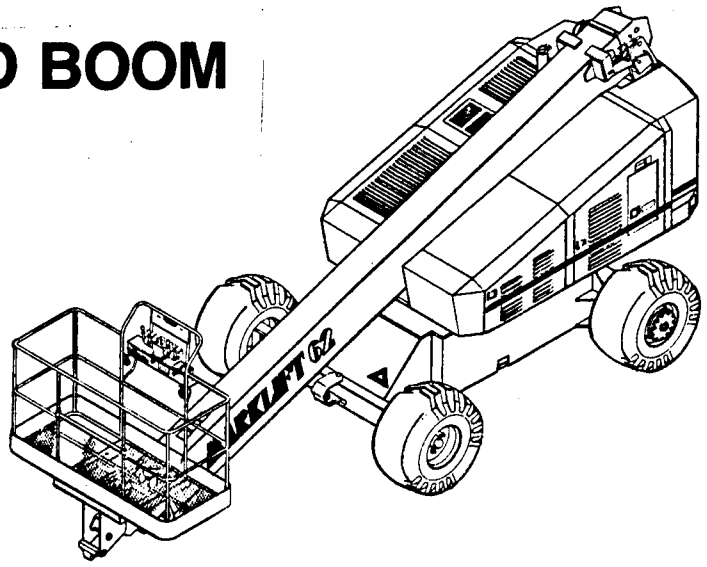
MARKLIFT®

SELF-PROPELLED BOOM (MODEL 62)

OPERATION MAINTENANCE AND PARTS MANUAL



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17002

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MARKLIFT SELF-PROPELLED BOOM
(MODEL 62)
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 62)

DESCRIPTION	ENGLISH	METRIC
HEIGHT	62	
WORKING (MAXIMUM)	68'4"*	20.83 m
PLATFORM (MAXIMUM)	62'4"**	19.0 m
LOWERED (MINIMUM)	8'3"	2.51 m
WIDTH (MAXIMUM)	7'11"	2.41 m
LENGTH (MINIMUM)	23'4"**	7.11 m
LIFT CAPACITY (UNRESTRICTED)	800 LB.	363 kg.
WHEEL BASE	8'	2.44 m
WHEEL TRACK	6'8"	2.03 m
TURNING RADIUS (INSIDE)	12'	3.65 m
TURRET ROTATION	CONTINUOUS	
TURRET TAILSWING	7'3" (FROM ℄ ROTATION)	2.21 m
ENGINE-GASOLINE (AIR COOLED)	37 HP WISC.	
TRAVEL SPEED (PROPORTIONAL)	0 TO 3 MPH	0 TO 4.8 km/hr.
CONTROLS	PROPORTIONAL & SOLENOID	
HYDRAULIC SYSTEM	LOAD SENSING & PRESSURE COMPENSATED	
TIRES	15 X 19.5 12 PLY RATING	
HORIZONTAL REACH (MAXIMUM)	48'9"	14.86 m
BOOM ELEVATION	+75° ABOVE HORIZONTAL	
	-20° BELOW HORIZONTAL	

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

DESCRIPTION	ENGLISH	METRIC
FUEL RESERVOIR CAPACITY	30 GAL.	113.5 l
HYDRAULIC RESERVOIR CAPACITY	40 GAL.	151.4 l
WEIGHT	24,000 LB.	10,886 kg.
SHIPPING CUBE	1490 CU. FT.	42.17 cu. m
PLATFORM DIMENSIONS	71" X 30" X 40"	1.80 m X 76 m X 1.01 m

NOTES: *OPTIONAL PLATFORM ROTATION DECREASES PLATFORM CAPACITY TO 700 LB.

**24'2" (7.36 m) WITH PLATFORM ROTATION

MARKLIFT SELF-PROPELLED BOOM
(MODEL 62)

OPTION	TITLE
20078	HEADLIGHTS
20079	CLEARANCE, STOP & TURNING LIGHTS
20081	TOWING KIT
20091	MONOFILLED TIRES
20097	RAISED PLATFORM ROTATION
20104	GROUND & AERIAL 110 VAC RECEPTACLES
20106	CLEARANCE, STOP & TURNING LIGHTS
20107	ROTATING BEACON
20108	TRAVEL HORN
20109	SELF CLOSING PLATFORM GATE
20110	PLATFORM ROTATION
20112	LIFTING LUGS
20113	SPECIAL PAINT
20121	ST 3 LISTER DIESEL
20122	CATALYTIC MUFFLER-ST 3 LISTER DIESEL
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

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

OPTION	TITLE
20147	FIBERGLASS BASKET
20148	DUAL FUEL TWIN TANK
20159	110 VAC GENERATOR FOR VG4D WISCONSIN
20161	110 VAC GENERATOR FOR ST 3 LISTER
20162	PLATFORM AT END OF BOOM-CONVERTS TO 60 FT. PLATFORM HEIGHT
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 62)
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.1 5-81	MAINT. 27,28		
REV.2 9-81	FRONT TITLE PAGE		
	CONTENTS ii,iii,iv		
	vi,viii,ix OPERATION		
	1,2,2.1,2.2 2,3,2.4,2.5		
	5,11,12,15 22,24		
	MAINT. 28.1,29,30		
	SCHEM. 38,38.1,39.1		
	PARTS INDEX i,ii		
	4,6,8,9.1 10,15,16A		
	17,18,19,23 23.1,26A,27		
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	49.1,50,51 51.1,52,55.1		
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	66.1,66.2, 66.3,66.4,		
	68,76,77, 78		
REV.3 4-84	FRONT TITLE PAGE		
	CONTENTS iv,v,vi,vi.1		

REV. DATE	PAGE NUMBERS	DATE INSERTED	BY
	OPS 1 MAINT.		
	27,28 SCHEM.		
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	42,43,44 44.1,44.2		
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MANUFACTURERS' LIMITED WARRANTY

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

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

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

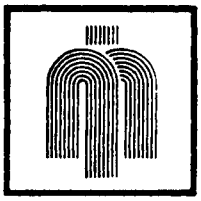
The sole obligation and liability of Mark Industries under this limited warranty (and the exclusive remedy for any purchaser, owner or user of Mark Industries products) is limited to the repair or replacement, at the option of Mark Industries, of any product (or any part or parts of any product) manufactured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

To make a claim under this limited warranty, contact Mark Industries or the Mark Industries distributor from whom the product was originally purchased. A statement giving the model and serial number of the allegedly defective product, the date and a 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. Carson, California. No credit will be given for any allegedly defective product (or any part or parts of any product) not returned to Mark Industries.

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

Mark Industries shall not be liable for any special, indirect or consequential damages. Further, no representation or warranty made by any person, including any representative of Mark Industries, which is inconsistent or in conflict with, or in addition to the terms of the foregoing limited warranty (or the limitations of the liability of Mark Industries as set forth above) shall be binding upon Mark 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 720 • Long Beach, CA 90801
213-639-9700 • 800-421-1826 • TELEX 677-361

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

NEW EQUIPMENT CONDITION REPORT

(WARRANTY REGISTRATION)

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

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

MODEL NUMBER_____ SERIAL NUMBER_____

OPTIONS_____

INSPECTOR #_____

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

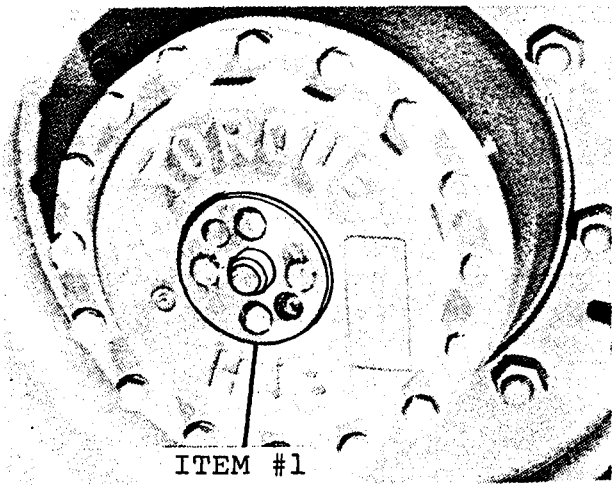
1. The truck must be fitted with adequate winch to handle the weight of equipment you are going to load/unload.

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 -----	39,800 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.		

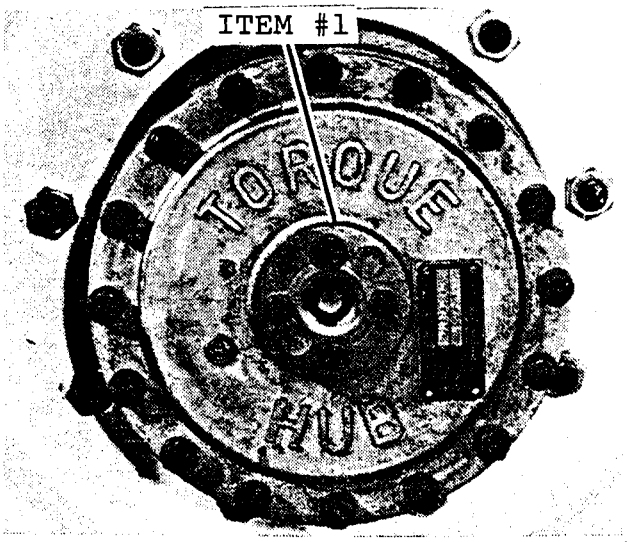
2. Align the boom with the steering wheels toward the trailer, and the basket in the horizontal or slightly above position.

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.)



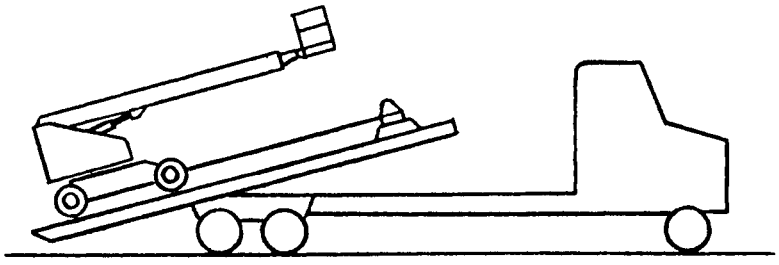
HUB ENGAGED

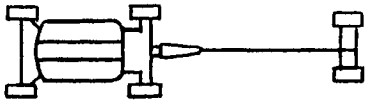


HUB DISENGAGED

CAUTION: BRAKES ARE ALSO AUTOMATICALLY DISENGAGED AT THIS TIME.

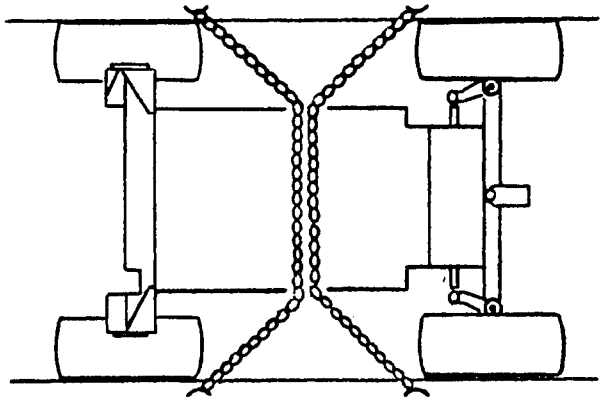
4. Attach the winch cable to the boom at the steering end on the center steering arm as shown.

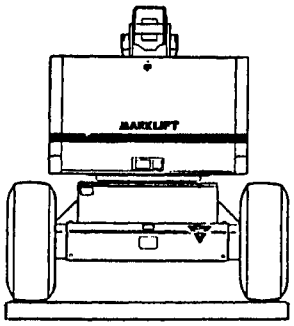




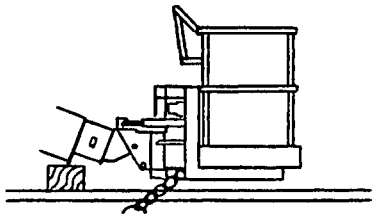
5. When truck bed is locked back into the horizontal position, rotate the boom 180° to a position where the counter weight is over the steering wheels. (This position would place the counterweight closest to the truck cab.)

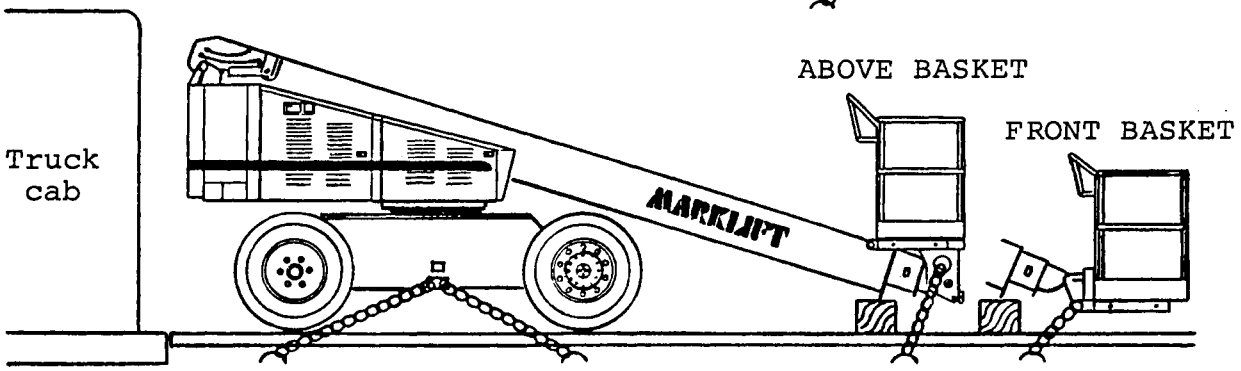
6. When the boom is on the truck in position for proper weight distribution, it is chained down in the manner illustrated by the drawings below.





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

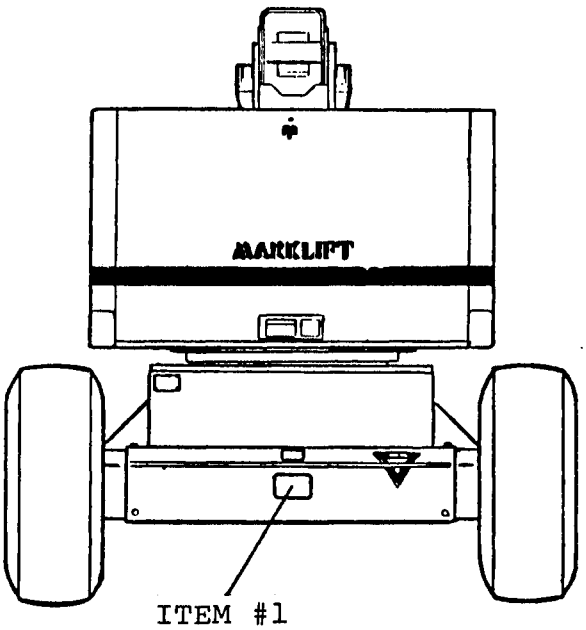
FLATBED WITH HYDRAULIC LIFT/LOWER REAR PORTION

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)



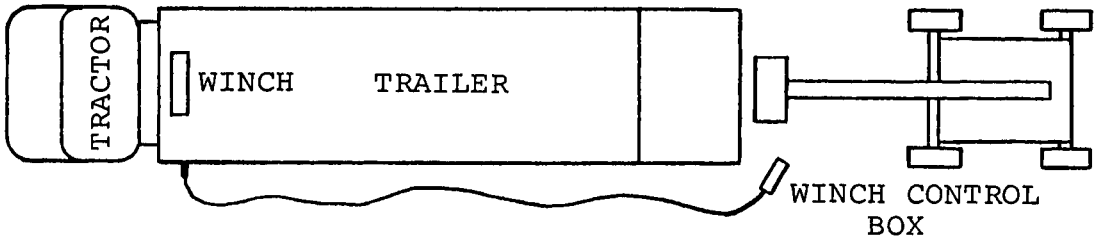
2. If the unit has the high/low drive option, it must be in low drive at all times when loading/unloading.

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.) <u>You must keep drive function engaged while winching or the brakes will stop the machine from rolling</u>.

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 62)

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

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

11. After check-out of ground control functions, position selector switch to AERIAL for operation at work platform. Depress foot switch prior to moving any control function switches. This increases engine RPM (if throttle HI/LO selector is positioned in HI), and electrically completes circuit to controls.

