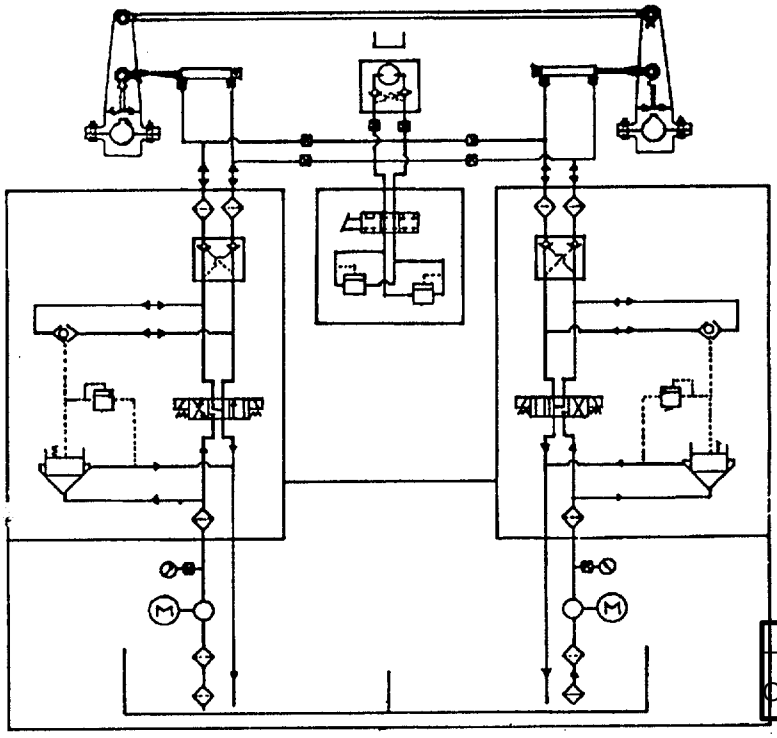
TECHNICAL MANUAL

UNIT, INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS STEERING GEAR SYSTEM FOR

LANDING CRAFT UTILITY (LCU)

NSN 1905-01-154-1191



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CHANGE
NO. 3

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DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 29 April 1994

**Unit, Intermediate Direct Support,
and Intermediate General Support
Maintenance Instructions
STEERING GEAR SYSTEM
for
LANDING CRAFT UTILITY (LCU)
NSN 1905-01-154-1191**

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NO. 1

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i and ii	i and ii
1-1 through 1-14	1-1 through 1-14
	1-15 through 1-19/(1-20 blank)
2-1 and 2-2	2-1 and 2-2
2-11 and 1-12	2-11 and 1-12
2-23 and 2-24	2-23 and 2-24
2-31 and 2-32	2-31 and 2-32
2-37 and 2-38	2-37 and 2-38
2-41 and 2-42	2-41 and 2-42
	2-43 through 2-53/(2-54 blank)
3-1 and 3-2	3-1 and 3-2
3-7 and 3-8	3-7 and 3-8
3-31/(3-32 blank)	3-31 through 3-36
4-1 through 4-4	4-1 through 4-4
4-21 and 4-22	4-21 and 4-22
	4-23 and 4-24
B-5 through B-8	B-5 through B-8
C-1 and C-2	C-1 and C-2
C-3/(C-4 blank)	C-3/(C- blank)
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WARNING

HIGH PRESSURE
HYDRAULIC SYSTEM HAZARDS

Hydraulic systems can cause serious injuries if high pressure lines or equipment fail.

Never work on hydraulic systems or equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment, and who can give first aid. A second person should stand by controls to turn off hydraulic pumps in an emergency. When the technicians are aided by the operators, the operators must be warned about dangerous areas.

ELECTRICAL HAZARDS

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Do not be misled by the term "low voltage." Potentials as low as 50 volts may cause death under adverse conditions.

Be careful not to contact 115-Vac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through the body.

For Artificial Respiration, refer to FM 21-11.
a/(b blank)

TECHNICAL MANUAL

No.55-1905-223-24-9

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 17 January 1989

UNIT, INTERMEDIATE DIRECT SUPPORT, AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

STEERING GEAR SYSTEM FOR LANDING CRAFT UTILITY (LCU) NSN 1905-01-154-1191

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 these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

1-1. **Scope**. The scope of this manual is as follows:

a. Type of Manual. Unit, intermediate direct support, and intermediate general support maintenance manual.

b. Name of Equipment. The equipment covered by this manual is the steering gear system that is installed aboard the LCU 2000 Class Watercraft. This manual is limited in scope to the hydraulic portion of the steering gear system. See FIGURES 1-1 and 1-2. The steering control system is covered in TM 55-1905-223-10. Hydraulic components are as follows:

(1) Twin pumpset, Model TA30D.
(2) Crossover relief valve used on hulls 2008 and subsequent.
(3) Double acting relief/bypass/shutoff (DARBS) valve.
(4) Pair of twin hydraulic cylinders, Model L 100-650.
(5) Emergency manual helm pump Model 83.
(6) Emergency hand pump used on hulls 2008 and subsequent.
(7) 2 Gallon header tank used on hulls 2008 and subsequent.
(8) Two-litre (1/2 U.S. Gallon) header tanks.

c. **Purpose of Equipment**. The steering gear system electrohydraulic equipment causes the watercraft rudders to move on command, which controls the direction of vessel travel.

1-2. **Maintenance Forms, Records, and Reports**. Department of the Army forms and procedures used for equipment maintenance are prescribed by DA Pam 738-750, The Army Maintenance Management System.

1-3. **Destruction of Army Materiel**. Refer to TM 750-244-3 for instructions covering the destruction of Army materiel to prevent enemy use.

1-4**. Reporting Equipment Improvement Recommendations (EIR**). If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to: Commander, U.S. Army Troop Support Command; ATTN: AMSTR-MEQ; 4300 Goodfellow Blvd.; St. Louis, I Missouri 63120-1798. We'll send you a reply.

1-5. **Preparation for Storage or Shipment**. Administrative storage of equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the Preventive Maintenance Checks and Services (PMCS) charts before storing. When removing the equipment from administrative storage, the PMCS should be performed to assure operational readiness. Repacking of equipment for shipment or short term storage, is covered in paragraph 2-27.

Hulls 2008 and subsequent

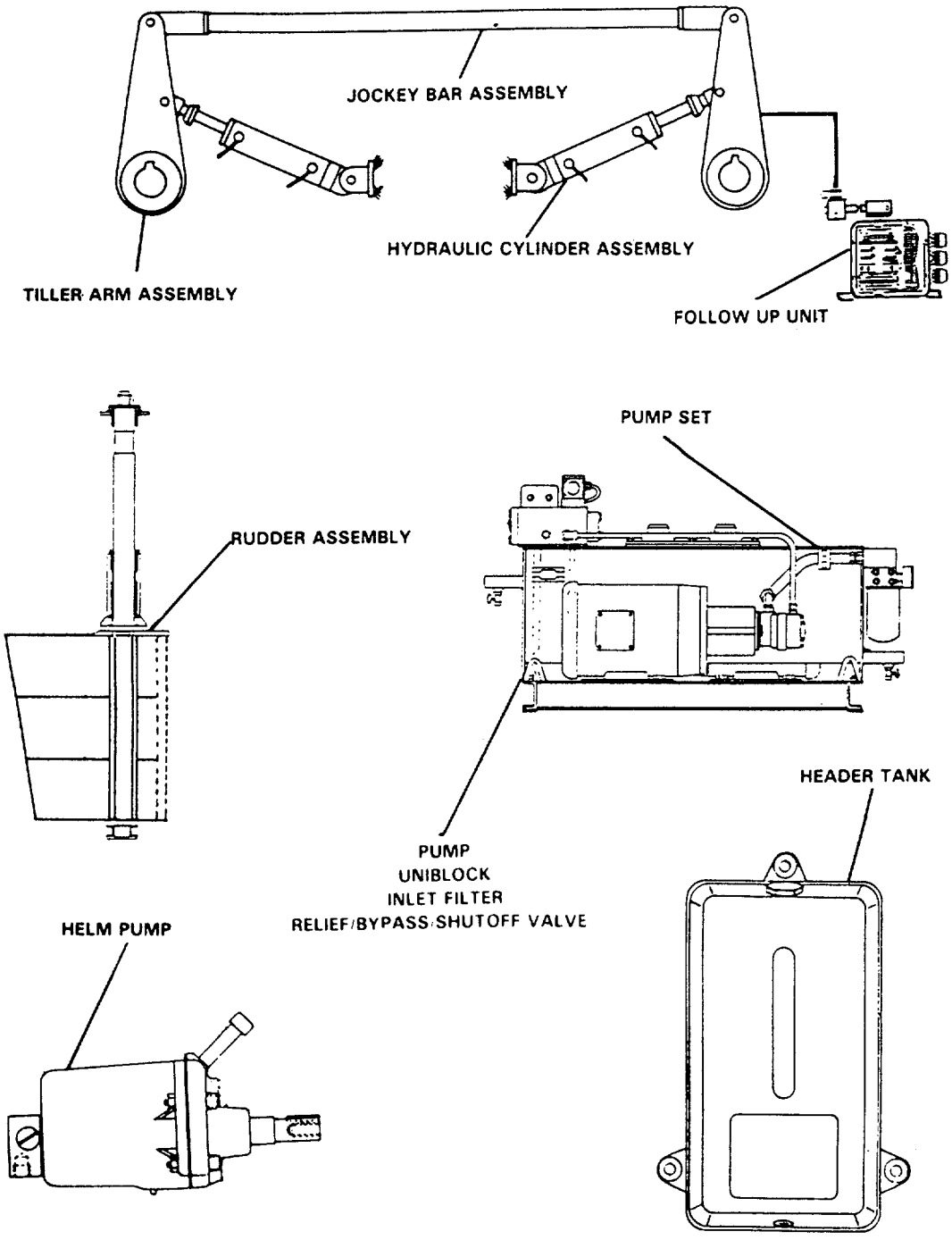


FIGURE 1-1. Electrohydraulic Steering Gear.

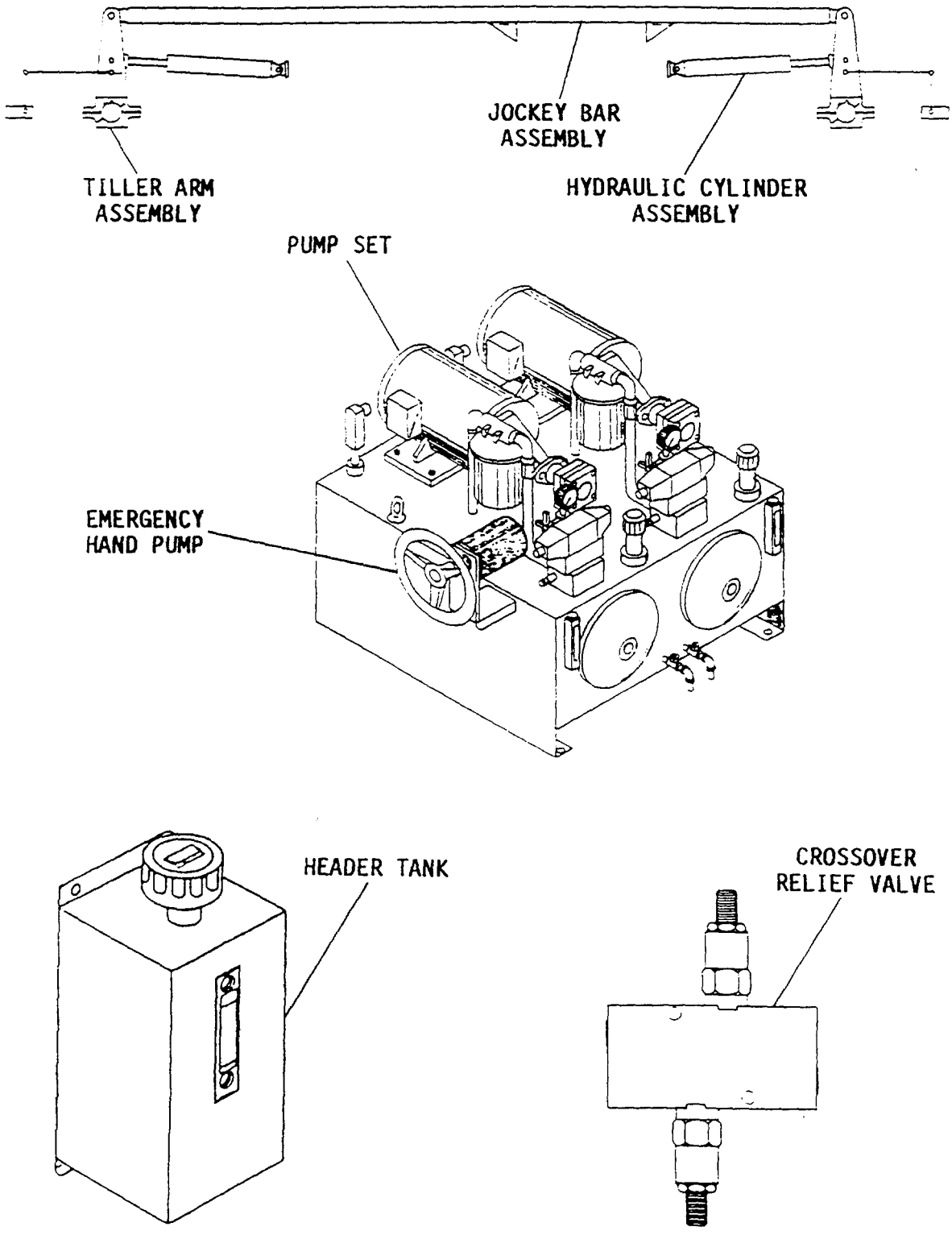


Figure 1-2. Electrohydraulic Steering Gear

Hulls 2008 and subsequent

Section II. EQUIPMENT DESCRIPTION AND DATA

1-6. **General Description**. The LCU 2000 Class Watercraft is equipped with twin propellers and rudders. The electrohydraulic system develops a total rudder torque of 1 3L ton-ft and is capable of rotating the rudders from 35 degrees right of center to 35 degrees left of center in 15 seconds. Steering gear hydraulic equipment includes a dual pumpset to generate hydraulic power, piping and hoselines to transmit pressurized fluid, hydraulic cylinders to convert fluid energy into mechanical work, and valves to control and direct fluid flow. The system also includes filters and strainers for fluid conditioning, relief valves for overload protection, and reservoirs for fluid supply and heat dissipation. When steering signals from the pilothouse are interrupted, the steering gear room takes control by using one of the two local control units near the pumpsets. In the event of a power loss to the pumpset, an emergency hand pump is used for emergency steering. The steering gear equipment is shown in FIGURES 1-1 and 1-2.

1-7. **Characteristics, Capabilities and Features**. A very broad view of the steering gear hydraulic system is as follows:

a. Characteristics

(1) Controls direction of vessel travel.
(2) Provides hydraulic power for the rudder movement.
(3) Controlled from pilothouse and/or steering gear room.

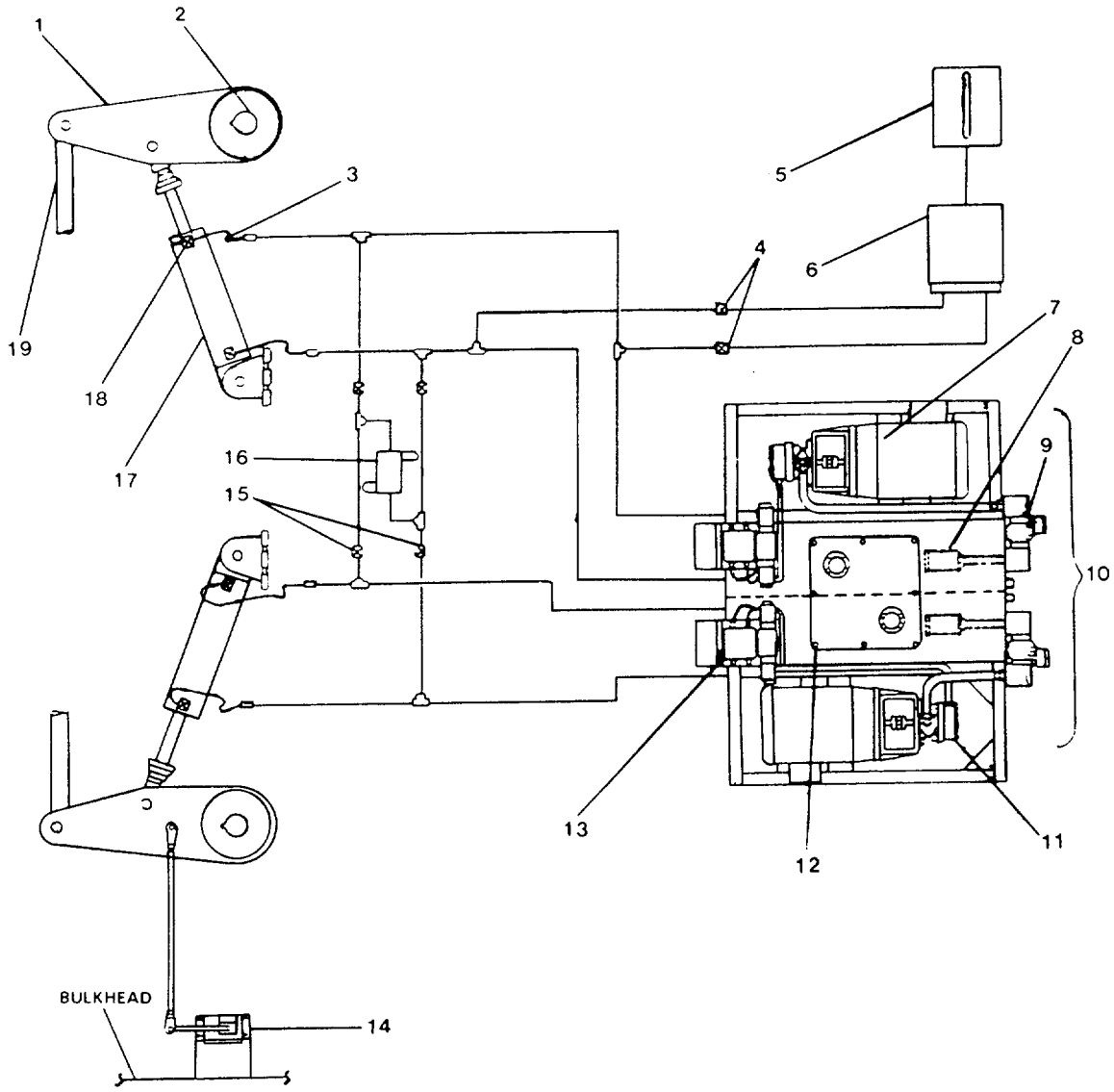
b. Capabilities and Features

(1) Can operate with only one cylinder.
(2) Emergency hand pump can replace twin pumpsets in emergency.
(3) Relief valve setting lets rudder move if it hits something.

1-8. **Location and Description of Major Components**. The steering gear room houses the primary mechanical and electrohydraulic components that make up the steering gear. At the heart of the system is the twin pumpset, plus port and starboard hydraulic cylinders. The pumpset is secured to a deck foundation on the port side of the steering gear room aft of the rudder stocks. The hydraulic cylinders are installed inboard of each tiller arm. Steering gear controls are located in the pilothouse. See TM 55-1905-223-10 for more information on the steering gear controls. Components described in the following paragraphs are illustrated in FIGURES 1-3 and 1-4 except where noted.

a. Reservoir. The rectangular enclosure under the twin pumpset is the hydraulic fluid reservoir. This 60-gallon tank is internally divided into two separate 30-gallon tanks with separate but identical fill openings, I sight gauges, internal suction strainers, low level sensors (used on Hulls 2008 and subsequent).

b. Reservoir. The rectangular enclosure in the center of the twin pumpset is the hydraulic fluid reservoir. This 30-gallon tank is internally divided into two separate 15-gallon tanks with separate but identical fill openings, sight gauges, internal suction strainers, low level sensors, and porting blocks. The porting blocks include inlets, outlets, and drains. The quantity of oil for normal operations is 11 gallons in each tank. The sight gauges register FULL for these quantities. The unused tank space allows for air/oil expansion and pitch and roll slosh. The tank partition is fluid tight, but is not built to the full height of the tank.



LEGEND

1. TILLER ARM
2. RUDDER POST
3. HYDRAULIC HOSE
4. SHUTOFF VALVE
5. HEADER TANK
6. HELM PUMP
7. ELECTRIC MOTOR
8. RESERVOIR INLET LINE STRAINER
9. INLET FILTER
10. DUAL PUMPSET
11. VANE PUMP
12. RESERVOIR
13. UNIBLOCK 2A MANIFOLD
14. FOLLOWUP TRANSMITTER
15. SHUTOFF VALVE
16. DOUBLE ACTING RELIEF/ BYPASS/SHUTOFF VALVE
17. HYDRAULIC CYLINDER
18. SHUTOFF VALVE
19. JOCKEY BAR

Figure 1-3. Steering Gear (Hydraulic Piping) System.

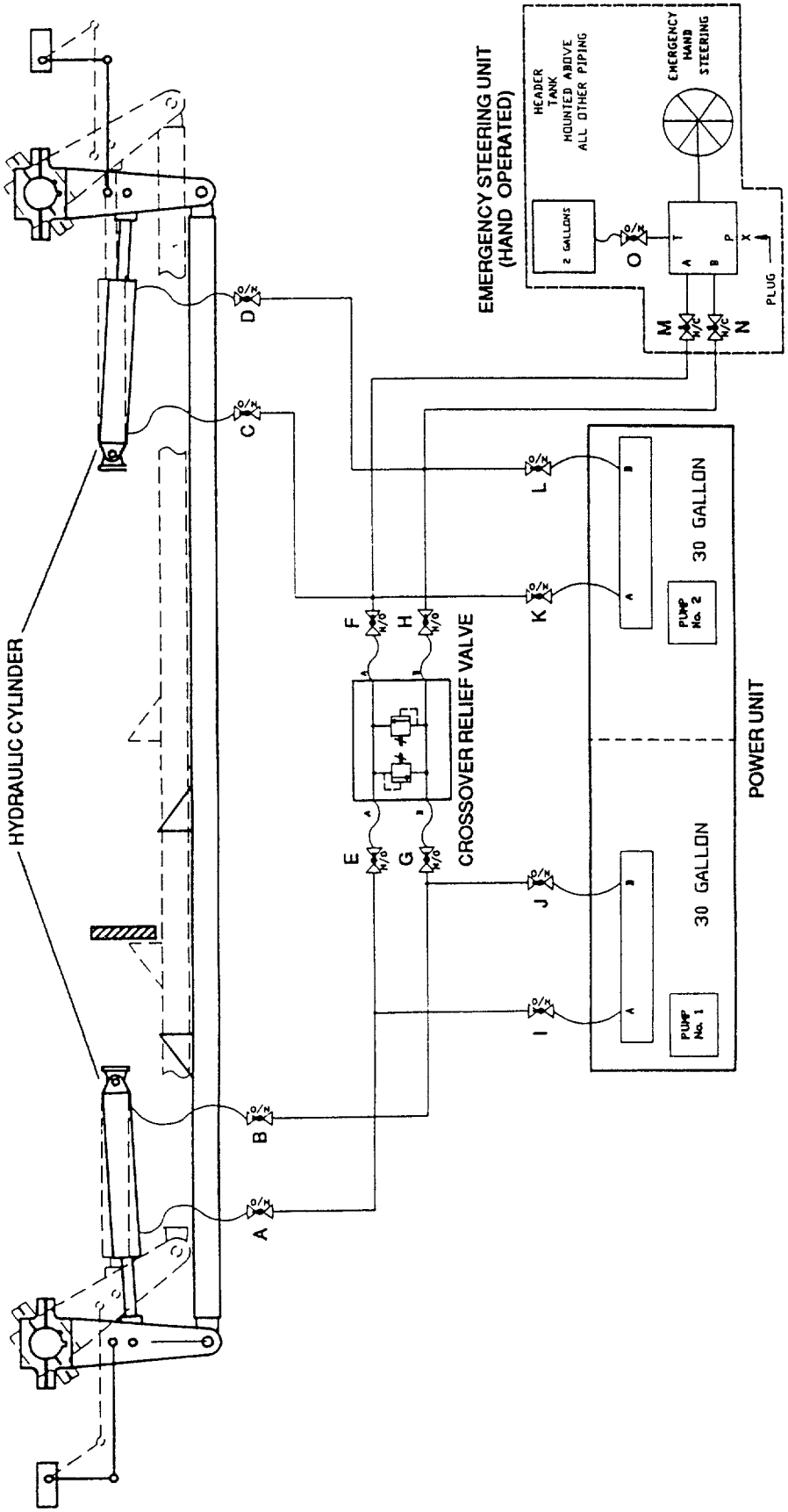


Figure 1-4. Steering Gear (Hydraulic Piping) System. Hulls 2008 and subsequent

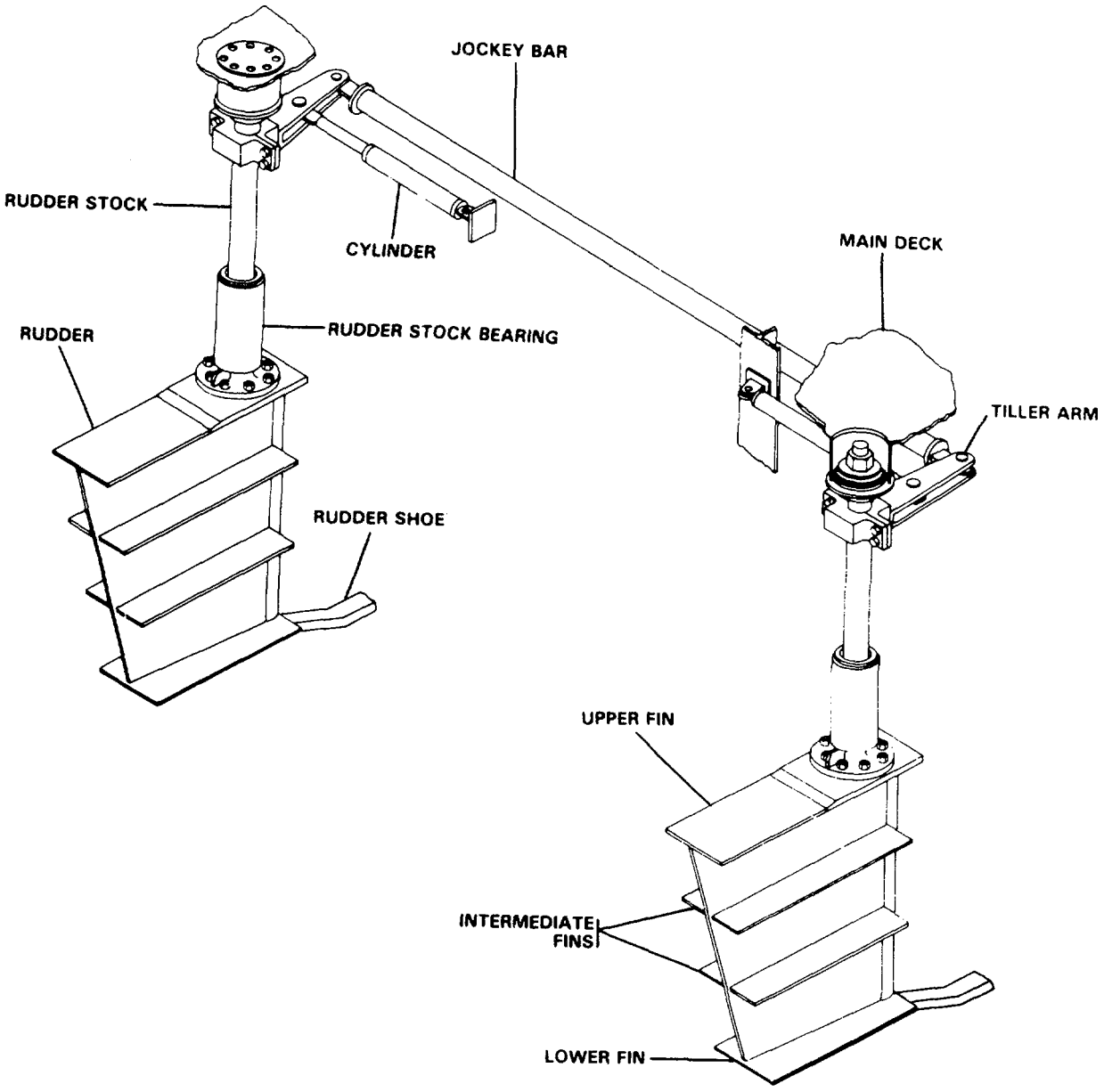
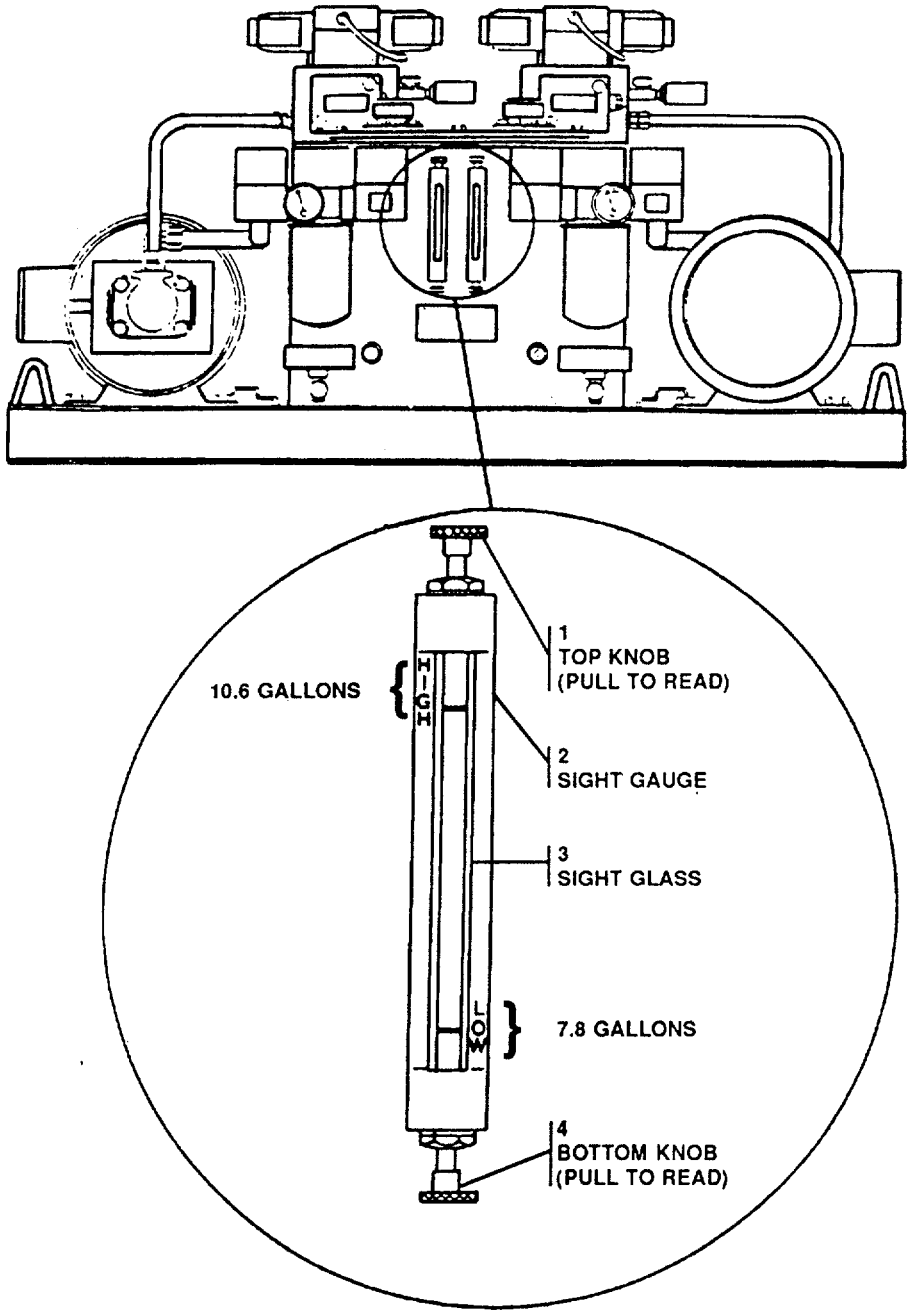


Figure 1-5. Rudder/Steering Gear Arrangement.



LEGEND:

1. **TOP KNOB**
2. **SIGHT GAUGE**
3. **SIGHT GLASS**
4. **BOTTOM KNOB (PULL TO READ)**

Figure 1-6. Reservoir Sight Gauge.

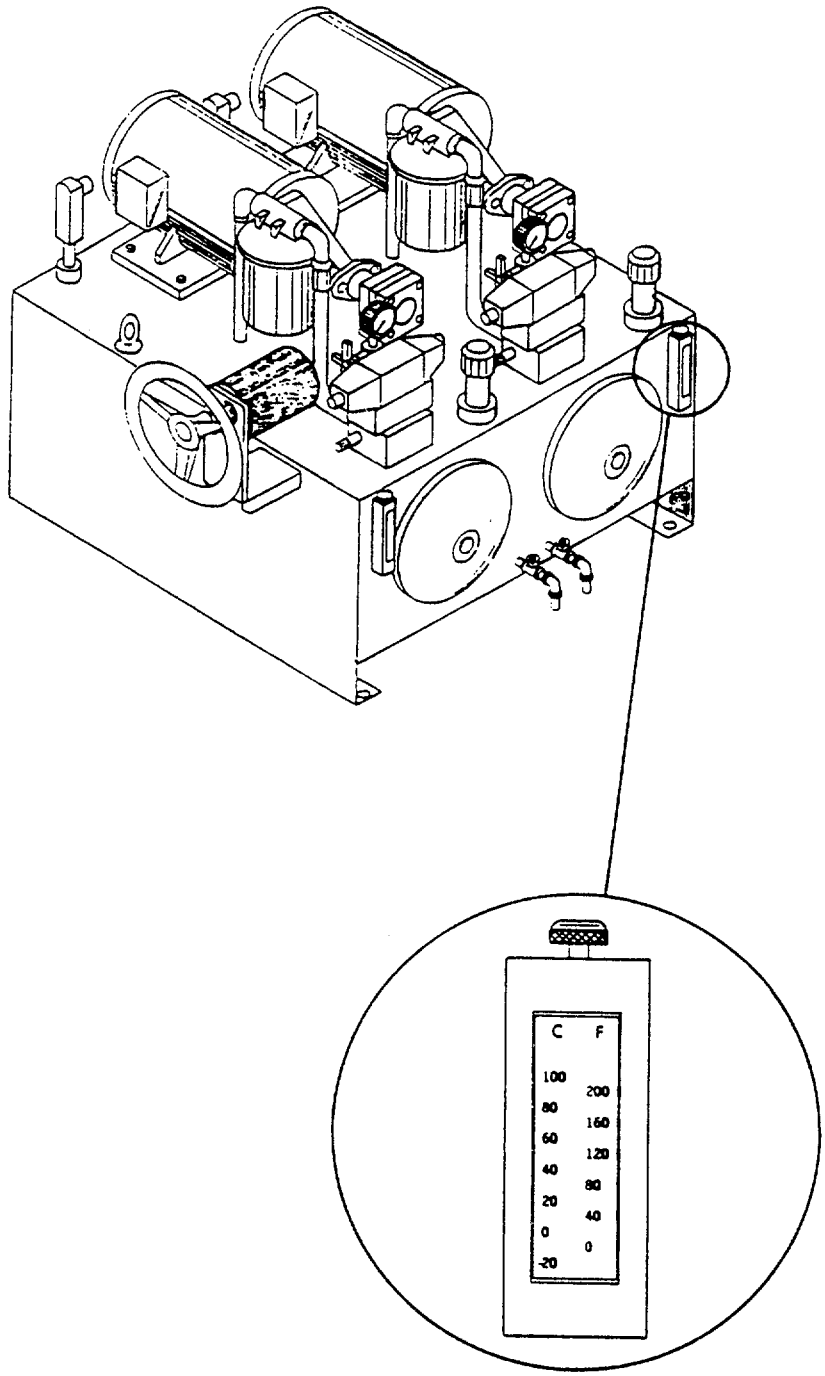


Figure 1-7. Reservoir Sight Gauge.

