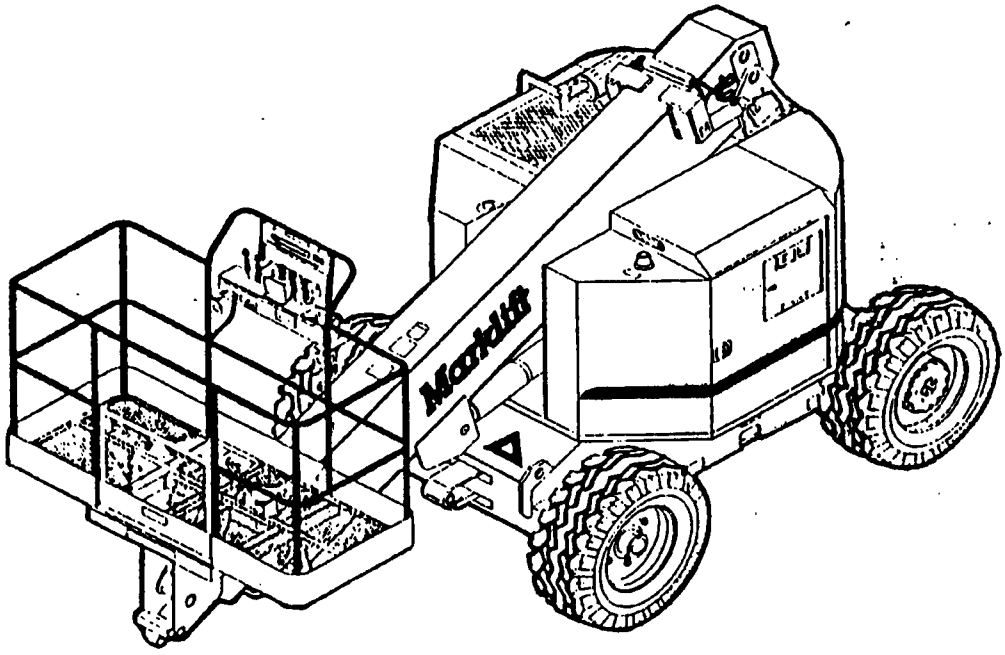
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED BOOM OPERATION MAINTENANCE AND PARTS MANUAL



Model: 60 I

FIRST EDITION: July 1987

Mark Industries

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THIS MARKLIFT SELF PROPELLED INDUSTRIAL BOOM MODEL 60I OPERATION MAINTENANCE AND PARTS MANUAL IS DESIGNED AS

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SERVICE BULLETINS

The purpose of this manual is to provide the customer with operation maintenance and parts information that will enhance the reliable performance of the **MARKLIFT.** Schematic and vendor information is also furnished.

WARNING: IMPROPER USE OF THIS MACHINE WILL RESULT IN SERIOUS INJURY OR DEATH! TO PROTECT YOURSELF AND THE EQUIPMENT, **STUDY THIS MANUAL BEFORE STARTING OPERATIONS.**

The model capacity, pressure settings and serial number can be found on the ID Plate mounted on the rear of the base.

The serial number should be used when ordering parts. This will help our parts department in giving prompt and accurate service.

If additional information or service is needed, we urge the customer to contact his local dealer. If this is not possible, please get in touch with the **MARK INDUSTRIES** Service Department.

All **MARKLIFTS** are tested and operated to assure their proper operating condition before shipment. At this time, all necessary adjustments are made and an overall physical inspection is conducted. After the unit is delivered, some minor adjustments and inspections must be made before putting the unit in service. These functions are outlined in the **INSPECTION AND CHECKOUT INSTRUCTIONS** in the operation section of this manual.

MARKLIFT SELF-PROPELLED BOOM
MODEL 60I

DESCRIPTION	ENGLISH	METRIC
HEIGHT	60 ft.	18.2 m
WORKING (MAXIMUM)	66 ft.	20.1 m
PLATFORM (MAXIMUM)	60 ft.	18.2 m
LOWERED (MAXIMUM)	7 ft. 3 in.	2.2 m
WIDTH (MAXIMUM)	5 ft. 11 in.	1.8 m
LENGTH (MINIMUM)	28 ft. 5 in.	8.6 m
LIFT CAPACITY (UNRESTRICTED)	500 lbs.	226.8 kg.
WHEEL BASE	6 ft.	1.8 m
TURNING RADIUS (INSIDE)	8 ft. 2 in.	2.4 m
TURRET ROTATION	CONTINUOUS	
TURRET TAILSWING	NONE	
FUEL CAPACITY (PROPANE)	1-10 GAL. TANK	37.8 L
ENGINE (LIQUID COOLED NISSAN)	60 H.P.(PROPANE)	
TRAVEL SPEED	0-2.3 MPH	0-3.7 KM.HR.
CONTROLS	4 PROPORTIONAL 2 SOLENOID	
HYDRAULIC OPERATING PRESSURE	2800 PSI	2800 PSI
TIRES (MONOFILLED)	12-16.5 ALL GRIP	
WEIGHT	30,000 lbs.	1360.8 kg.
SHIPPING CUBE	1243.8 CU.FT.	35.2 CU.M
PLATFORM DIMENSIONS	48" X 30" X 41"	1.2 X .7 X 1.0 m

MANUFACTURERS' LIMITED WARRANTY

Mark Industries makes no warranty, express or implied, on any product manufactured or sold by Mark Industries except for the following limited warranty against defects in materials and workmanship on products manufactured by Mark Industries.

Mark Industries warrants the products manufactured by Mark Industries to be free from defects in material and workmanship under normal use and service for a period of six (6) months from the date of shipment. This limited warranty does not extend to any product of another manufacturer or to any part, component, accessory or attachment not manufactured by Mark industries. The warranty, if any, with respect to any product of another manufacturer or to any part, component, accessory or attachment not manufactured by Mark Industries is limited to the warranty, if any extended to mark Industries by the manufacturer of the other product, part, component, accessory or attachment.

This limited warranty does not extend to any product (or any part or parts of any product) which has been subject to improper use or application, misuse, abuse, operation beyond its rated capacity, repair or maintenance except in accordance with the sales and service manuals and special instructions of Mark Industries, or modification without the prior written authorization of mark Industries (whether by the substitution of nonapproved parts or otherwise).

The sole obligation and liability of Mark Industries under this limited warranty (and the exclusive remedy for any purchaser, owner or user of Mark Industries products) is limited to the repair or replacement, at the option of Mark Industries, of any product (or any part or parts of any product) manufactured by Mark Industries which, within six (6) months from the date of shipment, shall have been returned to the mark Industries facility in Carson, California (or any other location within the United States as shall be designated by Mark Industries), at no expense to Mark Industries, and demonstrated to the satisfaction of Mark Industries as being defective in material or workmanship.

To make a claim under this limited warranty, contact Mark Industries or the Mark Industries distributor from whom the product was originally purchased. A statement giving the model and serial number of the allegedly defective product, the date and a descrtiption of the alleged defect, the date of the purchase and proof of the purchase and purchase date must accompany the returned product (or any part or parts of any product). Any product (or any part or parts of any product) determined by Mark Industries to be defective will be repaired or replaced, at the option of Mark Industries, free of charge, f.o.b. Carson, California. No credit will be given for any allegedly defective product (or any part or parts of any product) not returned to Mark Industries.

There are no other warranties, express or implied, in addition to this limited warranty. **This limited warranty is exclusive and in lieu of all other warranties, express or implied (in fact or by operation of law or otherwise), including the implied warranties of merchantability and fitness for a particular purpose.**

Mark Industries shall not be liable for any special, indirect or consequential damages. Further, no representation or warranty made by any person, including any representative of Mark Industries, which is inconsistent or in conflict with, or in addition to the terms of the foregoing limited warranty (or the limitations of the liability of mark Industries as set forth above) shall be binding upon Mark Indkustries unless reduced to writing and approved by an officer of Mark Industries.

Tires, batteries, filter elements and electrical components are specifically excluded from this limited warranty.

Mark Industries
P.O. Box 2255 • Brea, California 92622
(714) 879-MARK • FAX (714) 879-8884

WARRANTY REGISTRATION

PURCHASER

COMPANY NAME

ADDRESS

TELEPHONE NUMBER

DATE SHIPMENT RECEIVED

UNIT WILL BE USED

DATE OF INVOICE

UNIT WILL BE SOLD

DATE UNIT PUT INTO SERVICE

INSPECTION		GEN'L MAINTENANCE		PAINTING/SANDBLAST	
MINING		HEATING/AIR COND.		STEEL FABRICATION	
WELDING		CARPENTRY		RIGGING	
CONSTRUCTION		PLUMBING		ROOFING	
SCAFFOLDING		ELECTRICAL		GLAZING	
MECHANICAL		SPRINKLER		OTHER	

COMMENTS:

INSPECTION COMPLETED BY:

WARRANTY WILL BE VOID UNLESS THIS INSPECTION REPORT IS POSTMARKED TO MARK INDUSTRIES NOT MORE THAN 14 DAYS FROM DATE SHIPMENT RECEIVED.

NEW EQUIPMENT CONDITION REPORT

		YES	NO
1.	PLATFORM CAPACITY DECAL _____ LBS.	☐	☐
2.	ALL WARNING, CAUTION & EMERGENCY DECALS INSTALLED	☐	☐
3.	EMERGENCY DESCENT VALVE FUNCTIONS PROPERLY	☐	☐
4.	OPERATION INSTRUCTIONS PROPERLY INSTALLED	☐	☐
5.	OPERATION & SAFETY HANDBOOK RECEIVED	☐	☐
6.	ELECTRICAL SCHEMATIC RECEIVED	☐	☐
7.	ALL CONTROLS (AERIAL & GROUND) ARE IDENTIFIED AND OPERATE CORRECTLY	☐	☐
8.	STOP SWITCHES OPERATE PROPERLY (AERIAL & GROUND)	☐	☐
9.	PLATFORM GUARD RAILS, SECURE AND UNDAMAGED	☐	☐
10.	PLATFORM ACCESS GATE WORKS PROPERLY	☐	☐
11.	HORN AND BEACON OPERATE PROPERLY (OPTIONAL)	☐	☐
12.	BRAKES ADJUSTED AND OPERATE CORRECTLY	☐	☐
13.	CIRCUIT BREAKERS OPERATE PROPERLY	☐	☐
14.	ENGINE R.P.M. _____	☐	☐
15.	ALL HYDRAULIC CYLINDERS FREE OF LEAKS	☐	☐
16.	ALL HYDRAULIC CYLINDER RODS FREE OF PAINT OR SCRATCHES	☐	☐
17.	HYDRAULIC PUMP FREE OF LEAKS	☐	☐
18.	HYDRAULIC HOSES & FITTINGS TIGHT	☐	☐
19.	HYDRAULIC OIL LEVEL _____	☐	☐
20.	HYDRAULIC TANK & FITTINGS FREE OF LEAKS	☐	☐
21.	DRIVE MOTORS FREE OF LEAKS	☐	☐
22.	TURRET ROTATION GEAR BOX OIL LEVEL _____	☐	☐
23.	TURRET RING GEAR BOLTS TORQUED TO _____ FT. LBS.	☐	☐
24.	WHEEL LUG NUTS TORQUED TO _____ FT. LBS.	☐	☐
25.	BATTERY WATER LEVEL _____	☐	☐
26.	ENGINE COOLANT (RADIATOR) LEVEL _____	☐	☐
27.	COOLANT HOSES & FITTINGS FREE OF LEAKS	☐	☐
28.	ELECTRIC RADIATOR FAN OPERATES PROPERLY	☐	☐
29.	TIRE PRESSURE _____ PSI	☐	☐
30.	SYSTEM PRESSURE _____ PSIG	☐	☐
31.	PILOT PRESSURE _____ PSIG	☐	☐
32.	FUEL TANK & FITTINGS FREE OF LEAKS	☐	☐
33.	MANUAL OVERRIDES OPERATE PROPERLY	☐	☐
34.	MUFFLER TIGHT AND FREE OF LEAKS	☐	☐
35.	ENGINE OIL LEVEL _____	☐	☐
36.	ENGINE OIL FILTER, FREE OF LEAKS	☐	☐
37.	ALL ELECTRICAL CONNECTIONS TIGHT	☐	☐
38.	ENGINE ALTERNATOR FUNCTIONS PROPERLY	☐	☐
39.	VALVE MANIFOLD & FITTINGS, FREE OF LEAKS	☐	☐
40.	DRIVE WHEEL, TORQUE HUB OIL LEVEL _____	☐	☐
41.	RETRACTION CABLE TENSION _____ FT. LBS.	☐	☐
42.	110V GENERATOR OPERATES PROPERLY (OPTIONAL)	☐	☐

MODEL NUMBER_____ SERIAL NUMBER_____

INSPECTOR_____ OPTIONS_____

MARKLIFT SELF-PROPELLED BOOM

OPTION	TITLE
20104	GROUND AND AERIAL 110 VAC 20 AMP RECEPTACLES
	TOWING KIT
20106	CLEARANCE, STOP AND TURNING LIGHTS
20107	ROTATING BEACON
20108	TRAVEL HORN
20097	RAISED PLATFORM ROTATION
	LIFTING LUGS
20113	SPECIAL PAINT
20131	5 FT. PLATFORM
20132	8 FT. PLATFORM
20133	12 FT. PLATFORM
20130	6 FT. PLATFORM
20139	12 V PLATFORM WORK LIGHT
20140	AIR LINE TO PLATFORM (OUTSIDE BOOM)
20141	HYDRAULIC LINE TO PLATFORM
20142	PIPE HANDLING ATTACHMENT
20143	DESCENT HORN
20147	FIBERGLASS BASKET
20164	HEADLIGHTS-TAIL LIGHTS
20165	PLATFORM GROUND SENSOR
20168	PLATFORM HAND GUARDS
20169	AERIAL CONTROL PANEL LIGHTS
	AIR LINE TO PLATFORM (INSIDE BOOM)

MANUFACTURER'S AUTHORIZED LOADING/UNLOADING PROCEDURE FOR ALL **MARKLIFT** SELF PROPELLED BOOMS.

FIGURE 1

Tilt - Type Trucks (Any loading or unloading application other than horizontal)

IMPORTANT: All loading/unloading procedures onto and from TILT-TYPE TRUCKS, MUST NOT BE DRIVEN.

LOADING

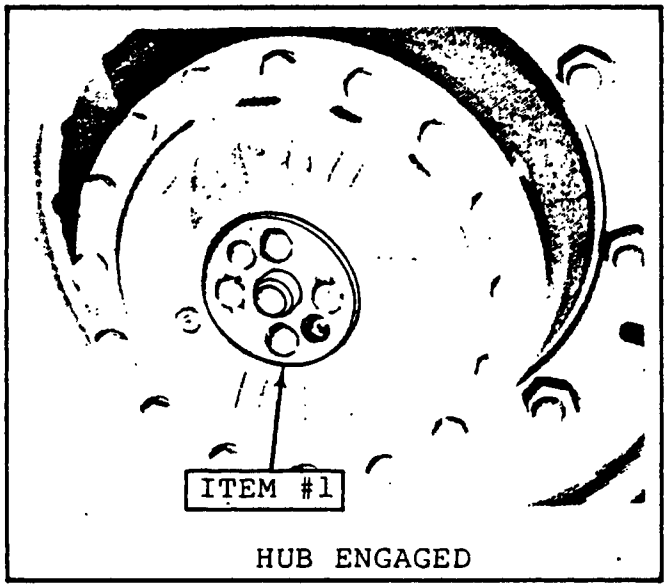
1. The truck must be fitted with adequate winch to handle the weight of equipment you are going to load/unload.

BOOM	GROSS VEHICLE WEIGHT
30I	11,670 Lbs.
40I (3-Section Boom)	17,000 Lbs.
40I (2-Section Boom)	16,700 Lbs.
55I	27,000 Lbs.
60I	30,000 Lbs.

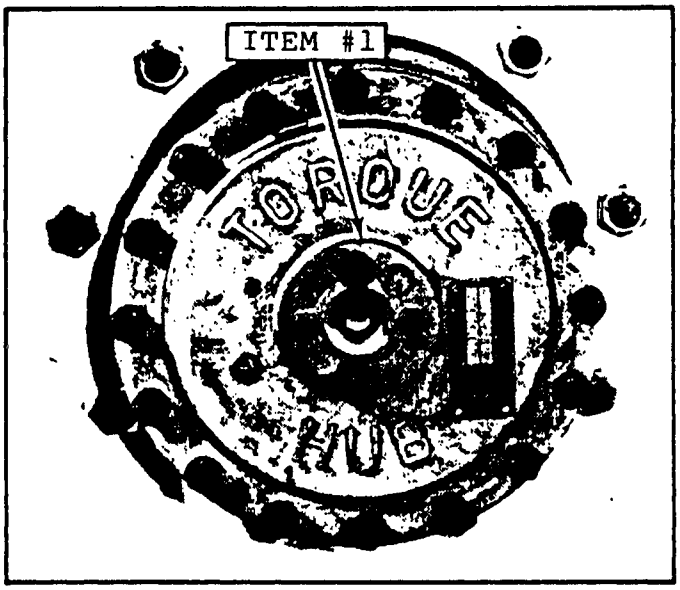
2. Align the boom with the steering wheels away from the trailer and the platform in a horizontal or slightly higher position.

3. Torque hubs must be disengaged for loading/unloading.

   * To disengage the torque hub, reverse the disconnect cap (Item #1). (The knob on the cap disengages the drive hub input shaft.)

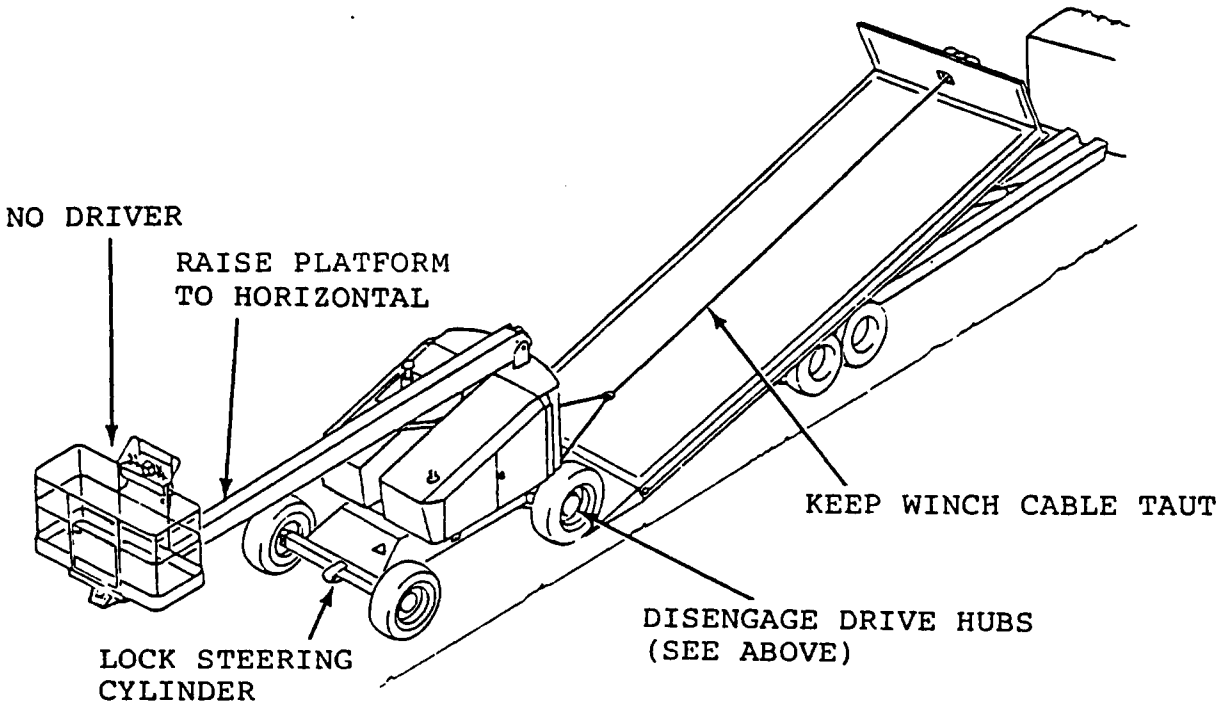


HUB ENGAGED



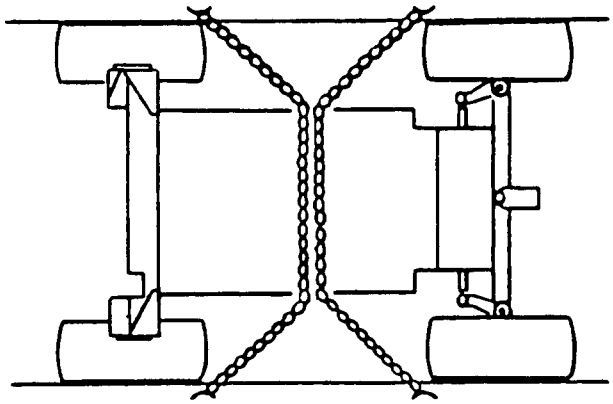
HUB DISENGAGED

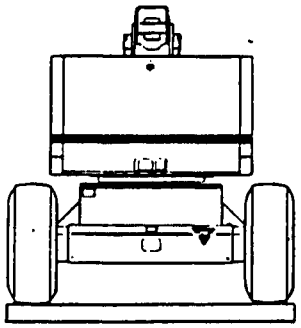
CAUTION: BRAKES ARE ALSO AUTOMATICALLY DISENGAGED AT THIS TIME.

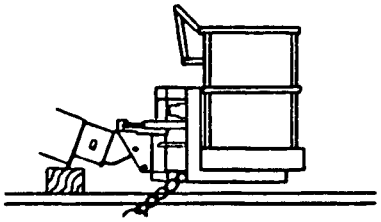


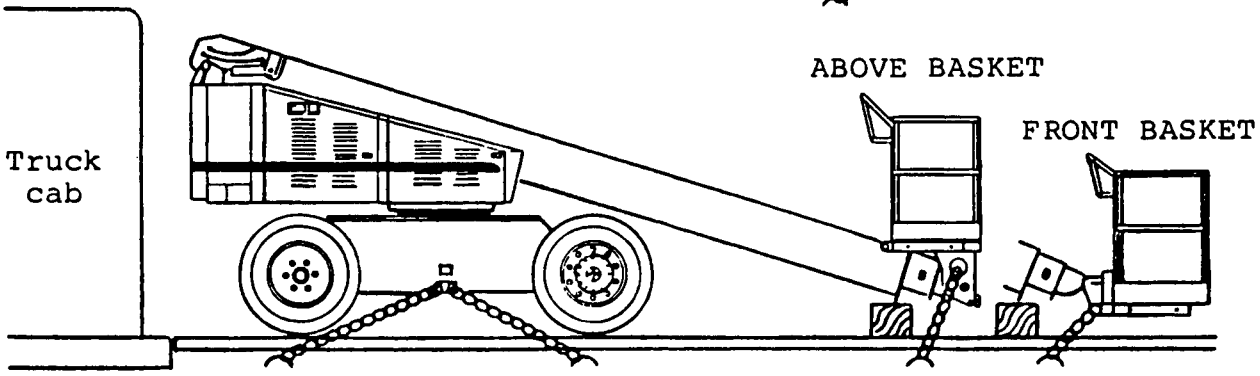
4. Attach winch cable to the boom at the drive wheel end of the base through the twin pad-eyes as shown.

5. When the boom is on the truck in position for proper weight distribution, it is chained down in the manner illustrated by the drawings below.









NOTE: Bottom of basket fork must not rest on truck bed.

UNLOADING

1. Release the hold down chains and remove the block under the basket end of the boom arm. Lift the boom arm to horizontal or slightly above the horizontal position.

2. Insure that the winch cable is in a taut position and then lower the truck bed.

3. Allow the boom to gradually roll down the truck bed by winching out.

4. When the boom is completely on level ground, engage the torque hubs and remove the winch cable from the boom.

5. Boom is now ready for normal operation.

FIGURE 2

FLATBED WITH HYDRAULIC LIFT/LOWER REAR PORTION

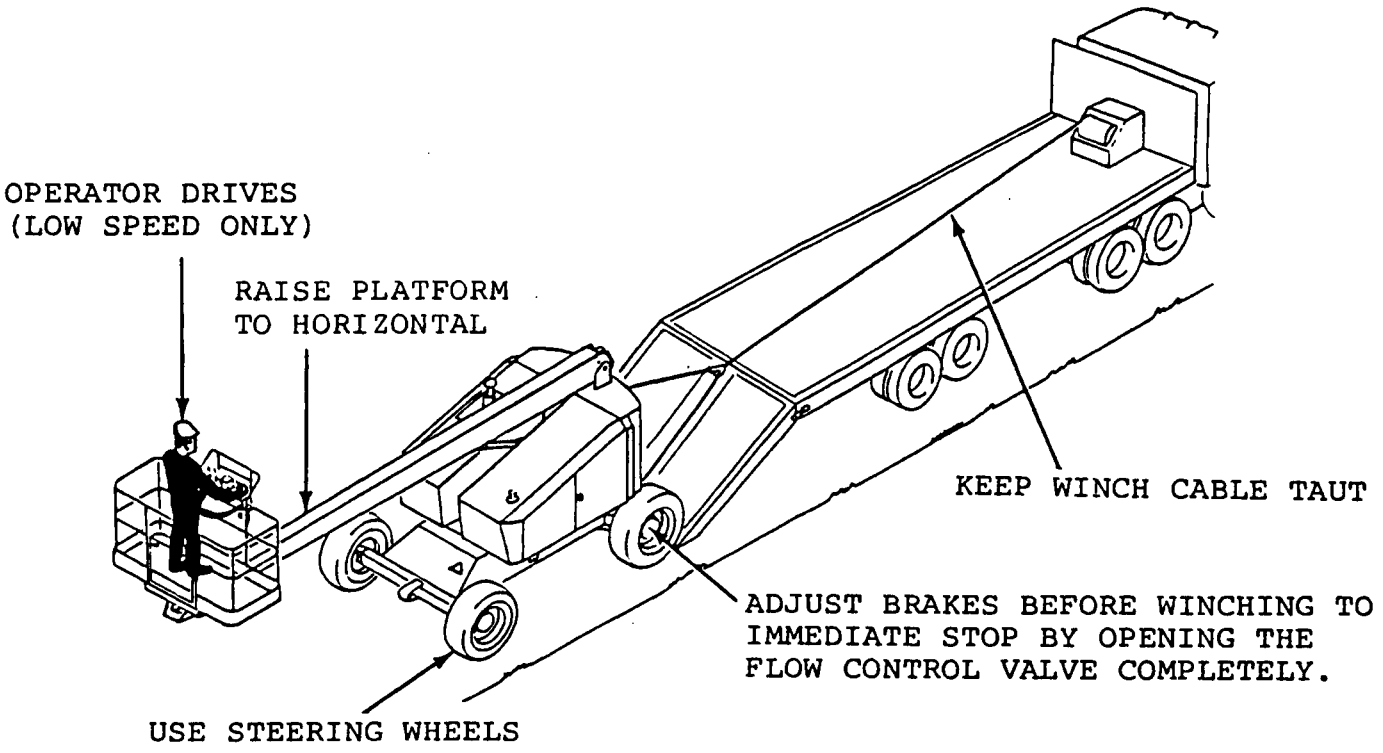
Flatbed Regular

> IMPORTANT: Due to the width of the booms and the overall width of the flatbed trailer...extreme caution must be used when loading or unloading.

In loading/unloading booms on flatbed trailers, a combination of winching and driving the boom in low drive speed must be utilized.

1. Insure that the parking brake is set to activate immediately. This is accomplished by opening the flow control valve

2. If the unit has the high/low drive option, it must be in low drive at all times when loading/unloading.



LOADING

* 2 man operation — 1 man to operate winch
1 man to drive boom

* 1 man operation — Winch unit must be fitted with an extension cord or remote control for the control box.

1. With the trailer on level ground, align the boom with the back end of the trailer.

2. Attach winch cable as described in FIGURE 1 of this instruction.

3. Using great care while driving and steering the boom up the ramp in low drive, keep all slack out of the winch cable. (If the ramp is too steep of a grade for the boom to climb, the winch will pull the unit up.) You must keep drive function engaged while winching or the brakes will stop the machine from rolling.

4. When the boom is in the position for the proper weight distribution for transporting, tie down to the trailer using the procedure described in FIGURE 1 of this instruction.

NOTE: Immediate full reversal of controller handle when driving will automatically change the direction of drive and will not stall the engine, even if attempted on a ramp. This procedure is not recommended as standard reversing of drive or any other function, but may be used in emergency situations without damage to the unit.

UNLOADING

1. With the trailer on level ground, disconnect the tie-downs from the boom and insure that the winch cable is still properly attached to the boom.

2. Select the low drive speed at the platform control console.

3. Using great care while driving and steering the boom off the trailer, keep all slack out of the winch cable.

> **WARNING:** Do not allow slack in the winch cable when descending the ramp, due to the possibility of snapping the cable if the unit descends too fast in drive.

4. When all wheels are on level ground, disconnect the winch cable from the boom.

5. Re-adjust the boom parking brakes to energize immediately after the dynamic brakes stop the unit. Procedure is as follows:

Place unit on flat surface, about 10' wide x 30' long. Position boom slightly below horizontal and completely retract. Select "High" drive speed and "High" throttle at the platform console. Drive MARKLIFT with controller handle in maximum position, approximately 15 feet letting go of the controller as one wheel is adjacent to a visual marker on the ground. A suitable deceleration and braking distance would be 18" measured from the marker to the center line of same wheel when unit has completely stopped. Adjust needle valve on parking brakes to achieve this dimension. Repeat above procedure, driving in both directions until MARKLIFT completely stops within the 18" to 24".

The deceleration valves have been set at the factory and should not be readjusted without first consulting MARK INDUSTRIES Field Service Department.

It is advisable to completely open the needle valve if the unit is to be used in a facility with severe ramps or inclines. However, very abrupt stops will be experienced with the unit driving on flat surfaces when drive controller is rapidly returned to the neutral position.

BEFORE OPERATING THE **MARKLIFT**, REVIEW THE FOLLOWING:

1. Visually inspect all exposed parts of the **MARKLIFT**. Secure any loose bolts and nuts. Replace any damaged hydraulic lines or broken wires. Check for any structural damage, including cut or damaged tires.

2. Check oil level in the engine.

3. Check hydraulic oil level - sight gauge shows full with unit in stowed position.

4. Fill fuel tank - use regular gasoline only or switch to propane.

5. Check battery for 1200 $\pm$ 50 reading on hydrometer. Charge battery if reading is below 1100.

6. Check hydraulic valve panel for loose hardware and broken fittings or tubing.

7. The ground control panel is accessible by opening the turret cover opposite the engine side of the machine.

8. Start engine. Allow engine to warm up.

9. After initial warm-up of gasoline engine, press engine stop button making sure stop circuit is operational. The ignition switch may be left in the "ON" position indefinitely if engine stop button has been pressed, without fear of burning distributor points. However, should engine stall, the operator must push the stop button or turn off ignition switch to prevent current path to coil.

10. Position selector switch to ground then operate switches, moving as follows: Boom UP/DOWN, rotation RIGHT/LEFT, and extend OUT/IN. Check for hose leaks.

11. After check-out of ground control functions, position selector switch to AERIAL for operation at work platform. After entering platform, depress foot switch before using any control function switches. This increases engine RPM (if throttle HIGH-LOW selector is positioned to high) and electrically completes circuit to controls.

Your **MARKLIFT** is equipped with proportional controls. When using any proportional function, press foot switch, raise controller locking device, then gradually move controller in direction selected. The controller handle is spring-centered and self locking to prevent accidental operation. Familiarize yourself with the operation of the controller until you are able to start and stop each function forward and reverse, obtaining a gradual, smooth movement.

12. The travel or drive configuration is with the boom over steering wheels. This provides the best weight distribution for maximum traction. If the boom is rotated 180 , the drive and steer decals read in reverse. The forward triangle decals on each end of the base will show drive direction correctly, regardless of turret position.

13. Brake adjustments may be made by turning a small needle valve. (See chapter parts, section 3, figure 7). This valve is merely a time delay for applying the brakes. With the valve completely open, the time delay for applying the brakes is minimum. Set the delay valve to stop the machine in approximately three feet on level ground driving in high speed.

NOTES: See Chapter General page 8 reduced copy of NEW EQUIPMENT CONDITION REPORT that is sent with each machine.

Every operator of the **MARKLIFT** must read, understand and follow the safety rules set forth herein.

1. The **MARKLIFT** self-propelled aerial work platform is a personnel lifting device, and it is essential that it be properly maintained and operated to perform all functions with maximum safety and efficiency.

2. The operation of any new and unfamiliar equipment can be hazardous in the hands of untrained operators. Only trained operators must be assigned to operate the **MARKLIFT.**

3. It is the responsibility of the operator to read and understand this manual and to follow all recommendations made. Never exceed manufacturer's recommended platform load capacity.

4. Although the **MARKLIFT** conforms to specified **ANSI & OSHA** requirements, it is the responsibility of the owner to instruct the operators with safety requirements made not only by **MARK INDUSTRIES,** but by the various safety boards in your area, as well as requirements set forth by **ANSI & OSHA.**

5. The **MARKLIFT** is a non-insulated personnel carrier and **must not** be operated within 10 feet of a 50,000 volt line. (See page 10 & 11 articles.)

6. Remember, the load capacity of the **MARKLIFT** is total combined weight of personnel and tools, fixtures, accessories, etc.

7. Always distribute load evenly over platform floor area.

8. The **MARKLIFT** platform is equipped with safety belt rings. A body belt for **each person must be worn attached** with lanyard to anchor points provided.

9. It is recommended that head gear (hard hats) be worn by all personnel in the work platform.

10. Under no circumstances should horseplay be tolerated.

11. The **MARKLIFT** structure must not be used as a welding ground. Disconnect both battery leads prior to performing any welding operations.

12. **DO NOT** lean over platform guard railings to perform work.

13. **DO NOT** use ladders or scaffolding on the platform to obtain greater height.

14. **DO NOT** raise or lower boom into protuding objects.

15. **DO NOT** drive carriage or platform into stationary objects.

16. **DO NOT** store loose material in the work platform such as pipe, rope, extension cords, wire or miscellaneous boxes. If necessary to store such items, they must be positioned in such a way that no one will trip over them when operating or working in the platform.

17. **DO NOT** alter equipment in any fashion.

18. **DO NOT** override any hydraulic, mechanical, or electrical safety devices.

19. **DO NOT** drive on uneven, sloping or soft terrain, as this is hazardous and must be avoided. The **MARKLIFT** must not be operated on more than a 5 degree out-of-plumb condition.

20. **DO NOT** work on platform if your physical condition is such that you feel dizzy or unsteady in any way.

21. **DO NOT** jump start other vehicles using **MARKLIFT** battery.

TITLE 8 DIVISION OF INDUSTRIAL SAFETY 358.38.113
(Register 73, No. 30--7-28-73)

Article 86. Provisions for Preventing Accidents

Article 86. Provisions for Preventing Accidents Due to Proximity to Overhead Lines

2946. Provisions for Preventing Accidents Due to Proximity to Overhead lines. (a) General. No person, firm, or corporation, or agent of same, shall require or permit any employee to perform any function in proximity to energized high-voltage lines; to enter upon any land, building, or other premises and thereto engage in any excavation, demolition, construction, repair, or other operation; or to erect, install, operate, or store in or upon such premises any tools, machinery, equipment, materials, or structures (including scaffolding, house moving, well drilling, pile driving, or hoisting equipment) unless and until danger from accidental contact with said high-voltage lines has been effectively guarded against.

(b) Clearances or Safeguards Required. Except where electrical distribution and transmission lines have been de-energized and visibly grounded or effective barriers have been erected to prevent physical and arcing contacts with the high-voltage lines, the following provisions shall be met:

(1) Over Lines. The operation, erection, or handling of tools, machinery, apparatus, supplies, or materials, or any part thereof, over energized high-voltage lines shall be prohibited.

(2) Equipment and Materials in Use. The operation, erection, or handling of tools, machinery, equipment, apparatus, materials, or supplies, or any part thereof within the minimum clearances from energized lines set forth in Table X shall be prohibited.

Table X
Required Clearances from Overhead High-Voltage Lines

Nominal voltage (Phase to Phase)	Minimum Required Clearance (Feet)
750 - 50,000	10
over 50,000 - 75,000	11
over 75,000 - 125,000	13
over 125,000 - 175,000	15
over 175,000 - 250,000	17
over 250,000 - 370,000	21
over 370,000 - 550,000	27
over 550,000 - 1,000,000	42

(3) Transportation or Transit. The transportation or transit of any tool, machinery, equipment, or apparatus, or the moving of any house or other building in proximity to overhead high-voltage lines shall be expressly prohibited if at any time during such transportation or transit such tool, machinery, equipment, apparatus, or building, or any part thereof, can come closer to high-voltage lines than the minimum clearances set forth in Table Y.

Article 86. Provisions for Preventing Accidents

Except where the boom of boom-type equipment is lowered and no load is imposed thereon, the equipment in transit shall conform to the minimum required clearances set forth in Table X.

Table Y
Required Clearances from Energized High-Voltage Conductors
(While in Transit)

Nominal Voltage (Phase to Phase)	Minimum Required Clearance (Feet)
750 - 50,000	6
over 50,000 - 345,000	10
over 345,000 - 750,000	16
over 750,000 - 1,000,000	20

(4) Storage. The storage of tools, machinery, equipment, supplies, materials, or apparatus under, by, or near energized high-voltage lines is hereby expressly prohibited if at any time during such handling or other manipulation it is possible to bring such tools, machinery, equipment, supplies, materials, or apparatus, or any part thereof, within the minimum required clearances from high-voltage lines as set forth in Table X.

(c) The specified clearance shall not be reduced by movement due to any strains impressed (by attachments or otherwise) upon the structures supporting the high-voltage line or upon any equipment, fixtures, or attachments thereon.

(d) Insulated cage-type boom guards, boom stops, insulating links, or proximity warning devices may be used on cranes, but the use of such devices shall not alter the required clearances set forth in Table X.

(e) Any overhead conductor shall be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized, and the line is visibly grounded at the work site.

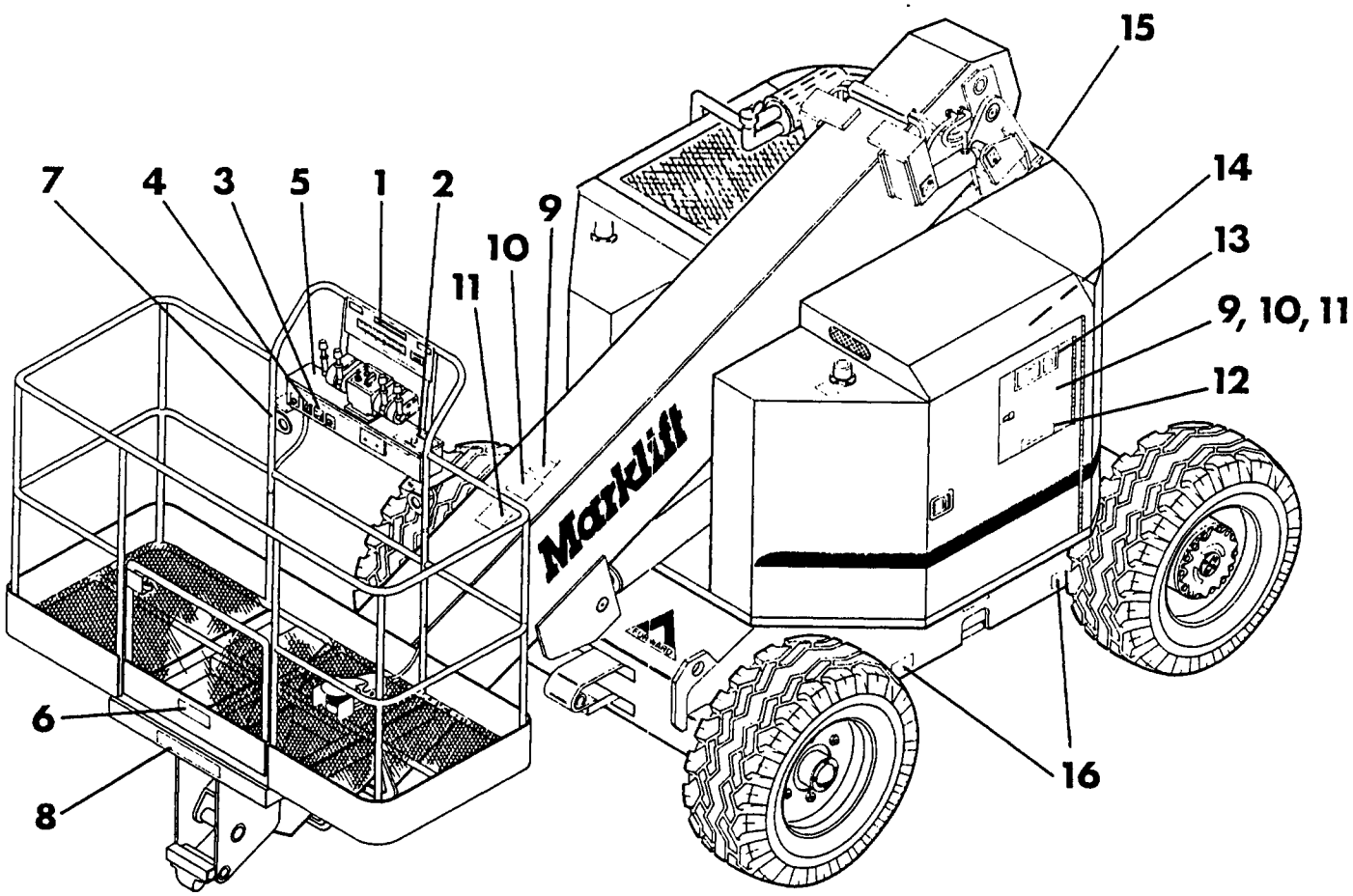
2947. Warning Signs Required. The owner, agent, or employer responsible for the operations of equipment shall post and maintain in plain view of the operator and driver on each crane, derrick, power shovel, drilling rig, hay loader, hay stacker, pile driver, or similar apparatus, a durable warning sign legible at 12 feet reading: "Unlawful To Operate This Equipment Within 10 Feet of High-Voltage Lines of 50,000 Volts Or Less."

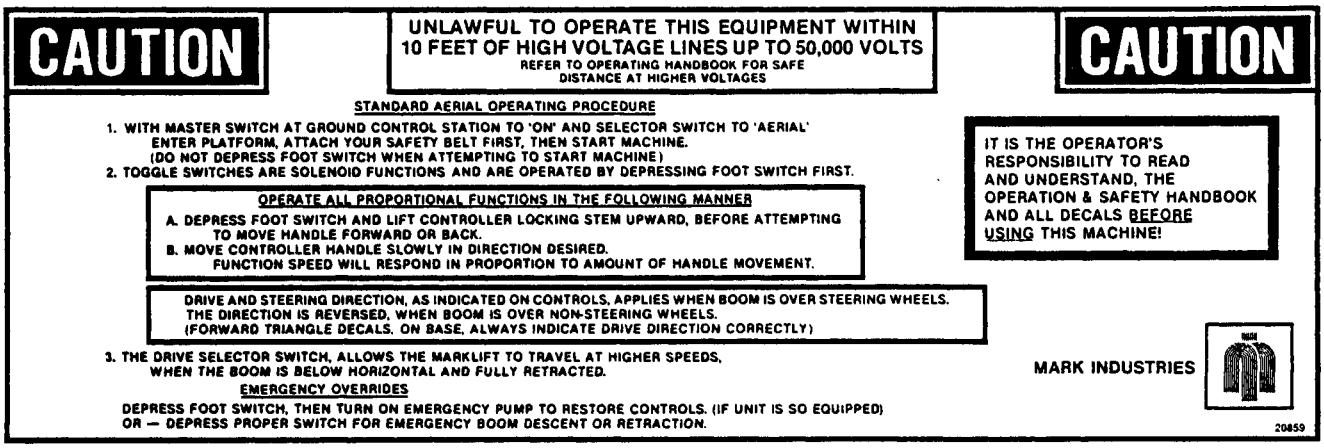
In addition to the above wording, the following statement in small lettering shall be provided on the warning sign: "For Minimum Clearances of High-Voltage Lines In Excess of 50,000 Volts, See Article 86, Title 8, High-Voltage Electrical Safety Orders."

WARNING, CAUTION & EMERGENCY DECALS

Be completely familiar with **ALL** warning, caution & emergency decals that are posted on the unit.

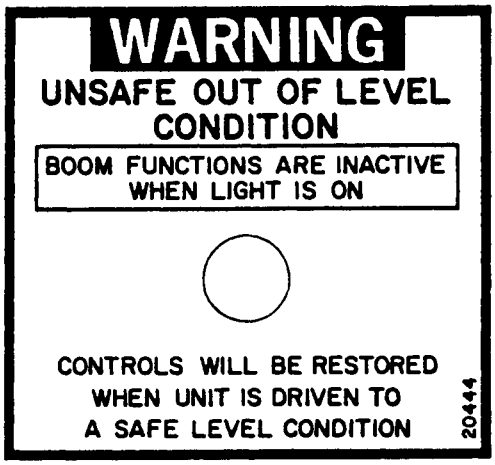
Keep in mind to be alert and use common sense and judgment in responding to dangerous situations and conditions that might develop during unit operation.





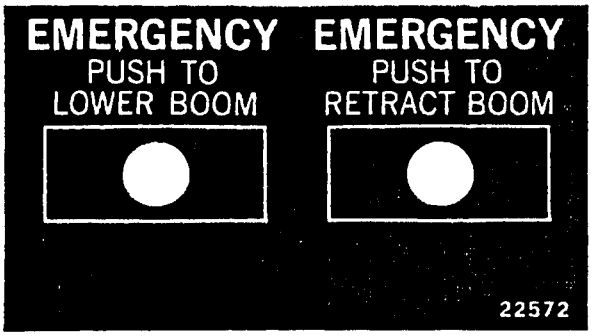
1 LOCATED ON PLATE ABOVE AERIAL CONTROLS

2

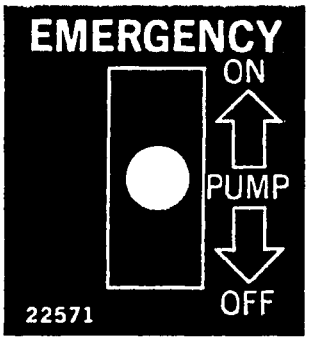


LOCATED ON TOP RIGHT, AERIAL CONTROL CONSOLE

3



4



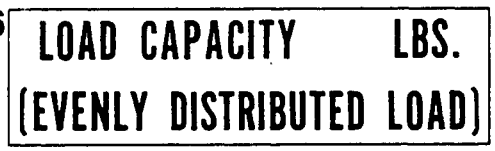
LOCATED AT FRONT LEFT, AERIAL CONTROL CONSOLE

7



LOCATED UNDER AERIAL CONTROL CONSOLE, NEXT TO SAFETY BELT "D" RINGS

6



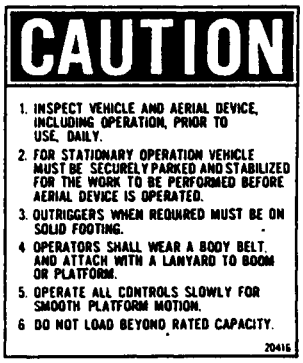
LOCATED ON PLATFORM SWING GATE KICKPLATE

8

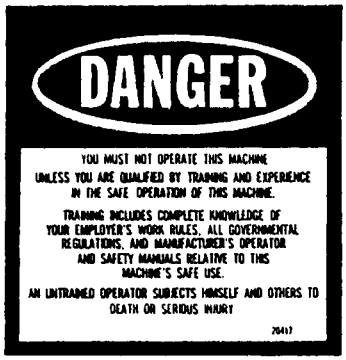
LOCATED ON
PLATFORM SWING
GATE KICKPLATE



9



10



11

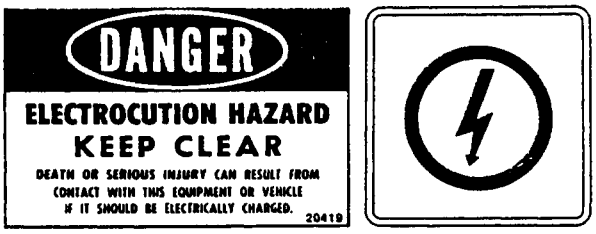


12



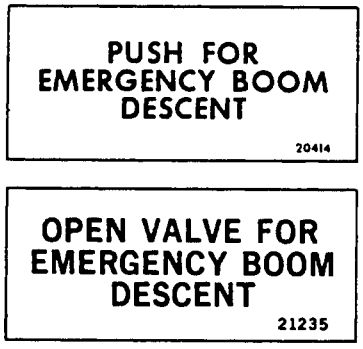
LOCATED ON GROUND CONTROL ACCESS DOOR
OF TURRET COVER

13



LOCATED ON BOTH SIDES OF TURRET COVERS

14



LOCATED NEAR GROUND CONTROL BOX IN
TURRET

16



LOCATED ON BASE, NEXT TO EACH TIRE

MARKLIFT SELF-PROPELLED BOOM

A working knowledge of the hydraulic system will assist trouble shooting or adjustments by a mechanic. The information below, although general, will provide the mechanic with such knowledge.

All Marklifts use the latest components in mobile hydraulic equipment. The hydraulic circuit contains an engine driven variable displacement piston pump combined with proportional control valves.

Both the pump and control valves are pressure compensated and load sensing, resulting in a highly efficient controllable system using less energy to drive, thus reducing fuel consumption.

The compensator has been pre-set at 2500 PSI to "DESTROKE" the pump. The pump compensator also receives a load sensing signal shuttled from each proportional control valve directly to cylinder load ports. Consequently the direct Boom loads are transmitted back to the pump so the pump only delivers enough flow and pressure to satisfy the cylinder, depending on command from the control valve orifice.

The load sensing system is automatically left out of the hydraulic circuit during the engine start operation, to prevent excessive starter drag.

The throttle is activated hydraulically directly from the pump high pressure discharge, through a solenoid valve. The throttle solenoid valve is energized through a selector switch in the platform, wired in series with the foot switch.

The proportional control valves require a small flow and pressure signal constantly while the engine is running. This supply is tapped off the high pressure pump discharge through a fixed pressure compensated orifice. This low pressure and flow system is connected directly to the proportional control valve after being filtered, and acts on the first stage pilot of the control valve.

A satisfactory pilot line pressure is maintained constantly at 210 psi $\pm$ 25 psi. A capped port has been provided for a test gauge.

Two directional solenoid valves are provided in the circuit for steering and platform leveling override. The operator has no metering capabilities with the use of these valves since they are fully opened or closed.

The hydraulic oil is filtered on the return line from the control valves to the tank. The element can be easily replaced. Allow the engine to idle 2 minutes after changing any filter elements. This enables filter cans to fill completely.

The **MARKLIFT** electrical system is very straight forward and easy to trouble shoot due to it's simplicity. There are two major junction boxes which also serve as the ground and aerial control consoles. The source for the electrical system is a 12 volt battery with a negative ground. All electrical components operate directly from the source through switches or proportional controllers.

The ground control console houses the necessary switches for starting and stopping the engine - a selector switch for selecting the ground or aerial control console, and the required toggle switches for moving the boom. The ground control console also contains a keyed master switch, as well as an engine stop switch, ammeter, hour gauge, and fuel gauge.

When the selector switch is placed in the aerial position, the electrical source is routed to the aerial control. The purpose of the footswitch is to provide an additional safety interlock in the control circuit to insure multiple physical movement by the operator, thereby requiring maximum operator attention. The function of the footswitch only completes the electrical circuit to the aerial control console and engine throttle. The footswitch is not connected to the drive braking system.

Engine start and stop are independently wired around the selector switch, making them active any time the master switch or ignition switch is on.

The aerial control console is equipped with all controllers and switches necessary to operate the boom functions, as well as drive and steer. It also contains a start/stop and an emergency pump switch. Your MARKLIFT is equipped with proportional control valves for all boom functions. The aerial

control console contains electrical controllers complete with manual lockouts. The controllers are spring-centered and are designed to produce a variable output signal to the control valve. The output signal is directly proportional to the handle movement of the controller. The valve is electrically coupled to the controller and responds only to the signal level transmitted by the operator.

The operator must learn how to move the controller slowly to obtain a smooth transition from start up to wide open and back to center.

The **MARKLIFT** Boom unit has additional safety systems for driving. When the unit is driven with the boom extended or raised above horizontal, the unit is automatically shifted into the low speed range. This is done through two limit switches sensing the attitude and extension positions of the Boom, wired in parallel to the solenoid valves that select HIGH & LOW speed.

An out of level sensor is also automatically engaged through the same limit switches in a series circuit and will activate a warning buzzer and light if the unit is 5° or more out of level. The out of level sensor prevents any operation of the Boom controls at 5° or more out of level. When the unit is driven to level ground (less than 5°) the buzzer and light go off, then the Boom controls become active again.

MARKLIFT Boom units equipped with a dual fuel system allow the operator to select gasoline or propane operation, with a 3-position selector switch located on the aerial control console. The selector switch energizes solenoid valves, which close one fuel line and open the other.

ENGINE STARTING

The engine should be started with propane. The propane system bypasses the fuel pump and carburetor bowl and supplies fuel directly into the carburetor for quick starting. If the engine has been run on propane and starting is done with gasoline, more than normal cranking and battery drainage is required for the fuel pump to fill the lines and carburetor bowl with gasoline.

ENGINE STOPPING

The engine is stopped by pushing the red "**STOP**" button on the ground or aerial console. The fuel selector switch need **not be moved** to the "**OFF**" position; the engine may be restarted with the ignition switch or aerial start button. Before starting from ground console, check fuel selector switch on aerial console for proper fuel source.

SWITCHING FROM PROPANE TO GASOLINE

With the engine running, step on the deadman footswitch and position the throttle switch to "**HIGH**" speed. Switch fuel selector to gasoline. The engine will begin to stall as the carburetor bowl starts filling with gasoline. Switch back to propane until the engine resumes high speed. Switch back and forth from propane to gasoline **(DO NOT STOP AT "OFF" POSITION)** until the engine is running smoothly on gasoline.

SWITCHING FROM GASOLINE TO PROPANE

With the engine running, step on the deadman footswitch and position the throttle switch to "**HIGH**" speed. Switch fuel selector to "**OFF.**" The engine will continue to run as it uses fuel from the carburetor bowl. When the engine begins to stall, allow it to run several seconds and then switch to propane. Switch throttle to "**LOW**" and release footswitch. Let the engine idle for 20-30 seconds to completely burn up any remaining gasoline in the bowl..

It is recommended that the **MARKLIFT** be moved into an area free of any overhead obstructions on a flat, level surface with no hazardous irregularities or accumulation of debris.

The operator should familiarize himself with the drive by raising the boom approximately 5 feet off the ground before driving the unit. You will soon find that gradual starts and stops are easy to perform. Gradually raise the boom higher, and drive unit again until you reach maximum height. Remember, at all times, that the proportional signal from the controller to the valve is controlled by the operator. There is approximately 3 degrees of "dead" motion each side of the controller center position.

For best operation, place thumb over controller knob and wrap fingers loosely around locking stem. Now, rest the heel of the hand on the controller housing and apply a downward pressure with the thumb, making the index finger lift the locking stem. Once the stem is disengaged and moved forward or reverse, the pressure on the thumb may be relaxed because the locking stem has engaged the cam and cannot drop into the locking position until the lever or handle is returned to the center position.

After the operator has been instructed by a trained operator and has spent 30 minutes practicing, he should be capable of smoothly starting and stopping the machine on all proportional functions.

In an emergency, all hydraulic functions are operable with the emergency pump running. From the aerial platform, position emergency pump switch to "ON." This will "KILL" the engine and start the emergency pump. Continue normal operation by depressing the foot switch and moving controllers or toggle switches in the desired direction of motion.

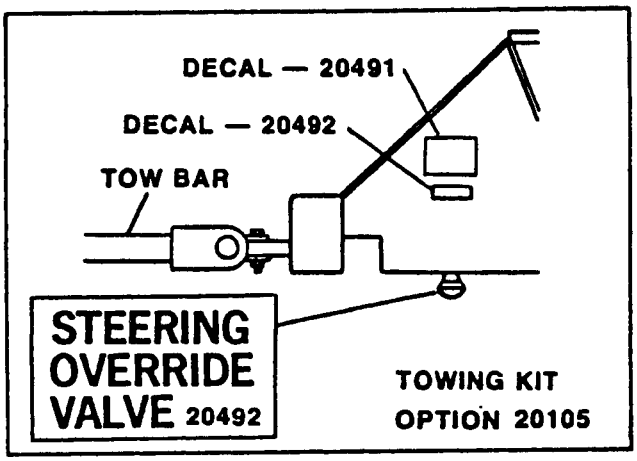
MARKLIFT SELF-PROPELLED BOOM

TOWING INSTRUCTIONS

1. ATTACH TOW BAR FROM MARKLIFT TO VEHICLE
2. PULL DOWN MANUAL STEERING OVERRIDE VALVE HANDLE
3. REVERSE DRIVE HUB DISENGAGEMENT CAPS

CAUTION: MARKLIFT BRAKES WILL BE DISENGAGED AT THIS TIME

DO NOT EXCEED 10 MPH WHILE TOWING 20491



TORQUE HUB MUST BE DISENGAGED FOR TOWING.

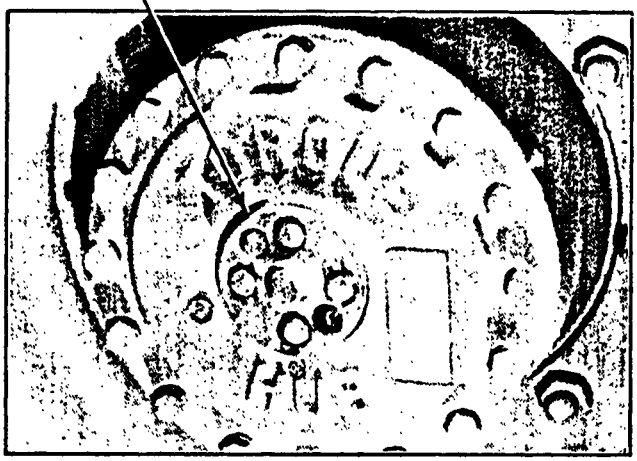
MAXIMUM TOWING SPEED IS 10 mph.

TO DISENGAGE TORQUE HUB, REVERSE THE DISCONNECT CAP. THE KNOB ON THE CAP DISENGAGES THE DRIVE HUB INPUT SHAFT.

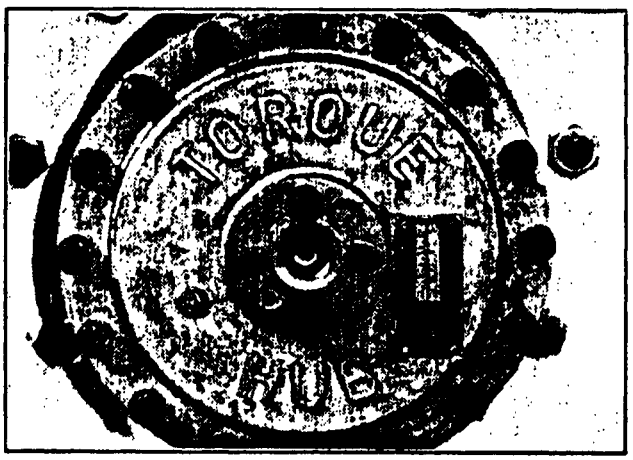
CAUTION: BRAKES ARE ALSO DISENGAGED!

DISCONNECT CAP

HUB ENGAGED



HUB DISENGAGED



This preventative maintenance information is intended as a general guide, refer to vendor section in this manual for detailed information on engine, battery, etc.

Mark Industries recommends the following items be checked:

DAILY

1. Operation and safety decals in place and legible.
2. Check gas & hydraulic tank levels.
3. Check engine oil level.
4. Check battery water level.
5. Check for loose or worn hardware.

WEEKLY

1. Check tire condition (free of serious cuts or defects)
2. Check & clean engine intake air cleaner.
3. Operation and safety decals in place and legible.
4. Proper brake operation.
5. Record hour meter reading.
6. Clean unit by removing all dirt, oil, and grease. Machine may be washed with soap and water.
7. Check for hydraulic leaks and correct.
8. Check for structural damage and correct.
9. Check overall performance.
10. Check for wear on cables and hoses.

MONTHLY (or first 50 hours)

1. Check and lube, if necessary. (See lubrication instructions).
2. Check battery condition.
3. Change engine oil & filter.
4. Change hydraulic oil return filter.
5. Check ring gear bolts in turret and base for correct torque.
   15/16 bolts - 175 ft. lbs. lubricated
   3/4 bolts - 87 ft. lbs. lubricated
6. Check oil level, turret rotation gear box.
7. Grease ring gear.
8. Grease steering linkage.
9. Check & clean engine intake air cleaner.

EVERY SIX MONTHS (or 100 hours)

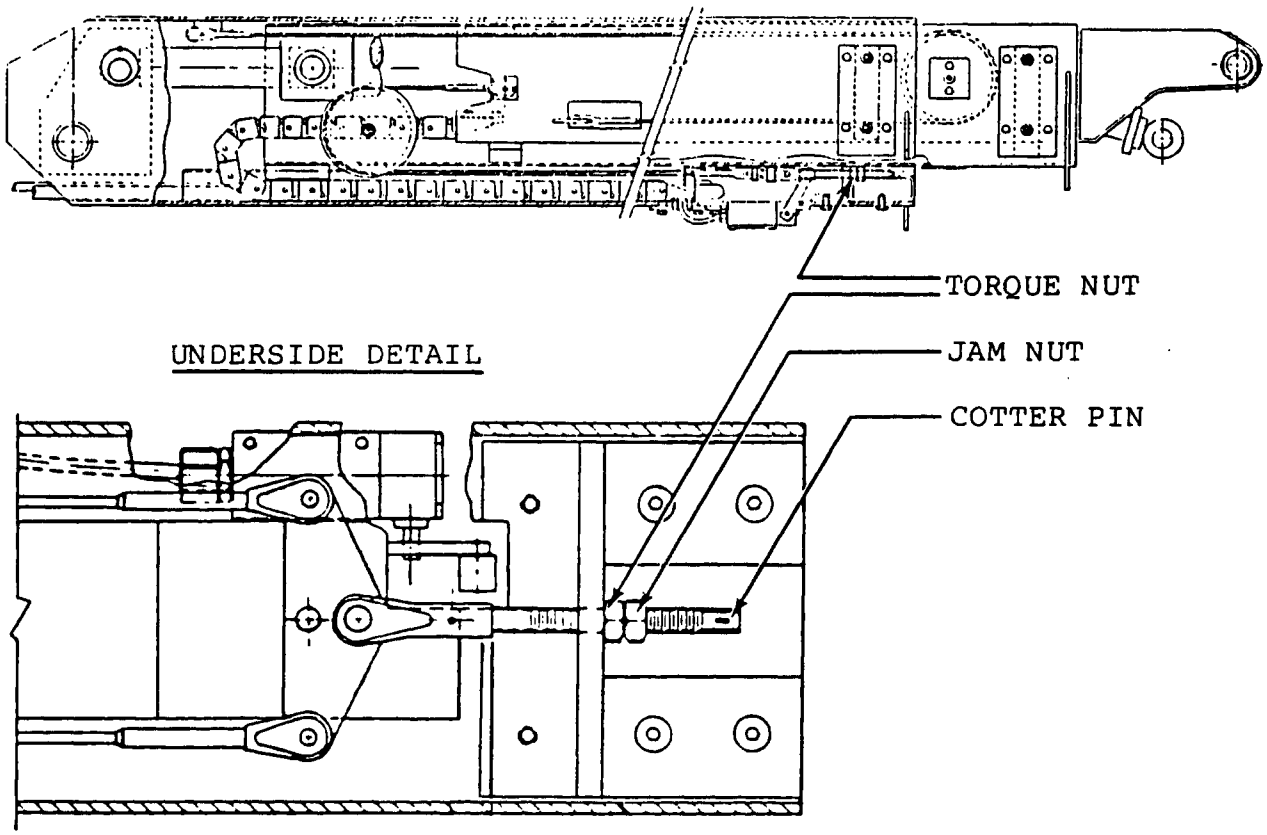
1. Check and lube, if necessary. (See lubrication instructions).
2. Change pilot filter element. (See lubrication instructions).
3. Change engine oil filter.
4. Change hydraulic oil return filter.

EVERY YEAR

1. Repack all wheel bearings.
2. Change hydraulic oil.
3. Check torque hub oil level.
4. Check ring gear bolts in turret and base, for correct torque.
5. Change hydraulic oil return filter.
6. Change pilot line filter.

RETRACTION CABLE TENSIONING

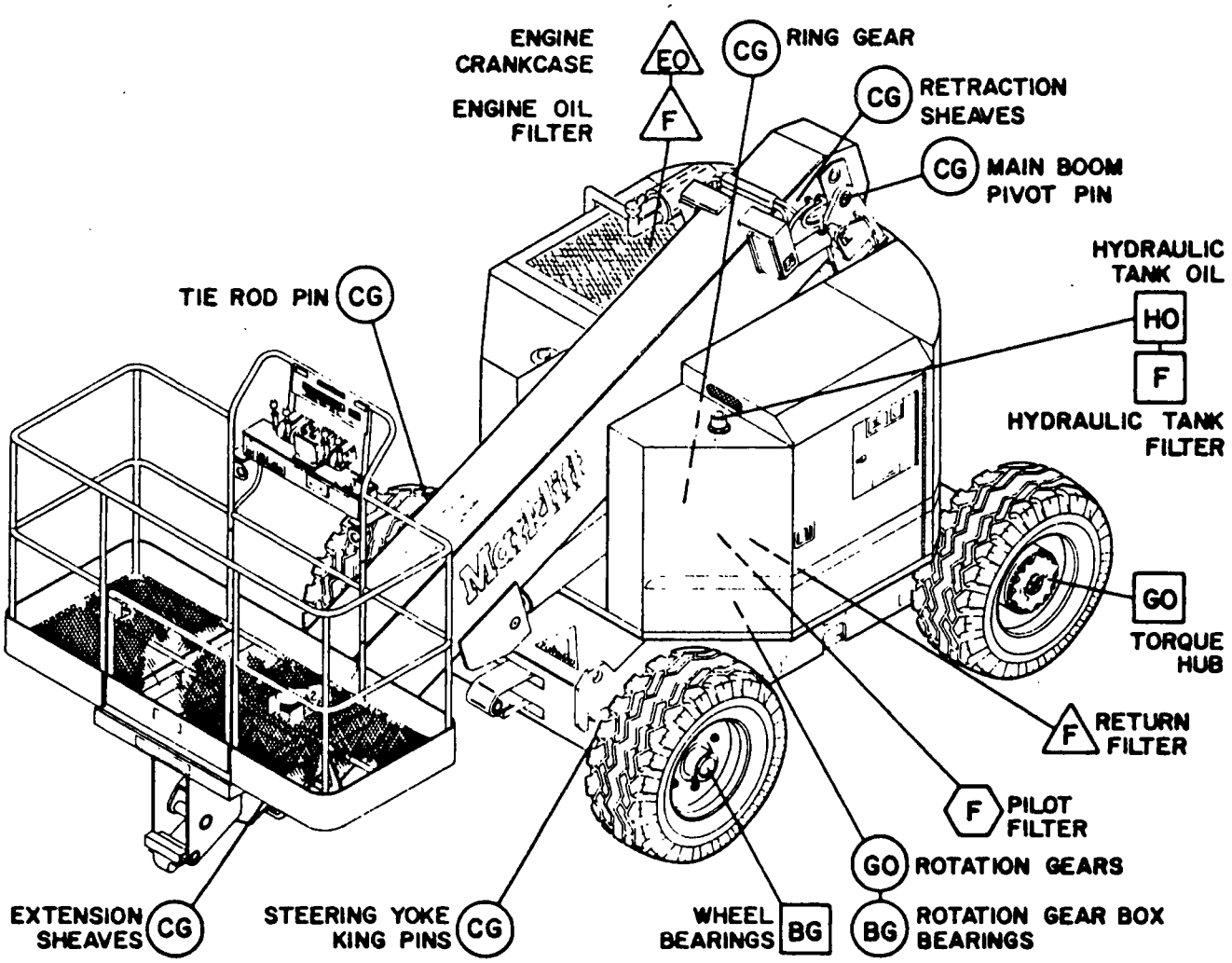
1. ELEVATE BOOM TO ALMOST HORIZONTAL POSITION.
2. EXTEND BOOM 3-4 FEET FROM FULLY RETRACTED POSITION.
3. SET TORQUE WRENCH AT 15 FOOT POUNDS.
4. LUBRICATE TORQUE NUT (INNER NUT) AND THREADED SHAFT WITH GENEROUS AMOUNTS OF OIL OR GREASE.
5. REMOVE COTTER PIN FROM THREADED SHAFT, THEN LOOSEN JAM NUT FROM TORQUE NUT WITH RATCHET WRENCH AND CORRECT SOCKET.
6. TIGHTEN TORQUE NUT WITH DEEP SOCKET AND TORQUE WRENCH TO 15 FOOT POUNDS.
7. EXTEND BOOM OUT 2 INCHES THEN REPEAT STEPS 6 & 7 UNTIL NO FURTHER TORQUING IS NEEDED.
8. TIGHTEN JAM NUT AGAINST TORQUE NUT THEN REINSTALL COTTER PIN.



LUBRICATION INSTRUCTIONS

LUBRICANT	TYPE
CG – CHASSIS GREASE	– MOBILCOTE TYPE S
BG – BEARING GREASE	– MOBIL VA6L36AG
EO – ENGINE OIL	– SAE 30
GO – GEAR OIL	– SAE 90

SYMBOL	INTERVAL
○	MONTHLY
⬡	300 HRS.
△	100 HRS.
□	YEARLY



MILESTONE			HYDRAULIC FLUID TABLE			
OIL COMPANY			CHEVRON	GULF	SHELL	UNION
BRAND NAME			ATF DEXRON II	ATF DEXRON II	DONAX-T6	ATF DEXRON
VISCOSITY	SUS AT 100°F (37.8°C)		187.4	195	200	200
	SUS AT 210°F (98.9°C)		49.2	50.4	50	52.3
	INDEX	°F	153°	155°	160°	172°
		°C	67.2°	68.3°	71.1°	77.8°
FLASH POINT		°F	400°	405°	390°	395°
		°C	204.4°	207.2°	198.9°	201.7°
POUR POINT		°F	-40°	-50°	-50°	-45°
		°C	-40°	-45.6°	-45.6°	-42.8°

1. TYPE - EP 90

   On normal application EP 90 should be used. On applications where the lubricant must meet special requirements, the manufacturer of the lubricant should be able to recommend a suitable substitute.

2. OIL TEMPERATURE

   Continous - 160°F
   Intermittent - 200°F

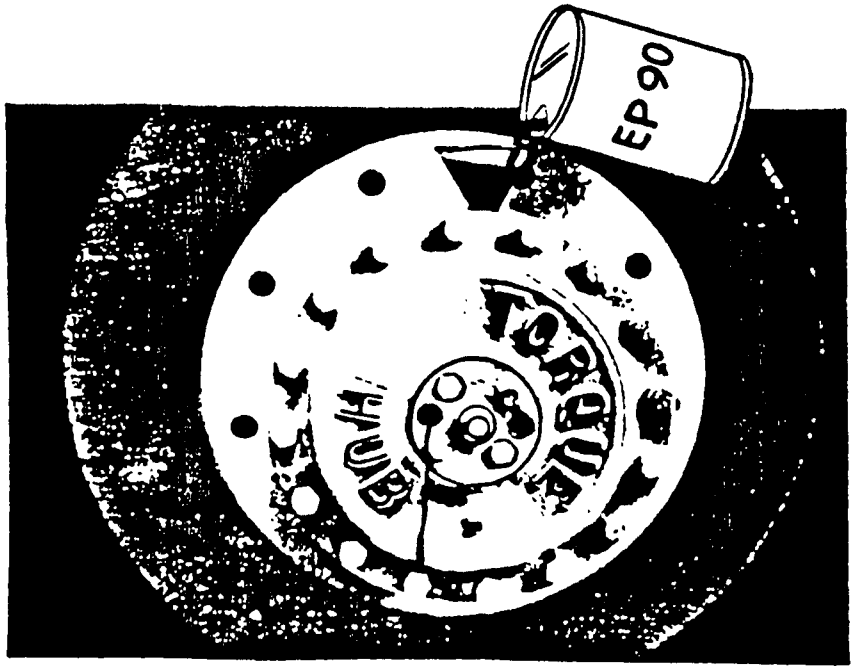
3. OIL CHANGE

   Initial - After 50 hours or 50,000 revolutions of operation. Preferable in a loaded condition.

   Subsequent - 1000 hours or (1) year whichever comes first. Higher temperatures make it necessary to change oil more frequently.

4. OIL FILL LEVEL

   Unit mounted horizontal - half-full.



ENGINE

1. Will not start or run.

   A. Check ground control box circuit breaker.
   B. Make sure fuel shut-off valve is open.
   C. Fuel selector should be in the "gasoline" position.
   D. Check for low battery
   E. Check for fouled spark plugs.
   F. Check for water in gas tank.
   G. Check engine points.
   H. Refer to your local service facility.

2. No high speed.

   A. Check aerial HIGH/LOW throttle switch.
   B. Check throttle solenoid valve.
   C. Refer to your local service facility.

3. No idle.

   A. Check aerial HIGH-LOW throttle switch.
   B. Check throttle solenoid valve.
   C. Refer to your local service facility.

4. Dies under load.

   A. Check governor setting.
   B. Check carburetor air/fuel mixture.
   C. Refer to your local service facility.

HYDRAULIC WHEEL DRIVE MOTOR

Turns wheel while unloaded, but slows down or stops when load is applied.

A. Check hydraulic high pressure port with 3000 PSI gauge.
B. Refer to your local service facility.

HYDRAULIC PUMP

1. Pump producing excessive noise.

   A. Check suction hose from tank to pump for kinks.
   B. Check hydraulic oil level (sight gauge on tank.)
   C. Check suction line fittings for tightness.
   D. Check oil. SEE PAGE 4 FLUID TABLE
   E. Refer to your local service facility.

LIFT

1. No functions operate from aerial control console.

   A. Check aerial/ground selector switch.
   B. Check foot switch continuity.
   C. Check for loose wire in aerial junction box.
   D. Check pilot valve pressure.
   E. Solenoid dump valve.

2. No functions operate from ground control box.

   A. Check position of aerial/ground box selector switch.
   B. Solenoid dump valve.
   C. Pilot valve pressure.
   D. Refer to your local service facility.

3. Functions too slow or too fast.

   A. Check pilot valve control pressure.
   B. Check flow control valve to solenoid valves.
   C. Refer to your local service facility.

DRIVE

   A. Make sure hydraulic system is up to recommended pressure.
   B. Check pilot valve control pressure.
   C. Refer to your local service facility.

MARKLIFT SELF-PROPELLED BOOM
INDUSTRIAL MODELS

ITEM	PART NO.	DESCRIPTION
1.	20477	Return line filter element.
2.	20472	Pilot filter element.
3.	66528	Steering cylinder seal kit.
4.	66045	Slave leveling cylinder seal kit
5.	66499	Master leveling cylinder seal kit.
6.	6502	Lift cylinder seal kit.
7.		Boom extension cylinder seal kit for 22366 cylinder (2 section.)
	66500	Boom extension cylinder seal kit for 21410 cylinder (3 section.)
8.	20035	2-speed shift cylinder seal kit.
9.	20042	Platform rotation cylinder seal kit (with option 20097.)
10.	20562	Ground control box circuit breaker.
11.	20481	Ground control box toggle switch.
12.	20482	Ground control box toggle switch.
13.	20580	Aerial control box potentiometer assembly.
14.	20581	Aerial controller lever lock.
15.		Thermostat.
16.		Radiator cap.
17.		Coolant hose clamps.

SERVICE TOOLS

1. Volt/OHM meter.
2. Hydraulic pressure gauge (0-3000 PSI)
3. Battery hydrometer.
4. Photo tachometer.
5. Standard mechanics hand tools.
6. Cable tensioning tool MI #20053.
7. Radiator pressure tester.

Either excessive overcharge or moderate undercharge can shorten battery life.

With proper attention to water level and charging time, compared to hydrometer reading, the batteries should give a long useful life.

TEMPERATURE/SPECIFIC GRAVITY CORRECTION TABLE FOR BATTERIES

Actual Hydrometer Reading at Actual Temperature*

80°F (27°C)	0°F (-18°C)	-10°F (-23°C)	-20°F (-29°C)	-30°F (-34°C)	-45°F (-43°C)	-65°F (-54°C)	Approx. State of Charge In %
1.280	1.312	1.316	1.320	1.324	1.330	1.338	100
1.250	1.282	1.286	1.290	1.294	1.300	1.308	75
1.220	1.252	1.256	1.260	1.264	1.270	1.278	50
1.190	1.222	1.226	1.230	1.234	1.240	1.248	25
1.160	1.192	1.196	1.200	1.204	1.210	1.218	0

Specific Gravity Corrected to 80°F (17°C)	Freezing Temperature	
1.280	-90°F	-68°C
1.250	-62°F	-52°C
1.200	-16°F	-27°C
1.150	+ 5°F	-15°C
1.000	+19°F	- 7°C

MODEL: _____ SER. NO.: _____ DATE SOLD _____

DATE IN SERVICE _____ OPTIONS _____ WARRANTY PERIOD _____

CODE:
C-CHECKED N-NEW PART
A-ADJUSTED X-NEEDS
R-REPAIRED REPAIR

DATE	W.O.	MECH.	HR METER	PREVENTIVE MAINT.											ELECTRICAL						HYDRAULIC								FUEL			STEER				TIRE		MAJ.		MISC.					
				OIL CHANGE	OIL FILTER	AIR CLEANER	HYDRAULIC OIL CHANGE	HYDRAULIC OIL FILTER	WHEEL BEARING PACK	DRIVE MOTOR	PUMP MOTOR BRUSHES	ELECTRICAL CONTROLS	TRANS & DIFF OIL CHG	TUNE UP SPARK PLUGS	GENERATOR REGULATOR	VOLTAGE REGULATOR	BATTERY	STARTER	SYSTEM AND CONDENSER	HYDRAULIC SYSTEM	LIFT CYL	LIFT CYL SEALS	HYD F WF	HYD CONTROL VALVE	ROTARY MANIFOLD	LIFT ROLLERS	HYD HOSES	FUEL SYS	CARBURATOR	FUEL PUMP	STEERING	STEERING HOSES	STEER GEAR	STEER CYL	DRIVE TIRE	STEER TIRE	ENGINE O/H	DRIVE AXLE O/H	BRAKES							

DATE	REMARKS	DATE	REMARKS	AGENCY

MAINTENANCE CHECK LIST

MARKLIFT SERVICE MAINTENANCE RECORD

MODEL: _____ SERIAL NO. _____

DATE: _____ EQUIP. NO. _____

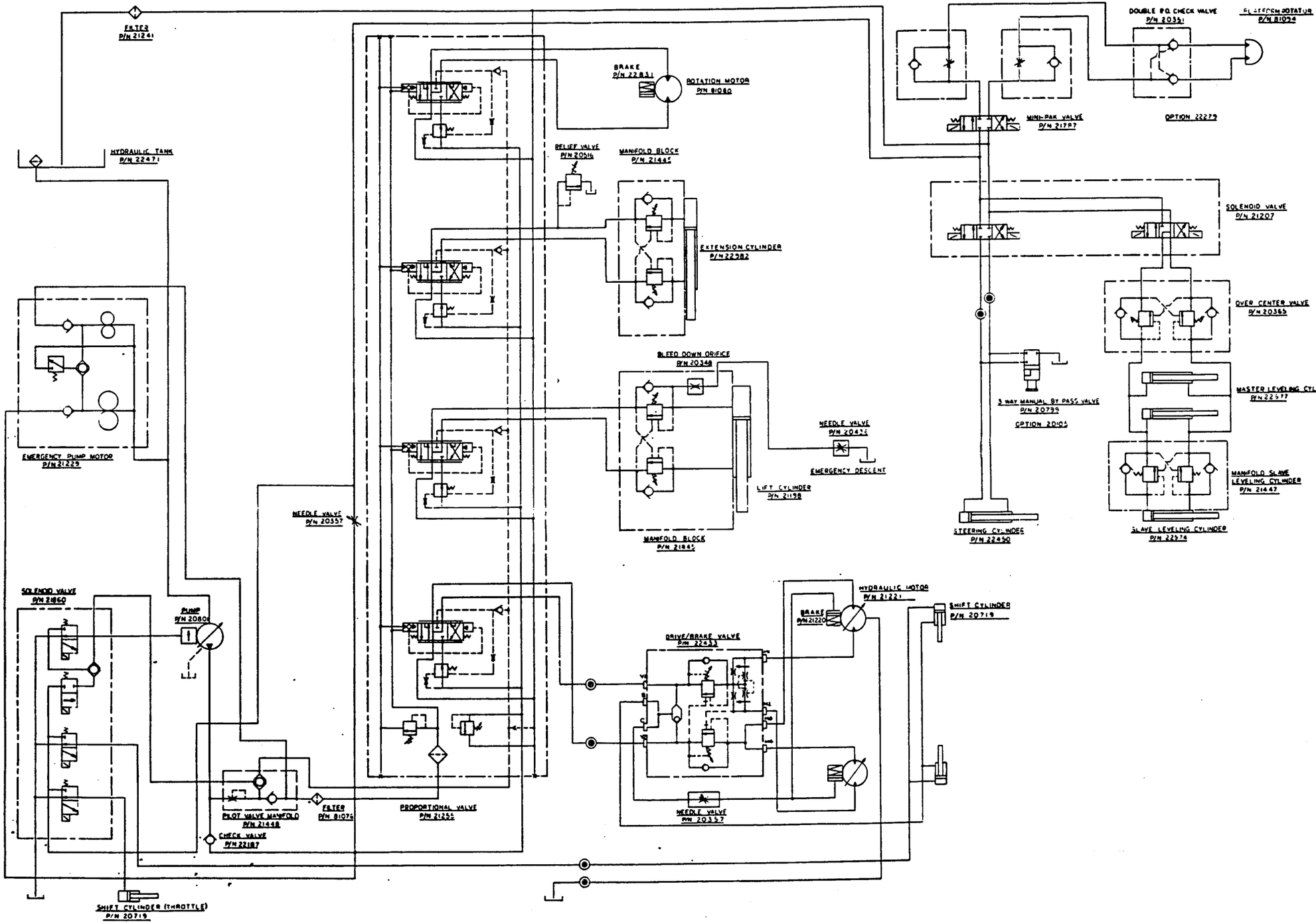
LOCATION: _____ MECHANIC: _____

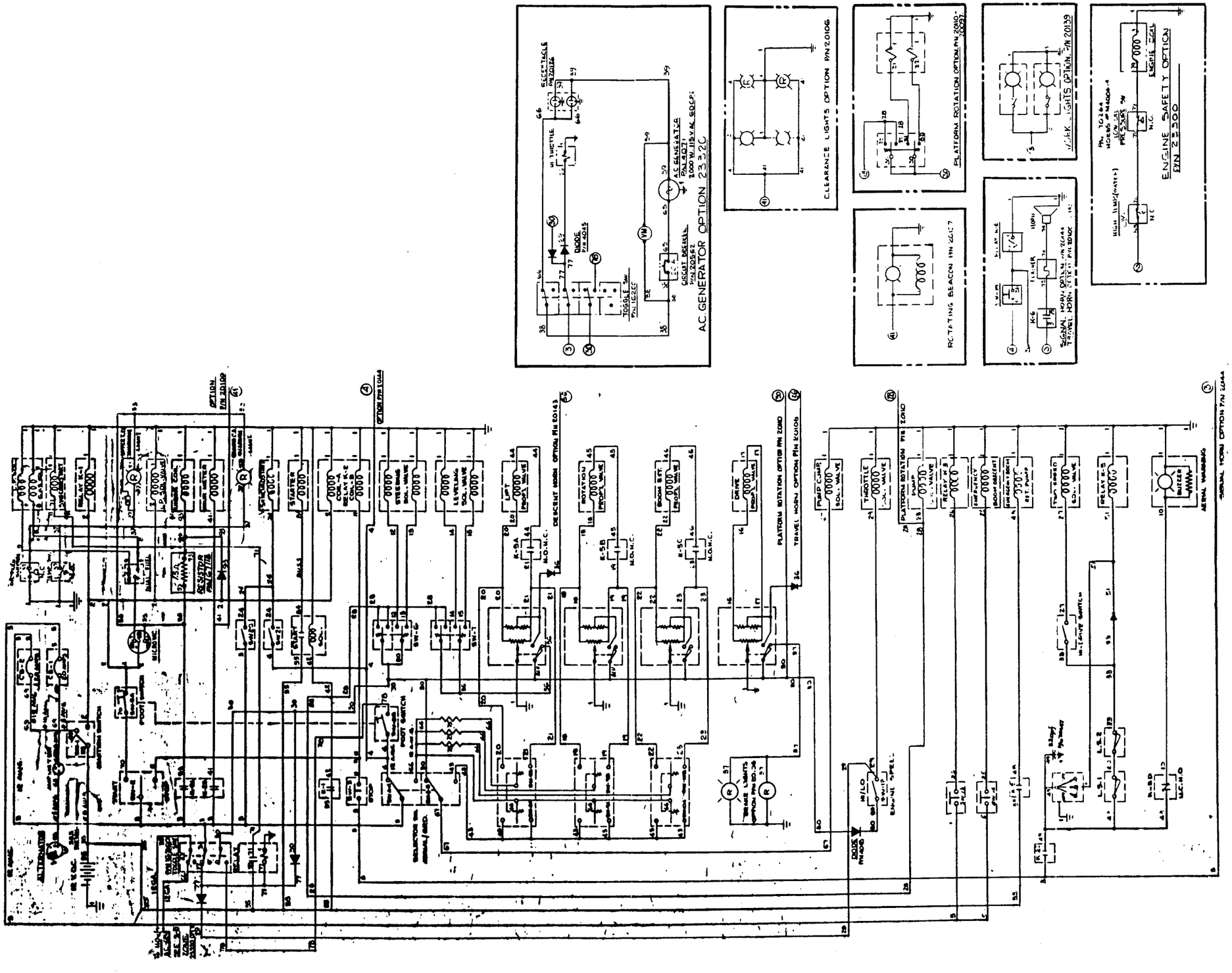
ITEM	CODE	COMMENTS	ITEM	CODE	COMMENTS
ENGINE OIL			SAFETY CUT-OUTS		
ENGINE OIL FILTER			BUSHINGS		
AIR FILTER			ROLLERS		
FUEL FILTER			WEAR PAD		
TUNE-UP			FRONT END ASSY.		
CHOKE			TIRE PRESSURE		
ENGINE RPM			TIRE CONDITION		
CHARGINE SYSTEM			WHEEL NUTS		
FUEL SYSTEM LPG-GAS			WHEEL BEARING		
BATTERIES			NUTS & BOLTS		
BATTERY TERMINALS			GUARD RAILS		
MOTOR BRUSHES			LUBRICATION		
HYDRAULIC FLUID			WARNING DECALS		
HYD. OIL FILTER			OPERATION INSTRUCTIONS		
HYDRAULIC SYSTEMS			GENERAL DECALS		
HYDRAULIC PRESSURE			PAINT		
HYDRAULIC HOSES			ALL OPERATIONS		
CYLINDERS			LIFT		
DRIVE MOTORS			STEERING		
BRAKES			FORWARD DRIVE		
EMERGENCY LOWERING VALVE			REVERSE DRIVE		
AERIAL CONTROL BOX			TILT SWITCHES		
GROUND CONTROL BOX			FUEL LEVEL		
RELAYS			LITERATURE		
WIRE CONNECTIONS			OPTIONS		

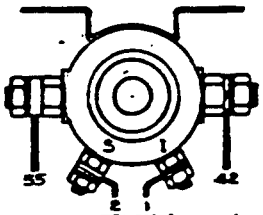
CODE

F - FILLED
R - REPAIRED
C - CHECKED
A - ADJUSTED
X - NEEDS REPAIR

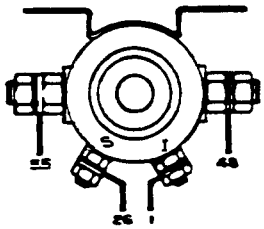
OTHER COMMENTS:


FILTER
P/N 21241
HYDRAULIC TANK
P/N 22471
EMERGENCY PUMP MOTOR
P/N 21229
NEEDLE VALVE
P/N 20357
SOLENOID VALVE
P/N 21460
PUMP
P/N 20806
PILOT VALVE MANIFOLD
P/N 21448
FILTER
P/N 81075
CHECK VALVE
P/N 22187
SHIFT CYLINDER (THROTTLE)
P/N 20719
PROPORTIONAL VALVE
P/N 21255
BRAKE
P/N 22831
ROTATION MOTOR
P/N 81080
RELIEF VALVE
P/N 20516
MANIFOLD BLOCK
P/N 21445
EXTENSION CYLINDER
P/N 22382
BLEED DOWN ORIFICE
P/N 20348
NEEDLE VALVE
P/N 20432
EMERGENCY DESCENT
LIFT CYLINDER
P/N 21198
MANIFOLD BLOCK
P/N 21845
DRIVE/BRAKE VALVE
P/N 22433
NEEDLE VALVE
P/N 20357
HYDRAULIC MOTOR
P/N 21221
BRAKE
P/N 21220
SHIFT CYLINDER
P/N 20719
DOUBLE P.O. CHECK VALVE
P/N 20351
OPTION 22279
MINI-PAK VALVE
P/N 21787
SOLENOID VALVE
P/N 21207
OVER CENTER VALVE
P/N 20365
3 WAY MANUAL BY PASS VALVE
P/N 20739
OPTION 20105
STEERING CYLINDER
P/N 22450
MASTER LEVELING CYLINDER
P/N 22577
MANIFOLD SLAVE
LEVELING CYLINDER
P/N 21647
SLAVE LEVELING CYLINDER
P/N 22574

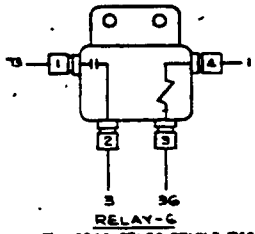

A.C. GENERATOR OPTION 23320
CLEARANCE LIGHTS OPTION P/N 20106
PLATFORM ROTATION OPTION P/N 20010-20021
WORK LIGHTS OPTION P/N 20139
ENGINE SAFETY OPTION P/N 22300
ROTATING BEACON P/N 20017
SIGNAL HORN OPTION P/N 20144
TRAVEL HORN OPTION P/N 20105
PLATFORM ROTATION OPTION P/N 20010
TRAVEL HORN OPTION P/N 20105
SIGNAL HORN OPTION P/N 20144
AERIAL WARNING



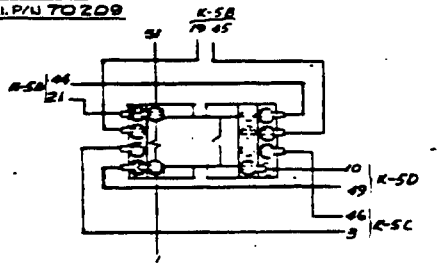
RELAY-1
POWER RELAY
P/N 1116547 DELCO REMY
M.I.P/N 70209



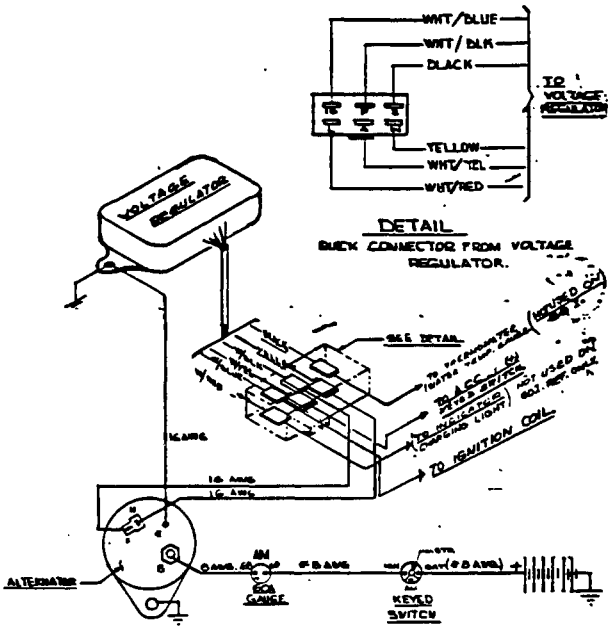
RELAY-3
POWER RELAY
P/N 1116547 DELCO REMY
M.I.P/N 70209



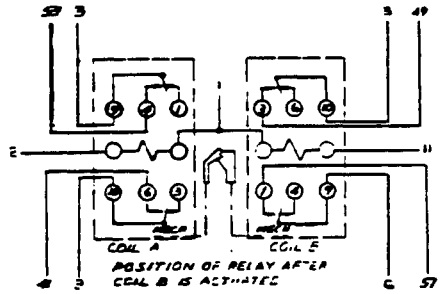
RELAY-6
P/N 6262 DELCO REMY D-1968



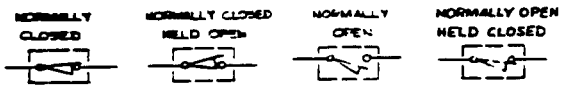
RELAY K-5
BASE RELAY MEC P/N 5745-05 M.I.P/N. 70214.
RELAY SQUARE "D" P/N BECI RSD14A OR 70215.