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

12. THE TRAVEL OR DRIVE CONFIGURATION IS WITH THE STEERING WHEELS UNDER THE BOOM. THIS PROVIDES THE BEST WEIGHT DISTRIBUTION FOR MAXIMUM TRACTION. IF THE BOOM IS ROTATED 180°, THE DRIVE AND STEER DECALS READ IN REVERSE. THE FORWARD DECALS ATTACHED TO EACH END OF THE CARRIAGE ASSEMBLY WILL HELP ORIENT THE OPERATOR TO THE CONTROL CONSOLE.

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

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

MARKLIFT SELF-PROPELLED BOOM
(MODEL 62)

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 9 & 10 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."

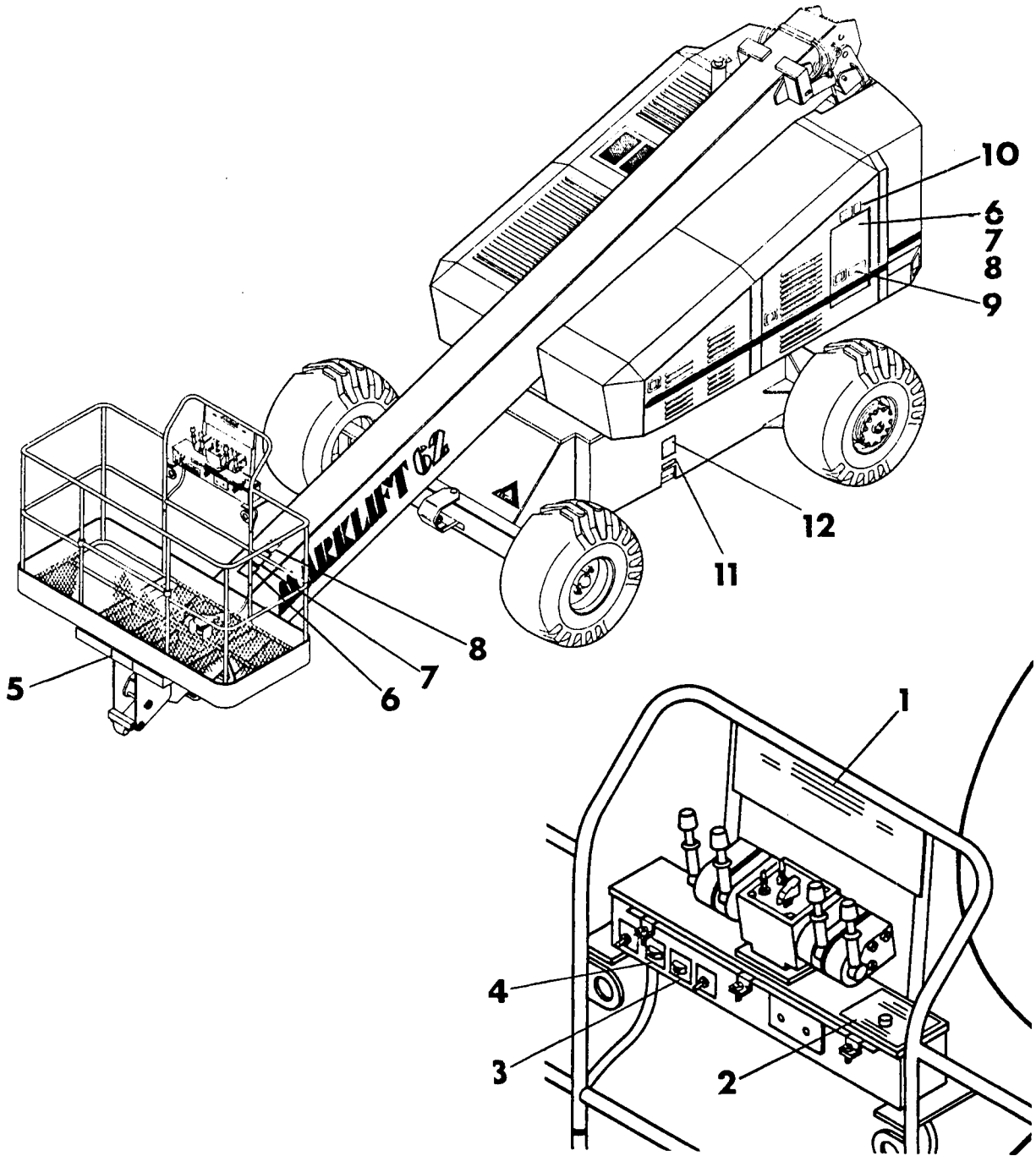
In addition to the above wording, the following statement in small lettering shall be provided on the warning sign: "For Minimum Clearances of High-Voltage Lines In Excess of 50,000 Volts, See Article 86, Title 8, High-Voltage Electrical Safety Orders."

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

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

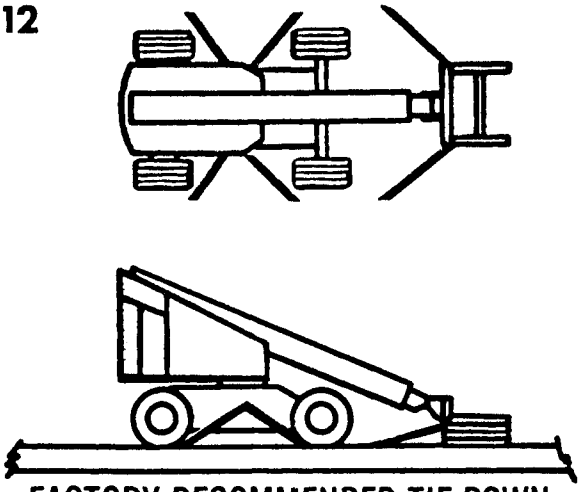
LIGHT INDICATES AN UNSAFE OUT OF LEVEL OPERATING CONDITION

BOOM FUNCTIONS ARE INOPERATIVE WHEN LIGHT IS ON

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

20444

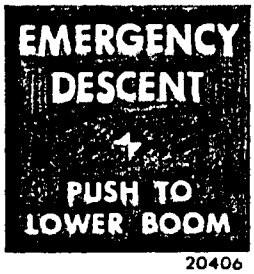
12



FACTORY RECOMMENDED TIE DOWN TRANSPORTING DIAGRAM 20508

4

THROTTLE
HI
LO

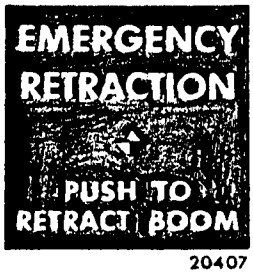


20406

11

TIRE PRESSURE 75 PSI 20420

3



20407

5

LOAD CAPACITY 800 LBS.
(EVENLY DISTRIBUTED LOAD)

20556

6

DANGER

YOU MUST NOT OPERATE THIS DEVICE UNLESS:

1. YOU HAVE BEEN TRAINED IN THE SAFE OPERATION OF THIS DEVICE, AND
2. YOU KNOW AND FOLLOW THE SAFETY AND OPERATING RECOMMENDATIONS CONTAINED IN THE MANUFACTURER'S MANUALS, YOUR EMPLOYER'S WORK RULES AND APPLICABLE GOVERNMENTAL REGULATIONS.

AN UNTRAINED OPERATOR SUBJECTS HIMSELF AND OTHERS TO DEATH OR SERIOUS INJURY. 2953

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

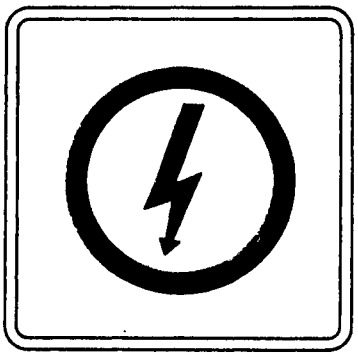
10

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 & BOTTOM REAR OF TURRET

MARKLIFT SELF-PROPELLED BOOM
(MODEL 62)

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 62)

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

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

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 62)

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

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

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

"Extendible and articulating Boom platforms"

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

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

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

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

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

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

(vii) Not applicable

(viii) Not applicable

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

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

(xi) Not applicable

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

GENERAL CHECKOUT AND OPERATING INSTRUCTIONS

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

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

OPERATE THE MARKLIFT IN FOLLOWING MANNER FROM GROUND CONTROL BOX.

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

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

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

The best operation position can be achieved by placing the thumb over the knob of the controller and wrapping the fingers loosely around the locking stem. Now, rest the heel of the hand on the controller housing and apply a downward motion with the thumb, making the index finger lift the locking stem. Once the controller is disengaged and moved foreward or reverse, the pressure on the thumb may be omitted because the locking stem has engaged the cam and cannot drop into the locking position until the lever or handle is returned to the center position.

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

The emergency pump/motor is a new safety feature that will be available Sept. 1980. Although at a reduced speed, all hydraulic functions are operable with the emergency pump runing. 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 26)
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 62)

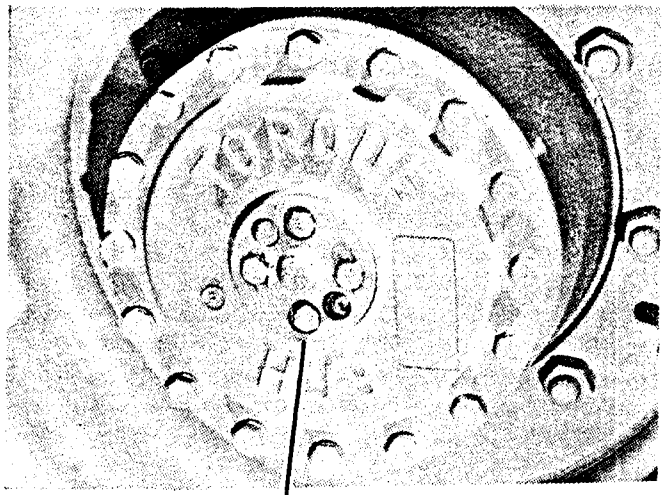
TORQUE HUB MUST BE DISENGAGED FOR TOWING.

MAXIMUM TOWING SPEED IS 10 mph.

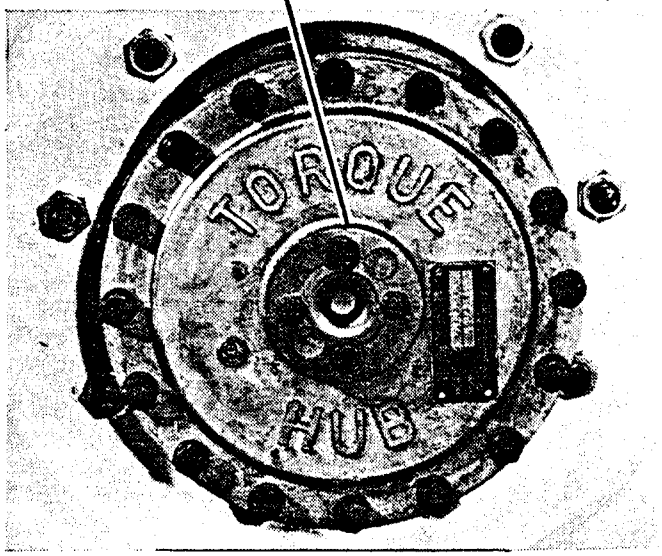
TO DISENGAGE TORQUE HUB, REVERSE THE DISCONNECT CAP. THE KNOB ON THE CAP DISENGAGES THE DRIVE HUB INPUT SHAFT.

CAUTION: BRAKES ARE ALSO DISENGAGED!

HUB ENGAGED



DISCONNECT CAP



HUB DISENGAGED

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

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 75 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 29)
12. Engine RPM should be
    WISC. - 1800 low
    2400 high
    LISTER - 2000 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 turret bolts for torque - 175 ft. lbs. Ring Gear, 85 ft. lbs. (Torque values are with lubrication).
6. Check torque hub oil level. (See page 32)
7. Check air cleaner.
8. Check oil level, rotation gear box.
9. Check retraction cables for proper tension.
   Extension - 27.5 ft. lbs.
   Retraction - 27.5 ft. lbs.

SIX MONTHS, OR 100 HOURS

1. Check and lube, if necessary.
2. Change pilot filter element. (Item 9, page 30)
3. Change engine oil filter.
4. Change hydraulic return line filter element. (Item 10, page 30)

ANNUALLY

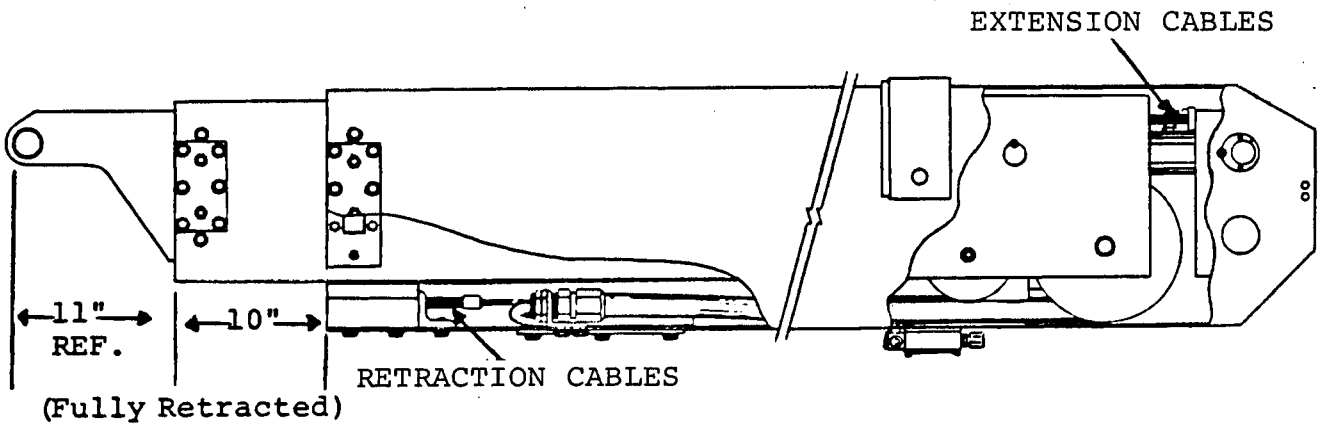
1. Repack all wheel bearings.
2. Change hydraulic oil.
3. Check Torque hub oil level.
4. Check Turret bolts for Torque - 175 ft. lbs.

   Ring Gear, 85 ft. lbs. (Torque values are with lubrication).
5. Change hydraulic return line filter.
6. Change pilot line filter element assembly. (MI part No. 16951)

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

1. Elevate boom approximately 7 feet above ground.
2. Extend boom arm out approximately 3 to 4 feet.
3. It is necessary to have a special cable tensioning wrench P/N 20053, which may be purchased through MARK INDUSTRIES Parts Department.
4. Set torque wrench at 27.5 foot pounds.
5. Apply a few drops of machinery oil or hydraulic oil to the cable stud threads and nuts.
6. Back out on jam nut from torque nut.
7. Tighten until proper torque is established.
8. Run jam nut down against torquing nut.