Hulls 2008 and subsequent
Change 1 1-9

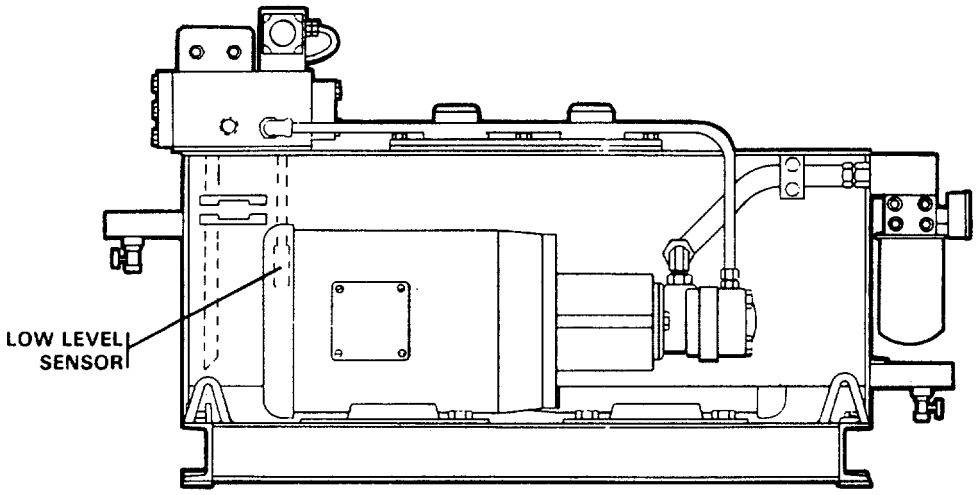


Figure 1-8. Reservoir Low Level Alarm Sensor.

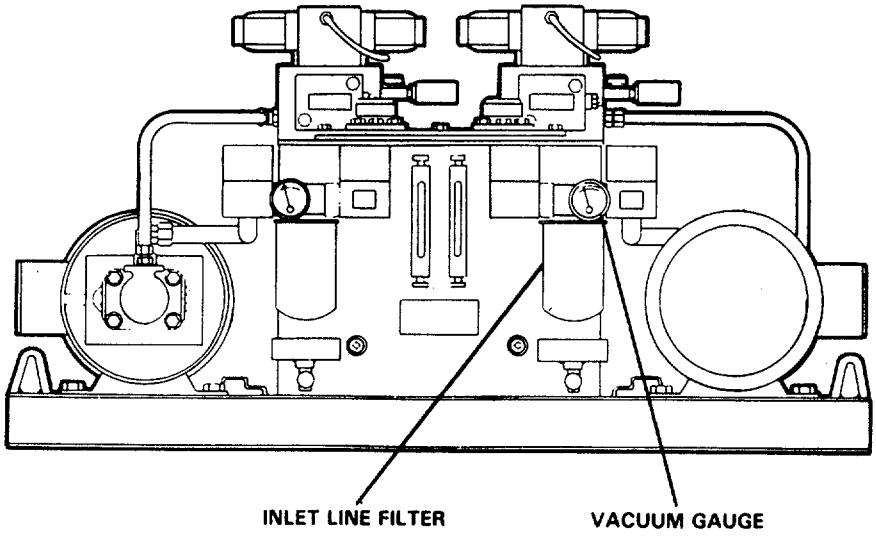


Figure 1-9. Pumpset Inlet Line Filter.

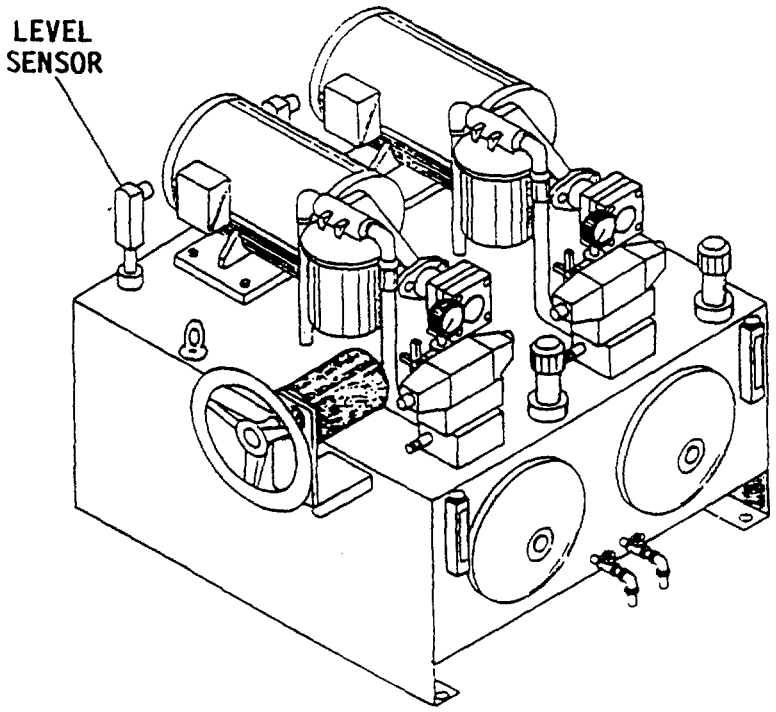


Figure 1-10. Reservoir Level Sensor.

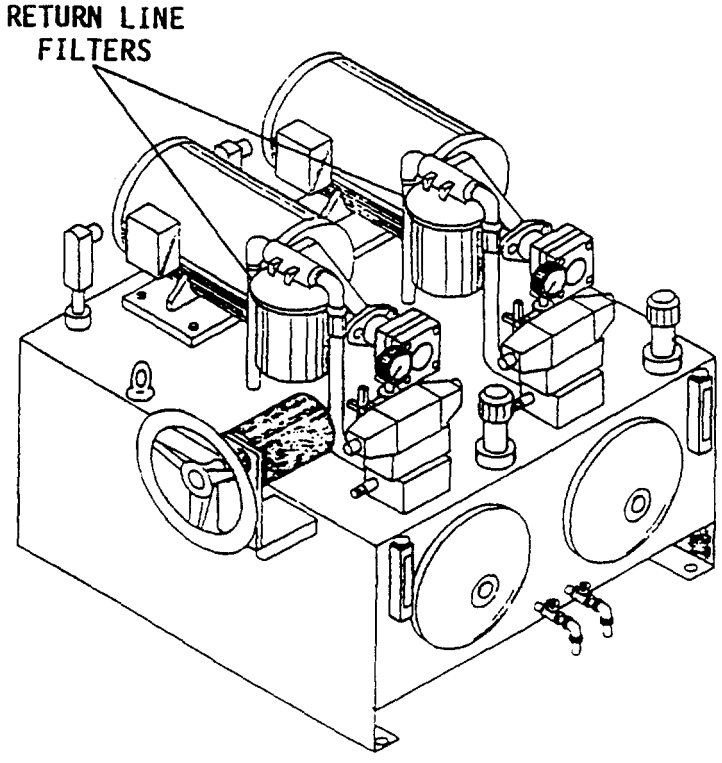


Figure 1-11. Pumpset Return Line Filter.

Hulls 2008 and subsequent

(1) Reservoir Sight Gauge (FIGURES 1-6 and 1-7). This gauge has spring return knobs above and below the sight glass. To read the oil level, pull and hold both knobs outward while oil finds its level within the glass. Take a reading, then release both knobs. The gauge reads HIGH when the reservoir contains 30 gallons and LOW when the reservoir contains 10 gallons.

(2) Level Sensor (FIGURES 1-8 and 1-10). In each section of the pumpset reservoir there is a probe containing a floating magnet and a reed switch. When the oil level drops below the set point of the probe, the magnet trips the reed switch and energizes an alarm on the control panel in the pilothouse. Mountings and electrical connections for each probe are in each uniblock manifold. The alarm sounds when only 15 gallons are left in the reservoir.

(3) Reservoir Inlet Line Strainer. The 100-wire mesh strainer, rated at a 20 gpm flow, traps contaminated particles over .010 inch in diameter. One unit is installed in each reservoir on the suction line to the hydraulic pump. The strainer element can be removed for periodic cleaning or be replaced when it is no longer serviceable.

c. Pumpset. The pumpset generates hydraulic energy to power the steering gear. The pumpset draws hydraulic fluid from integral reservoirs and circulates it under pressure through system piping. In each pumpset, a 10horsepower electric motor drives a vane-type hydraulic pump displacing 9.5 gpm at the nominal 930 psi charge pressure. Normally, only one pumpset powers the steering gear. The other is considered a standby. Each pump discharges into a separate four-way solenoid-controlled directional valve that is responsive to electrical commands from the pilothouse. On command, the valve diverts fluid into the starboard and port actuating cylinders, moving the tillers in the direction ordered to control the rudders. In the absence of any signal, a lockvalve applies a fluid lock to the pistons in both actuators. A threeposition DARBS (double acting relief/ bypass/shutoff) valve protects the system from overpressure damage if rudder movement is obstructed or a malfunction occurs.

(1) Return Line Filter(FIGURES 1-9 and 1-11). This 30-gpm rated filter is installed in the suction line to each vane pump. The filter head diverts hydraulic oil through a spin-on disposable cartridge rated for 10-micron filtration. The head design incorporates the oil inlet port, the oil outlet port, a vacuum gauge, and an internal bypass valve, in addition to mounting dogs for the head and the mounting flange for the spin-on cartridge. A gauge reading of 10 inches of mercury (5 psi) indicates that the cartridge should be changed. The bypass opens somewhat above this value to safeguard the pump from cavitation.

(2) Pump Motors. Identical I O-horsepower electric motors drive the two vane pumps at 1800 rpm. The motors operate on 230-Vac, 3-phase, 60-Hz power from the motor control switchboard located in the engine control room. Backup power is provided from the emergency switchboard located in the emergency generator room. The shafts of each motor and pump are directly coupled.

(3) Vane Pump. The pump shaft and motor shaft are aligned and mechanically coupled. At the heart of this pump is a slotted rotor into which 12 sliding vanes are fitted. Because these precision vanes are replaceable drop-in elements, repair and overhaul are simplified.

d. Uniblock 2A Manifold (FIGURE 1-12). System I and system 2 have identical uniblock 2A manifolds. I Input to each manifold is piped directly from outlet of the associated vane pump into the manifold inlet through an inlet filter. The manifold inlet provides two internal flow paths: path (a) flows into the pump port of the solenoid-operated four-way directional valve, and path (b) flows into the inlet port of the vent/relief cartridge. With no voltage on the solenoid valve, flow path (a) is closed. In this configuration, the vent/relief cartridge vents the low pressure flow back into the reservoir. Once the solenoid is energized, however, path (a) opens, causing path (b) to close. These actions couple the pump discharge directly to both actuating cylinders. In this configuration, system pressure builds up until the rudders respond. This pressure will not exceed the 930 psi setting of the manifold relief valve. In addition to the manifold body, each uniblock assembly incorporates the following components: directional valve, shuttle valve, lockvalve, and two outlet filters. Descriptions of the manifold components follow.

(1) Manifold Inlet Filter. This filter is a cleanable 60-wire mesh screen that traps particles over .010 inch in diameter.

(2) Solenoid-Operated Four-Way Directional Control Valve (FIGURE 1-12). This valve accepts 24 Vdc electrical rudder orders and initiates right or left rudder travel. The valve is made up of a central body with identical right and left operating solenoids. Lateral motion of the armature in either solenoid repositions the valve spool, changing the interconnections between inlet and outlet ports. Port P is the valve inlet from the vane pump. Port T is the valve outlet to the reservoir. Ports A and B are inlets or outlets, depending on the position of the sliding spool. Outflow from port A drives the piston in one direction, causing the displaced fluid on the other side of the piston to return to the reservoir via port B. When neither solenoid is energized, internal springs position the spool in the center. In this position, port P is blocked. This causes the pump discharge to open the vent/relief cartridge between the pump and the directional valve. The discharge returns to the reservoir. In the center position, ports A and B are internally connected to port T (and to the reservoir).

(3) Vent/Relief Cartridge. This assembly has three fluid ports: an inlet port, a vent/relief outlet port, and a pilot inlet port. When no pressure is sensed at the pilot inlet port, fluid enters the inlet port and flows out the vent/relief outlet port to the fluid reservoir. When the pilot inlet port is pressurized, flow between the inlet and outlet ports is cut off. Cutoff pressure is applied to the vent/relief cartridge via the shuttle valve as described below.

(4) Shuttle Valve (FIGURE 1 -12). The shuttle valve intercepts the flow of fluid out of ports A and B of I the solenoid valve so that when either solenoid is energized, a pilot inlet flow path to the vent/relief cartridge closes off the return of fluid to the reservoir via this cartridge. Outflow from the shuttle valve also enters the 930 psi relief valve, so that pressures exceeding 930 psi are vented back to the reservoir.

(5) Relief Valve. This valve diverts the vane pump discharge via the shuttle valve back into the fluid reservoir whenever system pressure exceeds 930 psi. The pressure at which this valve opens can be adjusted if necessary as described in paragraph 3-12.

(6) Lockvalve. The outflow from each pumpset passes through a lockvalve located in the uniblockjust before it is piped into the port and starboard cylinders located in the uniblock. When there is no rudder order, the lockvalves establish a bidirectional fluid lock around both pistons to prevent rudder travel. The lockvalves automatically isolate the idle pumpset so that pump changeover is accomplished without reconfiguring the system.

(7) Manifold Outlet Filters. These filter elements are cleanable, reusable 60-mesh wire screen.

e. DARBS Valve. A three-position double acting relief/bypass/shutoff (DARBS) valve protects the system from overpressure damage in the event the rudder strikes an underwater object. A three-position mode selector spool operates the valve in three ways:

(1) Relief. This is the normal operating position. Relief valves are factory set to open at 1160 psi. That way, they protect system piping from overpressurization.

(2) Bypass. In bypass, the rudders can be mechanically centered or moved as required during installation, removal, or maintenance.

(3) Shutoff. This position isolates the relief valves from the system so that a failure of one or both does not disable the steering gear.

f. Hydraulic Cylinders. Port/starboard tiller arms are operated by doubleacting hydraulic cylinders. This cylinder is closed at one end and has a piston and piston rod fitted into the other end. Fluid ports near each end drive the piston inward or outward as required for right or left rudder movement. Spherical mounted pivot pins couple the cylinder to its mounting pad and the piston rod to the tiller arm. O-rings limit fluid losses around the piston and the piston rod.

g. Hard-Over Stops. Rudder travel is limited to 35 degrees right or left by mechanical stops that limit the stroke of the pistons. In each cylinder, the outer limit is reached when the piston face contacts a fixed stop inside the tube. The inward stroke of the piston reaches a limit when a threaded collar on the outer end of the piston rod makes contact with the outer flange of the cylinder cap. Threads on this rod allow inward or outward adjustment of this stop. When both rudders are at the right hard-over limit, one piston is stroked to its outer limit and the other to its inward limit. Since the outer limit is fixed, the other piston must be adjusted so that its inward limit matches exactly. The same adjustment is made to the other piston with both rudders at the left hard-over limit.

h. Tiller Arms. A forward facing tiller arm is keyed to each rudder stock so that torque applied to the arm turns the rudder. The arm is made of upper and lower steel plates welded to a steel block. The block is machined in two halves that bolt together around the stock and provide a keyway for positive lock. The tapered arm has inner and outer bushings and pivots. The inner pivot couples the arm to the actuator piston rod. The outer pivot connects both tillers to a common tie rod (jockey bar). By joining the arms, the jockey bar makes it possible to operate the rudders with only one cylinder in use. Single cylinder steering is necessary for cylinder replacement when at sea. Also on each tiller arm is an attachment for the arm of the Model 306 Followup Unit. Used on Hulls 2001 through 2007.

i. Rudder Stocks. Identical port and starboard rudder stocks penetrate the main deck and the shell plating. Each stock turns on three nylon bearings. The upper carrier bearing transfers shaft weight to the main deck foundation. The rudder stock bearing is supported by inner and outer hull foundations which transfer steering loads to the ship's hull. The lower bearing is located in the rudder shoe and provides secondary thrust support and lateral support. Each stock is in two sections: an 8-inch diameter inboard section, and a 6-inch diameter outboard section. The sections are joined by a bolted flange between the rudder and the hull.

(1) Rudders. The rudder is a 6-foot high flat plate with upper and lower horizontal fins plus two intermediate fins. Fairings enclose the rudder post and mate with a rounded lead edge. The tapered profile measures 51 inches across the top and 38 inches across the bottom.

(2) Rudder Shoe. The rudder shoes are port and starboard stern pieces providing support and protection to the propellers and rudders. Each shoe supports the lower rudder bearing.

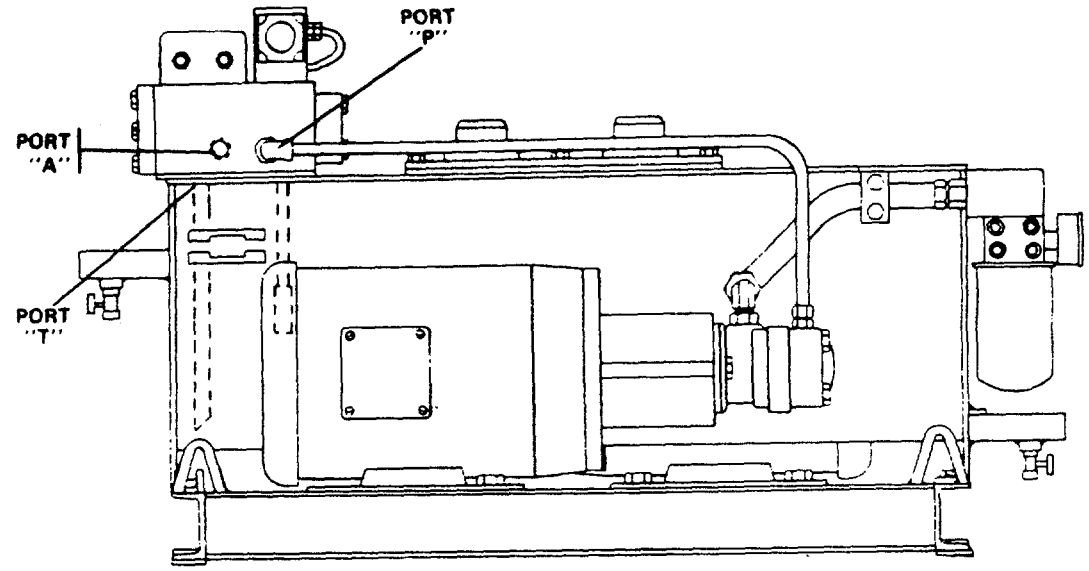
j. Emergency Hand Pump. The hand pump is a manually operated, reversible, positive displacement rotary pump used for emergency steering. The pump displaces 5.94 cubic inches per revolution of the handwheel, which moves the rudder 1.2 degrees. In the normal operating configuration, the hand pump and the associated header tank are isolated from the system by two normally closed shutoff lockvalves. During emergency steering, these valves open and lockvalves in control manifolds A and B automatically close off the remainder of the system.

k. Header Tank. This tank is a 2 U.S. gallon fluid reservoir serving only the emergency hand pump. This tank is mounted higher than the pump so that the pump is filled by gravity flow. The header tank serves the same function as the main reservoirs, which are isolated by the lockvalves during emergency steering.

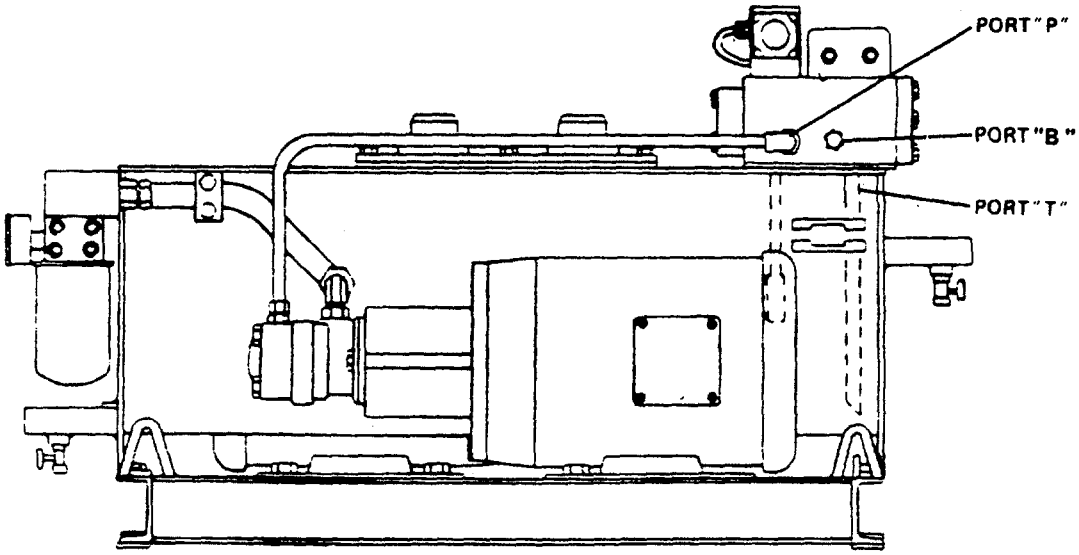
l. Model 306 Followup Transmitter. This unit is a mechanical/electrical device that continuously senses rudder angles and sends electrical signals to the rudder angle indicators. The unit also provides the followup input to the proportional steering logic. Port and starboard units are mounted to the ship structure outboard of each tiller arm. The precise locations and the precise mechanical alignments with the tiller arms are established geometrically, to assure that the transmitter shaft angle exactly duplicates the rudder angle. Inside each unit are two potentiometers that are gear driven by the input shaft to produce these signals. See TM 55-1905-223-10 for details.

m. Rudder Angle Indicator, Model 202. The rudder angle indicator provides a remote display of actual rudder angles. The indicator operates on electrical outputs from the followup transmitter.

Hulls 2008 and subsequent



STARBOARD



PORT

Figure 1-12. Port Location.

1-9. Equipment Data. Reference data for the steering gear is given in Table 1-1. Also see the equipment data given in the operator's manual, TM 55- 1905-223-10.

Table 1-1. Steering Gear Equipment Data

Characteristics	Reference Data
Twin Pumpset	Model TA30D
Overall dimensions	48" long, 45-3/4" wide, 24-1/8" high
Overall net weight	860 lbs dry; 1014 lbs wet
Hydraulic vane pump	Part/model: 80-100051 (V20- 1 P7S- 1 C- 11)
Output flow	9.5 gpm
Reservoir capacity	30 U.S. gal. (22 gal. to fill)
Maximum allowable roll and pitch	26 degrees
Rudder torque - continuous	13L Ton-Ft
Rudder control range	35° x 2 (port and starboard)
Single pump hard-over time	15 seconds
Twin pump hard-over time	7.5 seconds
System relief valve setting	930 psi
Double acting relief/bypass/shutoff valve setting	1 160 psi
Pressure gauge range	2000 psi
Solenoid valve voltage	24 Vdc
Inlet line strainer	20 gpm rated capacity .010 in. (60-wire mesh)
Inlet line filter	10 gpm rated capacity 25 micrometer filtration 100 psi operating pressure
Oil level indication	Isolated visual sight gauge
Low level alarm sensor	Reed switch
Cylinders (2 per shipset)	**Model L100-650**
Piston rods	Chrome plated steel
Rudder stops	Integral and adjustable
Bearings	Self-aligning
Displacement	527 cubic inches
Motors (2 per shipset)	**Baldor Series 30 Model 80-120055**
Enclosure	Totally enclosed drip-proof
Rated HP & FL speed	10 H.P. at 1750 rpm
Voltage/phase	230 Vac - 3 phase Delta
Frequency/power	60 Hz - 7.5 kw
Current rating	26 Amp at 230 Vac
Starting method	Direct across line
Rotating speed	1725 rpm
Bearing type	Ball bearing
Emergency Helm Pump	**Model B3**
Oil pumping capacity	6.33 cubic inches/rev
Header tank capacity	1/2 U.S. gal
Oil level monitoring	Visual sight gauge

1-9. 1 Equipment Data. Reference data for the steering gear is given in Table 1- 1.1. Also see the equipment data given in the operator's manual, TM 55- 1905-223-10.

Table 1-1.1 Steering Gear Equipment Data

Characteristics	Reference Data
Twin Pumpset	
Overall dimensions	34" long, 32" wide, 24-1/8 high
Overall net weight	900 lbs dry; 1250 lbs wet
Hydraulic vane pump	Part/model: 80-100051 (V20- 1 P7S- C-11)
Output flow	9.5 gpm
Reservoir capacity	60 U.S. gal.
Maximum allowable roll and pitch	26 degrees
Rudder torque - continuous	13L Ton-Ft
Rudder control range	35 x 2 (port and starboard)
Single pump hard-over time	15 seconds
Twin pump hard-over time	7.5 seconds
System relief valve setting	930 psi
Double acting relief/bypass/shutoff valve setting	1 160 psi
Pressure gauge range	3000 psi
Solenoid valve voltage	115 Vac
Inlet line strainer	20 gpm rated capacity .010 in. (100-wire mesh)
Inlet line filter	30 gpm rated capacity 10 micrometer filtration 100 psi operating pressure
Oil level indication	Isolated visual sight gauge
Low level alarm sensor	Reed switch
Cylinders (2 per shipset)	**Model L100-650**
Piston rods	Chrome plated steel
Rudder stops	Integral and adjustable
Bearings	Self-aligning
Displacement	527 cubic inches
Motors (2 per shipset)	**Leeson**
Enclosure	Totally enclosed drip-proof
Rated HP & FL speed	10 H.P. at 1800 rpm
Voltage/phase	230 Vac - 3 phase Delta
Frequency/power	60 Hz - 7.5 kw
Current rating	26 Amp at 230 Vac
Starting method	Direct across line
Rotating speed	1800 rpm
Bearing type	Ball bearing
Emergency Hand Pump	
Oil pumping capacity	5.94 cubic inches/rev
Header tank capacity	2 U.S. gal.
Oil level monitoring	Visual sight gauge

1-10. **Safety, Care and Handling**. WARNINGS and CAUTIONS that appear in this manual are of great importance to your personal safety and the safety of the equipment. Before you attempt to operate, maintain, troubleshoot, or repair any part of the steering gear system, be sure you review and understand all WARNINGS and CAUTIONS.

Section III. PRINCIPLES OF OPERATION

1-11. **General**. Port and starboard hydraulic cylinders in the steering gear room are coupled to port and starboard tiller arms. Stroking of the pistons causes rudder travel. When both pistons are at mid-stroke, the rudders reach a corresponding hard-over limit. Hydraulic piping delivers pressurized fluid from a vane pump to one side of each piston and from the other side of each piston back to the fluid reservoir. This loop converts pump displacement to piston stroke.

1-12. **Emergency Steering**. The steering gear is designed for primary control from the pilothouse, but also includes control components for emergency operation from the steering gear room. When normal pilothouse steering control is disabled, control can be switched to the steering gear room using one of the two local control units bulkhead mounted near the pumpsets. Unit A controls pumpset A and unit B controls pumpset B. The control transfer switch is set to LOCAL to provide rudder control. Communication with the pilothouse is also required for heading information. On the panel of each controller is a dip switch that will move the rudders right or left when pressed off neutral in either direction. Rudder travel continues while the switch is held in either direction, unless a hard-over stop is reached. Each local control unit has a rudder angle indicator above the dip switch.

NOTE

When maneuvering the ship in close quarters, the bowthruster water jet will normally be operated in conjunction with the steering gear. Refer to the LCU Operator's Manual (TM 55-1905-223-10) and the bowthruster water jet maintenance manual (TM 55-1905-223-24-6) for additional information about the steering system.

CHAPTER 2

UNIT MAINTENANCE INSTRUCTIONS

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

2-1. **Common Tools and Equipment**. For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

2-2. **Special Tools, TMDE and Support Equipment**. Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTLI, TM 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

2-3. **Repair Parts**. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

Section II. SERVICE UPON RECEIPT

2-4. **Checking Unpacked Equipment**.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage in accordance with the instructions of DA Pam 738-750.

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

d. Remove protective caps, plugs, inserts, wrappings, and tape when inspection/inventory is completed. Inspect piping openings for damage. Wipe off dirt, grease, or protective films at time of installation.

e. Remove chocks from resilient mounted components.

2-5. **Initial Setup Procedure**. Includes operational checks and inspections that are not performed for a routine startup. Direct support maintenance personnel will perform initial setup in accordance with the operator's manual, TM 55-1905-223-10.

2-6. **Normal Startup**. Refer to operator's manual, TM 55-1905-223-10.

2-7. **Shutdown Procedure (Normal or Emergency)**. Refer to operator's manual, TM 55-1905-223-10.

Section III. UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PKCS)

2-8. **Explanation of PKCS Table**. PMCS is designed to keep the equipment in good working condition. This is accomplished by performing certain tests, inspections, and services. Table 2-1 lists items to be serviced and the procedures needed to accomplish the PMCS. The "Interval" column tells you when to perform a check or service. If needed, PMCS may be performed more frequently than the indicated interval. The "Procedures" column tells you how to perform the required checks and services. If your equipment does not perform as required, see Table 2-2, Troubleshooting. Report any malfunctions or failures on DA Form 2404.' In the Item Number column on DA Form 2404, record the appropriate Item Number from the PMCS table.

Table 2-1. Preventive Maintenance Checks and Services

D - Daily **S - Semiannually** **A - Annually**

Item No.	Interval D	Interval S	Interval A	Item to be Inspected	Procedures
1	•			Fluid Levels	Pull out the top and bottom knobs of the sight gauge on the side of the reservoir. Hold knobs out while gauge fills. Read level. Above LOW is OK. Below LOW means reservoir needs fluid. Release knobs.
2	•			Filter elements	Put a waste oil container under filter. Read vacuum gauge. If it shows less than 10 inches of mercury (5 psi), unscrew and check the filter cartridge. If the cartridge is dirty, or if the vacuum gauge read 10 inches of mercury (5 psi), or more, the cartridge needs to be replaced. See paragraph 2-21. Wipe flange with clean rag. Lubricate seal of cartridge with hydraulic fluid and install. Secure hand-tight, then an additional one-quarter turn.
3		•		Bearing points	Refer to Lubrication Order, LO 55-1905-223-12.
4			•	Hydraulic fluid system	After repair of system and/or when the fluid has been contaminated, refer to paragraph 2-10 for drain/flush/fill/bleed instructions.
5	•			Bearings	Check temperatures with a thermometer, not by hand. If bearings are running hot (over 1800 F (82° C)), the condition may be a result of too much lubricant. If changing lubricant does not correct the condition, replace the motor(para. 2-18).

Section IV. UNIT TROUBLESHOOTING

2-9. **Troubleshooting**. Both a symptom index and troubleshooting table are provided. The symptom index will help you locate the information you need for troubleshooting.

SYMPTOM INDEX

Table 2-2 lists the common fault conditions that may be found during operation or maintenance of the equipment. Look for causes and do the corrective actions in the order listed. This manual cannot list every symptom that may occur, and it cannot list all probable causes and corrective actions. If a symptom is not listed or keeps up after you perform the corrective actions, notify your supervisor.

Table 2-2. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. Pumpset is noisy.

   STEP 1. Check for air in the system.
   a. Make sure oil levels are correct (para. 2-10).
   b. Make sure air is bled from the system (para. 2-10).
   c. Remove any kinks found in the system piping.

   STEP 2. Check for stopped up suction strainer.
   Drain tank, remove and clean suction strainer (para. 2-10).

2. Upon energizing the main directional control valve, the steering gear operates slower than normal and cannot develop system pressure.

   STEP 1. Check for contamination or faulty solenoid coil in directional control valve.
   Replace solenoid coil (para. 2-20).

3. Steering gear will not respond to command at main directional control valve.

   STEP 1. Check for faulty solenoid coils in directional control valves.
   a. Operate manually.
   b. Replace solenoid coils (para. 2-20).

   STEP 2. Check for air in the system.
   a. Make sure all fittings are secure.
   b. Make sure pump suction is connected properly to inlet filter.
   c. Remove all kinks found in system piping.
   d. Bleed system (para. 2-10).

4. Hydraulic fluid overheating.

   STEP 1. Check for contamination in inlet filter elements.
   Disassemble, clean and replace filter elements (para. 2-21).

Section V. UNIT MAINTENANCE PROCEDURES

MAINTENANCE OF STEERING GEAR SYSTEM

2-10. Service Steering Gear System. (FIGURE 2-1)

This task covers:
a. Inspect **b. Test** **c. Service.**

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Lint free cloth, Item 5, Appendix C
Sandpaper, Item 25, Appendix C
Nylon brush, Item 26, Appendix C
Cleaning solvent (PD 680), Item 23, Appendix C
Touchup paint, Item 27, Appendix C
Hydraulic oil, MIL-H-17672C, Type 2075-T-H-IS032
Utility pail, Item 28, Appendix C

Equipment Condition

Steering gear system shut down and tagged "Out of Service - Do not Operate." See TM 55-1905-223-10.

INSPECT

a. Visually inspect the entire steering system for leaks, contamination, deterioration, or broken parts. Include the reservoirs, pumpsets, valve blocks, helm pump, cylinders and associated hoses, piping, fittings, and fasteners.
b. Oil check.

(1) Check that hydraulic oil is clear and free of water or other contamination.
(2) Check the pullout level indicator. gauge (3) on the side of the pumpset reservoir. See FIGURE 2-1.
(3) Any unusual heating of the oil should be checked. After a while, oil that is too hot will reduce the efficiency and cause o-rings and other seals to fall apart.

TEST

a. Pull out top (4) and bottom (7) knobs on sight gauge (5).
b. Hold knobs outward while sight glass (5) fills. Read tank fluid level.
c. Release knobs. They have a spring return.
d. Fluid level above "LOW" (6) mark is OK.
e. If fluid is below "LOW" mark, reservoir needs to be topped off.
f. Repeat fluid level check for other reservoir.

SERVICE

WARNING

Keep hands, tools, and clothes away from rotating machinery, or personal injury could result.

CAUTION

Do not overfill the reservoir. "FULL" mark on sight gauge includes air space over fluid for air/fluid expansion and vessel pitch and roll.

NOTE

Do not attempt to read sight gauge or add fluid in rough seas.

a. Drain.

(1) Open six in-line shutoff valves.
(2) Position utility pail and funnel under reservoir drain plug on front of pumpset.
(3) Remove drain plug and drain reservoir. Replace plug.
(4) Remove inlet filter cartridge (paragraph 2-21).
(5) Repeat for other reservoir.

(6) Loosen piping connections at low points and drain trapped fluid into utility pail.
(7) Secure piping connections at low points.
(8) Close cylinder in-line shutoff valves and disconnect hose lines (cap open ends of hoses).
(9) Remove cylinders from tiller arms and mounting pads. (Direct Support maintenance personnel must be contacted for removal. ,Reference paragraph 3-9.).
(10) Turn cylinder so outer gear drains into utility pail.
(11) Remove connection from header tank and drain fluid into utility pail.
(12) Properly dispose of used hydraulic fluid.

b. Flush.

CAUTION
Use clean, filtered oil of specified grade, or hydraulic system could be damaged.

(1) Position utility pail and funnel under reservoir drain plug on front of pumpset.
(2) Remove drain plug.
(3) Flush all hydraulic lines with clean oil.
(4) Remove inspection cover (paragraph 2-16, see FIGURE 2-7) on top of reservoir. Rinse out tank interior with solvent and wipe dry. Clean (or replace if you need to) both suction strainers inside tank. Use same oil soluble solvent to clean strainers, and blow dry with compressed air.
(5) Replace drain plug.
(6) Install suction strainers and replace inspection cover.
(7) Install cylinders on tiller arms and mounting pads. (Direct support maintenance personnel must be contacted for replacement. Reference paragraph 3-9.) (8). Remove caps from ends of hose lines and connect to cylinders.
(9) Replace inlet filter cartridge (paragraph 2-21).
(10) Clean manifold inlet and outlet filter screen elements (refer to paragraph 3-12 for disassembly).
(11) Reconnect all hydraulic fluid lines.

