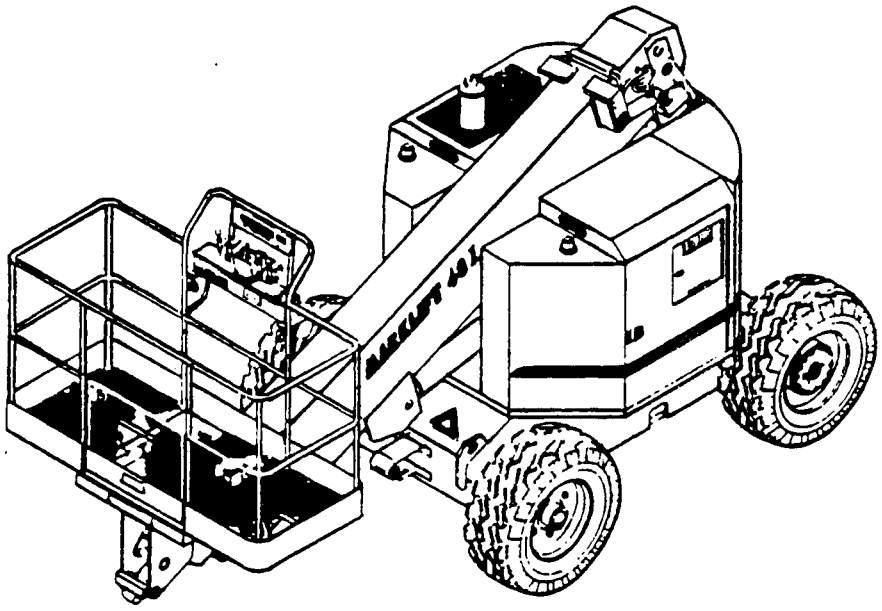
# The Marklifts.®

A Product of Mark Industries

# SELF-PROPELLED BOOM OPERATION MAINTENANCE AND PARTS MANUAL



# (MODEL 40 I)

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(MODEL 40I)
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FAIRFIELD TORQUE-HUB

FLUID POWER MINI-PAK VALVE

HUNTER HYDRAULIC THROTTLE

WISCONSIN ENGINE

SERVICE BULLETINS


Mark of Quality

# MARKLIFT SELF-PROPELLED BOOM
# (MODEL 40I)
# OPERATION MAINTENANCE AND PARTS MANUAL

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 USAGE OF THIS MACHINE MAY RESULT IN SERIOUS PERSONNEL INJURY. 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 carriage.

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 final minor adjustments and inspections must be made prior to 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 40I)

(2 SECTION BOOM)

| DESCRIPTION | ENGLISH | METRIC |
|---|---|---|
| HEIGHT | 40' | 12.19 m |
| WORKING (MAXIMUM) | 45'8" | 13.91 m |
| PLATFORM (MAXIMUM) | 39'8" | 12.09 m |
| LOWERED (MAXIMUM) | 7'2" | 2.18 m |
| WIDTH (MAXIMUM) | 6' | 1.82 m |
| LENGTH (MINIMUM) | 21'5" | 6.52 m |
| LIFT CAPACITY (UNRESTRICTED) | 600 LBS.* | 272.16 kg |
| WHEEL BASE | 6' | 1.82 m |
| TURNING RADIUS (OUTSIDE) | 14'1" | 4.29 m |
| TURRET ROTATION | CONTINUOUS | CONTINUOUS |
| TURRET TAILSWING | NONE | NONE |
| ENGINE (DUAL FUEL ONLY) | 25 H.P. WISC. | 25 H.P. WISC. |
| TRAVEL SPEED | 0-3 MPH | 0-4.8 km/hr. |
| CONTROLS | 4 PROPORTIONAL<br>2 SOLENOID | 4 PROPORTIONAL<br>2 SOLENOID |
| HYDRAULIC OPERATING PRESSURE | 2500 PSI | 2500 PSI |
| TIRES (MONO-FILLED) | 12-16.5 ALL GRIP | 12-16.5 ALL GRIP |
| HORIZONTAL REACH (MAXIMUM) | 32'1" | 9.77 m |
| GRADEABILITY | 22% OR 12° | 22% OR 12° |

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

(2 SECTION BOOM)

| DESCRIPTION | ENGLISH | METRIC |
|---|---|---|
| FUEL TANK CAPACITY . . . . | 36 GAL. | 136.26 l |
| HYDRAULIC TANK CAPACITY . | 36 GAL | 136.26 l |
| WEIGHT . . . . . | 16,700 LBS. | 7575.12 kg |
| PLATFORM DIMENSIONS . . . | 72" X 30" X 41 | 1.83 m X 76 m X 1.04 m |

NOTE: *OPTIONAL PLATFORM ROTATION DECREASES UNRESTRICTED LIFT CAPACITY TO 500 LBS.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

(3 SECTION BOOM)

| DESCRIPTION | ENGLISH | METRIC |
|---|---|---|
| HEIGHT . . . . . | 40' | 12.19 m |
| WORKING (MAXIMUM) . . . . | 46' | 14.02 m |
| PLATFORM (MAXIMUM) . . . . | 40' | 12.19 m |
| LOWERED (MAXIMUM) . . . . | 7'7" | 2.31 m |
| WIDTH (MAXIMUM) . . . . . | 6' | 1.82 m |
| LENGTH (MINIMUM) . . . . . | 15'5" | 4.69 m |
| LIFT CAPACITY . . . . . (UNRESTRICTED) | 600 LBS.* | 272.16 kg |
| WHEEL BASE . . . . . | 6' | 1.82 m |
| TURNING RADIUS (OUTSIDE) . | 14'1" | 4.29 m |
| TURRET ROTATION . . . . . | CONTINUOUS | CONTINUOUS |
| TURRET TAILSWING . . . . . | NONE | NONE |
| ENGINE (DUAL FUEL ONLY | 25 H.P. WISC. | 25 H.P. WISC. |
| TRAVEL SPEED . . . . . | 0-3 MPH | 0-4.8 km/hr. |
| CONTROLS . . . . . | 4 PROPORTIONAL | 4 PROPORTIONAL |
| | 2 SOLENOID | 2 SOLENOID |
| HYDRAULIC OPERATING PRESSURE | 2500 PSI | 2500 PSI |
| TIRES (MONO-FILLED) . . . | 12-16.5 ALL GRIP | 12-16.5 ALL GRIP |
| HORIZONTAL REACH . . . . . (MAXIMUM) | 32'1" | 9.77 m |
| GRADEABILITY . . . . . | 22% OR 12° | 22% OR 12° |

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

(3 SECTION BOOM)

| DESCRIPTION | ENGLISH | METRIC |
|---|---|---|
| FUEL TANK CAPACITY . . . . | 36 GAL. | 136.26 l |
| HYDRAULIC TANK CAPACITY . . . . . | 36 GAL. | 136.26 l |
| WEIGHT . . . . . | 17,000 LBS. | 7711.2 kg |
| PLATFORM DIMENSIONS . . . | 72" X 30" X 41 | 1.83 m X 76 m X 1.04 m |

NOTE: *OPTIONAL PLATFORM ROTATION DECREASES UNRESTRICTED LIFT CAPACITY TO 500 LBS.

MARKLIFT SELF-PROPELLED BOOM
(MODEL 40I)

| OPTION | TITLE |
|---|---|
| 20104 | GROUND AND AERIAL 110 VAC 20 AMP RECEPTACLES |
| 20105 | TOWING KIT |
| 20106 | CLEARANCE, STOP AND TURNING LIGHTS |
| 20107 | ROTATING BEACON |
| 20108 | TRAVEL HORN |
| 20097 | RAISED PLATFORM ROTATION |
| 20112 | LIFTING LUGS |
| 20113 | SPECIAL PAINT |
| 20122 | CATALYTIC MUFFLER |
| 20131 | 5 FT. PLATFORM |
| 20132 | 8 FT. PLATFORM |
| 20133 | 12 FT. PLATFORM |
| 20134 | 4 FT. PLATFORM |
| 20138 | SPARK ARRESTER MUFFLER |
| 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 |
| 20170 | AIR LINE TO PLATFORM (INSIDE BOOM) |

MARKLIFT SELF-PROPELLED BOOM
(MODEL 40I)
OPERATION MAINTENANCE AND PARTS MANUAL

| REV. DATE | PAGE NUMBERS | REV. DATE | PAGE NUMBERS | REV. DATE | PAGE NUMBERS | REV. DATE | PAGE NUMBERS |
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# 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 Brea, 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 description 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. Brea, 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 INDUSTRIES 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, CA 92622-2255
714-879-6275 800-448-MARK
TELEX 194402 FAX 1-714-879-8884

This is a reduced copy of the actual report that is sent with each Machine.

## NEW EQUIPMENT CONDITION REPORT

(WARRANTY REGISTRATION)

| BOOMS | YES | NO |
|---|---|---|
| 1 CAPACITY DECAL IS _____ | | |
| 2 ALL APPLICABLE WARNING DECALS ARE INSTALLED | | |
| 3 EMERGENCY DESCENT VALVE FUNCTIONS PROPERLY | | |
| 4 OPERATORS INSTRUCTIONS ARE PROPERLY INSTALLED | | |
| 5 OPERATORS GUIDE RECEIVED | | |
| 6 ELECTRIC SCHEMATIC RECEIVED | | |
| 7 ALL CONTROLS (UPPER & LOWER) ARE IDENTIFIED & OPERATE PROPERLY | | |
| 8 STOP SWITCHES OPERATE PROPERLY (UPPER & LOWER) | | |
| 9 CONDITION OF PLATFORM GUARD RAILS | | |
| 10 BASKET ACCESS GATE WORKS PROPERLY | | |
| 11 HORN/BEACON OPERATE PROPERLY (OPTIONAL) | | |
| 12 BRAKES ARE ADJUSTED AND OPERATE PROPERLY | | |
| 13 CIRCUIT BREAKERS OPERATE PROPERLY | | |
| 14 ENGINE RPM'S ARE _____ RPM'S | | |
| 15 ALL HYDRAULIC CYLINDERS ARE FREE OF LEAKS | | |
| 16 ALL HYDRAULIC CYLINDER RODS ARE FREE OF PAINT/SCRATCHES | | |
| 17 110V GENERATOR OPERATES PROPERLY (OPTIONAL) | | |
| 18 HYDRAULIC PUMP IS FREE OF LEAKS | | |
| 19 DRIVE MOTORS ARE FREE OF LEAKS | | |
| 20 ROTATION GEAR BOX OIL LEVEL IS _____ | | |
| 21 ROTATION RING GEAR BOLTS (UNDERCARRIAGE) ARE TORQUED AT _____ FT. LBS. | | |
| 22 LUG NUTS ON WHEELS ARE TORQUED AT _____ FT. LBS. | | |
| 23 BATTERY FLUID LEVEL IS FULL | | |
| 24 HYDRAULIC HOSES & FITTINGS ARE TIGHT & FREE OF LEAKS | | |
| 25 AIR PRESSURE IN TIRES IS _____ PSI | | |
| 26 HYDRAULIC OIL LEVEL IS _____ | | |
| 27 SYSTEM PRESSURE IS _____ PSIG | | |
| 28 PILOT PRESSURE IS _____ PSIG | | |
| 29 FUEL TANK AND FITTINGS ARE FREE OF LEAKS | | |
| 30 HYDRAULIC TANK AND FITTINGS FREE OF LEAKS | | |
| 31 MANUAL OVERRIDES OPERATE PROPERLY | | |
| 32 MUFFLER TIGHT AND FREE OF LEAKS | | |
| 33 ENGINE OIL LEVEL IS FULL | | |
| 34 ENGINE OIL FILTER IS FREE OF LEAKS | | |
| 35 ALL ELECTRICAL CONNECTIONS ARE TIGHT | | |
| 36 ENGINE ALTERNATOR FUNCTIONING PROPERLY | | |
| 37 VALVE MANIFOLD & FITTINGS ARE FREE OF LEAKS | | |
| 38 PROPER OIL LEVEL IN DRIVE WHEEL TORQUE HUB | | |
| 39 CABLE TENSION _____ | | |

| SCISSORS | YES | NO |
|---|---|---|
| 1 CAPACITY DECAL IS _____ | | |
| 2 ALL APPLICABLE WARNING DECALS ARE INSTALLED | | |
| 3 EMERGENCY DESCENT VALVE FUNCTIONS PROPERLY | | |
| 4 OPERATORS INSTRUCTIONS ARE PROPERLY INSTALLED | | |
| 5 OPERATORS GUIDE RECEIVED | | |
| 6 ELECTRICAL SCHEMATIC RECEIVED | | |
| 7 ALL CONTROLS (UPPER & LOWER) ARE IDENTIFIED AND OPERATE PROPERLY | | |
| 8 PLATFORM GUARD RAILS IN GOOD CONDITION AND ATTACHMENT BOLTS INCLUDED | | |
| 9 PLATFORM ACCESS GATE WORKS PROPERLY | | |
| 10 HORN/BEACON OPERATES PROPERLY (OPTIONAL) | | |
| 11 BRAKES (IF INSTALLED) OPERATE PROPERLY | | |
| 12 CIRCUIT BREAKER OPERATES PROPERLY | | |
| 13 ENGINE RPM'S ARE _____ RPM'S | | |
| 14 SCISSOR ARM SHAFT COLLARS ARE IN PLACE AND ARE TIGHT | | |
| 15 LIFT CYLINDER IS FREE OF LEAKS | | |
| 16 110V INVERTER OPERATES PROPERLY (OPTIONAL) | | |
| 17 110V GENERATOR OPERATES PROPERLY (OPTIONAL) | | |
| 18 HYDRAULIC PUMP IS FREE OF LEAKS | | |
| 19 SYSTEM PRESSURE IS SET AT _____ PSIG | | |
| 20 DRIVE MOTORS ARE FREE OF LEAKS | | |
| 21 DRIVE GEAR BOX OIL LEVEL (SRT MODELS) | | |
| 22 ALL NUTS & BOLTS ARE TIGHT | | |
| 23 (2) WHEEL NUTS ARE TORQUED AT ____ FT. LBS. | | |
| 24 LUG NUTS ON THE WHEELS ARE ___ FT. LBS | | |
| 25 BATTERY FLUID LEVEL IS CORRECT | | |
| 26 HYDRAULIC HOSES AND FITTINGS ARE FREE OF LEAKS | | |
| 27 AIR PRESSURE IN TIRES IS _____ PSI | | |
| 28 HYDRAULIC OIL LEVEL _____ | | |
| 29 FUEL TANK & FITTINGS ARE FREE OF LEAKS | | |
| 30 HYDRAULIC OIL TANK & FITTINGS ARE FREE OF LEAKS | | |
| 31 STEERING CYLINDER IS FREE OF LEAKS | | |
| 32 MANUAL OVERRIDE ON VALVES OPERATE PROPERLY | | |
| 33 MUFFLER TIGHT & FREE OF LEAKS | | |
| 34 ENGINE OIL LEVEL FULL | | |
| 35 ENGINE OIL FILTER FREE OF LEAKS | | |
| 36 ALL ELECTRICAL CONNECTIONS ARE TIGHT | | |
| 37 ENGINE ALTERNATOR FUNCTIONS PROPERLY | | |
| 38 CHARGER FUNCTIONS PROPERLY (ELECT. MACH.) | | |
| 39 VALVE MANIFOLD & FITTINGS ARE FREE OF LEAKS | | |

MODEL NUMBER _____ SERIAL NUMBER _____

OPTIONS _____

INSPECTOR # _____

X

PURCHASER

_____
COMPANY NAME

_____
ADDRESS

_____
CITY STATE ZIP CODE

( ) _____
AREA CODE TELEHONE NUMBER

DATE OF INVOICE _____ DATE SHIPMENT RECEIVED _____

DATE UNIT PUT INTO SERVICE _____

☐ UNIT WILL BE USED IN RENTAL FLEET

☐ UNIT WILL BE SOLD; THE INITIAL WORK APPLICATION WILL BE:

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

COMMENTS:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

INSPECTION COMPLETED BY: _____
(Please print legibly)

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

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## OPTIONS


| | | |
|---|---|---|
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NOTE: ADDITIONAL OPTIONS ARE LISTED IN FORE-MATTER SECTION.

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

## SECTION I

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

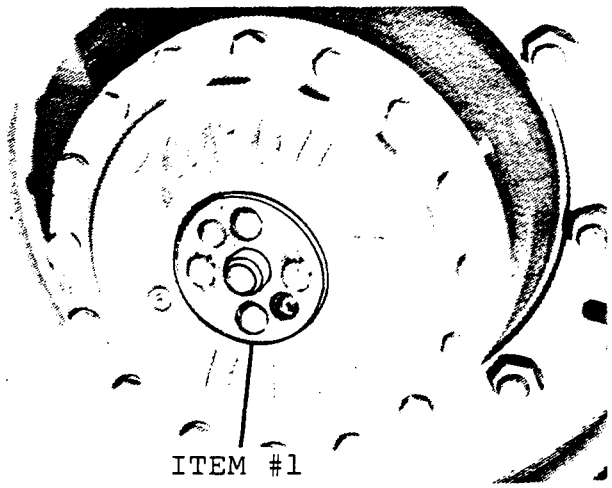
1. The truck must be fitted with adequate winch to handle the weight of equipment you are going to load/unload.

| BOOM | GROSS VEH. WT. | BOOM | GROSS VEH. WT. |
|---|---|---|---|
| 21 ------- | 7,600 LBS. | 62 ------- | 24,000 LBS. |
| 30L ------ | 11,170 LBS. | 62-4 ----- | 23,600 LBS. |
| 30RT ----- | 10,910 LBS. | 80 ------- | 39,500 LBS. |
| 30STD ---- | 11,420 LBS. | 80-4 ----- | 39,800 LBS. |
| 30I ------ | 11,670 LBS. | 30EB ----- | 13,660 LBS. |
| 32 ------- | 11,410 LBS. | 40EB ----- | 19,080 LBS. |
| 40STD ---- | 14,680 LBS. | 40I (2 SECT. BOOM) | 16,700 LBS |
| 40RT ----- | 15,400 LBS. | | |
| 42 ------- | 15,000 LBS. | 40I (3 SECT. BOOM) | 17,000 LBS. |
| 42-4 ----- | 15,500 LBS. | | |

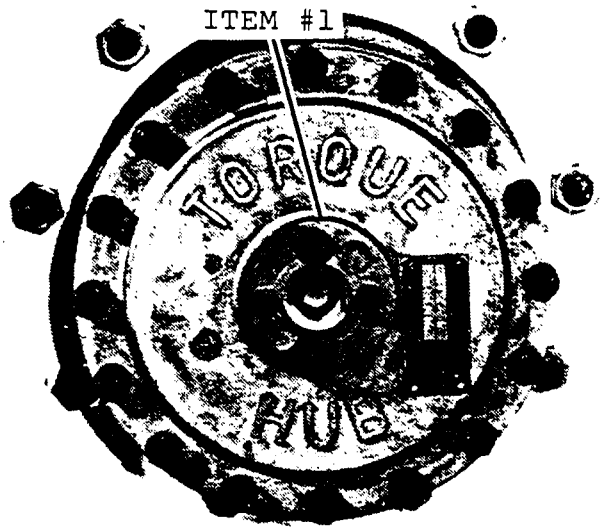
2. Align the boom with the steering wheels toward the trailer, and the basket in the horizontal or slightly above position.

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.)



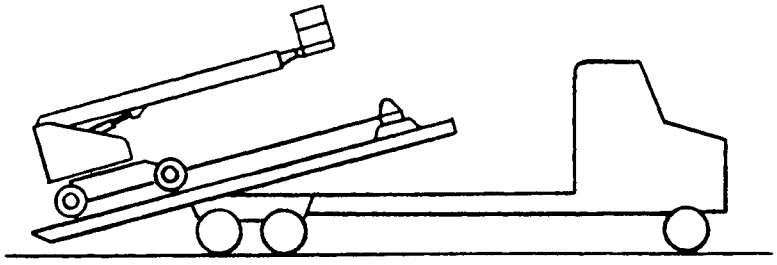

HUB ENGAGED

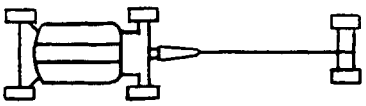



HUB DISENGAGED

| CAUTION: BRAKES ARE ALSO AUTOMATICALLY DISENGAGED AT THIS TIME. |
|---|

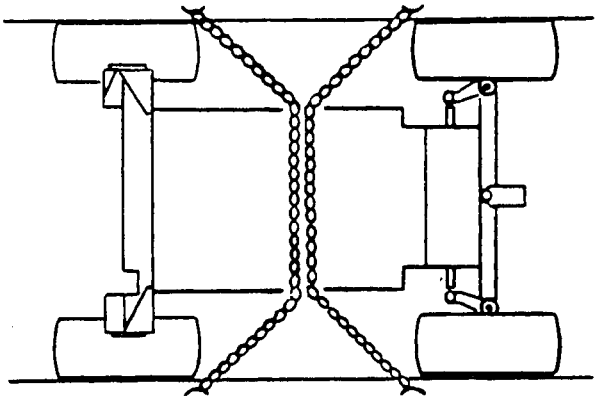
4. Attach the winch cable to the boom at the steering end on the center steering arm as shown.

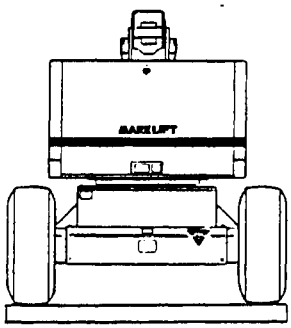




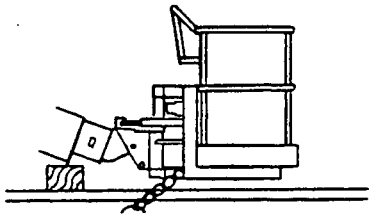
5. When truck bed is locked back into the horizontal position, rotate the boom 180° to a position where the counter weight is over the steering wheels. (This position would place the counterweight closest to the truck cab.)

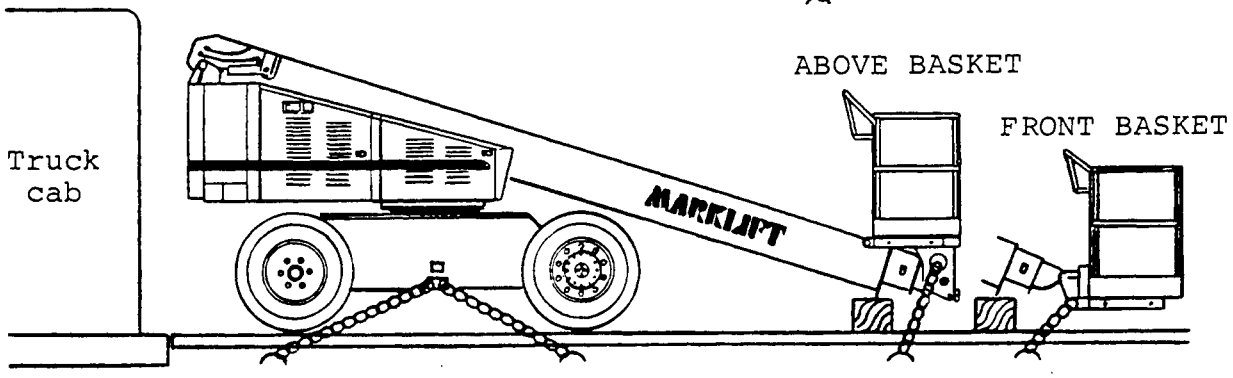
6. When the boom is on the truck in position for proper weight distribution, it is chained down in the manner illustrated by the drawings below.






ROTATOR






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 taught 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.

SECTION II

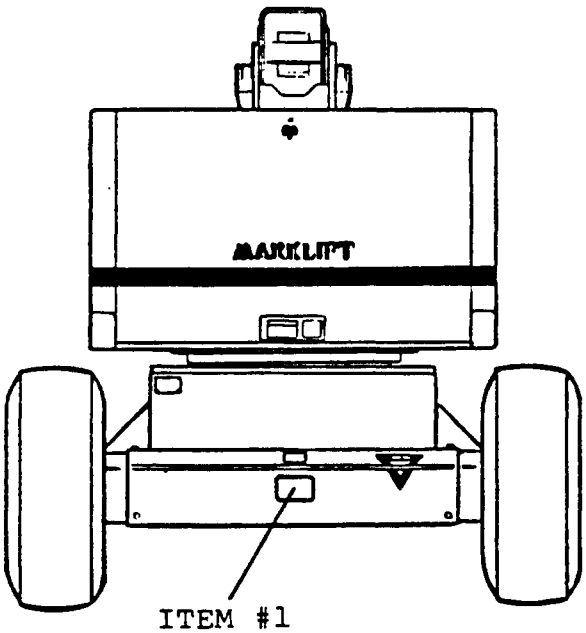
FLATBED WITH HYDRAULIC LIFT/LOWER REAR PORTION

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 (Item #1)



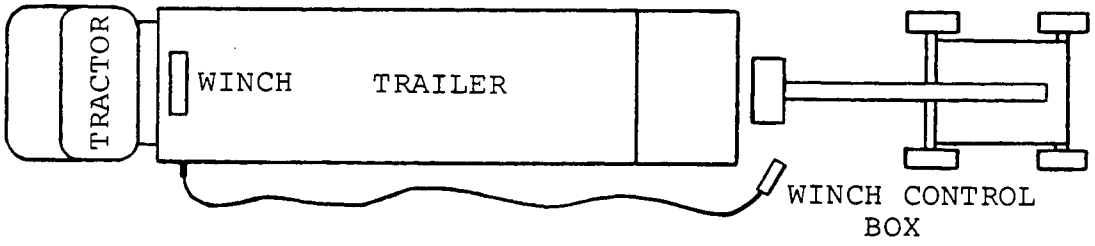

2. If the unit has the high/low drive option, it must be in low drive at all times when loading/unloading.

## 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 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 section I 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 boom is positioned approximately halfway forward on the trailer, rotate boom 180° to a position where the counterweight is over the steering wheels. (This position would place the counterweight closest to the truck cab.)

5. When the boom is in the position for the proper weight distribution for transporting, tie down to the trailer using the procedure described in section I 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.

MARKLIFT SELF-PROPELLED BOOM
(MODEL 40I)

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. Check tire pressure.

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 L.P. Use diesel fuel when unit is diesel.

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 door in 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 the engine stall, the operator must either push the stop button or turn off ignition switch to prevent current path to coil.

10. Position selector switch to ground and 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. Depress foot switch prior to moving any control function switches. This increases engine RPM ( if throttle HI/LO selector is positioned in HI ), 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 and gradually move controller in direction selected. The controller handle is spring-centered and self-locking to prevent inadvertent 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 STEERING WHEELS UNDER THE BOOM. 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 DECALS ATTACHED TO EACH END OF THE CARRIAGE ASSEMBLY WILL HELP ORIENT THE OPERATOR TO THE CONTROL CONSOLE.

13. Brake adjustments may be made by turning a small needle valve. (parts page 22 , item 7). The valve is merely a time delay for applying the brakes. With the valve completely open, the time delay for applying the brakes is at a minimum. Set the delay valve to stop the machine in approximately three feet on level ground driving in high speed.

NOTE: See forematter page viii reduced copy of New Equipment Condition Report that is sent with each machine.

MARKLIFT SELF-PROPELLED BOOM
(MODEL 40I)

Every operator of the MARKLIFT must know, 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 be familiar with 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 the 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 14 & 15 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 with the safety strap attached.

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. Report any misuse of equipment to the proper personnel.

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 protruding 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 and/or miscellaneous boxes. If required to store such items, they must be situated in such a way as to prevent walking and tripping over such items.

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.

## 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."

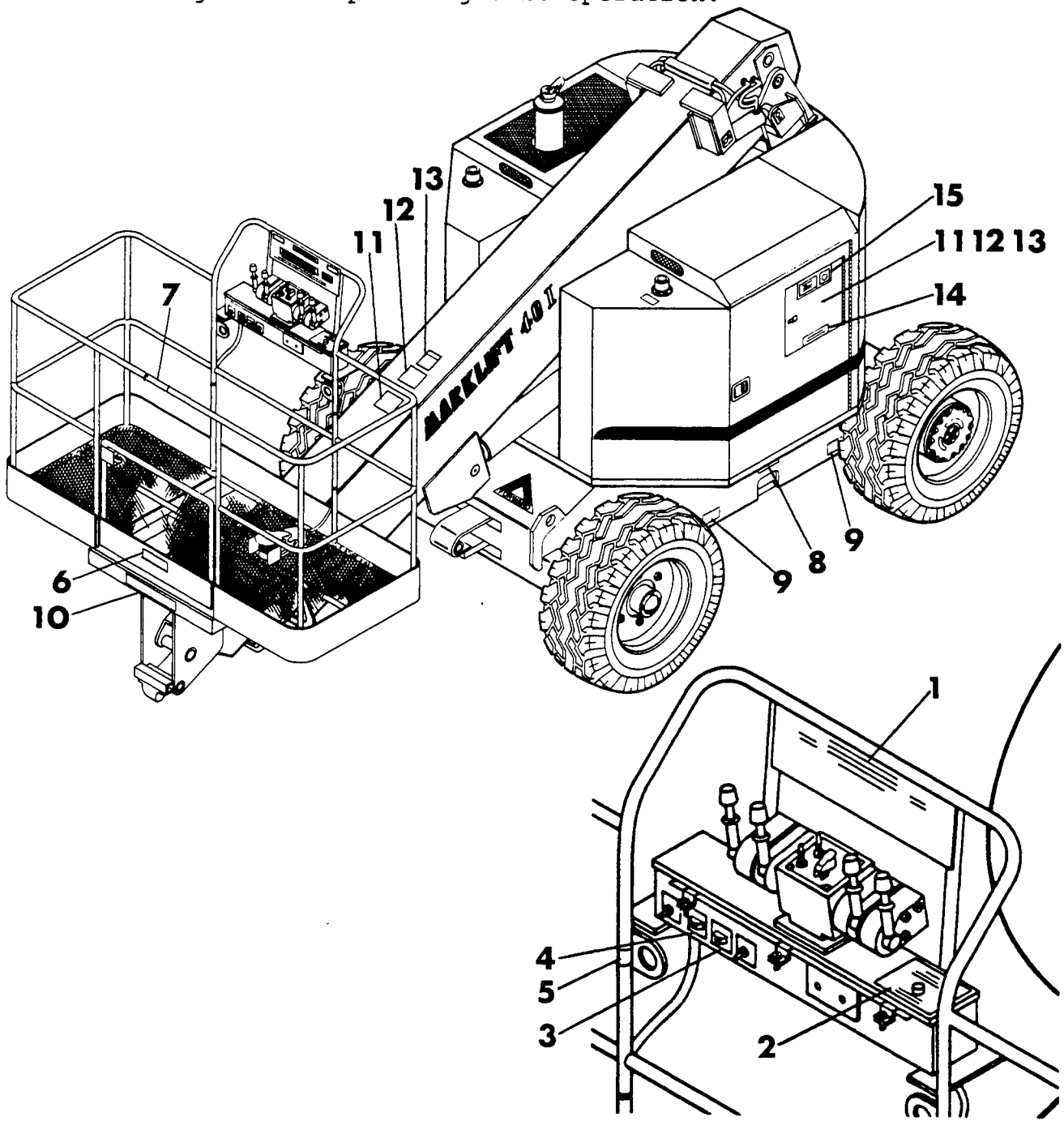
In addition to the above wording, the following statement in small lettering shall be provided on the warning sign: "For Minimum Clearances of High-Voltage Lines In Excess of 50,000 Volts, See Article 86, Title 8, High-Voltage Electrical Safety Orders."

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

Be completely familiar with all warning and caution decals that are posted on the unit.

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



1

**CAUTION**

UNLAWFUL TO OPERATE THIS EQUIPMENT WITHIN 10 FEET OF HIGH VOLTAGE LINES UP TO 50,000 VOLTS
REFER TO OPERATING HANDBOOK FOR SAFE DISTANCE AT HIGHER VOLTAGES

**CAUTION**

STANDARD AERIAL OPERATING PROCEDURE

1. WITH MASTER SWITCH AT GROUND CONTROL STATION TO 'ON' AND SELECTOR SWITCH TO 'AERIAL' ENTER PLATFORM, ATTACH YOUR SAFETY BELT FIRST, THEN START MACHINE. (DO NOT DEPRESS FOOT SWITCH WHEN ATTEMPTING TO START MACHINE)
2. TOGGLE SWITCHES ARE SOLENOID FUNCTIONS AND ARE OPERATED BY DEPRESSING FOOT SWITCH FIRST.

OPERATE ALL PROPORTIONAL FUNCTIONS IN THE FOLLOWING MANNER

A. DEPRESS FOOT SWITCH AND LIFT CONTROLLER LOCKING STEM UPWARD, BEFORE ATTEMPTING TO MOVE HANDLE FORWARD OR BACK.
B. MOVE CONTROLLER HANDLE SLOWLY IN DIRECTION DESIRED. FUNCTION SPEED WILL RESPOND IN PROPORTION TO AMOUNT OF HANDLE MOVEMENT.

DRIVE AND STEERING DIRECTION, AS INDICATED ON CONTROLS, APPLIES WHEN BOOM IS OVER STEERING WHEELS. THE DIRECTION IS REVERSED, WHEN BOOM IS OVER NON-STEERING WHEELS. (FORWARD TRIANGLE DECALS, ON BASE, ALWAYS INDICATE DRIVE DIRECTION CORRECTLY)

3. THE DRIVE SELECTOR SWITCH, ALLOWS THE MARKLIFT TO TRAVEL AT HIGHER SPEEDS, WHEN THE BOOM IS BELOW HORIZONTAL AND FULLY RETRACTED.

EMERGENCY OVERRIDES

DEPRESS FOOT SWITCH, THEN TURN ON EMERGENCY PUMP TO RESTORE CONTROLS. (IF UNIT IS SO EQUIPPED) OR - DEPRESS PROPER SWITCH FOR EMERGENCY BOOM DESCENT OR RETRACTION.

IT IS THE OPERATOR'S RESPONSIBILITY TO READ AND UNDERSTAND, THE OPERATION & SAFETY HANDBOOK AND ALL DECALS BEFORE USING THIS MACHINE!

20859

2

**CAUTION**

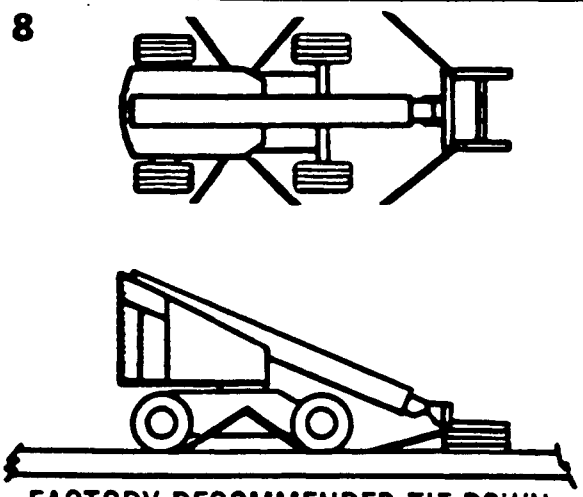
LIGHT INDICATES AN UNSAFE OUT OF LEVEL OPERATING CONDITION

BOOM FUNCTIONS ARE INOPERATIVE WHEN LIGHT IS ON

CONTROLS WILL BE RESTORED WHEN UNIT IS DRIVEN TO A SAFE LEVEL CONDITION

20444

8



FACTORY RECOMMENDED TIE DOWN TRANSPORTING DIAGRAM 20508

**CAUTION** UNLAWFUL TO OPERATE THIS EQUIPMENT WITHIN 10 FEET OF HIGH VOLTAGE LINES **CAUTION**

2014

7

4

THROTTLE
HI
LO

**EMERGENCY DESCENT**

PUSH TO LOWER BOOM

20406

9

**CAUTION**

MONOFILLED TIRES ONLY

**CAUTION**

22173

6

**LOAD CAPACITY 500 LBS.**

**(EVENLY DISTRIBUTED LOAD)**

2022

5

ATTACH SAFETY BELT

22174

3

**EMERGENCY RETRACTION**

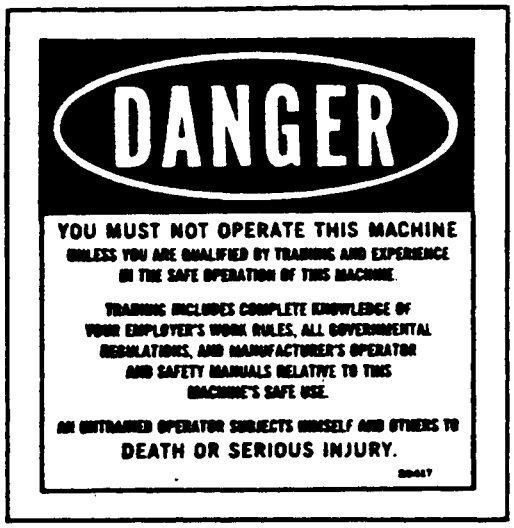
PUSH TO RETRACT BOOM

20407

10




11




12




13



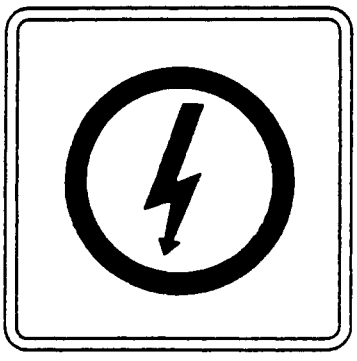

ONE EACH OF DECALS11,12&13
ARE ALSO LOCATED INSIDE GROUND
CONTROL BOX ACCESS DOOR

14




15



DECAL 15
IS ALSO
LOCATED
FARSIDE

MARKLIFT SELF-PROPELLED BOOM
(MODEL 40I)

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

The MARKLIFT employs 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 controlable system utilizing 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 connected 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 removed from the hydraulic circuit during the engine start operations so as not to create excessive starter drag.

The throttle is activated hydraulically directly from the pump high pressure discharge, though 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 350 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 completely fill automatically.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

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 either switches or proportional controllers.

The ground control console houses the necessary switches for starting and stopping the engine - a selector switch for isolating either the ground or aerial control console, and the required toggle switches for moving the boom. The ground console also contains a keyed ignition/start 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 junction box. The intent of the footswitch is to provide an additional safety interlock in the control circuit to produce foot as well as hand movement by the operator, thereby requiring maximum operator attention. The function of the footswitch only completes the electrical cicuit to the aerial control console and engine throttle. The footswitch, in no way, is directly connected to the drive braking system.

Engine start and stop are independently wired around the selector switch, making them operable 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 on the controller. The valve is electrically coupled to the controller and responds only to the signal level transmitted to it by the operator.

The operator must learn how to move the controller slowly to obtain a smooth, erratic-free transition from start up to wide open and back to neutral.

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 accomplished through two limit switches sensing the attitude and extension positions of the Boom, wired in parallel to the solenoid valves which selects HI & LO speed.

A 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 $5^{o}$ or more out of level.

The level sensor prevents any operation of the boom controls at $5^{\circ}$ or more out of level. When the unit is driven to a slope of less than $5^{\circ}$, the buzzer and light go off and the boom controls become operable.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

MARKLIFT Boom units equipped with a dual fuel system allow the operator to remotely 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.
Prior to 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 "HI" speed. Switch fuel selector to gasoline. The engine will begin to stall as the carburetor

SWITCHING FROM PROPANE TO GASOLINE

bowl starts filling with gasoline. Switch back to propane until the engine resumes high speed. Switch back and forth from LPG 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 "HI" 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.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

It shall be the responsibility of all users of the MARKLIFT to read and comply with the following operating instructions. They are designed to promote safety and a better understanding of the operation of the self-propelled aerial platform.

These instructions do not propose to be all inclusive, nor to supplement or replace other additional safety and/or precautionary measures covering usual or unusual conditions. If these instructions conflict in any way with the state, local or federal statute or regulations, said statute or regulations shall supercede these instructions, and it shall be the responsibility of each user to comply therewith, and inform MARK INDUSTRIES of the variances.

The following are applicable excerpts from the federal register, title 29, chapter XVII, O.S.H.A. - 1926.556.

"Extendible and articulating Boom platforms"

(i) Lift controls shall be tested each day, prior to use, to determine that such controls are in safe and working condition.

(ii) Only authorized persons shall operate an aerial lift.

(iii) Belting off to an adjacent pole, structure, or equipment while working from an aerial lift shall not be permitted.

(iv) Employees shall always stand firmly on the floor of the basket, and shall not sit or climb on edge of the basket or use planks, ladders, or other devices for a work position.

(v) A body belt shall be worn and a lanyard attached to the Boom or basket when working from an aerial lift.

(vi) Boom and basket load limits specified by the manufacturer shall not be exceeded.

(vii) Not applicable

(viii) Not applicable

(ix) Articulating Boom and extendible Boom platforms, primarily designed as personnel carriers, shall have both platform (upper) and lower controls. Upper controls shall be in or beside the platform within easy reach of the operator. Lower controls shall provide for over-riding the upper controls. Controls shall be plainly marked as to their function. Lower level controls shall not be operated unless permission has been obtained from the employee in the lift, except in case of emergency.

(x) Climbers shall not be worn while performing work from aerial lift.

(xi) Not applicable

(xii) Before moving an aerial lift for travel, the Boom(s) shall be inspected to see that it is properly cradled.

## GENERAL CHECKOUT AND OPERATING INSTRUCTIONS

| | GENERAL CHECK OUT LIST | DAILY | WEEKLY | MONTHLY |
|---|---|---|---|---|
| 1. | CHECK FUEL & HYDRAULIC TANK LEVELS | X | | |
| 2. | CHECK ENGINE OIL LEVEL | X | | |
| 3. | CHECK BATTERY WATER LEVEL | X | | |
| 4. | CHECK FOR ANY LOOSE OR WORN HARDWARE | X | | |
| 5. | CHECK CRITICAL WELD AREAS FOR CRACKS | X | | |
| 6. | CHECK TIRE PRESSURES (IF APPLICABLE) | X | | |
| 7. | CHECK FOR ANY HYDRAULIC LEAKS & CORRECT | | X | |
| 8. | CHECK FOR ANY STRUCTURAL DAMAGE & CORRECT | | X | |
| 9. | CHECK OVERALL PERFORMANCE OF MACHINE | | X | |
| 10. | CHECK & CLEAN ENGINE INTAKE AIR FILTER | | X | |
| 11. | CHECK FOR WEAR ON CABLES & HOSES | | X | |
| 12. | GREASE* STEERING LINKAGE | | | X |
| 13. | GREASE* TURRET ROTATION GEAR BOX | | | X |
| 14. | GREASE* RING GEAR | | | X |

* REFER TO OPERATION AND MAINTENANCE INSTRUCTION MANUAL FOR TYPE OF LUBRICANTS.

OPERATE THE MARKLIFT IN FOLLOWING MANNER FROM GROUND CONTROL BOX.

1. TURN IGNITION SWITCH TO START.
2. ALLOW ENGINE TO IDLE AT LEAST ONE MINUTE.
3. MAKE SURE AMMETER INDICATES "CHARGE".
4. POSITION AERIAL/GROUND SELECTOR SWITCH TO GROUND.
5. OPERATE ALL THREE BOOM FUNCTIONS MOMENTARILY IN BOTH DIRECTIONS MAKING SURE THE UNIT RESPONDS ACCORDINGLY.
6. POSITION SELECTOR SWITCH TO AERIAL AND ENTER WORK PLATFORM.

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 prior to driving the unit. He will soon find that gradual starts and stops are relatively easy to perform. Gradually raise the Boom higher, and drive unit again until maximum height is established. Remember, at all times, that the proportional signal from the controller to the valve is controlled by the operator. There is approximtely 3 degrees of "dead" motion each side of the controller NEUTRAL position.

The best operation position can be achieved by placing the thumb over the knob of the controller and wrapping the fingers loosely around the locking stem. Now, rest the heel of the hand on the controller housing and apply a downward motion with the thumb, making the index finger lift the locking stem. Once the controller is disengaged and moved foreward or reverse, the pressure on the thumb may be omitted 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 less than 30 minutes practicing, he should be capable of smoothly starting and stopping the machine on all proportional functions.

Although at a reduced speed, all hydraulic functions are operable with the emergency pump running. From the work platform, position emergency pump switch to "ON" position. This will "KILL" the engine and permit the emergency pump to run. Standard operation procedure then resumes by depressing the foot switch and moving controller handles or toggle switches in the desired direction of motion.

The MARKLIFT is designed to be towed in plant, only, and NOT to exceed 10 mph. The towing kit is available from the factory as on option. Towing the MARKLIFT can be accomplished by locking out the plantary drive hubs, and hydraulic steering. (see page 31)
When hubs are disengaged, there are no wheel brakes. Care should be taken to disengage on flat level ground and all precautions taken to prevent accidents.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

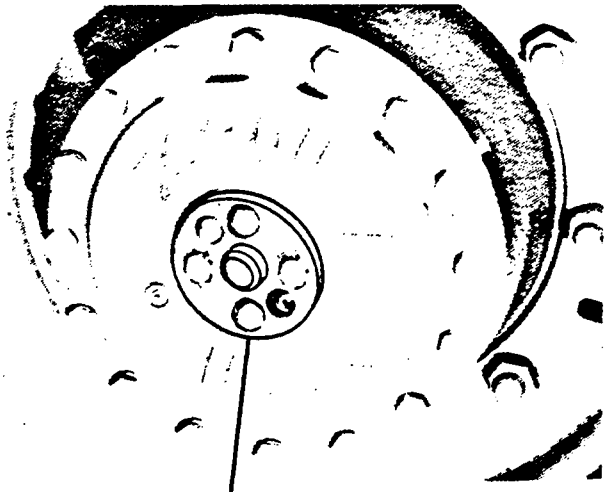
TORQUE HUB MUST BE DISENGAGED FOR TOWING.

MAXIMUM TOWING SPEED IS 10 mph.

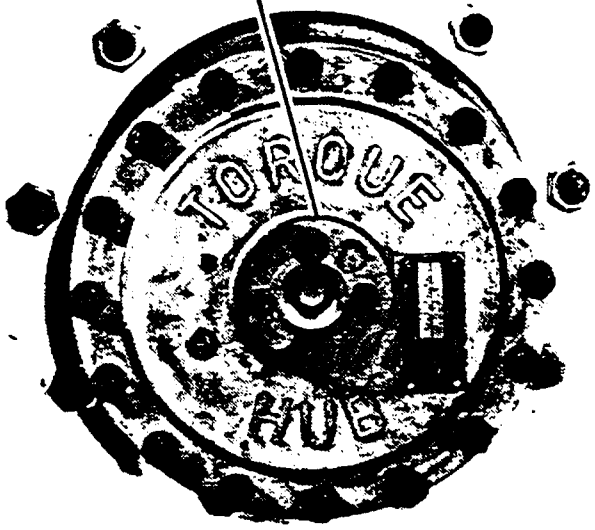
TO DISENGAGE TORQUE HUB, REVERSE THE DISCONNECT CAP. THE KNOB ON THE CAP DISENGAGES THE DRIVE HUB INPUT SHAFT.

CAUTION: BRAKES ARE ALSO DISENGAGED!

HUB ENGAGED



DISCONNECT CAP




HUB DISENGAGED

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

This preventative maintenance information is intended as a general guide which may be expanded by the owners normal maintenance program.

Mark Industries recommends the following items be checked:

WEEKLY

1. Clean unit by removing oil and grease with thinner. Machine may be washed with soap and water.
2. Operation and safety decals in place and legible.
3. Tire pressure at 35 P.S.I.
4. Tire condition (free of serious cuts or defects)
5. Proper engine oil level.
6. Proper hydraulic oil level.
7. Air cleaner.
8. Battery electrolyte level.
9. Battery fully charged.
10. Fuel level, daily.
11. Check and lube, if necessary. (See page 34)
12. Engine RPM should be
    WISC. - 1800 low
    2400 high
13. Proper brake operation.
14. Record hour meter reading.

MONTHLY, OR FIRST 50 HOURS

1. Check and lube, if necessary.
2. Check condition of battery.
3. Change engine oil filter.
4. Change hydraulic return oil filter.
5. Check ring gear bolt for torque - 175 ft. lbs. Turret, 85 ft. lbs. Torque values are with lubrication.
6. Check torque hub oil level. (See page 37)
7. Check air cleaner.
8. Check oil level, rotation gear box.

SIX MONTHS, OR 100 HOURS

1. Check and lube, if necessary.
2. Change pilot filter element. (Item 9, page 35)
3. Change engine oil filter.
4. Change hydraulic return line filter element. (Item 10, page 35)

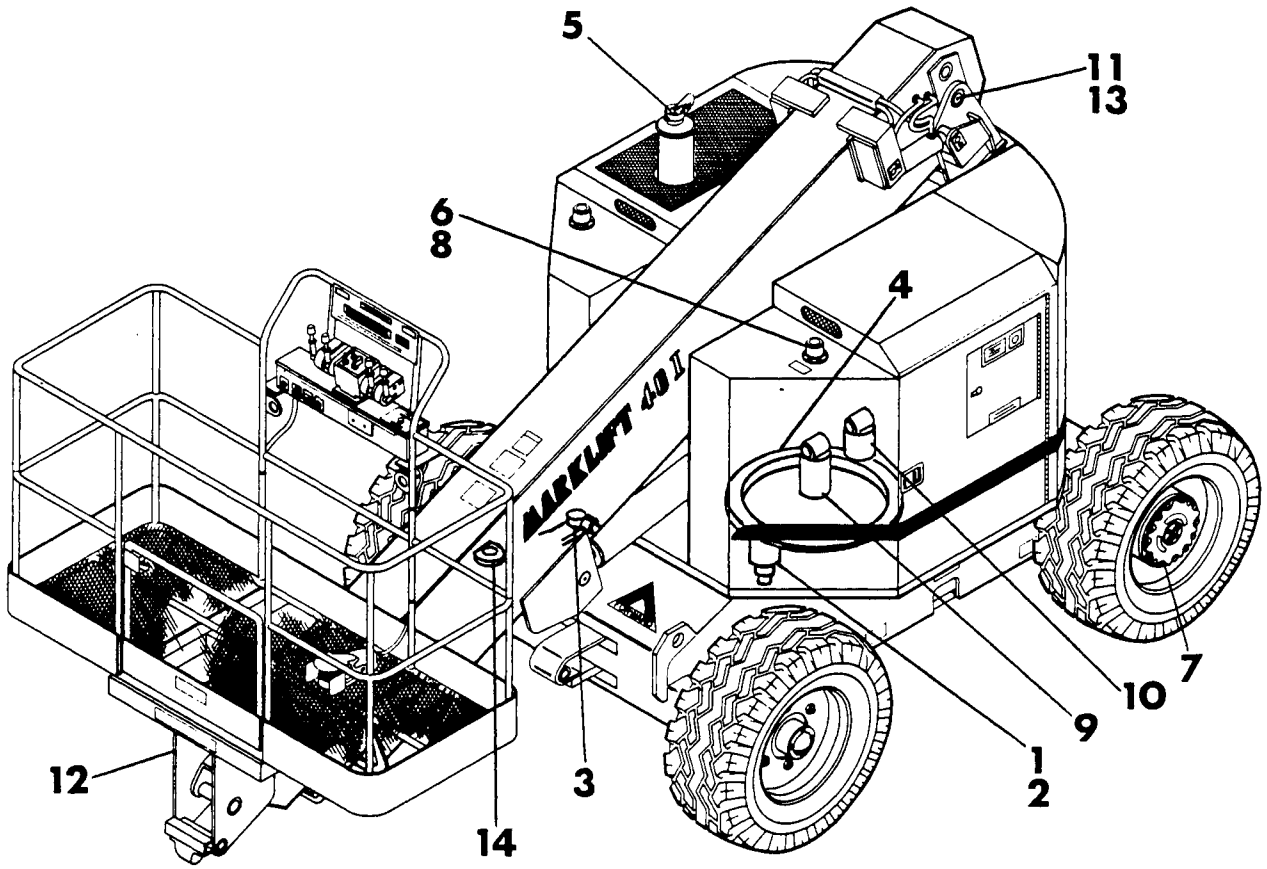
ANNUALLY

1. Replack all wheel bearings.
2. Change hydraulic oil.
3. Check Torque hub oil level.
4. Check ring gear bolts for Torque - 175 ft.lbs.

   Turret, 85 ft. lbs. base. (Torque values are with lubrication.
5. Change hydraulic return line filter.
6. Change pilot line filter.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)




| ITEM | DESCRIPTION | LUBRICANT | FREQUENCY |
|---|---|---|---|
| 1 | ROTATION GEAR BOX GEARING | GEAR OIL SAE 90 | MONTHLY |
| 2 | ROTATION GEAR BOX BEARINGS | MOBILCOTE TYPE-S GEAR GREASE OR EQUIVALENT | MONTHLY |
| 3 | TIE ROD PIN | MOBILCOTE TYPE-S GEAR GREASE | MONTHLY |
| 4 | RING GEAR | MOBILCOTE TYPE-S GEAR GREASE (4) ZERKS-ROTATE GEAR WHILE GREASING | MONTHLY |

| ITEM | DESCRIPTION | LUBRICANT | FREQUENCY |
|---|---|---|---|
| 5 | ENGINE | SAE 30 | SEE WISCONSIN OPERATING INSTRUCTIONS (PAGE 2) IN VENDOR SECTION |
| 6 | HYDRAULIC FLUID | SEE PAGE 36 | YEARLY |
| 7 | TORQUE HUB | SEE PAGE 37 | YEARLY |
| 8 | HYDRAULIC TANK STRAINER | | CLEAN YEARLY |
| 9 | PILOT FILTER ELEMENT-20472 | | REPLACE EVERY 300 HOURS |
| 10 | RETURN LINE FILTER ELEMENT-20477 | | REPLACE EVERY 100 HOURS |
| 11 | MAIN BOOM PIVOT PIN | MOBILCOTE TYPE-S GEAR GREASE | MONTHLY |
| 12 | EXTENSION SHEAVES | MOBILCOTE TYPE-S GEAR GREASE | MONTHLY |
| 13 | RETRACTION SHEAVES | MOBILCOTE TYPE-S GEAR GREASE | MONTHLY |
| 14 | STEERING YOKE KING PINS | MOBILCOTE TYPE-S GEAR GREASE | MONTHLY |

## EQUIVALENT BEARING GREASE

**UNION - UNOBA EP-2**

**SHELL - ALVINIA EP-2**

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

| OIL COMPANY | CHEVRON | GULF | SHELL | UNION |
|---|---|---|---|---|
| Brand Name | ATF Dexron 11 | ATF Dexron 11 | Donax-T6 | ATF Dexron |
| Viscosity - SUS @ 100°F | 187.4 | 195 | 200 | 200 |
| SUS @ 210°F | 49.2 | 50.4 | 50 | 52.3 |
| Viscosity Index Typical | 153° | 155° | 160° | 172° |
| Flash Point °F | 400° | 405° | 390° | 395° |
| Pour Point °F | -40° | -50° | -50° | -45° |

MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

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.



MARKLIFT SELF-PROPELLED BOOM

(MODEL 40I)

ENGINE

1. Will not start or run.

   A. Check ground control box ciruit breaker.
   B. Check for opened fuel shut-off valve.
   C. Check fuel selector to see if it is in L.P. 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 HI/LO selector switch.
   B. Check throttle solenoid valve.
   C. Refer to your local service facility.

3. No idle.

   A. Check aerial HI/LO selector switch.
   B. Check throttle solenoid valve.
   C. Refer to your local service facility.

4. Dies under load.

   A. Check governor setting.

   B. Check carburator air/fuel mixture

   C. Rever 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. Refer to your local service facility.

2. No functions operate from ground control box.

   A. Check position of aerial/ground box selector switch.

   B. Check pilot valve pressure.

   C. 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.

BRAKES

1. No brakes or slow pressure.

   A. Check drive hub disengagement caps.

   B. Check brake delay valve.

   C. Refer to your local service facility.

DRIVE

1. Low torque drive.

   A. Check high pressure.

   B. Check pilot valve control pressure.

   C. Refer to your local service facility.

HYDRAULIC MOTOR

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

   A. Check planetary wheel drive to be sure engaging disc is NOT positioned in free wheeling.

   B. Check high pressure hydraulic port with 3000 PSI guage.

   C. 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 reservoir hydraulic oil level guage.

   C. Check suction line fittings for tightness.

   D. Check oil. USE ATF DEXRON II ONLY.

   E. Refer to your local service facility.

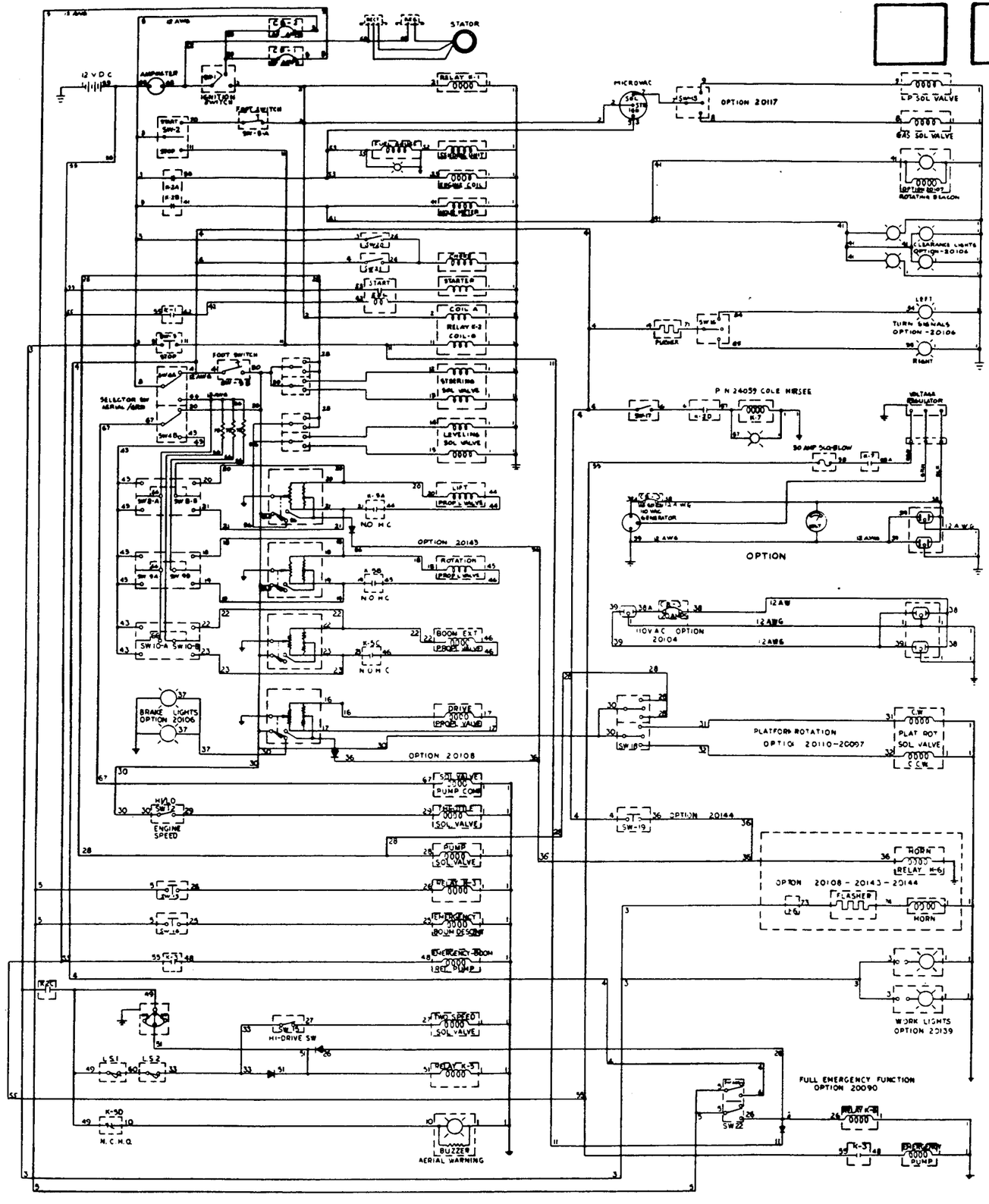
MARKLIFT SELF-PROPELLED BOOM

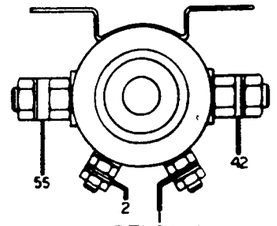
(MODEL 40I)

| ITEM | PART NO. | DESCRIPTION |
|---|---|---|
| 1. | 20477 | Return line filter element. |
| 2. | 20472 | Pilot filter element. |
| 3. | 66528 | Steering cylinder seal kit. |
| 4. | 21262 | Slave leveling cylinder seal kit (2 section boom.) |
| | 66045 | Slave leveling cylinder seal kit (3 section boom.) |
| 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. |

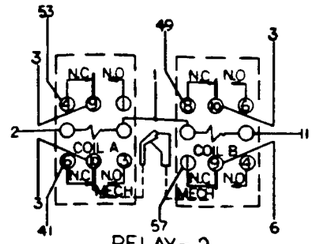
SERVICE TOOLS

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

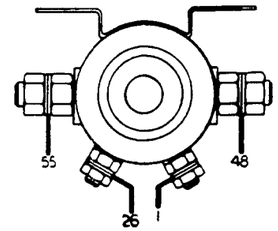


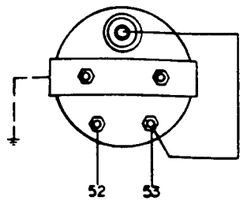

RELAY - 1
POWER RELAY
P/N 24059 COLE-HERSEE



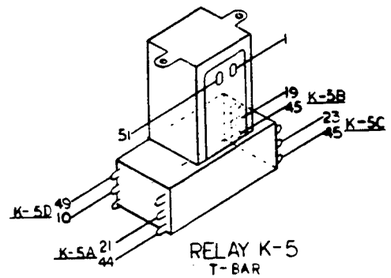

RELAY - 2
LATCHING TYPE
P/N KB 17DG POTTER-BRUMFIELD



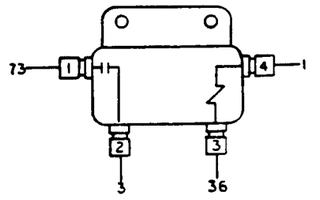

RELAY-3
POWER RELAY
P/N 24059 COLE HERSEE




FUEL GAUGE
P/N 82303 STEWART WARNER

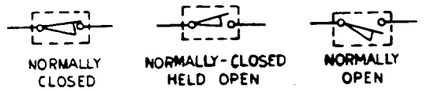



RELAY K-5
T-BAR

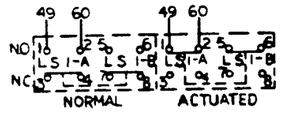



RELAY - 6
P/N D-1768 DELCO-REMY
P N 16262

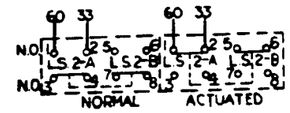
LEGEND FOR LIMIT SWITCHES



NORMALLY CLOSED | NORMALLY-CLOSED HELD OPEN | NORMALLY OPEN | NORMALLY-OPEN HELD CLOSED

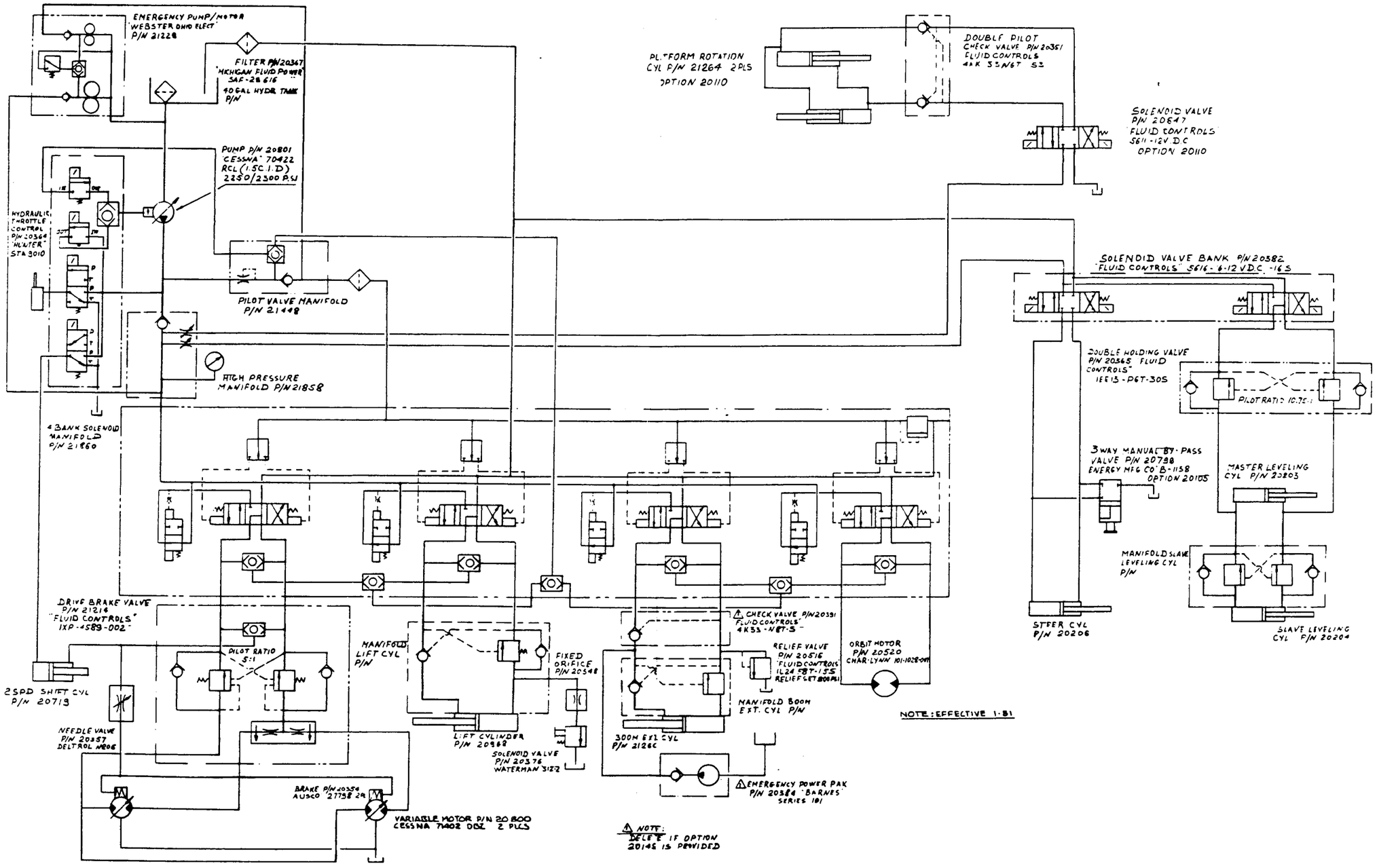



LIMIT SWITCH NO. 1




LIMIT SWITCH NO. 2

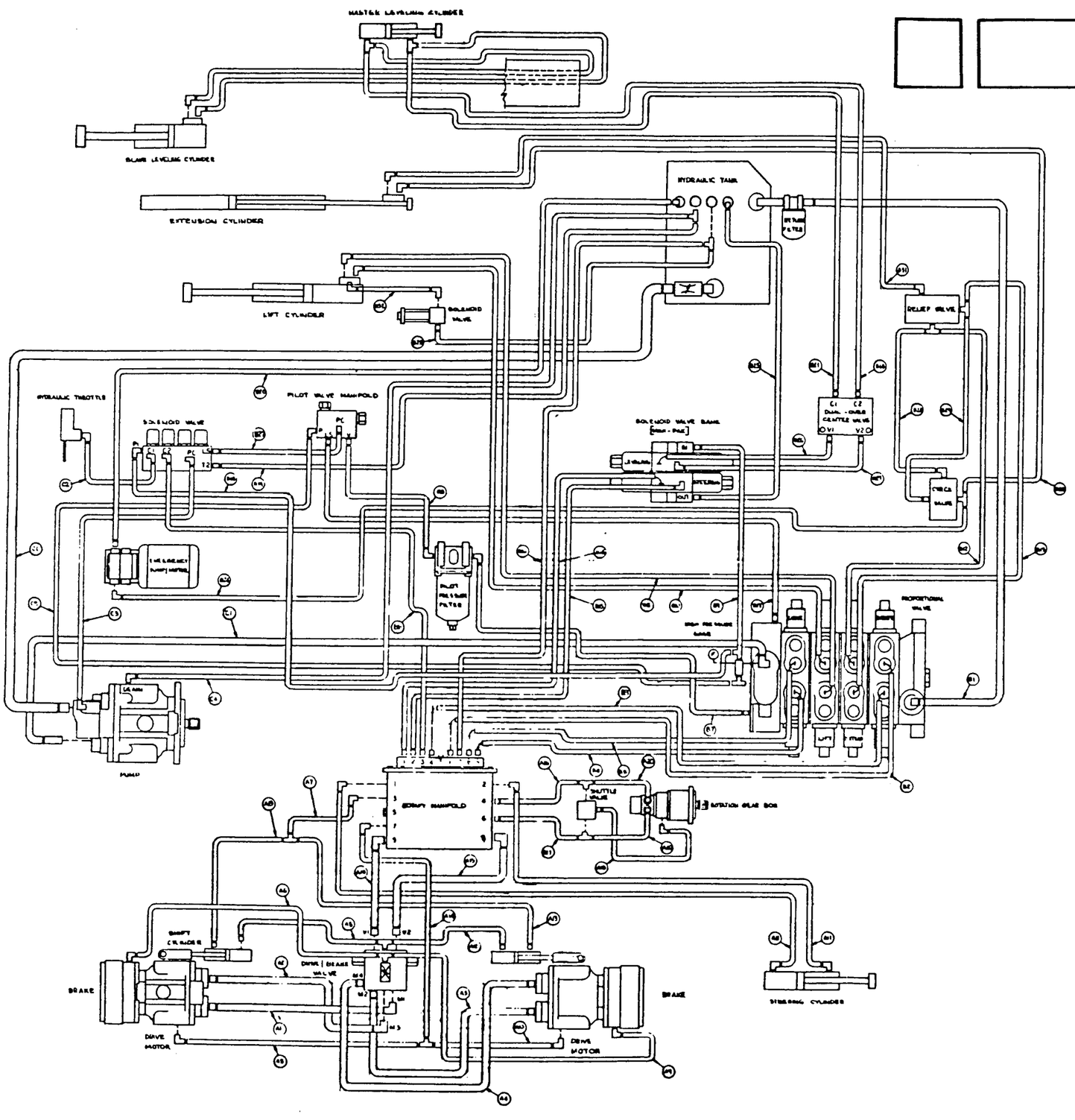
DWG NO. 20068


EMERGENCY PUMP/MOTOR
WEBSTER OHIO ELECT
P/N 21228
FILTER P/N 20367
MICHIGAN FLUID POWER
SAF-25 616
40 GAL HYDR TANK
P/N
PUMP P/N 20801
CESSNA 70422
RCL (1.5C.I.D)
2250/2300 P.S.I
HYDRAULIC
THROTTLE
CONTROL
P/N 20366
HUNTER
STA 3010
PILOT VALVE MANIFOLD
P/N 21448
HIGH PRESSURE
MANIFOLD P/N 21858
4 BANK SOLENOID
MANIFOLD
P/N 21860
DRIVE BRAKE VALVE
P/N 21216
FLUID CONTROLS
IXP-4589-002
PILOT RATIO
5:1
2 SPD SHIFT CYL
P/N 20719
NEEDLE VALVE
P/N 20357
DELTROL M806
BRAKE P/N 20356
AUSCO 27758 2A
VARIABLE MOTOR P/N 20 800
CESSNA 71402 DBZ 2 PLS
MANIFOLD
LIFT CYL
P/N
FIXED
ORIFICE
P/N 20548
LIFT CYLINDER
P/N 20988
SOLENOID VALVE
P/N 20376
WATERMAN 3122
300M EXT CYL
P/N 21266
CHECK VALVE P/N 20331
FLUID CONTROLS
4K33-NET-S
RELIEF VALVE
P/N 20516
FLUID CONTROLS
IL24 PBT-155
RELIEF SET @ 2000 PSI
ORBIT MOTOR
P/N 20520
CHAR-LYNN 101-1028-009
MANIFOLD BOOM
EXT. CYL P/N
EMERGENCY POWER PAK
P/N 20384 BARNES
SERIES 101
NOTE:
DELETE IF OPTION
20145 IS PROVIDED
NOTE: EFFECTIVE 1-81
PLATFORM ROTATION
CYL P/N 21264 2 PLS
OPTION 20110
DOUBLE PILOT
CHECK VALVE P/N 20351
FLUID CONTROLS
4AK 33 N/BT S2
SOLENOID VALVE
P/N 20647
FLUID CONTROLS
561I-12V.D.C
OPTION 20110
SOLENOID VALVE BANK P/N 20382
FLUID CONTROLS 5616-6-12 V.D.C. -16 S
DOUBLE HOLDING VALVE
P/N 20365 FLUID
CONTROLS
IEE13-P6T-30S
PILOT RATIO 10.75:1
3 WAY MANUAL BY-PASS
VALVE P/N 20798
ENERGY MFG CO B-1158
OPTION 20105
MASTER LEVELING
CYL P/N 23203
MANIFOLD SLAVE
LEVELING CYL
P/N
STEER CYL
P/N 20206
SLAVE LEVELING
CYL P/N 20204

DWG NO. 20073

# HYDRAULIC HOSE DIAGRAM - 22478 (40I)






KIT "B"

| ITEM NO. | QTY. REQ'D | NO. PART OF IDENTIFYING | DESCRIPTION |
|---|---|---|---|
| B9 | 1 | 13213-06-0460 | HOSE ASSEMBLY |
| B8 | 1 | 13210-06-0470 | |
| B7 | 1 | 13213-06-0200 | |
| B6 | 1 | 13210-04-0280 | |
| B5 | 1 | 13213-12-0280 | |
| B4 | 1 | 13212-12-0320 | |
| B3 | 1 | 13212-06-0290 | |
| B2 | 1 | 13213-06-0270 | |
| B1 | 1 | 13210-16-0270 | HOSE ASSEMBLY |
| | | | |

KIT "A"

| ITEM NO. | QTY. REQ'D | NO. PART OF IDENTIFYING | DESCRIPTION |
|---|---|---|---|
| A20 | 2 | 13210-06-0100 | HOSE ASSEMBLY |
| A19 | 1 | 13213-04-0250 | |
| A18 | 1 | 13213-04-0250 | |
| A17 | 1 | 13210-06-0140 | |
| A16 | 1 | 13210-06-0174 | |
| A15 | 2 | 13210-12-0450 | |
| A14 | 1 | 13210-06-0550 | |
| A13 | 1 | 13213-04-0190 | |
| A12 | 1 | 13213-04-0200 | |
| A11 | 2 | 13210-04-0450 | |
| A10 | 1 | 13210-06-0170 | |
| A9 | 1 | 13210-04-0180 | |
| A8 | 1 | 13213-04-0120 | |
| A7 | 1 | 13210-04-0600 | |
| A6 | 1 | 13210-04-0220 | |
| A5 | 1 | 13210-06-0120 | |
| A4 | 1 | 13213-12-0180 | |
| A3 | 1 | 13213-12-0270 | |
| A2 | 1 | 13213-12-0300 | |
| A1 | 1 | 13213-12-0260 | HOSE ASSEMBLY |

KIT "C"

| ITEM NO. | QTY. REQ'D | NO. PART OF IDENTIFYING | DESCRIPTION |
|---|---|---|---|
| C6 | 1 | 13205-20-0260 | HOSE ASSEMBLY |
| C5 | 1 | 13210-06-0310 | |
| C4 | 1 | 13210-06-0630 | |
| C3 | 1 | 13210-04-0230 | |
| C2 | 1 | 13210-12-0224 | |
| C1 | 1 | 13210-12-0224 | HOSE ASSEMBLY |
| | | | |

KIT "B"

| ITEM NO. | QTY. REQ'D | NO. PART OF IDENTIFYING | DESCRIPTION |
|---|---|---|---|
| B32 | 1 | 13210-04-0650 | HOSE ASSEMBLY |
| B31 | 1 | 13210-08-0400 | |
| B30 | 1 | 13210-08-0410 | |
| B29 | 1 | 13210-08-0150 | |
| B28 | 1 | 13213-04-0160 | |
| B27 | 1 | 13210-04-0130 | |
| B26 | 1 | 13210-04-0120 | |
| B25 | 1 | 13213-06-0110 | |
| B24 | 1 | 13213-06-0110 | |
| B23 | 1 | 13210-04-0740 | |
| B22 | 1 | 13213-04-0120 | |
| B21 | 1 | 13213-04-0500 | |
| B20 | 1 | 13213-06-0500 | |
| B19 | 1 | 13210-06-0340 | |
| B18 | 1 | 13210-60-0152 | |
| B17 | 1 | 13210-04-0270 | |
| B16 | 1 | 13210-08-0600 | |
| B15 | 2 | 13210-04-0330 | |
| B14 | 1 | 13213-04-0600 | |
| B13 | 1 | 13215-08-0360 | |
| B12 | 1 | 13213-08-0360 | |
| B11 | 1 | 13212-06-0650 | |
| B10 | 1 | 13213-06-0550 | HOSE ASSEMBLY |

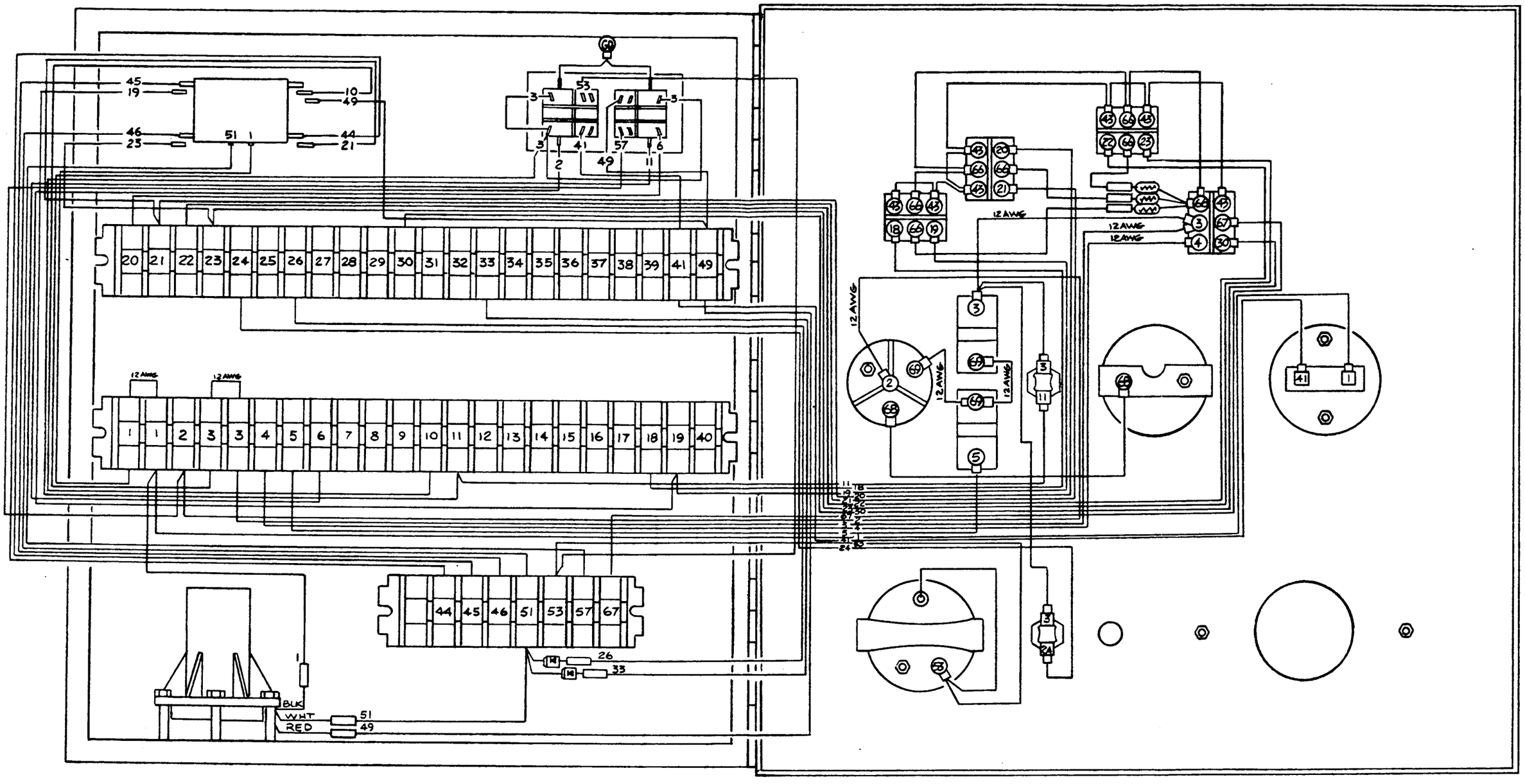
NOTES:

1. KIT "A" -- BASE
2. KIT "B" -- TURRET
3. KIT "C" -- GAS MODELS ONLY
4. KIT "D" -- DIESEL MODELS ONLY

GAS ENGINE WILL REQUIRE KITS "A","B",&"C"
DIESEL ENGINE WILL REQUIRE KITS "A","B",&"D"
EACH TO BE PACKED & SHIPPED SEPARATELY.

DWG. NO. 22478

FIGURE 15 - GROUND CONTROL BOX ASSEMBLY




WIRING DIAGRAM LEGEND

- ITEM 21
- ITEM 22
- ITEM 23
- ITEM 24
- ITEM 26
- ITEM 27

# MARKLIFT SELF-PROPELLED BOOM
## (MODEL 40I)
## INDEX


| FIG. NO. | TITLE | PAGE |
|---|---|---|
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| 1A | FINAL ASSEMBLY (3 SECTION BOOM) | 6 |
| 2 | CARRIAGE ASSEMBLY | 11 |
| 3 | STEERING ARM ASSEMBLY | 15 |
| 4 | STEERING HUB ASSEMBLY | 16 |
| 4A | STEERING YOKE ASSEMBLY (R.H.) | 17 |
| 4B | STEERING YOKE ASSEMBLY (L.H.) | 18 |
| 5 | STEERING TIE ROD ASSEMBLY | 19 |
| 6 | STEERING CYLINDER ASSEMBLY | 20 |
| 7 | DRIVE/BRAKE VALVE ASSEMBLY | 21 |
| 8 | HYDRAULIC MOTOR ASSEMBLY | 23 |
| 8A | 2-SPEED SHIFT CYLINDER ASSEMBLY | 25 |
| 9 | TURRET ASSEMBLY (2 SECTION BOOM) | 26 |
| 9A | TURRET ASSEMBLY (3 SECTION BOOM) | 32 |
| 10 | ENGINE & PUMP ASSEMBLY. | 38 |
| 11 | LIFT CYLINDER ASSEMBLY | 40 |
| 11.1 | LIFT CYLINDER ASSEMBLY REVISED | 40.1 |
| 11A | LIFT CYLINDER SUB-ASSEMBLY | 41 |
| 11A.1 | LIFT CYLINDER SUB-ASSEMBLY REVISED | 41.1 |
| 12 | DUAL OVER CENTER VALVE ASSEMBLY | 42 |
| 13 | FUEL TANK ASSEMBLY | 43 |
| 14 | ROTATION GEAR BOX ASSEMBLY | 44 |
| 15 | GROUND CONTROL BOX ASSEMBLY | 45 |
| 16 | FOUR SPOOL PROPORTIONAL VALVE ASSEMBLY | 49 |
| 16A | PROPORTIONAL VALVE ASSEMBLY REVISED | 50.1 |
| 17 | MINIPAK SUB-ASSEMBLY | 51 |
| 17A | MINIPAK SUB-ASSEMBLY (OPTION) | 51.1 |
| 18 | RELIEF VALVE ASSEMBLY | 52 |

| FIG. NO. | TITLE | PAGE |
|---|---|---|
| 18A | CHECK VALVE ASSEMBLY | 53 |
| 19 | PILOT VALVE MANIFOLD ASSEMBLY | 54 |
| 20 | HYDRAULIC TANK ASSEMBLY | 55 |
| 21 | MASTER LEVELING CYLINDER ASSEMBLY | 57 |
| 21.1 | MASTER LEVELING CYLINDER ASSEMBLY REVISED | 57.1 |
| 21A | MASTER LEVELING CYLINDER | 58 |
| 21A.1 | MASTER LEVELING CYLINDER REVISED | 58.1 |
| 22 | ROTARY MANIFOLD ASSEMBLY | 59 |
| 23 | SOLENOID VALVE ASSEMBLY | 60 |
| 23A | SOLENOID VALVE ASSEMBLY | 61 |
| 24 | EMERGENCY PUMP & MOTOR ASSEMBLY | 62 |
| 24A | EMERGENCY PUMP & MOTOR ASSEMBLY REVISED | 62.1 |
| 25 | AERIAL CONTROL CONSOLE ASSEMBLY | 63 |
| 25A | AERIAL CONTROL STATION ASSEMBLY | 65 |
| 26 | FINAL BOOM ASSEMBLY (2 SECTION) | 69 |
| 26A | FINAL BOOM ASSEMBLY (3 SECTION) | 72 |
| 26B | FINAL BOOM ASSEMBLY (MARK TRACK) | 73.1 |
| 26C | FINAL BOOM ASSEMBLY (MARK TRACK) REVISED | 73.4 |
| 27 | INTERMEDIATE BOOM ASSEMBLY (3 SECTION) | 74 |
| 27.1 | INTERMEDIATE BOOM ASSEMBLY (MARK TRACK) | 76.1 |
| 27.2 | INTERMEDIATE BOOM ASSEMBLY (MARK TRACK) REVISED | 76.4 |
| 27A | EXTENSION CYLINDER ASSEMBLY | 77 |
| 27A.1 | EXTENSION CYLINDER ASSEMBLY (MARK TRACK) | 77.1 |
| 27A.2 | EXTENSION CYLINDER ASSEMBLY REVISED | 77.2 |
| 27B | EXTENSION CYLINDER SUB-ASSEMBLY | 78 |
| 27C | EXTENSION CYLINDER SUB-ASSEMBLY (MARK TRACK) | 78.1 |
| 27D | EXTENSION CYLINDER SUB-ASSEMBLY REVISED | 78.2 |
| 28 | INNER BOOM ASSEMBLY (2 SECTION) | 79 |
| 28A | EXTENSION CYLINDER ASSEMBLY | 81 |
| 29 | INNER BOOM ASSEMBLY (3 SECTION) | 82 |

| FIG. NO. | TITLE | PAGE |
|---|---|---|
| 29A | INNER BOOM ASSEMBLY (MARK TRACK) | 83.1 |
| 29B | INNER BOOM ASSEMBLY (MARK TRACK) REVISED | 83.3 |
| 30 | SLAVE LEVELING CYLINDER ASSEMBLY (2 SECTION BOOM) | 84 |
| 30A | SLAVE LEVELING CYLINDER (2 SECTION BOOM) | 85 |
| 31 | SLAVE LEVELING CYLINDER ASSEMBLY (3 SECTION BOOM) | 86 |
| 31.1 | SLAVE LEVELING CYLINDER ASSEMBLY (MARK TRACK) | 86.1 |
| 31A | SLAVE LEVELING CYLINDER ASSEMBLY REVISED | 86.2 |
| 31B | SLAVE LEVELING CYLINDER SUB-ASSEMBLY REVISED | 86.4 |
| 32 | FOOT SWITCH ASSEMBLY | 87 |
| 32A | FOOT SWITCH ASSEMBLY REVISED | 87.1 |
| 33 | SHEET METAL COVER KIT | 88 |


## OPTIONS


| | | |
|---|---|---|
| 34 | GROUND & AERIAL 110 VAC RECEPTACLES | 89 |
| 35 | CLEARANCE, STOP AND TURNING LIGHTS | 90 |
| 36 | ROTATING BEACON INSTALLATION | 92 |
| 37 | RAISED PLATFORM ROTATION | 93 |
| 37A | PLATFORM ROTATION REVISED | 96.1 |
| 38 | 12 VOLT PLATFORM WORKLIGHT | 97 |
| 39 | FORK GROUND SENSOR | 98 |


NOTE: ADDITIONAL OPTIONS ARE LISTED IN FORE-MATTER SECTION.

