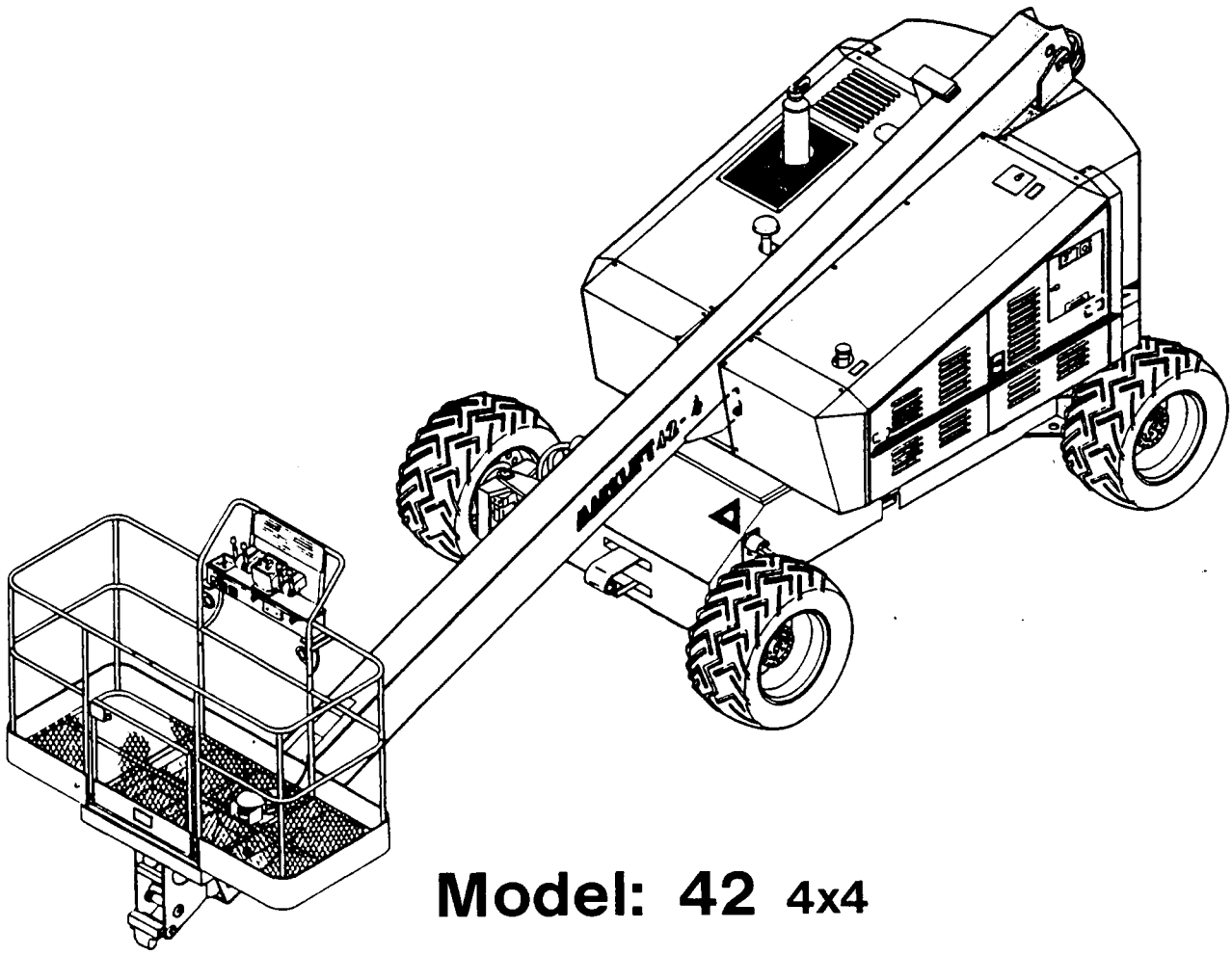
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED BOOM OPERATION MAINTENANCE AND PARTS MANUAL



Model: 42 4x4

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Mark Industries

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(MODEL 42-4)

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SERVICE BULLETINS

MARKLIFT SELF-PROPELLED BOOM
(MODEL 42-4)
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 42-4)

DESCRIPTION	ENGLISH	METRIC
HEIGHT	42'	12.80 m
WORKING (MAXIMUM)	48'	14.63 m
PLATFORM (MAXIMUM)	42'	12.80 m
LOWERED (MAXIMUM)	7'1"	2.17 m
WIDTH (MAXIMUM)	7'8"	2.33 m
LENGTH (MINIMUM)	20'9"	6.32 m
LIFT CAPACITY . . . . . (UNRESTRICTED)	900 LBS.*	408.24 kg
WHEEL BASE	8'	2.44 m
WHEEL TRACK	72½"	1.84 m
TURNING RADIUS (INSIDE) .	12'0"	3.66 m
TURRET ROTATION	CONTINUOUS	
TURRET TAILSWING	14" BEYOND TIRES	.35 m
ENGINE-GASOLINE . . . . . (AIR COOLED)	37 HP WISC.	
TRAVEL SPEED . . . . . (PROPORTIONAL)	0 TO 3.0 MPH	0 TO 4.8 km/hr
GRADEABILITY	17°-30%	
CONTROLS	4 PROPORTIONAL (DRIVE, ROTATION, ELEVATION, EXTENSION) 2 SOLENOID (STEERING, PLATFORM TILT)	
HYDRAULIC OPERATING PRESSURE	2150 PSI MAX.	
TIRES-PNEUMATIC	31 X 15.5-158 PR TERRA XTRA-TRAC (HI FLOTATION)	

MARKLIFT SELF-PROPELLED BOOM

(MODEL 42-4)

DESCRIPTION	ENGLISH	METRIC
OPTIONAL TIRES-PNEUMATIC	12.00 16.10 PR JUMBO SUPER ALL GRIP 31 X 15.5-158 PR TERRA RIB (SAND APPLICATIONS)	
HORIZONTAL REACH . . . . . (MAXIMUM)	31'0"	9.45 m
BOOM ELEVATION	+75° ABOVE HORIZONTAL -25° BELOW HORIZONTAL	
FUEL RESERVOIR CAPACITY .	22 GAL.	83.27 l
HYDRAULIC RESERVOIR . . .	40 GAL.	151.4 l
WEIGHT	15,500 LBS.	7030.8 kg
SHIPPING CUBE	1125 CU. FT.	31.86 cu. m
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 800 LBS.

MARKLIFT SELF-PROPELLED BOOM
(MODEL 42-4)

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
20110	PLATFORM ROTATION
20112	LIFTING LUGS
20113	SPECIAL PAINT
22237	833 LOMBARDINI DIESEL
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
20148	DUAL FUEL TWIN TANK
20091	MONOFILLED TIRES

MARKLIFT SELF-PROPELLED BOOM
(MODEL 42-4)

OPTION	TITLE
20159	110 VAC GENERATOR FOR VG4D WISCONSIN
22238	110 VAC GENERATOR FOR 833 LOMBARDINI
20162	PLATFORM AT END OF BOOM
20163	DUAL FUEL-VG4D WISCONSIN
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 42-4)

OPERATION MAINTENANCE AND PARTS MANUAL

When a revision is added to this manual, enter date inserted and initial.

REV. DATE	PAGE NUMBERS	DATE INSERTED	BY	REV. DATE	PAGE NUMBERS	DATE INSERTED	BY

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 (ERT 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_____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 #_____

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.

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

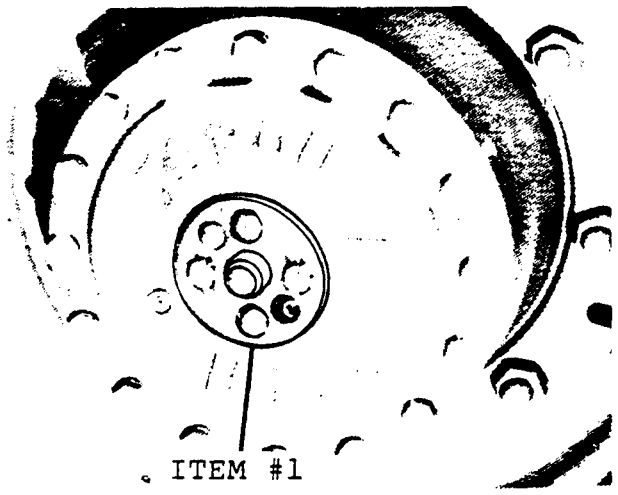
1. The truck must be fitted with adequate winch to handle the weight of equipment you are going to load/unload.

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 -----	39,500 LBS.
30I ------	11,670 LBS.		
32 -------	11,410 LBS.		
40STD ----	14,680 LBS.		
40RT -----	15,400 LBS.		
42 -------	15,000 LBS.		
42-4 -----	15,500 LBS.		

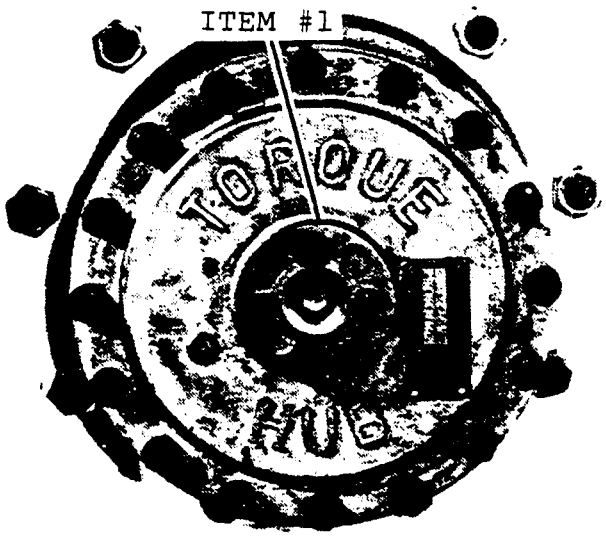
2. Align the boom with the steering wheels toward the trailer, and the basket in the horizontal or slightly above position.

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.)



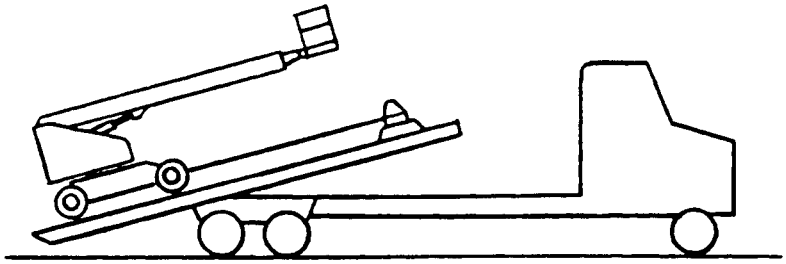
HUB ENGAGED

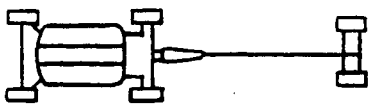


HUB DISENGAGED

CAUTION: BRAKES ARE ALSO AUTOMATICALLY DISENGAGED AT THIS TIME.

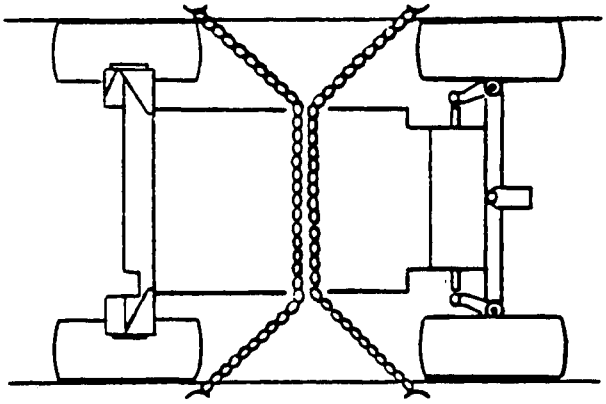
4. Attach the winch cable to the boom at the steering end on the center steering arm as shown.

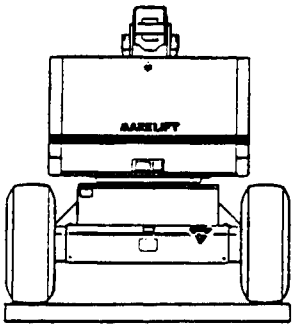




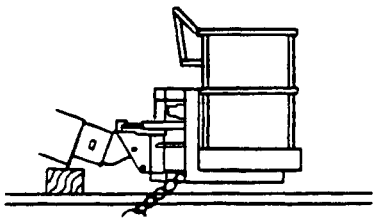
5. When truck bed is locked back into the horizontal position, rotate the boom 180° to a position where the counter weight is over the steering wheels. (This position would place the counterweight closest to the truck cab.)

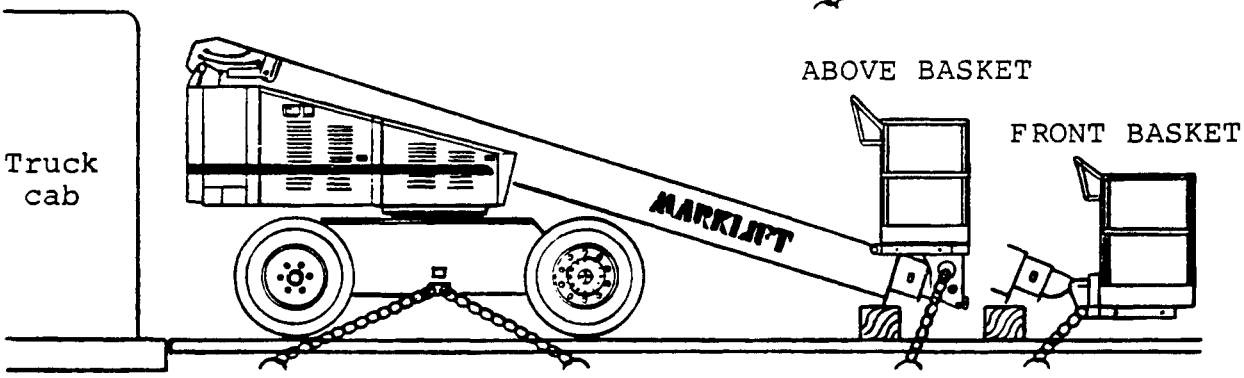
6. When the boom is on the truck in position for proper weight distribution, it is chained down in the manner illustrated by the drawings below.





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

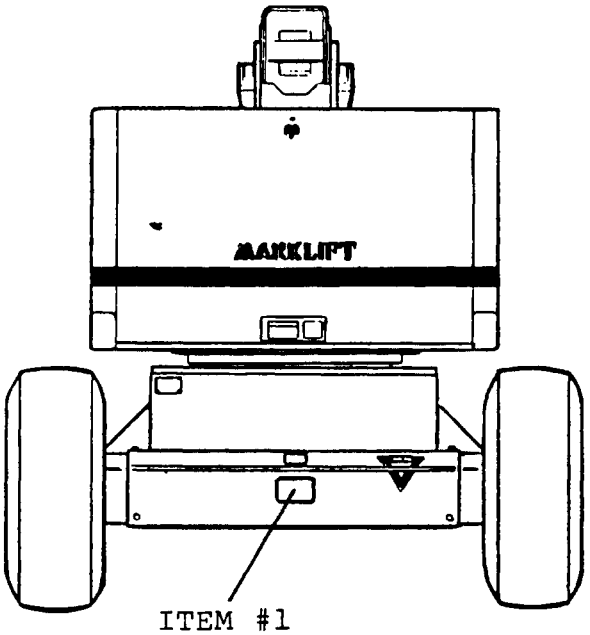
FLATBED WITH HYDRAULIC LIFT/LOWER REAR PORTION

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)



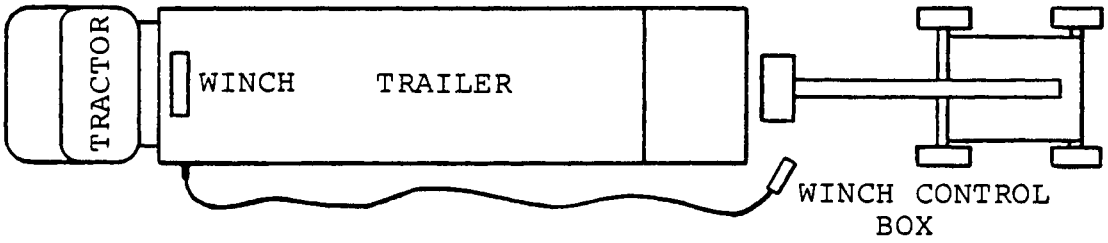
2. If the unit has the high/low drive option, it must be in low drive at all times when loading/unloading.

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 42-4)

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 Fig. 2 item 21) . 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 42-4)

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."

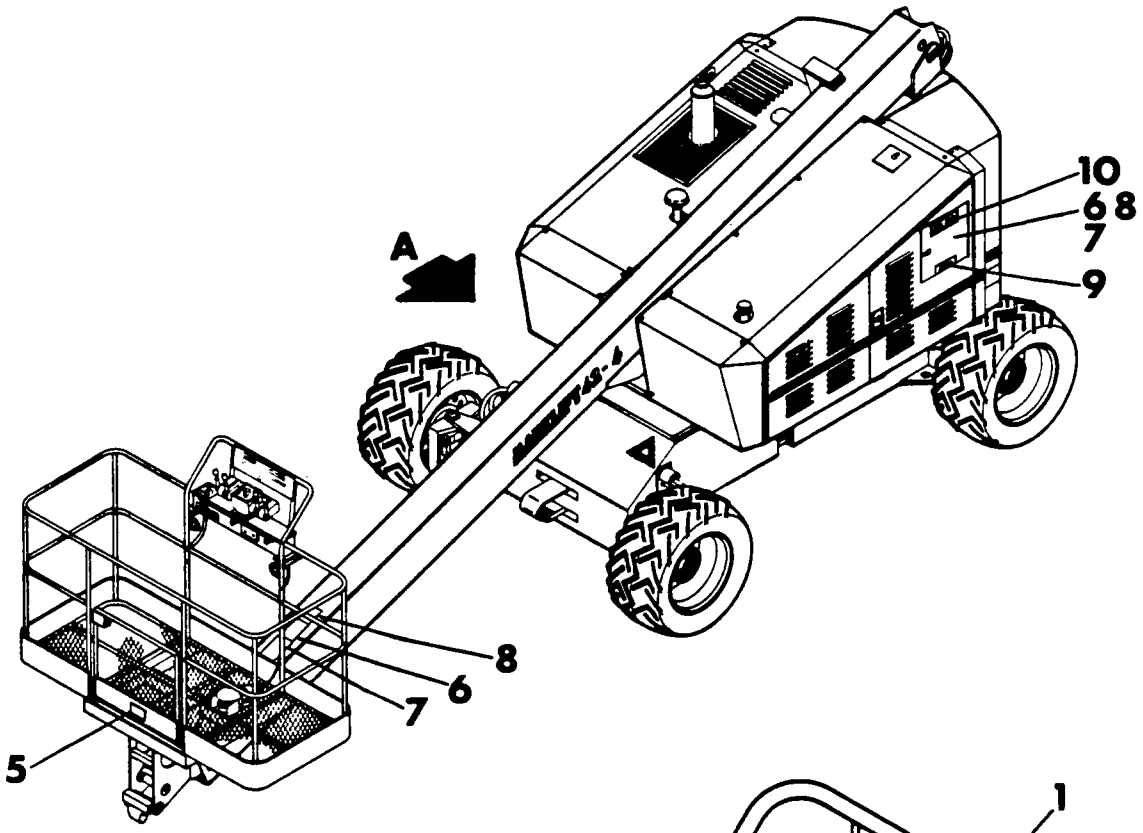
In addition to the above wording, the following statement in small lettering shall be provided on the warning sign: "For Minimum Clearances of High-Voltage Lines In Excess of 50,000 Volts, See Article 86, Title 8, High-Voltage Electrical Safety Orders."

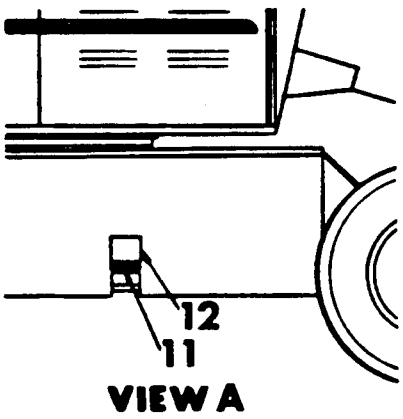
MARKLIFT SELF-PROPELLED BOOM

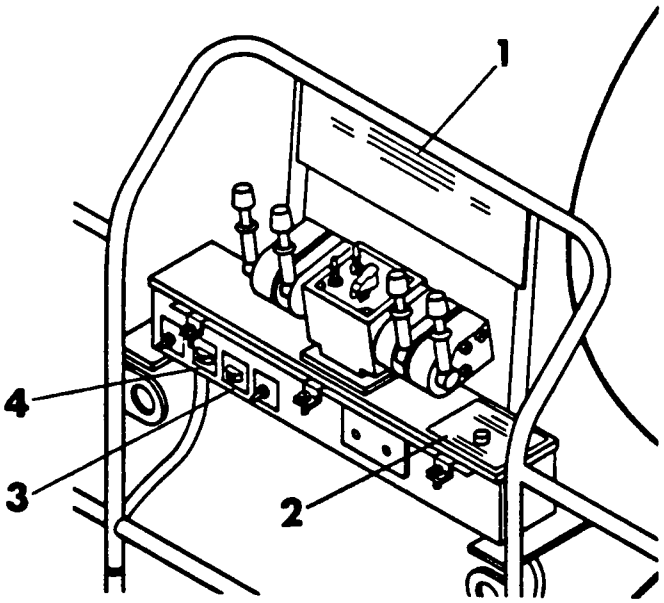
(MODEL 42-4)

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 OPERATING FUNCTIONS

1. WITH IGNITION SWITCH AT GROUND CONTROL STATION POSITIONED TO 'ON' AND THE SELECTOR SWITCH IN 'AERIAL' POSITION, START ENGINE FROM PLATFORM. DO NOT DEPRESS FOOT SWITCH WHILE ATTEMPTING TO START ENGINE.
2. OPERATE ALL PROPORTIONAL FUNCTIONS IN THE FOLLOWING MANNER:
   A. DEPRESS FOOT SWITCH AND LIFT CONTROLLER LOCKING STEM UPWARD BEFORE ATTEMPTING TO MOVE HANDLE FORE OR AFT.
   B. MOVE CONTROLLER HANDLE SLOWLY IN DIRECTION OF DECAL. FUNCTION SPEED WILL RESPOND DIRECTLY TO AMOUNT OF HANDLE MOVEMENT. DRIVE AND STEERING DIRECTION, AS SHOWN ON THE DECALS, IS APPLICABLE WITH BOOM OVER STEERING WHEELS. THE DIRECTION IS REVERSED WHEN BOOM IS OVER DRIVE WHEELS.
3. TOGGLE SWITCHES ARE SOLENOID FUNCTIONS AND ARE TO BE OPERATED BY DEPRESSING FOOT SWITCH PRIOR TO TOGGLE SWITCH.
4. ALL FUNCTIONS WILL OPERATE WITH THROTTLE SWITCH IN 'LO' POSITION IF UNIT IS SO EQUIPPED. 'HI' THROTTLE SETTING ALLOWS MULTIPLE HYDRAULIC FUNCTIONS.
5. THE DRIVE SELECTOR SWITCH ENABLES THE MARKLIFT TO TRAVEL AT HIGHER SPEEDS WHEN THE BOOM IS BELOW HORIZONTAL AND RETRACTED.

EMERGENCY OVERRIDES

EMERGENCY BOOM DESCENT AND RETRACTION CAN BE ACCOMPLISHED BY DEPRESSING PROPER SWITCH.

20859

2

CAUTION

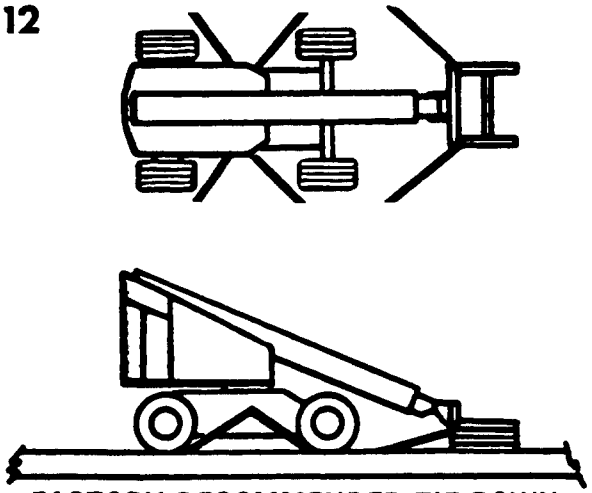
LIGHT INDICATES AN UNSAFE OUT OF LEVEL OPERATING CONDITION

BOOM FUNCTIONS ARE INOPERATIVE WHEN LIGHT IS ON

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

20444

12



FACTORY RECOMMENDED TIE DOWN TRANSPORTING DIAGRAM 20508

4

THROTTLE
HI
LO

EMERGENCY DESCENT

PUSH TO LOWER BOOM

20406

11

TIRE PRESSURE 35 PSI 20521

5

LOAD CAPACITY 800 LBS.

(EVENLY DISTRIBUTED LOAD)

20856

3

EMERGENCY RETRACTION

PUSH TO RETRACT BOOM

20407

6

DANGER

YOU MUST NOT OPERATE THIS MACHINE
UNLESS YOU ARE QUALIFIED BY TRAINING AND EXPERIENCE IN THE SAFE OPERATION OF THIS MACHINE.

TRAINING INCLUDES COMPLETE KNOWLEDGE OF YOUR EMPLOYER'S WORK RULES, ALL GOVERNMENTAL REGULATIONS, AND MANUFACTURER'S OPERATOR AND SAFETY MANUALS RELATIVE TO THIS MACHINE'S SAFE USE.

AN UNTRAINED OPERATOR SUBJECTS HIMSELF AND OTHERS TO
DEATH OR SERIOUS INJURY.

20417

7

DANGER

ELECTROCUTION HAZARD
THIS MACHINE IS NOT INSULATED

MAINTAIN SAFE CLEARANCES FROM ELECTRICAL POWER LINES AND APPARATUS. YOU MUST ALLOW FOR PLATFORM SWAY, ROCK, OR SAG.

THIS AERIAL DEVICE DOES NOT PROVIDE PROTECTION FROM CONTACT WITH OR PROXIMITY TO AN ELECTRICALLY CHARGED CONDUCTOR.

DEATH OR SERIOUS INJURY WILL RESULT FROM SUCH CONTACT OR INADEQUATE CLEARANCE

20418

8

CAUTION

1. INSPECT VEHICLE AND AERIAL DEVICE, INCLUDING OPERATION, PRIOR TO USE, DAILY.
2. FOR STATIONARY OPERATION VEHICLE MUST BE SECURELY PARKED AND STABILIZED FOR THE WORK TO BE PERFORMED BEFORE AERIAL DEVICE IS OPERATED.
3. OUTRIGGERS WHEN REQUIRED MUST BE ON SOLID FOOTING.
4. OPERATORS SHALL WEAR A BODY BELT, AND ATTACH WITH A LANYARD TO BOOM OR PLATFORM
5. OPERATE ALL CONTROLS SLOWLY FOR SMOOTH PLATFORM MOTION
6. DO NOT LOAD BEYOND RATED CAPACITY

20416

ONE EACH OF DECALS 6,7 & 8 ARE ALSO LOCATED INSIDE GROUND CONTROL BOX ACCESS DOOR

9

OPEN COVER FOR
EMERGENCY GROUND CONTROLS
20495

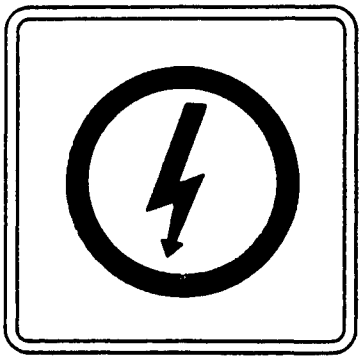
10

DANGER

ELECTROCUTION HAZARD
KEEP CLEAR

DEATH OR SERIOUS INJURY CAN RESULT FROM CONTACT WITH THIS EQUIPMENT OR VEHICLE IF IT SHOULD BE ELECTRICALLY CHARGED.

20419



DECAL 10 IS ALSO LOCATED FARSIDE

MARKLIFT SELF-PROPELLED BOOM

(MODEL 42-4)

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 controllable 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 42-4)

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° or more out of level. When the unit is driven to a slope of less than 5°, the buzzer and light go off and the boom controls become operable.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 42-4)

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 42-4)

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.

20860

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 42-4)

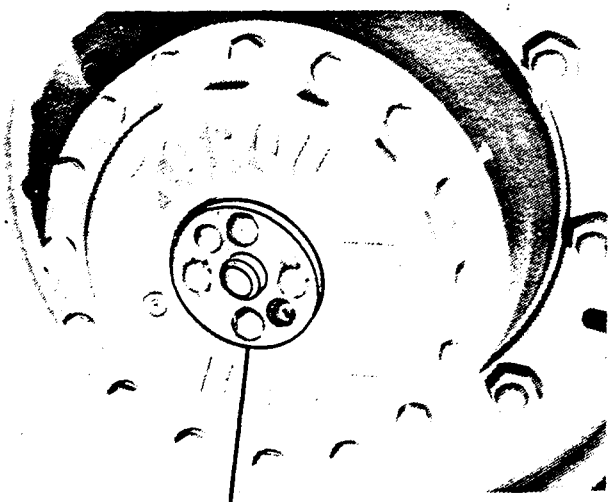
TORQUE HUB MUST BE DISENGAGED FOR TOWING.

MAXIMUM TOWING SPEED IS 10 mph.

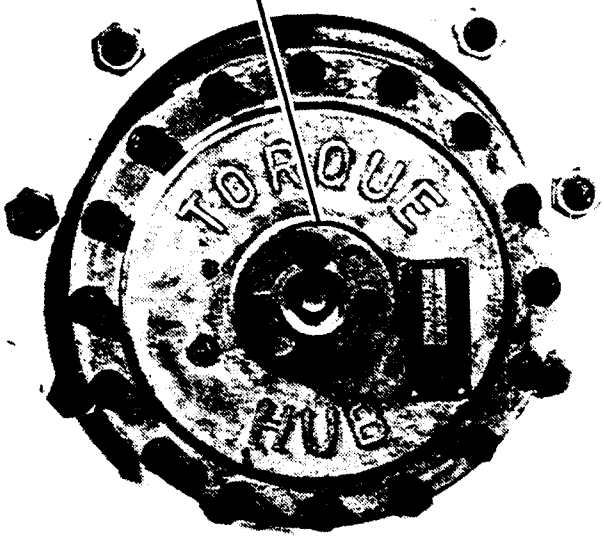
TO DISENGAGE TORQUE HUB, REVERSE THE DISCONNECT CAP. THE KNOB ON THE CAP DISENGAGES THE DRIVE HUB INPUT SHAFT.

CAUTION: BRAKES ARE ALSO DISENGAGED!

HUB ENGAGED



DISCONNECT CAP



HUB DISENGAGED

MARKLIFT SELF-PROPELLED BOOM

(MODEL 42-4)

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 36)
12. Engine RPM should be
    WISC. - 1800 low
    2400 high
    LOMBARDINI - 1800 low
    2600 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 39)
7. Check air cleaner.
8. Check oil level, rotation gear box.
9. Check retraction cables for proper tension. (See page 34)

SIX MONTHS, OR 100 HOURS

1. Check and lube, if necessary.
2. Change pilot filter element. (Item 9, page 37)
3. Change engine oil filter.
4. Change hydraulic return line filter element. (Item 10, page 37)

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 40STD, 40RT, 42 & 42-4)

Torquing the nut applies tension to the retraction cable which in turn, tensions or preloads the retraction housings. This assures a full 180 degree contact of both housings around the large retraction housing pullies.

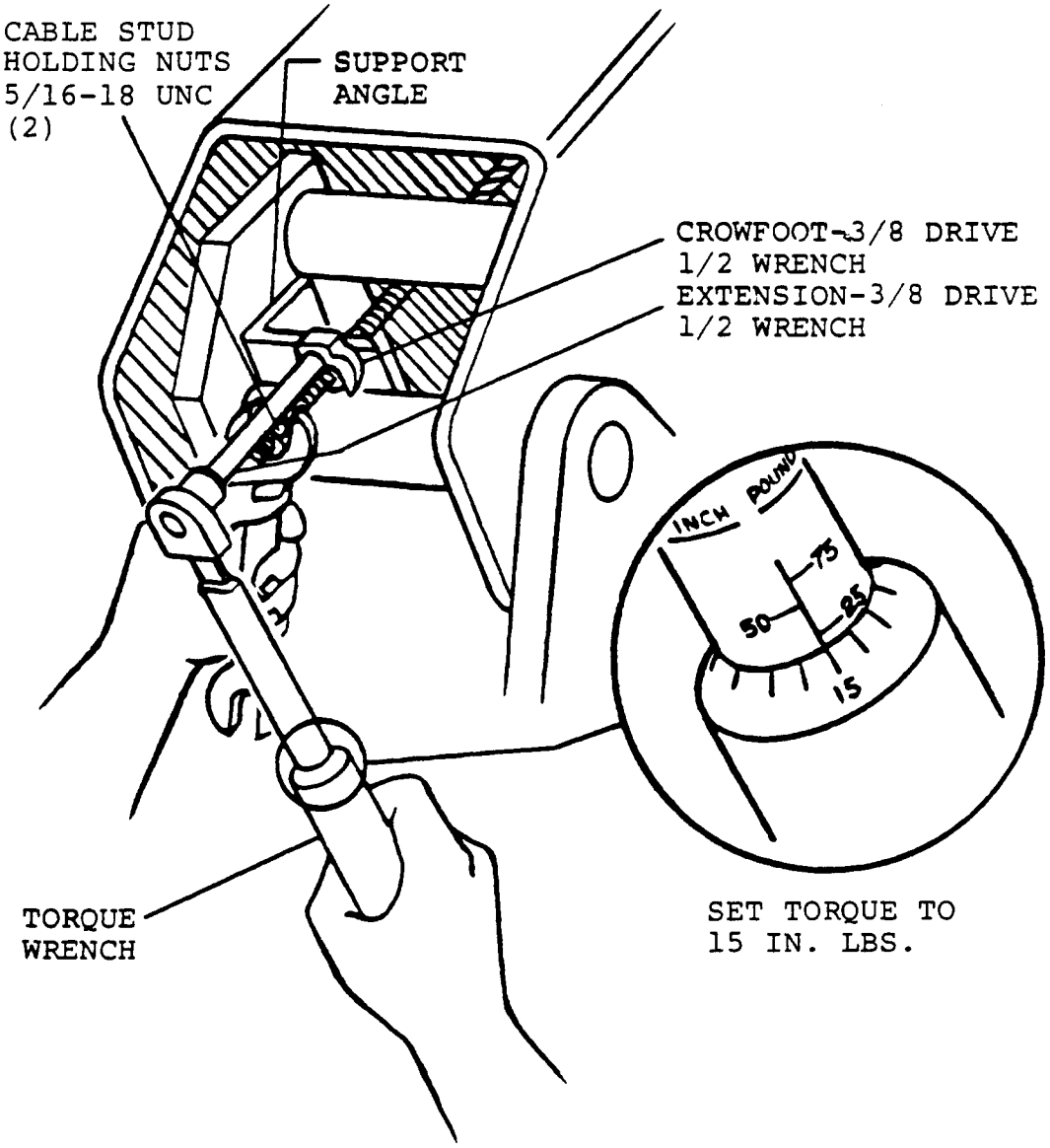
1. Elevate boom approximately 7 feet above ground.
2. Extend boom arm out approximately 3 to 4 feet.
3. On MARKLIFT units with holding valve directly behind the boom extension cylinder, movement will be necessary to provide access to tensioning stud as follows:
   A. Remove and cap both hydraulic hoses on the bottom side of valve.
   B. Remove cap screws (2) which anchor holding valve bracket to outer boom.
   C. Lift holding valve upward and to the right side of outer boom to allow wrench access to retraction cable tensioning nut.
4. Set torque wrench at 15 inch pounds.
5. Apply a few drops of machine or hydraulic oil to the cable stud threads on each side of 5/16-18 nut.
6. If stud threads are rusted or corroded, it may be necessary to turn torquing nut a few turns (2 or 3) in both directions to clean threads before torquing.
7. Back out on jam nut from torque nut.
8. Insert two 5/16-18 nuts on stud end and jam together, if stud end is not ground down to facilitate holding without damaging threads. This provides a means of preventing stud from turning during torquing operation.
9. Attach crowfoot to 5/16 nut and rotate torque wrench clockwise. If the wrench "clicks" before nut turns, do not attempt to further tighten nut.

10. Make certain, however, that cable stud is not binding on support angle or that nut has "bottomed out" on thread.

11. Continue to tighten nut until proper torque is established at 15 inch pounds.

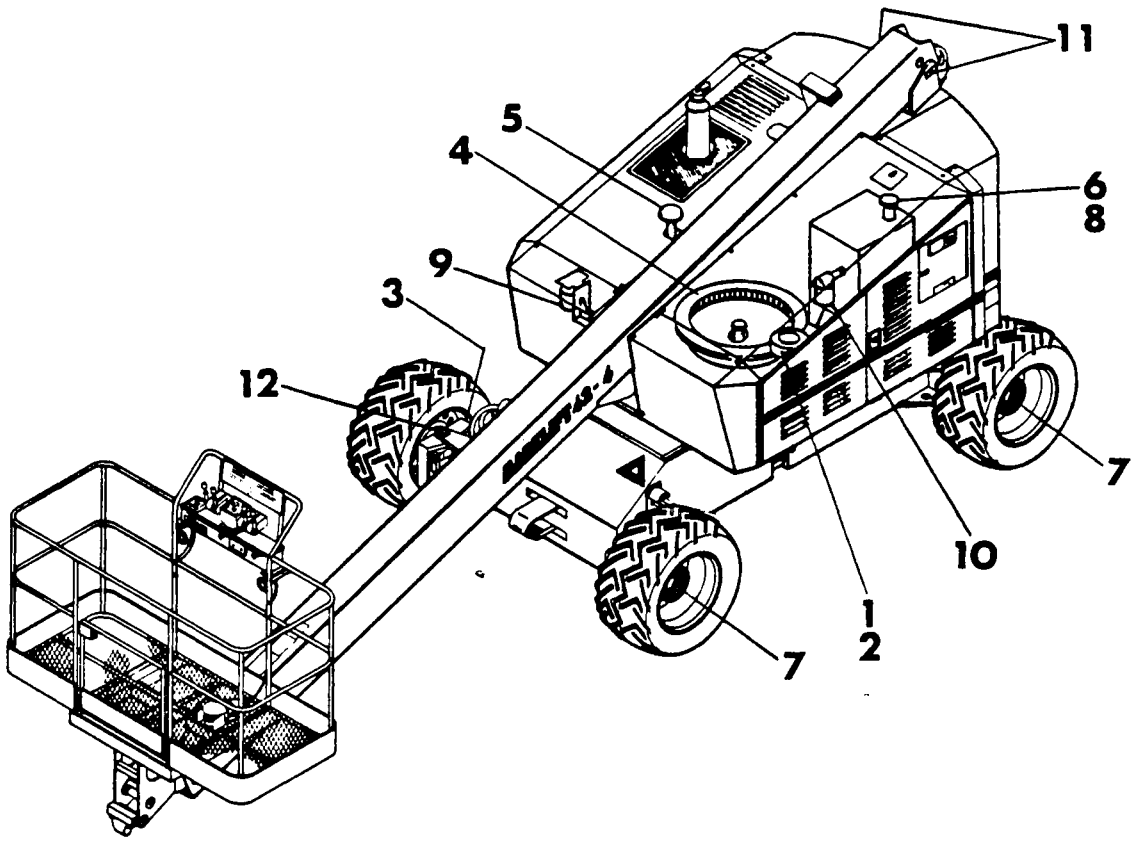
12. Run jam nut down against torquing nut.

13. Reinstall extension holding valve if it was removed for tensioning.



MARKLIFT SELF-PROPELLED BOOM

(MODEL 42-4)



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 38	YEARLY
7	TORQUE HUB	SEE PAGE 39	YEARLY
8	HYDRAULIC TANK STRAINER		CLEAN YEARLY
9	PILOT FILTER ELEMENT-20477		REPLACE EVERY 100 HOURS
10	RETURN LINE FILTER ELEMENT-21245		REPLACE EVERY 100 HOURS
11	MAIN BOOM PIVOT PIN	MOBILCOTE TYPE-S GEAR GREASE	MONTHLY
12	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 42-4)

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 42-4)

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

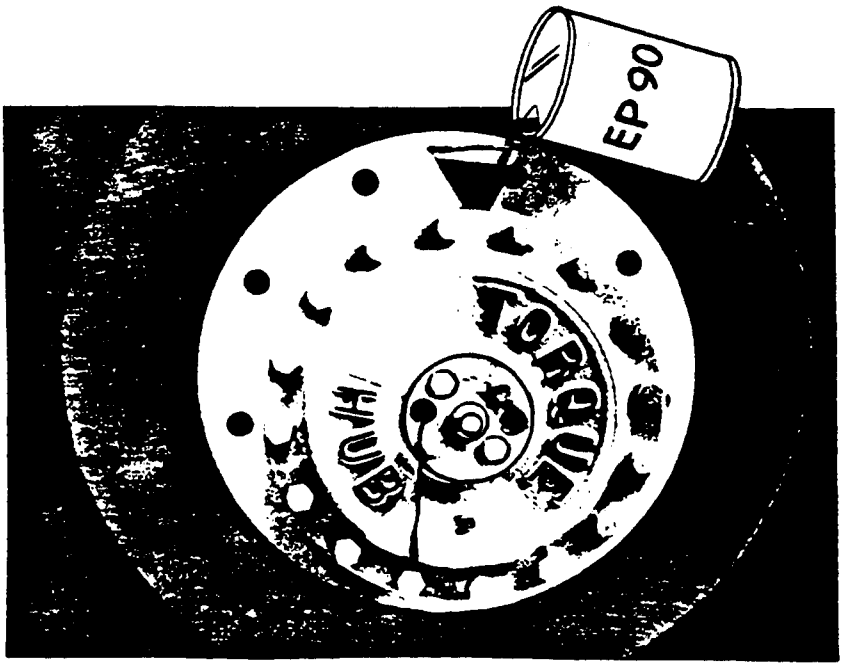
3. OIL CHANGE

   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 42-4)

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 distributor 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. Refer to your local service facility.

LIFT

1. No functions operate from aerial control console.

   A. Check aerial/ground selector switch.

   B. Check foot switch continuity.

   C. Check for loose wire in aerial junction box.

   D. Check pilot valve pressure.

   E. 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 low 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 gauge.
   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 gauge.
   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

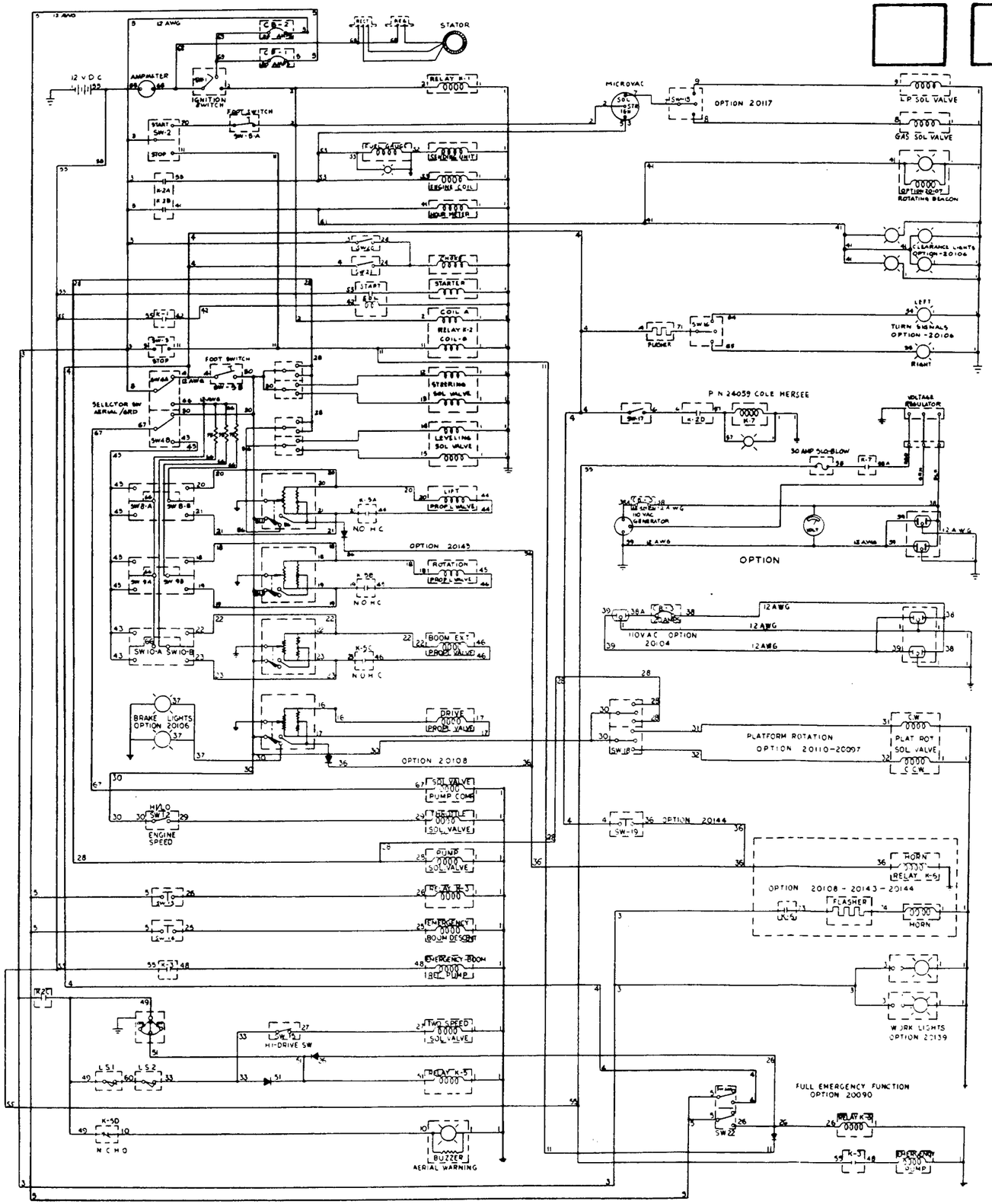
(MODEL 42-4)

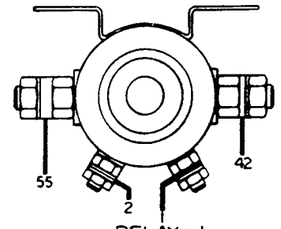
ITEM	PART NO.	DESCRIPTION
1.	20477	Pilot filter element.
2.	21245	Return line filter element.
3.	20127	Steering cylinder seal kit for 20728 cylinder.
	66226	Steering cylinder seal kit for 21756 cylinder (Jan 1982).
4.	66228	Slave leveling cylinder seal kit.
5.	20128	Master leveling cylinder seal kit.
6.	66165	Lift cylinder seal kit.
7.	66227	Boom extension cylinder seal kit.
8.	20035	2-speed shift cylinder seal kit.
9.	20036	Platform rotation cylinder seal kit (with option 20110).
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 potentio - meter assembly.
14.	20581	Aerial controller lever lock.