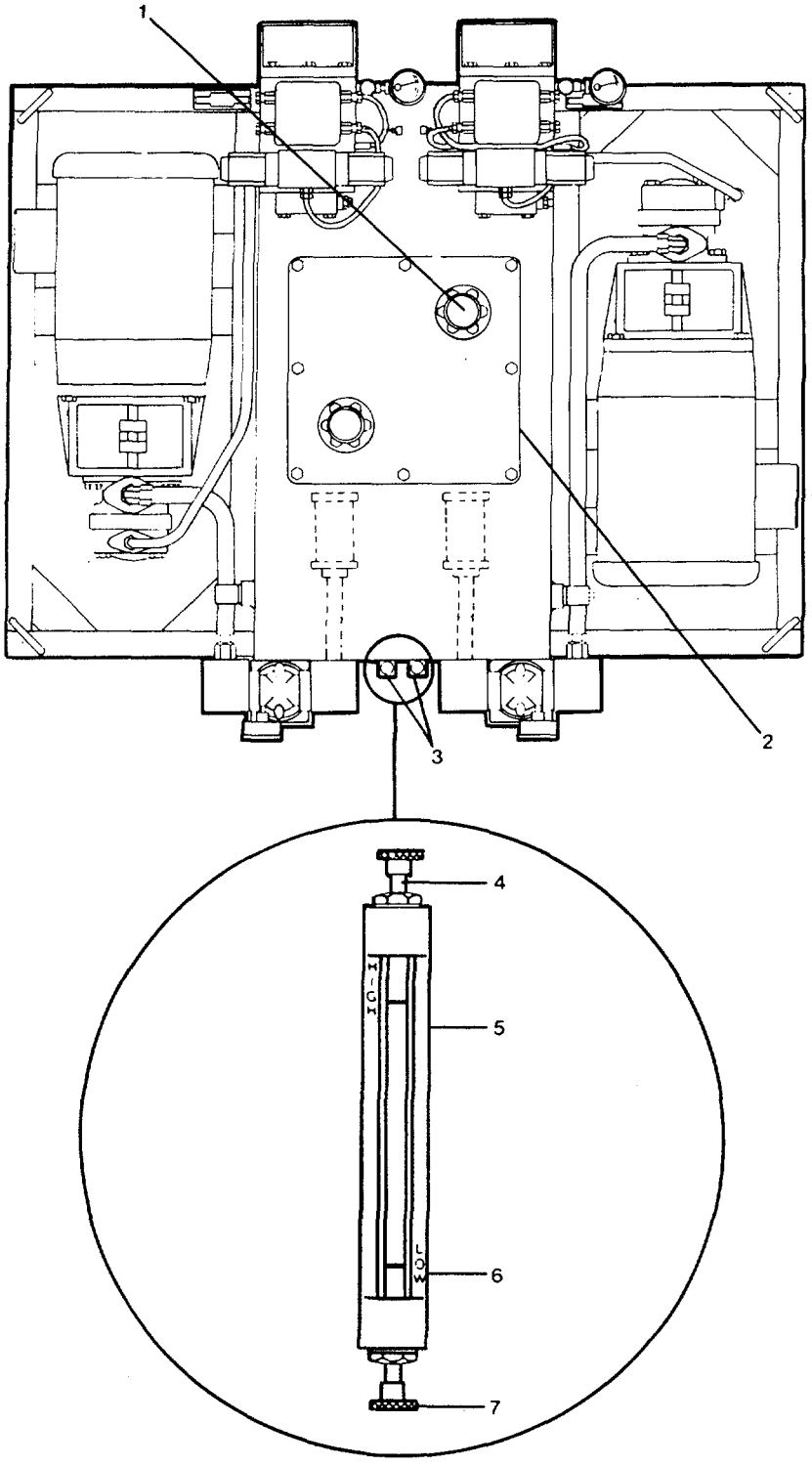


FIGURE 2-1. Reservoir Sight Gauge.

c. Fill. Remove filler cap (1, FIGURE 2-1) from hydraulic reservoir cover (2, FIGURE 2-1). Fill main reservoir and header tank with clean, filtered hydraulic fluid. See TM 55-1905-223-10.

d. Bleed.

(1) Restore power to pumpsets.

(2) Operate each vane pump, stroking cylinders several times back and forth with each pump. While stroking, unscrew fittings at cylinder slightly until air is removed and only oil seeps out. Secure fittings. Observe pressure gauge and check for leaks.

(3) To bleed helm pump, unscrew fittings on pump until oil seeps out. Stroke cylinders several times while monitoring header tank fluid level. Secure fittings and close helm pump shutoff valves.

(4) Re-check and fill hydraulic fluid levels in main reservoir and header tank to proper levels.

(5) Check for system leaks.

(6) Return pumpsets to normal operation (TM 55-1905-223-10).

(7) Properly dispose of used hydraulic fluid and spillage.

(8) Clean and store utility pail and funnel.

(9) Remove "Out of Service Do Not Operate" tag from circuit breaker.

2-11. Replace Followup Unit. (FIGURE 2-2)

This task covers:
a. Removal, b. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273
Tool kit, electrician's, 5180-00-391-1087

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate."
See TM 55-1905-223-10.

Materials/Parts

Followup unit, P/N 510-006

REMOVAL

a. Tag and remove three cable connectors (6) from unit.
b. Loosen capscrew (2) connecting gear arm (3) to followup unit (1).
c. Lift gear arm (3) and spring post (4) off straight shaft (5).
d. Remove four mounting bolts and washers (7, 8).
e. Remove followup unit (1) from mounting bracket (9).

REPLACEMENT

a. Position followup unit (1) over mounting bracket (9) with bolt holes aligned.
b. Install and secure four mounting bolts and washers (7, 8).
c. Install spring post (4) and gear arm (3) on straight shaft (5); secure capscrew (2).
d. Install three cable connectors (6) as tagged.
e. Remove "Out of Service - Do Not Operate" tag and restore unit to operation.

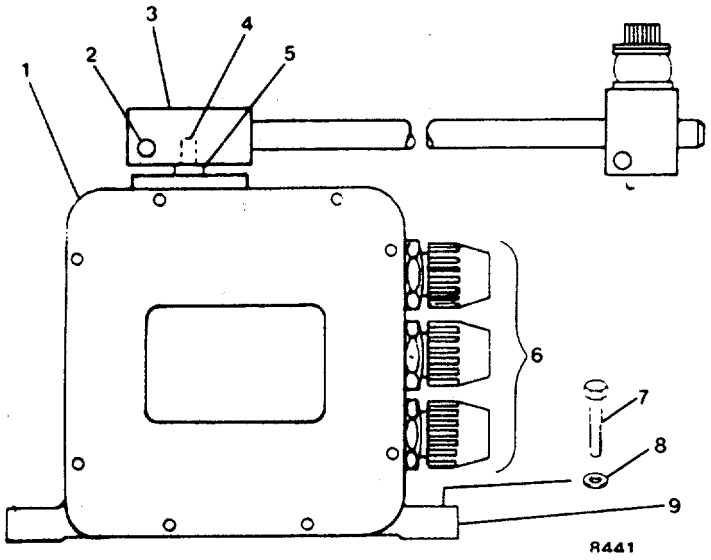


FIGURE 2-2. Followup Unit.

2-12. Repair Hydraulic Cylinder Assembly. (FIGURE 2-3)

This task covers:
a. Inspect, b. Service, c. Repair.

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Materials/Parts

Nylon brush, Item 26, Appendix C
Lint free cloth, Item 5, Appendix C
Lubrication fittings, P/N 41-200001
Cleaning solvent (PD 680), Item 23, Appendix C
Touchup paint, Item 27, Appendix C

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate."
See TM 55-1905-223-10.

INSPECT

a. Close shutoff valves at both fluid ports (4) and (5).
b. Verify valve operates smoothly with no binding or leakage.
c. Open shutoff valves at both fluid ports.
d. Inspect piston rod (6) for wiper leakage, roughness, cuts, nicks, or damage.
e. Make sure hard-over stop (2) is securely set. No looseness.
f. Make sure piston rod to tiller arm connection (1) is secure.
g. Make sure cylinder cap connection to mounting pad (3) is secure.

SERVICE

a. Secure loose fittings and fasteners.
b. Use cleaning solvent and lint free cloth to clean off dirt and fluid.
c. Touch up rust spots with nylon brush.
d. Make sure cylinder pins have enough lubrication. If not, grease in accordance with LO 55-1905-223-12.

REPAIR

Repair of hydraulic cylinder assembly is replacement of lubrication fittings (FIGURE 2-3). Unscrew lubrication fitting (7) and replace with new one.

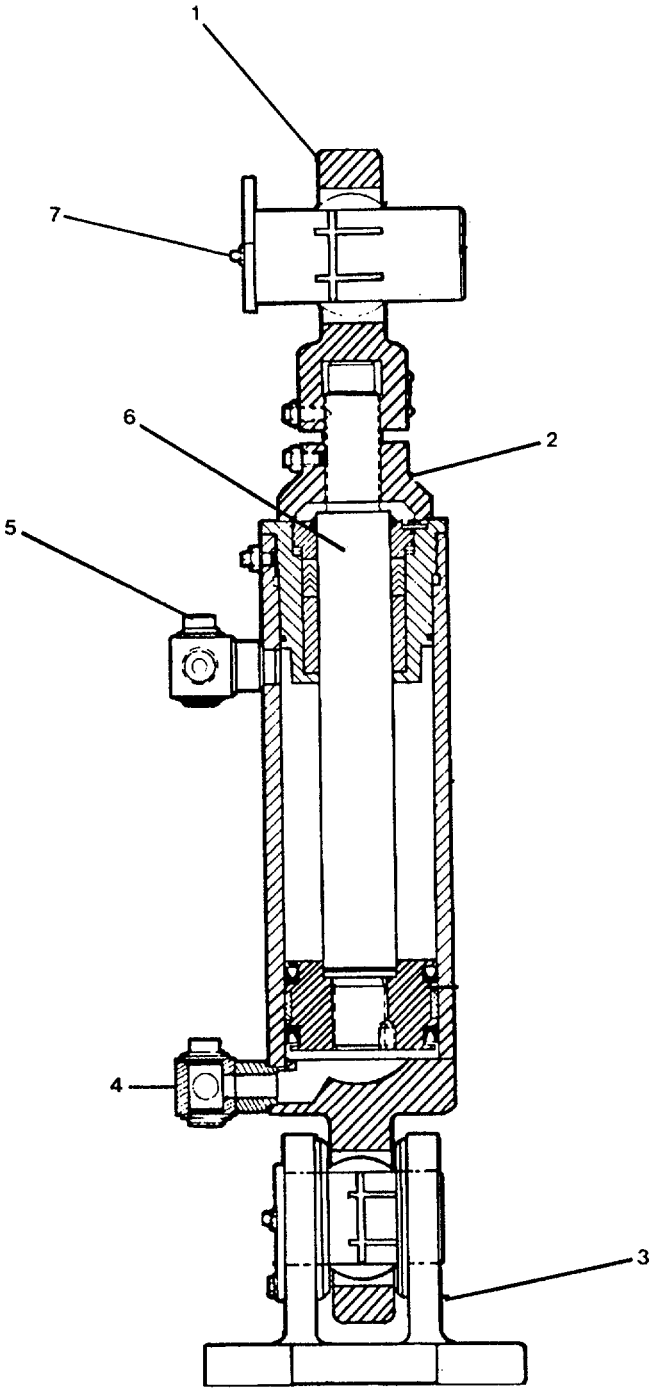


FIGURE 2-3. Hydraulic Cylinder Assembly.

2-13. Repair Tiller Arm Assembly (FIGURE 2-4)

This task covers:
a. Inspect, b. Service, c. Repair

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate." See TM 55-1905-223-10.

Materials/Parts

Sandpaper, Item 25, Appendix C
Lint free cloth, Item 5, Appendix C
Cleaning solvent (PD 680), Item 23, Appendix C
Lubrication fitting, P/N C5-2775-1005
Touchup paint, Item 27, Appendix C

INSPECT

a. At hub/shaft interface (1), inspect key (2), and keyway and interface area for broken parts and corrosion.

b. Inspect hub bolts, nuts and washers (3), and hub joint (4) for broken parts and corrosion.

c. Inspect jockey bar sleeve bushing (5) and pin (7) for broken parts and corrosion.

d. Inspect follow-up arm connection (8) for binding, broken parts, and corrosion.

SERVICE

a. Sand corrosion/rust off of components and touch up with paint.

b. Secure loose fittings or fasteners.

c. Wipe off dirt and fluids.

REPAIR

Repair of tiller arm assembly is replacement of lubrication fittings (FIGURE 2-4). Unscrew lubrication fitting (6) and replace with new one.

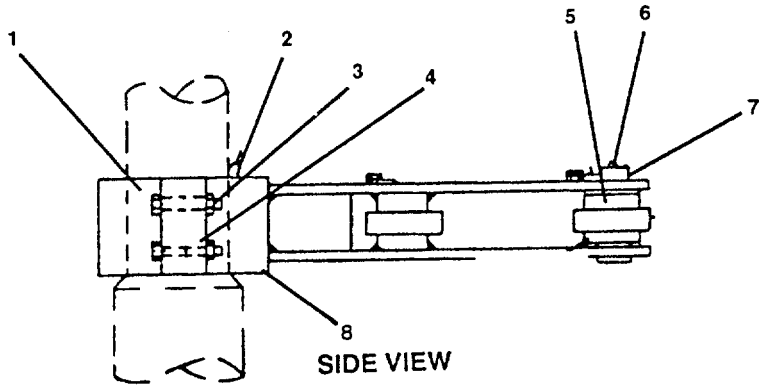


FIGURE 2-4. Tiller Arm Assembly.

2-14. Replace/Repair Helm Pump (Figure 2-5)

This task covers:

a. Service, b. Removal, c. Disassembly, d. Repair, e. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Equipment Condition

Equipment shut down and tagged
"Out of Service - Do Not Operate."
See TM 55-1905-223-10.

Materials/Parts

Helm pump, P/N 300-0010
Lint free cloth, Item 5, Appendix C
Utility pail, Item 28, Appendix C
Gasket, P/N 10-300015
Seal, P/N 10-500009

SERVICE

Make sure helm pump has adequate lubrication. Lubricate or add oil in accordance with LO 55-1905-223-12.

REMOVAL

a. Set local control unit switch located in steering gear room to LOCAL (1, FIGURE 2-5, Sheet 1).

b. Position utility pail under header tank (2) in steering gear room.

c. Disconnect header tank output line (3) at helm pump (4) and drain into waste oil container.

d. Disconnect and cap input and output lines (5, 6). Wipe up spillage.

e. Remove bolt (13, FIGURE 2-5, Sheet 2) securing wheel to pump. Remove wheel and guide key (14). Keep the key for assembly.

f. Remove two pump mounting bolts (15) and remove pump (16).

DISASSEMBLY

a. Remove pipe plug (7, FIGURE 2-5, Sheet 2).

b. Remove five plain hexagon nuts (9) and capscrews (10).

c. Remove front plate (11).

d. Remove gasket (8) and seal (12).

REPAIR

Repair at this level consists of replacing helm pump (16), gasket (8), and seal (12).

ASSEMBLY

a. Install seal (12) and gasket (8).

b. Replace front plate (11).

c. Replace five capscrews (10) and secure plain hexagon nuts (9).

d. Replace pipe plug (7).

REPLACEMENT

a. Position helm pump (16) over mounting bolt holes.

b. Install pump with two mounting bolts (15).

c. Remove caps and connect input and output lines (5, 6, FIGURE 2-5, Sheet 1) to pump.

d. Connect header tank output line (3, FIGURE 2-5, Sheet 1) to helm pump (4, FIGURE 2-5, Sheet 1).

e. Install guide key (14, FIGURE 2-5, Sheet 2) and wheel to pump.

f. Flush and fill header tank with filtered hydraulic fluid.

g. Operate pump by rotating wheel several turns in both directions while observing tiller arms. Movement should be 1.2 degrees per revolution of wheel.

h. Check header tank oil level. Top off as necessary.

i. Properly dispose of used hydraulic fluid. Wipe up any spills. Clean and store utility pail.

j. Return control to the bridge (TM 55-1905-223-10).

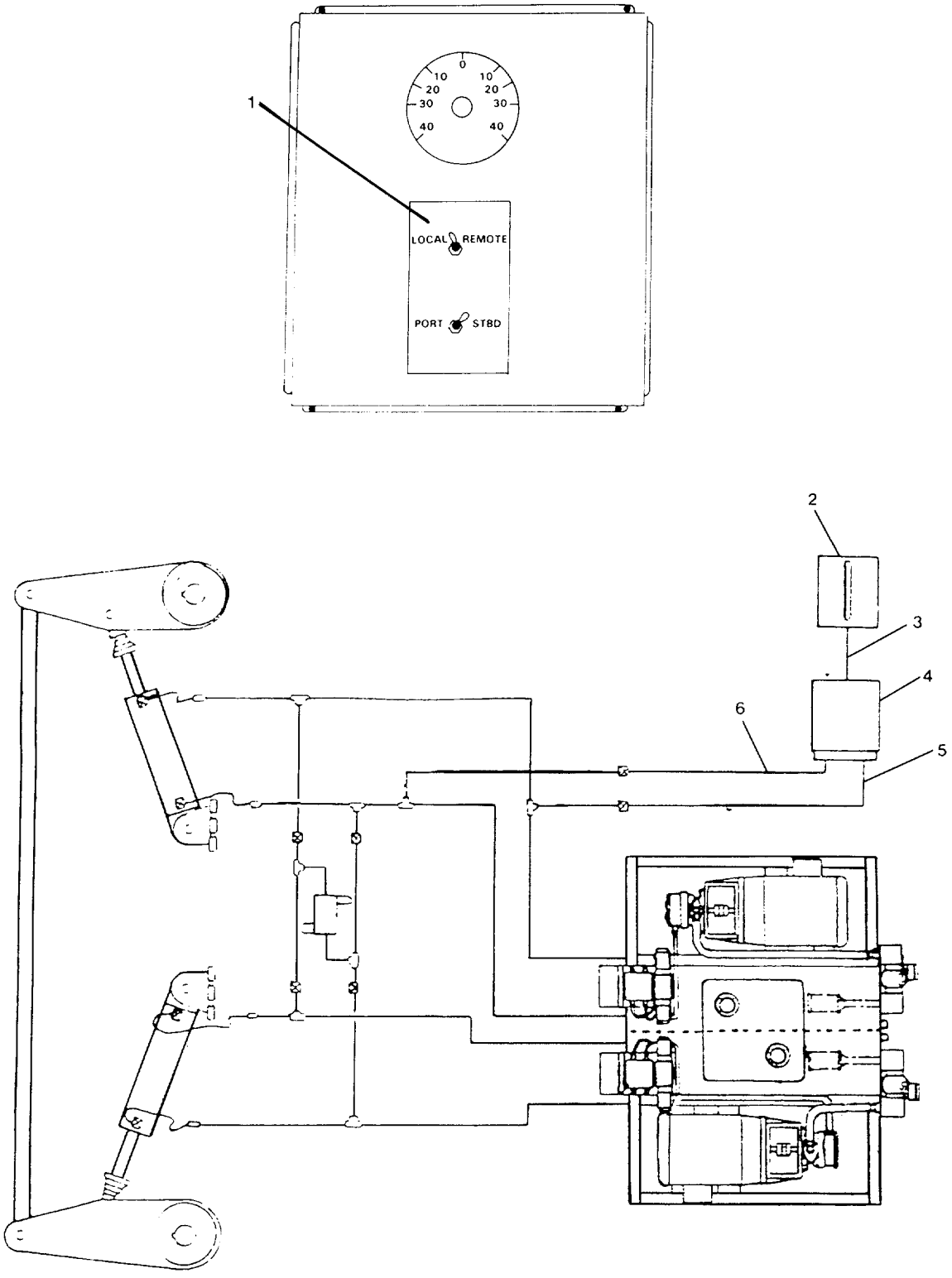
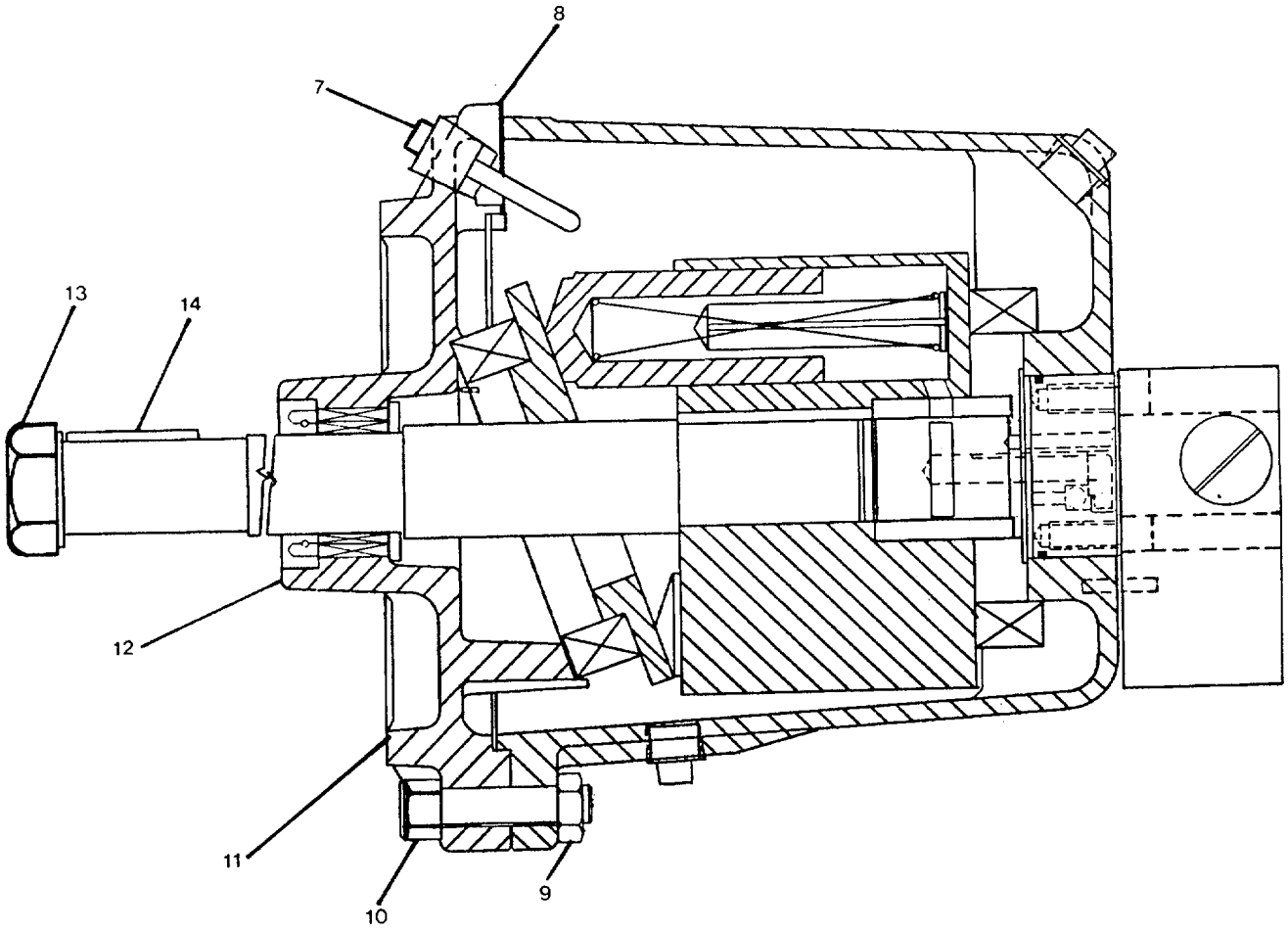
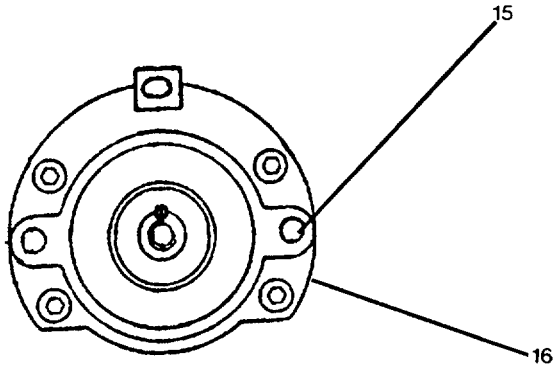


FIGURE 2-5. Helm Pump (Sheet 1 of 2).



SIDE VIEW CUTAWAY



FRONT VIEW

FIGURE 2-5. Helm Pump (Sheet 2 of 2).

2-15. Replace/Repair Header Tank. (FIGURE 2-6)

This task covers:
a. Removal, b. Repair, c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Equipment Condition

Equipment shut down and tagged
"Out of Service - Do Not Operate."
See TM 55-1905-223-10.

Materials/Parts

Lint free cloth, Item 5, Appendix C
Header tank, P/N 250-0010
Insert glass, P/N 92-992001
Utility pail, Item 28, Appendix C

WARNING

Keep hands, tools, and clothes away from rotating machinery or personal injury may result.

REMOVAL

a. Position utility pail under header tank.

b. Disconnect hydraulic line (4) at header tank (1) and drain fluid into utility pail.

c. Cap open end of hydraulic line.

d. Remove three tank mounting screws (2) and remove tank (1).

e. Remove glass insert (3).

REPAIR

Repair consists of replacing glass insert (2).

REPLACEMENT

a. Install glass insert (3).

b. Install tank with three mounting screws (2).

c. Remove cap and connect line (4) to header tank (1).

d. Flush and fill header tank with clean filtered hydraulic fluid.

e. Check fluid level in sight glass (3).

f. Check for leaks.

g. Properly dispose of used hydraulic fluid.

h. Clean and store utility pail.

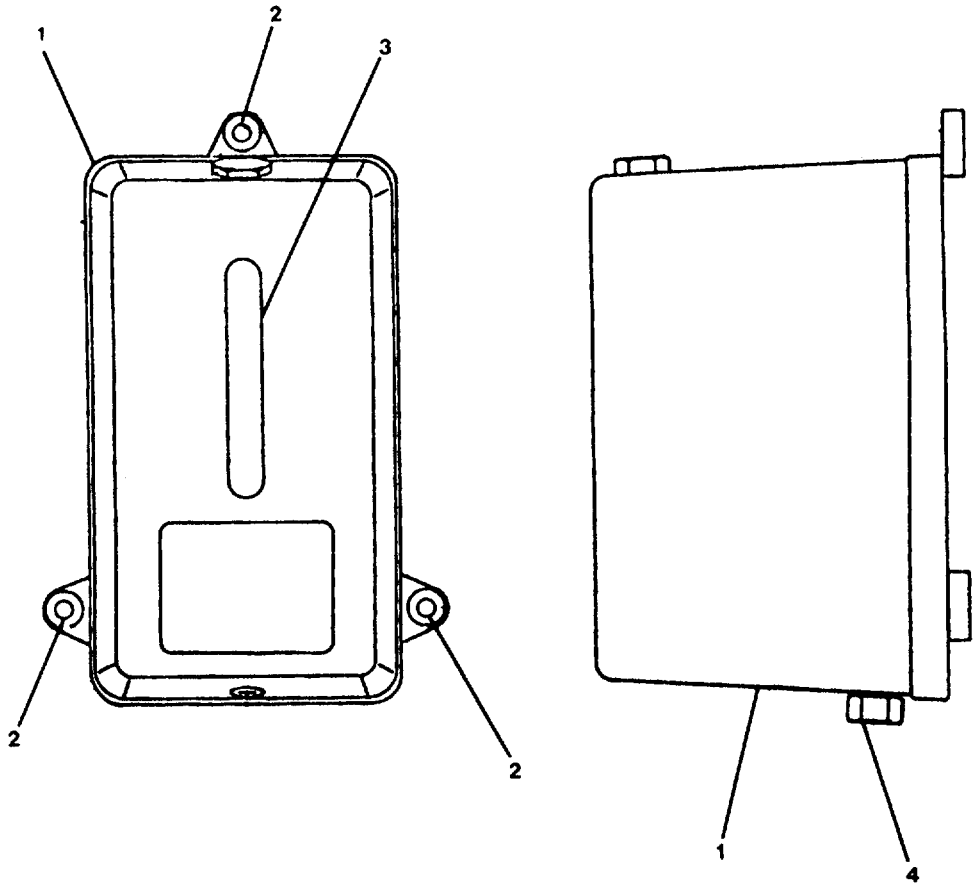


FIGURE 2-6. Header Tank.

2-16. Repair Twin Pumpset Assembly. (FIGURE 2-7)

This task covers:
a. Disassembly, b. Repair, c. Assembly

INITIAL SETUP

Tools

Tool, kit, general mechanic's, 5180-00-699-5273
Tool, kit, electrician's, 5180-00-391-1087

Equipment Conditions

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service - Do Not Operate."
Refer to the following paragraph in this maintenance manual:
Drain reservoir (paragraph 2-10).

Materials/Parts

Coupling insert, P/N 81-937005 (2)
Terminal connector, P/N 431-016 (10)
Cable sheathing, P/N 431-083 (v)
Wire, P/N 750-11 (v)
Electrical connector cable clamp, P/N 610-019 (2)
Shutoff valve, P/N 80-790001 (6)
Sight gauge, P/N 201-0042
Lint free cloth, Item 5, Appendix C
Sandpaper, Item 25, Appendix C
Nylon brush, Item 26, Appendix C
Touchup paint, Item 27, Appendix C
Cleaning solvent (PD 680), Item 23, Appendix C
Suction strainer, P/N 80-510009 (2)
Dial indicating pressure gauge, P/N 80-500001 (2)
Low level sensor, P/N 410-0058 (2)
Dial indicating vacuum gauge, P/N 80-510045 (2)
Flexible coupling, P/N 81-910007 (2)
Flexible coupling, P/N 81-910009 (2)
Gasket, P/N 10-300025 (2)
Lifting sling, P/N 3375957

DISASSEMBLY

a. Pumpset (Port Assembly Looking Aft).

(1) Reservoir Cover.

(a) Remove two strainer filler caps (23, FIGURE 2-7) from reservoir cover.

(b) Remove eight capscrews and lockwashers (3). Remove reservoir cover (4).

(c) Remove suction strainer (11, 14) from metallic pipes (10, 13) inside the reservoir attached to porting blocks (9, 12).

(d) Remove both low level sensors (39) from interior of reservoir.

(e) Remove six shutoff valves (40) from bottom of drip trays.

(2) Hydraulic Piping.

(a) Place utility pail under all tube fittings to be disconnected.

(b) Disconnect tube fitting (22) from pump (21) and tube fitting (16) from porting outlet left block (15).

(c) Remove clamp assembly (17). Remove inlet tubing (18).

(d) Disconnect tube fitting (20) from pump (21) and tube fitting (45) at port uniblock 2A assembly (44). Remove outlet tubing (19).

(3) Gauges.

(a) Tag and disconnect and remove electrical connector cable clamp (24), terminal connectors (25), cable sheathing (26), and wire (27) from uniblock 2A assembly (44). Remove dial indicating pressure gauge (28) and dial indicating vacuum gauge (46).

(b) Remove two hexhead capscrews and lockwashers (36, 37). Lift port uniblock 2A assembly (44) up and remove gasket (38).

b. Pumpset (Starboard Assembly Looking Aft). Reservoir cover disassembly is performed in DISASSEMBLY paragraph a(1).

(1) Hydraulic Piping.

(a) Place utility pail under all tube fittings to be disconnected.

(b) Disconnect tube fitting (34) from pump (35) and tube fitting (7) from porting outlet left block (8).

(c) Remove clamp assembly (6). Remove inlet tubing (5).

(d) Disconnect tube fitting (2) from pump (35) and tube fitting (42) at starboard uniblock 2A assembly (43). Remove outlet tubing (1).

(2) Gauges.

(a) Tag and disconnect and remove electrical connector cable clamp (32), terminal connectors (29), cable sheathing (30), and wire (31) from uniblock 2A assembly (43). Remove dial indicating pressure gauge (33) and dial indicating vacuum gauge (41).

(b) Remove two hexhead capscrews and lockwashers (36, 37). Lift starboard uniblock 2A assembly (43) up and remove gasket (38).

REPAIR

a. Pumpset (Port Assembly Looking Aft). Repair at this level is by replacement. Replace the following items: terminal connector (25), cable sheathing (26), wire (27), electrical connector cable clamp (24), dial indicating pressure gauge (28), low level sensor (39), shutoff valves (40), dial indicating vacuum gauge (46), suction strainer (11, 14), and gasket (38).

b. Pumpset (Starboard Assembly Looking Aft). Repair at this level is by replacement. Replace the following items: terminal connector (29), cable sheathing (30), wire (31), electrical connector cable clamp (32), dial indicating pressure gauge (33), low level sensor (39), shutoff valves (40), dial indicating vacuum gauge (41), suction strainer (11, 14), and gasket (38).

ASSEMBLY

a. Pumpset (Port Assembly).

(1) Gauges.

(a) Lift port uniblock 2A assembly (44) up and replace gasket (38). Secure with two hexhead capscrews and lockwashers (36, 37).

(b) Connect electrical cable clamp (24), terminal connectors (25), cable sheathing (26), and wire (27) to uniblock 2A assembly (44). Remove tags.

(2) Hydraulic Piping.

(a) Replace outlet tubing (19). Secure tube fitting (45) at port uniblock 2A assembly (44) and tube fitting (20) at pump (21).

(b) Replace inlet tubing (18). Secure tube fitting (16) at porting outlet left block (15) and tube fitting (22) at pump (21). Secure clamp assembly (17).

(c) Dispose of hydraulic fluids in utility pail, clean pail and stow away.

(3) Reservoir Cover.

(a) Replace six shutoff valves (40).on bottom of drip trays.

(b) Replace both low level sensors (39) inside reservoir.

(c) Install suction strainers (11, 14) to metallic pipes (10, 13) and porting blocks (9, 12) inside reservoir.

(d) Replace reservoir cover (4) and secure with eight capscrews and lockwashers (3).

(e) Check oil levels and top off as necessary (para. 2-10).

(f) Replace two strainer filler caps (23) in reservoir cover.

b. Pumpset (Starboard Assembly).

(1) Gauges.

(a) Lift starboard uniblock 2A assembly (43) up and replace gasket (38). Secure with two hexhead capscrews and lockwashers (36, 37).

(b) Connect electrical connector cable clamp (32), terminal connectors (29), cable sheathing (30), and wire (31) to uniblock 2A assembly (43). Remove tags.

(2) Hydraulic Piping.

(a) Replace outlet tubing (1). Secure tube fitting.(42) at starboard uniblock 2A assembly (43) and tube fitting (2) at pump (35).

(b) Replace inlet tubing (5). Secure tube fitting (7) at porting outlet left block (8) and tube fitting (34) at pump (35). Secure clamp assembly (6).

(c) Dispose of hydraulic fluids in utility pail, clean pail, and stow away.

(3) Reservoir Cover. Follow steps in ASSEMBLY paragraph a(3).

