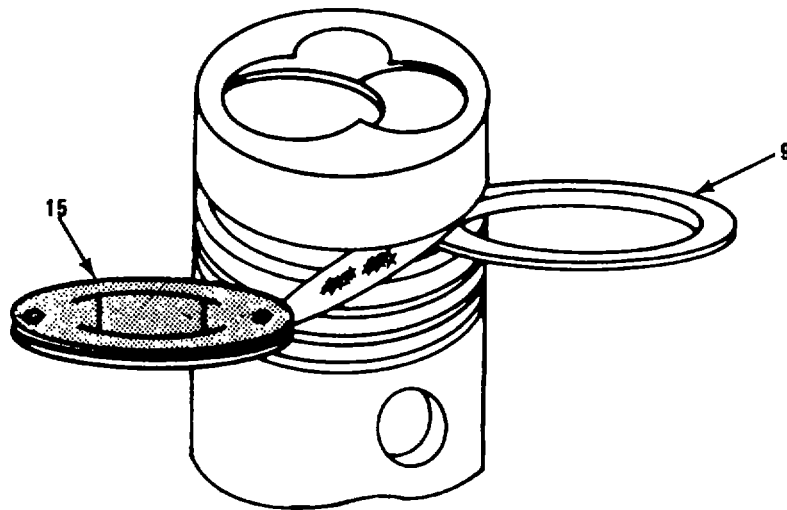
PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
6.	Rings (9) and (10)	c. If small end bushing is replaced, machine bore in bushing to 1.3751 - 1.3754 inch (34.95 to 35.028 mm). (See step 8 below.)	Use drilling machine.
<u>ASSEMBLY:</u>			
7. Connecting rod (4)	Small end bushing (5)	Press into place.	Align oil hole in bushing with hole in rod and position the split in bushing to non-thrust side of connecting rod (side opposite to bearing liner locating groove in bearing cap).

PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)



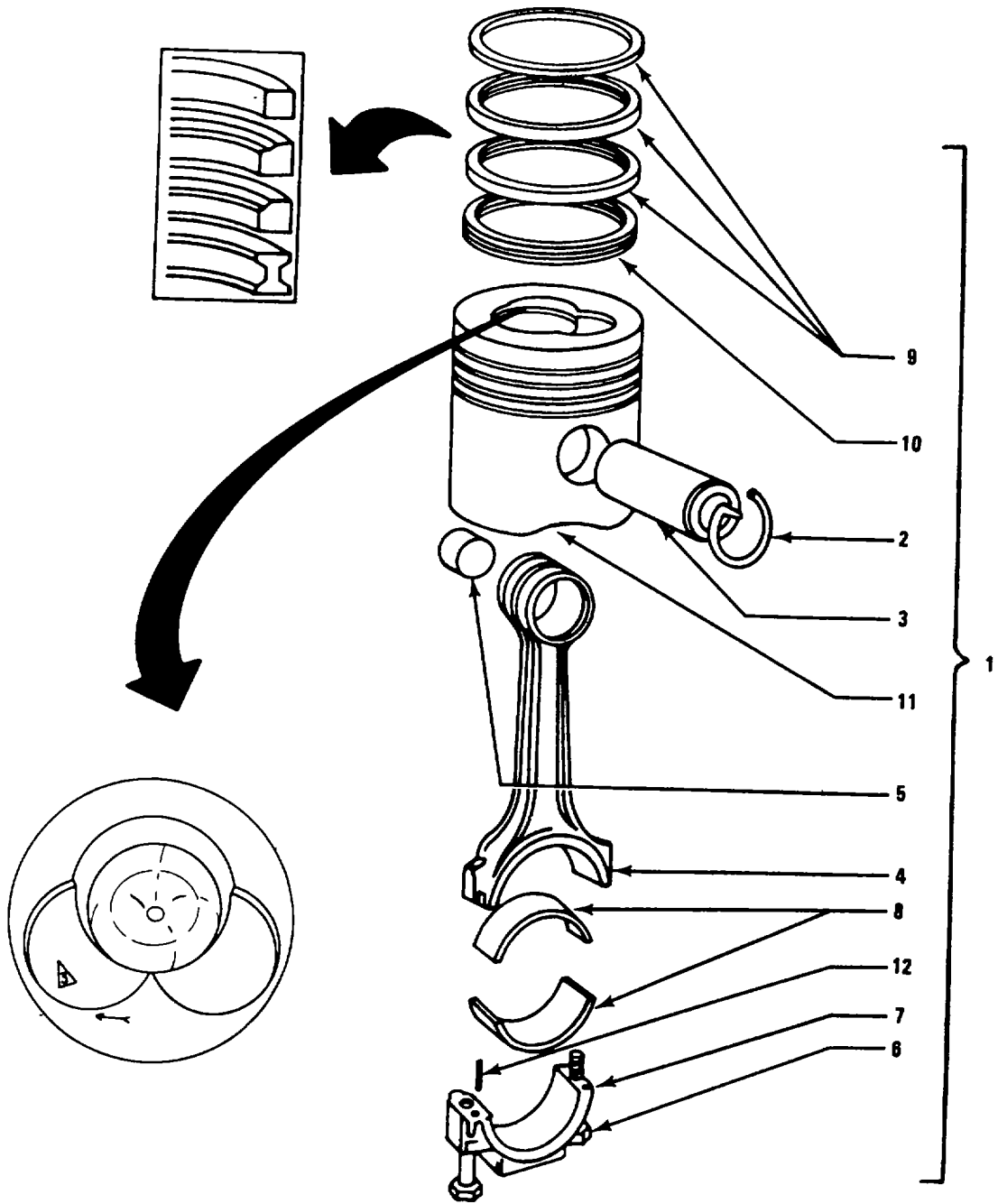
MEASURE PISTON RING GAP



PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS										
8. Rings (9) and (10)	New rings	a. Check each ring for specified gap by: <ul style="list-style-type: none"> • Pushing ring into bore to lower portion. • Using piston head (11) to make sure ring is square with wall. • Using feeler gage (15), measure gap. • Checking against specifications below. 	Rings must be checked in cylinder they will be used in.										
<table border="1" style="width: 100%;"> <thead> <tr> <th colspan="2">SPECIFICATION: PISTON RING GAP</th> </tr> </thead> <tbody> <tr> <td>Upper Compression</td> <td>0.016 to 0.031 in. (0.406 to 0.787 mm)</td> </tr> <tr> <td>Intermediate</td> <td>0.012 to 0.029 in. (0.305 to 0.737 mm)</td> </tr> <tr> <td>Lower</td> <td>0.012 to 0.029 in. (0.305 to 0.737 mm)</td> </tr> <tr> <td>Oil Control</td> <td>0.012 to 0.029 in. (0.305 to 0.737 mm)</td> </tr> </tbody> </table>				SPECIFICATION: PISTON RING GAP		Upper Compression	0.016 to 0.031 in. (0.406 to 0.787 mm)	Intermediate	0.012 to 0.029 in. (0.305 to 0.737 mm)	Lower	0.012 to 0.029 in. (0.305 to 0.737 mm)	Oil Control	0.012 to 0.029 in. (0.305 to 0.737 mm)
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Oil Control	0.012 to 0.029 in. (0.305 to 0.737 mm)												
		b. Check ring to groove clearance.	Use feeler gage (15).										
<table border="1" style="width: 100%;"> <thead> <tr> <th colspan="2">SPECIFICATION: RING TO GROOVE CLEARANCE</th> </tr> </thead> <tbody> <tr> <td>Upper Compression</td> <td>0.0025 to 0.0040 in (00.063 to 0.102 mm)</td> </tr> <tr> <td>Intermediate</td> <td>0.0027 to 0.0042 in (00.069 to 0.107 mm)</td> </tr> <tr> <td>Lower</td> <td>0.0027 to 0.0042 in (00.069 to 0.107 mm)</td> </tr> <tr> <td>Oil Control</td> <td>0.0025 to 0.0040 in (00.064 to 0.102 mm)</td> </tr> </tbody> </table>				SPECIFICATION: RING TO GROOVE CLEARANCE		Upper Compression	0.0025 to 0.0040 in (00.063 to 0.102 mm)	Intermediate	0.0027 to 0.0042 in (00.069 to 0.107 mm)	Lower	0.0027 to 0.0042 in (00.069 to 0.107 mm)	Oil Control	0.0025 to 0.0040 in (00.064 to 0.102 mm)
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Lower	0.0027 to 0.0042 in (00.069 to 0.107 mm)												
Oil Control	0.0025 to 0.0040 in (00.064 to 0.102 mm)												

PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
(Continued)



PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
9. Piston (11)	a. Connecting rod (4)	Insert into piston.	<p>a. Make sure arrowhead on piston crown and FRONT mark on connecting rod are pointing in the same direction</p> <p>b. Make sure re-installed rod and piston are matched to original mate.</p>
	b. Piston pin (3)	Insert.	
	c. 2 snap rings (2)	Install.	Use pliers.
	d. Rings (9) and (10)	Fit to piston.	Use piston ring assembly tool. Make sure intermediate and lower rings are fitted correct way up. (See figure.)
10. Connecting rod (4) and bearing cap (8)	a. Bearing halves (8)	Fit bearing halves, engaging locating tongues in locating grooves.	a. If refitting original bearing halves make sure they are mated with their original rod or cap.

PISTON AND CONNECTING ROD ASSEMBLY INSPECTION AND REPAIR INSTRUCTIONS
 (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Bearing cap (7) and 2 bolts (6)	Attach to rod.	b. Aline oil hole in upper bearing half with hole in rod. Tighten finger tight.
11. Piston and connecting rod assemblies (1)	Piston and connecting rod assemblies (1)	Weigh each assembly.	Use scale. Maximum variation of weight between assemblies is 1.7637 oz (50 g).

PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Installation

INITIAL SETUP

Tools:

1/2 in drive hinged handle
 15/16 in socket, 1/2 in drive
 3/8 in drive ratchet
 5/8 in socket, 3/8 in drive
 6 in extension, 3/8 in drive
 Torque wrench (0 - 175 ft-lb)
 Non-metallic hammer
 Ring compressor
 Engine maintenance stand

Equipment Condition:

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 Page 2-307

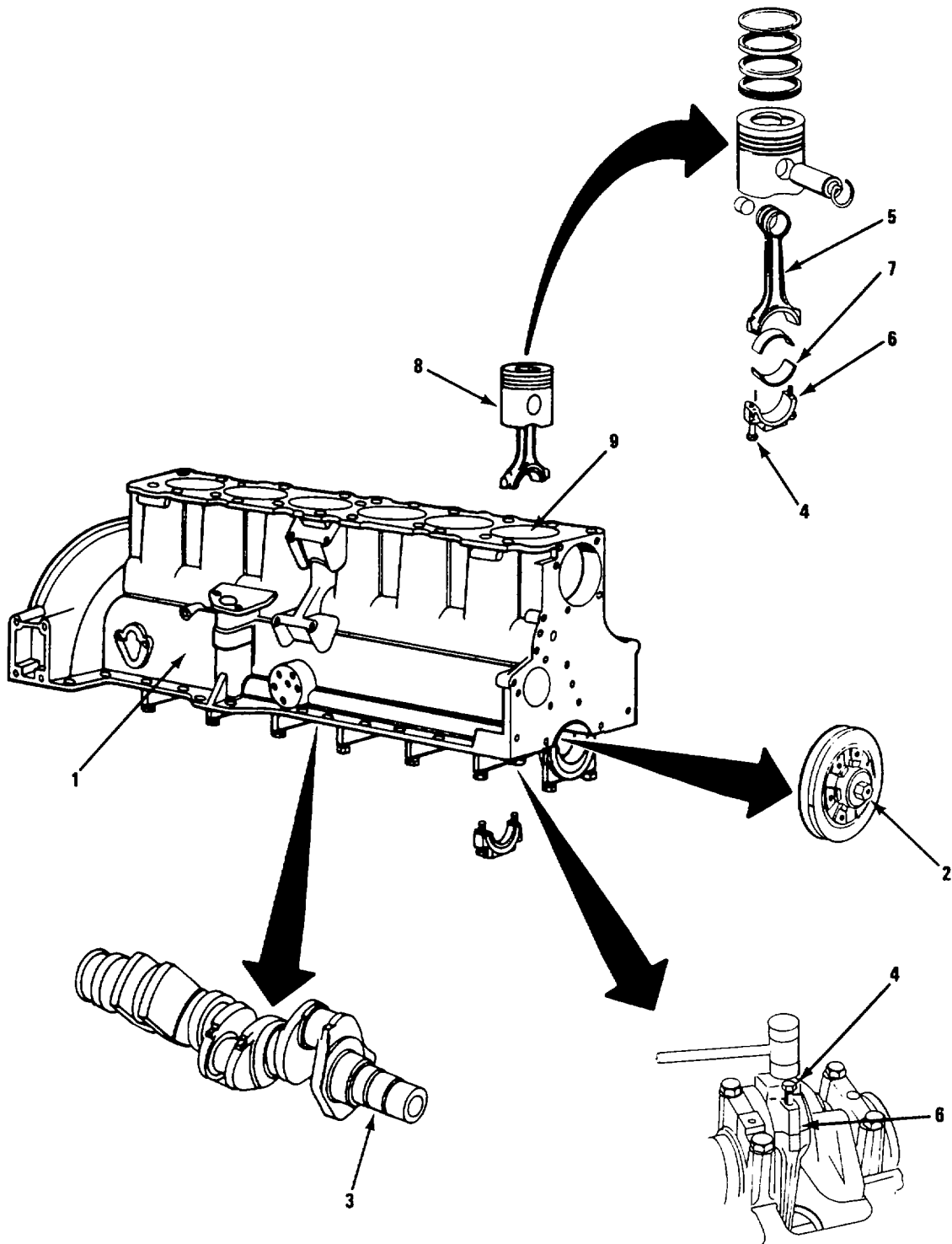
Condition Description:

Engine assembly removed
 from boat and mounted
 on engine maintenance
 stand or laid on side
 on top of work bench.
 Transmission removed.
 Cylinder head assembly
 removed.
 Oil sump removed.

Materials/Parts:

Engine oil

PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



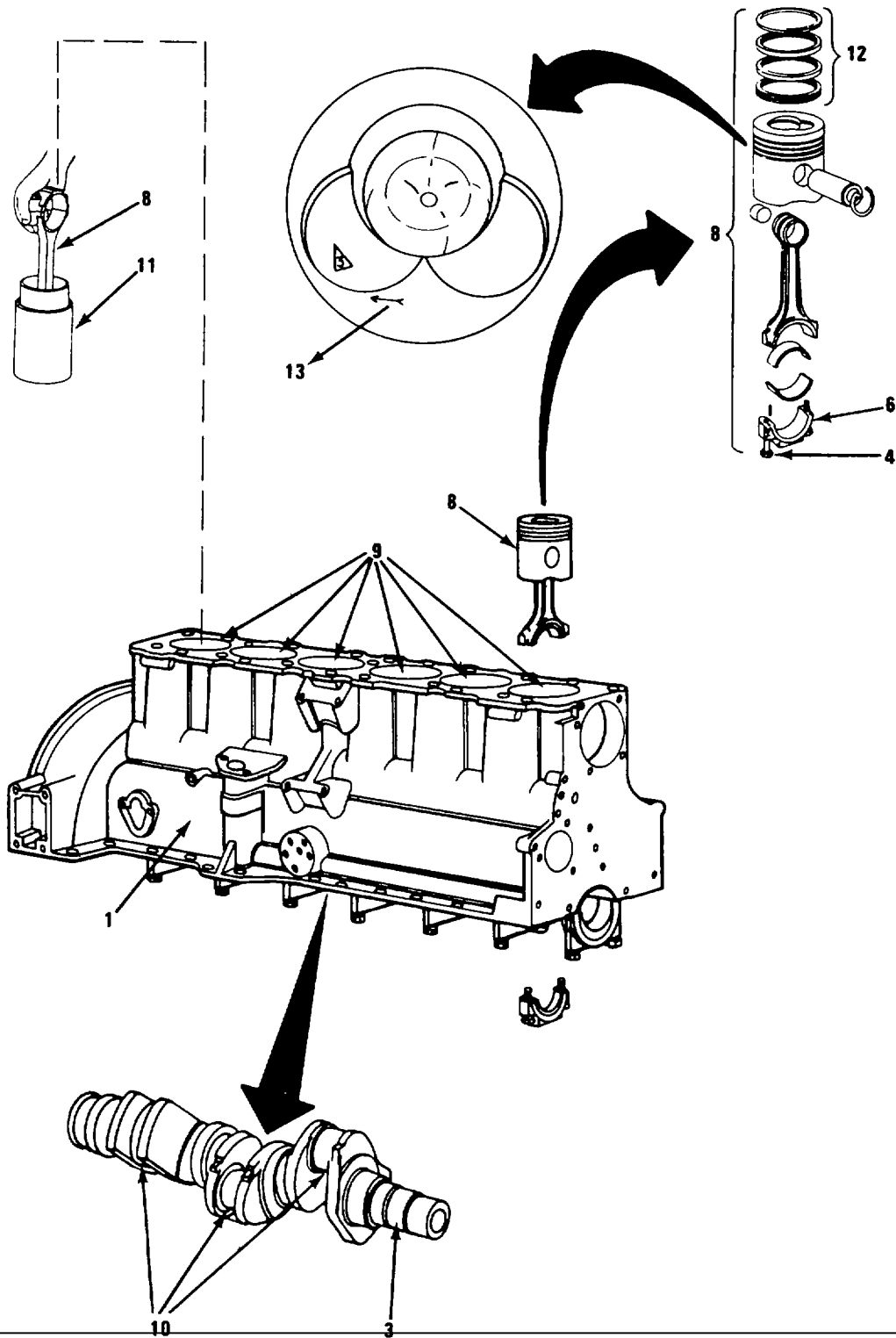
PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL:			
1. Cylinder block (1)	Crankshaft pulley nut (2)	Turn crankshaft to position piston at bottom dead center.	Use 15/16 in socket and 1/2 in drive handle.
2. Crankshaft (3)	a. Connecting rod bearing cap bolts (4)	a. Loosen bolts.	Use 5/8 in socket, 6 in extension and 3/8 in drive ratchet.
		b. Tap bolts lightly to release connecting rod cap (6).	Use non-metallic hammer.
		c. Remove bolts.	
	b. Bearing cap (6) and lower bearing half (7)	Remove lower bearing half.	
	c. Piston and connecting rod assembly (8)	Push assembly out of cylinder bore (9).	
	d. Bearing cap (6), lower bearing half (7) and bolts (4)	Reassemble to connecting rod.	Finger tight.

NOTE

Repeat steps 2a - 2d for each piston removed.

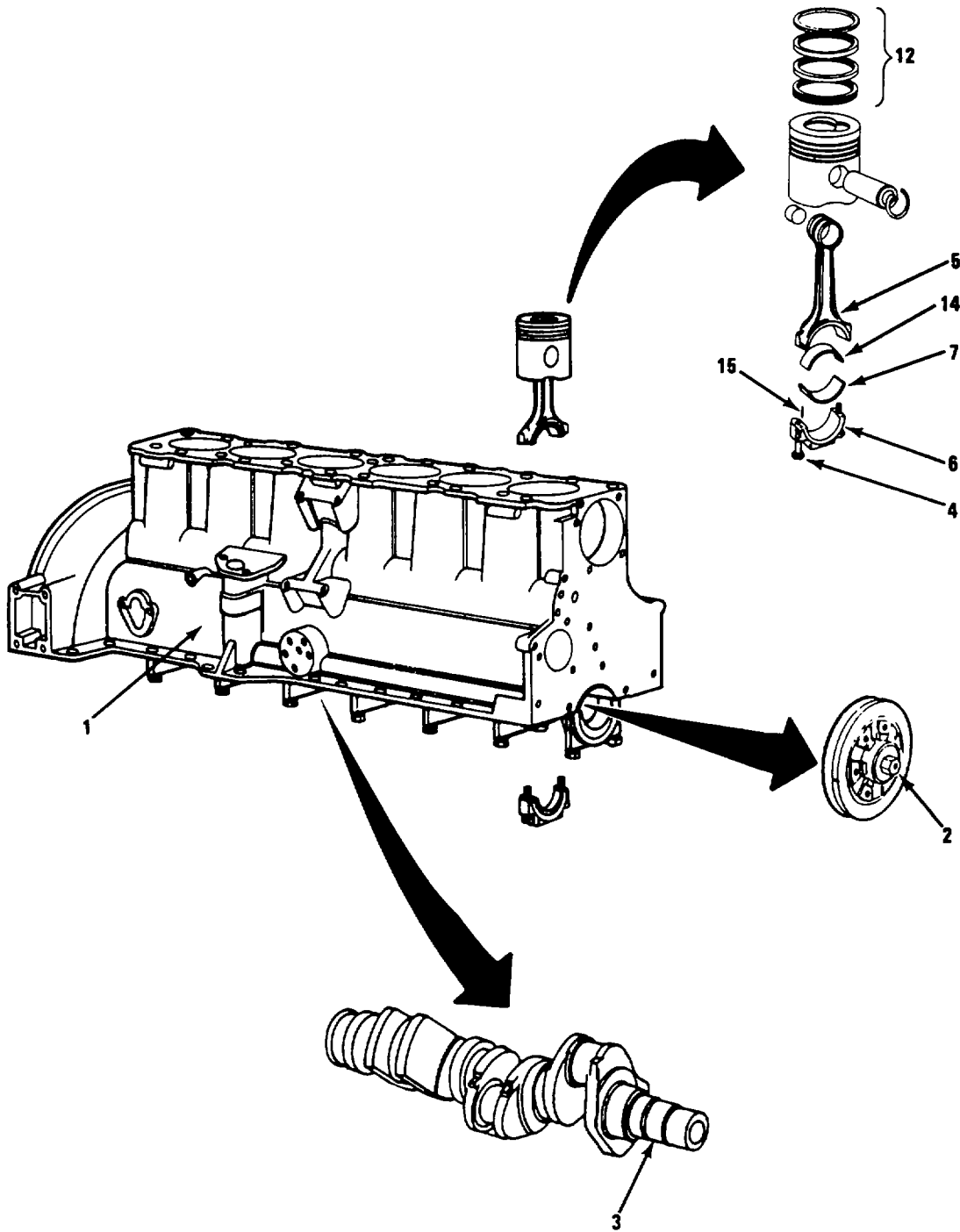
PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>INSTALLATION:</u>			
3. Cylinder block (1)	a. Cylinder block (1)	Rotate onto end.	
	b. Cylinder bores (9)	Clean and lubricate.	Use clean engine oil.
	c. Crankshaft journals (10)	Lubricate.	Use clean engine oil.
4. Ring compressor (11)	Ring compressor (11)	Lubricate inside.	Use clean engine oil.
5. Piston and connecting rod assembly (8)	a. Piston rings (12)	a. Lubricate.	Use clean engine oil.
		b. Space ring gaps at 90°	
	b. Piston and connecting rod assembly (8)	a. Push into ring compressor (11).	
		b. Remove bearing cap (6) and bolts (4).	
6. Cylinder block (1)	a. Ring compressor (11)	Position ring compressor over cylinder bore.	
	b. Piston and connecting rod assembly (8)	Push assembly out of ring compressor into cylinder.	Marking (13) on piston crown must point toward engine front.

PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)



PISTON AND CONNECTING ROD ASSEMBLY REPLACEMENT INSTRUCTIONS
(Continued)

	c. Big end bearing halves, upper (14) and lower (7)	Lubricate with clean lubricating oil.	
	d. Connecting rod (5)	Fit open end to crankshaft journal (9).	Rotate crankshaft as necessary.
	e. Bearing cap (6) and bolts (4)	a. Position on connecting rod (5) using dowels (15).	
		b. Install bolts, torque to 85 to 90 ft-lb (11.76 to 12.45 kg f).	Use 5/8 in socket, 6 in extension and torque wrench.
7. Cylinder block (1)	Crankshaft (8)	Check rotation after tightening each bearing cap (6) by turning crankshaft pulley nut (2).	Use 15/16 in socket and 1/2 in hinged handle.

NOTE

Repeat steps 5a - 6e for each piston.

CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS

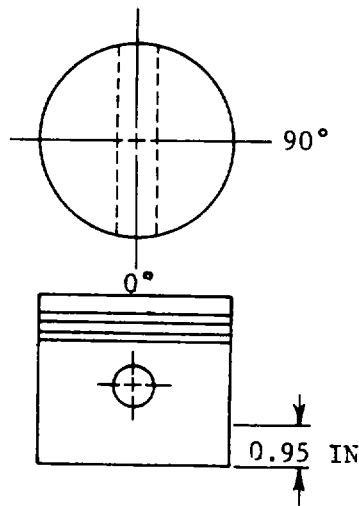
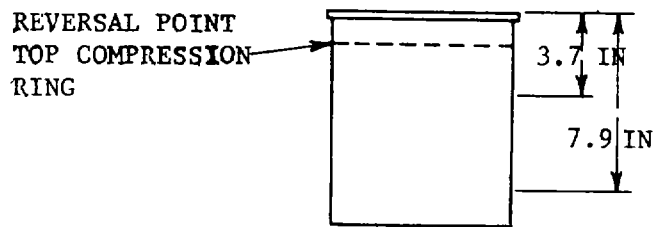
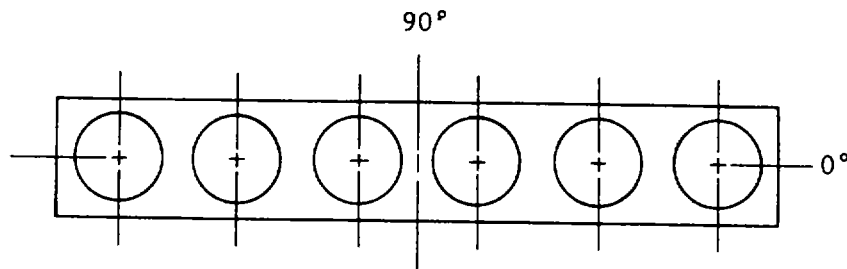
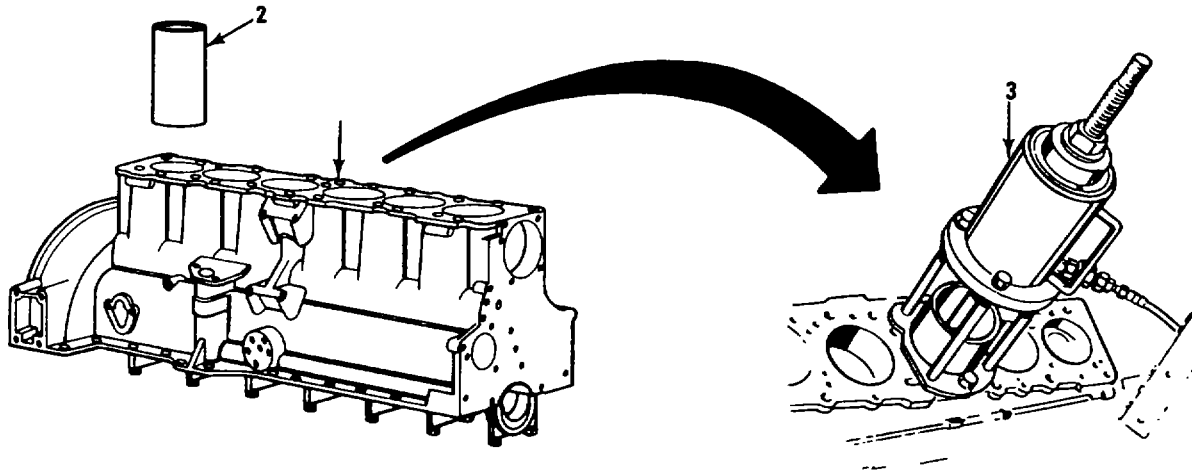
This task covers:

- | | |
|-------------------|------------------------|
| a. Removal | b. Inspection |
| c. Repair | d. Installation |

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Cylinder bore honing unit	Page 2-179	Engine assembly removed from boat and mounted on engine maintenance stand or laid on side on top of work bench.
Micrometer caliper, inside		
Micrometer caliper, outside		
Wire brush		
Wooden block		
Hammer	Page 2-291	Cylinder head assembly removed.
Engine maintenance stand	Page 2-345	Transmission removed.
Special Tools:	Page 2-317	Flywheel housing cover removed.
Cylinder liner remover and replacer	Page 2-307 Page 3-29	Oil sump removed. Pistons and connecting rod assemblies removed.
Materials/Parts:		
Solvent		
Sealant		

CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS
 (Continued)



CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

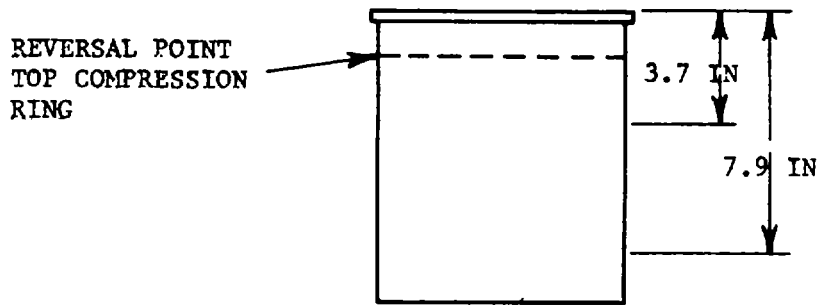
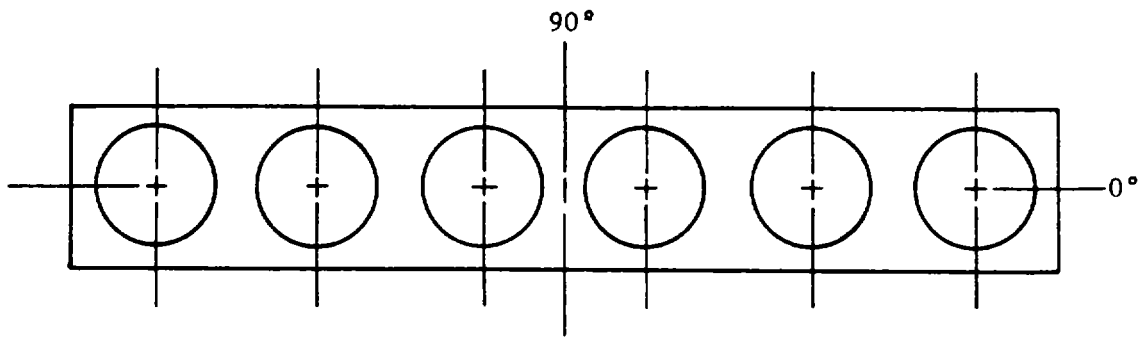
REMOVAL:

- | | | | | |
|----|-----------------------|-----------------------|---------|--|
| 1. | Cylinder block
(1) | Cylinder liner
(2) | Remove. | Use cylinder
liner remover
and replacer (3). |
|----|-----------------------|-----------------------|---------|--|

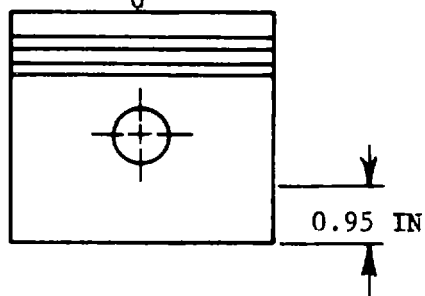
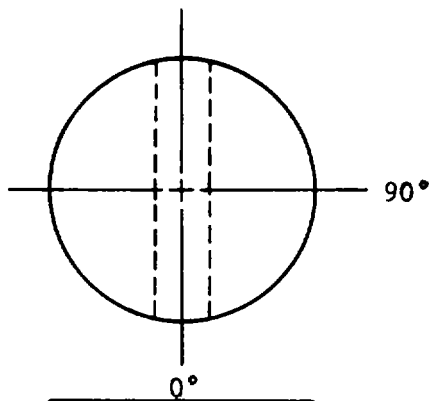
INSPECTION AND REPAIR:

- | | | | | |
|----|--|-----------------------|---|---------------------------------|
| 2. | | Cylinder liner
(2) | <ul style="list-style-type: none"> a. Inspect for Scoring, Scuffing, or Glazing. b. Hone if glazed. c. Replace if scored or if engine seized. | Use cylinder bore honing unit. |
| 3. | | Cylinder liner
(2) | <p>Check piston clearance in cylinder liner as follows:</p> <ul style="list-style-type: none"> a. Measure liner diameter in line with 0° and 90° to crankshaft as follows (see figure): <ul style="list-style-type: none"> o Immediately below top compression ring reversal point. o At 3.7 in. (93.9 mm) below top face of block. | Use micrometer caliper, inside. |

CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



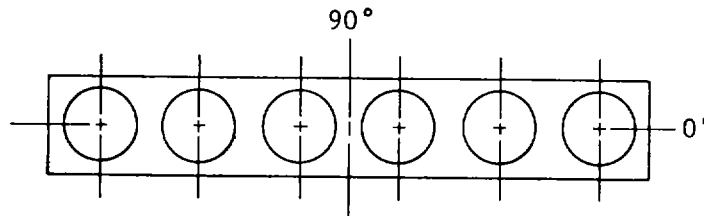
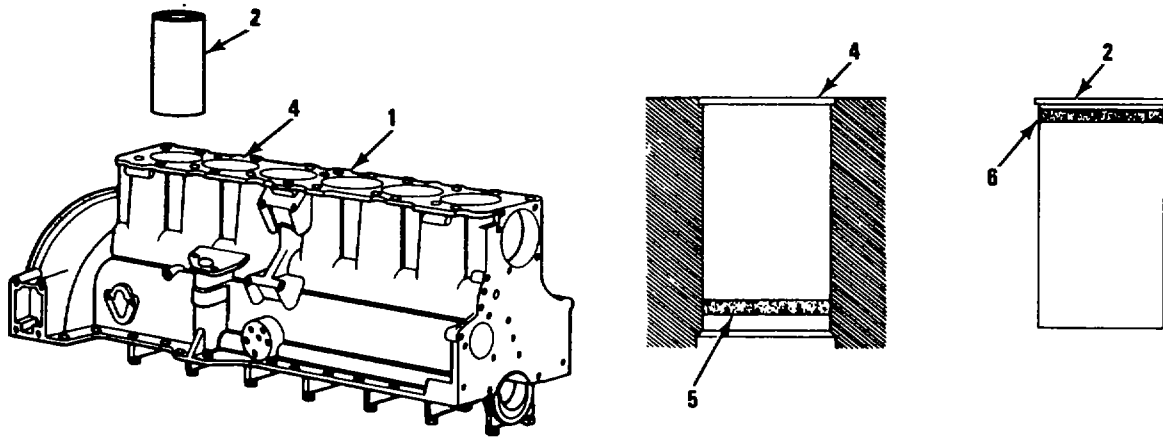
CYLINDER LINER MEASUREMENTS



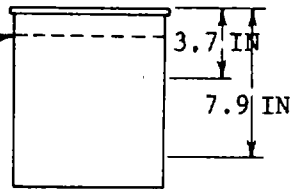
CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS**(Continued)**

- o At 7.9 in. (200 mm) below top face of block.
- b. Calculate each average cylinder liner diameter of 6 measurements.
- c. Measure piston diameter at 0.95 in. (24.13 mm) up from lower piston edge at 90° to and in line with piston pin axis (see figure).
Use micrometer caliper, outside.
- d. Calculate average piston diameter of 2 measurements.
- e. Calculate clearance.
This is difference between average liner diameter and average piston diameter.
- f. Replace liner if clearance not within limits 0.0058 to 0.0068 in. (0.147 to 0.172 mm).

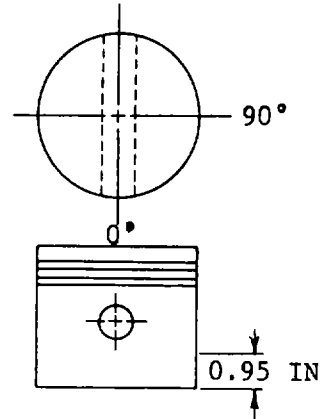
CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS
 (Continued)



REVERSAL POINT
 TOP COMPRESSION
 RING



CYLINDER LINER MEASUREMENTS



CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS

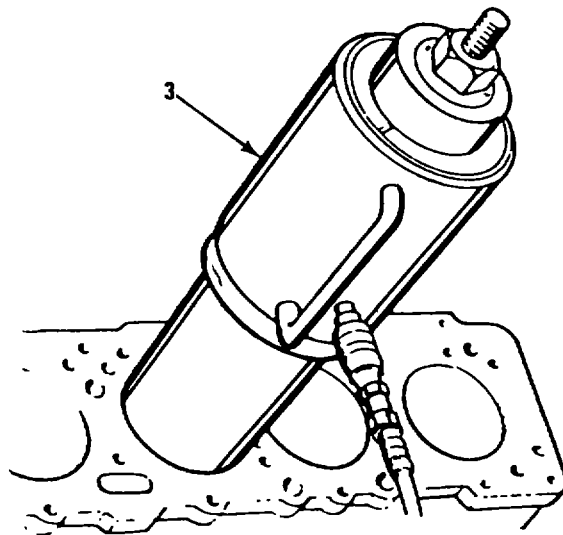
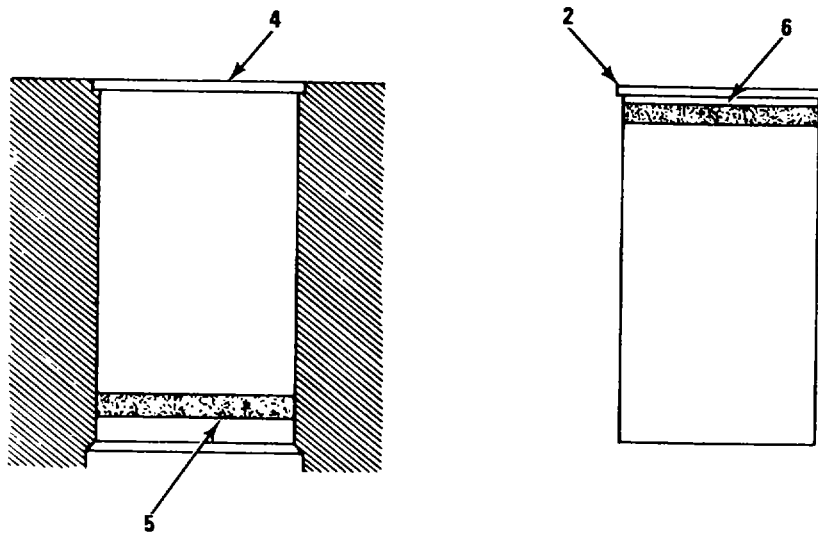
(Continued)

- | | | |
|----|-----------------------|--|
| 4. | Cylinder liner
(2) | Check roundness. |
| | | <ul style="list-style-type: none"> a. Calculate difference in diameters at each level (subtract diameter measured at 0° from that measured at 90°) in bore measured in a above. b. Replace if measurements are not within 0.003 in. (0.075 mm) of each location. |

INSTALLATION:

- | | | | |
|--------------------------|----------------------|--|--|
| 5. Cylinder block
(1) | a. Cylinder bore (4) | <ul style="list-style-type: none"> a. Remove all foreign matter by lightly brushing. b. Remove all traces of dust and oil. c. Apply 0.5 in. (13 mm) wide band of sealer (5) at bottom (see figure). | <p>Use wire brush.</p> <p>Use solvent.</p> |
|--------------------------|----------------------|--|--|

CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



CYLINDER LINER INSPECTION AND REPLACEMENT INSTRUCTIONS**(Continued)**

- | | | |
|--------------------------|---|---|
| b. Cylinder
liner (2) | a. Remove protective coating (new liner only). | Use honing unit. |
| | b. Apply 0.5 in. (13 mm) wide band of sealer (6) below cylinder liner lip (see figure). | Use sealer. |
| | c. Push into cylinder bore as far as possible by hand. | Make sure liner recess in block remains clean allowing liner to seat correctly. |
| | d. Press home squarely. | Use cylinder liner remover and replacer. |
| | e. Remove any sealer accumulated at bottom of liner. | |
| | f. Check piston to liner clearance - 0.0058 to 0.0068 in. (0.15 to 0.17 mm). | Follow step 3 for procedure. |
| | g. If necessary hone to clearance specification. | Use cylinder honing unit. |

MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Inspection

c. Installation

INITIAL SETUP

Tools: Equipment Condition:

Condition Description:

Torque wrench (0-175 ft-lb)
5/8 in socket

Page 2-179

Ratchet

Micrometer caliper, inside
Micrometer caliper, outside

Page 2-317

Engine maintenance stand

Non-metallic hammer

Handle, socket wrench

15/16 in socket

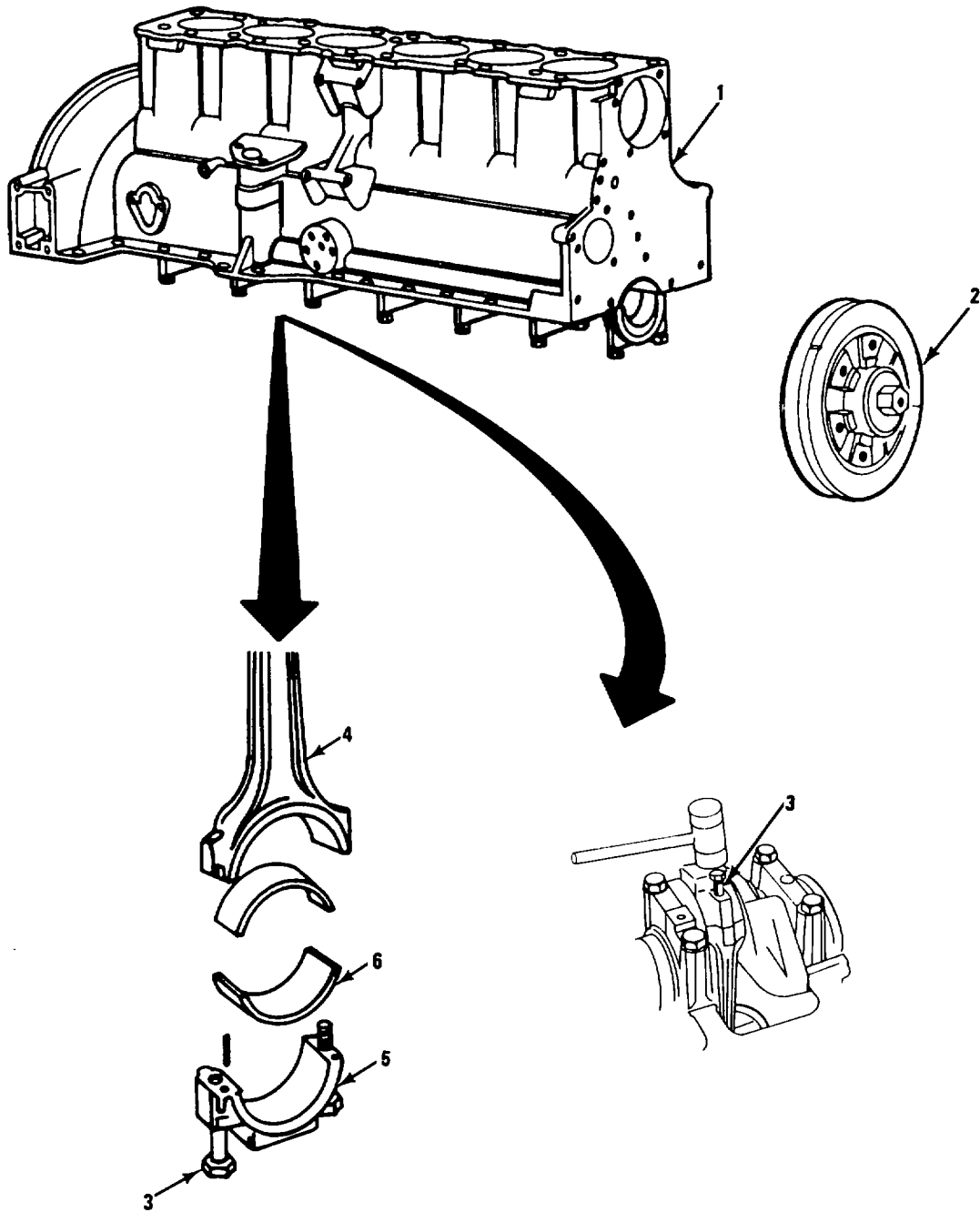
Page 2-307

Engine assembly removed from boat and mounted on engine maintenance stand or laid on side on top of work bench. Flywheel and flywheel housing removed. Oil sump (pan) removed.

Materials/Parts:

Shell main bearing wide upper with oil hole (2 each)
Shell main bearing narrow upper with oil hole (5 each)
Shell main bearing wide lower (2 each)
Shell main bearing narrow lower (5 each)

MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

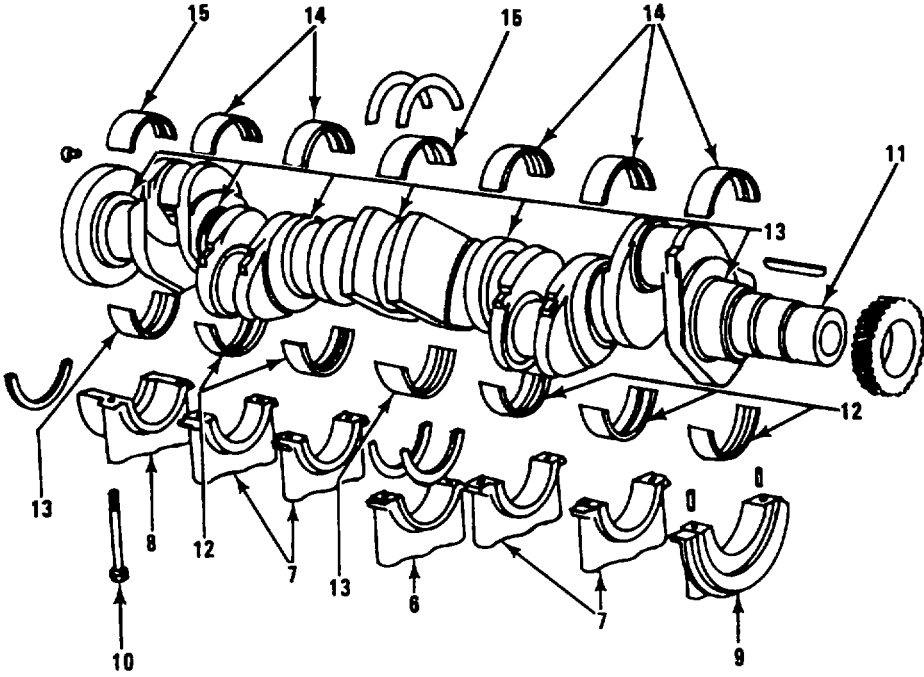
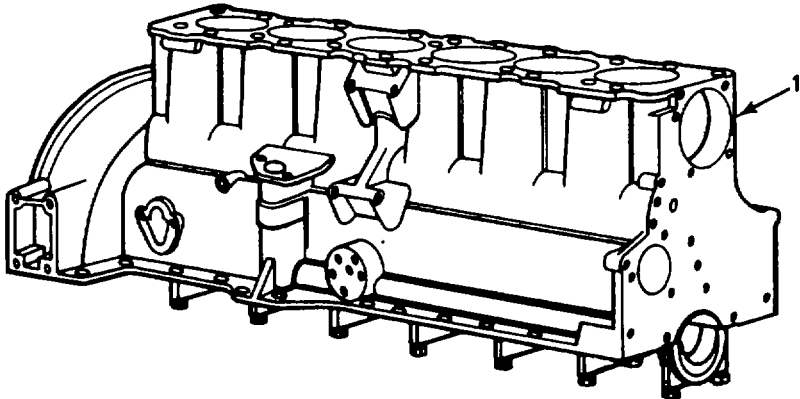


MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

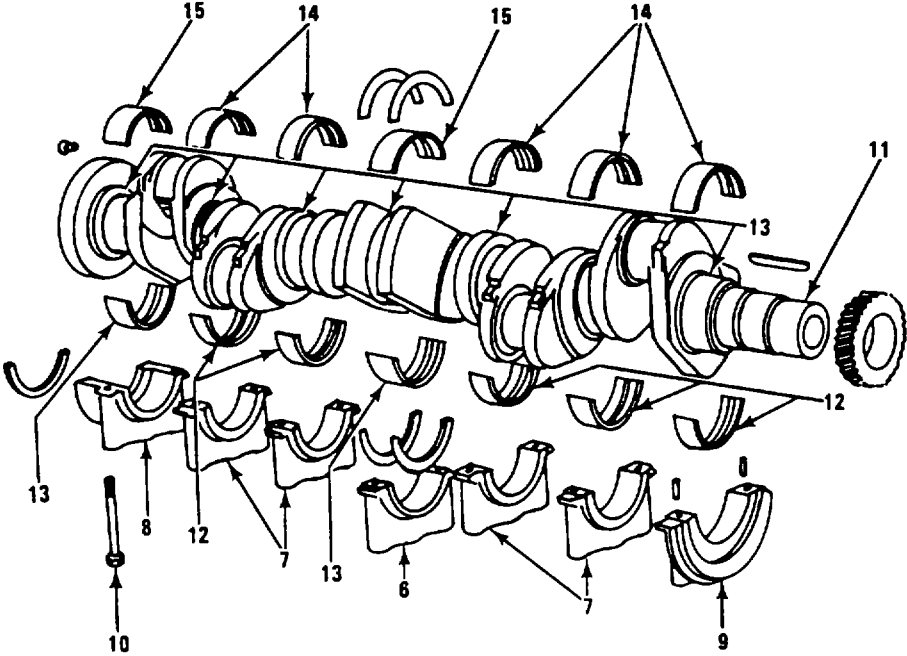
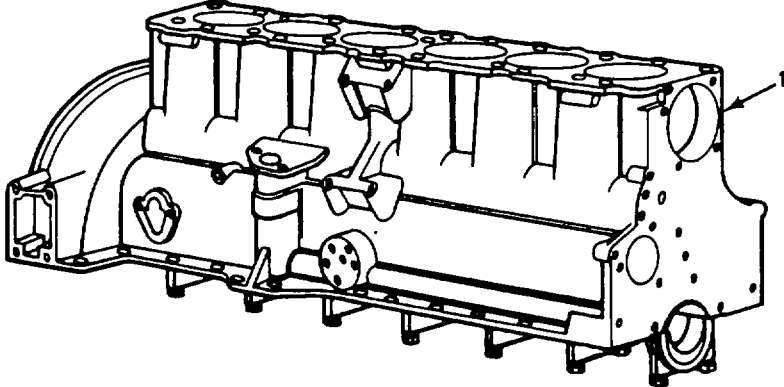
LOCATION	ITEM	ACTION	REMARKS
NOTE			
Engine is in inverted position on engine maintenance stand or laid on side on top of work bench.			
REMOVAL:			
1. Cylinder block (1)	a. Crankshaft pulley nut (2)	Turn crankshaft to position a piston at bot- tom dead center.	Use 15/16 in soc- ket and drive handle.
	b. Connecting rod bearing cap bolts (3)	a. Loosen bolts.	Use 5/8 in soc- ket, 6 in exten- sion and ratchet.
		b. Tap bolts lightly to release con- necting rod cap (5).	Use non-metallic hammer.
	c. Connecting rod bearing cap (5) and lower bearing half (6)	Remove lower bearing half.	
NOTE			
Repeat steps 1a thru 1c for each piston in turn.			

MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
	d. Main bearing caps (6,7,8, 9), 14 bolts (10) and lower bearing halves (12,13)	Remove.	Use 7/8 in socket and 1/2 in drive ratchet.
	e. Crankshaft (11)	Remove.	
	f. Upper bearing halves (14,15)	Remove from block (1).	
INSPECTION:			
2.	Main bearings (12,13,14,15)	a. Inspect for scoring or grooving. b. Replace if scored or grooved.	
3. Cylinder block (1)	Main bearing caps (6,7,8,9), main bearing halves (12,13, 14,15) and 14 bolts (10)	a. Reinstall after crankshaft removal. b. Torque bolts to 115 - 120 ft-lb (15.89 to 16.58 kfgm). c. Measure inside diameter of each set of main bearings.	Use 5/8 in socket and torque wrench (0 - 175 ft-lb). Use micrometer caliper, inside.

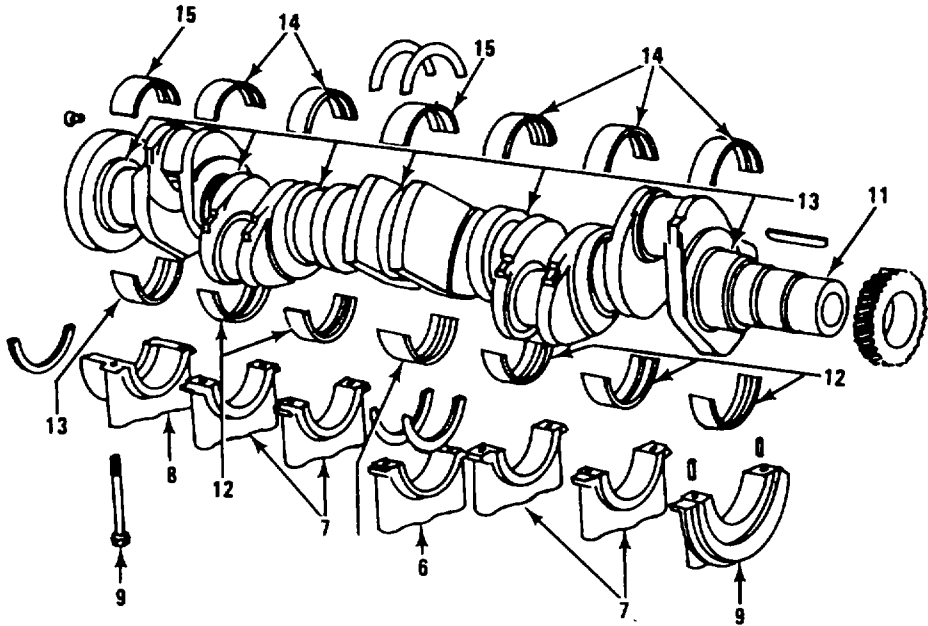
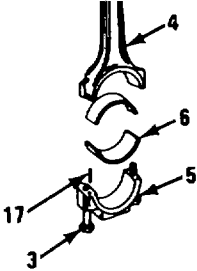
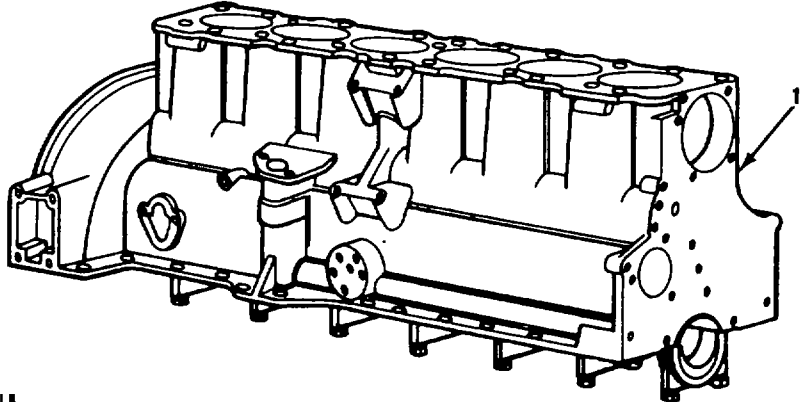
MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
4. Crankshaft (11)	Crankshaft main bearing journals (16)	Measure diameter of journals.	Use micrometer caliper, outside.
5. Cylinder block (1)	a. Main bearings (12,13,14,15)	a. Determine crankshaft to bearing liner clearance (diameter of step 2c minus diameter of step 3).	
		b. Replace all main bearings if clearance is out of limits. Specification: 0.002 to 0.0041 in. (0.051 to 0.104 mm).	
	b. 7 main bearing caps (6,7,8,9) and 14 bolts (10)	Remove.	Use 5/8 in socket and ratchet.

MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>INSTALLATION:</u>			
<u>CAUTION</u>			
All upper main bearing halves have oil holes and grooves. Do not fit any lower half main bearing liners to upper locations.			
6. Cylinder block (1) and main bearing caps (6,7,8,9)	a. New main bearings	a. Clean off any preservative.	Note that all upper bearing halves incorporate oil feed holes (lower bearing halves do not have holes) and oil grooves. Note that center and rear lower bearing halves have oil grooves.
		b. Match and fit upper bearing halves (14, 15) to block.	
		c. Fit lower bearing halves (12,13) to bearing caps (6,7,8,9).	
	b. Main bearing caps (6,7,8,9)	Repeat inspection procedures to make sure clearances are within limits.	Repeat steps 3 thru 5.
	c. Crankshaft (11)	Install into cylinder block.	
	d. Main bearing caps (6,7,8,9) and 14 bolts (10)	a. Install onto cylinder block.	
		b. Torque bolts to 115 - 120 ft-lb (15.89 to 16.58 kfgm).	Use 5/8 in socket and torque wrench (0 - 175 ft-lb).

MAIN BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	<p>e. Connecting rod bearing cap (5), lower bearing half (6) and bolts (3)</p>	<p>Fit to connecting rod (4) over crankshaft (11). Use dowels (17) for correct positioning.</p>	<p>a. Make sure to reinstall cap and bearing halves in original positions.</p> <p>b. Use 5/8 in socket, 6 in extension and ratchet.</p>

CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS

This task covers:

a. Removal

b. Inspection

c. Installation

INITIAL SETUP

Tools:

3/4 in drive hinged handle
 15/16 in socket, 3/4 in drive
 Ratchet
 Engine maintenance stand
 1/2 in socket
 9/16 in socket
 5/8 in socket
 7/8 in socket
 6 in extension
 5/16 in hex key wrench
 (Allen)
 7/8 in open end wrench
 Gear puller
 Non-metallic hammer
 Torque wrench (0 - 175 ft-lb)
 Torque wrench (0 - 600 ft-lb)
 Feeler gage
 Knife
 Drift, brass
 Hammer, ball peen

Equipment Condition:

Page 2-179

 TM 5-1940-277-20
 TM 5-1940-277-20

 Page 2-345
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 Page 2-307

 Page 3-75 (steps 1
 thru 2d)

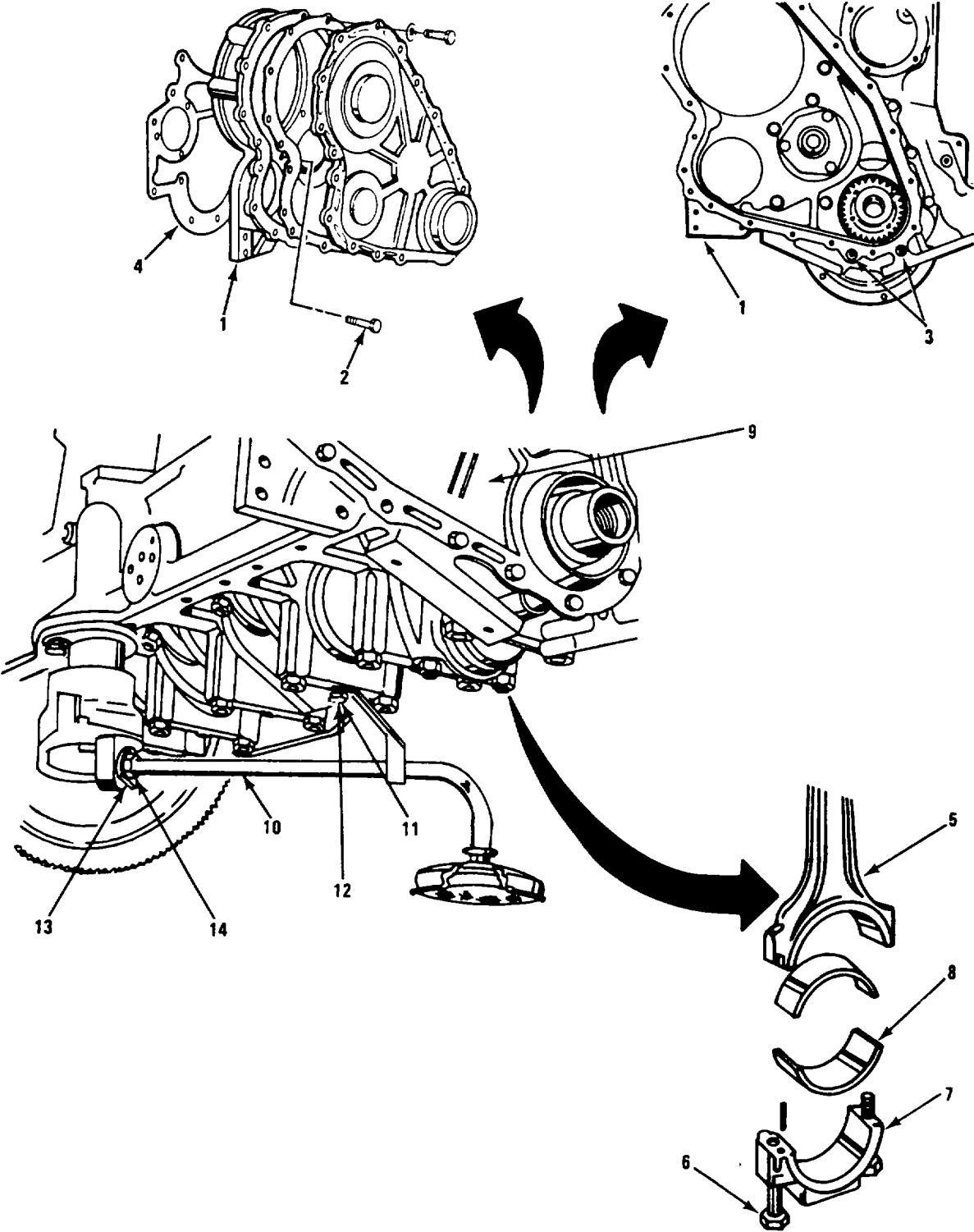
Condition Description:

Engine assembly removed
 from boat and mounted
 on engine maintenance
 stand or laid on side
 on top of work bench.
 Cooling system drained.
 Water pump and alter-
 nator belt removed.
 Transmission removed.
 Flywheel and housing
 removed.
 Oil sump (pan)
 removed.
 Camshaft removed.

Materials/Parts:

Sump and front cover gasket kit
 Sealant
 Engine oil
 Crocus cloth
 Emery paper

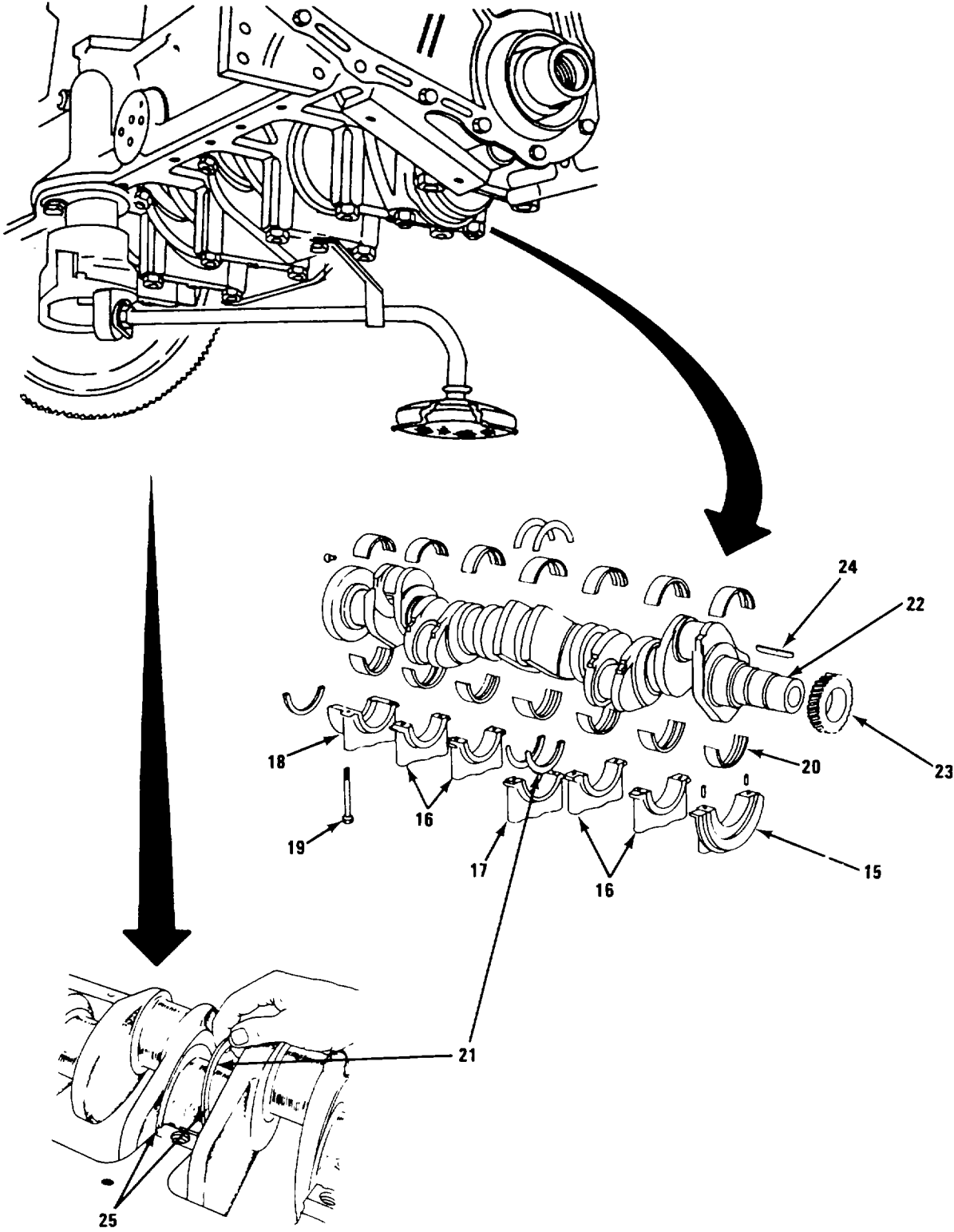
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL</u>			
1. Timing gear housing (1)	a. 8 bolts (2)	Remove.	Use 9/16 in socket and ratchet.
	b. 2 socket head screws (3), housing (1) and gasket (4)	Remove.	Use 5/16 in hex key wrench (Allen).
2. Connecting rod (5)	12 bearing cap bolts (6), 6 bearing caps (7) and 6 bearing liners (8)	a. Loosen bolts.	Use 5/8 in socket, 6 in extension and ratchet.
		b. Tap bolts lightly to release connecting rod cap from crankshaft.	Use non-metallic hammer.
		c. Remove caps and liners.	Make sure that caps and liners are kept in order for reassembly to original connecting rod.
3. Cylinder block (9)	Oil pump inlet pipe (10)	a. Unscrew and remove cap screw (11) and washer (12).	Use 1/2 in socket and ratchet.
		b. Bend back lockwasher tab (13) and unscrew pipe union (14).	Use 7/8 in wrench.

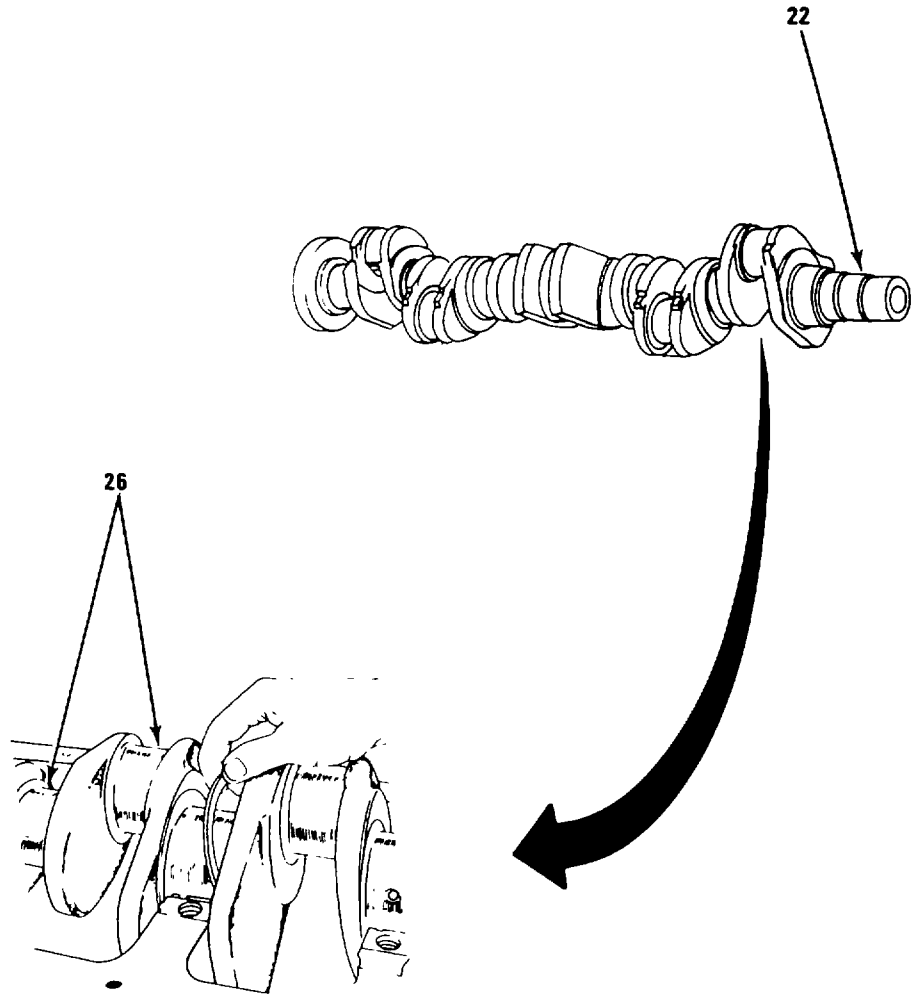
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
4. Main bearing caps (15, 16, 17 and 18)	a. Intermediate main bearing caps (16) b. 14 bolts (19), 7 main bearing caps (15 thru 18) and 7 main bearings (20). c. Thrust washers (21)	c. Remove. Mark for identification and position. Remove bolts and bearing caps in turn. Remove.	Assists in correct reassembly. Use 7/8 in socket, 6 in extension and ratchet.
5. Crankshaft (22)	Crankshaft (22), gear (23) and key (24)	a. Lift out of block. b. Remove gear (23). c. Remove key (24).	Use gear puller.
INSPECTION			
6. Crankshaft (22)	a. Center bearing journal thrust surfaces (25)	a. Inspect for: Grooving and Discoloration. b. Replace shaft if grooved or discolored.	Severe damage may indicate a bent shaft.

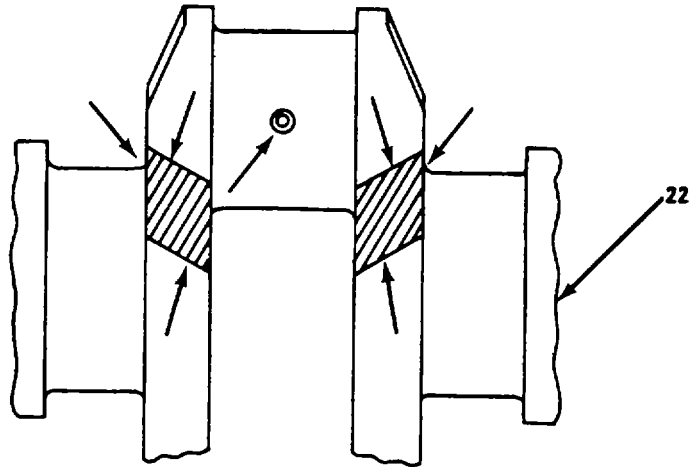
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



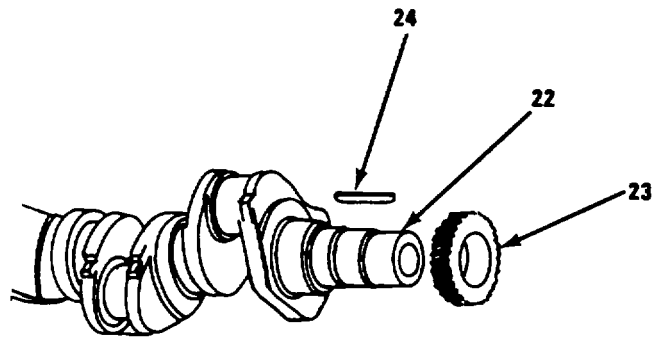
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. All Journal surfaces (26)	a. Inspect for: Scratching, Etching, Grooving, or Discoloration. b. Replace crankshaft if damaged or imperfection cannot be removed with crocus cloth wet with fuel oil and/or 240 grit emery cloth.	
	c. Crankshaft (22)	a. Inspect for oil seal grooving. b. Clean up any oil seal grooving with crocus cloth wet with fuel oil and/or 240 grit emery cloth. c. Replace if grooves cannot be removed.	Any imperfection of oil seal surface will cause oil leakage.

CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



CRITICAL CRANKSHAFT LOADING ZONES



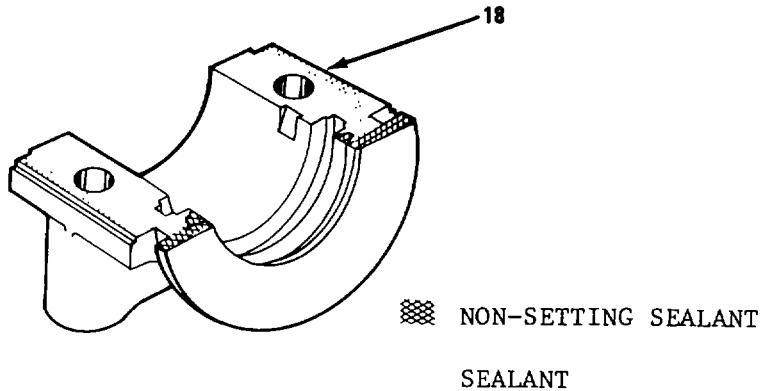
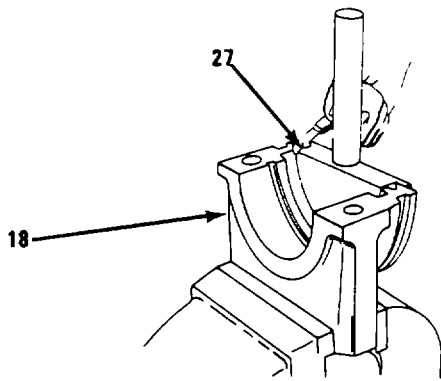
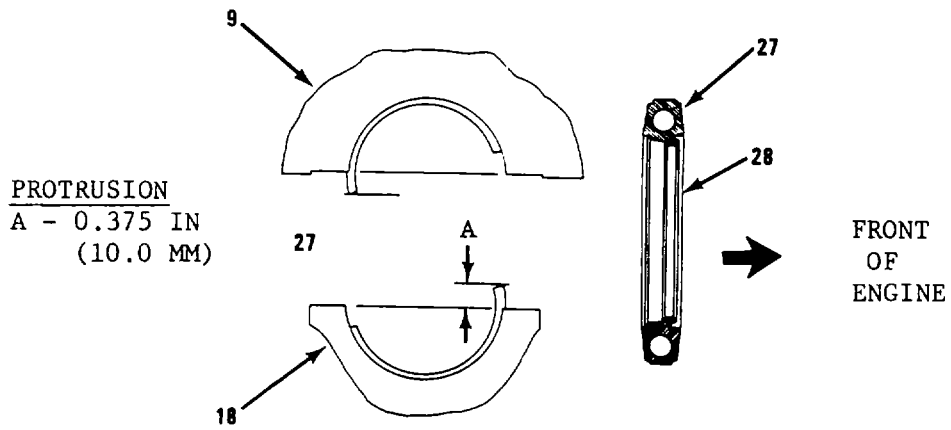
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	<p>d. Crankshaft (22)</p>	<p>a. Inspect for surface cracks along loading zones (see figure) using one of following methods:</p> <ul style="list-style-type: none"> • Magnetic Particle Method, • Fluorescent Magnetic Particle Method, • Fluorescent Penetrant Dye Method. <p>b. Verify crack indications.</p> <p>c. Replace if cracked.</p> <p>d. Replace shaft if heat damage is indicated by discoloration.</p>	<p>Check any indicated cracks with a pointed instrument to determine if it is a crack. Scratch along crack line to verify cracking.</p>

INSTALLATION

<p>7. Crankshaft (22)</p>	<p>a. Key (24)</p>	<p>Install to position gear correctly.</p>	
	<p>b. Gear (23)</p>	<p>Drive onto shaft. hammer.</p>	<p>Use brass drift and ball peen</p>

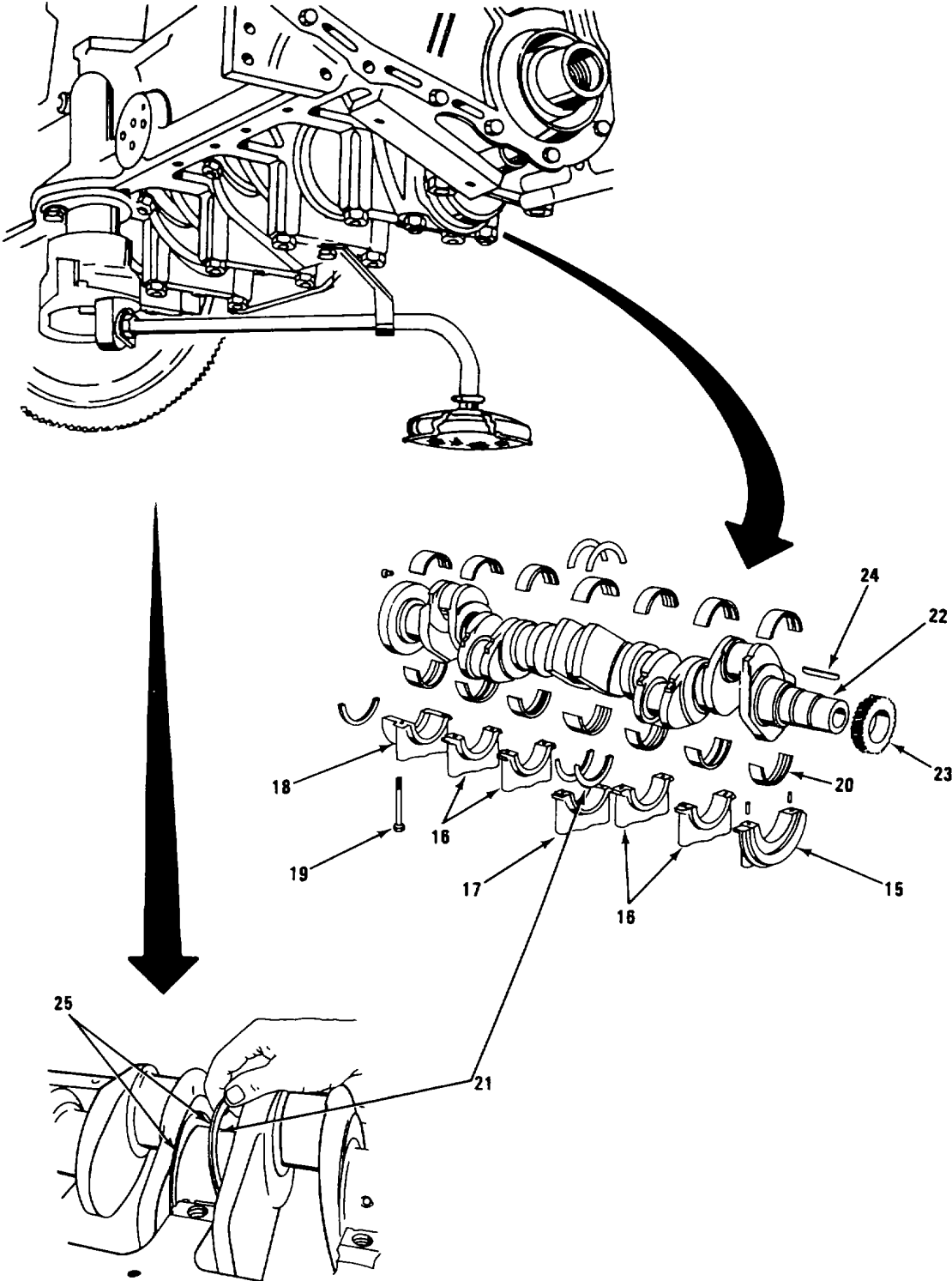
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
8. Cylinder block (9) and rear main bearing cap (18)	a. Rear main bearing cap (18) and cylinder block (9)	a. Clean out old seal. Make sure all traces of adhesive are removed. b. Coat seal grooves in block and cap with sealant immediately before fitting seal. c. Dip seal halves (27) in clean oil. d. Fit seal (27) into grooves. e. Trim ends of seal to 0.375 in. (10.0 mm) above surface (see figure). f. Apply non-setting sealant to ends of seal and along rear edge of bearing face (see figure).	Note in figure that seal undercut (28) is placed toward front of engine. Use knife. Make sure there are no frayed threads after trimming. Seal halves must protrude to ensure cap alignment.

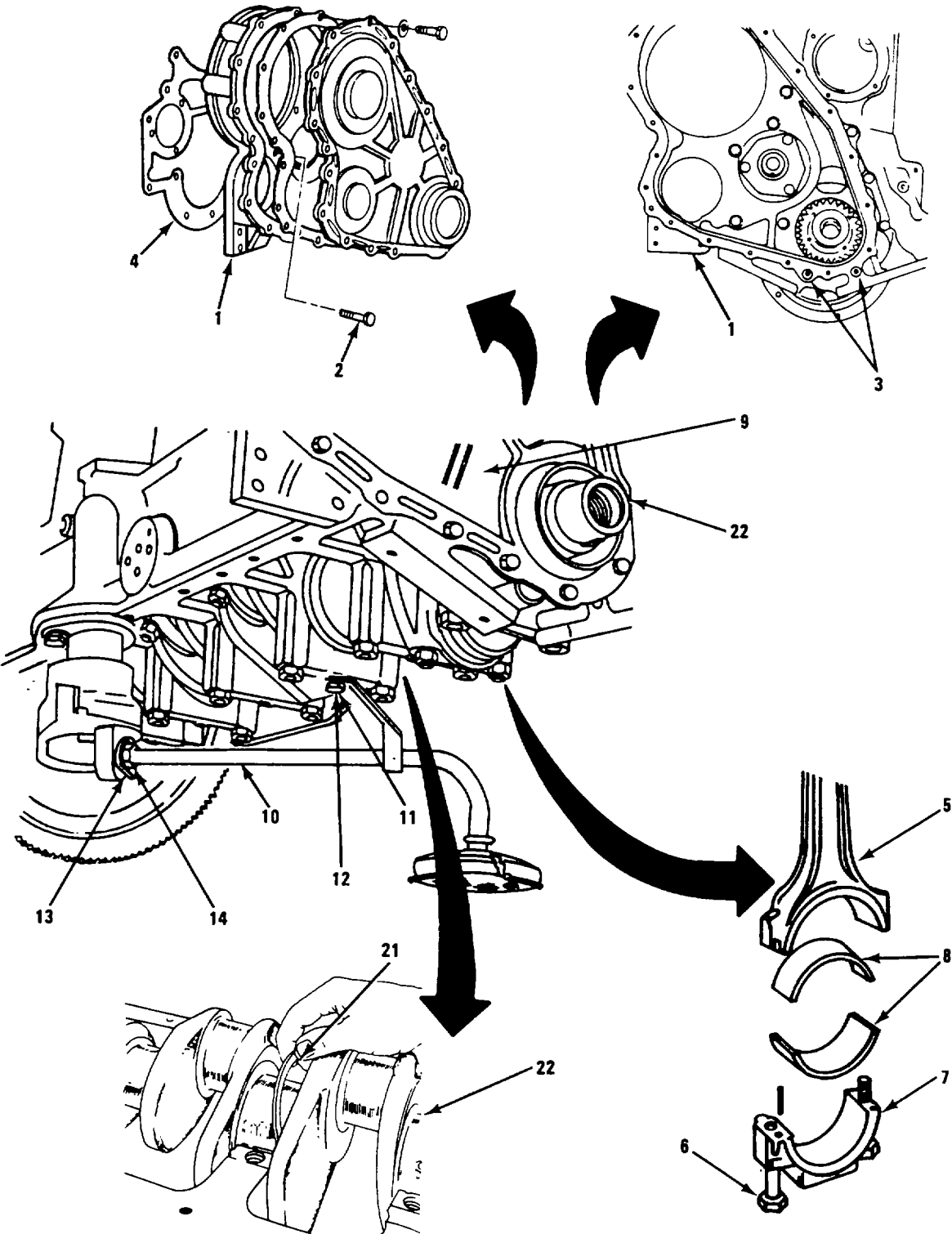
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Main bearings (20)	a. Clean. b. Lubricate. c. Check that locating tongues are engaged in locating grooves in block and caps.	Use clean engine oil.
9. Crankshaft (22)	c. Crankshaft (22)	Install in cylinder block.	
	a. Thrust washers (21)	Fit on either side center main bearing with oil groove facing crankshaft flange.	
	b. Main bearing caps (15, 16, 17 and 18) and 14 bolts (19)	a. Fit caps in correct position. b. Lubricate bolt threads. c. Insert bolts into caps. d. Move crankshaft back and forth to centralize center cap.	Match mating marks, make sure word REAR at back of cap. Use engine oil. Finger tight.

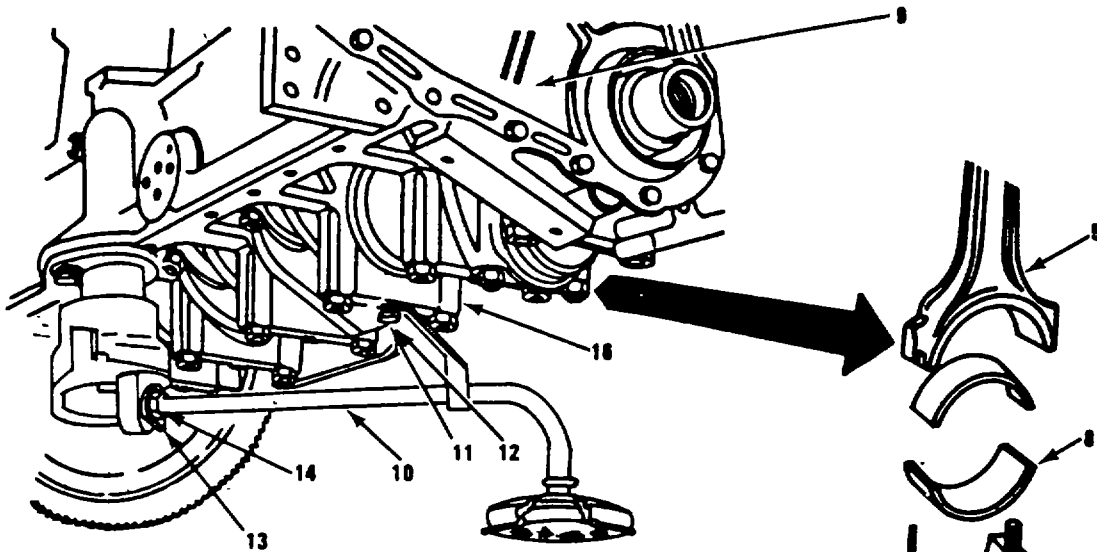
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



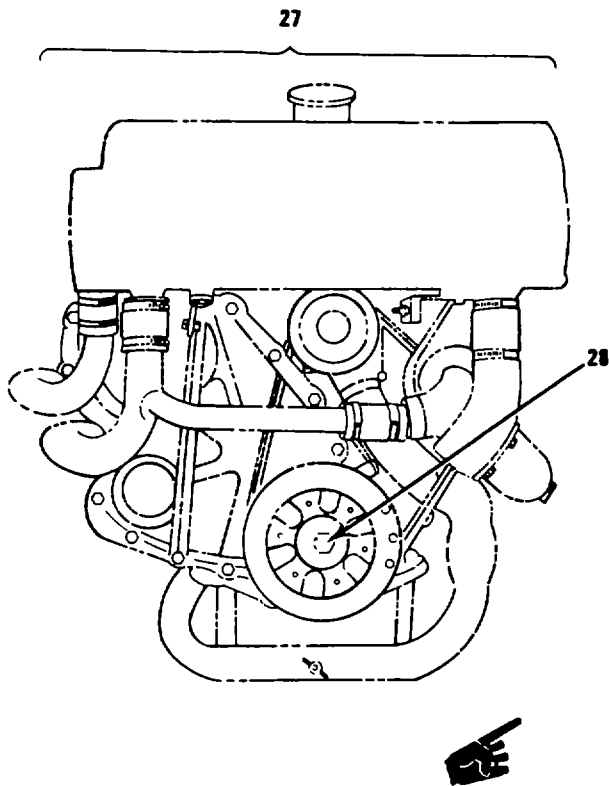
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		e. Torque bolts evenly to 115-120 ft-lb (15.89 to 16.58 kg m). cap.	Use 7/8 in socket and torque wrench Check crankshaft rotation after tightening each
	c. Crankshaft (22)	a. Move forward to take up end float.	
		b. Measure gap between crankshaft and forward thrust washer (21). Tolerance: 0.002 - 0.010 in. (0.051 - 0.254 mm).	Use feeler gage.
10. Cylinder block (9)	a. Timing gear housing (1) and timing scale	Position on cylinder block face and secure with bolts.	
NOTE			
Follow steps 8a thru g, page 3-77, for installation of camshaft parts and timing gear housing cover.			
11. Connecting rods (5)	a. Connecting rod bearings (8)	Lubricate.	Use clean engine oil.
	b. Connecting rod (5) (journal).	Fit big end to crankshaft	Rotate crankshaft as necessary.

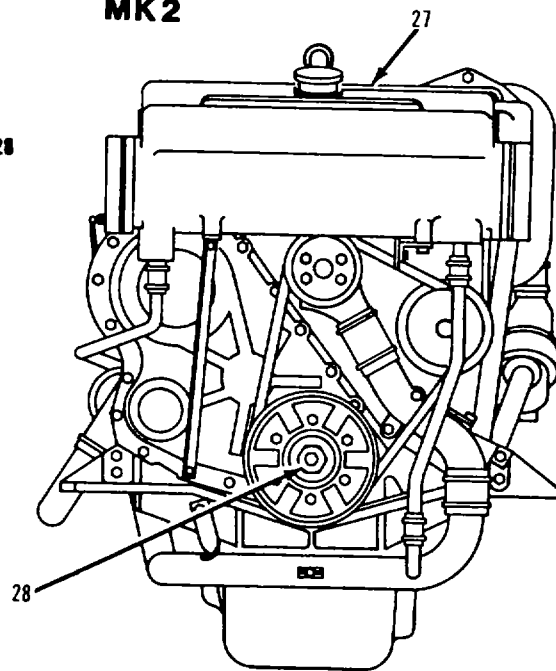
CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)



MK 1



MK 2



CRANKSHAFT INSPECTION AND REPLACEMENT INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
<p>NOTE</p> <p>Make sure to mate bearing caps to original connecting arms from which disassembled.</p>			
	<p>c. Bearing caps (7) and bolts (6)</p>	<p>a. In turn, position caps on connecting rod using dowels.</p> <p>b. Install bolts.</p> <p>c. Torque bolts to 85 - 90 ft-lb (11.76 - 12.45 kg-m).</p>	<p>Use 5/8 in socket, 6 in extension and torque wrench (0 - 175 ft-lb).</p>
<p>12. Cylinder block (9)</p>	<p>Oil pump inlet pipe (10)</p>	<p>a. Insert pipe into pump connection.</p> <p>b. Screw in union (14), bend down lock tab (13).</p> <p>c. Secure pipe bracket to main bearing cap (16) using cap screw (11) and washer (12).</p>	<p>Use 7/8 in open end wrench.</p> <p>Use 1/2 in socket and ratchet.</p>
<p>13. Engine assembly (27)</p>	<p>Crankshaft pulley nut (28)</p>	<p>Check crankshaft rotation after tightening each bearing cap.</p>	<p>Use 15/16 in socket and 3/4 in drive handle.</p>

CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

This task covers:

- a. Removal b. Inspection c. Repair d. Installation**

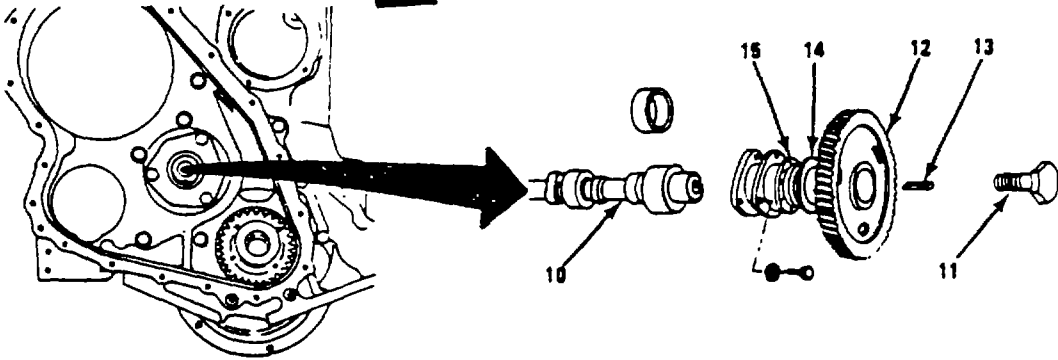
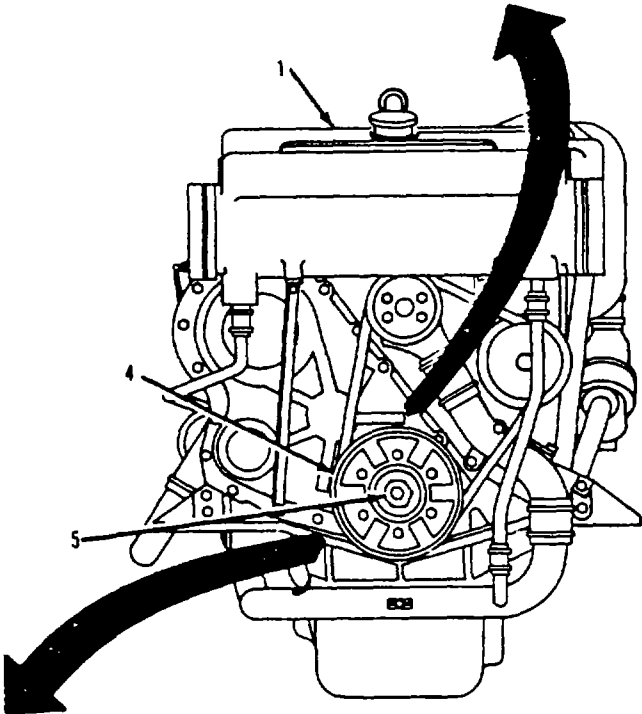
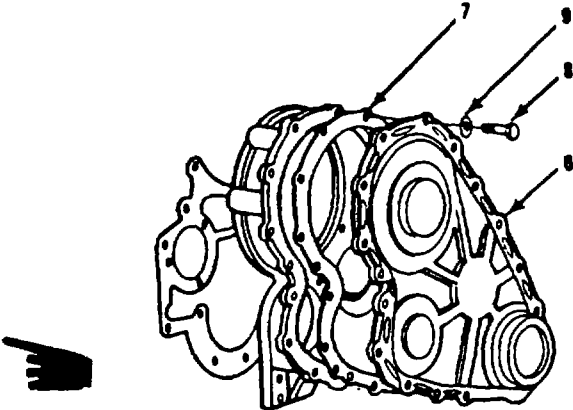
INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Bearing puller	Page 2-179	Engine assembly removed from boat and mounted on engine maintenance stand or laid on side on top of work bench. Water pump and alternator belt removed. Rocker arm assembly removed. Oil sump (pan) removed.
Micrometer calipers, outside		
Micrometer calipers, inside		
Flat tip screwdriver, 6 inch		
15/16 in socket		
Hinged handle	TM 5-1940-277-20	
1/2 in socket		
Ratchet	TM 5-1940-277-20	
1-7/8 in socket		
Gear puller	Page 2-307	
9/16 in socket		
Torque wrench (0 - 600 ft-lb)	TM 5-1940-277-20	Drain cooling system.
Brass drift		
Hammer, ball peen		
Torque wrench (0 - 175 ft-lb)		
Engine maintenance stand		
Materials/Parts:		
Emery cloth, 240 grit		
Solvent		

CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

MK 2

Callouts 2,3 deleted



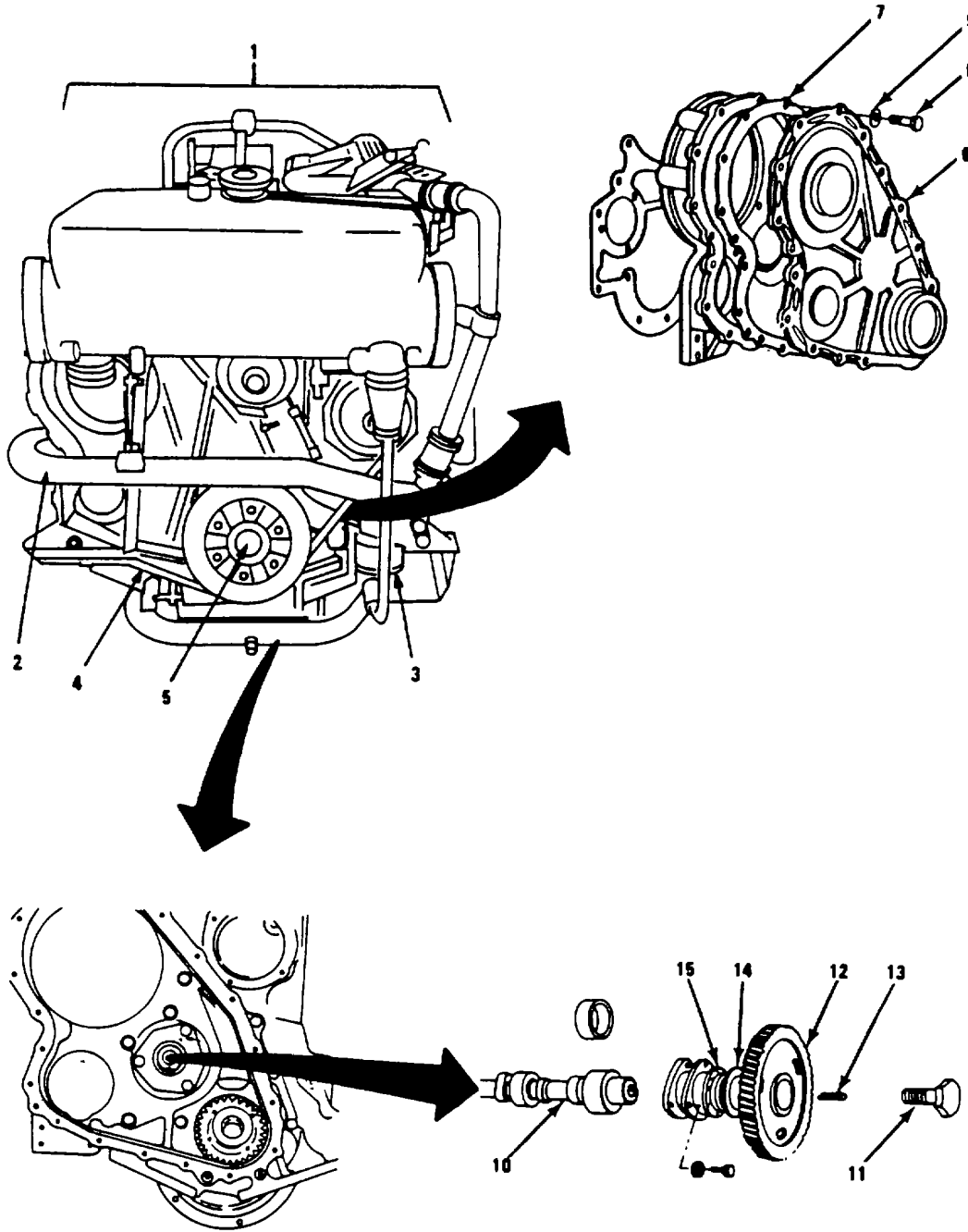
CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL (MK-2)</u>			
1. Engine assembly (1)	a. Crankshaft pulley (4) and bolt (5).	Remove	Use 15/16" socket, hinged handle, and gear puller.
	b. Timing gear housing front cover (6), gasket (7), 19 bolts (8) and 19 washers (9)	Remove.	Use 1/2 in socket and ratchet.
2. Camshaft (10)	a. Bolt (11) and camshaft gear (12)	Remove bolt and pull gear off shaft.	Use 1-7/8 in socket, hinged handle and gear puller.
	b. Camshaft key (13)	Remove from shaft.	
	c. Thrust washer (14) and collar (15)	Remove from shaft and discard.	
	d. Refer to page 3-79.		

CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

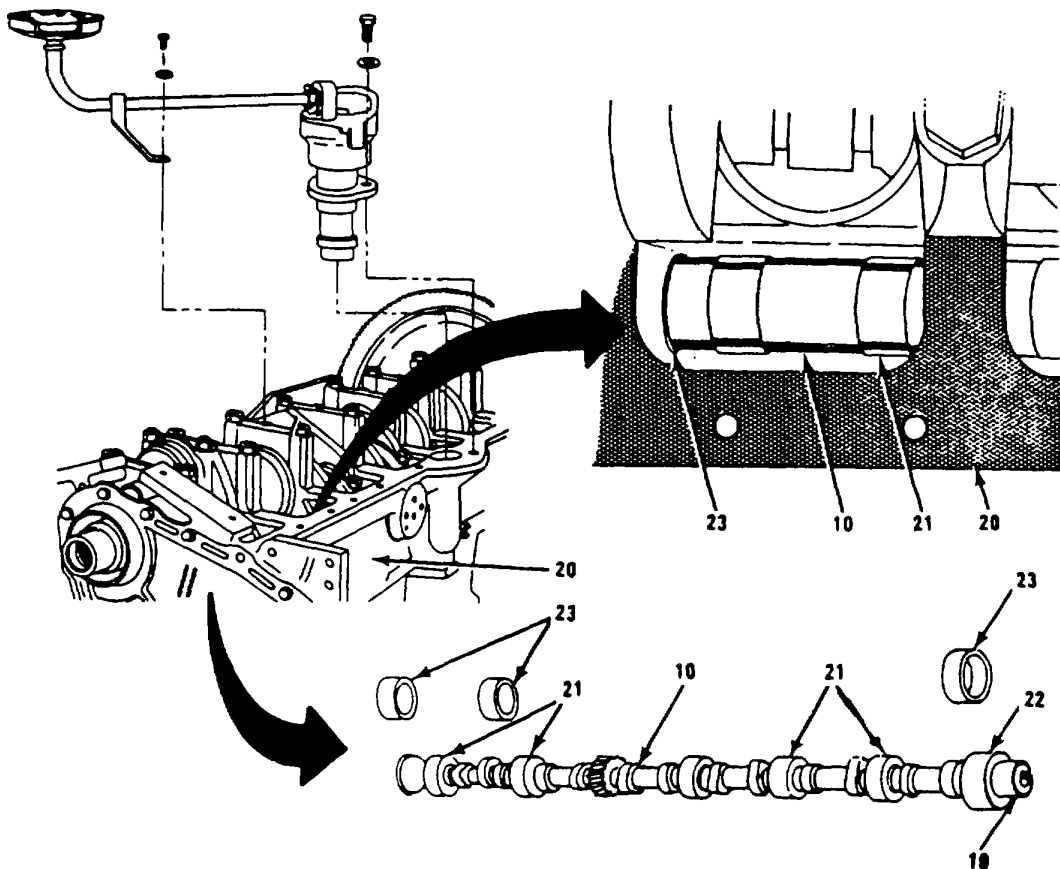
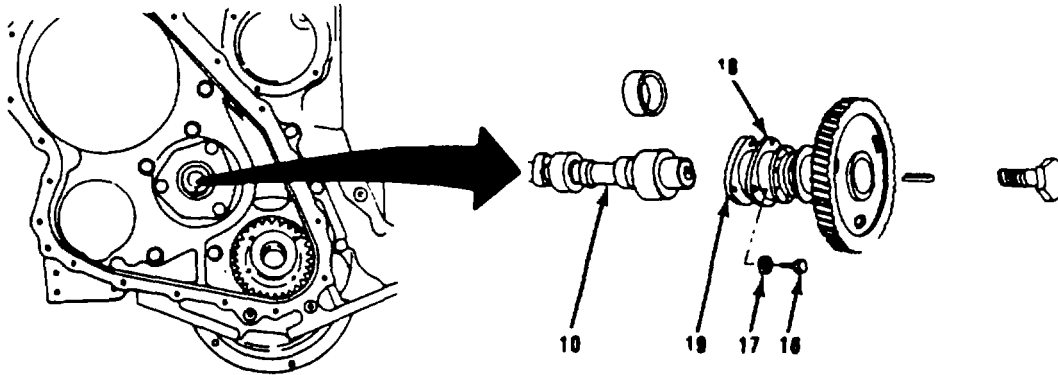
MK 1



CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
<u>REMOVAL (MK-1)</u>			
2.1. Engine assembly (1)	a. Cooling pipe (2) between thermostat and engine oil cooler.	Loosen 3 clamps, bracket and remove.	Use screwdrivers, and socket.
	b. Cooling Pipe (3) between header tank and pump.	Loosen 2 damps and remove.	Use screwdriver.
	c. Crankshaft pulley (4) and bolt (5)	Remove.	Use 15/16 in socket, hinged handle and gear puller.
	d. Timing gear housing front cover (6), gasket (7), 19 bolts (8) and 19 washers (9)	Remove.	Use 1/2 in socket and ratchet.
2.2. Camshaft (10)	a. Bolt (11) and camshaft gear (12)	Remove bolt and pull gear off shaft.	Use 1-7/8 in socket, hinged handle and gear puller.
	b. Camshaft key (13)	Remove from shaft.	
	c. Thrust washer (14) and collar (15)	Remove from shaft and discard.	

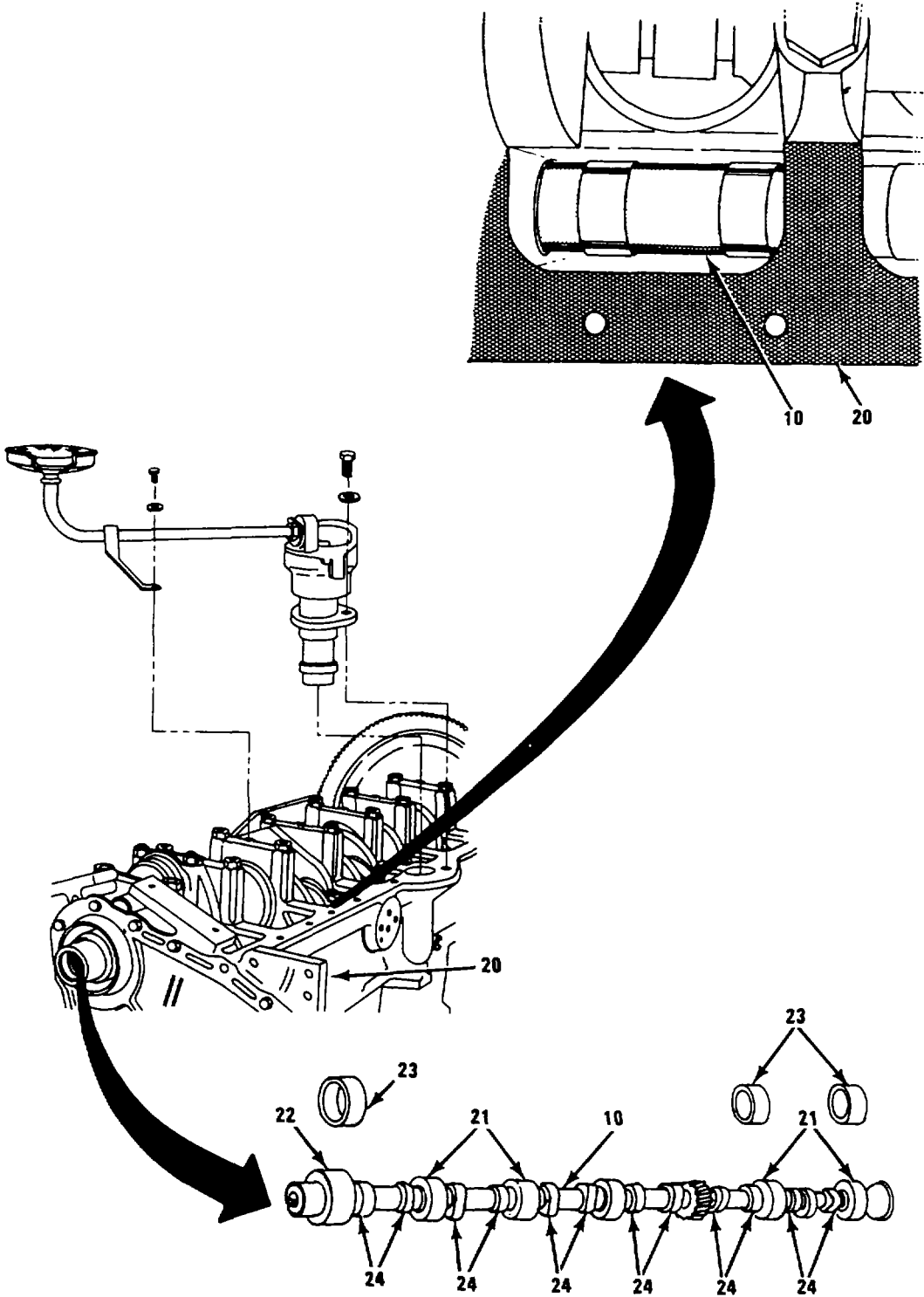
CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
 (Continued)



CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
	d. 3 bolts (16), 3 washers (17), locking plate (18) and thrust plate (19)	Remove.	Use 9/16 in soc- ket and ratchet.
	e. Camshaft (10)	Withdraw from cylinder block (20).	Take care not to damage bearings with cam lobes.
<u>INSPECTION</u>			
3.	Camshaft (10)	Measure diameter of all bearing journals (21) and (22).	Use micrometer calipers, outside
4. Cylinder block (20)	Camshaft bearings (23)	<p>a. Measure inside dia- meter of bearings.</p> <p>b. Determine camshaft to bearing clearance, (diameter of step 4a minus diameter of step 3), compare to specification: Front (24) - 0.0015 to 0.0025 in (0.038 to 0.063 mm) Rear and Interme- diate (23) - 0.001 to 0.002 in (0.025 to 0.051 mm).</p>	Use micrometer calipers, inside.

CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS

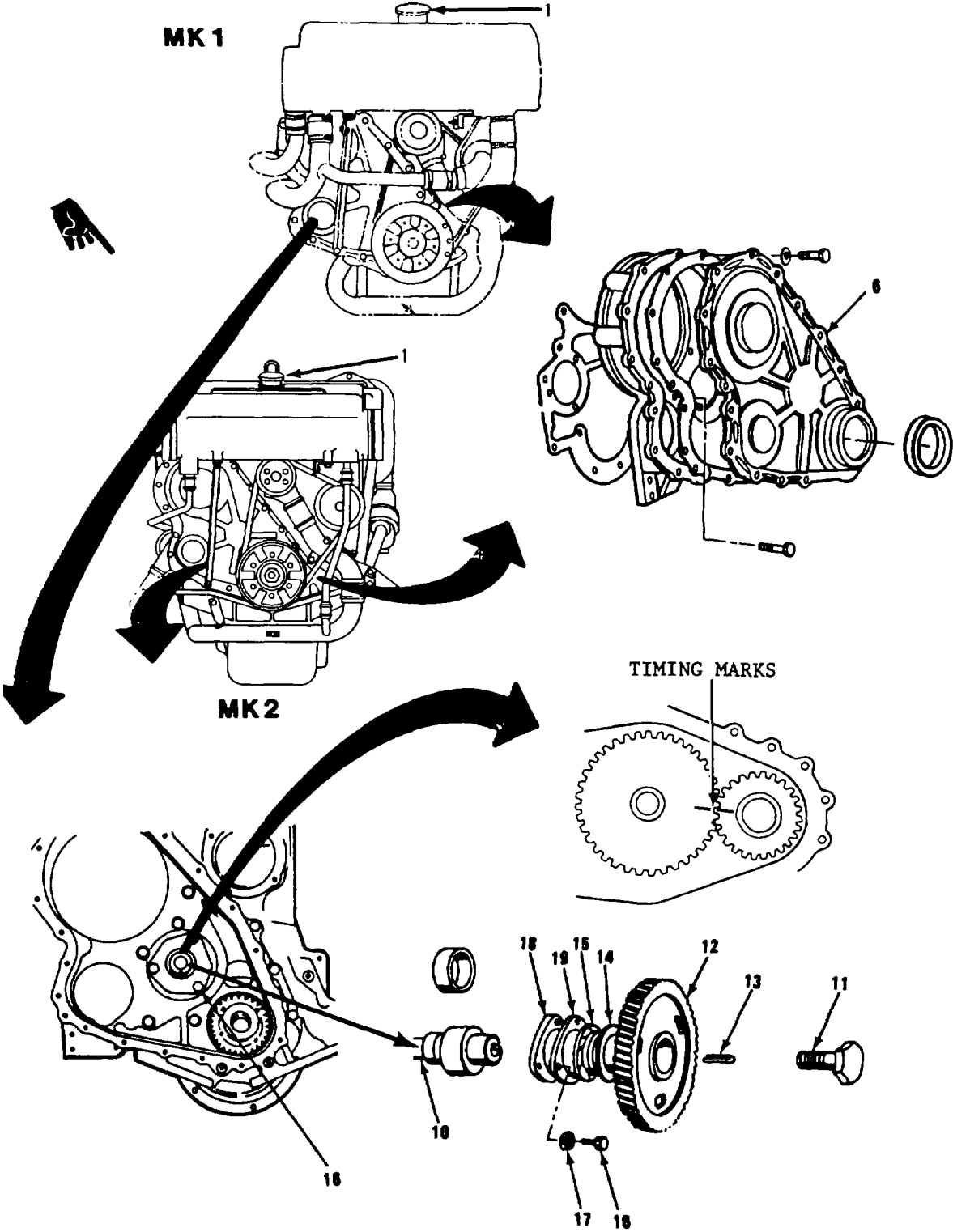
Continued

LOCATION	ITEM	ACTION	REMARKS
5. Camshaft (10)	Camshaft lobes (24) and bearing journals (21) and (22)	c. Replace all bearings if any are outside of limits. a. Inspect for: Scoring and Flat spots.	Use bearing puller.
		b. Replace camshaft if damaged.	Replace bearings at same time.

INSTALLATION

6. Cylinder block (20)	a. Camshaft bearings (23)	a. Clean preservative off new bearings.	Use solvent.
		b. Press into place.	Use bearing puller-pusher.
	b. Camshaft (10)	a. Clean preservative off new camshaft.	Use solvent.
		b. Insert camshaft into cylinder block.	Be careful not to damage bearings or edges of lobes and journals.

CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

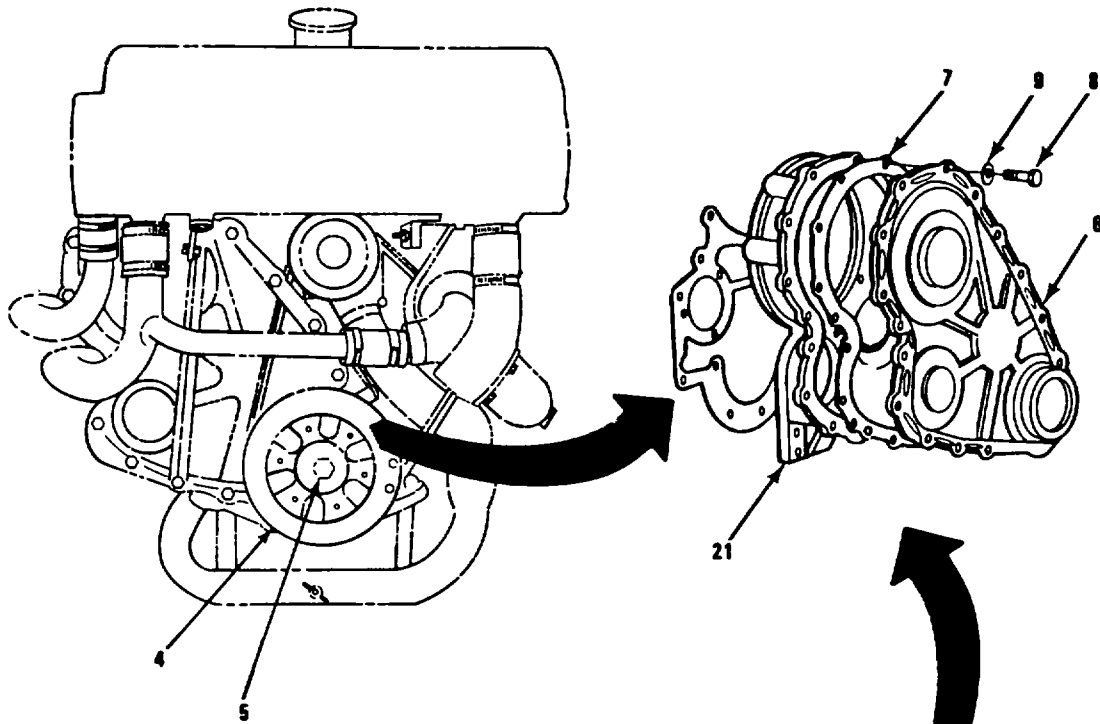


CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

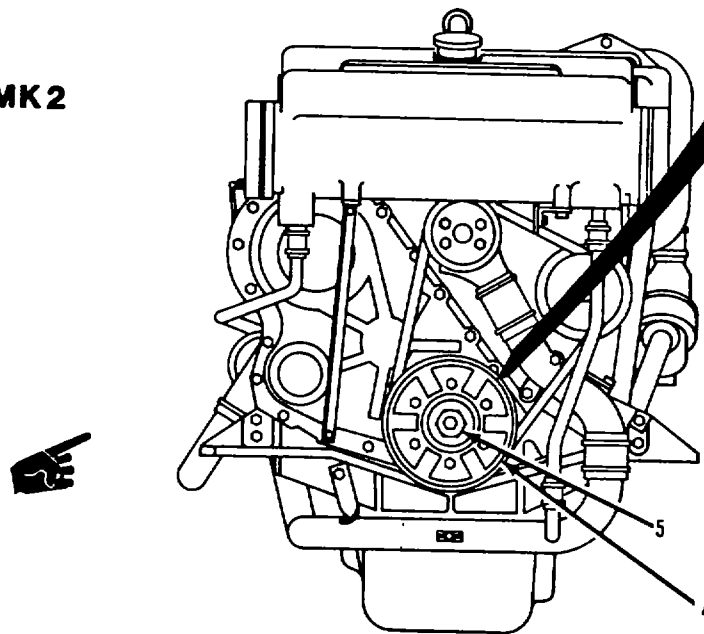
LOCATION	ITEM	ACTION	REMARKS
7. Engine assembly (1)	a. Camshaft thrust plate (18), locking plate (19), 3 bolts (16) and 3 washers (17)	Torque bolts, 30 ft-lb (4.15 kg-m) evenly in sequence (see figure).	Use 9/16 in socket and torque wrench.
		b. Camshaft thrust washer (14), collar (15) and key (13)	Install on end of camshaft. Make sure grooved face of washer is next to thrust plate.
	c. Camshaft gear (12)	a. Aline camshaft and crankshaft timing marks (see figure).	
		b. Drive gear onto camshaft.	Use brass drift and hammer.
	d. Camshaft bolt (11)	Screw in camshaft bolt. Torque to 150 - 155 ft-lb (20.74 to 21.43 kgfm).	Use 15/16 in socket and torque wrench.
	e. Timing gear housing front cover (6)	a. Inspect cover around oil seal for cracks. Replace cover if any cracks are present.	
		b. Remove old oil seal.	Be careful not to distort cover.

CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

MK 1



MK 2



CAMSHAFT AND CAMSHAFT BEARING INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Fit new oil seal with seal lip toward inside of cover.	
		d. Fit gasket (7) and cover (6) to housing (21).	
NOTE			
A bolt tightening sequence for cover bolts is not required.			
		e. Install 19 washers (9) and bolts (8).	Use 1/2 in socket and ratchet.
	f. Crankshaft pulley (4)	Fit onto crankshaft.	
	g. Crankshaft nose bolt (5)	Screw in. Torque to 240 ft-lb (33.20 kgfm).	Use 15/16 in socket and torque wrench.

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS

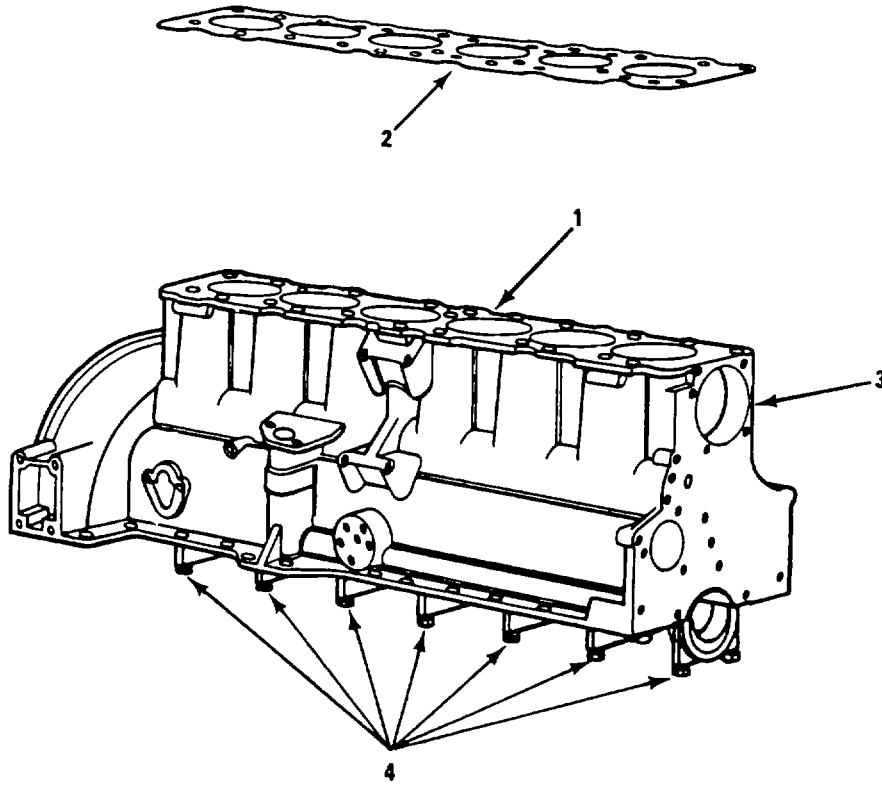
This task covers:

- a. Inspection**
- b. Replacement**

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
Ratchet	Page 3-75	Camshaft removed.
Torque wrench, (O - 175 ft-lb)	Page 3-75	Crankshaft removed.
7/8 in socket	Page 2-291	Cylinder head assembly removed.
3/4 in socket	Page 3-29	Pistons and connecting rod assemblies removed.
1/2 in socket		Starter removed.
Air compressor	TM 5-1940-277-20	Alternator removed.
Air blow gun	TM 5-1940-277-20	Water pump removed.
Hoist	TM 5-1940-277-20	Engine oil cooler removed.
Immersion tank	TM 5-1940-277-20	Fuel lift pump removed.
Steel straightedge		Engine oil pressure sender removed.
Feeler gage	TM 5-1940-277-20	Tachometer and drive removed.
1/2 in UNC-3A thread cutting die	TM 5-1940-277-20	
Safety goggles	TM 5-1940-277-20	
Dial indicator		
File		
Micrometer caliper, inside		
Electric drill, 3/8 in		
Materials/Parts:		
Cylinder head gasket		
Engine oil		

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

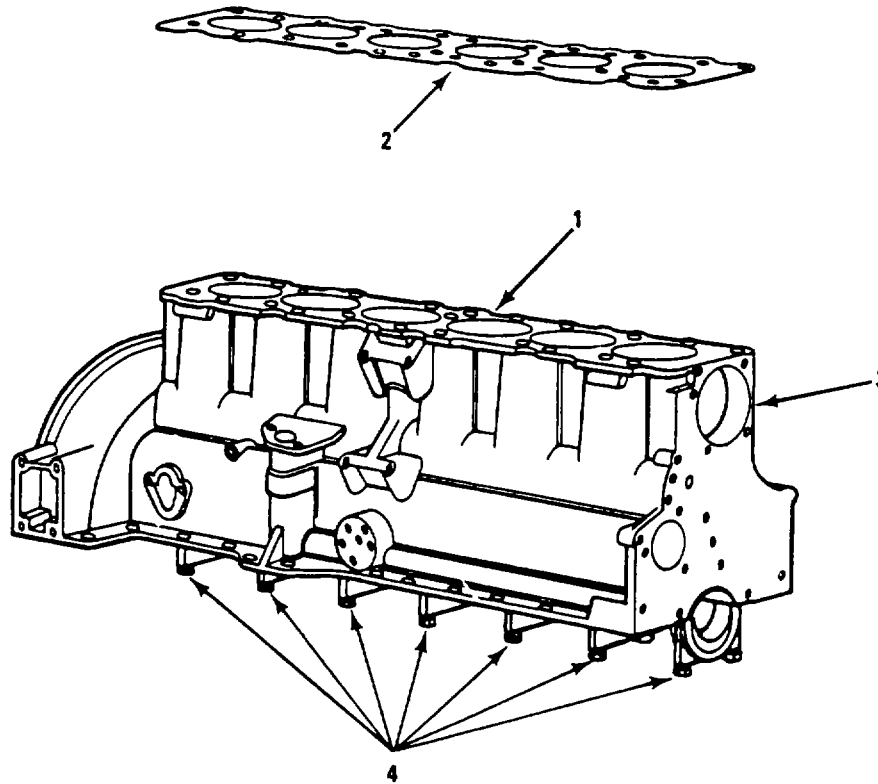


ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
NOTE			
<p>The cylinder block assembly consists of the cast cylinder block with the integrally cast upper half of the crankcase and the seven main bearing caps.</p>			
<u>INSPECTION AND REPLACEMENT</u>			
Cylinder block (1)	a. Cylinder block (1)	<p>a. Pressure test for cracks as follows:</p> <ul style="list-style-type: none"> * Fit new head gasket (2). * Install 1/2 in thick steel plate on top of cylinder block (1). * Install 25 bolts with washers to secure steel plate, torque bolts to 135 ft-lb. * Install suitable cover with air hose connection and new gasket over water pump hole (3) in front face of block. Secure cover using four 5/16 in UNC bolts. Torque to 15 ft-lb. * Attach air hose to water pump hole cover. 	<p>Head gasket can be used as pattern for boring bolt holes.</p> <p>Use torque wrench (0 - 175 ft-lb cap.) with 3/4 in socket.</p> <p>Use 1/2 in socket with torque wrench (0- 175 ft-lb).</p>

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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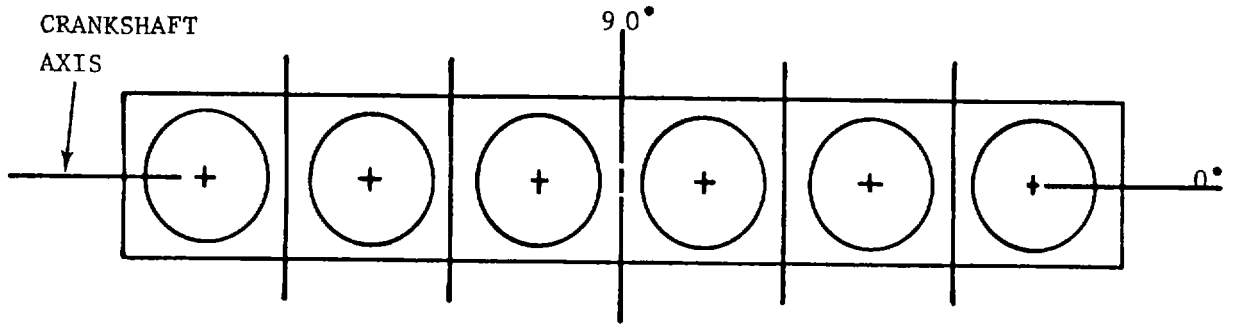
		* Place block in immersion tank of water, heated to 180 - 212° F for 20 minutes.	Use hoist to lift.
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WARNING

Always use safety goggles when using dry compressed air. High air pressure can cause injury and cut the skin.

- | | | | |
|--|--|--|---------------------|
| | | <ul style="list-style-type: none"> • After 20 minute immersion period apply 80 - 100 psi air pressure to block. • Check for air bubbles leaking from cylinder block (indication of cracks in block). • Release air pressure and remove block from immersion tank. • Remove cover over water pump hole (3) and 1/2 in steel plate and gasket (2) on top of block. | Use air compressor. |
|--|--|--|---------------------|

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS
 (Continued)



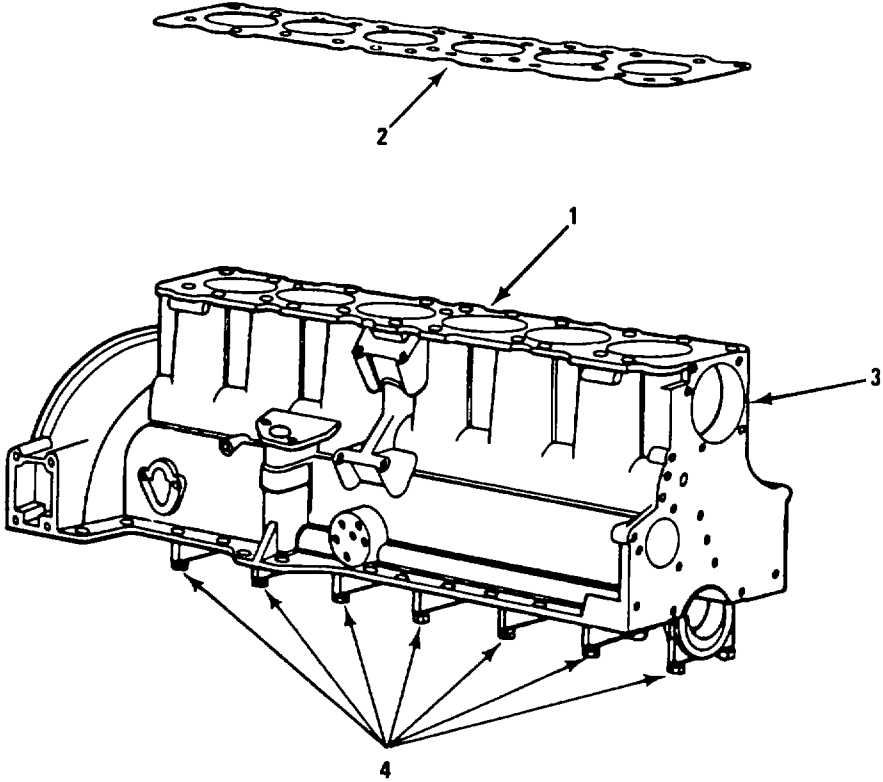
MEASUREMENT POINTS FOR ENGINE BLOCK WARPAGE

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
WARNING			
<p>Always use safety goggles when using dry compressed air. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.</p>			
		<ul style="list-style-type: none"> • Dry cylinder block and liner using compressed air. • Coat cylinder liner with oil to prevent rust. 	<p>Use air compressor with air gun.</p>
		<p>b. Inspect block for warpage parallel to length of crankshaft and at 90° to crankshaft axis (short axis) at each cylinder. Warpage limit 0.004 in except the warpage limit for the short axis in vicinity of number 3 and 4 cylinder is 0.002 in due to water bore arrangement.</p>	<p>Use steel straightedge and feeler gage.</p> <p>Lower warpage limit in vicinity of number 3 and 4 cylinders is due to water bore arrangement.</p>

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)

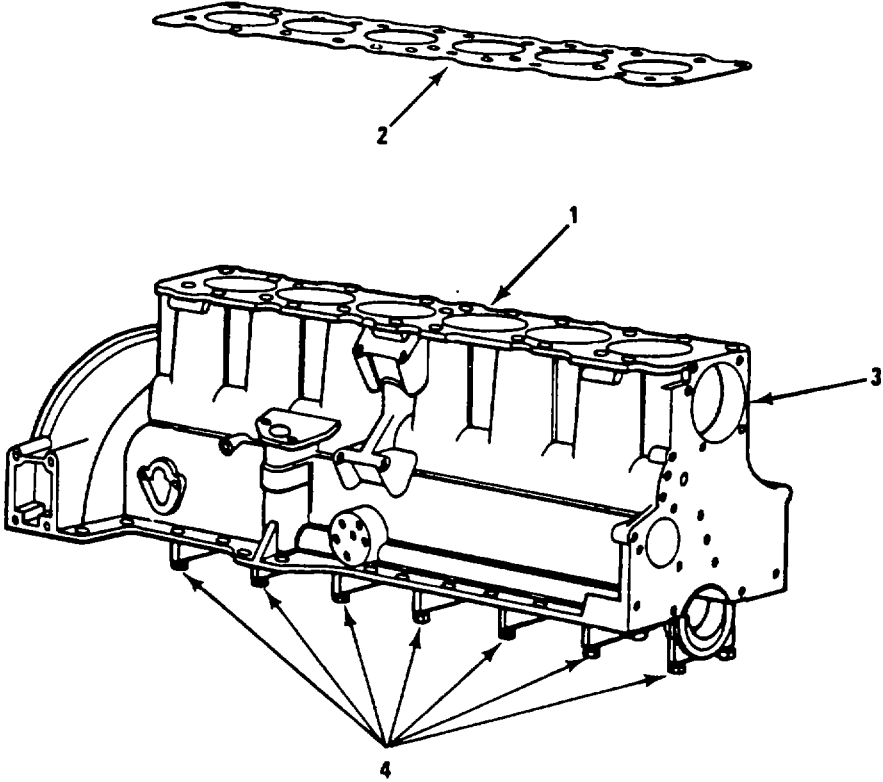


ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Inspect all threaded holes for cross threading.	Use 1/2 in UNC-3A thread cutting die if bolt holes need retapping. Full thread depth is 1 in. (25 mm).
		d. Replace block if: <ul style="list-style-type: none"> • Warped beyond limits • Cracked. 	
	b. Main bearing caps (4)	a. Inspect cap alignment: <ul style="list-style-type: none"> • Install 7 main bearing caps and 14 cap bolts, torque bolts to 115 - 120 ft-lb. • Measure main bearing bores, limit 3.1665 to 3.1673 in. • Remove main bearing caps and install lower main bearing halves into caps. • Install upper main bearing halves into cylinder block. 	Use 7/8 in socket and torque wrench (0 - 175 ft-lb).
			Use micrometer caliper, inside.
			Make sure locating tongues engage in locating grooves. The center and rear lower bearing halves have oil grooves. Make sure locating tongues engage in locating grooves. Upper bearing halves have oil feed hole and oil groove.

ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS
(Continued)



ENGINE BLOCK INSPECTION AND REPLACEMENT INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
		<ul style="list-style-type: none"> • Lubricate bearing halves. • Install crankshaft. • Reinstall main bearing caps and bolts. Torque to 115 - 120 ft-lb. • Rotate crankshaft. 	<p>Use clean engine oil.</p>
		<p>b. If bearing caps are defective replace engine block.</p>	<p>Binding crankshaft indicates main bearing caps are out-of-line longitudinally and that one or more of the caps are defective.</p>

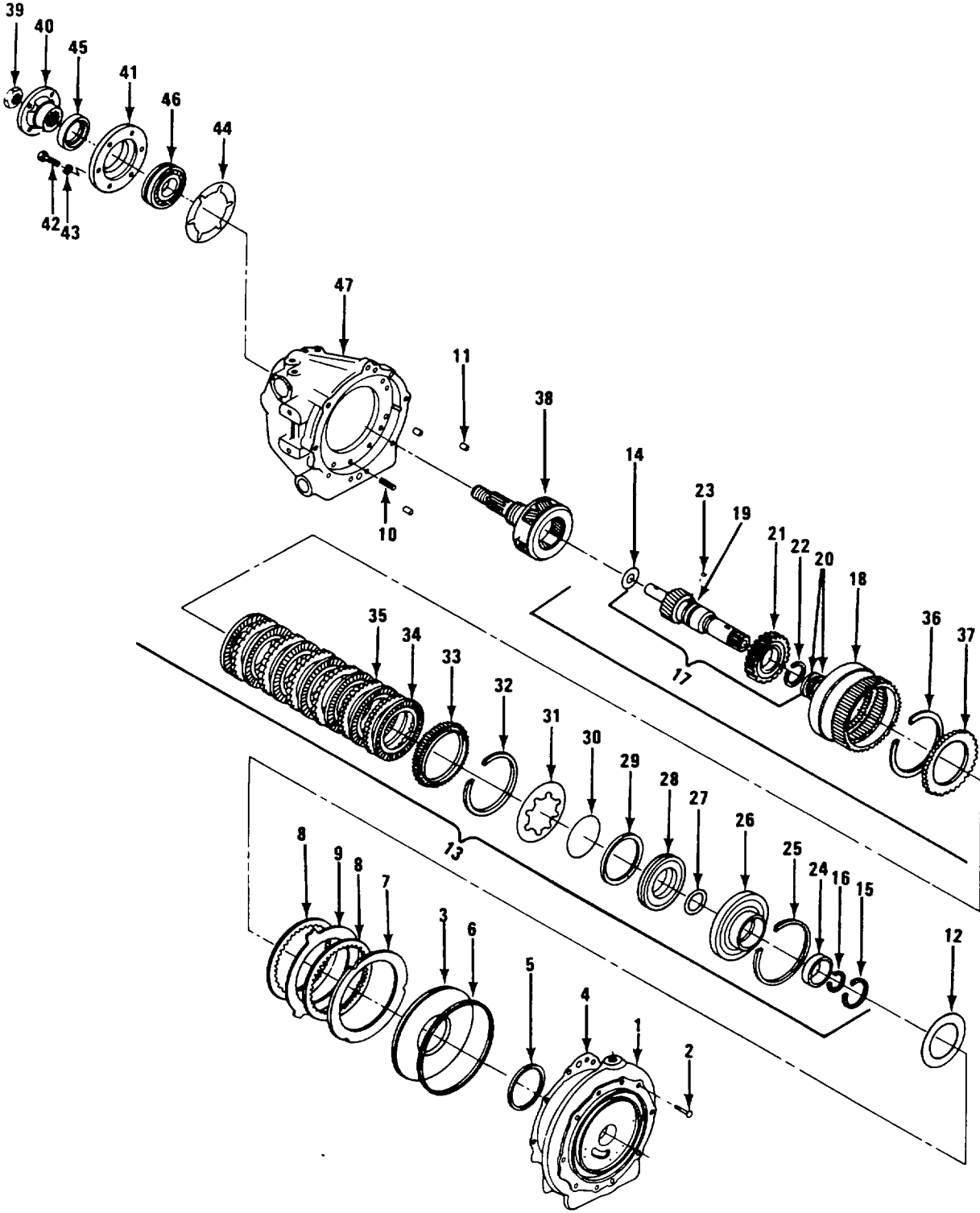
TRANSMISSION REPAIR INSTRUCTIONS**This task covers:**

- a. **Disassembly**
- b. **Inspection**
- c. **Assembly**

INITIAL SETUP

Tools:	Equipment Condition:	Condition Description:
3/8 in socket, thin wall	Page 2-345	Transmission removed
Ratchet		from engine.
5/8 in socket	Page 2-307	Oil pump removed.
Gear puller	Page 2-327	Control valve removed.
Arbor press with attachments		
Non-metallic hammer		
1-1/2 in socket		
Ratchet		
Torque wrench (0 - 175 ft-lb)		
Rearing puller		
Snap ring pliers		
Air blow gun		
Small flat tip screwdriver		
Flat tip screwdriver, 6 inch		
Pliers		
Safety goggles		
Bearing assembly tools C1 and C2		
Feeler gage		
Materials/Parts:		
Gaskets		
Engine oil		
O-rings		
Seals		
Petroleum jelly		
Clutch spring bearing ring		
Silicone sealant		
Padding		
Snap ring, selective package		

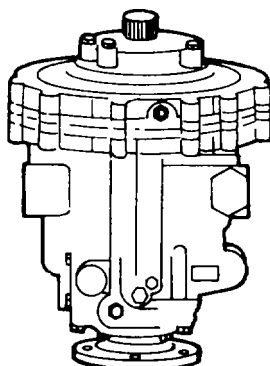
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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DISASSEMBLY

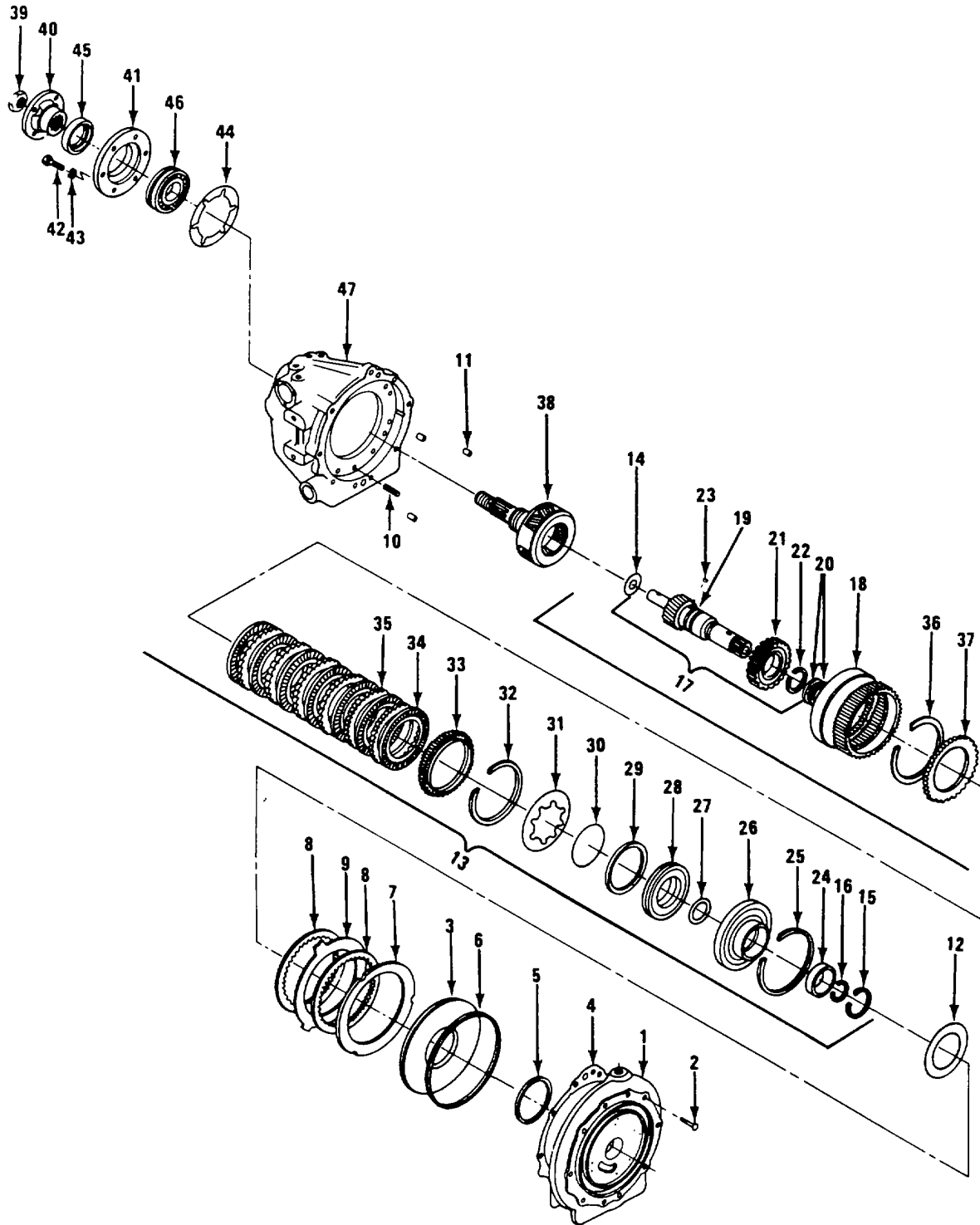


NOTE

Start procedure with transmission standing on coupling with adapter upward.

1. Adapter (1)	4 cap screws	(2) Remove.	Use 3/8 in thin wall socket with ratchet.
2. Transmission case (47)	a. Adapter (1) and reverse clutch piston (3)	Lift adapter and reverse clutch piston as a unit.	Tap adapter with non-metallic hammer if necessary. The reverse clutch plate (8) may momentarily stick to the reverse clutch piston (3). DO NOT ALLOW IT TO DROP.
	b. Adapter gasket (4)	Remove and discard.	

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

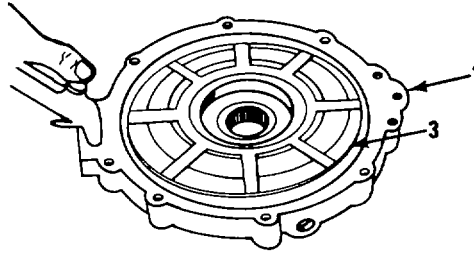


TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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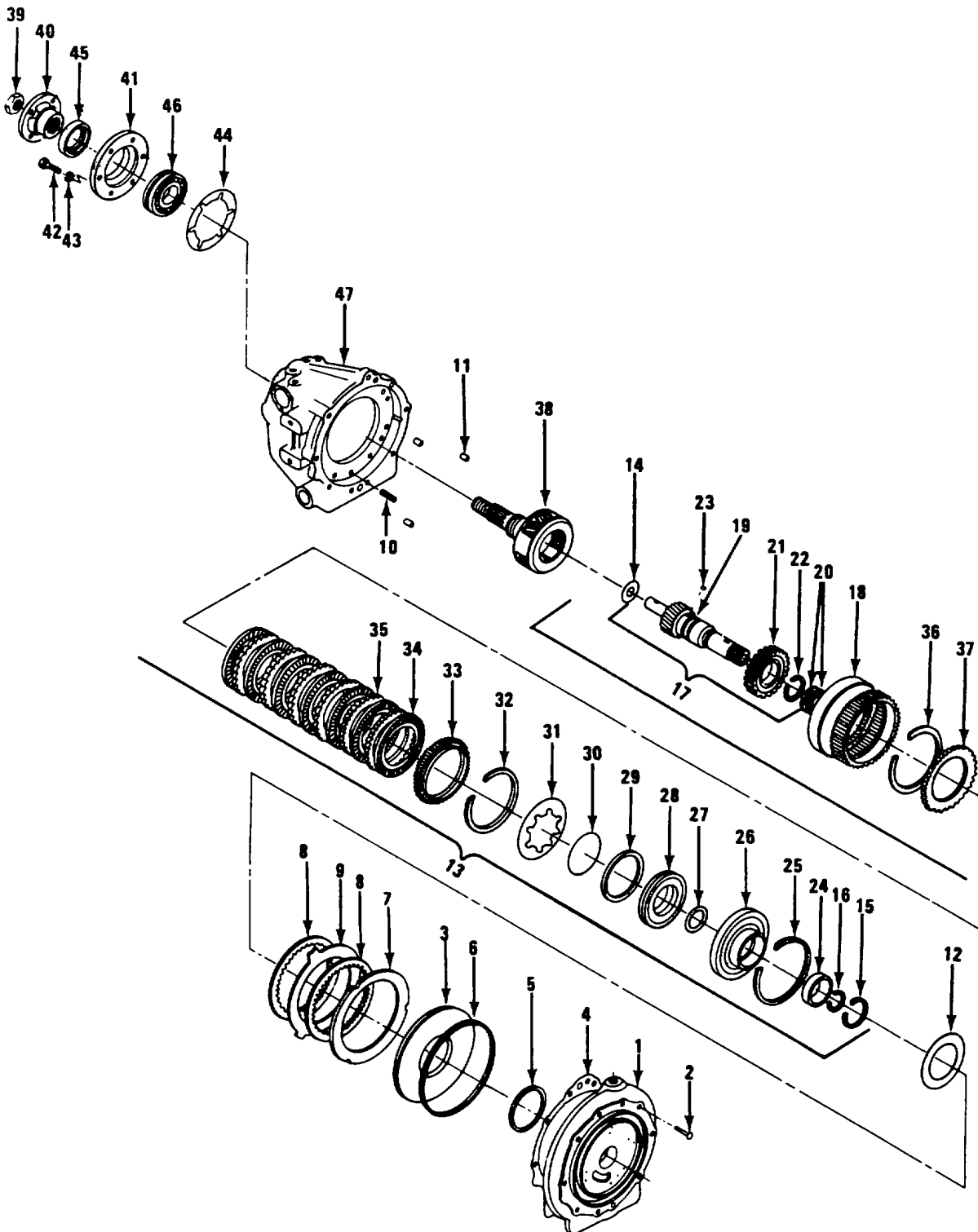
WARNING

Always use safety goggles when using dry compressed air. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.



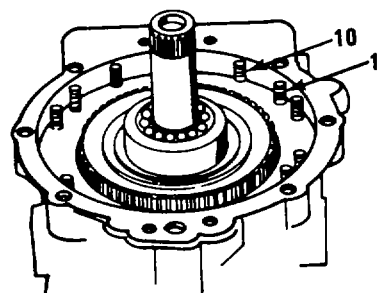
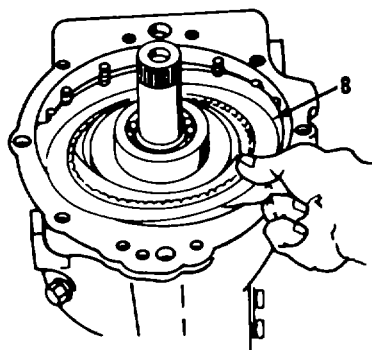
3. Adapter (1)	a. Reverse clutch piston (3)	a. Force compressed air into the large oil passage hole at either top or bottom of adapter.	Use air blow gun. Piston will pop out of cavity
		b. Remove.	
	b. Sealing ring (5)	Remove and discard.	Use small screwdriver.
4. Reverse clutch piston (3)	Sealing ring (6)	Remove from piston outer diameter and discard.	Use small screwdriver.

