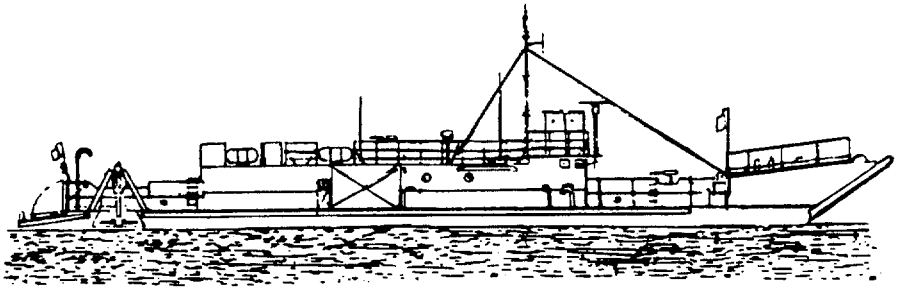
TECHNICAL MANUAL

OPERATOR'S ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

OPERATOR/CREW
MAST-CENTRALIZED HYDRAULIC SYSTEM-
STEERING SYSTEM
ANCHOR HANDLING SYSTEM
MAINTENANCE INSTRUCTIONS

LANDING CRAFT UTILITY
LCU 1671 1679
NSN 1905-01-009-1056



* This manual supersedes TM 55-1905-220-14-7, 19 September 1980

HEADQUARTERS, DEPARTMENT OF THE ARMY

31 MAY 1984

CHANGE

NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C.,31 December 1991

Operator's, Organizational,
Direct Support and General Support
Maintenance Manual

LANDING CRAFT UTILITY
LCU 1671 -1679
NSN 1905-01-009-1056

Approved for public release; distribution is unlimited

TM 55-1905-220-14-7, 31 May 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
3-3069 and 3-3070	3-3069 and 3-3070
3-3131 through 3-3134	3-3131 through 3-3134
3-3135 and 3-3136	- - - -
3-3137 through 3-3148	3-3137 through 3-3148
3-3151 through 3-3154	3-3151 through 3-3154
3-3157 through 3-3160	3-3157 through 3-3160

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:

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URGENT

CHANGE
NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 3 August 1984

Operator's, Organizational,
Direct Support, and General
Support Maintenance Manual

LANDING CRAFT UTILITY
LCU 1671-1679
NSN 1905-01-009-1056

TM 55-1905-220-14-7, 31 May 1984, is changed as follows:

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Remove pages	Insert pages
a and b	a and b
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ROBERT M. JOYCE
Major General, United States Army
The Adjutant Genera!

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25D, Operator Maintenance Requirements for Marine Equipment, A11.

WARNING

- Wear safety glasses, safety shoes, and a hard hat to provide adequate protection.
- Personnel should know the location and operation of all equipment for emergency use.
- Before attempting to operate any equipment, read the instructions completely. Then return to the appropriate section and follow the instructions.
- If cleaning agents are used, be sure area is adequately ventilated, and use protective gloves and goggles, or face shield and apron.
- When cutting with a torch, or when welding, always station fire watches, ready with fire extinguishers, in the vicinity on both sides of the plate that is being cut or welded.
- Prior to cutting or welding on the ramp, remove drain plugs on both sides of the ramp and check if ramp interior-is primer coated. If primer coated, flush thoroughly with steam, carbon dioxide, or water. Do not reinstall drain plugs until the cutting and/or welding operation is completed. Failure to take this precaution may result in explosion of accumulated primer vapors.
- When refueling, shut down the electrical system. Observe the no smoking rule. Do not permit anyone to operate tools or equipment which may produce sparks near the refueling operation. Sparks or fire may ignite the diesel fuel and produce an explosion.
- Fuel oil and other petroleum products are highly volatile in extreme heat. To minimize the possibility of explosion, wipe up all spills at once, see that fuel lines and valves are not leaking and pump bilges regularly.
- Before attempting to remove any compressed air system lines or components, relieve air pressure from system. Failure to do so may result in injury or possible death to maintenance personnel.
- Before disconnecting a line in the hydraulic system, bleed the pressure from that portion of the line. Failure to do so may result in injury or possible death to maintenance personnel.

WARNING

(Con't)

- When working inside the hydraulic oil supply tank, a portable-type circulating blower should be used to prevent vapor accumulation. For extended work periods inside the tank, an air line tube respirator should be worn. Station an observer outside tank in case worker is overcome by fumes

- Acids can cause serious burns or blindness. Avoid contact with eyes, skin, or clothing. Do not breathe vapors. Wear rubber gloves, goggles, and a rubber apron when handling them. When diluting acids, do not add water to acid; the acid must be added to the mixture slowly and with constant mixing. In case of contact with acid, flush the affected area with plenty of water and obtain medical aid immediately.

- Ramp hinge pins must be replaced one at a time, allowing three remaining pins to support ramp. Removal of two or more hinge pins may result in the weight of the ramp misaligning the remaining hinges, resulting in damage to ramp and possible injury or death to maintenance personnel.

- Use care when using power tools.

- Use the recommended air pressure when using compressed air to clean components. Too much air pressure can rupture, or in some way damage a component and create a hazardous situation that can lead to personal injury.

- Ear protection must be worn when engines or machinery are in operation.

- Avoid excessive injection of ether into an engine during starting attempts. Follow the instructions on the container or by the manufacturer of the starting aid.

- When working on an engine that is running, accidental contact with the hot exhaust manifold can cause severe burns.

- Improper functioning of the engine exhaust system can cause injury or death.

- Use extreme care when near rotating fans, belts, and pulleys.

- Keep clear of the anchor winch or bow ramp winch while it is in operation.

WARNING

(Con't)

- Do not enter the winch compartment alone.
- During any removal, disassembly, assembly, or installation of an electrical device, make sure all electrical power is disconnected and tagged (circuit breaker in the OFF position and tagged).
- Avoid making contact across the terminals of the batteries, and do not spill the contents of the battery.
- If the Halon Fire System is activated (horn sounds), leave the compartment immediately. Check that no one is left, and then close and dog the hatch.
- Use extreme care when handling gasoline for the salvage pump.
- Store ail flammable material in the flammable storage compartment.
- Death or severe injury may result if personnel fail to use a lifting device that is adequate for the item to be lifted.

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NO. 55-1905-220-14-7

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C.,31 May 1984

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LANDING CRAFT UTILITY
LCU 1671-1679
NSN 1905-01-009-1056

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, U.S. Army Troop Support Command, ATTN: DRSTR-MPS, 4300 Goodfellow Blvd., St. Louis, MO 63120. A reply will be furnished directly to you.

TABLE OF CONTENTS

SECTION V. MAINTENANCE PROCEDURES (Cont)

3-171. PISTONS, CONNECTING RODS, AND CYLINDER LINERS.

The following is an index to the piston connecting rods and cylinder liner maintenance instructions:

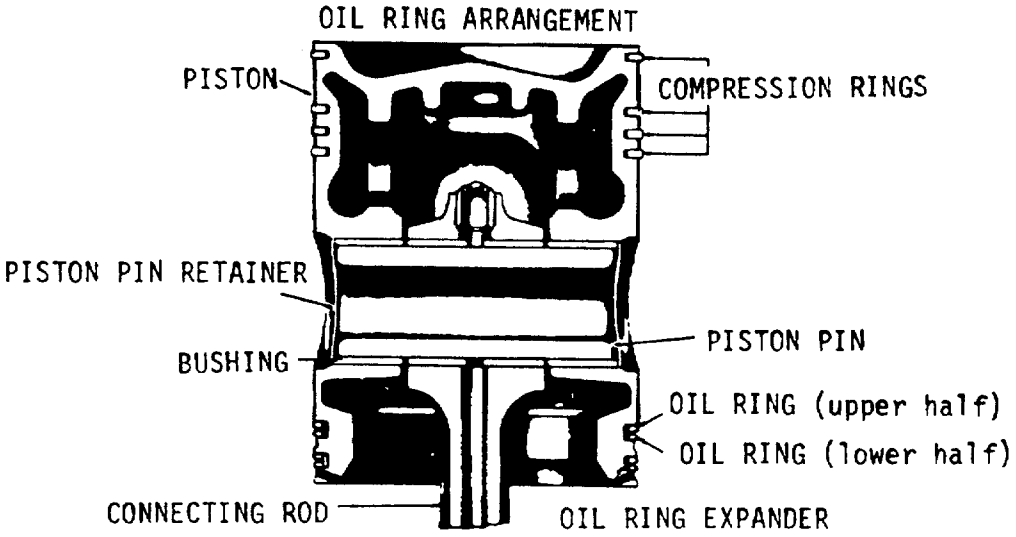
3-171.1. PISTON - MAINTENANCE INSTRUCTIONS.

a. The trunk-type malleable iron piston is plated with a protective coating of tin which permits close fitting, reduces scuffing and prolongs piston life. The top of the piston forms the combustion chamber bowl and is designed to compress the air into close proximity to the fuel spray.

b. Each piston is internally braced with fin-shaped ribs and circular struts, scientifically designed to draw heat rapidly from the piston crown and transfer it to the lubricating oil spray to ensure better control of piston ring temperature.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Continued).

c. The piston is cooled by a spray of lubricating oil directed at the underside of the piston head from a nozzle in the top of the connecting rod, by fresh air from the blower to the top of the piston and indirectly by the water jacket around the cylinder.



d. Each piston is balanced to close limits by machining a balancing rib, provided on the inside at the bottom of the piston skirt.

e. Two bushings, with helical grooved oil passages, are pressed into the piston to provide a bearing for the hardened, floating piston pin. After the piston pin has been installed, the hole in the piston at each end of the pin is sealed with a steel retainer. Thus, lubricating oil returning from the sprayed underside of the piston head and working it way through the grooves in the piston pin bushings, is prevented from reaching the cylinder walls.

f. Each piston is fitted with compression rings and oil control rings. Eight equally spaced drilled holes just below each oil control ring groove permit excess oil, scraped from the cylinder walls, to return to the crankcase.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Continued).

9. When an engine is hard to start, runs rough or lacks power, worn or sticking compression rings may be the cause. Replacing the rings will aid in restoring the engine to normal.

h. The compression rings may be inspected through the ports in the cylinder liners after the air box covers have been removed. If the rings are free and are not worn to the extent that the plating or grooves are gone, compression should be within operating specifications.

i. Excessively worn or scored pistons, rings or cylinder liners may be an indication of abnormal maintenance or operating conditions which should be corrected to avoid a recurrence of the failure. The use of the correct types and proper maintenance of the lubricating oil filters and air cleaners will reduce to a minimum the amount of abrasive dust and foreign material introduced into the cylinders and will reduce the rate of wear.

j. Long periods of operation at idle speed and the use of improper lubricating oil or fuel must be avoided, otherwise a heavy formation of carbon may result and cause the rings to stick.

k. Keep the lubricating oil and engine coolant at the proper levels to prevent overheating of the engine.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Pre-Inspection
b. Removal
c. Disassembly
d. Cleaning
e. Inspection
f. Reassembly
g. Installation

INITIAL SETUP:

Test Equipment

Feeler gage

Special Tools

Assembly tool piston ring J8128
Pump, hand NSN 4930-00-263-9886
Installer and remover piston and connecting rod bushings-J1513-02 (part J7032 and J7632

Material/Parts

Cylinder kit P/N 5149265

Personnel Required

2

References

None

Equipment Condition Paragraph | Condition Description

3-163	Oil Pan Removal
3-164	Cylinder Head Removal
3-169	Lube 0i1 Pump Removal
3-170	Oil Inlet Pipe Removal

Special Environmental Conditions

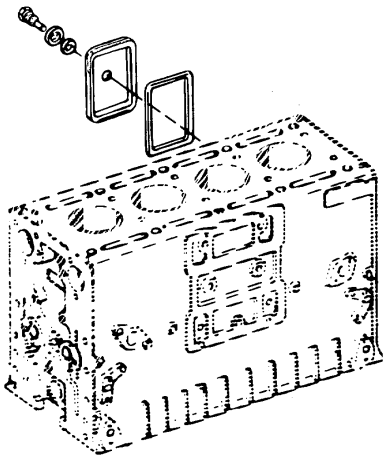
Do not drain oil into bilges.
Use the oil/water separation and recovery system to collect drained oil.

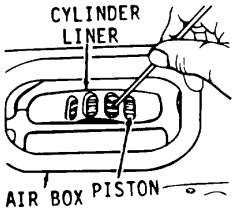
General Safety Instructions

Observe WARNING in procedure.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
PRE-INSPECTION			
1. Piston compression rings	a. Air box covers	Remove screws, flat-washers, lockwashers, covers, and gaskets.	Discard gaskets.
	b. Cylinder liners	Check that piston rings are free, and are not worn to the extent that plating or grooves are gone.	

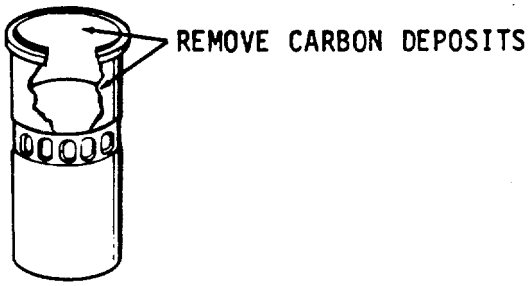




REMOVAL			
2. Piston and connecting rod	a. Cooling system	Drain.	
	b. Oil pan	1. Remove oil.	Pump oil into a suitable container.
		2. Remove pan.	Refer to paragraph 3-163.
	c. Oil inlet pipe	Remove.	Refer to paragraph 3-170.
	d. Lube oil pump	Remove.	Refer to paragraph 3-169.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	e. Cylinder head	Remove.	Refer to paragraph 3-164.
	f. Cylinder liner	1. Remove the carbon deposits from the upper inner surface of the cylinder liner.	



2. Use a ridge cutter to remove any ridges in the cylinder liner at the top of the piston ring travel.

NOTE

Move the piston to the bottom of its travel and place a cloth over the top of the piston to collect the cuttings. After the ridge has been removed, turn the crankshaft to bring the piston to the top of its stroke and carefully remove the cloth with the cuttings.

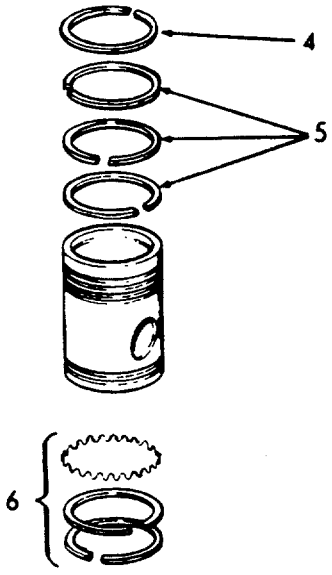
	g. Nut (1), bearing cap (2), and lower bearing shell (3)	Remove.	

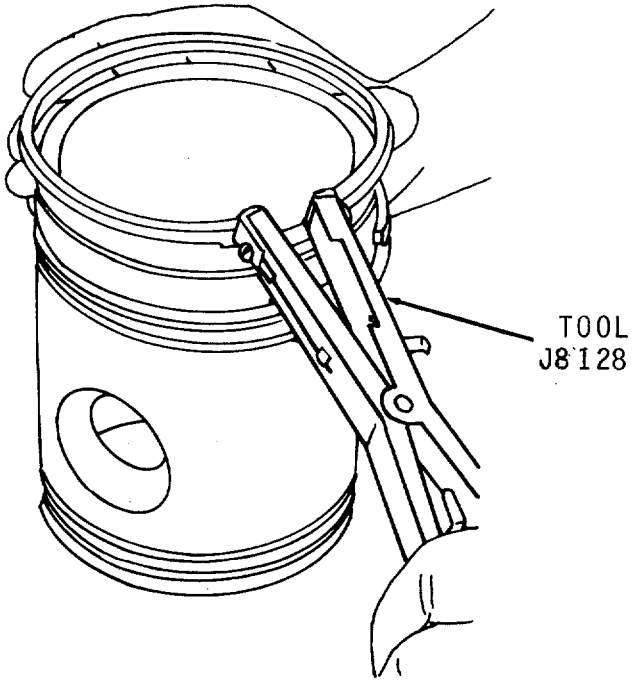
3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	h. Piston and connecting rod assembly	Push the piston and rod assembly out thru the top of the cylinder block.	The piston cannot be removed from the bottom of the cylinder block.
	i. Lower bearing shell (3), bearing cap (2), and nuts (1)	Reassemble to connecting rod.	

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

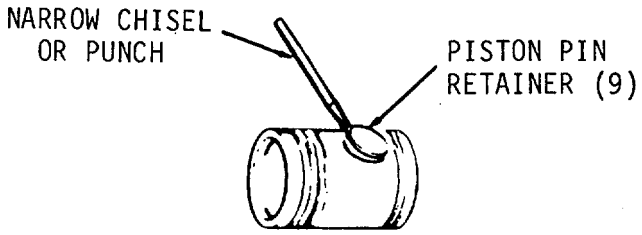
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3. Piston and Connecting rod	a. Piston and connecting rod assembly	Place connecting rod in a vise with soft jaws.	
	b. Ring (compression fire) (4)	Remove.	Use tool J8128.
	c. Rings (compression) (5)	Remove three rings.	Use tool J8128.
	d. Oil rings (6)	Remove.	Use tool J8128.



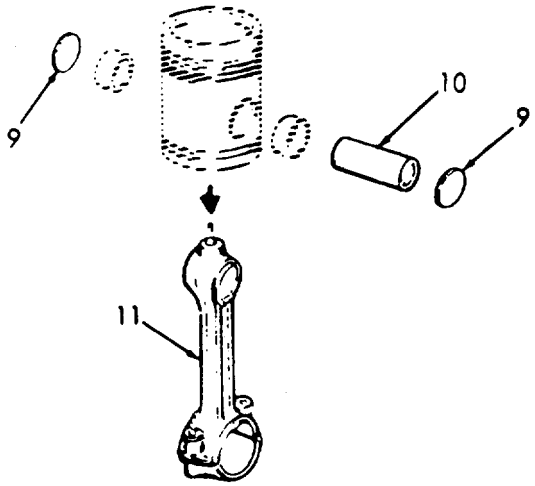


3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	e. Piston pin retainer (9)	Punch a hole thru the center of one of the piston pin retainers with a narrow chisel or punch, and pry the retainer from the piston.	Be careful not to damage the piston or bushings.



	f. Piston pin (10)	Remove.	
9.	Connecting rod (11)	Remove.	
	h. Piston pin retainer (9)	Drive out remaining retainer.	Use a brass rod or a suitable tool.



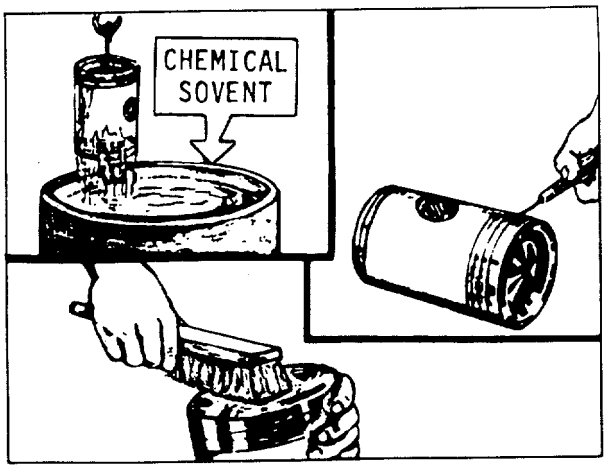
3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			

WARNING

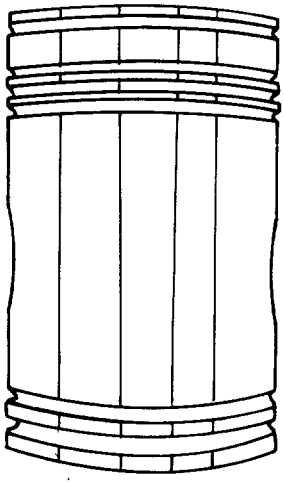
Wear protective eye goggles when using compressed air.

4.	Piston components	a. Clean the piston components with fuel oil and dry them with compressed air. If fuel oil does not remove the carbon deposits, use a chemical solvent that will not harm the piston pin bushings or the tin-plate on the piston. b. The upper part of the piston, including the compression ring lands and grooves, is not tin-plated and may be wire-brushed to remove any hard carbon. However, use care to avoid damage to the tin-plating on the piston skirt. Clean the ring grooves with a suitable tool or a piece of an old compression ring that has been ground to a bevel edge. c. Clean the inside surfaces of the piston and he oil drain holes in the piston skirt. Exercise care to avoid enlarging the holes while cleaning them.	

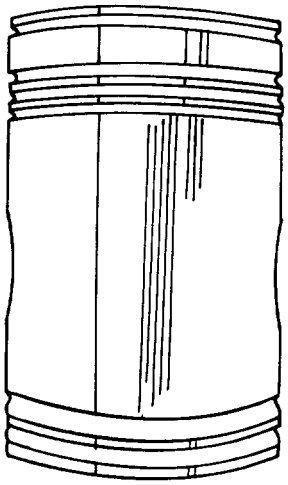


3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

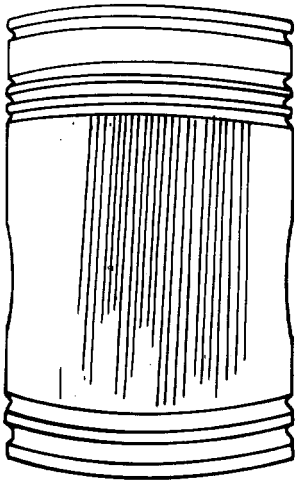
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
5. Piston		a. If the tin-plate on the piston and the original grooves in the piston rings are intact, it is an indication of very little wear.	
		b. Examine the piston for score marks, cracks, damaged ring groove lands or indications of overheating. A piston cleaned up may be reused. Any piston with light score marks which can be that has been severely scored or overheated must be replaced. Indications of overheating or burned spots on the piston may be the result of an obstruction in the connecting rod oil passage.	
		c. Replace the piston if cracks are found across the internal struts. Use the magnetic particle inspection method for locating cracks in the piston.	



THIS PISTON SUITABLE FOR INSTALLATION AS IS



SLIGHTLY SCORED, USE ONLY AFTER REMOVING SCORE MARKS BY POLISHING WITH CROCUS CLOTH OR HARD INDIA STONE



BADLY SCORED UNFIT FOR USE

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
6.	Cylinder liner and block Bore	Check the cylinder liner and block bore for excessive out-of-round, taper, or high spots which could cause failure of the piston.	Refer to paragraph 3-171.4 .
7.	Connecting rod, and piston pin	Inspect.	Refer to paragraph 3-171.2 .
8.	Piston pin bushing	Inspect and measure the piston pin bushings. The piston pin-to-bushing clearance with new parts is .0025 to .0034 inch (0.0064 to 0.0086 cm). A maximum clearance of .010 inch (0.025 cm) is allowable with worn parts. The piston pin bushings in the connecting rod are covered in paragraph 3-171.2.	
9.	Other	Other factors that may contribute to piston failure include oil leakage into the air box, oil pull-over from the air cleaner, dribbling injectors, combustion blow-by, and low oil pressure (dilution of the lubricating oil).	
REASSEMBLY			
		CAUTION	
		Do not remove the bushings from the piston. They are not serviced separately.	
10.	Piston	a. Piston and cylinder liner fitting	1. Measure the piston skirt diameter lengthwise and crosswise of the piston pin bore. Measurements should be taken at a room temperature of 70°F (21°C). The taper and out-of-round must not exceed .O005 inch (.0013 cm).

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

Refer to the Table for piston diameter specifications.

ENGINE PARTS (Standard Size, New)	MINIMUM (inches)	(cm)	MAXIMUM (inches)	(cm)	LIMITS (inches)	(cm)
Piston:						
Height (centerline of bushing to top)	3.5430	8.9992	3.5480	9.0119		
Diameter(above compression rings)	4.2225	10. 7252	4.2255	10.7328		
Diameter (at skirt)	4.2428	10.7767	4.2450	10.7823		
Clearance--piston skirt-to-liner	.0045	.0114	.0083	.0211	.0120	.0305
Out-of-round			.0005	.0013		
Taper			.0005	.0013		
Compression rings:						
Gap (top-fire ring)	.0230	.0584	.0380	.0965	.0600	.1524
Gap (No. 2, 3 and 4)	.0180	.0457	.0430	.1092	.0600	.1524
Clearance--ring-to-groove:						
No. 1 (top -f i re ring)	.0040	.0102	.0070	.0178	.0180	.0457
No. 2	.0100	.0254	.0130	.0330	.0220	.0559
No. 3 and 4	.0040	.0102	.0070	.0178	.0130	.0330
Oil control rings:						
Gap	.0080	.0203	.0230	.0584	.0430	.1092
Clearance	.0015	.0038	.0055	.0140	.0080	.0203

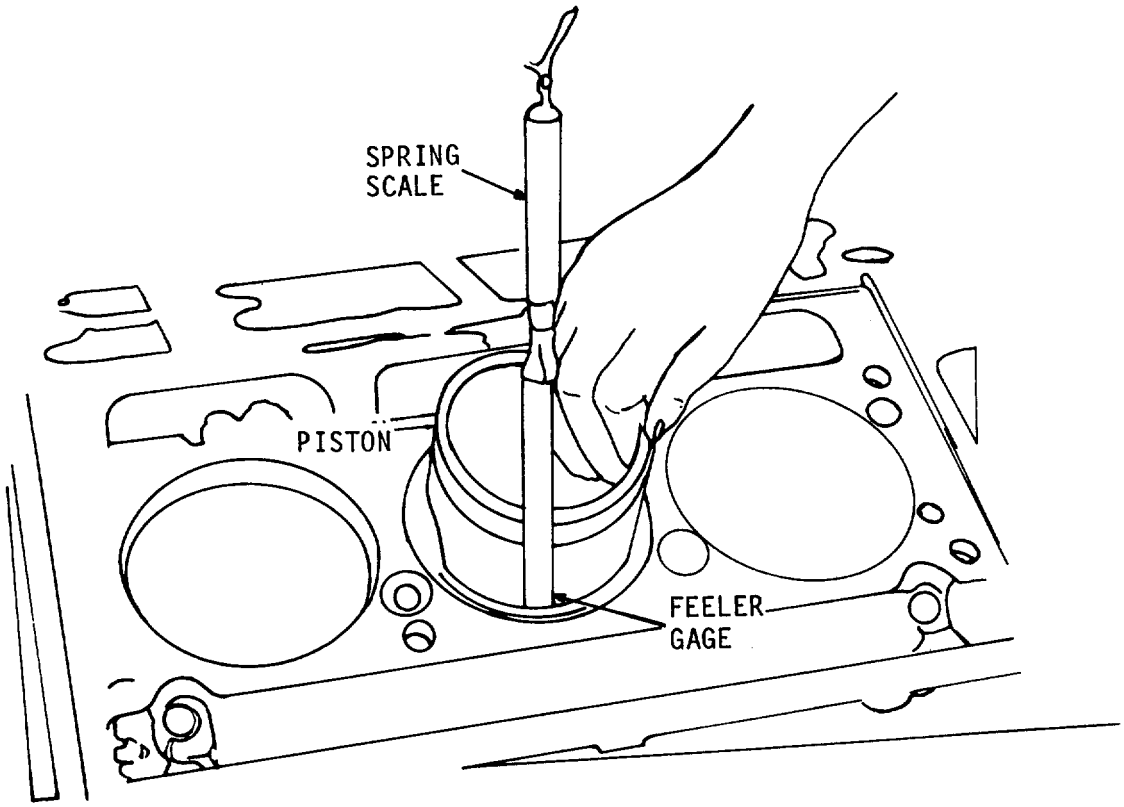
2. A new cylinder liner has an inside diameter of 4.2495 to 4.2511 inch (10.7937-10.7978 cm). Piston-to-liner clearance, with new parts, will vary with the particular piston diameter. A maximum clearance of .012 inch (0.030 cm) is allowed with used parts.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		3. With the cylinder liner installed in the cylinder block, hold the piston upside down in the liner and check the clearance in four places 90° (32.22°C) apart.	
		4. Use a feeler gage set to check the clearance. The spring scale attached to the proper feeler gage is used to measure the force in pounds required to withdraw the feeler gage.	
		5. Select a feeler gage with a thickness that will require a pull of six pounds (26.7 N) to remove. The clearance will be .001 inch (0.003 cm) greater than the thickness of the gage used, i.e., a .004 inch (0.010 cm) feeler gage will indicate a clearance of .005 inch (0.013 cm) when it is withdrawn. The feeler gage must be perfectly flat and free of nicks and bends.	

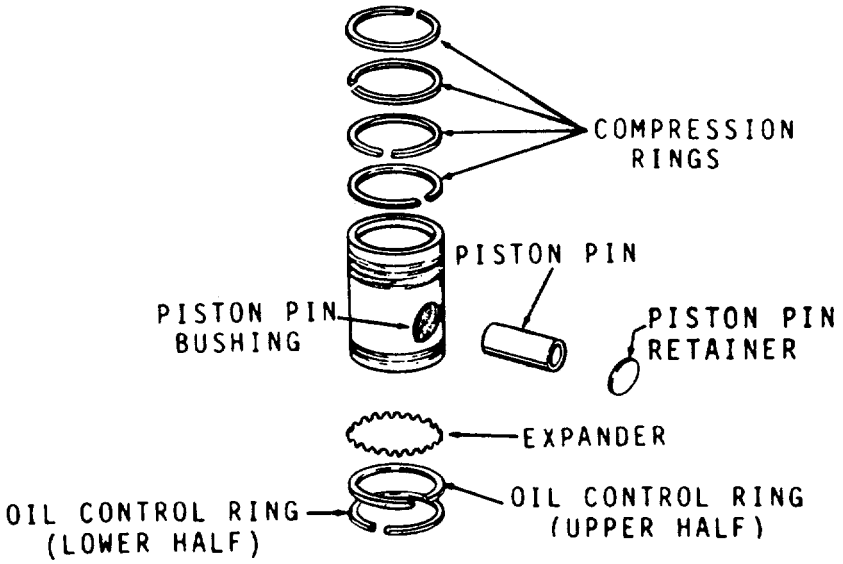
3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)]			
		6. If any bind occurs between the piston and liner, examine the piston and liner for burrs. Remove burns with a fine hone (a flat one is preferred), and recheck the clearance.	



3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cons)			
	b. Piston ring fitting	1. Each piston is fitted with a fire ring, three compression rings and two oil control rings.	
		2. The top compression (fire) ring can be identified by the bright chrome on the bottom side and black oxide or copper color on the top. The prestressed fire ring is further identified by an oval mark.	

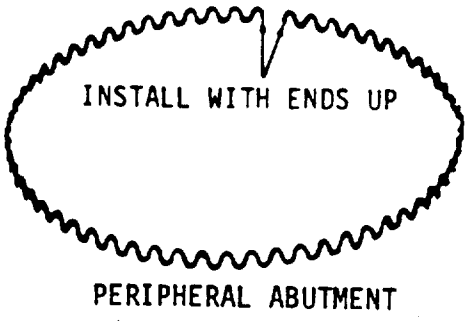


3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)|			

3. A pre-stressed com-Preston ring is also used in the ring groove immediately below the fire ring.

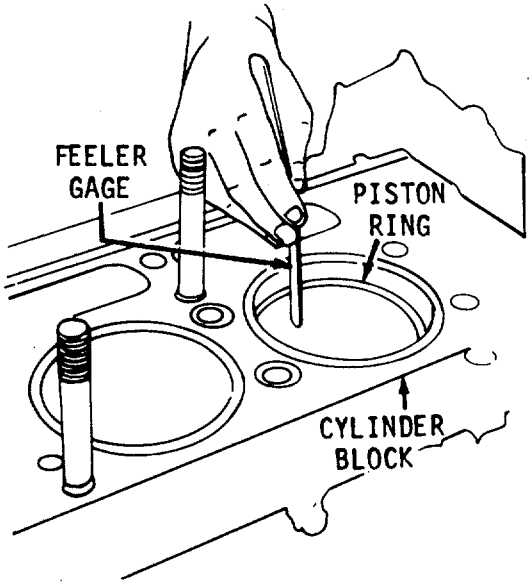
4. A two-piece oil control ring is used in both oil ring grooves in the piston, and a peripheral abutment type oil ring is used in the expander.



5. All crew piston rings must be installed whenever a piston is removed, regardless of whether a new or used piston or cylinder liner is installed.

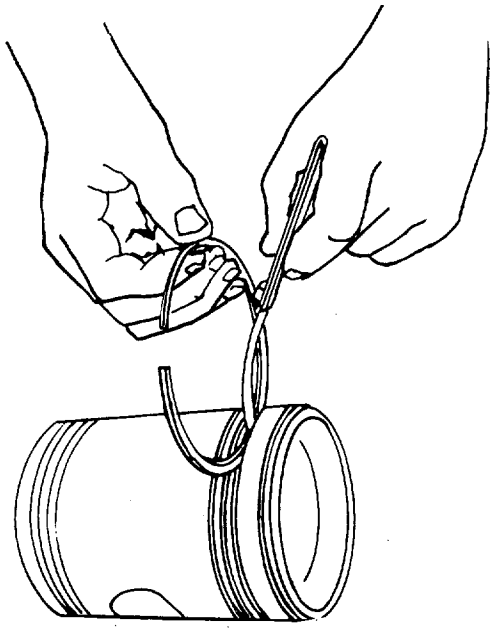
3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		6. Insert one ring at a time inside the cylinder liner and far enough normal area of ring travel. Use a piston to push the ring down to be sure it is parallel with the top of the liner. Then measure the ring gap with a feeler gage . Refer to the ring gap specifications.	



3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		7. If the gap on a compression ring is insufficient, it may be increased by filing or stoning the ends of the ring. File or stone both ends of the ring so the cutting action is from the outer surface to the inner surface. This will prevent any chipping or peeling of the chrome plate on the ring. The ends of the ring must remain square, and the chamfer on the outer edge must be approximately .0015 inch (.038 cm).	
		8. Check the ring side clearance as shown. Refer to ring side clearances chart.	



3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Piston and connecting rod	Assemble.	Refer to paragraph 3-171.2.
	d. Piston and all piston rings	Lubricate for installation.	Use engine oil.
	e. Compression rings (5)	Install, starting with the bottom ring.	Use tool J8128.

CAUTION

To avoid breaking or overstressing the rings, do not spread them any more than necessary to slip them over the piston.

	f. Compression fire rings (4)	Install.	Use tool J8128.

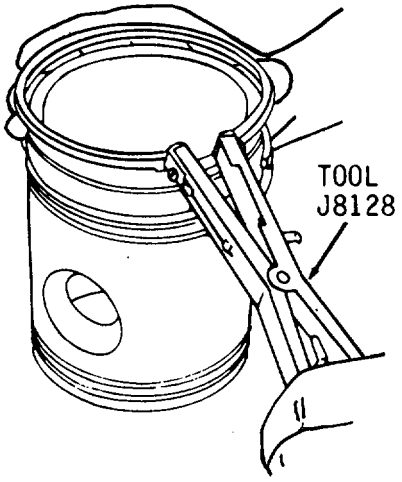
CAUTION

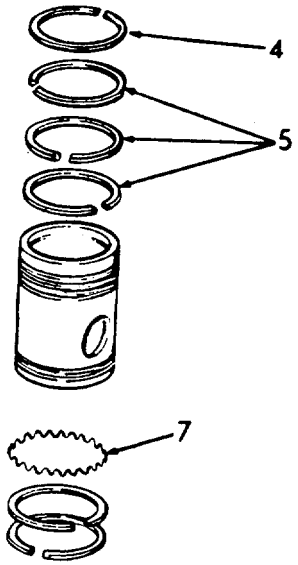
When installing the top compression (fire) ring, be sure the black oxide or copper color side (also identified by an oval mark) is toward the top of the piston.

	g. Compression rings (4 and 5)	Stagger ring gaps around the piston.	Rotate rings or piston.

3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	h. Ring expander (7)	Install in oil control ring groove.	Install with the legs of the free ends toward the top of the piston. With the free ends pointing up, a noticeable resistance will be encountered during installation of the piston if the ends of the expander are overlapped and corrective action can be taken before ring breakage occurs.





3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		CAUTION	
		When installing the oil control rings, use care to prevent overlapping the ends of the ring expanders. An overlapped expander will cause the oil ring to protrude beyond allowable limits and will result in breakage when the piston is inserted in the ring compressor during installation in the cylinder liner. Do not cut or grind the ends of the expanders to prevent overlapping. Cutting or grinding the ends will decrease the expanding force on the oil control rings and result in high lubricating oil consumption.	
	i. Oil control rings (8)	Install the upper and lower halfs.	Install by hand. Do not use tool. Install the upper half with the gap 180° from the gap in the expander. Then install the lower half with the gap 450 from the gap in the upper half of the ring. Make sure the scraper edges are facing down (toward the bottom of the piston).

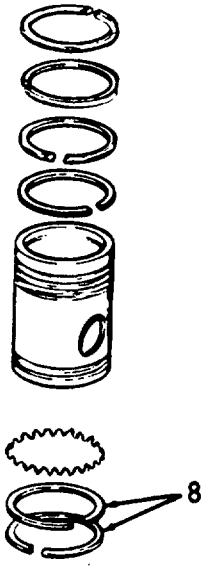
3-171.1. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

NOTES

- The face of the top half of the upper oil control ring used on V-71N engines is chrome-plated.
- The scraping edges of all oil control rings must face downward (toward the bottom of the piston) for proper oil control.
- If there is a noticeable resistance during installation of the piston, check for an overlapped ring expander.



INSTALLATION

11.	Piston, connecting rod, and cylinder liner		For installation, refer to paragraph 3-171.4 .

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS

a. Each connecting rod (trunk-type piston) is forged to an "I" section with a closed hub at the upper end and a bearing cap at the lower end. The connecting rod is drilled to provide lubrication to the piston pin at the upper end and is equipped with a nozzle to spray cooling oil to the underside of the piston head. An orifice is pressed into a counterbore at the lower end of the oil passage to meter the flow of oil.

b. A helically-grooved bushing is pressed into each side of the connecting rod at the upper end. The cavity between the inner ends of these bushings registers with the drilled oil passage in the connecting rod and forms a duct around the piston pin. Oil entering this cavity lubricates the piston pin bushings and is forced out the spray nozzle to oil the piston. The piston pin floats in the bushings of both the piston and connecting rod.

c. This paragraph also includes assembly of the piston onto a connecting rod.

3-171.2. PISTON - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal
b. Cleaning
c. Inspection
e. Disassembly
f. Reassembly
g. Assembly

INITIAL SETUP:

Test Equipment

None

Special Tools

Remover, connecting rod spray nozzle J8995
Reamer set, connecting rod bushing J1686-03
Installer and remover set, piston and connecting, rod J1513-02 (part J7032)
Pump, hand NSN 4930-00-263-9886

Material/Parts

Cylinder kit
P/N 5149265

Personnel Required

1

References

None

Equipment Condition Paragraph | Condition Description

3-163 Oil Pan Removal
3-164 Cylinder Head Removal
3-169 Lube Oil Pump Removal
3-170 Oil Inlet Pipe Removal
3-171.1 Piston Removal

Special Environmental Conditions

Do not drain oil into bilges.
Use the oil separation/recovery system to collect drained oil.

General Safety Instructions

Observe CAUTIONS and WARNINGS.

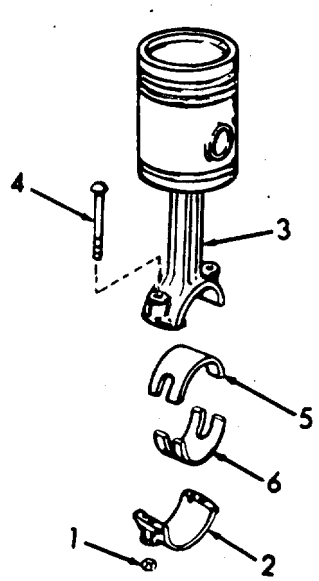
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Engine	a. Oil pan	1. Remove oil.	Pump oil into a suitable container.
		2. Remove pan.	Refer to paragraph 3-163.

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Continued).

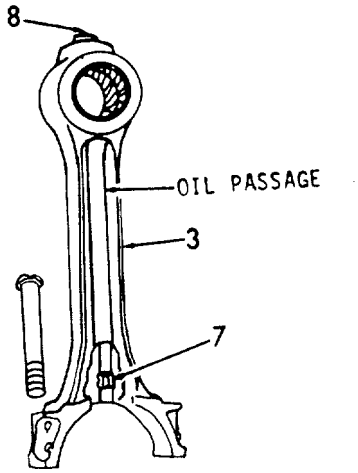
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Oil inlet pipe	Remove pan.	Refer to paragraph 3-170 .
	c. Lube oil pump	Remove.	Refer to paragraph 3-169 .
	d. Cylinder head	Remove.	Refer to paragraph 3-164 .
2. Connecting rod(s)			
	NOTE		
	The connecting rod bearing caps are numbered IL, IR, 2L, 2R, etc., with matching numbers and letters stamped on the connecting rods. When removed, each bearing cap and the bearing shells must always be reinstalled on the original connecting rod.		
	a. Nuts (1)	Remove.	
	b. Bearing cap (2)	Remove.	
	c. Connecting rod (3)	Push connecting rod and piston assembly up into the cylinder liner.	
	d. Bolts (4)	Remove.	

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	e. Upper bearing shell (5)	Remove from connecting rod.	Do not pound on edge of bearing shell with sharp tool.
	f. Lower bearing shell (6)	Remove if necessary.	Do not pound on edge of bearing shell with sharp
	g. Piston	Disassemble.	Refer to paragraph 3-171.1 .

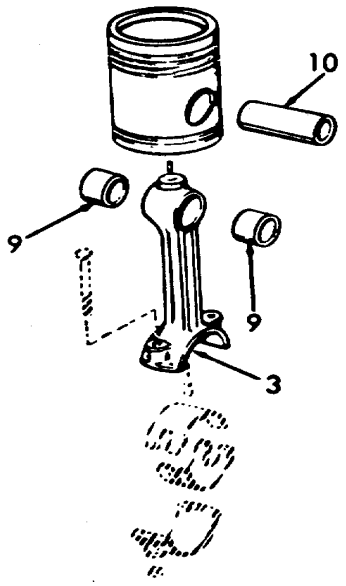


3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
CLEANING			
		WARNING Wear eye protection when using compressed air.	
3. Connecting rod	Connecting rod (3), orifice (7), and spray nozzle (8)	Clean the connecting rod and piston pin with fuel oil and dry them with compressed air. Blow compressed air through the drilled oil passage in the connecting rod to be sure the orifice, oil passage and spray nozzle are not clogged.	
INSPECTION			
			
4. Connecting rod	Connecting rod (3)	Inspect for cracks.	Magnetic particle is the preferred method.

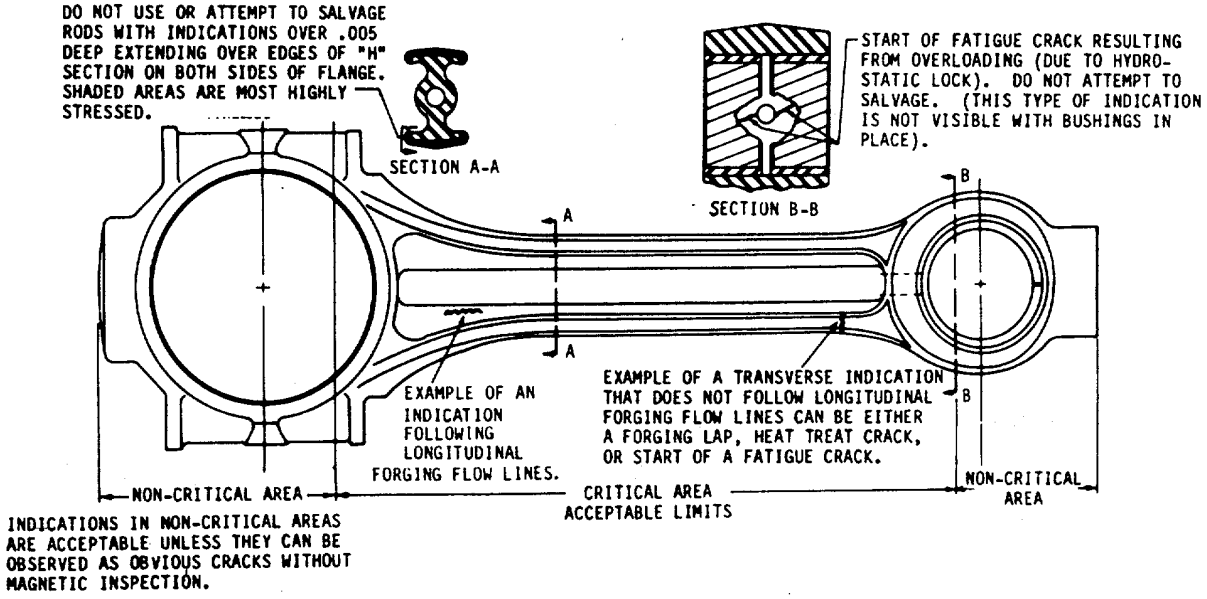
3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
5. Connecting rod bushings	Bushings (9)	Check the connecting rod bushings for indications of scoring, overheating, or other damage.	Bushings that have overheated may become loose and creep together, thus blocking off the supply of lubricating oil to the piston pin and spray nozzle.
6. Piston pin	Pin (10)	Inspect the piston pin for signs of fretting.	a. Bushings that have overheated may become loose and creep together, thus blocking off the supply of lubricating oil to the piston pin and spray nozzle. b. When reusing a piston pin, the highly polished and lapped surface must not be refinished. Polishing or refinishing the piston is not recommended. It could result in very rapid bushing wear.



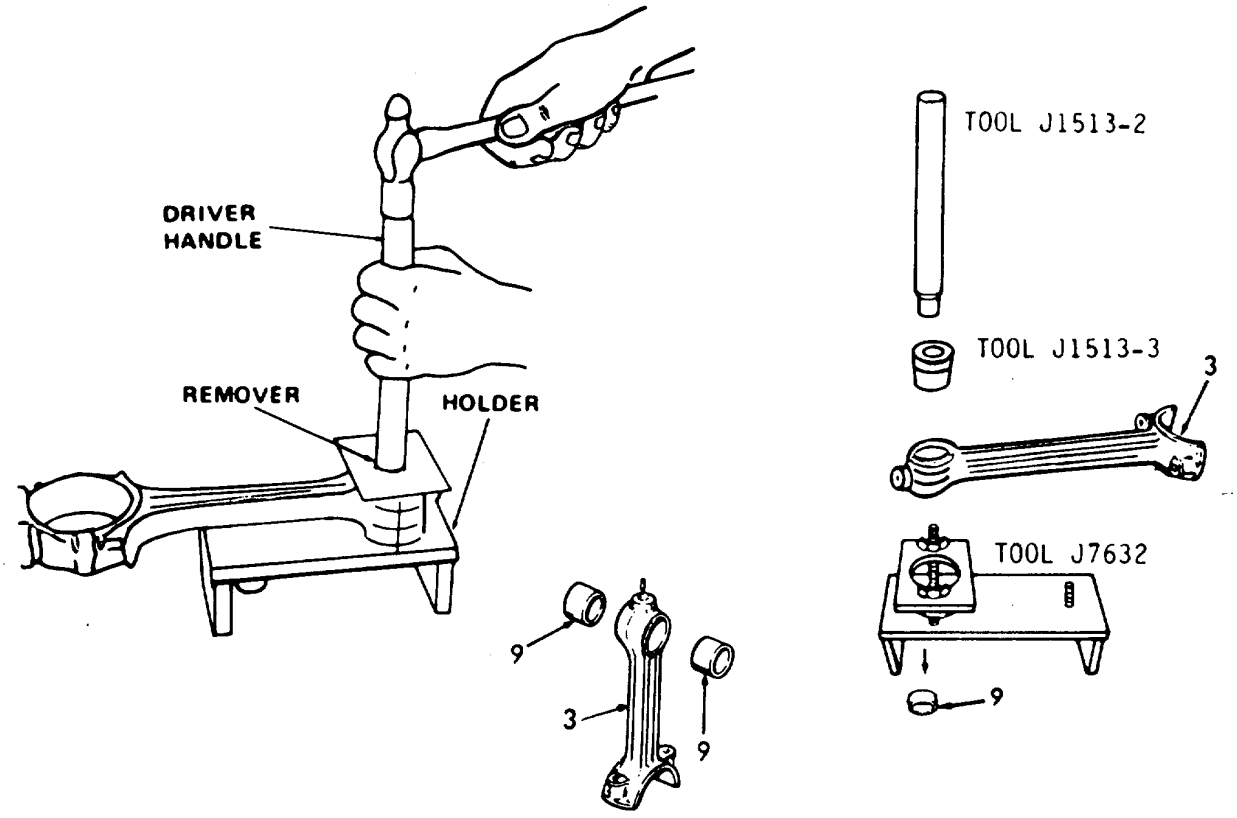
3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		c. Since it is subjected to downward loading only, free movement of the piston pin is desired to secure perfect alignment and uniform wear. Therefore, the piston pin is assembled with a full floating fit in the connecting rod and piston bushings with relatively large clearances. Worn piston pin clearances up to .010 inch (.025 cm) are satisfactory.	



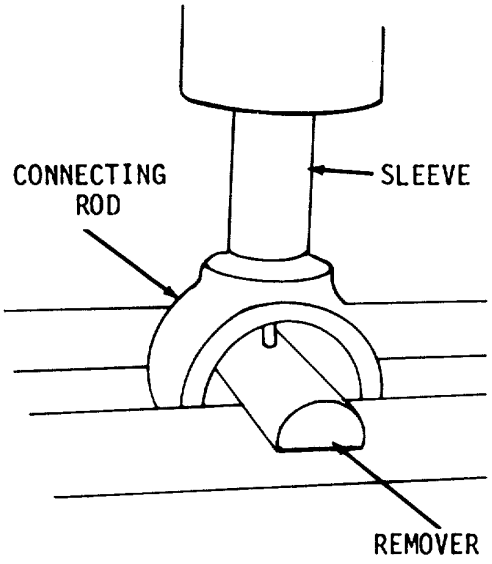
3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

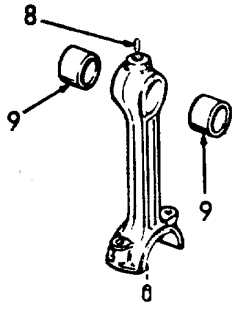
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
7. Bushings	Connecting rod (3)	a. Clamp under end of rod in holder, so that bore in the bushings is aligned with the hole in the base of the holder.	Use tool J7632.
		b. Place bushing remover into the connecting rod bushing.	Use tool J1513-2.
		c. Insert handle into the remover and drive the bushings (9) from the rod (3).	Use tool J1513-3.

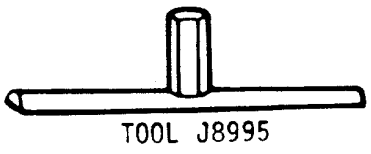


3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Continued)			
8. Spray nozzle (8)	a. Connecting rod bushings (9)	Remove.	Refer to step 7.
	b. Spray nozzle (8)	1. Insert spray nozzle remover through the upper end of the connecting rod and insert the pin into the curved side of the tool in the opening in the bottom of the spray nozzle. 2. Support the connecting rod and tool in an arbor press. 3. Place a short sleeve directly over the spray nozzle. Press the nozzle out of the connecting rod. 4. Remove the tool.	Use tool J8995.

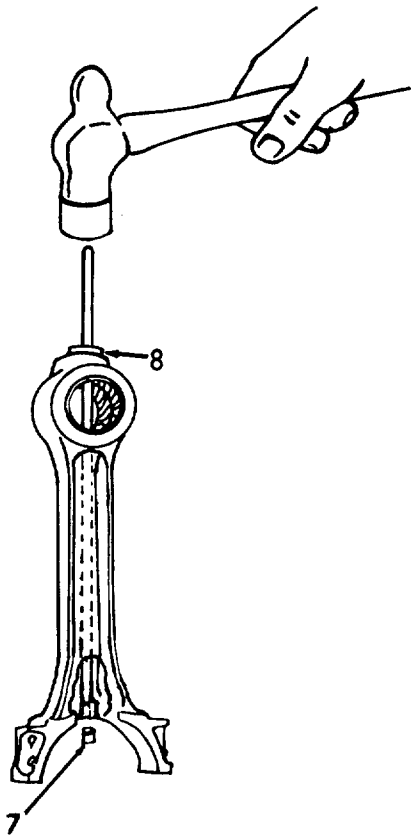




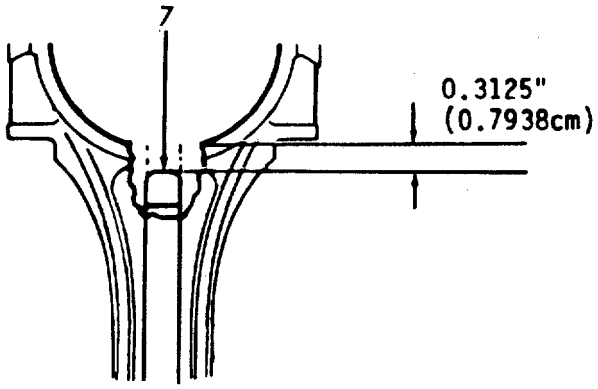


3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
9. Orifice (7)	a. Spray nozzle (8)	Remove.	
	b. Orifice (7)	Insert a rod in the oil passage and drive the orifice from the lower end of the connecting rod.	



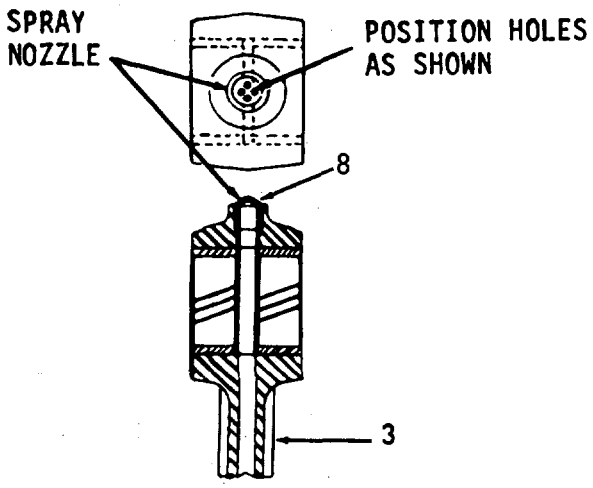
3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
10. Orifice	Orifice (7)	Install from the upper bearing area.	Install orifice 0.3125 inch (0.7938 cm) from lower surface.
			
11. Spray nozzle	Spray nozzle (8), and connecting rod (3)	a. Insert nozzle straight into the counterbore of the connecting rod.	Align holes in spray nozzle as shown.
		b. Support the connecting rod in the arbor press. Place a short 3/8 inch I.D. sleeve on top of the nozzle and press the nozzle into the connecting rod until it bottoms in the counterbore.	

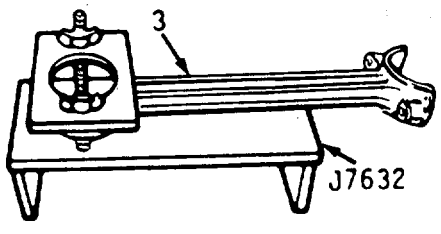
3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

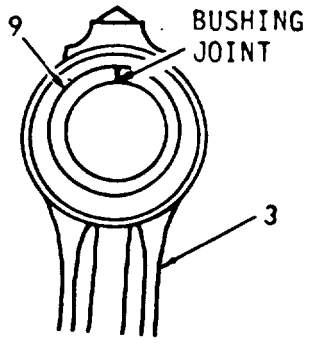
LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



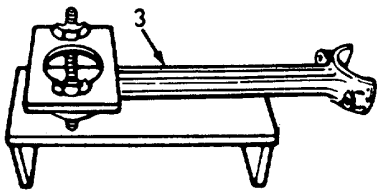
12. Bushings	a. Connecting rod (3)	Clamp upper end of connecting rod assembly into the holder.	Use tool J7632. Align bore of bushing with hole in base of the tool.
	b. Bushing (9)	1. Start a new bushing straight into the bore of the connecting rod, with the bushing joint at the top of the rod.	

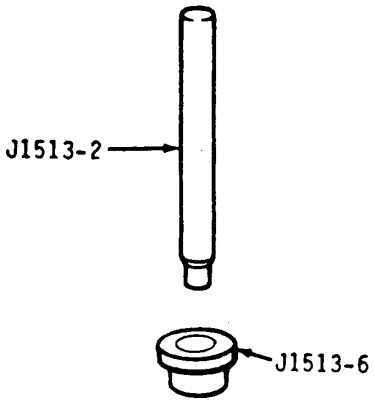




3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
		2. Insert installer in bushing, then insert handle in the installer.	Use installer tool J1513-6, and handle tool J1513-2.
		3. Drive the bushing in until the flange of the installer bottoms on the connecting rod.	
	c. Connecting rod (3)	Turn the connecting rod over in the holder and install the second bushing in the same manner.	





NOTE

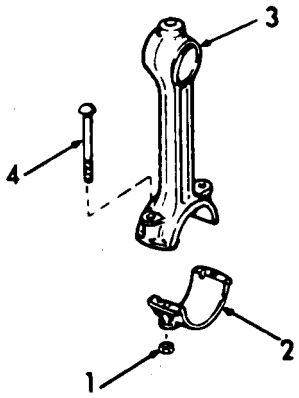
The bushings must withstand an end load of 2000 pounds (907 kg) without moving after installation.

13. Bushing Reaming	a. Connecting rod (3), bolts (4), bearing cap (2), and nuts (1)	Assemble.	

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

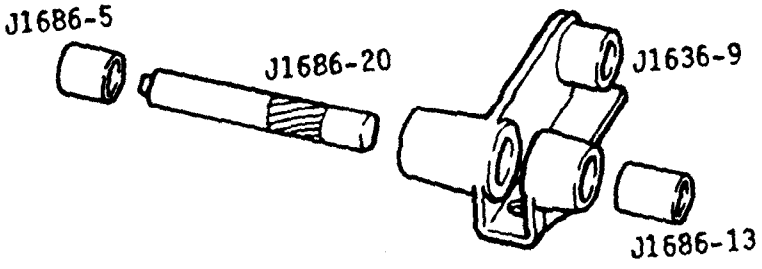
LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



b. Ream the bushings to size, using tool set J1686-03, as follows:

1. Clamp reaming fixture J1686-9 in a bench vise.
2. Position sleeve adapter J1686-13 on the arbor of the fixture.
3. Place the crankshaft end of the connecting rod on the arbor of the fixture and tighten the connecting rod cap nuts to 60-70 lb-ft (81-95 Nm) torque (Lubrite nut) or 65-75 lb-ft (88-102 Nm) torque (plain nut).
4. Slide the front guide bushing J1686-11, (with the pin end facing out) into the fixture.



3-2911

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)

5. Align the upper end of the connecting rod with the hole in the reaming fixture.

6. Install the rear guide bushing J1686-5 onto reamer J1686-20. Then slide the reamer and bushing into the fixture.

7. Turn the reamer in a clockwise direction only when reaming or withdrawing the reamer. For best results, use only moderate pressure on the reamer.

8. Remove the reamer and the connecting rod from the fixture. Blow out the chips and measure the inside diameter of the bushings. The inside diameter of the bushings must be 1.5015 to 1.5020 inch (3.8138 to 3.8151 cm). This will provide a piston pin-to-bushing clearance of .0015 to .0024 inch (0.0038 to 0.0061 cm) with a new piston pin. A new piston pin has a diameter of 1.4996 to 1.5000 inch (3.8090 to 3.8100 cm).

NOTE

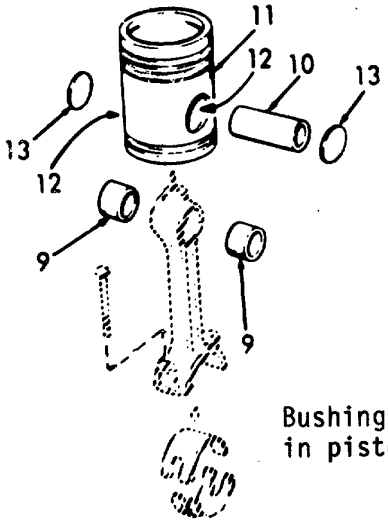
Piston bushings are installed into piston. Refer to paragraph 3-171.1.

ASSEMBLY

14. Connecting rod to piston	a.	Piston pin (10), piston bushings (12)	Lubricate.	Use clean engine oil. Refer to paragraph 3-171.1.

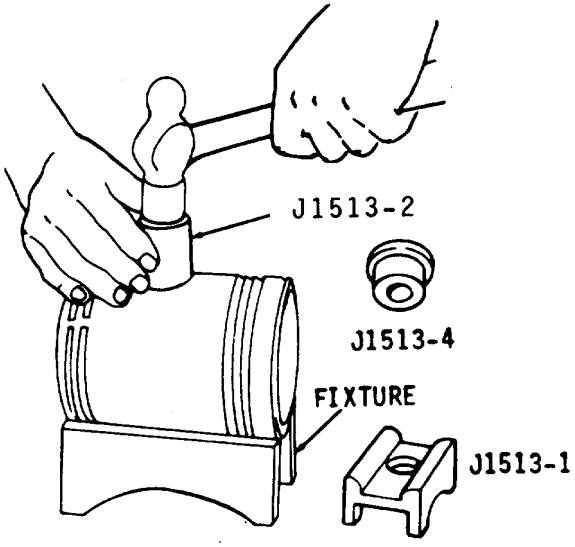
3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
	and connecting rod bushings (9)		
	b. Piston (11)	Place in holding fixture.	Use tool J1513-1.
	c. Piston pin retainer (13)	1. Place on piston. Then place crowned end of installer against the retainer.	Use tool J1513-4.
		2. Place handle onto installer.	Use tool J1513-2.
		3. Strike handle enough to deflect retainer and seat it evenly in the piston.	



NOTE

Bushings are installed in piston.



3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
	d. Connecting rod (3)	Place the upper end of the connecting rod between the piston pin bosses and in line with the piston pin holes.	
	e. Piston pin (10)	Slide the piston pin into place. If the piston pin-to-bushing clearances are within the specified limits, the pin will slip into place without the use of force.	
	f. Piston pin retainer (13)	1. Place on piston; then place crowned end of nstaller against the retainer.	Use tool J1513-4.
		2. Place handle on installer.	Use tool J1513-2.
		3. Strike the handle just hard enough to deflect the retainer, and seat it evenly in the piston.	

CAUTION

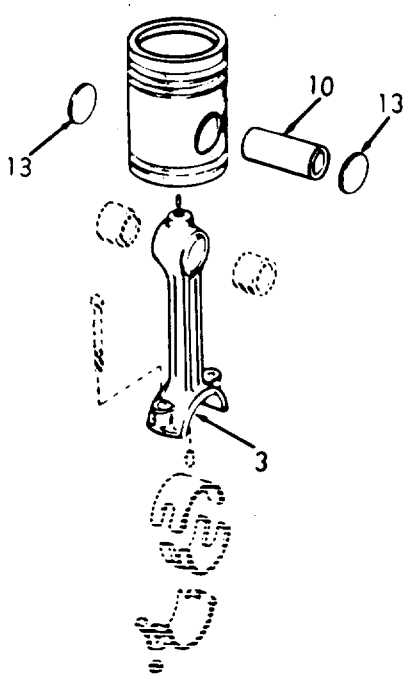
Do not drive retainer in too far or piston bushing may be moved inward and result in reduced piston pin end clearance.

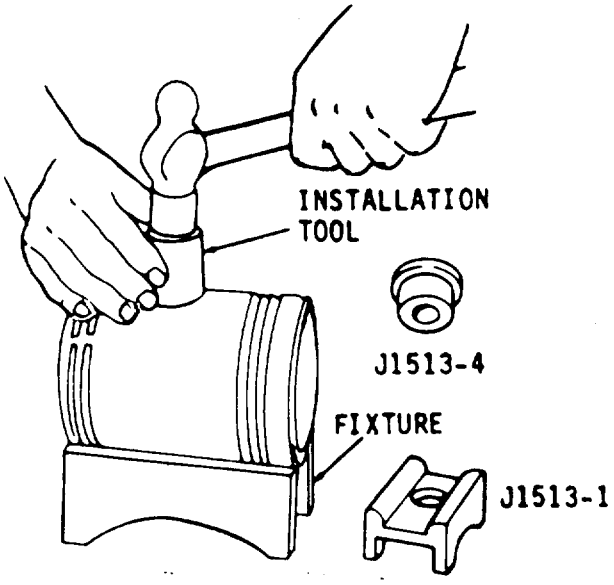
g. Piston pin (10), and connecting rod (3) assembled shifting the pin in its bushings.	After the piston pin retainers have been installed, check for piston pin end clearance by cocking the connecting rod, and	

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

ASSEMBLY (Cont)





3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
	h. Piston and connecting rod assembled	One important function of the piston pin retainer is to prevent the oil, which cools the underside of the piston and lubricates the piston pin bushings, from reaching the cylinder walls. Check the retainers for proper sealing as follows: 1. Place the piston and connecting rod assembly upside down on a bench. 2. Pour clean fuel oil into the piston to a level above the piston pin bosses. 3. Dry the external surfaces of the piston in the area around the retainers and allow the fuel oil to set for about fifteen minutes. 4. Check for seepage of fuel oil around the retainers. If the fuel oil leaks around the retainers, install new retainers. In extreme cases it may be necessary to replace the piston.	

3-171.2. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ASSEMBLY (Cont)			
		WARNING Wear protective eye goggles when using compressed air.	
		5. After the leakage test is completed, empty the fuel oil from the piston, dry the parts with compressed air and lubricate the piston pin with clean engine oil.	
	i. Piston and connecting rod assembly, and cylinder liner	Assemble.	Refer to paragraph 3-171.4 .

3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS

a. The connecting rod bearing shells are precision made and are replaceable with shim adjustments. They consist of an upper bearing shell seated in the connecting rod, and a lower bearing shell seated in the connecting rod case. The bearing shells are prevented from endwise or radial movement by a tang at the parting line at one end of each bearing shell.

b. Multiple layer copper-lead co-plated or aluminum triplated bearings are used. These bearings have an inner surface (matrix) of copper-lead or aluminum. A thin deposit of babbitt is plated onto the matrix. This babbitt overlay has excellent resistance to friction, corrosion and scoring tendencies which, combined with the the material of the matrix, provides improved load carrying characteristics. These bearings are identified by the satin silver sheen of the babbitt when new and a dull gray after being in service.

c. The upper and lower connecting rod bearing shells are different and are not interchangeable. Both shells are notched midway between the bearing edges approximately 3/4 of an inch in from each parting line. The lower bearing shell has a circumferential oil groove that terminates at the notched ends. These notches maintain a continuous registry with the oil hole in the crankshaft connecting rod journal, and provide a constant supply of lubricating oil to the connecting rod bearings, piston pin bushings and spray nozzle through the oil passage in the connecting rod.

3-171.3. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP:

Test Equipment

Micrometer

Special Tools

Torque wrench
Pump, hand
NSN 4930-00-263-9886

Material/Parts

None

Personnel Required

1

References

None

Equipment

Condition Paragraph	Condition Description
3-163	Oil Pan and Dipstick Removal
3-169	Lubricating Oil Pump Removal
3-170	Lube Oil Distribution System - Inlet Pipe Removal

Special Environmental Conditions

Do not drain oil into bilges. Use the oil separation and recovery system to collect drained oil.

General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Engine	a. Oil pan	1. Remove oil.	Pump oil into suitable container.
		2. Remove pan.	Refer to paragraph 3-163 .

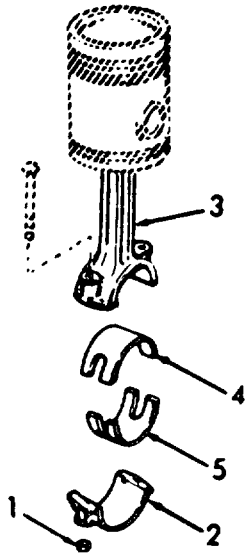
3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Oil inlet pipe	Remove.	Refer to paragraph 3-170 .
	c. Lube oil pump	Remove.	Refer to paragraph 3-169 .
2. Connecting rod(s)			
	NOTE The connecting rod bearing caps are numbered 1L, 1R, 2L, 2R, etc., with matching numbers and letters stamped on the connecting rods. When removed, each bearing cap and the bearing shells must always be reinstalled on the original connecting rod.		
	a. Nuts (1)	Remove.	
	b. Bearing cap (2)	Remove.	
	c. Connecting rod (3)	Push connecting rod and piston assembly up into the cylinder liner.	Push far enough to permit access to upper bearing shell.
	d. Upper bearing shell (4)	Remove from connecting rod.	Do not pound on edge of bearing shell with sharp tool.
	e. Lower bearing shell (5)	Remove from bearing cap (2).	Do not pound on edge of bearing shell with sharp tool.

3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



NOTE

Do not remove another bearing cap or bearing shells.

INSPECTION

3	Bearing shells	Bearing failures may result from deterioration (acid formation), contamination of the oil, or loss of oil. An analysis of the lubricating oil may be required to determine if corrosive acid and sulphur are present which cause acid etching, flaking and pitting. Bearing seizure may be due to low or no oil.		
		a. Upper and lower shells	1. Clean the bearings and inspect them for scoring, pitting, flaking, chipping, cracking, loss of babbitt, or signs of overheating.	If any of these defects are present, the bearings must be discarded. However, babbitt plated bearings may develop minute

3-171.3. CONNECTING ROD - MAINTENANCE INSTRUCTIONS (Cont).

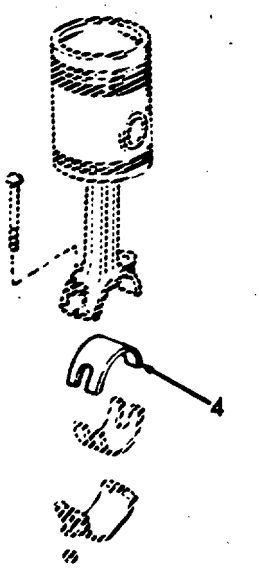
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
			cracks or small isolated cavities on the bearing surface during engine operation. These are characteristics of, and are NOT detrimental to, this type of bearing. The bearings should not be replaced for these minor surface imperfections. The upper bearing shells, which carry the load, will normally show signs of distress before the lower bearing shells do.
		2. Inspect the backs of the bearing shells for bright spots which indicate they have been shifting in their supports.	If such spots are present, discard the bearing shells.
		3. Measure the thickness of the bearing shells, using a micrometer and ball attachment.	The minimum thickness of a worn standard connecting rod bearing shell should not be less than .1230 inch (.3124 cm) and, if either bearing

3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
			shell is thinner than this dimension, replace both bearing shells. A new standard bearing shell has a thickness of .1238 to .1243 inch (0.3145 to 0.3157 cm).
4. Connecting rod	Bearing bore	Inspect for burrs, foreign particles etc.	
5 Crankshaft journal	Bearing shells	Check the clearance between the connecting rod bearing shells and the crankshaft journal.	This clearance may be checked by means of a soft plastic measuring strip which is squeezed between the journal and the bearing. The maximum connecting rod bearing-to-journal clearance with used parts is .006 inch (0.015 cm).

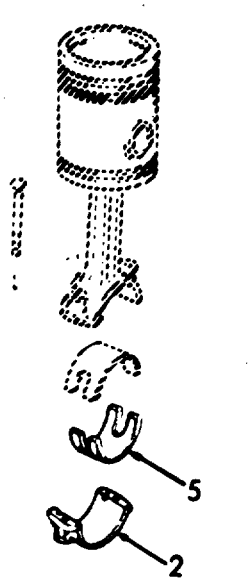
3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6. Connecting rod(s)			
		NOTE Do not replace one connecting rod bearing shell alone. If one bearing shell requires replacement, install both new upper and lower bearing shells. Bearing shells are available in .010 inch, .020 inch and .030 inch undersize for service with reground crankshafts. Do not use these bearing shells.	
	a. Upper bearing shell (4)	Install the upper bearing shell - the one without the continuous oil groove - in the connecting rod.	Be sure the tang on the bearing shell fits in the groove in the connecting rod.



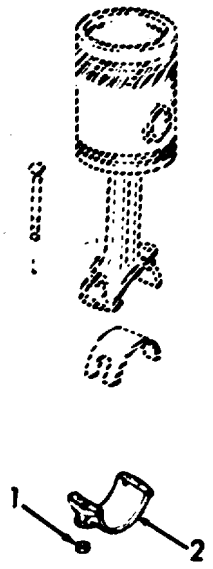
3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	b. Crank-shaft journal	Wipe clean and lubricate with clean engine oil.	
	c. Connecting rod and piston assembly	Pull assembly down until the upper bearing seats firmly on the crankshaft journal.	
	d. Bearing cap (2), and lower bearing shell (5)	Assemble.	Note the number and letter stamped on the connecting rod and the bearing cap and install the lower bearing shell-the one with the continuous oil groove-in the bearing cap, with the tang on the bearing shell in the groove in the bearing cap.



3-171.3. CONNECTING ROD BEARINGS - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	e. Bearing cap and lower bearing shell assembly (2), and nuts (1)	Install.	Torque to 60-70 lb-ft (81-95 Nm) torque (lubrite nut) or 65-75 lb-ft (88-102 Nm) torque (castellated nut).
	f. Lube oil pump	Install.	Refer to paragraph 3-169.
	g. Oil inlet pipe	Install.	Refer to paragraph 3-170.
	h. Oil pan	Install.	Refer to paragraph 3-163.
	i. Engine oil	Fill.	



3-2926

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS

a. The replaceable-type cylinder liner is machined and heat treated to provide a long wearing, scuff-resistant surface. The flange at the top fits into a counterbore in the cylinder block and rests on a replaceable cast iron insert which permits accurate alignment of the cylinder liner. Compression is sealed with an individual, laminated compression gasket for each cylinder.

b. The liner is cooled by a water jacket in the cylinder block and by the scavenging air introduced into the cylinder through the air inlet ports around the liner. These ports are machined at an angle to create a uniform swirling motion to the air as it enters the cylinder. This motion persists throughout the compression stroke and facilitates scavenging and combustion.

c. The wear on a liner and piston is directly related to the amount of abrasive dust and dirt introduced into the engine combustion chamber through the air intake. This dust, combined with lubricating oil on the cylinder wall, forms a lapping compound and will result in rapid wear. To avoid pulling contaminated air into the cylinder, the
air silencer must be serviced regularly.

d. This paragraph also includes installation of the piston and connecting rod assembly into the cylinder liner. These components are then installed in the engine.

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS

This task covers:

a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP:

Test Equipment

Gage Cylinder diameter Checking J5347-01
Gage Master Ring J8386-01

Special Tools

Remover Cylinder Liner J1918-02
Holddown Clamp Cylinder Liner J21793-01
Pump, hand NSN 4930-00-263-9886

Material/Parts

Cylinder Kit P/N 5149265

Personnel Required

2

References

None

Equipment Condition Paragraph	Condition Description
3-161	Rocker Arm Cover Removal
3-163	Oil Pan Removal
3-164	Cylinder Head Removal
3-169	Lube Oil Pump Removal
3-171.1	Piston Removal

Special Environmental Conditions

Do not drain oil into bilges. Use oil/water separation and recovery system to collect drained oil.

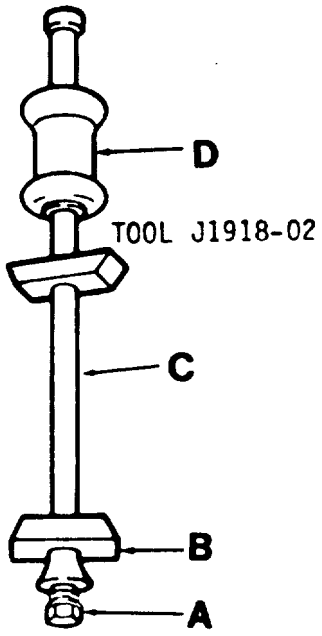
General Safety Instructions

Observe all CAUTIONS.

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Engine	a. Rocker arm cover	Remove.	Refer to paragraph 3-161 .
	b. Oil pan	1. Remove oil.	Pump into suitable container.
		2. Remove pan.	Refer to paragraph 3-163 .

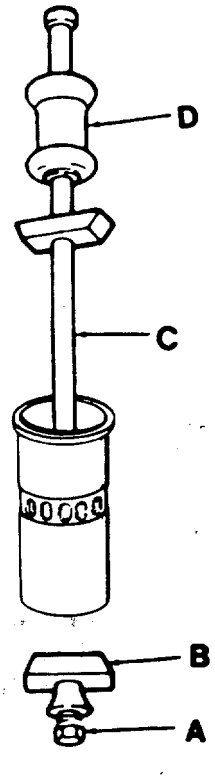
3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Lube oil pump	Remove.	Refer to paragraph 3-169 .
	d. Cylinder head	Remove.	Refer to paragraph 3-164 .
	e. Piston	Remove.	Refer to paragraph 3-171.1 .
2. Cylinder liner			
	NOTE It is very important that the proper method is followed when removing a cylinder liner. Do not attempt to push the liner out by inserting a bar in the liner ports and rotating the crankshaft. Otherwise, the piston may be damaged or the upper ring groove may collapse.		
Remover cylinder liner		a. Remove bolt (A), and lower shoe (B) from shaft (C).	Use tool J1918-02.



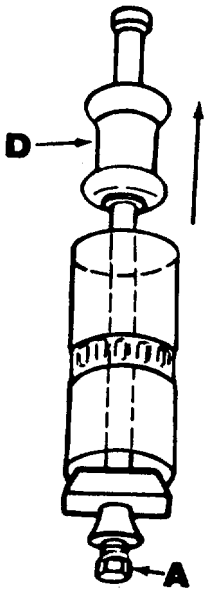
3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
		b. Lower the lower shoe through the cylinder liner.	
		c. Lower shaft (C) into the cylinder liner.	
		d. Attach lower shoe (B) and bolt (A) to shaft (C).	Place shoe on bottom edge of liner with flat on shoe parallel with the crankshaft bore.



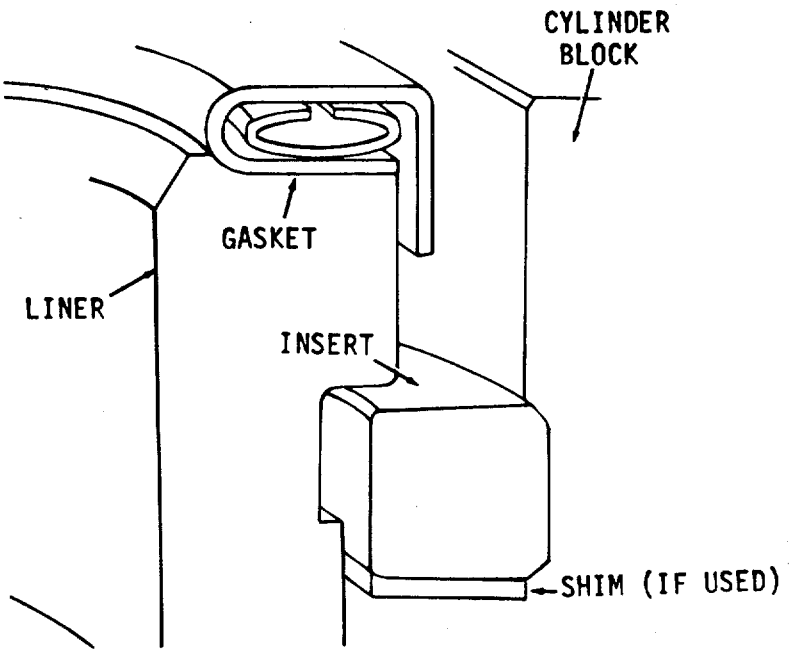
3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
		e. Hold the lower shoe and bolt assembly in the pulling position.	Place the upper shoe with flat in the same position as the lower shoe. Adjust, tighten bolt (A).
		f. Grasp handle (D) and pull up sharply.	Pull up until cylinder liner is removed from cylinder.
		g. Disassemble tool from cylinder liner.	



3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS

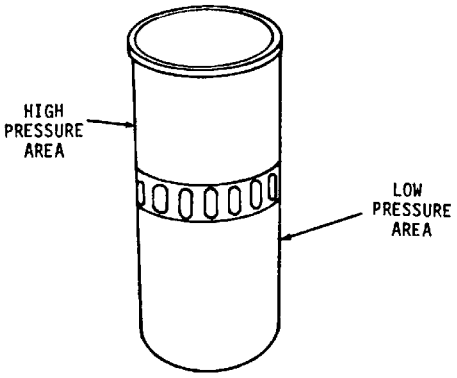
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
3. Cylinder liner insert	Insert shims (if used)	Remove and tag.	Remove from counterbore of engine block.



INSPECTION			
4. Cylinder Liner liner		a. Clean thoroughly.	
		b. Inspect for cracks or excessive scoring.	Discard. A slightly scored liner may be cleaned up and reused.
		c. Inspect for excessive liner-to-block clearance or block bore distortion.	Excessive liner-to-block clearance or block bore distortion

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			will reduce heat transfer from the liner to the block and to the engine coolant. Poor contact between the liner and the block bore may be indicated by stains or low pressure areas on the outer surface of the liner.
		d. Examine the outside diameter of the liner for fretting.	Fretting is the result of a slight movement of the liner in the block bore during engine operation, causing material from the block to adhere to the liner. These metal particles may be removed from E the surface of the liner with a coarse, flat stone.



3-2933

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		e. Inspect for cracks at the flange.	The liner flange must be smooth and flat on both top and bottom surfaces. The liner insert must also be smooth and flat on top and bottom surfaces. Replace insert if there is evidence of brinelling.
		f. Inspect the block bore and check the liner-to-block clearance whenever a liner is removed.	If the clearance exceeds zero to .002 inch (0.0051 cm), it will be necessary to bore the block for an oversized liner. Refer to Direct Support Maintenance.

NOTES

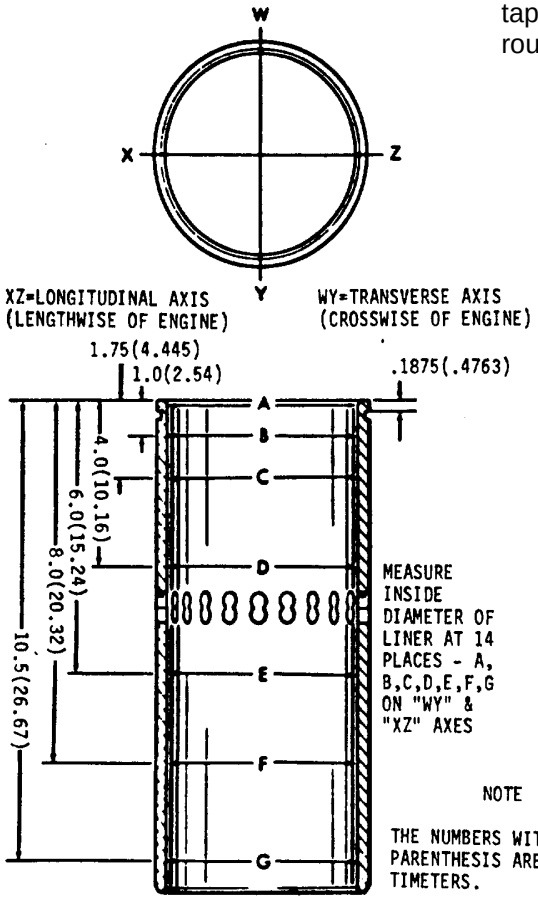
- Cylinder liners are available in .001, .005, .010, .020 and .030 inch (.0025, .0127, .0254, .0508, .0762 cm) oversize on the outside diameter. When an oversize liner is used, the amount of oversize is stamped on top of the cylinder block adjacent to the liner counterbore.

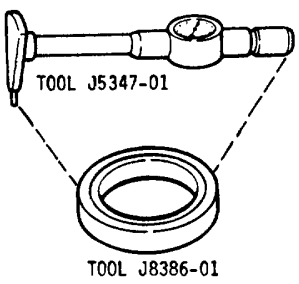
- New service liners, standard and oversize, have an inside diameter of 4.2495 to 4.2511 inch (10.7937 to 10.7978 cm).

- Do not modify the surface finish in a new service liner. Since the liner is properly finished at the factory, any change will adversely affect the seating of the piston rings.

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

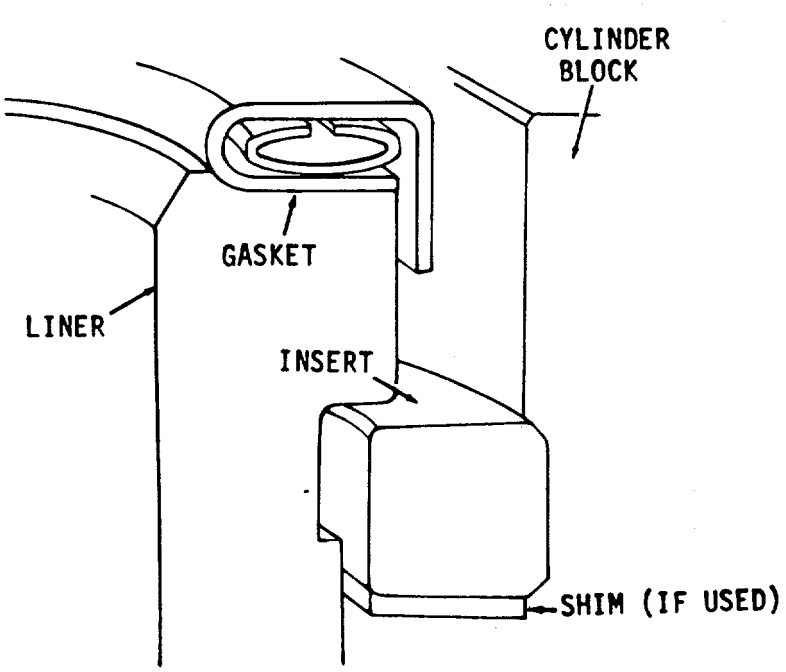
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
.		g. Install the liner in the proper bore of the cylinder block and measure the inside diameter at the various points shown. Use cylinder bore gage J5347-01, which has a dial indicator calibrated in .0001 inch increments, as it is rather difficult to obtain accurate measurements with a micrometer. Set the cylinder bore gage on zero in master ring gage J8386-01. Also, check the liner for taper and out-of-round.	To reuse the liner, the taper must not exceed .002 inch (.005 cm) and the out-of-round must not exceed .0025 inch (.0064 cm). in addition, the ridge formed at the top of the ring must be removed. If the out-of-round exceeds .0025 inch (.0064 cm), rotate the liner 90° (32.22°C) in the block bore and recheck.





3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
5. Engine Block	a. Engine block bore and counter-bore.	Wipe clean.	
	b. Cylinder liner insert	Insert in block counter-bore.	Use a standard size liner insert 0.1795 to 0.1800 inch (0.4559 to 0.4372 cm).



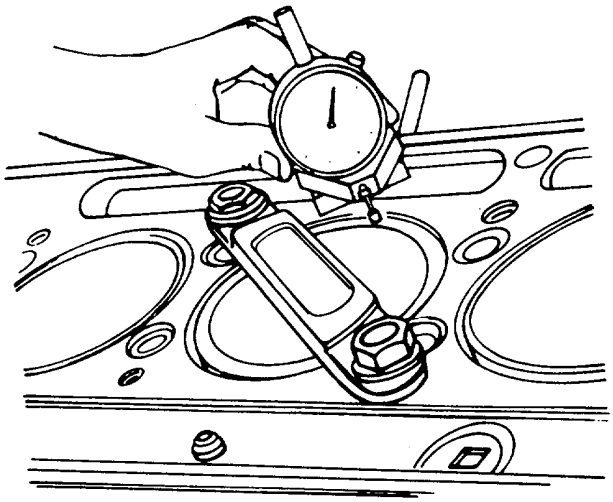
6. Cylinder liner	a. Liner	Push the cylinder into the cylinder block until the liner flange rests on the insert.	Do not use excessive force to install the liner. The liner should slide smoothly in place with thumb pressure.

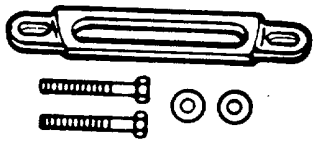
3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
			If a new liner cannot be pushed in place, light honing of the block bore may be necessary to obtain the desired fit for best heat transfer liner-to-block clearance.

MINIMUM	MAXIMUM	LIMIT
.0000 (.0000 cm)	.0020 (.0051 cm)	.0025 (.0064 cm)

	b. Hold down clamp	Install.	Use tool J21793-01.





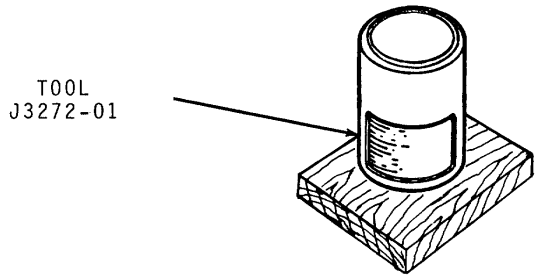
TOOL J21793-01

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Cylinder liner	1. Measure the distance from the top of liner to top of block with a dial indicator. The liner flange must be .045 to .050 inch (.1143 to .1270 cm) below the surface of the block. However, even though all of the liners are within these specifications, there must not be over .002 inch (.0051 cm) difference in depth between any two adjacent liners when measured along the cylinder longitudinal center line.	
		NOTE A .002 inch (.0051 cm) thick shim is available for adjusting the liner height. The shim must be installed underneath the liner insert. Do not cut the shim for installation. Liner inserts which are .0015 inch (.0038 cm) thicker or thinner than standard are also available for service.	
		2. Matchmark the liner and cylinder block with chalk or paint so the liner may be reinstalled in the same position in the same block bore. The matchmarks should be on the side opposite the camshaft.	
	d. Holddown clamp and cylinder liner	Remove.	

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	NOTE		
	Do not remove the liner insert.		
7. Piston and connecting rod assembly	a. Assembly, and piston ring assembly	Lubricate piston, rings and inside surface of compressor.	Use tool J3272-01. Use lubricant Cindol 1705 oil.

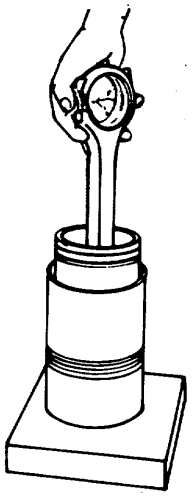


NOTE

Inspect ring compressor for nicks or burrs, especially at the non-tapered inside diameter end. Nicks or burrs on the inside diameter of the compressor will result in damage to the piston rings.

b. Compressor	Place on wood block with chamfered end up.	
c. Piston and connecting rod assembly	Position, (stagger) the piston ring gaps properly on the piston.	Make sure the ends of the oil control ring expanders are not overlapped.

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	d. Assembly and compressor	Start the top of the piston straight into the ring compressor. Then, push the piston down until it contacts the wood block. 	
	e. Cylinder liner	Note the position of the matchmark and place the liner, with the flange end down, on the wood block.	
	f. Compressor on piston, and connecting rod assembly, and cylinder liner	1. Place the ring compressor and the piston and connecting rod assembly on the liner so the numbers on the rod and cap are aligned with the matchmarks on the liner.	

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

NOTE

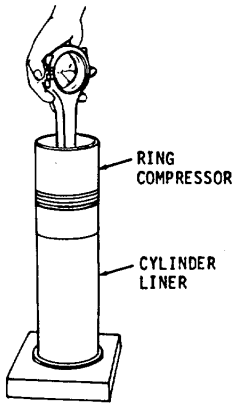
The numbers on the side of the connecting rod and cap identify the rod with the cap and indicates the particular cylinder in which they are used. If a new service connecting rod is to be installed, the same identification numbers must be stamped in the same location as on the connecting rod that was replaced.

2. Push piston and connecting rod assembly down into the liner until the piston is free of the ring compressor.

CAUTION

Do not force the piston into the liner. The peripheral abutment type expanders apply considerable more force on the oil ring than the standard expander. Therefore, extra care must be taken during the loading operation to prevent ring breakage.

g.	Connecting rod cap and ring compressor	1. Remove. 2. Push piston down until the compression rings pass cylinder liner ports.	



3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
8. Cylinder liner, piston and connecting rod assembly			

NOTES

1. If any of the pistons and liners are already in the engine, use hold-down clamps to retain the liners in place when the crankshaft is rotated.

2. Rotate the crankshaft until the connecting rod journal of the particular cylinder being worked on is at the bottom of its travel. Wipe journal clean and lubricate it with clean engine oil.

a. Upper bearing shell (1)	Install in connecting rod (2). Lubricate.	The upper bearing shell does not have a continuous oil groove. Lubricate the bearing shell with clean engine oil.