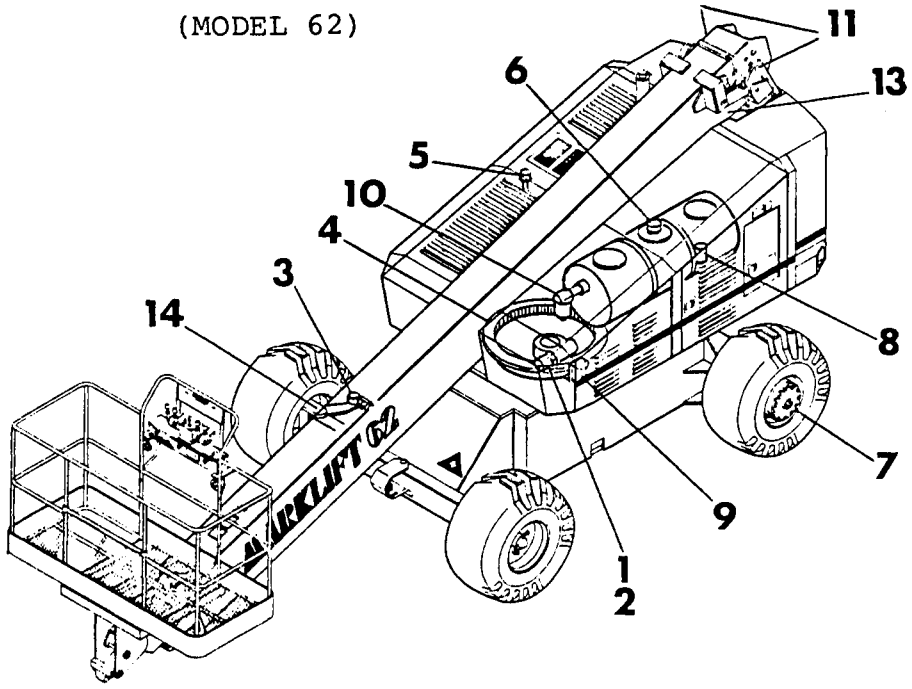


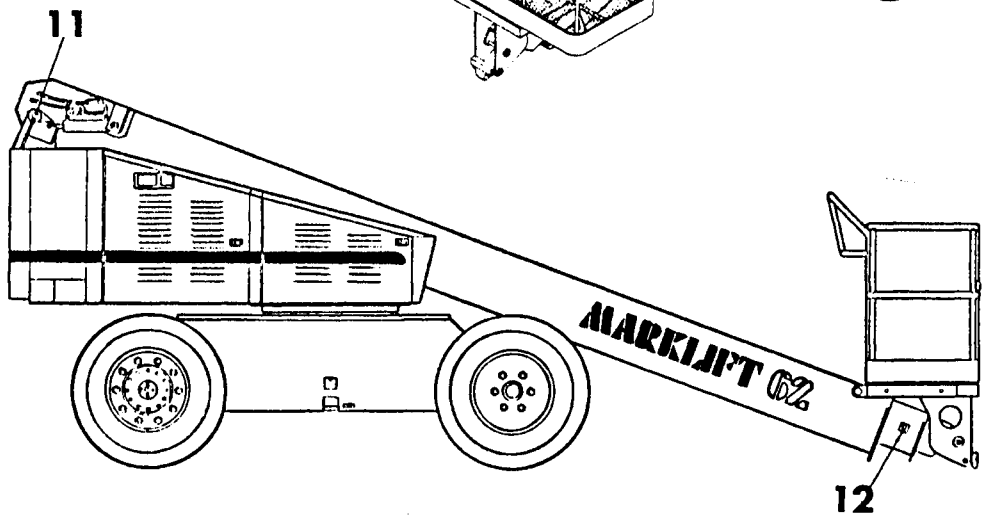
NOTE: It is extremely important that both the extension and retraction sets of cables are torqued evenly.

DO NOT TORQUE ONE SET TO 27.5 FT. LBS. BY ITSELF. THIS WILL TENSION CABLES UNEVENLY. WHEN TENSIONING, ALTERNATE BETWEEN EXTENSION AND RETRACTION CABLES UNTIL 27.5 FT. LBS. IS ACHIEVED.

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)





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 31	YEARLY
7	TORQUE HUB	SEE PAGE 32	YEARLY
8	HYDRAULIC TANK STRAINER		CLEAN YEARLY
9	PILOT FILTER ELEMENT-20472		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	EXTENSION SHEAVES	MOBILCOTE TYPE-S GEAR GREASE	MONTHLY
13	RETRACTION SHEAVES	MOBILCOTE TYPE-S GEAR GREASE	MONTHLY
14	STEERING YOKE KING PINS	MOBILCOTE TYPE-S GEAR GREASE	MONTHLY

* BOOMS BUILT AFTER 7-81 WILL HAVE ZERK FITTINGS ON MAIN BOOM ARM PIVOT PIN.

EQUIVALENT BEARING GREASE

UNION - UNOBA EP-2

SHELL - ALVINIA EP-2

MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

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 62)

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

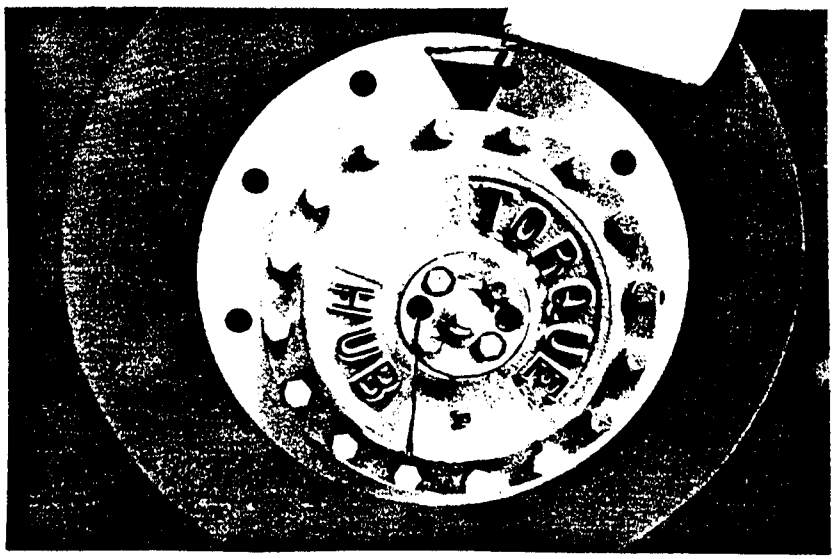
3. OIL CHANGE

   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 62)

ENGINE

1. Will not start or run.

   A. Check ground control box ciruit breaker.
   B. Check for opened fuel shut-off valve.
   C. Check fuel selector to see if it is in L.P. position.
   D. Check for low battery.
   E. Check for fouled spark plugs.
   F. Check for water in gas tank.
   G. Check engine points.
   H. Refer to your local service facility.

2. No high speed.

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

3. No idle.

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

4. Dies under load.

   A. Check governor setting.

   B. Check carburator air/fuel mixture

   C. Rever to your local service facility.

LIFT

1. No functions operate from aerial control console.

   A. Check aerial/ground selector switch.

   B. Check foot switch continuity.

   C. Check for loose wire in aerial junction box.

   D. Check pilot valve pressure.

   E. Refer to your local service facility.

2. No functions operate from ground control box.

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

   B. Check pilot valve pressure.

   C. Refer to your local service facility.

3. Functions too slow or too fast.

   A. Check pilot valve control pressure.

   B. Check flow control valve to solenoid valves.

   C. Refer to your local service facility.

BRAKES

1. No brakes or slow pressure.

   A. Check drive hub disengagement caps.

   B. Check brake delay valve.

   C. Refer to your local service facility.

DRIVE

1. Low torque drive.

   A. Check high pressure.

   B. Check pilot valve control pressure.

   C. Refer to your local service facility.

HYDRAULIC MOTOR

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

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

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

   C. Refer to your local service facility.

HYDRAULIC PUMP

1. Pump producing excessive noise.

   A. Check suction hose from tank to pump for kinks.

   B. Check reservoir hydraulic oil level guage.

   C. Check suction line fittings for tightness.

   D. Check oil. USE ATF DEXRON II ONLY.

   E. Refer to your local service facility.

MARKLIFT SELF-PROPELLED BOOM

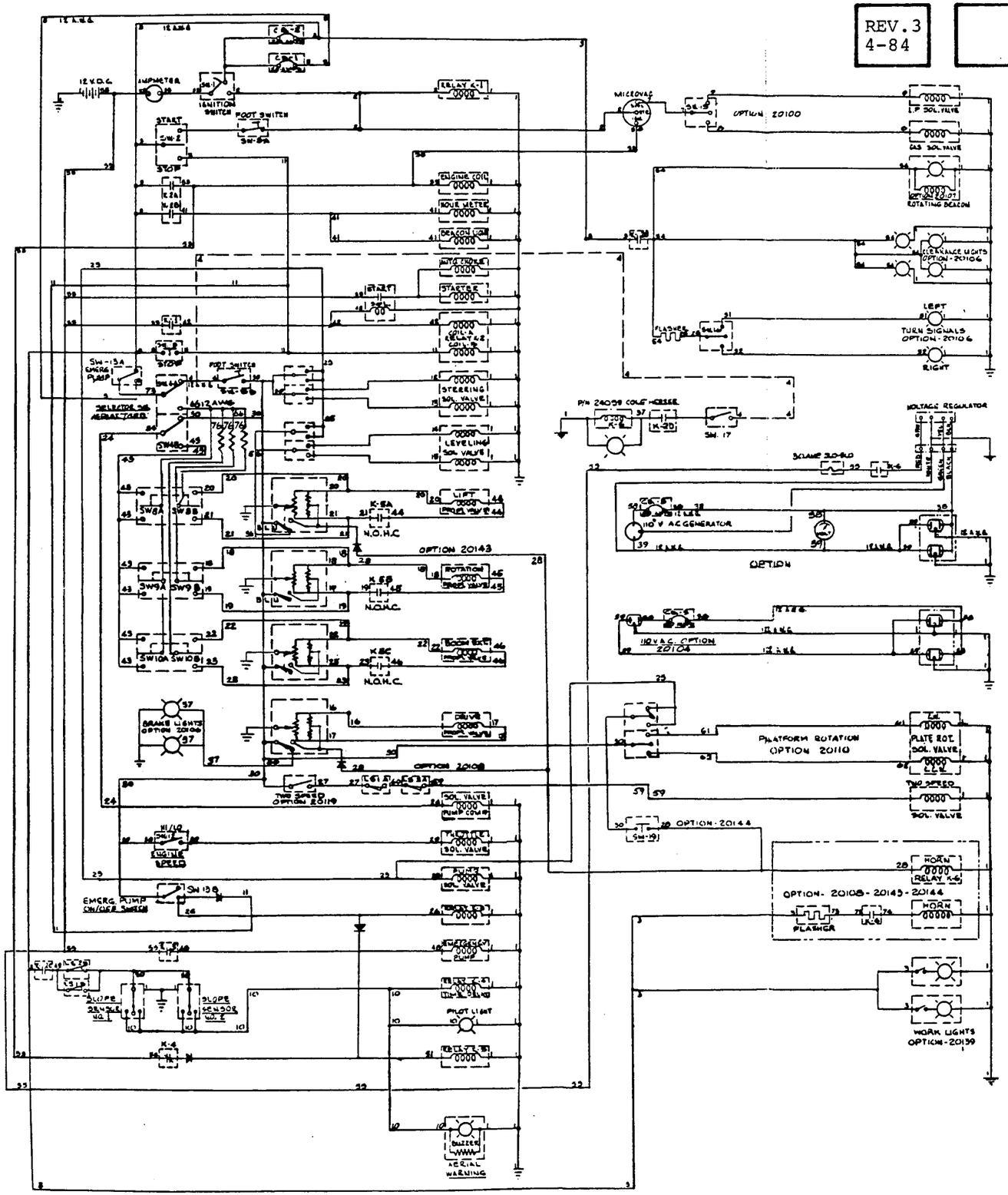
(MODEL 62)

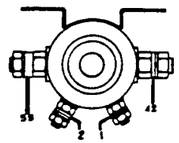
ITEM	PART NO.	DESCRIPTION
1.	20472	Pilot filter element.
2.	21245	Return line filter element.
3.	20030	Steering cylinder seal kit.
4.	20031	Slave leveling cylinder seal kit.
5.	20032	Master leveling cylinder seal kit.
6.	20033	Lift cylinder seal kit.
7.	20034	Boom extension cylinder seal kit.
8.	20035	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 potentiometer assembly.
14.	20581	Aerial controller lever lock.

SERVICE TOOLS

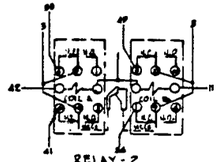
1. Volt/OHM meter.
2. Hydraulic pressure guage (0-3000 PSI)
3. Battery hydrometer.
4. Photo tachometer.
5. Standard mechanics hand tools.
6. Cable tensioning tool MI #20053

ELECTRICAL SCHEMATIC (MODEL 62)

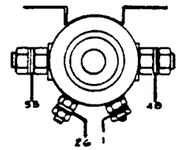




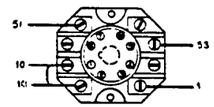
RELAY-1
POWER RELAY
P/N 24059 COLE-HERSEE



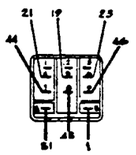
RELAY-2
LATCHING TYPE
P/N KB 170G, POTTER BRUMFIELD



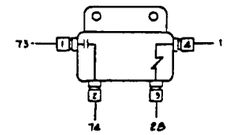
RELAY-3
POWER RELAY
P/N 24059 COLE-HERSEE



RELAY-4
TIME DELAY-2 SECONDS
P/N 1262 AMPERITE

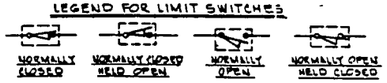


RELAY-5
P/N KUP11D55 POTTER & BRUMFIELD



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

LEGEND FOR LIMIT SWITCHES





LIMIT SWITCH NO 1



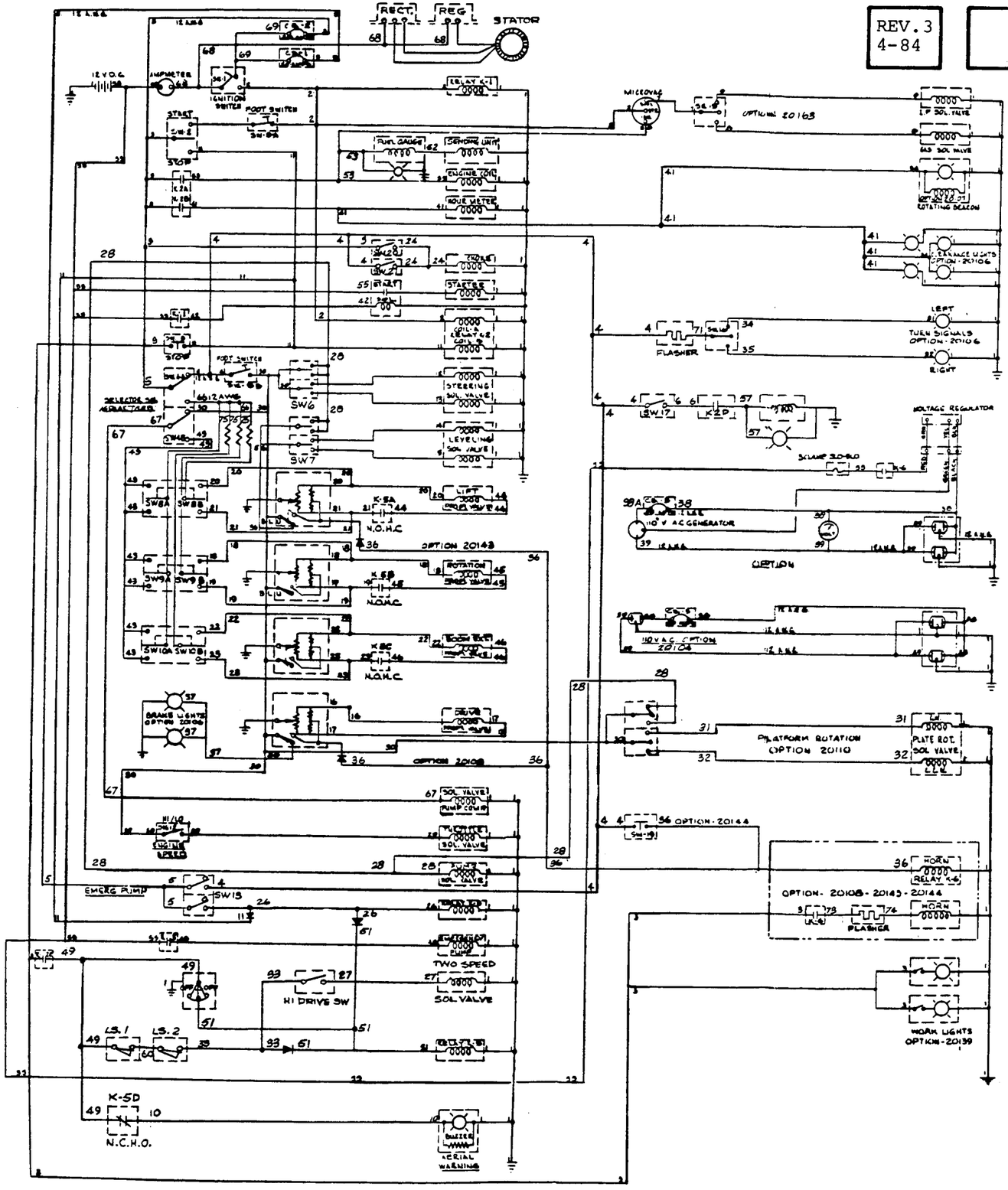
LIMIT SWITCH NO 2

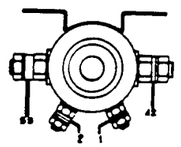
DWG No. 21058

REV. 3
4-84

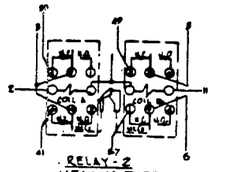
ELECTRICAL SCHEMATIC (MODEL 62) (JUNE 1981)