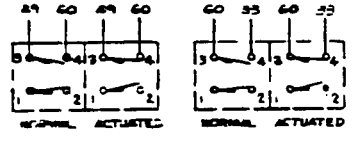
WIRING DIAGRAM FOR ALTERNATOR AND VOLTAGE REGULATOR
H-20 NISSAN MODEL



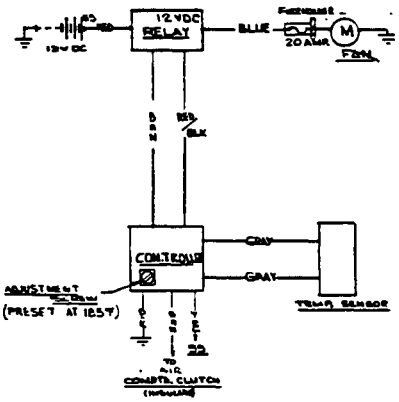
RELAY-2
LATCHING TYPE M.I.P/N 20573
P/N KB17DS POTTER-BRUMFIELD



LEGEND FOR LIMIT SWITCHES

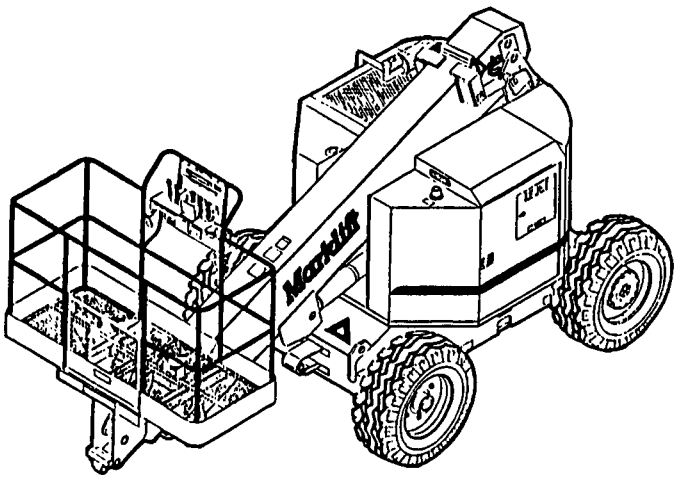


LIMIT SWITCH NO.1 LIMIT SWITCH NO.2



WIRING FOR 14" ELECTRA-SWIRL FAN
HAYDEN # 3655 M.I.P/N 65693

REV.



THIS **PARTS CHAPTER** IS DESIGNED AS:

SECTION 1 MARKLIFT PARTS CHAPTER
- FIGURE 1 HOW TO ORDER PARTS
- FIGURE 2 HOW TO USE PARTS CATALOG

SECTION 2 MARKLIFT
- FIGURE 1 FINAL ASSEMBLY **MARKLIFT**
- FIGURE 2 AERIAL CONTROL CONSOLE ASSEMBLY
- FIGURE 3 FOOT SWITCH ASSEMBLY
- FIGURE 4 SHEET METAL KIT
- FIGURE 5A HYDRAULIC HOSE DIAGRAM

SECTION 3 CARRIAGE ASSEMBLY
- FIGURE 1 CARRIAGE ASSEMBLY
- FIGURE 2 STEERING ASSEMBLY
- FIGURE 3 STEERING YOKE ASSEMBLY (L.H.)
- FIGURE 4 TIE ROD ASSEMBLY
- FIGURE 5 STEERING CYLINDER ASSEMBLY
- FIGURE 6 STEERING ARM ASSEMBLY
- FIGURE 7 STEERING YOKE ASSEMBLY (R.H.)
- FIGURE 8 BRAKE ASSEMBLY
- FIGURE 9 HYDRAULIC MOTOR ASSEMBLY
- FIGURE 10 DRIVE/BRAKE VALVE ASSEMBLY
- FIGURE 11 ROTATION GEAR BOX ASSEMBLY

SECTION 4 TURRET ASSEMBLY

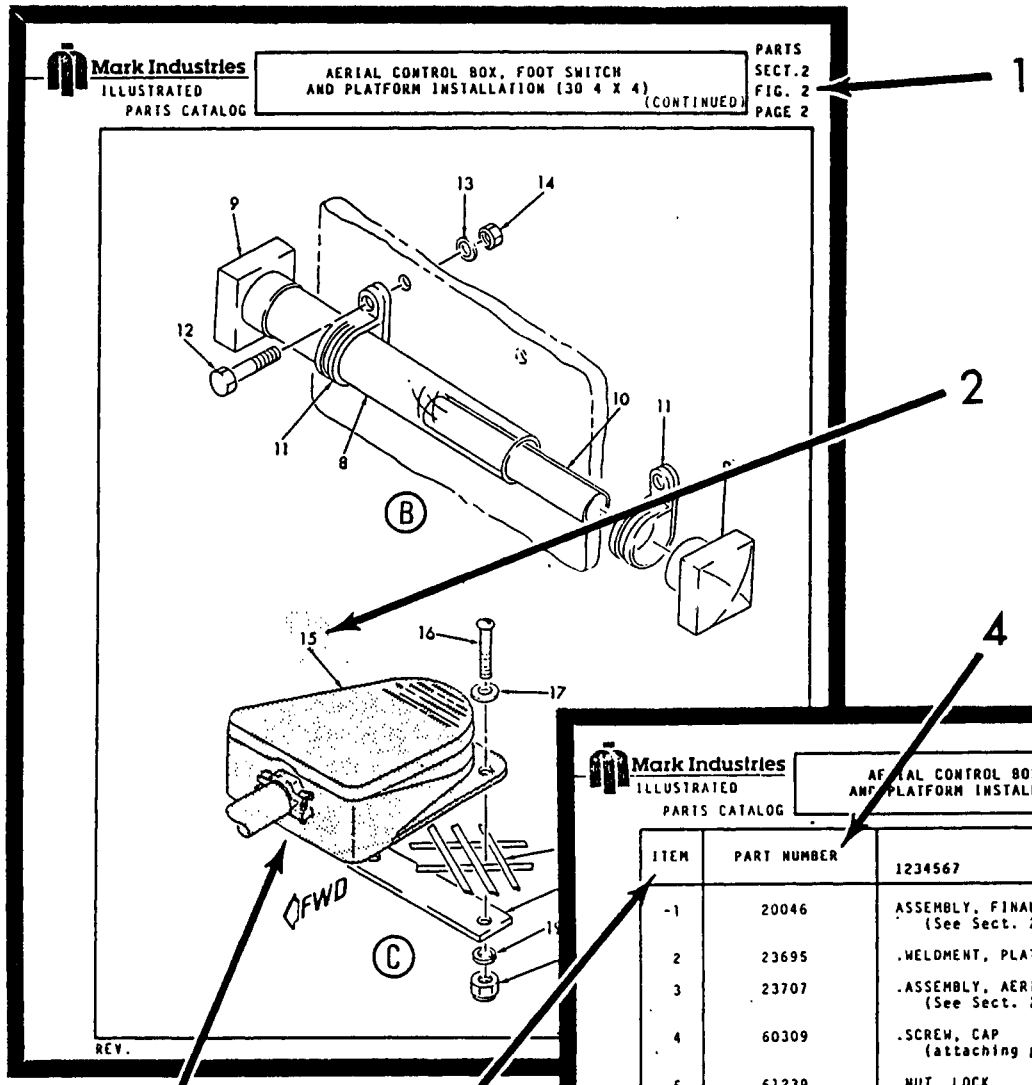
FIGURE 1 TURRET ASSEMBLY
FIGURE 2 ENGINE AND PUMP ASSEMBLY
FIGURE 3 ROTARY MANIFOLD ASSEMBLY
FIGURE 4 SHIFT CYLINDER ASSEMBLY
FIGURE 5 SOLENOID VALVE ASSEMBLY
FIGURE 6 GROUND CONTROL BOX ASSEMBLY
FIGURE 7 PROPORTIONAL VALVE ASSEMBLY
FIGURE 8 MINI-PAK ASSEMBLY
FIGURE 9 RELIEF VALVE ASSEMBLY
FIGURE 10 DUAL OVER CENTER VALVE ASSEMBLY
FIGURE 11 LIFT CYLINDER ASSEMBLY
FIGURE 12 MASTER LEVELING CYLINDER ASSEMBLY
FIGURE 13 PILOT MANIFOLD VALVE ASSEMBLY
FIGURE 14 L.P.G. LINE SWIVEL JOINT ASSEMBLY
FIGURE 15 HYDRAULIC TANK ASSEMBLY
FIGURE 16 SOLENOID VALVE ASSEMBLY
FIGURE 17 CHECK VALVE ASSEMBLY

SECTION 5 BOOM ASSEMBLY

FIGURE 1A FINAL BOOM ASSEMBLY (AFT. JUN. 86)
FIGURE 1B FINAL BOOM ASSEMBLY (BEF. JUN. 86)
FIGURE 2A INTERMEDIATE BOOM ASSEMBLY (AFT. JUN. 86)
FIGURE 2B INTERMEDIATE BOOM ASSEMBLY (BEF. JUN. 86)
FIGURE 3A INNER BOOM ASSEMBLY (AFT. JUN. 86)
FIGURE 3B INNER BOOM ASSEMBLY (BEF. JUN. 86)
FIGURE 4A EXTENSION CYLINDER ASSEMBLY (AFT. JUN. 86)
FIGURE 4B EXTENSION CYLINDER ASSEMBLY (BEF. JUN. 86)
FIGURE 5A EXTENSION CYLINDER SUB-ASSEMBLY (AFT. JUN. 86)
FIGURE 5B EXTENSION CYLINDER SUB-ASSEMBLY (BEF. JUN. 86)
FIGURE 6 SLAVE LEVELING CYLINDER ASSEMBLY
FIGURE 7 SLAVE LEVELING CYLINDER SUB-ASSEMBLY

SECTION 6 OPTIONAL ASSEMBLIES

FIGURE 1 GROUND AND AERIAL 110 VAC RECEPTACLES
FIGURE 2 CLEARANCE, STOP AND TURNING LIGHTS
FIGURE 3 ROTATING BEACON INSTALLATION
FIGURE 4 PLATFORM ROTATION INSTALLATION
FIGURE 5 MINI-PAK SUB-ASSEMBLY
FIGURE 6 12 VOLT PLATFORM WORKLIGHT



Mark Industries
ILLUSTRATED
PARTS CATALOG
AERIAL CONTROL BOX, FOOT SWITCH AND PLATFORM INSTALLATION (30 4 X 4) (CONTINUED)
PARTS
SECT.2
FIG. 2
PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20046	ASSEMBLY, FINAL (See Sect. 2, Fig. 1 for NHA)	REF
2	23695	.WELDMENT, PLATFORM 5'	1
3	23707	.ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for Details)	1
4	60309	.SCREW, CAP (attaching part)	AR
5	61239	.NUT, LOCK (attaching part)	AR
6	65910	.BOLT, SNAP OPEN EYE	4
7	255	.TIE, CABLE	9
8	130927	.CONTAINER, PLASTIC	1
9	65842	.CAP, ANTI-ROLL	2
10	16629	.HANDBOOK, OPERATION SAFETY	1
11	65867	.CLAMP, UMPCO	2
12	60314	.SCREW, CAP (attaching part)	2
13	63401	.WASHER, FLAT (attaching part)	2
14	61239	.NUT, LOCK (attaching part)	2
15	92202	.SWITCH, FOOT	1
[illegible]	60314	.SCREW, CAP (attaching part)	2
17	63401	.WASHER, FLAT (attaching part)	2
18	23753	.BACKING PLATE DEADMAN SWITCH	1
19	63301	.WASHER, LOCK (attaching part)	2
20	63701	.NUT, HEX (attaching part)	2

REV. - ITEM NOT ILLUSTRATED

1. **PART NUMBER**

   STEP 1. Locate Section and Figure number within the table of contents and each Section page.

   STEP 2. Match your required part with the illustration page.

   STEP 3. Refer to the item number on the detail part list page.

   STEP 4. Part number is located in the part number column. Order by using that part number.

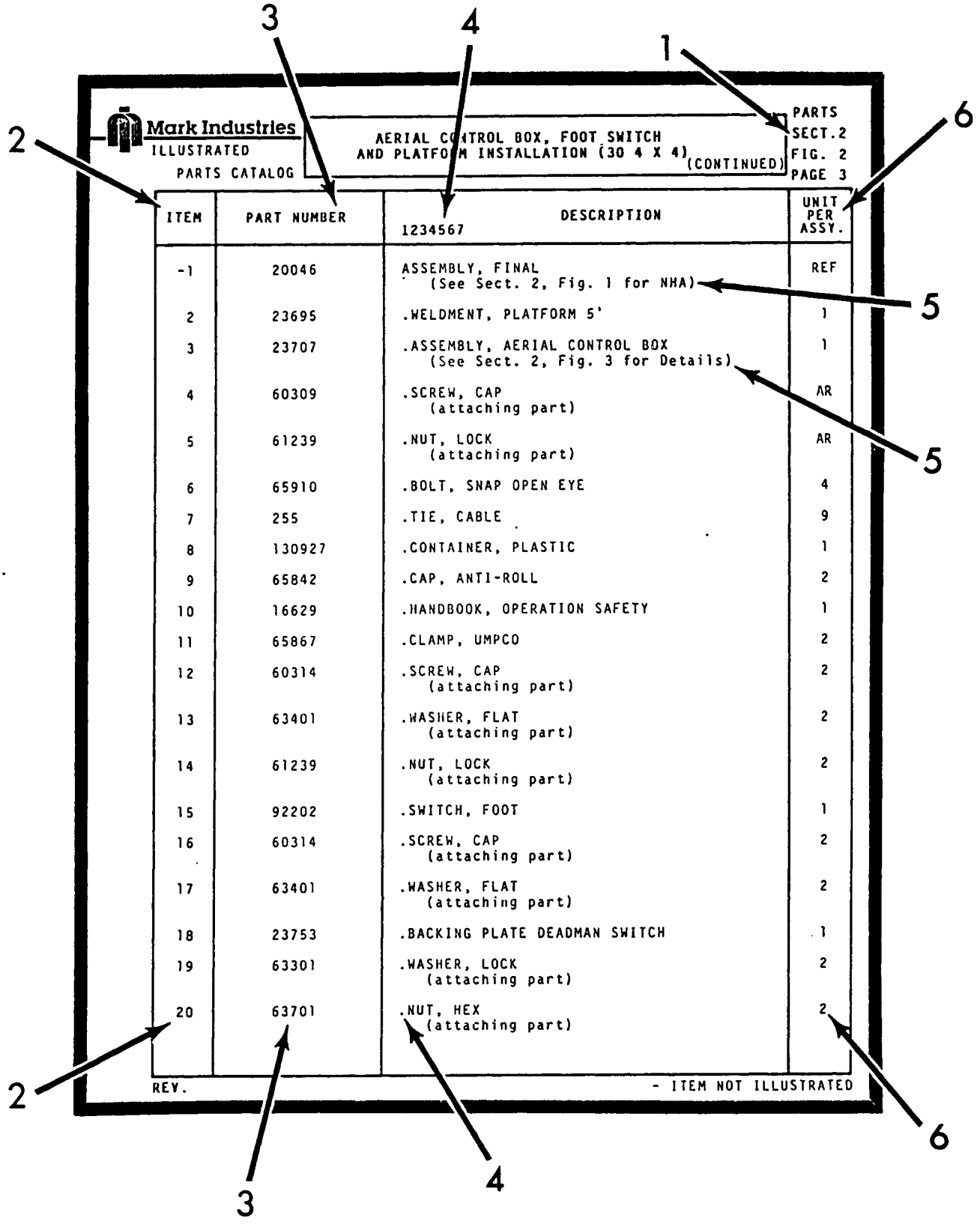
2. **TO ORDER:**

   By phone: Service Department

   (800) 421-1826
   or
   (213) 639-9700

   By mail: Attention Service Department

   MARK INDUSTRIES
   Post Office Box 720
   Long Beach, CA 90801



Mark Industries
ILLUSTRATED
PARTS CATALOG

AERIAL CONTROL BOX, FOOT SWITCH AND PLATFORM INSTALLATION (30 4 X 4) (CONTINUED)

PARTS
SECT. 2
FIG. 2
PAGE 3

ITEM	PART NUMBER	1234567 DESCRIPTION	UNIT PER ASSY.
-1	20046	ASSEMBLY, FINAL (See Sect. 2, Fig. 1 for NHA)	REF
2	23695	.WELDMENT, PLATFORM 5'	1
3	23707	.ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for Details)	1
4	60309	.SCREW, CAP (attaching part)	AR
5	61239	.NUT, LOCK (attaching part)	AR
6	65910	.BOLT, SNAP OPEN EYE	4
7	255	.TIE, CABLE	9
8	130927	.CONTAINER, PLASTIC	1
9	65842	.CAP, ANTI-ROLL	2
10	16629	.HANDBOOK, OPERATION SAFETY	1
11	65867	.CLAMP, UMPCO	2
12	60314	.SCREW, CAP (attaching part)	2
13	63401	.WASHER, FLAT (attaching part)	2
14	61239	.NUT, LOCK (attaching part)	2
15	92202	.SWITCH, FOOT	1
16	60314	.SCREW, CAP (attaching part)	2
17	63401	.WASHER, FLAT (attaching part)	2
18	23753	.BACKING PLATE DEADMAN SWITCH	1
19	63301	.WASHER, LOCK (attaching part)	2
20	63701	.NUT, HEX (attaching part)	2

REV. - ITEM NOT ILLUSTRATED

1. This area refers to the corresponding illustration.

   1) **Chapter** should be divided with General, Operation, Maintenance, Schematics, Parts, Vendor and Service Bulletins.

   2) **Section and Figure** belong to Parts Chapter only. Please check page of contents and each Section in Parts Chapter.

   3) Page numbers are followed for chapter or section, and figure.

2. The **Item Number** corresponds to the item number shown for the part in the illustration. (Parts with item numbers preceded by a dash are not illustrated such as -1, -5, etc.)

3. **Parts** that carry a **Mark Industries** part number.

4. The **Indenture System** used in the detail parts list of this catalog shows the relationship of one part to another. For a given item, the number of indentures depicts the relationship of the item to the associated installation, next higher assembly, or components of the item as follows:

   1 2 3 4 5 6 7

   Installation
   . Detail parts for installation
   . Assembly
   . Attaching parts for Assembly
   . . Detail parts for Assembly
   . . Sub-Assembly
   . . Attaching parts for Sub-Assembly
   . . . Detail parts for Sub-Assembly
   . . . Sub-Sub-Assembly
   . . . Attaching parts for Sub-Sub-Assembly
   . . . . Detail parts for Sub-Sub-Assembly
   . . . . Sub-Sub-Sub-Assembly

5. **NHA** (Next Higher Assembly) and **DETAILS** - Section and Figure reference catalog location indicates where the installation or assembly is listed under NHA and where illustrated for more detailed breakdown.

6. **UNIT PER ASSEMBLY** - Entries are as follows:

   1) **"REF"** indicates the item is listed previously in the NHA and then again in this figure.

   2) **"AR"** indicates the part is used in a quantity "As Required."

   3) **A number** entry indicates the quantity of the part used in its next higher application.

THIS SECTION 2 IS ILLUSTRATED AS:

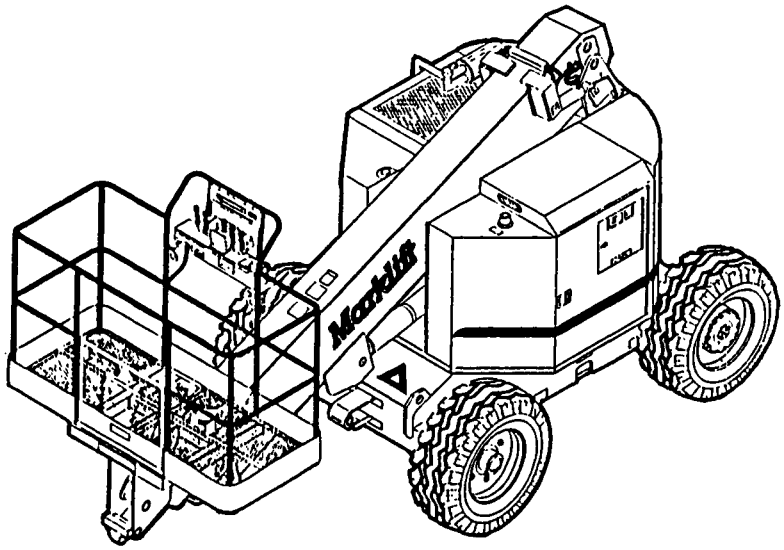
FIGURE 1 FINAL ASSEMBLY MARKLIFT

FIGURE 2 AERIAL CONTROL CONSOLE ASSEMBLY

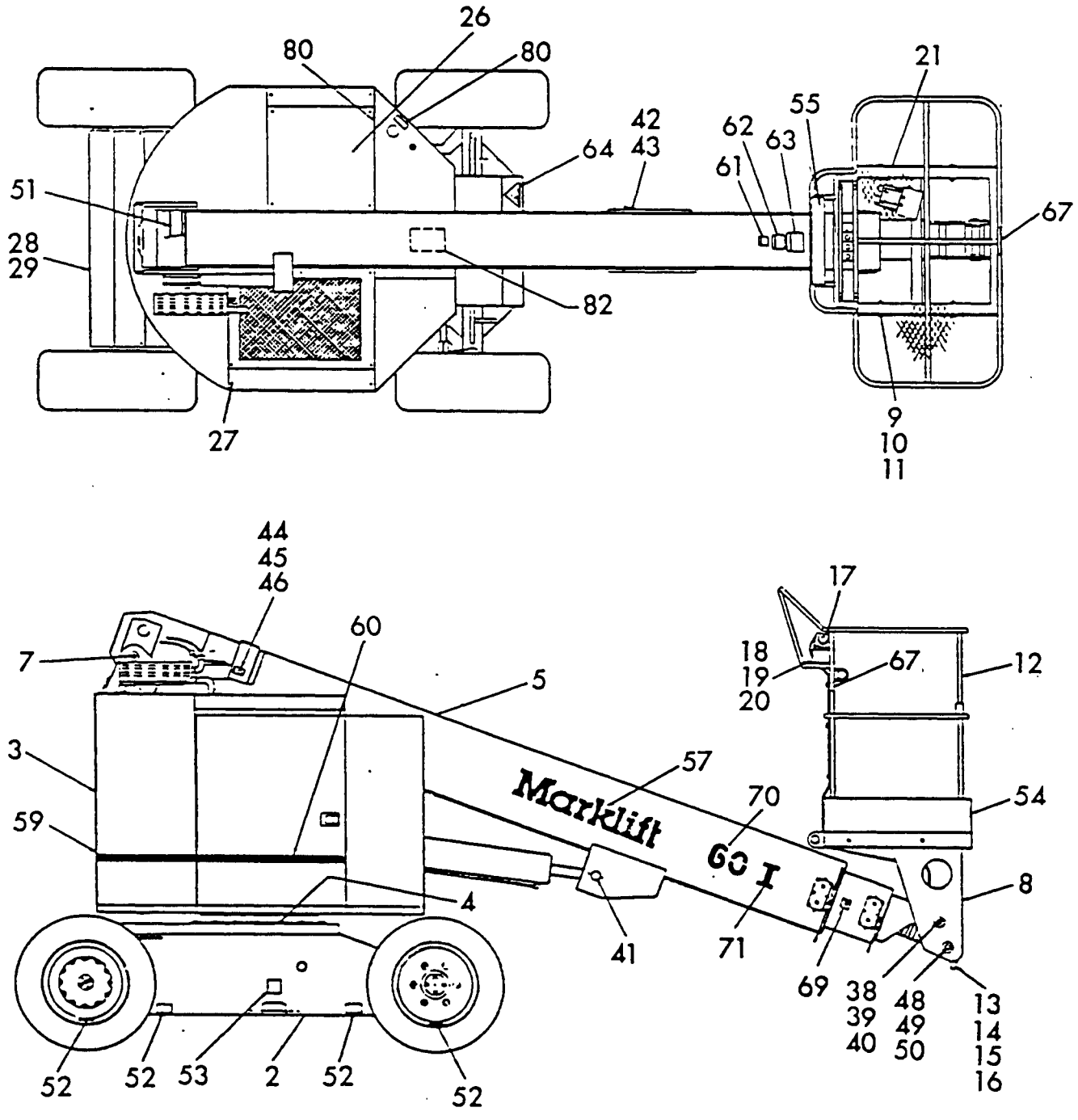
FIGURE 3 FOOT SWITCH ASSEMBLY

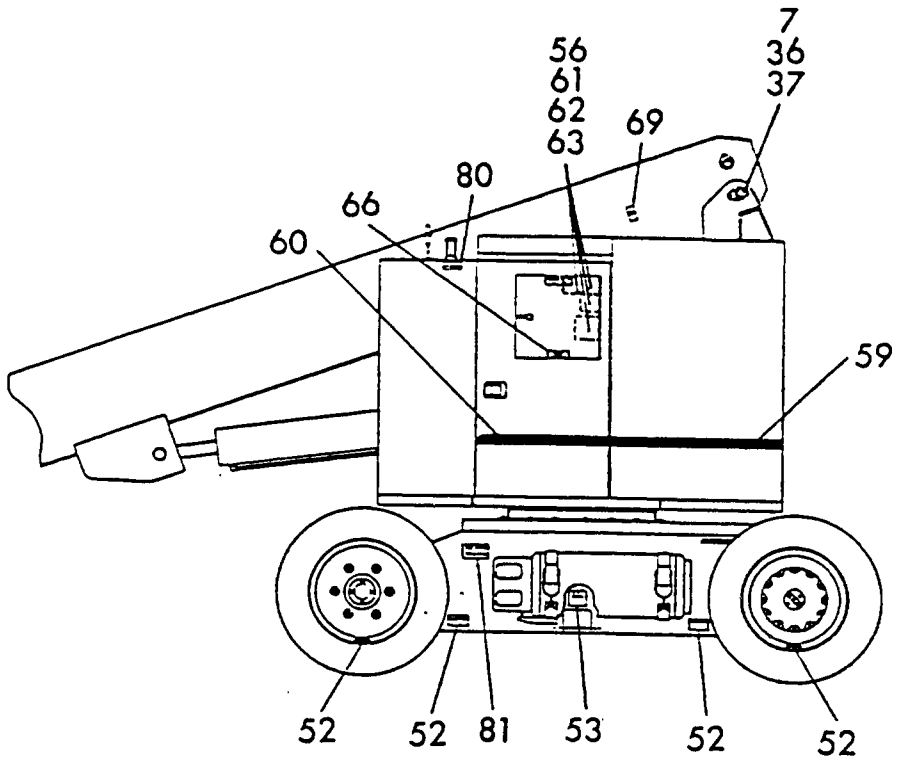
FIGURE 4 SHEET METAL KIT

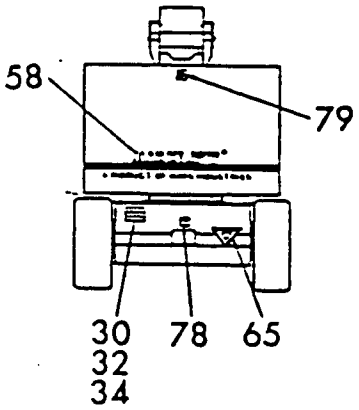
FIGURE 5 HYDRAULIC HOSE DIAGRAM

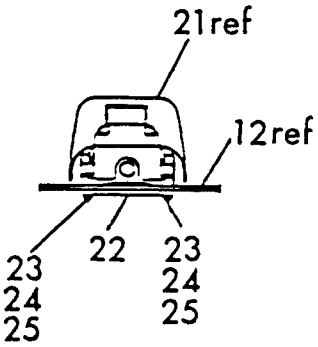


FINAL ASSEMBLY MARKLIFT 60I




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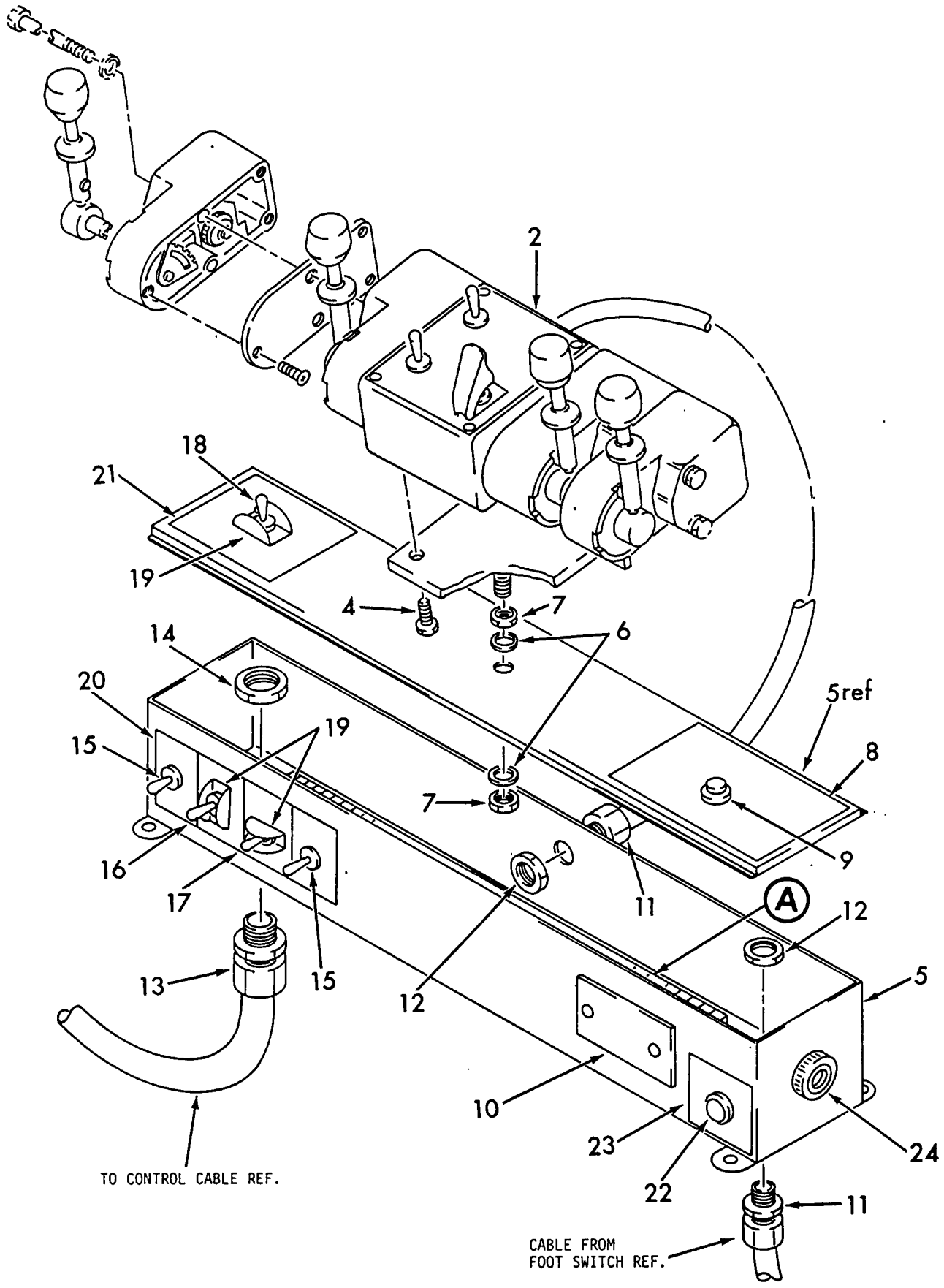
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20023	ASSEMBLY, FINAL MARKLIFT 60I	REF
2	23112	.ASSEMBLY, CARRIAGE (See Sect. 3, Fig. 1 for Details)	1
3	23268	.ASSEMBLY, TURRET (See Sect 4, Fig. 1 for Details)	1
4	60604	.SCREW, CAP (attaching part)	18
5	23026	.ASSEMBLY, FINAL BOOM (AFTER JUN 1986) (See Sect. 5, Fig. 1A for Details)	1
-6	22867	.ASSEMBLY, FINAL BOOM (BEFORE JUN 1986) (See Sect. 5, Fig. 1B for Details)	1
7	65103	.FITTING, GREASE	2
8	20535	.WELDMENT, FORK	1
9	60515	.SCREW, CAP (attaching part)	4
10	63403	.WASHER, FLAT (attaching part)	8
11	61302	.NUT, HEX (attaching part)	4
12	20134	.WELDMENT, PLATFORM	1
13	20552	.BUMPER, PLATFORM	1
14	60323	.SCREW, CAP (attaching part)	4
15	63302	.WASHER, LOCK (attaching part)	4
16	61322	.NUT, LOCK (attaching part)	4
17	23533	.ASSEMBLY, AERIAL CONTROL (See Sect. 2, Fig. 2 for Details)	1
18	60309	.SCREW, CAP (attaching part)	6
19	63301	.WASHER, LOCK (attaching part)	6
20	60701	.NUT, HEX (attaching part)	6
21	20480	.ASSEMBLY, FOOT SWITCH (See Sect. 2, Fig. 3 for Details)	1
22	22742	.PLATE-BACKING, FOOT SWITCH	1
23	60323	.SCREW, CAP (attaching part)	2
24	63302	.WASHER, LOCK (attaching part)	2

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	60702	.NUT, HEX (attaching part)	2
26	22987	.KIT, SHEET METAL (See Sect. 2, Fig. 4 for Details)	1
27	61902	.SCREW, CAP (attaching part)	20
28	22467	.COVER, DRIVE	1
29	61902	.SCREW, CAP (attaching part)	4
30	20660	.PLATE, I.D.	1
-31	63653	.RIVET, POP (attaching part)	4
32	20662	.PLATE, PATENT NUMBER	1
-33	63653	.RIVET, POP (attaching part)	4
34	20661	.PLATE, ANSI A92	1
-35	63653	.RIVET, POP (attaching part)	4
36	23196	.PIN	1
37	60607	.SCREW, CAP (attaching part)	1
38	20457	.PIN	1
39	60607	.SCREW, CAP (attaching part)	1
40	63303	.WASHER, LOCK (attaching part)	1
41	23510	.PIN	1
42	60607	.SCREW, CAP (attaching part)	1
43	63303	.WASHER, LOCK (attaching part)	1
44	22491	.PIN	1
45	60607	.SCREW, CAP (attaching part)	1
46	63303	.WASHER, LOCK (attaching part)	1
-47	65116	.FLUID, HYDRAULIC (46 G/A)	AR
48	20261	.PIN	1
49	60607	.SCREW, CAP (attaching part)	1
50	63303	.WASHER, LOCK (attaching part)	1

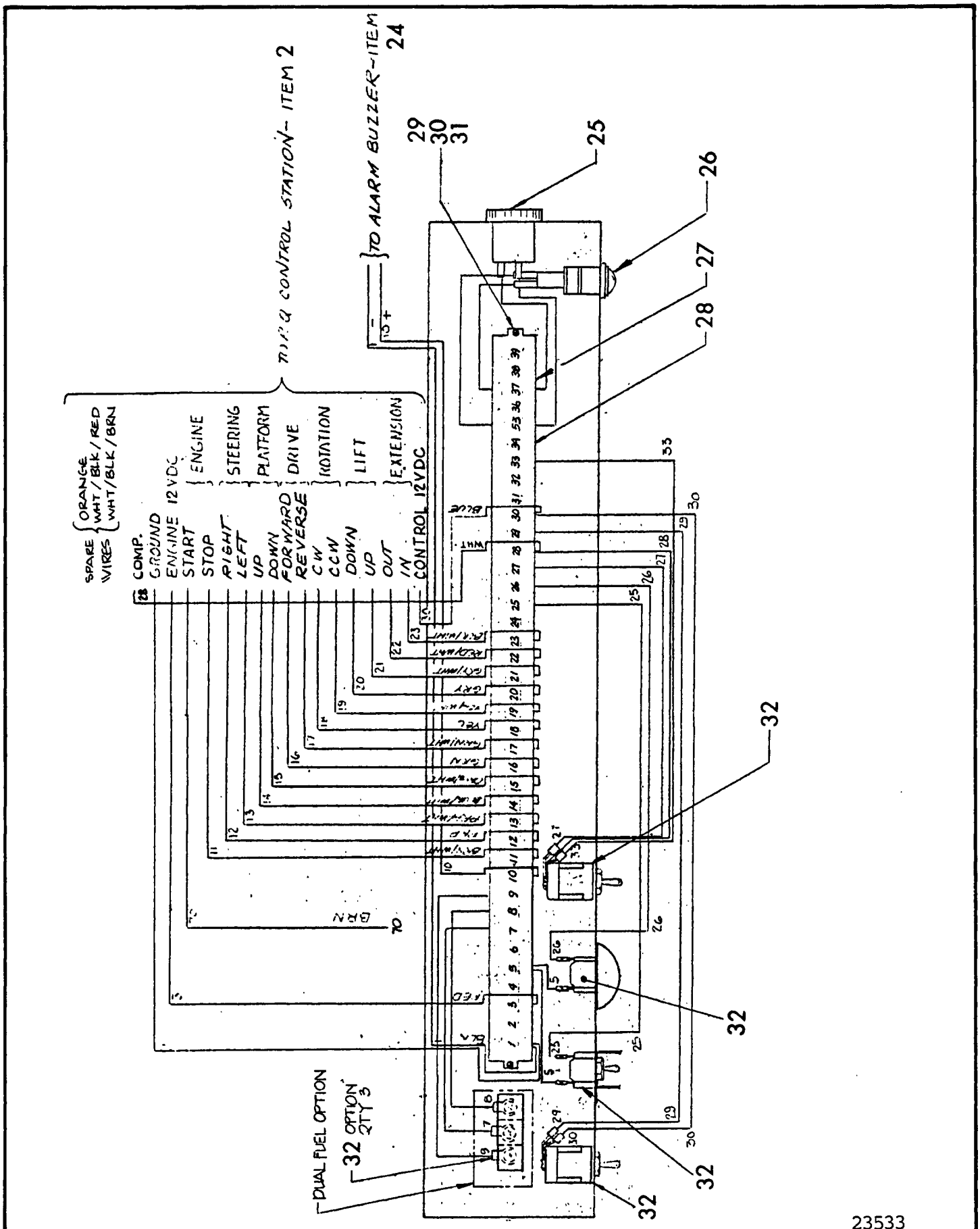
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
51	26454	.TUBE, ROD	1
52	22175	.DECAL, MONO FILLED TIRES	8
53	20508	.DECAL, TRANSPORTATION	2
54	20575	.DECAL, LOAD CAPACITY 600 LBS	1
55	20859	.DECAL, OPERATION INSTRUCTION (AERIAL)	1
56	20860	.DECAL, OPERATION INSTRUCTION (GROUND)	1
57	20408	.DECAL, MARKLIFT	2
58	20409	.DECAL, MARKLIFT PEDESTAL	1
59	20411	.DECAL, STRIPE SQUARE END	5
60	20412	.DECAL, STRIPE ROUND END	2
61	20416	.DECAL, CAUTION	2
62	20417	.DECAL, DANGER DO NOT OPERATE	2
63	20418	.DECAL, DANGER ELECTRICAL HAZARD	2
64	20461	.DECAL, FORWARD ARROW	1
65	20462	.DECAL, FORWARD ARROW AFT	1
66	20495	.DECAL, EMERGENCY GROUND CONTROLS	1
67	22386	.DECAL, ATTACH SAFETY BELT	2
68	2014	.DECAL, UNLAWFUL TO OPERATE	1
69	21237	.DECAL, GREASE FITTING	3
70	23149	.DECAL, 60	2
71	20998	.DECAL, I	2
-72	16608	.PAINT, WHITE FINISH (5 G/A)	AR
-73	16609	.PAINT, BLUE FINISH (0.5 G/A)	AR
-74	65112	.PAINT, (1 GA)	AR
-75	23294	.DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5 for Details)	1
-76	23506	.SCHEMATIC, ELECTRICAL (See Chapter Schematic)	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-77	23275	.SCHEMATIC, HYDRAULIC (See Chapter Schematic)	1
78	20896	.DECAL, OPEN FOR FASTER BRAKING	1
79	20410	.DECAL, **MARK INDUSTRIES** LOGO	1
80	2017	.DECAL, USE DEXRON HYDRAULIC FLUID	3
81	2004	.DECAL, USE VAPOR TANK ONLY	1
82	2003	.DECAL, CHECK BATTERY WATER LEVEL	1

AERIAL CONTROL CONSOLE ASSEMBLY FOR 60I



REV.


TO CONTROL STATION - ITEM 2
TO ALARM BUZZER - ITEM 24
SPARE WIRES ORANGE WHT/BLK/RED WHT/BLK/BRN
COMP. GROUND
ENGINE START
STOP
RIGHT
LEFT
UP
DOWN
FORWARD
REVERSE
CW
CCW
DOWN
UP
OUT
IN
CONTROL 12VDC
12 VDC
ENGINE
STEERING
PLATFORM
DRIVE
ROTATION
LIFT
EXTENSION
DUAL FUEL OPTION
32 OPTION QTY 3
23533

AERIAL CONTROL CONSOLE ASSEMBLY FOR 60I (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23533	ASSEMBLY, AERIAL CONTROL CONSOLE (See Sect. 2, Fig. 1 for NHA)	REF
2	22109	.STATION, AERIAL CONTROL	1
3	20217	.BRACKET, CONTROL MOUNTING	1
4	60633	.SCREW, CAP (attaching part)	4
5	20311	.MACHINING, AERIAL CONTROL BOX	1
6	63302	.WASHER, LOCK (attaching part)	2
7	60702	.NUT, HEX (attaching part)	2
8	20444	.DECAL, 5° SLOPE	1
9	20805	.BUZZER, ALARM	1
10	902	.PLATE, COVER	1
11	2806	.RELIEF, STRAIN	2
12	2808	.NUT, LOCK (attaching part)	2
13	16215	.RELIEF, STRAIN	1
14	16105	.NUT, LOCK (attaching part)	1
15	4017	.SWITCH, TOGGLE	2
16	70037	.SWITCH, MOMENTARY ON-OFF TOGGLE	1
17	20481	.SWITCH, TOGGLE	1
18	4019	.SWITCH, SP 3P	1
19	20884	.GUARD, SWITCH	3
20	22571	.DECAL, AERIAL CONTROL SWITCHES	1
21	20543	.DECAL, DUAL FUEL	1
22	4031	.LIGHT, PILOT INDICATOR	1
23	23630	.DECAL, WARNING LOW OIL PRESSURE OR ENGINE OVERHEAT	1
24	70326	.BUZZER, ALARMING	1
25	66356	.TERMINAL	2
26	117-E	.TERMINAL, PUSH-ON	8

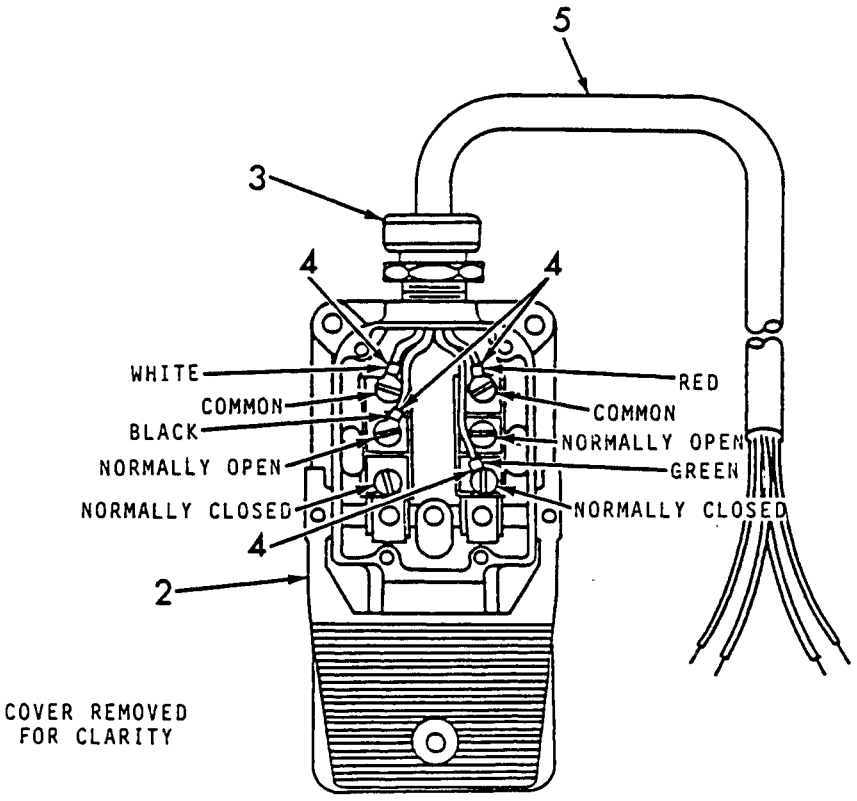
- ITEM NOT ILLUSTRATED

AERIAL CONTROL CONSOLE ASSEMBLY FOR 60I (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
27	117-A	.END, TERMINAL BLOCK	1
28	4027	.BLOCK, TERMINAL	39
29	62624	.SCREW, CAP (attaching part)	5
30	63311	.WASHER, LOCK (attaching part)	5
31	61501	.NUT, HEX (attaching part)	5
32	117-C	.RING, CONNECTOR	6

- ITEM NOT ILLUSTRATED

FOOT SWITCH ASSEMBLY

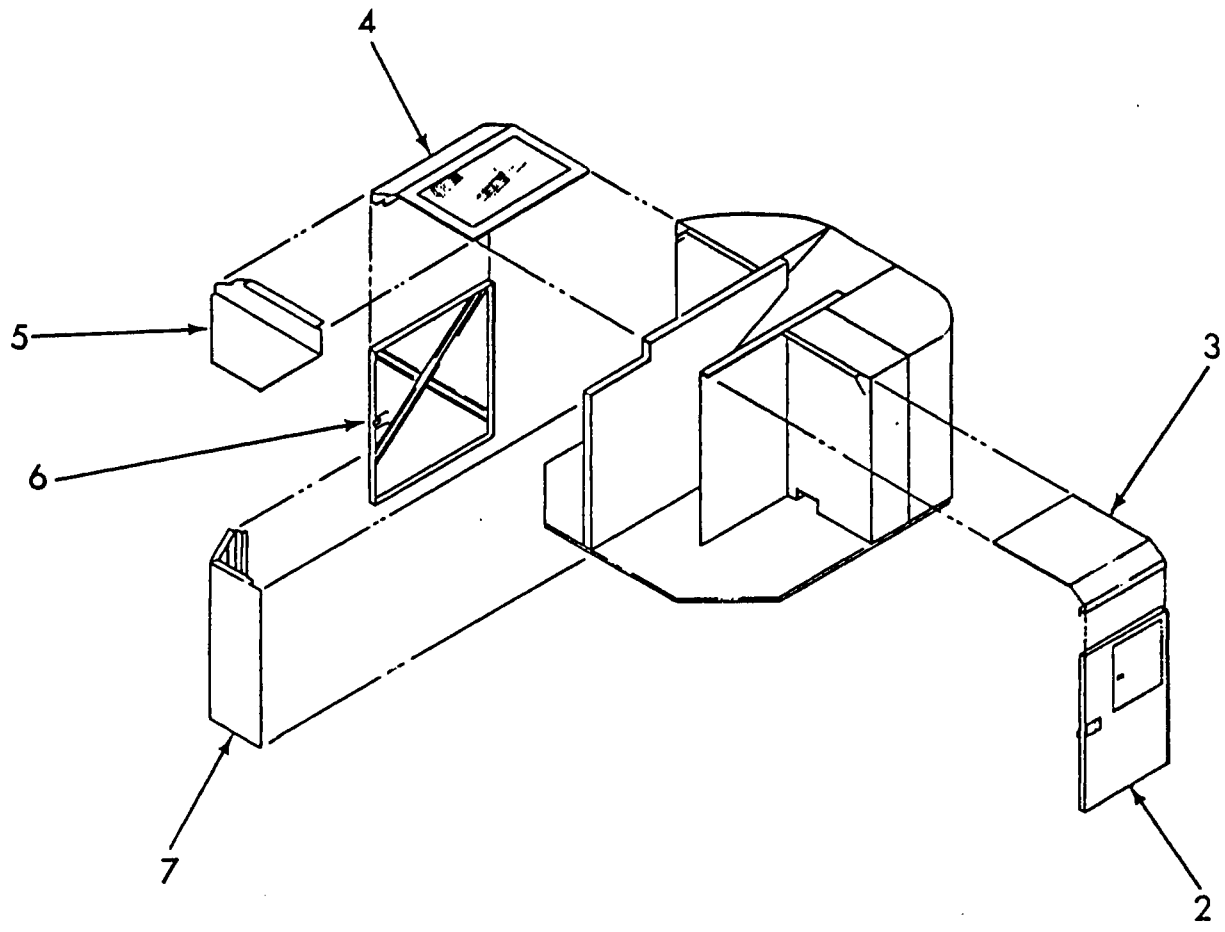


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20480	FOOT SWITCH ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	20212	.SWITCH, FOOT	1
3	2531	.RELIEF, STRAIN	1
4	876	.RING, TERMINAL	4
5	2912	.CABLE (5 FT.)	AR

REV

- ITEM NOT ILLUSTRATED

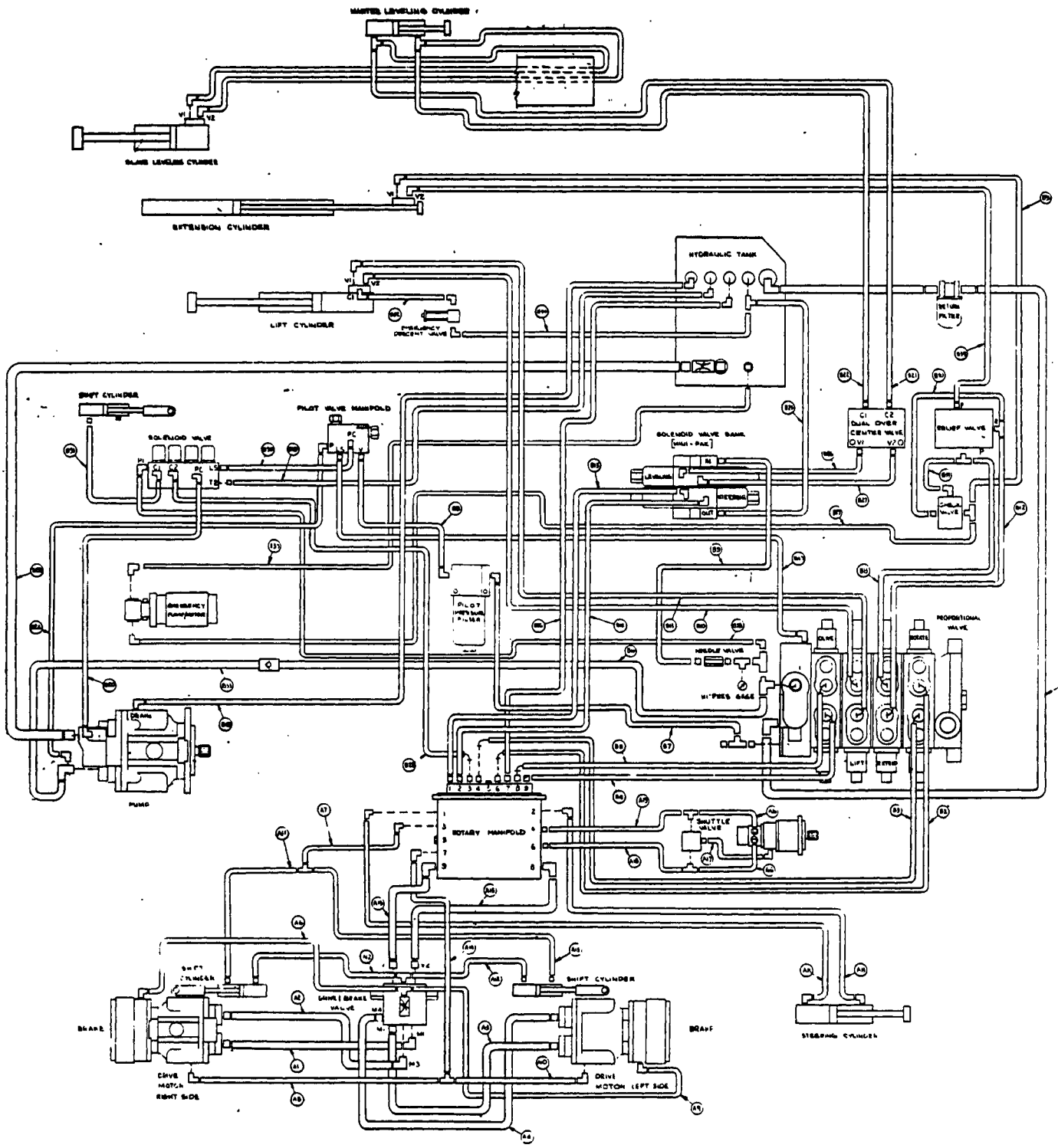
SHEET METAL KIT



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22987	KIT, SHEET METAL (See Sect. 2, Fig. 1 for NHA)	REF
2	22988	.DOOR, RIGHT	1
3	22989	.COVER, TOP RIGHT	1
4	21045	.COVER, TOP LEFT	1
5	21046	.COVER, TOP LEFT REAR	1
6	21047	.DOOR, LEFT	1
7	21048	.COVER, NOSE LEFT	1

- ITEM NOT ILLUSTRATED

HYDRAULIC HOSE DIAGRAM FOR 60I



REV.

HYDRAULIC HOSE DIAGRAM FOR 60I (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23294	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 1 for NHA)	REF
-2	23294 - KIT A	.KIT, HYDRAULIC HOSE BASE	1
A1	13215-12-0270	..ASSEMBLY, HOSE	1
A2	13214-12-0230-45°	..ASSEMBLY, HOSE	1
A3	13214-12-0210	..ASSEMBLY, HOSE	1
A4	13214-12-0190-180°	..ASSEMBLY, HOSE	1
A5	13210-06-0140	..ASSEMBLY, HOSE	1
A6	13213-04-0220	..ASSEMBLY, HOSE	1
A7	13210-04-0600	..ASSEMBLY, HOSE	1
A8	13210-04-0410	..ASSEMBLY, HOSE	2
A9	13213-04-0340	..ASSEMBLY, HOSE	1
A10	13210-06-0100	..ASSEMBLY, HOSE	1
A11	13213-04-0180	..ASSEMBLY, HOSE	1
A12	13213-04-0200	..ASSEMBLY, HOSE	2
A13	13213-04-0160	..ASSEMBLY, HOSE	1
A14	13210-06-0510	..ASSEMBLY, HOSE	1
A15	13213-12-0450	..ASSEMBLY, HOSE	2
A16	13210-06-0100	..ASSEMBLY, HOSE	2
A17	13213-04-0200	..ASSEMBLY, HOSE	1
A18	13210-06-0140	..ASSEMBLY, HOSE	1
A19	13210-06-0174	..ASSEMBLY, HOSE	1

- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-3	23294 - KIT B	.KIT, HYDRAULIC HOSE TURRET	1
B1	13205-16-0230	..ASSEMBLY, HOSE	1
B2	13214-06-0260	..ASSEMBLY, HOSE	1
B3	13215-06-0290	..ASSEMBLY, HOSE	1
B4	13215-12-0340	..ASSEMBLY, HOSE	1
B5	13214-12-0300	..ASSEMBLY, HOSE	1
B6	13210-12-0420	..ASSEMBLY, HOSE	1
B7	13210-06-0360	..ASSEMBLY, HOSE	1
B8	13210-06-0760	..ASSEMBLY, HOSE	1
B9	13213-06-0470	..ASSEMBLY, HOSE	1
B10	13213-06-0740	..ASSEMBLY, HOSE	1
B11	13212-06-0790	..ASSEMBLY, HOSE	1
B12	13215-08-0260-45°	..ASSEMBLY, HOSE	1
B13	13213-08-0270	..ASSEMBLY, HOSE	1
B14	13213-04-0350	..ASSEMBLY, HOSE	1
B15	13213-08-0300	..ASSEMBLY, HOSE	1
B16	13218-08-0540	..ASSEMBLY, HOSE	1
B17	13210-04-0590	..ASSEMBLY, HOSE	1
B18	13210-06-0770	..ASSEMBLY, HOSE	1
B19	13210-06-0750	..ASSEMBLY, HOSE	1
B20	13213-04-0600	..ASSEMBLY, HOSE	1
B21	13213-04-0580	..ASSEMBLY, HOSE	1
B22	13213-04-0690	..ASSEMBLY, HOSE	1
B23	13213-04-0460	..ASSEMBLY, HOSE	1
B24	13213-06-0670	..ASSEMBLY, HOSE	1
B25	13213-06-0620	..ASSEMBLY, HOSE	1
B26	13210-04-0164	..ASSEMBLY, HOSE	1

HYDRAULIC HOSE DIAGRAM FOR 60I (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
B27	13210-04-0170	..ASSEMBLY, HOSE	1
B28	13203-20-0500	..ASSEMBLY, HOSE	1
B29	13213-06-0130	..ASSEMBLY, HOSE	1
B30	13210-04-0280	..ASSEMBLY, HOSE	1
B31	13210-04-0530	..ASSEMBLY, HOSE	1
B32	13210-04-0770	..ASSEMBLY, HOSE	1
B33	13213-12-0090	..ASSEMBLY, HOSE	1
B34	13210-04-0630	..ASSEMBLY, HOSE	1
B35	13213-08-0470	..ASSEMBLY, HOSE	1
B36	13210-08-0490	..ASSEMBLY, HOSE	1
B37	13213-06-0460	..ASSEMBLY, HOSE	1
B38	13213-06-0610	..ASSEMBLY, HOSE	1
B39	13213-04-0130	..ASSEMBLY, HOSE	1
B40	13210-08-0110	..ASSEMBLY, HOSE	1

- ITEM NOT ILLUSTRATED

THIS SECTION 3 IS ILLUSTRATED AS:

FIGURE 1 CARRIAGE ASSEMBLY

FIGURE 2 STEERING ASSEMBLY

FIGURE 3 STEERING YOKE ASSEMBLY (L.H.)

FIGURE 4 TIE ROD ASSEMBLY

FIGURE 5 STEERING CYLINDER ASSEMBLY

FIGURE 6 STEERING ARM ASSEMBLY

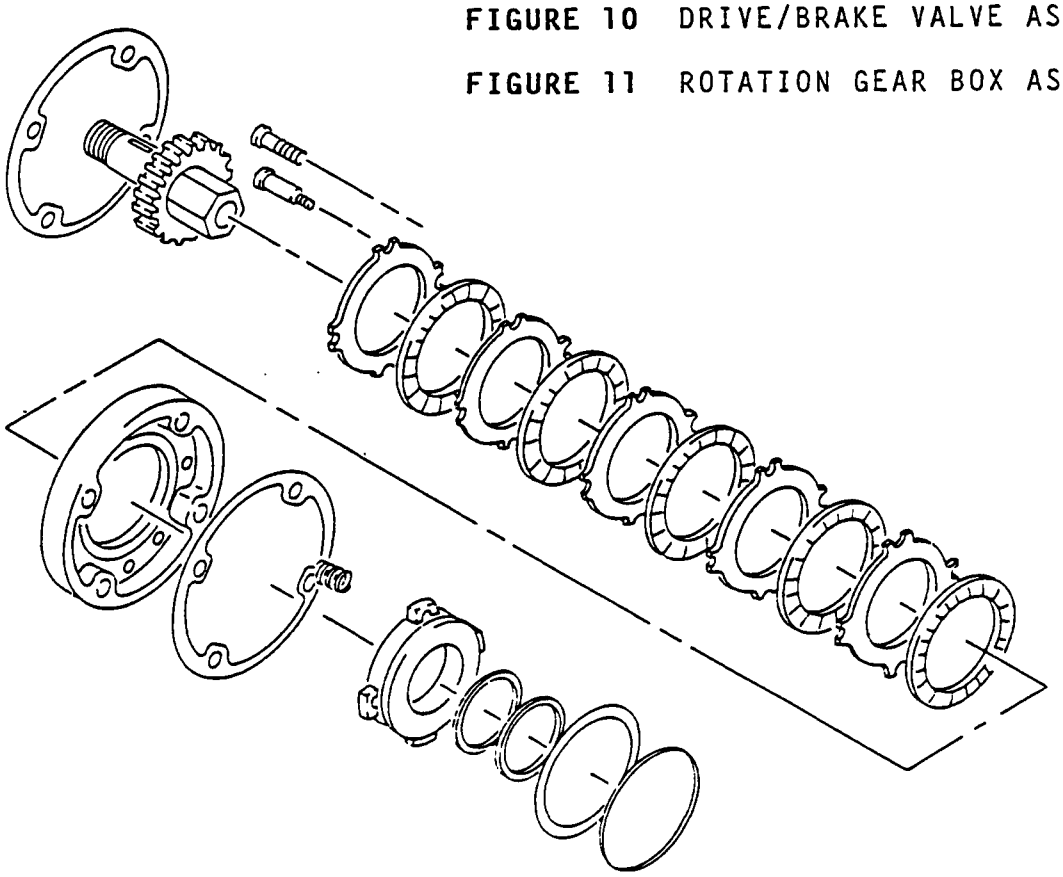
FIGURE 7 STEERING YOKE ASSEMBLY (R.H.)

FIGURE 8 BRAKE ASSEMBLY

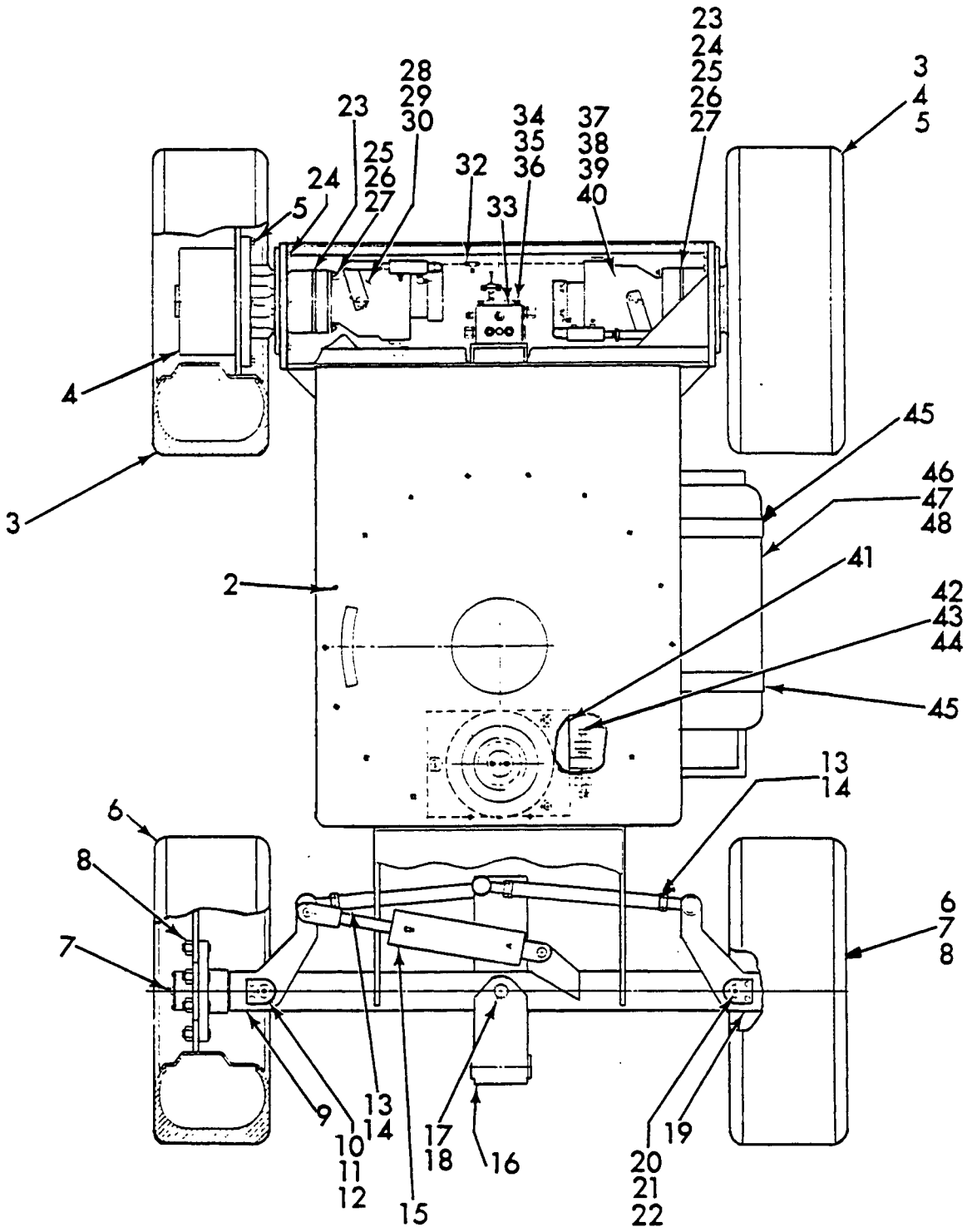
FIGURE 9 HYDRAULIC MOTOR ASSEMBLY

FIGURE 10 DRIVE/BRAKE VALVE ASSEMBLY

FIGURE 11 ROTATION GEAR BOX ASSEMBLY



CARRIAGE ASSEMBLY (60I)



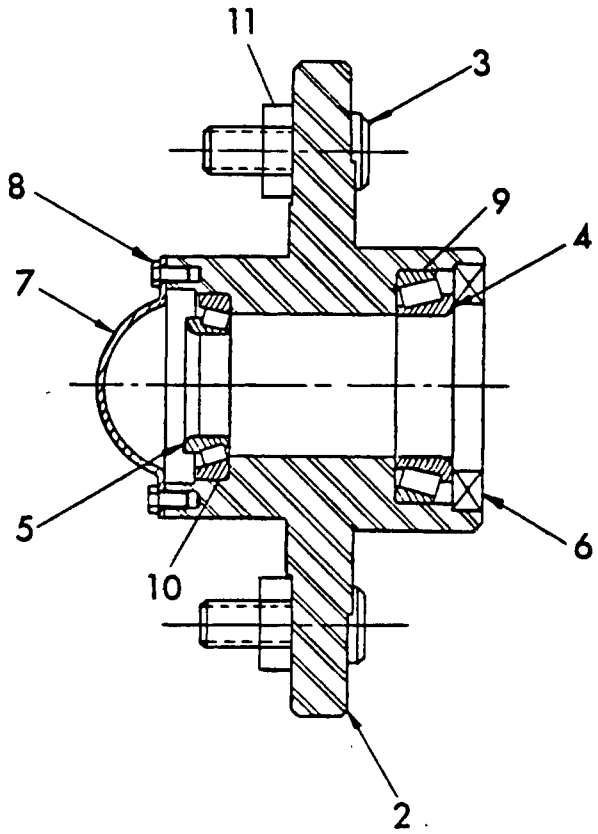
CARRIAGE ASSEMBLY (60I) (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23112	ASSEMBLY, CARRIAGE (See Sect. 2, Fig. 1 for NHA)	REF
2	22993	.WELDMENT, CARRIAGE	1
3	23111	.ASSEMBLY, DRIVE TIRE AND RIM	2
4	22496	.HUB, TORQUE	2
5	60611	.SCREW, CAP (attaching part)	20
6	23110	.ASSEMBLY, STEERING TIRE AND RIM	2
7	21791	.ASSEMBLY, STEERING HUB (See Sect. 3, Fig. 2 for Details)	2
8	65117	.NUT, BALL (attaching part)	12
9	21420	.ASSEMBLY, STEERING YOKE (L.H.) (See Sect. 3, Fig. 3 for Details)	1
10	21428	.PIN (attaching part)	1
11	60603	.SCREW, CAP (attaching part)	2
12	65103	.FITTING, GREASE	1
13	21422	.ASSEMBLY, TIE ROD (See Sect. 3, Fig. 4 for Details)	2
14	64310	.PIN, COTTER (attaching part)	4
15	22476	.ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 5 for Details)	1
16	23155	.ASSEMBLY, STEERING ARM (See Sect. 3, Fig. 6 for Details)	1
17	20794	.PIN (attaching part)	1
18	60603	.SCREW, CAP (attaching part)	2
19	21421	.ASSEMBLY, STEERING YOKE (R.H.) (See Sect. 3, Fig. 7 for Details)	1
20	21428	.PIN (attaching part)	1
21	60603	.SCREW, CAP (attaching part)	2
22	65103	.FITTING, GREASE	1
23	23145	.ASSEMBLY, BRAKE (See Sect. 3, Fig. 8 for Details)	2

- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	60604	.SCREW, CAP (attaching part)	16
25	63633	.STUD	8
26	63305	.WASHER, LOCK (attaching part)	4
27	60705	.NUT, HEX (attaching part)	4
28	21672	.ASSEMBLY, HYDRAULIC MOTOR (See Sect. 3, Fig. 9 for Details)	2
29	80012-10	.ELBOW	4
30	80012-21	.ELBOW	4
-31	65106	.OIL, GEAR (2 Pt)	AR
32	80031-05	.TEE, UNION	1
33	23122	.ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 10 for Details)	1
34	60356	.SCREW, CAP (attaching part)	2
35	63403	.WASHER, FLAT (attaching part)	2
36	63303	.WASHER, LOCK (attaching part)	2
37	23171	.ASSEMBLY, SHIFT CYLINDER STOP	2
38	20795	.PIN, CLEVIS	2
39	60519	.SCREW, CAP (attaching part)	2
40	60706	.NUT, HEX (attaching part)	2
41	22971	.ASSEMBLY, ROTATION GEAR (See Sect. 3, Fig. 11 for Details)	1
42	62224	.SCREW, SET (attaching part)	2
43	22169	.WASHER (attaching part)	2
44	61102	.NUT, JAM (attaching part)	2
45	486-A	.BRACKET, TANK	2
46	486-C	.TANK, LPG	1
47	60628	.SCREW, CAP (attaching part)	2
48	65518	.WASHER, FLAT (attaching part)	2

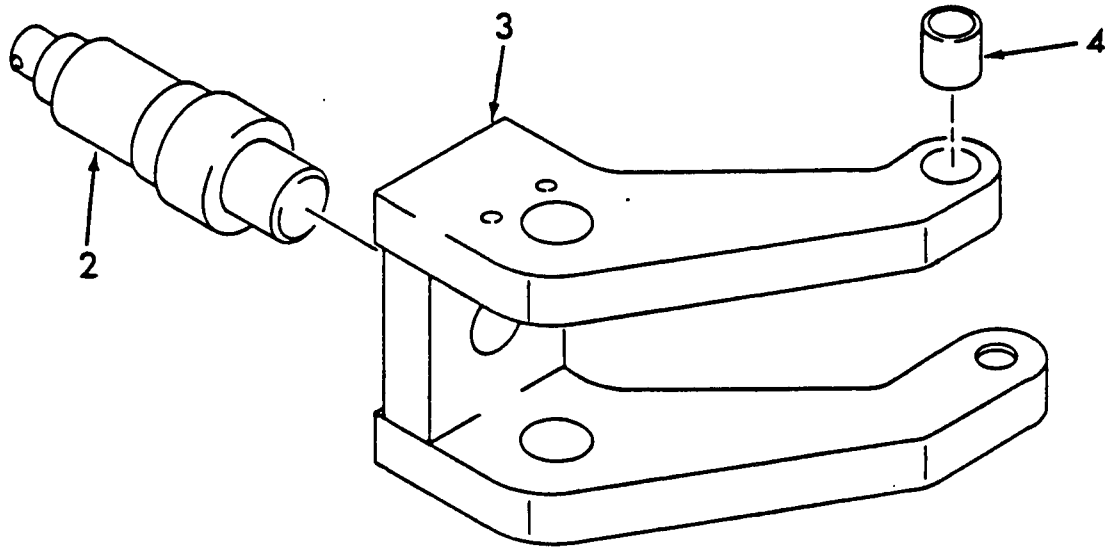
STEERING HUB ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21791	ASSEMBLY, STEERING HUB (See Sect. 3, Fig. 1 for NHA)	REF
2	21792	.HUB, MACHINED	1
3	65351	.BOLT, WHEEL	6
4	21794	.CONE, INNER	1
5	21796	.CONE, OUTER	1
6	21798	.SEAL, GREASE	1
7	21799	.CAP, DUST	1
8	60309	.SCREW, HEX	4
9	21795	.CUP, INNER	1
10	21797	.CUP, OUTER	1
11	65117	.NUT, BALL	6

- ITEM NOT ILLUSTRATED

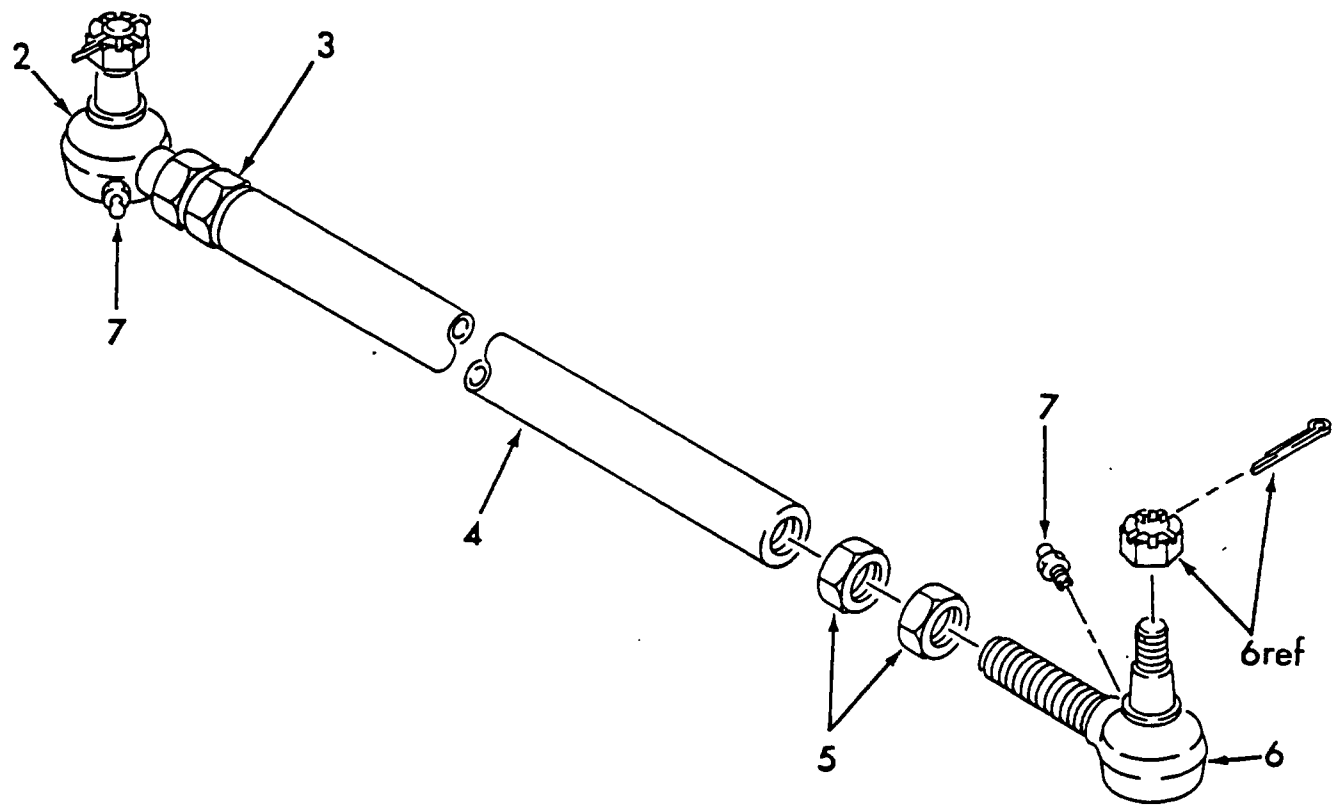
STEERING YOKE ASSEMBLY (L.H.)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21420	ASSEMBLY, STEERING YOKE (L.H.) (SEE SECT. 3, Fig. 1 for NHA)	REF
2	21788	.SPINDLE	1
3	21466	.YOKE (L.H.)	1
4	64913	.BUSHING	1

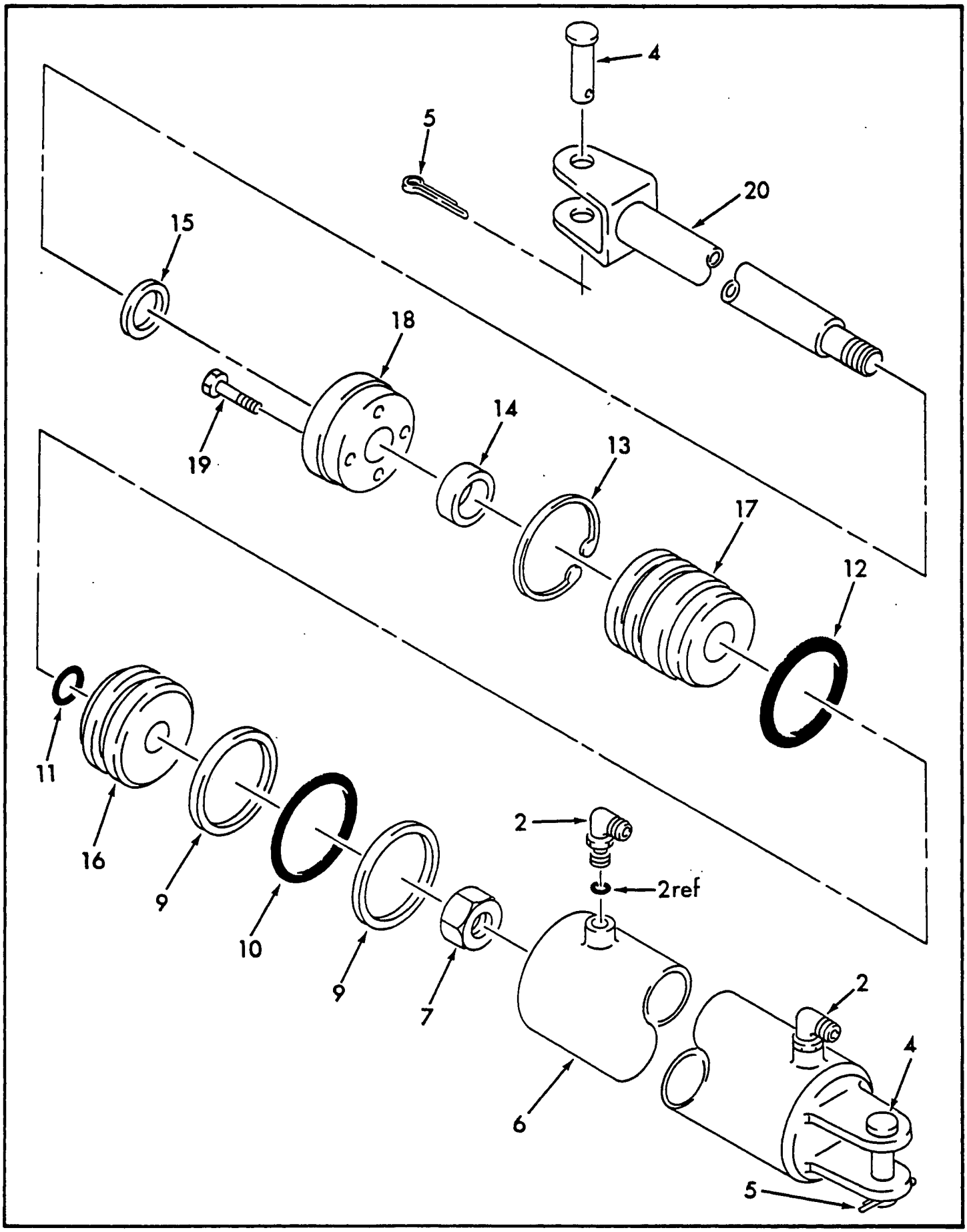
- ITEM NOT ILLUSTRATED

TIE ROD ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21422	ASSEMBLY, TIE ROD (See Sect. 3, Fig. 1 for NHA)	REF
2	20569	.END, TIE ROD	1
3	20567	.NUT, JAM	2
4	21596	.TUBING	1
5	20566	.NUT, JAM	2
6	20568	.END, TIE ROD	1
7	65103	.FITTING, GREASE	2

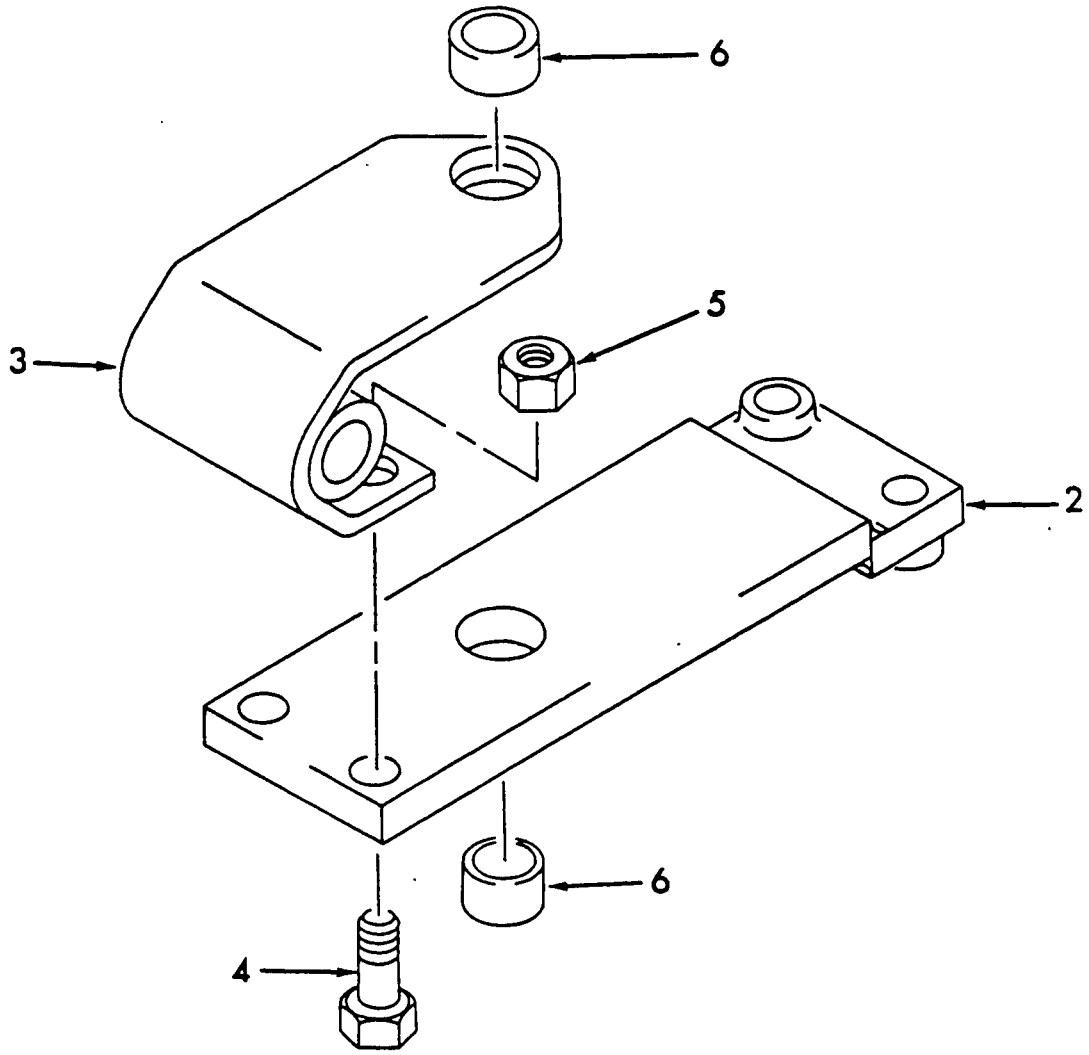
STEERING CYLINDER ASSEMBLY



STEERING CYLINDER ASSEMBLY (CONTINUED)

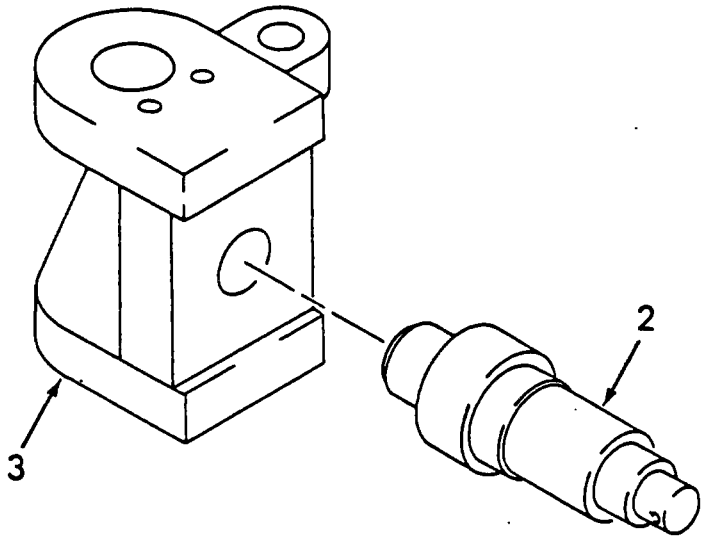
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22476	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 for NHA)	REF
2	80012-03	.ELBOW	2
-3	22450	.CYLINDER, STEERING	1
4		..PIN, CLEVIS	2
5		..PIN, COTTER	2
6		..END, CYLINDER TUBE	1
7		..NUT, SELF LOCKING	1
-8	66963	..KIT, SEAL	1
9		...RING, BACK-UP	2
10		...SEAL, PISTON	1
11		...O-RING	1
12		...SEAL, GLAND	1
13		...WIRE, SAFETY	1
14		...SEAL, ROD	1
15		...WIPER, ROD	1
16		..PISTON	1
17		..HEAD	1
18		..GLAND, PACKING	1
19		..BOLT, PACKING GLAND	1
20		..ROD	1