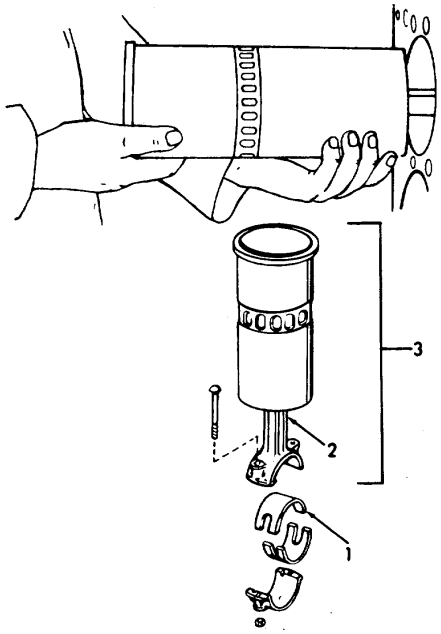
NOTE

Each connecting rod and its cap is numbered on one side - IL, IR, 2L, 2R, etc. These numbers and letters identify the caps with the rods and indicate the particular cylinder in which they are used. Maintain these positions when assembling the engine.

b. Piston rod and liner assembly (3)	1. Position the piston, rod and liner assembly in front of the cylinder block bore so the identification number and letter on the rod face the outer edge of the cylinder block, and the matchmarks on the liner and block are in alignment.	

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		2. Guide the end of the connecting rod through the block bore carefully to avoid damaging or dislodging the bearing shell.	
		3. Slide the piston, rod, and liner assembly straight into the block bore until the liner flange rests against the insert in the counterbore in the block.	



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3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	c. Piston and connecting rod (2)	Push or pull the piston and connecting rod into the liner until the upper bearing shell is firmly seated on the crankshaft journal.	

CAUTION

The distance from the vertical center line of the connecting rod bolts to the edges of the rod are not equal. Therefore, when installing the piston and connecting rod assembly, be sure that the narrow side of the two connecting rods on the crankshaft journal are together to avoid cocking of the rod.

d. Lower bearing shell (4), and bearing cap (5)	Assemble and lubricate.	The lower bearing shell has a continuous oil groove from one parting line to the other; use clean engine oil to lubricate.
e. Bearing cap with bearing shell, connecting rod (2), and nuts (6)	Install the bearing cap and the bearing shell on the connecting rod with the identification numbers on the cap and the rod adjacent to each other.	Tighten the connecting rod bolt nuts to 60-70 ft-lb (81-95 Nm) torque (notch or imbedded "O" lubrite nut) or 65-75 ft-lb (88-102 Nm) torque (castel - lated nut).
f. Connecting rod (2)	Check the connecting rod side clearance.	The clearance between each pair of connecting rods

3-171.4. CYLINDER LINER - MAINTENANCE INSTRUCTIONS (Continued).

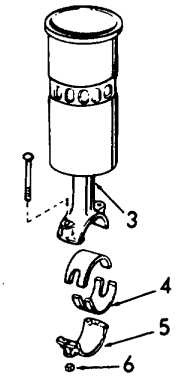
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
			should be .008 to .016 inch (0.020 to 0.041 cm) with new parts.

NOTES

1. Install the remaining liner, piston and rod assemblies in the same manner. Use hold-down clamps to hold each liner in place.

2. After all of the liners and pistons have been installed, remove the hold-down clamps.

g.	Cylinder head	Install.	Use new compression gaskets, water seals, and oil seals. Refer to paragraph 3-164.



h.	Lube oil pump	Install.	Refer to paragraph 3-164.
i.	Oil pan	Install.	Refer to paragraph 3-163.
j.	Rocker arm cover	Install.	Refer to paragraph 3-160.
k.	Engine	Add engine oil and coolant.	

3-172. CRANKSHAFT AND MAIN BEARINGS

The maintenance instructions for the crankshaft and the main bearings are contained in the following paragraphs:

DESCRIPTION	PARAGRAPH
Crankshaft Bearings	3-172.1
Crankshaft	3-172.2
Crankshaft Seals	3-172.3

3-172.1. CRANKSHAFT BEARINGS.

a. The crankshaft main bearings shells are precision made and are replaceable without machining. They consist of an upper bearing shell seated in each cylinder block main bearing support and a lower bearing shell seated in each main bearing cap. The bearing shells are prevented from endwise or radial movement by a tang at the parting line at one end of each bearing shell. The tangs on the lower bearing shells are off-center and the tangs on the upper bearing shells are centered to aid correct installation.

b. The bearing caps are numbered 1,2,3, etc., indicating their respective positions and when removed, must always be reinstalled in their original position.

c. An oil hole in the groove of each upper bearing shell, midway between the parting lines, registerswith a vertical oil passage in the cylinder block. Lubricating oil, under pressure, passes from the cylinder block oil gallery by way of the bearing shells to the drilled passages in the crankshaft, then to the connecting rods and connecting rod bearings.

d. The lower main bearing shells have no oil grooves; therefore, the upper and lower bearing shells must not be interchanged.

e. Thrust washers on each side of the rear main bearing, absorb the crankshaft thrust. The lower halves of the two-piece washers are doweled to the bearing cap; the upper halves are not doweled.

f. Main bearing trouble is ordinarily indicated by low or no oil pressure. All of the main bearing load is carried on the lower bearings; therefore, wear will occur on the lower bearing shells first. The condition of the lower bearing shells may be observed by removing the main bearing caps.

3-172.1. CRANKSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

g. Bearing failures may result from deterioration (acid formation) or contamination of the oil or loss of oil. An analysis of the lubricating oil may be required to determine if corrosive acid and sulphur are present which causes acid etching, flaking and pitting. Bearing seizure may be due to low oil or no oil.

h. Check the oil filter elements and replace them if necessary. Also check the oil by-pass valve to make sure it is operating freely.

This task covers:

a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP:

Test Equipment

Cylinder Diameter Gage
J5347-01
Micrometer (with ball end)

Special Tools

Torque wrench
Pump, hand
NSN 4930-00-263-9886

Material/Parts

None

Personnel Required

2

References

None

Equipment Condition Paragraph

Condition	Condition Description
3-163	Oil Pan Removal
3-169	Lube Oil Pump Removed
3-170	Oil Inlet Pipe Removed

Special Environmental Conditions

Do not drain oil into bilges. Use oil separation and recovery system to collect drained oil.

General Safety Instructions

None

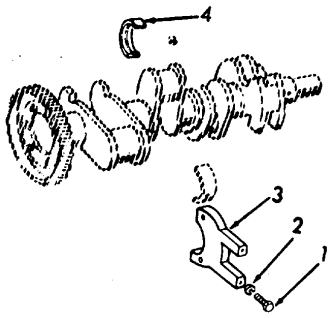
LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
1. Engine	a. Oil pan	1. Remove oil.	Use a suitable container.
		2. Remove pan.	Refer to paragraph 3-163.

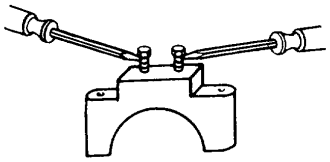
3-172.1. CRANKSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Oil inlet pipe	Remove.	Refer to paragraph 3-170.
	c. Lube oil pump	Remove.	Refer to paragraph 3-169.
2. Main bearings 1, 2, 3			
	NOTES • All crankshaft main bearing journals, except the rear journal, are drilled for an oil passage. Therefore, the procedure for removing the upper bearing shells with the crankshaft in place is somewhat different on the drilled journals than on the rear journal. • If shims are used between the oil pump and the main bearing caps, save the shims so that they may be reinstalled in exactly the same location. • Remove one main bearing cap at a time and inspect the bearing shells as outlined under inspection. Reinstall each bearing shell and bearing cap before removing another bearing cap.		
	a. Bolts (1), and lock-washers (2)	Remove.	
	b. Bearing cap (3)	1. Insert two bolts in bearing cap, leaving bottom of head accessible. 2. Pry cap off.	

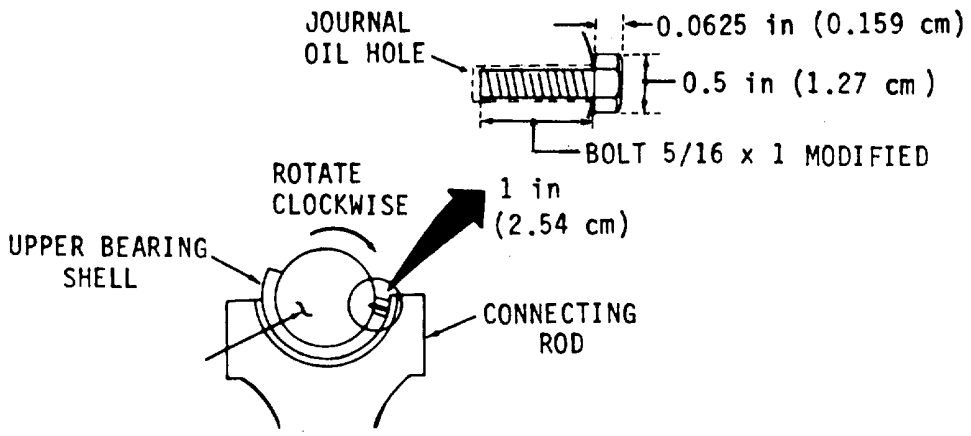
3-172.1. CRANKSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Upper main bearing shell (4)	1. Insert bolt in crankshaft journal oil hole.	Make bolt from 5/16 x 1 (standard bolt). Modify head to 1/2 inch (1.27 cm).



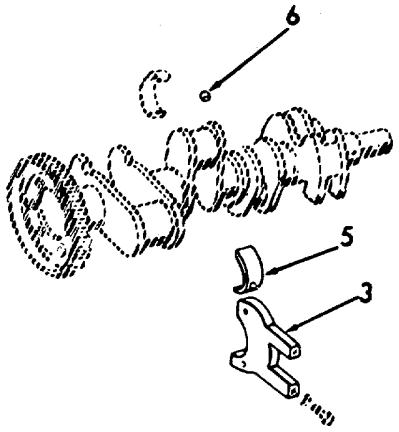


	2. Rotate crankshaft to the right (clockwise), and roll bearing shell out of piston.	The head of bolt must not extend beyond the outside diameter of the bearing shell.
	3. Remove bolt.	



3-172.1. CRANKSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

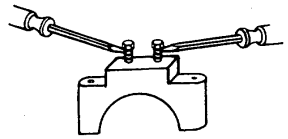
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Lower housing shell (5)	Remove from bearing cap (3).	
	e. Pipe plug (6)	Remove if necessary.	

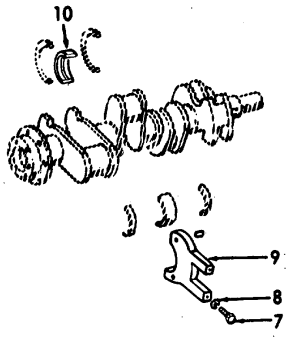


3. Main bearing number (4)	a. Bolts (7) and lock-washers (8)	Remove.	
	b. Bearing cap (9)	1. Insert two bolts in bearing cap, leaving bottom of head accessible. 2. Pry bearing cap off.	

3-172.1. CRANKSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Upper main bearing shell (10)	Remove by tapping on edge of bearing with a small, curved rod, revolving the crankshaft at the same time to roll the bearing shell out.	





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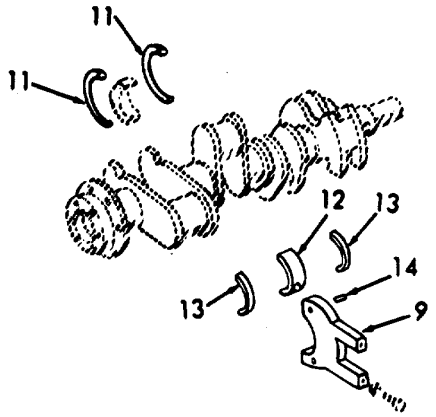
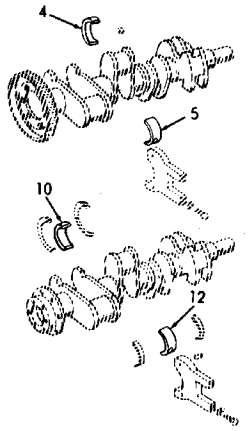
3-172.1. CRANKSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	d. Upper thrust washers (11)	Remove by pushing on end of washers with a small rod. Force washers around and out.	
	e. Lower bearing shell (12), and lower thrust washers (13)	Remove from bearing cap (9).	
	f. Dowel pins (14)	Remove if necessary.	



3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
4. Upper and lower bearing shells	a. Bearing shells (4 and 10), (5, and 12)	1. Clean. 2. Inspect for scoring, pitting, flaking, etching, loss of babbitt, and signs of overheating.	The lower bearing shells which carry the load, will normally show signs of distress before the upper bearing shells. However, babbitt plated bearings may develop minute cracks or small isolated cavities on the bearing surface during engine operation. These are characteristics of and are not detrimental to this type of bearing. They should not be replaced for these minor surface imperfections since function of the bearings is in no way impaired and they will give many additional hours of trouble-free operation.



3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

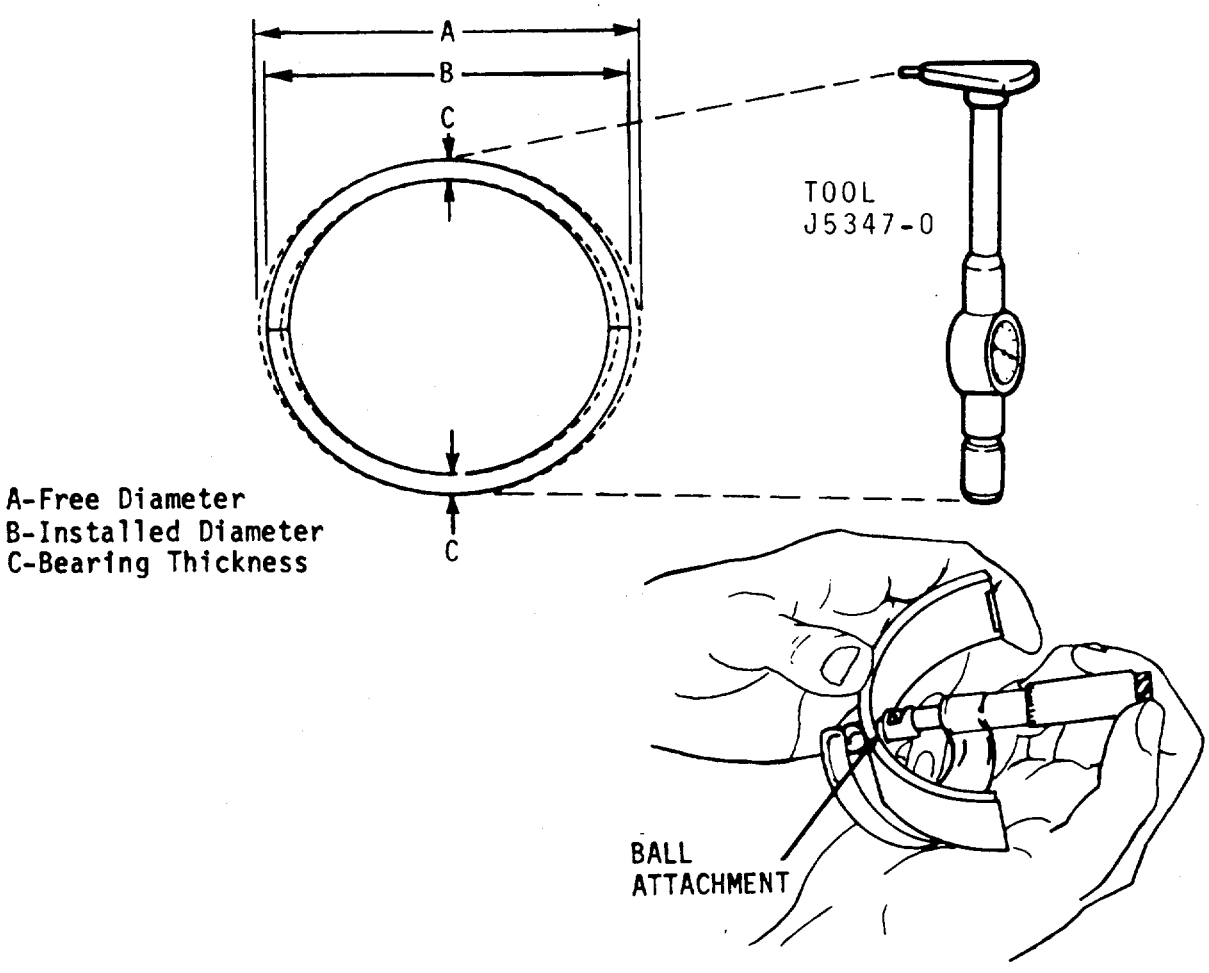
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		3. Inspect the backs of the bearing shells for bright spots which indicate they have been moving in the bearing caps or bearing supports.	If such spots are present, discard the bearing shells.
		4. Measure the thickness of the bearing shells at point "C", 90° (32.22°C) from the parting line. Tool J5347-01, placed between the bearing shell and a micrometer, will give an accurate measurement. The bearing shell thickness will be the total thickness of the steel ball in the tool, and the bearing shell, less the diameter of the ball. his is the only practical method for measuring bearing thickness, unless a special micrometer is available for this purpose. The minimum thickness of a worn standard main bearing shell is .1540 inch (0.3912 cm) and, if any of the bearing shells are thinner than this dimension, replace all of the bearing shells. A new standard bearing shell has a thickness of .1545 to .1552 inch (0.3932 to 0.3957 cm).	

3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

Bearing Size	Bearing Thickness	Minimum Thickness
Standard	.1548"/.1553"	.1530"
.002" Undersize	.1558"/.1563"	.1540"
.010" Undersize	.1598"/.1603"	.1580"
.020" Undersize	.1648"/.1653"	.1630"
.030" Undersize	.1698"/.1703"	.1680"



3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
		5. Check the clearance between the main bearings and the crankshaft journals. This clearance may be determined with the crankshaft in place by means of a soft plastic measuring strip which is squeezed between the journal and the bearing. Measure the outside diameter of the crankshaft main bearing journals and the inside diameter of the main bearing' shells when installed in place with the proper torque on the bearing cap bolts. When installed, the bearing shells are .001 inch (0.0025 cm) larger in diameter at the parting line than 90°(32.22°C) from the parting line.	

b. The bearing shells do not form a true circle when not installed. When installed, the bearing shells have a squeeze fit in the main bearing bore and must be tight when the bearing cap is drawn down. The crush assures a tight, uniform contact between the bearing shell and bearing seat. Bearing shells that do not have sufficient crush will not have uniform contact, as shown by shiny spots on the back, and must be replaced. If the clearance between any crankshaft journal and its bearing shells exceeds .0060 inch (0.0152 cm), all of the bearing shells must be discarded and replaced. This clearance is .0016 to .0050 inch (0.0041 to 0.0127 cm) with new parts.

c. Before installing new replacement bearings, it is very important to thoroughly inspect the crankshaft journals. Very often, after prolonged engine operation, a ridge is formed on the crankshaft

3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

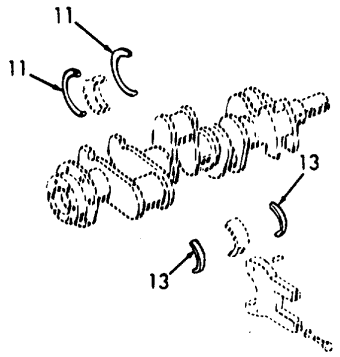
LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

journals in line with the journal oil holes. If this ridge is not removed before the new bearings are installed, then, during engine operation, localized high unit pressures in the center area of the bearing shell will cause pitting of the bearing surface. Also, damaged bearings may cause bending fatigue and resultant cracks in the crankshaft. Refer to Paragraph 3-172.2 under Crankshaft Inspection for removal of ridges and inspection of the crankshaft.

d. Do not replace one main bearing shell alone. If one bearing shell requires replacement, install both new upper and lower bearing shells. Also, if a new or reground crankshaft is to be used, install all new bearing shells.

5.	Upper and lower thrust washers	Thrust washers (11 and 13)	Inspect.	If the washers are scored or worn excessively or the crankshaft end play is excessive, they must be replaced. Improper clutch adjustments can contribute to excessive wear on the thrust washers. Inspect the crankshaft thrust surfaces. If after dressing or regrinding the thrust surfaces, new standard size thrust washers do not hold the crankshaft end play within the specified limits, it may be necessary to install an oversize thrust

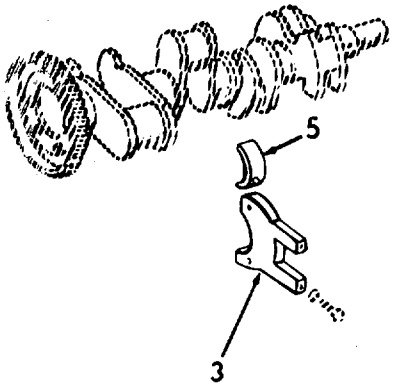


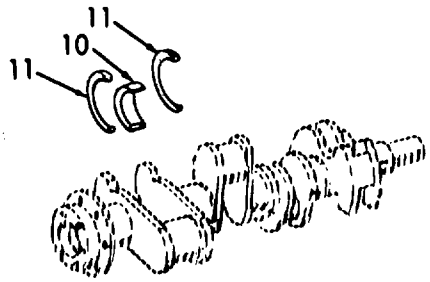
3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
			washer on one or both sides of the rear main bearing. A new standard size thrust washer is .1190 to .1220 inch (0.3023 to 0.3099 cm) thick. Thrust washers are available in .005 and .010 inch (0.0127 and 0.0254 cm) oversize.
INSTALLATION			
6. Upper bearing numbers 1, 2, 3	Upper bearing shells (4)	a. Clean.	
		b. Lubricate.	Use clean engine oil.
		NOTE The upper and lower main bearing shells are not alike: the upper bearing shell is grooved and drilled for lubrication - the lower bearing shell is not. Be sure to install the grooved and drilled bearing shells in the cylinder block and the plain bearing shells in the bearing caps. Otherwise, the oil flow to the bearings and to the upper end of the connecting rods will be blocked off. Used bearing shells must be reinstalled on the same journal from which they were removed.	
		c. Install.	Start the plain end of bearing shell around the crankshaft journal so that when the bear-

3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
			ing is in place the tang will fit into the groove in the bearing support.
7. Lower bearing numbers 1, 2, and 3	Lower bearing shell (5)	a. Clean.	
		b. Lubricate.	Use clean engine oil.
		c. Install, so that the tang on the bearing fits into the groove in the bearing cap (3).	
8. Upper bearing number 4	Upper bearing shell (10), and thrust washers (11)	a. Clean.	
		b. Lubricate.	Use clean engine oil.
		c. Inspect for burrs.	Remove from washer seats. The slightest particle of dirt or burr may decrease the clearance between washers and crankshaft.
		d. Slide upper halves of thrustwashers into place.	





3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

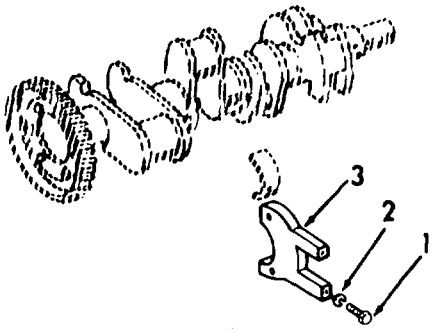
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		e. Install.	Remove the slightest particle of dirt or burr from washer seat. These may decrease the clearance between washers and crankshaft.
9. Lower bearing number 4	Lower bearing shell (12), and thrust washers (13)	a. Clean.	
		b. Lubricate.	Use clean engine oil.
		c. Inspect for burrs.	Remove the slightest particle of dirt or burr from washer seat. These may decrease the clearance between washers and crankshaft.
10. Bearing cap numbers 1, 2, 3	a. Bolts (1)	Place a small quantity of compound on threads and bolt head contact area.	Use International Compound #2 or equivalent.
	b. Bearing caps (3)	Position on crankshaft.	
		NOTE The main bearing caps are bored into position and stamped 1,2,3, etc. They must be installed in their original positions in the cylinder block.	
	c. Bolts (1), and lock-	1. Install and draw up tight. 2. Rap the bearing cap	

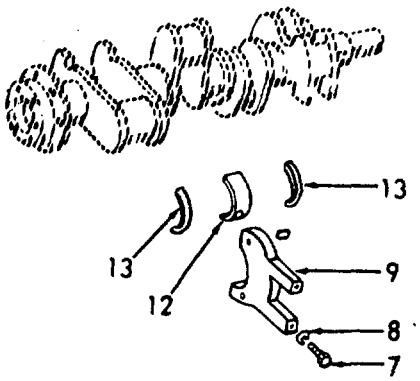
3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	washers (2)	sharply with a soft hammer to seat the bearing caps.	
		3. Tighten bolts uniformly.	Torque to 180-190 ft-lb (244.1-257.6 Nm).
11. Bearing cap number 4	a. Bolts (7)	Place a small quantity of compound on threads and the bolt head contact area.	Use International Compound #2 or equivalent.
	b. Bearing caps (9)	Position on crankshaft.	
	c. Bolts (7) and lockwashers (8)	Install.	Torque to 70-75 ft-lb (94.9-101.7 Nm).
		1. Install and draw up tight.	
		2. Rap the bearing cap sharply with a soft hammer.	To seat the bearing caps.

NOTE

If the bearings have been installed properly, the crankshaft will turn freely with all of the main bearing cap bolts drawn to the specified torque.





3-172.1. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
12. Engine	a. Lube oil pump	Install.	Refer to paragraph 3-169.
	b. Oil inlet pump	Install.	Refer to paragraph 3-170.
	NOTE If shims were used between the lube oil pump and the bearing caps, install them in their original positions.		
	c. Oil pan	1. Install.	Refer to paragraph 3-163.
		2. Fill with oil.	

3-172.2. CRANSHAFT - MAINTENANCE INSTRUCTIONS.

a. The crankshaft is one-piece steel forging, heat-treated to ensure strength and durability. The main and connecting rod bearing journal surfaces and fillers on all crankshafts are induction hardened.

b. Complete static and dynamic balance of the crankshaft has been achieved by counterweights incorporated into the crankshaft.

c. The crankshaft end play is controlled by thrust washers located at the rear main bearing cap of the engine. Full pressure lubrication to all connecting rod and main bearings is provided by drilled passages within the crankshaft and cylinder block.

d. Two dowels and six tapped holes are provided in the rear end of the crankshaft for locating and attaching the flywheel. One hole is unequally spaced so that the flywheel can be attached in only one position.

3-172.2. CRANSHAFT - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP:

Test Equipment
None

Special Tools

Chain hoist
Pump, hand
NSN 4930-00-263-9886
Gear puller

Material/Parts

None

References
None

Equipment Condition Condition Description

Paragraph	
3-157	Crankshaft Pulley Removal
3-163	Oil Pan Removal
3-164	Cylinder Head Removal
3-167	Flywheel and Housing Removal
3-169	Lube Oil Pump Removal
3-170	Oil Inlet Pipe Removal
3-172.1	Oil Inlet Pipe Removal
3-172.2	Front Cover and Oil Seals Removal

Special Environmental Conditions

Do not drain oil into bilges.
Use the oil/water separation and recovery system to collect drained oil.

Personnel Required

1

General Safety Instructions

None

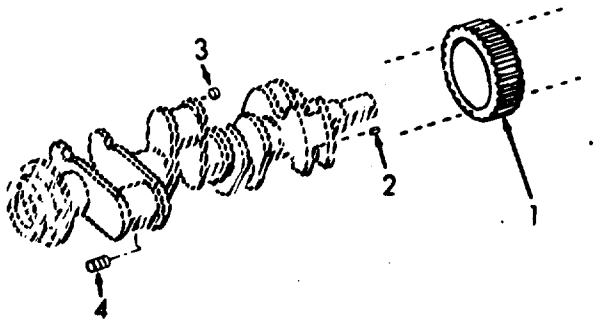
LOCATION	ITEM	ACTION	REMARK
REMOVAL			
1. Engine	a. Cooling system	Drain.	
	b. Engine oil	Pump into a suitable container.	

3-172.2. CRANSHAFT - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Engine mounts	Disconnect	
	d. Accessories and assemblies	Remove to permit engine to be laid over on one side.	
	e. Oil pan	Remove.	Refer to paragraph 3-163 .
	f. Lube oil pump	Remove.	Refer to paragraph 3-169 .
	g. Flywheel and housing	Remove.	Refer to paragraph 3-167 .
	h. Crankshaft pulley	Remove.	Refer to paragraph 3-157 .
	i. Front engine support	Remove.	Refer to paragraph 3-172 .
	j. Cylinder head	Remove.	Refer to paragraph 3-164 .
	k. Connecting rod bearing caps	Remove.	Refer to paragraph 3-171 .
	l. Pistons and connecting rods	Remove.	Refer to paragraph 3-172.1 .

3-172.2. CRANSHAFT BEARINGS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	m. Crankshaft, timing gear, and oil pump drive gear	Remove.	
	n. Timing gear	Remove.	Refer to paragraph 3-166.4 .
2. Oil pump drive gear	a. Gear (1)	Install a gear puller and remove gear.	
	b. Woodruff key (2)	Remove.	
3. Crankshaft	a. Pipe plugs (3)	Remove if necessary.	
	b. Pipe plugs (4)	Remove if necessary.	



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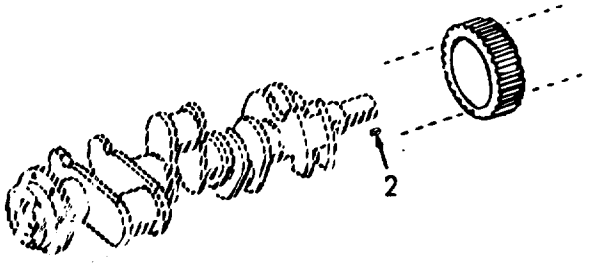
3-172.2. CRANSHAFT - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
4. Engine	Crankshaft	a. Inspect for cracks which start at an oil hole and follow the journal surface at an angle of 45° (7.22°C) to the axis. b. Inspect for cracks or wear around keyways. c. Inspect for overheating. d. Inspect oil seal for roughness or grooves. e. Check gears for damage.	
INSTALLATION			
5. Oil pump drive gear	Woodruff key (2)	Place in crankshaft. Slide on crankshaft. The gear should be tight against the shoulder on the crankshaft.	
6. Timing gear		Install.	Refer to paragraph 3-166.4 .
7. Crankshaft		Install in engine.	
8. Engine		Replace all assemblies and parts removed in step 1 above.	



3-172.3. CRANSHAFT SEALS - MAINTENANCE INSTRUCTIONS.

a. The crankshaft front cover is mounted against the cylinder block end plate at the lower front end of the engine. The engine is supported at the front end by engine supports attached to the front cover.

b. It will be necessary to remove the crankshaft front cover to remove and install the crankshaft.

c. An oil seal is used at each end of the crankshaft to retain the lubricating oil in the crankcase. The sealing lips of the oil seals are held firmly, but not tight against the crankshaft sealing surfaces by a coil spring.

d. The front oil seal is pressed into the crankshaft front cover. The lip of the seal bears against a removable spacer or vibration damper inner cone on the end of the crankshaft.

e. A double-lip oil seal is used in engines where there is oil on both sides of the oil seal; the lips of the seal face in opposite directions. The rear oil seal is pressed into the flywheel housing.

f. Oil leaks indicate worn or damaged oil seals. Oil seals may become worn or damaged due to improper installation, excessive main bearing clearances, excessive flywheel housing bore runout or grooved sealing surfaces on the crankshaft or oil seal spacers. To prevent a repetition of any oil seal leaks, these conditions must be checked and corrected.

3-172.3. CRANSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Removal **b. Inspection** **c. Installation**

INITIAL SETUP:

Test Equipment

None

Special Tools

Hammer (soft)

Material/Parts

Gasket kit P/N 5193114
Shellac
Oil seal P/N 5115454
Oil seal P/N 5115335
Grease or vegetable shortening

Personnel Required

1

References

None

Equipment Condition Condition Description

Paragraph	
3-157	Crankshaft Pulley Removal
3-159	Lifter Brackets and Supports
3-163	Oil Pan Removal
3-167	Flywheel and Housing Removal
3-169	Lube Oil Pump Removal
3-170	Oil Inlet Pipe Removal
3-171.1	Piston Removal

Special Environmental Conditions

None

General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARK
REMOVAL			
1. Engine front	Lifter supports	Place a wooden block under engine. Remove supports.	Refer to paragraph 3-159 .

3-172.3. CRANSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

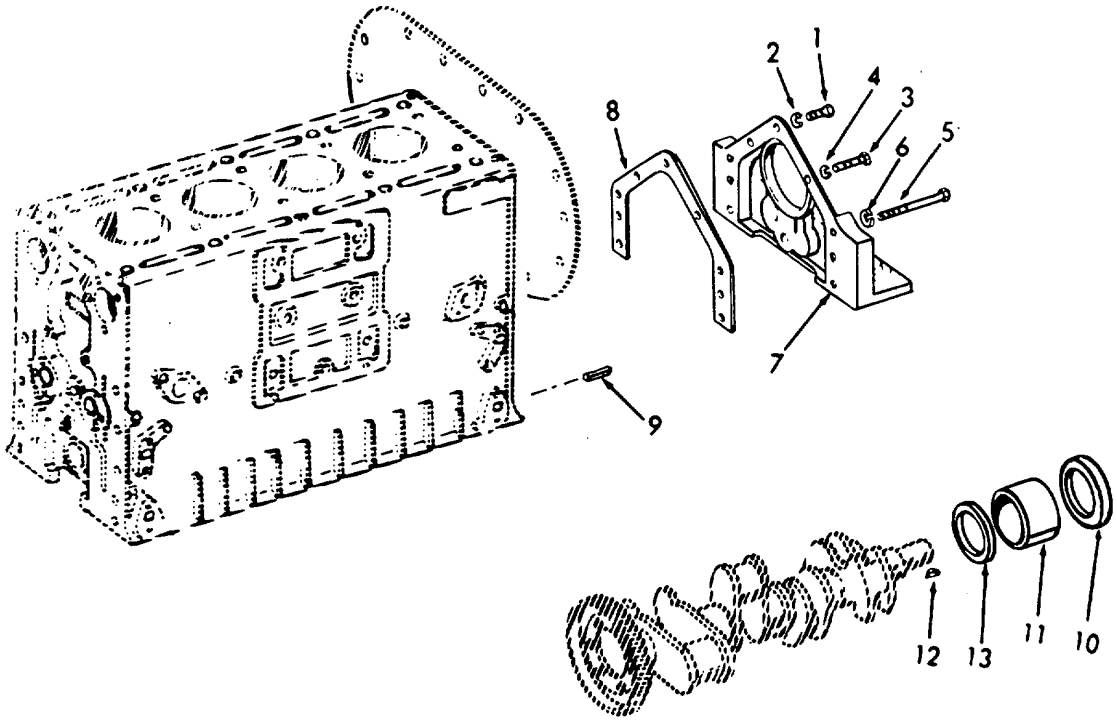
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
2. Crank-shaft front Cover	a. Three screws (1), and lock-washers (2)	Remove.	Screws are 3/8-24x3/4 inch long.
	b. Two screws (3), and lock-washers (4)	Remove.	Screws are 1/2-13 x 2 1/4 inch long.
	c. Two screws (5), and lock-washers (6)	Remove.	Screws are 1/2-13 x 3 3/4 inch long.
	d. Front cover (7)	1. Strike the rear face of ears on the cover with a soft hammer to free cover from dowels. 2. Pull cover straight off the end of the crankshaft.	
	e. Gasket (8)	Remove.	Discard gasket.
	f. Dowels (9)	Remove if necessary.	
3. Oil seal (front)	a. Oil seal (10)	1. Drive the seal out of front cover. 2. Clean seal bore in the front cover.	Discard oil seal.

3-172.3. CRANSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	b. Spacer (11), and woodruff key (12)	Remove.	
	c. Oil slinger (13)	Remove.	

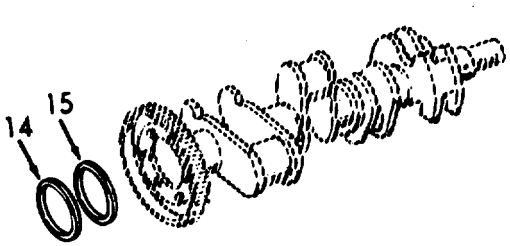
NOTE

When necessary, an oil seal may be removed without removing the front cover or flywheel housing. This may be done by drilling diametrically opposite holes in the seal casing and threading metal screws, backed by flatwashers, into the casing. Remove the seal by prying against the washers with pry bars.



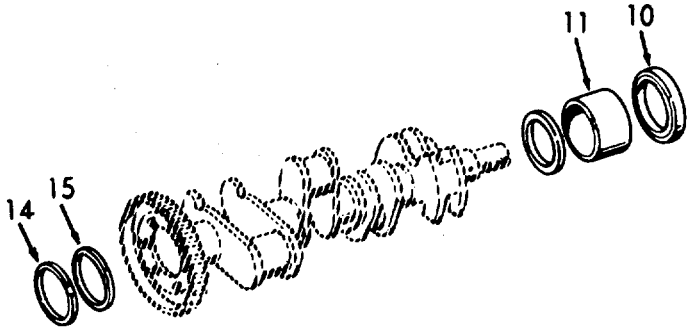
3-172.3. CRANSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
4. Oil sea rear	a. Flywheel and flywheel housing	Remove.	Refer to paragraph 3-167.
	b. Oil seal (14)	1. Drive the seal out of the flywheel housing. 2. Clean the seal bore in the flywheel housing.	
	c. Spacer (15)	Remove.	



3-172.3. CRANKSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
5. Engine	a. Oil seals rear (14), and spacer (15)	1. Inspect for wear due to the rubbing action of the oil seal.	
		2. Inspect for dirt build-up or fretting by the action of the flywheel.	
		3. Check for oil leaks.	
	b. Oil seal front (10) and spacer (11)	1. Inspect for wear or dirt build-up.	
		2. Check for oil leaks.	



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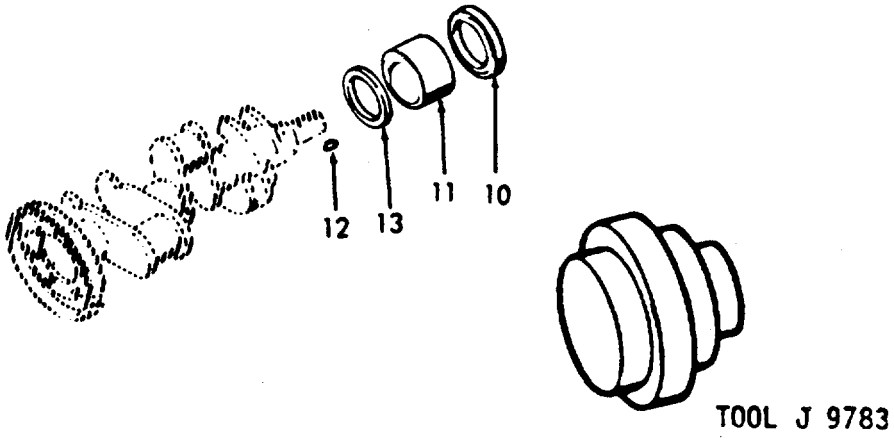
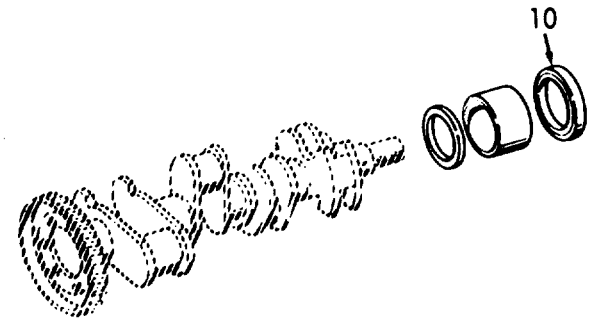
3-172.3. CRANKSHAFT SEAL - MAINTENANCE INSTRUCTIONS (Continued).

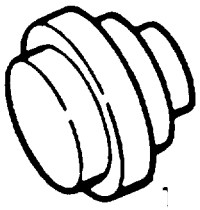
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
		NOTE	
		Oil seals are made of an oil-resistant, synthetic rubber which is pre-lubricated with a special lubricant. Do not remove this lubricant. Keep the sealing lip clean and free from scratches. In addition, a plastic coating which acts as a sealant has been applied to the outer surface of the casing. Do not remove this coating.	
6. Front oil seal	a. Oil slinger (13), spacer (11), and Woodruff (12)	Install slinger with the dished outer diameter of the slinger facing away from the gear.	



3-172.3. CRANKSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	b. Oil seal (10)	1. Coat the lip of the new oil seal lightly with grease or vegetable shortening. Position the seal in the front cover with the lip of the seal pointed toward the inner face of cover. 2. Drive the seal into the front cover with installer J9783. The installer prevents damage to the seal by exerting force only on the outer edge of the seal casing. 3. Remove excess sealant from front cover and seal.	





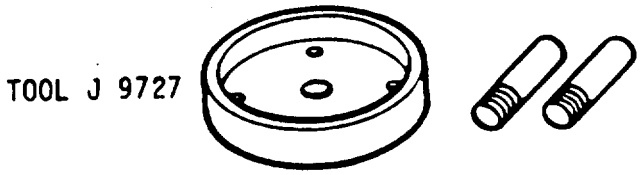
TOOL J 9783

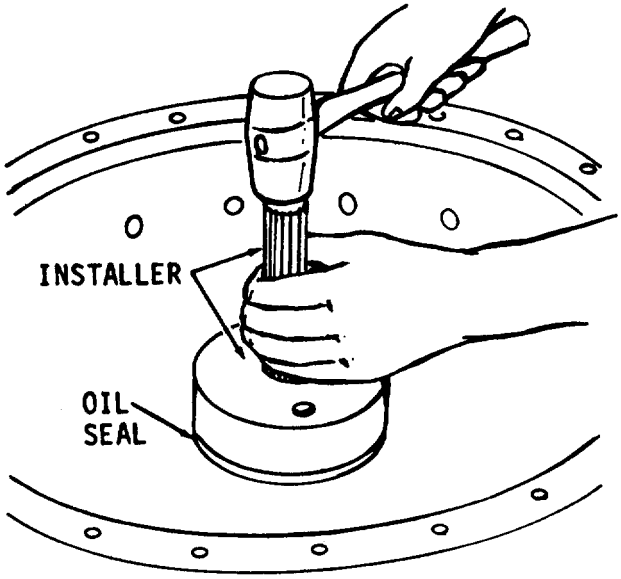
3-172.3. CRANKSHAFT SEALS - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
7. Rear oil seal	a. Spacer (15)	Install in spacer against the shoulder in the flywheel housing oil seal bore.	
	b. Oil seal (14)	1. Coat the lip of the oil seal lightly with engine oil (single lip seal) or vegetable shortening (double-lip seal). Do not scratch or nick the sealing edge of the oil seal.	
		2. Drive the seal into the housing with installer J9727 and handle until it is seated against the seal spacer (if used) or on shoulder in the housing bore. The installer prevents damage to the seal by exerting force only on the outer edge of the seal casing. If it is necessary to install the oil seal with the flywheel housing on the engine, place oil seal expander against end of crankshaft. Then, with the lip of the seal pointed toward the engine, slide the seal over the tool and onto the crankshaft. Remove the seal expander and drive the seal in place with installer J9727 and handle.	

3-172.3. CRANKSHAFT SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)		3. Remove any excess sealant from the flywheel housing and the seal.	



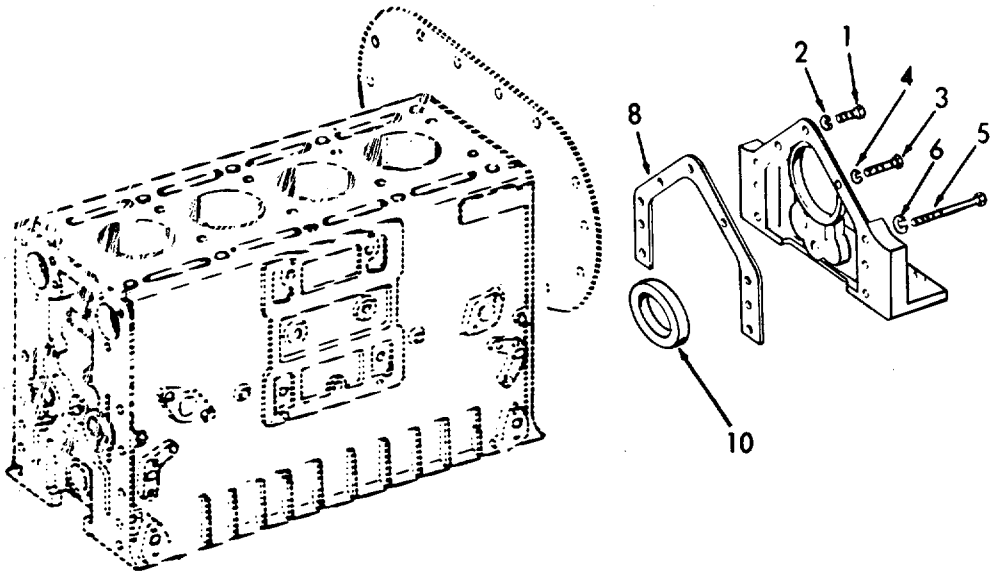


3-172.3. CRANKSHAFT SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
8. Front cover	a. Gasket (8)	Shellac a new gasket to the bolting flange of the front cover.	
	b. Oil seal (10)	Coat the lip of the seal lightly with cup grease.	
	c. Two screws (5), and lock-washers (6)	Install.	Screws are 1/2-13 x 3 3/4 inch long.
	d. Two screws (3), and lock-washers (4)	Install.	Screws are 1/2-13 x 2 1/4 inch long.
	e. Three screws (1), and lock-washers (2)	Install.	Screws are 3/8-24 x 3/4 inch long.
	f. Screws (1, 3 and 5)	Tighten the cover attaching screws by following the tightening sequence shown. Follow this sequence as the screws are drawn up and then tightened to their proper torque to effect a good seal between the mating parts. Tighten the 3/8-24 screws to 25-30 lb.-ft	

3-172.3. CRANKSHAFT SEAL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
		(34.1-41.0 Nm) and the 1/2-13 screws to 80-90 ft-lb. (109.2-122.9 Nm) torque.	
9.	Flywheel housing	Replace the flywheel housing and flywheel.	Refer to paragraph 3-167 .



3-173. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS.

a. The cylinder block serves as the main structural part of the engine. Transverse webs provide rigidity and strength and ensure alignment of the block bores and bearings under load.

b. The block is bored to receive replaceable cylinder liners. The cylinder block is designed to provide water cooling below the air inlet port belt. An air box between the cylinder banks and extending around the cylinders at the air inlet port belt conducts the air from the blower to the cylinders. Air box openings on each side of the block permit inspection of the pistons and compression rings through the air inlet ports in the cylinder liners. The air box openings in the cylinder block assembly are about 1 7/8 inch x 3 1/8 inch (4.76 x 7.94 cm) and are covered with cast covers. The camshaft bores are located on the inner side of each cylinder bank near the top of the block.

c. The upper halves of the main bearing supports are cast integral with the block. The main bearing bores are line-bored with the bearing caps in place to ensure longitudinal alignment. Drilled passages in the block carry the lubricating oil to all moving parts of the engine.

d. The top surface of each cylinder bank is grooved to accommodate a block-to-head oil seal ring. Each water or oil hole is counterbored to provide for individual seal rings.

e. Each cylinder liner is retained in the block by a flange at its upper end. The liner flange rests on an insert located in the counter- bore in the block bore. An individual compression gasket is used at each cylinder. When the cylinder heads are installed, the gaskets and seal rings compress to form a tight metal-to-metal contact between the heads and the block.

f. Cylinder block assemblies include the main bearing caps and bolts, dowels and the necessary plugs. Since the cylinder block is the main structural part of the engine, the various subassemblies must be removed from the cylinder block when an engine is overhauled.

3-173. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection **b. Repair**

INITIAL SETUP:

Test Equipment
None

References
None

Special Tools
None

Equipment Condition: Condition Description
None

Material/Parts
Gasket kit P/N 5196375

Special Environmental Conditions
None

Personnel Required
1

General Safety Instructions
None

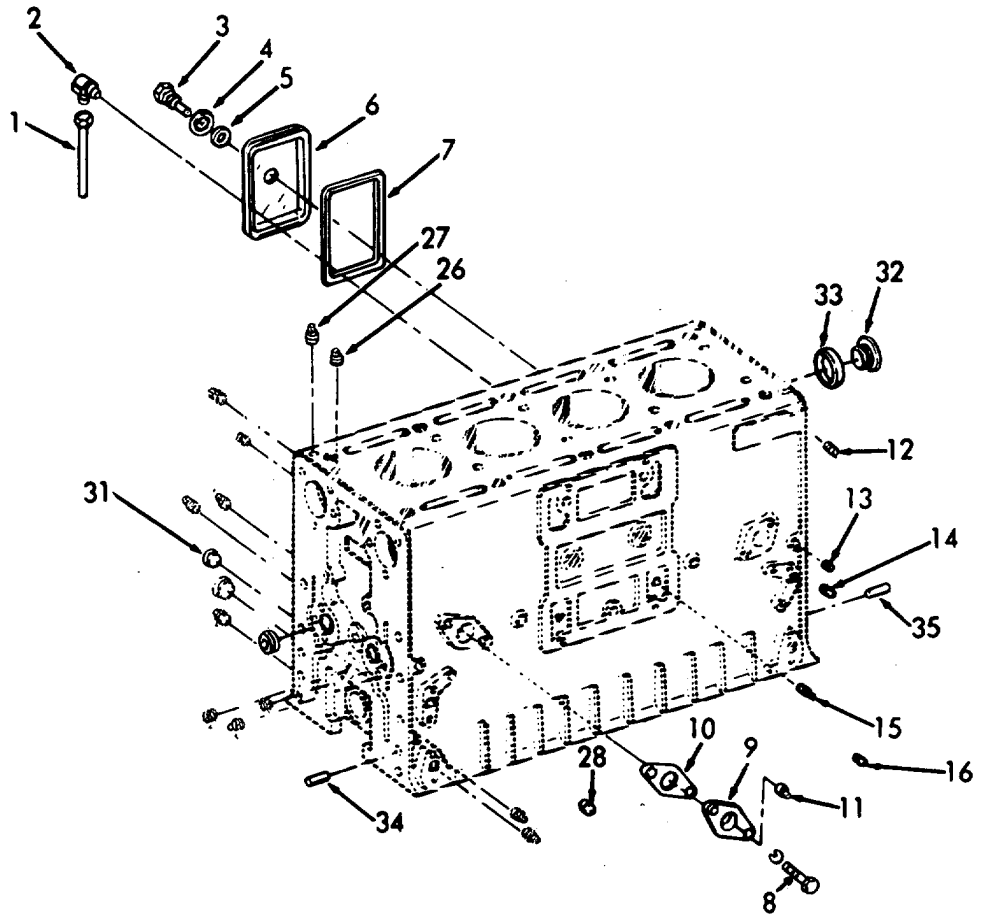
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Engine	a. Cylinder block	Inspect for cracks, and signs of damage.	Refer to Direct Support Maintenance.
	b. Air box covers	Inspect for leaking gaskets.	Replace.
	c. Air box drains	Inspect for bent or broken tubes.	Replace.
	d. Water holes	Inspect for leaking gaskets.	Replace.
	e. Pipe plugs	Inspect for leaking.	Replace.
	f. End plate gaskets	Inspect for leaking gaskets.	Replace.

3-173. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2. Cylinder Block	a. Air box drain	Remove tube (1), and elbow (2).	If damaged.
	b. Air box cover	Remove bolt (3); flat-washer (4), copper gasket (5), cover (6), and gasket (7).	If gasket is leaking.
	c. Water hole cover	Remove bolt assemblies (8), cover (9), gasket (10), and pipe plug (11)	If gasket is leaking.
	d. Pipe plugs (12 thru 26)	Replace.	If damaged.
	e. Special plug (27)	Replace.	If damaged.
	f. Plug cups (28 thru 31)	Replace.	If damaged.
	g. Four plugs (32) and gasket (33)	Replace.	If gasket is leaking.
	h. Dowel pins (34 and 35)	Remove if damaged.	The dowels must extend 5/8 inch from block.

3-173. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



3-2983

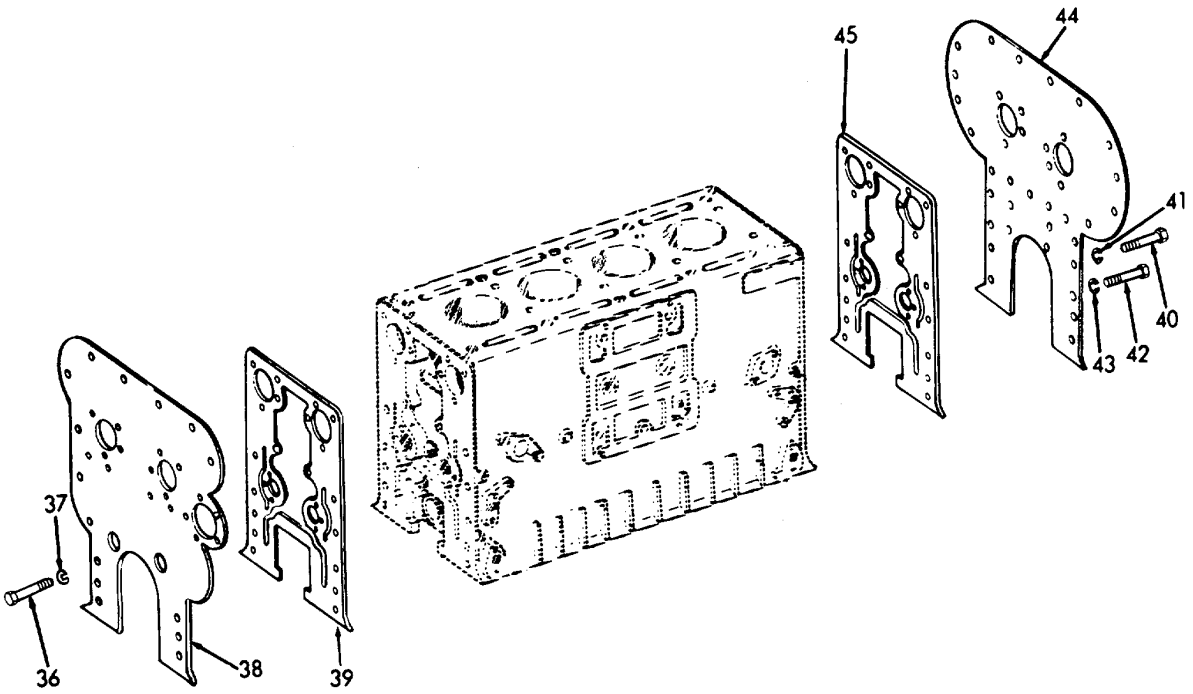
3-173. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Cylinder block end rear plate	a. Six screws (36), and lock-washers (37)	Remove if necessary.	
	b. Rear plate (38), and gasket (39)	Remove if necessary.	
4. Cylinder block front end plate	a. Six screws (40), and lock-washers (41)	Remove if necessary.	
	b. Two screws (42), and lock-washers (43)	Remove if necessary.	
	c. Front end plate (44), and gasket (45)	Remove if necessary.	

3-173. CYLINDER BLOCK - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-174. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS

The instrument panel consists of an engine oil pressure gage, water temperature gage, start switch and a tachometer. A remote starting and stopping control is mounted near the Anchor "A" Frame.

a. Oil Pressure Gage.

The oil pressure gage registers the pressure of the lubricating oil in the engine. As soon as the engine is started, the oil pressure gage should start to register. If not, the engine should be stopped and the cause of the low oil pressure determined and corrected before the engine is started again.

b. Water Temperature Gage.

The engine coolant temperature is registered on the water temper- ature gage.

c. Engine Starting Motor Switch.

The engine starting motor switch is used to energize the starting motor. As soon as the engine starts, the switch is released. The starting switch is mounted on the instrument panel with the contact button extending through the front face of the panel.

d. Tachometer.

Refer to Paragraph 3-155 .

This task covers:

a. Inspection **b. Repair**

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition — Condition Description

None

Special Environmental Condition

None

General Safety Instructions

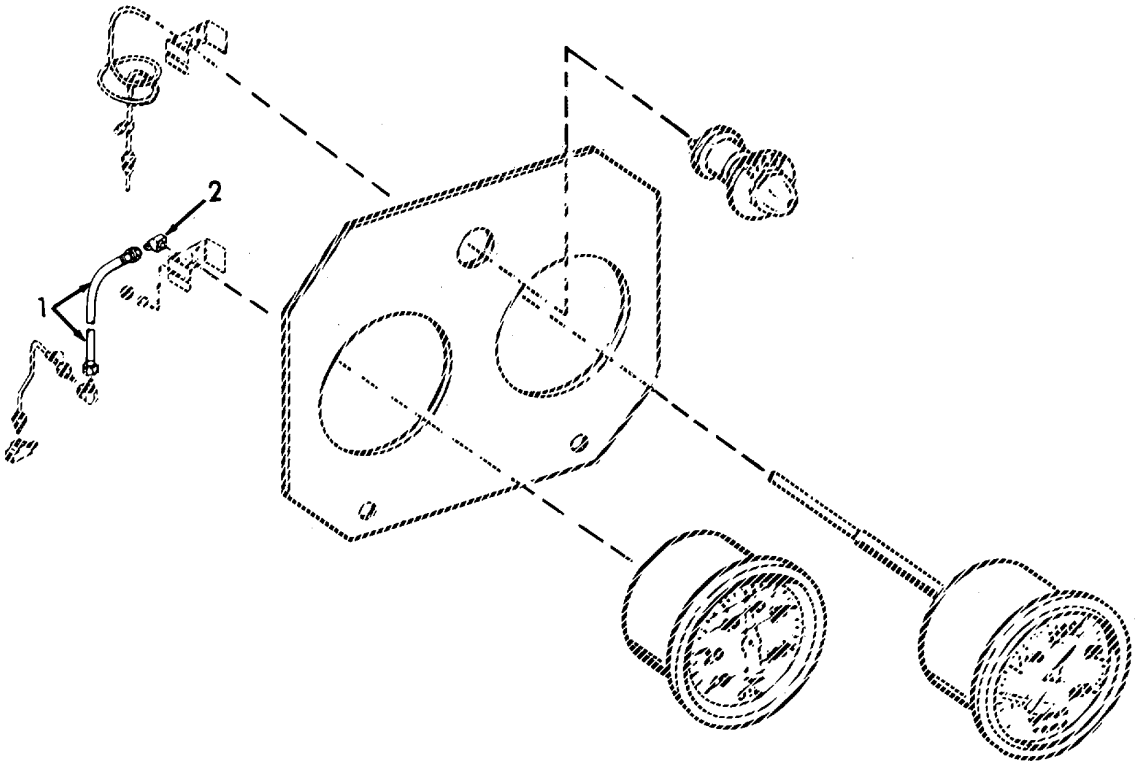
None

3-174. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Instrument panel	a. Oil pressure gage	1. Inspect for broken glass, bent pointer and other signs of damage.	
		2. Inspect for presence of oil in gage.	
		3. With engine running, does gage function and indicate properly?	Defective gage or tubing?
	b. Water tempera-ture gage	1. Inspect for broken glass, bent pointer and other signs of damage. damage.	
		2. Inspect for presence of water in gage.	
		3. With engine running, does gage function and indicate properly?	Defective gage or tubing?
	c. Start switch	Inspect for proper oper-ation.	
REPAIR			
2. Oil pressure gage	a. Flexible hose (1)	Loosen at hose nuts.	Remove hose.
	b. Elbow (2)	Remove.	

3-174. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			



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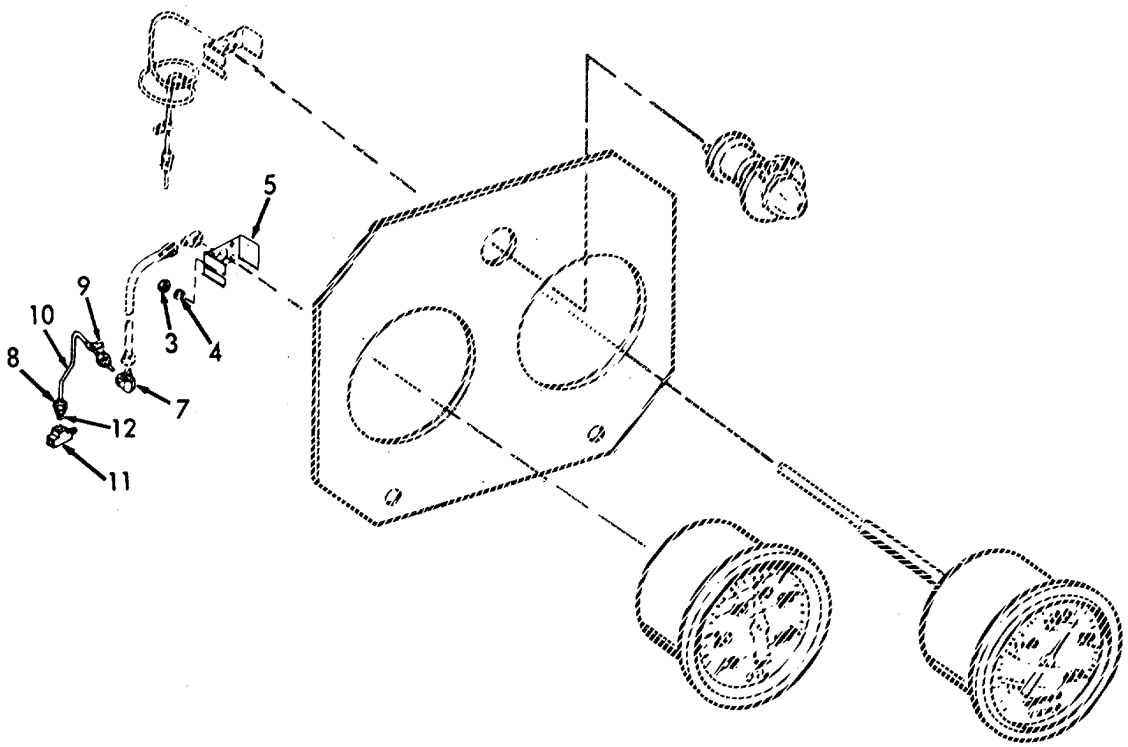
3-174. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			
	c. Nuts (3) and lock-washers (4)	Remove.	
	d. Gage clamp (5)	Remove.	
	e. Gage (6)	Remove.	
	f. Elbow (7)	Remove.	
	g. Connec-tor (8)	Loosen.	
	h. Tube clip (9)	Loosen.	
	i Tube (10)	Remove.	
	j. Pipe tee (11)	Remove.	
	k. Restric-tion fitting (12)	Replace if necessary.	
	l. Pipe tee (11)	Install.	

3-174. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			

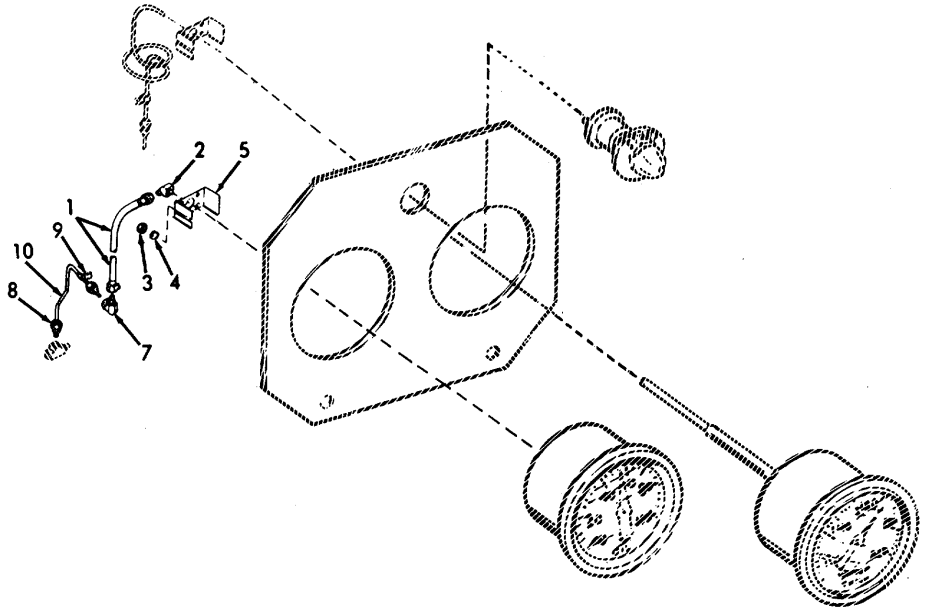


3-174. INSTRUMENT PANEL - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont.)			
	m. Tube (10)	Install.	
	n. Tube clip (9)	Install.	
	o. Connector (8)	Tighten.	
	p. Elbow (7)	Install.	
	q. Gage (6)	Install.	
	r. Gage clamp (5)	Install.	
	s. Nuts (3), lockwashers (4), and elbow (2)	Install.	
	t. Flexible hose (1)	Install.	

3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



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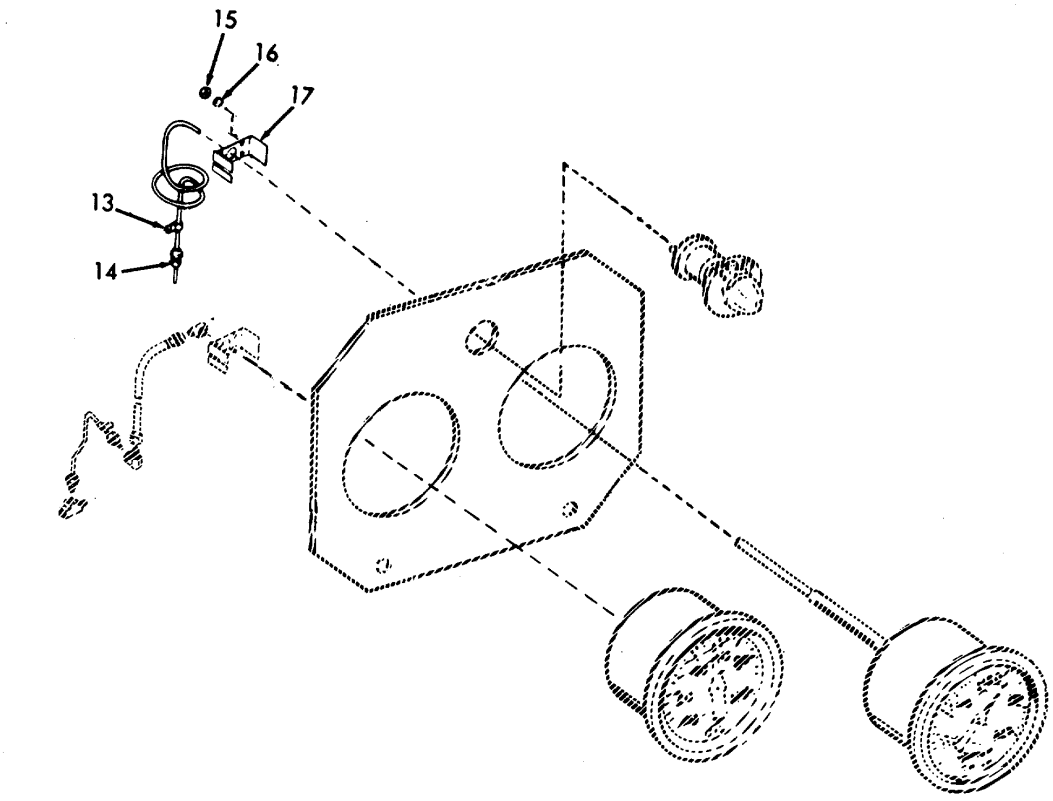
3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Water temperature gage	a. Clip (13)	Remove.	
	b. Adaptor (14)	Remove.	
	c. Nuts (15), lockwashers (16), and gage clamp (17)	Disassemble.	
	d. Gage (18)	Remove.	
	e. Gage (18)	Install.	
	f. Gage clamp (17), nuts (15) and lockwashers (16)	Assemble.	Incorrect coolant temperature readings will be registered if the gage assembly is incorrectly installed or the capillary tube is damaged.
	g. Clip (13)	Install.	1. To prevent damage to the gage assembly from vibration, the capillary tube must be securely fastened to the engine the full length, with suitable clips at intervals of ten inches (15 cm) or

3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-2995

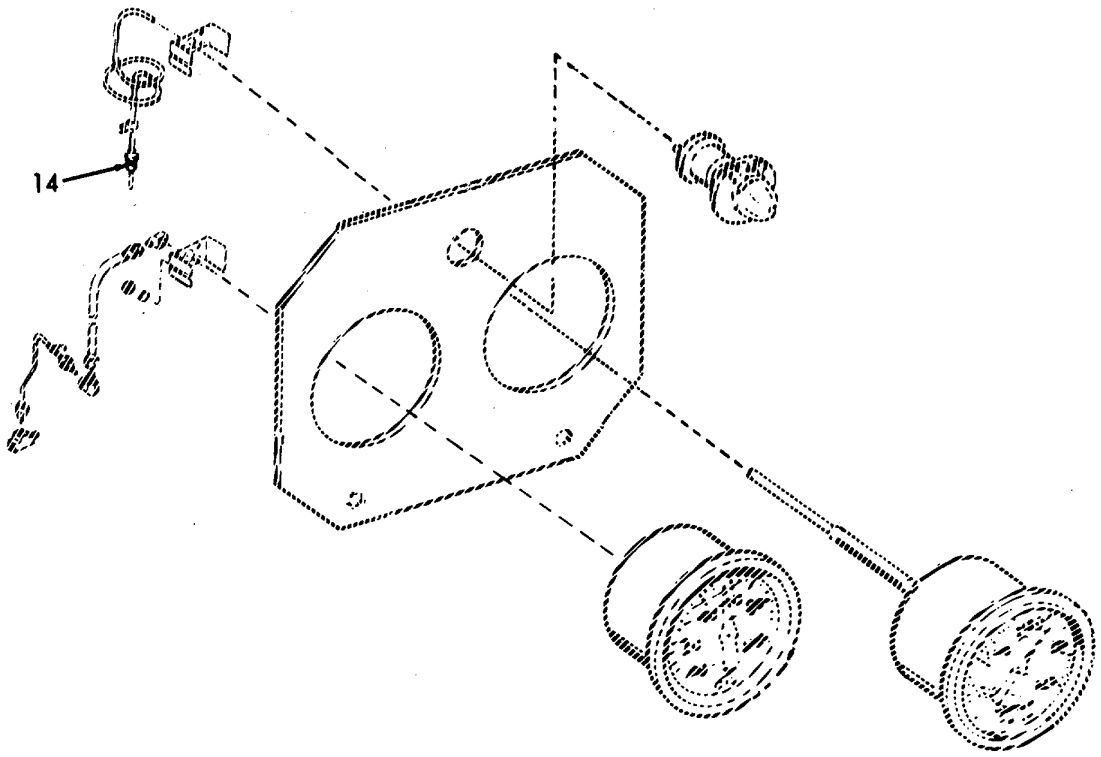
3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
			less. Sharp bends in the tube must be avoided, particularly at the gage or bulb connection areas. Where the tube must be bent around any object, the bend must not be less than one inch (2.54 cm) radius.
			2. Any extra length can be taken up by coiling, the diameter of which should not be less than two inches (5.1 cm). The coils must be located so that they may be securely fastened to prevent vibration.
	h. Adaptor (14)	Install.	

3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



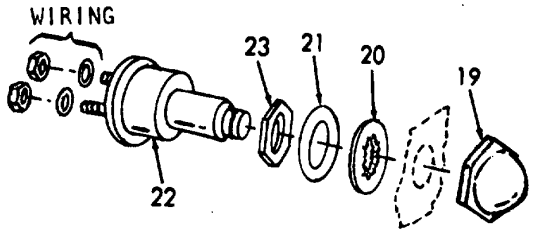
3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

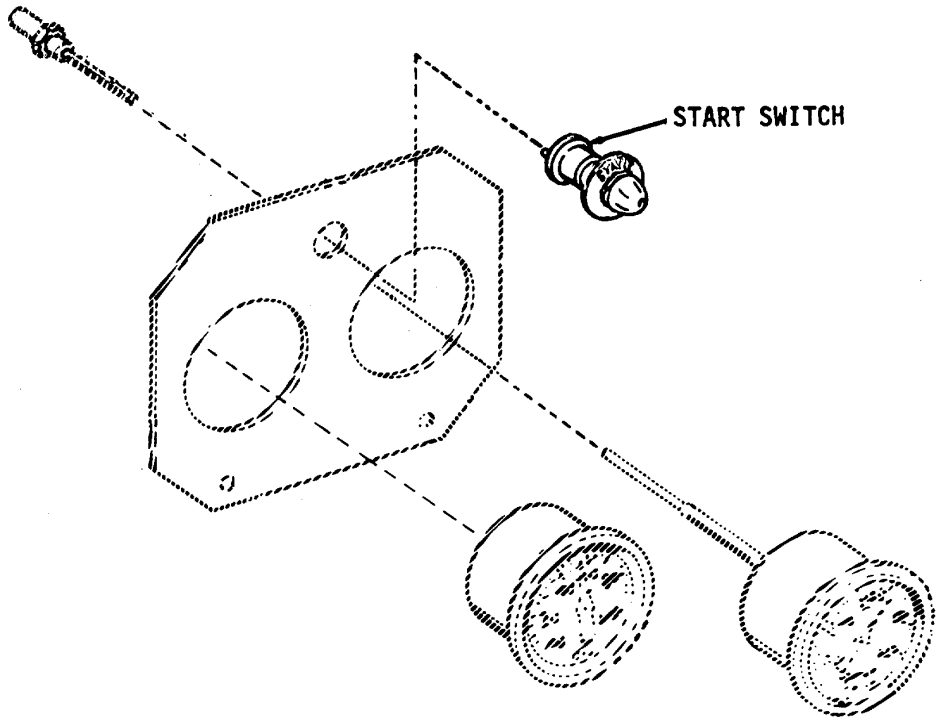
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
4. Start switch	a. Wiring	Tag and disconnect.	
	b. Nut (19)	Remove.	On front of panel.
	c. Lock-washer (20), flat-washer (21), and switch (22)	Remove.	
	d. Switch (22), nut (23), flat-washer (21), and lock-washer (20)	Assemble.	Position assembled switch in panel. Adjust nut (23) as required.
	e. Nut (19)	Install.	Torque to 36-48 inch-lbs, (4.07-5.42 Nm).
	f. Wiring	Reinstall.	

3-174. INSTRUMENT PANEL- MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)





3-2999

3-175. STARTING AID - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS

a. When starting an internal combustion engine in cold weather, a large part of energy is absorbed by the pistons, cylinder walls, coolant and in overcoming friction.

b. Under extremely low temperatures the cold oil in the bearings and between pistons and cylinder walls creates high friction, thus engine starting is harder than when the engine is warm.

c. The normal diesel starting is to ignite the fuel sprayed into the combustion chamber by the heat of air compressed in the cylinder. This temperature is high enough for normal operating conditions, but at extremely low temperatures may not be high enough to ignite the injected fuel.

WARNING

Do not activate the starting aid more than once with the engine stopped. Overloading the engine air box with this highly volatile fluid could result in a minor explosion.

NOTE

The starting aid is not intended to correct deficiencies but for use when other conditions are normal and air temperature is too low for heat of compression to ignite the fuel-air mixture.

This task covers:

a. Inspection
b. Service
c. Replacement
d. Disassembly

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Cylinder starting aid LP-535
Valve repair kit LP-3250

Personnel Required

1

Reference

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

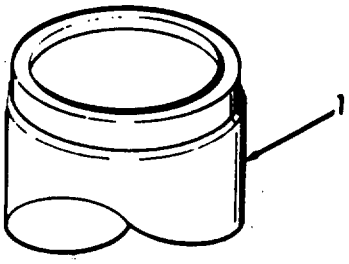
None

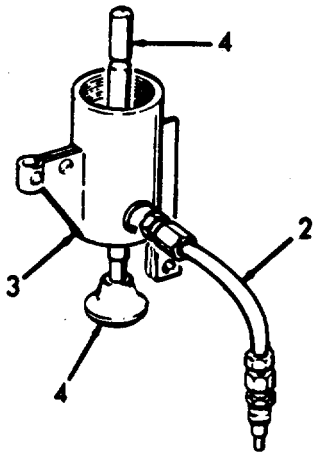
General Safety Instructions

None

3-175. STARTING AID - MAINTENANCE INSTRUCTIONS (Continued).

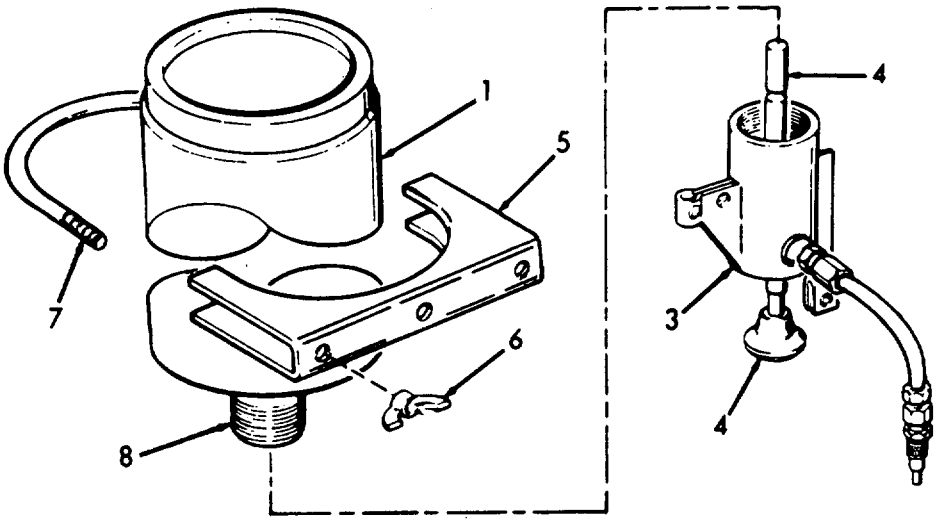
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Starting aid	Cylinder (1)	a. Visually inspect for wear and cracks.	
		b. Check for fluid leakage.	
2. Engine	Atomizer and filling valve assembly (2)	a. Visual.	
		b. Check fitting valve for wear, cracks, and leakage.	
		c. Check atomizer for wear, cracks and leakage.	
3. Starting aid	Body quick start (3)	a. Visually inspect for wear and cracks.	
		b. Check for leakage.	
4.	Pin assembly (4)	Check for wear and cracks.	





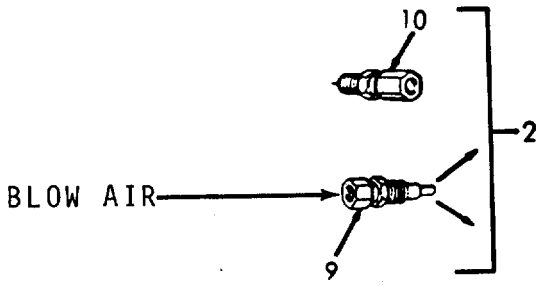
3-175. STARTING AID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
5. Starting aid	Clamp (5)	a. Remove wingnut (6) and U-bolt (7).	
		b. Unscrew cylinder (1) from quick start body (3).	
		c. Lubricate cylinder valve (8) and pin assembly (4).	Use light oil.
		d. Replace cylinder (1).	



3-175. STARTING AID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
6. Engine	Atomizer and fitting valve assembly (2)	a. Remove atomizer (9) and fitting valve (10).	
		b. Remove dirt from atomizer orifice (9), and screen.	
		c. Blow air through orifice end only.	
		d. Replace atomizer (9), and fitting valve (10) to assembly (2).	



3-3003

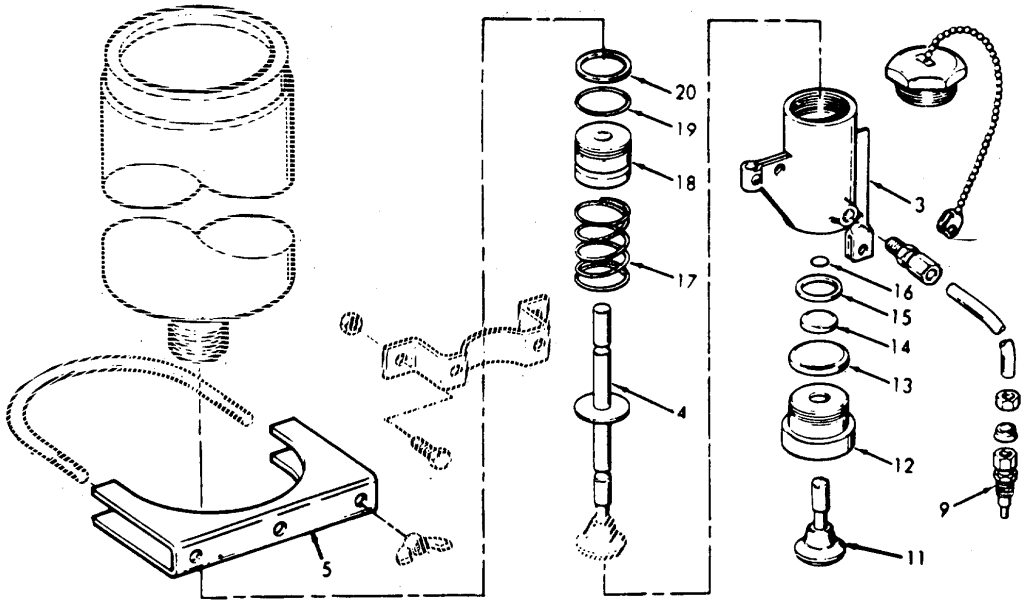
3-175. STARTING AID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
7. Starting aid	Pin assembly (4)	a. Remove knob (11).	
		b. Remove bushing (12), preformed packing (13), preformed packing (14), nylon washer (15), pin assembly (5), preformed packing (16), spring (17), bushing (18), preformed packing (19) and gasket (20).	Discard.
8. Starting aid	Body quick start (3)	a. Install gasket (20), preformed packing (19), bushing (18), spring (17), preformed packing (16), pin assembly (4), nylon washer (15), preformed packing (14), preformed packing (13), and bushing (12).	Replace with new parts.
		b. Install knob (11).	
		c. Lubricate pin assembly (4) and gasket (20).	

3-175. STARTING AID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

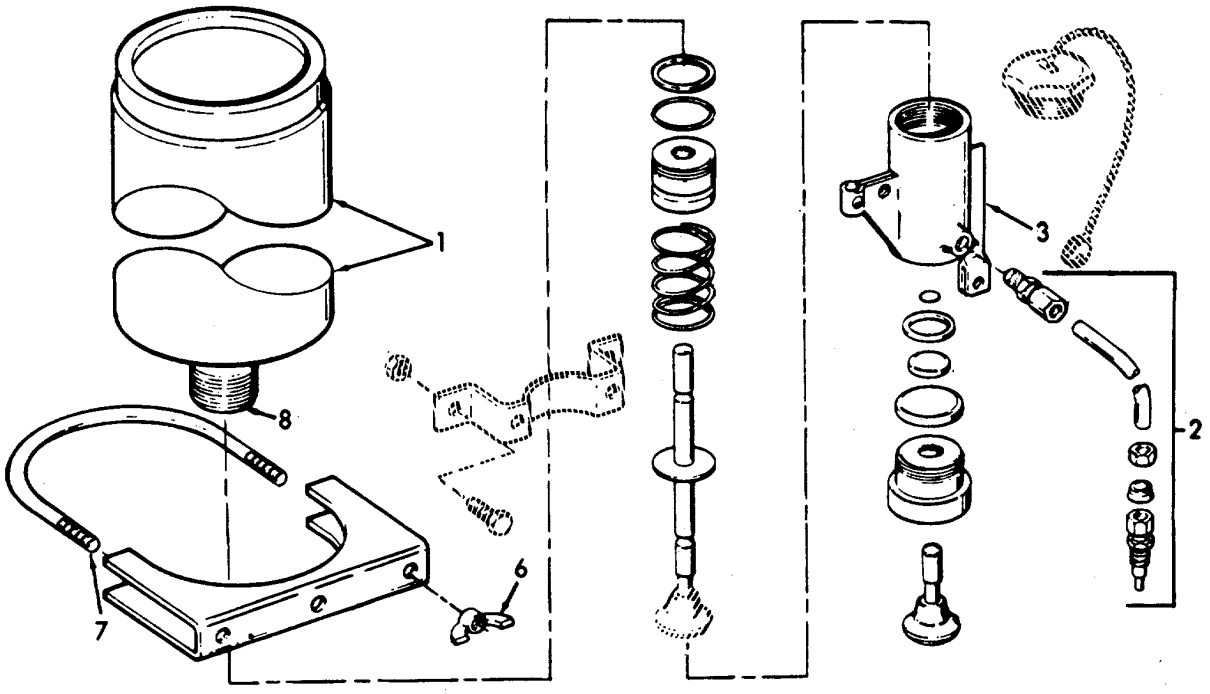
DISASSEMBLY (Cont)



3-3005

3-175. STARTING AID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
9.	Cylinder (1)	a. Lubricate valve (8).	
		b. Screw cylinder (1) into body quick start (3).	Hand tight.
		c. Install U-bolt (7), and wing nut (6) onto clamp (2).	
10.	Atomizer and fitting valve assembly (2)	a. Check for fluid leakage on engine air inlet housing.	If fluid occurs: disassemble and retighten air inlet housing fitting.
		b. Actuate starting aid with engine stopped.	



3-3006

3-176. HYDROSTARTER - MAINTENANCE INSTRUCTIONS.

a. The hydrostarter (starting) motor is mounted on the flywheel housing. The hydrostarter has a high rate of acceleration; therefore, the engine is cranked faster than other starting systems

b. An overruning clutch protects the starting motor at all times from being driven at high speeds by the engine before disengagement of the pinion.

This task covers:

a. Inspection
b. Replacement
c. Repair
d. Installation

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Teflon tape

Personnel Required

1

References

None

Equipment
Condition Condition Description

None

Special Environmental Conditions

None

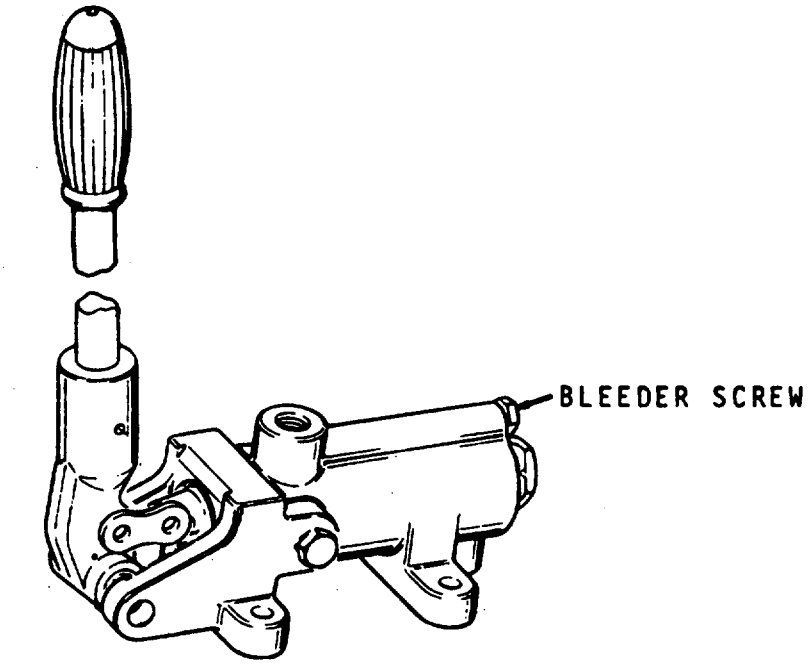
General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Hydro-starter	Hydro starter	a. Check for leaks, cracks, dents or wear. b. Check inlet and outlet connections for leaks. c. Check gasket for leaks	

3-176. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
2. Hand pump	Bleeder screw	Release the oil pressure in hoses and accumulator by opening the bleeder screw on the side of the hand pump approximately 1/2 turn.	



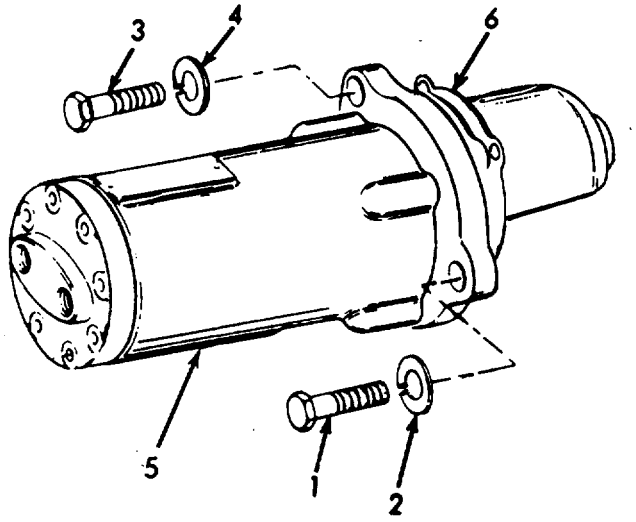
WARNING

The oil pressure in the system must be released prior to servicing the hydrostarter or any other components on the system to prevent possible injury to personnel or equipment.

3. Hydraulic hoses	a. Inlet hose	Disconnect from the hydrostarter.	
	b. Outlet hose	Disconnect from the hydrostarter.	

3-176. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

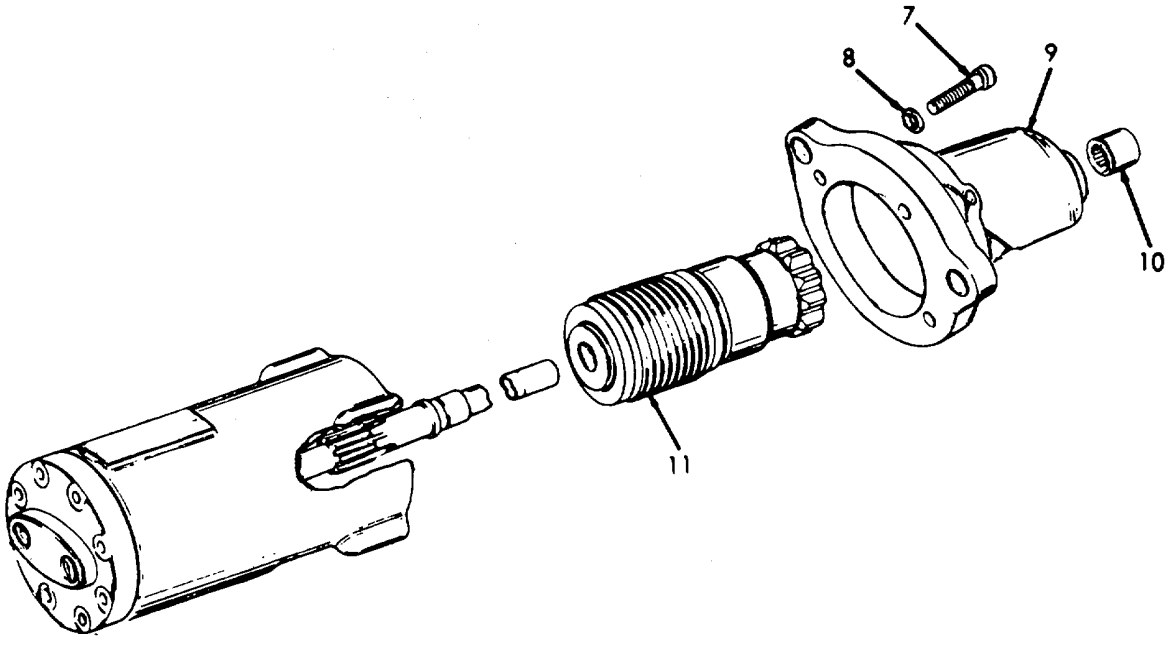
LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
4. Hydro-starter	Hydro-starter	a. Remove two screws (1), and lockwashers (2).	
		b. Remove screw (3) and lockwasher (4).	
		c. Remove starter (5) from flywheel housing.	
		d. Remove gasket (6).	Discard gasket.



3-3010

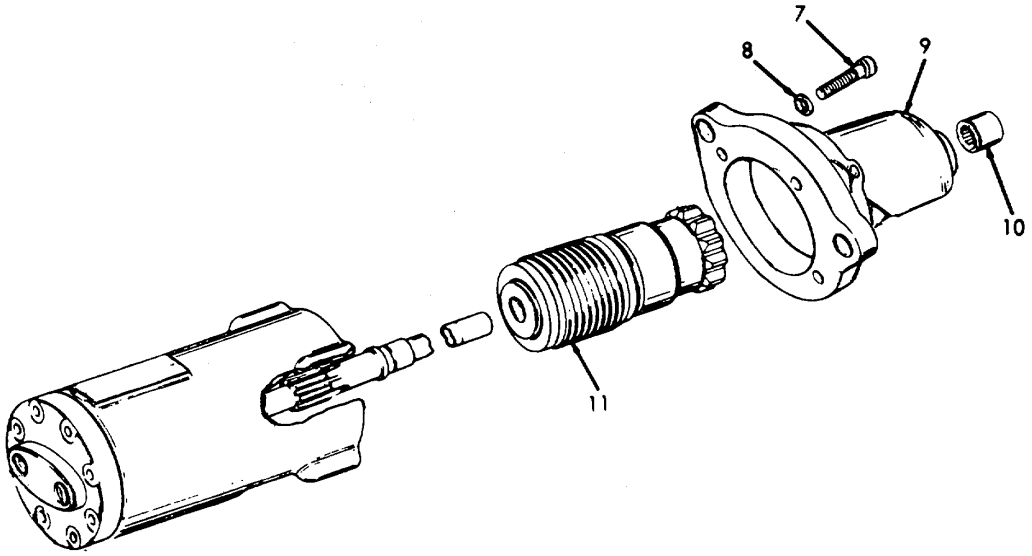
3-176. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5. Hydro-starter	Hydro-starter	a. Clamp motor in a vise.	
		b. Remove screws (7) and lockwashers (8).	
		c. Remove pinion gear housing (9).	Inspect for cracks and damage.
		d. Remove needle bearing (10).	Inspect for damage or wear. Replace if necessary.
		e. Slide Bendix drive assembly (11) off shaft.	Inspect drive for worn, or chipped teeth. Inspect spring for damage or breaks.