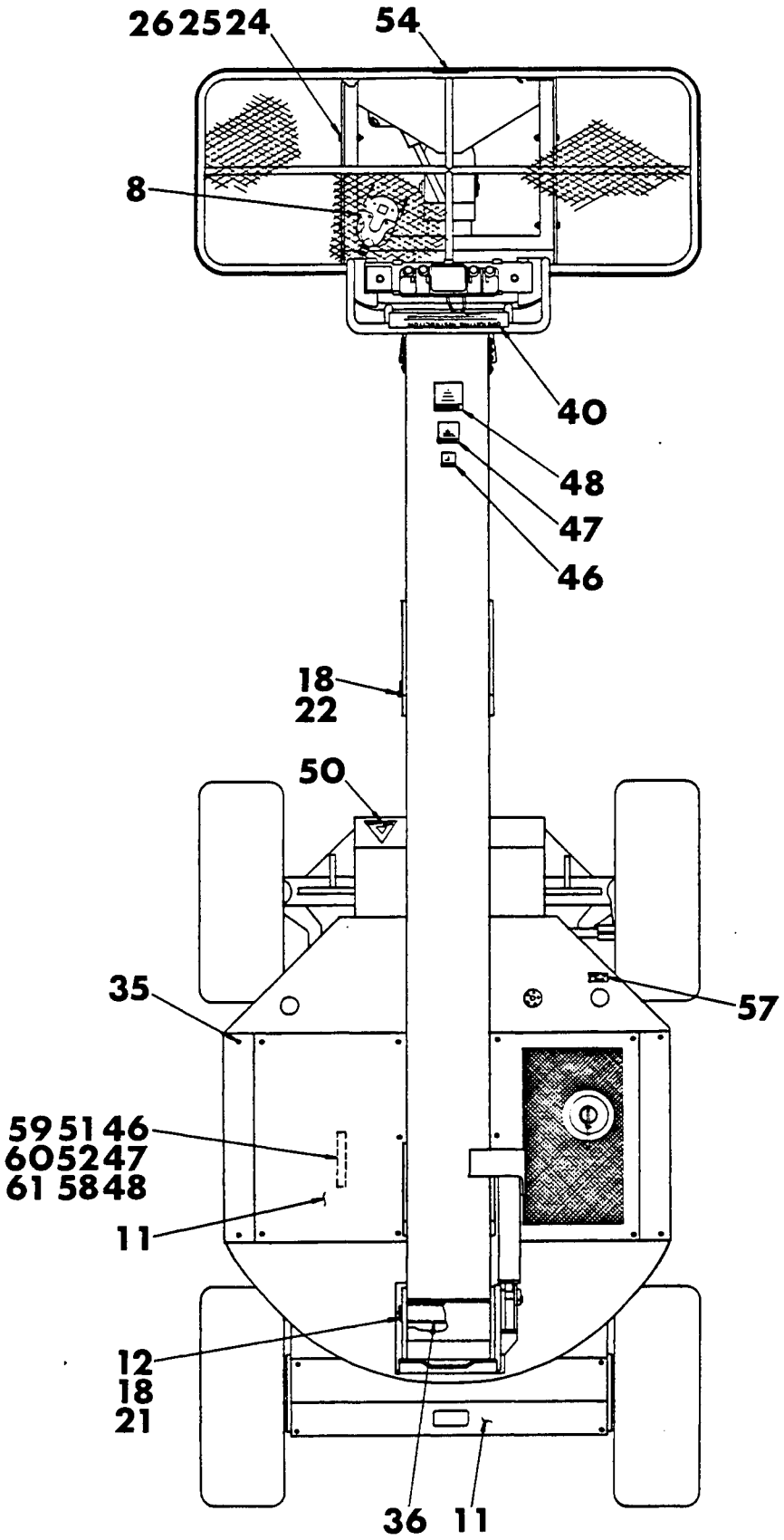

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FIGURE 1 - FINAL ASSEMBLY (2 SECTION BOOM)

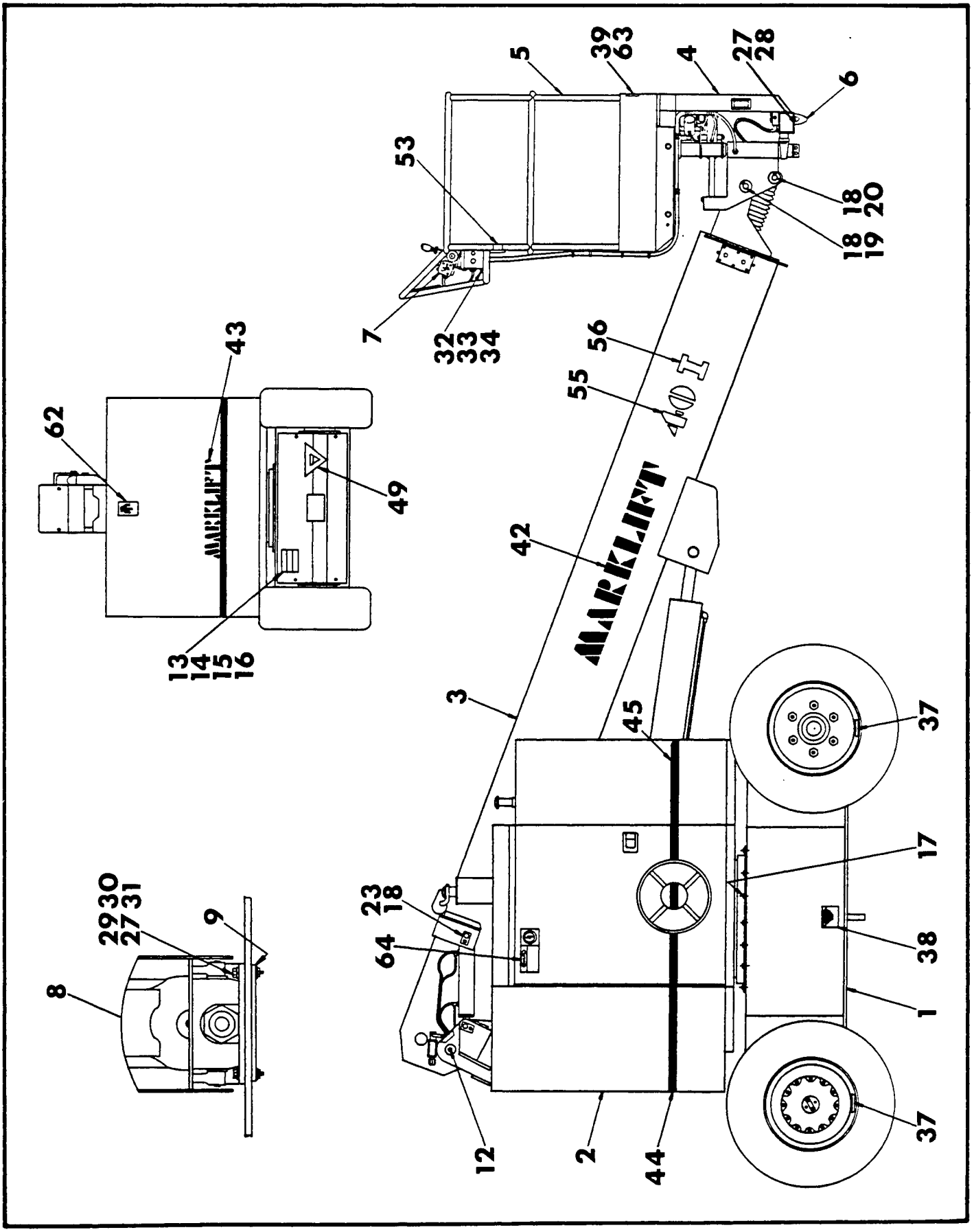


FIGURE 1 - FINAL ASSEMBLY (2 SECTION BOOM)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 1- | 20018 | FINAL ASSEMBLY (2 SECTION BOOM) | 1 |
| -1 | 22463 | CARRIAGE ASSEMBLY (SEE FIG. 2) | 1 |
| -2 | 22466 | TURRET ASSEMBLY (2 SECTION BOOM) (SEE FIG. 9) | 1 |
| -3 | 22493 | FINAL BOOM ASSEMBLY (2 SECTION) (SEE FIG. 26) | 1 |
| -4 | 20535 | FORK WELDMENT | 1 |
| -5 | 20538 | PLATFORM WELDMENT | 1 |
| -6 | 20552 | PLATFORM BUMPER | 2 |
| -7 | 20782 | AERIAL CONTROL CONSOLE ASSEMBLY (SEE FIG. 25) | 1 |
| -8 | 20480 | FOOT SWITCH ASSEMBLY (SEE FIG. 32) | 1 |
| -9 | 20663 | FOOT SWITCH BACKING PLATE | 1 |
| -10 | 22469 | SHEET METAL COVER KIT (SEE FIG. 33) | 1 |
| -11 | 22467 | DRIVE COVER | 1 |
| -12 | 65103 | GREASE FITTING - 1/8 | 2 |
| -13 | 20660 | I.D. PLATE | 1 |
| -14 | 63653 | POP RIVET | 12 |
| -15 | 20662 | PATENTED NUMBERS PLATE | 1 |
| -16 | 20661 | ANSI A92 PLATE | 1 |
| -17 | 60606 | HEX HEAD CAP SCREW - 5/8-11 UNC X 1 1/4 (BOWMALOK 41031-1) | 12 |
| -18 | 60607 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (BOWMALOK 41012) | 8 |
| -19 | 20457 | BOOM TO FORK PIN | 1 |
| -20 | 20261 | SLAVE CYLINDER TO FORK PIN | 1 |
| -21 | 21784 | BOOM TO TURRET PIN | 1 |
| -22 | 21489 | LIFT CYLINDER TO BOOM PIN | 1 |
| -23 | 21334 | LEVELING CYLINDER TO BOOM PIN | 2 |
| -24 | 60515 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3 (BOWMALLOY 36062) | 4 |
| -25 | 61302 | HEX NUT - 3/8-16 UNC (BOWMAGRIP 36782) | 4 |
| -26 | 63403 | FLAT WASHER - 3/8 | 8 |
| -27 | 60323 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 1/2 (GR. 5) | 6 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -28 | 61322 | LOCK NUT - 5/16-18 UNC | 4 |
| -29 | 60702 | HEX NUT - 5/16-18 UNC | 2 |
| -30 | 63302 | SPLIT LOCK WASHER - 5/16 | 2 |
| -31 | 63402 | FLAT WASHER - 5/16 | 2 |
| -32 | 60309 | HEX HEAD CAP SCREW - 1/4-20 UNC X 3/4 (GR. 5) | 6 |
| -33 | 60701 | HEX NUT - 1/4-20 UNC | 6 |
| -34 | 63301 | SPLIT LOCK WASHER - 1/4 | 6 |
| -35 | 61902 | HEX SOCKET BUTTON HEAD CAP SCREW - 1/4 -20 UNC X 3/4 | 24 |
| -36 | 20830 | PIN SPACER | 1 |
| -37 | 22175 | CAUTION - MONOFILLED TIRES ONLY DECAL | 4 |
| -38 | 20508 | TRANSPORTATION DECAL | 1 |
| -39 | 2022 | LOAD CAPACITY 500 LBS DECAL (WITH ROTATING PLATFORM) | 1 |
| -40 | 20859 | AERIAL OPERATING INSTRUCTIONS DECAL | 1 |
| -41 | 20860 | GROUND OPERATING INSTRUCTIONS DECAL | 1 |
| -42 | 20408 | BOOM MARKLIFT DECAL | 2 |
| -43 | 20409 | MARKLIFT PEDESTAL DECAL | 1 |
| -44 | 20411 | SQUARE END STRIP DECAL | 5 |
| -45 | 20412 | ROUND END STRIP DECAL | 2 |
| -46 | 20416 | CAUTION DECAL | 2 |
| -47 | 20417 | DANGER - NO NOT OPERATE DECAL | 2 |
| -48 | 20418 | DANGER - ELECTRICAL HAZARD DECAL | 2 |
| -49 | 20461 | FORWARD ARROW-AHEAD DECAL | 1 |
| -50 | 20462 | FORWARD ARROW-AFT DECAL | 1 |
| -51 | 20460 | GROUND CONTROL CONSOLE DECAL | 1 |
| -52 | 20495 | EMERGENCY GROUND CONTROLS DECAL | 1 |
| -53 | 22386 | ATTACH SAFETY BELT DECAL | 2 |
| -54 | 2014 | UNLAWFUL TO OPERATE DECAL | 1 |
| -55 | 21461 | 40 DECAL | 2 |
| -56 | 20998 | I DECAL | 2 |
| -57 | 2020 | GAS OR PETRAL DECAL | 1 |
| -58 | 20413 | ENGINE CHOKE DECAL | 1 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -59 | 2017 | HYDRAULIC FLUID DECAL | 1 |
| -60 | 20414 | EMERGENCY BOOM DESCENT DECAL | 1 |
| -61 | 2003 | BATTERY WATER LEVEL DECAL | 1 |
| -62 | 20410 | MARK INDUSTRIES LOGO DECAL | 1 |
| -63 | 22385 | "CAUTION - ATTACH YOUR SAFETY BELT FIRST" DECAL | 1 |
| -64 | 20419 | DANGER KEEP CLEAR DECAL | 2 |

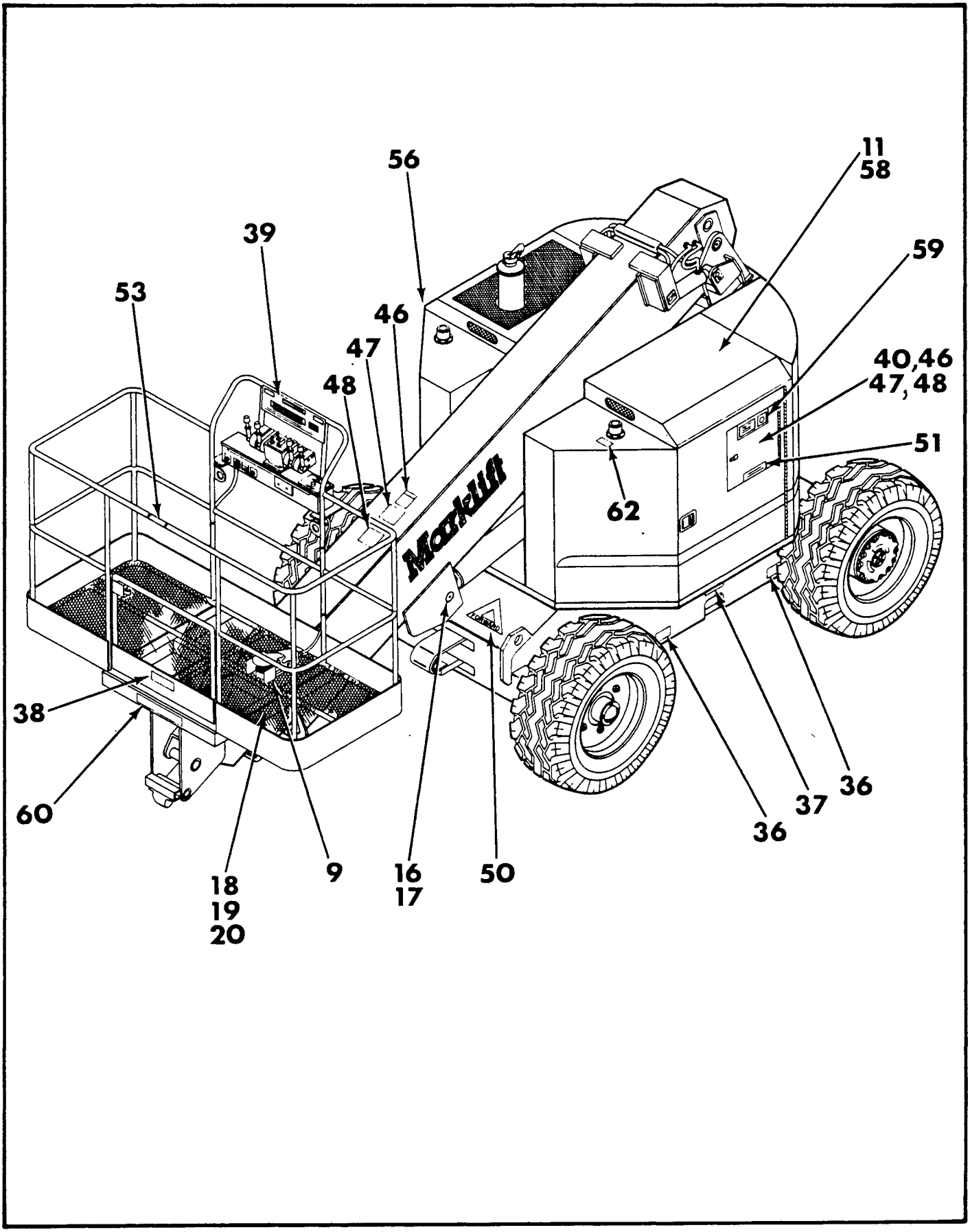

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FIGURE 1A - FINAL ASSEMBLY (3 SECTION BOOM)

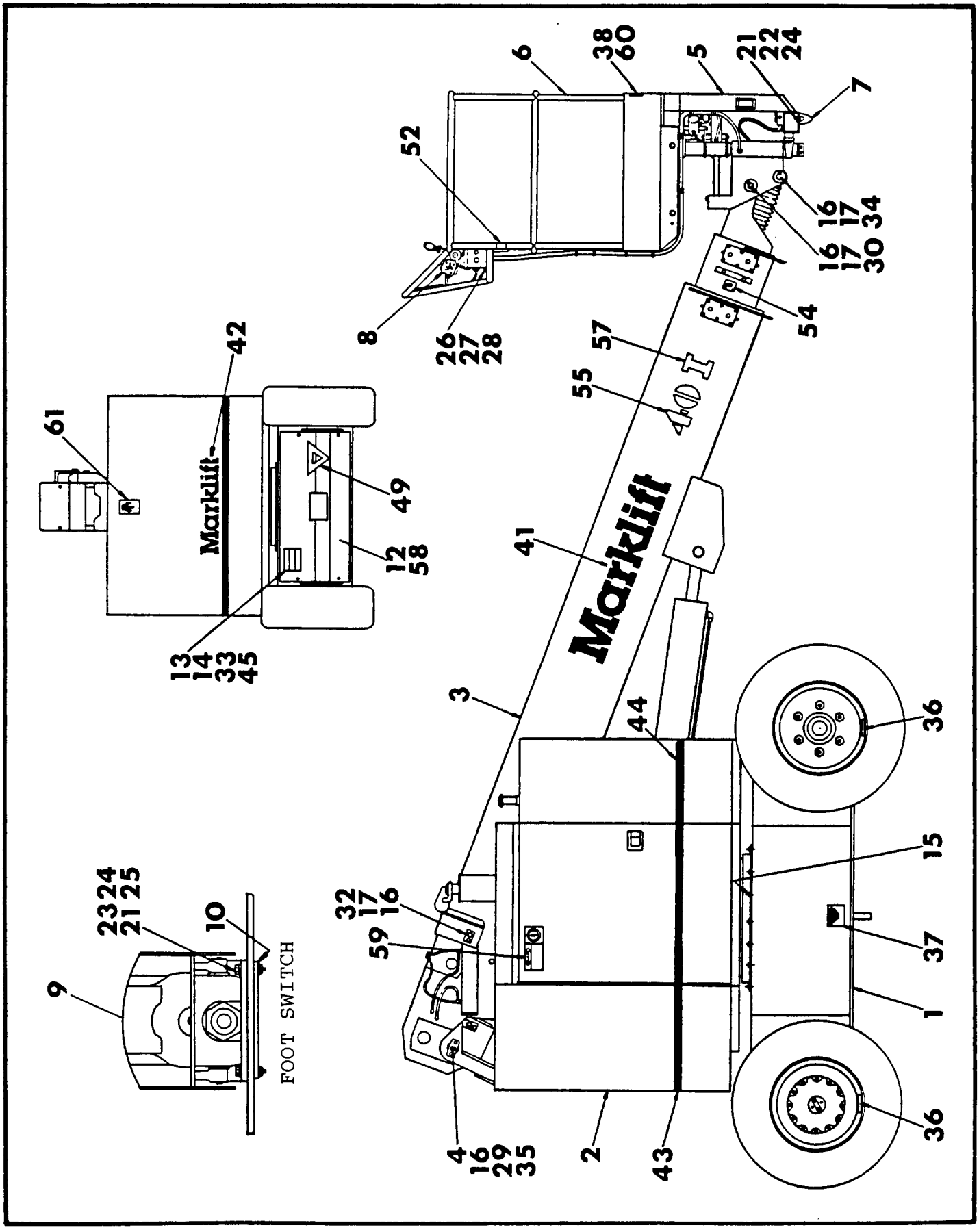


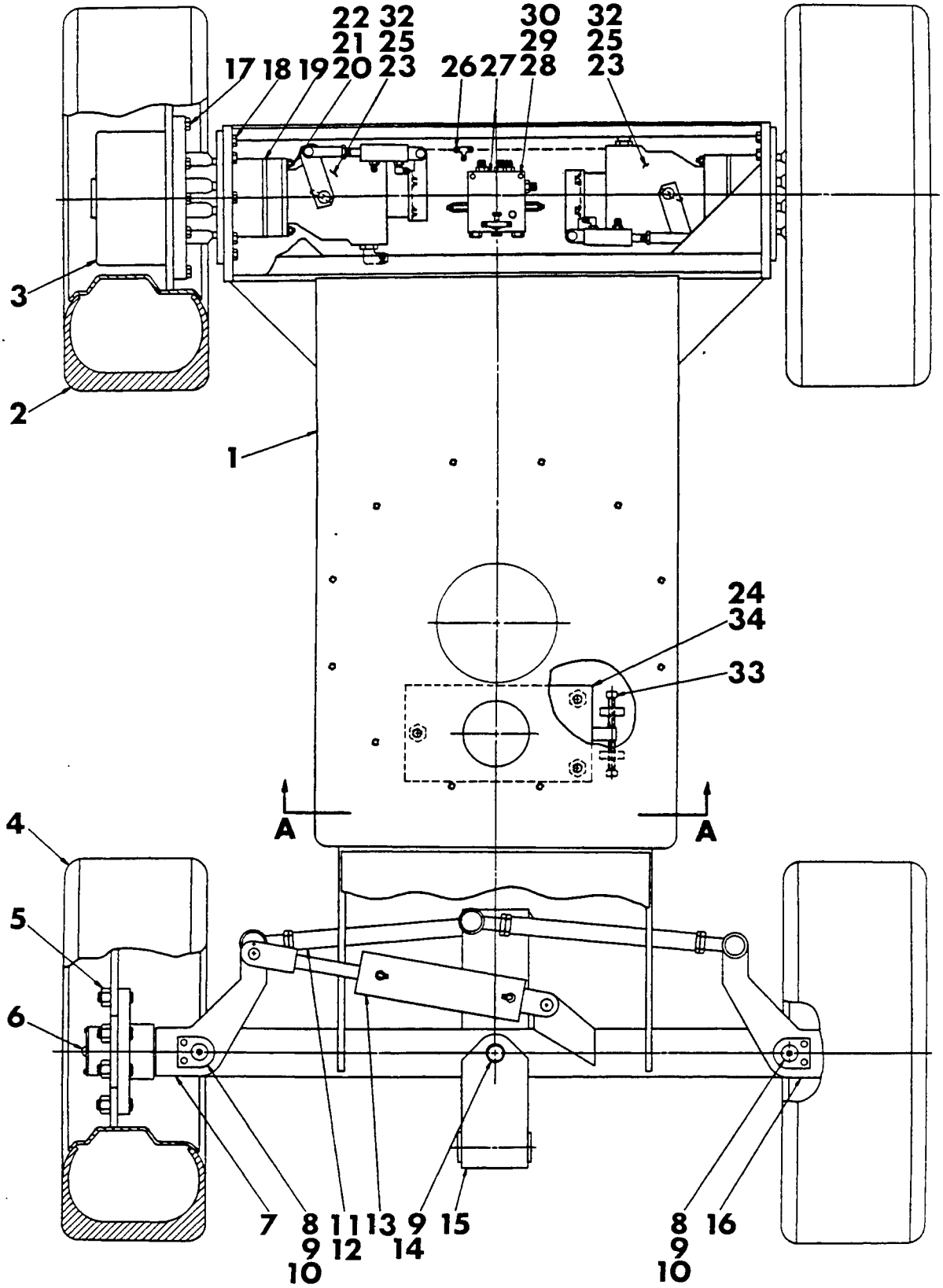
FIGURE 1A - FINAL ASSEMBLY (3 SECTION BOOM)

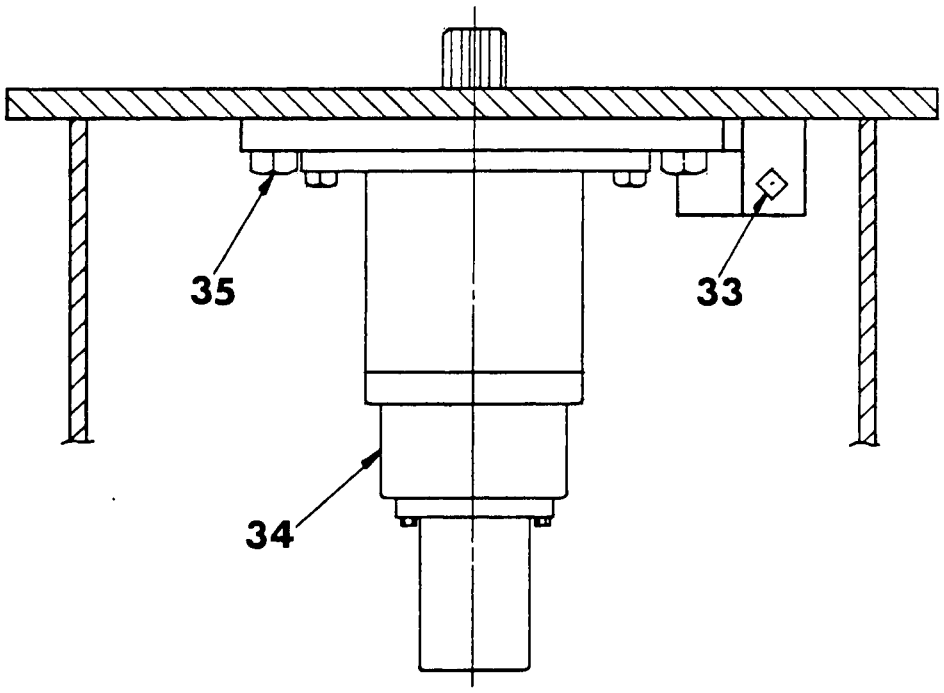
| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 1A- | 20020 | FINAL ASSEMBLY (3 SECTION BOOM) | 1 |
| -1 | 22463 | CARRIAGE ASSEMBLY (SEE FIG. 2) | 1 |
| -2 | 22465 | TURRET ASSEMBLY (3 SECTION BOOM) (SEE FIG. 9A) | 1 |
| -3 | 22760 | FINAL BOOM ASSEMBLY (3 SECTION) (SEE FIG. 26A) | 1 |
| -4 | 65103 | GREASE FITTING - 1/8 | 2 |
| -5 | 20535 | FORK WELDMENT | 1 |
| -6 | 20134 | PLATFORM WELDMENT | 1 |
| -7 | 20552 | PLATFORM BUMPER | 2 |
| -8 | 20782 | AERIAL CONTROL CONSOLE ASSEMBLY (SEE FIG. 25) | 1 |
| -9 | 20480 | FOOT SWITCH ASSEMBLY (SEE FIG. 32) | 1 |
| -10 | 20663 | FOOT SWITCH BACKING PLATE | 1 |
| -11 | 22469 | SHEET METAL COVER KIT (SEE FIG. 33) | 1 |
| -12 | 22467 | DRIVE COVER | 1 |
| -13 | 20660 | I.D. PLATE | 1 |
| -14 | 63653 | POP RIVET - 1/8 DIA. X 1/4 | 12 |
| -15 | 60606 | HEX HEAD CAP SCREW - 5/8-11 UNC X 1 1/4 (BOWMALOK 41031-1) | 12 |
| -16 | 60607 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (BOWMALOK 41012) | 8 |
| -17 | 63303 | SPLIT LOCK WASHER - 3/8 | 4 |
| -18 | 60515 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3 (BOWMALLOY 36062) | 4 |
| -19 | 61302 | HEX NUT - 3/8-16 UNC X 3 (BOWMALLOY 36062) | 4 |
| -20 | 63403 | FLAT WASHER - 3/8 | 8 |
| -21 | 60323 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 1/2 | 6 |
| -22 | 61322 | LOCK NUT - 5/16-18 UNC | 4 |
| -23 | 60702 | HEX NUT - 5/16-18 UNC | 2 |
| -24 | 63302 | SPLIT LOCK WASHER - 5/16 | 6 |
| -25 | 63402 | FLAT WASHER - 5/16 | 4 |
| -26 | 60309 | HEX HEAD CAP SCREW - 1/4-20 UNC X 3/4 | 6 |
| -27 | 60701 | HEX NUT - 1/4-20 UNC | 6 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -28 | 63301 | SPLIT LOCK WASHER - 1/4 | 6 |
| -29 | 21785 | BOOM TO TURRET PIN | 1 |
| -30 | 20457 | BOOM TO FORK PIN | 1 |
| -31 | 21331 | LIFT CYLINDER TO BOOM PIN | 1 |
| -32 | 21334 | LEVELING CYLINDER TO BOOM PIN | 2 |
| -33 | 20661 | ANSI A92 PLATE | 1 |
| -34 | 20261 | SLAVE CYLINDER TO FORK PIN | 1 |
| -35 | 20830 | PIN SPACER | 1 |
| -36 | 22175 | CAUTION - MONOFILLED TIRES ONLY | 4 |
| -37 | 20508 | TRANSPORTATION DECAL | 2 |
| -38 | 2022 | LOAD CAPACITY 500 LBS DECAL (WITH ROTATING PLATFORM) | 1 |
| -39 | 20859 | AERIAL OPERATING INSTRUCTIONS DECAL | 1 |
| -40 | 20860 | GROUND OPERATING INSTRUCTIONS DECAL | 1 |
| -41 | 20408 | MARKLIFT BOOM DECAL | 2 |
| -42 | 20409 | MARKLIFT PEDESTAL DECAL | 1 |
| -43 | 20411 | SQUARE END STRIPE DECAL | 5 |
| -44 | 20412 | ROUND END STRIPE DECAL | 2 |
| -45 | 20662 | PATENTED NUMBERS PLATE | 1 |
| -46 | 20416 | CAUTION DECAL | 2 |
| -47 | 20417 | DANGER DO NOT OPERATE DECAL | 2 |
| -48 | 20418 | DANGER ELECTRICAL HAZARD DECAL | 2 |
| -49 | 20461 | FORWARD ARROW - AHEAD DECAL | 1 |
| -50 | 20462 | FORWARD ARROW - AFT DECAL | 1 |
| -51 | 20495 | EMERGENCY GROUND CONTROLS DECAL | 1 |
| -52 | 22386 | ATTACH SAFETY BELT DECAL | 2 |
| -53 | 2014 | UNLAWFUL TO OPERATE DECAL | 1 |
| -54 | 21237 | GREASE FITTING | 3 |
| -55 | 21461 | 40 DECAL | 2 |
| -56 | 2020 | GAS OR PETROL DECAL | 1 |
| -57 | 20998 | I DECAL | 2 |
| -58 | 61902 | HEX SOCKET BUTTON HEAD CAP SCREW - 1/4-20 UNC X 3/4 | 24 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -59 | 20419 | DANGER KEEP CLEAR DECAL | 2 |
| -60 | 22385 | "CAUTION - ATTACH YOUR SAFETY BELT FIRST" DECAL | 1 |
| -61 | 20410 | MARK INDUSTRIES LOGO DECAL | 1 |
| -62 | 2017 | HYDRAULIC FLUID DECAL | 1 |

FIGURE 2 - CARRIAGE ASSEMBLY





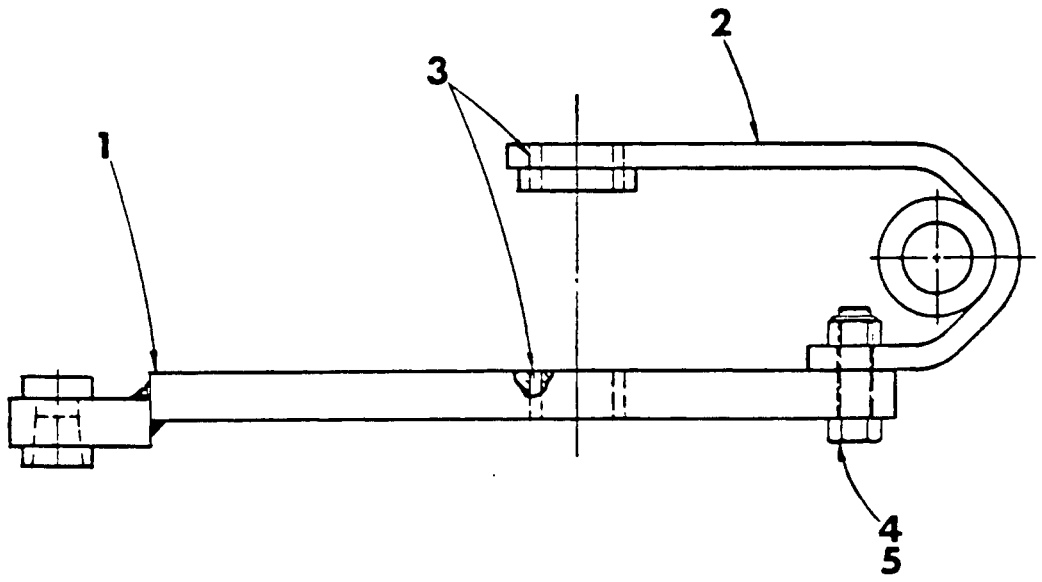

**SECTION A**

## FIGURE 2 - CARRIAGE ASSEMBLY

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 2- | 22463 | CARRIAGE ASSEMBLY | 1 |
| -1 | 22364 | CARRIAGE WELDMENT | 1 |
| -2 | 20995 | DRIVE TIRE & RIM ASSEMBLY | 2 |
| -3 | 22496 | TORQUE HUB | 2 |
| -4 | 21730 | STEERING TIRE & RIM ASSEMBLY | 2 |
| -5 | 65117 | BALL NUT - 3/4-16 UNF | 12 |
| -6 | 21791 | STEERING HUB ASSEMBLY (SEE FIG. 4) | 2 |
| -7 | 21420 | STEERING YOKE (R.H.) | 1 |
| -8 | 21428 | STEERING PIN | 2 |
| -9 | 60603 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 (BOWMALOK 41006) | 6 |
| -10 | 65103 | GREASE FITTING - 1/8 NPT | 2 |
| -11 | 21422 | STEERING TIE ROD ASSEMBLY (SEE FIG. 5) | 2 |
| -12 | 64310 | COTTER PIN - 1/8 DIA. X 2 | 4 |
| -13 | 22476 | STEERING CYLINDER ASSEMBLY (SEE FIG. 6) | 1 |
| -14 | 20794 | MAIN STEERING PIN | 1 |
| -15 | 21429 | STEERING ARM ASSEMBLY (SEE FIG. 3) | 1 |
| -16 | 21421 | STEERING YOKE (L.H.) | 1 |
| -17 | 60611 | HEX HEAD CAP SCREW - 1/2-13 UNC X 1 3/4 (BOWMALOK 41027) | 20 |
| -18 | 60604 | HEX HEAD CAP SCREW - 5/8-11 UNC X 1 1/2 (BOWMALOK 41032) | 16 |
| -19 | 21668 | BRAKE ASSEMBLY | 2 |
| -20 | 63633 | STUD - 1/2-13 UNC X 7 1/2 | 8 |
| -21 | 60705 | HEX NUT - 1/2-13 UNC | 4 |
| -22 | 63305 | SPLIT LOCK WASHER - 1/2 | 4 |
| -23 | 21672 | HYDRAULIC MOTOR ASSEMBLY (SEE FIG. 8) | 2 |
| -24 | 60637 | HEX HEAD CAP SCREW - 3/4-10 UNC X 2 (BOWMALOK 41040) | 3 |
| -25 | 80012-10 | STRAIGHT THREAD ELBOW | 4 |
| -26 | 80031-05 | UNION TEE | 1 |
| -27 | 20912 | DRIVE/BRAKE VALVE ASSEMBLY (SEE FIG. 7) | 1 |
| -28 | 60362 | HEX HEAD CAP SCREW - 5/16-18 UNX X 3 1/2 (GR. 5) | 2 |

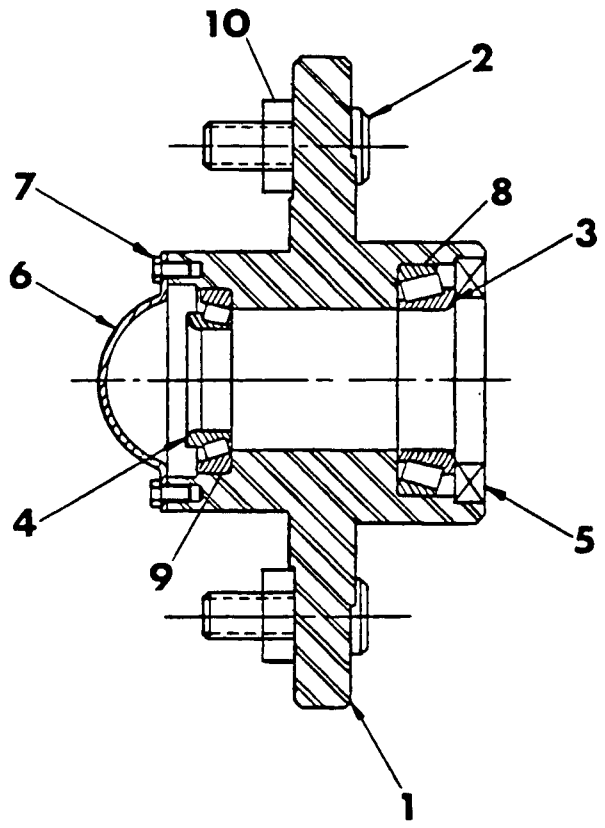
| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -29 | 63402 | FLAT WASHER - 5/16 | 2 |
| -30 | 63302 | SPLIT LOCK WASHER - 5/16 | 2 |
| -31 | 20795 | SHIFT CLEVIS PIN | 2 |
| -32 | 80012-21 | STRAIGHT THREAD ELBOW | 4 |
| -33 | 62224 | SET SCREW - 5/8-11 UNC X 2 1/2 (GR. 5) | 2 |
| -34 | 22475 | ROTATION GEAR BOX ASSEMBLY (SEE FIG. 14) | 1 |
| | 486-C | LPG TANK | |
| | 486-A | TANK BRACKET | |

FIGURE 3 - STEERING ARM ASSEMBLY



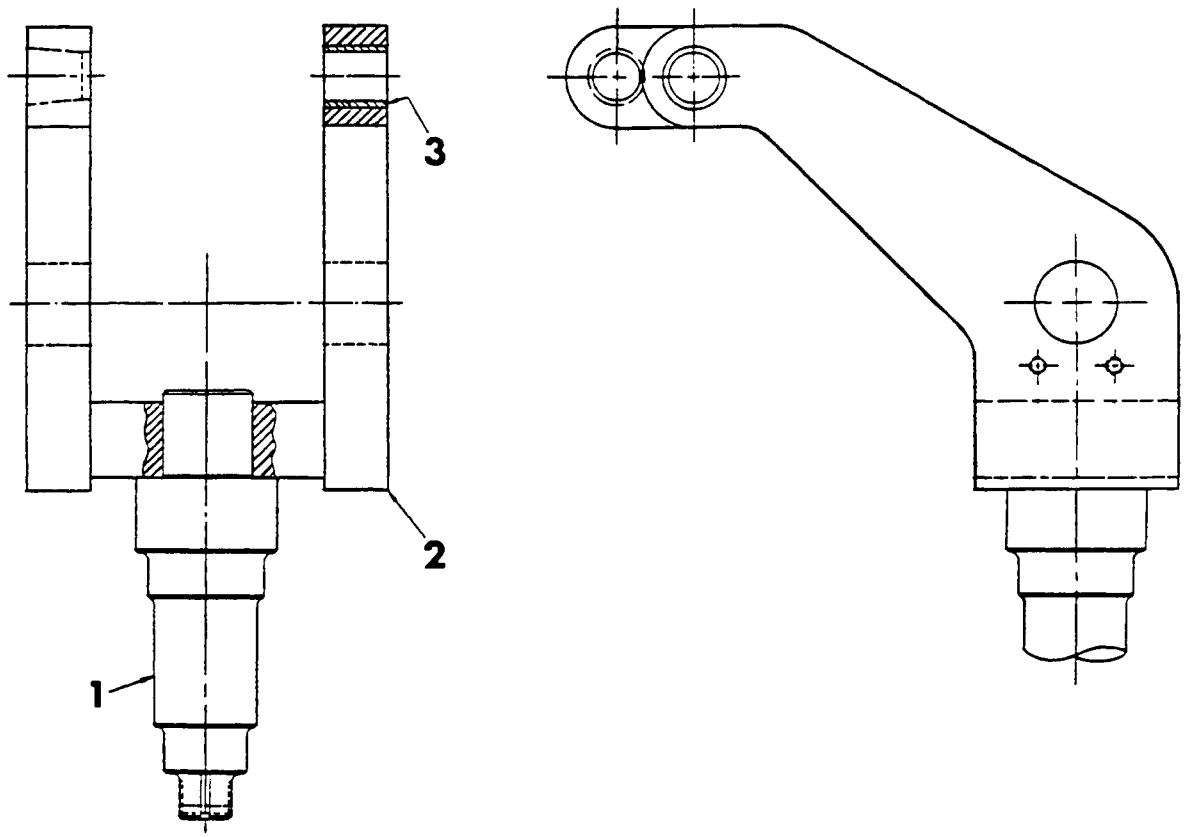

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 3 - | 21429 | STEERING ARM ASSEMBLY | 1 |
| -1 | 21430 | STEERING ARM | 1 |
| -2 | 20777 | STEERING ARM SUPPORT BRACKET | 1 |
| -3 | 64901 | BUSHING | 2 |
| -4 | 60506 | HEX HEAD CAPSCREW-3/4-10UNC X 2 1/4 (GR.8) | 2 |
| -5 | 61304 | LOCK NUT - 3/4-10UNC BOWMAGRIP 36787 | 2 |

## FIGURE 4 - STEERING HUB ASSEMBLY



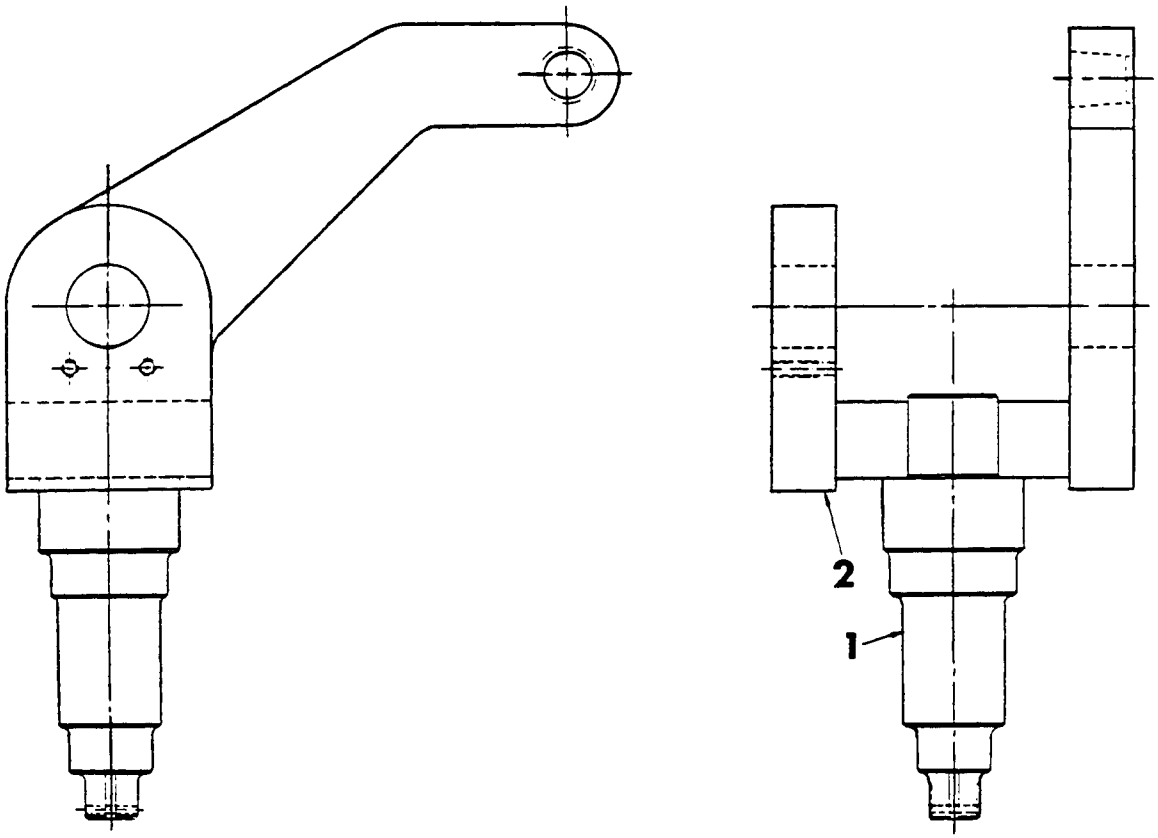

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 4 - | 21791 | STEERING HUB ASSEMBLY | 1 |
| -1 | 21792 | MACHINED HUB | 1 |
| -2 | 65351 | WHEEL BOLT | 6 |
| -3 | 21794 | INNER CONE | 1 |
| -4 | 21796 | OUTER CONE | 1 |
| -5 | 21798 | GREASE SEAL | 1 |
| -6 | 21799 | DUST CAP | 1 |
| -7 | 60309 | HEX HEAD CAPSCREW-1/4-20UNC X 3/4 | 4 |
| -8 | 21795 | INNER CUP | 1 |
| -9 | 21797 | OUTER CUP | 1 |
| -10 | 65117 | BALL NUT - 3/4-16 UNF | 6 |

FIGURE 4A - STEERING YOKE ASSEMBLY (R.H.)



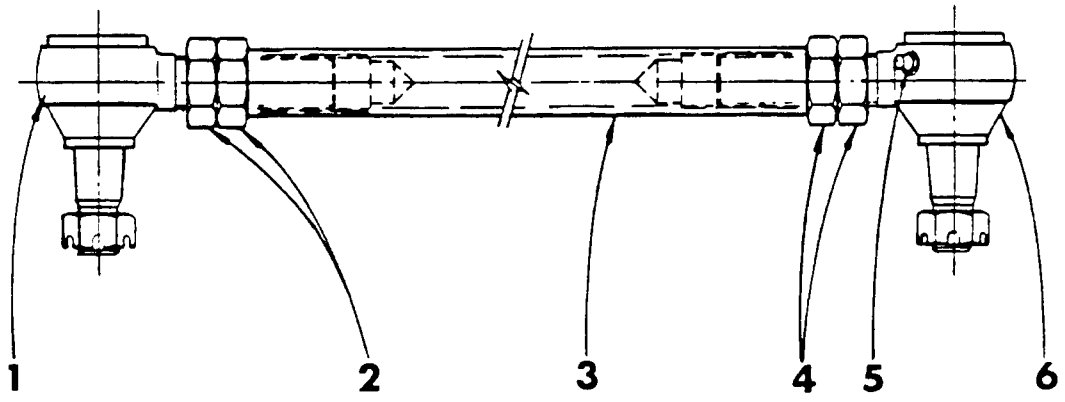

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 4A- | 21420 | STEERING YOKE ASSEMBLY (R.H.) | 1 |
| -1 | 21788 | SPINDLE | 1 |
| -2 | 21466 | YOKE (R.H.) | 1 |
| -3 | 64913 | BUSHING | 1 |

FIGURE 4B - STEERING YOKE ASSEMBLY (L.H.)

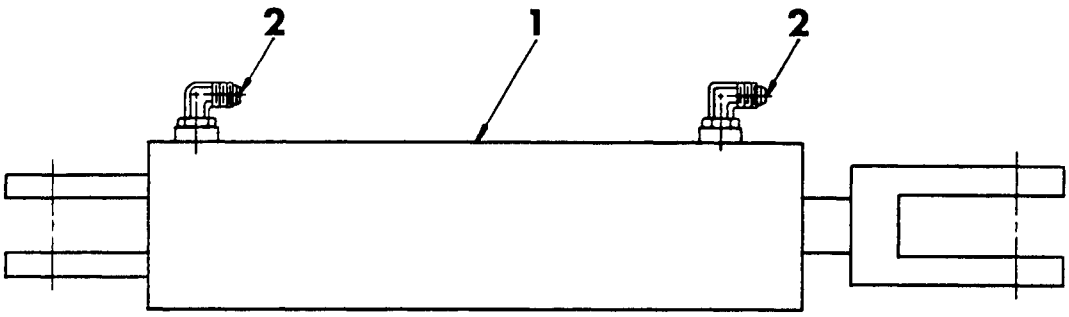



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 4B- | 21421 | STEERING YOKE ASSEMBLY (L.H.) | 1 |
| -1 | 21788 | SPINDLE | 1 |
| -2 | 21590 | YOKE (L.H.) | 1 |

## FIGURE 5 - STEERING TIE ROD ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 5 - | 21422 | STEERING TIE ROD ASSEMBLY | 1 |
| -1 | 20569 | TIE ROD END (L.H.) | 1 |
| -2 | 20567 | JAM NUT - 1 1/8-12 UNF (L.H.) THREAD | 2 |
| -3 | 21596 | TUBING | 1 |
| -4 | 20566 | JAM NUT - 1 1/8-12 UNF (R.H.) THREAD | 2 |
| -5 | 65103 | GREASE FITTING - 1/8 NPT | 2 |
| -6 | 20568 | TIE ROD END (R.H.) | 2 |




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 6- | 22476 | STEERING CYLINDER ASSEMBLY | 1 |
| -1 | 22450 | STEERING CYLINDER | 1 |
| -2 | 80012-03 | STRAIGHT THREAD ELBOW | 2 |
| -3 | 66528 | SEAL KIT | 1 |

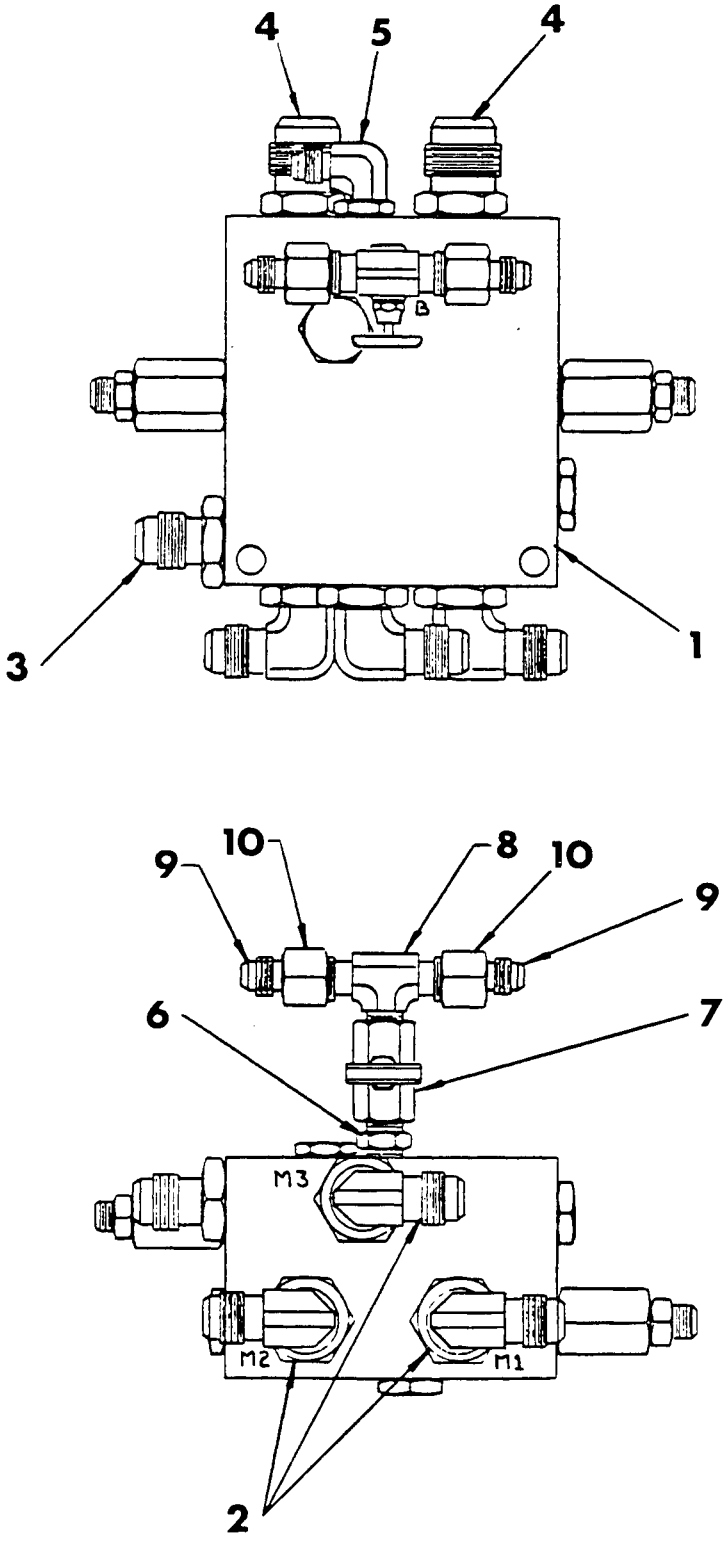
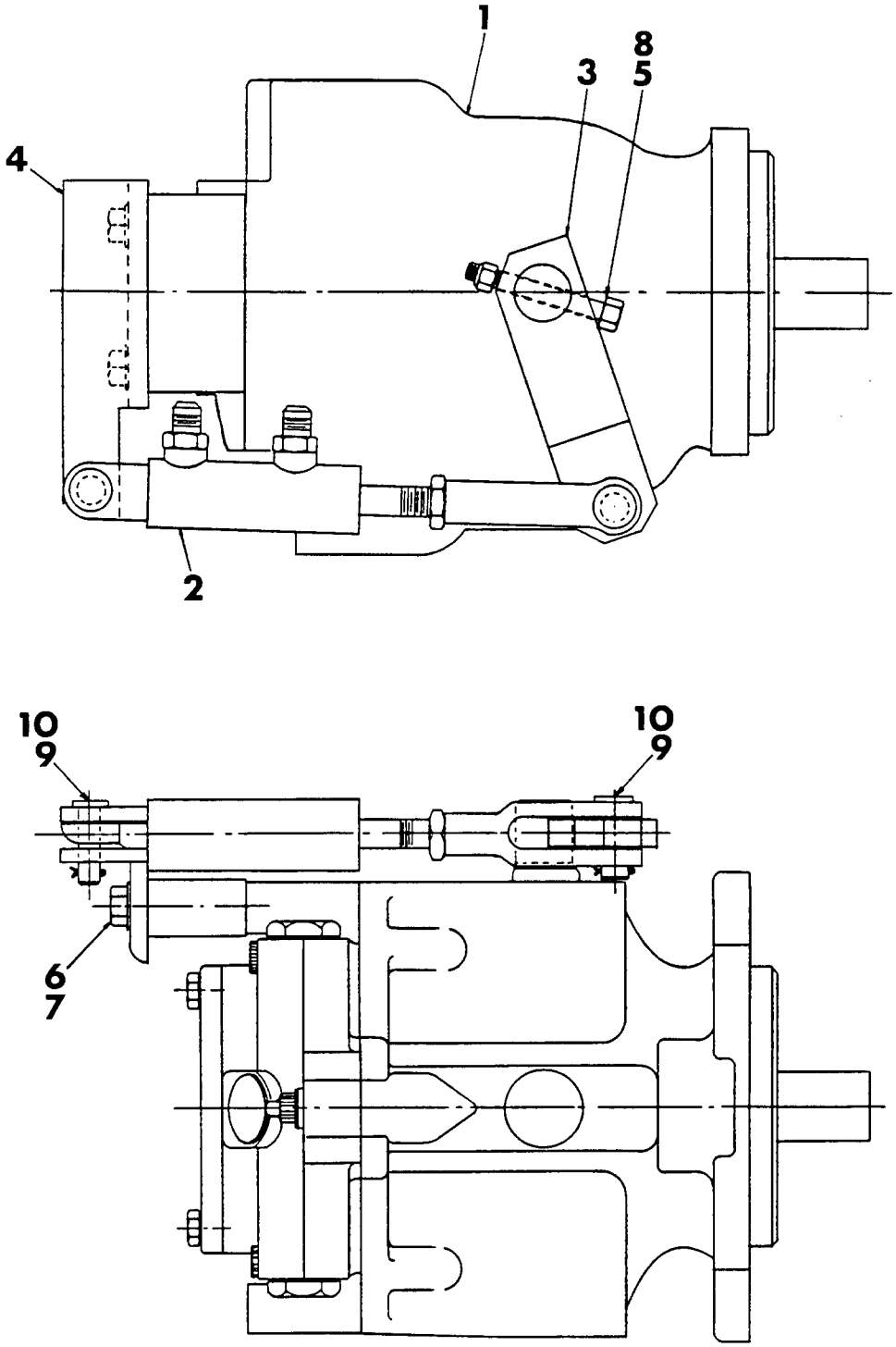

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FIGURE 7 - DRIVE/BRAKE VALVE ASSEMBLY



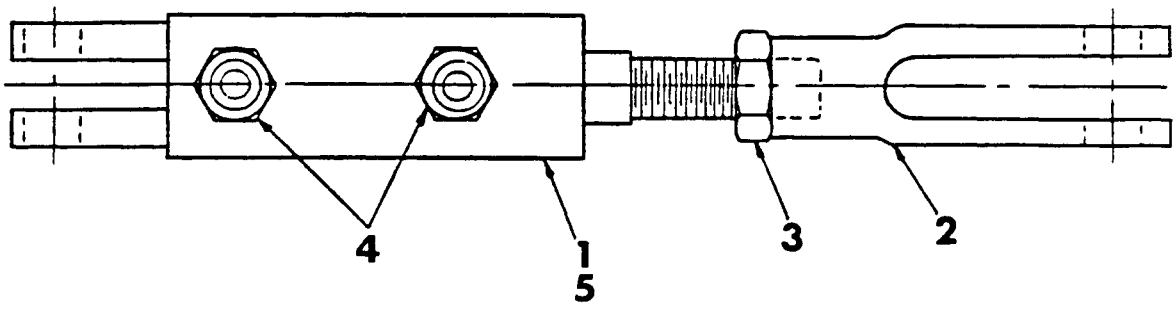
| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 7- | 20912 | DRIVE/BRAKE VALVE ASSEMBLY | 1 |
| -1 | 21214 | VALVE | 1 |
| -2 | 80012-11 | STRAIGHT THREAD ELBOW | 3 |
| -3 | 80004-11 | STRAIGHT THREAD CONNECTOR | 1 |
| -4 | 80004-19 | STRAIGHT THREAD CONNECTOR | 2 |
| -5 | 80012-03 | STRAIGHT THREAD ELBOW | 1 |
| -6 | 80052-04 | PIPE NIPPLE | 1 |
| -7 | 20357 | NEEDLE VALVE (FOR BRAKE ADJUSTMENT) | 1 |
| -8 | 88034-08 | MALE BRANCH TEE | 1 |
| -9 | 80056-01 | TUBE END REDUCER | 2 |
| -10 | 80060-05 | HEX NUT | 2 |

FIGURE 8 - HYDRAULIC MOTOR ASSEMBLY



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 8- | 21672 | HYDRAULIC MOTOR ASSEMBLY | 1 |
| -1 | 21221 | HYDRAULIC MOTOR | 1 |
| -2 | 21660 | 2-SPEED SHIFT CYLINDER ASSEMBLY (SEE FIG. 8A) | 1 |
| -3 | 21637 | ACTUATOR LEVER | 1 |
| -4 | 21658 | SHIFT CYLINDER BRACKET | 1 |
| -5 | 60615 | HEX HEAD CAP SCREW - 3/8-16 UNC X 2 1/2 (GR. 8) | 1 |
| -6 | 60524 | HEX HEAD CAP SCREW - 7/16-14 UNC X 2 3/4 (GR. 8) | 2 |
| -7 | 63304 | SPLIT LOCK WASHER - 7/16 | 2 |
| -8 | 61245 | LOCK NUT - 3/8-16 UNC | 1 |
| -9 | 64106 | CLEVIS PIN - 1/2 DIA. X 1 3/8 | 2 |
| -10 | 64301 | COTTER PIN - 1/8 DIA. X 1 | 2 |

FIGURE 8A - 2-SPEED SHIFT CYLINDER ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 8A- | 21660 | 2-SPEED SHIFT CYLINDER ASSEMBLY | 1 |
| -1 | 20719 | SHIFTING CYLINDER | 1 |
| -2 | 20789 | SHIFT CLEVIS | 1 |
| -3 | 61101 | JAM NUT - 1/2-13 UNC | 1 |
| -4 | 80004-03 | STRAIGHT THREAD CONNECTOR | 2 |
| -5 | 20035 | SHIFTING CYLINDER SEAL KIT | 1 |

# FIGURE 9 - TURRET ASSEMBLY (2 SECTION BOOM)

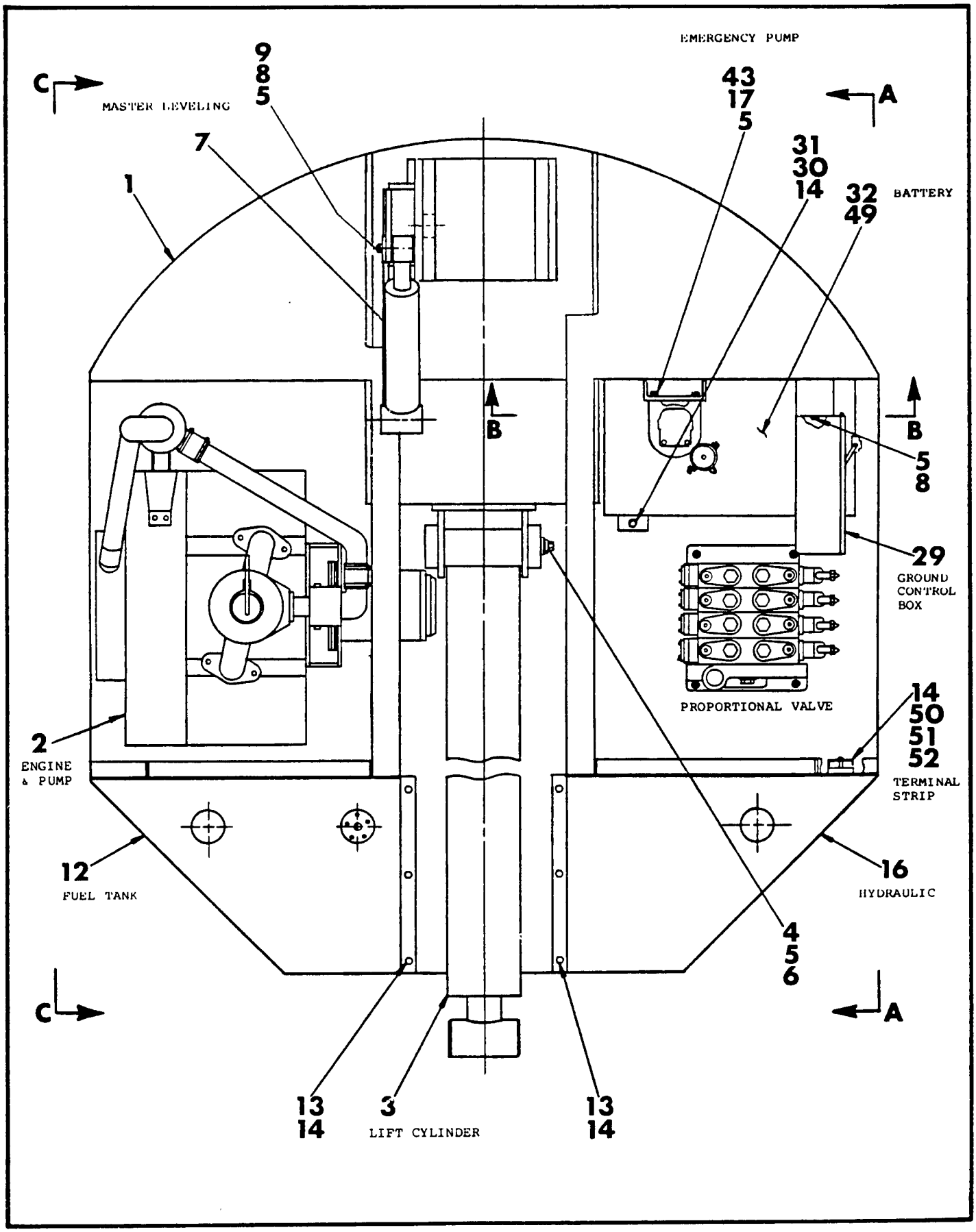


FIGURE 9 - TURRET ASSEMBLY (2 SECTION BOOM)

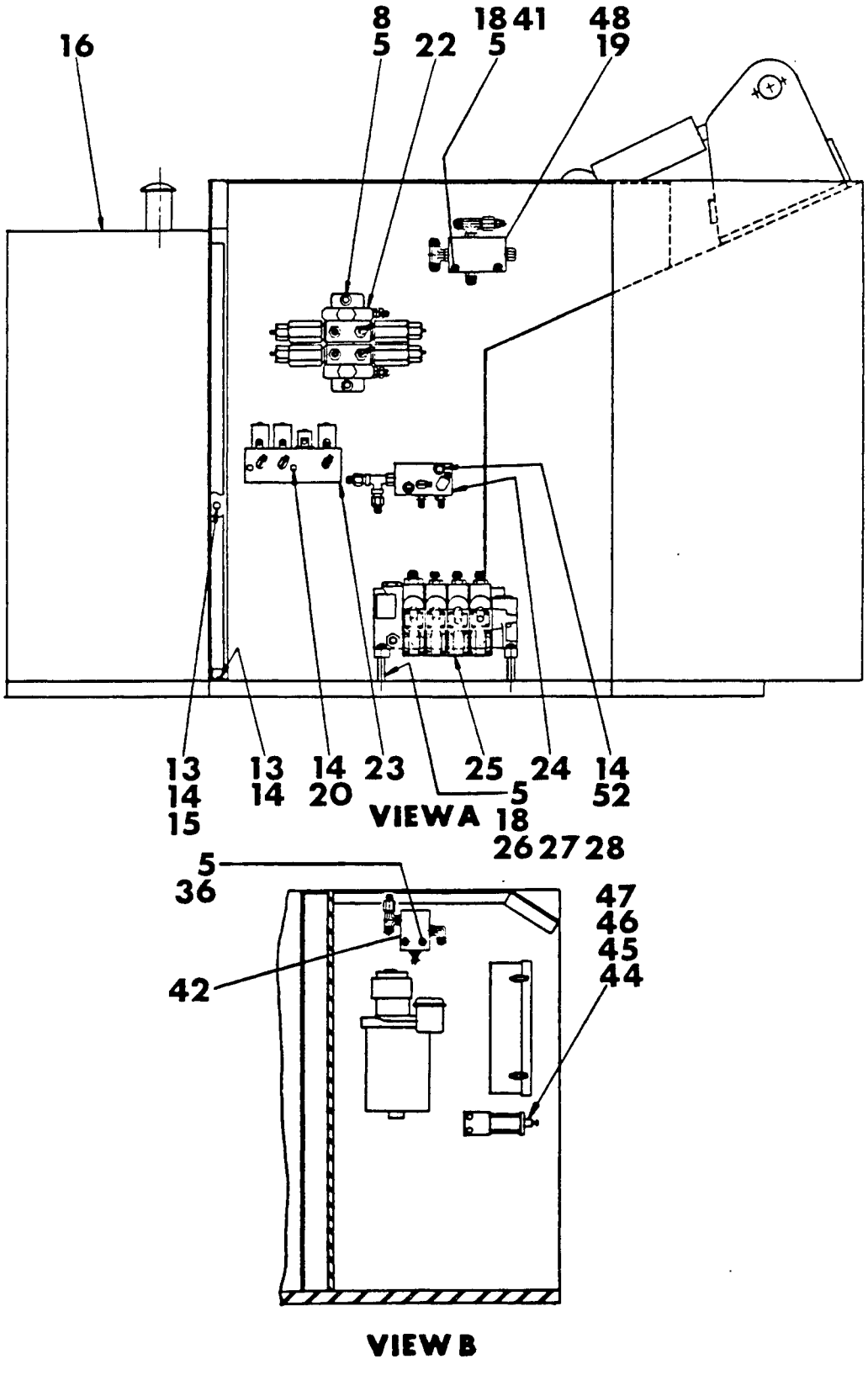


FIGURE 9 - TURRET ASSEMBLY (2 SECTION BOOM)

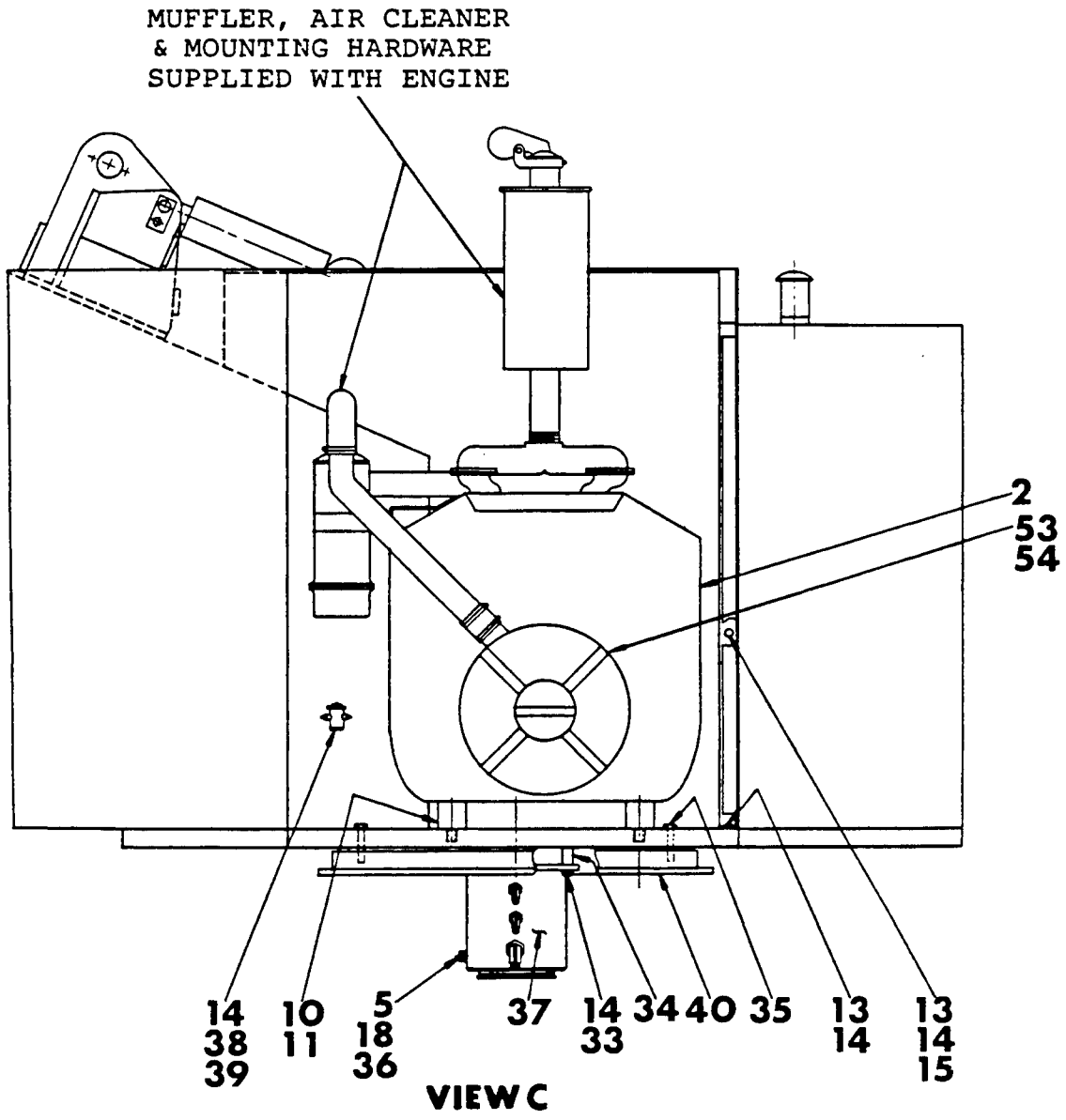


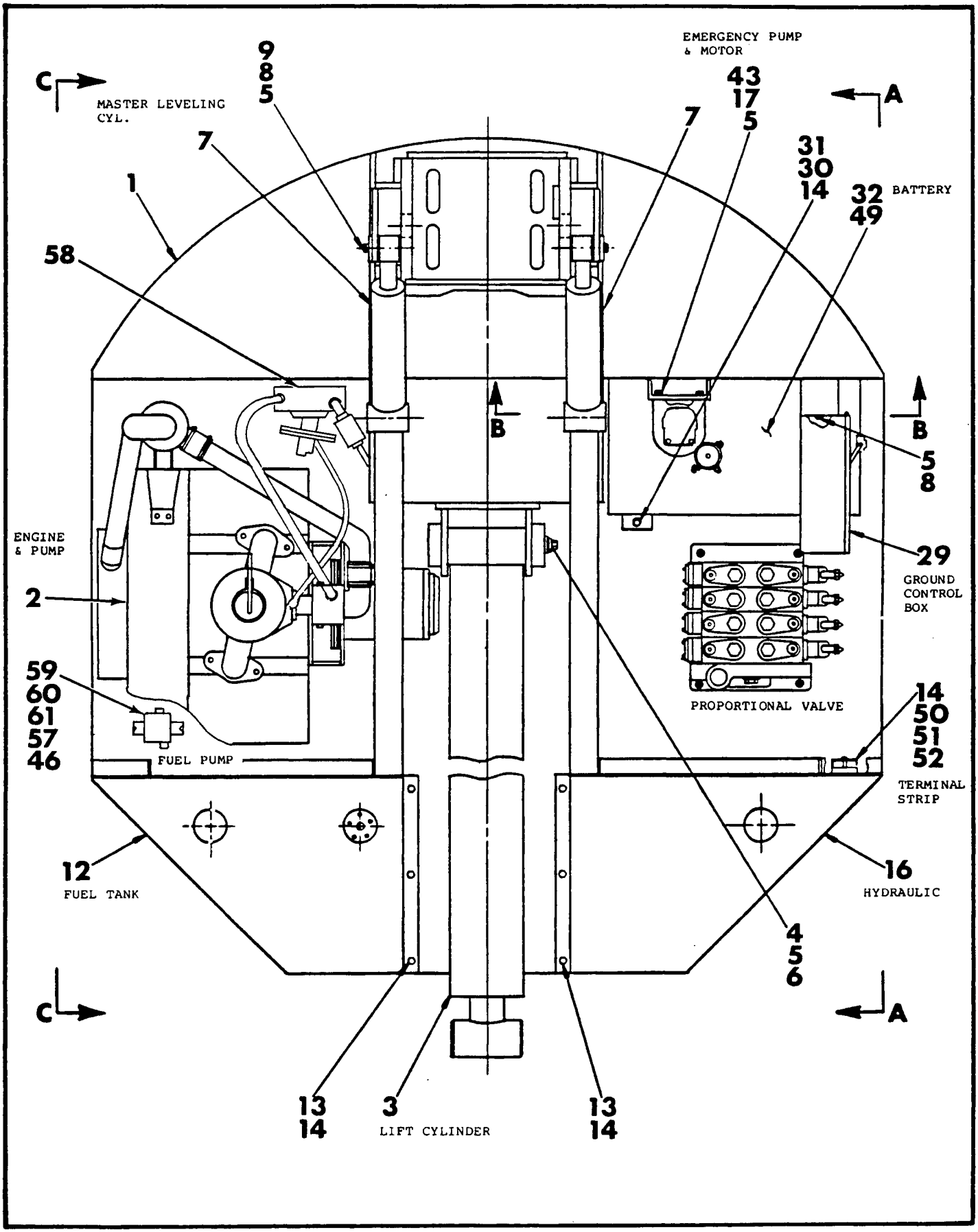
FIGURE 9 - TURRET ASSEMBLY (2 SECTION BOOM)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 9 - | 22466 | TURRET ASSEMBLY (2 SECTION BOOM) | 1 |
| -1 | 22464 | TURRET WELDMENT | 1 |
| -2 | 22468 | ENGINE & PUMP ASSEMBLY (SEE FIG. 10) | 1 |
| -3 | 21432 | LIFT CYLINDER ASSEMBLY (SEE FIG. 11) | 1 |
| -4 | 21780 | LIFT CYLINDER PIN | 1 |
| -5 | 63303 | SPLIT LOCK WASHER - 3/8 | 24 |
| -6 | 60607 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (BOWMALOK 41012) | 2 |
| -7 | 21084 | MASTER LEVELING CYLINDER ASSEMBLY (SEE FIG. 21) | 2 |
| -8 | 60320 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1/2 (GR. 5) | 10 |
| -9 | 21337 | MASTER LEVELING CYLINDER PIN | 1 |
| -10 | 22455 | SPACER | 4 |
| -11 | 60610 | HEX HEAD CAP SCREW - 1/2-13 UNC X 1 (BOWMALOK 41024) | 4 |
| -12 | 22485 | FUEL TANK ASSEMBLY (SEE FIG. 13) | 1 |
| -13 | 60322 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 (GR. 5) | 22 |
| -14 | 63302 | SPLIT LOCK WASHER - 5/16 | 40 |
| -15 | 60702 | HEX NUT - 5/16-18 UNC | 8 |
| -16 | 22486 | HYDRAULIC TANK ASSEMBLY (SEE FIG. 20) | 1 |
| -17 | 22390 | EMERGENCY PUMP & MOTOR ASSEMBLY (SEE FIG. 24) | 1 |
| -18 | 63403 | FLAT WASHER - 3/8 | 11 |
| -19 | 21584 | DUAL OVER CENTER VALVE ASSEMBLY (SEE FIG. 12) | 1 |
| -20 | 60339 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3 (GR. 5) | 2 |
| -21 | 63402 | FLAT WASHER - 5/16 | 4 |
| -22 | 21712 | MINIPAK SUB-ASSEMBLY (SEE FIG. 17) | 1 |
| -23 | 21692 | SOLENOID VALVE ASSEMBLY (SEE FIG. 23A) | 1 |
| -24 | 21573 | PILOT VALVE MANIFOLD ASSEMBLY (SEE FIG. 19) | 1 |
| -25 | 21537 | PROPORTIONAL VALVE ASSEMBLY (SEE FIG. 16) | 1 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -26 | 63636 | THREADED ROD - 3/8-16 UNC X 3 3/4 | 4 |
| -27 | 60703 | HEX NUT - 3/8-16 UNC | 4 |
| -28 | 25497 | ROUND TUBE | 4 |
| -29 | 21703 | GROUND CONTROL BOX ASSEMBLY (SEE FIG. 15) | 1 |
| -30 | 22522 | BATTERY HOLD DOWN BRACKET | 2 |
| -31 | 60316 | HEX HEAD CAP SCREW - 5/16-18 UNC X 4 1/2 (GR. 5) | 2 |
| -32 | 21244 | BATTERY | 1 |
| -33 | 60511 | HEX HEAD CAP SCREW - 5/16-18 UNC X 2 3/4 (BOWMALLOY 36036) | 4 |
| -34 | 20445 | SPACER | 4 |
| -35 | 60609 | HEX HEAD CAP SCREW - 1/2-13 UNC X 2 (BOWMALOK 41028) | 18 |
| -36 | 60307 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 1/2 (GR. 5) | 3 |
| -37 | 22495 | ROTARY MANIFOLD ASSEMBLY (SEE FIG. 22) | 1 |
| -38 | 4082 | RELAY | 1 |
| -39 | 60324 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1/2 (GR. 5) | 2 |
| -40 | 20740 | SLEWING RING | 1 |
| -41 | 60356 | HEX HEAD CAP SCREW - 3/8-16 UNC X 4 1/2 (GR. 5) | 2 |
| -42 | 21599 | CHECK VALVE ASSEMBLY (SEE FIG. 18A) | 1 |
| -43 | 60325 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (GR. 5) | 2 |
| -44 | 21623 | SOLENOID VALVE ASSEMBLY (SEE FIG. 23) | 1 |
| -45 | 60319 | HEX HEAD CAP SCREW - 1/4-20 UNC X 1 3/4 (GR. 5) | 2 |
| -46 | 63301 | SPLIT LOCK WASHER - 1/4 | 2 |
| -47 | 63401 | FLAT WASHER - 1/4 | 2 |
| -48 | 21598 | RELIEF VALVE ASSEMBLY (SEE FIG. 18) | 1 |
| -49 | 20671 | BATTERY CABLE KIT | 1 |
| -50 | 21217 | TERMINAL STRIP | 1 |
| -51 | 21386 | TERMINAL STRIP COVER | 1 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -52 | 60355 | HEX HEAD CAP SCREW - 5/16-18 UNC X 2 1/2 (GR. 5) | 4 |
| -53 | 62724 | SLOTTED ROUND HEAD MACHINE SCREW - NO. 10-24 UNC X 1/2 | 8 |
| -54 | 22461 | FLYWHEEL SHROUD | 1 |

# FIGURE 9A - TURRET ASSEMBLY (3 SECTION BOOM)



# FIGURE 9A - TURRET ASSEMBLY (3 SECTION BOOM)

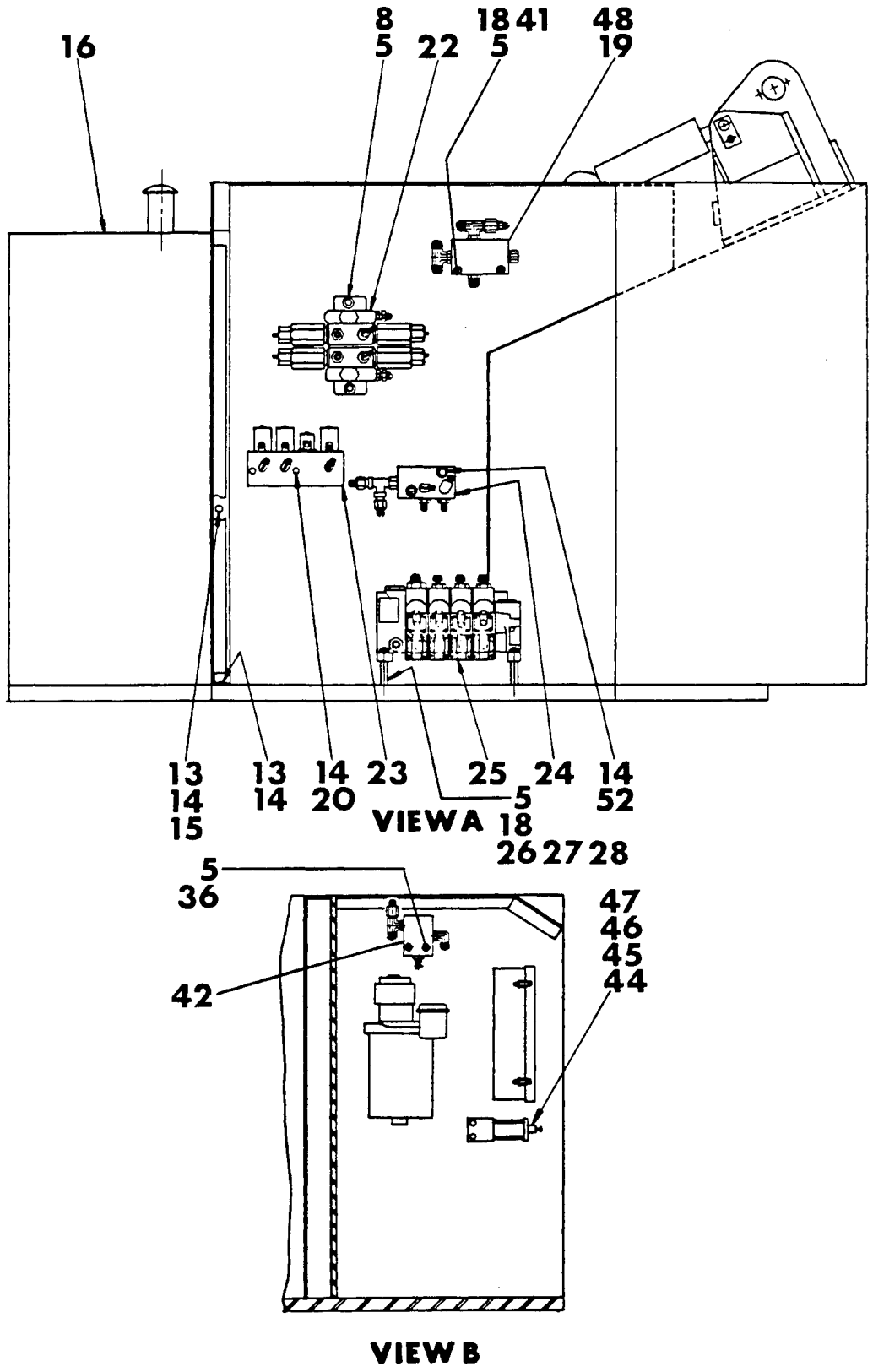


FIGURE 9A - TURRET ASSEMBLY (3 SECTION BOOM)