STEERING ARM ASSEMBLY



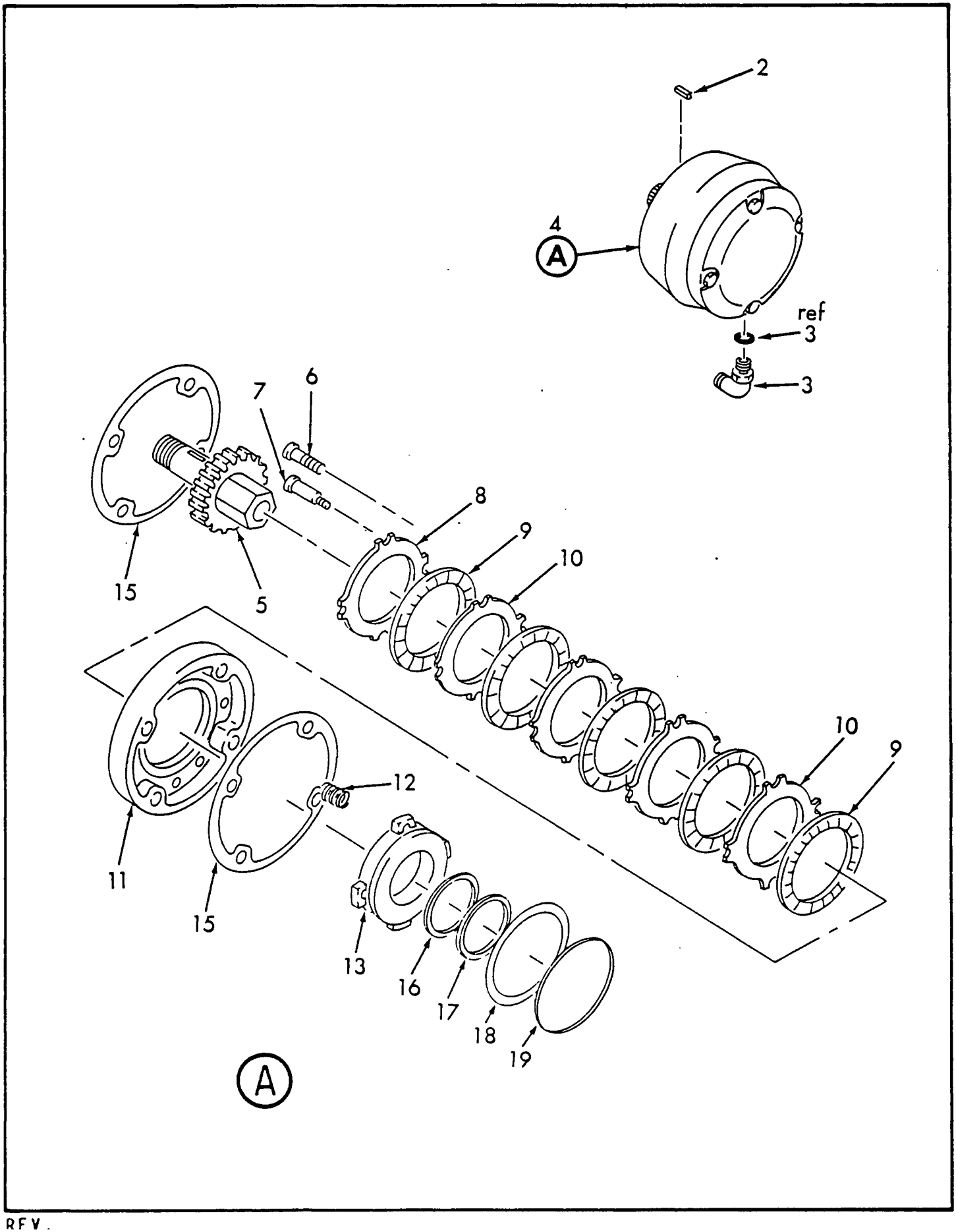
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23155	ASSEMBLY, STEERING ARM (See Sect. 3, Fig. 1 for NHA)	REF
2	21430	.ARM, STEERING	1
3	20777	.BRACKET, SUPPORT	1
4	60506	.SCREW, CAP (attaching part)	2
5	61304	.NUT, LOCK (attaching part)	2
6	23152	.BEARING, SLEEVE	2

STEERING YOKE ASSEMBLY



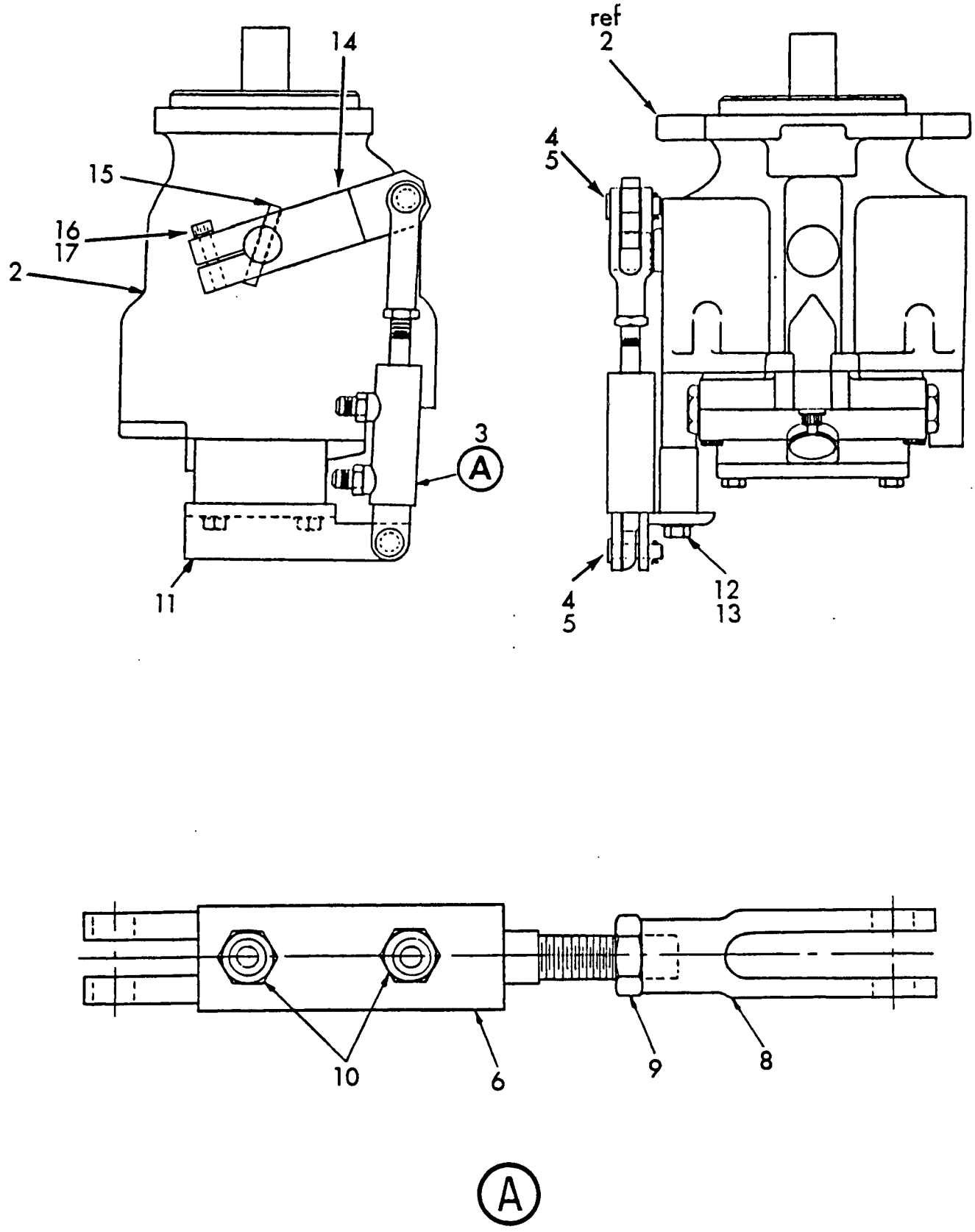
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21421	ASSEMBLY, STEERING YOKE (R.H.) (See Sect. 3, Fig. 1 for NHA)	REF
2	21788	.SPINDLE	1
3	21590	.YOKE (R.H.)	1

BRAKE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23145	ASSEMBLY, BRAKE (See Sect. 3, Fig. 1 for NHA)	REF
2		.KEY, WOODRUFF	1
3	80012-03	.ELBOW	1
4	81131	.BRAKE	1
5		..ASSEMBLY, SPLINE SHAFT	1
6		..SCREW, SOCKET HEAD	4
7		..BOLT, SOCKET HEAD	4
8		..DISC, PRIMARY	1
9		..DISC, ROTOR	5
10		..DISC, STATOR	4
11		..PLATE, SPRING	1
12		..SPRING	8
13		..PISTON	1
-14	66972	..KIT, SEAL	1
15		...GASKET, CASE	2
16		...RING, BACK-UP	1
17		...O-RING	1
18		...RING, BACK-UP	1
19		...O-RING	1

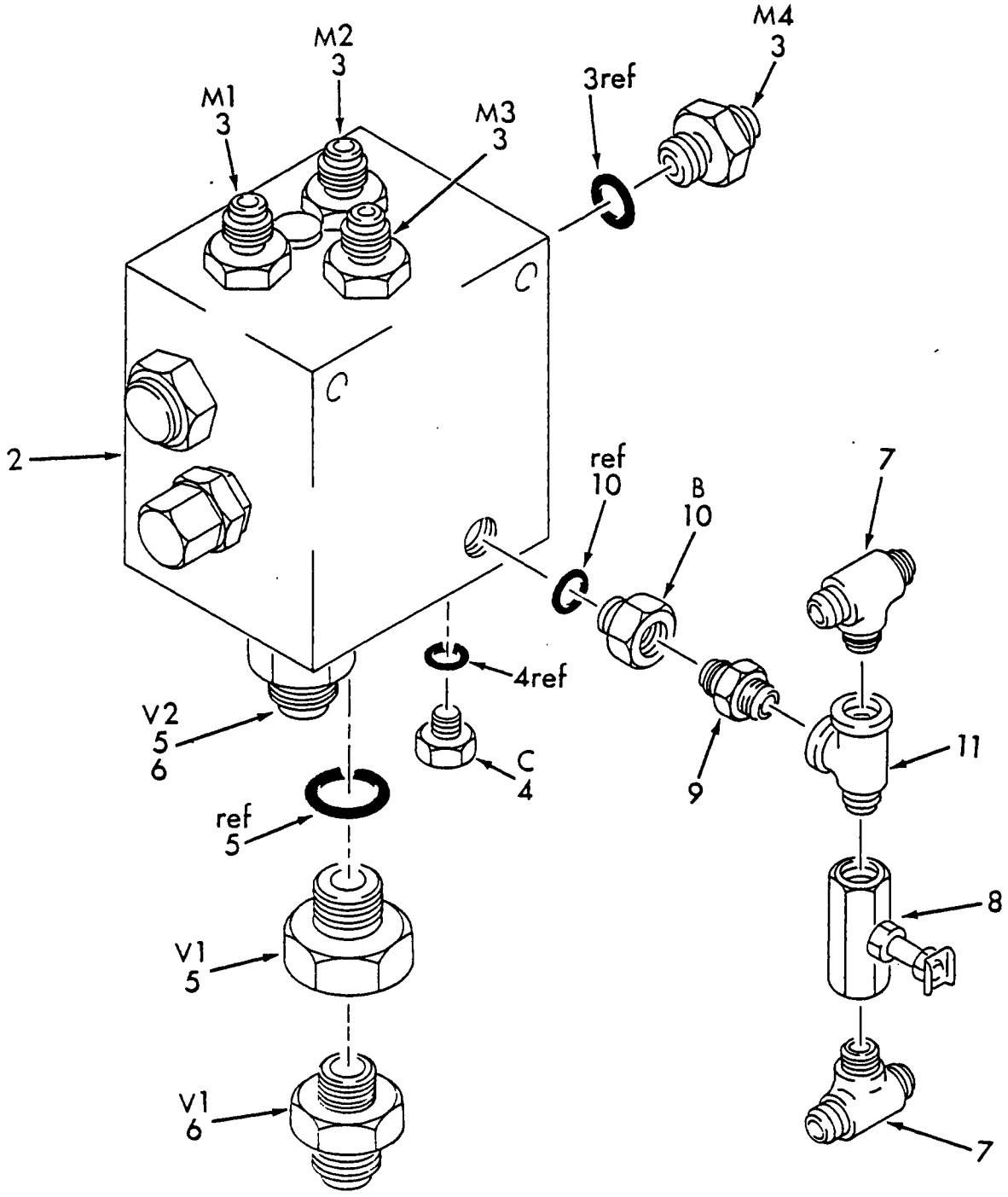
HYDRAULIC MOTOR ASSEMBLY



HYDRAULIC MOTOR ASSEMBLY (CONTINUED)

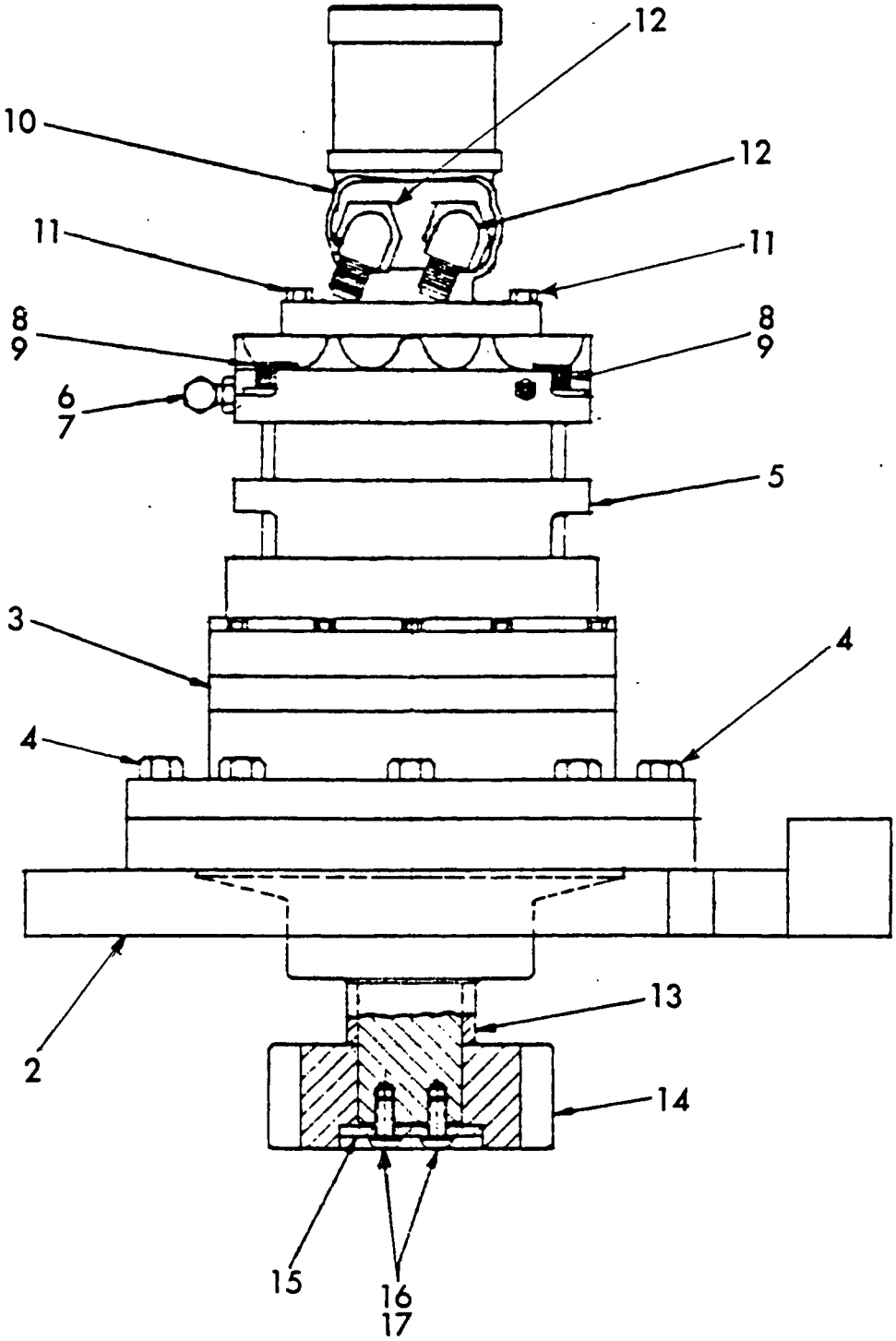
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21672	ASSEMBLY, HYDRAULIC MOTOR (See Sect. 3, Fig. 1 for NHA)	REF
2	21221	.MOTOR, HYDRAULIC	1
3	21660	.ASSEMBLY, SHIFT CYLINDER	1
4	64109	.PIN, CLEVIS (attaching part)	2
5	64801	.PIN, COTTER (attaching part)	2
6	20719	..CYLINDER, SHIFT	1
-7	20035	...KIT, SEAL	1
8	20789	..CLEVIS, SHIFTING	1
9	60901	..NUT, JAM	1
10	80004-03	..CONNECTOR	2
11	21658	.BRACKET, SHIFT CYLINDER	1
12	60524	.SCREW, CAP (attaching part)	2
13	63304	.WASHER, LOCK (attaching part)	2
14	23221	.LEVER, ACTUATOR	1
15	64218	.PIN, ROLL	1
16	61903	.SCREW, CAP (attaching part)	1
17	63303	.WASHER, LOCK (attaching part)	1

DRIVE/BRAKE VALVE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23122	ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 1 for NHA)	REF
2	22433	.VALVE, DRIVE/BRAKE	1
3	80004-18	.CONNECTOR (M1, M2, M3, M4)	4
4	80050-05	.PLUG (C)	1
5	80063-16	.ADAPTER (V1, V2)	2
6	80001-21	.CONNECTOR (V1, V2)	2
7	80004-04	.TEE	2
8	20357	.VALVE, NEEDLE	1
9	80052-04	.NIPPLE, PIPE	1
10	80063-01	.ADAPTER (B)	1
11	80041-03	.TEE, STREET	1

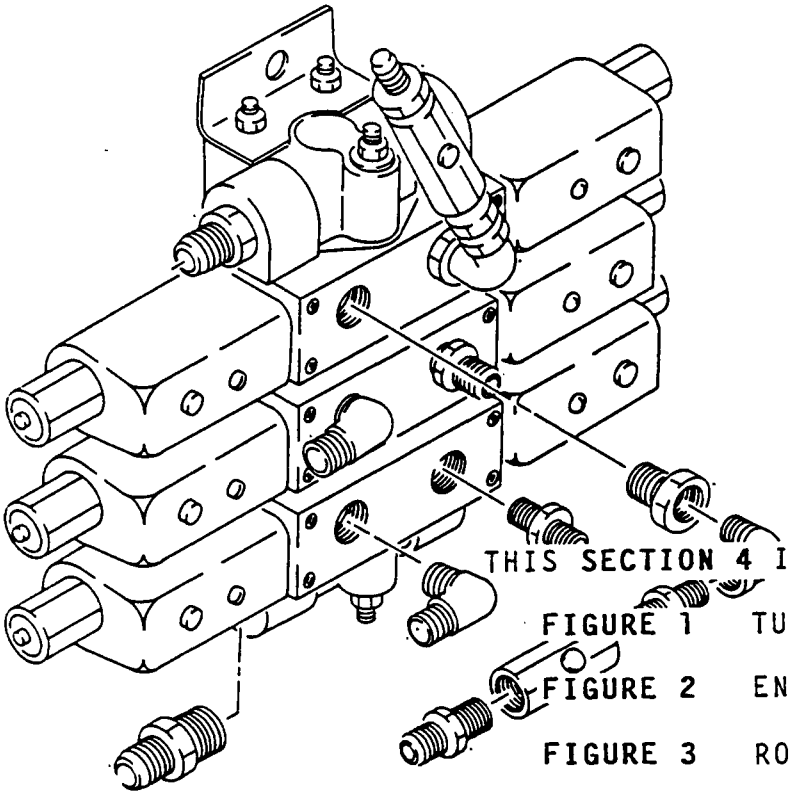
ROTATION GEAR BOX ASSEMBLY



ROTATION GEAR BOX ASSEMBLY (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22971	ASSEMBLY, ROTATION GEAR BOX (See Sect. 3, Fig. 1 for NHA)	REF
2	22996	.WELDMENT, MTG. PLATE	1
3	22830	.HUB, TORQUE	1
4	60602	.SCREW, CAP (attaching part)	9
5	22831	.BRAKE	1
6	80036-03	.TEE	1
7	80059-03	.CAP	1
8	61940	.SCREW, CAP (attaching part)	2
9	63305	.WASHER, LOCK (attaching part)	2
10	81080	.MOTOR, HYDRAULIC	1
11	60622	.SCREW, CAP (attaching part)	2
12	80018-13	.ELBOW	2
13	22099	.SPACER, PINION	1
14	22818	.PINION	1
15	22829	.RETAINER, PINION	1
16	61919	.SCREW, CAP (attaching part)	2
17	63303	.WASHER, LOCK (attaching part)	2

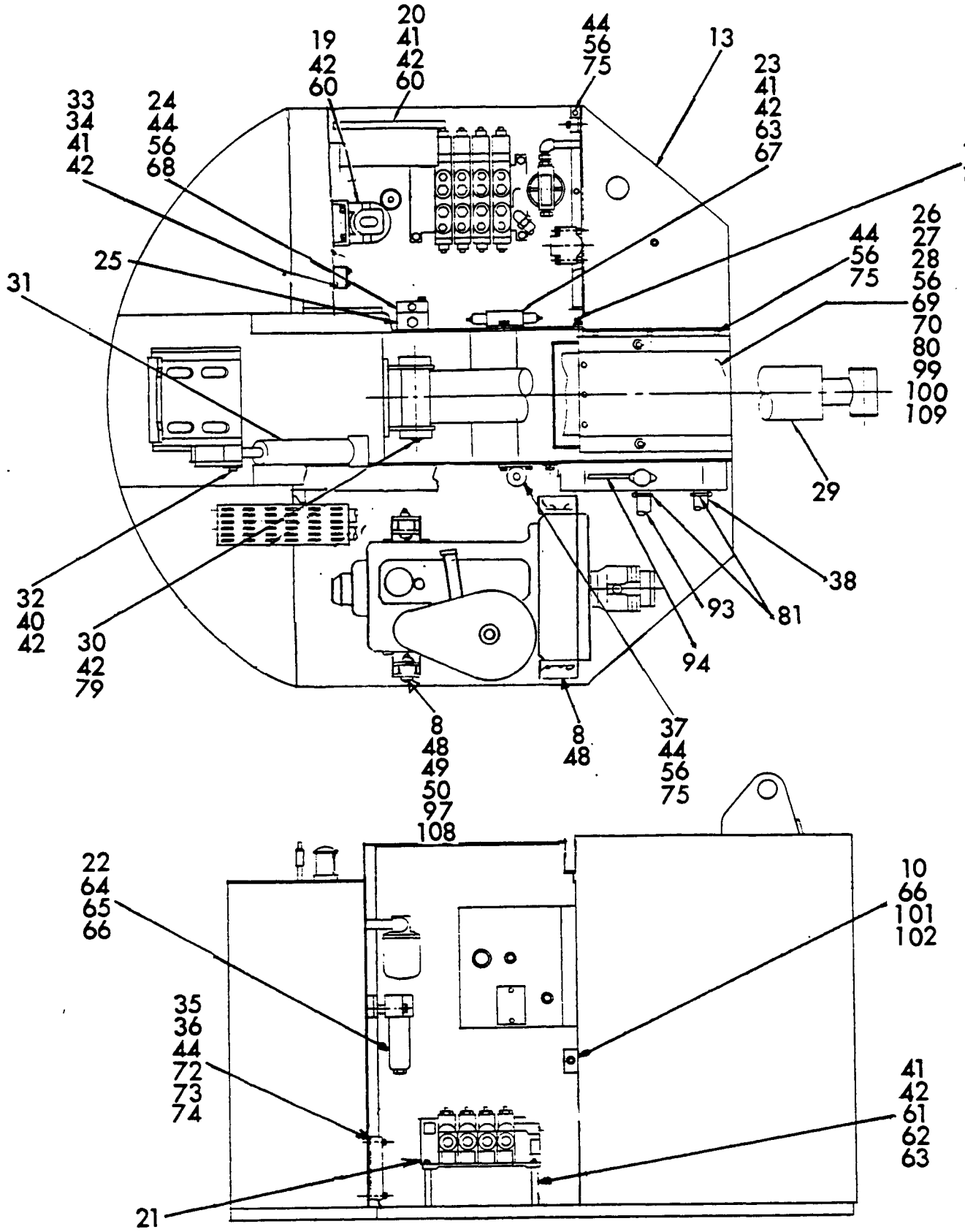
THE MARKLIFT TURRET ASSEMBLY



THIS SECTION 4 IS ILLUSTRATED AS:

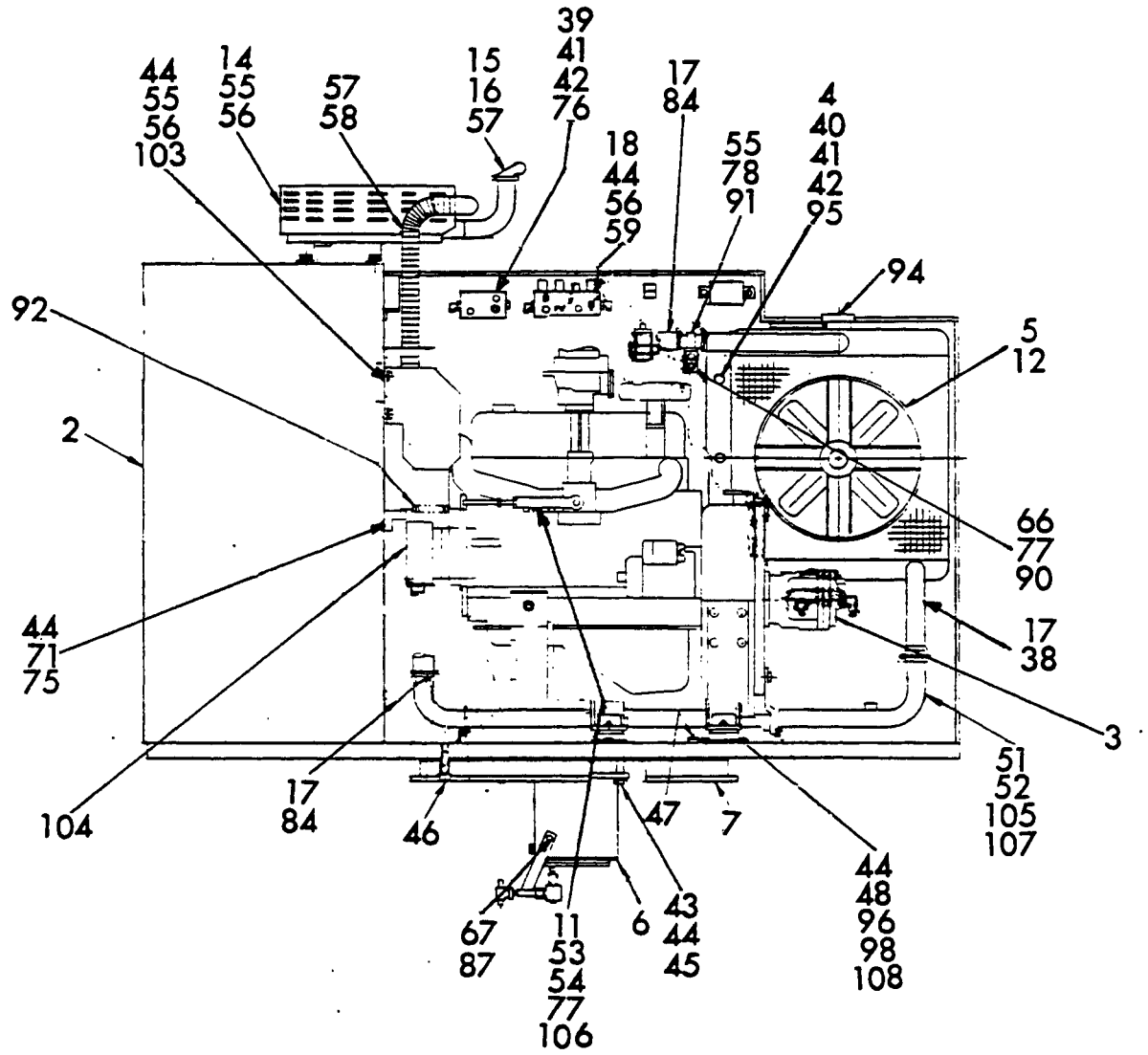
FIGURE 1	TURRET ASSEMBLY
FIGURE 2	ENGINE AND PUMP ASSEMBLY
FIGURE 3	ROTARY MANIFOLD ASSEMBLY
FIGURE 4	SHIFT CYLINDER ASSEMBLY
FIGURE 5	SOLENOID VALVE ASSEMBLY
FIGURE 6	GROUND CONTROL BOX ASSEMBLY
FIGURE 7	PROPORTIONAL VALVE ASSEMBLY
FIGURE 8	MINI-PAK ASSEMBLY
FIGURE 9	RELIEF VALVE ASSEMBLY
FIGURE 10	DUAL OVER CENTER VALVE ASSEMBLY
FIGURE 11	LIFT CYLINDER ASSEMBLY
FIGURE 12	MASTER LEVELING CYLINDER ASSEMBLY
FIGURE 13	PILOT MANIFOLD VALVE ASSEMBLY
FIGURE 14	L.P.G. LINE SWIVEL JOINT ASSEMBLY
FIGURE 15	HYDRAULIC TANK ASSEMBLY
FIGURE 16	SOLENOID VALVE ASSEMBLY
FIGURE 17	CHECK VALVE ASSEMBLY

TURRET ASSEMBLY (60I)

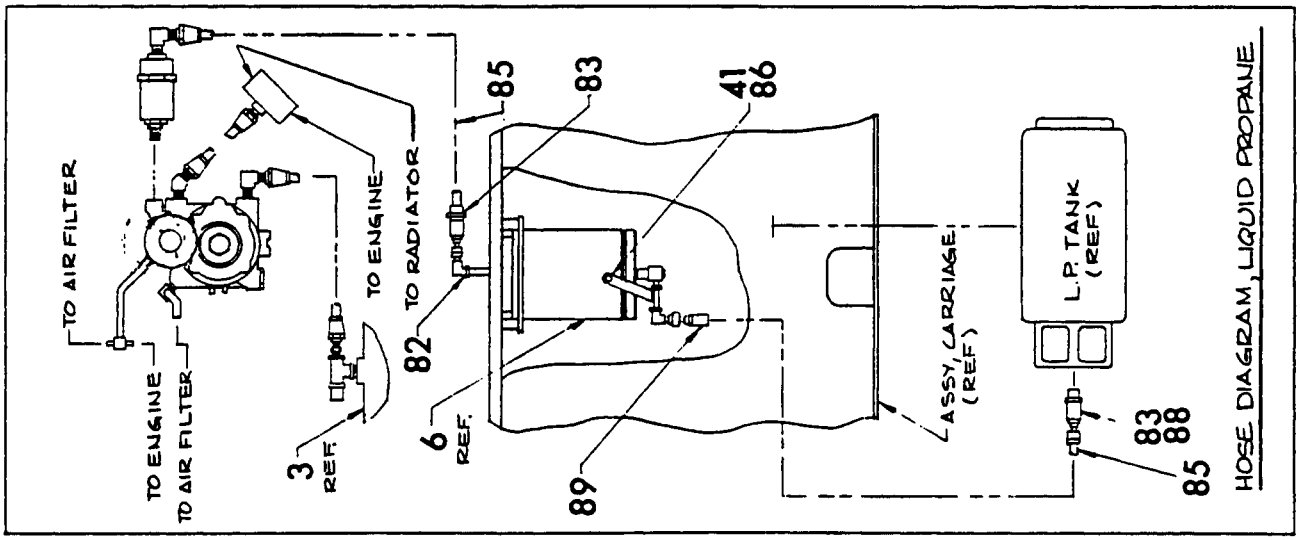


RIGHT SIDE VIEW

REV.



LEFT SIDE VIEW



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23268	ASSEMBLY, TURRET (See Sect. 2, Fig. 1 for NHA)	REF
2	23081	.WELDMENT, TURRET	1
3	23262	.ASSEMBLY, ENGINE AND PUMP (See Sect. 4, Fig. 2 for Details)	1
4	65881	.RADIATOR	1
5	65693	.FAN, ELECTRIC	1
6	22495	.ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 3 for Details)	1
7	22979	.RING, SLEWING	1
8	23535	.MOUNT, FRONT ENGINE	2
9	23536	.MOUNT, REAR ENGINE	2
10	21623	.ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 16 for Details)	1
11	23525	.ASSEMBLY, SHIFT CYLINDER (See Sect. 4, Fig. 4 for Details)	1
12	16337	.FUSE, IN-LINE	1
13	23289	.ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 15 for Details)	1
14	65751	.MUFFLER	1
15	23546	.MODIFIED, ELBOW MUFFLER	1
16	21288	.CAP, RAIN	1
17	55	.CLAMP, HOSE	1
18	21692	.ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 5 for Details)	1
19	22390	.ASSEMBLY, EMERGENCY PUMP AND MOTOR	1
20	21703	.ASSEMBLY GROUND CONTROL BOX (See Sect. 4, Fig. 6 for Details)	1
21	22387	.ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 7 for Details)	1
22	22963	.ASSEMBLY, FILTER	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23	21712	.ASSEMBLY, MINI-PAK (See Sect. 4, Fig. 8 for Details)	1
24	22144	.ASSEMBLY, RELIEF VALVE (See Sect. 4, Fig. 9 for Details)	1
25	21584	.ASSEMBLY, DUAL OVER CENTER VALVE (See Sect. 4, Fig. 10 for Details)	1
26	21244	.BATTERY	1
27	23154	.TRAY, BATTERY	1
28	23153	.COVER, BATTERY	1
29	21705	.ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 11 for Details)	1
30	21780	.PIN	1
31	22583	.ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 12 for Details)	1
32	22492	.PIN	1
33	21599	.ASSEMBLY, CHECK VALVE (See Sect. 4, Fig. 17 for Details)	1
34	60307	.SCREW, CAP	1
35	21217	.STRIP, TERMINAL	1
36	21386	.COVER, TERMINAL STRIP	1
37	70209	.SOLENOID	1
38	65743	.HOSE, RADIATOR	1
39	21472	.ASSEMBLY, PILOT MANIFOLD VALVE (See Sect. 4, Fig. 13 for Details)	1
40	60320	.SCREW, CAP	6
41	63403	.WASHER, FLAT	13
42	63303	.WASHER, LOCk	15
43	60511	.SCREW, CAP	4
44	63302	.WASHER, LOCK	33
45	20445	.SPACER	4

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
46	61942	.SCREW, CAP	4
47	60609	.SCREW, CAP	6
48	60719	.NUT, HEX	8
49	63305	.WASHER, LOCK	16
50	61936	.SCREW, CAP	4
51	23516	.WELDMENT, RADIATOR TUBE	1
52	65838	.CLAMP, MUFFLER	3
53	64106	.PIN, CLEVIS	1
54	64317	.PIN, COTTER	1
55	60324	.SCREW, CAP	4
56	63402	.WASHER, FLAT	25
57	16230	.CLAMP, MUFFLE	2
58	23548	.WELDMENT, FLEX HOSE	1
59	60339	.SCREW, CAP	2
60	60325	.SCREW, CAP	6
61	25325	.TUBE, ROUND	4
62	63623	.ROD, THREADED	4
63	60703	.NUT, HEX	10
64	26055	.TUBE, ROUND	2
65	60377	.SCREW, CAP	2
66	63301	.WASHER, LOCK	12
67	60343	.SCREW, CAP	3
68	60316	.SCREW, CAP	2
69	65798	.BOLT, ANCHOR	2
70	65125	.NUT, WING	2
71	23523	.MOUNT, SPRING	1
72	62607	.SCREW, MACHINE	2

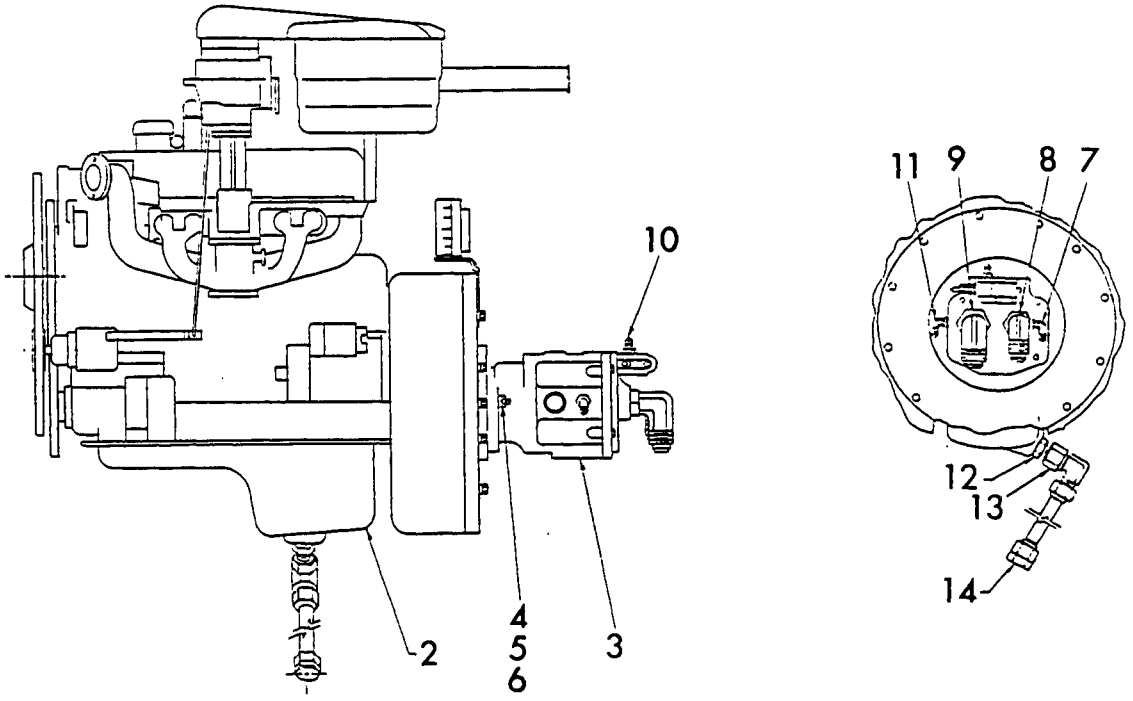
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
73	63313	.WASHER, LOCK	2
74	60323	.SCREW, CAP	4
75	60322	.SCREW, CAP	9
76	60317	.SCREW, CAP	2
77	60353	.SCREW, CAP	6
78	35280	.TUBE, ROUND	2
79	60607	.SCREW, CAP	1
80	23270	.KIT, BATTERY CABLE	1
81	65417	.CLAMP, HOSE	2
82	22741	.ASSEMBLY, L.P.G. LINE SWIVEL JOINT (See Sect. 4, Fig. 14 for Details)	1
83	65141	.NIPPLE, FEMALE	2
84	65827	.HOSE, RADIATOR	2
85	2616-54	.HOSE	2
86	60613	.SCREW, CAP	1
87	60612	.SCREW, CAP	1
88	16451	.FITTING	1
89	16452	.FITTING	1
90	23508	.BRACKET, HOSE CLAMP	1
91	65463	.CLAMP, HOSE	3
92	65839	.SPRING, EXIT	1
93	65744	.HOSE, RADIATOR	1
94	65830	.HOSE, RADIATOR OVER FLOW	1
95	65774	.CAP, RADIATOR	1
96	65858	.MOUNT, MOTOR	2
97	65859	.MOUNT, REAR MOTOR	2
98	60338	.SCREW, CAP	8

TURRET ASSEMBLY (60I) (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
99	61828	.SCREW, CAP	4
100	65796	.PLYWOOD	1
101	60319	.SCREW, CAP	2
102	63401	.WASHER, FLAT	2
103	23222	.GUARD, MUFFLER	1
104	23223	.GUARD, PULLEY	1
105	23529	.CLAMP, HOSE	1
106	23519	.MOUNT, SHIFT CYLINDER	1
107	23628	.BRACKET, MUFFLER CLAMP	1
108	63326	.WASHER, LOCK	4

- ITEM NOT ILLUSTRATED

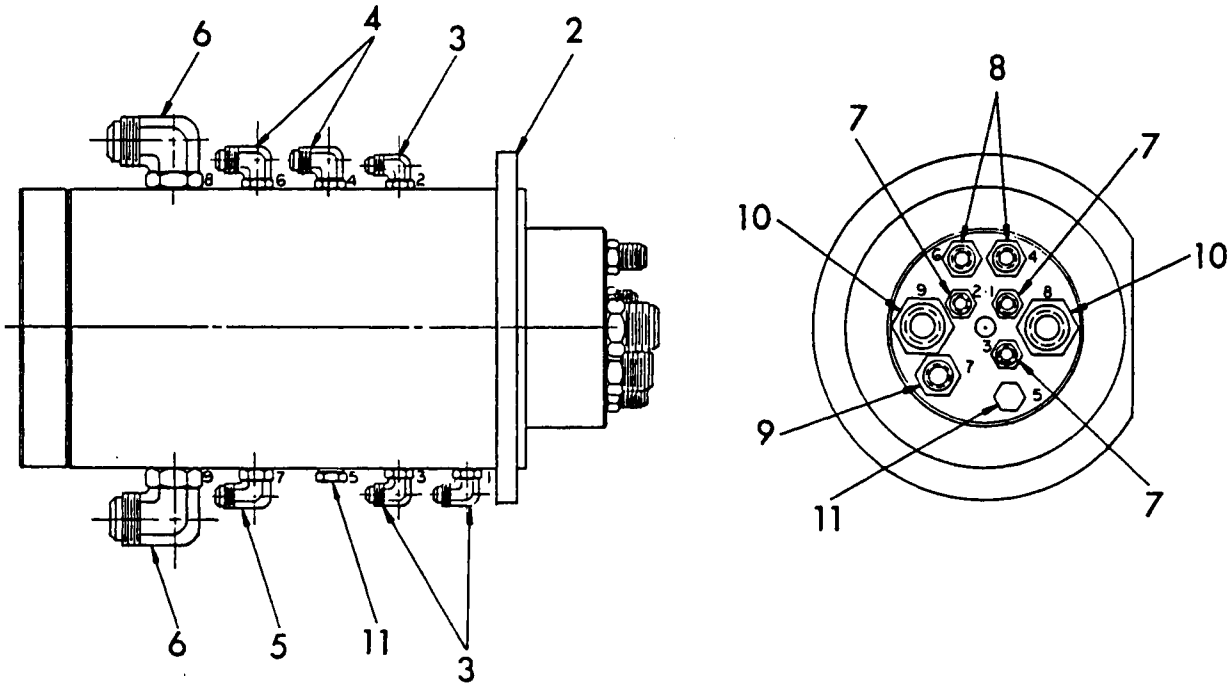
ENGINE AND PUMP ASSEMBLY (60I)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23262	ASSEMBLY, ENGINE & PUMP (See Sect. 4, Fig. 1 for NHA)	REF
2	22999	.ENGINE	1
3	20753	.PUMP	1
4	63613	.STUD (attaching part)	2
5	63305	.WASHER, LOCK (attaching part)	2
6	60705	.NUT, HEX (attaching part)	2
7	80008-08	.ELBOW, MALE	1
8	20798	.ELBOW, MODIFIED STRAIGHT THREAD	1
9	80012-28	.ELBOW, STRAIGHT THREAD	1
10	80004-03	.CONNECTOR, STRAIGHT THREAD	1
11	80012-08	.ELBOW, STRAIGHT THREAD	1
12	81152	.FITTING, METRIC	1
13	80015-06	.ELBOW, SWIVEL NUT	1
14	23501	.ASSEMBLY, TUBE DRAIN	1

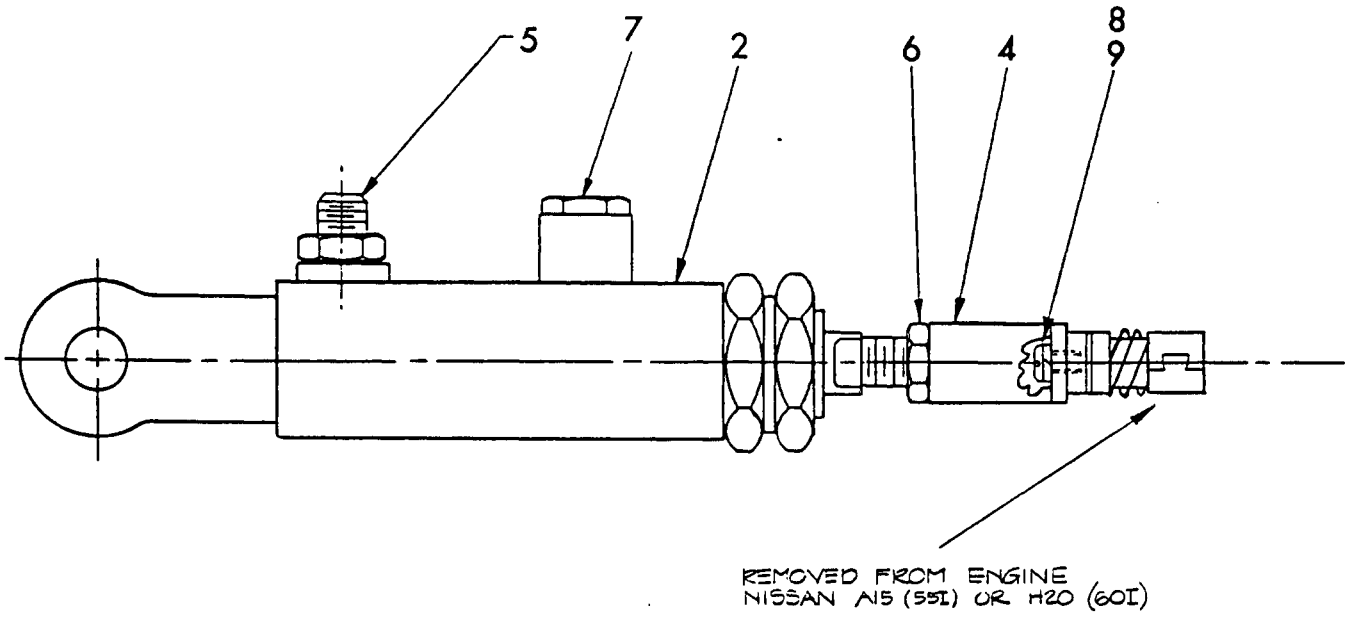
- ITEM NOT ILLUSTRATED

ROTARY MANIFOLD ASSEMBLY



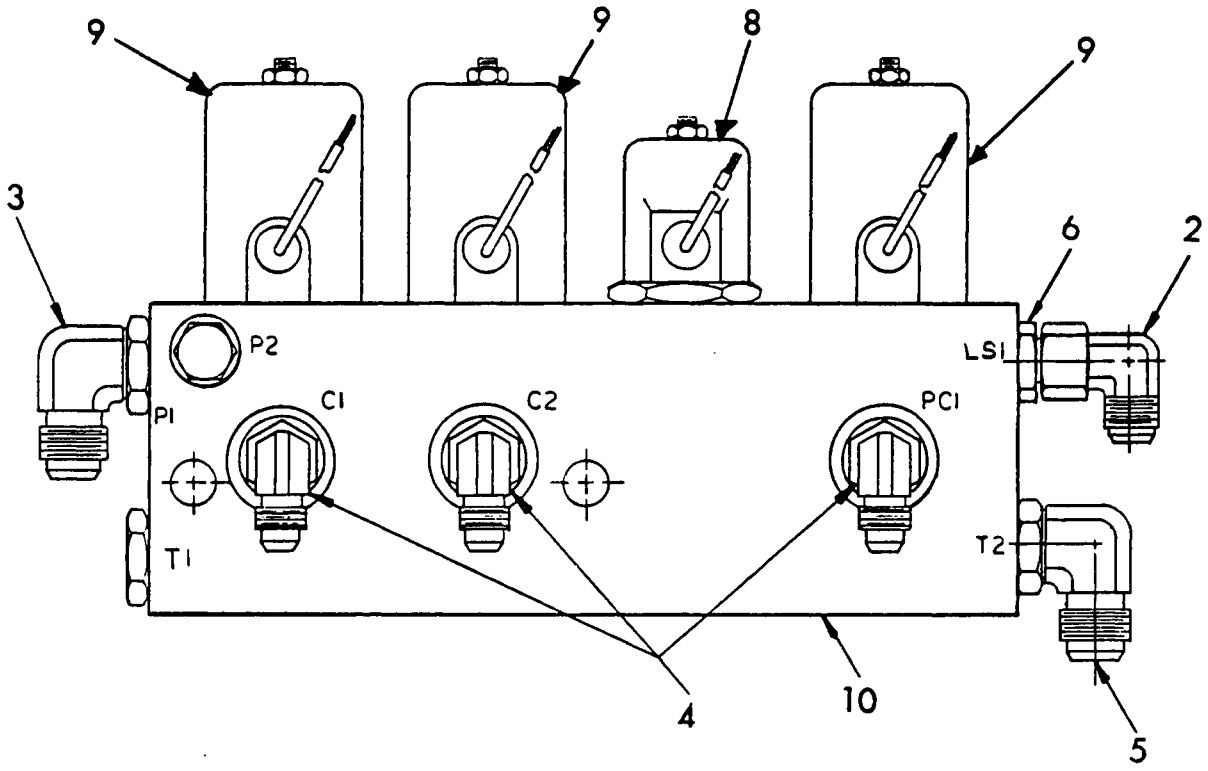
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22495	ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 1 for NHA)	REF
2	22363	.MANIFOLD, ROTARY	1
3	80012-03	.ELBOW	3
4	80012-08	.ELBOW	2
5	80012-09	.ELBOW	1
6	80012-18	.ELBOW	2
7	80004-03	.CONNECTOR	3
8	80004-08	.CONNECTOR	2
9	80004-11	.CONNECTOR	1
10	80004-18	.CONNECTOR	2
11	80050-05	.PLUG, HEX	2

SHIFT CYLINDER ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23525	ASSEMBLY, SHIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	20719	.CYLINDER, SHIFT	1
-3		..KIT, SEAL	1
4	23524	.ADAPTER, SHIFT CYLINDER	1
5	80004-03	.CONNECTOR	1
6	60901	.NUT, JAM	1
7	23650	.PLUG, MODIFIED	1
8	62619	.SCREW, MACHINE	1
9	63313	.WASHER, LOCK	1

SOLENOID VALVE ASSEMBLY

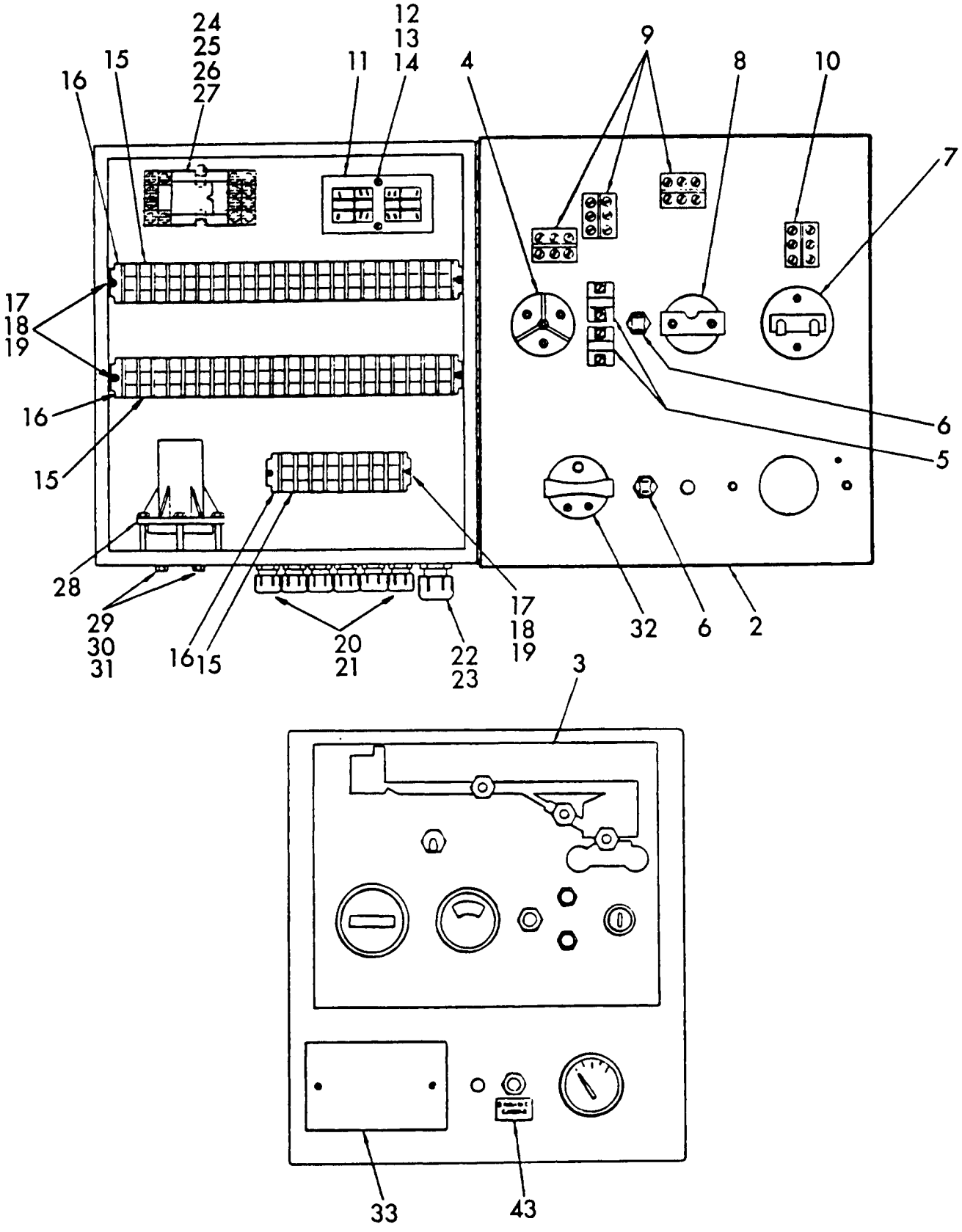


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21692	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	80015-03	.ELBOW, SWIVEL NUT	1
3	50900	.ELBOW	1
4	80012-03	.ELBOW	3
5	80012-08	.ELBOW	1
6	80004-03	.CONNECTOR	1
-7	21860	.VALVE, SOLENOID	1
8	66883	..CARTRIDGE, SOLENOID	1
9	66884	..CARTRIDGE, SOLENOID	3
10	66885	..BLOCK, MANIFOLD	1

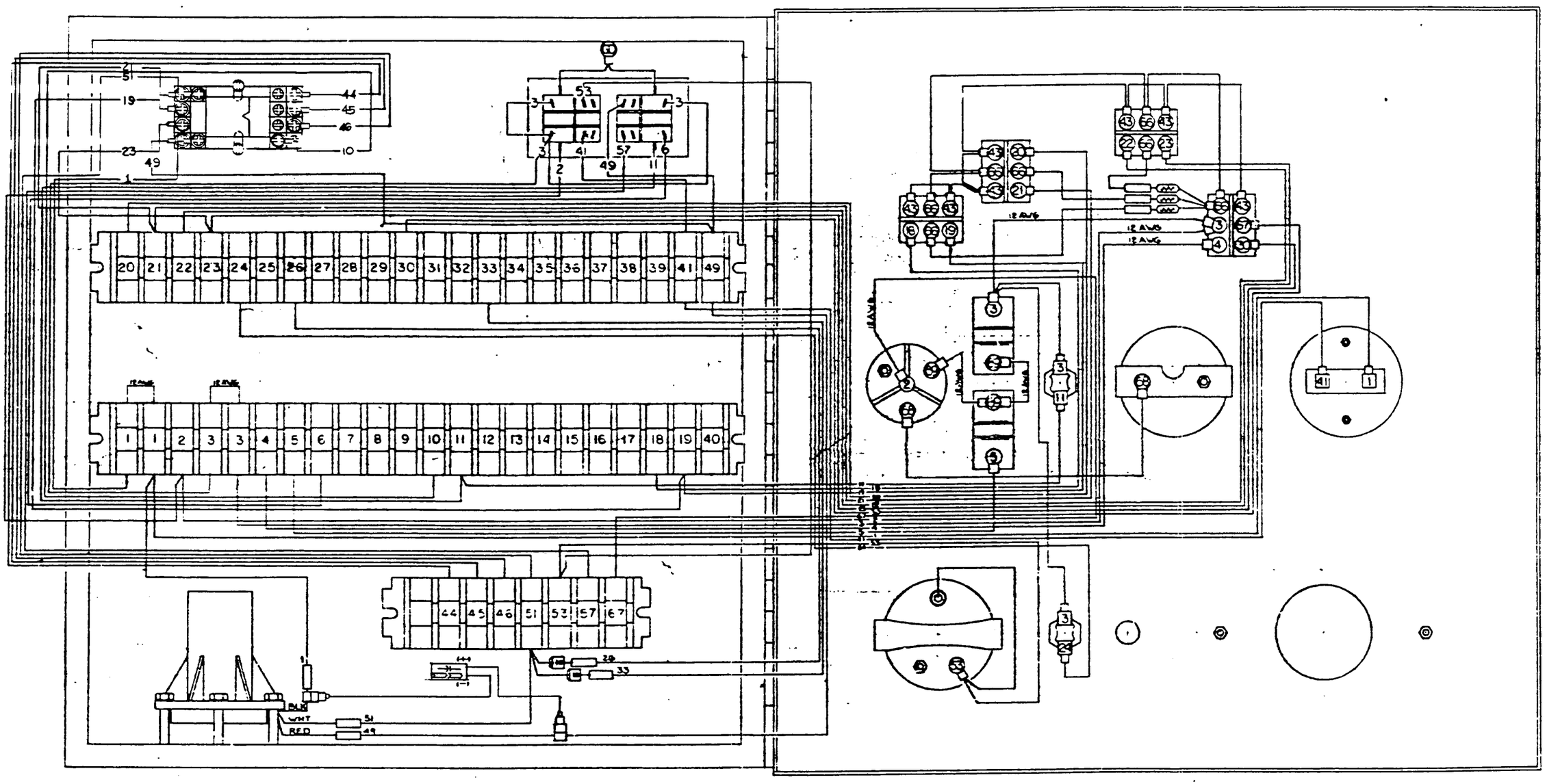
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- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY



COVER



WIRING DIAGRAM

ITEM 34
ITEM 35
ITEM 36
ITEM 37
ITEM 42
ITEM 41
ITEM 38
ITEM 39
ITEM 40

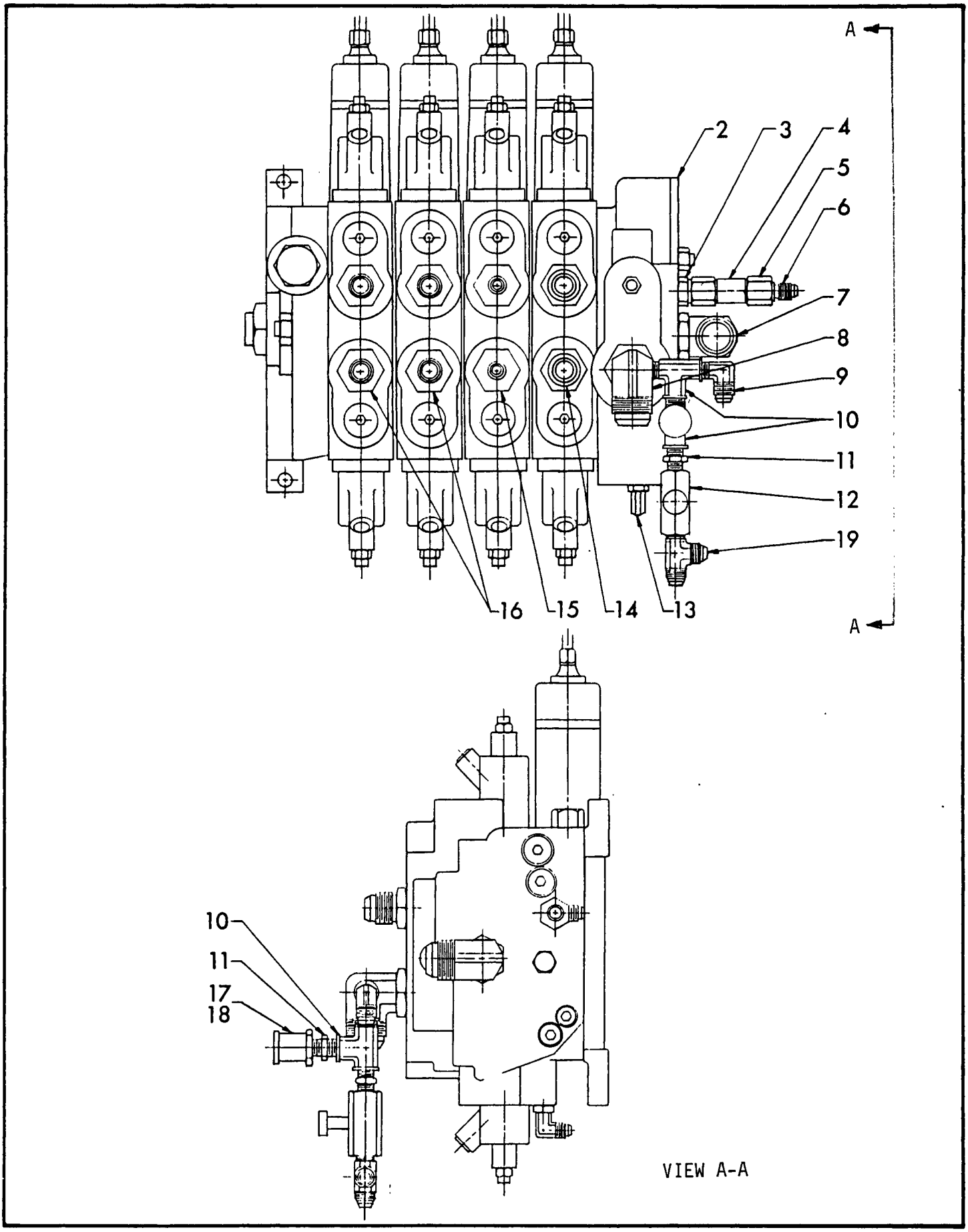
GROUND CONTROL BOX ASSEMBLY (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21703	ASSEMBLY, GROUND CONTROL BOX (See Sect. 4, Fig. 1 for NHA)	REF
2	20977	.ENCLOSURE	1
3	20460	.DECAL, COVER	1
4	2717	.SWITCH, IGNITION	1
5	20562	.BREAKER, CIRCUIT	2
6	4011	.SWITCH, PUSH BUTTON	2
7	20571	.METER, HOUR	1
8	20572	.AMMETER	1
9	20481	.SWITCH, TOGGLE	3
10	20482	.SWITCH, TOGGLE	1
11	20573	.RELAY, LATCHING	1
12	62609	.SCREW, CAP (attaching part)	2
13	63311	.WASHER, LOCK (attaching part)	2
14	61501	.NUT, HEX (attaching part)	2
15	4027	.BLOCK, TERMINAL	52
16	117-A	.END, TERMINAL BLOCK	3
17	62609	.SCREW, CAP (attaching part)	10
18	63311	.WASHER, LOCK (attaching part)	10
19	61501	.NUT, HEX (attaching part)	10
20	2806	.RELIEF, STRAIN	6
21	2808	.NUT, LOCK (attaching part)	6
22	2807	.RELIEF, STRAIN	1
23	2809	.NUT, LOCK (attaching part)	1
24	70213	.RELAY	1
25	70214	.BASE, RELAY	1
26	62630	.SCREW, MACHINE (attaching part)	2

GROUND CONTROL BOX ASSEMBLY (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
27	63311	.WASHER, LOCK (attaching part)	2
28	21250	.SENSOR, SLOPE	1
29	60116	.SCREW, CAP (attaching part)	4
30	63303	.WASHER, LOCK (attaching part)	4
31	60703	.NUT, HEX (attaching part)	4
32	21219	.GAUGE, FUEL	1
33	902	.PLATE, COVER	1
34	4045	.DIODE	2
35	70142	.RESISTOR	3
36	117-D	.CONNECTOR, BUTT	8
37	LL&_E	.TERMINAL, PUSH-ON	6
38	2859	.TONGUE, RING	25
39	876	.TONGUE, RING	10
40	70147	.CAPACITOR	1
41	117-CC	.TERMINAL, PUSH-ON	2
42	70029	.CONNECTOR, FEMALE	2
43	20413	.DECAL, ENGINE CHOKE	1

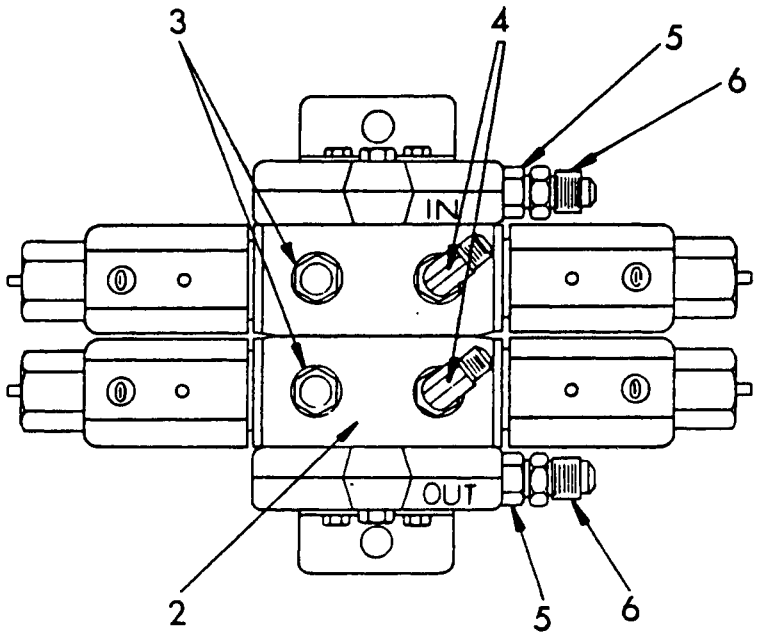
PROPORTIONAL VALVE ASSEMBLY



PROPORTIONAL VALVE ASSEMBLY (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22387	ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	21255	.VALVE, PROPORTIONAL (See Chapter Vendor Sect. 3 for Details)	1
3	80004-09	.CONNECTOR	1
4	80028-05	.TEE	1
5	80060-05	.NUT	1
6	80056-01	.REDUCER, TUBE END	1
7	80012-24	.ELBOW	1
8	20798	.ELBOW, MODIFIED	1
9	80008-08	.ELBOW, MALE	1
10	80041-03	.TEE, STREET	2
11	80052-04	.NIPPLE, PIPE	2
12	20357	.VALVE, NEEDLE	1
13	80012-03	.ELBOW	1
14	80004-18	.CONNECTOR	2
15	50844	.CONNECTOR	2
16	80004-14	.CONNECTOR	4
17	2527	.COUPLING, QUICK DISCONNECT	1
18	845	.CAP	1
19	80037-08	.TEE	1

MINI-PAK ASSEMBLY

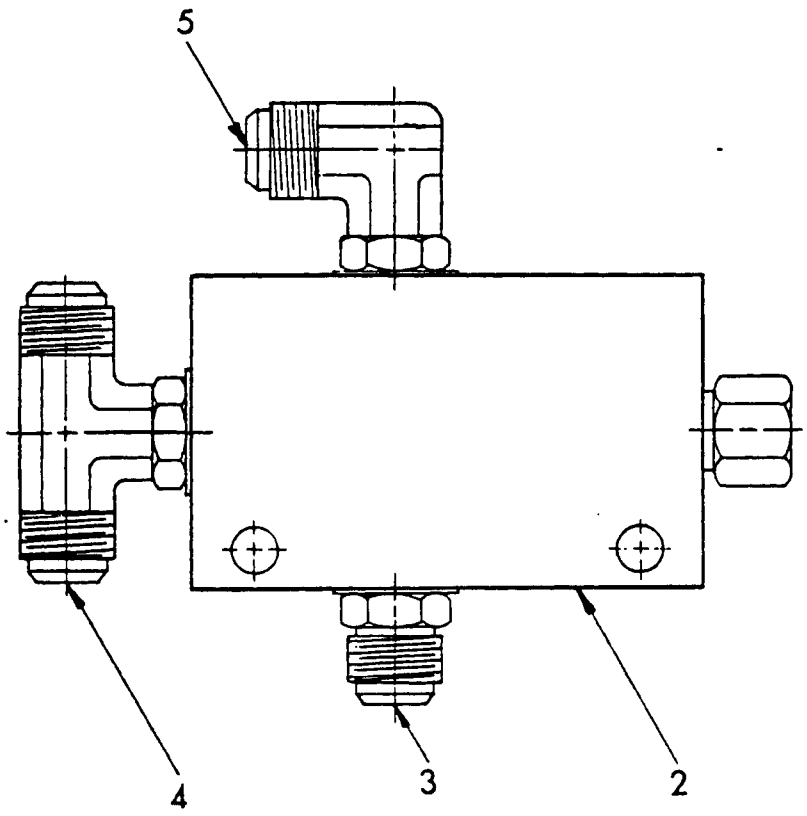


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21712	ASSEMBLY, MINI-PAK (See Sect. 4, Fig. 1 for NHA)	REF
2	21207	.BANK, SOLENOID VALVE	1
3	80004-05	.CONNECTOR	2
4	80012-05	.ELBOW, 90°	2
5	80063-01	.ADAPTER, FEMALE PIPE	2
6	80001-08	.CONNECTOR, MALE	2

REV.

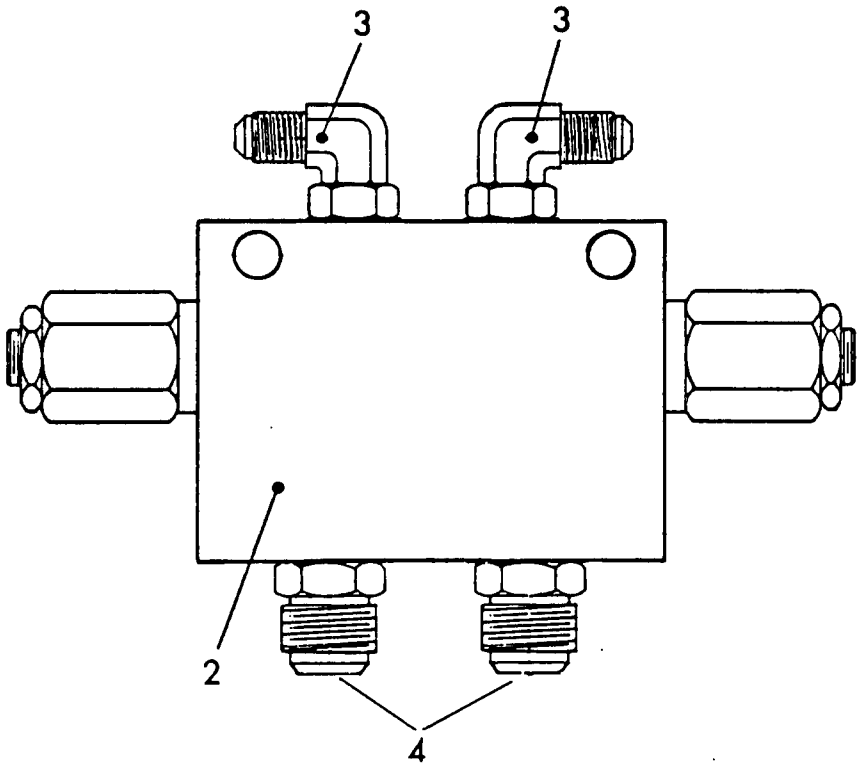
- ITEM NOT ILLUSTRATED

RELIEF VALVE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22144	ASSEMBLY, RELIEF VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	20564	.VALVE, RELIEF	1
3	80004-11	.CONNECTOR	1
4	80036-11	.TEE, BRANCH	1
5	80012-11	.ELBOW	1

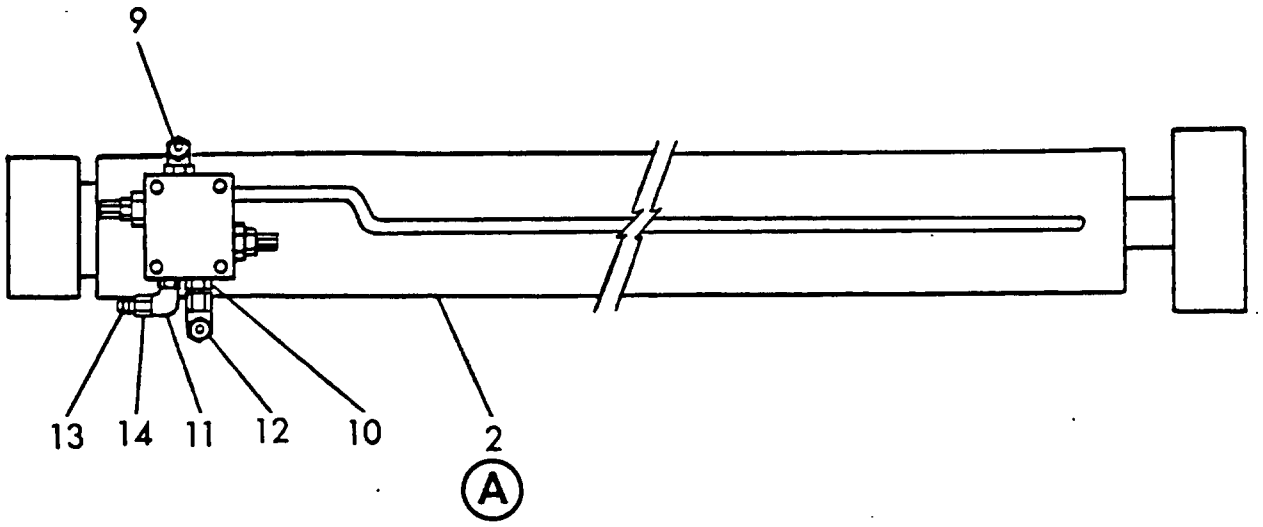
DUAL OVER CENTER VALVE ASSEMBLY

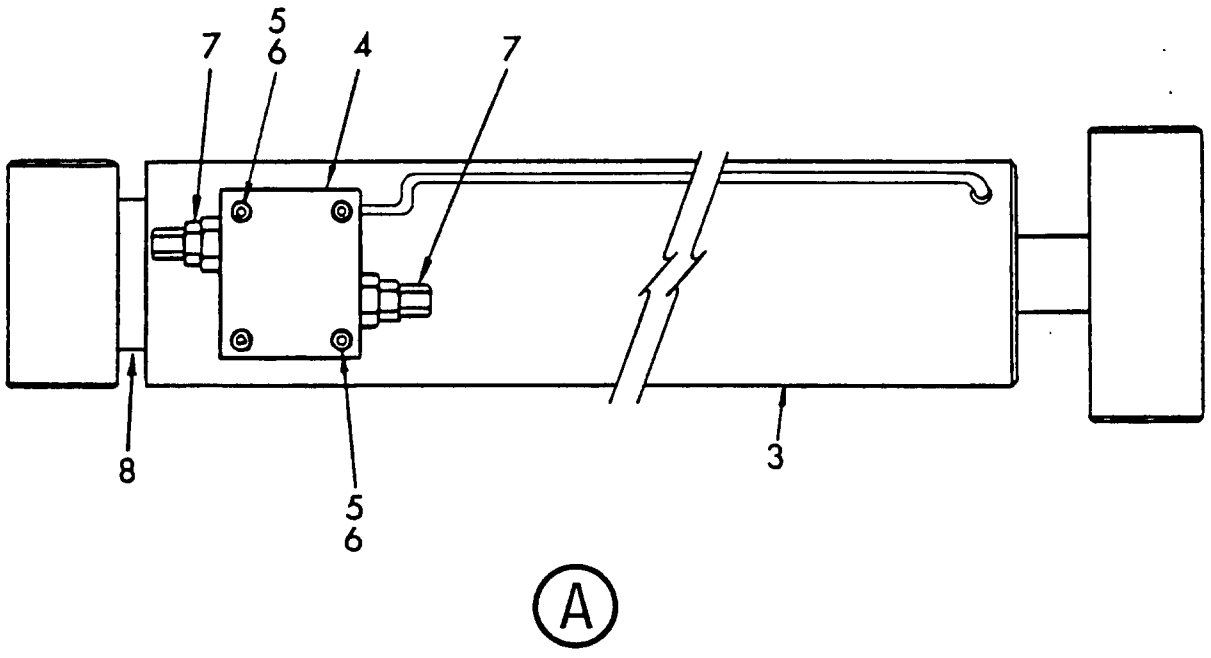


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21584	ASSEMBLY, DUAL OVER CENTER VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	20365	.VALVE, DUAL OVER CENTER	1
3	80012-05	.ELBOW	2
4	80004-05	.CONNECTOR	2

- ITEM NOT ILLUSTRATED

LIFT CYLINDER ASSEMBLY

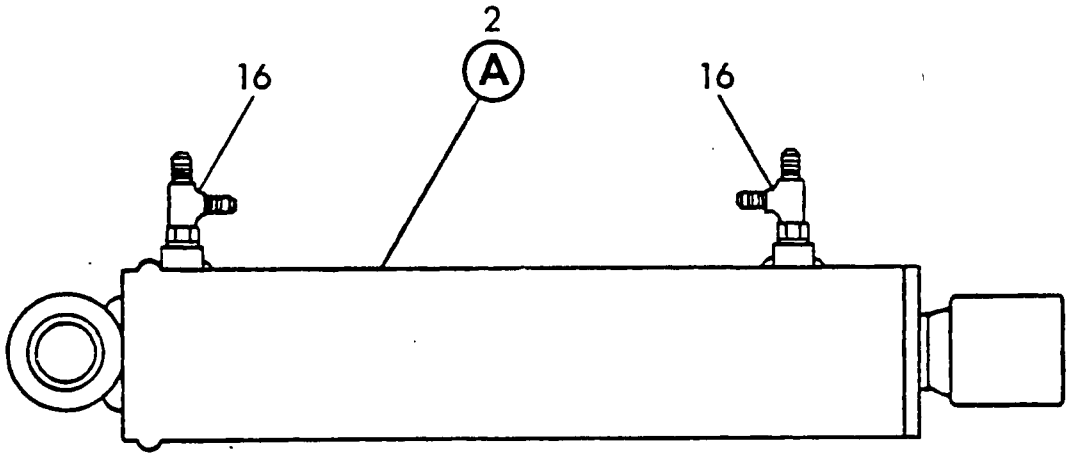


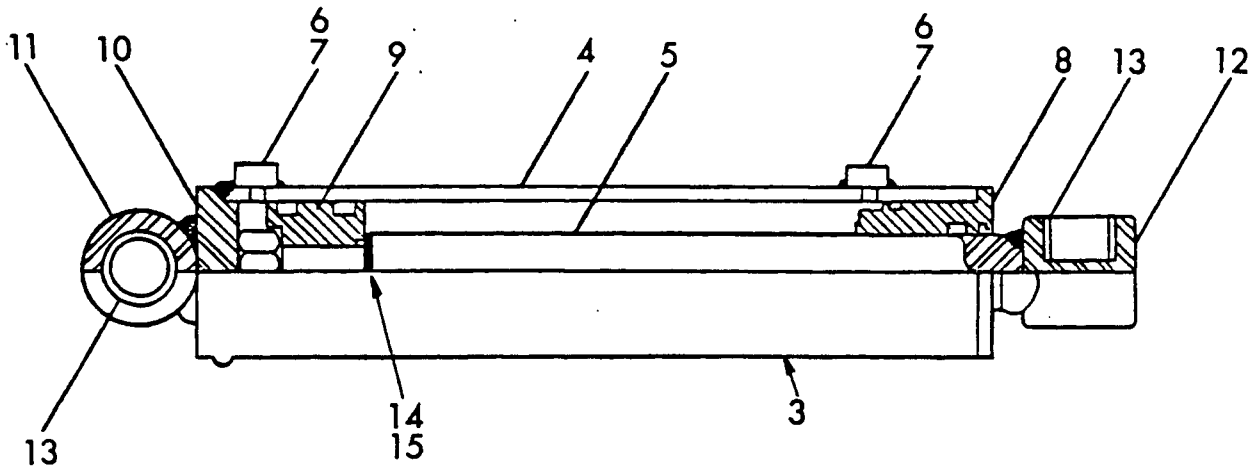


LIFT CYLINDER ASSEMBLY (CONTINUED)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21705	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	20968	.SUB-ASSEMBLY	1
3	21198	..CYLINDER, LIFT	1
4	21445	..CYLINDER BOOM, VALVE BLOCK	1
5	61918	..SCREW, CAP (attaching part)	4
6	63302	..WASHER, LOCK (attaching part)	4
7	81006	..CARTRIDGE, OVERCENTER	2
8	66502	..KIT, SEAL	1
9	80012-09	.ELBOW	1
10	80004-09	.CONNECTRO	1
11	50900	.ELBOW	1
12	80015-05	.NUT, SWIVEL	1
13	20348	.ORIFICE, BLEED DOWN	1
14	80060-05	.NUT	1

MASTER LEVELING CYLINDER ASSEMBLY



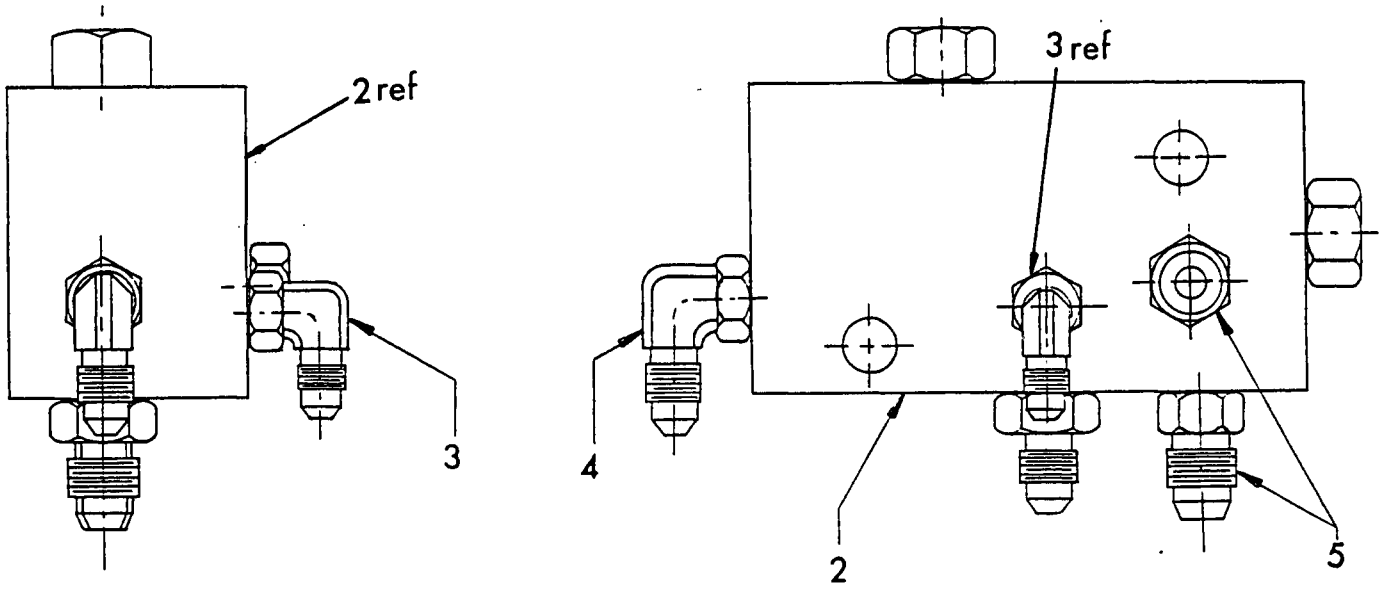


A

MASTER LEVELING CYLINDER ASSEMBLY (CONTINUED)

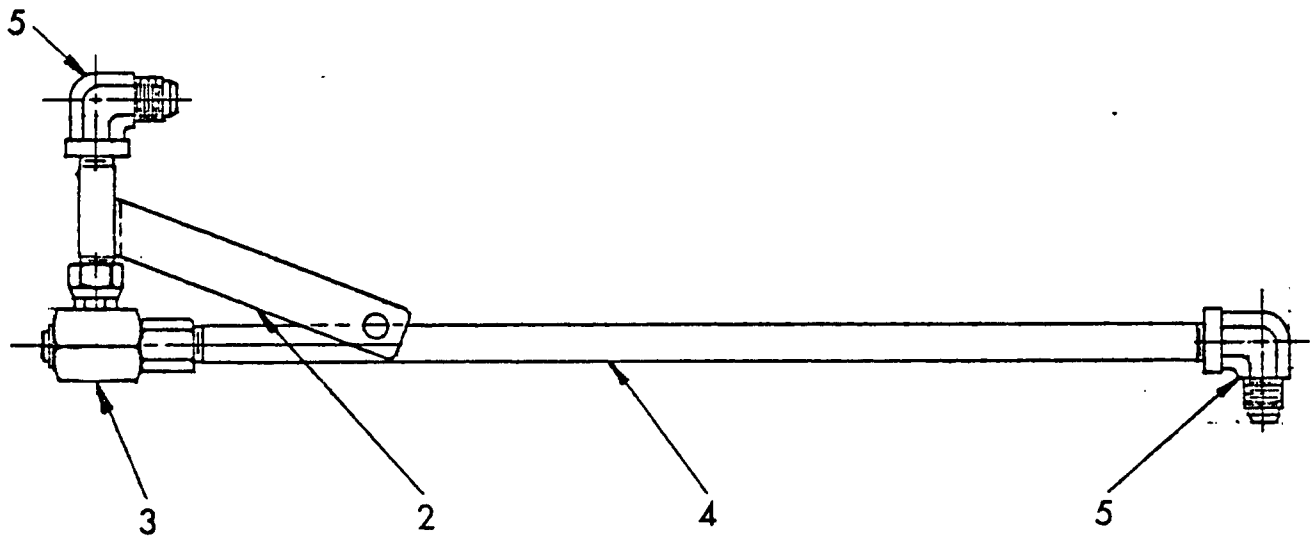
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22583	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	22577	.CYLINDER, MASTER LEVELING	1
3		..BARREL (SE00211B)	1
4		..NAMEPLATE, MARK (9303)	1
5		..ROD (SE00211R)	1
6		..PORT (9885)	2
7		..PLUG, CAP (9810)	2
8		..HEAD, TEE (13204)	1
9		..PISTON (14139)	1
10		..BASE, PLAIN (16011)	1
11		..BASE (18609)	1
12		..ROD (18610)	1
13		..BEARING, DUIZ (9506)	4
14	66499	..KIT, SEAL (SIERRA)	1
15	66651	..KIT, SEAL (R.A. INDUSTRIES)	1
16	80033-05	.TEE	2

PILOT MANIFOLD VALVE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21472	ASSEMBLY, PILOT VALVE MANIFOLD (See Sect. 4, Fig. 1 for NHA)	REF
2	21448	.MANIFOLD, PILOT VALVE	1
3	80012-03	.ELBOW	1
4	80012-08	.ELBOW	1
5	80004-08	.CONNECTOR	2

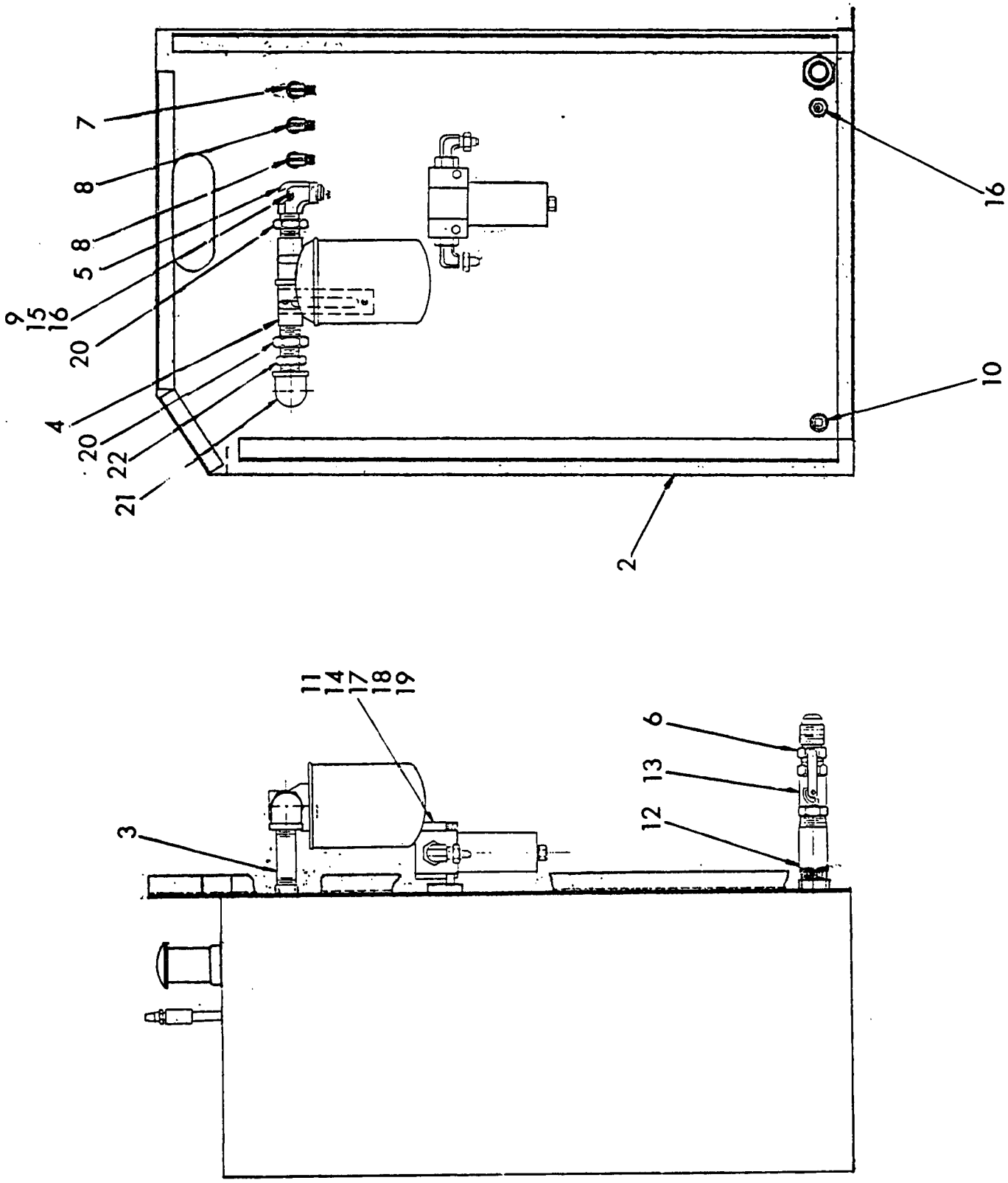
L.P.G. LINE SWIVEL JOINT ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22741	ASSEMBLY, L.P.G. LINE SWIVEL JOINT (See Sect. 4, Fig. 1 for NHA)	REF
2	21896	.BRACKET, L.P.G. LINE SWIVEL	1
3	20815	.JOINT, SWIVEL	1
4	65535	.NIPPLE	1
5	80009-07	.ELBOW, FEMALE	2

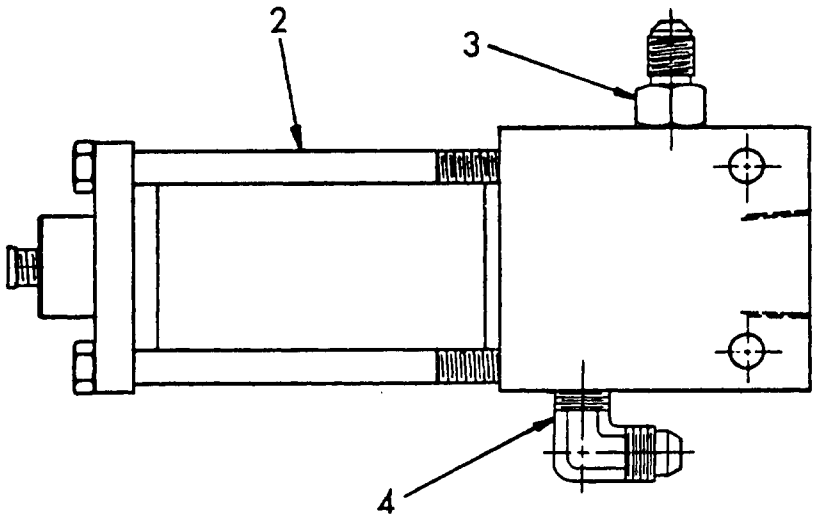
- ITEM NOT ILLUSTRATED

HYDRAULIC TANK ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23289	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 1 for NHA)	REF
2	22471	.TANK, HYDRAULIC	1
3	54701	.NIPPLE	1
4	21241	.FILTER, RETURN UNE	1
5	80008-23	.ELBOW	
6	2968	.CONNECTOR	
7	80008-14	.ELBOW	
8	80008-11	.ELBOW	2
9	80008-05	.ELBOW	1
10	53903	.PLUG	1
11	63301	.WASHER, LOCK	2
12	16551	.NIPPLE	1
13	20050	.VALVE, BUTTERFLY	1
14	22963	.ASSEMBLY, FILTER	1
15	80041-10	.TEE, STREET	1
16	80001-11	.CONNECTOR	2
17	26055	.TUBE	2
18	60377	.SCREW, CAP	2
19	63401	.WASHER, FLAT	2
20	53801	.REDUCER, PIPE	2
21	80020-13	.ELBOW	1
22	80052-12	.NIPPLE, PIPE	1

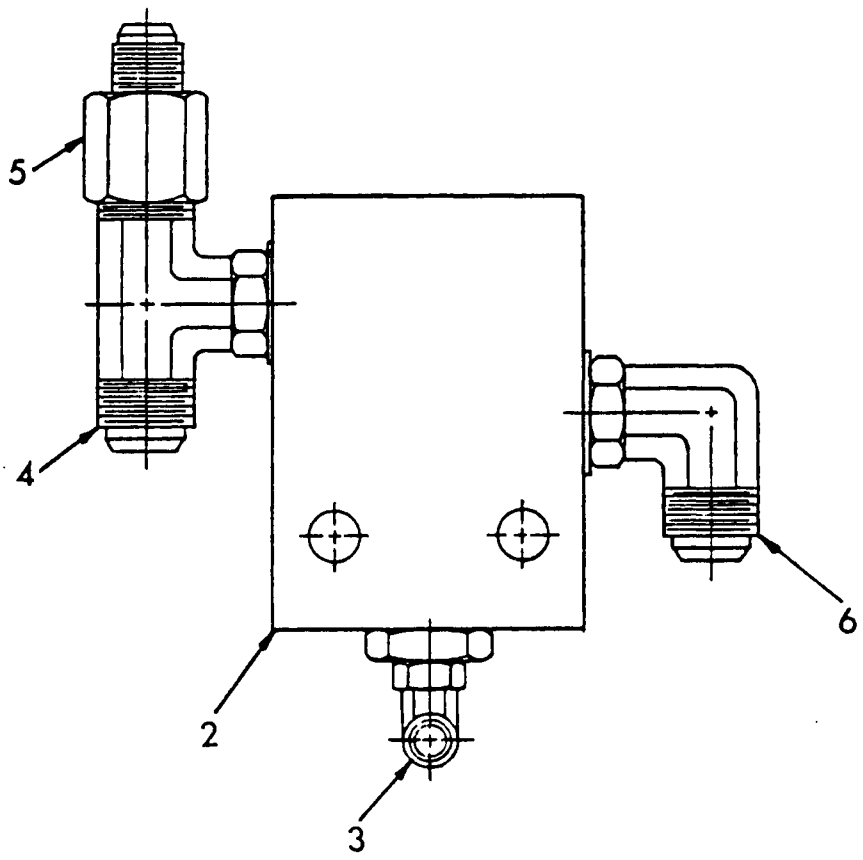
SOLENOID VALVE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21623	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	20376	.VALVE, SOLENOID	1
3	80001-04	.CONNECTOR	1
4	80008-04	.ELBOW, MALE	1

- ITEM NOT ILLUSTRATED

CHECK VALVE ASSEMBLY



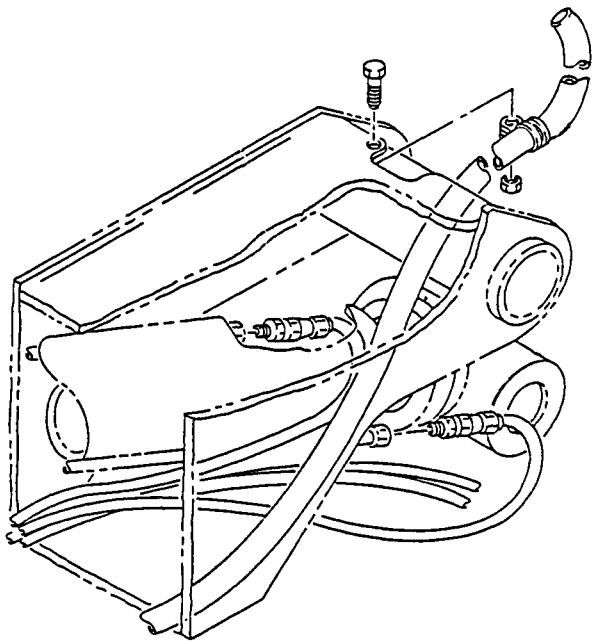
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21599	ASSEMBLY, CHECK VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	20391	.VALVE, CHECK PILOT OPERATED	1
3	80012-03	.ELBOW	1
4	80036-11	.TEE	1
5	80056-03	.REDUCER, TUBE END	1
6	80012-11	.ELBOW	1

REV.