3-176. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

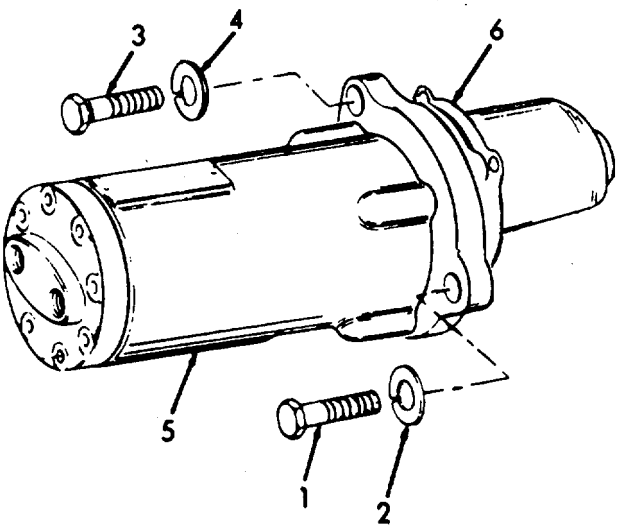
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		f. Remove hose adapter (12) and O-ring gasket (13).	Remove if damaged, and discard adaptor and gasket.
		g. Remove hose adaptor (14), and O-ring gasket (15).	Discard if damaged.
		h. Install Bendix drive assembly (11).	Lubricate with light oil before assembly.
		i. Install needle bearing (10) into pinion gear housing (9).	Lubricate with light oil before assembly.
		j. Install pinion gear housing (9) with lockwashers (8), and screws (7).	
		k. Install hose adaptor (12), and O-ring gasket (13).	Use new gasket and adaptor.
		l. Install hose adaptor (14), and O-ring gasket (15	Use new gasket and adaptor.



3-3012

3-176. HYDROSTARTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6. Hydro-starter	Hydro-starter	a. Install gasket (6). b. Install starter (5) onto flywheel housing. c. Install lockwasher (4) and screw (3). d. Install two lockwashers (2), and screws (1). e. Install inlet hose to inlet. f. Install outlet hose to outlet.	



7. Hand pump	Hand pump	Operate until all air is purged from the system.	Refer to paragraph 3-179 .

3-177. ACCUMULATOR - MAINTENANCE INSTRUCTIONS

a. The accumulator is a heavy duty shell assembly and piston de-signed to hold nitrogen pressure for an extended period of time.

b. The accumulator is preloaded with nitrogen through a small valve and sealed at the time of manufacture. A seal ring, in the groove of the piston between two back-up rings, prevents the nitrogen from entering the hydraulic system. The nitrogen is stored in the air valve end of the accumulator and the fluid is discharged at the opposite end.

c. A seal ring and back-up ring at each cap prevents escape of fluid and nitrogen from the shell. Nitrogen is an inert gas. Nitrogen will not rust or corrode the piston or accumulator.

d. Oil enters the accumulator under pressure from either the engine-driven pump or hand pump and forces the piston back, compressing the nitrogen and stores energy to operate the system.

e. Service replacement accumulators are supplied with a precharge of nitrogen (1250 ± 50 psi (8619 ± 345 kpa)).

This task covers:

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

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

Reference

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

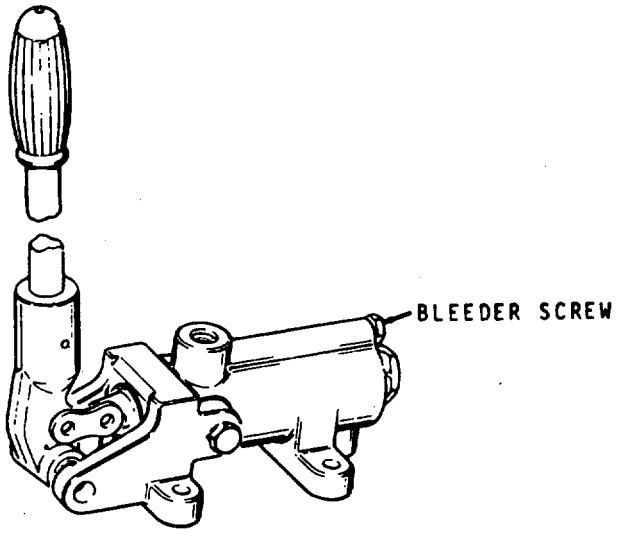
None

General Safety Instructions

Observe WARNING in this procedure.

3-177. ACCUMULATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Accumulator	Accumulator	a. Visually inspect accumulator cylinder for leakage. b. Apply a light oil or soapy solution on the end of the accumulator.	Bubbling indicates a leak. Replace.
2.	Valve caps	Check for leaks.	
3.	Accumulator	Apply a light oil or soapy solution on the accumulator valve (air check valve) to test for leakage.	If bubbles appear, replace.
REPLACEMENT			
4. Hand pump	Bleeder screw valve	Release the oil pressure in the hoses and accumulator by opening the bleeder screw valve on the side of the hand pump approximately 1/2 turn.	



3-177. ACCUMULATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

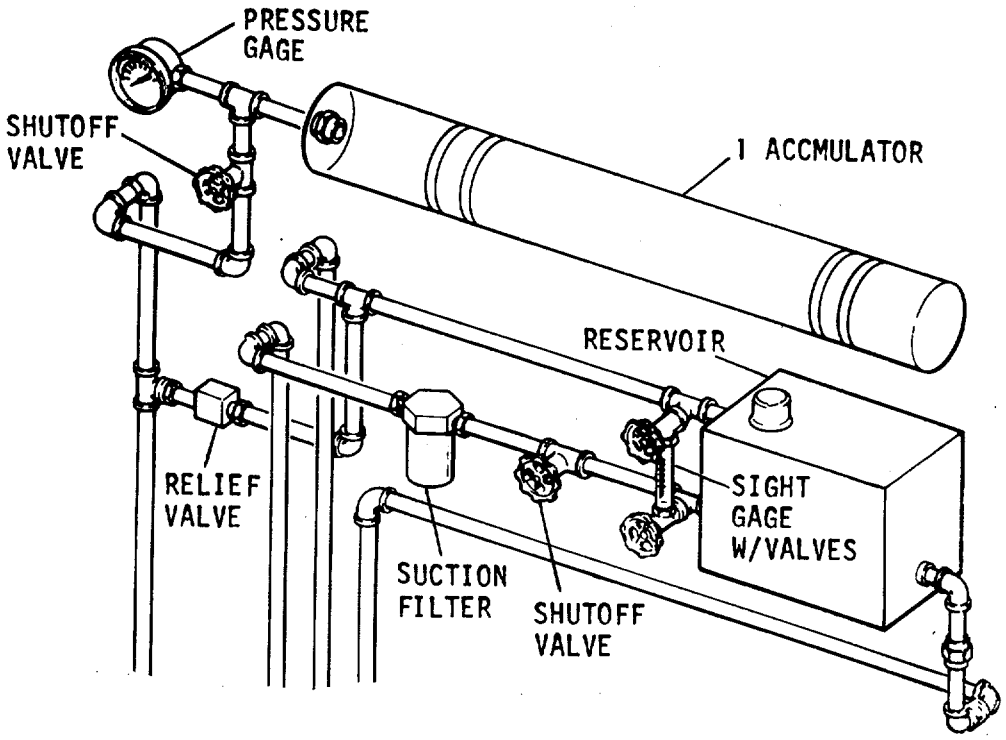
REPLACEMENT (Cont)

WARNING

The oil pressure in the system must be released prior to servicing the accumulator or any other components on the system to prevent possible injury to personnel or equipment.

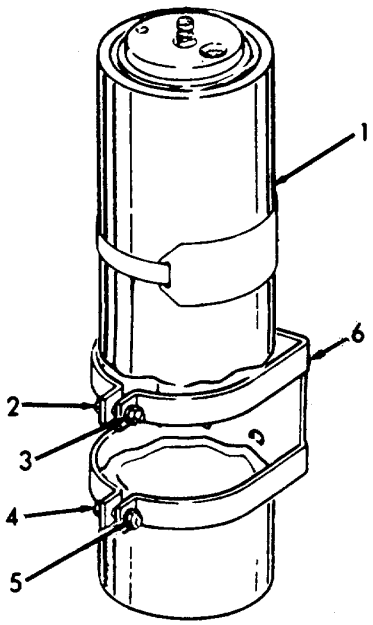
5. Accumulator (1)

a. Turn shut off valve clockwise to close.



b. Remove capscrews (2 and 4) and nuts (3 and 5) from bracket (6).

3-177. ACCUMULATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
		c. Unscrew accumulator (1) from piping.	
		d. Replace accumulator (1) with a new cylinder supplied with a precharge of nitrogen (1250 ± 50 psi (8919 ± 345 kPa)).	
		e. Install capscrews (2 and 4) and nuts (3 and 5) to bracket (6).	
		f. Open shut-off valve by rotating counter-clockwise.	
			
6.	Hand pump	Operate to pressurize system	

3-178. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS.

a. The hydrostarter charging pump maintains a pressure of approximately 2900-3300 psi (19996 - 22754 kPa) in the accumulator. Do not drive pump at a speed over 2500 rpms. The pump body has an unloading valve. The unloading valve by-passes the pump discharge to the resevoir once operating pressure is reached. This allows the pump to work at a reduced load.

b. The hydrostarter charging pump is a single-piston positive displacement pump. The ball check valves and the unloading valve are controlled by the accumulator pressure. The pump shaft is supported on ball bearings and a seal. The pump is pressed into the bearing retainer to prevent leaks. The pump is attached to the flywheel housing and is driven by a drive plate bolted to the camshaft.

This task covers:
a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP

Test Equipment	Reference
None	None
Special Tools	Equipment Condition Condition Description
None	None
Material/Parts	Special Environmental Conditions
Sealant (Permatex No. 2)	None
Personnel Required	General Safety Instructions
1	Observe WARNINGS in this procedure.

3-178. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTI ONS (Continued).

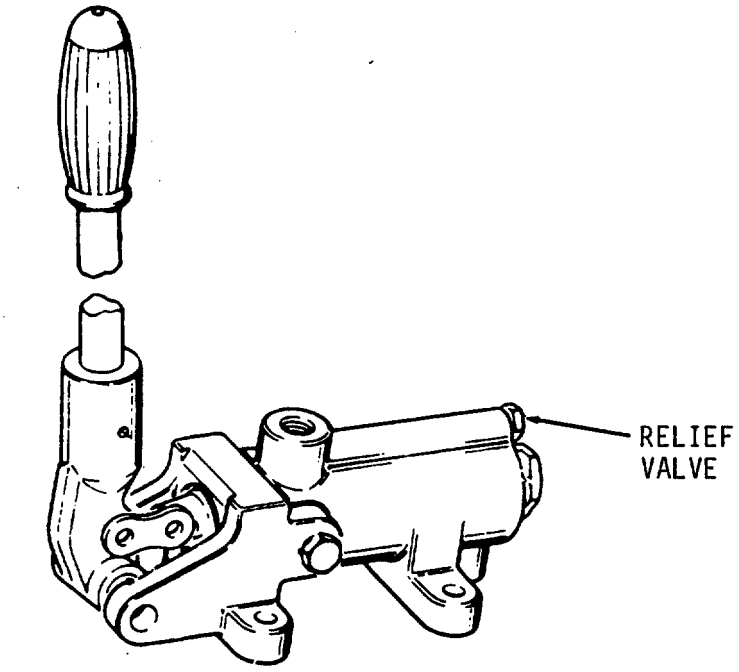
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Engine	Charging pump assembly	a. Check for cracks, dents, and wear.	
		b. Check for leaks.	
2.	Housing assembly	a. Check for cracks, dents and wear.	
		b. Check for leaks.	
3.	Supply hose	a. Check fittings.	
		b. Check for leaks.	
		c. Check for cracks, breaks, or wear.	
4.	Pressure hose	a. Check fittings.	
		b. Check for leaks.	
		c. Check for cracks, breaks, or wear.	
5.	Return hose	a. Check fittings.	
		b. Check for leaks.	
		c. Check for cracks, breaks, or wear.	

3-178. HYDROSTARTER PUMP (ENGINE - DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

6.	Hand pump	Relief valve	Release the oil pressure in the system by opening relief valve on side of the hand pump about 1/2 turn.	



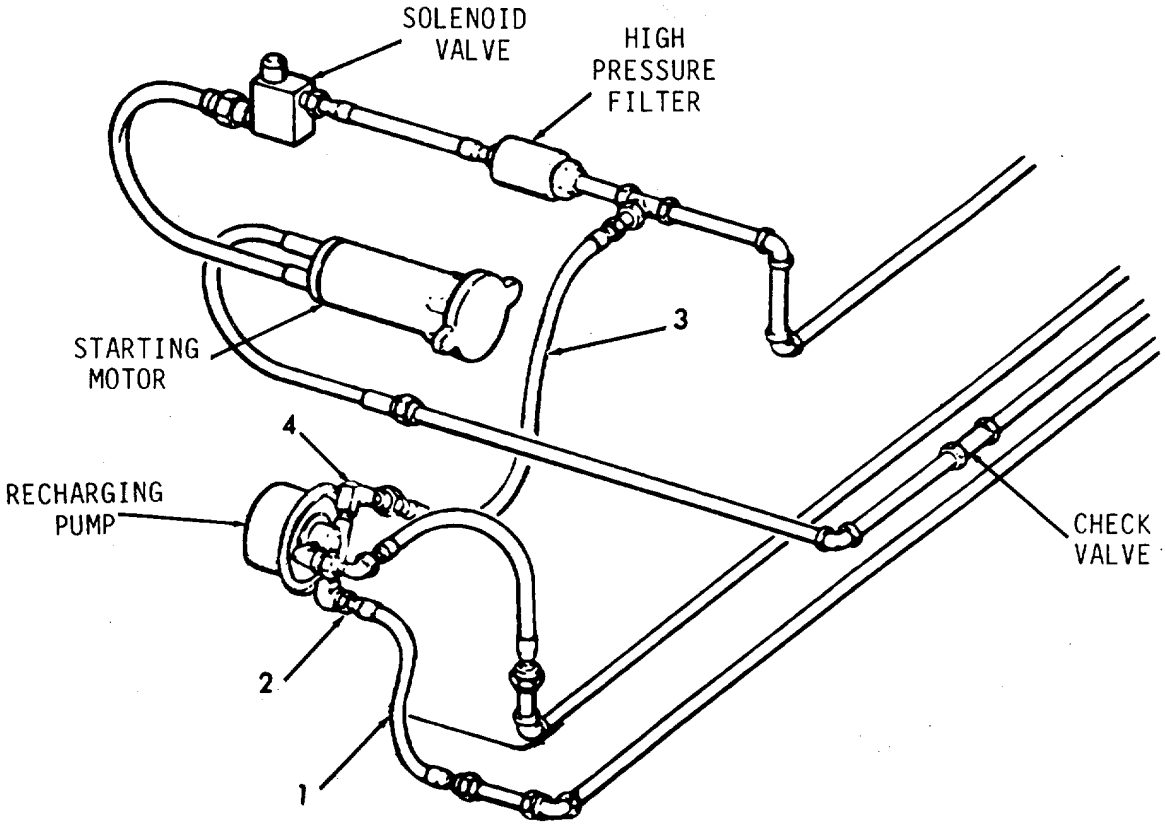
WARNING

The oil pressure in the system must be released prior to servicing the pump or other parts to prevent possible injure to personnel or equipment.

7.	Supply hose	a. Clean exterior dirt off.	
		b. Disconnect supply hose (1) at swivel fitting (2)	
		c. Tape hose end to keep out dirt.	Use masking Tape

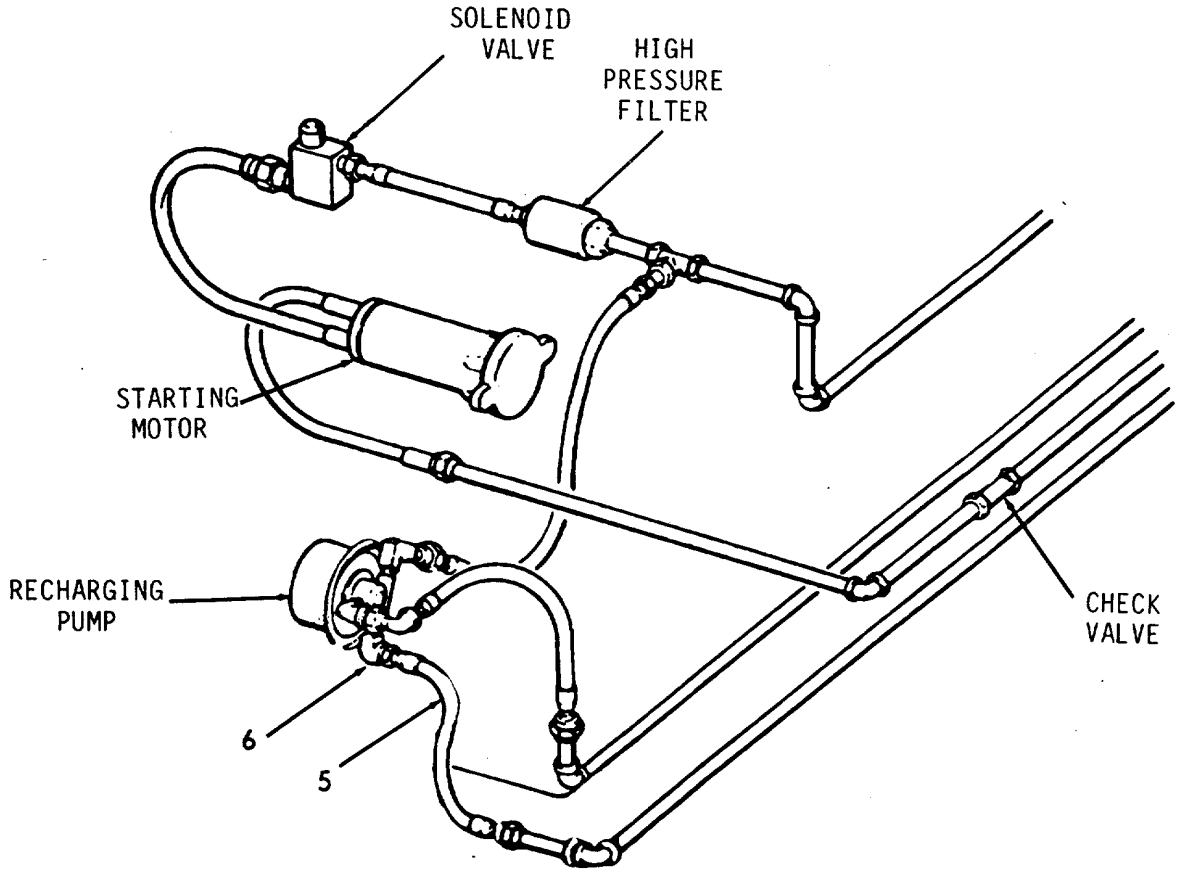
3-178. HYDROSTARTER PUM (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
8.	Pressure hose	a. Clean exterior dirt off.	
		b. Disconnect pressure hose (3) at swivel fitting (4).	
		c. Tape hose end to keep out dirt.	Use masking tape.



3-178. HYDROSTARTER PUMP (ENGINE - DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued).

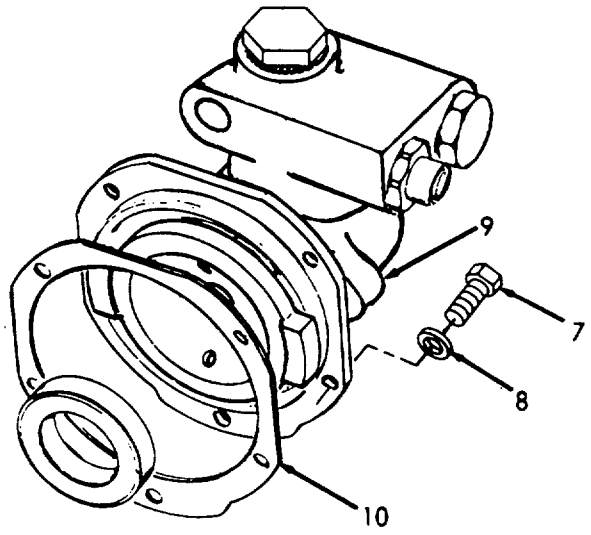
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
9.	Return hose	a. Clean exterior dirt off.	
		b. Disconnect return hose (5) at swivel fitting (6).	
		c. Tape hose end to keep dirt out.	Use masking tape.



3-3022

3-178. HYDROSTARTER PUMP (ENGINE-DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued).

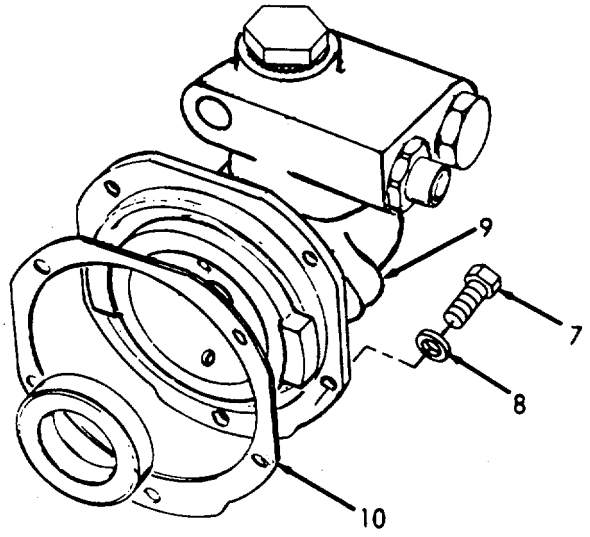
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
10.	Charging pump	a. Remove five capscrews (7) and lockwashers (8). b. Remove charging pump (9) from fly wheel housing. c. Remove gasket (10).	



3-3023

3-178. HYDROSTARTER PUMP (ENGINE - DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11. Engine driven pump	Charging pump	a. Install gasket (10) and charging pump (9).	Use a new gasket. Use Permatex #2 sealant on the flywheel side only.
		b. Align the tangs on the pump drive with the slots in the drive plate.	
		c. Install five lock-washers (8) and cap-screws (7).	



3-178. HYDROSTARTER PUMP (ENGINE - DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued)

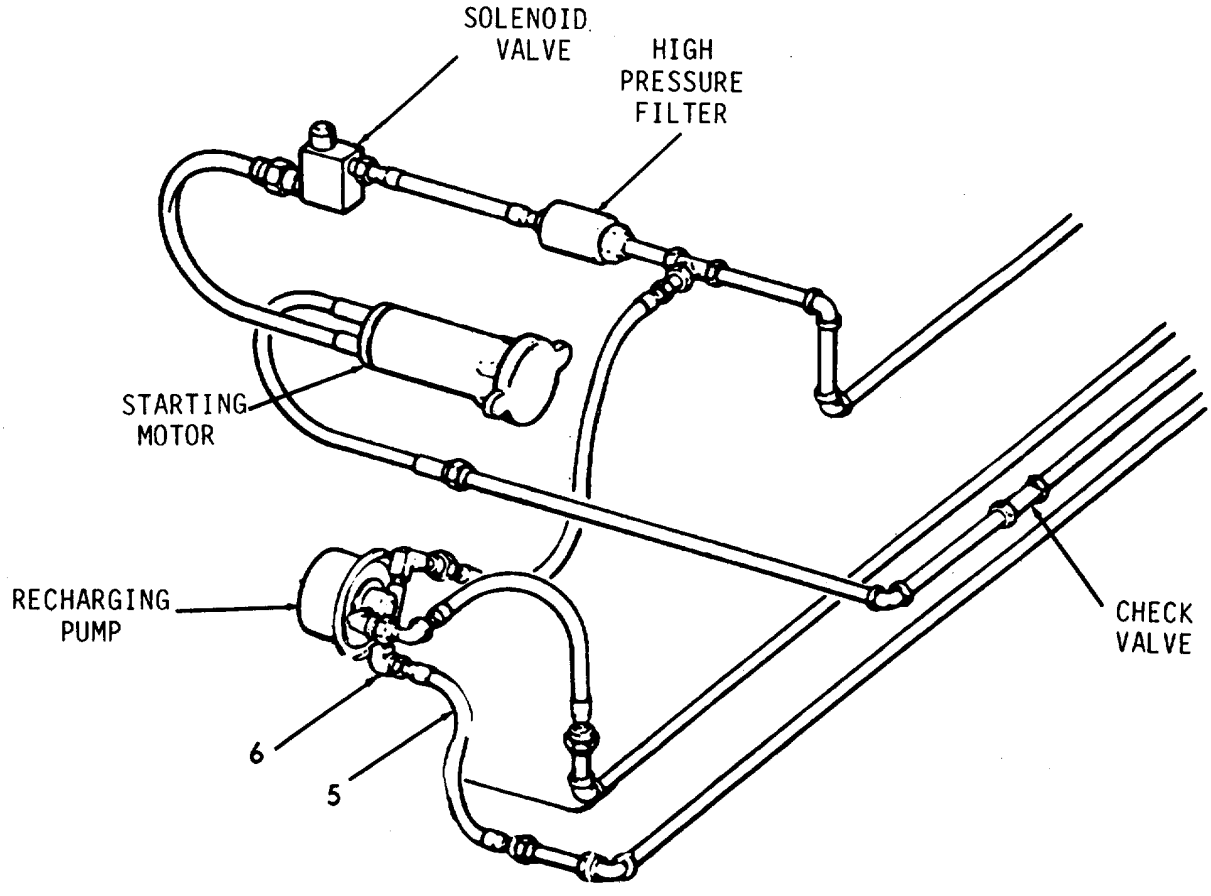
LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)

CAUTION

Do not force the pump into place. Use of force, or tightening the bolts when the mounting flange is not against the flywheel housing, will force the drive arm against the pump body and result in damage to the pump when the engine is started.

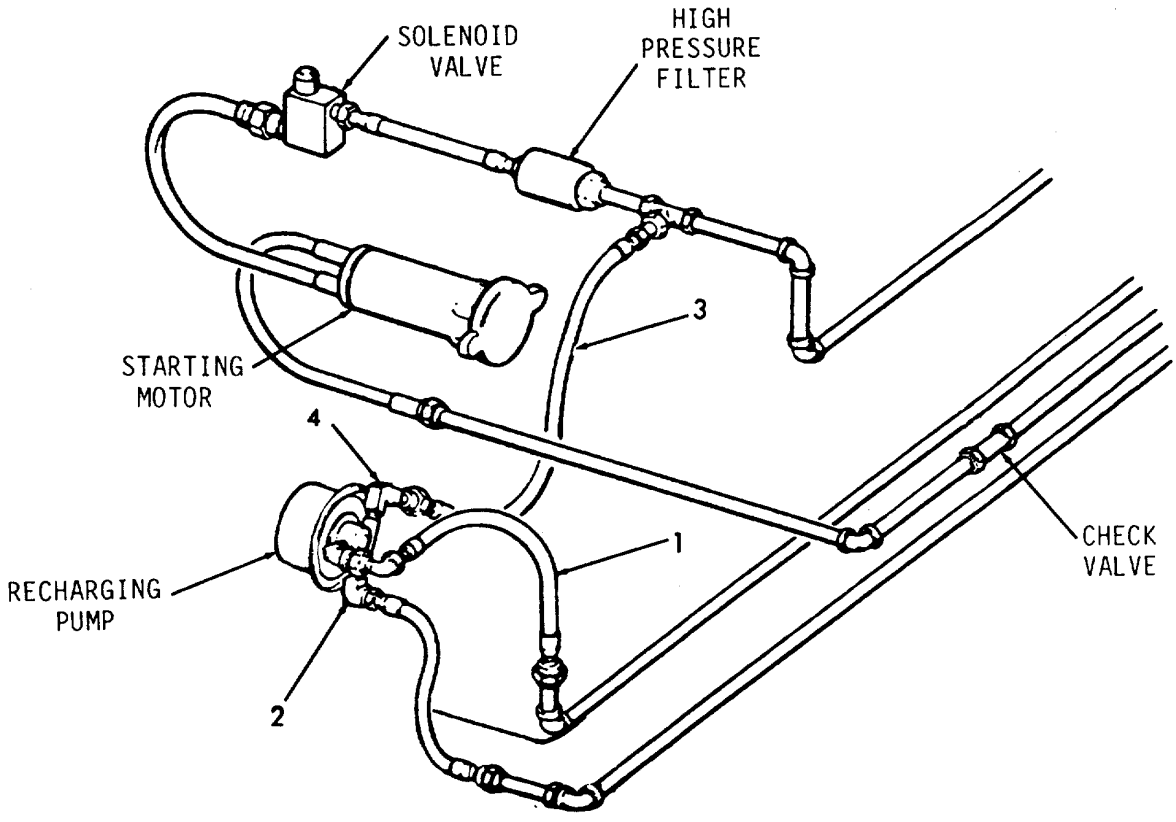
12.	Return hose	a. Remove tape from hose. b. Connect return hose (5) at swivel fitting (6).	



3-3025

3-178. HYDROSTARTER PUMP (ENGINE - DRIVEN) - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
13.	Pressure hose	a. Remove tape from hose. b. Connect pressure hose (3) at swivel fitting (4).	
14.	Supply hose	a. Remove tape from hose. b. Connect inlet hose (1) at swivel fitting (2).	



15	Hand pump	Relief valve	Close and pressurize system.

3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS

a. The hand pump is a single piston double-acting positive displacement pump. The pumping action is never in a vertical direction and the handle clears all obstructions throughout its stroke. Remove the handle and store when pump is not in use.

b. Use the hand pump to provide initial hydraulic pressure and to build up pressure if pressure was released from the hydrostarter.

c. A ball check valve controls the flow through the pump. A bleeder screw valve is manually operated to release the pressure before work can be done on the hydrostarter system at the hand pump.

This task covers:

a. Inspection
b. Removal
c. Repair
d. Reassembly
e. Installation

INITIAL SETUP

Test Equipment

None

Special Tools

None

Material/Parts

Repair kit KT202565

Personnel Required

1

Reference

None

Equipment Condition — Condition Description

None

Special Environmental Conditions

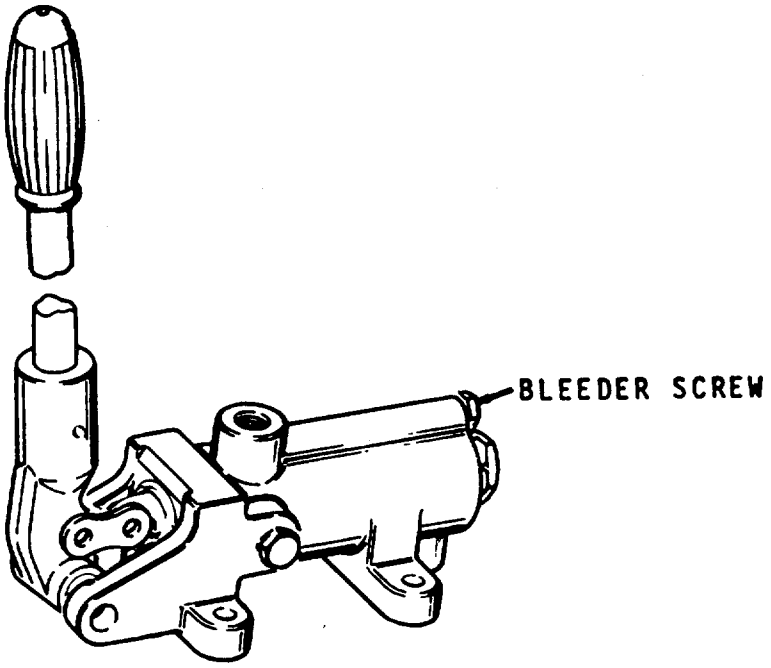
None

General Safety Instructions

Observe WARNING in this procedure.

3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Hand pump	Hand pump assembly	Check for leaks, cracks and wear.	
2.	Pump lever handle	Check for cracks.	
3.	Inlet and outlet hoses	Check for leaks, cracks, and wear. Check to see that hoses are installed properly.	
REMOVAL			
4. Hand pump	a. Bleeder screw valve	Release the pressure in the hydraulic system by opening the bleeder screw on side of the pump approximately 1/2 turn.	



3-179. HYDROSTARTER PUMP (ENGINE - DRIVEN) - MAINTENANCE IN STRUCTIONS (Continued)

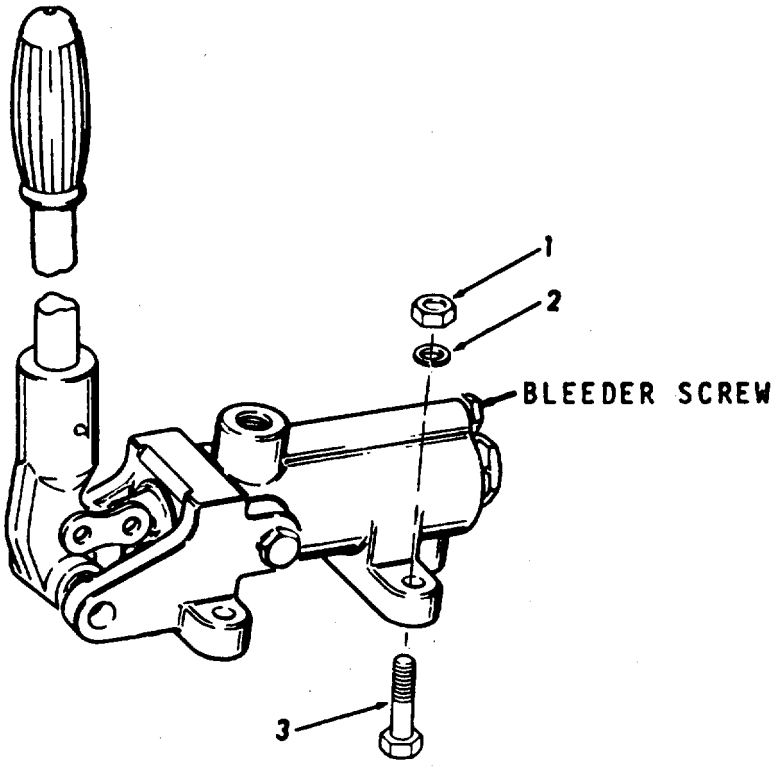
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

WARNING

The oil pressure in this system must be released prior to servicing the hand pump or any other components of the system to prevent possible injury to personnel or equipment.

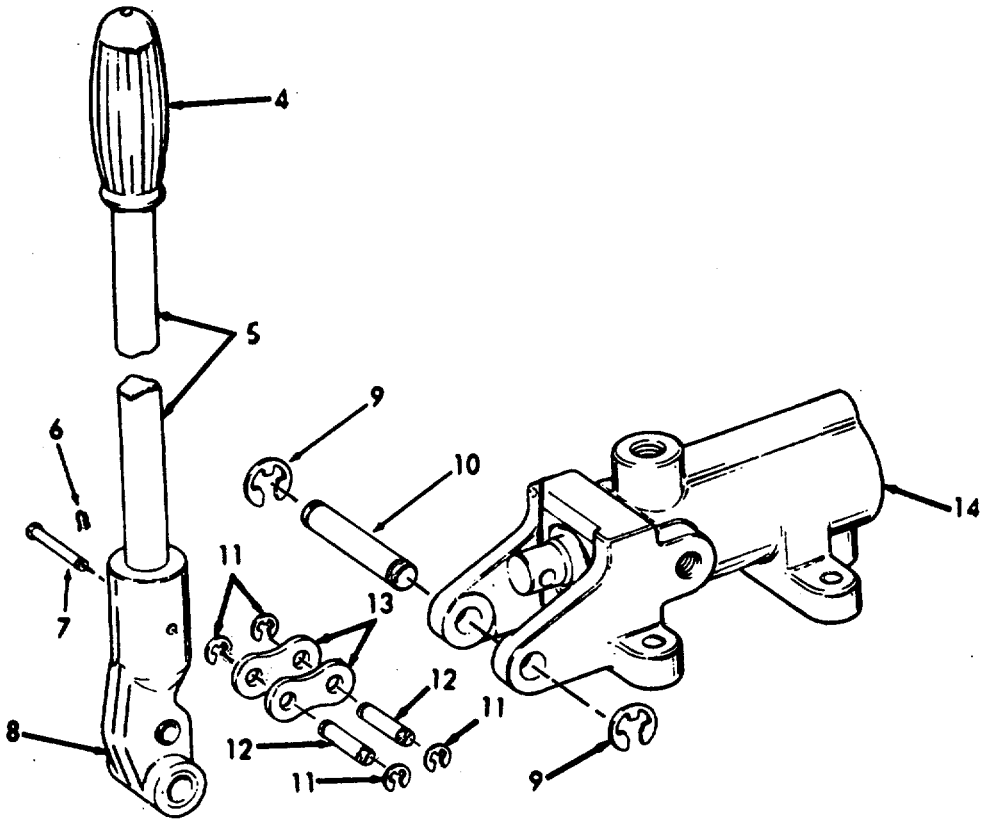
b.	Hand pump assembly	1. Clean exterior dirt from hand pump and hydraulic hoses. 2. Disconnect hydraulic hoses at the pump. 3. Remove nut (1), lock-washer (2), and cap-screw (3) and lift pump from its mounting.	



3-3029

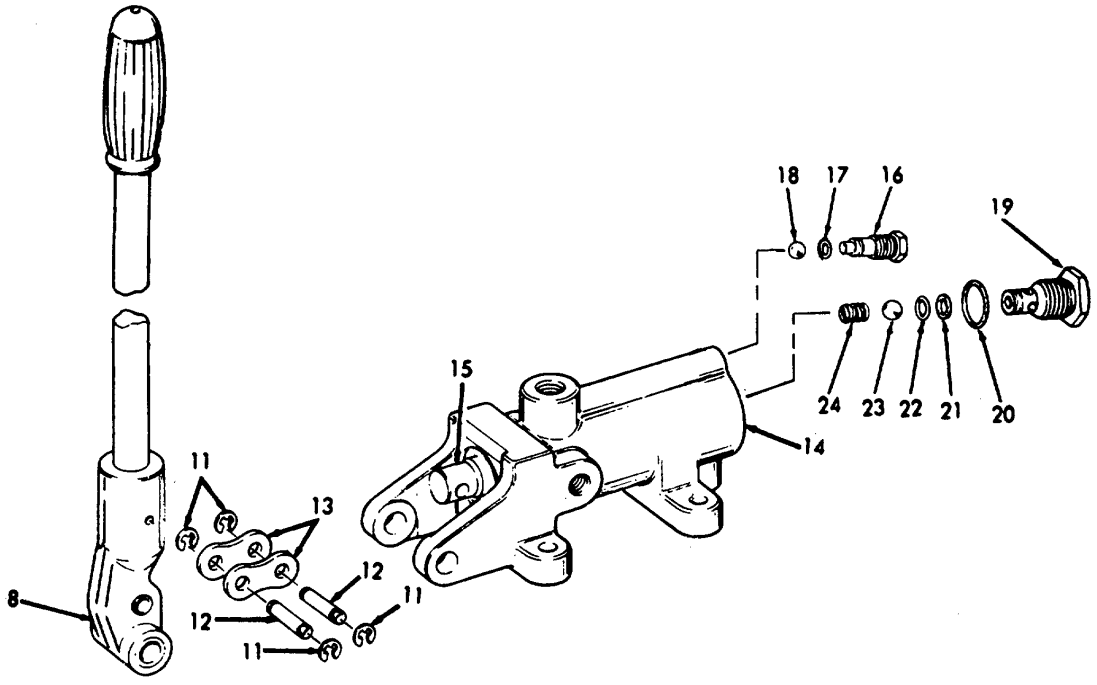
3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
5.	Pump handle	a. Pull pump handle grip (4) from hand pump operating handle (5). b. Remove cotter pin (6), and pin (7). Then lift handle (5) from operating lever (8). c. Remove retaining rings (9) from clevis pin (10). d. Remove retaining ring (11), clevis pin (12), and links (13), to remove hand pump operating lever (8) from the pump body (14).	Only if grip is damaged.



3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued)

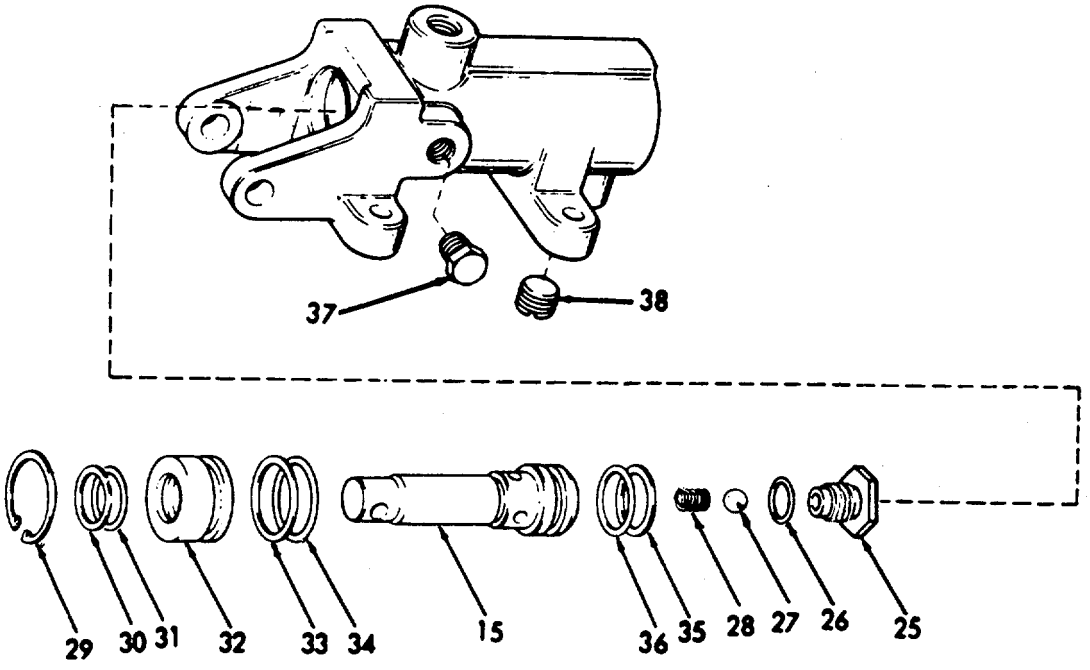
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6.	Pump body	a. Remove retaining rings (11), clevis pin (12), and links (13), from the plunger (15) after removing hand pump operating lever (8) from the pump body (14).	
		b. Remove bleeder screw (16), O-ring gasket (17), and ball bleed valve (18) from pump body (14).	Discard O-ring gasket.
		c. Remove inlet oil fitting (19), 0-ring gasket (20), back-up ring (21), O-ring gasket (22), ball check valve (23), and spring (24) from 1. the plunger (15), and the pump body (14).	Discard O-ring gasket (20), back-up ring (21), O-ring gasket (22) and spring (24).



3-3031

3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued)

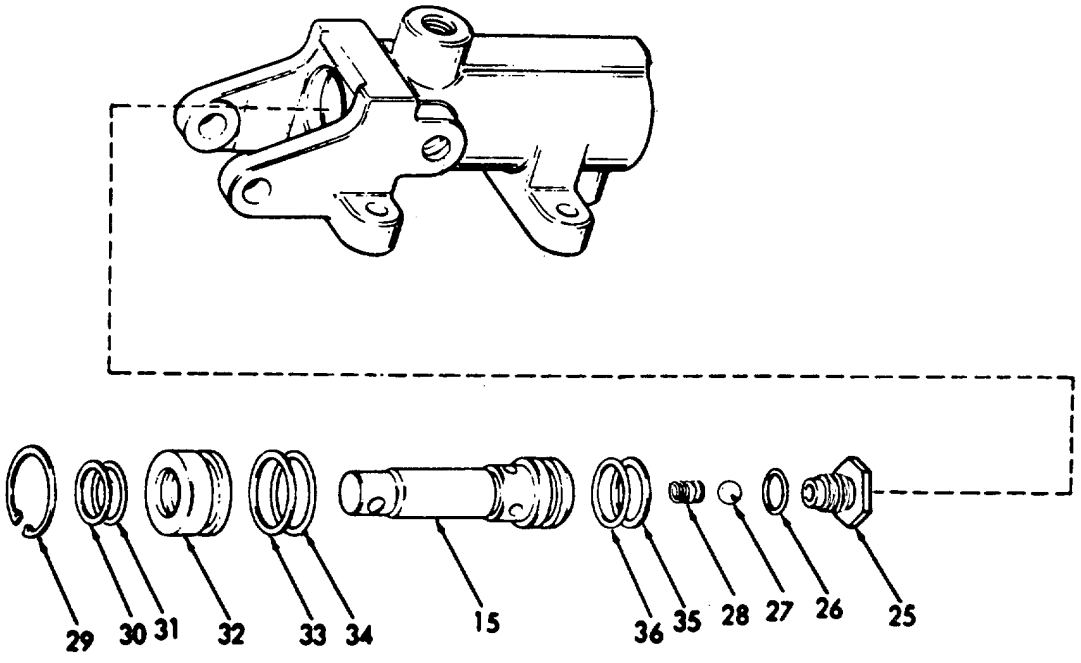
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		d. Remove seat check valve (25), O-ring gasket (26), ball check valve (27), and spring check valve (28).	Discard O-ring gasket (26), and spring check valve (28).
		e. Remove retaining ring (29), back-up ring (30), O-ring gasket (31), plunger gland (32), back-up ring (33), and O-ring gasket (34).	Discard back-up ring (30), O-ring gasket (31), back-up ring (33), and O-ring gasket (34).
		f. Remove back-up ring (35), O-ring gasket (36), and plunger (15).	Discard back-up ring (35), and O-ring gasket (36).
		g. Remove pipe plugs (37 and 38).	If necessary.



3-3032

3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
7. Pump body	Plunger	a. Install O-ring gasket (34), back-up ring (33), plunger gland (32), O-ring gasket (31), back-up ring (30), and retaining ring (29).	Thoroughly soak new back-up rings (30, 33, 35) in warm oil. Use repair kit for back-up ring (30), gasket (31), back-up ring (33), and gasket (34).
		b. Insert plunger (15).	
		c. Install O-ring gasket (35), back-up ring (36), spring (28), ball check valve (27), O-ring gasket (26), and seat check valve on plunger (25).	Use repair kit for back-up ring (35), O-ring gasket (36), spring (28), and O-ring gasket (26).



3-3033

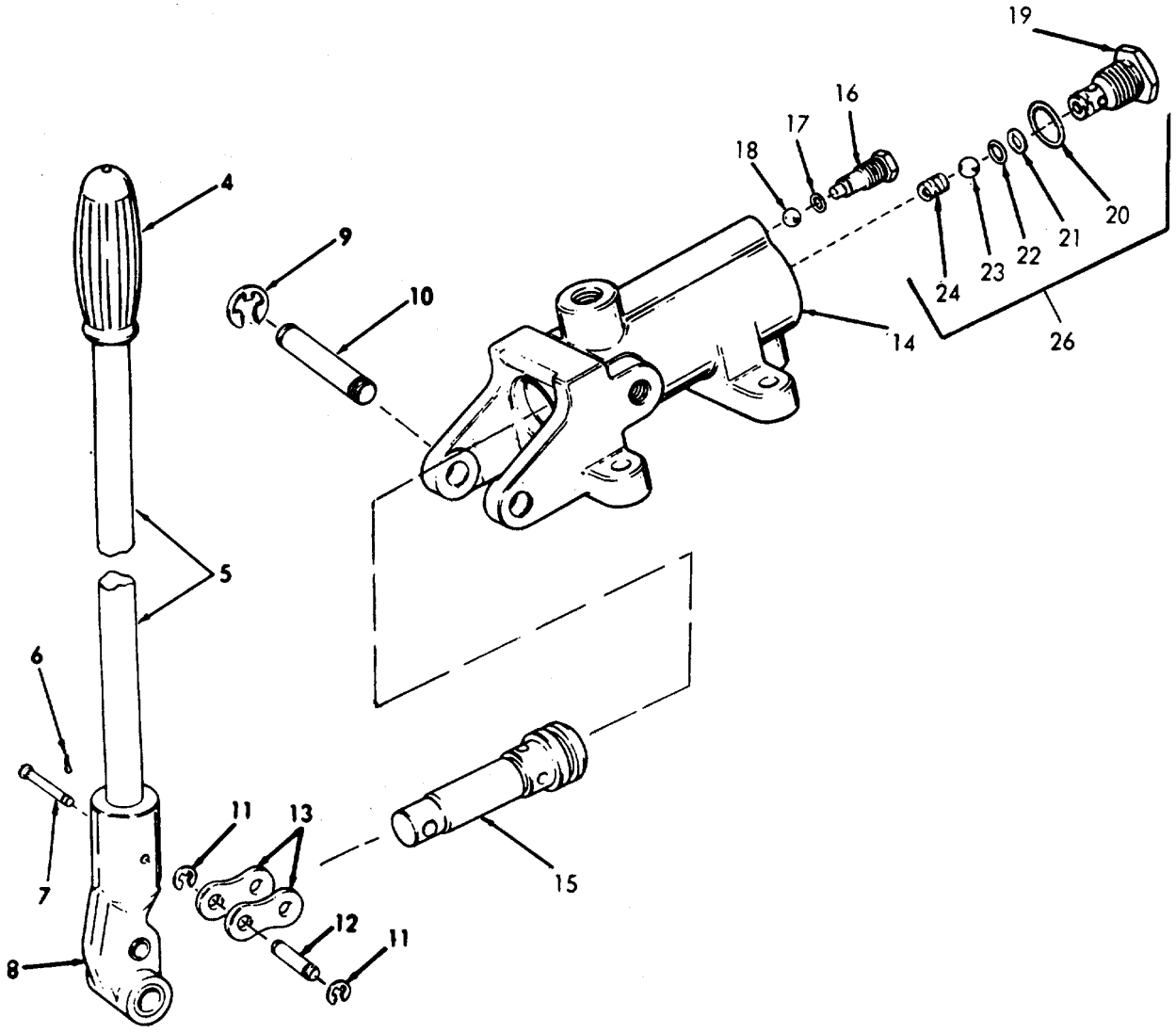
3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
8.	Inlet oil fitting valve (26)	Install spring (24), ball valve (23), O-ring gasket (22), back-up ring (21), 0-ring gasket (20), and inlet oil fitting (19) into pump body (14).	Use repair kit for spring (24), O-ring gasket (20), back-up ring (21), and O-ring gasket (22).
9.	Bleeder screw valve	a. Install O-ring gasket (17), onto bleeder screw valve (16). b. Insert bleeder ball valve (18) in place. c. Secure with bleeder screw valve (16).	Use repair kit for O-ring gasket (17).
10.	Handle	a. Install retaining rings (11), clevis pin (12), and links (13) to the hand pump operating lever (8), and piston (15). b. Insert clevis pin (10), and retaining ring (9) to hand pump operating lever (8), and pump body (14). c. Insert handle (5), pin (7), and cotter pin (6) into hand pump operating lever (8). d. Install grip (4).	

3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

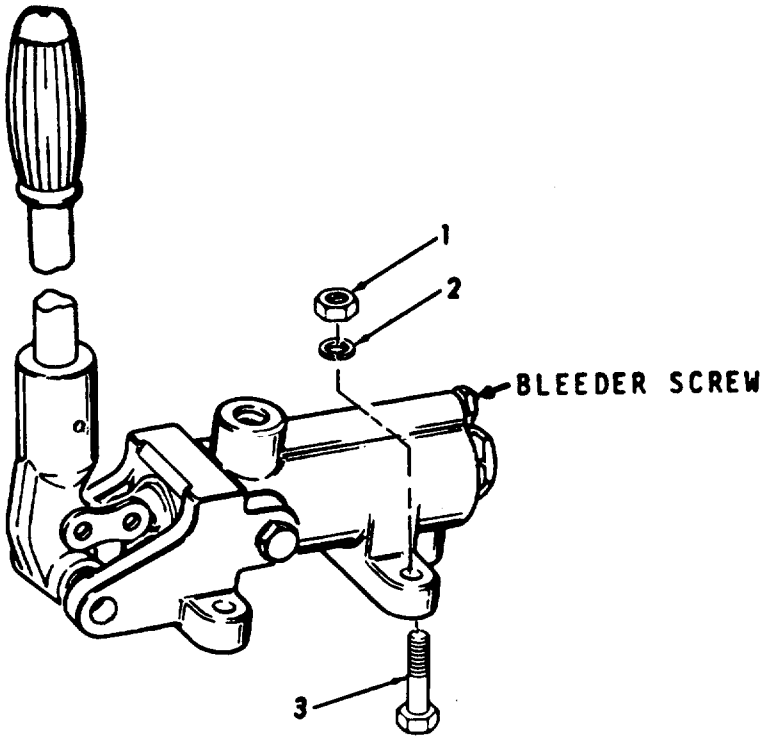
REASSEMBLY (Cont)



3-3035

3-179. HYDROSTARTER HAND PUMP - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
11.	Hand pump assembly	a. Place hand pump on its mounting. b. Attach to mounting with capscrews (3), lockwashers (2), and nuts (1). c. Connect the hydraulic hoses to pump. **NOTE** Make sure the hose and fittings are clean before any connections are made. d. Check assemblies. Make sure all fittings are tight and there are no leaks.	



3-3036

3-180. HYDROSTARTER RESERVOIR AND FILTER - MAINTENANCE INSTRUCTIONS.

a. The reservoir is a cylindrical steel tank. The reservoir will hold the entire oil supply for the hydrostarter system. A filler cap with a dry-type filter is at the top of the reservoir. A fine mesh screen inside the reservoir filters the fluid flowing to the pump from the supply hose.

b. The supply hose is connected to the fine mesh screen at the bottom of the reservoir. One return hose connects to the top of the reservoir. The other hydrostarter return hose connects into the side.

c. A filter is installed on the suction hose to provide a finer filtration that protects the pump mechanism. The filter is a stacked element that can be cleaned and reused.

3-180 1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection
b. Service
c. Replacement
d. Installation

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

Reference

None

Equipment Condition Condition Description

None

Special Environmental Conditions

None

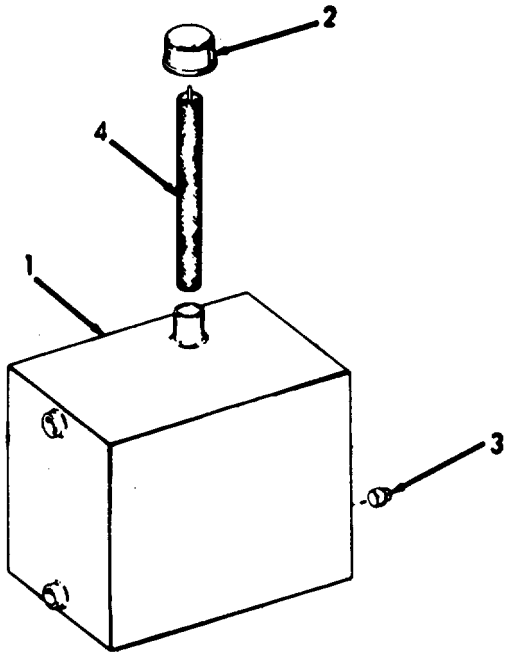
General Safety Instructions

Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1.	Reservoir (1)	a. Check for dents, cracks and leaks.	
		b. Check return, relief, and supply pipes, and all fittings for leaks.	Refer to Direct Support Maintenance.
2.	Breather ventilator cap (2)	a. Check for dents, cracks, and leaks.	
		b. Check for tightness.	
		c. Check for clogging.	

3-180.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Continued).

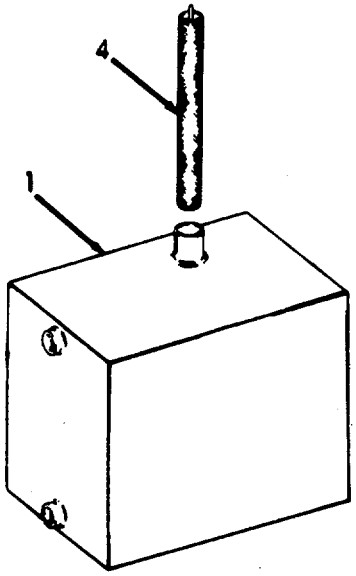
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
3.	Drain plug (3)	a. Check fittings for tightness. b. Check for leaks.	



SERVICE			
4.	Drain plug (3)	a. Place suitable container under drain plug (3). b. Turn drain plug (3) counter-clockwise to remove. c. Drain reservoir.	
5.	Strainer screen (4)	a. Remove breather ventilator cap (2). b. Remove strainer screen (4).	Replace, if necessary.

3-180.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Continued).

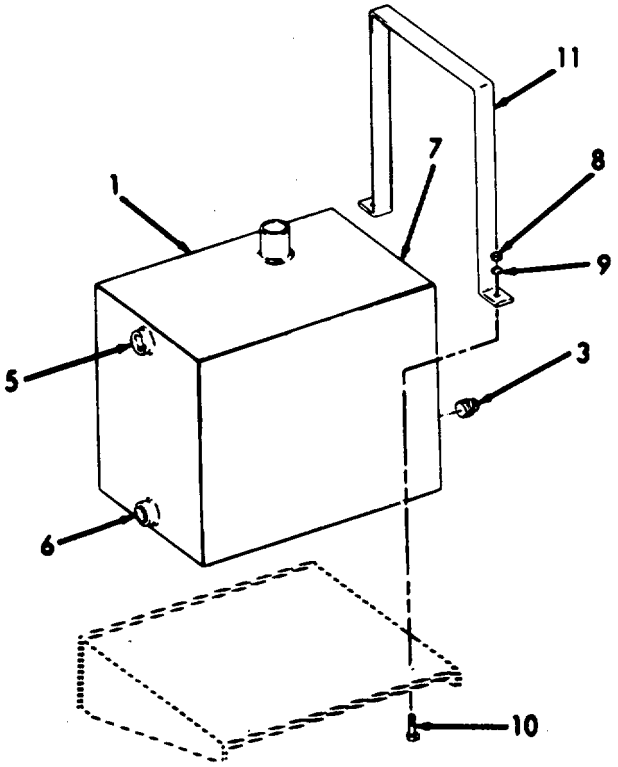
LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
		WARNING Wear protective eye goggles when using compressed air.	
		c. Clean strainer screen (4).	Clean in fuel oil, and dry with compressed air.
		d. Clean reservoir (1) by flushing out the old hydraulic fluid.	



REPLACEMENT			
6.	Reservoir (1)	a. Place container under drain plug (3).	
		b. Turn drain plug (3) counter-clockwise to remove.	
		c. Drain hydraulic oil into a suitable container.	

3-180.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
		d. Disconnect return piping (5).	
		e. Disconnect supply piping (6).	
		f. Disconnect relief piping (7).	
		g. Remove nuts (8), lockashers (9), and capcrews (10) from brackets (11).	
		h. Remove reservoir (1) from its mountings.	



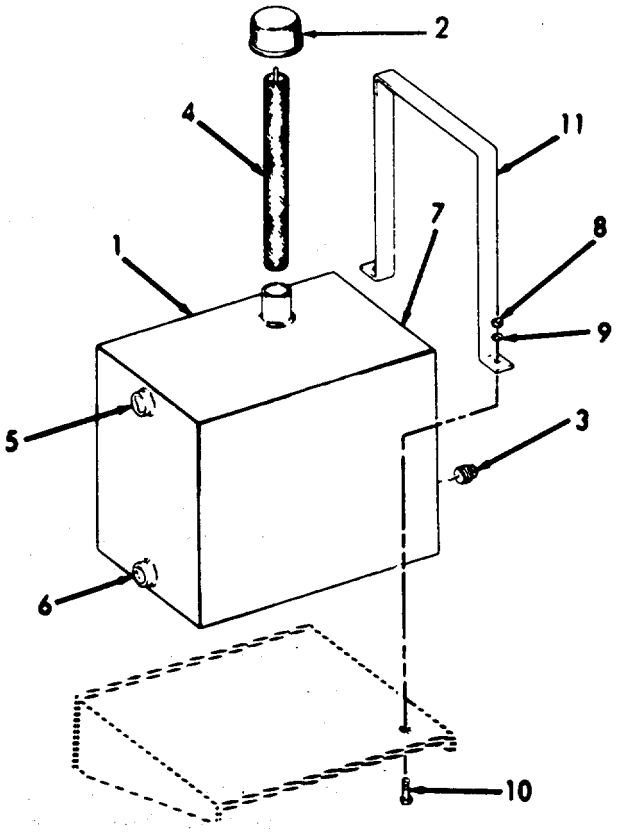
3-180.1. HYDROSTARTER RESERVOIR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
7.	Reservoir (1)	a. Replace reservoir (1).	
		b. Install brackets (11), nuts (8), lockwashers (9), and capscrews (10).	
		c. Install strainer screen (4).	
		d. Install drain plug (3).	
		e. Connect supply piping (6).	
		f. Connect return piping (5).	
		g. Connect relief piping (7).	
		h. Fill reservoir with hydraulic fluid (MIL-L-17672, Type 2135 TH).	Reservoir capacity is 7.5 gallons (28.4 liters).
		i. Replace and tighten breather ventilator cap (2).	
		j. Check all fittings and plugs for leaks.	

3-180.1. HYDROSTARTER RESEVOIR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-3043

3-180.2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection
b. Service
c. Removal
d. Installation

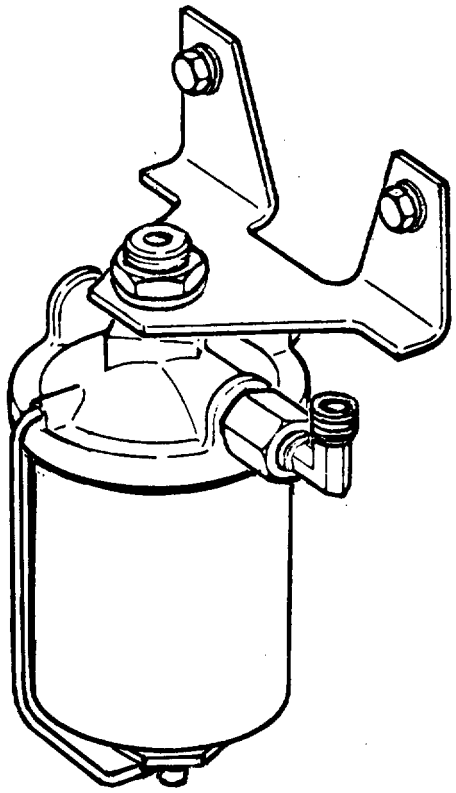
INITIAL SETUP:

Test Equipment	Reference
None	None
Special Tools	**Equipment Condition / Condition Description**
None	None
Material/Parts	**Special Environmental Conditions**
None	None
Personnel Required	**General Safety Instructions**
1	Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Filter assembly	a. Cover	1. Check for leaks.	
		2. Check for dents.	
		3. Check for cracks.	
	b. Canister	1. Check for leaks.	
		2. Check for dents.	
		3. Check for cracks.	
	c. Adapter	1. Check connections at cover and elbow for leaks.	
		2. Check for cracks.	

3-180.2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

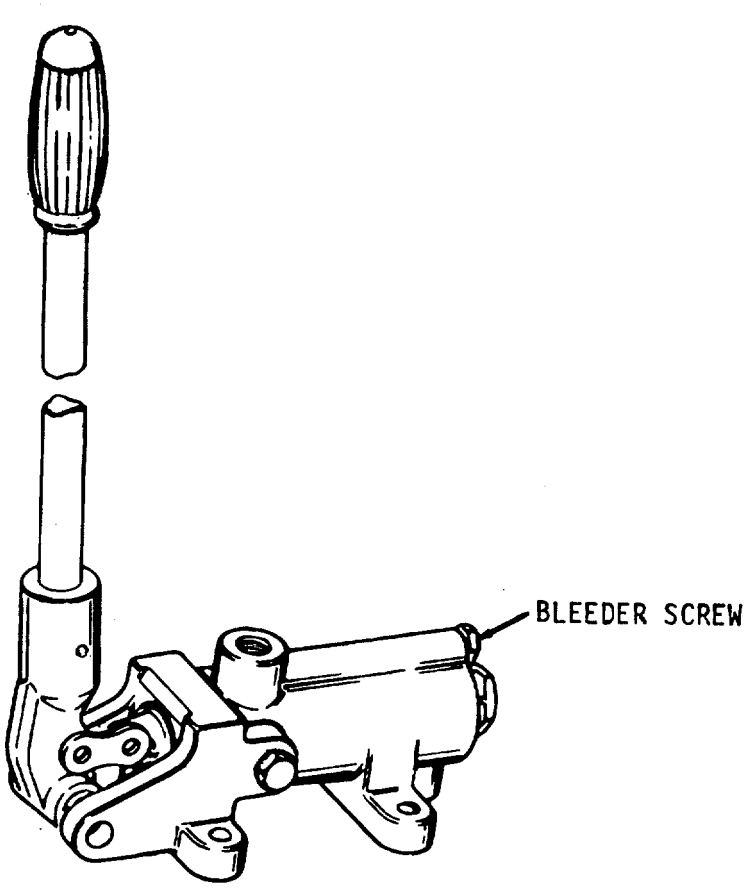
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	d. Elbow	1. Check connection at adapter and supply hose for leaks.	
		2. Check for cracks.	
2.	Mounting bracket	a. Check for dents, breaks, cracks and wear.	
		b. Check fittings. Make sure they are tight.	



3-3045

3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
3. Hand pump	Bleeder screw valve	Release the pressure in the hydrostarter system by opening the bleeder screw valve on side of pump approximately 1/2 turn.	



3-3046

3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

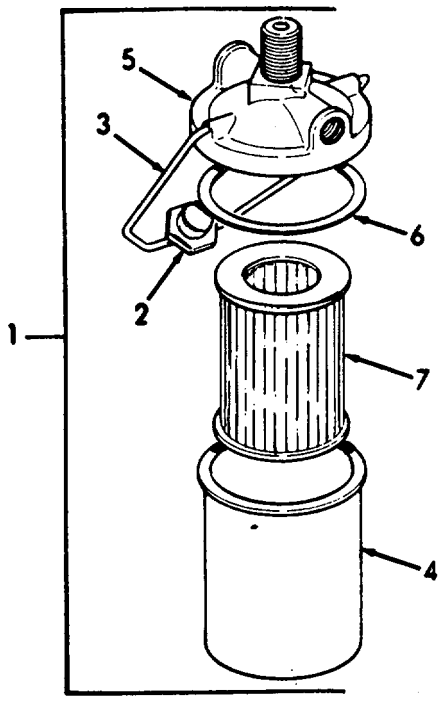
LOCATION	ITEM	ACTION	REMARKS

SERVICE (Cont)

WARNING

The oil pressure in the system must be released prior to servicing the filter or any other components of the system to prevent possible injury to personnel or equipment.

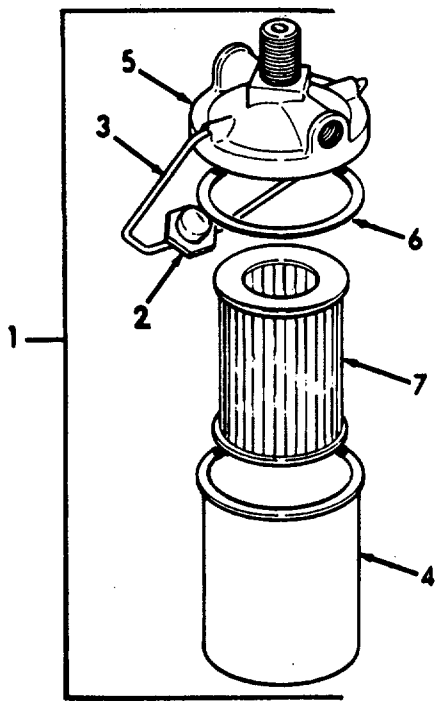
4.	Filter assembly (1)	Canister	a. Loosen bail nut (2).	
			b. Swing bail (3) from canister (4).	
			c. Remove canister (4) from cover (5).	
			d. Remove gasket (6).	Discard.
			e. Drain hydraulic fluid.	Dispose of used hydraulic fluid properly.
5.		Filter element (7)	Remove.	Dispose of properly.



3-3047

3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

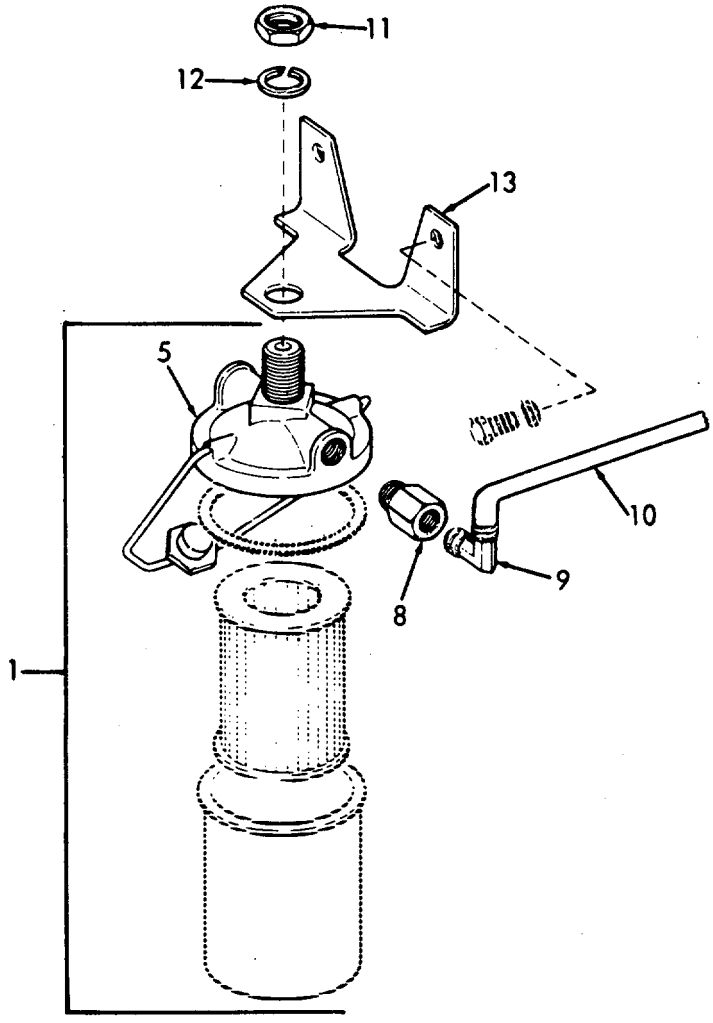
LOCATION	ITEM	ACTION	REMARKS
SERVICE (Cont)			
6. Filter assembly (1)	Canister	a. Replace gasket (6).	Wipe gasket with hydraulic oil before assembly.
		b. Insert filter (7) in canister (4).	Use new filter.
		c. Place canister (4) under cover (5).	
		d. Swing bail (3) into place.	
		e. Tighten bail nut (2) to secure canister (4) to cover (5)	



3-3048

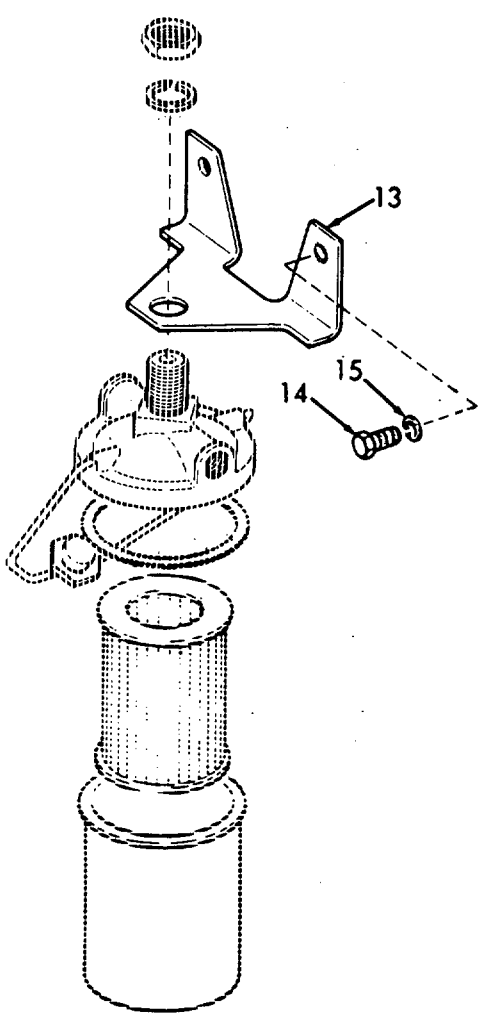
3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
7. Filter assembly (1)	Cover (5)	a. Remove adapters (8), elbows (9), and hoses (10) from cover (5). b. Remove nut (11), and lockwasher (12). c. Remove cover (5) from mounting bracket (13)	



3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

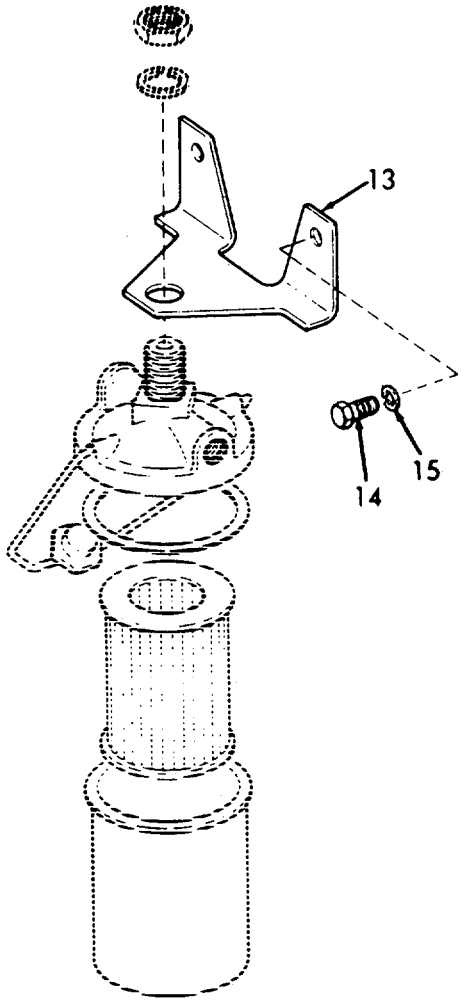
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
8. Mounting bracket (13)	Mounting bracket	a. Remove capscrews (14), and lockwashers (15). b. Remove mounting bracket (13) from bulkhead.	



3-3050

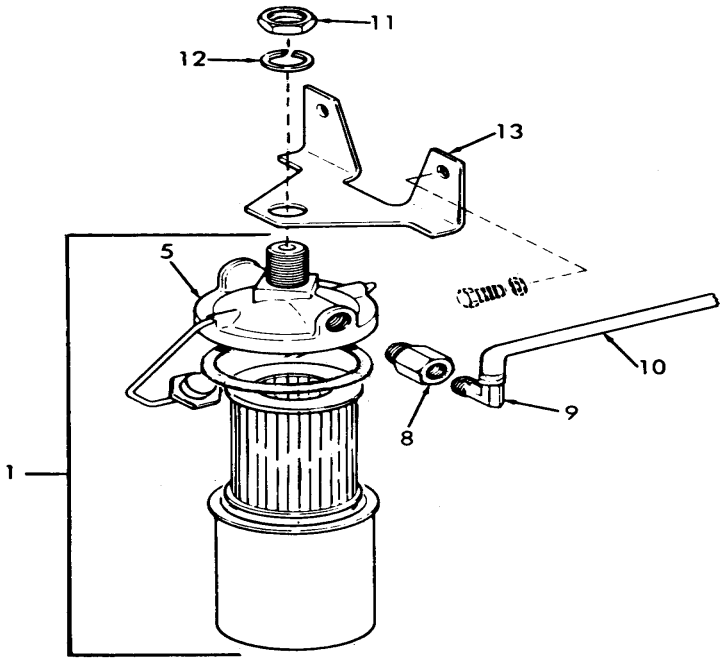
3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
9. Mounting bracket	Mounting bracket (13)	a. Replace bracket (13) onto bulkhead. b. Install lockwashers (15), and capscrews (14). c. Tighten.	



3-180 2. HYDROSTARTER FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
10. Filter assembly (1)	a. Cover (5)	1. Replace with new assembly.	
		2. Insert cover (5) into mounting bracket (13).	
		3. Install lockwasher (12) and nut (11).	
		4. Tighten.	
	b. Cover (5)	Install adapters (8), elbows (9), and hoses (10).	Make sure fittings are tight and leaks do not occur.



3-3052

3-180 3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Repair
d. Reassembly
e. Installation

INITIAL SETUP:

Test Equipment	References
None	None
Special Tools	**Equipment Condition / Condition Description**
None	None
Material/Parts	**Special Environmental Conditions**
None	None
Personnel Required	**General Safety Instructions**
1	Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Solenoid	Solenoid housing	a. Check for leaks.	
		b. Check for cracks, dents, and wear.	
		c. Check electrical connections.	
2.	Manual control valve	a. Check for leaks.	
		b. Check fittings.	
3.	Supply pipe	Check fittings for leaks.	
4.	Return pipe	Check fittings for leaks.	

3-180.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

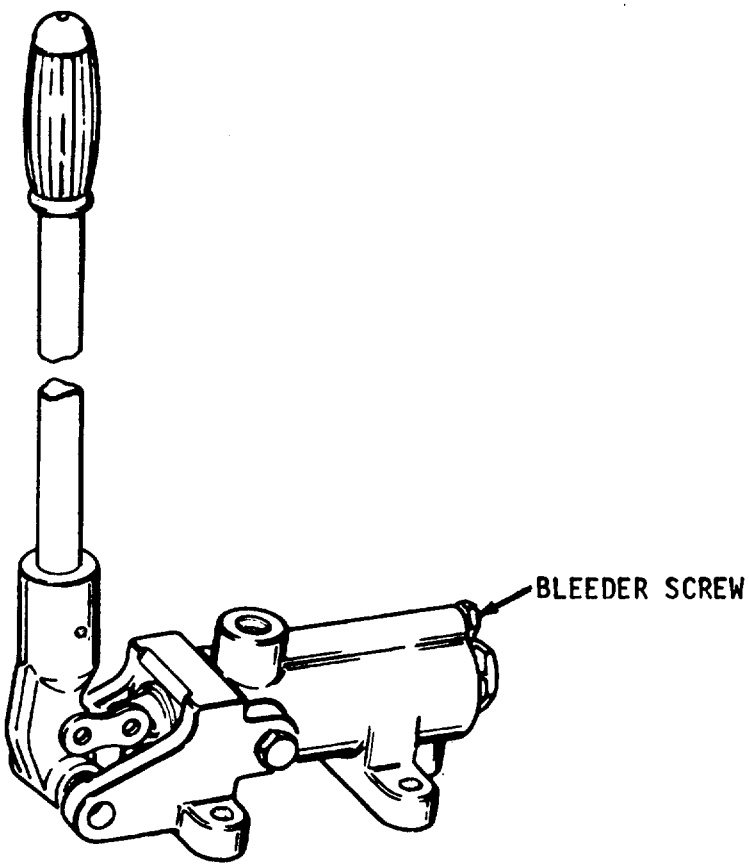
LOCATION	ITEM	ACTION	REMARKS

REMOVAL

WARNING

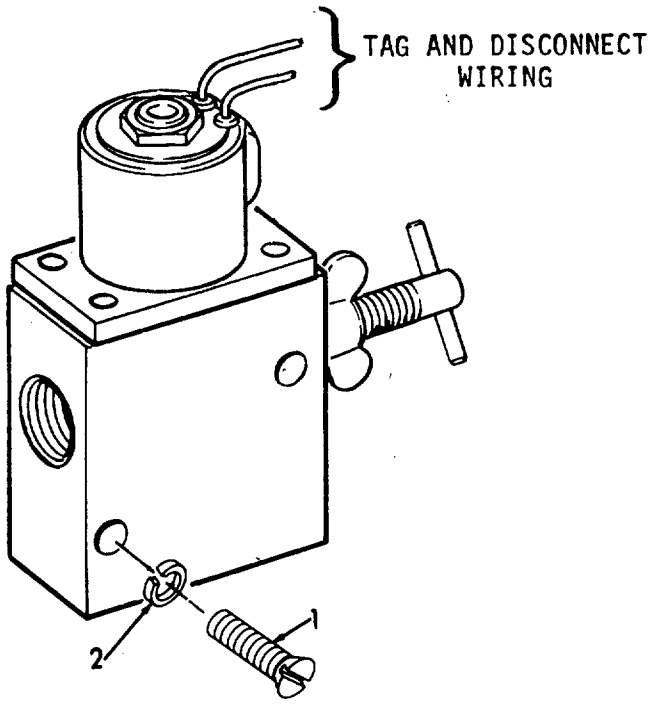
The oil pressure in this system must be released prior to servicing the solenoid valve or any other components of the system to prevent possible injury to personnel or equipment.

5.	Hand pump	Bleeder screw valve	Release the pressure in the hydrostarter system by opening bleeder screw valve on side of pump approximately 1/2 turn.



3-180.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

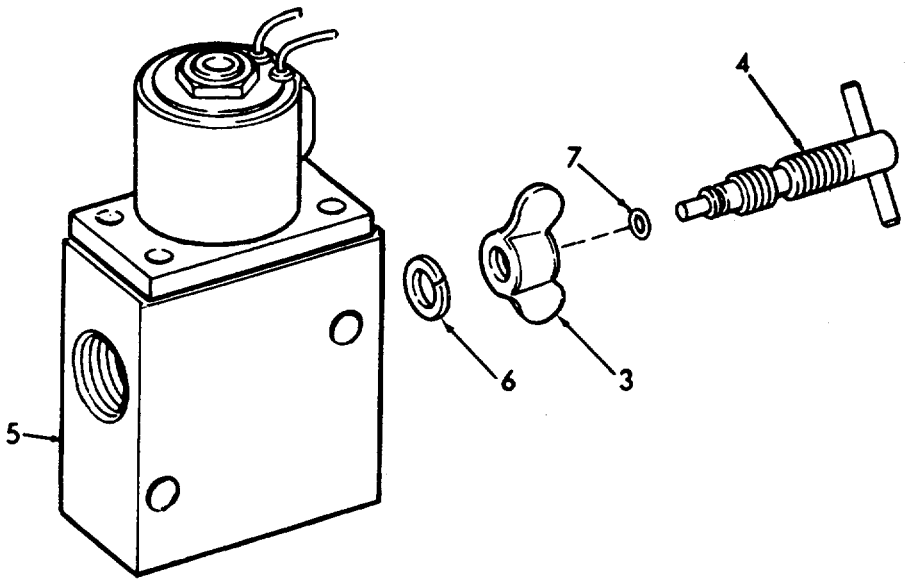
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.) I			
6.	Supply pipe	Disconnect supply pipe.	
7.	Return pipe	Disconnect return pipe.	
8.	Solenoid housing	a. Disconnect electrical connections. b. Remove screws (1) and lockwashers (2). c. Remove from mount.	



3-3056

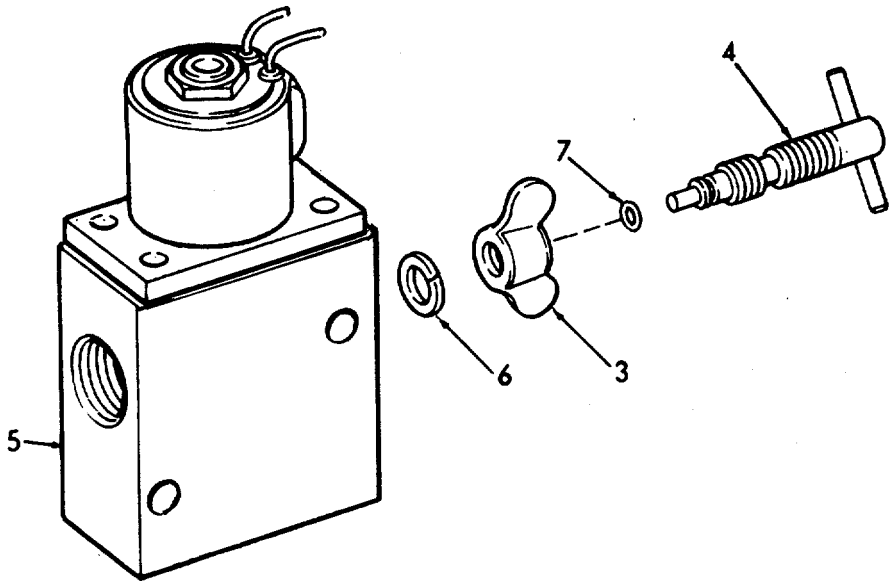
3-180.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
9.	Solenoid housing	Repair.	Refer to Direct Support Maintenance.
10.	Manual control screw	a. Loosen wing nut (3).	
		b. Unscrew manual control screw (4) from solenoid housing (5).	
		c. Remove lockwasher (6).	
		d. Remove wing nut (3).	
		e. Remove seal ring (7) from manual control screw (4).	Discard seal ring.



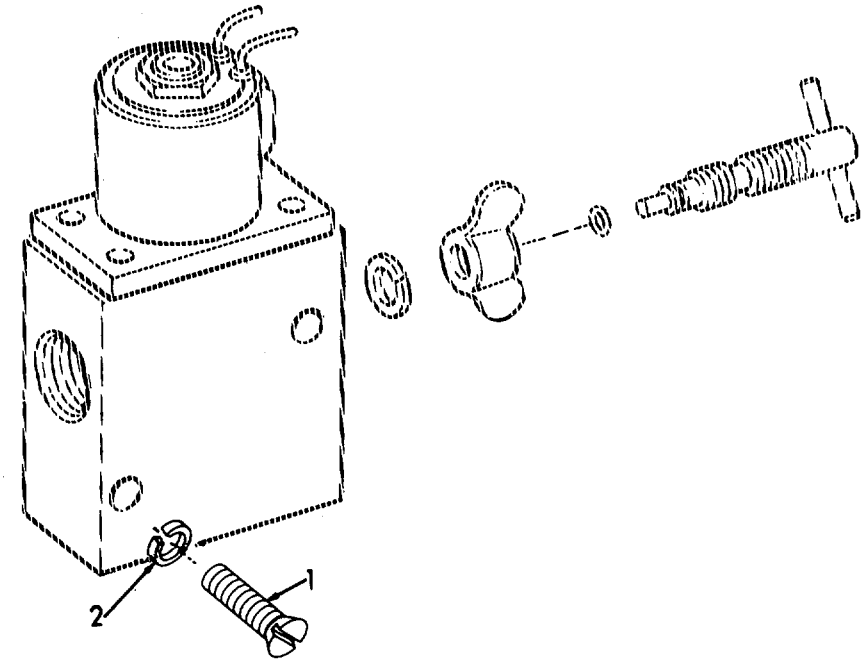
3-180.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
11.	Manual control screw (4)	a. Install new seal ring (7) on manual control screw (4). b. Replace wing nut (3) on manual control screw (4). c. Install manual control screw (4) into solenoid housing (5), and lock-washer (6). d. Tighten wing nut (3).	



3-180.3. HYDROSTARTER SOLENOID - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
12.	Solenoid housing	a. Place on mounting.	
		b. Install lockwashers (2) and screws (1).	
		c. Connect electrical connections.	
13.	Return piping	Connect.	
14.	Supply Piping	Connect.	



3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS.

a. The hydrostarter supply lines carry the hydraulic fluid from the reservoir to the engine driven pump or the hand pump.

b. The hydrostarter return lines carry the hydraulic fluid from the engine-driven pump or the engine starter to the reservoir.

c. The hydrostarter pressure lines carry the hydraulic fluid from the accumulator to the engine-driven pump, hand pump and the starter.

This task covers:

Inspection

INITIAL SETUP:

Test Equipment	Reference
None	None
Special Tools	**Equipment Condition** / **Condition Description**
None	None
Material/Parts	**Special Environmental Conditions**
None	None
Personnel Required	**General Safety Instructions**
1	Observe CAUTIONS in this procedure.

LOCATION	ITEM	ACTION	REMARKS

NOTE

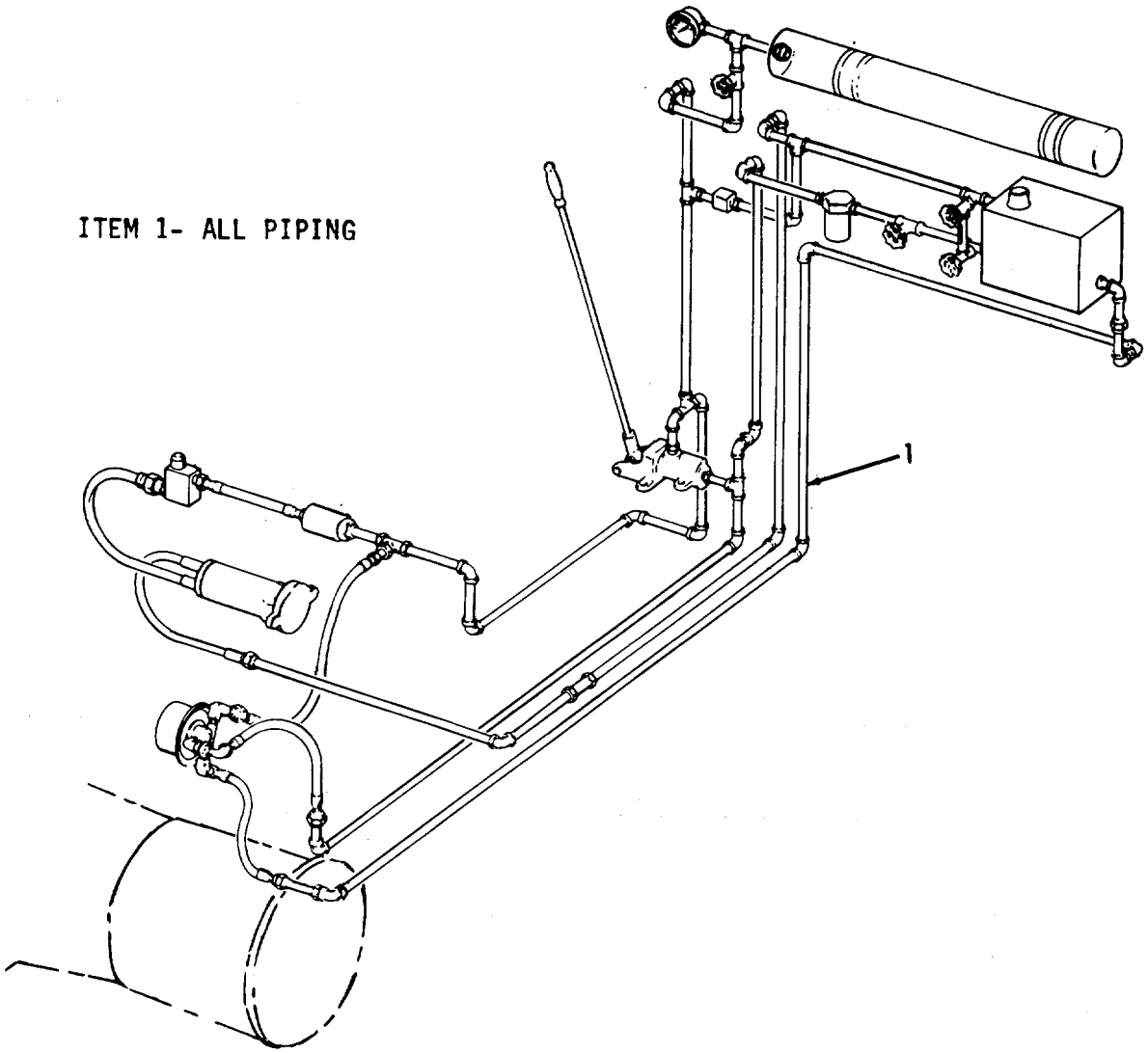
All maintenance to be preformed by Direct Support Maintenance unless otherwise noted.

INSPECTION

1.	Hydro-starter piping (1)	a. Check all pipes for leaks, damage, dents, cracks or breaks.	
		b. Check all pipe fittings. Make sure they are tight and do not leak.	

3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont.)			