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

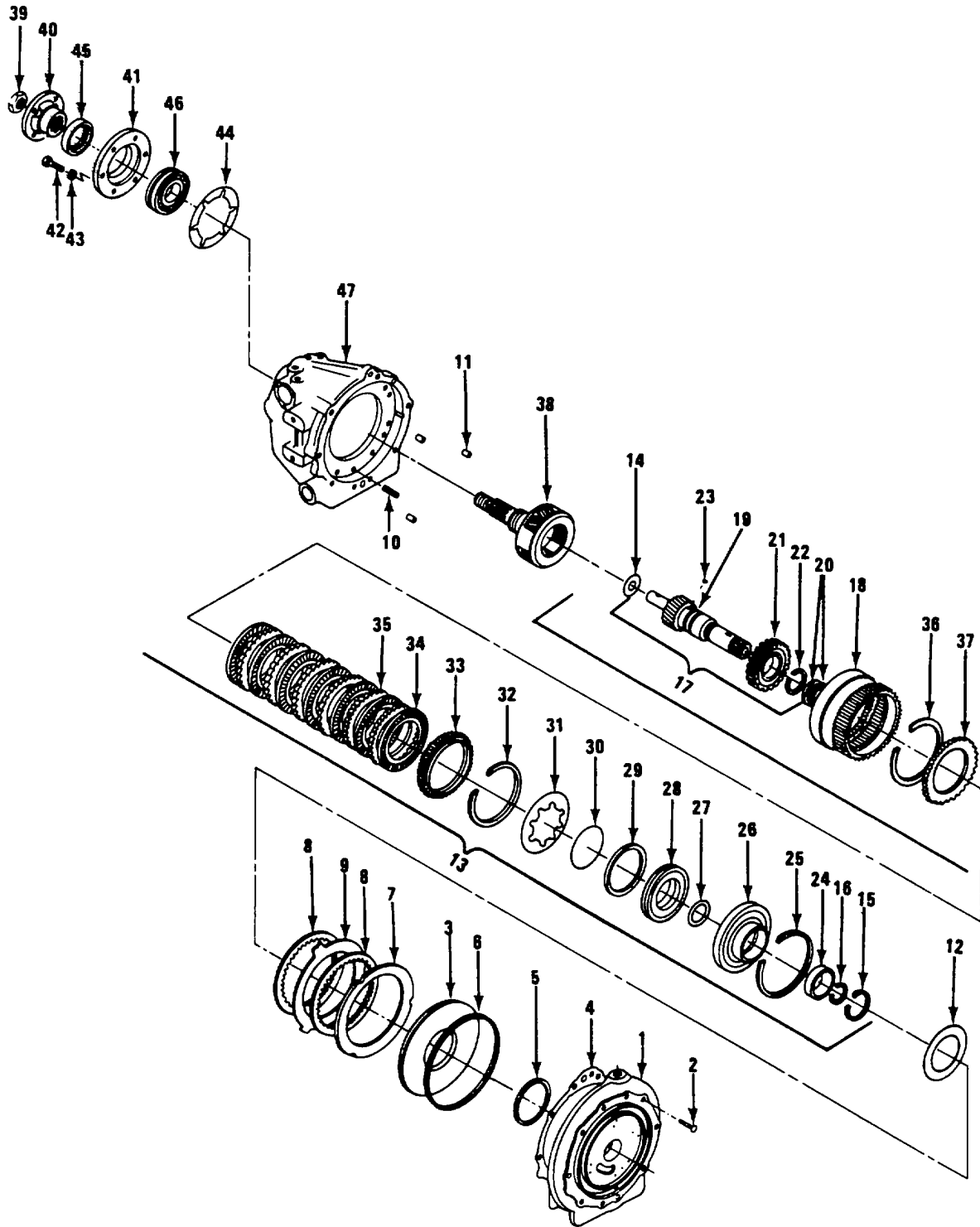


TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

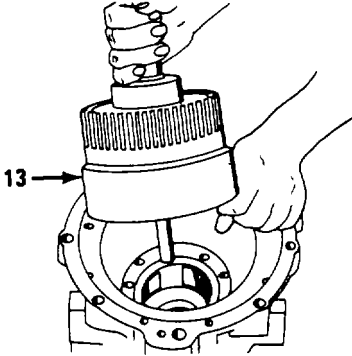
LOCATION	ITEM	ACTION	REMARKS
5. Transmission case (47)	a. Clutch pressure plate (7)	Remove.	Use hands.
	b. Reverse clutch plate (8)	Remove.	Use hands.
	c. Outer clutch plate (9)	Remove.	Use hands.
	d. Reverse clutch plate (8)	Remove.	Use hands.
	e. 12 pressure plate springs (10)	Remove.	Use hands.
	f. 3 dowel pins (11)	Remove.	Use fingers.
	g. Thrust washer (12)	Remove from forward clutch cylinder (26).	Use fingers.



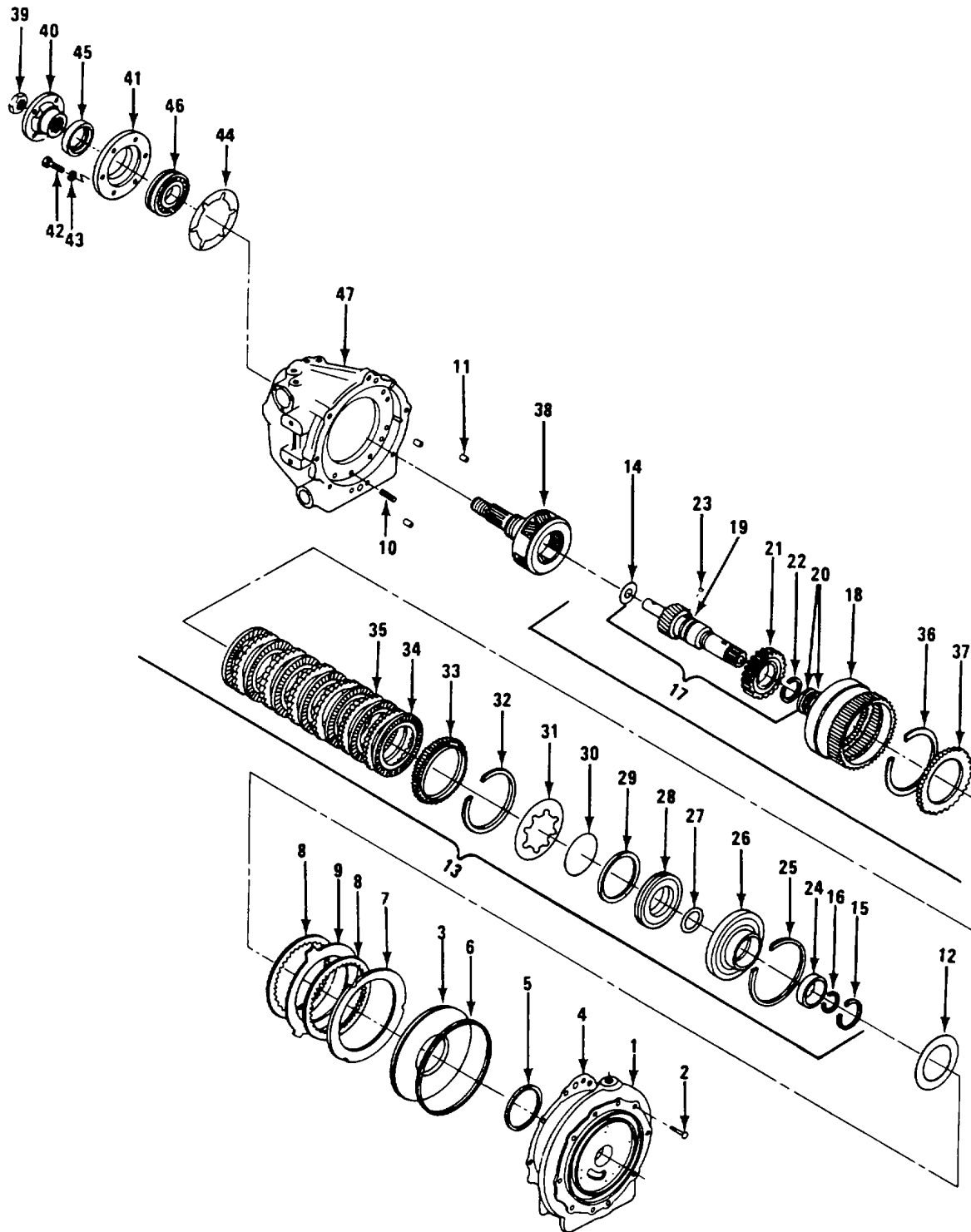
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
			
	h. Ring gear subassembly (13)	a. Remove from transmission by lifting straight up. b. Carry assembly to work bench in preparation for disassembly.	Grasp exposed front end of drive gear (shaft) and lift. Assembly should come out easily.
	i. Thrust washer (14)	Remove washer located between drive gear (19) and planetary carrier (38).	Use fingers.
<p>NOTE</p> <p>The ring gear subassembly must be placed in a suitable fixture with ball bearing end up before further disassembly is attempted.</p>			
6.	Ring gear subassembly (13)	a. Internal snap ring (15)	Remove. Use snap ring pliers.

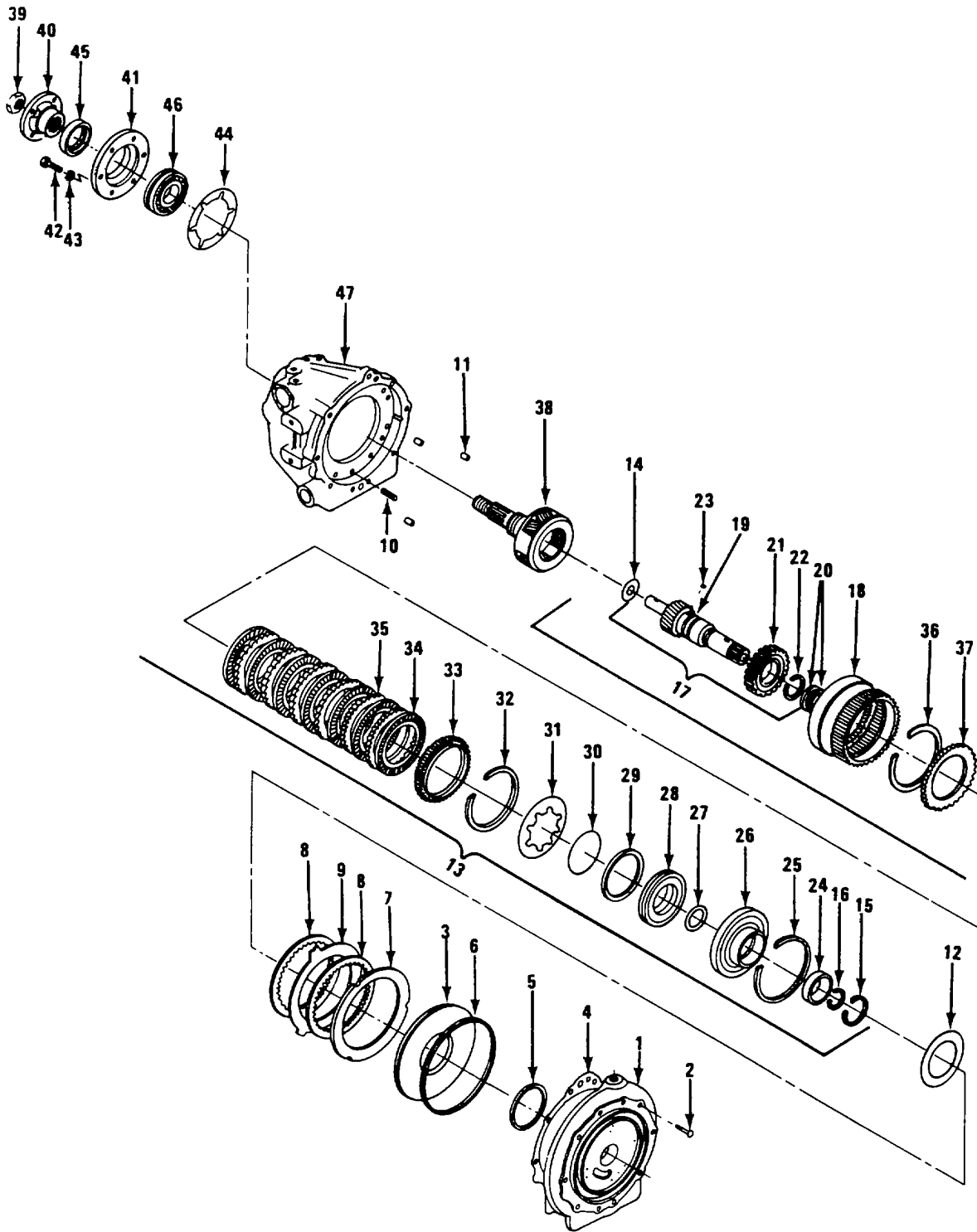
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	b. External snap ring (16)	Remove.	Use snap ring pliers. DO NOT ALLOW DRIVE GEAR TO MOVE FORWARD AFTER SNAP RING REMOVED.
	c. Drive gear and forward clutch hub assembly (17)	a. Hold ring gear (18) and tap front end of drive gear shaft (19) with non-metallic hammer. b. Remove.	Use non-metallic hammer. Assembly will pass through ring gear and forward clutch assembly to come out rear end of ring gear.
7. Drive gear shaft (19)	a. 2 sealing rings (20)	Remove and discard.	Use small screw-driver.
	b. Snap ring (21)	Remove.	Use snap ring pliers.
	c. Forward clutch hub (22)	Remove by pulling off.	Use gear puller.
	d. Woodruff key (23)	Remove.	Use fingers or pliers if stuck.
8. Ring gear (18)	a. Bearing (24)	Remove from clutch cylinder (26) by tapping with non-metallic hammer.	Use non-metallic hammer.

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

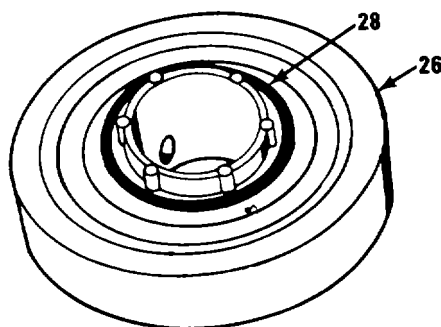


TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Ring gear snap ring (25)	Remove.	Use pliers or screwdriver.
	c. Forward clutch cylinder (26)	Hold ring gear and tap exposed face of forward clutch cylinder with soft hammer. Cylinder will move forward and can be removed.	Use non-metallic hammer.

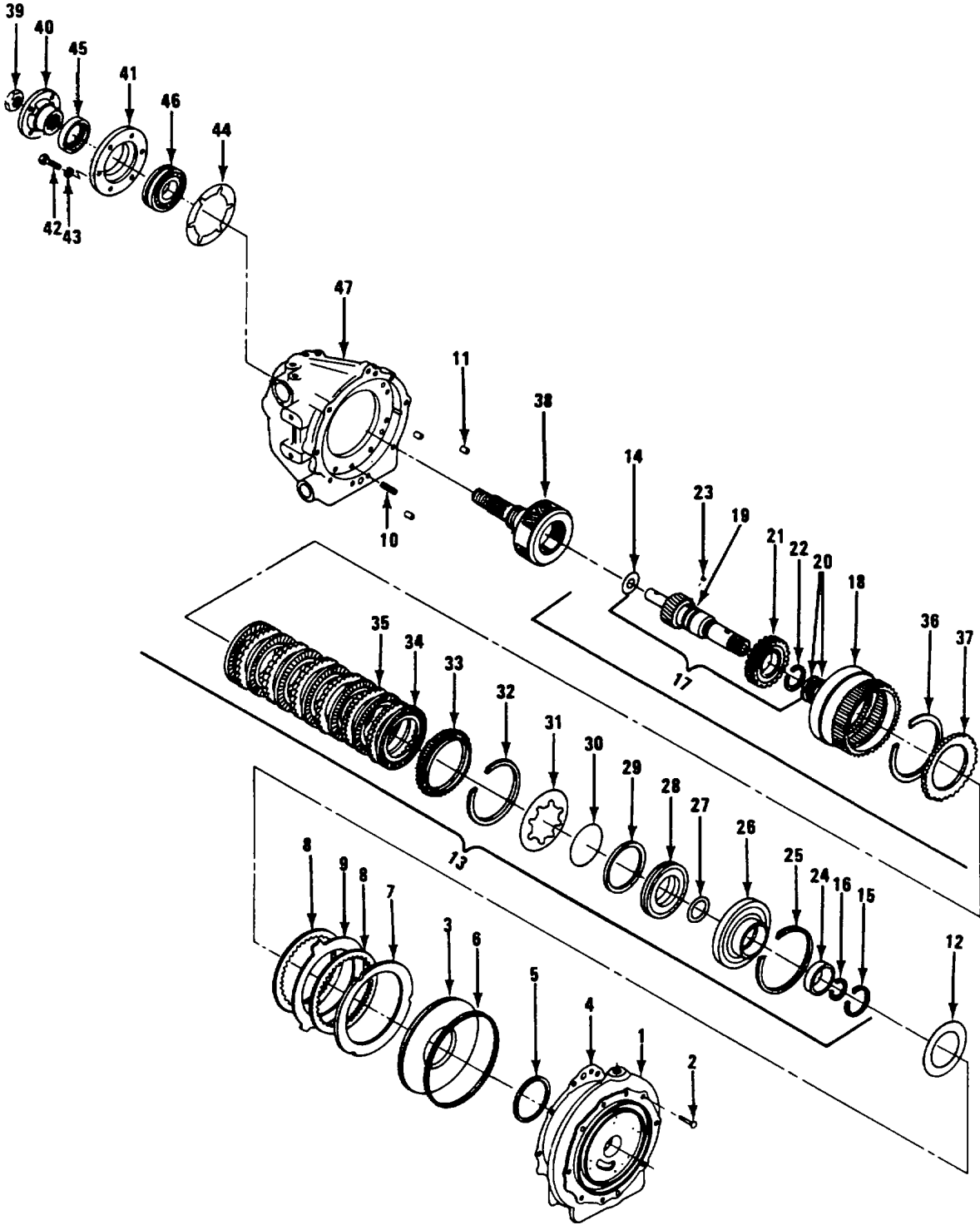
WARNING

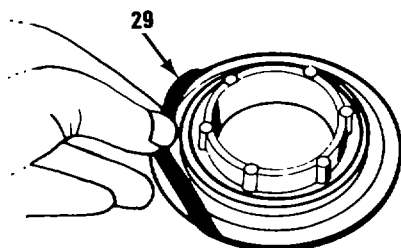
Always use safety goggles when using dry compressed air. Do not use pressures greater than 30 psi. High air pressure can cause injury and cut the skin.



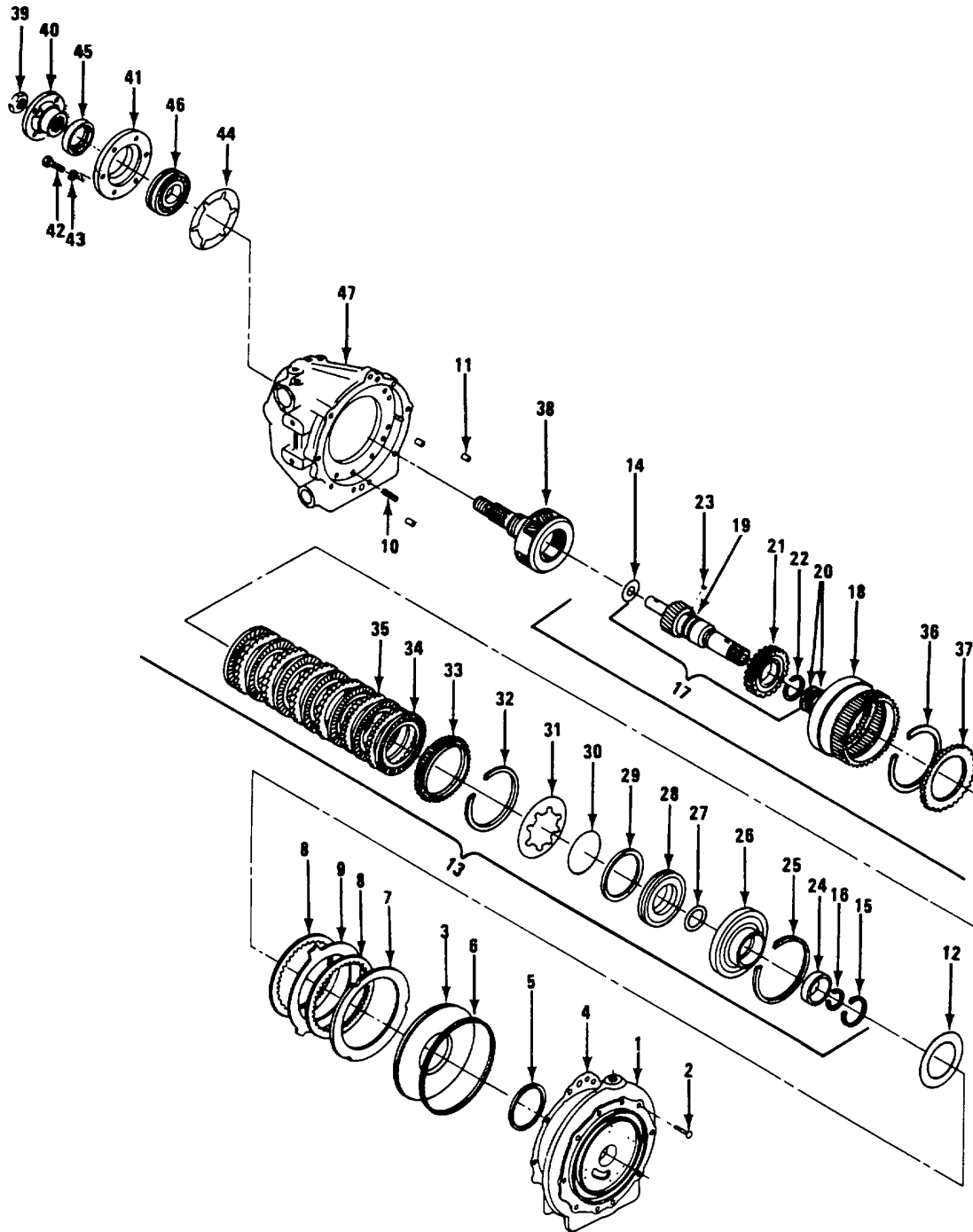
9. Forward clutch cylinder (26)	a. Forward clutch piston (28)	a. Apply compressed air through one of three holes in inside diameter of forward clutch cylinder (26) while other holes are blocked.	Use air blow gun. Hold fingers over two holes. Piston will be blown out of cylinder.
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TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
		b. Remove.	
	b. Sealing ring (27)	Remove from forward clutch cylinder cavity and discard.	Use small screwdriver.
 <p>The diagram shows a hand holding a screwdriver to pry a sealing ring, labeled '29', out of a circular component, likely a piston. The ring is being lifted from a groove on the inner surface of the component.</p>			
10. Forward clutch piston (28)	a. Sealing ring (29)	Remove from diameter of piston and discard.	Use small screwdriver.
	b. Clutch spring bearing ring (30)	Remove from face of piston and discard.	Use small screwdriver.
11. Ring gear (18)	a. Clutch spring (31)	Remove.	Use hands.
	b. Clutch spring snap ring (32)	Remove.	Use screwdriver. Ring is not located in a groove.
	c. Clutch pressure plate (front) (33)	Remove.	Use hands.

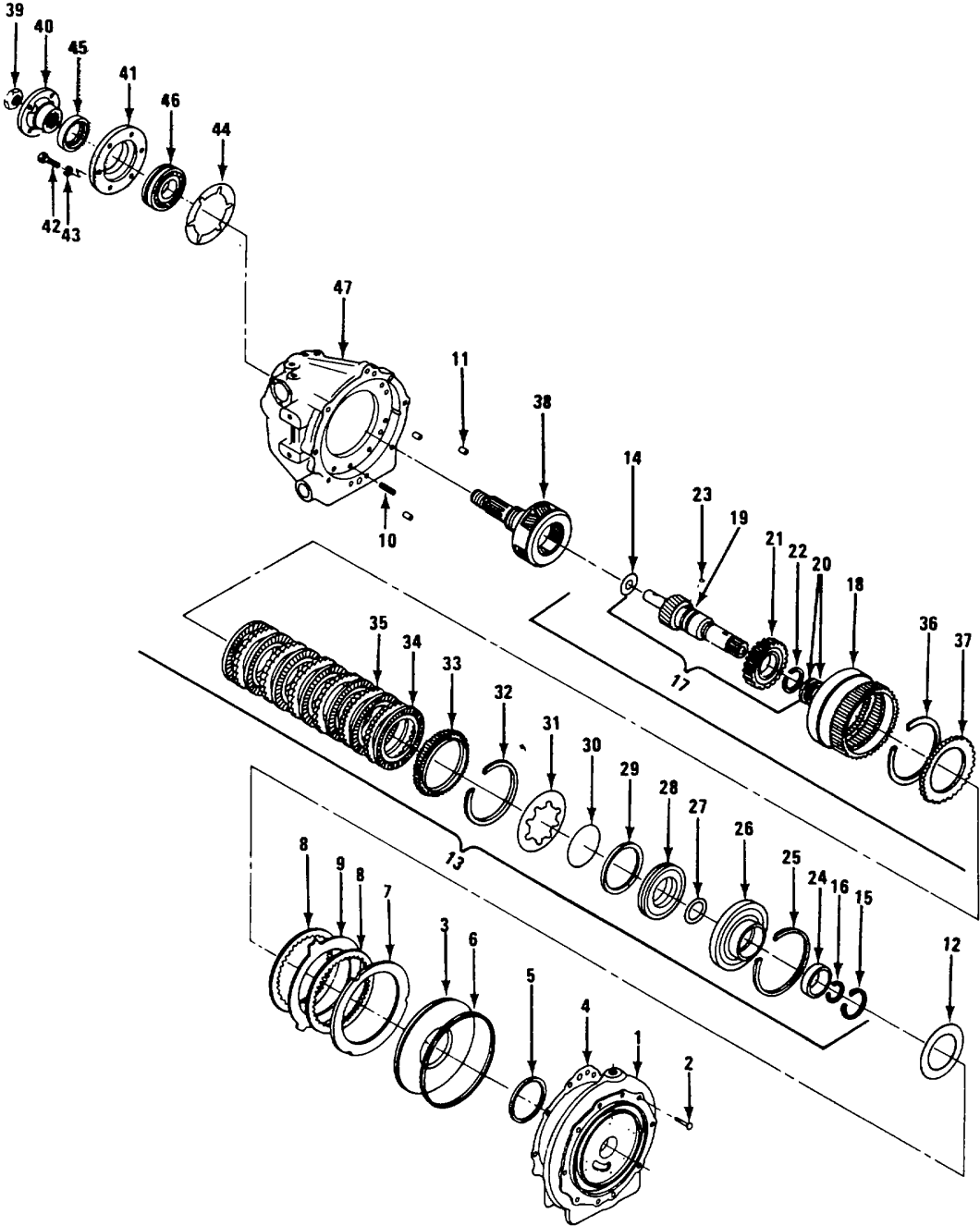
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)

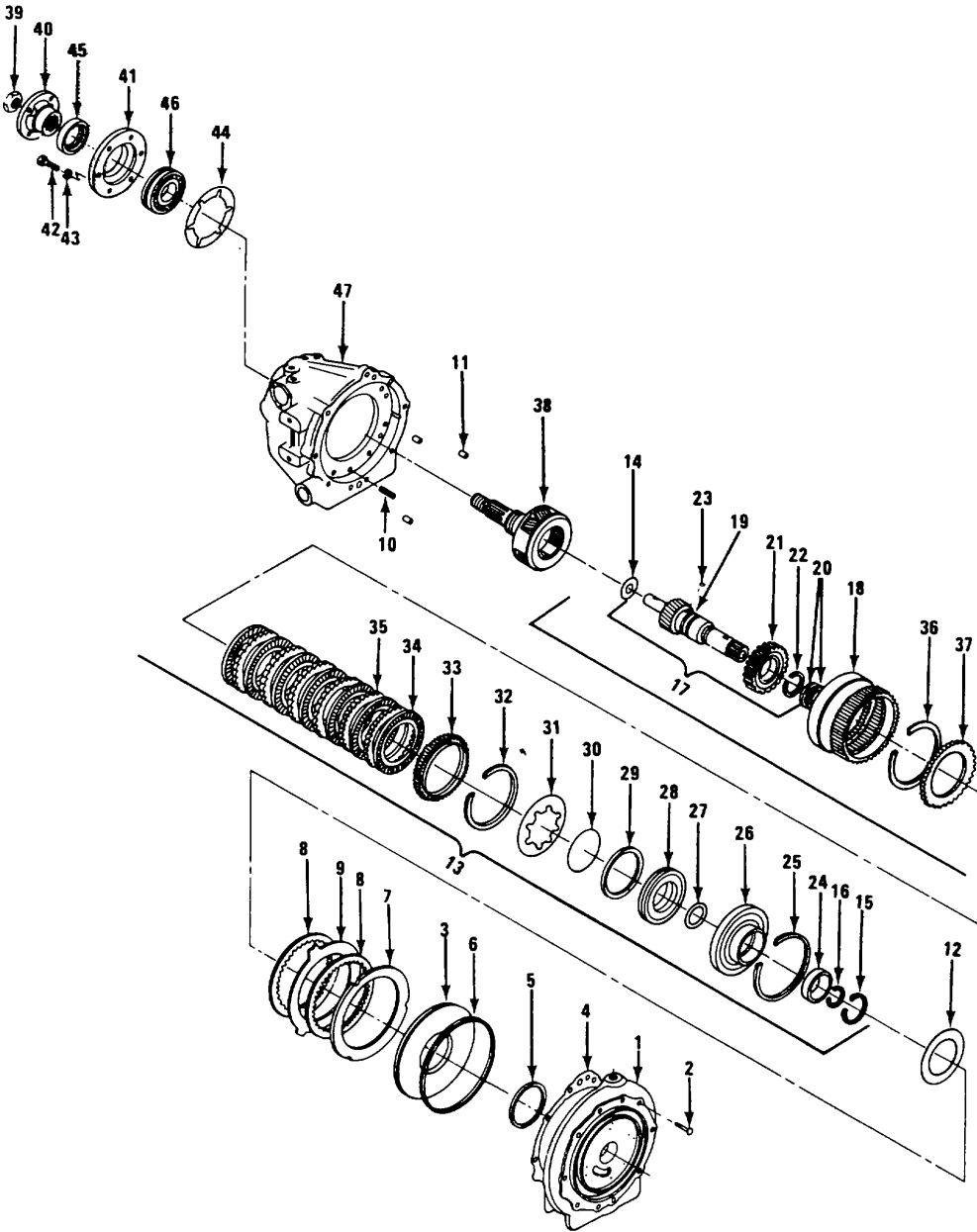
LOCATION	ITEM	ACTION	REMARKS
	d. 7 clutch inner plates (34) and 6 clutch outer plates (35)	Remove.	Use hands.
	e. Pressure plate (rear) (36)	Remove.	Use hands.
	f. Snap ring selective (37)	Remove.	Use screwdriver.
NOTE			
Transmission coupling (40) must be clamped in vise for next step.			
12. Pinion cage and output shaft (38)	a. Main shaft nut (39)	Remove.	Use 1-1/2 in socket and ratchet.
NOTE			
Remove coupling from vise and place transmission case (47) on face to continue procedures.			
	b. Coupling (40)	Pull from shaft.	Use bearing puller.
13. Bearing retainer (41)	6 bolts (42) and lockwashers (43)	Remove.	Use 5/8 in socket with ratchet.
14. Transmission case (47)	Bearing retainer (41) and gasket (44)	a. Remove. b. Discard gasket.	

TRANSMISSION REPAIR INSTRUCTIONS (Continued)



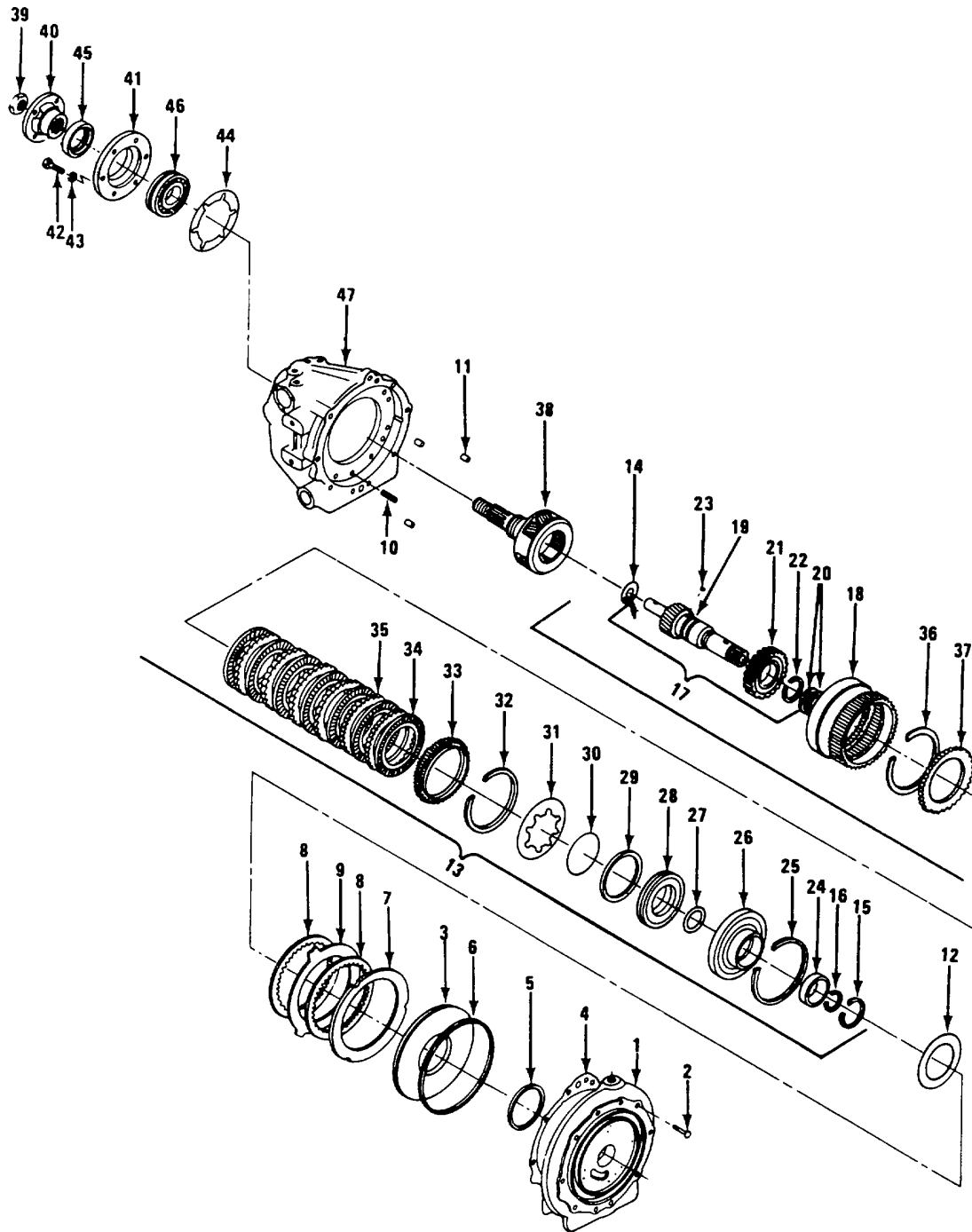
TRANSMISSION REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
15. Bearing retainer (41)	Seal (45)	Remove.	Use seal puller.
CAUTION			
Before performing next step place cushioning material under transmission case for pinion cage and output shaft (38) to fall on when pushed out.			
16. Pinion cage and output shaft (38)	Annular bearing (46)	Push shaft out of bearing.	Use bearing puller to grasp bearing by exposed groove in outside diameter. Pinion cage and output shaft will be pushed out of bearing.
17. Transmission case (47)	Annular bearing (46)	Remove from case.	Case may have to be turned and bearing tapped gently with hammer handle to loosen.
NOTE			
Lift transmission case (47) from pinion cage and output shaft (38) and place on base.			
<u>INSPECTION</u>			
18.	Bearings	a. Visually inspect for Chips, Cracks, or Discoloration.	

TRANSMISSION REPAIR INSTRUCTIONS (Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
19.	Gears, splines	<p>b. Replace any bearing found to have chips, cracks, or discoloration.</p> <p>a. Visually inspect for Burrs or Nicks.</p> <p>b. Remove small burrs with fine stone.</p> <p>c. Replace if gear or spline is nicked or burred.</p>	
20.	Shafts	<p>a. Visually inspect for Scratches or Scouring.</p> <p>b. Replace any shaft that is scratched or scoured.</p>	
21.	Clutches	<p>a. Visually inspect metal clutch plates for Scouring.</p> <p>b. Replace any scoured metal plates.</p>	

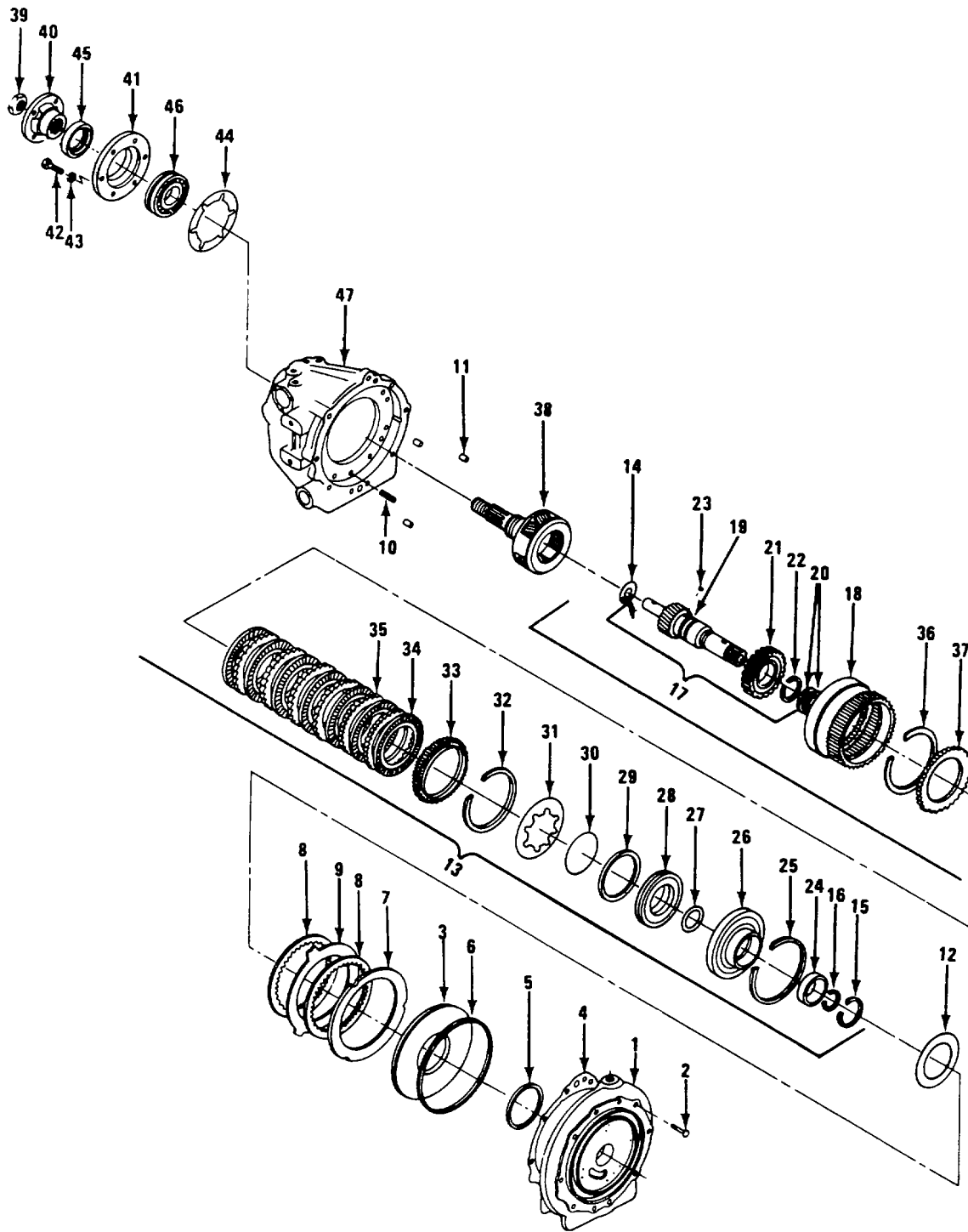
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



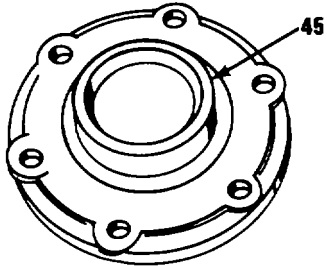
TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
22.	Rear coupling		c. Visually inspect non-metallic clutches for Glazing or Tearing.
			d. Replace any glazed or torn non-metallic plates.
			a. Visually inspect hub diameter for Scratches or Burrs.
			b. Replace if defective.
23.	Forward clutch piston		a. Visually inspect inner diameter for Burrs or Scratches.
			b. Remove burrs. Use crocus cloth. or scratches.

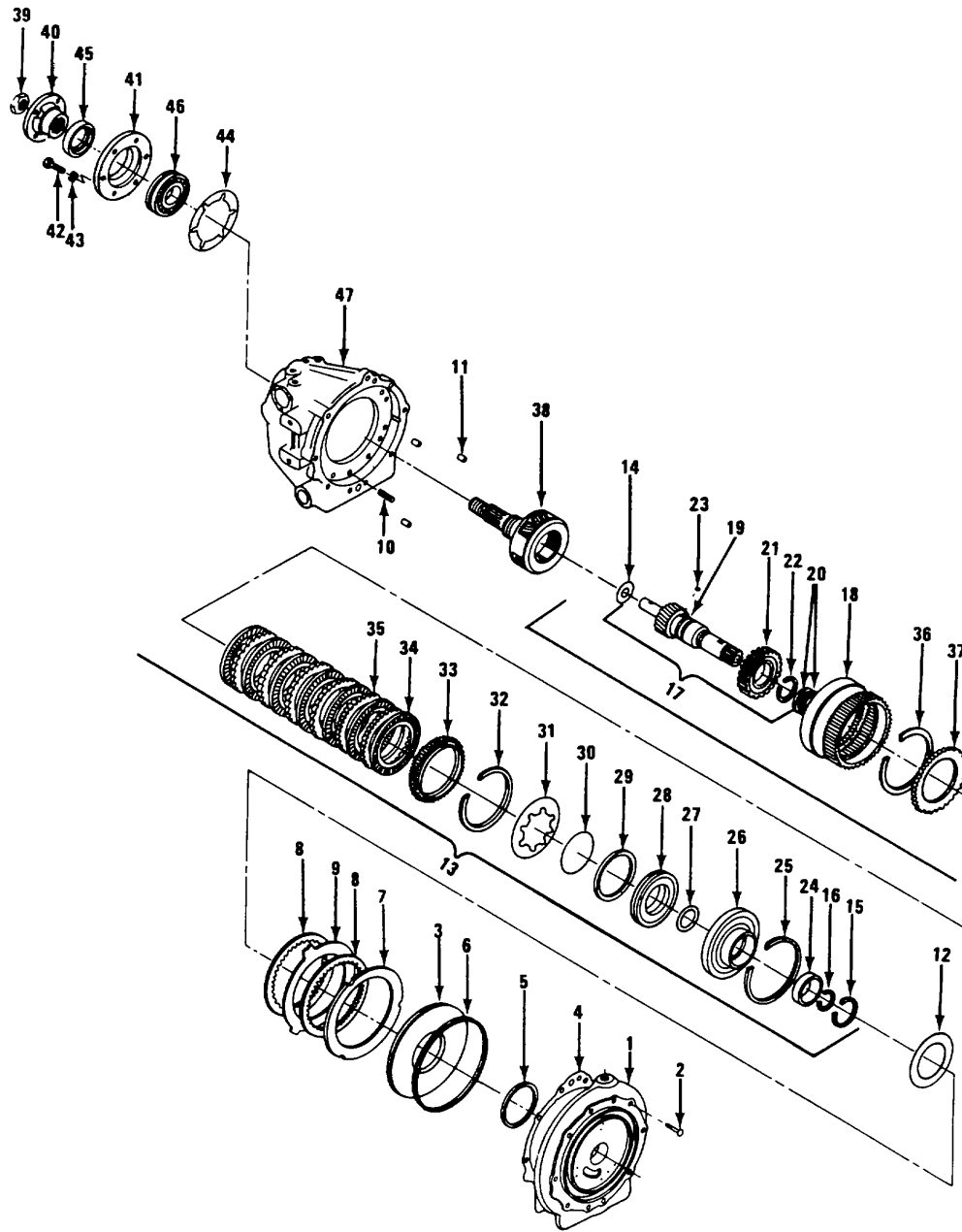
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)

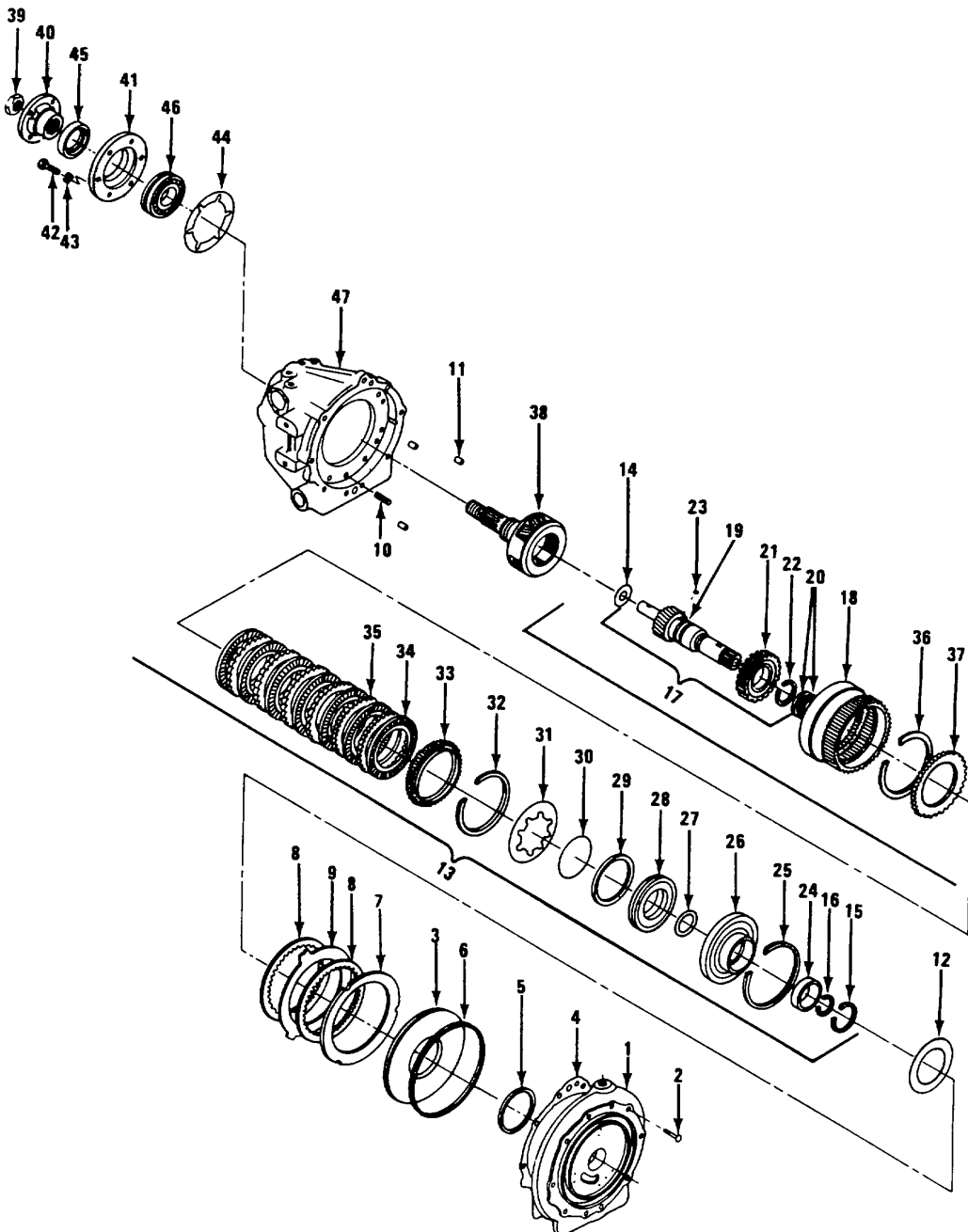
LOCATION	ITEM	ACTION	REMARKS
<u>ASSEMBLY</u>			
			
24. Bearing retainer (41)	Oil seal (45)	<p>a. Place front face of retainer on arbor press table.</p> <p>b. Apply sealant to outside diameter of seal.</p> <p>c. Place seal squarely into bore of retainer with seal lip down.</p> <p>d. Press seal into retainer until rear face of seal is flush with retainer rear face.</p>	Use arbor press and bearing assembly tool of correct size.

TRANSMISSION REPAIR INSTRUCTIONS (Continued)



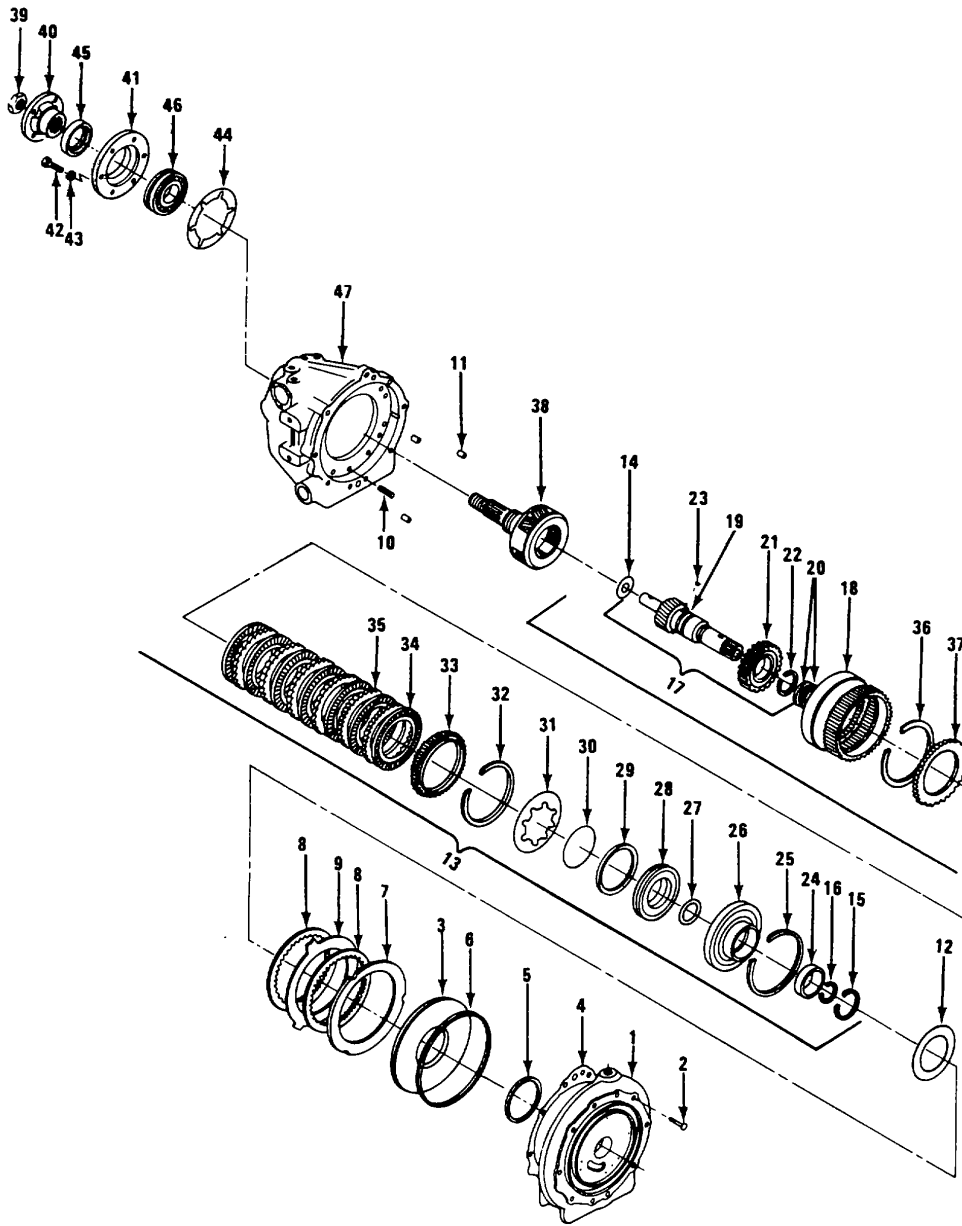
TRANSMISSION REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
25. Arbor press table	a. Pinion cage and output shaft assembly (38)	Place assembly with shaft pointing upward on 5 in diameter 2-7/8 in long assembly tool which is resting on arbor press table.	Use bearing assembly tool.
	b. Transmission case (47)	Place case over shaft and tool so case rests squarely on arbor press table.	
26. Pinion cage and shaft assembly (38)	Annular bearing (46)	a. Lubricate all parts with clean engine oil before assembly. Move case as necessary to align shaft, bearing and case.	Use arbor press and bearing assembly tool which is locally fabricated (refer to Appendix C).
		b. Place bearing with groove in outer diameter away from transmission case over shaft and squarely in bearing bore on case.	
		c. Press bearing down until seated against shaft or case shoulder.	