SERVICE TOOLS

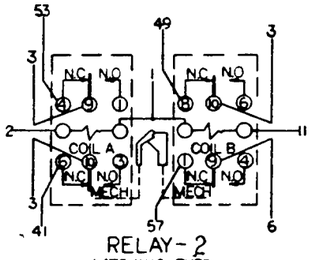
1. Volt/OHM meter.
2. Hydraulic pressure guage (0-3000 PSI)
3. Battery hydrometer.
4. Photo tachometer.
5. Standard mechanics hand tools.
6. Cable tensioning tool MI #20053

ELECTRICAL SCHEMATIC - GAS (MODEL 42-4)

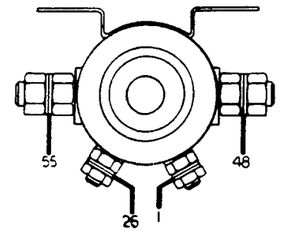




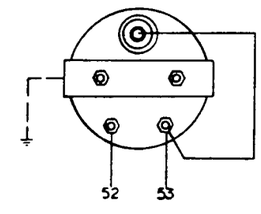
RELAY - 1
POWER RELAY
P/N 24059 COLE-HERSEE



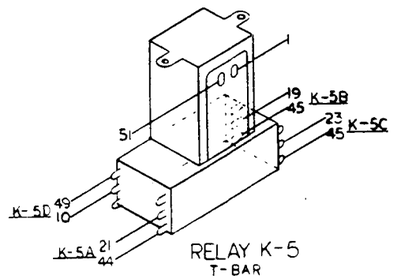
RELAY - 2
LATCHING TYPE
P/N KB 17DG POTTER-BRUMFIELD



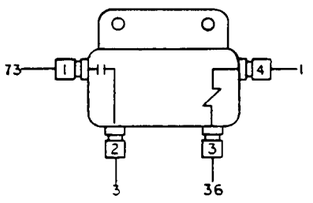
RELAY-3
POWER RELAY
P/N 24059 COLE HERSEE



FUEL GAUGE
P/N 82303 STEWART WARNER

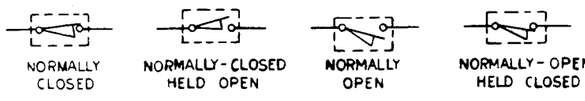


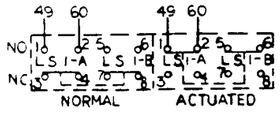
RELAY K-5
T-BAR



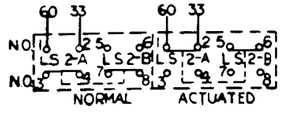
RELAY - 6
P/N D-1768 DELCO-REMY
P N 16262

LEGEND FOR LIMIT SWITCHES



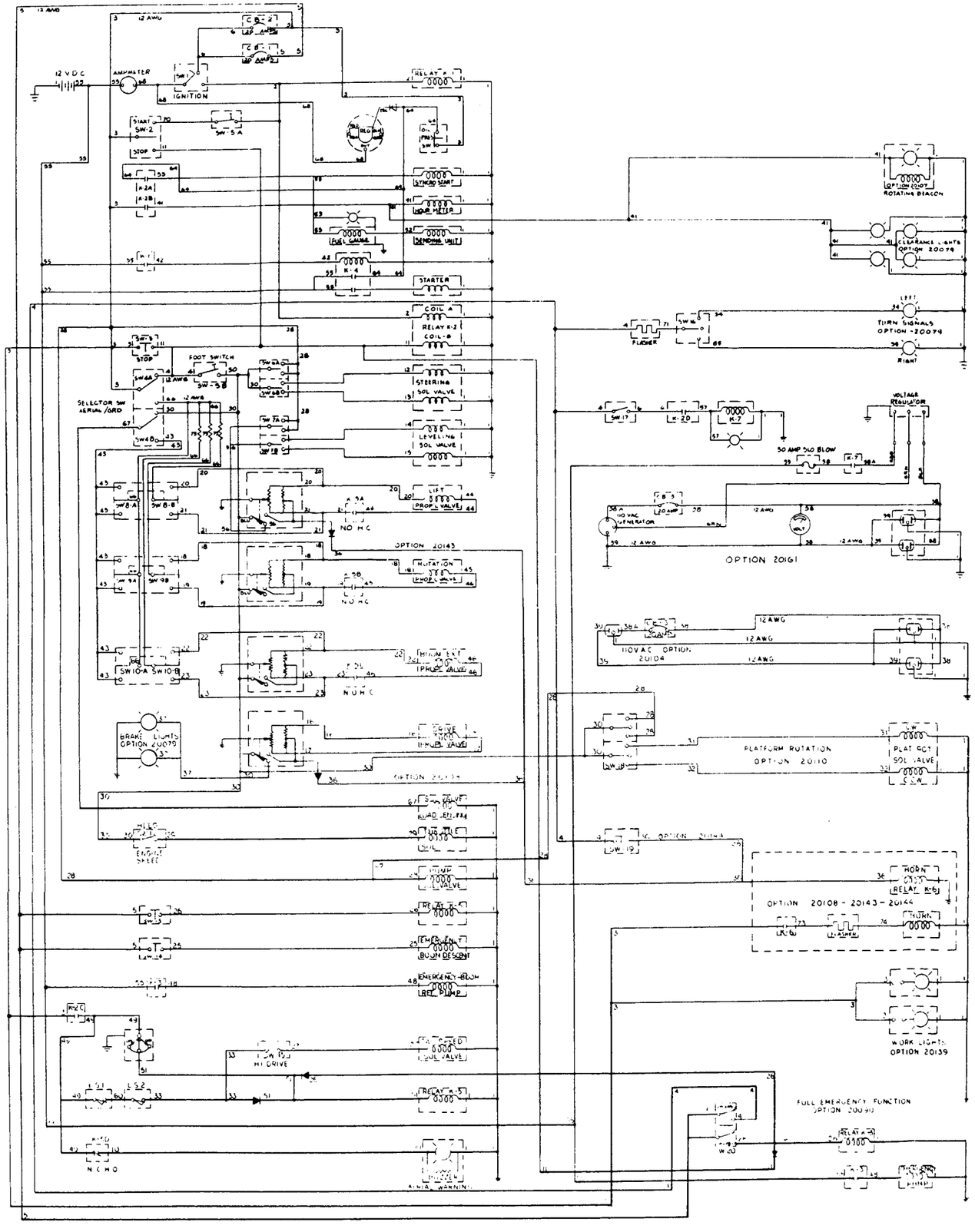


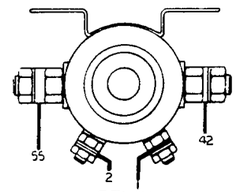
LIMIT SWITCH NO. 1



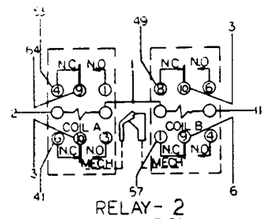
LIMIT SWITCH NO. 2

DWG NO. 20068

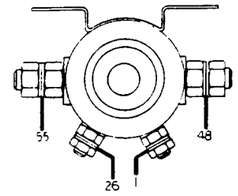




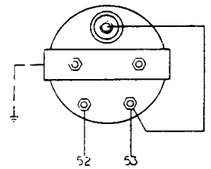
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POWER RELAY
P/N 24059 COLE HERSEE



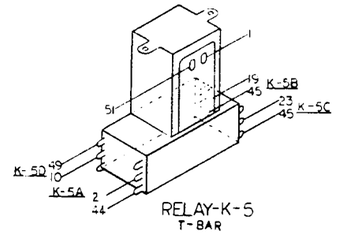
RELAY - 2
LATCHING TYPE
P/N KB 17DG POTTER-BRUMFIELD



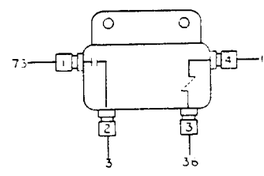
RELAY-3
POWER RELAY
P/N 24059 COLE HERSEE



FUEL GAUGE
P/N 82303 STEWART WARNER

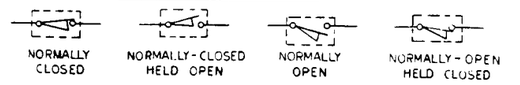


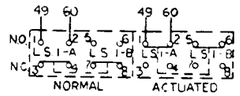
RELAY-K-5
T-BAR



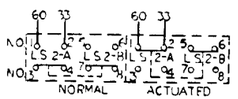
RELAY-6
P/N D-1768 DELCO-REMY
P N 16262

LEGEND FOR LIMIT SWITCHES

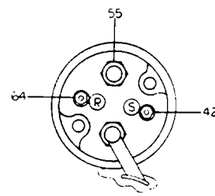




LIMIT SWITCH NO. 1



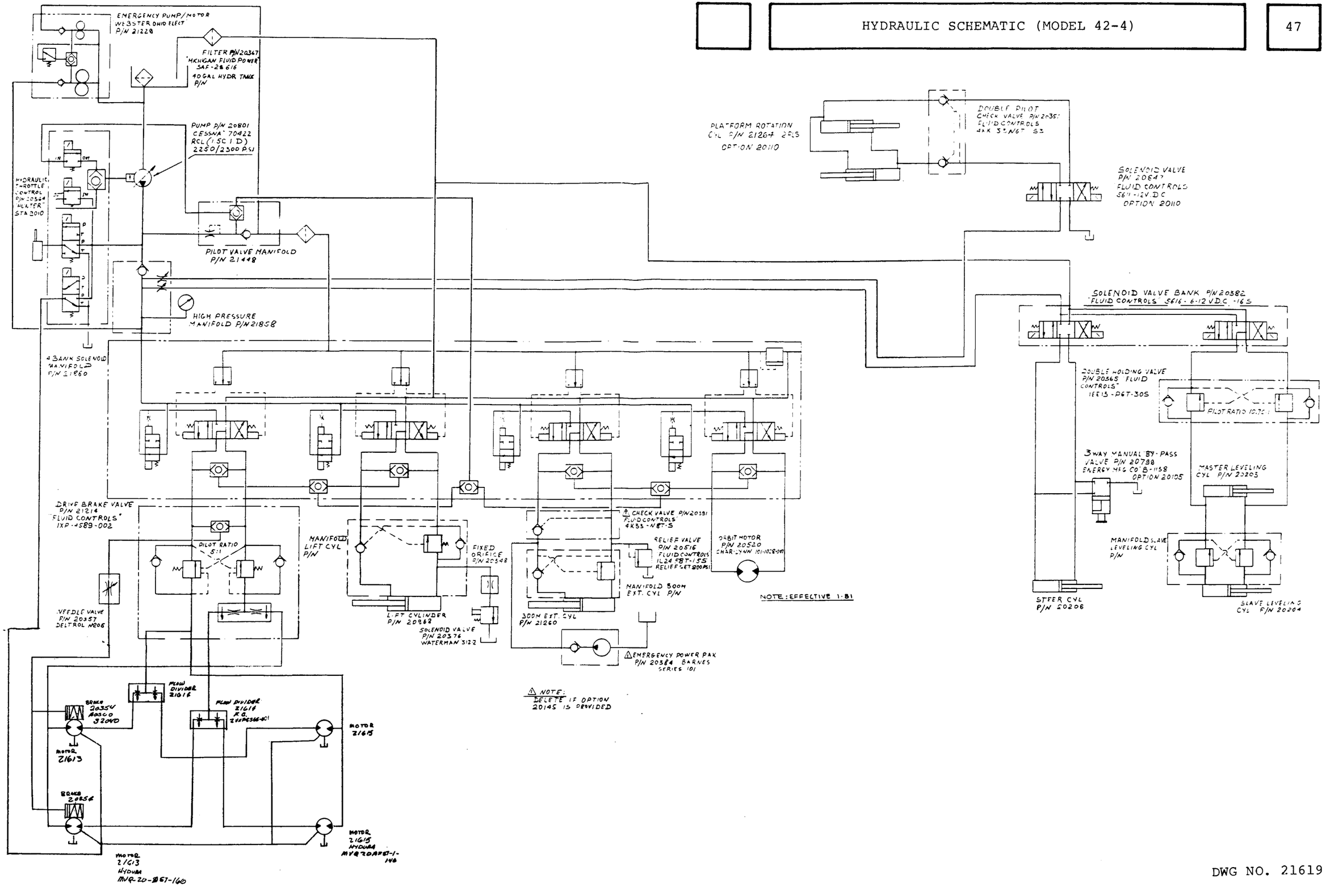
LIMIT SWITCH NO. 2



RELAY K-4
STARTER SOLENOID

DWG NO. 20069

HYDRAULIC SCHEMATIC (MODEL 42-4)



DWG NO. 21619

MARKLIFT SELF-PROPELLED BOOM
(MODEL 42-4)

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NOTE:
1. ALL PART NUMBERS LISTED IN THE FOLLOWING "PART NUMBER" COLUMNS ARE MARK INDUSTRIES NUMBERS.
2. ADDITIONAL OPTIONS ARE LISTED IN FORE-MATTER SECTION.

FIGURE 1 - FINAL ASSEMBLY

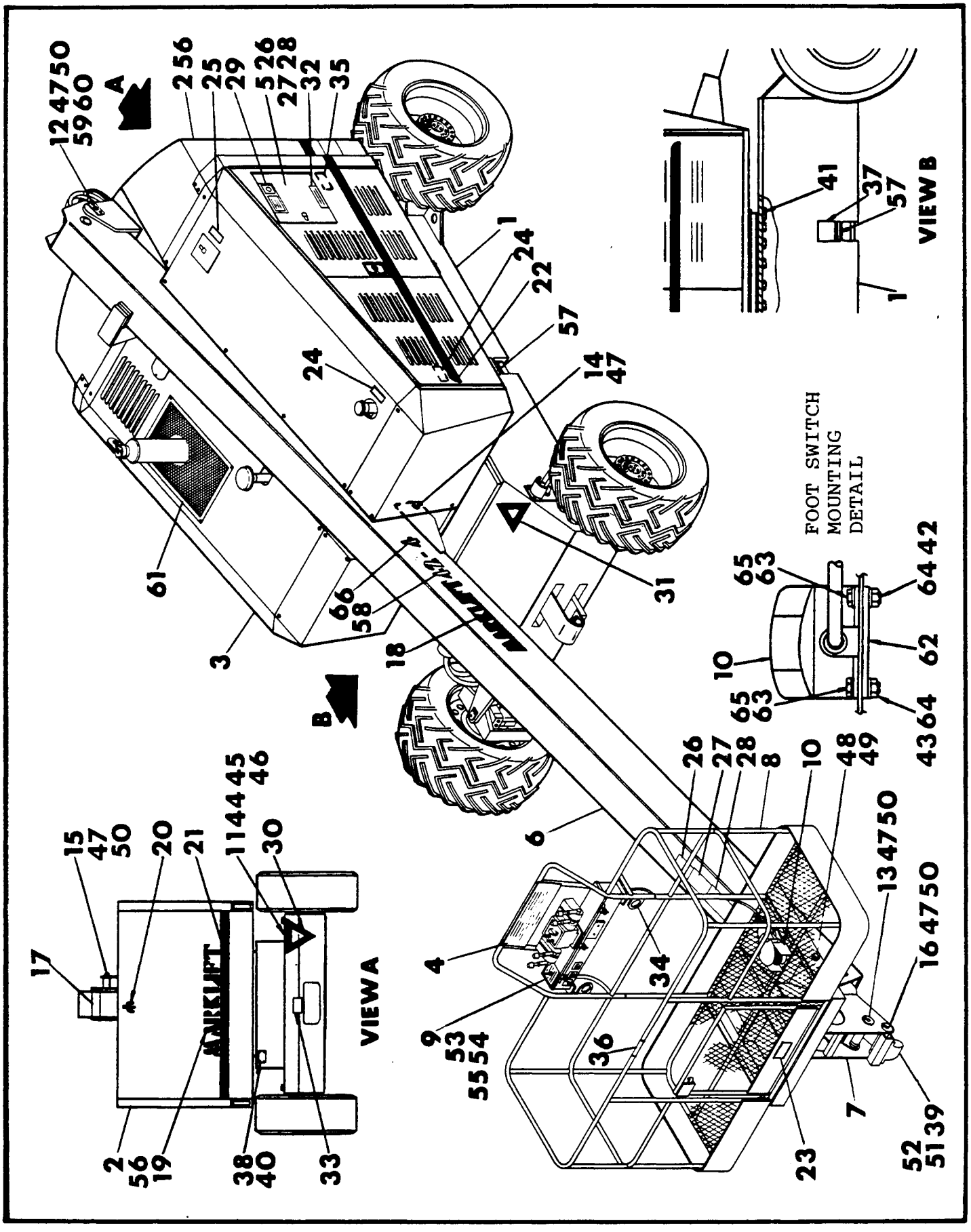


FIGURE 1 - FINAL ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
1-	20015	FINAL ASSEMBLY	1
-1	21616	CARRIAGE ASSEMBLY (SEE FIG. 2)	1
-2	21700	TURRET ASSEMBLY (SEE FIG. 9)	1
-3	21706	SHEET METAL COVER KIT (SEE FIG. 24)	1
-4	20859	AERIAL OPERATING INSTRUCTIONS DECAL	1
-5	20860	GROUND OPERATING INSTRUCTIONS DECAL (INSIDE GROUND CONTROL BOX ACCESS DOOR)	1
-6	20748	FINAL BOOM ASSEMBLY (SEE FIG. 26)	1
-7	20535	FORK WELDMENT	1
-8	20538	PLATFORM WELDMENT	1
-9	20782	AERIAL CONTROL CONSOLE ASSEMBLY (SEE FIG. 25)	1
-10	20480	FOOT SWITCH ASSEMBLY (SEE FIG. 31)	1
-11	20746	DRIVE COVER	1
-12	21784	BOOM TO TURRET PIN	1
-13	20457	BOOM TO FORK PIN	1
-14	20259	LIFT CYLINDER TO BOOM PIN	1
-15	20264	LEVELING CYLINDER TO BOOM PIN	1
-16	20261	SLAVE CYLINDER TO FORK PIN	1
-17	20830	BOOM TO TURRET PIN SPACER	1
-18	20408	MARKLIFT BOOM DECAL	2
-19	20409	MARKLIFT PEDESTAL DECAL	1
-20	20410	MARK INDUSTRIES LOGO DECAL	1
-21	20411	SQUARE END STRIPE DECAL	5
-22	20412	ROUND END STRIPE DECAL	1
-23	20556	LOAD CAPACITY 800 LBS DECAL	1
-24	2020	GAS DECAL	2
-25	2017	HYDRAULIC DECAL	2
-26	20416	CAUTION DECAL	2
-27	20417	DANGER DO NOT OPERATE DECAL	2
-28	20418	DANGER ELECTRICAL HAZARD DECAL (1 EACH OF ITEMS 26, 27 & 28 ARE LOCATED INSIDE GROUND CONTROL BOX ACCESS DOOR)	2
-29	20419	DANGER KEEP CLEAR DECAL	2

ITEM	PART NUMBER	DESCRIPTION	QTY
-30	20461	AHEAD FORWARD ARROW DECAL	1
-31	20462	AFT FORWARD ARROW DECAL	1
-32	20495	EMERGENCY GROUND CONTROLS DECAL	1
-33	20896	BRAKE DECAL	1
-34	20542	SAFETY BELT EAR DECAL	2
-35	20414	EMERGENCY BOOM DESCENT DECAL	1
-36	2014	UNLAWFUL TO OPERATE DECAL	1
-37	20508	TRANSPORTATION DECAL	2
-38	20964	I.D. PLATE	1
-39	20552	PLATFORM BUMPER	1
-40	63653	POP RIVET	4
-41	2692	HEX HEAD CAPSCREW - 1/2-13UNC X 2 BOWMALOK 41028	18
-42	60114	HEX HEAD CAPSCREW - 5/16-18UNC X 3/4	3
-43	63302	SPLIT LOCKWASHER - 5/16	7
-44	60121	HEX HEAD CAPSCREW - 5/16-18UNC X 3/8	2
-45	60120	HEX HEAD CAPSCREW - 1/2-13UNC X 3/4	4
-46	63305	SPLIT LOCKWASHER - 1/2	4
-47	60607	CAPSCREW - 3/8-16UNC X 3/4 (BOWMALOK 41012)	6
-48	60515	HEX HEAD CAPSCREW - 3/8-16UNC X 3 (BOWMALLOY 36062)	4
-49	61302	HEX NUT - 3/8-16UNC (BOWMAGRIP SELF-LOCKING 36782)	4
-50	63303	SPLIT LOCKWASHER - 3/8	2
-51	60122	HEX HEAD CAPSCREW - 3/8-16UNC X 1 1/2	2
-52	61318	LOCK NUT - 3/8-16UNC	2
-53	60123	HEX HEAD CAPSCREW - 1/4-20UNC X 3/4	6
-54	60701	HEX NUT - 1/4-20UNC	6
-55	63301	SPLIT LOCKWASHER - 1/4	6
-56	21624	HYDRAULIC HOSE DIAGRAM (SEE FIG. 32)	1
-57	20521	TIRE PRESSURE 35 PSI DECAL	2
-58	20873	42 DECAL	2
-59	21237	GREASE FITTING DECAL	2

ITEM	PART NUMBER	DESCRIPTION	QTY
-60	65103	GREASE FITTING - 1/8NPT	2
-61	21678	METAL SCREEN - GAS MODEL	1
-62	20663	FOOT SWITCH BACKING PLATE	1
-63	60346	HEX HEAD CAPSCREW - 5/16-18UNC X 1 1/4	2
-64	60702	HEX NUT - 5/16-18UNC	2
-65	63402	FLAT WASHER - 5/16	4
-66	21597	-4 DECAL	2

FIGURE 2 - CARRIAGE ASSEMBLY

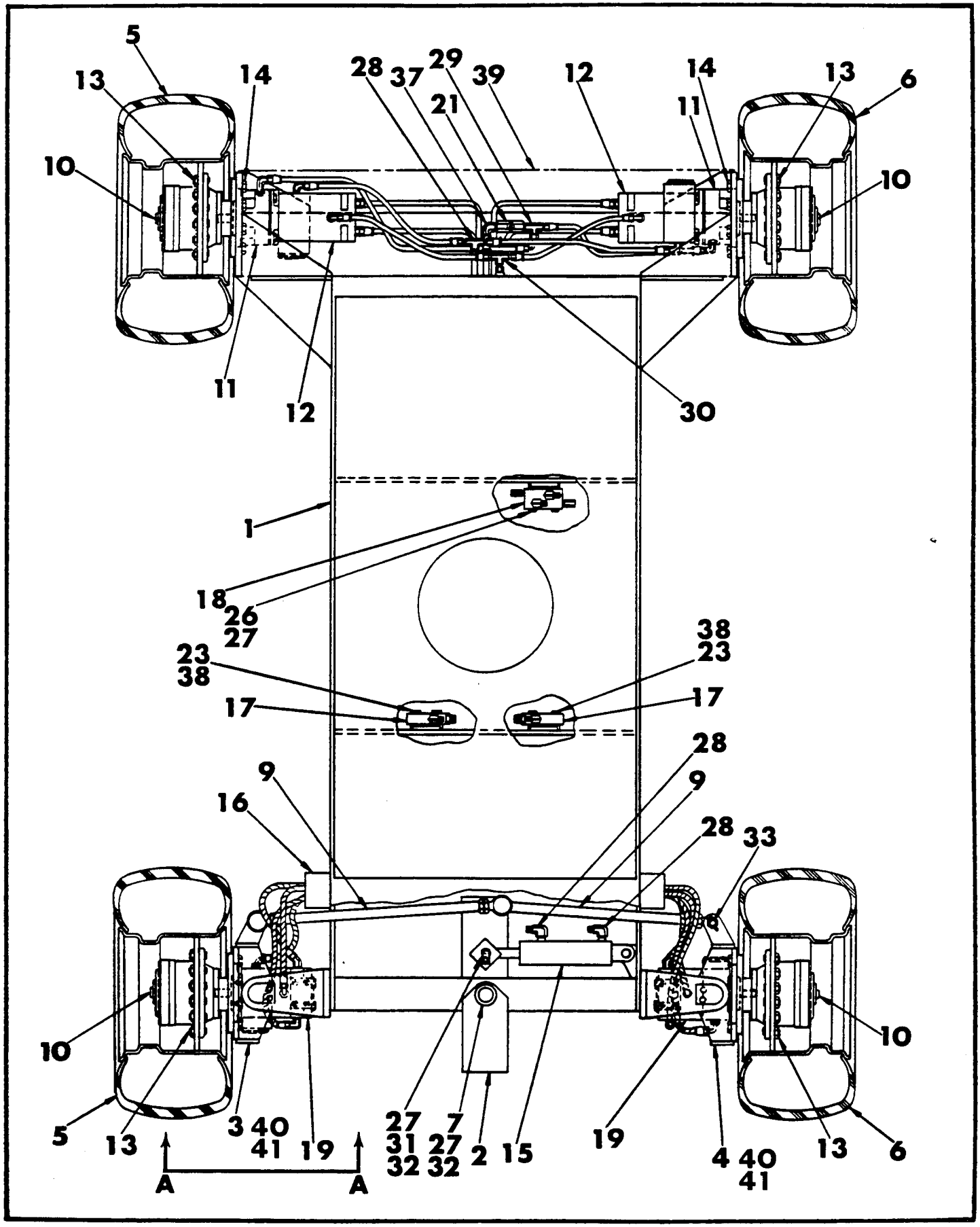
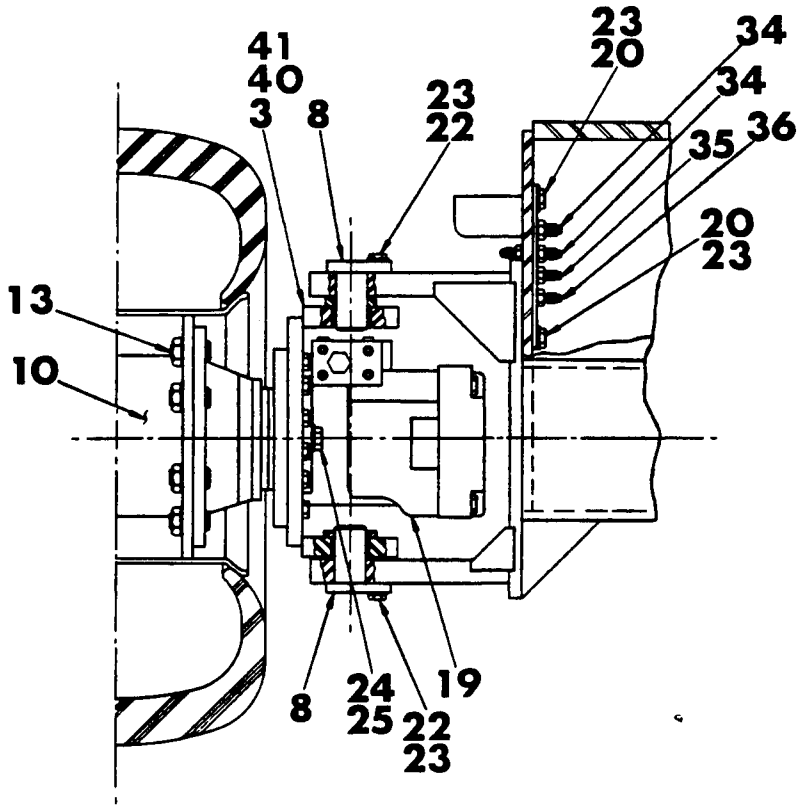


FIGURE 2 - CARRIAGE ASSEMBLY



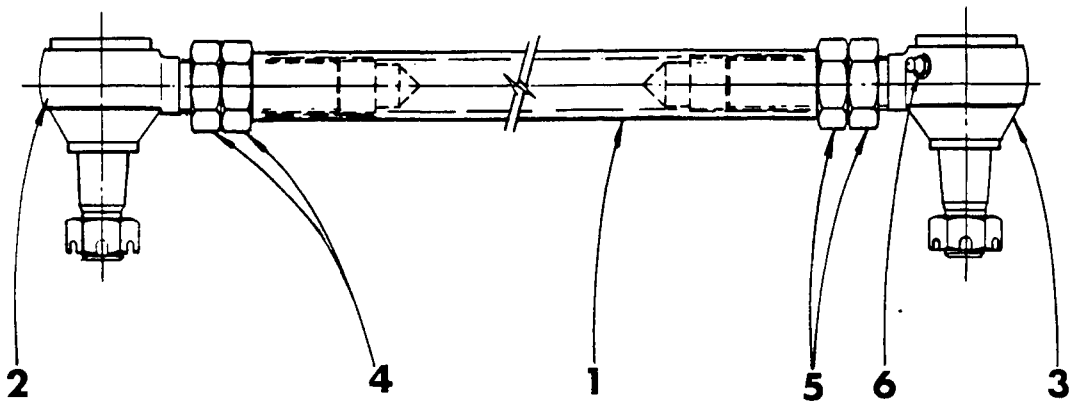
SECTION A

FIGURE 2 - CARRIAGE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
2-	21616	CARRIAGE ASSEMBLY	1
-1	21601	CARRIAGE WELDMENT	1
-2	20776	STEERING ARM	1
-3	21604	YOKE (R.H.)	1
-4	21603	YOKE (L.H.)	1
-5	21609	TIRE (R.H.)	2
-6	21606	TIRE (L.H.)	2
-7	21328	STEERING PIN	1
-8	21605	KING PIN	4
-9	20718	TIE ROD ASSEMBLY (SEE FIG. 3)	2
-10	21612	TORQUE HUB	4
-11	21668	BRAKE ASSEMBLY (SEE FIG. 4)	2
-12	21667	HYDRAULIC MOTOR ASSEMBLY - REAR (SEE FIG. 5)	2
-13	61316	BALL NUT - 1/2-20UNF	36
-14	60606	HEX HEAD CAPSCREW - 5/8-11UNC X 1 1/4 (BOWMALOK 41031-1)	24
-15	21756	STEERING CYLINDER (SEE FIG. 6)	1
-16	21617	BULKHEAD PLATE	2
-17	21591	FLOW DIVIDER ASSEMBLY (SEE FIG. 8)	2
-18	21592	DRIVE BRAKE VALVE ASSEMBLY (SEE FIG. 7)	1
-19	21594	HYDRAULIC MOTOR ASSEMBLY - FRONT (SEE FIG. 5A)	2
-20	60331	HEX HEAD CAPSCREW - 3/8-16UNC X 1 1/4	12
-21	20357	NEEDLE VALVE	1
-22	60372	HEX HEAD CAPSCREW - 3/8-16UNC X 7/8	8
-23	63303	SPLIT LOCKWASHER - 3/8	18
-24	60370	HEX HEAD CAPSCREW - 1/2-13UNC X 2	8
-25	63305	SPLIT LOCKWASHER - 1/2	8
-26	60362	HEX HEAD CAPSCREW - 5/16-18UNC X 3 1/2	2
-27	63302	SPLIT LOCKWASHER - 5/16	5
-28	2417	UNION TEE	1
-29	2575	MALE RUN TEE	1
-30	2421	UNION TEE	2

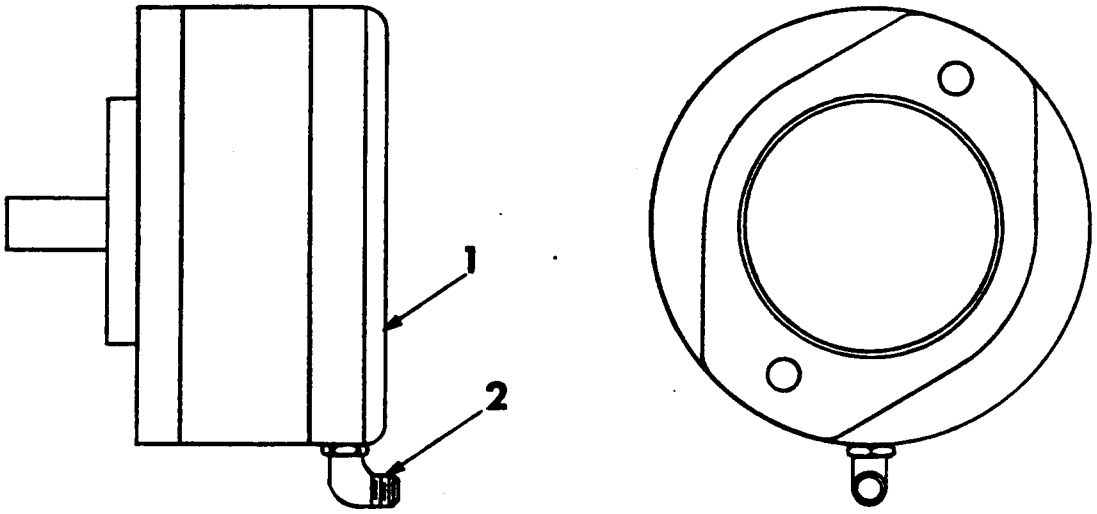
ITEM	PART NUMBER	DESCRIPTION	QTY
-31	20796	PIN	1
-32	60603	HEX HEAD CAPSCREW - 5/16-18UNC X 3/4 (BOWMALOK 41006)	2
-33	64306	COTTER PIN - 1/8 DIA. X 1 3/4	4
-34	53402	BULKHEAD UNION	4
-35	53400	BULKHEAD UNION	2
-36	16408	BULKHEAD UNION	2
-37	2435	MALE ELBOW	1
-38	60345	HEX HEAD CAPSCREW - 3/8-16UNC X 2 3/4	4
-39	21611	REAR DRIVE COVER	1
-40	21675	YOKE BUSHING	2
-41	21676	YOKE BUSHING	2

FIGURE 3 - STEERING TIE ROD ASSEMBLY



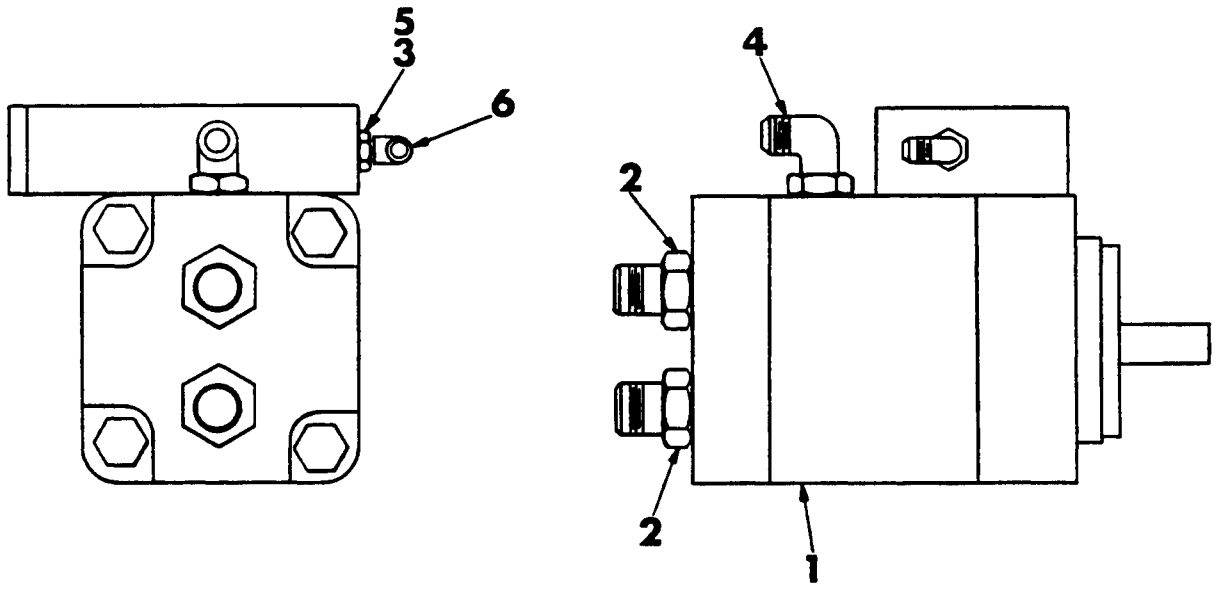
ITEM	PART NUMBER	DESCRIPTION	QTY
3-	20718	STEERING TIE ROD ASSEMBLY	1
-1		ROUND TUBE	1
-2	20569	TIE ROD END	1
-3	20568	TIE ROD END	1
-4	20567	JAM NUT - 1 1/8-12 (L.H.) THREAD	2
-5	20566	JAM NUT - 1 1/8-12 (R.H.) THREAD	2
-6		GREASE FITTING - 1/8NPT	2

FIGURE 4 - BRAKE ASSEMBLY



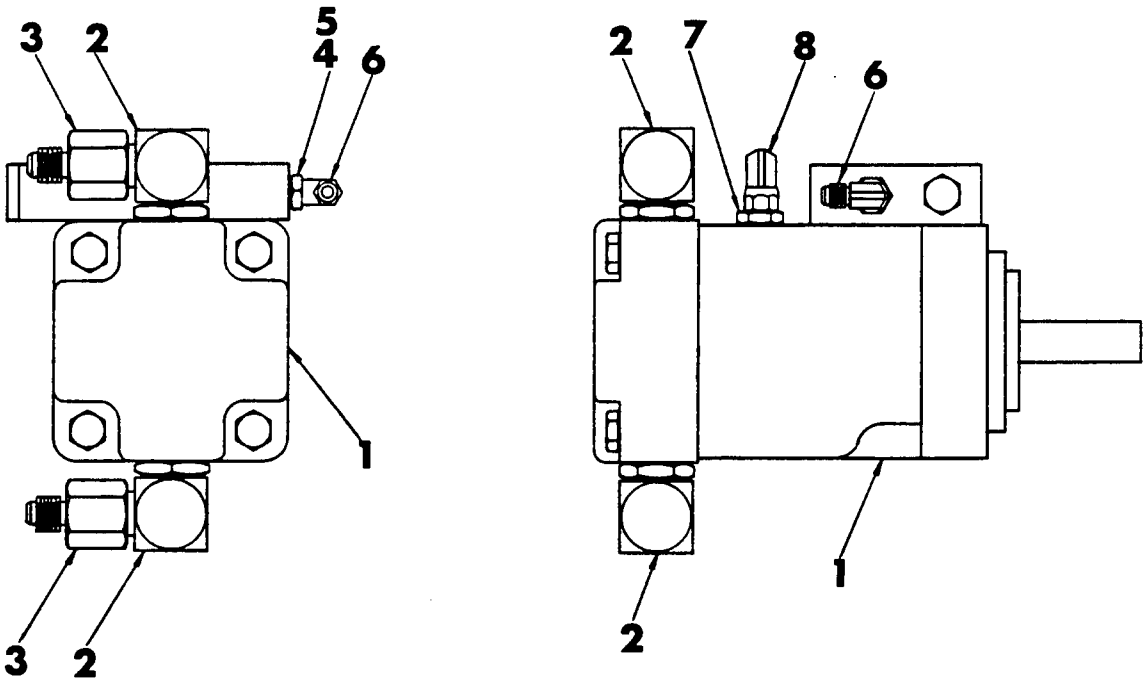
ITEM	PART NUMBER	DESCRIPTION	QTY
4-	21668	BRAKE ASSEMBLY	2
-1	20354	BRAKE	1
-2	2532	STRAIGHT THREAD ELBOW	1

FIGURE 5 - HYDRAULIC MOTOR ASSEMBLY - REAR



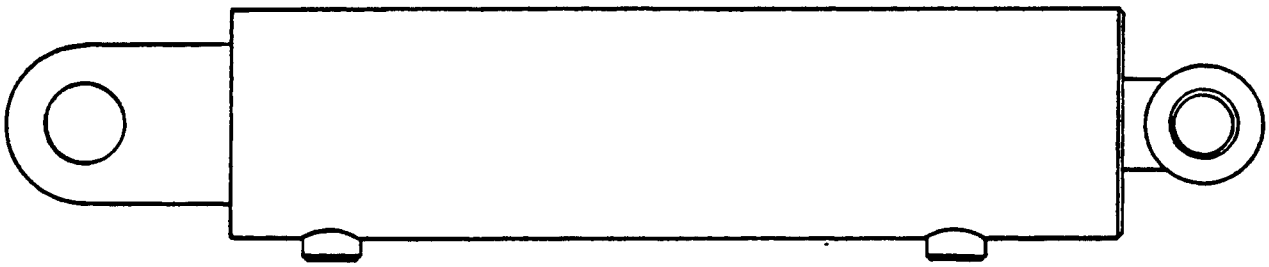
ITEM	PART NUMBER	DESCRIPTION	QTY
5-	21667	HYDRAULIC MOTOR ASSEMBLY - REAR	2
-1	21613	MOTOR	1
-2	50831	STRAIGHT THREAD CONNECTOR	2
-3	65314	O-RING	1
-4	50908	STRAIGHT THREAD ELBOW	1
-5	51006	MALE CONNECTOR	1
-6	52200	FEMALE ELBOW	1

FIGURE 5A - HYDRAULIC MOTOR ASSEMBLY - FRONT



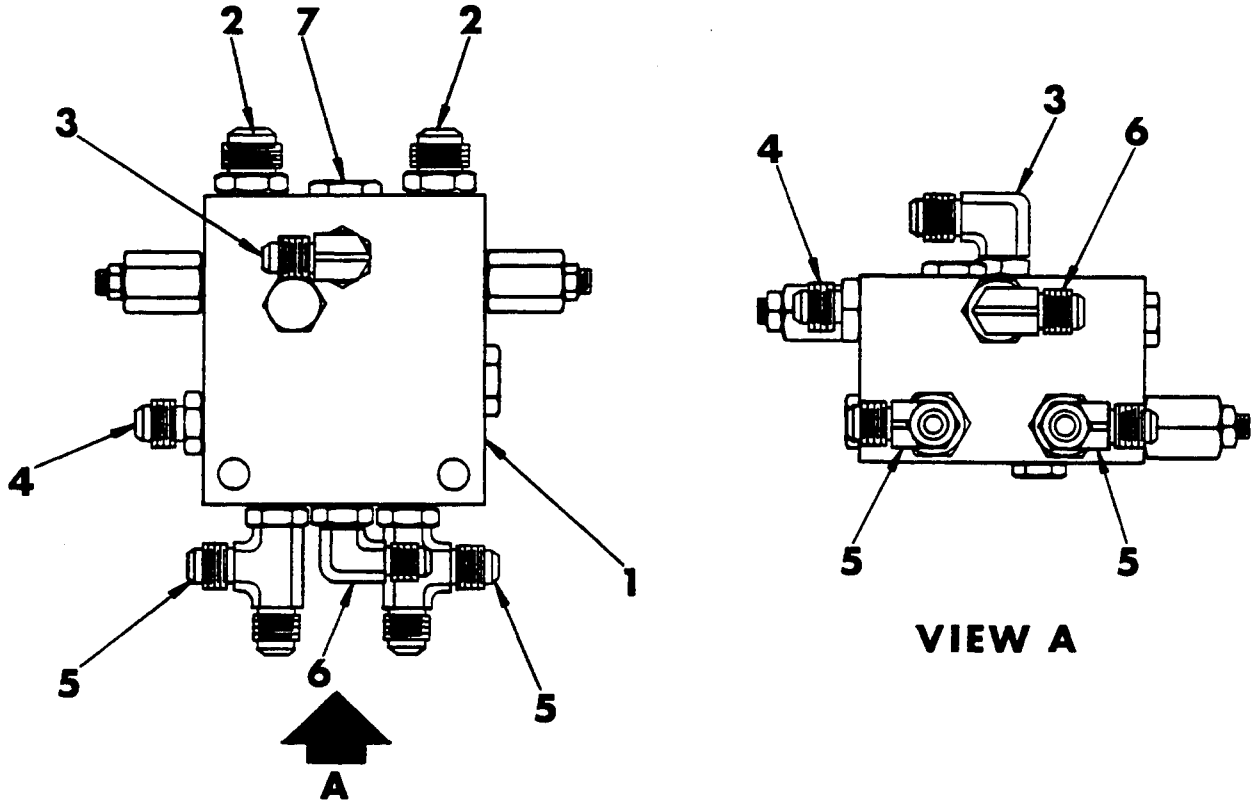
ITEM	PART NUMBER	DESCRIPTION	QTY
5A-	21594	HYDRAULIC MOTOR ASSEMBLY - FRONT	2
-1	21616	HYDRAULIC MOTOR	1
-2	20907	STRAIGHT THREAD ELBOW	2
-3	54101	REDUCER	2
-4	51006	MALE CONNECTOR	1
-5	65314	O-RING	1
-6	52200	MALE ELBOW	1
-7	50845	STRAIGHT THREAD CONNECTOR	1
-8	2538	SWIVEL NUT ELBOW	1

FIGURE 6 - STEERING CYLINDER



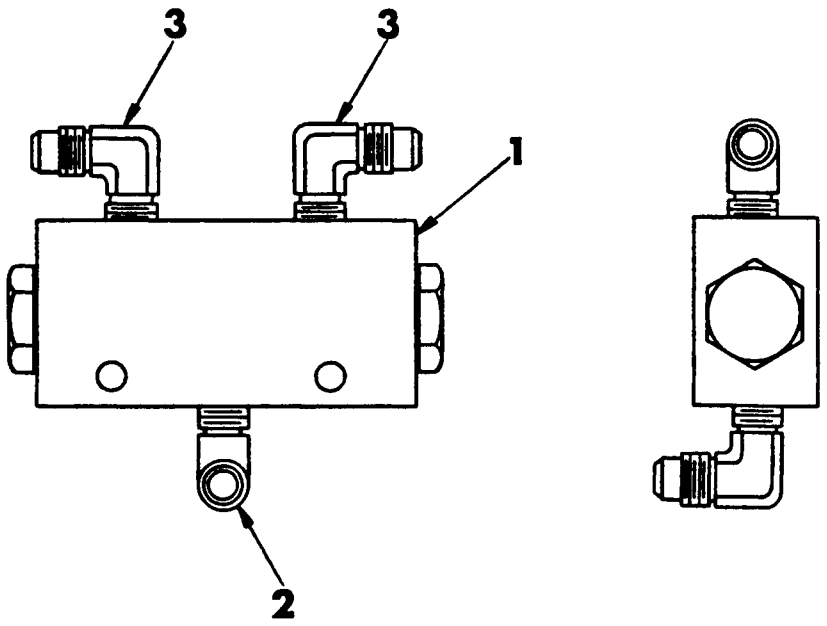
ITEM	PART NUMBER	DESCRIPTION	QTY
6 -	21756	STEERING CYLINDER	1
-1	66226	SEAL KIT	1

FIGURE 7 - DRIVE BRAKE VALVE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
7-	21592	DRIVE BRAKE VALVE ASSEMBLY	1
-1	21214	VALVE	1
-2	2544	STRAIGHT THREAD CONNECTOR	2
-3	2532	STRAIGHT THREAD ELBOW	1
-4	2542	STRAIGHT THREAD CONNECTOR	1
-5	2576	STRAIGHT THREAD RUN TEE	2
-6	2523	STRAIGHT THREAD ELBOW	1
-7	53701	STRAIGHT THREAD HEX HEAD PLUG	1

FIGURE 8 - FLOW DIVIDER ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
8-	21591	FLOW DIVIDER ASSEMBLY	1
-1	21614	FLOW DIVIDER	1
-2	2442	MALE ELBOW	1
-3	2451	MALE ELBOW	2