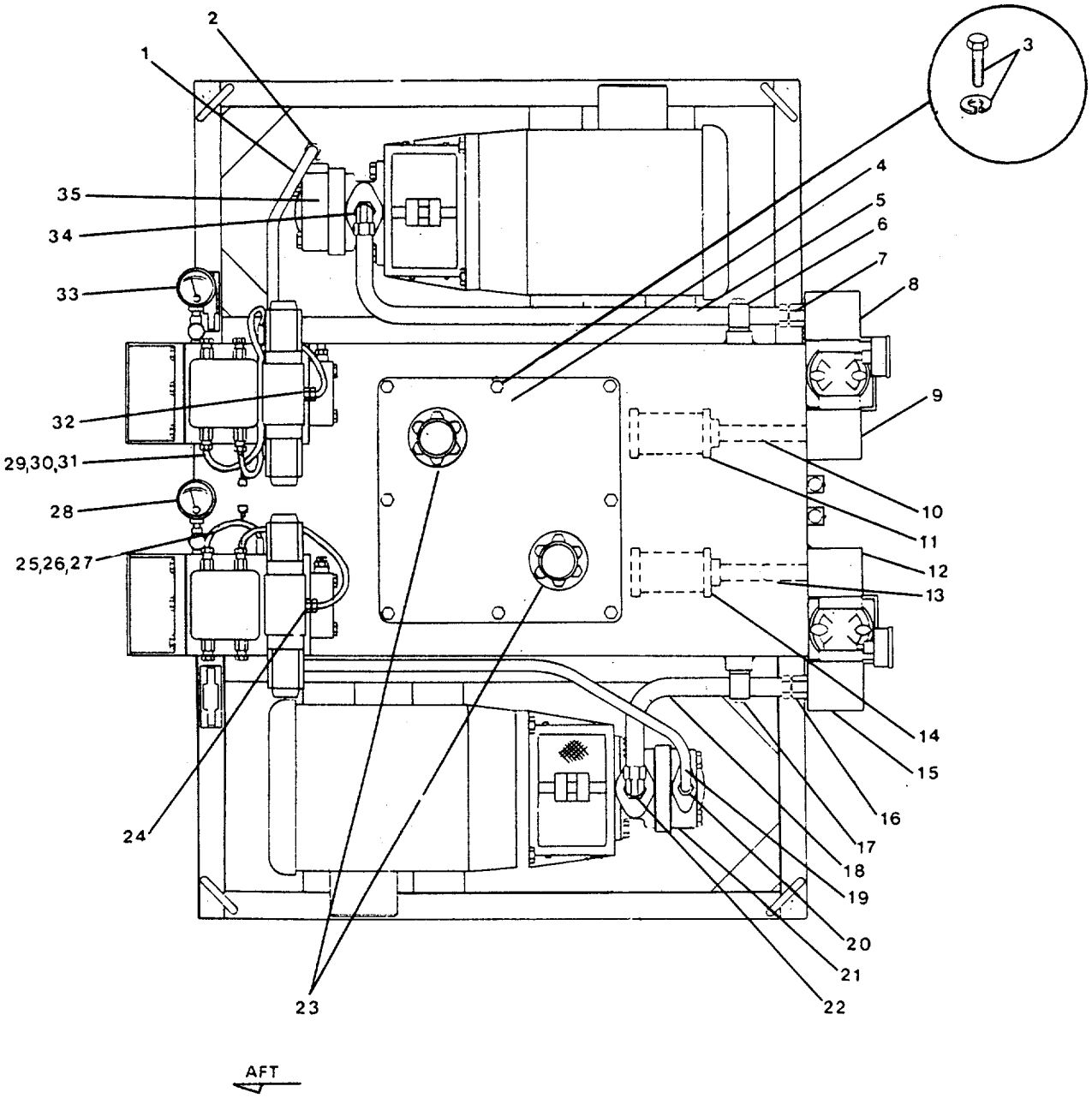


FIGURE 2-7. Twin Pumpset TA30D (Sheet 1 of 2).

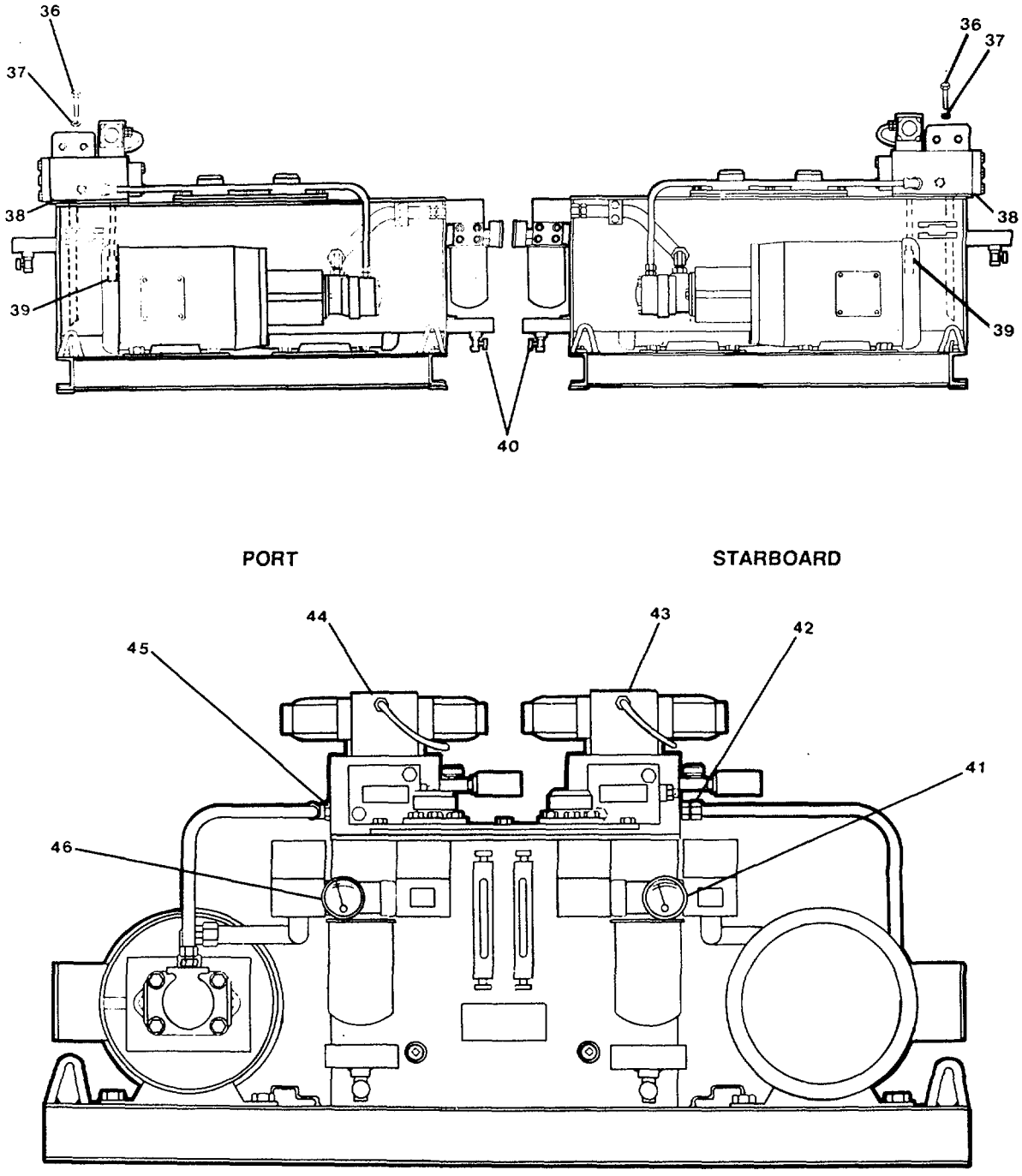


FIGURE 2-7. Twin Pumpset TA30D (Sheet 2 of 2).

2-17. Replace Hydraulic Pump. (FIGURE 2-8)

This task covers:
a. Removal, b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Pump, P/N V20-lP7S-lCll

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate." See TM 55-1905-223-10.
Drain reservoir (paragraph 2-10).

REMOVAL

a. Disconnect and cap input (1) and output (2) lines from pump.
b. Remove two bolts (3) and separate pump (4) from motor (5).
c. Remove pump (4).

REPLACEMENT

a. Position pump (4) to engage motor (5) and secure with two mounting bolts (3).
b. Remove caps and connect input (1) and output (2) lines.
c. Fill and bleed system (paragraph 2-10).

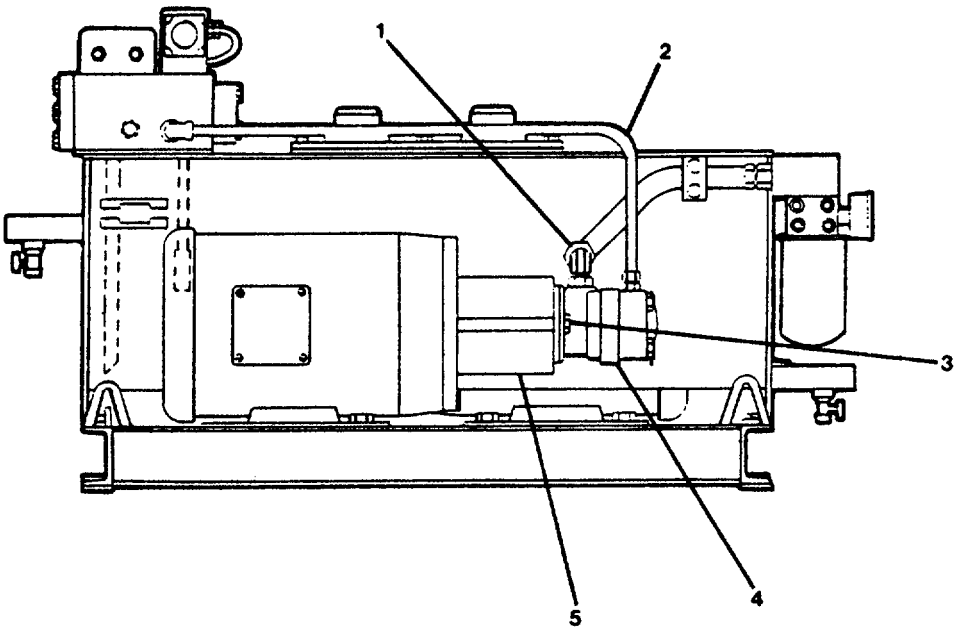


FIGURE 2-8. Remove Hydraulic Pump.

2-18. Replace Electric Motor. (FIGURE 2-9)

This task covers:

a. Check **b. Removal** **c. Replacement**

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273
Tool kit, electrician's, 5180-00-391-1087

Materials/Parts

Motor, P/N 80-120055

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate." See TM 55-1905-223-10.
Refer to the following paragraph in this maintenance manual:
Pump removed (paragraph 2-17).

CHECK

Check bearing temperature with thermometer and not by hand. If bearings are hot (over 180 degrees F.), the condition may be the result of too much lubricant. If changing lubricant does not correct condition, replace motor.

REMOVAL

a. Remove four cover screws (2) from electrical connection box. Remove cover (1).
b. Tag and disconnect electrical wires.
c. Remove four hexagon head capscrews (3), lockwashers (4), and hexagon plain nuts (5) securing motor to pumpset frame.
d. Remove motor (6) from pumpset frame (7).

REPLACEMENT

a. Position motor over mounting holes and secure with four hexagon head capscrews (3), lockwashers (4), and hexagon plain nuts (5).
b. Connect wires and remove tags.
c. Install cover (1) and secure with cover screws (2) to electrical connection box.

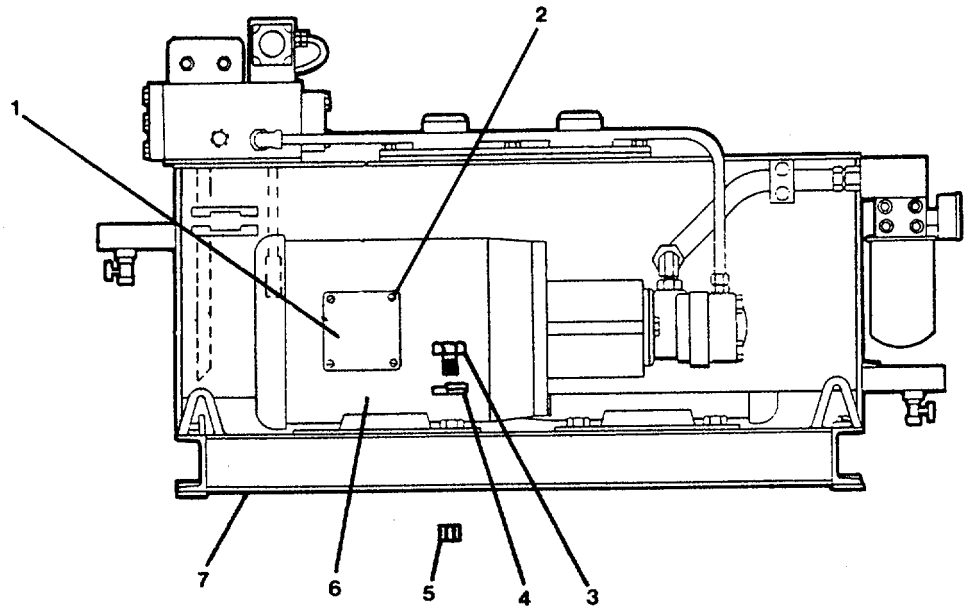


FIGURE 2-9. Remove Electric Motor.

2-19. Replace/Repair Uniblock 2A Assembly (FIGURE 2-10)

This task covers:
a. Removal, b. Repair, c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Materials/Parts

Solenoid valve, P/N 80-700050

Equipment Condition

Equipment shut down and tagged
"Out of Service - Do Not Operate"
See TM 55-1905-223-10.

REMOVAL

a. Disconnect and cap input line (3) and two output lines (2) from uniblock assembly (10).
b. Remove cover screws and lockwashers (6, 7) from junction box (8). Remove cover (9).
c. Tag and disconnect wires.
d. Remove hexhead capscrews and lockwashers (4, 5) securing uniblock assembly (10) and solenoid valve (11) to reservoir (1). Remove solenoid valve (11).

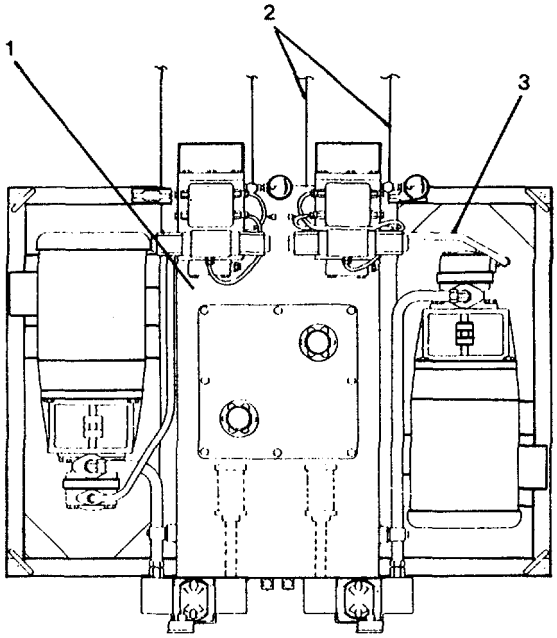
REPAIR

Repair of uniblock 2A assembly at this level consists of replacing solenoid valve (11).

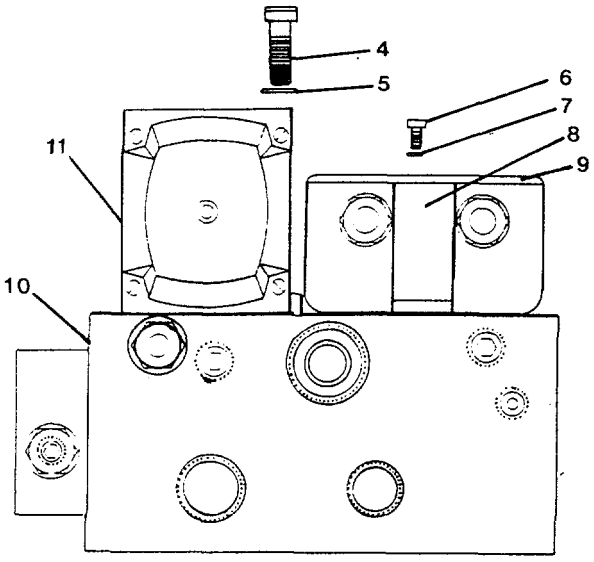
REPLACEMENT

a. Position uniblock assembly (10) and solenoid valve (11) over mounting holes on reservoir (1) and secure capscrews and lockwashers (4, 5).
b. Connect wires as tagged.
c. Install cover screws and lockwashers (6, 7) and secure cover (9) to junction box (8).
d. Remove caps and connect input line (3) and two output lines (2) to uniblock assembly (10).

e. Restore power and check for proper operation and system leaks.
f. Return pumpsets to normal operation (TM 55-1905-223-10).
g. Remove "Out of Service - Do Not Operate" tag from circuit breaker.



TOP VIEW



FRONT VIEW

FIGURE 2-10. Uniblock 2A Assembly.

2-20. Replace/Repair Coil Assembly (FIGURE 2-11)

This task covers:
a. Removal, b. Repair, c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273
Tool kit, electrician's, 5180-00-391-1087

Materials/Parts

Seal washer, P/N 610-011
Spring pin, P/N 51-170015
Coil, P/N 400827
Preformed packing, P/N 11-106013
Electrical connector plug, P/N 610-009

Equipment Condition

TM 55-1905-223-10. Equipment shut down, tagged "Out of Service - Do Not Operate."
Refer to the following paragraph in this maintenance manual:
Solenoid valve removed (paragraph 2-19).

REMOVAL

a. Remove four machine screws (1) securing cover to solenoid valve (3). Remove cover (2).
b. Remove spring pin (4).
c. Tag and remove electrical wires (5).
d. Remove machine screws (6) and remove coil (7).
e. Remove electrical plug connector (9) and seal washer (8).
f. Remove and discard preformed packing (10).

REPAIR

Repair at this level consists of replacing: seal washer (8), spring pin (4), coil (7), preformed packing (10), and electrical plug connector (9).

REPLACEMENT

a. Install preformed packing (10).

b. Replace seal washer (8) and secure electrical plug connector (9).
c. Position coil (7) in solenoid valve assembly (3) and secure machine screws (6).
d. Connect electrical wires (5) and remove tags.
e. Replace spring pin (4).
f. Secure cover (2) to solenoid valve assembly (3) with four machine screws (1).
g. Install solenoid valve (paragraph 2-19).
h. Restore power to pumpset.
i. Restore equipment to normal operation (TM 55-1905-223-10).
j. Remove "Out of Service - Do Not Operate" tag from circuit breaker.

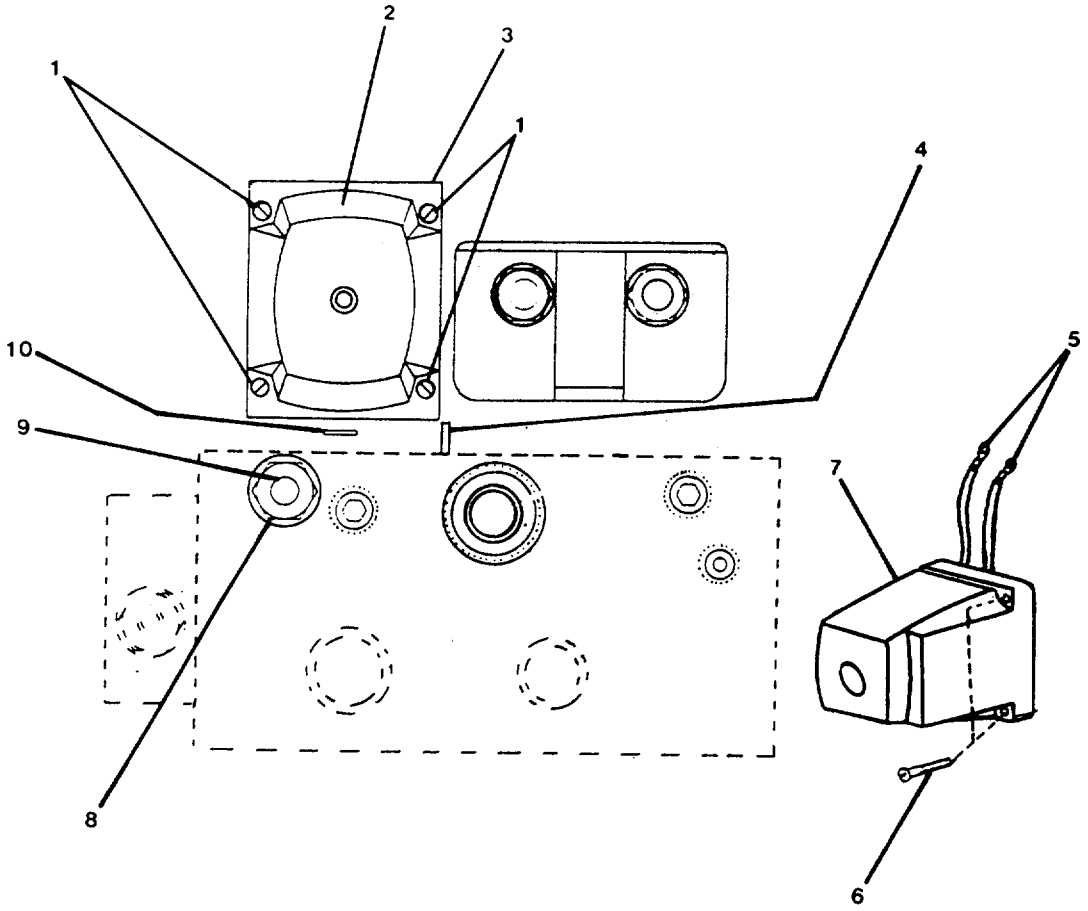


FIGURE 2-11. Coil Assembly.

2-21. Replace/Repair Inlet Filter Assembly. (FIGURE 2-12)

This task covers:
a. Removal, b. Repair, c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Materials/Parts

Utility pail, Item 28, Appendix C
Fluid filter element, P/N 573083
Dial-indicating vacuum gauge,
P/N 80-510045

Equipment Condition

Equipment shut down and tagged
"Out of Service - Do Not Operate."
See TM 55-1905-223-10.

REMOVAL

a. Inlet Filter Assembly.

(1) Position utility pail under inlet filter assembly (1).
(2) Remove inlet filter cartridge (2).
(3) Dispose of used filter cartridge in utility pail.
(4) Wipe flange/assembly with clean rag.
(5) Clean and store pail.

b. Dial-Indicating Vacuum Gauge. Remove vacuum gauge (4) by using wrench on nut (3) at back of gauge.

REPAIR

Repair at this level consists of replacing inlet filter cartridge (2) and dial-indicating vacuum gauge (4).

REPLACEMENT

a. Inlet Filter Assembly.

(1) Lubricate seal of replacement cartridge with hydraulic fluid and install.
(2) Secure hand-tight, then an additional one-quarter turn.

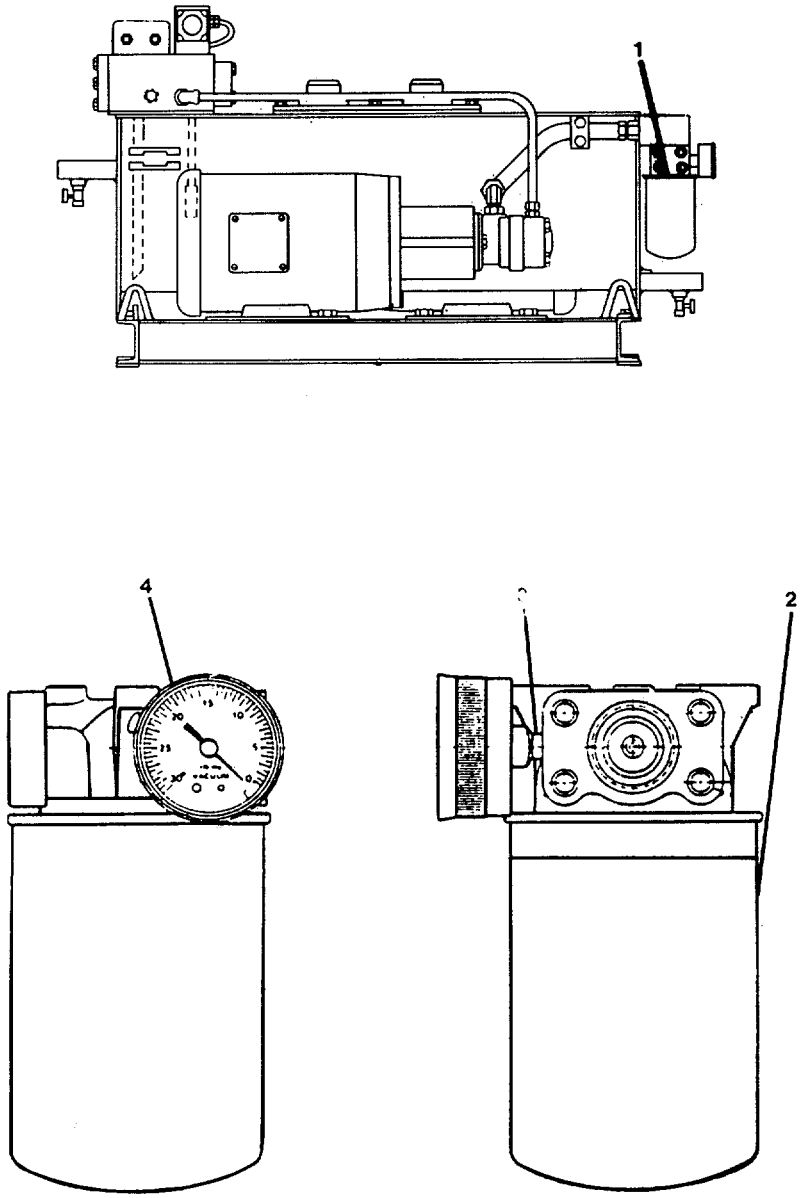


FIGURE 2-12. Inlet Filter Assembly.

b. Dial Indicating Vacuum Gauge.

(1) Install vacuum gauge on inlet filter assembly (1). Ensure that dial indicator is correctly positioned.
(2) Use wrench on nut at back of gauge to secure hand tight.

c. Operate and Test.

(1) Restore power to pumpset.
(2) Check for leaks.
(3) Return pumpset to normal operation (TM 55-1905-223-10).
(4) Remove "Out of Service - Do Not Operate" tag from circuit breaker.

2-22. Replace/Repair Header Tank (FIGURE 2-13)

This task covers:
a. Removal, b. Repair, c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics'
5180-00-699-5273

Equipment Condition

Equipment shutdown and tagged
"Out of Service - Do not Operate."
See TM 55-1905-223-10

Materials/Parts

Utility pail, item 28, Appendix C
Header tank, P/N 1200-40770
Filler/breather cap, P/N ABS10
Level sight glass, P/N LG-5

REMOVAL

a. Position utility pail under header tank.
b. Remove filler/breather cap (2).
c. Disconnect hydraulic line (5) at header tank (1) and drain fluid into utility pail.
d. Remove the four nuts, bolts and washers (3).
e. Remove tank (1).
f. Remove level sight glass (4).

REPAIR

Repair consists of replacing sight glass (4) and filler/breather cap (2).

REPLACEMENT

a. Install level sight glass (4).
b. Install tank (1) with four bolts, washers and nuts (3).
c. Connect hydraulic line (5) to header tank.
d. Fill header tank with clean filtered hydraulic fluid.
e. Install filler/breather cap (2).
f. Check for leaks.
g. Properly dispose of used hydraulic fluid.
h. Clean and store utility pail.

Hulls 2008 and subsequent

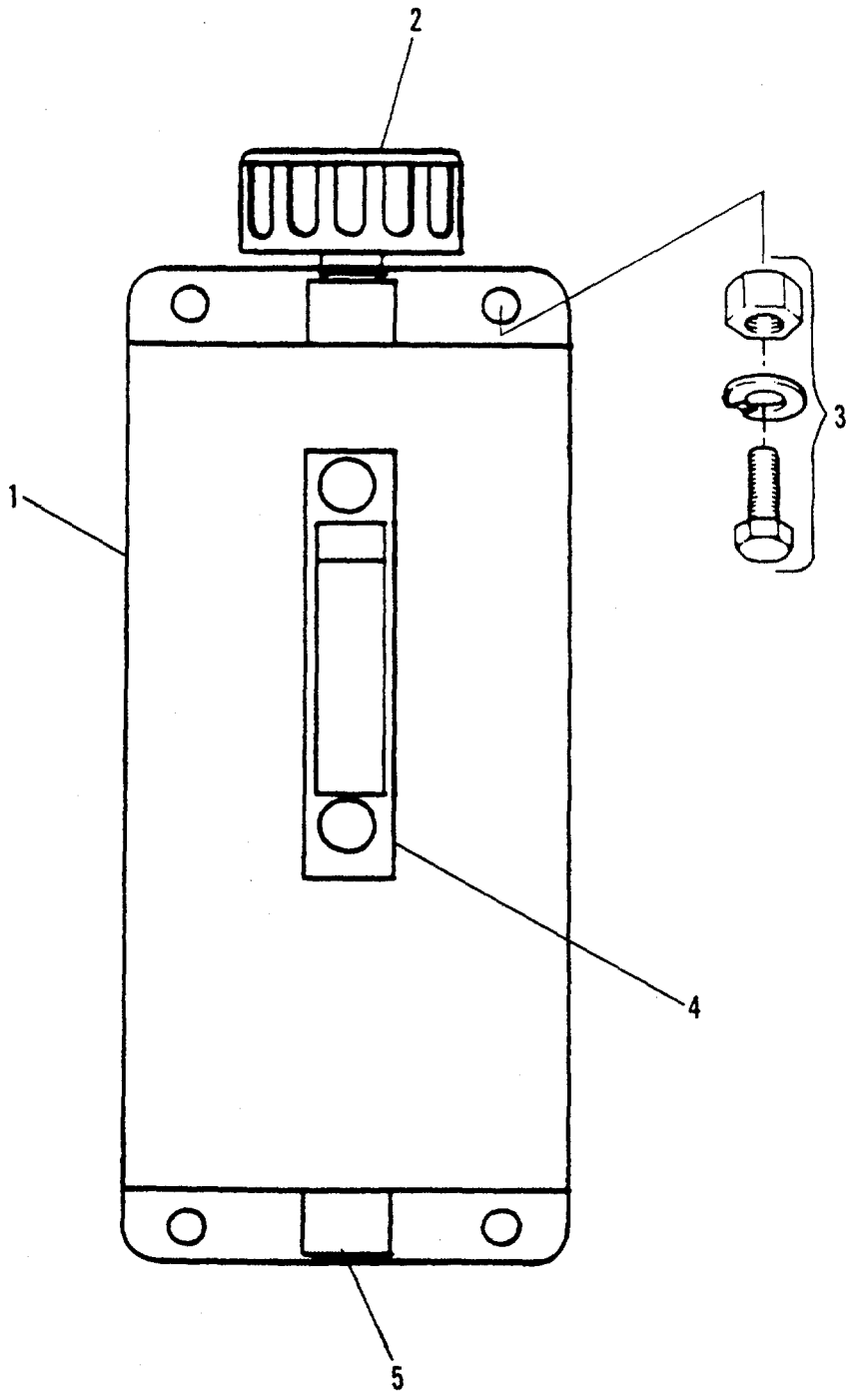


Figure 2-13 Header Tank

Hulls 2008 and subsequent

2-23. Service Hydraulic Power Unit (FIGURE 2-14)

This task covers:
a. Inspect, b. Service, c. Repair

INITIAL SETUP

Tools

Tool kit, general mechanics'
5180-00-699-5273

Equipment Condition

Equipment shutdown and tagged
"Out of Service - Do not Operate"
See TM 55-1905-223-10

Materials/Parts

Lint free cloth, Item 5, Appendix C
Cleaning solvent (PD 680), Item 23, Appendix C
Utility pail, Item 28, Appendix C
Hydraulic Oil, MIL-H-17672C, Type 2075-T-H-IS032
Suction strainer, P/N SEH-10-1-100-RV3 (2)
Filler breather, P/N AB1010-6-HNGO (2)
Level sensor, P/N 9999-40900 (2)

INSPECT

a. Visually inspect the entire unit for leaks, contamination, deterioration, or broken parts.
b. Oil check
   (1) Check that hydraulic fluid is clear and free of water or other contamination.
   (2) Check the level gauge (6) on the front of the reservoir.
c. Remove the cable from the level sensor, remove and inspect the sensor (2).

SERVICE

CAUTION
Do not overfill the reservoir. The reservoir must include air space over the fluid for air/fluid expansion and vessel pitch and roll.

NOTE
Do not attempt to read the level gauge or add fluid in rough seas.

a. Drain
   (1) Position utility pail under reservoir drain valve (5) on front of the unit.

Hulls 2008 and subsequent

(2) Open the valve and drain reservoir.
(3) Close drain valve.
(4) Properly dispose of used hydraulic fluid.

b. Clean

(1) Remove the reservoir end cover (4).
(2) Reach into the reservoir and unscrew the suction strainer (1).
(3) Clean (or replace if you need to) the strainer.
(4) Rinse out reservoir interior with solvent and wipe dry.
(5) Install suction strainer (1).
(6) Install the reservoir end cover (4).
(7) Remove and clean or replace filler/breather (3).

c. Fill

(1) Remove filler/breather (3) from reservoir.
(2) Fill the reservoir with clean, filtered hydraulic fluid.
(3) Install the filler/breather (3).
(4) Wipe up any spillage.
(5) Repeat the entire procedure for the other reservoir.
(6) Return unit to normal operation (TM 55-1905-223-10).

REPAIR

Repair consists of replacement of the suction strainers (1), level sensors (2) or filler/breather (3).

Hulls 2008 and subsequent

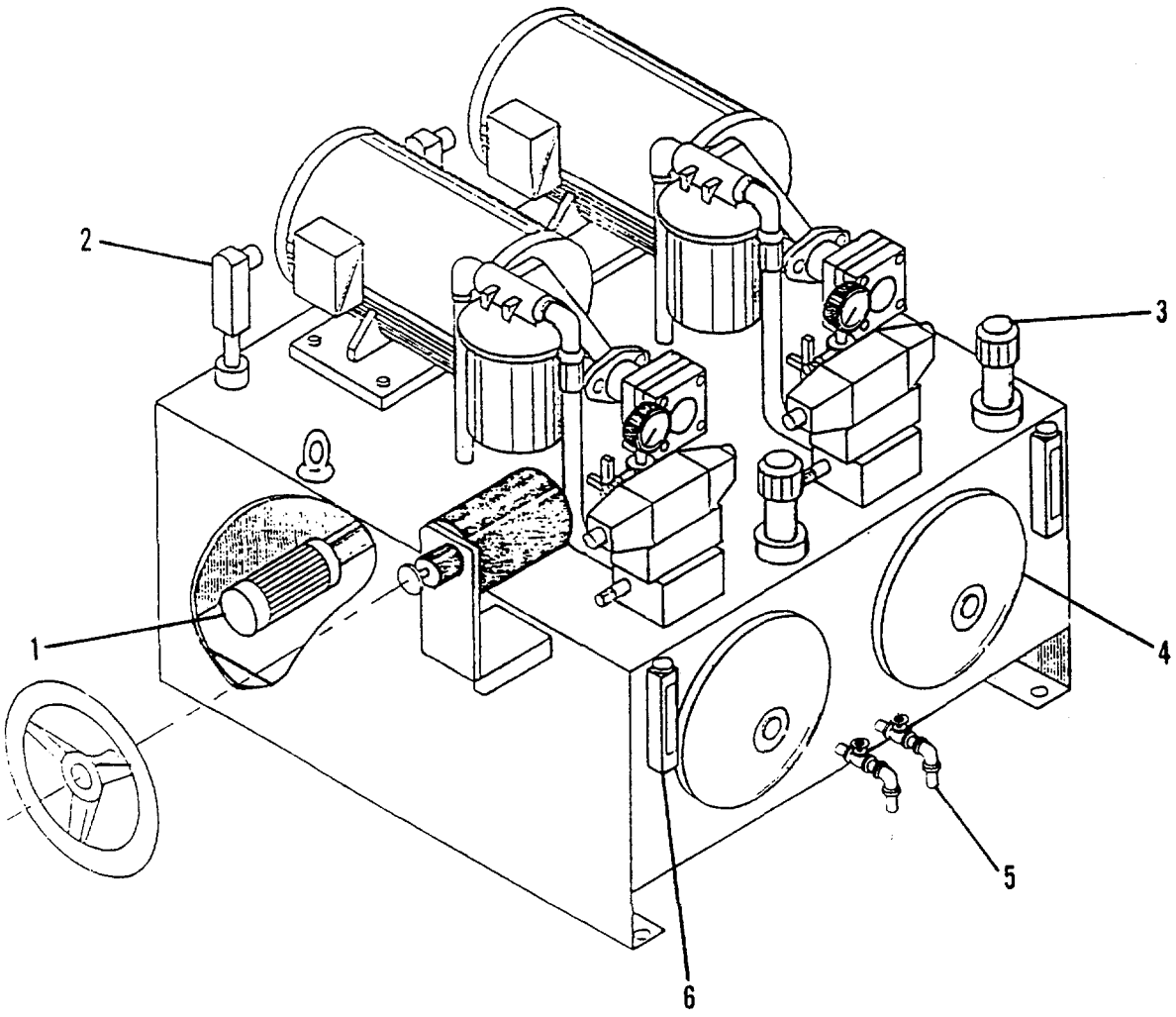


Figure 2-14 Hydraulic Power Unit

Hulls 2008 and subsequent

2-24. Replace Feedback Unit #1 (FIGURE 2-15)

This task covers:
a. Removal, b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics'
5180-00-6899-5273

Equipment Condition

Equipment shutdown and tagged "Out of Service - Do not Operate."
See TM 55-1905-223-10
Feedback linkage removed.