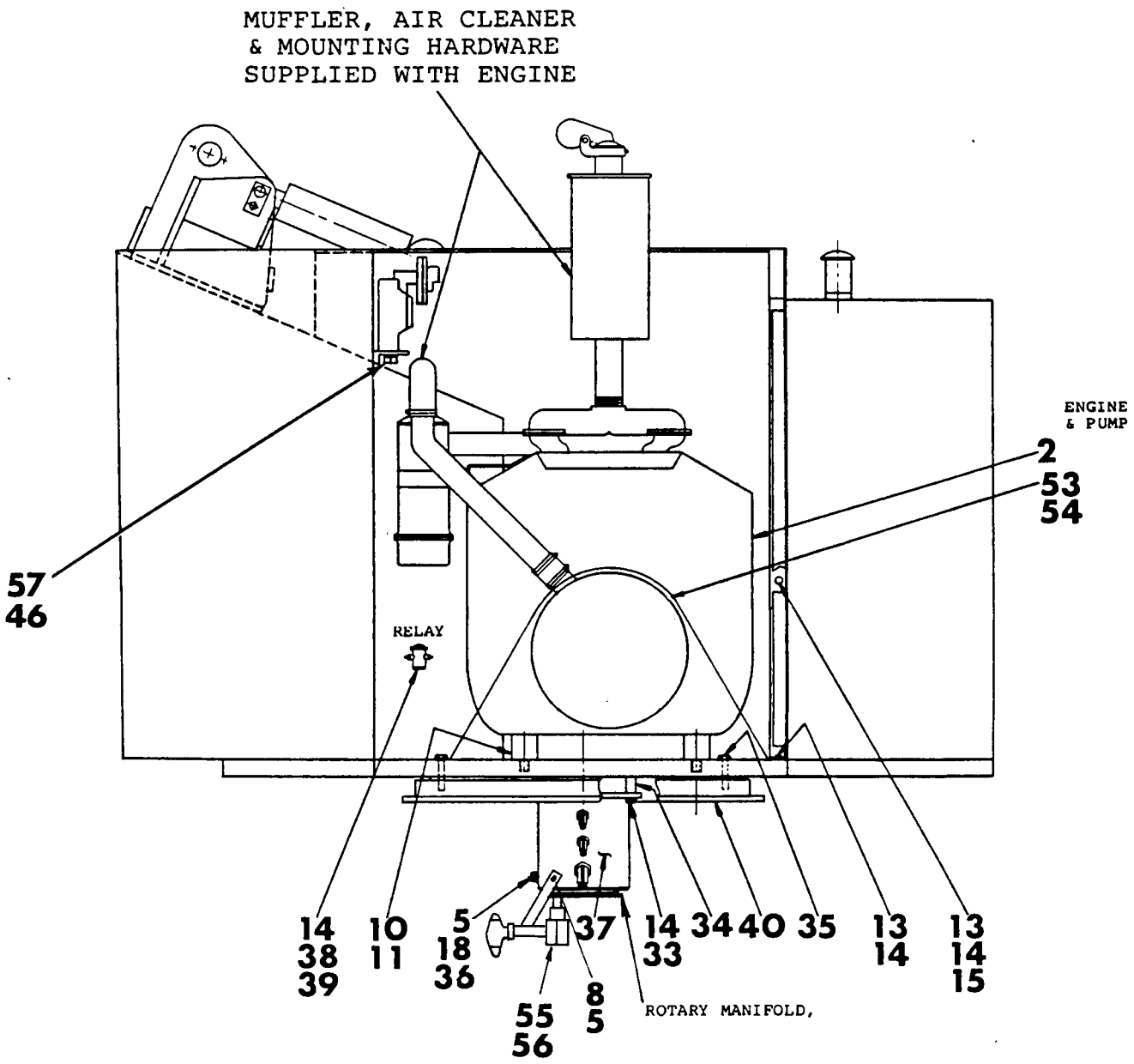


FIGURE 9A - TURRET ASSEMBLY (3 SECTION BOOM)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 9A- | 22465 | TURRET ASSEMBLY (3 SECTION BOOM) | 1 |
| -1 | 22384 | TURRET WELDMENT | 1 |
| -2 | 22468 | ENGINE & PUMP ASSEMBLY (SEE FIG. 10) | 1 |
| -3 | 21432 | LIFT CYLINDER ASSEMBLY (SEE FIG. 11) | 1 |
| -4 | 21780 | LIFT CYLINDER PIN | 1 |
| -5 | 63303 | SPLIT LOCK WASHER - 3/8 | 25 |
| -6 | 60607 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (BOWMALOK 41012) | 2 |
| -7 | 21084 | MASTER LEVELING CYLINDER ASSEMBLY (SEE FIG. 21) | 2 |
| -8 | 60320 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1/2 (GR. 5) | 11 |
| -9 | 21337 | MASTER LEVELING CYLINDER PIN | 2 |
| -10 | 22455 | SPACER | 4 |
| -11 | 60610 | HEX HEAD CAP SCREW - 1/2-13 UNC X 1 (BOWMALOK 41024) | 4 |
| -12 | 22485 | FUEL TANK ASSEMBLY (SEE FIG. 13) | 1 |
| -13 | 60322 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 (GR. 5) | 22 |
| -14 | 63302 | SPLIT LOCK WASHER - 5/16 | 40 |
| -15 | 60702 | HEX NUT - 5/16-18 UNC | 8 |
| -16 | 22486 | HYDRAULIC TANK ASSEMBLY (SEE FIG. 20) | 1 |
| -17 | 22390 | EMERGENCY PUMP & MOTOR ASSEMBLY (SEE FIG. 24) | 1 |
| -18 | 63403 | FLAT WASHER - 3/8 | 11 |
| -19 | 21584 | DUAL OVER CENTER VALVE ASSEMBLY (SEE FIG. 12) | 1 |
| -20 | 60339 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3 (GR. 5) | 2 |
| -21 | 63402 | FLAT WASHER - 5/16 | 4 |
| -22 | 21712 | MINIPAK SUB-ASSEMBLY (SEE FIG. 17) | 1 |
| -23 | 21692 | SOLENOID VALVE ASSEMBLY (SEE FIG. 23A) | 1 |
| -24 | 21573 | PILOT VALVE MANIFOLD ASSEMBLY (SEE FIG. 19) | 1 |
| -25 | 21537 | PROPORTIONAL VALVE ASSEMBLY (SEE FIG. 16) | 1 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -26 | 63636 | THREADED ROD - 3/8-16 UNC X 3 3/4 | 4 |
| -27 | 60703 | HEX NUT - 3/8-16 UNC | 4 |
| -28 | 25497 | ROUND TUBE | 4 |
| -29 | 21703 | GROUND CONTROL BOX ASSEMBLY (SEE FIG. 15) | 1 |
| -30 | 22522 | BATTERY HOLD DOWN BRACKET | 2 |
| -31 | 60316 | HEX HEAD CAP SCREW - 5/16-18 UNC X 4 1/2 (GR. 5) | 2 |
| -32 | 21244 | BATTERY | 1 |
| -33 | 60511 | HEX HEAD CAP SCREW - 5/16-18 UNC X 2 3/4 (BOWMALLOY 36036) | 4 |
| -34 | 20445 | SPACER | 4 |
| -35 | 60609 | HEX HEAD CAP SCREW - 1/2-13 UNC X 2 (BOWMALOK 41028) | 18 |
| -36 | 60307 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 1/2 (GR. 5) | 3 |
| -37 | 22495 | ROTARY MANIFOLD ASSEMBLY (SEE FIG. 22) | 1 |
| -38 | 4082 | RELAY | 1 |
| -39 | 60324 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1/2 (GR. 5) | 2 |
| -40 | 20740 | SLEWING RING | 1 |
| -41 | 60356 | HEX HEAD CAP SCREW - 3/8-16 UNC X 4 1/2 (GR. 5) | 2 |
| -42 | 21599 | CHECK VALVE ASSEMBLY (SEE FIG. 18A) | 1 |
| -43 | 60325 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (GR. 5) | 2 |
| -44 | 21623 | SOLENOID VALVE ASSEMBLY (SEE FIG. 23) | 1 |
| -45 | 60319 | HEX HEAD CAP SCREW - 1/4-20 UNC X 1 3/4 (GR. 5) | 2 |
| -46 | 63301 | SPLIT LOCK WASHER - 1/4 | 2 |
| -47 | 63401 | FLAT WASHER - 1/4 | 2 |
| -48 | 21598 | RELIEF VALVE ASSEMBLY (SEE FIG. 18) | 1 |
| -49 | 20671 | BATTERY CABLE KIT | 1 |
| -50 | 21217 | TERMINAL STRIP | 1 |
| -51 | 21386 | TERMINAL STRIP COVER | 1 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -52 | 60355 | HEX HEAD CAP SCREW - 5/16-18 UNC X 2 1/2 (GR. 5) | 4 |
| -53 | 62724 | SLOTTED ROUND HEAD MACHINE SCREW - NO. 10-24 UNC X 1/2 | 8 |
| -54 | 22878 | DUCT, AIR | 1 |
| -55 | 22741 | ASSY,LPG LINE SWIVEL JOINT | 1 |
| -56 | 80029-07 | TEE FEMALE BRANCH | 1 |
| -57 | 60342 | SCREW, CAP | 4 |
| -58 | 22665 | KIT, DUEL FUEL | 1 |
| -59 | 70256 | PUMP, ELECTRIC FUEL | 2 |
| -60 | 66196 | ELBOW, STREET | 2 |
| -61 | 240 | HOSE BARB | 2 |

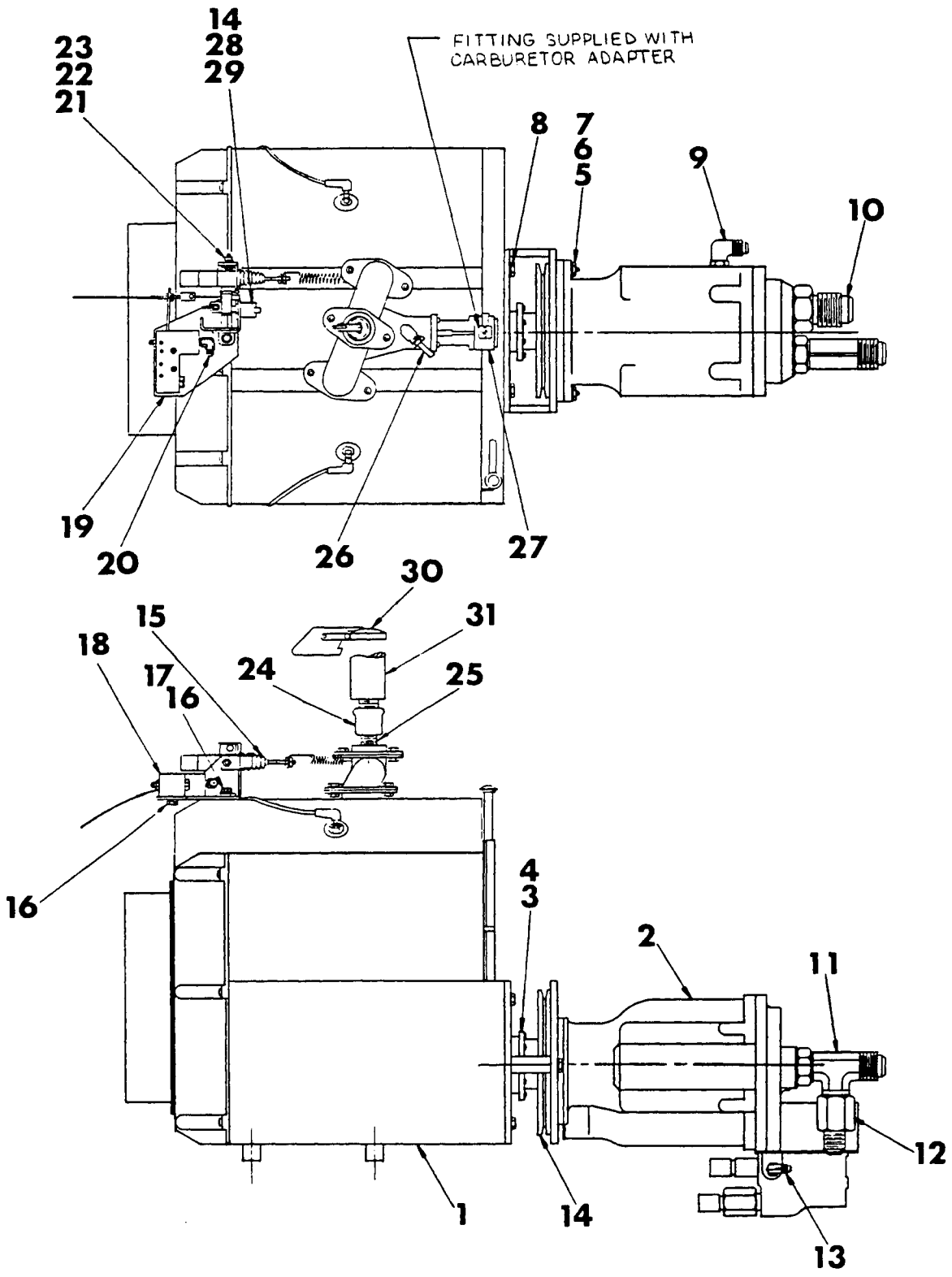
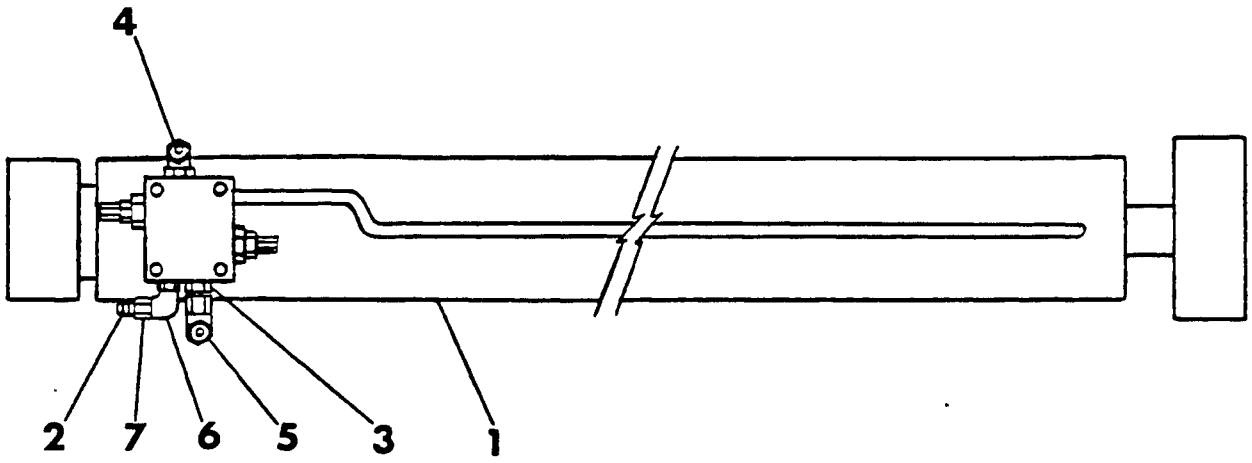

FITTING SUPPLIED WITH CARBURETOR ADAPTER
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FIGURE 10 - ENGINE & PUMP ASSEMBLY



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 10- | 22468 | ENGINE & PUMP ASSEMBLY | 1 |
| -1 | 21802 | ENGINE | 1 |
| -2 | 21458 | PUMP | 1 |
| -3 | 22458 | STUB SHAFT | 1 |
| -4 | 60625 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 (BOWMALOK 41007) | 8 |
| -5 | 63613 | STUD - 1/2-13 UNC X 2 1/2 (GR. 5) | 2 |
| -6 | 63305 | SPLIT LOCK WASHER - 1/2 | 2 |
| -7 | 60705 | HEX NUT - 1/2-13 UNC | 2 |
| -8 | 60630 | HEX HEAD CAP SCREW - 7/16-14 UNC X 1 1/4 (BOWMAN) | 4 |
| -9 | 80012-05 | STRAIGHT THREAD ELBOW | 1 |
| -10 | 80004-28 | STRAIGHT THREAD CONNECTOR | 1 |
| -11 | 80033-21 | STRAIGHT THREAD RUN TEE | 1 |
| -12 | 80056-08 | TUBE END REDUCER | 1 |
| -13 | 80012-03 | STRAIGHT THREAD ELBOW | 1 |
| -14 | 65008 | TAPER LOCK SHEAVE | 1 |
| -15 | 21777 | SYNCHRO START | 1 |
| -16 | 60322 | SCREW, CAP | 4 |
| -17 | 63302 | WASHER, LOCK | 4 |
| -18 | 20364 | THROTTLE, HYD. | 1 |
| -19 | 22521 | BRACKET,MNTG.SOL.VALVE & HYD.THROTTLE | 1 |
| -20 | 80008-04 | ELBOW, MALE | 1 |
| -21 | 60701 | NUT, HEX | 2 |
| -22 | 63301 | WASHER, LOCK | 2 |
| -23 | 60309 | SCREW, CAP | 2 |
| -24 | 16701 | REDUCER, BELL | 1 |
| -25 | 16552 | NIPPLE, CLOSE | 1 |
| -26 | 65509 | ADAPTER, TUBE | 1 |
| -27 | 65510 | ADAPTER, CARBURETOR | 1 |
| -28 | 65511 | DASHPOT | 1 |
| -29 | 22663 | BRACKET, DASHPOT | 1 |
| -30 | 65508 | RAINCAP | 1 |
| -31 | 65629 | MUFFLER | 1 |

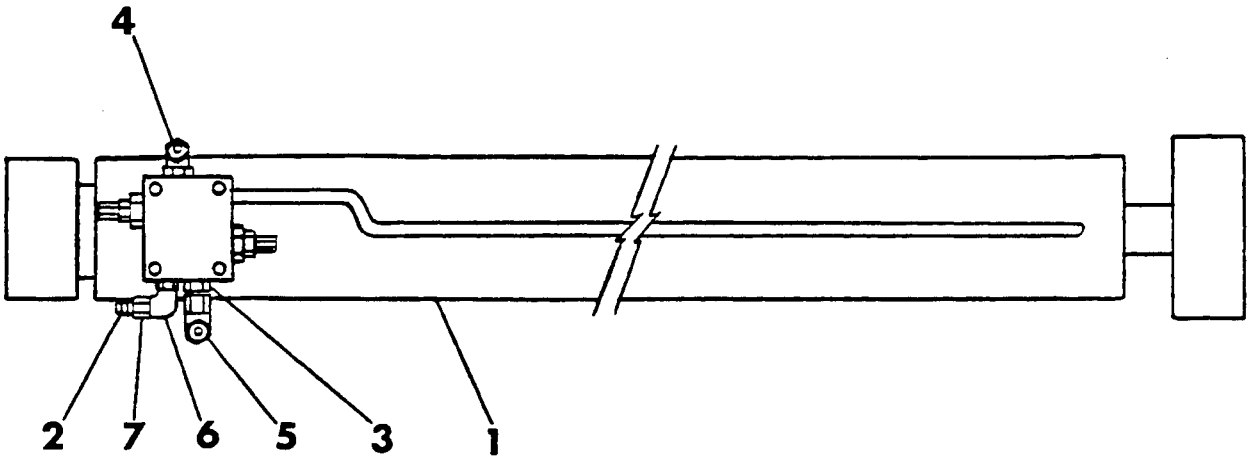
FIGURE 11 - LIFT CYLINDER ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 11- | 21432 | LIFT CYLINDER ASSEMBLY | 1 |
| -1 | 21454 | LIFT CYLINDER SUB-ASSEMBLY (SEE FIG. 11A) | 1 |
| -2 | 20348 | BLEED DOWN ORIFICE | 1 |
| -3 | 2542 | STRAIGHT THREAD CONNECTOR | 1 |
| -4 | 2523 | STRAIGHT THREAD ELBOW | 1 |
| -5 | 2441 | SWIVEL NUT ELBOW | 1 |
| -6 | 50900 | STRAIGHT THREAD ELBOW | 1 |
| -7 | 2539 | "B" NUT | 1 |
| | | | 1 |

FIGURE 11.1 - LIFT CYLINDER ASSEMBLY

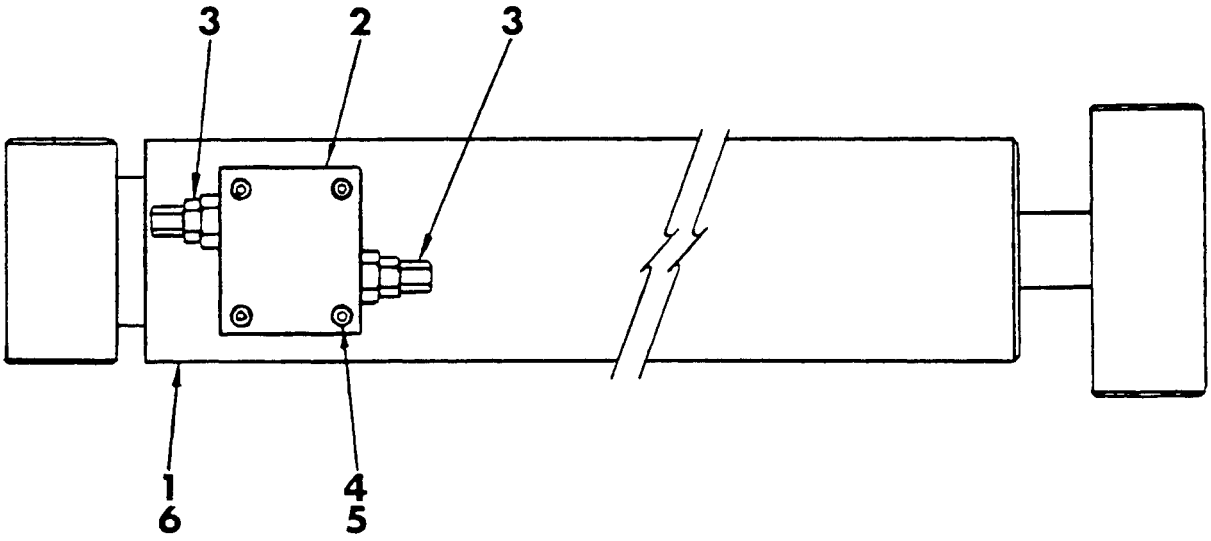





| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| | 21705 | LIFT CYLINDER ASSEMBLY | 1 |
| -1 | 20968 | LIFT CYLINDER SUB-ASSEMBLY (SEE FIG. 11A.1) | 1 |
| -2 | 20348 | BLEED DOWN ORIFICE | 1 |
| -3 | 80004-09 | STRAIGHT THREAD CONNECTOR | 1 |
| -4 | 80012-09 | STRAIGHT THREAD ELBOW | 1 |
| -5 | 80015-05 | SWIVEL NUT ELBOW | 1 |
| -6 | 50900 | STRAIGHT THREAD ELBOW | 1 |
| -7 | 80060-05 | "B" NUT | 1 |
| | | | 1 |

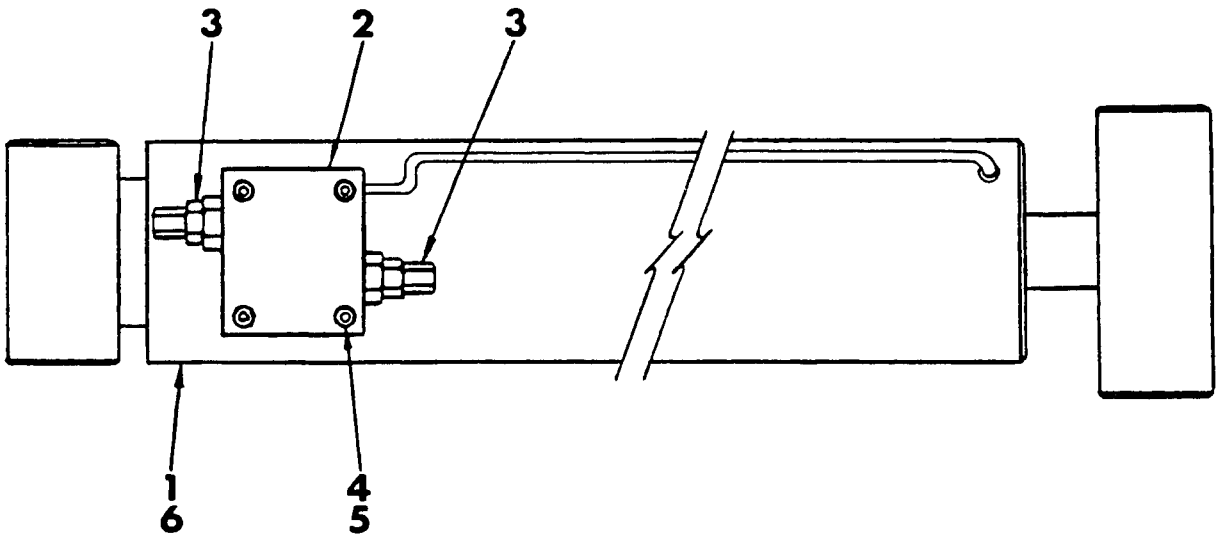
NOTE: WHEN ORDERING PARTS, SPECIFY MACHINES I.D. NUMBER AND WHO MFG. THE CYLINDER. FOR EXAMPLE, SIERRA, R.A. INDUSTRIES, CESSNA OR TEXAS HYDRAULIC.

FIGURE 11A - LIFT CYLINDER SUB-ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 11A- | 21454 | LIFT CYLINDER SUB-ASSEMBLY | 1 |
| -1 | 21409 | LIFT CYLINDER | 1 |
| -2 | 22130 | MANIFOLD BLOCK | 1 |
| -3 | 21580 | OVER CENTER CARTRIDGE | 2 |
| -4 | 61820 | SOCKET HEAD CAP SCREW - 5/16-24 UNF X 2 | 4 |
| -5 | 63302 | SPLIT LOCK WASHER - 5/16 | 4 |
| -6 | 66502 | LIFT CYLINDER SEAL KIT | 1 |

# FIGURE 11A.1- LIFT CYLINDER SUB-ASSEMBLY

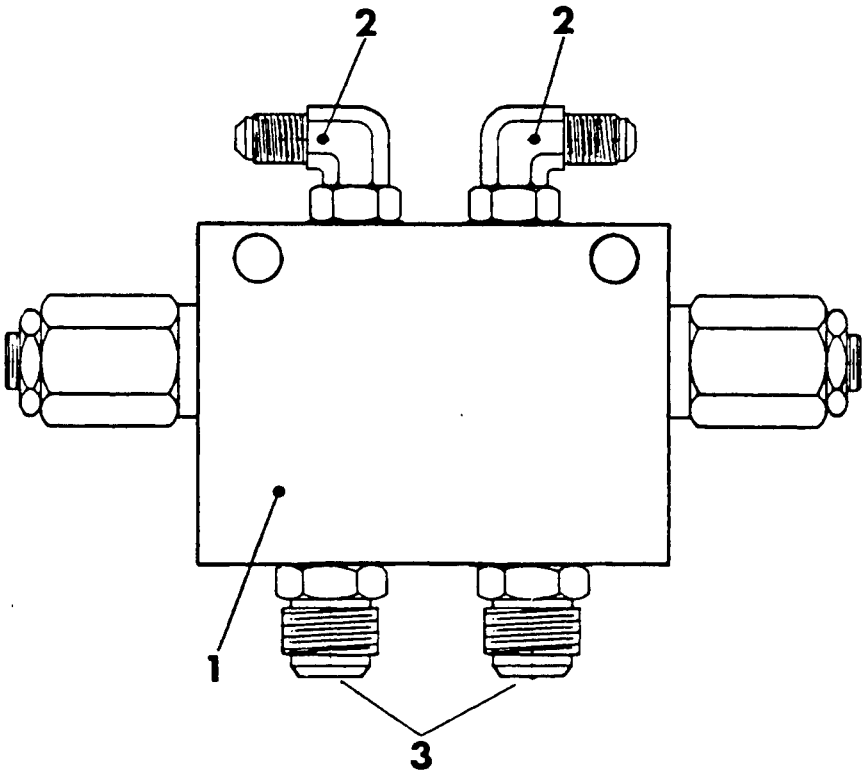



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| | 20968 | LIFT CYLINDER SUB-ASSEMBLY | 1 |
| -1 | 21198 | LIFT CYLINDER | 1 |
| -2 | 21445 | MANIFOLD BLOCK | 1 |
| -3 | 81006 | OVER CENTER CARTRIDGE | 2 |
| -4 | 61918 | SOCKET HEAD CAP SCREW - 5/16-24 UNF X 2 | 4 |
| -5 | 63302 | SPLIT LOCK WASHER - 5/16 | 4 |
| -6 | 66502 | LIFT CYLINDER SEAL KIT | 1 |

NOTE: WHEN ORDERING PARTS, SPECIFY MACHINES I.D. NUMBER AND WHO MFG. THE CYLINDER. FOR EXAMPLE, SIERRA, R.A. INDUSTRIES, CESSNA OR TEXAS HYDRAULIC.

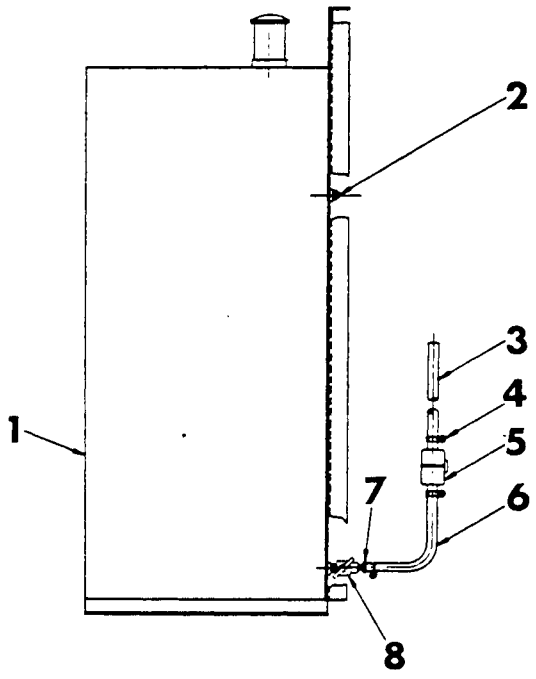
FIGURE 12 - DUAL OVER CENTER VALVE ASSEMBLY





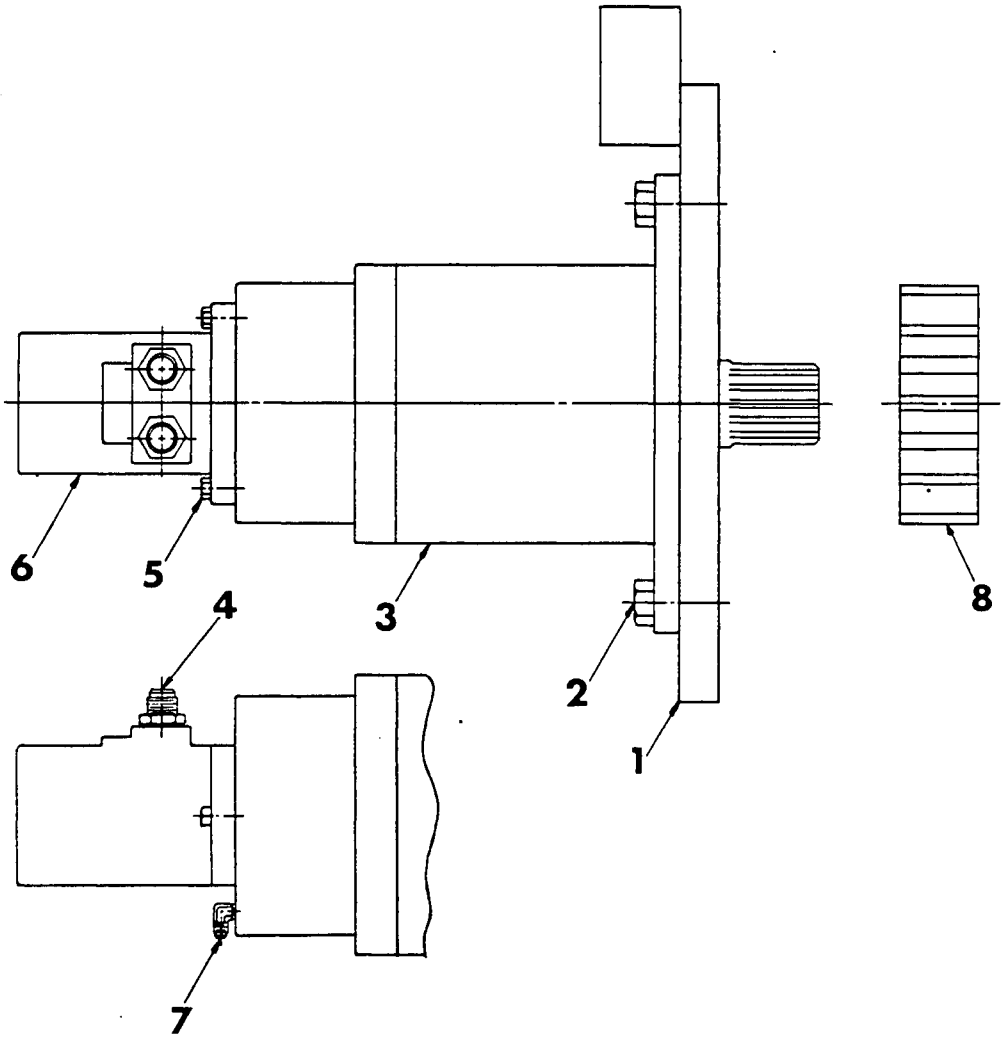

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 23- | 21584 | DUAL OVER CENTER VALVE ASSEMBLY | 1 |
| -1 | 20365 | D.O.C. VALVE | 1 |
| -2 | 80012-05 | STRAIGHT THREAD ELBOW | 2 |
| -3 | 80004-05 | STRAIGHT THREAD ELBOW | 2 |

# FIGURE 13 - FUEL TANK ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 13- | 22485 | FUEL TANK ASSEMBLY | 1 |
| -1 | 22382 | FUEL TANK | 1 |
| -2 | 53911 | PIPE PLUG | 1 |
| -3 | 160-B | HOSE | 1 |
| -4 | 161-A | HOSE CLAMP | 3 |
| -5 | 160 | FUEL FILTER | 1 |
| -6 | 160 | HOSE | 1 |
| -7 | 2589 | HOSE FITTING | 1 |
| -8 | 12000 | SHUT OFF VALVE | 1 |

FIGURE 14 - ROTATION GEAR BOX ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 14- | 22475 | ROTATION GEAR BOX ASSEMBLY | 1 |
| -1 | 22460 | GEAR BOX MOUNTING PLATE | 1 |
| -2 | 60604 | HEX HEAD CAP SCREW - 5/8-11 UNC X 1 1/2 (BOWMALOK 41032) | 4 |
| -3 | 22362 | GEAR BOX | 1 |
| -4 | 80001-14 | MALE CONNECTOR | 2 |
| -5 | 60625 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 (BOWMALOK 41007) | 2 |
| -6 | 20520 | ORBIT MOTOR | 1 |
| -7 | 80008-03 | MALE ELBOW | 1 |
| -8 | | PINION GEAR (FURNISHED WITH ROTATION GEAR BOX) | 1 |

FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

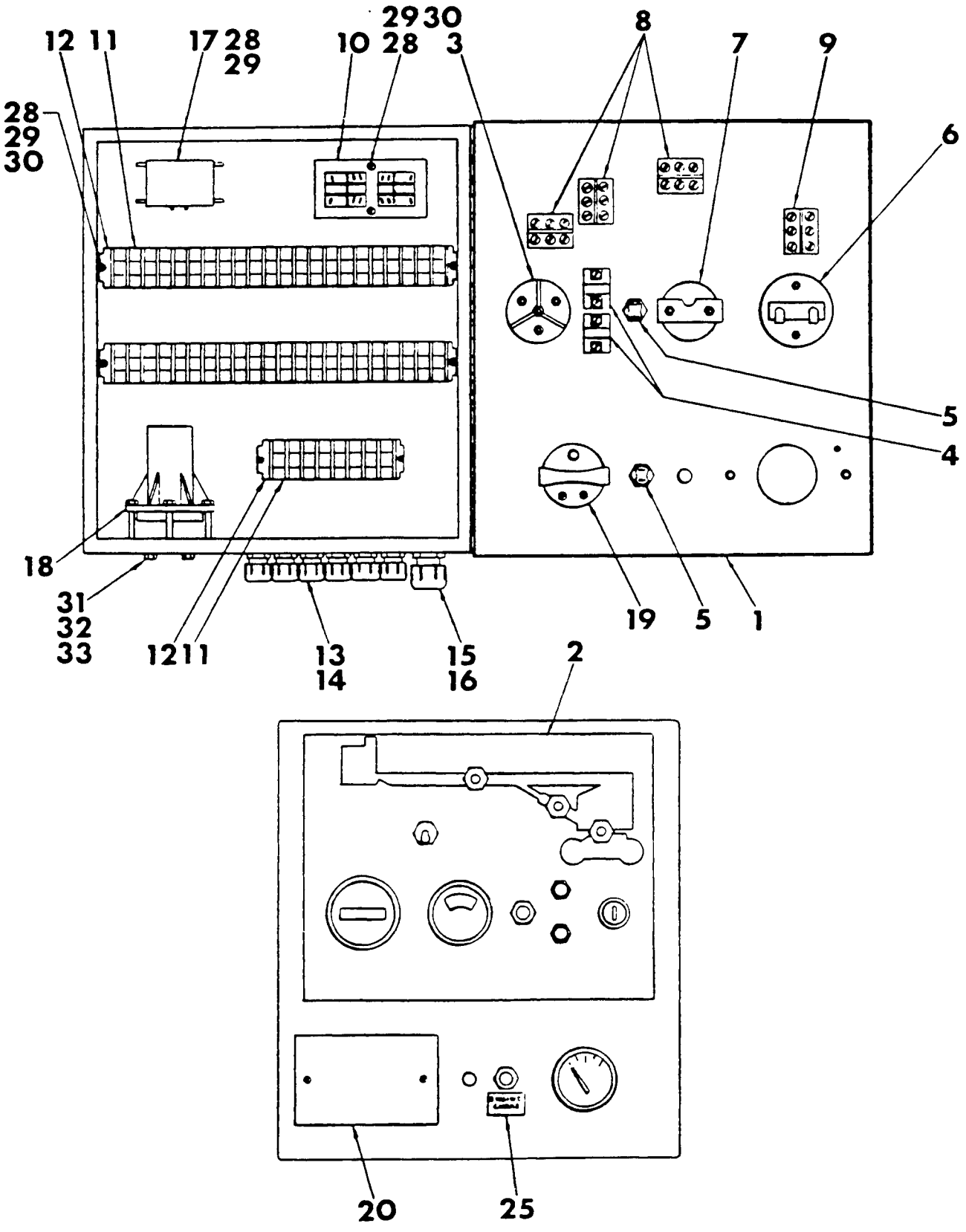


FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 15- | 21703 | GROUND CONTROL BOX ASSEMBLY | 1 |
| -1 | 20977 | ENCLOSURE | 1 |
| -2 | 20460 | DECAL - COVER | 1 |
| -3 | 2717 | IGNITION SWITCH | 1 |
| -4 | 20562 | CIRCUIT BREAKER | 2 |
| -5 | 4011 | PUSH BUTTON SWITCH | 2 |
| -6 | 20571 | HOUR METER | 1 |
| -7 | 20572 | AMMETER | 1 |
| -8 | 20481 | TOGGLE SWITCH | 3 |
| -9 | 20482 | TOGGLE SWITCH | 1 |
| -10 | 20573 | LATCHING RELAY | 1 |
| -11 | 4027 | TERMINAL BLOCK | 52 |
| -12 | 117A | TERMINAL BLOCK END | 3 |
| -13 | 2806 | STRAIN RELIEF | 6 |
| -14 | 2808 | LOCK NUT | 6 |
| -15 | 2807 | STRAIN RELIEF | 1 |
| -16 | 2809 | LOCK NUT | 1 |
| -17 | 21253 | RELAY T-BAR | 1 |
| -18 | 21250 | SLOPE SENSOR | 1 |
| -19 | 21219 | FUEL GAUGE | 1 |
| -20 | 902 | COVER PLATE | 1 |
| -21 | 4045 | DIODE | 2 |
| -22 | 70142 | RESISTOR | 3 |
| -23 | 117D | BUTT CONNECTOR | 8 |
| -24 | 117E | PUSH ON TERMINAL | 6 |
| -25 | 20413 | DECAL-"ENGINE CHOKE" | 1 |
| -26 | 2859 | RING TONGUE | 25 |
| -27 | 876 | RING TONGUE | 10 |
| -28 | 62609 | ROUND HEAD SLOTTED CAPSCREW NO. 6-32UNC X 1/2 | 14 |
| -29 | 63311 | LOCKWASHER - No. 6 | 14 |
| -30 | 61501 | HEX NUT - NO. 6-32UNC | 12 |
| -31 | 60116 | HEX HEAD CAPSCREW - 3/8-16UNC X 3/4 | 4 |

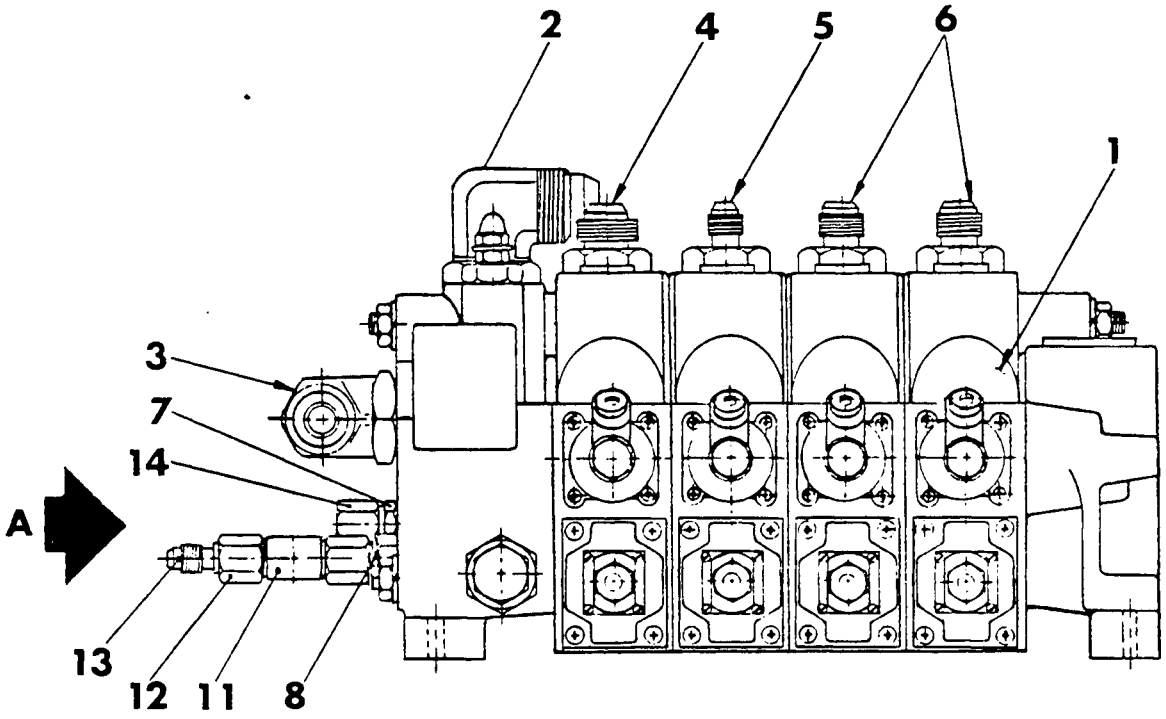
FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

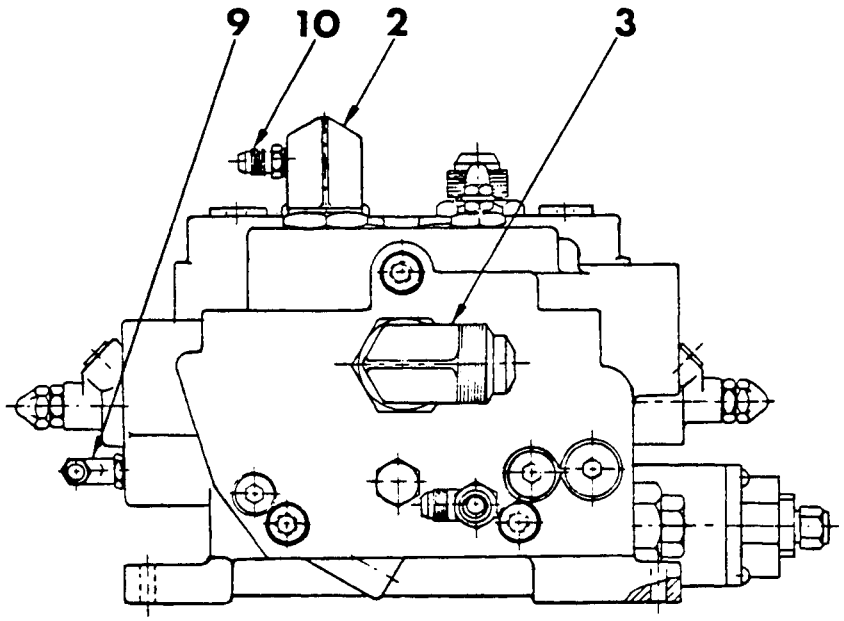


| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -32 | 63303 | LOCKWASHER - 3/8 | 4 |
| -33 | 60703 | HEX NUT - 3/8-16UNC | 4 |
| | 70147 | CAPACITOR | |

FIGURE 16 - FOUR SPOOL PROPORTIONAL VALVE ASSEMBLY





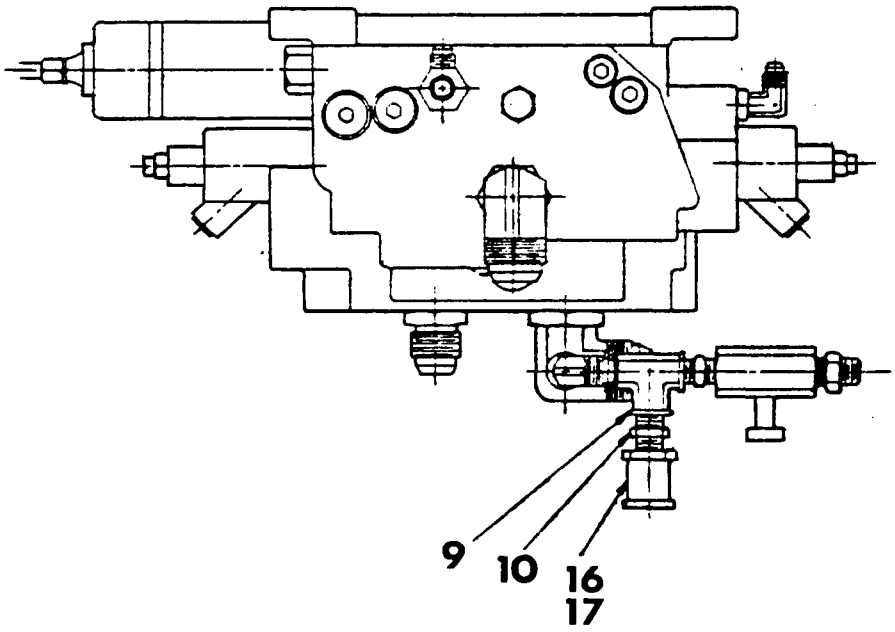

VIEW A

FIGURE 16 - FOUR SPOOL PROPORTIONAL VALVE ASSEMBLY



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 16- | 21537 | FOUR SPOOL PROPORTIONAL VALVE ASSEMBLY | 1 |
| -1 | 21255 | PROPORTIONAL VALVE | 1 |
| -2 | 20798 | MODIFIED STRAIGHT THREAD ELBOW | 1 |
| -3 | 2528 | STRAIGHT THREAD ELBOW | 1 |
| -4 | 2543 | STRAIGHT THREAD CONNECTOR | 2 |
| -5 | 50844 | STRAIGHT THREAD CONNECTOR | 2 |
| -6 | 50823 | STRAIGHT THREAD CONNECTOR | 4 |
| -7 | 50808 | STRAIGHT THREAD CONNECTOR | 1 |
| -8 | 2511 | STRAIGHT THREAD CONNECTOR | 1 |
| -9 | 2532 | STRAIGHT THREAD ELBOW | 1 |
| -10 | 2415 | MALE CONNECTOR | 1 |
| -11 | 2604 | SWIVEL NUT RUN TEE | 1 |
| -12 | 2539 | B-NUT | 1 |
| -13 | 54100 | TUBE END REDUCER | 1 |
| -14 | 2412 | CAP | 1 |

FIGURE 16A - PROPORTIONAL VALVE ASSEMBLY REVISED



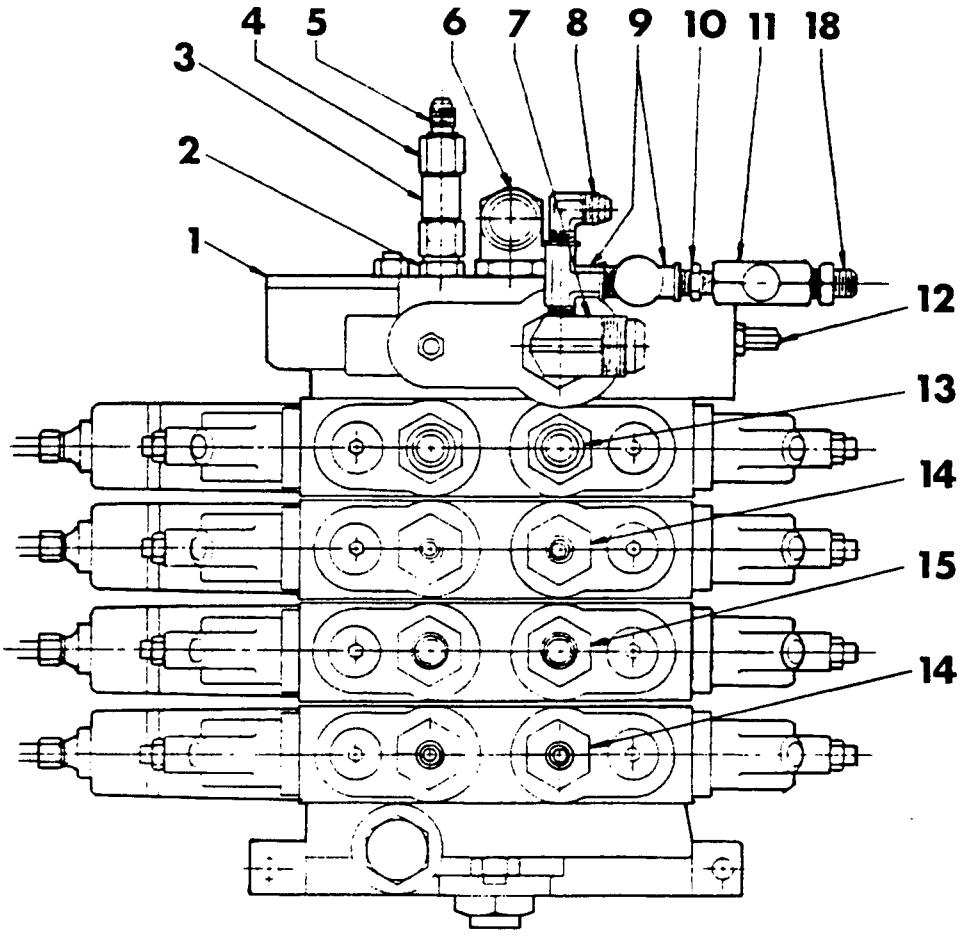
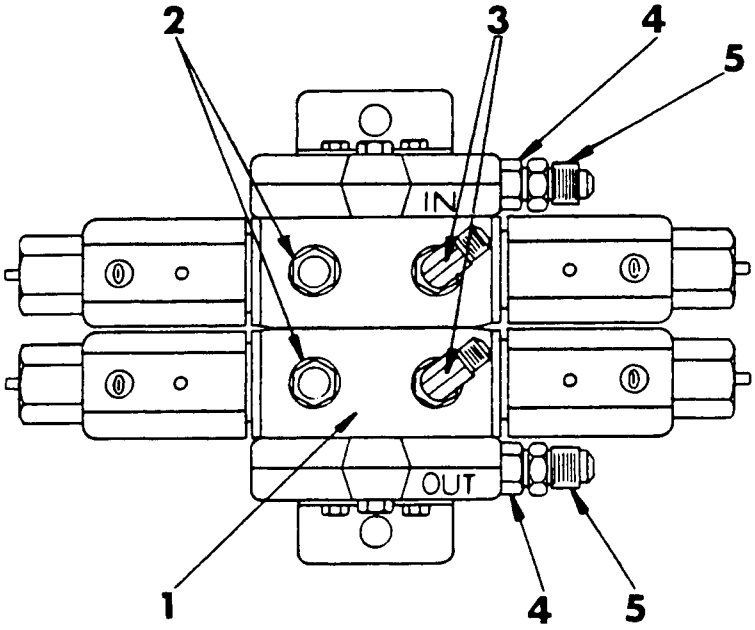



FIGURE 16A - PROPORTIONAL VALVE ASSEMBLY REVISED

| ITEM | QTY | PART NO. | DESCRIPTION |
|---|---|---|---|
| | 1 | 22599 | PROPORTIONAL VALVE ASSEMBLY |
| 1 | 1 | 21255 | VALVE, PROPORTIONAL |
| 2 | 1 | 80004-09 | CONNECTOR, STRAIGHT THREAD |
| 3 | 1 | 80028-05 | TEE, SWIVEL NUT RUN |
| 4 | 1 | 80060-05 | NUT |
| 5 | 1 | 80056-01 | REDUCER, TUBE END |
| 6 | 1 | 80012-24 | ELBOW, STRAIGHT THREAD |
| 7 | 1 | 20798 | ELBOW, MODIFIED STRAIGHT THREAD |
| 8 | 1 | 80008-08 | ELBOW, MALE |
| 9 | 2 | 80041-03 | TEE, STREET |
| 10 | 2 | 80052-04 | NIPPLE, PIPE |
| 11 | 1 | 20357 | VALVE, NEEDLE |
| 12 | 1 | 80012-03 | ELBOW, STRAIGHT THREAD |
| 13 | 2 | 80004-18 | CONNECTOR, STRAIGHT THREAD |
| 14 | 4 | 50844 | CONNECTOR, STRAIGHT THREAD |
| 15 | 2 | 80004-14 | CONNECTOR, STRAIGHT THREAD |
| 16 | 1 | 2527 | COUPLING, QUICK DISCONNECT |
| 17 | 1 | 845 | CAP |
| 18 | 1 | 80004-08 | CONNECTOR, STRAIGHT THREAD |

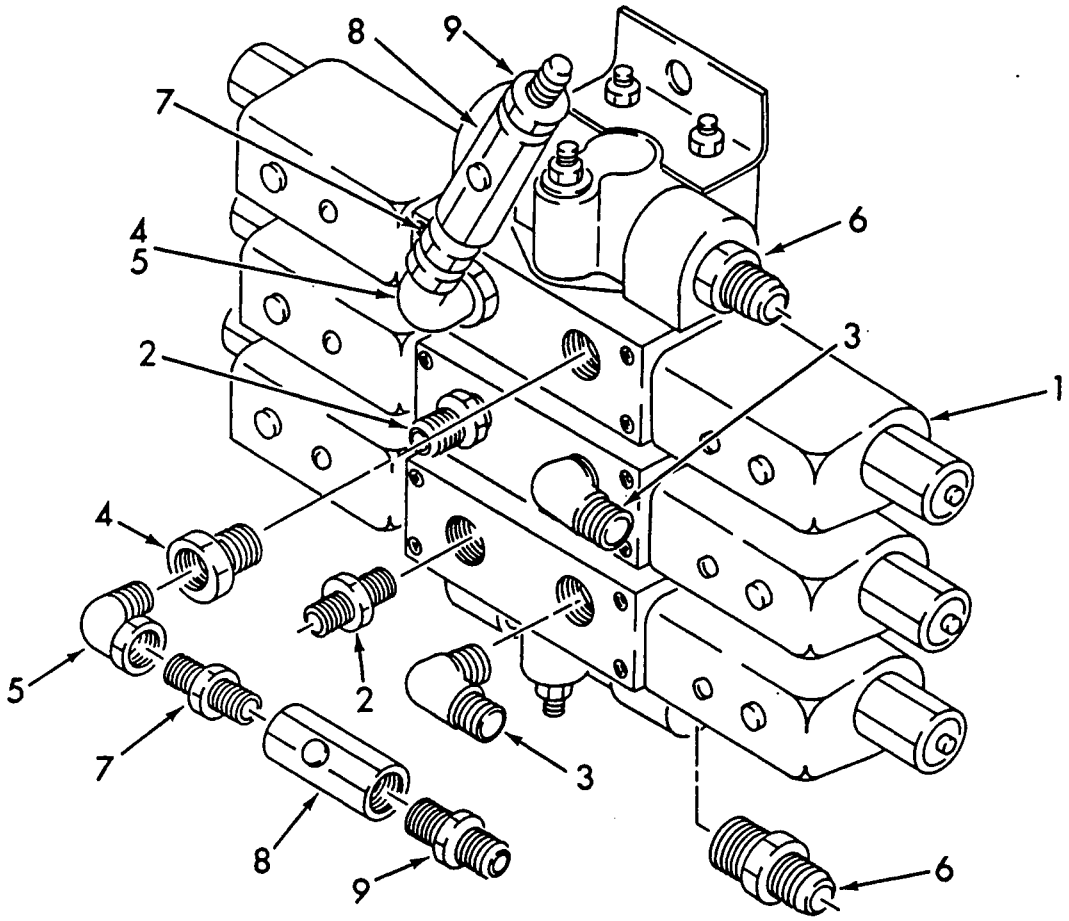
FIGURE 17 - MINIPAK SUB-ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 17- | 21712 | MINIPAK SUB-ASSEMBLY | 1 |
| -1 | 21207 | SOLENOID VALVE BANK | 1 |
| -2 | 80004-05 | CONNECTOR | 2 |
| -3 | 80012-05 | 90° ELBOW | 2 |
| -4 | 80063-01 | FEMALE PIPE ADAPTER | 2 |
| -5 | 80001-08 | CONNECTOR | 2 |

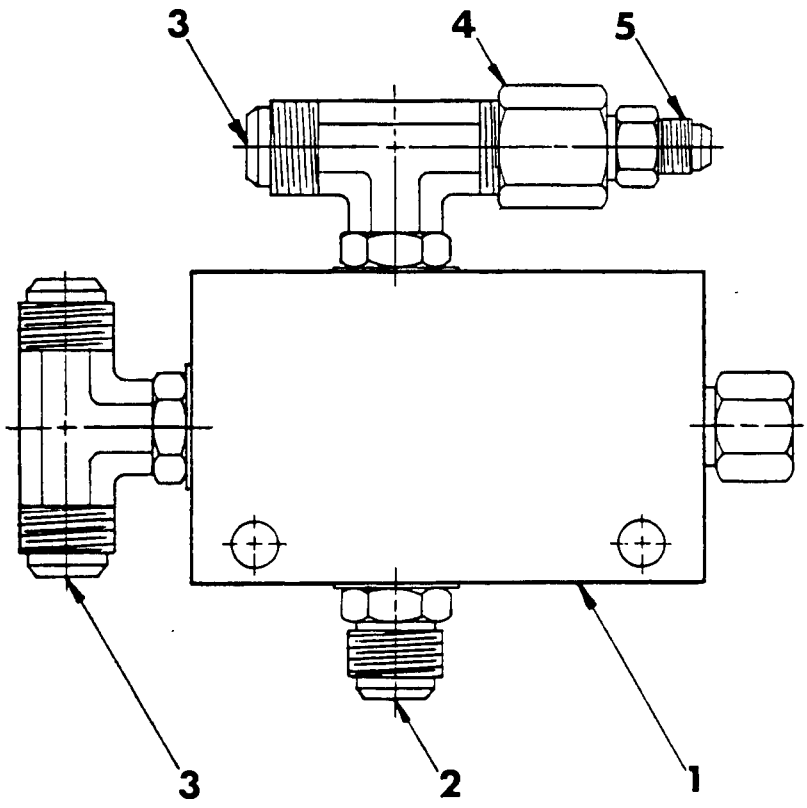
FIGURE 17A - MINIPAK SUB-ASSEMBLY FOR PLATFORM ROTATION OPTION





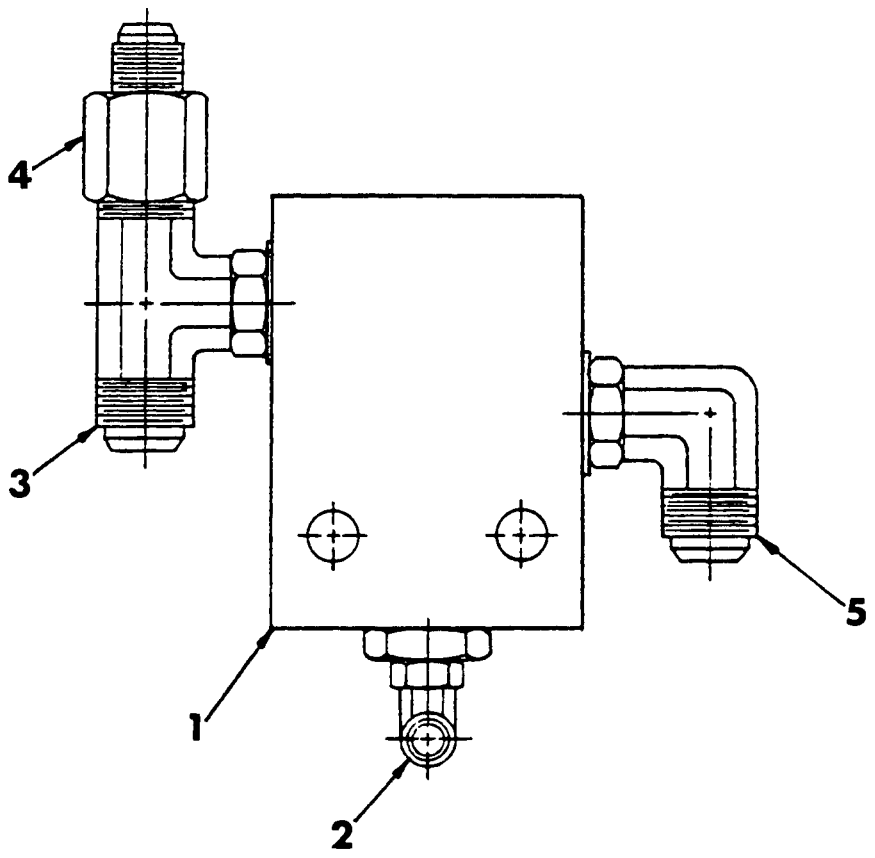

| ITEM | QTY | PART NO. | DESCRIPTION |
|---|---|---|---|
| | 1 | 21713 | MINIPAK SUB - ASSEMBLY |
| 1 | 1 | 21787 | SOLENOID VALVE BANK |
| 2 | 2 | 80004-05 | STRAIGHT THREAD CONNECTOR |
| 3 | 2 | 80012-05 | STRAIGHT THREAD ELBOW |
| 4 | 2 | 80063-01 | FEMALE PIPE ADAPTER |
| 5 | 2 | 80021-03 | STREET ELBOW |
| 6 | 2 | 80004-08 | STRAIGHT THREAD CONNECTOR |
| 7 | 2 | 80052-04 | PIPE NIPPLE |
| 8 | 2 | 20370 | NEEDLE VALVE W/ REV. FREE FLOW |
| 9 | 2 | 80001-04 | MALE CONNECTOR |

# FIGURE 18 - RELIEF VALVE ASSEMBLY



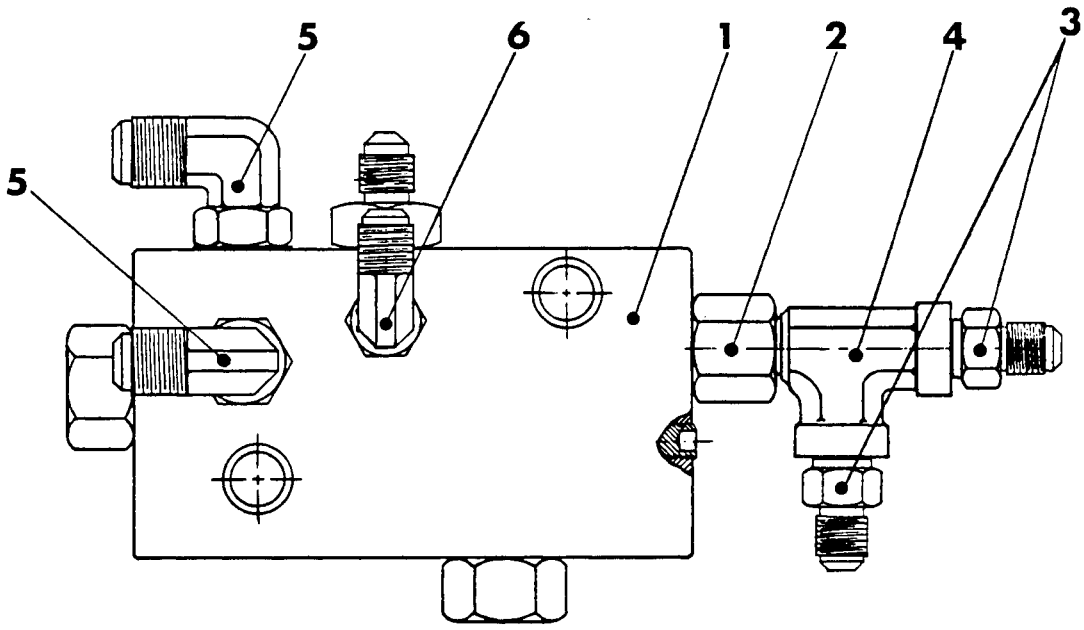

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 18- | 21598 | RELIEF VALVE ASSEMBLY | 1 |
| -1 | 20564 | RELIEF VALVE (REWORKED) | 1 |
| -2 | 80004-11 | STRAIGHT THREAD CONNECTOR | 1 |
| -3 | 80036-11 | STRAIGHT THREAD BRANCH TEE | 2 |
| -4 | 80060-06 | B-NUT | 1 |
| -5 | 80056-02 | TUBE END REDUCER | 1 |

# FIGURE 18A - CHECK VALVE ASSEMBLY



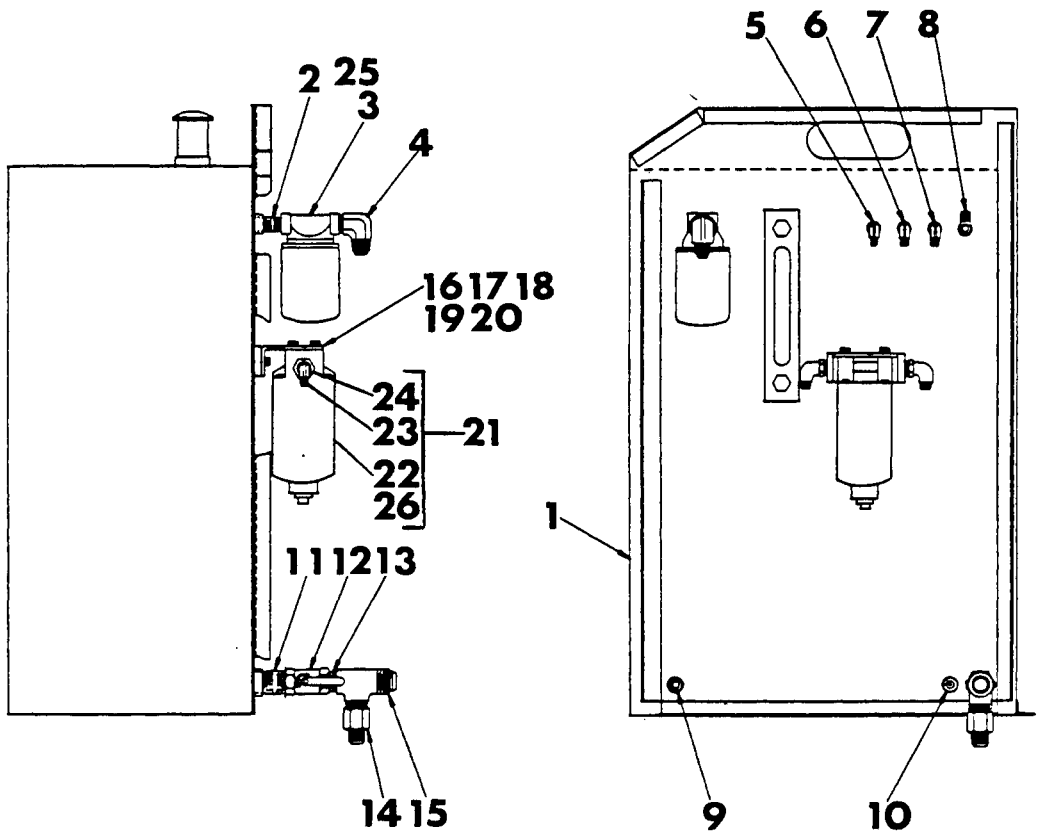

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 18A- | 21599 | CHECK VALVE ASSEMBLY | 1 |
| -1 | 20391 | PILOT OPERATED CHECK VALVE | 1 |
| -2 | 80012-03 | STRAIGHT THREAD ELBOW | 1 |
| -3 | 80036-11 | STRAIGHT THREAD BRANCH TEE | 1 |
| -4 | 80056-03 | TUBE END REDUCER | 1 |
| -5 | 80012-11 | STRAIGHT THREAD ELBOW | 1 |

FIGURE 19 - PILOT VALVE MANIFOLD ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 19- | 21573 | PILOT VALVE MANIFOLD ASSEMBLY | 1 |
| -1 | 21574 | PILOT VALVE MANIFOLD | 1 |
| -2 | 80063-03 | FEMALE PIPE ADAPTER | 1 |
| -3 | 51010 | MALE CONNECTOR | 2 |
| -4 | 80041-03 | STREET TEE | 1 |
| -5 | 80012-09 | STRAIGHT THREAD ELBOW | 2 |
| -6 | 80012-03 | STRAIGHT THREAD ELBOW | 1 |

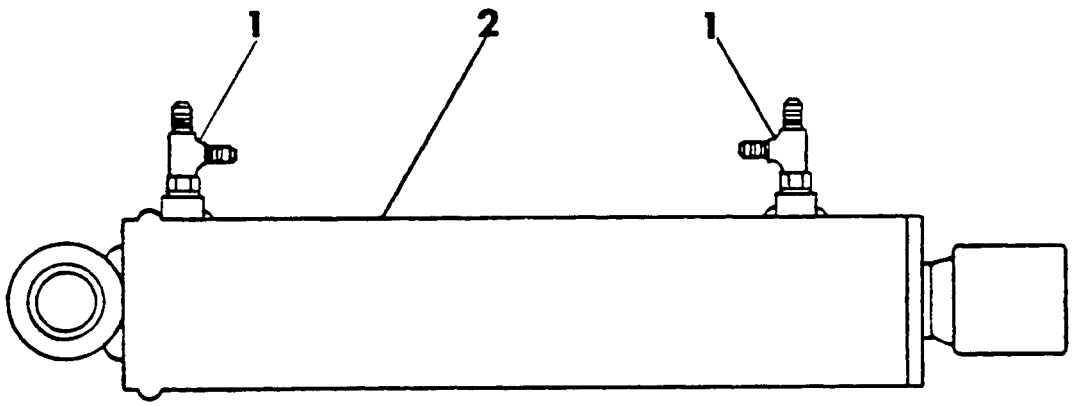
# FIGURE 20 - HYDRAULIC TANK ASSEMBLY



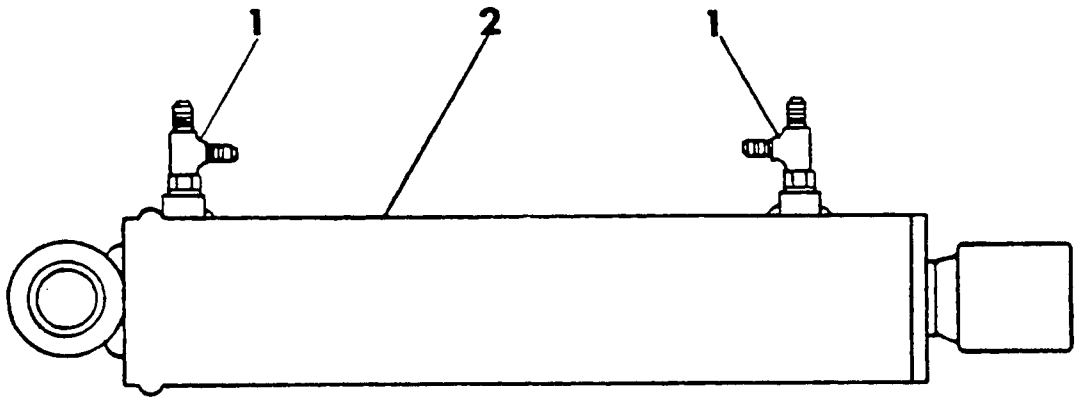

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 20- | 22486 | HYDRAULIC TANK ASSEMBLY | 1 |
| -1 | 22471 | HYDRAULIC TANK | 1 |
| -2 | 80052-12 | NIPPLE | 1 |
| -3 | 20367 | RETURN LINE FILTER | 1 |
| -4 | 80022-12 | MALE ELBOW | 1 |
| -5 | 80008-05 | MALE ELBOW | 1 |
| -6 | 80008-14 | MALE ELBOW | 1 |
| -7 | 80008-11 | MALE ELBOW | 1 |
| -8 | 80037-11 | MALE RUN TEE | 1 |
| -9 | 53903 | PLUG | 1 |
| -10 | 80001-11 | MALE CONNECTOR | 1 |
| -11 | 54700 | NIPPLE | 1 |
| -12 | 20050 | BUTTERFLY VALVE | 1 |
| -13 | 80007-23 | REDUCER CONNECTOR | 1 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -14 | 80056-16 | TUBE END REDUCER | 1 |
| -15 | 80037-25 | MALE RUN TEE | 1 |
| -16 | 20333 | PRESSURE LINE FILTER BRACKET | 1 |
| -17 | 60343 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 (GR. 5) | 2 |
| -18 | 63303 | SPLIT LOCK WASHER - 3/8 | 2 |
| -19 | 60322 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 (GR. 5) | 2 |
| -20 | 63302 | SPLIT LOCK WASHER - 5/16 | 2 |
| -21 | 22146 | FILTER ASSEMBLY | 1 |
| -22 | 20368 | PILOT FILTER | 1 |
| -23 | 2448 | MALE ELBOW | 2 |
| -24 | 2548 | REDUCER | 2 |
| -25 | 20477 | RETURN LINE FILTER ELEMENT | 1 |
| -26 | 20472 | PILOT FILTER ELEMENT | 1 |

FIGURE 21 - MASTER LEVELING CYLINDER ASSEMBLY



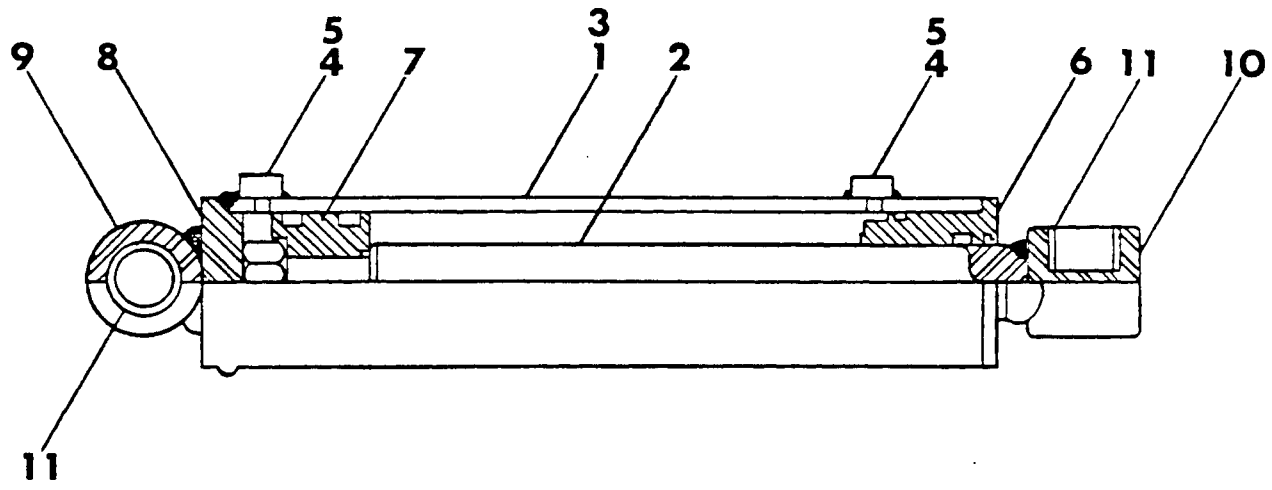

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 21 - | 21804 | MASTER LEVELING CYLINDER ASSEMBLY | 1 |
| -1 | 2545 | BRANCH TEE | 2 |
| -2 | 21111 | MASTER LEVELING CYLINDER (SEE FIG. 21A) | 1 |




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| | 22583 | MASTER LEVELING CYLINDER ASSEMBLY | 1 |
| -1 | 80033-05 | BRANCH TEE | 2 |
| -2 | 22577 | MASTER LEVELING CYLINDER (SEE FIG. 21A.1) | 1 |

NOTE: WHEN ORDERING PARTS, SPECIFY MACHINES I.D. NUMBER AND WHO MFG. THE CYLINDER. FOR EXAMPLE, SIERRA, R.A. INDUSTRIES, CESSNA OR TEXAS HYDRAULIC.

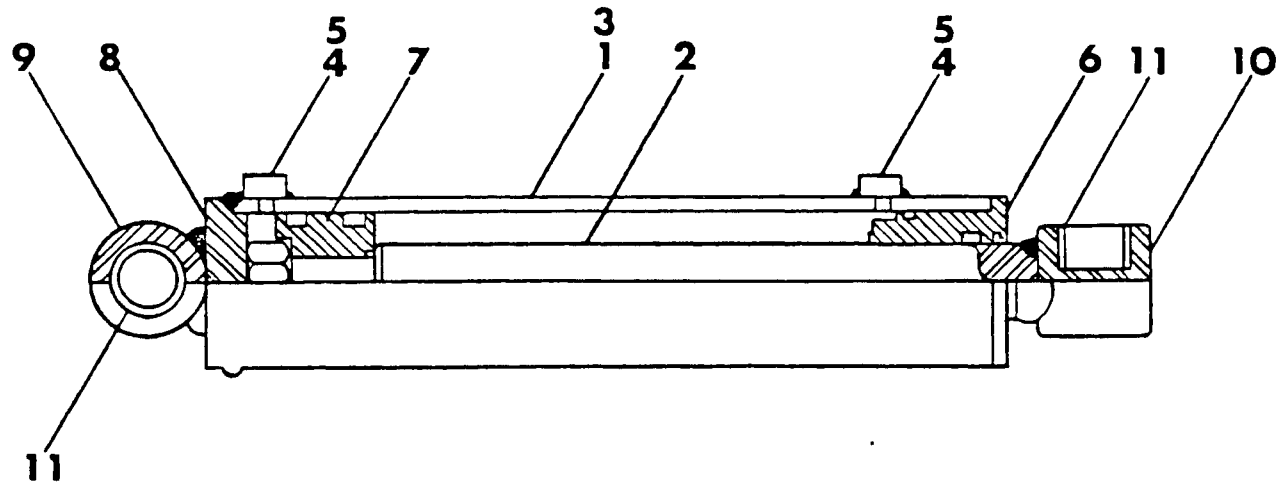
FIGURE 21A - MASTER LEVELING CYLINDER




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 21A- | 21111 | MASTER LEVELING CYLINDER | 1 |
| -1 | | BARREL - SE00211B | 1 |
| -2 | | ROD - SE00211R | 1 |
| -3 | | MARK NAMEPLATE - 9303 | 1 |
| -4 | | PORT - 9885 | 2 |
| -5 | | CAP PLUG - 9810 | 2 |
| -6 | | TEE HEAD - 13204 | 1 |
| -7 | | PISTON - 14139 | 1 |
| -8 | | PLAIN BASE - 16011 | 1 |
| -9 | | BASE PINEYE - 18609 | 1 |
| -10 | | ROD PINEYE - 18610 | 1 |
| -11 | | DUIZ BEARING - 9506 | 4 |
| -12 | 66499 | SEAL KIT - 25138 | 1 |

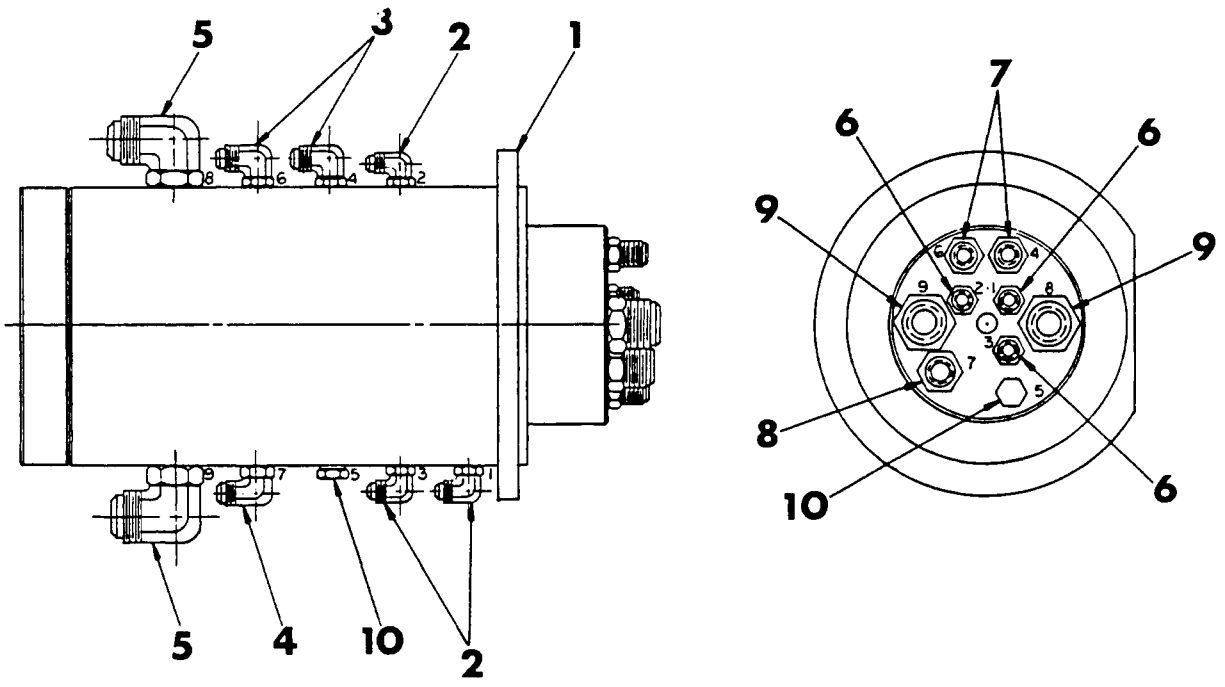
FIGURE 21A.1- MASTER LEVELING CYLINDER REVISED





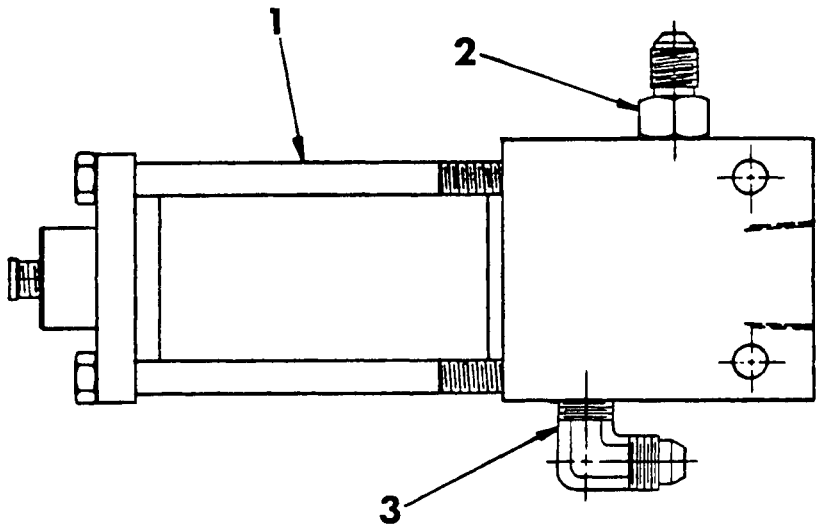

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 38 - | 22577 | MASTER LEVELING CYLINDER | 1 |
| -1 | | BARREL - SE00211B | 1 |
| -2 | | ROD - SE00211R | 1 |
| -3 | | MARK NAMEPLATE - 9303 | 1 |
| -4 | | PORT - 9885 | 2 |
| -5 | | CAP PLUG - 9810 | 2 |
| -6 | | TEE HEAD - 13204 | 1 |
| -7 | | PISTON - 14139 | 1 |
| -8 | | PLAIN BASE - 16011 | 1 |
| -9 | | BASE PINEYE - 18609 | 1 |
| -10 | | ROD PINEYE - 18610 | 1 |
| -11 | | DUIZ BEARING - 9506 | 4 |
| -12 | 66499 - SIERRA<br>66651 - R.A.I. | SEAL KIT - 25138 | 1 |

NOTE: WHEN ORDERING PARTS, SPECIFY MACHINES I.D. NUMBER AND WHO MFG. THE CYLINDER. FOR EXAMPLE, SIERRA, R.A. INDUSTRIES, CESSNA OR TEXAS HYDRAULIC.