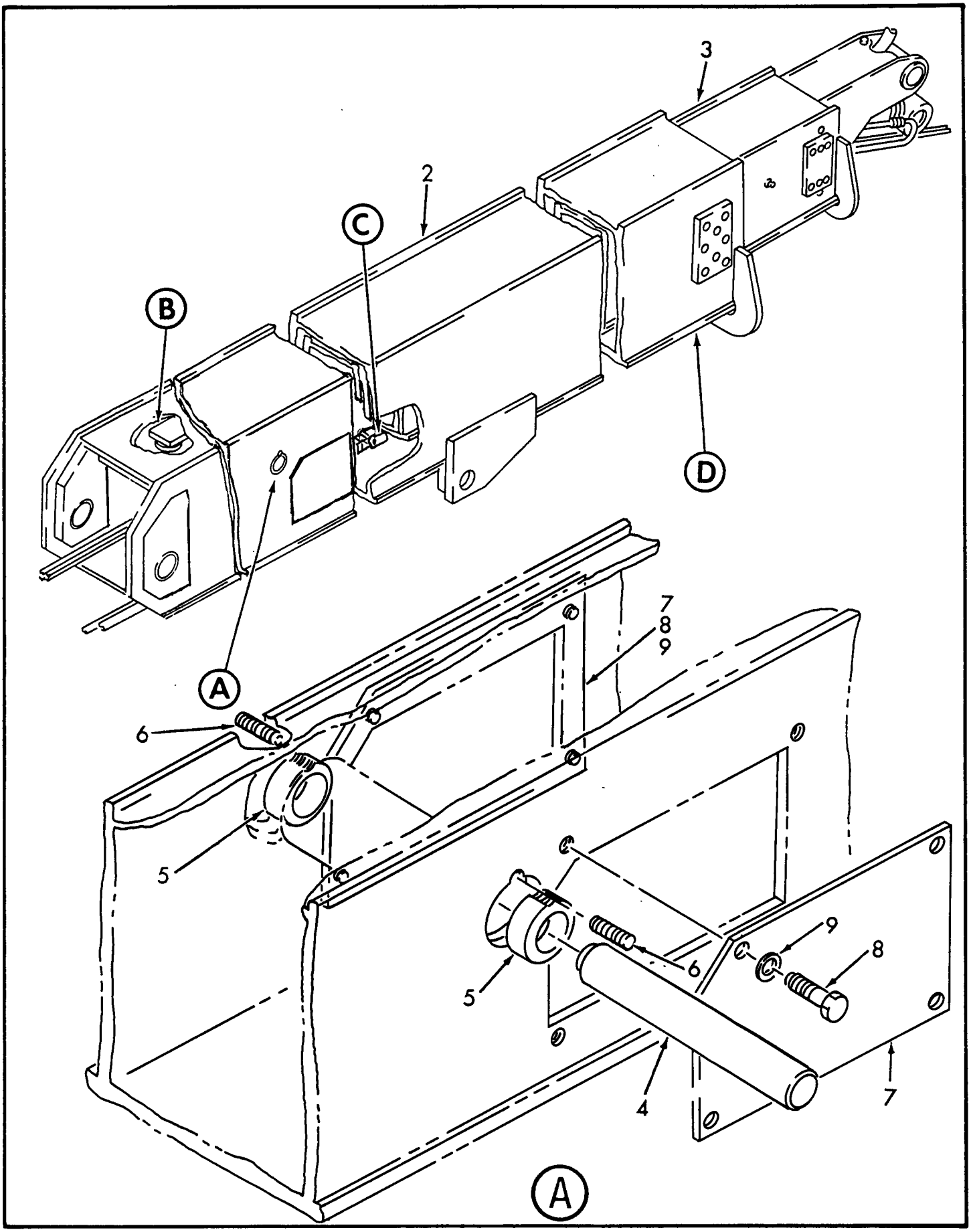
- ITEM NOT ILLUSTRATED

THIS **SECTION 5** IS ILLUSTRATED AS:

FIGURE 1A	FINAL BOOM ASSEMBLY	(AFT. JUN. 86)
FIGURE 1B	FINAL BOOM ASSEMBLY	(BEF. JUN. 86)
FIGURE 2A	INTERMEDIATE BOOM ASSEMBLY	(AFT. JUN. 86)
FIGURE 2B	INTERMEDIATE BOOM ASSEMBLY	(BEF. JUN. 86)
FIGURE 3A	INNER BOOM ASSEMBLY	(AFT. JUN. 86)
FIGURE 3B	INNER BOOM ASSEMBLY	(BEF. JUN. 86)
FIGURE 4A	EXTENSION CYLINDER ASSEMBLY	(AFT. JUN. 86)
FIGURE 4B	EXTENSION CYLINDER ASSEMBLY	(BEF. JUN. 86)
FIGURE 5A	EXTENSION CYLINDER SUB-ASSEMBLY	(AFT. JUN. 86)
FIGURE 5B	EXTENSION CYLINDER SUB-ASSEMBLY	(BEF. JUN. 86)
FIGURE 6	SLAVE LEVELING CYLINDER ASSEMBLY	
FIGURE 7	SLAVE LEVELING CYLINDER SUB-ASSEMBLY	

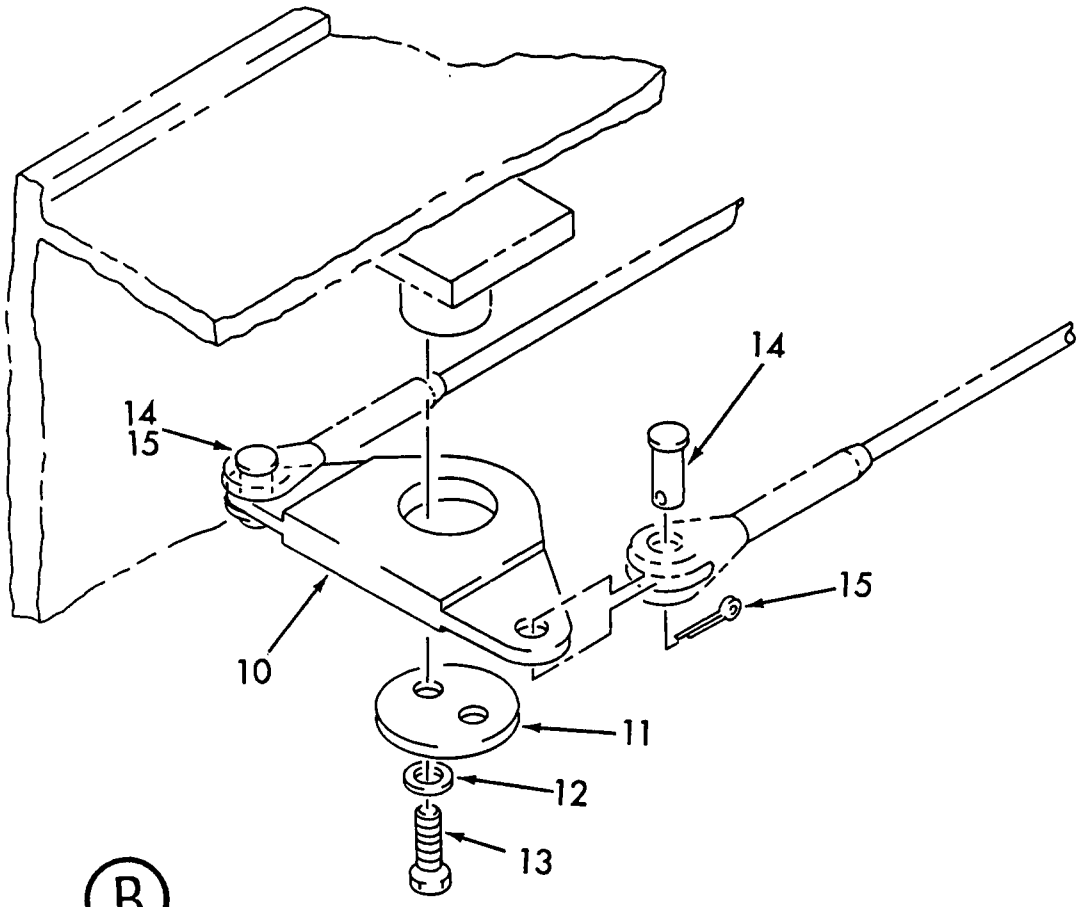


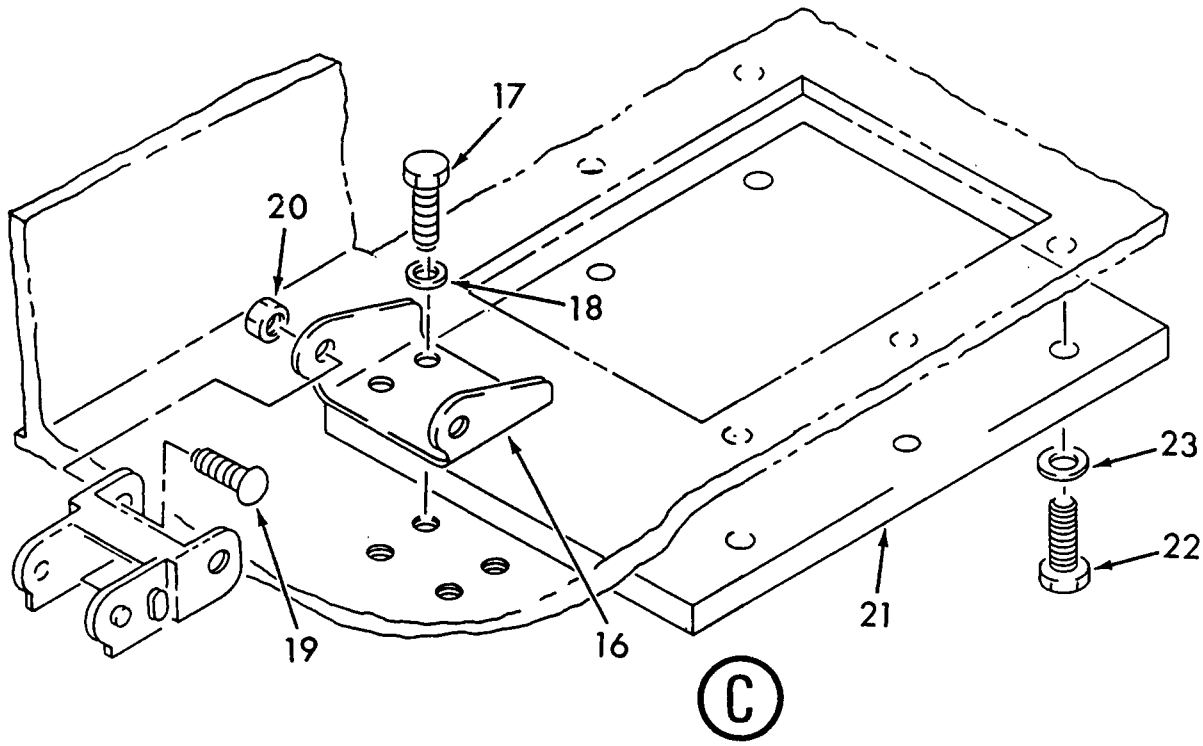
FINAL BOOM ASSEMBLY (60I) (AFT. JUN. 86)



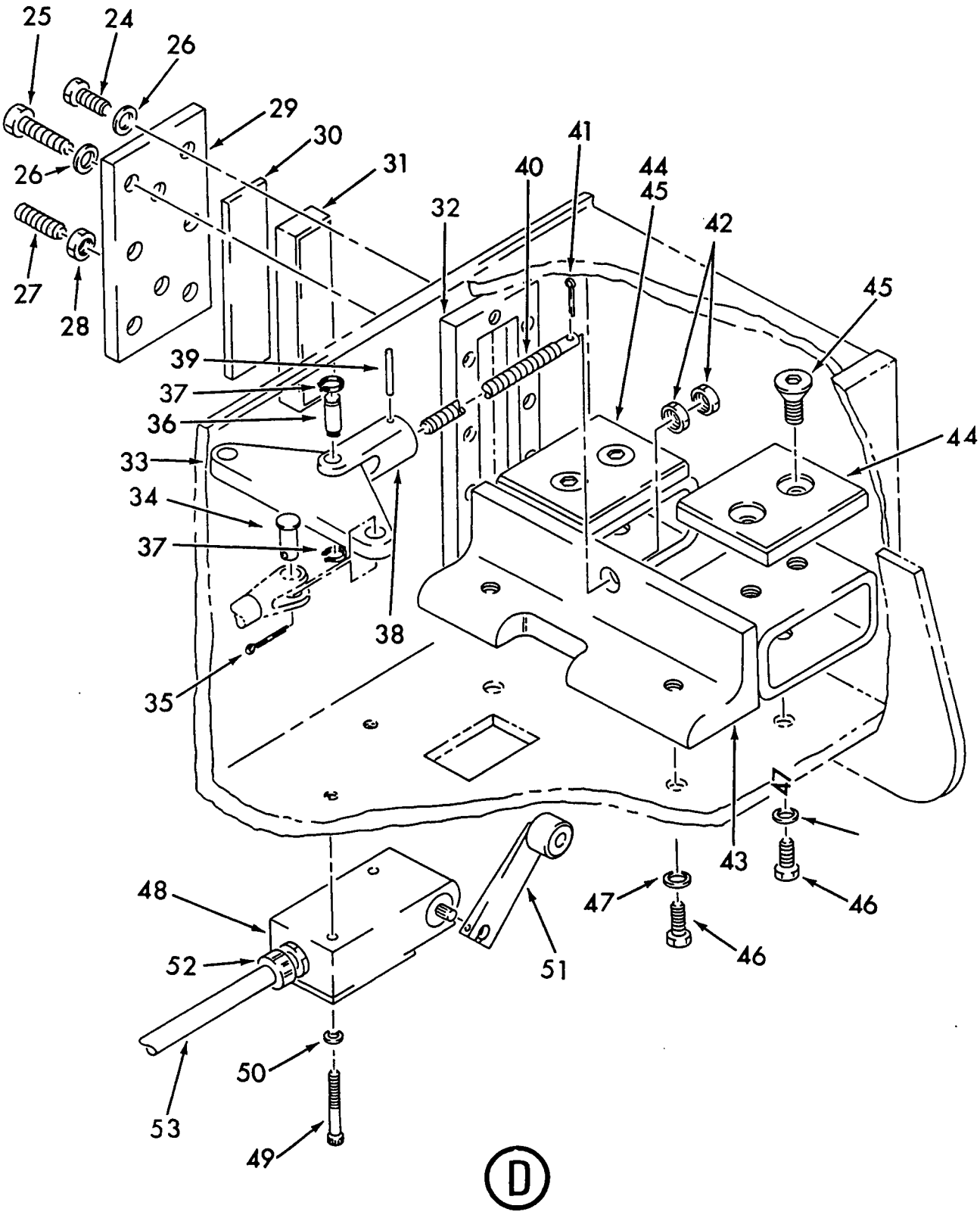
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FINAL BOOM ASSEMBLY (60I) (AFT. JUN. 86)





FINAL BOOM ASSEMBLY (60I) (AFT. JUN. 86)



FINAL BOOM ASSEMBLY (60I) (AFT. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23026	ASSEMBLY, FINAL BOOM (See Sect. 2, Fig. 1 for NHA)	REF
2	23025	.MACHINING, OUTER BOOM	1
3	23027	.ASSEMBLY, INTERMEDIATE BOOM (See Sect. 5, Fig. 2A for Details)	1
4	23169	.PIN, BOOM EXTENSION CYLINDER	1
5	20268	.BUSHING, ECCENTRIC	2
6	62203	.SCREW, SET	2
7	22684	.COVER	2
8	60367	.SCREW, CAP	8
9	63302	.WASHER, LOCK	8
10	23097	.LEVER, EXTENSION CABLE	1
11	22593	.RETAINER	1
12	63302	.WASHER, LOCK	2
13	60533	.SCREW, CAP	2
14	23697	.PIN, CLEVIS	2
15	64301	.PIN, COTTER	2
16	23751	.BRACKET, STATIONARY (PLASTITRAK)	1
17	60501	.SCREW, CAP	4
18	63301	.WASHER, LOCK	4
19	61931	.SCREW, CAP	2
20	60702	.NUT, HEX	2
21	21320	.COVER, PLATE	1
22	60367	.SCREW, CAP	6
23	63302	.WASHER, LOCK	6

- ITEM NOT ILLUSTRATED

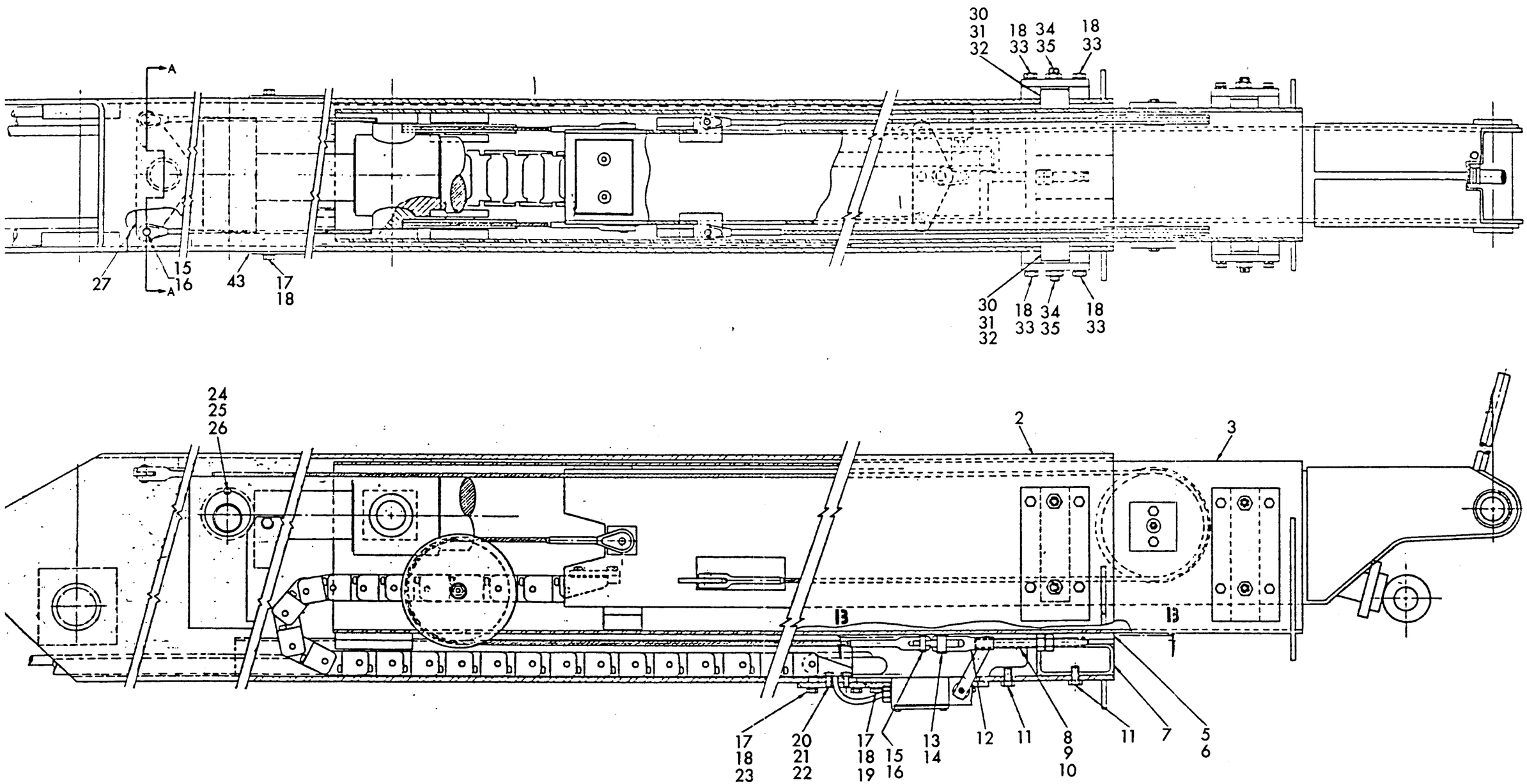
FINAL BOOM ASSEMBLY (60I) (AFT. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	60395	.SCREW, CAP	4
25	60343	.SCREW, CAP	12
26	63303	.WASHER, LOCK	16
27	62204	.SCREW, SET	4
28	61101	.NUT, JAM	4
29	21321	.PLATE, COVER	2
30	20453	.PLATE, PAD PRESSURE	2
31	23170	.PAD, WEAR	2
32	21358	.RETAINER, WEAR PAD	2
33	23098	.LEVER, RETRACTION CABLE	1
34	23697	.PIN, CLEVIS	2
35	64301	.PIN, COTTER	2
36	22548	.PIN	1
37	65081	.RING, SNAP	2
38	23269	.TERMINAL, CABLE	1
39	64204	.PIN, ROLL	1
40	22594	.SLEEVE, THREADED	1
41	64301	.PIN, COTTER	1
42	60801	.NUT, HEX	2
43	23096	.BRACKET, BOOM END	1
44	23168	.PAD, WEAR	2

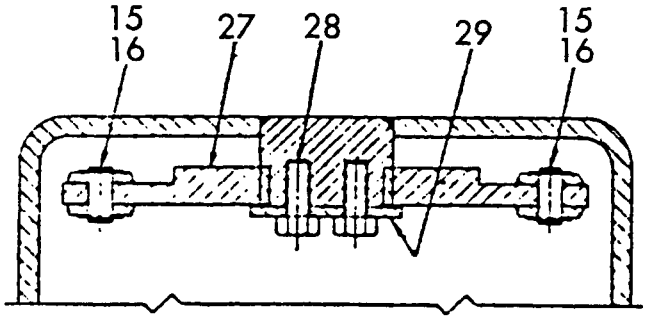
- ITEM NOT ILLUSTRATED

FINAL BOOM ASSEMBLY (60I) (AFT. JUN. 86)

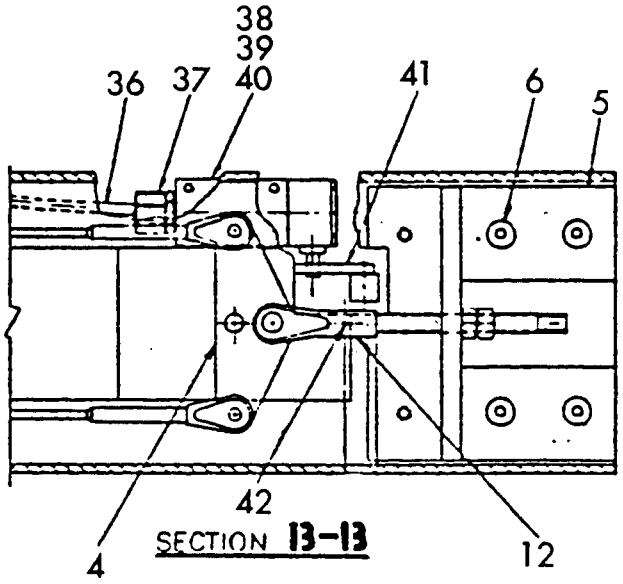
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
45	61801	.SCREW, CAP	4
46	60542	.SCREW, CAP	4
47	63303	.WASHER, LOCK	4
48	70107	.SWITCH, LIMIT	1
49	62615	.SCREW, MACHINE	2
50	63313	.WASHER, LOCK	2
51	70148	.LEVER, ARM	1
52	2806	.RELIEF, STRAIN	1
53	70036-2100	.CABLE, ELECTRICAL	1


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FINAL BOOM ASSEMBLY (60I) (BEF. JUN. 86)



SECTION A-A



SECTION B-B

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22867	ASSEMBLY, FINAL BOOM (See Sect. 2 Fig. 1 for NHA)	REF
2	22751	.MACHINING, OUTER BOOM	1
3	22868	.ASSEMBLY, INTERMEDIATE BOOM (See Sect. 5, Fig. 2B for Details)	1
4	22549	.LEVER, RETRACTION CABLE	1
5	22570	.PAD, WEAR	2
6	61805	.SCREW, CAP	4
7	22545	.BRACKET, BOOM END	1
8	22594	.SLEEVE, THREADED	1
9	60801	.NUT, HEX	2
10	64301	.PIN, COTTER	1
11	60607	.SCREW, CAP	4
12	65477	.TERMINAL	1
13	22548	.PIN	1
14	65081	.RING, SNAP	2
15	22547	.PIN, CABLE	4

- ITEM NOT ILLUSTRATED

FINAL BOOM ASSEMBLY (60I) (BEF. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
16	65080	.RING, SNAP	8
17	60367	.SCREW, CAP	8
18	63302	.WASHER, LOCK	16
19	22563	.COVER, ACCESS	1
20	60631	.SCREW, CAP	4
21	22586	.BRACKET, STATIONARY L.H. MOUNTING	1
22	22585	.BRACKET, STATIONARY R.H. MOUNTING	1
23	22541	.BRACKET, PLASTITRAK	1
24	20267	.PIN, BOOM EXTENSION CYLINDER	1
25	20268	.BUSHING, ECCENTRIC	2
26	62203	.SCREW, SET	2
27	22546	.LEVER	1
28	60603	.SCREW, CAP	2
29	22593	.RETAINER	1
30	22172	.PAD, WEAR	2
31	20453	.PLATE, PAD PRESSURE	2
32	20452	.COVER, PRESSURE PAD	2
33	60338	.SCREW, CAP	8
34	62204	.SCREW, SET	4
35	61101	.NUT, JAM	4

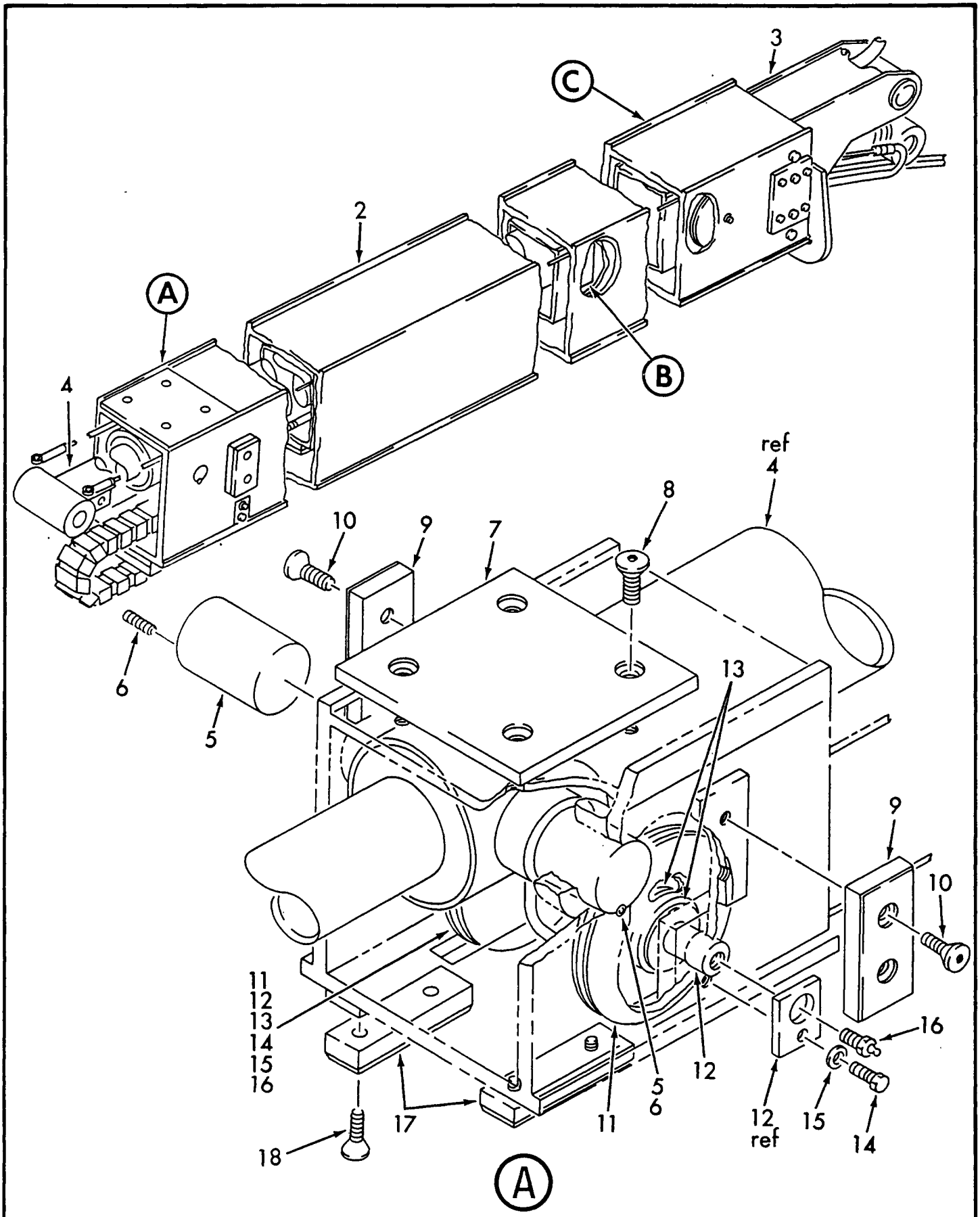
- ITEM NOT ILLUSTRATED

FINAL BOOM ASSEMBLY (60I) (BEF. JUN. 86)

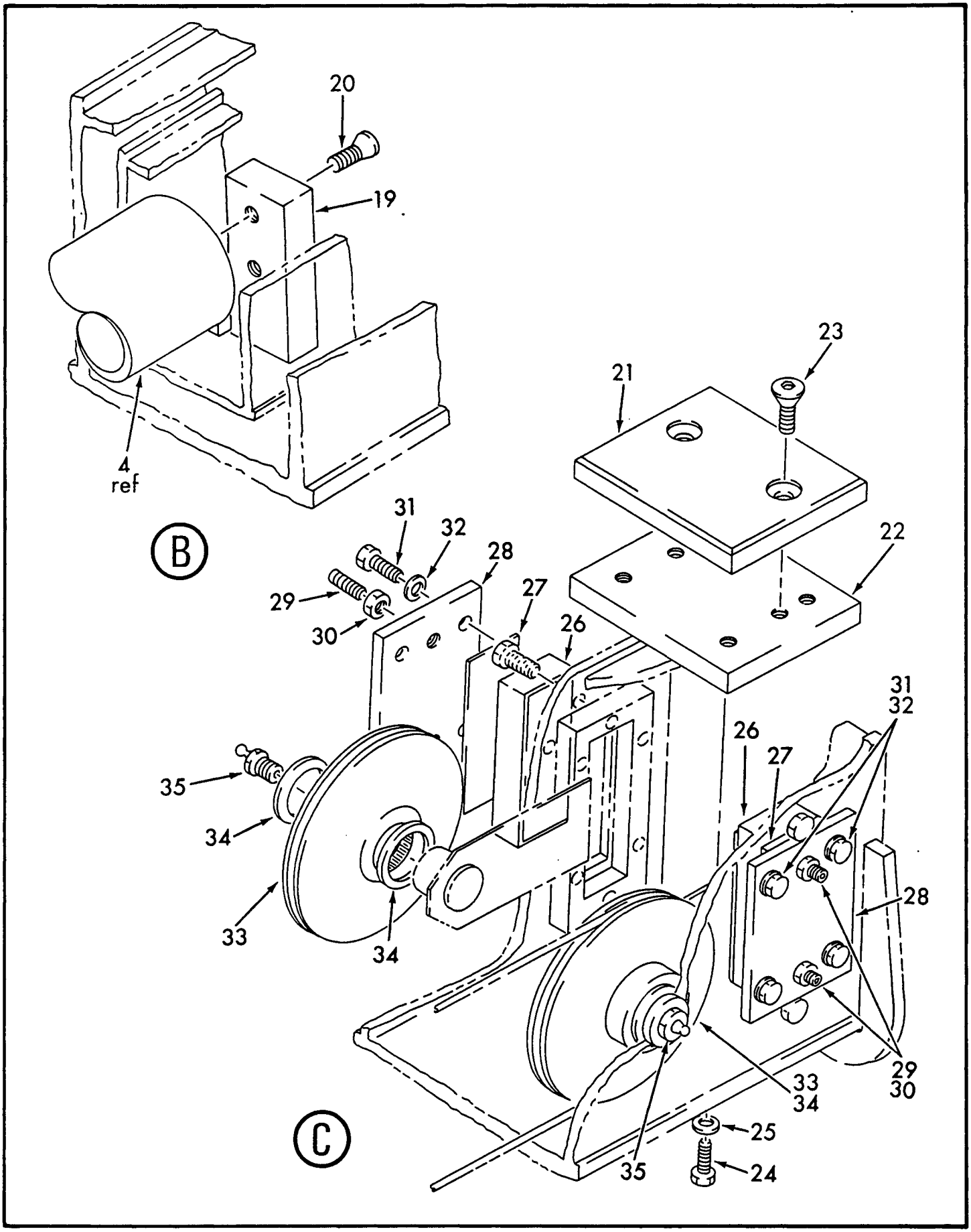
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
36	70036-2100	.CABLE, ELECTRICAL	1
37	2806	.STRAIN, RELIEF	1
38	70107	.SWITCH, LIMIT	1
39	62615	.SCREW, MACHINE	2
40	63313	.WASHER, LOCK	2
41	70148	.LEVER, ARM	1
42	64204	.PIN, ROLL	1
43	22684	.COVER	2

- ITEM NOT ILLUSTRATED

INTERMEDIATE BOOM ASSEMBLY (60I) (AFT. JUN. 86)



INTERMEDIATE BOOM ASSEMBLY (60I) (AFT. JUN. 86)



INTERMEDIATE BOOM ASSEMBLY (60I) (AFT. JUN. 86)

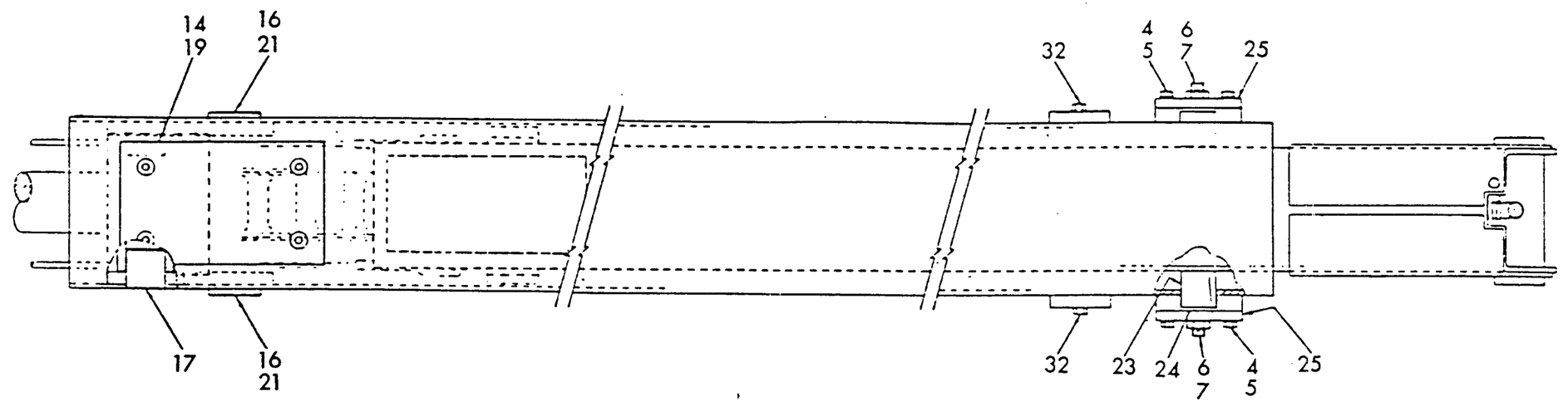
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23027	ASSEMBLY, INTERMEDIATE BOOM (See Sect. 5, Fig. 1A for NHA)	REF
2	23008	.MACHINING, INTERMEDIATE BOOM	1
3	23028	.ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 3A for Details)	1
4	23107	.ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 4A for Details)	1
5	23101	.PIN, TRUNNION	2
6	62203	.SCREW, SET	2
7	23102	.PAD, WEAR	1
8	61822	.SCREW, CAP	4
9	22567	.PAD, WEAR	2
10	61801	.SCREW, CAP	4
11	23095	.ASSEMBLY, CABLE SHEAVE	2
12	23144	.PIN, CABLE SHEAVE	2
13	65534	.WASHER, THRUST	4
14	60553	.SCREW, CAP	2
15	63302	.WASHER, LOCK	2
16	65103	.FITTING, GREASE	2
17	23309	.PAD, WEAR	2
18	61805	.SCREW, CAP	4
19	23100	.PAD, WEAR	1
20	61806	.SCREW, CAP	2
21	23106	.PAD, WEAR	1
22	23104	.SUPPORT, WEAR PAD	1
23	61801	.SCREW, CAP	2

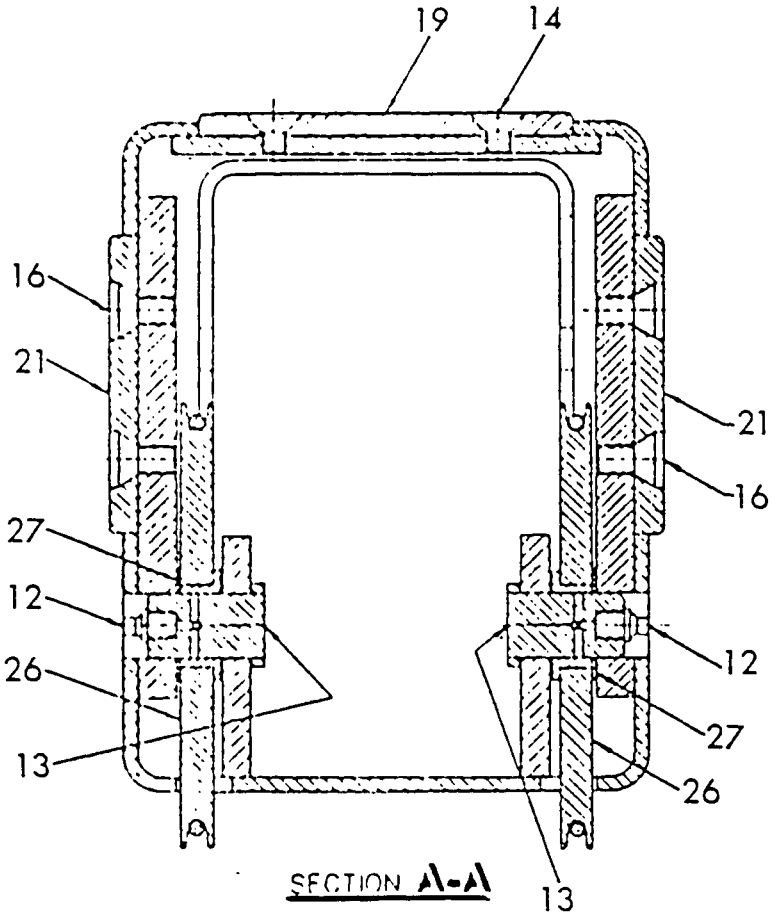
- ITEM NOT ILLUSTRATED

INTERMEDIATE BOOM ASSEMBLY (60I) (AFT. JUN. 86)

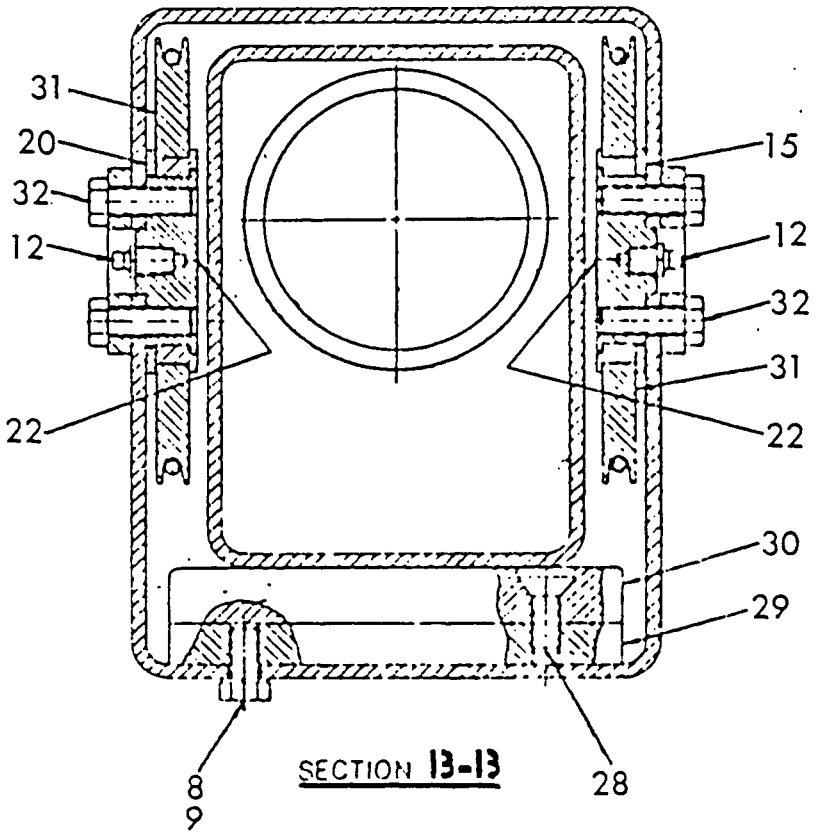
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	60325	.SCREW, CAP	4
25	63303	.WASHER, LOCK	4
26	23103	.PAD, WEAR	2
27	22372	.PLATE, PRESSURE PAD	2
28	23105	.COVER, PRESSURE PAD	2
29	61101	.NUT, JAM	4
30	62204	.SCREW, SET	4
31	60541	.SCREW, CAP	8
32	63303	.WASHER, LOCK	8
33	23095	.ASSEMBLY, CABLE SHEAVE	2
34	65534	.WASHER, THRUST	4
35	65103	.FITTING, GREASE	2

- ITEM NOT ILLUSTRATED


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SECTION A1-A1



SECTION 13-13

INTERMEDIATE BOOM ASSEMBLY (60I) (BEF. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22868	ASSEMBLY, INTERMEDIATE BOOM (See Sect. 5, Fig. 1B for NHA)	REF
2	22895	.MACHINING, INTERMEDIATE BOOM	1
3	22869	.ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 3B for Details)	1
4	60338	.SCREW, CAP	8
5	63302	.WASHER, LOCK	8
6	61101	.NUT, JAM	4
7	62204	.SCREW, SET	4
8	60325	.SCREW, CAP	4
9	63303	.WASHER, LOCK	4
10	22779	.PAD, WEAR	1
11	61806	.SCREW, CAP	2
12	65103	.FITTING, GREASE	4
13	22543	.PIN, CABLE SHEAVE	2
14	61806	.SCREW, CAP	6
15	22569	.PAD, WEAR	2
16	61806	.SCREW, CAP	8
17	20266	.PIN, TRUNNION	2
18	62203	.SCREW, SET	2
19	21029	.PAD, WEAR	1
20	22590	.WASHER, THRUST	2
21	22786	.PAD, WEAR	2
22	22544	.PIN, CABLE SHEAVE	2
23	22562	.PAD, WEAR	2
24	20453	.PLATE, PAD PRESSURE	2
25	20452	.COVER, PRESSURE PAD	2

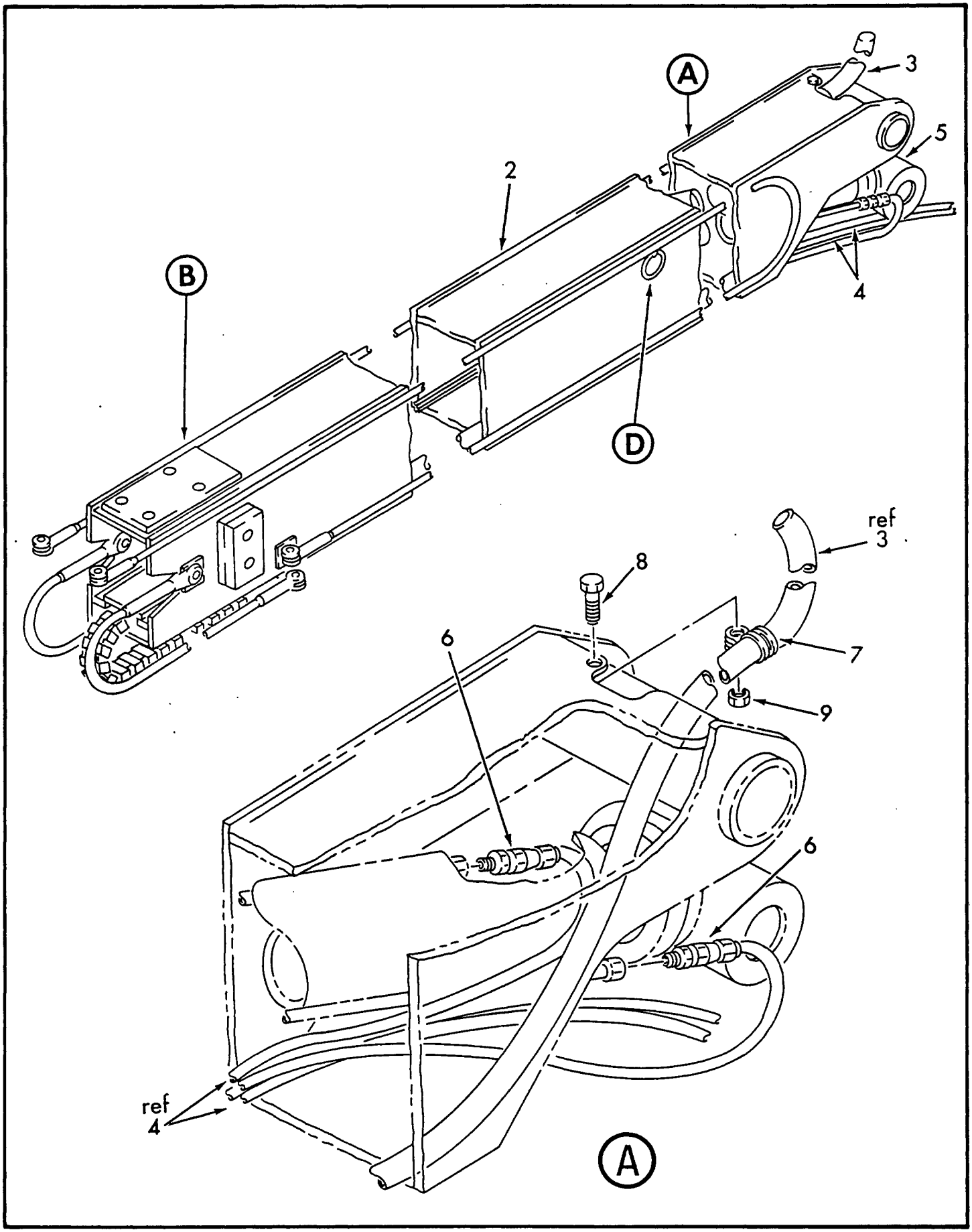
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INTERMEDIATE BOOM ASSEMBLY (60I) (BEF. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	22540	.SHEAVE, CABLE	2
27	65476	.WASHER, THRUST	2
28	61805	.SCREW, CAP	2
29	22780	.SUPPORT, WEAR PAD	1
30	22566	.PAD, WEAR	1
31	22592	.SHEAVE, CABLE	2
32	60643	.SCREW, CAP	4
33	22980	.ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 4B for Details)	1

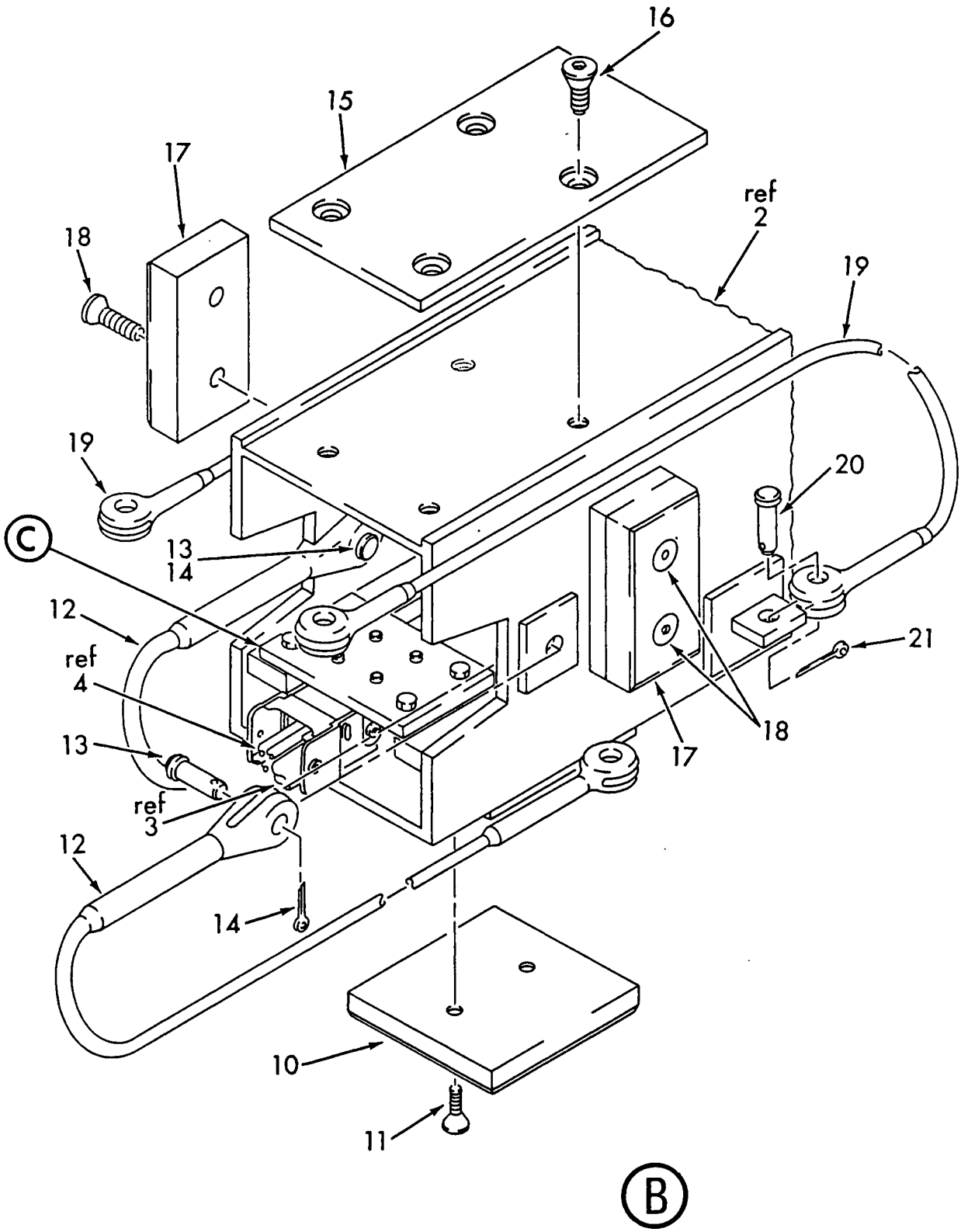
- ITEM NOT ILLUSTRATED

INNER BOOM ASSEMBLY (60I) (AFT. JUN. 86)

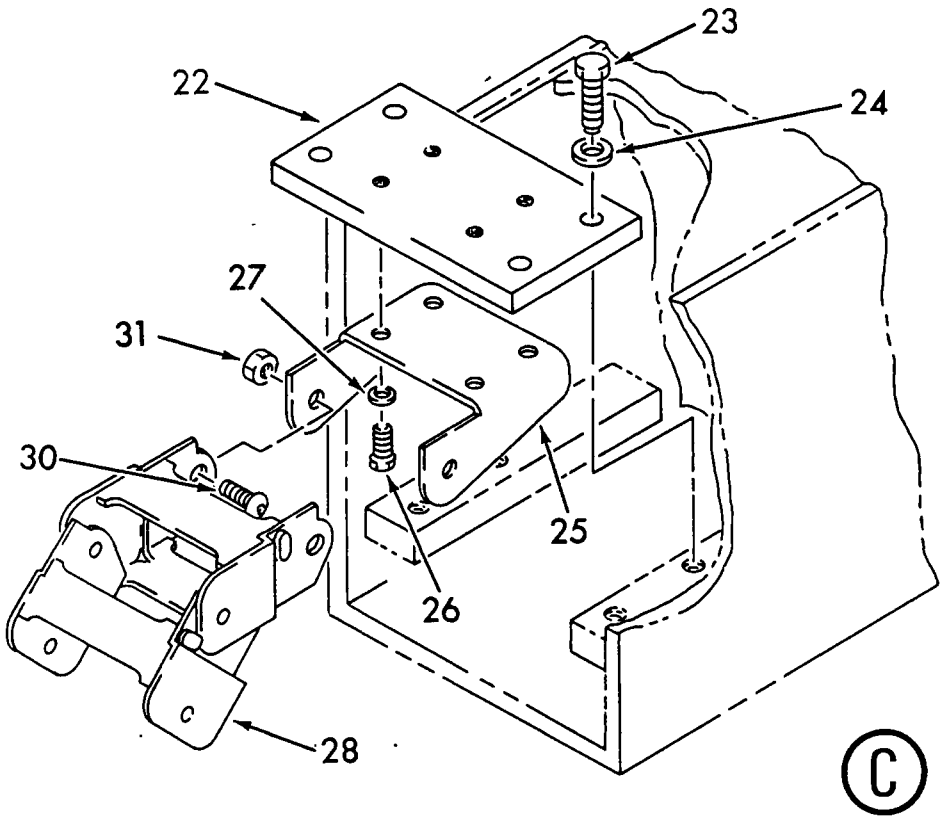


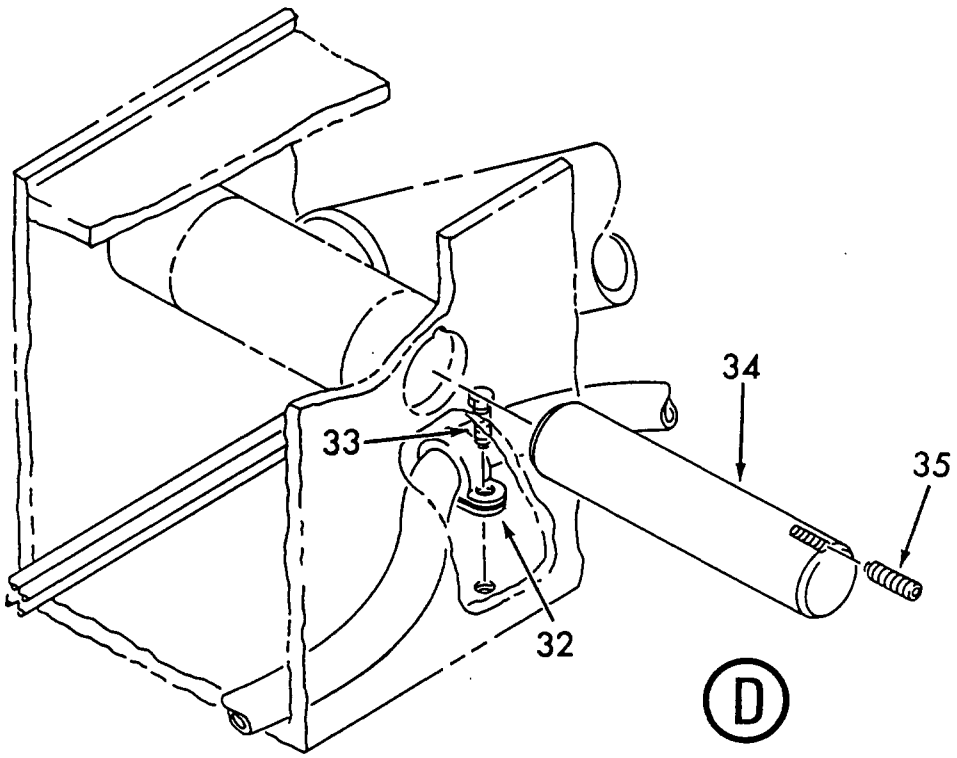
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INNER BOOM ASSEMBLY (60I) (AFT. JUN. 86)



INNER BOOM ASSEMBLY (60I) (AFT. JUN. 86)





INNER BOOM ASSEMBLY (60I) (AFT. JUN. 86)

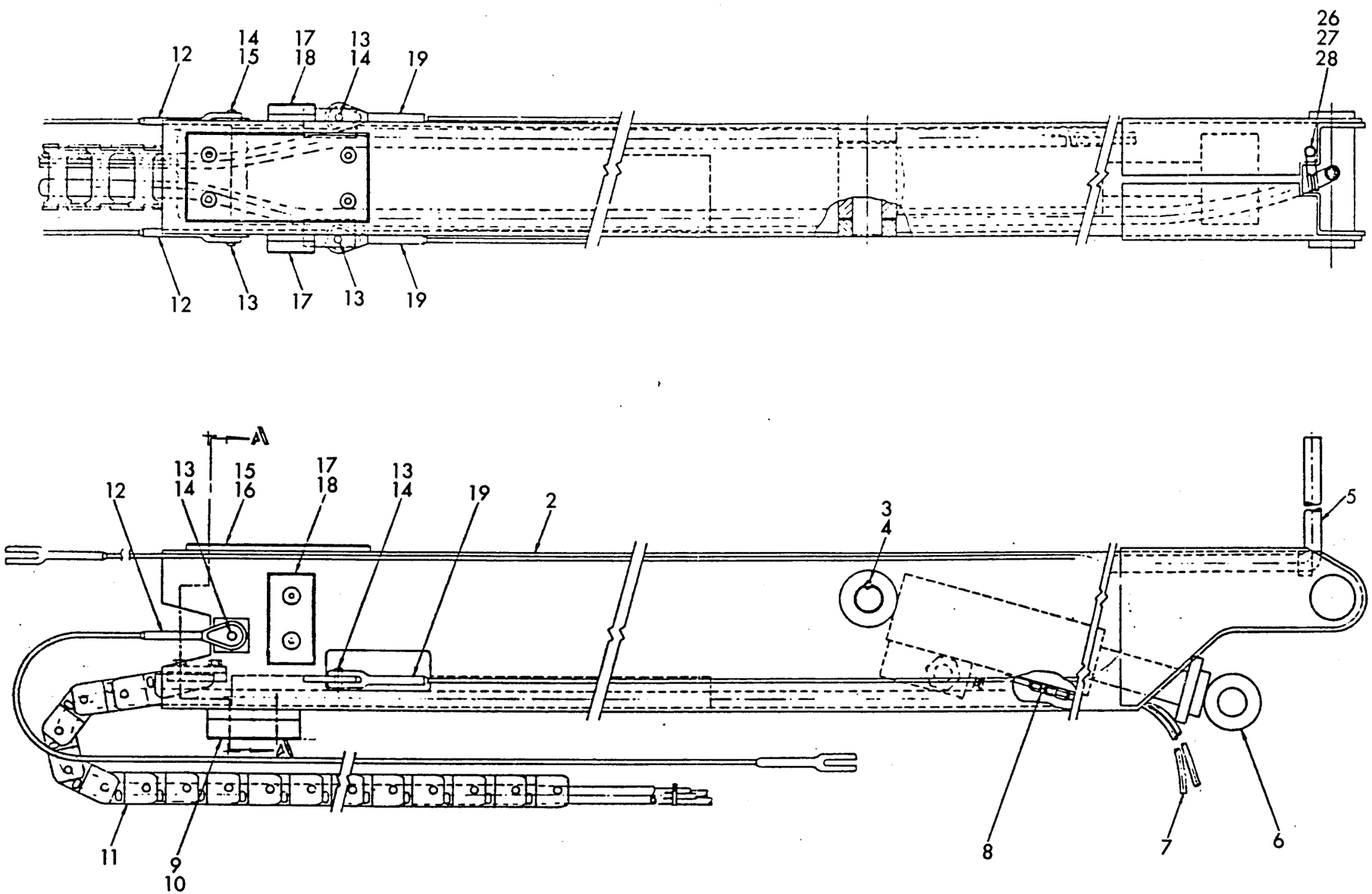
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23028	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 2A for NHA)	REF
2	23011	.MACHINING, INNER BOOM	1
3	20802-1120	.CABLE, ELECTRIC	1
4	2568-960	.HOSE, HYDRAULIC	4
5	22584	.ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 6 for Details)	1
6	2562	.FITTING, STRAIGHT SWIVEL	2
7	16268	.CLAMP, RUBBER	1
8	60309	.SCREW, CAP	1
9	60711	.NUT, HEX	1
10	23083	.PAD, WEAR	1
11	61827	.SCREW, CAP	2
12	22983	.CABLE, RETRACTION	2
13	23697	.PIN, CLEVIS	2
14	64301	.PIN, COTTER	2
15	23082	.PAD, WEAR	1
16	61822	.SCREW, CAP	4
17	22569	.PAD, WEAR	2
18	61805	.SCREW, CAP	4
19	22727	.CABLE, EXTENSION	2
20	23697	.PIN, CLEVIS	2
21	64301	.PIN, COTTER	2
22	22560	.PLATE, MOUNTING PLASTITRAK	1
23	60322	.SCREW, CAP	4
24	63302	.WASHER, LOCK	4

- ITEM NOT ILLUSTRATED

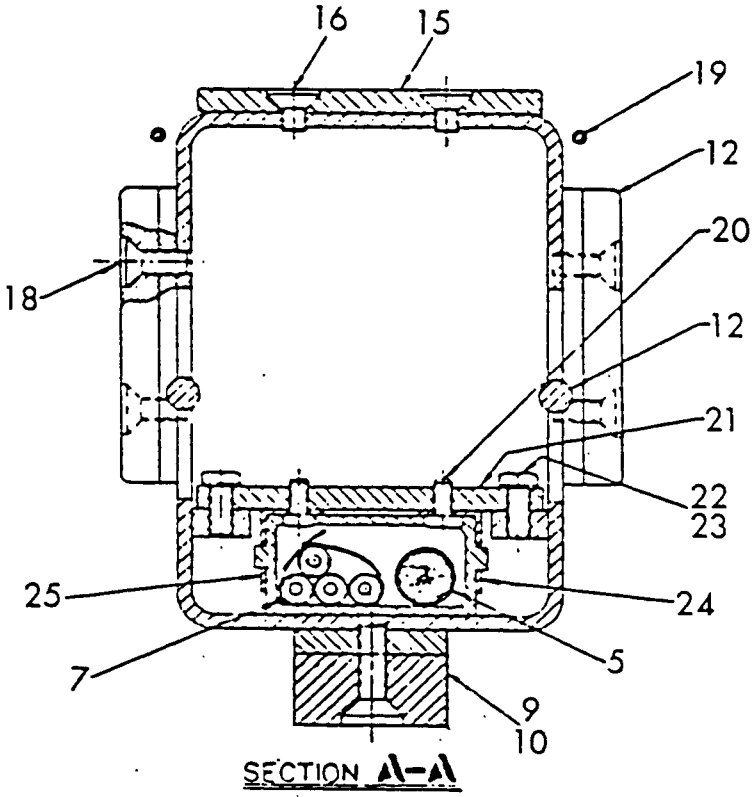
INNER BOOM ASSEMBLY (60I) (AFT. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	23752	.BRACKET, MOVABLE PLASTITRAK	1
26	60543	.SCREW, CAP	4
27	63301	.WASHER, LOCK	4
28	22985	.ASSEMBLY, MARK TRACK	1
-29	21933	..TRACK, MARK	116
30	61931	.SCREW, CAP	2
31	61322	.NUT, LOCK	2
32	16268	.CLAMP, RUBBER	1
33	60309	.SCREW, CAP	1
34	23084	.PIN, SLAVE LEVELING CYLINDER	1
35	62203	.SCREW, SET	1

- ITEM NOT ILLUSTRATED


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INNER BOOM ASSEMBLY (60I) (BEF. JUN. 86)



SECTION A1-A1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22869	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 2B for NHA)	REF
2	22898	.MACHINING, INNER BOOM	1
3	62203	.SCREW, SET	1
4	22573	.PIN, SLAVE LEVELING CYLINDER	1
5	20802-1120	.CABLE, ELECTRICAL	1
6	22584	.ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 6 for Details)	1
7	2568-960	.HOSE, HYDRAULIC	4
8	2562	.FITTING, STRAIGHT SWIVEL	2
9	22568	.PAD, WEAR	1
10	61806	.SCREW, CAP	2
11	22985	.ASSEMBLY, MARK TRACK	1
-11A	21933	..TRACK, MARK	116

REV.

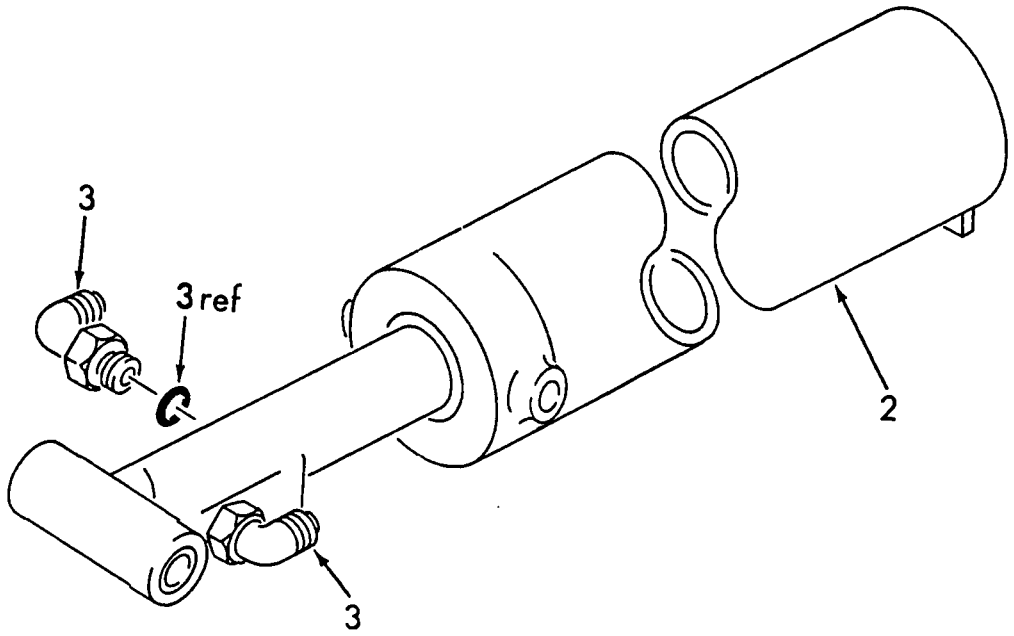
- ITEM NOT ILLUSTRATED

INNER BOOM ASSEMBLY (60I) (BEF. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
12	22983	.CABLE, RETRACTION	2
13	22547	.PIN, CABLE	4
14	65080	.RING, SNAP	8
15	21030	PAD, WEAR	1
16	61822	.SCREW, CAP	4
17	22567	.PAD, WEAR	2
18	61801	.SCREW, CAP	4
19	22727	.CABLE, EXTENSION	2
20	60633	.SCREW, CAP	4
21	22560	.PLATE, MOUNTING PLASTITRAK	1
22	60322	.SCREW, CAP	4
23	63302	.WASHER, LOCK	4
24	22588	.BRACKET, MOVABLE L.H. MOUNTING	1
25	22587	.BRACKET, MOVABLE R.H. MOUNTING	1
26	60309	.SCREW, CAP	1
27	60711	.NUT, HEX	1
28	16268	.CLAMP, RUBBER	1

- ITEM NOT ILLUSTRATED

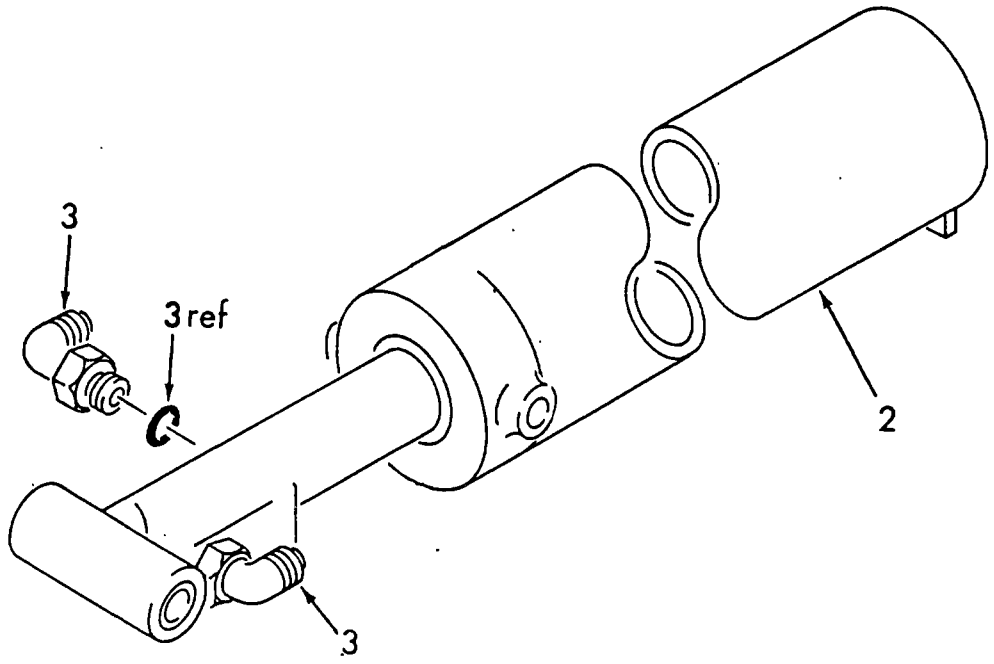
EXTENSION CYLINDER ASSEMBLY (AFT. JUN. 86)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23107	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig. 2A for NHA)	REF
2	23108	.SUB-ASSEMBLY, EXTENSION CYLINDER (See Sect. 5 Fig. 5A for Details)	1
3	80012-11	.ELBOW, STRAIGHT THREAD	2

- ITEM NOT ILLUSTRATED

EXTENSION CYLINDER ASSEMBLY (BEF. JUN. 86)

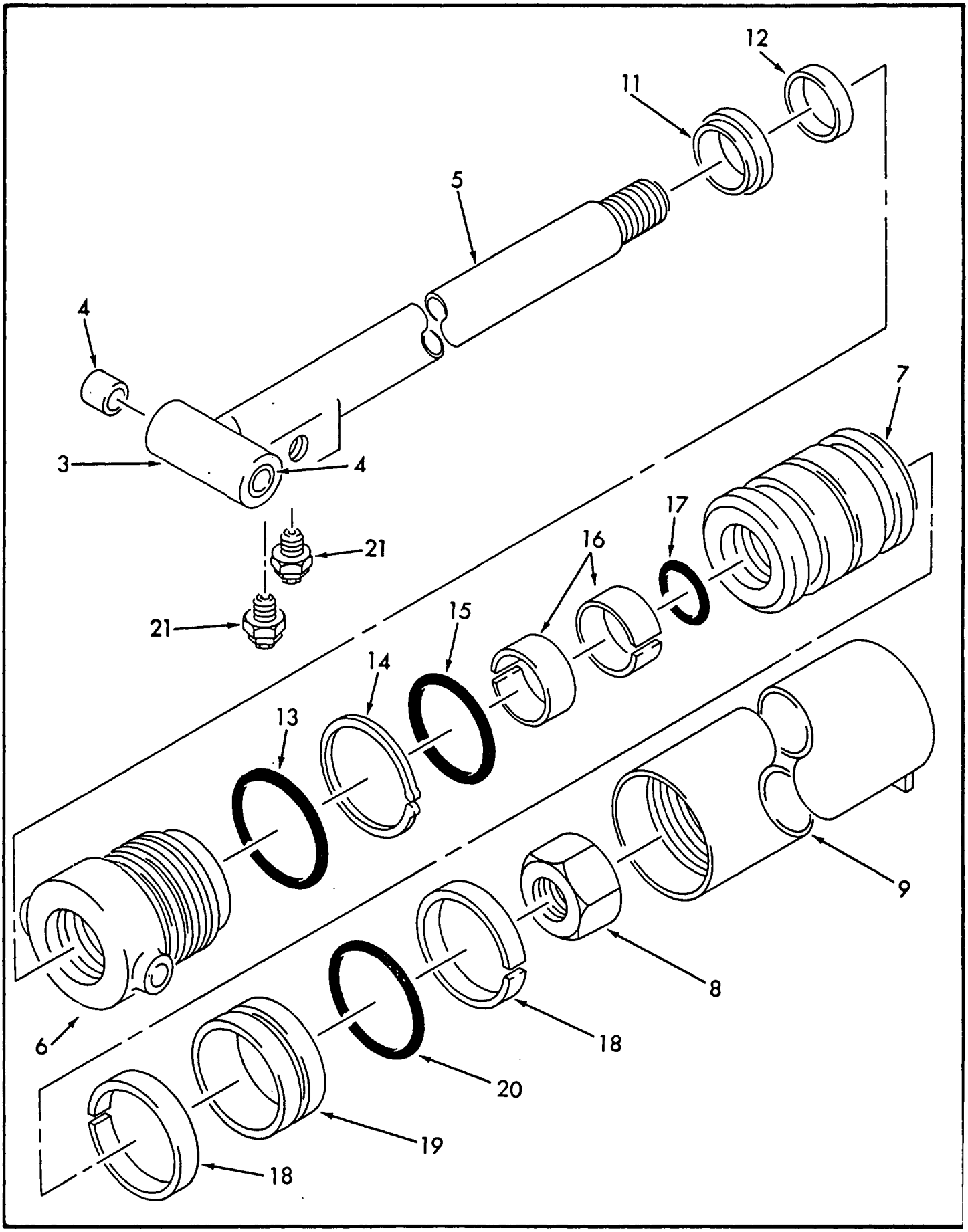


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22980	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig. 2B for NHA)	REF
2	22981	.SUB-ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 5B for Details)	1
3	80012-11	.ELBOW, STRAIGHT THREAD	2

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- ITEM NOT ILLUSTRATED

EXTENSION CYLINDER SUB-ASSEMBLY (AFT. JUN. 86)



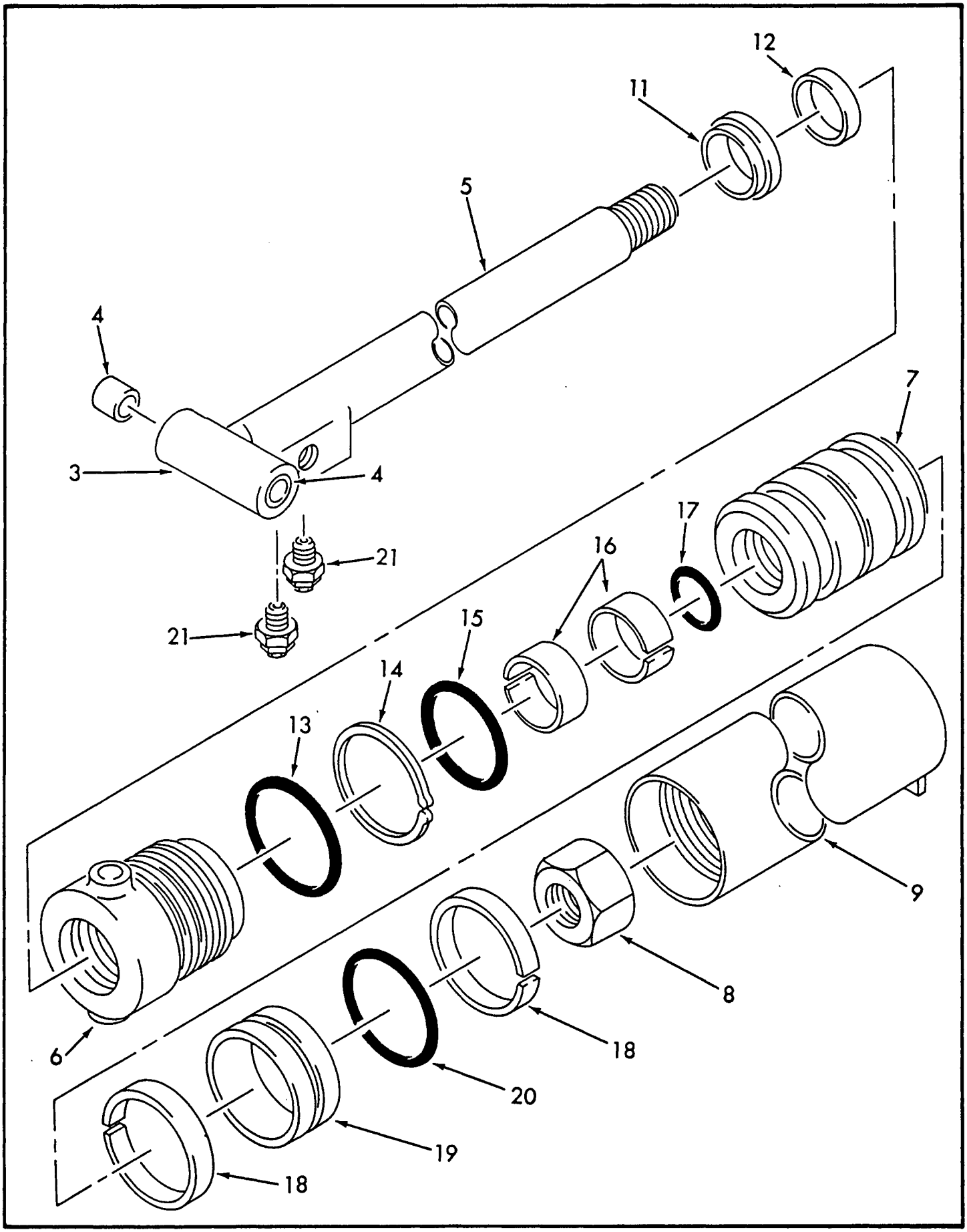
REV.