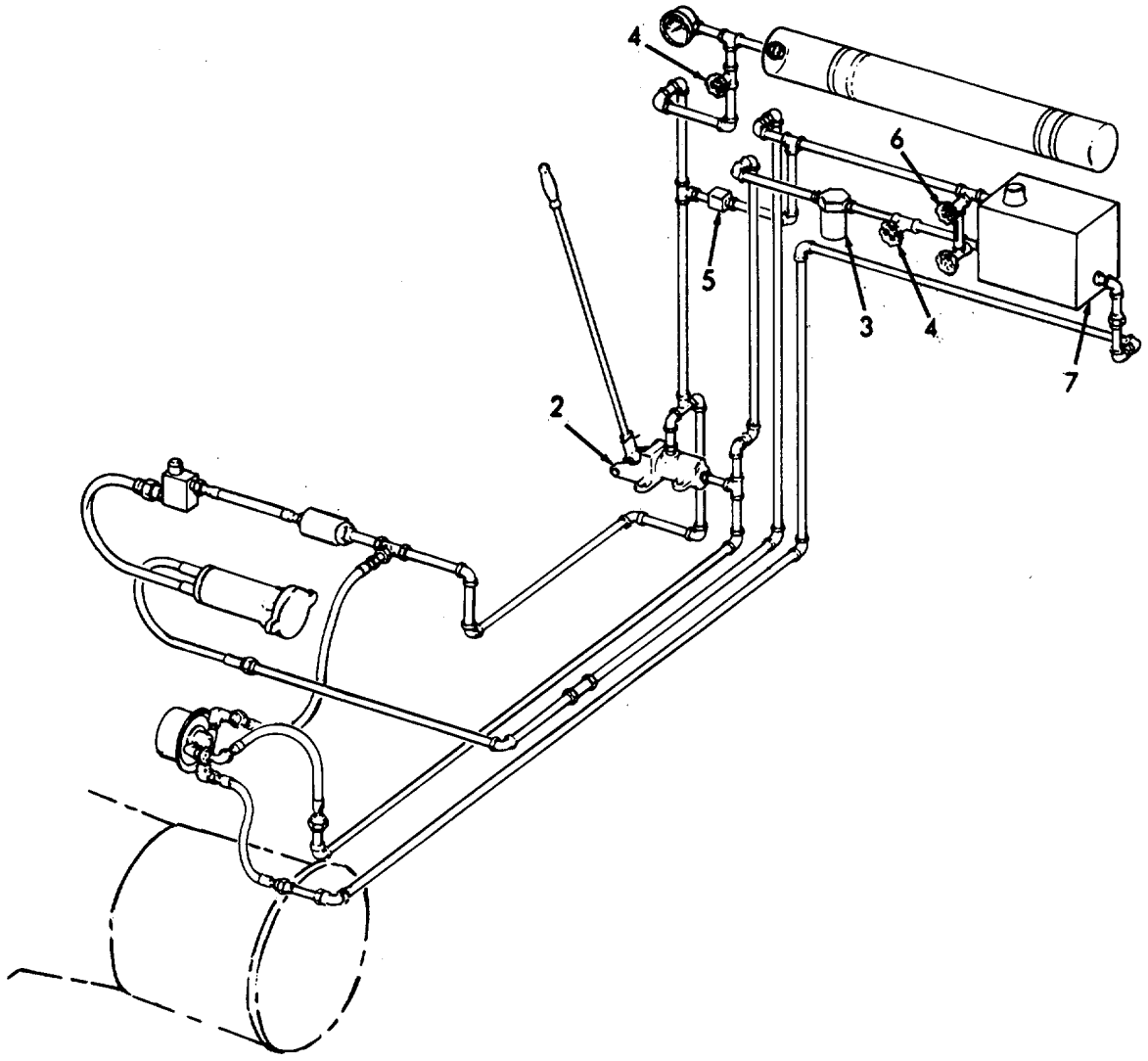
3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont.)			
2.	Hand pump (2)	Check for leaks.	Refer to paragraph 3-179 for maintenance.
3.	Suction filter (3)	a. Check for leaks.	Refer to paragraph 3-180 for maintenance.
		b. Check fittings. Make sure they are tight.	
4.	Shut-off valves (4)	a. Check for leaks.	
		b. Check for cracks, or wear.	
		c. Check fittings for tightness.	
5.	Relief valve (5)	a. Check for leaks.	
		b. Check for cracks, wear or dents.	
		c. Check fittings for tightness.	
6.	Sight glass with valves (6)	a. Check for leaks.	
		b. Check glass for cracks or breaks.	
		c. Check valves for wear, cracks, or dents.	
7.	Reservoir (7)	a. Check for leaks, dents or cracks.	Refer to paragraph 3-180 for maintenance.
		b. Check pipe connections for leaks.	

3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont.)



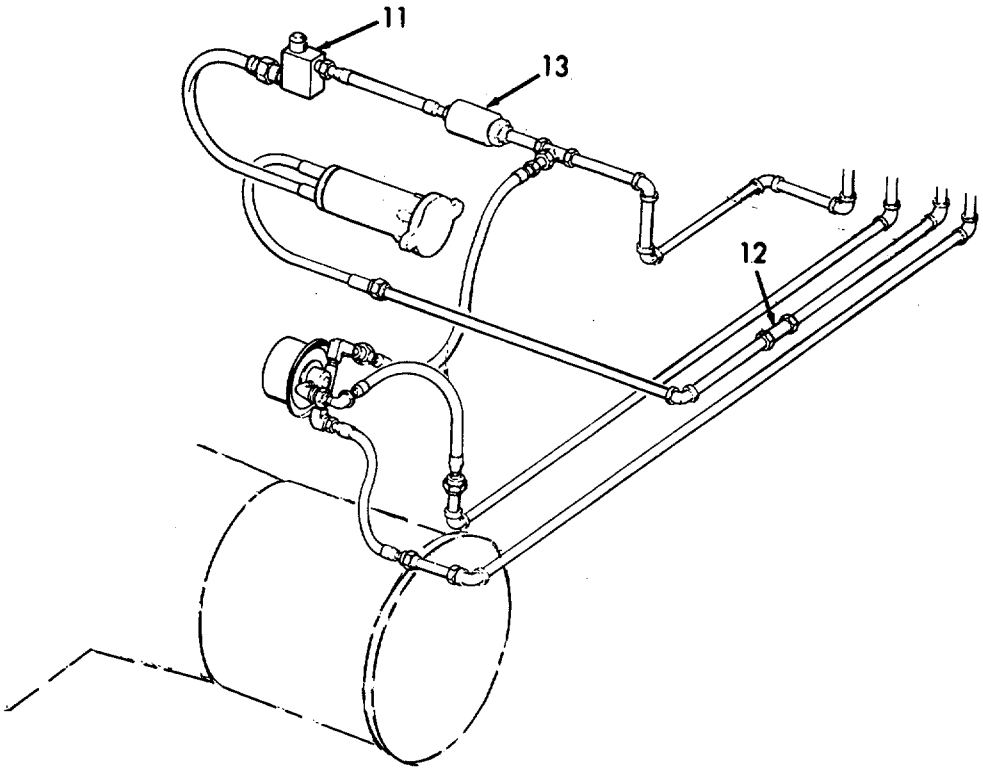
3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont.)			
8.	Pressure gage (8)	a. Check gage glass for cracks or breaks. b. Check fittings and connections for tightness and leaks.	
9.	Accumulator (9)	a. Check for leaks. b. Check for dents or cracks. c. Check pipe connections for leaks. d. Make sure all fittings are tight.	Refer to paragraph 3-177 for replacement and to Direct Support Maintenance for repair.
10.	Hydrostarter (10)	a. Check for leaks. b. Check piping connections for leaks. c. Check to see that the return, supply and accumulator (pressure) lines are tight.	Refer to paragraph 3-176 for maintenance.

3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

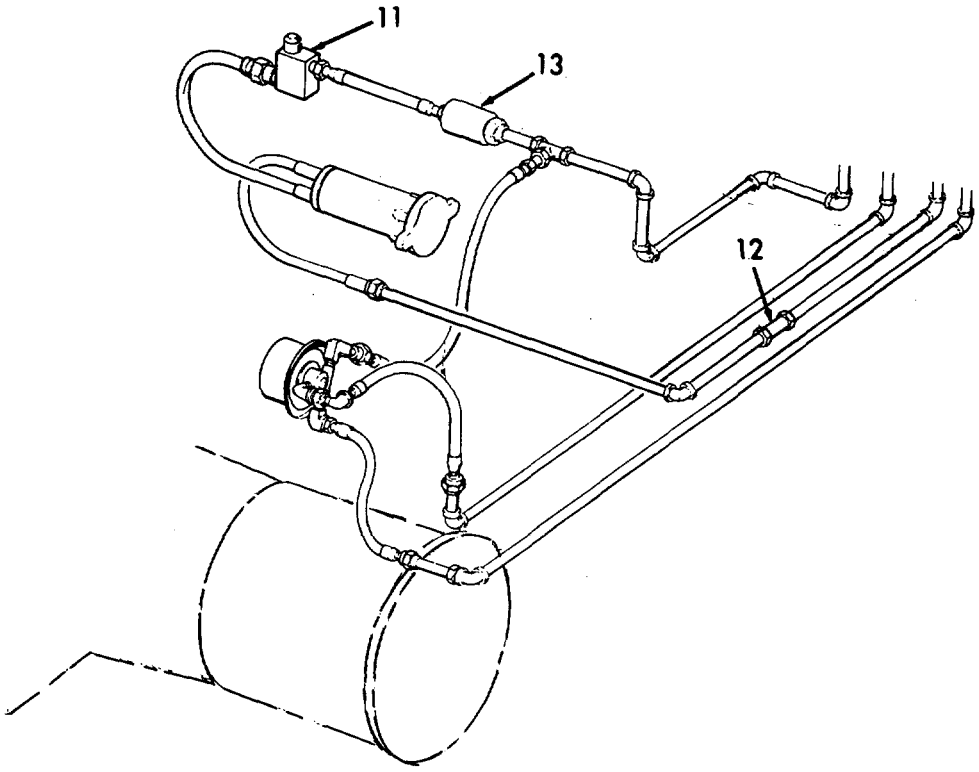
INSPECTION (Cont.)



3-3065

3-181. HYDROSTARTER PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont.)			
11.	Solenoid valve (11)	a. Check for leaks.	Refer to paragraph 3-180 for maintenance.
		b. Check fittings, pipes, and wiring. Make sure they are tight.	
12.	Check	a. Check for leaks. valve (12)	
		b. Make sure fittings are tight.	
13.	High pressure filter (13)	Check for leaks.	Refer to paragraph 3-180 for maintenance.



3-3066

3-182. "A" FRAME, WIRE ROPE AND ANCHOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Service**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Grease MIL-G-10924 Type GAA

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

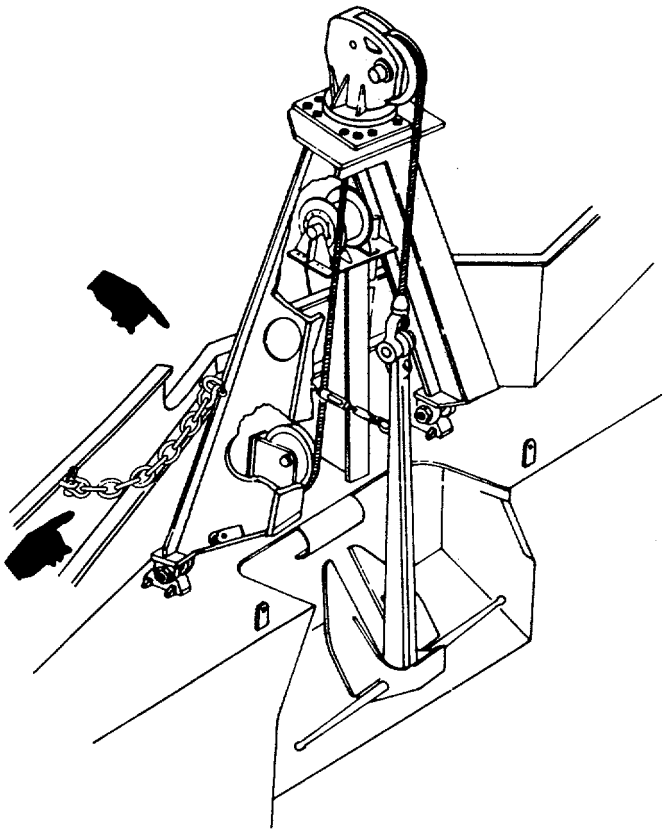
General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1 "A" Frame	a. "A" Frame	Inspect for cracks, bends, breaks, and signs of fatigue.	
	b. Welds	Inspect for breaks, cracks, and fatigue.	
	c. Hard-ware	Insure all hardware is properly installed.	
	d. Toggle pins	Inspect for missing toggle pins.	
2. Anchor	a. Shackle	Inspect for cracks, breaks, fatigue and missing hardware.	
	b. Welds	Inspect for cracks, breaks and fatigue.	

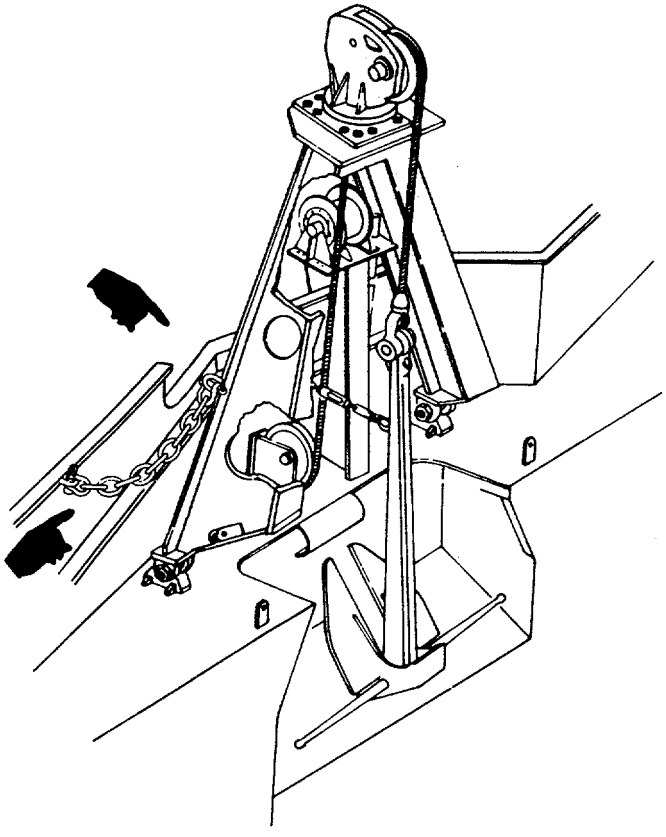
3-182. "A" FRAME, WIRE ROPE AND ANCHOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont.)			
	c. Anchor	Inspect for breaks and missing metal.	
3. Wire rope	a. Rope	Inspect for wear, frays and breaks.	
	b. Shackles	Inspect for cracks, breaks, fatigue and missing hardware.	
	c. Links, turn-buckles	Inspect for wear, breaks, cracks, and bends.	
4. Sheaves	Sheave	Inspect for breaks, cracks, bends, and missing hardware.	



3-182. "A" FRAME, WIRE ROPE AND ANCHOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
5. "A" Frame	Hinge pins (1)	Grease two places weekly.	
6. Wire Rope	a. Anchor cable sheave (2)	Grease weekly.	
	b. Anchor tie-down (3)	Grease weekly.	
	c. Wire ropes	Grease. Wipe on light coating.	



3-183. FAIRLEADER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

INITIAL SETUP

Test Equipment

None

Special Tools

None

Material/Parts

Grease MIL-G-10924
Type GAA

Personnel Required
1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

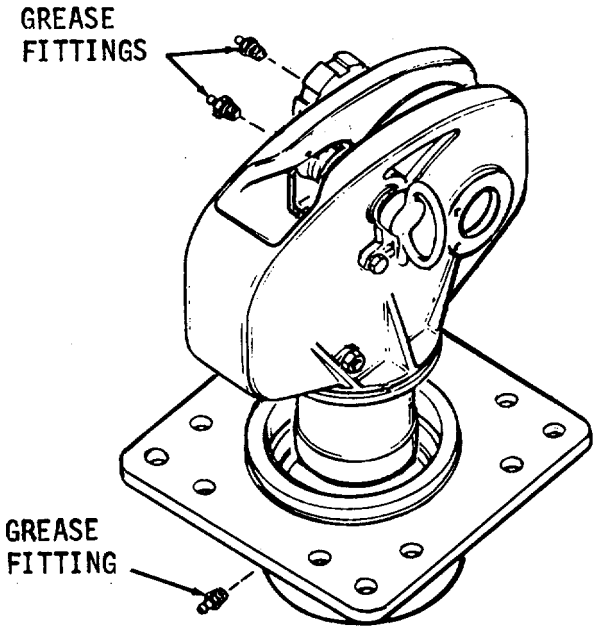
None

General Safety Instructions
None

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Fair leader	a. Swivel head	1. Inspect for cracks, breaks and fatigue.	
		2. Insure all hardware is properly installed.	
	b. Flange and hub	1. Inspect for cracks, breaks and fatigue.	
		2. Insure all hardware is properly installed.	

3-183. FAIRLEADER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
2.	Grease fittings	Lubricate every fifty hours of operation.	



3-184. WIRE ROPE CUTTER - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Repair**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Grease MIL-G-10924
Type GAA

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Wire rope cutter	a. Base and breaks.	1. Inspect for cracks,	
		2. Ensure all hardware is tight.	
	b. Blade	Inspect for breaks, cracks, and sharpness.	
	c. Shear rod, and sledge hammer	Ensure parts are not missing.	

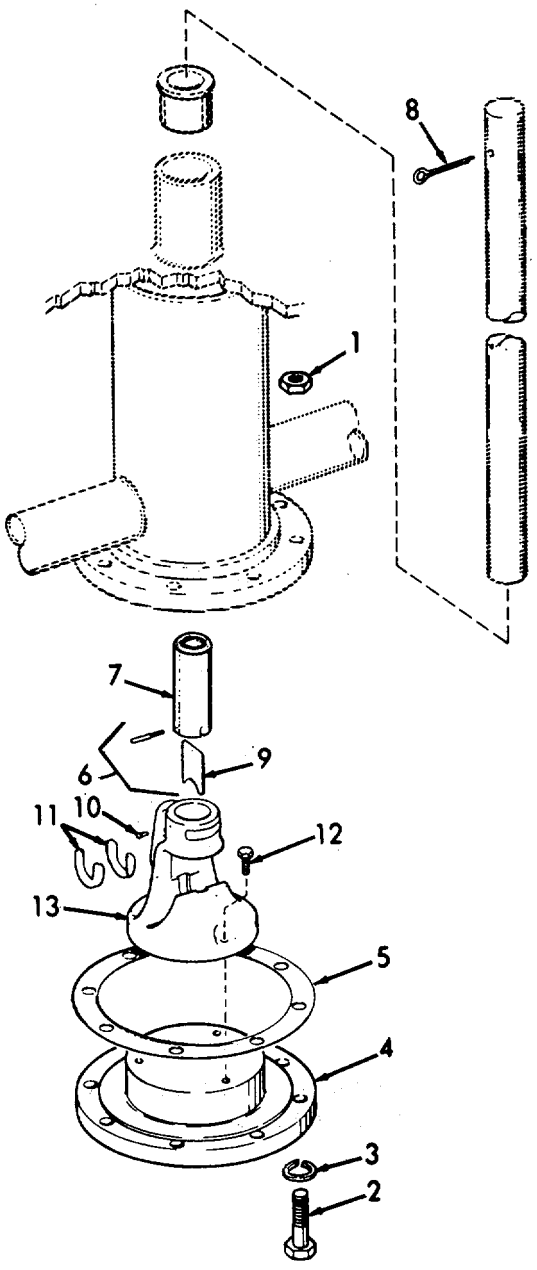
3-184. WIRE ROPE CUTTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2.	a. Nuts (1), screws (2) and lock-washers (3)	Remove.	
	b Base (4), and gasket (5)	Remove.	
	c. Plunger assembly (6)	Lift out.	
	d. Plunger (7), pin (8), and blade (9)	Disassemble.	
	e. Guide pin (10), and die set (11)	Remove.	
	f. Three screws (12), cutter base (13), and base (4)	Remove screws and separate.	If necessary.

3-184. WIRE ROPE CUTTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)

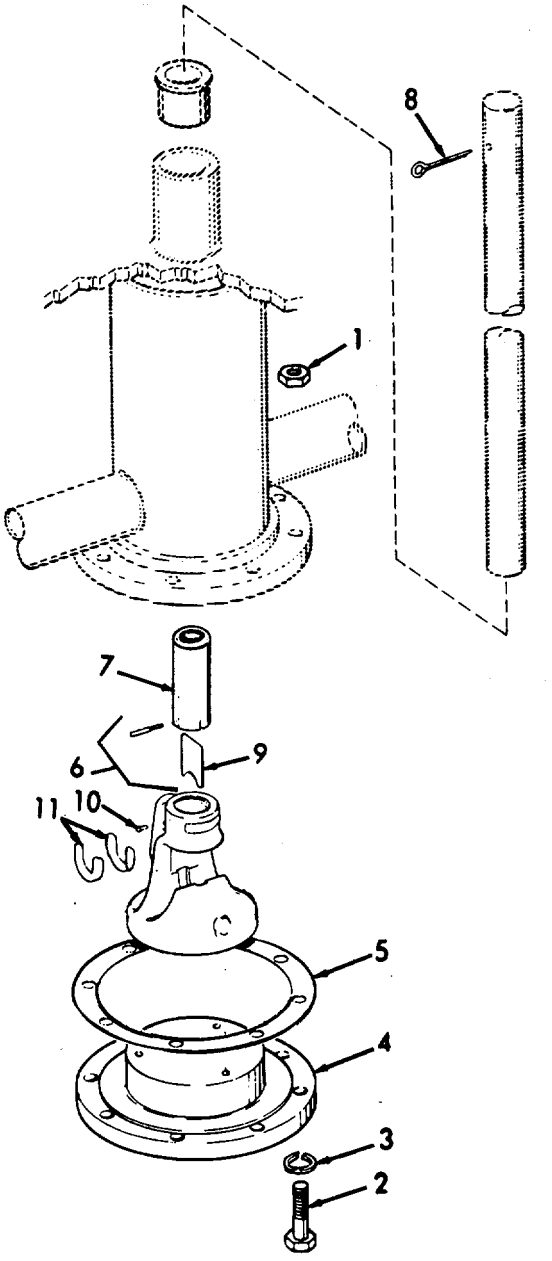


3-184. WIRE ROPE CUTTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Die set (11), and guide pin (10)	Install.	
	h. Plunger (7), pin (8), and blade (9)	Assemble.	
	i. Plunger assembly (6)	Install.	
	j. Gasket (5), base (4), lock-washers (3), screws (2), and nuts (1)	Reassemble..	
	k. Cutter	Grease.	

3-184. WIRE ROPE CUTTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



3-3077

3-185. MAST - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Inspection **b. Service** **c. Repair**

INITIAL SETUP:

Test Equipment
None

References
None

Special Tools
None

Equipment Condition
Condition Description
None

Material/Parts
Grease MIL-G-10924 Type GAA

Special Environmental Conditions
None

Personnel Required
2

General Safety Instructions
Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

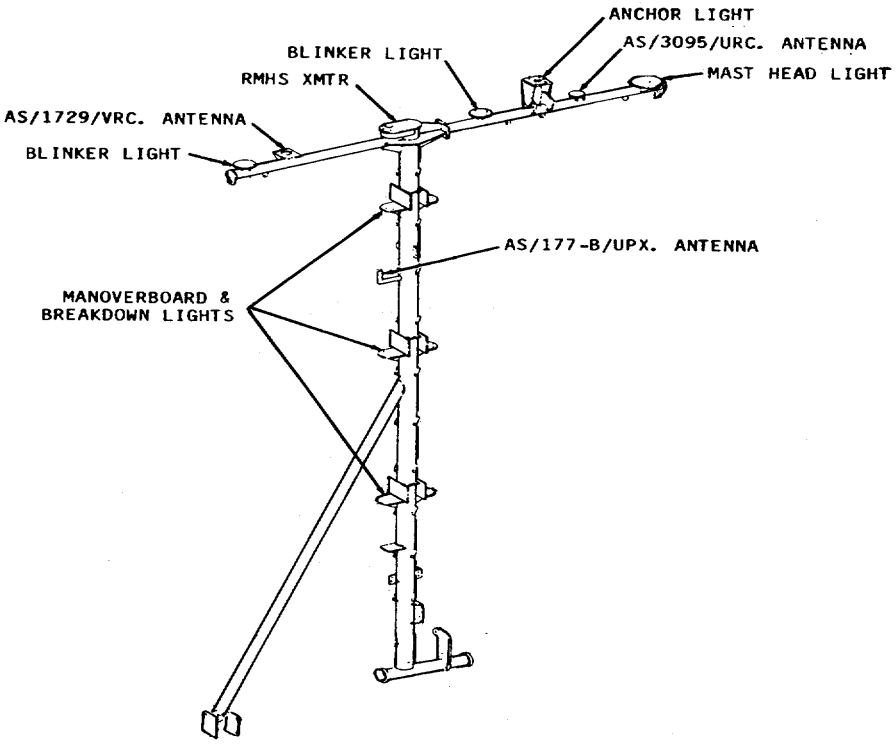
To avoid possible shock and death, make sure all switches and transmitters are turned off and tagged.

INSPECTION

1.	Mast	a.	Blinker Lights	Inspect for proper operation.	Refer to paragraph 3-113.9 .
		b.	Anchor Light	Inspect for proper operation.	Refer to paragraph 3-113.7 .

3-185. MAST - MAINTENANCE INSTRUCTIONS (Cont).

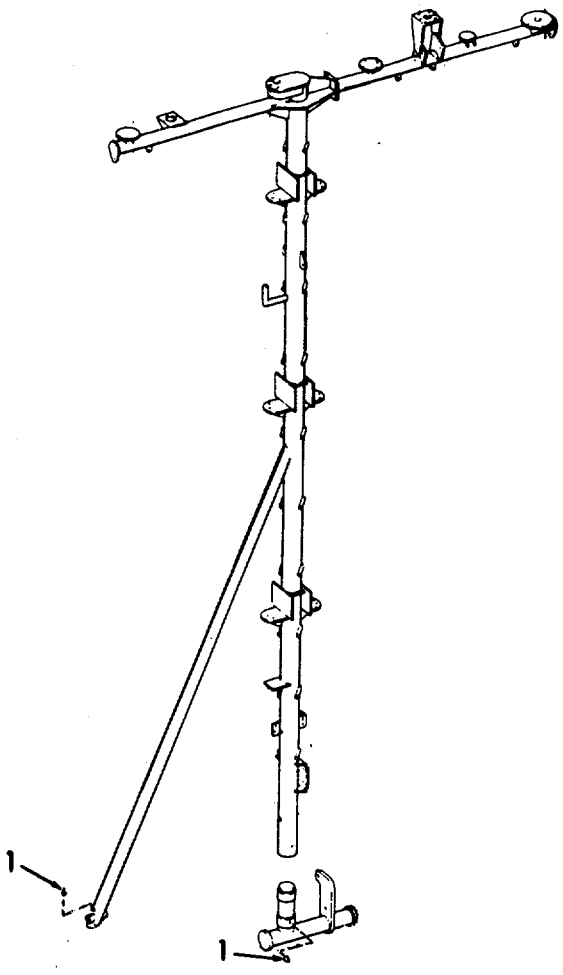
LOCATION	ITEM	ACTION	REMARKS
INSPECTIONS (Cont)			
	c. Masthead Light	Inspect for proper operation.	Refer to paragraph 113.4 .
	d. Manover-board and Breakdown Lights	Inspect for proper operation.	Refer to paragraph 113.8 .
	e. Mast	Inspect for breaks, cracks and broken welds.	Refer to Direct Support Maintenance.



3-3079

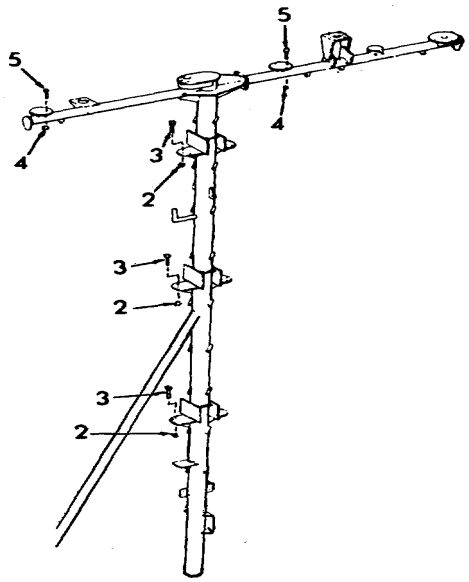
3-185. MAST - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSPECTIONS (Cont)			
	f. Struts	Inspect for breaks, cracks and broken welds.	Refer to Direct Support Maintenance.
	g. Hardware	Insure all hardware is tight.	
SERVICE			
2.	Grease fittings (1)	Lubricate three fittings with grease.	



3-185. MAST CUTTER - MAINTENANCE INSTRUCTIONS (Cont)inued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
3. Manover-board and Breakdown Lights	a. Light and wiring	Disassemble.	Refer to paragraph 113.8 .
	b. Nuts (2), and screws (3)	Remove.	If necessary.
4. Blinker Lights	a. Light and wiring	Disassemble.	Refer to paragraph 3-113.9 .
	b. Nuts (4), and screws (5)	Remove.	If necessary.



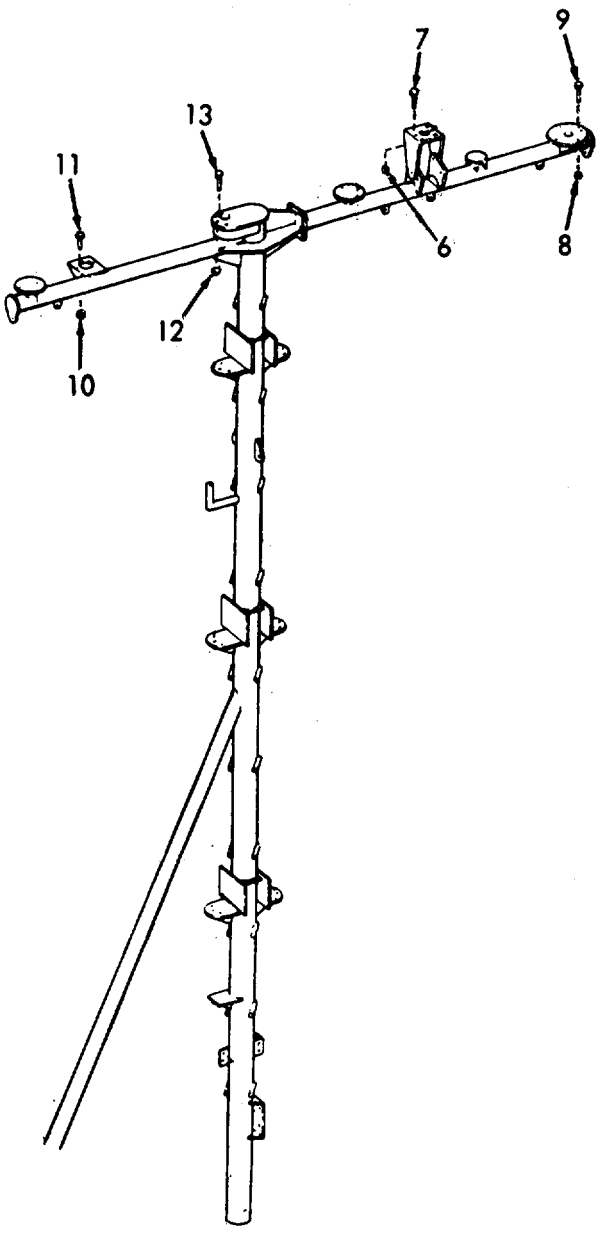
3-3081

3-185. MAST CUTTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Anchor Light	a. Light and wiring	Disassemble.	Refer to paragraph 3-113.7 .
	b. Nuts (6), and screws (7)	Remove.	If necessary.
6. Masthead Light	a. Light and wiring	Disassemble.	Refer to paragraph 3-113.4 .
	b. Nuts (8), and screws (9)	Remove.	If necessary.
7. Antenna AN/1729/VRC	a. Wiring	Disconnect.	
	b. Nuts (10), and screws (11)	Remove.	If necessary.
8. Remote Magnetic Heading System Transmitter	a. Wiring	Disconnect.	
	b. Nuts (12), and screws (13)	Remove	If necessary.

3-185. MAST - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



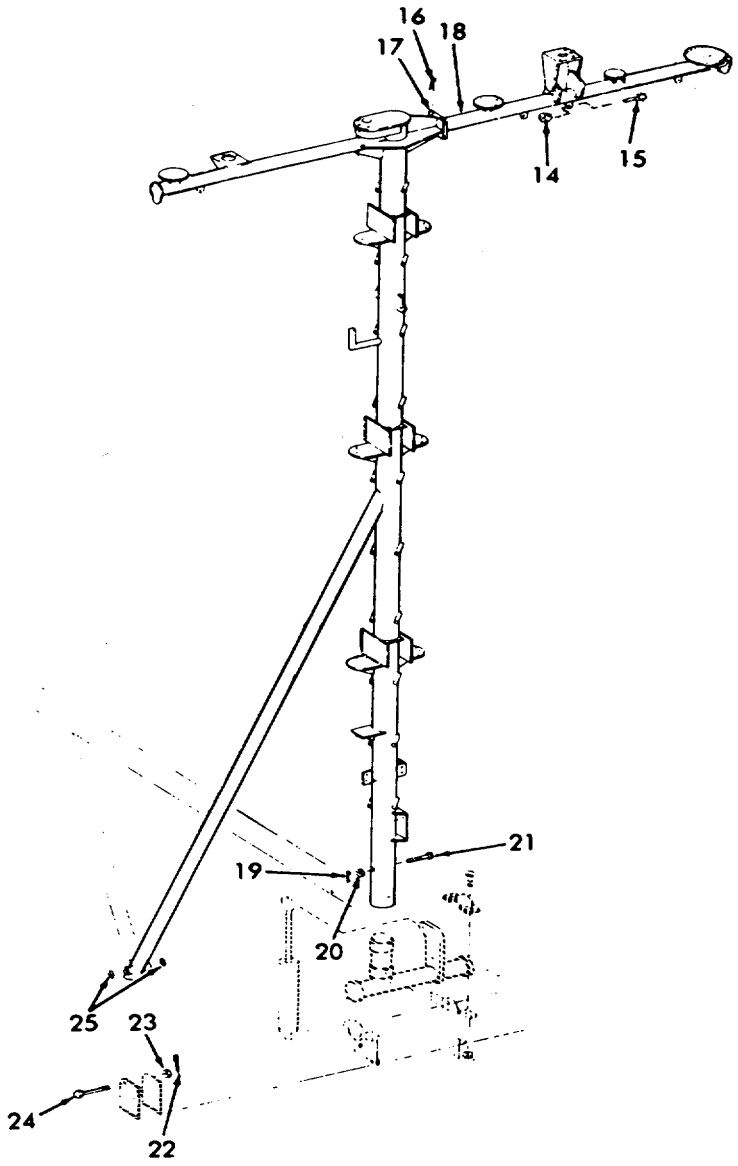
3-185. MAST - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Anchor Light Found-ation	Nuts (14), and screws (15)	Remove.	
10. Pivot	a. Two cotter pins (16), and pivot pin (17)	Remove.	
	b. Yardarm (18)	Pivot upwards.	
11. Mast	Cotter pin (19), nut (20), and bolt (21)	Replace.	
12. Brace	Cotter pin (22), nut (23), bolt (24), and teflon washers (25)	Replace.	

3-185. MAST - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



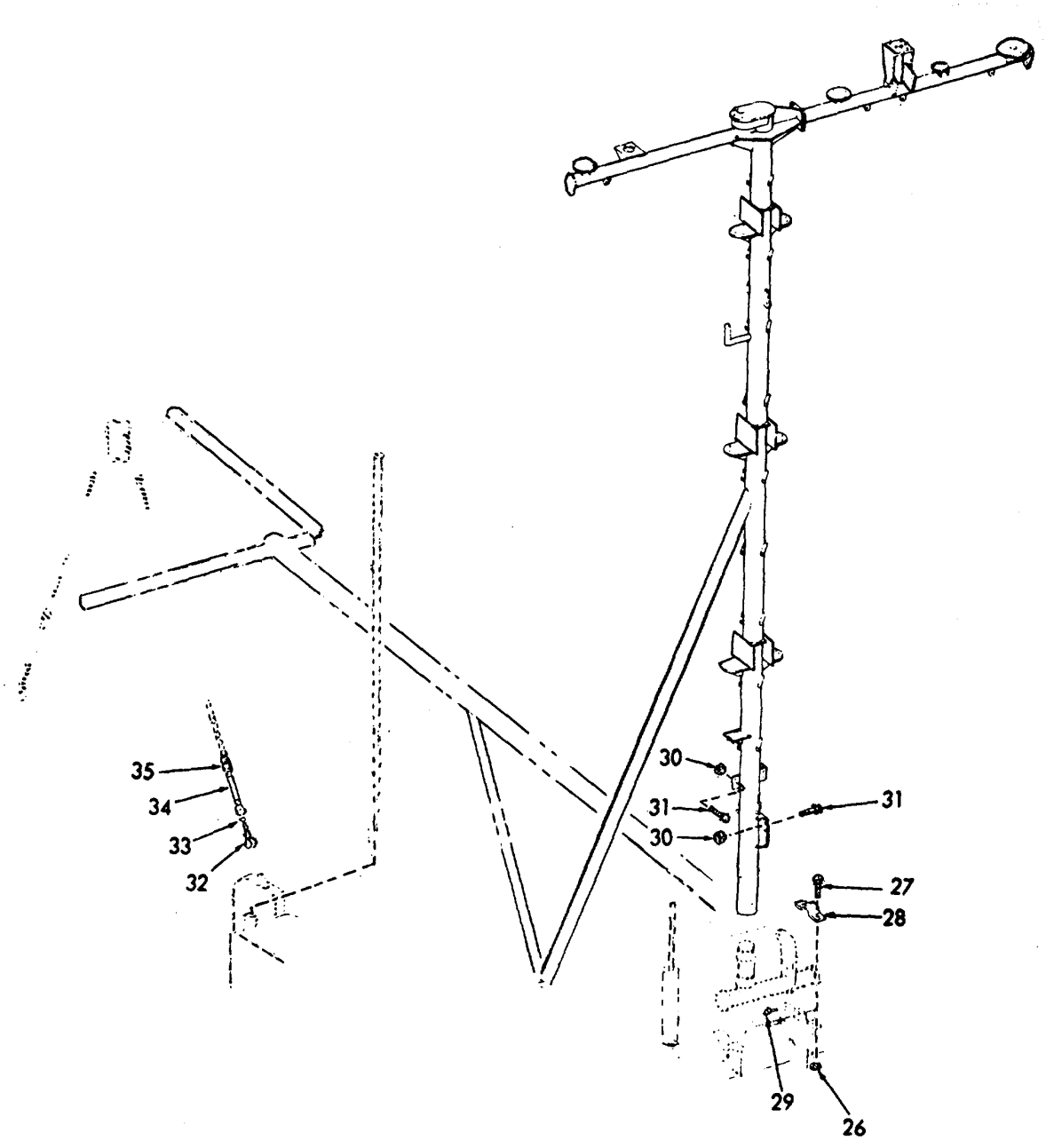
3-3085

3-185. MAST - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
13. Base Pivot	a. Nuts (26), screws (27), and clamp (28)	Replace.	
	b. Toggle bolt (29)	Replace.	
14. Mast (misc)	Nuts (30), and screws (31)	Replace.	
15. Guywires	Shackle (32), pelican hook (33), turn-buckle (34), and sling link (35)	Replace.	

3-185. MAST - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



3-3087

3-186. CENTRALIZED HYDRAULIC SYSTEM - MAINTENANCE INSTRUCTIONS.

a. The centralized hydraulic system is used to raise and lower the stern gate, mast and the anchor "A" frame. Refer to foldout 1 for an overall view of the system.

b. The maintenance instructions are contained in the following paragraphs.

3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Inspection **b. Replacement** **c. Repair**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Filter element-
NSN 4330-01-019-8959
Hydraulic fluid MIL-L-
17672 Type 211oTH or
2135-TH

Personnel Required

1

References

None

Equipment
Condition Condition Description
Paragraph

3-190 Reservoir Drained

Special Environmental Conditions

Do not drain oil into bilges. Use the oil separation and recovery system to collect drained oil.

General Safety Instructions

Observe WARNINGS in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

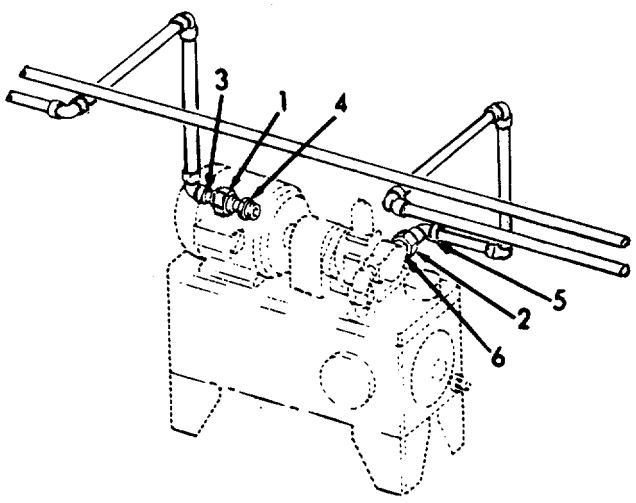
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Hydraulic Power Unit	a. Piping	Inspect for breaks, cracks, bends or leaking.
		b. Filter	Inspect for breaks, cracks and leaking.

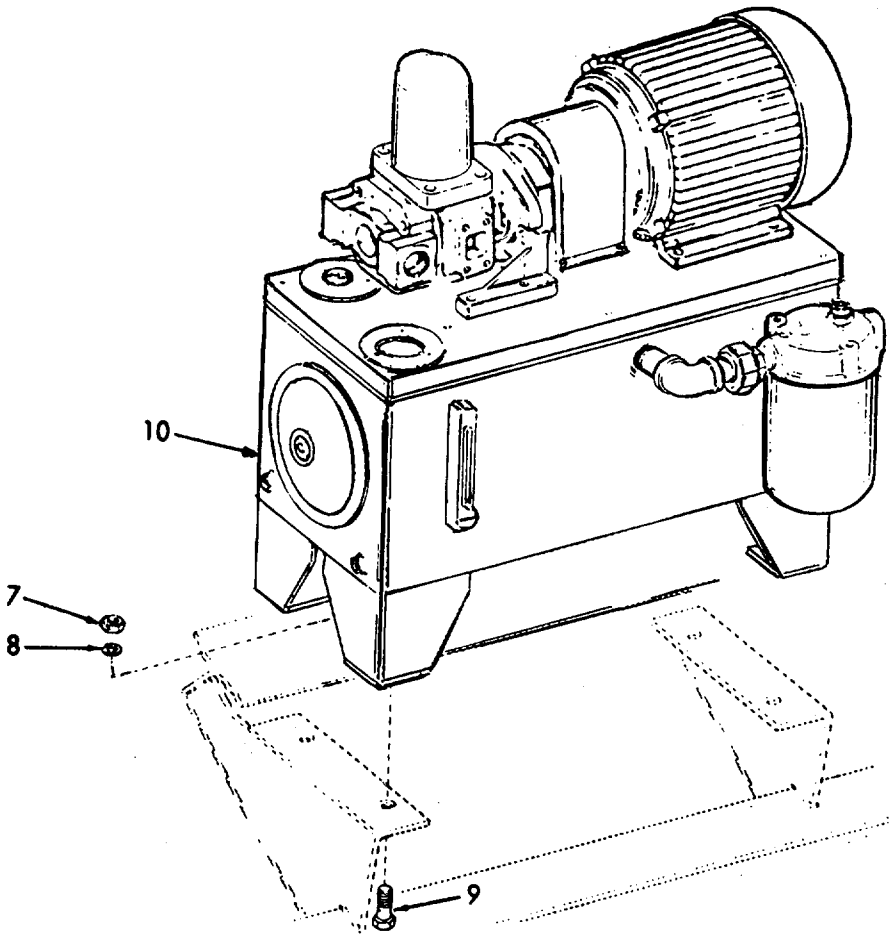
3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
2.	a. Wiring	Tag and disconnect all wiring to motor.	
	b. Union nut (1) (return)	Loosen and separate.	Drain hydraulic fluid into a suitable container.
	c. Union nut (2) (output)	Loosen and separate	
	d. Nipple (3), and, tail-piece (4)	Remove.	
	e. Nipple (5), and tail-piece (6)	Remove.	



3-187. HYDRAULIC POWER UIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
f.	Nuts (7), lock-washers (8), and screws (9)	Remove.	
g.	Hydraulic Power Unit (10)	Remove.	



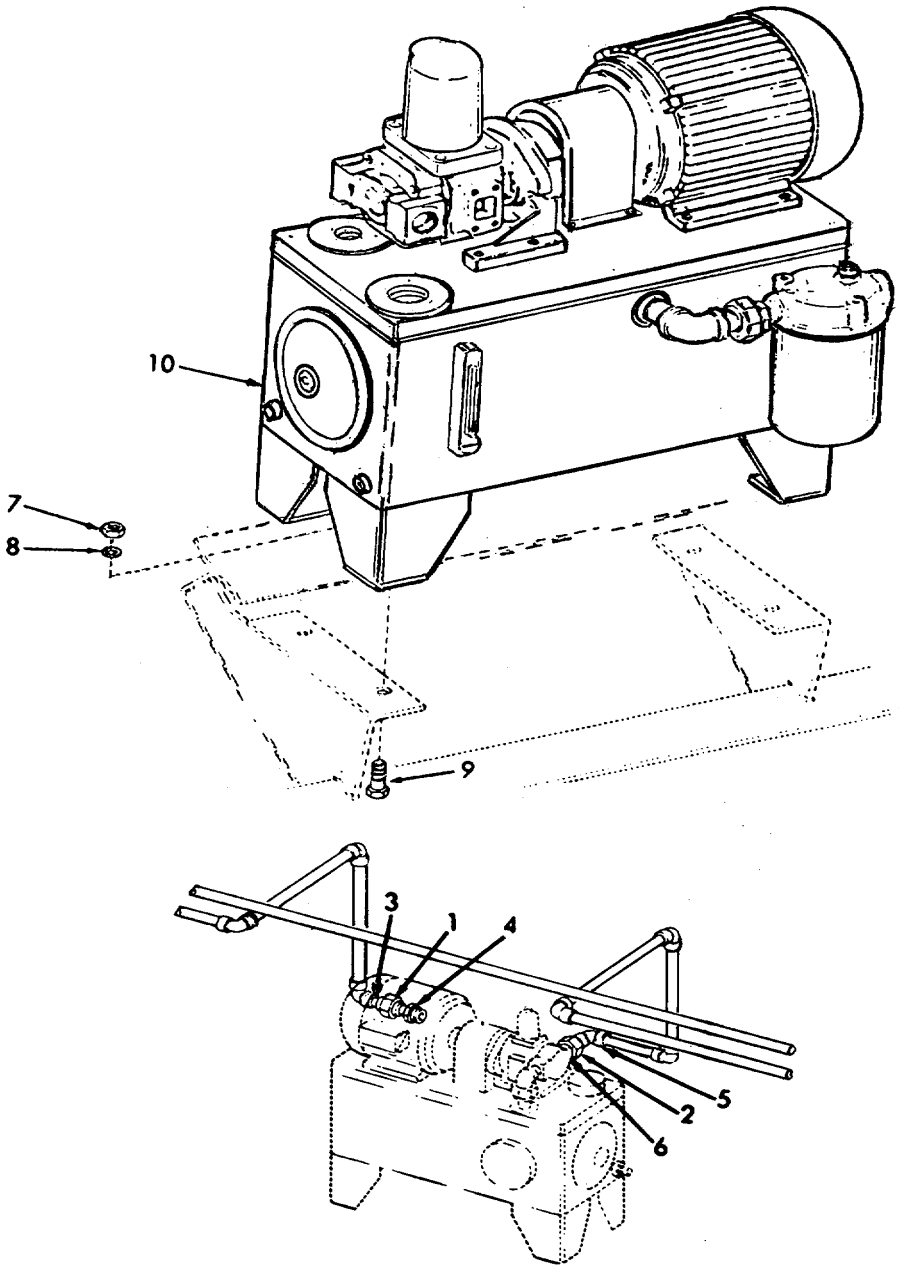
3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
	h. Hydraulic Power Unit (10), screws (9), lock-washers (8), and nuts (7)	Install.	
	i. Nipples (3 and 5), and tail-pieces (4 and 6)	Replace.	
	j. Union nuts (1 and 2)	Reassemble and tighten.	
	k. Hydraulic Power Unit	Refill with hydraulic fluid.	Refer to para-graph 3-190 .
	1. Wiring	Reconnect and remove tags.	

3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPLACEMENT (Cont)



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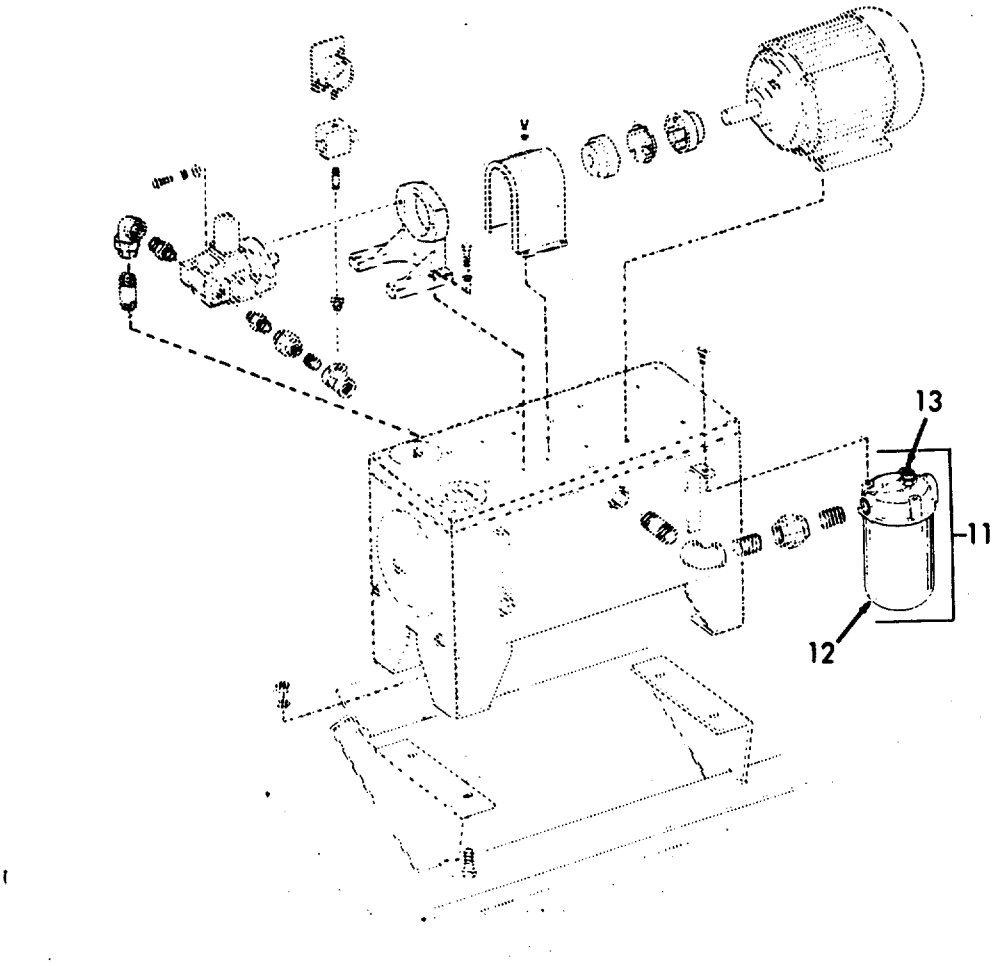
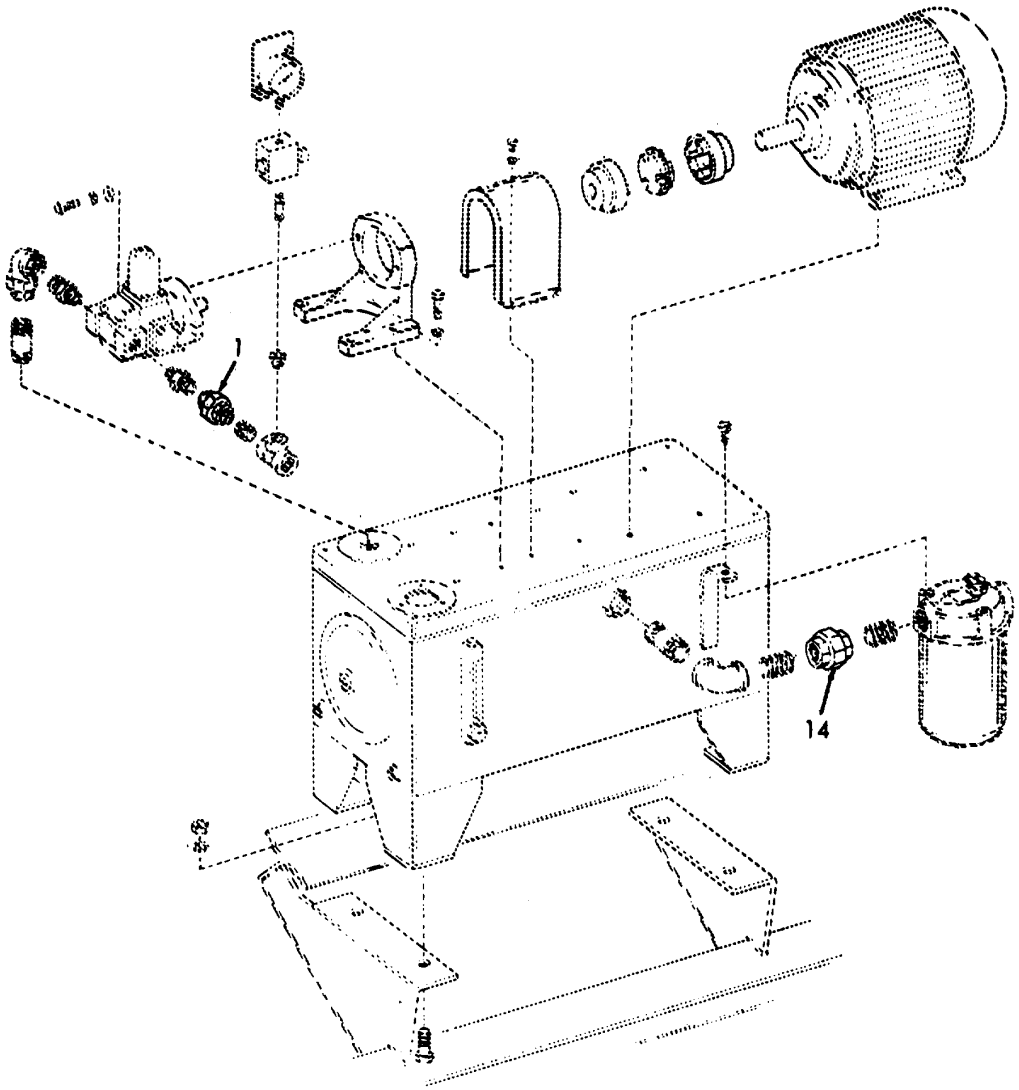
3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
3. Return line Filter (11)	a. Filter element (12)	Unscrew and remove.	Dispose of prop erly.
	b. Filter element (12)	Replace.	Use a new fil- ter element.
	c. Pipe plug (13)	1. Remove. 2. Add hydraulic fluid. 3. Replace.	Fill filter element.



3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPAIR			
4. Repair Line Filter and Return Line	a. Union nuts, (1 and 14)	Loosen.	



3-3095

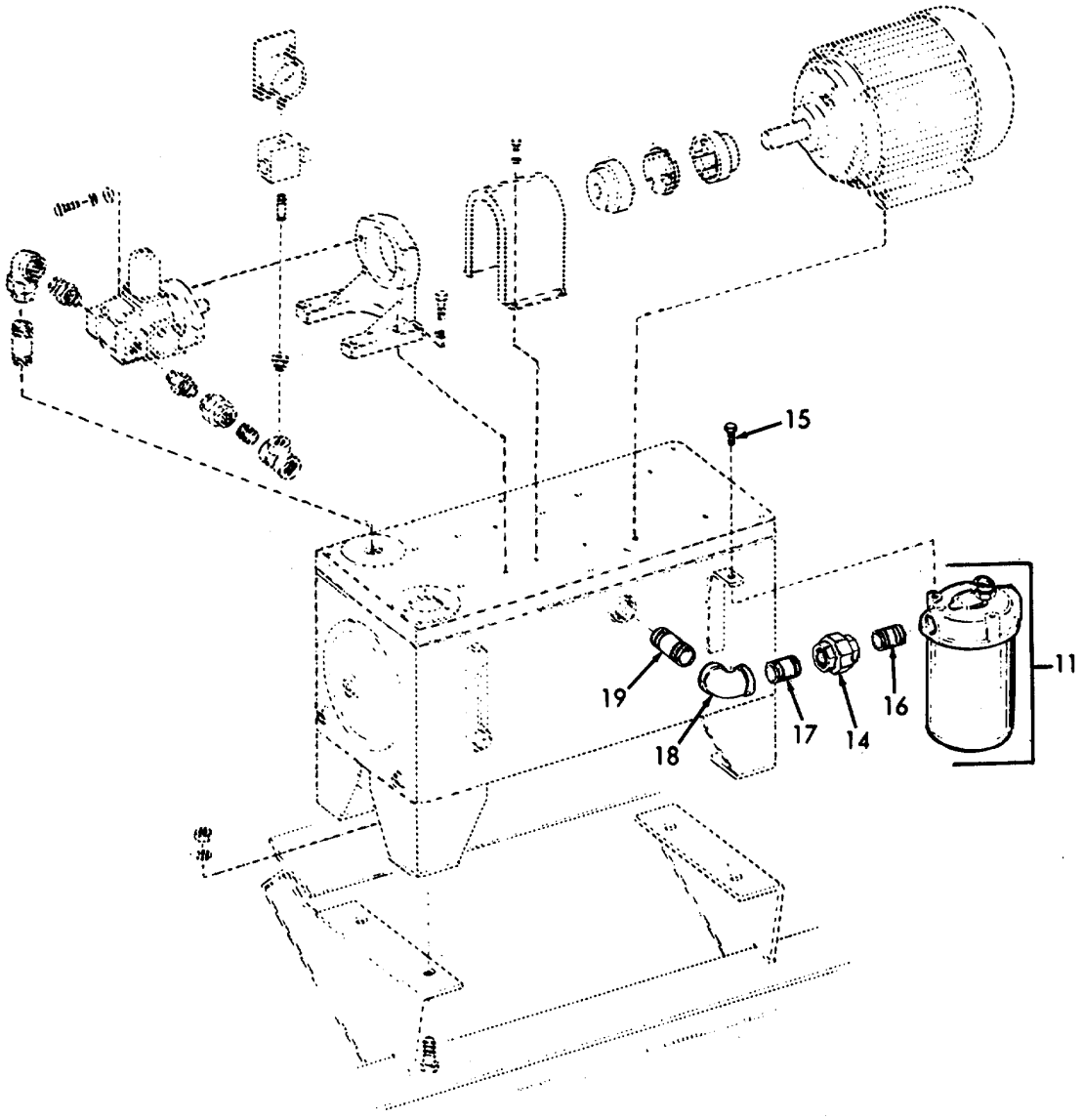
3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPAIR (Cont)			
	b. Screw (15), and filter (11)	Remove.	
	c. Nipple (16), and union half (14)	Remove from filter (11).	
	d. Union half (14), nipple (17), elbow (18), and nipple (19)	Disassemble.	
	e. Nipple (19), elbow (18), nipple (17), and union half (14)	Reassemble.	

3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

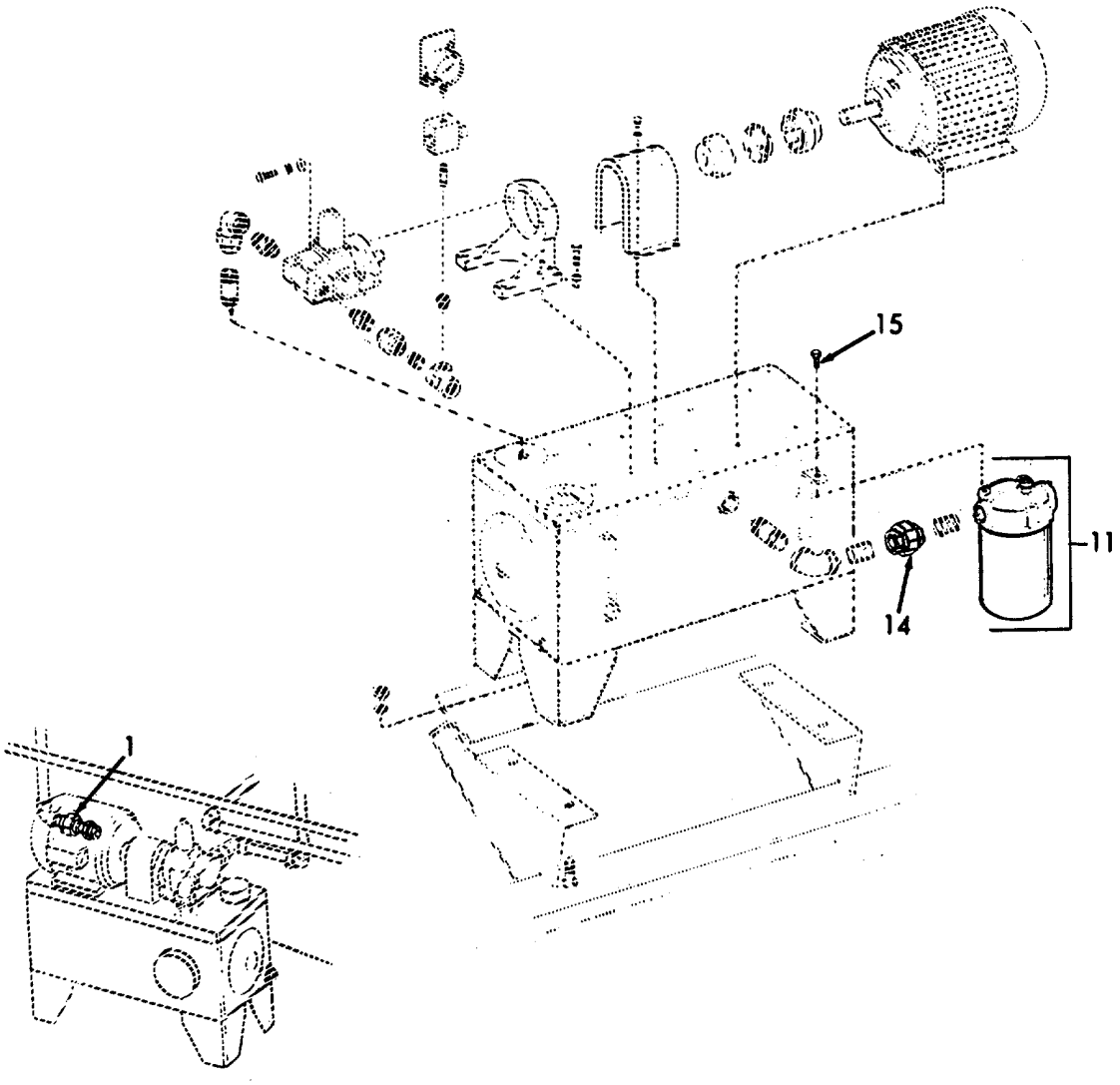
LOCATION	ITEM	ACTION	REMARK

REPAIR (Cont)



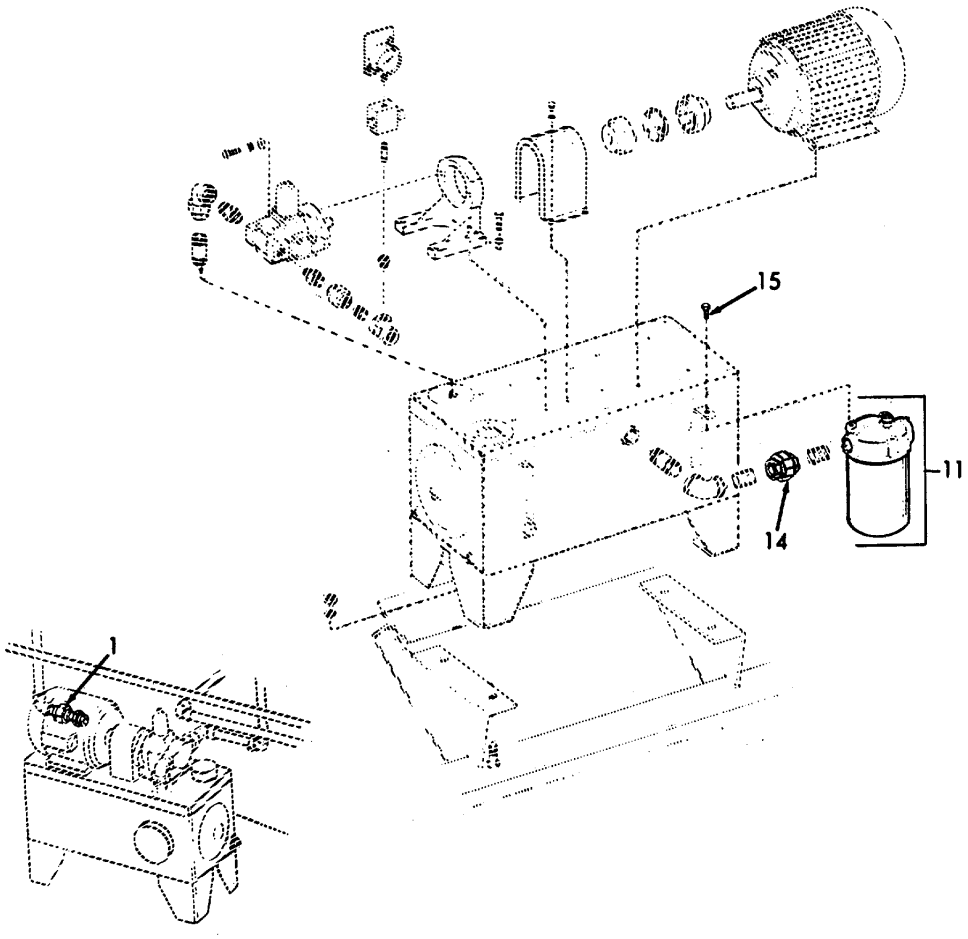
3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPAIR (Cont)			
	f. Nipple (16), union half (14), and filter (11)	Reassemble.	



3-187. HYDRAULIC POWER UNIT, FILTER AND RETURN - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPAIR (Cont)			
	g. Screw (15), and filter (11)	Install.	
	h. Union nuts (1), and union bolts (14	Reconnect and tighten.	



3-188. ELECTRIC MOTOR AND COUPLING - MAINTENANCE INSTRUCTIONS

This task covers:

a. Inspection **b. Replacement**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARK

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1. Hydraulic Power Unit	a. Electric motor	1. Inspect for worn, frayed, or broken wiring.	
		2. Insure all mounting hardware is tight.	

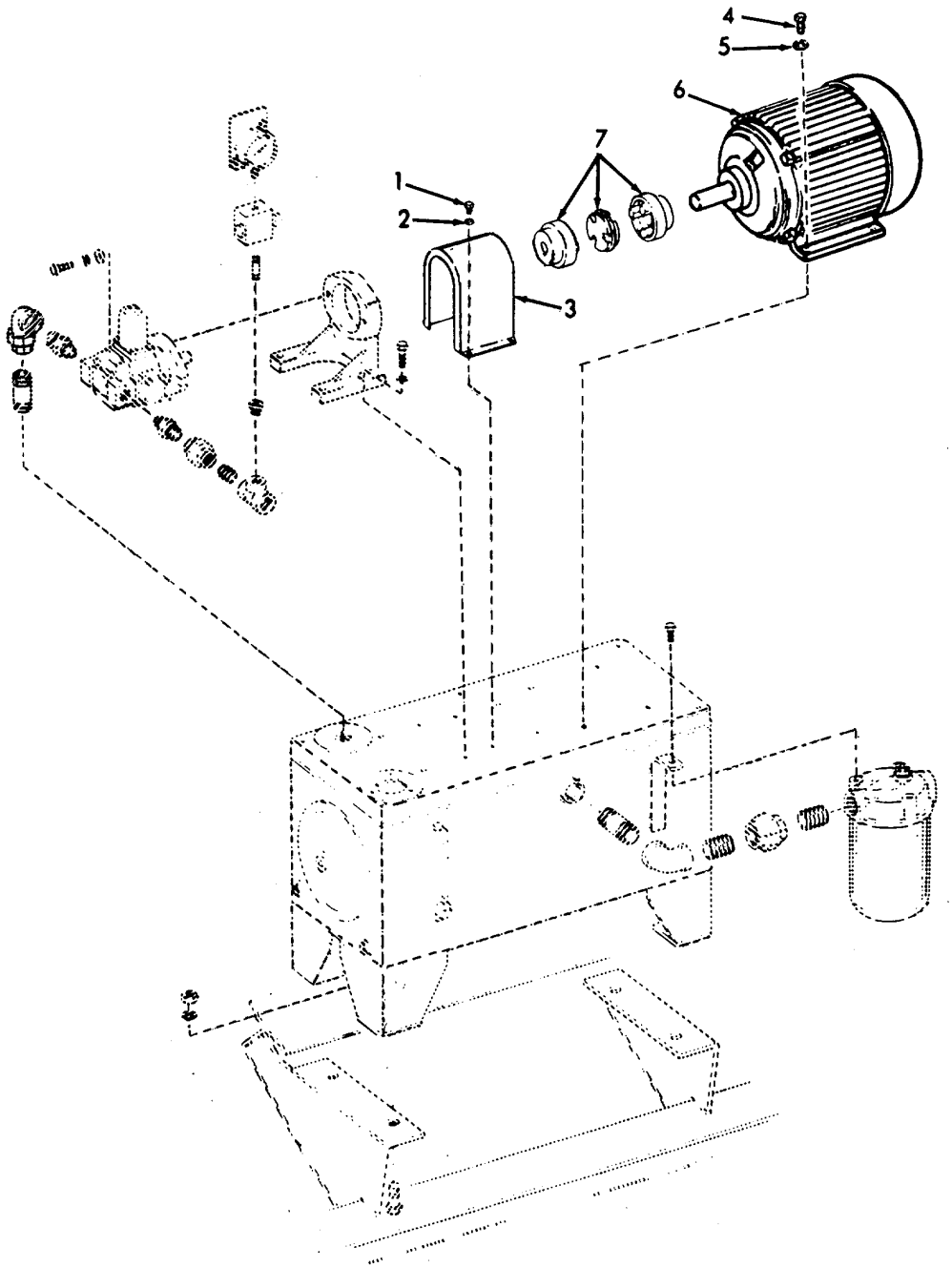
3-188. ELECTRIC MOTOR AND COUPLING - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARK
INSPECTION (Cont)			
	b. Coupling guard	1. Inspect for breaks, cracks and dents.	
		2. Insure all mounting hardware is tight.	
	c. Coupling	Inspect for loose, damaged or missing parts.	
REPLACEMENT			
2. Electric motor and Coupling	a. Wiring	Tag and disconnect.	
	b. Screws (1) and lock-washers (2)	Remove.	
	c. Coupling guard (3)	Remove.	
	d. Screws (4) and lock-washers (5)	Remove.	
	e. Motor (6)	Remove.	
	f. Coupling (7)	Loosen setscrews and disassemble coupling halfs and spiders.	

3-188. ELECTRIC MOTOR AND COUPLING - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARK

REPLACEMENT (Cont)



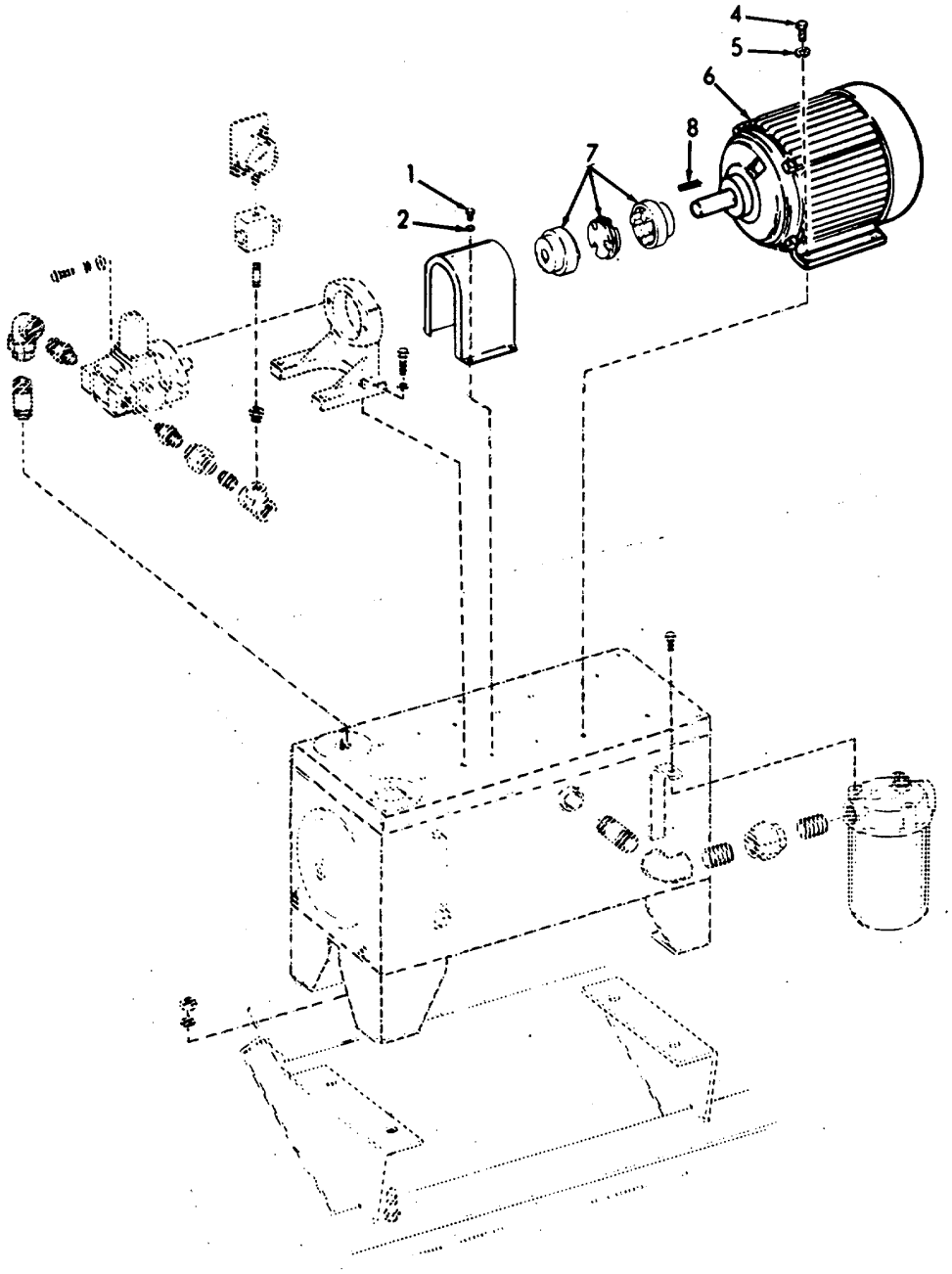
3-188. ELECTRIC MOTOR AND COUPLING - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT (Cont)			
	g. Woodruff key (8)	Remove.	
	h. Coupling (7), and Woodruff key (8)	1. Reassemble to pump and motor. 2. Tighten setscrews.	
	i. Motor (6), screws (4) and lock-washers (5)	Install.	
	j. Coupling guard (3), screws (1), and lock-washers (2)	Install.	
	k. Wiring	Reconnect and remove tags.	

3-188. ELECTRIC MOTOR AND COUPLING - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARK

REPLACEMENT (Cont)



3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Inspection **b. Replacement** **c. Inspection**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition Paragraph | Condition Description

3-192 | Gage and Isolator

Special Environmental Conditions

None

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARK

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

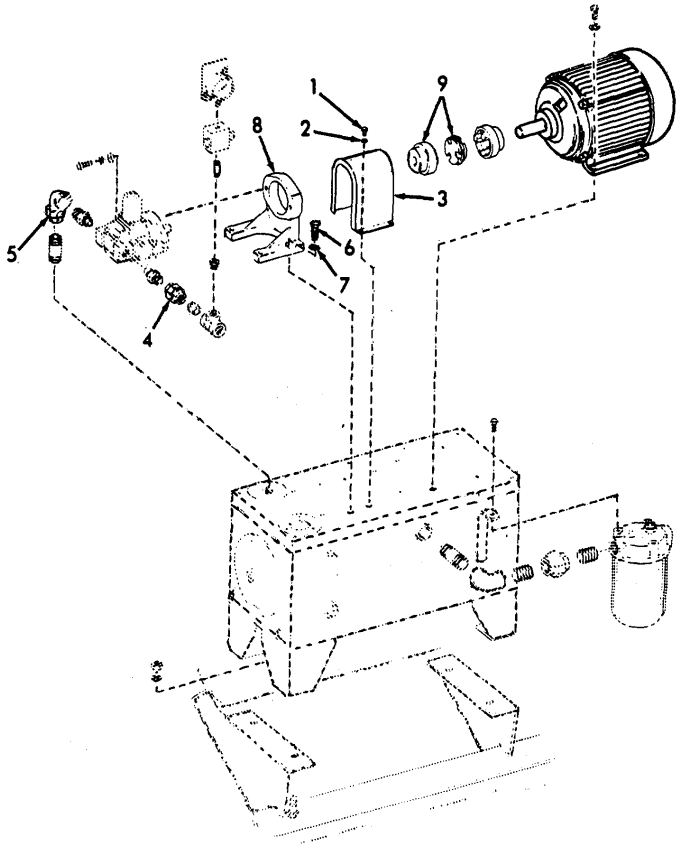
1.	Hydraulic Power Unit	a. Pump	Inspect for cracks, breaks and leaking.
		b. Piping	Inspect for cracks, breaks and leaking.

3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSPECTION (Cont)			
	c. Pump mounting bracket	Inspect for breaks and cracks.	
	d. Coupling guard	Inspect for cracks, dents and breaks.	
	e. Hardware	Insure all hardware is tight.	
REPLACEMENT			
2. Hydraulic Pump	a. Screws (1), and lock-washers (2)	Remove.	
	b. Coupling guard (3)	Remove.	
	c. Union (4), and union elbow (5)	Loosen and separate.	
	d. Screws (6), and lock-washers (7)	Remove.	

3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT (Cont)			
	e. Pump mounting bracket (8) and pump assembly	Remove.	
	f. Coupling (9)	Loosen setscrew and remove spider and coupling half.	

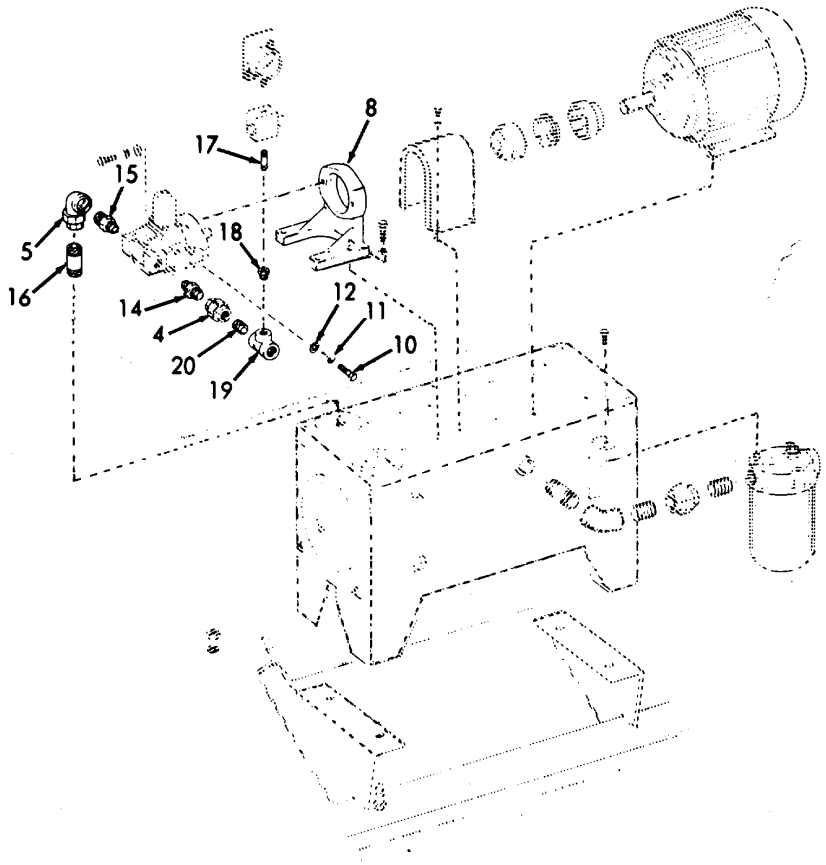


3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT (Cont)			
	g. Screws (10), lock-washers (11), and flat-washers (12)	Remove.	
	h. Pump (13), and mounting bracket (8)	Separate.	
	i. Pump outlet adapter (14)	Remove.	
	j. Pump inlet adapter (15)	Remove.	
	k. Union elbow (5) and nipple (16)	Remove.	

3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT (Cont)			
	1. Gage and isolator, nipple (17), reducer (18), tee (19), nipple (20), and union (4)	Disassemble	If necessary.

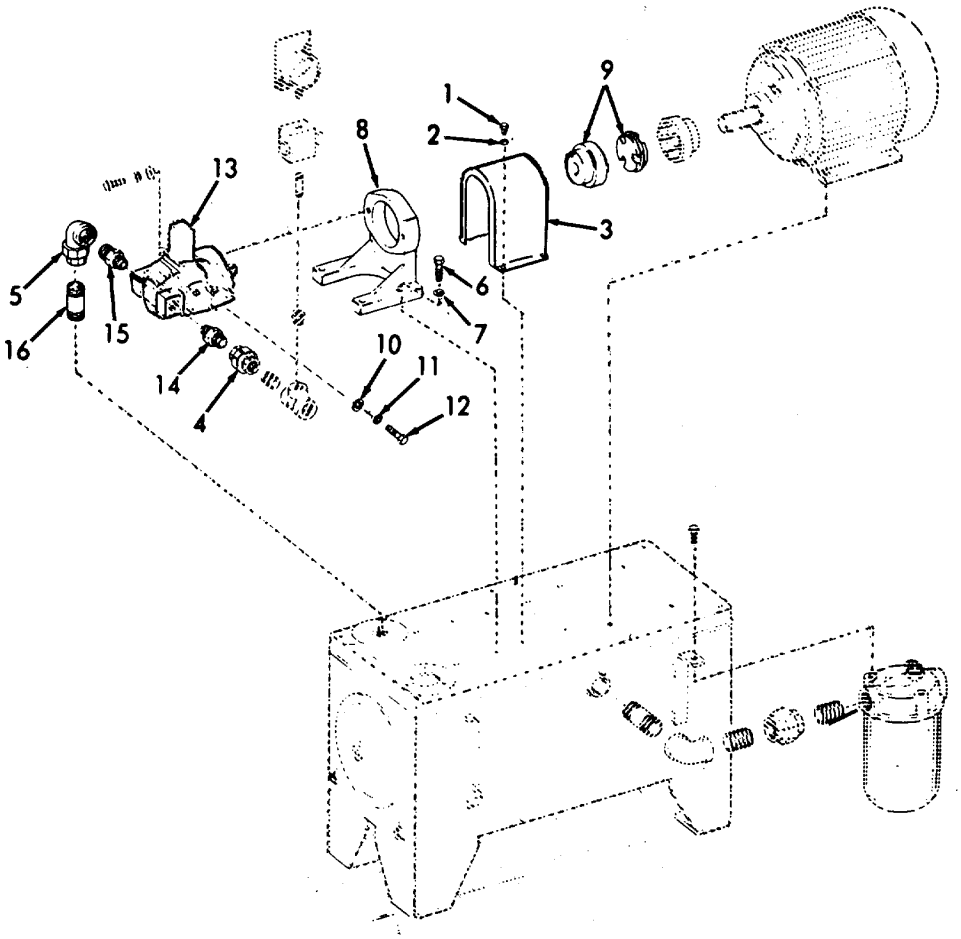


3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION			
	a. Nipple (16) and union elbow (5)	Install.	
	b. Pump inlet adapter (15)	Install.	
	c. Pump outlet adapter (14)	Install.	
	d. Pump (13), mounting bracket (8), screws (10), lock-washers (11) and flat-washers (12)	Assemble.	
	e. Coupling (9)	Reassemble and tighten setscrews.	
	f. Pump mounting bracket (8), screws (6) and lock-washers (7)	Align spider in coupling and install.	

3-189. HYDRAULIC MOTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION (Cont)			
	g. Union (4), and union elbow (5)	Assemble and tighten.	
	h. Coupling guard (3), screws (1), and lock-washers (2)	Install.	



3-190. HYDRAULIC RESEVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS

This task covers:

a. Inspection **b. Service** **c. Repair**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Hydraulic fluid MIL-L-17672 Type 2110TH or 2135TH

Personnel Required

2

References

None

Equipment Condition: 3-192 — Condition Description: Gage and Isolator

Special Environmental Conditions

Do not drain oil into bilges. Use the oil separation and recovery system to collect drained oil.

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARK

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Hydraulic reservoir	a. Reservoir	Inspect for cracks, breaks and leaking.
		b. Filler cap	Inspect for dirt in screen and metal fragments on magnet.

3-190. HYDRAULIC RESEVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
INSPECTION (Cont)			
	c. Suction filter	1. Inspect for leaks.	
		2. Inspect for dirty filter warning lever.	
	d. Sight gage, and thermo-meter	Inspect for broken glass, leaking, and a damaged thermometer.	
SERVICE			
2.	a. Drain plug(s)	Remove.	Drain hydraulic fluid into a suitable con-tainer. Do not drain fluid into bilges. Use the oil and water separation and recovery system to collect drained oil.
	b. Clean-out cover	Remove.	Clean inside of reservoir with clean, lint-free rags.
	c. Filter	Remove three screws and remove filter.	Clean filter screen and magnet.
	d. Clean-out cover, and drain plugs	Replace.	

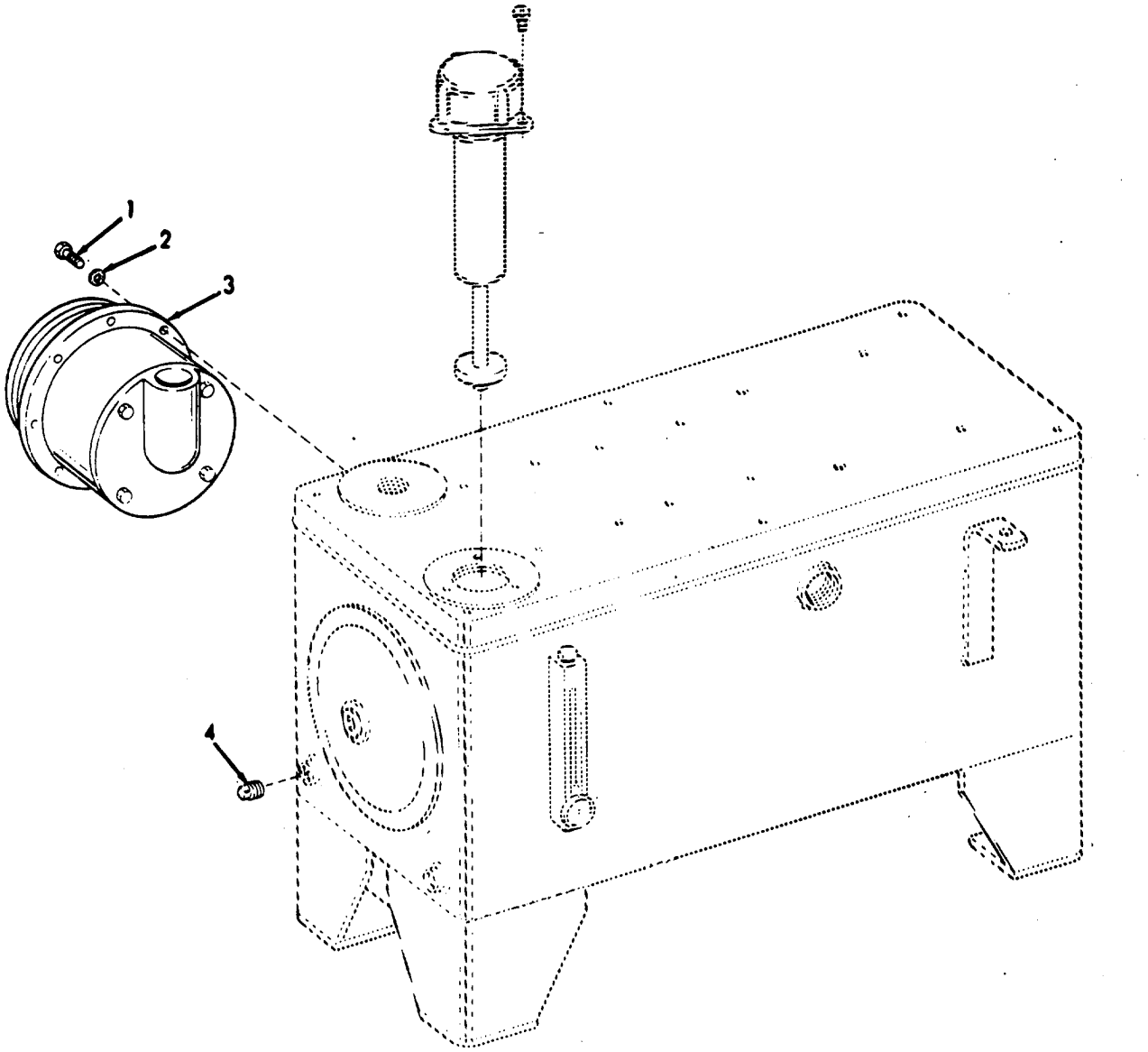
3-190. HYDRAULIC RESEVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
SERVICE (Cont)			
	e. Filter	1. Replace. 2. Fill reservoir with 10 gallons (37.9 liters) of hydraulic fluid. 3. Operate system - then check fluid level in reservoir.	
REPAIR			
3. Suction Filter	a. Eight bolts (1), and lock-washers (2)	Remove.	
	b. Suction filter (3)	Remove.	
	c. Suction filter (3)	Replace.	
	d. Eight bolts (1), and lock-washers (2)	Reinstall.	
4. Pipe plug	Plug (4)	Replace if necessary.	

3-190. HYDRAULIC RESERVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-3117

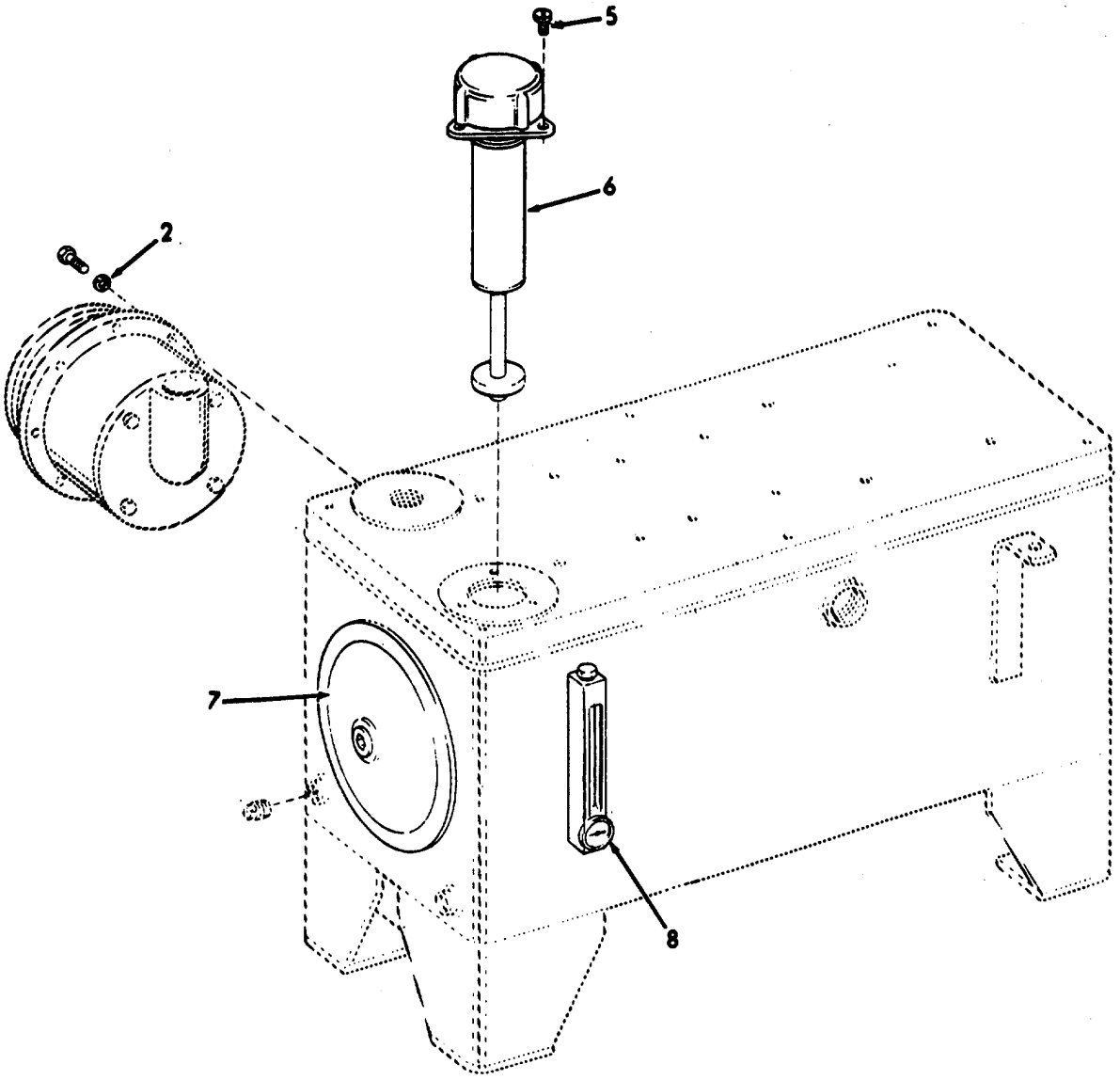
3-190. HYDRAULIC RESERVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Filter	a. Bolts (5)	Remove.	
	b. Filter/ cap (6)	Remove.	
	c. Screen, magnet and lock-washers (2)	Clean thoroughly.	
	d. Filter/ cap (6) and bolts (5)	Reinstall.	
6. Cleanout cover	Cover (7)	Replace.	If necessary.
7. Sight gage and ther-mometer	Sight gage (8)	Replace.	If necessary.