TRANSMISSION REPAIR INSTRUCTIONS (Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)			
LOCATION	ITEM	ACTION	REMARKS
27. Transmission case (47)	a. Bearing retainer gasket (44)	Smear with petroleum jelly and position on case.	Arbor press must be raised.
	b. Bearing retainer (41)	Position over bearing (46).	
28. Bearing retainer (41)	6 lockwashers (43) and 6 bolts (42)	Install and torque to 42 - 50 ft-lb.	
29. Pinion cage and output shaft (38)	a. Coupling (40)	a. Lubricate all surfaces with clean engine oil.	
		b. Assemble splined portion of coupling onto splined portion of output shaft by hand as far as possible.	
		c. Gently press coupling onto shaft until contact with bearing inner race is made.	Use arbor press.
NOTE			
Case with pinion cage and output shaft assembly may now be removed from arbor press table. Coupling flange should be clamped in vise to secure it for next step.			

TRANSMISSION REPAIR INSTRUCTIONS (Continued)

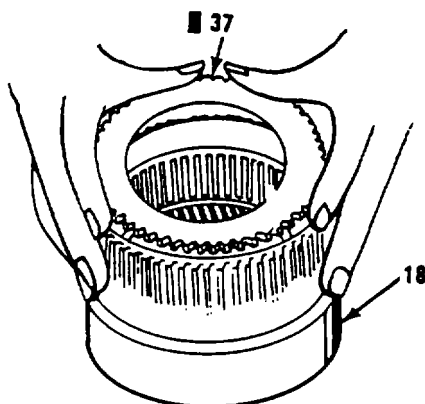


TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Main shaft nut (39)	a. Install and torque to 140 - 150 ft-lb. b. After tightening remove assembly from vise.	There should be no detectable end play in coupling-output shaft combination.

NOTE

Transmission case-pinion cage output shaft subassembly should be placed on work surface with face up and resting on coupling face to be ready for further assembly.



30. Ring gear (18)

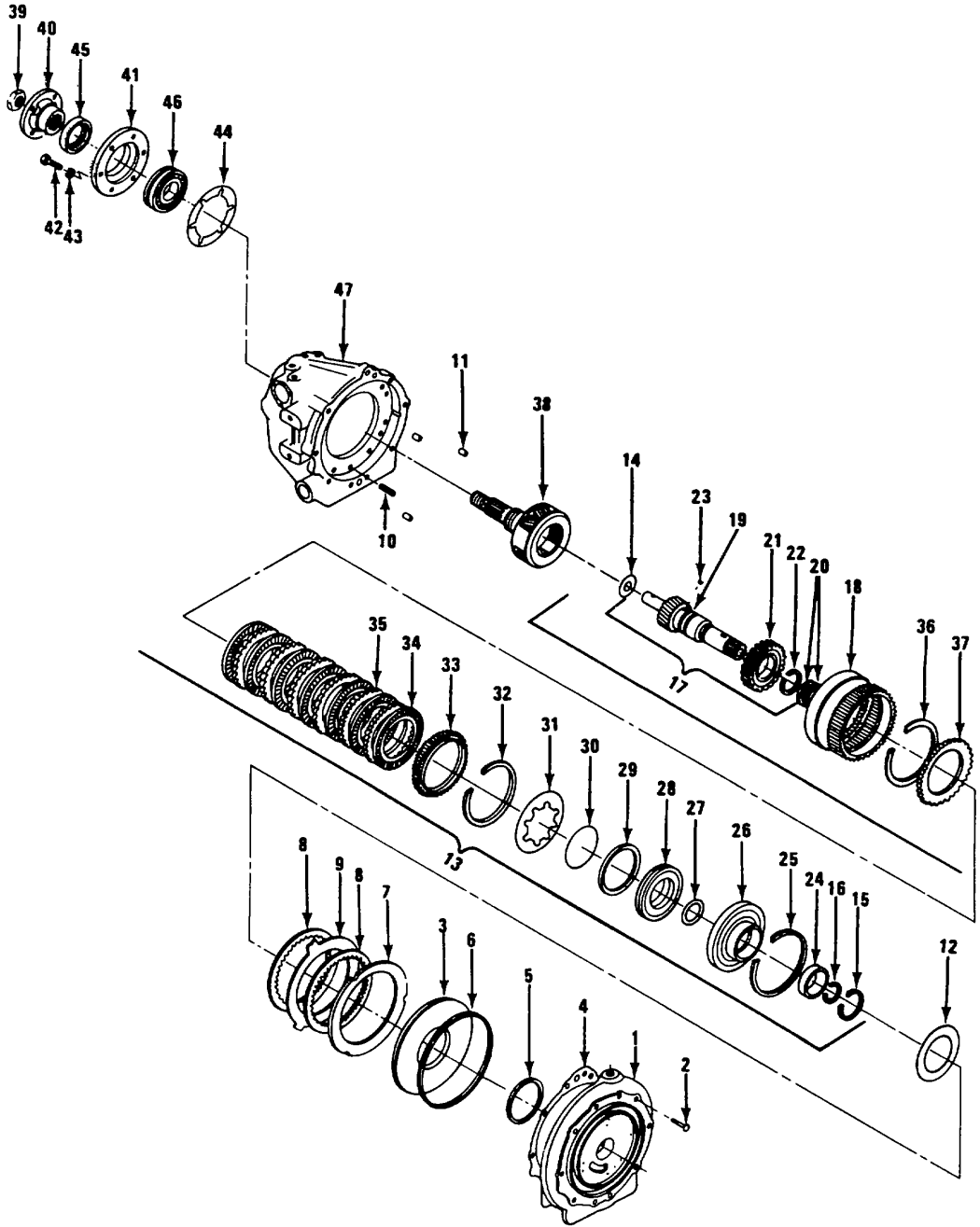
a. Clutch pressure plate should (rear) (37)

a. Place ring gear on clean surface with external teeth up.

b. Place clutch pressure plate, smoothly ground face up, into ring gear

The clutch pressure seat firmly and squarely on shoulder at bottom of internal splines. This is above internal helical teeth.

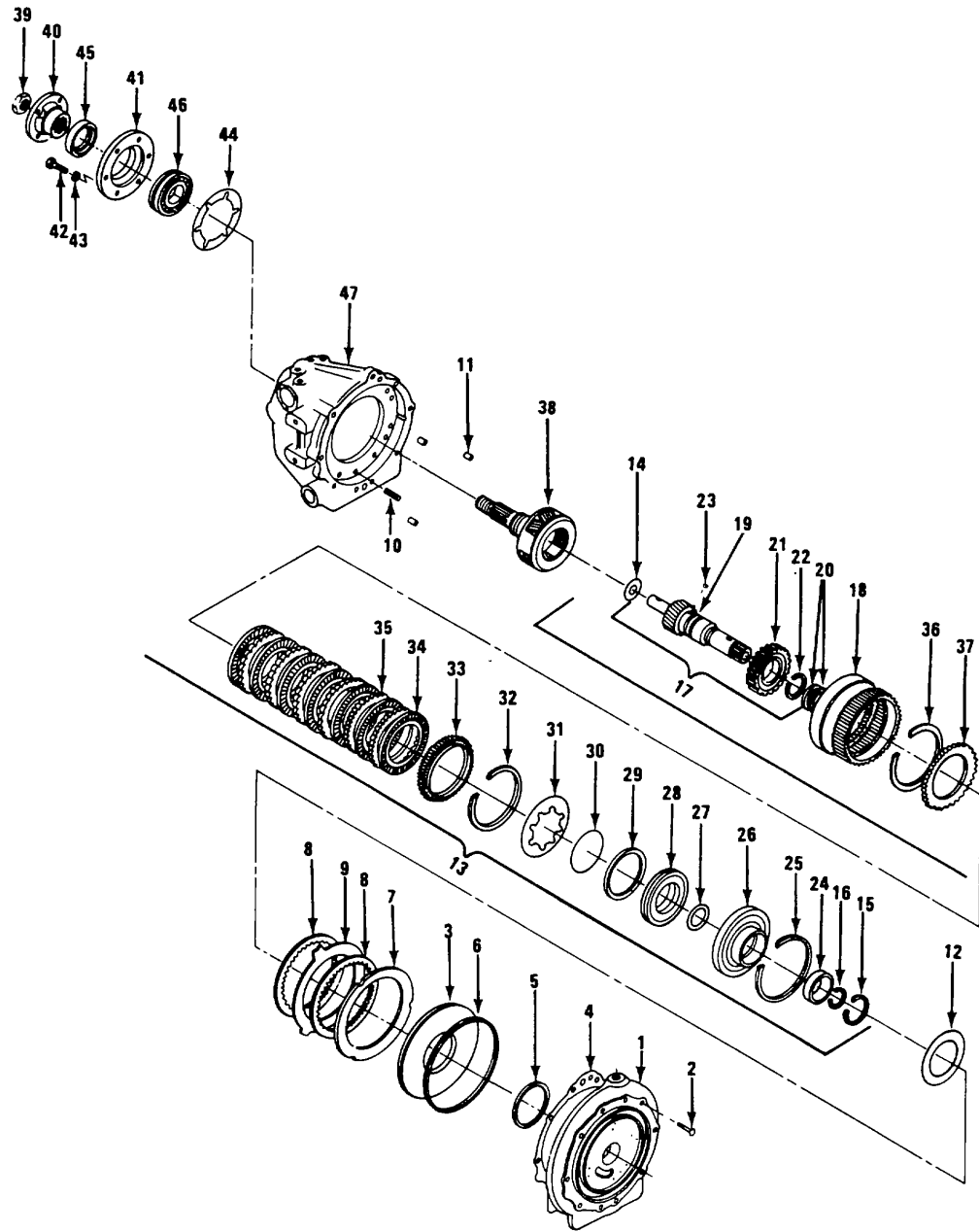
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



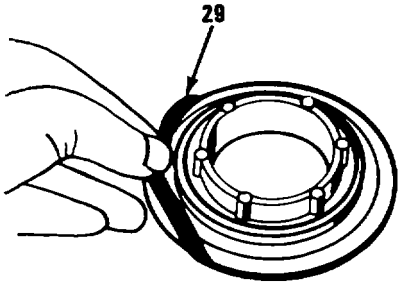
TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Clutch inner plates (34) and clutch outer plates (35)	<p>a. Lubricate all plates with clean engine oil.</p> <p>b. Starting with an inner plate alternately install inner plates - outer plates in sandwich fashion.</p>	Use 7 inner plates and 6 outer plates. Start and end with inner plate.
	c. Clutch pressure plate (front) (33)	Install with smooth face down in contact with clutch inner plate.	
	d. Clutch spring snap ring (32)	Install.	This ring seats on internal splines, not into ring groove. Snap ring is .090 to .093 inches thick and has free diameter 5-19/32 in + 1/16 in. BE SURE YOU HAVE RIGHT RING.
	e. Clutch spring (31)	Install with concave side down and seat firmly on snap ring.	Domed side is up.

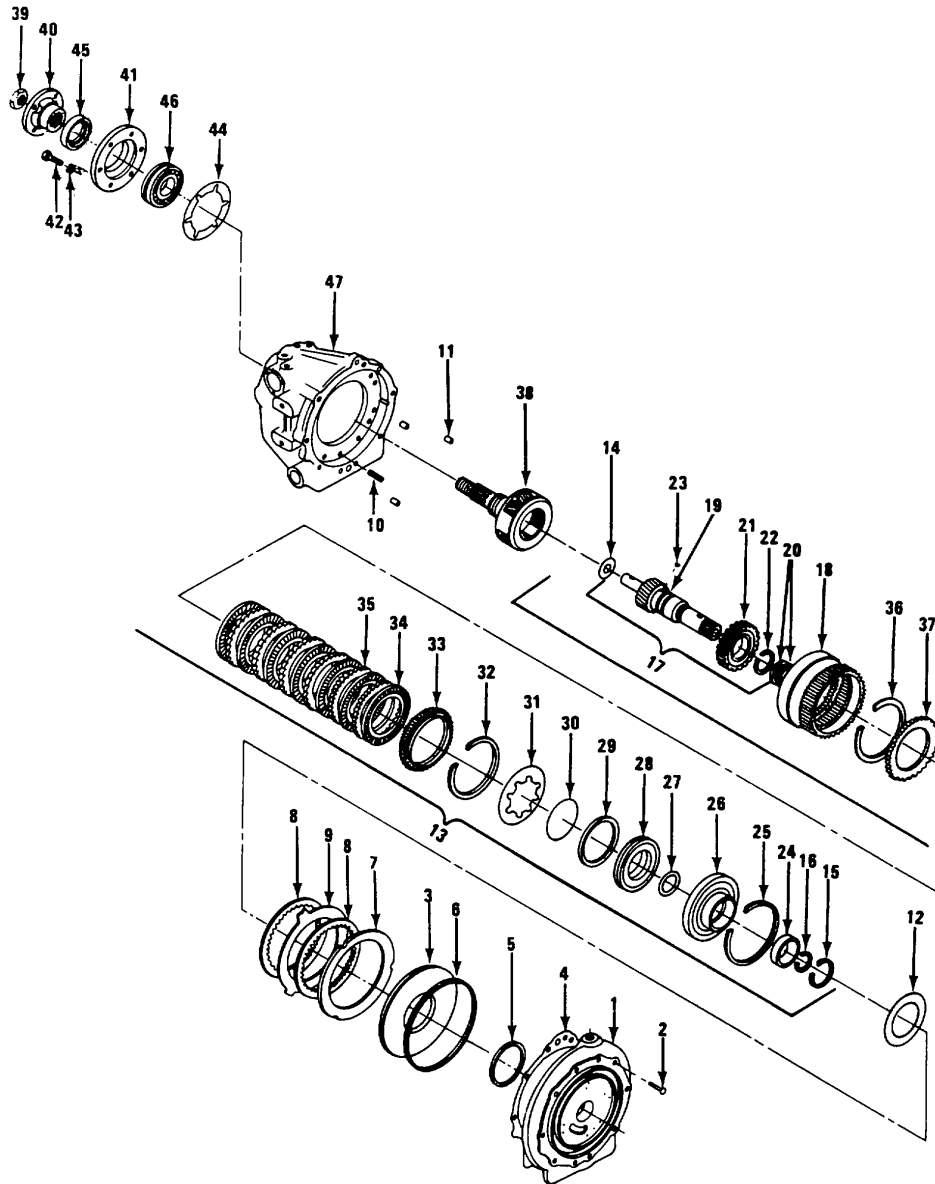
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
			
<p>31. Forward clutch piston (28)</p>	<p>a. Clutch spring bearing ring (30)</p>	<p>a. Lubricate with clean engine oil.</p> <p>b. Install in groove in piston face.</p>	
	<p>b. Clutch sealing ring (29)</p>	<p>a. Lubricate with clean engine oil.</p> <p>b. Install in piston outer diameter groove.</p>	
<p>32. Forward clutch cylinder (26)</p>	<p>a. Sealing ring (27)</p>	<p>a. Lubricate with clean engine oil.</p> <p>b. Install in groove in forward clutch, cylinder cavity.</p>	

TRANSMISSION REPAIR INSTRUCTIONS (Continued)

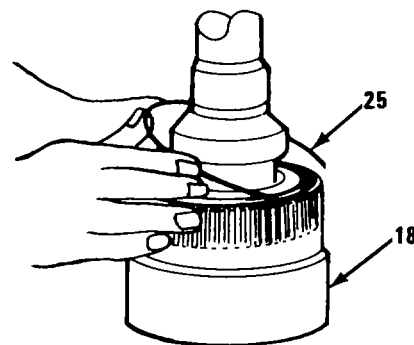
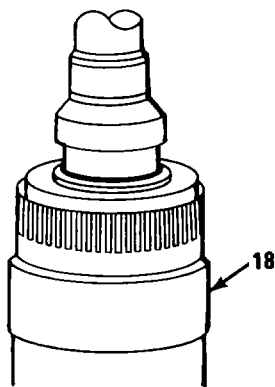


TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Forward clutch piston (28)	a. Aline piston squarely on forward clutch cylinder. b. Press piston into cylinder cavity making sure forward clutch cylinder sealing ring (27) remains in place.	This is hand assembled and requires no hammering or pressing. Piston will bottom in forward clutch cylinder.

NOTE

Take subassembly put together in step 30 and place on arbor press table.



33. Ring gear (18) subassembly

a. Clutch spring (31)

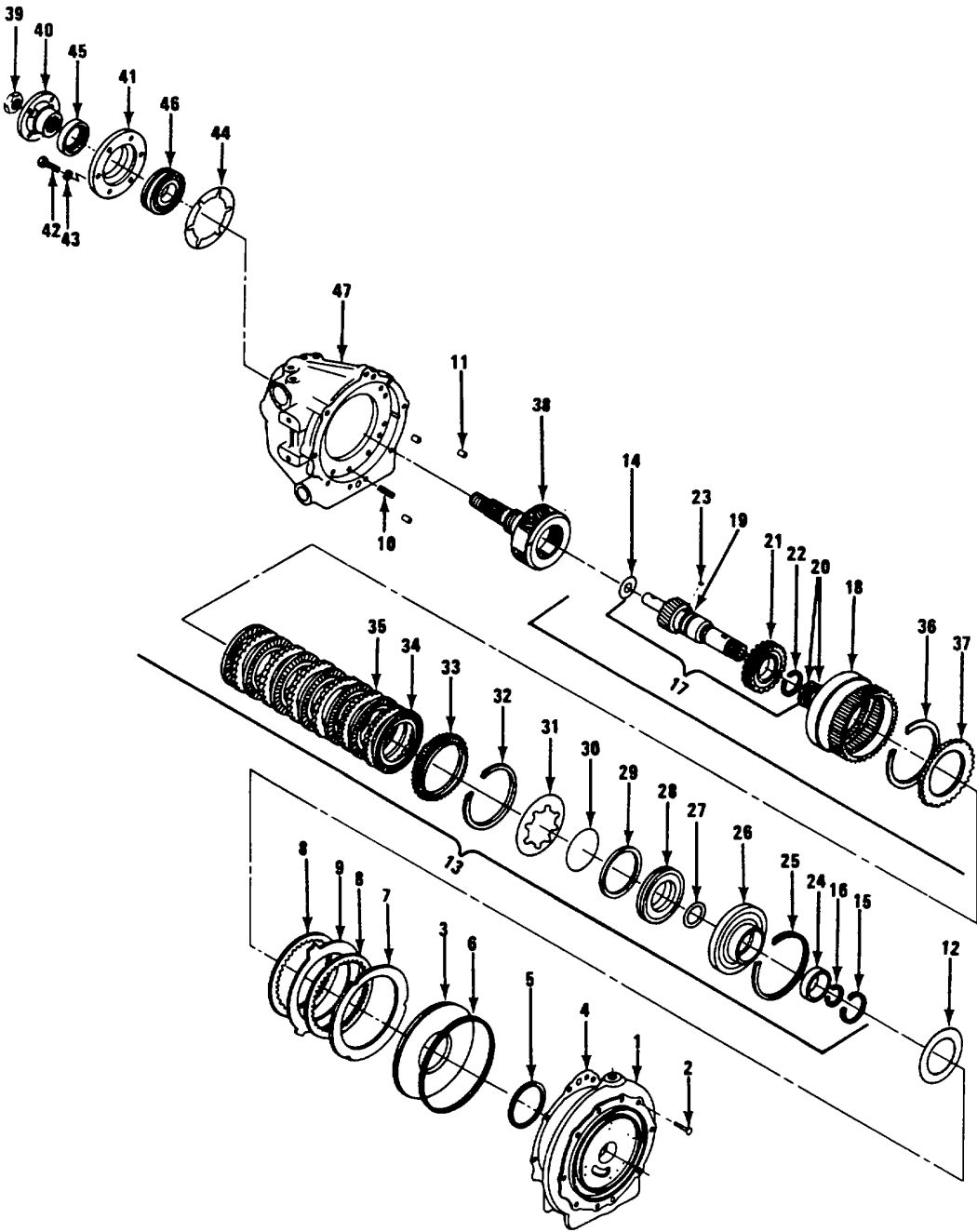
Center in ring gear.

b. Forward clutch cylinder (26) as assembled in step 31

a. Place in open top of ring gear.

The clutch spring bearing ring (30) in face of clutch cylinder piston (28) must face down and come in contact with

TRANSMISSION REPAIR INSTRUCTIONS (Continued)



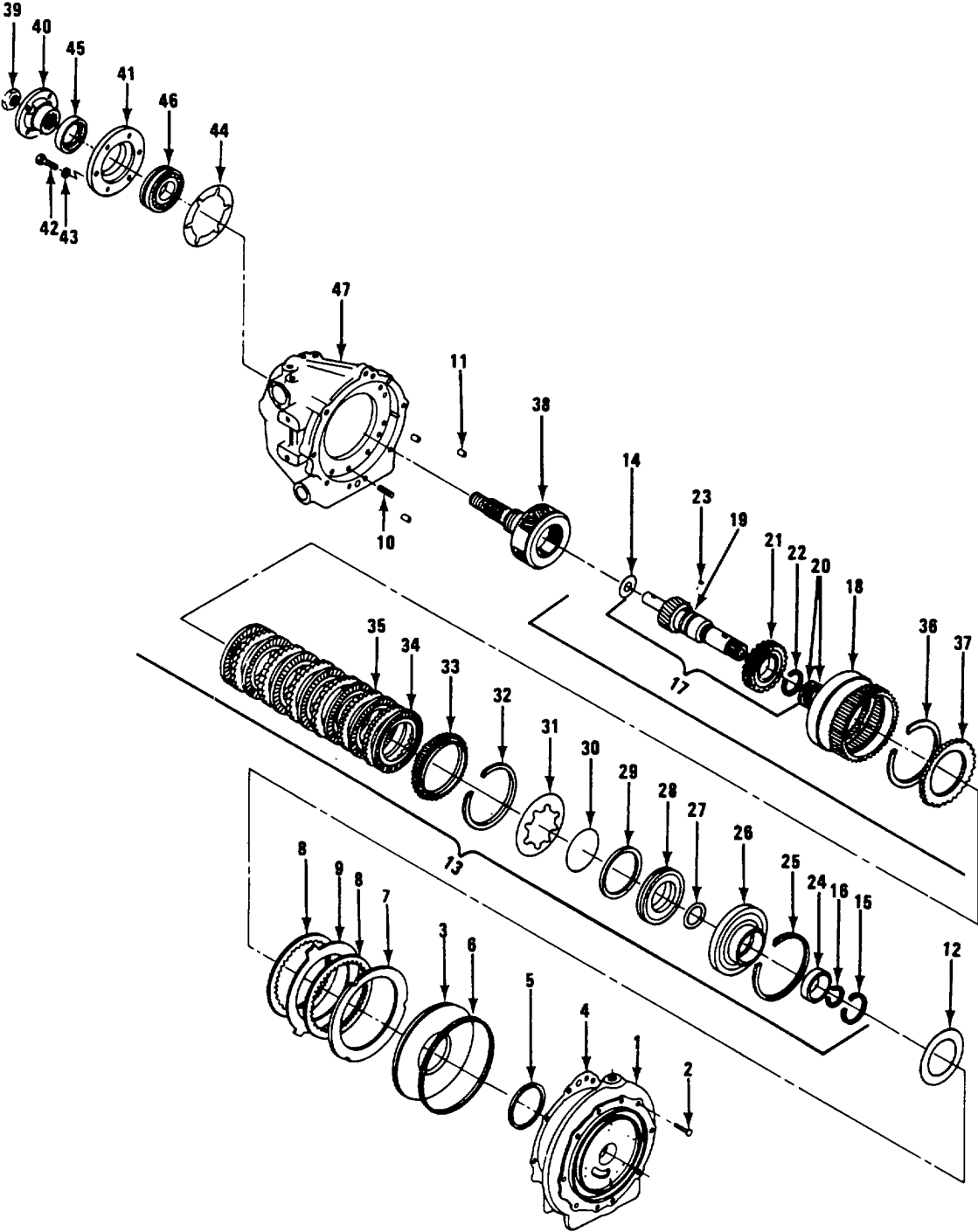
TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
		<p>b. Place assembly tool squarely on top of forward clutch cylinder and press down until the forward clutch cylinder is firmly seated on the clutch spring snap ring (32) and the gear snap ring groove is exposed.</p>	<p>clutch spring (31). Assembly tool must fit over the collar on forward clutch cylinder and set squarely on cylinder body.</p>
	<p>c. Ring gear snap ring (25)</p>	<p>Install and tap to make sure ring seats in groove.</p>	<p>Use non-metallic hammer. Snap ring is .074 to .078 inches (1.89 to 1.99 mm) thick and has free diameter of 5-7/8 in + 1/16 in. BE SURE YOU HAVE RIGHT SNAP RING.</p>

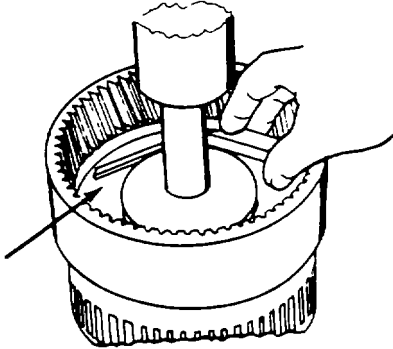
NOTE

The ring gear subassembly must be turned over at this point. The external splines will now be on the bottom rather than the top.

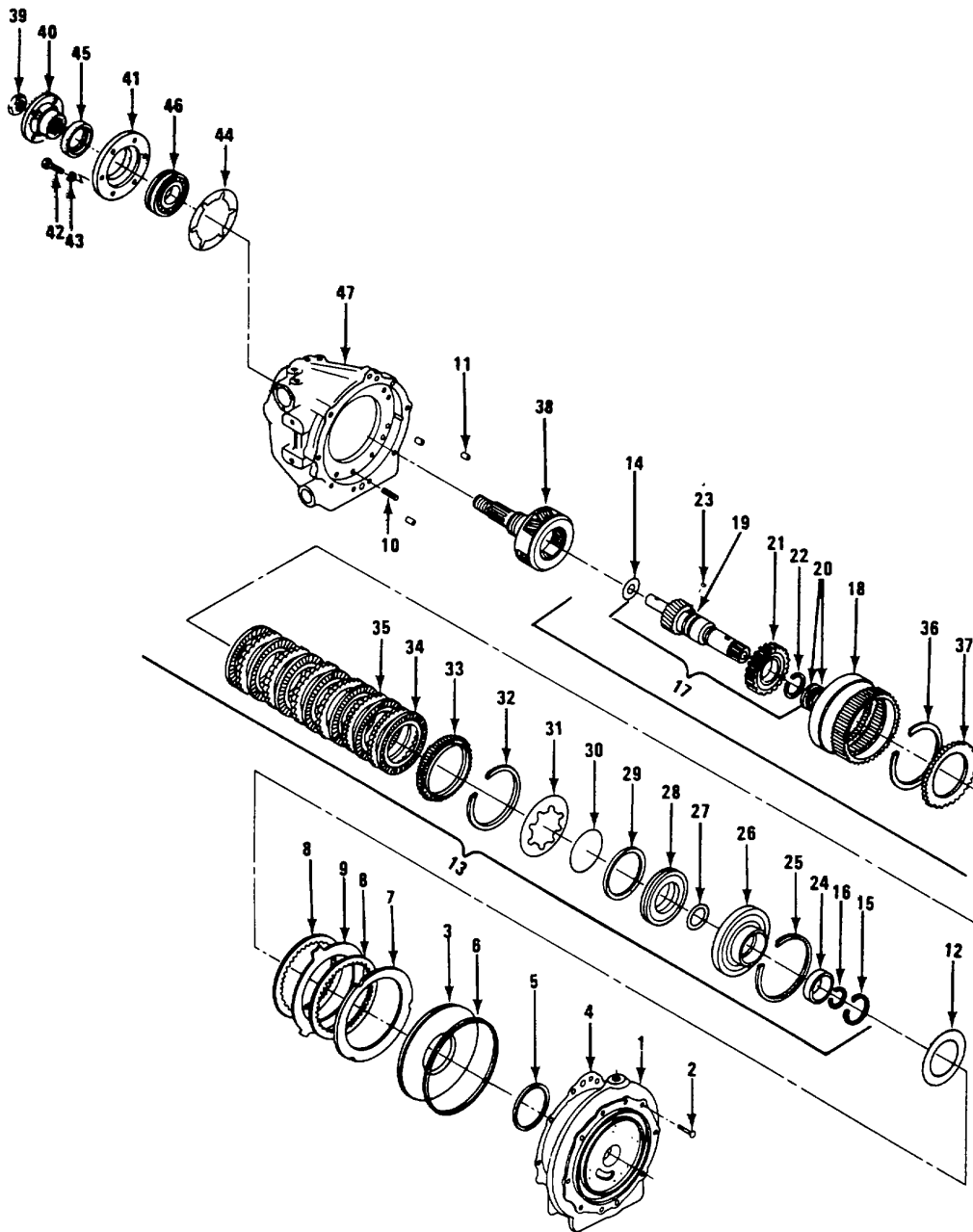
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



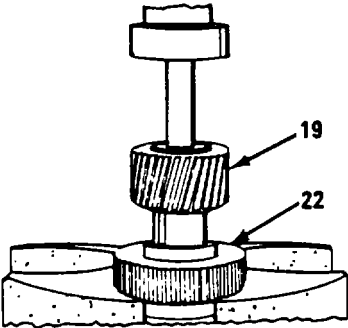
TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
	<p>d. Clutch pressure plate (rear) (37)</p>	<p>a. Place assembly tool on plate and press down on plate.</p>	<p>This will compress the clutch plates and pressure plates against clutch snap ring.</p>
		<p>b. Measure the gap between snap ring groove shoulder and pressure plate.</p>	<p>Use feeler gage to measure gap.</p>
		<p>c. Select one or more selective snap rings so as to obtain a clearance of .040 - .065 inches (.102 - .175 mm) between snap rings and the pressure plate.</p>	<p>The selective snap ring has a free diameter of 5-11/16 inches. The rings are variable in thickness and color coded as follows: Green - .050 - .054 inches (.127 to .137 mm) thick; Orange - .074 - .078</p>

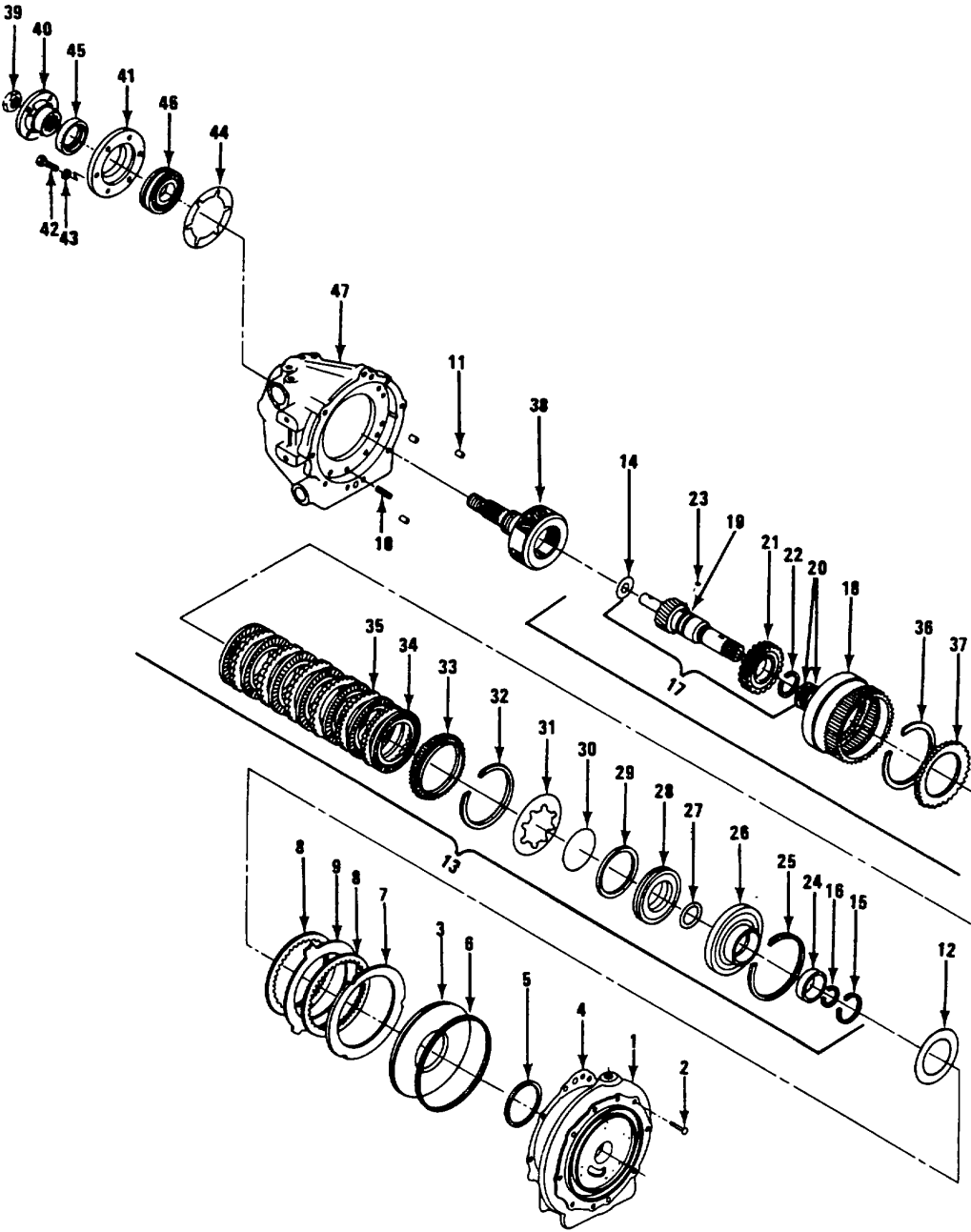
TRANSMISSION REPAIR INSTRUCTIONS (Continued)



TRANSMISSION REPAIR INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
			<p>inches (.188 to .198 mm) thick; Blue - .084 - .088 inches (.213 to .223 mm) thick; White - .096 - .100 inches (.244 to .254 mm) thick.</p>
	e. Snap ring selective (36)	Install and tap to make sure ring seats in groove.	Use non-metallic hammer.
34. Arbor press table	Forward clutch hub (22)	Place on suitable support.	Support must have opening allowing shaft to be pressed through hub.
35. Drive gear (19)	Woodruff key (23)	Put into keyway on drive gear.	
			
36. Forward clutch hub (22)	Drive gear (19)	a. Lubricate gear with clean engine oil.	Use arbor press to press drive gear into forward clutch hub.

TRANSMISSION REPAIR INSTRUCTIONS (Continued)

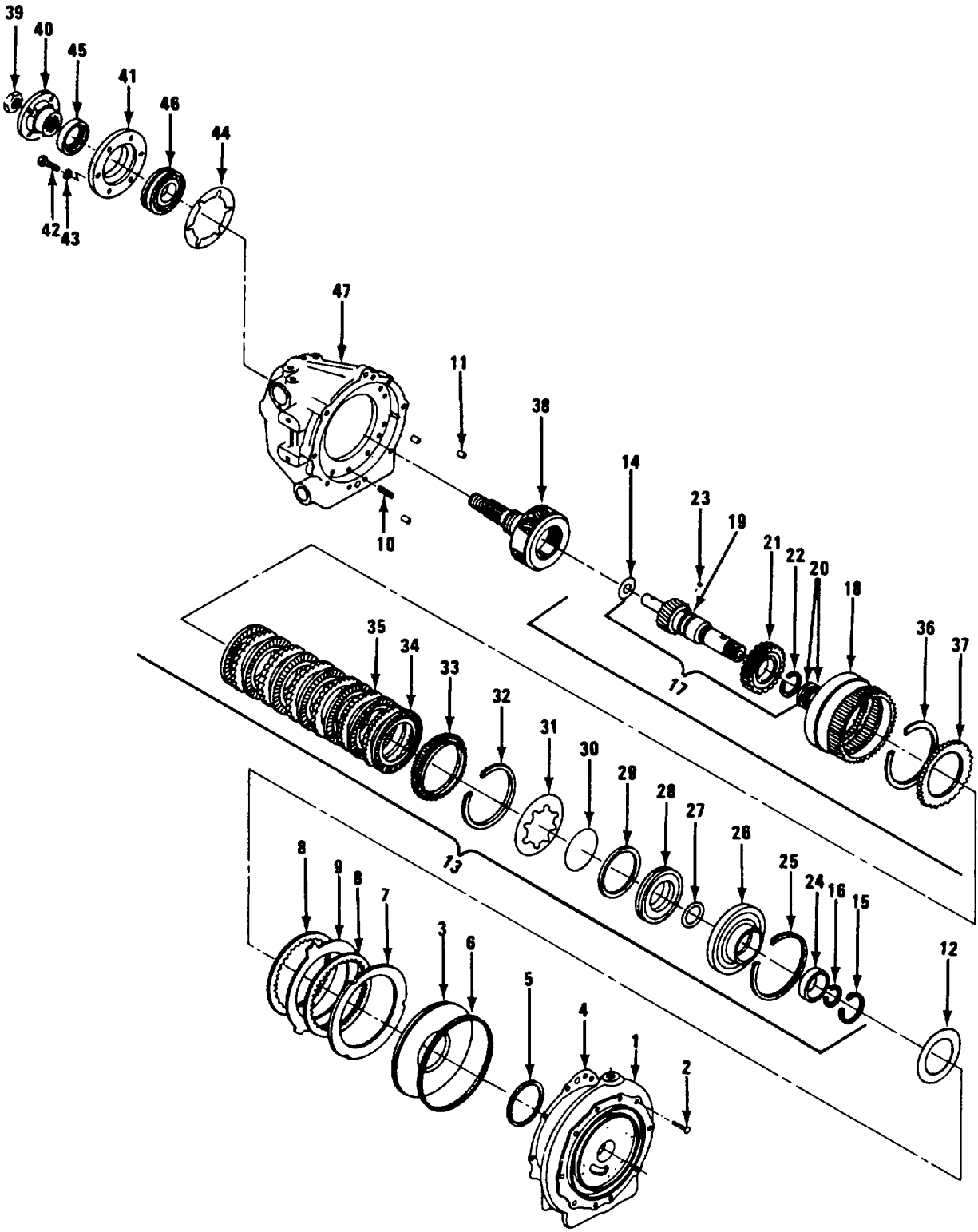


TRANSMISSION REPAIR INSTRUCTIONS

(Continued)

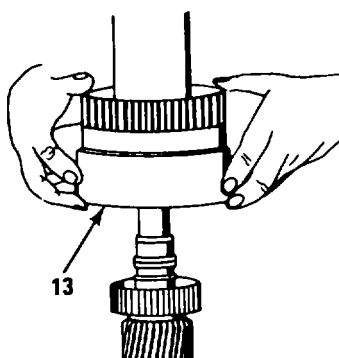
LOCATION	ITEM	ACTION	REMARKS
		<ul style="list-style-type: none"> b. Install gear and key squarely into hub being careful to align the key and keyway in hub. c. Press drive gear into forward clutch hub until gear bottoms on hub and groove for snap ring is fully uncovered. 	
<p>NOTE</p> <p>Remove items from press before next step.</p>			
37. Drive gear shaft (19)	a. Snap ring (21)	Install in groove.	
	b. 2 sealing rings (20)	<ul style="list-style-type: none"> a. Install in groove. b. After installation hold ends of shaft and turn rings to insure freedom of movement. 	

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
 (Continued)

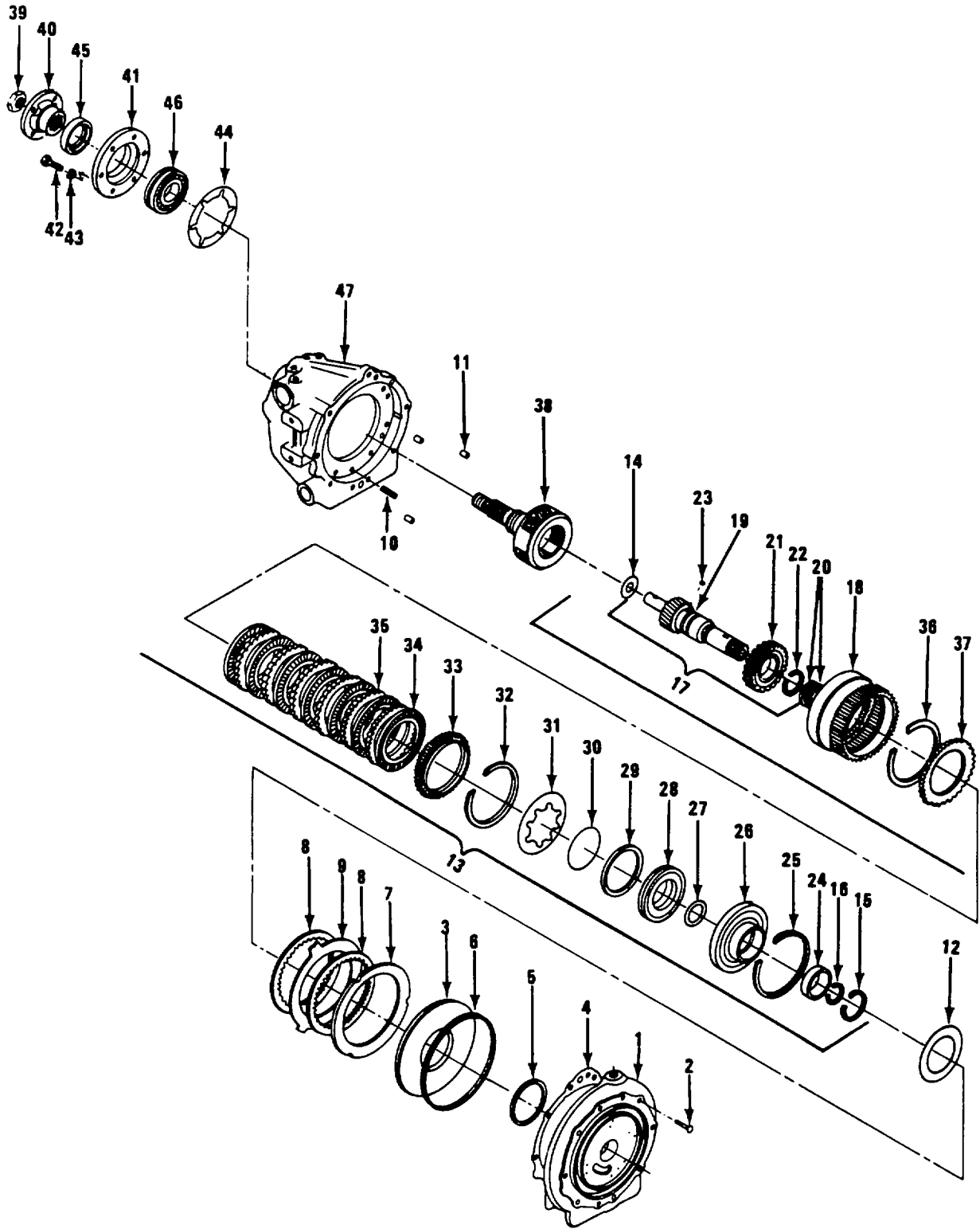
LOCATION	ITEM	ACTION	REMARKS
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NOTE

The drive gear-clutch hub subassembly must be placed in an assembly tool before proceeding with next step. Place subassembly so that drive gear rests on tool and clutch hub is on top.

- | | |
|--|---|
| c. Ring gear (13) subassembly as put together in steps 29, 30, 31. | a. Pick up and place over drive gear. |
| | b. Lower subassembly until internal teeth of clutch plates begin to engage teeth on forward clutch hub. |

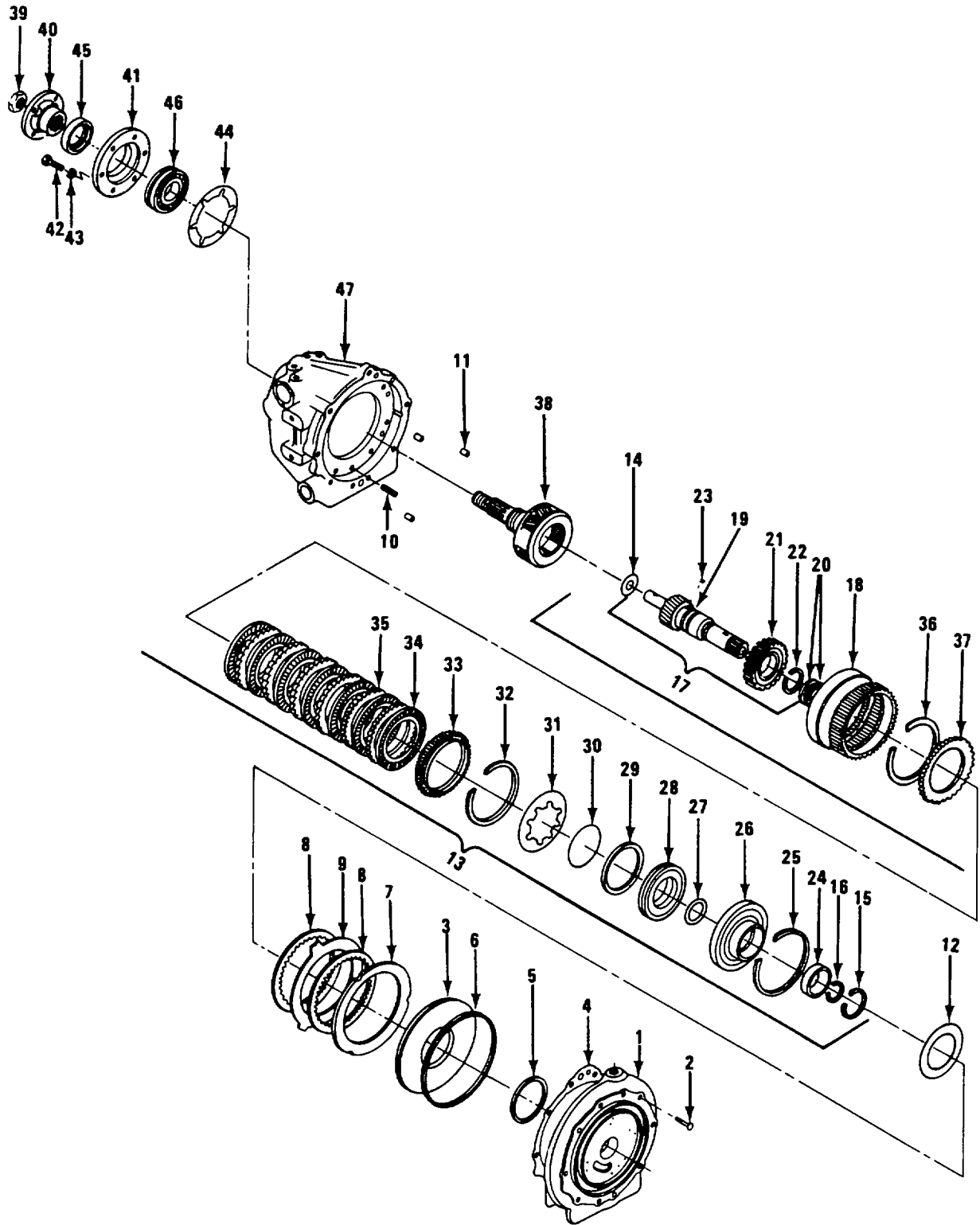
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
		c. Rotate ring gear to aline teeth of plates with teeth on clutch hub. DO NOT FORCE.	When everything is in correct position the rear of ring gear should be against assembly tool or flush with rear thrust face of drive gear. DO NOT MOVE SUBASSEMBLY FROM ASSEMBLY TOOL OR MOVE GEAR FORWARD.
NOTE			
Subassembly on assembly tool must be placed on arbor press table before next step.			
	d. Bearing (24)	a. Place over protruding drive gear shaft (19) and aline with bore at front of forward clutch cylinder (26).	
		b. Press bearing down until bearing is fully seated and snap ring grooves in front of bearing are exposed.	
	e. External snap ring (16)	Install on drive gear shaft.	
	f. Internal snap ring (15)	Install in clutch cylinder.	

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

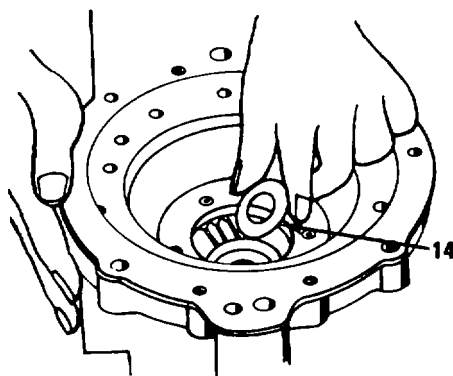


TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
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NOTE

Transmission case must be positioned so that it is resting on rear face of rear coupling for next steps.