EXTENSION CYLINDER SUB-ASSEMBLY (AFT. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23108	EXTENSION CYLINDER SUB-ASSEMBLY (See Sect. 5, Fig.4A for NHA)	REF
-2	23109	.CYLINDER, EXTENSION	REF
3		..END, ROD	1
4		..BUSHING	2
5		..ROD	1
6		..NUT, GLAND	1
7		..PISTON	1
8		..NUT, LOCK	1
9		..BARREL	1
-10		..KIT, SEAL	REF
11		...WIPER, ROD	1
12		...SEAL, ROD	1
13		...O-RING	1
14		...RING, BACK-UP	1
15		...O-RING	1
16		...BEARING, WEAR	2
17		...O-RING	1
18		...RING, WEAR	2
19		...SEAL, SQUARE	1
20		...O-RING	1
21	81006	.CARTRIDGE, OVERCENTER	2

- ITEM NOT ILLUSTRATED

EXTENSION CYLINDER SUB-ASSEMBLY (BEF. JUN. 86)

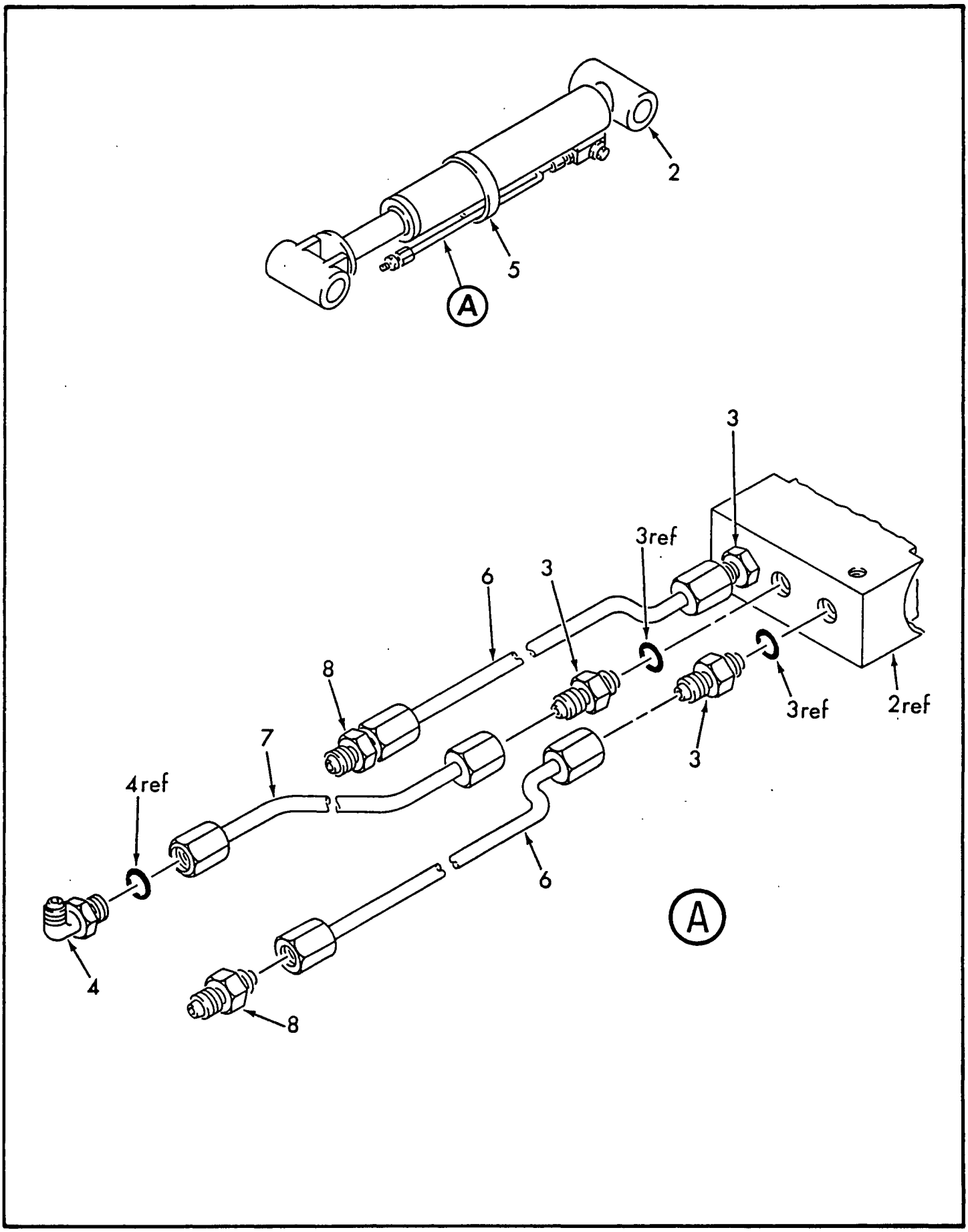


EXTENSION CYLINDER SUB-ASSEMBLY (BEF. JUN. 86)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22981	SUB-ASSEMBLY, EXTENSION CYLINDER (SEE SECT. 5 FIG. 4B FOR NHA)	REF
-2	22982	CYLINDER, BOOM EXTENSION	1
3		..END, ROD	1
4		..BUSHING	2
5		..ROD	1
6		..NUT, GLAND	1
7		..PISTON	1
8		..NUT, LOCK	1
9		..BARREL	1
-10		..KIT, SEAL	1
11		...WIPER, ROD	1
12		...SEAL, ROD	1
13		...O-RING	1
14		...RING, BACK-UP	1
15		...O-RING	1
16		...BEARING, WEAR	2
17		...O-RING	1
18		...RING, WEAR	2
19		...SEAL, SQUARE	1
20		...O-RING	1
21	81006	.CARTRIDGE, OVERCENTER	2

- ITEM NOT ILLUSTRATED

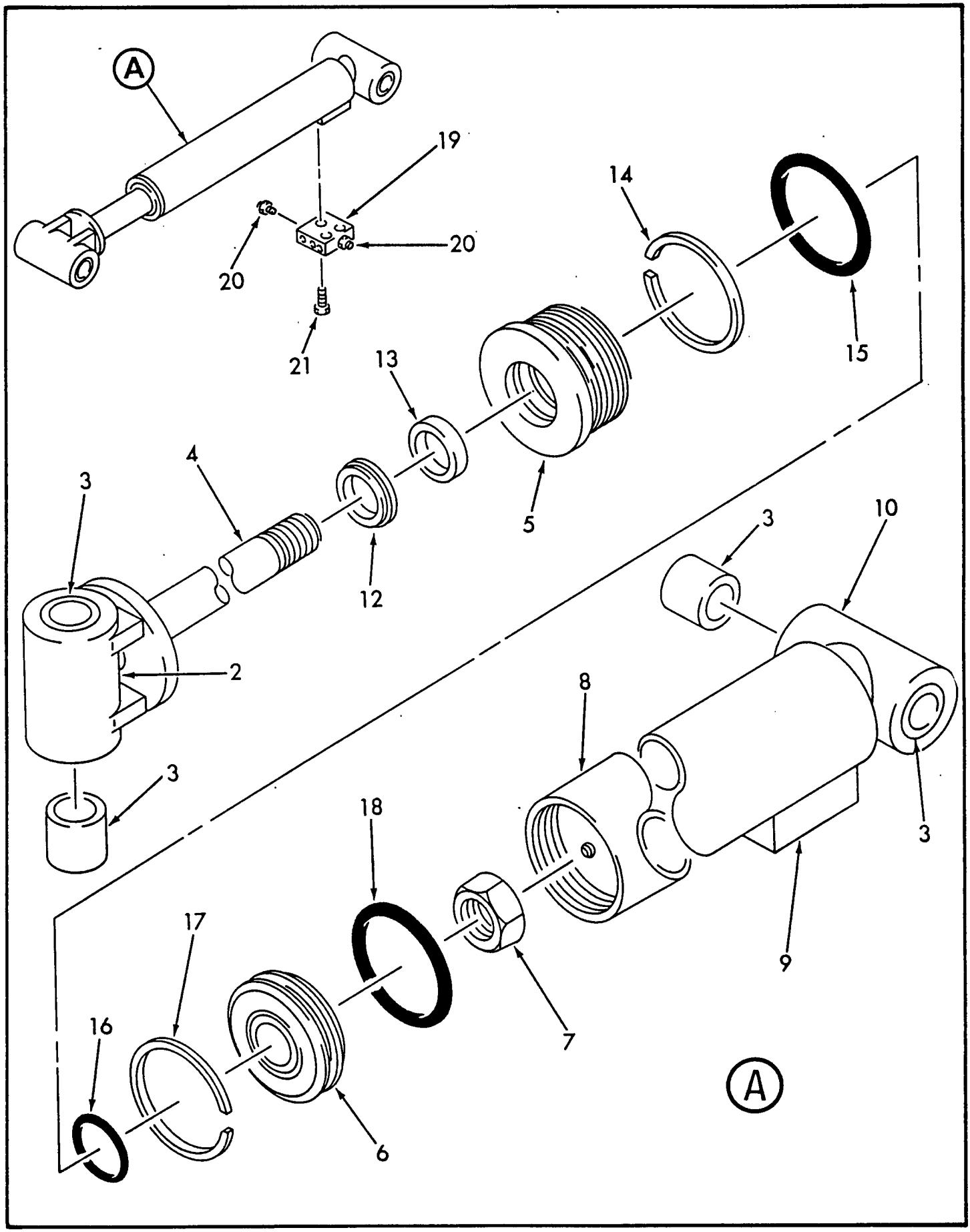
SLAVE LEVELING CYLINDER ASSEMBLY



SLAVE LEVELING CYLINDER ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22584	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 3A or 3B for NHA)	REF
2	22576	.SUB-ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 7 for Details)	1
3	80004-03	.CONNECTOR	3
4	80012-03	.ELBOW	1
5	16206	.STRAP	1
6	22584-6	.ASSEMBLY, TUBE	2
7	22584-7	.ASSEMBLY, TUBE	1
8	80042-03	.UNION	2

SLAVE LEVELING CYLINDER SUB-ASSEMBLY



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SLAVE LEVELING CYLINDER SUB-ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22576	SUB-ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 6 for NHA)	REF
-1A	22574	.CYLINDER, SLAVE LEVELING	1
2		..END, ROD	1
3		..BUSHING	4
4		..ROD, CYLINDER	1
5		..ROD, GLAND	1
6		..PISTON	1
7		..NUT, SELF LOCKING	1
8		..TUBE, CYLINDER	1
9		..PAD, MANIFOLD	1
10		..END, CYLINDER	1
-11	66564	..KIT, SEAL	REF
12		..WIPER, ROD	1
13		...SEAL	1
14		...WIRE, SAFETY	1
15		...SEAL	1
16		...O-RING	1
17		...RING, BACK-UP	1
18		...O-RING	1
19	21447	.BLOCK, MANIFOLD	1
20	21267	.CARTRIDGE, OVERCENTER	2
21	61903	.SCREW, CAP	3

THIS **SECTION 6** IS ILLUSTRATED AS:

FIGURE 1. GROUND AND AERIAL 110 RECEPTACLES

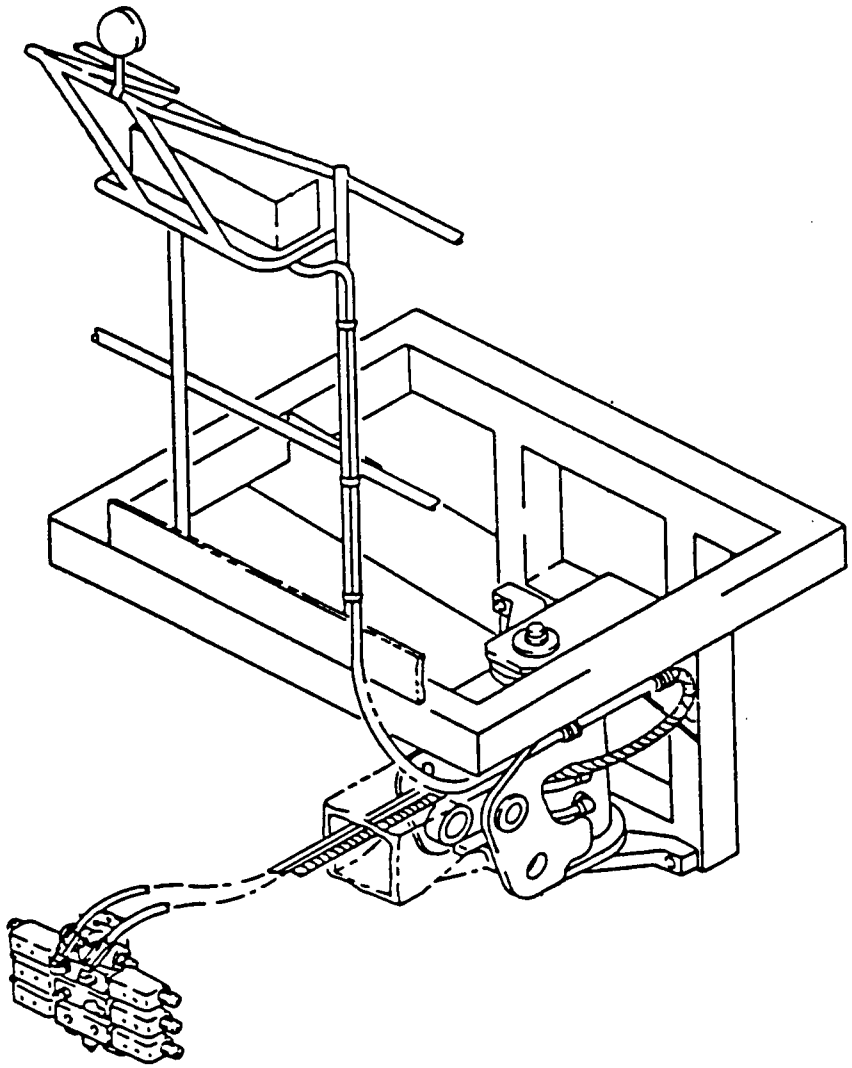
FIGURE 2. CLEARANCE, STOP AND TURNING LIGHTS

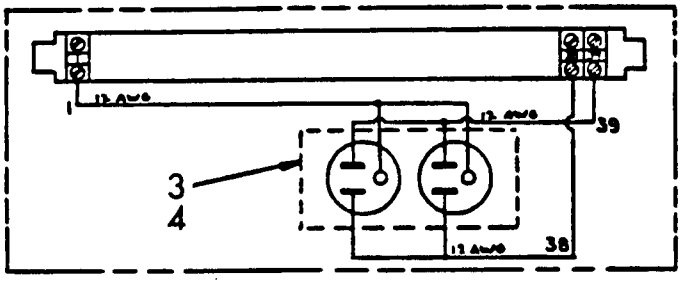
FIGURE 3. ROTATING BEACON INSTALLATION

FIGURE 4. PLATFORM ROTATION INSTALLATION

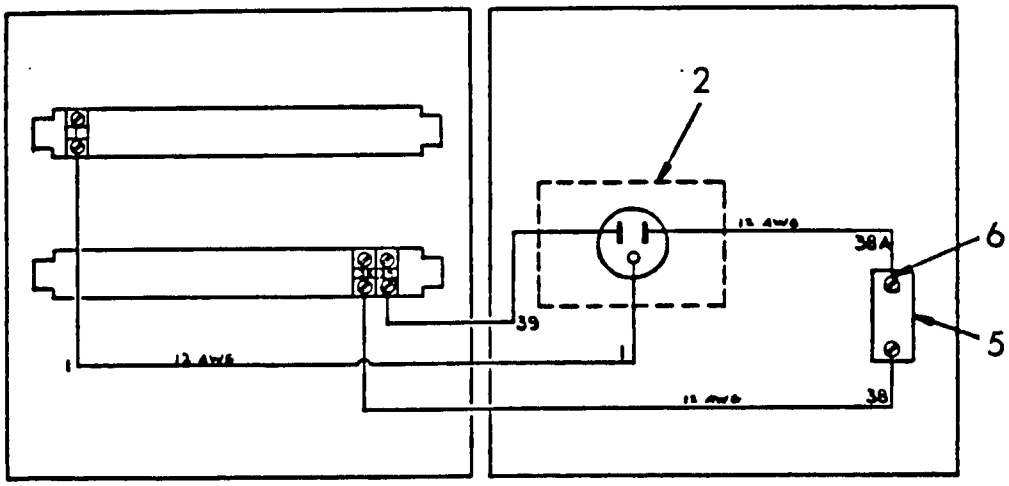
FIGURE 5. MINI-PAK SUB-ASSEMBLY

FIGURE 6. 12 VOLT PLATFORM WORKLIGHT



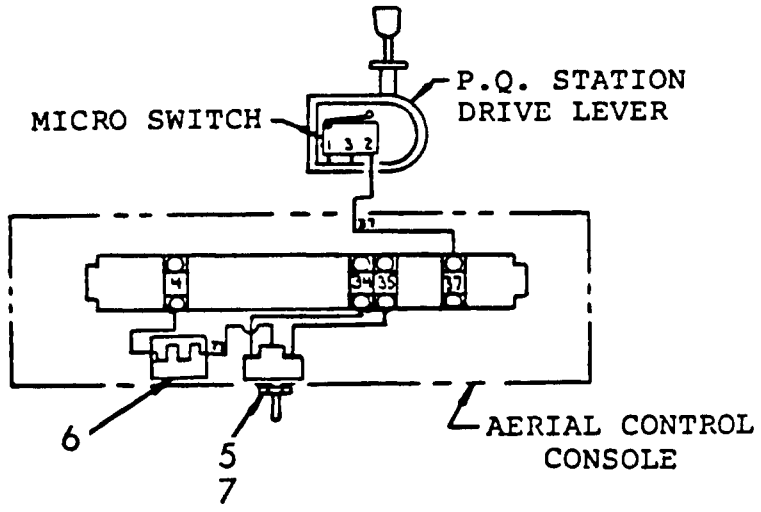


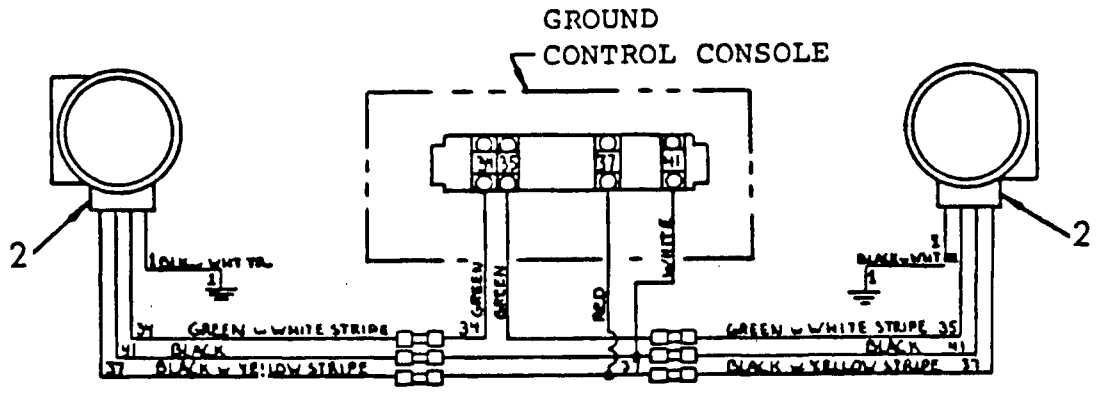
AERIAL CONTROL CONSOLE



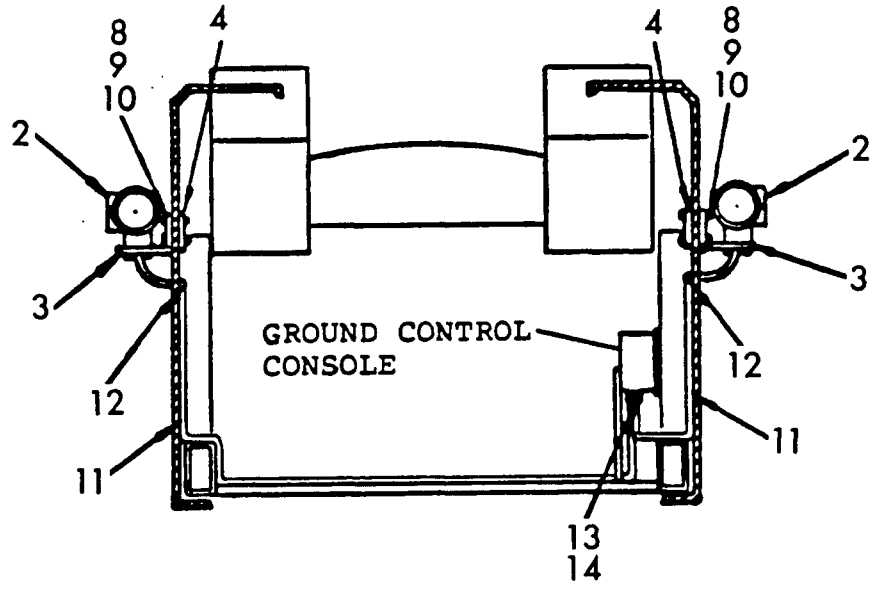
GROUND CONTROL CONSOLE

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20104	INSTALLATION, GROUND AND AERIAL 110 VAC RECEPTACLES	REF
2	70119	.PLATE, COVER	1
3	288	.PLATE, COVER	1
4	70126	.RECEPTACLE	1
5	20562	.BREAKER, CIRCUIT	1
6	2832	.CONNECTOR	7



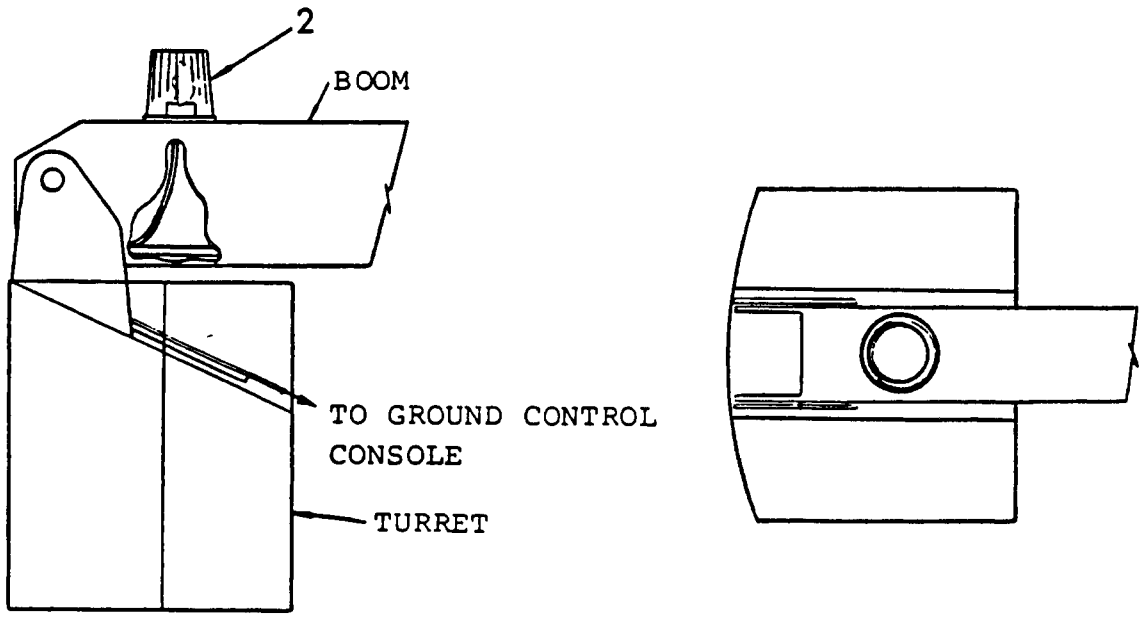


ELECTRICAL DIAGRAM



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20106	INSTALLATION, CLEARANCE, STOP AND TURNING LIGHT	REF
2	20838	.LIGHT, CLEARANCE	2
3	20864	.BRACKET, MOUNTING	2
4	20865	.PLATE, BACK-UP	2
5	4019	.SWITCH, TOGGLE	1
6	448-A	.FLASHER	2
7	20866	.DECAL, TURN INDICATOR	1
8	60331	.SCREW, CAP	4
9	60703	.NUT, HEX	4
10	63303	.WASHER, LOCK	4
11	2912	.CABLE	2
12	117-0	.CONNECTOR	8
13	2806	.RELIEF, STRAIN	2
14	2808	.NUT, LOCK	2

ROTATING BEACON INSTALLATION

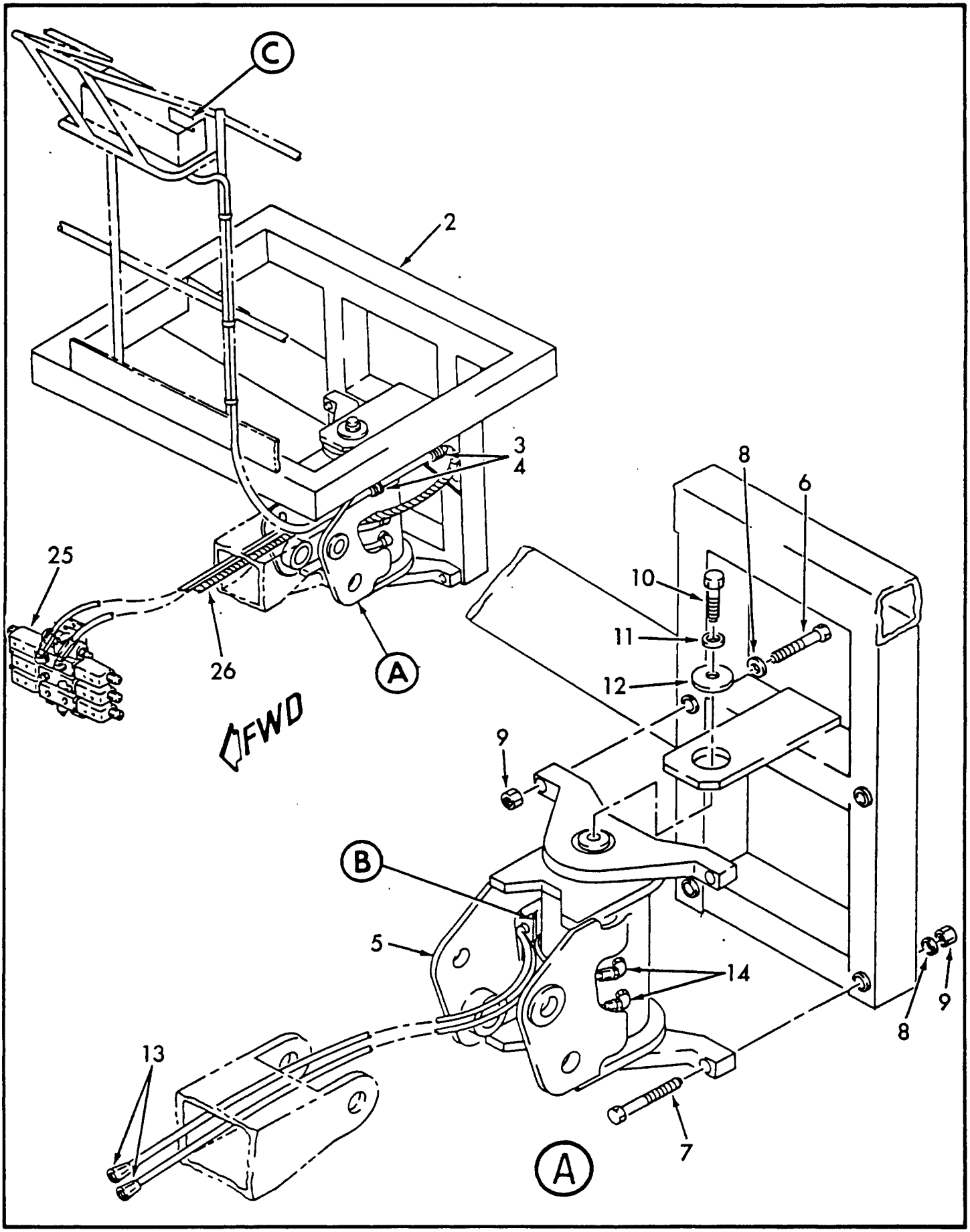


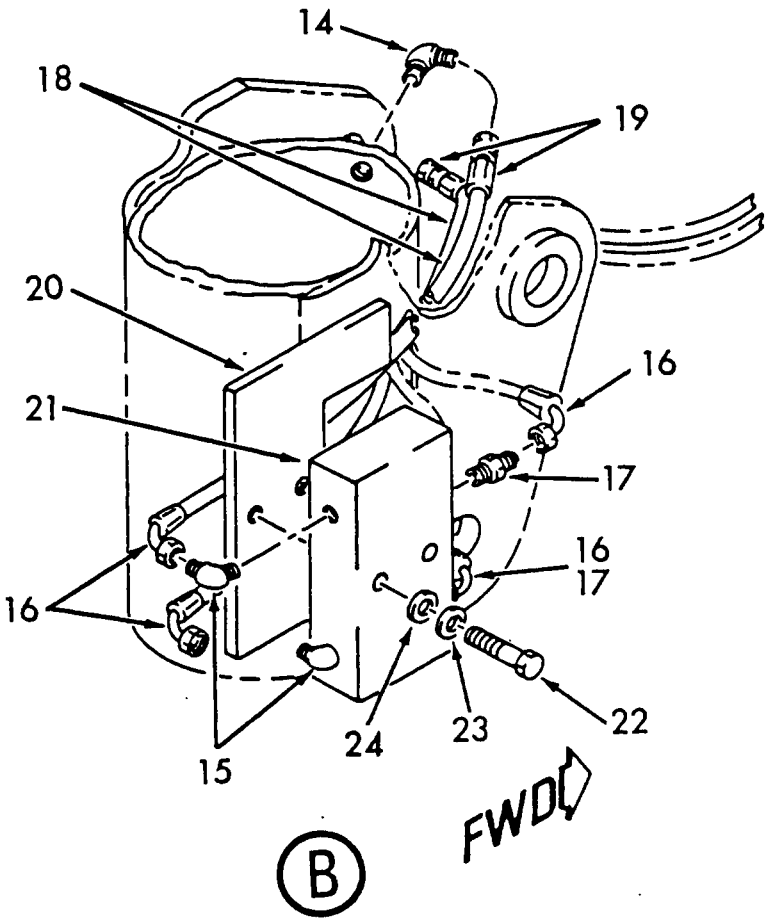
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20107	INSTALLATION, ROTATING BEACON	REF
2	20863	.BEACON, ROTATING (YELLOW)	1

REV.

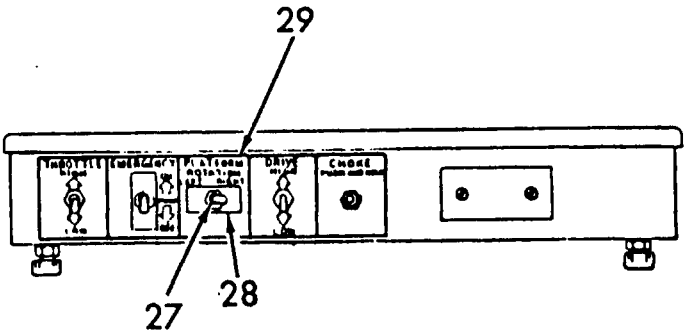
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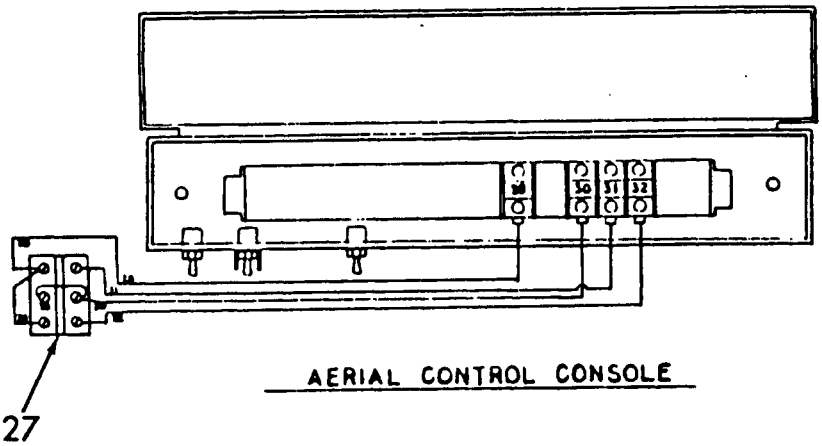
PLATFORM ROTATION . INSTALLATION





B





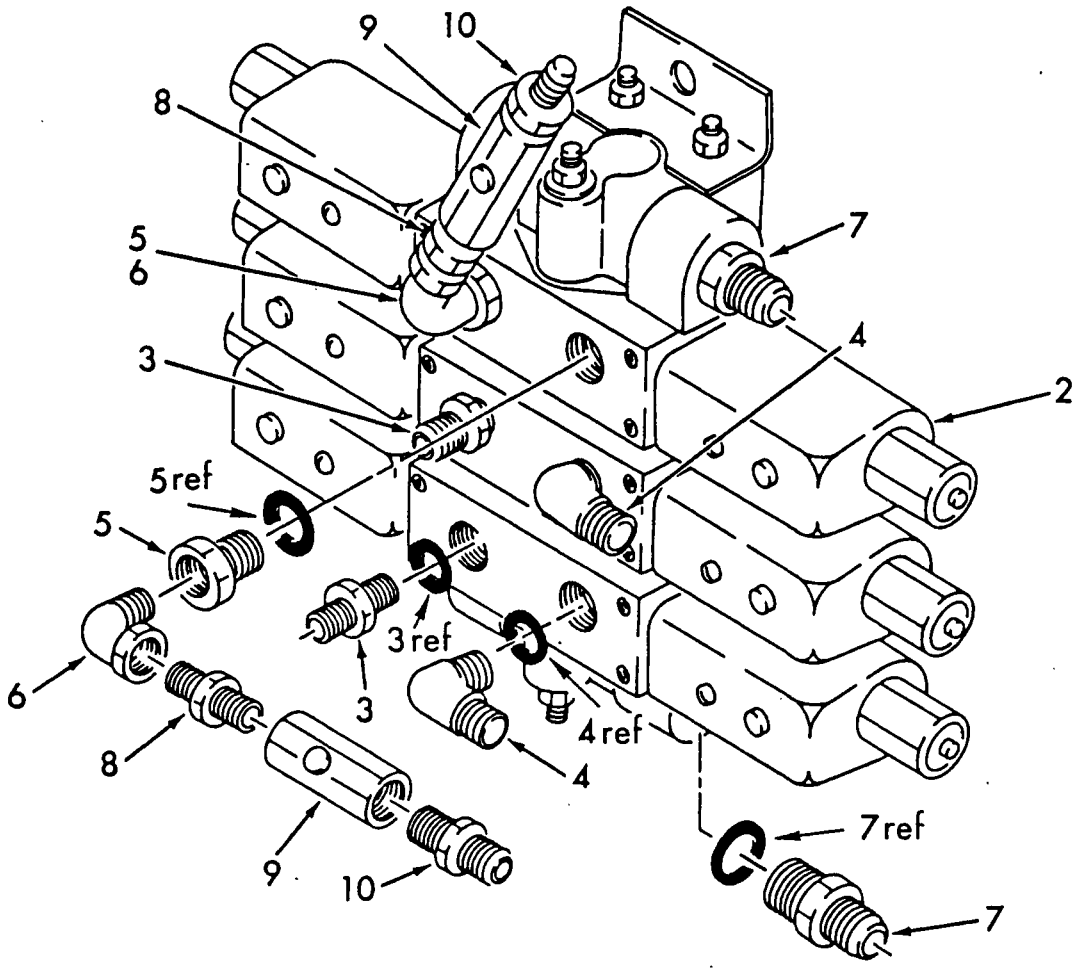
AERIAL CONTROL CONSOLE

C

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22279	INSTALLATION, PLATFORM ROTATION	REF
2	23065	.WELDMENT, FORK PLATFORM ROTATION	1
3	16268	.CLAMP, HOSE	7
4	61902	.SCREW, CAP	7
5	81094	.ROTATOR, HELAC	1
6	60540	.SCREW, CAP	2
7	60513	.SCREW, CAP	2
8	63415	.WASHER, FLAT	4
9	61305	.NUT, LOCK	4
10	60516	.SCREW, CAP	1
11	63303	.WASHER, LOCK	1
12	23565	.WASHER	1
13	2562	.FITTING	2
14	80012-03	.ELBOW	2
15	80012-05	.ELBOW	2
16	2594	.ELBOW	4
17	80004-05	.CONNECTOR	2
18	2568-0144	.HOSE, HYDRAULIC	2
19	2562	.FITTING	2
20	23197	.BRACKET, CHECK VALVE	1
21	20351	.VALVE, CHECK	1
22	60360	.SCREW, CAP	2
23	63302	.WASHER, LOCK	2
24	63402	.WASHER, FLAT	2
25	21713	.SUB-ASSEMBLY, MINI-PAK (See Sect. 6, Fig. 5 for Details)	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	65321-42	.SLEEVE, PLASTIC COIL	1
27	4021	.SWITCH, TOGGLE	1
28	20884	.GUARD, SWITCH	1
29	22571	.DECAL	1

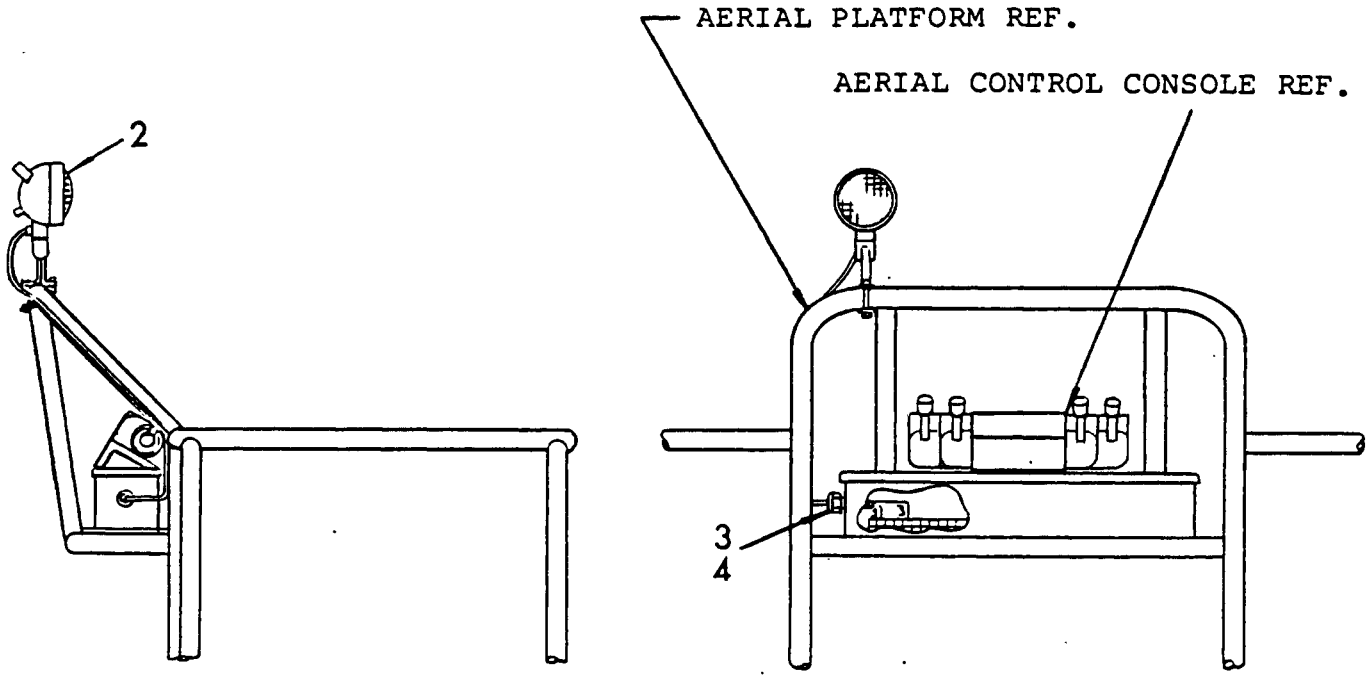
MINI-PAK SUB-ASSEMBLY



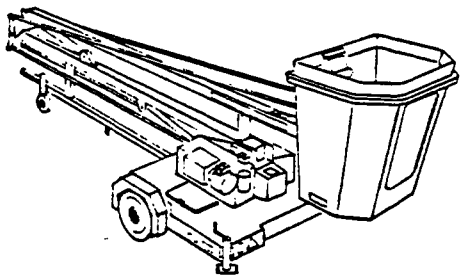
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21713	SUB-ASSEMBLY, MINI-PAK (See Sect. 6, Fig. 4 for NHA)	1
2	21787	.BANK, SOLENOID VALVE	1
3	80004-05	.CONNECTOR	2
4	80012-05	.ELBOW	2
5	80063-01	.ADAPTER	2
6	80021-03	.ELBOW, STREET	2
7	80004-08	.CONNECTOR	2
8	80052-04	.NIPPLE, PIPE	2
9	20370	.VALVE, NEEDLE	2
10	80001-04	.CONNECTOR	2

REV.

12 VOLT PLATFORM WORKLIGHT

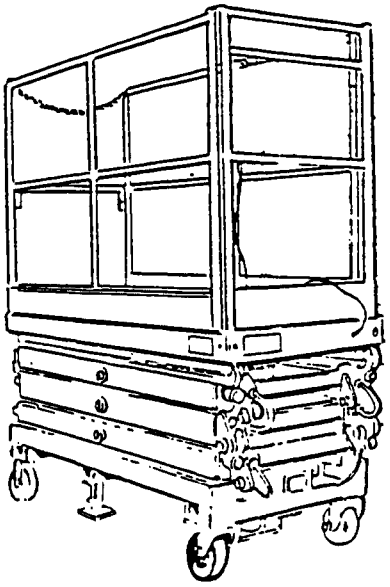


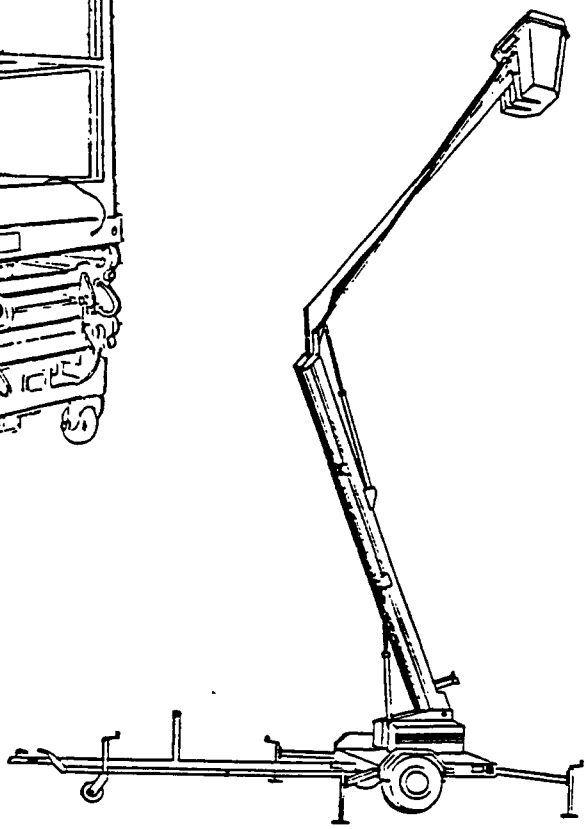
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20139	ASSEMBLY, 12V PLATFORM WORKLIGHT	REF
2	20862	.WORKLIGHT	1
3	2522	.RELIEF, STRAIN	1
4	141	.NUT, LOCK	1

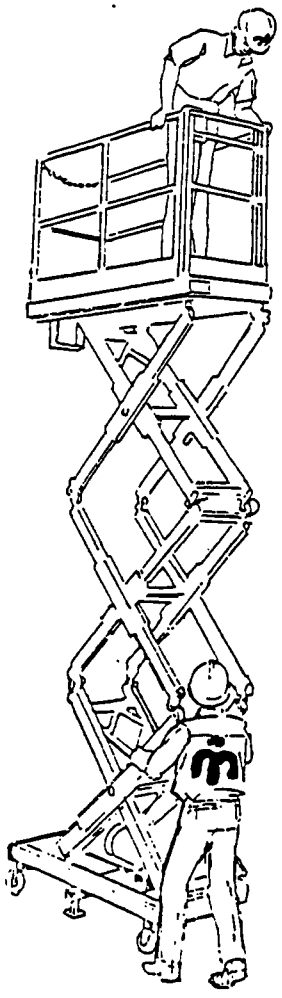


THIS VENDOR CHAPTER IS DESIGNED AS:

SECTION 1	NISSAN:	ENGINE (A12/15-A)
SECTION 2	HOOF:	GOVERNOR
SECTION 3	BERTEA:	PROPORTIONAL VALVE
SECTION 4	FAIRFIELD:	TORQUE-HUB FINAL DRIVES
SECTION 5	MINI-PAK:	SOLENOID OPERATED VALVE
SECTION 6	HUNTER:	THROTTLE CONTROL
SECTION 7	HELAC:	PIVOT ROTARY ACTUATORS









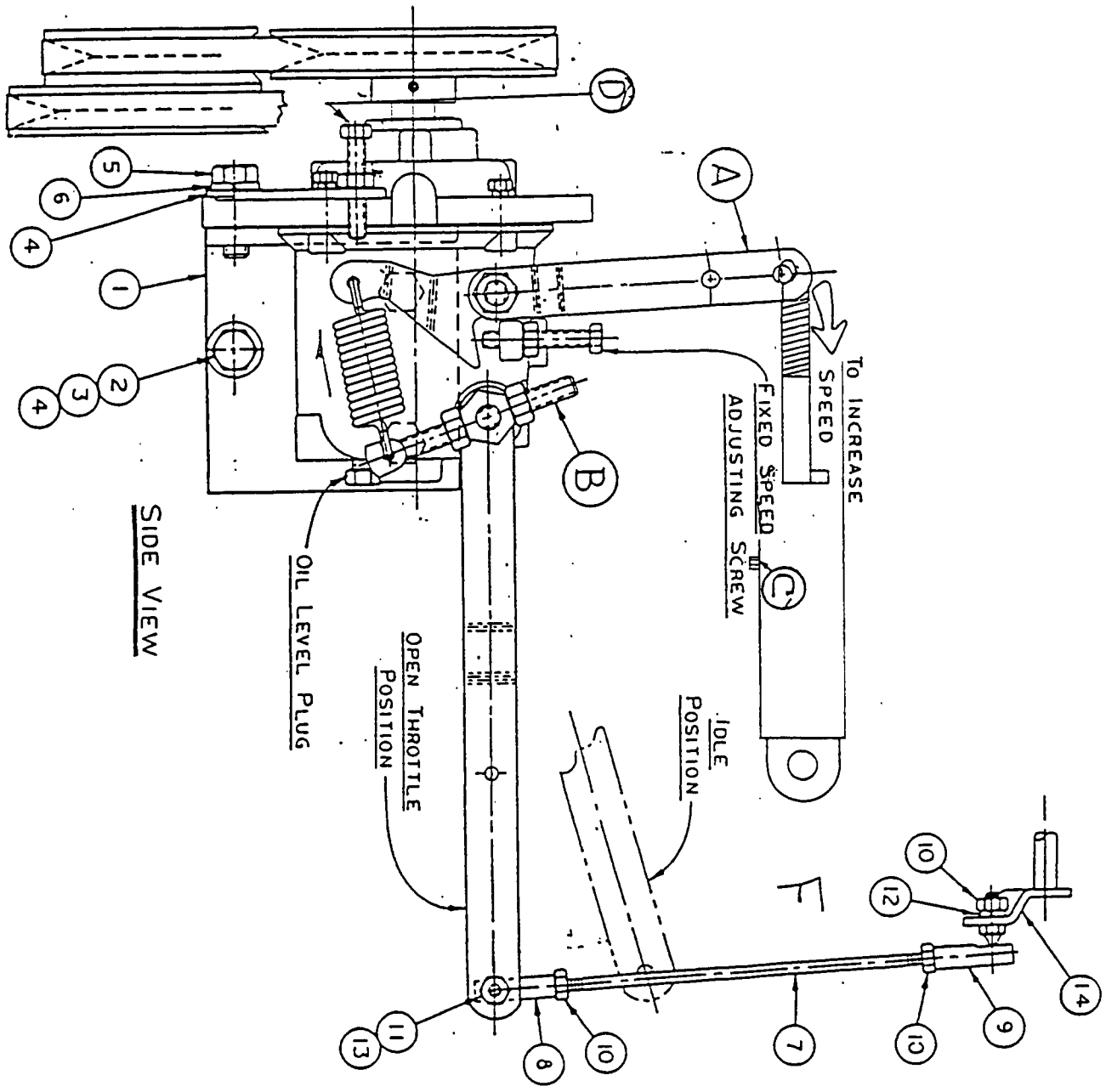
1. PUT TENSION ON GOVERNOR SPRING WITH LEVER (A),ADJUST CARB. LINKAGE LENGHT TO OBTAIN W.O.T. THIS IS WITH ENGINE NOT RUNNING.

2. START ENGINE AND WARM TO OPERATING TEMPERATURE.

3. ADJUST SCREW (C) TO 1800 RPM WITH NO LOAD.

4. ADJUST SCREW (D) TO 2800 RPM WITH NO LOAD.

5. CHECK REGULATION BY APPLYING AND REMOVING ENGINE LOAD. IF DROP IN ENGINE SPEED BETWEEN LOAD AND NO LOAD IS TOO MUCH,ADJUST SCREW (B) TO PULL SPRING CLOSER TO SHAFT HUB. IF GOVERNOR HUNTS UNDER LOAD, ADJUST SCREW (B) TO MOVE SPRING AWAY FROM SHAFT HUB. REPEAT UNTIL DESIRED REGULATION IS OBTAINED.



NISSAN ENGINE

OPERATION & MAINTENANCE MANUAL
MODEL H SERIES

NISSAN MOTOR CO., LTD.
Tokyo, Japan

H20/30-A

Foreword

This booklet has been prepared to provide the necessary information for the operation, inspection and maintenance of the Nissan Engine.

We urge you to follow the recommendations contained in this booklet, so that the Nissan Engine will remain free of trouble throughout its working life. Please familiarize yourself with this booklet, and refer to it when necessary.

If you encounter any problems with your Nissan Engine, contact the authorized Nissan dealer in your area.

All information, specifications and illustrations in this manual are on a basis of the latest data obtainable at the time of the publication. Nissan reserves the right to make changes or improvements at any time without notice.

NISSAN

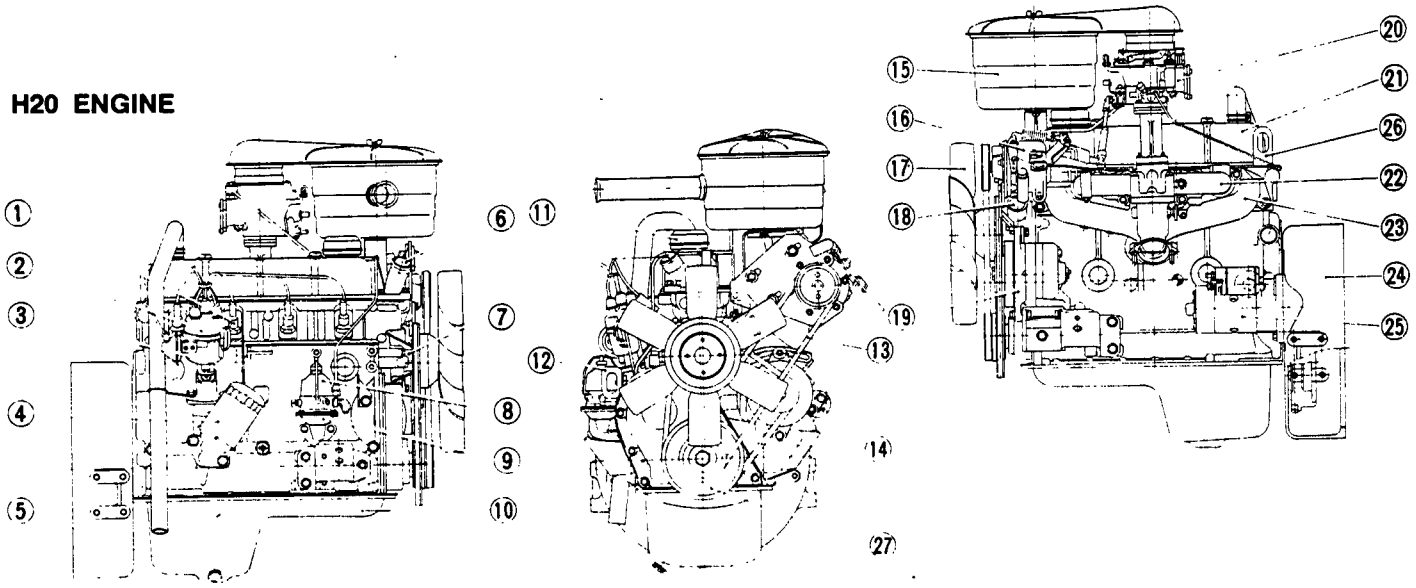
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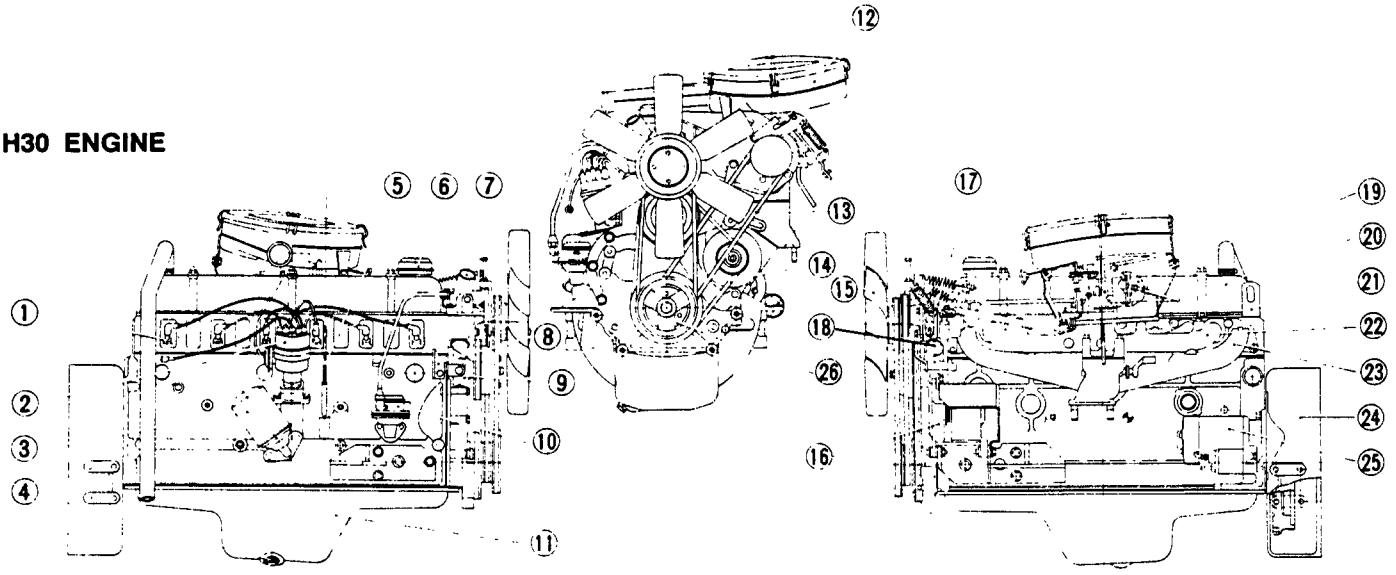
Names of Parts

H20 ENGINE



(1) Spark plug
(2) Distributor
(3) Oil level gauge
(4) Oil filter
(5) Oil drain plug
(6) Water outlet
(7) Water pump
(8) Fuel filter
(9) Fuel pump
(10) Oil pan
(11) Oil filler cap
(12) Front engine slinger
(13) V Belt (for governor)
(14) V Belt (for fan & alternator)
(15) Air cleaner
(16) Governor
(17) Cooling fan
(18) Water inlet
(19) Alternator
(20) Carburetor
(21) Rocker cover
(22) Intake manifold
(23) Exhaust manifold
(24) Flywheel housing
(25) Starter motor
(26) Rear engine slinger
(27) Crank pulley

H30 ENGINE



(1) Spark plug
(2) Distributor
(3) Oil filter
(4) Oil drain plug
(5) Oil level gauge
(6) Oil filler cap
(7) Water outlet
(8) Front engine slinger
(9) Water pump
(10) Fuel pump
(11) Oil pan
(12) Air cleaner
(13) V Belt (for governor)
(14) V Belt (for fan & alternator)
(15) Cooling fan
(16) Alternator
(17) Governor
(18) Water inlet
(19) Carburetor
(20) Rocker cover
(21) Rear engine slinger
(22) Intake manifold
(23) Exhaust manifold
(24) Flywheel housing
(25) Starter motor
(26) Crank pulley

Operation

HANDLING OF NEW ENGINE

The life and performance of an engine are greatly influenced by how it is handled and serviced during the initial period.

Operate the engine by observing the following the precautions during the initial 100 hours of operation.

Cautions in operation

1. After starting, warm the engine thoroughly by means of warning-up operation until the cooling water temperature rises above 50°C (122°F).
2. Never attempt to race the engine under non-loaded conditions.
3. Always maintain the operating speed of the engine below 70% of the maximum engine rpm.
4. Avoid overloading.

ENGINE HANDLING PRECAUTIONS

When handling the engine, be sure to observe the following precautions:

When starting the engine

1. Check the engine oil and coolant level, and refill if necessary.
2. After the engine starts, make sure that the oil and charge warning lamps are off.
3. Warm up the engine until it runs smoothly, emitting normal exhaust gases.
4. During this warming up operation, or when the cooling water the cooling water temperature is still low, never attempt to race the engine.

During engine operation

1. During operation, always make sure that the cooling water temperature and lubricating oil pressure are both normal. Normal cooling water temperature is 75 to 90°C (167 to 194°F).

   Oil pressure is normal if the "OIL" warning lamp remains OFF during engine operation.
2. Always be aware of the condition of the engine, paying attention to any abnormal vibration, noise or other unusual circumstances. If any abnormality is found, immediately stop the operation, examine the cause, and make the necessary correction.

When stopping the engine

Upon completion of operation, idle the engine for some time to lower its temperature before stopping. This procedure will help to extend the engine life.

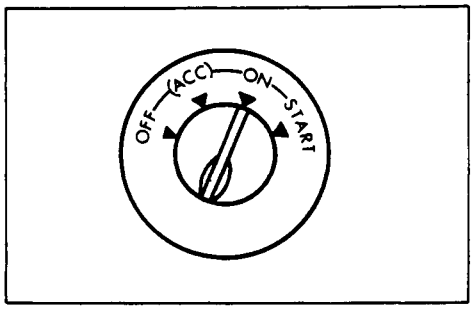
Note that stopping the engine immediately after heavily loaded operation will deteriorate the engine because it is still in a very hot state.

Others

Perform periodical inspection and replacement of the following items:

Engine oil, oil filter, air cleaner element, fuel filter element.

STARTING AND OPERATING



Starting

1. Pull out the choke control knob.
2. Turn the ignition key to the extreme right. Release the key as soon as the engine starts.

Do not turn the starting motor for more than 10 seconds at any time. It is not good for starter motor to run for long time.

3. Push in the choke control knob after the warning-up operation is over.
   Never race the engine during this warming-up period.

Stopping

To stop the engine, idle the engine, turn the ignition key to the "OFF" position, then the engine will stop.

Except in an emergency, be sure to turn the ignition key of only after the engine speed has returned to idle.

CAUTIONS DURING OPERATION

During engine operation, the warning light should remain OFF. If it comes ON, immediately stop operation, and take the actions that are described below.

If any other abnormalities such as unusual noise, vibration, or shocks are observed, again, stop the operation, and make the necessary inspection and repair.

At completion of the day's operations

1. Make sure that there is no oil leak, water leak, or any other defects.
2. Clean the exterior of the engine so that any oil leak, water leak, fuel leak or other defect may be easily detected.
3. If antifreeze is not used in the cooling system in cold weather, be sure to discharge the cooling water to prevent damage to the engine and/or radiator due to freezing water.
4. Repair any faulty parts detected during operation.

Other Handling and Operations

AGAINST COLD AND HOT WEATHER

In cold weather

● **Oil**

Use engine oil suitable for ambient temperature. (Refer to RECOMMENDED LUBRICANTS)

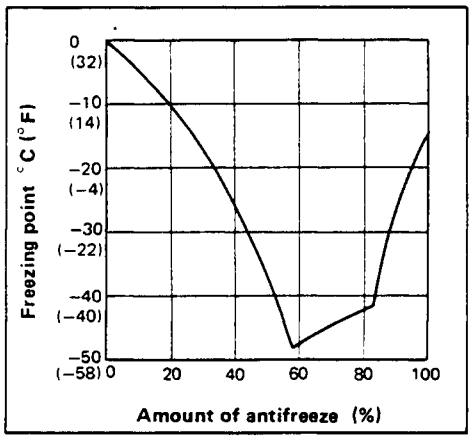
● **Coolant**

When coolant might freeze under low ambient temperature, drain out the coolant completely.

In such a cold weather, it is recommended to mix anti-freeze solution into cooling system because it make you free from draining coolant.

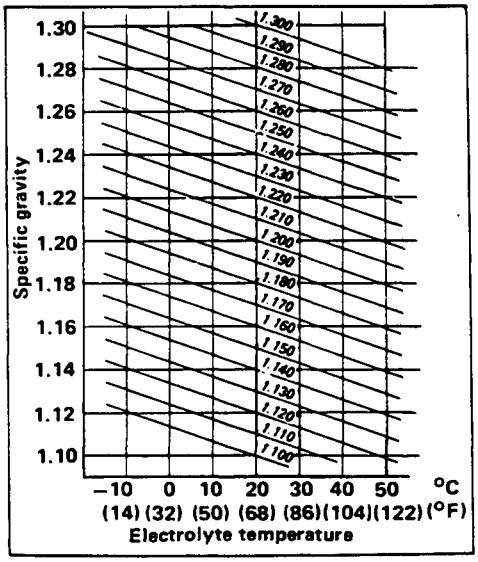
Coolant capacity (Engine proper):
H20 ... 3.5 ℓ (3-3/4 US qt, 3-1/8 Imp qt)
H30 ... 4.7 ℓ (5 US qt, 4-1/8 Imp qt)

Coolant mixture ratio



● **Battery**

Battery should not be left in discharged state. When battery performance becomes questionable, check the specific gravity of the electrolyte, terminals of battery and alternator for looseness.



The normal specific gravity is 1.260 as corrected at 20°C (68°F). If changes about 0.0007 for every 1°C (1.8°F). If the specific gravity of electrolyte does not reach the desirable value, charge the battery soon.

In hot weather

● **Oil**

Engine oil should be changed to summer type oil. (Refer to RECOMMENDED LUBRICANTS)

● **Coolant**

Because the engine is more likely to overheat in hot weather, the engine should be placed in the shade. Overheating sometimes comes from defective hoses, connections, loosened radiator cap, or defective fan belt. So check carefully the cooling system to maintain the best cooling effect.

It is recommended to add antifreeze solution into the cooling system because it increases the coolant boiling point.

● **Battery**

Since the battery electrolyte evaporates much in hot weather, it is necessary to top up distilled water frequently.

WHEN USING THE ENGINE ONLY DURING A PARTICULAR PERIOD OF THE YEAR

When the engine is to be used only in a particular period of the year, such as summer or winter, the service life of the engine will be determined by how it is maintained during the out-of-use period. Follow the procedures below when preparing the engine.

During in-use period

Follow the normal handling procedures during this period. However, it will be necessary to shorten the oil replacement internal and other service intervals, because the engine will often be operated for a longer than normal period of time during a single day and the load applied will often be greater than usual.

During out-of-use period

During the out-of-use period, perform the following maintenance procedures for the engine. If it is impossible to perform these operations, refer to "Long Term Storage".

1. Perform non-loaded engine operation once a week.

● Conduct checks prescribed in the "daily inspection" before starting the engine.

● Start the engine, and idle it for about 30 seconds.

- Slowly raise the engine rpm to the rated rpm, and run the engine at this speed for about 10 minutes. Make sure that no abnormal noise or vibration is produced.
- Operate the engine at idling speed for one minute before stopping it.

2. Perform loaded operation once a month.

- Run the engine and perform checks set forth in item 1 above.
- Apply a load in excess of 50% of the rated load to the engine, and operate it for more than 10 minutes. Make sure that no abnormal noise or vibration is produced.

3. Perform the following inspection and adjustment before placing the engine in use period.

- Drain sediment from the fuel system (fuel filter and fuel tank).
- Change engine oil and oil filter element.
- Check and adjust valve clearance.
- Check and adjust fan and governor belt tension.
- Check battery electrolyte level and specific gravity.
- Change air cleaner element.
- Check cooling water
- Check exhaust leakage

PROCEDURES FOR PLACING THE ENGINE IN LONG-TERM STORAGE

Before storing the engine for a long period of time (more than 3 months), perform the following procedures to prevent formation of rust. If the storage period is short, follow the maintenance procedures for the engine as described in the previous paragraph.

Lubricating system

Drain the engine oil, pour the specified amount of rust preventive oil into the oil pan, and then run the engine under no load at approximately 1,500 rpm for about 10 minutes. Stop the engine, and seal all the openings of the lubricating system with sealing tape.

For a greater rust preventing effect, perform this operation in combination with the rust preventing procedure for the fuel system and cooling system.

Fuel system

Drain fuel from the fuel system, and pour the mixed fuel (the ratio of fuel to rust preventing oil should be 1 : 1) into the fuel tank. Operate the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, drain the mixed fuel, and then seal all of the openings in the fuel system (such as the breather of the fuel tank) with sealing tape.

Cooling system

Flush the cooling system, and pour anti-freeze or an anti-rust agent into the cooling water. Run the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, and seal all of the openings in the cooling system (such as overflow pipe, etc.) with sealing tape. If antifreeze is used, keep the cooling water in the system. If an anti-rust agent is used, thoroughly drain the cooling water before sealing.

When using antifreeze, pay attention to the freezing point of coolant and choose a mixing ratio of at least 30%, a mixing ratio of less than 30% provides only a limited rust preventing effect. Note that the anti-rust agent will freeze when the temperature falls below 0°C (32°F). In such event, either thoroughly drain the cooling water or use antifreeze.

Combustion chamber

After completing the rust preventive procedure, allow the engine temperature to drop to room temperature. Then disconnect the air cleaner from the carburetor, and spray or pour rust preventing oil into the combustion chamber. Next, disconnect the high tension cable from the spark plugs, turn the ignition switch to the "START" position, and crank the engine five to ten times, and than install the high tension cables and air cleaner.

Engine exterior

Using a petroleum solvent, remove dirt and oil from the uncoated metal surfaces of the engine (intake manifold, exhaust manifold, rocker cover, fan and governor belt grooves of pulleys, etc.). Spray or apply anti-rust agent to the cleaned surfaced. Do not apply any type mineral or vegetable oil to the fan and governor belt grooves of pulleys.

Others

1. Remove the fan and governor belt or keep it loosened.
2. Seal the air intake hole of the air cleaner and air outlet hole of the exhaust tube with adhesive tape.
3. Wrap the open type generator with a porous bag, and fasten the bag with a rubber band or similar item.
4. If the engine is equipped with a clutch, spray an evaporative anti-rust agent into the clutch housing, and seal the opening with adhesive tape.
5. When storing the engine as a complete assembly outdoors, cover it fully with a porous water-proof sheet.
   Do not use a vinyl sheet, because it lacks porosity and retains water inside.

Preparations for operation after long-term storage

1. Remove all adhesive sealing tapes from the openings of the engine.
2. Drain the rust preventing oil and anti-rust agent by using the following procedure, and replace it with the specified amount of engine oil, fuel and cooling water.

Lubricating system:
Drain oil through the drain plug of oil pan and oil filter.

Fuel system:
First operate the engine with the mixed fuel that is used in the rust preventing operation, and then drain the fuel.

Cooling system:
If antifreeze is used, drain cooling water from the drain valves on each of the radiator and cylinder block, and flush the cooling system.
If an anti-rust agent is used, flush the cooling system.

Exterior of engine:
Clean the exterior surfaces of the engine with a petroleum solvent (Trichlene).

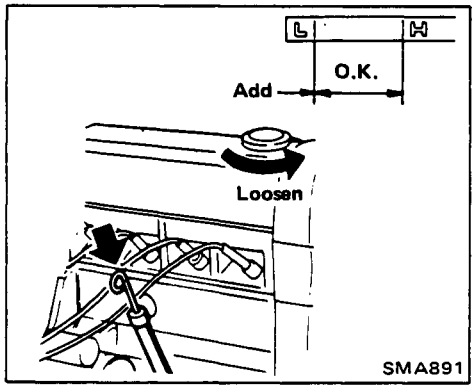
3. Replace the elements of the oil filter, the air cleaner and the fuel filter with new ones.
4. Adjust the fan and governor belt for proper tension.
5. Check and adjust valve clearance. Apply engine oil to the rocker arm and other valve mechanism.
6. Check the battery electrolyte level and specific gravity. Refill and/or recharge if it is necessary.
7. Before the engine starts, disconnect the high tension cables from the spark plugs.
8. Set the ignition switch at the "START" position, and crank the engine for about 10 seconds. Repeat this cranking operation two or three times in order to disperse engine oil to every portion of the engine, and then install the high tension cable.
9. Start the engine, and let it idle for about 5 minutes.
10. Gradually increase the engine speed to the rated rpm, and run the engine for about 10 minutes under no load. Make sure that the charge warning lamp and oil warning lamp are off and cooling water temperature are normal, and that the engine does not produced any abnormal vibration or noise.

Daily Care

In order to prevent trouble in daily operation, it is necessary that the operator be constantly aware of the condition of the engine. To achieve this awareness, the operator must personally inspect the engine before starting the day's activities.

If you note any defects, notify your authorized NISSAN dealer.

CHECK ENGINE OIL LEVEL



To check the oil level, pull out the level gauge, wipe it clean and reinsert it; remove it again to read the oil level. The level should be between the "L" and "H" marks.

CHECK COOLING WATER LEVEL

Remove the radiator cap, and check the cooling water level. Also check the cap and determine if it functions correctly. The cooling water level is correct if it is near to the filler neck of radiator. Insufficient water level may be caused by leakage from the engine or radiator. Check carefully for any sign of leakage; if no leaks are discovered, add water to the filler neck portion.

If cooling water is dirty, flush the cooling system.

When replacing the radiator cap, be sure to fit it securely. If replaced loosely or improperly, the cooling water will quickly evaporate, causing the engine to overheat.

CHECKING THE ENGINE FOR LEAKAGE

1. Insure that the engine, radiator and hoses are not leaking.
2. Check each portion of the engine, and make sure that there is no sign of an oil leak.
3. Check the fuel system to make sure that there is no sign of fuel leaking from the fuel pipe and hose.

CHECKING THE ENGINE OPERATION DURING BOTH IDLING AND ACCELERATION

Make sure that the engine runs normally at idling speed, and that engine rpm increases smoothly as it is accelerated.

OTHERS

Correct all of the faults and problems that were observed during the previous day's operation.

If any faults are discovered during the daily inspection, contact an authorized NISSAN dealer for additional inspection, adjustment or repair. Always maintain the engine in its top condition.

Maintenance

PERIODIC MAINTENANCE AND LUBRICANT SCHEDULE

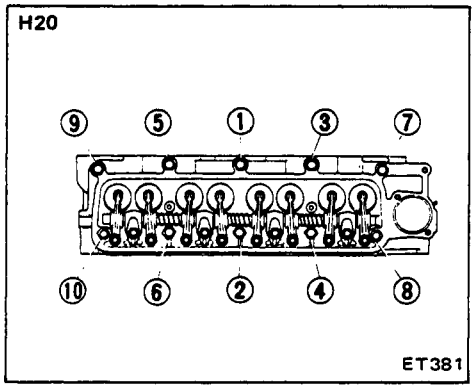
The following table lists the servicing required to keep your engine operating in top mechanical condition, and should be attended to as indicated, preferably by an authorized NISSAN dealer.

MAINTENANCE OPERATION			MAINTENANCE INTERVAL											
Periodic maintenance should be performed after specified intervals have elapsed in month or hours, whichever comes first.		Months	1	2	3	4	5	6	7	8	9	10	11	12
		Hundreds of hours	2	4	6	8	10	12	14	16	18	20	22	24
Retighten cylinder head bolts, manifolds & exhaust tube nuts & carburetor attaching nuts			X											
Adjust intake & exhaust valve clearance			X		X			X			X			X
Check drive belts for cracks, fraying, wear and tension			X	X	X	X	X	X	X	X	X	X	X	X
Change engine oil		(1)	X	X	X	X	X	X	X	X	X	X	X	X
Replace engine oil filter		(1)	X		X			X			X			X
Change engine anti-freeze coolant (L.L.C., Ethylene glycol base)														X
Change engine coolant (Soft water)														X
Clean radiator outside		(2)												
Check cooling system hoses & connections		(2)												
Clean or replace fuel strainer element (H20)	(1)	Clean	X		X			X			X			
		Replace												X
Clean or replace fuel strainer element		(2)												
Check or replace fuel strainer		(2)												
Check fuel lines (Hoses, piping, connections, etc.)		(2)												
Clean & replace air cleaner element (Dry paper type)	(1)	Clean	X	X	X	X	X		X	X	X	X	X	
		Replace						X						X
Check crankcase ventilation hose														X
Check & replace spark plugs		Check	X	X	X	X	X	X	X	X	X	X	X	
		Replace												X
Check distributor point, cap and rotor			X	X	X	X	X	X	X	X	X	X	X	X
Check ignition wiring														X
Lubricate governor					X			X			X			X
Check governor oil			X	X	X	X	X	X	X	X	X	X	X	X
Adjust ignition timing			X	X	X	X	X	X	X	X	X	X	X	X
Adjust engine idle rpm			X	X	X	X	X	X	X	X	X	X	X	X
Adjust governor			X	X	X	X	X	X	X	X	X	X	X	X
Check battery specific gravity								X						X

Notes: (1) Under dusty or other dirty operating conditions, more frequent maintenance should be necessary.
(2) Follow the original equipment manufacturer's (O.E.M.) instructions.

Check: Check, correct and replace if necessary.

MAINTENANCE OPERATION

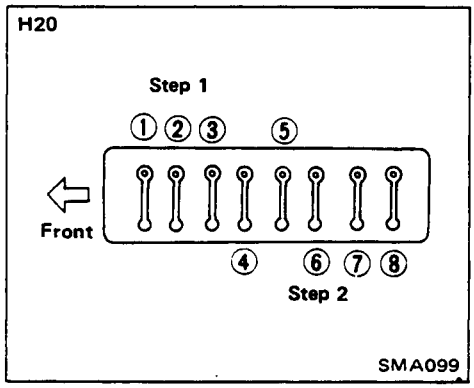


Retightening cylinder head nuts, manifold bolts and nuts and carburetor securing nuts

Cylinder head bolts

When the engine is cold, retightening should be made in the sequence shown.

Ⓣ : **Cylinder head bolt**
H20
78 to 93 N·m
(8.0 to 9.5 kg-m,
58 to 69 ft-lb)
H30
69 to 82 N·m
(7.0 to 8.4 kg-m,
51 to 61 ft-lb)



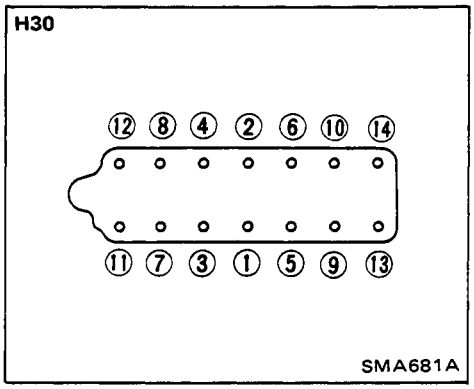
Adjusting intake and exhaust valve clearance

Adjustment should be made while engine is warm but not running.

1. Start engine and warm it up sufficiently. Then turn off engine.
2. Remove valve rocker cover.
3. Rotate crankshaft.

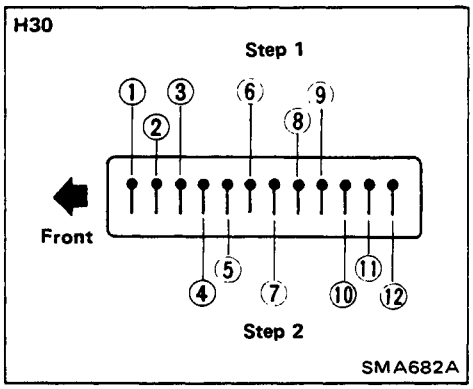
(1) Set No. 1 cylinder in top dead center on its compression stroke, and adjust valve clearance.

H20:
①, ②, ③ & ⑤
H30:
1, 2, 3, ⑥, ⑧ & ⑨



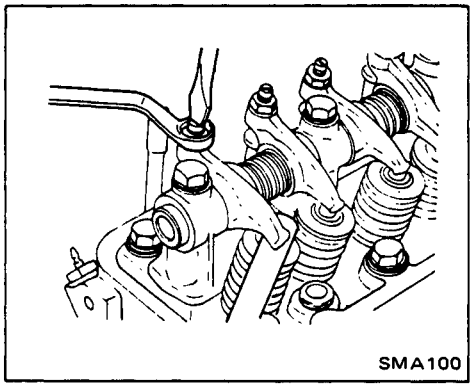
Manifold and exhaust tube nut and carburetor attaching nut

Ⓣ : **Carburetor nuts**
8 to 12 N·m
(0.8 to 1.2 kg-m,
5.8 to 8.7 ft-lb)
Manifold nuts
14 to 18 N·m
(1.4 to 1.8 kg-m,
10 to 13 ft-lb)



(2) Set No. 4 cylinder in top dead center on its compression stroke and adjust valve clearance.

H20:
④, ⑥, ⑦ & ⑧
H30:
④, ⑤, ⑦, ⑩, ⑪ & ⑫

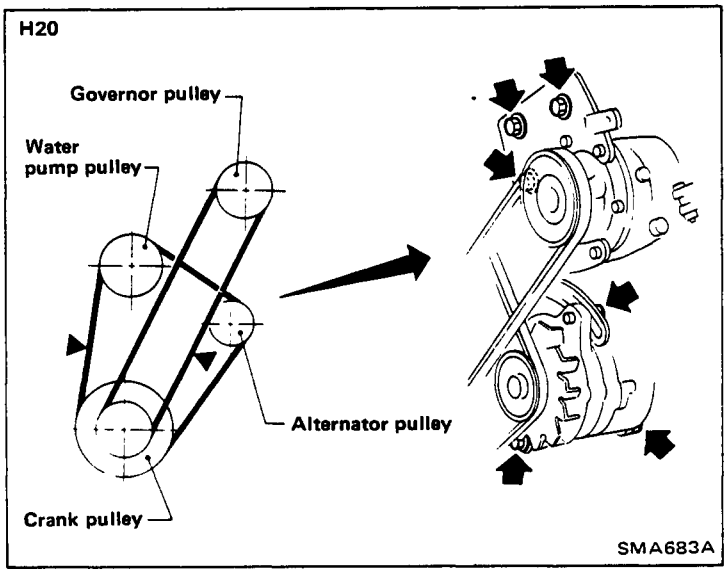


Valve clearance (Hot):
Intake & exhaust:
0.38 mm (0.015 in)

Checking and adjusting drive belts

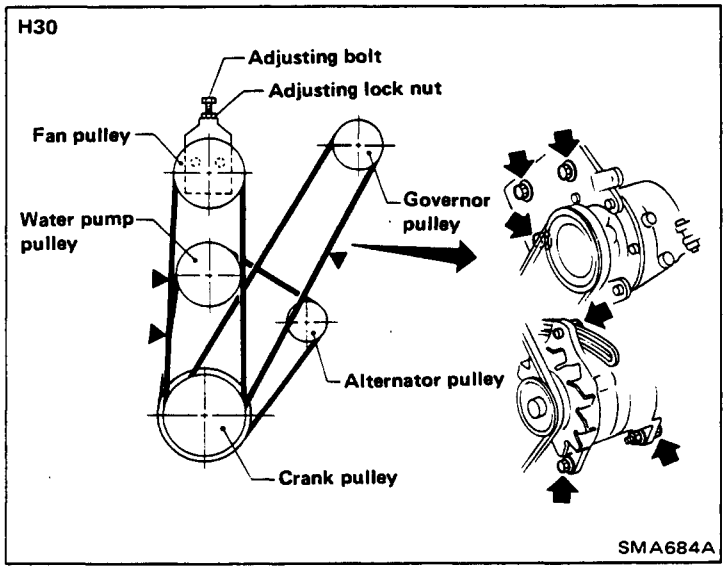
1. Visually inspect for cracks, fraying, wear or oiliness.

The belts should not touch the bottom of the pulley groove.



2. Check belt tension by pushing midway between pulleys.

Drive belt deflection:
8 to 12 mm (0.31 to 0.47 in)
Pushing force:
98 N (10 kg, 22 lb)



Changing engine oil and oil filter

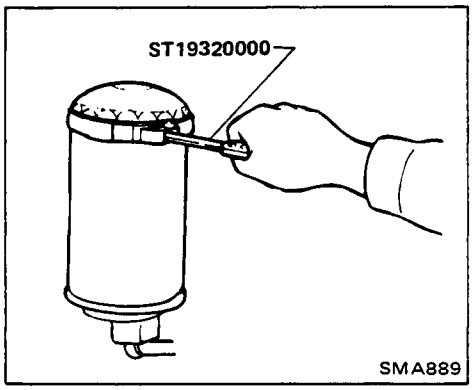
1. Start engine and warm up engine sufficiently, then stop engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

WARNING:
Be careful not to burn yourself, as the engine oil may be hot.

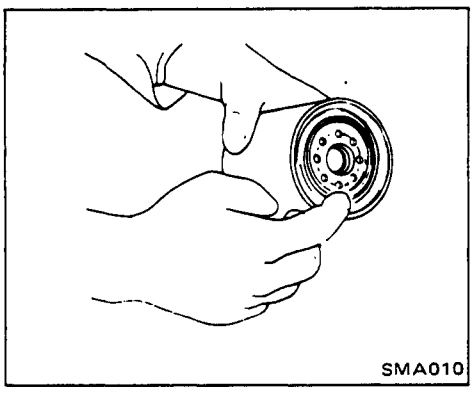
- **A milky oil indicates the presence of cooling water. Isolate the cause and take corrective measure.**
- **An oil with extremely low viscosity indicates dilution with fuel.**

3. Clean and install oil pan drain plug with washer.

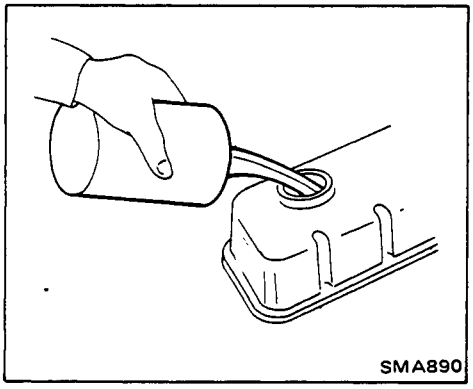
Ⓣ: **Oil pan drain plug**
20 to 39 N·m
(2.0 to 4.0 kg-m,
14 to 29 ft-lb)



4. Using Tool, remove oil filter.
5. Wipe oil filter mounting surface with a clean rag.



6. Smear a little engine oil on rubber gasket of new oil filter.
7. Install new oil filter. Handtighten ONLY. DO NOT use a wrench to tighten the filter.


SMA890

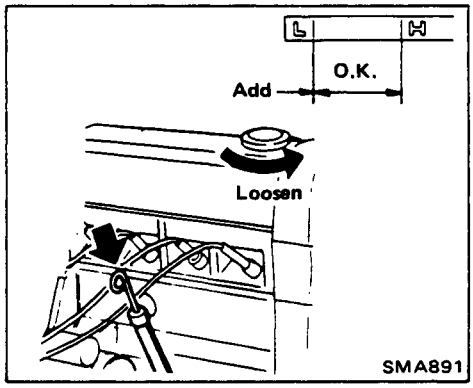
8. Refill engine with new recommended engine oil, referring to Recommended Lubricants.

Check oil level with dipstick.

Oil capacity:

Unit: liter (US qt, Imp qt)

	H20	H30
With oil filter	4.2 (4-1/2, 3-3/4)	4.7 (5, 4-1/8)
Without oil filter	3.7 (3-7/8, 3-1/4)	4.2 (4-1/2, 3-3/4)



SMA891

9. Start engine. Check area around drain plug and oil filter for any sign of oil leakage.

If any leakage is evident, these parts have not been properly installed.

10. Warm up engine sufficiently. Then stop engine and wait a few minutes. Check oil level. If necessary, add engine oil.

When checking oil level, set engine at level.

Changing engine coolant

WARNING:

To avoid the danger of being scalded, never attempt to change the coolant when the engine is hot.

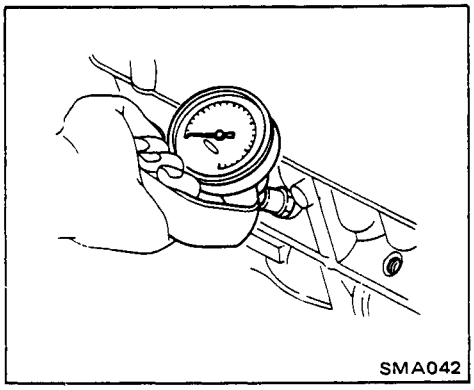
When using antifreeze coolant, mix the antifreeze coolant with water, observing instructions attached to antifreeze container.

Cleaning radiator outside

Clean outside of radiator with dry compressed air.

Checking cooling system, hoses and connections

Check hoses and fittings for loose connections or deterioration. Retighten or replace if necessary.


SMA042

Checking engine compression pressure

1. Warm up engine sufficiently, then stop engine.
2. Remove all spark plugs.
3. Properly attach a compression tester to spark plug hole in cylinder being tested.
4. Set carburetor throttle valve at fully-open position.
5. Crank engine and read gauge indication.

- Engine compression measurement should be made as quickly as possible.

Compression pressure:

Standard

1,079 kPa (10.79 bar, 11.0 kg/cm², 156 psi)/300 rpm

Minimum

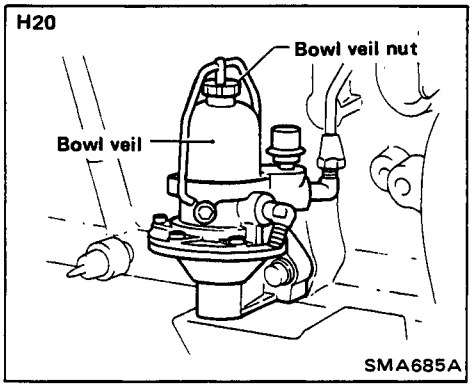
883 kPa (8.83 bar, 9.0 kg/cm², 128 psi)/300 rpm

6. Cylinder compression in cylinders should not be less than 80% of the highest reading.

If cylinder compression in one of more cylinders is low, pour a small quantity of engine oil into cylinders through the spark plug holes and retest compression.

- If adding oil helps the compression pressure, chances are that piston rings are worn or damaged.
- If pressure stays low, valve may be sticking or seating improperly.
- If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression, there is leakage past the gasketed surface.

Oil and water in combustion chambers can result from this problem.



Cleaning or replacing fuel strainer element

The fuel strainer or fuel strainer element should be checked, cleaned or replaced periodically.

Refer to Periodic Maintenance Recommended by Original Equipment Manufacturers (O.E.M.).

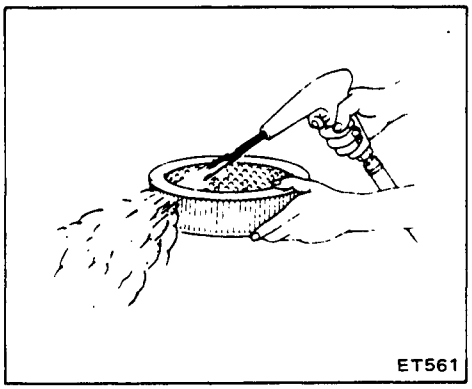
Checking fuel lines (Hoses, piping, connections, etc.)

Check fuel lines for proper attachment, leaks, cracks, damage, loose connections, chaffing and deterioration. If necessary, replace any damaged or defective parts.

Adjusting choke mechanism (Choke valve and linkage)

1. Check choke valve and mechanism for free operation, and clean or replace if necessary. Binding can result from petroleum gum formation on choke shaft or from damage.
2. Check for smooth operation of choke control wire. Ascertain that choke valve is fully opened when choke control knob is depressed fully.

Adjust stroke if necessary.

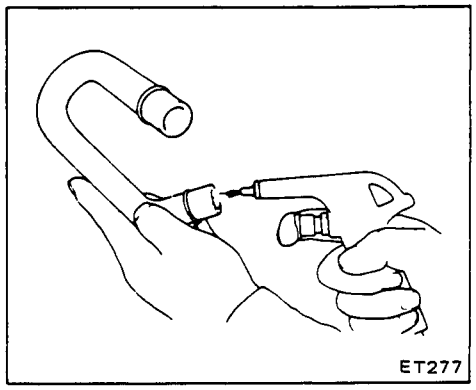


Cleaning and replacing air cleaner element (Dry paper type)

1. Remove air cleaner cover and filter element.
2. Blow dust off inner side of element with dry compressed air.
3. Wipe inside of air cleaner housing and cover with damp cloth.

Be careful not to drop into carburetor.

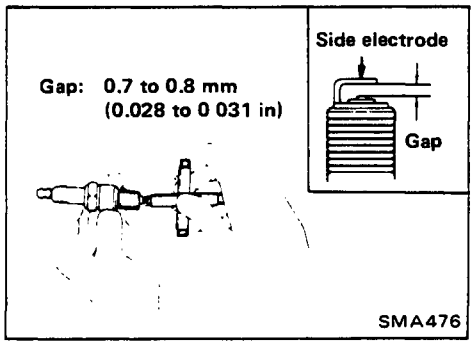
4. Install element and air cleaner cover.



Checking crankcase ventilation hose

1. Check hoses and hose connections for leaks.
2. Check each hose for cracks or distortion.
3. Disconnect all hoses and blow them out with dry compressed air.

If any hose cannot be made free of obstructions, replace with a new one.



Checking and replacing spark plugs

1. Disconnect the high tension cables from the spark plugs.

Do not pull on the cable.

2. Remove spark plugs with spark plug wrench.
3. Clean plugs in sand blast cleaner.
4. Inspect insulator for cracks or chips, gasket for damage or deterioration and electrode for wear or burning. If they are excessively worn, replace with new ones.
5. Check spark plug gap.

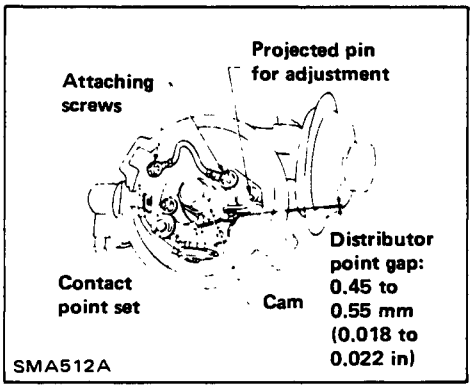
Spark plug type:
B4ES
Gap:
0.7 to 0.8 mm
(0.028 to 0.031 in)
(T): 15 to 20 N·m
(1.5 to 2.0 kg-m, 11 to 14 ft-lb)

Checking distributor point cap and rotor

Visual check

1. Inspect point, cap and rotor for excessive burning or pitting.
2. Use a point file to clean contact area and remove scale from point.

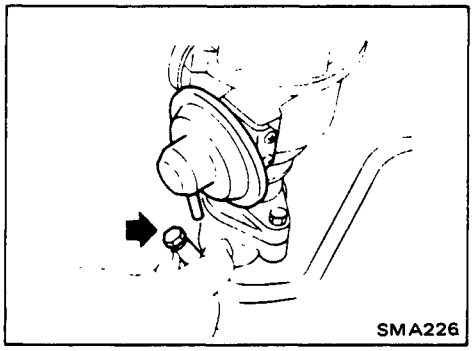
Do not attempt to remove all roughness.