FIGURE 9 - TURRET ASSEMBLY

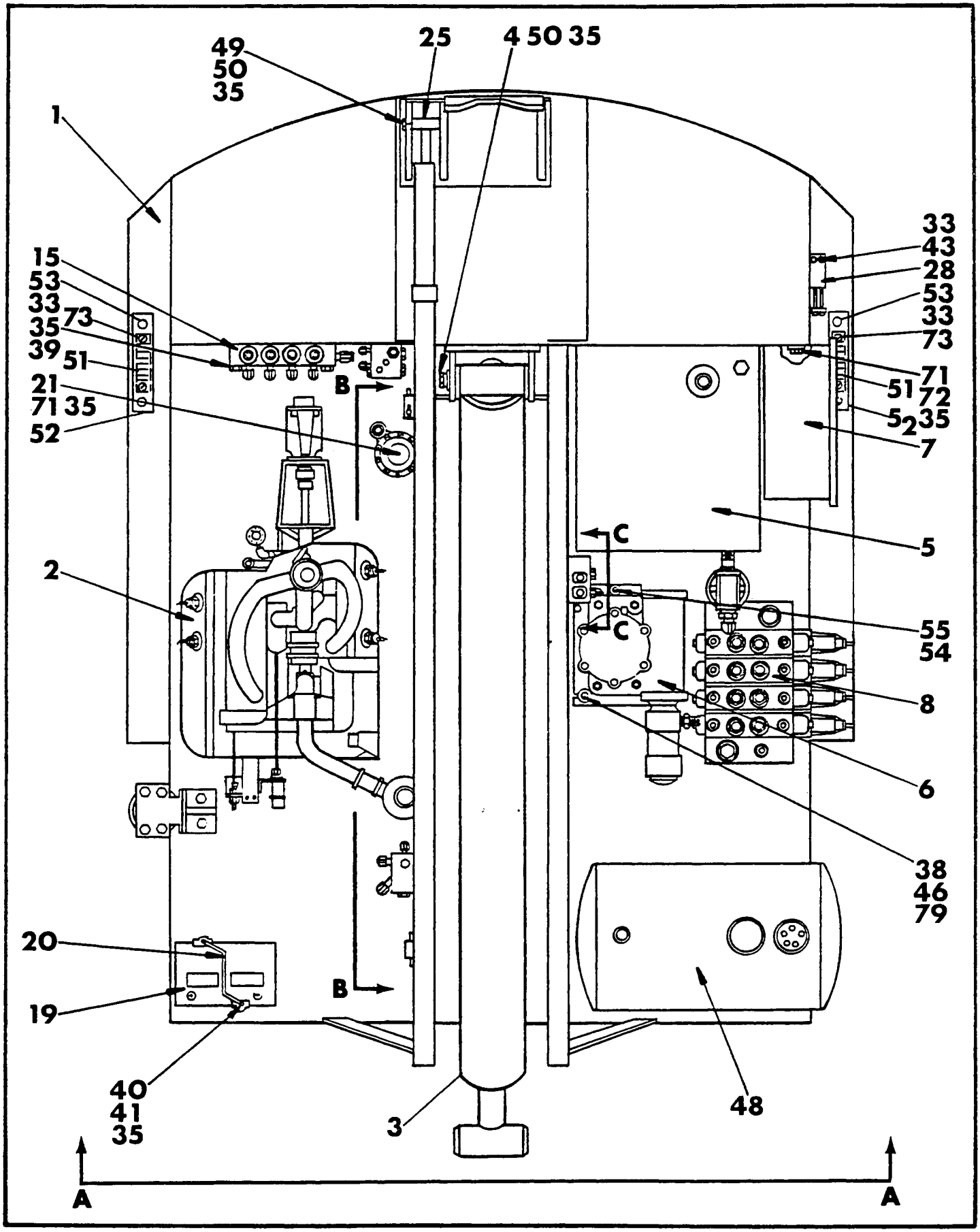
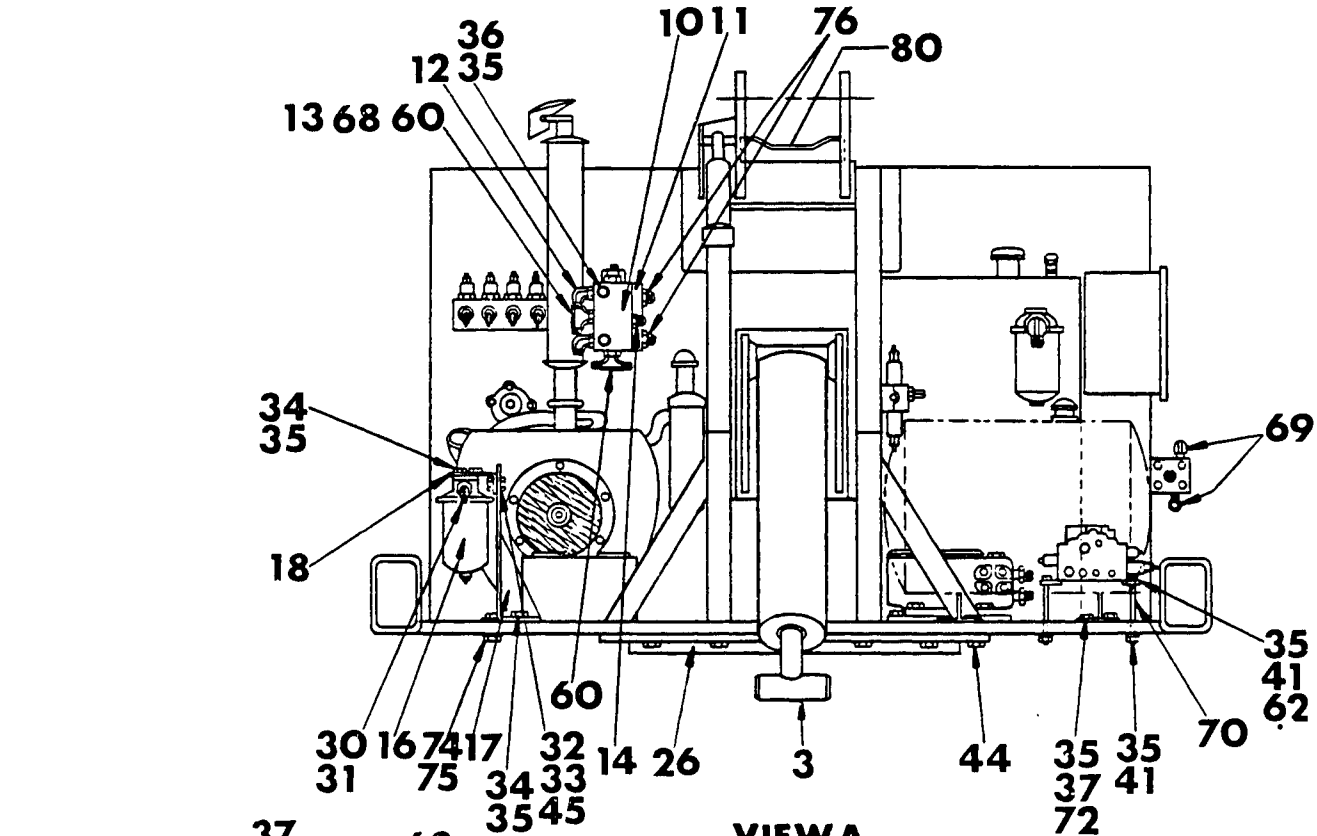
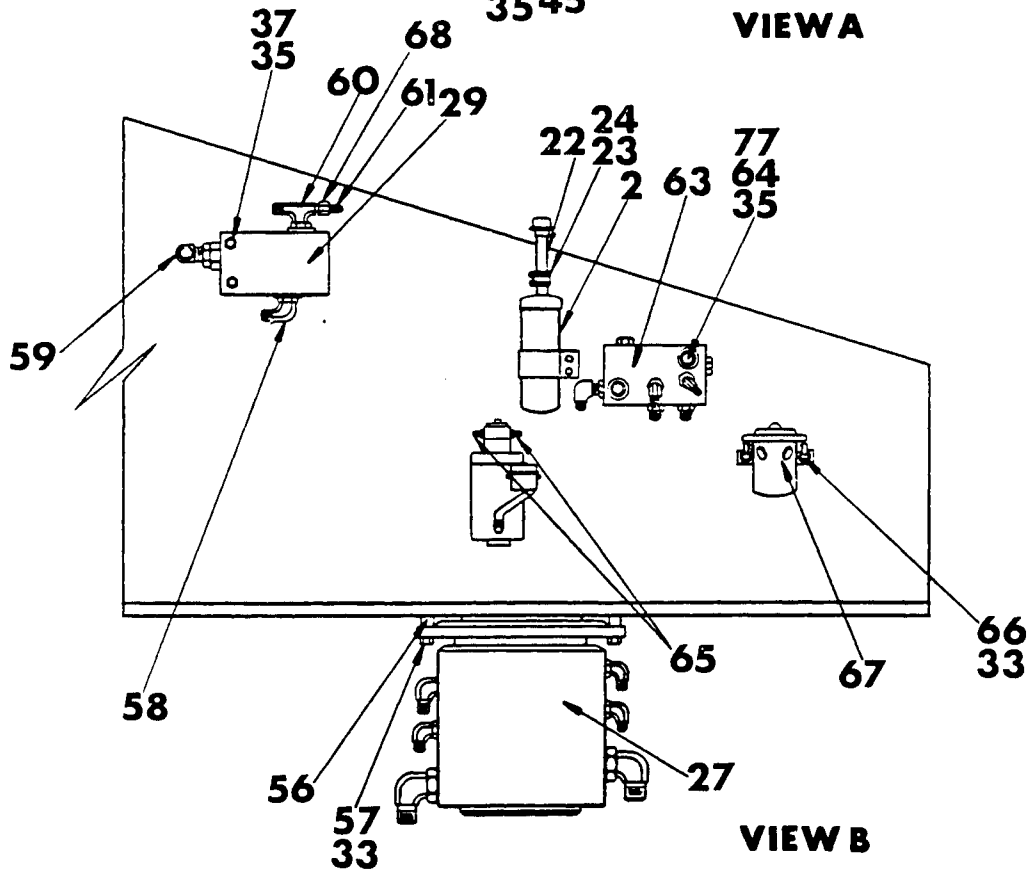


FIGURE 9 - TURRET ASSEMBLY



VIEW A



VIEW B

FIGURE 9 - TURRET ASSEMBLY

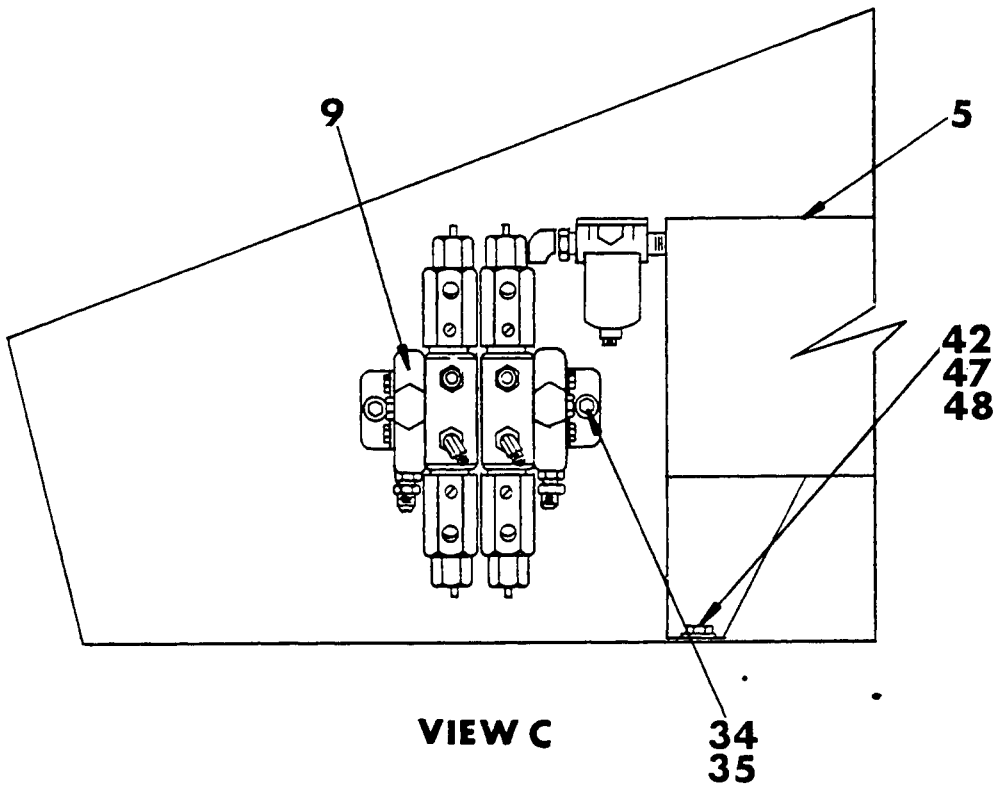


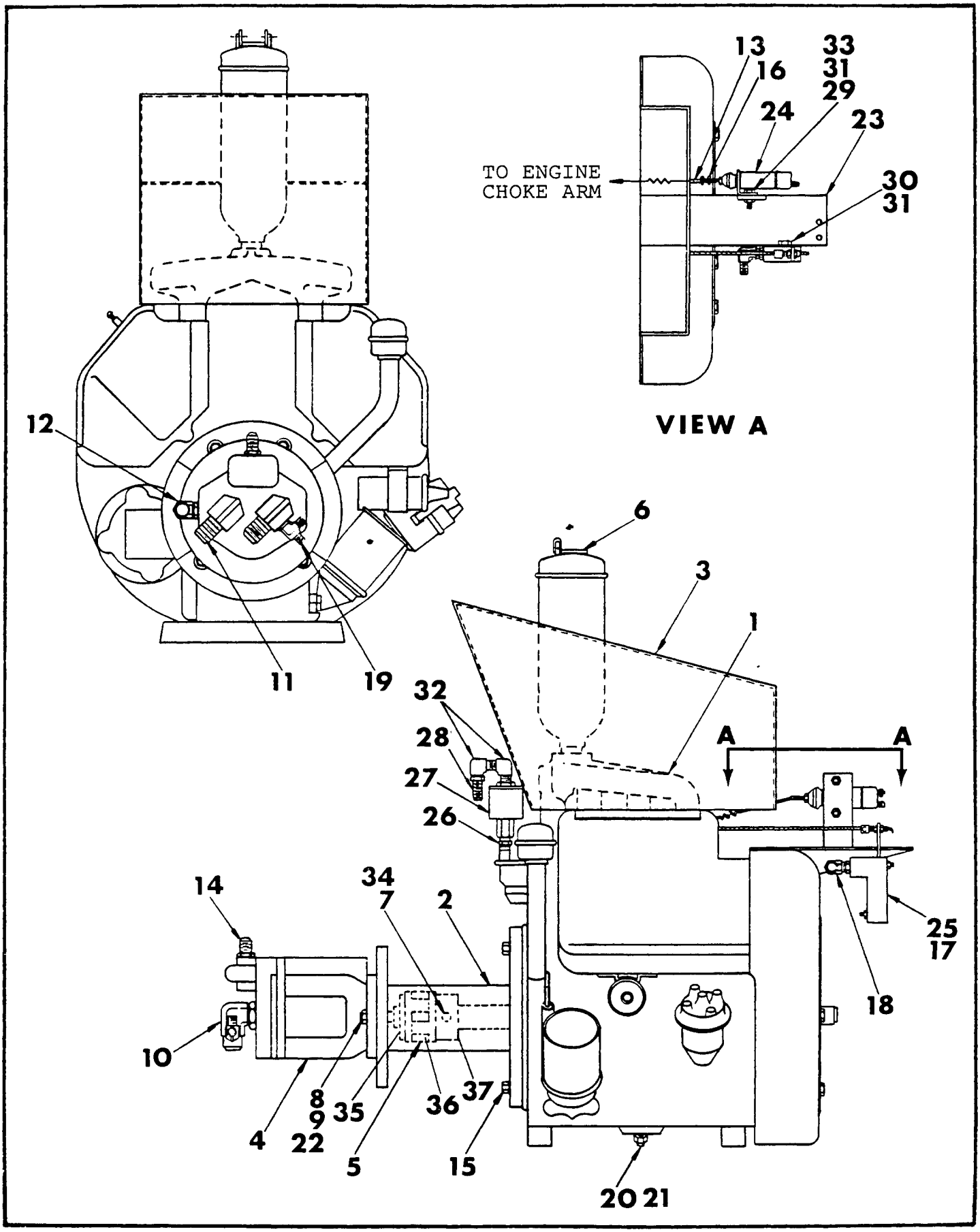
FIGURE 9 - TURRET ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
9-	21700	TURRET ASSEMBLY	1
-1	21751	TURRET WELDMENT	1
-2	21701	ENGINE & PUMP ASSEMBLY (AIR CLEANER & MOUNTING HARDWARE SUPPLIED WITH ENGINE) (SEE FIG. 10)	1
-3	21705	LIFT CYLINDER ASSEMBLY (SEE FIG.11)	1
-4	21780	LIFT CYLINDER PIN	1
-5	21704	HYDRAULIC TANK ASSEMBLY (SEE FIG. 20)	1
-6	20758	ROTATION GEAR BOX ASSEMBLY (SEE FIG.14)	1
-7	21703	GROUND CONTROL BOX ASSY (SEE FIG. 15)	1
-8	21710	PROPORTIONAL VALVE ASSEMBLY (SEE FIG. 16)	1
-9	21712	MINI-PAK SUB-ASSEMBLY (SEE FIG.17)	1
-10	20516	RELIEF VALVE	1
-11	20365	OVER CENTER VALVE	1
-12	2572	STRAIGHT THREAD ELBOW	2
-13	2497	TUBE END REDUCER	1
-14	2542	STRAIGHT THREAD CONNECTOR	1
-15	21692	SOLENOID VALVE ASSEMBLY (SEE FIG.18)	1
-16	20367	PILOT FILTER (ELEMENT-20477)	1
-17	20741	FILTER MOUNTING BRACKET	1
-18	20333	FILTER MOUNTING BRACKET	1
-19	4030	BATTERY - RV27P TROJAN	1
-20	20375	HOLD DOWN BRACKET	1
-21	20384	EMERGENCY PUMP MOTOR	1
-22	25317	ROUND TUBING	1
-23	65250	HOSE	1
-24	55	BAND CLAMP	2
-25	20237	MASTER LEVELING CYLINDER ASSEMBLY (SEE FIG. 21)	1
-26	20740	SLEWING RING	1
-27	20793	ROTARY MANIFOLD ASSEMBLY (SEE FIG.23)	1
-28	20376	SOLENOID VALVE	1
-29	20391	CHECK VALVE	1
-30	2548	REDUCER	2

ITEM	PART NUMBER	DESCRIPTION	QTY
-31	2448	MALE ELBOW	3
-32	60322	HEX HEAD CAPSCREW - 3/8-16UNC X 1 1/8	2
-33	63302	SPLIT LOCKWASHER - 5/16	12
-34	60102	HEX HEAD CAPSCREW - 3/8-16UNC X 1	7
-35	63303	SPLIT LOCKWASHER - 3/8	37
-36	60356	HEX HEAD CAPSCREW - 3/8-16UNC X 4 1/2	2
-37	60307	HEX HEAD CAPSCREW - 3/8-16UNC X 1 1/2	6
-38	21696	FLAT WASHER	1
-39	60321	HEX HEAD CAPSCREW - 3/8-16UNC X 1 3/4	2
-40	65108	HOLD DOWN BOLT - 1048 BOWMAN	2
-41	60703	HEX NUT - 3/8-16UNC	14
-42	63305	SPLIT LOCKWASHER - 1/2	4
-43	60329	HEX HEAD CAPSCREW - 5/16-18UNC X 2	2
-44	60606	HEX HEAD CAPSCREW - 5/8-11UNC X 1 1/4 BOWMALOK 41031-1	12
-45	60702	HEX NUT - 5/16-18UNC	2
-46	60609	HEX HEAD CAPSCREW - 1/2-13UNC X 2 BOWMALOK	1
-47	63405	FLAT WASHER - 1/2	4
-48	21702	FUEL TANK ASSEMBLY (SEE FIG.13)	1
-49	20255	MASTER LEVELING CYLINDER TO TURRET PIN	1
-50	60607	HEX HEAD CAPSCREW - 3/8-16UNC X 3/4 BOWMALOK 41021	2
-51	21217	TERMINAL STRIP	2
-52	21386	TERMINAL STRIP COVER	2
-53	60355	HEX HEAD CAPSCREW - 5/16-18UNC X 1 1/2	4
-54	60601	HEX HEAD CAPSCREW - 3/4-10UNC X 1 1/2 BOWMALOK 41039	1
-55	63307	FLAT WASHER - 3/4	1
-56	20445	SPACER	4
-57	60330	HEX HEAD CAPSCREW - 5/16-18UNC X 2 3/4	4
-58	2523	STRAIGHT THREAD ELBOW	1
-59	2532	STRAIGHT THREAD ELBOW	1
-60	2546	STRAIGHT THREAD BRANCH TEE	3

ITEM	PART NUMBER	DESCRIPTION	QTY
-61	2578	TUBE END REDUCER	1
-62	63623	THREADED ROD - 3/8-16UNC X 9 1/4	4
-63	21472	PILOT VALVE MANIFOLD ASSEMBLY (SEE FIG. 19)	1
-64	60169	HEX HEAD CAPSCREW - 3/8-16UNC X 2 1/2	2
-65	2476	MALE CONNECTOR	2
-66	60123	HEX HEAD CAPSCREW - 1/4-20UNC X 3/4	2
-67	4082	RELAY	1
-68	2501	NUT	2
-69	2435	MALE ELBOW	2
-70	25325	ROUND TUBING	4
-71	60325	HEX HEAD CAPSCREW - 3/8-16 X 3/4	5
-72	63403	FLAT WASHER - 3/8	7
-73	62612	ROUND HEAD SLOTTED CAPSCREW -8- 32UNC X 1 1/2	4
-74	60614	BOLT - 1/2-20UNF X 3 1/2-BOWMALLOY-36414	4
-75	61301	LOCK NUT - 1/2-20UNF -BOWMAGRIP 36799	4
-76	2608	STRAIGHT THREAD CONNECTOR	2
-77	63402	FLAT WASHER - 5/16	2
-78	60308	HEX HEAD CAPSCREW - 1/2-13UNC X 1 1/2	4
-79	63501	FLAT WASHER - 1/2 (GR. 8) HEAVY DUTY	1
-80	21886	HOSE GUARD	1

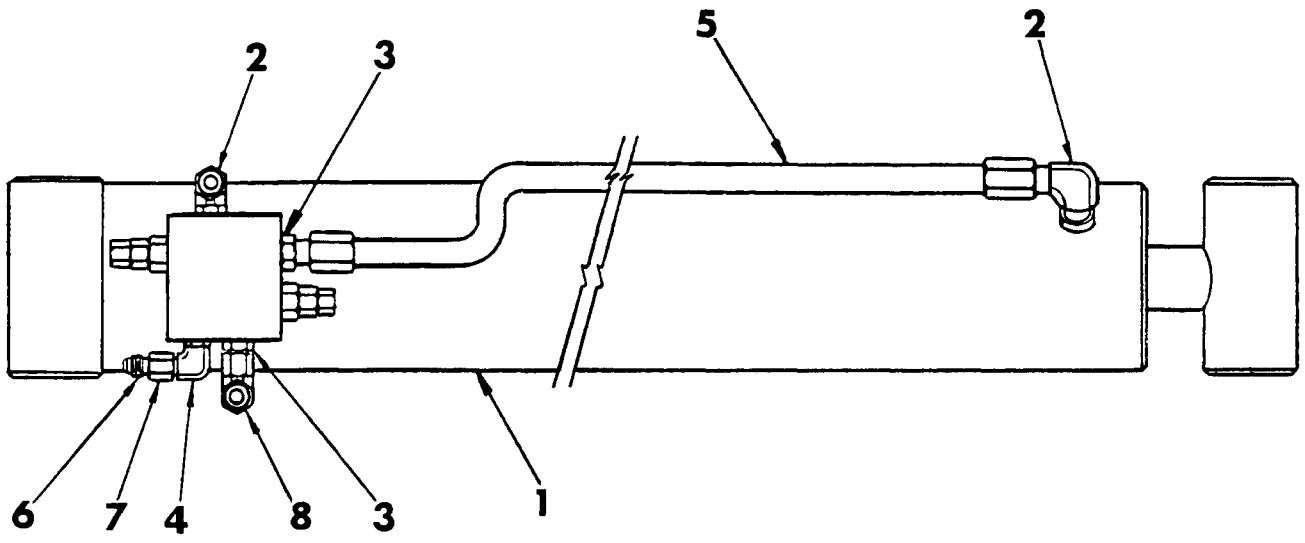
FIGURE 10 - ENGINE & PUMP ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
10-	21701	ENGINE & PUMP ASSEMBLY	1
-1	20750	ENGINE	1
-2	20918	PUMP ADAPTER	1
-3	21707	CHIMNEY	1
-4	20801	PUMP	1
-5	20724	COUPLING ASSEMBLY	1
-6	21288	RAIN CAP	1
-7	25005	KEY - 3/8 SQ. X 2	1
-8	63622	STUD - 1/2 - 13UNC X 3 (BOWMAN 90597)	2
-9	63305	SPLIT LOCKWASHER - 1/2	2
-10	20798	90° STRAIGHT THREAD ELBOW (MODIFIED)	1
-11	2529	90° STRAIGHT THREAD ELBOW	1
-12	2447	90° STRAIGHT THREAD ELBOW	1
-13	65199	UNIVERSAL THROTTLE SPRING	1
-14	51001	MALE CONNECTOR	1
-15	60616	HEX HEAD CAPSCREW - 7/16 - 14UNC X 1 1/2 (BOWMAN 41021)	4
-16	60805	HEX NUT - 1/4 - 28UNF	2
-17	3B	CHAIN	1
-18	2435	90° MALE ELBOW	1
-19	2425	RUN TEE	1
-20	2478	MALE CONNECTOR	1
-21	2412	CAP NUT	1
-22	60705	HEX NUT - 1/2 -13UNC	2
-23	21775	THROTTLE & CHOKE MOUNTING BRACKET	1
-24	21777	SYNCRO START CHOKE	1
-25	20364	HYDRAULIC THROTTLE	1
-26	16550	PIPE NIPPLE	1
-27	20832	FUEL SHUT OFF VALVE	1
-28	240	HOSE BARB	1
-29	60114	HEX HEAD CAPSCREW - 5/16 -18UNC X 3/4	2
-30	60201	HEX HEAD CAPSCREW - 5/16 -24UNF X 1	2
-31	63302	SPLIT LOCKWASHER - 5/16	4

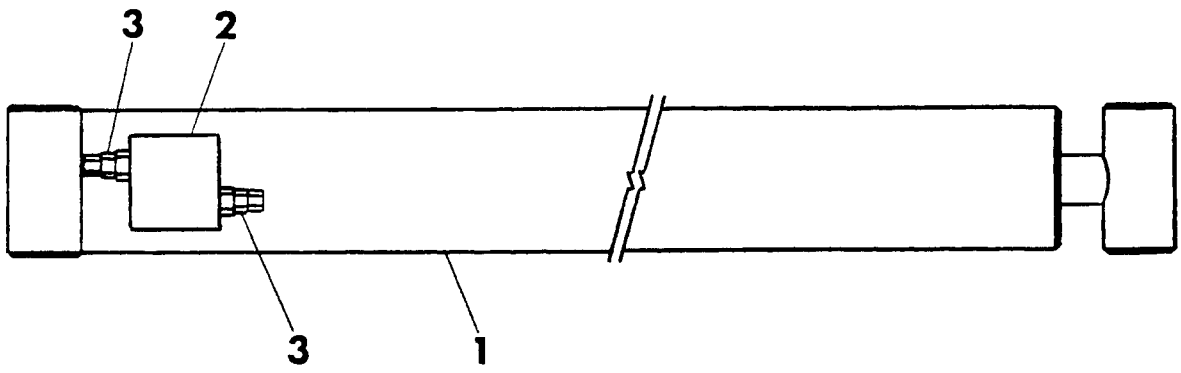
ITEM	PART NUMBER	DESCRIPTION	QTY
-32	16500	90° STREET ELBOW	2
-33	60702	HEX NUT - 5/16 -18UNC	2
-34		SET SCREW - 1/4 -20UNC X 1/2	2
-35	20925	3 - JAW COUPLING	1
-36	20930	INSERT	1
-37	20926	3 - JAW COUPLING	1

FIGURE 11 - LIFT CYLINDER ASSEMBLY



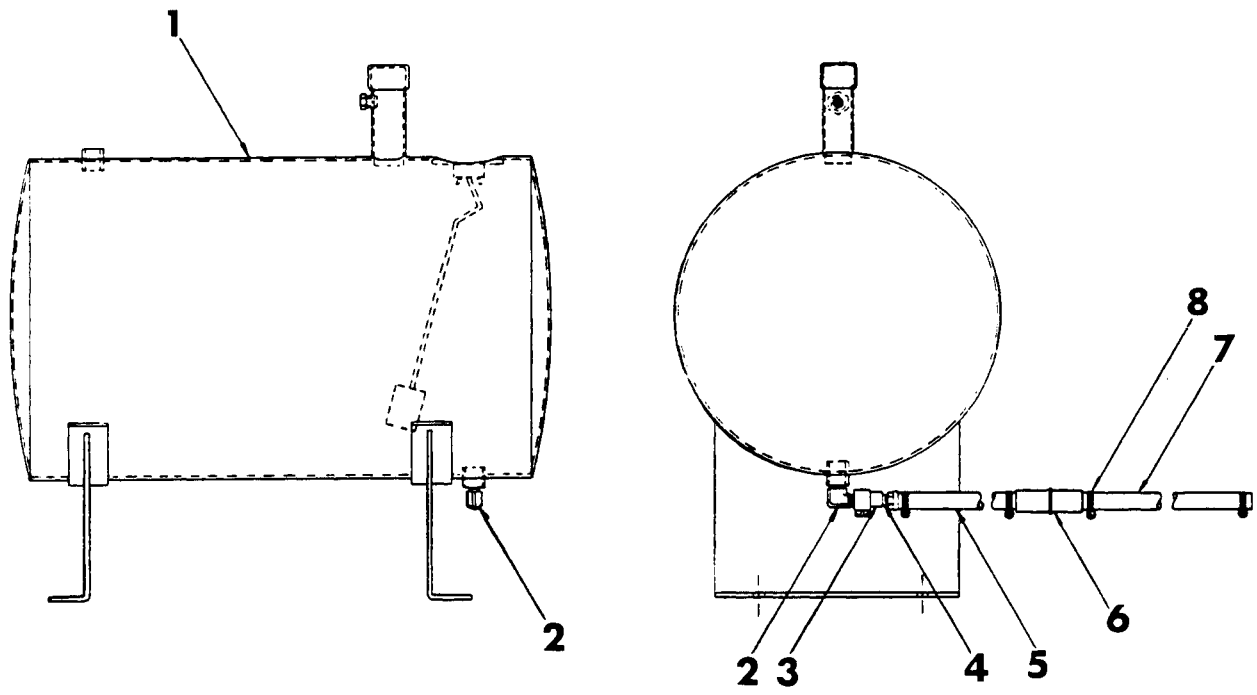
ITEM	PART NUMBER	DESCRIPTION	QTY
11-	21705	LIFT CYLINDER ASSEMBLY	1
-1	20968	LIFT CYLINDER (SEE FIG. 12)	1
-2	2523	STRAIGHT THREAD ELBOW	2
-3	2542	STRAIGHT THREAD CONNECTOR	2
-4	50900	STRAIGHT THREAD ELBOW	1
-5	20633	TUBE ASSEMBLY - 1/2	1
-6	20348	BLEED DOWN ORIFICE	1
-7	2539	"B" NUT	1
-8	2441	SWIVEL NUT ELBOW	1

FIGURE 12 - LIFT CYLINDER



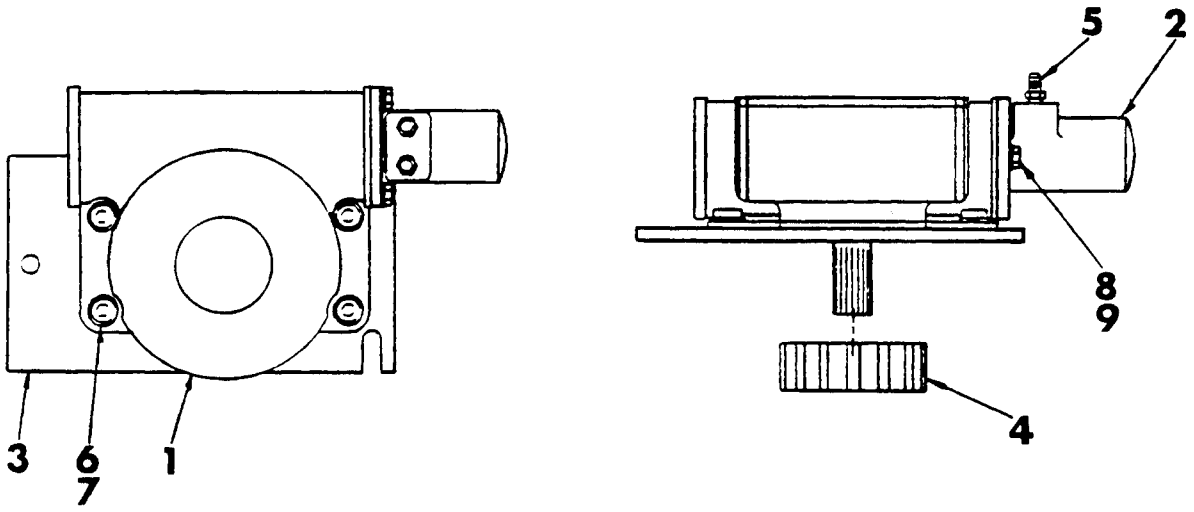
ITEM	PART NUMBER	DESCRIPTION	QTY
12-	20968	LIFT CYLINDER	1
-1	21198	CYLINDER	1
-2	21445	MANIFOLD BLOCK	1
-3	21265	OVER CENTER CARTRIDGE	2
-4	66165	SEAL KIT	

FIGURE 13 - FUEL TANK ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
13-	21702	FUEL TANK ASSEMBLY (22 GAL)	1
-1	21762	FUEL TANK	1
-2	16501	STREET ELBOW	1
-3	65134	SHUT-OFF VALVE	1
-4	2589	MALE CONNECTOR	1
-5	160B	HOSE - 1/4 FUEL X 16	1
-6	160	FUEL FILTER - ACGF453	1
-7	160B	HOSE - 1/4 FUEL X 100	1
-8	161-1A	HOSE CLAMP	4

FIGURE 14 - ROTATION GEAR BOX ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
14-	20758	ROTATION GEAR BOX ASSEMBLY	1
-1	20726	ROTATION GEAR BOX	1
-2	20520	MOTOR	1
-3	20736	SUB PLATE	1
-4	20725	PINION GEAR	1
-5	2464	CONNECTOR	2
-6	61901	SOCKET HEAD CAPSCREW-5/8-11UNC X 2	4
-7	63306	SPLIT LOCKWASHER - 5/8	4
-8	60311	HEX HEAD CAPSCREW-1/2-13UNC X 1 1/4	2
-9	63305	SPLIT LOCKWASHER - 1/2	2

FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

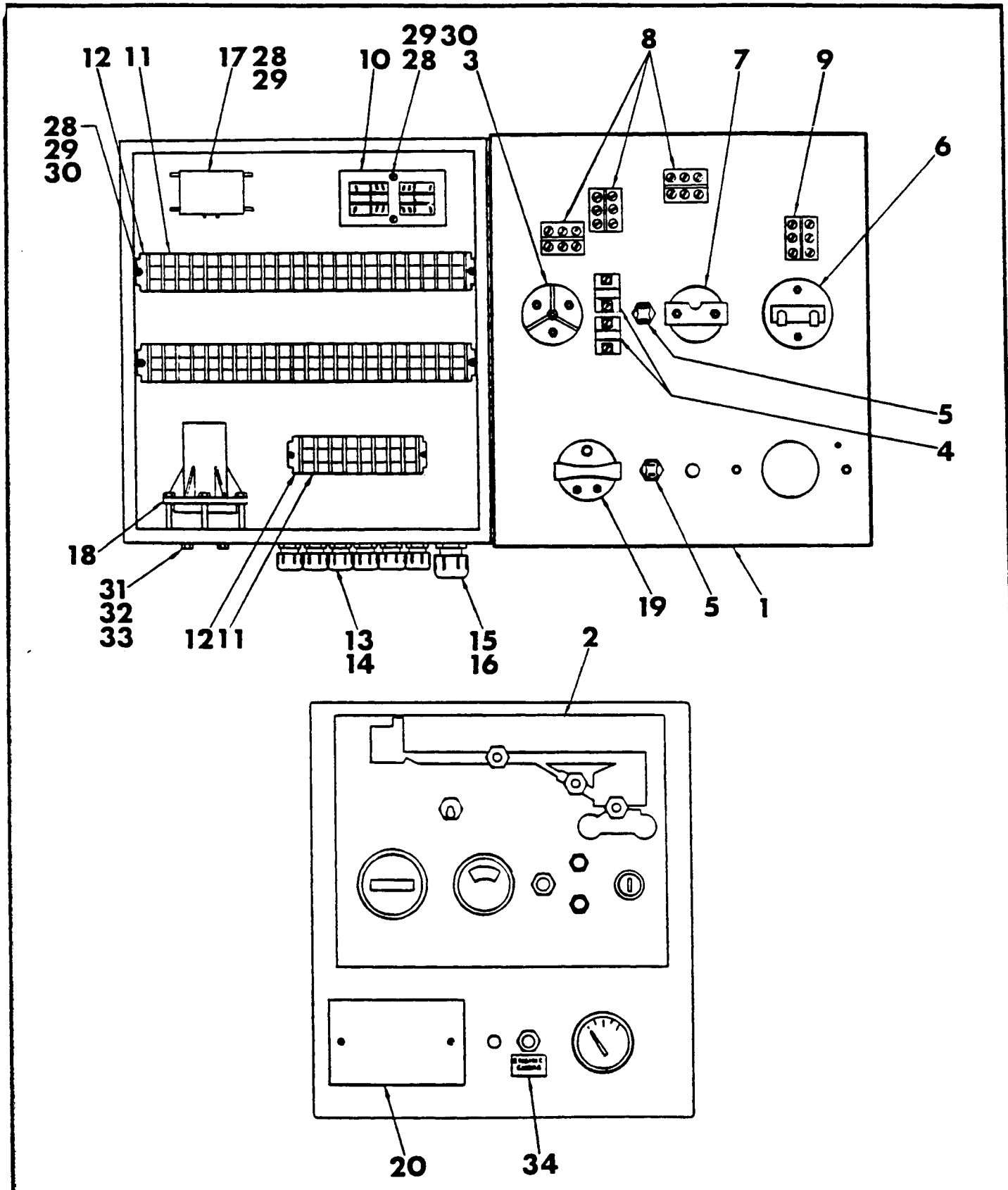
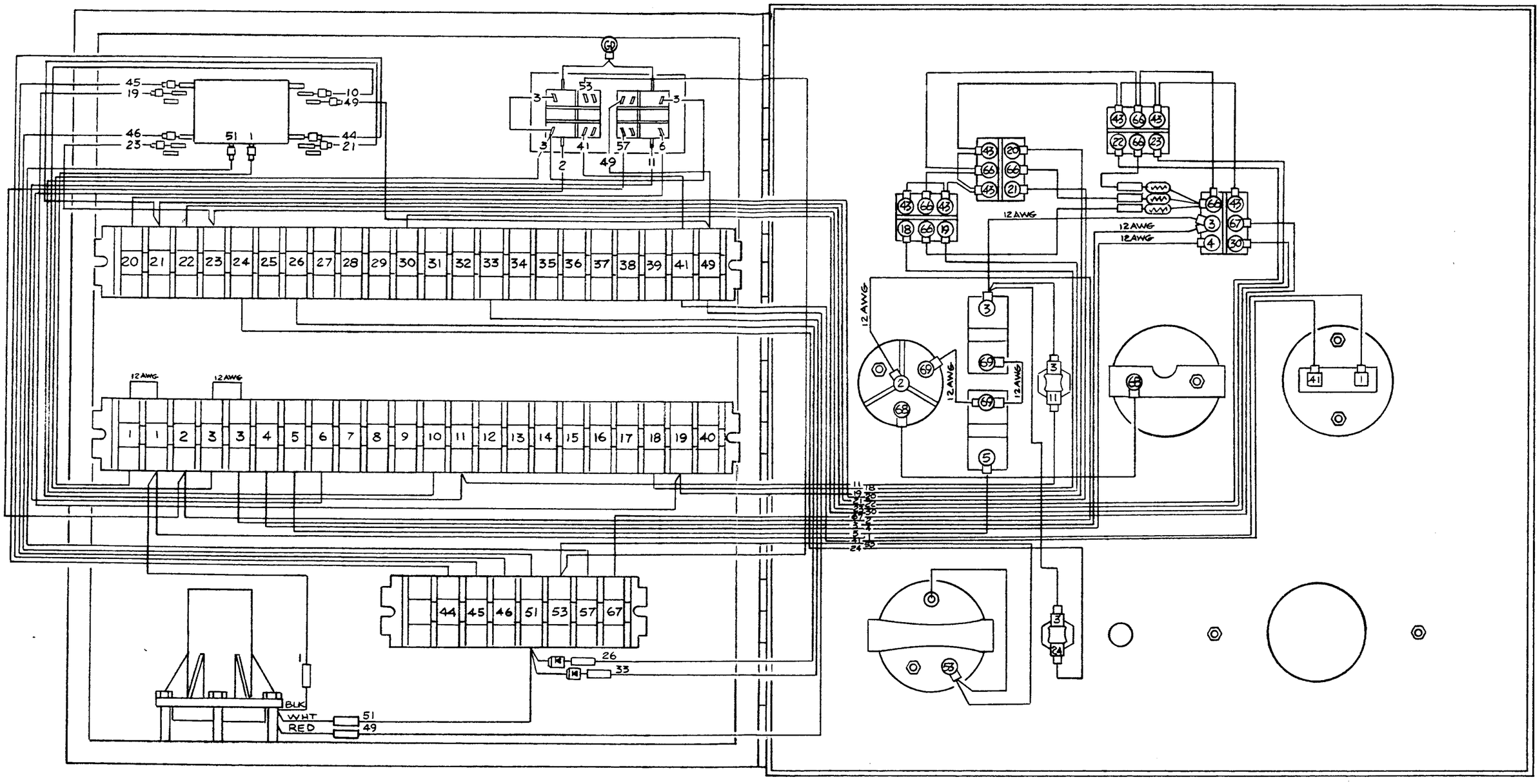


FIGURE 15 - GROUND CONTROL BOX ASSEMBLY



WIRING DIAGRAM LEGEND

ITEM 21	ITEM 25
ITEM 22	ITEM 26
ITEM 23	ITEM 27
ITEM 24	

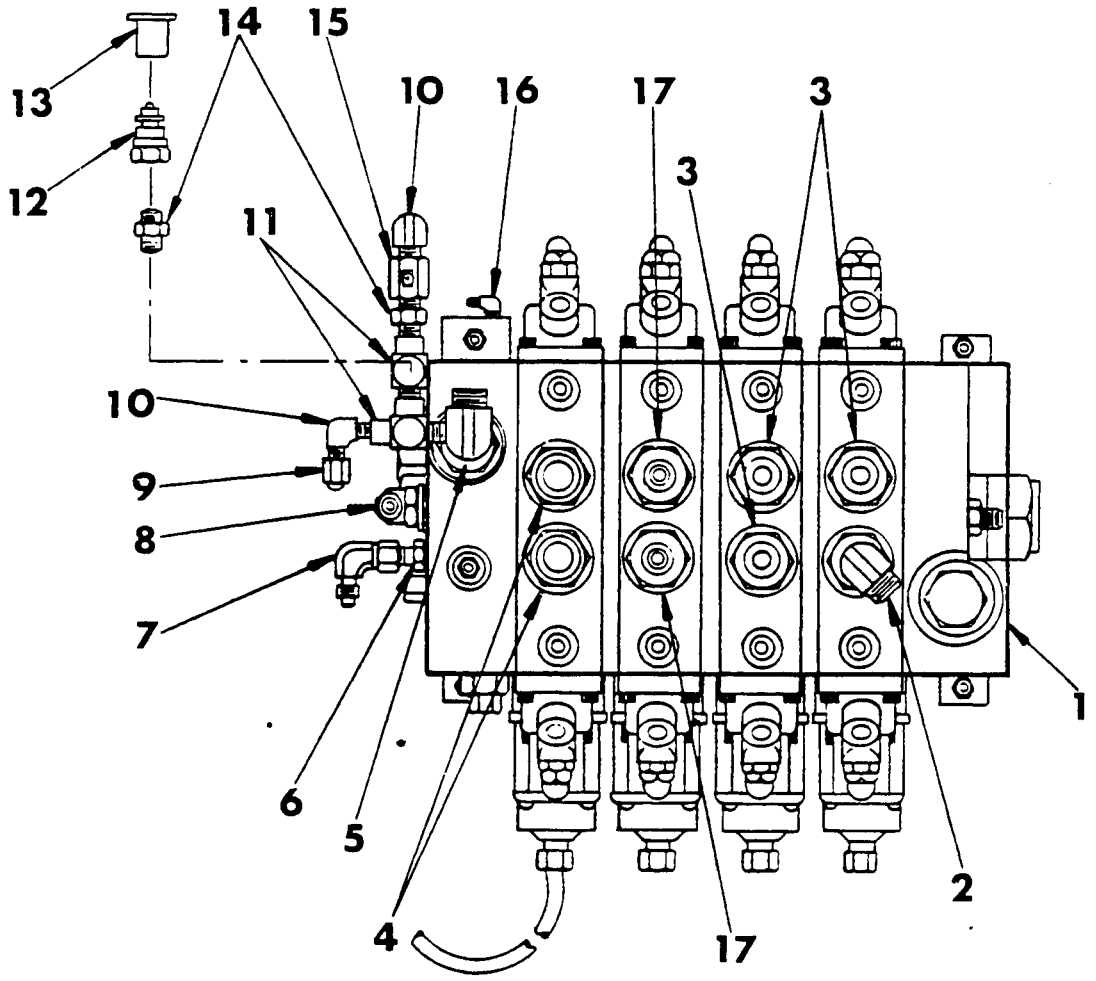
FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
15-	21703	GROUND CONTROL BOX ASSEMBLY	1
-1	20977	ENCLOSURE	1
-2	20460	DECAL - COVER	1
-3	405	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 GUAGE	1
-20	902	COVER PLATE	1
-21	4045	DIODE	2
-22	70037	RESISTOR	3
-23	117D	BUTT CONNECTOR	8
-24	117E	PUSH ON TERMINAL	6
-25	496A	PUSH ON TERMINAL	8
-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
-34	20413	DECAL - "ENGINE CHOKE"	1

FIGURE 16 - PROPORTIONAL VALVE ASSEMBLY

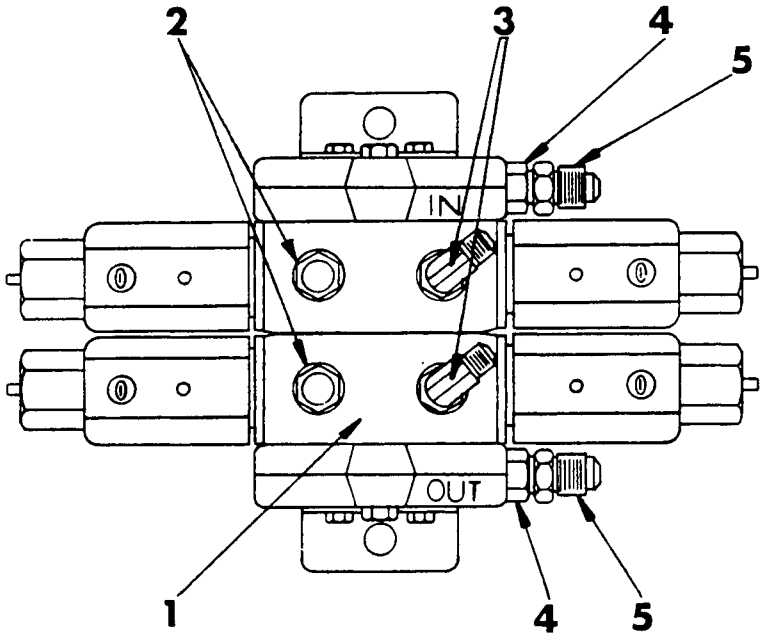


ITEM	PART NUMBER	DESCRIPTION	QTY
16-	21710	PROPORTIONAL VALVE ASSEMBLY	1
-1	21255	PROPORTIONAL VALVE	1
-2	2577	90° ELBOW	1
-3	780	CONNECTOR	3
-4	2543	CONNECTOR	2
-5	20798	90° ELBOW	1
-6	2511	CONNECTOR	1
-7	2538	SWIVEL NUT ELBOW	1
-8	2528	90° ELBOW	1
-9	2412	CAP NUT	1
-10	2448	90° ELBOW	2
-11	2420	TEE	2
-12	2527	QUICK DISCONNECT COUPLING	1