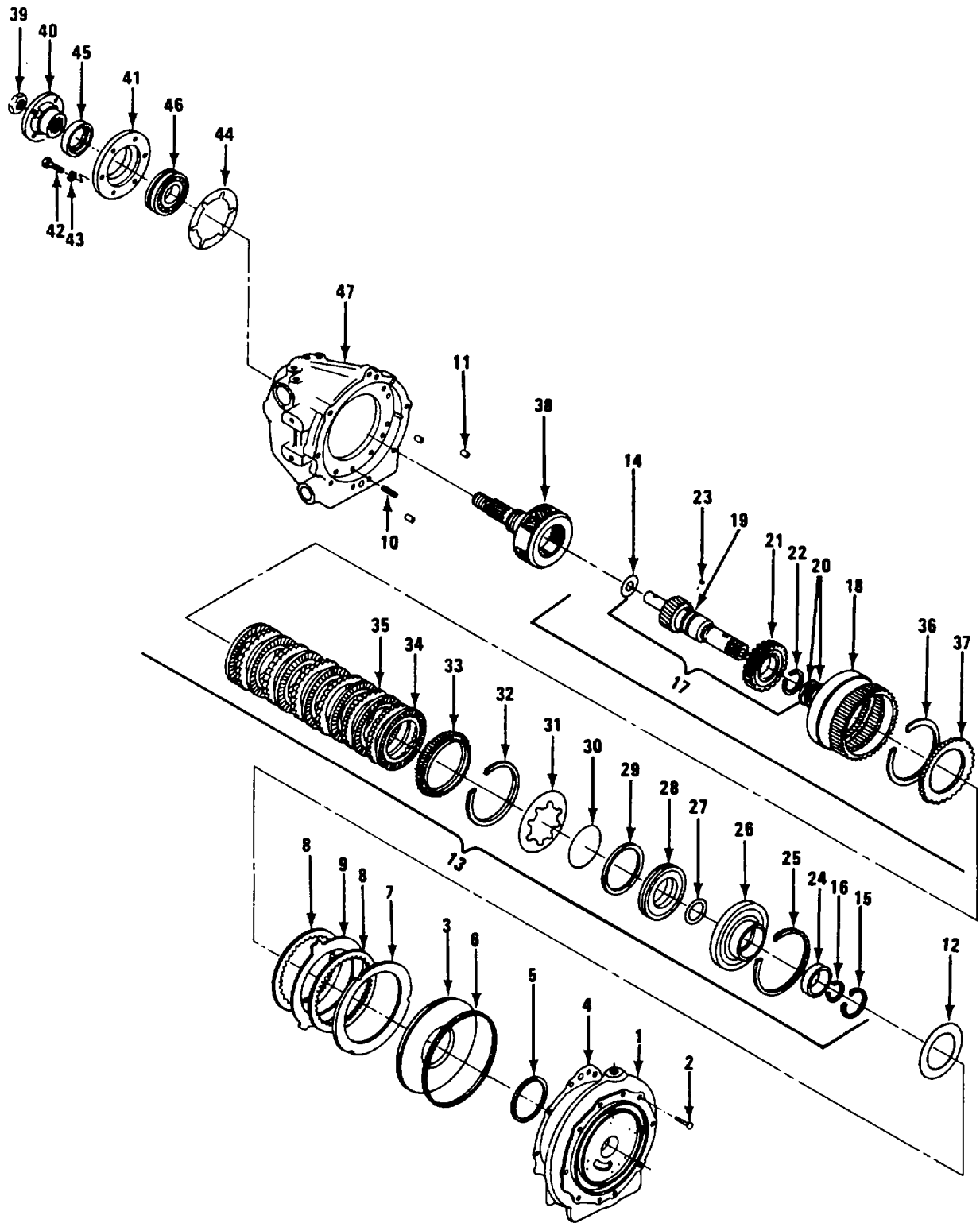
38. Pinion cage and output shaft (38)

a. Thrust washer (14)

- a. Coat with petroleum jelly.
- b. Assemble into pinion cage, centering washer carefully over bore in output shaft.

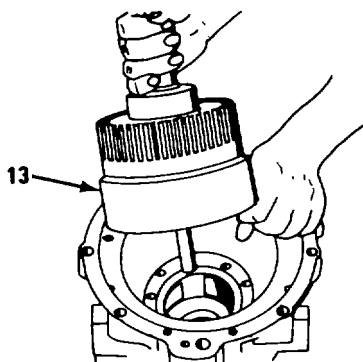
Output shaft has hollow center to receive drive gear protrusion when ring gear subassembly is fitted into transmission.

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

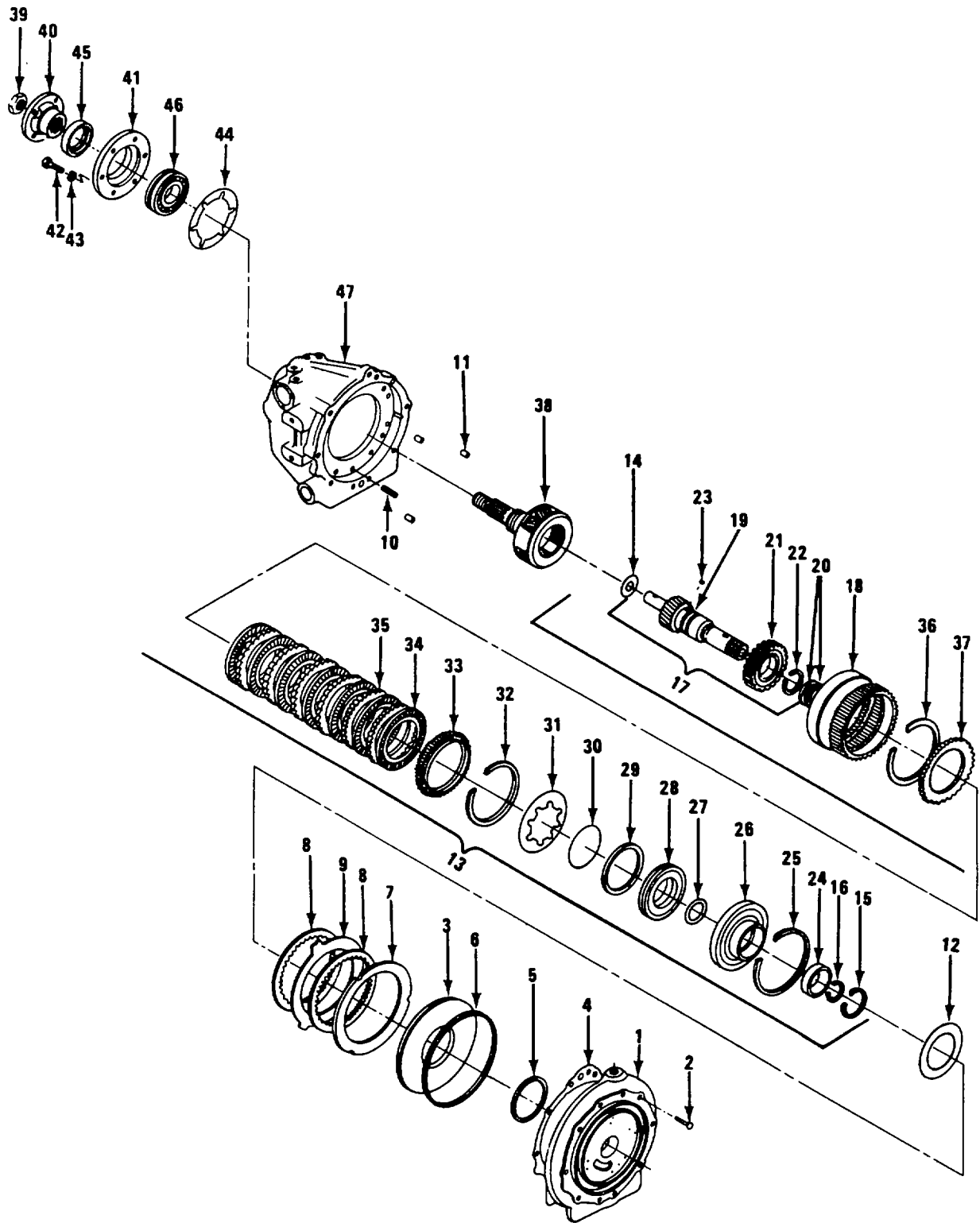


TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

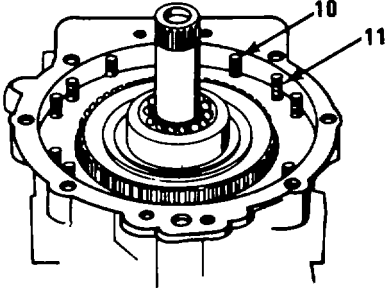
LOCATION	ITEM	ACTION	REMARKS
	<p>b. Ring gear subassembly (13)</p>	<p>a. Lubricate rear end of drive gear shaft (19).</p> <p>b. Check centered position of thrust washer.</p> <p>c. Install ring gear subassembly into pinion cage.</p>	<p>External splines on ring gear are up. Exercise care and proper centering to prevent damage when rear diameter of drive gear enters pinion cage.</p>
	<p>c. Ring gear subassembly (13)</p>	<p>a. Lubricate with engine oil.</p> <p>b. Place in ease (47).</p>	



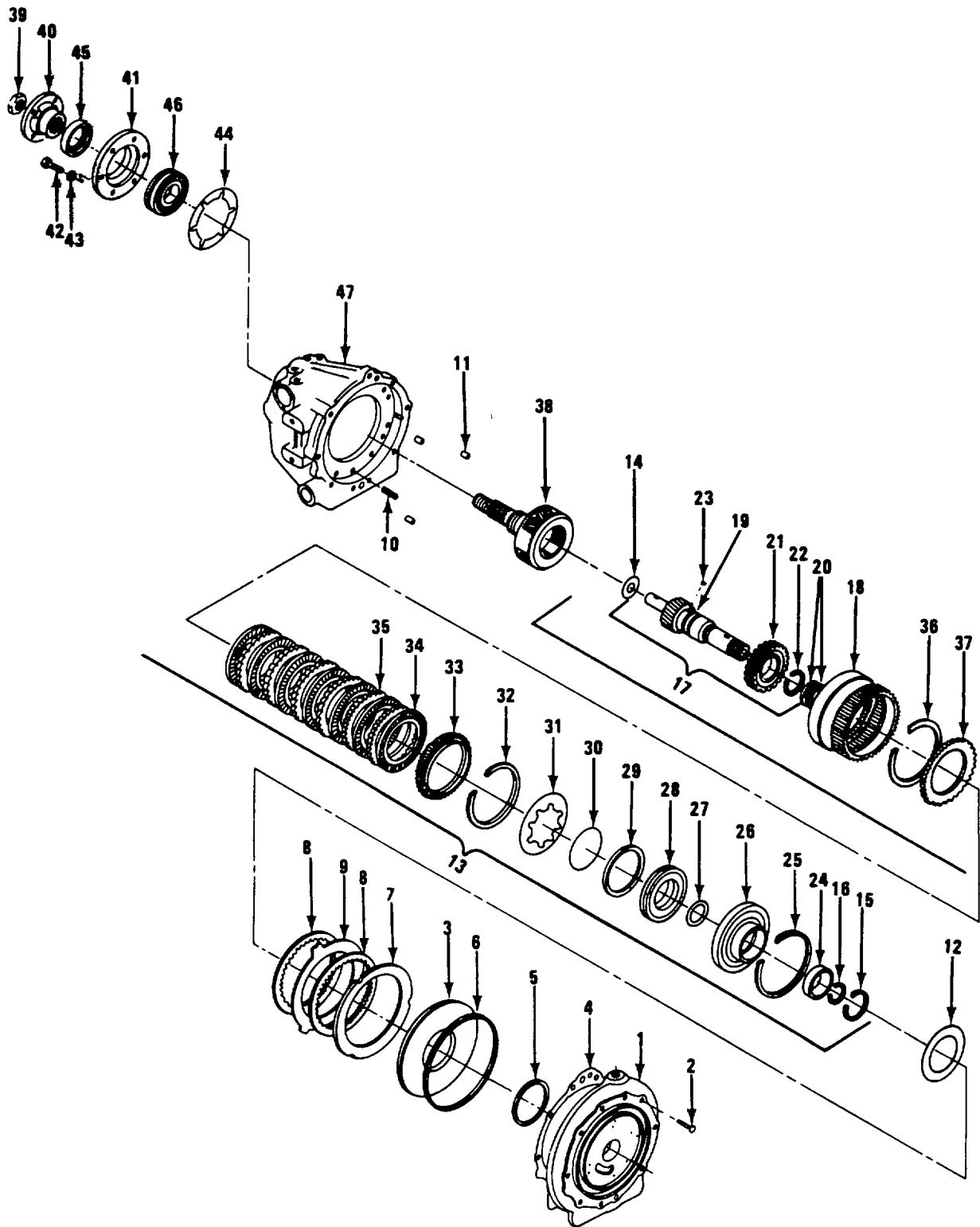
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
			
39. Transmission case (47)	a. 12 pressure plate springs (10)	Place springs in holes in reverse clutch cavity in case (47).	Holes free of dirt and springs firmly seated.
	b. Dowel pins (11)	a. Coat with petroleum jelly. b. Install in three grooves at outside diameter of reverse clutch cavity in case (47).	Pin goes into groove as far as possible and seats firmly.
	c. Reverse clutch plate (8)	Install over exposed spline teeth of ring gear (18).	

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

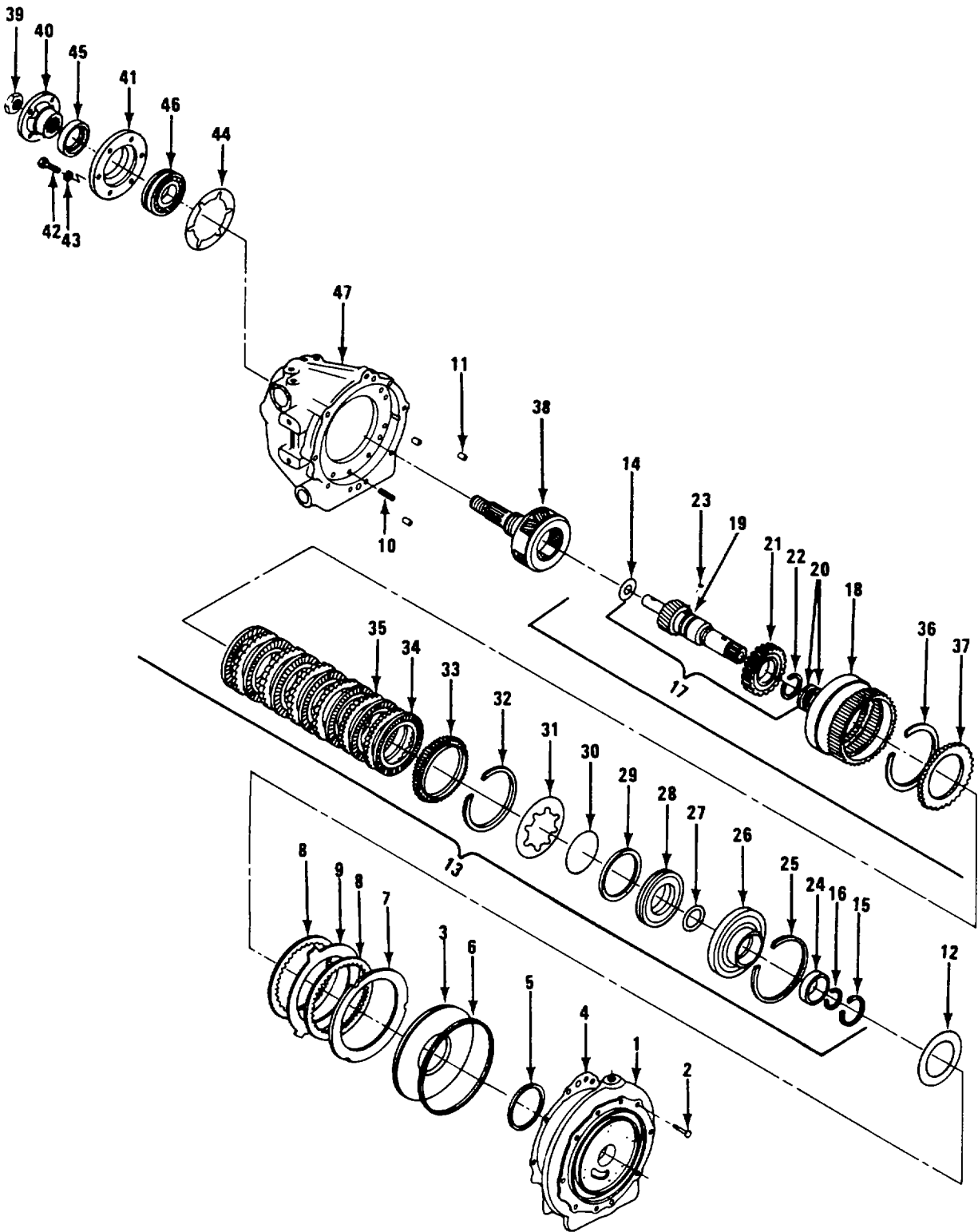


TRANSMISSION REPAIR INSTRUCTIONS

(Continued)

LOCATION	ITEM	ACTION	REMARKS
	d. Outer clutch plate (9)	Install with odd shaped lug to lower left as one would face the open transmission.	Lower left is approximately 8 o'clock when facing open end of transmission.
	e. Reverse clutch plate (8)	Install second plate on top of outer clutch plate and over exposed splined teeth of ring gear.	
	f. Reverse clutch pressure plate (7)	<p>a. Install with 12 holes down and over springs (10).</p> <p>b. Aline cast slot in plate outer diameter with large oil hole in top of transmission case face.</p>	<p>There is large oil hole in bottom of transmission face case. Do not use this hole as alignment hole. Pressure plate should position with face approximately flush</p>

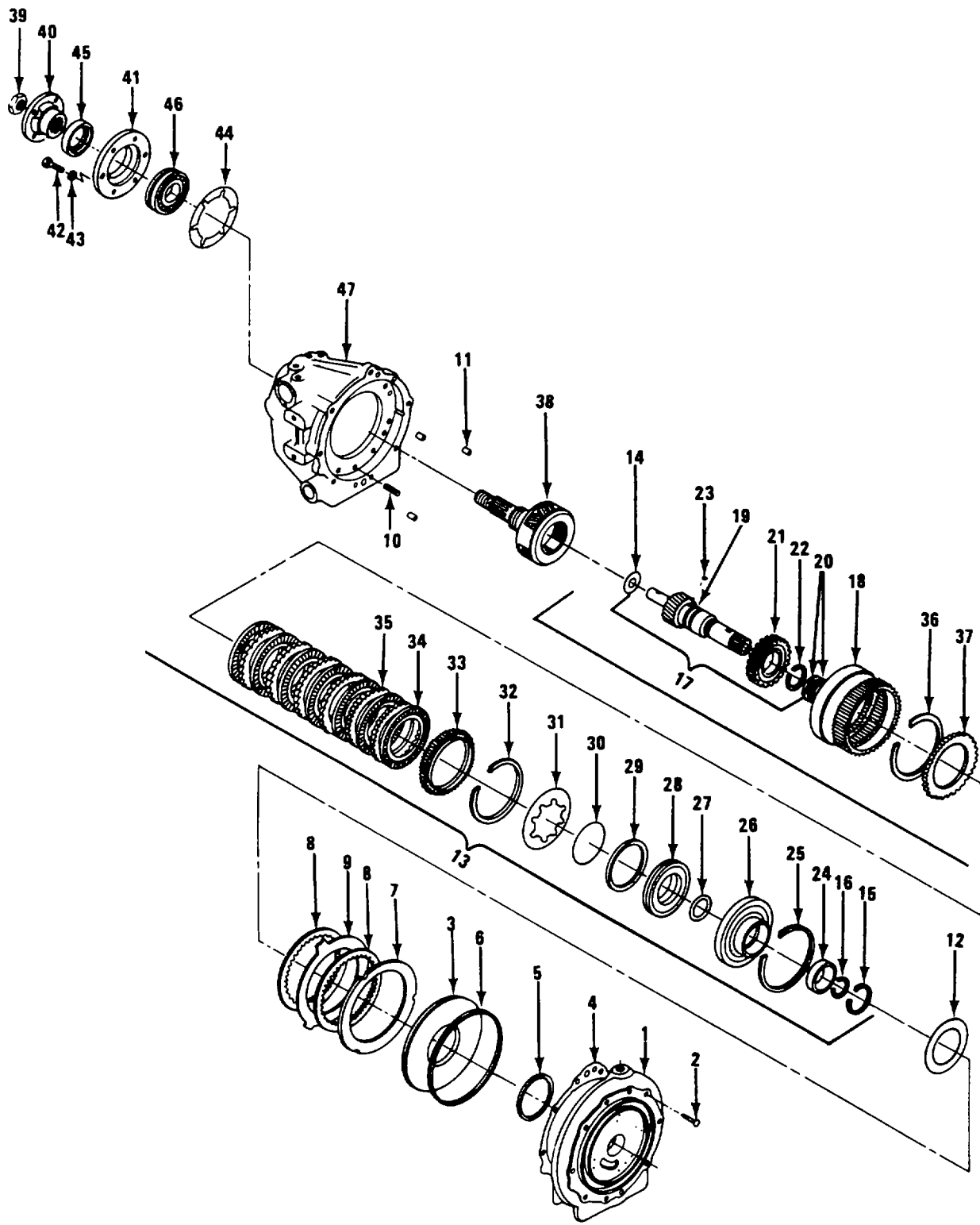
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

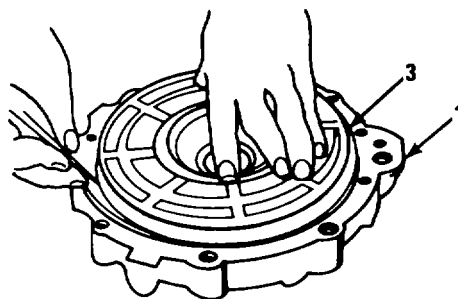
LOCATION	ITEM	ACTION	REMARKS
			with case front face. If it does not check dowel pins and springs for misalignment.
	g. Thrust washer (12)	a. Coat with petroleum jelly. b. Install onto forward clutch cylinder (26).	
NOTE			
Before next step place forward-reverse adapter (1) with open face up on flat surface.			
40. Forward and reverse adapter (1)	Sealing ring (5)	a. Lubricate with clean engine oil. b. Install in groove in adapter.	
41. Reverse clutch piston (3)	Sealing ring (6)	a. Lubricate with clean engine oil. b. Install in groove on piston outer diameter.	

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS
42. Forward and reverse adapter (1)	Reverse clutch piston (3)	<ul style="list-style-type: none"> a. Lubricate all surfaces with clean engine oil prior to starting procedure. Exposed face of clutch piston should be flush with adapter when assembly completed. b. Place piston, ribbed side up, on adapter. c. Press down on piston while pulling a clean, smooth screwdriver blade around the exposed portion of sealing ring. 	This compresses ring to allow piston to slip into adapter.



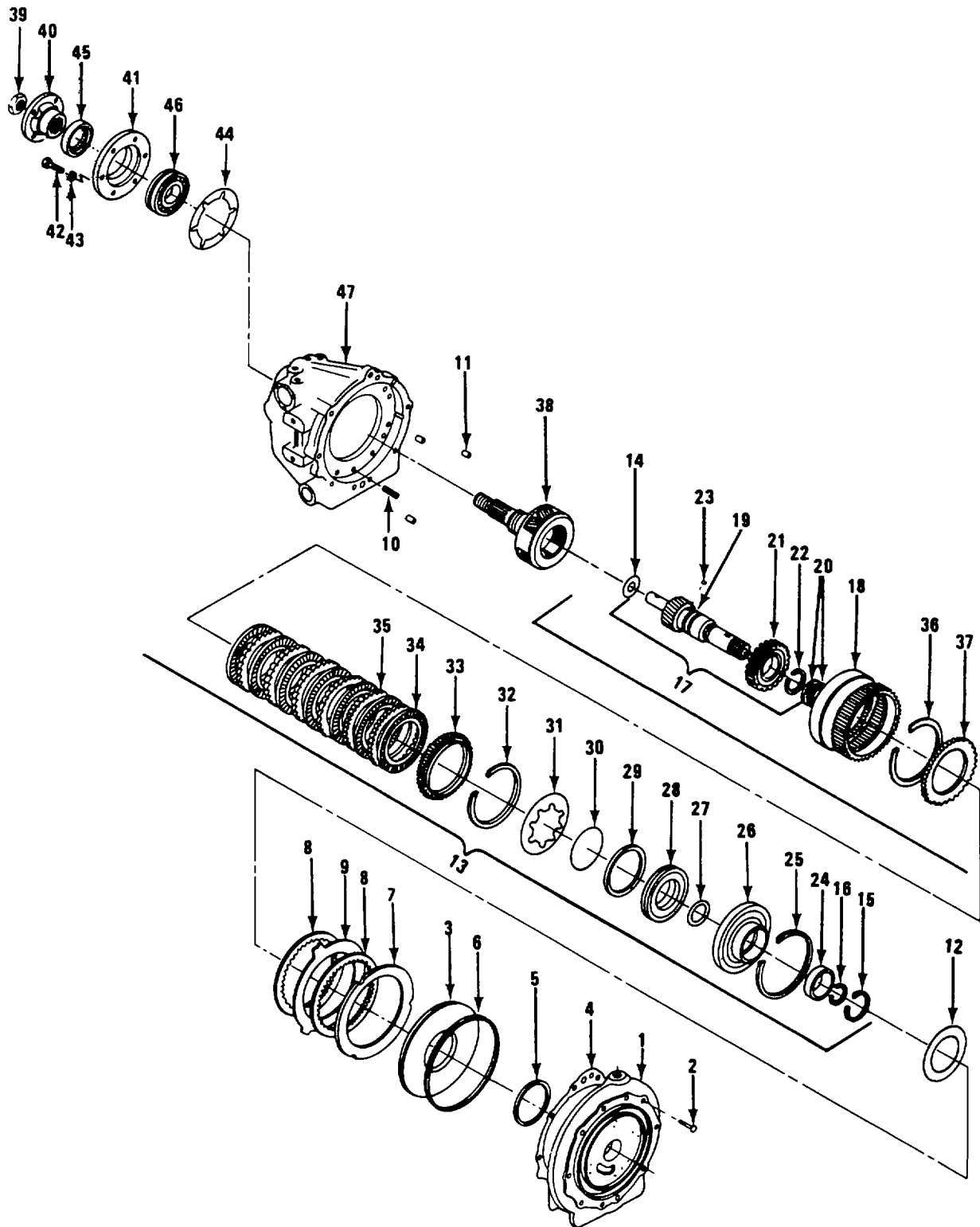
TRANSMISSION REPAIR INSTRUCTIONS
(Continued)

LOCATION	ITEM	ACTION	REMARKS

TRANSMISSION REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
43. Transmission case (47)	a. Adapter gasket (4)	d. Assembly can be completed using hand pressure until piston bottoms in adapter (1). a. Coat with petroleum jelly. b. Position on exposed front face of case.	Aline all holes.
	b. Forward and reverse adapter (1)	a. Fit squarely over input shaft and lower as far it will go. b. Aline oil holes in adapter with those cavity in case.	The plug in adapter is at top of adapter. This alines with top of transmission. Shoulder on rear of adapter should enter mating bore in reverse clutch
NOTE			
Before proceeding to next step check gap between adapter and case at several points to insure that adapter is squarely in place.			
44. Adapter (1)	4 cap screws (2)	a. Install and tighten finger tight. Alternately tighten each cap screw 1/2 turn at a time to draw adapter into place.	Tighten the bolts in an X pattern to insure proper draw down.

TRANSMISSION REPAIR INSTRUCTIONS
(Continued)



TRANSMISSION REPAIR INSTRUCTIONS**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
		b. When seated, torque cap screws to 27-37ft-lb.	
		NOTE	
		FOLLOW-ON MAINTENANCE PROCEDURE: Perform transmission oil pump installation procedure (reference page 2-337). Perform control valve installation procedure (reference page 2-327).	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION

This task covers:

a. Disassembly

b. Inspection

c. Assembly

INITIAL SETUP

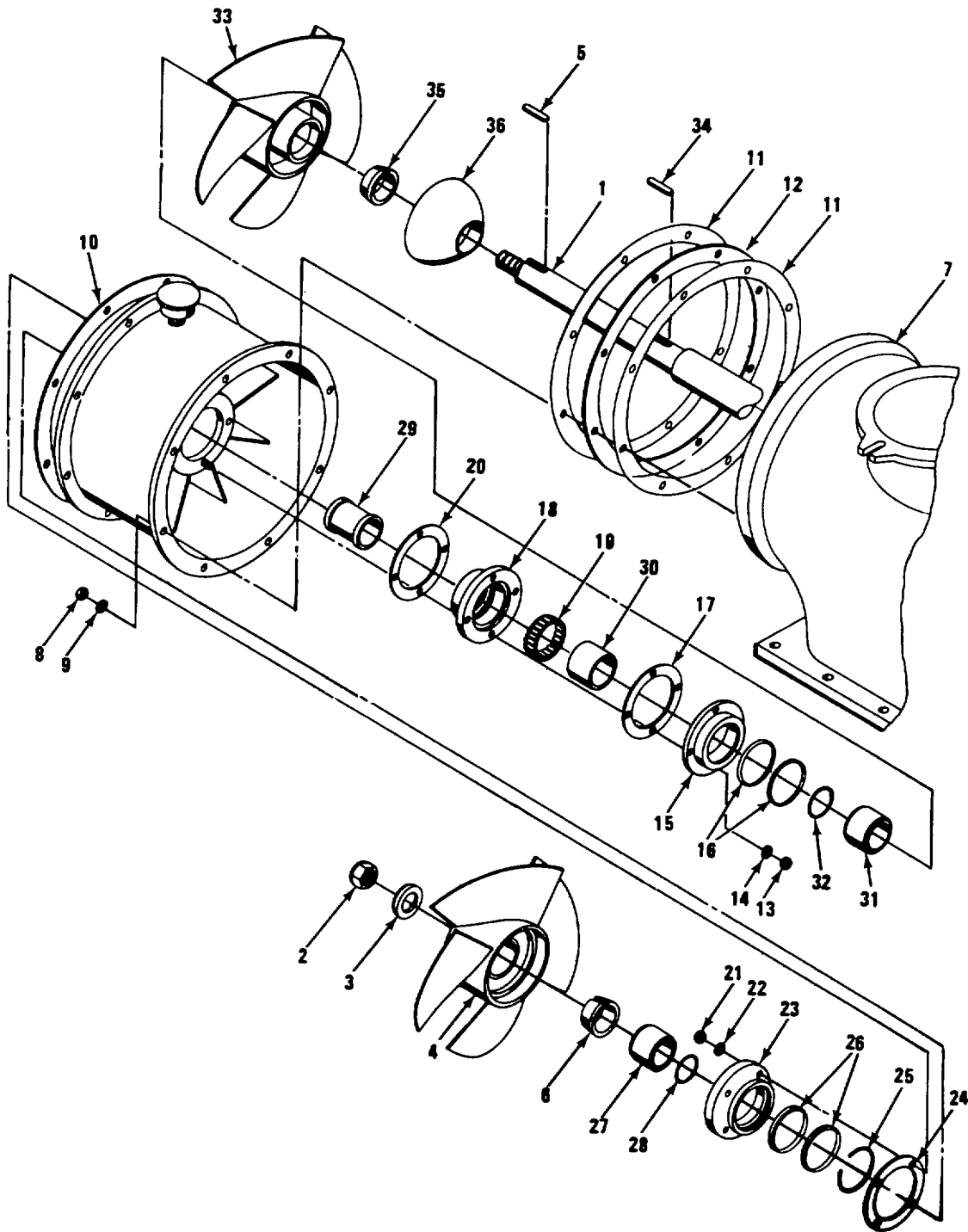
Tools:	Equipment Condition	Condition Description
30 mm socket Torque wrench (0 - 175 ft-lb) 8 mm hex key wrench (Allen) 12 mm open/box wrench 13 mm open end wrench Snap ring pliers Strap wrench Long nose pliers Ratchet Feeler gage	Page 2-353	Hydrojet assembly removed from boat.

Materials/Parts:

- Gaskets
- Shaft seals
- Front reaction case gaskets
- Grease
- O-rings

Personnel Required: Two

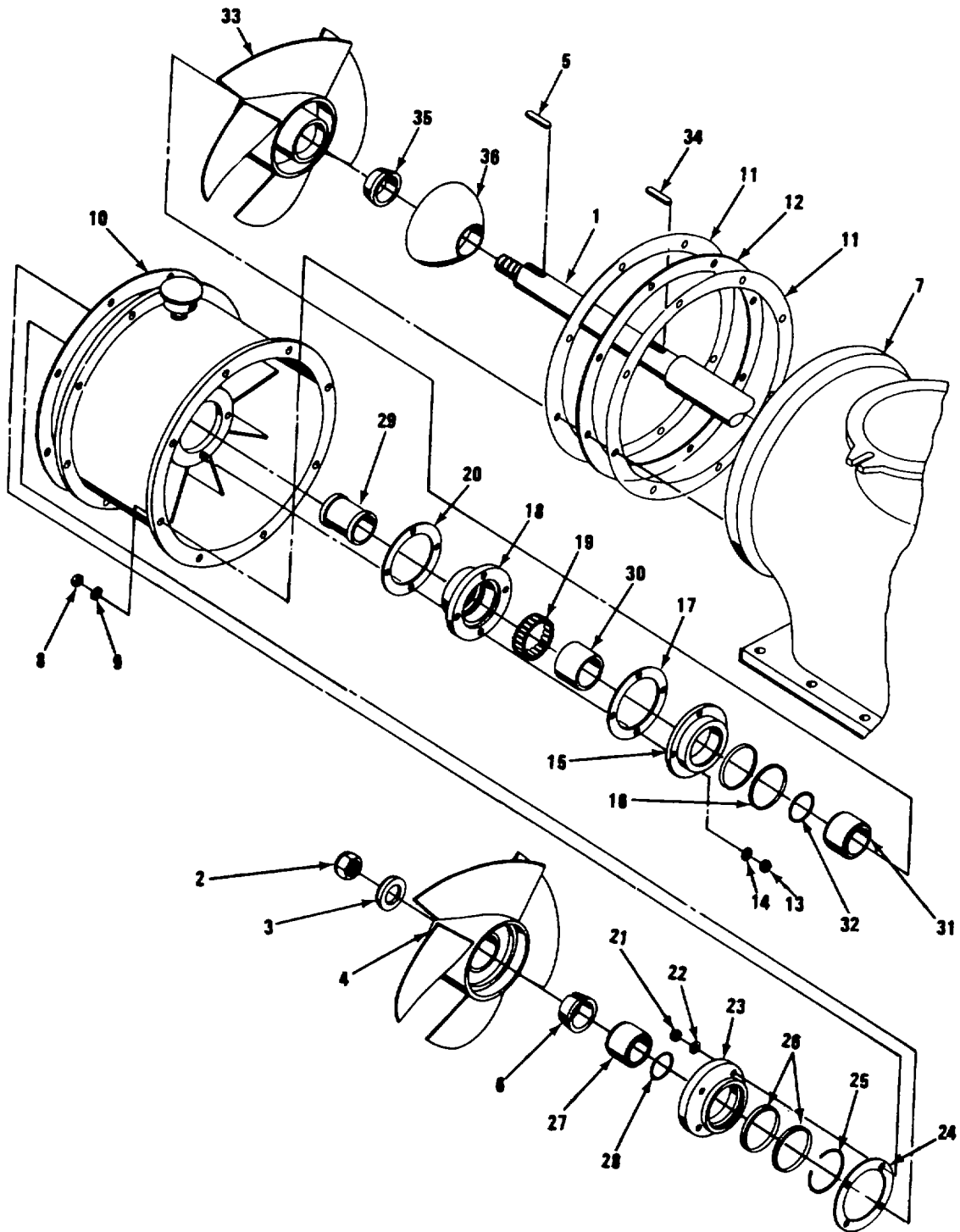
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION
 (Continued)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>			
1. Hydrojet assembly shaft (1)	a. Rear shaft nut (2), washer (3)	a. Hold drive flange located at other end of shaft and unscrew.	Use strap wrench to hold flange.
		b. Remove.	Use 30 mm socket and ratchet.
	b. Rear impeller (4)	Slide off shaft.	
	c. Key (5)	Remove.	
2. Front reaction case (10)	Wear measurement	d. Rear impeller cone (6)	Slide off shaft.
		Measure clearance between tip of impeller blade and case. Should be not greater than .0591 inch (1.5 mm). Replace impeller and case if clearance too great.	Use feeler gage.
3. Intake case (7)	a. 8 nuts (8) and 8 washers (9) securing front reaction case (10) to intake case (7)	Remove.	Use 12 mm wrench.

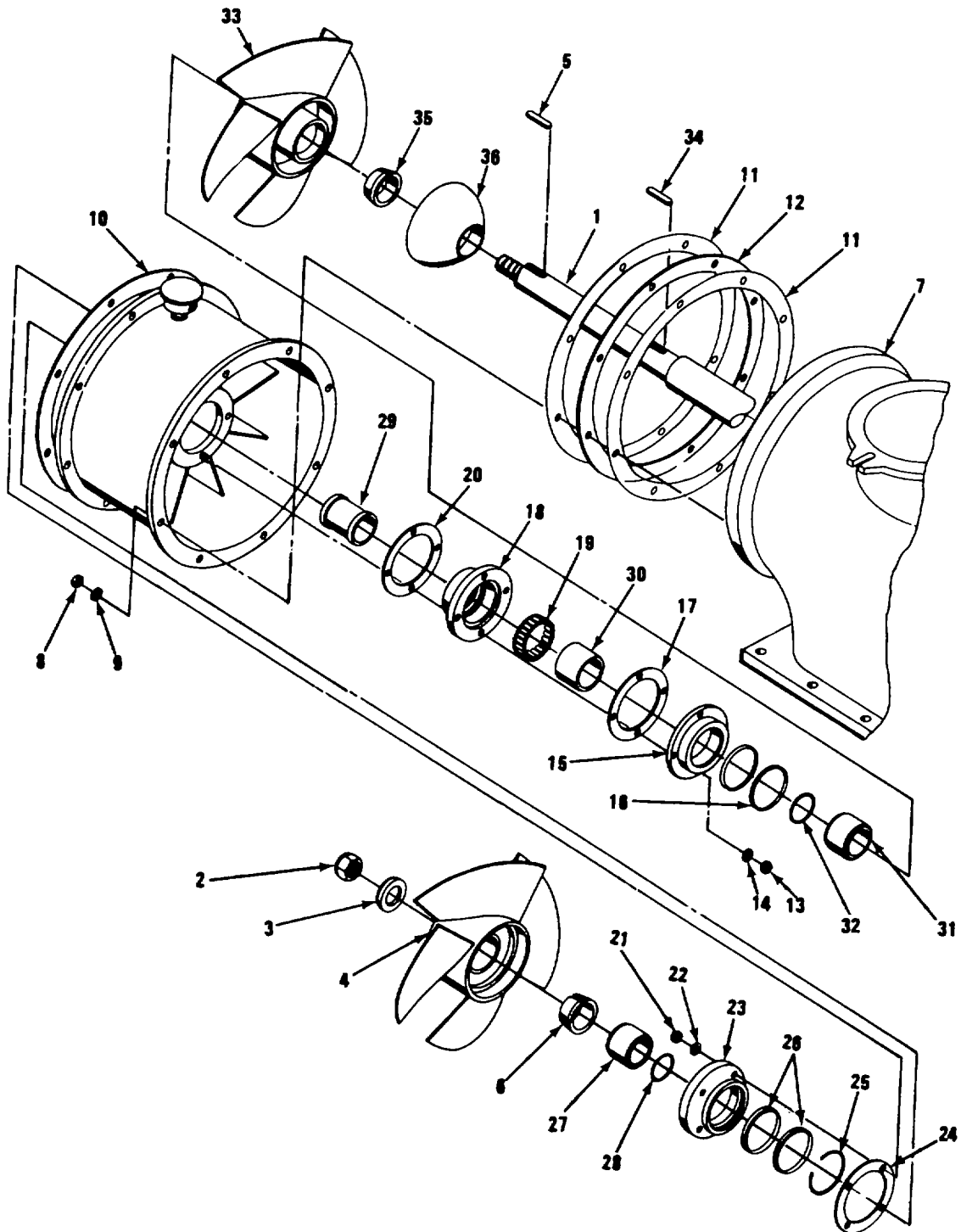
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION
(Continued)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION
(Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Front reaction case (10)	a. Remove, while holding all spacers, and seal sleeves in place on shaft while doing so.	
		b. Lay side for further disassembly.	
	c. 2 front reaction case gaskets (11) and front reaction insulating ring (12)	a. Remove. b. Discard gaskets.	
4. Front reaction case (10)	a. 4 seal and bearing housing retaining nuts (13) and 4 lockwashers (14) retaining seal and bearing housing	Remove.	Use 13 mm wrench.
	b. Seal housing (15)	Remove.	
	c. 2 seals (16)	Remove from seal housing.	Use seal puller.
	d. Seal housing gasket (17)	Remove.	Discard.

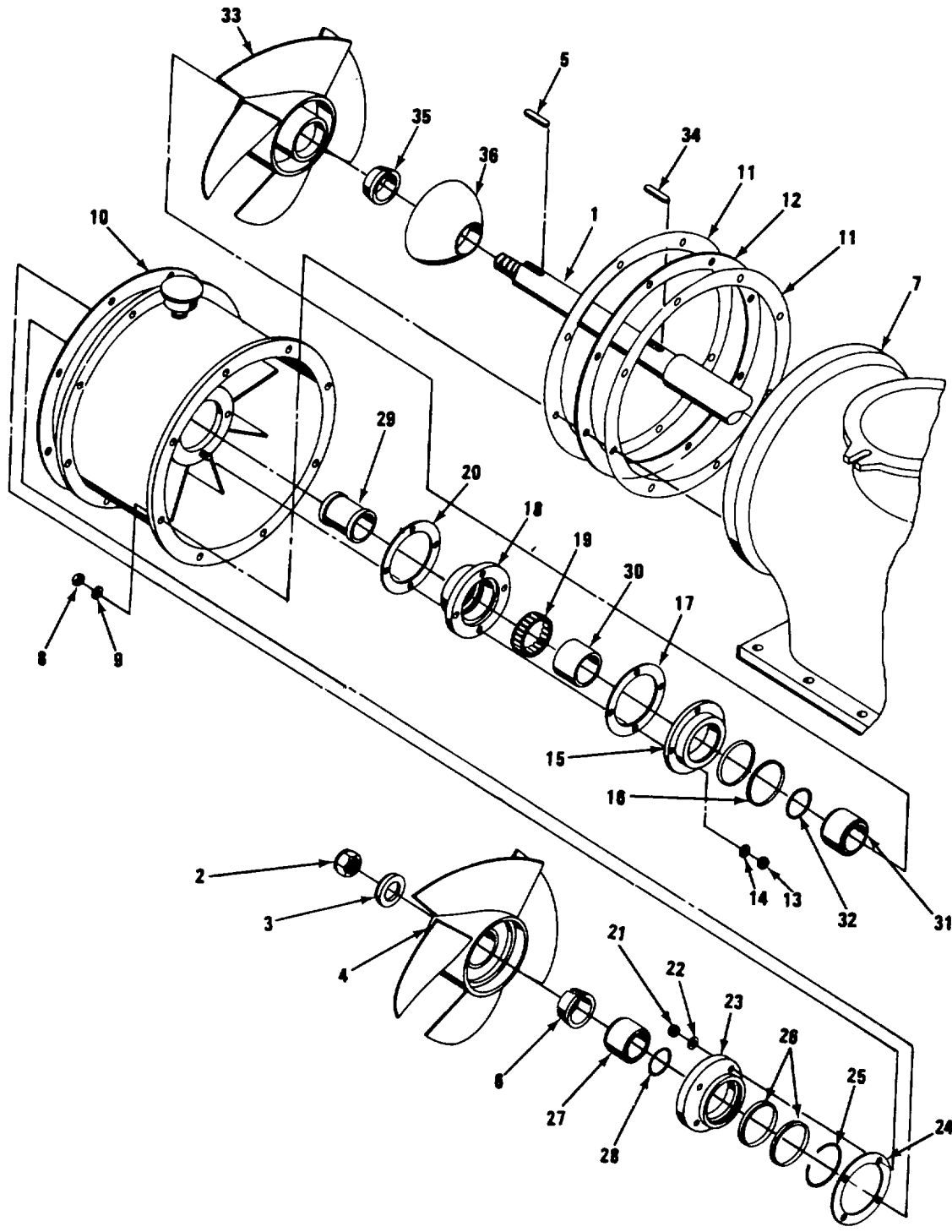
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION
 (Continued)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION**(Continued)**

LOCATION	ITEM	ACTION	REMARKS
	e. Bearing housing (18)	Remove.	With bearing.
	f. Bearing housing gasket (20)	Remove and discard.	
5. Bearing housing (18)	Bearing (19)	a. Press out of small end of housing. b. Lay aside for inspection.	Use press.
6. Front reaction case (10)	a. 4 nuts (21) and 4 washers (22) retaining seal housing b. Seal housing (23) c. Seal housing gasket (24)	Remove.	Use 13 mm wrench.
7. Seal housing (23)	a. Snap ring (25) b. 2 seals (26)	Remove.	Use long nose pliers. Use seal puller. Note direction of old installation for reference in new seal installation.
8. Hydrojet assembly shaft (1)	Seal sleeve (27)	Slide off shaft.	