Checking point gap

Set contact point on the nose of cam, and check point gap with oilless thickness gauge.

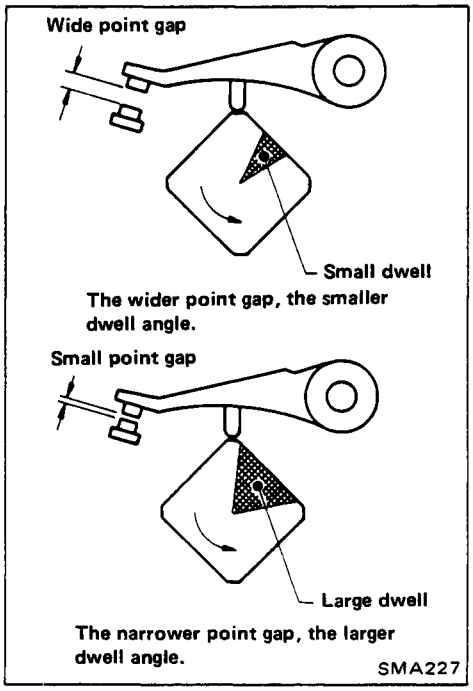
If the gap is out of specification, loosen contact point plate attaching screws and adjust point gap by pivoting projected pin.

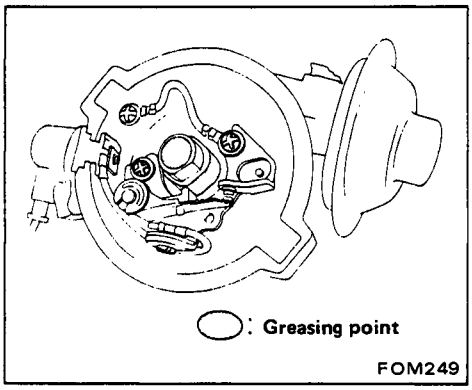


Checking dwell angle

1. Start engine and warm it up.
2. Disconnect distributor vacuum hose from distributor vacuum controller, and plug the hose with proper plug.
3. Run engine at idle speed and measure dwell angle with a dwell meter.

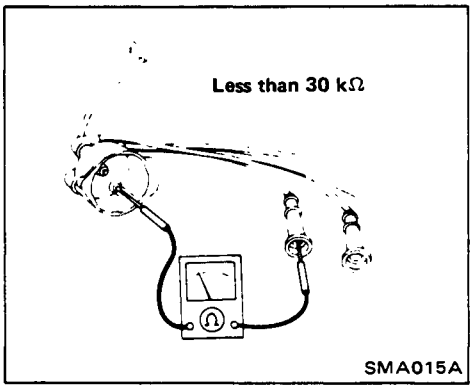
   Dwell angle:
   H20
   49° to 55°
   H30
   35° to 41°
4. If dwell angle is not within the specified value turn off engine and adjust point gap.
5. If dwell angle is not within the specified value when point gap is correct, cam lobe is worn. Replace cam.





Greasing distributor cam and cam heel

When checking distributor point, clean and apply the specified grease to cam and cam heel.



Checking ignition high tension cable

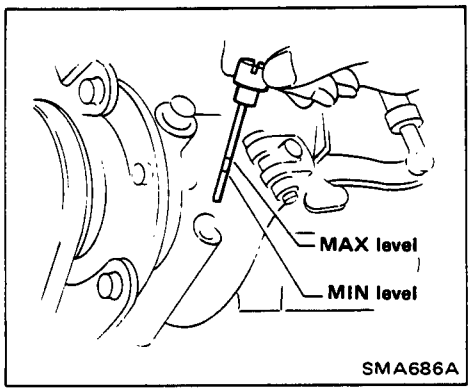
1. Visually check the cable for cracks, and damaged and burned terminals.

2. Using an ohmmeter, measure the resistance between cable terminal on the spark plug side and corresponding electrode inside cap.

Shake the cable while measuring resistance to check for intermittent brakes.

Lubricating governor

Lubricate lever and the sliding part of link mechanism.



Check governor oil

1. Check governor oil level with level gauge.
1) Remove oil level gauge and wipe oil off from gauge.
2) Insert level gauge into gauge hole and check oil level without turning level gauge.
2. If oil level is low, add recommended engine oil up to "MAX" level through oil filler hole.
3. When changing oil, first drain it out through drain hole.

Governor oil capacity:
Approximately
30 mℓ (1.0 US fl oz, 1.1 Imp fl oz)

Checking and adjusting ignition timing, idle-rpm and mixture ratio

CAUTION:

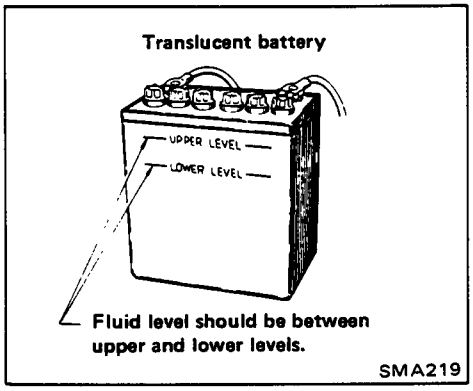
a. Idle mixture ratio is adjusted at factory and requires no further adjustment. If it becomes necessary to adjust it, proceed with the following steps.

b. Do not attempt to screw the idle adjusting screw down completely. Doing so could cause damage to screw tip, which in turn will tend to cause malfunctions.

Preparation

1. Make sure that the following parts are in good order.
- **Ignition system**
- **Engine oil and coolant levels**
- **Valve clearance**
- **Float level at idling speed**

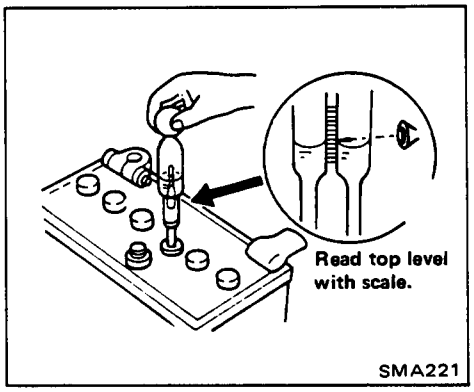
2. Set shift lever in "Neutral" position.



Checking electrolyte level

Check the fluid level in each filler. If necessary, add only distilled water.

Do not overfill.



Checking electrolyte gravity

1. Place the hydrometer in the cell.
   Be sure the float is not in contact with the cylinder wall.
2. Take in enough electrolyte into the hydrometer to allow the float to suspend freely between the top and bottom of the cylinder.
3. Read indication.

	Permissible value	Fully charged value [at 20°C (68°F)]
Other climates	Over 1.20	1.26
Frigid climate	Over 1.22	1.28
Tropical climate	Over 1.18	1.24

Checking and adjusting idle-rpm ignition timing

START

Start engine and warm it up sufficiently.

Run engine at idle speed for 2 minutes.

Race engine (1,500 to 3,000 rpm) 2 or 3 times under no-load, and then run engine at idle speed.

Check idle speed.

Idle speed:
below 800 rpm

O.K.

N.G.

Adjust idle speed by turning throttle adjusting screw.

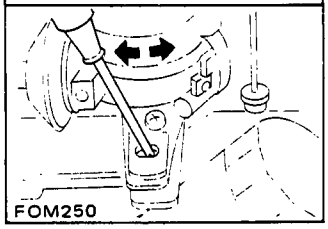
Check ignition timing at idle speed.

Ignition timing (B.T.D.C. degree):
H20: 7°
H30: 5°

O.K.

N.G.

Adjust ignition timing by turning distributor.

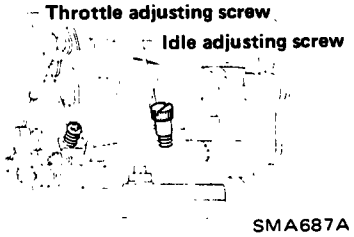


Race engine (1,500 to 3,000 rpm) 2 or 3 times under no-load, and then run engine at idle speed.

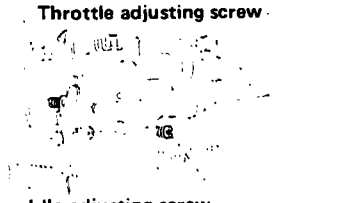
Adjust idle speed by turning throttle adjusting screws.

Idle speed: rpm
H20: 550
H30: 600

H20



H30



END

Checking and adjustment mixture ratio

START

Check and adjust idle speed and ignition timing.

Turn out idle adjusting screw approximately two turns, starting from fully closed position.

Adjust engine speed by turning throttle adjusting screw.

Engine speed: rpm
H20: 550
H30: 600

Turn the idle adjusting screw until engine runs smoothly at highest speed.

Does engine speed not raise in spite of turning idle adjusting screw?

YES

NO

Adjust engine speed by turning in idle adjusting screw.

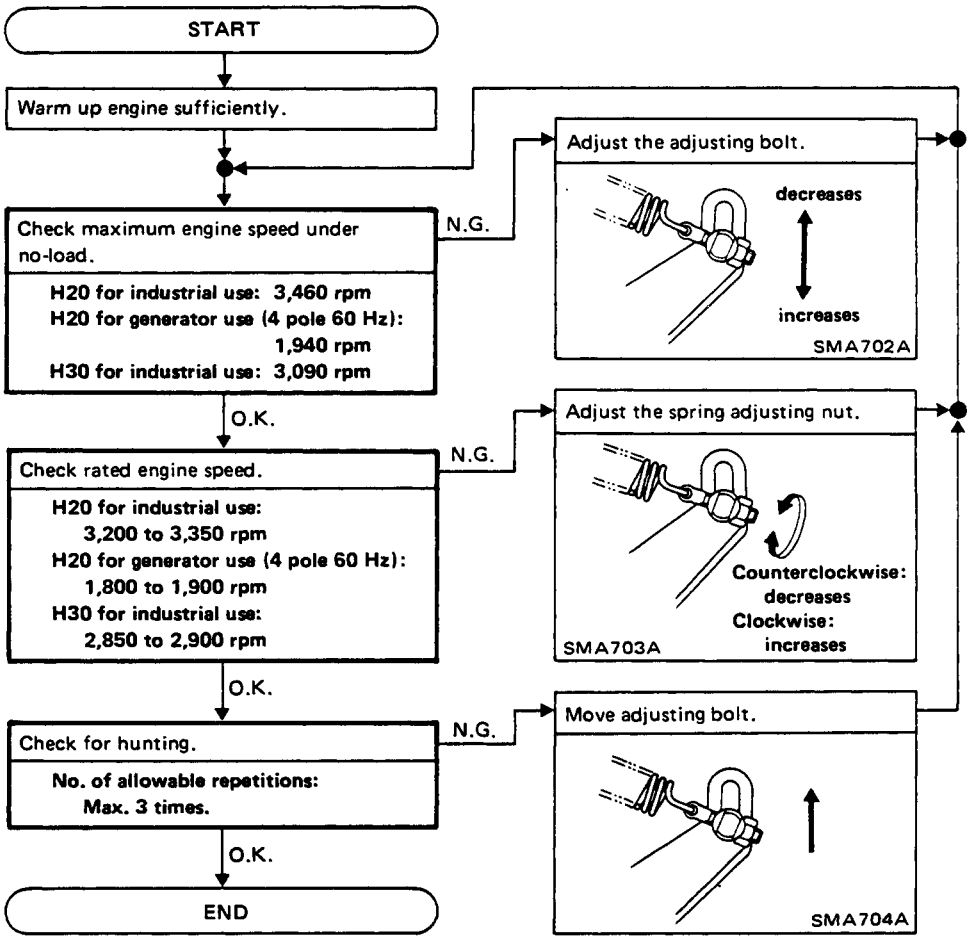
Idle speed: rpm
H20: 550
H30: 600

END

Adjusting governor

Governor is adjusted at factory and requires no further adjustment.

If it becomes necessary to adjust it, proceed with the following steps.



Trouble Diagnosis and Corrections

Condition	Probable cause	Corrective action
CANNOT CRANK ENGINE OR SLOW CRANKING	Improper grade oil.	Replace with proper grade oil.
	Partially discharged battery.	Charge battery.
	Malfunctioning battery.	Replace.
	Loose alternator belt.	Adjust.
	Trouble in charging system.	Inspect.
	Wiring connection trouble in starting circuit.	Correct.
	Malfunctioning ignition switch.	Repair or replace.
	Malfunctioning starting motor.	Repair or replace.

ENGINE WILL CRANK NORMALLY BUT WILL NOT START

In this case, the following trouble causes may exist, but in many cases ignition system or fuel system is in trouble.

Ignition system in trouble
Fuel system in trouble
Valve mechanism does not work properly
Low compression

(Trouble-shooting procedure)
Check spark plug firstly by following procedure.
Disconnect high tension cable from one spark plug and hold it about 10 mm (0.39 in) from the engine metal part and crank the engine.

Good spark occurs.

a. Check spark plug.
b. Check ignition timing.
c. Check fuel system.
d. Check cylinder compression.

No spark occurs.	Very high current.	Check the current flow in primary circuit. Inspect primary circuit for short. Check distributor pick-up coil operation.
	Low or no current.	Check for loose terminal or disconnection in primary circuit. Check for burned points.

Ignition system out of order	Burned distributor point.	Repair or replace.
	Improper point gap.	Adjust.
	Faulty condenser.	Replace.
	Leak at rotor cap and rotor.	Clean or replace.
	Faulty spark plug.	Clean, adjust plug gap or replace.
	Improper ignition timing.	Adjust.
	Faulty ignition coil.	Replace.

Condition	Probable cause	Corrective action
Ignition system out of order	Disconnection of high tension cable.	Replace.
	Loose connection or disconnection in primary circuit.	Repair or replace.
Fuel system out of order	Lack of fuel	Supply.
	Dirty fuel filter.	Replace.
	Dirty or clogged fuel pipe.	Clean.
	Fuel pump will not work properly.	Repair or replace.
	Carburetor choke will not work properly.	Check and adjust.
	Improper adjustment of float level.	Correct.
	Improper idling.	Adjust.
	Dirty or clogged carburetor.	Disassemble and clean.
	Clogged breather pipe of fuel tank.	Repair and clean.
Low compression	Incorrect spark plug tightening or faulty gasket.	Tighten to normal torque or replace gasket.
	Improper grade engine oil or low viscosity.	Replace with proper grade oil.
	Incorrect valve clearance.	Adjust.
	Compression leak from valve seat.	Remove cylinder head and lap valves.
	Sticky valve stem.	Correct or replace valve and valve guide.
Low compression	Weak or damaged valve springs.	Replace.
	Compression leak at cylinder head gasket.	Replace gasket.
	Sticking damaged piston ring.	Replace piston rings.
	Worn piston ring or cylinder.	Overhaul engine.
	(Trouble-shooting procedure) Inject a small quantity of engine oil in spark plug hole, and then measure cylinder compression.	
	Compression increases.	Malfunctioning cylinder or piston ring.
	Compression does not change.	Compression leaks from valve, cylinder head or head gasket.
UNSTABLE ENGINE IDLING		
Ignition system in trouble	Malfunctioning ignition system (spark plug, high tension cable, distributor, ignition coil, etc.)	Replace.
	Incorrect basic ignition timing	Adjust.
Engine mechanical system in trouble	Loose manifold and cylinder head bolts.	Retighten bolts.
	Incorrect valve clearance.	Adjust.
HIGH ENGINE IDLE SPEED		
Fuel system malfunction	Malfunctioning carburetor choke.	Replace.
	Incorrect idle adjustment.	Adjust idle speed.
Others	Worn throttle valve.	Replace throttle chamber.
	Dragged accelerator control wire.	Check and correct accelerator control wire.

Condition	Probable cause	Corrective action
Fuel system malfunction	Clogged or damaged carburetor jets.	Clean or replace.
	Clogged air cleaner filter.	Clean or replace filter.
	Damaged manifold gaskets or carburetor insulator.	Replace gasket or insulator.
	Improper float level adjustment.	Adjust.
	Loose or cracked vacuum hoses or air hoses from carburetor.	Check for loose connections or cracks and replace if necessary.
	Malfunctioning carburetor choke.	Replace.
Low compression		Previously mentioned.
ENGINE POWER BELOW NORMAL		
Low compression		Previously mentioned.
Ignition system in trouble	Incorrect ignition timing.	Adjust.
	Malfunctioning spark plugs.	Clean, adjust or replace plugs.
	Worn distributor point.	Clean, adjust or replace point. Also check condenser.
Fuel system malfunction	Throttle valve does not open fully.	Adjust.
	Malfunction of choke system.	Replace.
	Clogged fuel pipe.	Clean or replace.
	Dirty or clogged float valve filter.	Clean or replace.
	Fuel pump will not work properly.	Repair or replace.
	Clogged carburetor jets.	Clean or replace.
	Dirty or clogged fuel filter.	Replace.
Air intake system malfunction	Clogged air cleaner filter.	Clean or replace filter.
	Air leaking from manifold gasket or carburetor insulator.	Replace gasket or insulator.
Overheating	Insufficient coolant.	Replenish.
	Loose fan belt.	Adjust fan belt.
	Worn or damaged fan belt.	Replace.
	Malfunctioning thermostat.	Replace.
	Malfunctioning water pump.	Replace.
	Clogged or leaky radiator.	Flush, repair or replace.
	Malfunctioning radiator filler cap.	Replace.
	Air in cooling system.	Retighten each part of cooling system.
	Improper engine oil grade.	Replace with proper grade oil.
	Incorrect ignition timing.	Adjust.
Overcooling	Malfunctioning thermostat.	Replace.
Others	Improper octane fuel.	Replace with specified octane fuel.
	Clutch shipping.	Adjust.
	Improper governor setting.	Adjust.

Condition	Probable cause	Corrective action
NOISY ENGINE		
Engine knocking	Overloaded engine.	Use right gear in driving.
	Carbon knocking.	Disassemble cylinder head and remove carbon.
Engine knocking	Timing knocking.	Adjust ignition timing.
	Fuel knocking.	Use specified octane fuel.
	Preignition (misusing of spark plug).	Use specified spark plug.
Mechanical knocking		
Crankshaft bearing knocking.	This strong dull noise increases when engine is accelerated. To locate the place, cause a misfire in each cylinder. If the noise stops by the misfire, this cylinder generates the noise.	This is caused by worn or damaged bearings, or unevenly worn crankshaft. Renew bearings and adjust or change crankshaft. Check lubrication system.
Connecting rod bearing knocking.	This is a little higher-pitched noise than the crankshaft knocking, and also increases when engine is accelerated. Cause a misfire in each cylinder and if the noise diminishes almost completely, this crankshaft bearing generates the noise.	Same as the case of crankshaft bearings.
Piston and cylinder noise.	When you hear an overlapping metallic noise which increases its magnitude with the revolution of engine and which decreases as engine is warmed up, this noise is caused by piston and cylinder. To locate the place, cause a misfire one each cylinder.	This may cause an abnormal wearing of cylinder and lower compression which in turn will cause a lower out-put power and excessive consumption of oil. Overhaul engine.
Mechanical knocking		
Piston pin noise.	This noise is heard at each highest and lowest dead end of piston. To locate the place, cause a misfire on each cylinder.	This may cause a wear on piston pin, or piston pin hole. Renew piston and piston pin assembly.
Water pump noise.	This noise may be caused by worn or damaged bearings, or by the uneven surface of sliding parts.	Replace water pump with a new one.
Others	An improper adjustment of valve clearance.	Adjust.
	Noise of timing chain.	Replace the chain or chain tensioner.
	An excessive end-play on crankshaft.	Disassemble engine and renew main bearing.
ABNORMAL COMBUSTION (backfire, after fire run-on etc.)		
Ignition system in trouble	Improper ignition timing.	Adjust ignition timing.
	Improper heat range of spark plugs.	Use specified spark plugs.
Fuel system malfunction	Damaged carburetor or manifold gasket. (backfire, afterfire)	Replace them with new parts.
Fuel system malfunction	Clogged carburetor jet.	Disassemble carburetor and check it.
	Improper function of the float.	Adjust the level, and check needle valve.

Condition	Probable cause	Corrective action
Defective cylinder head, etc.	Improper adjusted valve clearance.	Adjust.
	Excess carbon in combustion chamber.	Remove head and get rid of carbon.
EXCESSIVE OIL CONSUMPTION		
Oil leakage	Loose oil drain plug.	Tighten it.
	Loose or damaged oil pan gasket.	Replace or tighten it.
	Loose or damaged chain cover gasket.	Replace or tighten it.
	Damaged oil seal in front and rear of crankshaft.	Replace.
	Loosen or damaged rocker cover gasket.	Replace or tighten it (but not too much).
	Improper tightening of oil filter.	Replace and tighten it with the proper torque.
	Loosen or damaged oil pressure switch.	Replace or tighten it.
Oil burning	Cylinder and piston wear.	Overhaul cylinder and renew piston.
	Improper location of piston rings or reversely assembled piston rings.	Remount piston rings.
	Damaged piston rings.	Repair or replace piston and cylinder if necessary.
	Worn piston ring groove and ring.	Replace piston and piston ring.
	Fatigue of valve oil seal lip.	Replace seal lip with a new one.
	Worn valve stem.	Replace valve or guide.
Others	Improper grade oil.	Replace with proper grade oil.
	Engine overheat.	Previously mentioned.
POOR FUEL ECONOMY		
Engine power below normal		Previously mentioned.
Fuel system malfunction	Fuel leakage from fuel line.	Repair, replace or tighten the connection of fuel pipes.
TROUBLE IN OTHER FUNCTIONS		
Decreased oil pressure	Improper grade oil.	Replace with proper grade oil.
	Overheat.	Previously mentioned.
	Malfunctioning oil pump regulator valve.	Disassemble oil pump and repair or replace it.
Decreased oil pressure	Functional deterioration of oil pump.	Repair or replace it with a new one.
	Blocked oil filter.	Replace with a new one.
	Increased clearance in various sliding parts.	Disassemble and replace the worn parts with new ones.
	Blocked oil strainer.	Clean it.
	Malfunctioning oil gauge pressure switch.	Replace it with a new one.

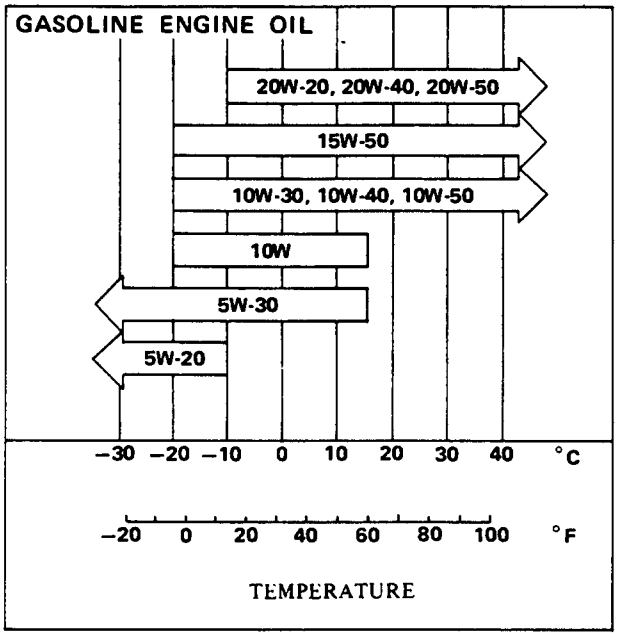
Condition	Probable cause	Corrective action
Excessive wear on the sliding parts	Oil pressure decreases.	Previously mentioned.
	Damaged quality or contamination of oil.	Exchange the oil with proper one and change oil filter.
	Clogged air cleaner filter.	Clean or replace filter.
	Overheat or overcool.	Previously mentioned.
	Improper fuel mixture.	Check the fuel system.
Scuffing of sliding parts	Decrease of oil pressure.	Previously mentioned.
	Insufficient clearances.	Adjust to the sufficient clearances.
	Overheat.	Previously mentioned.
	Improper fuel mixture.	Check the fuel system.
	Improper ignition timing.	Adjust.

Recommended Lubricant

LUBRICANT

Lubricant	Specifications	Remarks
Gasoline engine oil	API SD or SE	For further details, refer to the recommended SAE viscosity chart.
Antifreeze	–	Ethylene glycol base

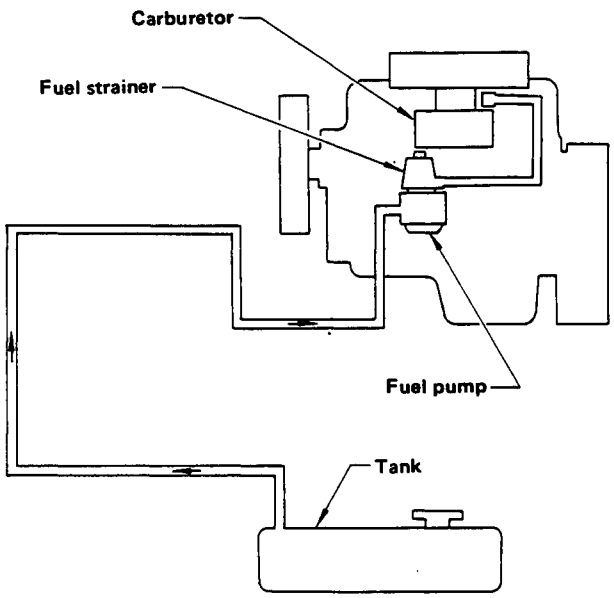
SAE VISCOSITY NUMBER



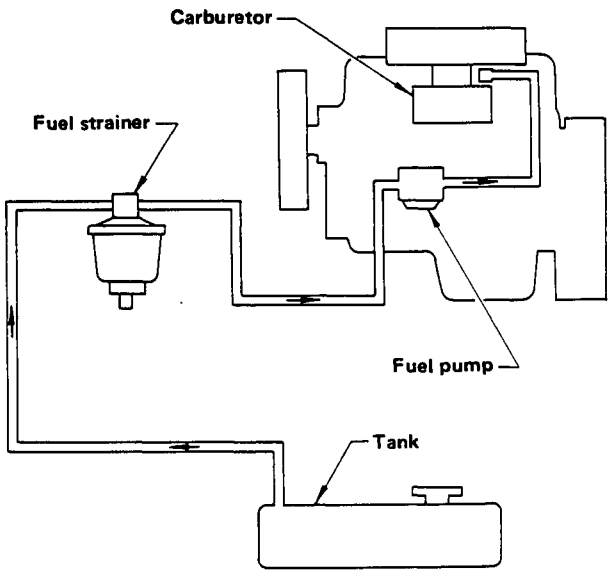
System Diagram

FUEL SYSTEM DIAGRAM

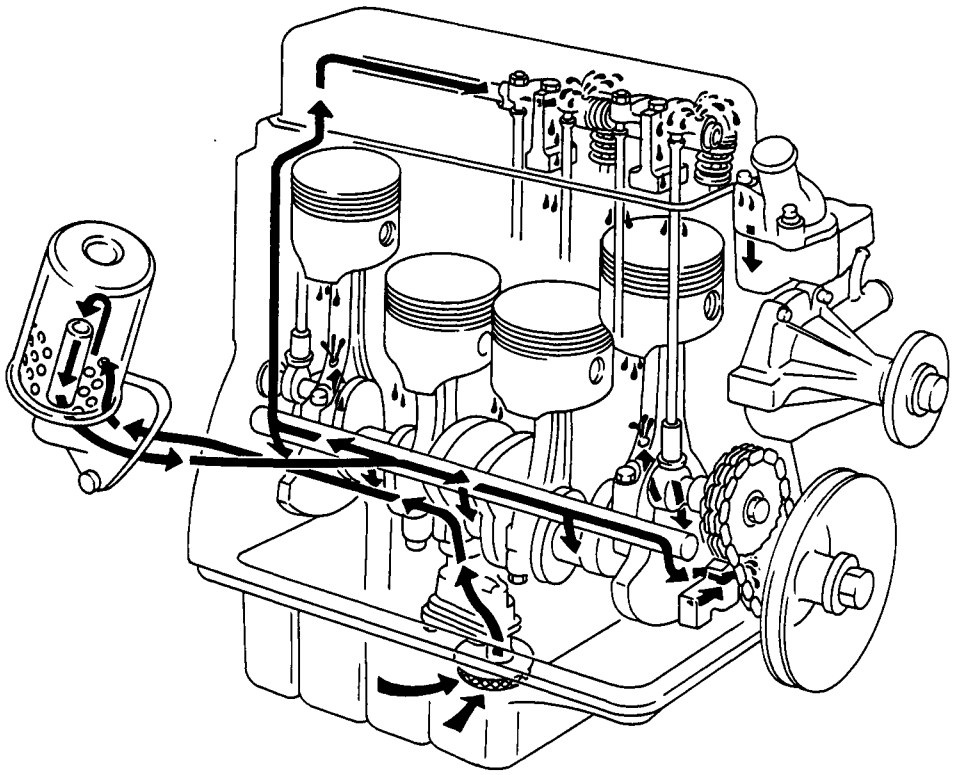
H20 Engine



H30 Engine

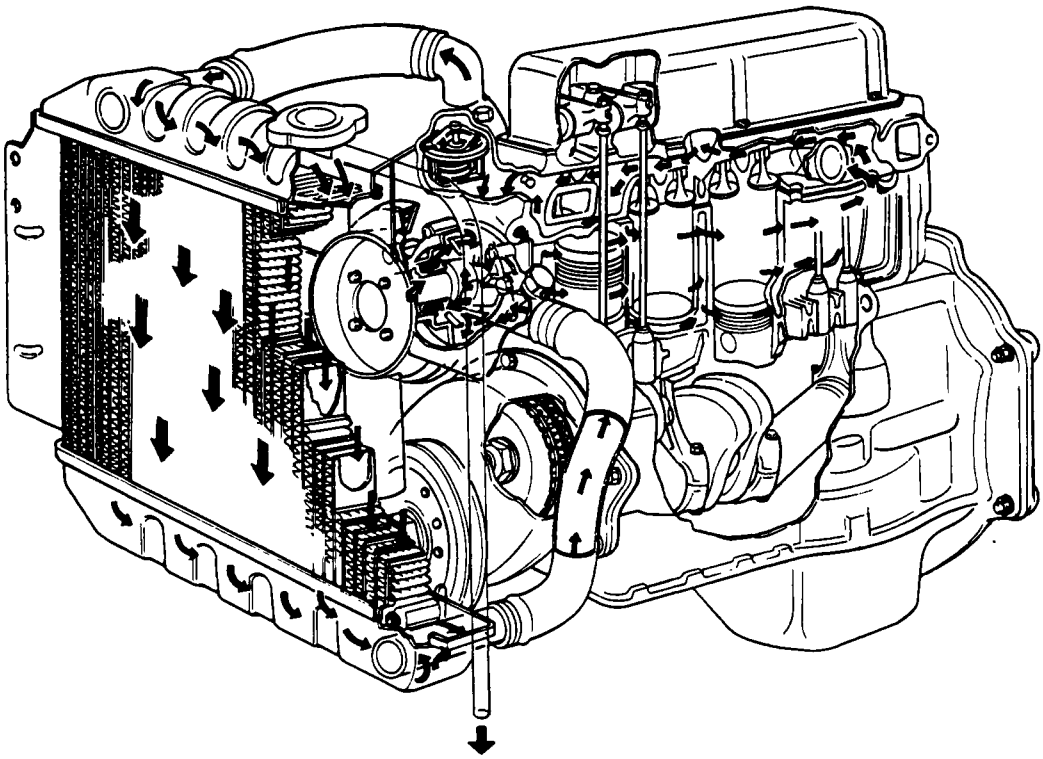


LUBRICATION SYSTEM DIAGRAM

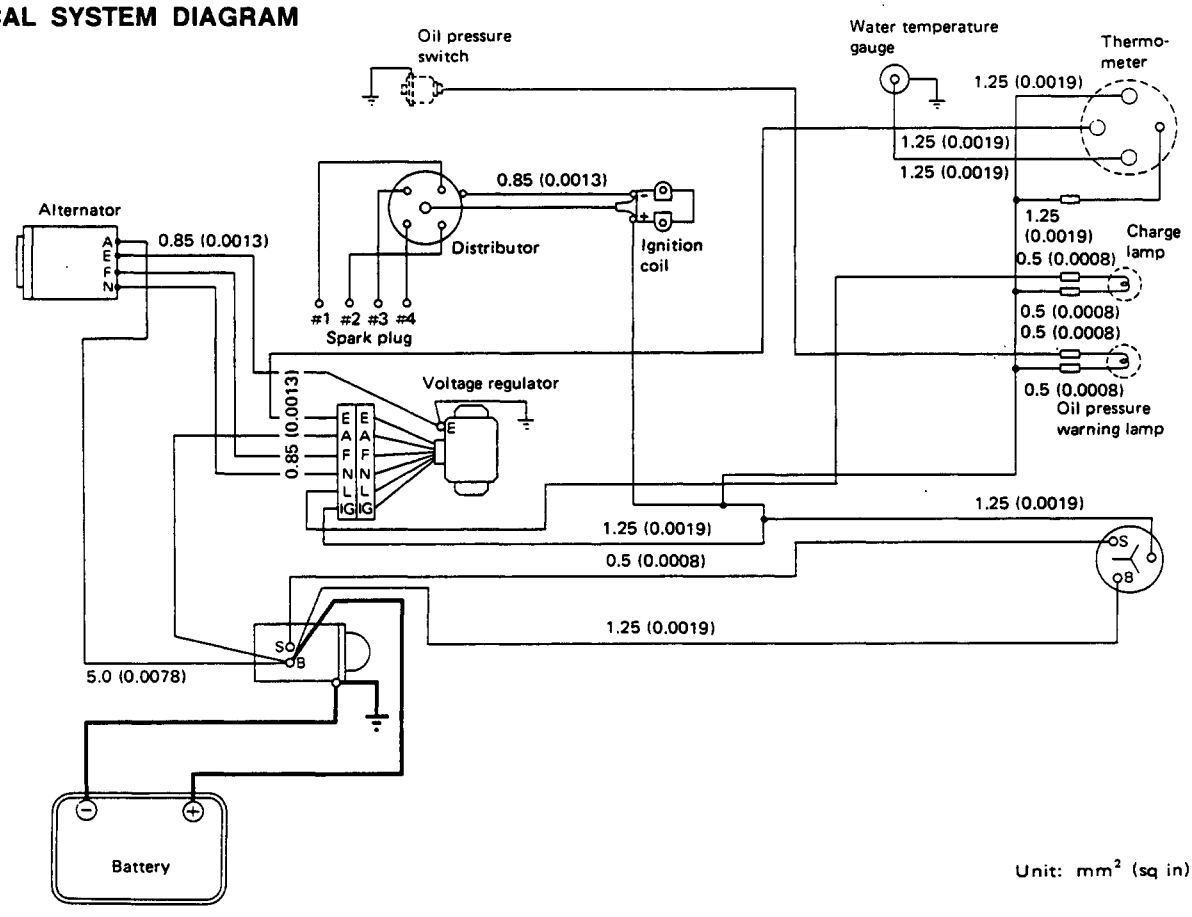


COOLING SYSTEM DIAGRAM

Cooling circuit

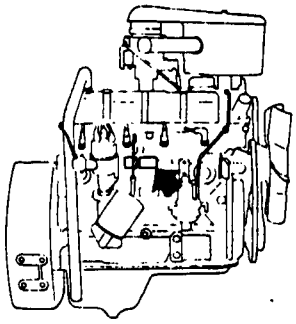


ELECTRICAL SYSTEM DIAGRAM



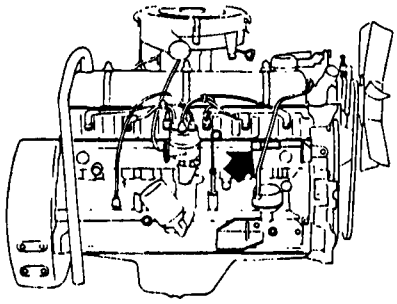
Engine Serial Number

H20



SGI263

H30



SGI1264

The engine serial number is stamped on the right side of cylinder block.

H20-Sxxxxx

H30-Sxxxxx

Serial number

Engine model

Specifications

ENGINE GENERAL

Item \ Engine model	H20	H30
Engine general specifications Classification	Gasoline	
Cycle	4	
No. of cylinders and arrangement	4, in-line	6, in-line
Valve arrangement	O.H.V. (Overhead valve)	
Bore x stroke mm (in)	87.2 x 83.0 (3.433 x 3.268)	
Displacement cm^3 (cu in)	1,982 (120.94)	2,974 (181.47)
Compression ratio	8.2	
Number of piston rings Compression	2	
Oil	1	
Number of main bearings	5	4
Firing order	1-3-4-2	1-5-3-6-2-4

TIGHTENING TORQUE

N·m (kg-m, ft-lb)

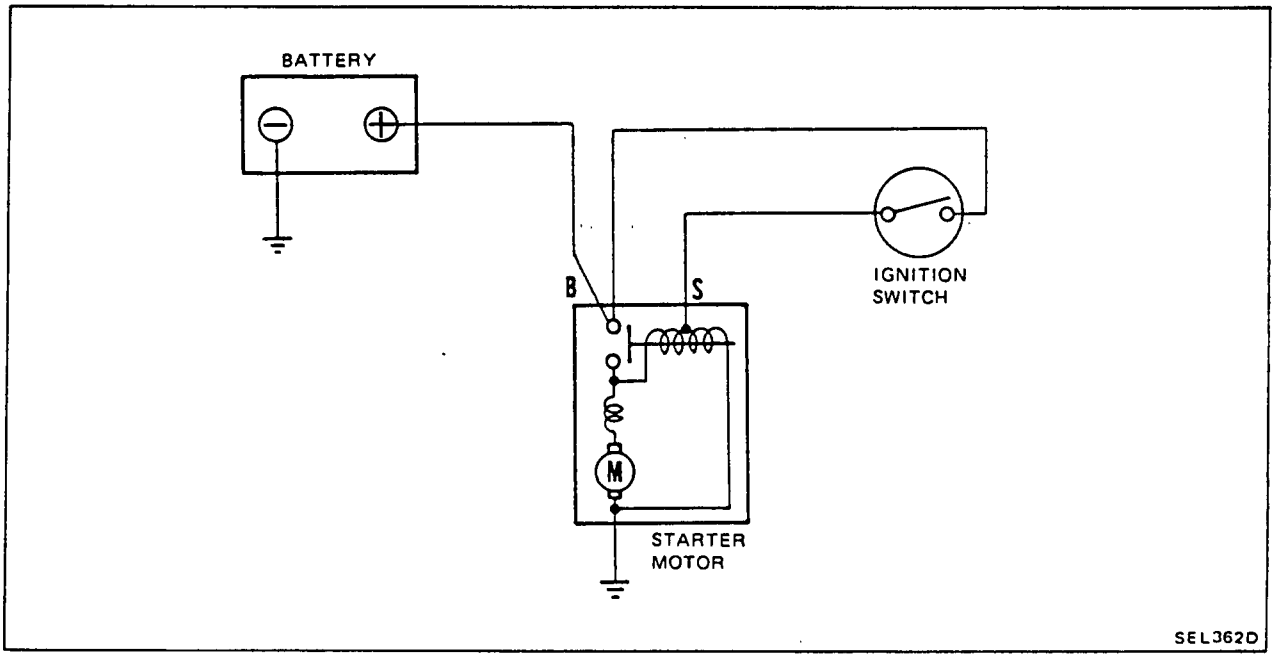
	H20	H30
Cylinder head bolt	78 to 93 (8.0 to 9.5, 58 to 69)	69 to 82 (7.0 to 8.4, 51 to 61)
Manifold nut	14 to 18 (1.4 to 1.8, 10 to 13)	
Carburetor nut	14 to 18 (1.4 to 1.8, 10 to 13)	
Oil pan drain plug	20 to 29 (2.0 to 3.0, 14 to 22)	
Spark plug	15 to 20 (1.5 to 2.0, 11 to 14)	

INSPECTION AND ADJUSTMENT

Valve clearance (Hot) mm (in)	Intake	0.38 (0.015)	
	Exhaust		
Drive belt deflection mm (in)		8 to 12 (0.31 to 0.47)	
Applied pushing force N (kg, lb)		98 (10, 22)	
Engine oil capacity ℓ (US qt, Imp qt)		H20	H30
With oil filter		4.2 (4-1/2, 3-3/4)	4.7 (5, 4-1/8)
Without oil filter		3.7 (3-7/8, 3-1/4)	4.2 (4-1/2, 3-3/4)
Engine compression pressure kPa (bar, kg/cm^2, psi)/rpm Standard		1,079 (10.79, 11.0, 156)/300	
Minimum		883 (8.83, 9.0, 128)/300	
Spark plug Type		B4ES	
Gap mm (in)		0.7 to 0.8 (0.028 to 0.031)	
Distributor Point gap mm (in)		0.45 to 0.55 (0.018 to 0.022)	
Dwell angle (degree)		H20	H30
		49 to 55°	35 to 41°
High tension cable resistance (Ohm)		Less than 30,000	
Ignition timing idle speed B.T.D.C. degree/rpm		H20	H30
		7°/550	5°/600

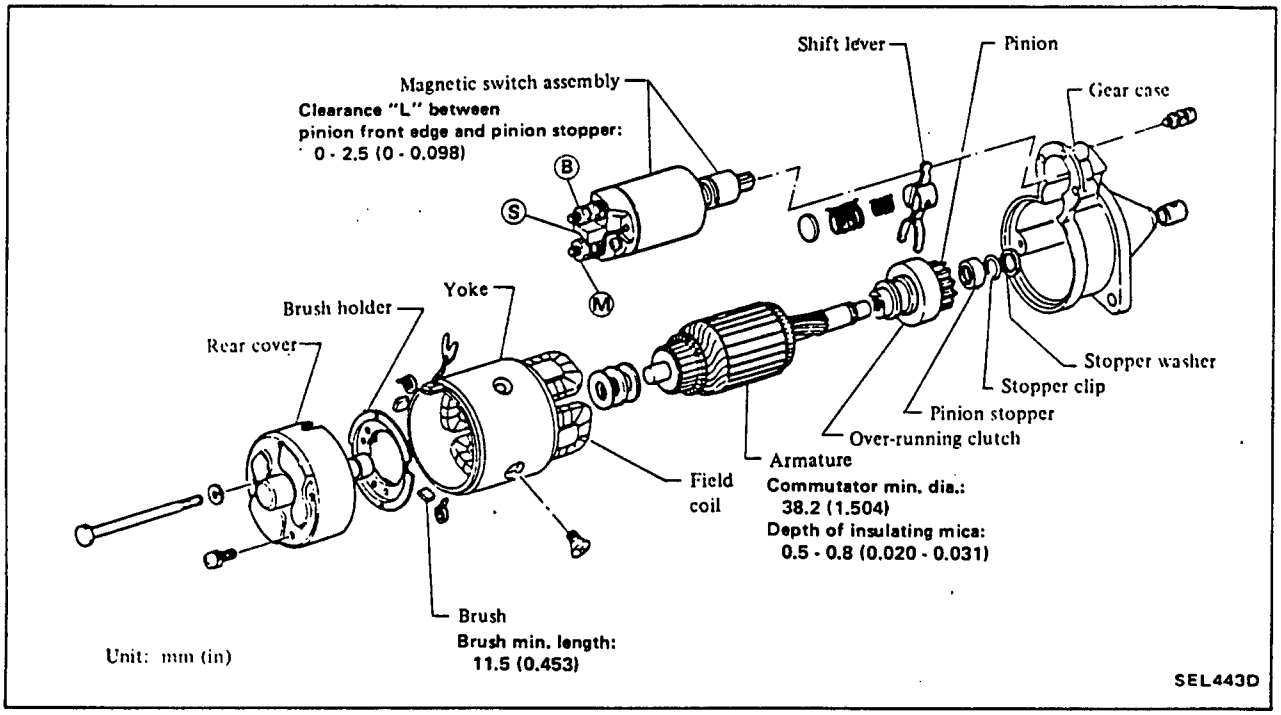
CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

SCHEMATIC

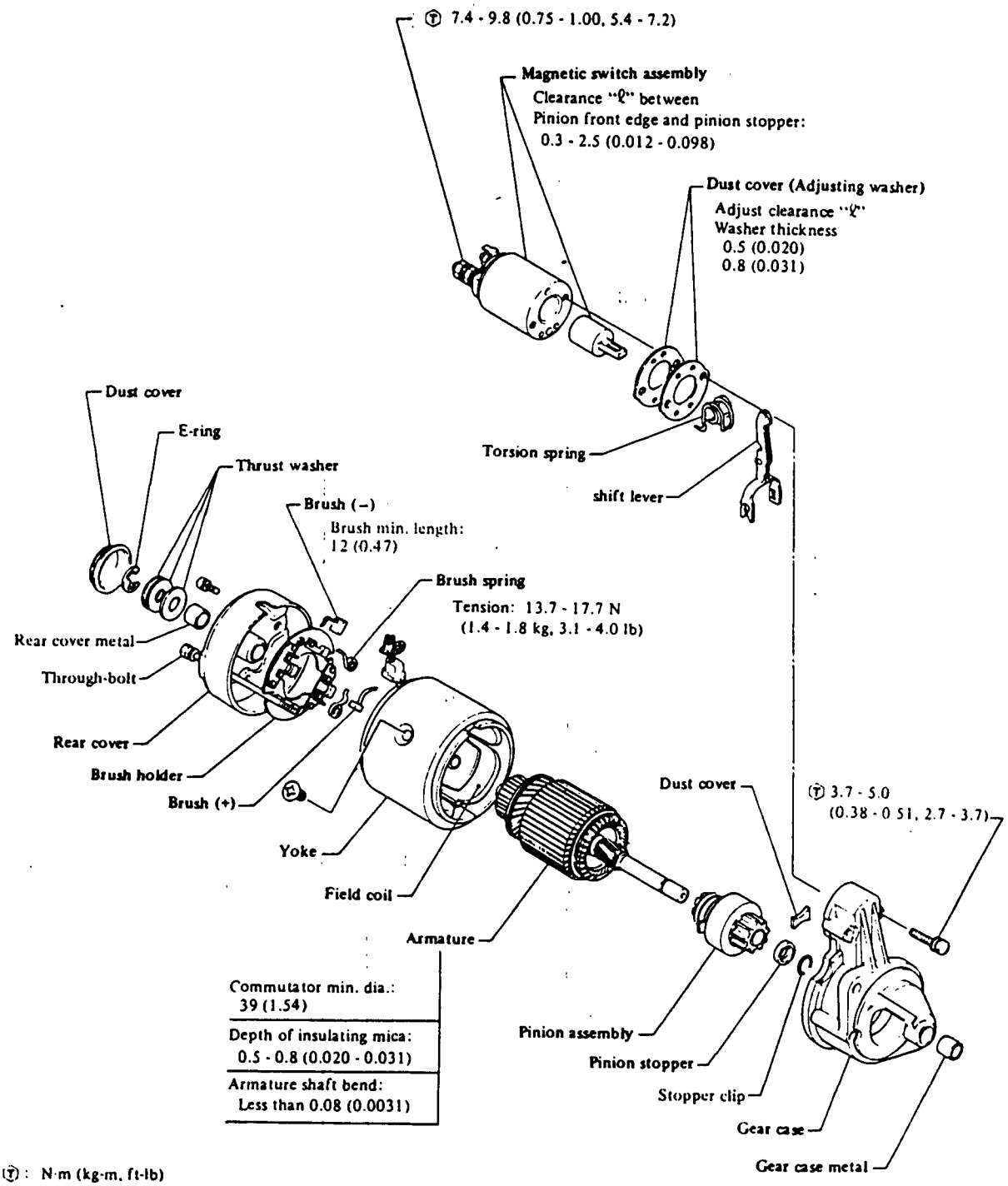


STARTER MOTOR

For H20 engine



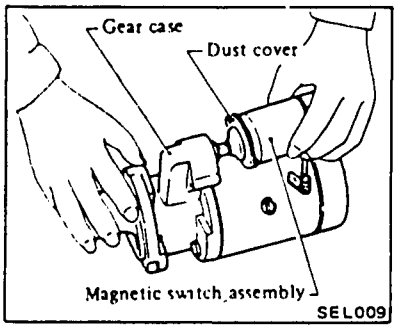
For H30 engine



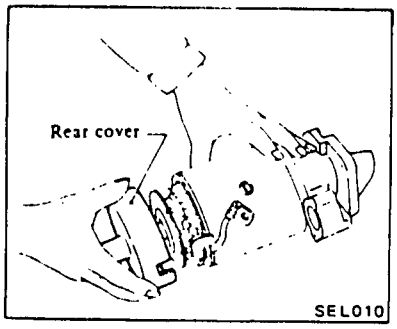
Ⓣ: N·m (kg-m, ft-lb)
Unit: mm (in)

DISASSEMBLY

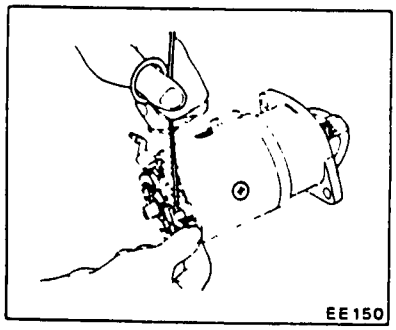
1. Remove magnetic switch.



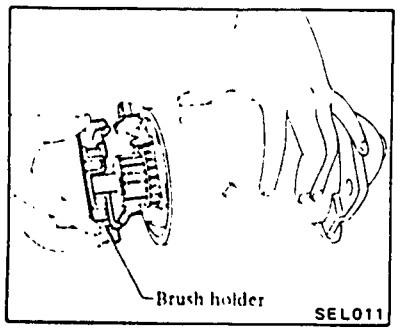
2. Remove rear cover.
(1) Remove dust cover, E-ring and thrust washer(s).
(2) Remove brush holder setscrews.
(3) Remove through bolts.



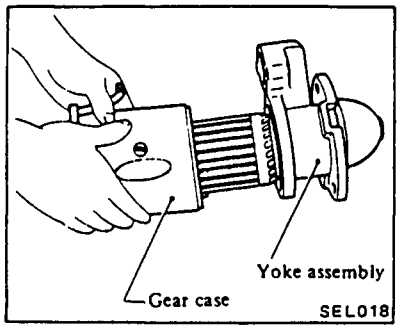
3. Lift up brush springs.



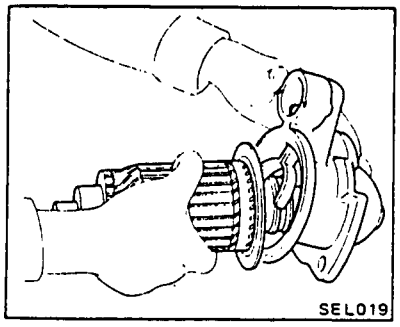
4. Remove brush holder



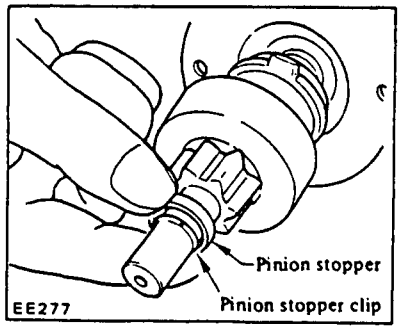
5. Remove yoke.



6. Withdraw armature and shift lever.



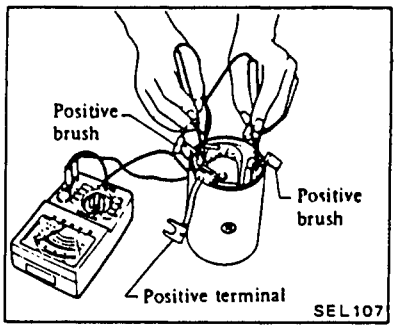
7. Remove overrunning clutch.
- Remove pinion stopper clip, pushing pinion stopper toward clutch side.



INSPECTION

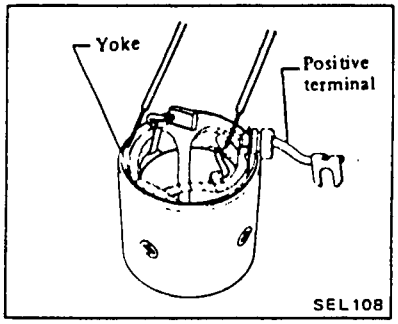
Field coil

1. Continuity test (between field coil positive terminal and positive brushes).



- No continuity ... Replace field coil.

2. Insulation test (between field coil positive terminal and yoke).



- Continuity exists ... Replace field coil.

Brush

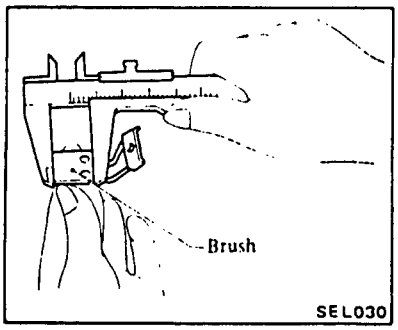
Check the surface condition of brush contact.
- Loose contact ... Replace.

Check wear of brush.

Minimum length of brush:

H20 (M003T21281)	11.5 mm (0.453 in)
H30 (S114-182G)	12.0 mm (0.472 in)

- Excessive wear ... Replace.

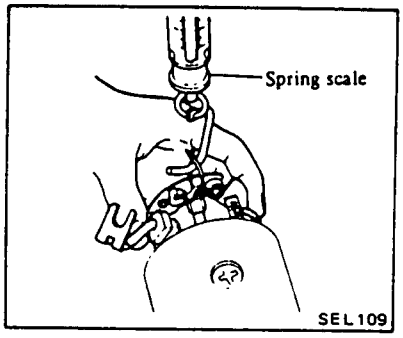


Brush spring

Check brush spring tension.

Spring tension:
13.7 - 17.7 N
(1.4 - 1.8 kg,
3.1 - 4.0 lb)

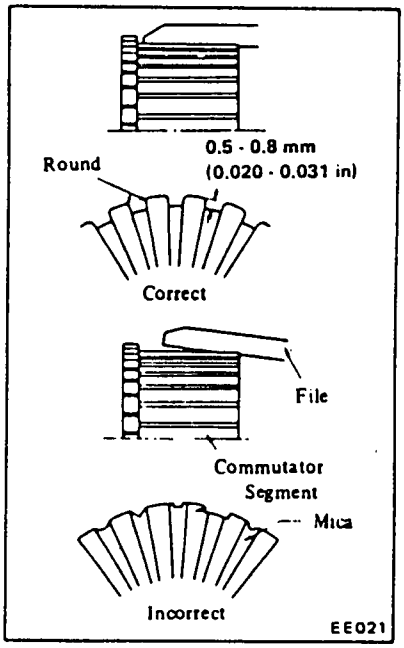
- Not in the specified value. ... Repair or replace.



Armature assembly

1. Check commutator surface.
- Rough ... Sand lightly with No. 500 sandpaper.

2. Check depth of insulating mica from commutator surface.
- Less than 0.2 mm (0.008 in) ... Undercut to 0.5 - 0.8 mm (0.020 - 0.031 in)

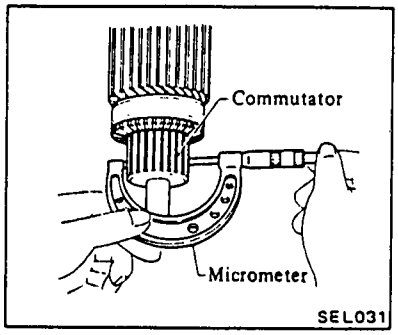


3. Check diameter of commutator.

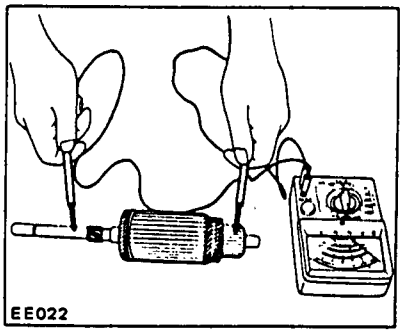
Commutator minimum diameter:

H20 (M003T21281)	**38.2 mm (1.504 in)**
H30 (S114-182G)	**39.0 mm (1.535 in)**

- Less than specified value ... Replace.

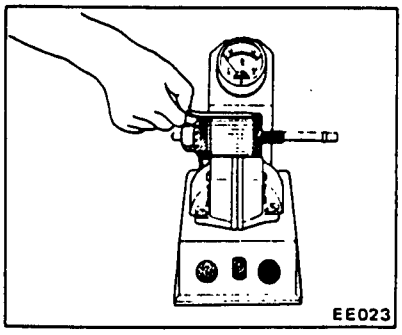


4. Insulation test (between each commutator bar and shaft).



- Continuity exists ... Replace.

5. Short test with armature tester (growler) and a piece of iron over armature core.



- Plate vibrates ... Replace.

6. Continuity test (between two segments side by side).
- No continuity ... Replace.

Overrunning clutch assembly

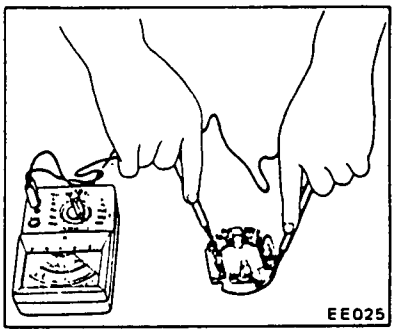
1. Inspect smooth sliding of pinion gear.
- Abnormal resistance ... Repair.

2. Inspect pinion teeth.
- Excessive rubbing ... Replace.

CAUTION:
Flywheel ring gear also must be inspected.

Brush holder

Insulation test (between negative side of brush holder and another positive side).



- Continuity exists ... Replace.

Pinion case bearing metal

Check clearance between bearing metal and armature shaft

Bearing metal to armature shaft clearance:
Less than 0.2 mm (0.008 in)

- More than specified value ... Replace.

Magnetic switch assembly

1. Continuity test (between "S" terminal and switch body).
- No continuity ... Replace.

2. Continuity test (between terminals "S" and "M").
- No continuity ... Replace.

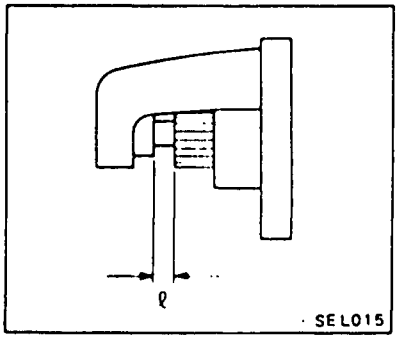
ASSEMBLY

- Apply grease to gear case and rear cover bearing metal, and apply oil to pinion slightly.

With the switch on, push pinion back to remove all slack and measure the clearance "ℓ" between pinion front edge and pinion stopper.

Clearance "ℓ"

H20 (M003T21281)	0 - 2.0 mm (0 - 0.079 in)
H30 (S114-182G)	0.3 - 2.5 mm (0.012 - 0.098 in)



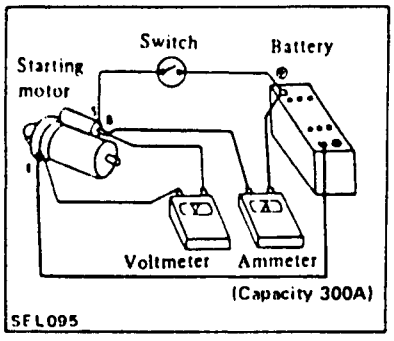
- Not in the specified value ... Adjust by adjusting washer(s). (Only for H30 engine)

Adjusting washer thickness:
0.2 mm (0.008 in)
0.3 mm (0.012 in)

TESTING

Performance test

No-load test



Specifications

Refer to S.D.S.

Diagnosis of test

1. Low speed with no-load and high current draw.

(1) Tight, dirty or worn bearings.
(2) Bent armature shaft or loosened field probe.
(3) Shorted armature coil.
(4) A grounded armature of field coil.

2. Failure to operate with high current draw.

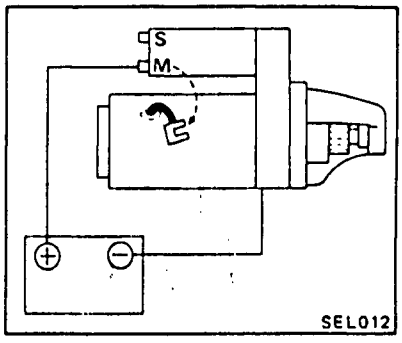
(1) A grounded or open field coil.
(2) Burned out commutator bar.
- Weak brush spring tension
- Thrust out of mica in commutator
- Loose contact between brush and commutator.

3. Low current draw and low no-load speed.

(1) Loose connections.
(2) Dirty commutator.
(3) Burned out commutator bar.

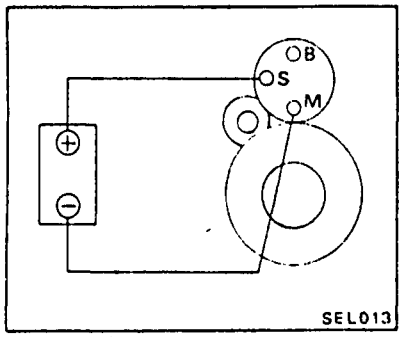
Magnetic switch returnability

1. Disconnect lead wire from terminal "M" of magnetic switch.
2. Connect terminal "M" and positive ⊕ terminal of battery with a jumper lead wire.
3. Connect starter motor body and negative ⊖ terminal of battery with a jumper lead wire.
4. Pull pinion gear all the way out with your hands.
5. Release your hands from pinion gear.
6. If pinion gear returns to its original position, magnetic switch is properly functioning.



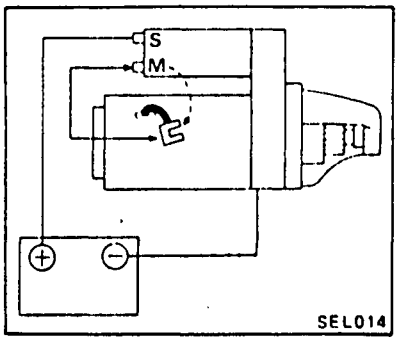
Series coil

1. Connect terminal "M" of magnetic switch and negative ⊖ terminal of battery with a jumper lead wire.
2. Connect terminal "S" of magnetic switch and positive ⊕ terminal of battery with a jumper wire.
3. With these connections having been made, if plunger is pulled in by force, series coil is properly functioning.



Shunt coil

1. Disconnect lead wire which connect terminal "M" of magnetic switch and starter motor terminal, and connect a jumper wire in its place.
2. Connect terminal "S" of magnetic switch and positive ⊕ terminal of battery with a jumper wire.
3. Connect negative ⊖ terminal of battery and starter motor body with a jumper wire. Plunger should be pulled in by force.
4. Disconnect jumper wire from terminal "M".
5. If plunger continues to be pulled in with jumper wire disconnected from terminal "M", shut coil is properly functioning.



CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

DESCRIPTION

The charging circuit consists of the battery, alternator, regulator and necessary wiring to connect these parts.

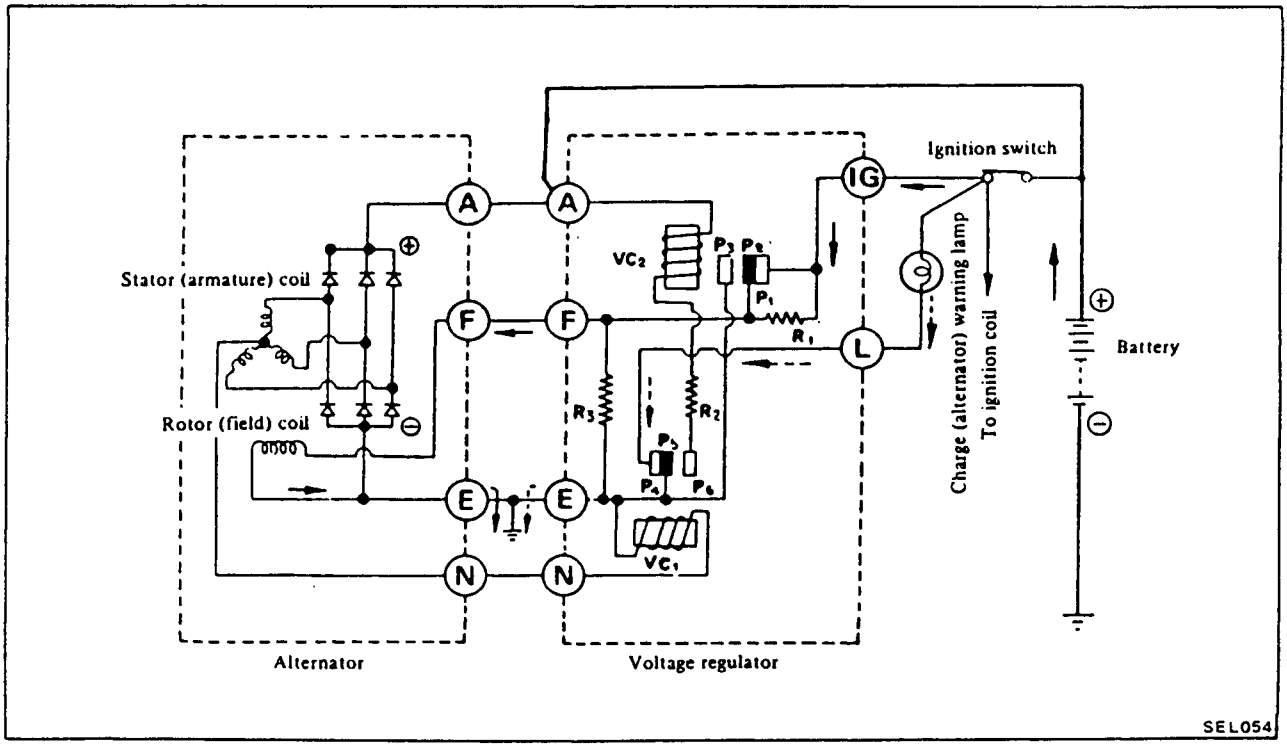
When the ignition switch is set to "ON", current flows from the battery to ground through the ignition switch, voltage regulator IG terminal, primary side contact point "P1", movable contact point "P2", voltage regulator "F" terminal, alternator "F" terminal, rotor (field) coil and alternator "E" terminal, as shown in Figure by full line arrow marks. Then the rotor in the alternator is excited. On the other hand, current flows from the battery to ground through the ignition switch, warning lamp, voltage regulator "L" terminal, lamp side contact point "P4", movable contact point "P5", and voltage regulator "E" terminal, as shown by dotted line arrow marks. Then, the warning lamp lights.

When the alternator begins to operate, three-phase alternating current is induced in the stator (armature) coil. This alternating current is rectified by the positive and negative silicon diodes. The rectified direct current output reaches the alternator "A" and "E" terminals.

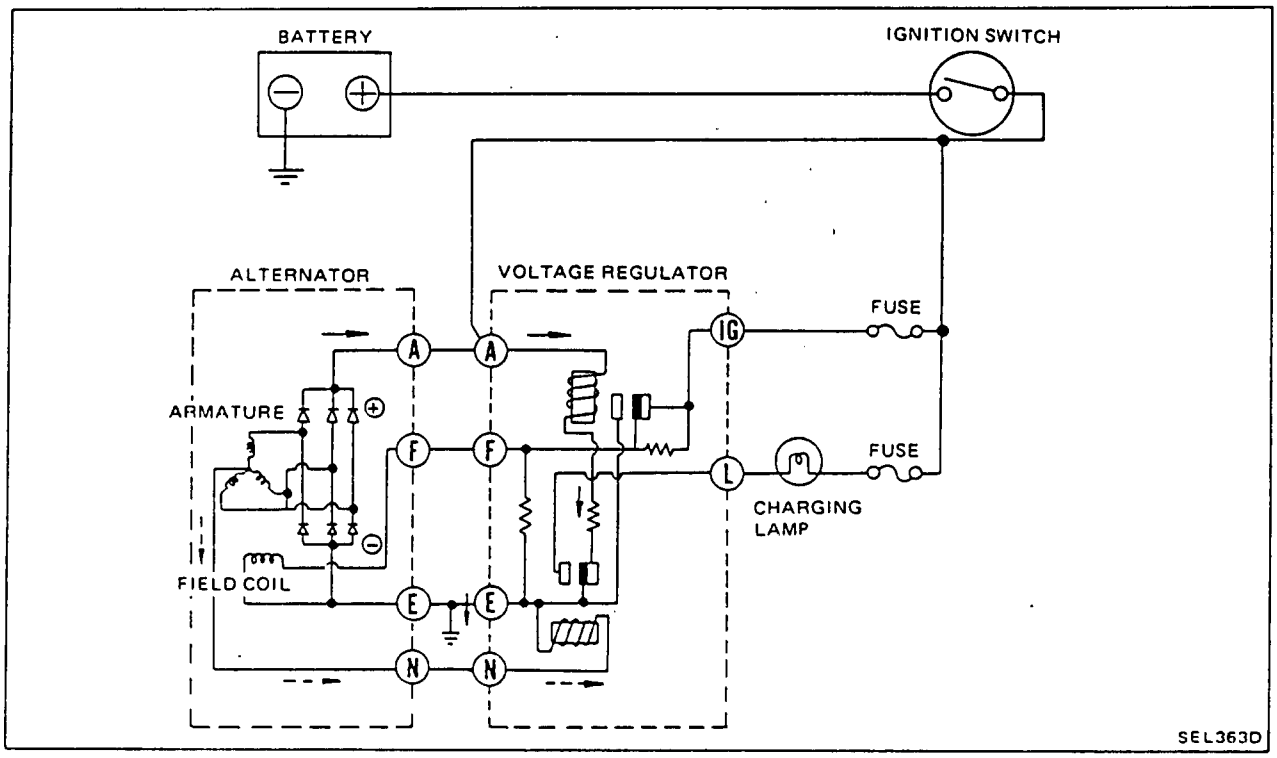
On the other hand, the neutral point voltage reaches "N" and "E" terminals (nearly a half of the output voltage), and current flows from voltage regulator "N" terminal to "E" terminal or ground through the coil "VC1" by the dotted line arrow marks. Then, the coil "VC1" is excited, and the movable contact point "P5" comes into contact with voltage winding side contact point "P6". This action turns off the warning lamp and completes the voltage winding circuit, as shown by the full line arrow marks.

When the alternator speed is increased or the voltage starts to rise excessively, the movable contact point "P2" is separated from the primary side contact "P1" by the magnetic force of coil "VC2". Therefore, register "R1" is applied into the rotor circuit and output voltage is decreased. As the output voltage is decreased, the movable contact point "P2" and primary side contact "P1" comes into contact once again, and the alternator voltage increases. Thus, the rapid vibration of the movable contact point "P2", maintains an alternator output voltage contact.

When the alternator speed is further increased or the voltage starts to rise excessively, the movable contact point "P2" comes into contact with secondary side contact point "P3". Then, the rotor current is shut off and alternator output voltage is decreased immediately. This action separates movable contact "P2" from secondary contact "P3". Thus, the rapid vibration of the movable contact point "P2" or breaking and completing the rotor circuit maintains constant alternator output voltage.



SCHEMATIC



CHARGING SYSTEM TROUBLE-SHOOTING

Before conducting an alternator test, make sure battery is fully charged.

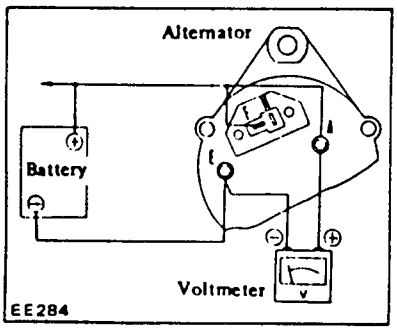
To conduct test, it is necessary to use a 30-volt voltmeter and suitable test probes.

Set up a test circuit as shown in Figure and test alternator in manner indicated in flow chart below:

1. Disconnect connectors at alternator.
2. Connect "A" terminal to "F" terminal.
3. Connect one test probe from voltmeter positive terminal to "A" terminal. Connect the other test probe to ground. Make sure that voltmeter registers battery voltage.
4. Turn on headlights and switch to High Beam.
5. Start engine.
6. Increase engine speed gradually until it is approximately 1,100 rpm, and take the voltmeter reading.

Measured value: Below 12.5 volts
Alternator is run-down. Remove and check it for condition.

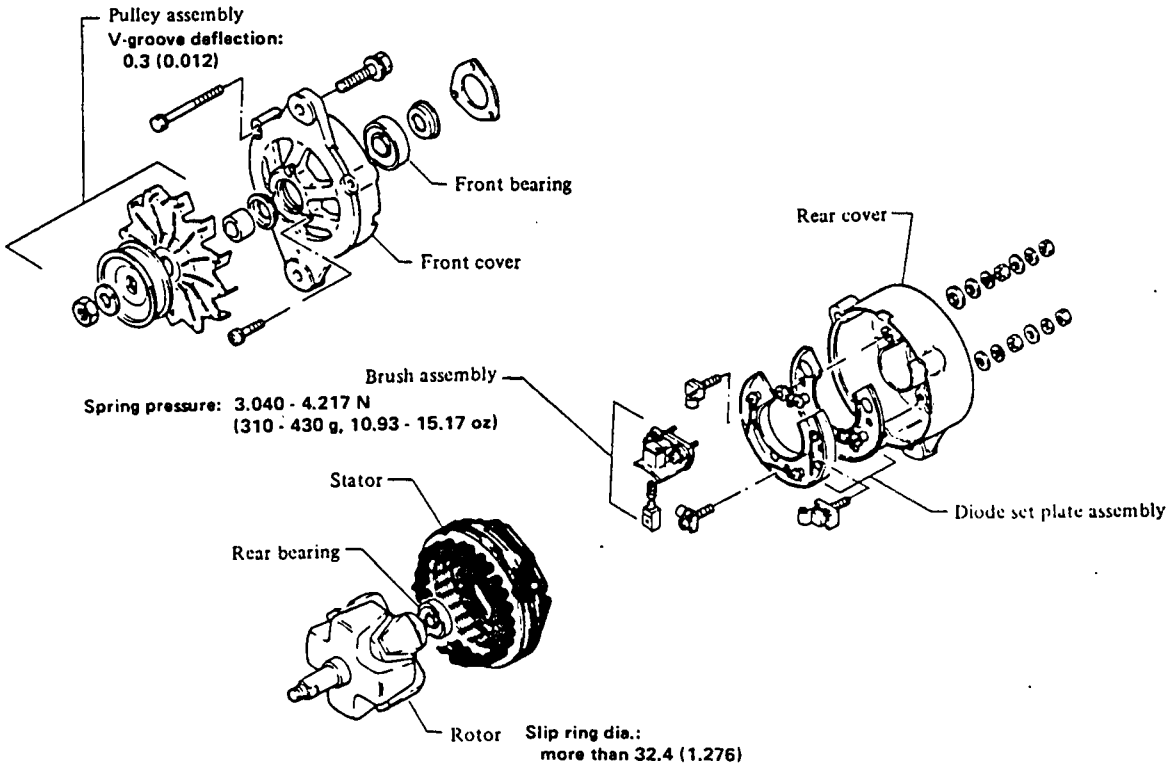
Measured value: Over 12.5 volts
Alternator is in good condition.



a. Do not run engine at more than 1,100 rpm while test is being conducted on alternator.
b. Do not race engine.

ALTERNATOR

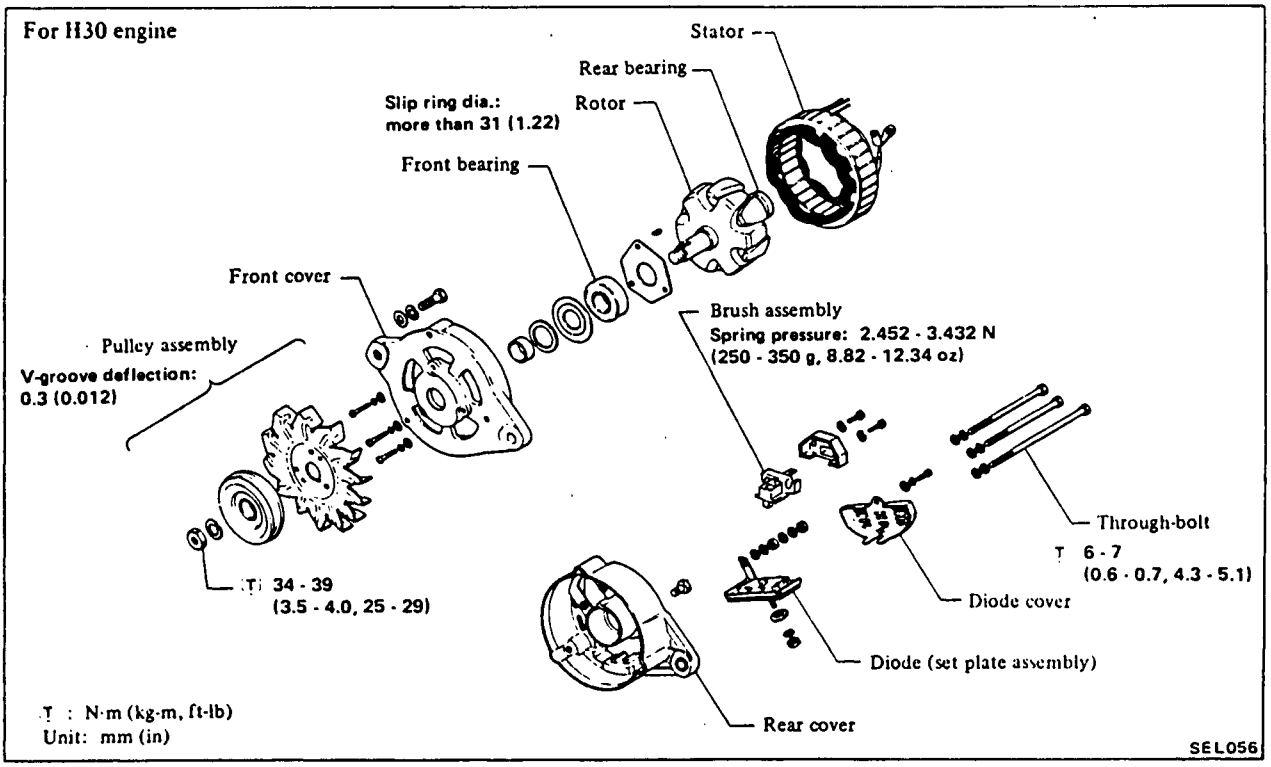
For H20 engine



Unit: mm (in)

SEL444D

For H30 engine



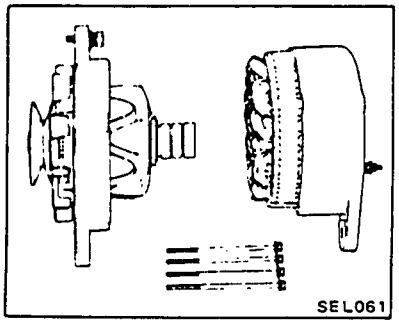
T : N·m (kg-m, ft-lb)
Unit: mm (in)

SEL056

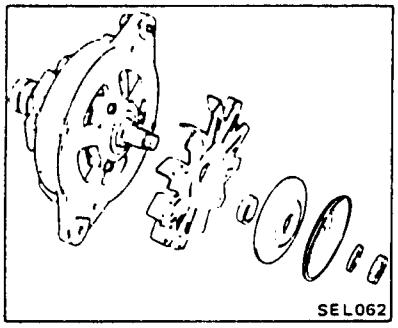
REV.

DISASSEMBLY

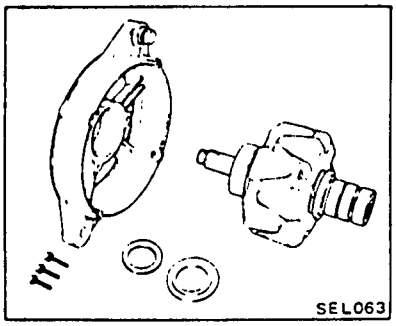
1. Remove through-bolts.
2. Separate front cover from rear cover.



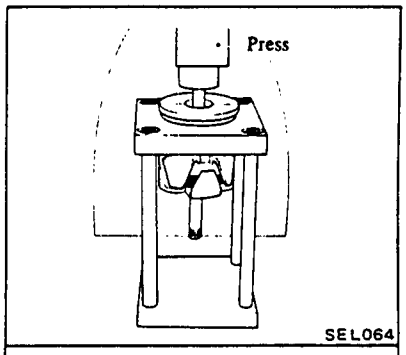
3. Remove pulley and fan.
(1) Place rear cover side of rotor in a vice.
(2) Remove pulley nut.

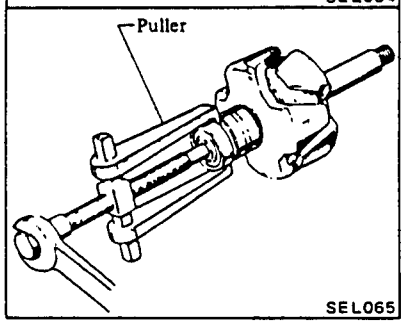


4. Separate rotor front cover.
- Remove setscrews from bearing retainer.

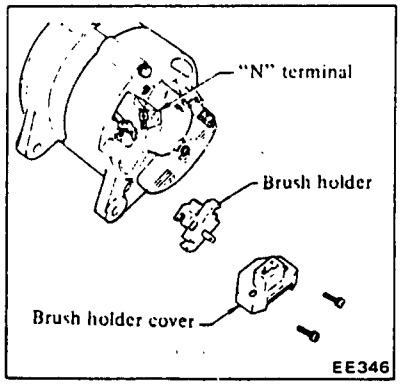


5. Pull rear bearing off rotor assembly.



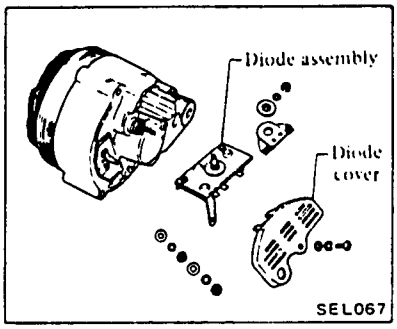


6. Remove brush holder cover.
7. Remove brushes together with brush holder.



8. Remove diode cover.
9. Disconnect stator coil lead wires from diode terminal with a soldering iron.
10. Remove "A" terminal nut and diode installation nut.
11. Remove diode assembly.

CAUTION:
Place packings and insulators in order so that they can be placed back in their original places or locations from which they were removed.

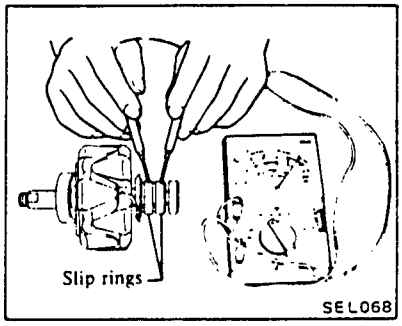


12. Pull stator coils out of rear cover.

INSPECTION

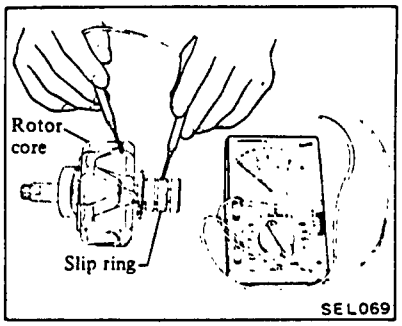
Rotor

1. Continuity test.



- No continuity ... Replace rotor.

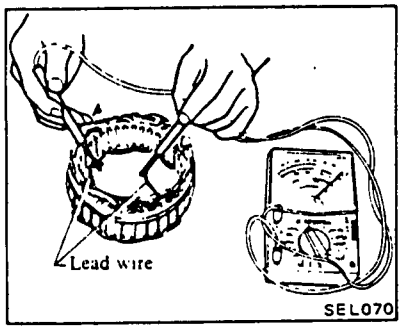
2. Insulation test



- Continuity exists ... Replace rotor.

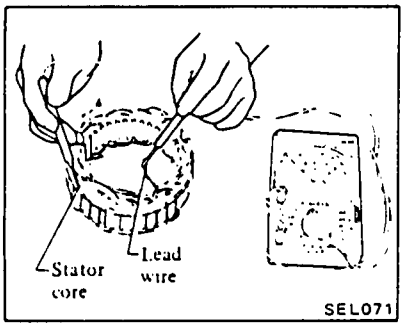
Stator

1. Continuity test



- No continuity ... Replace stator.

2. Insulation test

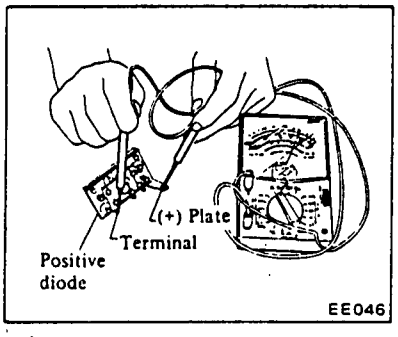


Diode

Perform a continuity test on diodes in both directions, using an ohmmeter.

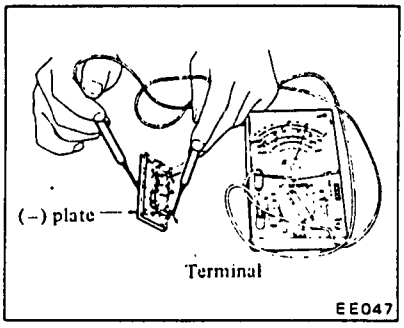
Circuit tester terminal		Conduction
Positive	Negative	
(+) plate Holder plate	Diode terminal	Yes
Diode terminal	(+) plate Holder plate	No
(−) plate Rear cover	Diode terminal	No
Diode terminal	(−) plate Rear cover	Yes

Positive diode



- Conduction test is N.G. ... Replace diode assembly.

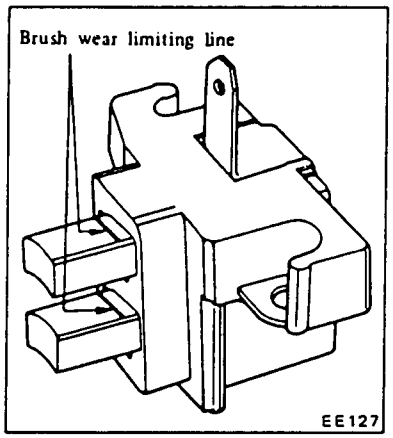
Negative diode



- Conduction test is N.G. ... Replace diode assembly.

Brush

1. Check smooth movement of brush.
- Not smooth ... Check brush holder and clean.
2. Check brush for wear.



- Less than the specified value ... Replace.

3. Check brush pig tail for damage.
- Damaged ... Replace.

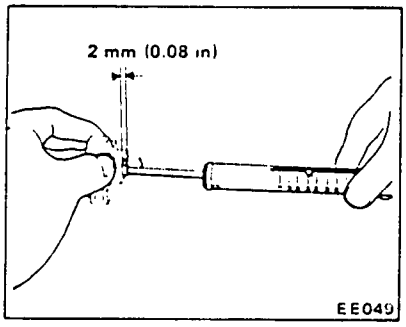
4. Check brush spring pressure.

Measure brush spring pressure with brush projected approximately 2 mm (0.08 in) from brush holder.

Spring pressure:

H20 (A001T22581)	3.040 - 4.217 N (310 - 430 g, 10.93 - 15.17 oz)
H30 (LT135-17)	2.452 - 3.432 N (250 - 350 g, 8.82 - 12.34 oz)

When brush is worn, pressure decreases approximately 0.196 N (20 g, 0.71 oz) per 1 mm (0.04 in) wear.



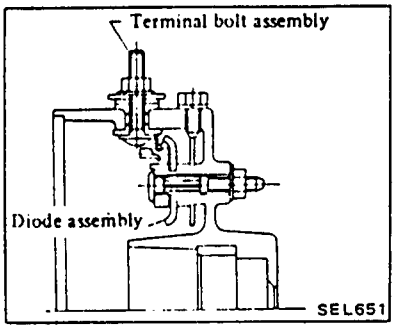
- Not in the specified value ... Replace.

ASSEMBLY

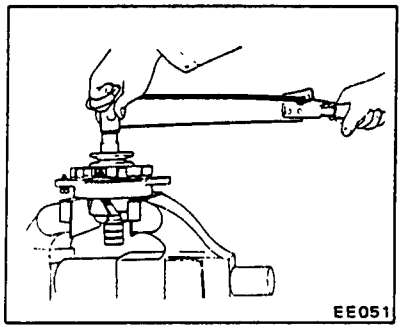
Assemble alternator in the reverse order of disassembly, noting the following:

1. When soldering each stator coil lead wire to diode assembly terminal, carry out the operation as fast as possible.

2. When installing diode "A" terminal, install insulating bushing correctly.



3. Tighten pulley nut and make sure that deflection of V-groove is proper.



Ⓣ : Pulley nut
34 - 39 N·m
(3.5 - 4.0 kg-m,
25 - 29 ft-lb)

V-groove deflection:
0.3 mm (0.012 in)

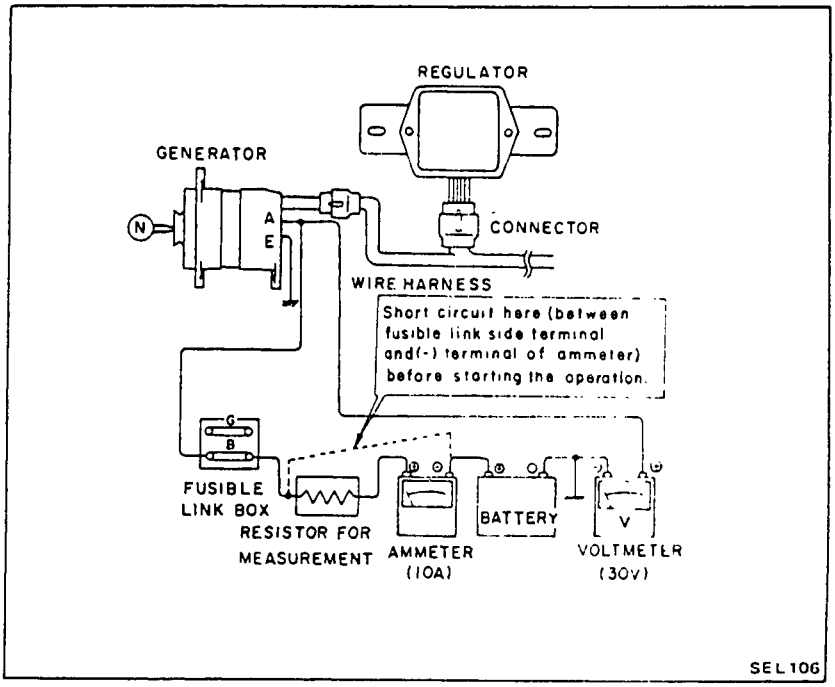
VOLTAGE REGULATOR

MEASUREMENT OF REGULATING VOLTAGE

1. Connect DC voltmeter (15-30V), DC ammeter (15-30A), battery and resistor (0.25Ω) with cables as shown.
   Check to be sure that all electrical loads such as lamps, air conditioner, radio, etc. are disconnected.