38.1

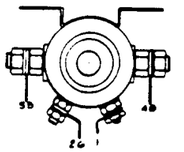




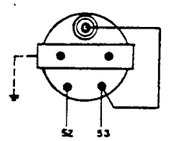
RELAY-1
POWER RELAY
P/N 24059 COLE-HERSEE



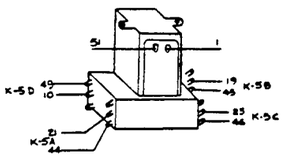
RELAY-2
LATCHING TYPE
P/N KB 11DG, POTTER BRUMFIELD

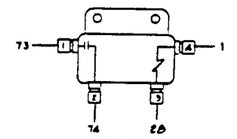


RELAY-3
POWER RELAY
P/N 24059 COLE-HERSEE



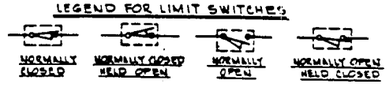
FUEL GAUGE
P/N 82303 STEWART WARNER

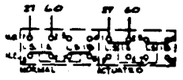




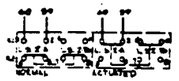
RELAY-4
P/N D-1768 DELCO-REMY

LEGEND FOR LIMIT SWITCHES





LIMIT SWITCH NO 1



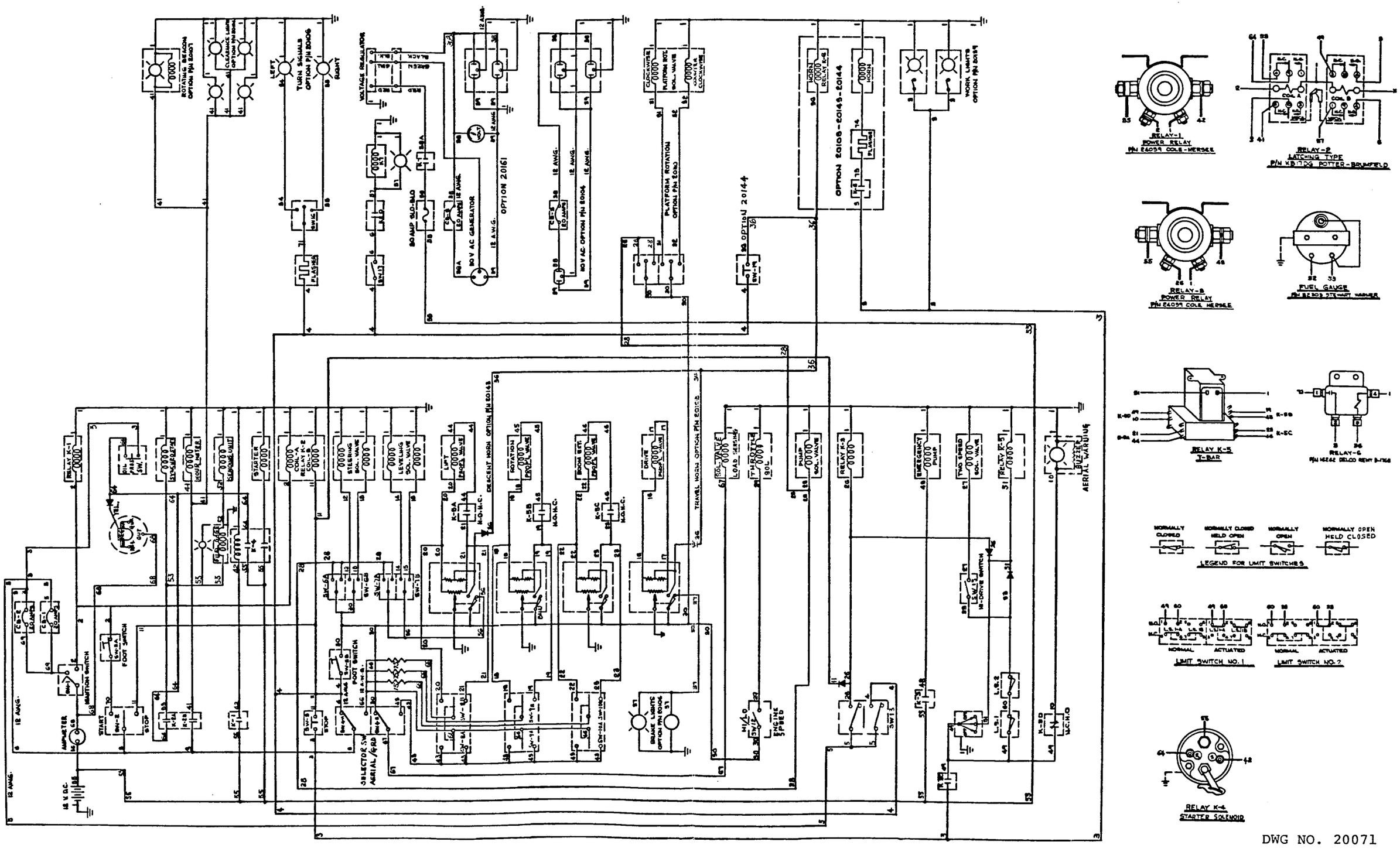
LIMIT SWITCH NO 2

20070

REV.3
4-84

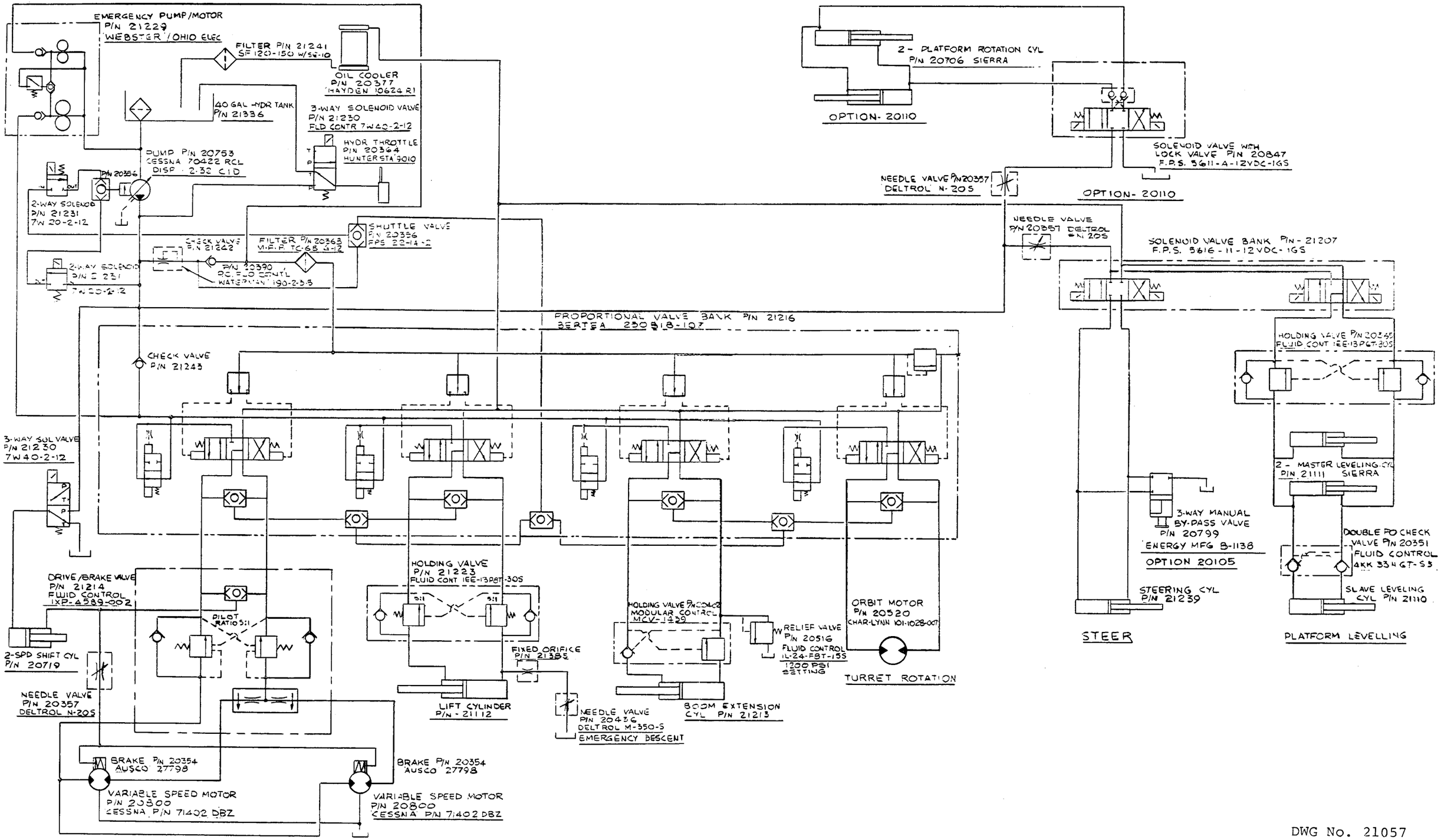
ELECTRICAL SCHEMATIC-DIESEL (MODEL 62)

38.2



DWG NO. 20071

HYDRAULIC SCHEMATIC (MODEL 62)



DWG No. 21057

REV.3
4-84

HYDRAULIC SCHEMATIC (MODEL 62) (SEPT. 1981)

39.1

EMERGENCY PUMP/MOTOR
P/N 21229
'WEBSTER'/OHIO ELEC.

FILTER P/N 21241
SF 120-150 W/SE-10

OIL COOLER
P/N 20377
'HAYDEN' 10624 R1

40 GAL HYDR. TANK
P/N 21336

HYDR. THROTTLE
P/N 20364
HUNTER STA'9010

PUMP P/N 20753
CESSNA' 70422 RCL
DISP'- 2.32 C.I.D

20356

FILTER P/N 20368
M.F.P. TC-68 G-12

PILOT VALVE MANIFOLD
P/N 21448

PROPORTIONAL VALVE BANK P/N 21216
'BERTEA' 250 B 1 B-107

2-PLATFORM ROTATION
CYL. P/N 21706 -'SIERRA'

OPTION- 20110

DOUBL P.O. CHECK VALVE
P/N 20351 - FLUID CONTR.
4KK-33 NGT-S5

SOLENOID VALVE P/N-21787
F P S 5616-16-11-12VDC-16S

OPTION- 20110

SOLENOID VALVE BANK P/N-21207
F.P.S. 5616-11-12VDC-16S

HOLDING VALVE P/N 20365
FLUID CONT. 1EE-13PGT-305

2'- MASTER LEVELING CYL.
P/N 21111 'SIERRA'

3 WAY MANUAL
BY-PASS VALVE
P/N 20799
ENERGY MFG B-1138
OPTION 20105

STEERING CYL
P/N 21239

MANIFOLD
SLAVE LEVELING
CYL. P/N

SLAVE LEVELING
CYL P/N 21110

STEER

PLATFORM LEVELLING

DRIVE/BRAKE VALVE
P/N 21214
FLUID CONTROL
1XP-4599-002

PILOT
RATIO 5:1

2-SPD SHIFT CYL
P/N 20719

NEEDLE VALVE
P/N 20357
DELTROL N-205

HOLDING VALVE
P/N 21223
FLUID CONT 1EE-13PGT-305

FIXED ORIFICE
P/N 21333

LIFT CYLINDER
P/N - 21112

HOLDING VALVE P/N 20432
MODULAR CONTROL
M-CV-16-S5

RELIEF VALVE
P/N 20516
FLUID CONTROL
IL-24-FB1-153
1200 PSI
SETTING

NEEDLE VALVE
P/N 20436
DELTROL M-350-S
EMERGENCY DESCENT

BOOM EXTENSION
CYL. P/N 21213

ORBIT MOTOR
P/N 20520
CHAR-LYNN 101-1028-007

TURRET ROTATION

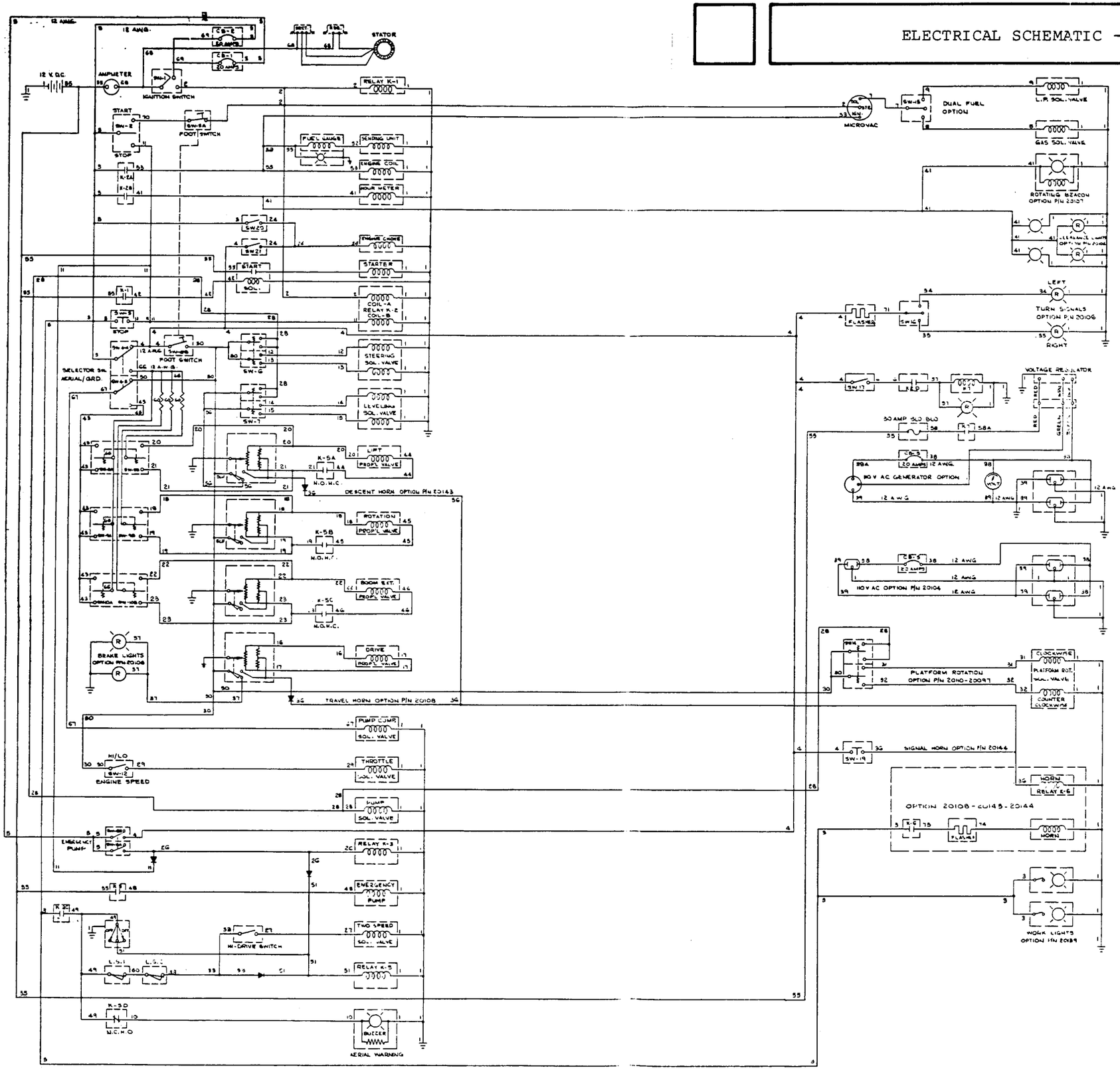
BRAKE P/N 20354
'AUSCO' 27798

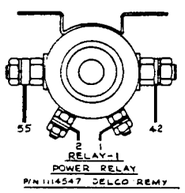
VARIABLE SPEED MOTOR
P/N 20800
'CESSNA' P/N 71402 DBZ

BRAKE P/N 20354
'AUSCO' 27798

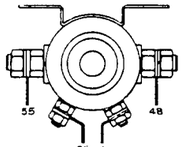
VARIABLE SPEED MOTOR
P/N 20800
'CESSNA' P/N 71402 DBZ

DWG NO. 21057

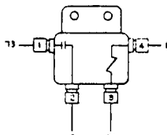




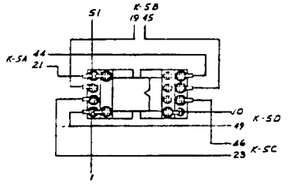
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POWER RELAY
P/N 1114547 DELCO REMY