FIGURE 16 - PROPORTIONAL VALVE ASSEMBLY

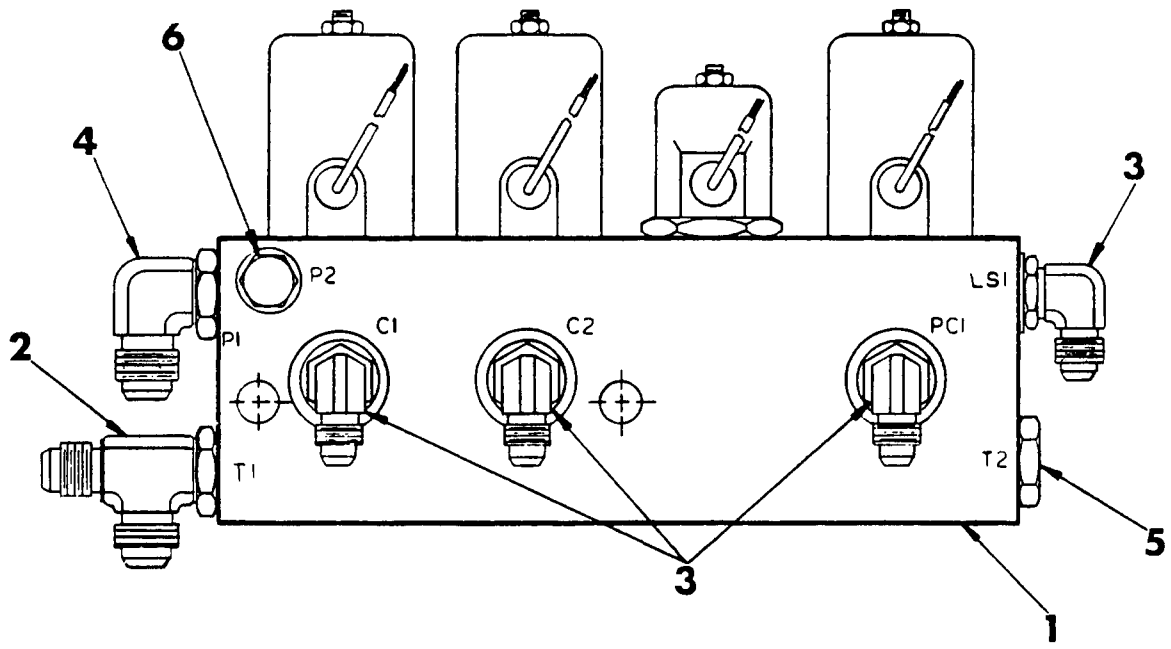
ITEM	PART NUMBER	DESCRIPTION	QTY
-13	845	CAP	1
-14	2475	PIPE NIPPLE	1
-15	20357	NEEDLE VALVE	1
-16	2532	90° ELBOW	1
-17	50844	CONNECTOR	2

FIGURE 17 - MINIPAK SUB-ASSEMBLY

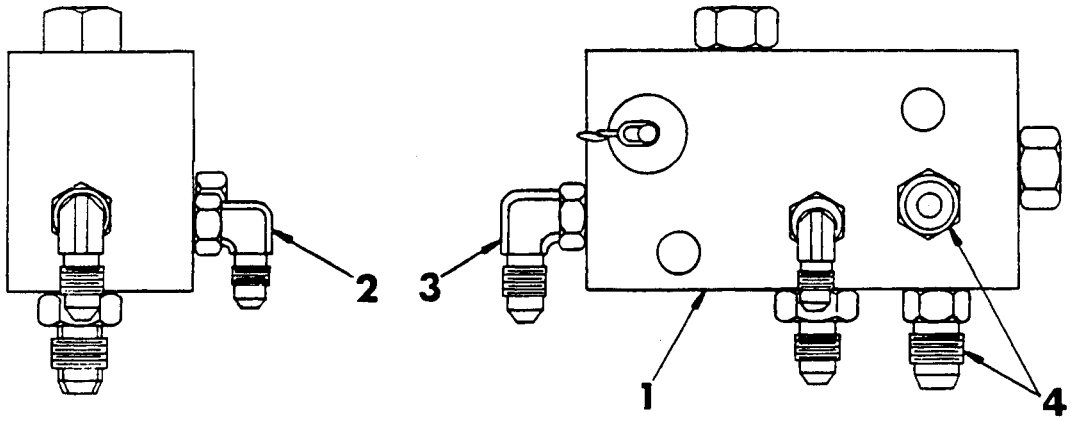


ITEM	PART NUMBER	DESCRIPTION	QTY
17-	21712	MINIPAK SUB-ASSEMBLY	1
-1	21207	SOLENOID VALVE BANK	1
-2	2608	CONNECTOR	2
-3	2572	90° ELBOW	2
-4	2498	FEMALE PIPE ADAPTER	2
-5	2476	CONNECTOR	2

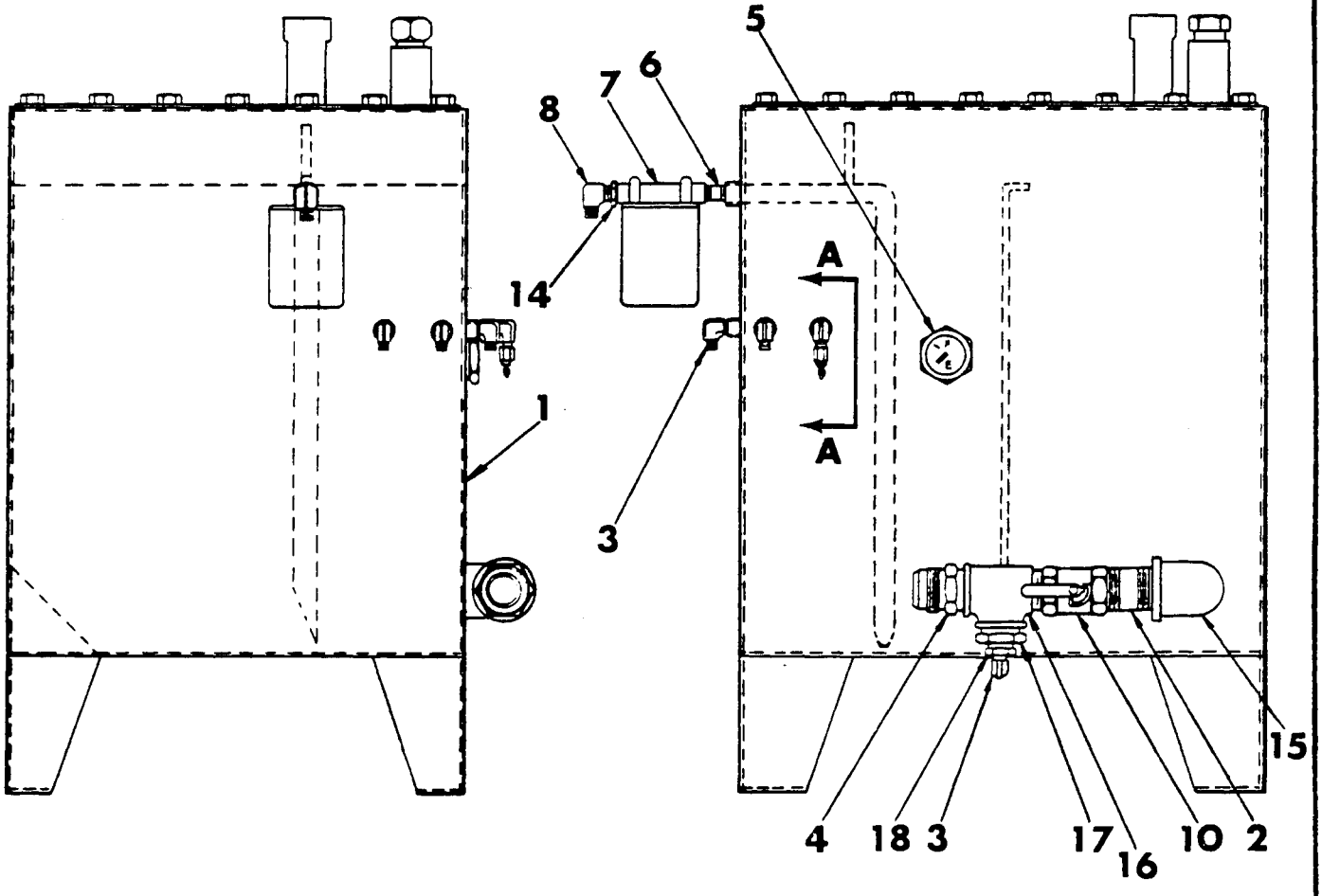
FIGURE 18 - SOLENOID VALVE ASSEMBLY

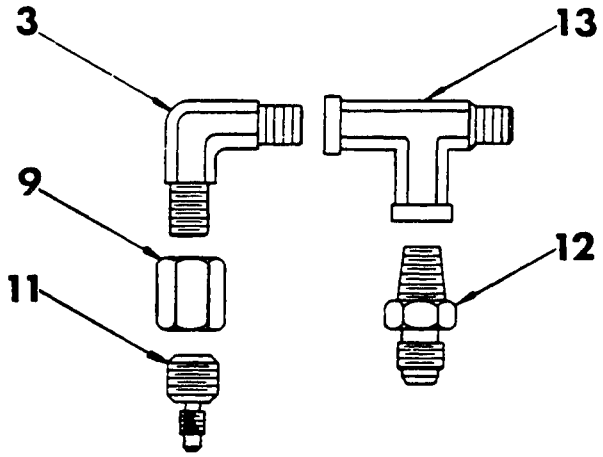


ITEM	PART NUMBER	DESCRIPTION	QTY
18-	21692	SOLENOID VALVE ASSEMBLY	1
-1	21860	MANIFOLD BLOCK	1
-2	53201	RUN TEE	1
-3	2532	90° ELBOW	4
-4	2447	90° ELBOW	1
-5	2405	HEX HEAD PLUG	1
-6	53900	HOLLOW HEX PLUG	1



ITEM	PART NUMBER	DESCRIPTION	QTY
19-	21472	PILOT VALVE MANIFOLD ASSEMBLY	1
-1	21574	PILOT VALVE MANIFOLD	1
-2	2532	STRAIGHT THREAD ELBOW	1
-3	2447	STRAIGHT THREAD ELBOW	1
-4	2474	STRAIGHT THREAD CONNECTOR	2



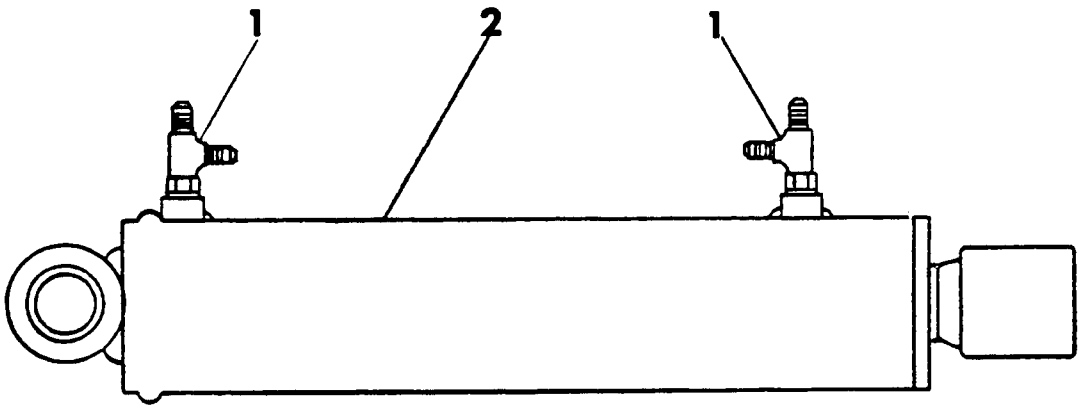


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FIGURE 20 - HYDRAULIC TANK ASSEMBLY

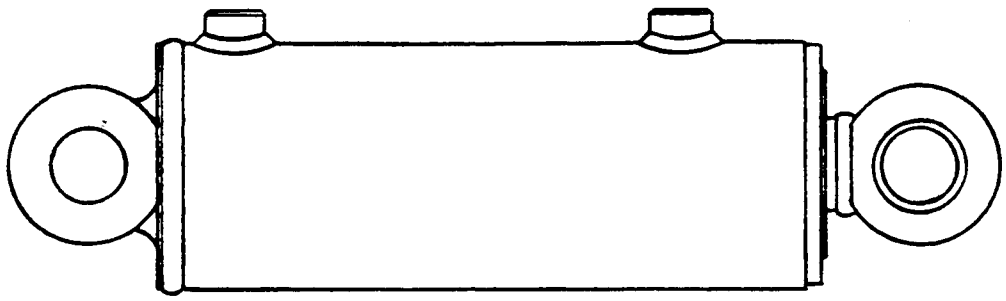
ITEM	PART NUMBER	DESCRIPTION	QTY
20-	21704	HYDRAULIC TANK ASSEMBLY	1
-1	21761	HYDRAULIC TANK	1
-2	54700	PIPE NIPPLE	1
-3	2449	90° ELBOW	5
-4	2814	CONNECTOR	1
-5	20041	GAUGE	1
-6	16658	NIPPLE - 1 1/4 NPT X 3 1/2 BLK PIPE	1
-7	21241	RETURN LINE FILTER (ELEMENT-21245)	1
-8	2409	90° ELBOW	1
-9	2539	NUT	1
-10	20050	BUTTERBALL VALVE - 1 1/2 NPT	1
-11	2496	TUBE END REDUCER	1
-12	2478	CONNECTOR	1
-13	53100	STREET TEE	1
-14	53801	PIPE REDUCER	1
-15	16508	FEMALE ELBOW	1
-16	55100	STREET TEE	1
-17	53800	PIPE REDUCER	1
-18	2516	PIPE REDUCER	1

FIGURE 21- MASTER LEVELING CYLINDER ASSEMBLY



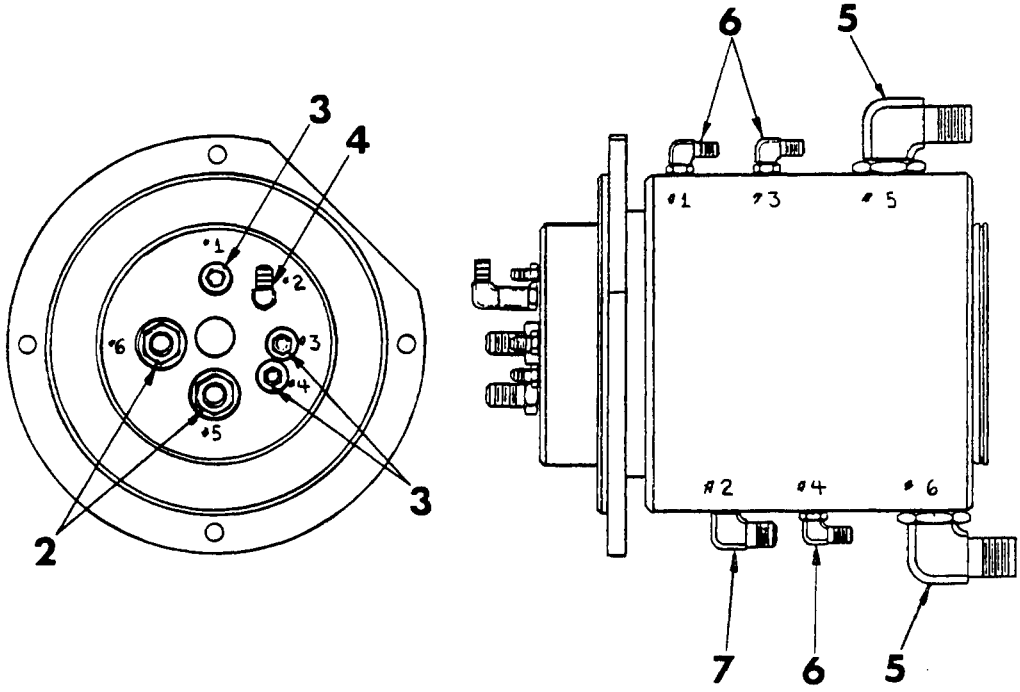
ITEM	PART NUMBER	DESCRIPTION	QTY
21-	20237	MASTER LEVELING CYLINDER ASSEMBLY	1
-1	2545	BRANCH TEE	2
-2	20203	MASTER LEVELING CYLINDER (SEE FIG. 22)	1

FIGURE 22 - MASTER LEVELING CYLINDER



ITEM	PART NUMBER	DESCRIPTION	QTY
22-	20203	MASTER LEVELING CYLINDER	1
-1	20128	SEAL KIT	

FIGURE 23- ROTARY MANIFOLD ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
23-	20793	ROTARY MANIFOLD ASSEMBLY	1
-1	20324	HYDRAULIC ROTARY MANIFOLD	1
-2	2543	STRAIGHT THREAD CONNECTOR	2
-3	2581	STRAIGHT THREAD CONNECTOR	3
-4	2437	EXTRA LONG MALE ELBOW	1
-5	2524	STRAIGHT THREAD ELBOW	2
-6	2532	STRAIGHT THREAD ELBOW	3
-7	2448	MALE ELBOW	1

FIGURE 24 - SHEET METAL COVER KIT

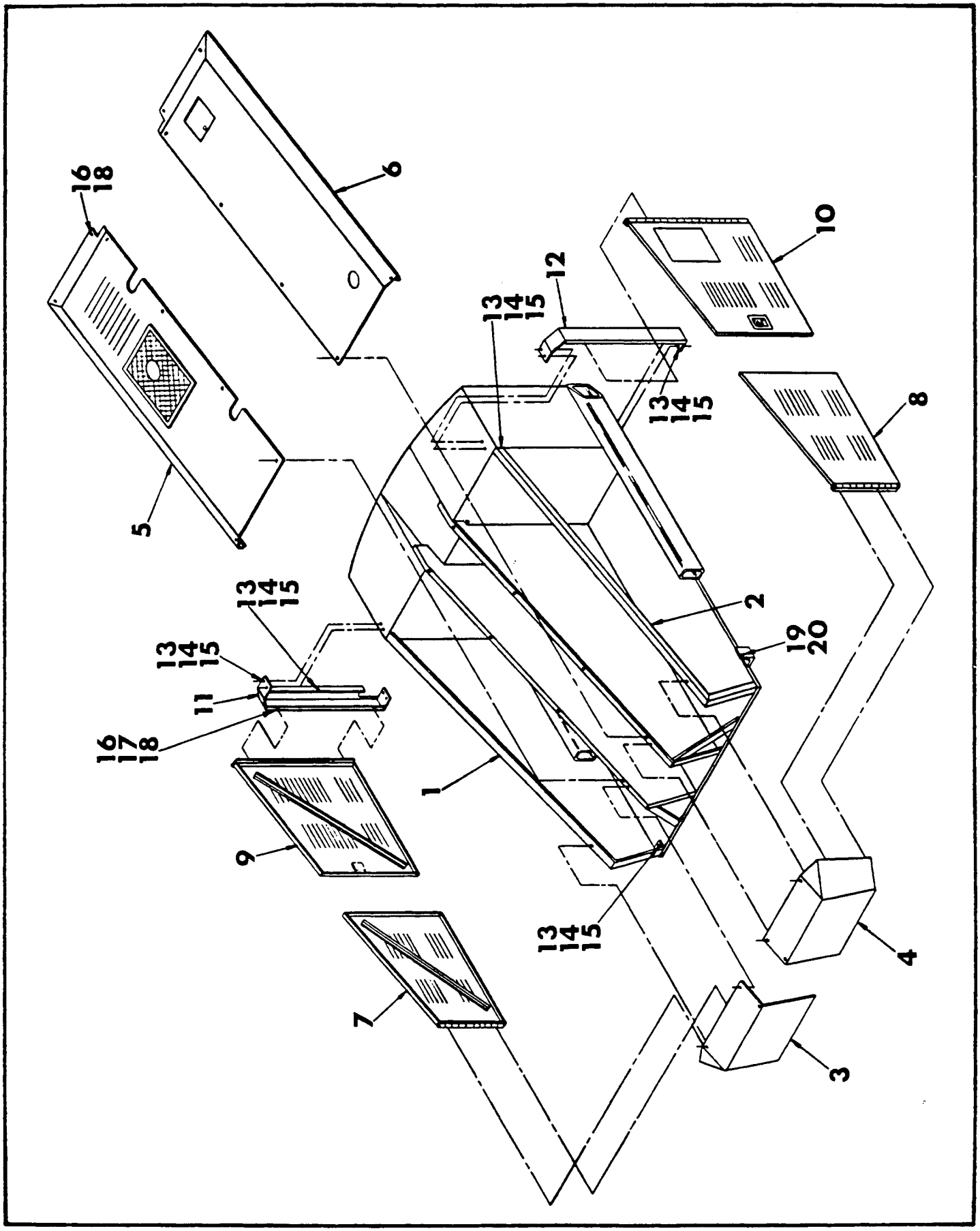


FIGURE 24 - SHEET METAL COVER KIT

ITEM	PART NUMBER	DESCRIPTION	QTY
24-	21706	SHEET METAL COVER KIT	1
-1	21742	LEFT ANGLE BRACKET	1
-2	21741	RIGHT ANGLE BRACKET	1
-3	21736	LEFT NOSE PIECE	1
-4	21735	RIGHT NOSE PIECE	1
-5	21746	LEFT TOP COVER	1
-6	21745	RIGHT TOP COVER	1
-7	21740	LEFT REAR DOOR	1
-8	21739	RIGHT REAR DOOR	1
-9	21738	LEFT FRONT DOOR	1
-10	21737	RIGHT FRONT DOOR	1
-11	21744	LEFT FRONT SUPPORT	1
-12	21743	RIGHT FRONT SUPPORT	1
-13	60102	HEX HEAD CAPSCREW-3/8-16UNC X 1	18
-14	63403	FLAT WASHER - 3/8	18
-15	63303	LOCK WASHER - 3/8	18
-16	61902	ROUND SOCKET HEAD CAPSCREW 1/4-20UNC X 3/4	40
-17	61313	LOCK NUT - 1/4-20UNC	18
-18	63401	FLAT WASHER - 1/4	40
-19	61816	FLAT SLOTTED HEAD CAPSCREW-1/4-20UNC X 1/2	2
-20	63301	LOCK WASHER - 1/4	2

FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY

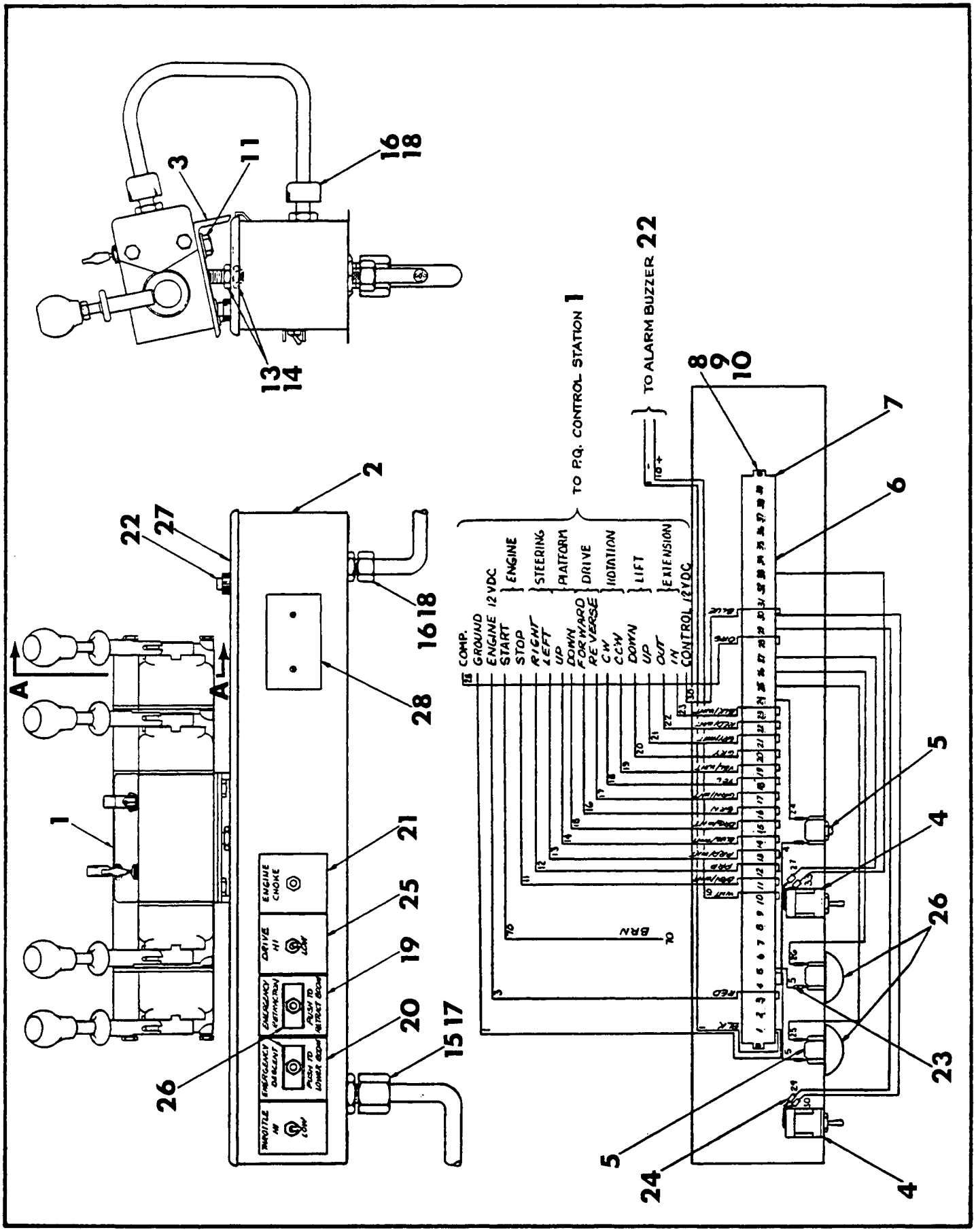
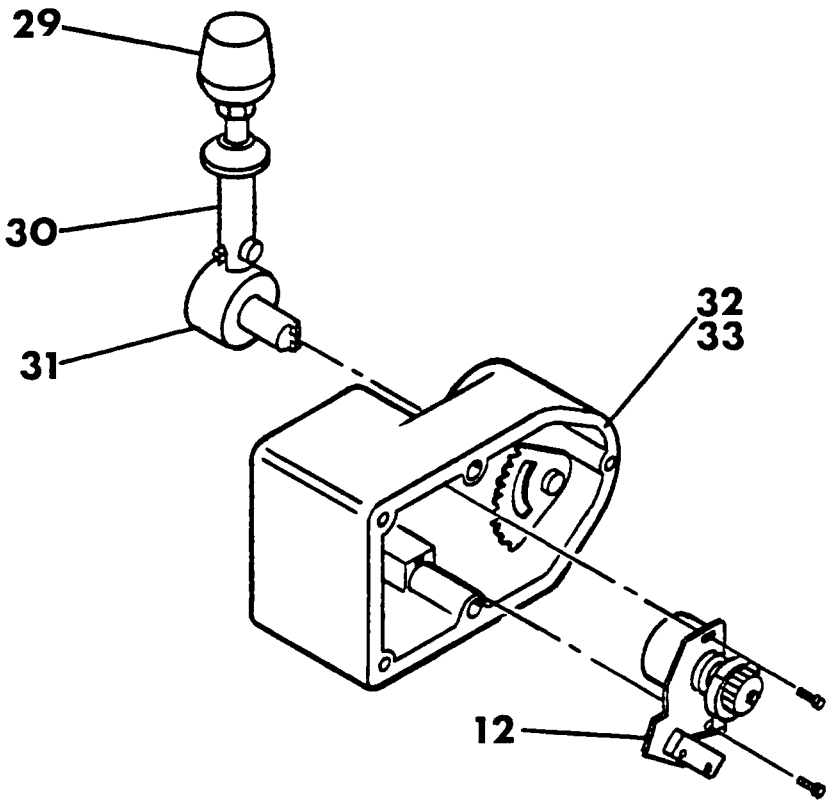


FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY



VIEW A

FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
25-	20782	AERIAL CONTROL CONSOLE ASSEMBLY	1
-1	20392	AERIAL CONTROL STATION	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 CAPSCREW-NO. 6-32UNC X 3/8	5
-9	60710	HEX NUT - 6-32UNC	5
-10	63311	LOCKWASHER - NO. 6	5
-11	60633	HEX HEAD CAPSCREW - 1/4-20UNC X 1/2 (BOWMALOK 41000)	4
-12	20580	POTENTIOMETER ASSEMBLY	1
-13	60702	HEX NUT - 5/16-18UNC	4
-14	63302	LOCKWASHER - 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
-28	902	COVER PLATE	1
-29	20479	KNOB	1
-30	20581	CONTROLLER LOCK-OUT	1
-31	20539	CONTROLLER HANDLE ASSEMBLY	1
-32	20597	GASKET	1

ITEM	PART NUMBER	DESCRIPTION	QTY
-33	20598	GASKET - CENTER COVER	1

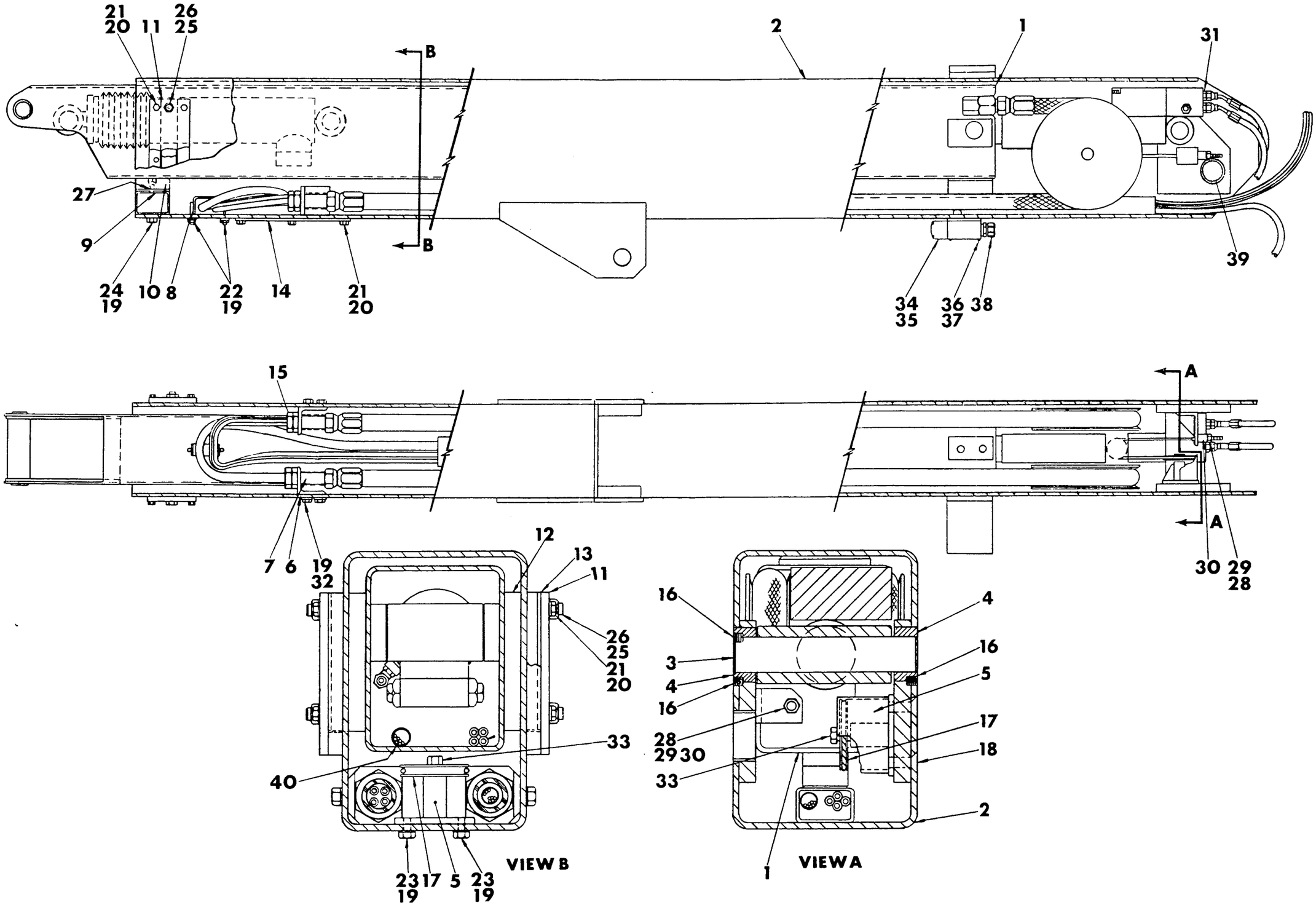

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FIGURE 26 - FINAL BOOM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
26-	20748	FINAL BOOM ASSEMBLY	1
-1	20747	INNER BOOM ASSEMBLY (SEE FIG. 27)	1
-2	20733	OUTER BOOM MACHINING	1
-3	20267	EXTENSION CYLINDER PIN	1
-4	20268	ECCENTRIC BUSHING	2
-5	20245	RETRACTION SHEAVE BRACKET	2
-6	20298	RETRACTION HOSE BRACKET	2
-7	20211	HOSE ADAPTER	2
-8	20277	HOLD DOWN BRACKET FOR HOSES	1
-9	20278	OUTER BOOM WEAR PAD BRACKET	1
-10	20284	OUTER BOOM WEAR PAD	1
-11	20452	OUTER BOOM SIDE WEAR PAD COVER	2
-12	20454	OUTER BOOM SIDE WEAR PAD	2
-13	20453	PAD PRESSURE PLATE	2
-14	20275	OUTER BOOM COVER PLATE	1
-15	2596	BULKHEAD LOCKNUT	4
-16	62203	HEX SOCKET HEAD SET SCREW-3/8-16UNC X 3/8	3
-17	20387	SHEAVE	2
-18	61802	FLAT SOCKET HEAD CAPSCREW-3/8 X 24UNF X 1 1/2	2
-19	63303	LOCKWASHER - 3/8	10
-20	60114	HEX HEAD CAPSCREW-5/16-18UNC X 3/4	18
-21	63302	LOCKWASHER - 5/16	14
-22	60703	HEX NUT - 3/8-16UNC	2
-23	60202	HEX HEAD CAPSCREW-3/8-24UNF X 5/8	2
-24	60102	HEX HEAD CAPSCREW-3/8-16UNC X 1	2
-25	62204	HEX SOCKET HEAD SET SCREW 1/2-13UNC X1	4
-26	61101	JAM NUT -1/2-13UNC	4
-27	61804	FLAT SOCKET HEAD CAPSCREW-3/8-24UNF X1	2
-28	63403	FLAT WASHER - 3/8	1
-29	60703	HEX NUT-3/8-16UNC	2
-30	25053	ROUND TUBING - 3/4	1
-31	2542	CONNECTOR	2

ITEM	PART NUMBER	DESCRIPTION	QTY
-32	60607	CAPSCREW-3/8-16UNC X 3/4 BOWMALOK 41012	4
-33	60608	CAPSCREW-5/16-18UNF X 1 1/4 BOWMALOK 41008	2
-34	70107	LIMIT SWITCH	1
-35	20804	SWITCH LEVER	1
-36	62615	ROUND HEAD CAPSCREW NO.10-32UNF X 1 3/4	2
-37	63313	LOCKWASHER - NO. 10	2
-38	2806	STRAIN RELIEF	1
-39	21782	BUSHING	2
-40	20802	40 CONDUCTOR ELECTRICAL CABLE (REF)	1

FIGURE 27--INNER BOOM ASSEMBLY

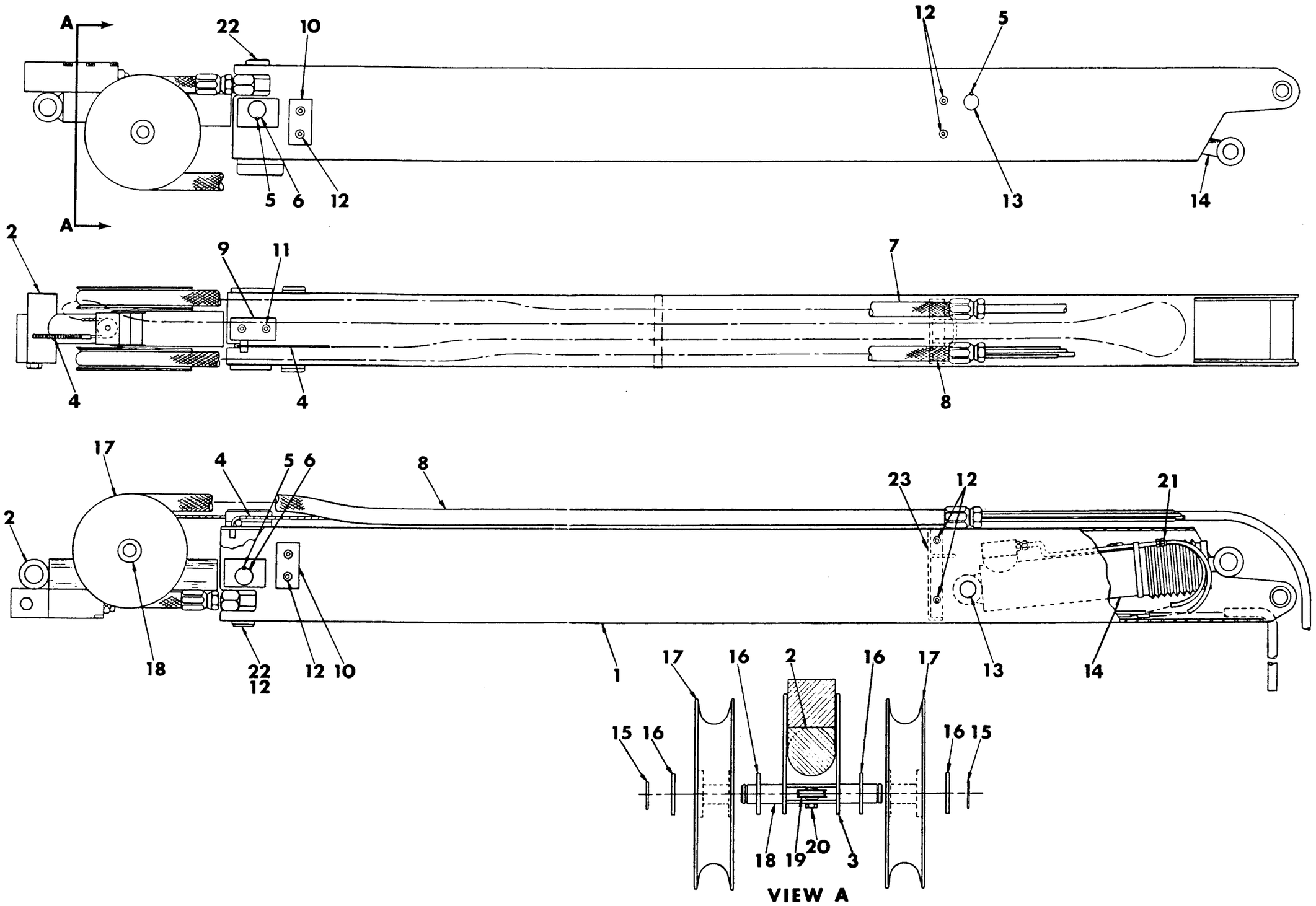
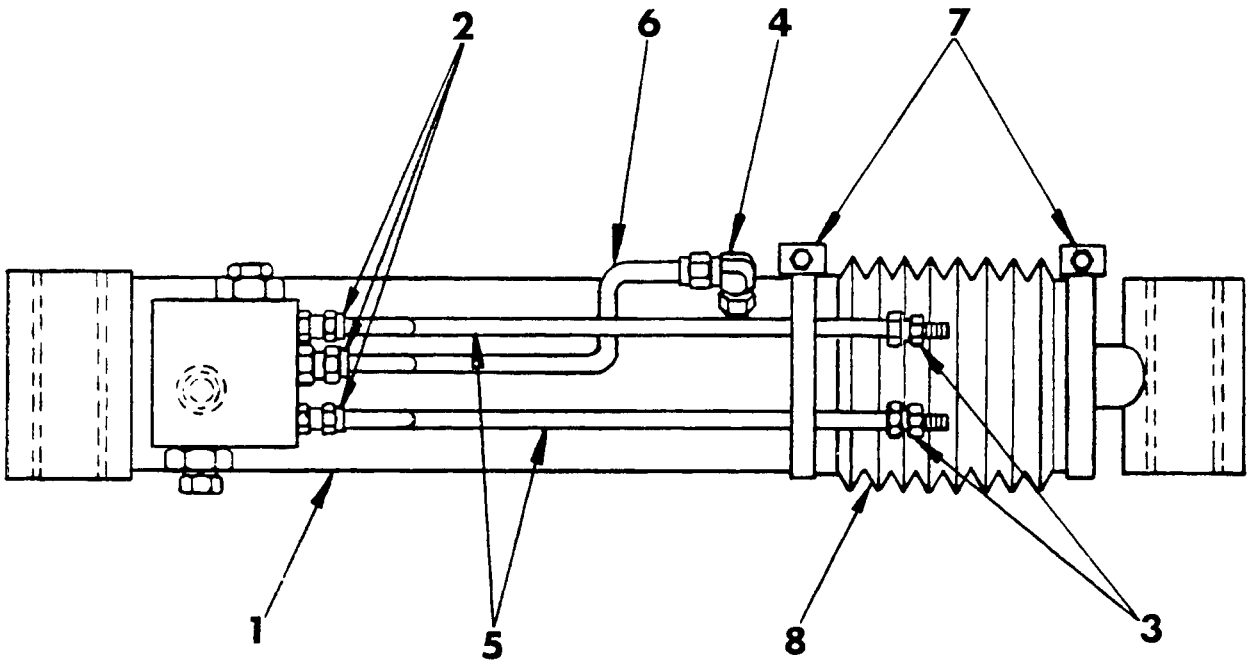


FIGURE 27 - INNER BOOM ASSEMBLY

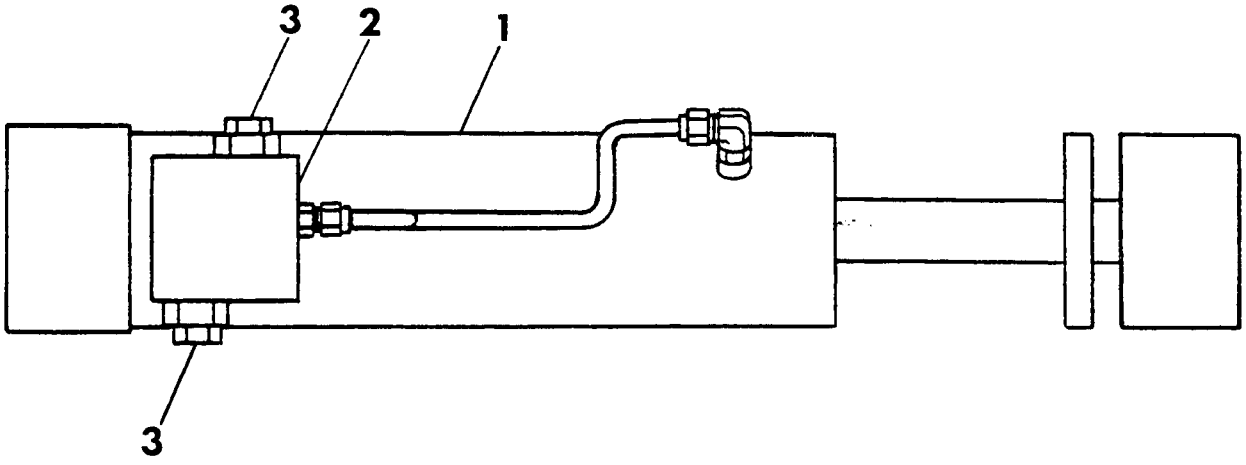
ITEM	PART NUMBER	DESCRIPTION	QTY
27-	20747	INNER BOOM ASSEMBLY	1
-1	20734	INNER BOOM MACHINING	1
-2	21260	BOOM EXTENSION CYLINDER (SEE FIG. 30)	1
-3	20297	SHEAVE GUARD	1
-4	20730	RETRACTION CABLE ASSEMBLY	1
-5	62203	SOCKET HEAD SET SCREW-3/8-16UNC -3/8	3
-6	20266	TRUNNION PIN	2
-7	20744	ELECTRIC HOUSING ASSEMBLY	1
-8	20745	HYDRAULIC HOSE ASSEMBLY	1
-9	20281	WEAR PAD-BOTTOM	1
-10	20280	WEAR PAD	2
-11	61802	FLAT HEX SOCKET HEAD CAPSCREW-3/8-24UNF X 1 1/2	2
-12	61801	FLAT HEX SOCKET HEAD CAPSCREW-3/8-24UNF X 3/4	10
-13	20262	LEVELING CYLINDER PIN	1
-14	21711	SLAVE LEVELING CYLINDER ASSEMBLY (SEE FIG. 28)	1
-15	65075	SNAP RING	2
-16	63417	FLAT WASHER	4
-17	20247	SHEAVE-HYDRAULIC & ELECTRIC	2
-18	20265	SHEAVE PIN	1
-19	20388	CABLE SHEAVE	1
-20	60608	CAPSCREW-5/16-18UNC X 1 1/4 BOWMALOK 41008	1
-21	65133	SWIVEL HOSE FITTING	2
-22	20892	WEAR PAD-TOP	1
-23	20915	BULKHEAD PLATE	1

FIGURE 28 - SLAVE LEVELING CYLINDER ASSEMBLY



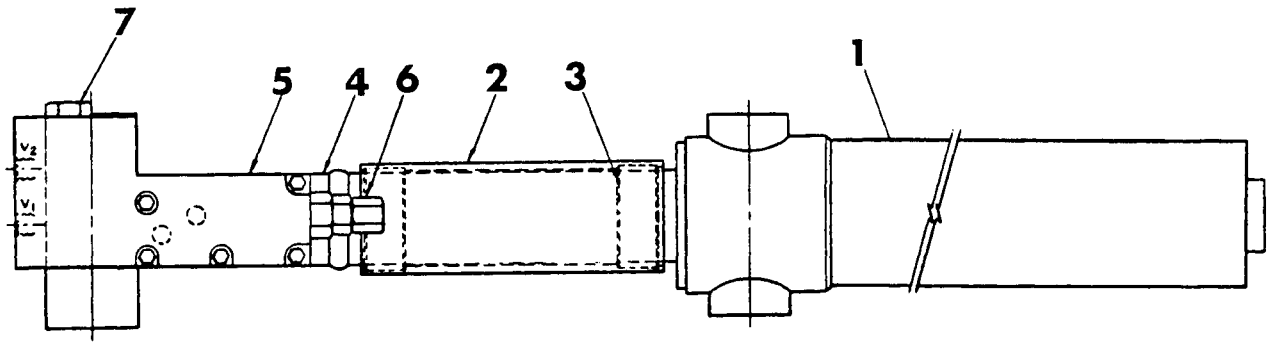
ITEM	PART NUMBER	DESCRIPTION	QTY
28-	21711	SLAVE LEVELING CYLINDER ASSEMBLY	1
-1	21262	SLAVE LEVELING CYLINDER (SEE FIG.29)	1
-2	2581	CONNECTOR	3
-3	2465	UNION CONNECTOR	2
-4	2532	90° ELBOW	1
-5	20631	TUBE ASSEMBLY - 1/4	2
-6	20632	TUBE ASSEMBLY - 1/4	1
-7	65111	STRAP	2
-8	21388	CONVOLUTED TUBING	1