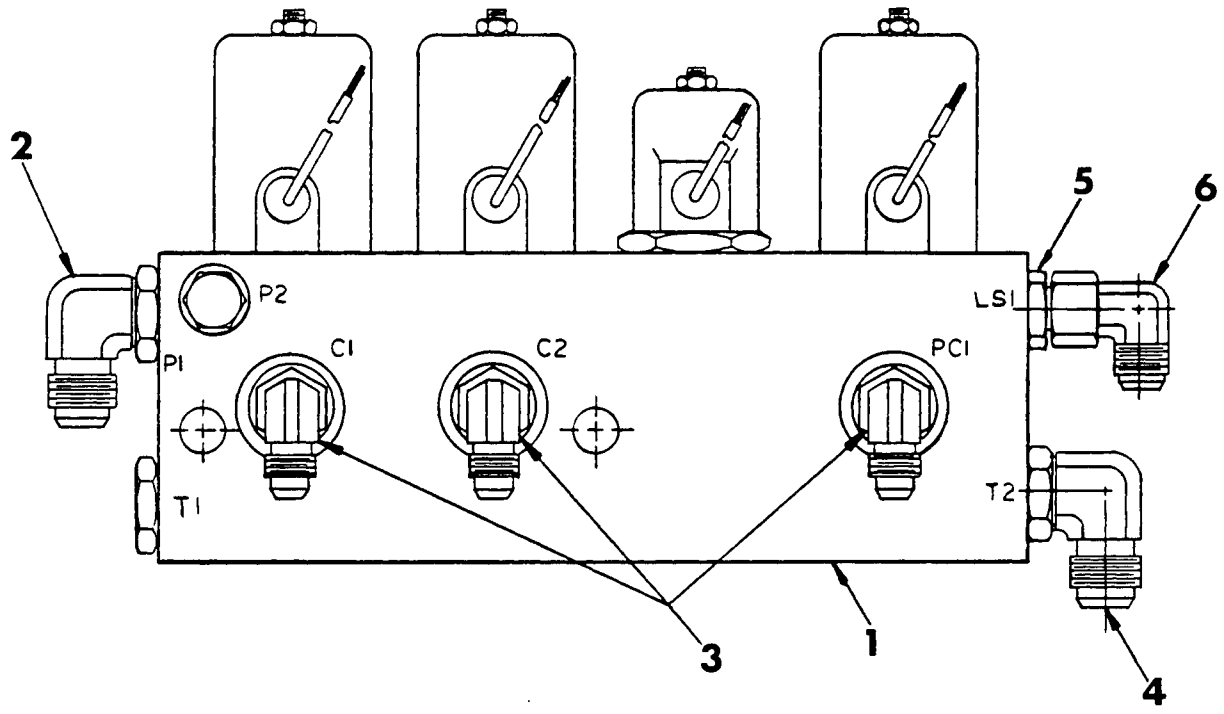

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 22- | 22495 | ROTARY MANIFOLD ASSEMBLY | 1 |
| -1 | 22363 | ROTARY MANIFOLD | 1 |
| -2 | 80012-03 | STRAIGHT THREAD ELBOW | 3 |
| -3 | 80012-08 | STRAIGHT THREAD ELBOW | 2 |
| -4 | 80012-09 | STRAIGHT THREAD ELBOW | 1 |
| -5 | 80012-18 | STRAIGHT THREAD ELBOW | 2 |
| -6 | 80004-03 | STRAIGHT THREAD CONNECTOR | 3 |
| -7 | 80004-08 | STRAIGHT THREAD CONNECTOR | 2 |
| -8 | 80004-11 | STRAIGHT THREAD CONNECTOR | 1 |
| -9 | 80004-18 | STRAIGHT THREAD CONNECTOR | 2 |
| -10 | 80050-05 | HEX HEAD PLUG | 2 |

# FIGURE 23 - SOLENOID VALVE ASSEMBLY



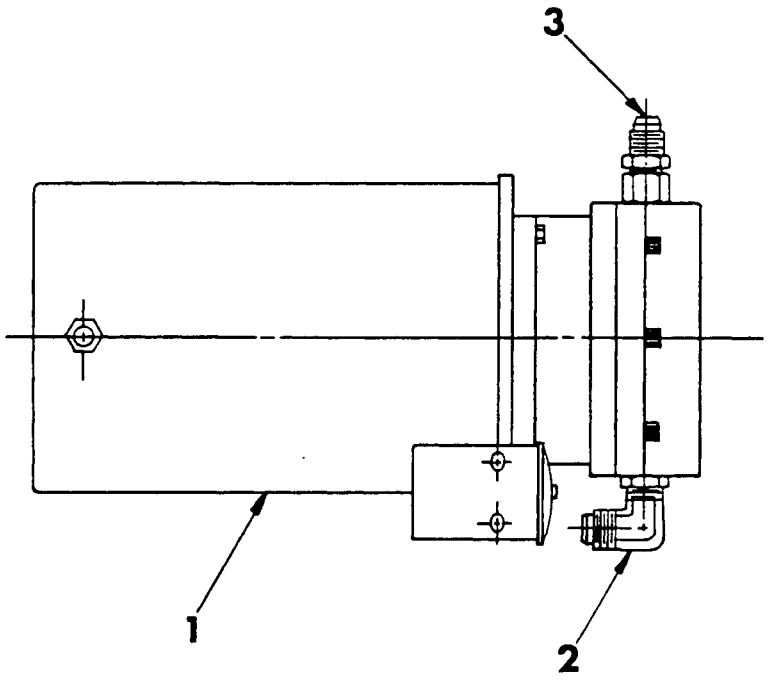

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 23- | 21623 | SOLENOID VALVE ASSEMBLY | 1 |
| -1 | 20376 | SOLENOID VALVE | 1 |
| -2 | 80001-04 | MALE CONNECTOR | 1 |
| -3 | 80008-04 | MALE ELBOW | 1 |

FIGURE 23A - SOLENOID VALVE ASSEMBLY

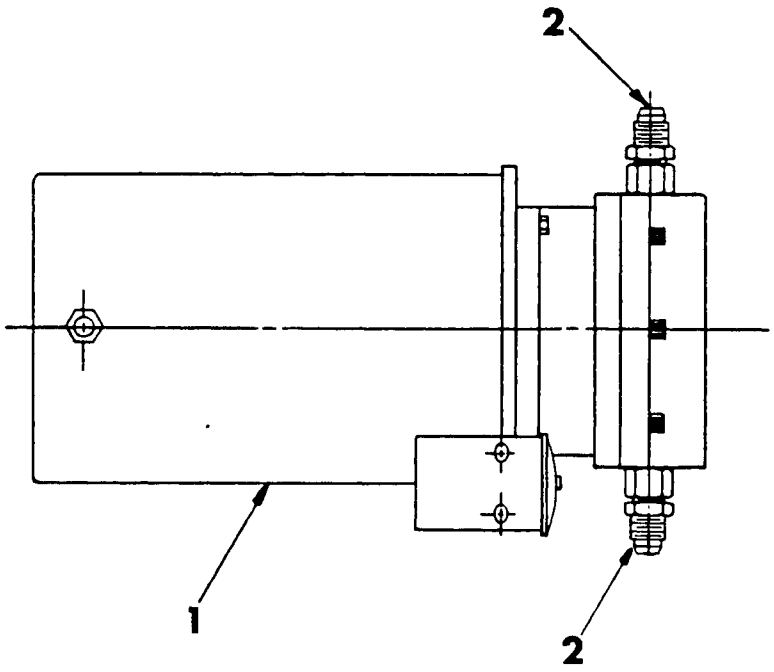



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 23A- | 21692 | SOLENOID VALVE ASSEMBLY | 1 |
| -1 | 21860 | SOLENOID VALVE | 1 |
| -2 | 50900 | STRAIGHT THREAD ELBOW | 1 |
| -3 | 80012-03 | STRAIGHT THREAD ELBOW | 3 |
| -4 | 80012-08 | STRAIGHT THREAD ELBOW | 1 |
| -5 | 80004-03 | STRAIGHT THREAD CONNECTOR | 1 |
| -6 | 80015-03 | SWIVEL NUT ELBOW | 1 |

# FIGURE 24 - EMERGENCY PUMP & MOTOR ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 24- | 22390 | EMERGENCY PUMP & MOTOR ASSEMBLY | 1 |
| -1 | 20384 | EMERGENCY PUMP & MOTOR | 1 |
| -2 | 51100 | MALE ELBOW | 1 |
| -3 | 2476 | MALE CONNECTOR | 1 |




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 24A- | 22390 | EMERGENCY PUMP & MOTOR ASSEMBLY | 1 |
| -1 | 20384 | EMERGENCY PUMP & MOTOR | 1 |
| -2 | 80001-08 | MALE CONNECTOR | 2 |

FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY



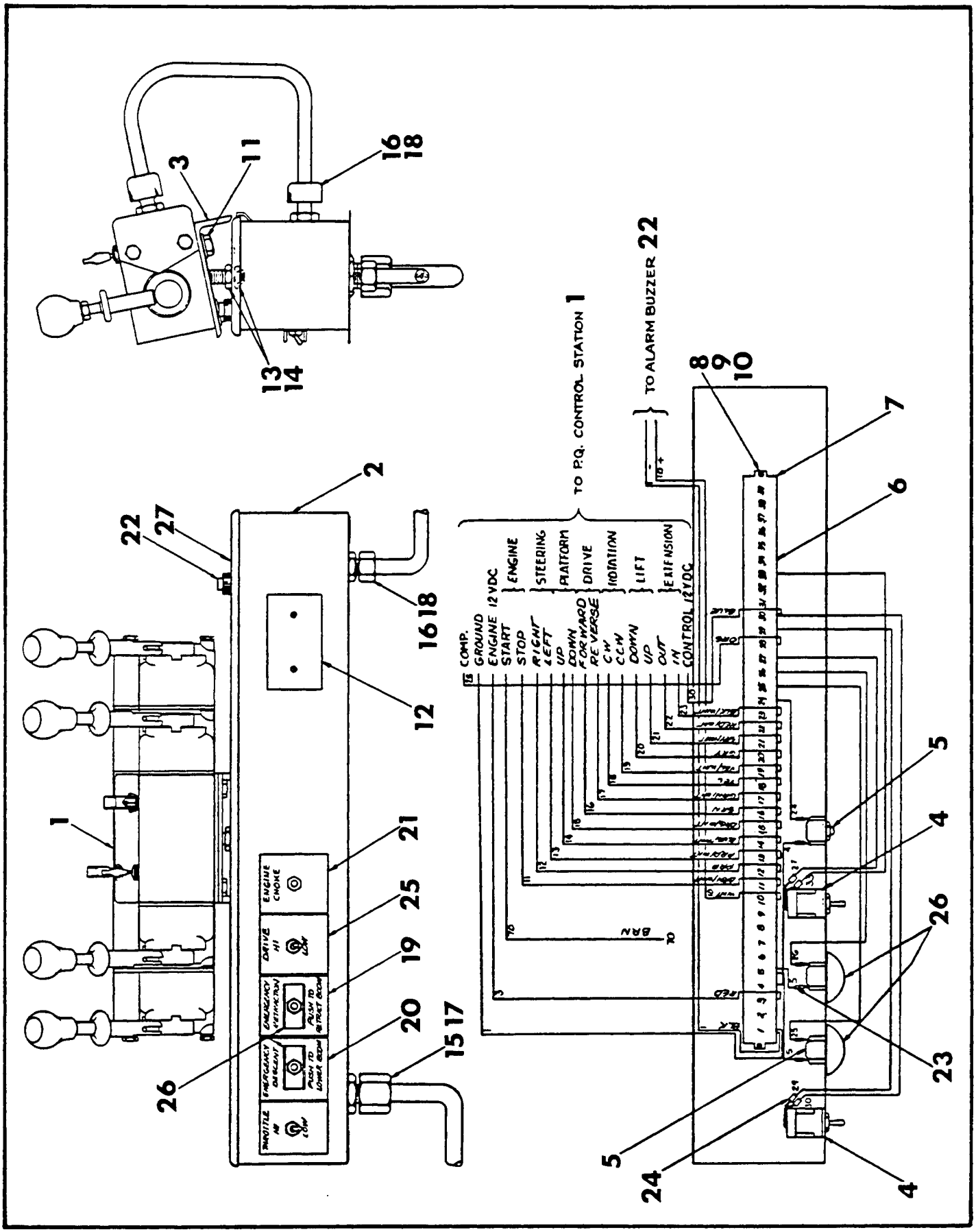
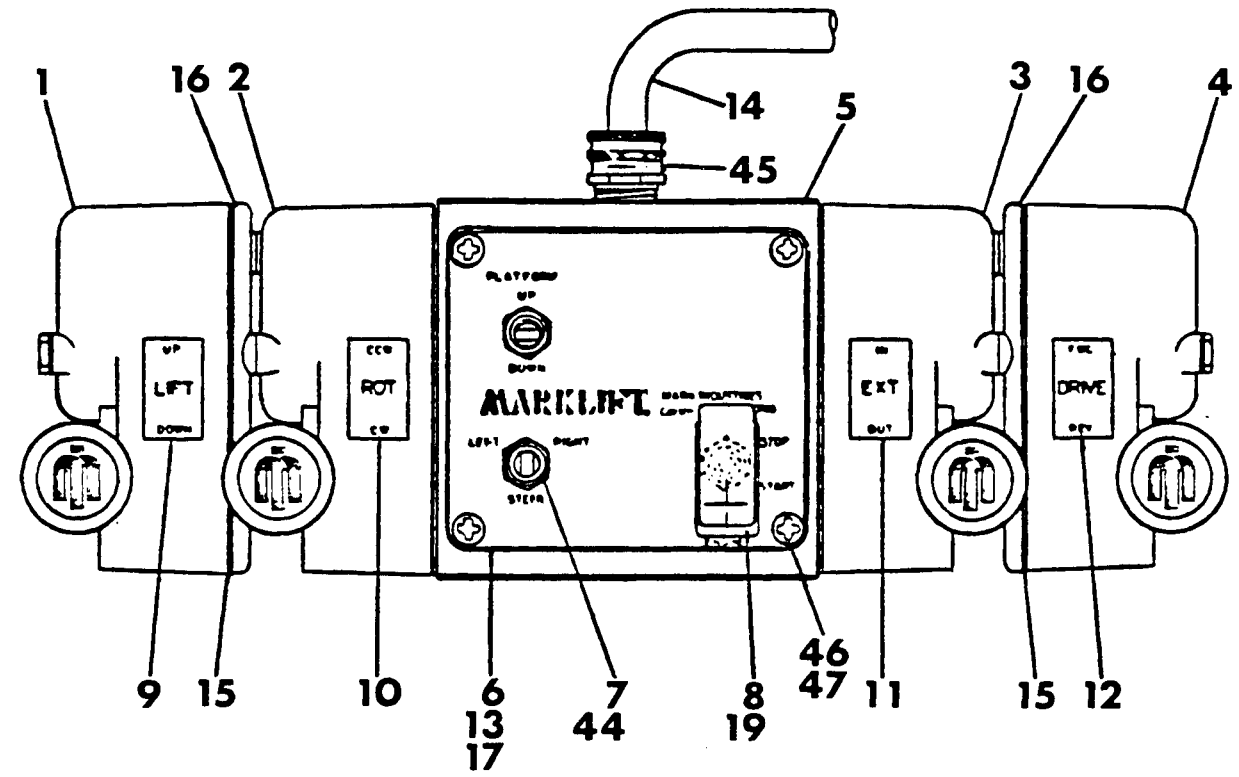


FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 25- | 20782 | AERIAL CONTROL CONSOLE ASSEMBLY | 1 |
| -1 | 20392 | AERIAL CONTROL STATION ASSEMBLY (SEE FIG. 25A) | 1 |
| -2 | 20311 | ENCLOSURE | 1 |
| -3 | 20217 | CONTROLLER MOUNTING BRACKET | 1 |
| -4 | 4017 | TOGGLE SWITCH | 2 |
| -5 | 4011 | PUSH BUTTON SWITCH | 3 |
| -6 | 4027 | TERMINAL BLOCK | 39 |
| -7 | 117A | TERMINAL BLOCK END | 1 |
| -8 | 62624 | TRUSS HEAD CAP SCREW - NO. 6-32 UNC X 3/8 | 5 |
| -9 | 60710 | HEX NUT - NO. 6-32 UNC | 5 |
| -10 | 63311 | LOCK WASHER - NO. 6 | 5 |
| -11 | 60633 | HEX HEAD CAP SCREW - 1/4-20 UNC X 1/2 (BOWMALOK 41000) | 4 |
| -12 | 902 | COVER PLATE | 1 |
| -13 | 60702 | HEX NUT - 5/16-18 UNC | 4 |
| -14 | 63302 | LOCK WASHER - 5/16 | 4 |
| -15 | 16215 | STRAIN RELIEF | 1 |
| -16 | 2806 | STRAIN RELIEF | 2 |
| -17 | 16105 | LOCK NUT | 1 |
| -18 | 2808 | LOCK NUT | 2 |
| -19 | 20407 | DECAL - EMERGENCY BOOM RETRACTION | 1 |
| -20 | 20406 | DECAL - THROTTLE/DESCENT | 1 |
| -21 | 20413 | DECAL - "ENGINE CHOKE" | 1 |
| -22 | 20805 | ALARM BUZZER | 1 |
| -23 | 117E | PUSH-ON TERMINAL | 6 |
| -24 | 2859 | RING TONGUE | 9 |
| -25 | 20456 | DECAL - "DRIVE HI/LOW" | 1 |
| -26 | 20884 | SWITCH GUARD | 2 |
| -27 | 20444 | DECAL - "5° SLOPE" | 1 |

FIGURE 25A - AERIAL CONTROL STATION ASSEMBLY





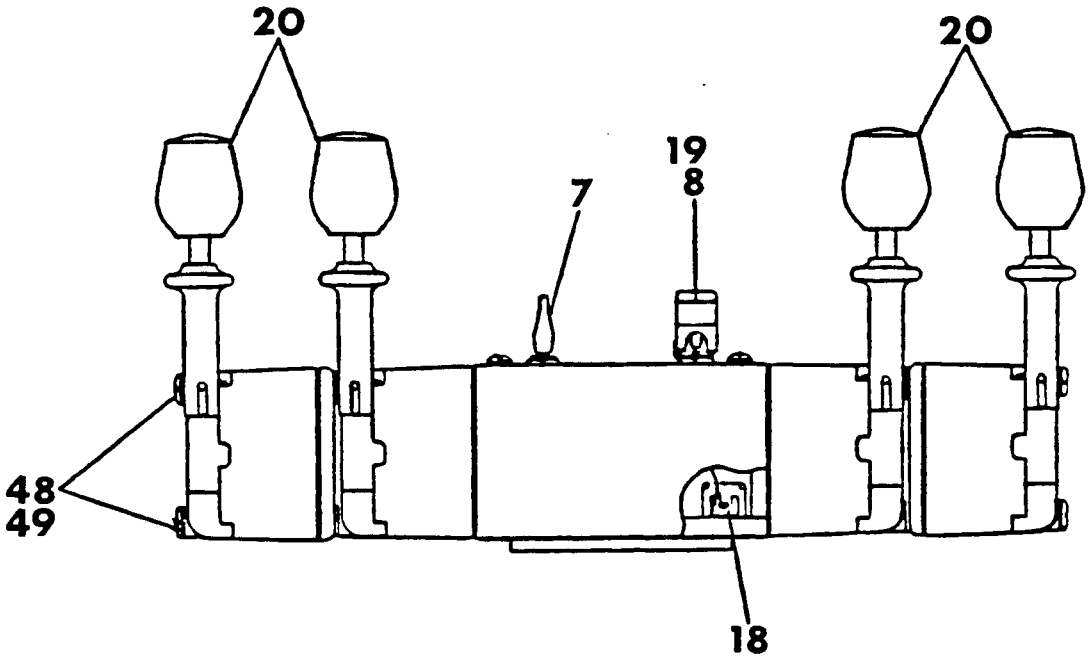
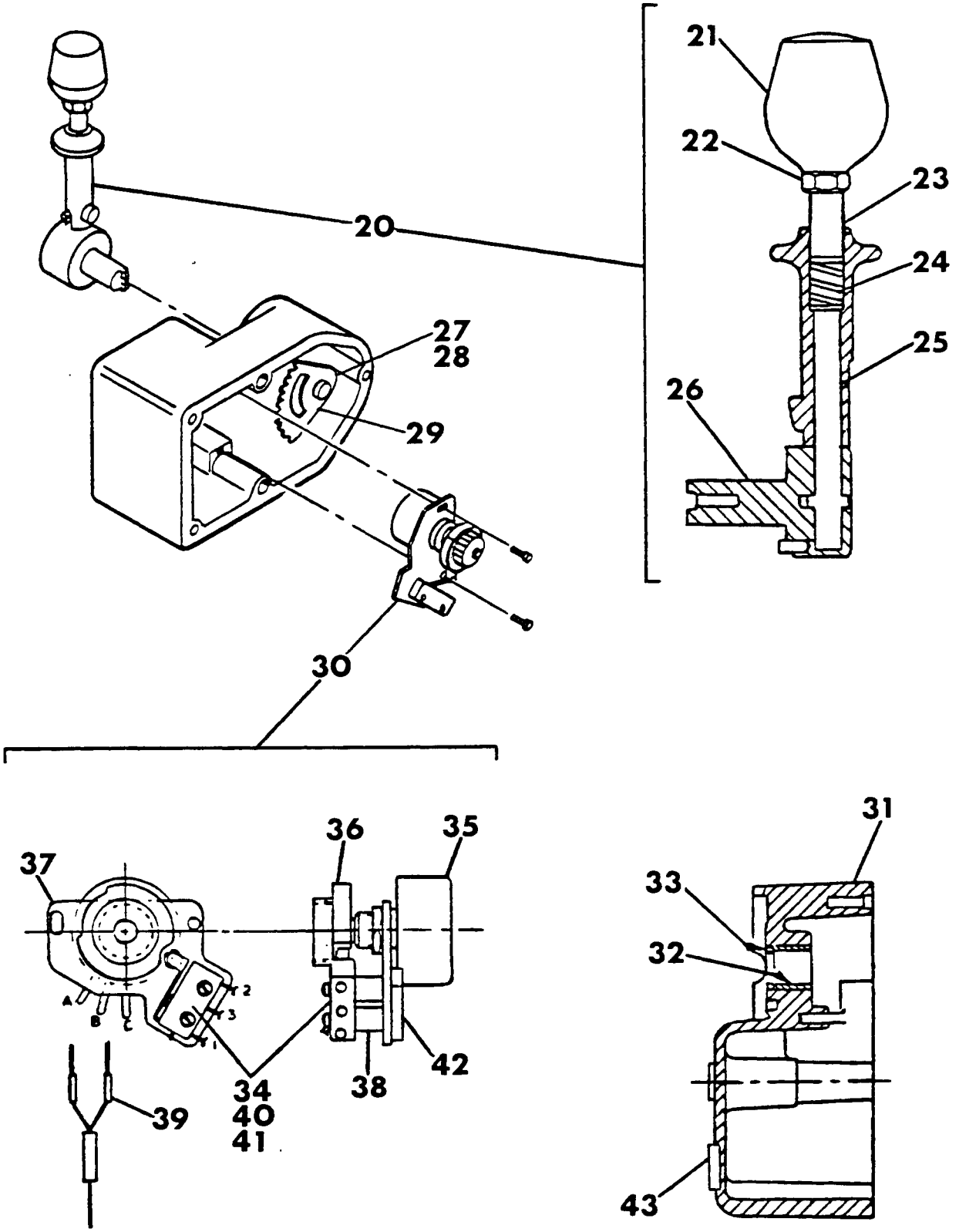



FIGURE 25A - AERIAL CONTROL STATION ASSEMBLY





## FIGURE 25A - AERIAL CONTROL STATION ASSEMBLY

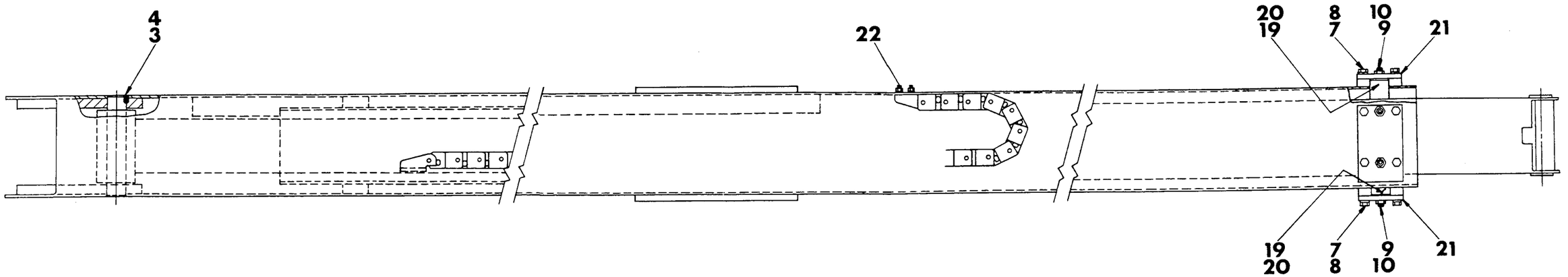
| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 25A- | 20392 | AERIAL CONTROL STATION ASSEMBLY (PQ) | 1 |
| -1 | 2962 | LIFT CONTROLLER ASSEMBLY | 1 |
| -2 | 2959 | ROTATION CONTROLLER ASSEMBLY | 1 |
| -3 | 2960 | EXTENSION CONTROLLER ASSEMBLY | 1 |
| -4 | 2963 | DRIVE CONTROLLER ASSEMBLY | 1 |
| -5 | 16907 | CENTER HOUSING | 1 |
| -6 | 16908 | SWITCH MOUNTING PLATE | 1 |
| -7 | 20618 | MOMENTARY SWITCH | 2 |
| -8 | 16912 | SWITCH GUARD (RED) | 1 |
| -9 | 16901 | LIFT METAL DECAL | 1 |
| -10 | 16910 | ROTATION METAL DECAL | 1 |
| -11 | 16905 | EXTENSION METAL DECAL | 1 |
| -12 | 16909 | DRIVE METAL DECAL | 1 |
| -13 | 16913 | SWITCH MOUNTING PLATE (USED ON S21 ONLY) | 1 |
| -14 | 16914 | CONTROLLER CABLE | 1 |
| -15 | 20597 | CONTROLLER HOUSING GASKET | 4 |
| -16 | 16900 | CONTROLLER HOUSING COVER PLATE | 2 |
| -17 | 20598 | SWITCH PLATE MOUNTING GASKET | 1 |
| -18 | 66161 | TERMINAL STRIP | 2 |
| -19 | 4021 | START/STOP SWITCH | 1 |
| -20 | 20539 | CONTROLLER HANDLE ASSEMBLY | 4 |
| -21 | 20479 | CONTROLLER KNOB W/LOGO | 4 |
| -22 | 60708 | 5/16" HEX NUT | 4 |
| -23 | 16916 | SAFETY LOCK SPACER | 4 |
| -24 | 16915 | SAFETY LOCK SPRING | 4 |
| -25 | 20581 | SAFETY LOCK | 4 |
| -26 | 16903 | CONTROLLER HANDLE | 4 |
| -27 | 16904 | TORSION SPRING | 4 |
| -28 | 16917 | TORSION SPRING SPACER | 4 |
| -29 | 16906 | SELECTOR GEAR | 4 |
| -30 | 20580 | POTENTIOMETER ASSEMBLY | 4 |
| -31 | * 16902 | CONTROLLER HOUSING | 4 |
| -32 | 66222 | BUSHING-CONTROLLER HOUSING | 4 |

FIGURE 25A - AERIAL CONTROL STATION ASSEMBLY

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -33 | 66223 | O'RING-CONTROLLER HOUSING | 4 |
| -34 | 16918 | MICROSWITCH | 4 |
| -35 | 66034 | POTENTIOMETER ONLY | 4 |
| -36 | 66040 | CAM & GEAR ASSEMBLY | 4 |
| -37 | 66489 | SWITCH MOUNTING PLATE | 4 |
| -38 | 66490 | NYLON SPACER | 8 |
| -39 | 66488 | RESISTOR (82 OHM) | 8 |
| -40 | 66491 | SWITCH MOUNTING SCREW | 8 |
| -41 | 66492 | LOCK WASHER | 8 |
| -42 | 66493 | SWITCH FASTENER PLATE | 4 |
| -43 | 66494 | GROMMET | 4 |
| -44 | 66120 | SWITCH DIODE (NOT USED) | 4 |
| -45 | 2806 | STRAIN RELIEF | 1 |
| -46 | 66497 | SCREW SWITCH PLATE | 4 |
| -47 | 66498 | LOCK WASHER | 4 |
| -48 | 66496 | CONTROLLER MOUNTING BOLT | 4 |
| -49 | 66495 | SPACER MOUNTING BOLT | 4 |

* NOTE:
SPECIFY INSIDE OR OUTSIDE HOUSING.

FIGURE 26 - FINAL BOOM ASSEMBLY (2 SECTION)



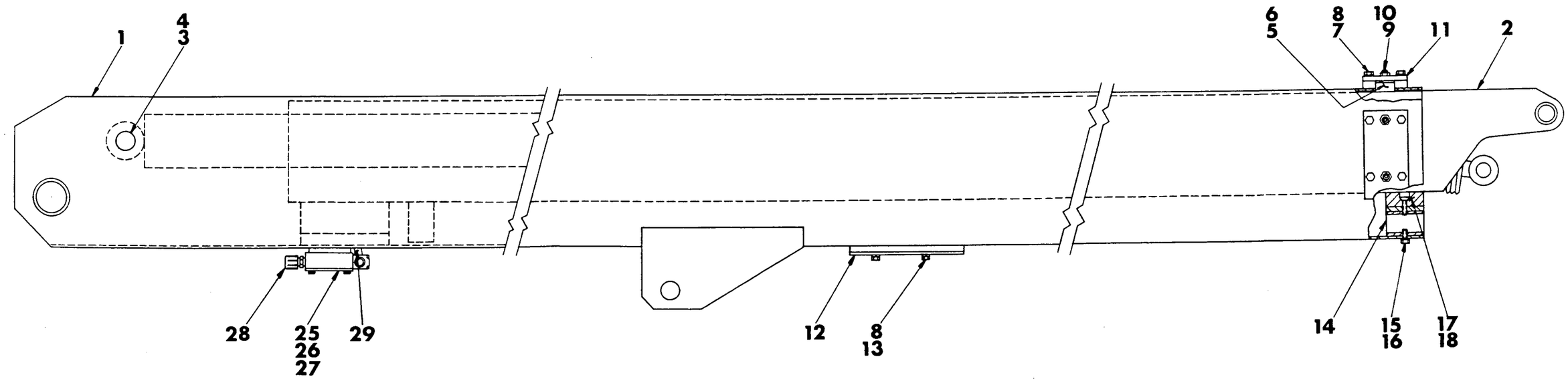



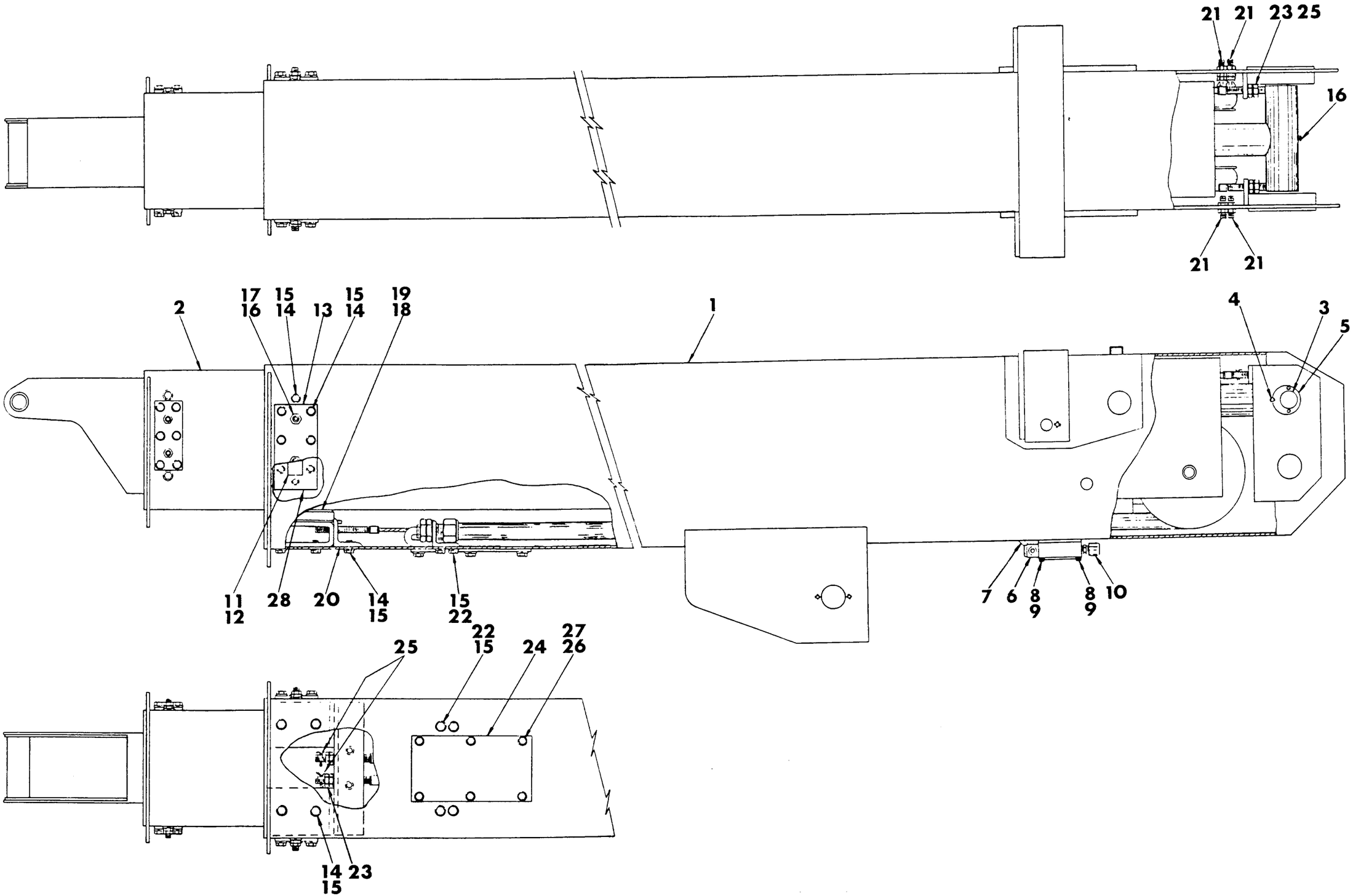
FIGURE 26 - FINAL BOOM ASSEMBLY (2 SECTION)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 26- | 22493 | FINAL BOOM ASSEMBLY (2 SECTION) | 1 |
| -1 | 22437 | OUTER BOOM MACHINING | 1 |
| -2 | 22494 | INNER BOOM ASSEMBLY (SEE FIG. 28) | 1 |
| -3 | 20267 | BOOM EXTENSION CYLINDER PIN | 1 |
| -4 | 62203 | SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 1 |
| -5 | 22369 | TOP WEAR PAD | 1 |
| -6 | 22372 | PRESSURE PAD PLATE | 1 |
| -7 | 60346 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 1/4 (GR. 5) | 12 |
| -8 | 63302 | SPLIT LOCK WASHER - 5/16 | 16 |
| -9 | 62204 | SOCKET HEAD SET SCREW - 1/2-13 UNC X 1 | 6 |
| -10 | 61101 | JAM NUT - 1/2-13 UNC | 6 |
| -11 | 22371 | TOP WEAR PAD COVER | 1 |
| -12 | 22373 | ACCESS COVER | 1 |
| -13 | 60338 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 (GR. 5) | 4 |
| -14 | 22370 | WEAR PAD BRACKET | 1 |
| -15 | 60325 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (GR. 5) | 2 |
| -16 | 63303 | SPLIT LOCK WASHER - 3/8 | 2 |
| -17 | 20284 | WEAR PAD | 1 |
| -18 | 61809 | FLAT HEX SOCKET HEAD CAP SCREW - 3/8-16 UNC X 1 1/2 | 2 |
| -19 | 20454 | SIDE WEAR PAD | 2 |
| -20 | 20453 | PRESSURE PAD PLATE | 2 |
| -21 | 20452 | PRESSURE PAD COVER | 2 |
| -22 | 16021 | HEX HEAD CAP SCREW - 1/4-20 UNC X 3/4 | 4 |
| -23 | 63301 | SPLIT LOCK WASHER - 1/4 | 4 |
| -24 | 60701 | HEX NUT - 1/4-20 UNC | 4 |
| -25 | 70107 | LIMIT SWITCH | 1 |
| -26 | 62704 | ROUND SLOTTED HEAD MACHINE SCREW - NO. 10-32 UNF X 2 | 2 |
| -27 | 63313 | SPLIT LOCK WASHER - NO. 10 | 2 |

FIGURE 26 - FINAL BOOM ASSEMBLY (2 SECTION)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -28 | 2806 | STRAIN RELIEF | 1 |
| -29 | 70206 | LIMIT SWITCH LEVER | 1 |

FIGURE 26A - FINAL BOOM ASSEMBLY (3 SECTION)

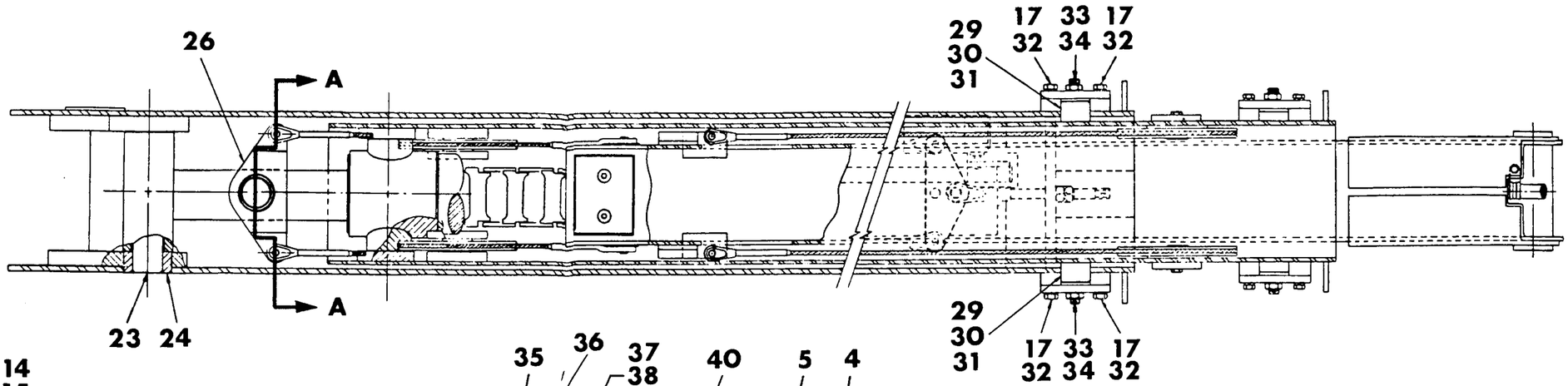


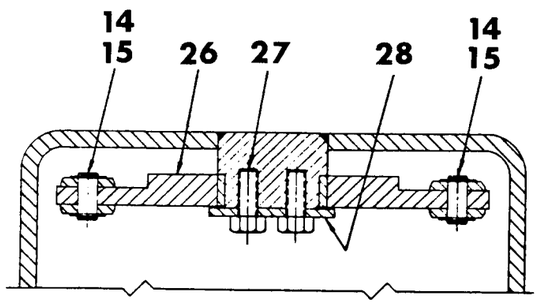
## FIGURE 26A - FINAL BOOM ASSEMBLY (3 SECTION)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 26A- | 21402 | FINAL BOOM ASSEMBLY (3 SECTION) | 1 |
| -1 | 21405 | OUTER BOOM MACHINING | 1 |
| -2 | 21434 | INTERMEDIATE BOOM ASSEMBLY (SEE FIG. 27) | 1 |
| -3 | 21340 | PIN | 1 |
| -4 | 62203 | HEX SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 2 |
| -5 | 21353 | ECCENTRIC BUSHING | 2 |
| -6 | 70107 | LIMIT SWITCH | 1 |
| -7 | 20804 | ACTUATOR ARM | 1 |
| -8 | 61916 | HEX HEAD CAP SCREW NO. 10-32 UNF X 2 | 2 |
| -9 | 63313 | SPLIT LOCK WASHER - NO. 10 | 2 |
| -10 | 2806 | STRAIN RELIEF | 1 |
| -11 | 20453 | PAD PRESSURE PLATE | 2 |
| -12 | 21315 | WEAR PAD | 2 |
| -13 | 21321 | COVER PLATE | 2 |
| -14 | 60343 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 (GR. 5) | 22 |
| -15 | 63303 | SPLIT LOCK WASHER - 3/8 | 26 |
| -16 | 62204 | HEX SOCKET HEAD SET SCREW - 1/2-13 UNC X 1 | 5 |
| -17 | 61101 | JAM NUT - 1/2-13 UNC | 4 |
| -18 | 21311 | WEAR PAD | 2 |
| -19 | 61806 | FLAT HEX SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 1/4 | 4 |
| -20 | 21310 | BOOM END BRACKET | 1 |
| -21 | 16408 | BULKHEAD UNION | 4 |
| -22 | 60607 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (BOWMALOCK 41012) | 4 |
| -23 | 61102 | JAM NUT - 5/8-11 UNC | 8 |
| -24 | 21320 | ACCESS COVER PLATE | 1 |
| -25 | 64301 | COTTER PIN - 1/8 DIA. X 1 | 4 |
| -26 | 60322 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 (GR. 5) | 6 |
| -27 | 63302 | SPLIT LOCK WASHER - 5/16 | 6 |
| -28 | 21358 | WEAR PAD RETAINER | 2 |

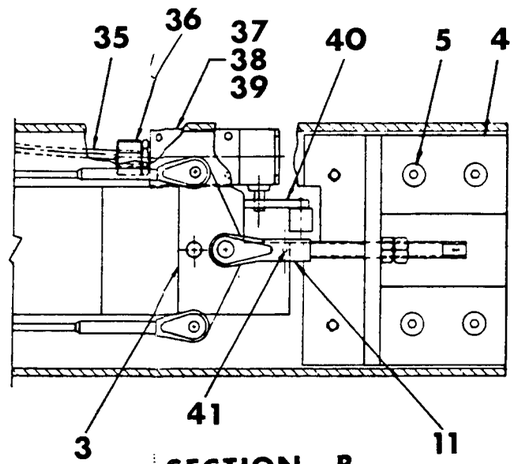
# FIGURE 26B - FINAL BOOM ASSEMBLY (3 SECTION) (MARK TRACK)



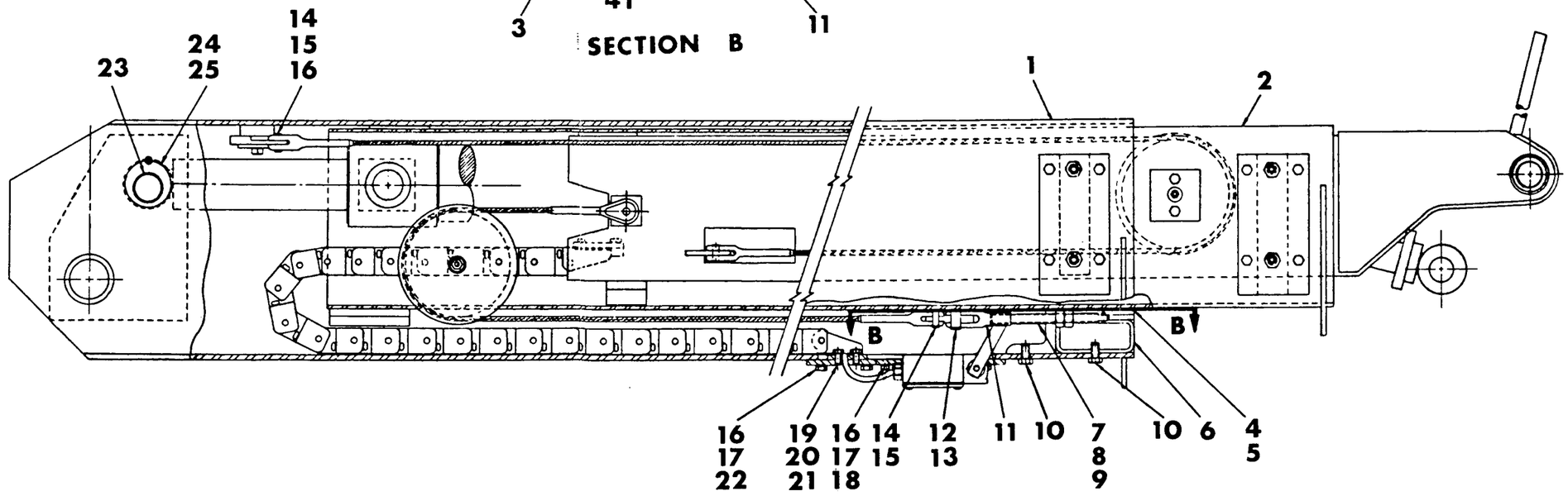



SECTION A




SECTION B



# FIGURE 26B - FINAL BOOM ASSEMBLY (3 SECTION) (MARK TRACK)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 26B- | 22760 | FINAL BOOM ASSEMBLY | 1 |
| -1 | 22765 | OUTER BOOM MACHINING | 1 |
| -2 | 22536 | INTERMEDIATE BOOM ASSEMBLY (SEE FIG. 27.1) | 1 |
| -3 | 22549 | RETRACTION CABLE LEVER | 1 |
| -4 | 22570 | WEAR PAD | 2 |
| -5 | 61805 | SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 | 4 |
| -6 | 22545 | BOOM END BRACKET | 1 |
| -7 | 22594 | THREADED SLEEVE | 1 |
| -8 | 60801 | HEX NUT - 1/2-20 UNF | 2 |
| -9 | 64301 | COTTER PIN - 1/8 DIA. X 1 | 1 |
| -10 | 60607 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 BOWMALOK 41012 | 4 |
| -11 | 65477 | TERMINAL | 1 |
| -12 | 22548 | PIN | 1 |
| -13 | 65081 | SNAP RING | 2 |
| -14 | 22547 | CABLE PIN | 2 |
| -15 | 65080 | SNAP RING | 8 |
| -16 | 60367 | HEX HEAD CAP SCREW - 5/16-18 UNC X 5/8 (GR. 5) | 8 |
| -17 | 63302 | SPLIT LOCKWASHER - 5/16 | 16 |
| -18 | 22784 | ACCESS COVER | 1 |
| -19 | 60631 | HEX HEAD CAP SCREW - 1/4-20 UNC X 5/8 BOWMALOK 41000-1 | 4 |
| -20 | 22586 | LEFT HAND STATIONARY MOUNTING BRACKET | 1 |
| -21 | 22585 | RIGHT HAND STATIONARY MOUNTING BRACKET | 1 |
| -22 | 22541 | PLASTITRAK BRACKET | 1 |
| -23 | 20267 | BOOM EXTENSION CYLINDER PIN | 1 |
| -24 | 20268 | ECCENTRIC BUSHING | 2 |
| -25 | 62203 | SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 2 |
| -26 | 22546 | EXTENSION LEVER CABLE | 1 |
| -27 | 60603 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 BOWMALOK 41006 | 2 |
| -28 | 22593 | RETAINER | 1 |
| -29 | 22172 | WEAR PAD | 2 |

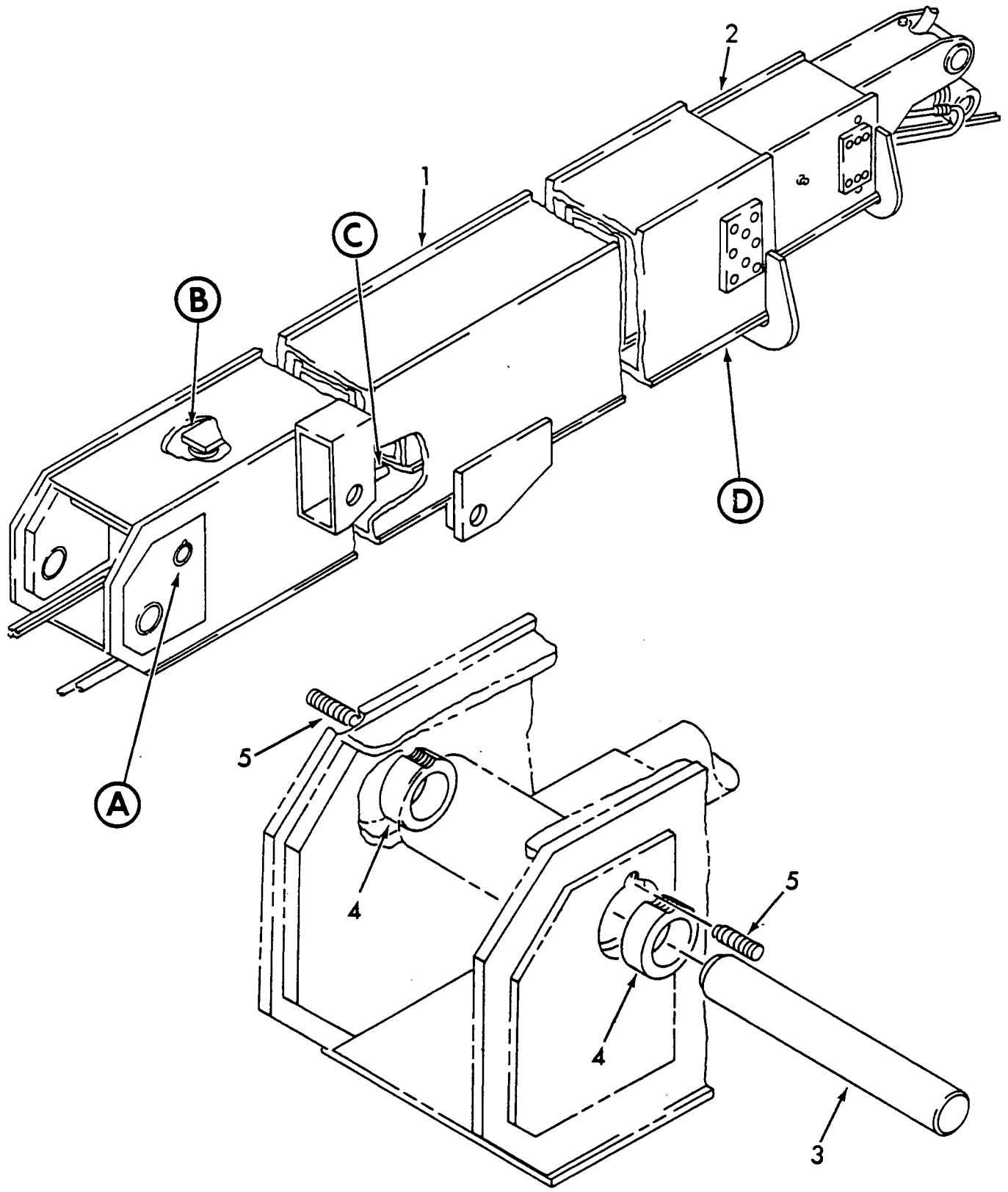
FIGURE 26B - FINAL BOOM ASSEMBLY (3 SECTION)
(MARK TRACK)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -30 | 20453 | PRESSURE PLATE PAD | 2 |
| -31 | 20452 | PRESSURE PAD COVER | 2 |
| -32 | 60338 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 (GR. 5) | 8 |
| -33 | 62204 | HEX SOCKET HEAD SET SCREW - 1/2-13 UNC X 1 | 4 |
| -34 | 61101 | HEX JAM NUT - 1/2-13 UNC | 4 |
| -35 | 70036-0210 | ELECTRICAL CABLE | 1 |
| -36 | 2806 | STRAIN RELIEF | 1 |
| -37 | 70107 | LIMIT SWITCH | 1 |
| -38 | 62615 | ROUND HEAD SLOTTED MACHINE SCREW - NO. 10-32 UNF X 1 3/4 | 2 |
| -39 | 63313 | SPLIT LOCK WASHER - NO. 10 | 2 |
| -40 | 20807 | ARM LEVER | 1 |
| -41 | 64204 | ROLL PIN - 1/8 DIA. X 1" LG. | 1 |

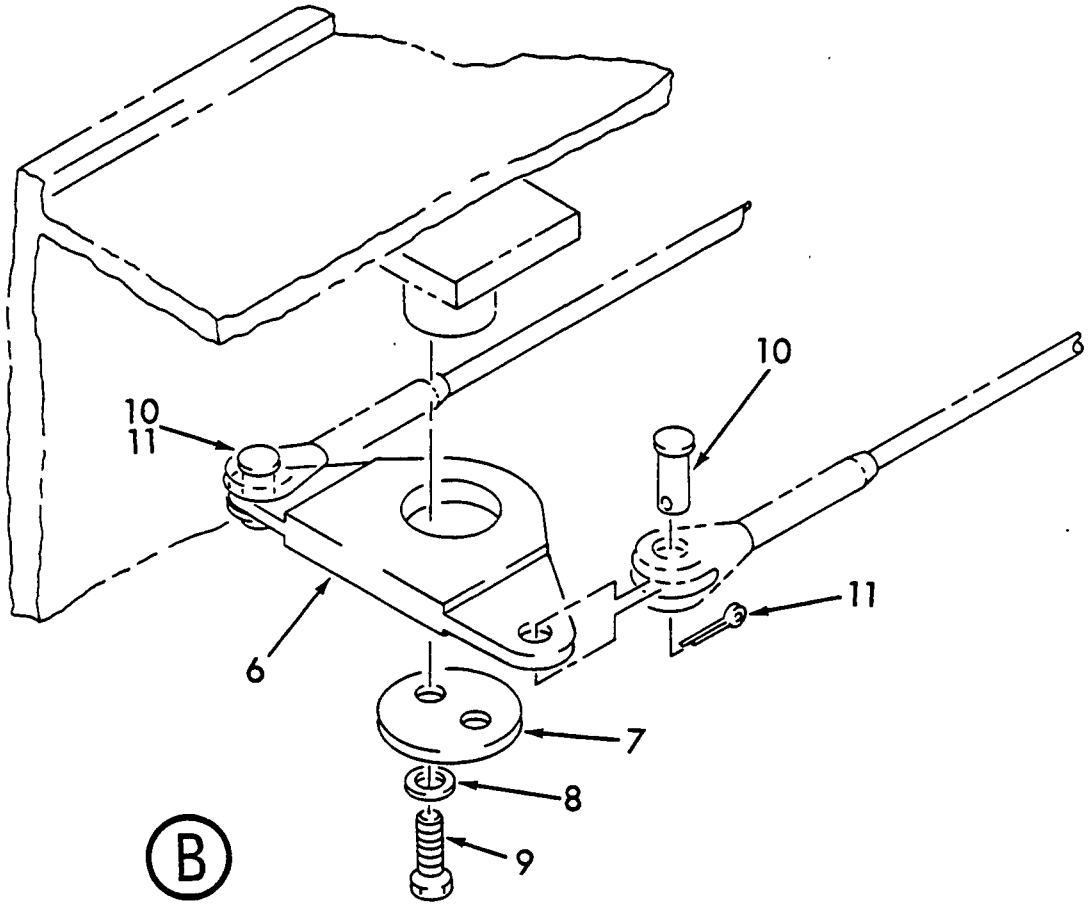
# FIGURE 26C - FINAL BOOM ASSEMBLY (MARK TRACK) REVISED

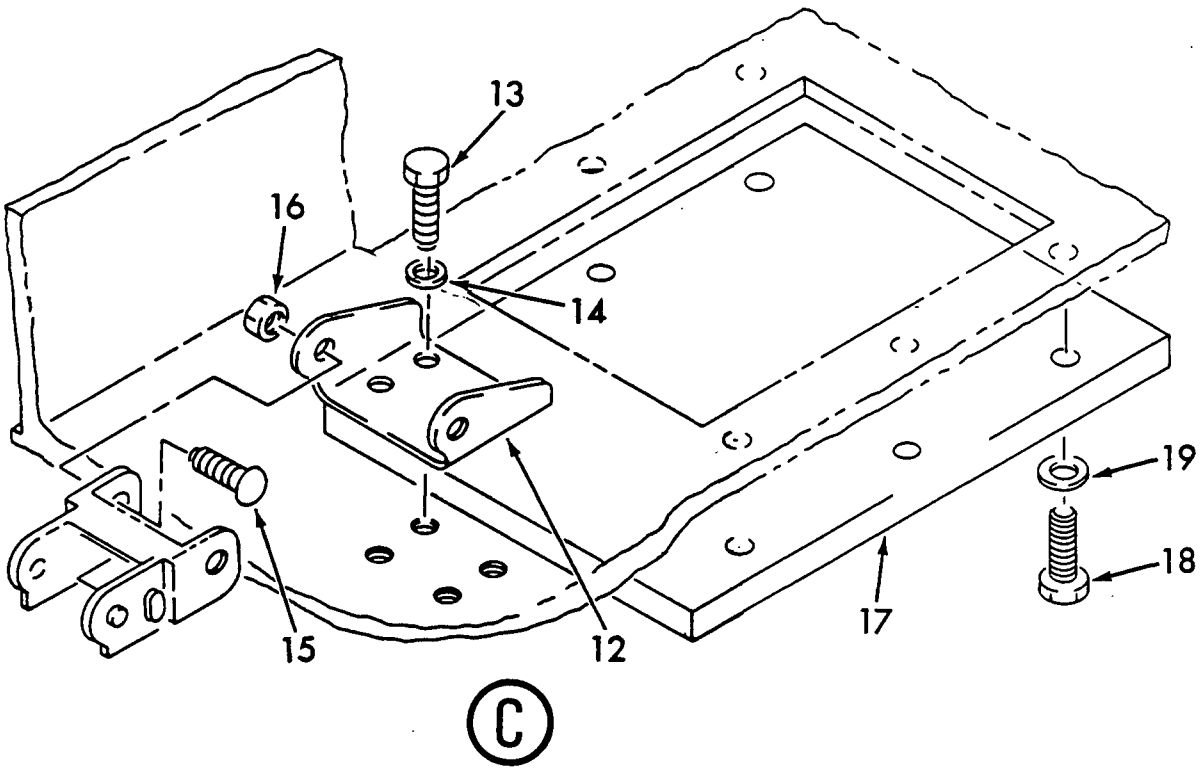




# FIGURE 26C - FINAL BOOM ASSEMBLY (MARK TRACK) REVISED



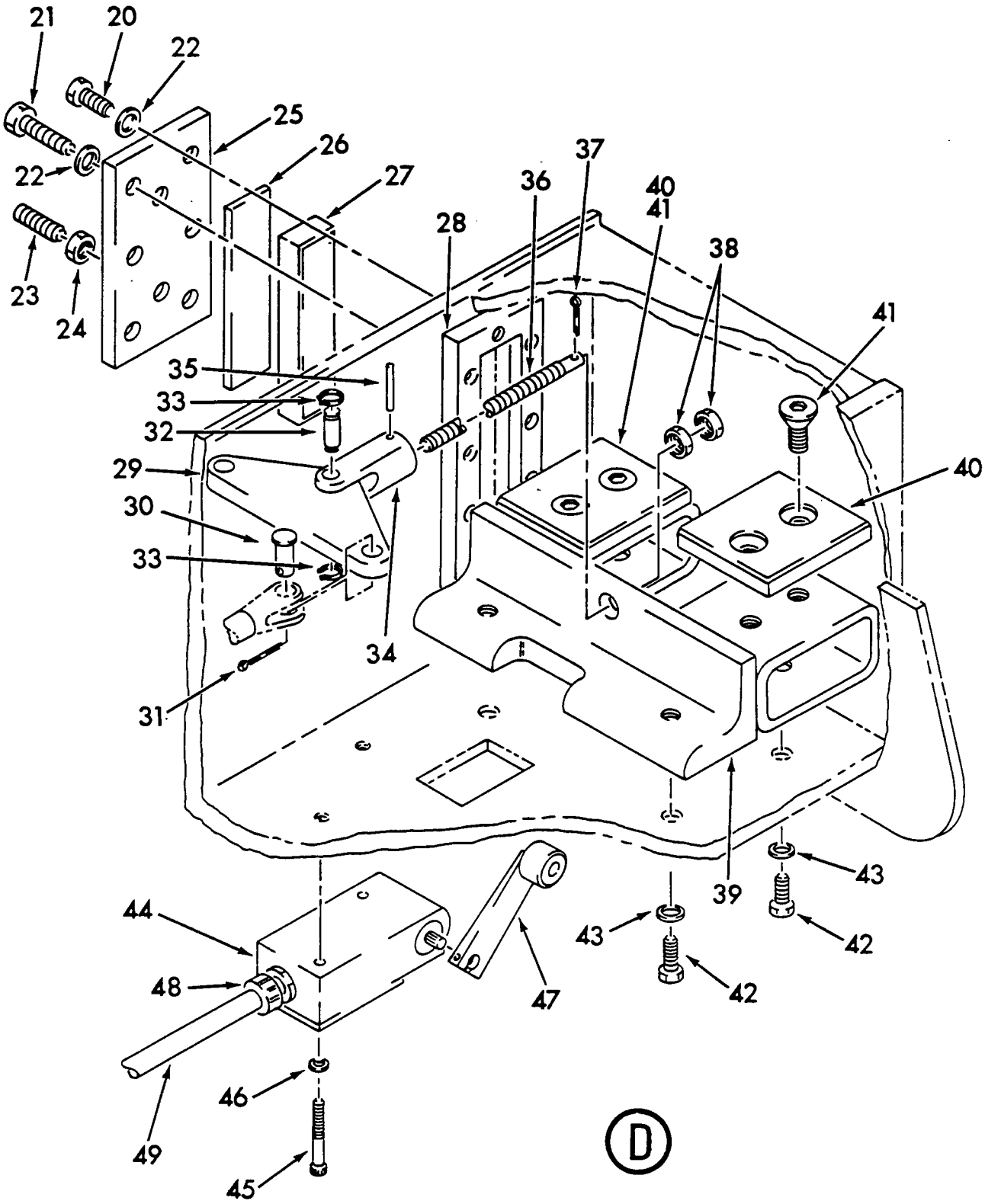



REV.

# FIGURE 26C - FINAL BOOM ASSEMBLY (MARK TRACK) REVISED





# FIGURE 26C - FINAL BOOM ASSEMBLY (MARK TRACK) REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| | 23038 | ASSEMBLY, FINAL BOOM | REF |
| -1 | 23031 | MACHINING, OUTER BOOM | 1 |
| -2 | 23039 | ASSEMBLY, INTERMEDIATE BOOM (See Fig. 27.2) | 1 |
| -3 | 23169 | PIN, BOOM EXTENSION CYLINDER | 1 |
| -4 | 20268 | BUSHING, ECCENTRIC | 2 |
| -5 | 62203 | SCREW, SET | 2 |
| -6 | 23097 | LEVER, EXTENSION CABLE | 1 |
| -7 | 22593 | RETAINER | 1 |
| -8 | 63302 | WASHER, LOCK | 2 |
| -9 | 60533 | SCREW, CAP | 2 |
| -10 | 23697 | PIN, CLEVIS | 2 |
| -11 | 64301 | PIN, COTTER | 2 |
| -12 | 23751 | BRACKET, STATIONARY (PLASTITRAK) | 1 |
| -13 | 60501 | SCREW, CAP | 4 |
| -14 | 63301 | WASHER, LOCK | 4 |
| -15 | 61931 | SCREW, CAP | 2 |
| -16 | 60702 | NUT, HEX | 2 |
| -17 | 23537 | COVER, PLATE | 1 |
| -18 | 60367 | SCREW, CAP | 6 |
| -19 | 63302 | WASHER, LOCK | 6 |
| -20 | 60395 | SCREW, CAP | 4 |

FIGURE 26C - FINAL BOOM ASSEMBLY
(MARK TRACK) REVISED

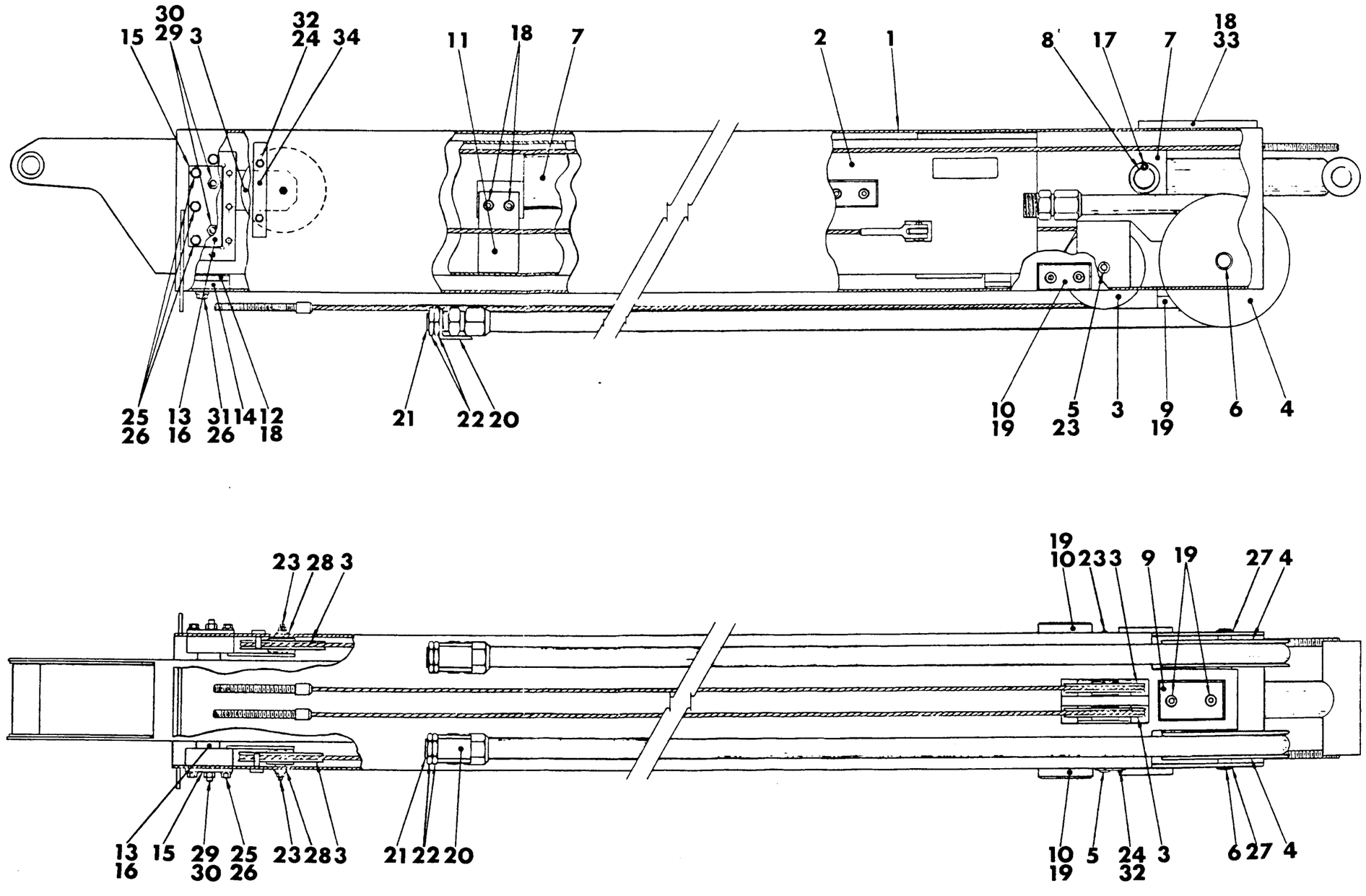


| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -21 | 60343 | SCREW, CAP | 12 |
| -22 | 63303 | WASHER, LOCK | 16 |
| -23 | 62204 | SCREW, SET | 4 |
| -24 | 61101 | NUT, JAM | 4 |
| -25 | 21321 | PLATE, COVER | 2 |
| -26 | 20453 | PLATE, PAD PRESSURE | 2 |
| -27 | 23170 | PAD, WEAR | 2 |
| -28 | 21358 | RETAINER, WEAR PAD | 2 |
| -29 | 23098 | LEVER, RETRACTION CABLE | 1 |
| -30 | 23697 | PIN, CLEVIS | 2 |
| -31 | 64301 | PIN, COTTER | 2 |
| -32 | 22548 | PIN | 1 |
| -33 | 65081 | RING, SNAP | 2 |
| -34 | 23269 | TERMINAL, CABLE | 1 |
| -35 | 64204 | PIN, ROLL | 1 |
| -36 | 22594 | SLEEVE, THREADED | 1 |
| -37 | 64301 | PIN, COTTER | 1 |
| -38 | 60801 | NUT, HEX | 2 |
| -39 | 23096 | BRACKET, BOOM END | 1 |
| -40 | 23168 | PAD, WEAR | 2 |

FIGURE 26C - FINAL BOOM ASSEMBLY
(MARK TRACK) REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -41 | 61801 | SCREW, CAP | 4 |
| -42 | 60542 | SCREW, CAP | 4 |
| -43 | 63303 | WASHER, LOCK | 4 |
| -44 | 70107 | SWITCH, LIMIT | 1 |
| -45 | 62615 | SCREW, MACHINE | 2 |
| -46 | 63313 | WASHER, LOCK | 2 |
| -47 | 70148 | LEVER, ARM | 1 |
| -48 | 2806 | RELIEF, STRAIN | 1 |
| -49 | 70036-2100 | CABLE, ELECTRICAL | 1 |

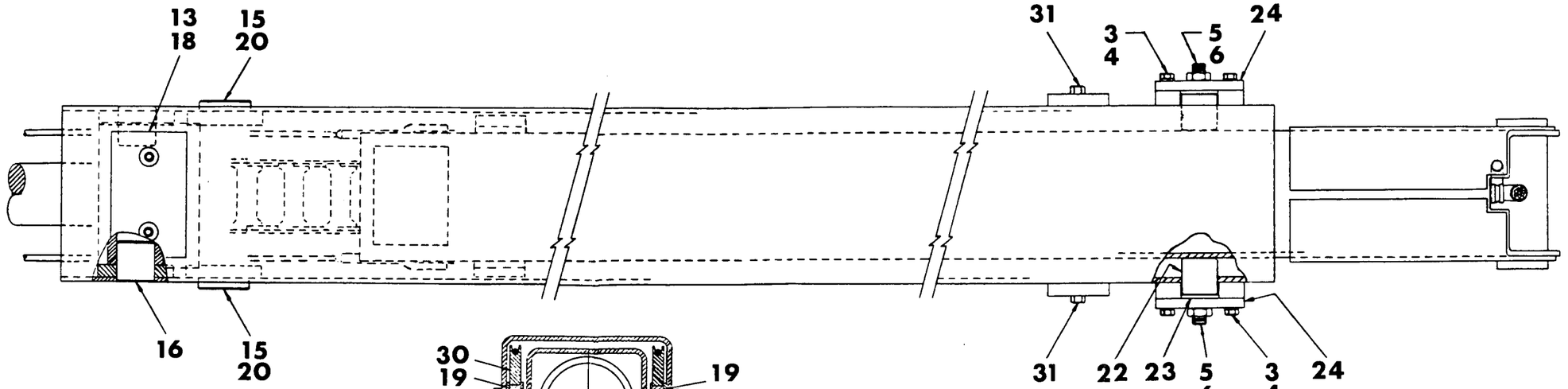

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26 16 26 18
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22 20
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19 23 19
19 10 23 3 9 19 27 4
13 15 29 25 23 28 3
16 30 26
21 22 20
10 5 24 3 6 27 4
19 32

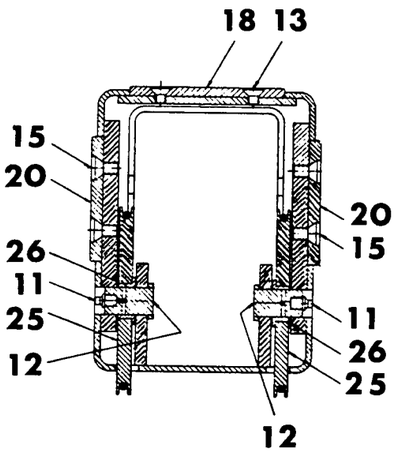
| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 27- | 21434 | INTERMEDIATE BOOM ASSEMBLY (3 SECTION) | 1 |
| -1 | 21406 | INTERMEDIATE BOOM MACHINING | 1 |
| -2 | 21435 | INNER BOOM ASSEMBLY (SEE FIG. 29) | 1 |
| -3 | 21303 | CABLE SHEAVE ASSEMBLY | 4 |
| -4 | 20247 | HOSE SHEAVE | 2 |
| -5 | 21302 | CABLE SHEAVE SHAFT | 1 |
| -6 | 21300 | HOSE SHEAVE PIN | 1 |
| -7 | 21456 | EXTENSION CYLINDER ASSEMBLY (SEE FIG. 27A) | 1 |
| -8 | 21338 | TRUNNION PIN | 2 |
| -9 | 20284 | WEAR PAD | 1 |
| -10 | 21317 | WEAR PAD | 2 |
| -11 | 21312 | WEAR PAD | 2 |
| -12 | 21391 | WEAR PAD | 1 |
| -13 | 21314 | WEAR PAD | 2 |
| -14 | 21343 | WEAR PAD SUPPORT PLATE | 1 |
| -15 | 21321 | COVER PLATE | 2 |
| -16 | 20453 | PAD PRESSURE PLATE | 2 |
| -17 | 62203 | HEX SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 2 |
| -18 | 61801 | HEX SOCKET FLAT HEAD CAP SCREW - 3/8-24 UNF X 3/4 | 16 |
| -19 | 61805 | HEX SOCKET FLAT HEAD CAP SCREW - 3/8-24 UNF X 1 | 6 |
| -20 | 20298 | RETRACTION HOSE BRACKET | 2 |
| -21 | 20211 | HOSE ADAPTER | 2 |
| -22 | 2596 | BULK HEAD LOCK NUT | 4 |
| -23 | 65103 | GREASE FITTING - 1/8 NPT | 3 |
| -24 | 60324 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1/2 (GR. 5) | 5 |
| -25 | 60307 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 1/2 (GR. 5) | 12 |
| -26 | 63303 | SPLIT LOCK WASHER - 3/8 | 14 |
| -27 | 65075 | SNAP RING | 2 |
| -28 | 65076 | SNAP RING | 2 |

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -29 | 62204 | HEX SOCKET HEAD SET SCREW - 1/2-13 UNC X 1 | 4 |
| -30 | 61101 | JAM NUT - 1/2-13 UNC | 4 |
| -31 | 60343 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 (GR. 5) | 2 |
| -32 | 63302 | SPLIT LOCK WASHER - 5/16 | 5 |
| -33 | 21316 | WEAR PAD | 2 |
| -34 | 21287 | CABLE KEEPER | 2 |

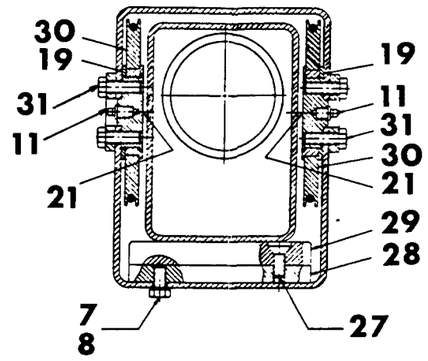
# FIGURE 27.1 - INTERMEDIATE BOOM ASSEMBLY (3 SECTION) (MARK TRACK)



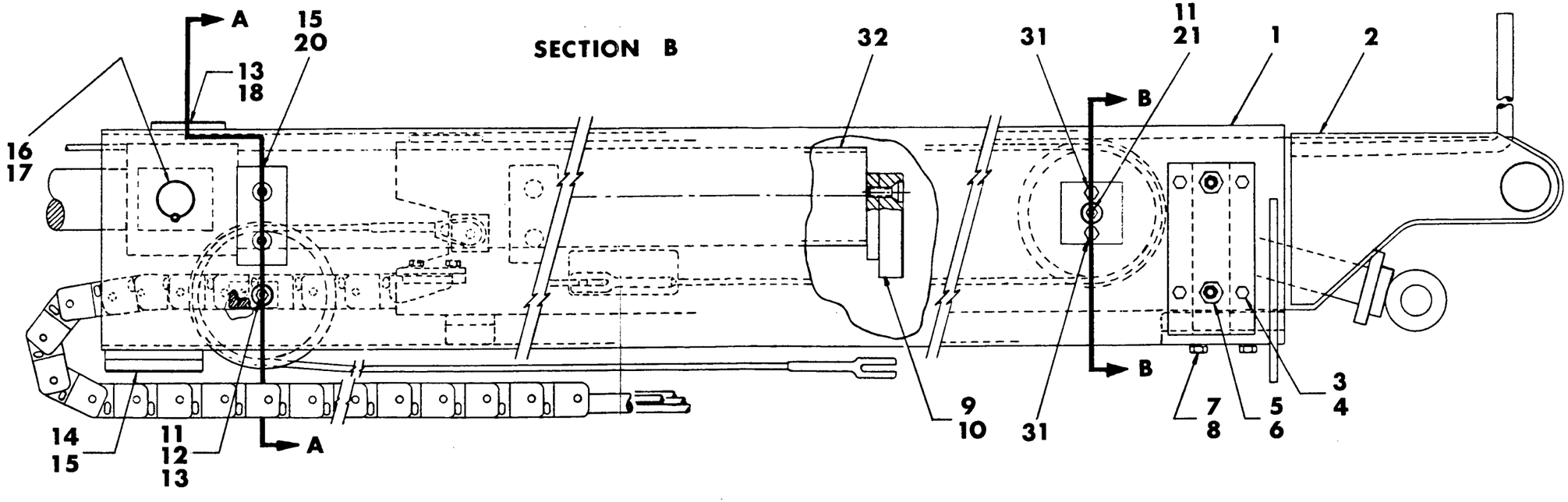



SECTION A




SECTION B



# FIGURE 27.1 - INTERMEDIATE BOOM ASSEMBLY (3 SECTION) (MARK TRACK)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 27.1- | 22761 | INTERMEDIATE BOOM ASSEMBLY (3 SECTION) (MARK TRACK) | 1 |
| -1 | 22768 | INTERMEDIATE BOOM MACHINING | 1 |
| -2 | 22762 | INNER BOOM ASSEMBLY (SEE FIG. 29A) | 1 |
| -3 | 60338 | HEX HEAD CAP SCREW - 5/16-18 UNC X 1 (GR. 5) | 8 |
| -4 | 63302 | SPLIT LOCK WASHER - 5/16 | 8 |
| -5 | 61101 | HEX JAM NUT - 1/2-13 UNC | 4 |
| -6 | 62204 | HEX SOCKET HEAD SET SCREW - 1/2-13 UNC X 1 | 4 |
| -7 | 60325 | HEX HEAD CAP SCREW - 3/8-16 UNC X 3/4 (GR. 5) | 4 |
| -8 | 63303 | SPLIT LOCK WASHER - 3/8 | 4 |
| -9 | 22779 | WEAR PAD | 1 |
| -10 | 61806 | FLAT SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 1/4 | 2 |
| -11 | 65103 | GREASE FITTING - 1/8 NPT | 4 |
| -12 | 22543 | CABLE SHEAVE PIN | 2 |
| -13 | 61822 | FLAT SOCKET HEAD CAP SCREW - 5/16-24 UNF X 1/2 | 4 |
| -14 | 22569 | WEAR PAD | 2 |
| -15 | 61806 | FLAT SOCKET HEAD CAP SCREW - 3/8-24 UNF X 3/4 | 8 |
| -16 | 20266 | TRUNNION PIN | 2 |
| -17 | 62203 | HEX SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 2 |
| -18 | 22785 | WEAR PAD | 1 |
| -19 | 22590 | THRUST WASHER | 2 |
| -20 | 22786 | WEAR PAD | 2 |
| -21 | 22544 | SHEAVE CABLE PIN | 2 |
| -22 | 22562 | WEAR PAD | 2 |
| -23 | 20453 | PAD PRESSURE PLATE | 2 |
| -24 | 20452 | PRESSURE PAD COVER | 2 |
| -25 | 22540 | CABLE SHEAVE | 2 |
| -26 | 65476 | THRUST WASHER | 2 |
| -27 | 61805 | FLAT SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 | 2 |

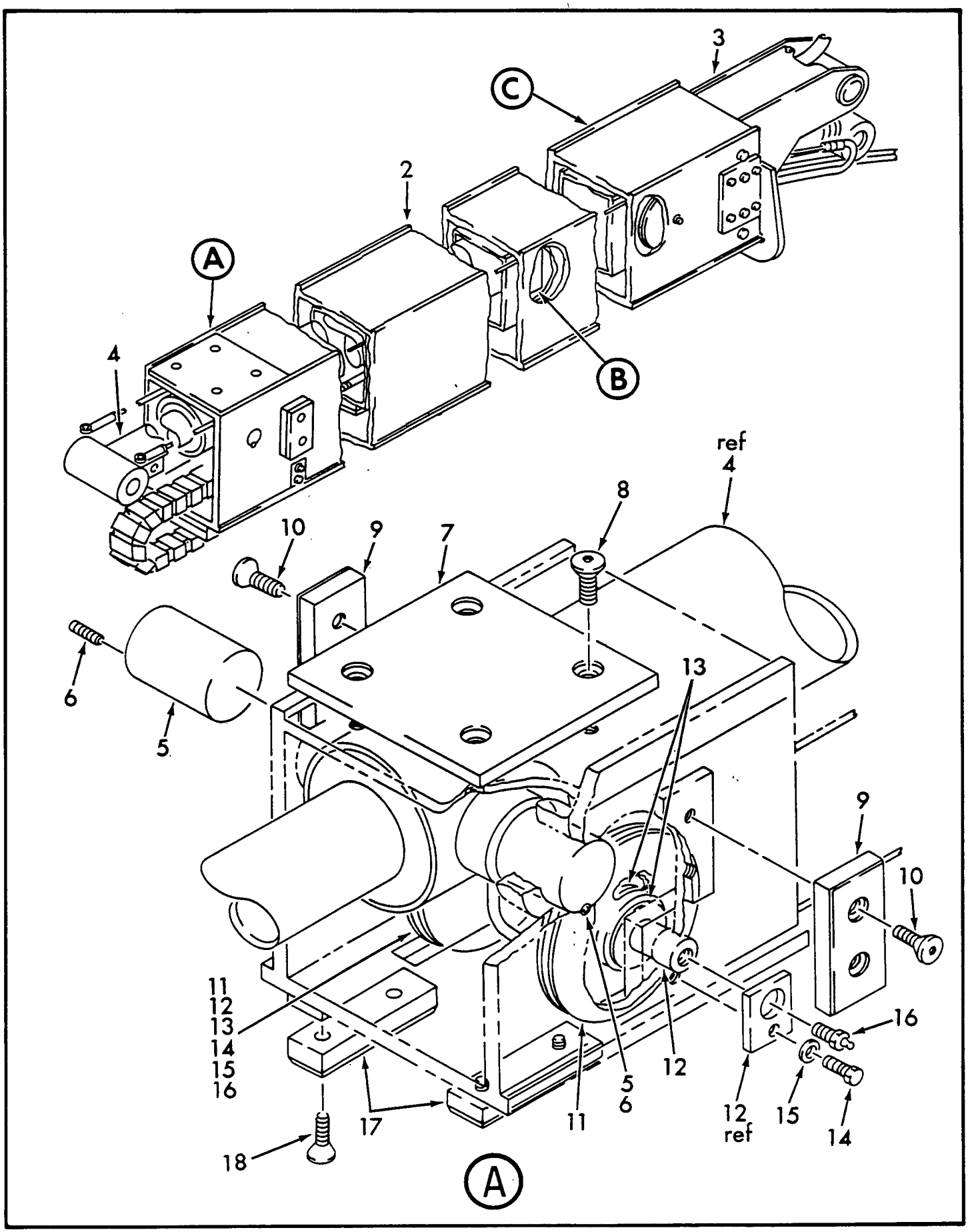
FIGURE 27.1 - INTERMEDIATE BOOM ASSEMBLY
(3 SECTION) (MARK TRACK)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -28 | 22780 | WEAR PAD SUPPORT | 1 |
| -29 | 22566 | WEAR PAD | 1 |
| -30 | 22592 | CABLE SHEAVE | 2 |
| -31 | 60643 | HEX HEAD CAP SCREW - 3/8-16 UNC X 1 1/8 (BOWMALOK 41013-1) | 4 |
| -32 | 22774 | BOOM EXTENSION CYLINDER ASSEMBLY (SEE FIG. 27A.1) | 1 |

# FIGURE 27.2 - INTERMEDIATE BOOM ASSEMBLY (MARK TRACK) REVISED





# FIGURE 27.2 - INTERMEDIATE BOOM ASSEMBLY (MARK TRACK) REVISED



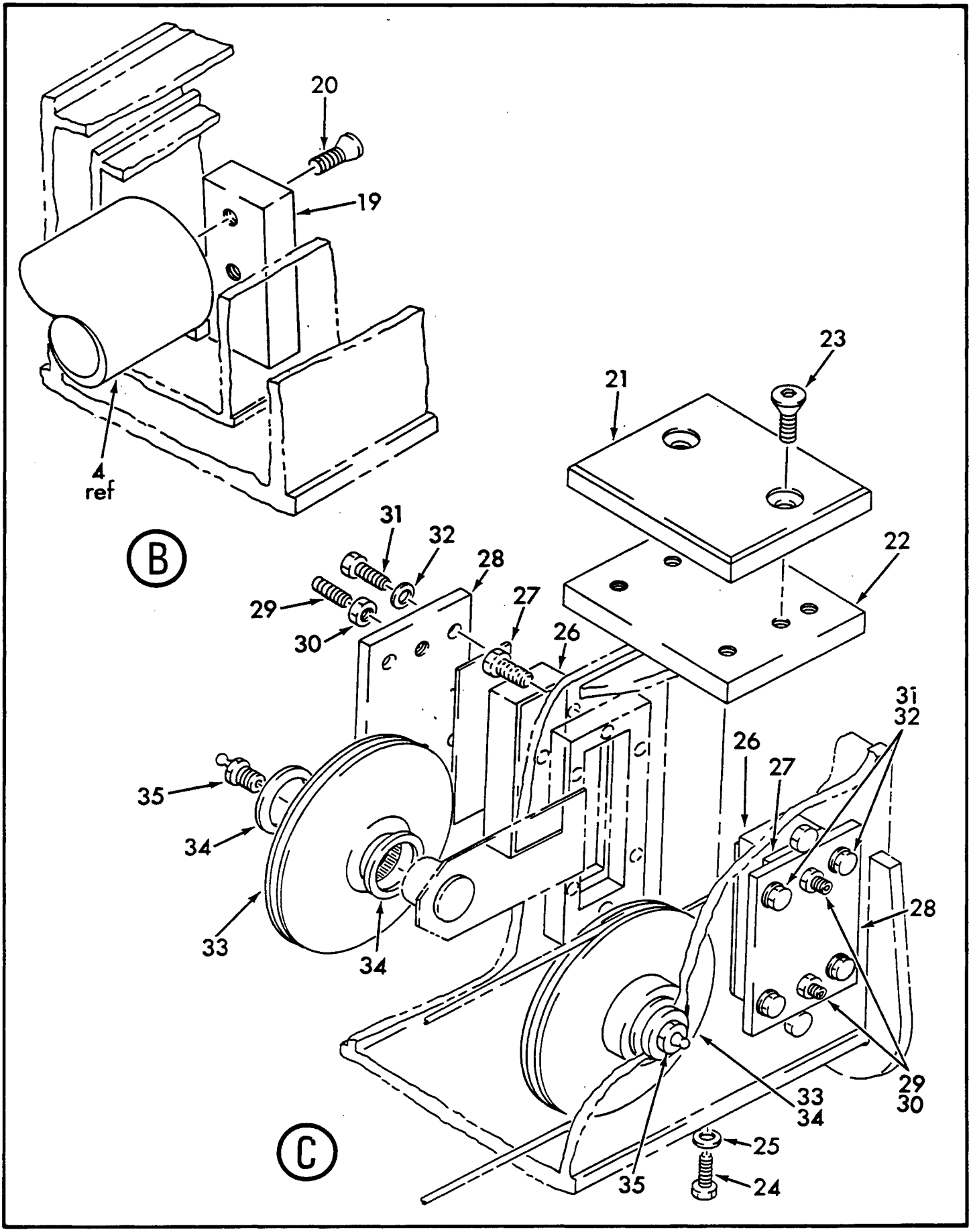


FIGURE 27.2 - INTERMEDIATE BOOM ASSEMBLY (MARK TRACK) REVISED



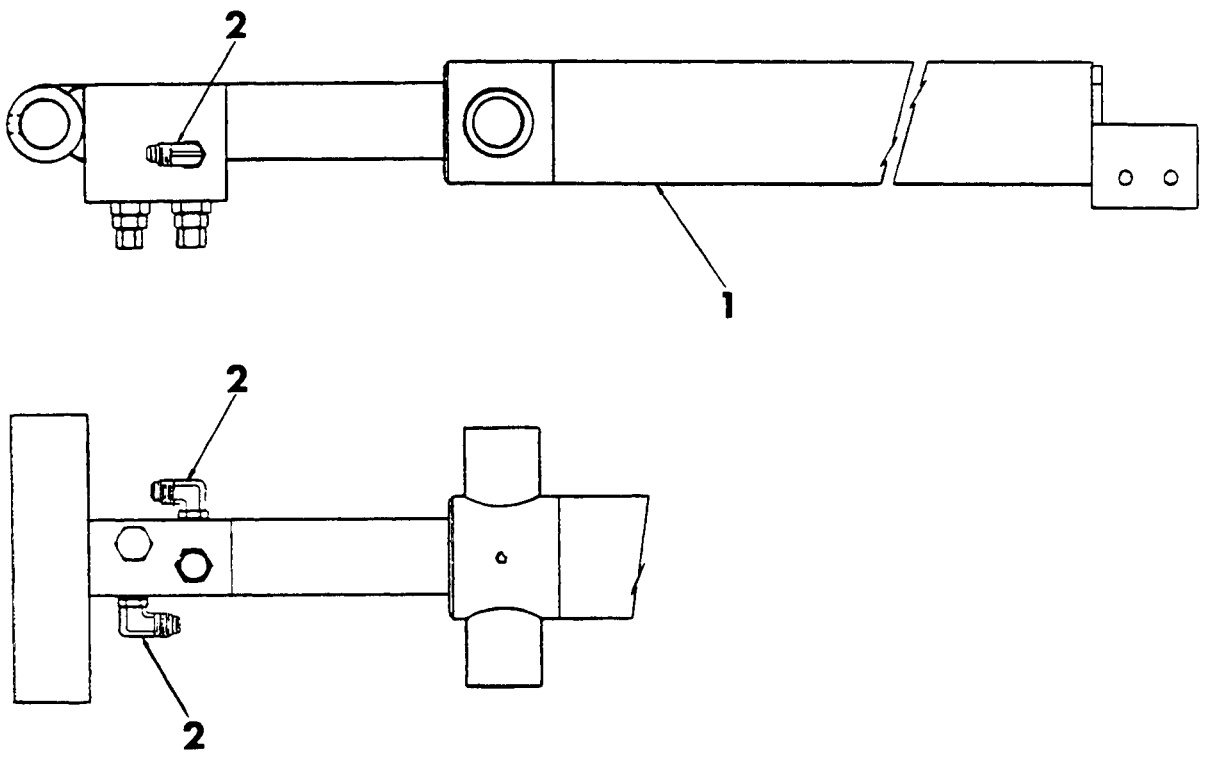
| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -1 | 23039 | ASSEMBLY, INTERMEDIATE BOOM | REF |
| -2 | 23034 | MACHINING, INTERMEDIATE BOOM | 1 |
| -3 | 23040 | ASSEMBLY, INNER BOOM (See Fig. 29B) | 1 |
| -4 | 23182 | ASSEMBLY, BOOM EXTENSION CYLINDER (See Fig. 27A.2) | 1 |
| -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 |

FIGURE 27.2 - INTERMEDIATE BOOM ASSEMBLY
(MARK TRACK) REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -24 | 60325 | SCREW, CAP | 4 |
| -25 | 63303 | WASHER, LOCK | 4 |
| -26 | 23103 | PAD, WEAR | 2 |
| -27 | 23272 | 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 |

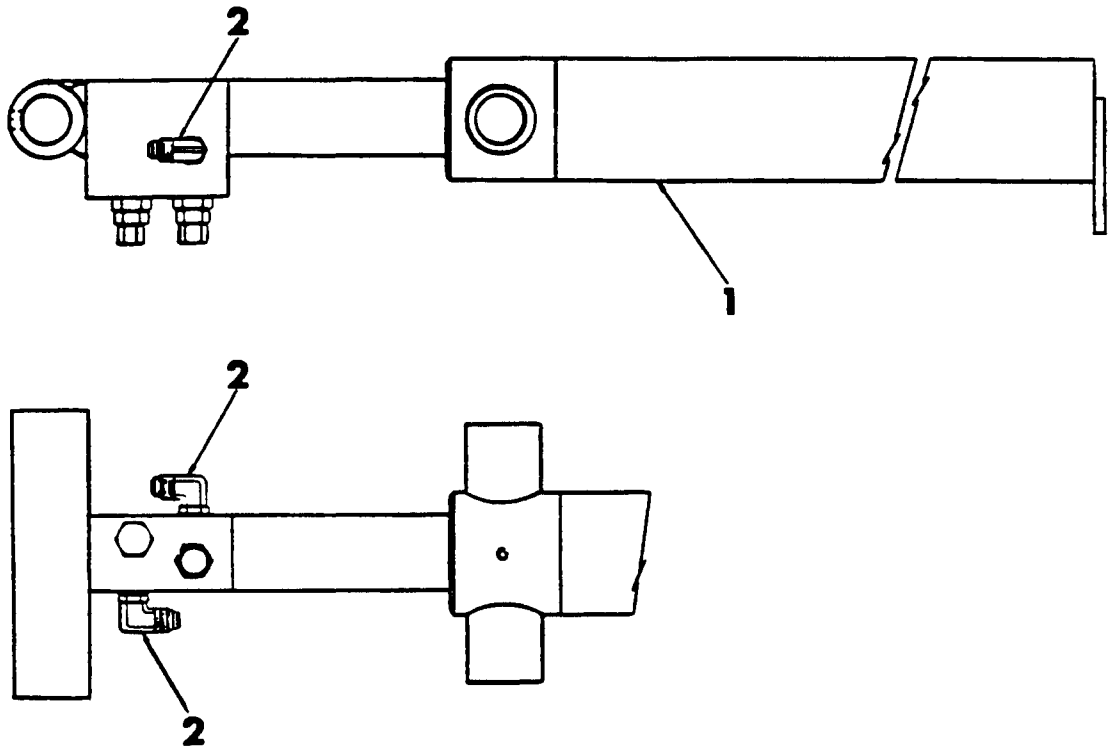
# FIGURE 27A - BOOM EXTENSION CYLINDER ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 27A- | 21456 | BOOM EXTENSION CYLINDER ASSEMBLY | 1 |
| -1 | 21468 | BOOM EXTENSION SUB-ASSEMBLY (SEE FIG. 27B) | 1 |
| -2 | 2523 | STRAIGHT THREAD ELBOW | 2 |

# FIGURE 27A.1 - BOOM EXTENSION CYLINDER ASSEMBLY (NEW P/N)

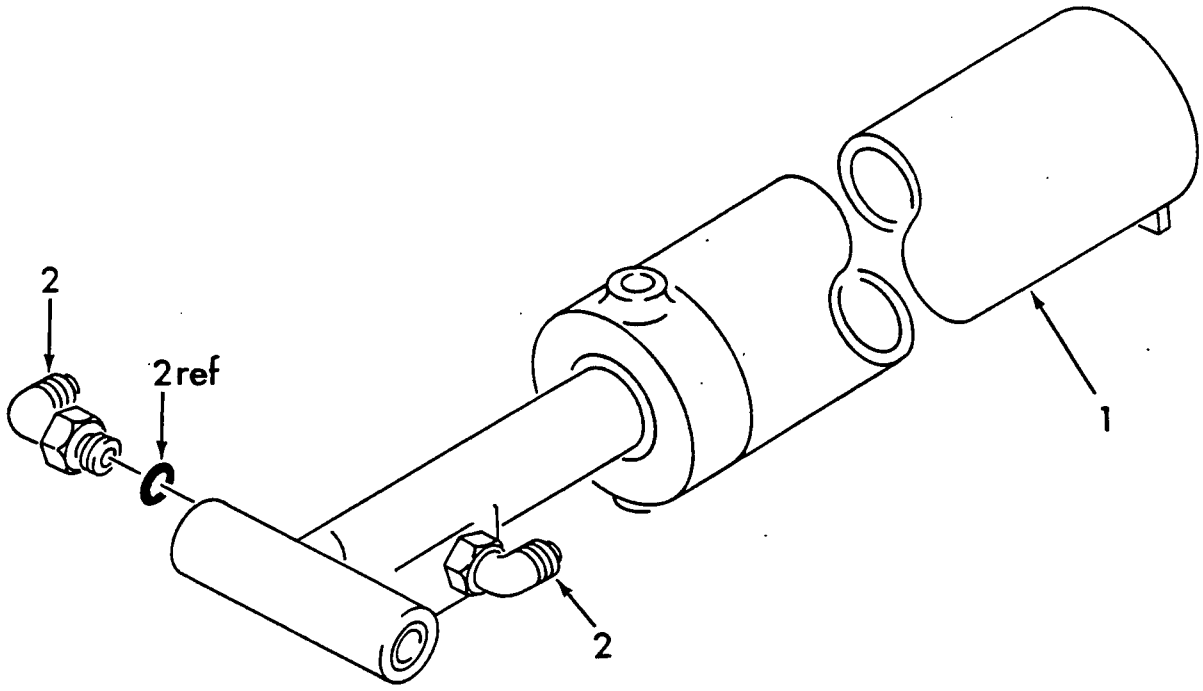





| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 27A.1- | 22774 | BOOM EXTENSION CYLINDER ASSEMBLY | 1 |
| -1 | 22773 | BOOM EXTENSION SUB-ASSEMBLY (SEE FIG. 27C) | 1 |
| -2 | 80012-11 | STRAIGHT THREAD ELBOW | 2 |

# FIGURE 27A.2 - EXTENSION CYLINDER ASSEMBLY REVISED

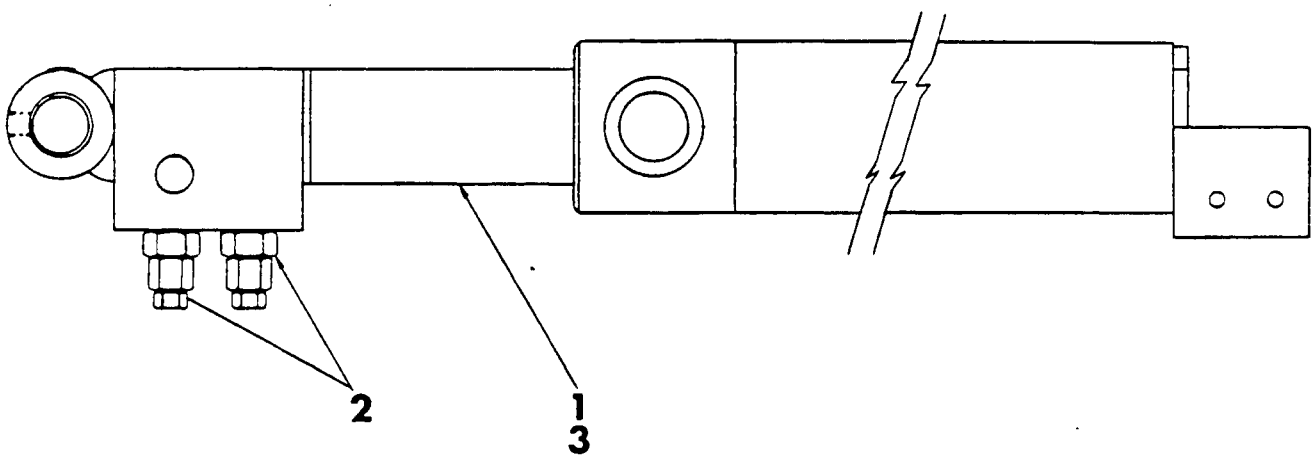





| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| | 23182 | EXTENSION CYLINDER ASSEMBLY | REF |
| -1 | 23183 | EXTENSION CYLINDER SUB-ASSEMBLY | 1 |
| -2 | 80012-11 | ELBOW | 2 |

REV.