Materials/Parts

Feedback unit, P/N 9999-10200

REMOVAL

a. Remove fourteen screws (3) and washers (4) from the cover (2).
b. Remove the cover (2).
c. Remove and tag wires from terminal boards (1).
d. Pull the three cables from the case.
e. Remove four mounting bolts (7), nuts (5) and washers (6).
f. Remove the feedback unit.

REPLACEMENT

a. Set the feedback unit in place and align the mounting holes.
b. Install the four mounting bolts (7), nuts (5) and washers (6).
c. Feed the three cables into the case.
d. Connect the wires to the terminal boards (1) and remove tags.
e. Place the cover (2) on the unit and secure with fourteen screws (3) and washers (4).
f. Restore equipment to normal operation (TM 55-1905-223-10).

Hulls 2008 and subsequent

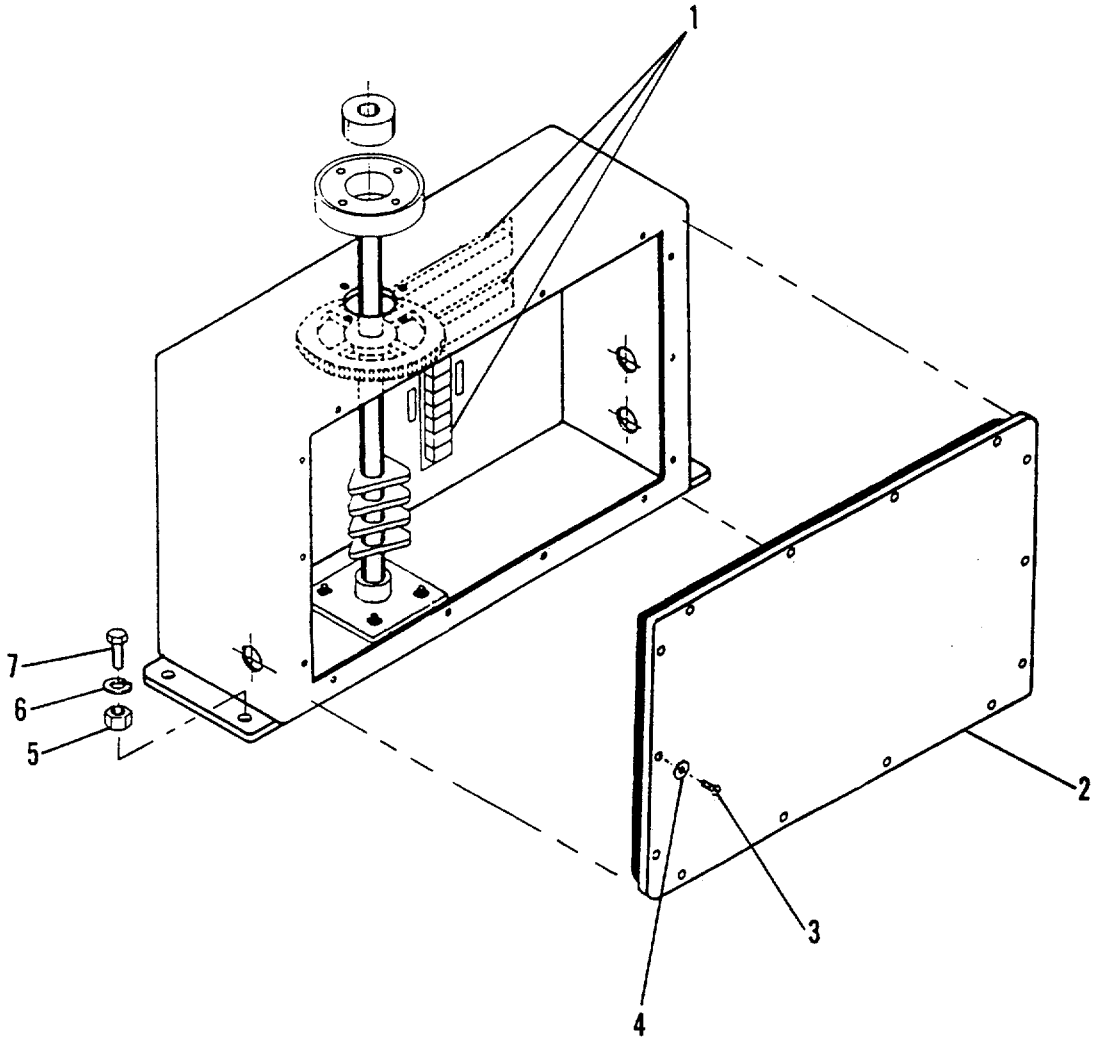


Figure 2-15. Feedback Unit #1

Hulls 2008 and subsequent

2-25. Replace Feedback Unit #2 (FIGURE 2-16)

This task covers:
a. Removal, b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics'
5180-00-6899-5273

Equipment Condition

Equipment shutdown and tagged "Out of Service - Do not Operate."
Feedback linkage removed.

Materials/Parts

Feedback unit, P/N 9999-10100

REMOVAL

a. Remove fourteen screws (3) and washers (4) from the cover (2).
b. Remove the cover (2).
c. Remove and tag wires from terminal boards (1).
d. Pull the cable from the case.
e. Remove four mounting bolts (7), nuts (5) and washers (6).
f. Remove the feedback unit.

REPLACEMENT

a. Set the feedback unit in place and align the mounting holes.
b. Install the four mounting bolts (7), nuts (5) and washers (6).
c. Feed the cable into the case.
d. Connect the wires to the terminal boards (1) and remove tags.
e. Place the cover (2) on the unit and secure with fourteen screws (3) and washers (4).
f. Restore equipment to normal operation (TM 55-1905-223-10).

Hulls 2008 and subsequent

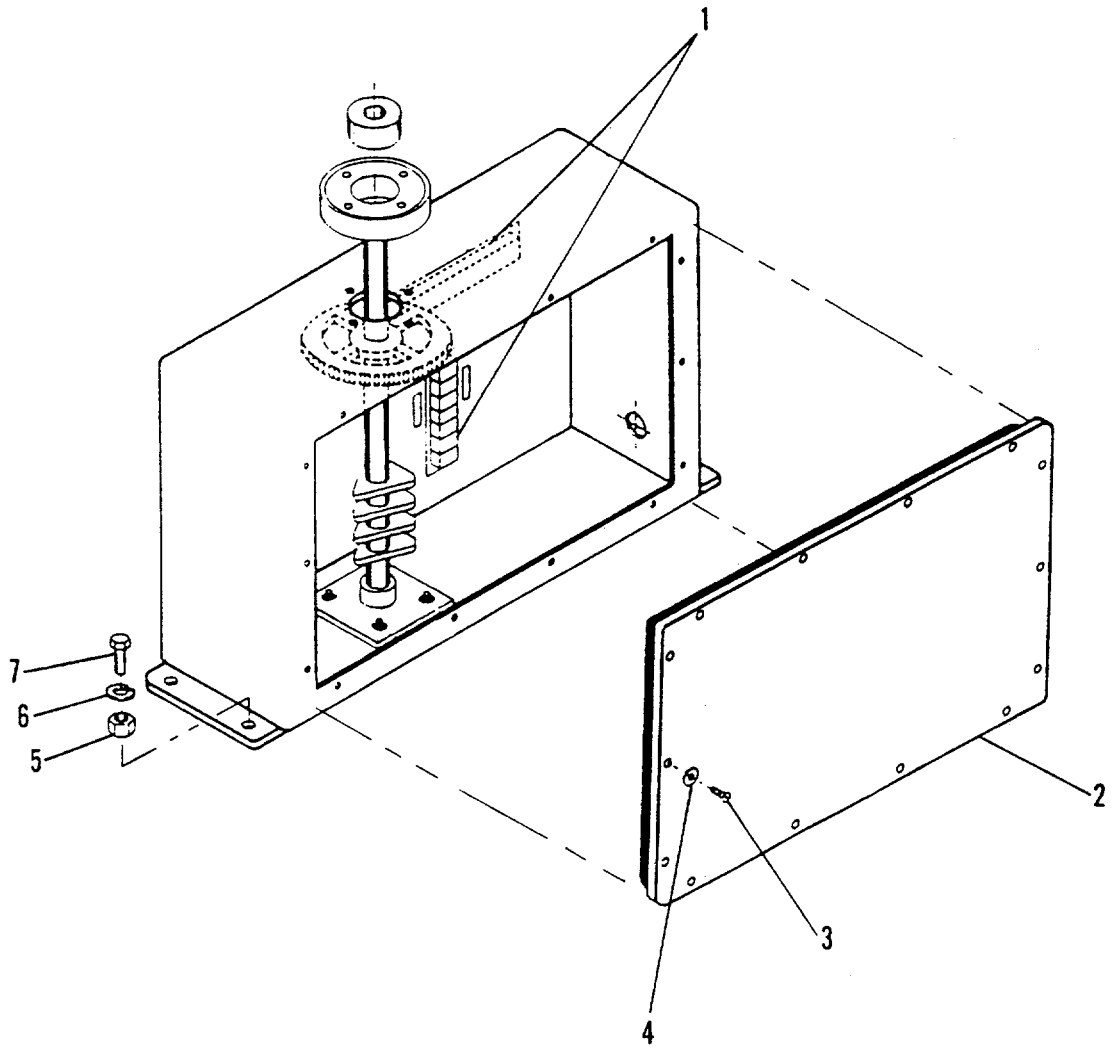


Figure 2-16 Feedback Unit #2

Hulls 2008 and subsequent

2-26 Replace Electric Motor (FIGURE 2-17)

This task covers:
a. Check, b. Removal, c. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics'
5180-00-6899-5273

Equipment Condition

Equipment shutdown and tagged
"Out of Service - Do not Operate."
See TM 55-1905-223-10

Materials/Parts

Motor, P/N 150172-60

CHECK

Check bearing temperature with a thermometer and not by hand. If bearings are hot (over 180 degrees F), the condition may be the result of too much lubricant. If changing lubricant does not correct the condition, replace motor.

REMOVAL

a. Remove two screws (3) from electrical conduit box. Remove cover.
b. Disconnect electrical wires and tag.
c. Remove four bolts (5) and washers (6) securing the motor (4) to the pump/motor adapter (7).
d. Remove four bolts (2) and washers (1) securing the motor to the unit.
e. Remove motor (4).

REPLACEMENT

a. Place the motor (4) on the unit and align the mounting holes.
b. Secure the motor to the unit using four bolts (2) and washers (1).
c. Secure the motor to the pump/motor adapter using four bolts (5) and washers (6).
d. Connect the electrical wires to the motor conduit box and remove tags.
e. Place cover on conduit box and secure with two screws (3).

Hulls 2008 and subsequent

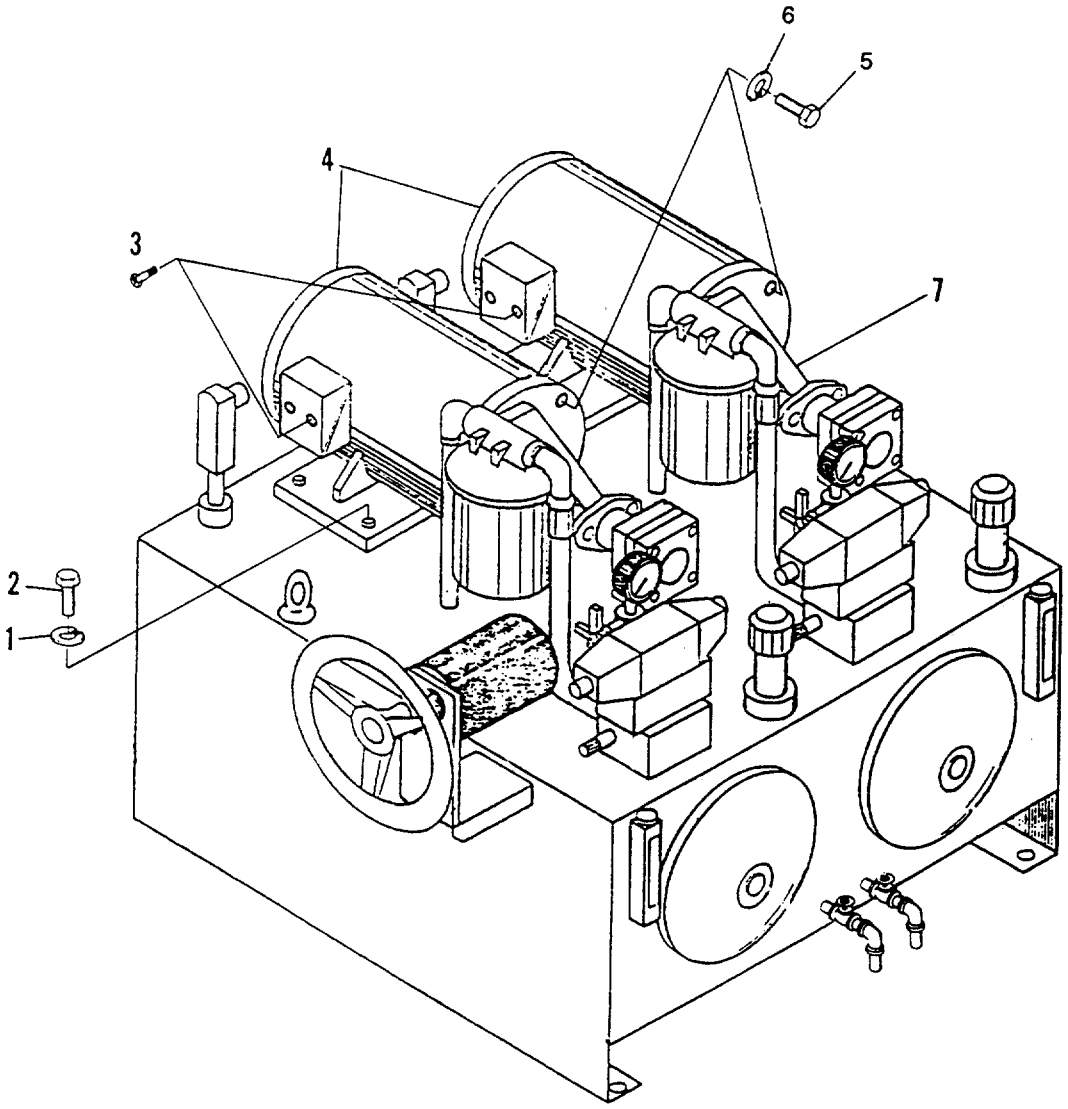


Figure 2-17 Electric Motor

Hulls 2008 and subsequent

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

2-27. **Administrative Storage**. Prepare steering gear system for storage in accordance with the following instructions:

a. Twin Pumpset. It is always better to store equipment and hardware indoors. When this is not possible, or when storage is for a period longer than I year, follow these instructions.

(1) Twin pumpset should never be exposed to the elements. If the unit is stored outdoors, cover it with a tarpaulin that can be secured to the base of the dual pumpset.

(2) Fill reservoir completely with a heavy rust inhibitor such as Gulf No-Rust Engine Oil, Grade 3, which conforms to Military Specification MIL-L-21260.

(3) Apply a coating of rust inhibitor to all exposed fittings, shaft couplings, motors, and pumps. Use Cosmoline 11-2 MIL-C-16173 Grade 2 or equivalent.

(4) At least every 3 months, check reservoir for water contamination by removing drain plug and allowing a small amount of oil to drain. All water that may have accumulated will be at the bottom of reservoir and will drain out first.

(5) Check all exposed areas of dual pumpset for integrity of the protective coating every 3 months. Reapply coating if required, to prevent possible corrosion.

(6) Before twin pumpset is placed in operation, remove preservative coating from all exposed areas. Drain and flush rust inhibitor from reservoir. Fill and bleed dual pumpset reservoir (paragraph 2-10).

b. Cylinders, Jockey Bar, and Tiller Arms. It is always better to store equipment and hardware indoors. When this is not possible, or when storage is for a period of longer than 1 year, follow these instructions:

(1) Apply a coating of rust inhibitor to all exposed areas of each assembly. Use Cosmoline 11-2 MIL-C-16173 Grade 2 or equivalent.

(2) If stored outdoors, cover each assembly with a tarpaulin that can be secured to prevent exposure to the elements.

(3) Check all exposed areas of each assembly for integrity of the protective coating every 3 months. Reapply coating if required, to prevent possible corrosion.

(4) Before cylinders, jockey bar and tiller arms are placed in operation, remove preservative coating from all exposed areas.

CHAPTER 3

INTERMEDIATE DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

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

3-1. **Common Tools and Equipment**. For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

3-2. **Special Tools, TMDE, and Support Equipment**. Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

3-3. **Repair Parts**. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

Section II. SERVICE UPON RECEIPT

3-4. Checking Unpacked Equipment.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage in accordance with the instructions of DA Pam 738-750.
b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.
c. Check to see whether the equipment has been modified.

d. Remove protective caps, plugs, inserts, wrappings, and tape when inspection/inventory is completed. Inspect piping openings for damage. Wipe off dirt, grease, or protective films at time of installation.
e. Remove chocks from resilient mounted components.

Section III. INTERMEDIATE DIRECT SUPPORT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PHCS)

3-5. **Explanation of PHCS Table**. PMCS is designed to keep the equipment in good working condition. This is accomplished by performing certain tests, inspections, and services. Table 3-1 lists items to be serviced and the procedures needed to accomplish the PMCS. The "Interval" column tells you when to perform a check or service. If needed, PMCS may be performed more frequently than the indicated interval. The "Procedures" column tells you how to perform the required checks and services. If your equipment does not perform as required, see Table 3-2, Troubleshooting. Report any malfunctions or failures on DA Form 2404. In the Item Number column on DA Form 2404, record the appropriate Item Number from the PMCS table.

Table 3-1. Preventive Maintenance Checks and Services (Perform as required)

Item No.	Items To Be Inspected	Procedures
1	Relief valve	Valve is preset for 930 psi. Should not require adjustment except when system pressure exceeds this pressure. If valve needs to be adjusted, see paragraph 3-12.

Section IV. INTERMEDIATE DIRECT SUPPORT TROUBLESHOOTING

3-6. **Troubleshooting**. Both a symptom index and troubleshooting table are provided. The symptom index will help you locate the information you need for troubleshooting.

SYMPTOM INDEX

Table 3-2 lists the common fault conditions that may be found during operation or maintenance of the equipment. Perform the test/inspections and corrective actions in the order listed. This manual cannot list every symptom that may occur, and it cannot list all probable causes and corrective actions. If a symptom is not listed or keeps up after you perform the corrective actions, notify your supervisor.

Table 3-2. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. Upon energizing the main directional control valve, the steering gear operates slower than normal and cannot develop full system pressure.
STEP 1. Check for contamination in manifold relief valve. Disassemble, clean internal parts, and assemble valve (para. 3-12).
2. Steering gear will not respond to command at the main directional control valve.
STEP 1. Check for contamination in DARBS valve. Disassemble, clean internal parts and assemble valve (para. 3-13).
STEP 2. Check to see if uniblock 2A filters are plugged by contamination. Remove and clean inlet and outlet filter (para. 3-12).

Section V. INTERMEDIATE DIRECT SUPPORT MAINTENANCE PROCEDURES

3-7. **General**. The following paragraphs give principles of operation applicable to this maintenance chapter and overall instructions for disassembly, cleaning, and assembly procedures.

a. Principles of Operation. (Also see Chapter 1, Section III). The dual pumpset has lockvalves between the solenoid valves and the actuating cylinders. This valve prevents rudder movement in the absence of a rudder command. To protect this loop from overpressurization damage in case a hard object strikes the rudders, a DARBS valve is installed to open at 1160 psi. The steering gear is designed for primary control from the pilot house, but also includes control components for emergency operation from the steering gear room. When normal pilot house steering control is disabled, control can be switched to the steering gear room using one of the two local control units bulkhead mounted near the pumpsets. Unit A controls pumpset A and unit B controls pumpset B. The control transfer switch is set to LOCAL to provide rudder control. Communication with the pilot house is also required for heading information. On the panel of each controller is a dip switch that will move the rudders right or left when pressed off neutral in either direction. Rudder travel continues while the switch is held in either direction, unless a hard-over stop is reached. Each local control unit has a rudder angle indicator above the dip switch.

NOTE

When maneuvering the ship in close quarters, the bowthruster water jet will normally be operated in conjunction with the steering gear. Refer to the LCU Operator's Manual (TM 55-1905-223-10) and the bowthruster water jet maintenance manual (TM 55-1905-22324-6) for additional information about the steering system.

b. General Instructions. Before beginning disassembly of any steering gear component, a thorough inspection should be made to determine its overall condition and whether, in fact, it should be repaired. Many times it is better to replace the component with a new one rather than spend time and effort to repair it. When you find you need to repair the component, it should be disassembled carefully (see a. below) and all parts should be cleaned.

(1) Disassembly. Information written down during disassembly can save a lot of time during assembly.

(a) Mark or identify the location and position of mounting components when you remove them.

(b) When removing capscrews, record type, length, and location. This will make sure you replace the right ones in the right order when you assemble the equipment.

(c) Tag electrical wires, tubing, and bearing position to ensure correct assembly.

(d) Discard hoses, preformed packings, seals, and gaskets.

(e) Be careful when removing attaching hardware and wiring, to avoid the possibility of broken or stripped capscrews, bent tubing, or broken wire terminals.

(2) Cleaning. It is very important to clean properly. If you don't, you could get inaccurate torque readings, reduced or restricted lubrication and/or contamination, and other problems that will reduce the effectiveness of the repair action.

(a) The most common contaminants are: Teflon tape, pipe fitting compound, metal filings and chips, sawdust, and parts of cleaning rags.

(b) To avoid contamination with pipe fitting compounds such as Teflon tape or Permatex, it is important to apply them to the male threads only. Make sure the female threads do not have any compound or tape still on them.

(c) Protect open piping during the repair process to prevent contamination.

(d) Copper tubing, seamless steel tubing, and galvanized pipe should be flushed out with diesel oil, kerosene, varsol, or any other solvent compatible with mineral oil; then, blow out with air.

(3) Assembly. Be sure to follow assembly procedures as outlined. If torque values are not specified in the procedure, follow the guidance found in Appendix D, General Bolt Torque Data.

NOTE

When Teflon tape is used in place of pipe dope, reduce the tightening effort to avoid distortions or cracks in the female (threaded) connection.

3-8. Repair Followup Unit. (FIGURE 3-1)

This task covers:
a. Disassembly, b. Repair, c. Assembly.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273
Tool kit, electrician's, 5180-00-391-1087

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraph in this maintenance manual:
Followup unit removed, paragraph 2-11.

Materials/Parts

Retaining ring, P/N 605-002
Potentiometer, P/N 550-154
Sensitive switch, P/N 212-001
Gasket, P/N 617-015
Spring post, P/N 690-160
Preformed packing, P/N 615-010
Sleeve bearing, P/N 600-035
Spring pin, P/N 600-048
Spur gear, P/N 655-156
Shaft collar, P/N 690-140
Sleeve bearing, P/N 655-140
Voltage regulator, P/N 130-041

DISASSEMBLY

a. Straight Shaft.

(1) Remove screws (10) securing access cover to followup unit housing (21).

(2) Remove cover (11) and gasket (9).

(3) Remove capscrew (3) connecting gear arm (29) to followup unit.

(4) Lift gear arm and remove spring post (1) and retaining ring (2) from upper end of shaft (25).

(5) Remove setscrew (30) from shaft collar (28). Remove shaft collar. Remove spur gear (6).

(6) Loosen two capscrews (18) at cams (17).

(7) Remove shaft (25) from housing (21). Remove sleeve bearing (16).

(8) Remove sleeve bearing (4). Remove and discard preformed packing (31) and flat washer (5).

b. Electrical Components.

(1) Potentiometers (pots).

(a) Remove setscrew (8) from spring pin. Remove spring pin (7).

(b) Tag and desolder electrical leads (12) to pots.

(c) Remove machine screws (19) securing pots to bracket (27). Remove pots (26).

(2) Sensitive Switch.

(a) Tag and desolder electrical leads (13, 23) to switches.

(b) Remove screws and nuts (24, 20) from switches.

(c) Remove switches (22) from bracket (27).

(3) Voltage Regulator.

(a) Remove voltage regulator adapter (14).

(b) Remove voltage regulator (15).

REPAIR

Repair consists of replacing: retaining ring (2), spring post (1), gasket (9), preformed packing (31), sleeve bearing (4), spring pin (7), spur gear (6), shaft collar (28), potentiometer (26), sensitive switch (22), sleeve bearing (16), and voltage regulator (15).

ASSEMBLY

a. Electrical Components.

(1) Voltage Regulator.

(a) Position voltage regulator (15) in followup unit.

(b) Secure voltage regulator adapter (14).

(2) Sensitive Switch.

(a) Position sensitive switches (22) over mounting holes in bracket (27) and secure screws and nuts (24, 20).

(b) Solder electrical leads (13, 23) to switches and remove tags.

(3) Potentiometers.

(a) Position pots (26) in bracket (27). Secure with machine screws (19).

(b) Solder electrical leads (12) to pots and remove tags.

(c) Replace spring pin (7) and secure setscrew (8).

b. Straight Shaft.

(1) Lubricate preformed packing (31) and install on shaft end (25).

(2) Position spur gear (6), flat washer (5), and cams (17) in alignment before inserting shaft (25).

(3) Slide shaft through upper sleeve bearing (4), shaft collar (28), and lower bearing (16).

(4) Replace setscrew (30) into shaft collar (28), securing shaft to followup unit.

(5) Replace retaining ring (2), spring post (1), and lower gear arm (29).

(6) Replace capscrew (3) connecting gear arm to followup unit.

(7) Replace gasket (9) and access cover (11) secure screws (10) to followup unit housing (21).

(8) Replace followup unit (paragraph 2-11).

(9) Remove "Out of Service Do Not Operate" tag and restore equipment to normal operation.

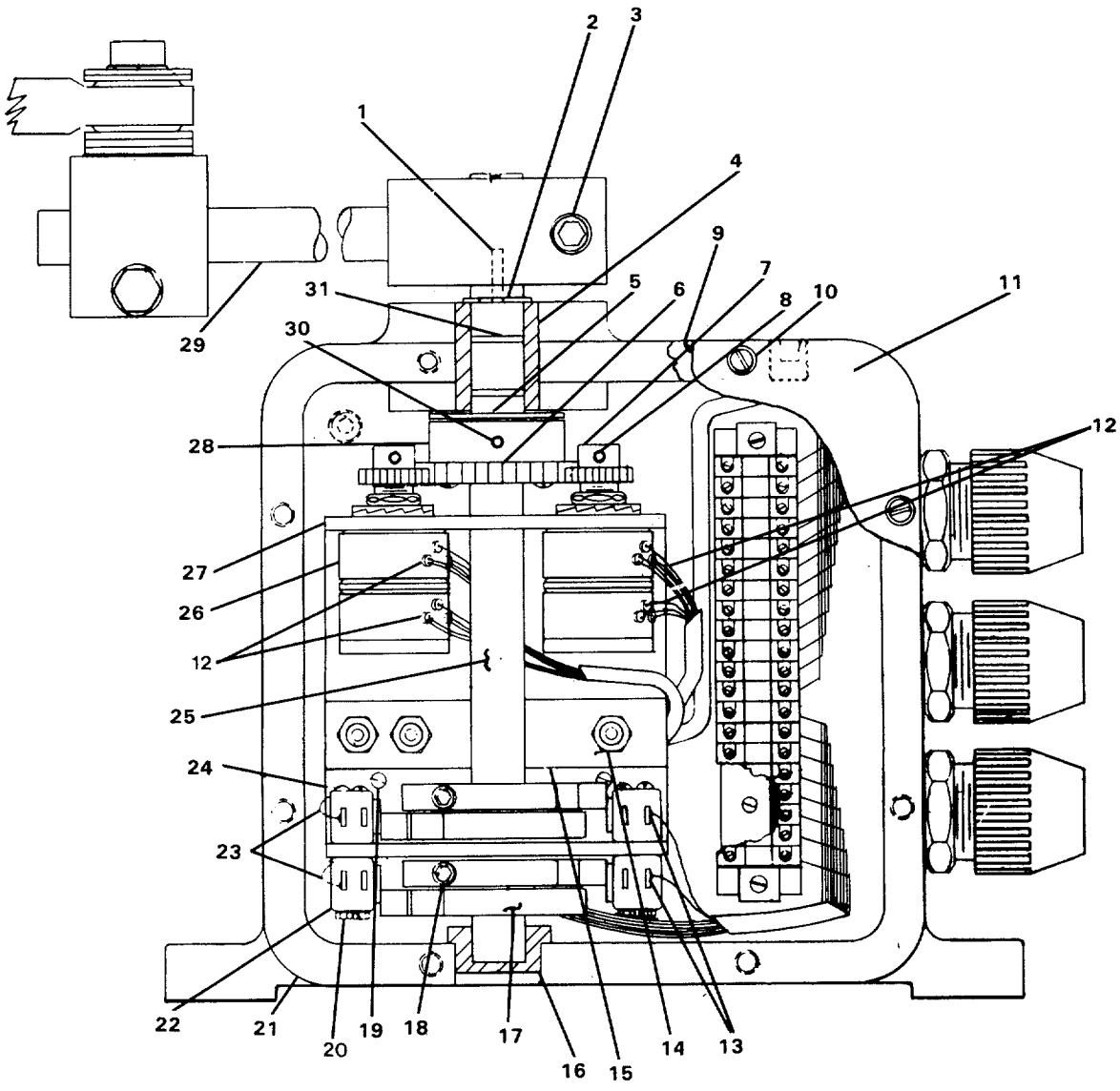


FIGURE 3-1. Followup Unit.

3-9. Replace/Repair Hydraulic Cylinder Assembly. (FIGURE 3-2)

This task covers:

a. Removal, b. Repair, c. Replacement, d. Adjustment.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate." See TM 55-1905-223-10.

Materials/Parts

Tiller pin, P/N 620-0061
Hydraulic cylinder assembly, P/N 600-0045
Bearing, P/N 610-0079
Utility pail, Item 28, Appendix C

REMOVAL

a. Close the two shutoff valves to the cylinder.
b. Position utility pail at hydraulic cylinder assembly (1).
c. Disconnect two hydraulic hoses (2) at cylinder and cap two hydraulic hoses.
d. Remove setscrew (11) and lockwasher (10).
e. Turn clevis (5) counterclockwise off rod (8) and remove.
f. Remove locking plate (12).

CAUTION

Wipe up oil spills.

g. Remove tiller pin (6) and bearing (7) connecting cylinder to tiller arm (4) and lower cylinder end to deck.
h. Support cylinder and remove mounting pad connecting pin (3). Lower cylinder assembly to deck.

REPAIR

Repair at this level consists of replacing: hydraulic cylinder assembly (1), tiller pin (6), and bearing (7).

REPLACEMENT

a. Position tiller arm end of cylinder on deck. Raise cylinder to mate with mounting pad and insert mounting pad pin (3).
b. Raise tiller arm end of cylinder to tiller arm (4) connection. Insert bearing (7) and tiller pin (6).
c. Install locking plate (12).
d. Position clevis (5) on rod (8) and turn clockwise.
e. Install lockwasher (10) and secure setscrew (11).
f. Remove caps and connect two hydraulic hoses (2) to cylinder assembly (1).
g. Fill system and bleed (paragraph 2-10).

ADJUSTMENT

a. Cylinder Stop Adjustment.
   (1) Loosen setscrew (11) and position threaded stop (9), at extreme top of cylinder rod (8).
   (2) Manually move steering gear to a hard-over position.
   (3) Adjust threaded stop (9) until it contacts the front face of cylinder. Tighten setscrew (11).
   (4) Manually move steering gear to the opposite hard-over position.

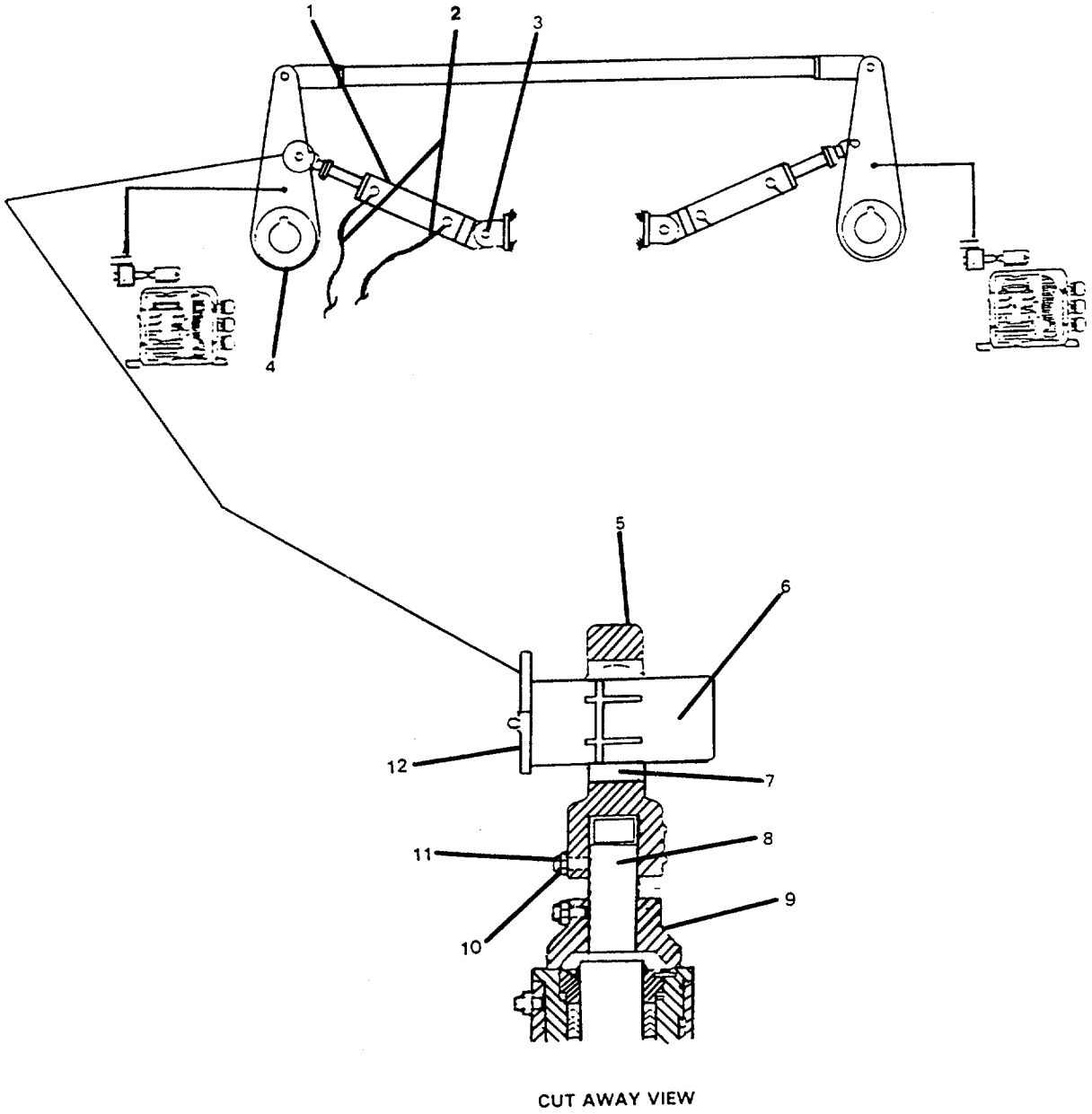


FIGURE 3-2. Hydraulic Cylinder Assembly.

3-10. Replace/Repair Twin Pumpset Assembly.

This task covers:

a. Replacement, b. Repair.

REPLACE

Replacement of the twin pumpset assembly is by replacement of hydraulic pump, paragraph 2-17; electric motor, paragraph 2-18; uniblock 2A assembly, paragraph 2-19; coil assembly, paragraph 2-20; and inlet filter assembly, paragraph 2-21.

REPAIR

For repair of twin pumpset assembly, refer to paragraph 2-16.