FIGURE 29 - SLAVE LEVELING CYLINDER



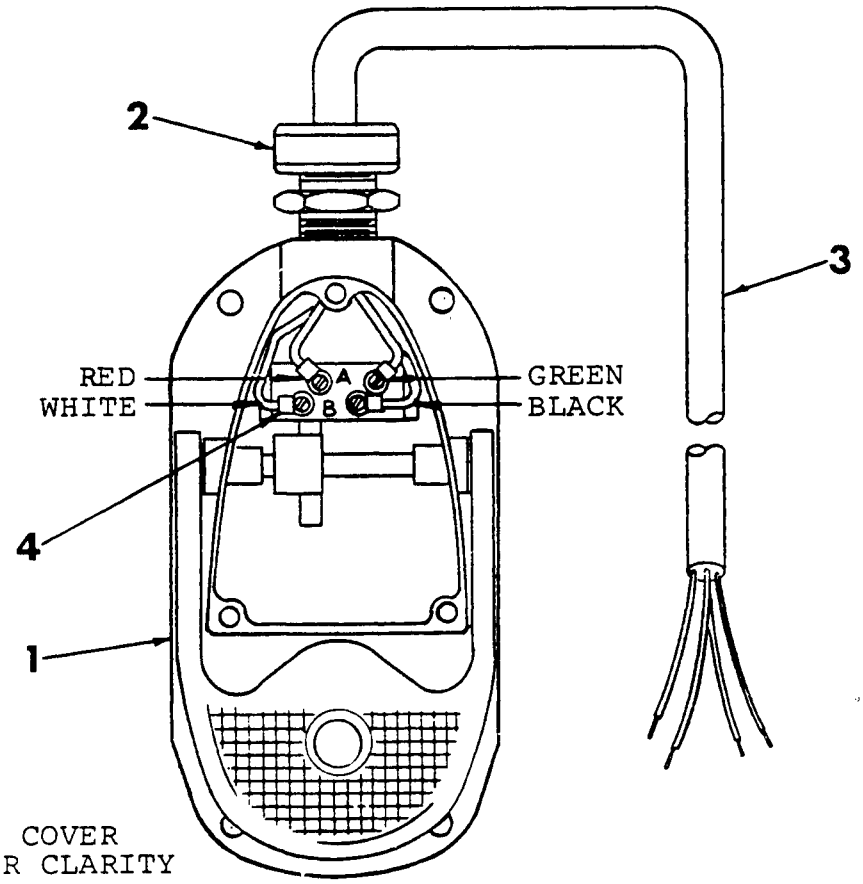
ITEM	PART NUMBER	DESCRIPTION	QTY
29-	21262	SLAVE LEVELING CYLINDER	1
-1	21274	CYLINDER	1
-2	21447	MANIFOLD BLOCK	1
-3	21267	OVER CENTER CARTRIDGE	2
-4	66228	SEAL KIT	1

FIGURE 30-BOOM EXTENSION CYLINDER



ITEM	PART NUMBER	DESCRIPTION	QTY
30-	21260	BOOM EXTENSION CYLINDER	1
-1	21272	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	66227	SEAL KIT	1

FIGURE 31 - FOOT SWITCH ASSEMBLY



NOTE:
SHOWN WITH COVER
REMOVED FOR CLARITY

ITEM	PART NUMBER	DESCRIPTION	QTY
31-	20480	FOOT SWITCH ASSEMBLY	1
-1	20379	FOOT SWITCH	1
-2	2531	STRAIN RELIEF	1
-3		CABLE - 18/4 SJO OIL RESISTANT X 60'	1
-4	876	TERMINAL RING	1

FIGURE 32 - HYDRAULIC HOSE DIAGRAM

FIGURE 32 - HYDRAULIC HOSE DIAGRAM

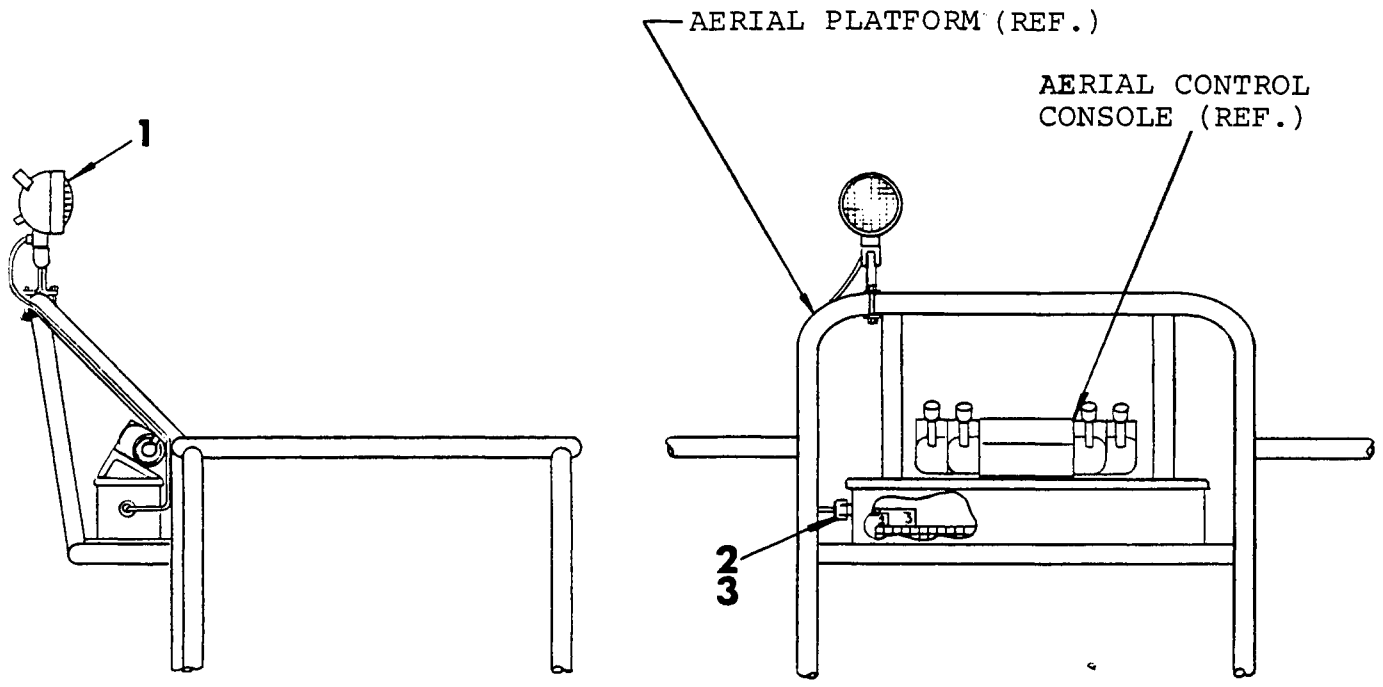
ITEM	PART NUMBER	DESCRIPTION	QTY
	NOTE:	KIT "A" - BASE KIT "B" - TURRET KIT "C" - GAS MODELS ONLY KIT "D" - DIESEL MODELS ONLY	
32-	21624	HYDRAULIC HOSE DIAGRAM	1
-A1	13210-04-0640	HOSE ASSEMBLY	1
-A2	13213-04-0250	" "	1
-A3	13210-04-0250	" "	2
-A4	13210-06-0560	" "	1
-A5	13213-06-0200	" "	1
-A6	13213-06-0370	" "	2
-A7	13213-06-0220	" "	2
-A8	13210-08-0380	" "	2
-A9	13210-08-0820	" "	2
-A10	13210-04-0600	" "	2
-A11	13213-04-0450	" "	1
-A12	13213-04-0320	" "	1
-A13	13210-04-0270	" "	1
-A14	13210-12-0240	" "	1
-A15	13213-08-0740	" "	1
-A16	13210-08-0600	" "	1
-A17	13210-08-0650	" "	1
-A18	13210-08-0680	" "	1
-A19	13210-08-0400	" "	2
-A20	13213-08-0360	" "	2
-A21	13211-08-0314	" "	2
-A22	13210-08-0160	" "	2
-A23	13213-04-0190	" "	2
-A24	13213-04-0164	" "	1
-A25	13213-04-0234	" "	1
-A26	13210-12-0260	" "	1
-B1	13210-04-0320	" "	1
-B2	13211-08-0540	" "	1
-B3	13212-06-0900	" "	1

ITEM	PART NUMBER	DESCRIPTION	QTY
-B4	13213-06-0800	HOSE ASSEMBLY	1
-B5	13213-04-1050	" "	1
-B6	13210-08-0120	" "	1
-B7	13211-08-0500	" "	1
-B8	13210-16-0200	" "	1
-B9	13210-06-1100	" "	1
-B10	13213-04-0970	" "	1
-B11	13210-04-0260	" "	1
-B12	13213-04-0290	" "	1
-B13	13210-04-0840	" "	1
-B14	13213-04-0840	" "	1
-B15	13210-06-0380	" "	1
-B16	13215-12-0370-0°	" "	1
-B17	13214-12-0370-0°	" "	1
-B18	13212-08-0380	" "	1
-B19	13213-08-0430	" "	1
-B20	13213-08-0760	" "	1
-B21	13215-08-0820-180°	" "	1
-B22	13210-06-0460	" "	1
-B23	13213-04-0150	" "	1
-B24	13210-06-0500	" "	1
-B25	13210-06-0510	" "	1
-B26	13210-04-0920	" "	1
-B27	13210-06-0900	" "	1
-B28	13210-04-0890	" "	1
-C1	13213-06-0240	" "	1
-C2	13210-06-0680	" "	1
-C3	13213-06-0600	" "	1
-C4	13214-06-0160-0°	" "	1
-C5	13205-20-0650	" "	1
-C6	13210-12-0720	" "	1
-C7	13213-06-0700	" "	1
-C8	13210-04-0180	" "	1

FIGURE 32 - HYDRAULIC HOSE DIAGRAM

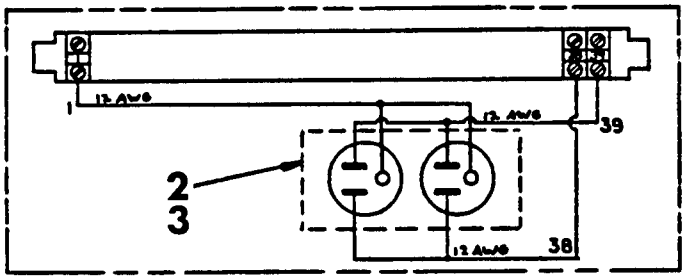
ITEM	PART NUMBER	DESCRIPTION	QTY
-C9	13210-04-1080	HOSE ASSEMBLY	1
-D1	13213-06-0800	" "	1
-D2	13210-06-0500	" "	1
-D3	13213-06-0800	" "	1
-D4	13214-06-0670-180°	" "	1
-D5	13203-20-0900	" "	1
-D6	13213-12-0870	" "	1
-D7	13210-06-0960	" "	1
-D8	13213-04-0700	" "	1

FIGURE 33- 12 VOLT PLATFORM WORKLIGHT (OPTION)

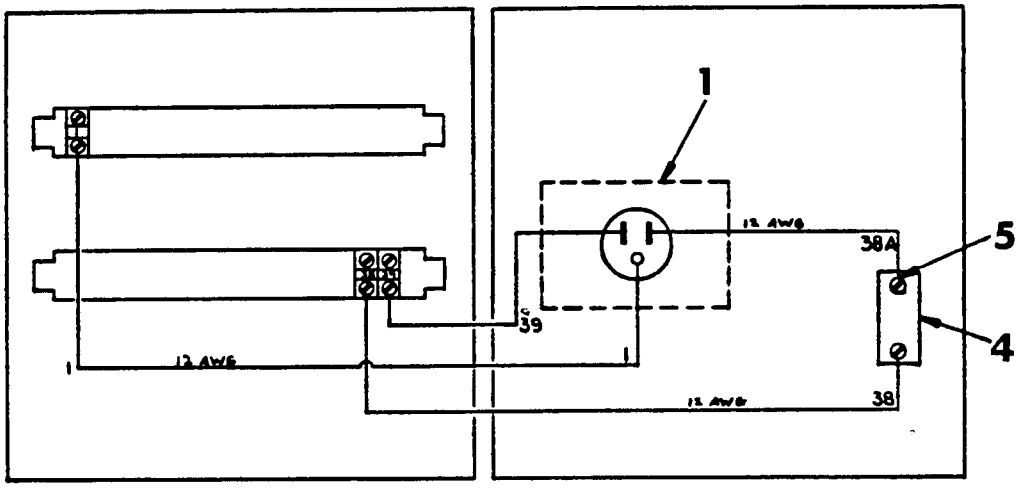


ITEM	PART NUMBER	DESCRIPTION	QTY
33-	20139	12V PLATFORM WORKLIGHT	1
-1	20862	WORKLIGHT	1
-2	2522	STRAIN RELIEF	1
-3	141	LOCK NUT	1

FIGURE 34 - GROUND & AERIAL 110 VAC RECEPTACLE (OPTION)



AERIAL CONTROL CONSOLE



GROUND CONTROL CONSOLE

ITEM	PART NUMBER	DESCRIPTION	QTY
34-	20104	GROUND & AERIAL 110 VAC RECEPTACLE	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

FIGURE 35 - TOWING KIT INSTALLATION (OPTION)

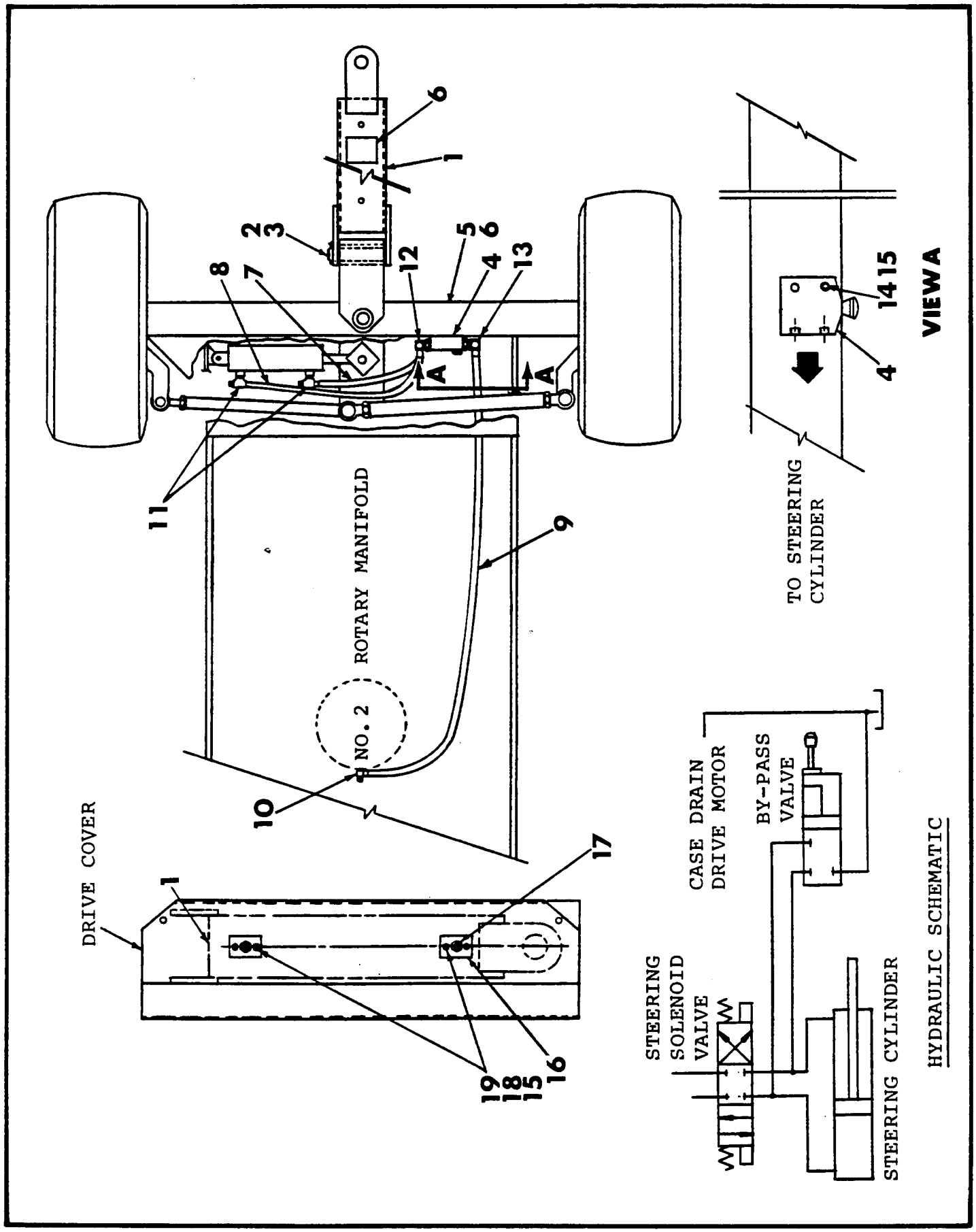
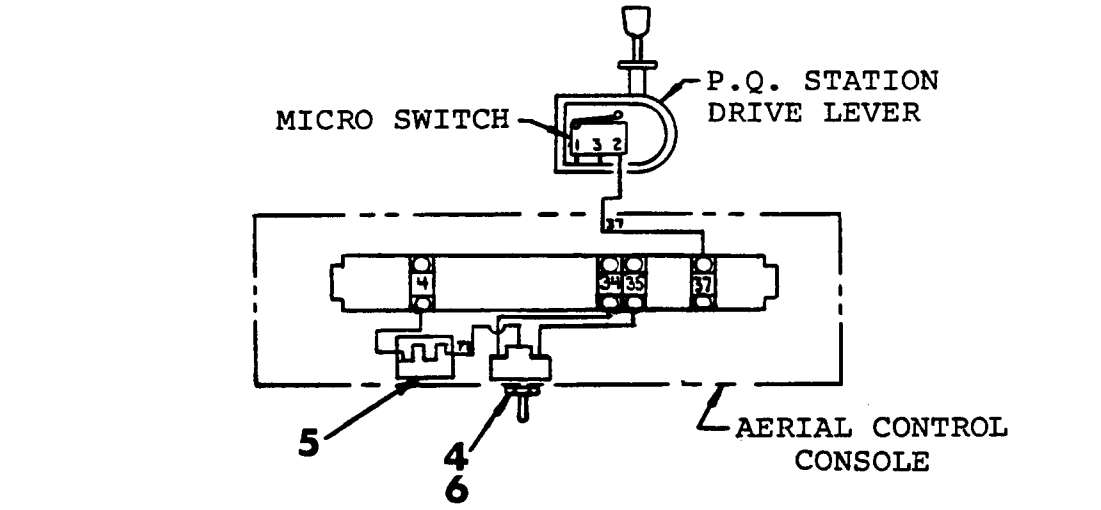
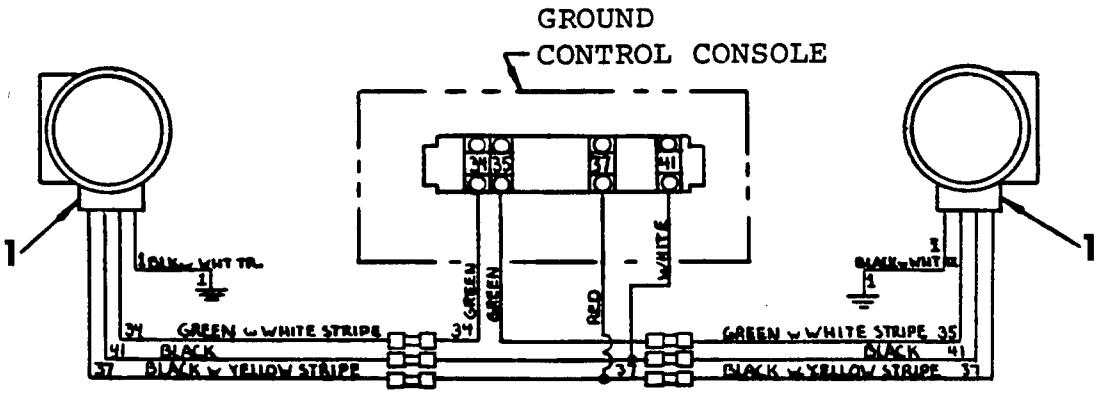


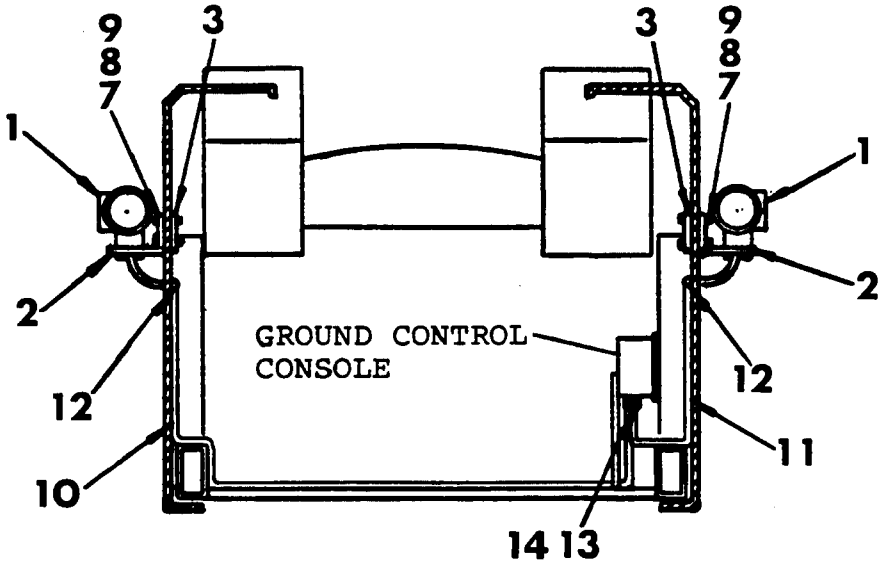
FIGURE 35 - TOWING KIT INSTALLATION (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
35-	20105	TOWING KIT INSTALLATION	1
-1	20425	TOWING BAR	1
-2	20426	PIN	1
-3	64314	COTTER PIN - 1/4 X 2 1/2	1
-4	20799	BY-PASS VALVE	1
-5	20492	STEERING OVERRIDE DECAL	1
-6	20491	TOWING INSTRUCTIONS DECAL	2
-7	13210-04-0300	HOSE ASSEMBLY	1
-8	13210-04-0340	HOSE ASSEMBLY	1
-9	13213-06-0700	HOSE ASSEMBLY	1
-10	2425	RUN TEE	1
-11	53200	STRAIGHT THREAD RUN TEE	2
-12	2584	90° ELBOW	2
-13	2443	90° ELBOW	1
-14	60317	HEX HEAD CAPSCREW - 3/8-16UNC X 2 1/2	2
-15	63303	SPLIT LOCKWASHER - 3/8	6
-16	20837	FLANGED STUD - 3/8	2
-17	60705	HEX NUT - 1/2-13UNC	2
-18	60343	HEX HEAD CAPSCREW - 3/8-16UNC X 1	4
-19	60703	HEX NUT - 3/8-16UNC	4



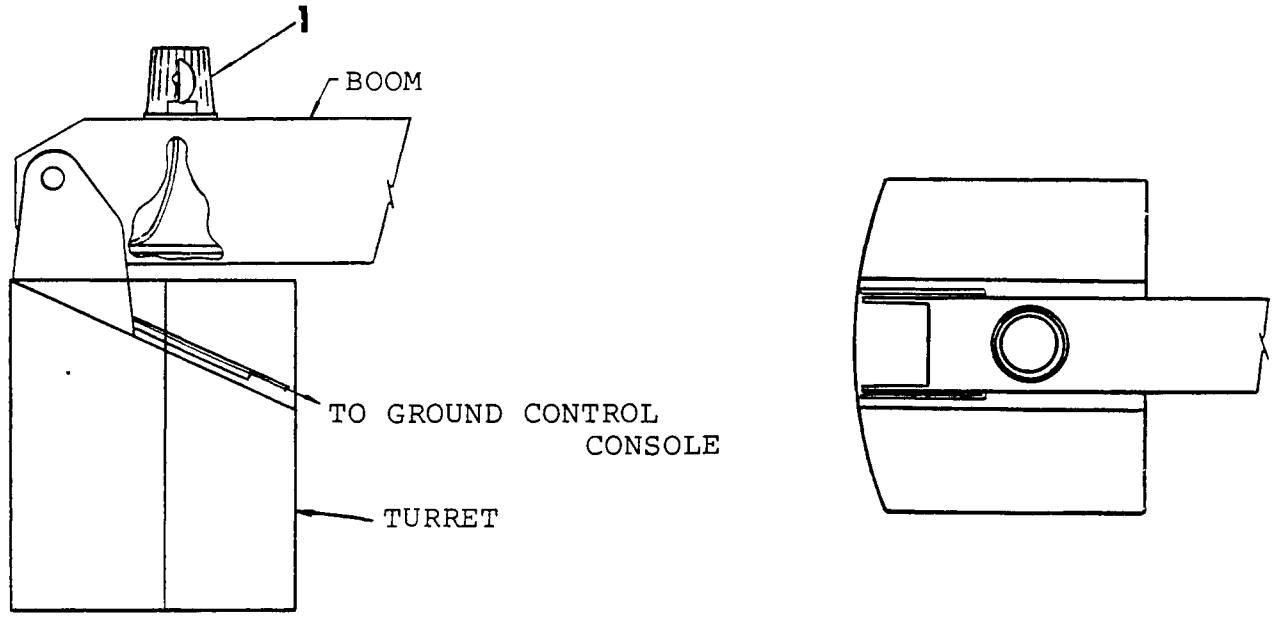


ELECTRICAL DIAGRAM



ITEM	PART NUMBER	DESCRIPTION	QTY
36-	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 37- ROTATING BEACON INSTALLATION (OPTION)



ITEM	PART NUMBER	DESCRIPTION	QTY
37-	20107	ROTATING BEACON INSTALLATION	1
-1	20863	ROTATING BEACON -- YELLOW, RED OR BLUE	1

FIGURE 38 - RAISED PLATFORM ROTATION (OPTION)

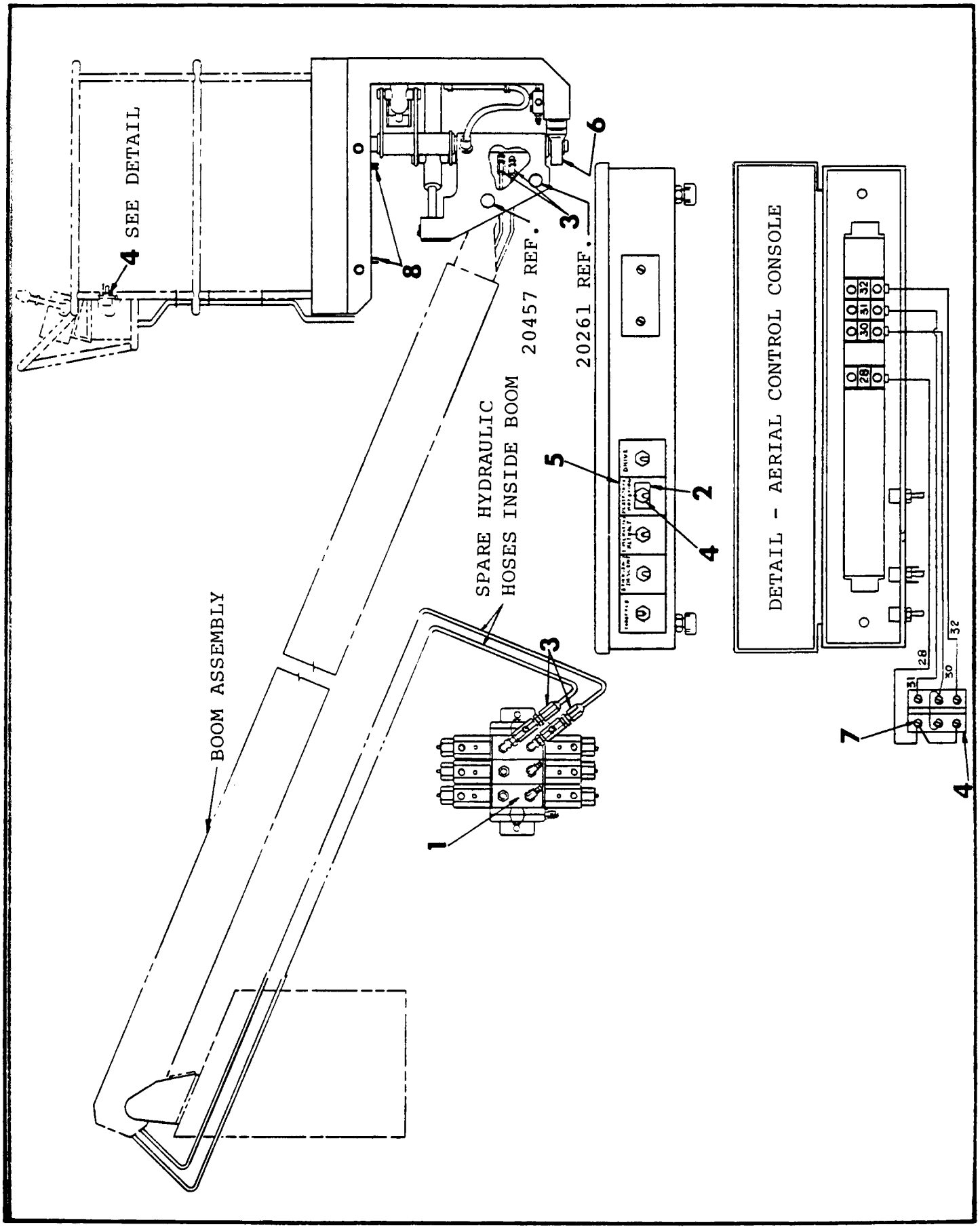


FIGURE 38 - RAISED PLATFORM ROTATION (OPTION)

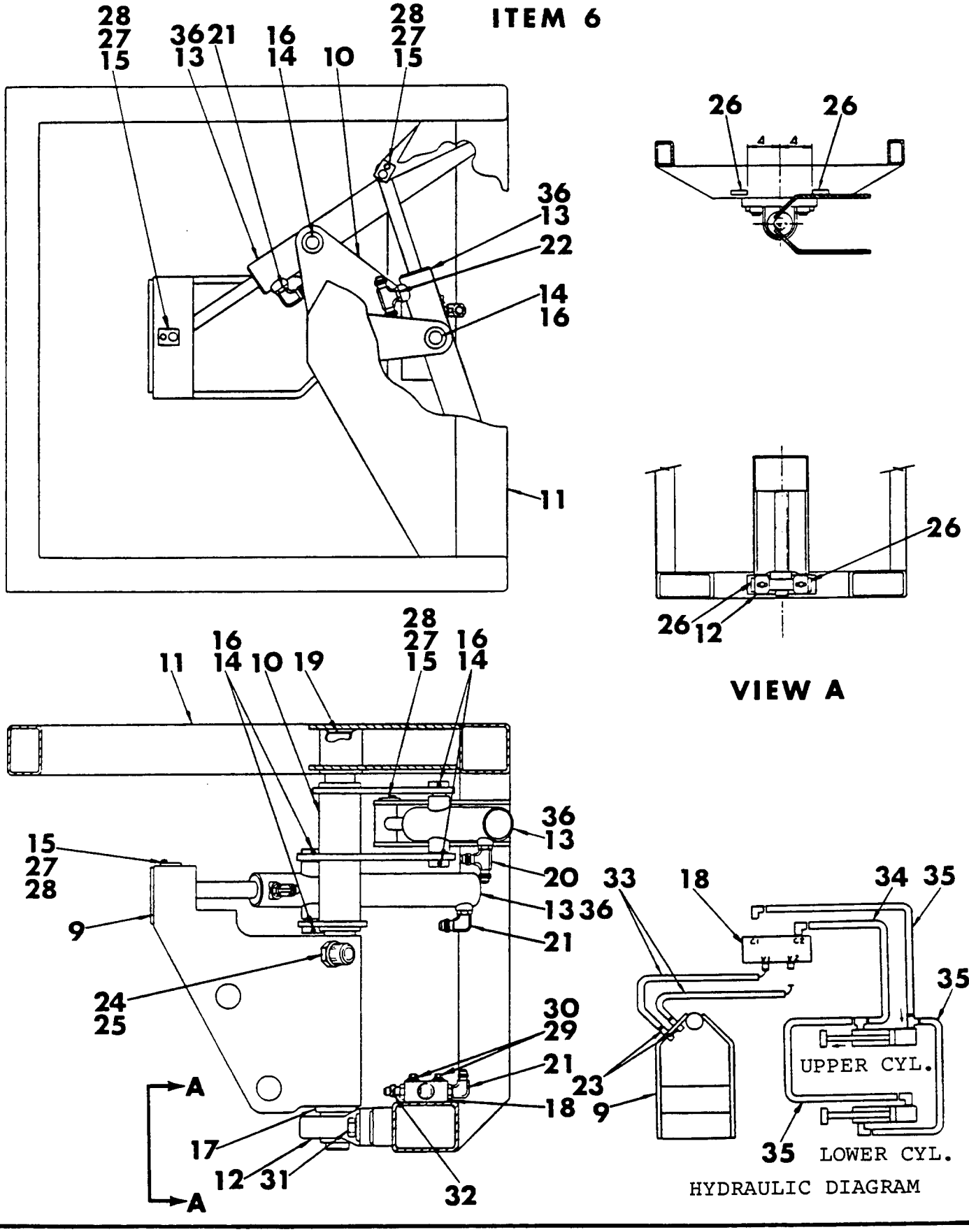


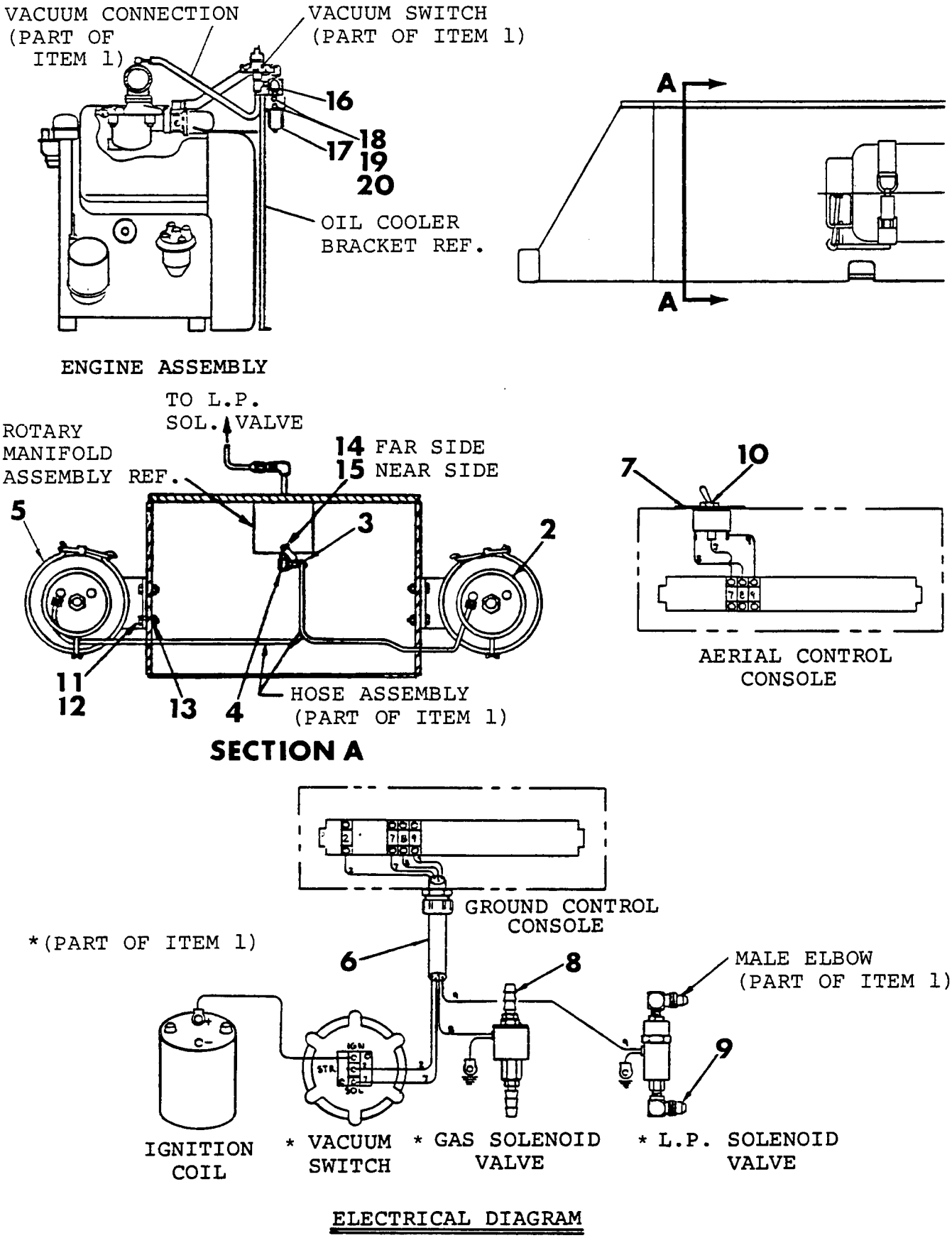
FIGURE 38 - RAISED PLATFORM ROTATION (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
38-	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 - PLATFORM ROTATION	1
-6	20960	PLATFORM ROTATION ASSEMBLY	1
-7	117B	RING TONGUE	6
-8	16268	HOSE CLAMP	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	64215	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 - 3/8 - 16 UNC X 2	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 38 - 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	66255	PLATFORM ROTATION CYLINDER SEAL KIT	1

FIGURE 39 - DUAL FUEL (OPTION)



ELECTRICAL DIAGRAM

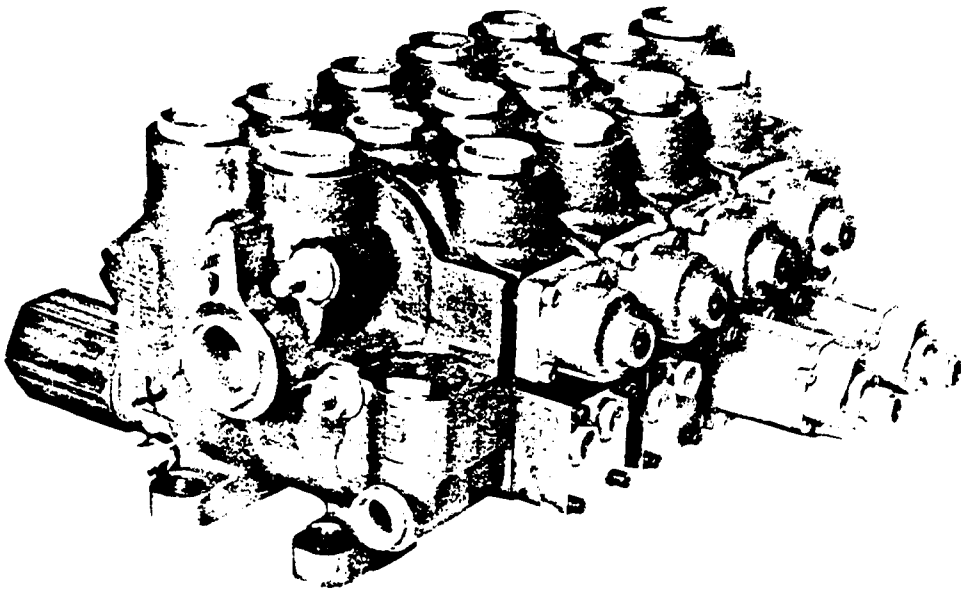
FIGURE 39 - DUAL FUEL (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
39-	20163	DUAL FUEL	1
-1	2124	DUAL FUEL KIT (FOR ASSEMBLY REFER TO KIT BEAM PRODUCTS PARTS LIST & INSTRUCTION SHEET)	1
-2	486-C	LPG TANK	2
-3	2419	FEMALE BRANCH TEE	1
-4	20238	SWIVEL JOINT ASSEMBLY	1
-5	486-A	TANK BRACKET	2
-6	2912	ELECTRICAL CABLE-18AWG 4 COND. X 15'	1
-7	20543	DECAL-DUAL FUEL	1
-8	65209	HOSE BARB-1/8NPT X 1/4 HOSE	2
-9	16506	FEMALE ELBOW	1
-10	4019	TOGGLE SWITCH	1
-11	63303	SPLIT LOCKWASHER-3/8	8
-12	60307	HEX HEAD CAPSCREW-3/8-16UNC X 1 1/2	8
-13	60703	HEX NUT-3/8-16UNC	8
-14	60612	CAPSCREW-3/8-16UNC X 1 1/2 BOWMALOK 41015	1
-15	60613	CAPSCREW-3/8-16UNC X 1 BOWMALOK 41013	1
-16	2476	MALE CONNECTOR	1
-17	20886	MOUNTING BRACKET	1
-18	60312	HEX HEAD CAPSCREW-1/4-20UNC X 1	2
-19	60701	HEX NUT-1/4-20UNC	2
-20	63401	FLAT WASHER-1/4	4

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

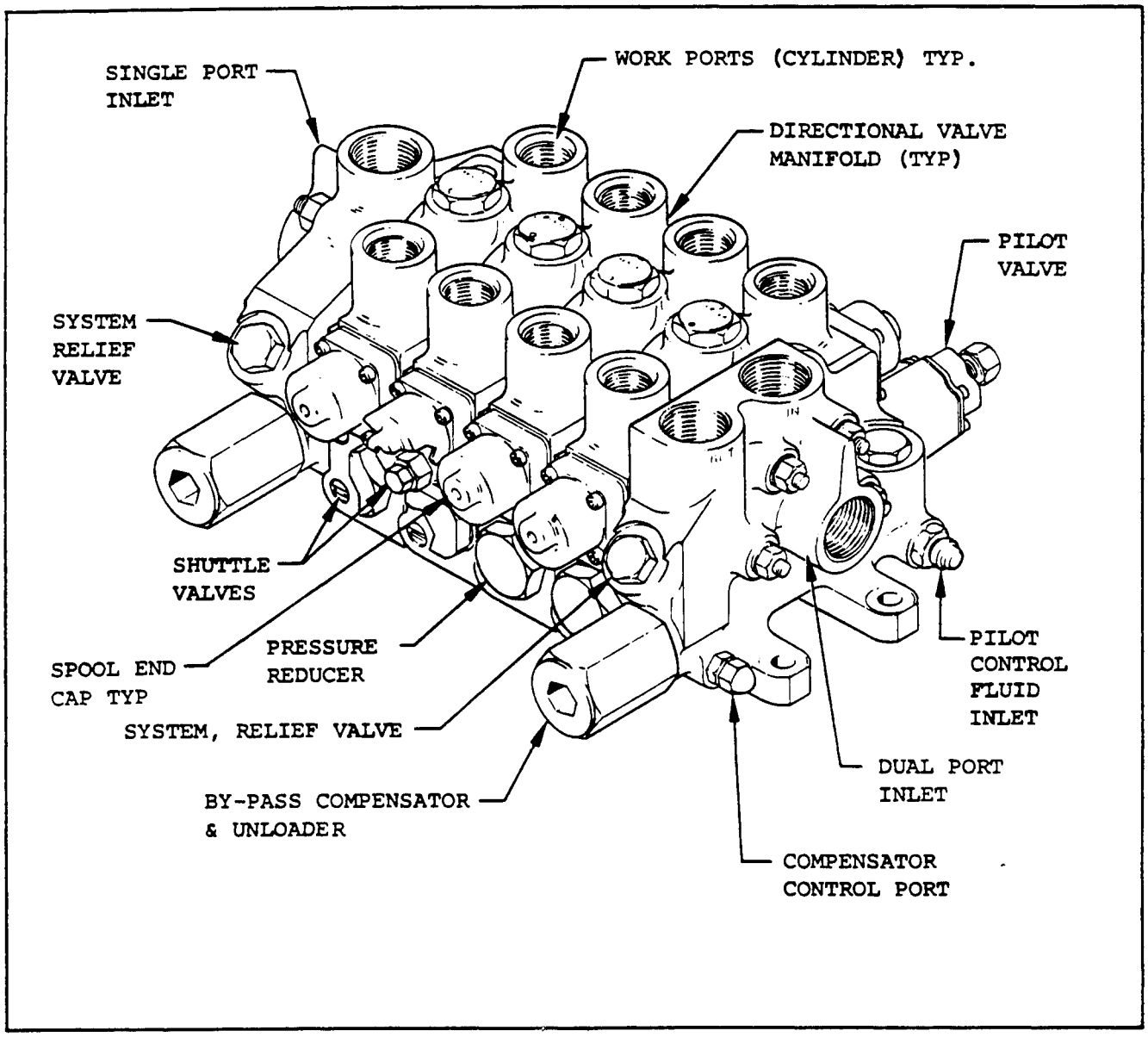
Figure #12 - Bertea Valve Installation

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.

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.

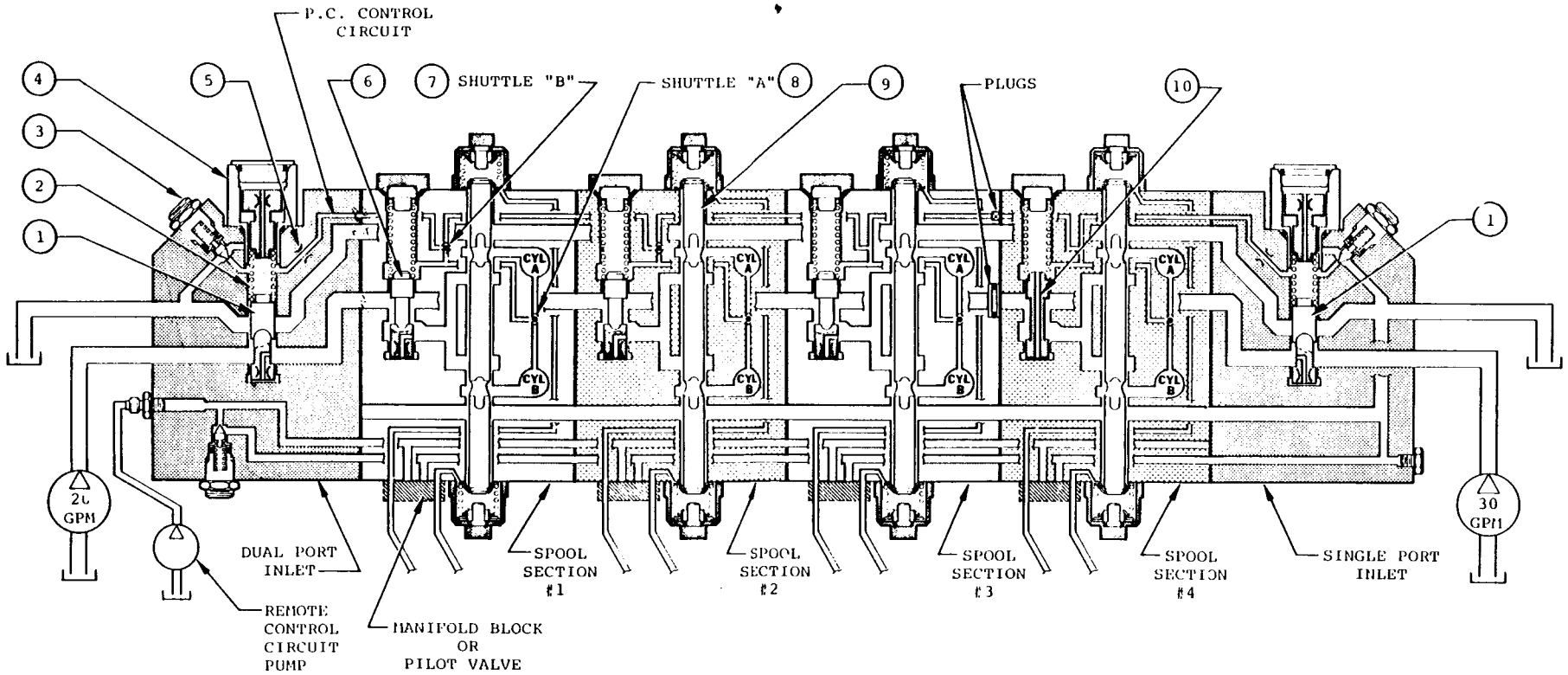
Since the 30 gpm pump supplies fluid to only spool section #4, it is not required to use a pressure reducer spool in the manifold, because the by-pass compensator (Item 1) of the single port inlet will hold 150 psi differential pressure across the directional valve spool. This 150 psi will maintain constant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

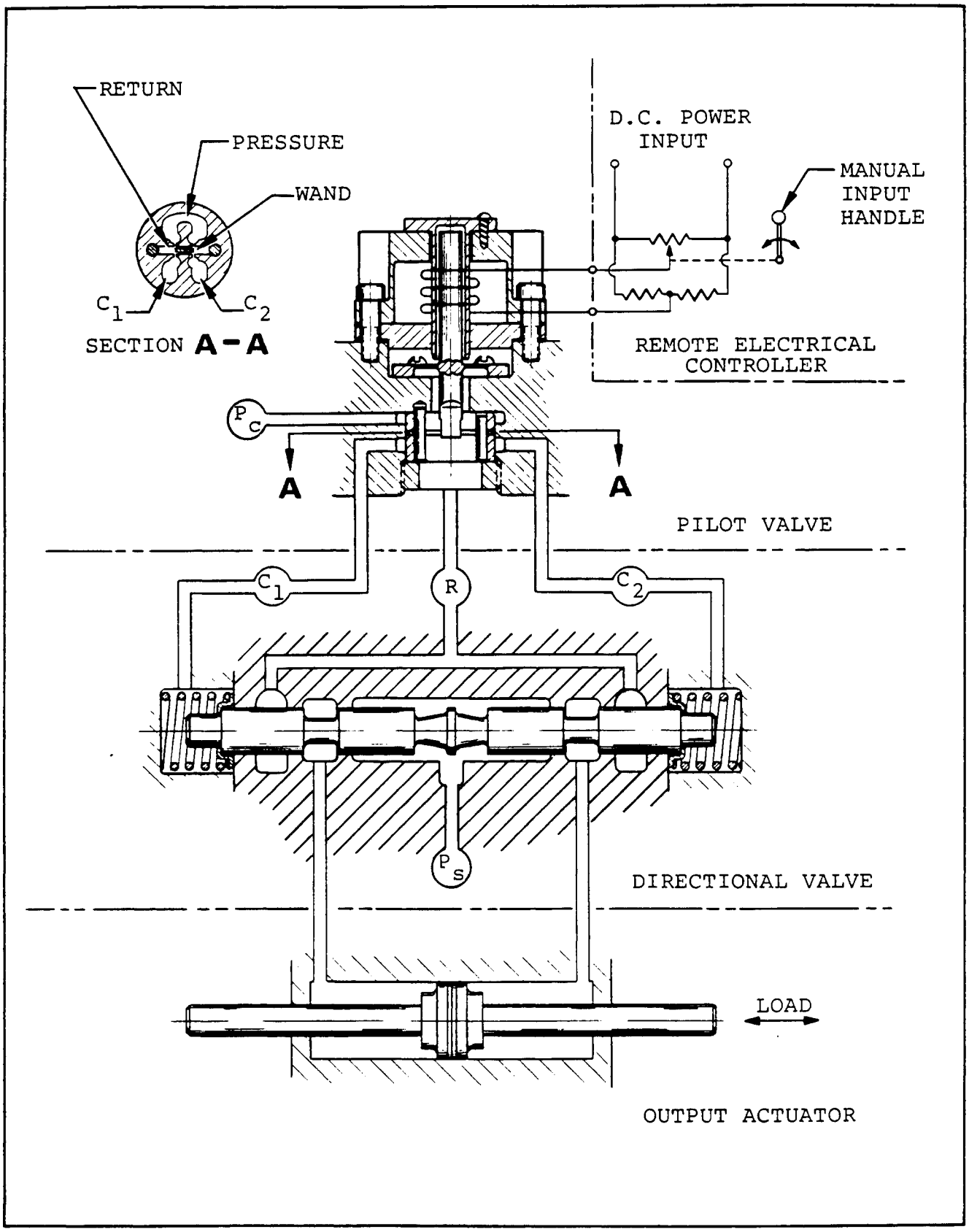
The two basic systems used to control the position of the directional valve spool, and thus control the speed or position of the function are (1) Electro-Hydraulic or (2) Remote Pilot Oil. Each system varies the differential pressure in the end caps to position the spool proportional to input command! 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.