3-190. HYDRAULIC RESERVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



3-3119

3-191. HYDRAULIC RESERVOIR TANK AND SUCTION FILTER - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:
a. Inspection **b. Replacement**

INITIAL SETUP

Test Equipment	References
None	None
Special Tools	**Equipment Condition** / **Condition Description**
None	None
Material/Parts	**Special Environmental Conditions**
None	None
Personnel Required	**General Safety Instructions**
1	Observe WARNING in this procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

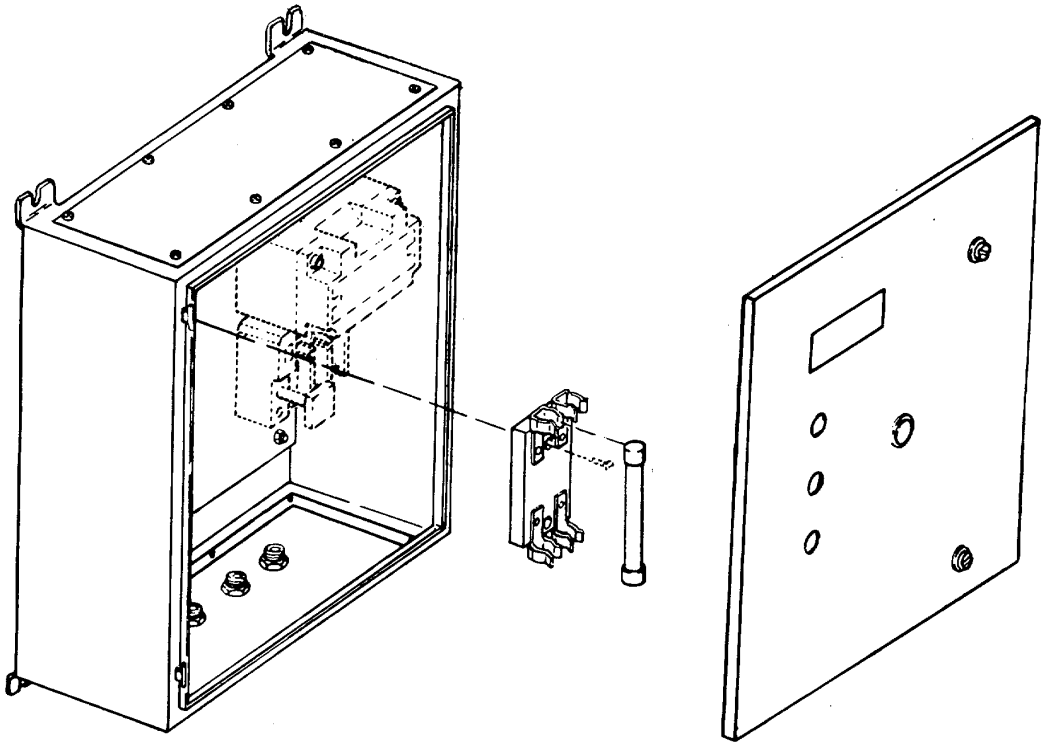
To avoid serious injury or death, shut off and tag circuit breaker on main power panel.

INSPECTION

1. Controller	a. Enclosure	1. Inspect for dents, breaks, and loose hardware.	Refer to Direct Support Maintenance.
		2. Inspect for bent door.	
		3. Inspect for bent, or broken hinge.	

3-191. CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	b. Wiring	Inspect for breaks, fraying, and damaged insulation and wire terminations.	
	c. Electrical components	Inspect for breaks, cracks, and signs of burned contacts.	Refer to Direct Support Maintenance.



3-3121

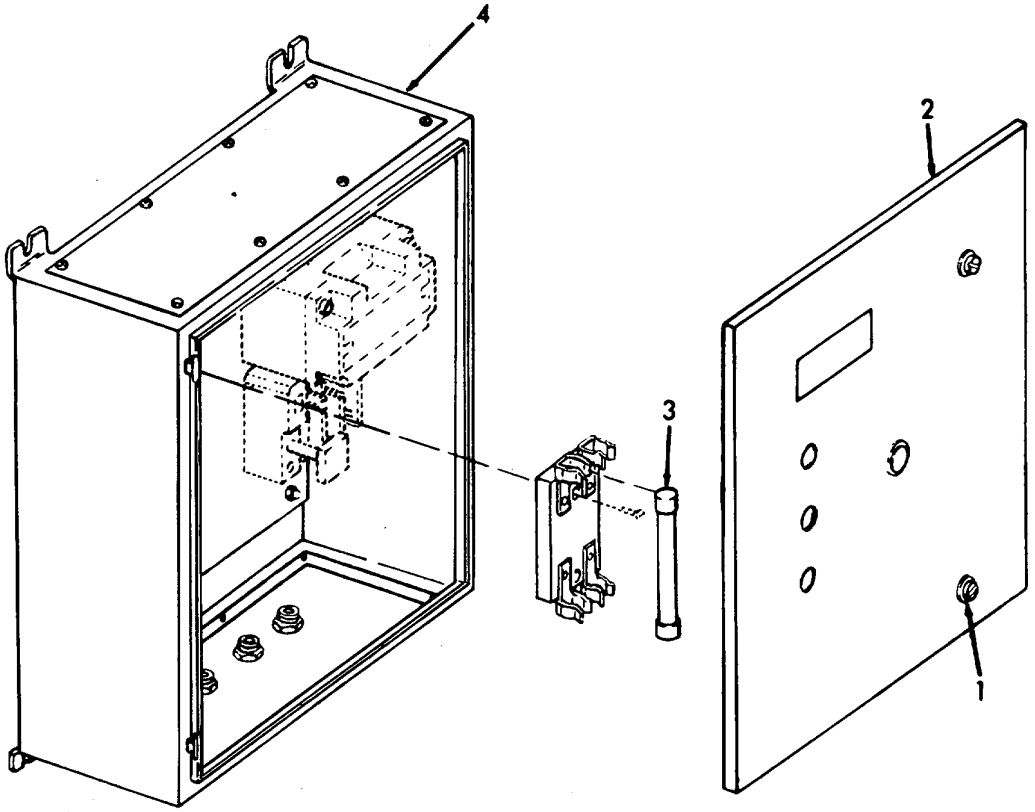
3-191. CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
2. Fuse	a. Captive screws (1)	Loosen.	
	b. Door (2)	Swing open.	
	c. Fuse (3)	Extract and replace.	
	d. Door (2), and captive screws (1)	Swing closed and tighten screws.	
3. Controller	a. Captive screws (1)	Loosen.	
	b. Door (2)	Swing open.	
	c. Wiring	Tag and disconnect.	
	d. Enclosure (4)	Disconnect from bulkhead.	
	e. Enclosure (4)	Replace on bulkhead.	
	f. Wiring	Reconnect and remove tags.	
	g. Door (2), and captive screws (1)	Swing closed and tighten screws.	

3-191. CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACEMENT (Cont)



3-3123

3-192. GAGE AND ISOLATOR - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Inspection **b. Replacement**

INITIAL SETUP

Test Equipment
None

References
None

Special Tools
None

Equipment Condition: Condition Description
None

Material/Parts
None

Special Environmental Conditions
None

Personnel Required
1

General Safety Instructions
Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

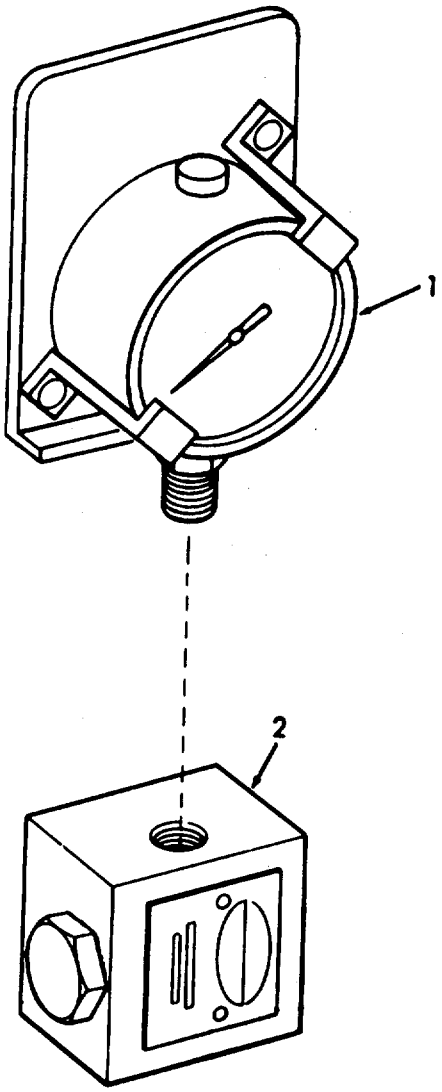
To avoid serious injury or death, shut off and tag circuit breaker on main power panel.

INSPECTION

1.	Hydraulic pump unit	Gage	a. Inspect for leaking. b. Inspect for broken glass and bent needle. c. Inspect for proper operation.

3-192. GAGE AND ISOLATOR - MAINTENANCE INSTRUCTIIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
2. Gage	Gage (1)	Unscrew from isolator (2).	



3-3125

3-193. PUSHBUTTON SWITCH - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Disassembly**
c. Replacement **d. Reassembly**

INITIAL SETUP

Test Equipment

None

References

None

Special Tools

None

Equipment Condition: Condition Description

None

Material/Parts

None

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

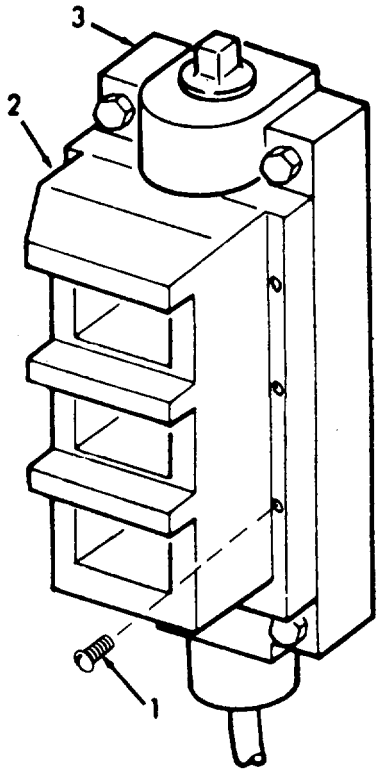
To avoid serious injury or death, shut off and tag centralized hydraulic magnetic controller.

INSPECTION

1.	Push-button Switch Control Station	a. Indicator	Inspect for burned out indicator lamp.
		b. Switches	Inspect for proper operation.

3-193. PUSHBUTTOM SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Screws (1)	Remove.	
	b. Cover (2) and case (3)	Separate.	



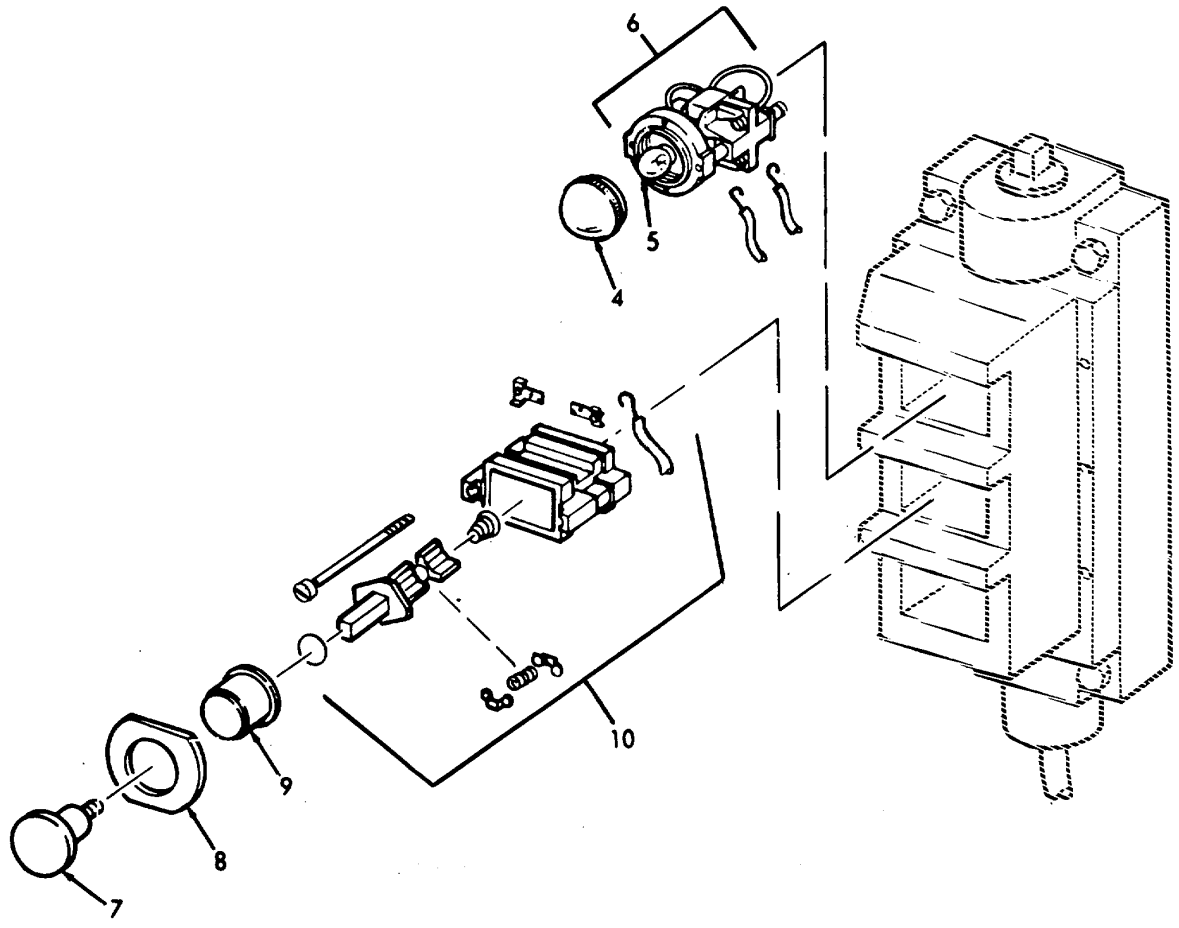
3-3127

3-193. PUSHBUTTON SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
3. Indicator lamp holder	a. Red lens (4)	Unscrew.	
	b. Indicator lamp (5)	Unscrew.	
	c. Wiring	Tag and disconnect.	
	d. Lamp socket and, transformer	Unscrew and replace.	
	e. Wiring tags.	Reconnect and remove	
	f. Lamp (5)	Replace.	
	g. Red lens (4)	Replace.	
4. Push-button switch	a. Diaphragm (7)	Unscrew.	
	b. Gasket (8)	Remove.	
	c. Push-button (9)	Remove.	
	d. Wiring	Tag and disconnect.	
	e. Switch (10)	Unscrew and replace.	

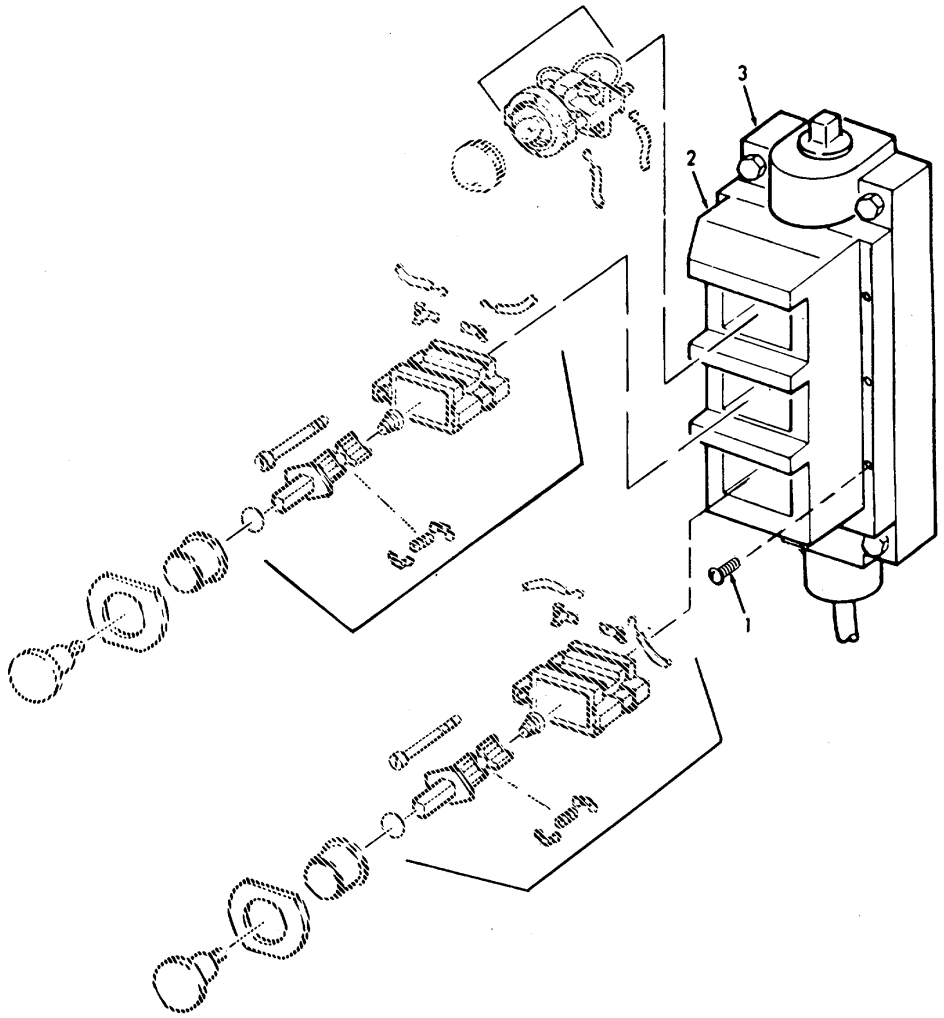
3-193. PUSHBUTTON SWITCH - MAINTENACE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont)			
	f. Wiring	Reconnect and remove tags.	
	g. Push-button (9)	Replace.	
	h. Gasket (8) and dia-phragm (7)	Replace.	



3-193. PUSHBUTTON SWITCH - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
5. Push-button Switch Control Station	Cover (2), case (3) and screws (1)	Reassemble.	



3-3130

3-194. STERN GATE HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS

This task covers: **a. Inspection** **b. Removal** **c. Installation**

INITIAL SETUP

Test Equipment
None

References
Paragraph
3-195 Hydraulic Hoses, Fittings and Piping

Special Tools
None

Equipment Condition
None

Condition Description

Material/Parts
None

Special Environmental Conditions
None

Personnel Required
2

General Safety Instructions
Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

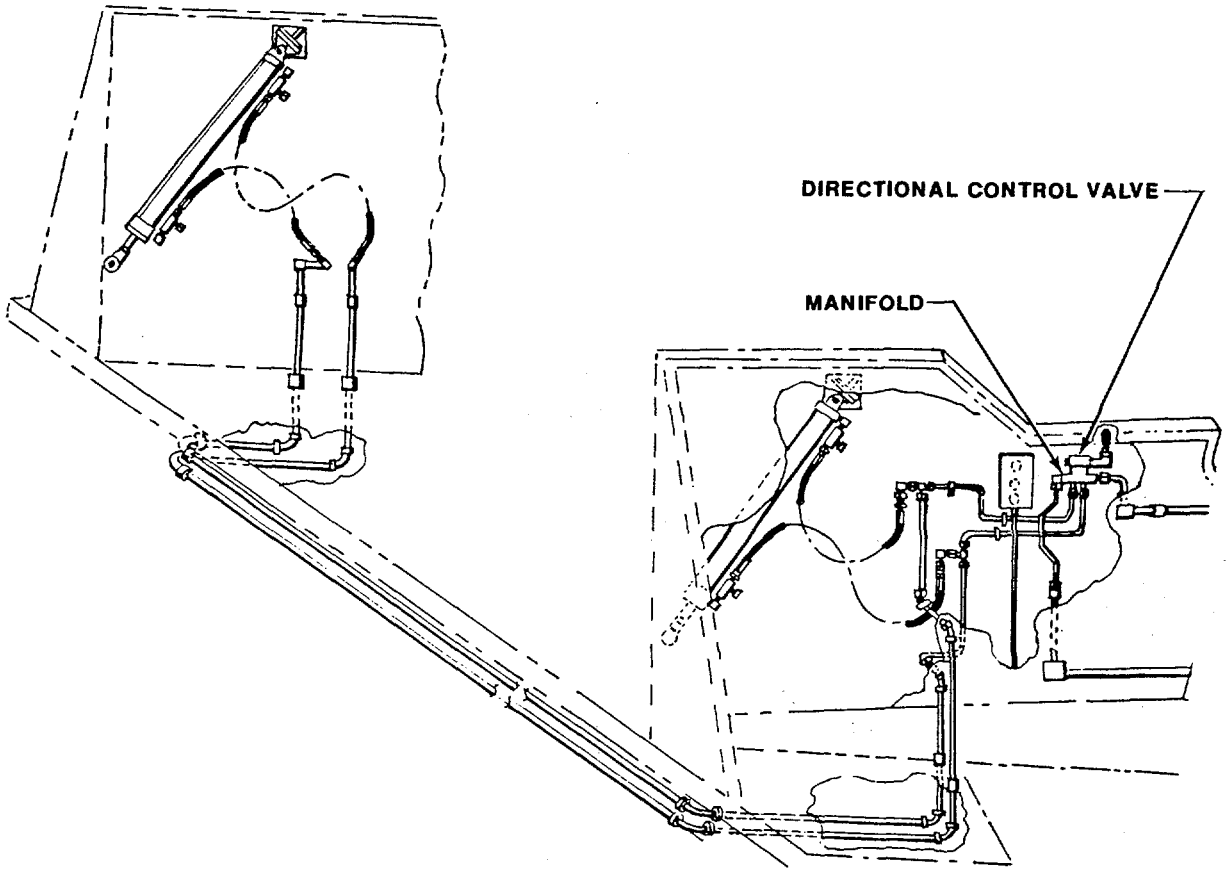
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1. Vehicle Deck Aft Stbd	a. Control valve	1. Inspect for leaks, damage and missing parts.	
		2. Insure all hardware is tight.	

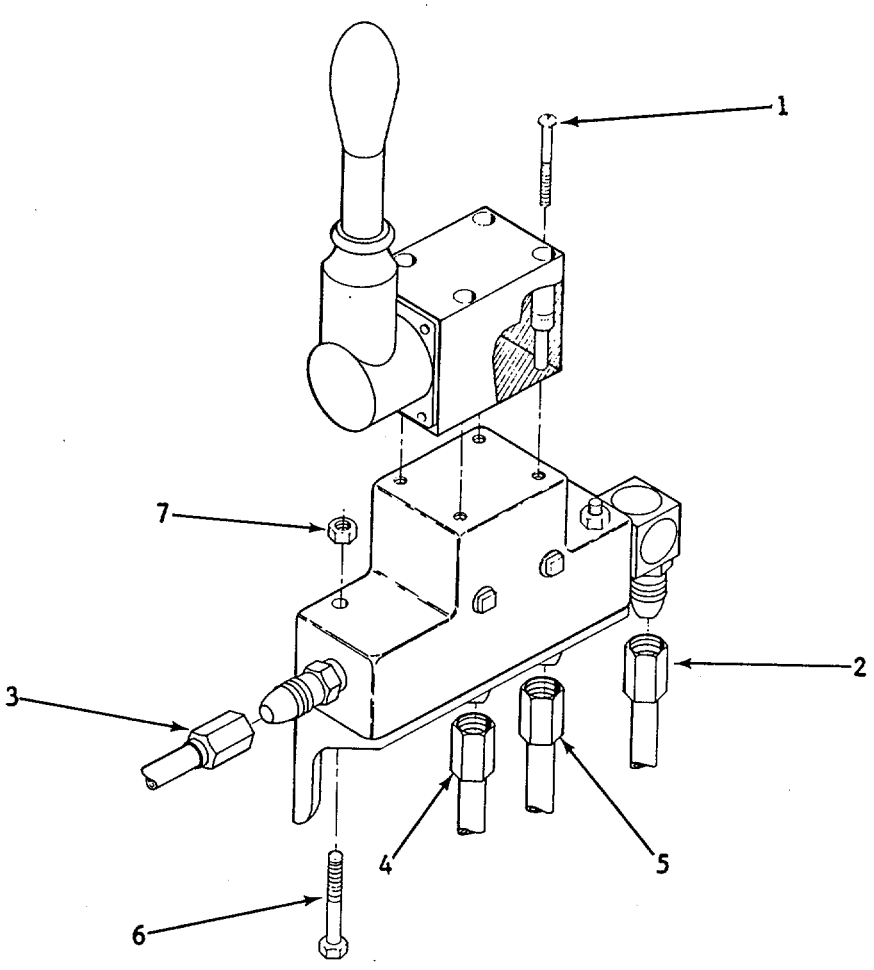
3-194. STERN GATE HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	b. Tubing	Inspect for leaks, cracks, breaks and bends	Refer to Direct Support Maintenance.
REMOVAL			
2. Directional Control Valve, and Manifold	a. Directional control valve bolts (1)	Remove.	Valve to be replaced by new unit.



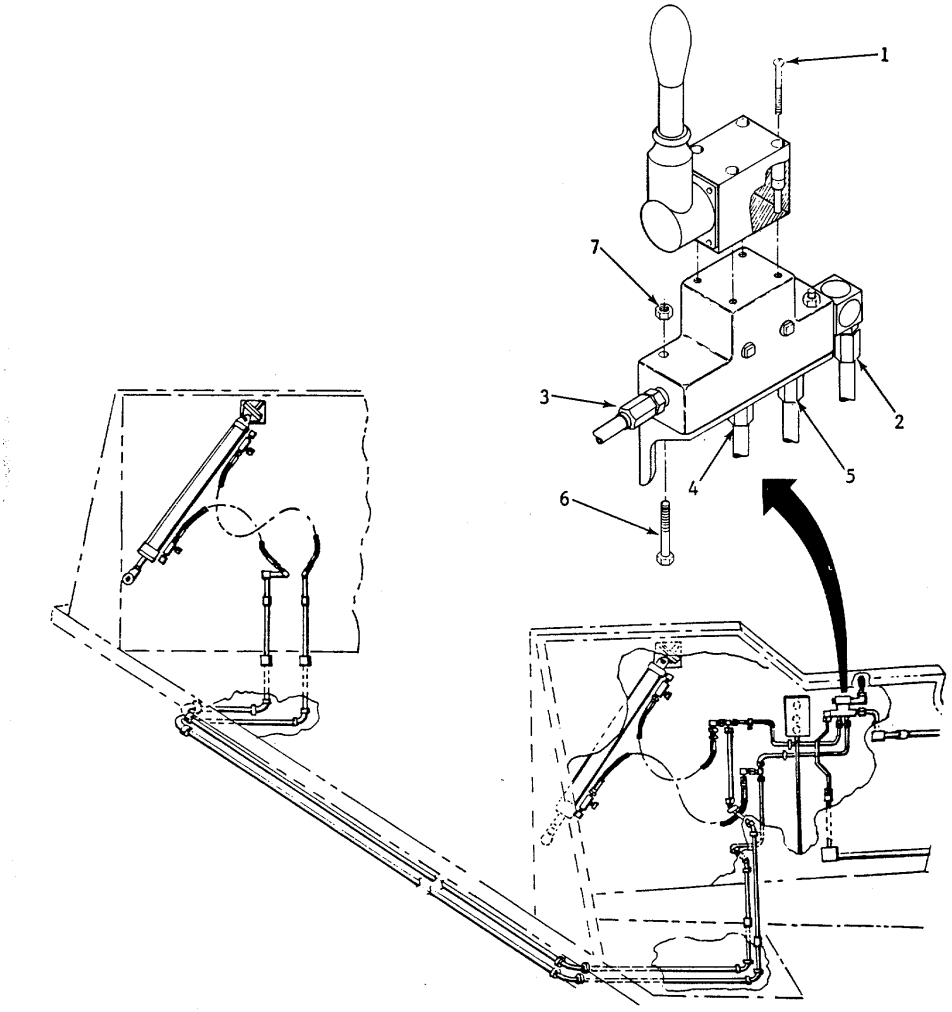
3-194. STERN GATE HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (CONT)			
	b. Manifold Unions (2, 3,4, and 5)	Disconnect.	
	c. Manifold screws (6 and nut 7)	Remove.	Mainfold to be replaced by new unit.



3-194. STERN GATE HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3. Directional Control Valve and-fold	a. Manifold screws (6, and nut 7)	Install.	
	b. Manifold Unions (2, 3,4 and 5)	Reconnect.	
	c. Directional control valve bolts (1)	Install.	



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3-195. STERN GATE HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS

This task covers:
a. Inspection **b. Replacement**

INITIAL SETUP

Test Equipment
None

References
Paragraph

3-208 Directional Control Valve
3-197 Hydraulic Ram

Special Tools
None

Equipment
Condition Condition Description
None

Material/ Parts
None

Special Environmental Conditions
None

Personnel Required
2

General Safety Instructions
Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

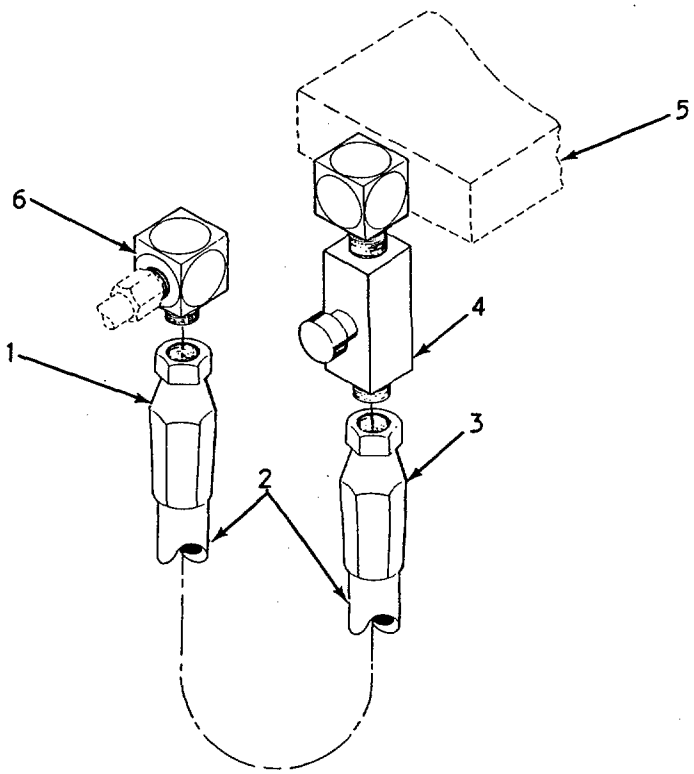
1. Vehicle Deck Aft	a. Hoses	Inspect for breaks, cracks, bends and leaking.	
	b. Fittings	Inspect for breaks, cracks and leaking.	

3-195. STERN GATE HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Tubing	Inspect for breaks, cracks, dents and leaking.	
REPLACEMENT			
2. Hose and control valve flow.	a. Union nut (1)	Unscrew and separate hose (2) from union.	
	b. Union nut (3)	Unscrew and separate hose (2) from control valve flow (4)	
	c. Hydraulic cylinder (5)	Unscrew and separate control valve flow (4).	
	d. Control valve flow (4)	Install to hydraulic cylinder.	

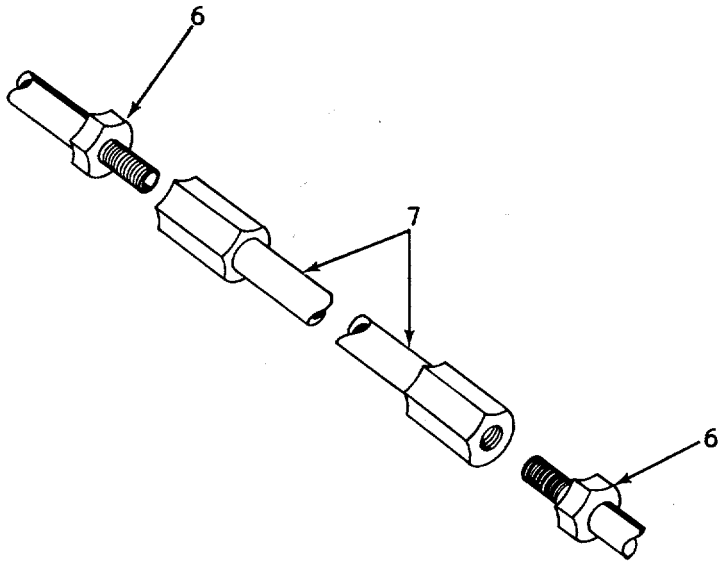
3-195. STERN GATE HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (CONT)			
	e. Union nut (3) flow (4).	Connect hose control valve	
	f. Union nut (1)	Connect hose to elbow (6).	



3-195. STERN GATE HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT (Cont.)			
3. Tubing	a. Union nut (6)	Uncrew and separate union.	
	b. Tubing (7)	Replace.	
	c. Union nut (6)	Reinstall.	



3-196. STERN GATE HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

This task covers:

a. Inspection
b. Removal
c. Installation
d. Adjustment

INITIAL SETUP:

Test Equipment

None

References
Paragraph

3-195 Hydraulic Hoses, Fittings and Piping

Special Tools

None

Equipment Condition: None

Condition Description: None

Material/Parts

None

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions,

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

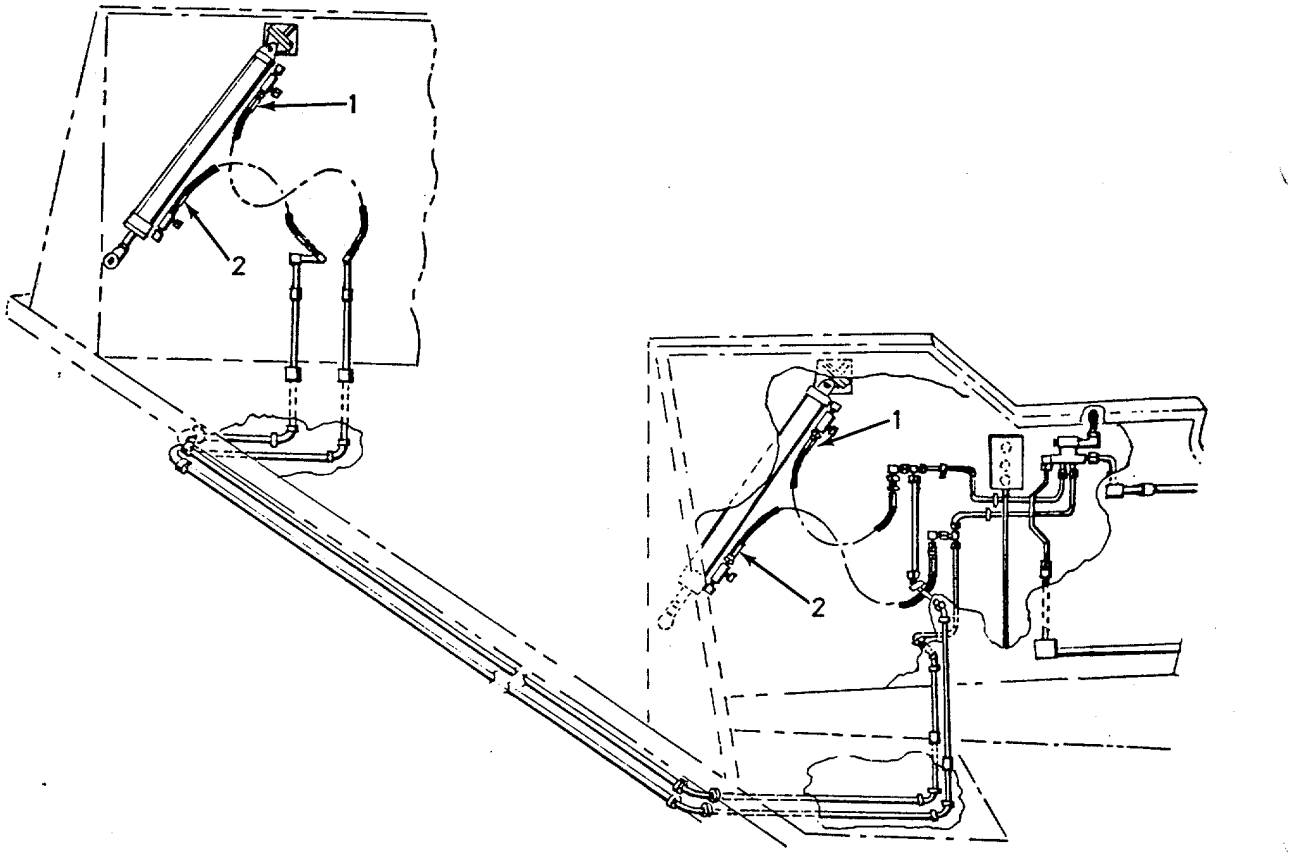
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Vehicle Deck Aft	a. Hoses	Inspect for leaks, cracks, bends and breaks.	Refer to paragraph 3-195 .
		b. Clevis	Inspect for breaks, cracks and missing parts.	

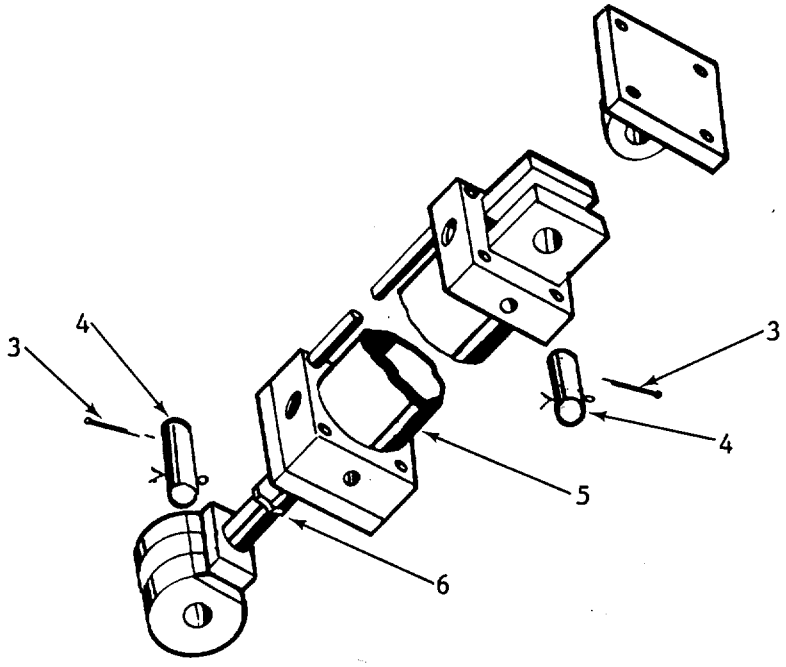
3-196. STERN GATE HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont.)			
	c. Ram	Inspect for leaks, dents, cracks, and breaks	
REMOVAL			
2. Hydraulic Ram	a. Unions (1 and 2)	Disconnect and remove hoses.	Refer to paragraph 3-195.



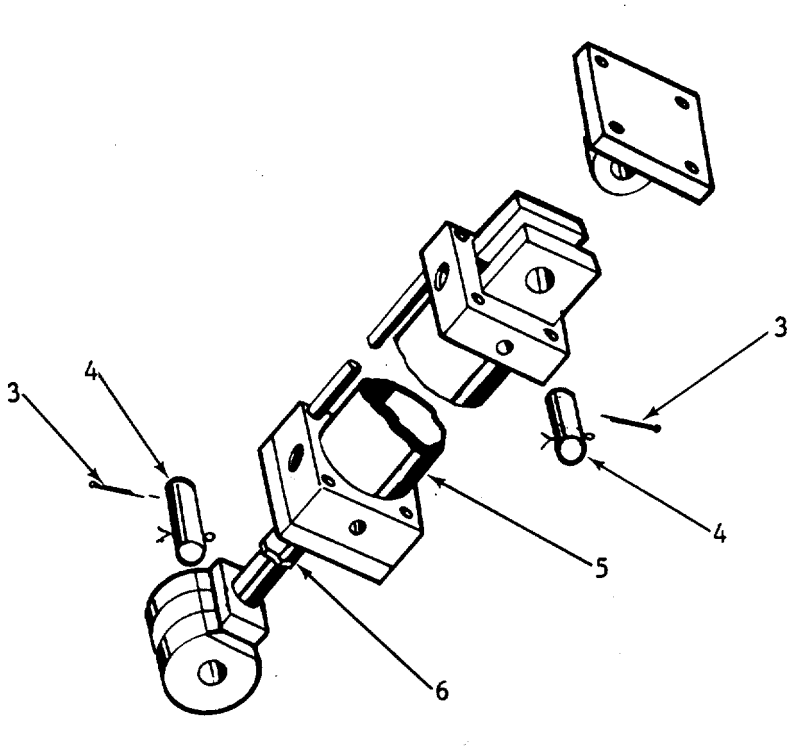
3-196. STERN GATE HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.)			
	b. Cotter pins (3), and swivel pins (4)	Remove.	
	c. Hydraulic Ram (5)	Remove.	
	d. Clevis (6)	Loosen nut and unscrew clevis.	Use wrench on flat of piston rod to prevent damage to seals.



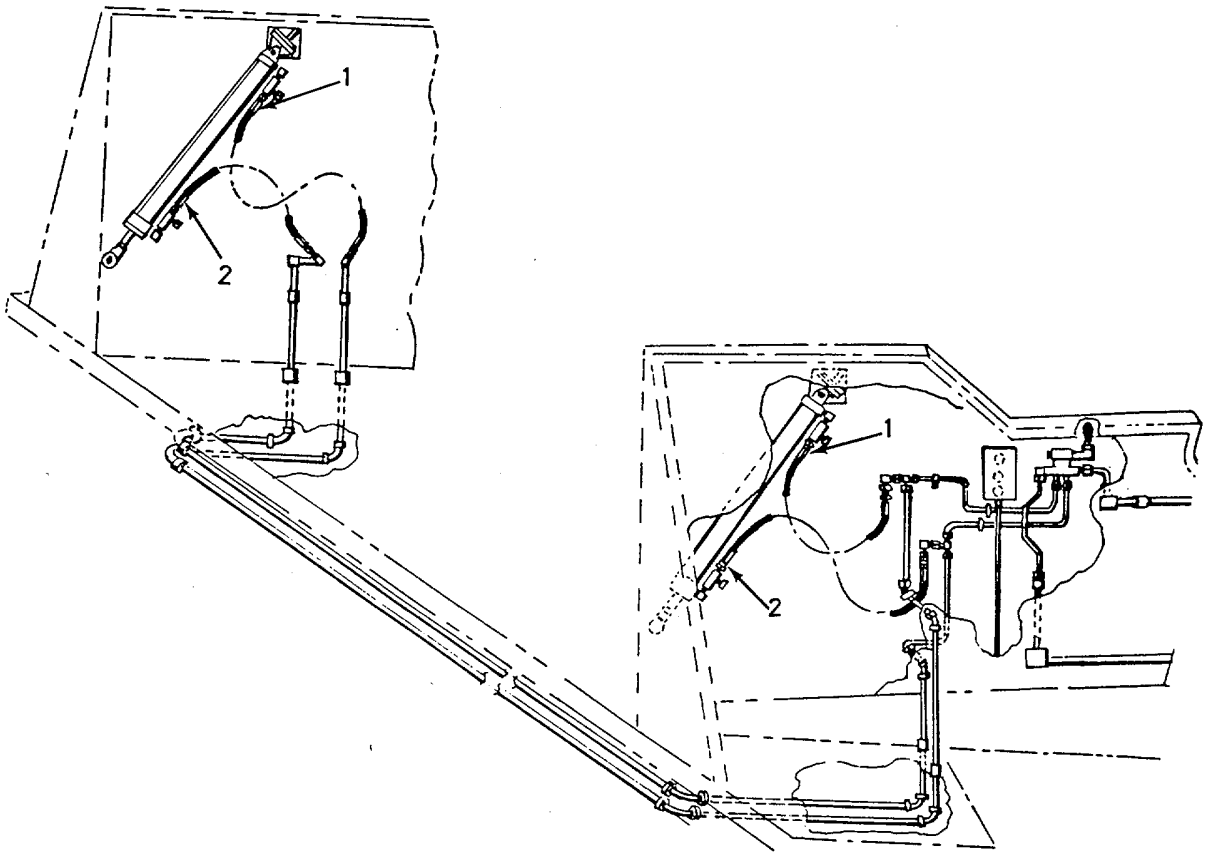
3-196. STERN GATE HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Clevis (6)	Install nut and clevis	
	b. Hydraulic Ram (5) swivel pins (4), and cotter pins (3)	Install, and adjust position of clevis	Use wrench on flat of piston rod to prevent damage to seals.



3-196. STERN GATE HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont.)			
	c. Unions (1 and 2)	Reconnect.	Refer to paragraph 3-195.



ADJUSTMENT

4.	Cushion	Operate cylinder a few times with reduced load and pressure. Hydraulic cylinders may be erratic due to trapped air, but will normally purge themselves after several cycles. If not, loosen a fitting near the cylinder until all air is removed.

3-197. MAST HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Installation
d. Adjustment

INITIAL SETUP

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

References
Paragraph
3-199 Hydraulic Hoses and Fittings

Equipment Condition: None
Condition Description: None

Special Environmental Conditions
None

General Safety Instructions
Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

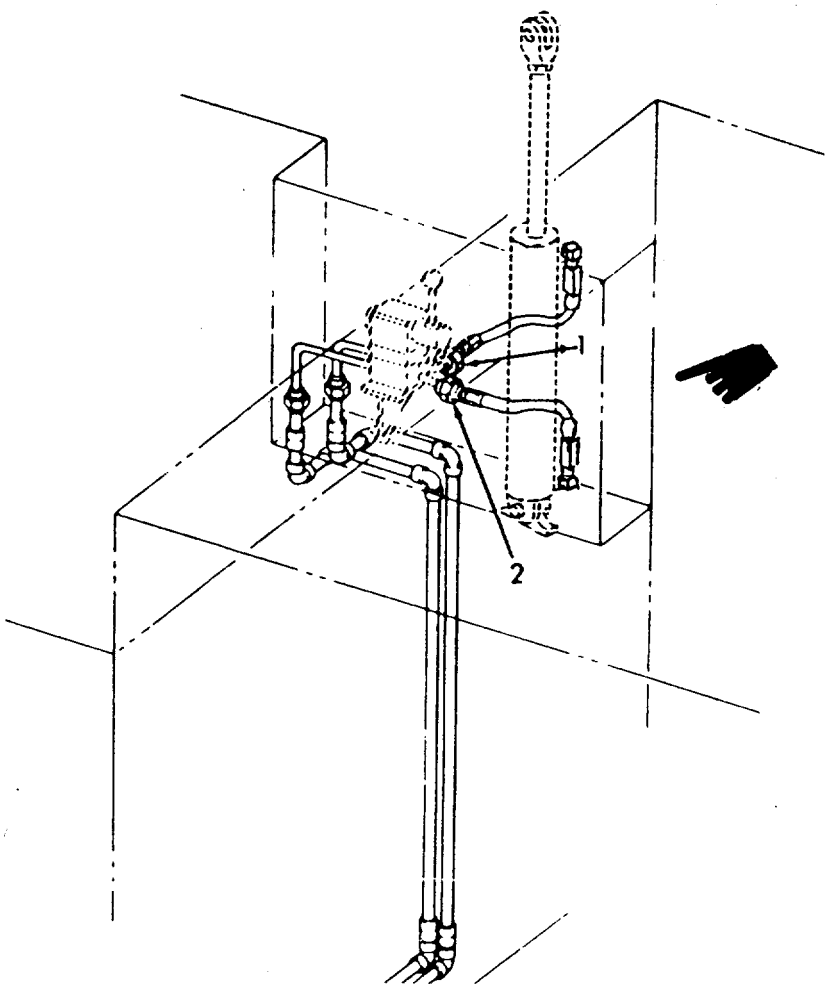
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Vehicle Deck Stdb side	a. Hoses	Inspect for leaks, cracks, bends and breaks.	Refer to paragraph 3-199.
		b. Clevis	Inspect for breaks, cracks and missing parts.	

3-197. MAST HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Ram	Inspect for leaks, bends, cracks, and dents.	
REMOVAL			
2. Hydraulic Ram	a. Unions (1 and 2)	Disconnect.	



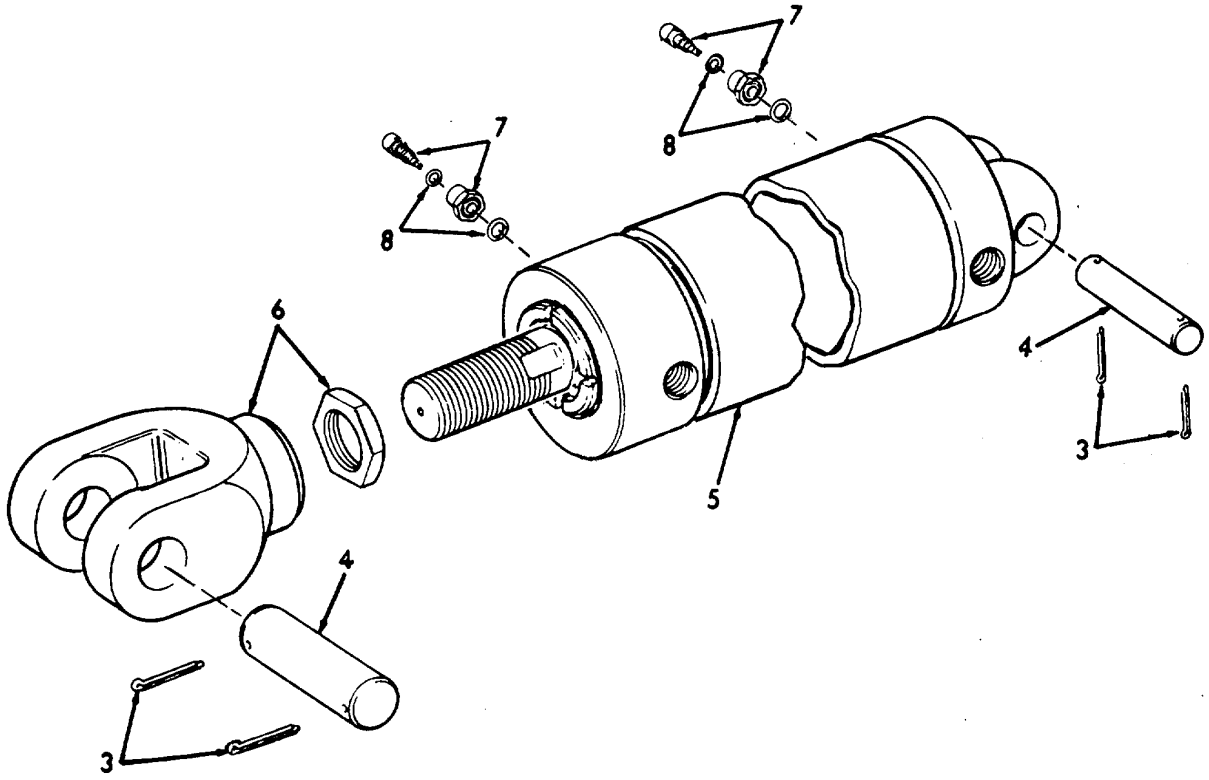
3-197. MAST HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont.)			
	b. Cotter pins (3), and swivel pin (4)	Remove.	
	c. Hydraulic ram (5)	Remove.	
	d. Hoses	Remove.	Refer to paragraph 3-199 .
	e. Clevis (6)	Loosen nut and unscrew clevis.	Use wrench on flats of piston rod to prevent damage to seals.
	f. Adjusting screws (7), and " O " rings (8)	Remove.	If necessary.

3-197. MAST HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

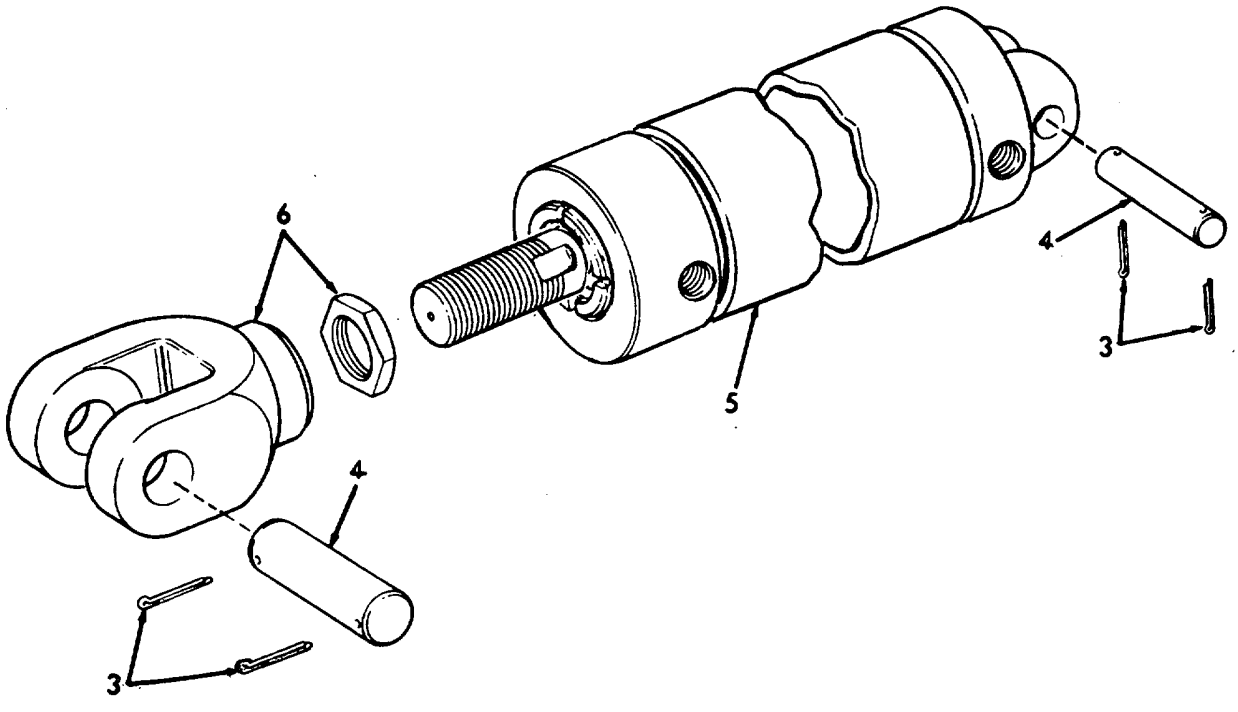
LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



3-197. MAST HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Clevis (6)	Install nut and clevis.	
	b. Hydraulic ram (5), swivel pins (4), and cotter pins (3)	Install and adjust position of clevis.	Use wrench on flats of piston rod to prevent damage to seals.

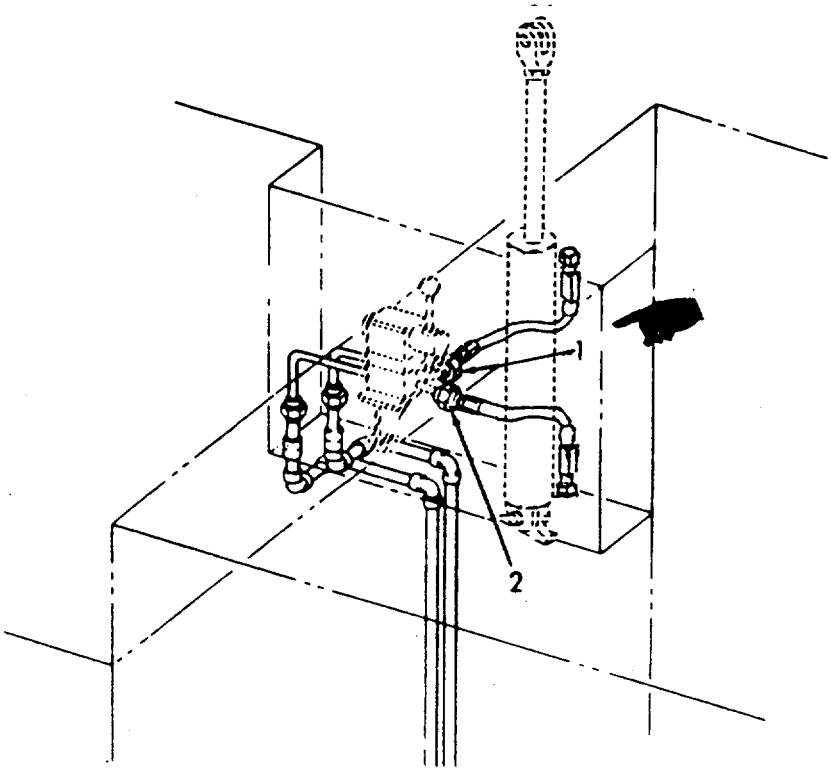


	c. Unions (1 and 2)	Reconnect.	

3-197. MAST HYDRAULIC RAM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



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ADJUSTMENT

4. a. Operate cylinder a few times with reduced load and pressure. Hydraulic cylinders may be erratic due to trapped air, but will normally purge them- selves after several cycles. If not, loosen a fitting near cylinder until all air is removed.

b. Cushion adjustments - Loosen locknut and hold with wrench while turning screw.

1. To increase cushion - turn screw clockwise.
2. To reduce cushion - turn screw counter-clockwise.

NOTE

Full OPEN to full CLOSED is two full turns of the screw. Final position of screw should be a balance between any shock or bounce at the start of the cushion and the final impact of the piston at the end of the stroke.

3-198. MAST HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

References
Paragraph
3-199 Hydraulic Hoses and Fittings

Equipment
Condition Condition Description
None

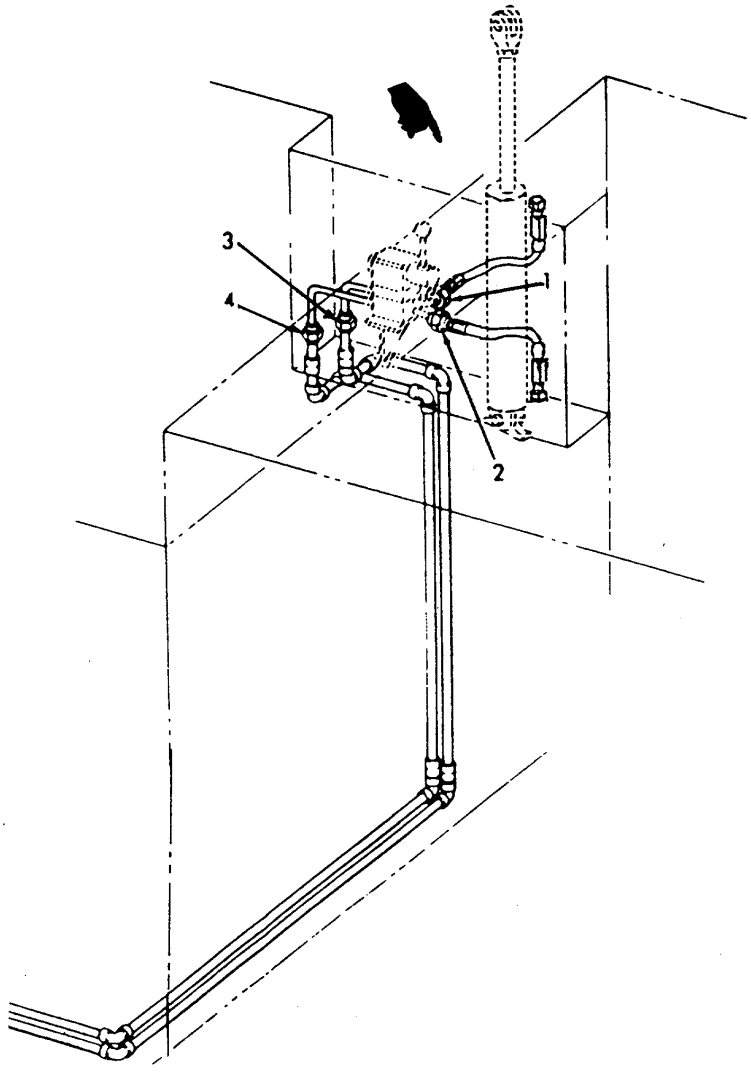
Special Environmental Conditions
None

General Safety Instructions
Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS
		WARNING To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.	
INSPECTION			
1. Vehicle Deck Stbd side	a. Control valve	1. Inspect for leaks, damage and missing parts.	
		2. Insure all hardware is tight.	
	b. Tubing	Inspect for leaks, bends, cracks, and breaks.	Refer to Direct Support Maintenance.

3-198. MAST HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS. (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2. Directional Control Valve and Manifold	a. Unions (1, 2, 3 and 4)'	Disconnect.	



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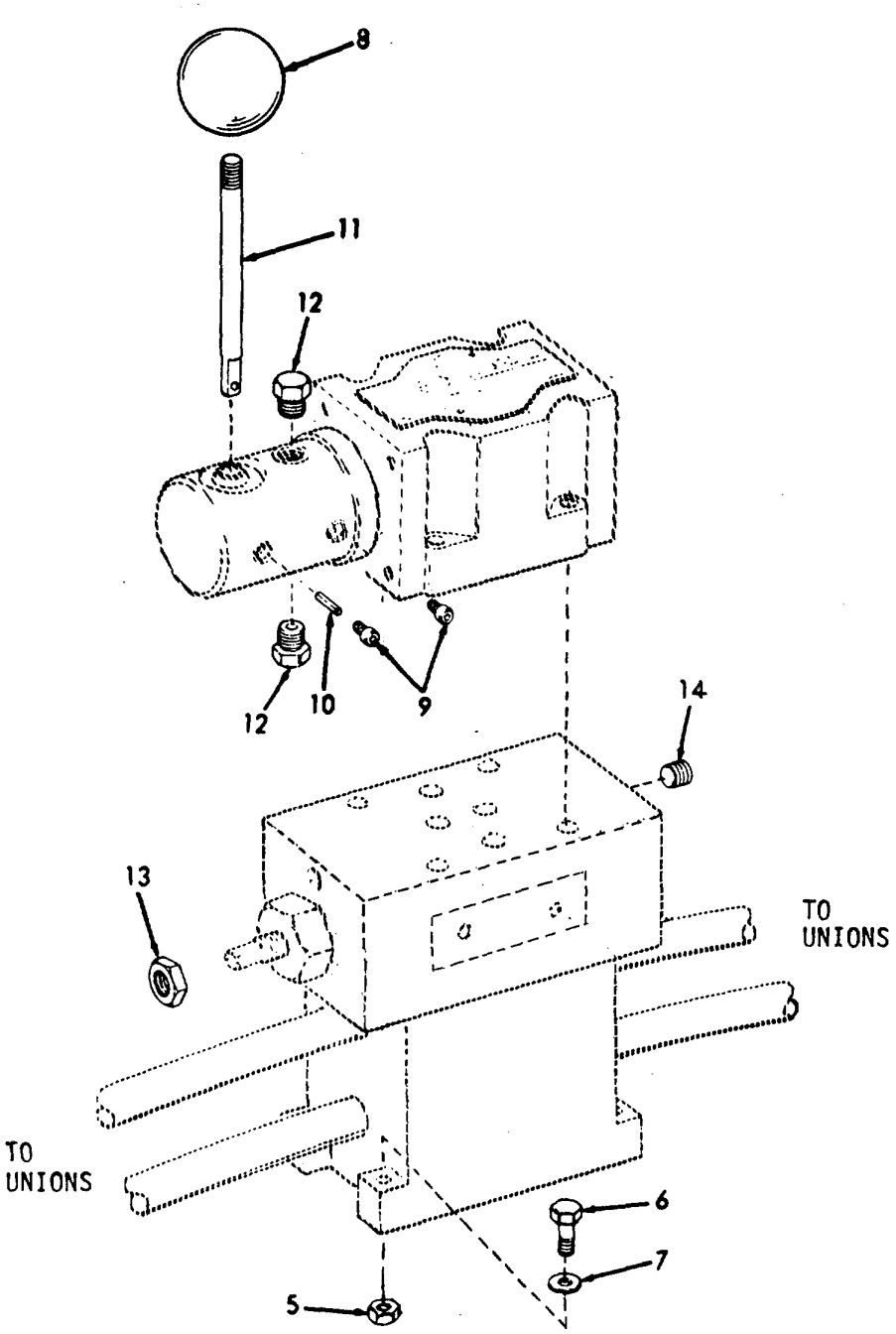
3-198. MAST HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS. (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)l			
	b. Nuts (5), screws (6), and lock-washers (7)	Remove.	
3. Directional Control Valve	a Knob (8)	Unscrew.	
	b. Socket head screws (9)	Remove.	
	c. Spring pin (10)	Remove.	
	d. Control lever (11)	Remove.	
	e. Cap plugs (12)	Remove.	If necessary.
4. Manifold	a. Jam nuts (13)	Remove.	If necessary.
	b. Pipe plugs (14)	Remove.	If necessary.

3-198. MAST HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS. (Continued)

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont.)



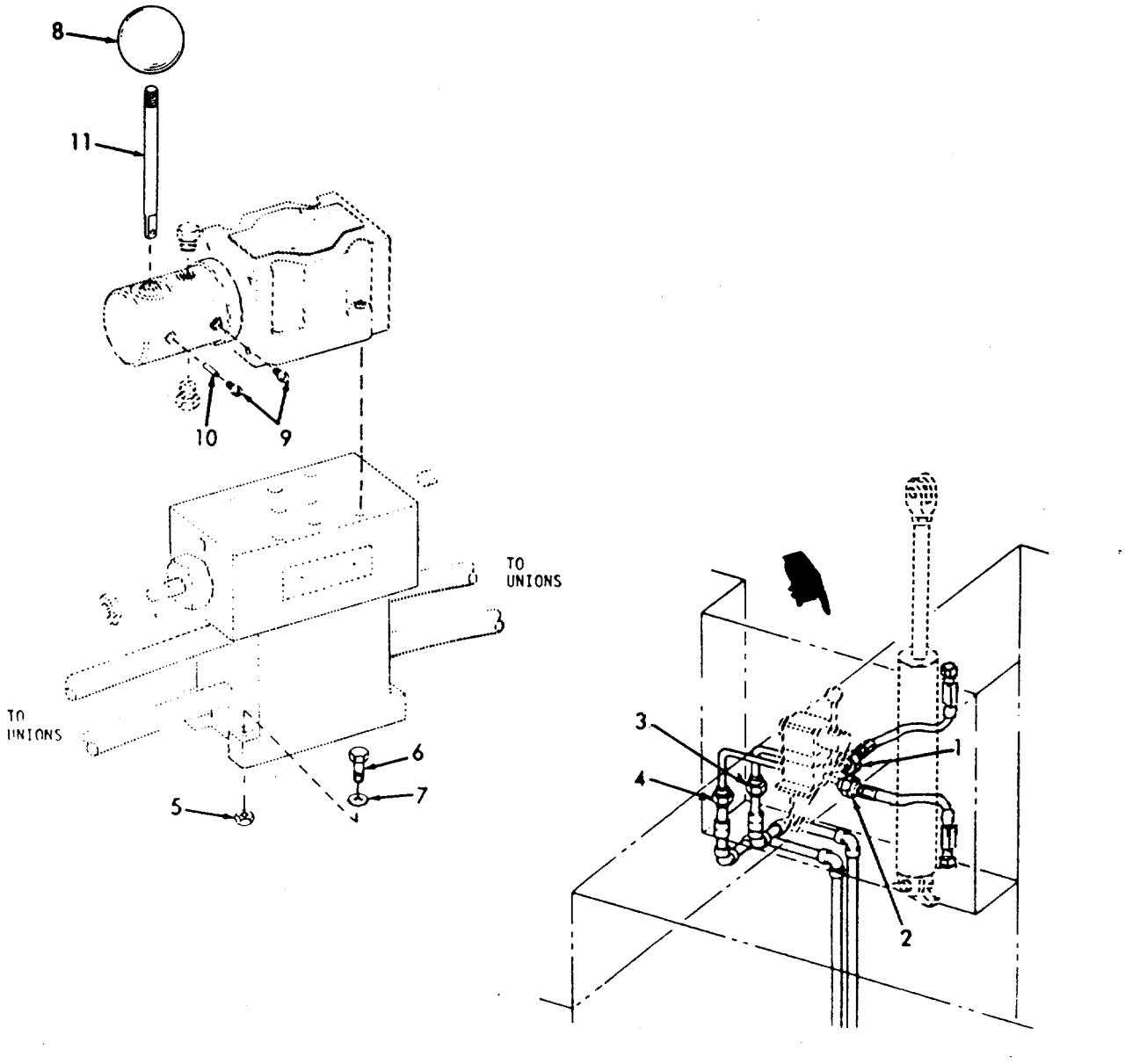
3-198. MAST HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS. (Continued)

LOCATION	ITEM	ACTION	REMARKS
INSTALLATIONI			
5. Directional Control Valve	a. Control lever (11)	Install.	
	b. Spring pin (10)	Install.	
	c. Knob (8)	Install.	
	d. Socket head screws (9)	Install.	
6. Directional Control Valve and Manifold	a. Screws (6), lock-washers (7), and nuts (5)	Install.	
	b. Unions (1, 2, 3, and 4)	Reconnect.	

3-198. MAST HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS. (Continued)

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



3-199. MAST HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS.

This task covers:
a. Inspection **b. Replacement**

INITIAL SETUP:

Test Equipment

None

References
Paragraph

3-197 Hydraulic Ram
3-198 Directional Control Valve and Manifold

Special Tools

None

Equipment Condition: None

Material/Parts

None

Special Environmental Conditions

None

Personnel Required
1

General Safety Instructions
Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

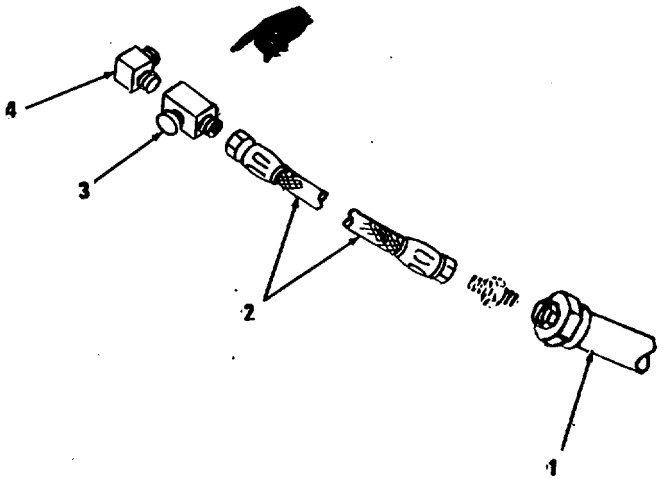
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1. Vehicle Deck Stbd Side	a. Hoses	Inspect for breaks, bends, cracks, and leaking.	
	b. Fittings	Inspect for breaks, cracks and leaking.	
	c. Tubing	Inspect for breaks, cracks, dents and leaking.	

3-199. MAST HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT			
2. Hoses	a. Union nut (1)	Unscrew and separate union.	
	b. Hose (2) and union	Unscrew.	
	c. Hose (2) and control valve (3)	Disassemble.	
	d. Control valve (3) and elbow (4)	Disassemble.	
	e. Elbow (4)	Remove from hydraulic motor.	
	f. Elbow (4)	Install.	
	g. Hose (2)	Reassemble to elbow.	
	h. Union nut (1)	Slide on hose.	
	i. Hose (2), and union	Assemble and tighten union nut (1).	



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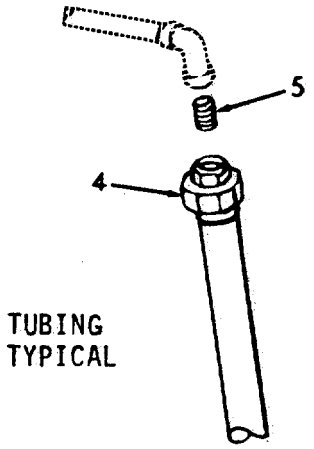
3-199. MAST HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT			
3. Tubing	a. Union nut (4)	Unscrew and separate union.	
	b. Nipple (5)	1. Unscrew from union and elbow.	
		2. Replace.	
	c. Union nut (4)	Reinstall.	



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3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Repair
c. Removal
d. Disassembly
e. Reassembly
f. Installation

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

2

References
Paragraph

3-202 Hydraulic Hoses, Fittings and Piping

Equipment
Condition Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNINGS in procedure.

LOCATION	ITEM	ACTION	REMARK

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

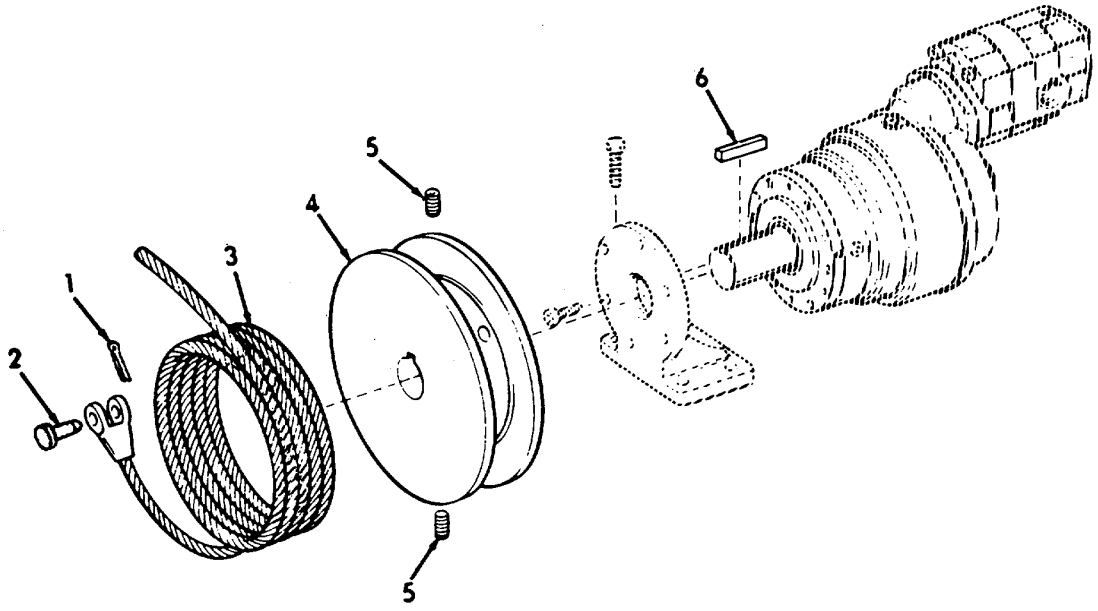
1.	Vehicle Deck Aft	a. Cable	Inspect for wear, fraying, bends, broken strands and damaged or missing parts of socket.

3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
INSPECTION (Cont)			
	b. Winch motor	Inspect for leaks, cracks, breaks and missing hardware.	
	c. Hoses	Inspect for leaks, cracks, bends and breaks.	Refer to paragraph 3-202.
	d. Winch assembly	Insure all hardware is tight.	
REPAIR			
		WARNING	
		Secure Anchor "A" frame prior to releasing cable.	
2. Cable	a. Cotter pin (1), and pin (2)	Remove.	
	b. Winch control	Operate to unspool wire (3).	
	c. Winch drum (4)	1. Release wire from winch drum (4). 2. Check setscrews (5) and key (6).	

3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
REPAIR (Cont)			
	d. Wire (3)	Secure in winch drum (4).	
	e. Winch control	Operate to respool wire (3).	
	f. Pin (2) and cotter pin (1)	Install wire to anchor "A" frame.	



3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

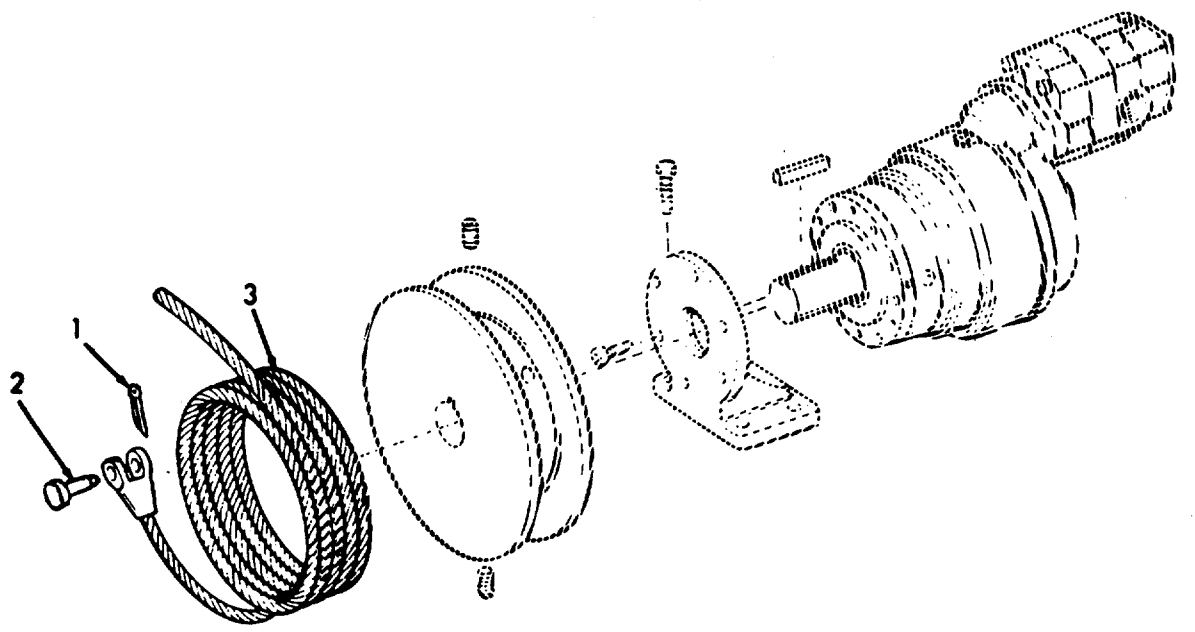
LOCATION	ITEM	ACTION	REMARK

REMOVAL

WARNING

Secure Anchor "A" frame prior to releasing cable.

3.	Anchor Hydraulic Winch Assembly	a. Cotter pin (1), and pin (2)	Remove.
		b. Wire (3)	Disconnect from anchor "A" frame.



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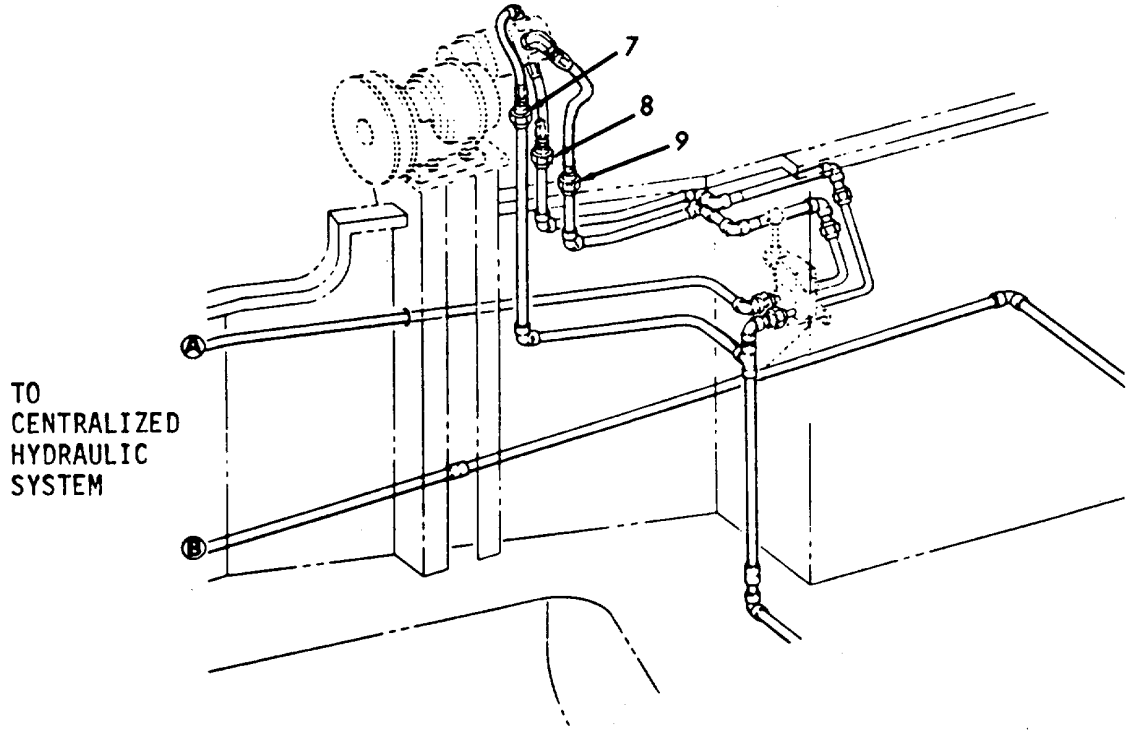
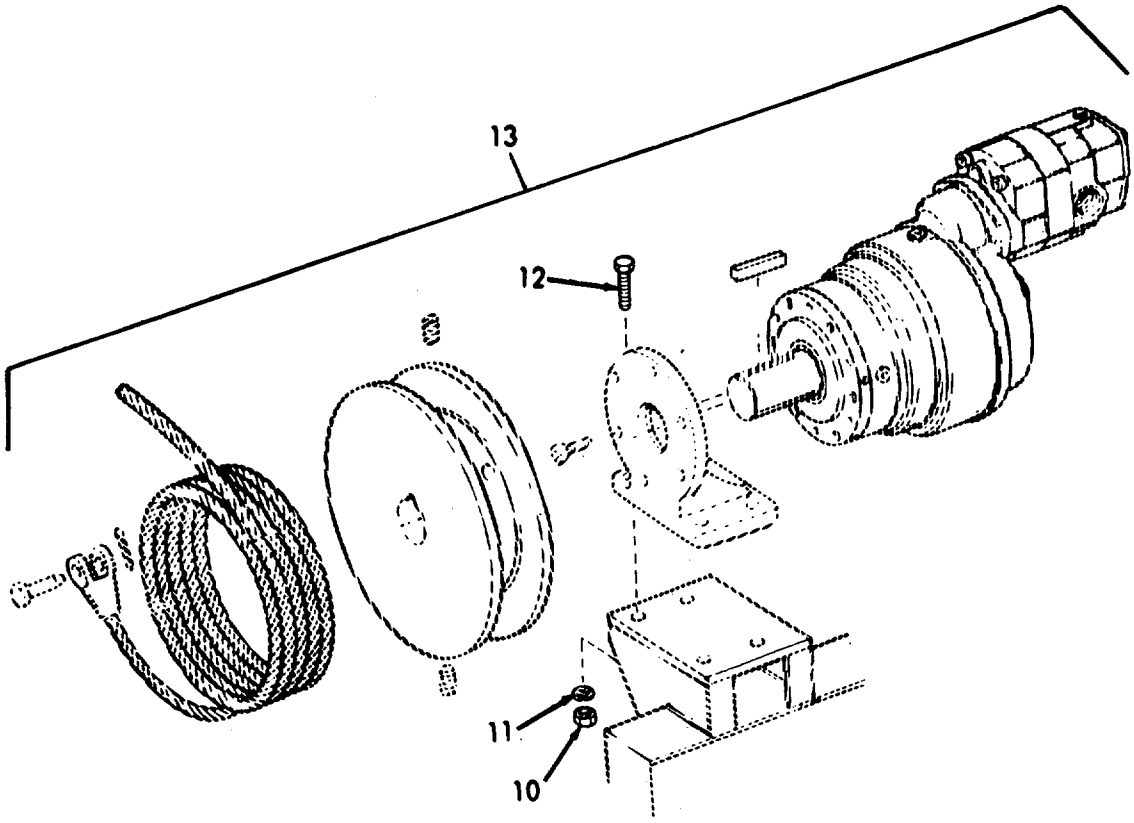
3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
REMOVAL (Cont)			
	c. Hose unions (7, 8 and 9)	Disassemble.	Remove hoses as per paragraph 3-202 .



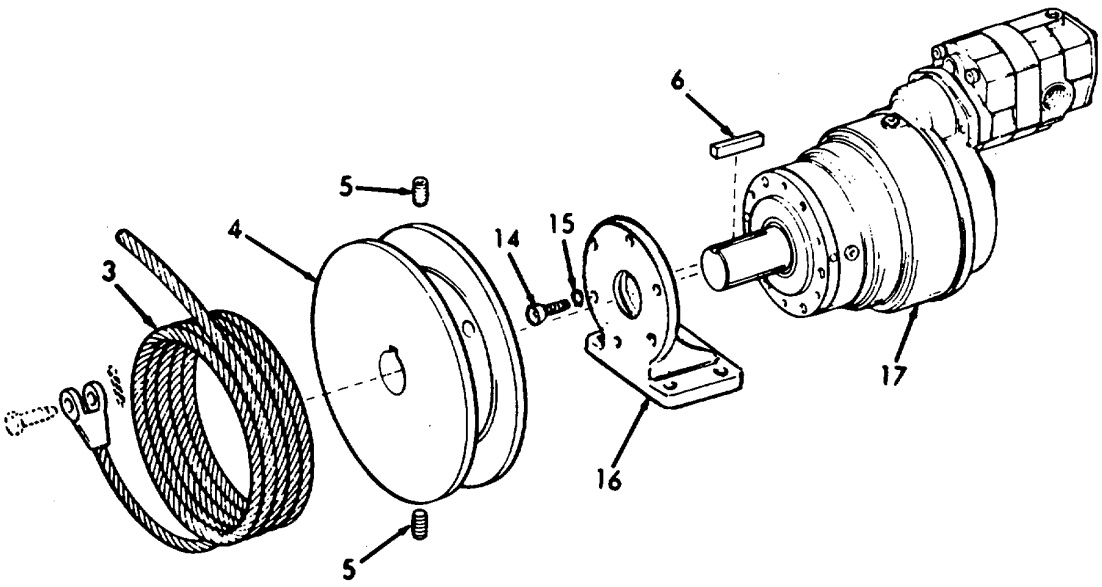
3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
REPAIR (Cont)			
	d. Nuts (10), lock-washers (11), and screws (12)	Remove.	
	e. Winch assembly (13)	Remove.	



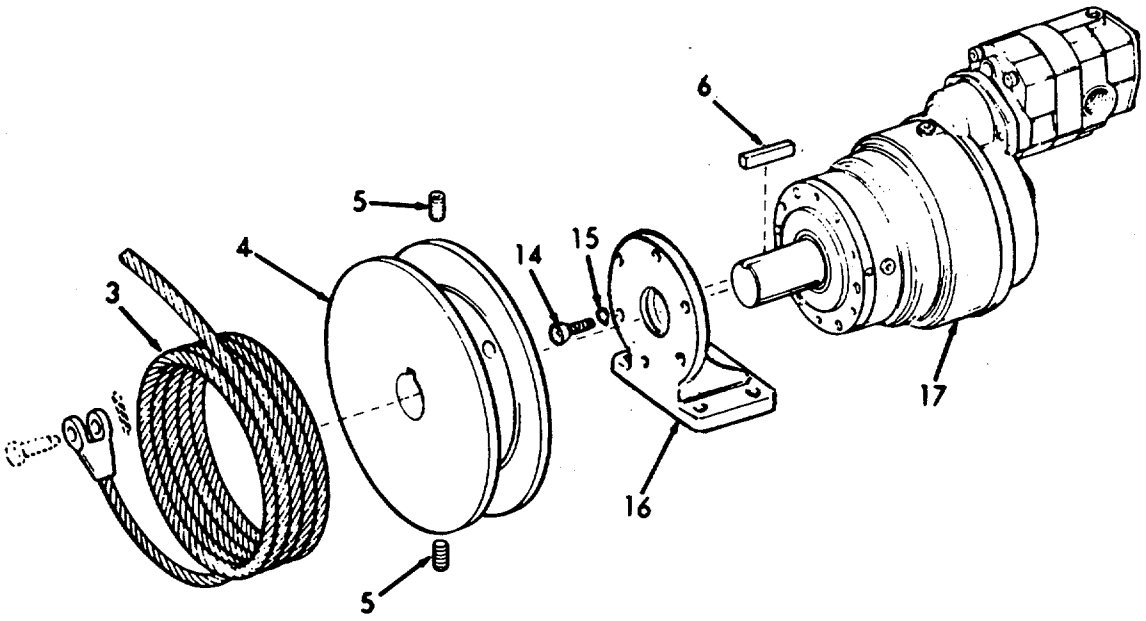
3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
DISASSEMBLY			
4.	a. Wire (3)	Unspool and release from winch drum (4).	
	b. Setscrews (5)	Loosen.	
	c. Winch drum (4), and key (6)	Remove.	
	d. Screws (14), and lock-washers (15)	Remove.	
	e. Mounting bracket (16)	Remove from hydraulic motor (17).	



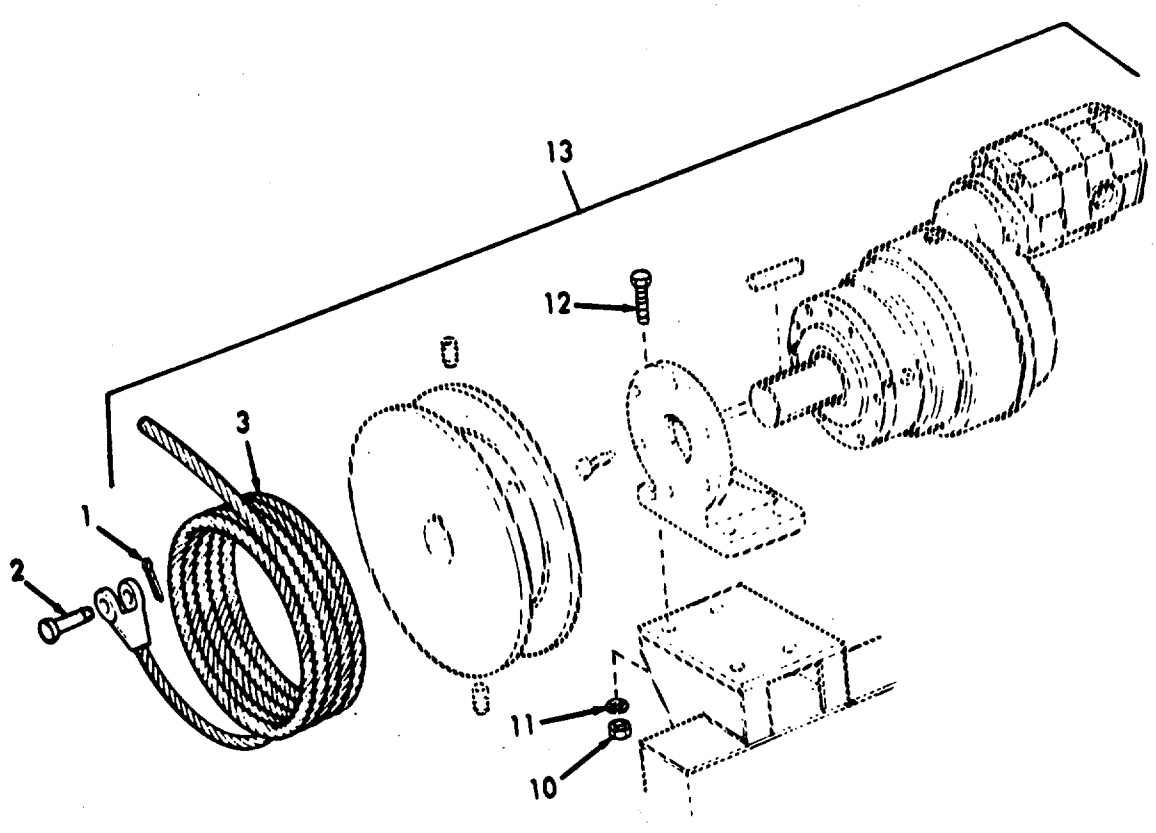
3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
REASSEMBLY			
5	a. Hydraulic motor (17), mounting bracket (16), screws (14), and lock-washers (15)	Reassemble.	
	b. Key (6), and winch drum (4)	Install.	
	c. Setscrews (5)	Tighten.	
	d. Wire (3)	Respool on winch drum (4).	