3-11. Repair Hydraulic Pump. (FIGURE 3-3)

This task covers:
a. Disassembly, b. Repair, c. Assembly.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Ring, P/N 328152
Bushing P/N 280267
Preformed packing P/N 154090 (2 required)
Vane set P/N 923493
Seal P/N 229235
Bearing P/N 98574
Spring P/N 28422
Retaining ring, P/N 109975
Machine key, P/N 5881
Rotor, P/N 358330
Pin, P/N 2478
Retaining ring, P/N 98653

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraph in this maintenance manual:
Hydraulic pump removed (paragraph 2-17).

DISASSEMBLY

a. Remove four machine screws (17), keeping pressure on cover. Release spring pressure slowly and remove cover (18).
b. Remove spring (16), pressure plate (15), bushing (14), preformed packing (10), ring (13), rotor (9), vane set (12), preformed packing (10), and pin (11).
c. Remove shaft nut (7) and retaining ring (8). Withdraw shaft (5) from body (1) and remove machine key (6).
d. Remove bearing (4) from body.
e. Remove retaining ring (3) and seal (2) from body.

REPAIR

Repair at this level consists of replacing: bearing (4), retaining ring (3), seal (2), pin (11), vane set (12), rotor (9), ring (13), preformed packing (10), bushing (14), spring (16), machine key (6), and retaining ring (8).

ASSEMBLY

a. Lubricate with clean hydraulic oil and insert new seal (2) into body (1).

b. Install retaining ring (3).

c. Install bearing (4) in body.

d. Install shaft (5), machine key (6), shaft nut (7), and retaining ring (8) into body.

e. Lubricate with clean hydraulic oil and insert new preformed packing (10) in body (1) and cover (18). Insert pin (11) in body (1).

f. Position rotor (9) and vane set (12) over shaft (5).

g. Install bushing (14) in pressure plate.

h. Position ring (13), lubricated performed packing (10) and pressure plate (15) to body over alignment pin (11).

i. Place spring (16) on pressure plate (15).

j. Position cover (18) over pressure plate and ring (13).

k. Apply pressure to cover and install four machine screws (17) through cover ring and mounting holes on body (1). Secure all four machine screws.

l. Replace hydraulic pump (paragraph 2-17).

m. Restore power to pump.

n. Check for leaks

o. Remove tags and restore equipment to normal operation.

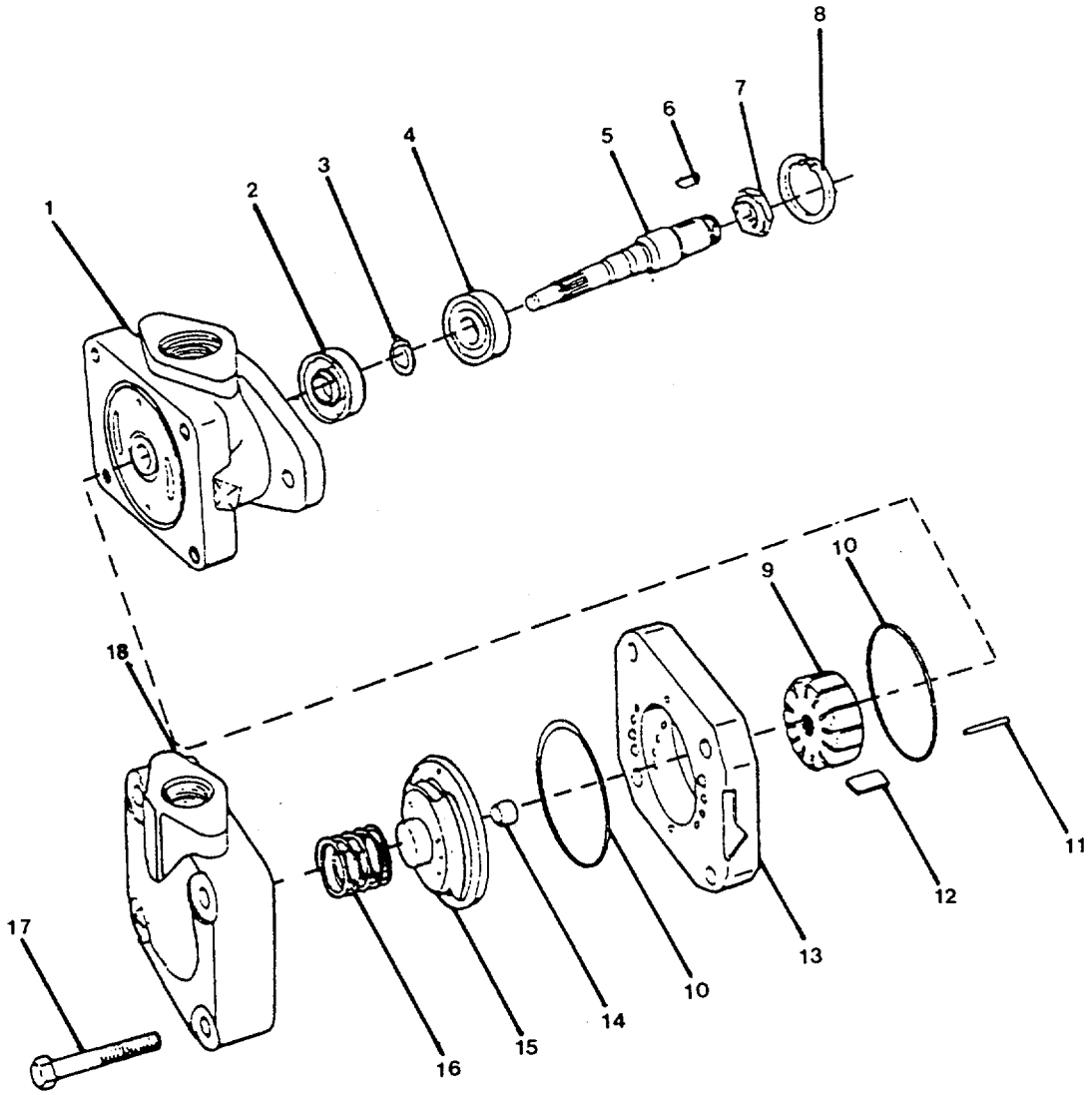


FIGURE 3-3. Hydraulic Pump Assembly.

3-12. Repair Uniblock 2A Assembly. (FIGURE 3-4).

This task covers:
a. Disassembly, b. Repair, c. Assembly.
d. Adjustment

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Preformed packing, P/N 11-106124
Spring guide, P/N 420-0024
Spring, P/N 31-100107
Spindle, P/N 420-0017
Preformed packing, P/N 11-106012 (2)
Preformed packing, P/N 10-400014
Plug, P/N 420-0571
Spring, P/N 31-100121
Ball bearing, P/N 21-300003
Preformed packing, P/N 11-106125
Outlet filter, P/N 251-0008
Preformed packing, P/N 11-106136
Inlet filter, P/N 251-0005
Preformed packing, P/N 10-400116
Spring, P/N 31-100008
Ball cup, P/N 420-0579
Ball cup, P/N 420-0141
Ball bearing, P/N 21-300002
Preformed packing, P/N 11-106011
Preformed packing, P/N 11-106214
Preformed packing, P/N 11-106010
Preformed packing, P/N 11-106113

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraph in this maintenance manual:
Uniblock 2A assembly removed (paragraph 2-19).

DISASSEMBLY

a. End Cap.
   (1) Remove end caps (1) and preformed packings (2).
   (2) Remove spring guides (3) and springs (4).
   (3) Remove lockwashers (5) and spindle (6).

b. Filters.

(1) Outlet Filter.

(a) Remove machine bolt (15) and lockwasher (14).

(b) Remove end plate (13).

(c) Remove pipe plug (8), preformed packing (7, 12), plug (11), spring (10), and ported ball valve (9).

(d) Remove preformed packing (16), machine screw (17), retaining disk (18), and outlet filter (19).

(2) Inlet Filter.

(a) Remove preformed packing (20), machine screw (17), and retaining disk (21).

(b) Remove inlet filter (22).

c. Shuttle Valve and Relief Vent.

(1) Remove machine bolt (23) and lockwasher (14) and separate shuttle valve body (39) from uniblock body (47).

(2) Remove wire (31), self-locking nut (33), flat washer (34), seal washer (35), adjusting screw (32), preformed packing (30), spring (29), ported valve ball (27), ball cup (28), preformed packing (36), and relief valve body (37).

(3) Remove pipe plug (24), shuttle screw (40), preformed packing (7, 25), ported valve ball (26), and ball cup (38).

(4) Remove preformed packing (41, 42) and pipe plug (43).

(5) Remove relief vent (44) from uniblock body (47).

(6) Remove pipe plug (45) and preformed packing (46).

REPAIR

Repair consists of replacing: spring guides (3), springs (4), spindle (6), plug (11), spring (10), ported ball valve (9, and 27), outlet filter (19), inlet filter (22), spring (29), ball cup (28 and 38), preformed packing (2, 7, 12, 16, 20, 25, 30, 36, 41, 42, and 46).

ASSEMBLY

NOTE

Lubricate parts with clean hydraulic fluid during installation.

a. Shuttle Valve and Relief Vent.

(1) Install preformed packing (46) and pipe plug (45) into relief vent (44).

(2) Install relief vent (44) into uniblock body (47).

(3) Install pipe plug (43) and preformed packing (41, 42).

(4) Install ball cup (38), ported valve ball (26), preformed packing (7, 25), shuttle screw (40), and pipe plug (24).

(5) Install relief valve body (37), preformed packing (36), ported valve ball (27), ball cup (28), spring (29), preformed packing (30), seal washer (35), adjusting screw (32), flat washer (34), self-locking nut (33), and wire (31).

(6) Secure shuttle valve body (39) to uniblock body (67) with lockwasher (14) and machine bolt (23).

b. Filters.

(1) Inlet Filter.

(a) Install inlet filter (22).

(b) Install retaining disk (21), machine screw (17), and preformed packing (20).

(2) Outlet Filter.

(a) Install outlet filter (19).

(b) Install retaining disk (18), machine screw (17), and preformed packing (16).

(c) Install ported ball valve (9), spring (10), preformed packing (7, 12), plug (11), and pipe plug (8).

(d) Install end plate (13).

(e) Secure end plate with lockwasher (14) and machine bolt (15).

c. End Cap.

(1) Install spindle (6) and lockwashers (5).

(2) Install springs (4) and spring guides (3).

(3) Install preformed packings (2) and end caps (1).

d. Operate and Test.

(1) Replace uniblock 2A assembly (paragraph 2-19).

(2) Restore power to pumpset.

(3) Check for leaks.

(4) Return pumpset to normal operation (TM 55-1905-223-10).

(5) Remove "Out of Service - Do Not Operate" tag from circuit breaker.

WARNING

Keep hands, tools, and clothes away from rotating machinery, or personal injury could result.

ADJUSTMENT

NOTE

Adjust shuttle valve only if pressure exceeds 930 psi. Valve is factory set at this pressure and should normally not require adjustment.

a. Set one of two local control unit switches to LOCAL.

b. Open shutoff valve to pressure gauge on uniblock 2A assembly.

c. Close four cylinder valves.

d. Remove lockwire (31) from relief valve jamnut (self-locking nut) (33) and loosen nut.

e. Hold jog lever to one side. System pressure gauge should read 930 psi. If not, turn adjustment screw (32) with allen key:

In - to adjust the pressure higher

Out - to adjust the pressure lower

f. Secure jamnut. Make sure that system pressure remains constant, then release jog lever.

g. Thread wire through jamnut and secure.

h. Close shutoff valve to pressure gauge.

i. Repeat adjustment procedure for other pumpset.

j. Open four-cylinder valves.

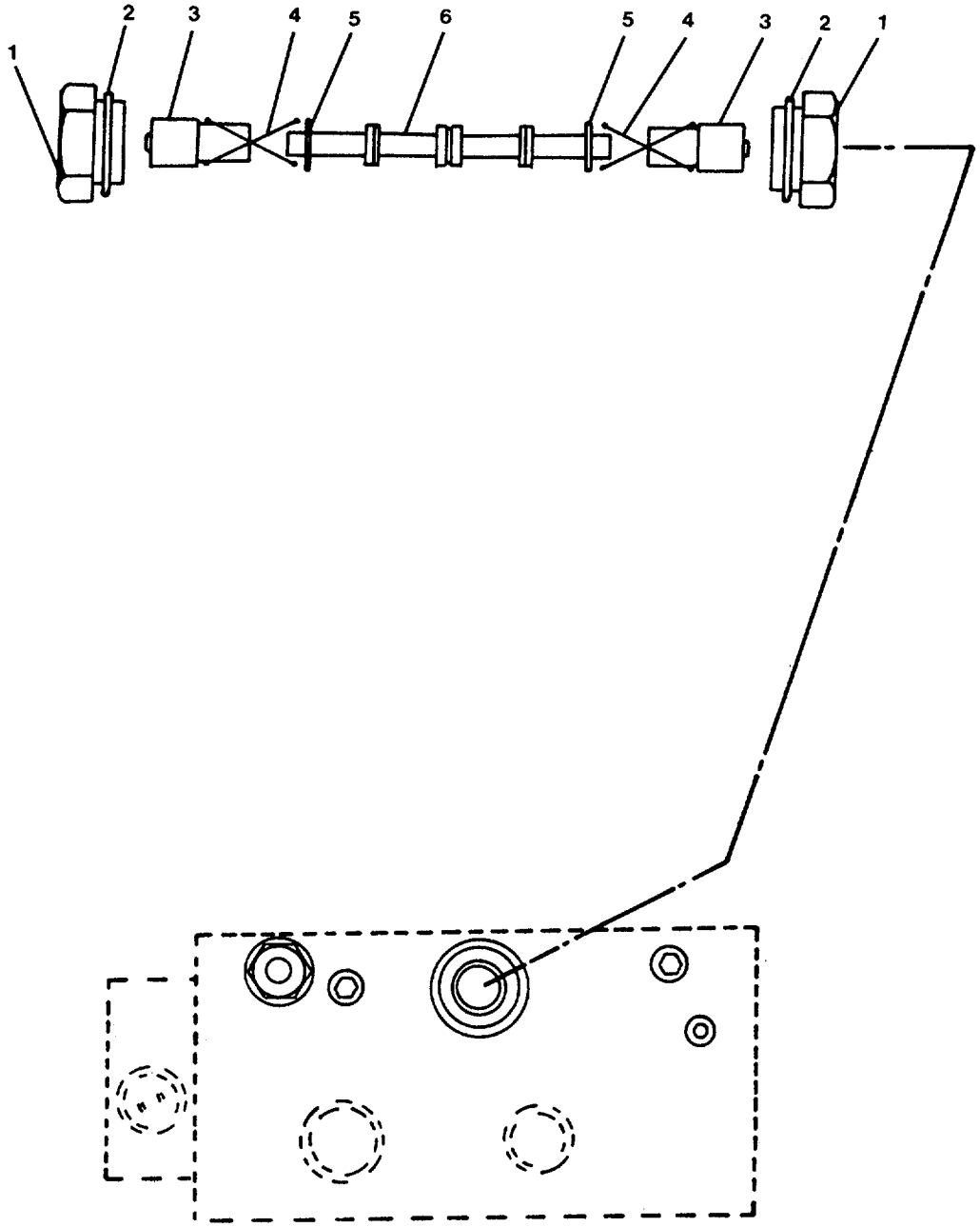


FIGURE 3-4. Uniblock 2-A Assembly (Sheet 1 of 3).

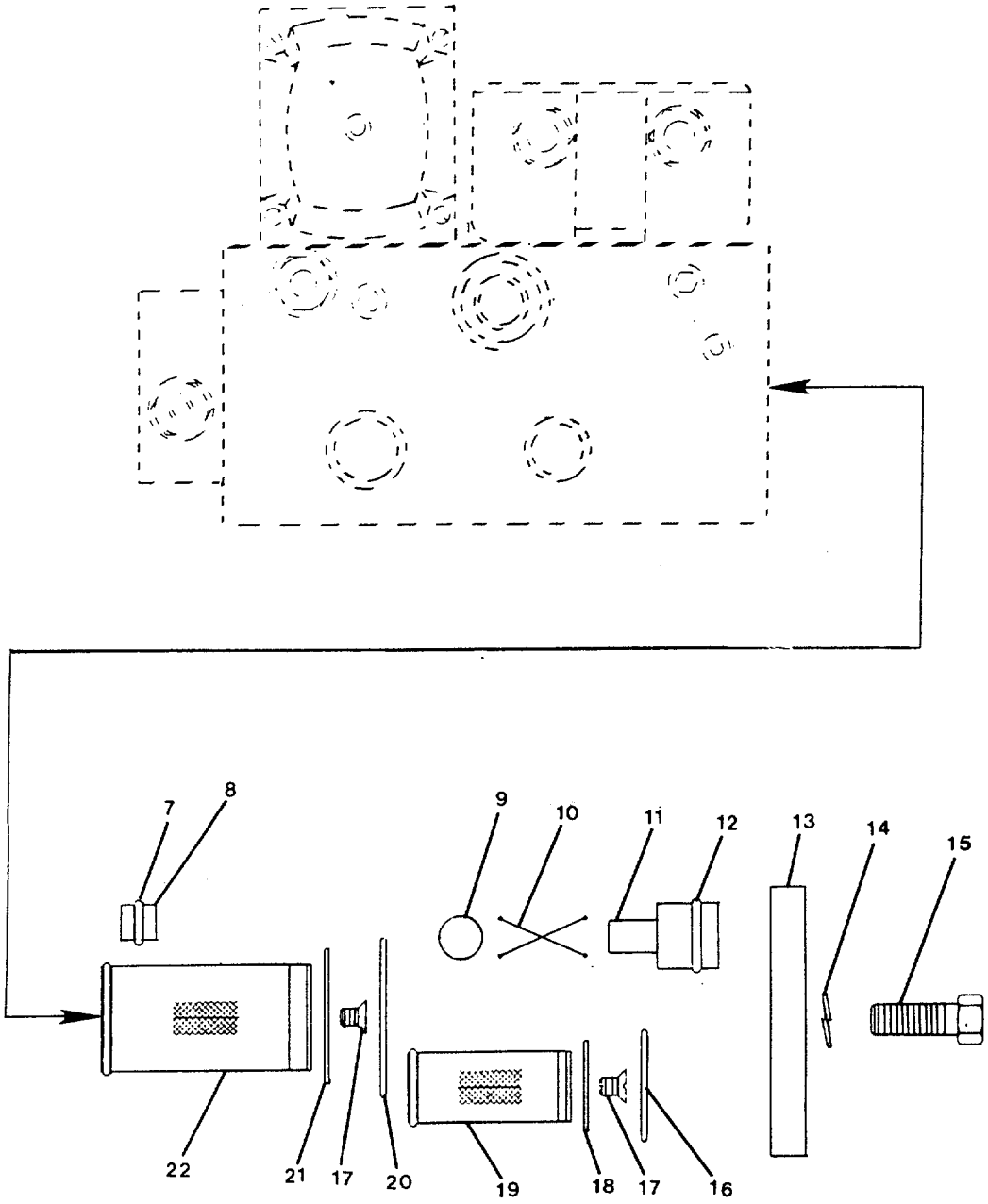


FIGURE 3-4. Uniblock 2A Assembly (Sheet 2 of 3).

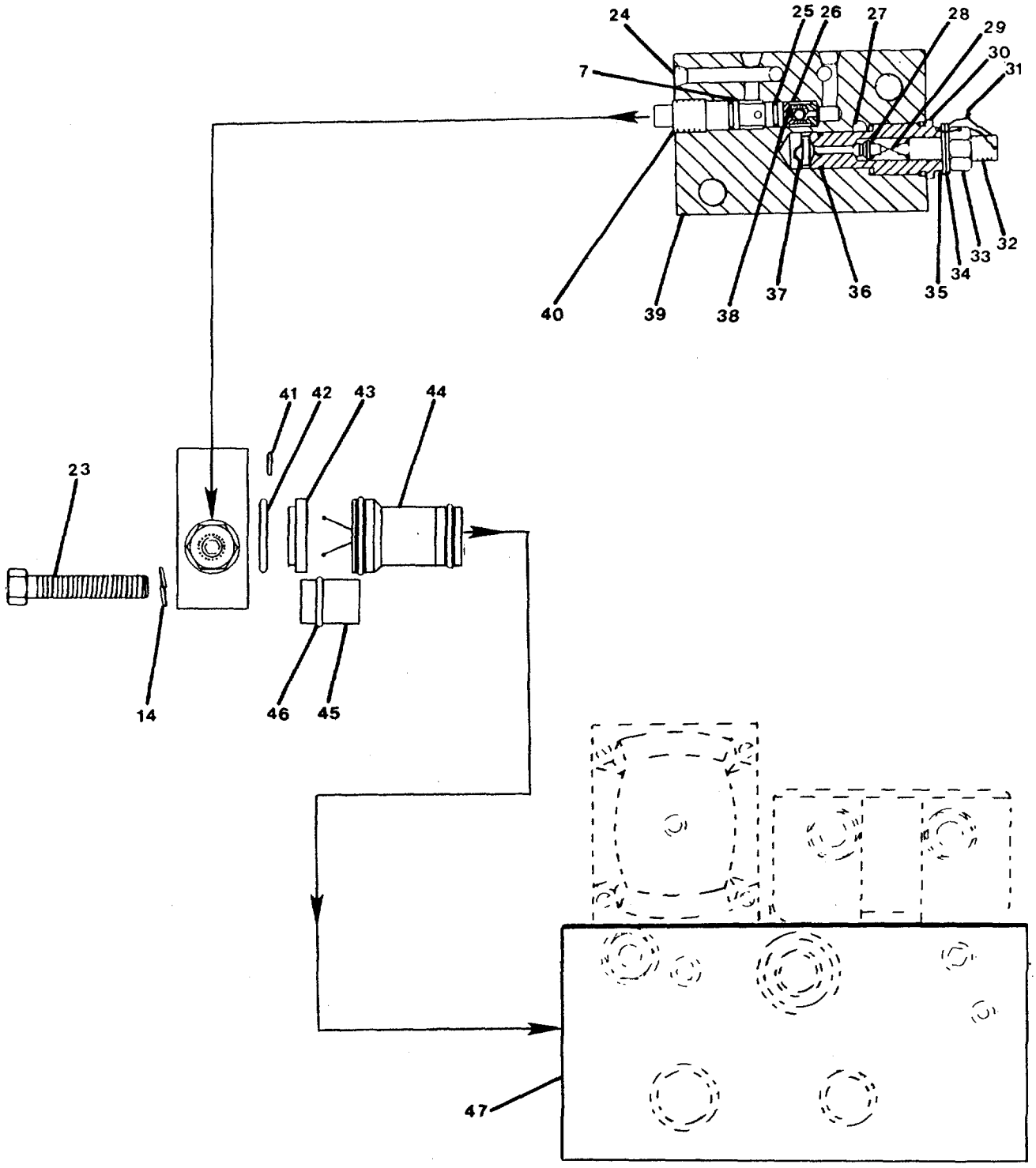


FIGURE 3-4. Uniblock 2A Assembly (Sheet 3 of 3).

3-13. Replace/Repair Relief/Bypass/Shutoff Valve. (FIGURE 3-5)'

This task covers:

a. Removal, b. Disassembly, c. Repair,
d. Assembly, e. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Equipment Conditions

Equipment shut down and tagged
"Out of Service - Do Not Operate."
See TM 55-1905-223-10.

Materials/Parts

Preformed packing, P/N 11-106123
Retaining ring, P/N 51-300007
Spring pin, P/N 51-170002
Relief/bypass/shutoff valve
P/N 400-0024
Utility pail, Item 28, Appendix C

REMOVAL

a. Close four shutoff valves (1).
b. Place utility pail under inlet and outlet hydraulic lines.
c. Disconnect inlet (2) and outlet (3) hydraulic lines.
d. Remove relief/bypass/shutoff valve (4).

DISASSEMBLY

a. Remove four machine screws (5) securing identification plate (6) to relief/bypass valve. Remove identification plate (6).
b. Remove relief cartridge (9) from body (10).
c. Remove preformed packing (13) and retaining ring (12) from spool (11).
d. Remove pipe plug (7) and spring pin (8) from body (10).

REPAIR

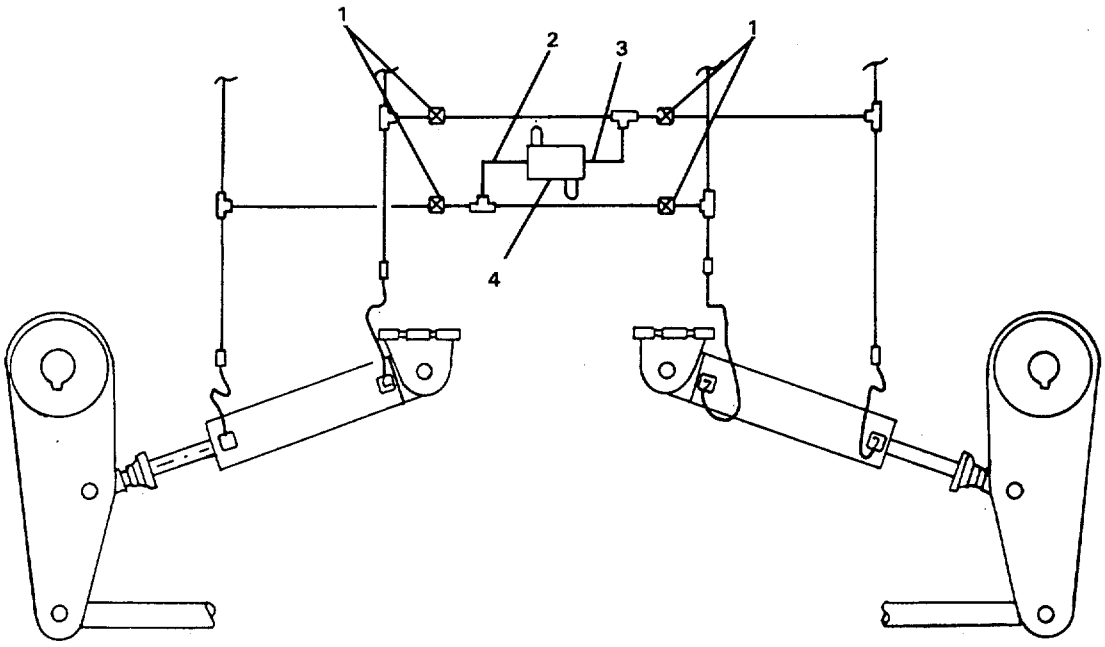
Repair at this level consists of replacing: preformed packing (13), retaining ring (12), and spring pin (8).

ASSEMBLY

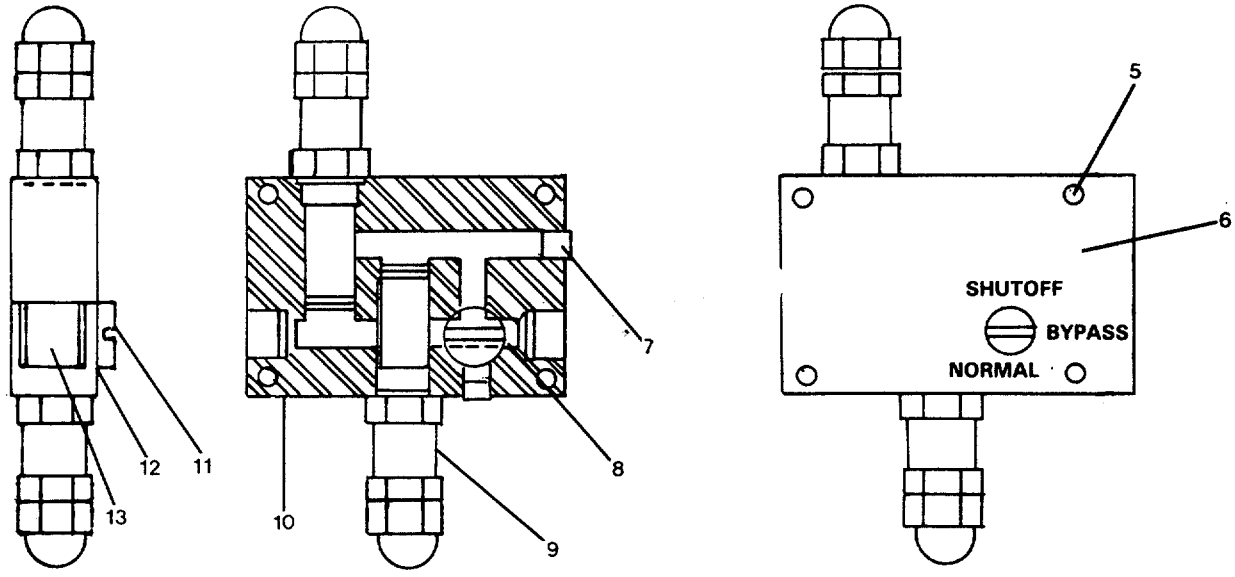
a. Install spring pin (8) and pipe plug (7) into body (10).
b. Install preformed packing (13) and retaining ring (12) in spool (11).
c. Install relief cartridge (9) in body (10).
d. Replace identification plate (6) and secure with four machine screws (5).

REPLACEMENT

a. Connect relief/bypass/shutoff valve (4) to outlet (3) and inlet (2) hydraulic lines.
b. Remove utility pail and dispose of hydraulic fluid.
c. Open four shutoff valves (1).
d. Check for leaks.
e. Restore to normal operation (TM 55-1905-223-10).



STEERING GEAR



SIDE VIEW

CUT AWAY VIEW

FRONT VIEW

FIGURE 3-5. Relief/Bypass/Shutoff Valve.

3-14. Replace/Repair Relief Cartridge. (FIGURE 3-6)

This task covers:

a. Repair, **b. Replacement.**

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Relief cartridge, P/N 80-200002
Preformed packing, P/N 11-106914
Preformed packing, P/N 11-106010

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraph in this maintenance manual:
Relief/bypass/shutoff valve removed and disassembled, paragraph 3-13.

REPAIR/REPLACEMENT

a. Repair consists of replacing relief cartridge (1) and preformed packing (2, 3).
b. Assemble and install relief/bypass/shutoff valve (paragraph 3-13).
c. Restore power to pumpset.
d. Check for leaks.
e. Return equipment to normal operation (TM 55-1905-223-10).
f. Remove "Out of Service - Do Not Operate" tag from circuit breaker.

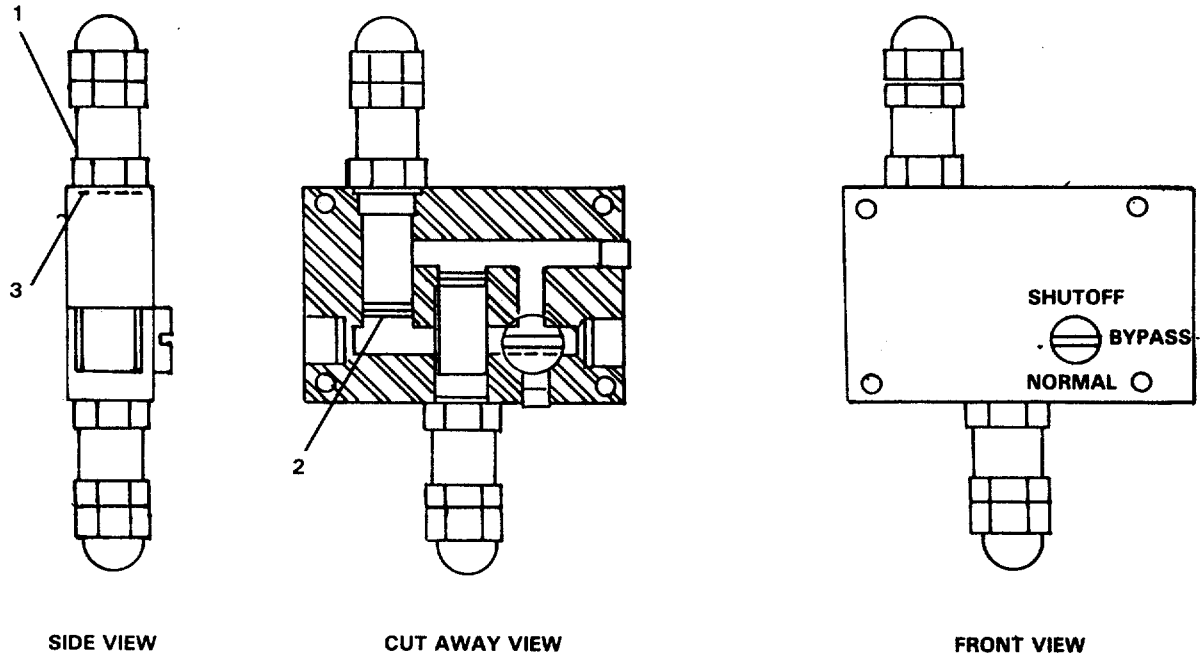


FIGURE 3-6. Relief Cartridge.

3-15 Repair Feedback Unit #1 (FIGURE 3-7)

This task covers:
a. Disassembly, b. Repair, c. Assembly.

INITIAL SETUP

Tools

Tool kit, electricians
5180-00-392-2895

Equipment Condition

Equipment shutdown and tagged
"Out of Service - Do not Operate".
Feedback unit removed, paragraph 2-24.

Material s/Parts

Shaft bearing bushing, P/N SF2432-16
Shaft base, P/N 1200-10106
Heater, P/N B205-1K5 (2)
Cover gasket, P/N 1200-10109
Shaft bearing, P/N 58KDD
Spur gear, P/N NBS 2484
Spur gear, P/N NBS 2424
Potentiometer, P/N C158-3CP-3
Limit switch, P/N BA-2RV22-A2 (2)
Switch adapter, P/N 17MA1B (2)
Seal, P/N 7572

DISASSEMBLY

a. Remove fourteen screws (12) and washers (13) and remove the cover (11).
b. Remove the cover gasket (10) and discard.
c. Remove four screws (3) from the shaft bearing bushing (6).
d. Remove the bushing (6), bearing (5) and seal (4) from the shaft (2).
e. Remove any wires from potentiometer (9) and tag.
f. Remove four screws, lockwashers and flat washers from bracket (14).
g. Remove bracket (14) with potentiometer (9) and spur gear (8).
h. Remove four nuts, flat washers and lockwashers from bracket (15). Remove wires from switches (19) and tag.
i. Remove bracket (15) with limit switches (19) and switch adapters (17).
j. Remove four screws, nuts and washers (18) and remove switches (19) and adapters (17) from bracket (15).
k. Loose set screw on spur gear (1) and slide gear down on shaft (2).

Hulls 2008 and subsequent

l. Remove four nuts, flat washers and lockwashers (20) from shaft base (21)
m. Lift up on shaft (2) and tilt to remove from unit.
n. Remove gear (1) from shaft (2).
o. Remove spur gear (8) and potentiometer from bracket (14).

REPAIR

Repair consists of replacing: spur gear (1), seal (4), bearing (5), bushing (6), heaters (7), spur gear (8), potentiometer (9), cover gasket (10), switch adapters (17), switches (19) and shaft base (21).

ASSEMBLY

a. Slide spur gear (1) on shaft (2) but do not tighten in place.
b. Tilt shaft (2) and position in unit aligning mounting holes in shaft base (21) with studs in unit.
c. Install four nuts, flat washers and lockwashers (20) to secure the shaft base.
d. Position spur gear (1) on shaft (2) and tighten setscrew.
e. Install switches (19) and adapters (17) on bracket (15) using four screws, nuts and washers (18).
f. Install bracket (15) in unit using four nuts, flat washers and lockwashers. Connect wires to switches (19) and remove tags.
h. Install spur gear (8) and potentiometer (9) on bracket (14).
i. Install bracket (14) in unit using four nuts, flat washers and lockwashers.
j. Connect wires to potentiometer (9) and remove tags.
k. Install bushing (6), bearing (5) and seal (4) on shaft (2).
1. Secure bushing (6) with four screws (3).
m. Install feedback unit per paragraph 2-24 using a new cover gasket (10).
n. Remove "Out of Service Do Not Operate" tag and restore equipment to normal operation (TM 55-1905-223-10).