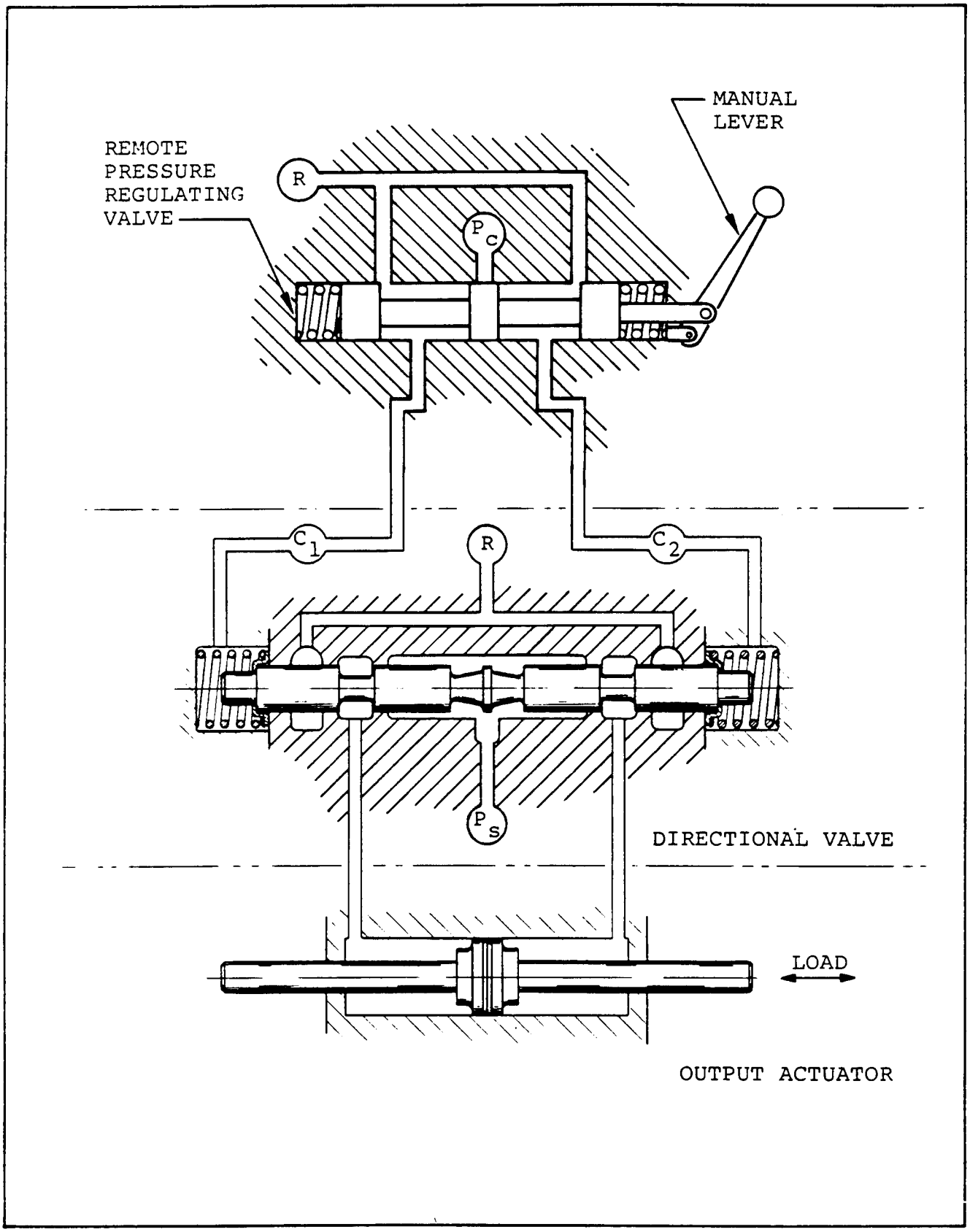
The pilot valve operates on a 300 psi differential pressure across its supply to tank ports and will provide a maximum differential output control pressure between its C_1 and C_2 output ports of 240 psi. (ie - minimum pressure recovery of 80%) Each pilot valve requires a continous flow of 0.5 to 0.6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



LOAD SENSING - PRESSURE COMPENSATING
CIRCUIT SCHEMATIC
FIGURE 2



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

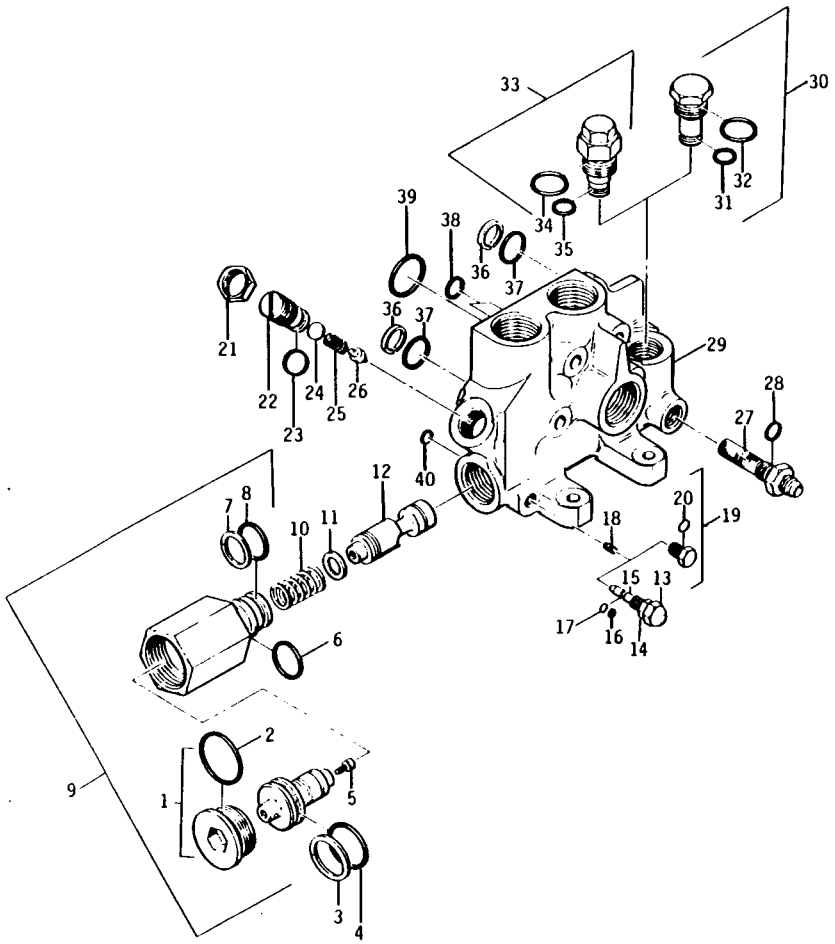
The dual port manifold assembly provides inlet porting for both the power fluid circuit and, also, the pilot valve control fluid circuit. The power fluid circuit contains both inlet and outlet porting, but the control fluid circuit is inlet porting only. The system relief valve (Item 21 thru 26) is adjustable 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	269341-3	ORIFICE PLUG
6	1	3-916N552-90	"O" RING
7	1	6-922N300-30	BACKUP RING
8	1	2-022N674-70	"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	5/8x1/4x3/8-24 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
Δ 36	2	2-117N674-70	"O" RING
Δ 37	2	24854-3	BACKUP RING
Δ 38	2	2-112N674-70	"O" RING
Δ 39	1	2-122N674-70	"O" RING
Δ 40	1	2-107N674-70	"O" RING

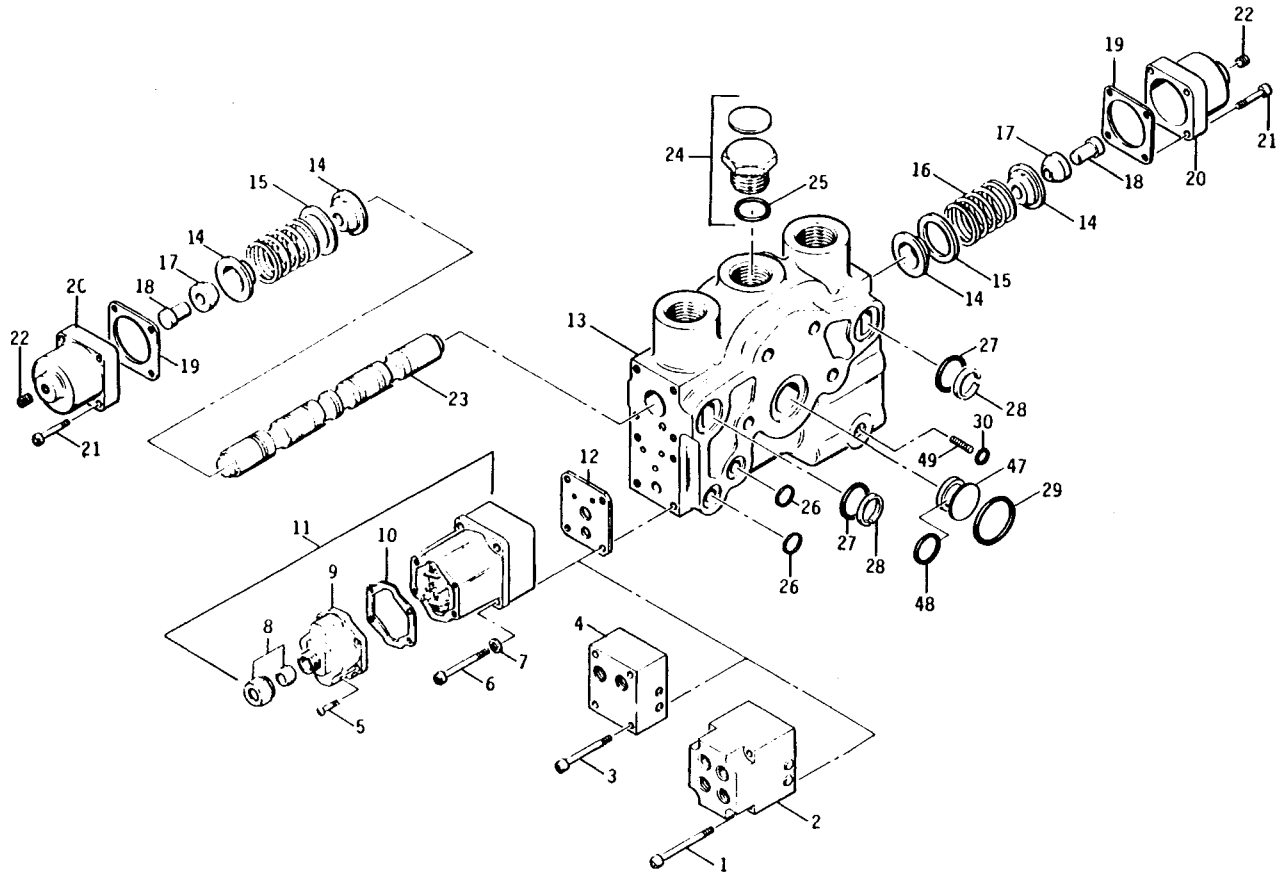
Δ 269344-1 "O" RING KIT



DUAL PORT INLET MANIFOLD
FIGURE 5

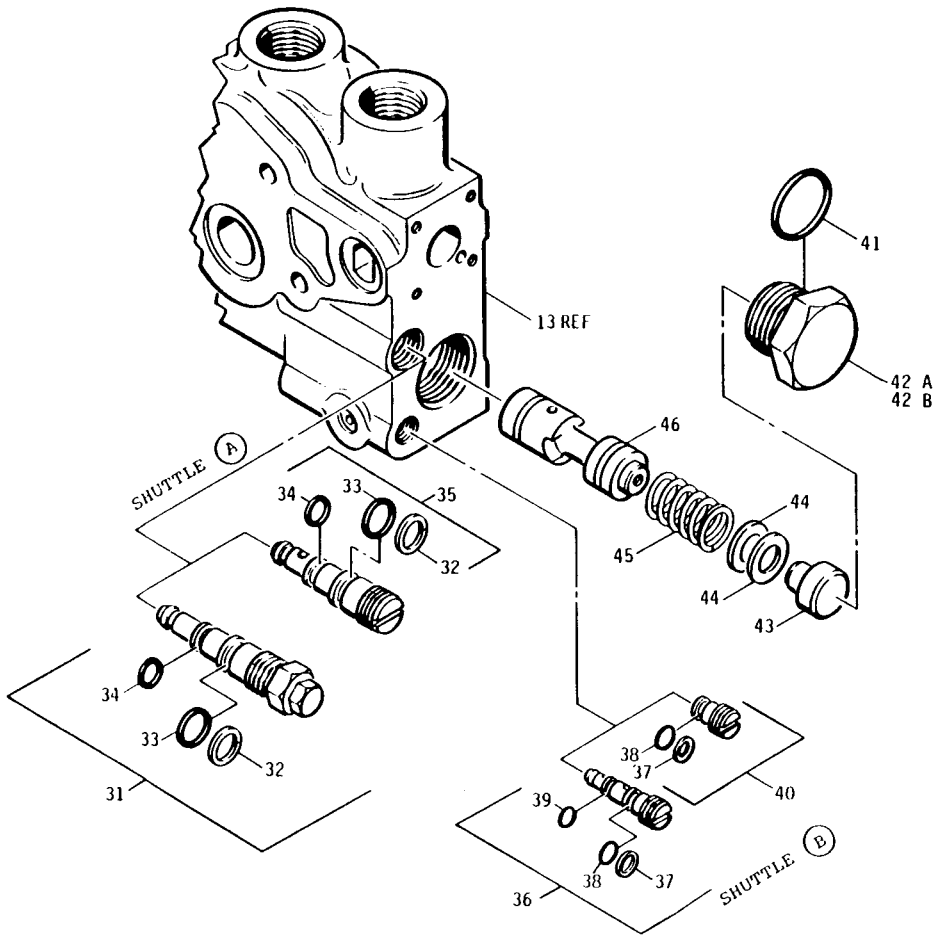
ITEM NO.	QTY	PART NUMBER	DESCRIPTION
1	4	10-24x1 3/4	SCREW-SOC. HEAD
2	1	269357-1	MANIFILD ASSY.-PURGE & SHUTTLE VALVE
3	4	10-24x1 1/2	SCREW-SOC. HEAD
4	1	269327-1	MANIFOLD ASSY.- PURGE CIRCUIT
5	4	#6-32x1/2	SCREW-PHILLIPS HD.
6	4	234980	SCREW-SOC. HEAD
7	4	234959	WASHER
8	1	249896	SEAL KIT
9	1	242933	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.

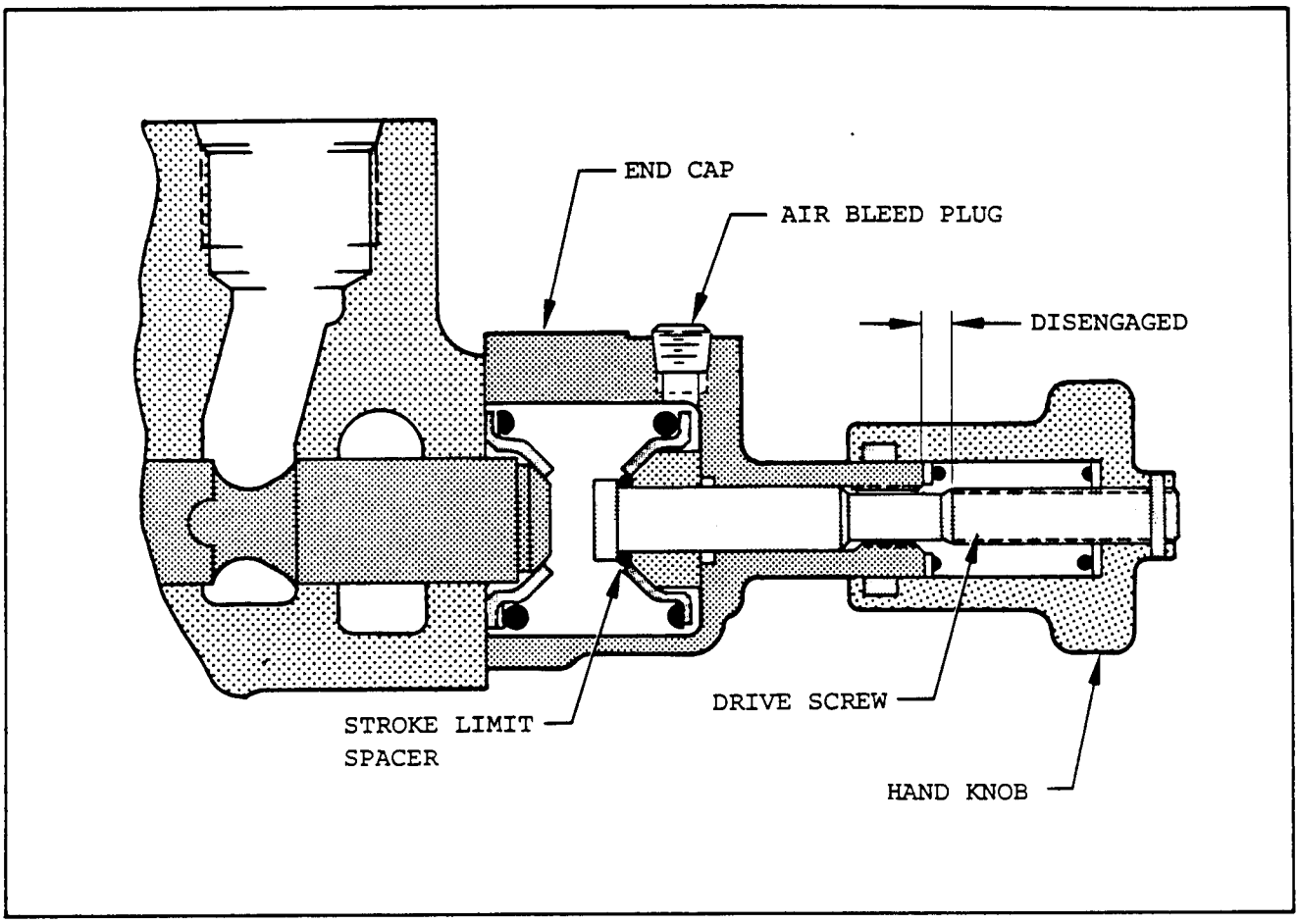
The hand knob is held in the thread disengaged position by a light spring to prevent inadvertent operation. Press the knob inward while rotating to engage the threads in the cap and the drive screw. Continued rotation clockwise will move the spool from center and will provide flow from the cylinder port 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

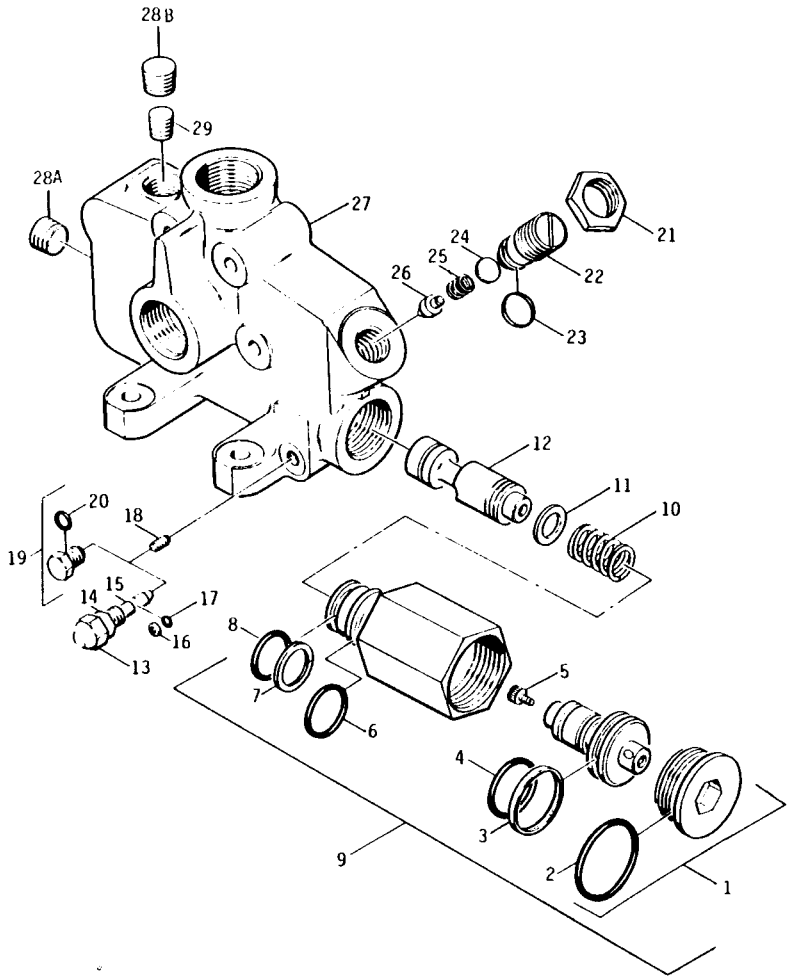
The system relief valve (21 thru 26) is adjustable up to 3000 psi. The orifice (Item 18) limits the flow into the compensator spring cavity, permitting the relief valve to limit system pressure by porting this fluid to tank.

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

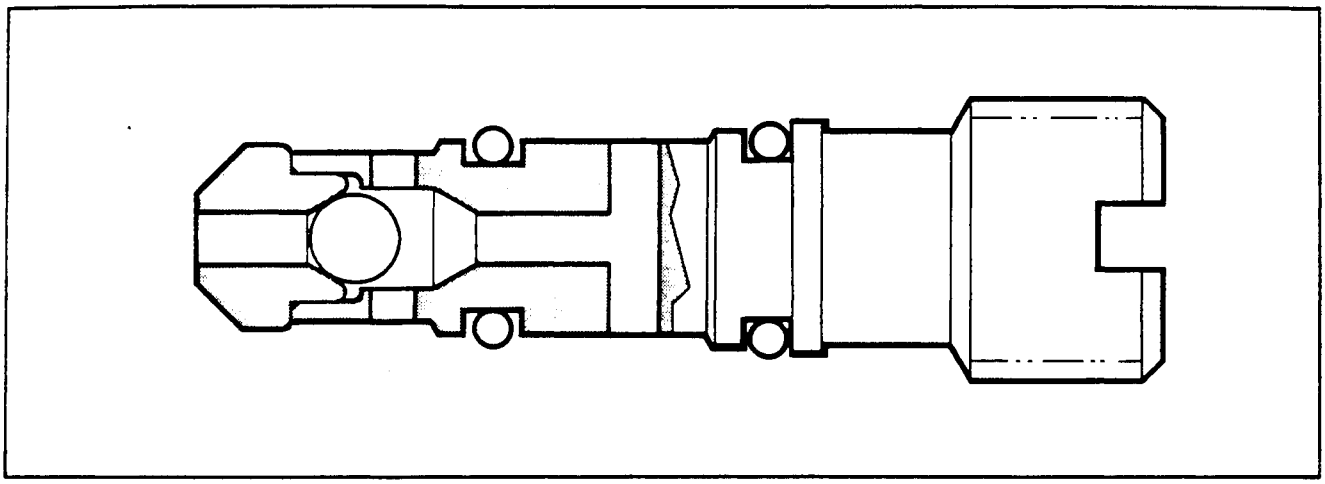
Pilot Valve Assembly

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

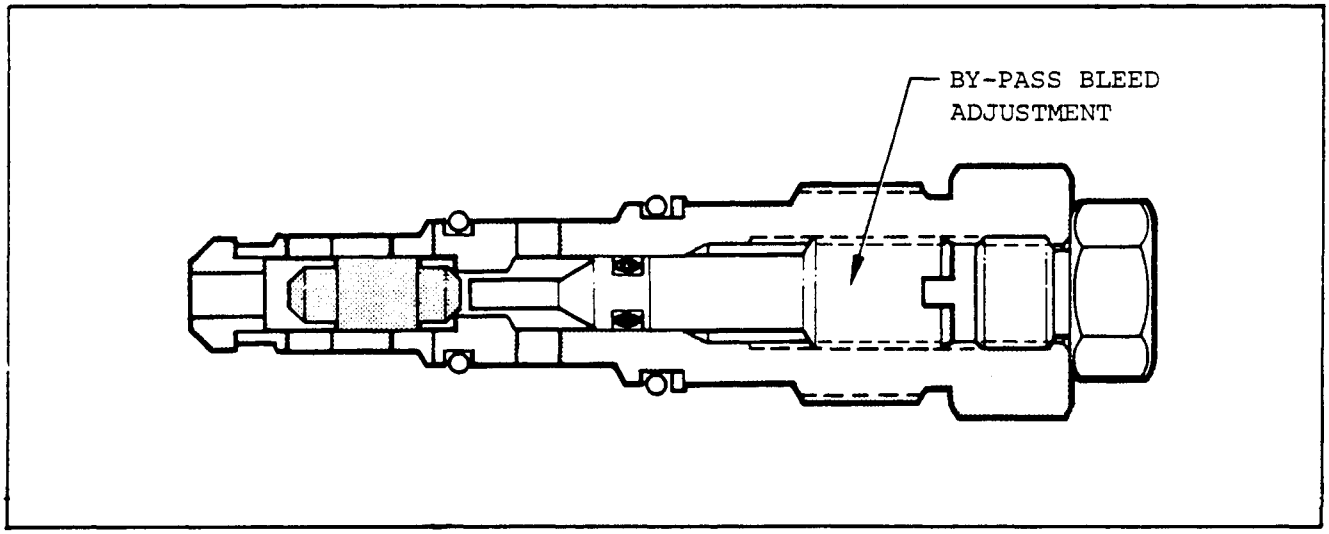


BASIC SHUTTLE
FIGURE 9

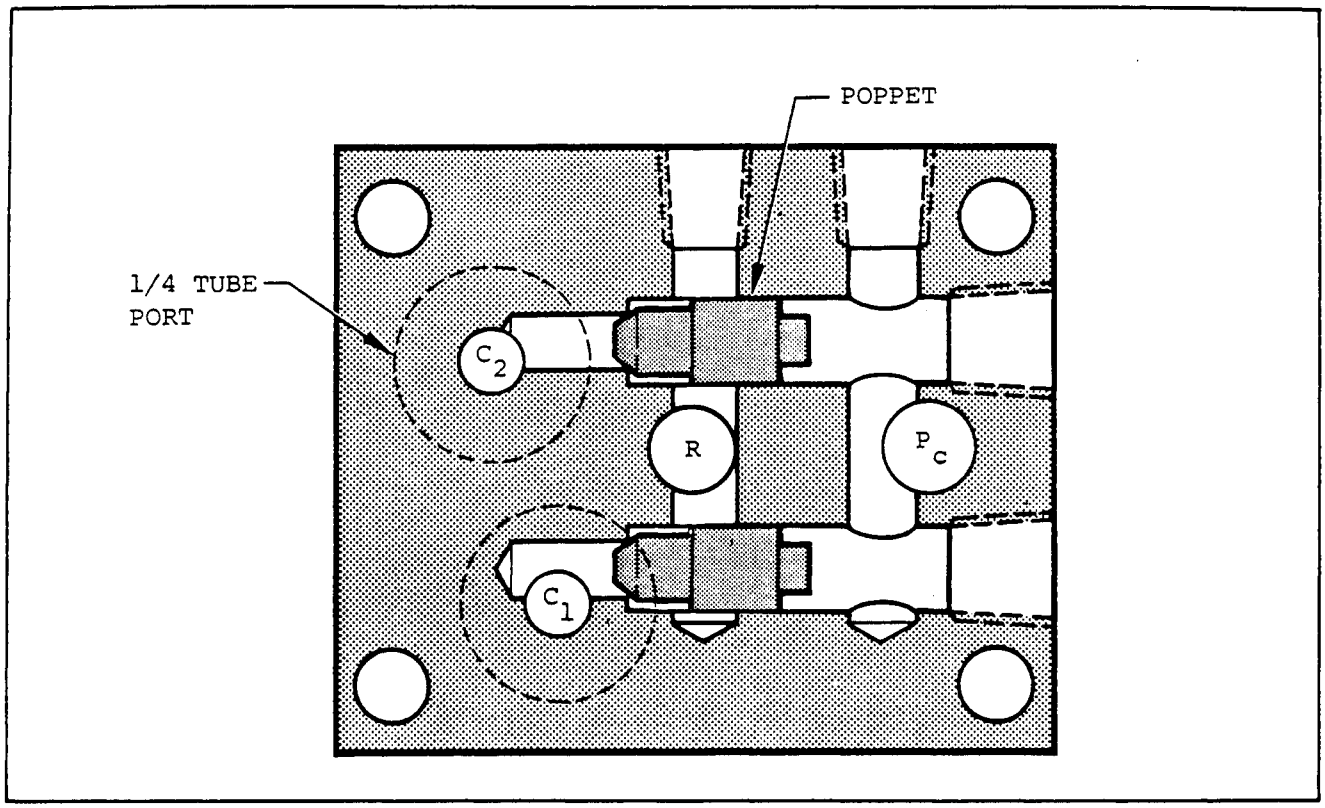
Shuttle Assemblies

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



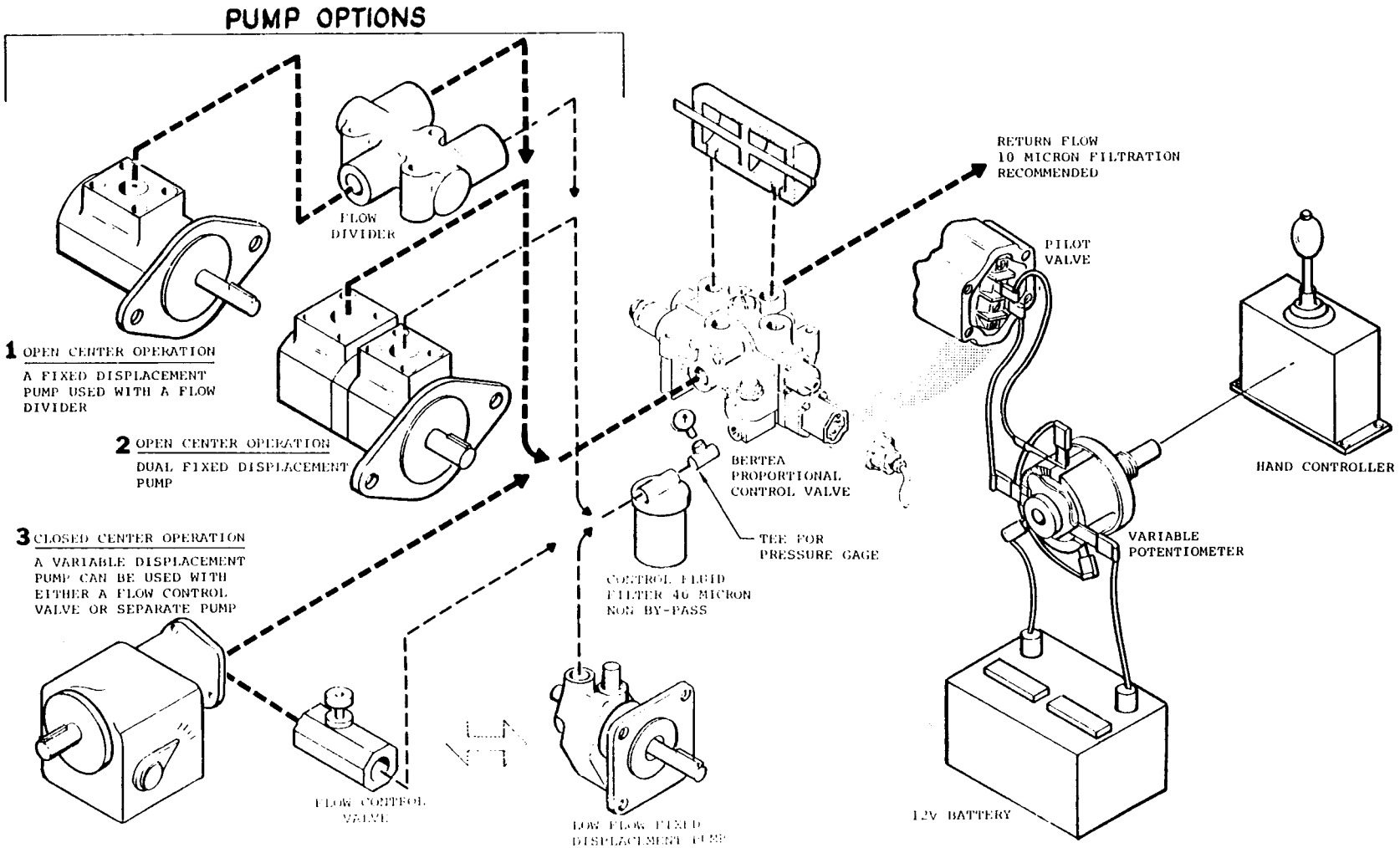
PURGE MANIFOLD ASSEMBLY
FIGURE 11

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.


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
BERTEA PROPORTIONAL CONTROL VALVE
TEE FOR PRESSURE GAGE
CONTROL FLUID FILTER 40 MICRON NON BY-PASS
RETURN FLOW 10 MICRON FILTRATION RECOMMENDED
PILOT VALVE
HAND CONTROLLER
VARIABLE POTENTIOMETER
12V BATTERY

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.

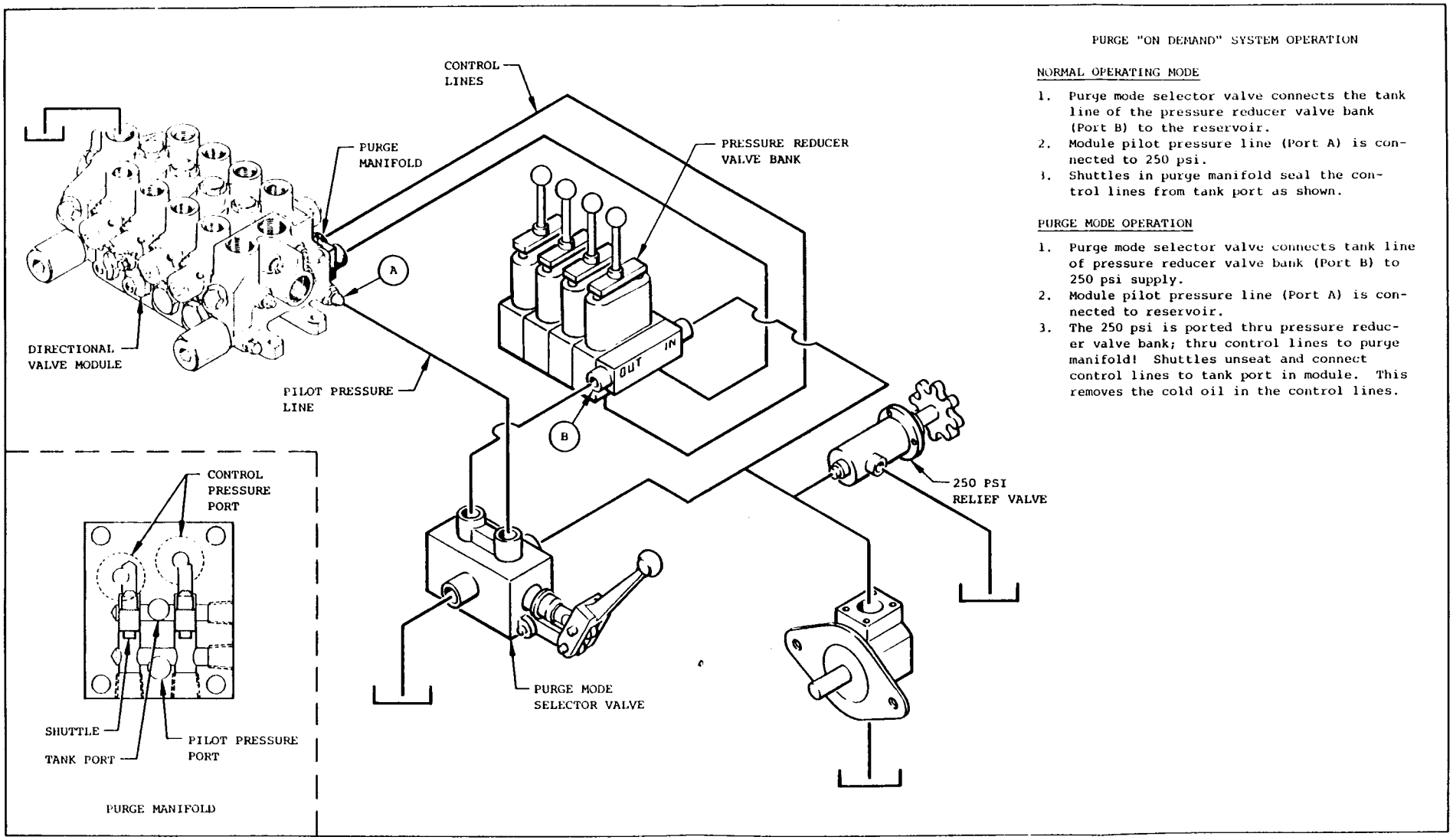
Since this pilot circuit is a constant flow, if the filter is the same micron size as the system filter, it will have a short life. The small tube type filter in the inlet manifold (234950, Figure #5) is 100 micron rating and is only intended for coarse material. Each pilot valve has a 150 micron filter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



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 ΔP
REQUIRED Flow - 0.6 gpm per valve
Plus - 1.0 gpm for relief valve
REQUIRED Filtration - 40 micron

C. PORT SIZES

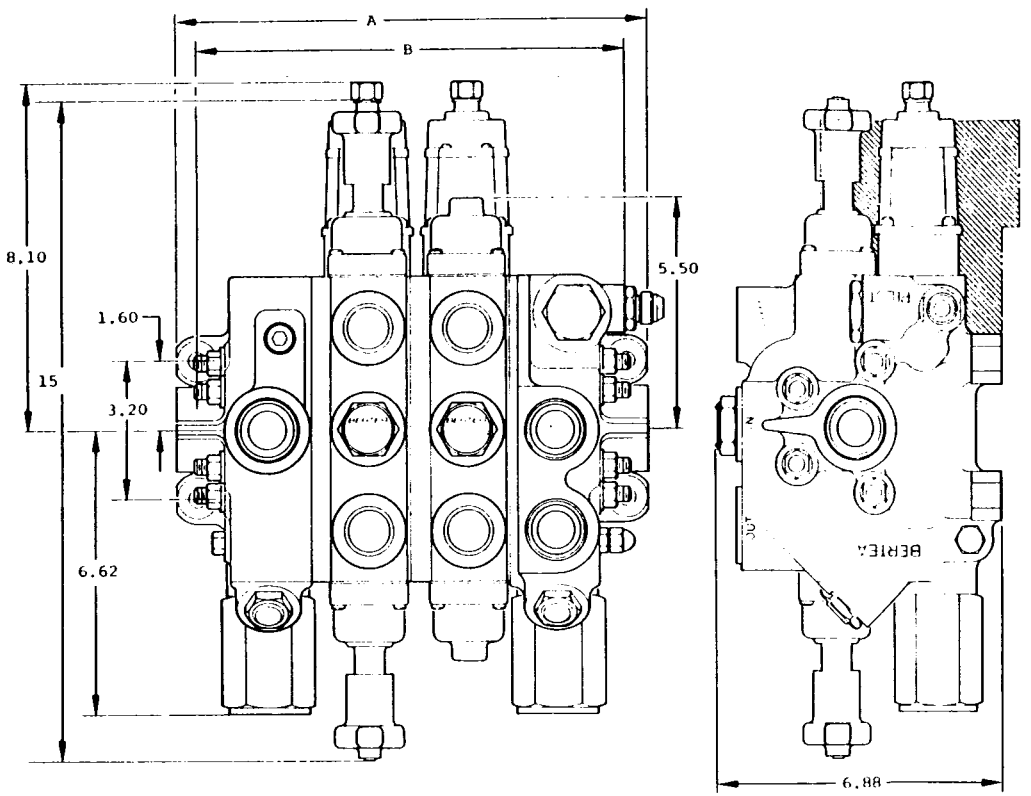
Inlet - 1 5/16-12 (1" Tube)
Cylinder - 1 1/16-12 (3/4" Tube)
Outlet - 1 5/16-12 (1" Tube)
Pilot Control - 3/8 Flared Tube Male
Purge Manifolds - 7/16-20 (1/4" Tube)

D. BOLT TORQUES

3/8-16 Clamping Studs	-	23 lb-ft Lube 30 lb-ft Dry
10-24 Screws	-	30 in lb Lube 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.

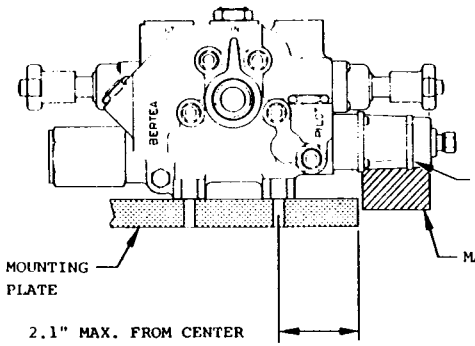


⚠ CAUTION: NO MAGNETIC METAL WITHIN 1.5 OF PILOT VALVE AS SHOWN.

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

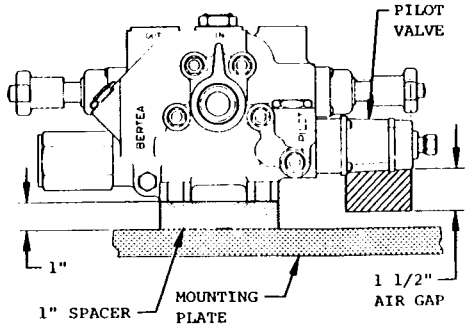
INSTALLATION
FIGURE 14

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



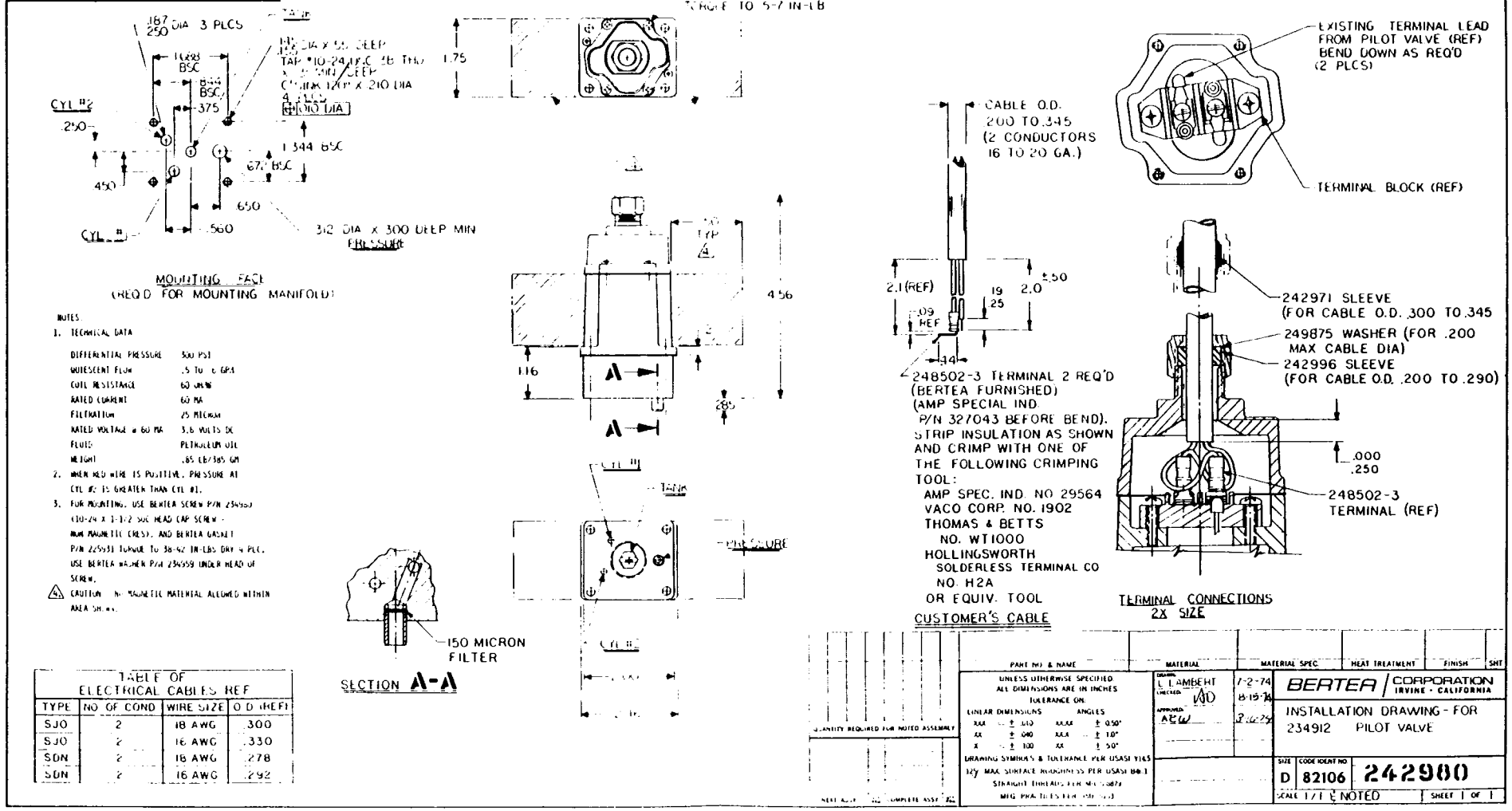
If the mounting plate extends underneath the pilot valve magnet the module must be raised at least one (1) inch in order to provide an air gap of 1-1/2 inch beneath the pilot valve.