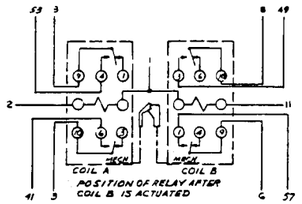
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POWER RELAY
P/N 1114547 DELCO REMY



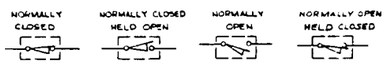
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P/N 1162B2 DELCO REMY D 1768



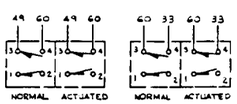
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BASE RELAY IDEC P/N SY4S-05
RELAY SQUARE "D" P/N BSCI RSD14B



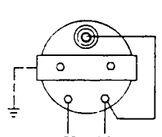
RELAY-2
LATCHING TYPE
P/N KBIIDG POTTER-BRUMFIELD



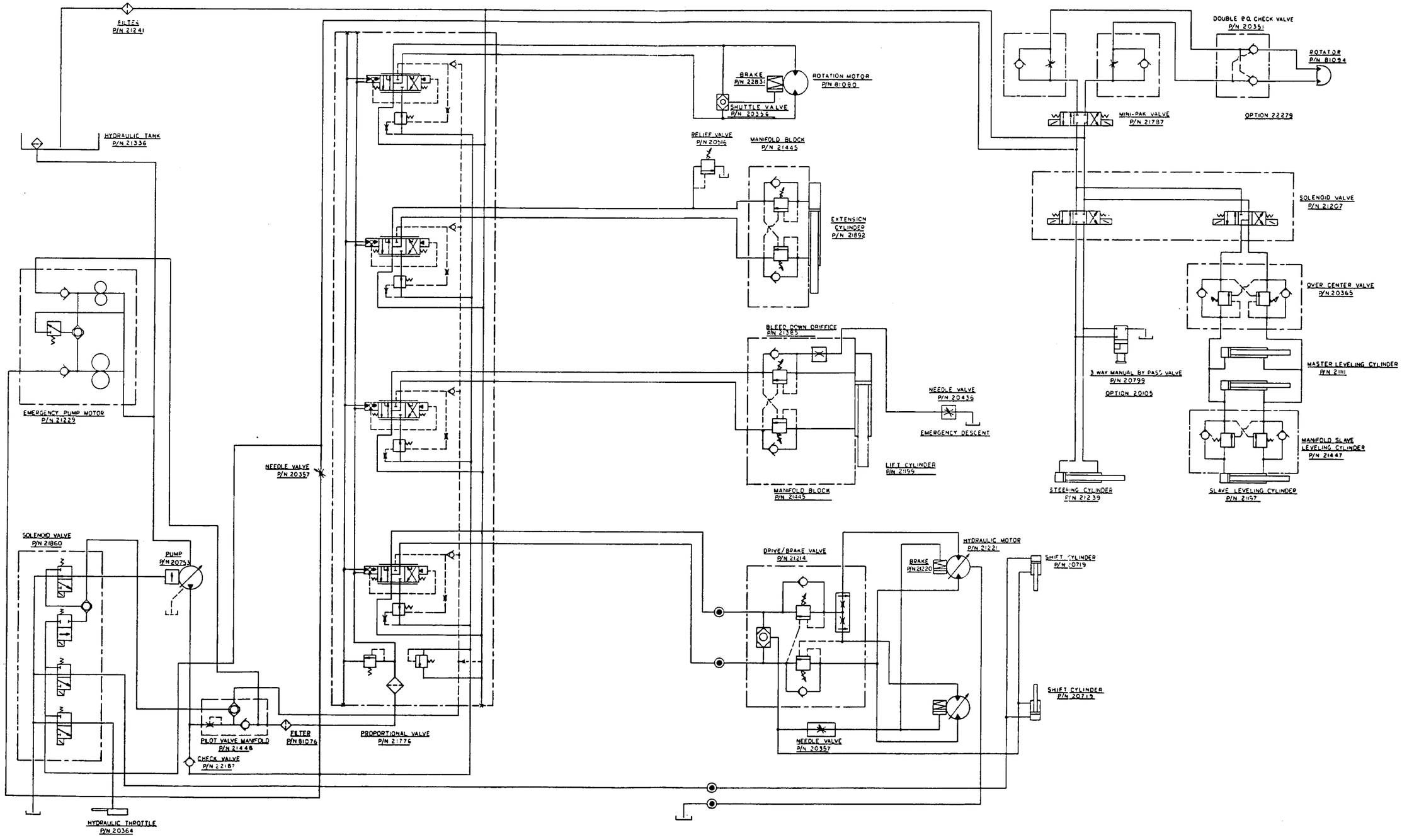
LEGEND FOR LIMIT SWITCHES



LIMIT SWITCH NO.1 LIMIT SWITCH NO.2



FUEL GAUGE
P/N BE303 STEWART WARNER


FILTER
P/N 21241
HYDRAULIC TANK
P/N 21336
EMERGENCY PUMP MOTOR
P/N 21229
SOLENOID VALVE
P/N 21860
PUMP
P/N 20753
HYDRAULIC THROTTLE
P/N 20364
NEEDLE VALVE
P/N 20357
PILOT VALVE MANIFOLD
P/N 21446
CHECK VALVE
P/N 22187
FILTER
P/N 81076
PROPORTIONAL VALVE
P/N 21776
BRAKE
P/N 22831
ROTATION MOTOR
P/N 81080
SHUTTLE VALVE
P/N 20356
RELIEF VALVE
P/N 20516
MANIFOLD BLOCK
P/N 21445
EXTENSION CYLINDER
P/N 21892
BLEED DOWN ORIFFICE
P/N 21385
MANIFOLD BLOCK
P/N 21445
NEEDLE VALVE
P/N 20436
EMERGENCY DESCENT
LIFT CYLINDER
P/N 21195
DRIVE/BRAKE VALVE
P/N 21214
NEEDLE VALVE
P/N 20357
BRAKE
P/N 21220
HYDRAULIC MOTOR
P/N 21221
SHIFT CYLINDER
P/N 10719
SHIFT CYLINDER
P/N 20719
DOUBLE P.O. CHECK VALVE
P/N 20351
ROTATOR
P/N 81054
OPTION 22279
MINI-PAK VALVE
P/N 21787
SOLENOID VALVE
P/N 21207
OVER CENTER VALVE
P/N 20365
3 WAY MANUAL BY PASS VALVE
P/N 20799
OPTION 20105
STEERING CYLINDER
P/N 21239
MASTER LEVELING CYLINDER
P/N 21111
MANIFOLD SLAVE LEVELING CYLINDER
P/N 21447
SLAVE LEVELING CYLINDER
P/N 21157

HYDRAULIC HOSE DIAGRAM - 21938 (6/86)

ITEM	QTY	PART NO.	DESCRIPTION
A1	2	13213-04-0230	HOSE ASSEMBLY
A2	2	13213-04-0340	HOSE ASSEMBLY
A3	2	13213-06-0270	HOSE ASSEMBLY
A4	1	13220-12-0204	HOSE ASSEMBLY
A5	2	13223-12-0240	HOSE ASSEMBLY
A6	1	13223-12-0260	HOSE ASSEMBLY
A7	2	13210-04-0600	HOSE ASSEMBLY
A8	1	13210-04-0600	HOSE ASSEMBLY
A9	1	13220-12-0540	HOSE ASSEMBLY
A10	1	13220-12-0560	HOSE ASSEMBLY
A11	1	13210-06-0650	HOSE ASSEMBLY
A12	2	13213-04-0210	HOSE ASSEMBLY

KIT A

B1	1	13210-04-1050	HOSE ASSEMBLY
B2	1	13210-08-0970	HOSE ASSEMBLY
B3	1	13212-08-1260	HOSE ASSEMBLY
B4	1	13213-08-1190	HOSE ASSEMBLY
B5	1	13210-04-0600	HOSE ASSEMBLY
B6	2	13213-04-0170	HOSE ASSEMBLY
B7	1	13213-06-0280	HOSE ASSEMBLY
B8	1	13213-08-0980	HOSE ASSEMBLY
B9	1	13205-16-0220	HOSE ASSEMBLY
B10	1	13213-12-0270	HOSE ASSEMBLY
B11			
B12	1	13213-06-1310	HOSE ASSEMBLY
B13	1	13212-12-0280	HOSE ASSEMBLY
B14	1	13213-04-0180	HOSE ASSEMBLY
B15	1	13213-06-0144	HOSE ASSEMBLY
B16	1	13213-04-0190	HOSE ASSEMBLY
B17	2	13213-04-0200	HOSE ASSEMBLY
B18	1	13213-06-0290	HOSE ASSEMBLY
B19	1	13213-12-0150	HOSE ASSEMBLY
B20	1	13213-12-0230	HOSE ASSEMBLY
B21	1	13212-08-0750	HOSE ASSEMBLY
B22	1	13213-08-0740	HOSE ASSEMBLY
B23	1	13213-08-0234	HOSE ASSEMBLY
B24	1	13212-08-0264	HOSE ASSEMBLY
B25	1	13213-06-0290	HOSE ASSEMBLY
B26	1	13210-04-0990	HOSE ASSEMBLY
B27	1	13210-04-1010	HOSE ASSEMBLY
B28	4	13213-04-0150	HOSE ASSEMBLY
B29	1	13210-04-0750	HOSE ASSEMBLY
B30	2	13213-06-0070	HOSE ASSEMBLY

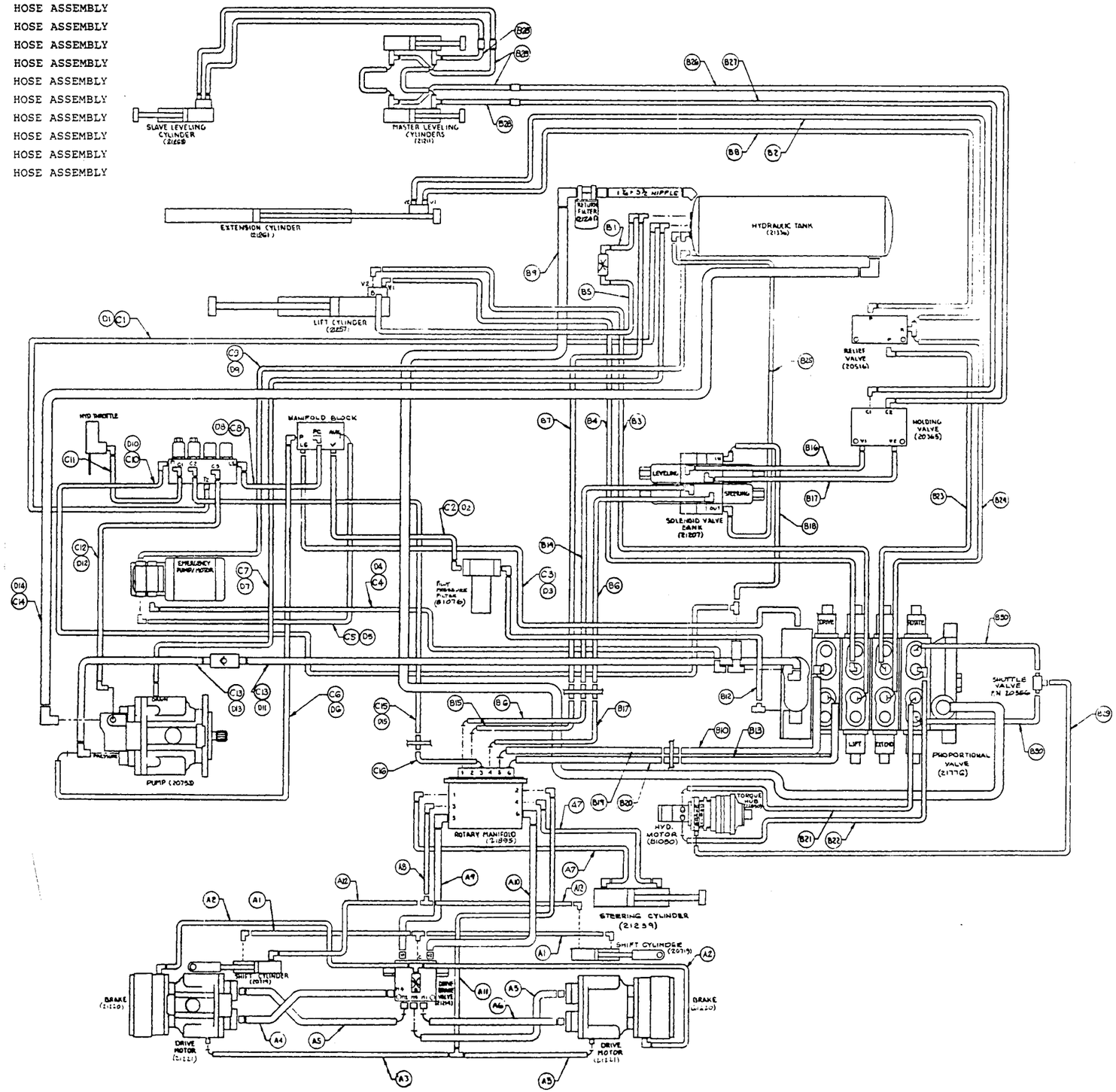
KIT B

C1	1	13210-06-1230	HOSE ASSEMBLY
C2	1	13210-06-0550	HOSE ASSEMBLY
C3	1	13210-04-1110	HOSE ASSEMBLY
C4	1	13210-06-1110	HOSE ASSEMBLY
C5	1	13213-06-0190	HOSE ASSEMBLY
C6	1	13213-06-0380	HOSE ASSEMBLY
C7	1	13210-06-0900	HOSE ASSEMBLY
C8	1	13210-04-0140	HOSE ASSEMBLY
C9	1	13203-12-0710	HOSE ASSEMBLY
C10	1	13213-06-1320	HOSE ASSEMBLY
C11	1	13210-04-1050	HOSE ASSEMBLY
C12	1	13211-04-0160	HOSE ASSEMBLY
C13	2	13210-16-0560	HOSE ASSEMBLY
C14	1	13205-20-0400	HOSE ASSEMBLY
C15	1	13213-04-1200	HOSE ASSEMBLY
C16	1	13213-04-0160	HOSE ASSEMBLY

KIT C

D1	1	13210-06-0690	HOSE ASSEMBLY
D2	1	13210-06-1030	HOSE ASSEMBLY
D3	1	13210-04-0870	HOSE ASSEMBLY
D4	1	13213-06-0900	HOSE ASSEMBLY
D5		13213-06-0160	HOSE ASSEMBLY
D6	1	13213-06-0870	HOSE ASSEMBLY
D7	1	13210-06-0710	HOSE ASSEMBLY
D8	1	13213-04-0160	HOSE ASSEMBLY
D9	1	13203-12-0710	HOSE ASSEMBLY
D10	1	13210-06-0230	HOSE ASSEMBLY
D11	1	13210-16-0260	HOSE ASSEMBLY
D12	1	13210-04-0170	HOSE ASSEMBLY
D13	1	13210-16-0410	HOSE ASSEMBLY
D14	1	13203-20-0760	HOSE ASSEMBLY
D15	1	13213-04-0620	HOSE ASSEMBLY

KIT D



MARKLIFT SELF-PROPELLED BOOM

(MODEL 62)

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NOTE: ALL PART NUMBERS LISTED IN THE FOLLOWING "PART NUMBER" COLUMNS ARE MARK INDUSTRIES NUMBERS.