Hulls 2008 and subsequent

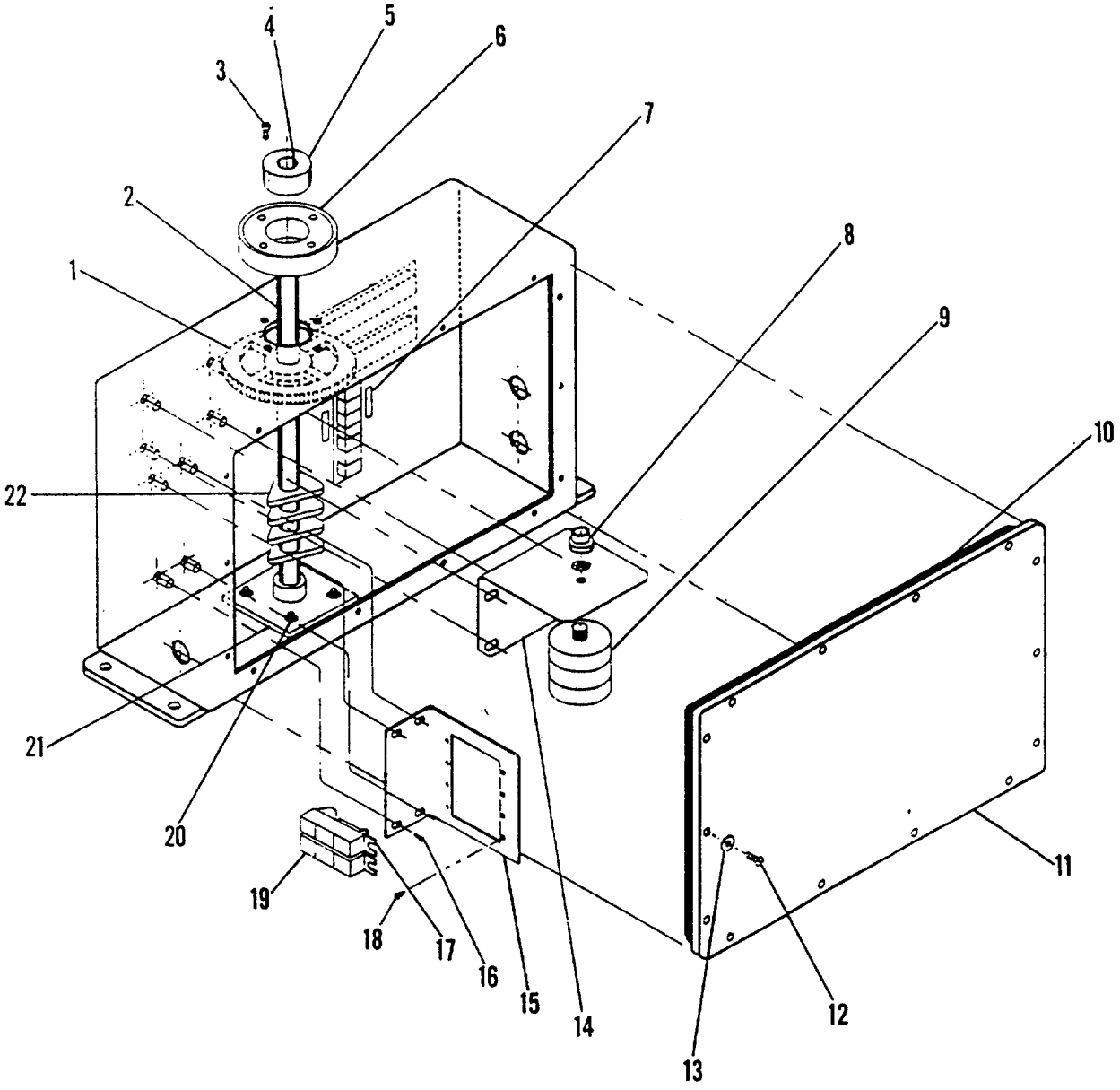


Figure 3-7 Feedback Unit #1
Hulls 2008 and subsequent

3-16 Repair Feedback Unit #2 (FIGURE 3-8)

This task covers:
a. Disassembly, b. Repair, c. Assembly.

INITIAL SETUP

Tools

Tool kit, electricians
5180-00-392-2895

Equipment Condition

Equipment shutdown and tagged "Out of Service - Do Not Operate".
Feedback Unit removed, paragraph 2-25.

Material/Parts

Shaft bearing bushing, P/N SF ?432-16
Shaft base, P/N 1200-10106
Heater, P/N B205-1K5 (2)
Cover gasket, P/N 1200-10109
Shaft bearing, P/N 58KDD
Spur gear, P/N NBS2484
Spur gear, P/N NBS2424
Potentiometer, P/N C158-3CP-2
Limit switch, P/N BA-2RV22-A2 (2)
Switch adapter, P/N 17MA1B (2)
Seal, P/N 7572

DISASSEMBLY

Disassemble the feedback unit per paragraph 3-15.

REPAIR

Repair is per paragraph 3-15.

ASSEMBLY

a. Assemble the feedback unit per paragraph 3-15.
b. Install the feedback unit per paragraph 2-25.

Hulls 2000 and subsequent

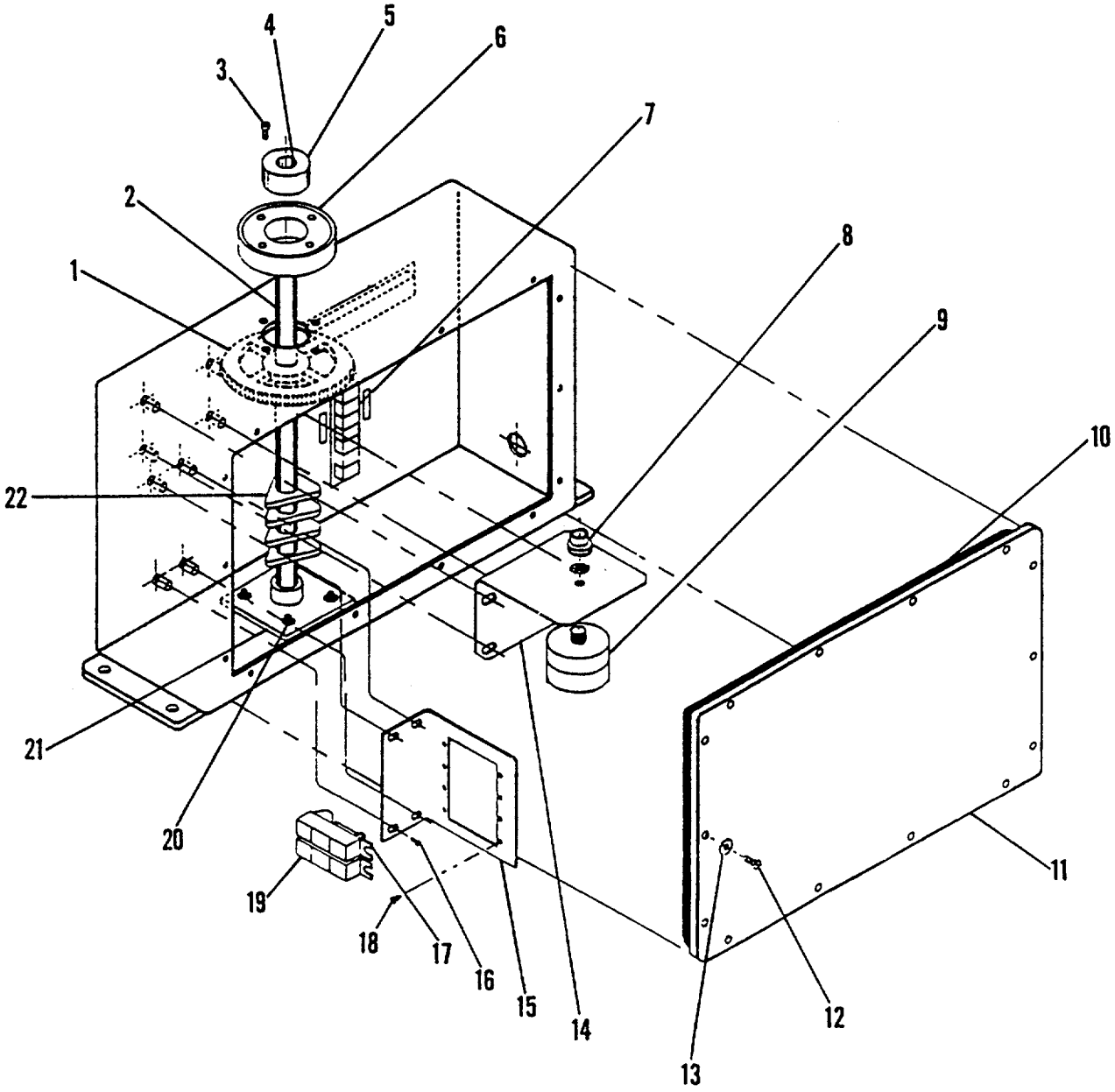


Figure 3-8 Feedback Unit #2

Hulls 2000 and subsequent

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

■ 3-17. **Administrative Storage**. See paragraph 2-27.

Hulls 2008 and subsequent

Change 1 3-36

CHAPTER 4

INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AN DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

4-1. **Common on Tools and Equipment**. For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

4-2. **Special Tools, TMDE, and Support Equipment**. Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TN 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

4-3. **Repair Parts**. Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

Section II. SERVICE UPON RECEIPT

4-4. **Checking Unpacked Equipment.**

a. Inspect the equipment for damage incurred, during shipment. If the equipment has been damaged, report the damage in accordance with the instructions of DA Pam 738-750.
b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.
c. Check to see whether the equipment has been modified.
d. Remove protective caps, plugs, inserts, wrappings and tape when inspection/delivery is completed. Inspect piping openings for damage. Wipe off dirt, grease, or protective film at time of installation.

e. Remove chocks from resilient mounted components.

Section III. INTERMEDIATE GENERAL SUPPORT PREVENTIVE MAINTENANCE CHEKCS AND SERVICES (PMCS)

4-5. **PMCS**. Refer to paragraphs 2-8 and 3-5 for PMCS.

Section IV. INTERMEDIATE GENERAL SUPPORT TROUBLESHOOTING

4-6. **Troubleshooting**. A symptom index and troubleshooting actions are provided,

SYMPTOM INDEX

	Troubleshooting Procedure (Table 4-1)
RUDDER	
Will not stay in position	Item 2
STEERING GEAR	
Will not respond to command	Item 1

Table 4-1 lists the common fault conditions that may be found during operation or maintenance of the equipment. Perform the test/inspections and corrective actions in the order listed. This manual cannot list every symptom that may occur, and it cannot list all probable causes and corrective actions. If a symptom is not listed or keeps up after you perform the corrective actions, notify your supervisor.

Table 4-1. Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. Steering gear will not respond to command at main directional control valve.

   STEP 1. Check to see if the uniblock has a defective lockvalve (helm steering wheel turns when the solenoid valve is energized.) Disassemble and clean lockvalve (para. 4-12). Lockvalve is mounted to the rear of the helm pump.

2. When main directional control valve is de-energized, rudder fails to remain in position.

   STEP 1. Check for contamination in lockvalve. Disassemble and clean lockvalve (para. 4-12).

Section V. INTEREDIATE GENERAL SUPPORT MAINTENANCE PROCEDURES

4-7. **General**. The following paragraphs give principles of operation applicable to this maintenance chapter and overall instructions for disassembly, cleaning, and assembly procedures.

a. Principles of Operation. (Also see Chapter 1, Section III and Chapter 3, Section V.)

(1) Steering System Valves. In order to move the rudders either right or left using a pump that operates continuously in the same direction, a directional valve is installed between the pump and the pistons to stop, start, or reverse the flow. The valve has two solenoids, one for the right rudder and the other for the left. When neither solenoid is energized, springs position the valve in neutral, cutting off flow. In each pumpset, a relief valve between the pump and the solenoid valve limits operating pressure to 930 psi.

(2) Emergency Steering. The steering gear is designed for primary control from the pilot house, but also includes control components for emergency operation from the steering gear room. When normal pilot house steering control is disabled, control can be switched to the steering gear room using one of the two local control units bulkhead mounted near the pumpsets. Unit A controls pumpset A and unit B controls pumpset B. The control transfer switch is set to LOCAL to provide rudder control. Communication with the pilot house is also required for heading information. On the panel of each controller is a dip switch that will move the rudders right or left when pressed off neutral in either direction. Rudder travel continues while the switch is held in either direction, unless a hard-over stop is reached. Each local control unit has a rudder angle indicator above the dip switch.

NOTE

When maneuvering the ship in close quarters, the bowthruster water jet will normally be operated in conjunction with the steering gear. Refer to the LCU Operator's Manual (TM 551905-223-10) and the bowthruster water jet maintenance manual (TM 55-1905-223-24-6) for additional information about the steering system.

b. General Instructions. Repair at this level consists of replacement of components within steering gear sub-assemblies. Procedures for disassembly, inspection, repair, assembly, and adjustment are detailed in the following paragraphs. See also general instructions in Chapter 3, Section V.

4-8. Repair Hydraulic Cylinder Assembly. (FIGURE 4-1)

This task covers:

a. Disassembly, b. Repair, c. Assembly, d. Adjustment.

INITIAL SETUP

Tools

Tool kit, electrician's, 5180-00-391-1087
Tool kit, general mechanic's, 5180-00-699-5273
Test kit, oil condition, 6630-00-531-1968

Materials/Parts

Wiper, P/N 11-606004
Wiper ring, P/N 620-0021
Preformed packing, P/N 11-106154
Packing assembly, P/N 11-406012
Bushing, P/N 620-0019
Lubrication fitting, P/N 41-200001
Pin, P/N 620-0054
Mounting pad, P/N 620-0243
Tail, P/N 620-0014
Retaining ring, P/N 51-300001
Preformed packing, P/N 11-106117
Wear strip, P/N 10-800007
U-cup, P/N 11-216009
Preformed packing, P/N 11-106224

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraphs in this maintenance manual:
Hydraulic cylinder assembly removed (paragraph 3-9).
Lubrication fitting removed (paragraph 2-13).
Tiller pin and bearing removed (paragraph 3-9).

DISASSEMBLY

a. Stop.

(1) Remove nut (32) and setscrew (33).
(2) Turn threaded stop (4) and wiper (5) counterclockwise off rod (34).

b. Head.

(1) Remove nut (29) and setscrew (30).
(2) Remove machine screw (6) and locking tab (7).
(3) Remove head (31).

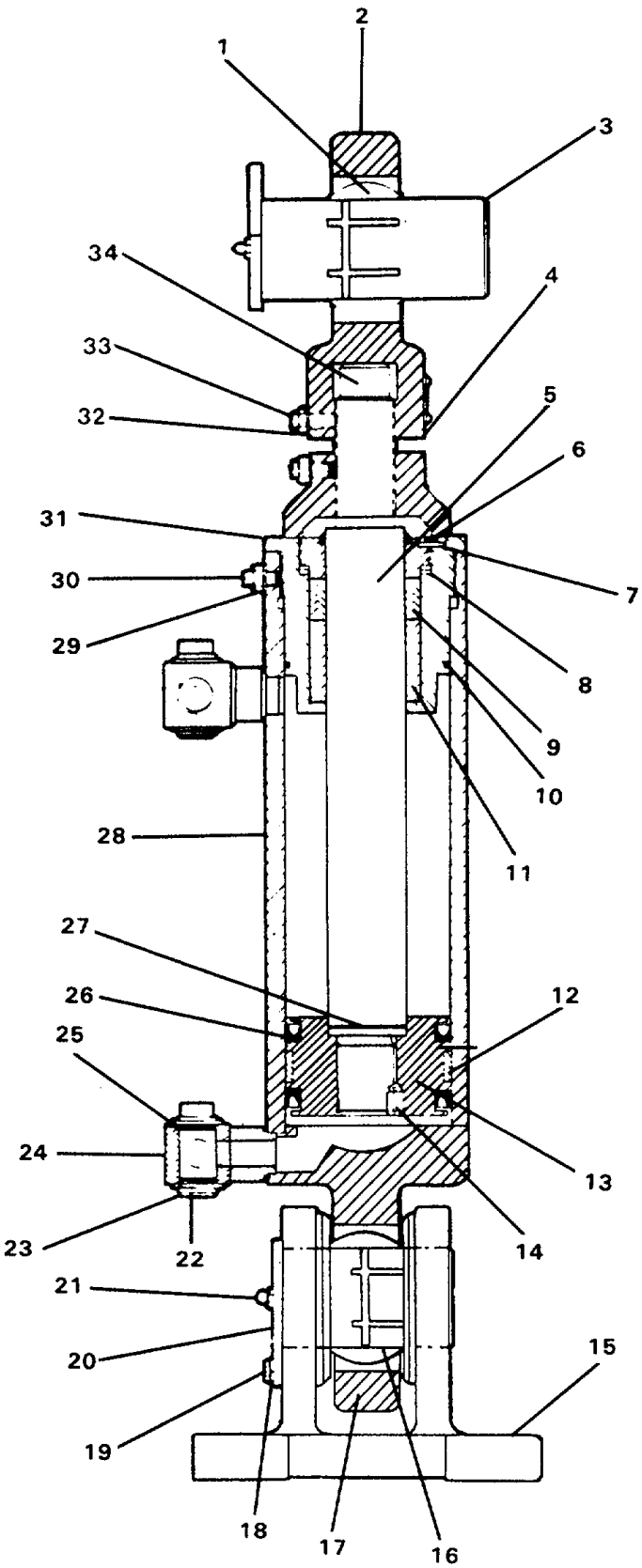


FIGURE 4-1. Hydraulic Cylinder Assembly.

(4) Remove wiper ring (8), preformed packing (9, 10), and bushing (11).

c. Piston Head.

(1) Slide rod (34) out of cylinder barrel (20).
(2) Remove setscrew (14).
(3) Separate piston head (13) from rod.
(4) Remove wear strip (12), U-cups (26), and preformed packing (27).

d. Body.

(1) Remove snap rings (23).
(2) Remove spools (22) and preformed packing (25) from body (24).

e. Tail.

(1) Remove machine screw (19) and lockwasher (18).
(2) Remove pin (16) securing tail (17) to mounting pad (15). Remove tail (17).

REPAIR

Repair consists of replacing: lubrication fittings (21), wiper (5), wiper ring (8), preformed packing (10), packing assembly (9), bushing (11), pin (16), mounting pad (15), tail (17), retaining ring (23), preformed packing (25, 27) wear strip (12), and U-cup (26).

ASSEMBLY

a. Tail.

(1) Position tail (17) over mounting pad (15).
(2) Install pin (16) and secure tail with lockwasher (18) and machine screw (19).

b. Body.

(1) Install preformed packing (25) and spools (22) in body (24).
(2) Install snap rings (23) in body.

c. Piston Head.

(1) Install preformed packing (27), U-cups (26), and wear strip (12).

(2) Install piston head (13) on rod (34).
(3) Install setscrew (14).
(4) Slide rod into cylinder barrel (20).

d. Head.

(1) Install bushing (11), preformed packing (10, 9), and wiper ring (8).
(2) Install head (31).
(3) Install locking tab (7) and secure with machine screw (6).
(4) Install setscrew (30) and secure with nut (33).

e. Stop.

(1) Turn threaded stop (4) and wiper (5) clockwise on rod (34).
(2) Install nut (32) and secure with setscrew (33).

f. Install equipment.

(1) Install lubrication fitting (paragraph 2-13).
(2) Install bearing and tiller pin (paragraph 3-9).
(3) Install cylinder assembly (paragraph 3-9).

ADJUSTMENT

a. Cylinder Stop Adjustment.

(1) Loosen setscrew (33) and position threaded stop (4), at extreme top of cylinder rod.
(2) Manually move steering gear to a hard-over position.
(3) Adjust threaded stop until it contacts the front face of cylinder. Tighten setscrew.
(4) Manually move steering gear to the opposite hard-over position.

b. Operate and Test.

(1) Restore power to pumpset.
(2) Check for leaks.
(3) Return pumpset to normal operation (TM 55-1905-223-10).
(4) Remove "Out of Service - Do Not Operate" tag from circuit breaker.

4-9. Replace/Repair Jockey Bar Assembly. (FIGURE 4-2)

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Equipment Condition

Equipment shut down and tagged
"Out of Service - Do Not Operate."
See TM 55-1905-223-10.

Materials/Parts

Jockey bar assembly, P/N 8562035-3

REMOVAL

WARNING
Support jockey bar before removal. The bar is very heavy and could cause injury.

a. Remove machine bolts (3), lockwashers (4), and pin stop plate (5) from tiller arm (1).
b. Remove jockey bar round pin (6), and remove jockey bar assembly (2) from tiller arm assembly. Remove sleeve bushing (7).
c. Repeat steps a. and b. for the other side of the rudder assembly.

REPAIR

Repair at this level is by replacement of the jockey bar assembly (2).

REPLACEMENT

WARNING
Support jockey bar before removal. The bar is very heavy and could cause injury.

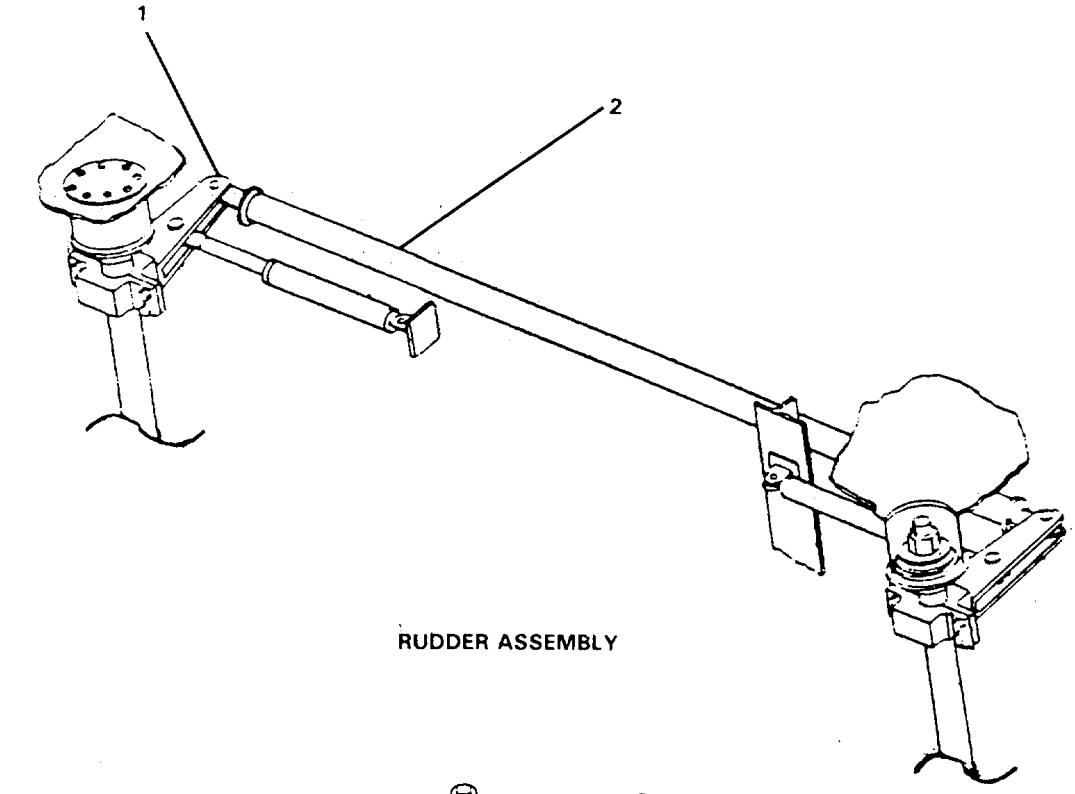
a. Install sleeve bushing (7) in jockey bar assembly (2).

b. Position jockey bar assembly in tiller arm assembly (1) and secure with jockey bar round pin (6).

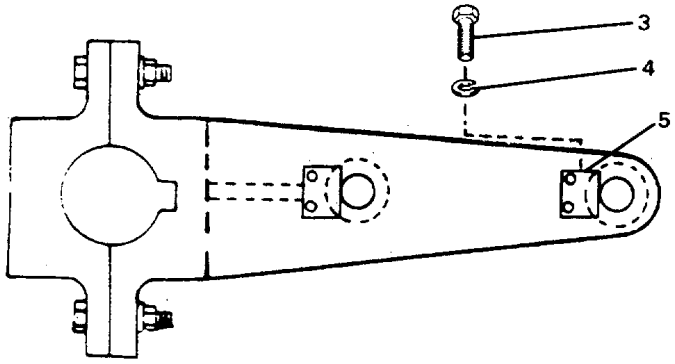
c. Position pin stop plate (5) over mounting bolt holes. Secure to tiller arm assembly with lockwashers (4) and machine bolts (3).

d. Restore power to pumpset and return to normal operation (TM 55-1905-223-10).

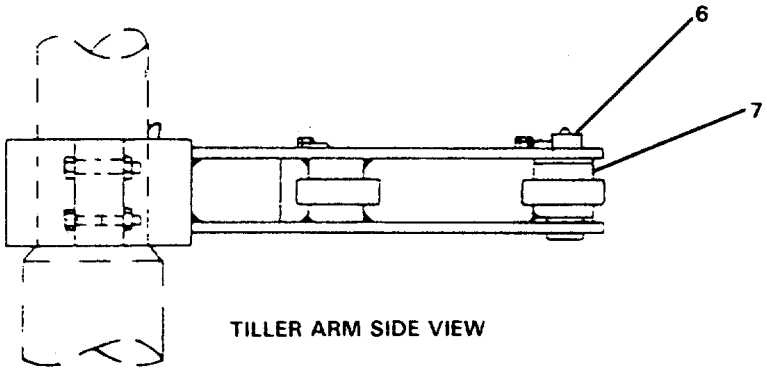
e. Remove to "Out of Service Do Not Operate" tag from circuit breaker.



RUDDER ASSEMBLY



TILLER ARM TOP VIEW



TILLER ARM SIDE VIEW

FIGURE 4-2. Jockey Bar Assembly.

4-10. Replace/Repair Tiller Arm Assembly. (FIGURE 4-3)

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's,
5180-00-699-5273

Materials/Parts

Tiller arm assembly
P/N 8562035-7

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraphs in this maintenance manual:
Followup unit removed, paragraph 2-11.
Hydraulic cylinder assembly removed, paragraph 3-9.
Jockey bar assembly removed, paragraph 4-9.

REMOVAL

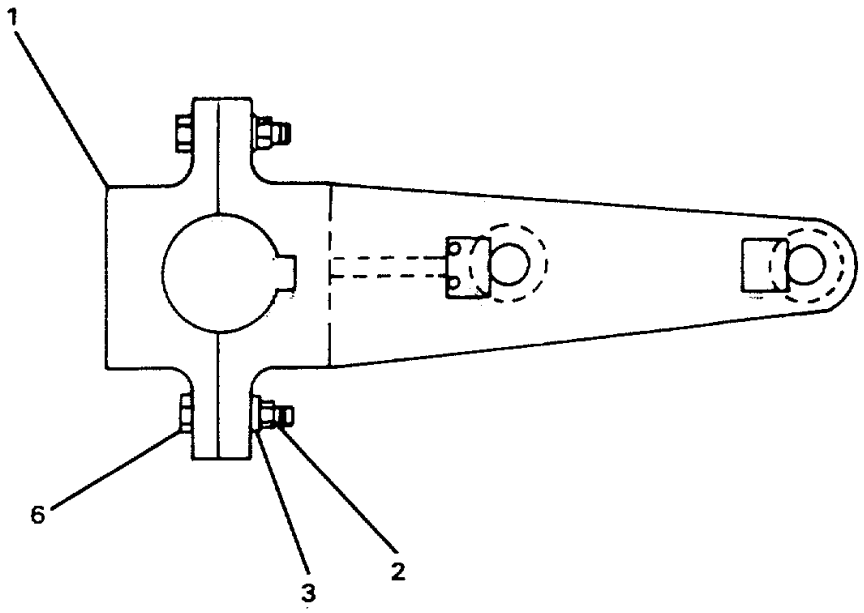
a. Remove two hexagon nuts (2), two lockwashers (3), and two machine bolts (6). Remove tiller arm (1) from rudder stock (5).
b. Remove woodruff key (4) and keep it for assembly.
c. Repeat steps a. and b. for the other tiller arm assembly.

REPAIR

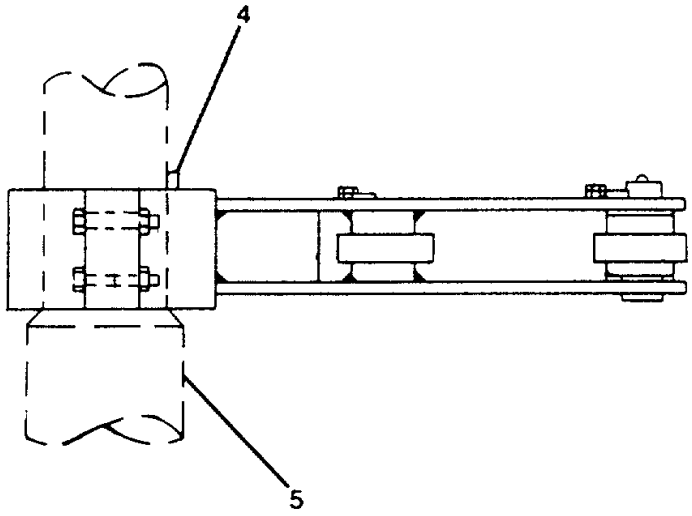
Repair at this level is by replacement of the tiller arm assembly (1).

REPLACEMENT

a. Insert woodruff key (4) in slot on rudder stock (5).
b. Position tiller arm (1) on rudder stock and secure tiller arm with machine bolts (6), lockwashers (3), and hexagon nuts (2).
c. Repeat steps a. and b. for the other tiller arm assembly.
d. Lubricate tiller arm assembly (LO 55-1905-223-12).
e. Restore power to pumpset.
f. Return equipment to service. Refer to TM 55-1905-223-10.
g. Remove "Out of Service - Do Not Operate" tag from circuit breaker.



TOP VIEW



SIDE VIEW

FIGURE 4-3. Tiller Arm Assembly.

4-11. Replace/Repair Rudder Assembly. (FIGURE 4-4)

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5723

Materials/Parts

Rudder P/N 77408 8562019-EL 198

Equipment Condition

Equipment shut down and tagged "Out of Service - Do Not Operate."

Function to be performed in drydock facilities.

REMOVAL

a. Rudder (Port).

NOTE
Support weight of rudder assembly.

(1) Remove tiller arm assembly (paragraph 4-9).

(2) Remove machine bolts (18), shoe plate (19), lower spacer bearing (20), shoe bushing (21), upper spacer bearing (22), and pintle (23) from rudder lower unit.

(3) Remove nut (4), thrust bearing (5), carrier bearing (6), carrier bearing (7), upper bearing (8), and upper bearing housing (10) from rudder stock (3).

(4) Remove continuous thread studs (9), gland packing (14), preformed packing (12), ring packing (13), rudder trunk (15), lower bearing (16), and bearing retainer (17) from rudder stock (3).

(5) Lower rudder assembly and remove to a clear area.

(6) Remove nuts and bolts (2) from rudder (1) and remove rudder stock (3).

b. Rudder (Starboard). Repeat steps a(l) through a(6) above.

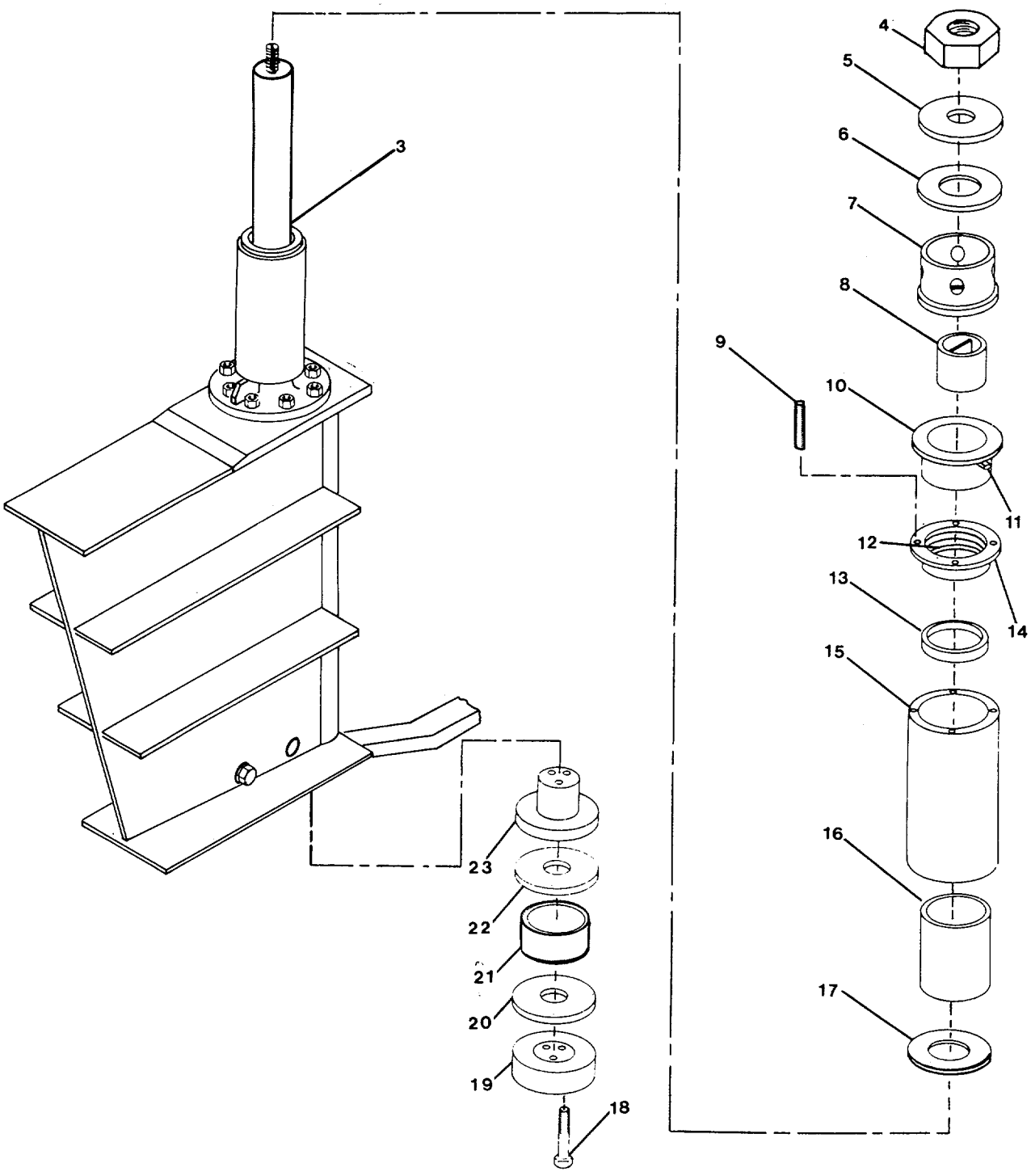


FIGURE 4-4. Rudder Assembly.

REPAIR

Repair or replacement of rudder assembly is performed in drydock facilities.

REPLACEMENT

a. Rudder (Port).

(1) Secure rudder stock (3) to rudder (1) with nuts and bolts (2).

(2) Raise rudder into position for installation.

(3) Install bearing retainer (17), lower bearing (16), rudder trunk (15), ring packing (13), preformed packing (12) and gland packing (14), and continuous thread studs (9) on rudder stock (3).

(4) Install upper bearing (8), upper bearing housing (10), carrier bearing (7), carrier bearing (6), thrust bearing (5), and nut (4) on rudder stock (3).

(5) Install pintle (23), upper spacer bearing (22), shoe bushing (21), lower spacer bearing (20), shoe plate (19), and machine bolts (18) on rudder lower unit.

(6) Replace tiller arm assembly (paragraph 4-9).

(7) Lubricate rudder assembly at lube fitting (11) (LO 55-1905-223-12).

b. Rudder (Starboard). Repeat steps a(1) through a(7) above.

c. Operate and Test.

(1) Restore power to pumpset.

(2) Return equipment to service.

(3) Remove "Out of Service - Do Not Operate" tag from circuit breaker.