FIGURE 2

26

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REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL
C	SEE E O	4-26-77	AEW



NOTES:

1. TECHNICAL DATA

DIFFERENTIAL PRESSURE	500 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/365 GM

2. WHEN MID WIRE IS POSITIVE, PRESSURE AT CYL #2 IS GREATER THAN CYL #1.
3. FOR MOUNTING, USE BERTEA SCREW P/N 234560 (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 234559 UNDER HEAD OF SCREW.

⚠4 CAUTION - NO MAGNETIC MATERIAL ALLOWED WITHIN AREA SHOWN.

TABLE OF ELECTRICAL CABLES REF

TYPE	NO OF COND	WIRE SIZE	O D (REF)
SJO	2	18 AWG	.300
SJO	2	16 AWG	.330
SDN	2	18 AWG	.278
SDN	2	16 AWG	.292

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 PER MIL-S-7742
MFG PRACTICES PER MIL-I-45208

DRAWN L LAMBERT 7-2-74
CHECKED MD 8-15-74
APPROVED AEW 8-26-74

BERTEA / CORPORATION IRVINE - CALIFORNIA

INSTALLATION DRAWING - FOR 234912 PILOT VALVE

SIZE D | CODE IDENT NO 82106 | 242980

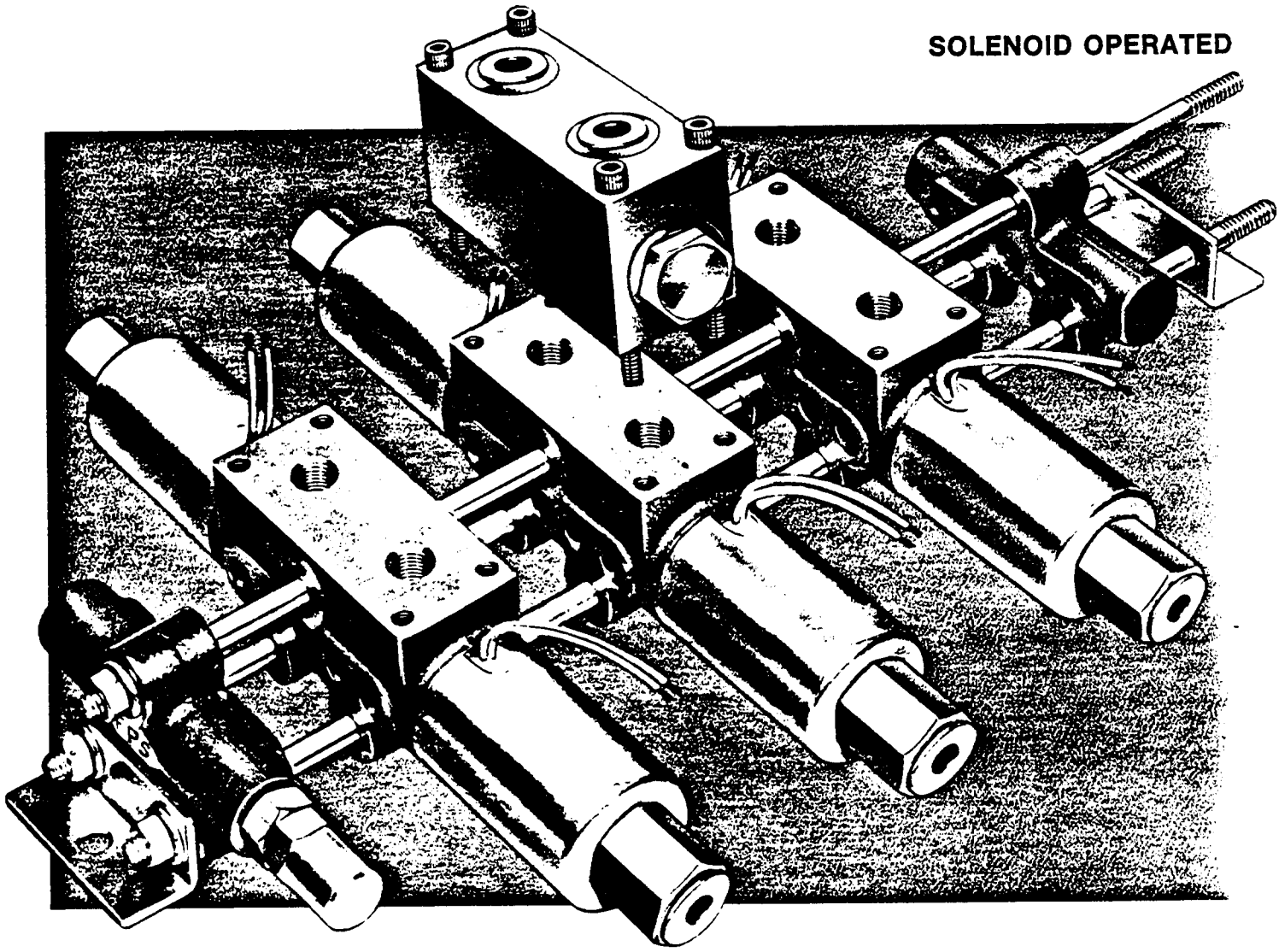
SCALE 1/1 E NOTED | SHEET 1 OF 1

PILOT VALVE INSTALLATION
FIGURE 15

Bulletin No. 5-2360-4

mini-pak valves

SOLENOID OPERATED



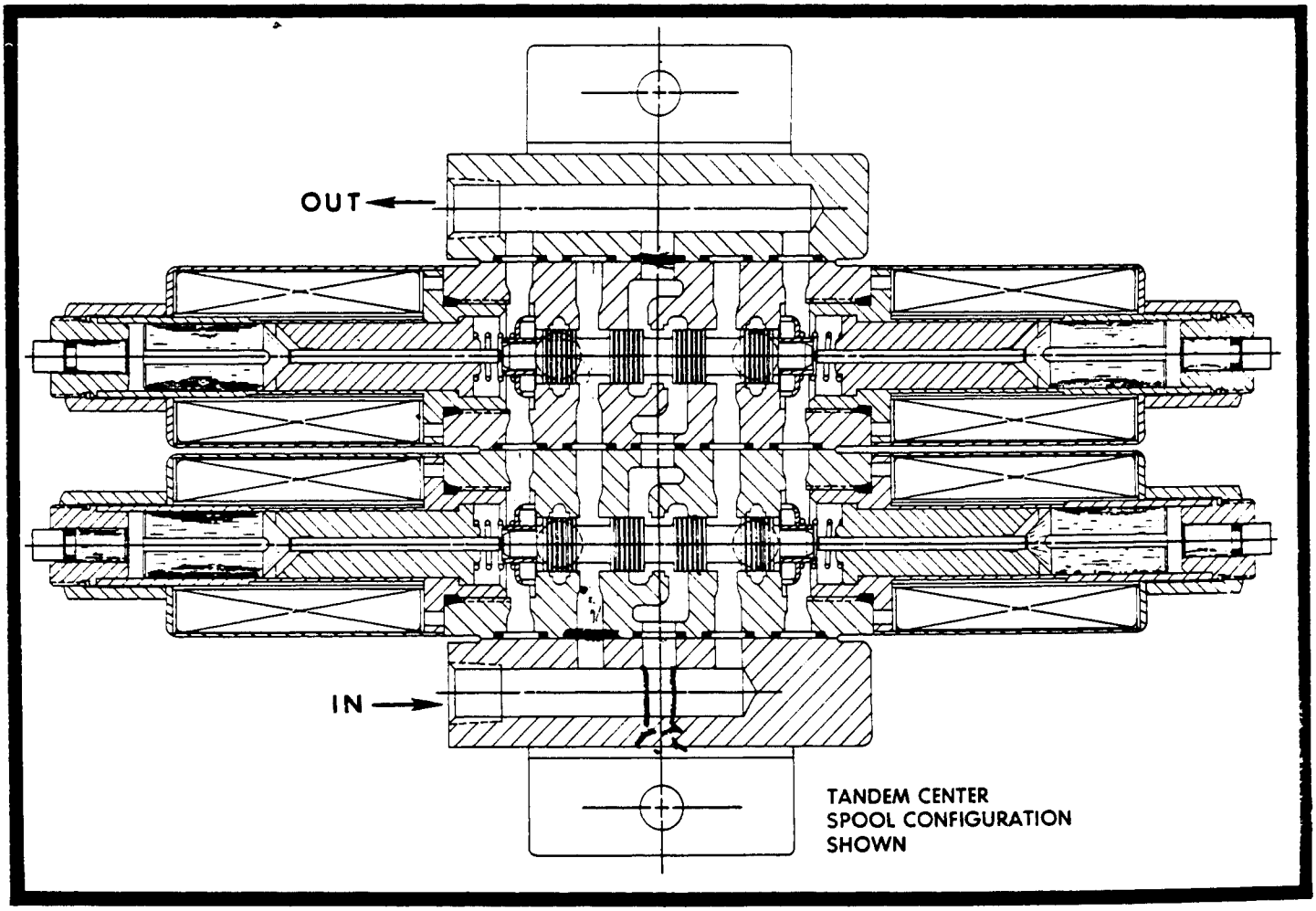
- maximum flow rate 19 L/min (5 gpm)
- working pressures to 207 BAR (3000 psi)
- direct solenoid operated — dc
- series-parallel circuit

AMBAC Industries Incorporated
FLUID POWER SYSTEMS DIVISION

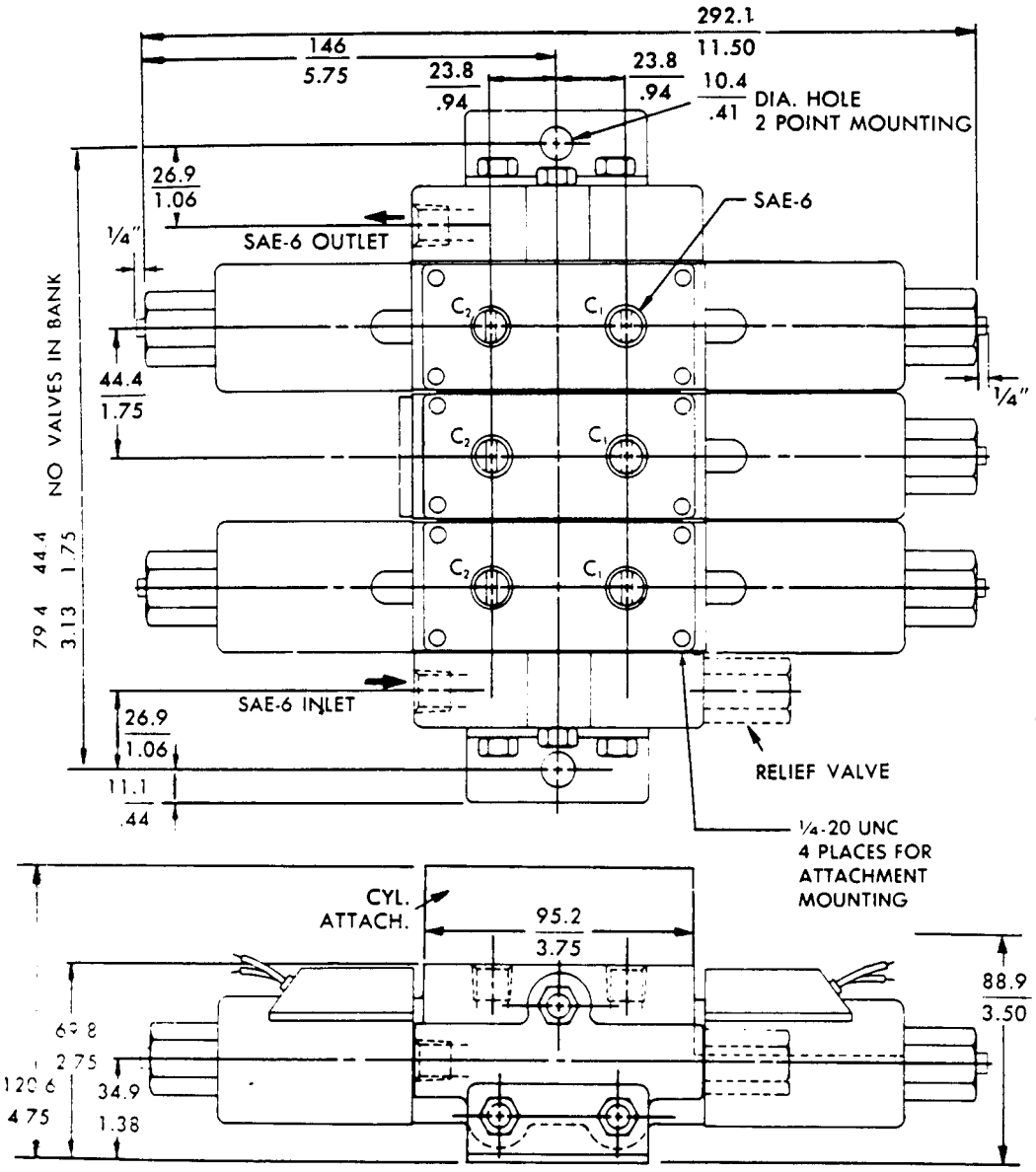
mini-pak
solenoid valve features

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

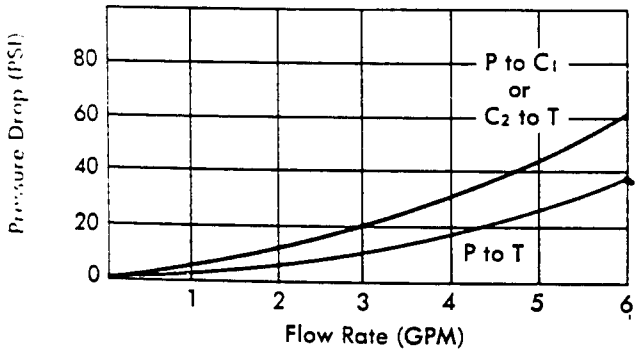


- Two position and Three Position Spools Available—Spool Types, Page 4.
- Rated Pressure 207 BAR (3000 PSI).
- Rated Oil Temperature 74°C (165°F).
- Available Voltages 12, 24 and 36 VDC.
- Current Draw 2.8 amp. @ 12 VDC @ 21°C (70°F).
- Can Be Mounted In Any Position.
- Weight 3.6 kg (8 lbs.) Per Section.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

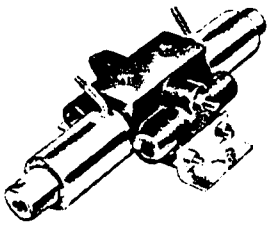
$$\frac{MM}{INCH} = MM/INCH.$$

FLOW L/MIN	PRESSURE DROP P-C1, C2-T BAR	PRESSURE DROP P-T BAR
10	1	0.5
20	3.5	2

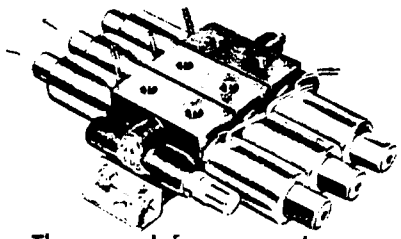
Pressure drop data for valve Model 56-10 (Tandem center 3 position 4-way, pressure to tank open — C_1 and C_2 blocked.) Maximum flow rate 19L/min (5 GPM). 150 SSU oil at 38°C (100°F).



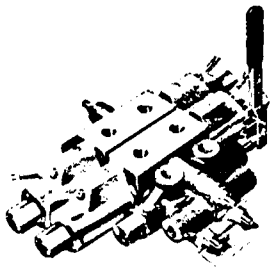
Available options (consult factory).



Four-way, three position double solenoid valve.

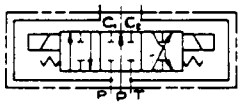
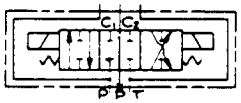
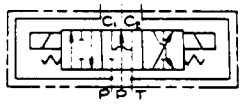
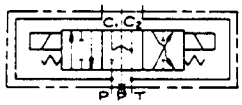
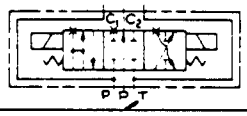
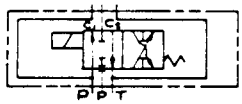
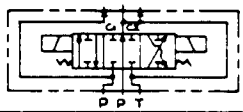


Three spool, four-way valve assembly with relief valve at inlet.



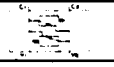
Three spool, four-way valve assembly with relief valve (Manual-Solenoid-Solenoid).

spool type (flow pattern) — TABLE I

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

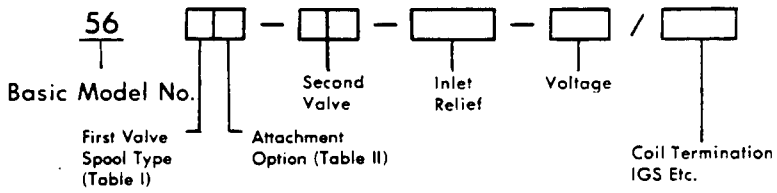
For spool configurations other than shown consult factory.

cylinder attachment valves — C_1C_2 — TABLE II

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

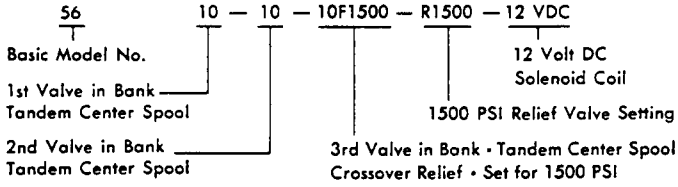
Code letter JJ indicates Palm Button Manual Override

ordering information



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

example of three bank assembly



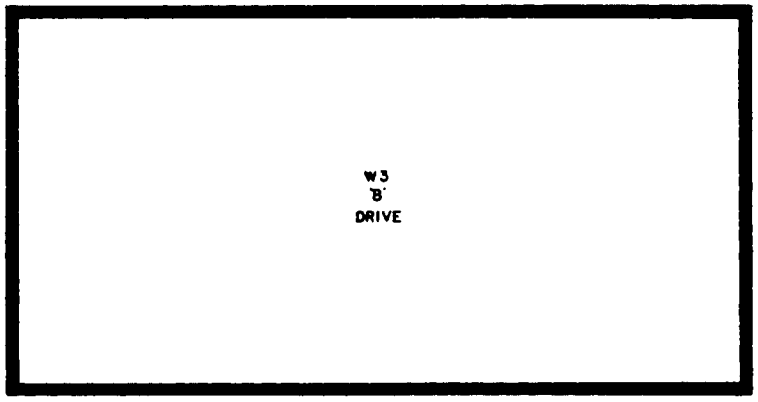
AMBAC Industries Incorporated
FLUID POWER SYSTEMS DIVISION
511 South Glenn Avenue • Wheeling, Illinois 60090
Phone: 312-541-3000

FO-LC-5M-3 78

Printed in U.S.A.

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.

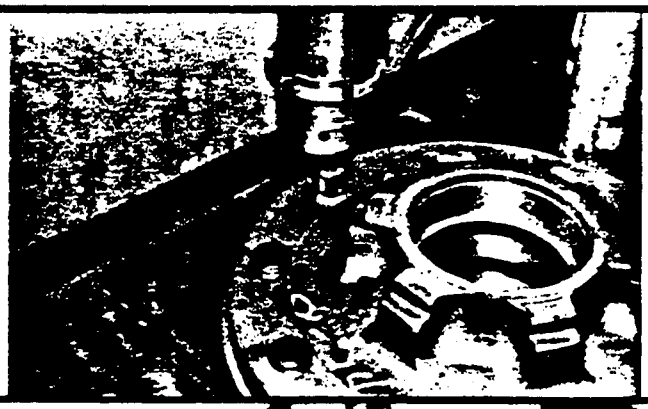
9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

   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

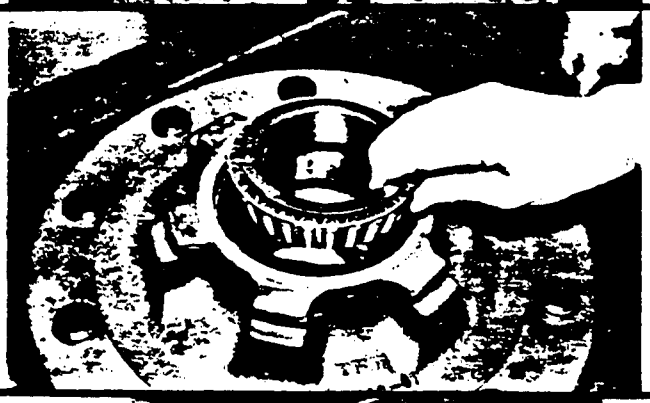


1. Using an arbor type press if available, (if not, a hammer may be used), install the wheel studs. The hub flange should be supported from the underside during this operation.

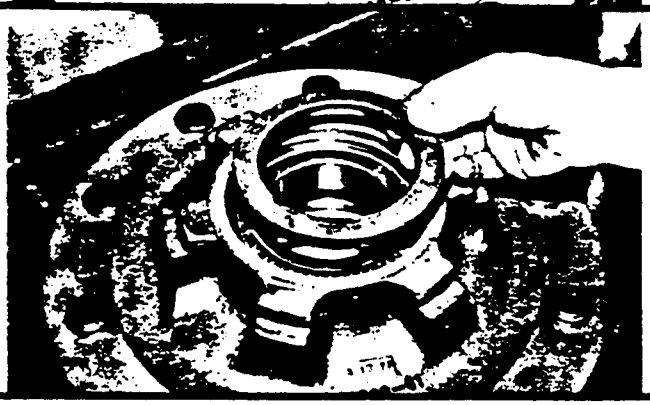
   Note: Wheel studs are optional.



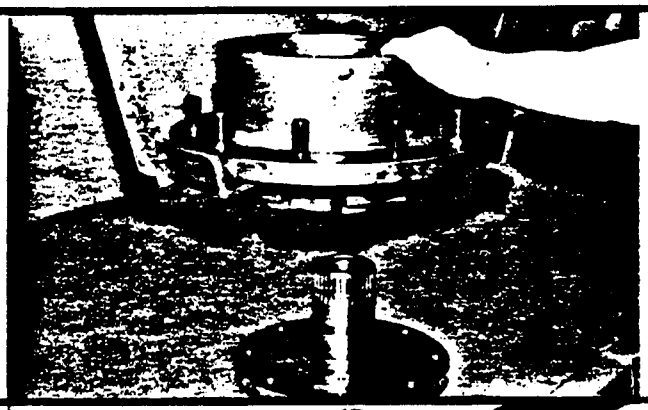
2. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JM716610 will go into small end of Hub, and Cup #JM515610 will go into large end of Hub.



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



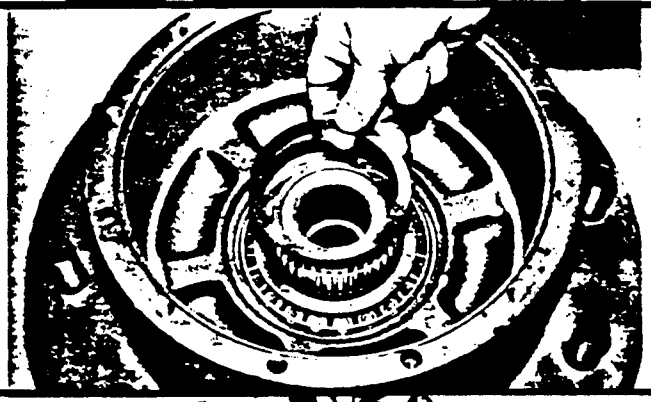
4. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.



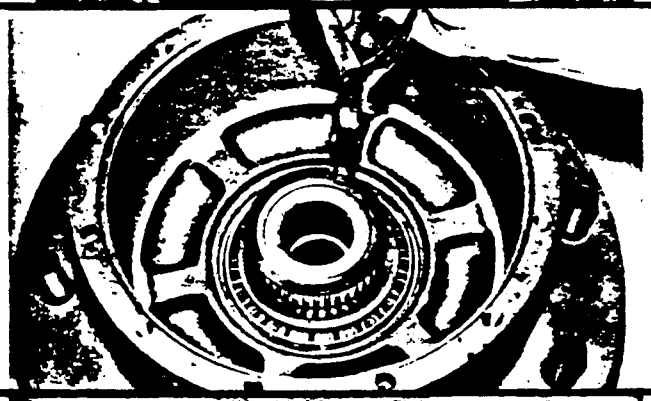
5. Lower Hub onto Spindle with large open end up.



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

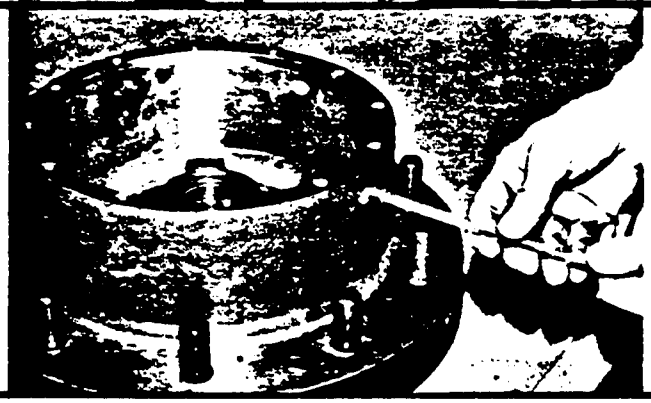


7. Place Bearing Shim over end of Spindle and against Bearing Cone.

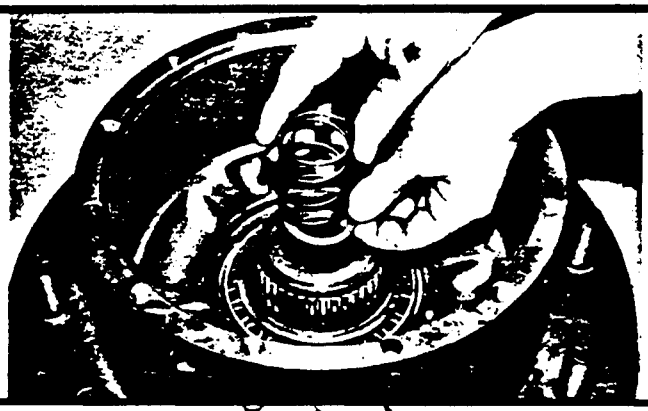


8. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

⚠ 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.

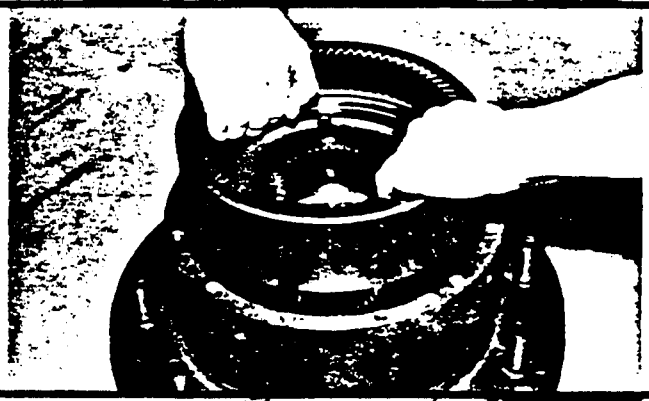


10. The disengage spacer and spring are installed into the co'bore of the Spindle.

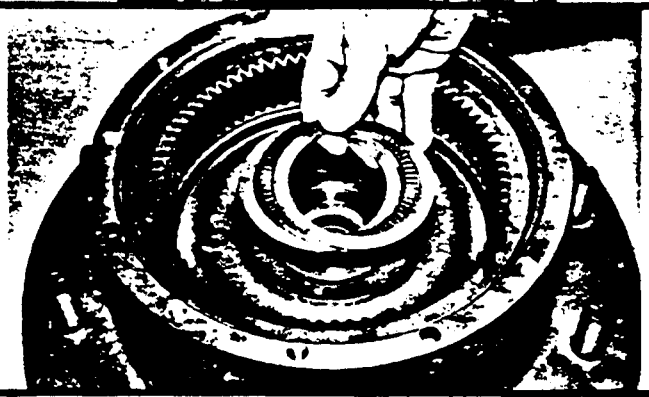


11. Another spacer and the correct Retaining Ring are installed into the Spindle co'bore and Retaining Ring groove provided.

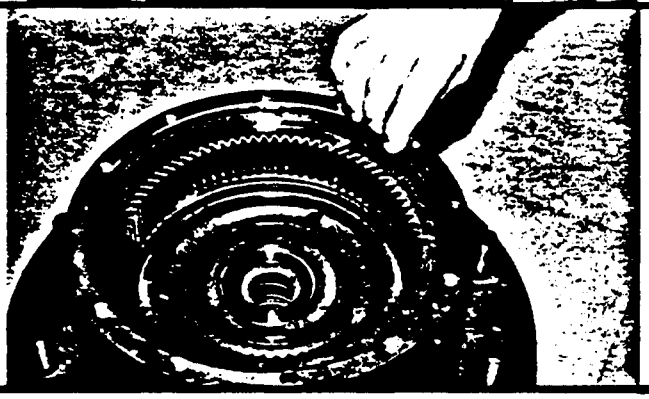
⚠ Eye protection should be worn during Retaining Ring installation.



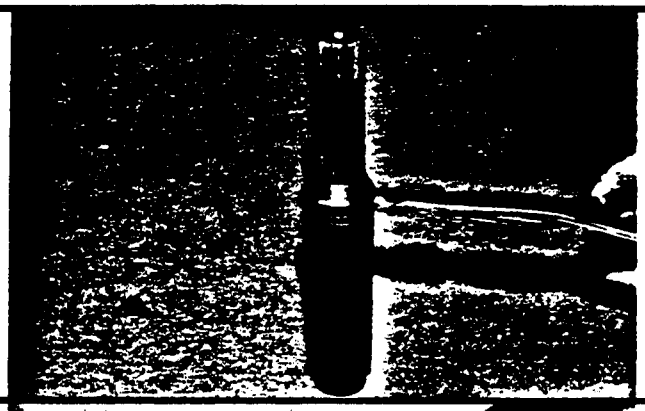
12. The internal gear is installed matching the Bore Spline to the Spindle Spline.



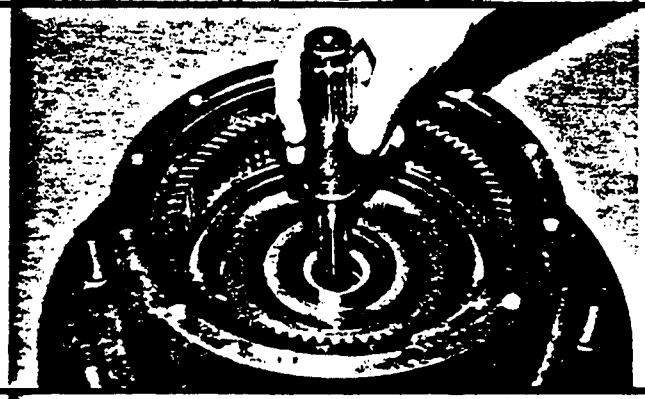
13. The thrust washer/thrust bearing set is installed on the portion of the Spindle which extends into the internal gear.



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.

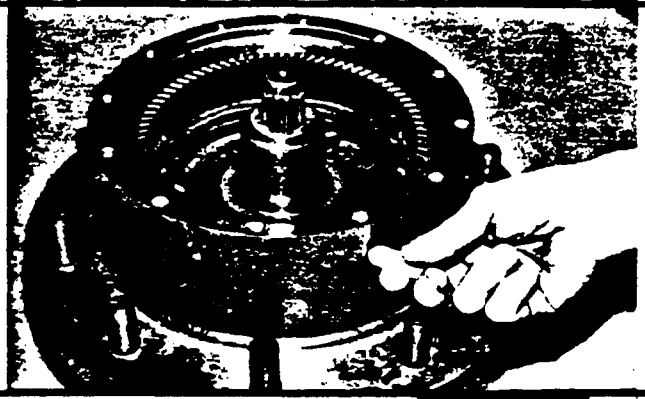


16.The input shaft is installed into the spindle.

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

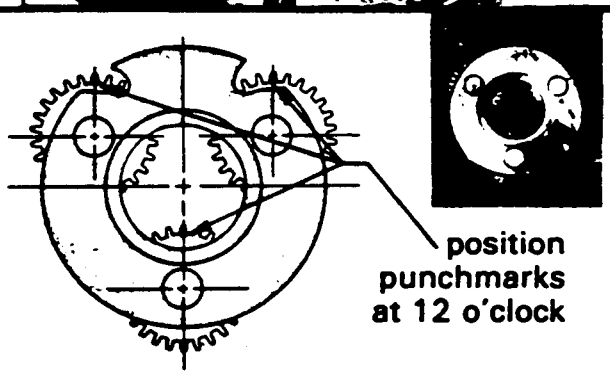


17.The thrust spacer is installed on the input shaft.

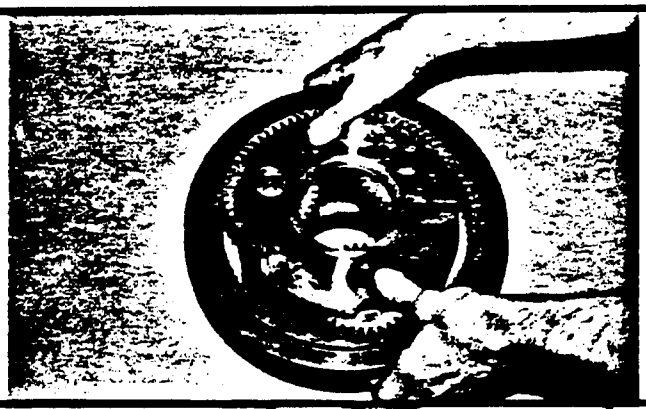


18.Locating the four counter reamed holes in the face of the hub, mark them for later identification.

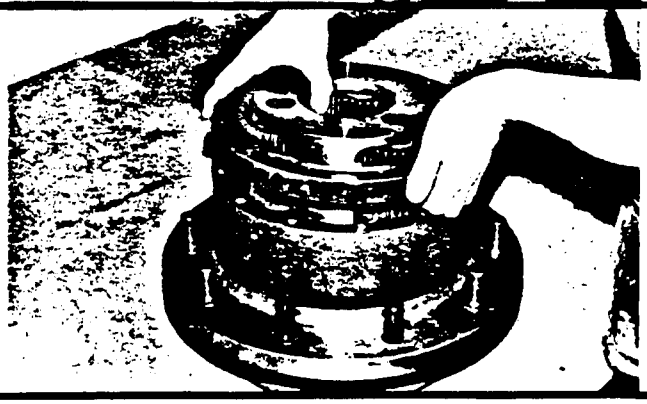
These holes are reamed to accept the shoulder bolts.



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.

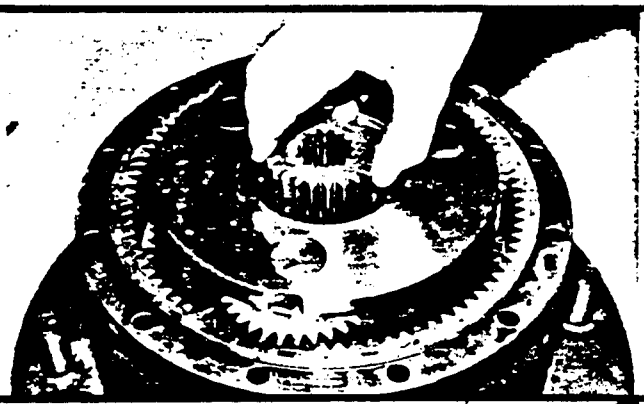


20. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation. The side of the Ring Gear with an "X" stamped on it should be up.



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.

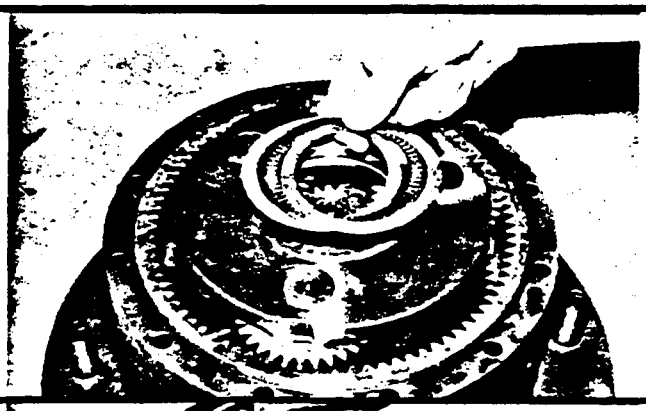
Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.



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.



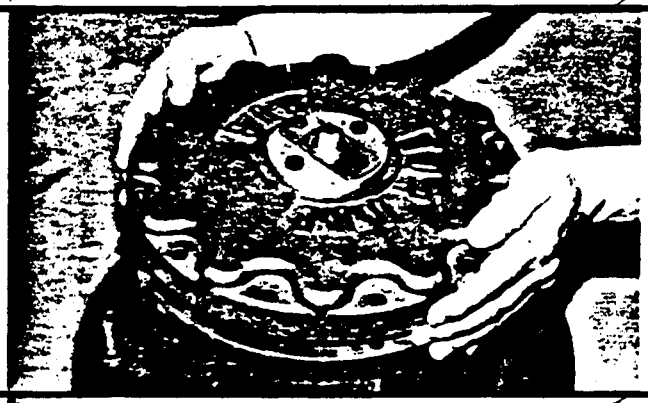
23. After inserting at least one Shoulder Bolt in the proper location, rotate the Carrier. This is to check freedom of rotation and recheck the timing.



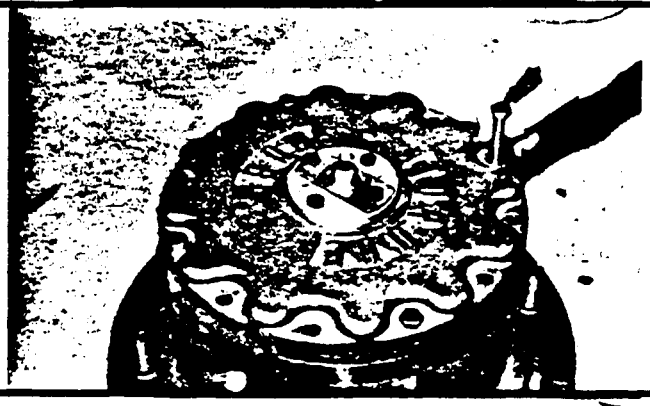
24. Another thrust washer/thrust bearing set is now installed into the counterbore in the face of the carrier.



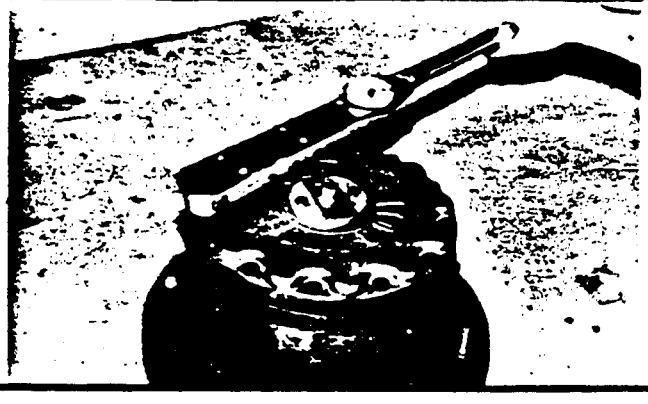
25. Place O'Ring into cover assembly counterbore. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.



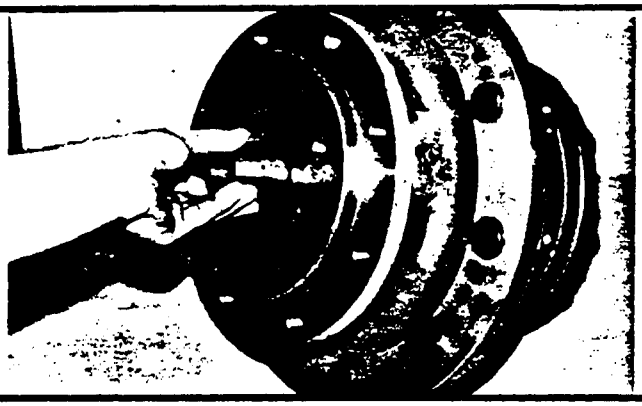
26. Place cover assembly on Ring Gear with oil level, check plug in cover located approximately 90° from oil fill plug in Hub.



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.

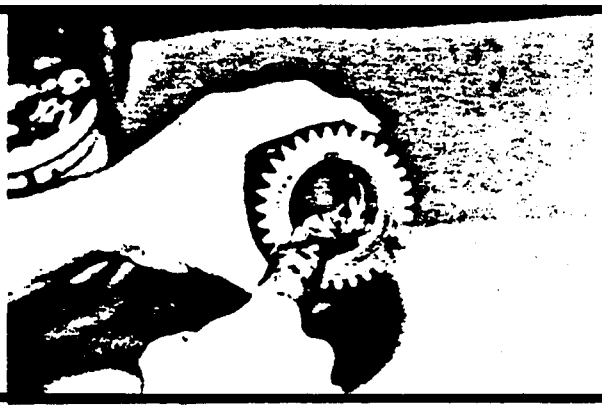


29. Place Coupling into the Spindle and onto the Input Shaft.

    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



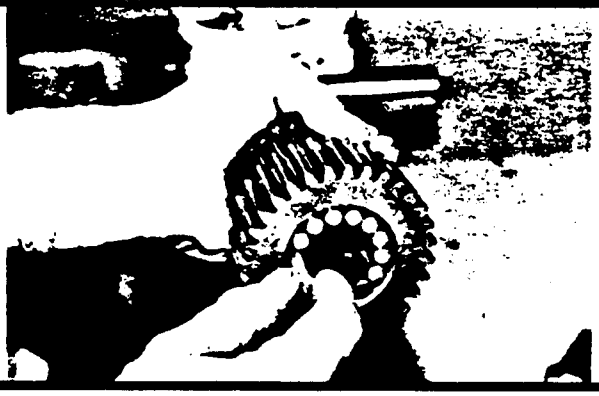
1. Apply a coat of grease or petroleum jelly to Cluster Gear bore.



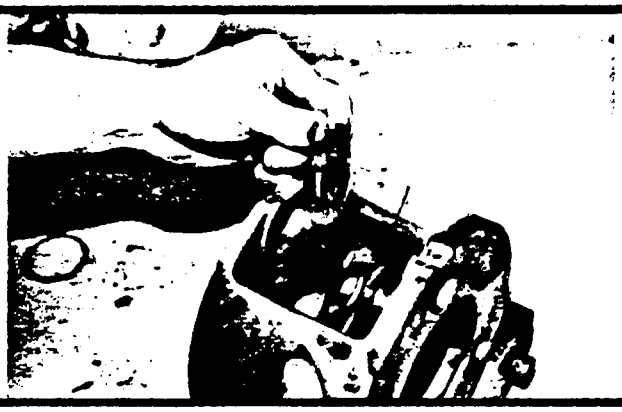
2. Place fourteen Needle Rollers into Cluster Gear bore.



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

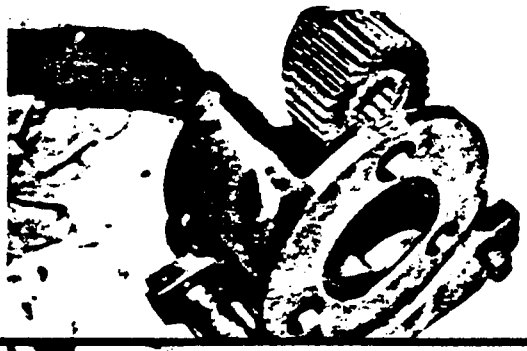


4. Place second set of fourteen Needle Rollers into Cluster Gear.

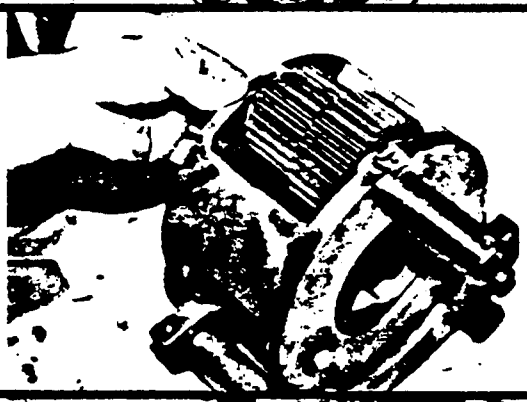


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

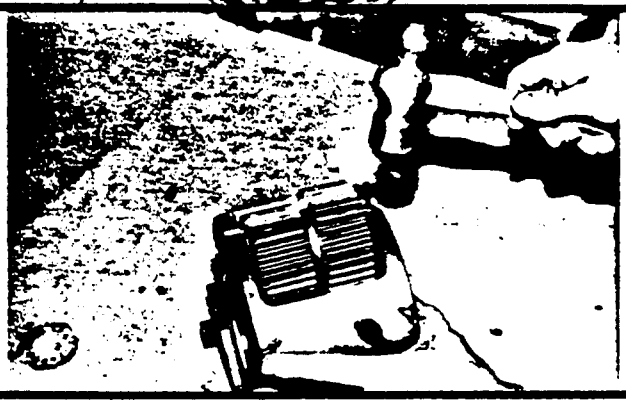
   Note: Some old style Carriers will not have slots and tangs should be located inside boss relief.



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



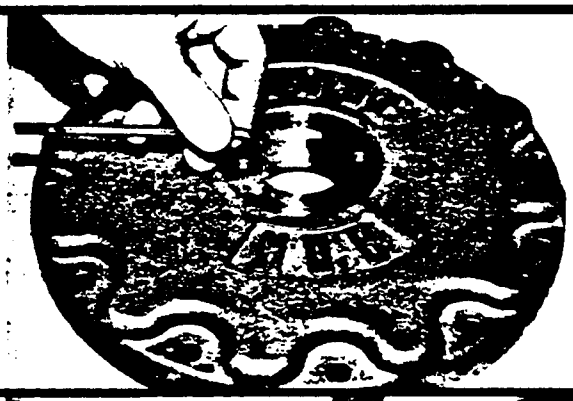
7. Line up Cluster Gear and thrust Washers with hole in Carrier and slide Planet Shaft through. Line up chamfered side of hole in Planet Shaft with pin hole in Carrier.



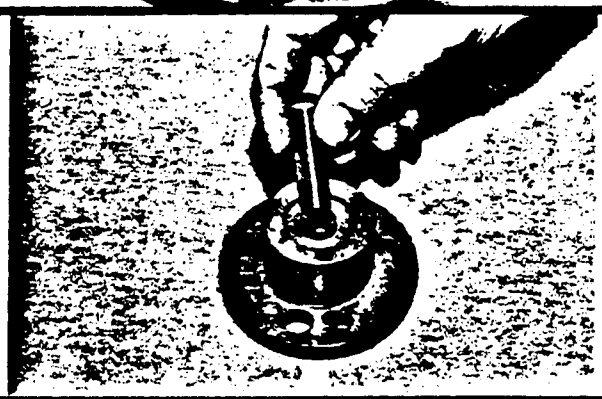
8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

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

Cover Sub-Assembly



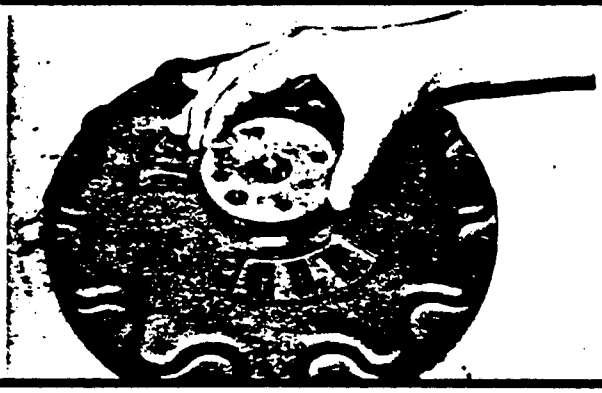
1. Screw Pipe Plug into Cover.