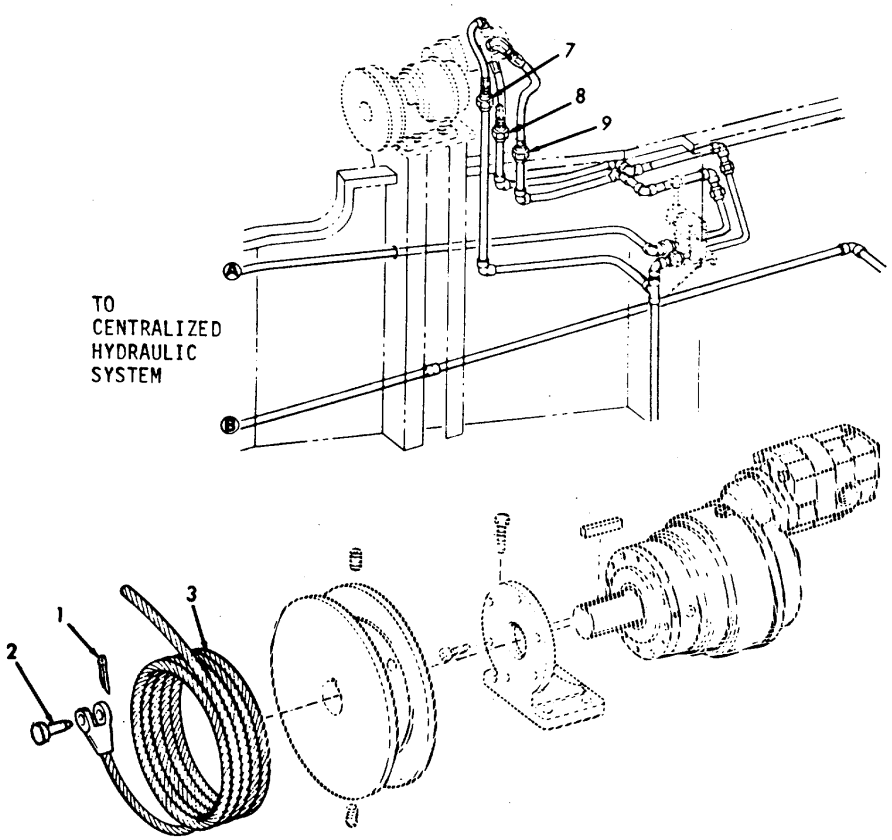
3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION			
6.	a. Winch assembly (13), screws (12), lock-washers (11) and nuts (10)	Install.	



3-200. ANCHOR "A" FRAME HYDRAULIC WINCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION (Cont)			
	b. Hose unions (7, 8 and 9)	Reconnect.	
	c. Wire (3), pin (2) and cotter pin (1)	Reconnect and secure.	



3-201. ANCHOR "A" FRAME HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP:

Test Equipment

None

References
Paragraph

3-202 Hydraulic Hoses, Fittings and Piping

Special Tools

None

Equipment Condition: Condition Description

None

Material/Parts

None

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARK
		WARNING To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.	
INSPECTION			
1. Vehicle Deck Aft	a. Control valve	1. Inspect for leaks, damage and missing parts.	
		2. Insure all hardware is tight.	
	b. Tubing	Inspect for leaks, cracks, breaks and bends.	Refer to Direct Support Maintenance.

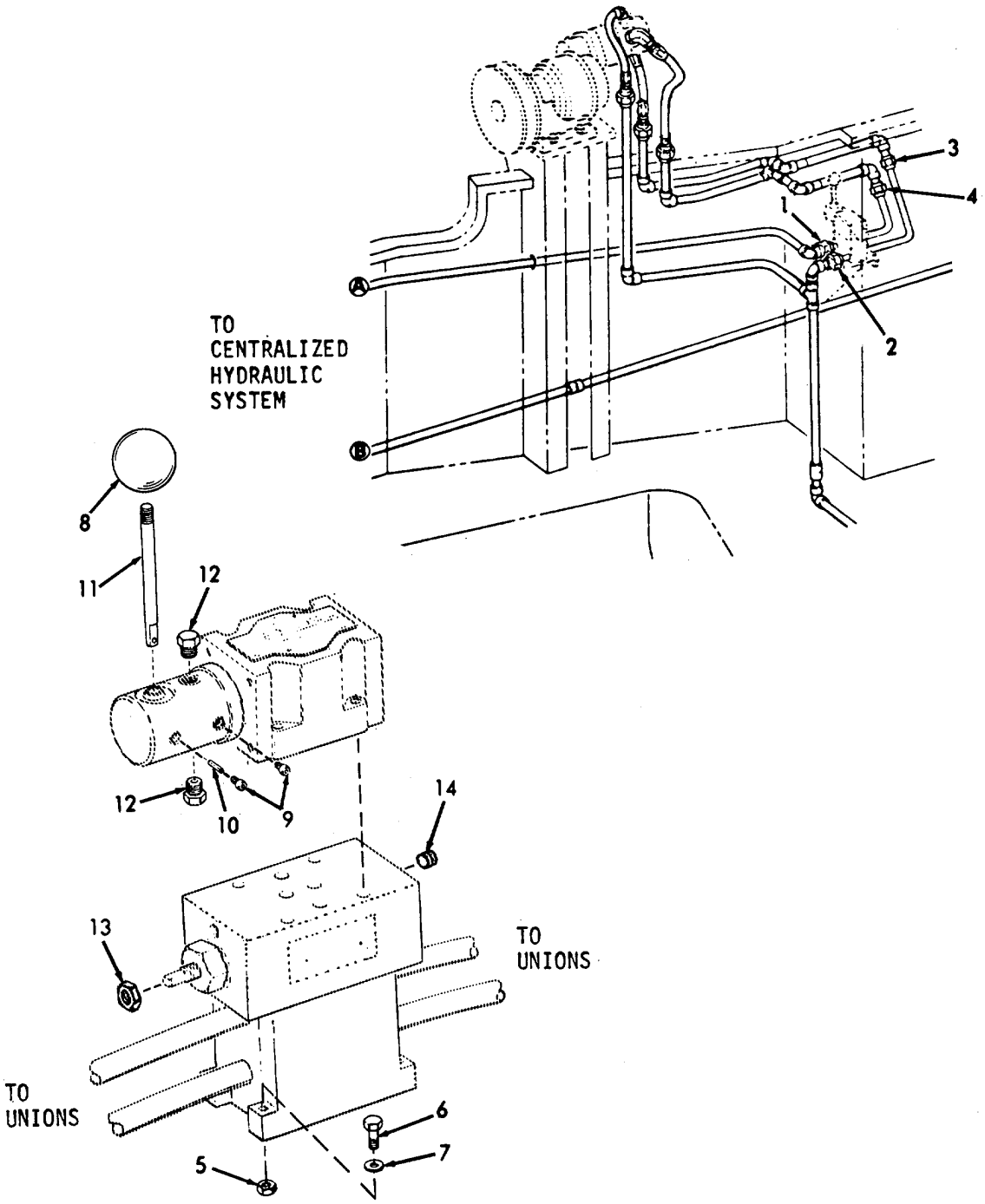
3-201. ANCHOR "A" FRAME HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARK
REMOVAL (Cont)			
2. Directional Control Valve and Manifold	a. Unions (1, 2, 3 and 4)	Disconnect.	
	b. Nuts (5), screws (6), and lock-washers (7)	Remove.	
3. Directional Control Valve	a. Knob (8)	Unscrew.	
	b. Socket head screws (9)	Remove.	
	c. Spring pin (10)	Remove.	
	d. Control lever (11)	Remove.	
	e. Cap plugs (12)	Remove.	If necessary.
4. Manifold	a. Jam nuts (13)	Remove.	If necessary.
	b. Pipe plugs (14)	Remove.	If necessary.

3-201. ANCHOR "A" FRAME HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARK

REMOVAL (Cont)



3-3173

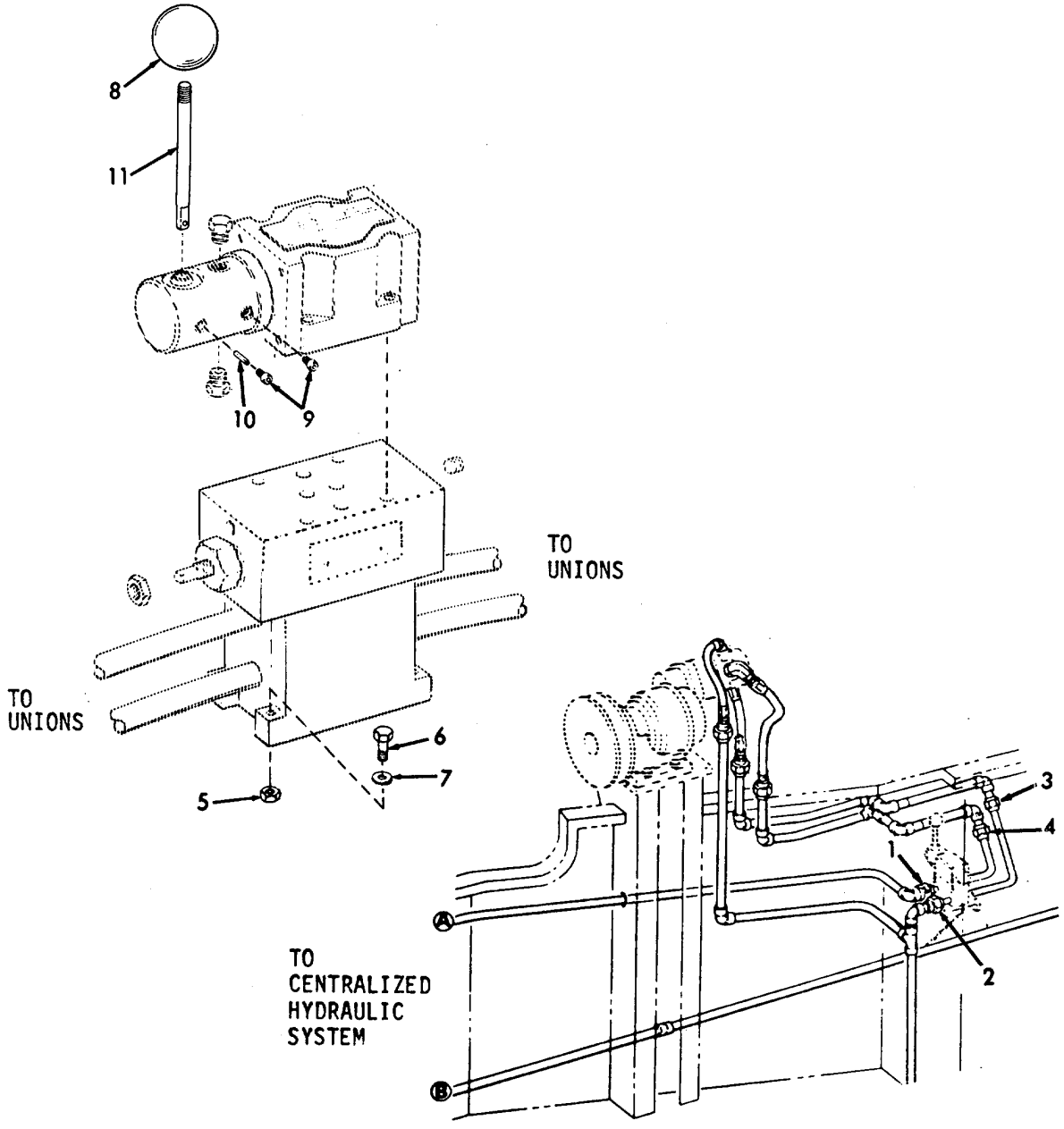
3-201. ANCHOR "A" FRAME HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARK
INSTALLATION			
5. Directional Control Valve	a. Control lever (11)	Install.	
	b. Spring pin (10)	Install.	
	c. Knob (8)	Install.	
	d. Socket head screws (9)	Install.	
6. Directional Control Valve and Manifold	a. Screws (6), lock-washers (7), and nuts (5)	Install.	
	b. Unions (1, 2, 3 and 4)	Reconnect.	

3-201. ANCHOR "A" FRAME HYDRAULIC DIRECTIONAL CONTROL VALVE AND MANIFOLD - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARK

INSTALLATION (Cont)



3-3175

3-202. ANCHOR "A" FRAME HYDRAULIC HOSES, FITTINGS, AND PIPING - MAINTENANCE INSTRUCTIONS .

This task covers:

a. Inspection **b. Replacement**

INITIAL SETUP:

Test Equipment

None

References
Paragraph

3-200 Hydraulic Winch
3-201 Direction Control Valve and Manifold

Special Tools

None

Equipment
Condition Condition Description

None

Material/Parts

None

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARK

WARNING

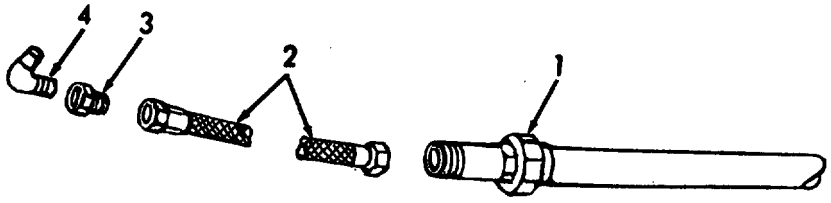
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Vehicle Deck Aft	a. Hoses	Inspect for breaks, cracks, bends and leaking.

3-202. ANCHOR "A" FRAME HYDRAULIC HOSES, FITTINGS, AND PIPING - MAINTENANCE INSTRUCTIONS (Continued)..

LOCATION	ITEM	ACTION	REMARK
INSPECTION (Cont)			
	b. Fittings	Inspect for breaks, cracks and leaking.	
	c. Tubing	Inspect for breaks, cracks, dents and leaking.	
REPLACEMENT			
2. Hoses	a. Union nut (1)	Unscrew and separate union.	
	b. Hose (2) and union	Unscrew.	
	c. Hose (2), bushing (3) and elbow (4)	Disassemble.	
	d. Elbow (4)	Remove from hydraulic motor.	



3-3177

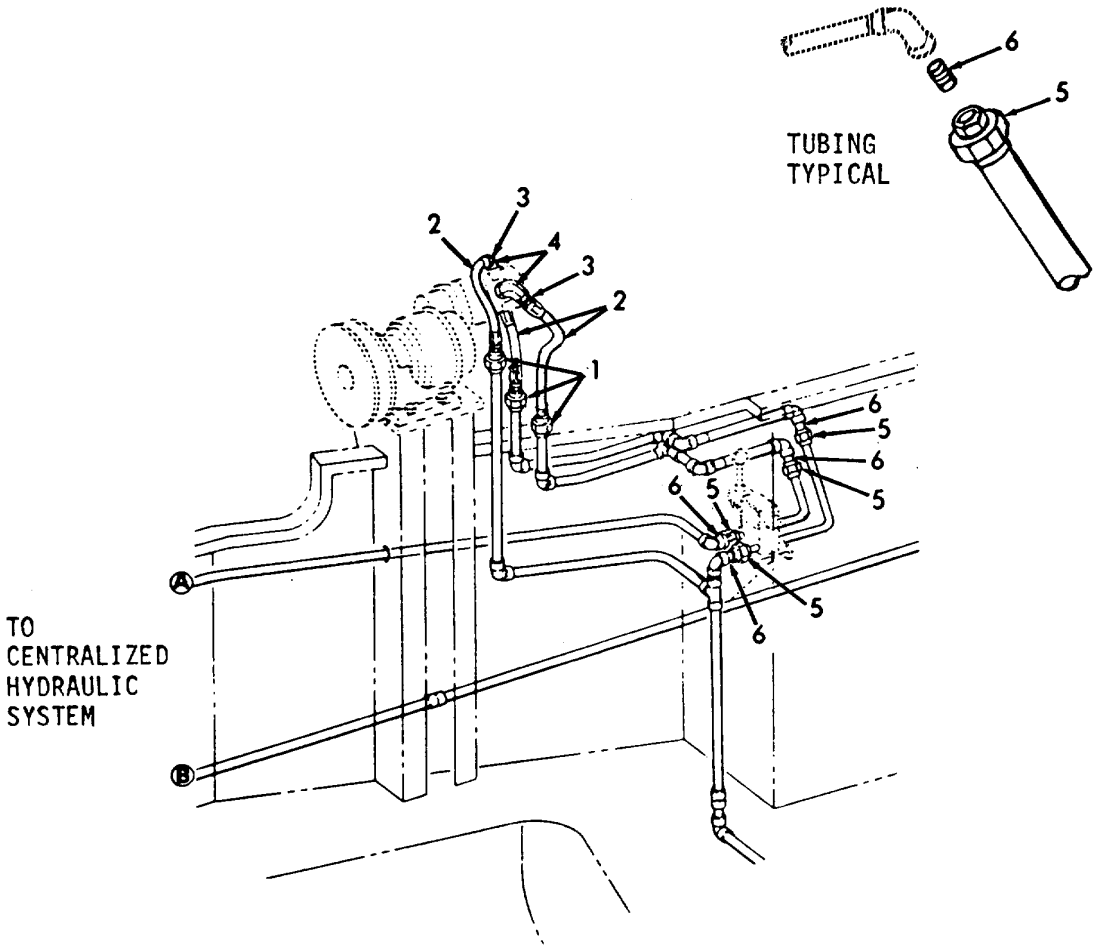
3-202. ANCHOR "A" FRAME HYDRAULIC HOSES, FITTINGS, AND PIPING - MAINTENANCE INSTRUCTIONS (Continued)..

LOCATION	ITEM	ACTION	REMARK
REPLACEMENT (Cont)			
	e. Elbow (4)	Install.	
	f. Bushing (3) and hose (2)	Reassemble to elbow.	
	g. Union nut (1)	Slide on hose.	
	h. Hose (2) and union	Assemble and tighten union nut (1).	
3. Tubing	a. Union nut (5)	Unscrew and separate union.	
	b. Nipple (6)	1. Unscrew from union and elbow. 2. Replace.	
	c. Union nut (5)	Re-install.	

3-202. ANCHOR "A" FRAME HYDRAULIC HOSES, FITTINGS AND PIPING - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACEMENT (Cont)



3-203. STEERING SYSTEM - MAINTENANCE INSTRUCTIONS.

The steering system consists of a Cub Hydraulic Pump Unit and the following associated components; a Rudder Angle Indicator, a Flanking Rudder Limit Switch and a Steering Control Panel.

a. Cub Hydraulic Pump Unit.

(1) The Cub Hydraulic Pump Unit is a power source for hydraulic steering systems. This pump unit is used in conjunction with control and follow-up equipment to make up a complete steering system.

(2) Variations of the basic pump unit are available to suit power requirements and needs of each particular installation.

(3) The following description of the pump unit is taken in the order of flow of hydraulic fluid. Refer to the block diagram of the system.

(4) This pump unit is mounted on a 10-gallon (37.85 liter) tank. A 100-mesh strainer located in the sump filters the fluid.

(5) An electric motor drives the pump unit.

b. Vane Pump.

(1) This pump is a rotary, single-stage sliding vane unit consisting of a housing and rotor assembly.

(2) The rotor has a series of slots into which are fitted movable vanes. As the rotor turns, the vanes are thrown outward by centrifugal force to bear against the surface of an oval shaped ring (cam). As the vanes move across the inlet chamber, the radius of the oval ring increases to create an increasing space between the rotor and the ring. Atmospheric pressure acting upon the inlet fluid forces it into this space. Fluid is trapped between vanes as they move past the in-let chamber. At this point, the radius of the contour decreases and the fluid is forced into the outlet chamber.

c. Pump Relief Valve.

The pump relief valve is set to operate at a pressure which acts to divert oil back to the tank whenever the pressure rises above the established point. The valve is set at installation and need not be readjusted.

3-203. STEERING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

d. Directional Valve.

The directional valve is a solenoid-operated valve which controls the flow to operate the rudder-positioning cylinders. This valve is electrically controlled from the external electronic control amplifier. The solenoids of the valve are de-energized if the rudder limit switches are activated.

e. Brake Valves.

Brake valves lock the cylinders into any position when no changes are being ordered. This valve is set at installation.

f. Cylinder Relief Valves.

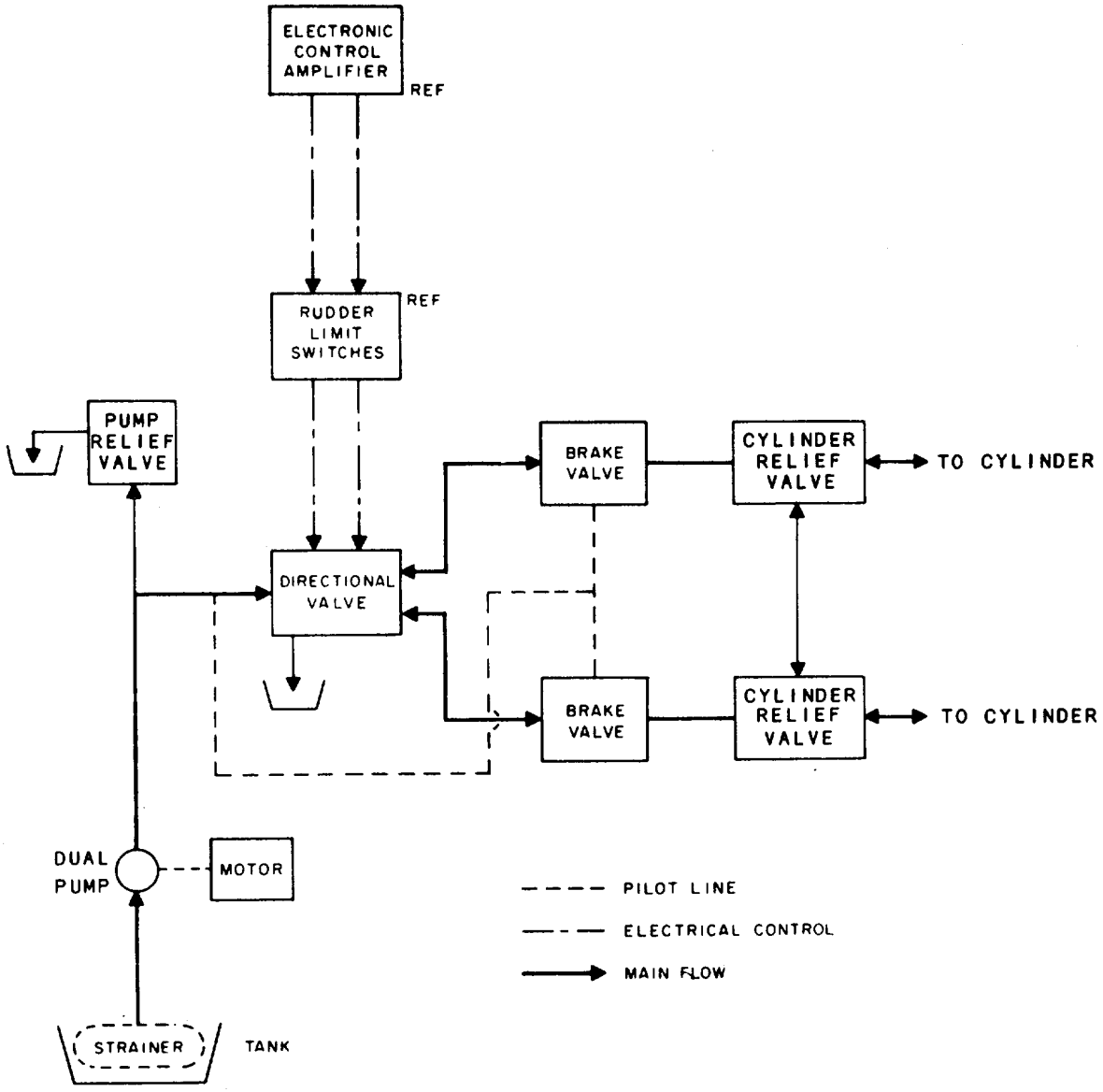
(1) The cylinder relief valves are connected across the lines that link the pump unit to the rudder-positioning cylinders. These valves limit pressure build-up as a result of an object striking the rudder by allowing the rudder to move even though the brake valves are closed. This prevents damaging the steering gear.

WARNING

It is very important that all hydraulic lines and components be free of foreign matter before the hydraulic system is operated, so as to ensure trouble-free operation and to keep wear of the system to a minimum.

(2) In addition, the steering system contains a Heading Selector, a Remote Magnetic Heading Compass, an Emergency Steering System, and a Ships' Course Indicator.

3-203. STEERING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).



3-203. STEERING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

The following is an index to the steering system maintenance instructions:

3-204. HYDRAULIC CUB PUMP UNIT - MOTOR - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Disassembly** **c. Reassembly**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

2

References

None

Equipment Condition Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

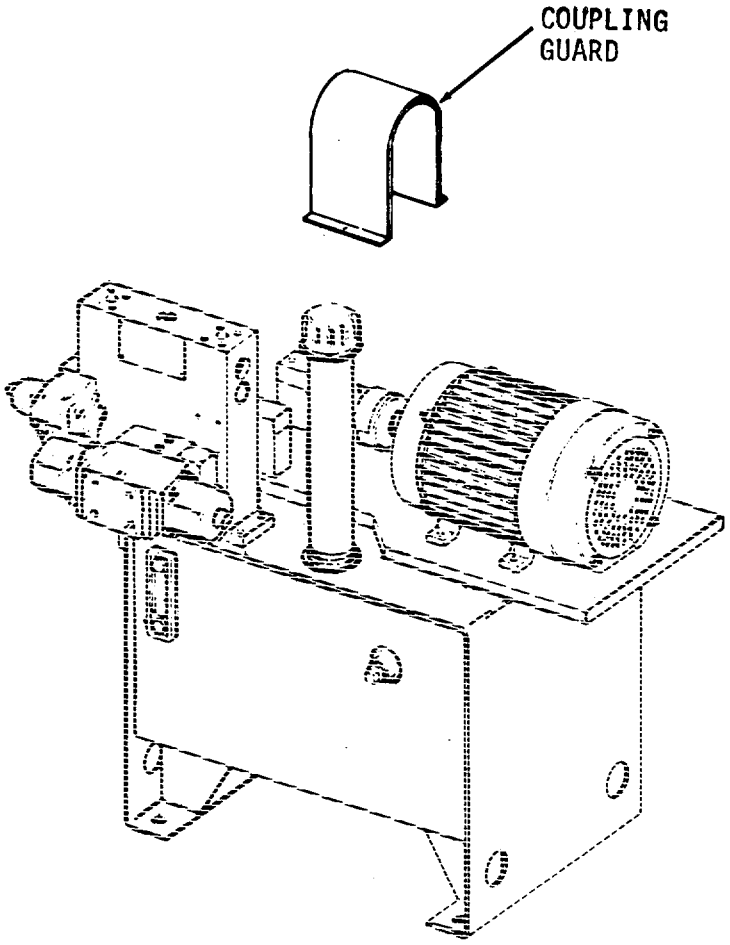
To prevent electrical shock, tag the motor controller and place in the OFF position.

INSPECTION

1. Motor	a. Wiring	Inspect for broken, frayed, or damaged wires.	
	b. Frame	1. Inspect for cracks or breaks.	
		2. Insure that all mounting hardware is tight.	
	c. Coupling	1. Inspect for cracks, breaks, and worn parts.	
		2. Insure that all hardware is tight.	

3-204. HYDRAULIC CUB PUMP UNIT - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. Coupling guard	Guard	Inspect for cracks, breaks, or dents.	



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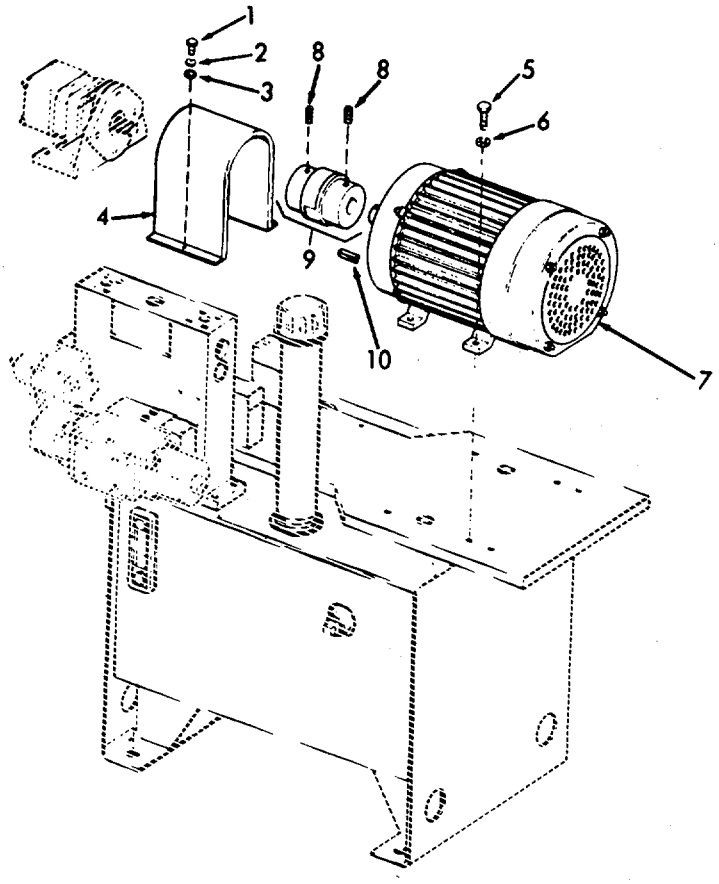
3-204. HYDRAULIC CUB PUMP UNIT - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3. Hydraulic pump unit	a. Wiring	Tag and disconnect.	
	b. Hex head screws (1), lock-washers (2), and washers (3)	Remove.	
	c. Coupling guard (4)	Remove.	
	d. Hex head screws (5), and lock-washer (6)	Remove.	
	e. Electric motor (7)	Slide back.	
	f. Setscrew (8)	Loosen.	
	g. Flexible coupling (9), and key (10)	Remove.	
	h. Electric motor (7)	Remove.	Return to Direct Support Maintenance.

3-204. HYDRAULIC CUB PUMP UNIT - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

DISASSEMBLY (Cont)



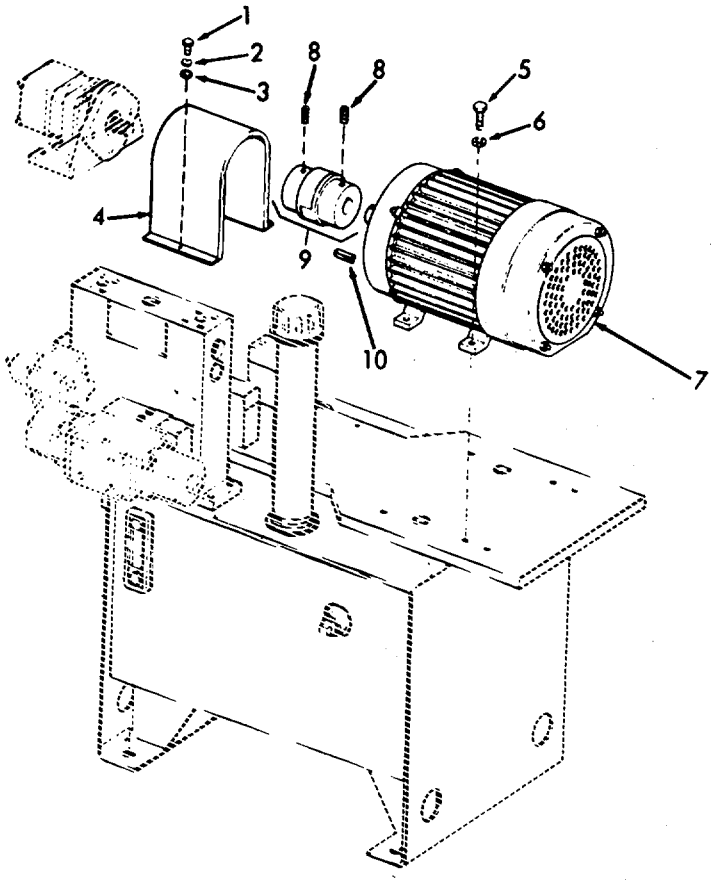
3-204. HYDRAULIC CUB PUMP UNIT - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
4.	a. Electric motor (7), key (10), and flexible coupling (9)	Reassemble.	
	b. Hex head screws (5), and lock-washers (6)	Reassemble.	
	c. Flexible coupling (9)	Adjust.	
	d. Setscrews (8)	Tighten.	
	e. Coupling guard (4), washers (3), lock-washers (2), and hex head screws (1)	Reassemble.	

3-204. HYDRAULIC CUB PUMP UNIT - MOTOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



3-205. HYDRAULIC CUB PUMP UNIT - MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS.

A. GENERAL

(1) The motor controller is an A-C across-the-line non-reversing unit that controls the three-phase electric motor used with the hydraulic pump on the steering system.

(2) The controller contains a LOCAL-OFF-REMOTE switch and a RESET control on the front panel and houses a line contactor, power transformer, control relay, and fuses. The controller is used with a steering panel which provides remote control of the motor starter. In such an installation, the control switch is normally in its REMOTE position. For testing purposes, the switch can be turned to the LOCAL position, thereby energizing the contactor coil. In the OFF position, the contactor control circuit is de-energized. The controller contains terminals to which the remote pump run indicator lamp is connected to show when the motor is energized.

B. DESCRIPTION.

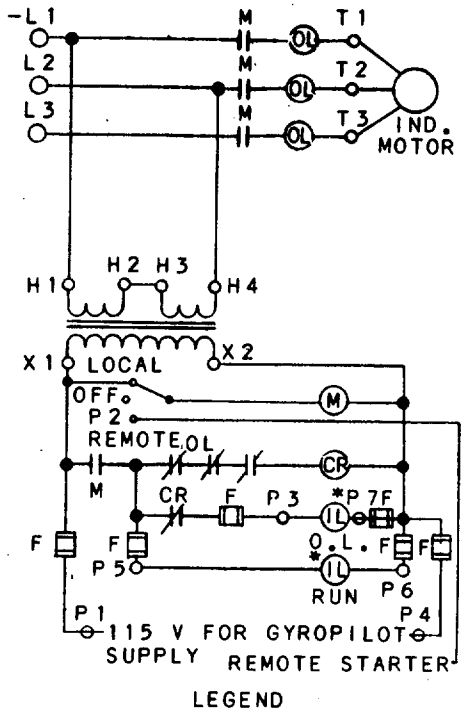
(1) Starter contacts connect the motor directly to the power line upon actuation of the controller. Control circuits are isolated from the power line by a 500-volt-ampere transformer that steps down the ship's supply to 115 volts. This low voltage can also be used to energize indicator lamps and to supply 115 volts at 60 cps to the steering panel with which the started may be used.

(2) A remote start switch (in a steering panel), or the LOCAL-OFF-REMOTE switch on the controller panel closes a circuit through the coil of the main line contactor. The coil closes the three line contactors and connects the motor to the power line as long as the switch remains closed. The main line contactor also closes the circuit to light a "run" indicator lamp.

(3) If the motor load becomes excessive, either of three over-current thermal heaters in series with the motor input opens the normally closed contacts in series with the coil of a control relay. This coil then releases its spring-loaded contacts which close and energizes the overload circuit. The overload relay remains open until it is mechanically closed by means of the RESET control. The motor remains connected to the power line despite the over-current because continued operation is usually more important than possible damage to the motor and hydraulic steering equipment. For this reason, an overload indication should be investigated immediately and corrective action taken as soon as possible.

3-205. HYDRAULIC CUB PUMP UNIT - MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS.

(4) The indicator circuit is fused in both legs. Also, the circuit that supplies 115 volts 60 cps to a steering panel is fused in both legs. The 115-volt steering panel supply is energized at all times that power is applied to the controller even though the motor controlled by the starter is not energized.



LEGEND

M - LINE CONTACTOR

OL - OVERLOAD RELAY

CR - CONTROL RELAY

* IL - INDICATING LAMP (NOT SUPPLIED)

F - FUSE

3-205. HYDRAULIC CUB PUMP UNIT - MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS

This task covers:

a. Inspection **b. Repair** **c. Replacement**

INITIAL SETUP:

Test Equipment	References
None	None
Special Tools	Equipment Condition Condition Description
None	None
Material/Parts	Special Environmental Conditions
Kraft or coarse paper	None
Personnel Required	General Safety Instructions
1	Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

To prevent electrical shock and possible death, tag the motor controller and place all circuit breakers in the OFF position.

INSPECTION

1. Controller	a. Housing	1. Inspect for cracks, breaks or dents.	
		2. Inspect door for defective hinge and closure screws.	

3-205. HYDRAULIC CUB PUMP UNIT - MOTOR CONT5ROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	b. External wiring	1. Inspect for frayed, broken or worn wires.	
		2. Insure all terminal lugs are tight.	
	c. Internal	1. Inspect all components for signs of damage or wear.	
		2. Inspect for clear lines.	
		3. Insure all hardware is tight.	
REPAIR			
2.	a. Uses	Remove and test.	Replace as required.
	b. Contacts	1. Keep contacts free of dust.	
		2. Use rough paper to clean the contacts.	Use Kraft paper or coarse wrapping paper.
	c. Stationary contacts	Remove terminal screw. Withdraw spring clip and contact.	
	d. Movable contact	1. Pull out the horizontal key that connects the contact assembly to the plunger.	

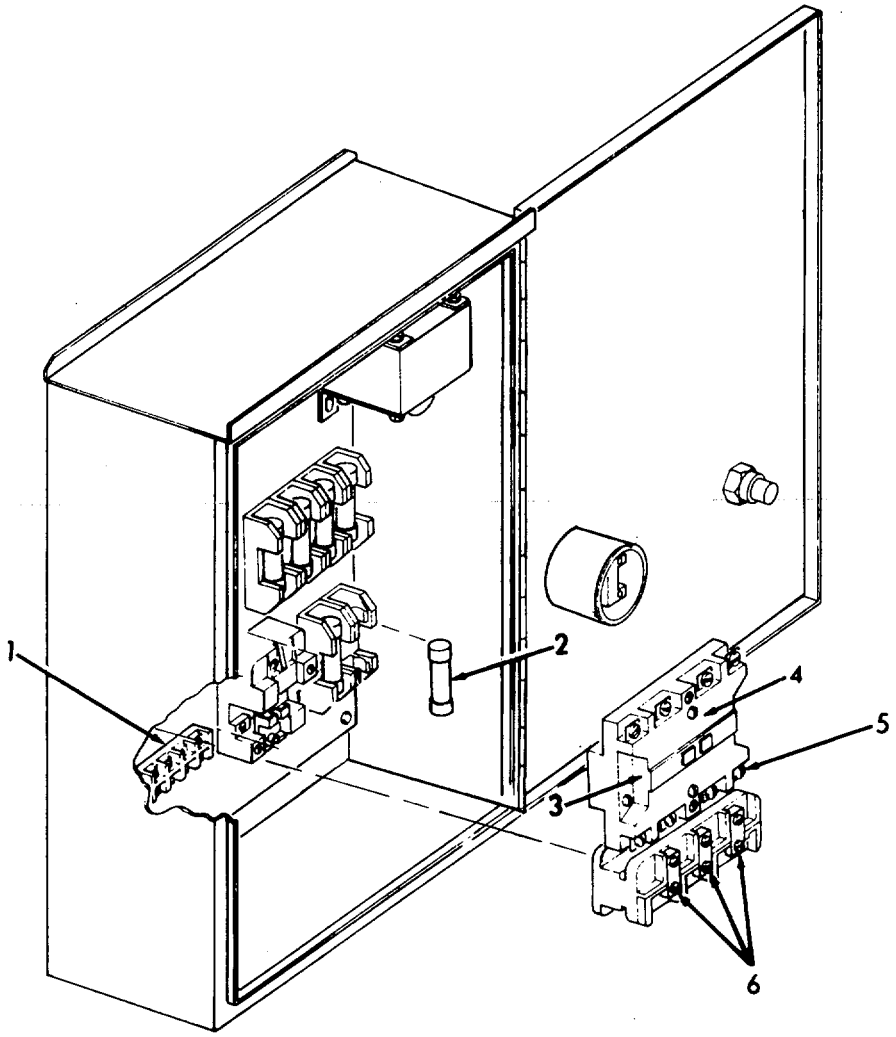
3-205. HYDRAULIC CUB PUMP UNIT - MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		2. Push down on double contact bridge and rotate it 1/4 turn.	
		3. Remove the bridge.	
		4. The spring beneath the bridge can be replaced after the bridge is removed.	
	e. Coil	1. Remove plunger.	
		2. Pull down on two vertical guides; one in front and one in back of coil.	
REPLACEMENT			
3.	a. Wiring	Tag and disconnect all wiring.	
	b. Case	Remove from bulkhead.	

3-205. HYDRAULIC CUB PUMP UNIT - MOTOR CONTROLLER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPLACEMENT (Cont)



1. TERMINAL STRIP
2. FUSES
3. MOTOR STARTER
4. COIL
5. CONTACT (Replacement Kit)
6. OVERLOAD HEATER

3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS

A. GENERAL.

(1) This pump is used to develop hydraulic fluid flow for the operation of the steering system equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced.

(2) All units are designed so that the direction of rotation, pumping capacity and port positions can be readily changed to suit particular applications.

B. ASSEMBLY AND CONSTRUCTION.

(1) The unit consists principally of a ported body, a ported cover and a pumping cartridge. Components of the pumping cartridge are an elliptical cam ring, a slotted rotor splined to fit the drive shaft and twelve vanes fitted to the rotor slots.

(2) The pumping cartridge cam ring is sandwiched between the body and cover. A ball bearing and bushing located in the body and pressure plate respectively support each end of the drive shaft and center the rotor within the cam ring. As the drive shaft is driven by the prime mover, the rotor and vanes generate flow by carrying fluid around the elliptical cam ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate into the outlet port of the cover.

(3) Fluid flow is developed by the pumping cartridge. The action of the cartridge is illustrated below. The rotor is driven within the cam ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam ring.

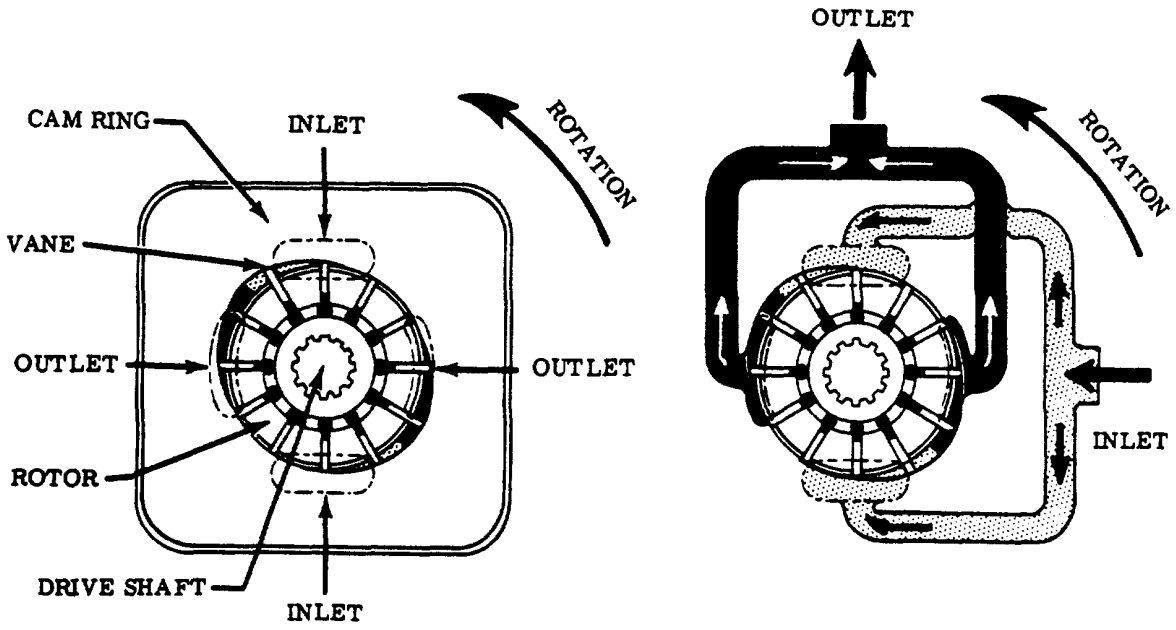
(4) Radial movement of the vanes and turning of the rotor cause the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher).

(5) This fluid is trapped between the vanes and carried past the large diameter or dwell section of the cam ring. As the outlet section is approached, the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

(6) The pump cam ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft are cancelled.

(7) The pressure plate seals the pumping chamber. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.



3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

This task covers: **a. Inspection** **b. Disassembly** **c. Reassembly**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: None

Condition Description: None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in procedure.

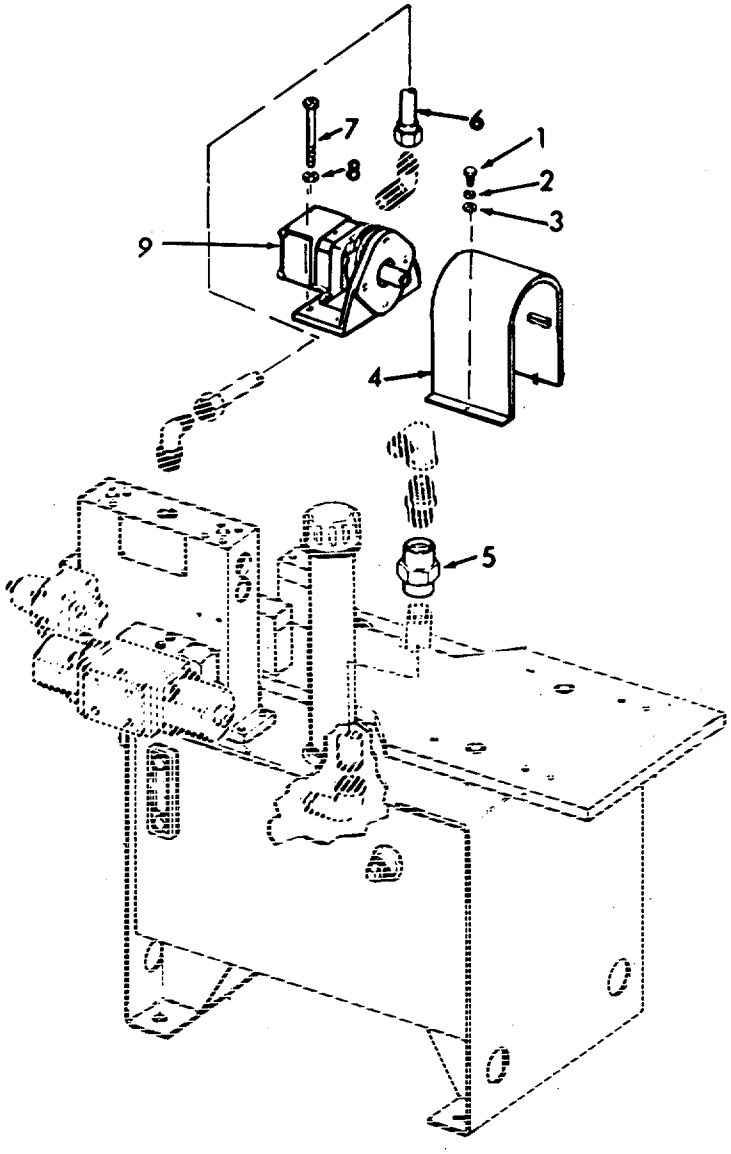
LOCATION	ITEM	ACTION	REMARK
INSPECTION			
		WARNING To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.	
1. Hydraulic Power Unit	a. Pump	Inspect for cracks, breaks, and leaking.	
	b. Piping	Inspect for cracks, breaks, and leaking.	
	c. Pump mounting bracket	Inspect for breaks and cracks.	
	d. Coupling guard	Inspect for cracks, dents, and breaks.	
	e. Hardware	Insure hardware is tight.	

3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
DISASSEMBLY			
2.	a. Hex head screw cap (1), lock-washer (2), and flat washer (3)	Remove.	
	b. Coupling guard (4)	Remove.	
	c. Pipe union (5)	Loosen.	
	d. Steel tubing (6)	Loosen.	
	e. Hex socket screw cap (7), and lock-washer (8)	Remove.	
	f. Vane pump and bracket assembly (9)	Pull back and remove.	

3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

DISASSEMBLY (Cont)



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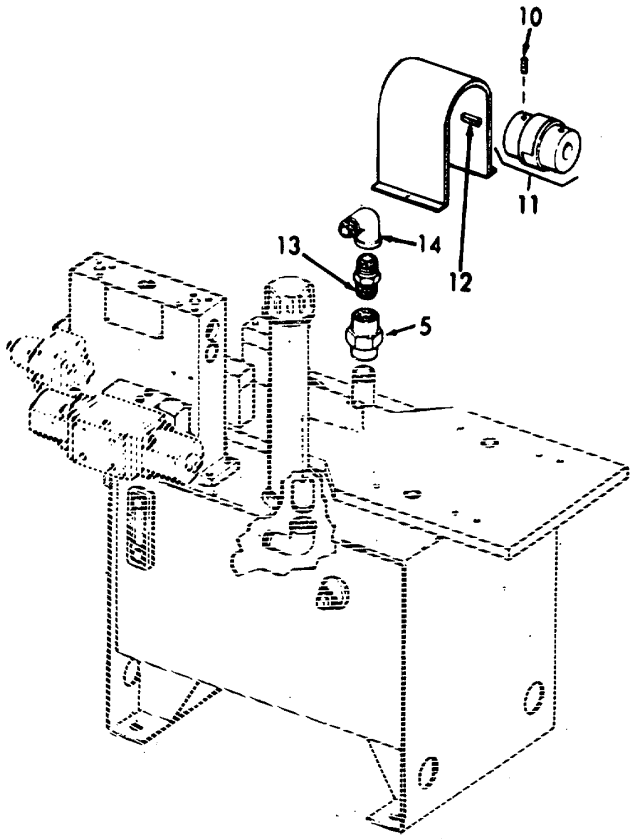
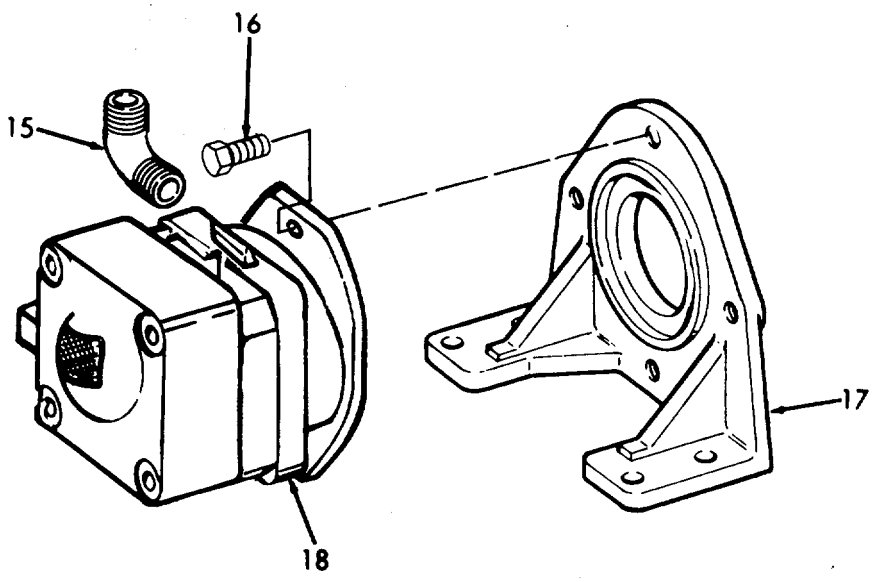
3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
DISASSEMBLY (Cont)			
	g. Setscrew (10)	Loosen.	
	h. Flexible coupling (11a), and key (12)	Remove.	
	i. Pipe nipple (13), union (5), and elbow (14)	Disassemble.	



3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
DISASSEMBLY (Cont)			
	j. Elbow (15)	Remove.	
	k. Hex head screw cap (16), and mounting bracket (17)	Remove.	
	l. Vane pump (18)	Remove.	

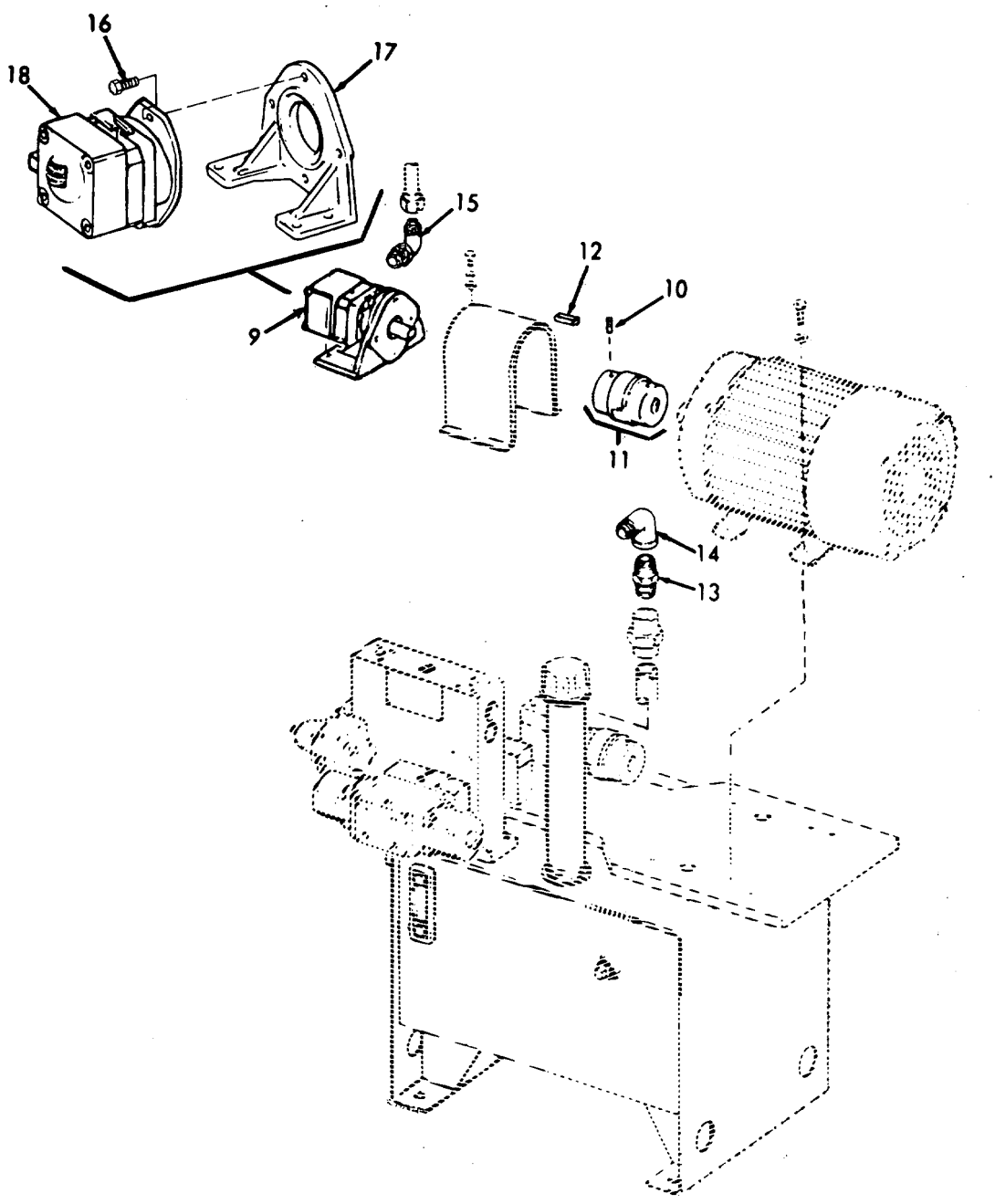


3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REASSEMBLY			
3.	a. Elbow (15)	Install.	
	b. Elbow (14), and pipe nipple (13)	Install.	
	c. Vane pump (18), hex head screw cap (16), and mounting bracket (17)	Reassemble.	
	d. Key (12), and flexible coupling (11a)	Reassemble.	
	e. Vane pump and bracket assembly (9)	Push back.	
	f. Flexible coupling (11)	Adjust.	
	g. Setscrew (10)	Tighten.	

3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REASSEMBLY (Cont).			

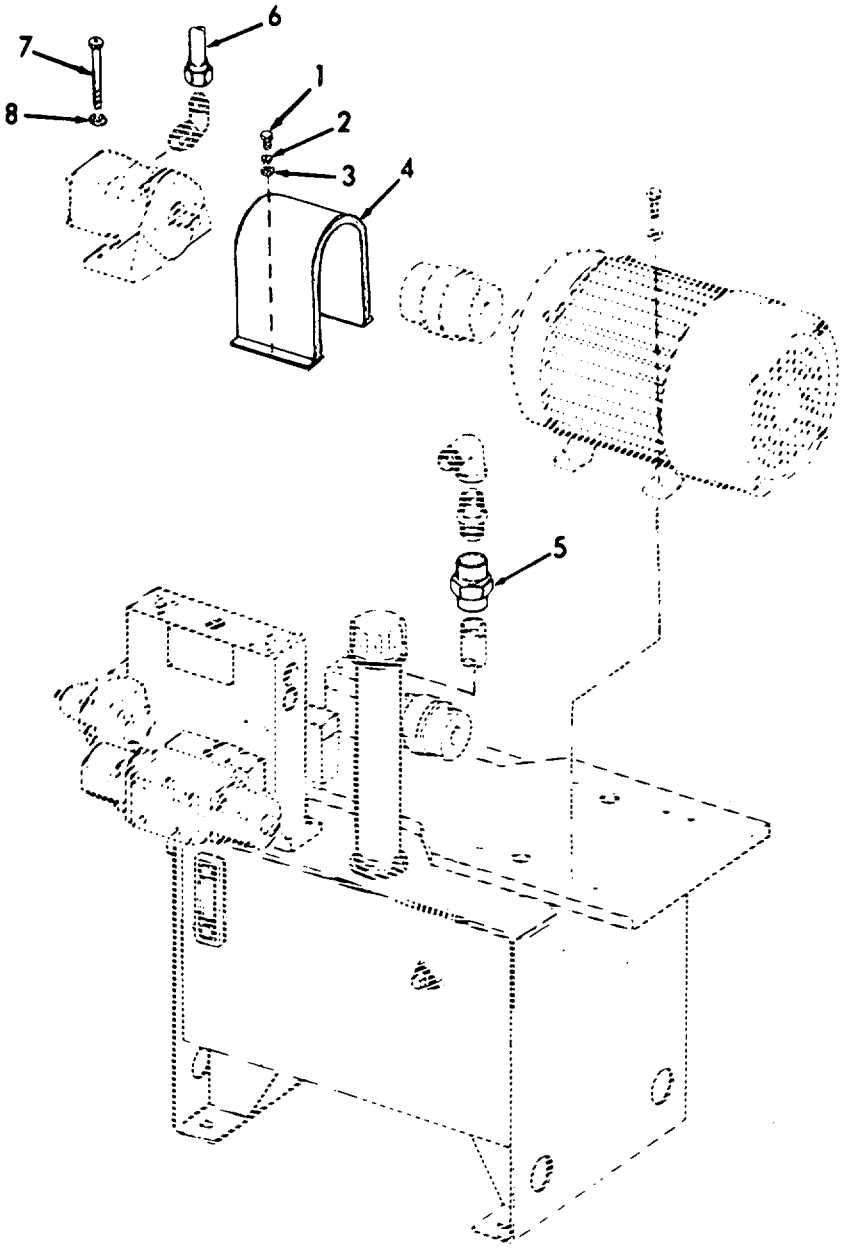


3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REASSEMBLY (Cont).			
	h. Hex socket screw cap (7), and lock-washer (8)	Reassemble.	
	i. Steel tubing (6)	Install.	
	j. Pipe union (5)	Reassemble.	
	k. Coupling guard (4), flat-washer (3), lock-washer (2), and hex head screw cap (1)	Reassemble.	

3-206. HYDRAULIC CUB PUMP UNIT - HYDRAULIC PUMP - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REASSEMBLY (Cont).			



3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS

A. DESCRIPTION.

(1) The brake valve is provided with an integral check valve which permits reverse free flow from the secondary port to the primary port when the valve is closed.

(2) The brake valve is internally drained and remotely operated. It is used primarily as an unloading valve where the secondary port must be connected directly to the tank. Application of external pressure permits the valve to open fully independent of the primary pressure. Type 4 valves can also be used as remotely operated counterbalance or brake valves when provided with the integral check valve.

B. INSTALLATION.

(1) These gasket mounted valves are teed into the supply line. The tee connection is piped to the bottom, or pressure port in the subplate, or to the back surface of the mounting area. The top, or secondary port is piped to the tank or to the secondary circuit with the covers arranged for internal or external draining and direct or remote control depending on the valve action required.

(2) The point at which the valve begins to function is determined by the position of the adjusting screw (which varies the force exerted by the spring on the spool), referred to as the pressure setting of the valve. Clockwise rotation of the screw increases pressure. Counterclockwise rotation decreases pressure.

(3) The effective areas of the spool exposed to hydraulic pressure in primary chamber A being equal, the spool is hydraulically balanced and held in a normally closed position by the force of the spring. When pressure in primary chamber A - which is effective on the piston through passages C - exceeds the adjusted pressure setting, the piston is forced upward, moving the spool accordingly.

(4) The spool moving upward opens secondary chamber B permitting pump delivery to flow into the secondary circuit, while maintaining a minimum pressure in primary chamber A equal to the pressure setting of the valve.

(5) When the primary pressure decreases, compression of the spring overcomes the hydraulic force effective on the piston and the spool closes blocking flow to chamber B.

3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

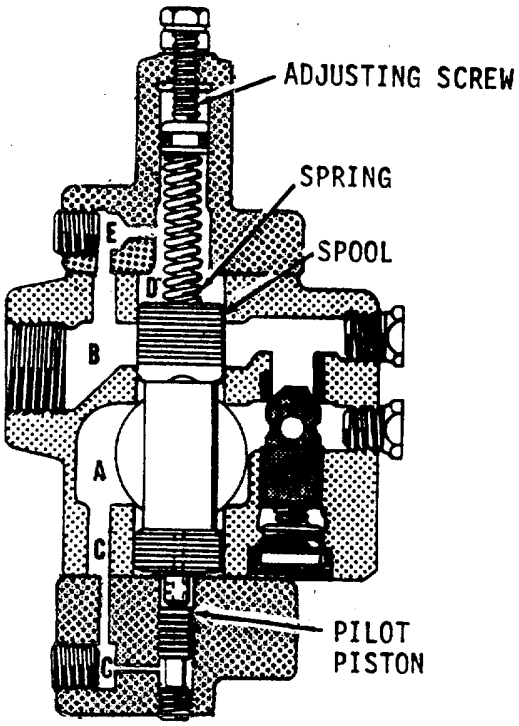
(6) Fluid leakage trapped between the piston and the spool escapes through the center hole of the spool, into spring chamber D, through drain passage E to chamber B and tank, or externally to tank depending on the position of the top cover.

(7) Operation of this valve when used with a gravity returned single acting ram is such that pump fluid passes free flow into secondary chamber B, then through the check valve and chamber A into the ram. Pressure buildup in the ram closes the spool.

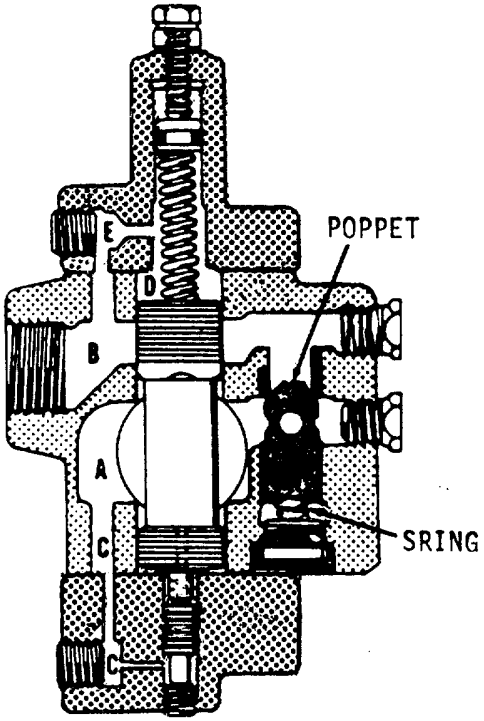
(8) When the work stroke is completed, fluid flow is diverted from the secondary port by directing the pump delivery to tank.

(9) On the return stroke, trapped fluid under pressure in the primary port holds the valve spool and check valve closed until a small amount of fluid bleeding-off through the needle valve or orifice reduces the trapped pressure.

(10) When pressure drops below the valve setting, the spring forces the valve spool to open directing the discharge flow through the secondary port to tank.



CLOSED POSITION



OPEN POSITION

3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:
a. Inspection **b. Disassembly** **c. Reassembly**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

Hydraulic fluid MIL-L-17672 - Type 2135TH

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING.

LOCATION	ITEM	ACTION	REMARK

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1. Brake valve	Valve	1. Inspect for cracks, and leaking. 2. Insure all hardware is tight.	

3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
DISASSEMBLY			
2.	a. Nut (1) and adjusting screw (2)	Loosen nut and remove screw.	
	b. Screws (3)	Remove.	
	c. Top cover (4), and gasket (5)	Remove.	Do not discard gasket.
	d. Preformed packing (6), spring plug (7), spring (8), and spool (9)	Remove.	
	e. Spool (9)	Inspect spool for binding or excessive clearance in the body bore.	

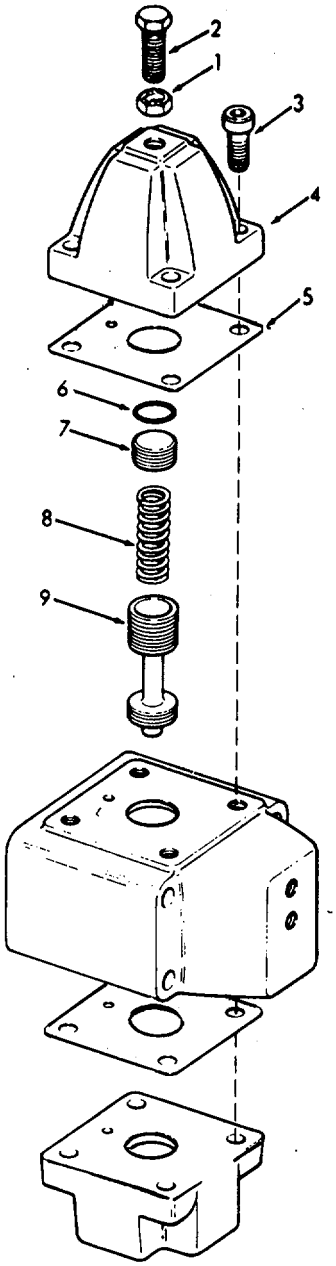
NOTE

If spool checks out satisfactory, omit g thru n.

3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK

DISASSEMBLY (Cont)



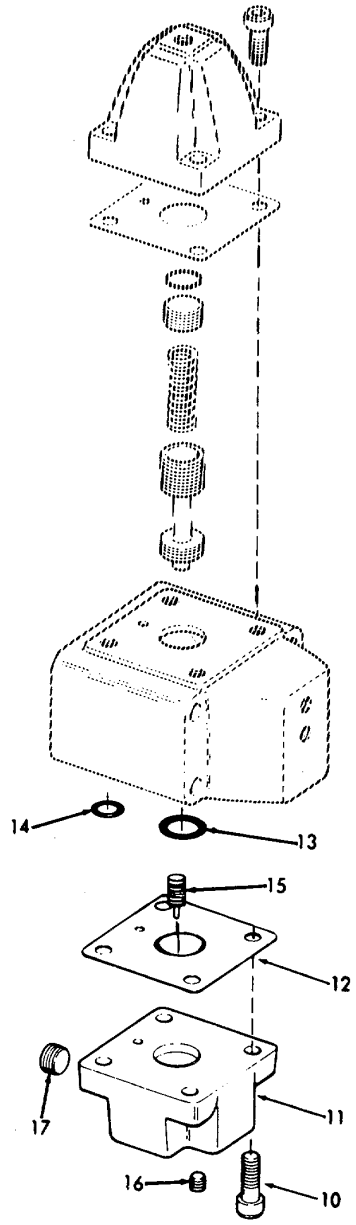
3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
DISASSEMBLY (Cont)			
	f. Screws (10)	Remove.	
	g. Bottom cover (11)	Remove.	
	h. Bottom cover (11)	Inspect for clogged control passages.	
	i. Gasket (12)	Remove.	
	j. Seals (13 and 14)	Remove.	
	k. Pilot piston (15)	Remove.	
	1. Pilot piston (15)	Inspect for burrs or excessive clearance in the cover bore.	
	m. Plugs (16 and 17)	Remove if necessary.	

3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK

DISASSEMBLY (Cont)



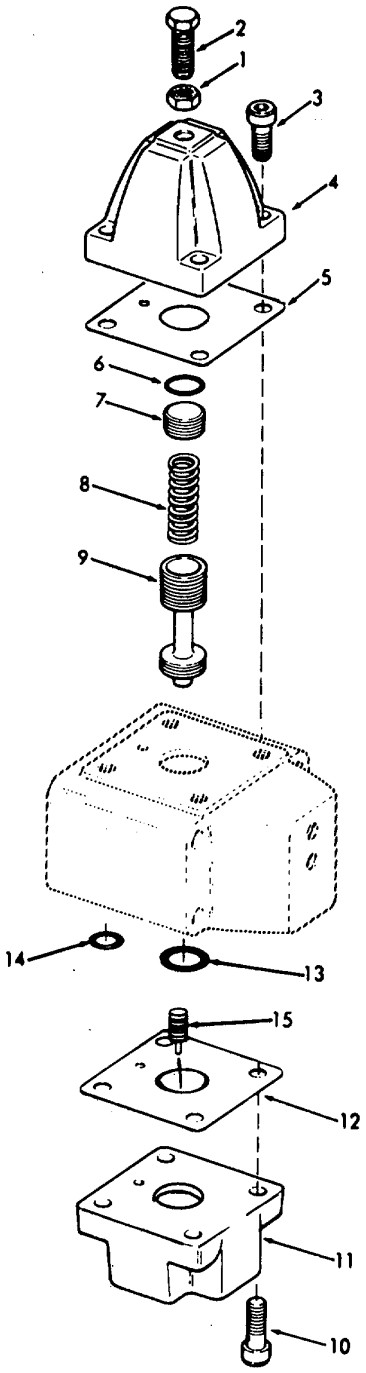
3-207. HYDRAULIC CUB PUMP UNIT - BRAKE VALVE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REASSEMBLY			
3.	a. Pilot piston (15), seals (14 and 13), and gasket (12)	Reassemble.	Lubricate seals with hydraulic fluid.
	b. Bottom cover (11), and screws (10)	Reassemble.	
	c. Spool (9), spring (8), spring plug (7), and pre-formed packing (6)	Reassemble.	Lubricate pre-formed packing with hydraulic fluid.
	d. Gasket (5), top cover (4), screws (3), adjusting screw (2), and bolt (1)	Reassemble.	

3-207. HYDRAULIC CUB PUMP UNIT - BRAKE - VALVE - MAINTENACE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

REASSEMBLY (Cont)



3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS

a. GENERAL

The directional control valve is comprised of a rectangular valve body containing a precision fitted sliding spool in a central, longitudinal bore. Spool lands serve to divide the bore into a series of separate chambers, and ports in the valve body lead into these chambers. The position of the spool determines which ports are open to each other and which are sealed off from the others. Thus, oil flow is directed from one port to another within the valve body.

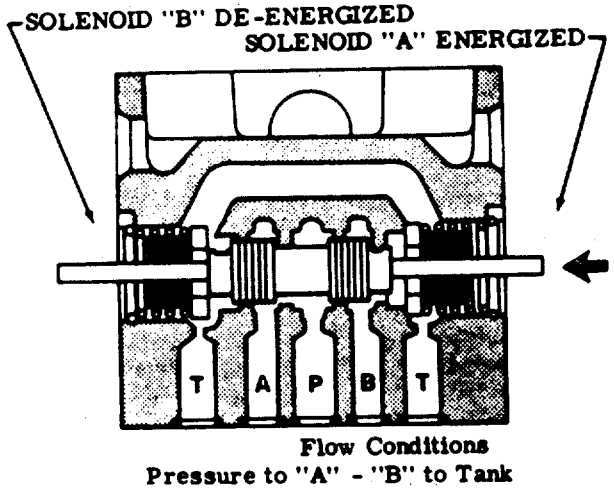
b. PRINCIPLES OF OPERATION

(1) Valve Type:

SPRING CENTERED - Spring centered valves are provided with a spring and centering washer at each end of the spool. The springs and washers center the spool within the valve body, when solenoids are de-energized.

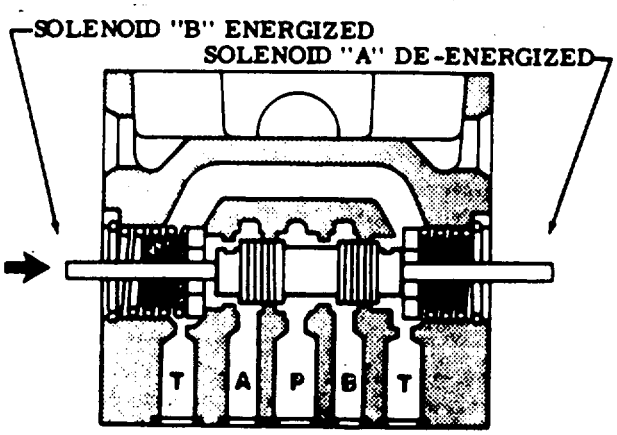
(2) Function

(a) Three cross section views of a valve are shown. The cross sections show location of the spool lands and the basic valve block machining. Each cross section is provided to show porting of the valve as the spool is moved within the valve block. Assume the spool is moved to the left within the valve body. The "P" pressure port will connect to the "A" cylinder port and the "B" cylinder port will open to the "T" tank port.



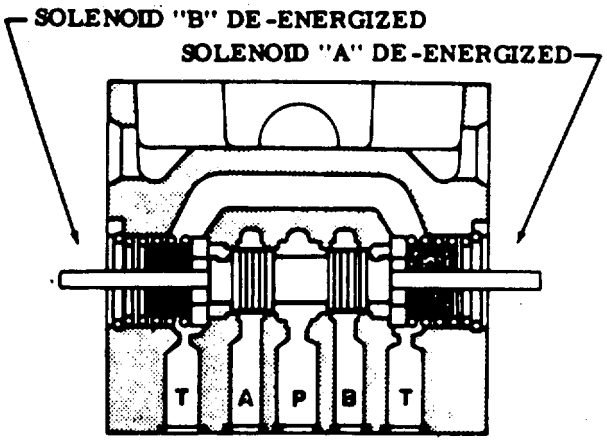
3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued).

(b) If the spool is moved to the right as shown, the "P" pressure port will connect to the "B" cylinder port and the "A" cylinder port will connect to "T" tank.



Flow Conditions
Pressure to "B" - "A" to Tank

(c) When the spool returns to center, (solenoids de-energized), flow is blocked in all ports. It can be seen that the function of a valve is to direct the flow of system fluid within a circuit. The valve is actually used to direct the flow from the pump to the actuator and from the actuator to the tank or reservoir.

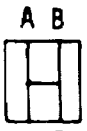


Flow Conditions
Flow Blocked (Center Condition #2 Spool)

3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

(3) Valve Spools

Each spool is constructed for a specific valve application and is dynamically and hydrostatically balanced to prevent pressure forces from moving the spool within the bore. The spool used is a four-way type.

CENTER CONDITION DIAGRAM	SPOOL NUMBER	DESCRIPTION
	0	Open center. all ports.

(4) Methods of Control

SOLENOID - Push type solenoids are used to control movement of the spool. A manual plunger is available in each solenoid to check spool movement during test. Push type solenoids move the spool away from the solenoid when energized.

CAUTION

When a valve uses two solenoids, only one solenoid should be energized at a time or damage may result.

3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

This task covers:

a. Inspection
b. Removal
c. Disassembly
d. Cleaning
e. Reassembly
f. Installation

INITIAL SETUP

Test Equipment

None

References

None

Special Tools

None

Equipment Condition: None

Condition Description

Material/Parts

Gasket kit P/N 919428

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

WARNING

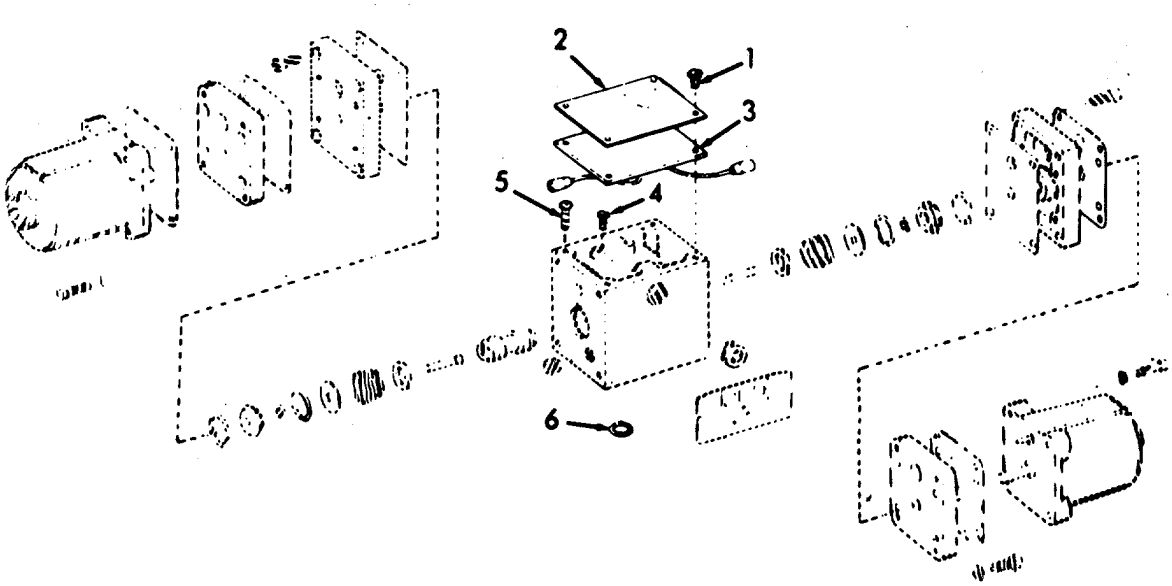
To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

INSPECTION

1.	Directional Valve	a. Tubing	Inspect for breaks, bends, cracks, and leaking.
		b. Wiring	Inspect for breaks, cracks and worn insulation.
		c. Valve	Inspect for cracks and leaking and that hardware is tight.

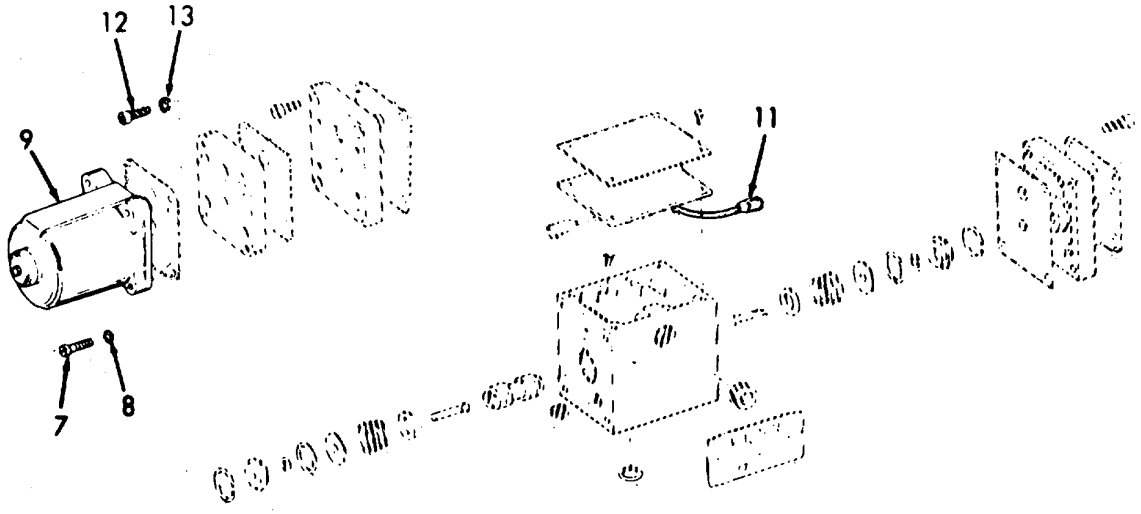
3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screw (1), and identi - fication plate (2)	Remove.	
	b. Gasket and wire sub- assembly (3)	1. Lift to disconnect ground screw (4). 2. Tag and disconnect external wiring. 3. Remove gasket and wire subassembly (3).	
	c. Piping	Disconnect piping at union.	
	d. Receptacle (5)	Remove.	
	e. Valve, and "0" ring (6)	Remove from mounting.	Discard 0 ring.



3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
3.	a. Screws (7), and lock-washers (8)	Remove.	
	b. Solenoid (9)	1. Remove. 2. Disconnect receptacle (11).	Discard gasket.
	c. Screws (12), and lock-washers (13)	Remove.	



3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

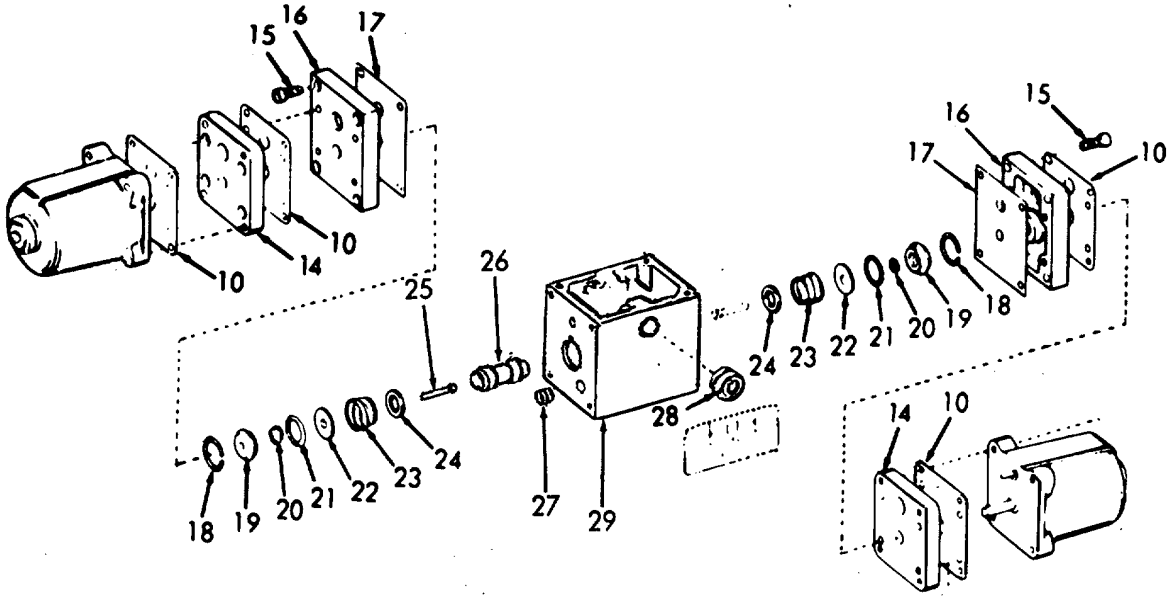
LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	d. Solenoid mounting plate (14), and gasket (10)	Remove.	Discard gasket.
	e. Screw (15)	Remove.	
	f. Adapter plate (16), and gasket (17)	Remove.	Discard gasket.
	g. Retaining ring (18), spring guide (19), " 0 " rings (20 and 21), washers (22), spring (23), and spring washers (24)	Remove.	Discard "O" rings.

NOTE

To help remove retaining ring (18), apply force to the end of the push pin (25) located in the opposite end of the valve.

3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY (Cont)			
	h. Push pin (25), and spool (26)	Remove and disassemble.	
	i. Plugs (27 and 28)	Remove from body (29).	If necessary.



3-3227

3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS

CLEANING

4. All parts must be thoroughly cleaned and kept clean during inspection and assembly. Contamination inthe unit will cause excessive wear, leakage and decreased service life. Clean in accordance with standard procedures for hydraulic parts. Do not use compressed air to dry parts unless the air is completely filtered in order to remove water and contaminants.

REASSEMBLY

5.

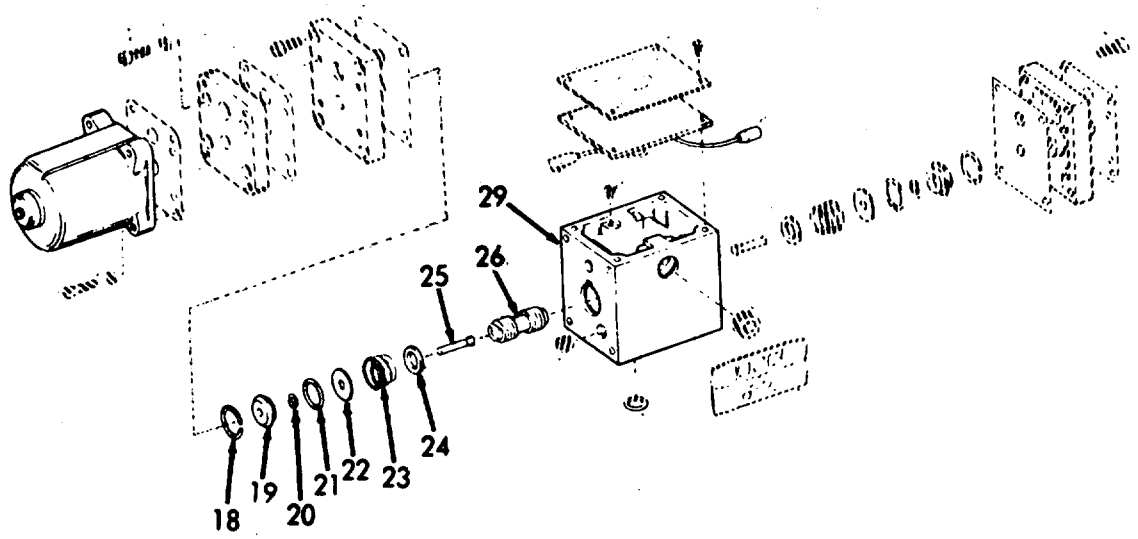
NOTE
Coat all internal parts lightly with lubricating oil.

a.	Push pin (25), and spool (26)	Reassemble and insert into body (29).	
b.	Spring washer (24), spring (23), washer (22), O-rings (21 and 20, spring guide (19), and retaining ring (18)	Install in body (29).	Use new "0" rings.

3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKSS

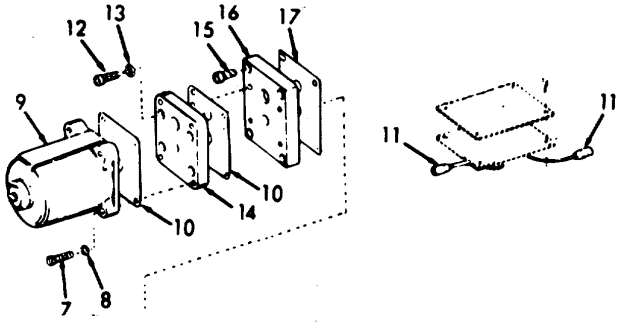
REASSEMBLY (Cont)



3-3229

3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued)

LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY (Cont)			
	c. Gasket (17), adapter plate (16), and screws (15)	Reassemble.	Use new gasket.
	d. Gasket (10), solenoid mounting plate (14), screws (12) and lockwashers (13)	Reassemble.	Use new gasket.
	e. Receptacle (11)	Feed thru holes in gasket (17), adapter plate (16), gasket (10), and solenoid mounting plate (14). Attach receptacles (5) to solenoid (9).	
	f. Gasket (10), solenoid (9), screws (7) and lockwashers (8)	Reassemble.	Use new gasket.



3-208. DIRECTIONAL CONTROL VALVE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6.	a. "O" rings (6)	Lubricate and install.	Use new "0" rings.
	b. Wiring and piping	Install.	
	c. Gasket and wire sub-assembly (3), identi-fication plate (2), and screw (1)	1. Install wire sub-assembly to ground screw (4). 2. Install remaining parts.	

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Service
c. Cleaning and Flushing
d. Removal
e. Installation
f. Repair
g. Initial Start-up

INITIAL SETUP

Test Equipment

Pressure gauge 0-3000 psi

References
Paragraph

3-204	Motor
3-206	Hydraulic Pump
3-207	Brake Valve
3-208	Directional Control Valve

Special Tools
None

Equipment
Condition — Condition Description
None

Material/Parts

Hydraulic fluid MIL-L-17672 Type 2135TH

Special Environmental Conditions

Do not drain oil into bilges. Use the oil separation and recovery system to collect used oil.

Personnel Required

2

General Safety Instructions

Observe WARNINGS in procedure.

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
	WARNING To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.		
1. Hydraulic Reservoir Tank	a. Piping	Inspect for breaks, dents, cracks, and leaking.	Refer to Direct Support Maintenance.
	b. Directional control valve	Inspect.	Refer to paragraph 3-208 .
	c. Brake valves	Inspect.	Refer to paragraph 3-207 .
	d. Hydraulic pump	Inspect.	Refer to paragraph 3-206 .
	e. Motor	Inspect.	Refer to paragraph 3-204 .
	f. Reservoir tank	Inspect for breaks, cracks, dents and leaking.	
	g. Hardware	Ensure all hardware is tight.	

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
SERVICE			
2. Hydraulic system	a. System	1. Operate until oil is warm.	
		2. Stop operation.	
		3. Remove oil from reservoir.	Drain oil into a suitable container.
	b. Access plate (1)	Loosen screw and remove plate.	
		WARNING	
		Wear protective eye goggles when using compressed air.	
	c. Strainer (2)	Remove and clean.	Clean with fuel oil and blow dry with compressed air.
	d. Reservoir (3)	Clean.	
	e. Filter breather (4)	Remove and clean.	Clean with fuel oil and blow dry with compressed air.
	f. Strainer (2)	Reinstall.	
	g. Access plate (1	Reinstall.	
	h. Filter pipe (5)	Refill.	The reservoir holds 10 gallons (37.85 liters) of hydraulic fluid.

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER MAINTENANCE INSTRUCTIONS.

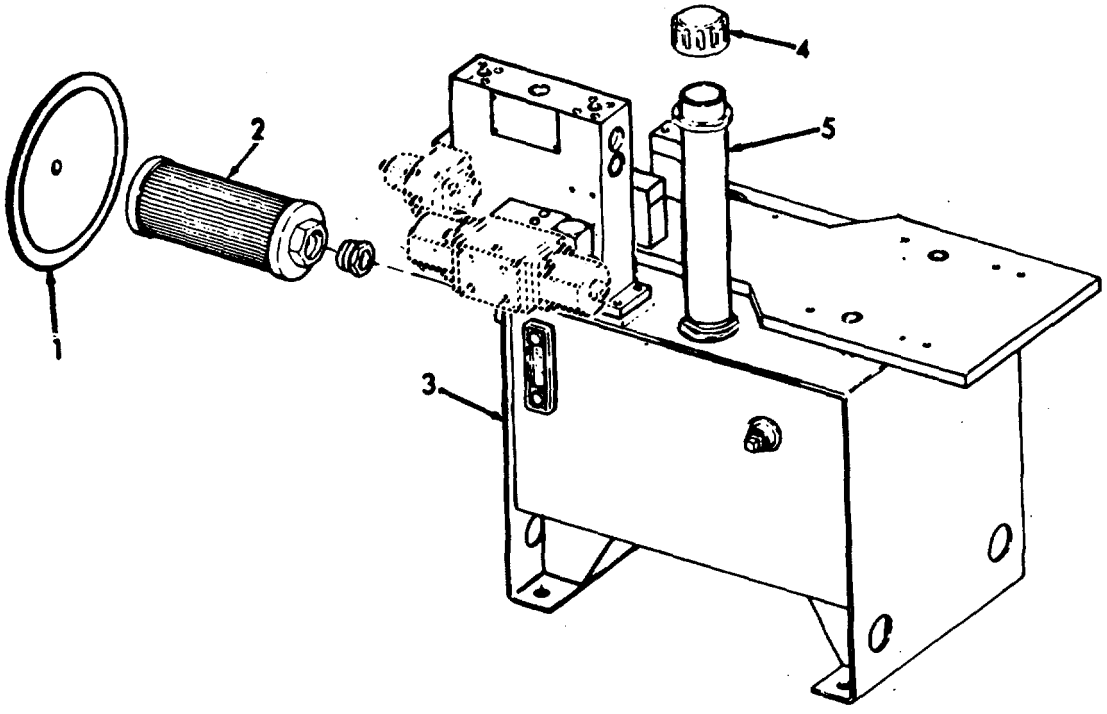
LOCATION	ITEM	ACTION	REMARKS

SERVICE (Cont)

NOTE

The entire system holds 30 gallons (113.55 liters)of hydraulic fluid.

i.	Initial start-up	Refer to step 7.	
j.	Filter breather (4)	Replace.	



3-3235

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

CLEANING AND FLUSHING

3. If the system has accumulated sufficient deposits to interfere with normal operation, it must be flushed with light mineral oil, or it may require more extensive cleaning.

   If light mineral oil is used, it must contain a rust-inhibitor to protect the metal surfaces against rust after draining.