CAUTION:
Before starting engine, be sure to make short circuit with a cable as shown in Figure.
Failure to follow this caution causes a damaged ammeter.

2. Refer to the following chart to determine if regulator and relative parts are in good condition:



1. Start engine.
2. Rotate engine at 2,500 rpm for several minutes.

After racing for several minutes, ammeter reading below 5A.

Fully charged battery available.
1. Replace with fully charged battery.
2. Check to see if current falls below 5A.

Current falls below 5A.

After racing for several minutes, ammeter reading over 5A.

Fully charged battery not available.
1. Connect a 0.25Ω resistor in series.

Current does not fall below 5A.

Recharge battery and see if current falls below 5A.

Reduce engine speed to idling and then raise it to 2,500 rpm while observing needle of voltmeter.

Needle of voltmeter held within limits shown in the table below.
Regulator functioning properly.

Needle of voltmeter out of limits shown in the following chart.
Regulator out of order. Have it repaired at authorized shop.

Temperature °C (°F)	Voltage V
10 (14)	14.75 - 15.25
0 (32)	14.60 - 15.10
10 (50)	14.45 - 14.95
20 (68)	14.30 - 14.80
30 (86)	14.15 - 14.65
40 (104)	14.00 - 14.50

a. Do not measure voltage immediately after driving. Do this while regulator is cold.

b. To measure voltage, raise engine speed gradually from idling to rated speed.

c. Voltage may be approximately 0.3V higher than the rated for two to three minutes after engine is started, or more specifically, when regulator becomes self-heated. Measurements should then be made within one minute after starting engine, or when regulator is cold.

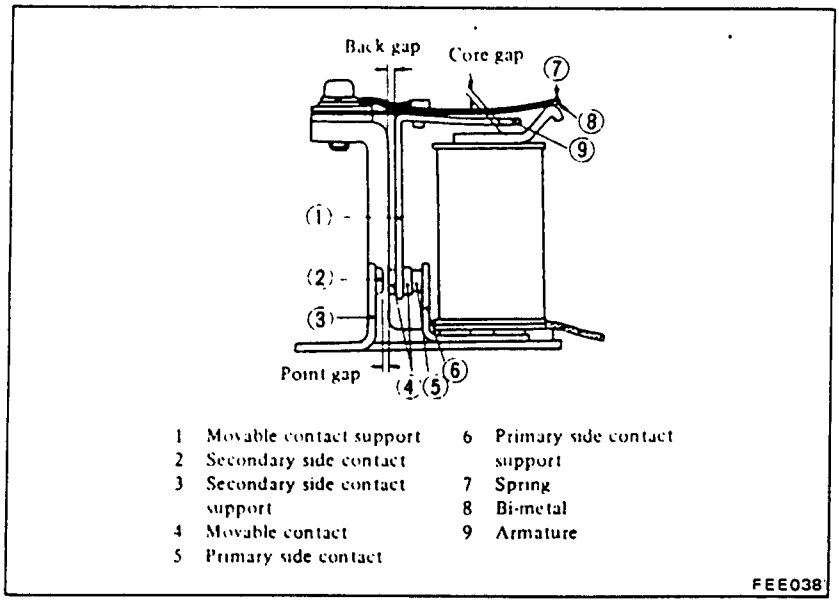
d. The regulator is of a temperature-compensating type. Before measuring voltage, be sure to measure surrounding temperature.

ADJUSTMENT

Voltage regulator

Inspect contact surface. If necessary, lightly polish with sandpaper (#500 or 600).

H20 engine (RLB2220B6)



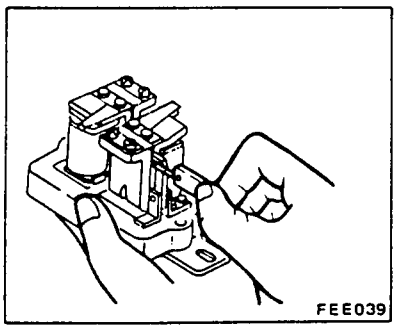
1 Movable contact support
2 Secondary side contact
3 Secondary side contact support
4 Movable contact
5 Primary side contact
6 Primary side contact support
7 Spring
8 Bi-metal
9 Armature

FEE038

1. Adjusting back gap

Loosen armature hinge screw and adjust position by sliding armature.

Back gap:
0.8 - 1.1 mm (0.031 - 0.043 in)

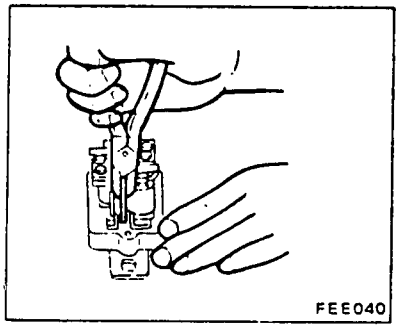


FEE039

2. Adjusting core gap

Adjust gap by bending movable contact support.

Core gap:
0.7 - 1.3 mm (0.028 - 0.051 in)

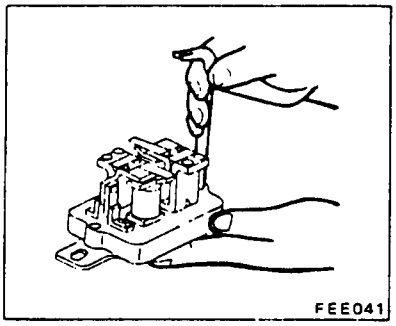


FEE040

3. Adjusting point gap

Adjust gap by bending secondary contact support.

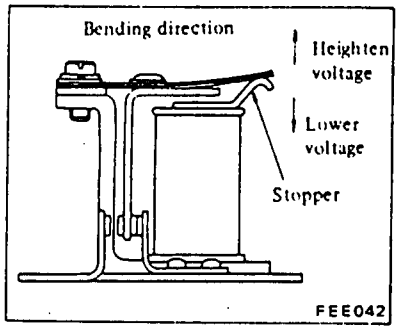
Point gap:
0.3 - 0.45 mm (0.012 - 0.018 in)



FEE041

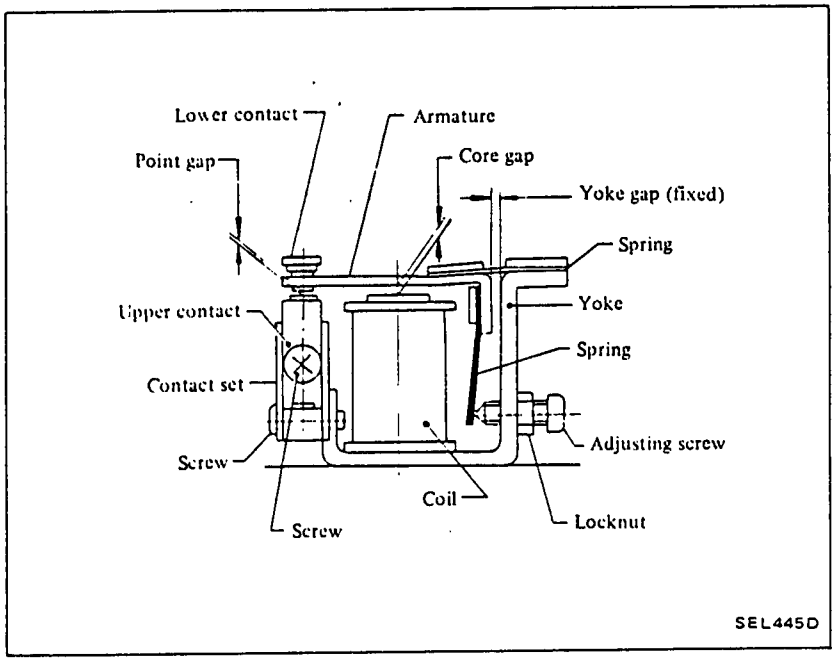
4. Adjusting voltage

Adjust voltage by bending stopper. Bend upward to increase adjusting value, and downward to lower adjusting value.



FEE042

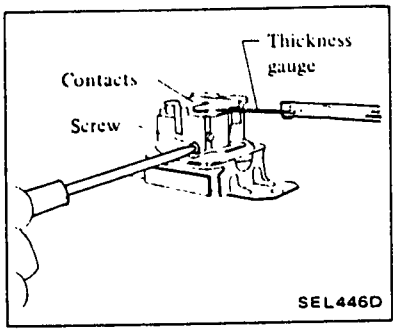
H30 engine (TL1Z-61G)



1. Adjusting core gap

Loosen the screw holding the contacts to the yoke, adjusting the core gap.

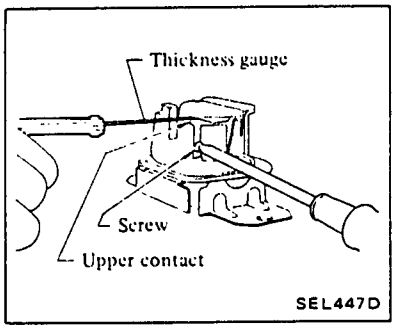
Core gap:
0.6 - 1.0 mm
(0.024 - 0.039 in)



2. Adjusting point gap

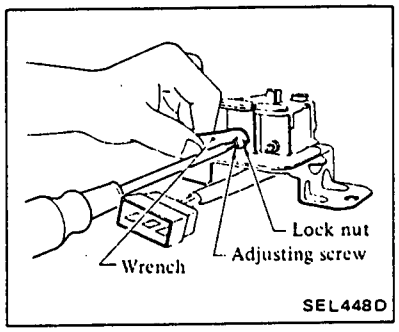
Loosen the screws holding the upper contact. Move the upper contact up or down to adjust.

Point gap:
0.3 - 0.4 mm
(0.012 - 0.016 in)

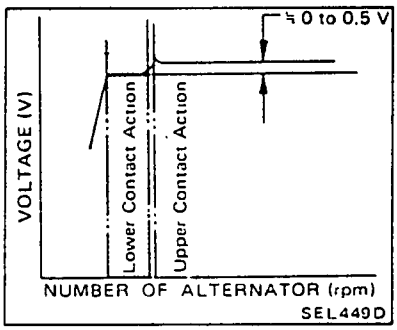


3. Adjusting voltage

When the voltage is high, loosen the lock nut and turn in the adjusting screw. Reverse this procedure when the voltage is low. Retighten the lock nut upon completion of adjustment.



The difference between the voltage at which the lower contact operates and that at which the upper contact operates should be zero to 0.5V. When the difference is more than 0.5V (less than 0V), the core gap should be made smaller (larger).



Charge relay

Inspect contact surface and adjust back, core and point gap in the same manner as voltage regulator.

H20 engine (RLB2220B6)	
Back gap	0.75 - 1.1 mm (0.030 - 0.043 in)
Core gap	0.9 - 1.5 mm (0.035 - 0.059 in)
Point gap	0.7 - 1.1 mm (0.028 - 0.043 in)

H30 engine (TL1Z-61G)	
Yoke gap	0.9 mm (0.035 in)
Core gap	0.8 - 1.0 mm (0.031 - 0.039 in)
Point gap	0.4 - 0.6 mm (0.016 - 0.024 in)

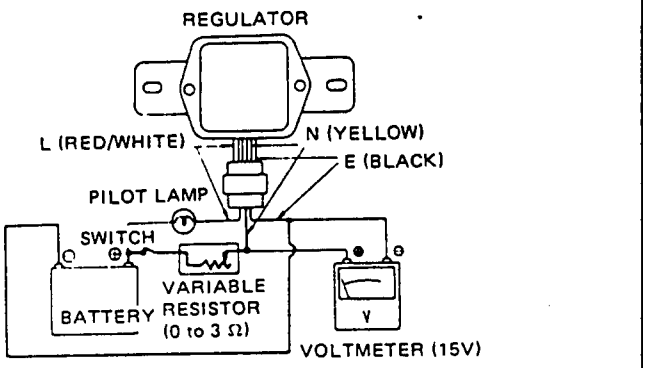
Nominal charge relay operating voltage is 3.7 - 5.7V (RLB2220B6) or 4.2 - 5.2V (TL1Z-61G) at alternator "N" terminal.

Using a battery, DC voltmeter and variable resistor, set up a circuit as shown below.

Set the variable resistor to "MAX" position, apply current (turn on the switch), and reduce resistance gradually.

When resistance is reduced to a certain level, the charge lamp goes off. This level indicates the charge relay operating voltage. The rated value is 3.7 - 5.7V (RLB2220B6) or 4.2 - 5.2V (TL1Z-61G). When outside these values, readjust.

The adjustment is carried out in the same manner as the voltage regulator.



Precautions for adjustment

1. Upon completion of adjustment, reinstall cover and make sure that regulator operates correctly.
2. When cover is removed or bending stopper is adjusted during voltage adjustment, be sure to disconnect regulator, and reconnect when making actual measurements. Otherwise battery circuit may be short-circuited.

IGNITION SYSTEM

CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

DESCRIPTION

The ignition circuit consists of the ignition switch, coil, distributor, wiring, spark plugs and battery.

The circuit is equipped with a resistor. During cranking, electrical current bypasses the resistor, thereby connecting the ignition coil directly to battery. This provides full battery voltage at coil and keeps ignition voltage as high as possible.

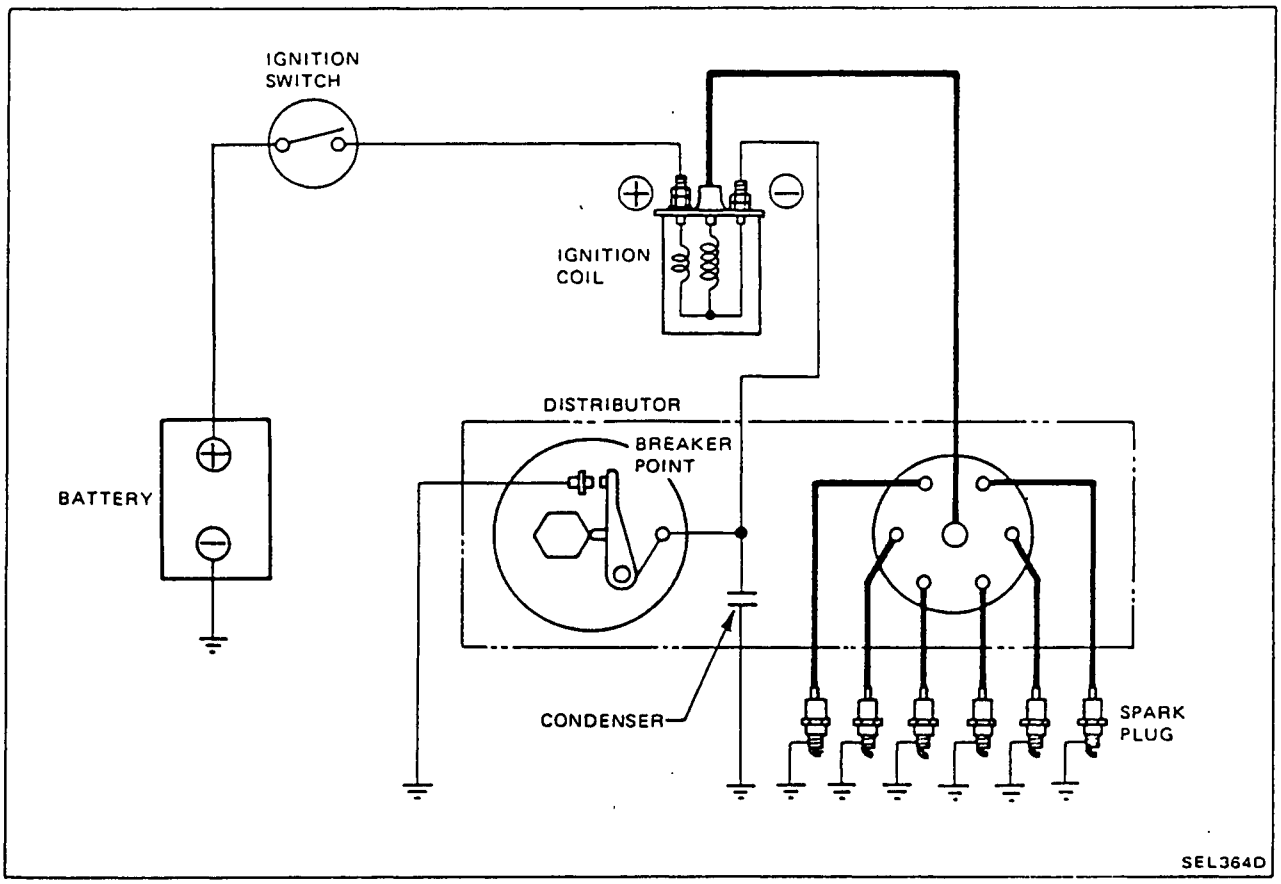
Low voltage current is supplied by the battery or alternator and flows through the primary circuit. It consists of the ignition switch, resistor, primary winding of the ignition coil, distributor contact points, condenser and all connecting low tension wiring.

High voltage current is produced by the ignition coil and flows through the secondary circuit, resulting in high voltage spark between the electrodes of the spark plugs in engine cylinders. This circuit contains the secondary winding of the ignition coil, high tension wiring, distributor rotor and cap.

When the ignition switch is turned on and the distributor contact points are closed, the primary current flows through the primary winding of the coil and through the contact points to ground.

When the contact points are opened by the revolving distributor cam, the magnetic field built up in the primary winding of the coil moves through the secondary winding of the coil inducing high voltage. The high voltage is produced every time the contact points open. The high voltage current flows through the high tension wire to the distributor cap. Then the rotor distributes the current to one of the spark plug terminals in the distributor cap.

The spark is obtained when the high voltage current jumps the gap between the insulated electrode and the ground side electrode of the spark plug. This process is repeated for each power stroke of the engine.



DISTRIBUTOR

CHECKING AND ADJUSTMENT

Cap and rotor head

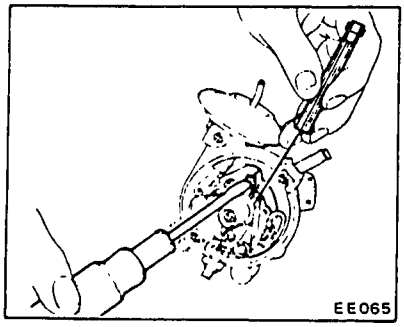
Check cap and rotor head for dust, carbon deposits and cracks.

Contact point

1. Adjust point gap.

Loosen point screw and adjust gap with a gap gauge.

Point gap:
0.45 - 0.55 mm
(0.018 - 0.022 in)

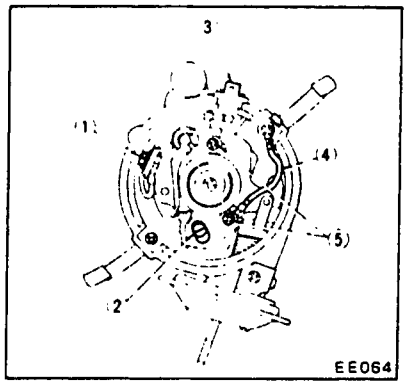


2. Check the point surface.

Take off any irregularities with fine sandpaper (No. 500 or 600) or with oil stone.

3. Removal of contact point

(1) Disconnect primary lead wire from contact set.
(2) Remove contact set fixing screws.
(3) Remove contact set.



1 Screw
2 Adjuster
3 Primary lead terminal
4 Earth lead wire
5 Set screw

Condenser

Checking of condenser is made by a capacity tester. This can also be made by a circuit tester with its range set to high resistance reading. When needle of tester swings violently and then moves back to infinite gradually, it is an indication that condenser is in good condition.

If needle shows any steady reading or if it registers zero, the likelihood is that transformer is out of order, calling for replacement.

Condenser capacity:
0.2 - 0.24 μF
Condenser insulation resistance:
More than 5MΩ

Advance mechanism

Specifications

Refer to S.D.S.

Vacuum advance mechanism mechanical parts

1. Check vacuum inlet for signs of leakage at its connection.
2. Check vacuum diaphragm for air leak.

If leak is found, replace vacuum controller assembly.

3. Inspect breaker plate for smooth moving.

If plate does not move smoothly, this condition could be due to sticky steel balls or pivot. Apply grease to steel balls or, if necessary, replace breaker plate as an assembly.

Centrifugal advance mechanical parts

When cause of engine malfunction is traced to centrifugal advance mechanical part, use distributor tester to check its characteristic.

When nothing is wrong with its characteristic, conceivable causes are break-down or abnormal wearing-out of driving part or others. So do not disassemble it.

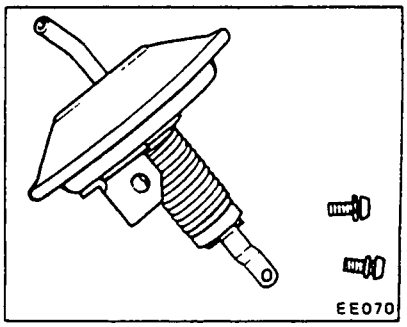
In case of improper characteristic, take off contact breaker assembly part and check closely cam assembly, governor weight, shaft and governor spring, etc.

In case centrifugal advance mechanical part is reassembled, be sure to check advance characteristic with distributor tester.

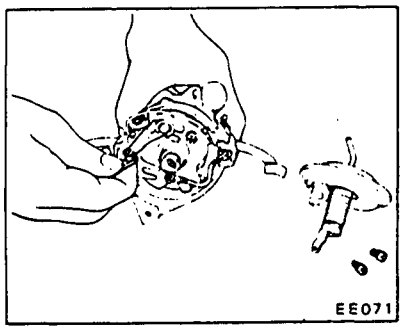
DISASSEMBLY

To disassemble, follow the procedure below.

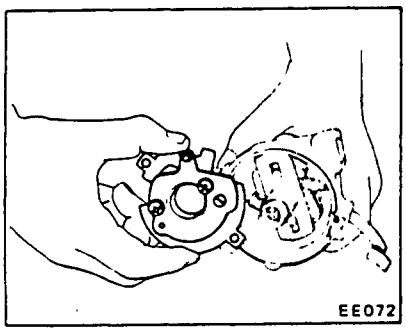
1. Take off cap and remove rotor head.
2. Remove vacuum controller.



3. Remove contact set.

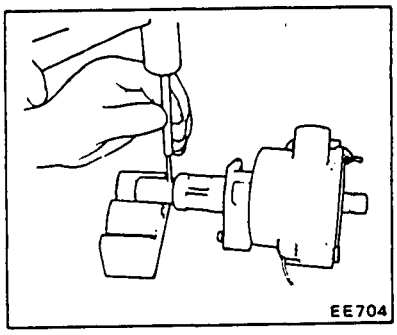


4. Remove contact breaker.

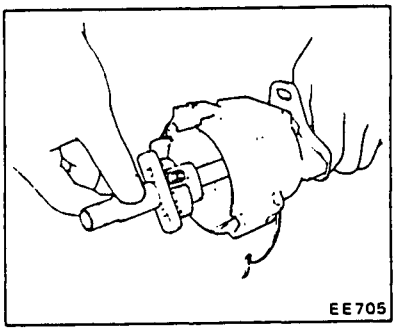


Be careful not to lose steel balls between breaker spring and breaker plate.

5. Pull knock pin out and disconnect collar.

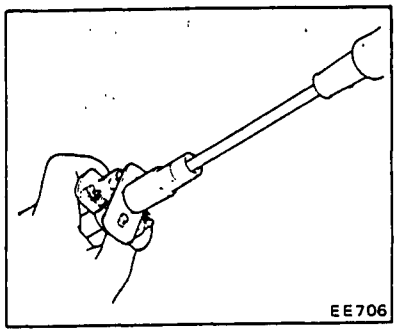


6. Remove the entire rotating parts.



7. Remove set screw at shaft head, and remove cam.

CAUTION:
Put match mark across cam and shaft so that original combination can be restored at assembly.



8. Remove governor weight and spring.

CAUTION:
Be careful not to stretch or deform governor spring.

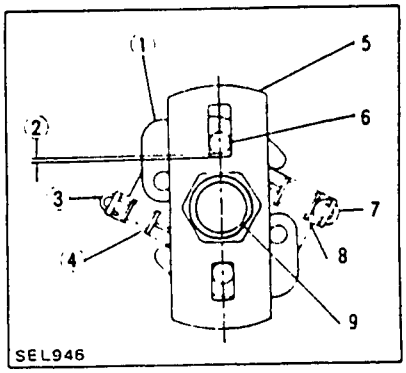
Apply grease to governor weight.

ASSEMBLY

To assemble, reverse the order of disassembly.

Carefully observe the following instructions.

1. Rotor head positioning tip at cam is set on governor spring circular hook side.
2. Weight pin for governor spring "A" with circular hook fits in long rectangular hole.
3. Check to be sure that weight pin on spring "A" is in slit in cam plate with a clearance between the two at beginning and end of governor operation. Meanwhile, weight pin on opposite side fits in short rectangular hole.
4. With unit assembled, check to be sure that driven slit and rotor positioning tip are set in the same direction.
5. Apply grease to top of cam assembly as required.
6. After assembly, check operation of governor before installing it on engine.
7. Ignition timing should be tested with unit mounted on engine.



1 Governor weight
2 Clearance for start and end of advancing angle
3 Rectangular hook
4 Governor spring (B)
5 Cam plate
6 Weight pin
7 Circular hook
8 Governor spring (A)
9 Rotor positioning tip

SERVICE DATA AND SPECIFICATIONS

STARTER MOTOR

Applied engine		H20	H30
Model		M003T21281	S114-182G
System voltage	V	12	12
No load			
Terminal voltage	V	11.5	11.5
Current	A	Less than 60	Less than 60
Revolution	rpm	More than 6,800	More than 5,000
Outer diameter of commutator	mm (in)	More than 38.2 (1.504)	More than 39 (1.54)
Minimum length of brush	mm (in)	11.5 (0.453)	12 (0.47)
Brush spring tension	N (kg, lb)	13.7 - 17.7 (1.4 - 1.8, 3.1 - 4.0)	13.7 - 17.7 (1.4 - 1.8, 3.1 - 4.0)
Clearance between bearing metal and armature shaft	mm (in)	Less than 0.2 (0.008)	Less than 0.2 (0.008)
Clearance "a" between pinion front edge and pinion stopper	mm (in)	0 - 2.0 (0 - 0.079)	0.3 - 2.5 (0.012 - 0.098)

ALTERNATOR

Applied engine		H20	H30
Model		A001T22581	LT135-17
Nominal rating	V-A	12-35	12-35
Ground polarity		Negative	Negative
Minimum revolution under no-load (When 14 volts is applied)	rpm	Less than 1,000	Less than 1,000
Hot output current	A/rpm	More than 27.5/2,500 More than 35/5,000	More than 28/2,500 More than 35/5,000
Pulley ratio		2.56	2.56
Minimum length of brush	mm (in)	8 (0.31)	7.5 (0.295)
Brush spring pressure	N (g, oz)	3.040 - 4.217 (310 - 430, 10.93 - 15.17)	2.452 - 3.432 (250 - 350, 8.82 - 12.34)
Slip ring outer diameter	mm (in)	More than 32.4 (1.276)	More than 31.0 (1.220)

VOLTAGE REGULATOR

Applied engine		H20	H30
Model		RLB2220B5	TL1Z-61G
Regulator voltage [at 20°C (68°F)] (With fully charged battery)	V	14.3 - 15.3	13.8 - 14.8
Voltage coil resistance [at 20°C (68°F)]	Ω	21.3	10.3
Rotor coil inserting resistance	Ω	10	10
Voltage coil series resistance	Ω	38	31
Smoothing resistance	Ω	10	40
Core gap	mm (in)	0.7 - 1.3 (0.028 - 0.051)	0.6 - 1.0 (0.024 - 0.039)
Point gap	mm (in)	0.3 - 0.45 (0.012 - 0.018)	0.3 - 0.4 (0.012 - 0.016)
Back gap	mm (in)	0.8 - 1.1 (0.031 - 0.043)	–
Charge relay			
Release voltage at "N" terminal	V	3.7 - 5.7	4.2 - 5.2
Voltage coil resistance	Ω	23.6	31.9
Core gap	mm (in)	0.9 - 1.5 (0.035 - 0.059)	0.8 - 1.0 (0.031 - 0.039)
Point gap	mm (in)	0.7 - 1.1 (0.028 - 0.043)	0.4 - 0.6 (0.016 - 0.024)
Back gap/Yoke gap	mm (in)	0.75 - 1.1 (0.030 - 0.043)	0.9 (0.035)

DISTRIBUTOR

Applied engine		H20	H30
Model		TVB-4K$_1$ L	D611-52K
Firing order		1-3-4-2	1-5-3-6-2-4
Rotating direction		Counter-clockwise	Counter-clockwise
Dwell angle	degree	49° - 55°	35° - 41°
Point gap	mm (in)	0.45 - 0.55 (0.018 - 0.022)	0.45 - 0.55 (0.018 - 0.022)
Cap insulation resistance	MΩ	More than 50	More than 50
Rotor head insulation resistance	MΩ	More than 50	More than 50
Cap carbon point length	mm (in)	14.5 (0.571)	12 (0.47)
Vacuum advance [Distributor degree/distributor kPa (mbar, mmHg, inHg)]		0°/20.0 (200, 150, 5.91) 11.25°/52.0 (520, 390, 15.35)	0°/13.3 (133, 100, 3.94) 7.5°/–44.0 (–440, –330, –12.99)
Centrifugal advance [Distributor degree/distributor rpm]		0°/450 11°/1,800	0°/400 11°/1,250

IGNITION COIL

Model		HPS-10F
Primary voltage	V	12
Spark gap	mm (in)	More than 7 (0.28)
Primary resistance [at 20°C (68°F)]	Ω	2.7 - 3.3
Secondary resistance [at 20°C (68°F)]	kΩ	13.5

SPARK PLUG

Size (Screw dia. x reach)	mm (in)	14 x 19 (0.55 x 0.75)
Plug gap	mm (in)	0.7 - 0.8 (0.028 - 0.031)
Tightening torque	N-m (kg-m, ft-lb)	15 - 20 (1.5 - 2.0, 11 - 14)

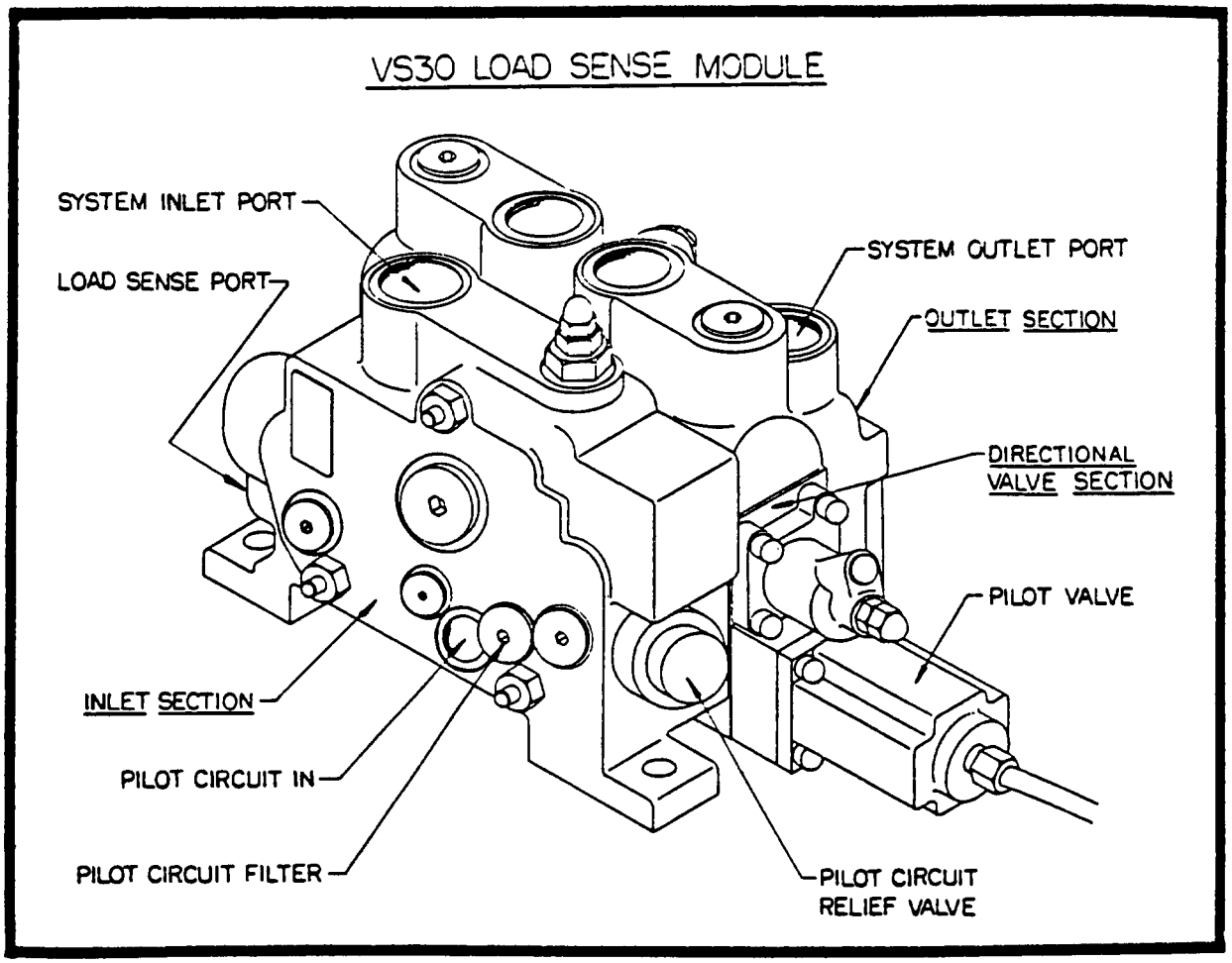
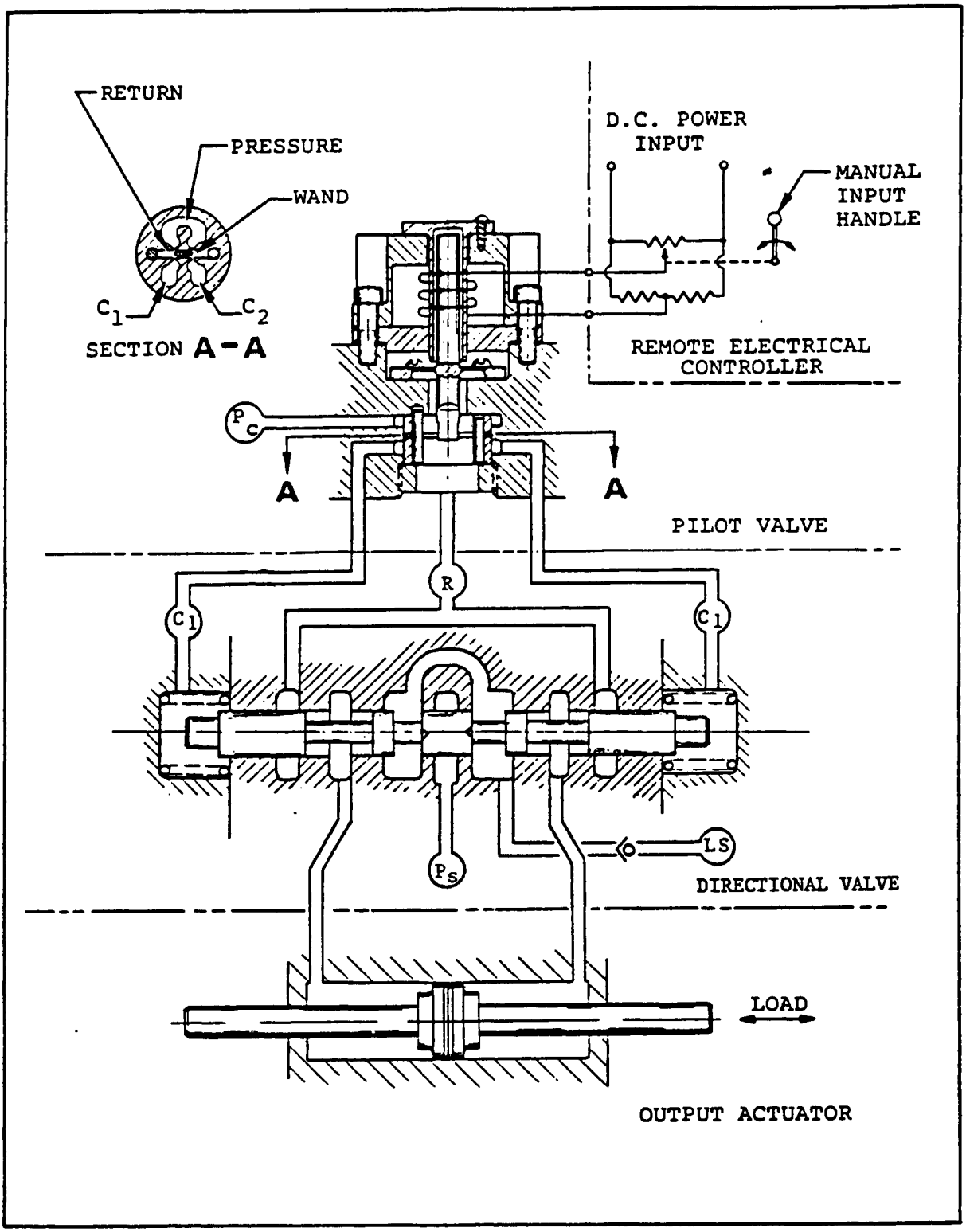


FIGURE 1

This Parker/Bertea electrohydraulic control valve is a stack configuration to provide remote control for circuits using load sense pumps. The basic module consists of an inlet manifold assembly with a load sense port, a number of directional valve section assemblies with pilot valves, plus an outlet section as shown in Figure 1.

These load sensing modules contain three separate circuits. A pilot fluid circuit to provide remote control of the directional valve spool position, a main power circuit to perform the hydraulic work and a load sensing circuit to monitor the maximum working load pressure.

The valve is designed for open loop, visual feedback control of hydraulic circuits at supply pressures up to 3000 psi and flow rates to 30 gpm. The recommended viscosity range is 50 to 2000 SUS for continuous operation. Operating ambient temperature is -30°F to 200°F.



SCHEMATIC
SINGLE FUNCTION LOAD SENSE REMOTE CONTROL VALVE
FIGURE 2

OPERATION (Figure 2)

The Bertea proportional valve control system converts a low power electrical signal (0.25 watts) into a differential hydraulic control pressure which is used to position the directional valve spool.

The control for each spool section contains three basic components as shown on Figure #12.

1. A remote electrical controller that operates on 12 VDC and provides a 0-60 ma command that is proportional to lever position.

2. An electrohydraulic pilot valve to convert this 0 to 60 ma command into a 0-240 psi differential control pressure.

3. A directional valve module to control the volume and direction of the main power system flow.

The remote controller consists of a simple potentiometer and resistors wired into a bridge network in a manner to provide a plus or minus command related to the direction of lever movement from center. Also, to provide a proportional command related to lever position or degree of lever rotation. The controller is designed to provide single or multi station control for a single pilot valve. The controller operates on 12 VDC supply and provides a 0 to 60 ma output command.

The pilot valve is an electrohydraulic device that converts this 0 to 60 ma command into a 0-240 psi differential control pressure to be used to control the position of the directional valve spool. The configuration is a pressure recovery unit with approximately 80% recovery efficiency. This means that with a 300 psi drop across the pilot valve from supply to tank, it will provide a proportional differential control pressure of 0 to 240 psi between its output cylinder ports (C_1 & C_2). The cylinder ports (C_1 & C_2) are connected to the ends of the directional valve spool.

The fluid circuit of the pilot valve is based on two jets of fluid that are formed by the supply pressure of 300 psi being converted into velocity as the fluid escapes through the supply nozzles. These two jet streams, if not interrupted, will impact into the two receivers (C_1 & C_2) where the velocity is converted back into pressure.

The command voltage from the remote controller is passed through the coil of the pilot valve. This creates a magnetic field based on the polarity of the command signal. As the command signal, and therefore the magnetic field, increases the armature is deflected and pivots on the suspension member (Figure 3 and 4). This moves the diverter blade that is located between the two jet streams (Figure 5, 6, and 7). The direction of movement is dependent upon the polarity of the command, and the degree of movement upon the magnitude of the command.

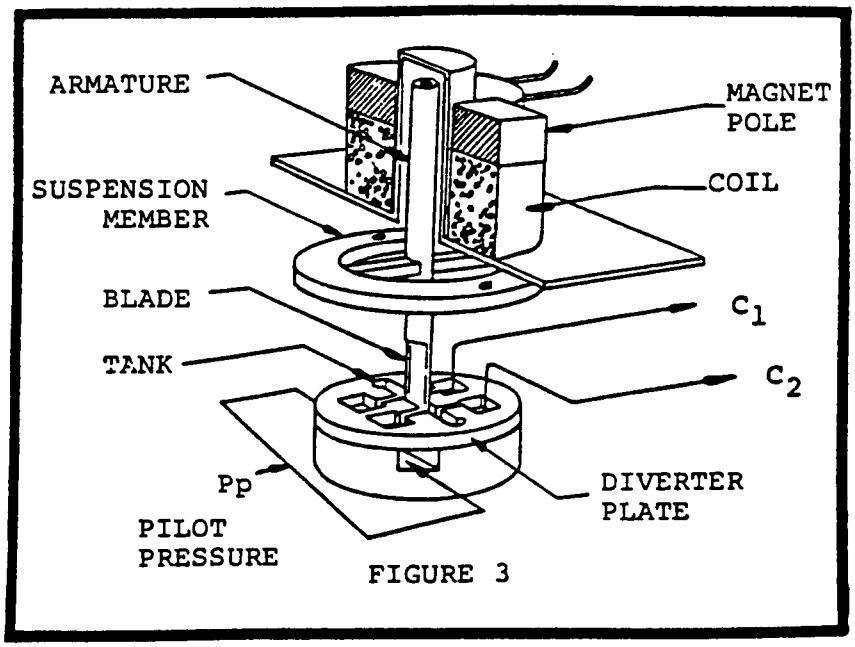


FIGURE 3

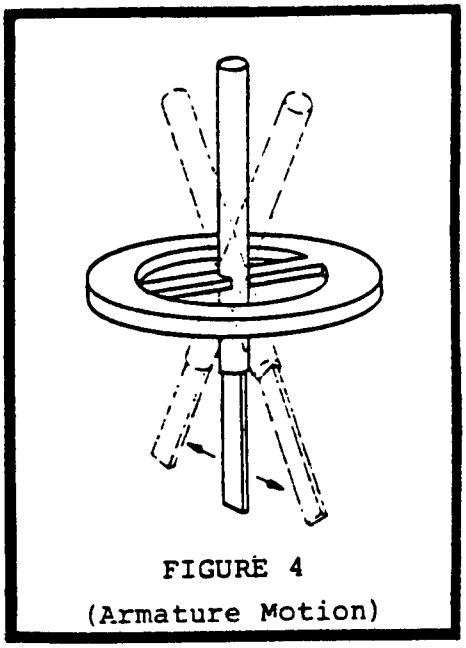


FIGURE 4
(Armature Motion)

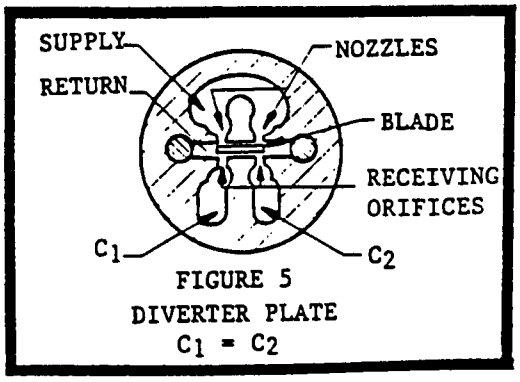


FIGURE 5
DIVERTER PLATE
$C_1 = C_2$

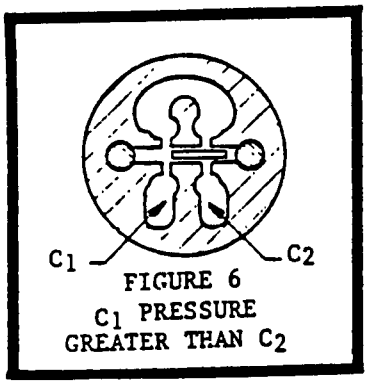


FIGURE 6
C_1 PRESSURE
GREATER THAN C_2

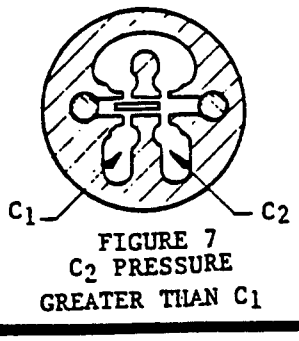


FIGURE 7
C_2 PRESSURE
GREATER THAN C_1

The center position of the blade (no command signal) partially interrupts both jets and is adjusted to provide equal pressure at C_1 and C_2 (Figure 5). This equal pressure is called the null of the valve. As the command signal is increased, the blade will interrupt one jet to a larger degree and reduce its interruption of the other jet. This generates a differential pressure between C_1 and C_2 that is proportional to input command. At maximum command, the blade completely blocks one jet and is free from the other jet.

The directional valve spool section is a modified 30 gpm, closed center, stack valve rated at 3000 psi operating pressure for a six spool section stack assembly. Each spool section is configured with high rate springs in each end cap that oppose spool movement in one direction only. Therefore, when the control pressure from the pilot valve C_1 and C_2 ports is ported to the end caps, the in-

crease in pressure in one end cap, onto the end of the spool is resisted by the spring on the oppoiste end.

As the differential pressure between C_1 and C_2 is increased by the pilot valve, in response to an increase in electrical command, the differential pressure across the spool increases, resulting in spool movement proportional to the spring rate versus pressure differential. The spool is 0.75" diameter and the springs have a 200 #/in rate. The failure modes of this configuration are safe since any loss of electrical command or control pressure results in the spool returned to the center position by a very high spring load.

The purpose of a load sensing pump is to provide variable flow and variable pressure in response to the working circuit requirements. Therefore, each spool section contains a load sense pressure pick-up circuit to be used to transmit the highest working pressure signal, in the module, to the load sense port of the pump. This pick-up port, in each spool section, is downstream of the metering notch on the directional valve spool and is isolated from both the pump supply and cylinder ports by the spool overlap when the spool is in the center position.

An additional feature provided in the spool section is a compensator spool (pressure reducing), Figure 9, that will maintain 100 psi drop across the metering notch of the directional valve spool. This is accomplished by porting controlled pressure to one end of the compensator spool and the load pressure to the other end with the spring load. This combination will provide a constant flow for any directional valve spool position, regardless of fluctuating load pressures or supply pressures. For example, the operation of a rotation function will not be affected when a lift function is added to the load demand.

The load sense logic circuit is configured to always provide the highest working pressure signal from the spool sections to be transmitted, thru the inlet section, to the load sense port of the pump. These pumps are designed to maintain an output pressure of 150 to 400 psi above the pressure signal at the load sense port. Therefore, as load pressures fluctuate, the pump pressure will always be higher by this delta pressure value.

The compensating feature in each spool section provides a pressure compensated flow control for each input command. The metering notch opening on the directional valve spool creates a fixed flow area related to spool movement. The compensator spool (i.e. - pressure reducer) varies the supply pressure to the notch, as the cylinder load varies, to always maintain a 100 psi drop across the notch. Therefore, changes in pump and/or load pressure will have minimal effect on the flow to the function. This permits simultaneous operation of multiple functions with supply from one pump.

In order to provide the desired control over as broad a flow range as possible, the spool configurations have four basic flow notches available. The ratings of 2.6, 6.5, 13 and 26 gpm are based on maximum spool stroke and 100 psi drop across the metering notch. Flows above 25 gpm require special notches.

An additional advantage of load sense systems is that the logic circuit can often be used to provide special control for specific functions. For example, single or multiple pressure limitation can be added to a function as shown on Figure 12 and as described under the installation section.

The stack valve module provides a separate hydraulic circuit for the power system fluid and a separate circuit for the pilot valve control fluid. The pilot valve control fluid circuit operates at 300 to 400 psi and at a flow related to the number of pilot valves in the stack requiring 0.6 gpm each. The advantage of this separate circuit is that it provides a means of filtering the important control system fluid at 25 micron independent of the power system fluid. In addition, it allows for a low pressure operation at 300 psi of the parasitic control system rather than at system pressure. Optional circuits to provide this flow are shown on Figure 12.

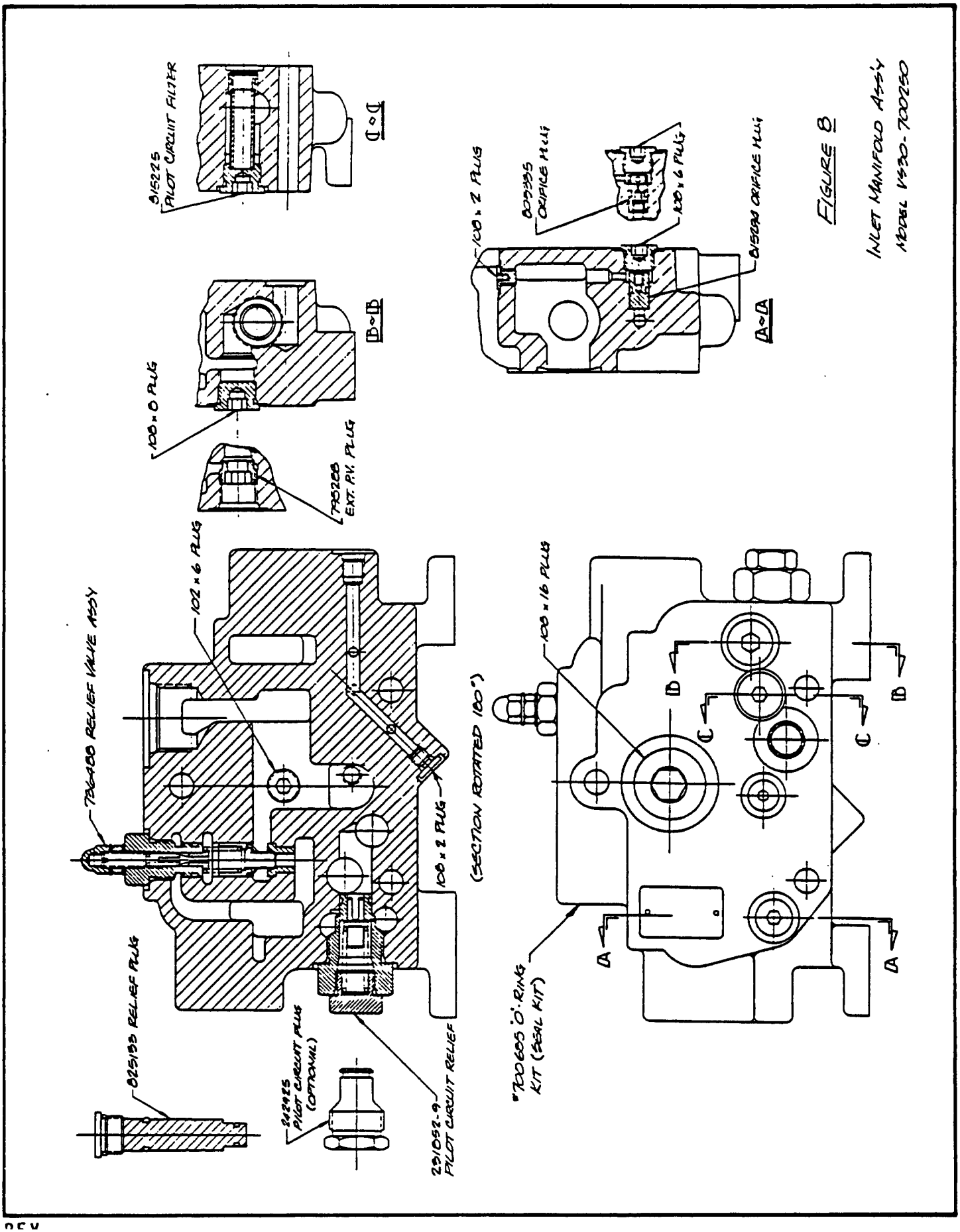
FILTRATION AND HYDRAULIC SYSTEM PREPARATION

The life of any hydraulic system is sensitive to the cleanliness of the fluid stream. It is recommended that good cleaning and flushing procedures be followed in the assembly and test of the system. The purpose of separating the control pressure fluid from the main power circuit fluid as shown on Figure 12 is to assure continuous filtration of the fluid supply to the pilot valves.

Although the minimum flow rate will be based on the number of pilot valves used, it is recommended that a filter as large as possible be used to insure long filter life.

The main power fluid circuit filtration should be 10 micron as shown on Figure 12. A suction strainer on the pump and magnetic tank unit are beneficial to filter life. A magnetic unit in the circuit is required to remove the very fine ferrous wear debris that typically is not removed by the standard filters. This debris not only acts as a lapping compound in the spool bore fit but also may be attracted into the magnetic field of the pilot valve resulting in sludge in the armature area.

A 100 micron strainer is installed into each inlet manifold (Figure 8) to provide second level protection in case of debris in tubing, etc.


INLET MANIFOLD ASSY
MODEL V430-700250
FIGURE 8
A-A
B-B
C-C
D-D
.100 x 2 PLUG
803395 ORIFICE HOUS
.120 x 6 PLUG
.0938 ORIFICE HOUS
.100 x 16 PLUG
(SECTION ROTATED 180°)
.102 x 6 PLUG
.100 x 8 PLUG
.100 x 2 PLUG
736400 RELIEF VALVE ASSY
025195 RELIEF PLUG
241925 PILOT CIRCUIT PLUG (OPTIONAL)
25/1052-9 PILOT CIRCUIT RELIEF
*700605 O-RING KIT (SEAL KIT)
785288 EXT. PIL. PLUG
.100 x 8 PLUG
3/15225 PILOT CIRCUIT FILTER

ASSEMBLY AND SERVICE

The Bertea electrohydraulic control valve module was designed for easy field service and repair. All components are interchangeable except the directional valve spools and conpensator spools as noted in the related sections.

A. Inlet Manifold Assembly (Figure 8)

The inlet manifold provides the porting for the main power fluid circuit, the pilot valve fluid circuit and the load sense port. Although, the system relief valve has an optional plug, this conversion cannot be made in the field because the seat for the relief valve is pressed into the body. All other components are field interchangeable.

Each inlet manifold assembly will normally contain the pilot circuit relief valve that is set for 300 psi differential pressure. This relief valve will provide 300 psi differential pressure across the pilot circuit regardless of tank pressure. Therefore, if the vehicle return line has 100 psi back pressure, the inlet pressure to the pilot valves will be 400 psi. An optional plug assembly is provided when required.

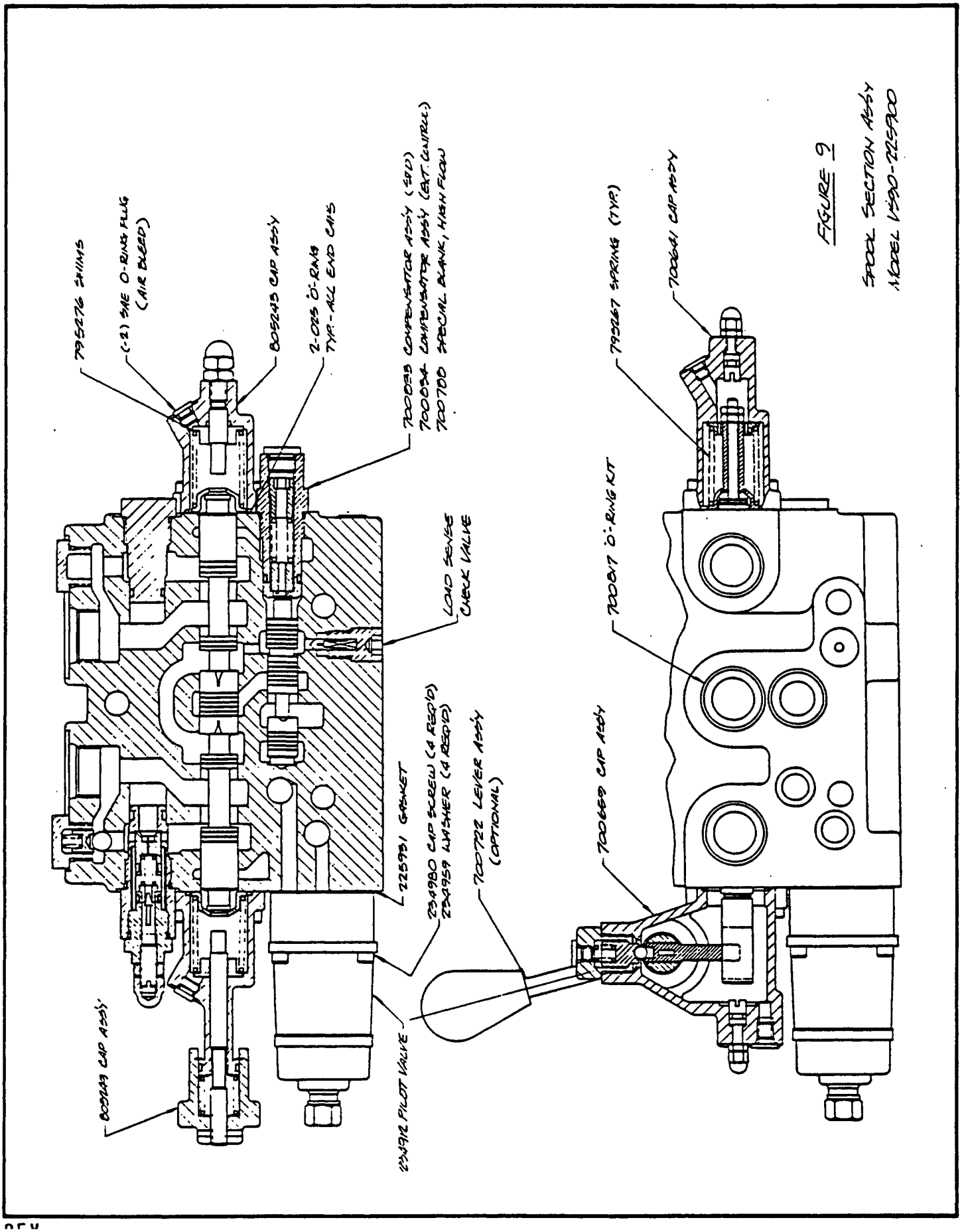
The normal pilot circuit drain configuration is to join it to the directional valve return, internal to the stack valve. If it is anticipated that the stack valve return pressure would exceed 100 psi, then a separate pilot circuit return to tank should be used. This requires removing the standard (-8) "O" ring plug from the pilot drain port in the face of the inlet manifold and installing the 795288 hollow hex sleeve into the port as shown in Figure 8. This port should then be plumbed to the tank separately.

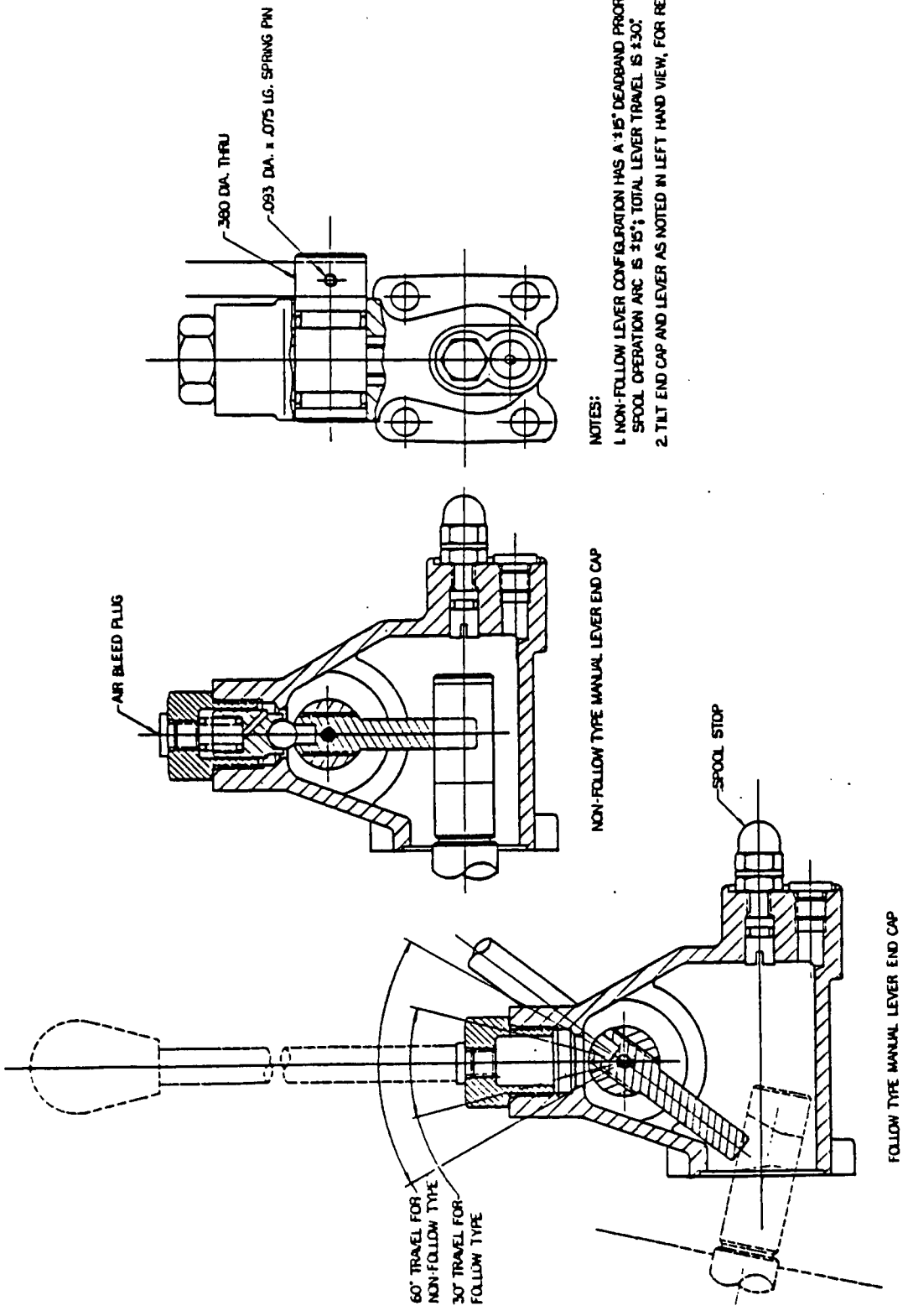
An optional bleed down orifice is provided for the load sense logic circuit. The orifice is normally required for pumps that have very low internal leakage in their control circuit. The "O" ring face seals are the same as the ones used in the directional valve section (Figure 9). Care should be taken to assure that each ring is in its respective groove when clamping the module together.

B. Directional Valve Section (Figure 9)

Each valve section consists of directional valve spool, a compensator and a pilot valve. Manually adjustable spool stops are provided in each end cap to limit the maximum flow from that spool section.

The standard end cap is the 805243 assembly, with optional Manual Override or Manual Lever configurations available.


795276 SHIMS
(-2) SAE O-RING PLUG (AIR BLEED)
800245 CAP ASSY
2-025 O-RING TYP - ALL END CAPS
700093 COMPENSATOR ASSY (STD)
700094 COMPENSATOR ASSY (EXT. CAL/REL.)
700700 SPECIAL BLANK, HIGH FLOW
LOAD SENSE CHECK VALVE
225931 GASKET
234980 CAP SCREW (4 REQ'D)
234959 WASHER (4 REQ'D)
700722 LEVER ASSY (OPTIONAL)
800243 CAP ASSY
233912 PILOT VALVE
795267 SPRING (TYP)
700641 CAP ASSY
700817 O-RING KIT
700689 CAP ASSY
FIGURE 9
SPOOL SECTION ASSY
MODEL 1290-225A00


.380 DIA. THRU
.093 DIA. x .075 LG. SPRING PIN
NOTES:
1. NON-FOLLOW LEVER CONFIGURATION HAS A ±15° DEADBAND PRIOR TO SPOOL CONTACT. SPOOL OPERATION ARC IS ±15°; TOTAL LEVER TRAVEL IS ±30°.
2. TILT END CAP AND LEVER AS NOTED IN LEFT HAND VIEW, FOR REMOVAL.
AIR BLEED PLUG
NON-FOLLOW TYPE MANUAL LEVER END CAP
SPOOL STOP
60° TRAVEL FOR NON-FOLLOW TYPE
30° TRAVEL FOR FOLLOW TYPE
FOLLOW TYPE MANUAL LEVER END CAP

The manual override assembly (805249) will provide direct manual control of the spool in the event of a failure in the remote control system. The hand knob is held in the thread disengaged position by a light spring to prevent inadvertent operation. Press the knob inward while rotating to engage the threads in the cap and drive screw. Continued rotation clockwise will provide flow from the cylinder port adjacent to this end cap.

A plug is provided, as shown, to bleed the air from each end cap after initial assembly and operation. Air trapped in the spool end cap will reduce the response of the valve assembly. The screw in the end of the cap provides an adjustable spool stop to limit maximum travel.

The manual lever end cap assembly (700659) with the single spring end cap assembly (700641) provides direct control of the spool with or without the pilot valve. The standard configuration is a non-follow type (Figure 10) which permits the pilot valve to move the spool without moving the lever. A $\pm$ 15° deadband is built into the assembly to provide this feature. The follow type provides direction connection to the spool.

Each load sensing spool section contains a spool compensator to maintain a 100 psi drop across the metering notch on the directional valve spool. The options in the compensator assembly include:

#700833 Standard Compensator

#700834 Compensator, External Control

#700788 Special Blank, High Flow

The 700834 External Control Compensator provides an external port from the spring cavity that can be used to control the load pressure of the spool section from an external source such as a relief valve. This is shown on Figure 12.

The 700788 Special Blank Compensator eliminates the compensation feature and is normally used for flows in excess of 30 gpm in order to minimize pressure drop.

Each spool section contains a load sense circuit check valve to isolate individual spool sections from higher pressure that may be in the load sense logic circuit.

C. Outlet Manifold (Figure 11)

The outlet manifold provides the function of being the end section of the stack and provides connection to the tank. Either port may be used for the tank connection.

D. Pilot Valve (Figure 14)

The pilot valve ratings include the following:

Coil	60 ohm resistance
Operating Current	60 ma
Operating Voltage	3.6 volts
Maximum Current	100 ma
Required Flow	.55 to .65 gpm at 300 gpm differential

The correct mounting orientation of the pilot valve is determined by the locating pin in the pilot valve body. Care must be exercised to assure correct matching of the gasket between the two faces.

A positive polarity of the red wire of the pilot valve will provide flow from the cylinder port on the opposite side of the spool section from the pilot valve (Cylinder Port "B").

There are no external adjustments for the pilot valve nor mechanical connections to the spool. If a problem related to the pilot valve develops, the unit should be replaced and returned to the factory.

INSTALLATION (Figure 12)

This stack valve was designed for simple installation and easy field trouble shooting. All subassemblies are interchangeable and easily replaced. With electrohydraulic control systems, the most sensitive component is the pilot valve and therefore the installation of the module should consider the accessibility of the pilot valves for easy replacement.

The valves are not sensitive to attitude and may be installed in any reasonable manner on the vehicle. Caution should be exercised to avoid placing steel tubing or magnetic material within 1.5 inches of the pilot valve as shown in Figure 13. Magnetic material will affect the flux field of the pilot valve permanent magnet and may cause a shift in the valve null position.

The 231852 pilot pressure relief valve establishes the 300 psi differential pressure for the pilot valve circuit. Only one pilot pressure relief valve is required per vehicle and therefore when two or more modules are used, this port must be closed with a 231856 plug in the extra modules. Each pilot valve requires a continuous flow of .55 to .65 gpm at 300 psi ΔP. A four spool section installation would require four times .6 gpm plus 1.0 gpm for assurance or a 3.4 gpm supply.

LOAD SENSE PUMP

A pump that has less than 400 psi standby pressure will require a circuit that permits the pump to unload during standby and also provide pilot circuit pressure (300 psi) prior to movement of the directional valve spool. The use of a pilot circuit pressure sensing line connected thru a shuttle and a 3-way normally closed solenoid valve to the load sense port of the pump will provide this feature.

During standby, the valve is closed, allowing the pump control circuit to bleed down to tank pressure and unload the pump for standby. Moving the lever of a remote electrical controller will close a switch and energize the solenoid valve to the open position. The pump load sense control port is now connected to the pilot circuit pressure requirement (300 psi) and it will provide the flow and pressure to meet this demand.

When a directional valve spool is moved into a fluid metering position, it will connect the pump load sensing line to the cylinder port through the shuttle. The pump control system will now follow this higher pressure demand.

COMPENSATED PUMPS

Since a compensated pump typically holds a high pressure during standby, the pilot circuit always has adequate pressure for operation.

LOAD SENSE VALVE MODULE (VARIABLE PUMPS)

A typical (4) spool valve module is shown in Figure 12 with the inlet and outlet manifolds. Each spool section contains a load sensing circuit with a compensator to hold 100 psi differential across the metering notch of the directional valve spool. The check valve in the load sense line of each section provides control pressure isolation for that section.

An optional feature is available to provide external load pressure limitation for individual spool sections, as shown. For example, if one function requires a maximum continuous limitation of 1000 psi, a small relief valve, set at that pressure, can be installed on the optional external load control line. The maximum pressure of the other functions will be limited by the system relief valve or pump compensator setting.

If a dual pressure limitation is desired, a solenoid valve can be used on the external line as shown. One mode of operation would be limited by the system relief valve and the second mode by the relief valve on the external load control line. Logically, multiple relief valves can be used if required.

TROUBLE SHOOTING

The modular design of the valve provides simple field trouble shooting and service. The first step should be to isolate the problem to a specific component if possible. For example, change the remote controller leads from one pilot valve to another to check if the problem follows the remote controller.

The same procedure can then be used to check the pilot valves by interchanging two units. Care should be taken to avoid introducing dirt into the system when removing pilot valves.

The pilot valve converts an electrical input signal of 0 to 3.6 volts into a pressure unbalance across the directional valve spool. At the factory setting of 300 psi differential pressure across the pilot valve, the directional valve spool deadband will be a minimum of 20%. Increasing the differential pressure across the pilot valve will reduce the deadband significantly.

Control problems are usually either electrical, hydraulic, or mechanical.

ELECTRICAL PROBLEMS

1. Use a voltmeter to check for zero command and a maximum command of 3.6 volts. When controller lever is in the center position, the output command should be zero.

2. Disconnect the wires from the pilot valve with 300 psi at the pilot circuit. If function operates replace pilot valve.

HYDRAULIC PROBLEMS

A very important requirement in load sense circuits is that the load sense pump must provide at least 400 psi when the directional valve spool begins to move. This will assure a continuous 300 psi to the pilot circuit during the initial metering (see - Load Sense Pump on page 14).

1. Poor Metering Control

   This can be caused by the use of a directional valve spool with a metering notch that is too large. For example, a 30 gpm notch where a 8 gpm should be used.

   When the standby pump pressure is less than 400 psi, resulting in less than 300 psi pilot circuit pressure, the initial load sense signal from the cylinder port will cause both the pump and pilot circuit pressure to jump up. This results in additional spool movement for the same command.

TROUBLE SHOOTING CHART

POTENTIAL TROUBLE	PROBABLE CAUSE	REMEDY
Control valve does not respond to command.	1. Controller does not provide signal (60 ma max reqd).	1. Replace controller.
	2. Open wire in control cable.	2. Replace cable.
	3. Shorted Terminal connection.	3. Check for terminal end contacting case or poor clamping of wire ends on terminal strip.
	4. Failed pilot valve.	4. Replace pilot valve.
	5. Jammed spool.	5. Remove end cap and check spool freedom.
High null bias (Actuator drifts or hydraulic motor slowly rotates when controller returns to neutral).	1. Failed controller resulting in a command at neutral position.	1. Replace controller.
	2. Failed pilot valve.	2. Replace pilot valve.
	3. Sticking spool due to contamination.	3. Remove end cap and check spool freedom.
Low flow rate from cylinder port, motor turns slowly or cylinder moves slowly at maximum command.	Directional valve spool is not traveling far enough.	
	1. Caused by low pressure gain of pilot valve.	1. Check filter in the inlet section for plugging.
	2. Caused by low control pressure supply.	2. Replace pressure regulator if necessary.
	3. Plugged pilot valve.	3. Change pilot valve.
Poor response, function shuts off slowly when command is removed.	1. Restricted tank return line.	1. Check for restrictions in tank return line.
	2. Low spool spring preload.	2. Check for correct spring and shims in end caps.
	3. Sticking spool due to contamination.	3. Remove end cap and check spool freedom.
	4. Air in end caps.	4. Bleed air from end caps.

Slow response by the pump to increase output pressure above the working cylinder pressure will cause a jerk in the operation. This can be checked by comparing the pressure at a gauge in the load sense line with a gauge in the pump output line. These readings should maintain a constant differential during spool operation.

2. LOW FUNCTION SPEED

Low function speed at maximum command may be caused by low pump pressure differential over the working cylinder pressure. The pump pressure should be a minimum of 200 psi over the working cylinder pressure in order to accommodate the 100 psi drop across the spool metering notch plus other circuit losses.

If the pilot circuit pressure is low or if contamination is restricting the flow thru the filters or pilot valve, the control circuit may not generate enough pressure in the spool end cap to move the spool full stroke. Check for inlet filter contamination and/or replace the pilot valve.

3. NULL SHIFT

If the function continues to operate after removal of the input command the problem could be a null shift in the pilot valve or center position of the controller. Check the controller by removing the wires from the pilot valve with 300 psi in the pilot circuit. If the problem continues, remove the 300 psi in the pilot circuit while the main power circuit is still operating. If this stops the function, it would indicate that the pilot valve is providing output differential pressure without an input command (ie - null shift).

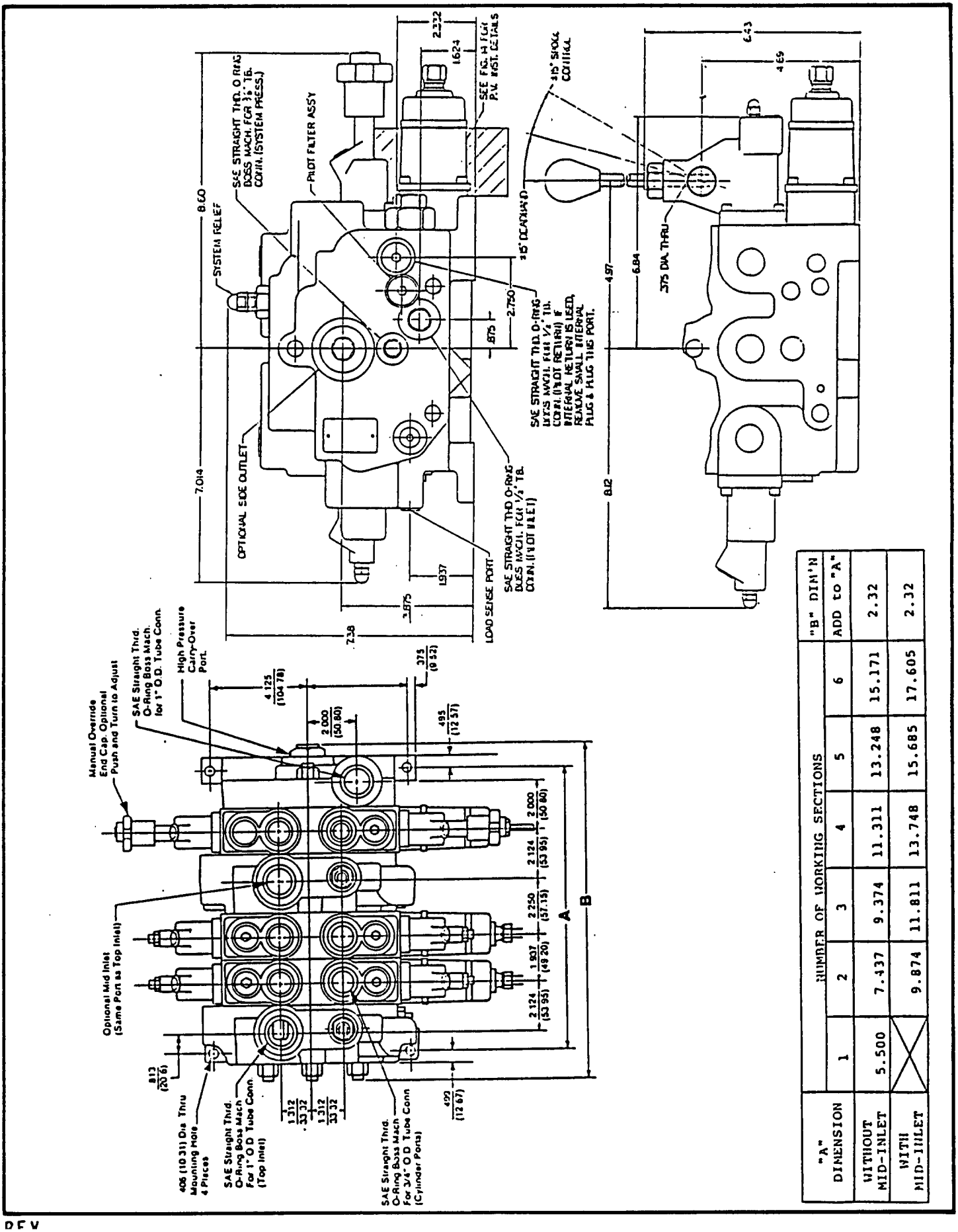
A null shift is quite often caused by contamination in the nozzles. These pilot valves are easily replaced and should be returned to Bertea for clean up. The control system filter and the filter in the inlet manifold should be checked for plugging or failure.

4. ENGINE START MOTION

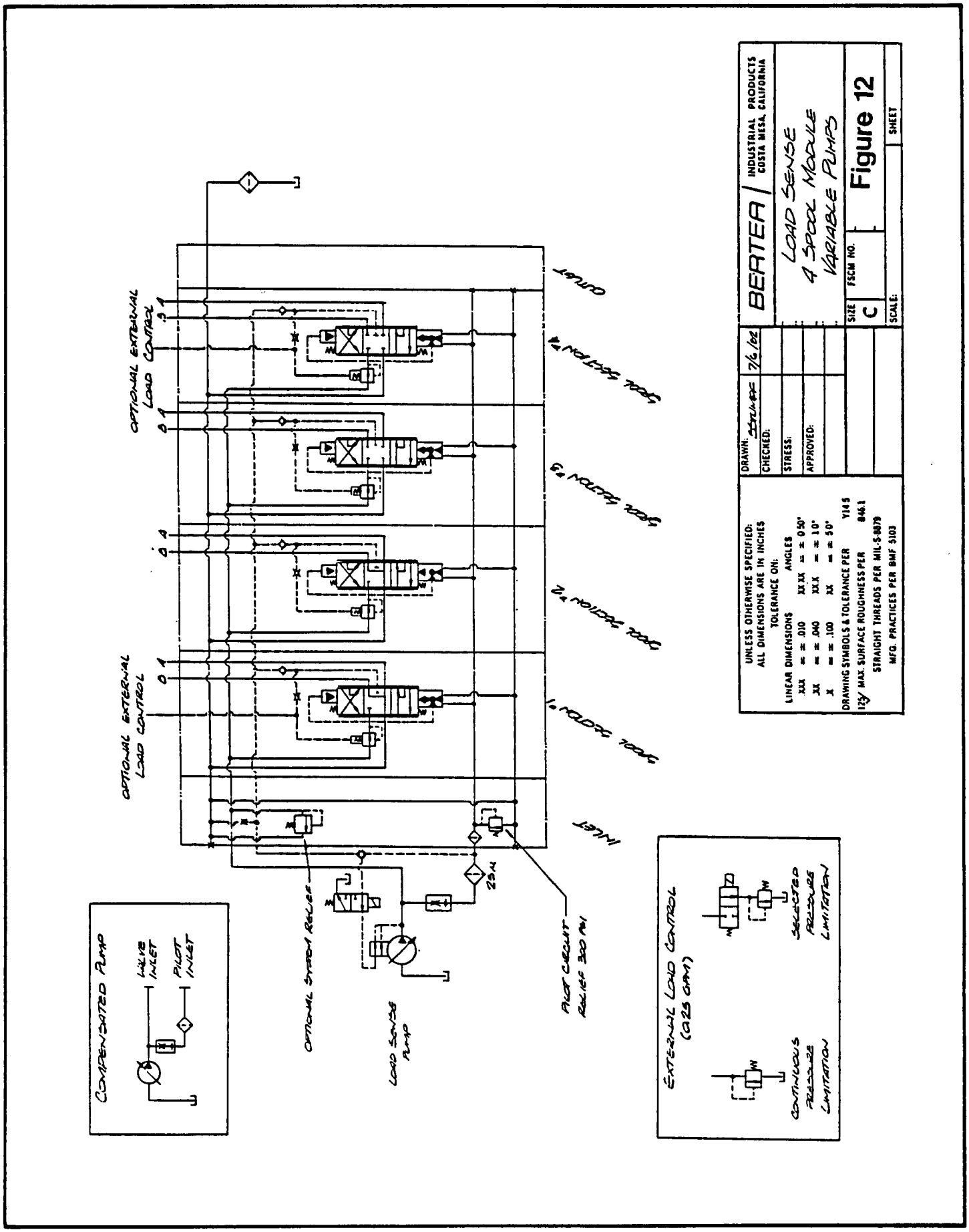
Unwanted motions that occur during engine start are usually caused by air in the spool end caps. Each cap has an air bleed plug that should be used while the pilot circuit is operating at 300 psi.

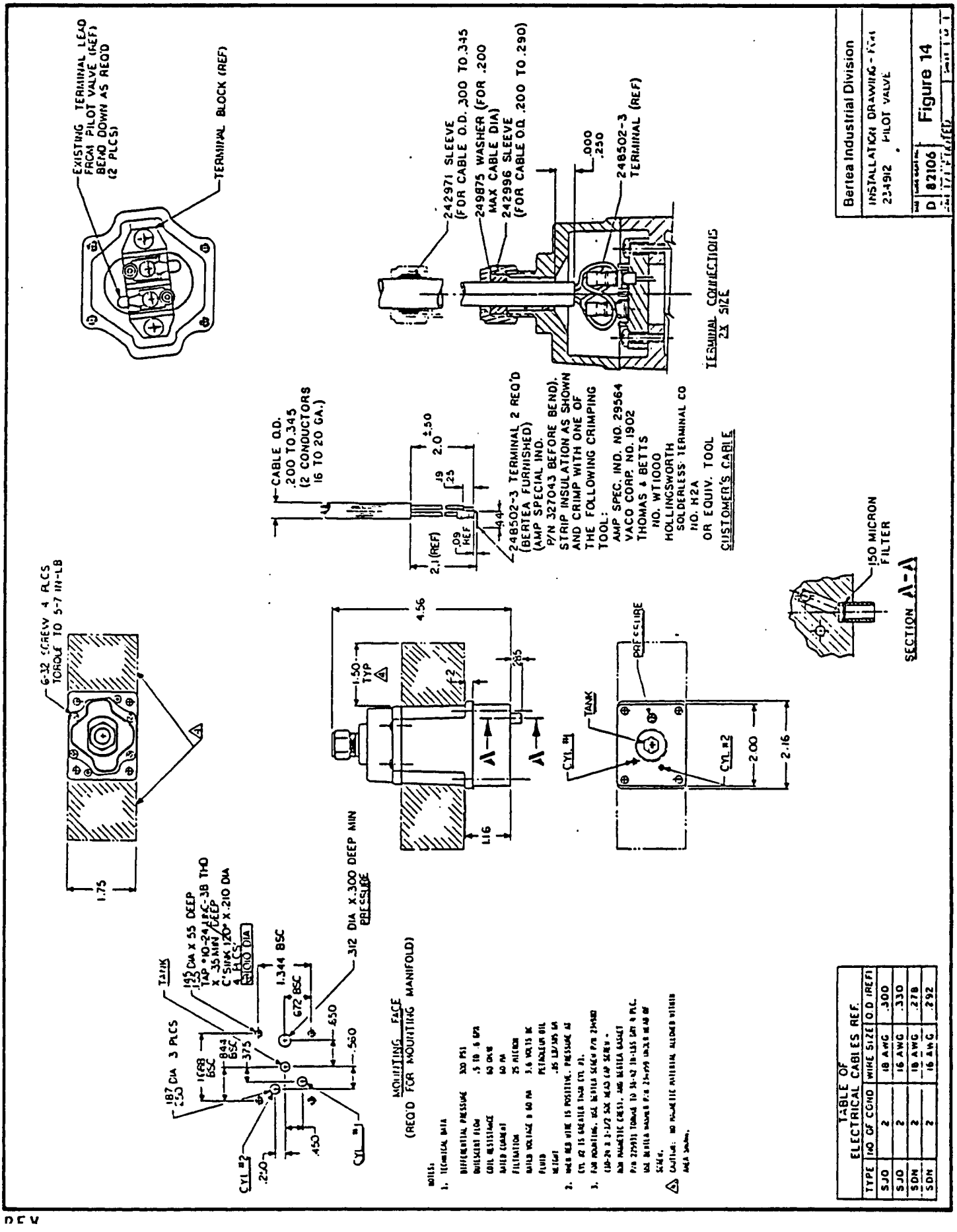
The electromechanical operation of the pilot valve can be checked by removing the valve and observing the motion of the end of the diverter blade while moving the remote control lever. The end of the blade is visible in the center slot of the gasket face of the valve.

Mechanical failure, such as a broken part or mechanical null shift, can be checked by replacing the pilot valve.