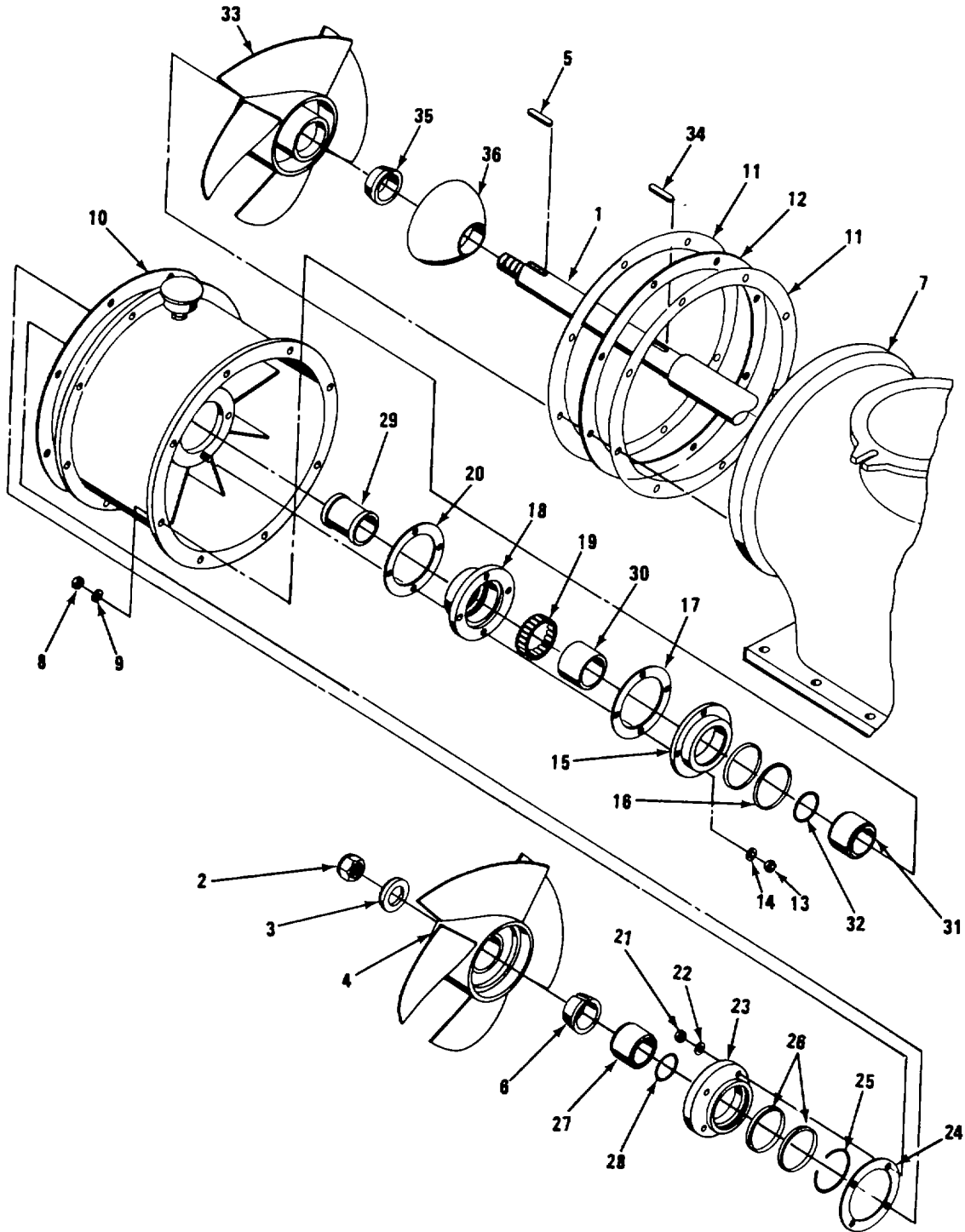
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION
 (Continued)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION**(Continued)**

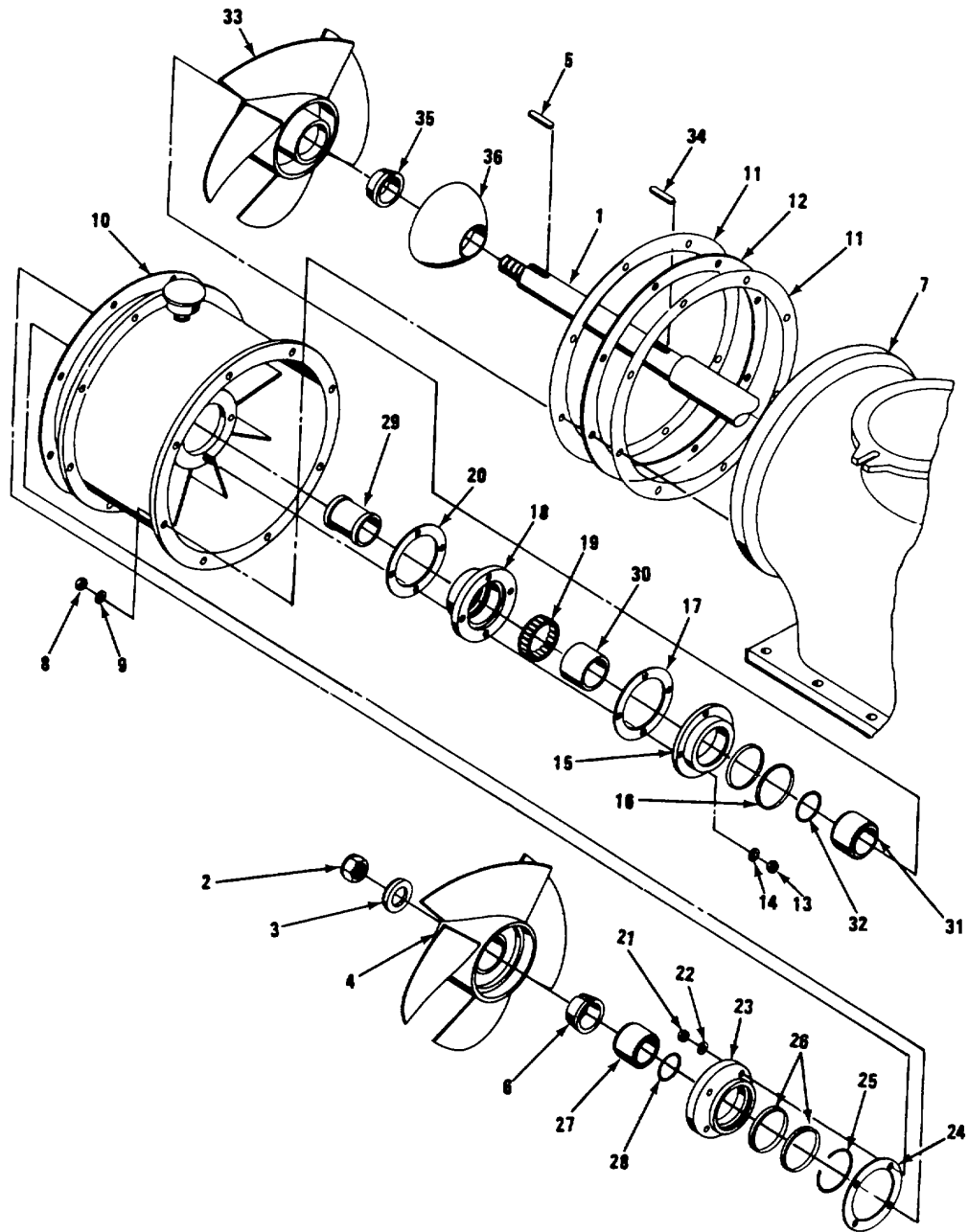
LOCATION	ITEM	ACTION	REMARKS
9. Seal sleeve (26)	O-ring (28)	Remove and discard.	
10. Hydrojet assembly shaft (1)	a. Spacer (29)	Slide off shaft.	
	b. Bearing inner race (30)	Slide off shaft.	
	c. Seal sleeve (31)	Slide off shaft.	
11. Seal sleeve (31)	O-ring (32)	Remove and discard.	
12. Hydrojet assembly shaft (1)	a. Front impeller (33)	Slide off shaft.	
	b. Key (34)	Pull out.	
	c. Impeller cone (35)	Slide off shaft.	
	d. Fairing (36)	Slide off shaft.	
<u>INSPECTION</u>			
13.	Impeller (33)	a. Inspect for cracks. b. Replace if cracked.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS - TWO STAGE IMPELLER SECTION
 (Continued)



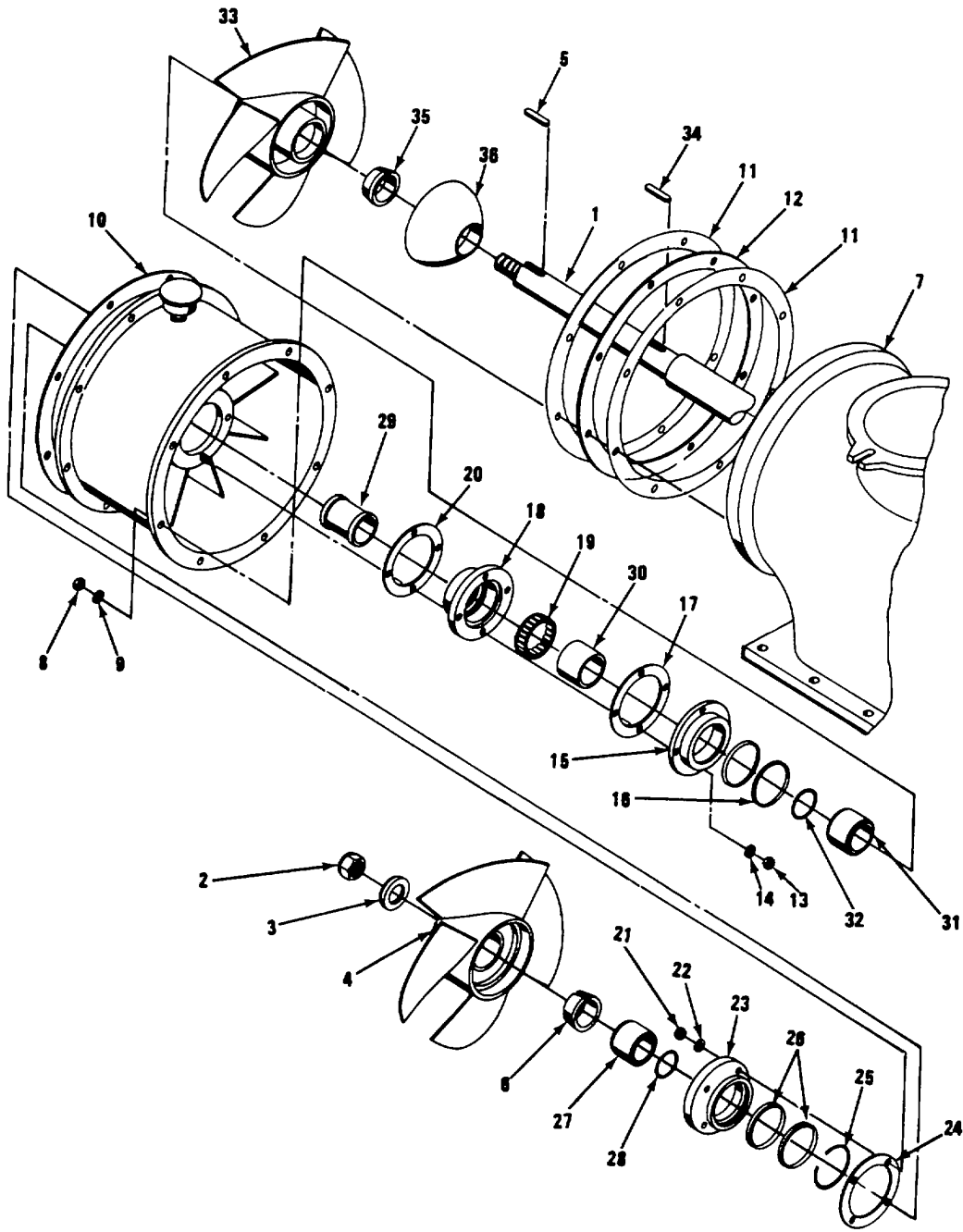
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)			
LOCATION	ITEM	ACTION	REMARKS
14.	Front reaction case (10)	Inspect case for wear in impeller action area. Replace the case if groove is over .0787 inch (2 mm) deep.	Normally both cases would be replaced at the same time.
15.	Bearing (19)	a. Inspect bearing for cracks, broken needles or discoloration. b. Replace if bearing found damaged.	
<u>ASSEMBLY</u>			
16.	Intake case (7) and mount.	a. Gasket (11) b. Insulating ring (12) c. Gasket (11)	Smear with grease Install. Smear with grease and mount.
NOTE			
Before next step pack interior cavity of reaction case with grease.			
	d. Reaction case (10)	Carefully slide case assembly over shaft into positioning grease fitting on top.	Do not use force as this could damage seals. If case does not slide easily work seals carefully over obstruction.
3-175			

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)



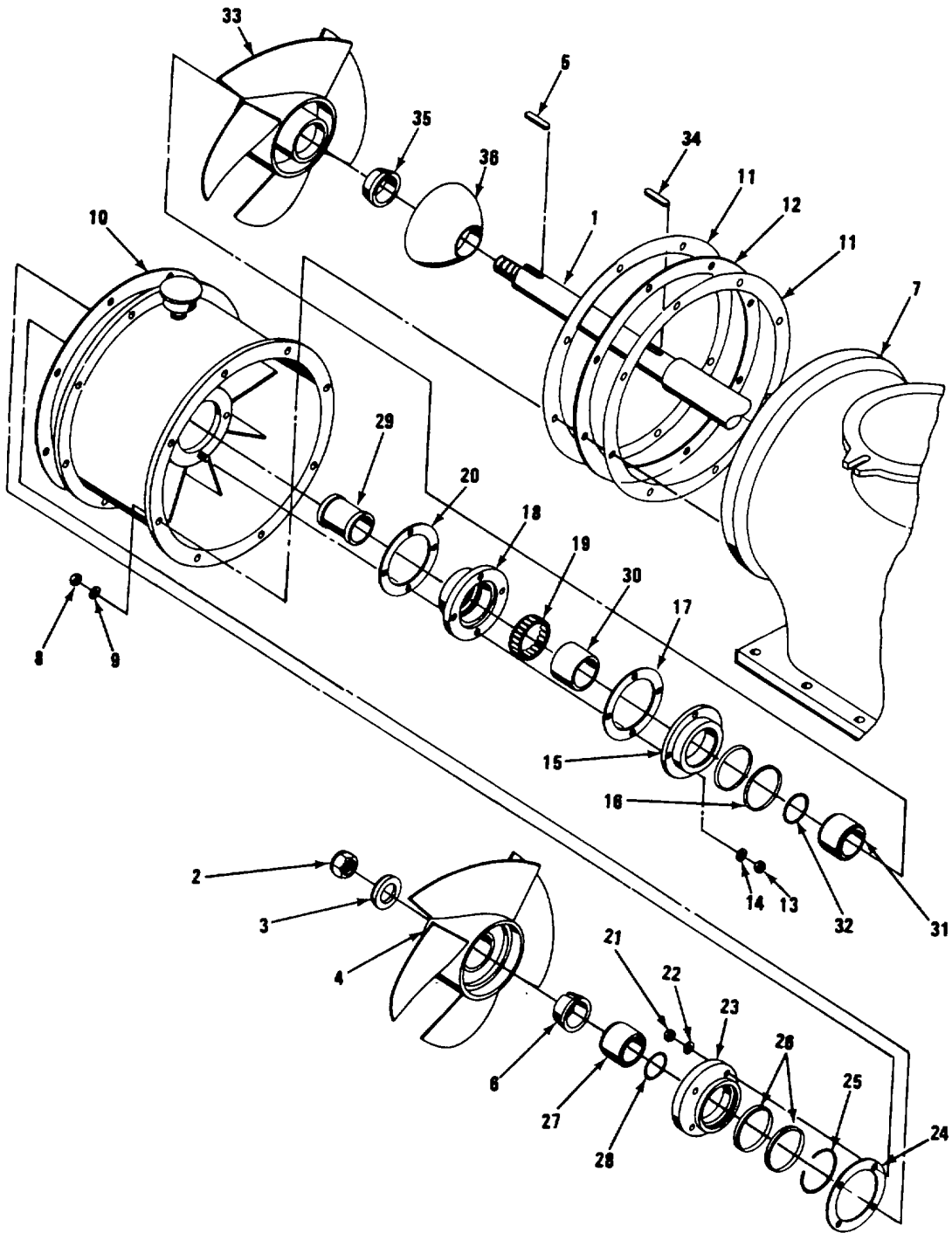
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)			
LOCATION	ITEM	ACTION	REMARKS
	e. 8 washers (9) and 8 nuts retaining reaction case	Install and tighten.	Use 12 mm wrench.
17. Hydrojet assembly shaft (1)	a. Fairing (36)	Slide on shaft. greased for ease of fitting.	Shaft may be
	b. Impeller cone (35)	Slide on shaft.	Cone base forward.
	c. Key (34)	Place in groove on shaft.	
	d. Front impeller (33)	Slide on shaft and fit over key.	Protruding collar should be toward fairing.
18. Seal sleeve (31)	O-ring (32)	Fit O-ring.	
19. Hydrojet assembly shaft (1)	a. Seal sleeve (31)	Slide on shaft.	
	b. Bearing inner race (30)	Slide on shaft.	
	c. Spacer (29)	Slide on shaft.	
20. Seal sleeve (27)	O-ring (28)	Fit to sleeve.	
21. Hydrojet assembly shaft (1)	Seal sleeve (27)	Slide on shaft.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)			
LOCATION	ITEM	ACTION	REMARKS
22. Seal housing (23)	a. 2 seals (26)	Install. from case center. Snap ring groove goes toward case center.	Seal lip away
	b. Snap ring (25)	Install. meter of housing for ring to fit into.	There is groove on inside dia-
23. Front reaction case (10)	a. Seal housing gasket (24)	Smear with grease and mount.	
	b. Seal housing (23)	Install.	
	c. Seal housing retaining washer (22), nut (21)	Install and tighten.	Use 13 mm open end wrench.
24. Bearing housing (18)	Bearing (19)	Pack with grease and fit bearing to housing.	Make certain all needles are installed.
25. Seal housing (15)	Seal (16)	Install.	Lip away from case center. Housing mounts with shoulder away from case.
26. Front reaction case (10)	a. Bearing housing gasket (20)	Smear with grease and mount.	
	b. Bearing housing (18)	Install.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE IMPELLER SECTION (CONTINUED)			
LOCATION	ITEM	ACTION	REMARKS
	c. Seal housing gasket (17)	Smear with grease and mount.	
	d. Seal housing (15)	Install.	
	e. 4 washers (14) and 4 nuts (13) retaining seal housing	Install and tighten.	Use 13 mm open end wrench.
27. Hydrojet assembly shaft (1)	a. Impeller cone (6)	Slide on shaft.	Cone base first.
	b. Key (5)	Install.	
	c. Rear impeller (4)	Slide on shaft.	Impeller collar is pointing out.
NOTE			
Before next step put nonhardening Loctite on shaft threads.			
	d. Washer (3) and nut (2)	a. Install and tighten.	Use 30 mm socket, strap wrench, and torque wrench.
		b. Hold drive flange at other end of shaft.	
		c. Torque to 150 ft-lb.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION

This task covers:

- a. Disassembly**
- b. Inspection**
- c. Repair**
- d. Assembly**

INITIAL SETUP

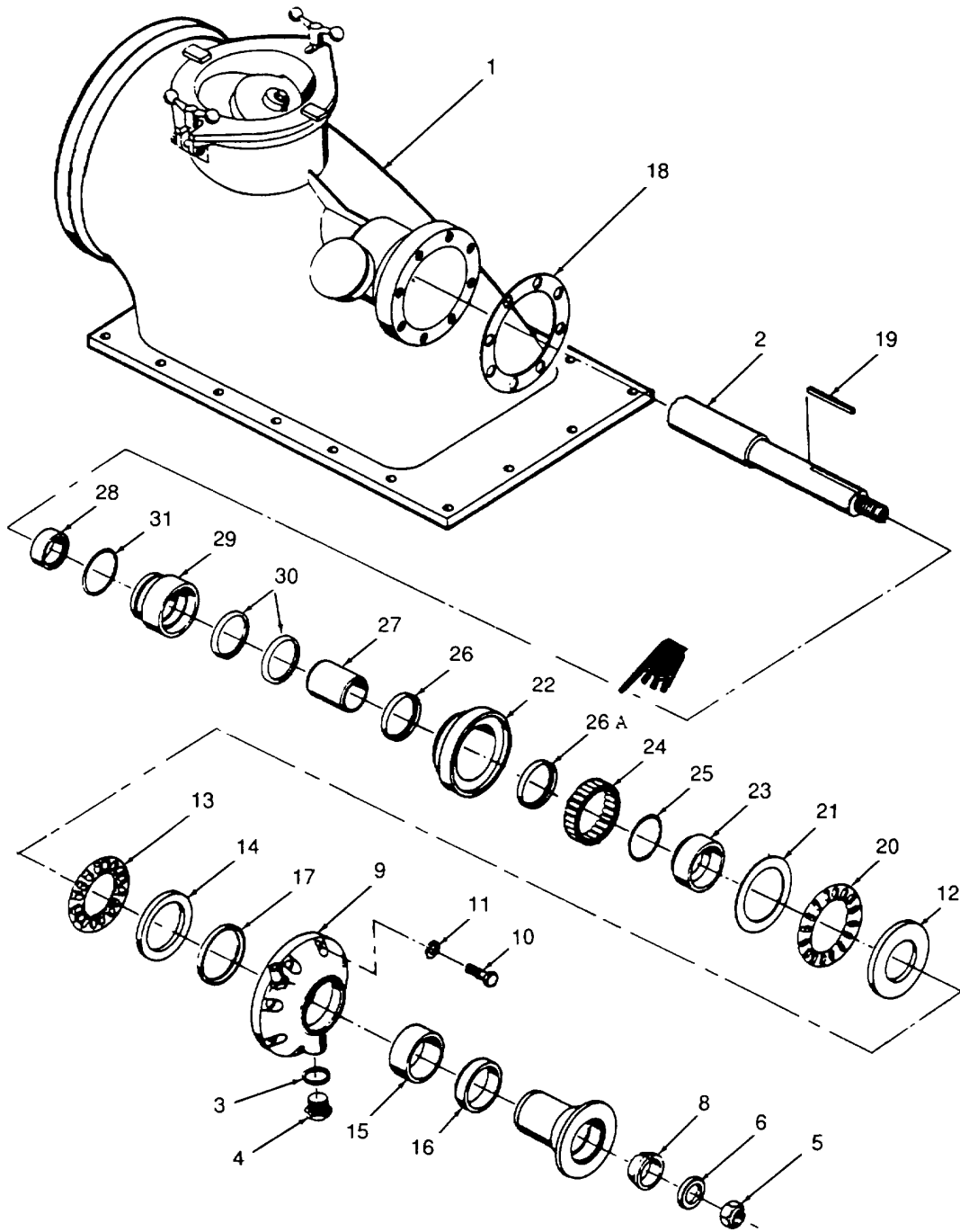
Tools:	Equipment Condition	Condition Description
30 mm socket	Page 2-353	Hydrojet assembly removed from boat. Hydrojet assembly two stage impeller section disassembled.
Ratchet		
Torque wrench (0-175 ft-lb)	Page 3-165	
8 mm hex key wrench (Allen)		
17 mm open/box wrench		
13 mm open/box wrench		
Hammer, ball peen		
Drift, 6 in		
1-1/16 in open end wrench		
Strap wrench		
Bearing puller		
Feeler gage		

Materials/Parts:

- Gaskets
- Shaft seals
- O-rings

Personnel Required: Two

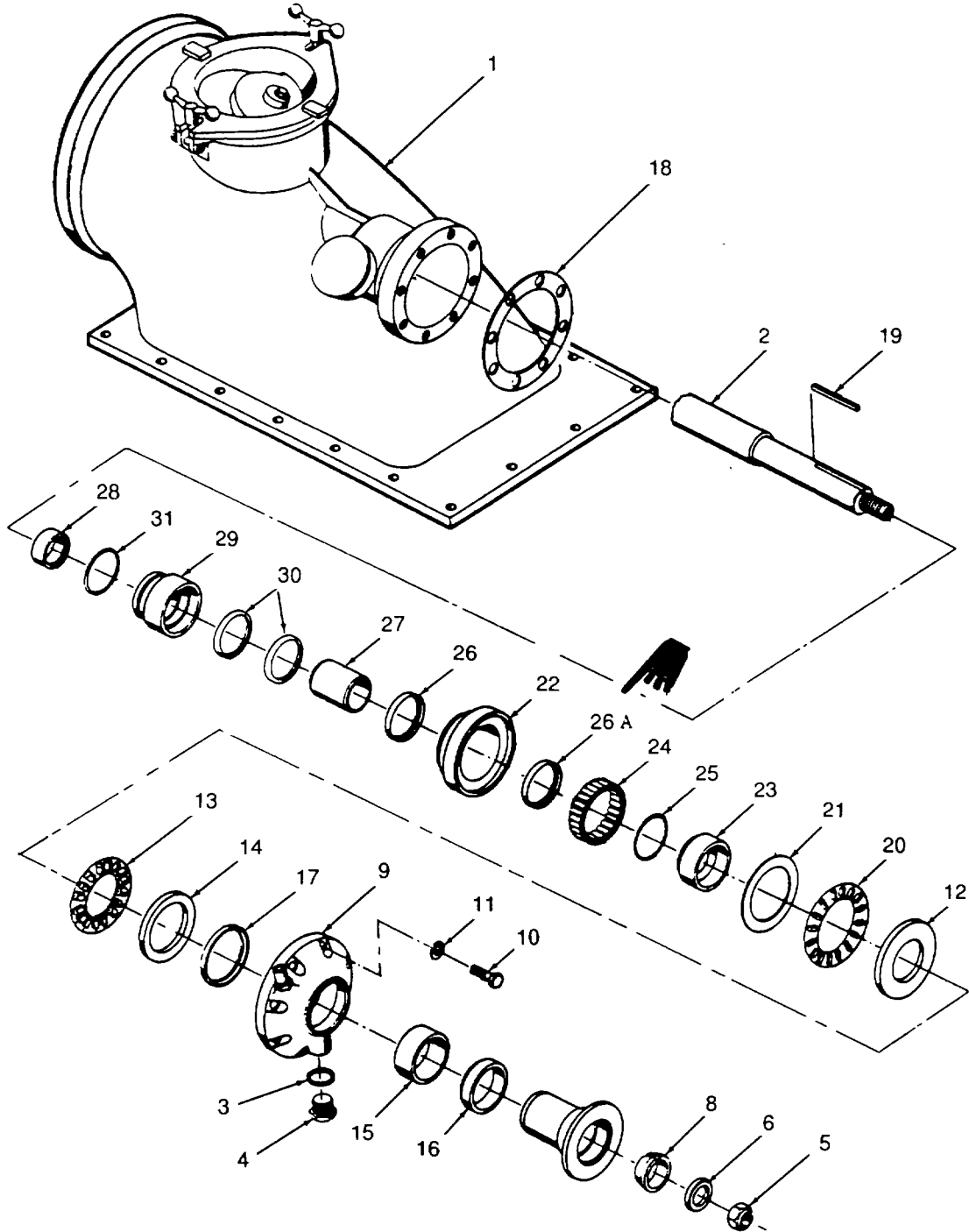
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)



Change 5 3-184

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)			
LOCATION	ITEM	ACTION	REMARKS
<u>DISASSEMBLY</u>			
1. Intake case (1)	a. Hydrojet assembly shaft (2)	Place support under rear end of shaft.	Keeps shaft level when forward supports are loosened.
	b. Washer (3) and plug (4)	a. Remove.	Use 1-1/16 in wrench.
		b. Catch oil in suitable container.	Case contains approximately 1/2 pint.
2. Hydrojet assembly shaft (2)	a. Shaft nut (5) and washer (6)	Hold drive flange (7) and remove nut and washer.	Use 30 mm socket and ratchet. Use strap wrench to hold flange.
	b. Drive flange (7)	Tap back and forward to loosen cone (8).	Use hammer.
	c. Drive flange cone (8)	Remove.	
3. Bearing cap (9)	a. 8 socket head screws (10), 8 washers (11)	Remove.	Use 8 mm hex key wrench (Allen).
	b. Bearing cap (9)	Tap lightly and remove flange (7) and bearing assembly.	Use hammer. Bearing assembly contains main thrust washer, thrust bearing, front thrust washer, front seal sleeve, spacer.

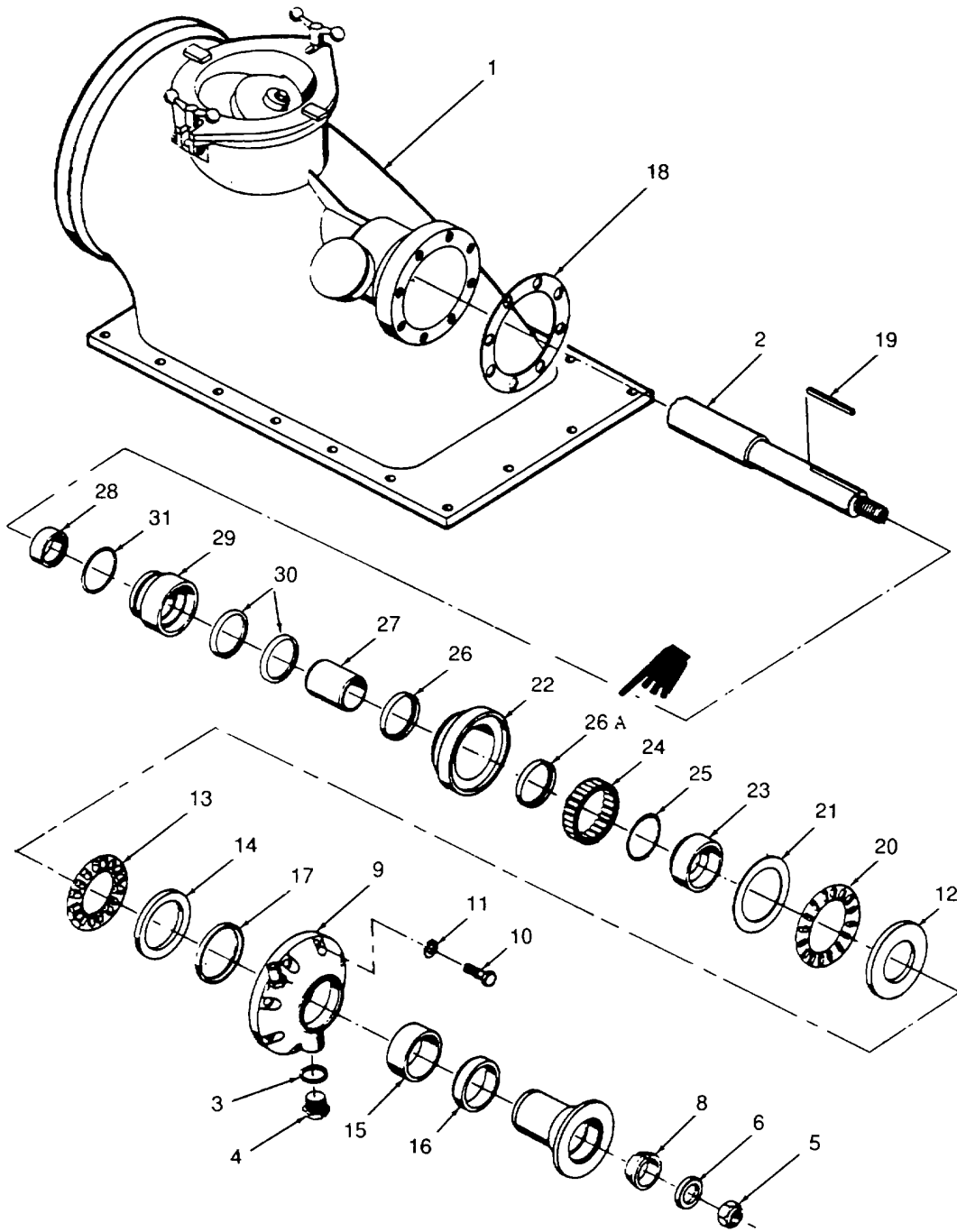
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)



Change 5 3-186

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)			
LOCATION	ITEM	ACTION	REMARKS
	c. Drive flange (7)	Slide drive flange out and then remove in order: main thrust washer (12), thrust bearing (13), front thrust washer (14), spacer (15), and front seal sleeve (16).	Lay parts in order or tag for identification.
4. Bearing cap (9)	a. Seal (17)	Remove.	Use seal puller. Note way seal is mounted.
	b. Gasket (18)	Remove and discard.	
5. Hydrojet assembly shaft (2)	a. Key (19)	Remove.	Use fingers or pliers if key sticks.
	b. Reverse thrust bearing (20)	Remove.	Slide off shaft.
	c. Reverse thrust washer (21)	Remove.	Slide off shaft.
	d. Inner seal housing (22)	a. Take two bearing cap retaining screws (10), screw into holes in housing.	Use hand or if stuck too tight use pliers.

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

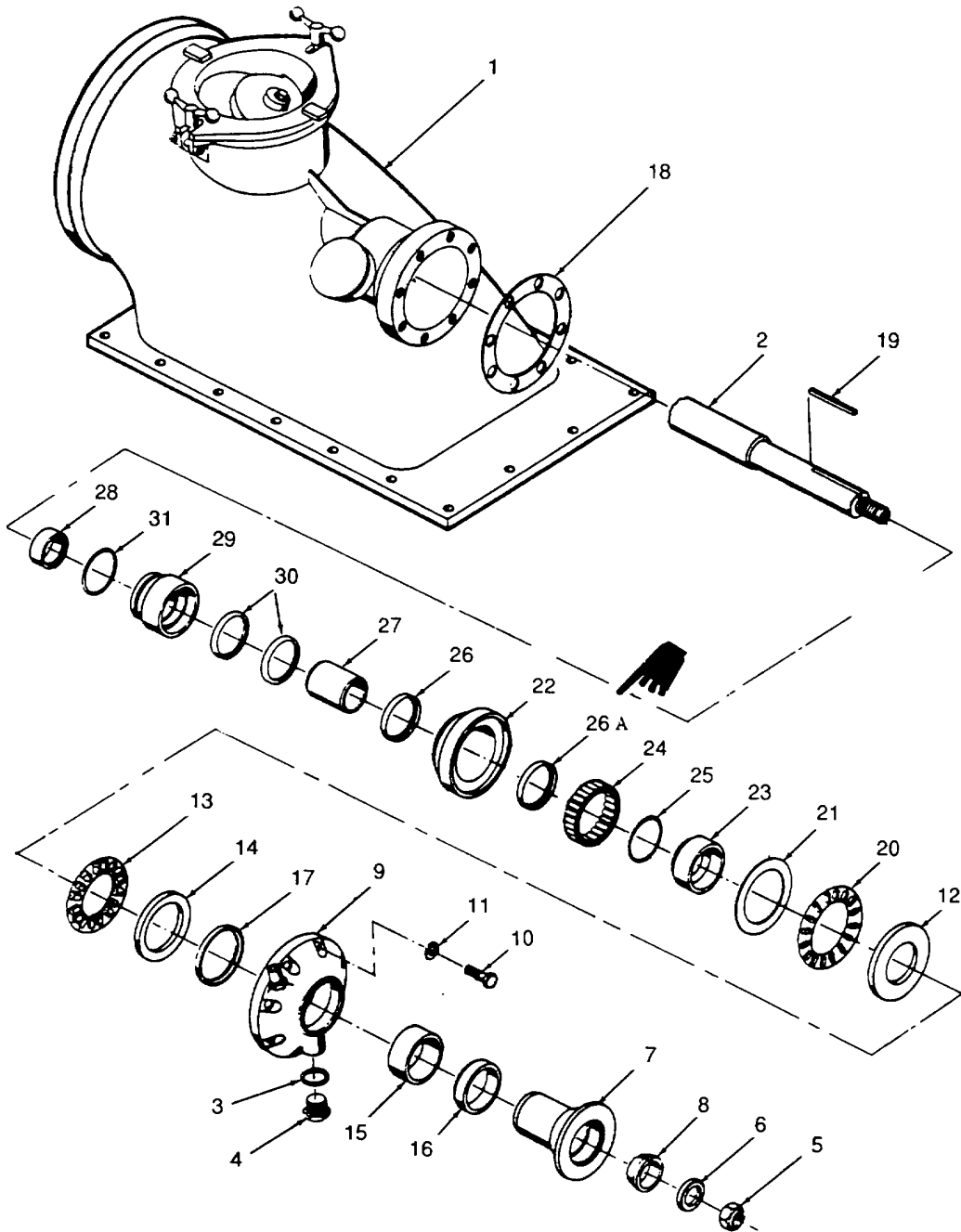


Change 5 3-188

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Pull inner seal housing out with thrust collar (23) and needle bearing (24).	
		c. Separate thrust collar from housing.	
6. Thrust collar (23)	O-ring (25)	Remove and discard.	
7. Inner seal housing (22)	a. Needle bearing (24)	a. Remove from front of housing.	Use bearing puller.
		b. Retain all bearing parts.	
	b. Seal (26) and O-Ring (26a)	Remove from rear of housing and discard.	Use seal puller. Note how seal is positioned.
8. Hydrojet assembly shaft (2)	Seal sleeve (27)	Slide off shaft.	
9. Intake case (1)	a. Hydrojet assembly shaft (2) and plain sleeve (28)	a. Remove shaft by sliding toward rear of intake case.	Plain sleeve (28) will slide out along with shaft.
		b. Slide sleeve off shaft after removal.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

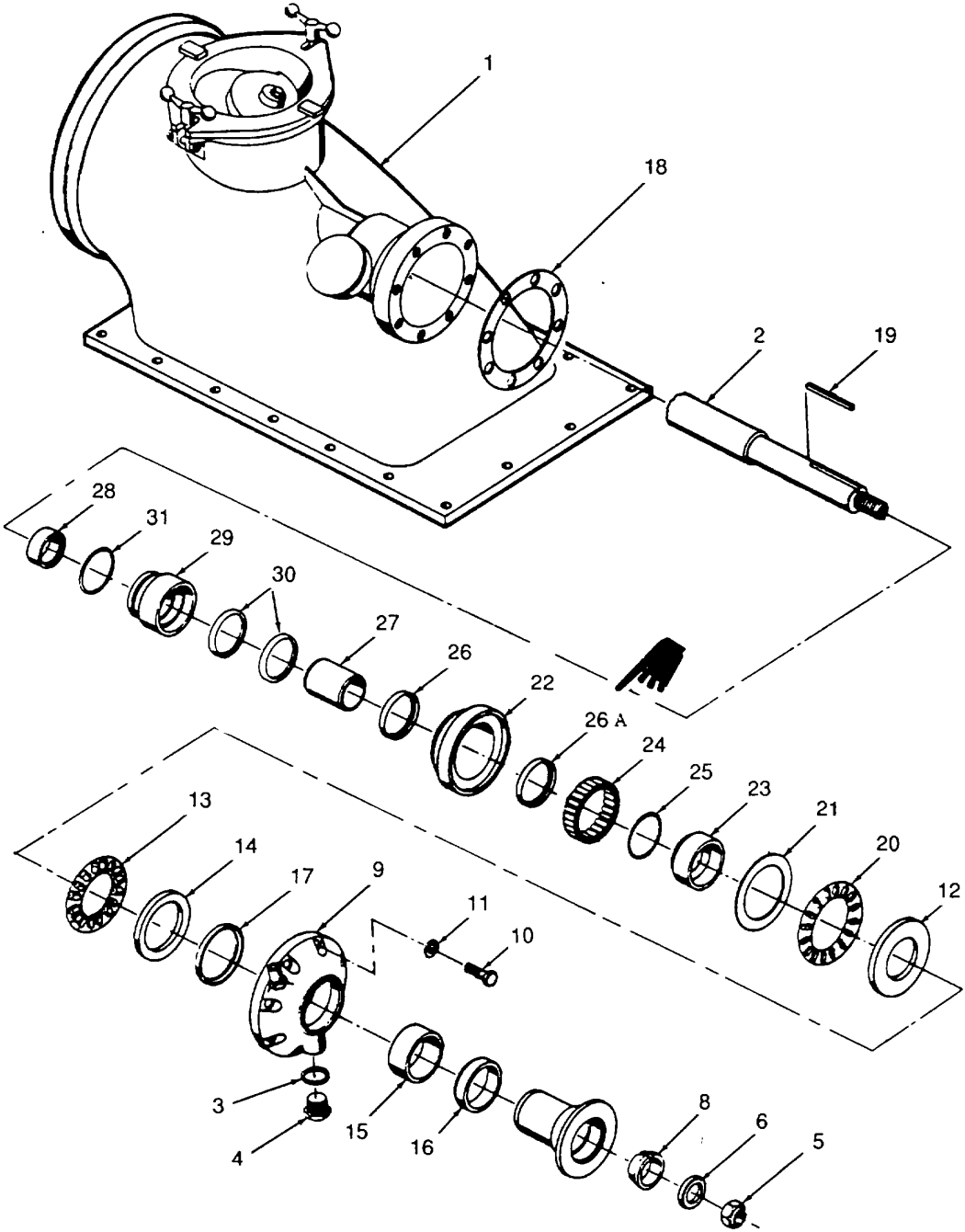


Change 5 3-190

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

LOCATION	ITEM	ACTION	REMARKS
	b. Seal housing (29)	Tap out from rear toward front.	Use hammer and drift.
	c. Seals (30)	Remove and discard.	Use seal puller.
	d. O-ring (32)	Remove from outer diameter of housing and discard.	
INSPECTION AND REPAIR			
10.	Bearings (13, 20, 24)	a. Inspect for cracks or chipped rollers or discoloration. b. Replace bearing if cracked, chipped or discolored.	
11.	Main thrust washer (12)	a. Inspect for cracks, visible steps between used and unused portion or discoloration. b. Measure washer thickness. Thickness should be not less than .4091 inch (.0161 mm).	Use feeler gage.

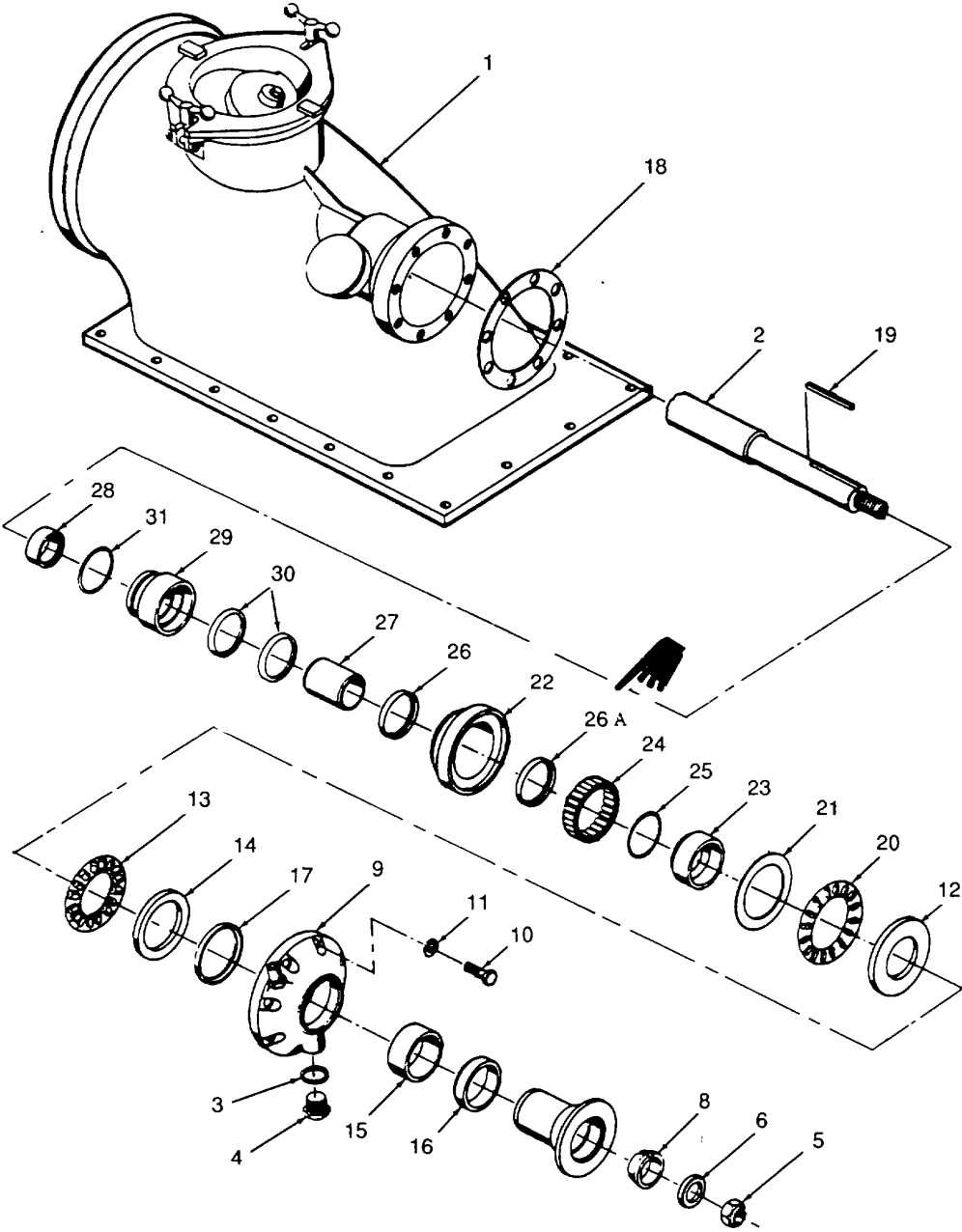
HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)



Change 5 3-192

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)			
LOCATION	ITEM	ACTION	REMARKS
12.	Reverse thrust washer (21)	<p>c. Replace if cracked, stepped, discolored from overheating or not thick enough.</p> <p>a. Inspect for cracks, visible steps between used and unused portion, or discoloration.</p> <p>b. Measure washer thickness. Thickness should be .0414 to .0374 inch (1.05 to 0.95 mm).</p> <p>c. Replace if cracked, stepped, discolored from overheating or not thick enough.</p>	Use feeler gage.
13.	Front thrust washer (14)	<p>a. Inspect for cracks, visible steps between used and unused portion or discoloration.</p> <p>b. Measure washer thickness. Thickness should be not less than .3115 inch (7.91 mm).</p>	Use feeler gage.

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

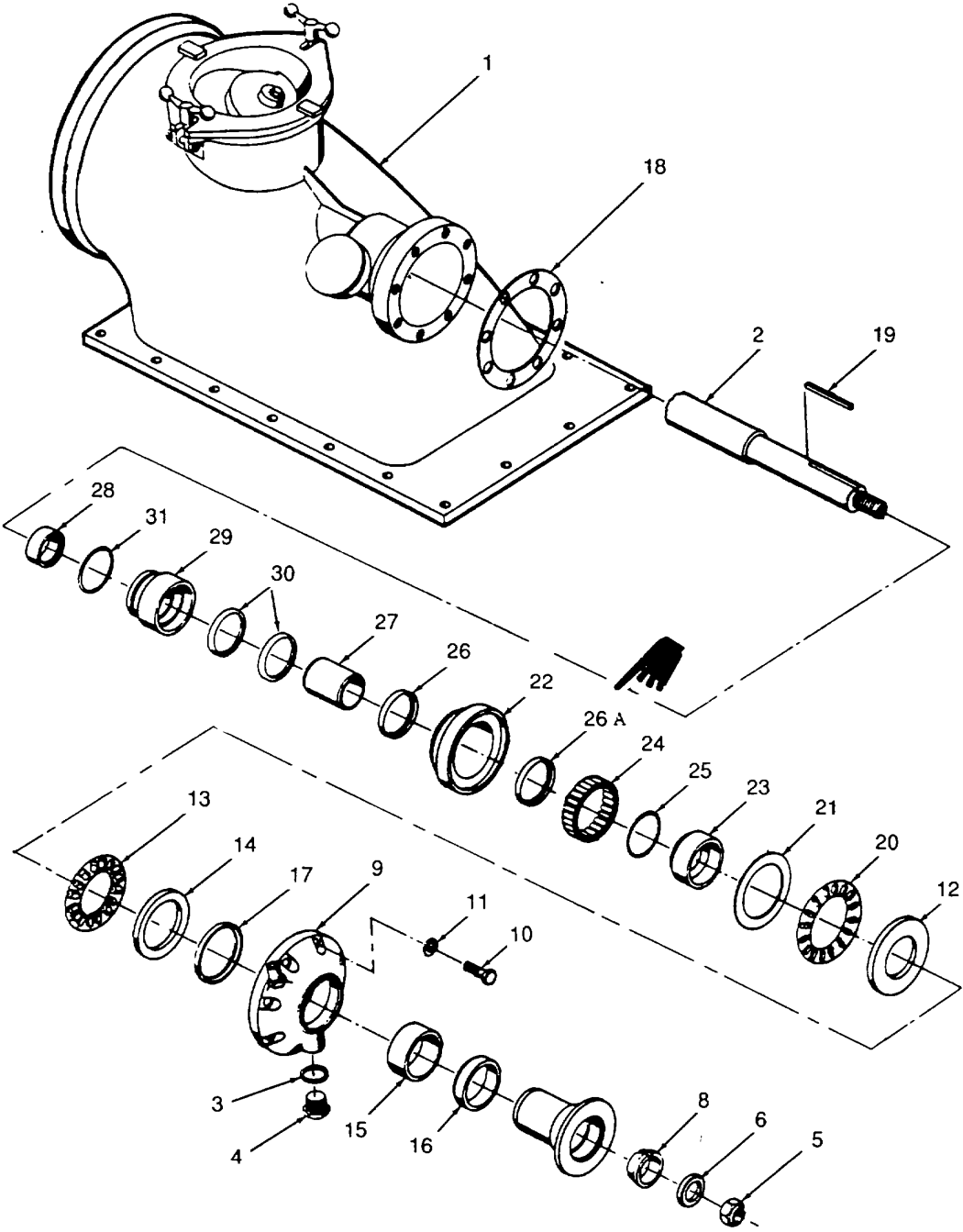


Change 5 3-194

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

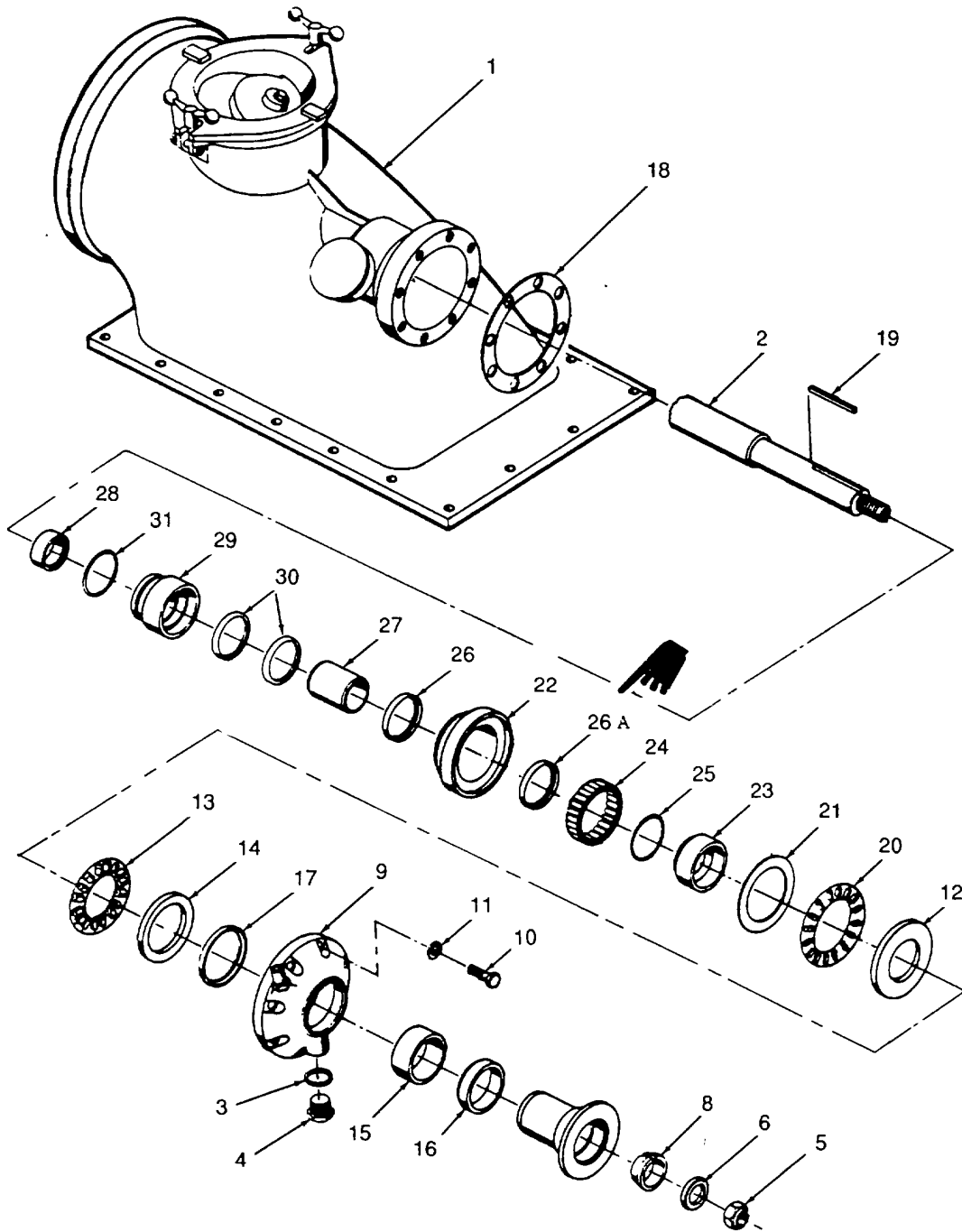
LOCATION	ITEM	ACTION	REMARKS
14.	Thrust collar (23), seal sleeves (16 and 27), plain sleeves (28)	<ul style="list-style-type: none"> c. Replace if cracked, stepped, discolored from overheating or not thick enough. a. Inspect for cracks. b. Replace if cracked. c. Polish with crocus cloth to clean. 	
<u>ASSEMBLY</u>			
15. Seal housing (29)	<ul style="list-style-type: none"> a. O-ring (31) b. Seals (30) 	<ul style="list-style-type: none"> Fit on housing. Fit into housing. 	<ul style="list-style-type: none"> Use new O-ring. Use new seals. Lip points to smaller housing diameter.
16. Intake case (1)	Seal housing (29)	<ul style="list-style-type: none"> a. Fit into housing. b. Insert from front toward rear. c. If necessary tap lightly to seat. 	Use drift and hammer.