4-12. Repair Helm Pump. (FIGURE 4-5)

This task covers:
a. Disassembly, b. Repair, c. Assembly.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Inner race bearing, P/N 21-200009
Bearing, P/N 21-200010
Annular ball bearing, P/N 21-100016 (2 each)
Piston, P/N 320-0078
Helical compression spring, P/N 31-100055
Piston insert, P/N 92-991005
Rotor, P/N 320-0080
Woodruff key, P/N 51-102010
Sleeve, P/N 320-0082
Lockvalve, P/N 400-0164
Preformed packing, P/N 11-106133
Ball bearing, P/N 21-300002
Preformed packing, P/N 11-106006
Preformed packing, P/N 11-106016

Equipment Condition

TM 55-1905-223-10, Equipment shut down, tagged "Out of Service."
Refer to the following paragraph in this maintenance manual:
Helm pump removed, gasket (1) and seal (28) removed (paragraph 2-14).

DISASSEMBLY

a. Hand Wheel.

(1) Remove machine bolt (25) and slide hand wheel (not shown) off straight shaft (27).
(2) Remove machine key (26) from slot in shaft. Keep the key for assembly.

b. Front Plate.

(1) Remove hexagon nuts (22) and capscrews (23).
(2) Separate front plate (31) from roll pins (2) and pump housing (3).
(3) Remove bearing (30), inner race bearing (29), and flat washer (24) from front plate.

c. Rotor.

(1) Slide bearing cage (21) and bearing plate (20) off straight shaft (27). Remove annular ball bearing (10) from straight shaft.

(2) Slide rotor (7) off woodruff key (8) and shaft.

(a) Slide piston (4), helical compression spring (5) and piston insert (6) out of rotor.
(b) Repeat step for other pistons.

d. Straight Shaft.

(1) Remove straight shaft (27) from pump housing (3).

(2) Remove woodruff key (8) and sleeve (9) from shaft.

(3) Remove annular ball bearing (10) from pump housing.

e. Lockvalve.

(1) Remove capscrews (14).

(2) Separate lockvalve (15) from locating pin (18) and pump housing (3).

(a) Remove pintle (17), preformed packing (19), and ball bearings (16) from lockvalve.
(b) Remove wires (12) and preformed packing (11, 13) from lockvalve.

REPAIR

Consists of replacement of: inner race bearing (29), bearing (30), annular ball bearing (10), piston (4), helical compression spring (5), piston insert (6), rotor (7), woodruff key (8), sleeve (9), lockvalve (15), preformed packing (19), ball bearing (16), and preformed packing (11, 13).

ASSEMBLY

a. Lockvalve.

(1) Install preformed packing (11, 13) and wires (12) on lockvalve.

(2) Install ball bearings (16), preformed packing (19), and pintle (17) on lockvalve.

(a) Install lockvalve on pump housing (3). Ensure proper alignment with locating pin (18).
(b) Secure lockvalve (15) to pump housing with capscrews (14).

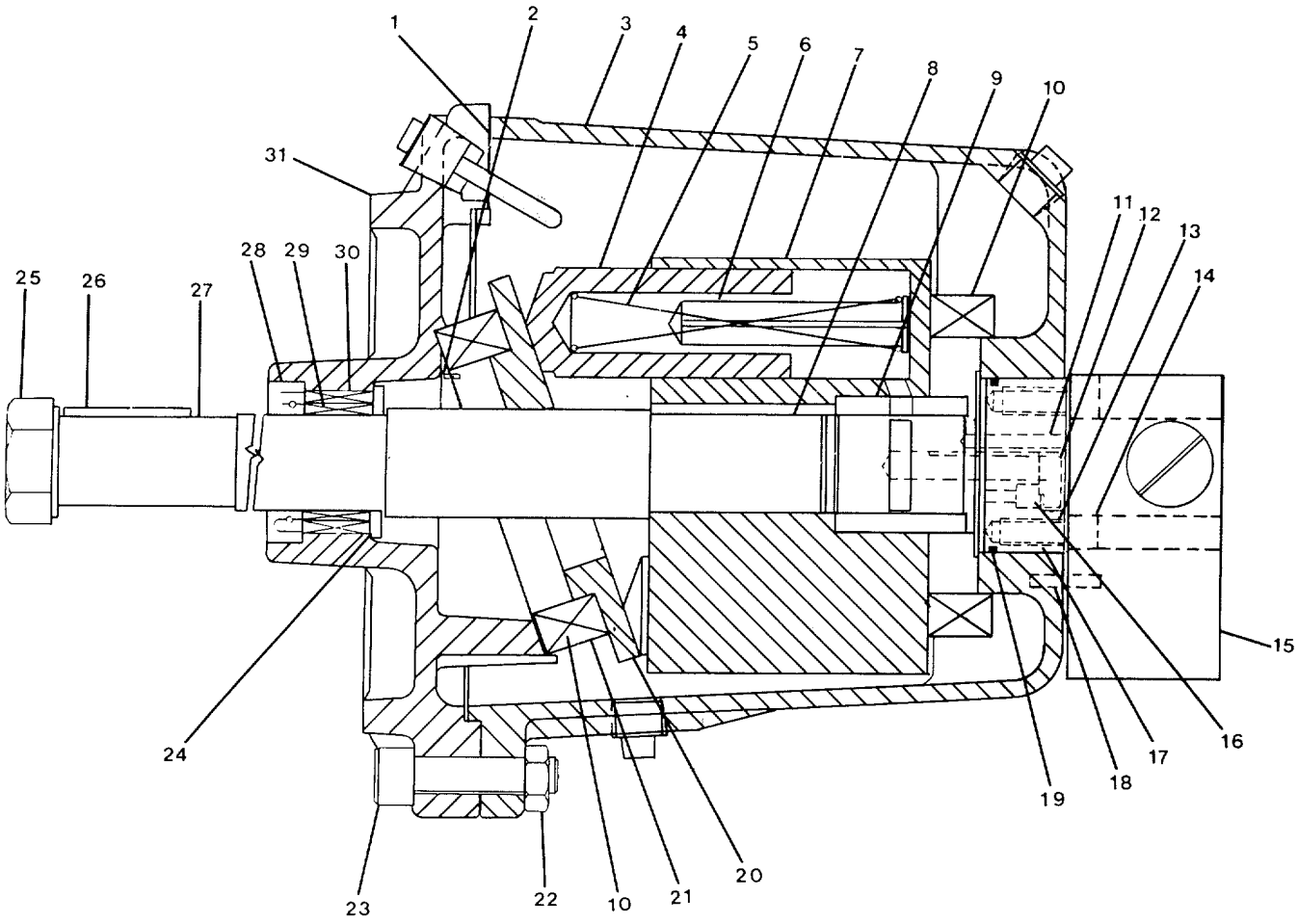


FIGURE 4-5. Helm Pump.

b. Straight Shaft.

(1) Install annular ball bearing (10) in pump housing (3).

(2) Install sleeve (9) and woodruff key (8) on shaft.

(3) Slide straight shaft and sleeve into annular ball bearing (10). Ensure proper alignment with ball bearings (16) and wires (12), part of lockvalve.

c. Rotor.

(1) Install piston insert (6), helical compression spring (5), and piston (4) into rotor (7).

(2) Repeat step for remaining pistons.

(a) Install rotor (7) on woodruff key (8) and straight shaft (27).

(b) Install annular ball bearing (10), bearing plate (20), and bearing cage (21) on straight shaft.

d. Front Plate.

(1) Install flat washer (24), inner race bearing (29), and bearing (30).

(2) Install front plate on straight shaft and ensure proper alignment with roll pins (2) and mounting screw holes on pump housing.

(3) Secure front plate to pump housing (3) with capscrews (23) and hexagon nuts (22).

e. Hand Wheel.

(1) Install machine key (26) in slot on straight shaft.

(2) Install hand wheel (not shown) on straight shaft (27) and secure with bolt (25).

f. Install helm pump with seal and gasket (paragraph 2-14).

g. Restore power to pumpset.

h. Return equipment to service. Refer to TM 55-1905-223-10.

i. Remove "Out of Service - Do Not Operate" tag from circuit breaker.

4-13. Repair Twin Pumpset Assembly. (FIGURE 4-6)

This task covers:
a. Disassembly, b. Repair, c. Assembly.

INITIAL SETUP

Tools

Tool kit, general mechanic's, 5180-00-699-5273

Materials/Parts

Reservoir, P/N 202-0140

Equipment Condition

TM 55-1905-223-10, Engine shut down, tagged "Out of Service."
Refer to the following paragraphs in this maintenance manual:
Hydraulic pump removed, paragraph 2-17.
Electric motor removed, paragraph 2-18.
Uniblock 2A assembly removed, paragraph 2-19.
Inlet filter assembly removed, paragraph 2-21.

DISASSEMBLY

Remove eight hexhead capscrews (2), 16 lockwashers (3), and eight nuts (4).

REPAIR

a. Remove reservoir (1).
b. Install reservoir (1).

ASSEMBLY

a. Install eight nuts (4) and 16 lockwashers (3). Secure with eight hexhead capscrews (2).
b. Install inlet filter assembly, paragraph 2-21.
c. Install uniblock 2A assembly, paragraph 2-19.
d. Install electric motor, paragraph 2-18.
e. Install hydraulic pump, paragraph 2-17.
f. Restore power to pumpset assembly and return to service (TM 55-1905-223-10).
g. Remove "Out of Service - Do Not Operate" tag from circuit breaker.

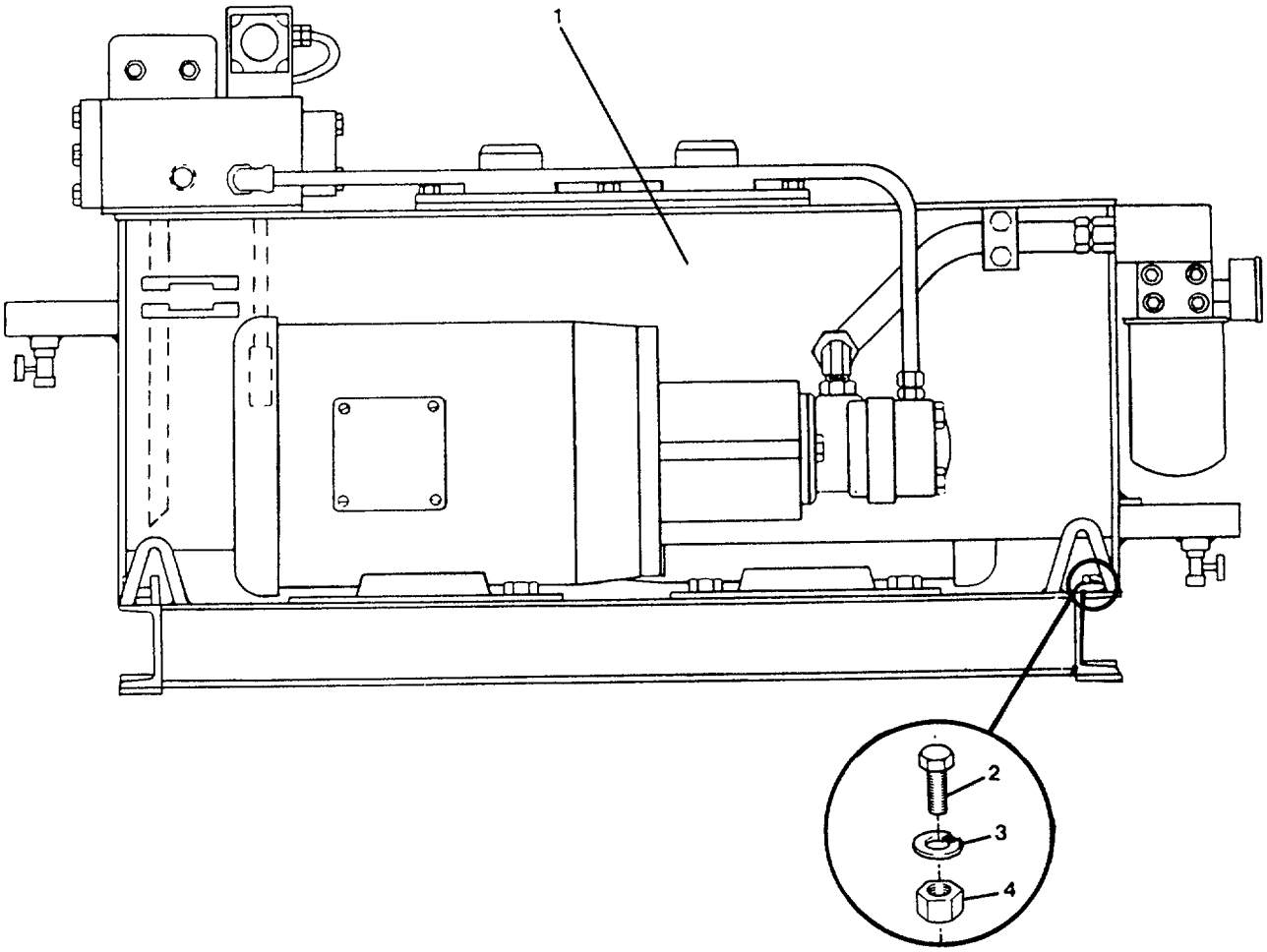


FIGURE 4-6. Twin Pumpset Assembly.

4-14 Repair Feedback Linkage (FIGURE 4-7)

This task covers:
a. Removal, b. Repair, c. Replacement.

INITIAL SETUP

Tools

Tool kit, general mechanic's
5180-00-699-5273

Equipment Condition

Equipment shutdown and tagged "Out of Service - Do Not Operate."
See TM 55-1905-223-10.

Materials/Parts

Brass adapter block, P/N 2825-17301
Brass adapter block, P/N 2825-17303
Bearing - right hand, P/N 2825-00003
Bearing - left hand, P/N 2825-00009
Cotter pin, P/N 2825-00010 (2)

REMOVAL

a. Remove cotter pin (13) that secures the linkage to the tiller arm.
b. Remove cotter pin (6) that secures the linkage to adapter block (5).
c. Lift the brass pipe portion of the linkage off.
d. Remove the two bolts (1) and lockwashers (2) from adapter block (3).
e. Lift the stainless steel red portion of the linkage off the feedback unit.

REPAIR

Repair consists of replacing adapter block (3), adapter block (5), cotter pin (6), bearing right hand (7), bearing left hand (12) and cotter pin (13).

REPLACEMENT

a. Set adapter block (3) with rod (4) and adapter block (5) onto the feedback unit.
b. Secure adapter block (3) with two bolts (1) and lockwashers (2).
c. Set the brass pipe portion of the linkage onto the adapter block (5) and the tiller arm.
d. Secure with cotter pins (6) and (13).

Hulls 2008 and subsequent

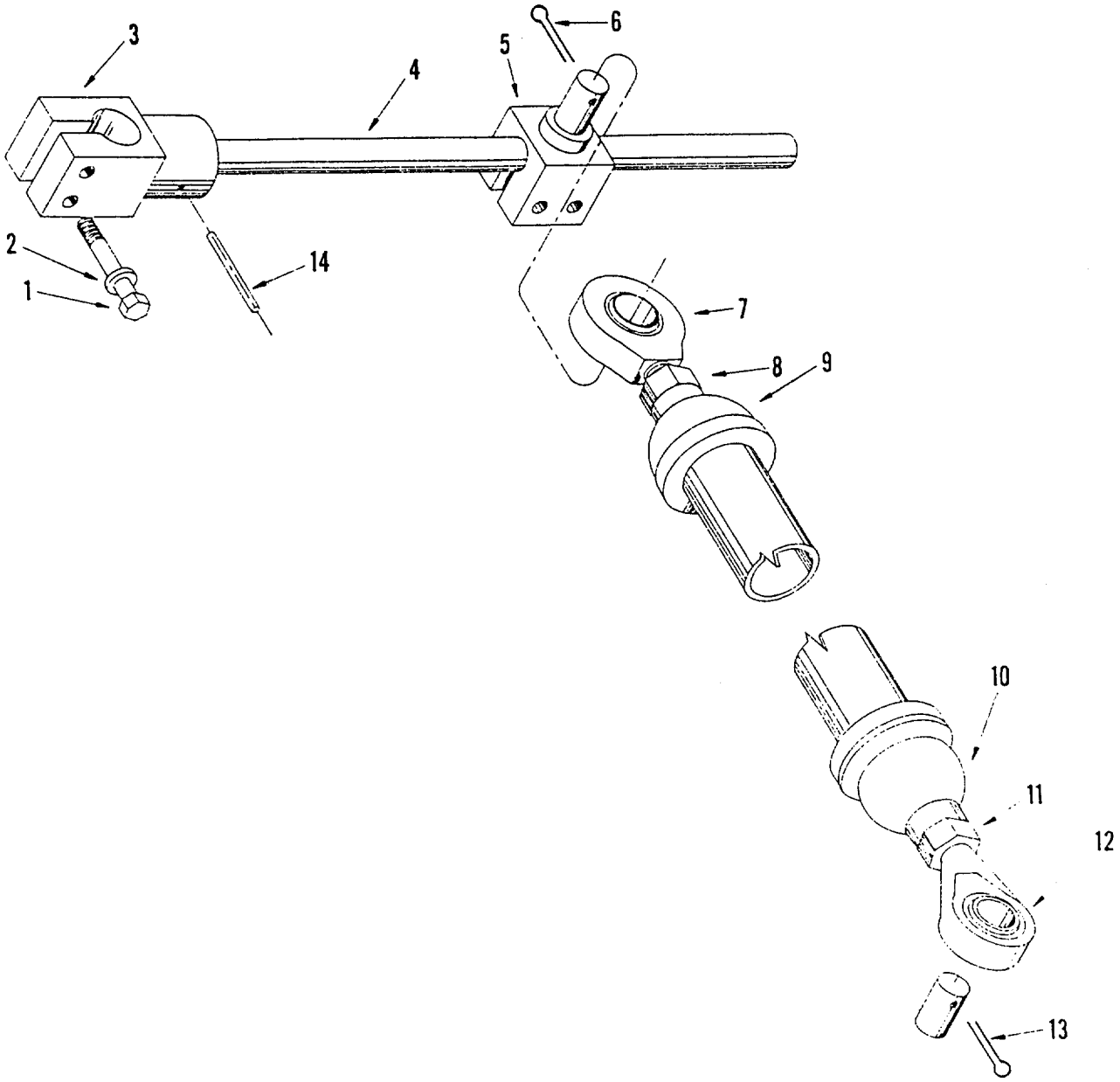


Figure 4-7 Feedback Linkage

Hulls 2008 and subsequent

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

4-15. Administrative Storage. See paragraph 2-27.

Hulls 2008 and subsequent

APPENDIX A

REFERENCES

A-1. Scope. This paragraph lists the manuals, bulletins, specifications, and miscellaneous publications referenced in this manual or required for maintenance activities.

A-2. Field Manuals.

FM 21-11	First Aid For Soldiers
FM 31-70	Basic Cold Weather Manual
FM 55-501	Marine Crewman's Handbook

A-3. Technical Manuals.

TM 43-0139	Painting Instructions for Field Use
TM 43-0144	Painting of Vessels
TM 55-1905-223-10	Operator's Manual for Landing Craft, Utility (LCU)
TM 55-1905-223-24-18	LCU 2000 Class Basic Craft Maintenance Manual
TM 55-1905-223-24P	Repair Parts and Special Tools List for the LCU 2000 Class Watercraft
TM 750-244-3	Destruction of Army Materiel to Prevent Enemy Use

A-4. Technical Bulletins.

TB 55-1900-207-24	Treatment of Cooling Water in Marine Diesel Engines
TB 740-97-4	Preservation of Vessels for Storage

A-5. Military Specifications.

MIL-C-16173C	Rust Preventive, Type P-1
MIL-L-644	Preservative Oil, Type P-9
MIL-L-21260	Preservative Oil, Type P-10

A-6. Miscellaneous Publications.

DA Pam 738-750	The Army Maintenance Management System
LO 55-1905-223-12	Lubrication Order for the LCU 2000 Class Watercraft
*AMC-R 750-11	Use of Lubricants, Fluids, and Associated Products

A-7. Forms.

DA Form 2028 and 2028-2	Recommended Changes to Publications and Blank Forms
DA Form 2404	Equipment Maintenance and Inspection Worksheet
DA Form 2408-16	Logsheet
DA Form 2410	Logsheet
SF Form 368	Quality Deficiency Report.

*Supersedes Darcom-R 750-11

Appendix B. MAINTENANCE ALLOCATION CHART (MAC)

Section I. INTRODUCTION

B-1 THE ARMY MAINTENANCE SYSTEM MAC.

a This introduction (Section I) provides a general explanation of all maintenance and repair functions authorized at various maintenance levels under the standard Army Maintenance System concept.

b The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels, which are shown in the MAC in column (4) as:

Unit - includes two subcolumns: C (operator/crew) and O (unit) maintenance.
Direct Support - includes an F subcolumn.
General Support - includes an H subcolumn.
Depot - includes a D subcolumn.

c Section III lists the tools and test equipment (both special tools and common tools sets) required for each maintenance function as referenced from Section II.

d Section IV contains supplemental instructions and explanatory notes for a particular maintenance function as referenced from Section II.

B-2 MAINTENANCE FUNCTIONS. Maintenance functions will be limited to and defined as follows:

a Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (i.e., by sight, sound, or feel).

b Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontamination, when required), to replace filters, to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f 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. Consists of comparisons 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.

g Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h Replace. To remove an unserviceable item and install a serviceable counterpart in its place. Replace is authorized by the MAC and is shown as the 3rd position code of the SMR code.

i Repair. The application of maintenance services[1] including fault location/troubleshootfing[2], removal/installation, and disassembly/assembly[3] procedures, and maintenance actions[4] to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), and item, or system.

j Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul in normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k Rebuild. Consists of those service/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original 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 equipment and components.

B-3 EXPLANATION OF COLUMNS IN THE MAC, SECTION II

a Column 1 - Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly.

b Column 2 - Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c Column 3 - Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2. (For detailed explanation of these functions, see paragraph A-2.)

d Column 4 - Maintenance Category. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function varies at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

C Operator or Crew
O Unit Maintenance
F Direct Support Maintenance (DS)
H General Support Maintenance (GS)
D Depot Maintenance

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[1]Service Inspect, test, service, adjust, align, calibrate, and/or replace.

[2]Fault location/troubleshooting The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).

[3]Disassembly/assembly The step-by-step breakdown (taking apart) of a spare/functional group coded item to the level of its least component, that is assigned an SMR code for the level of maintenance under consideration (i.e., identification as maintenance significant).

[4]Actions Welding, grinding, riveting, straightening, facing, machining, and/or resurfacing.

e Column 5 - Tools and Equipment. Column 5 specifies, by number code, those common tool sets (not individual tools); special tools; Test, Measurement, and Diagnostic Equipment (TMDE); and support equipment required to perform the designated function, which shall be keyed to the tools listed in Section III.

f Column 6 - Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

B-4 EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a Column 1 - Reference Code. The tool and test equipment reference code correlates with a number code used in the MAC, Section II, Column 5.

b Column 2 - Maintenance Category. The lowest category 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 Stock Number. The National stock number (NSN) of the tool or test equipment.

e Column 5 - Tool Number. The manufacturer's part number.

B-5 EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

a Column 1 - Reference Code. The letter code recorded in Column 6, Section II.

b Column 2 - Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II. MAINTENANCE ALLOCATION CHART FOR STEERING GEAR

(1) Group Number	(2) Component/ Assembly	(3) Maint. Function	(4) MAINTENANCE LEVEL Unit C	Unit O	Direct Support F	General Support H	Depot D	(5) Tools and Equipment	(6) Remarks
09	STEERING GEAR SYSTEM	INSPECT	2.5						A
		TEST	1.5						B
		SERVICE	2.5					1	D
		REPLACE				7.0		1,3	
		REPAIR	2.5	2.5	8.5	16.0		1,2, 3	H, I, J
		OVERHAUL					*		L
0901	FOLLOW UP UNIT	REPLACE		1.0				1,3	
		REPAIR			2.0			1,3	
0902	HYDRAULIC CYLINDER ASSEMBLY	INSPECT	0.5						A
		SERVICE	0.5					1	D
		REPLACE			2.0			1	
		REPAIR		0.2	1.0	5.0		1,2, 3	
0903	JOCKEY BAR	REPLACE ASSEMBLY				2.0		1	F
		REPAIR				2.5		1	
0904	TILLER ARM ASSEMBLY	INSPECT	0.5						A
		SERVICE	0.5					1	D
		REPLACE				2.0		1	
		REPAIR		0.5		2.5		1	C
0905	RUDDER ASSEMBLY	REPLACE				3.0		1	E
		REPAIR				3.5		1	
0906	PUMP, HELM	SERVICE	0.5					1	D
		REPLACE	1.0					1	
		REPAIR		1.0		2.5		1	
0907	TANK, HEADER	REPLACE		2.0				1	
		REPAIR		2.5				1	
0908	TWIN PUMPSET ASSEMBLY	INSPECT	1.0						A, B
		SERVICE	1.0					1	D
		REPLACE				4.5		1,3	
		REPAIR	2.5	1.5	5.0	8.0		1,3	C, F

Section II. MAINTENANCE ALLOCATION CHART FOR STEERING GEAR (Cont.)

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			Unit		Direct Support	General Support	Depot		
Group Number	Component/ Assembly	Maint. Function	C	O	F	H	D	Tools and Equipment	Remarks
090801	MOTOR, ELECTRIC	REPLACE	1.0					1,3	G
090802	PUMP, HYDRAULIC	INSPECT	0.5						
		SERVICE	0.5					1	
		REPLACE	1.0					1	
		REPAIR			1.5			1	
090803	UNIBLOCK 2A ASSEMBLY SOLENOID	INSPECT	0.5						
		SERVICE	0.5					1	
		REPLACE	2.0					1	
		REPAIR	1.5	1.0	2.0			1	C, F
09080301	COIL ASSEMBLY	REPLACE	1.0					1,3	K
090804	INLET FILTER ASSEMBLY	REPLACE	0.5					1	
		REPAIR		1.0				1	
0909	VALVE, RELIEF BYPASS/ SHUT-OFF	INSPECT	0.5						
		REPLACE			1.0			1	
		REPAIR			1.5			1	
090901	VALVE, RELIEF, SAFETY	REPLACE			0.5			1	

Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS FOR STEERING GEAR

(1) Tool or Test Equipment Ref Code	(2) Maintenance Category	(3) Nomenclature	(4) National/NATO Stock Number	(5) Tool Number
1	C, O, F, H	Tool Kit, General Mechanics	5180-00-699-5273	(50980) SC-5180-90-CL-N05
2	H	Tool Kit, Oil Condition	6630-00-531-1968	
3	O, H	Tool Kit, Electricians	5180-00-391-1087	(80064) 9000S6202-73125ALT2

Section IV. REMARKS FOR STEERING GEAR

Reference Code	Remarks
A	VISUALLY INSPECT FOR OBVIOUS DEFECTS SUCH AS LOOSE / DAMAGED COMPONENTS AND FLUID LEAKS.
B	OPERATIONAL TEST - OBSERVE FLUID SITE GAGE LEVEL, OIL FILTER CONDITION AND HYDRAULIC PRESSURE.
C	ALL WELD REPAIR WILL BE DONE AT GS LEVEL.
D	LUBRICATE OR ADD OIL.
E	FUNCTION TO BE PERFORMED IN DRYDOCK FACILITIES.
F	USE APPROPRIATE TOOLS AND TECHNICAL DATA AT DEPOT OR CONTRACTED REPAIR ACTIVITY TO EFFECT OVERHAUL.
G	CHECK BEARING TEMPERATURE WITH THERMOMETER AND NOT BY HAND. IF BEARINGS ARE RUNNING HOT (OVER 180 DEG.), THE CONDITION MAY BE THE RESULT OF TOO MUCH LUBRICANT. IF CHANGING LUBRICANT DOES NOT CORRECT CONDITION, REPLACE MOTOR.
H	NOT REPLACED AS A UNIT. REPLACEMENT IS BY INDIVIDUAL COMPONENTS
I	LIMITED REPAIR AT DS / GS LEVEL. WHEN REPAIR I IN-DEPTH REPAIR IS REQUIRED, REFER TO THE NATIONAL MAINTENANCE POINT (NMP) FOR INSTRUCTIONS / APPROVAL.
J	COMPLETE REPAIR / IN-DEPTH REPAIR TO BE PERFORMED BY THE MANUFACTURER.
K	REPAIR OF THIS ITEM IS BY REPLACEMENT.
L	DEPOT LEVEL REPAIR / MAINTENANCE WILL BE PERFORMED ON A CASE BY CASE BASIS SUBJECT TO APPROVAL AND FUNDING BY THE NATIONAL MAINTENANCE POINT (NMP).

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR
STEERING GEAR

(1) Tool or Test Equipment Ref Code	(2) Maintenance Category	(3) Nomenclature	(4) National/NATO Stock Number	(5) Tool Number
1	C,O,F,H	Tool kit, general mechanics	5180-00-699-5273	(50980) SC-5180-90 -CL-N05
2	H	Tool kit, oil condition	6630-00-531-1968	
3	O,H	Tool kit, electricians	5180-00-391-1087	

SECTION IV REMARKS
STEERING GEAR

Reference Code	Remarks
A	VISUALLY INSPECT FOR OBVIOUS DEFECTS SUCH AS LOOSE/DAMAGED COMPONENTS AND FLUID LEAKS.
B	OPERATIONAL TEST-OBSERVE FLUID SITE GAGE LEVEL, OIL FILTER CONDITION AND HYDRAULIC PRESSURE.
C	ALL WELD REPAIR WILL BE DONE AT H LEVEL.
D	LUBRICATE OR ADD OIL.
E	FUNCTION TO BE PERFORMED IN DRYDOCK FACILITIES.
F	USE APPROPRIATE TOOLS AND TECHNICAL DATA AT DEPOT OR CONTRACTED REPAIR ACTIVITY TO EFFECT OVERHAUL.
G	CHECK BEARING TEMPERATURE WITH THERMOMETER AND NOT BY HAND. IF BEARINGS ARE RUNNING HOT (OVER 180 DEG), THE CONDITION MAY BE THE RESULT OF TOO MUCH LUBRICANT. IF CHANGING LUBRICANT DOES NOT CORRECT CONDITION, REPLACE MOTOR.
H	NOT REPLACED AS A UNIT. REPLACEMENT IS BY INDIVIDUAL COMPONENTS.
I	LIMITED REPAIR AT DS/GS LEVEL. WHEN REPAIR/IN-DEPTH REPAIR IS REQUIRED, REFER TO THE NICP FOR INSTRUCTIONS/APPROVAL.
J	COMPLETE REPAIR/IN-DEPTH REPAIR TO BE PERFORMED BY THE MANUFACTURER.
K	REPAIR OF THIS ITEM IS BY REPLACEMENT.

APPENDIX C

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

SECTION I. INTRODUCTION

C-1. Scope. This appendix lists expendable supplies and materials needed to operate and maintain the LCU 2000 Class Watercraft. These items are authorized by CTA 50-970, Expendable/Durable Items (except Medical, Class V, Repair Parts and Heraldic Items), or CTA 8-100, Army Medical Department Expendable Items.

C-2. Explanation of Columns.

a. Column (1) Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (for example, "Use cleaning compound, Item 5, App. C").

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

As applicable:

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

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

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

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

SECTION II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	F	6850-00-292-9700	Acid, Muriatic	
2	F	6810-00-132-4020	Acid, Oxalic	BT
3	O	7510-00-282-6924	Chalk, Marking	AT
4	F	6810-00-227-0407	Pyridene	
5	O	7920-00-044-9281	Cloth, Lint-free	BX
6	H	5350-00-193-1348	Compound, Lapping	LB
7	O	2835-01-170-9896	Tape, Teflon	RO
8	O	8030-00-223-3193	Cosmoline 11-2, MIL-C-16173, Grade 2	GL
9	H	6685-00-938-0435	Crayon, Heat Determining	
10	O	5350-00-221-0872	Crocus Cloth, Fine	PG
11	O	9150-00-111-0209	Gulf No-Rust Engine Oil, MIL-L-21260, Grade 3	CN
12	O	8030-00-680-0889	Loctite (or equivalent)	BT
13	O	6640-00-315-3022	Teflon Sealant	TU
14	O	9150-00-985-7237	Lubricant, Vegetable Oil Type	CN
15	O	· 050-00-961-7663	Lubriplate (or equivalent)	
16	F	7510-00-223-6708	Metal Marker, Liquid	EA
17	F	8010-00-441-3931	Mineral Spirits	
18	O	9150-00-240-2251	Oil, Light Machine	CN
19	H	5350-00-161-9715	Paper, Abrasive, Aluminum Oxide (240 grit)	PG
20	H	8010-00-652-3626	Paste, Prussian Blue	
21	F	8030-00-999-6313	Sealant, Cup Plug	LB
22	O	9150-00-180-6382	Grease	CN

SECTION II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
23	F	6810-00-233-1715	Solution, Cleaning, 5% Sodium Carbonate	
24	O	6850-00-110-4498	Solvent, Cleaning (PD 680 - Dry Cleaning Solvent)	CN
25	H	7920-00-965-1709	Towels, Paper, Lint-Free	BX
26	O	5350-00-264-3485	Paper, Abrasive Closed Coat, Class 2 (Ex. Fine)	PG
27	O	7920-00-205-2401	Brush, Nylon	EA
28	O	8020-00-244-0153	Paint, Touchup	EA
29	O	7240-00-160-4550	Pail, Utility	EA

APPENDIX D

GENERAL BOLT TORQUE DATA (unless specified otherwise)

Metric (Class 8.8)

SIZE	PITCH	TORQUE * (N•m)
M4	0.7	13.56
M5	0.8	14.91
M6	1.0	27.12
M8	1.0	31.18
M8	1.25	47.46
M10	1.25	52.24
M10	1.5	74.58
M12	1.25	81.36
M12	1.5	122.04
M12	1.75	128.82
M14	1.5	155.94
M14	2.0	162.72
M16	1.5	230.52
M16	2.0	257.64
M18	1.5	447.48
M18	2.5	474.6
M20	1.5	678
M20	2.5	718.68
M22	1.5	1017
M22	2.5	1017.24
M24	2.0	1762.8
M24	3.0	1898.4
M27	2.0	3118.8
M27	3.0	3254.4
M30	2.0	4746
M30	3.5	6780

Inch (Grade 5)

SIZE	PITCH	TORQUE (ft-lb)
1/4	20	10
1/4	28	11
5/16	18	20
5/16	24	23
3/8	16	35
3/8	24	40
7/16	14	55
7/16	20	60
1/2	13	90
1/2	20	95
9/16	12	115
9/16	18	120
5/8	11	170
5/8	18	190
3/4	10	330
3/4	16	350
7/8	9	500
7/8	14	530
1	8	750
1	12	790
1-1/4	7	1300
1-1/4	12	1400
1-1/2	6	2300
1-1/2	12	2400
1-3/4	5	3500
2	4.5	5000

* Denotes torque reading in Newton-meters.

NOTE: These figures are bolt torques for the grade or class generally supplied by Wagner and assume parent threaded materials are of sufficient strength and thread engagement, i.e., bolt torque in shallow tapped holes in aluminum would be considerably less.

GLOSSARY

List of Abbreviations

AC	Air Conditioner
Amp	Ampere
AT	Automatic Trip
AUTO	Autopilot
BKR	Breaker
CP1-A	Steering Control Panel
DARBS	Double Acting Relief Bypass and Shutoff
DIST	Distribution
DITA	Direct Injection Turbo Aftercooled
FL	Full Load
ft-lb	Foot-Pound(s)
GPM	Gallons per Minute
Hz	Hertz
in-lb	Inch-Pound(s)
kVA	Kilovolt Ampere
kW	Kilowatt
LCU	Landing Craft, Utility
NFU	Non Followup
N•M	Newton meter
P	Phase
Psi	Pounds Per Square Inch
RPM	Revolutions Per Minute
SP	Shore Power
TX-5	Wheel Controller
Vdc	Volts Direct Current

Glossary

BULKHEAD	Partition dividing the interior of a vessel into various compartments.
PORT	Left side of a vessel looking forward; opening in a ship's side; harbor for embarkation and discharge of cargo.
RUDDER	Flat structure hung vertically on the sternpost, just aft of the screw, and used to steer a vessel by offering resistance to the water when turned to an angle with the centerline.
STARBOARD	Right side of a vessel looking forward.

ALPHABETICAL INDEX

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN, II
Brigadier 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 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 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

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