REV.3
4-84

FIGURE 1--FINAL ASSEMBLY

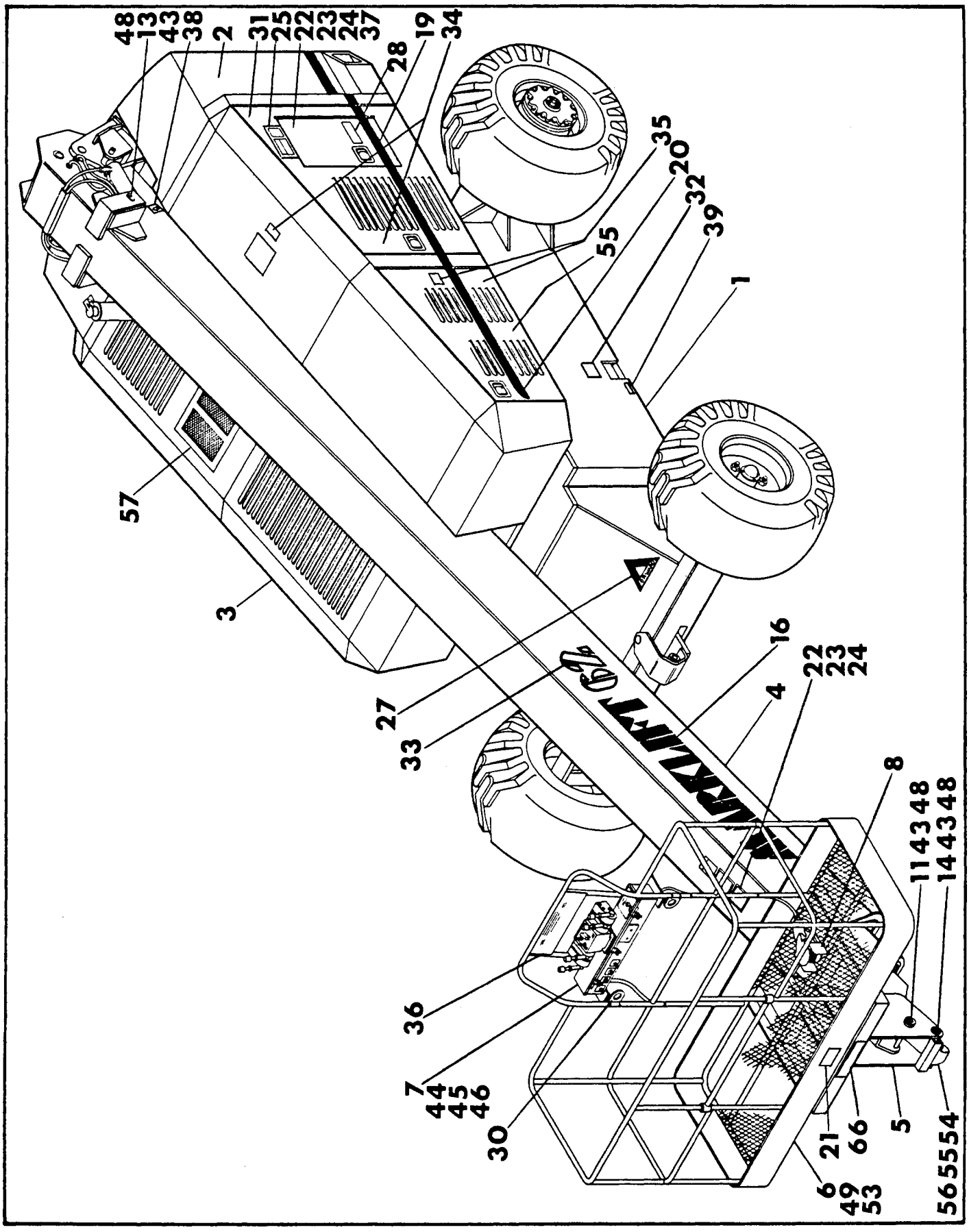


FIGURE 1--FINAL ASSEMBLY

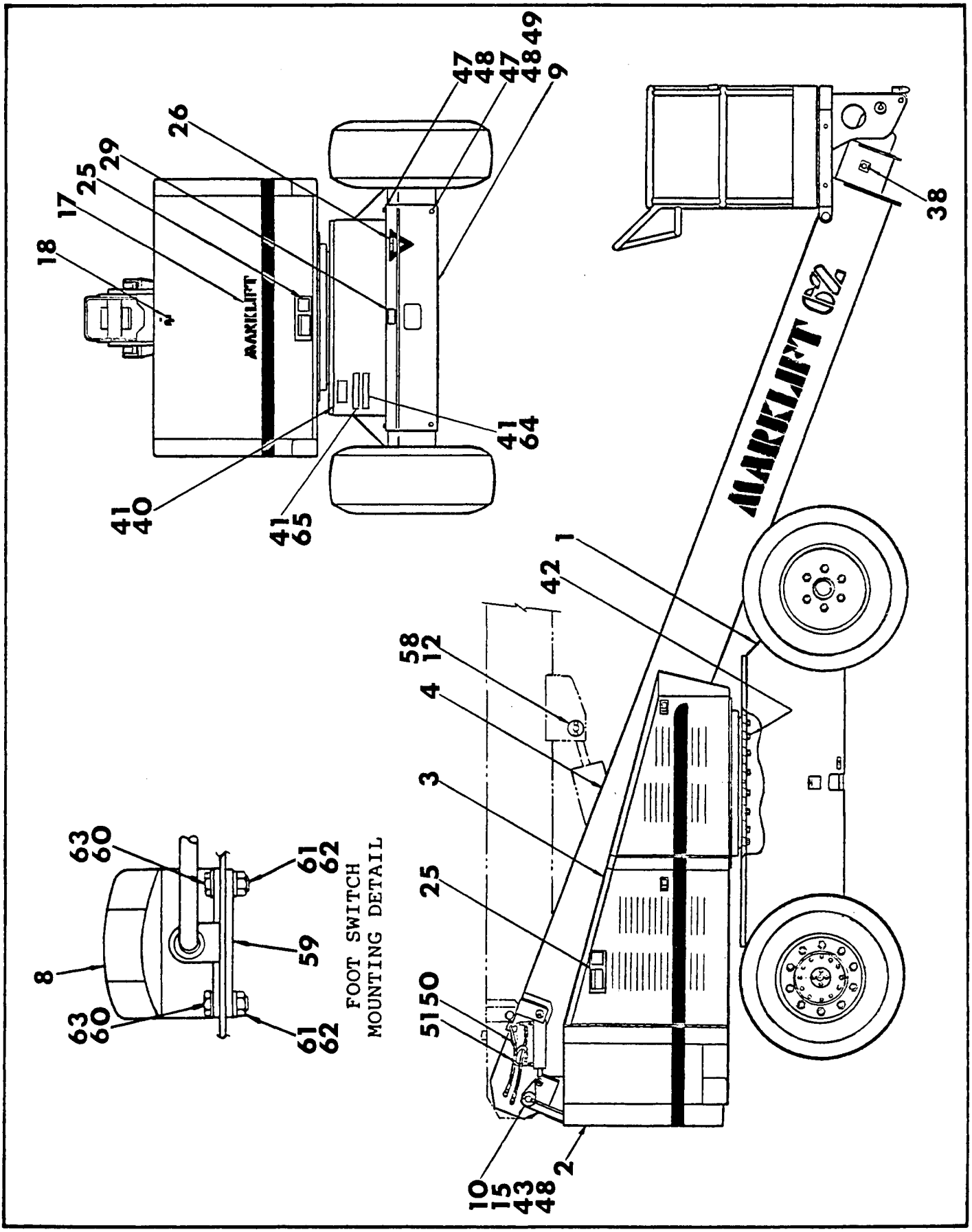
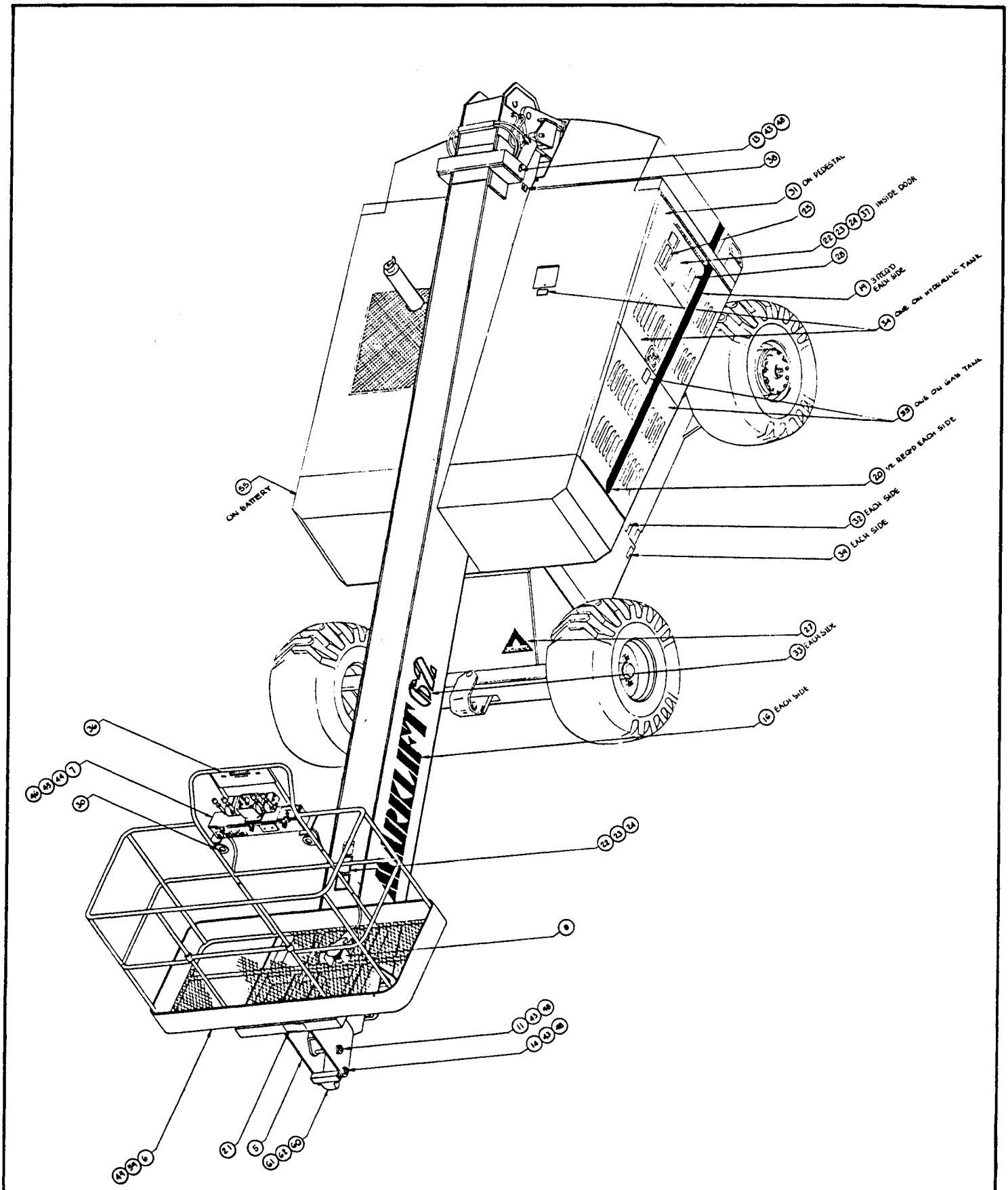


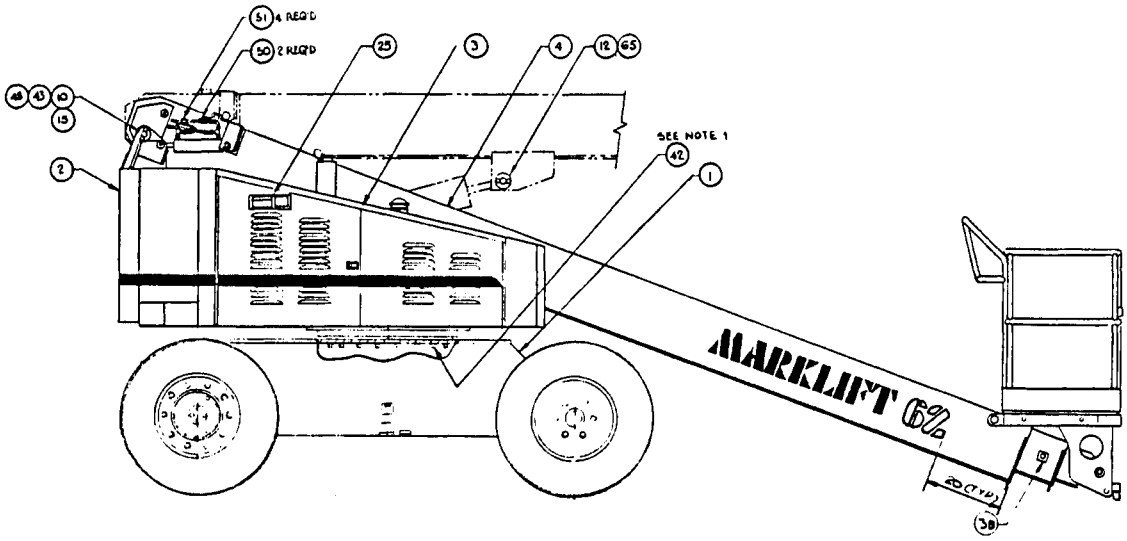
FIGURE 1--FINAL ASSEMBLY

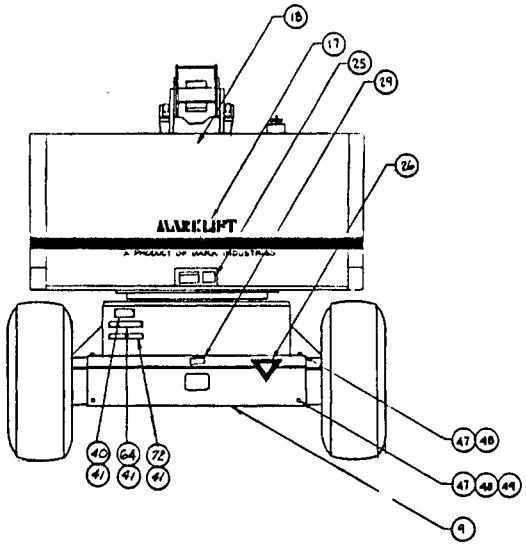
ITEM	PART NUMBER	DESCRIPTION	QTY
1-	20007	FINAL ASSEMBLY	1
-1	21497	CARRIAGE ASSEMBLY (SEE FIG. 2)	1
-2	21051	TURRET ASSEMBLY (SEE FIG.9)	1
-3	21224	SHEET METAL COVER KIT (SEE FIG. 24)	1
-4	21052 OR 22700	FINAL BOOM ASSEMBLY (SEE FIG. 26 OR 26.1)	1
-5	20535	FORK WELDMENT	1
-6	20538	PLATFORM WELDMENT	1
-7	21090	AERIAL CONTROL BOX ASSEMBLY (SEE FIG. 25)	1
-8	20480	FOOT SWITCH ASSEMBLY (SEE FIG. 32)	1
-9	21341	DRIVE COVER	1
-10	21785	BOOM TO TURRET PIN	1
-11	20457	BOOM TO FORK PIN	1
-12	21331	LIFT CYLINDER TO BOOM PIN	1
-13	21334	LEVELING CYLINDER TO BOOM PIN	2
-14	20261	SLAVE CYLINDER TO FORK PIN	1
-15	21333	BOOM TO TURRET PIN SPACER	1
-16	21236	MARKLIFT BOOM DECAL	2
-17	20409	MARKLIFT PEDESTAL DECAL	1
-18	20410	MARK INDUSTRIES LOGO DECAL	1
-19	20411	SQUARE END STRIPE DECAL (2 REQ'D EACH SIDE)	6
-20	20412	ROUND END STRIPE DECAL	1
-21	20556	LOAD CAPACITY 800 LBS DECAL	1
-22	20416	CAUTION DECAL	2
-23	20417	DANGER DO NOT OPERATE DECAL	2
-24	20418	DANGER--ELECTRICAL HAZARD DECAL (1 EACH OF ITEMS 22, 23 & 24 ARE LOCATED IN-SIDE GROUND CONTROL BOX ACCESS DOOR)	2
-25	20419	DANGER--KEEP CLEAR DECAL	3
-26	20461	AHEAD FORWARD ARROW DECAL	1
-27	20462	AFT FORWARD ARROW DECAL	1
-28	20495	EMERGENCY GROUND CONTROLS DECAL	1
-29	20896	BRAKE DECAL	1
-30	22386	ATTACH SAFETY BELT DECAL	2
-31	21235	EMERGENCY BOOM DESCENT DECAL (INSIDE ON PEDESTAL)	1