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.



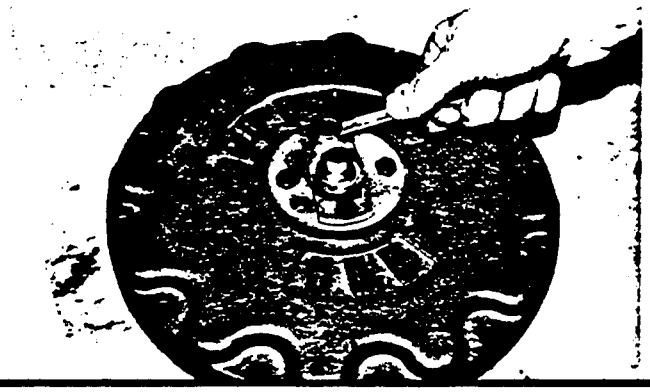
3. Slip 'O' Ring over Cover Cap and against face.



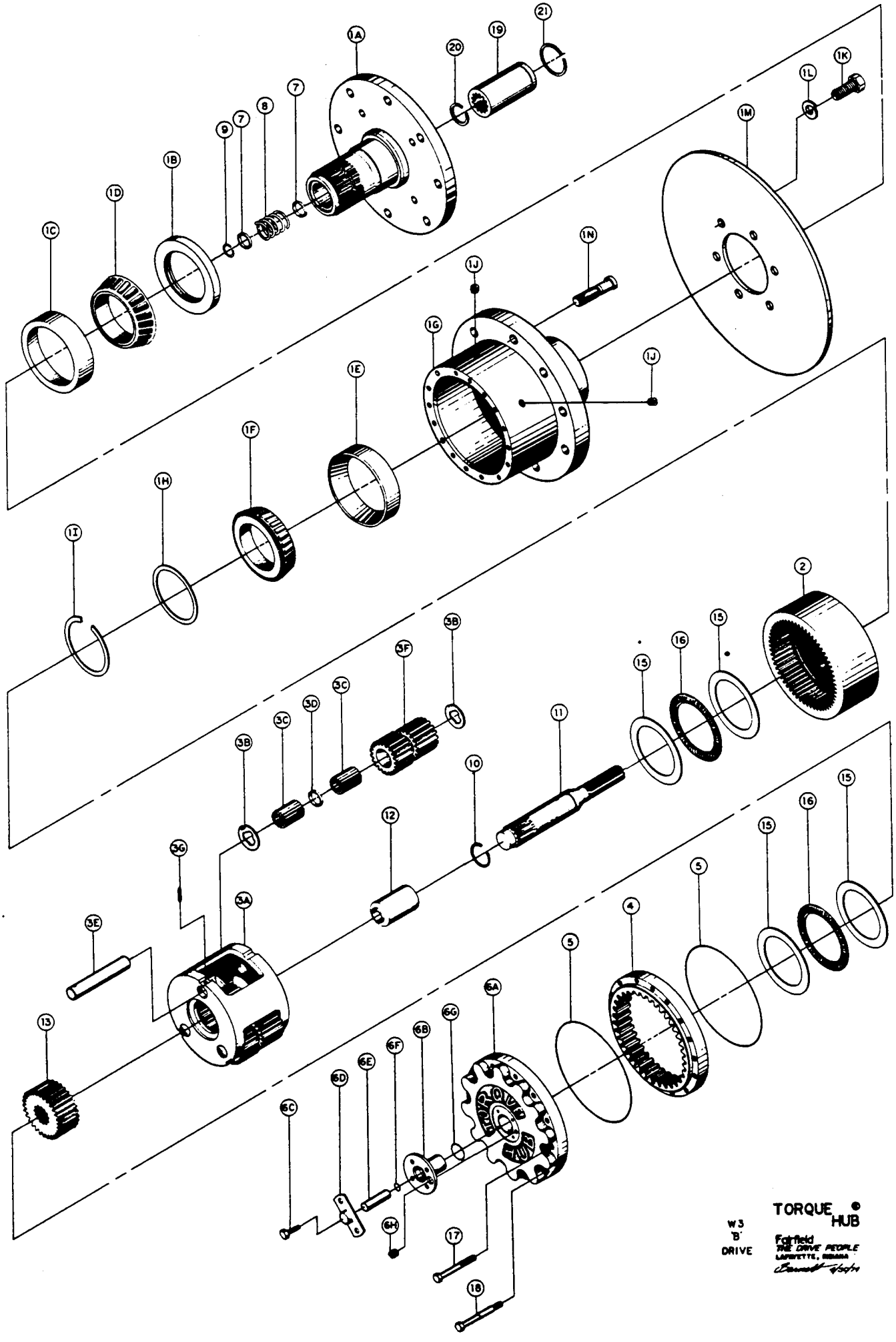
4. Place Cover Cap into Cover with large hole located over Pipe Plug.

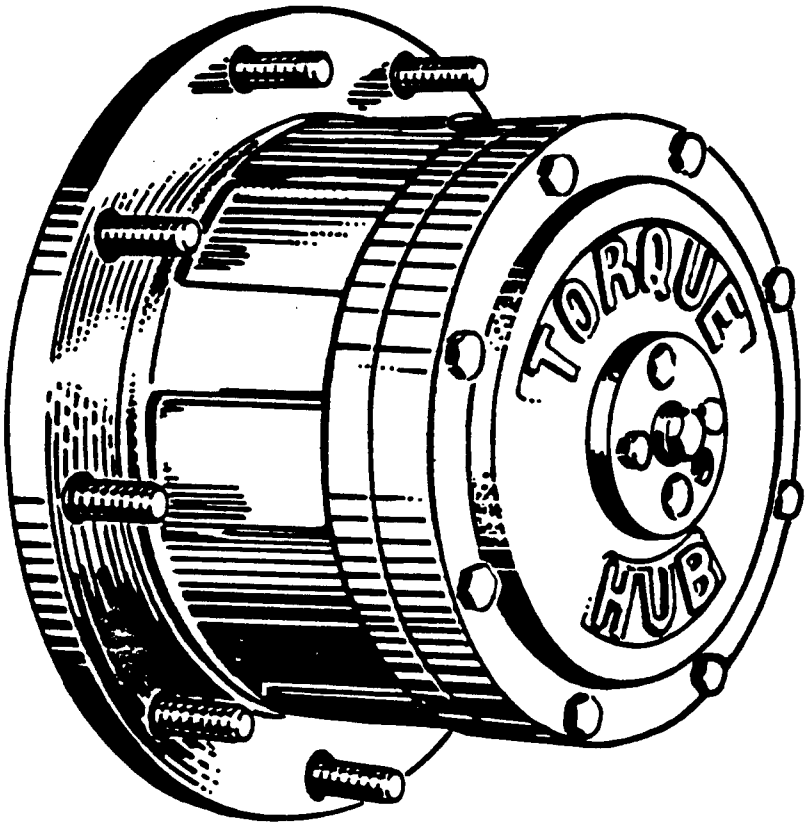


5. Install two 1/4 × 20 × 3/4 bolts 180° apart and torque to 70 - 80 in. lbs.



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.


1A
1B
1C
1D
1E
1F
1G
1H
1I
1J
1K
1L
1M
1N
2
3A
3B
3C
3D
3E
3F
3G
4
5
6A
6B
6C
6D
6E
6F
6G
6H
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21
W3
'B'
DRIVE
TORQUE HUB
Fairfield
THE DRIVE PEOPLE
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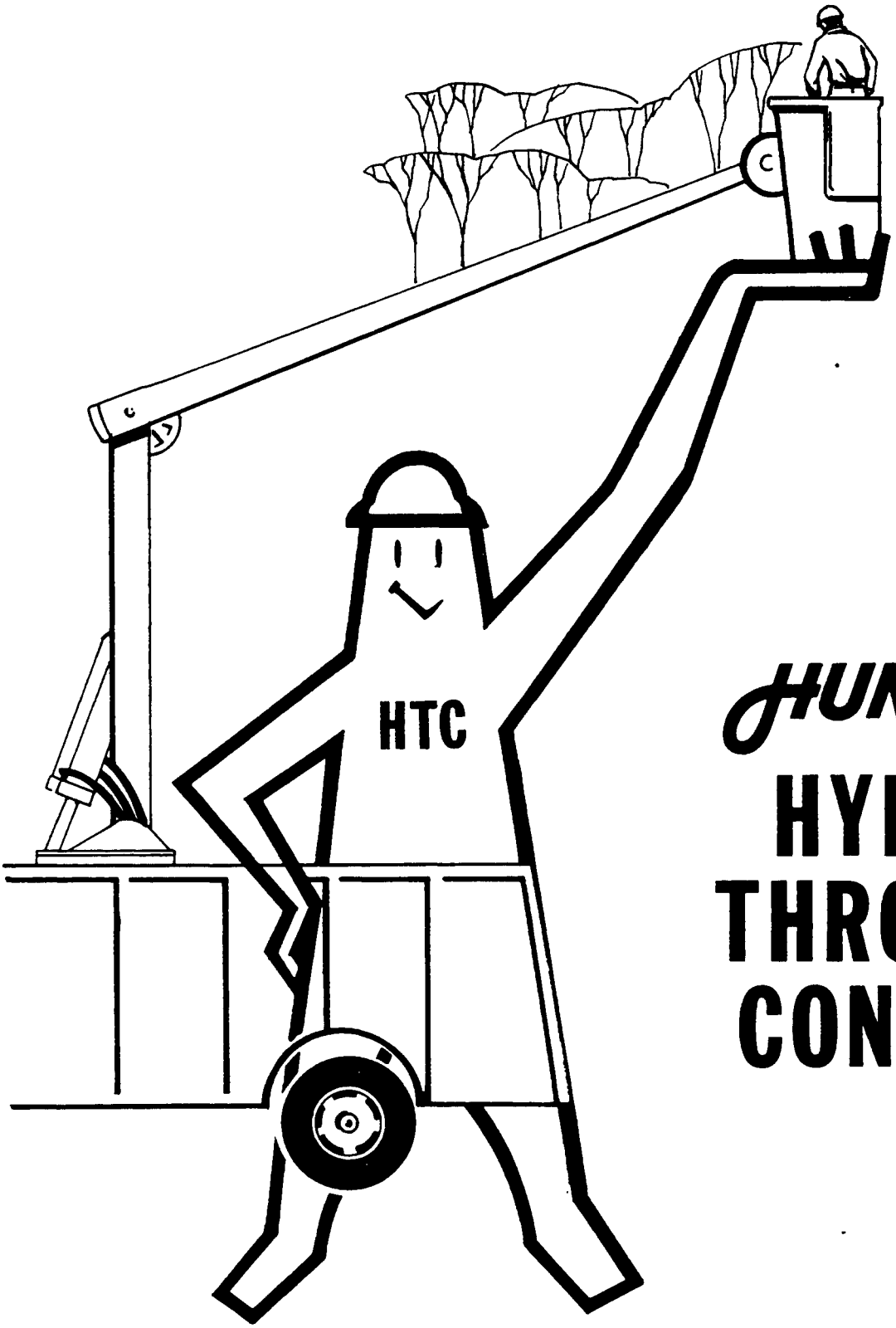
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Fairfield

THE DRIVE PEOPLE

INSTALLATION INSTRUCTIONS



HUNTER

HYDRO-THROTTLE CONTROL

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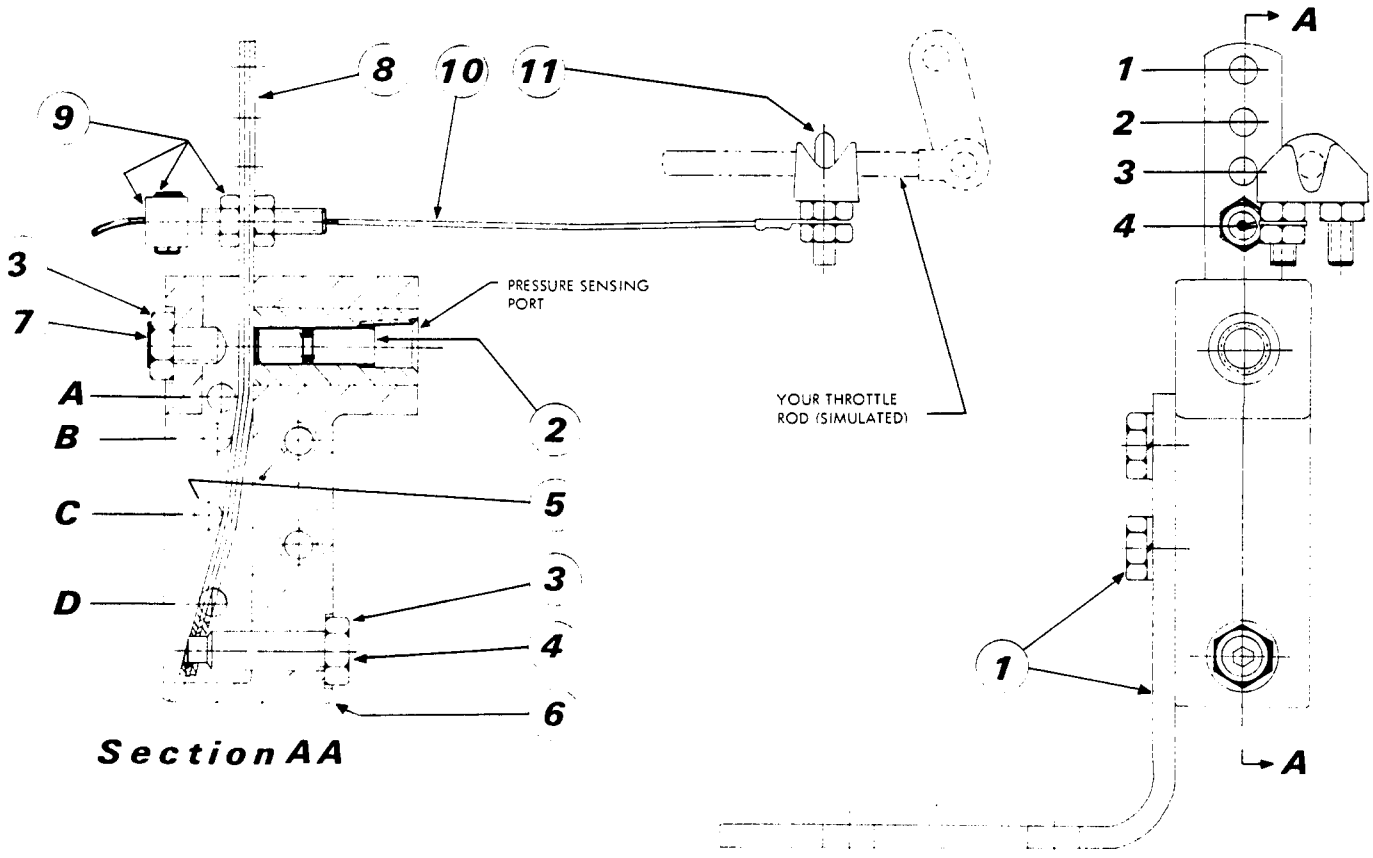
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PARTS LIST

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

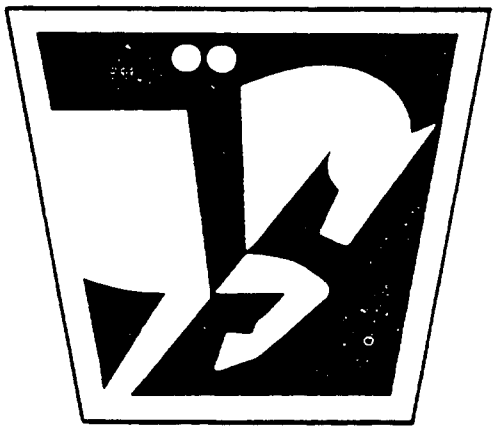
Probable Cause	Remedy
1. Engine speed excessive.	1. Reset speed screw adjustment.
2. Your engine.	2. Make sure it can idle.
3. Connecting cable.	3. Check for slack.
4. Low leaf spring rate.	4. Increase spring rate. See table in Part I, Section "F".
5. Low leaf spring rate.	5. Repeat calibration.
6. Excessive 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

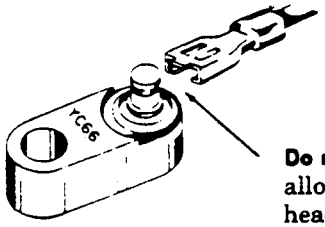
, if engine is equipped with STARTING MOTOR, DISTRIBUTOR IGNITION and FLYWHEEL ALTERNATOR, or GENERATOR.



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



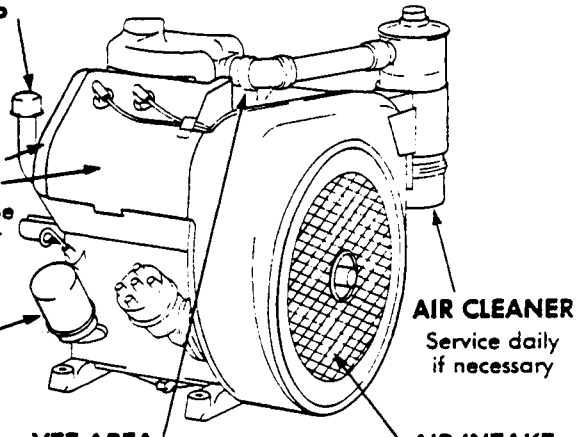
Temperature Safety Switch

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.

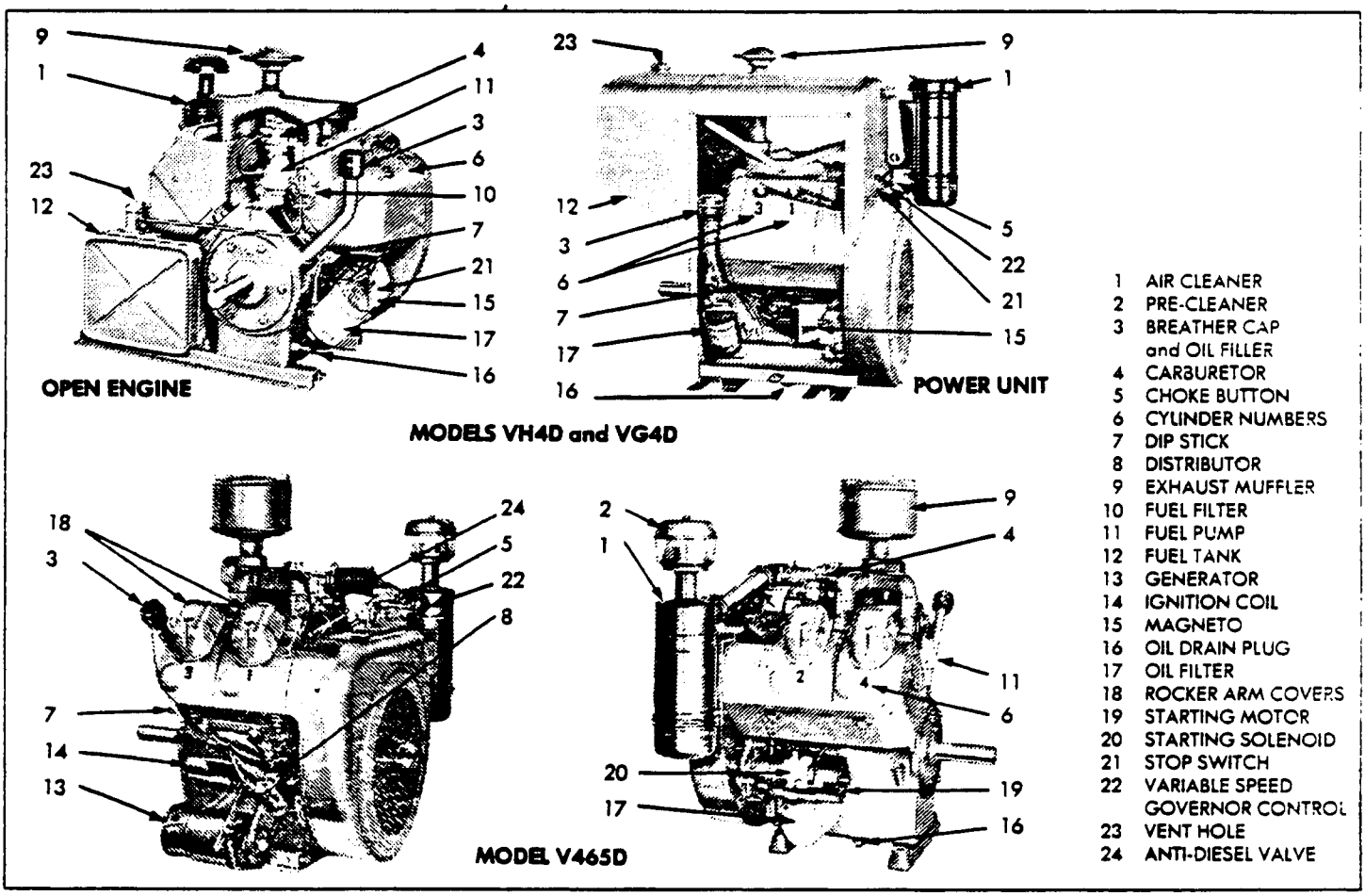


Fig. 1, REFERENCE VIEWS

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 +15°F to 0°F Below 0°F	SAE 20-20W SAE 10W SAE 5W-20
Use oils classified as Service MS, SDorSE	

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.

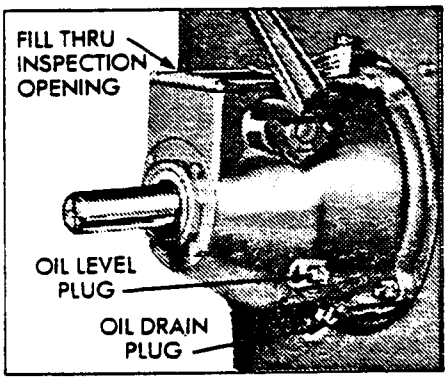


Fig. 2, VH4D
CLUTCH LUBRICATION

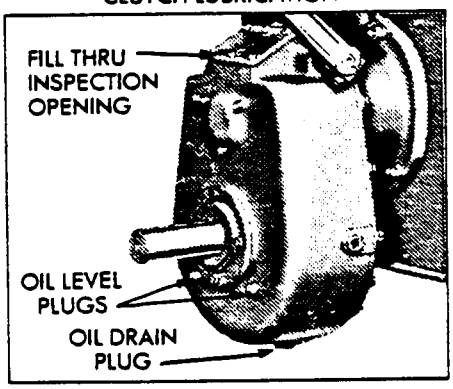


Fig. 3, VH4D
CLUTCH REDUCTION LUBRICATION

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

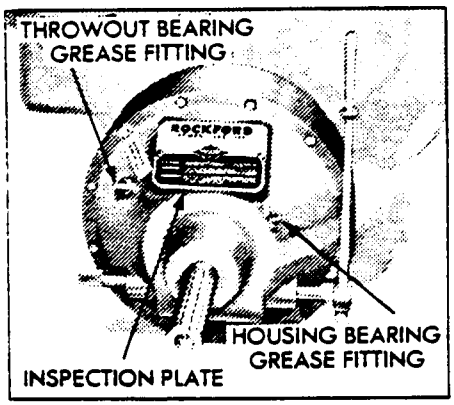


Fig. 4, VG4D, V465D
CLUTCH LUBRICATION

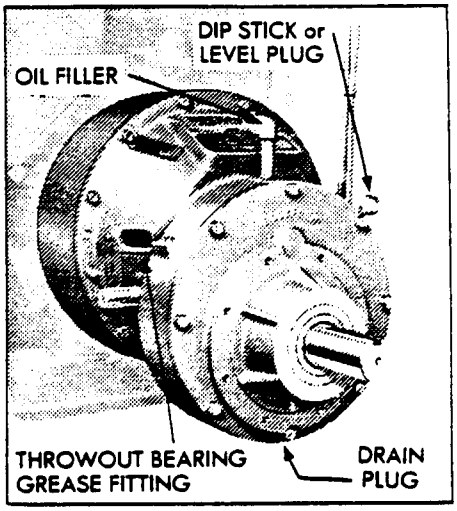


Fig. 5, VG4D, V465D
CLUTCH REDUCTION LUBRICATION

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.

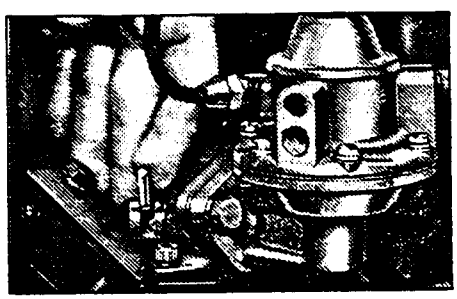


Fig. 6, FUEL PUMP PRIMER

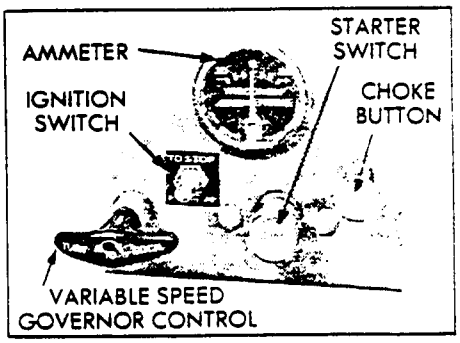


Fig. 7, VH4D, VG4D
CONTROL PANEL

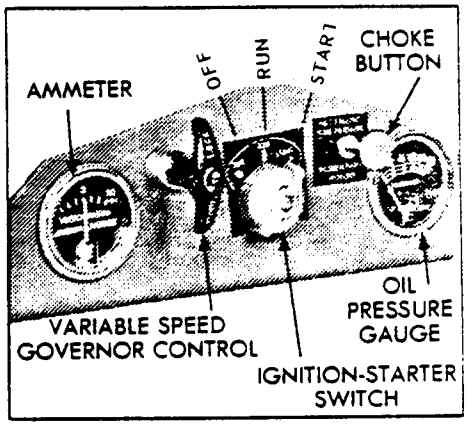


Fig. 8, V465D
CONTROL PANEL

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 halfway 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.

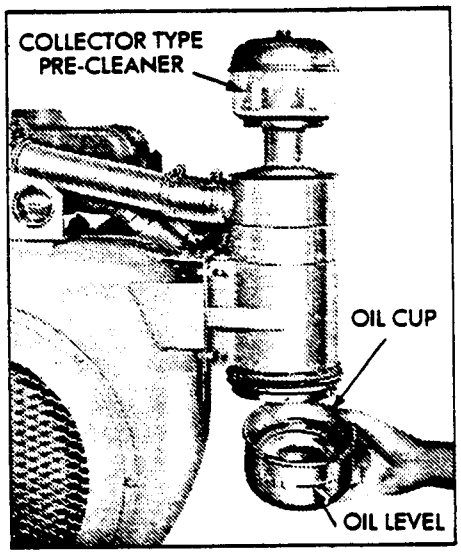


Fig. 9 OIL BATH AIR CLEANER

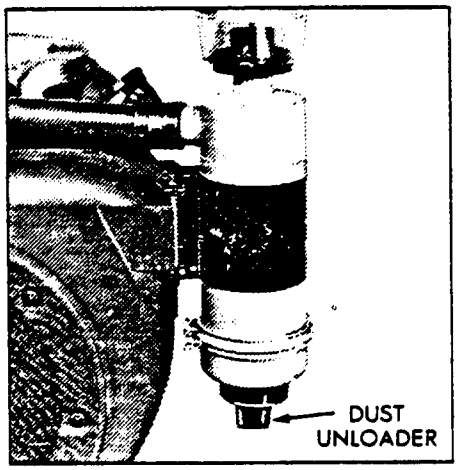


Fig. 10, DRY TYPE AIR CLEANER

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 precleaner, 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.

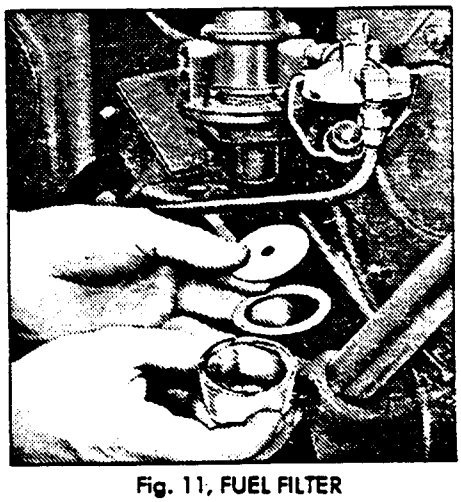


Fig. 11, FUEL FILTER

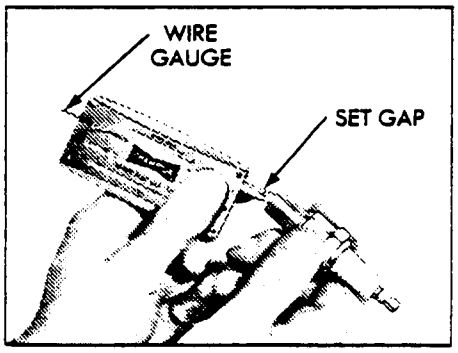


Fig. 12

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 VG4D	18mm	Champion D-16J (Wisconsin YD-6)
V465D	14mm	Champion N-12Y 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

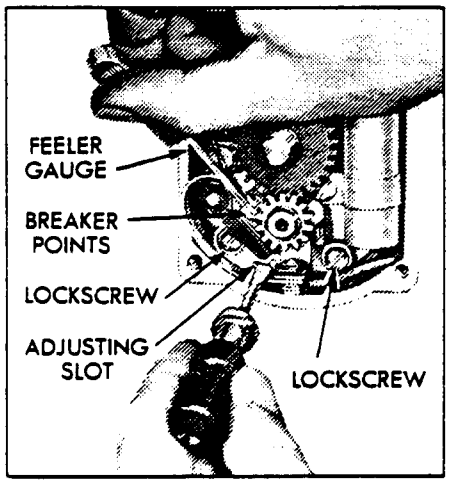


Fig. 13

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.

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.

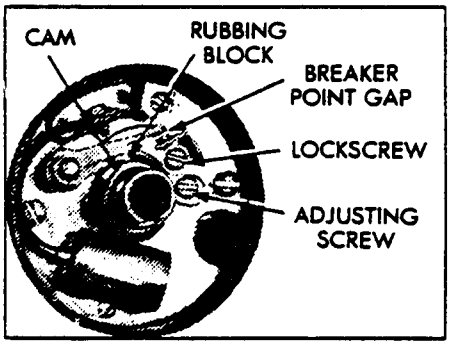


Fig. 14

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

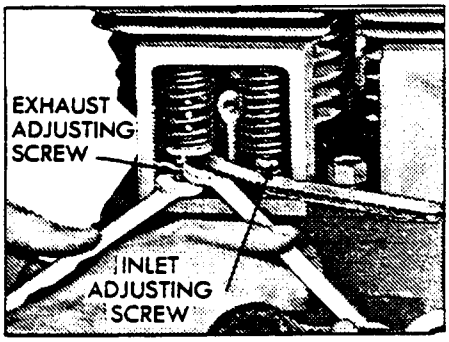


Fig. 15, VH4D, VG4D
VALVE TAPPET ADJUSTMENT

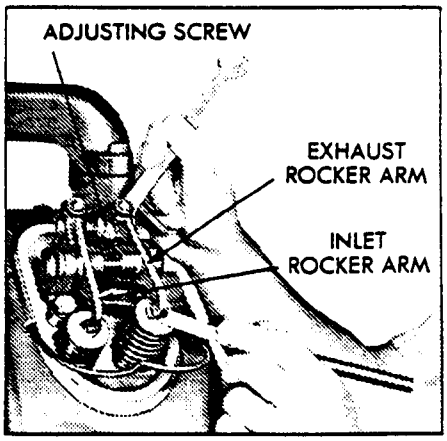


Fig. 16, V465D
VALVE TAPPET ADJUSTMENT

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.

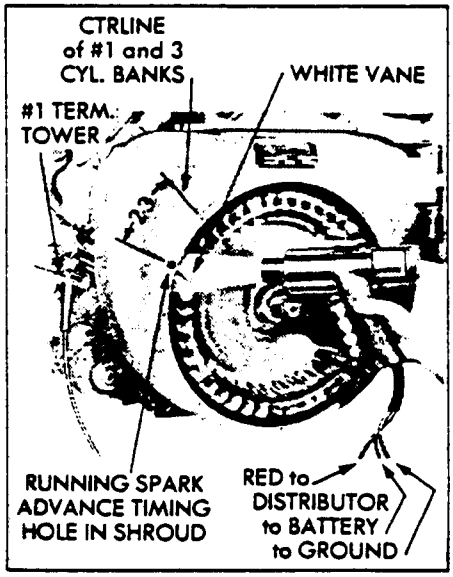


Fig. 17

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.

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.

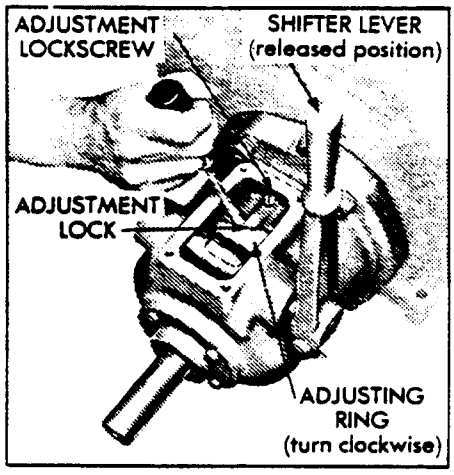


Fig. 18, VH4D
CLUTCH ADJUSTMENT

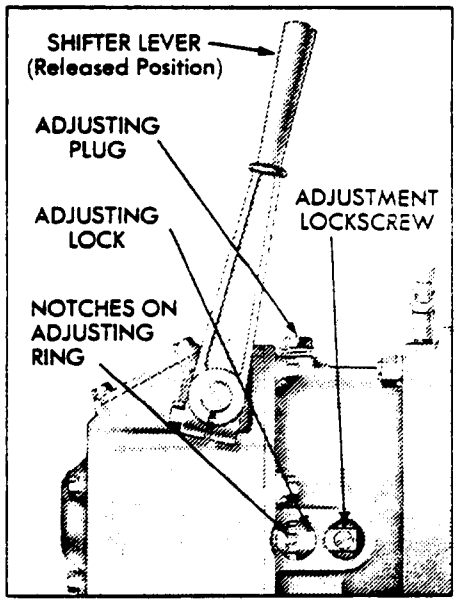


Fig. 19, VH4D
CLUTCH REDUCTION ADJUSTMENT

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

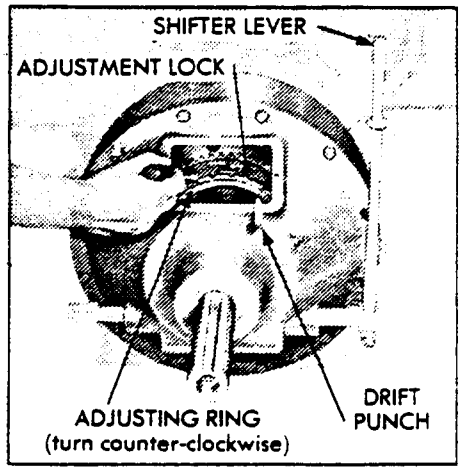


Fig. 20, VG4D, V465D
ROCKFORD CLUTCH ADJUSTMENT

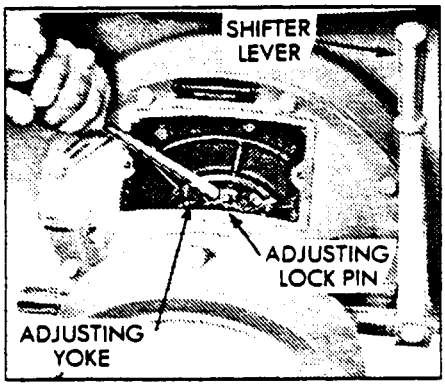


Fig. 21, VG4D, V465D
TWIN DISC CLUTCH ADJUSTMENT

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 lock-pin 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.

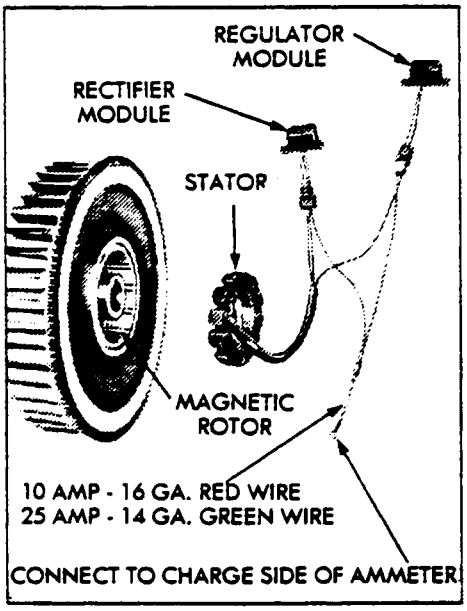


Fig. 22, FLYWHEEL ALTERNATOR

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.

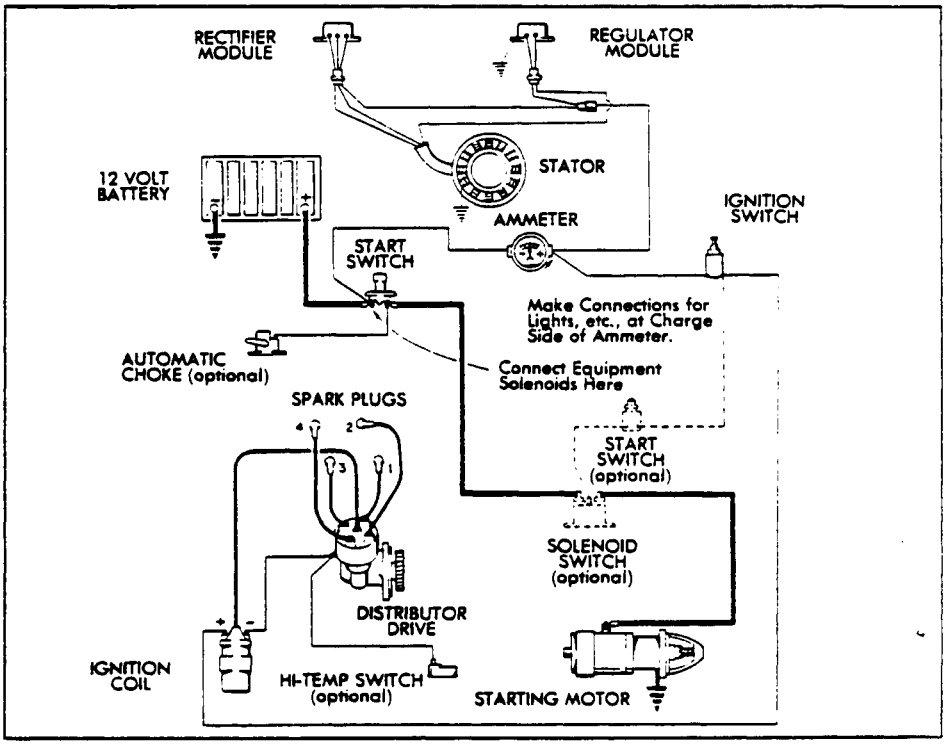


Fig. 23, WIRING DIAGRAM,Flywheel Alternator and Battery Ignition, Models VH4D, VG4D

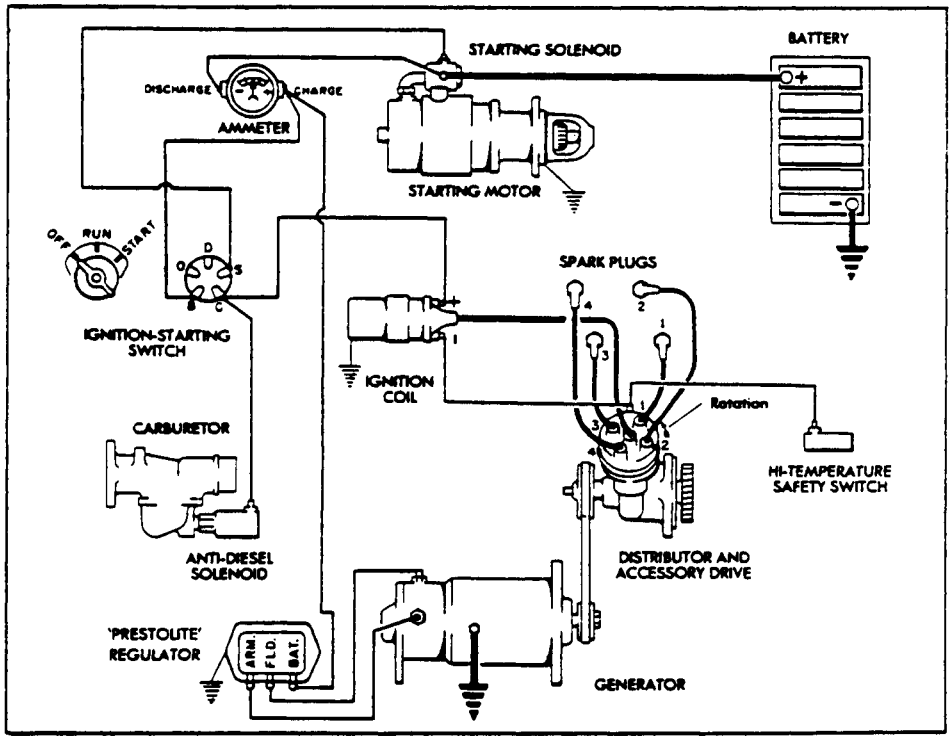


Fig. 24, WIRING DIAGRAM,Generator and Battery Ignition, Model V465D

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.

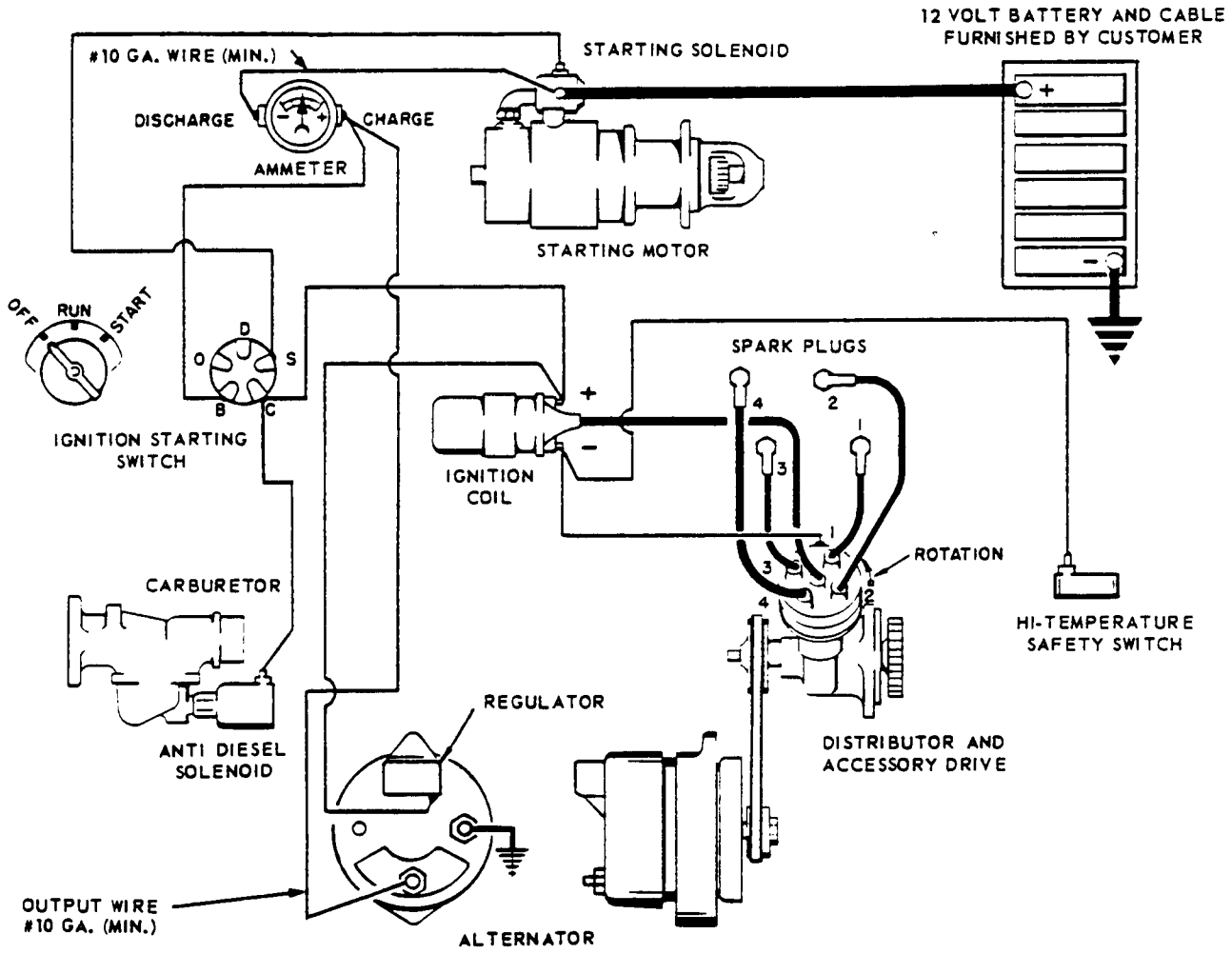
Do Not, remove the alternator from the vehicle without first disconnecting the grounded battery cable.

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

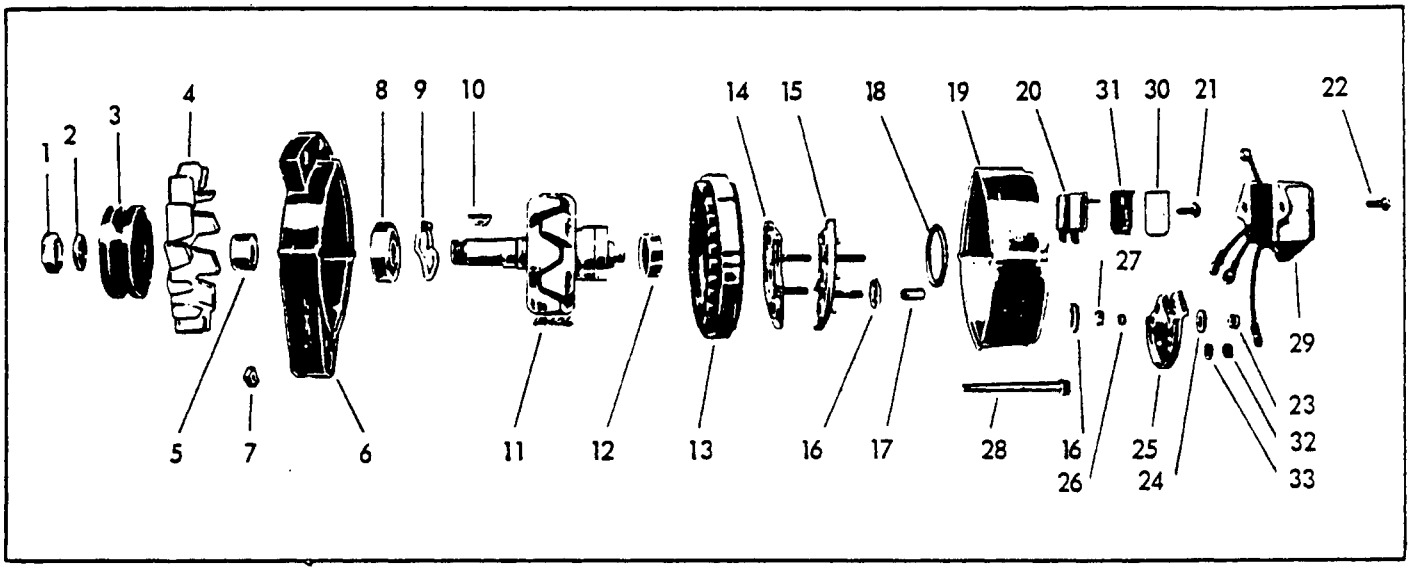
MY-93-3
(over)

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

Printed in U.S.A.

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

Printed in U.S.A.

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.