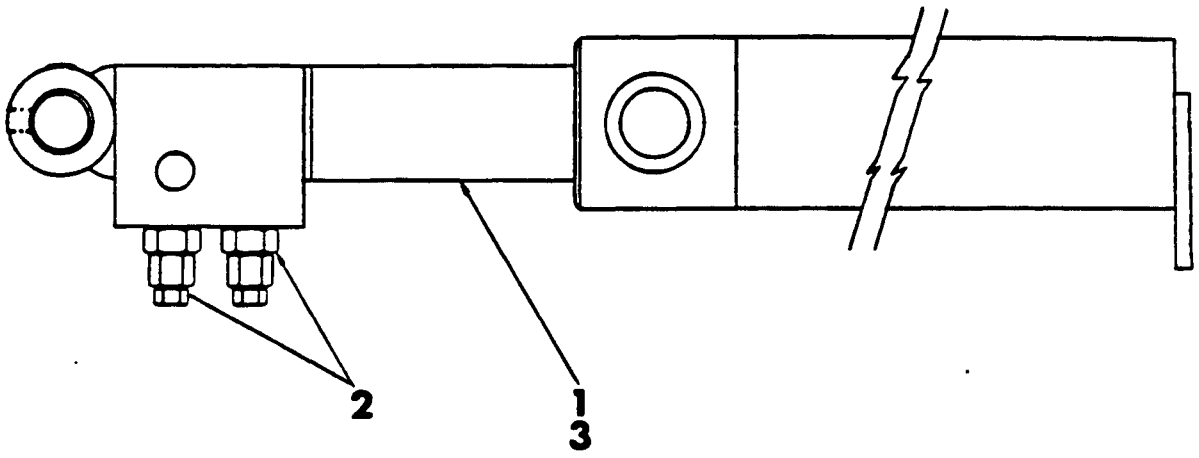
# FIGURE 27B - BOOM EXTENSION CYLINDER SUB-ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 27B- | 21468 | BOOM EXTENSION CYLINDER SUB-ASSEMBLY | 1 |
| -1 | 21410 | BOOM EXTENSION CYLINDER | 1 |
| -2 | 21580 | OVER CENTER CARTRIDGE | 2 |
| -3 | 66500 | SEAL KIT | 1 |

# FIGURE 27C - BOOM EXTENSION CYLINDER SUB-ASSEMBLY (NEW P/N)

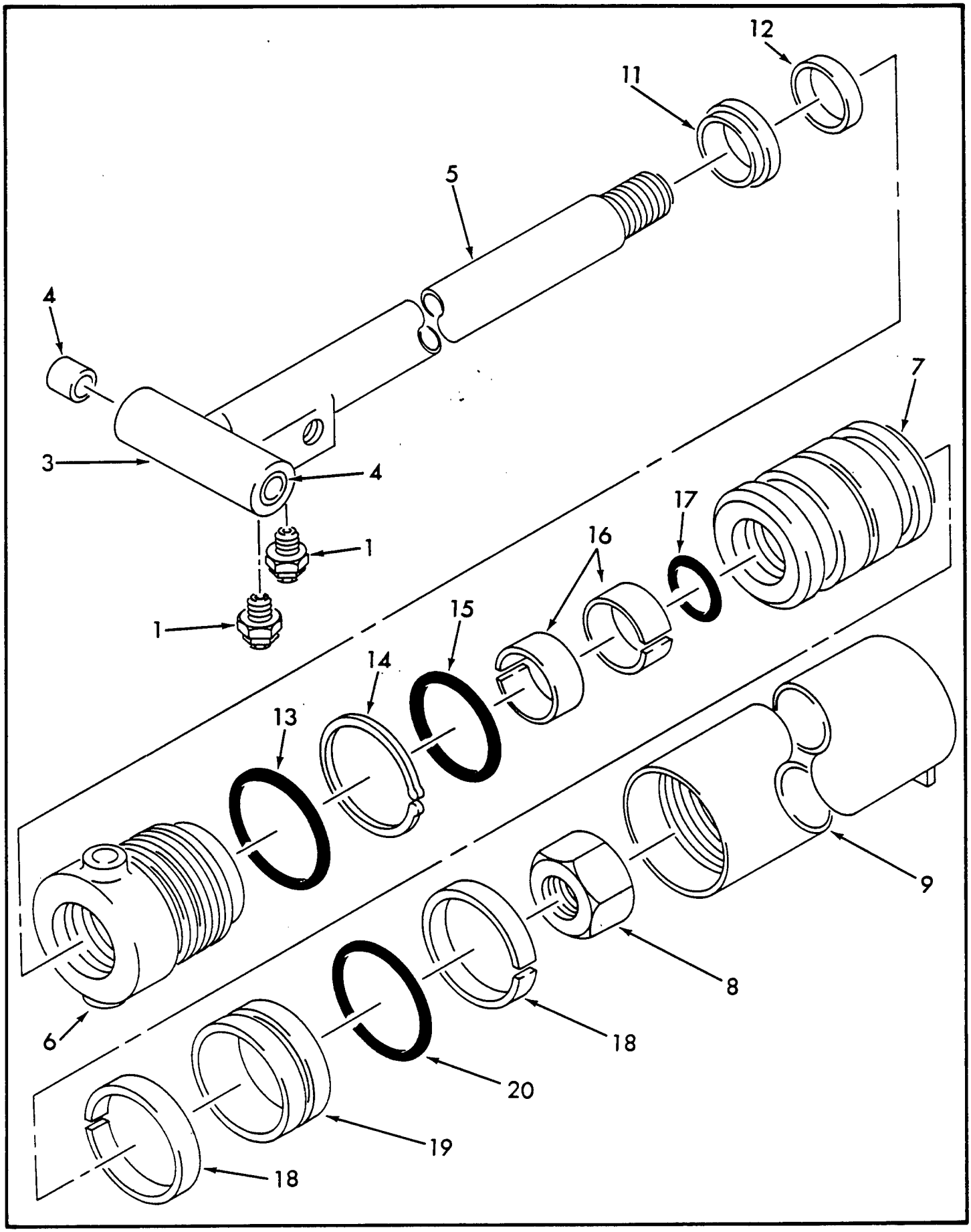





| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 27C- | 22773 | BOOM EXTENSION CYLINDER SUB-ASSEMBLY | 1 |
| -1 | 22772 | BOOM EXTENSION CYLINDER | 1 |
| -2 | 81006 | OVER CENTER CARTRIDGE | 2 |
| -3 | 66500 | SEAL KIT | 1 |

# FIGURE 27D - EXTENSION CYLINDER SUB ASSEMBLY REVISED






REV.

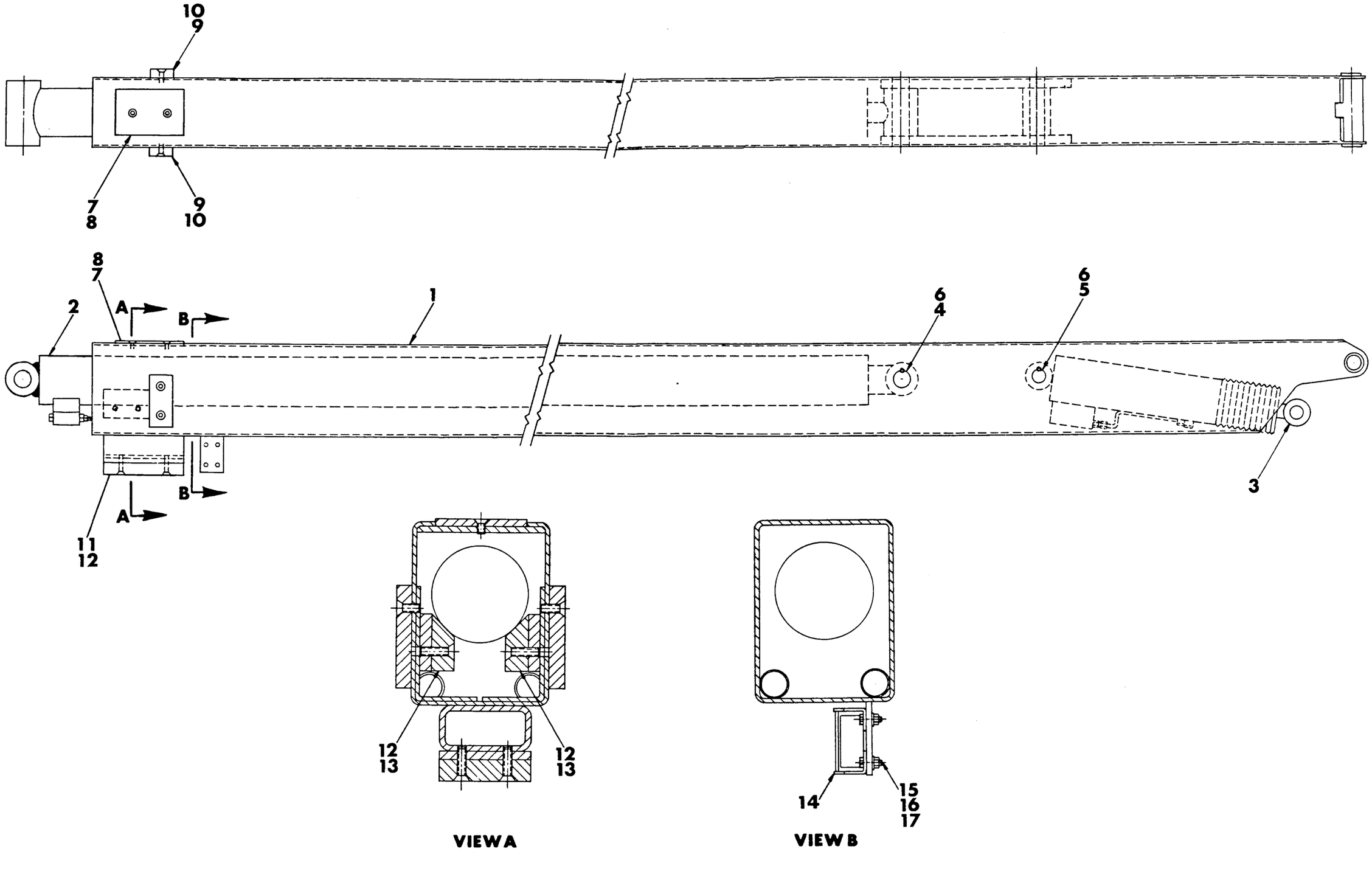
# FIGURE 27D - EXTENSION CYLINDER SUB ASSEMBLY REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| | 23183 | EXTENSION CYLINDER SUB-ASSEMBLY | REF |
| -1 | 81006 | OVERCENTER CARTRIDGE | 2 |
| -2 | 23184 | EXTENSION CYLINDER | REF |
| -3 | | ROD END | 1 |
| -4 | | BUSHING | 2 |
| -5 | | ROD | 1 |
| -6 | | GLAND NUT | 1 |
| -7 | | PISTON | 1 |
| -8 | | LOCK NUT | 1 |
| -9 | | BARREL | 1 |
| -10 | | SEAL KIT | REF |
| -11 | | ROD WIPER | 1 |
| -12 | | ROD SEAL | 1 |
| -13 | | O-RING | 1 |
| -14 | | BACK-UP RING | 1 |
| -15 | | O-RING | 1 |
| -16 | | WEAR BEARING | 2 |
| -17 | | O-RING | 1 |
| -18 | | WEAR RING | 2 |
| -19 | | SQUARE SEAL | 1 |
| -20 | | O-RING | 1 |

NOTE: ITEM NO. 2 AND NO. 10 ARE NOT ILLUSTRATED

FIGURE 28 - INNER BOOM ASSEMBLY (2 SECTION)



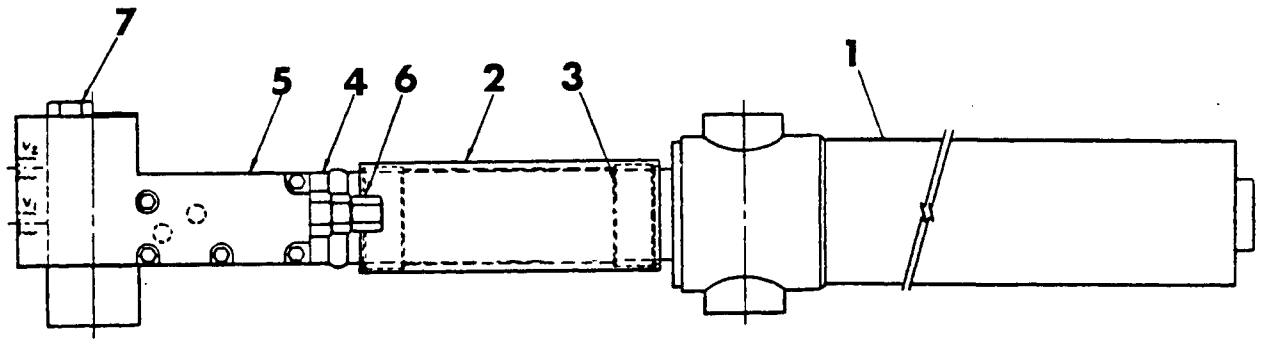

VIEW A

VIEW B

FIGURE 28 - INNER BOOM ASSEMBLY (2 SECTION)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 28- | 22494 | INNER BOOM ASSEMBLY (2 SECTION) | 1 |
| -1 | 22435 | INNER BOOM MACHINING | 1 |
| -2 | | BOOM EXTENSION CYLINDER ASSEMBLY (SEE FIG. 28A) | 1 |
| -3 | 21711 | SLAVE LEVELING CYLINDER ASSEMBLY (SEE FIG. 30) | 1 |
| -4 | 22378 | EXTENSION CYLINDER PIN | 1 |
| -5 | 20262 | LEVELING CYLINDER PIN | 1 |
| -6 | 62203 | SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 2 |
| -7 | 22377 | WEAR PAD | 1 |
| -8 | | FLAT HEX SOCKET HEAD CAP SCREW - 5/16-18 UNC X 5/8 | 2 |
| -9 | 22375 | WEAR PAD | 2 |
| -10 | 61805 | FLAT HEX SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 | 4 |
| -11 | 22374 | WEAR PAD | 1 |
| -12 | 61802 | FLAT HEX SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 1/2 | 4 |
| -13 | 22376 | WEAR PAD | 2 |
| -14 | | PLASTITRAK ASSEMBLY | 1 |
| -15 | 16021 | HEX HEAD CAP SCREW - 1/4-20 UNC X 3/4 (GR. 8) | 4 |
| -16 | 63301 | SPLIT LOCK WASHER - 1/4 | 4 |
| -17 | 60701 | HEX NUT - 1/4-20 UNC | 4 |

# FIGURE 28A - BOOM EXTENSION CYLINDER ASSEMBLY




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 28A- | | BOOM EXTENSION CYLINDER ASSEMBLY | 1 |
| -1 | 22366 | CYLINDER | 1 |
| -2 | 20273 | SLIDE WELDMENT | 1 |
| -3 | 20274 | RETRACTOR BUSHING | 2 |
| -4 | 21446 | ROD END | 1 |
| -5 | 21444 | MANIFOLD BLOCK | 1 |
| -6 | 21265 | OVER CENTER CARTRIDGE | 1 |
| -7 | 21266 | P.O. CHECK CARTRIDGE | 1 |
| -8 | | SEAL KIT | 1 |

FIGURE 29 - INNER BOOM ASSEMBLY (3 SECTION)

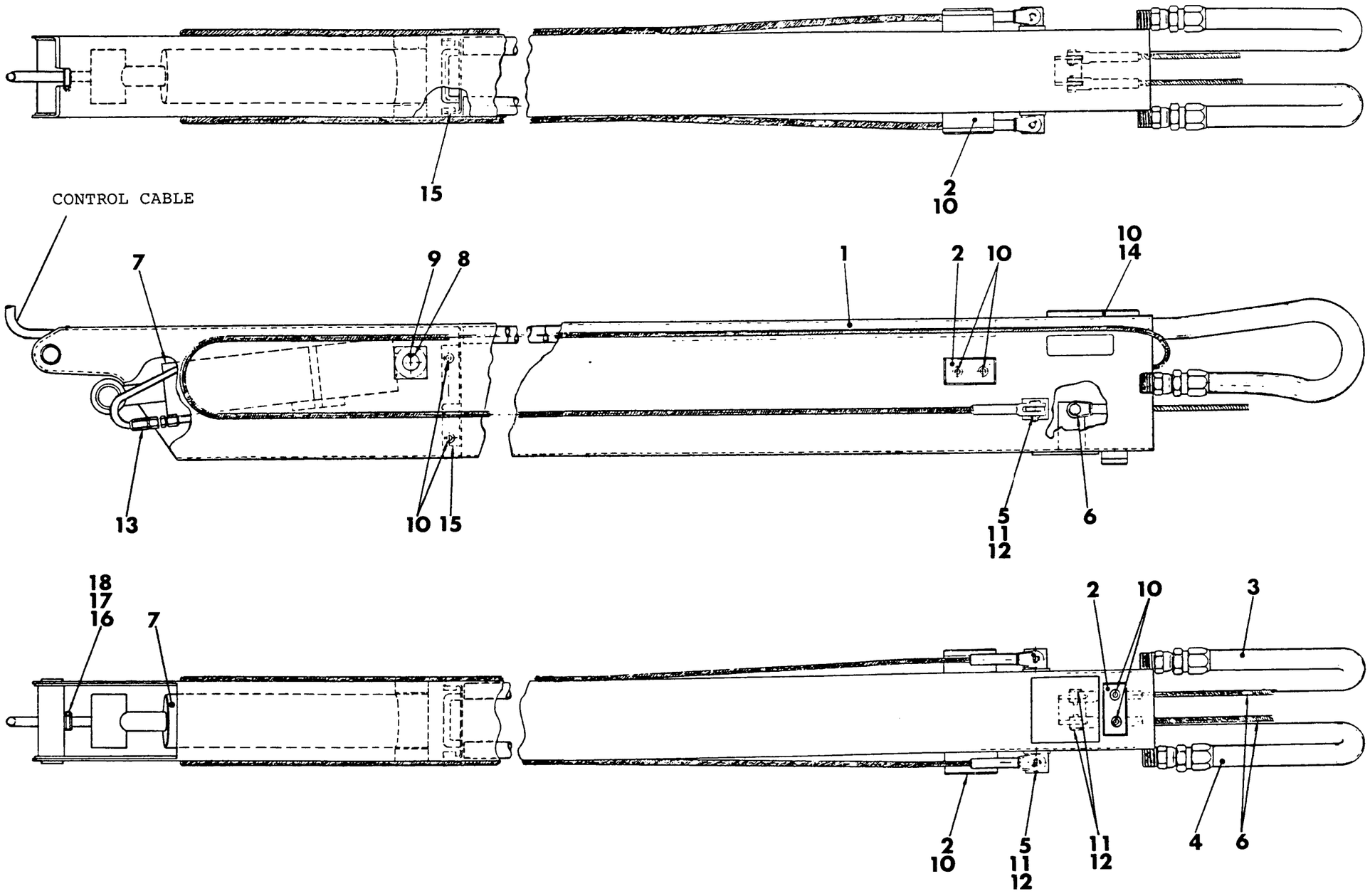
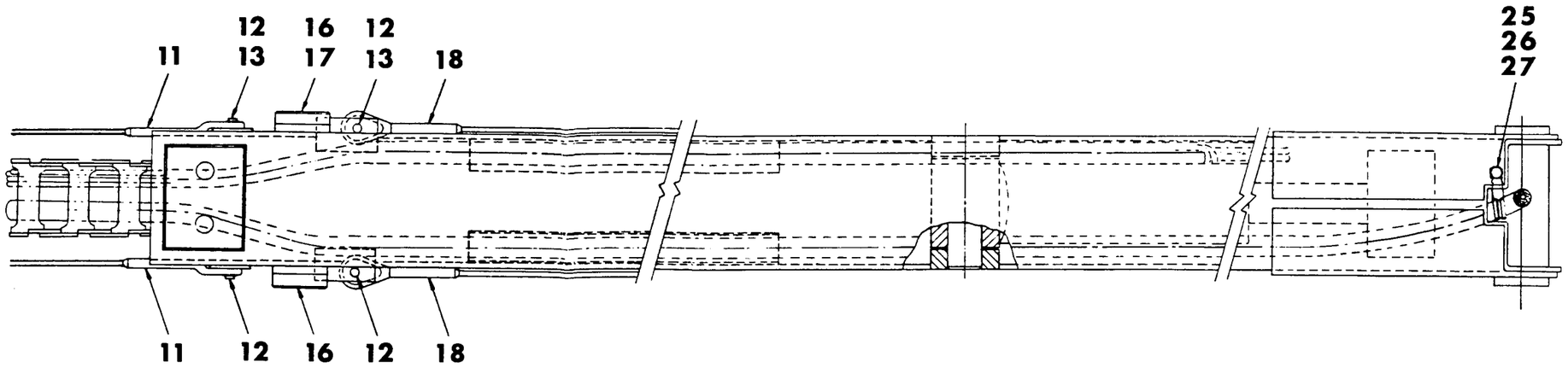


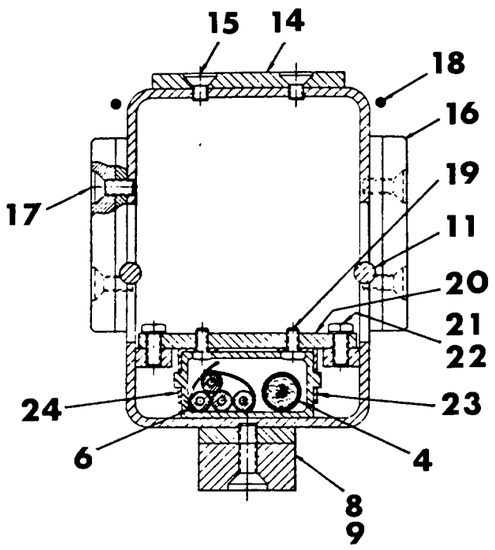
FIGURE 29 - INNER BOOM ASSEMBLY (3 SECTION)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 29 - | 21435 | INNER BOOM ASSEMBLY (3 SECTION) | 1 |
| -1 | 21407 | INNER BOOM MACHINING | 1 |
| -2 | 21313 | WEAR PAD | 3 |
| -3 | 21436 | HYDRAULIC HOSE ASSEMBLY | 1 |
| -4 | 21437 | ELECTRICAL HOSE ASSEMBLY | 1 |
| -5 | 21423 | EXTENSION CABLE ASSEMBLY | 2 |
| -6 | 21424 | RETRACTION CABLE ASSEMBLY | 2 |
| -7 | 21094 | LEVELING CYLINDER ASSEMBLY (SEE FIG. 31) | 1 |
| -8 | 20262 | LEVELING CYLINDER PIN | 1 |
| -9 | 62203 | SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 2 |
| -10 | 61801 | FLAT SOCKET HEAD CAP SCREW - 3/8-24 UNF X 3/4 | 14 |
| -11 | 21318 | CLEVIS PIN | 4 |
| -12 | 64302 | COTTER PIN - 3/32 DIA. X 1 | 4 |
| -13 | 2562 | STRAIGHT SWIVEL HOSE FITTING | 2 |
| -14 | 21391 | WEAR PAD | 1 |
| -15 | 21350 | BULK HEAD PLATE | 1 |
| -16 | 16268 | HOSE CLAMP | 1 |
| -17 | 60309 | HEX HEAD CAP SCREW - 1/4-20 UNC X 3/4 (GR. 5) | 1 |
| -18 | 60701 | HEX NUT - 1/4-20 UNC | 1 |

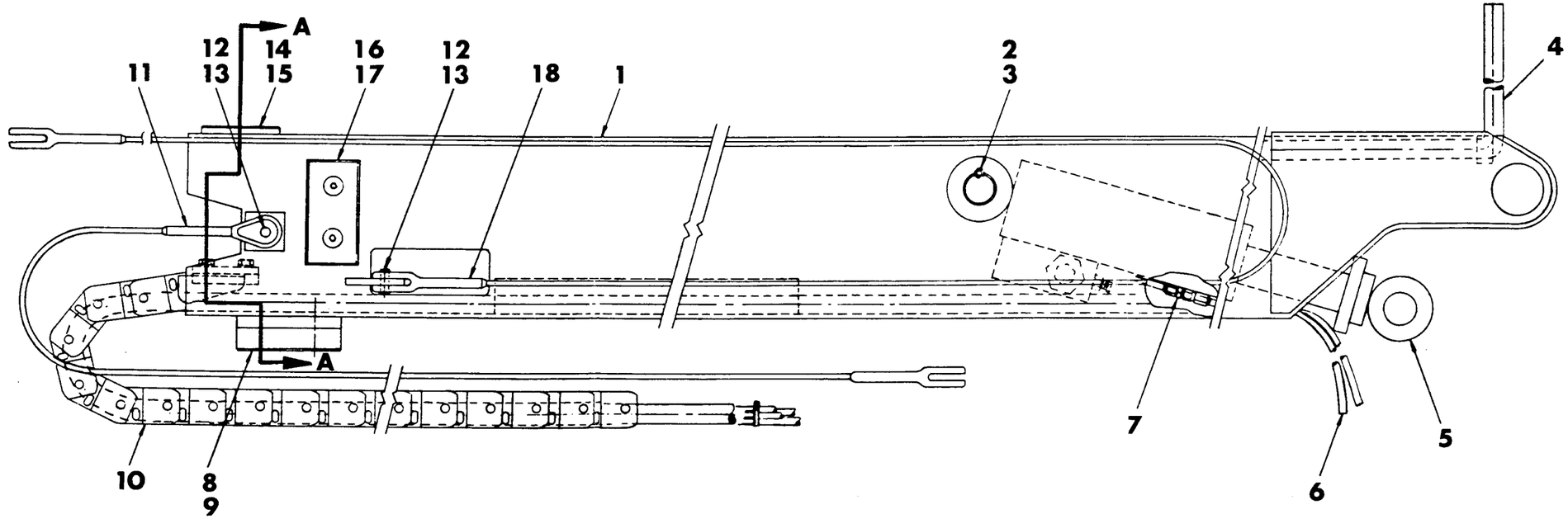
# FIGURE 29A - INNER BOOM ASSEMBLY (3 SECTION) (MARK TRACK)






SECTION A



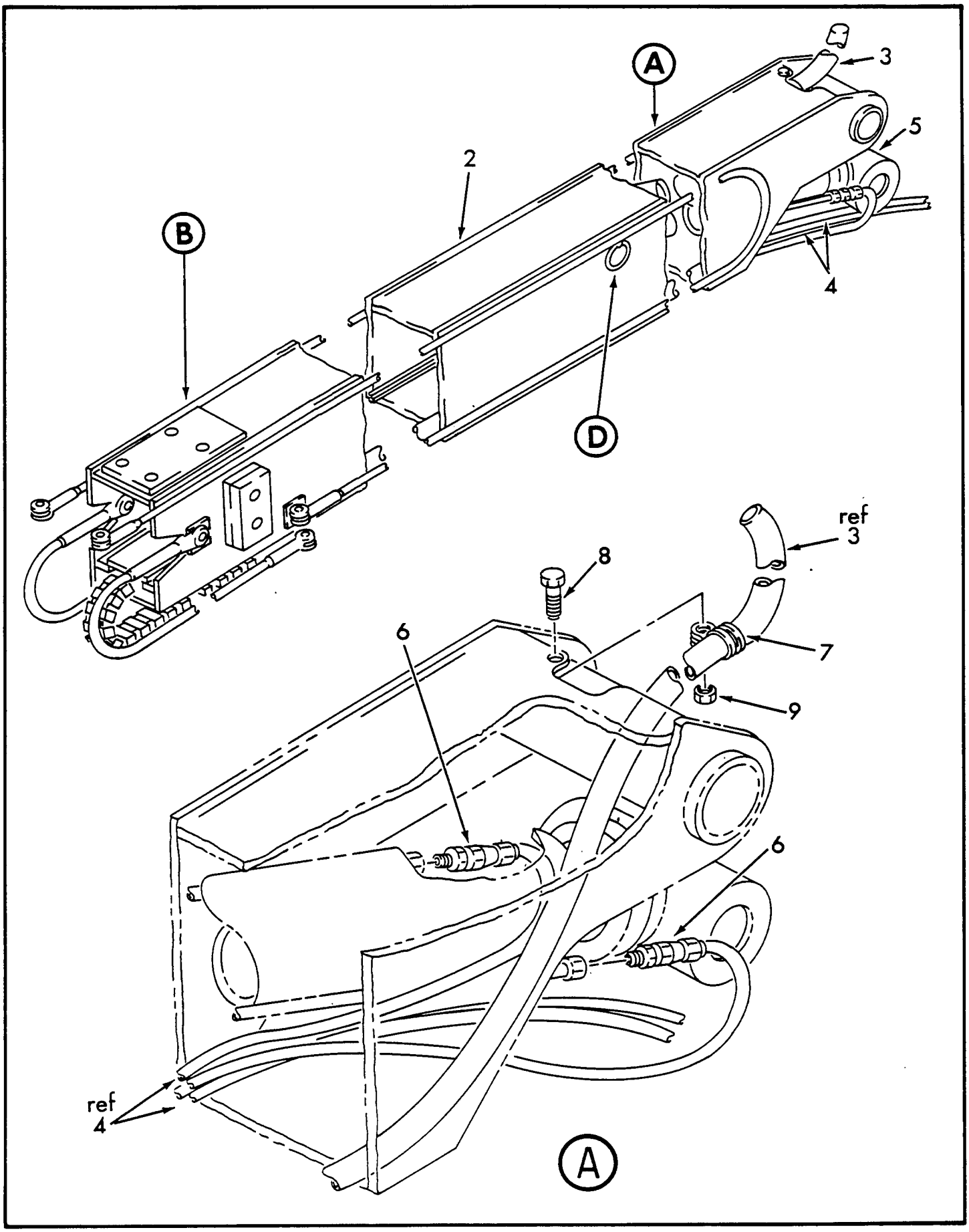
# FIGURE 29A - INNER BOOM ASSEMBLY (3 SECTION) (MARK TRACK)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 28B- | 22762 | INNER BOOM ASSEMBLY | 1 |
| -1 | 22771 | INNER BOOM MACHINING | 1 |
| -2 | 62203 | HEX SOCKET HEAD SET SCREW - 3/8-16 UNC X 3/8 | 1 |
| -3 | 22573 | SLAVE LEVELING CYLINDER PIN | 1 |
| -4 | 20802-872 | ELECTRICAL CABLE | 1 |
| -5 | 22584 | SLAVE LEVELING CYLINDER ASSEMBLY (SEE FIG. 29B) | 1 |
| -6 | 2568-648 | HYDRAULIC HOSE | 4 |
| -7 | 2562 | STRAIGHT SWIVEL FITTING | 2 |
| -8 | 22568 | WEAR PAD | 1 |
| -9 | 61806 | FLAT SOCKET HEAD CAP SCREW - 3/8-24 UNF X 1 1/4 | 2 |
| -10 | 22775 | MARK TRACK | 1 |
| -11 | 22776 | RETRACTION CABLE | 2 |
| -12 | 22547 | CABLE PIN | 4 |
| -13 | 65080 | SNAP RING | 8 |
| -14 | 22777 | WEAR PAD | 1 |
| -15 | 61822 | FLAT SOCKET HEAD CAP SCREW - 5/16-24 UNF X 1/2 | 2 |
| -16 | 22567 | WEAR PAD | 2 |
| -17 | 61801 | FLAT SOCKET HEAD CAP SCREW - 3/8-24 UNF X 3/4 | 4 |
| -18 | 22778 | EXTENSION CABLE | 2 |
| -19 | 60633 | HEX HEAD CAP SCREW - 1/4-20 UNC X 1/2 (BOWMALOK 41000) | 4 |
| -20 | 22560 | PLASTITRAK MOUNTING PLATE | 1 |
| -21 | 60322 | HEX HEAD CAP SCREW - 5/16-18 UNC X 3/4 (GR. 5) | 4 |
| -22 | 63302 | SPLIT LOCK WASHER - 5/16 | 4 |
| -23 | 22588 | MOVABLE-LEFT HAND MOUNTING BRACKET | 1 |
| -24 | 22587 | MOVABLE-RIGHT HAND MOUNTING BRACKET | 1 |
| -25 | 60309 | HEX HEAD CAP SCREW - 1/4-20 UNC X 3/4 (GR. 5) | 1 |
| -26 | 60711 | HEX NUT - 1/4-20 UNC (NYLON INSERT) | 1 |
| -27 | 16268 | RUBBER CLAMP | 1 |

# FIGURE 29B - INNER BOOM ASSEMBLY (MARK TRACK) REVISED

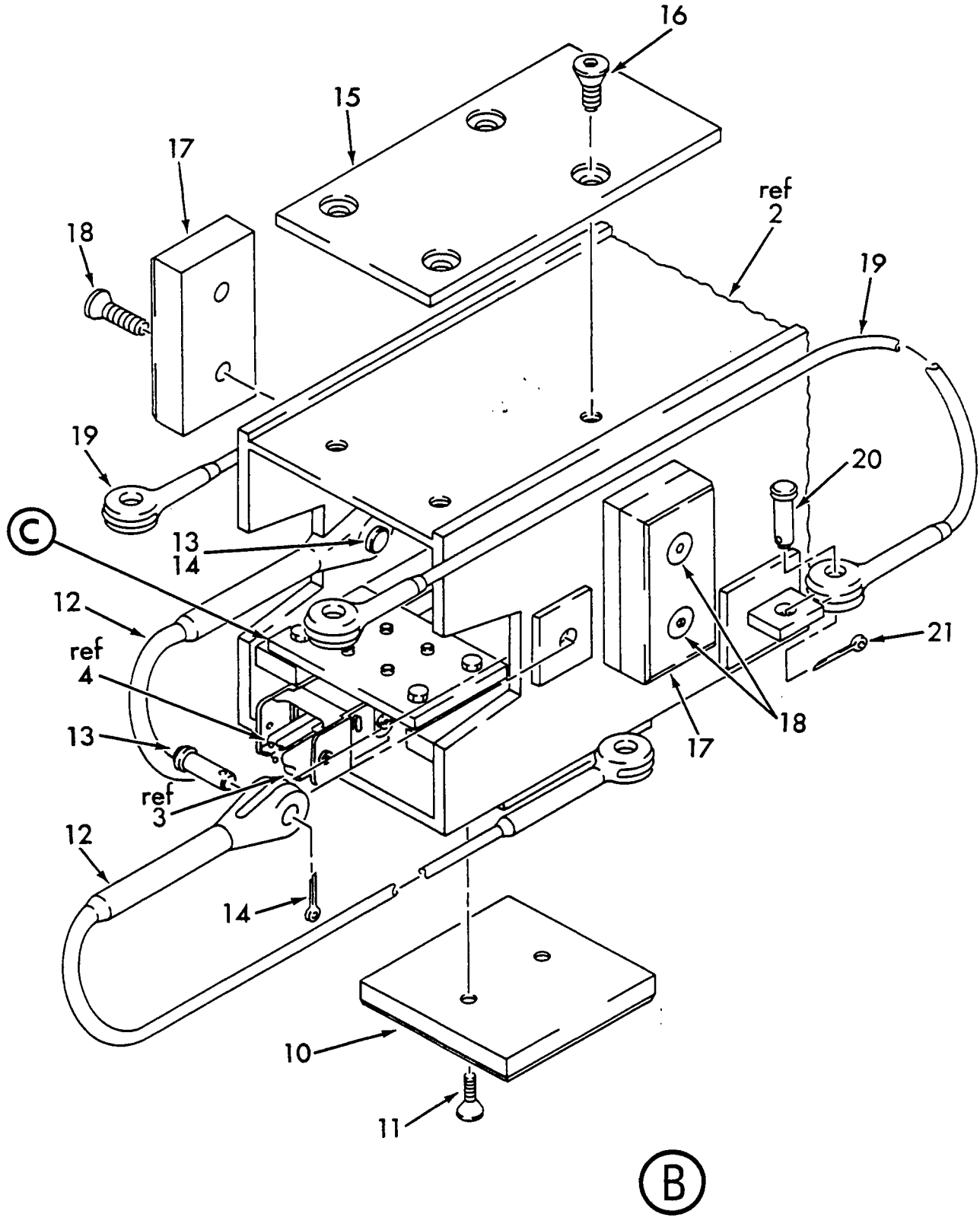





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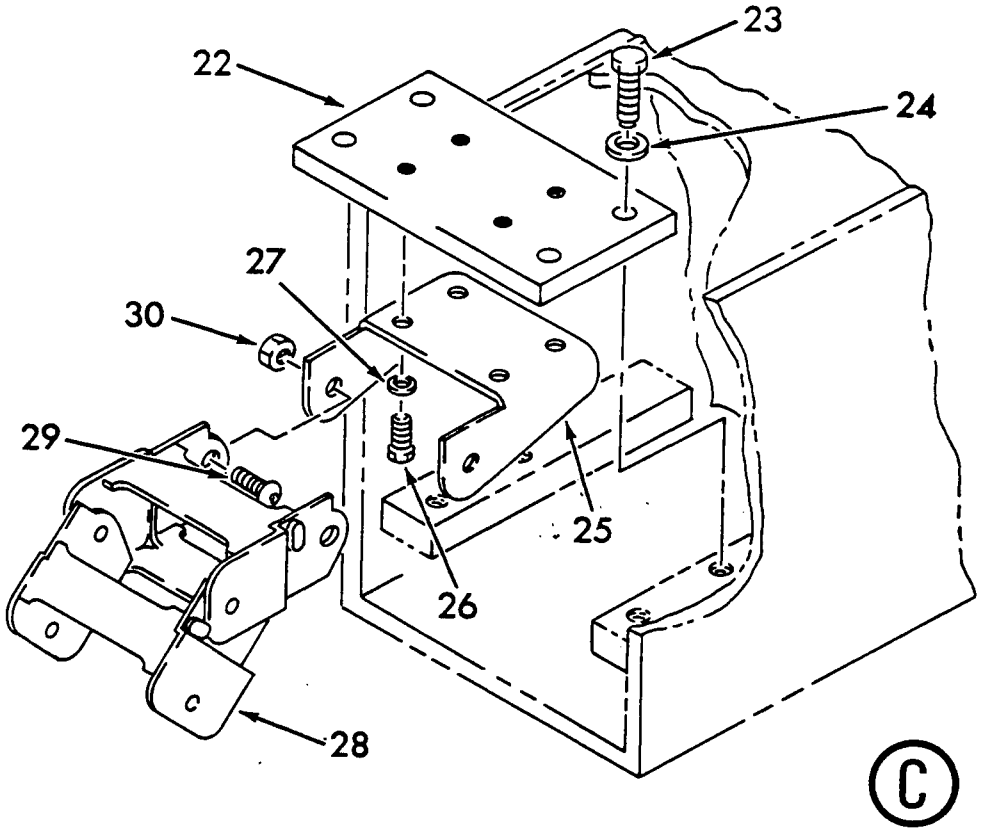
# FIGURE 29B - INNER BOOM ASSEMBLY (MARK TRACK) REVISED





# FIGURE 29B - INNER BOOM ASSEMBLY (MARK TRACK) REVISED





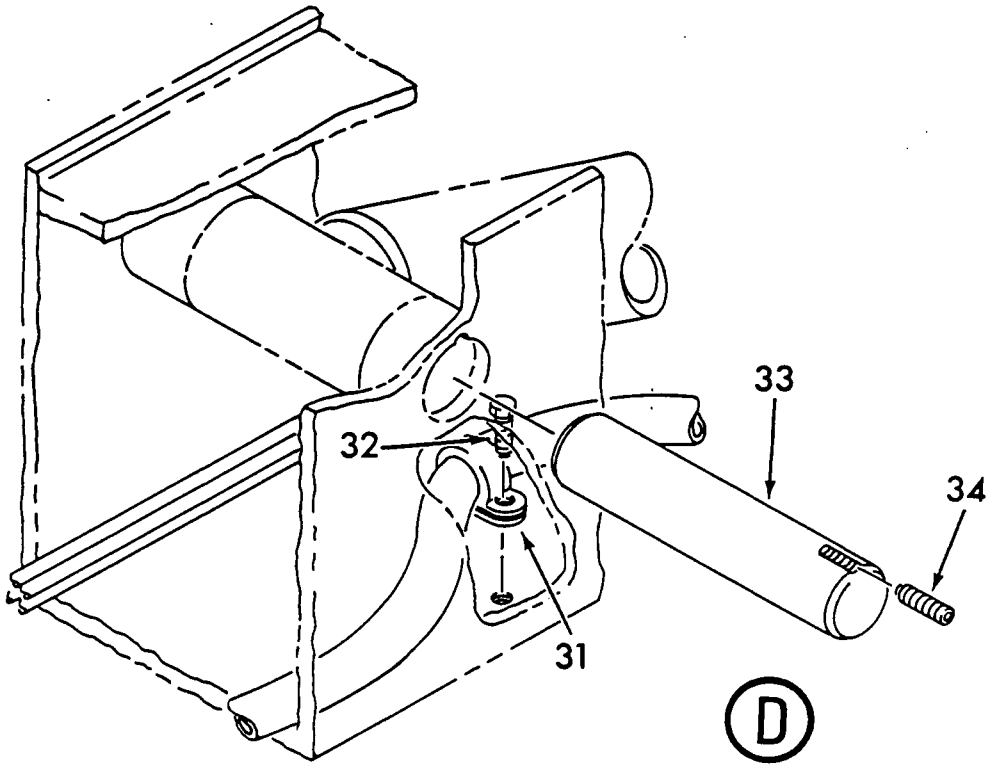



FIGURE 29B - INNER BOOM ASSEMBLY
(MARK TRACK) REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -1 | 23040 | ASSEMBLY, INNER BOOM | REF |
| -2 | 23037 | MACHINING, INNER BOOM | 1 |
| -3 | 20802-780 | CABLE, ELECTRIC | 1 |
| -4 | 2568-648 | HOSE, HYDRAULIC | 4 |
| -5 | 22584 | ASSEMBLY, SLAVE LEVELING CYLINDER (See Fig. 31A) | 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 | 23193 | 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 | 23192 | 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 |

REV.

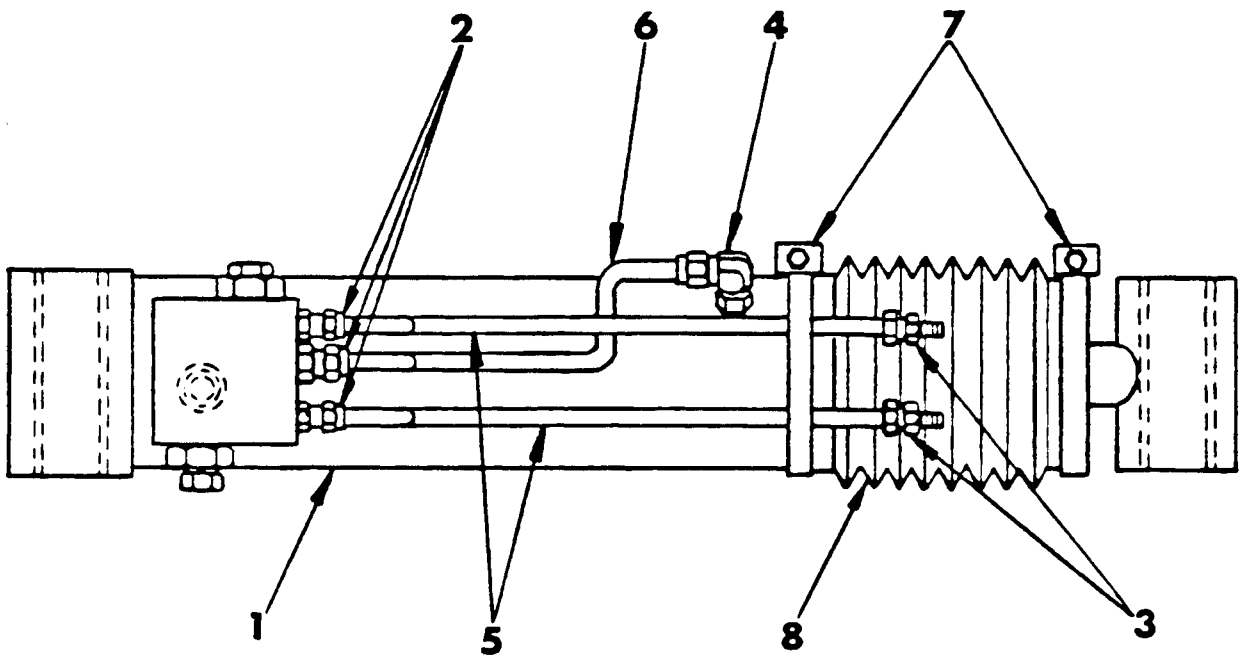
FIGURE 29B - INNER BOOM ASSEMBLY
(MARK TRACK) REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -25 | 23752 | BRACKET, MOVABLE PLASTITRAK | 1 |
| -26 | 60543 | SCREW, CAP | 4 |
| -27 | 63301 | WASHER, LOCK | 4 |
| -28 | 22775 | ASSEMBLY, MARKTRAK | 1 |
| -29 | 61931 | SCREW, CAP | 2 |
| -30 | 61322 | NUT, LOCK | 2 |
| -31 | 16268 | CLAMP, RUBBER | 1 |
| -32 | 60309 | SCREW, CAP | 1 |
| -33 | 23084 | PIN, SLAVE LEVELING CYLINDER | 1 |
| -34 | 62203 | SCREW, SET | 1 |

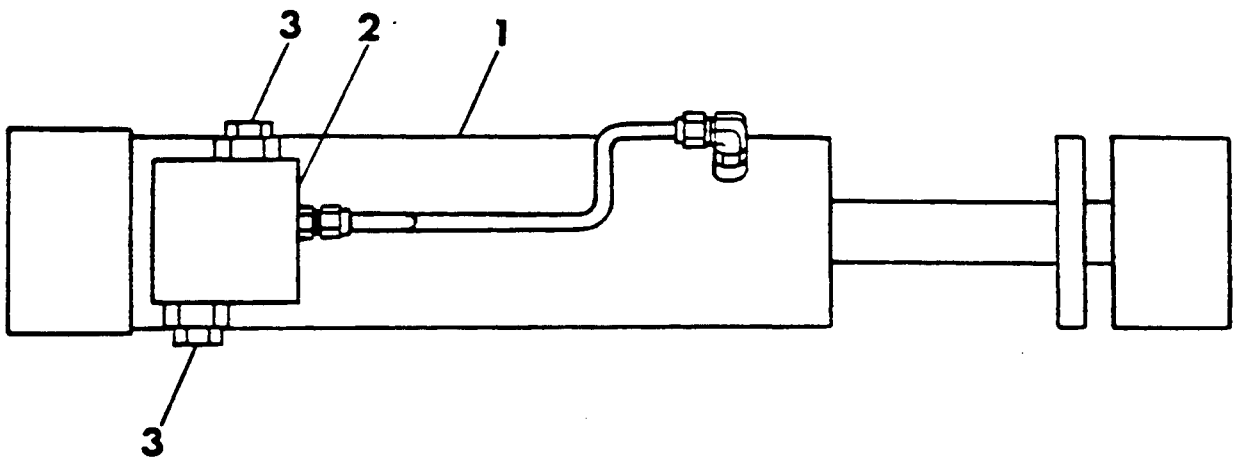
REV.

FIGURE 30 - SLAVE LEVELING CYLINDER ASSEMBLY
(2 SECTION BOOM)



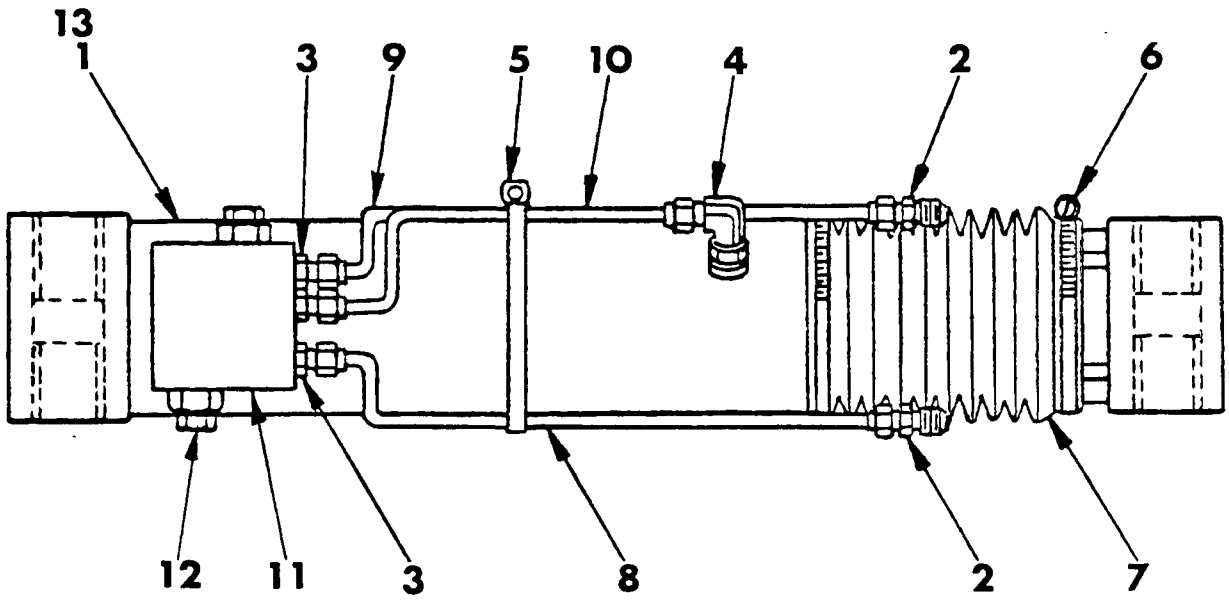

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 30- | 21711 | SLAVE LEVELING CYLINDER ASSEMBLY | 1 |
| -1 | 21262 | SLAVE LEVELING CYLINDER (SEE FIG.30A) | 1 |
| -2 | 2581 | CONNECTOR | 3 |
| -3 | 2465 | UNION CONNECTOR | 2 |
| -4 | 2532 | 90° ELBOW | 1 |
| -5 | 20631 | TUBE ASSEMBLY - 1/4 | 2 |
| -6 | 20632 | TUBE ASSEMBLY - 1/4 | 1 |
| -7 | 65111 | STRAP | 2 |
| -8 | 21388 | CONVOLUTED TUBING | 1 |

# FIGURE 30A - SLAVE LEVELING CYLINDER (2 SECTION BOOM)




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 30A- | 21262 | SLAVE LEVELING CYLINDER | 1 |
| -1 | 21274 | CYLINDER | 1 |
| -2 | 21447 | MANIFOLD BLOCK | 1 |
| -3 | 21267 | OVER CENTER CARTRIDGE | 2 |
| -4 | 66228 | SEAL KIT | 1 |

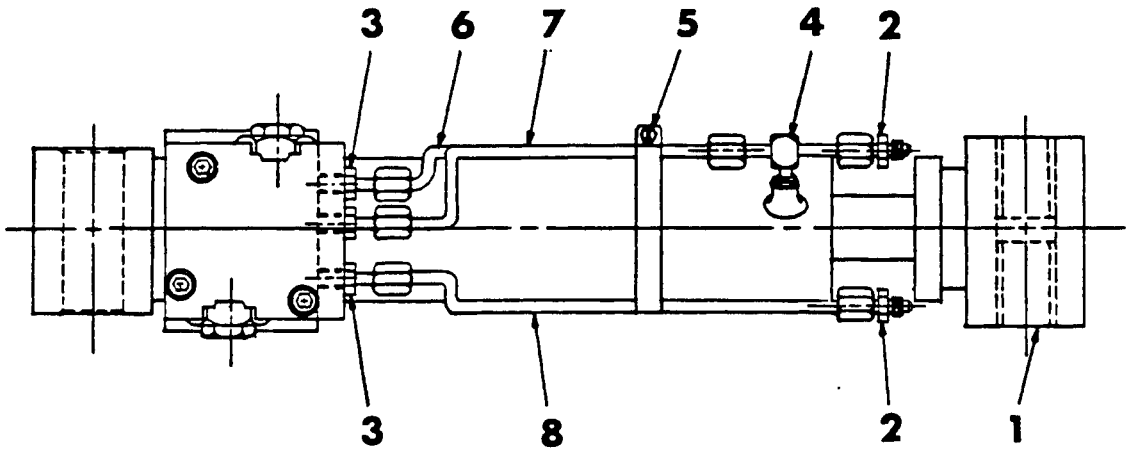
FIGURE 31 - SLAVE LEVELING CYLINDER ASSEMBLY
(3 SECTION BOOM)




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 31- | 21094 | SLAVE LEVELING CYLINDER ASSEMBLY | 1 |
| -1 | 21263 | SLAVE LEVELING CYLINDER SUB-ASSEMBLY | 1 |
| -2 | 2465 | CONNECTOR | 2 |
| -3 | 50801 | STRAIGHT THREAD CONNECTOR | 3 |
| -4 | 2532 | STRAIGHT THREAD ELBOW | 1 |
| -5 | 16206 | STRAP | 1 |
| -6 | 16318 | CLAMP | 2 |
| -7 | 21388 | CONVOLUTED TUBING (DUST BOOT) | 1 |
| -8 | 21094-8 | TUBE ASSEMBLY - 1/4 | 1 |
| -9 | 21094-9 | TUBE ASSEMBLY - 1/4 | 1 |
| -10 | 21094-10 | TUBE ASSEMBLY - 1/4 | 1 |
| -11 | 21447 | MANIFOLD BLOCK | 1 |
| -12 | 21267 | OVER CENTER CARTRIDGE | 2 |
| -13 | 66045 | SLAVE LEVELING CYLINDER SEAL KIT | 1 |

# FIGURE 31.1 - SLAVE LEVELING CYLINDER ASSEMBLY (3 SECTION BOOM) (NEW P/N)






| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 31.1- | 22584 | SLAVE LEVELING CYLINDER ASSEMBLY | 1 |
| -1 | 22576 | SLAVE LEVELING CYLINDER SUB-ASSEMBLY | 1 |
| -2 | 80042-03 | UNION CONNECTOR | 2 |
| -3 | 80004-03 | STRAIGHT THREAD CONNECTOR | 3 |
| -4 | 80012-03 | STRAIGHT THREAD ELBOW | 1 |
| -5 | 16206 | STRAP | 1 |
| -6 | 22584-6 | TUBE ASSEMBLY - 1/4 | 1 |
| -7 | 22584-7 | TUBE ASSEMBLY - 1/4 | 1 |
| -8 | 22584-8 | TUBE ASSEMBLY - 1/4 | 1 |

# FIGURE 31A - SLAVE LEVELING CYLINDER ASSEMBLY REVISED



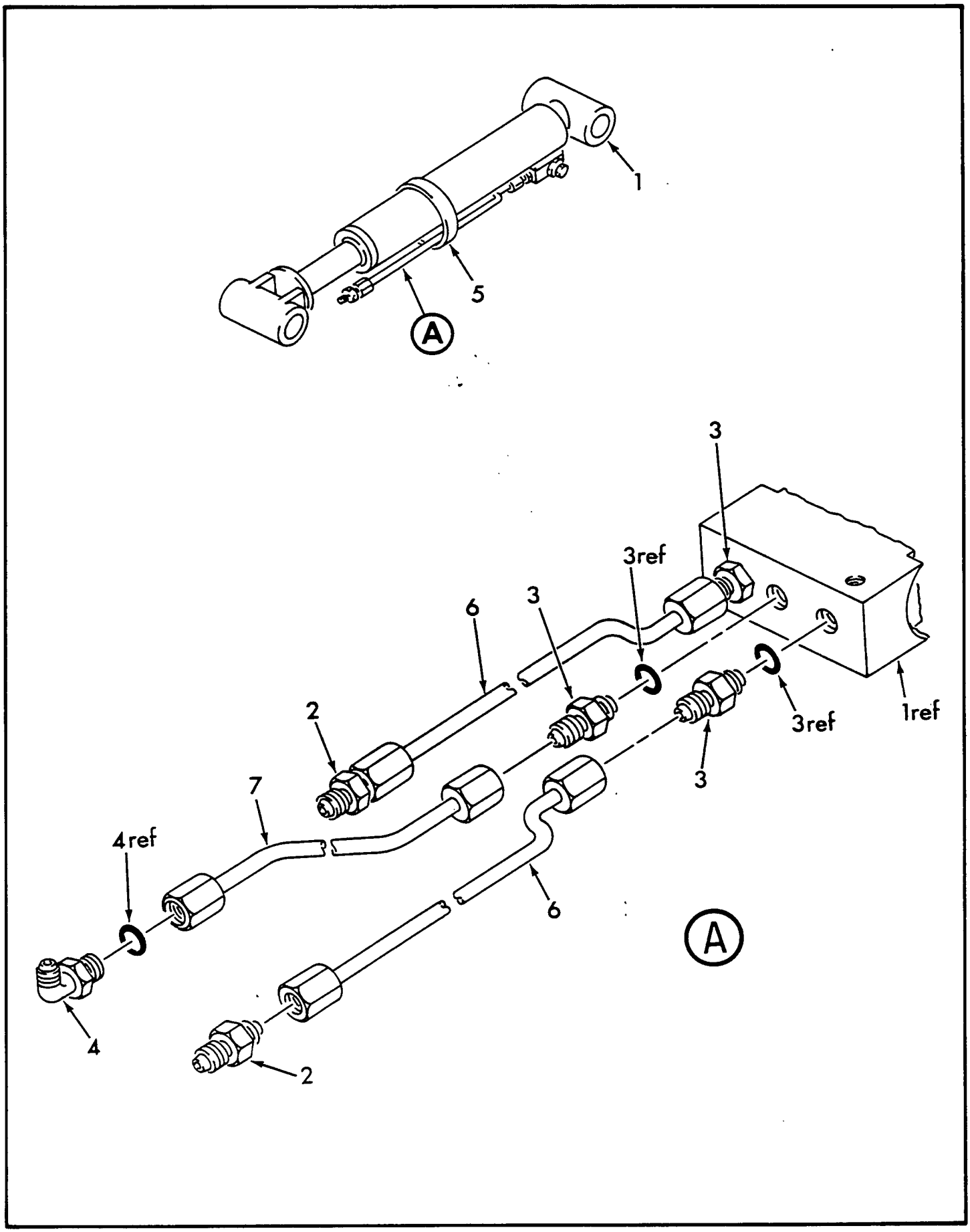


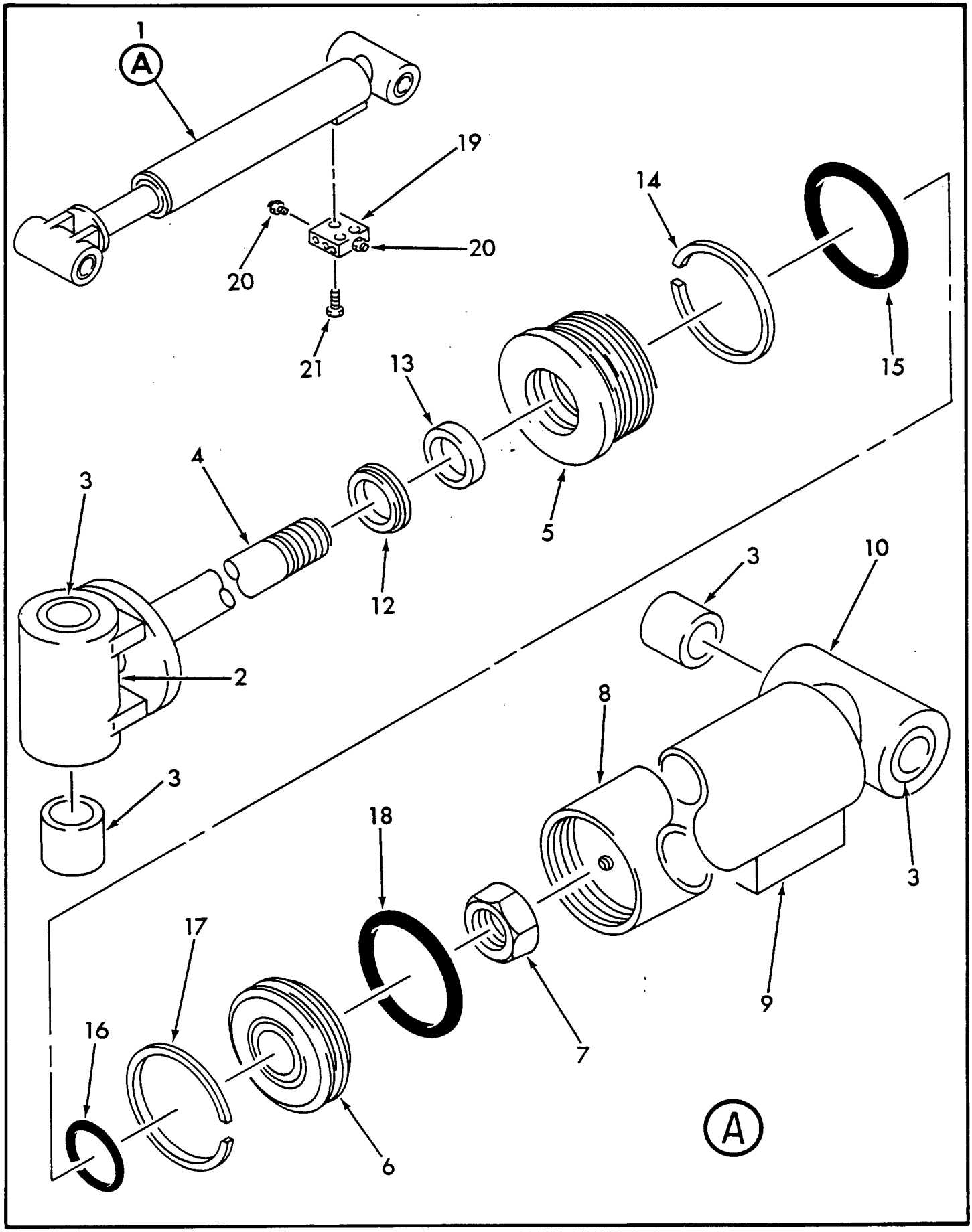
FIGURE 31A - SLAVE LEVELING CYLINDER ASSEMBLY REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| | 22584 | SLAVE LEVELING CYLINDER ASSEMBLY | REF |
| -1 | 22576 | SLAVE LEVELING CYLINDER SUB-ASSEMBLY (See Fig. 31B) | 1 |
| -2 | 80042-03 | UNION | 2 |
| -3 | 80004-03 | CONNECTOR | 3 |
| -4 | 80012-03 | ELBOW | 1 |
| -5 | 16206 | STRAP | 1 |
| -6 | 22584-6 | TUBE ASSEMBLY | 2 |
| -7 | 22584-7 | TUBE ASSEMBLY | 1 |

# FIGURE 31B - SLAVE LEVELING CYLINDER SUB-ASSEMBLY REVISED






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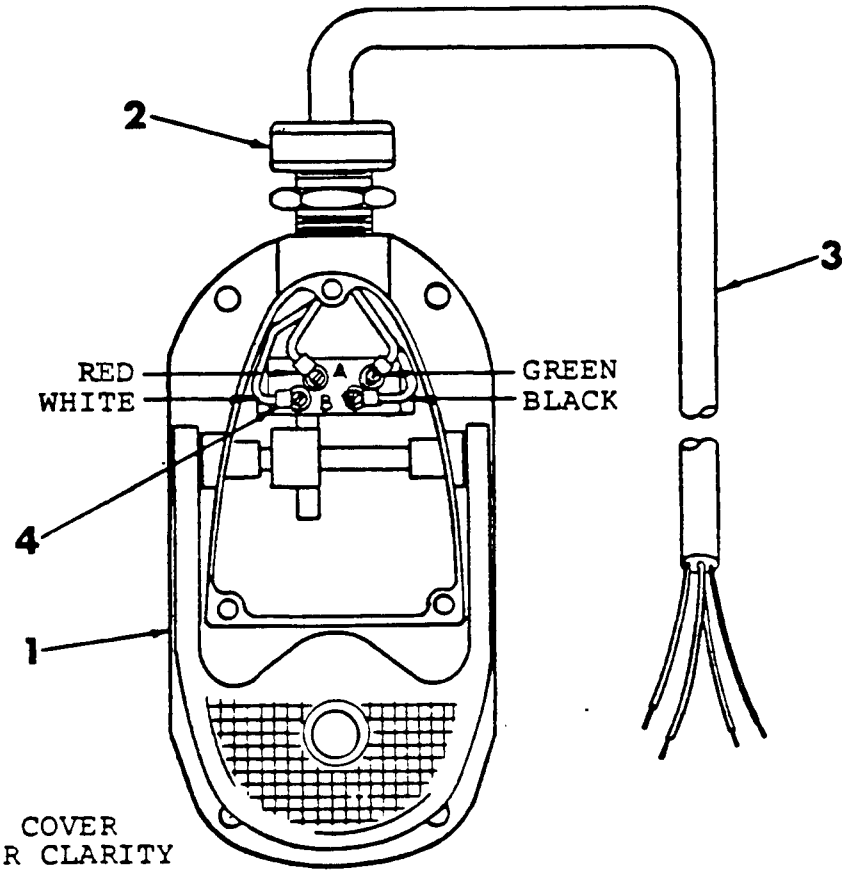
# FIGURE 31B - SLAVE LEVELING CYLINDER SUB-ASSEMBLY REVISED



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

NOTE: ITEM NO. 11 IS NOT ILLUSTRATED

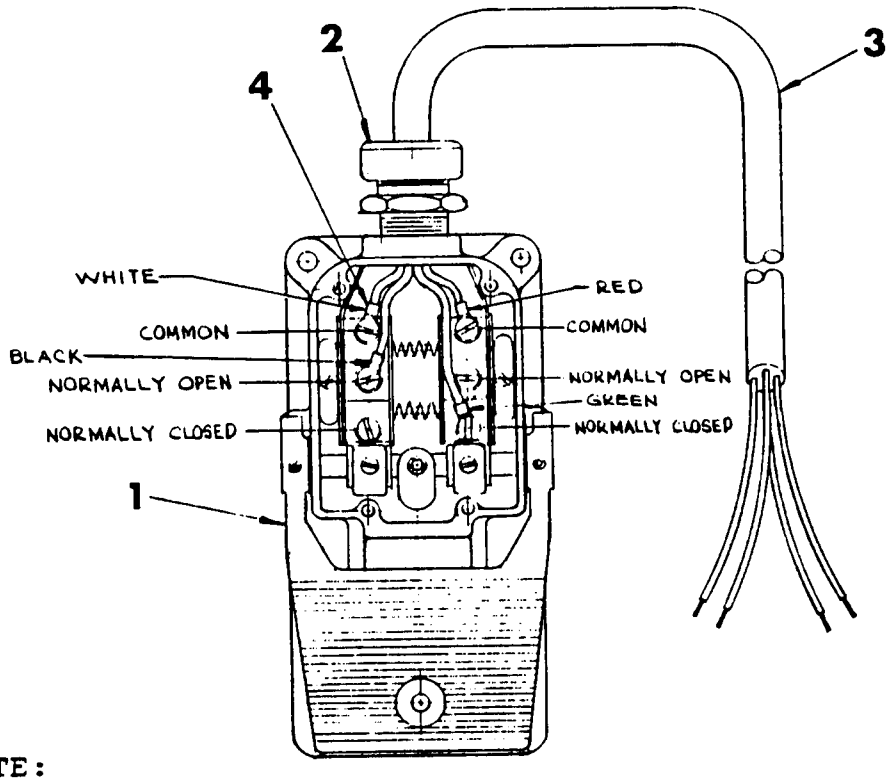
# FIGURE 32 - FOOT SWITCH ASSEMBLY




NOTE:
SHOWN WITH COVER
REMOVED FOR CLARITY

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 32- | 20480 | FOOT SWITCH ASSEMBLY | 1 |
| -1 | 20379 | FOOT SWITCH | 1 |
| -2 | 2531 | STRAIN RELIEF | 1 |
| -3 | 2912 | CABLE - 18/4 SJO OIL RESISTANT X 60' | 1 |
| -4 | 876 | TERMINAL RING | 1 |

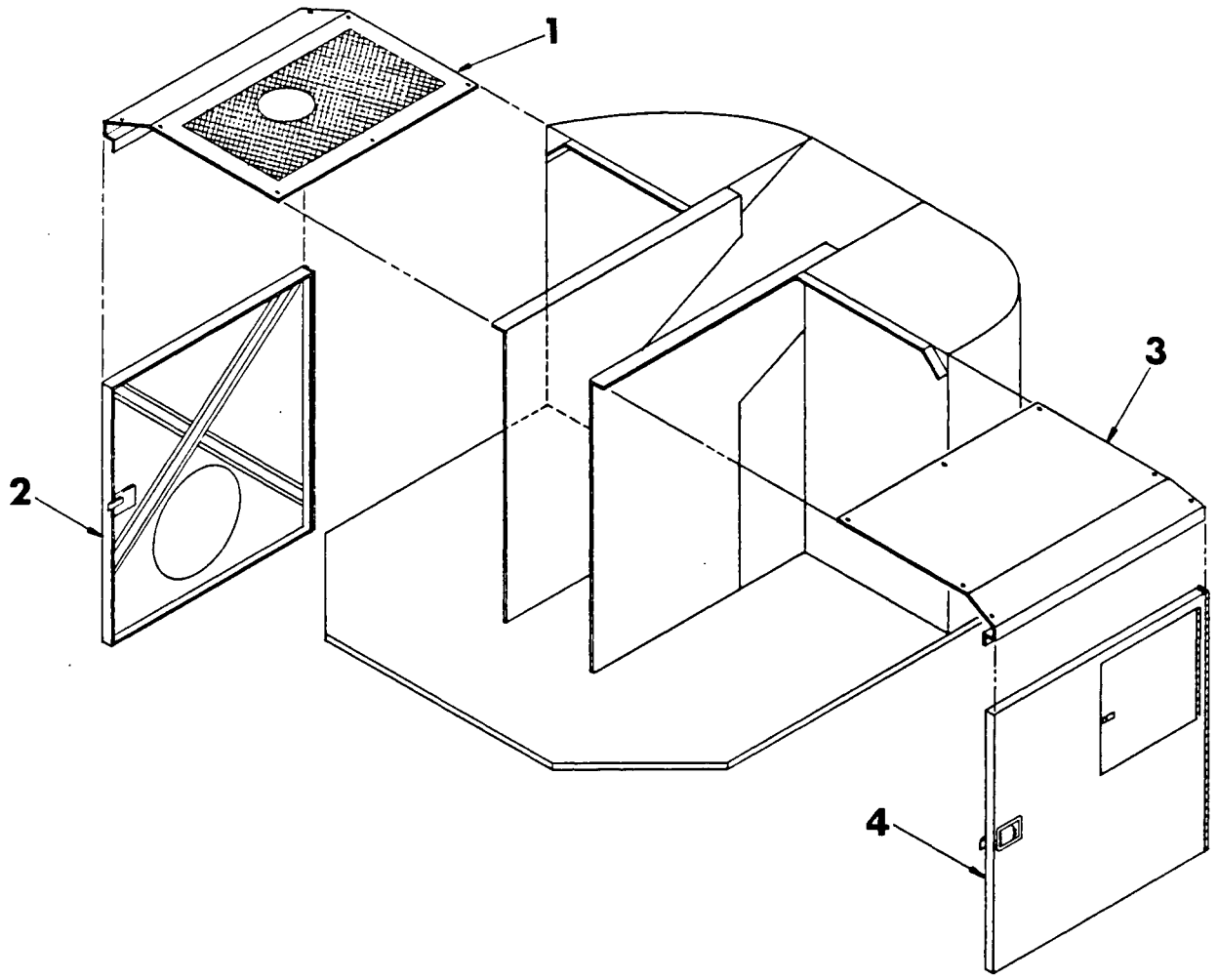
# FIGURE 32A- FOOT SWITCH ASSEMBLY REVISED



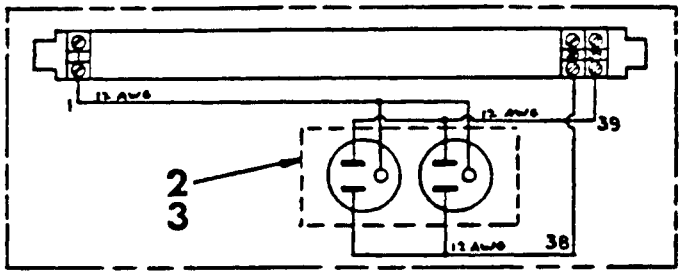

NOTE:
SHOWN WITH COVER
REMOVED FOR CLARITY

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| | 20480 | FOOT SWITCH ASSEMBLY | 1 |
| -1 | 70212 | FOOT SWITCH | 1 |
| -2 | 2531 | STRAIN RELIEF | 1 |
| -3 | 2912 | CABLE - 18/4 SJO OIL RESISTANT X 60' | 1 |
| -4 | 876 | TERMINAL RING | 1 |

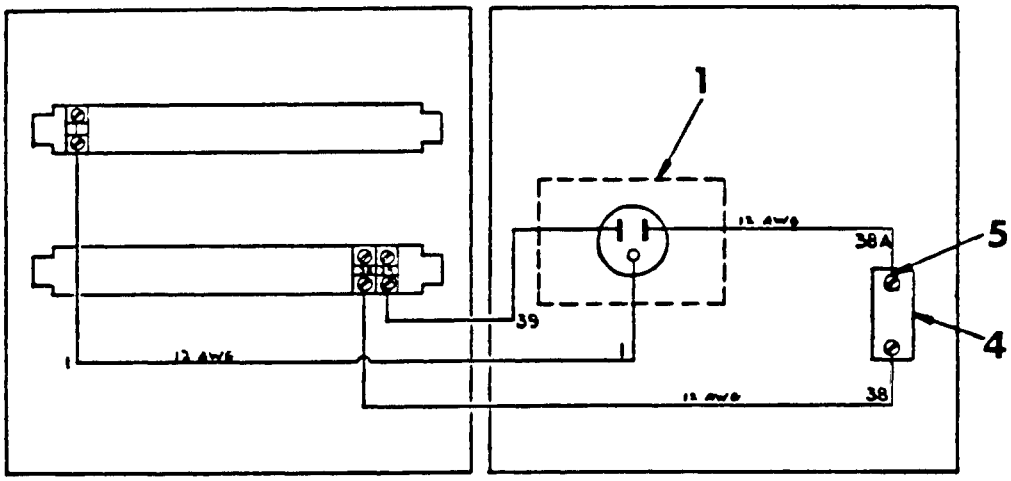
# FIGURE 33 - SHEET METAL COVER KIT




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 33- | 22469 | SHEET METAL COVER KIT | 1 |
| -1 | 22470 | TOP LEFT COVER | 1 |
| -2 | 22473 | LEFT DOOR | 1 |
| -3 | 22472 | TOP RIGHT COVER | 1 |
| -4 | 22474 | RIGHT DOOR | 1 |