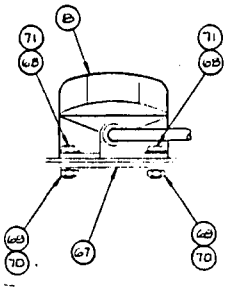
ITEM	PART NUMBER	DESCRIPTION	QTY
-32	20508	TRANSPORTATION DECAL	2
-33	21227	62 DECAL	2
-34	2017	HYDRAULIC DECAL (INSIDE ON UPPER TANK)	2
-35	2020	GAS DECAL (INSIDE ON LOWER TANK)	2
-36	20859	AERIAL OPERATING INSTRUCTIONS DECAL	1
-37	20860	GROUND OPERATING INSTRUCTIONS DECAL (INSIDE GROUND CONTROL BOX ACCESS DOOR)	1
-38	21237	GREASE FITTING DECAL	3
-39	20420	TIRE PRESSURE 75 PSI DECAL	2
-40	20660	I.D. PLATE	1
-41	63653	POP RIVET - 1/8 X 1/4	12
-42	60609	HEX HEAD CAP SCREW - 1/2-13UNC X 2 (BOWMALOK 41028)	22
-43	60607	HEX HEAD CAP SCREW - 3/8-16UNC X 3/4 (BOWMALOK 41012)	6
-44	60309	HEX HEAD CAP SCREW - 1/4-20UNC X 3/4	2
-45	60701	HEX NUT - 1/4-20UNC	2
-46	63301	SPLIT LOCK WASHER - 1/4	2
-47	60325	HEX HEAD CAP SCREW - 3/8-16UNC X 3/4	6
-48	63303	SPLIT LOCK WASHER - 3/8	12
-49	61302	SELF-LOCKING HEX NUT - 3/8-16UNC	6
-50	2617	HYDRAULIC HOSE - FC-120-03 X 30	2
-51	2594	90° REUSABLE SWIVEL HOSE FITTING	4
-52	2003	BATTERY WATER LEVEL DECAL	1
-53	60515	HEX HEAD CAP SCREW - 3/8-16UNC X 3 (BOWMALLOY 36062)	4
-54	60307	HEX HEAD CAP SCREW - 3/8-16UNC X 1 1/2	2
-55	61318	LOCK NUT - 3/8-16UNC	2
-56	20552	PLATFORM BUMPER	1
-57	21680	METAL SCREEN (GAS MODEL)	1
-58	61813	FLAT SOCKET HEAD CAP SCREW - 3/8-16UNC X 3/4	2
-59	20663	DEADMAN SWITCH BACKING PLATE	1
-60	60346	HEX HEAD CAP SCREW - 5/16-18UNC X 1 1/4	2

ITEM	PART NUMBER	DESCRIPTION	QTY
-61	60702	HEX NUT - 5/16-18UNC	2
-62	63302	SPLIT LOCK WASHER - 5/16	2
-63	63402	FLAT WASHER - 5/16	2
-64	20661	ANSI A92 PLATE	1
-65	20662	PATENT NUMBERS PLATE	1
-66	22385	"CAUTION - ATTACH YOUR SAFETY BELT FIRST" DECAL	1
	20070	ELECTRICAL SCHEMATIC	
	21057	HYDRAULIC SCHEMATIC	
	21938	HYDRAULIC HOSE DIAGRAM	


ON PEDESTAL
INSIDE DOOR
3 REQD EACH SIDE
ONE ON HYDRAULIC TANK
ONE ON GAS TANK
2 REQD EACH SIDE
EACH SIDE
EACH SIDE
EACH SIDE
ON BATTERY
SKYLIFT 62







DETAIL MOUNTING FOOT SWITCH

ITEM	QTY	PART NO.	DESCRIPTION
1	1	21497	ASSY., CARRIAGE
2	1	21940	ASSY., TURRET
3	1	22618	SHEET METAL KIT
4	1	23062	ASSY., FINAL BOOM
5	1	20535	WELDMENT, FORK
6	1	20538	WELDMENT, PLATFORM
7	1	21090	ASSY., AERIAL CONTROL CONSOLE
8	1	20480	ASSY., FOOT SWITCH
9	1	21341	COVER, DRIVE
10	1	23198	PIN
11	1	20457	PIN
12	1	23511	PIN
13	2	21334	PIN
14	1	20261	PIN
15	1	26460	TUBE, ROUND
16	2	21236	DECAL
17	1	20409	DECAL
18	1	20410	DECAL
19	6	20411	DECAL
20	1	20412	DECAL
21	1	20556	DECAL
22	2	20416	DECAL
23	2	20417	DECAL
24	2	20418	DECAL
25	3	20419	DECAL
26	1	20461	DECAL
27	1	20462	DECAL
28	1	20495	DECAL
29	1	20896	DECAL
30	2	22386	DECAL
31	1	21235	DECAL
32	2	20508	DECAL
33	2	21227	DECAL
34	2	2017	DECAL
35	2	2020	DECAL

ITEM	QTY	PART NO.	DESCRIPTION
36	1	20859	DECAL
37	1	20860	DECAL
38	3	21237	DECAL
39	2	20420	DECAL
40	1	20660	PLATE, I.D.
41	12	63653	RIVET, POP
42	22	60609	SCREW, CAP
43	6	60607	SCREW, CAP
44	2	60309	SCREW, CAP
45	2	60701	NUT, HEX
46	2	63301	WASHER, LOCK
47	6	60325	SCREW, CAP
48	12	63303	WASHER, LOCK
49	6	61302	NUT, HEX
50	2	2617	HOSE, HYDRAULIC
51	4	2594	FITTING SWIVEL HOSE 90° REUSABLE
52	10 GAL.	16608	PAINT
53	1 GAL.	65112	PAINT
54	5 GAL.	65114	GASOLINE
55	1	2003	DECAL
56	1	21938	DIAGRAM, HYD. HOSE
57	1	20070	SCHEMATIC, ELECT.
58	1	21057	SCHEMATIC, HYD.
59	4	60515	SCREW, CAP
60	2	60307	SCREW, CAP
61	2	61318	NUT, LOCK
62	1	20552	BUMPER, PLATFORM
63	45 GAL.	65116	OIL, HYDRAULIC
64	1	20662	PLATE PATENT NOS.
65	2	61813	SCREW, CAP
66	1 GAL.	16609	PAINT

ITEM	QTY	PART NO.	DESCRIPTION
67	1	22742	SWITCH, DEADMAN BACKING PLATE
68	2	60346	SCREW, CAP
69	2	60702	NUT
70	2	63302	WASHER, LOCK
71	2	63402	WASHER, FLAT
72	1	20661	PLATE, ANSI A92
		20070	ELECTRICAL SCHEMATIC
		21057	HYDRAULIC SCHEMATIC
		21938	HYDRAULIC HOSE DIAGRAM

FIGURE 2--CARRIAGE ASSEMBLY

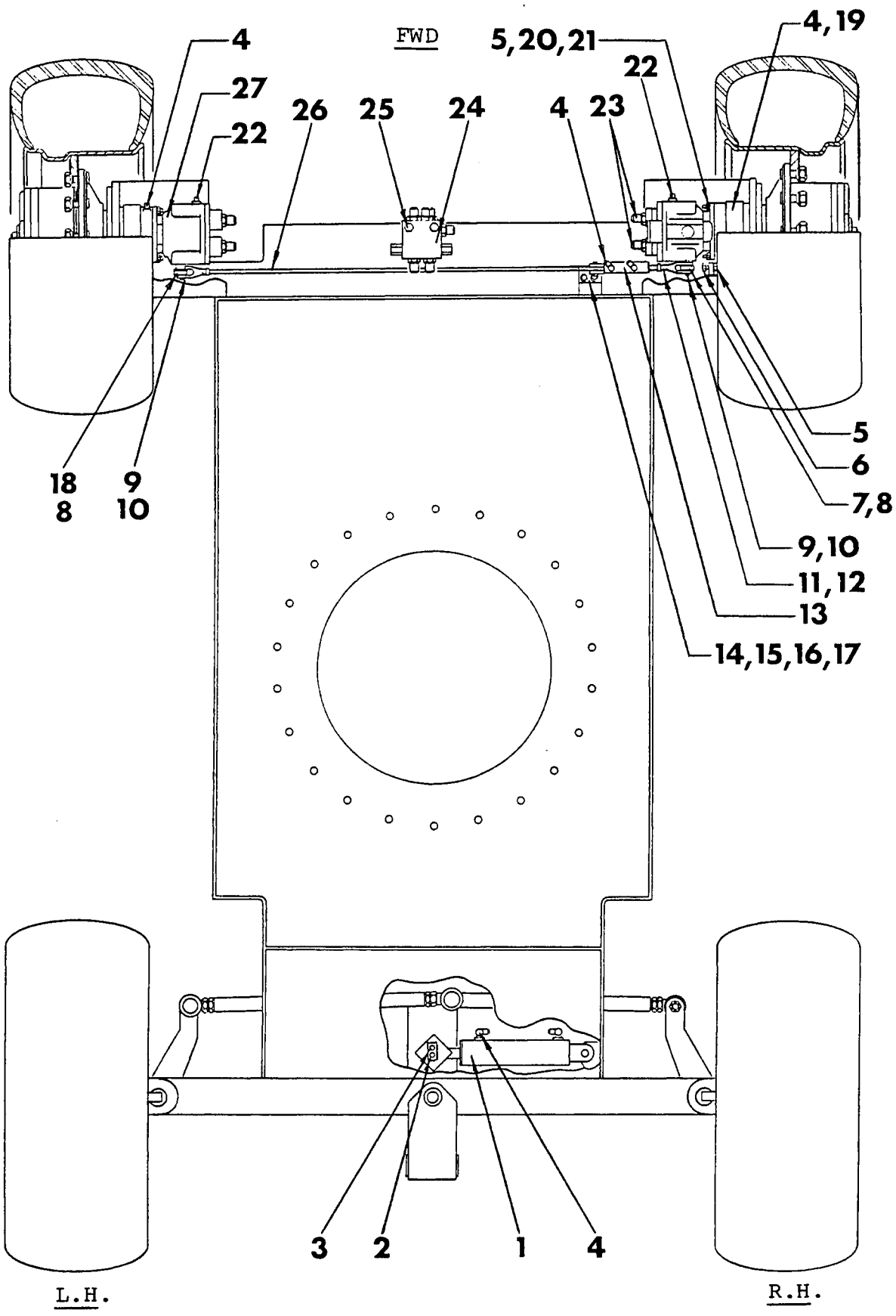


FIGURE 2--CARRIAGE ASSEMBLY

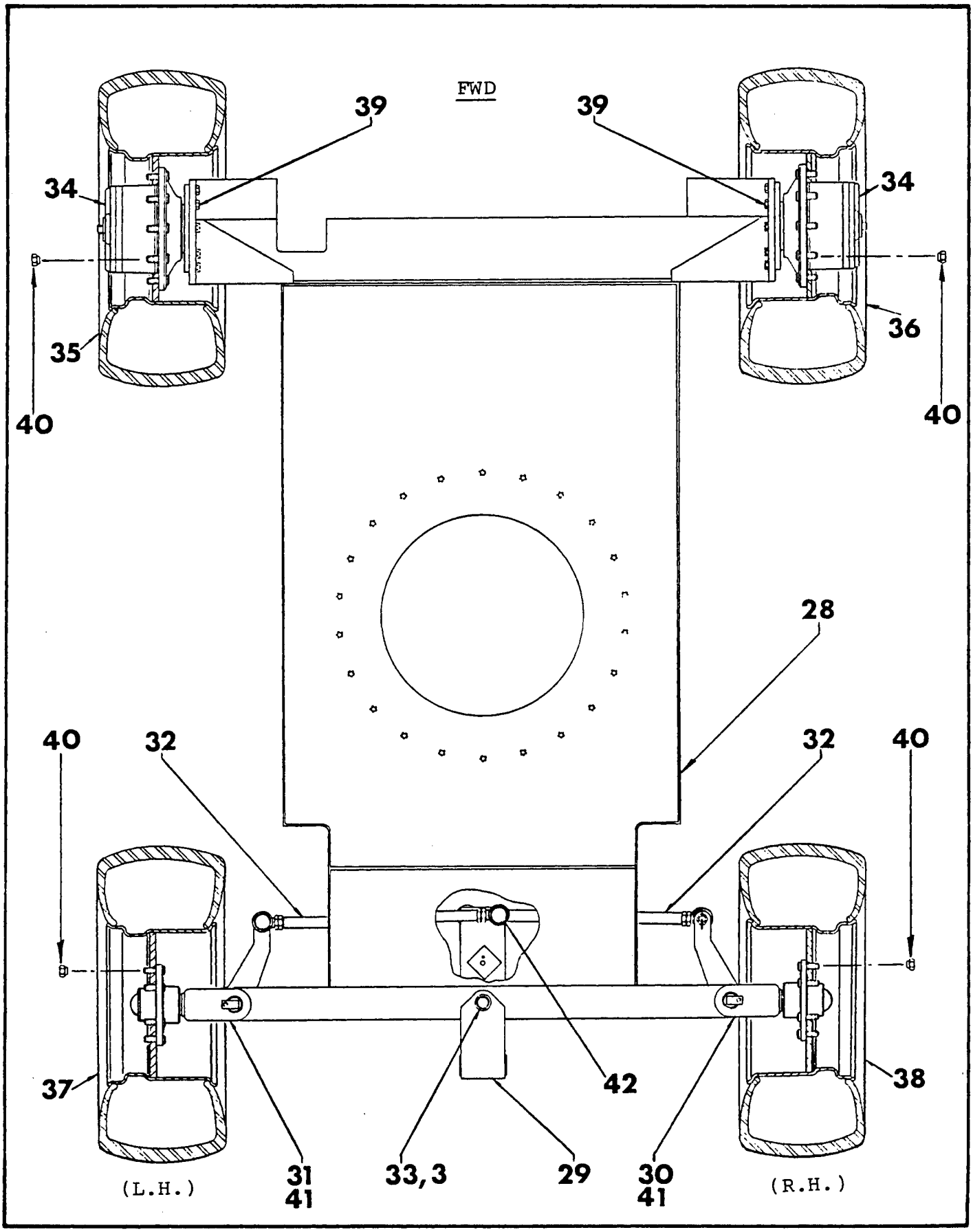


FIGURE 2--CARRIAGE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
2-	21050	CARRIAGE ASSEMBLY	1
-1	21239	STEERING CYLINDER (SEE FIG. 6)	1
-2	21298	PIN	1
-3	60603	CAPSCREW 5/16-18UNC X 3/4 LG (BOWMALOK 41006)	3
-4	80012-03	STRAIGHT THREAD ELBOW (2532 old no.)	6
-5	60705	HEX NUT 1/2-13UNC	5
-6	60125	HEX HEAD CAPSCREW 1/2-13UNC X 3 LG	2
-7	20737	BELL CRANK	1
-8	64201	ROLL PIN 3/8 DIA X 2 LG	2
-9	20795	PIN, SHIFT CLEVIS	4
-10	64301	COTTER PIN 1/8 DIA X 1 LG	8
-11	20789	CLEVIS	1
-12	60901	JAM NUT 1/2-20UNF	1
-13	20719	SHIFT CYLINDER (SEE FIG. 8)	1
-14	20814	MOUNTING BRACKET (SHIFT CYL.)	1
-15	60613	HEX HEAD CAPSCREW 3/8-16UNC X 1 LG	2
-16	63403	FLAT WASHER 3/8	2
-17	63303	SPLIT LOCKWASHER 3/8	4
-18	20738	LEVER ACTUATOR	1
-19	20354	BRAKE	2
-20	63601	STUD 1/2-13UNC X 6 1/2 LG	4
-21	63305	SPLIT LOCKWASHER 1/2	4
-22	80004-08	STRAIGHT THREAD CONNECTOR (2474 old no.)	2
-23	80004-18	STRAIGHT THREAD CONNECTOR (2543 old no.)	4
-24	21082	DRIVE VALVE ASS'Y (SEE FIG. 7)	1
-25	60124	HEX HEAD CAPSCREW 3/8-16UNC X 3 1/2 LG	2
-26	21329	SHIFT ROD ASS'Y	1
-27	20800	MOTOR	2
-28	21100	CARRIAGE WELDMENT	1
-29	21327	STEERING ARM ASS'Y (SEE FIG. 3)	1
-30	21106	HUB AND YOKE ASS'Y L.H. (SEE FIG. 4)	1
-31	21107	HUB AND YOKE ASS'Y R.H. (SEE FIG. 4)	1
-32	21354	TIE ROD ASS'Y (SEE FIG. 5)	2
-33	21328	PIN--STEERING ARM	1