   Systems sludged so much that they cannot be thoroughly cleaned with mineral oil must be dismantled and cleaned mechanically. Solvents and chemical cleaners are not recommended for use in hydraulic systems because they do not offer sufficient lubricating value, and result in damage to moving parts. It is very difficult to remove all solvent or cleaner from the system and any remaining solvent will dilute the fresh hydraulic oil, forming gummy deposits, or an emulsion.

REMOVAL

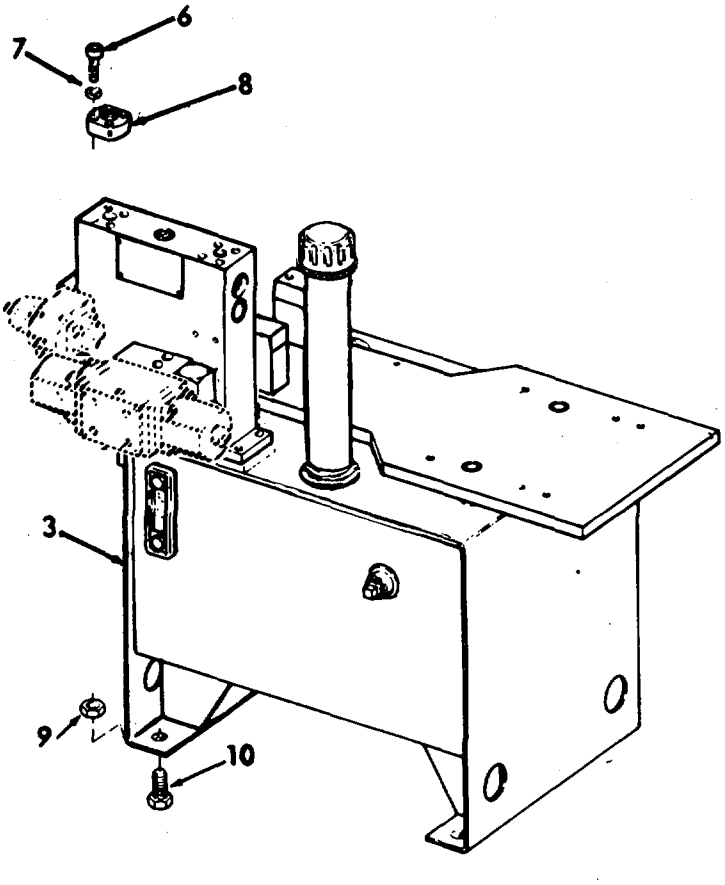
4.	Hydraulic Reservoir Tank	a.	Reservoir	Drain or pump oil from reservoir.
		b.	Wiring	Tag and disconnect wiring to motor and directional control valve.
		c.	Eight screws (6), and lock-washers (7	Remove.
		d.	Two manifold fittings (8)	Lift up to release piping.

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

e.	Nuts (9), and screws (10)	Remove.	
f.	Reservoir assembly (3)	Remove.	



3-3237

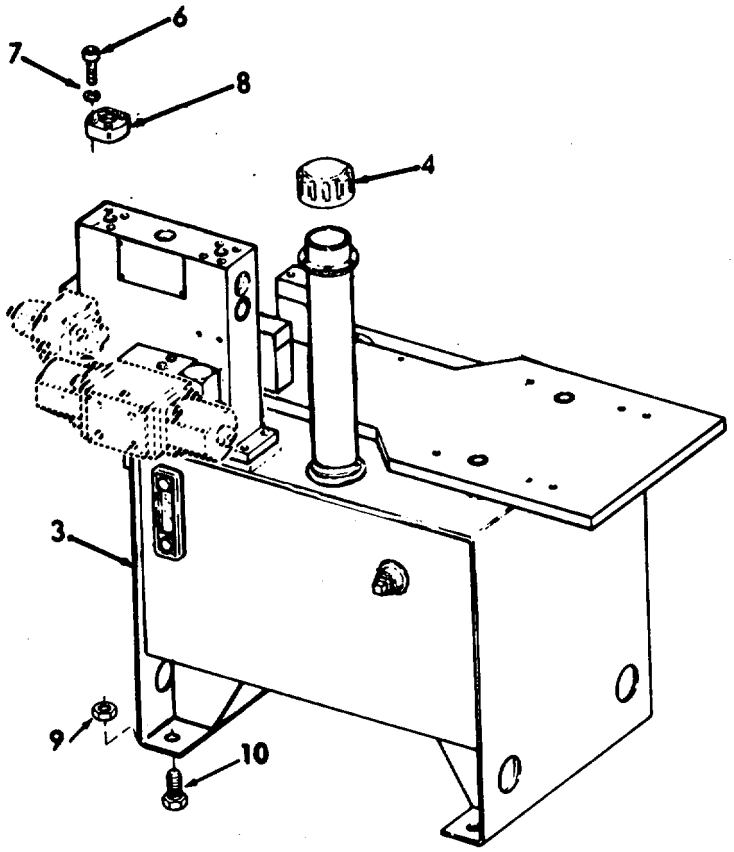
3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
5.	a. Reservoir (3), screws (10), and nuts (9)	Install.	
	b. Two manifold fittings (8), eight screws (6), and lock-washers (7)	Install.	
	c. Wiring tags.	Reconnect and remove	
	d. Filter breather (4)	Remove.	
	e. Reservoir (3)	Refill.	The reservoir holds 10 gallons (37.85 liters) of hydraulic fluid.
	f. Initial start-up		Refer to step 7.
	g. Filter breather (4)	Replace.	

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

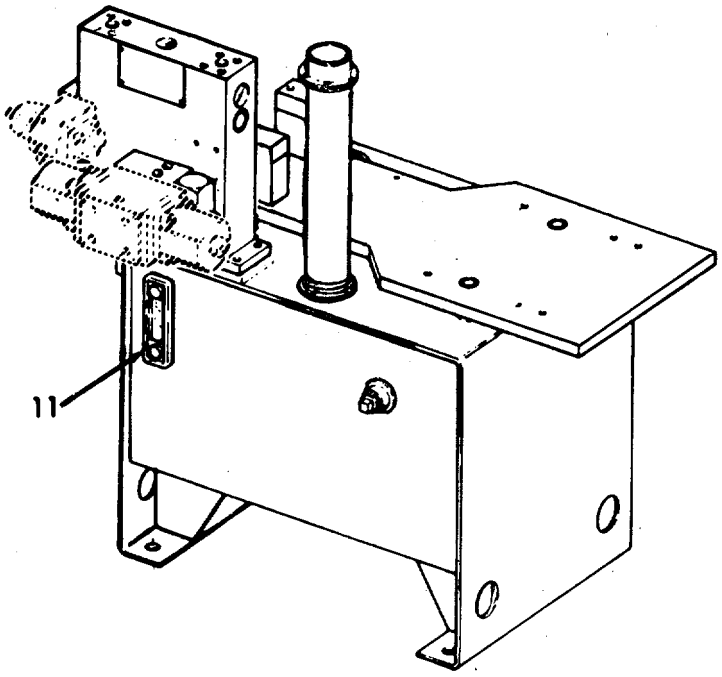
INSTALLATION (Cont)



3-3239

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
6. Sight Gage	Gage (11)		Replace if damaged.



3-3240

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INITIAL STARTUP

7. Hydraulic System.

The following procedure should be followed to ensure that the pump unit is not damaged during initial startup:

a. Fill tank to proper level as indicated on the oil level gauge. Disconnect tubing between the pump and manifold and fill the pump with oil. Reconnect tubing.

b. Remove a plug from the front of a brake valve and install a 0-3000 psi pressure gage.

c. Check direction of motor shaft rotation by starting the motor long enough to determine the direction of rotation. Ensure that motor rotation is in the same direction as the arrow on the pump. If the motor rotates in the wrong direction, reverse two of the motor leads to change the direction of rotation.

CAUTION

Do not allow the pump to run at full speed for more than 30 seconds if it does not pick up suction. If the pump does not pick up suction, it may be due to oil with too high a viscosity, low oil level in the tank, a leak in the tank, or a leak in the suction line to the tank.

d. Prime the pump by turning the motor on and off several times in rapid succession.

e. Operate the hydraulic system and fill it with oil by moving rudder from hardover to hardover.

3-209. HYDRAULIC CUB PUMP UNIT - HYDRAULIC RESERVOIR TANK AND STRAINER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INITIAL STARTUP (Cont)

CAUTION

Add oil to the tank to maintain the proper oil level as the system fills.

Operation will be smooth when all air is purged from the system by continuing to move the rudder for several minutes.

f. The pump relief valve is set at the factory; however, if a different pressure setting should be required proceed as follows. Note the reading of the pressure gauge as the directional valve is manually activated for right or left rudder. After the rudder reaches the hard-over position, adjust the pump relief valve, if necessary, until the indication is 2200 psi or less, as required.

g. The cylinder relief valves are set at the factory to 200 psi above the pump relief valve setting. If resetting is required, follow the procedure in Step f. The pump relief setting must be temporarily increased while setting the cylinder relief valve.

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection
b. Removal
c. Repair
d. Installation
e. Adjustment

INITIAL SETUP:

Test Equipment

None

Special Tools

Spanner Wrench - hooked

Material/Parts

Hydraulic fluid MIL-L-17672 Type 2135TH

Personnel Required

2

References

None

Equipment Condition Condition Description Paragraph

3-211 Hydraulic Hoses Removed

Special Environmental Conditions

Do not drain oil into bilges. Use the oil separation and recovery system to collect used oil.

General Safety Instructions

Observe WARNING in procedure.

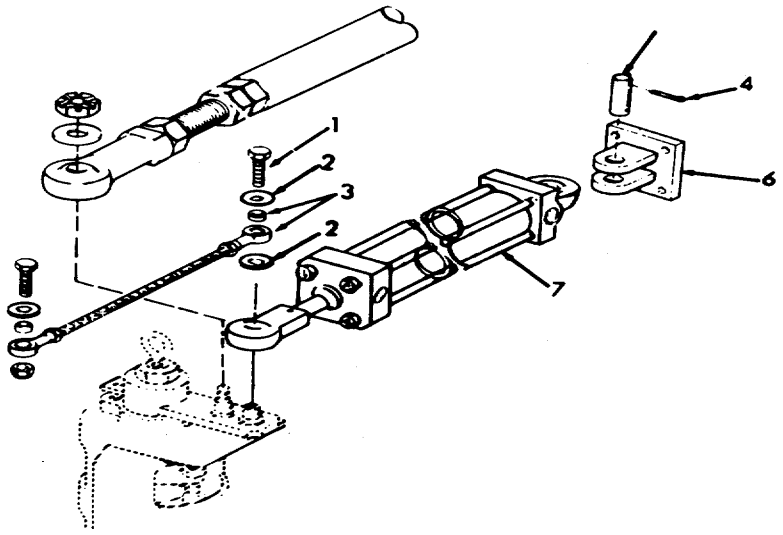
LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
		WARNING To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.	
1. Hydraulic cylinders	a. Hoses	Inspect for cracks, breaks, bends and leaking.	Refer to paragraph 3-211.

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	b. Hydraulic cylinder	1. Inspect for cracks, breaks and leaking.	
		2. Inspect for missing and broken hardware.	
		3. Insure all hardware is tight.	
		4. Inspect for wear.	
		5. During operation, inspect for binding and ease of operation.	
2. Adjustable Links links		a. Inspect for missing and broken hardware. b. Inspect for wear.	
		c. Inspect for breaks and cracks.	
		d. During operation, inspect for binding and ease of movement.	
		e. Insure all hardware is tight.	
3. Threaded rods		a. Inspect for cracks, breaks and leaking.	
		b. Inspect for missing and broken hardware.	
		c. Insure all hardware is tight.	
		d. Inspect for wear.	
		e. During operation, inspect for binding and ease of operation.	

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
4. Hydraulic Cylinder Main Rudder Linkage	a. Screw (1), flat-washers (2), spherical bearing and threaded rod (3)	Remove.	
	b. Cotter pins (4), and pivot pin (5)	Remove from clevis bracket (6).	
	c. Hydraulic cylinder (7)	Remove.	



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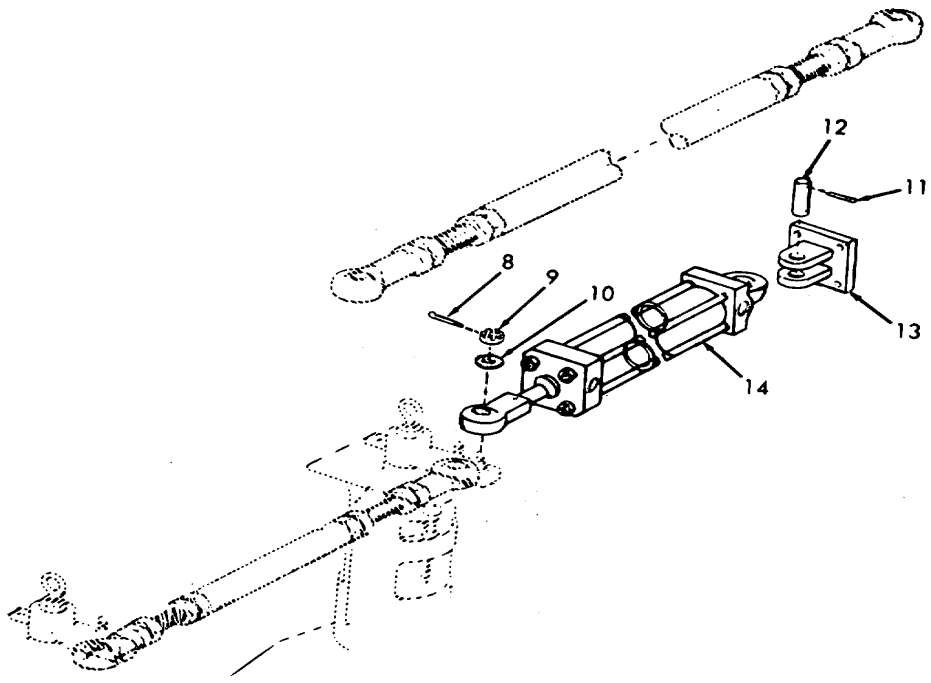
3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

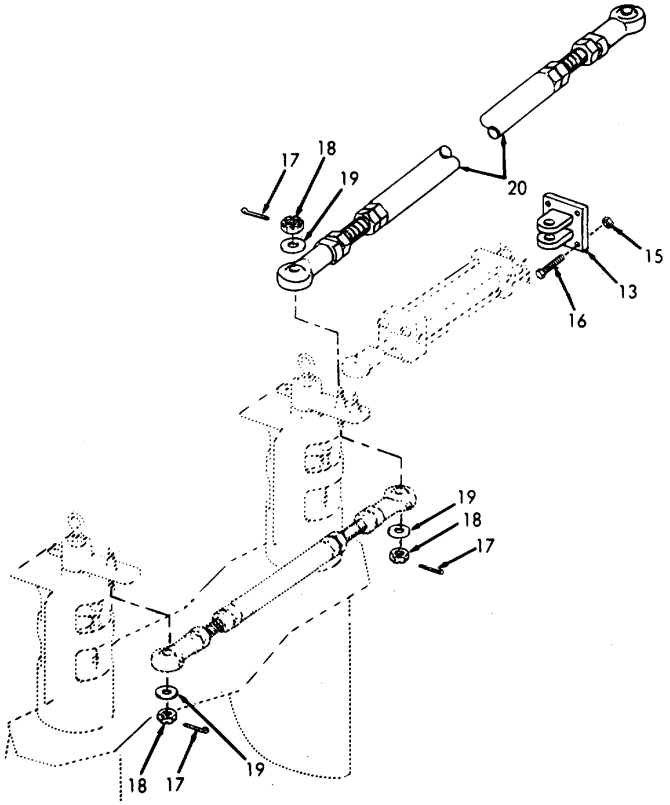
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
5. Hydraulic Cylinder Flanking Rudder	a. Cotter pin (8), slotted hex nut (9), and flatwasher (10)	Remove.	
	b. Cotter pins (11), and pivot pin (12)	Remove from clevis bracket (13).	
	c. Hydraulic cylinder (14)	Remove.	



3-3247

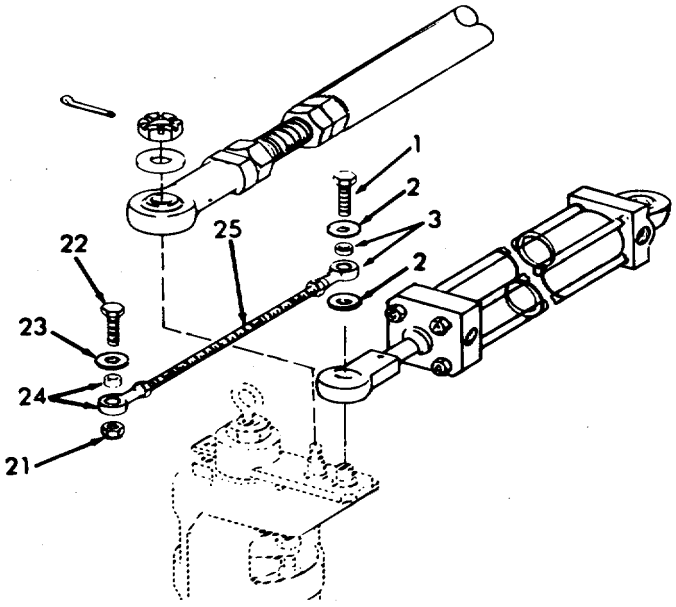
3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
6. Clevis Bracket (13)	a. Nuts (15), and screws (16)	Remove.	
	b. Clevis bracket (13)	Remove.	
7. Adjustable Links	a. Cotter pins (17), slotted hex nuts (18), and flat-washers (19)	Remove.	
	b. Link (20)	Remove.	



3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
8. Threaded Rods	a. Screw (1), flat-washers (2), spherical bearing and threaded rod (3)	Remove.	
	b. Nut (21), screw (22), flat-washers (23), and spherical bearing (24)	Remove.	
	c. Rod (25)	Remove.	

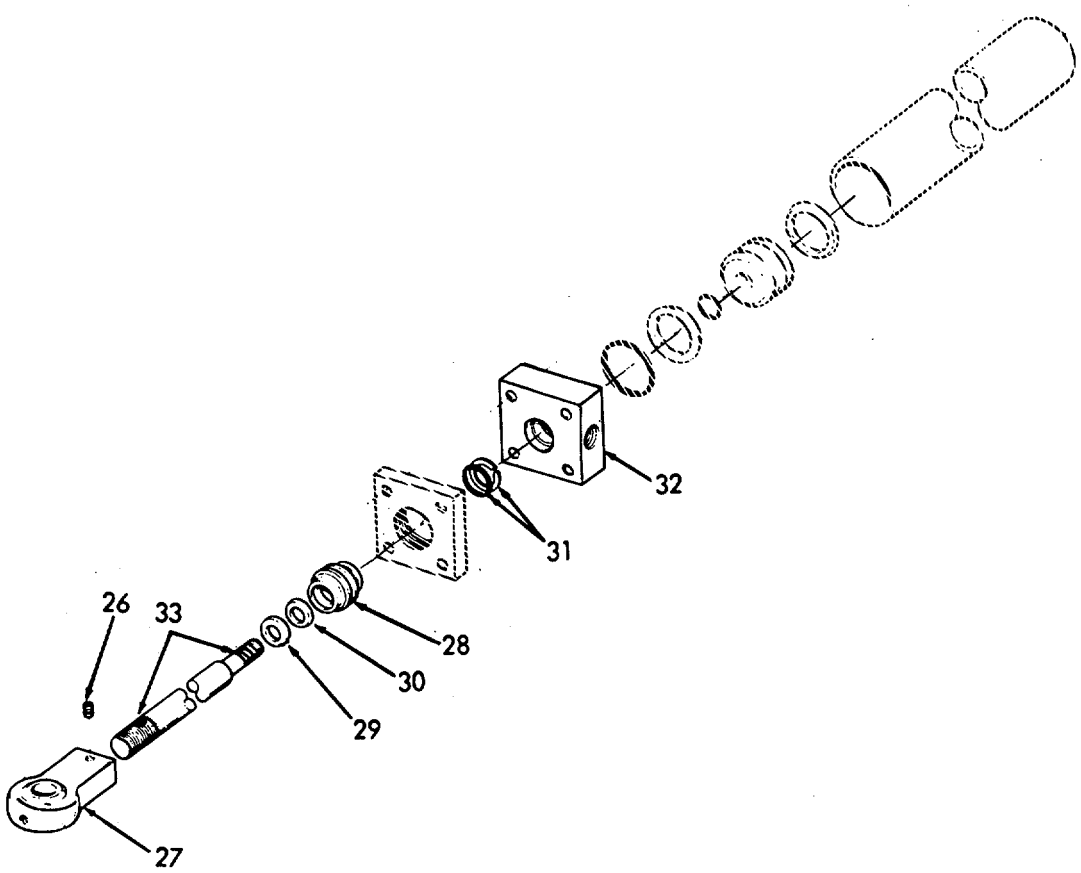


3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
9. Hydraulic Cylinder rod seal	a. Setscrew (26)	Remove.	
	b. Rod eye (27)	Unscrew.	
	c. Rod cartridge (28)	Unscrew.	Use a hooked spanner wrench, and discard.
	d. Rod scraper (29), rod seal cup (30), back-up and seal ring (31)	Remove.	Discard.
	e. Back-up and Seal ring (31), rod seal cup (30), and rod scraper (29)	Assemble to rod cartridge (28).	1. Use new parts. 2. Coat seals with clean hydraulic fluid.

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Rod cartridge (28)	Install.	1. Use hooked Spanner wrench. 2. Install until it is firmly seated to the rod end head (32).
	g. Rod eye (27)	Screw onto piston rod (33).	
	h. Setscrew (26)	Install.	

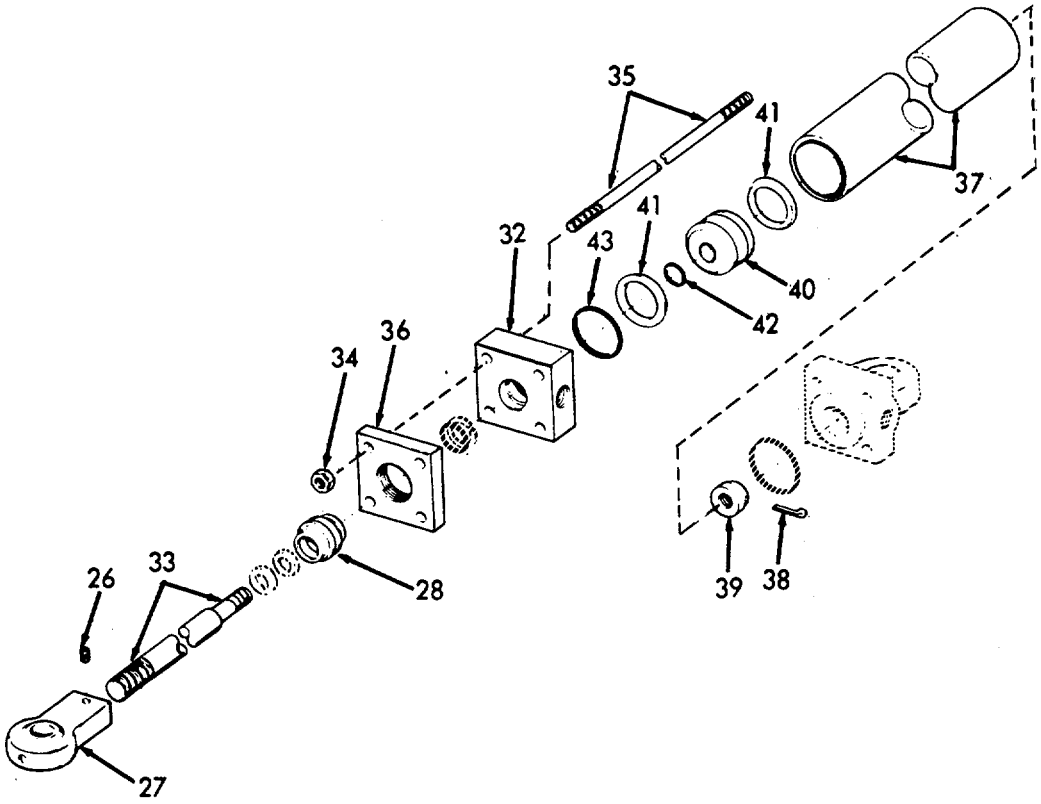


3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
10. Piston Seal	a. Setscrew (26)	Remove.	
	b. Rod eye (27)	Unscrew.	
	c. Rod cartridge (28)	Unscrew.	Use a hooked Spanner wrench.
	d. Nuts (34)	Remove from tie rod (35).	
	e. Retainer plate (36), and rod end head (32)	Remove.	
	f. Piston rod (33)	Slide out of cylinder barrel (37).	
	g. Cotter pin (38), and blank end cushion sleeve (39)	Remove.	
	h. Piston (40)	Remove from piston rod (33).	

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	i. Two piston seal cups (41), and piston ring seal (42)	Remove from piston (40).	
	j. Two barrel seal rings (43)	Remove from cylinder barrel (37).	Discard.

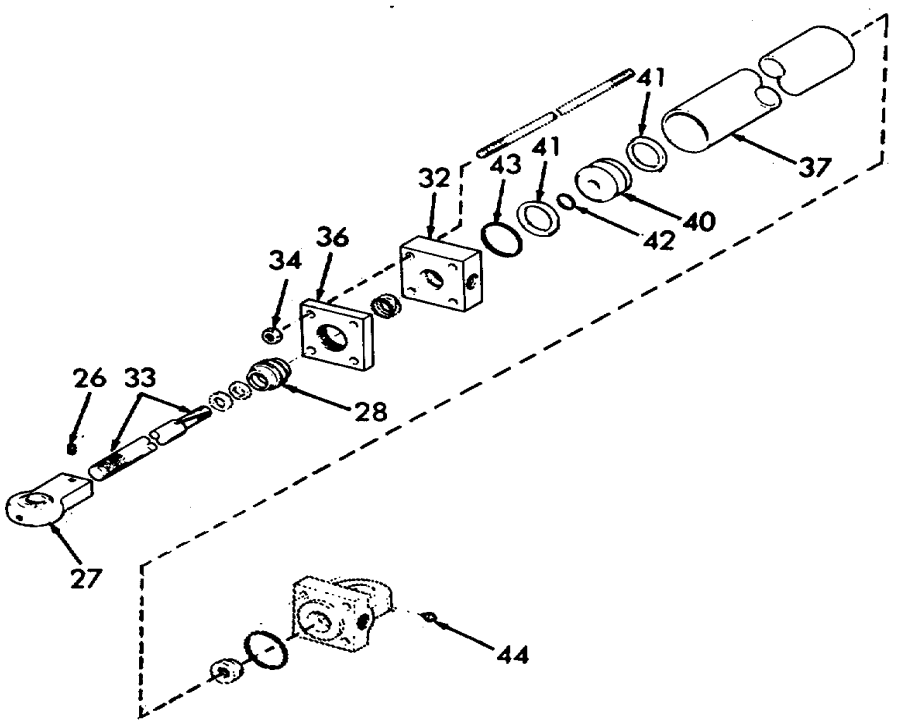


3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
		NOTE Lubricate all seal rings and seals with hydraulic fluid before installing.	
	k. Barrel seal rings (43)	Install in the cylinder barrel (37).	
	l. Piston ring seal (42)	Install in piston (40).	
	m. Piston seal cups (41)	Install as follows: 1. Install one seal in the groove nearest the rod end with lips of the seal facing the rod end of the piston. 2. Insert piston into cylinder, and push it through the barrel just far enough to expose the groove for the second seal. 3. Install the second seal with the lips of the seal facing the mounting end of cylinder. 4. Push the piston into the cylinder barrel.	
	n. Rod end head (32), and retainer plate (36)	Install.	

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	o. Nuts (34)	Install.	Tighten each alternately to 30 ft-lb (40.7 Nm) torque.
	p. Rod cartridge (28)	Install.	1. Use hooked Spanner wrench. 2. Install until it seats firmly to rod end head (32).
	q. Rod eye (27)	Screw onto piston rod (33).	
	r. Setscrew (26)	Replace.	If necessary.
11. Grease fittings	Fittings (34)	Replace.	If necessary.

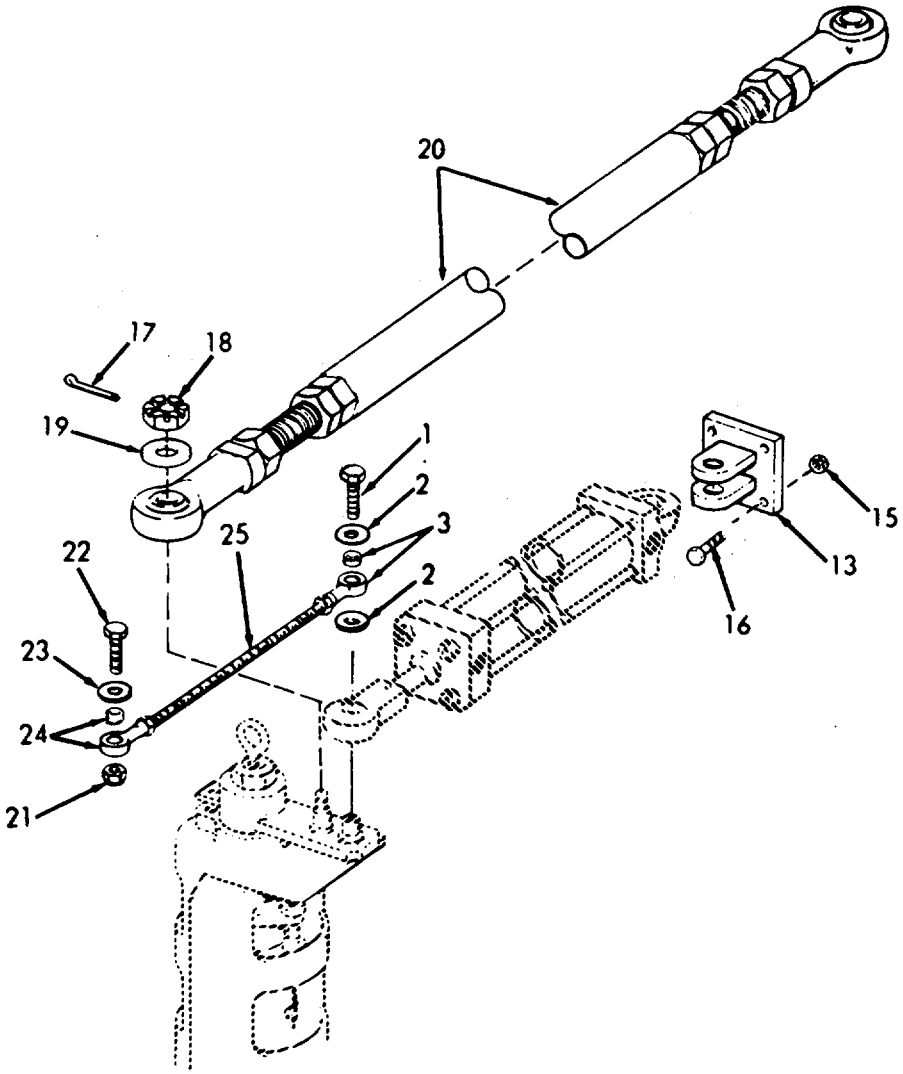


3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
12. Threaded Rods	a. Rod (25), spherical bearing (24), flat-washers (23), screw (22), and nut (21)	Install.	
	b. Spherical bearing and threaded rod (3), flat-washer (2), and screw (1)	Install.	
13. Adjust-able link	Link (20), flat-washers (19), slotted hex nuts (18) and cotter pin (17)	Install.	

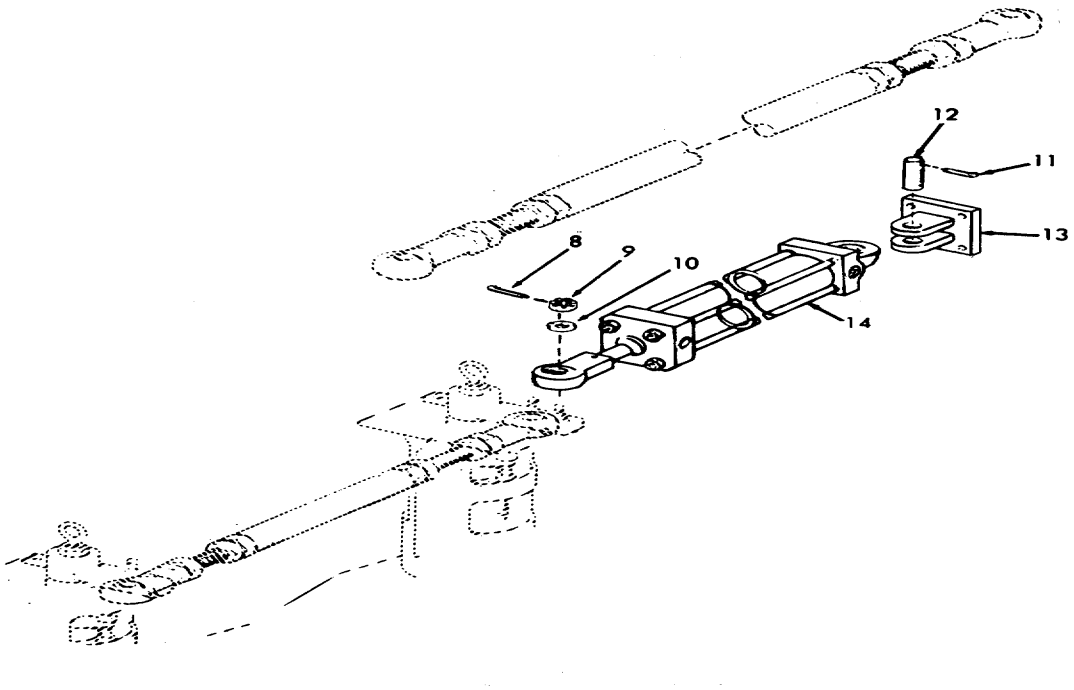
3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
14. Clevis bracket	Clevis bracket (13), screws (16) and nuts (15)	Install.	



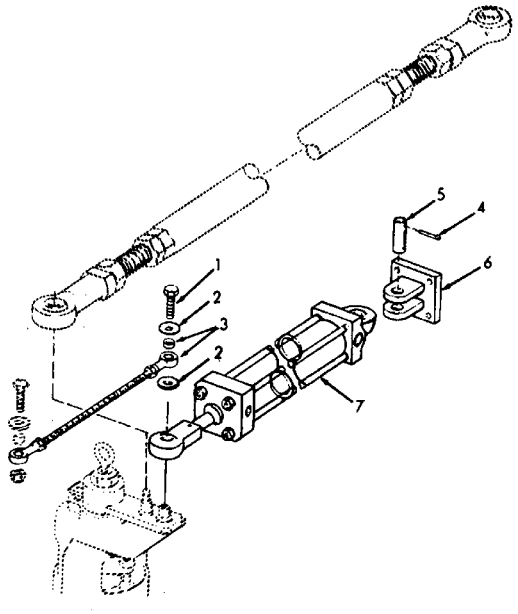
3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
15. Hydraulic Cylinder Flanking Rudder Linkage	a. Hydraulic cylinder (14), pivot pin (12), and cotter pins (11)	Install in clevis bracket (13).	
	b. Flat-washer (10), slotted hex nut (9), and cotter pin (8)	Install.	



3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
16. Hydraulic Cylinder Main Rudder Linkage	a. Hydraulic cylinder (7), pivot pin (5), and cotter pins (4)	Install in clevis bracket (6).	
	b. Threaded rod with spherical bearing (3), flat-washers (2), and screw (1)	Install.	



3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT			
17. Adjustable rods, threaded rods, and Hydraulic Cylinders	a. Hydraulic cylinders	1. Remove cotter pin, slotted hex nut, and washer attaching cylinder to rudder post.	
		2. Manually move rudder until it is aligned parallel to the fore and aft line.	
		3. Loosen setscrew and adjust position of rod end eye.	
		4. Reinstall rod end eye and all hardware.	
	b. Adjustable rod	1. Remove cotter pins, slotted hex nuts and washer attaching rod to rudder post.	
		2. Manually move rudder until it is aligned parallel to the fore and aft line.	
		3. Loosen locknuts and rotate rod end eye.	
		4. Reinstall rod end eye and all hardware.	
		NOTE Make sure that all rudders are parallel to fore and aft line.	
	c. Threaded rod	1. Remove screws and flatwashers.	

3-210. STEERING SYSTEM - HYDRAULIC CYLINDER AND LINKAGE - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
		2. Adjust spherical bearing rod end so that either the flanking rudder limit switch, or the rudder repeat-back transmitter indicates and operates correctly.	
		3. Reinstall spherical bearing, flatwashers and screws.	

3-211. STEERING SYSTEM - HYDRAULIC HOSES, PIPING AND VALVES - MAINTENANCE INSTRUCTIONS

This task covers: **a. Inspection** **b. Disassembly** **c. Reassembly**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

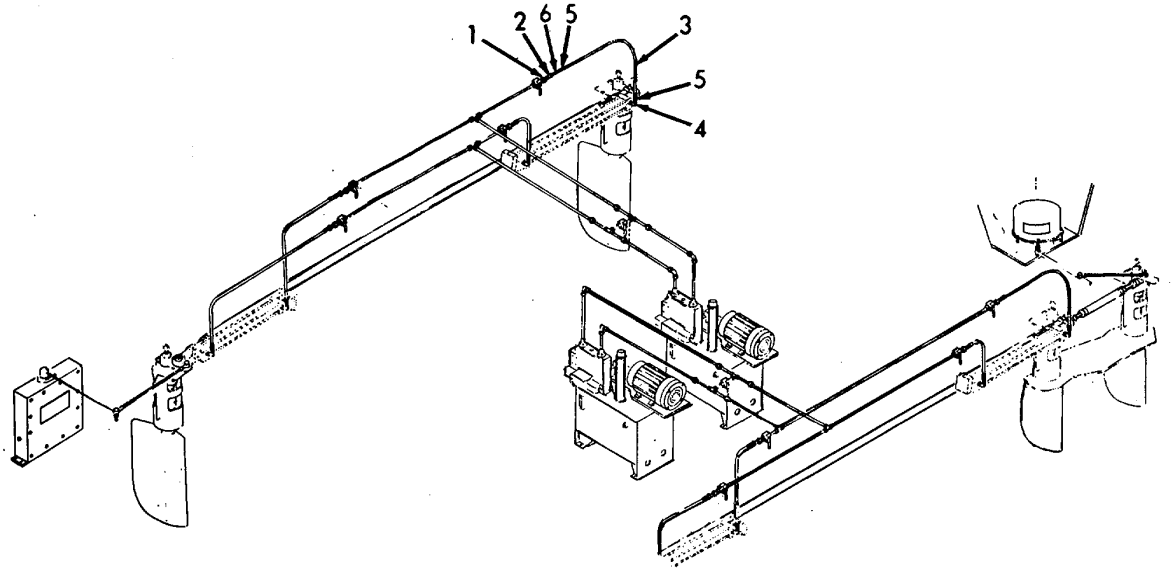
General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
		WARNING To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.	
1. Steering compartment	a. Hoses	Inspect for cracks, breaks or leaks.	
	b. Piping	Inspect for cracks, breaks or leaks.	Refer to Direct Support Maintenance.
	c. Valves	Inspect for cracks, breaks or leaks.	Refer to Direct Support Maintenance.

3-211. STEERING SYSTEM - HYDRAULIC HOSES, PIPING AND VALVES - MAINTENANCE INSTRUCTIONS

LOCATION	ITEM	ACTION	REMARKS
DISASSEMBLY			
2.	a. Valve (1)	Turn off.	
	b. Union nut (2)	Remove.	
	c. Hose assembly (3), and pipe elbow (4)	Unscrew at pipe elbow.	
	d. Hose fitting (5), and union halve (6)	Unscrew.	



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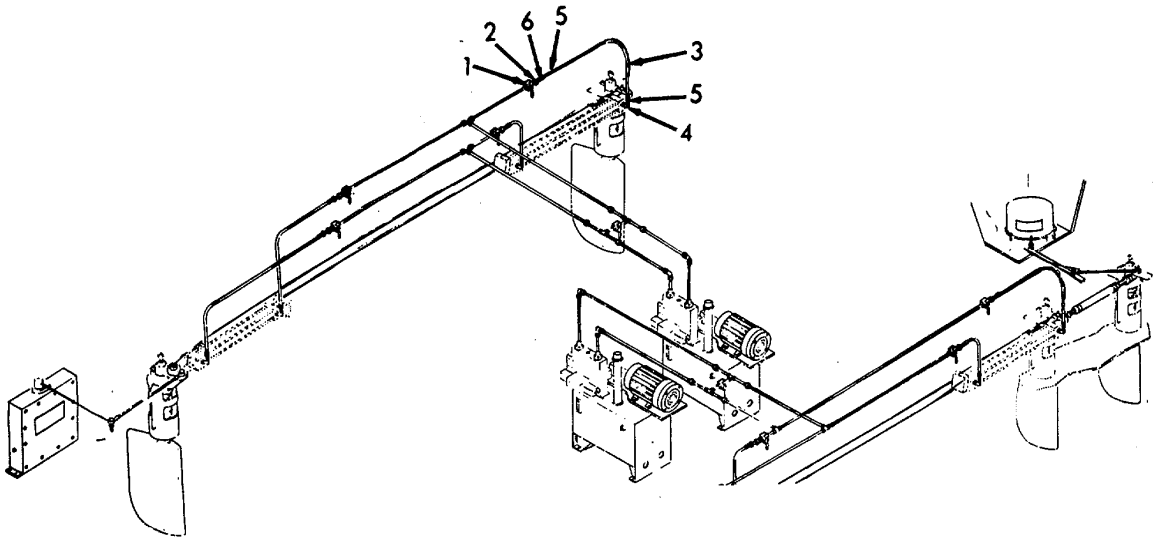
3-211. STEERING SYSTEM - HYDRAULIC HOSES, PIPING AND VALVES - MAINTENANCE INSTRUCTIONS

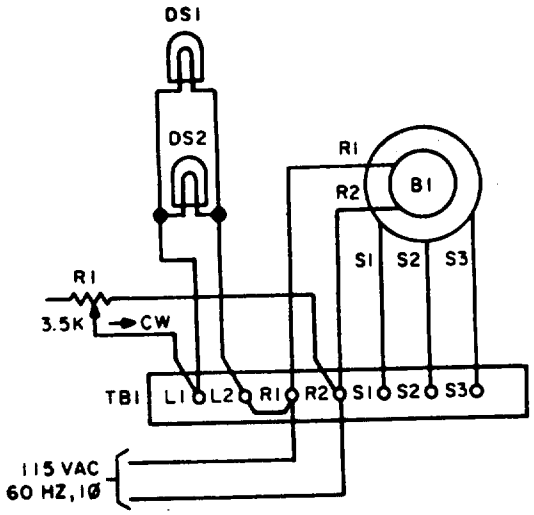
LOCATION	ITEM	ACTION	REMARKS
REASSEMBLY			
3.	a. Hose fitting (5), and union halve (6)	Reassemble.	
	b. Hose assembly (3), and pipe elbow (4)	Reassemble.	
	c. Union nut (2)	Tighten.	
	d. Valve (1)	Turn on.	



3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS

The Rudder Angle Indicator indicates the angle of the rudder (right or left) in degrees.

A synchro in the rudder angle indicator is excited by 115-volt, 60-hertz, 1-phase ship's power and aligns with a similar synchro in the rudder transmitter. Two ratios are available between the Rudder Repeatback and the Rudder Angle Indicator pointer to give ±40 degrees or ±50 degrees maximum rudder angle indication. The unit is waterproofed, with stuffing tubes supplied for wiring. Red back panel lighting with a dimmer control is also provided.



3-3265

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **b. Removal**
c. Repair **d. Installation** **e. Adjustment**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in procedure.

INSPECTION

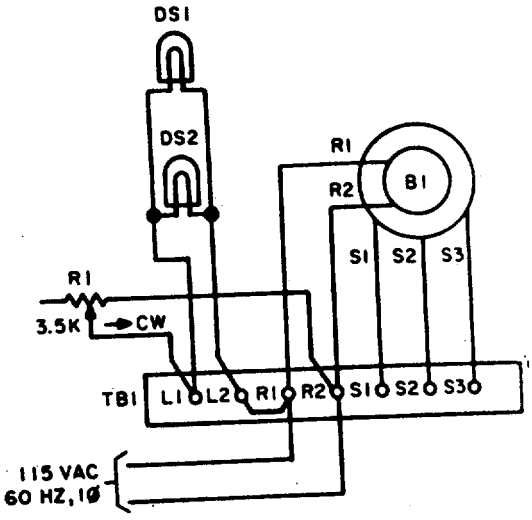
WARNING

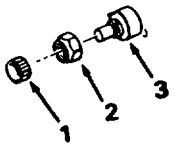
To avoid electrical shock, tag and place circuit breaker in the OFF position.

1.	Rudder Angle Indicator	a. Lamp dimmer	1. Inspect for missing knob.
			2. Rotate knob to determine if lamps dim.
		b. Glass	Inspect for cracks and broken glass.
		c. Housing	Inspect for dents.
		d. Lamps	Inspect for burned out lamps.

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
2 Dimmer	a. Knob (1)	Loosen setscrew and remove.	
	b. Wiring	Unsolder and remove.	Refer to schematic.
	c. Seal nut (2)	Remove.	
	d. Rheostat (3)	Remove.	
	e. Rheostat (3), and seal nut (2)	Replace.	
	f. Wiring	Reconnect and solder.	Refer to schematic.
	g. Knob (1)	Install and tighten setscrew.	



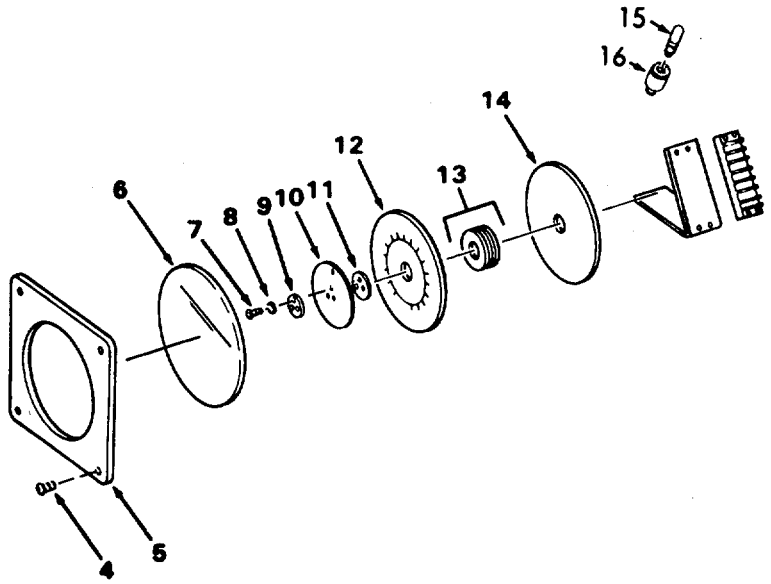


3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
3. Window	Four screws (4), cover (5), and window (6)	Remove and replace.	
4. Pointer, dial and Indicator Lamps	a. Four screws (4), cover (5), and window (6)	Remove.	
	b. Three screws (7), lock-washers (8), clamp (9), and pointer disc (10)	Remove.	
	c. Pointer hub (11), dial indicator (12), dial spacer (13), and light defuser (14)	Remove.	
	d. Lamps (15)	Remove.	

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	e. Lamp sockets (16)	Unsolder wires and remove.	Refer to schematic.



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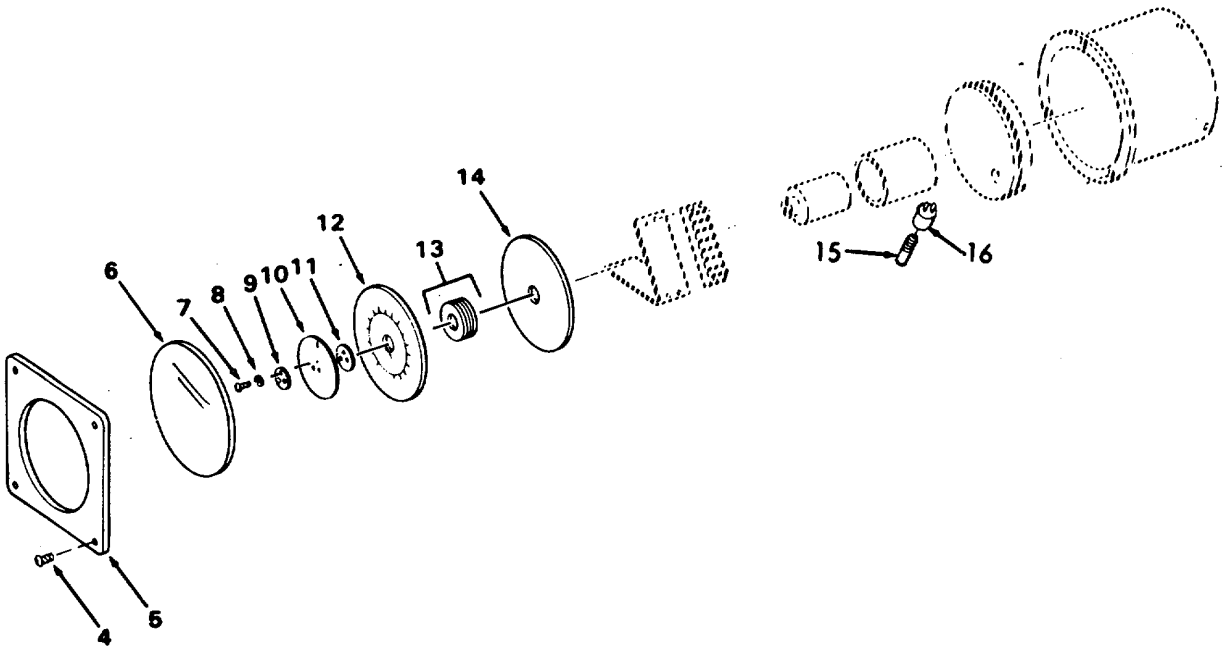
3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK
REPAIR (Cont)			
	f. Lamp sockets (16)	Install and resolder.	
	g. Lamps (15)	Install.	
	h. Light defuser (14), dial spacer (13), dial indicator (12), and pointer hub (11)	Assemble.	
	i. Pointer disc (10), clamp (9), screws (7), and lock-washers (8)	Install.	
	j. Window (6), cover (5), and screws 4)	Install.	

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARK

REPAIR (Cont)



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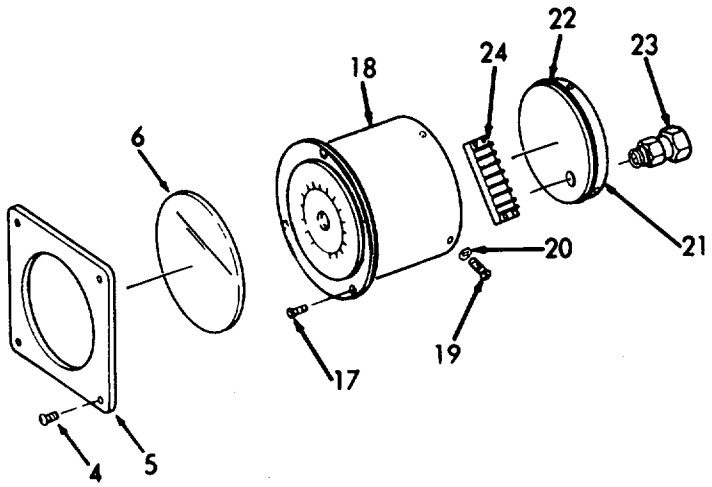
3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
5. Rudder Angle Indicator	a. Screws (4), cover (5), and window (6)	Remove.	
	b. Screws (17)	Remove.	
	c. Cover (18)	Remove.	
	d. Screws (19), and flat-washers (20)	Remove.	
	e. Back-casting (21), and pre-formed packing (22)	Move away from cover (18) for access to terminal strip.	Slide wiring through stuffing tube (23).
	f. Terminal strip (24)	Tag and disconnect wires.	Refer to schematic.

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



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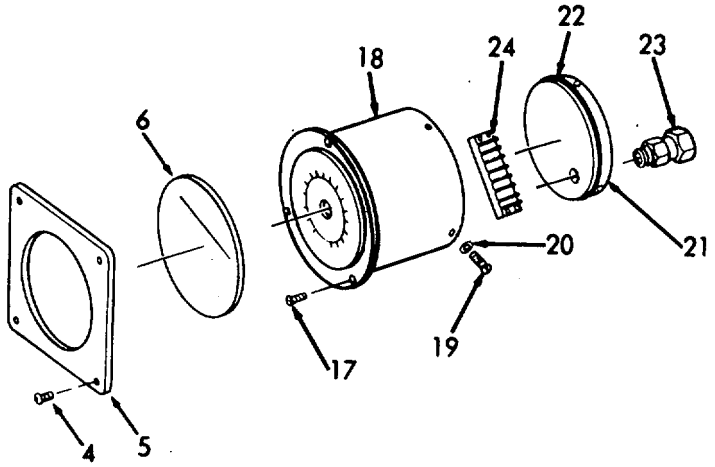
3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
6.	a. Terminal strip (24)	Reconnect wires and remove tags.	Refer to schematic.
	b. Preformed packing (22), back casting (21), cover (18), screws (19), and flat washers (20)	Reassemble.	
	c. Cover (18), and screws (17)	Install in panel.	
	d. Window (6), cover (5), and screws (4)	Install.	

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

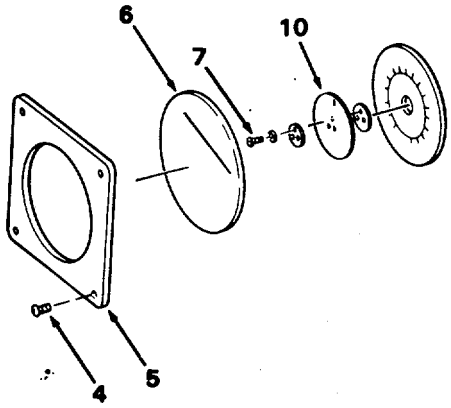
INSTALLATION (Cont)



3-3275

3-212. RUDDER ANGLE INDICATOR - MAINTENANCE INSTRUCTIONS (Cont).

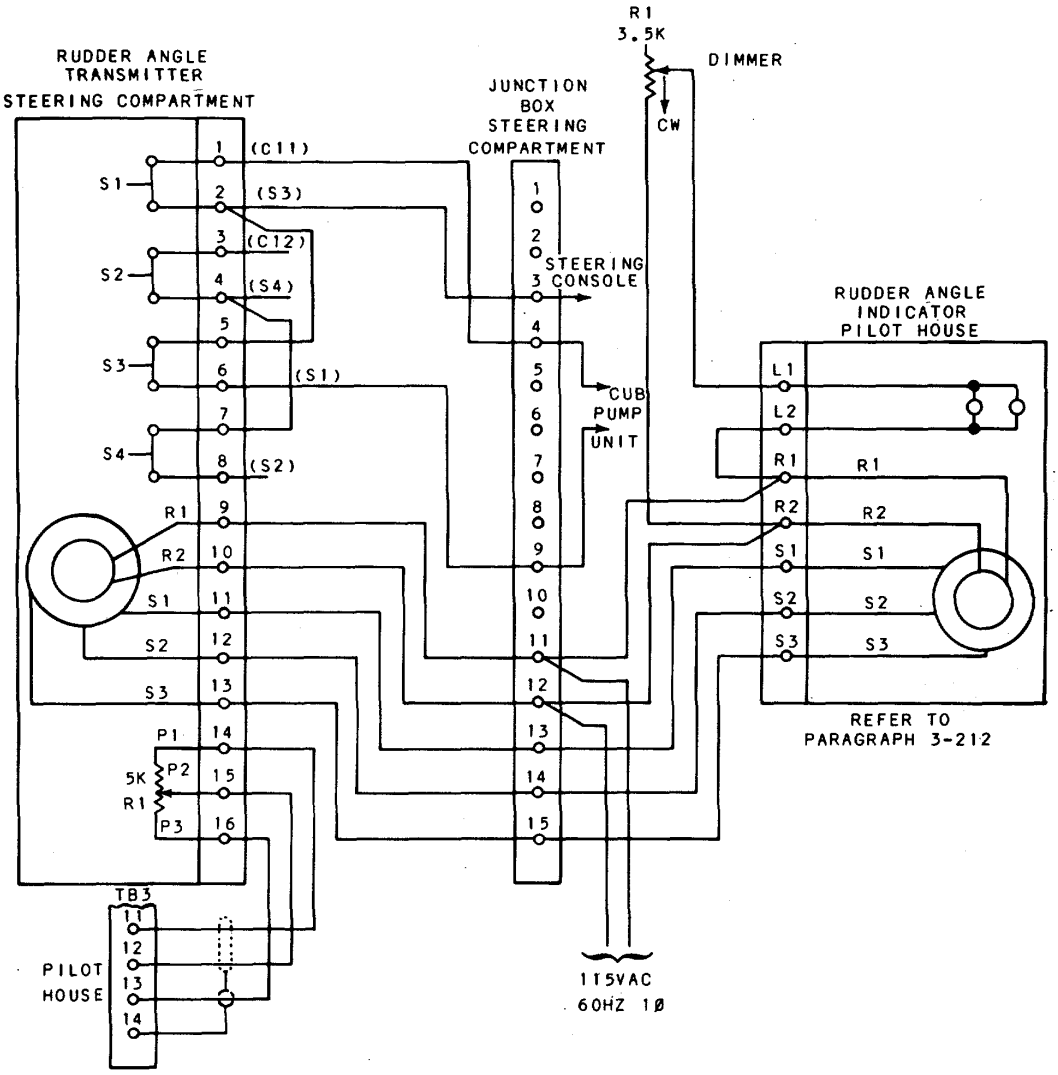
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT			
7. Dial Zeroing	a. Screws (4), cover (5), and window (6),	Remove.	
	b. Screws (7)	Loosen.	
	c. Pointer disc (10)	Rotate until pointer indicates zero.	
	d. Screws (7)	Tighten.	
	e. Window (6), cover (5), and screws (4)	Install.	



3-3276

3-213. RUDDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS.

The Rudder Repeatback/Rudder Angle Transmitter contains a torque synchro which generates a rudder position signal for driving rudder angle indicators and a rudder repeatback potentiometer which is used with other steering equipment to position the rudder to a predetermined angle. The rudder repeatback signal is connected to an amplifier in the steering control equipment where it is compared to a rudder order signal; when the rudder order and repeatback signals are equal, rudder movement stops. Both units include limit switches to limit rudder travel.



This task covers:

a. Inspection **c. Installation**
b. Removal **d. Repair** **e. Adjustment**

INITIAL SETUP:

Test Equipment

Ohm-Voltmeter

References
Paragraph

3-210 Hydraulic Cylinders and Linkage

Special Tools

None

Equipment Condition: None

Condition Description

Material/Parts

None

Special Environmental Conditions

None

Personnel Required

1

General Safety Instructions

Observe WARNING in procedure.

INSPECTION

1.	Rudder Repeatback Transmitter	a. Tie rods	1. Inspect for breaks and cracks.	Refer to paragraph 3-210.
			2. Ensure hardware is tight.	
		b. Transmitter arm	Inspect for cracks, breaks and defective pin.	
		c. Transmitter Box	1. Inspect for cracks, breaks and dents. 2. Insure hardware is tight.	
		d. Wiring	Inspect for worn, frayed or broken wiring.	

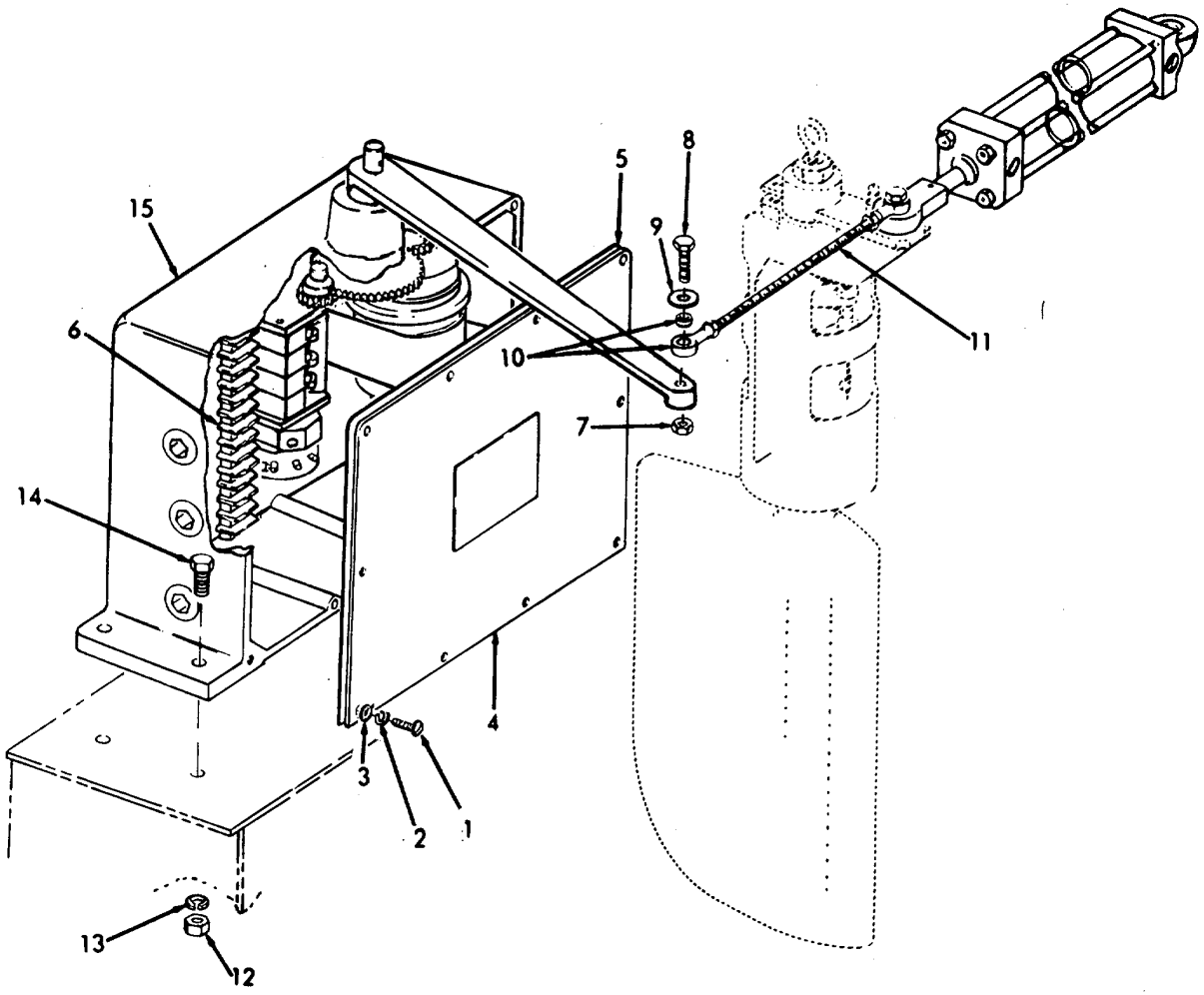
3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Screws (1), lock-washers (2), and flat-washers (3)	Remove.	
	b. Cover (4), and gasket (5)	Remove.	
	c. Wiring	Tag and disconnect external wiring to terminal strip (6).	Refer to schematic.
	d. Nut (7), screw (8), and flat-washer (9)	Remove.	
	e. Spherical bearing (10), and tie-rod (11)	Remove.	
	f. Nuts (12), lock-washers (13), and screws (14)	Remove.	
	g. Transmitter (15)	Remove.	

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)



3-3281

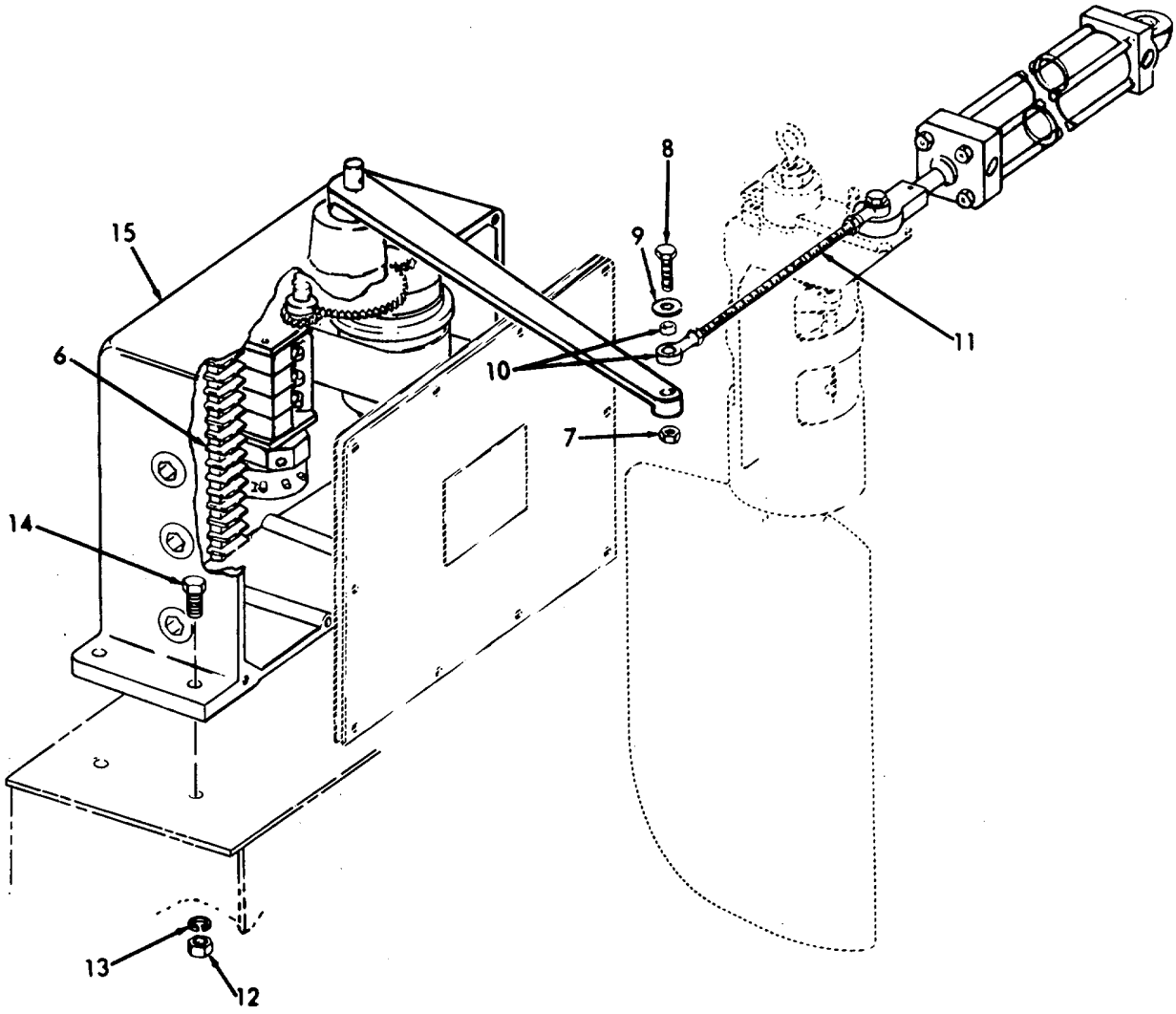
3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Transmitter (15), screws (14), lockwashers (13), and nuts (12)	Install.	
	b. Tie-rod (11), and spherical bearing (10)	Install.	
	c. Screw (8), flatwasher (9), and nut (7)	Install.	
	d. Wiring	Reconnect to terminal strip (6).	Refer to schematic.
	e. Transmitter (15)	Adjust.	Refer to step 6 .

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

INSTALLATION (Cont)



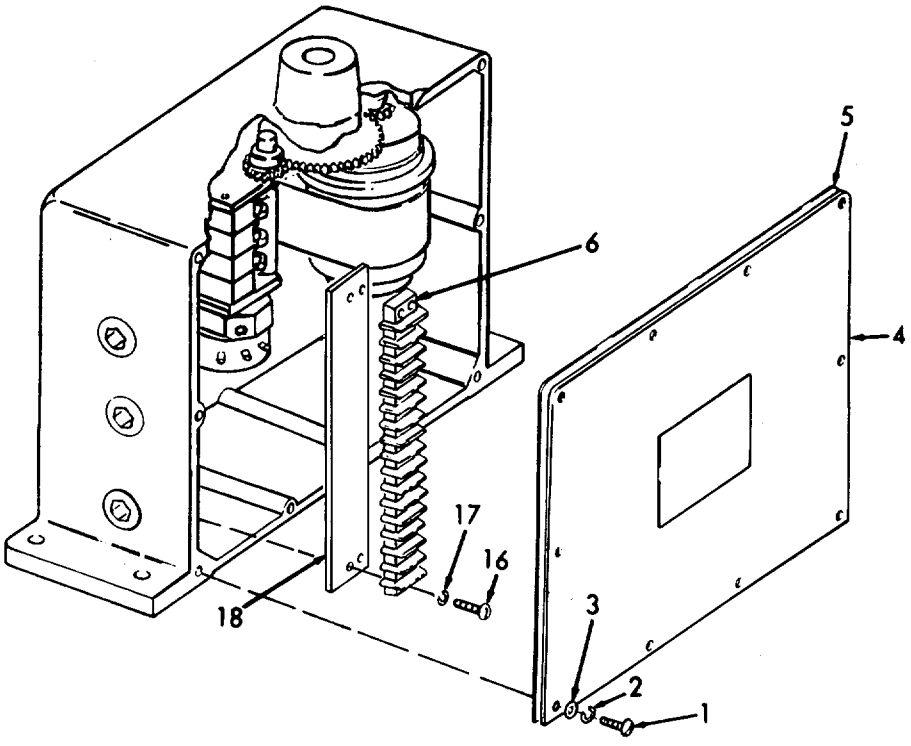
3-3283

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Terminal strip and Identification strip	a. Screws (1), lockwashers (2), and flatwashers (3)	Remove.	
	b. Cover (4), and gasket (5)	Remove.	
	c. Wiring	Tag and disconnect all wiring to terminal strip **6**.	Refer to schematic.
	d. Screws (16), and lockwashers (17)	Remove.	
	e. Terminal strip (6), and identification strip (18)	Remove.	

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



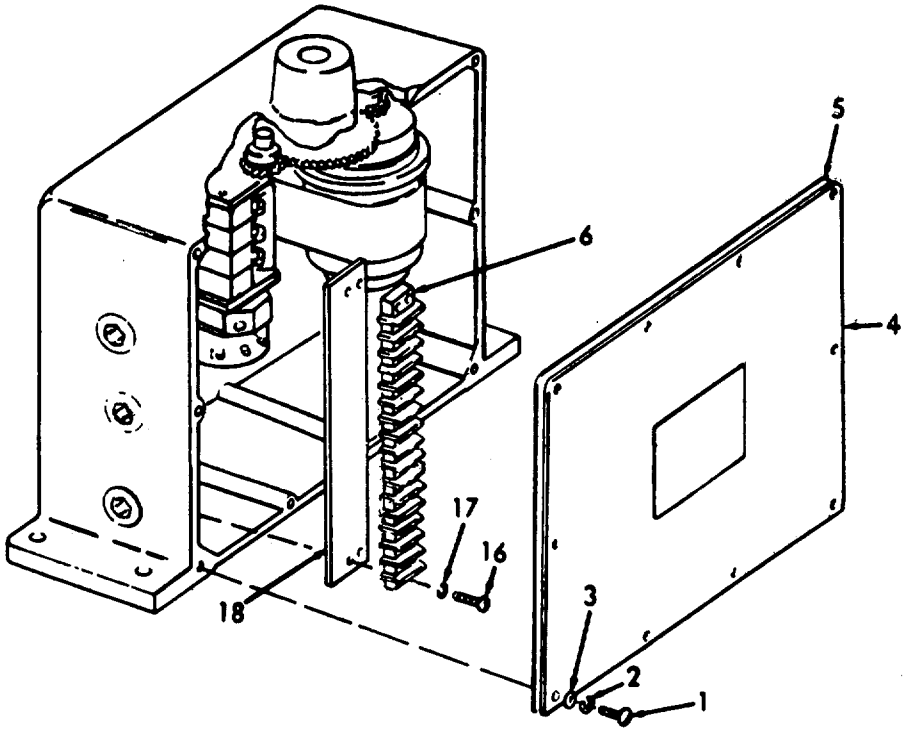
3-3285

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Identification strip (18), terminal strip (6), screws (16), and lockwashers (17)	Install.	
	g. Wiring	Reconnect all wiring to terminal strip (6).	Refer to schematic.
	h. Cover (4), gasket (5), screws (1), lockwashers (2), and flatwashers (3)	Install.	

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



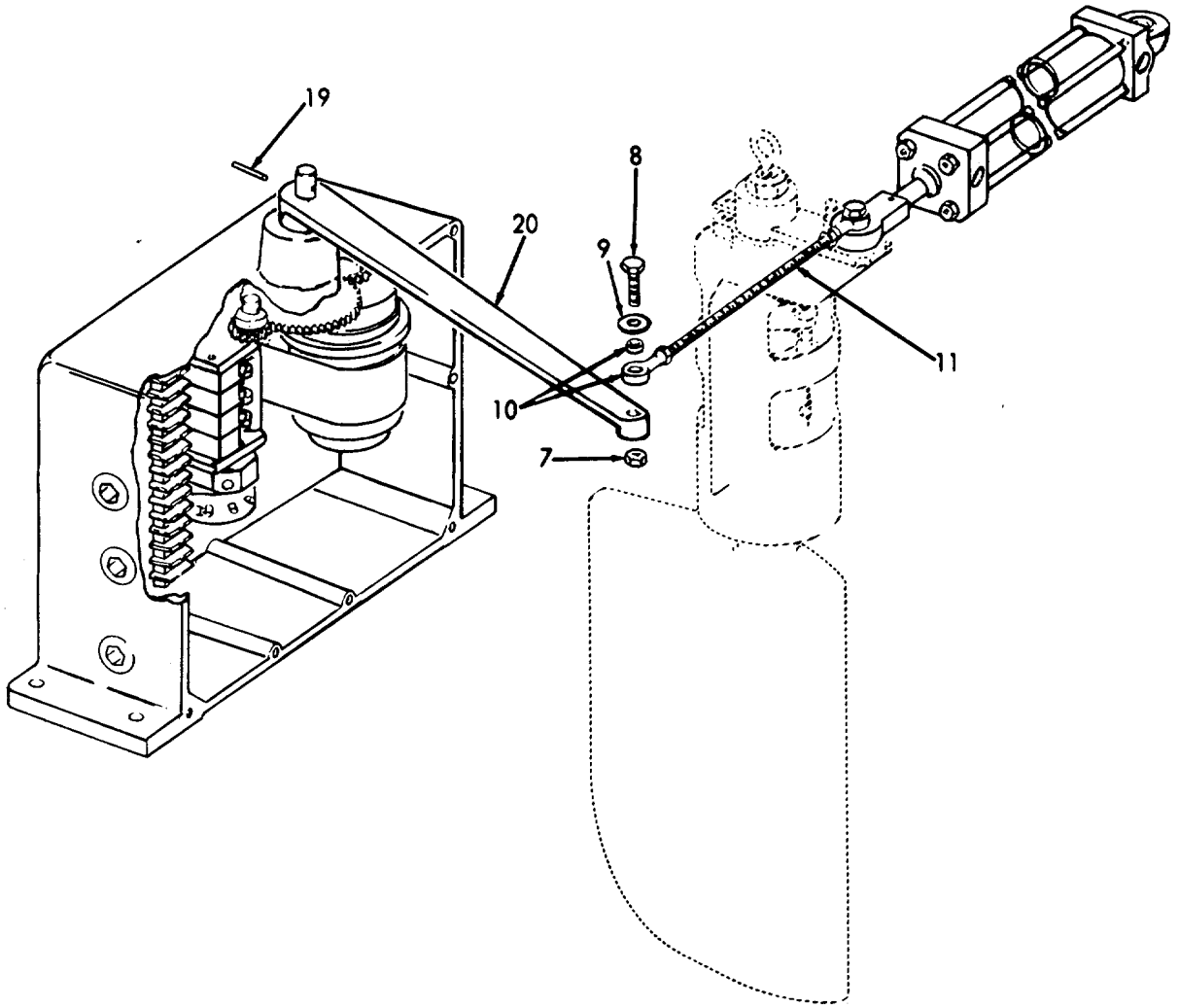
3-3287

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
5. Transmitter arm	a. Nut (7), screw (8), flatwasher (9), spherical bearing (10), and tie-rod (11)	Remove.	
	b. Spring pin (19), and transmitter arm (20)	Remove.	
	c. Transmitter arm (20), and spring pin (19)	Install.	
	d. Tie-rod (11), spherical bearing (10), flatwasher (9), screw (8), and nut (7)	Install.	

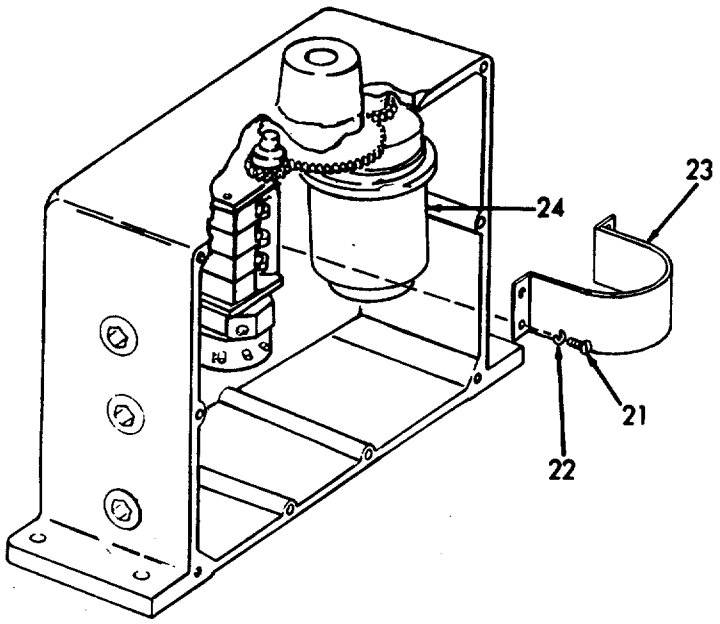
3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			



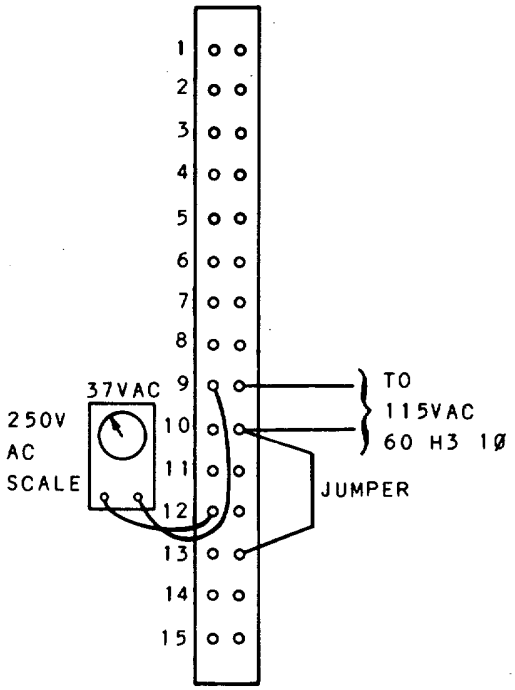
3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

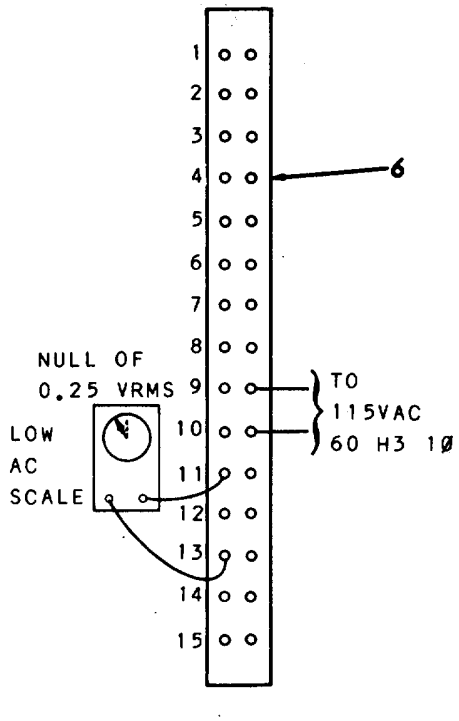
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT			
6. Zeroing Synchro			
		While performing the following procedure, make certain the rudder is positioned amidships at all times.	
	a. Screws (21), and lock-washers (22)	Loosen clamp (23) to allow synchro (24) to be rotated.	Do not remove.



3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

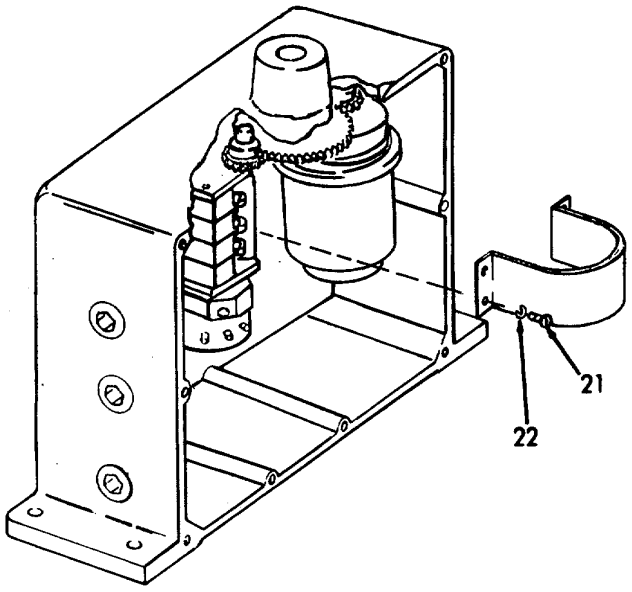
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
	b. Wiring	Tag and disconnect all wires to terminal strip (6) - Terminals 9 (R1), 10 (R2), 11 (S1), 12 (S2) and 13 (S3).	Refer to schematic.
	c. Power source 115 VAC	Connect to terminals 9 and 10.	
	d. Jumper wire	Place between terminals 10 and 13.	
	e. Voltmeter	1. Place on 250 VAC scale. 2. Connect to terminals 9 and 12.	
	f. Power Source	Turn on.	





3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

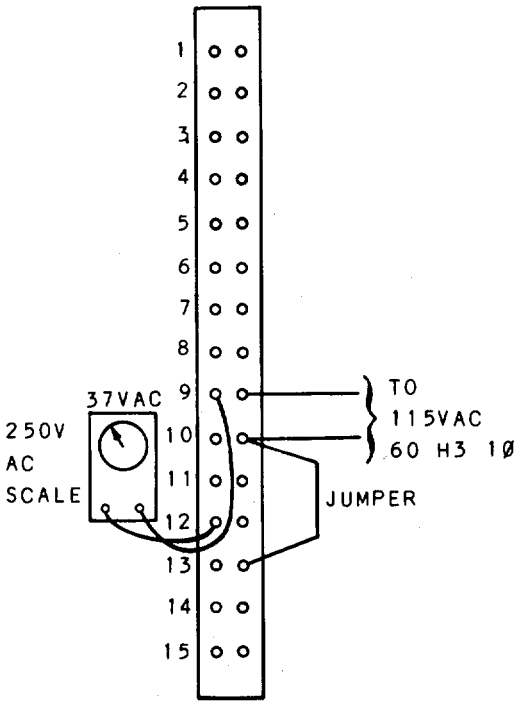
LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
	g. Synchro	Rotate in either direction until meter reads approximately 37 VAC.	This is the approximate zero setting.
	h Power	Turn off at source.	
	i. Jumper wire	Remove from terminals 10 and 13.	
	j. Voltmeter	1. Disconnect.	
		2. Reconnect to terminals 11 and 13.	
		3. Place on low AC scale.	
	k. Power	Turn on at source.	
	l. Synchro	Turn slowly until a null (minimum reading) is indicated on meter.	Null should be less than 0.25 Volt tms.,
	m. Power	Turn off.	
	n. Screws (21, and lockwashers (22)	Tighten.	

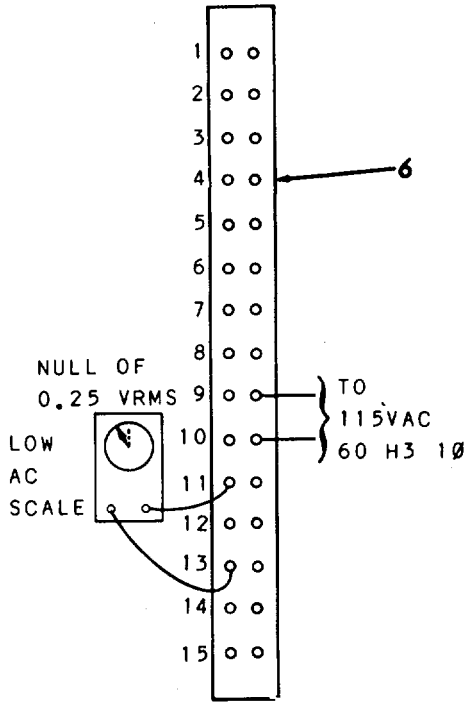


3-3292

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
	o. Power	1. Turn on.	Null should be less than 0.25 Volt tms.
		2. Recheck null.	
		3. Turn off.	
		4. Remove wires from terminals 9 and 10.	
	p. Voltmeter Disconnect.		
	q. Wiring	Reconnect wires to terminal strip (6)-terminals 9 (R1), 10 (R2), 11 (S1), 12 (S2) and 13 (S3).	





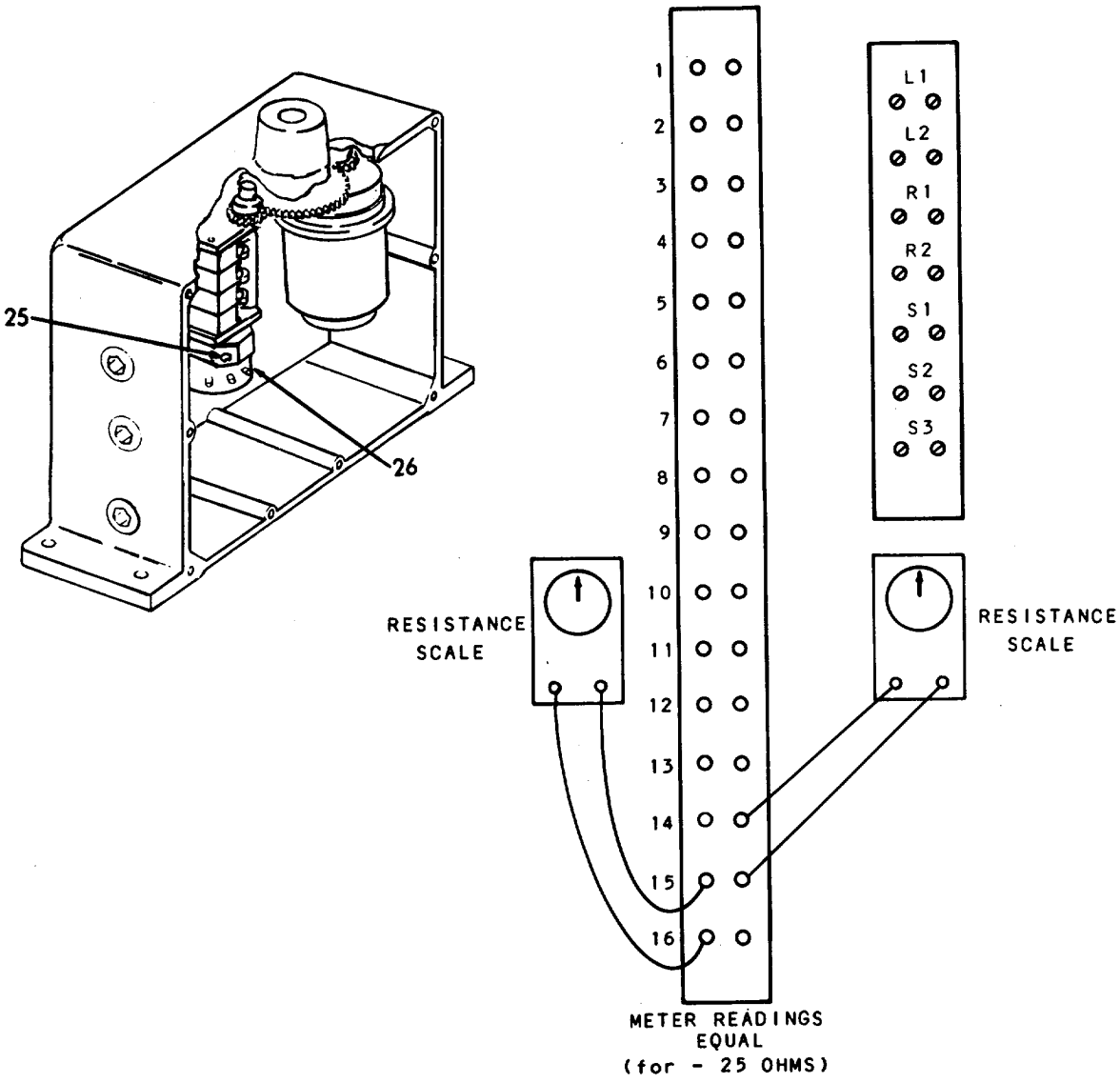
3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
7. Repeatback Potentiometer Zeroing	a. Rudder	Position to amidships.	
	b. Ohmmeter	1. Connect to terminal strip (6), terminals (14 (P1) and 15 (P2).	Observe reading.
		2. Connect to terminals 15 (P2), and 16 (P3).	Observe reading.
		3. Compare readings.	Readings should be equal (within 25 ohms).
	c. Setscrew (25), and potentiometer (26)	Loosen setscrew and rotate potentiometer.	If necessary to obtain an equal reading on ohmmeter.
	d. Setscrew (25)	Tighten.	
	e. Ohmmeter	Remove.	

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT (Cont)



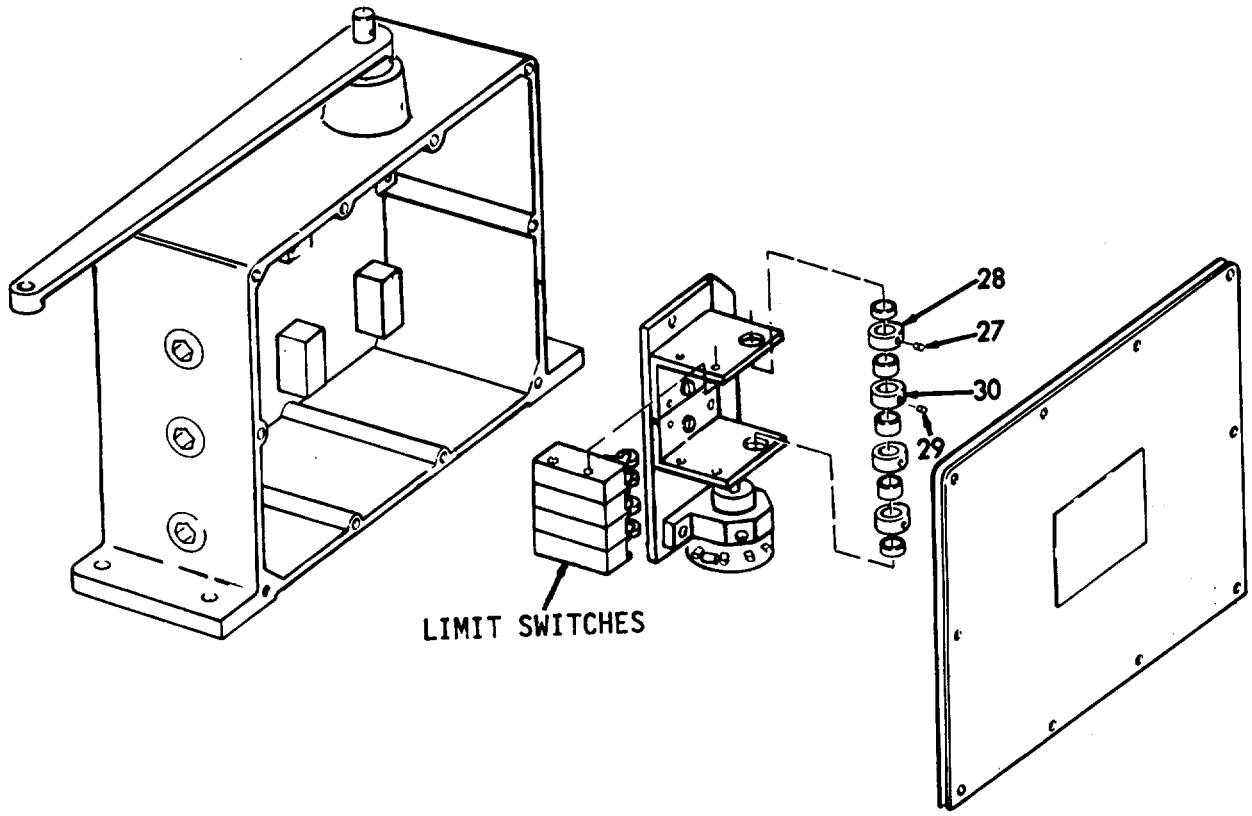
3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
ADJUSTMENT (Cont)			
8. Outside Limit Switch Adjustment	a. Rudder side limit.	Place in desired out-	
	b. Set-screws (27)	Loosen on cam (28);	
	c. Cam (28)	Rotate until limit switch opens at slightly before the rudder setting.	
	d. Set-screws (27)	Tighten.	
9. Inside Limit Switch Adjustment	a. Rudder	Set at the desired maximum limit for automatic steering, (usually 10 to 15 degrees in either direction).	
	b. Set-screws (29)	Loosen on cam (30).	
	c. Cam (30)	Rotate until limit switch opens at exactly this rudder section.	
	d. Set-screws (29)	Tighten.	