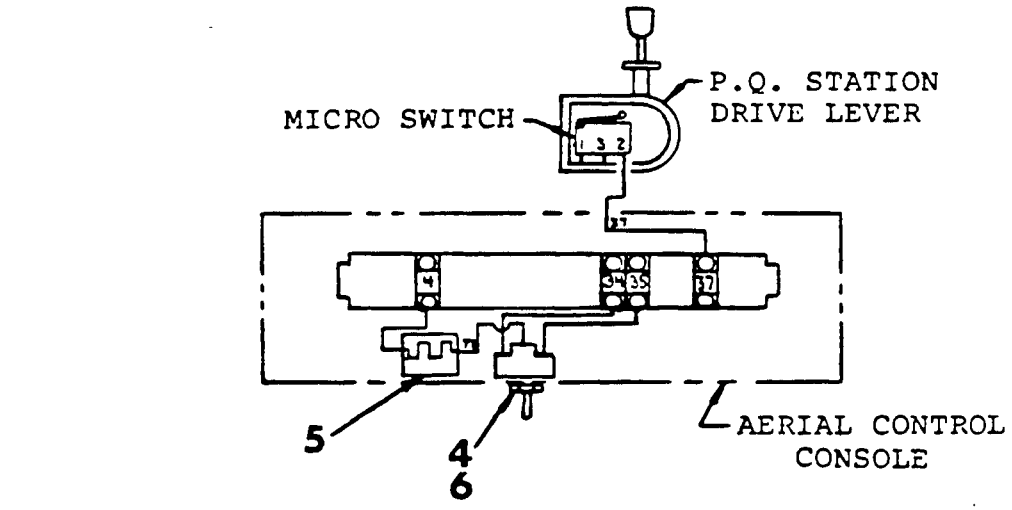


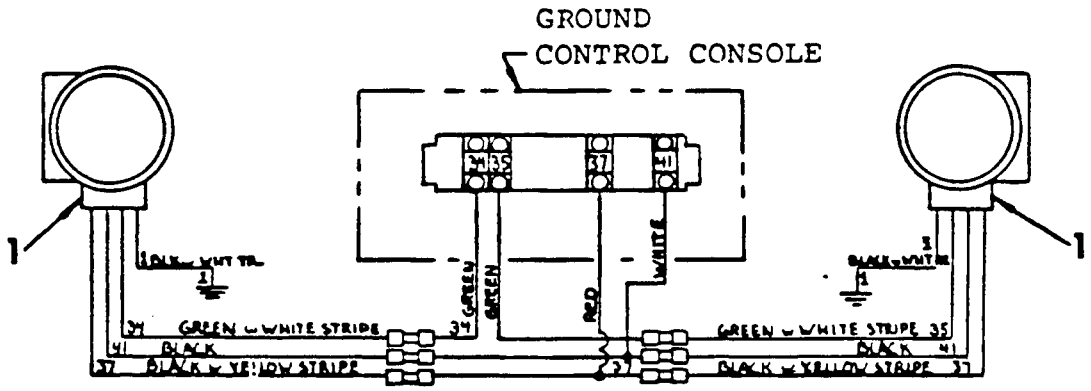

AERIAL CONTROL CONSOLE




GROUND CONTROL CONSOLE

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 34- | 20104 | GROUND & AERIAL 110 VAC RECEPTACLES | 1 |
| -1 | 70119 | COVER PLATE - WITH MALE RECEPTACLE | 1 |
| -2 | 288 | COVER PLATE | 1 |
| -3 | 70126 | RECEPTACLE | 1 |
| -4 | 20562 | CIRCUIT BREAKER | 1 |
| -5 | 2832 | RING TONGUE CONNECTOR | 7 |




ELECTRICAL DIAGRAM

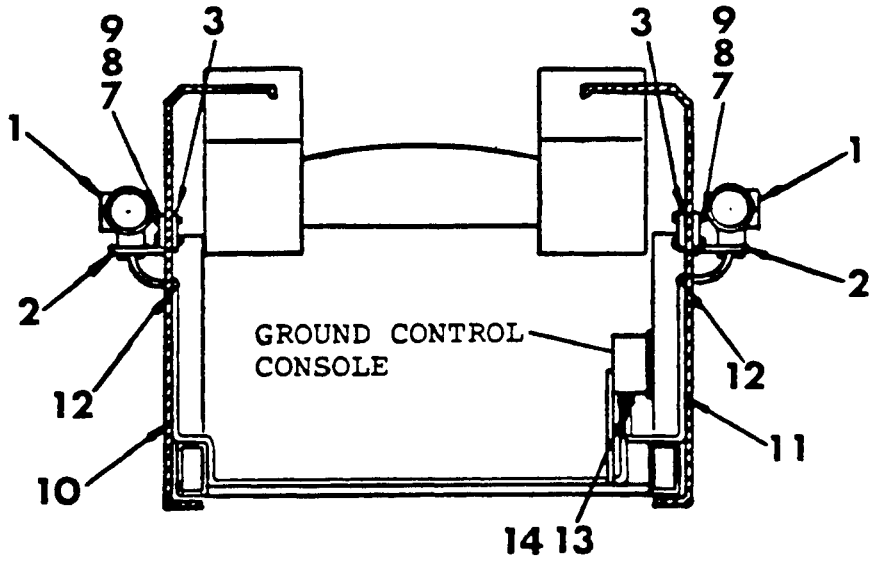
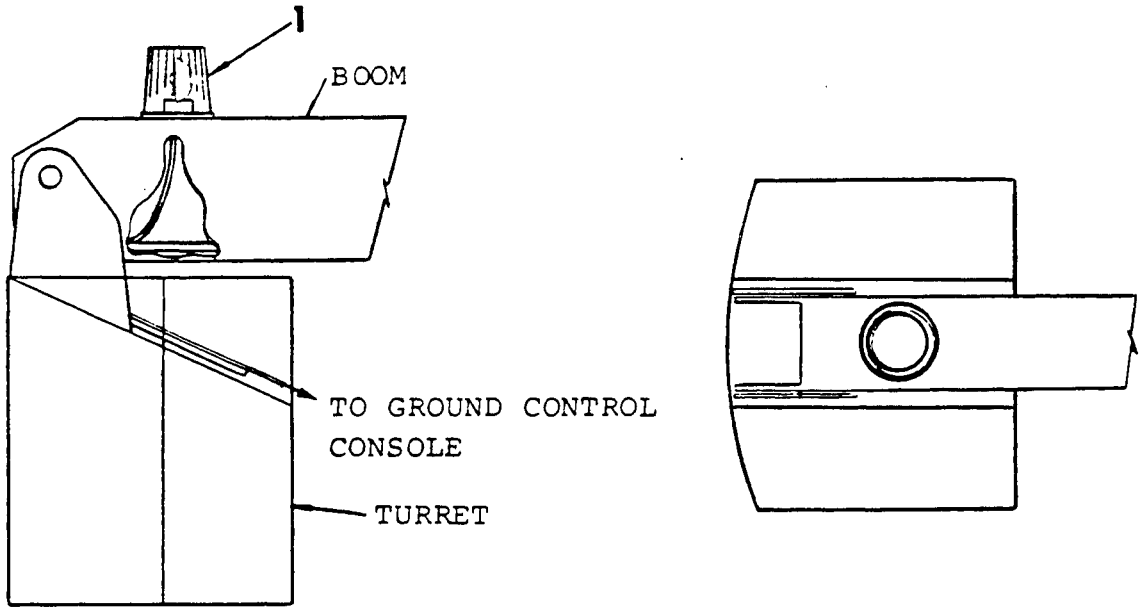


FIGURE 35-CLEARANCE, STOP AND TURNING LIGHTS (OPTION)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 35- | 20106 | CLEARANCE, STOP AND TURNING LIGHTS | 1 |
| -1 | 20838 | CLEARANCE LIGHT | 2 |
| -2 | 20864 | MOUNTING BRACKET | 2 |
| -3 | 20865 | BACK-UP PLATE | 2 |
| -4 | 4019 | TOGGLE SWITCH | 1 |
| -5 | 448-A | FLASHER | 2 |
| -6 | 20866 | TURN INDICATOR DECAL | 1 |
| -7 | 60331 | HEX HEAD CAPSCREW - 3/8-16UNC X 1 1/4 | 4 |
| -8 | 60703 | HEX NUT - 3/8-16UNC | 4 |
| -9 | 63303 | SPLIT LOCKWASHER - 3/8 | 4 |
| -10 | 2912 | CABLE - 18AWG 4 COND X A/R | 1 |
| -11 | 2912 | CABLE - 18AWG 4 COND X A/R | 1 |
| -12 | 117-0 | BUTT CONNECTOR | 8 |
| -13 | 2806 | STRAIN RELIEF | 2 |
| -14 | 2808 | LOCK NUT | 2 |

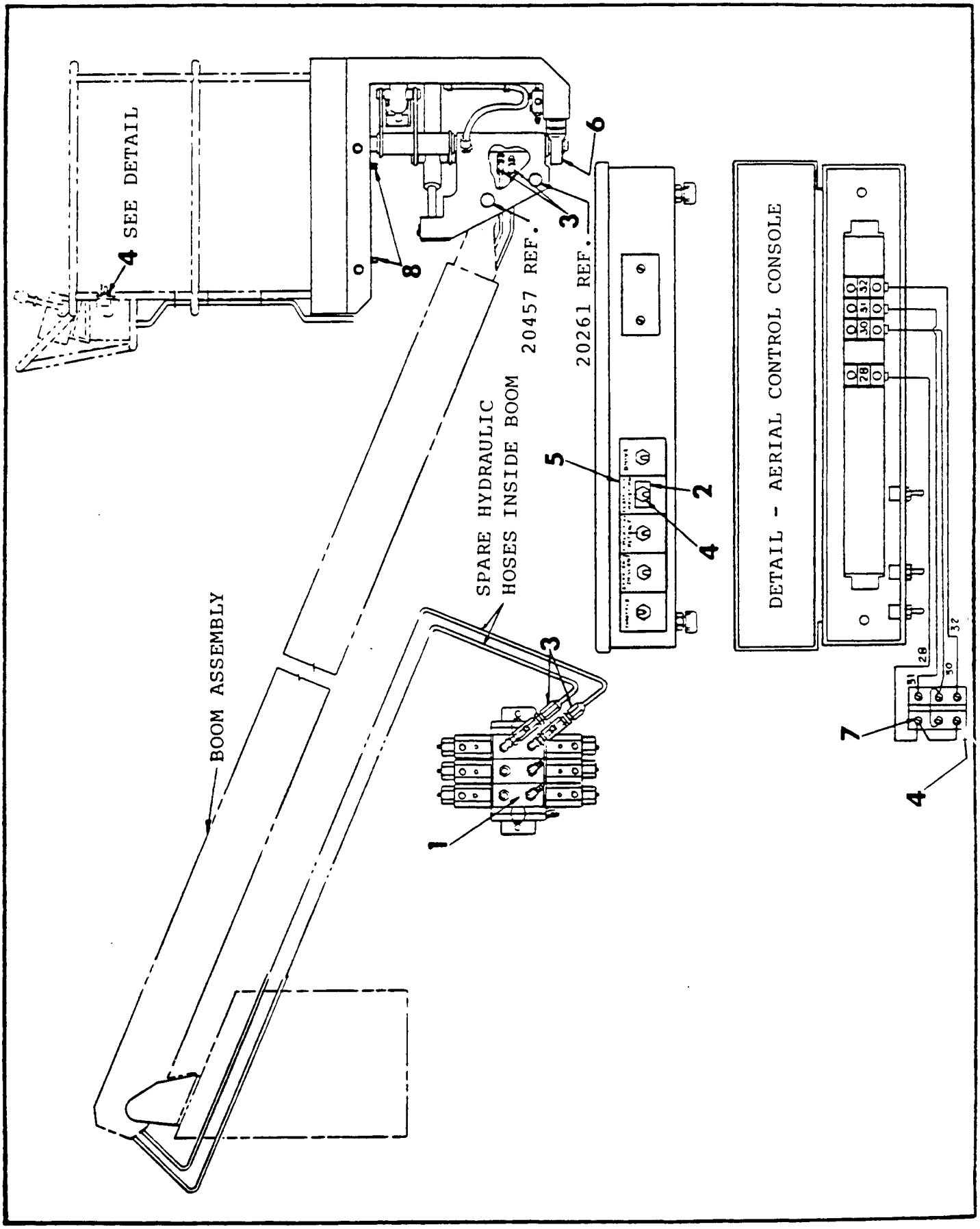
FIGURE 36 - ROTATING BEACON INSTALLATION (OPTION)




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 36 - | 20107 | ROTATING BEACON INSTALLATION | 1 |
| -1 | 20863 | ROTATING BEACON -- YELLOW | 1 |

FIGURE 37 - RAISED PLATFORM ROTATION (OPTION)





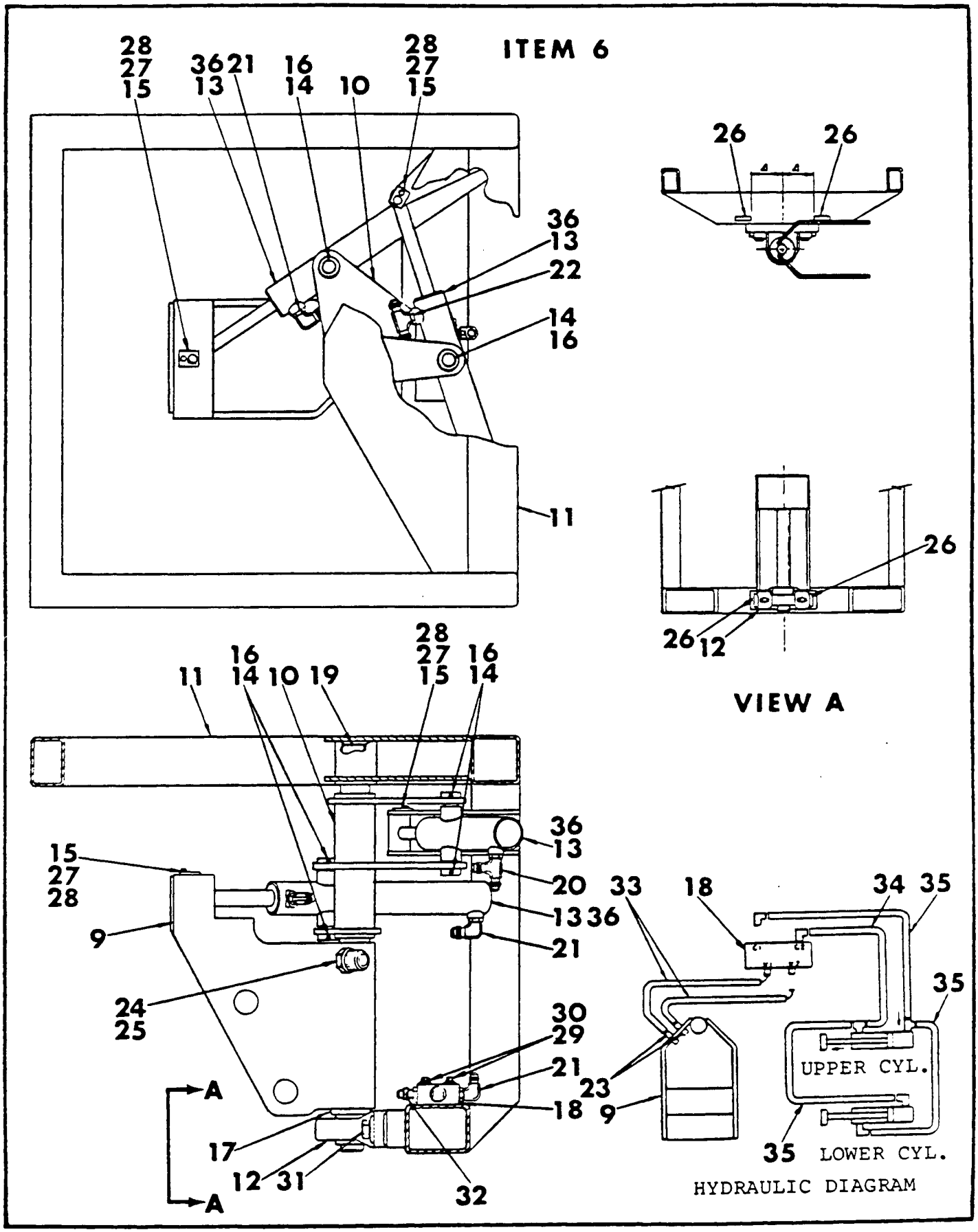

ITEM 6
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9
UPPER CYL.
35
LOWER CYL.
HYDRAULIC DIAGRAM

FIGURE 37 - RAISED PLATFORM ROTATION (OPTION)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 37- | 20097 | PLATFORM ROTATION | 1 |
| -1 | 21713 | MINI-PACK SUB ASSEMBLY | 1 |
| -2 | 20884 | SWITCH GUARD | 1 |
| -3 | 2562 | STRAIGHT SWIVEL HOSE FITTING | 4 |
| -4 | 4021 | TOGGLE SWITCH | 1 |
| -5 | 20839 | DECAL | 1 |
| -6 | 20960 | FORK ASSEMBLY | 1 |
| -7 | 117B | RING TONGUE | 6 |
| -8 | 16268 | HOSE CLAMPS | 4 |
| -9 | 20818 | LEVELING SKIRT | 1 |
| -10 | 20985 | IDLER WELDMENT | 1 |
| -11 | 20997 | FORK WELDMENT | 1 |
| -12 | 20848 | PILLOW BLOCK | 1 |
| -13 | 21264 | PLATFORM ROTATION CYLINDER | 2 |
| -14 | 20821 | CYLINDER TRUNNION PIN | 4 |
| -15 | 20822 | CYLINDER ROD PIN | 2 |
| -16 | 16232 | ROLL PIN | 4 |
| -17 | 20914 | SPACER | 1 |
| -18 | 20351 | DOUBLE P.O. CHECK VALVE | 1 |
| -19 | 20846 | THRUST WASHER | 1 |
| -20 | 16400 | RUN TEE | 1 |
| -21 | 2532 | 90° ELBOW | 4 |
| -22 | 2545 | BRANCH TEE | 1 |
| -23 | 2502 | BULKHEAD UNION | 2 |
| -24 | 30038 | STRAIN RELIEF | 1 |
| -25 | 61120 | CONDUIT NUT | 1 |
| -26 | 25253 | KEYSTOCK | 4 |
| -27 | 60121 | HEX HEAD CAPSCREW - 5/16 - 18 UNC X 3/8 | 2 |
| -28 | 63302 | SPLIT LOCK WASHER - 5/16 | 2 |
| -29 | 60128 | HEX HEAD CAPSCREW | 2 |
| -30 | 63303 | SPLIT LOCK WASHER - 3/8 | 2 |
| -31 | 60602 | HEX HEAD CAPSCREW - 1/2 - 13 UNC X 1 1/2 BOWMALOK | 2 |
| -32 | 2581 | STRAIGHT THREAD CONNECTOR | 2 |

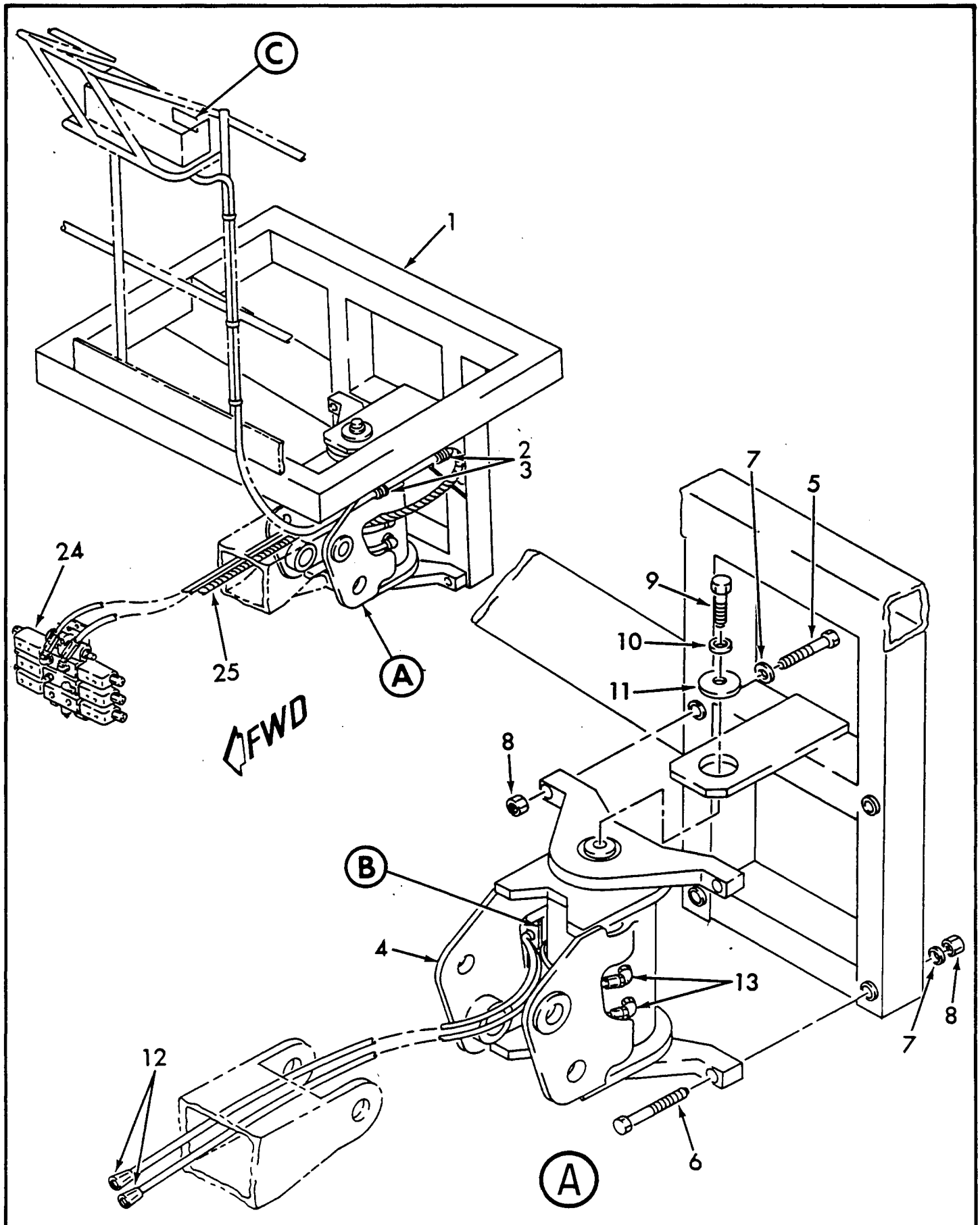
FIGURE 37 - RAISED PLATFORM ROTATION (OPTION)



| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| -33 | 13213-04-0200 | HOSE ASSEMBLY | 2 |
| -34 | 13210-04-0240 | HOSE ASSEMBLY | 1 |
| -35 | 13210-04-0220 | HOSE ASSEMBLY | 3 |
| -36 | 20042 | PLATFORM ROTATION CYLINDER SEAL KIT | 1 |

# FIGURE 37A - PLATFORM ROTATION REVISED

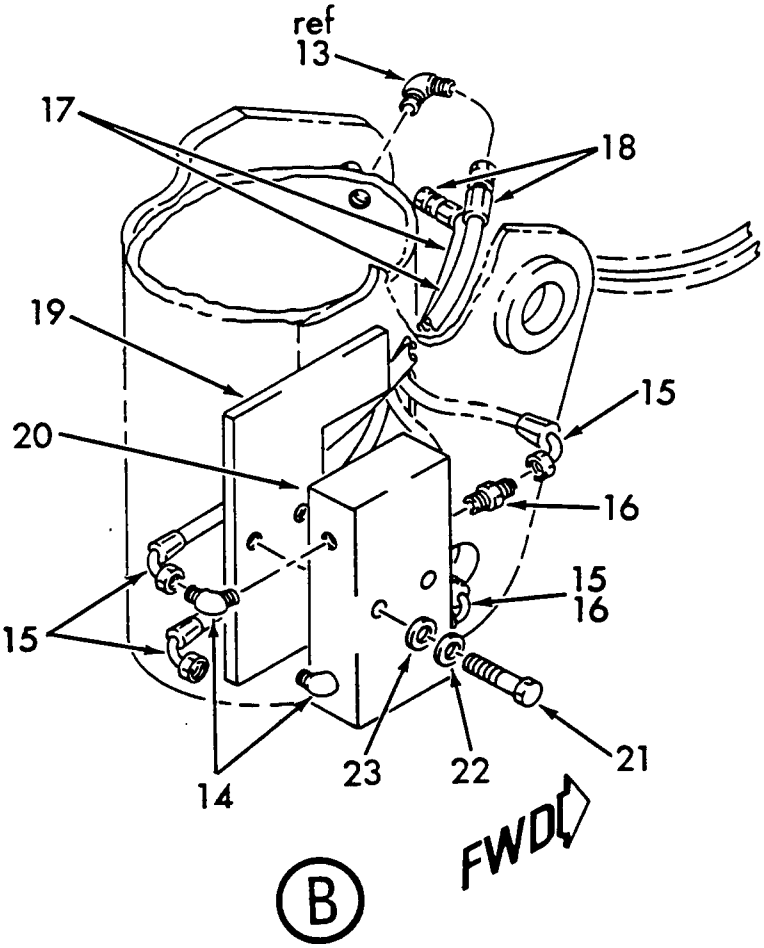


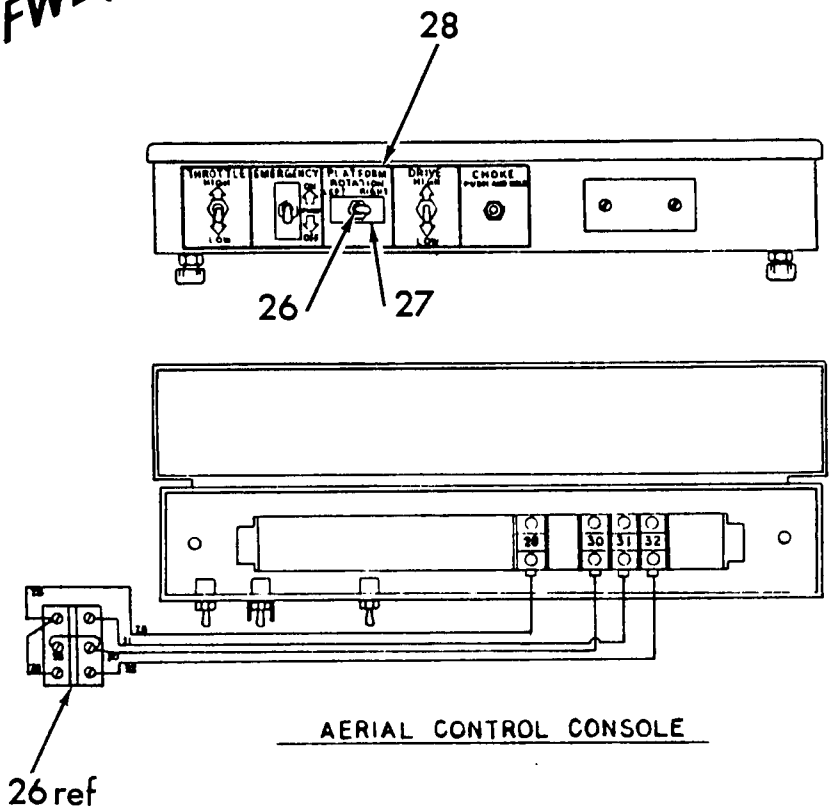



REV.

# FIGURE 37A - PLATFORM ROTATION REVISED





# FIGURE 37A - PLATFORM ROTATION REVISED



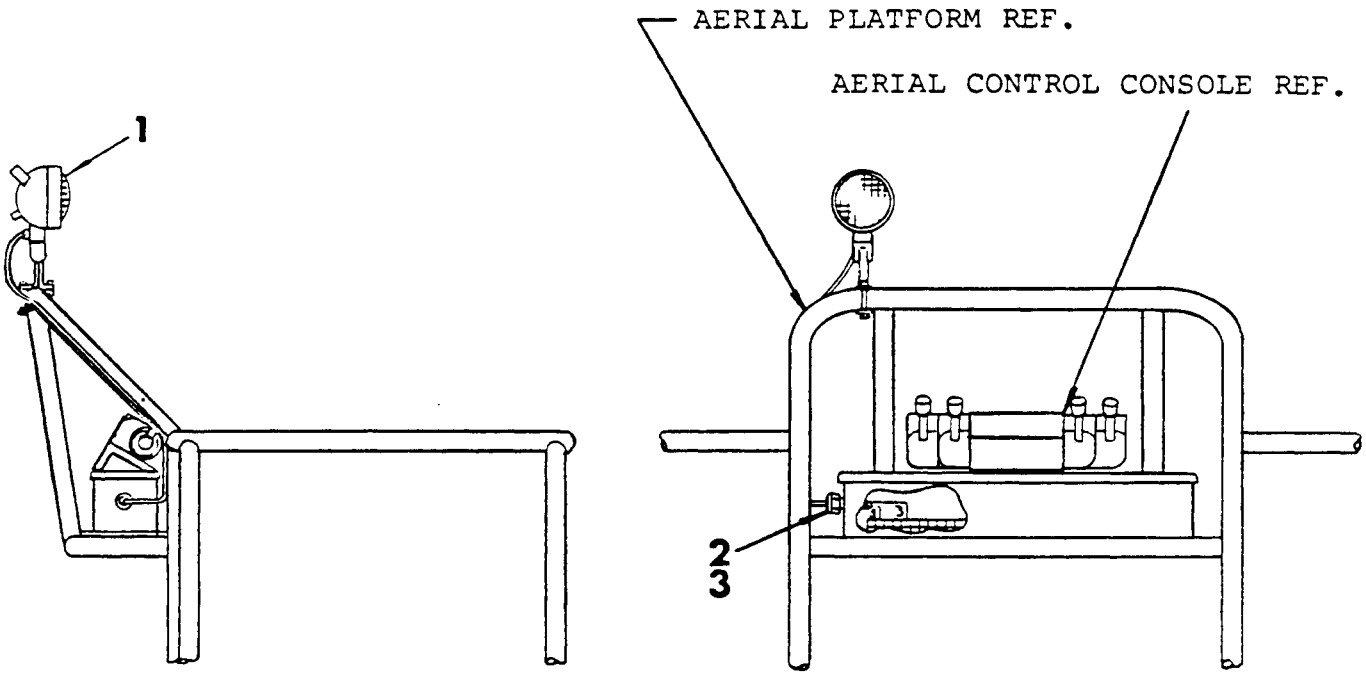
| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| | 22279 | PLATFORM ROTATION | REF |
| -1 | 23065 | FORK PLATFORM ROTATION WELDMENT | 1 |
| -2 | 16268 | HOSE CLAMP | 7 |
| -3 | 61902 | CAP SCREW | 7 |
| -4 | 81094 | HELAC ROTATOR | 1 |
| -5 | 60540 | CAP SCREW | 2 |
| -6 | 60513 | CAP SCREW | 2 |
| -7 | 63415 | FLAT WASHER | 4 |
| -8 | 61305 | LOCK NUT | 4 |
| -9 | 60516 | CAP SCREW | 1 |
| -10 | 63303 | LOCK WASHER | 1 |
| -11 | 23565 | WASHER | 1 |
| -12 | 2562 | FITTING | 2 |
| -13 | 80012-03 | ELBOW | 2 |
| -14 | 80012-05 | ELBOW | 2 |
| -15 | 2594 | ELBOW | 4 |
| -16 | 80004-05 | CONNECTOR | 2 |
| -17 | 2568-0144 | HYDRAULIC HOSE | 2 |
| -18 | 2562 | FITTING | 2 |
| -19 | 23197 | CHECK VALVE BRACKET | 1 |
| -20 | 20351 | CHECK VALVE | 1 |
| -21 | 60360 | CAP SCREW | 2 |
| -22 | 63302 | LOCK WASHER | 2 |
| -23 | 63402 | FLAT WASHER | 2 |
| -24 | 21713 | MINIPAK SUB-ASSEMBLY (See Fig. 17A) | 1 |
| -25 | 65321-42 | PLASTIC COIL SLEEVE | 1 |

FIGURE 37A - PLATFORM ROTATION REVISED



| ITEM | PART NUMBER | DESCRIPTION | UNIT PER ASSY. |
|---|---|---|---|
| -26 | 4021 | TOGGLE SWITCH | 1 |
| -27 | 20884 | SWITCH GUARD | 1 |
| -28 | 22571 | DECAL | 1 |

FIGURE 38 - 12 VOLT PLATFORM WORKLIGHT (OPTION)




| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 38- | 20139 | 12V PLATFORM WORKLIGHT | 1 |
| -1 | 20862 | WORKLIGHT | 1 |
| -2 | 2522 | STRAIN RELIEF | 1 |
| -3 | 141 | LOCK NUT | 1 |

# FIGURE 39 -FORK GROUND SENSOR (OPTION)

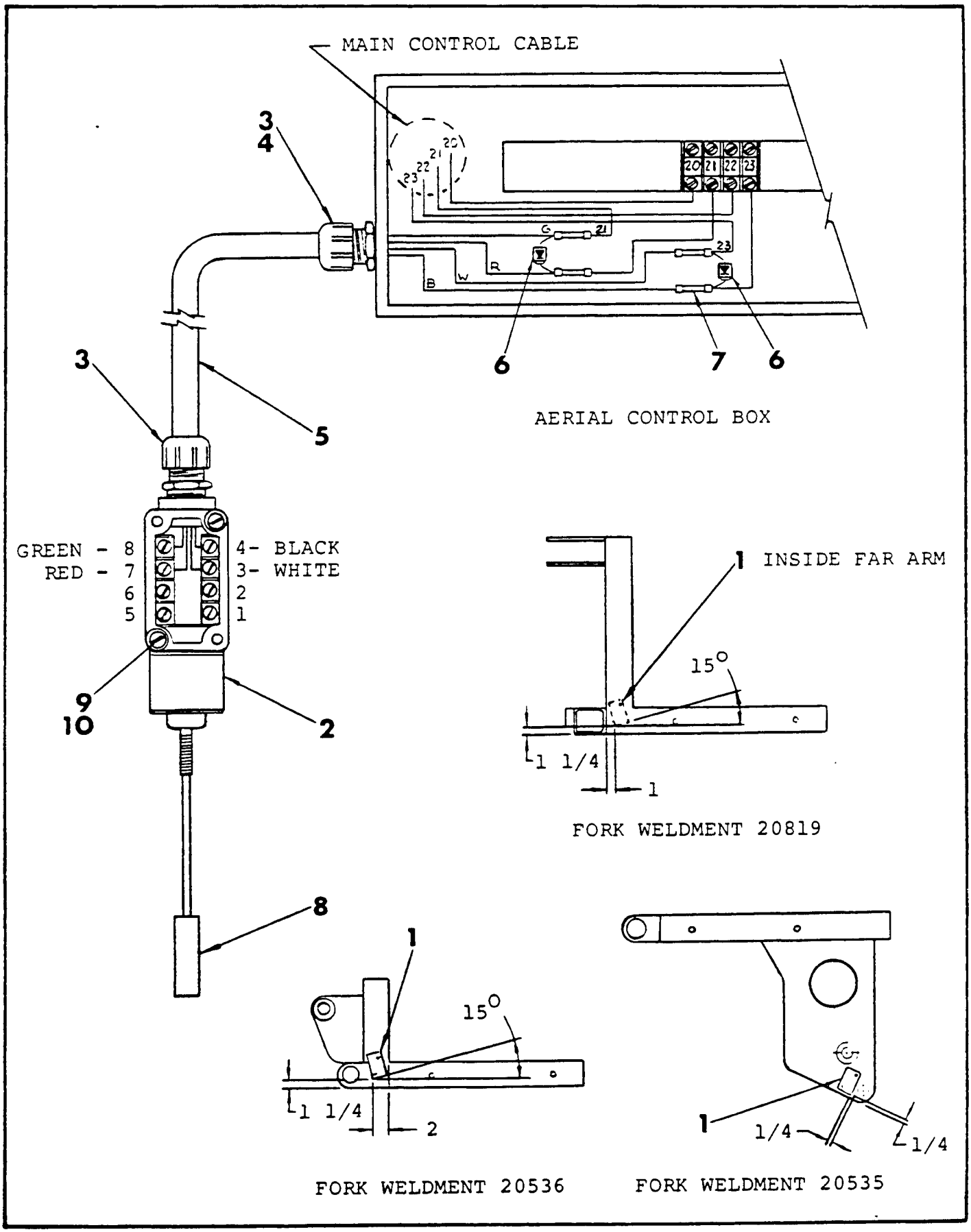


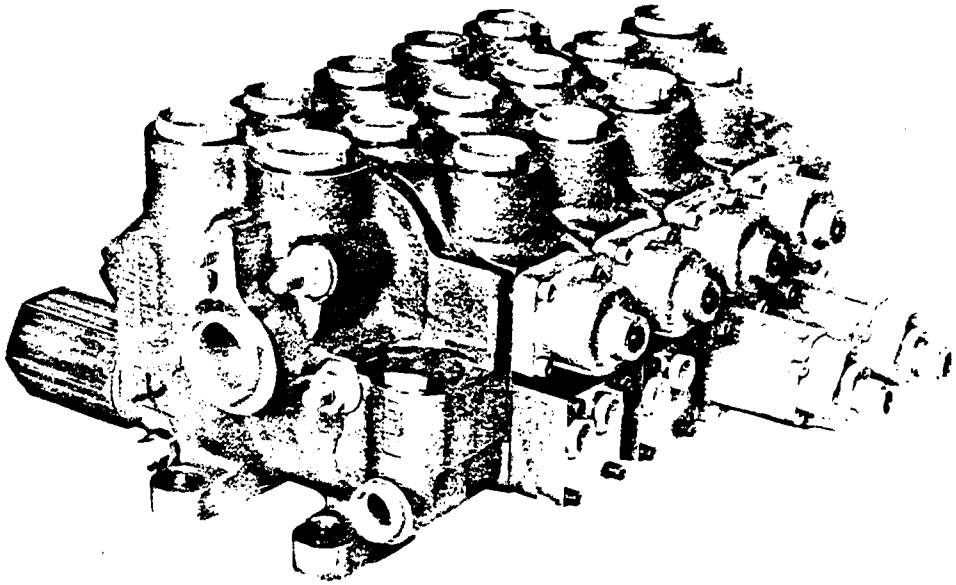
FIGURE 39 -FORK GROUND SENSOR (OPTION)

| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|---|---|---|
| 39- | 20164 | FORK GROUND SENSOR | 1 |
| -1 | 20761 | MOUNTING PLATE | 1 |
| -2 | 20919 | LIMIT SWITCH | 1 |
| -3 | 2806 | STRAIN RELIEF | 1 |
| -4 | 2808 | LOCK NUT | 1 |
| -5 | 70019 | CABLE--4 COND 18GA X 60 | 1 |
| -6 | 4045 | DIODE | 2 |
| -7 | 117D | BUTT CONNECTOR | 4 |
| -8 | | HOSE--3/16 ID X 2 | 1 |
| -9 | | HEX HEAD CAPSCREW--10-32UNF X 2 | 2 |
| -10 | 63310 | SPLIT LOCKWASHER | 2 |

JULY 1977

# SERVICE MANUAL

## LOAD SENSING PRESSURE COMPENSATING PROPORTIONAL DIRECTIONAL VALVE



## MODEL NO. 269300

BERTEA / INDUSTRIAL PRODUCTS

# S E R V I C E  M A N U A L

## MODEL 269300 SERIES


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# FIGURE IDENTIFICATION


Figure #1 - Module Assembly

Figure #2 - Circuit Schematic

Figure #3 - Remote Electro-Hydraulic Control Schematic

Figure #4 - Remote Pilot Oil Control Schematic

Figure #5 - Dual Port Inlet Manifold

Figure #6 - Directional Valve Manifold

Figure #7 - Manual Override End Cap

Figure #8 - Single Port Inlet Manifold

Figure #9 - Basic Shuttle

Figure #10 - Adjustable Shuttle

Figure #11 - Purge Manifold Assembly

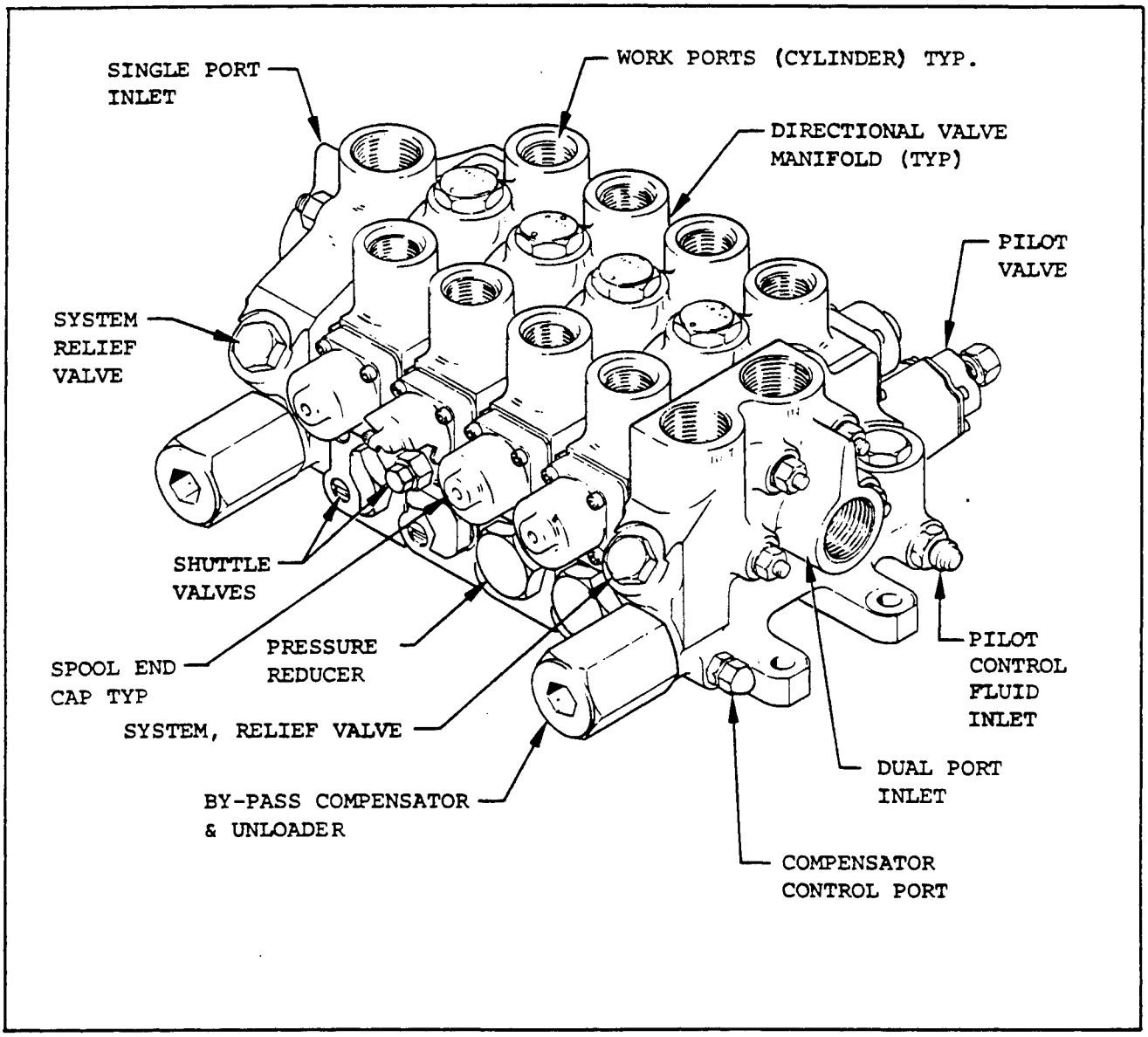
Figure #12 - Bertea Valve Installation

Figure #13 - Remote Purge System Schematic

Figure #14 - Installation Drawing 269300

Figure #15 - Pilot Valve Installation

BERTEA LOAD SENSING - PRESSURE COMPENSATING
PROPORTIONAL DIRECTIONAL VALVE




MODULE ASSEMBLY
FIGURE 1

## I INTRODUCTION

The Bertea Load Sensing Pressure Compensating directional valve module, Figure #1, provides a means of sensing the highest "work cylinder port" pressure and then adjust a by-pass compensator or variable pump compensator to provide a pump pressure of 150 psi above this value.

Since the pump pressure is always held at only 150 psi above the highest load pressure, this system reduces the energy requirements

and heat generation. Additional features are provided; such as, unloading the pump to 50 psi when the valves are not in use; providing constant rate control for multiple function operation, and providing a single module for dual pump application.

In order to provide control of the directional valve spools under various system configurations and operating modes, the module is designed to contain two separate hydraulic circuits. The main power pump circuit is configured in the normal manner to provide power oil to the working cylinder ports. The control circuit used to position the directional valve spool is independent of the power oil circuit and operates at approximately 300 to 400 psi. This circuit separation, also, provides the capability to control the module from a remote location with electro hydraulic controls or by a remote pilot oil system with variable pressure capability.

The method used to port the Pressure Compensating Control Circuit to tank when not in use requires all directional valve spools to be open cylinder port configuration. Therefore, external controls will be required for load holding capability.

## II SYSTEM DESCRIPTION

The Bertea pressure compensating valve module consists of (5) basic sub-systems as noted: (Ref: Figure 1)

A. The shuttle valves, within the spool sections, sense the highest cylinder port pressure within each spool section manifold assembly and, also, select the highest load pressure among all of the spool sections in the complete module, and port this signal to the by-pass compensator. These shuttles, also, connect the pressure compensation control circuit to tank thru the open cylinder port type directional valve spools.

B. The by-pass compensator, within the inlet manifold, is controlled by the highest load pressure and it will by-pass all excess pump flow at 150 psi above the highest load pressure.

C. The optional pressure reducer, within the spool section manifold, is controlled by the highest cylinder port pressure of that spool section and maintains 100 psi pressure drop across the directional valve spool regardless of supply pressure.

D. The directional valve spool directs and meters the fluid to the function as specified by the amount of spool travel from its neutral or shut off position. This travel is determined by the difference in pressure established in the two spool end caps by the external control source.

   Since the pressure reducer holds 100 psi pressure drop across this spool, then for any fixed spool position the flow to the

function thru the spool metering notch will be constant regardless of load. This provides constant rate for the function.

E. The remote control system determines the directional valve spool position by varying the pressure in each spool end cap. The two commonly used control systems are:

1) Remote pilot control oil ported to each end cap thru external tubing from a remote pressure reducing valve.

2) Electro-hydraulic pilot valves, manifold to the spool section, and controlled electrically from a remote location. This pilot valve obtains its pilot supply oil from the module and ports it to the spool end cap at various pressure levels proportional to the electrical command.

Figure 1 & 2 shows a typical 4 spool section module of the following configuration in sequence, starting with the dual port inlet:

Dual Port Inlet Manifold Assembly with a by-pass compensator, unloader, system relief valve and an optional pilot control circuit relief valve.

Directional Valve Manifold Assemblies with shuttles and pressure reducers.

Plugs in the pressure compensation control line and main pump line between directional valve manifold #3 and #4.

Directional Valve Manifold with one shuttle and a blank spool in the pressure reducer cavity.

Single Port Inlet Manifold Assembly with a by-pass compensator, unloader, and system relief valve.

This module is supplied by one 20 gpm pump ported into the dual port inlet for directional valves #1, #2, & #3, and one 30 gpm pump ported into the single port inlet for directional valve #4.

The remote control configuration can be electro-hydraulic using the Bertea pilot valve and electrical controllers or it can be the remote pilot oil system using lever operated pressure reducing valves to provide control oil from 0 to 200 psi into either spool end cap.

## III OPERATION (Figure #2)

### A. LOAD SENSING & PRESSURE COMPENSATING

When the system is not in use and the directional valve spools are in the center position, the pressure compensating (P.C.)

control circuit is connected to tank thru the shuttles and open cylinder port spools! Since this connects the large area of the unloading piston (Item 4) to tank allowing the piston to move away from the compensator and the spring to relax its preload; the pump output is by-passed to tank at 50 psi, rather than the 150 psi control level. This results in lower stand by heat generation.

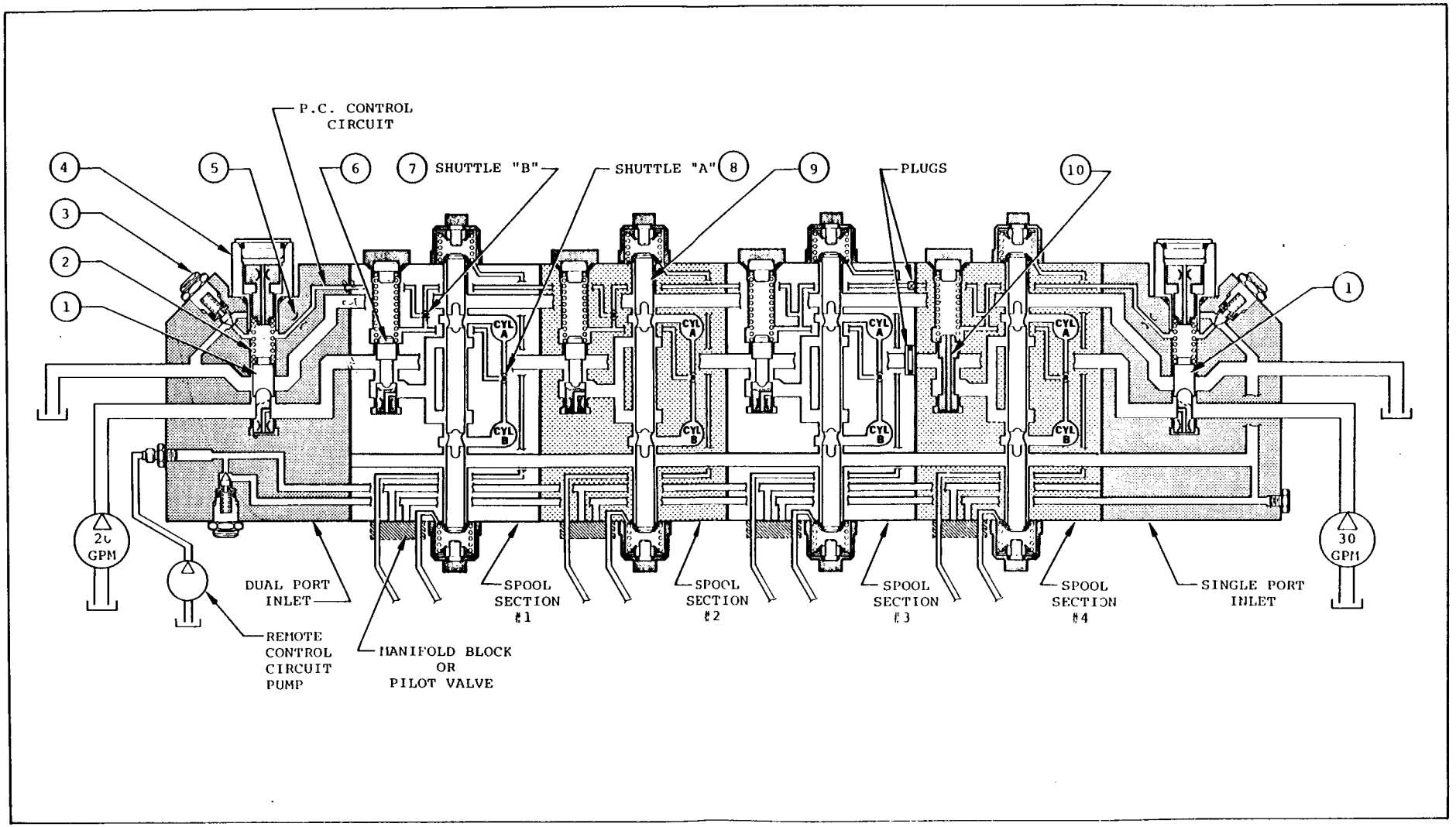
The directional valve spool (Item 9) is spring caged to the center position with a 19# preload. As the remote control system builds up a differential pressure across the spool - ie increases the pressure in one end cap and lowers the pressure in the other end cap - the spool will move out of center detent at about 40 psi differential pressure. Increasing the differential pressure will move the spool thru its 0.100 inch over lap length to the initial metering area and, also, with this movement, close off the open path across the spool from the cylinder port to the tank port. (Additional increase in differential pressure, up to 200 psi, will move the spool thru the metering notch area to full stroke of .350 travel and maximum flow.)

The shuttle system of spool section #1 is now connected to the cylinder load instead of the tank port. Shuttle "A" (Item 8 - Large Shuttle) senses this load pressure and passes it thru shuttle "B" (Item 7 - Small Shuttle) to the P.C. control circuit. This pressure moves the unloading piston (Item 4) into the operating position which preloads the spring (Item 2) to the 150 psi operating position.

The compensator spool (Item 1) will now vary the metering notch opening from pump supply to tank return, holding pump pressure at 150 psi above the cylinder port load pressure. If the directional valve spool #1 is set to flow 5 gpm, the remaining 15 gpm of the pump will be by-passed.

The pressure reducer spool (Item 6), also receives a load pressure signal from shuttle "A", and begins to reduce its meter notch area to hold a 100 psi pressure drop across the directional valve spool. It is this feature that provides constant flow regardless of changes in load pressure or pump pressure. Logically if only one spool section were to be used this reducer would not be required, since the by-pass compensator always holds the pump at 150 psi above the load.

Assume that the load pressure of directional valve spool #1 is 500 psi and the pump pressure is 150 psi higher or 650 psi! Then the directional valve spool, of section #3, is moved to operate its function at 7 gpm. The load pressure of #3 is 1500 psi.




LOAD SENSING - PRESSURE COMPENSATING
CIRCUIT SCHEMATIC
FIGURE 2

Shuttle "A" of spool section #3 senses this 1500 psi load and ports it to the pressure reducer (Item 6) of this spool section and, also, on to the P.C. control circuit. Shuttle "B" is omitted in this manifold since the P.C. circuit of #4 is blocked from this #3 spool section system.

This 1500 psi load signal is transmitted thru the "B" shuttles of the P.C. control circuit to the by-pass compensator which in turn increases pump pressure to 1650 psi. Now the pressure reducer (Item 6) of spool section #1 must operate to reduce the 1650 psi pump pressure to 600 psi in order to maintain the 100 psi differential across the directional valve spool and thus hold constant rate.

The system relief valve (Item 3) limits maximum pump pressure by bleeding off the P.C. control circuit at the pre-set level. The flow limiting orifice (Item 5) permits the small poppet of the relief valve to control the pressure level in the spring cavity of the compensator. This results in the pump output being by-passed to tank at relief setting.

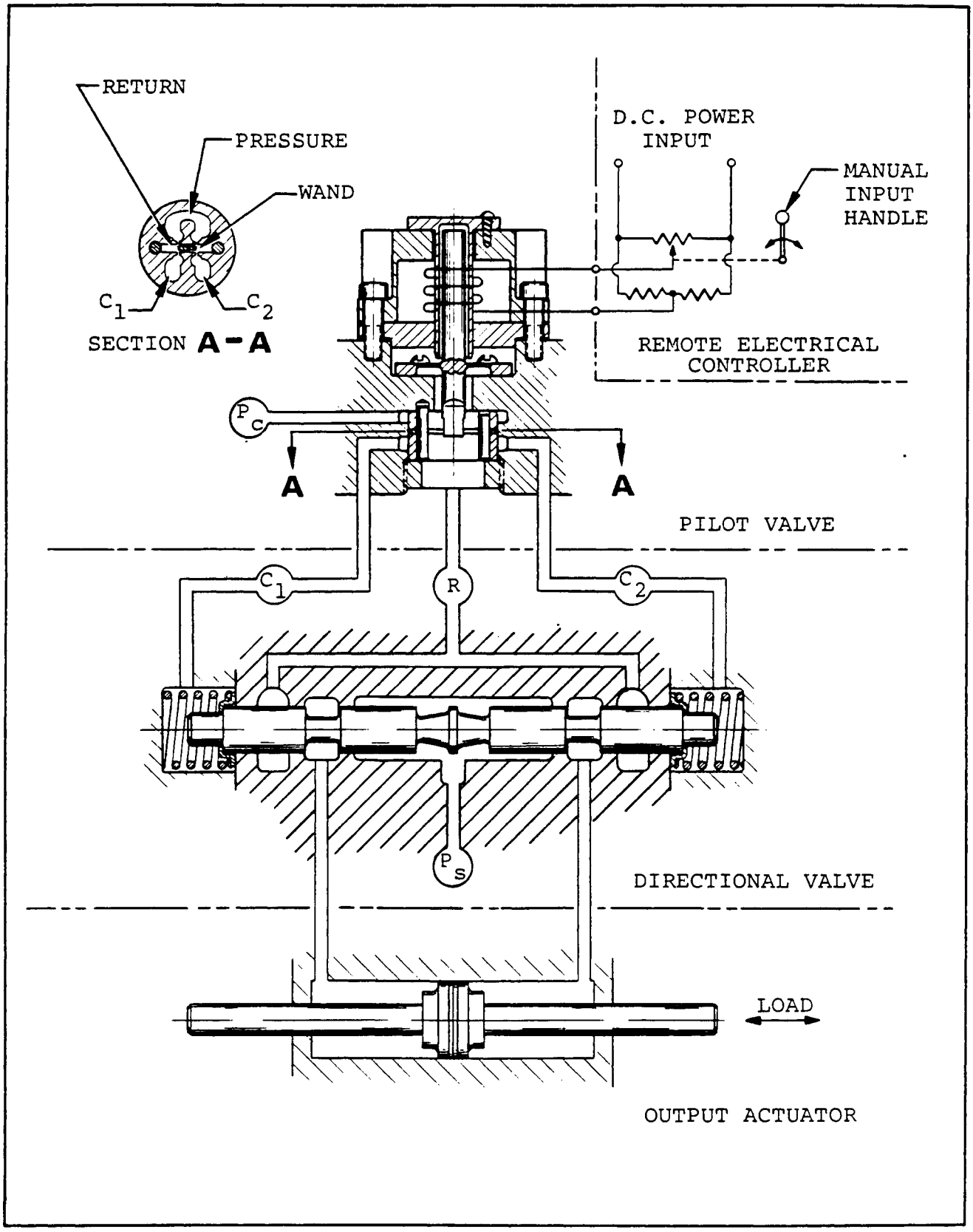
Since the 30 gpm pump supplies fluid to only spool section #4, it is not required to use a pressure reducer spool in the manifold, because the by-pass compensator (Item 1) of the single port inlet will hold 150 psi differential pressure across the directional valve spool. This 150 psi will maintain constant rate of the function for any directional valve spool position. A simple blocking spool (Item 10) is used in place of a pressure reducer spool.

B. REMOTE CONTROL OF DIRECTIONAL VALVE SPOOL

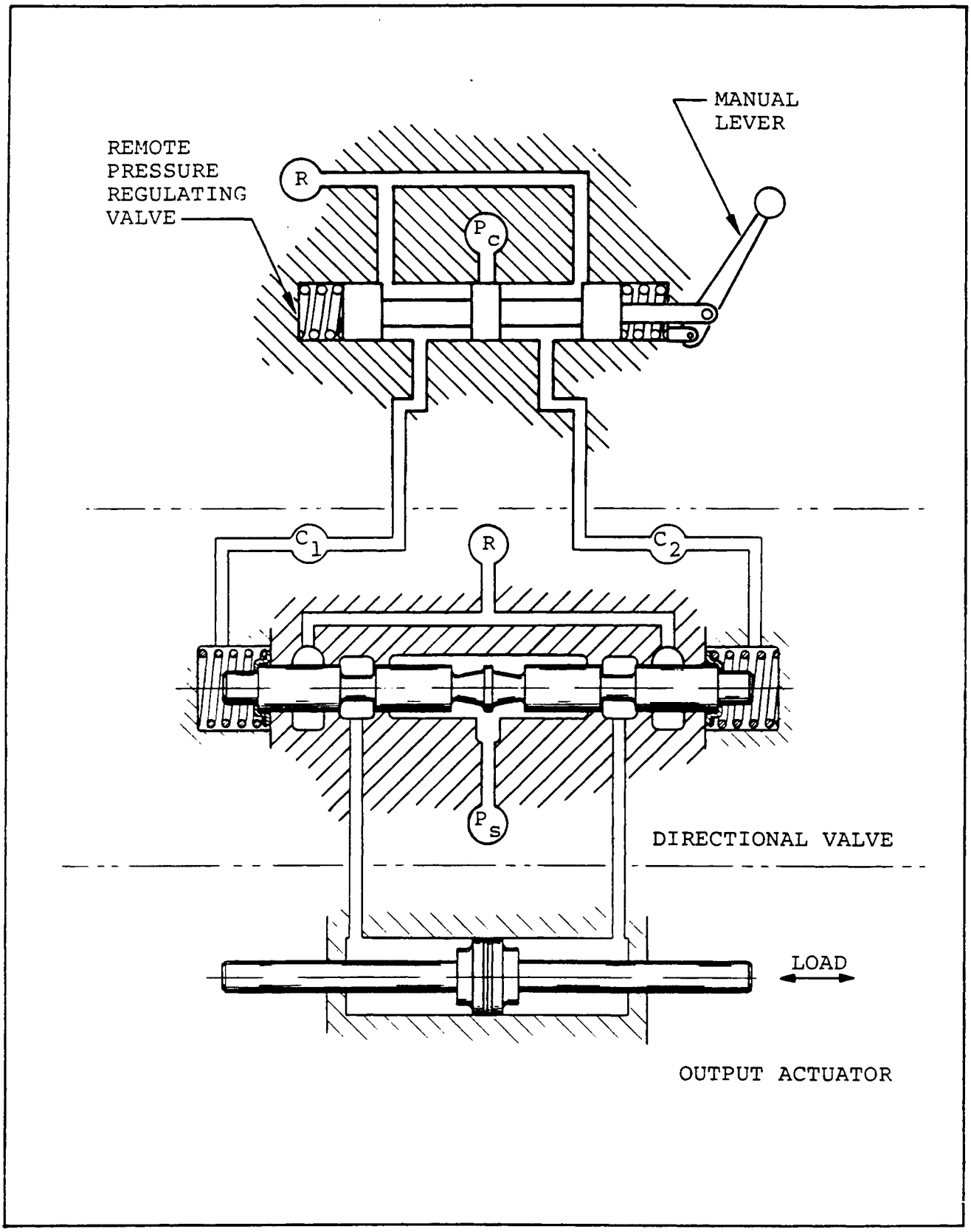
The two basic systems used to control the position of the directional valve spool, and thus control the speed or position of the function are (1) Electro-Hydraulic or (2) Remote Pilot Oil. Each system varies the differential pressure in the end caps to position the spool proportional to input command! Power system output flow will be provided from the cylinder port adjacent to the end cap with the highest pressure.

The Remote Electro-Hydraulic system uses the pilot valve and remote electrical controller as shown on figure 3. The operation starts with a manual input to the remote electrical controller that provides an output signal(0 to 3.6 volts) proportional to handle position. This signal is conducted to the pilot valve where it is converted to a differential control pressure by the movement of the jet diverter wand.

The pilot valve operates on a 300 psi differential pressure across its supply to tank ports and will provide a maximum differential output control pressure between its $C_1$ and $C_2$ output ports of 240 psi. (ie - minimum pressure recovery of 80%) Each pilot valve requires a continous flow of 0.5 to 0.6 gpm




REMOTE ELECTRO-HYDRAULIC CONTROL
FIGURE 3




REMOTE PILOT OIL CONTROL
FIGURE 4

at 300 psi differential pressure. An isolated source of control fluid is required as shown on figure 12!

A positive polarity of the red wire of the pilot valve coil will provide flow from the cylinder port adjacent to the pilot valve.

The Remote Pilot Oil Control system, Figure #4, starts with a remote pressure regulating valve that will provide an output pressure (0 to 200 psi) that is proportional to valve lever position. When the pressure regulating spool is in the neutral position, both control ports ($C_1$ and $C_2$) are connected to tank.

As the spool is moved with manual lever travel, the pressure will increase in the selected control port, overcoming the 19# directional valve spool spring detent. Additional pressure increase with the remote pressure regulating valve operation will position the directional valve spool in proportion to command.

An optional purge manifold assembly is discussed in section IV, and figure #11.

## IV ASSEMBLY & SERVICE

The Bertea module is a stack type valve that permits the use of multiple spool sections and various options of controls in the inlets or directional valve manifolds.

### Dual Port Inlet Manifold Assembly Figure #5

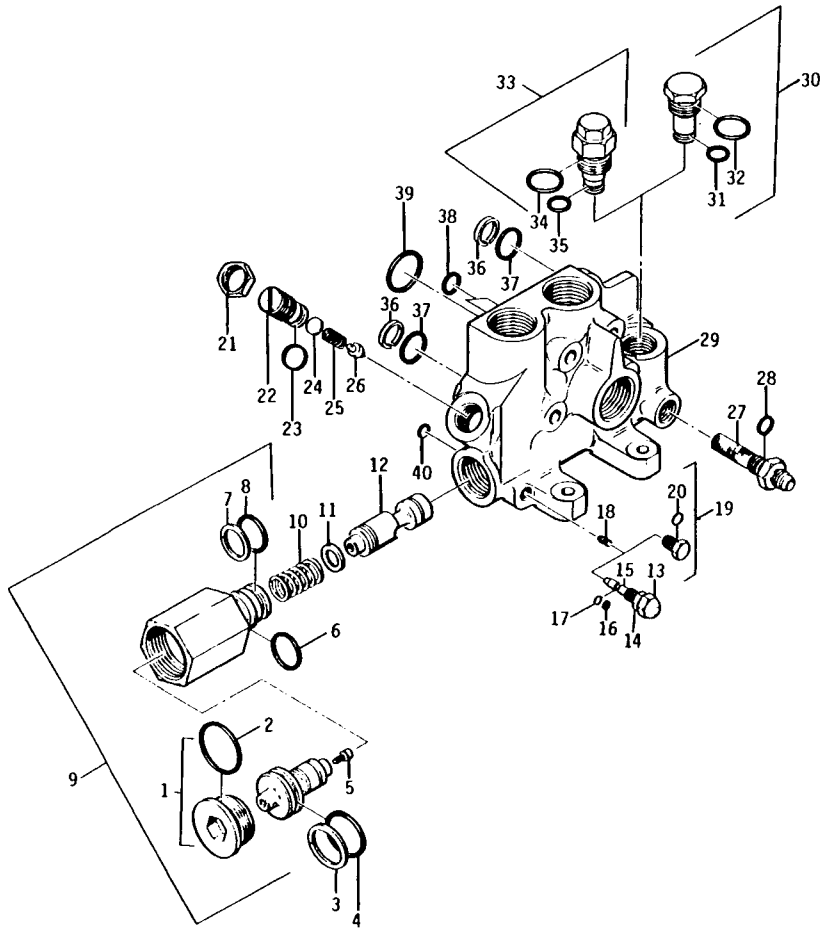
The dual port manifold assembly provides inlet porting for both the power fluid circuit and, also, the pilot valve control fluid circuit. The power fluid circuit contains both inlet and outlet porting, but the control fluid circuit is inlet porting only. The system relief valve (Item 21 thru 26) is adjustable up to 3000 psi. The orifice (Item 18) limits the flow into the compensator spring cavity, permitting the relief valve to limit system pressure by porting this fluid to tank.

The compensator unloader (Item 9) is a selected fit of the piston to the housing and, therefore, must be changed as an assembly.

When electro-hydraulic pilot valves are used for directional valve spool control, the dual port inlet should contain a pilot pressure relief valve (Item 33) to maintain the required 300 psi control pressure. All other inlets may use the optional port plug (Item 30).

| ITEM NO. | QTY. | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 269342-20 | HEX. PLUG |
| 2 | 1 | 3-920N552-90 | "O" RING |
| 3 | 1 | 261895-5 | GLYD RING |
| 4 | 1 | 2-122N674-70 | "O" RING |
| 5 | 1 | 259341-3 | ORIFICE PLUG |
| 6 | 1 | 3-916N552-90 | "O" RING |
| 7 | 1 | 3-922N303-90 | BACKUP RING |
| 8 | 1 | 2-022N674-70 | "O" RING |
| 9 | 1 | 259388-1 | UNLOADER ASSY. |
| 10 | 1 | 259337-1 | SPRING |
| 11 | AS REQ'D | 249899-11 | SHIM |
| 12 | 1 | 259336-1 | SPOOL |
| 13 | 1 | 3/8-24 UNF | ACORN NUT |
| 14 | 1 | 5/8x1/4x3/8-24 UNF | HEX. NUT |
| 15 | 1 | 269343-1 | THROTTLE |
| 16 | 1 | MS28774-006 | BACKUP RING |
| 17 | 1 | 2-006N674-70 | "O" RING |
| 18 | 1 | 269374-1 | ORIFICE PLUG |
| 19 | 1 | 269376-3 | HEX. HD. PLUG |
| 20 | 1 | 3-903N552-90 | "O" RING |
| 21 | 1 | 1x5/16x3/4-16UNF | HEX. NUT |
| 22 | 1 | 269316-1 | PLUG |
| 23 | 1 | 2-014N674-70 | "O" RING |
| 24 | AS REQ'D | 249899-12 | SHIM |
| 25 | 1 | 269318-1 | SPRING |
| 26 | 1 | 269317-1 | POPPET |
| 27 | 1 | 234950-1 | FILTER |
| 28 | 1 | 3-908N552-90 | "O" RING |
| 29 | 1 | 269307-1 | INLET MANIFOLD |
| 30 | 1 | 242925 | PLUG ASSY. |
| 31 | 1 | 3-912N552-90 | "O" RING |
| 32 | 1 | 2-014N674-70 | "O" RING |
| 33 | 1 | 231852-1 | PILOT PRESS. RELIEF VALVE |
| 34 | 1 | 3-912N552-90 | "O" RING |
| 35 | 1 | 2-014N674-70 | "O" RING |
| △ 36 | 2 | 2-117N674-70 | "O" RING |
| △ 37 | 2 | 24854-3 | BACKUP RING |
| △ 38 | 2 | 2-112N674-70 | "O" RING |
| △ 39 | 1 | 2-122N674-70 | "O" RING |
| △ 40 | 1 | 2-107N674-70 | "O" RING |

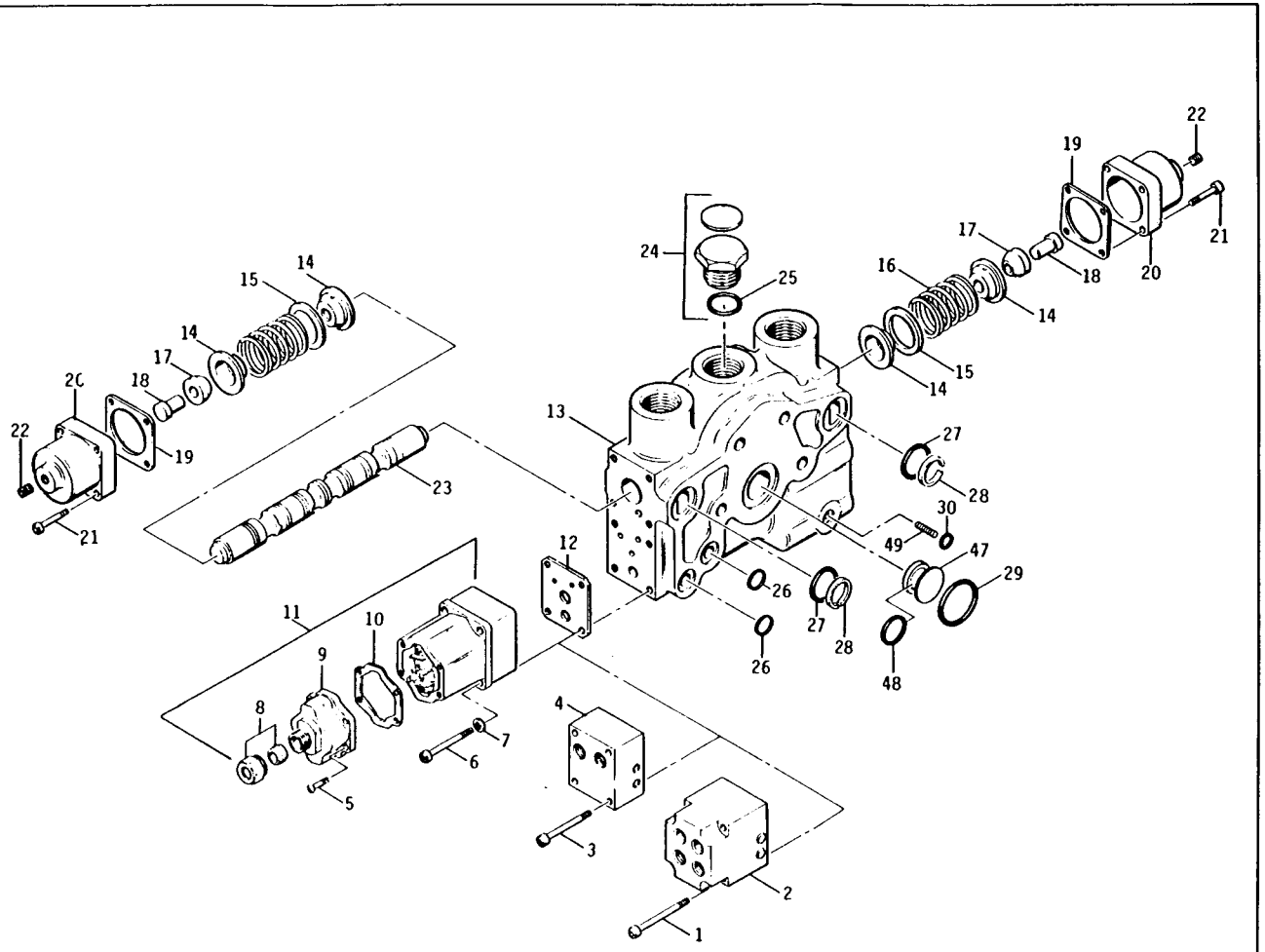
△ 269344-1 "O" RING KIT




DUAL PORT INLET MANIFOLD
FIGURE 5

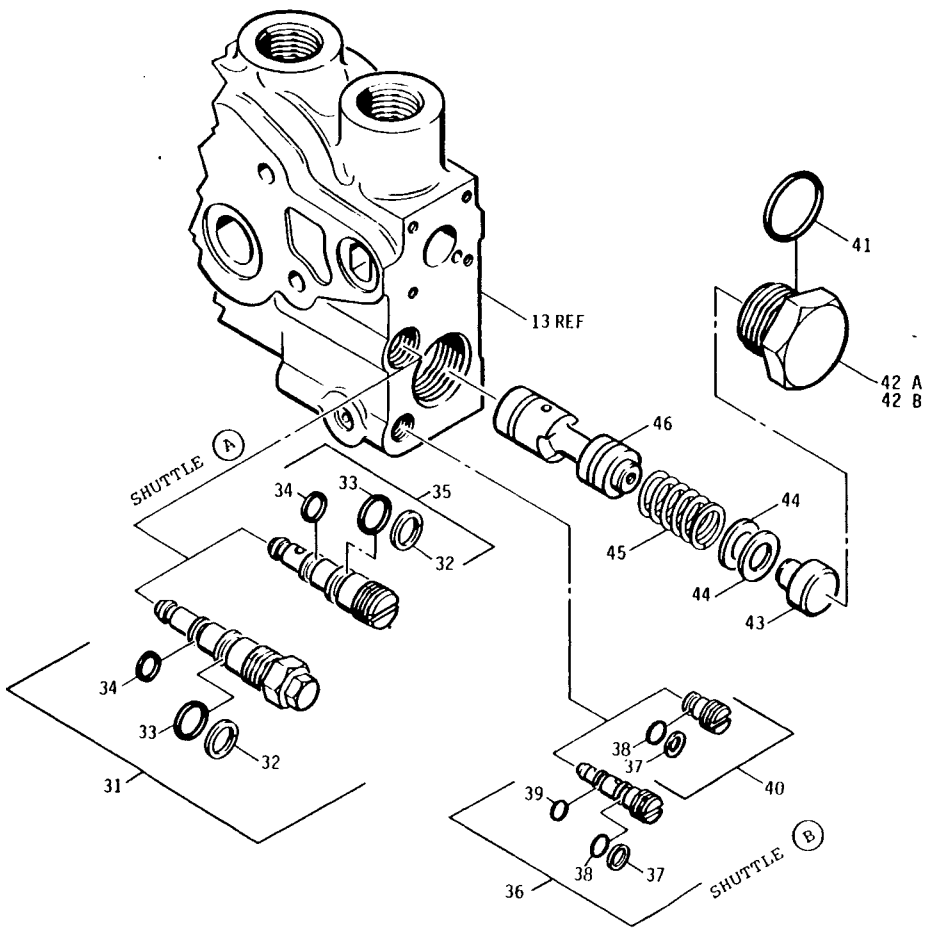
| ITEM NO. | QTY | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| 1 | 4 | 10-24x1 3/4 | SCREW-SOC. HEAD |
| 2 | 1 | 269357-1 | MANIFILD ASSY.-PURGE & SHUTTLE VALVE |
| 3 | 4 | 10-24x1 1/2 | SCREW-SOC. HEAD |
| 4 | 1 | 269327-1 | MANIFOLD ASSY.-PURGE CIRCUIT |
| 5 | 4 | #6-32x1/2 | SCREW-PHILLIPS HD. |
| 6 | 4 | 234980 | SCREW-SOC. HEAD |
| 7 | 4 | 234959 | WASHER |
| 8 | 1 | 249896 | SEAL KIT |
| 9 | 1 | 242933 | COVER |
| 10 | 1 | 242907 | GASKET |
| 11 | 1 | 234912 | PILOT VALVE |
| 12 | 1 | 225931-1 | GASKET |
| 13 | 1 | 269305-1 | BODY |
| 14 | 4 | 234927-1 | SPRING GUIDE |
| 15 | 2 | 234953-1 | SHIM |
| 16 | 2 | 231830-1 | SPRING |
| 17 | 2 | 234932-1 | PIVOT |
| 18 | 2 | 234931-1 | PIN .350 SPOOL TRVL |
| | | -3 | PIN .300 SPOOL TRVL |
| | | -9 | PIN .250 SPOOL TRVL |
| 19 | 2 | 225989-1 | GASKET |
| 20 | 2 | 269315-1 | END CAP |
| 21 | 8 | #10-24x3/4 | SCREW-SOC. HEAD |
| 22 | 2 | 1/8-27 NPT | PLUG SOC. HEAD |
| 23 | 1 | AS REQ'D | SPOOL |
| 24 | 1 | 261850-3 | PLUG ASSY. |
| 25 | 1 | 3-912N300-90 | "O" RING |
| △ 26 | 2 | 2-112N674-70 | "O" RING |
| △ 27 | 2 | 2-114N674-70 | "O" RING |
| △ 28 | 2 | 248584-3 | BACKUP RING |
| △ 29 | 1 | 2-122N674-70 | "O" RING |
| △ 30 | 1 | 2-107N674-70 | "O" RING |

△ 269344-1 "O" RING KIT




DIRECTIONAL VALVE MANIFOLD (SHEET 1 OF 2)
FIGURE 6

| ITEM NO. | QTY. | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| 31 | 1 | 269360-1 | SHUTTLE BY-PASS VALVE ASSY. |
| 32 | 1 | 8-014 | BACKUP RING |
| 33 | 1 | 2-014 N64-70 | "O" RING |
| 34 | 1 | 269370-012 | "O" RING |
| 35 | 1 | 269364-1 | SHUTTLE VALVE ASSY. (1/4 BALL) |
| 36 | 1 | 269330-1 | SHUTTLE VALVE ASSY. (5/32 BALL) |
| 37 | 1 | 8-010 | BACKUP RING |
| 38 | 1 | 2-010N64-70 | "O" RING |
| 39 | 1 | 269379-009 | "O" RING |
| 40 | 1 | 269359-1 | PLUG ASSY. (SHUTTLE VALVE) |
| 41 | 1 | 3-916N552-90 | "O" RING |
| 42a | 1 | 269335-1 | PLUG, PRESSURE REDUCER (USE WITH ITEM 35) |
| 42B | 1 | 269340-1 | PLUG, PRESSURE REDUCER (USE WITH ITEM 31) |
| 43 | 1 | 269347-1 | RETAINER |
| 44 | 2 | 249899-11 | SHIM |
| 45 | 1 | 269375-1 | SPRING |
| 46 | 1 | 269333-1 | SPOOL-PRESSURE REDUCER |
| | | 269349-1 | SPOOL-BLANK |
| 47 | 1 | 269345-1 | PLUG |
| 48 | 1 | 2-115 | O'RING |
| 49 | 1 | 269394-1 | PLUG |




DIRECTIONAL VALVE MANIFOLD (SHEET 2 OF 2)
FIGURE 6

Directional Valve Manifold Assembly Figure #6

Each directional valve assembly consists of the directional valve spool (Item 23); a means to position the spool by either the electro-hydraulic pilot valve (Item 11) or a remote pilot oil system (Item 2 or 4); a shuttle to sense highest working cylinder port pressure (Item 31 or 35); and a shuttle (Item 36) to transmit the highest pressure with in the total module to the inlet compensator.

An optional pressure reducer spool (Item 46) is provided when constant rate for the function is required in multiple spool section stacks. When only single functions are operated at one time, a blank spool is provided in order to simplify the system.

The standard end cap (Item 20) with various length pins (Item 18) determine the maximum spool travel and hence the maximum flow rate for any specific spool. This selction of spool and pins provide field adjustment of desired function speeds.

The optional manual override assembly for a remote controlled spool is shown in Figure #7. This assembly will provide direct manual control of the spool in the event of a failure in the remote controller, the electrical power supply, or a malfunction of the pilot valve.

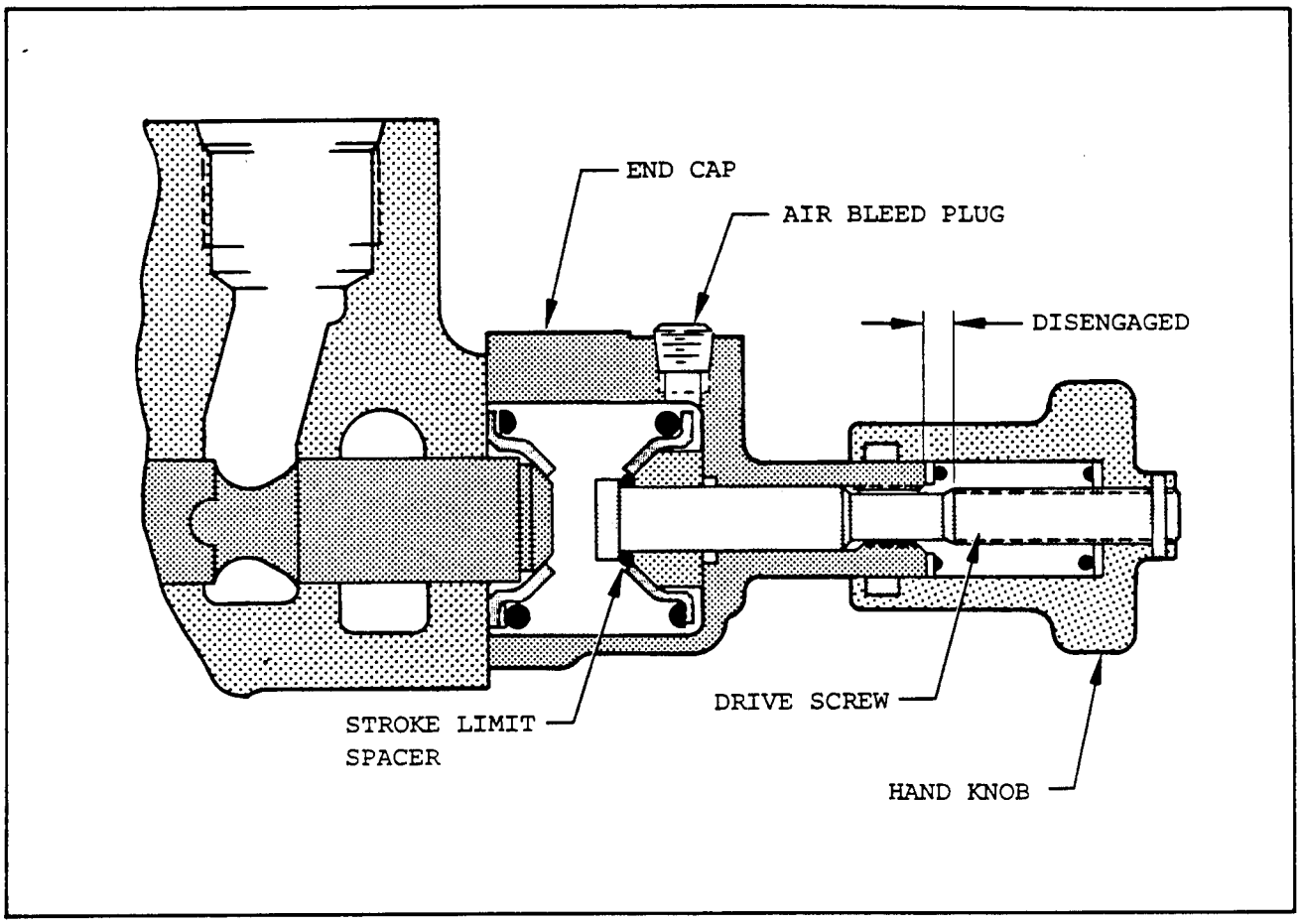
The hand knob is held in the thread disengaged position by a light spring to prevent inadvertent operation. Press the knob inward while rotating to engage the threads in the cap and the drive screw. Continued rotation clockwise will move the spool from center and will provide flow from the cylinder port adjacent to this end cap. The knob must be rotated outward and disengaged prior to operating the manual override on the opposite 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.

Single Port Inlet Manifold Assembly Figure #8

The single port manifold provides inlet porting for the power system fluid only. The tank return porting has an optional configuration of joining the pilot valve control fluid tank return, to the power fluid return for common porting to tank or separating the two return circuits for independent tank lines.

When the ¼ NPTF pipe plug (Item 29) is installed, it will block the pilot control return fluid from the power system tank line! With this configuration the pilot fluid must be connected to tank from port 28A. Without the ¼ NPTF plug installed, both fluid return circuits are common.




MANUAL OVERRIDE END CAP ASSEMBLY NO. 234955
FIGURE 7

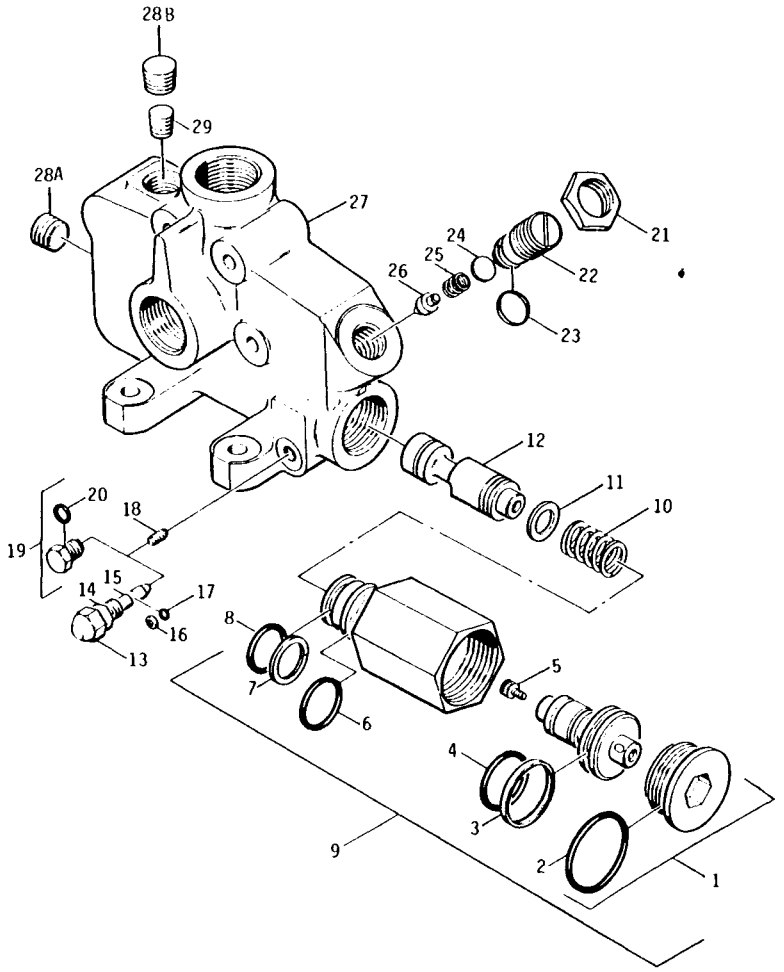
The system relief valve (21 thru 26) is adjustable up to 3000 psi. The orifice (Item 18) limits the flow into the compensator spring cavity, permitting the relief valve to limit system pressure by porting this fluid to tank.