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)



HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)			
LOCATION	ITEM	ACTION	REMARKS
17. Hydrojet assembly shaft (2)	Plain sleeve (28)	Slide on shaft.	
18. Intake case (1)	Hydrojet assembly shaft (2)	Fit into case from rear.	Support at end as in disassembly.
19. Hydrojet assembly shaft (2)	Seal sleeve (27)	Slide on shaft.	
NOTE			
Pack cavity around seal housing-with grease and remove bearing grease cap (32) to relieve pressure before next step.			
20. Inner seal housing (22)	a. Needle bearing (24)	Fit into housing.	Fits in front. Grease to hold in position.
	b. Shaft seal (26)	Fit into housing.	Use new seal. Position lip toward large diameter.
	c. O-Ring (26a)	Fit around housing.	Use new O-Ring.
21. Intake case (1)	Inner seal housing (22)	a. Fit into case.	
		b. Slide on over shaft.	
22. Thrust collar (23)	O-ring (25)	Fit to collar.	Use new O-ring.
23. Hydrojet assembly shaft (2)	a. Thrust collar (23)	Fit over shaft.	
	b. Thrust washer (21)	a. Fit over shaft on outside of needle bearing.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

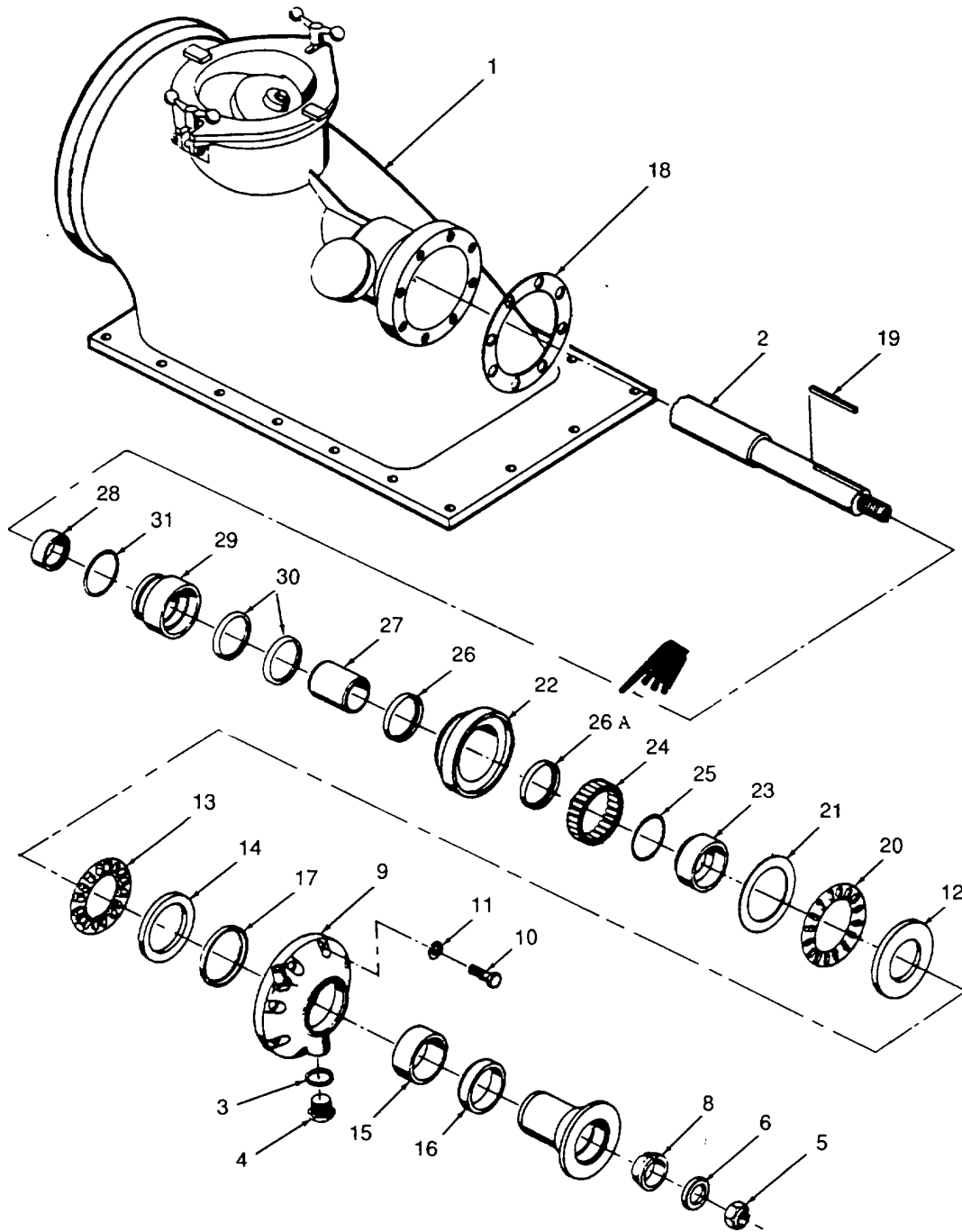


Change 5 3-198

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)

LOCATION	ITEM	ACTION	REMARKS
		b. Grease lightly to hold.	
	c. Reverse thrust bearing (20)	a. Fit over shaft on outside of needle bearing.	
		b. Grease lightly to hold in position.	
24. Bearing cap (9)	a. Seal (17)	Fit into cap.	Use new seal Position lip toward open face of cap.
	b. Gasket (18)	a. Lightly grease and stick to cap.	
		b. Aline bolt holes.	
25. Drive flange (7)	a. Seal sleeve (16)	Slide on flange.	
	b. Bearing cap (9)	Slide over seal sleeve on flange.	
	c. Spacer (15)	Slide on flange.	
	d. Thrust washer (14)	Fit into bearing cap.	
	e. Thrust bearing (13)	a. Fit into bearing cap.	

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)



Change 5 3-200

HYDROJET ASSEMBLY REPAIR INSTRUCTIONS-TWO STAGE DRIVE SECTION (Continued)			
LOCATION	ITEM	ACTION	REMARKS
		b. Grease to hold in position.	
	f. Main thrust washer (12)	Fit into bearing cap.	
26. Hydrojet assembly shaft (2)	a. Key (19)	Fit into groove on shaft.	
	b. Bearing cap (9) subassembly	Slide on shaft.	Assembly includes drive flange.
27. Bearing cap (9)	8 washers (11) and 8 socket head screws (10)	Install.	When installing cap make sure oil connection is straight up.
28. Hydrojet assembly shaft (2)	a. Drive flange cone (8)	Slide over shaft and key.	
	b. Washer (6) and main shaft nut (5)	a. Put nonhardening loc-tite on threads and install washer and nut.	Flange side of washer goes toward cone (18).
		b. Tighten to 150 ft-lb.	
29. Bearing cap (9)	Washer (3) and plug (4)	Install in cap (9).	

APPENDIX A

REFERENCES

A-1. Fire Protection	
TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users
A-2. Lubrication	
C9100-IL	Identification List for Fuels, Lubricants, Oils and Waxes
LO 5-1940-277-12/ LI 1940-12	Lubrication Order
A-3. Maintenance	
TM 43-0139	Painting Instructions for Field Use
TB 750-651 K	Use of Antifreeze Solutions and Cleaning Compounds in Cooling System
DA Pam 738-750	The Army Maintenance Management System (TAMMS)
TM 5-1940-277-20	Organizational Maintenance Manual for Boat, Bridge Erection, Twin Jet, Aluminum Hull, Models USCSBMK1 and USCSBMK2
TM 5-1940-277-20P	Organizational Repair Parts and Special Tools List for Boat. Bridge Erection, Twin Jet, Aluminum Hull, Models USCSBMK1 and USCSBMK2
TM 5-1940-277-34P	Direct and General Support Repair Parts and Special Tools List for Boat, Bridge Erection, Twin Jet, Aluminum Hull, Models USCSBMK1 and USCSBMK2
TM 9-4910-458-12	Operator and Organizational Maintenance Manual, Test Stand, Automotive Generator, Alternator and Starter
TM 9-6140-200-14	Operation and Organizational, Field, and Depot Maintenance: Storage Batteries, Lead-Acid Type
TM 9-247	Materials Used for Cleaning, Preserving, Abrading and Cementing Ordnance Material
TM 9-214	Inspection, Care, and Maintenance of Anti-friction Bearings

TM 5-2090-202-12&P	Operator and Organizational Maintenance Manual, Cradle, Twin Jet, Bridge Erection Boat
TM 9-237	Operator's Manual for Welding Theory and Application
TM 4700-15/1	Equipment Record Procedures
A-4. Shipment and Storage	
TB 740-93-4	Preservation of Vessels for Storage
TB 55-46-1	Standard Characteristics (Dimensions, Weight, and Cube) for Transportability of Military Vehicles and Other Outsize/Overweight Equipment
A-5. Destruction to Prevent Enemy Use	
TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use
A-6. Forms	
DA Form 2028	Recommended Changes to Publications and Blank Forms
DA Form 2028-2	Recommended Changes to Equipment Technical Publications
DA Form 2408-9	Equipment Control Record
MCO 1650.17	Marine Corps Military Incentive Awards Program
MCO 4855.10	Quality Deficiency Report for MC Users
NAVMC Form 10772	Recommended Changes to Technical Publications
SF 368	Quality Deficiency Report
A-7. Miscellaneous	
FM 21-11	First Aid for Soldiers

APPENDIX B

EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

B-1. SCOPE

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

B-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 parentheses 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.

Change 4 B-1

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	O	9150-00-190-0907	GREASE, AUTOMOTIVE AND ARTILLERY (GAA), (81349) MIL-G-10924	CN
2	O	8030-00-889-3535	TAPE, ANTISEIZE, SIZE 1/2" X 260" (18876) 11072502	RO
3	O	8330-00-538-5212	SEALANT, SILICONE (71984) 732RTV	TB
4	O	8305-00-267-3015	CLOTH, COTTON, CHEESE (81348)	YD
5	O	7930-00-249-8036	DETERGENT, GENERAL PURPOSE (81348) P-D-220	
6	C	9150-00-186-6681	OIL, ENGINE, OE/HDO-10 MIL-L-2104	QT
7	C	9150-00-177-3988	OIL, ENGINE OE/HDO-10 MIL-L-2104	QT
8	C	9140-00-286-5296	FUEL, DIESEL, DF-2, VV F-800 (81348) 5 GALLON DRUM	GA
9	O		ANTIFREEZE, ETHYLENE GLYCOL INHIBITED, HEAVY DUTY, SINGLE PACKAGE, MIL-A-46153	GA
10	O	6850-00-274-5421	DRY CLEANING SOLVENT P-D-680, TYPE II (81348) 5 GALLON DRUM	GA
11	O	7510-00-285-6403	TAPE, PSA, CELLULOSE, BLACK (81349) MIL-T-40620	RO
12	F	8040-00-221-3811	ADHESIVE, RUBBER BASE, GENERAL PURPOSE (80244) MM-A-1617 TYPE II	BT
13	F	9320-01-165-0861	GASKET, RUBBER (81346) ASTM-D2000	RO

APPENDIX C**ILLUSTRATED LIST OF MANUFACTURED ITEMS****INTRODUCTION**

This appendix includes complete instructions for making items authorized to be manufactured or fabricated at direct and general support maintenance level.

A part number index in alphanumeric order is provided for cross-referencing the part number of the item to be manufactured to the figure which covers fabrication criteria.

All bulk material needed for manufacture of an item is listed in a tabular form for each illustration.

MANUFACTURED ITEMS PART NUMBER INDEX

C-1. Bearing Assembly Tool

C-2. Clutch and Planetary Assembly Fixture

C-3. Control Valve Assembly Fixture

C-4. Pump Oil Seal Sleeve

MANUFACTURED ITEMS ILLUSTRATIONS

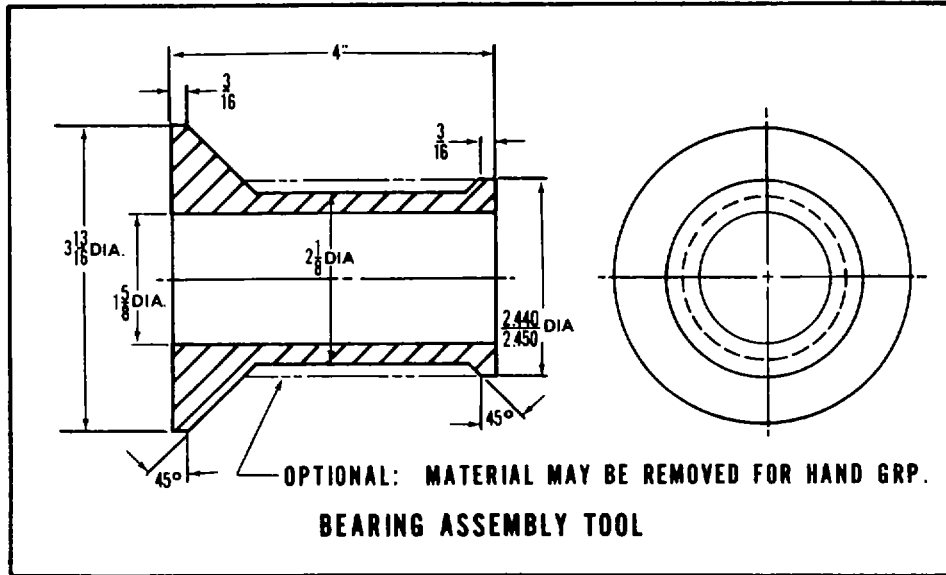


Figure C-1

Low Carbon Steel Bar 3-7/8 in diameter x 4 in long

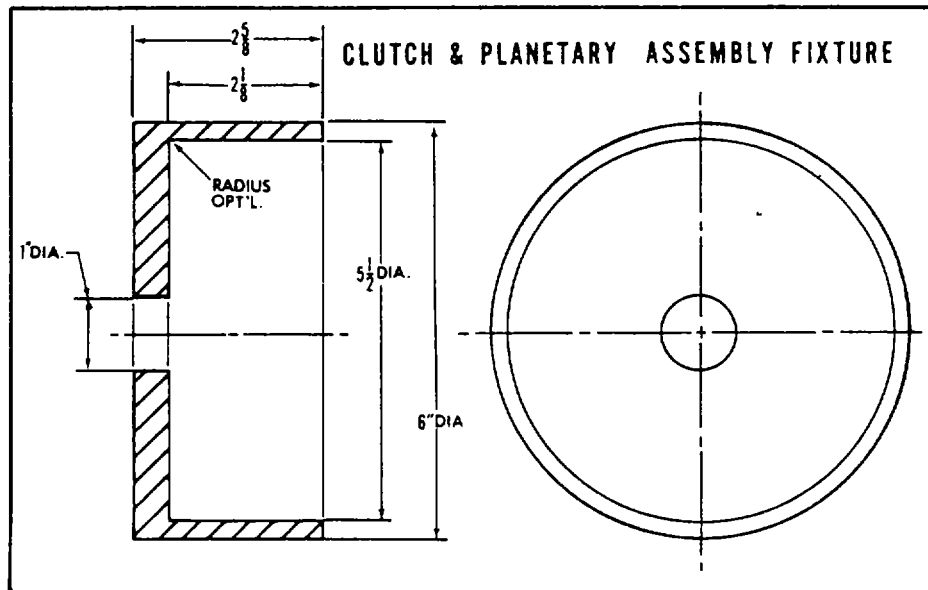
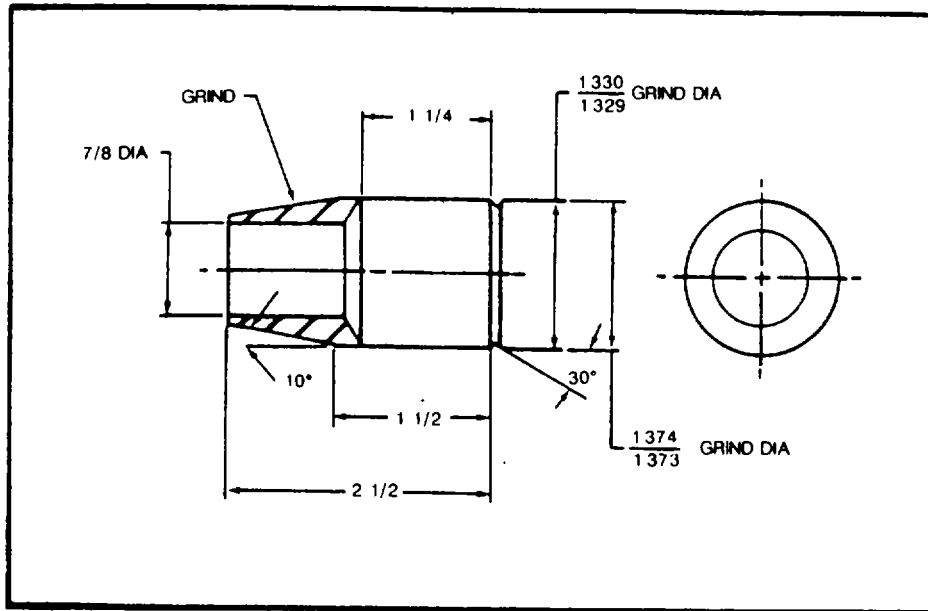


Figure C-2

Round Mechanical Tubing Carbon Steel

6 in OD x 1/4 in wall thickness x 2-1/8 in long

Carbon Steel Flat Plate 12 in x 12 in x 1/2 in thick



PUMP OIL SEAL SLEEVE

Figure C-3.

Low Carbon Stock 1-3/8 in Diameter x 2-1/2 in Long

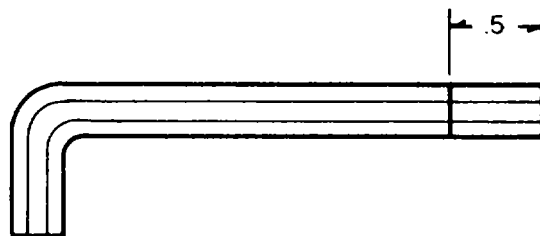


Figure C-4.

Cut 1/2 in from Standard 3/8 in Allen Wrench (L TYPE)

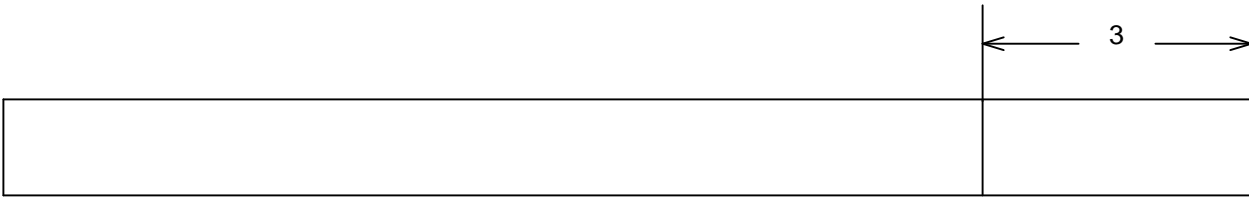


Figure C-5.

Cut 3 in from Brass Welding Rod 1/8 in Dia.

APPENDIX D

GLOSSARY

Section I. ABBREVIATIONS

cc	cubic centimeters
dc	direct current
rpm	revolutions per minute

Section II. DEFINITION OF UNUSUAL TERMS

Aft - At, near or toward rear of boat.

Bow - Front of boat.

Forward - At or toward front of boat.

Gearbox - Transmission.

HydroJet - Water Jet propulsion system.

Port - Left side of boat looking toward bow.

Sedimenter - Fuel strainer and water collector.

Starboard - Right side of boat looking toward bow.

Stern - Rear of boat.

Tachgenerator - Low voltage generator whose output indicates engine rpm.

Thermostart unit - A combined fuel Jet and glow plug used to pre-heat air going into intake manifold.

Transom - Stern structural member of boat.

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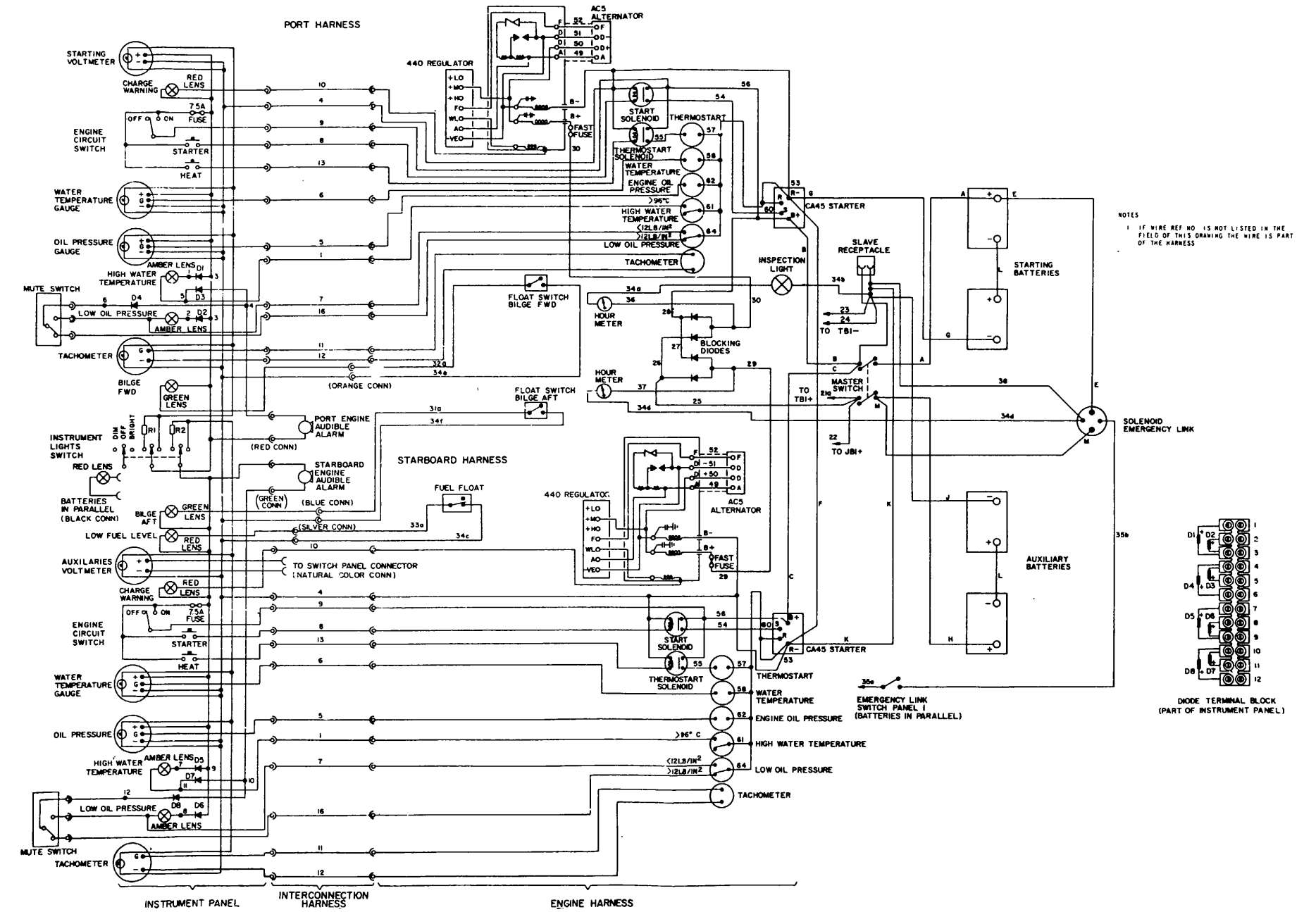
WIRE INDEX 1

REF NO.	COLOR	FUNCTION	WIRE SIZE (AWG)
1	YELLOW/BLUE	HIGH WATER TEMP LIGHT	16
2	WHITE/VIOLET	SPARE	16
3	RED/WHITE	SPARE	14
4	BLACK	NEGATIVE	14
5	YELLOW	ENG OIL PRESSURE	16
6	WHITE/BLUE	WATER TEMP	16
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14	RED/BLACK	SPARE	14
15	BLACK/WHITE	SPARE	16
16	BLACK/YELLOW	LOW OPRS/WATER HTM ALARM	16
25	RED	CHARGING CIRCUITS	10
26	BROWN/WHITE	CHARGING CIRCUITS	10
27	YELLOW	CHARGING CIRCUITS	10
28	BROWN/YELLOW	CHARGING CIRCUITS	10
29	WHITE/RED	CHARGING CIRCUITS	10
30	WHITE/RED	CHARGING CIRCUITS	10
31	PINK	AFT BILGE FLOAT LIGHT	16
32	WHITE	AMID BILGE FLOAT LIGHT	16
33	PURPLE/RED	FUEL LEVEL FLOAT LIGHT	16
35	BROWN	+ VE EMERGENCY LINK	14

INTERCONNECTION HARNESS AND ENGINE HARNESS

WIRE INDEX 1 (CONTINUED)

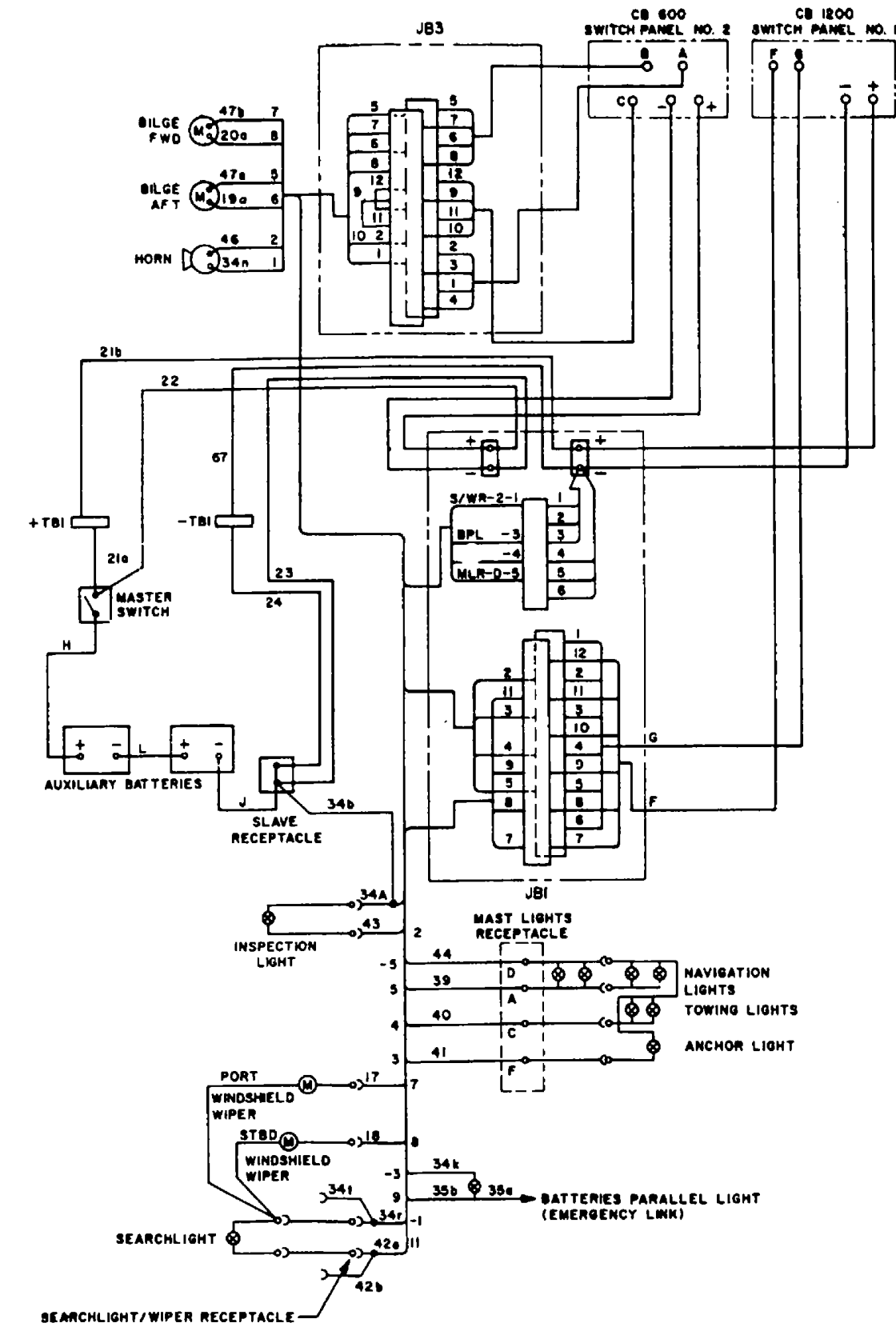
REF NO.	COLOR	FUNCTION	WIRE SIZE (AWG)
36	PURPLE/WHITE	HOUR METER	16
37	BLUE/GREEN	HOUR METER	16
38	BLACK	- VE EMERGENCY LINK	14
49	BLUE	ALTERNATOR	16
50	BROWN	ALTERNATOR + OUT	12
51	BLACK	ALTERNATOR - OUT	12
52	GREEN	ALTERNATOR	16
53	BLACK	STARTER NEGATIVE STUD	12
54	GREEN/BROWN	STARTER ENERGIZE	14
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57	BLACK	THERMAL START NEGATIVE	16
58	BLACK	NEGATIVE	16
59	BLACK	SPARE NEGATIVE	16
60	BLACK	STARTER NEGATIVE	16
61	BLACK	HIGH WATER TEMP. WARN	14
		NEGATIVE	
62	BLACK	OIL PRESSURE SENSOR	16
		NEGATIVE	
63	BLACK	SPARE NEGATIVE	16
64	BLACK	LOW OIL PRESSURE	16
		WARNING NEGATIVE	
68	RED	AUX VOLTMETER	16



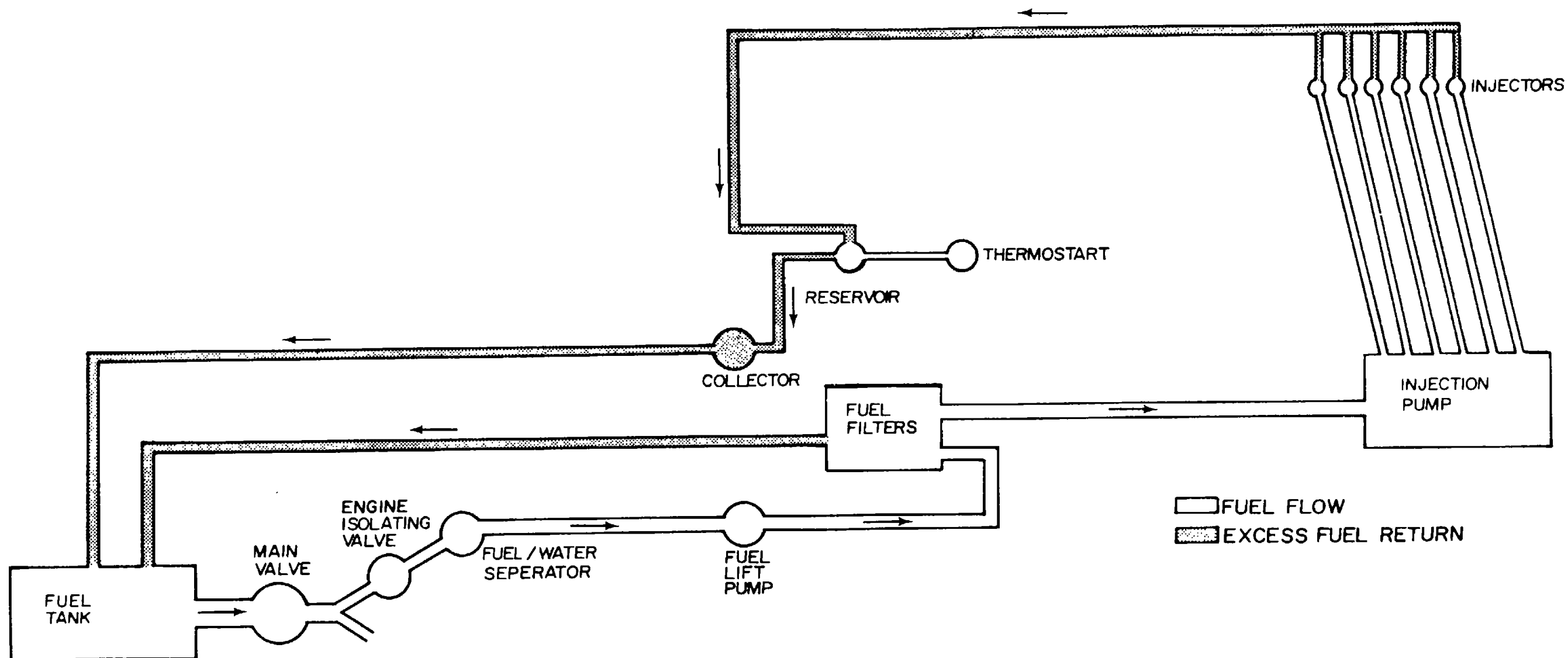
(FO-1, FO-1.1, FO-1.2 deleted) - Wiring Diagram (Sheet 1 of 2) Change 7 FO-1.3

WIRE INDEX 2

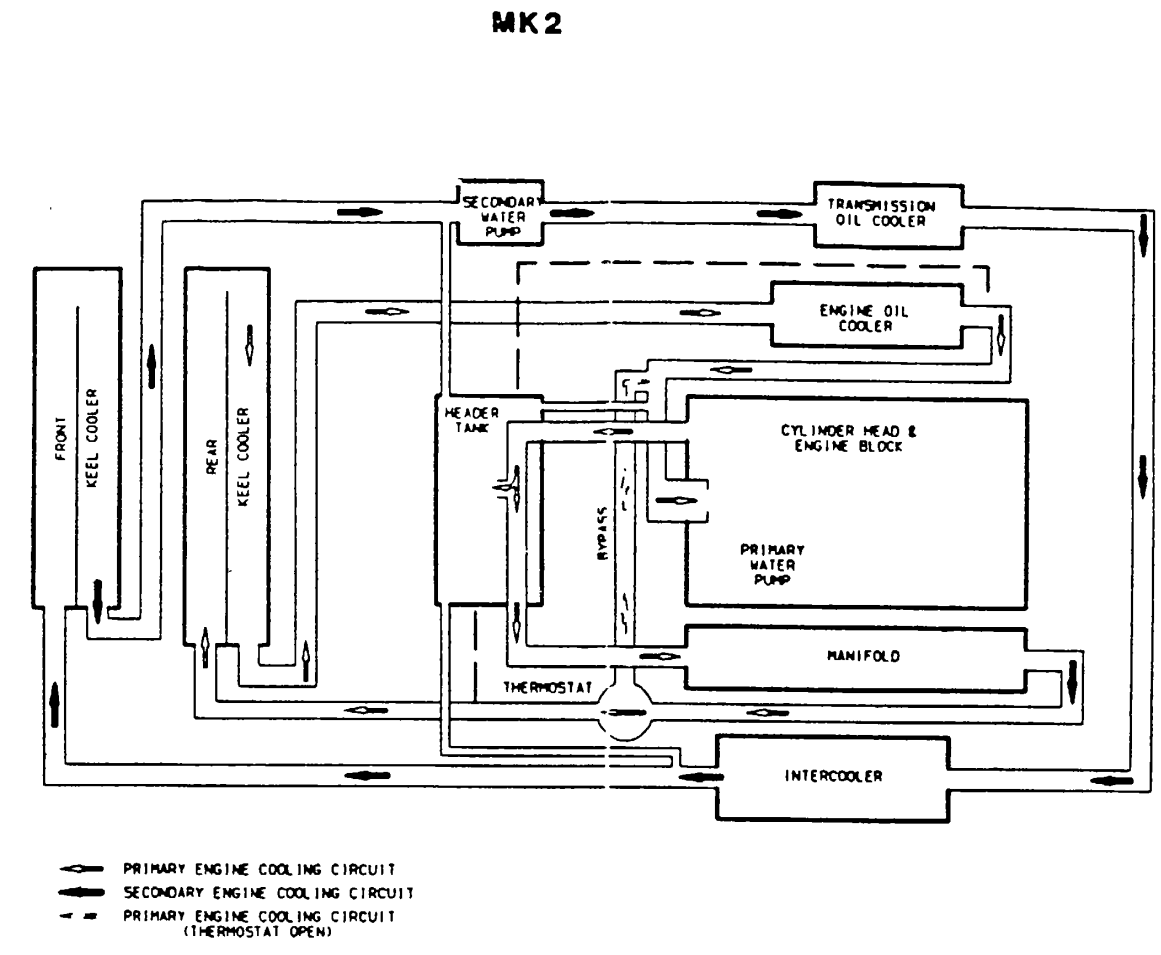
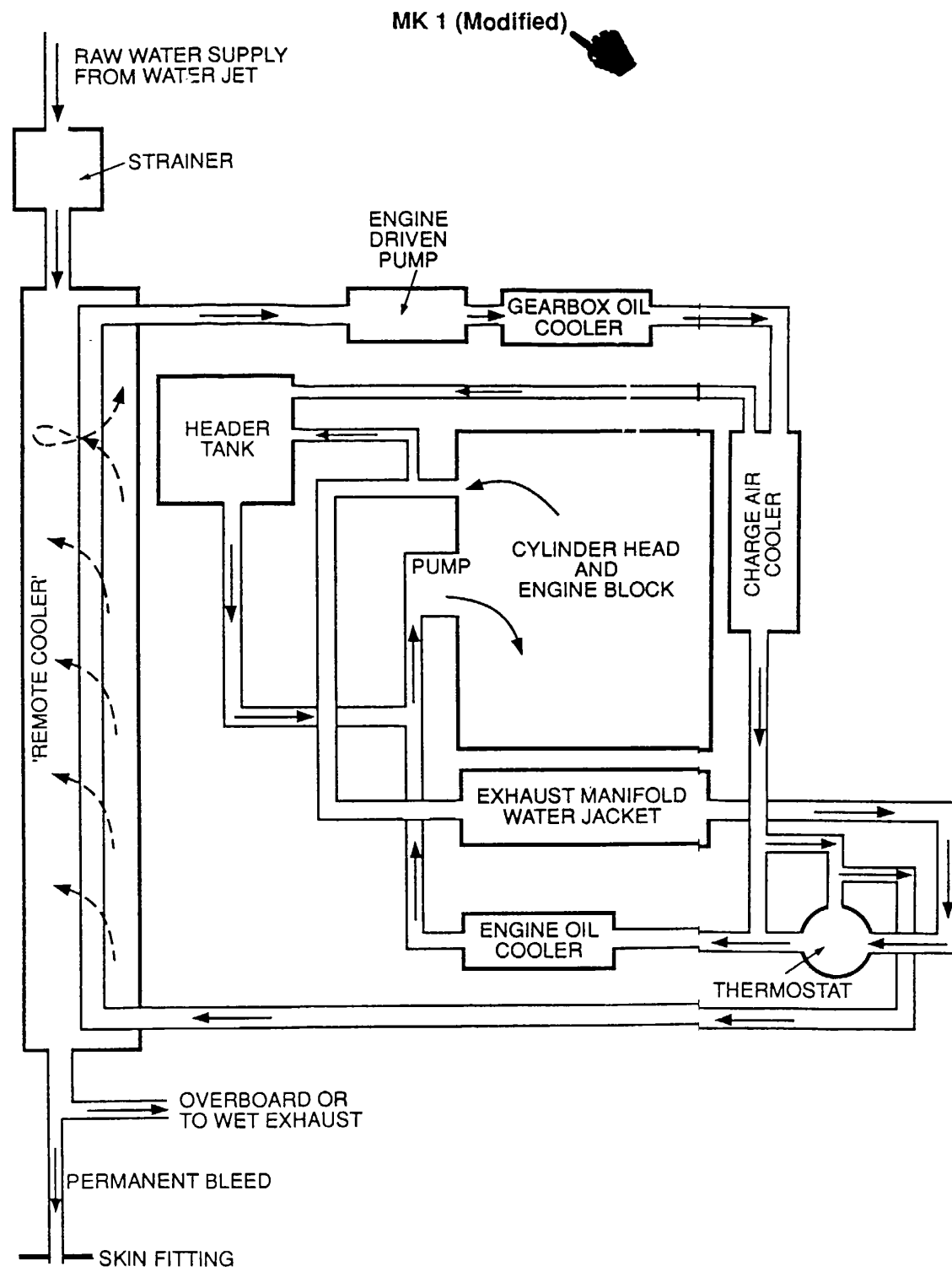
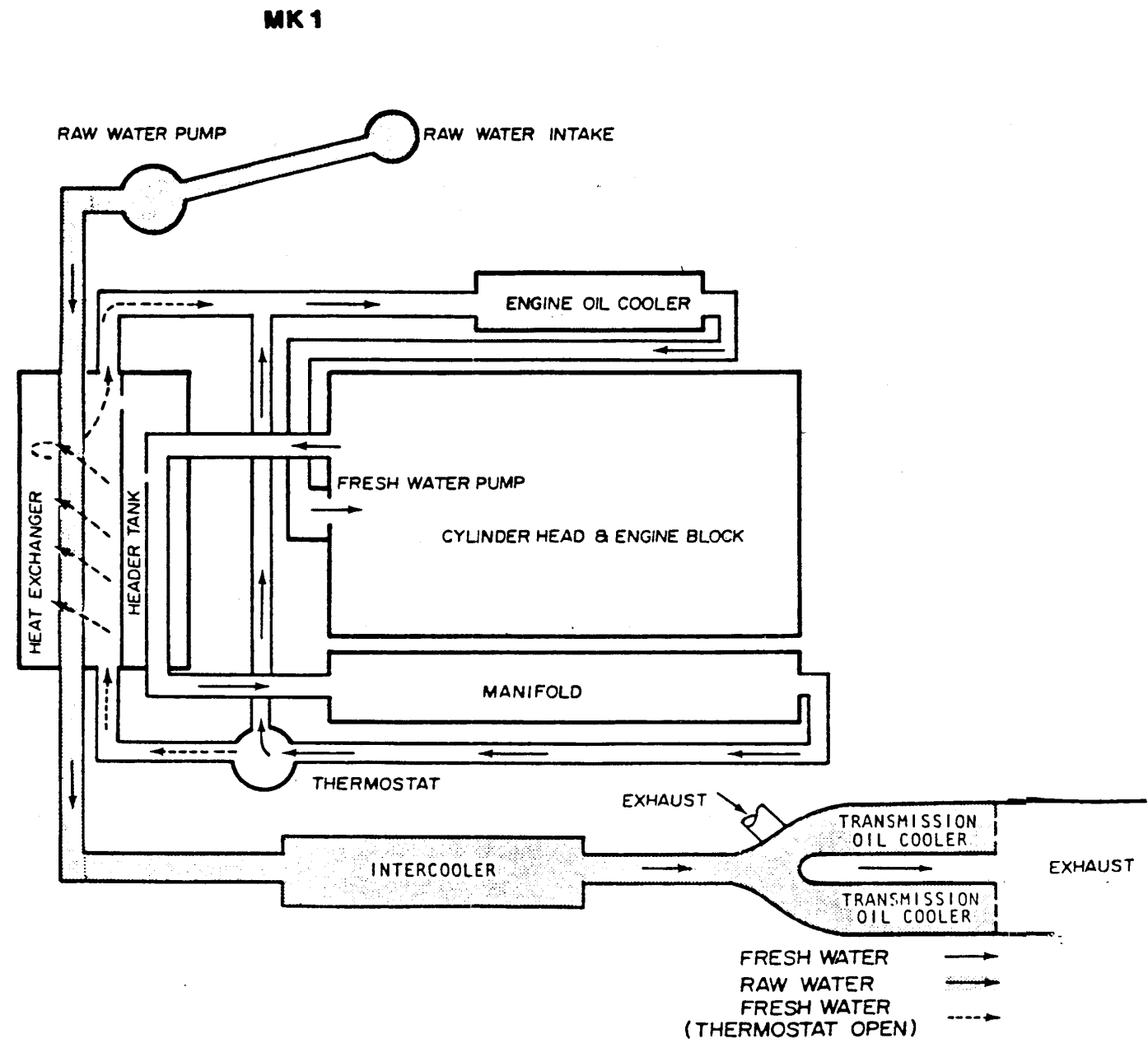
REF NO.	COLOR	FUNCTION	WIRE SIZE (AWG)
17	YELLOW/BROWN	WIPER PORT	16
18	GREEN/RED	WIPER STBD	16
19	GREEN	AFT BILGE PUMP	12
20	WHITE	FWD BILGE PUMP	12
21	RED	+ VE AUX CIRCUITS	8
22	RED	+ VE AUX CIRCUITS	8
23	BLACK	- VE AUX CIRCUITS	8
24	BLACK	- VE AUX CIRCUITS	8
34	BLACK	NEGATIVE	16
35	BROWN	+ VE EMERGENCY LINK	14
39	BLUE	NAV. LIGHTS	16
40	BROWN	TOWING LIGHTS	16
41	GREEN	ANCHOR LIGHT	16
42	GREEN/BROWN	SEARCH LIGHT	16
43	RED	INSPECTION LIGHT	16
44	BLACK	NEGATIVE	14
46	GREEN/YELLOW	HORN	16
47	BLACK	NEGATIVE	12
67	BLACK	JUMPER	8



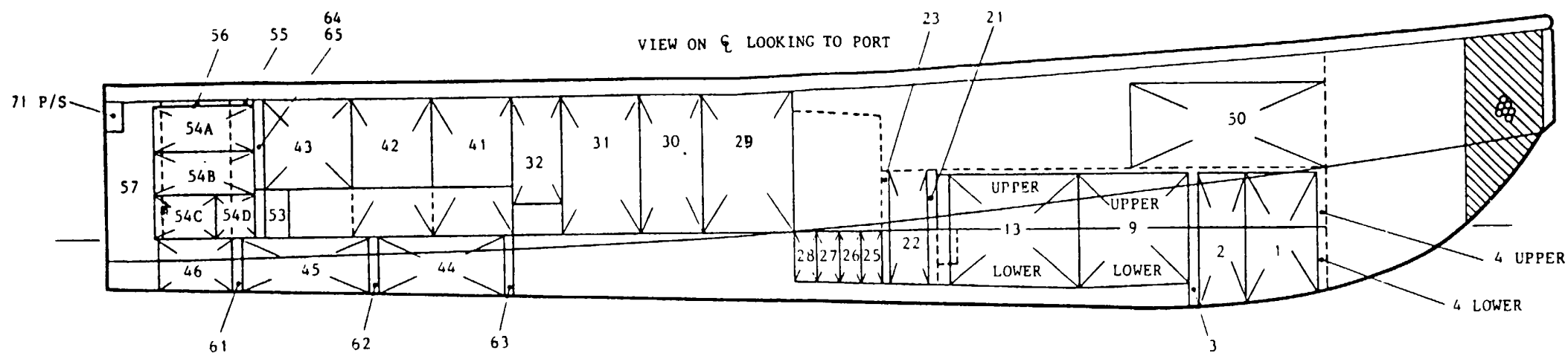
Wiring Diagram (Sheet 2 of 2) Change 7 FO-1.4



FUEL SYSTEM DIAGRAM



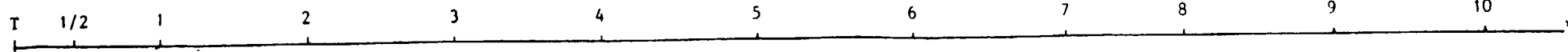
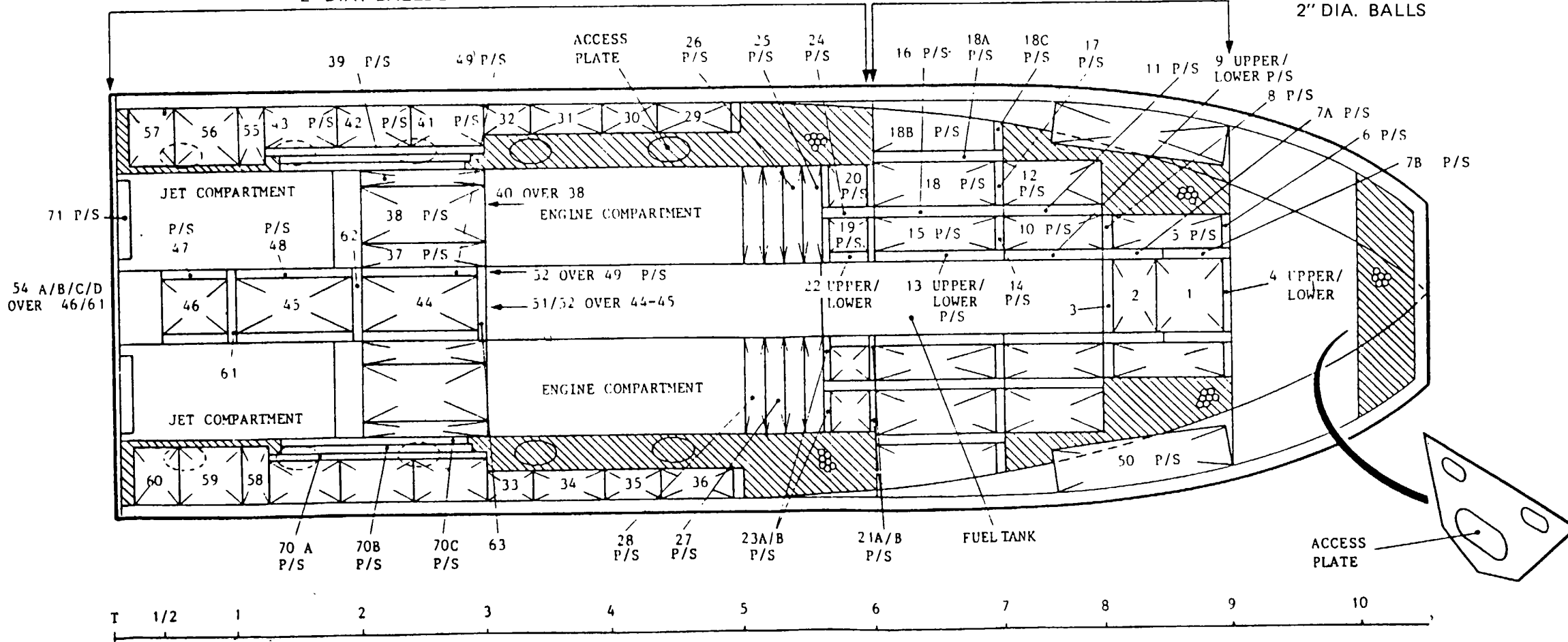
COOLING SYSTEM DIAGRAM



2" DIA. BALLS BETWEEN TRANSOM AND FR. 6 P/S

2" DIA. BALLS BETWEEN FR. 5 & 9 P/S

2" DIA. BALLS



Bouyancy Materials General Arrangement Change 4 FO-4

By Order of the Secretary of the Army:

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 decigrams = .035 ounce
 1 decagram = 10 grams = .35 ounce
 1 hectogram = 10 decagrams = 3.52 ounces
 1 kilogram = 10 hectograms = 2.2 pounds
 1 quintal = 100 kilograms = 220.46 pounds
 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
 1 deciliter = 10 centiliters = 3.38 fl. ounces
 1 liter = 10 deciliters = 33.81 fl. ounces
 1 dekaliter = 10 liters = 2.64 gallons
 1 hectoliter = 10 dekaliters = 26.42 gallons
 1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	To	Multiply by	To change	To	Multiply by
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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PIN: 049895-000