3-213. RUDER ANGLE TRANSMITTER - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

ADJUSTMENT (Cont)



3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS.

The Flanking Rudder Limit Switch electrically limits the maximum movement of the rudder to hard left - midships - or hard right. When the ordained rudder position is achieved, the rudder limit switch assembly activates the rudder position lights on the steering panel.

This task covers:

a. Inspection **b. Removal** **c. Installation**

INITIAL SETUP

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in procedure.

WARNING

To avoid possible injury, turn off all electrical power and relieve hydraulic pressure.

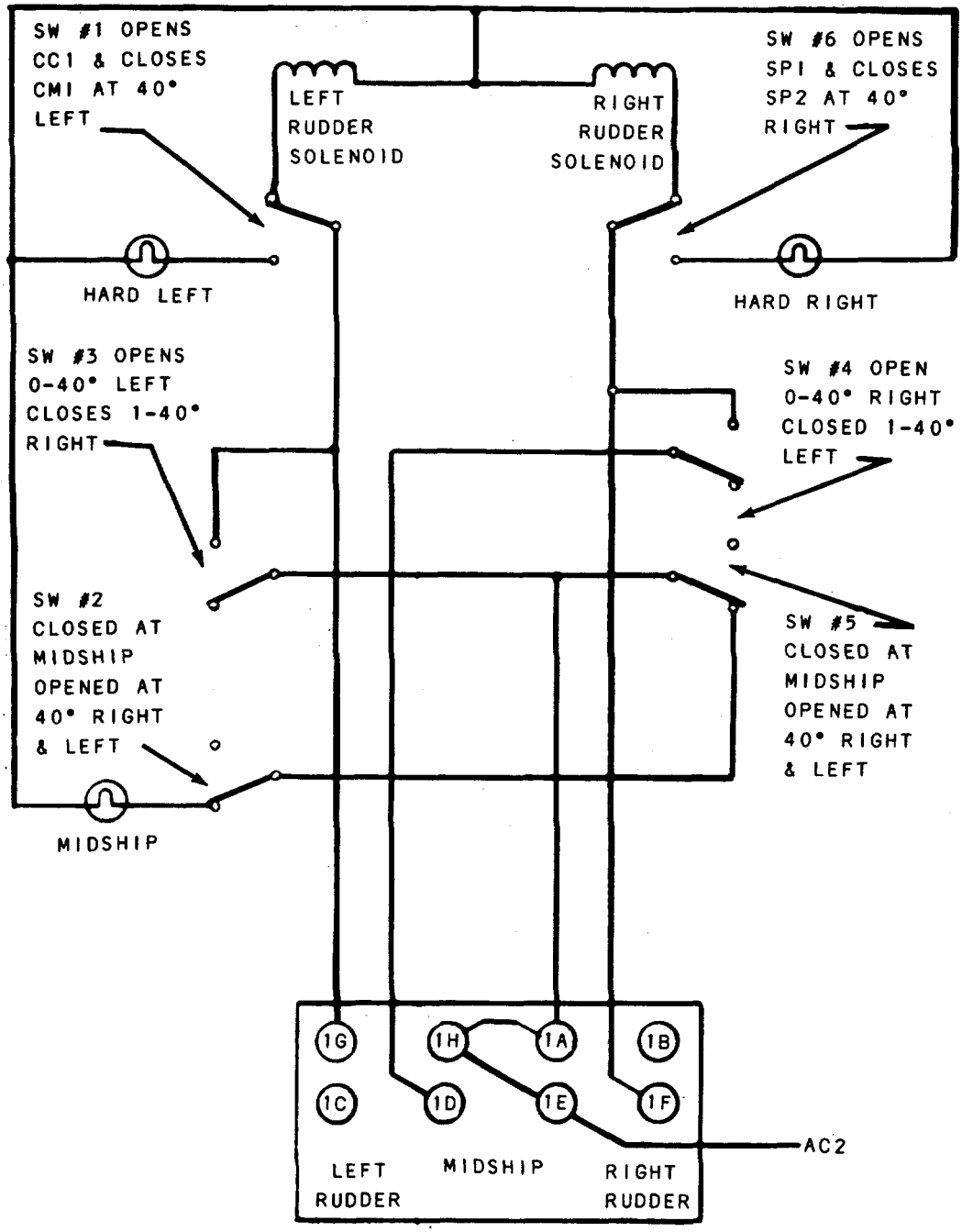
INSPECTION

1.	Flanking Rudder Limit Switch	a. Wiring	Inspect for breaks, cracks, and damage.
		b. Linkage	Inspect for breaks and cracks.
		c. Housing	Inspect for breaks, dents, and dents.
		d. Hardware	Ensure hardware is tight

3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

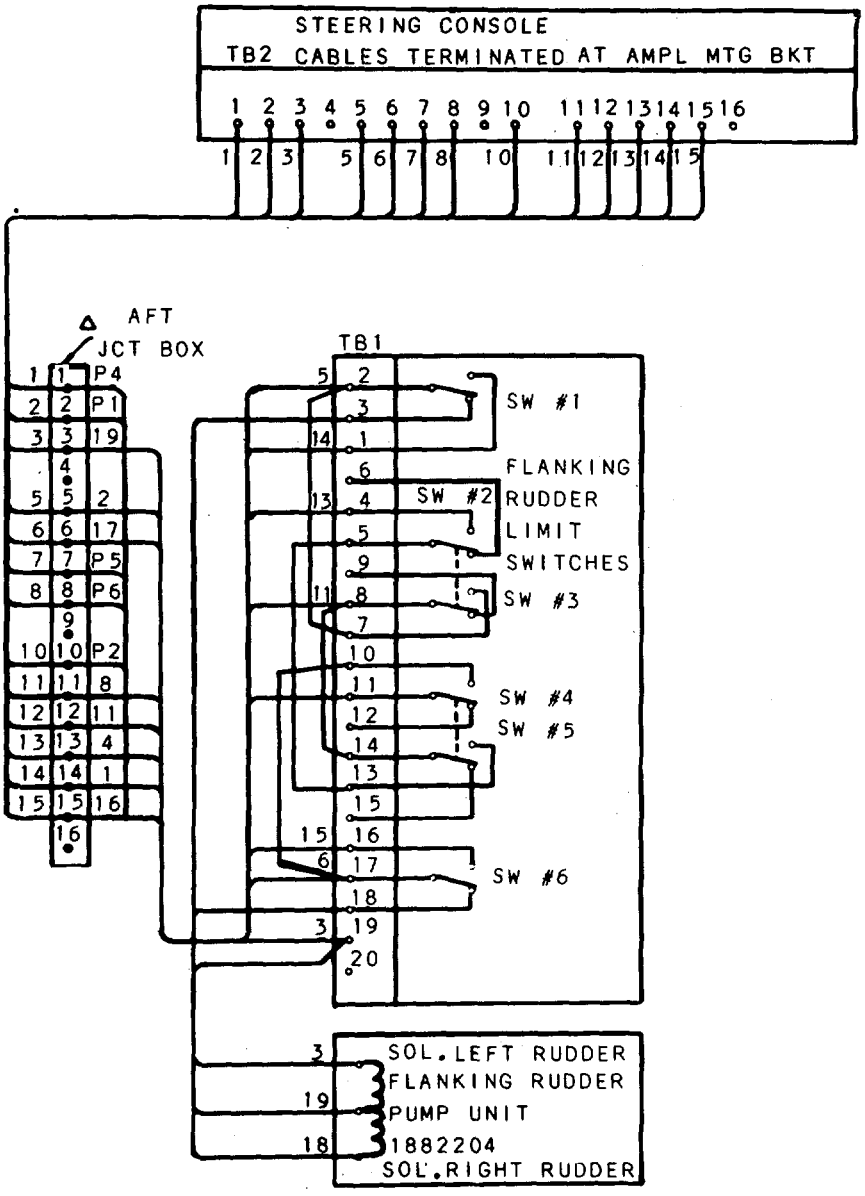
INSPECTION (Cont)



3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS. (Continued).

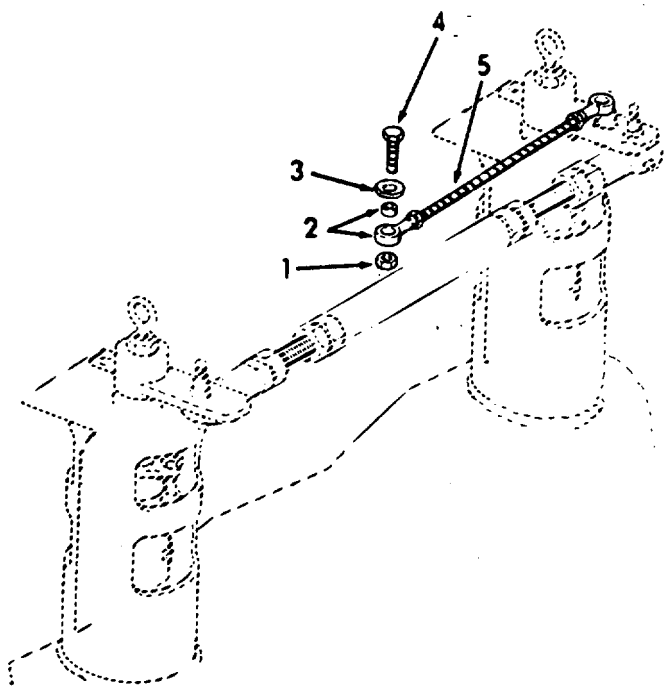
LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)



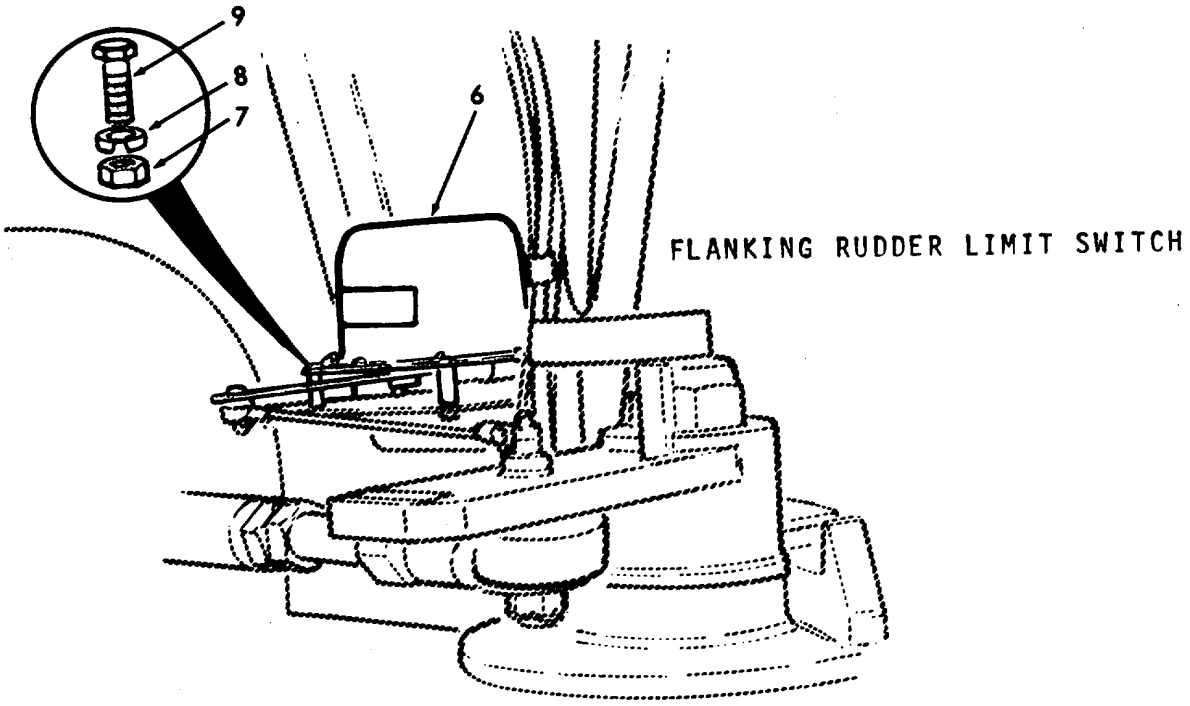
3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Nut (1), spherical bearing (2), flat-washer (3), and screw (4)	Remove.	
	b. Tie-rod (5)	Disconnect.	



3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS. (Continued).

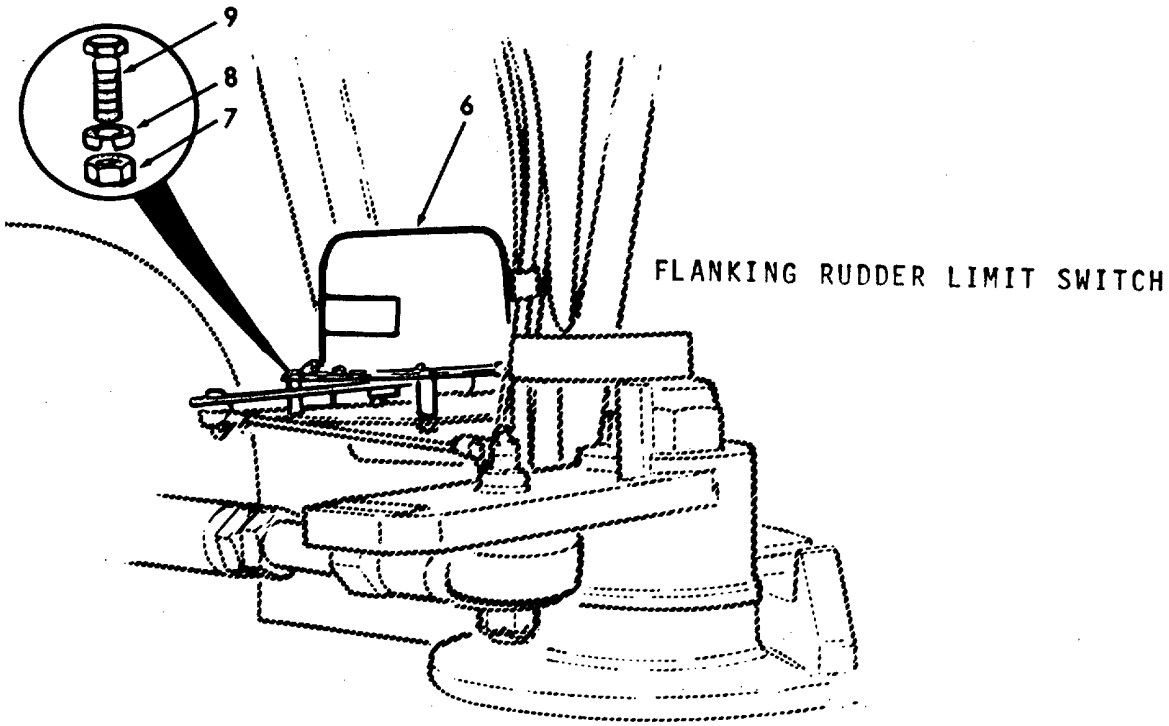
LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	c. Housing cover (6)	Remove.	
	d. Wiring	Tag and disconnect wiring from terminal board (TB1).	Refer to wiring diagram.
	e. Nuts (7), lock-washer (8), and screw (9)	Remove.	
	f. Limit switch assembly	Remove.	



FLANKING RUDDER LIMIT SWITCH

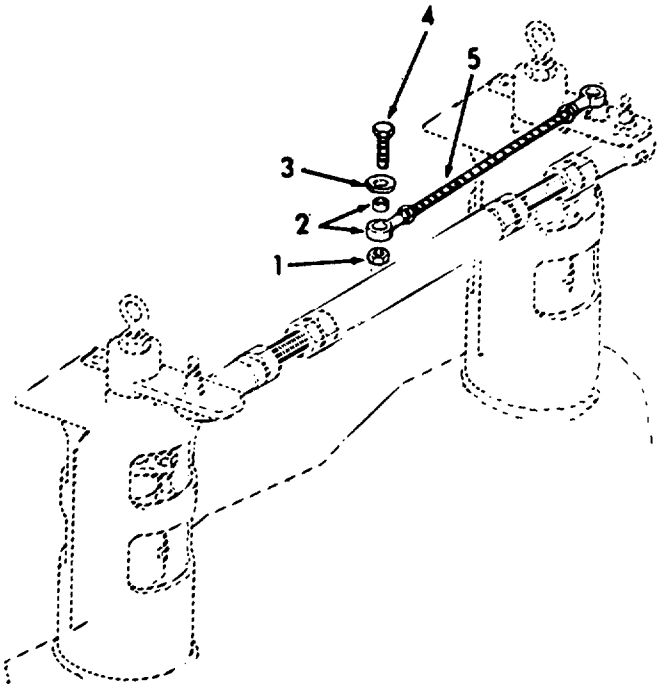
3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Limit switch assembly, screws (9), lock-washers (8), and nuts (7)	Install.	
	b. Wiring	Reconnect to terminal board (TB1).	Refer to wiring diagram.
	c. Housing cover (6)	Install.	



3-214. FLANKING RUDDER LIMIT SWITCH - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	d. Tie-rod (5), screw (4), flat-washers (3), spherical bearing (2), and nut (1)	Assemble.	



3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

This task covers:

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

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in procedure.

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Control Panel	a. Fuses	Observe fuse holders. If lit, a blown fuse is indicated.	
	b. Indicator lamps	1. Inspect for broken or missing lens caps.	
		2. Inspect for burned out lamps.	
	c. Switch (Toggle)	Inspect for proper operation.	
	d. Switch (Rotary)	1. Inspect for missing knobs.	
		2. Inspect for proper operation.	
	e. Potenti-ometer	1. Inspect for missing knobs.	
	f. Steering lever	1. Inspect for breaks, cracks and damaged or missing parts.	
		2. Inspect for ease of operation.	

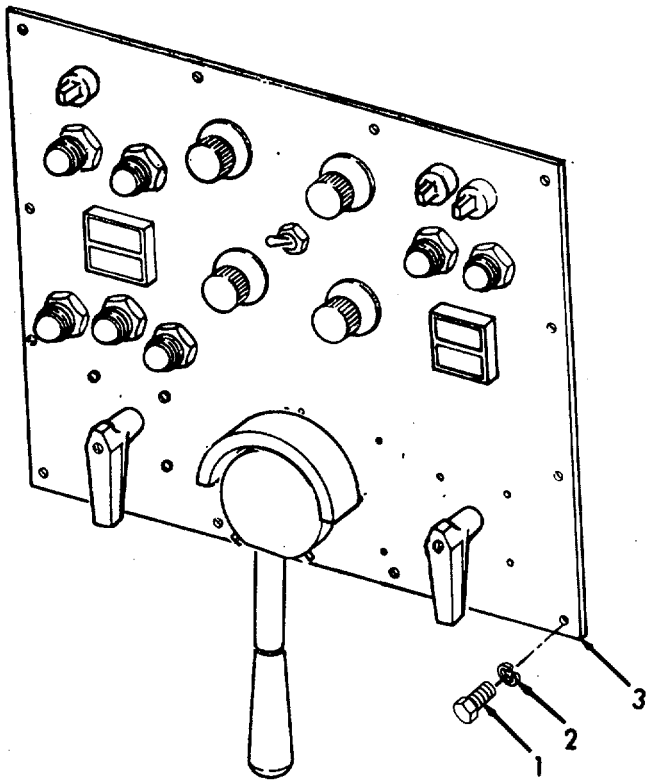
3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL

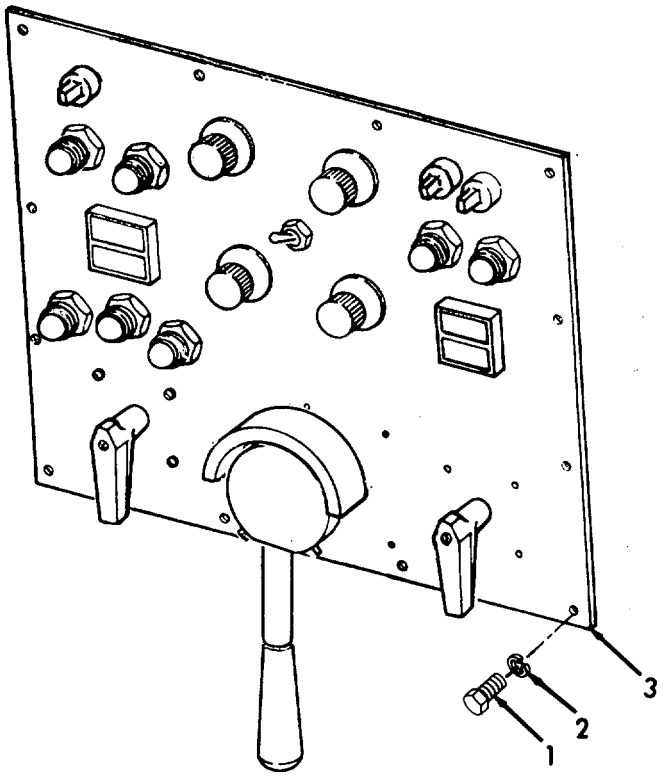
In order to prevent shock, tag and place circuit breaker in the OFF position.

2	a. Twelve screws (1), and lock-washers (2)	Remove.	
	b. Panel (3)	Lift up.	
	c. Wiring	Tag and disconnect wiring at terminal strips.	
	d. Panel (3)	Remove.	



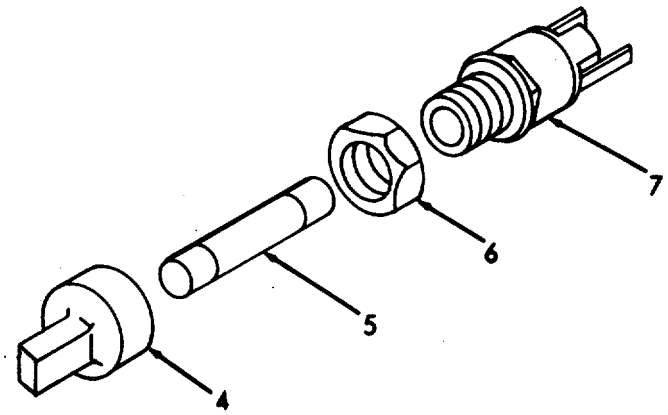
3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Panel (3)	Reconnect wiring at terminal strips.	
	b. Screws (1), and lock-washers (2)	Install.	



3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4.	a. Fuse caps (4)	Unscrew and remove.	
	b. Fuses (5)	Remove.	
	c. Wiring	Tag and disconnect.	
	d. Nut (6), and fuse-holder (7)	Remove.	
	e. Fuse-holder (7), and nut (6)	Replace.	
	f. Wiring	Reconnect.	
	g. Fuse (5), and fuse cap (4)	Replace.	

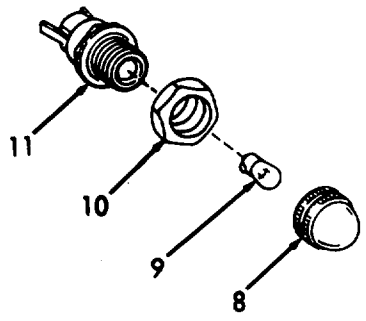


3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

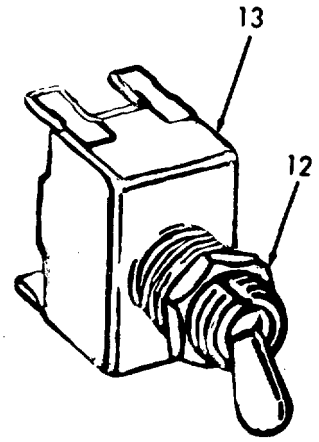
REPAIR (Cont)

5.	Lamp Holders	a. Lens caps (8)	Unscrew and remove.
		b. Indicator lamp (9)	Remove.
		c. Wiring	Tag and disconnect.
		d. Nut (10), and lamp-holder (11)	Remove.
		e. Lamp-holder (11), and nut (10)	Replace.
		f. Wiring	Reconnect.
		g. Lamp (9), and lens cap (8)	Replace.



3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

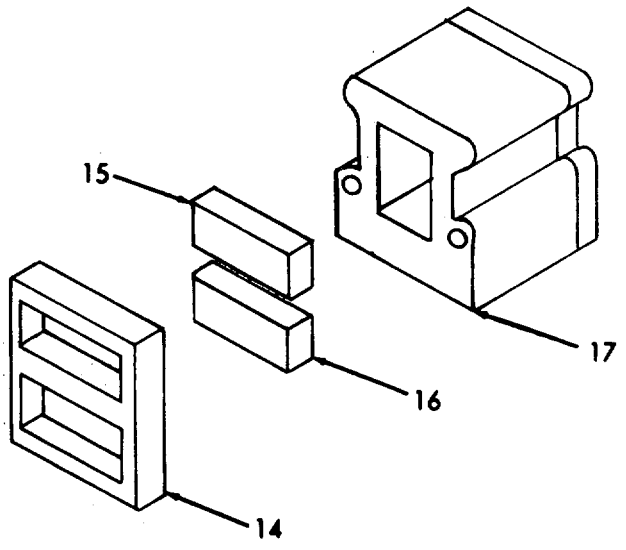
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Switch (Toggle)	a. Wiring	Tag and disconnect.	
	b. Nut (12), and switch (13)	Remove.	
	c. Switch (13), and nut (12)	Install.	
	d. Wiring	Reconnect.	



3-3312

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

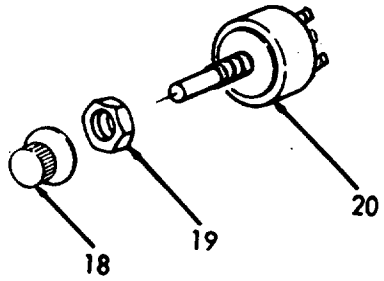
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
7. Switch (Push-button)	a. Wiring	Tag and disconnect.	
	b. Button holder (14)	Pull off.	
	c. Buttons (15 and 16)	Remove.	
	d. Switch (17)	Remove.	
	e. Switch (17)	Insert in panel.	
	f. Button-holder (14), and buttons (15 and 16)	Replace.	
	g. Wiring	Reconnect.	



3-3313

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

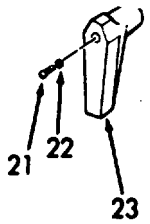
LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
8. Variable Resistors	a. Knob (18)	Remove.	
	b. Wiring	Tag and disconnect.	
	c. Nut (19), and resistor (20)	Unscrew and remove.	
	d. Resistor (20), and nut (19	Install.	
	e. Wiring	Reconnect.	
	f. Knob (18)	Install.	



3-3314

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
9. Pistol grip handle	a. Screw (21), lock-washer (22)	Remove.	
	b. Handle (23)	Remove.	
	c. Handle (23), screw (21), and lock-washer (22)	Install.	



3-3315

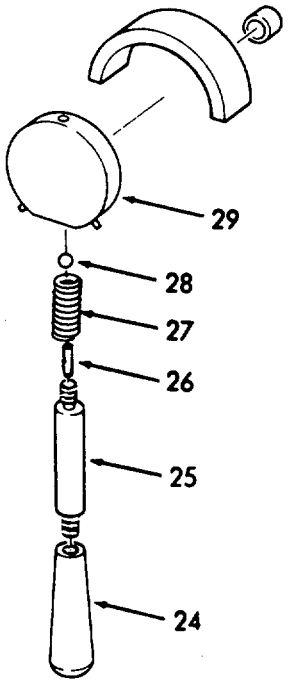
3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
10. Rudder control lever	a. Rubber handle (24)	Unscrew.	
	b. Shaft (25), spring pin (26), spring (27) and ball (28)	Remove.	
	c. Shaft hub (29)	Remove.	
	d. Shaft hub (29)	Install.	
	e. Ball (28), spring (27), spring pin (26), and shaft (25)	Install.	
	f. Rubber handle (24)	Install.	

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



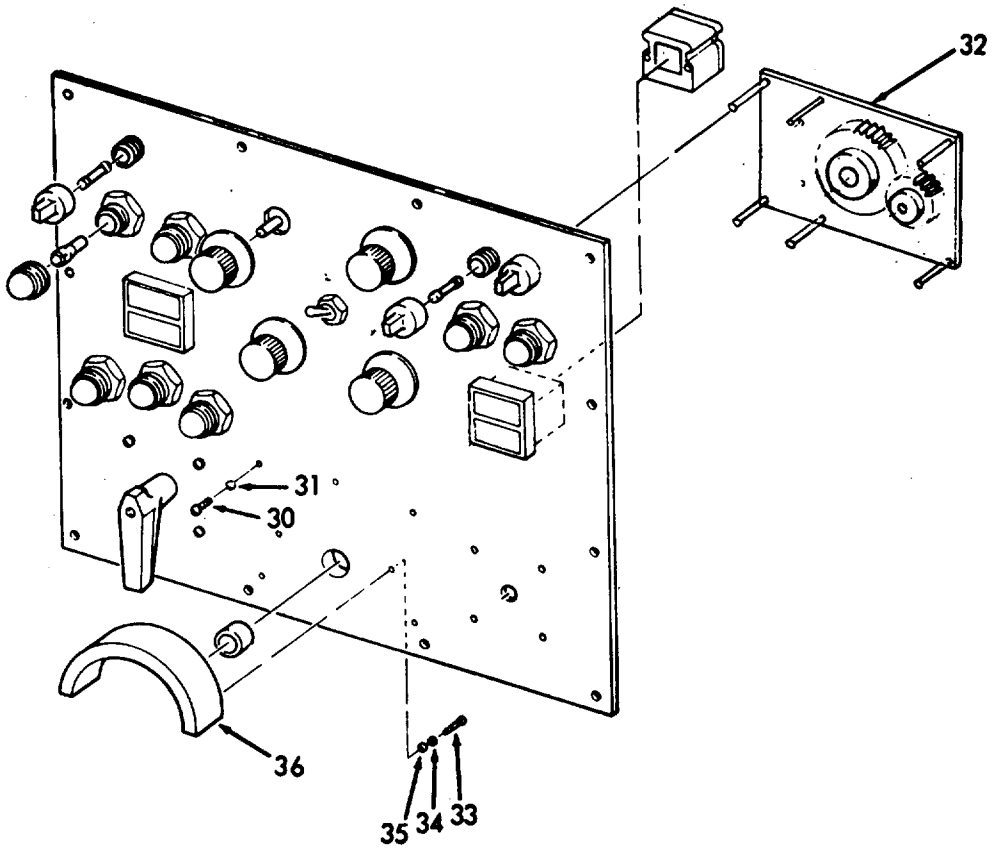
3-3317

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS. (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
11. Detail Stop	a. Screws (30), and seal washers (31)	Remove.	
	b. Resistor mounting plate (32)	Move out of way.	
	c. Screws (33), lock-washers (34), and flat-washers (35)	Remove.	
	d. Detail stop (36)	Remove.	
	e. Detail stop (36), screws (33), lock-washers (34), and flat-washers (35)	Install.	

3-215. STEERING CONTROL PANEL - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	f. Resistor mounting plate (32), screws (30), and seal washers (31)	Install.	

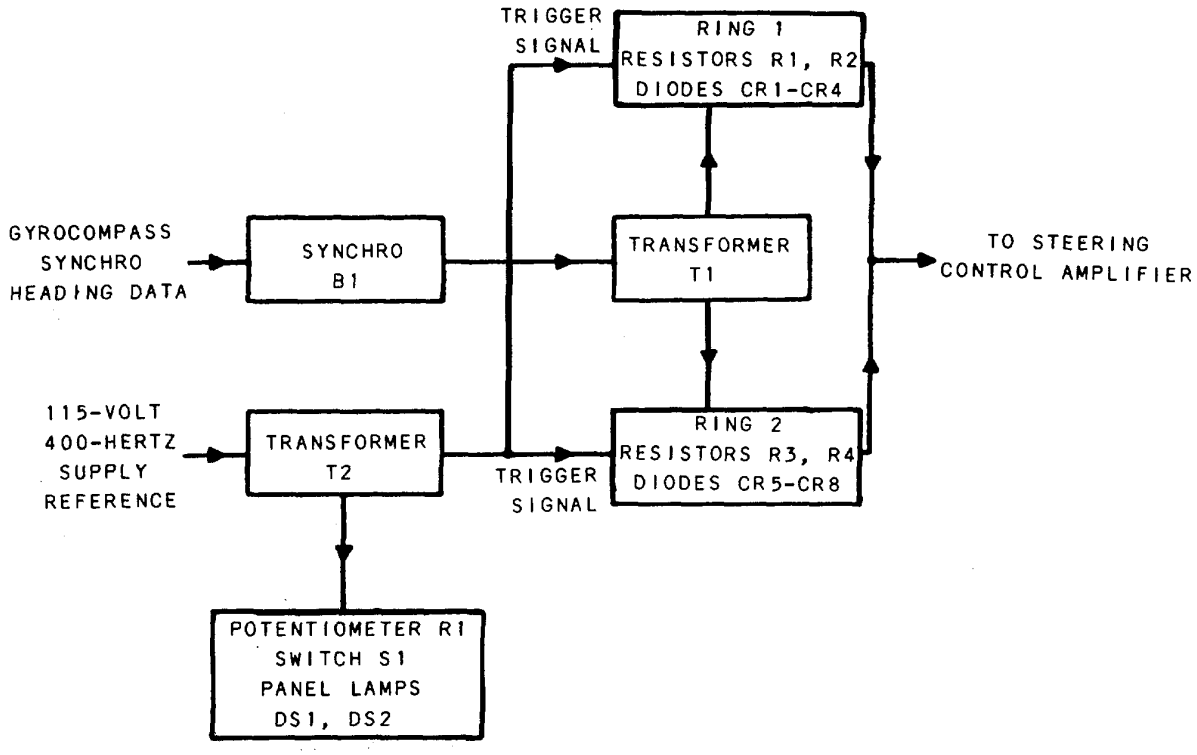


3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

The Heading Selector is used as an interface between a gyrocompass and steering control panel to select the desired heading of the vessel. The gyrocompass transmits actual heading data to the Heading Selector for comparing the actual heading data with the ordered head- ing data. If the actual heading and the ordered heading are the same, there is no signal output from the Heading Selector. If the actual heading and the ordered heading differ, the Heading Selector will produce a signal that will cause the rudder positioning equipment to change the vessel's actual heading to its ordered heading.

Three-wire synchro data from the gyrocompass provides the heading information, and the same 115-volt, 400-hertz supply that powers the gyrocompass is needed for reference and illumination requirements.

The gyrocompass card is connected to a synchro which is excited by a 115-volt, 400-hertz supply. Three-wire heading data is transmitted by this synchro to synchro B1 of the Heading Selector. The heading selector card is connected to synchro B1 rotor so that for any reading of the gyrocompass card, the voltage induced in synchro B1 rotor will be zero when the heading selector card is set to the same heading. When the heading selector card and the gyrocompass card are on different headings, an error voltage is induced in synchro B2 rotor.



3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

Any voltage that is induced in synchro B1 rotor is applied to the primary of transformer T1. A demodulator ring is connected in series with a leg of each secondary winding of transformer T1.

The same 115-volt, 400-hertz supply that excites the gyrocompass synchro must also be used for reference purposes in the Heading Selector. This reference voltage is applied to the primary of transformer T2. The output from transformer T2 secondaries is applied across the demodulator rings. This voltage serves as a trigger to turn the demodulator rings on or off. Ring 1 (resistors R1, R2; diodes CR1-CR4) conducts during the negative portions of each reference voltage cycle, and ring 2 (resistors R3, R4; diodes CR5-CR8) conducts only when the reference (trigger) signal is positive.

When there is any induced voltage across synchro B1 rotor, it will appear across both secondaries of transformer T1. This voltage can be either positive or negative with respect to the reference volt- age at any given instant. The reference voltage is alternating continuously, and the output from the Heading Selector must be a direct current.

The reference voltage, in effect, switches the demodulator rings on and off in step with its cycles. This forces the proper transformer T2 secondary to be connected to the output at the right time. The net result is a pulsating d-c voltage that is proportional to the difference between the actual heading and the ordered heading. Resistor R5 and capacitor C1 provide filtering for the output. TM 55-1905-220-14-7

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

This task covers:

a. Inspection **c. Installation** **e. Initial Check Out**
b. Removal **d. Repair** **f. Alignment**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

1

References

None

Equipment Condition: None

Condition Description: None

Special Environmental Conditions

None

General Safety Instructions

Observe WARNING in procedure.

LOCATION	ITEM	ACTION	REMARKS

INSPECTION

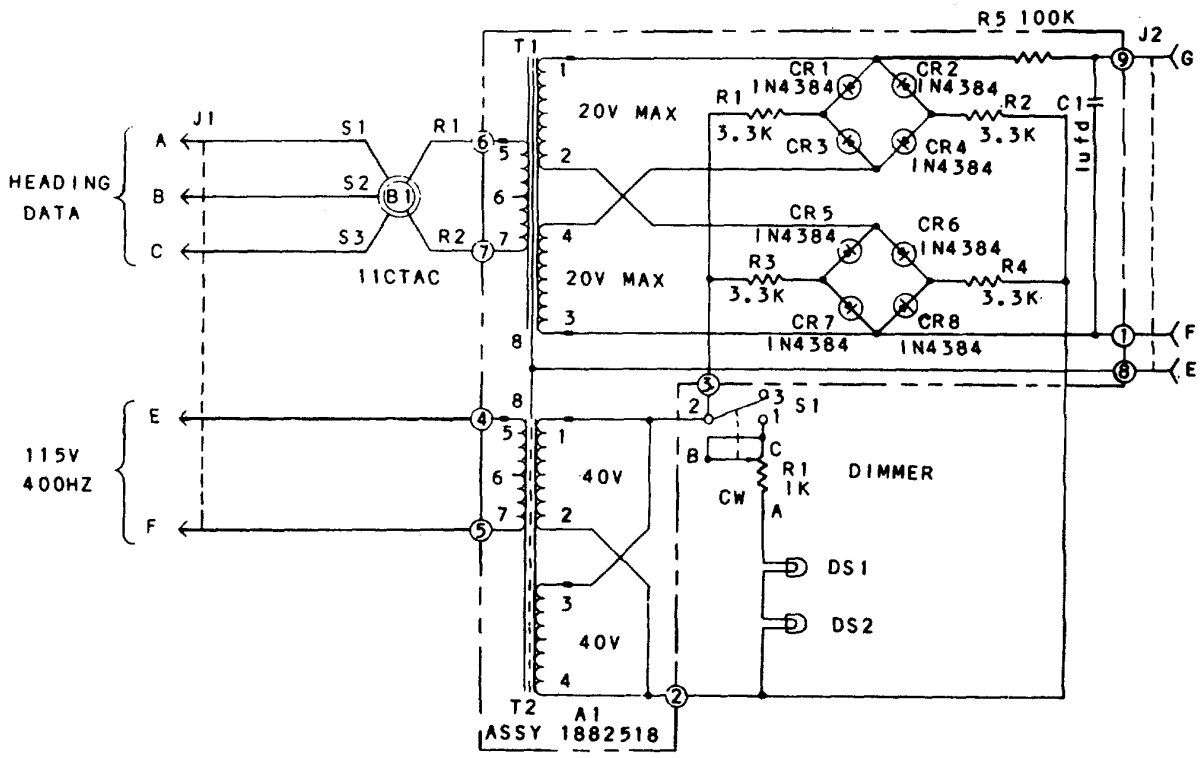
WARNING

In order to avoid a potential shock hazard, tag and place circuit breaker in the OFF position.

1. Heading Selector	a. Dial lamps	1. Inspect for broken or missing panel lights.	
		2. Inspect for burned out lamps.	
	b. Dimmer	1. Inspect for missing knob.	
		2. Operate dimmer to turn on/off and adjust lamps.	

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

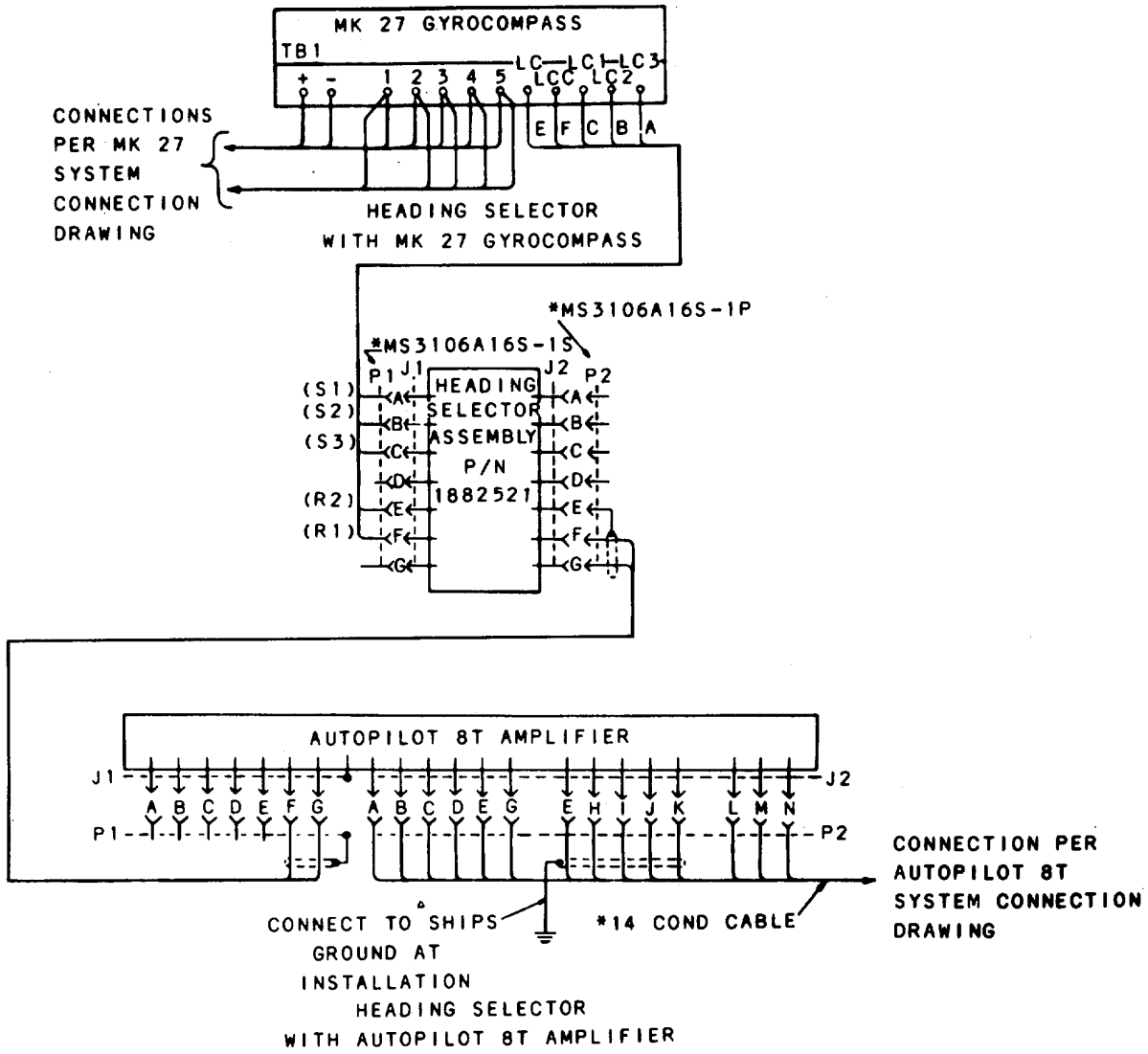
LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
	c. Heading Selector	1. Inspect for missing knob.	
		2. Operate and observe ease of operation.	



3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

INSPECTION (Cont)

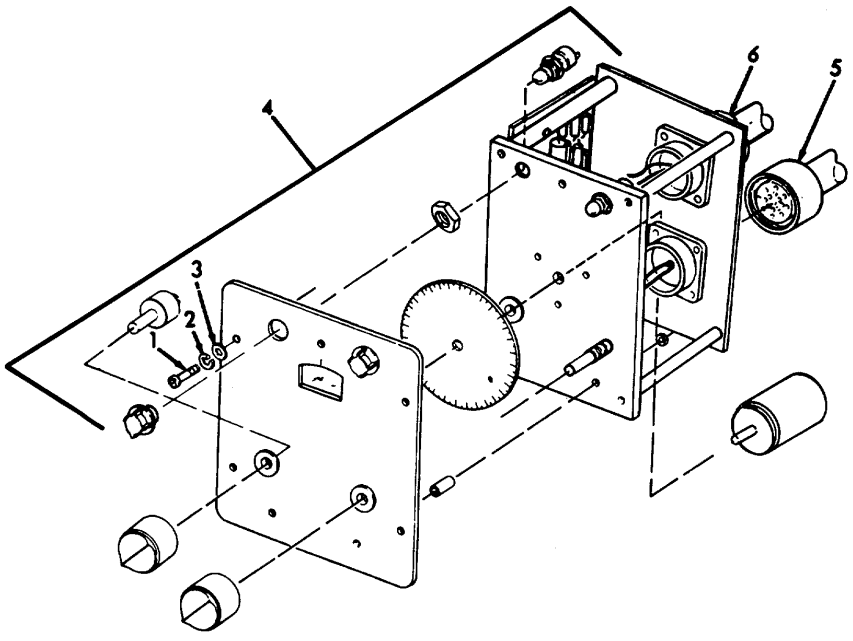


NOTE:

* INDICATES SPERRY SUPPLIED.

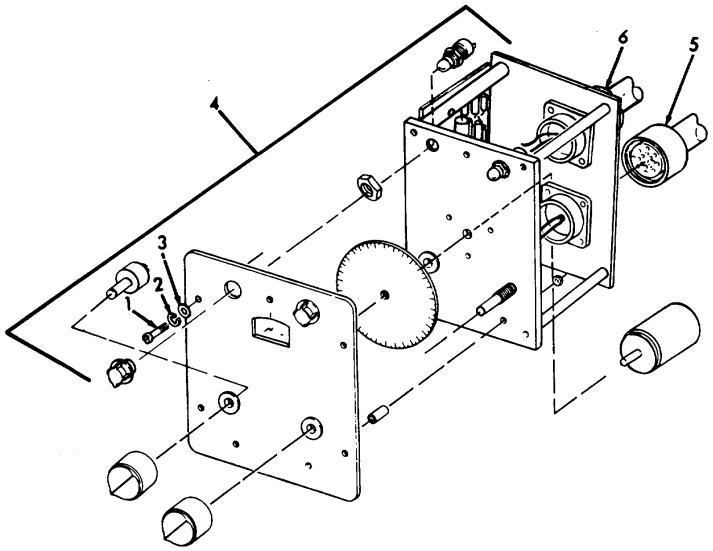
3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
2.	a. Four screws (1), lock-washers (2), and flat-washers (3)	Remove.	
	b. Heading selector (4)	Remove.	
	c. Connectors (5 and 6)	Unscrew and remove.	



3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.	a. Connectors (5 and 6)	Reconnect to heading selector (4).	
	b. Heading selector (4)	Adjust.	Refer to step 7.
	c. Screws (1), lock-washers (2), and flat-washers (3)	Install.	



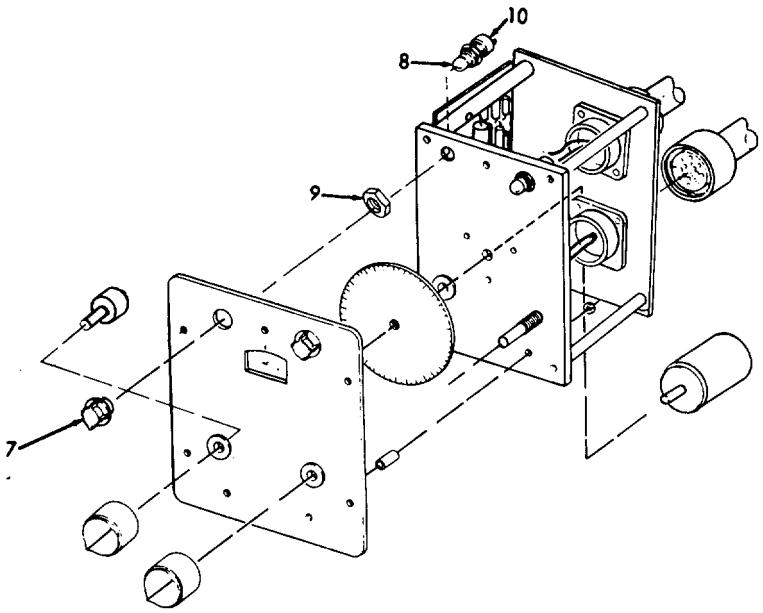
3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Panel lights	a. Panel light (7)	Unscrew counter-clockwise.	
	b. Lamp (8)	Press and rotate to remove.	
	c. Wiring	Tag and disconnect.	
	d. Nut (9), and lamp-holder (10)	Remove.	
	e. Lamp-Holder and nut (9)	Install.	
	f. Wiring	Reconnect.	
	g. Lamp (8)	Press and rotate clockwise to install.	Use lamp type 327 or 387.
	h. Panel light (7)	Install.	
5. Dimmer	Knob (11)	Remove and replace.	If necessary.

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

REPAIR (Cont)



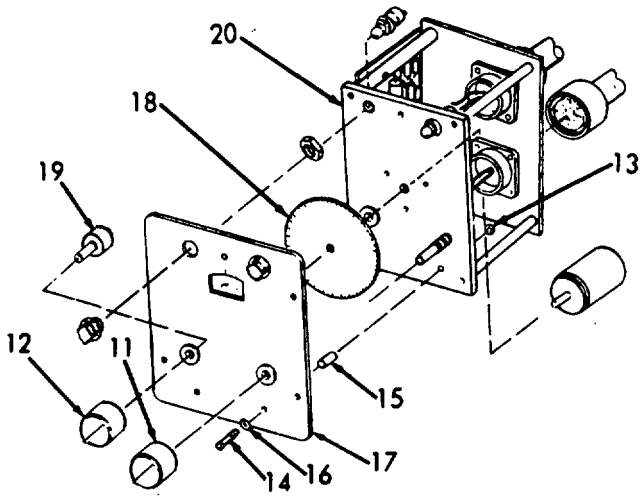
3-3329

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
6. Dial	a. Knobs (11 and 12)	Remove.	
	b. Three nuts (13), screws (14), spacers (15), and lock-washers (16)	Remove.	
	c. Control panel (17)	Remove.	
	d. Dial (18)	Remove.	Before removal, mark orientation of dial.
	e. Control shaft (19)	Remove from front plate (20).	
	f. Control shaft (19)	Insert in front plate (20).	
	g. Dial (18)	Re-orient and install.	
	h. Control panel (17)	Install.	
	i. Screws (14), lock-washers (16), spacers (15), and nuts (13)	Install.	

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	j. Knobs (11 and 12)	Install.	Refer to step 7.
	k. Heading selector	Perform initial check-out and/or alignment.	



3-3331

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
INITIAL CHECK-OUT			
	7. Heading Selector	After the Heading Selector has been installed and all connections have been made, proceed with the following: a. Start the gyrocompass and wait for it to settle. b. Set HEADING SELECTOR control to same heading as that indicated by gyrocompass card. c. Energize the steering equipment and position the rudder to amidships. Place control equipment in the gyrocompass mode. d. Set HEADING SELECTOR control first to the right, then to the left of the actual heading as indicated by the gyrocompass card. The rudder should move so as to turn the vessel toward the ordered headings. e. If the rudder does not respond properly in Step d, turn the HEADING SELECTOR control to the point that the rudder stops at amidships. When the rudder cannot be positioned with this control, check the steering equipment. When no problem is found with the steering equipment, check the HEADING SELECTOR alignment.	
ALIGNMENT			
	8. Heading Selector	After any repair has been made to the Heading Selector, perform the initial check-out procedure. The actual heading may be slightly different from the ordered heading when the rudder is at amidships. This difference can be eliminated by aligning the heading selector synchro as follows: a. Remove the heading selector from the enclosure. b. Start the gyrocompass and wait for it to settle.	

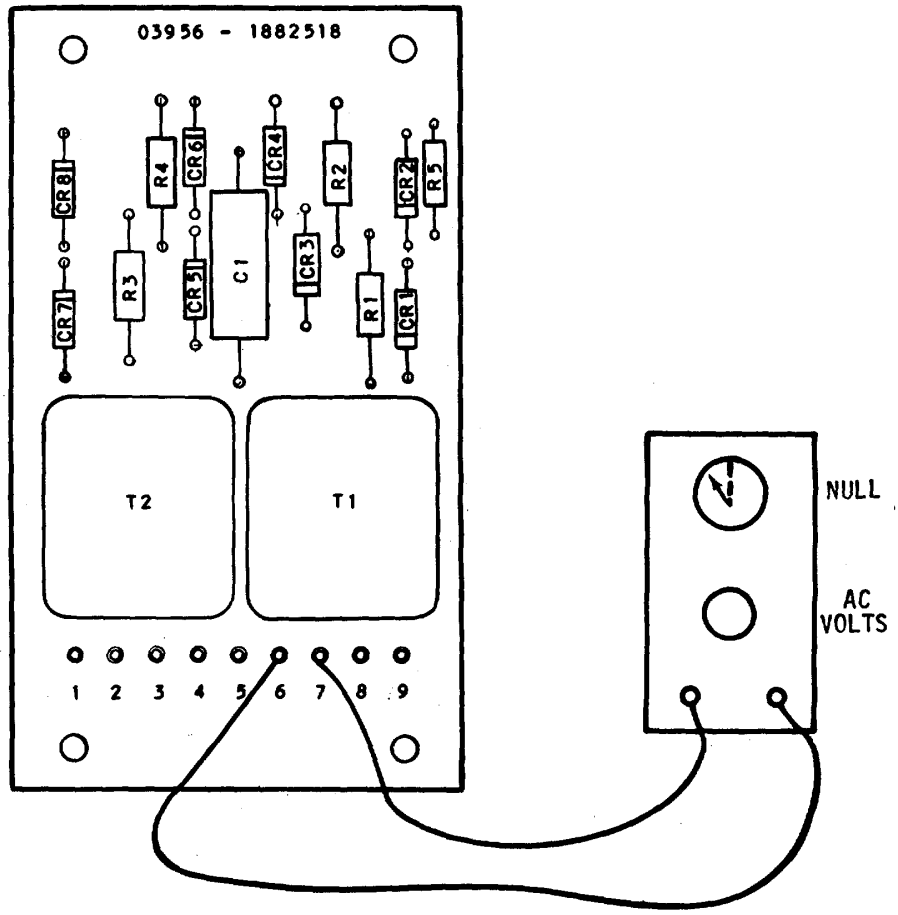
3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

ALIGNMENT (Cont)

c. Energize the steering equipment and position the rudder to amidships. Place the control equipment in the gyrocompass mode.

d. Set and hold the ordered heading to the actual heading and measure the A-C voltage between circuit card terminals 6 and 7.

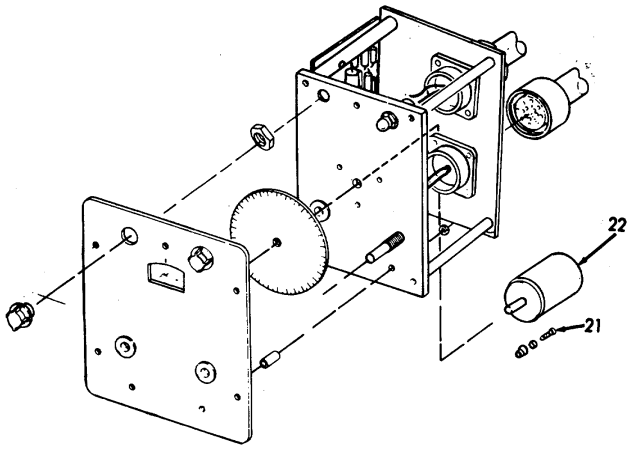


3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS

ALIGNMENT (Cont).

Loosen the three screws (21) that secure the synchro body (22) to the mounting surface. Rotate the synchro body until the AC voltage between circuit card terminals 6 and 7 are nulled. Tighten the synchro clamp screws while holding the synchro body in the null-voltage position.



e. Order a change in heading. The rudder should respond properly and should return to the amidships position when the ordered heading and the actual heading are the same.

3-216. HEADING SELECTOR - MAINTENANCE INSTRUCTIONS (Cont).

LOCATION	ITEM	ACTION	REMARKS
ALIGNMENT (Cont)			
		f. When the rudder travels in the wrong direction, rotate the synchro body 180 degrees and repeat Step d.	
		g. Reinsert unit into the enclosure, and tighten four Screws that secure unit to the enclosure.	

3-217. REMOTE MAGNETIC HEADING COMPASS (RHMS) - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection

INITIAL SETUP:

Test Equipment
None

Special Tools
None

Material/Parts
None

Personnel Required
1

References
None

Equipment Condition: Condition Description
None

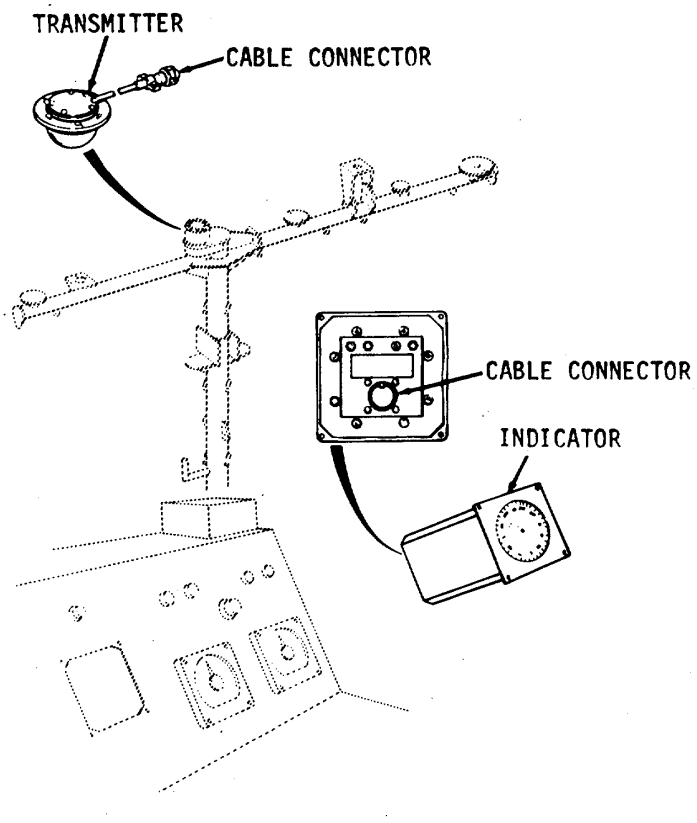
Special Environmental Conditions
None

General Safety Instructions
None

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
		NOTE All maintenance is to be performed by Direct Support Maintenance. Overhaul is to be performed by the designated General Support Organization.	
1. RHMS Trans-mitter	Transmitter	a. Inspect for breaks, cracks, housing corrosion, and signs of wear.	Inspect when mast is lowered.
		b. Inspect for breaks, cracks, and damaged wiring.	

3-217. REMOTE MAGNETIC HEADING COMPASS (RHMS) - MAINTENANCE INSTRUCTIONS.

LOCATION	ITEM	ACTION	REMARKS
INSPECTION (Cont)			
2. RHMS Indicator	Indicator	a. Inspect for broken or cracked lens.	
		b. Inspect for proper operation.	
		c. Inspect for breaks, cracks and damaged wiring.	



3-218. EMERGENCY STEERING SYSTEM - MAINTENANCE INSTRUCTIONS.

This task covers:

a. Inspection **b. Replacement** **c. Repair**

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

2

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

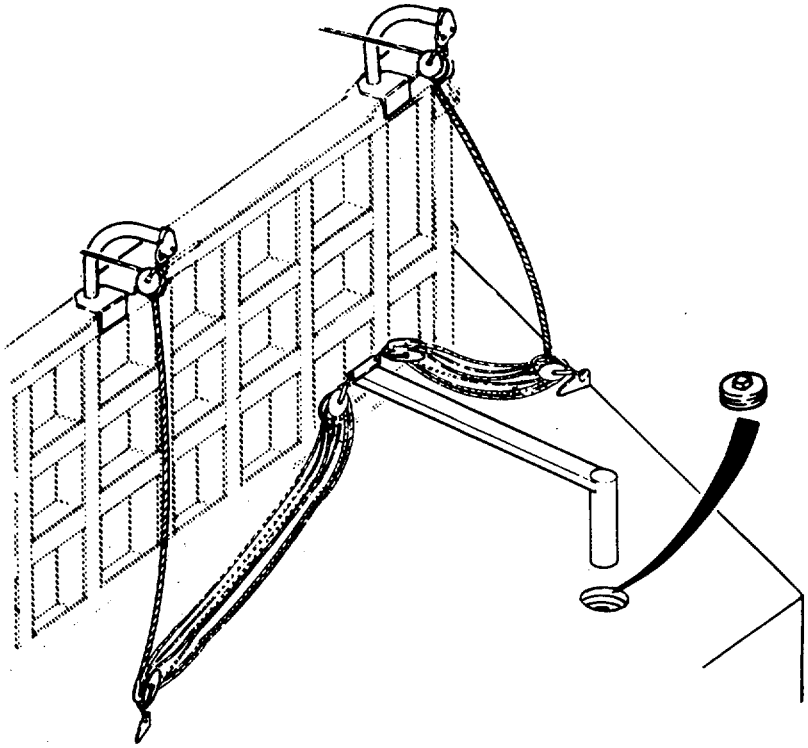
General Safety Instructions

None

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Emergency steering	a. Pipe plug	Inspect for missing pipe plug.	
	b. Tiller	Inspect for breaks, cracks and bends.	
	c. Block and tackle	1. Inspect blocks for splits, breaks and worn parts.	
		2. Inspect tackle for wear, moisture damage, broken strands and dirt.	
	d. Davit	Inspect for cracks, breaks, and binding.	

3-218. EMERGENCY STEERING SYSTEM - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPLACEMENT			
2.		Replace all parts that do not meet the inspection requirements.	
REPAIR			
3.	Block and tackle	Replace any defective line used in the block and tackle. Route the line and wip the ends in accordance with standard practices.	



3-3339

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

The ship's course indicator is a servo-driven remote repeater that indicates the ship's heading. The indicator receives heading data from the ship's gyrocompass. The indicator also receives reference power from the ship's supply. The gyrocompass signals and reference power actuate the indicator to position graduated dials that show the ship's heading.

The ship's course indicator is designated a Mark 2, Mod 6 and is a 400-cps two-speed single dial type.

This task covers:

a. Inspection
c. Installation
d. Removal
d. Repair

INITIAL SETUP:

Test Equipment

None

Special Tools

None

Material/Parts

None

Personnel Required

2

References

None

Equipment Condition: Condition Description

None

Special Environmental Conditions

None

General Safety Instructions

None

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSPECTION			
1. Ship's Course Indicator	a. Indicator	1. Inspect for breaks, cracks and signs of leakage in the housing.	
		2. Inspect for cracks, and broken lens.	
		3. Inspect for burned out dial lamps.	
		4. Insure all hardware is tight.	
	b. Gimbal bracket	1. Inspect for breaks and cracks.	
		2. Insure all hardware is tight.	
		3. Insure indicator is sufficiently tight to prevent lateral movement, but not tight enough to prevent indicator from swinging freely.	
	c. Pedestal	1. Inspect for cracks and breaks.	
		2. Inspect for missing or damaged terminal box.	
		3. Insure all hardware is tight.	

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL			
		CAUTION	
		The ship's course indicator is a delicate device. Avoid mishandling during removal.	
2. Ship's Course Indicator	a. Six screws (1), flat-washers (2), and lock-washers (3)	Remove.	
	b. Cover (4)	Remove.	
	c. Wiring	Tag and disconnect wiring to terminal strip (5).	
	d. Knurled cap (6)	Loosen.	
	e. Cable harness (7)	Remove.	Feed through elongated hole (8).
	f. Cover (4), screws (1), flat-washers (2), and lock-washers (3)	Reassemble.	

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS

REMOVAL (Cont)

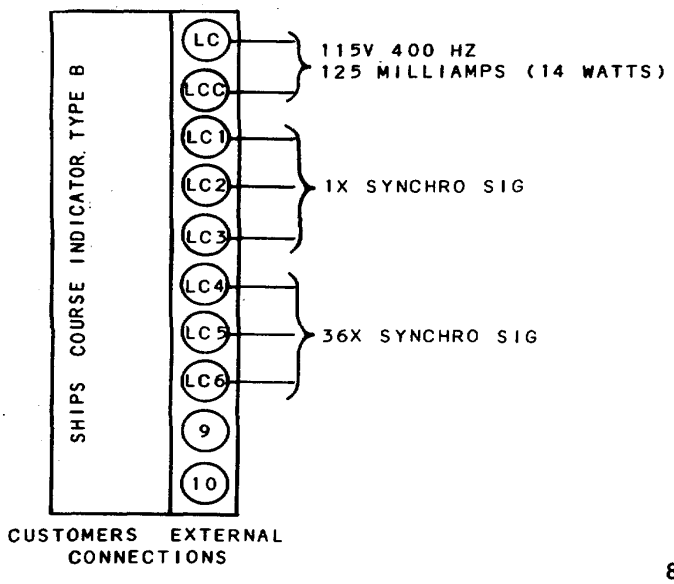
g. Nut (9) — Loosen.

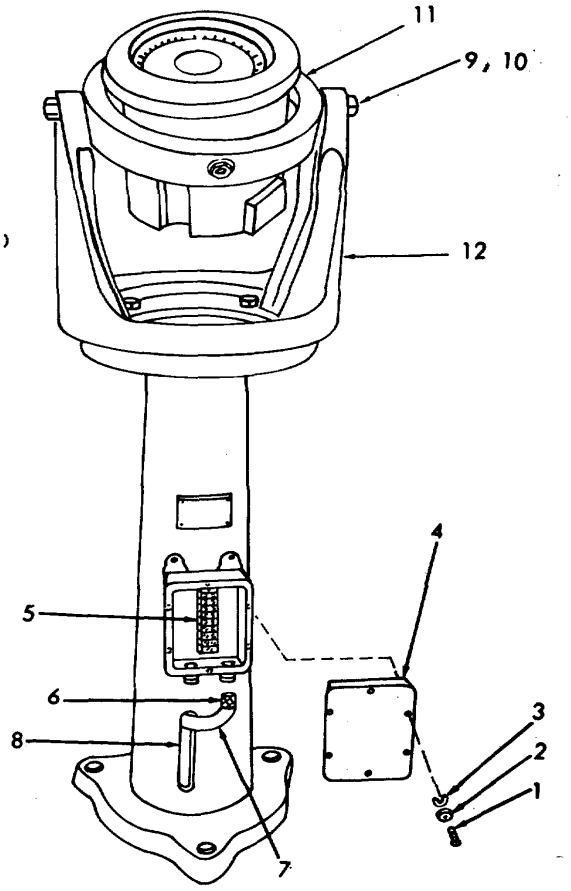
NOTE

Do not remove studs.

h. Studs (10) — Backout.

i. Ship's course indicator (11) — Remove from gimbal bracket (12).



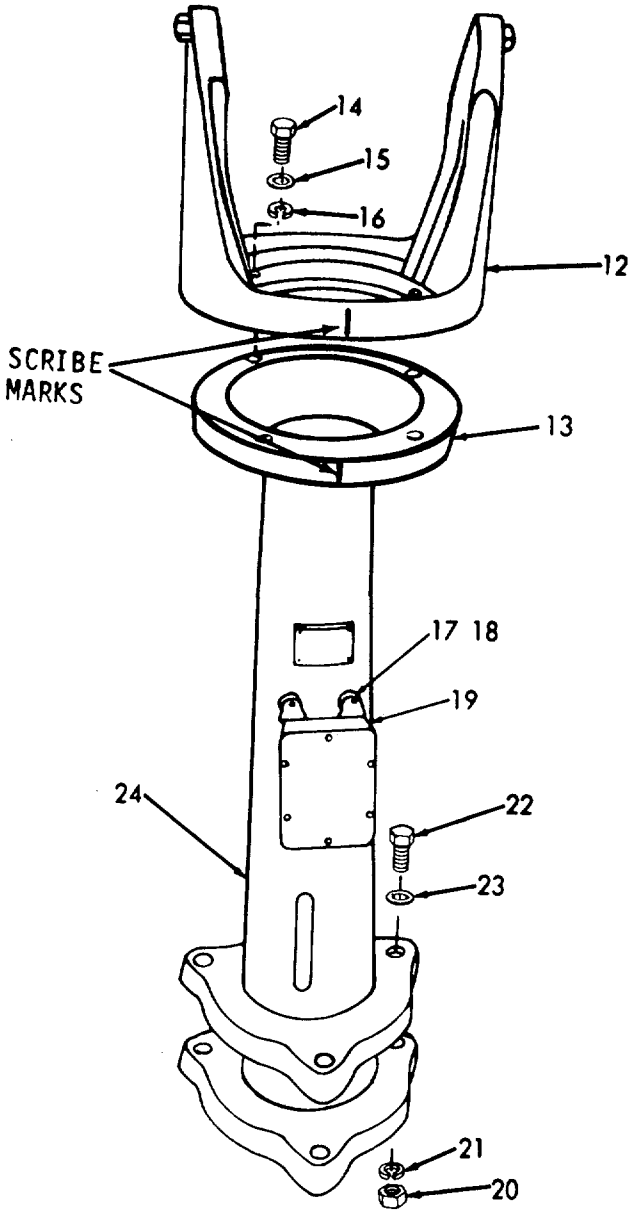


3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			
	j. Bracket (12), and pedestal (13)	Scribe or mark both.	
	k. Bolts (14), washers (15) and lock-washers (16)	Remove.	
	l. Bracket (12)	Remove.	
	m. Screws (17), and lock-washers (18)	Remove.	
	n. Terminal box (19)	Remove.	
	o. Nuts (20), lock-washers (21), bolts (22) and washers (23)	Remove.	
	p. Pedestal (24)	Remove.	

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REMOVAL (Cont)			



3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

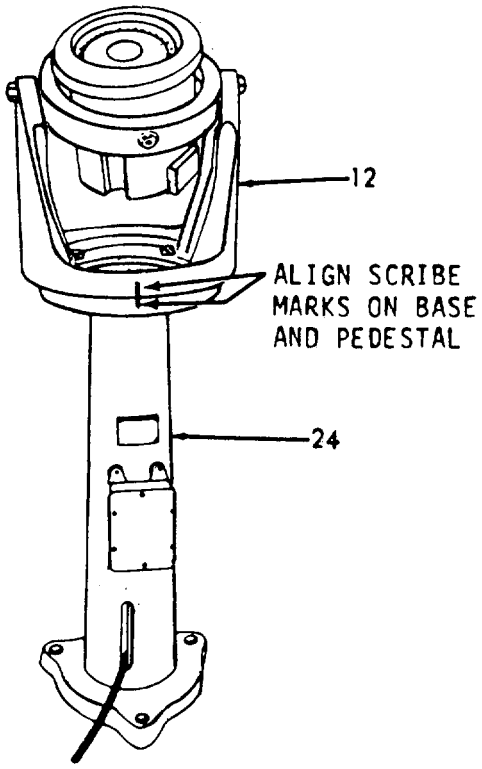
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION			
3.		**CAUTION** The ship's course indicator is a delicate device. Avoid mishandling during movement and assembly.	
	a. Pedestal (24)	Place on base.	
	b. Bolts (22), washers (23), lock-washers (21), and nuts (20)	Install.	
	c. Terminal box (19), screws (17), and lock-washers (18)	Install.	
	d. Bracket (12)	Place on pedestal (24).	
	e. Bolts (14), washers (15), and lock-washers (16)	Install.	Do not tighten.

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	f. Bracket (12), and pedestal (24)	1. Align scribe marks. 2. Tighten.	

NOTE

If scribe marks are missing, continue assembly.

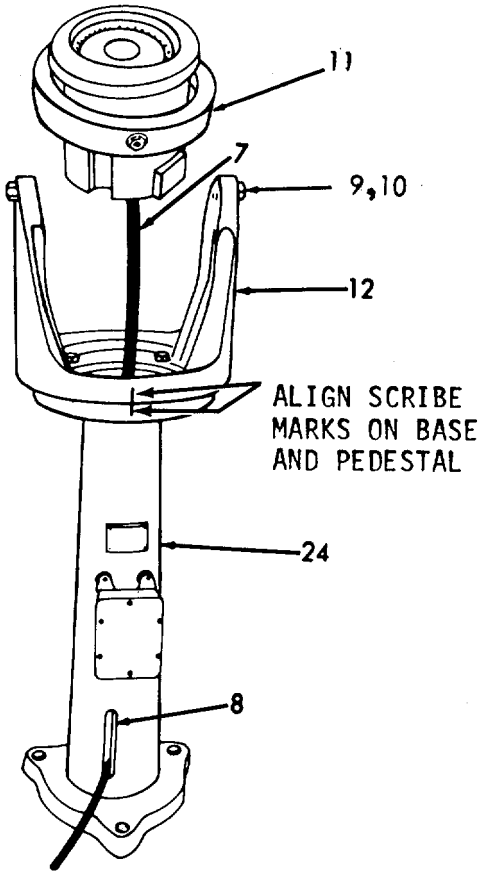


3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	g. Cable harness (7)	1. Feed through bracket (12) and pedestal (24). 2. Feed through elongated hole (8).	
	h. Ship's course indicator (11)	Position in bracket (12).	
	i. Studs (10)	Tighten sufficiently to prevent lateral movement, but not tight enough to prevent the indicator from swinging freely.	
	j. Nut (9)	Tighten.	
	k. Screws (1), flat-washers (2), lock-washers (3), and cover (4)	Remove.	

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			



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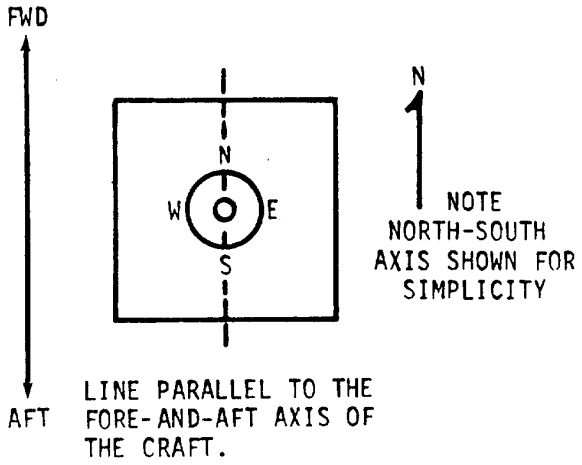
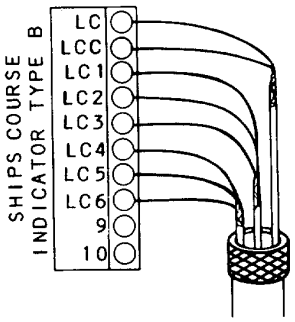
3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

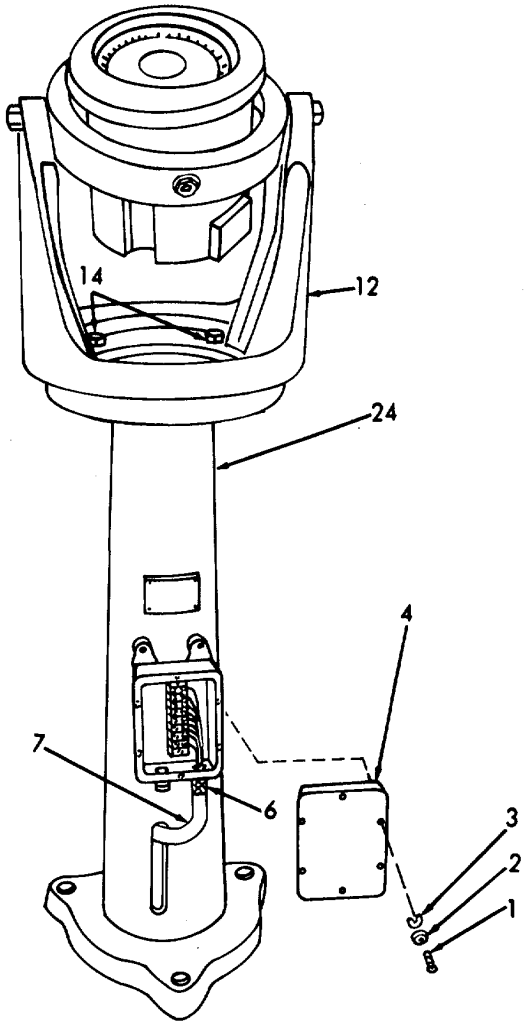
LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	l. Knurled cap (6)	Place over end of cable (7).	
	m. Cable (7)	Insert through stuffing tube.	
		NOTE	
	Pack stuffing tube in accordance with standard procedures.		
	n. Knurled cap	Tighten.	
	o. Cable (7)	Attach as shown.	
	p. Cover (4), screws (1), flat-washers (2), and lock-washers (3)	Replace.	
		NOTE	
	If the scribe marks on the bracket (12) and pedestal (24) are missing, proceed as follows:		
	q. Screws (14)	Screws that attach the bracket (12) to pedestal (24) must be loose.	

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
INSTALLATION (Cont)			
	r. Bracket (12)	Rotate bracket until the North-South axis of the indicator is parallel to fore and aft axis of craft.	This alignment must be exact.
	s. Screws (14)	Tighten.	





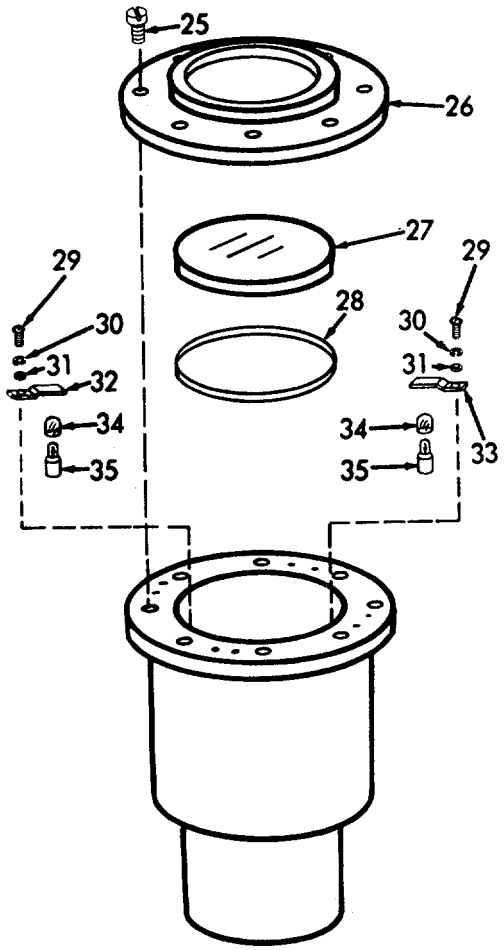


3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR			
4. Dial Light	a. Eight screws (25)	Remove.	
	b. Cover (26), lens (27), and pre-formed packing (28)	Remove.	
	c. Screws (29), lock-washers (30), flat-washers (31), retainers (32 and 33), and filter (34)	Remove where lamp is burned out.	
	d. Dial light (35)	Push in and turn slightly counter-clockwise to remove.	
	e. Dial light (35)	Push in and turn slightly clockwise.	
	f. Filter (34) retainer (32 or 33), screws (29), lock-washer (30), and flatwasher (31)	Install.	

3-219. SHIP'S COURSE INDICATOR - MAINTENANCE INSTRUCTIONS (Continued).

LOCATION	ITEM	ACTION	REMARKS
REPAIR (Cont)			
	g. Cover (26), lens (27), and preformed packing (28)	Assemble.	
	h. Screws (25)	Install.	



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SECTION VI. STORAGE AND REACTIVATION

3-220. GENERAL.

When a component, such as an engine, is to be stored or removed from operation for a period of time, special precautions should be taken to protect the component. The interior and exterior of the component should be protected from rust accumulation and corrosion.

It will be necessary to remove all rust or corrosion from any exposed part before applying a rust preventive compound. Therefore, it is recommended that the component be processed for storage as soon as possible after removal from operation.

The components should be kept as dry as possible during storage. Heat equipment in the winter months and dehumidify equipment in the summer.

3-221. ADMINISTRATIVE STORAGE.

To place a component in administrative storage (1 to 45 days) proceed as follows:

1. Perform the next scheduled preventive maintenance checks and services (PMCS).
2. Correct all known deficiencies.
3. Clean the exterior of all components with fuel oil (except electrical wiring) and dry with compressed air.
4. Seal all openings with barrier material. The material used must be waterproof, vaporproof, and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air. Use metal or wood covers where practical.
5. In freezing weather, drain all water from the components.
6. Cover with a clear plastic cover.

3-222. INTERMEDIATE STORAGE.

To place a component in intermediate storage (46 to 180) days, proceed as follows:

A. General

1. Perform the next scheduled preventive maintenance checks and services. (PMCS).

2. Correct all known deficiencies.

3. Clean the exterior of all components with fuel oil (except electrical wiring) and dry with compressed air.

4. Seal all openings with barrier material. The material used must be waterproof, vaporproof, and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air. Use metal or wood covers where practical.

5. In freezing weather, drain all water from the components.

6. Cover with a clear plastic cover.

7. Inspect periodically. If there are any indications of rust or corrosion, take corrective action.

8. At the end of one year, perform a complete inspection and apply additional treatment as required.

B. Engines

1. Add a rust inhibitor to the cooling system.

2. Remove, check and recondition injectors.

3. Reinstall injectors in the engine, time them, and adjust exhaust valve clearance.

4. Operate engine until operating temperature is reached (160°F to 185°F) (71°C to 85°C).

   a. Stop engine.

   b. Remove oil from crankcase.

   c. Install new oil filters and gaskets.

   d. Fill crankcase with 30 weight preservative lubricating oil [MIL-L-21260 Grade 2 (PlO)].

   e. Drain and change fuel filter and strainer. Refill cavity between element and shell with rust preventive fuel oil. Reinstall filter and strainer.

3-222. INTERMEDIATE STORAGE (Cont).

f. Disconnect fuel line. Place in container containing 10 minutes running time of rust preventive fuel oil.

g. Operate engine for five minutes.

h. Loosen tension on belt drive to bilge pump.

C. Marine Gear.

Operate engine at 600 RPM for 10 minutes. Engage clutches alternately to circulate oil through all moving parts.

D. Torque Converter.

1. Operate engine until temperature reaches 150°F (66°C).

a. Remove oil from the converter.

b. Remove the filter.

CAUTION

Due to lack of lubrication, do not exceed 20 second limit.

c. Start the engine and stall the converter for twenty seconds at 1000 RPM to scavenge oil from converter.

d. Replace filter and new element.

2. Fill converter with preservative oil (MIL-L-2126 0, Grade 1).

CAUTION

Do not stall converter for longer than 30 seconds.

3. Start engine and operate converter for at least 10 minutes at a maximum of 1000 RPM. Engage clutch on an arbor winch and stall the converter to raise the oil temperature to 225°F (107°C).

4. Stop the engine.

E. Hydrostarters

Apply a non-friction rust preventive compound to all exposed parts.

3-223. REACTIVATION FROM STORAGE.

To remove a component from storage, perform the following:

A Engine.

1. Remove the valve rocker covers and pour one gallon of engine oil over the rocker arms and push rods.
2. Re-install valve rocker covers.
3. Remove all covers from openings. Do not forget the exhaust outlet.
4. Wash the exterior with fuel oil and dry with compressed air.
5. Tighten belts to bilge pump.
6. Check crankcase oil level.
7. Drain all anti-freeze from cooling system. Refill and add a rust inhibitor.
8. Service the air cleaner.

B. Marine Gear.

Check the marine gear and refill if necessary.

C. Torquematic Converter.

1. Remove covers from all openings.
2. Wash the exterior with fuel oil and dry with compressed air.
3. Start the engine and operate the unit until the temperature reaches 150° F (66° C).

a. Drain the preservative oil.

b. Change the filter.

c. Start the engine and stall the converter for twenty seconds at 1000 RPM to scavenge the oil from the converter.

CAUTION

The torquematic converter containing preservative oil should only be operated enough to bring the oil temperature to 150° F (66° C).

d. Install a new filter and drain plug.

3-223. REACTIVATION FROM STORAGE (Cont).

e. Refill the converter.

D. Hydrostarter System.

1. Open the relief valve on the side of the pump and release the pressure.

2. Drain, refill and purge the system.

APPENDIX A

REFERENCES

REFER TO VOLUME 12

APPENDIX B

MAINTENANCE ALLOCATION CHART

SECTION I. INTRODUCTION

B-1. GENERAL.

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component and the work measurement time required to perform the functions by the designated maintenance level. The implementation of the maintenance functions upon the end item or components will be consistent with the assigned maintenance functions.

c. Section III lists the tools and test equipment required for each maintenance function as referenced from Section II.

d. Section IV lists the remarks referenced from Section II.

B-2. EXPLANATION OF COLUMNS IN SECTION II.

a. Column (1), Group Number. Column 1 lists group numbers to identify related components, assemblies, subassemblies, and modules with their next higher assembly. The applicable groups are listed in the MAC in disassembly sequence beginning with the first group removed.

b. Column (2), Component/Assembly. This column contains the known names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column (3), Maintenance Functions. This column lists the functions to be performed on the item-listed in Column 2. The maintenance functions are defined as follows:

(1) Inspect. To determine serviceability of an item by comparing its physical, mechanical, or electrical characteristics with established standards through examination.

(2) Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item, and comparing those characteristics with prescribed standards.

(3) Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

(4) Adjust. To maintain within prescribed limits, by grinding into proper or exact position, or by setting the operating characteristics to specified parameters.

(5) Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

(6 Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consist of comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

(7) Install. The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

(8) Replace. The act of substituting a serviceable "like type" part, subassembly or module (component or assembly) for an unserviceable counterpart.

(9) Repair. The application of maintenance services (inspect, 'm test, service, adjust, align, calibrate, or replace) or other maintenance actions (welding, grinding, riveting, straightening, facing remachining or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

(10) Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards in appropriate technical manuals. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to a like-new condition.

(11) Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with organizational manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipments/components.

d. Column (4), Maintenance Level. This column is made up of subcolumns for each category of maintenance. Work time figures are listed in these subcolumns for the lowest level of maintenance authorized to perform the function listed in Column 3. These figures indicate the average active time required to perform the maintenance function at the indicated category of maintenance under typical field operating conditions.

e. Column (5), Tools and Equipment. This column is provided for referencing by code, the common tool sets (not individual tools) special tools, test and support equipment required to perform the designated functions.

f. Column (6), Remarks. This column is provided for referencing by code the remarks pertaining to the designated functions.

B-3. EXPLANATION OF COLUMNS IN Section III.

a. Column (1), Reference Code. The tool and test equipment referenced code correlates with a maintenance function on the identi- fied end item or component.

b. Column (2), Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

c. Column (3), Nomenclature. Name or identification of the tool or test equipment.

d. Column (4), National/NATO Stock Number. The National or NATO stock number of the tool or test equipment.

e. Column (5), Tool Number. The manufacturer's part number.

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0550	Pistons, Connecting Rods, Liner	Inspect	1.0					37,38,39,	
		Replace	4.5					40,41,42,	
		Repair	5.5					43,44,45,46	
0551	Crankshaft	Inspect	.5						
		Replace	6.5					47	
0551A	Bearings, Mains	Inspect	.5						
		Replace	6.5					47	
0552	Cylinder Block	Inspect	.5						
		Replace			10.5				
		Repair	1.0		4.5				
0553	Instrument Panel	Inspect	.1						
		Replace	1.5						
		Repair	2.0						
0554	Starting Aid	Inspect	.1						
		Service	.2						
		Replace	1.5						
		Repair	2.0						
0560	Hydrostarter (Hydrotor)	Inspect	.2						
		Test			1.5			55	
		Replace	1.5						
		Repair	1.2						
		Overhaul			4.5				
0561	Accumulator	Inspect	.1					54	
		Service				1.0			
		Replace	1.4						
		Repair				3.5			
0562	Hydrostarter Pump (Engine Driven)	Inspect	.2						
		Replace	1.2						
		Repair				2.5			
		Overhaul				3.0			
0563	Hydraulic Pump (Hand)	Inspect	.2						
		Replace	1.0						
		Repair	3.5						
0564	Reservoir	Inspect	.2						
		Replace	1.9						
		Repair				1.0			
0565	Hydraulic Filter & Hoses	Inspect	.2						
		Replace	2.0						
		Repair	1.0			2.0			

SECTION II. MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0570	"A" Frame, Wire Rope & Anchor	Inspect	.5						
		Service	1.0						
		Replace			2.0				
		Repair			1.0				
0571	Fairleader	Inspect	.2						
		Service	.3						
		Replace			6.0				
		Overhaul			8.0				
0572	Wire Rope Cutter	Inspect	.5						
		Repair	4.0						
0600	Mast	Inspect	.5						
		Service	.5						
		Replace			12.0				
		Repair	5.5		29.0				
0700	Ships' Hydraulic System	Service	.2						
0710	Hydraulic Power Unit								
0711	Electric Motor	Inspect	.2		1.0				
		Replace	1.5						
		Repair			7.5				
0712	Hydraulic Pump	Inspect	.3						
		Replace	3.5						
		Repair			5.5				
		Overhaul			7.5				
0713	Relief Valve	Inspect	.3						
		Adjust	.5						
		Replace	1.0						
		Repair	.5		2.0				
0714	Hydraulic Reservoir	Inspect	.3						
		Replace	2.5						
		Repair	1.0		3.0				
0715	Controller	Inspect	.3						
		Replace	2.5						
		Repair			4.5				
0716	Gages	Inspect	.5						
		Replace	1.3						
0717	Push Button Switch	Inspect	.2						
		Replace	1.7						
		Repair	1.0						

SECTION II. MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0720	Stern Gate Hydraulic System								
0721	Hydraulic Control	Inspect	.4						
		Replace	3.0						
		Repair			10.5				
0723	Hoses, Fittings and Piping	Inspect	.5						
		Replace	4.2		10.5				
0724	Hydraulic Ram	Inspect	.5						
		Replace	3.5						
		Repair			10.5				
0730	Mast Hydraulic System								
0731	Hydraulic Ram	Inspect	.5						
		Replace	3.5						
		Repair			10.5				
0732	Hydraulic Control	Inspect	.4						
		Replace	3.0						
		Repair			10.5				
0734	Hoses and Fittings	Inspect	.5		10.5				
		Replace	4.2						
0740	Stern Anchor Hydraulic System								
0741	Hydraulic Winch	Inspect	.5						
		Replace	3.0						
		Repair	2.0		10.5				
0742	Hydraulic Control	Inspect	.4						
		Replace	3.0						
		Repair			10.5				
0743	Hoses and Fittings	Inspect	.5						
		Replace	4.2						
0800	Steering Systems								
0810	Motor	Inspect	.3						
		Replace	2.0						
		Repair	2.0		7.0				
0811	Motor Controller	Inspect	.5						
		Replace	2.5						
		Repair			4.5				

SECTION II. MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0812	Hydraulic Pump	Inspect	.3						
		Replace	2.0						
		Repair	2.0		7.0				
0813	Brake Valve	Inspect	.3						
		Replace	2.5						
		Repair			4.5				
0814	Directional Control Valve	Inspect	.3						
		Replace	2.5						
		Repair	4.5						
0815	Hydraulic Cylinder and Linkage	Inspect	1.0						
		Adjust	1.0						
		Replace			15.0				
		Repair	1.8		13.0				
0816	Hydraulic Hoses, Piping and Valves	Inspect	1.0						
		Replace			15.0				
		Repair	2.0		12.0				
0817	Main and Flanking Rudders	Inspect			4.0				
		Replace			20.0				
		Repair			10.0				
0820	Rudder Angle Indicator	Inspect	.5						
		Replace			4.0				
		Repair	1.5						
		Overhaul			10.5				
0821	Rudder Angle Transmitter	Inspect	.5						
		Replace	4.0						
		Repair	1.0						
		Overhaul			10.5				
0830	Flanking Rudder Limit Switch	Inspect	.2						
		Replace	1.0						
		Repair	.2						
		Overhaul			10.0				
0840	Steering Control Panel and Gyro Computer	Inspect	.5						
		Replace	2.5						
		Repair	2.0						
		Overhaul			40.0	20.0			
0850	Heading Selector	Inspect	.5						
		Replace	.5						
		Repair	1.5						
		Overhaul			10.0				

SECTION II. MAINTENANCE ALLOCATION CHART (CONTINUED)

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
0860	Remote Magnetic Heading Compass	Inspect	.5						H
		Adjust			2.5				
		Replace			7.0				
		Calibrate			3.5				
		Overhaul				10.0			
0870	Emergency Steering System	Inspect	1.0						
		Replace	2.0						
		Repair	2.5						
0880	Ships' Course Indicator	Inspect	.7						
		Replace	5.0						
		Repair	12.5		40.0				

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By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

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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 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 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 milliters = .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

PIN: 046753