The compensator unloader (Item 9) is a selected fit assembly of the piston to the housing and, therefore, must be changed as an assembly.

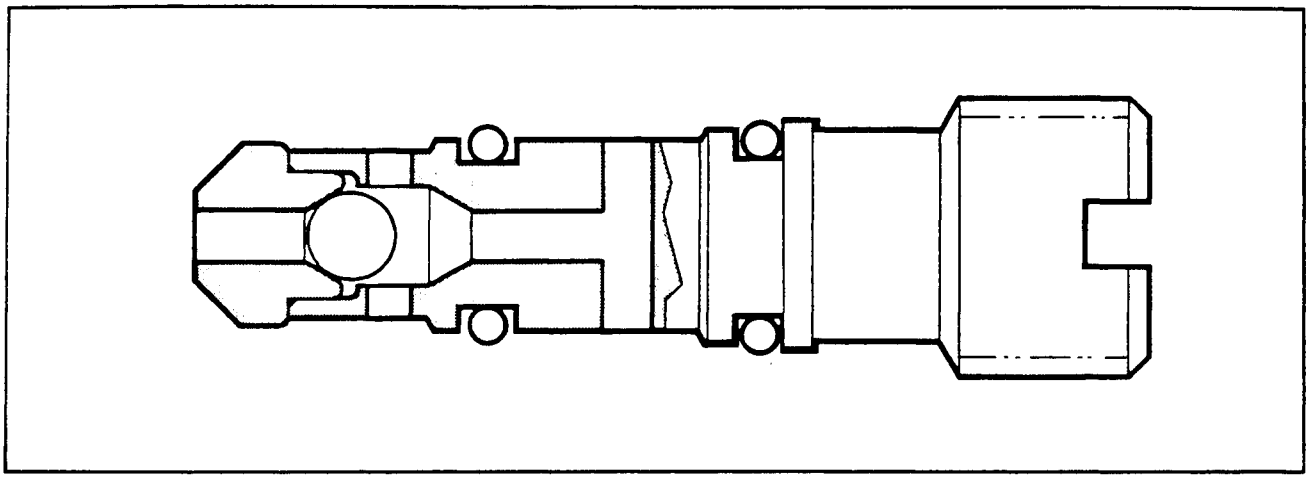
Pilot Valve Assembly

The electro-hydraulic pilot valve is a separate, replaceable assembly as shown on Figure #6 and #15. Each valve has 150 micron filter, installed beneath the roll pin that is used for installation orientation.

| ITEM NO. | QTY. | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 269342-20 | HEX. PLUG |
| 2 | 1 | 3-920N552-90 | "O" RING |
| 3 | 1 | 261895-5 | GLYD RING |
| 4 | 1 | 2-122N674-70 | "O" RING |
| 5 | 1 | 269341-3 | ORIFICE PLUG |
| 6 | 1 | 3-916N 552-90 | "O" RING |
| 7 | 1 | 8-022N300-90 | BACKUP RING |
| 8 | 1 | 2-022N784-70 | "O" RING |
| 9 | 1 | 269388-1 | UNLOADER ASSY. |
| 10 | 1 | 269337-1 | SPRING |
| 11 | AS REQ'D | 249899-11 | SHIM |
| 12 | 1 | 269336-1 | SPOOL |
| 13 | 1 | 3/8-24 UNF | ACORN NUT |
| 14 | 1 | 5/8x1/4x3/8-24UNF | HEX. NUT |
| 15 | 1 | 269343-1 | THROTTLE |
| 16 | 1 | MS28774-006 | BACKUP RING |
| 17 | 1 | 2-006N674-70 | "O" RING |
| 18 | 1 | 269374-1 | ORIFICE PLUG |
| 19 | 1 | 269376-3 | HEX. HD. PLUG |
| 20 | 1 | 3-903N552-90 | "O" RING |
| 21 | 1 | 1"x5/16x3/4-16 UNF | HEX NUT |
| 22 | 1 | 269316-1 | PLUG |
| 23 | 1 | 2-014N674-70 | "O" RING |
| 24 | AS REQ'D | 249899-12 | SHIM |
| 25 | 1 | 269318-1 | SPRING |
| 26 | 1 | 269317-1 | POPPET |
| 27 | 1 | 269310-1 | OUTLET MANIFOLD |
| 28 | 1 | 3/8-18 NPT | PIPE PLUG SOCKET HD. |
| 29 | AS REQ'D | 1/4-18 NPT | PIPE PLUG SOCKET HD. |




SINGLE PORT INLET MANIFOLD
FIGURE 8

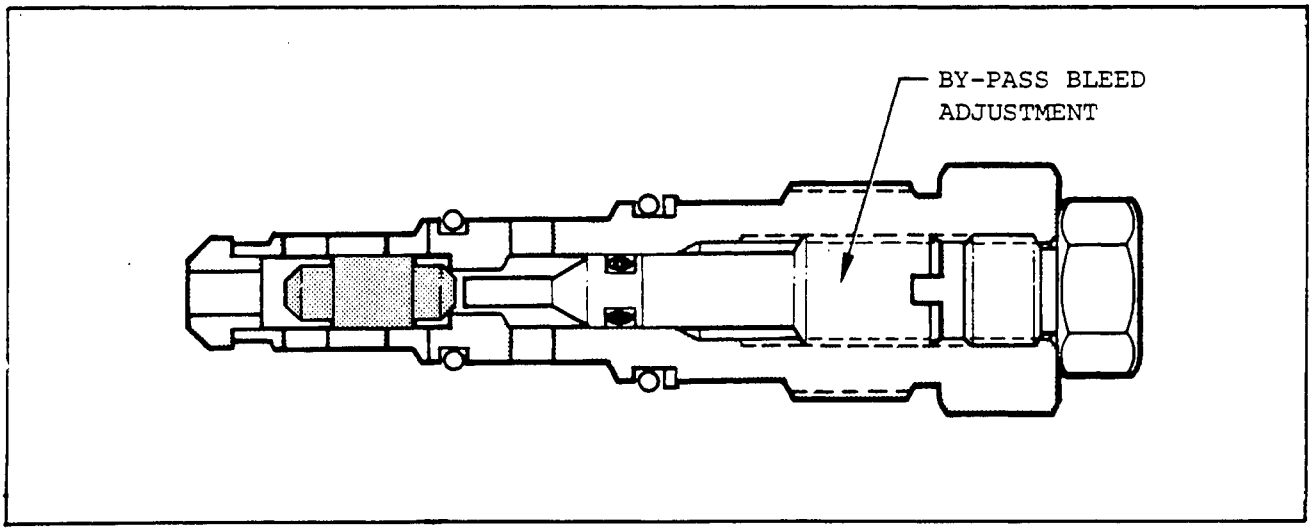


BASIC SHUTTLE
FIGURE 9

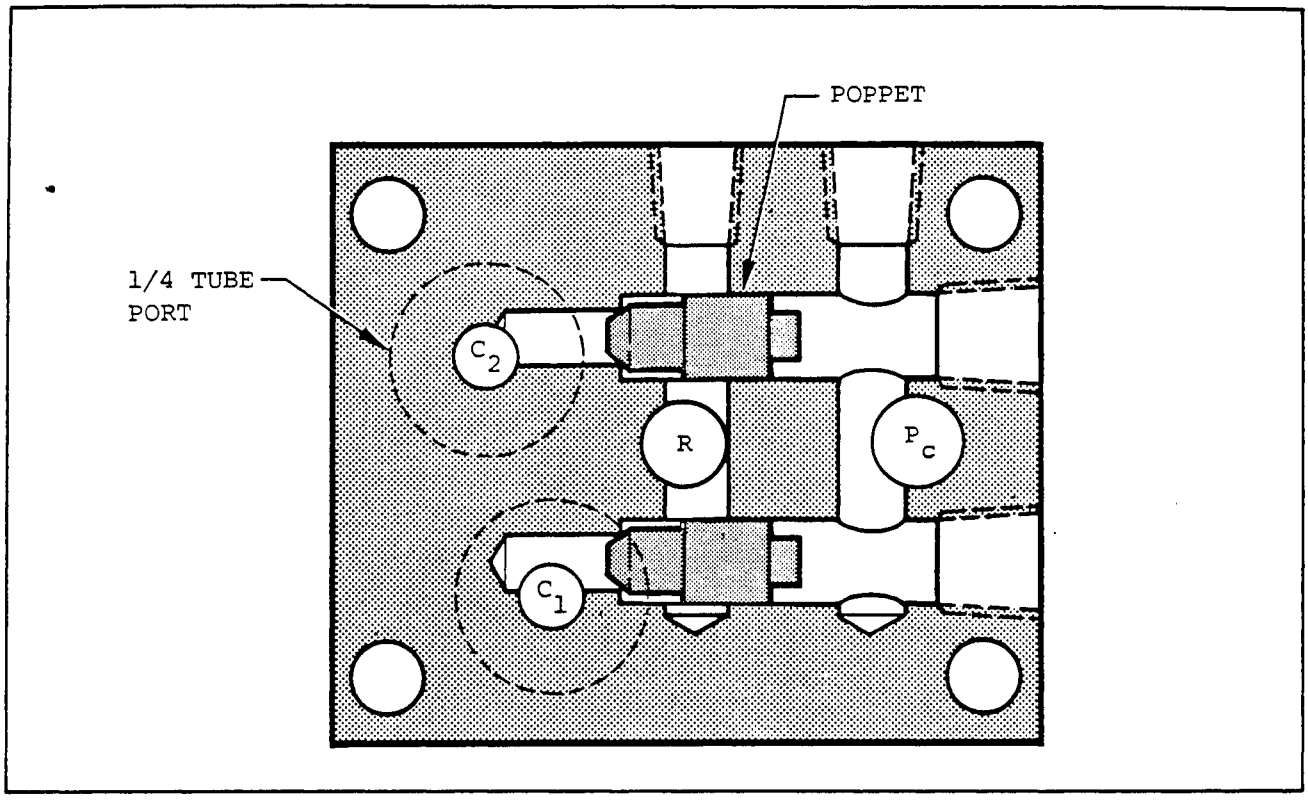
Shuttle Assemblies

Two types of shuttle assemblies are used in the P.C. control circuit. The basic shuttle shown in Figure #9, is a single ball unit that seals in either position. This type is the standard configuration for shuttle "B" (Ref: Figure #2), and is optional for shuttle "A" usage. There are no adjustments in this shuttle.

Figure #10 shows the second shuttle configuration used as shuttle "A", and it provides an adjustable by-pass bleed from cylinder port "B" to cylinder port "A", as shown on Figure #2. This is used to smooth the operation of a holding valve in a topping cylinder application. Therefore, cylinder port "B", which is adjacent to the pilot valve or purge manifold mounting face must be connected to lower the function.




ADJUSTABLE BY-PASS SHUTTLE
FIGURE 10




PURGE MANIFOLD ASSEMBLY
FIGURE 11

Purge Manifold Assembly

The purge manifold assembly, shown in Figure #11, provides the interface porting for the Remote Pilot Oil applications. The manifold is ported to receive control oil from the remote valve into the ¼" tube ports on the top surface, and, also, to provide porting into the directional valve spool section for $C_1$, $C_2$, R (return), and $P_C$ (control pressure). This control pressure ($P_c$) is received internally from the inlet manifold and is not from the remote pressure reducer valve. The external circuit is shown on Figure #13.

When 200 psi pressure is applied at $P_C$, the poppets are held in the position shown, which isolates $C_1$ and $C_2$ from R (return). This is the normal operating configuration for the system.

In order to purge cold oil from the lines connecting the purge manifold to the remote pressure reducing valve, the $P_C$ port is connected to tank. Now the 100 to 200 psi pressure in the control lines $C_1$ and $C_2$ will unseat the poppets, and the oil will flow into the return port (R), and back to tank.

# V INSTALLATION

## A. FILTRATION & 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 filtration configuration recommended for the Bertea system is shown on Figure #12. A power system filter of 10 micron rating is to be used either as a return line unit or a full flow high pressure filter on the power system pump discharge. The non by-pass filter for the pilot fluid line should be as large a flow rating as possible and of a 25 or 40 micron rating.

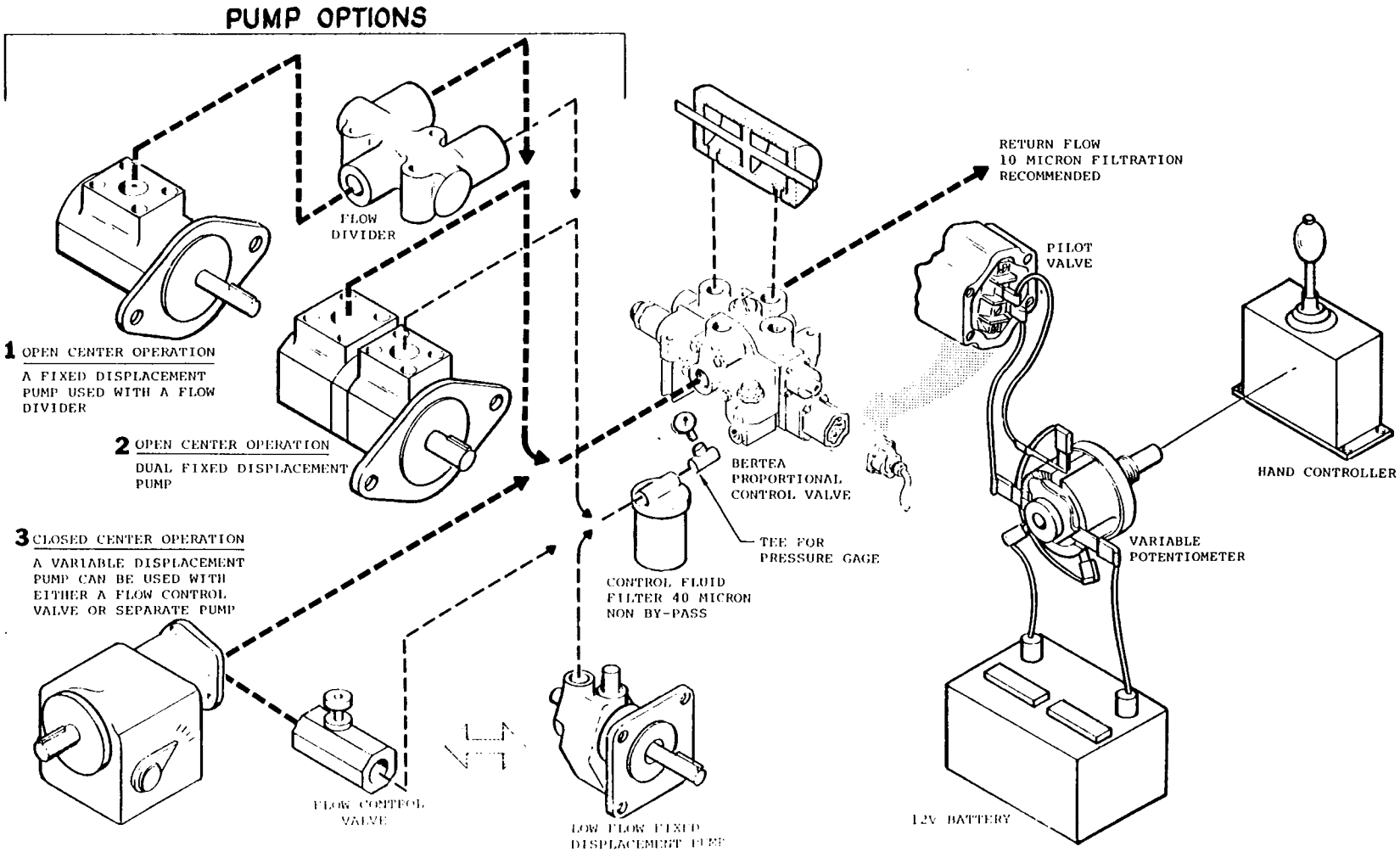
Since this pilot circuit is a constant flow, if the filter is the same micron size as the system filter, it will have a short life. The small tube type filter in the inlet manifold (234950, Figure #5) is 100 micron rating and is only intended for coarse material. Each pilot valve has a 150 micron filter on its inlet port as a protection while replacing units on a manifold.

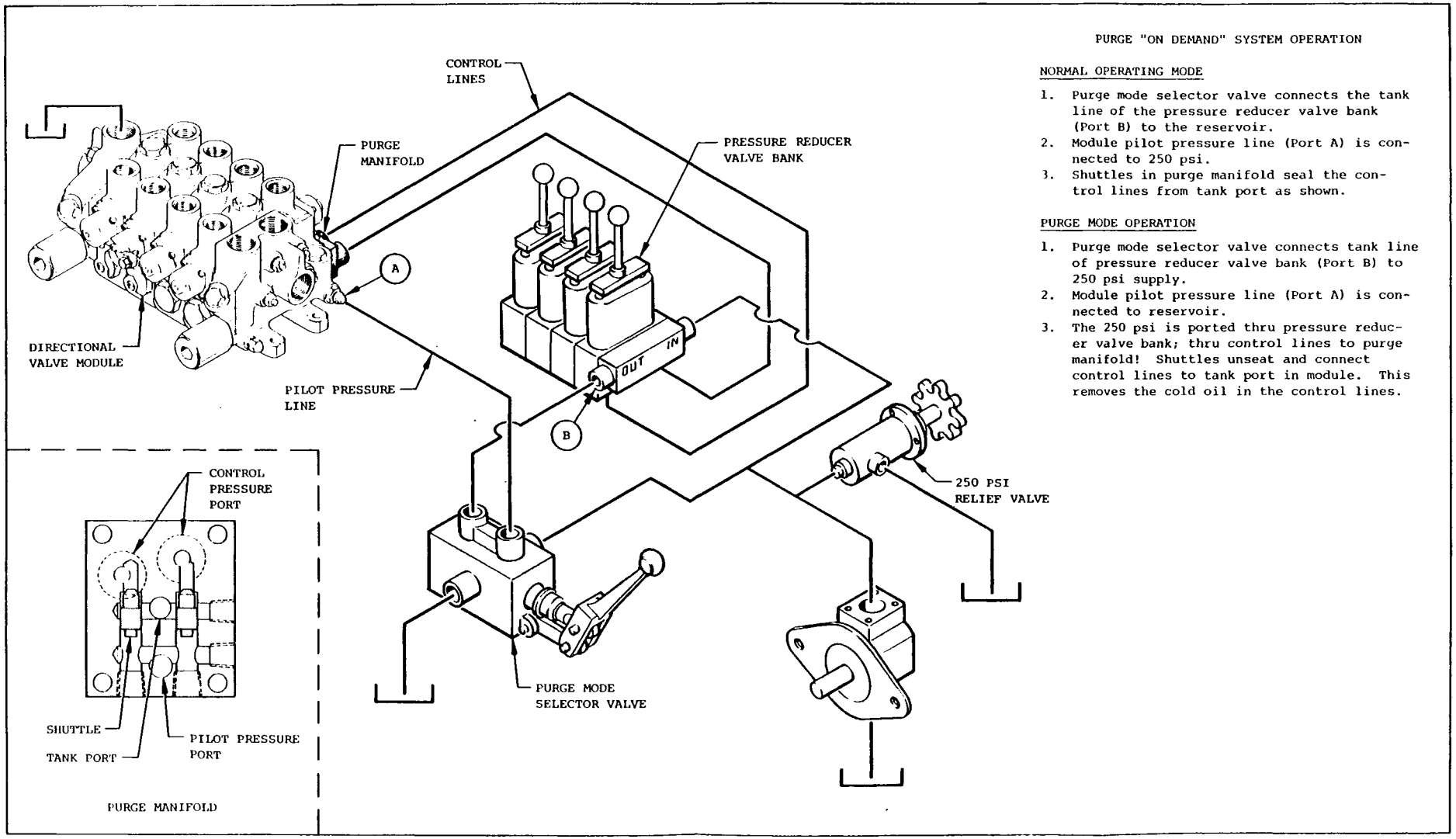
## B. PILOT FLUID CIRCUIT

The separate pilot fluid circuit options, as shown on Figure #12 and #13, provide capability of controlling the directional valve spool under any operating mode.

When using electro-hydraulic pilot valves, (Ref: Figure #12), a differential pressure of 300 to 350 psi is required across the module. If the return line pressure is 50 psi, an inlet pressure of 350 psi would be required. Each standard pilot valve requires a continous flow of 0.5 to 0.6 gpm and the pilot pressure relief valve is set to flow 0.5 gpm at 300 psi $\Delta p$. Therefore, a (4) spool section module would require 4 x 0.5 gpm plus 1.0 gpm for the relief valve (plus flow tolerance) or 3 gpm total constant flow.

If a remote pilot oil system is used as shown on Figure #13, the method of obtaining the pilot oil can be the same, but the required flow rate and pressure will be lower. Since the manual pressure reducer valves are blocked center, they only flow oil when actuated. Therefore, a flow rate of 2 to 3 gpm is adequate for control and, also, for the purge mode. The required pressure is 250 psi.


PUMP OPTIONS
FLOW DIVIDER
1 OPEN CENTER OPERATION
A FIXED DISPLACEMENT PUMP USED WITH A FLOW DIVIDER
2 OPEN CENTER OPERATION
DUAL FIXED DISPLACEMENT PUMP
3 CLOSED CENTER OPERATION
A VARIABLE DISPLACEMENT PUMP CAN BE USED WITH EITHER A FLOW CONTROL VALVE OR SEPARATE PUMP
FLOW CONTROL VALVE
LOW FLOW FIXED DISPLACEMENT PUMP
CONTROL FLUID FILTER 40 MICRON NON BY-PASS
TEE FOR PRESSURE GAGE
BERTEA PROPORTIONAL CONTROL VALVE
RETURN FLOW 10 MICRON FILTRATION RECOMMENDED
PILOT VALVE
HAND CONTROLLER
VARIABLE POTENTIOMETER
12V BATTERY




REMOTE PURGE SYSTEM SCHEMATIC
FIGURE 13

PURGE "ON DEMAND" SYSTEM OPERATION

NORMAL OPERATING MODE

1. Purge mode selector valve connects the tank line of the pressure reducer valve bank (Port B) to the reservoir.
2. Module pilot pressure line (Port A) is connected to 250 psi.
3. Shuttles in purge manifold seal the control lines from tank port as shown.

PURGE MODE OPERATION

1. Purge mode selector valve connects tank line of pressure reducer valve bank (Port B) to 250 psi supply.
2. Module pilot pressure line (Port A) is connected to reservoir.
3. The 250 psi is ported thru pressure reducer valve bank; thru control lines to purge manifold! Shuttles unseat and connect control lines to tank port in module. This removes the cold oil in the control lines.

C. REMOTE PILOT OIL WITH PURGE OPTION

The remote pilot oil system uses manually operated pressure reducers to vary the control pressure in the directional valve spool end caps from 0 to 200 psi. Spool position is proportional to the differential pressure in the end caps.

The addition of a manually selected purge system that will flow oil from the pressure reducers, thru the control lines, then thru the purge manifold and into the tank return line of the module is, also, shown on Figure #13. This is a demand system that is energized by putting the selector valve in the purge mode. This applies pressure to port (B) and connects port (A) to tank and causes the purge flow as noted. Normal control operation is resumed when the lever is returned to the operating mode by connecting (B) to tank and control pressure to port (A).

D. MODULE INSTALLATION

The Bertea proportional control valve module can be mounted in any position or attitude, except in the case where in a severe shock load would be imposed parallel to the axis of movement of the directional valve spool. For example, with a scoop loader impacting into a material pile, the module should be installed with the spool axis 90° to the direction of impact.

Figure #14 shows the installation dimensions of the module. It should be noted that when using the electro-hydraulic pilot valves, the 1½" air gap should be maintained as shown.

VI START-UP AND TROUBLE SHOOTING (Figure #2)

| PROBLEM | POSSIBLE CAUSES | REMEDY |
|---|---|---|
| A. Functions will not move and pump is at full system pressure. | | |
| | 1) Inlet and outlet plumbing are reversed. | |
| | | a. Reverse plumbing. |
| | 2) Inlet spool is stuck. | |
| | | a. Remove spool (1) and check for burrs, and/or foreign material. |
| B. Functions will not move and pump is at low press. (approximately 100 psi) | | |

1) No pilot pressure to spool section spool.

   a. Apply pilot pressure ΔP across spool and to pilot inlet.

2) Small shuttle plugged.

   a. Clean shuttle (7).

3) Orifice in inlet plugged.

   a. Clean orifice (5).

C. First function speeds up when a second function is operated.

1) Small shuttle in first function is plugged.

   a. Clean shuttle (7).

2) Pressure reducer spool in first function is stuck.

   a. Remove spool (6) and check for burrs and/or foreign material.

D. Function operates in one direction only.

1) Large shuttle stuck.

   a. Clean shuttle (8).

2) Directional valve spool stuck.

   a. Remove spool (9) and check for burrs and/or foreign material.

3) Pilot pressure to spool section spool in one direction only.

   a. Check ΔP across spool in both directions: See paragraph 8 for remote pilot oil applications. See paragraph 9 for electro-hydraulic pilot valve applications.

E. Function continues to move with no input command.

1) Directional valve spool stuck.

   a. Remove spool (9) and check for burrs and/or foreign material.

2) Pilot pressure to spool section spool is unbalanced.

   a. Check ΔP across spool in both directions: See paragraph 8 for remote pilot oil applications. See paragraph 9 for electro-hydraulic pilot valve applications.

F. Can Not obtain full system pressure.

1) System relief valves adjusted too low.

a. Increase relief valve setting (3) by adjusting the cap clockwise.

2) Inlet control orifice plugged.

a. clean orifice (5).

3) Foreign material on relief valve seat.

a. Remove relief valve cap (3), spring, and poppet. Flush the cavity.

4) Damaged "o" ring on unloader.

a. Remove unloader body (4) and replace "o" ring.

G. By-pass pressure too high.

1) Excessive flow.

a. Reduce pump output.

2) Excessive return pressure.

a. Remove return line restriction.

3) Unloader piston stuck in the "in" position.

a. Remove unloader (4) and clean orifice.

4) Directional valve spool stuck.

a. Remove spool (9) and check for burrs and/or foreign material.

H. Remote Pilot Oil Applications

Control problems with remote pilot oil systems are usually caused by a mal-function of either the pressure reducer or purge manifold assembly.

Disconnect the control lines at the purge manifold and attach pressure gages to the lines. With the manual lever in the center position the pressure in the lines should be equal. Movement of the lever should increase the pressure proportionally in one line to at least 200 psi greater than the other line pressure. Opposite lever travel should reverse the pressure differential.

Stuck poppets in the purge manifold block normally occur in the sealed or non purge mode! This mal-function is demonstrated by a function operating in one direction when switching to the purge mode, but stopping when returning to the operating mode. Remove poppet and deburr or replace purge manifold assembly.

I. Electro-Hydraulic Pilot Valve Applications

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 are isolated by disconnecting the wires from the pilot valve to determine if the problem is caused by the remote electrical controller or the pilot valve.

Hydraulic control problems, such as poor feathering, can be caused by very high or very low differential pressure across the pilot valve. Hydraulic mal-function problems, such as unwanted motion or non operation, can be caused by contamination failures. Check the control system filter and the inlet manifold filter (Item 27, Figure #5) for plugging or failure. Replace the pilot valve with a spare unit or one from another function to check for a plugged valve.

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

## VII SPECIFICATIONS

### A. POWER OIL SYSTEM

Rated Flow - 30 gpm
Rated Pressure - 2500 psi
By-Pass Compensator - 150 psi setting
Pressure Reducer - 100 psi setting
Recommended Filtration - 10 micron

### B. PILOT VALVE OIL SYSTEM

REQUIRED Pressure - 300 psi $\Delta P$
REQUIRED Flow - 0.6 gpm per valve
Plus - 1.0 gpm for relief valve
REQUIRED Filtration - 40 micron

C. PORT SIZES

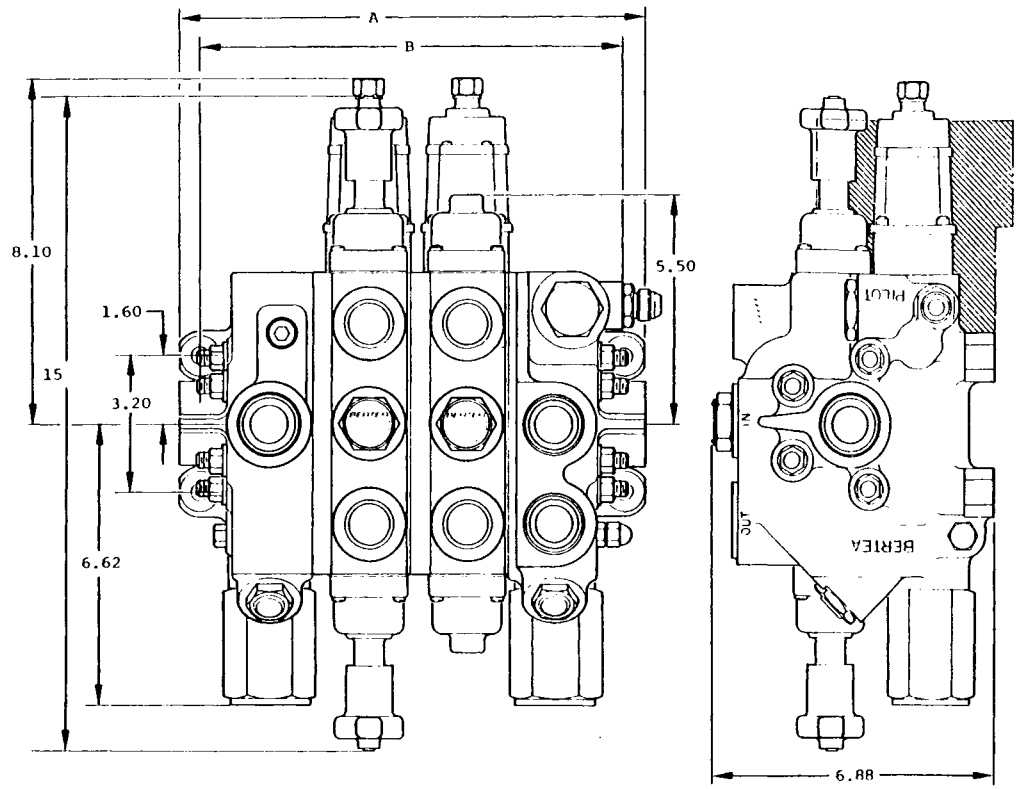
Inlet - 1 5/16-12 (1" Tube)
Cylinder - 1 1/16-12 (3/4" Tube)
Outlet - 1 5/16-12 (1" Tube)
Pilot Control - 3/8 Flared Tube Male
Purge Manifolds - 7/16-20 (1/4" Tube)

D. BOLT TORQUES

| | | |
|---|---|---|
| 3/8-16 Clamping Studs | - | 23 lb-ft Lube<br>30 lb-ft Dry |
| 10-24 Screws | - | 30 in lb Lube<br>40 in lb Dry |

E. HYDRAULIC OIL

The recommended viscosity range is 50 to 4000 SSU which is typical for most pumps! Operating temperature range is -40°F to 200°F. Extreme cold weather operation will require fluids simular to automatic transmission fluids in order to minimize pump cavitation and excessive pressure loss in lines during start-up and initial warm-up.

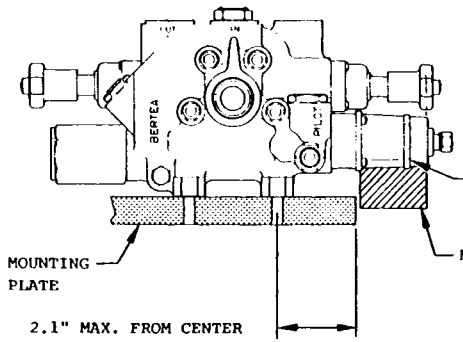



⚠ CAUTION: NO MAGNETIC METAL WITHIN 1.5 OF PILOT VALVE AS SHOWN.

| NUMBER OF SPOOL SECTIONS | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| DIMENSION "A" | 8.62 | 10.94 | 13.26 | 15.58 | 17.90 | 20.22 |
| DIMENSION "B" | 7.62 | 9.94 | 12.26 | 14.58 | 16.90 | 19.22 |
| CLAMPING KIT P/N 269350 DASH NO. | -1 | -2 | -3 | -4 | -5 | -6 |

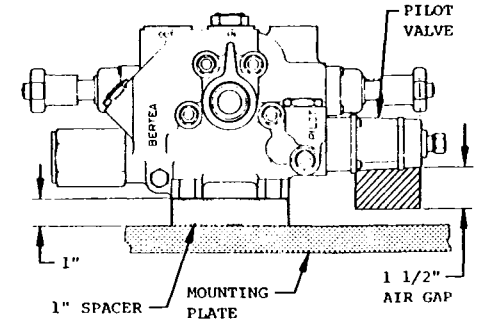
INSTALLATION
FIGURE 14

The pilot valve is mounted on the directional valve in a location to provide the easiest access for wiring and field replacement. This mounting configuration does present restraints when installing the complete valve module on a vehicle because of the permanent magnet in the pilot valve.
A large mass of magnetic metal adjacent to the magnet will offset the flux field and may cause a null shift in the valve. Therefore, the recommended mounting is shown in Figure 1 and 2 in order to provide at least 1-1/2 inches air gap beneath the magnet of the pilot valve.




If the mounting plate does not extend beneath the pilot valve, as shown, the module may be mounted directly to the plate.

FIGURE 1



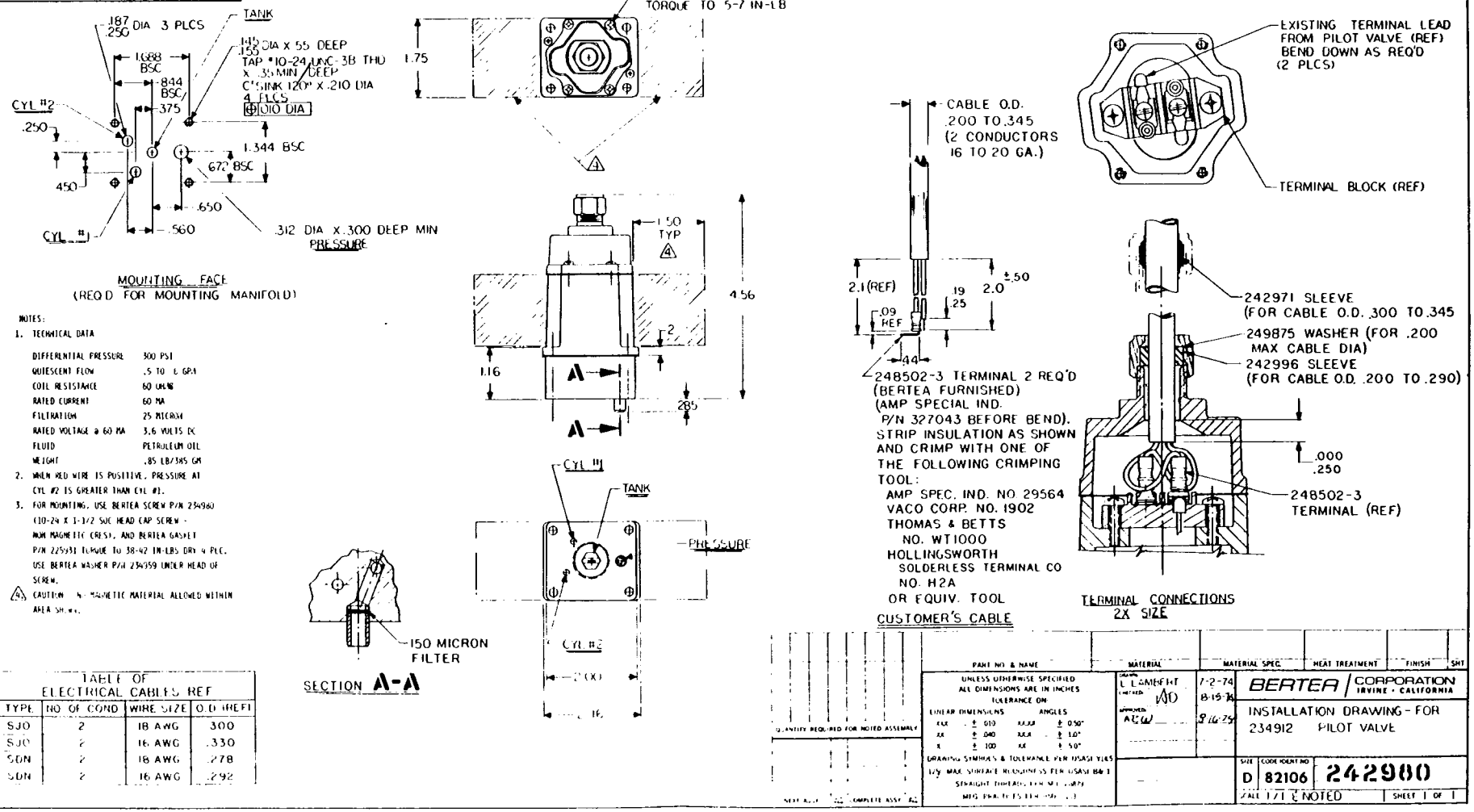

If the mounting plate extends underneath the pilot valve magnet the module must be raised at least one (1) inch in order to provide an air gap of 1-1/2 inch beneath the pilot valve.

FIGURE 2


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| REVISIONS | | | |
|---|---|---|---|
| SYM | DESCRIPTION | DATE | APPROVAL |
| C | SEE E O | 4-26-77 | |




MOUNTING FACE
(REQ'D FOR MOUNTING MANIFOLD)

NOTES:

1. TECHNICAL DATA

| | |
|---|---|
| DIFFERENTIAL PRESSURE | 300 PSI |
| QUIESCENT FLOW | .5 TO .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 | .85 LB/385 GM |

2. WHEN RED WIRE IS POSITIVE, PRESSURE AT CYL #2 IS GREATER THAN CYL #1.
3. FOR MOUNTING, USE BERTEA SCREW P/N 234980 (10-24 X 1-1/2 SOC HEAD CAP SCREW - NON MAGNETIC CRES), AND BERTEA GASKET P/N 225931 TORQUE TO 38-42 IN-LBS DRY 4 PLC. USE BERTEA WASHER P/N 234959 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 |
| SON | 2 | 18 AWG | .278 |
| SON | 2 | 16 AWG | .292 |

| PART NO. & NAME | MATERIAL | MATERIAL SPEC | HEAT TREATMENT | FINISH | SHT |
|---|---|---|---|---|---|
| | | | | | |

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCE ON:
LINEAR DIMENSIONS: .XXX ± .010; .XX ± .040; .X ± .100
ANGLES: .XXX ± 0.50°; .XX ± 1.0°; .X ± 5.0°
DRAWING SYMBOLS & TOLERANCE PER USASI Y14.5
125 MAX SURFACE ROUGHNESS PER USASI B46.1
STRAIGHT THREADS FOR SET SCREWS
MFG PRACTICES PER MIL-STD-12

DRAWN: L LAMBERT 7-2-74
CHECKED: MD 8-19-75
APPROVED: AEW 9/16/75

BERTEA / CORPORATION IRVINE • CALIFORNIA

INSTALLATION DRAWING - FOR
234912 PILOT VALVE

SIZE D | CODE IDENT NO 82106 | 242980

SCALE 1/1 & NOTED | SHEET 1 OF 1

QUANTITY REQUIRED FOR NOTED ASSEMBLY

NEXT ASSY | COMPLETE ASSY

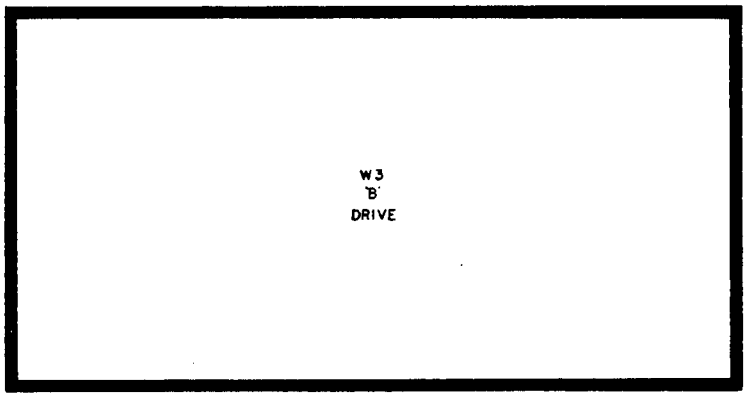
PILOT VALVE INSTALLATION
FIGURE 15



27

# Torque-Hub® Final Drives

# Service Manual




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

Fairfield

THE DRIVE PEOPLE

# Introduction

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.

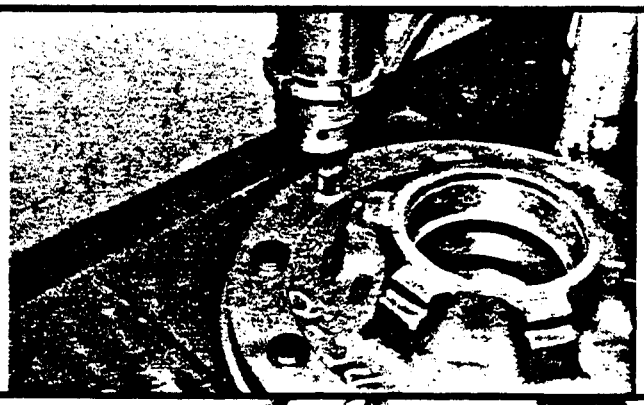
9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

   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.

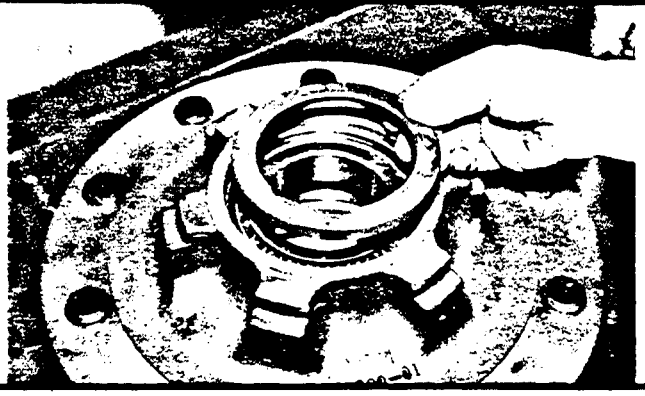
   Note: Wheel studs are optional.



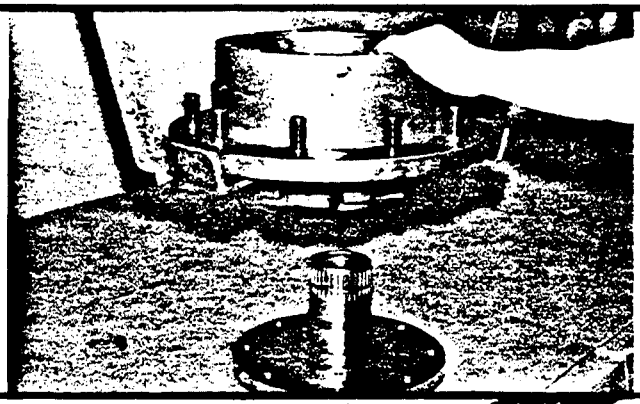
2. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JM716610 will go into small end of Hub, and Cup #JM515610 will go into large end of Hub.



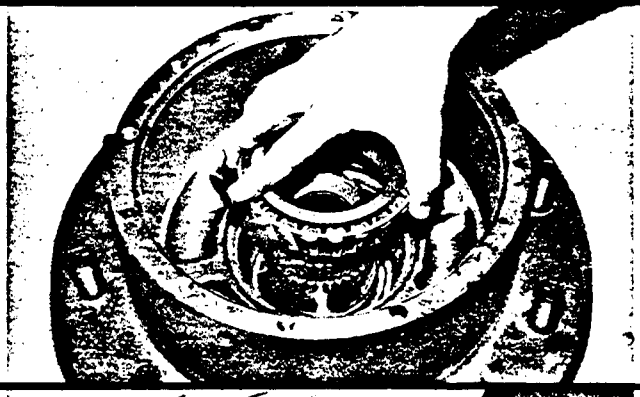
3. Place Bearing cone #JM716649 into Bearing Cup in small end of Hub.



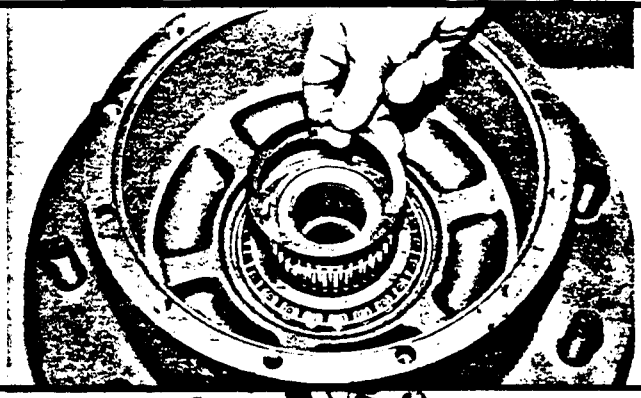
4. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.



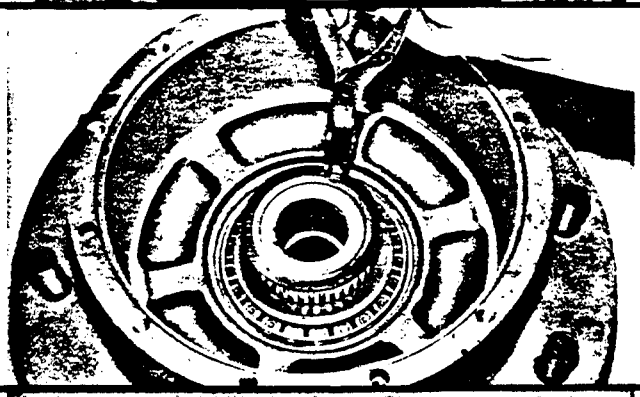
5. Lower Hub onto Spindle with large open end up.



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

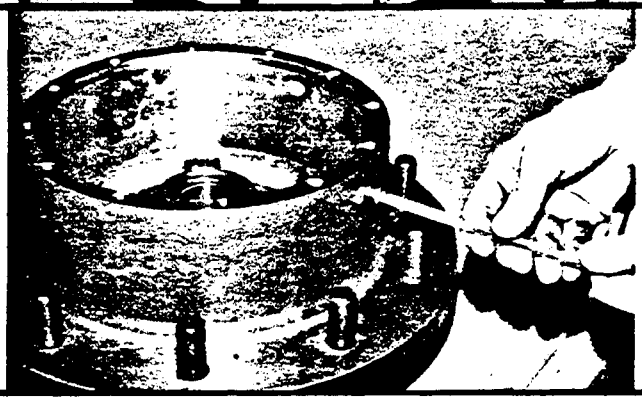


7. Place Bearing Shim over end of Spindle and against Bearing Cone.

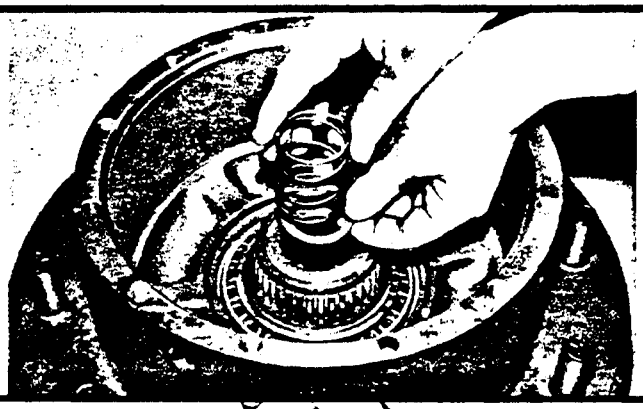


8. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

⚠ 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.

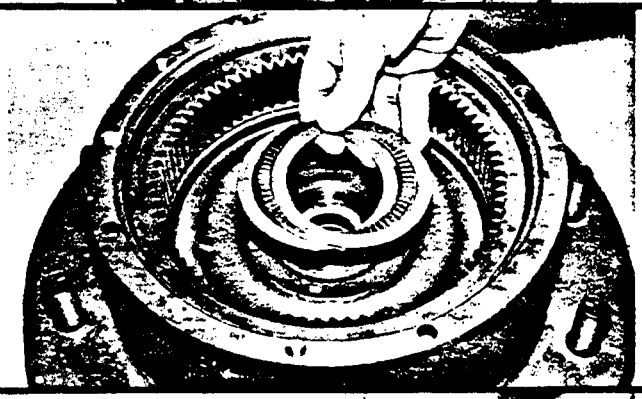


11. Another spacer and the correct Retaining Ring are installed into the Spindle co'bore and Retaining Ring groove provided.

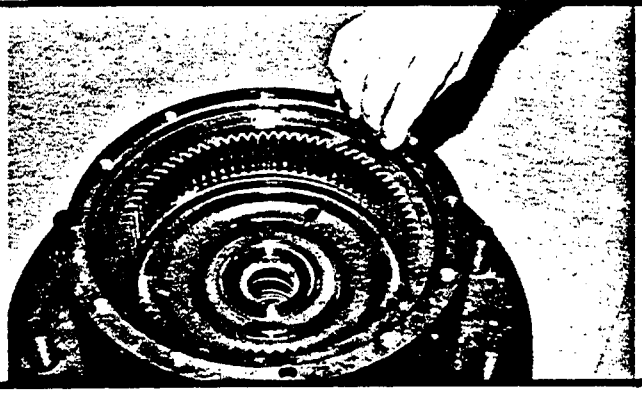
⚠ Eye protection should be worn during Retaining Ring installation.



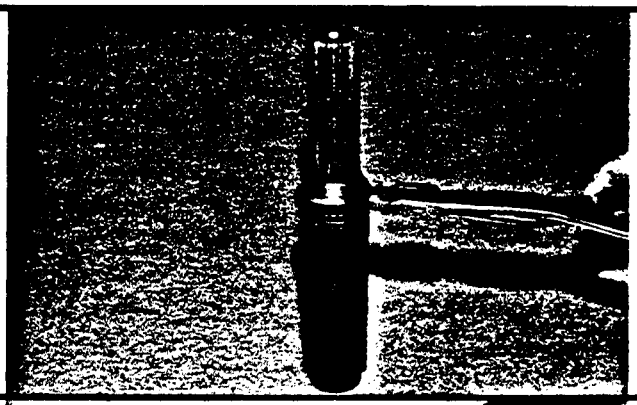
12. The internal gear is installed matching the Bore Spline to the Spindle Spline.



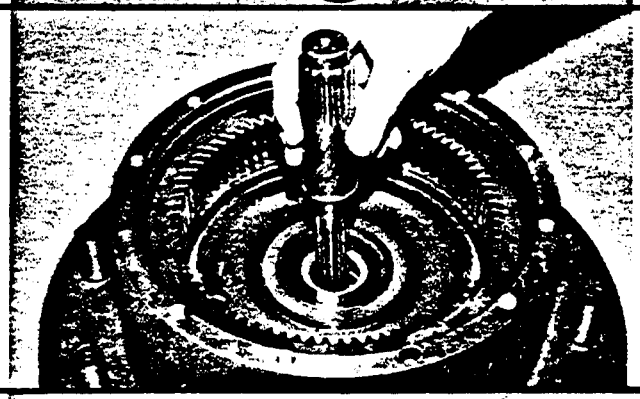
13. The thrust washer/thrust bearing set is installed on the portion of the Spindle which extends into the internal gear.



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.

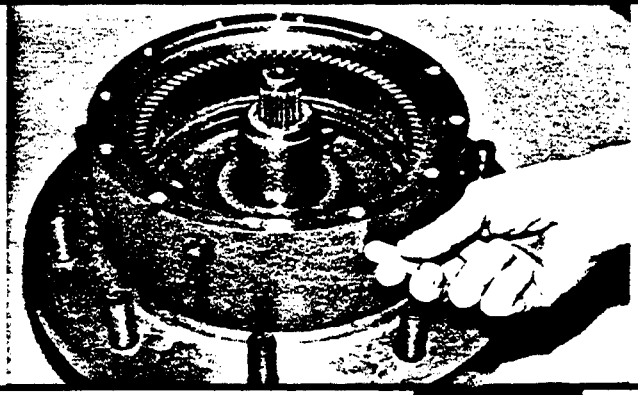


16.The input shaft is installed into the spindle.

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

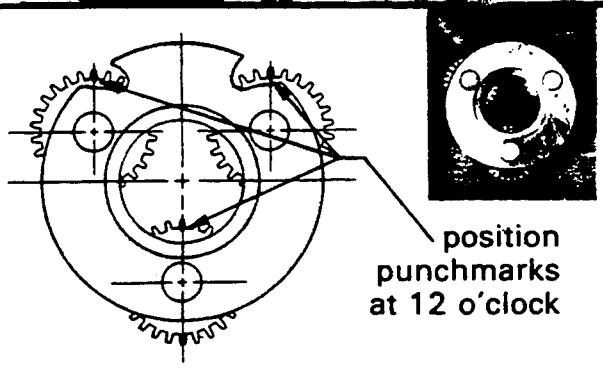


17.The thrust spacer is installed on the input shaft.

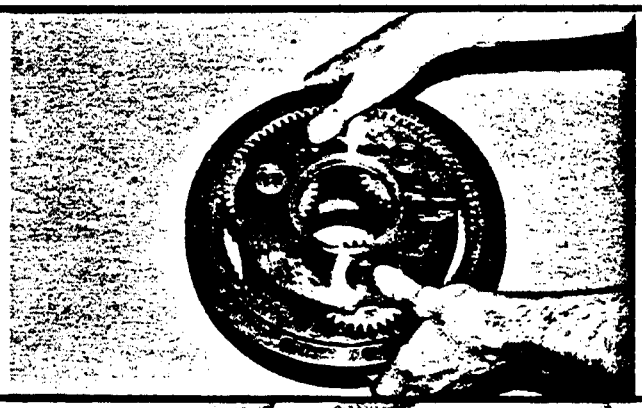


18.Locating the four counter reamed holes in the face of the hub, mark them for later identification.

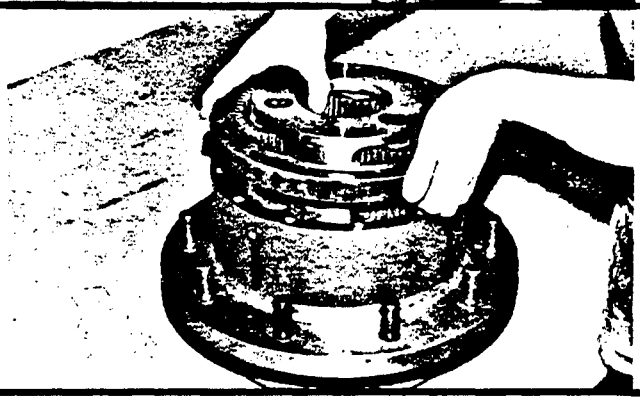
These holes are reamed to accept the shoulder bolts.




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.

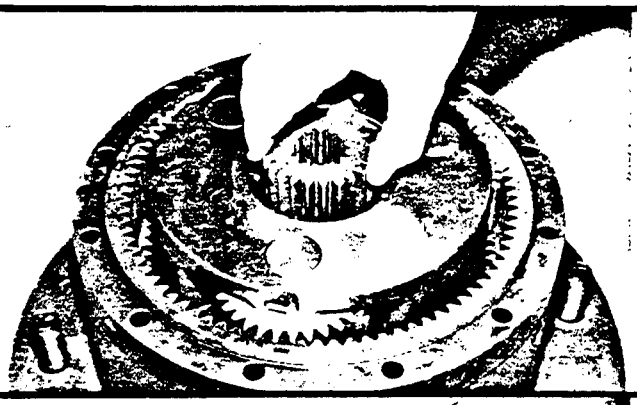


20. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation. The side of the Ring Gear with an "X" stamped on it should be up.

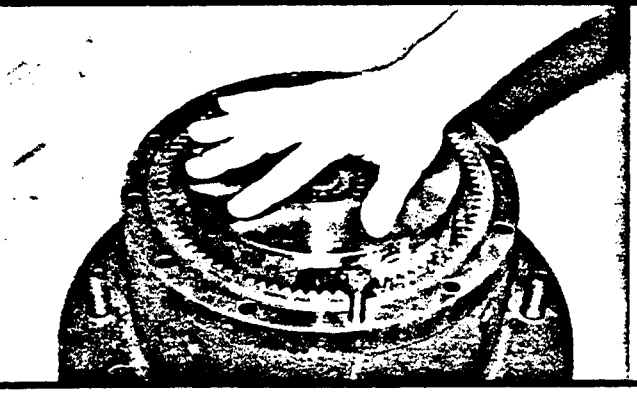


21. While holding Ring Gear and Cluster Gears in mesh, place small side of Cluster Gears into mesh with the Internal Gear. On the Ring Gear locate the hole marked "X" over one of the marked counterbored holes in Hub.

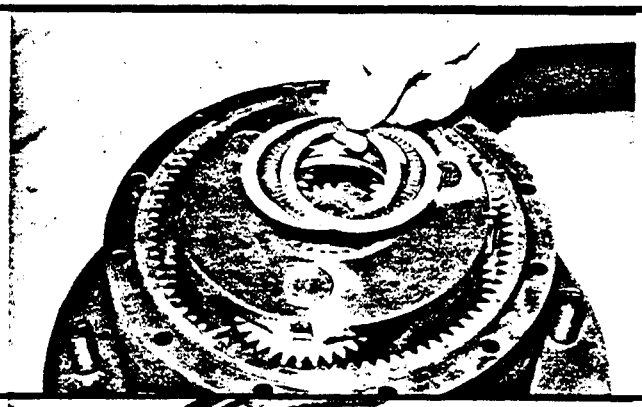
Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.



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.



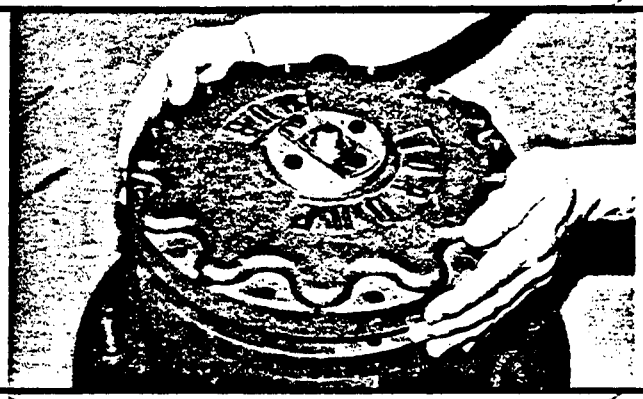
23. After inserting at least one Shoulder Bolt in the proper location, rotate the Carrier. This is to check freedom of rotation and recheck the timing.



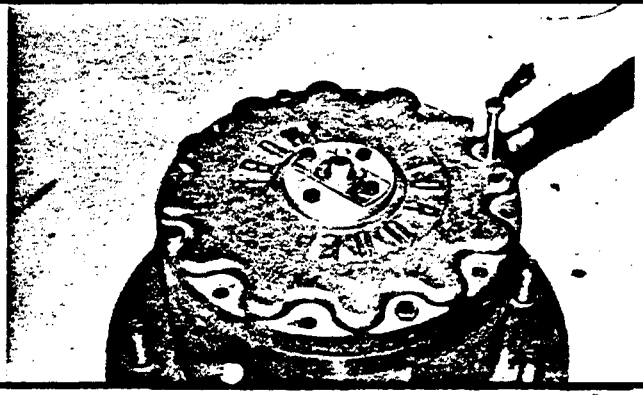
24. Another thrust washer/thrust bearing set is now installed into the counterbore in the face of the carrier.



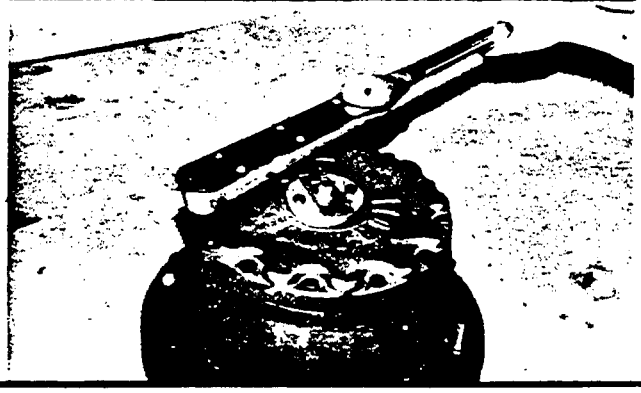
25. Place O'Ring into cover assembly counterbore. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.



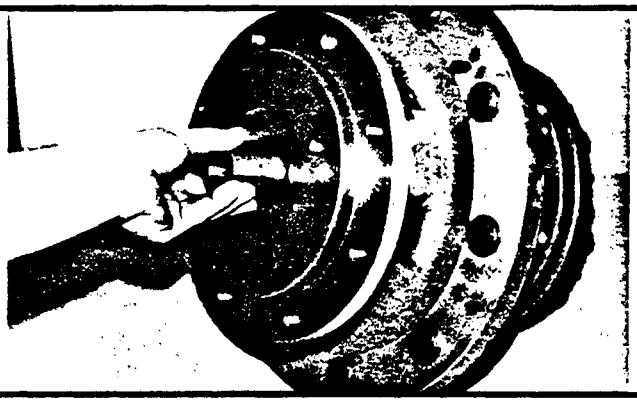
26. Place cover assembly on Ring Gear with oil level, check plug in cover located approximately 90° from oil fill plug in Hub.



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.

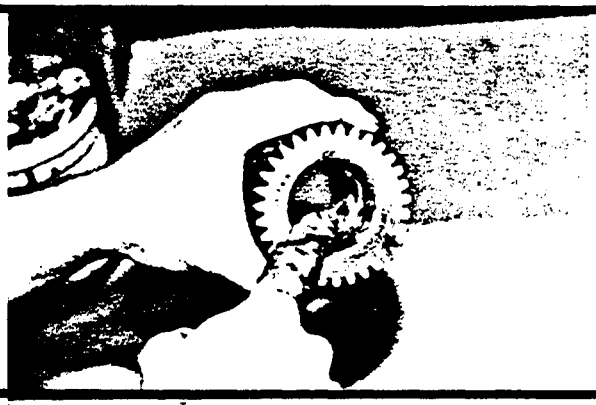


29. Place Coupling into the Spindle and onto the Input Shaft.

    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.

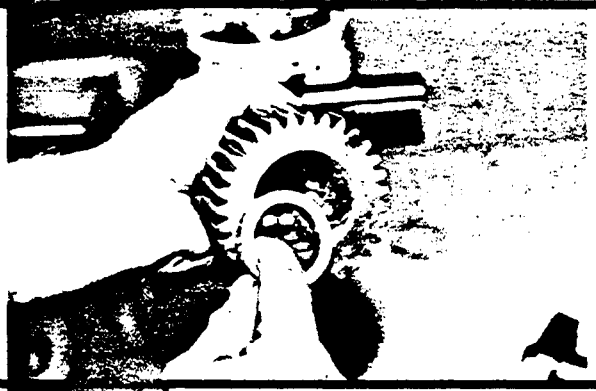
# Carrier Sub-Assembly



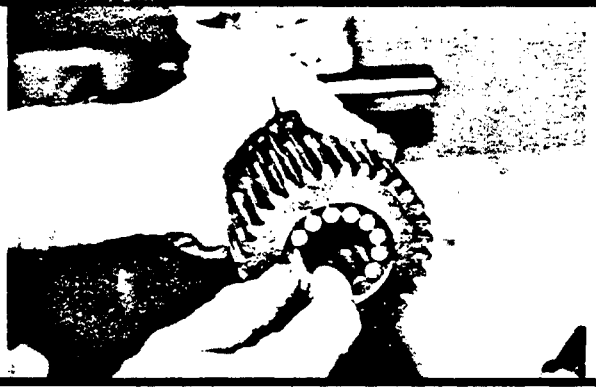
1. Apply a coat of grease or petroleum jelly to Cluster Gear bore.



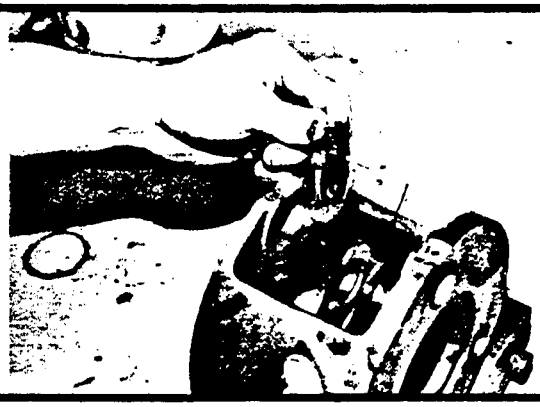
2. Place fourteen Needle Rollers into Cluster Gear bore.



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

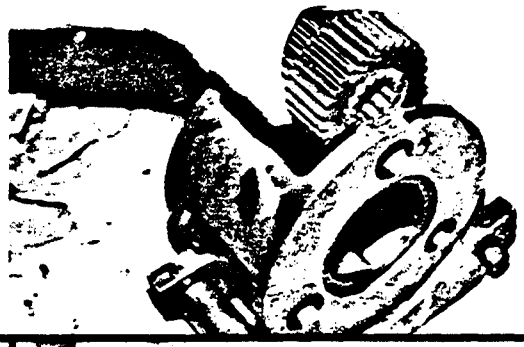


4. Place second set of fourteen Needle Rollers into Cluster Gear.

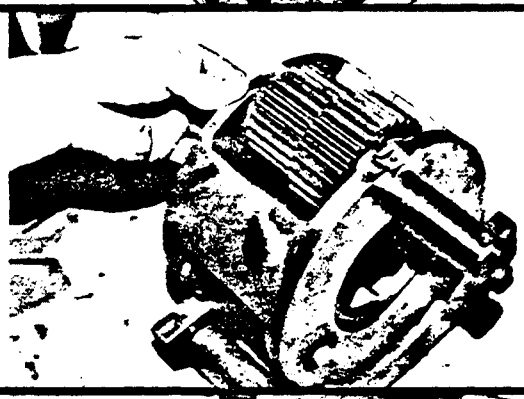


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

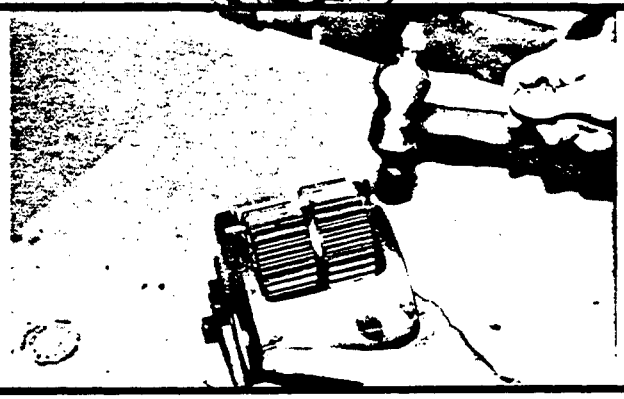
   Note: Some old style Carriers will not have slots and tangs should be located inside boss relief.



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



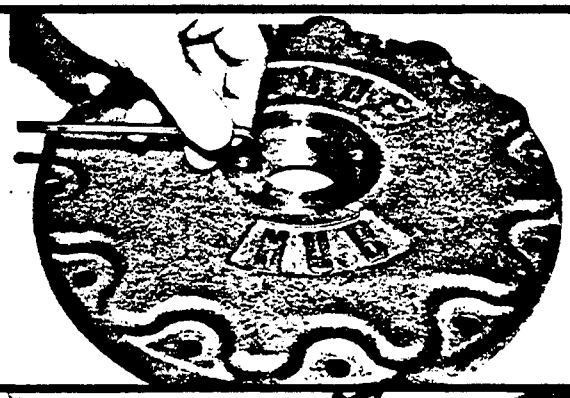
7. Line up Cluster Gear and thrust Washers with hole in Carrier and slide Planet Shaft through. Line up chamfered side of hole in Planet Shaft with pin hole in Carrier.



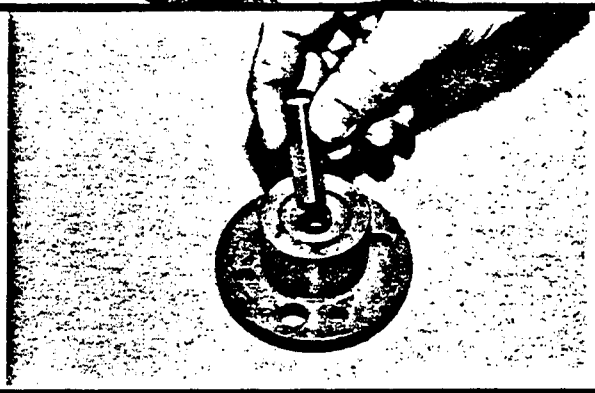
8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

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

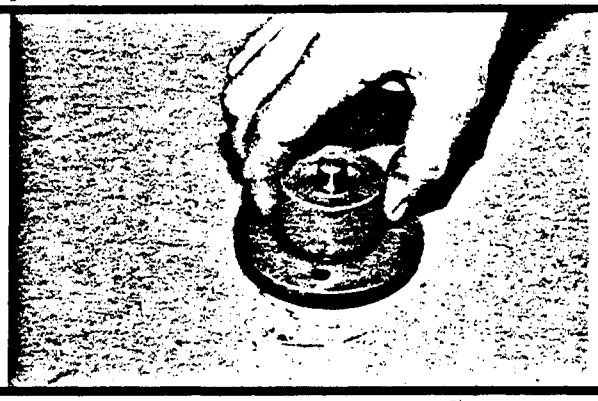
# Cover Sub-Assembly



1. Screw Pipe Plug into Cover.



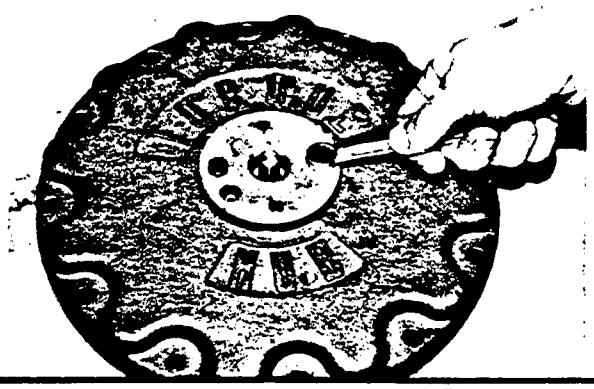
2. Place 'O' Ring into Cover Cap internal groove. The Disconnect Rod may be used to push 'O' Ring into groove. Rod will be held in place by friction from the 'O' Ring.



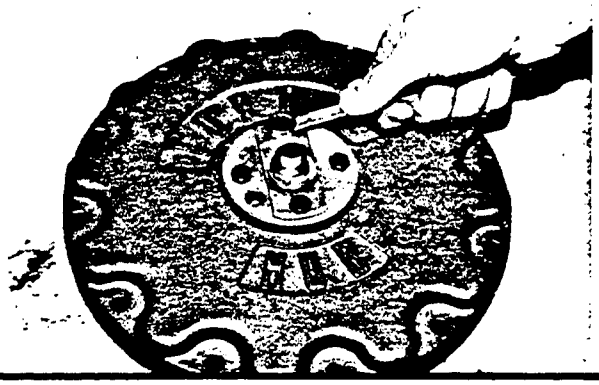
3. Slip 'O' Ring over Cover Cap and against face.



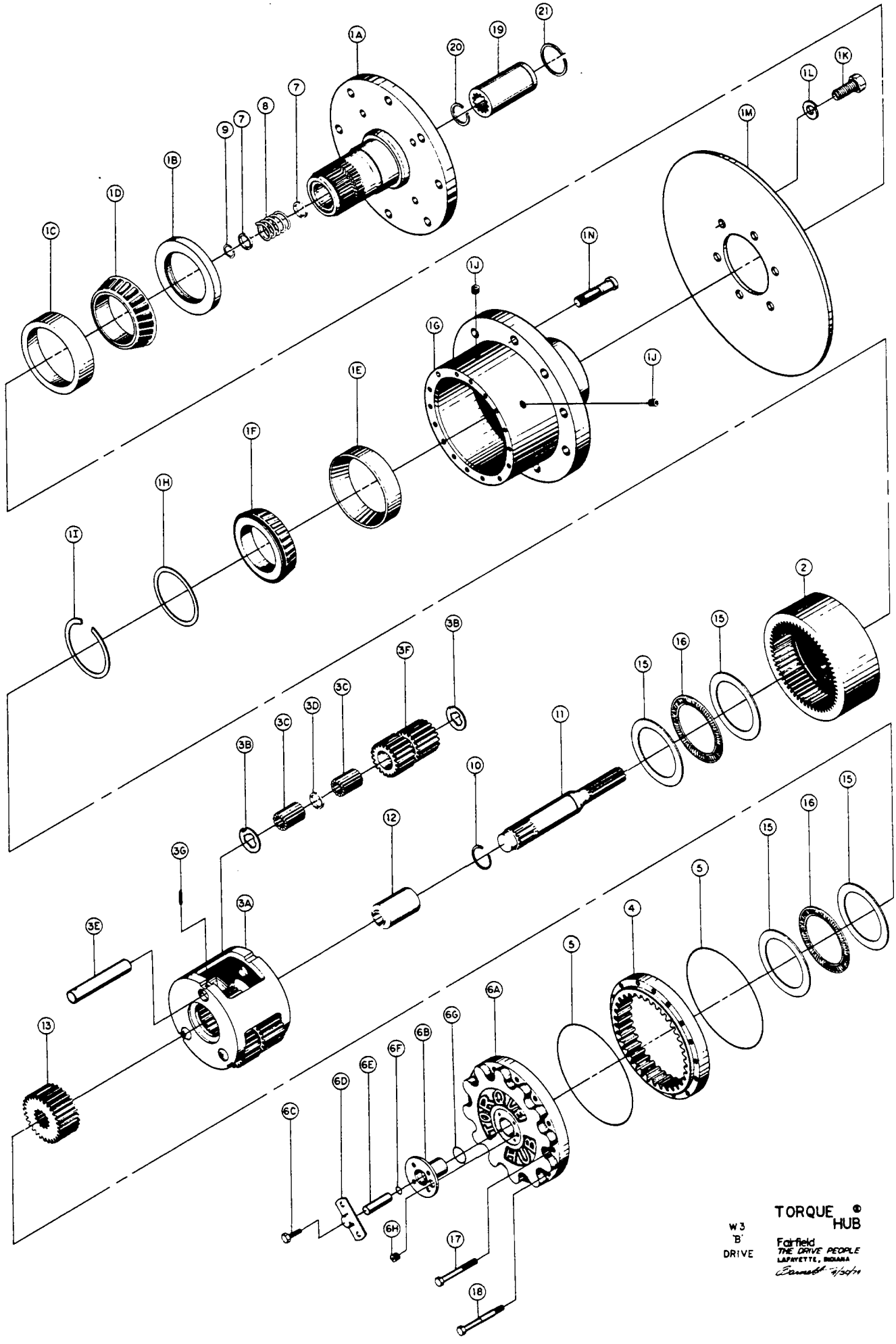
4. Place Cover Cap into Cover with large hole located over Pipe Plug.



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



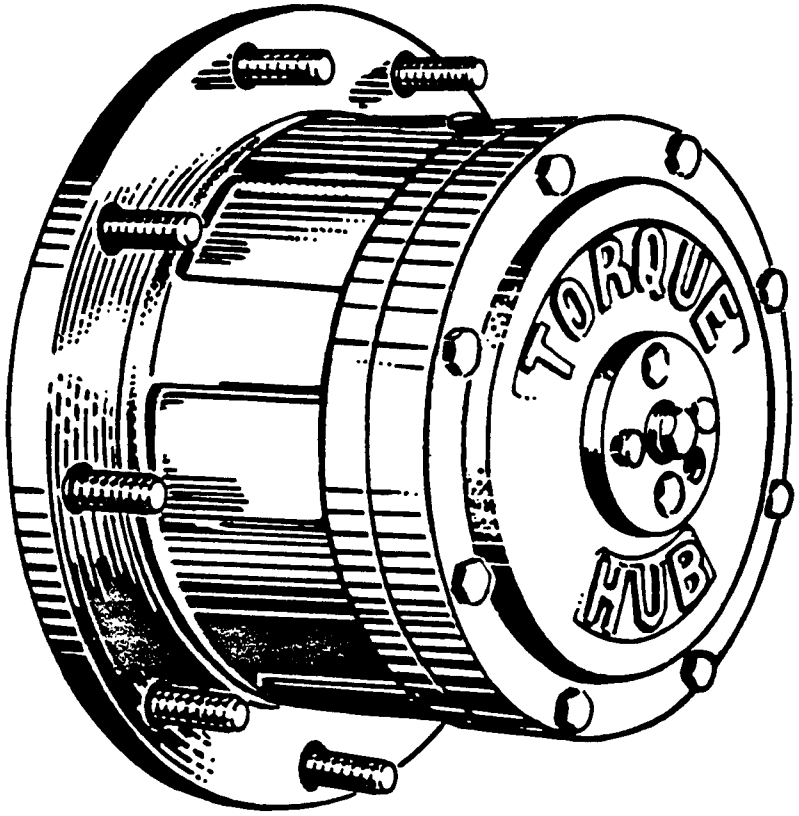
6. Place disconnect cap over cover cap with nipple facing out and align with two open holes. Secure disconnect cap to cover with two 1/4 × 20 × 3/4 and 70 - 80 in. lbs.




W3
'B'
DRIVE

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FOR MATERIAL HANDLING EQUIPMENT, FARM MACHINERY, ROAD EQUIPMENT, MINING MACHINERY, ETC.

Fairfield Manufacturing Company, Inc.
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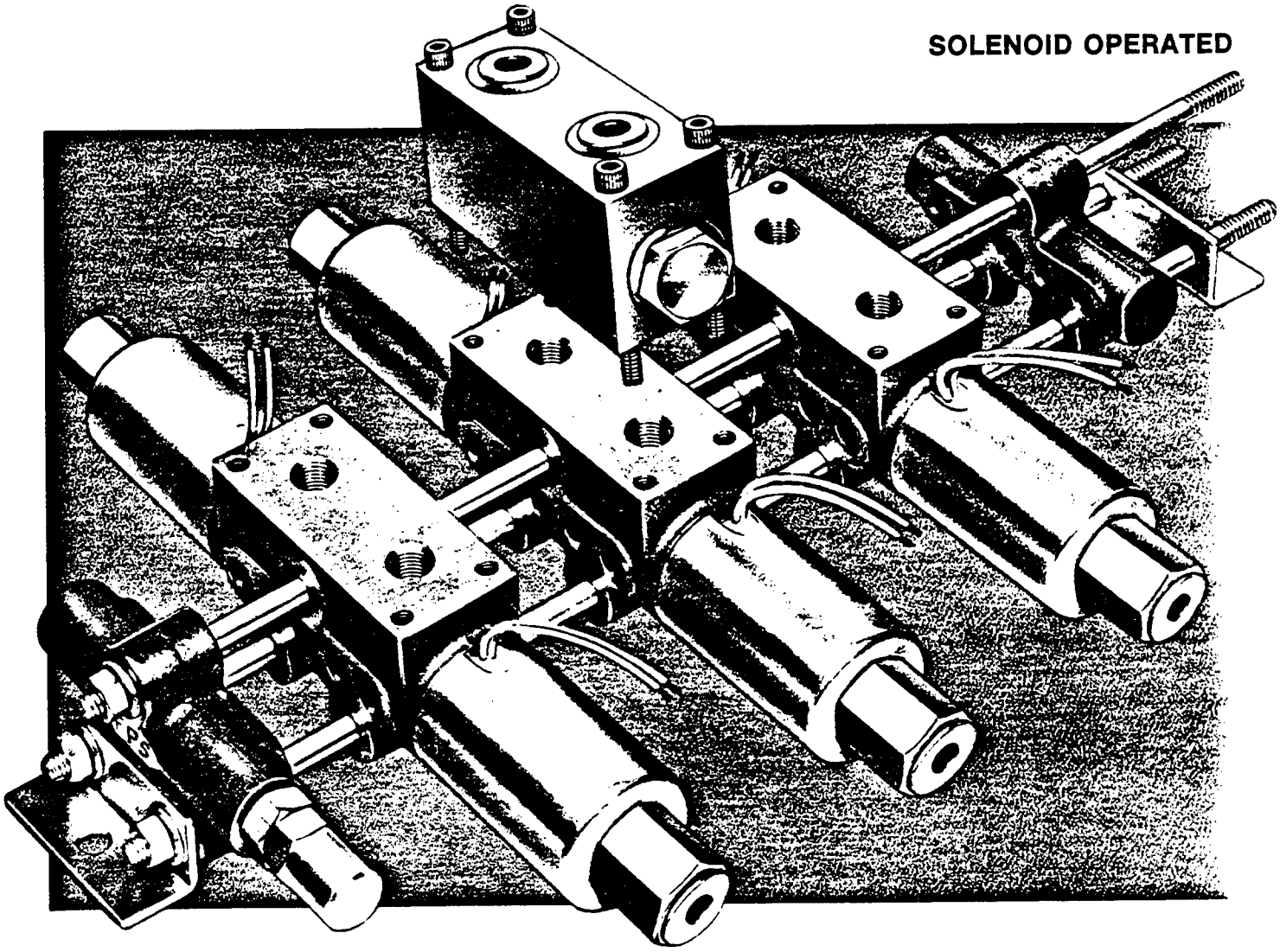
# Fairfield

THE DRIVE PEOPLE

Bulletin No. 5-2360-4

# mini-pak valves

## SOLENOID OPERATED



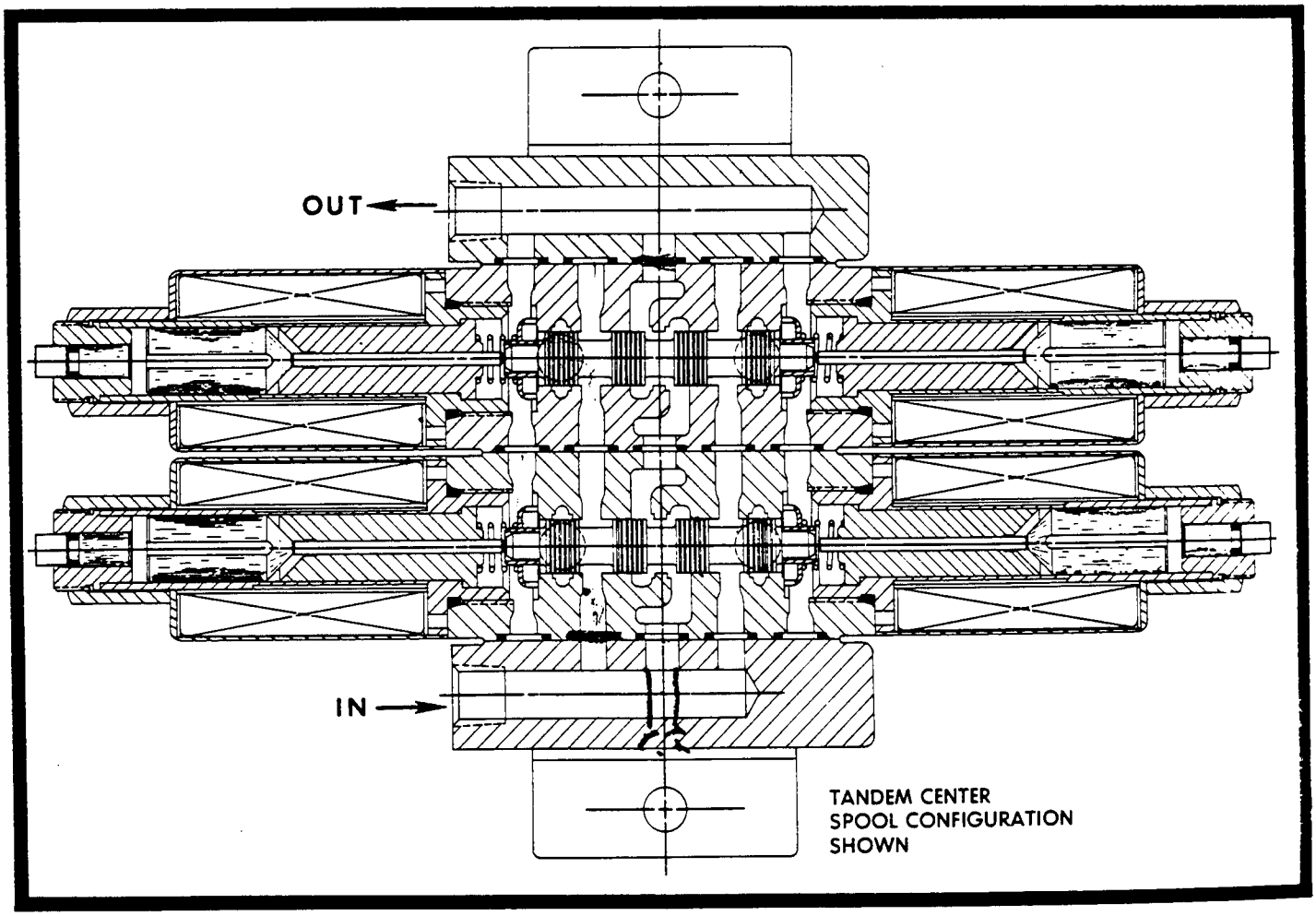
- maximum flow rate 19 L/min (5 gpm)
- working pressures to 207 BAR (3000 psi)
- direct solenoid operated — dc
- series-parallel circuit

AMBAC Industries Incorporated
FLUID POWER SYSTEMS DIVISION

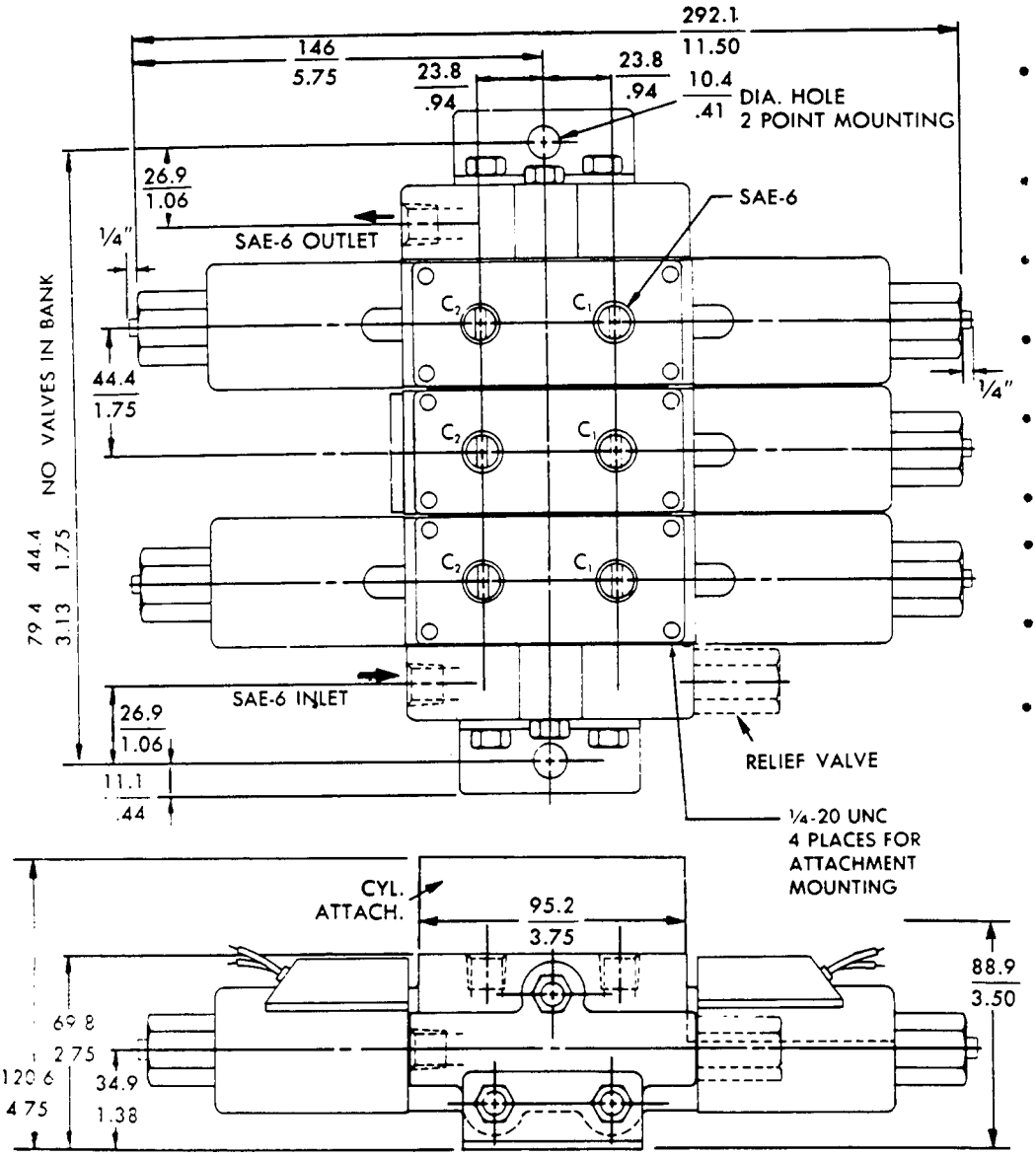
# mini-pak
# solenoid valve features

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

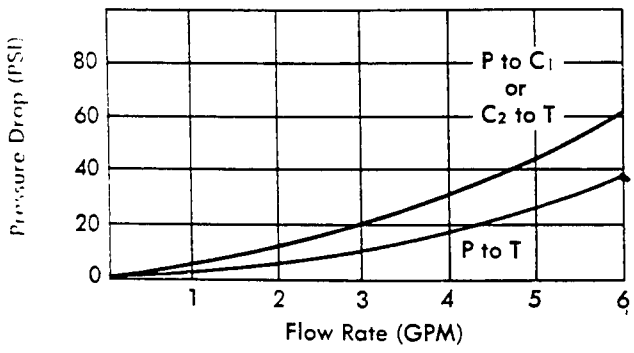



- Two position and Three Position Spools Available—Spool Types, Page 4.
- Rated Pressure 207 BAR (3000 PSI).
- Rated Oil Temperature 74°C (165°F).
- Available Voltages 12, 24 and 36 VDC.
- Current Draw 2.8 amp. @ 12 VDC @ 21°C (70°F).
- Can Be Mounted In Any Position.
- Weight 3.6 kg (8 lbs.) Per Section.
- **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.