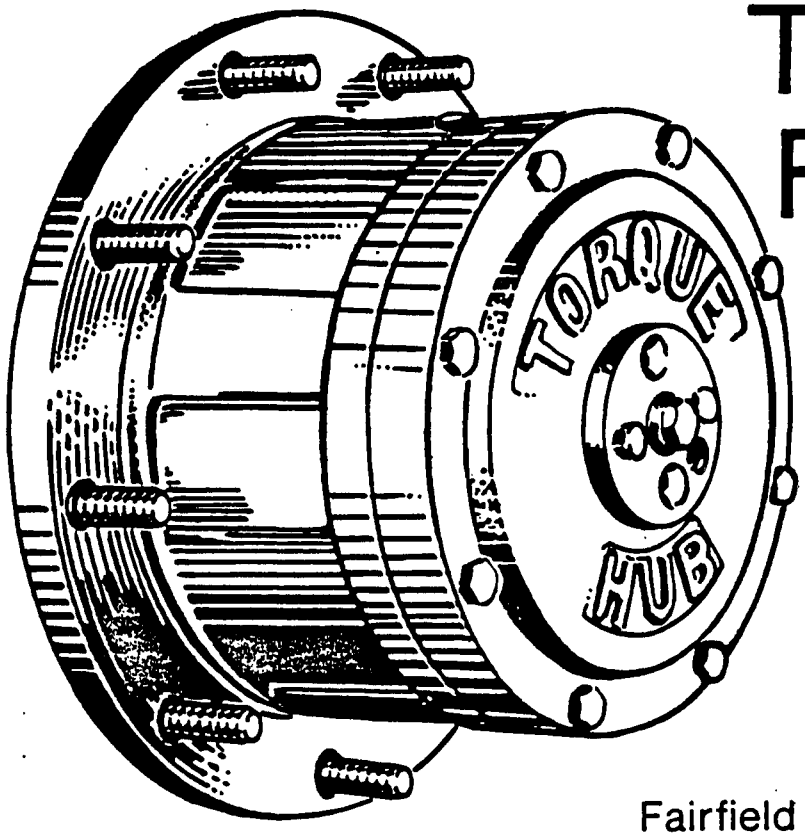


"A" DIMENSION	NUMBER OF WORKING SECTIONS						"B" DIM'N
	1	2	3	4	5	6	ADD to "A"
WITHOUT MID-INLET	5.500	7.437	9.374	11.311	13.248	15.171	2.32
WITH MID-INLET	X	9.874	11.811	13.748	15.685	17.605	2.32


OPTIONAL EXTERNAL LOAD CONTROL
OPTIONAL EXTERNAL LOAD CONTROL
INLET
OPTIONAL SYSTEM RELIEF
LOAD SENSE PUMP
PILOT CIRCUIT RELIEF 300 PSI
COMPENSATED PUMP
VALVE INLET
PILOT INLET
EXTERNAL LOAD CONTROL (GPM)
CONTINUOUS PRESSURE LIMITATION
SELECTED PRESSURE LIMITATION
UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE IN INCHES
TOLERANCE ON:
LINEAR DIMENSIONS ANGLES
XXX ± ± .010 XX XX ± ± 0.50°
XX ± ± .040 XX.X ± ± 1.0°
X ± ± .100 XX ± ± 5.0°
DRAWING SYMBOLS & TOLERANCE PER Y14.5
125 MAX. SURFACE ROUGHNESS PER B46.1
STRAIGHT THREADS PER MIL-S-8879
MFG. PRACTICES PER BMF 5103
DRAWN:
CHECKED:
STRESS:
APPROVED:
7/6/82
BERTEA | INDUSTRIAL PRODUCTS COSTA MESA, CALIFORNIA
LOAD SENSE
4 SPOOL MODULE
VARIABLE PUMPS
SIZE C
FSCM NO.
SCALE:
SHEET
Figure 12


Bertea Industrial Division
INSTALLATION DRAWING - Pilot Valve
234912
D 82106
Figure 14
EXISTING TERMINAL LEAD FROM PILOT VALVE (REF) BEND DOWN AS REQD (2 PLCS)
TERMINAL BLOCK (REF)
242971 SLEEVE (FOR CABLE O.D. .300 TO .345
249875 WASHER (FOR .200 MAX CABLE DIA)
242996 SLEEVE (FOR CABLE O.D. .200 TO .290)
248502-3 TERMINAL (REF)
TERMINAL CONNECTIONS 2X SIZE
CABLE O.D. .200 TO .345 (2 CONDUCTORS 16 TO 20 GA.)
248502-3 TERMINAL 2 REQ'D (BERTEA FURNISHED) (AMP SPECIAL IND. P/N 327043 BEFORE BEND). STRIP INSULATION AS SHOWN AND CRIMP WITH ONE OF THE FOLLOWING CRIMPING TOOL:
AMP SPEC. IND. NO. 29564
VACO CORP. NO. 1902
THOMAS & BETTS NO. WT1000
HOLLINGSWORTH SOLDERLESS TERMINAL CO NO. H2A
OR EQUIV. TOOL
CUSTOMER'S CABLE
150 MICRON FILTER
SECTION A1-A1
6-32 SCREW 4 PLCS TORQUE TO 5-7 IN-LB
1.75
TANK
CYL #1
CYL #2
PRESSURE
1.50 TYP
4.56
2.85
1.16
2.00
2.16
.312 DIA X .300 DEEP MIN
MOUNTING FACE (REQ'D FOR MOUNTING MANIFOLD)
1.344 BSC
.672 BSC
.650
.560
.450
.220
.375
.843 BSC
1.688 BSC
.187 DIA 3 PLCS
.250
.145 DIA X .55 DEEP TAP #10-24 UNC-3B THD X .35 MIN DEEP C'SINK 120° X .210 DIA 4 PLCS
.250 DIA
NOTES:
1. TECHNICAL DATA
DIFFERENTIAL PRESSURE 300 PSI
BURST PRESSURE 5.10 - 6 GPM
COIL RESISTANCE 60 OHMS
RATED CURRENT 60 MA
FILTRATION 25 MICRON
RATED VOLTAGE @ 60 MA 3.6 VOLTS DC
FLUID PETROLEUM OIL
WEIGHT .25 LBS/KG GA
2. WIRE LEAD WIRE IS POSITIVE. PRESSURE AT CYL #2 IS GREATER THAN CYL #1.
3. FOR MOUNTING, USE BERTEA SCREW P/N 234502 (10-24 X 1-1/2 SOC HEAD CAP SCREW) FOR MAGNETIC CASES, AND BERTEA GASKET P/N 229911 THREAD TO 34-42 IN-LBS (AT 5 PLCS. USE BERTEA WASHER P/N 234999 UNDER HEAD OF SCREW.
4. CAUTION: NO MAGNETIC MATERIAL ALLOWED WITHIN AREA SHOWN.
TABLE OF ELECTRICAL CABLES REF.
TYPE | NO OF COND | WIRE SIZE | O.D. (REF)
SJO | 2 | 18 AWG | .300
SJO | 2 | 16 AWG | .330
SDN | 2 | 18 AWG | .278
SDN | 2 | 16 AWG | .292

Service Manual Torque-Hub® Final Drives



Fairfield Manufacturing Company, Inc.
South Concord Road, Lafayette, Indiana 47902, U.S.A. 317/474-3474

This Service Manual is a step-by-step guide designed for the customer or shop mechanic who is servicing or repairing a particular model of Torque-Hub Final Drive. (The model covered by this copy of the Manual is specified on the Manual cover.)

Included are —

1. assembly and exploded view drawings
2. disassembly procedure
3. main assembly procedure (assuming all sub-assemblies to be intact)
4. sub-assembly procedures.

At the time of printing, this Manual was complete for the specific Torque-Hub model designated. However, Fairfield Manufacturing Co., Inc., reserves the right to update and improve its products at any time. All specifications and procedures are therefore subject to change without notice.

Safety

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn; heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see a caution symbol (⚠). This symbol indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

W3B-W3C Disassembly Procedure

1. Loosen all 12 Cover Bolts and drain the oil from the unit.

2. Remove the 12 Cover Bolts and lift off the Cover Sub-Assembly. Discard the 'O' ring Seal from the Cover counterbore.

3. Lift out the Carrier Sub-Assembly and *Thrust Bearing Set. A Thrust Washer may stick inside the Cover.

4. Pry the Ring Gear loose and remove it. Discard the 'O' ring Seal from the Hub counterbore.

5. Remove the Input Shaft, Input Gear, and the Thrust Spacers that are on the Input Shaft.

6. Lift out the Internal Gear and Thrust *Bearing Set. A Thrust Washer may stick to the bottom of the Carrier.

7. Remove the Retaining Ring from the Spindle and discard; then lift the hub off the Spindle.
   Eye protection should be worn during Retaining Ring removal.

8. The inside Bearing Cone and the Bearing Shim can now be removed.

9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

   Note: If bearing replacement is necessary, the Bearing Cups can be removed with a "slide hammer puller" or driven out with a punch.

10. To remove the Cluster Gears from the Carrier, drive the anti-roll pin into the Planet Shaft of the Cluster Gear. After the Planet Shaft is removed the roll pin should be driven out of the Planet Shaft.

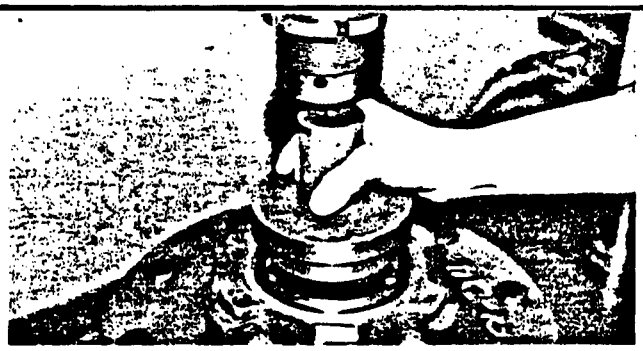
WARNING: When rebuilding the unit, the 'O' rings and Retaining Rings should <u>always</u> be replaced.

Main Assembly Procedure



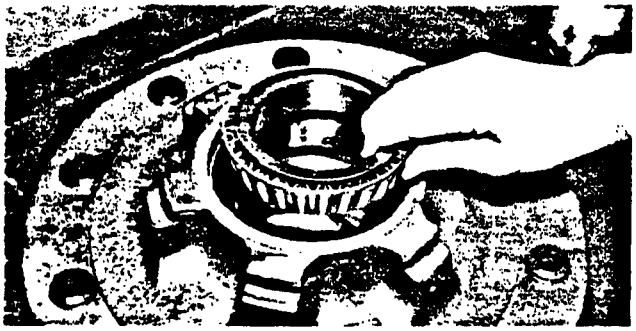
1. Using an arbor type press if available, (if not, a hammer may be used), install the wheel studs. The hub flange should be supported from the underside during this operation.

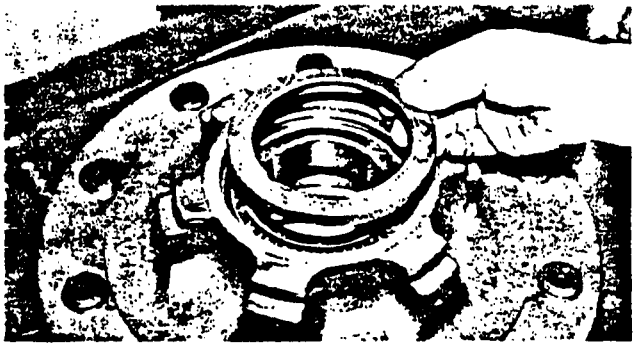
   Note: Wheel studs are optional.



2. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JM716610 will go into small end of Hub, and Cup #JM515610 will go into large end of Hub.

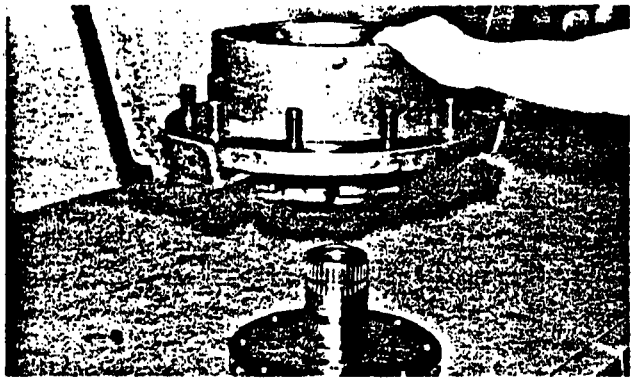
3. Place Bearing cone #JM716649 into Bearing Cup in small end of Hub.

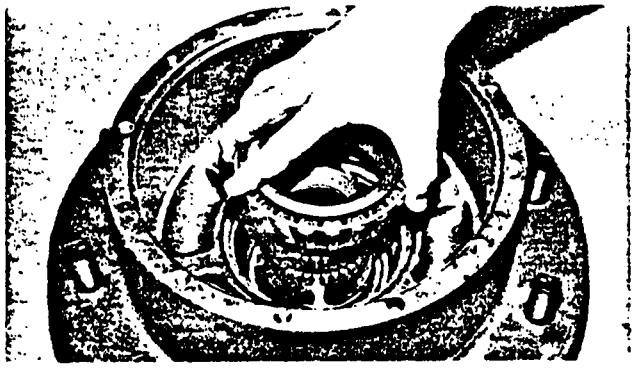




4. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.

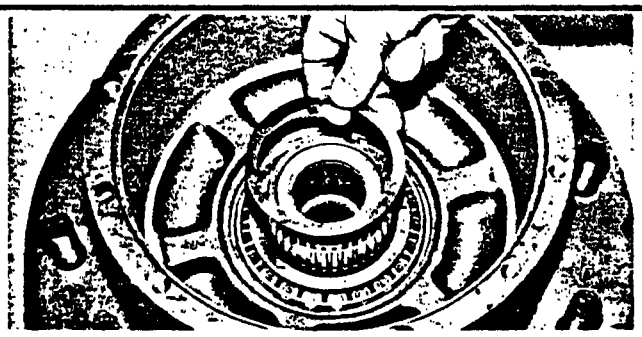
5. Lower Hub onto Spindle with large open end up.

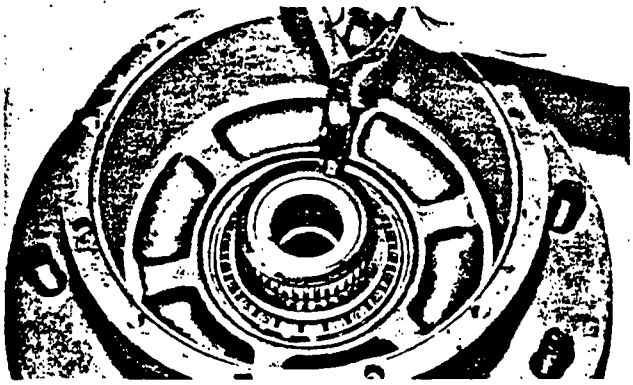




6. Place Bearing cone #JM515649 over end of Spindle and into Bearing Cone.

7. Place Bearing Shim over end of Spindle and against Bearing Cone.

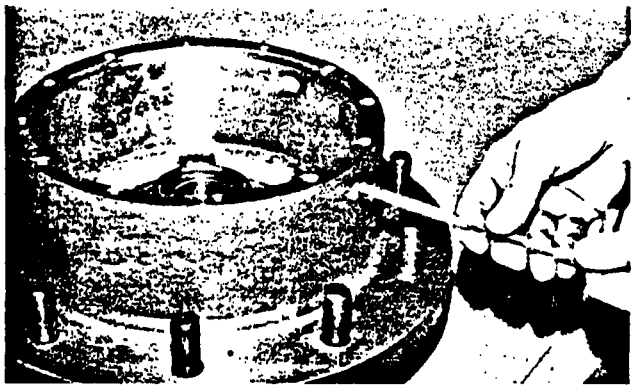




8. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

⚠ Eye protection should be worn during Retaining Ring installation.

9. The pipe plugs are installed in the Hub. The use of lub-seal is recommended on the pipe plug.

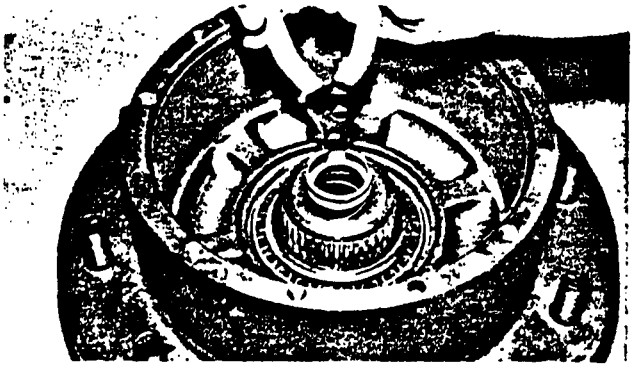


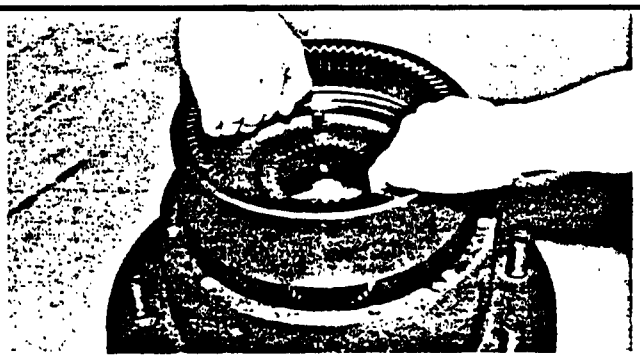


10. The disengage spacer and spring are installed into the co'bore of the Spindle.

11. Another spacer and the correct Retaining Ring are installed into the Spindle co'bore and Retaining Ring groove provided.

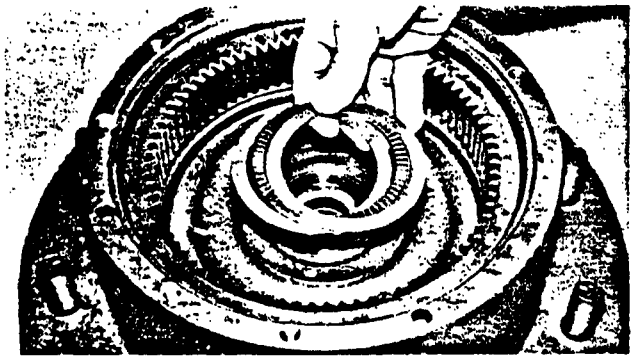
⚠ Eye protection should be worn during Retaining Ring installation.

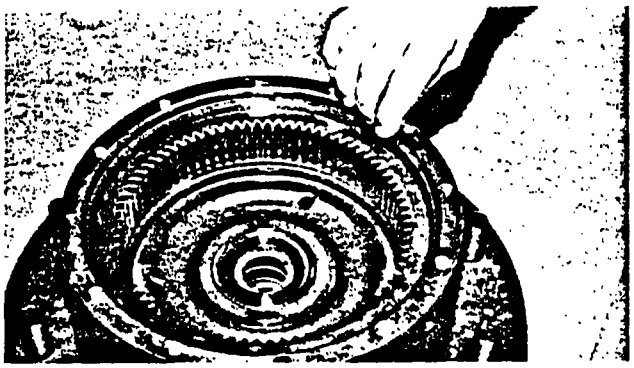




12. The internal gear is installed matching the Bore Spline to the Spindle Spline.

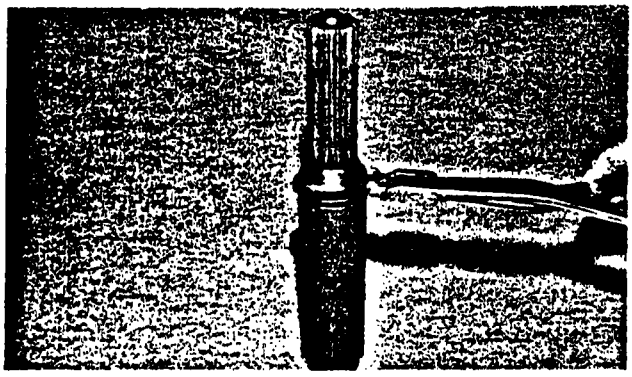
13. The thrust washer/thrust bearing set is installed on the portion of the Spindle which extends into the internal gear.

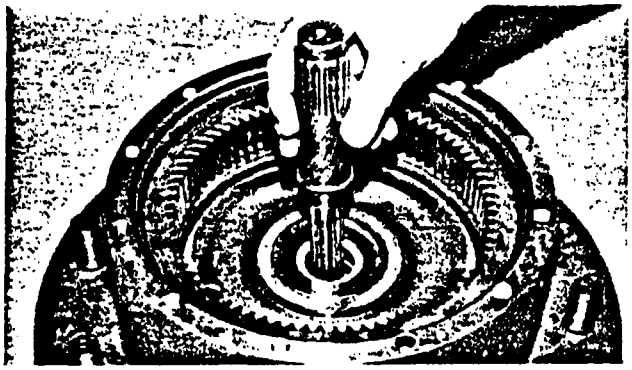




14. The O'Ring is placed into the counterbore provided in the Hub. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.

15. Install retaining ring into input shaft retaining ring groove.

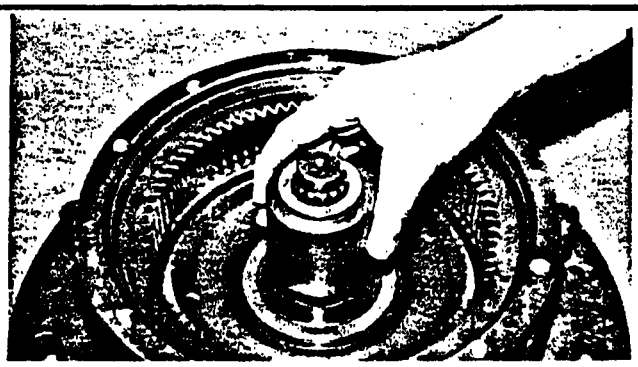


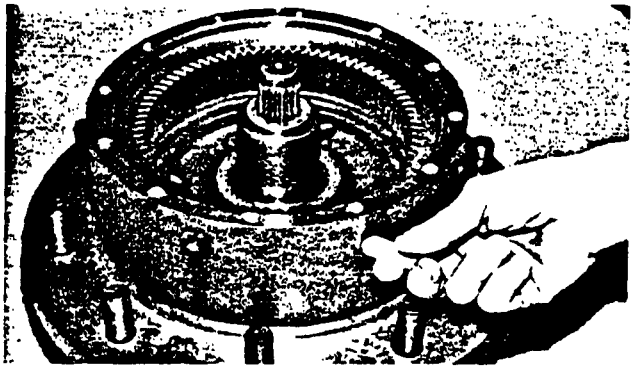


16. The input shaft is installed into the spindle.

The action of the spring should be checked at this point.

17. The thrust spacer is installed on the input shaft.

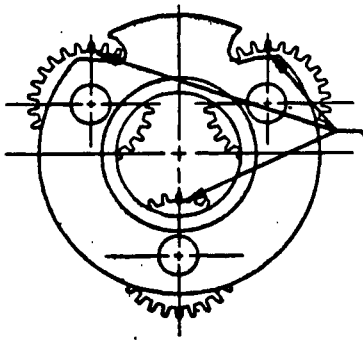




18. Locating the four counter reamed holes in the face of the hub, mark them for later identification.

These holes are reamed to accept the shoulder bolts.

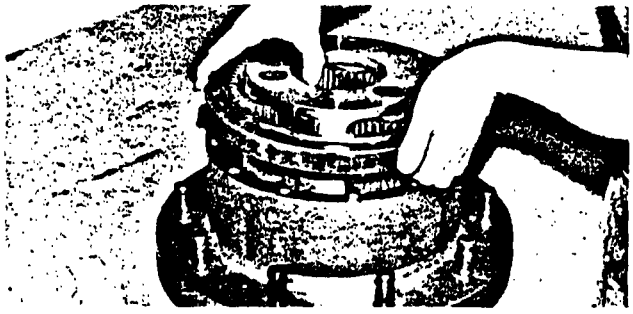
19. Place Carrier Assembly on a flat surface with the large gears up and positioned as shown. Find the punch marked tooth on each large gear and locate at 12 o'clock (straight-up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears.



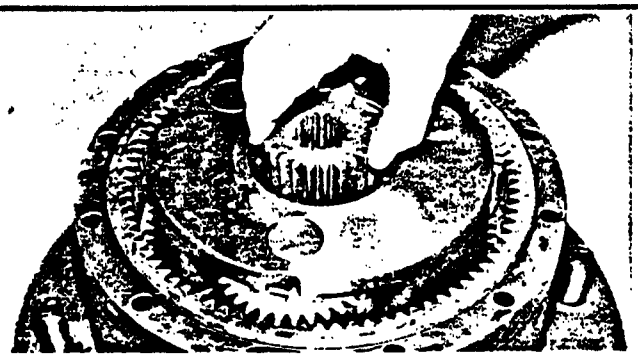


20. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation. The side of the Ring Gear with an "X" stamped on it should be up.

21. While holding Ring Gear and Cluster Gears in mesh, place small side of Cluster Gears into mesh with the Internal Gear. On the Ring Gear locate the hole marked "X" over one of the marked counterbored holes in Hub.



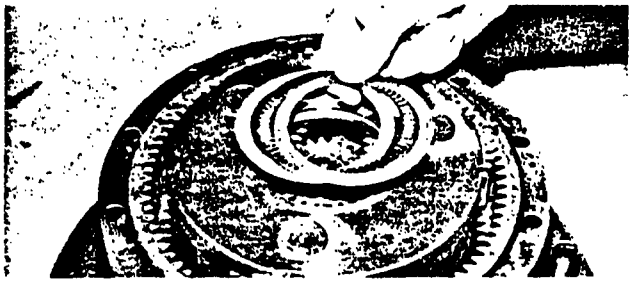
Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.



22. The Input Gear is installed into this assembly meshing with the larger diameter Cluster Gear. The counterbored side of the Input Gear is installed down or to the inside of the unit.

23. After inserting at least one Shoulder Bolt in the proper location, rotate the Carrier. This is to check freedom of rotation and recheck the timing.





24. Another thrust washer/thrust bearing set is now installed into the counterbore in the face of the carrier.

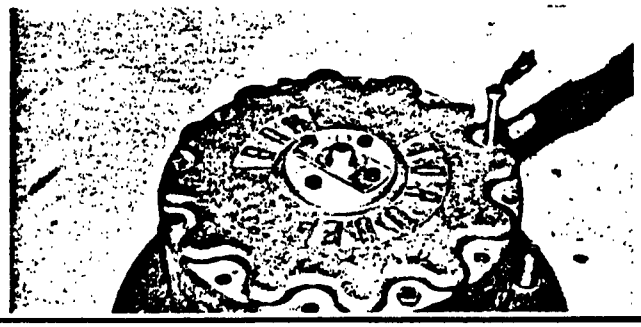
25. Place O'Ring into cover assembly counterbore. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.

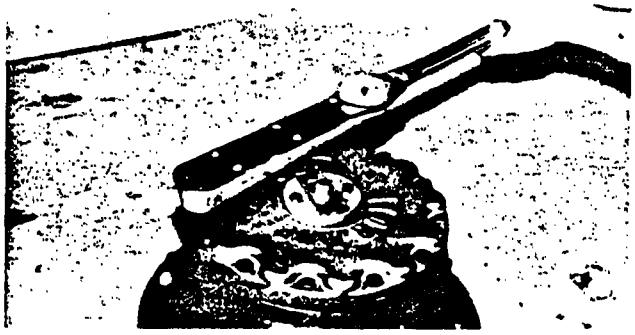




26. Place cover assembly on Ring Gear with oil level, check plug in cover located approximately 90° from oil fill plug in Hub.

27. Locate four shoulder bolts 90° apart into counterbored hole in Hub which were marked in step 17. Torque each bolt to 47 ft. lbs.

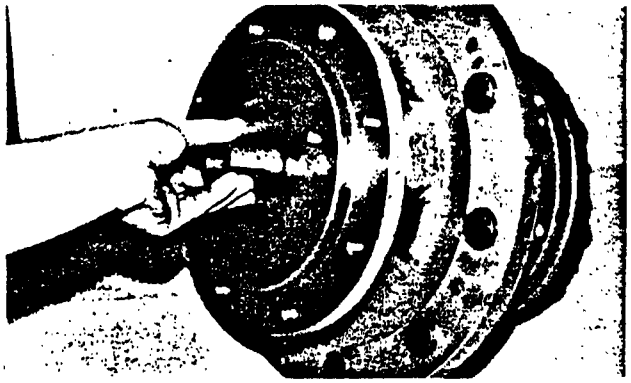




28. Install grade eight bolts into the remaining eight holes and torque all bolts to 47 ft. lbs. Use the 180° to 90° method in torqueing all bolts.

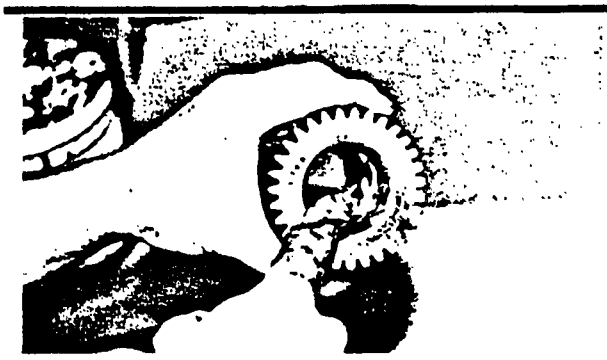
29. Place Coupling into the Spindle and onto the Input Shaft.

Note: W3C units must have one external and one internal Snap Ring installed. All units with a "X" on the end of the model number must have two internal Snap Rings with a spacer between them installed in the Coupling.



This completes the assembly. The unit must be filled one-half full of EP 90 lubricant before operation.

Carrier Sub-Assembly

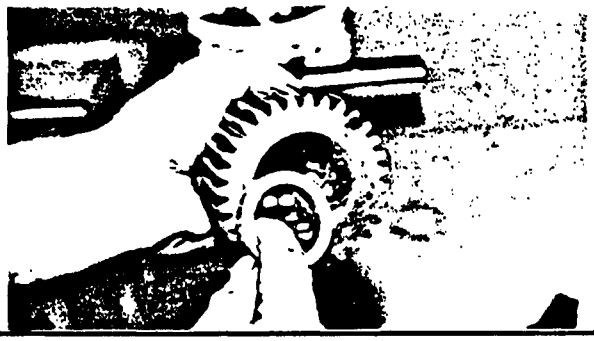


1. Apply a coat of grease or petroleum jelly to Cluster Gear bore.

Carrier Sub-Assembly

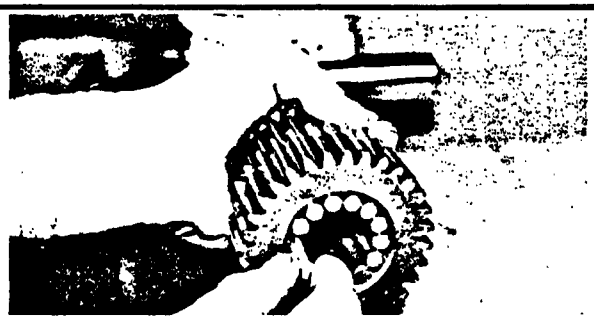
2. Place fourteen Needle Rollers into Cluster Gear bore.

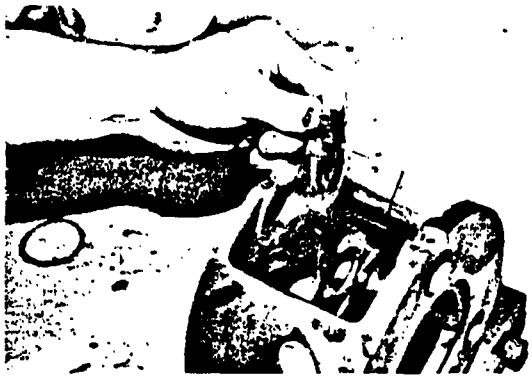




3. Place Spacer washer into opposite side of Cluster Gear and against Needle Rollers.

4. Place second set of fourteen Needle Rollers into Cluster Gear.



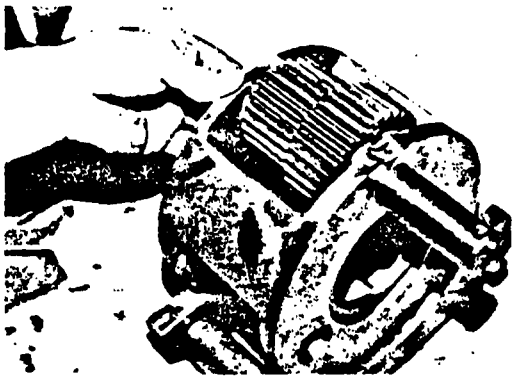


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

   Note: Some old style Carriers will not have slots and tangs should be located inside boss relief.

6. While keeping Thrust Washers in place, slide Cluster Gear into Carrier with the larger gear on the side with the small pin hole.

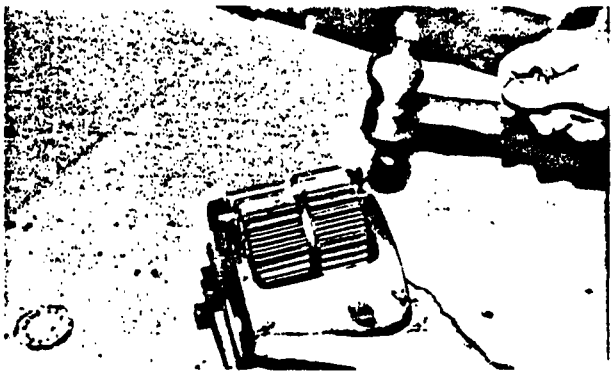




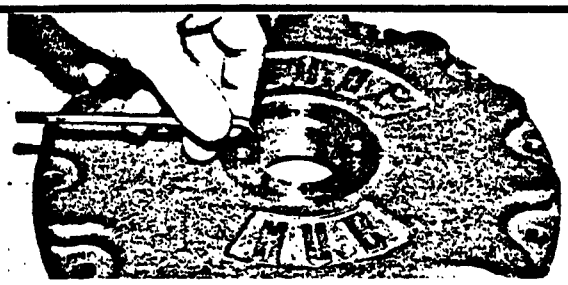
7. Line up Cluster Gear and thrust Washers with hole in Carrier and slide Planet Shaft through. Line up chamfered side of hole in Planet Shaft with pin hole in Carrier.

8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

   Repeat these steps for remaining two Cluster Gears to complete Carrier Sub Assembly.

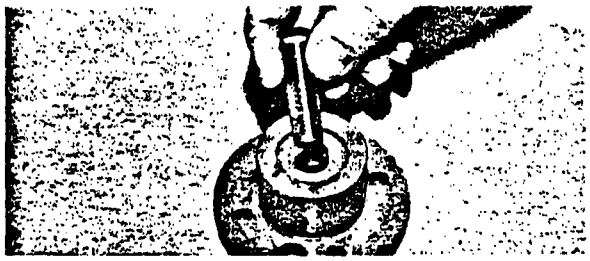


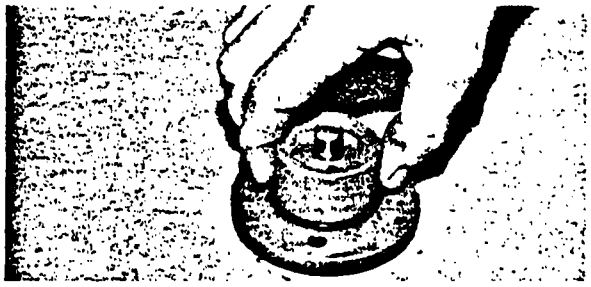
Cover Sub-Assembly



1. Screw Pipe Plug into Cover.

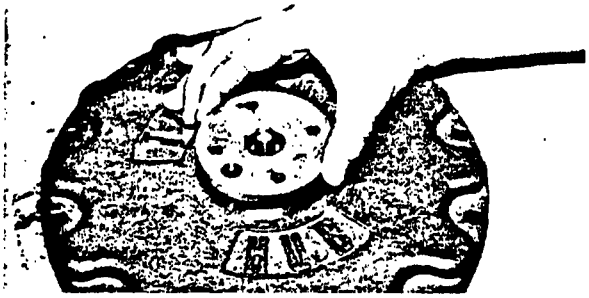
2. Place 'O' Ring into Cover Cap internal groove. The Disconnect Rod may be used to push 'O' Ring into groove. Rod will be held in place by friction from the 'O' Ring.

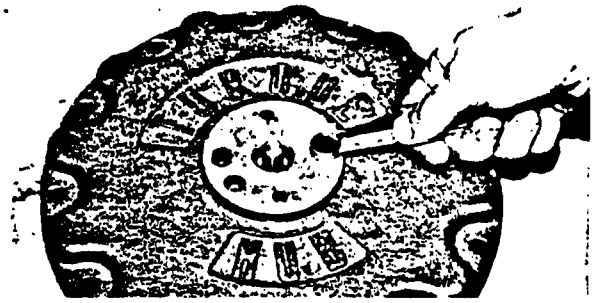




3. Slip 'O' Ring over Cover Cap and against face.

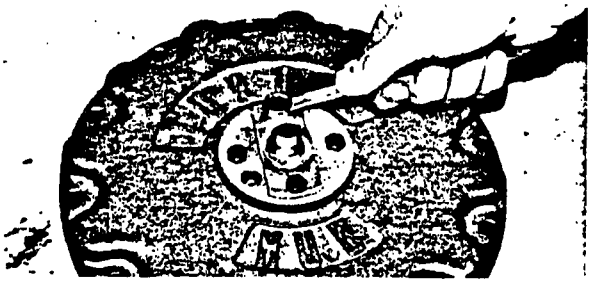
4. Place Cover Cap into Cover with large hole located over Pipe Plug.

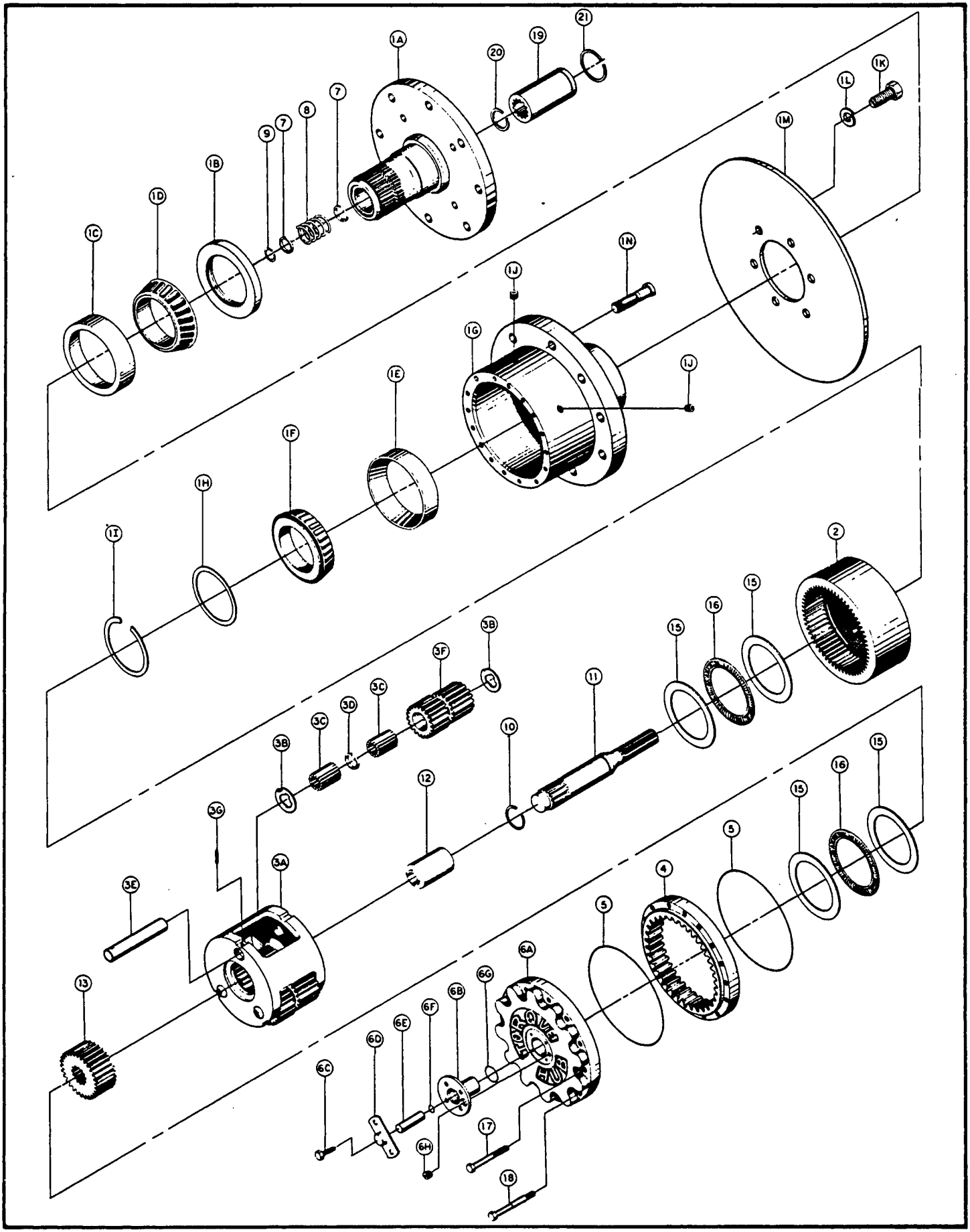




5. Install two 1/4 × 20 × 3/4 bolts 180° apart and torque to 70 - 80 in. lbs.

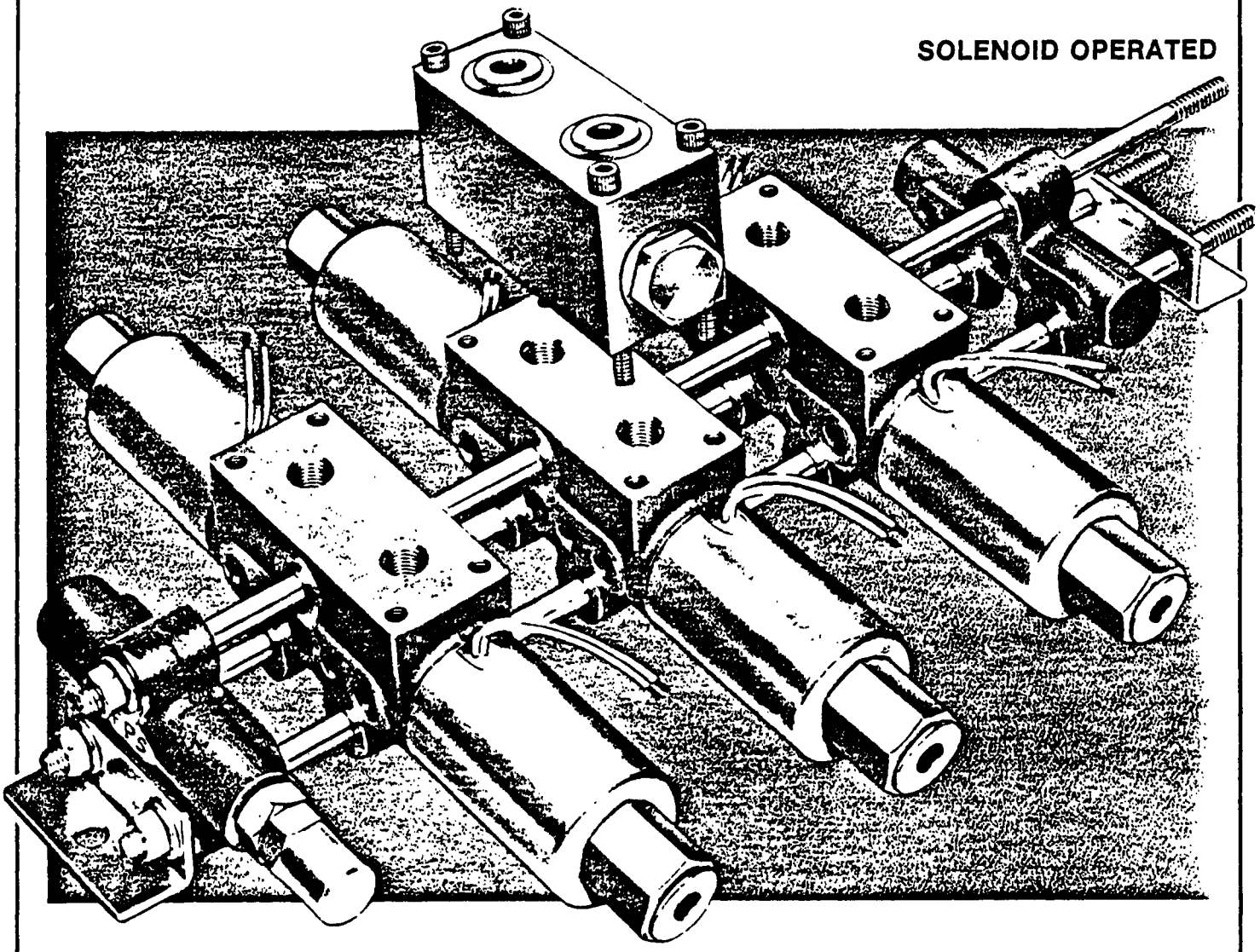
6. Place disconnect cap over cover cap with nipple facing out and align with two open holes. Secure disconnect cap to cover with two 1/4 × 20 × 3/4 and 70 - 80 in. lbs.




1A
1B
1C
1D
1E
1F
1G
1H
1I
1J
1K
1L
1M
1N
2
3A
3B
3C
3D
3E
3F
3G
4
5
6A
6B
6C
6D
6E
6F
6G
6H
7
8
9
10
11
12
13
15
16
17
18
19
20
21

mini-pak valves

SOLENOID OPERATED



- maximum flow rate 19 L/min (5 gpm)
- working pressures to 207 BAR (3000 psi)
- direct solenoid operated — dc
- series-parallel circuit

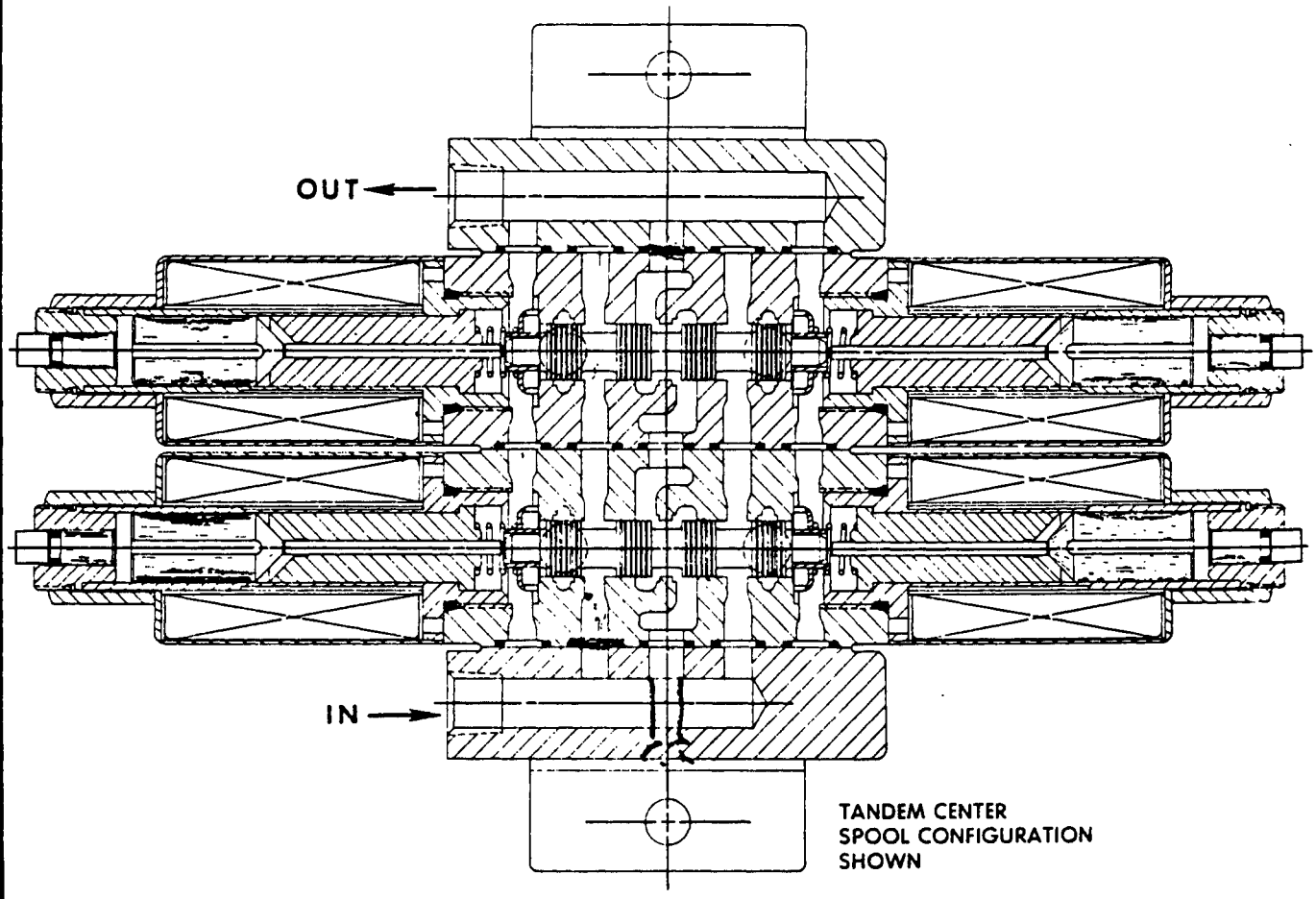
AMBAC Industries Incorporated
FLUID POWER SYSTEMS DIVISION

REV

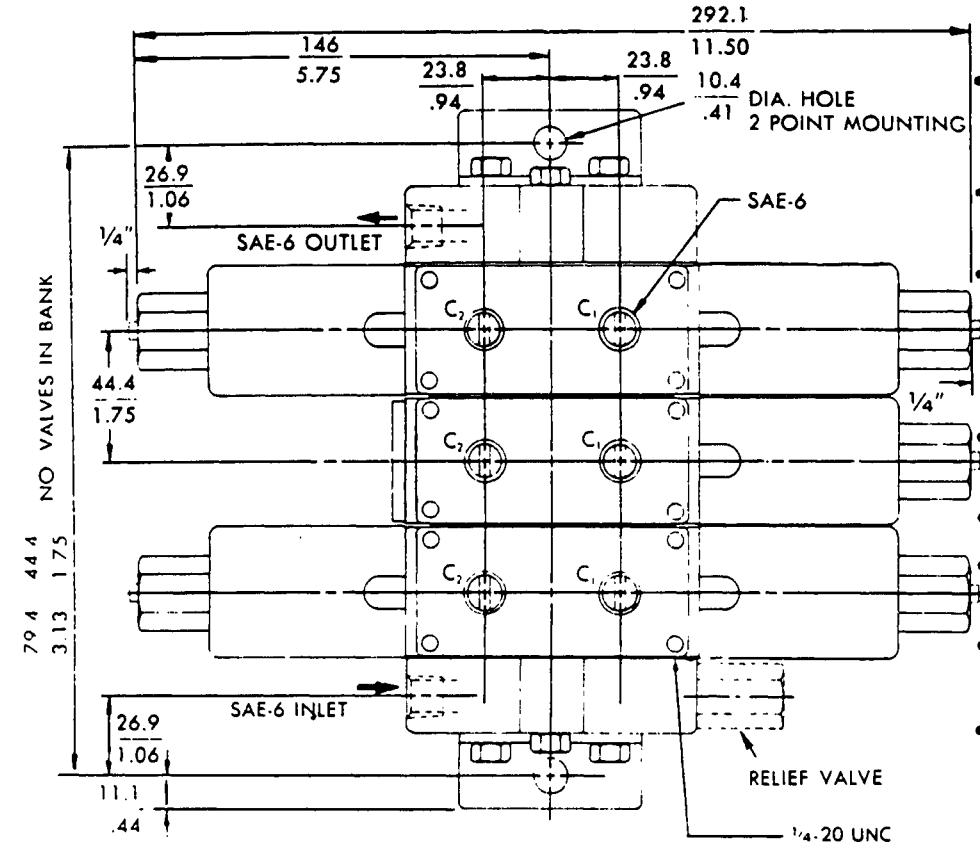
mini-pak
solenoid valve features

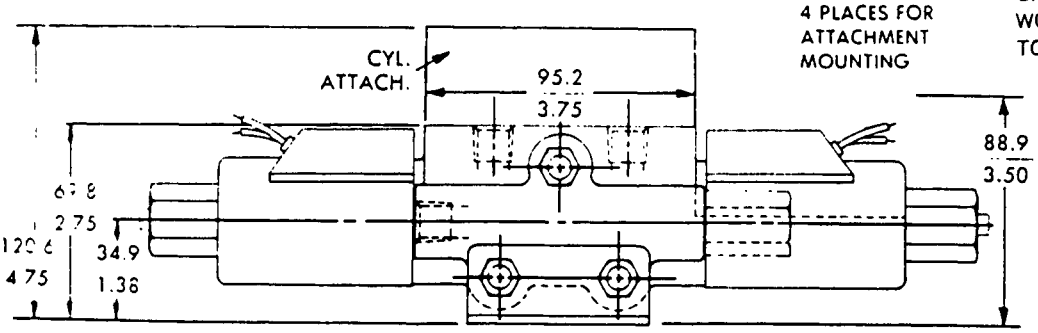
FPS MINI-PAK Solenoid Valves offer a new concept in valve assembly allowing greater circuit flexibility in less space than with conventional valves. This modular banking design concept eliminates costly fittings, potential leak points and simplifies factory and field installations. In addition to banking directional control valves, you can also stack the main system relief valve. Maximum flow rate 19L/MIN. (5 GPM.) Operating pressures to 207 BAR (3000 PSI.) Construction features include hardened steel spools, precision fit into a high strength alloy cast body. Solenoid actuator construction utilizes the proven wet plunger design. The series-parallel circuitry, within the valve, offers greater application flexibility.

- Stackable Valve Sections (Up to 5)
- New Circuit Versatility
- Series-Parallel Circuits
- Low Pressure Drop
- Low Current Consumption
- Direct Operated
- Manual Over-rides
- 7 Standard Spool Configurations
- Single or Double Solenoids
- Weather Resistant Solenoids, Continuous Duty at Rated Voltage
- DC Service
- Stackable Relief Valve
- Stackable Manual Sections When Installed Upstream of Solenoid Section
- Accessory Attachments Available



TANDEM CENTER
SPOOL CONFIGURATION
SHOWN



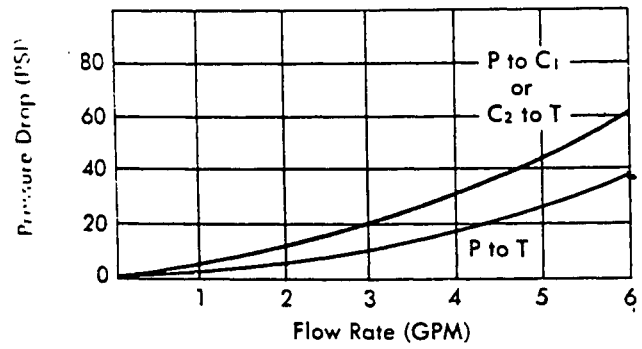


- Two position and Three Position Spools Available—Spool Types, Page 4.
- Rated Pressure 207 BAR (3000 PSI).
- Rated Oil Temperature 74°C (165°F).
- Available Voltages 12, 24 and 36 VDC.
- Current Draw 2.8 amp. @ 12 VDC @ 21°C (70°F).
- Can Be Mounted In Any Position.
- Weight 3.6 kg (8 lbs.) Per Section.
- Recommended 10 Micron Filtration.
- "O" RING SEAL BETWEEN SECTIONS INSURES LEAK-FREE OPERATION AND PROVIDES EASY FIELD CONVERSION FOR ADDITIONAL WORKING SECTIONS. TORQUE TO 12 Newton meter / 110 IN LBS.

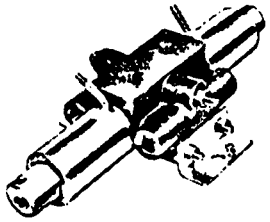
MM / INCH = MM/INCH.

FLOW L/MIN	PRESSURE DROP P-C_1, C_2-T BAR	PRESSURE DROP P-T BAR
10	1	0.5
20	3.5	2

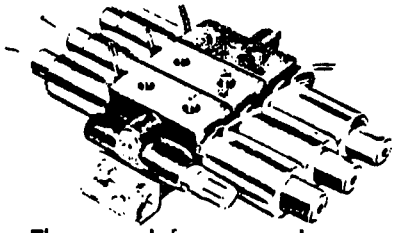
Pressure drop data for valve Model 56-10 (Tandem center 3 position 4-way, pressure to tank open — C_1 and C_2 blocked.) Maximum flow rate 19L/min (5 GPM). 150 SSU oil at 38°C (100°F).



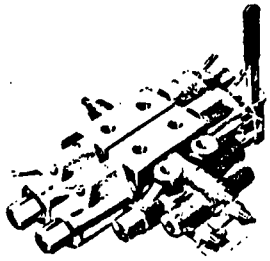
Available options (consult factory).



Four-way, three position double solenoid valve.

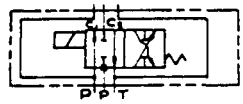
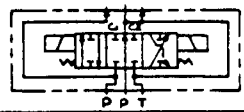


Three spool, four-way valve assembly with relief valve at inlet.



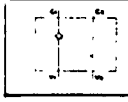
Three spool, four-way valve assembly with relief valve (Manual-Solenoid-Solenoid).

spool type (flow pattern) — TABLE I

	Valve Type	A.S.A. Symbol	Spool Des.
Standard Spools	Tandem Center Series — Parallel Circuit Cyl. Ports Blocked P-T Open		10
	Closed Center Parallel Circuit Cyl. Ports Blocked P-T Blocked		11
	Open Center Series — Parallel Circuit Cyl. Ports Open To Tank		14
	Closed Center Parallel Circuit Cyl: Ports Open To Tank		16
	Tandem Center Series — Parallel Circuit Cyl. Port Blocked P-T Open (Single Acting Cylinder)		17
	Motor Spool Parallel Circuit		25
	Tandem Center Series Circuit Cyl. Ports Blocked P-T Open		40

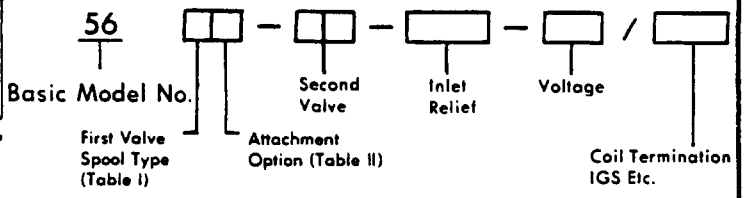
For spool configurations other than shown consult factory.

cylinder attachment valves — C_1C_2 — TABLE II

A.S.A. Symbol	Valve Type	Code	Description	
	Lock Valve	A	Without Thermal Reliefs	
		B	One Thermal Relief	241 BAR (3500 PSI)
		C	Two Thermal Reliefs	
	Cross Over Relief	F	Specify Pressure Settings	
	Pilot Operated Check	L	Without Thermal Reliefs	
		Y	One Thermal Relief	
		Z	Two Thermal Reliefs	

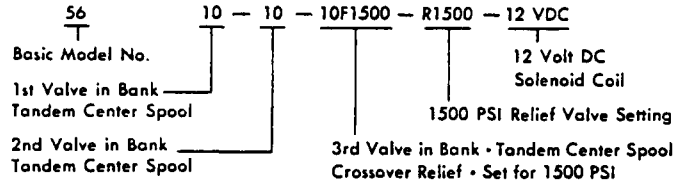
Code letter JJ indicates Palm Button Manual Override

ordering information



Attach. Provided Where Specified. All Sections Machined For Attachments.

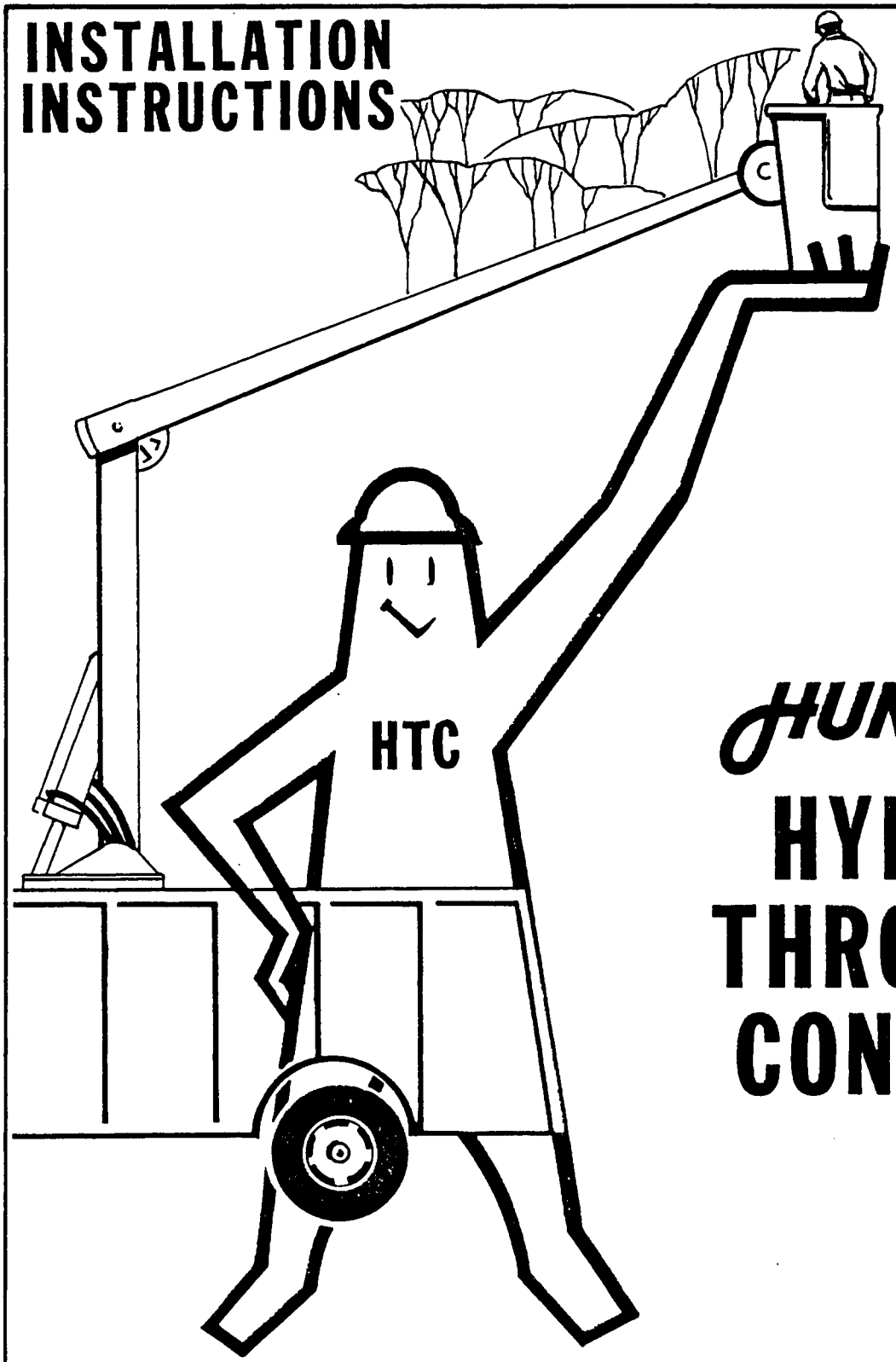
example of three bank assembly



AMBAC Industries Incorporated
FLUID POWER SYSTEMS DIVISION
511 South Glenn Avenue • Wheeling, Illinois 60090
Phone: 312-541-3000

REV

INSTALLATION INSTRUCTIONS



HUNTER

HYDRO-THROTTLE CONTROL

MUNCIE PARTS MFG. CO., INC.

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Phone (317) 284 7721

ATLANTA DIVISION
P O Box 43468 • Atlanta, Georgia 30336
Phone (404) 349 4402

CHICAGO DIVISION
P O Box 66151 • AMF, O'Hare 60666
Phone (312) 298-6860

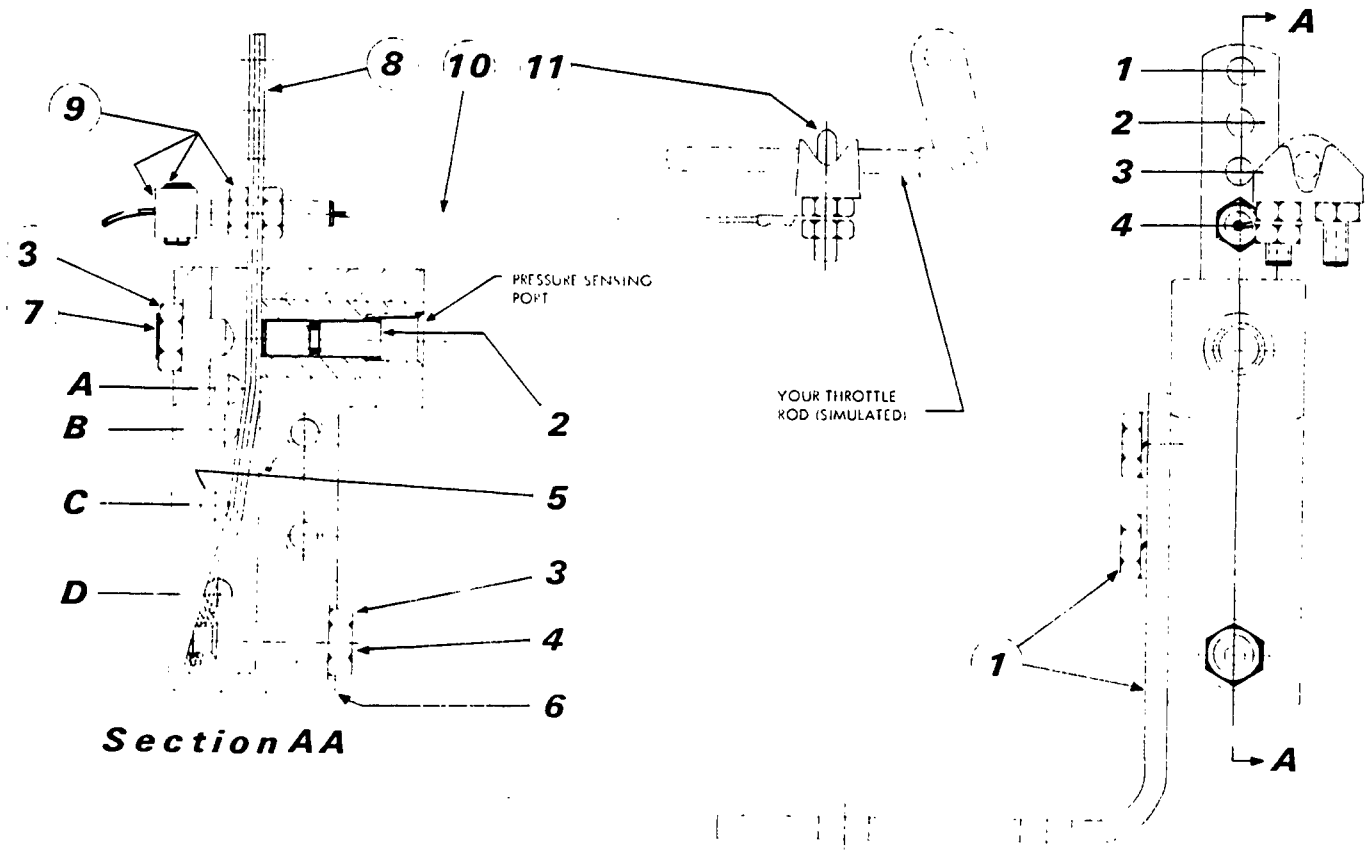
SEATTLE
Subsidiary of Muncie Parts Mfg. Co., Inc.
The Blackler Company • 317 So. Bennett St
Seattle, Wash. 98108 • Ph. (206) 763 2230

TOLEDO DIVISION
P O Box 6593 • Toledo, Ohio 43612
Phone (419) 729-3861

MUNCIE CANADA LIMITED
P O. Box 113, Malton Station
Mississauga, Ontario L4T 3B5
Phone (416) 677-9852 • Telex No. 06-968841

PARTS LIST

SERIES 90 THROTTLE CONTROL



Model 1-9010

Item	Part No.	Description
1	2-8124	Bracket and Bolt Assembly
2	2-9002	Piston Assembly
3	5322	Nut, Jam 3/8 - 16
4	5050	Screw 3/8 - 16 x 1-1/4 Spring Tension Adjusting
5	9004	Screw, Fulcrum
6	2-9007	Housing and Liner Assembly
7	5049	Screw 3/8 - 16 x 3/4 Speed Adjusting
8	8118	Spring, Leaf (3 required)
9	1-170211	Rod, Actuating, with Nuts and Set Screws
10	2-170212	Cable Assembly
11	180960	Clamp

I. INSTALLATION OF THE THROTTLE CONTROL

A. Introduction

Refer to sketch shown with parts list, included on page 2.

One Throttle Control can operate an unlimited number of circuits, that are driven by the same pump discharge line in the hydraulic system.

The Throttle Control piston (2) senses the pump discharge line pressure. The pressure increases, and pulls the throttle open, when you operate a circuit to move a load. The pump by-passes, and allows the throttle to close when the valve circuit lever is returned to neutral.

The pressure must increase, above by-passing pressure, at least 15 PSI for each pound of throttle pull, plus the amount your by-passing pressure will vary, due to oil viscosity changes, over your oil operating temperature range.

Highly loaded circuits usually increase the pressure to a level far above the pump by-passing pressure, and produce a motivating force far beyond the minimum required to open the throttle.

Lightly loaded circuits, such as, when the boom is lowering, swing circuits, outriggers lowering, etc., produce the least pressure. The plumbing flow restrictions must be revised in these circuits if the load cannot increase the circuit pressure sufficiently above by-passing pressure to produce the motivating force needed to open the throttle.

The pressure will increase at a greater rate as the engine speed increases because the plumbing relating to the circuits usually contain greater restrictions. A lightly loaded circuit may then become operable at a higher engine speed, if it did not operate at idle.

The motivating force can be increased by revising your plumbing, downstream of the throttle control connection, as follows:

Restrict the plumbing relating to the circuits. (1) Add an orifice. (2) Reduce diameter and/or lengthen line size. (3) Add a two-way check valve with a heavier spring in the direction of flow. This will increase pressure more at idle speed where needed most. It, therefore, is the best type of restriction.

Decrease your by-passing pressure. (1) Remove "bottle necks", and elbows. (2) Increase diameter and/or shorten line size.

B. Mounting Bracket

One is furnished in the kit. Modify it to fit if necessary. Make the bracket rigid and mount it to your engine rather than another surface to prevent erratic operation due to flexing and/or movement.

Position the Throttle Control so the connecting cable is in line with the accelerator rod and pulls in the same direction.

C. Pressure Connection to Pump Discharge Line

Use a 1/4" minimum sized high pressure tube or hose.

Make the connection at the control valve inlet rather than the pump discharge so it will sense the lowest pressure. The pressure will then change by a smaller amount when the oil viscosity changes. The spring tension will also become more effective.

For cold climates, consider whether you need to add a heater to your reservoir and/or shut off valve in this pressure connection to prevent high speed operation of your hydraulic components with cold oil. An oil temperature sensing switch would make them automatic.

D. Engine Throttle Linkage Check

Start the engine. Engage PTO to load the idling engine with by-passing oil pressure. Try to reduce the engine throttle pull to a minimum. Make sure it is well oiled and in good repair. Check with the engine manufacturer whether the return spring load can be reduced if it appears to be excessive for its application.

When the engine has warmed up, make sure it is capable of returning to its proper idle speed after operating the accelerator. Make necessary adjustments now before the connecting cable is applied.

E. Cable Slack Adjustment

Refer to the sketch on page 2. Make sure the actuating rod (9) is still located in hole 4 as shipped.

Secure the clamp (11) to the throttle rod. Engage the cable (10) eyelet to one of the clamp studs. Thread the cable through the hole in the rod, remove almost all slack, and secure it with the set screws.

Finalize the cable slack adjustment with the nuts provided on the actuating rod (9). The cable should have some slack but not excessive. Check to make sure the engine returns to idle after operating the accelerator.

F. Adjusting Procedure

The spring rate is adjustable by moving the fulcrum screw (5) and changing the number of leaf springs (8). See table below for the possible variations. The spring rate increases as the variation number decreases. For instance, the table indicates the spring will be three (3) times stiffer with variation No. 2 than No. 3.

Variation Number	No. of Springs	Fulcrum Hole	Spring Tension *Turns	Spring Tension *Pressure	Spring Tension Rate	Actuating Rod Hole Location
1	3	A	3	1100	11X	4
2	3	B	3	780	3X	4
3	3	C	2-1/2	640	Normal	4
4	2	C	2	370	3/4X	4
5	2	D	5/8	300	1/4X	4

* Note: Apply turns from when the screw (4) just begins to deflect the spring at zero load. Pressure is approximate when piston will begin to move.

The control was shipped with variation 3. Try it first. The adjusting procedure will direct you to another variation, if another is needed.

1. Disengage PTO. Turn in speed screw (7) until it touches spring (8). Then turn out one turn, temporarily, to limit stroke and prevent accidental racing of engine.

2. Engage PTO. Air bleed sensing line by cracking fitting at Throttle Control. Proceed after oil warms up to within normal operating temperature range.

3. Operate a highly loaded circuit valve lever. Bottom out a cylinder to obtain system relief valve pressure if this is easier. The throttle will open.

4. Make speed adjustment. Turn speed screw (7) in or out with the circuit loaded. Use the nut (3) to lock it when it regulates your desired speed. Move actuating rod from hole 4 to hole 3, only if the spring should stop on the housing instead of the screw.

5. Return lever to neutral. The throttle must close and the engine must return to idle. Check Trouble Shooting section, Part II, Section C. If unsuccessful, increase the spring rate, see table above. Repeat entire procedure.

F. Adjusting Procedure (Continued)

6. Determine which of the circuits produce the lowest pressure. Operate it and decide which of the following applies, paragraph 6a, 6b, or 6c.

a. Throttle Opens and Closes Properly From Idle

(1) Finalize engine speed screw (7) adjustment by alternately operating the lowest and the highest loaded circuits. Lock nut (3) securely.

(2) Operate and check all other circuits. They should operate because they are loaded between the highest and lowest circuits used for adjustments.

(3) Installation is now complete.

b. Throttle Does Not Open From Idle Speed, but Will at Higher Speed

Check if it will open at higher engine speeds.

(1) Operate a higher pressure circuit lever to open the throttle and bring the engine up to speed, then operate the lowest pressure circuit lever.

(2) If it stays open, after the higher pressure lever is returned, decide whether the required sequence of operation is acceptable. It usually is acceptable. It now contains the highest spring setting.

(3) If not acceptable, or if it did not stay open, proceed with step (c) below.

c. Throttle Will Not Open at All

Make spring tension adjustment. Proceed as follows:

(1) Disengage PTO. Turn out screw (4) until leaf spring (8) is loose. Then turn it in until the spring just begins to deflect and is at zero load.

(2) Engage PTO. The throttle will open.

(3) Turn screw (4) in gradually. Count turns, and record as "B", until the throttle just closes. Do not overshoot and leave the screw at this point. Note how the throttle closed. If it closed suddenly, increase the spring rate, see table above. Repeat adjustment from paragraph c (1).

6c. (Continued)

(4) Operate the lowest pressure circuit. The throttle must open. If it opened, proceed directly to step 5. Otherwise, choose between (a) and (b) below.

(a) If it did not open, the motivating force is below zero. Revise the plumbing to increase the amount the pressure will increase when the circuit is operated. See Section A.

(b) Operate the next higher loaded circuit, etc. until you find a circuit that does operate from idle. Use this circuit for the adjustments specified in paragraph 5 below. You will find out later whether the lower pressure circuits, that did not operate from idle, will become operable at a higher speed.

(5) Turn in on screw (4) in small increments equal to approximately 10% of the total turns given in the table above.

After each increment, operate the lowest pressure circuit lever from neutral to fully open the throttle, and then return it to neutral to fully close the throttle.

Wait for the engine to idle before repeating.

Count, and record as "C", the number of turns to exactly when the throttle no longer opens from idle.

Note: Increase the spring rate, see table above, if the total turns counted (B plus C), exceeds by more than 20% the number of turns noted in the table above.

Decrease your spring rate if you observed the throttle will no longer fully open.

Repeat adjustment from paragraph c(1), if spring rate was changed.

(6) Turn screw (4) out 1/8 turn or 1/4 times "C" turns whichever is greater to provide an operating margin between the lowest circuit pressure and the final spring tension.

(7) Check operation as per paragraph F6a or F6b. If the lighter loaded circuits do not operate, revise the plumbing to increase the amount the pressure will increase when these circuits are operated. See Section A.

II. TROUBLE SHOOTING HINTS

A. Problem: Engine Does Not Idle But Speeds Up When PTO Is Engaged

Probable Cause	Remedy
1. Control lever stuck open.	1. Return all valves to neutral.
2. Low leaf spring tension.	2. Repeat calibration.
3. Cold Oil.	3. Warm oil. Also check Part I, Section "C".

B. Problem: Engine Does Not Speed Up When Light Load Is Applied

Probable Cause	Remedy
1. PTO not engaged.	1. Engage PTO.
2. Air in sensing line.	2. Bleed line. Crack fitting at control.
3. Connecting cable.	3. Reduce slack to minimum.
4. Stops on speed screw.	4. Adjust screw.
5. Hot oil.	5. Allow oil to cool.
6. Your engine throttle linkage.	6. Oil and repair. Check manufacturer for lighter spring if it is excessive.
7. Circuit pressure is too low.	7. Revise plumbing to increase spread between your circuit and by-passing pressures. See Part I, Section "A".
8. Excessive leaf spring tension.	8. Repeat calibration.
9. Excessive leaf spring rate.	9. Reduce spring rate. See table in Part I, Section "F".

C. Problem: Engine Does Not Return To Idle After A Load Is Applied

Probable Cause	Remedy
1. Engine speed excessive.	1. Reset speed screw adjustment.
2. Your engine.	2. Make sure it can idle.
3. Connecting cable.	3. Check for slack.
4. Low leaf spring rate.	4. Increase spring rate. See table in Part I, Section "F".
5. Low leaf spring rate.	5. Repeat calibration.
6. Excessive by-passing pressure.	6. Remove "bottlenecks" or increase line size downstream of the control connection.

HELAC

MAINTENANCE MANUAL

FOR

"HELAC" PIVOT

ROTARY ACTUATORS

HP-SERIES

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I. THEORY OF OPERATION

In reference to Fig. I, fluid entering Port E2 under pressure will bear on piston (4) and force piston sleeve (3) upwards. The left-handed spline of piston sleeve (3) will combine with the right-handed spline of shaft (2) and cause rapid CW rotation of shaft and flange (2) (looking down). Fluid entering Port E1 will reverse this rotation.

Displacement and torque are identical for CW and CCW rotation.

Shaft (2A) is integral with shaft flange (2B) and bearing tube (2C). The shaft is supported radially by the large upper radial bearing (19) and the lower radial bearing (18). Axially, the shaft is separated from the housing by upper and lower thrust rings (20). End cap (5) is adjusted for axial clearance and locked in position by cap screw (7).

II. HYDRAULIC LINE ATTACHMENT

Ports E1 and E2 are provided with either NPT or SAE threads. The hydraulic lines from the control valve to the actuator should be as short as possible. If the lines are too long, the actuator cycles the fluid back and forth, not allowing sufficient fluid to reach the continuous flow circuit for filtering.

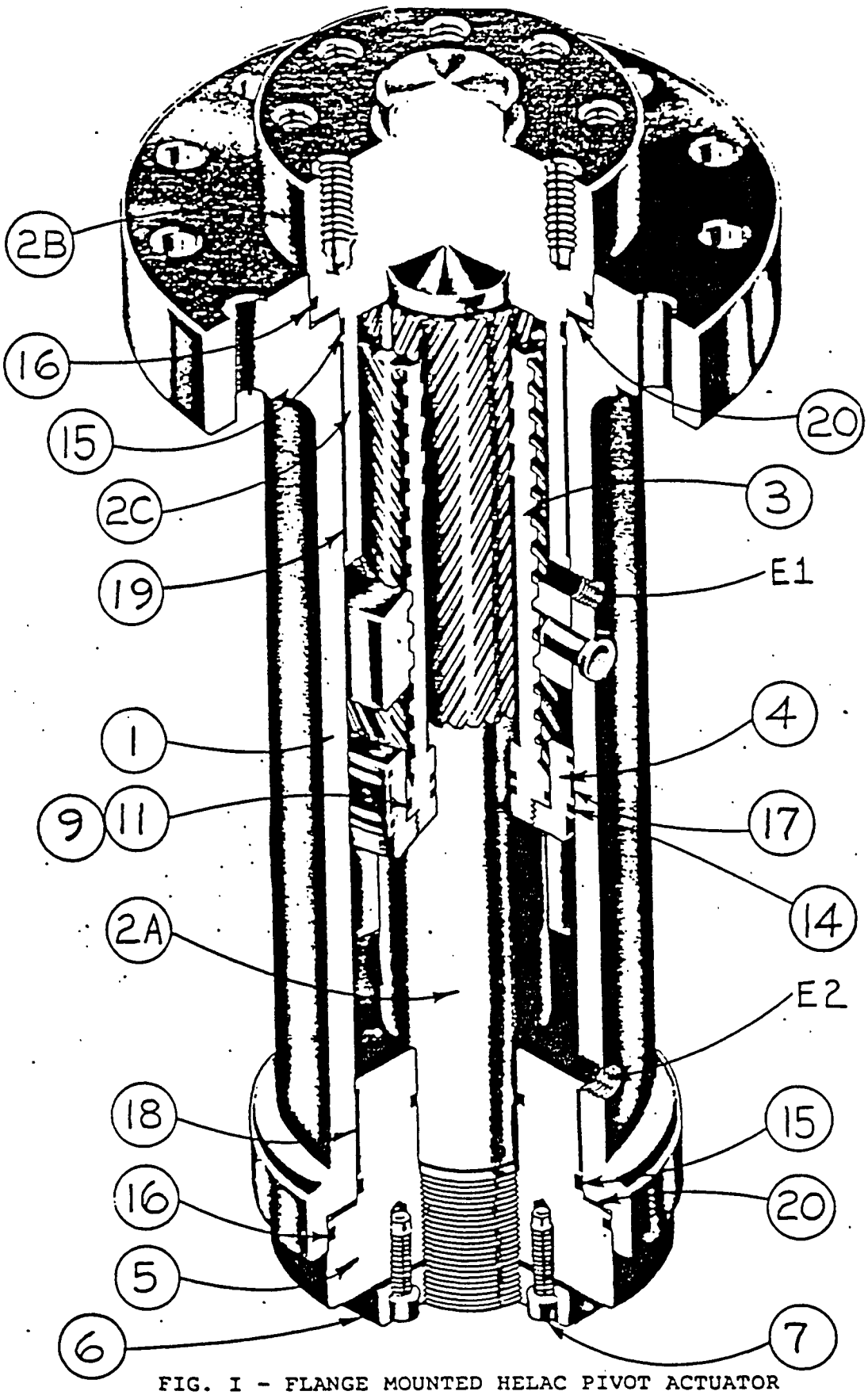


FIG. I - FLANGE MOUNTED HELAC PIVOT ACTUATOR

III. DISASSEMBLY AND INSPECTION

Place on clean work bench with room to place the internal parts as they are removed. Remove all hydraulic fittings. Loosen cap screws (7) and unscrew locknut (6) and end cap (5). The shaft is now free to slide up and out of engagement with the piston sleeve (3). Note the orientation (see Fig. II) between the spline teeth, as this will greatly simplify actuator timing upon reassembly.

After removing the shaft, the piston sleeve and the piston assembly can now be moved down and out of the housing. Remove all seals and wear strips from their grooves, except static piston seals (9) and (11). These seals generally do not require replacement. Clean all parts thoroughly and inspect for wear. A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about .005 per mating set. After long service, a backlash of about .015 per set may still be acceptable in most cases, depending on the required accuracy of the application.

Item (1) is the integral housing and ring. Check the ring gear for wear and weld damage to the pins. Inspect the cylinder bore for wear and scratches. The surface finish should be 32 RMS or better, rehone if necessary. The radial bearing (18) and (19) and the piston wear strip (17) should have maximum radial clearance of

III. DISASSEMBLY AND INSPECTION (CONT'D)

.006. A clearance in excess of .008 calls for replacement of the bearings. Rough and grooved shaft journals require shaft replacement.

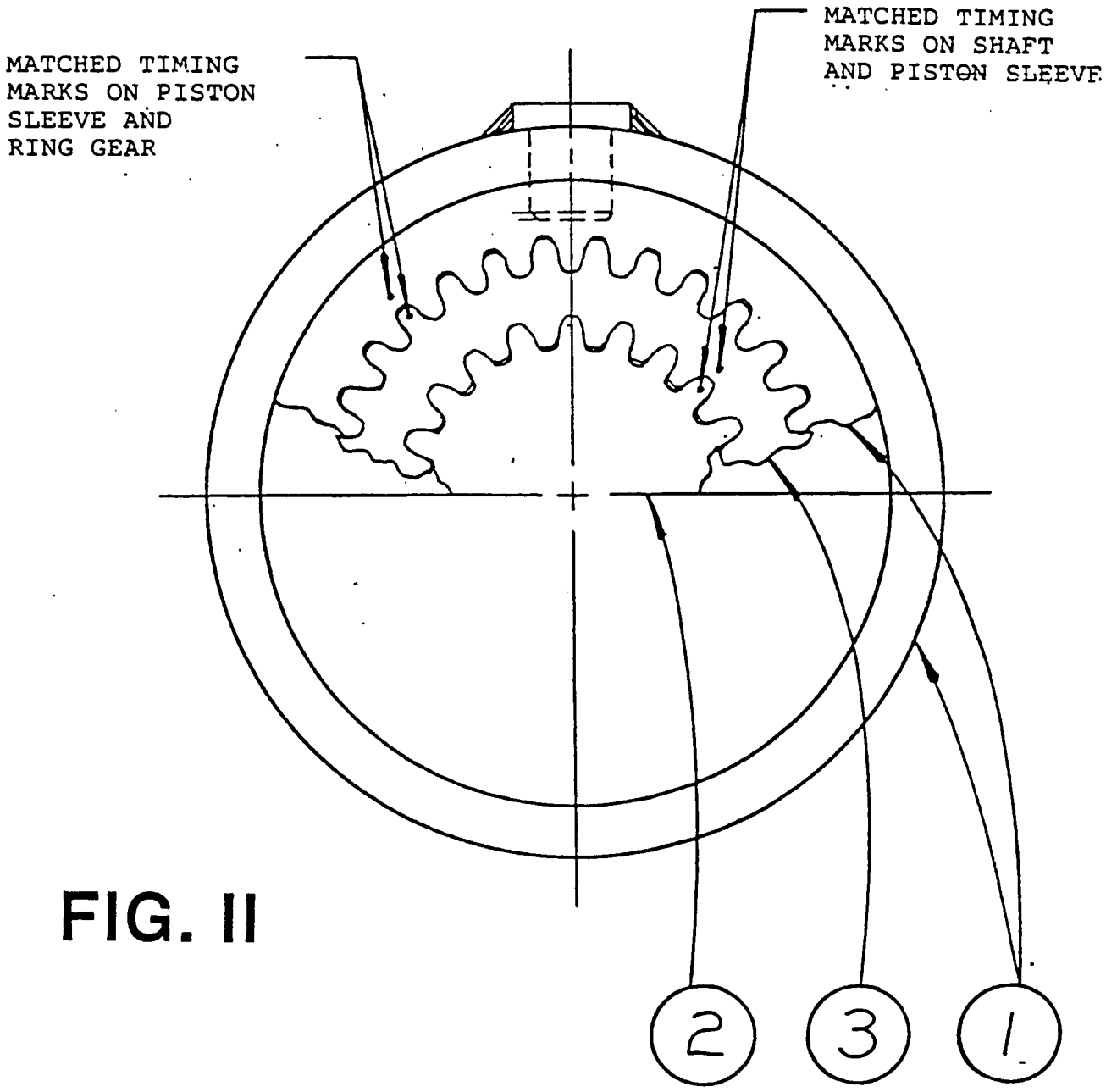


FIG. II

IV. ASSEMBLY AND TESTING

Wash all parts thoroughly in cleaning solvent and blow dry. Coat all sealing and working surfaces with a good grade hydraulic oil. Install seals in piston sleeve, piston and end caps. The lips of exclusion seals (16) face outward, and the lips of high pressure seals (15) face inwards.

Place the actuator in a vertical position, install the piston sleeve (3) in timed relation to the housing, applying firm pressure as the new seals and wear strip enter the housing and become compressed by the housing chamber. (CAUTION: Do not cock the sleeve too much any one way, for it will mar the cylinder bore). The timing marks (small punch marks on the face of each gear), must be lined up for proper shaft orientation. (Fig. II).

Thrust rings (20) are coated with good grease before sliding on the shaft and end cap. The shaft is installed by again aligning the proper punched timing marks (Fig. II). Temporary taping (masking tape works well) of threaded portion of shaft will help installation past the shaft seals. Apply antiseize to threaded and surrounding areas of end caps. Also depending on the size of the actuator (some 60K's& up), the end cap may need to be installed with the actuator in a vertical position.

IV. ASSEMBLY AND TESTING (CONT'D)

End cap (5) is torque to 40-80 ft-lb depending on the actuator size, such that the actuator begins rotation at approximately 100 PSI pressure. The torque flange cannot be rotated by hand. The combined back-drive efficiency and friction prevent manual rotation. If the end cap is torqued too high, the actuator may take as much as 300 PSI to rotate. If end cap is not torqued high enough, shaft axial motion in excess of .015 will occur and damage the ring gear, piston, sleeve and/or shaft can result. The end cap must be secured against the shaft by tightening cap screws (7). Apply hydraulic pressure and check for shaft axial motion.

To test for leakage, pressurize port E2 to 3000 PSI. No oil should seep from port E1 or from around end cap (5). Repeat test for pressurizing port E1 and check for leakage out of port E2 and around shaft flange (2B).

Note: End cap torque should be checked at least every 800 hours or once a year. If end play is observed, (the torque flange moving out of the housing), tighten end cap.

TESTING & STORAGE

All Helac Corp. actuators have been tested and operated through at least twenty-five (25) full cycles. Test pressure is normally 3000 psi, except where working pressures have been designated higher, then testing is done above the required working pressure.

Helac Corp. actuators are normally shipped filled with petroleum base hydraulic oil, and the ports are plugged with the proper high strength steel plugs to prevent leakage during shipment.

If Helac Corp. actuators are not placed into service immediately, they should be stored in an even temperature location to avoid condensation moisture from forming and the hydraulic port plugs must be left in place to prevent oil loss from the cylinder and possible contamination.

LIMITED WARRANTY

HELAC CORPORATION warrants equipment manufactured by it to be free from defective material and defective factory workmanship. HELAC CORPORATION shall replace or repair such equipment, which under normal use and service discloses such defects. Equipment under warranty shall be returned to our factory at 1462 Blake St., Enumclaw, Washington 98022, transportation prepaid by the purchaser, for inspection by HELAC CORPORATION whose opinion as to defects shall be conclusive.

The warranty period shall be 12 months from the date of shipment from the HELAC plant or 6 months from the time of final installation within the application assembly, whichever occurs first. This warranty shall be voided as to any products which have been repaired, worked upon or altered by persons not authorized by HELAC CORPORATION, or which have been subject to misuse, negligence or accident.

HELAC CORPORATION, reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligations to make changes or alterations in products previously sold.

This warranty is in lieu of all other warranties, expressed or implied and no company or person is authorized to represent or assume for HELAC CORPORATION any liability in connection with the sale of HELAC products other than set forth herein. In no event shall HELAC be liable for any incidental or consequential damages. This includes, but is not limited to, operator use and/or neglect, incorrect design application and structural failure of any components attached to the HELAC CORPORATION product.

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