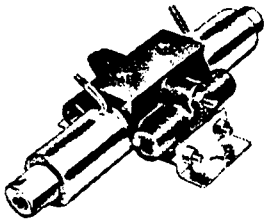
$$\frac{MM}{INCH} = MM/INCH.$$

| 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 |

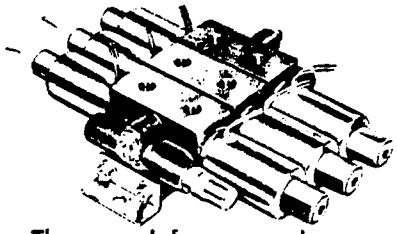
Pressure drop data for valve Model 56-10 (Tandem center 3 position 4-way, pressure to tank open — $C_1$ and $C_2$ blocked.) Maximum flow rate 19L/min (5 GPM). 150 SSU oil at 38°C (100°F).



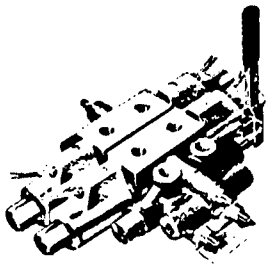

**Available options (consult factory).**



Four-way, three position double solenoid valve.

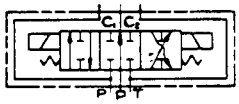
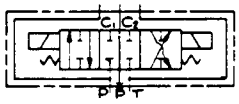
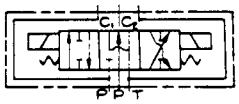
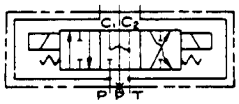
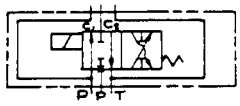
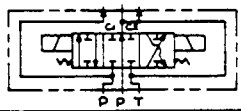


Three spool, four-way valve assembly with relief valve at inlet.



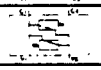
Three spool, four-way valve assembly with relief valve (Manual-Solenoid-Solenoid).

## 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 |

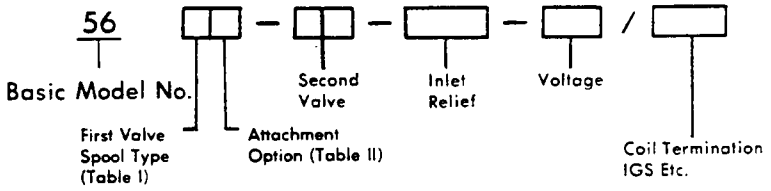
***For spool configurations other than shown consult factory.***

## 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 |
| | | C | Two Thermal Reliefs (3500 PSI) |
|  | Cross Over Relief | F | Specify Pressure Settings |
|  | Pilot Operated Check | L | Without Thermal Reliefs |
| | | Y | One Thermal Relief |
| | | Z | Two Thermal Reliefs |

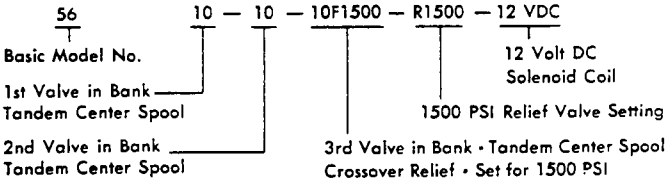
Code letter JJ indicates Palm Button Manual Override

## 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

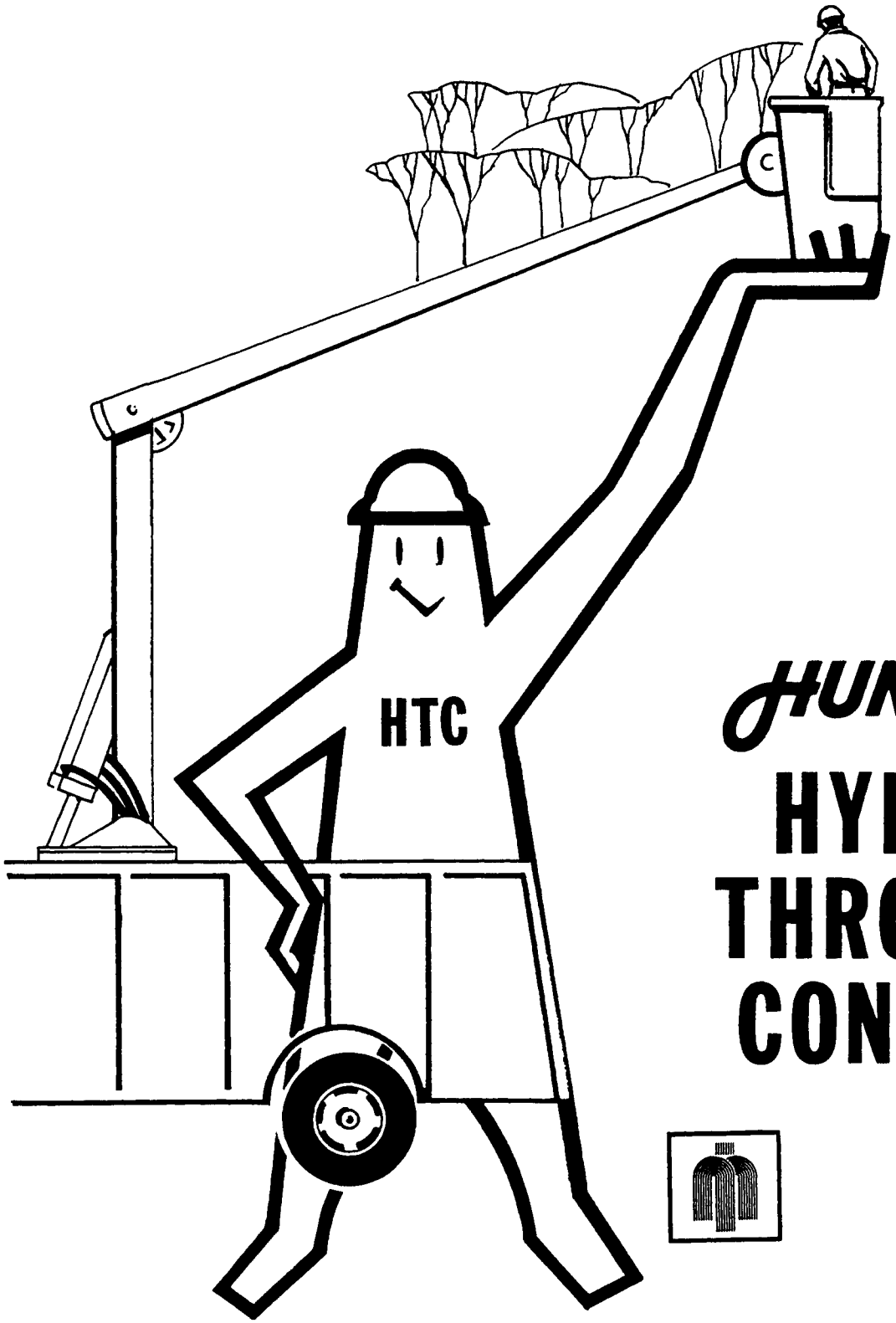




FO-LC-5M-3'78

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# INSTALLATION INSTRUCTIONS




## HUNTER

# HYDRO-THROTTLE CONTROL

**MARK INDUSTRIES**

## MUNCIE PARTS MFG. CO., INC.

**GENERAL OFFICES**
P.O. Box 548 • Muncie, Indiana 47305
Phone (317) 284-7721

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

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

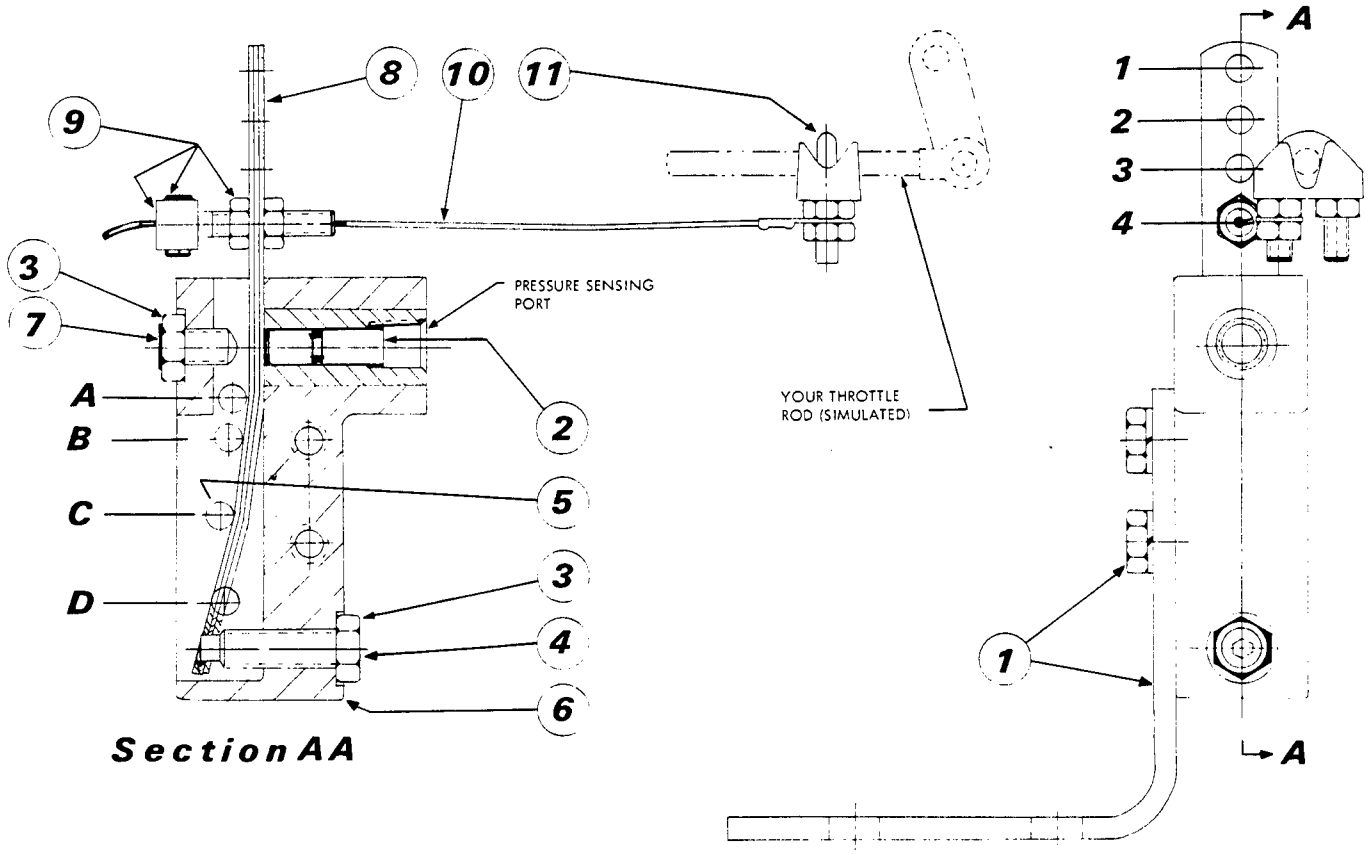
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P.O. Box 6593 • Toledo, Ohio 43612
Phone (419) 729-3861

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

**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 | | | Actuating Rod Hole Location |
|---|---|---|---|---|---|---|
| | | | *Turns | *Pressure | Rate | |
| 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. |

# STARTING and OPERATING INSTRUCTIONS

ISSUE MM-357

# WISCONSIN

## *Air-Cooled* Engines



## Four Cylinder Engine Models

## VH4D • VG4D • V-465D

TELEDYNE WISCONSIN MOTOR

WORLD'S FOREMOST SOURCE FOR HEAVY DUTY AIR COOLED ENGINES

# INTRODUCTION

*WISCONSIN* heavy duty air cooled engines are of the most advanced design and are built in a modern factory, equipped with the latest machinery available. Only the best materials, most suitable for the particular part, are used. During production, every part is subjected to rigid inspection, as are also the completely assembled engines. After assembly, every engine is operated on its own power and all adjustments are carefully made so that each engine will be in perfect operating condition when it leaves the factory.

Teledyne Wisconsin Motor is backed by over 65 years of engineering experience in the design of internal-combustion engines for every conceivable type of service. The performance of these engines is proof of the long satisfactory service you too can expect from your engine.

Like all fine machinery, the engine must be given regular care and be operated in accordance with the instructions.

# SPECIFICATIONS

## MODEL VH4D

| | |
|---|---|
| Bore | 3¼" |
| Stroke | 3¼" |
| Piston Displacement — cu. in. | 107.7 |
| Horsepower — 1400 R.P.M. | 17.2 |
| 1600 R.P.M. | 20.0 |
| 1800 R.P.M. | 22.5 |
| 2000 R.P.M. | 24.7 |
| 2200 R.P.M. | 26.5 |
| 2400 R.P.M. | 28.0 |
| 2600 R.P.M. | 29.2 |
| 2800 R.P.M. | 30.0 |

## MODEL VG4D

| | |
|---|---|
| Bore | 3½" |
| Stroke | 4 " |
| Piston Displacement — cu. in. | 154 |
| Horsepower — 1400 R.P.M. | 25 |
| 1600 R.P.M. | 29 |
| 1800 R.P.M. | 32 |
| 2000 R.P.M. | 34 |
| 2200 R.P.M. | 36 |
| 2400 R.P.M. | 37 |

## MODEL V-465D

| | |
|---|---|
| Bore | 3¾" |
| Stroke | 4 " |
| Piston Displacement — cu. in. | 177 |
| Horsepower — 1600 R.P.M. | 41.6 |
| 1800 R.P.M. | 47.5 |
| 2000 R.P.M. | 52.4 |
| 2200 R.P.M. | 56.7 |
| 2400 R.P.M. | 60.0 |
| 2600 R.P.M. | 63.0 |
| 2800 R.P.M. | 64.5 |
| 3000 R.P.M. | 65.9 |

Note: For continuous operation, allow 20% of horsepower shown, as a safety factor.

# SAFETY PRECAUTIONS

- Never fill fuel tank while engine is running or hot; avoid the possibility of spilled fuel causing a fire.
- Always refuel slowly to avoid spillage.
- When starting engine, maintain a safe distance from moving parts of equipment.
- Do not start engine with clutch engaged.
- Do not spin hand crank when starting. Keep cranking components clean and free from conditions which might cause the crank jaw to bind and not release properly. Oil periodically to prevent rust.
- Never run engine with governor disconnected, or operate at load speeds in excess of: 2800 R.P.M. for model VH4D, 2400 R.P.M. for model VG4D and 3000 R.P.M. for model V-465D.
- Do not operate engine in a closed building unless the exhaust is piped outside. This exhaust contains carbon monoxide, a poisonous, odorless and invisible gas, which if breathed causes serious illness and possible death.
- Never make adjustments on machinery while it is connected to the engine without first removing the ignition cables from the spark plugs. Turning the machinery over by hand during adjusting or cleaning might start the engine and machinery with it, causing serious injury to the operator.
- Precaution is the best insurance against accidents.

# NEW ENGINE Instructions

## • LUBRICATION

Operating without oil will ruin engine.

**IMPORTANT**

There is **NO OIL** in this unit.
Fill crankcase to proper oil level, also clutch or gear box if furnished, and oil bath air cleaner.

Refer to *GRADE OF OIL* chart (page 2) and fill with proper oil *before* starting engine.

## • AIR CLEANER

*Oil bath type* — Add same grade oil as used in crankcase to the level line indicated on cleaner bowl. Maintain oil level or dirt will be drawn in and damage engine.

*Dry element type, optional equipment* – DO NOT OIL – Follow instructions on cleaner body.

## • FUEL

*Use 'REGULAR' grade gasoline.* Engines built to operate on FUEL OIL, KEROSENE, L.P.G. or NATURAL GAS are so identified in the model designation. Refer to *'FUEL'* paragraphs of instructions.

Buy fresh fuel. Do not use *out-of-season* gasoline.

## • NEGATIVE GROUND CIRCUIT

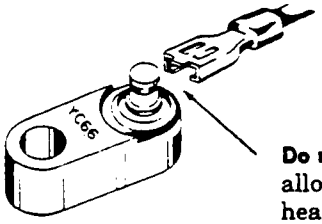
, if engine is equipped with STARTING MOTOR, DISTRIBUTOR IGNITION and FLYWHEEL ALTERNATOR, or GENERATOR.



**GROUND ENGINE TO NEGATIVE TERMINAL ON BATTERY.**

*CAUTION:* Be absolutely sure of proper connection or damage to the Alternator or Generator circuits will result.

## • PREVENT OVERHEATING



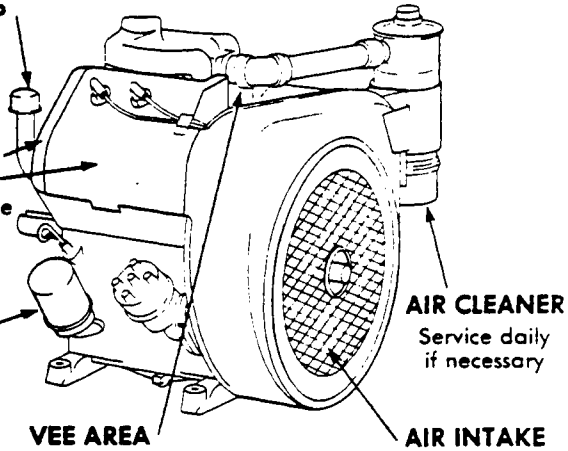

**Temperature Safety Switch**

**Do not** disconnect wire or allow terminal to touch head fins or shrouding.

Optional accessory mounted to cylinder head bolt near spark plug — *TO PROTECT ENGINE AGAINST OVERHEATING.* If engine stops, check first to see if engine is overheated. Other conditions may have caused the engine to stop. Clean air cleaner, air intake screen, fins, and check oil level, spark plugs and wiring. Let engine cool at least 10 minutes before restarting.

## Keep Engine Clean

External dirt restricts cooling and internal dirt causes wear.




## • NEW ENGINE BREAK-IN

Proper *break-in* will lead to trouble-free operation and increased engine life. The factory test given to a new engine is not sufficient to establish the polished bearing surfaces which are so necessary for good performance and long engine life. There is no quick way to force the establishment of good bearing surfaces, and these can only be obtained by running a new engine carefully and under reduced speeds and loads for a short period of time. Run the engine for a half hour without load at low idle speed (1000 to 1200 R.P.M.). The speed should then be increased gradually, to engine operating r.p.m. still without load, for an additional two hours. If at all possible, operate the engine at light loads for a period totaling about eight hours, before maximum load is applied.

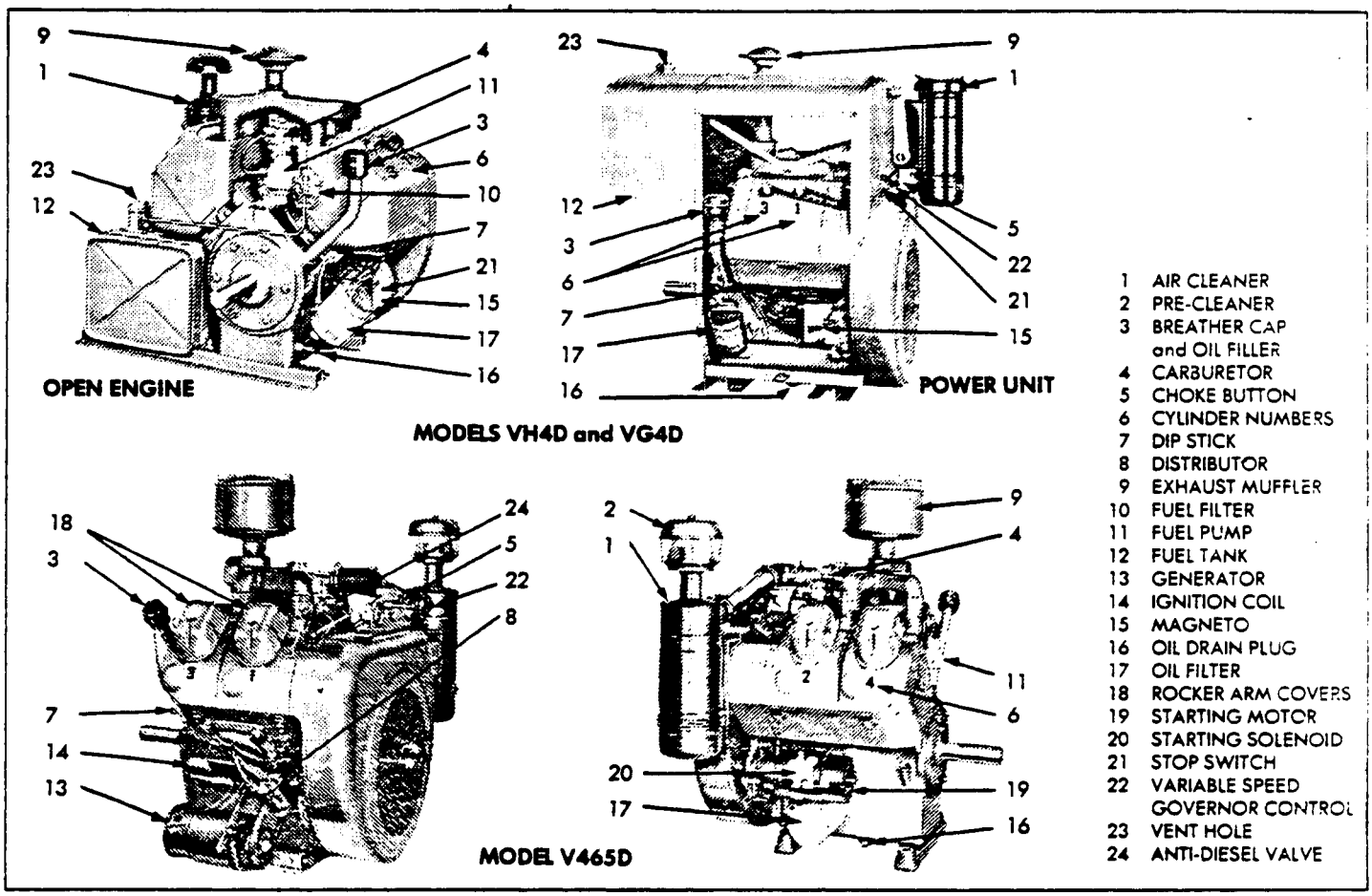



Fig. 1, REFERENCE VIEWS

## GENERAL INFORMATION

These engines are of the four cycle type, in which each of the four operations of suction, compression, expansion and exhaust constitutes a complete stroke. This gives one power stroke per cylinder for each two revolutions of the crankshaft.

### COOLING

Cooling is accomplished by a flow of air circulated over the cylinders and heads of the engine from a combination fan-flywheel encased in a sheet metal shroud. The air is divided and directed by ducts and baffles to insure uniform cooling of all parts.

NEVER OPERATE AN ENGINE WITH ANY PART OF THE SHROUDING REMOVED — this will retard air cooling.

### IGNITION

The spark for ignition of the fuel mixture is furnished by a high tension magneto driven by the timing gears at crankshaft speed (models VH4D and VG4D).

Battery ignition (12 volt) distributor, is furnished in place of magneto on engines equipped with flywheel alternator, or as optional ignition (Std. on model V-465D).

### ROTATION

The rotation of the crankshaft is clockwise when viewing from the flywheel or front end of the engine, and counterclockwise rotation of the power takeoff or rear end of the engine.

## BEFORE STARTING NEW ENGINE

1. Fill tank with Regular grade gasoline.

   OIL BURNING engine has letter 'O' suffixed to model designation — use 35 minimum octane fuel oil.

   L.P.G. BURNING engine has letter 'G' added to model designation — use propane HD5.

   NATURAL GAS burning engines require a B.T.U. content of at least 1000.

2. Fill crankcase base with the proper grade of engine oil as specified in "GRADE OF OIL" chart. Fill through the breather tube opening to the level indicated by the FULL mark on DIPSTICK.

   For run-in of new engines, use same oil as recommended in GRADE OF OIL chart.

   Check crankcase oil level every 8 hours, change oil every 50 hours of operation.

   To change oil, remove drain plug from oil pan. Oil should be drained while engine is hot; it will flow more freely.

3. Clutch and gear reduction unit lubrication differs between the various engine models. All units operating in oil are furnished with oil filler, level and drain plugs, suitable for any take-off shaft position.

GRADE OF OIL

| SEASON OR TEMPERATURE | GRADE OF OIL |
|---|---|
| Spring, Summer or Autumn +120°F to +40°F | SAE 30 |
| Winter +40°F to +15°F<br>+15°F to 0°F<br>Below 0°F | SAE 20-20W<br>SAE 10W<br>SAE 5W-20 |
| Use oils classified as Service MS, SD or SE | |

| Crankcase Capacity | VH4D | VG4D | V465D |
|---|---|---|---|
| New Engine | 3½ qts. | 4½ qts. | 6 qts. |
| Oil and filter change | 4 qts. | 5 qts. | 7qts. |
| Less — oil filter or filter change | 3½ qts. | 4½ qts. | 6 qts. |

Model VH4D, Fig 2 and Fig. 3:

Fill clutch and gear reduction units to the height of the oil level plug opening. Use same grade oil as used in engine crankcase. Add sufficient oil between changes to keep oil up to the level plug opening.

Change oil in clutch and reduction units at least every 500 hours of operation.

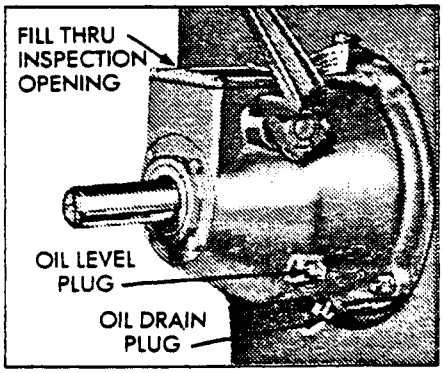



Fig. 2, VH4D
CLUTCH LUBRICATION

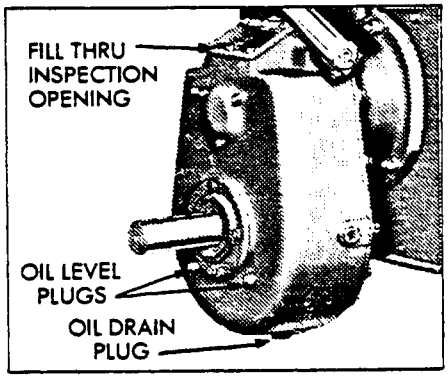



Fig. 3, VH4D
CLUTCH REDUCTION LUBRICATION

Models VG4D and V465, Fig. 4 and Fig. 5:

The clutch in both the power take-off and clutch reduction units is of the dry disc type, therefore NO OIL should be put into the clutch housing. Grease fittings are provided for periodic lubrication of the bearings. The HOUSING BEARING should be greased every 50 hours of operation, and the THROWOUT BEARING every day before starting. use Mobil Gargoyle grease BRB No 3, Sinclair AF-1 grease, or equal.

The PILOT BEARING is sealed and requires no external lubrication.

The SHIFTER SHAFT should be lubricated periodically if external oil fittings are provided.

THE REDUCTION UNIT IS OPERATED IN OIL and the gear case oil level must be maintained to the oil DIPSTICK mark or PLUG opening, which ever is applicable. In ROCKFORD units use No. 30 S.A.E. crankcase oil, for TWIN DISC units use

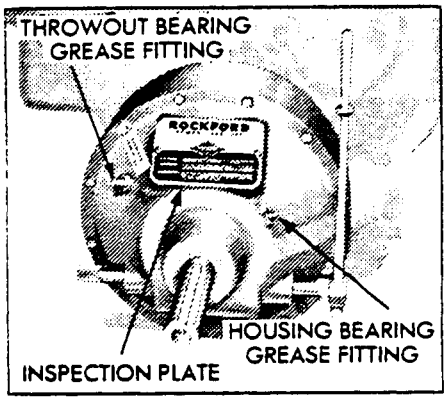



Fig. 4, VG4D, V465D
CLUTCH LUBRICATION

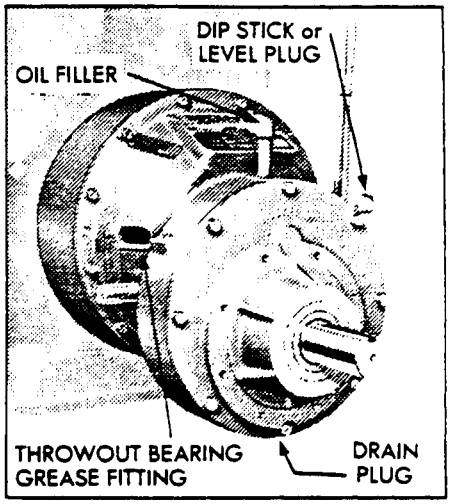



Fig. 5, VG4D, V465D
CLUTCH REDUCTION LUBRICATION

high grade transmission oil, S.A.E. No. 90 to No. 110 viscosity. Change oil every 500 hours of service, while unit is warm.

## STARTING

With reference to Fig. 1: Engines enclosed in a sheet metal house are referred to as Power Units, whereas those without a house are called Open Engines.

**Power Unit side doors should always be removed when operating.**

STARTING PROCEDURE Fig.'s 6,7,8

1. Check crankcase oil level and gasoline supply. Open shut-off valve in fuel strainer.

   OIL BURNING engines must be started on gasoline and run for 2 or 3 minutes before switching to oil. Special instructions are available for starting L.P.G. and NATURAL GAS burning engines.

2. Disengage clutch, if furnished.

3. Prime new engine — if necessary, see Fig. 6. Hand primer lever at fuel pump (available option), should be worked-back and forth until strainer bowl is full — then an additional 5 or 10 strokes to fill carburetor bowl. If primer does not function — turn crankshaft one complete revolution.

   Gravity feed (power units), and electric start engines do not require priming.

4. Set throttle about 1/2 open if variable speed governor control is furnished. With a two speed control, start in full load position — idle after engine starts.

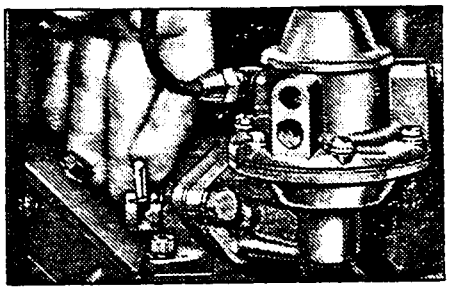


Fig. 6, FUEL PUMP PRIMER

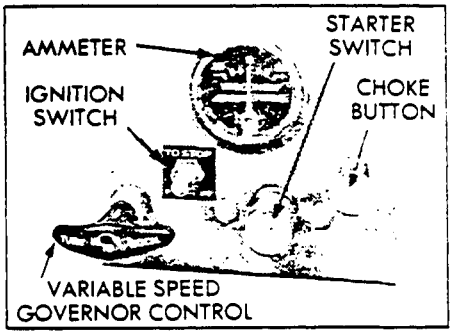



Fig. 7, VH4D, VG4D
CONTROL PANEL

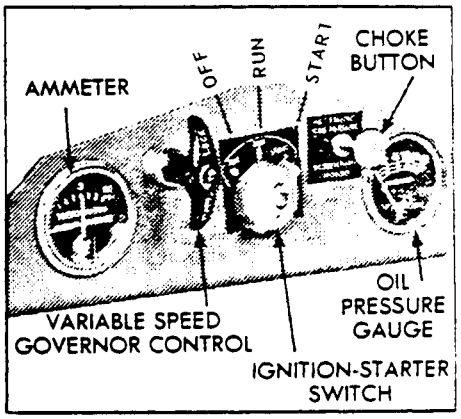



Fig. 8, V465D
CONTROL PANEL

Models VH4D and VG4D only, Fig. 7

5. Pull out ignition switch, if applicable (tag reads "TO STOP PUSH IN").

   Magneto ignition engines (less ignition switch), have a lever type ground switch on side of magneto which is always in the ON or running position, except when depressed for stopping.

5a. Close choke by pulling choke button to extreme out position.

5b. Turn engine over slowly one or two revolutions. CAUTION: Be sure that crank does not bind — apply oil to the crank jaw and crank nut extension for ease of engagement and release.

   Push choke control button in about half-way and then pull up rapidly on the starting crank. Do not attempt to spin the engine with the starting crank. If engine does not start on the first pull up of the crank, re-engage the crank and repeat the operation.

   With electric starting motor; depress starter switch button in place of hand cranking. See Fig. 7.

5c. After engine starts, push choke button in as required for smooth running. Choke should be completely open (button in), when engine is warmed up.

Less choking is necessary in warm weather or when engine is warm, than when cold. Should flooding occur, open choke fully and continue cranking.

Model V465D only, Fig. 8

6. After setting throttle as per paragraph 4.

   Turn IGNITION-STARTING SWITCH to 'Start' position and at the same time pull out choke button only sufficient to start the engine.

6a. Release choke button to open position after engine starts, but rechoke if it tends to stop. EVEN A HOT ENGINE REQUIRES MOMENTARY CHOKING WHEN STARTING. When engine starts release switch to 'RUN' position.

If flooding should occur, continue cranking with the starting motor, but with the choke open (choke button in).

WARM-UP

If all conditions are right, engine will start promptly in one or two attempts. After engine starts, allow it to warm up a few minutes before applying load. Do not race or gun engine to hurry WARM-UP. The proper oil film on various surfaces of the pistons, cylinders, bearings, etc., cannot be established until the oil has warmed up and become sufficiently fluid. Break-in new engine per instructions on page 1.

TO STOP ENGINE

Magneto ignition (open engines) have a lever type ground switch on the side of the magneto. DEPRESS AND HOLD DOWN UNTIL ENGINE STOPS. See Fig. 1, Ref. 21.

Power units and battery ignition, Fig. 7, are furnished with an ignition switch, "TO STOP PUSH IN".

Model V465D; turn IGNITION-STARTING SWITCH to OFF position. See Fig. 8.

If engine has been running hard and is hot, do not stop it abruptly from full load. Remove the load and allow the engine to run idle (1000 to 1200 R.P.M.), for 3 to 5 minutes. Air circulation from the flywheel will reduce the temperature of the engine much faster and minimize valve warping.

## MAINTENANCE

AIR CLEANERS

The air cleaner is an essential accessory, filtering the air entering the carburetor and preventing abrasive dirt from entering the engine and wearing out valves and piston rings in a very short time.

The air cleaner must be serviced frequently, depending on the dust conditions in which the engine is operated. Check hose connections for leaks or breaks and replace all broken or damaged hose clamps.

Excessive smoke or loss of power are good indications that the air cleaner requires attention.

OIL BATH AIR CLEANER, Fig. 9

Service daily; or twice a day if engine is operating in very dusty conditions. Once each week; in comparatively clean conditions.

Remove oil cup from bottom of air cleaner and clean thoroughly. Add the same grade of oil, as used in the engine crankcase, to the LEVEL LINE indicated on the oil cup.

Operating the engine under dusty conditions without oil in the air cleaner or with dirty oil, may wear out cylinders, pistons, rings and bearings in just a few days time.

Once a year; or oftener if conditions are severe, the air cleaner should be removed from the engine and the element, which is not removable, should be washed in a solvent to clean out accumulated dust and dirt.

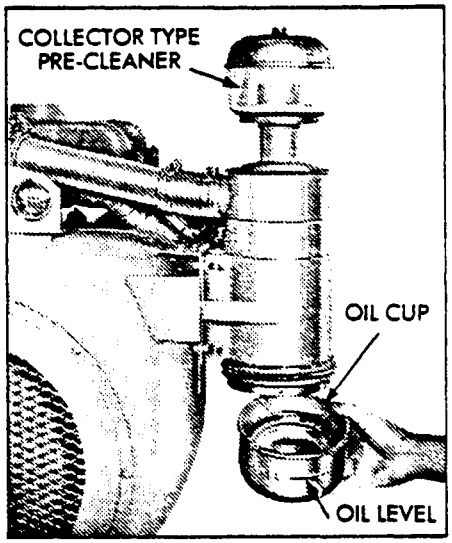


Fig. 9 OIL BATH AIR CLEANER

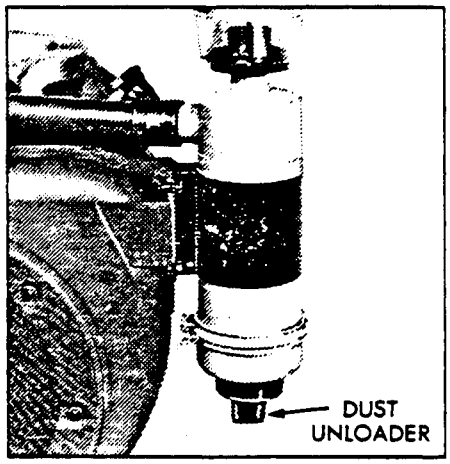


Fig. 10, DRY TYPE AIR CLEANER

DRY TYPE AIR CLEANER, Fig. 10

Service daily; squeeze rubber dust unloader once or twice a day to check for possible obstruction. If engine is operating in very dusty conditions, remove cartridge and shake out the accumulated dirt (do not tap or strike element — it may become damaged). Wipe out dirt from inside cover and bowl, after removing baffle and dumping out dust.

Once each week; the filtering cartridge should be taken out and rinsed under a faucet with cold water, then wash by repeated dippings for several minutes in a solution of lukewarm water and a mild, NON-SUDSING detergent. Rinse in cold water from the inside out, and allow to dry overnight before re-installing. In cold weather, protect element from freezing until dry.

DO NOT USE GASOLINE, KEROSENE OR SOLVENT — DO NOT OIL ELEMENT.

After ten washings or one year of service, replace cartridge. New cartridges are available at your TELEDYNE WISCONSIN MOTOR Service Center.

PRE-CLEANER

The collector type pre-cleaner, mounted to the top of the air cleaner as illustrated in Fig. 9, removes the larger dirt and dust particles before the air reaches the main air cleaner.

Clean bowl regularly of accumulated dust and dirt. Do not put oil or water in pre-cleaner, this must be kept dry.

BREATHER CAP, Fig. 1, Ref.3

The crankcase is ventilated thru a breather cap mounted ot the top of the oil filler tube. At every oil change, it is recommended that the cap be cleaned by washing in kerosene.

DISTRIBUTOR, Fig. 1, Ref. 8

If engine is equipped with battery ignition distributor:

Every 250 hours of operation; add 3 to 5 drops of medium engine oil to the oiler on side of distributor base.

Every 250 hours, apply 3 to 5 drops of light engine oil (10W), to the felt in the top of the cam sleeve, and 1 or 2 drops to the breaker arm pivot.

Every 250 hours, add a small amount of high melting point grease to the breaker arm rubbing block.

Avoid excessive lubrication. Oil on the contact points will cause them to burn.

GENERATOR - Belt Driver, Fig. 1, Ref 13

Every 50 hours of operation; add 3 to 5 drops of medium engine oil into the oil cups at both ends of the generator.

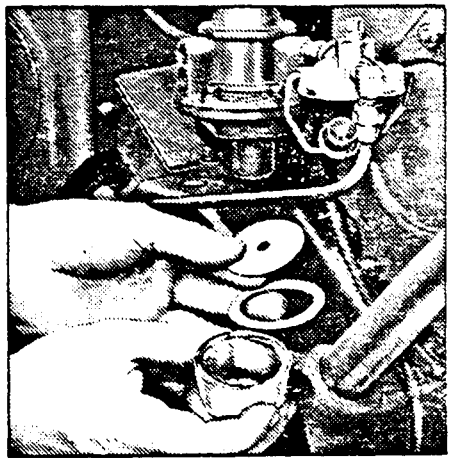
FUEL FILTER, Fig. 11

It is very important that the fuel be filtered to prevent sediment, dirt and water from entering the carburetor and causing trouble or even complete stoppage of the engine. The glass filter bowl should be inspected frequently, and cleaned if dirt or water are present.

To remove sediment bowl, loosen nut below bowl, swing bail to one side and twist bowl as it is being removed. Clean screen and bowl thoroughly — replace gasket if it is damaged or hardened.

OIL FILTER, Fig. 1, Ref. 17

A BY-PASS type oil filter is furnished on all Model VH4D and VG4D engines, except where the use of other accessories prevent mounting an oil filter.


Fig. 11, FUEL FILTER

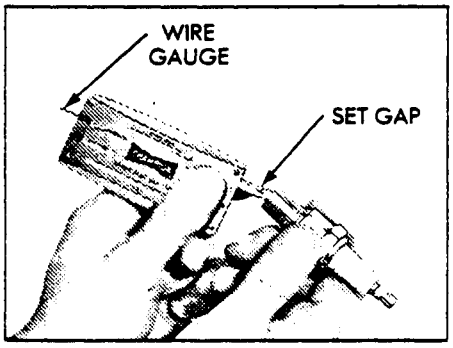



Fig. 12

A FULL-FLOW oil filter is furnished on model V465D engines as standard equipment. Since all of the circulated oil passes thru the filter, it is very important that it be serviced regularly.

The oil filtering cartridge should be replaced after EVERY OTHER OIL CHANGE. If operating conditions are extremely dusty, replace cartridge after every oil change. Use only Wisconsin Micro-Fine or Full-Flo oil filter cartridges from your nearby Teledyne Wisconsin Motor Service Center.

### SPARK PLUGS, Fig. 12

Incorrect gap, fouled or worn spark plug electrodes, will have an adverse affect on engine operation. Remove spark plugs periodically — clean, regap or replace if necessary.

Spark plug gap - .030 inch.

Use new spark plugs at the beginning of a new season. Replacement plug must be of the correct heat range, equal to:

| Model | Thread Size | Make |
|---|---|---|
| VH4D<br>VG4D | 18mm | Champion D-16J<br>(Wisconsin YD-6) |
| V465D | 14mm | Champion N-12Y<br>Wisconsin YD-301 |

Torque spark plugs 25 to 30 foot pounds for Models VH4D, VG4D, and to 22 foot pounds for Model V465D.

### STARTING MOTOR, Fig. 1, Ref. 19

No maintenance is required other than keeping the outside of the starting motor clean, and periodic inspection for insecure mounting and loose or corroded cable connections.

In extreme dust and dirt conditions it may be necessary to occasionally remove the starter from the engine and clean the Bendix by brushing with Kerosene. Do not oil Bendix.

## ADJUSTMENTS

### CARBURETOR

The carburetor MAIN METERING JET is of the fixed type and therefore no adjustment is necessary.

The correct amount of throttle plate opening for the proper low idle speed is obtained by means of the THROTTLE STOP SCREW. However, this is set at the factory so that no immediate adjustment is necessary. The IDLE ADJUSTMENT is for smooth low speed operation and this adjustment, if necessary, must be made with the carburetor throttle lever closed. Initial setting is approximately 1½ turns open.

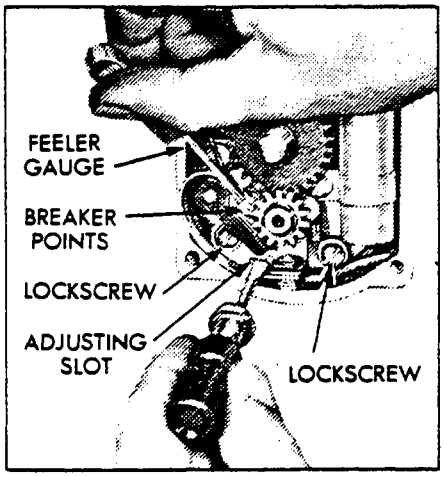



Fig. 13

### MAGNETO BREAKER POINTS, Fig. 13

At least once each season or when ignition spark becomes weak, remove magneto end cover, inspect points and check gap opening. If there is evidence of pitting or pyramiding and it becomes necessary to resurface or replace points, it will also be necessary to readjust the gap clearance. The BREAKER POINT GAP should be:

.015 inch at full separation.

Turn engine crankshaft over until breaker points are at their maximum opening. Loosen the two lockscrews on breaker plate just enough so that plate can be moved. Place a 0.015 inch feeler gauge between points. Insert end of small screw driver into adjusting slot at bottom of breaker plate and open or close the contacts by moving plate until a slight drag is felt when sliding the feeler gauge from between the points. Tighten lockscrews and recheck point gap.

Before placing end cover on frame, clean contact surfaces, coat with gasket cement and mount new gasket. Assemble cover, rotor and end cap.

### DISTRIBUTOR (Battery Ignition), Fig. 14

The breaker point gap should be:

.020 inch at full separation.

To readjust point gap, turn engine over by means of the hand crank until the distributor breaker arm RUBBING BLOCK is on a high point of the CAM. Loosen the stationary contact LOCKSCREW slightly and insert a feeler gauge between the points. By means of a screw driver, turn ADJUSTING SCREW until correct gap is obtained. Tighten lockscrew and recheck gap.

Points that are badly pitted or worn should be replaced.

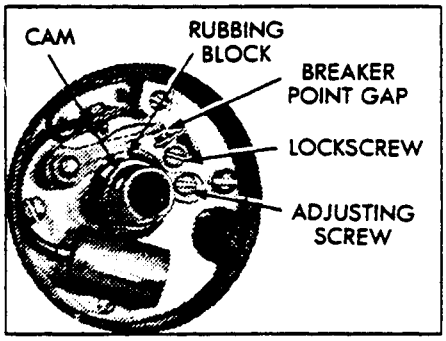



Fig. 14

### VALVE TAPPET ADJUSTMENT

Models VH4D, VG4D, Fig. 15

With the tappets in their lowest position (valves completely closed) and engine cold, the clearance between valve stem and tappet adjusting screw should be:

Inlet - .008" Exhaust - .016"

The inlet valves are to the inside of the cylinder block, the exhaust valves are toward the outside. Place feeler gauge between valve stem and tappet screw, and adjust clearance by means of two ½ inch tappet wrenches.

Model V465D, Fig. 16

The clearance between the valve and rocher arm, with the tappet in its lowest position (valve completely closed) and the engine cold.

Inlet - .008" Exhaust - .014"

The rocker arms can be identified as follows: When facing toward the sideof the engine, the Exhaust Rocker Arm is to the right in the cylinder head and the inlet rocker arm to the left.

Measure clearance between the top of the valve and nose of rocker arm with a feeler

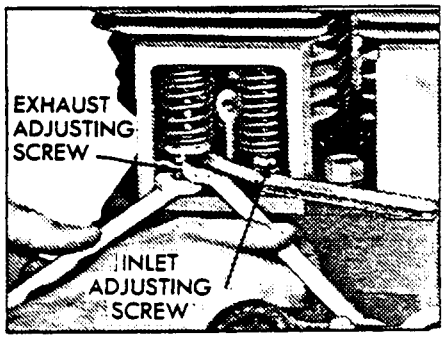



Fig. 15, VH4D, VG4D
VALVE TAPPET ADJUSTMENT

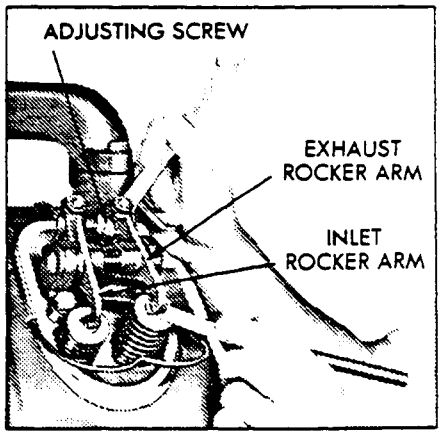



Fig. 16, V465D
VALVE TAPPET ADJUSTMENT

gauge as shown. By means of a ½ inch tappet wrench, turn the adjusting screw clockwise to decrease valve clearance and counter-clockwise to increase the clearance.

The sequence in which the tappets are adjusted is determined by the 1-3-4-2 firing order. Start by adjusting No. 1 inlet valve clearance first, then by just a short turn of the crank, No. 3 inlet can be adjusted. Return to No. 1 cylinder and adjust the exhaust clearance, then adjust the No. 3 exhaust.

The same procedure applies to the No. 2 and No. 4 bank of cylinders, starting with No. 4 inlet valve. Mark each rocker arm with chalk as adjustment is completed, to prevent repetition.

## TIMING

### FIRING ORDER

The firing order of the cylinders is 1-3-4-2, and the magneto or distributor rotor turns at one-half engine speed, as is the case with conventional 'In Line' engines.

The intervals between the firing of the cylinders is 180°. No. 1 cylinder is the one nearest to the flywheel in the left bank of cylinders, when viewed from the flywheel end of the engine. No. 3 cylinder is the other cylinder in this bank. No. 2 cylinder is the one nearest to the flywheel in the right bank of cylinders and No. 4 is the other cylinder in this bank. The cylinders are numbered on the head covers.

Note: When disconnecting ignition wires, mark cap, and tag wires for correct re-assembly.

### TIMING CHECK, Fig. 17

The running spark advance for both magneto and battery ignition, is 23°, and timing must be checked with the engine running at 2000 R.P.M. or over.

Insert a small screw driver into the No. 1 terminal tower on the distributor cap, making contact with the ignition wire terminal. Connect the red terminal clip, from an automotive Timing Light to the metal part of the screw driver. Connect the other two wires of the timing light; one to the positive side of the battery, the other to ground. Chalk or paint the end of the 'X' marked vane of the flywheel, white. Then, with the engine operating at 2000 r.p.m. or over, allow the flash from the timing light to illuminate the white vane. At the time of the flash the leading edge of the vane should line up with the running spark advance timing hole in the front face of the flywheel shroud.

Note: Timing can be checked without removing flywheel shroud screen (Fig. 17 shows screen removed), by illuminating leading edge of white vane with timing light thru the ⅜" diameter hole in rim face of flywheel screen.

Timing Adjustment for either battery or magneto ignition: Refer to the INSTRUCTION and PARTS MANUAL of the specific engine model for adjustment procedure.

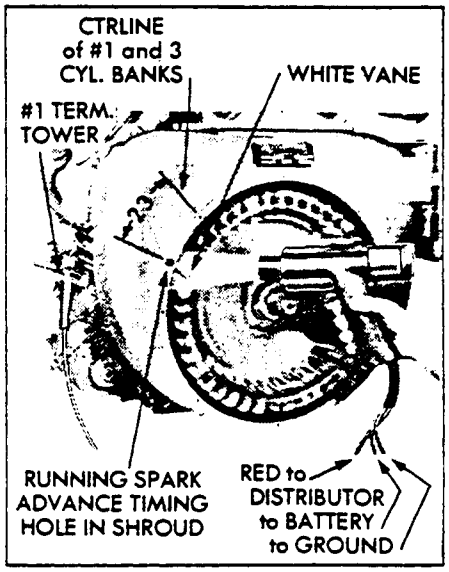



Fig. 17

## CLUTCH ADJUSTMENT

If the clutch begins to slip, it should be readjusted to prevent it from becoming overheated and damaged. First, remove inspection plate to expose the adjusting ring. Release clutch by pushing shifter lever forward (toward engine).

### VH4D Clutch, Fig. 18

Turn engine over by means of the starting crank until clutch adjustment lock is visible thru the inspection opening. Loosen adjustment lockscrew one full turn. Keep clutch from turning by securing the crankshaft at cranking end. Then, by means of a screw driver, turn adjusting ring one notch at a time in a clockwise direction, until a very firm pressure is required when engaging the clutch shifter lever, and as the clutch snaps into engaged position. Securely tighten adjustment lockscrew.

### VH4D CLUTCH REDUCTION, Fig. 19

The clutch in the clutch reduction unit is the same as used in the power take-off unit and is adjusted thru two pipe tap openings; one for the adjustment lockscrew and the other for turning the adjusting ring. If one of the taps is inaccessible, adjustment can be made thru just one opening by rotating clutch slightly after adjustment lockscrew is loosened. Follow adjustment procedures as outlined in preceding paragraph.

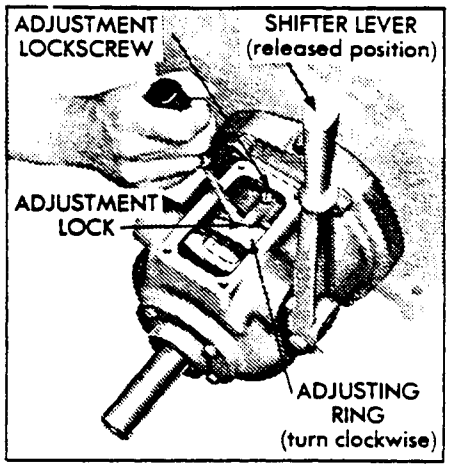



Fig. 18, VH4D
CLUTCH ADJUSTMENT

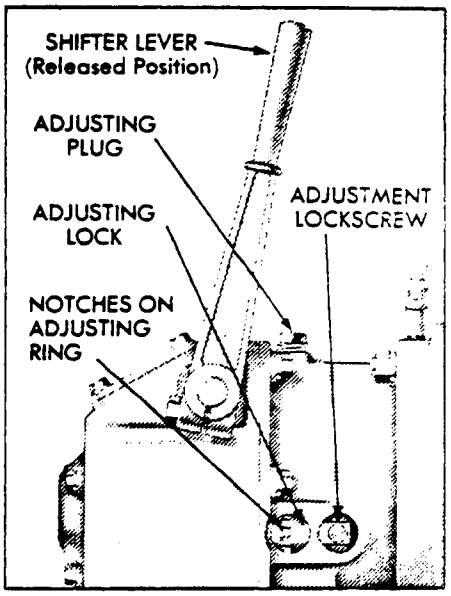



Fig. 19, VH4D
CLUTCH REDUCTION ADJUSTMENT

### VG4D, V465D CLUTCH ADJUSTMENT

Rockford Clutch Fig. 20: After removing the inspection cover and disengaging clutch with the shifter lever, turn engine over by means of the hand crank, until the clutch adjustment lock is visible thru the inspection opening in the clutch housing. Prevent take-off shaft from turning by means of a drift punch wedged in place as shown. Then, loosen the lockscrew holding the adjustment lock in place. Insert a screwdriver in one of the notches and turn the adjusting ring, in a counter-clockwise direction, one notch at a time, until a very firm pressure is required to engage the clutch with the shifter lever. Tighten adjusting lockscrew and mount inspection cover.

TWIN DISC CLUTCH, Fig. 21: Pull adjusting lockpin out and insert a piece of 1/16" diameter wire into the hole on the side of the lockpin to keep pin in outer position. Turn the adjusting yoke in a clockwise direction

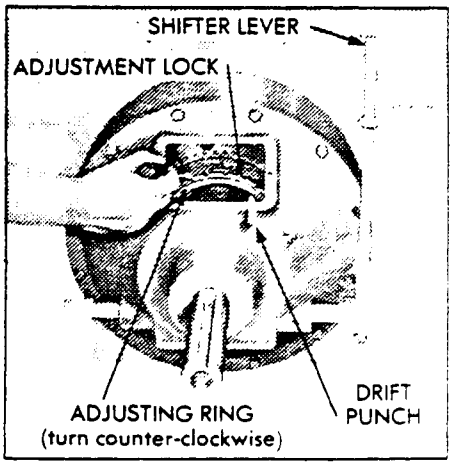



Fig. 20, VG4D, V465D
ROCKFORD CLUTCH ADJUSTMENT

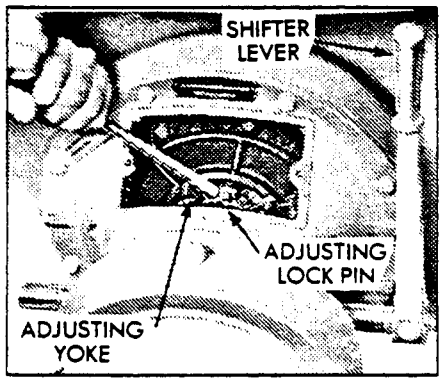



Fig. 21, VG4D, V465D
TWIN DISC CLUTCH ADJUSTMENT

as shown, or wedge a screw driver into the adjusting yoke and against the side of the inspection hole openings to keep the yoke from turning, then turn the take-off shaft counter-clockwise to adjust yoke enough so that the shifter lever requires a distinct pressure to engage. Remove wire from lockpin and turn adjusting yoke slightly, to allow lockpin to snap into hole in floating plate.

A new clutch generally requires several adjustments until the friction surfaces are worn in. Do Not let a new clutch slip, this will ruin the friction surfaces.

## FLYWHEEL ALTERNATOR

Fig. 22 and Fig. 23

12 Volt - 10 Amp or 25 Amp Flywheel Alternator, consisting of a flywheel with Magnetic Rotor, Stator and Rectifier- Regulator modules, is optional equipment on models VH4D and VG4D-furnished when battery ignition is required. There are no brushes, commutator or belts to contend with and no adjustments are necessary.

Since the physical appearance of both 10 amp and 25 amp alternator systems are very similar, they can be distinguished from each other by the ammeter calibrations; 0 to 15 amps for the 10 amp circuit and 0 to 30 amps for the 25 amp circuit.

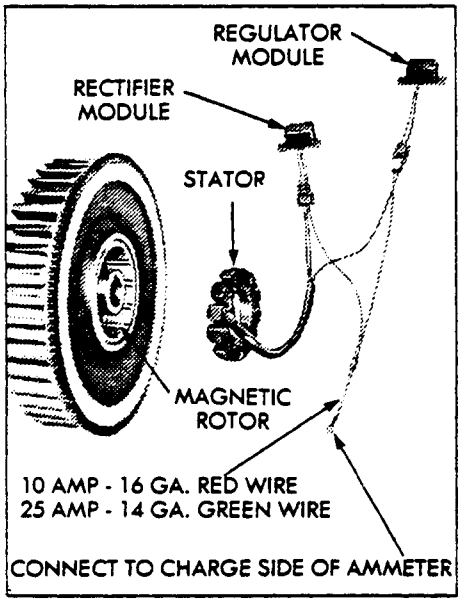



Fig. 22, FLYWHEEL ALTERNATOR

***PRECAUTIONS*** to be exercised in the use of this flywheel alternator:

1. Do not reverse battery connections. This is a negative ground system only.
2. Connect booster batteries — positive to positive and negative to negative.
3. Do not polarize the alternator.
4. Do not ground any wires from stator or modules which terminate at connectors.
5. Do not operate engine with battery disconnected from system.
6. Disconnect at least one battery lead if a battery charger is used.

### GENERATOR — WIRING CIRCUIT, Fig. 24

The model V465D engine is equipped with a 12 volt-17 amp generator in a negative ground electrical system. Do not reverse polarity-damage to both generator and regulator will occur. Engine will not operate with carburetor anti-diesel solenoid wire disconnected.

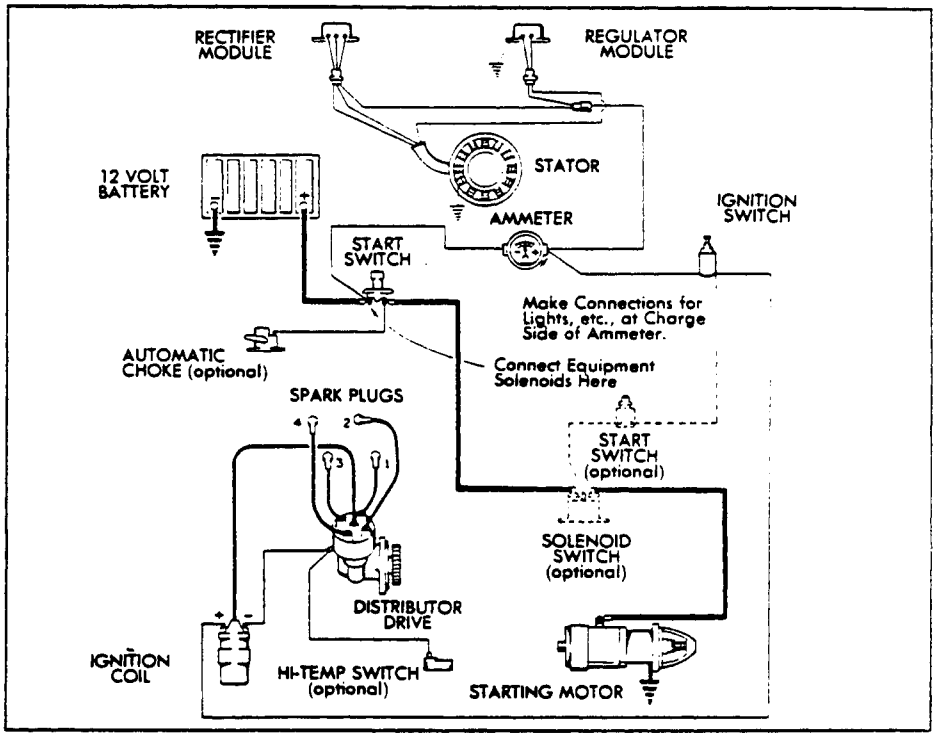



Fig. 23, WIRING DIAGRAM,Flywheel Alternator and Battery Ignition, Models VH4D, VG4D

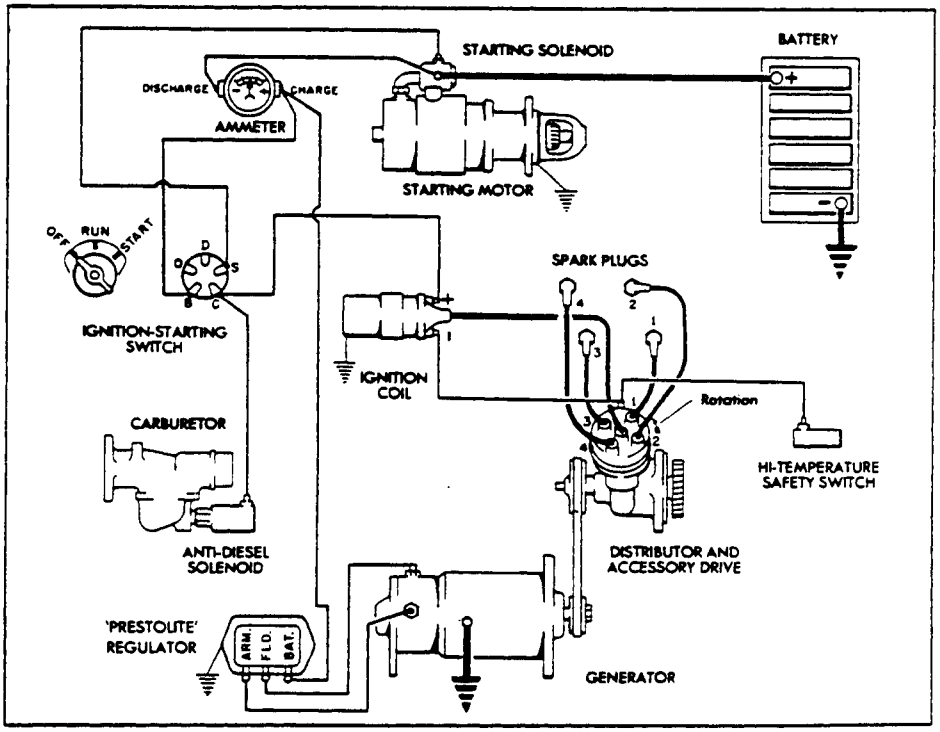



Fig. 24, WIRING DIAGRAM,Generator and Battery Ignition, Model V465D

# TROUBLE SHOOTING

The three prime requisites essential to starting and maintaining satisfactory operation of internal combustion engines are:

1. A proper fuel mixture in the cylinder.
2. Good compression in the cylinder.
3. Good spark, properly timed, to ignite the mixture.

If all three of these conditions do not exist the engine cannot be started.

As a guide to locating some of the difficulties in starting, causes are listed under the three main headings of:
Fuel Mixture, Compression, and Ignition.

## FUEL MIXTURE

No fuel in tank or fuel valve closed.

Plugged vent hole in fuel tank cap.

Fuel line clogged.

Fuel pump diaphragm worn or punctured.

Anti-diesel solenoid valve at carburetor inoperative (model V465D).
Check for disconnected, loose or broken wire.

Carburetor not choked sufficiently, especially if engine is cold.

Water, dirt, or gum in gasoline interfering with free flow of fuel to carburetor.

Poor grade, stale or out-of-season gasoline.

Carburetor flooded, caused by too much choking especially if engine is hot.

Carburetor float needle valve stuck open. This condition would be indicated if fuel continues to drip from carburetor with engine standing idle.

## COMPRESSION

Cylinders dry due to engine having been out of use. Pour one fluid ounce of crankcase oil through spark plug holes.

Loose or broken spark plug. A hissing noise will be heard in cranking due to escaping gas mixture on compression stroke.

Damaged cylinder head gasket or loose cylinder head. This will likewise cause hissing noise on compression stroke.

Valve stuck open. Piston rings stuck or worn.

Valves adjusted with insufficient clearance.

## IGNITION

Test for spark by removing spark plugs and observe spark at plug gap while turning engine over, No spark or weak spark may be attributed to the following:

Ignition wires loose or disconnected at magneto, spark plug, distributor or coil.

Broken or frayed ignition wires.

Spark plug insulator broken.

Spark plugs wet or dirty.

Spark plug gap incorrect.

Condensation on spark plug electrodes.

Breaker point gap incorrect.

Breaker points pitted or fused.

Breaker arm sticking.

Condenser leaking or grounded.

Spark timing wrong.

Weak battery. Faulty ignition coil.

## ENGINE MISSES

Spark plug gap incorrect.

Worn, leaking or loose ignition cables.

Weak spark. See 'Ignition' test for spark.

Breaker points pitted or worn.

Water in gasoline.

Poor compression. See 'Compression'.

Sticky valves.

## ENGINE STOPS

Fuel tank empty.

Water, dirt or gum in gasoline.

Gasoline vaporized in fuel lines, due to excessive heat around engine (Vapor Lock). See 'Stopping Engine'.

Vapor lock in fuel lines due to using winter gas (too volatile) in hot weather.

Air vent hole in fuel tank cap plugged.

Ignition troubles. See 'Ignition'.

## OVERHEATING

Crankcase oil supply low.

Ignition timing wrong.

Low grade of gasoline.

Engine overloaded.

Restricted cooling air circulation.

Part of air shroud removed from engine.

Dirt between cooling fins.

Intake or rotating screen clogged with dirt.

Restricted exhaust.

| ENGINE MAINTENANCE SCHEDULE | Page Ref. | Daily | Weekly or 50 hrs. | 100 hrs. | 250 hrs. | Seasonally or 500 hrs. |
|---|---|---|---|---|---|---|
| CHECK OIL LEVEL. Add to full mark - Do not overfill. | 2 | ● | | | | |
| CHECK AIR CLEANER. Shake out accumulated dirt from dry element cleaner - Maintain oil level in oil bath type cleaner. | 4 | ● | | | | |
| CLEAN AIR INTAKE SCREEN. Clean cooling fins if necessary. | 1 | ● | | | | |
| GREASE CLUTCH THROWOUT BEARING (VG4D, V465D). | 3 | ● | | | | |
| CHANGE CRANKCASE OIL. | 2 | | ● | | | |
| CLEAN AIR FILTER ELEMENT. DRY Element and OIL Bath types. | 4 | | ● | | | |
| CLEAN CRANKCASE BREATHER CAP. | 4 | | ● | | | |
| GREASE CLUTCH HOUSING BEARING (VG4D, V465D). | 3 | | ● | | | |
| REPLACE OIL FILTER. In adverse conditions replace every oil change. | 4 | | | ● | | |
| LUBRICATE DISTRIBUTOR SHAFT. | 4 | | | | ● | |
| CHECK COMPRESSION. Pressure should not vary more than 10 p.s.i. between cylinders. Remove head - clean out carbon deposits. Reseat valves if necessary. | - | | | | ● | |
| INSPECT SPARK PLUGS and BREAKER POINTS. Replace if necessary and regap to specification. | 5 | | | | ● | |
| INSPECT FUEL FILTER. Clean filter screen and glass bowl. | 4 | | | | ● | |
| LUBRICATE DISTRIBUTOR CAM and breaker arm pivot. | 4 | | | | ● | |
| INSPECT COOLING SYSTEM. Remove shrouding and scrape off dirt from between fins, around cylinders and from shrouding. | 1 | | | | ● | |
| INSPECT STARTING MOTOR. Check for loose mounting and cable connections. | 5 | | | | ● | |
| CHANGE OIL IN CLUTCH and REDUCTION GEAR HOUSINGS. | 2 | | | | | ● |

# YB-69 ALTERNATOR

## WISCONSIN Engine Model V-465D

### *SPECIFICATIONS*

| | | |
|---|---|---|
| VOLTS – 12 | VENTILATED – Yes | RATED OUTPUT – 37 Amperes |
| BRUSHES – 2 | CONTROL – Voltage Regulator | ROTATION – Clockwise at drive end |

LUBRICATION – Bearings are pre-lubricated. No additional lubrication necessary.

### PRECAUTIONS:

Observe proper polarity when installing battery; negative battery terminal must be grounded. Reverse polarity will destroy the rectifier diodes in alternator.

As a precautionary measure, disconnect ground battery terminal when charging battery in vehicle. Connecting charger in reverse will destroy the rectifier diodes in the alternator.

Do Not, under any circumstances, short the field terminal of the alternator to ground, as permanent damage to the regulator may occur.

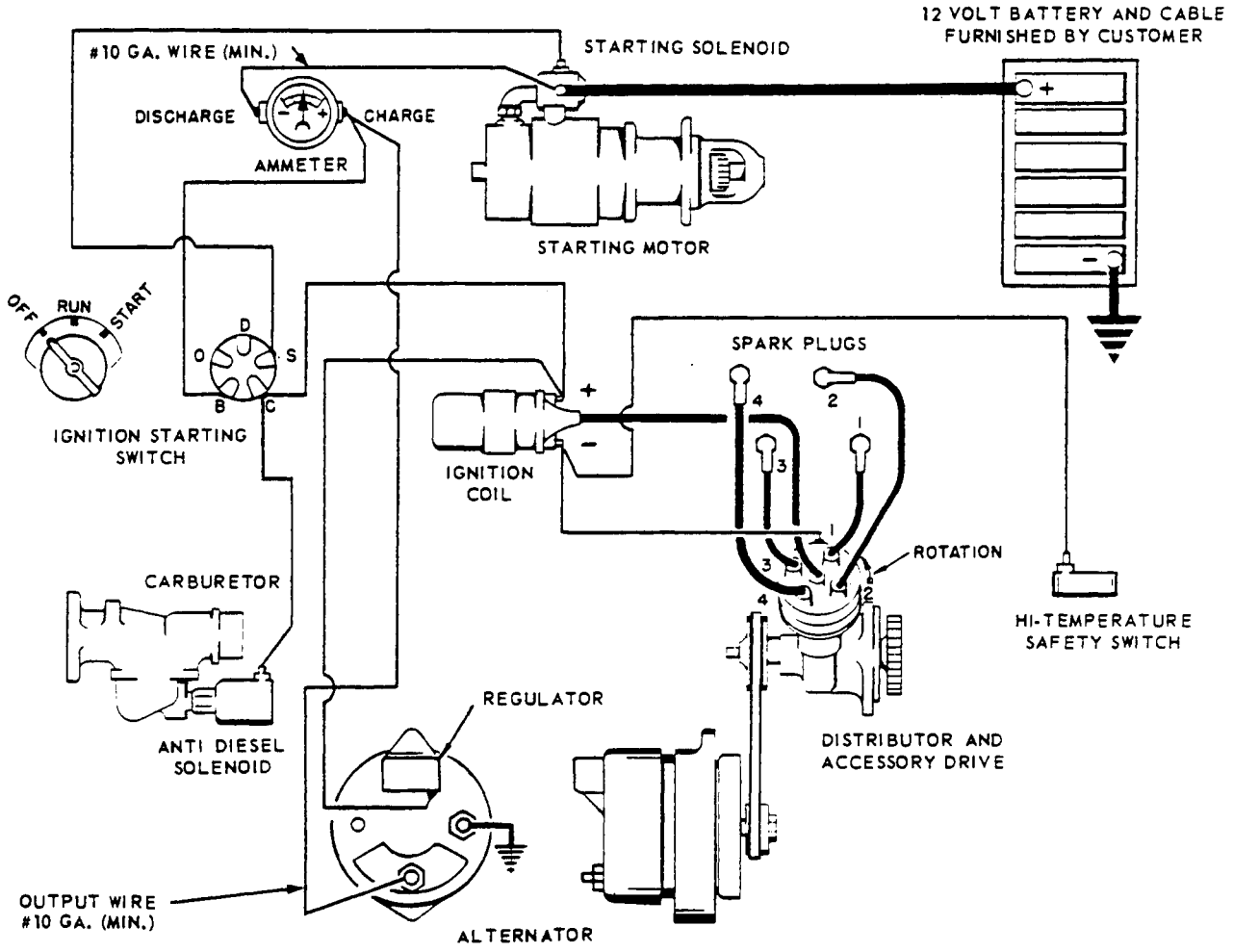
Do Not, remove the alternator from the vehicle without first disconnecting the grounded battery cable.

Do Not, operate engine with battery disconnected, or disconnect the alternator output lead while the alternator is operating, as damping effect of the battery will be lost. The voltage will rise to an extreme value and permanent damage to the regulator may occur.

Do Not, disconnect the voltage regulator while the alternator is operating, because the large voltage transient that occurs when disconnection takes place may damage the regulator.

Caution: Output wires from Alternator to Ammeter, and from Ammeter to battery terminal on starting solenoid must be of sufficient size for charging 37 amps. Use No. 10 gage stranded wire, or larger.

### *WIRING DIAGRAM*




TELEDYNE WISCONSIN MOTOR MILWAUKEE, WISCONSIN 53219



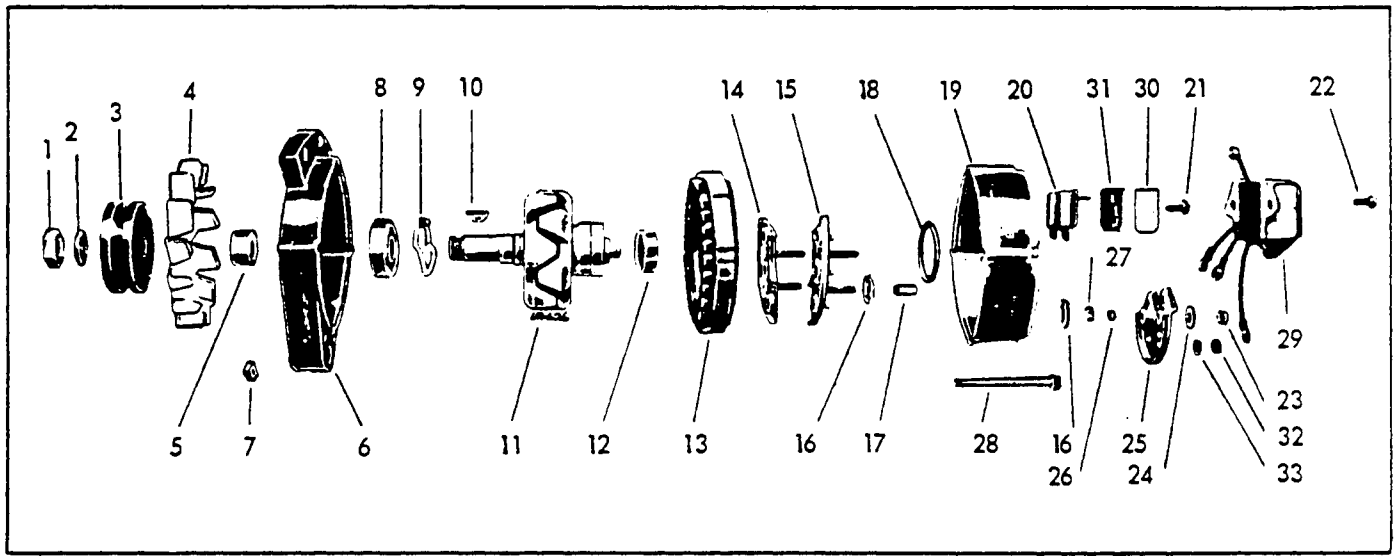
MY-93-3
(over)

# YB 69 ALTERNATOR

## MOTOROLA Part No. RA 12N451

**SERVICE INSTRUCTIONS** – In Motorola Automotive Products Inc., RA Series Alternator Systems, 25-49 Service Manual. MOTOROLA AUTOMOTIVE PRODUCTS INC., 9401 W. GRAND AVE., FRANKLIN PARK, ILLINOIS.

**SERVICE PARTS** – Except for Drive Pulley, Ref. 3, and Regulator, Ref. 29, all other Alternator components should be ordered from a Motorola Automotive Products Distributor or Dealer.




| Ref No | Motorola Part No. | Description | No Req |
|---|---|---|---|
| 1 | 20-136 | **NUT,** pulley mounting, 5/8-18 thread, hex. | 1 |
| 2 | 20-5 | **WASHER,** split lock, 5/8" | 1 |
| 3 | MD 405 Wisconsin Part No. | **PULLEY,** drive | 1 |
| 4 | 7-8 | **FAN,** normal rotation (clockwise) | 1 |
| 5 | 20-92 | **SPACER,** fan and pulley, 7/16" | 1 |
| 6 | 14-1 | **HOUSING,** front | 1 |
| 7 | 20-3 | **NUT,** square, No. 10-32 thread | 4 |
| 8 | 11-21 | **BEARING,** front | 1 |
| 9 | 11-3 | **RETAINER,** front bearing | 1 |
| 10 | 20-7 | **WOODRUFF KEY,** No. 5 | 1 |
| 11 | 12-1 | **ROTOR ASSEMBLY** | 1 |
| 12 | 11-23 | **BEARING,** (No. 202) sealed | 1 |
| 13 | 13-1 | **STATOR ASSEMBLY** | 1 |
| 14 | 1-2 | **DIODE ASSEMBLY,** rectifying, negative (black printing) | 1 |
| 15 | 1-1 | **DIODE ASSEMBLY,** rectifying, positive (red printing) | 1 |
| 16 | 15-3 | **INSULATING WASHER,** No. 10 x 3/4 O.D. | 5 |

| Ref No | Motorola Part No. | Description | No Req |
|---|---|---|---|
| 17 | 15-1 | **INSULATOR SLEEVE,** nylon, 19/32" long | 2 |
| 18 | 11-25 | **RETAINER,** rear bearing | 1 |
| 19 | 14-18 | **HOUSING,** rear | 1 |
| 20 | 3-1 | **BRUSH ASSEMBLY** | 1 |
| 21 | 20-32 | **SCREW,** tapping, No. 8 x 1/2" | 2 |
| 22 | 20-99 | **SCREW,** tapping, No. 10 x 1/2" (with lockwasher) | 3 |
| 23 | 20-33 | **LOCKNUT,** hex., No. 10-24 thread | 6 |
| 24 | 15-4 | **INSULATING WASHER,** No. 10 x 1/2" O.D. | 1 |
| 25 | 1-29 | **DIODE ASSEMBLY,** isolation | 1 |
| 26 | 15-2 | **INSULATOR SLEEVE,** nylon, 3/32" long | 1 |
| 27 | 20-34 | **NUT,** hex., No. 10-24 thread | 2 |
| 28 | 20-1 | **BOLT,** machine, No. 10-32 x 2-7/8" long | 4 |
| 29 | YJ 53 Wisconsin Part No. | **REGULATOR,** Model 8 RF 2011 A | 1 |
| 30 | 3-6 | **COVER,** brush holder | 1 |
| 31 | 3-13 | **SHIELD,** dust | 1 |
| 32 | 20-146 | **NUT,** terminal, 1/4"-20 thread, hex. | 1 |
| 33 | 20-62 | **WASHER,** terminal, 1/4" split-lock | 1 |

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# Limited Engine Warranty

TELEDYNE WISCONSIN MOTOR, hereinafter referred to as "Manufacturer", warrants each new Wisconsin engine sold by the Manufacturer to be free from defects in material and workmanship, under normal use and service, for a period of one (1) year (except in the case of an engine used on any recreational type vehicle the period shall be ninety (90) days) after the date of delivery to the original retail purchaser, and Manufacturer will, at its option, replace or repair, at one of the Manufacturer's factories, or at a point designated by the Manufacturer, any part or parts which shall appear to the satisfaction of the Manufacturer upon inspection at such point, to have been defective in material or workmanship. This Warranty does not obligate the manufacturer to bear any transportation charges in connection with the replacement or repair of defective parts.

This Warranty shall not apply to any engine which shall have been installed or operated in a manner not recommended by the Manufacturer; nor to any engine which shall have been repaired, altered, used in any type of competition, neglected or used in any way which, in the Manufacturer's opinion, adversely affects its performance; nor to any engine in which parts not manufactured or approved by the Manufacturer have been used; nor to any accessories installed on the engine where the accessory manufacturer has its own warranty; nor to normal maintenance services or replacement of normal service items.

Manufacturer reserves the right to modify, alter, and improve any engine or parts without incurring any obligation to replace any engine or parts previously sold with such modified, altered, or improved engine or part.

THIS WARRANTY, AND THE MANUFACTURER'S OBLIGATION HEREUNDER, IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE, and all other obligations or liabilities, including special or consequential damages or contingent liabilities arising out of the failure of any engine or part to operate properly. No person is authorized to give any other warranty or to assume any additional obligation on the Manufacturer's behalf unless made in writing and signed by an officer of the Manufacturer.

**TELEDYNE WISCONSIN MOTOR**
**MILWAUKEE, WISCONSIN 53219**

THIS MANUAL IS FOR MY WISCONSIN MODEL .....
ENGINE

SPEC. No. ..... SERIAL No. .....

THE ABOVE INFORMATION, WHICH WILL BE FOUND ON THE NAME PLATE ATTACHED TO THE AIR SHROUD OF THE ENGINE, SHOULD BE FILLED IN. YOUR PROMPT ATTENTION TO THIS MATTER WILL MAKE IT CONVENIENT FOR YOU IN THE FUTURE, AS THIS INFORMATION MUST BE GIVEN WHEN ORDERING SERVICE PARTS, OR WHEN ADVICE TO AN ENGINE PROBLEM IS REQUESTED.

Individual INSTRUCTION and SERVICE PARTS MANUAL available from all Wisconsin Distributors,

cut along dotted line

return to
**TELEDYNE WISCONSIN MOTOR**
**PRODUCT SUPPORT CENTER**
**1910 SO. 53 RD STREET**
**MILWAUKEE, WISCONSIN 53219**

Dear Customer:

If you would like to receive a free copy of a list of Authorized Teledyne Wisconsin Motor DISTRIBUTORS and SERVICE CENTERS in your area, please complete the following;

NAME _____

STREET _____

CITY _____ STATE _____ ZIP _____

ENGINE MODEL _____ SERIAL NO. _____

**FOR SERVICE and PARTS - - - contact your nearest authorized Wisconsin Distributor or Service Center.**

## ENGINE STORAGE

To protect the cylinders, pistons, rings and valves and keep them from rusting and sticking, a half and half mixture of kerosene and good "gasoline engine" oil (the same kind of oil as used in the crankcase of the engine), should be injected into the *pipe tap* opening on the *intake manifold* while the engine is warm and running at moderate speed. About a quarter of a pint is necessary, or enough so that a heavy bluish smoke will appear at the exhaust. The ignition switch should then be shut off and the engine stopped. This fogging operation will leave a coating of oil on the above mentioned parts, protecting them from the atmosphere.

Drain crankcase oil while engine is warm.

Drain fuel lines, carburetor, fuel pump and tank, to prevent lead and gum sediment from interfering with future operation. Gasoline fumes from gradual evaporation is a dangerous *fire hazard.*

The air cleaner and filter element should be thoroughly cleaned. Tape or otherwise seal off the exhaust and air cleaner openings for the duration of storage.

The outside of the engine, including the cooling fins on the cylinder block and head, should be thoroughly cleaned of all dirt and other deposits. All exposed unpainted metal parts should be coated with grease or heavy oil.

*Before starting the engine,* after the storage period, remove crankcase drain plug so that any condensation which may have collected may be drained, before new crankcase oil is added. It is advisable to remove the crankcase oil base and scrub off all sediment which may have collected there. Use a new gasket when reassembling the engine base.

Use new spark plugs at the beginning of the operating interval, especially if the engine has given considerable service.

*It is highly recommended that machines be stored inside a building through the winter. If this is not possible, the engine should be protected from snow and ice by a proper covering.*

TELEDYNE
WISCONSIN MOTOR
MILWAUKEE, WISCONSIN 53219

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# SERVICE BULLETINS

As we make improvements to the **MARKLIFTS**, we like to supply you, the customer, with updated information which applies to your machine.

This section is provided as a place to store Service Bulletins as you receive them from MARK INDUSTRIES.