ITEM	PART NUMBER	DESCRIPTION	QTY
-34	21209	TORQUE HUB	2
-35	21204-1	DRIVE TIRE & WHEEL	1
-36	21204-2	DRIVE TIRE & WHEEL	1
-37	21205-1	STEERING TIRE & WHEEL	1
-38	21205-2	STEERING TIRE & WHEEL	1
-39	60604	HEX HEAD CAP SCREW - BOWMALOK 41032	16
-40	65117	BALL NUT - 3/4-16UNF	32
-41	66169	KING PIN BUSHING SET	2
-42	61315	SELF LOCKING HEX NUT - 7/8-14UNF BOWMAN 36803	2
-43	21252	RIM ONLY (FOR 21204 DRIVE TIRE & WHEEL)	2
-44	21246	15-19.5 x 12 ply TIRE ONLY (FOR 21204 DRIVE TIRE & WHEEL)	4
-45	21251	RIM ONLY (FOR 21205 STEER TIRE & WHEEL)	2
-46	16964	SEAL KIT (FOR 20800 DRIVE MOTOR)	1
-47	16963	SEAL KIT (FOR 20354 BRAKE)	1
-48	66720	SHAFT (FOR 20354 BRAKE)	1
-49			
-50			
-51			

FIGURE 2.1 - CARRIAGE ASSEMBLY (JANUARY 1982)

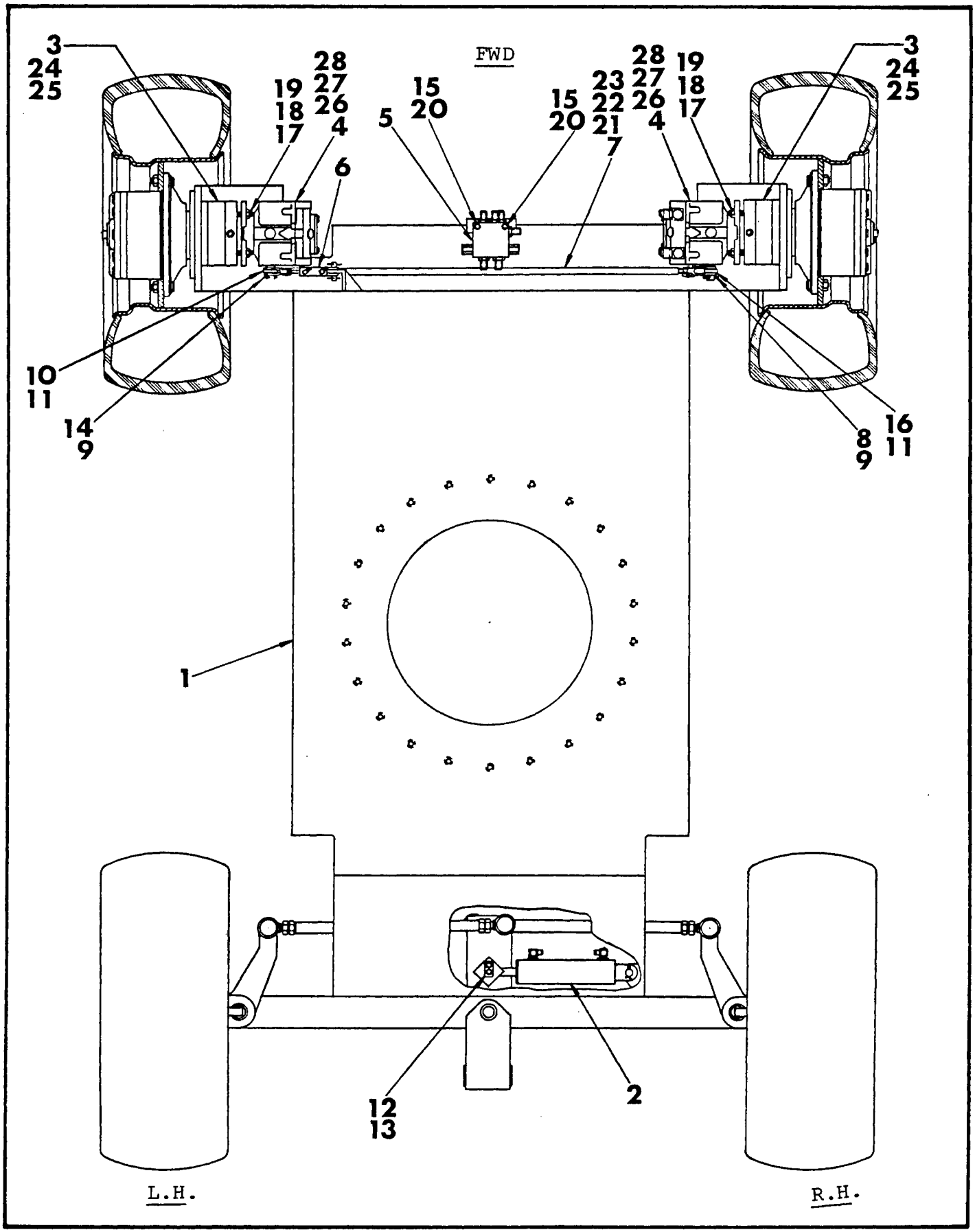


FIGURE 2.1 - CARRIAGE ASSEMBLY
(JANUARY 1982)

ITEM	PART NUMBER	DESCRIPTION	QTY
2.1-	21497	CARRIAGE ASSEMBLY	1
-1	21498	CARRIAGE SUB-ASSEMBLY (SEE FIG. 2.2)	1
-2	21663	STEERING CYLINDER ASSEMBLY (SEE FIG. 6)	1
-3	22603	BRAKE ASSEMBLY	2
-4	22605	MOTOR ASSEMBLY (21672,8/86)	2
-5	21082	DRIVE/BRAKE VALVE ASSEMBLY (SEE FIG. 7)	1
-6	22604	2-SPEED SHIFT CYLINDER ASSEMBLY (SEE FIG. 8)	1
-7	21495	SHIFTING ROD ASSEMBLY	1
-8	20795	SHIFT CLEVIS PIN	2
-9	64301	COTTER PIN - 1/8 DIA. X 1	10
-10	21295	BELL CRANK	1
-11	64201	ROLL PIN - 3/8 DIA. X 2	2
-12	21298	STEERING CYLINDER ROD PIN	1
-13	60607	HEX HEAD CAP SCREW - 3/8-16UNC X 3/4 (BOWMALOK 41012)	1
-14	64106	CLEVIS PIN - 1/2 DIA. X 1 3/8	2
-15	63302	SPLIT LOCK WASHER - 5/16	2
-16	21293	LEVER ACTUATOR	1
-17	63633	STUD - 1/2-13UNC X 7 1/2	8
-18	60705	HEX NUT - 1/2-13UNC	8
-19	63305	SPLIT LOCK WASHER - 1/2	8
-20	60362	HEX HEAD CAP SCREW - 5/16-18UNC X 3 1/2	2
-21	21496	SHIFTING ROD WELDMENT	1
-22	60901	JAM NUT	2
-23	20789	CLEVIS	2
-24	21220	BRAKE	1
-25	80004-03	STRIAGHT THREAD CONNECTOR	1
-26	21221	DRIVE MOTOR	1
-27	80012-21	STRAIGHT THREAD ELBOW	2
-28	80004-10	STRAIGHT THREAD CONNECTOR	1

FIGURE 2.2 - CARRIAGE SUB-ASSEMBLY
(JANUARY 1982)

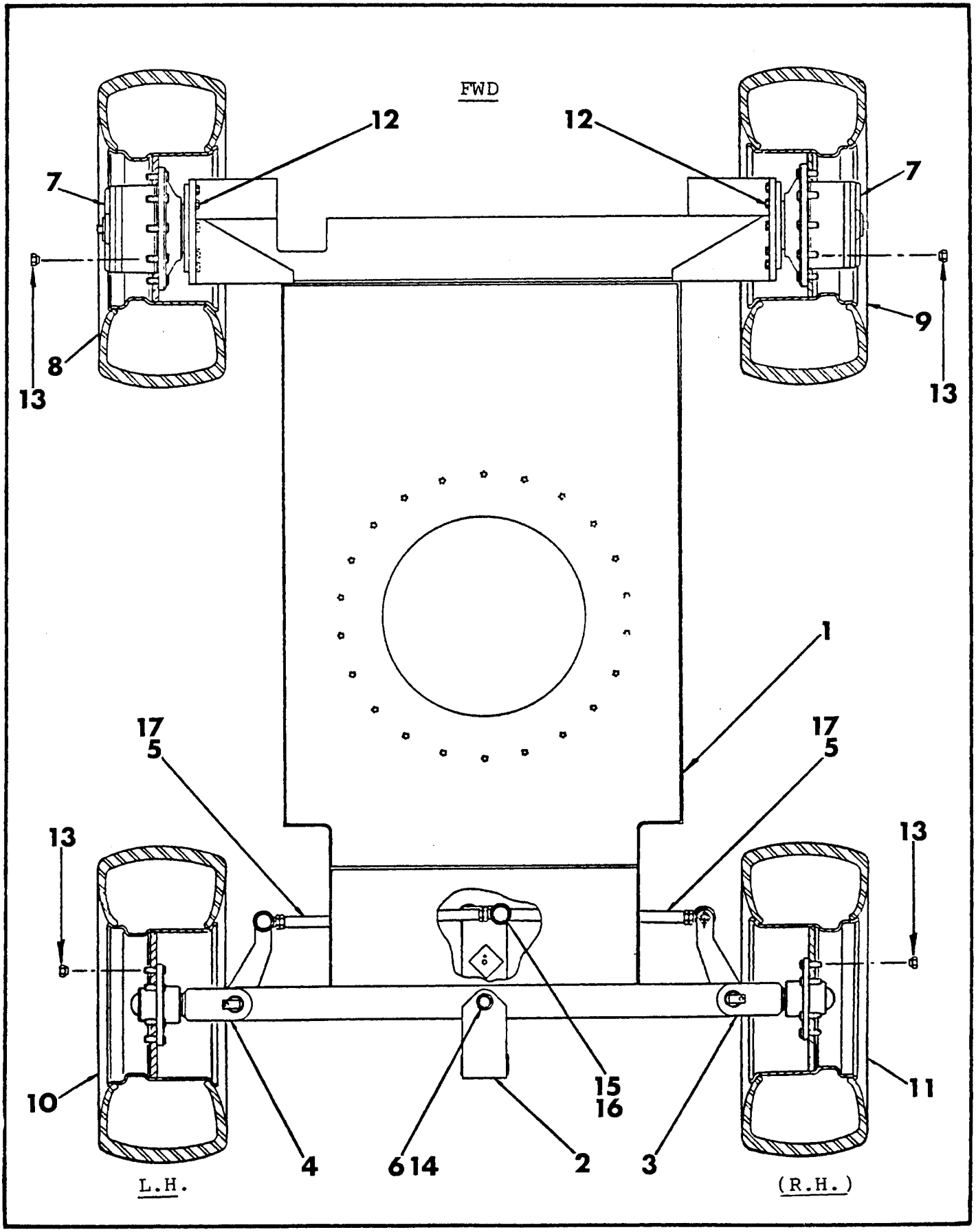
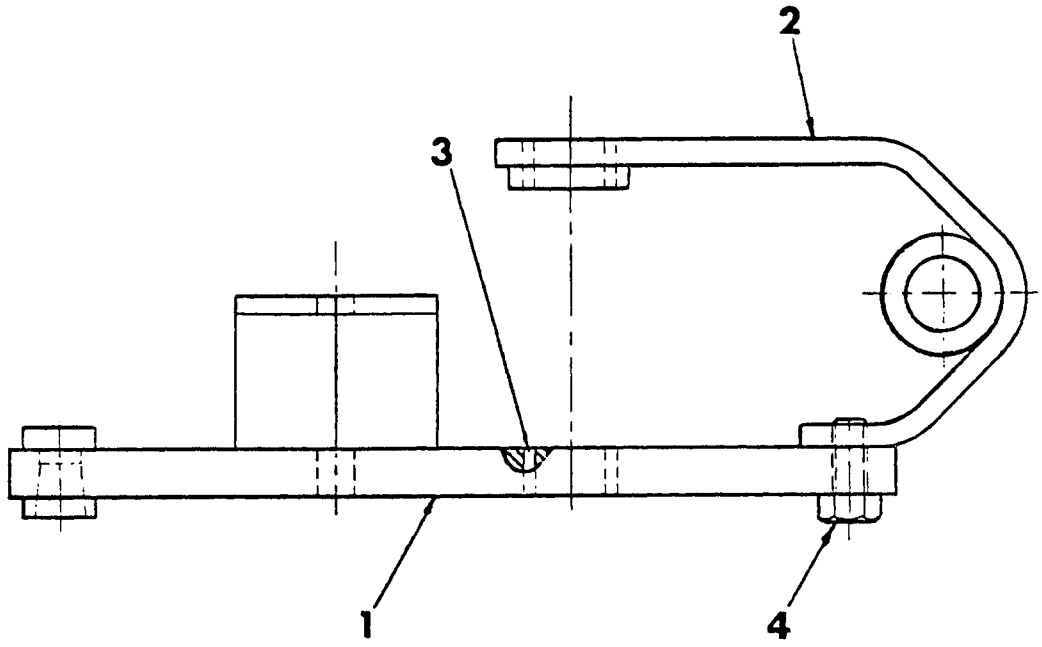


FIGURE 2.2 - CARRIAGE SUB-ASSEMBLY
(JANUARY 1982)

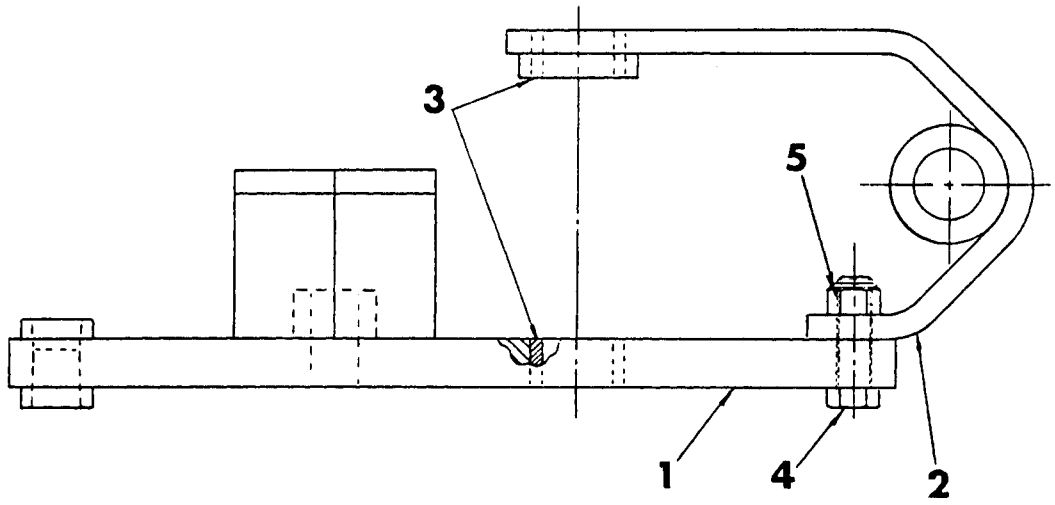
ITEM	PART NUMBER	DESCRIPTION	QTY
2.2-	21498	CARRIAGE ASSEMBLY	1
-1	21100	CARRIAGE WELDMENT	1
-2	21289	STEERING ARM ASSEMBLY (SEE FIG. 3.1)	1
-3	21106	HUB AND YOKE ASSEMBLY (L.H.)	1
-4	21107	HUB AND YOKE ASSEMBLY (R.H.)	1
-5	21354	TIE ROD ASSEMBLY (SEE FIG. 5)	2
-6	21328	STEERING ARM PIN	1
-7	21222	TORQUE HUB	2
-8	21204-1	DRIVE TIRE & WHEEL	1
-9	21204-1	DRIVE TIRE & WHEEL	1
-10	21205-1	STEERING TIRE & WHEEL	1
-11	21205-2	STEERING TIRE & WHEEL	1
-12	60604	HEX HEAD CAP SCREW - 5/8-11UNC X 1 1/2	16
-13	65117	BALL NUT - 3/4-16UNF	20
-14	60603	HEX HEAD CAP SCREW - 5/16-18UNC X 3/4 (BOWMALOK 41006)	2
-15	16101	LOCK NUT - 7/8-14UNF	2
-16	63432	FLAT WASHER - 7/8	2
-17	64310	COTTER PIN	4
-18	66715	SEAL KIT (FOR 21220 BRAKE)	1
-19	66769	SHAFT (FOR 21220 BRAKE)	1
-20	6607	REPAIR KIT (FOR 21221 MOTOR)	1
-21			
-22			

FIGURE 3--STEERING ARM ASSEMBLY



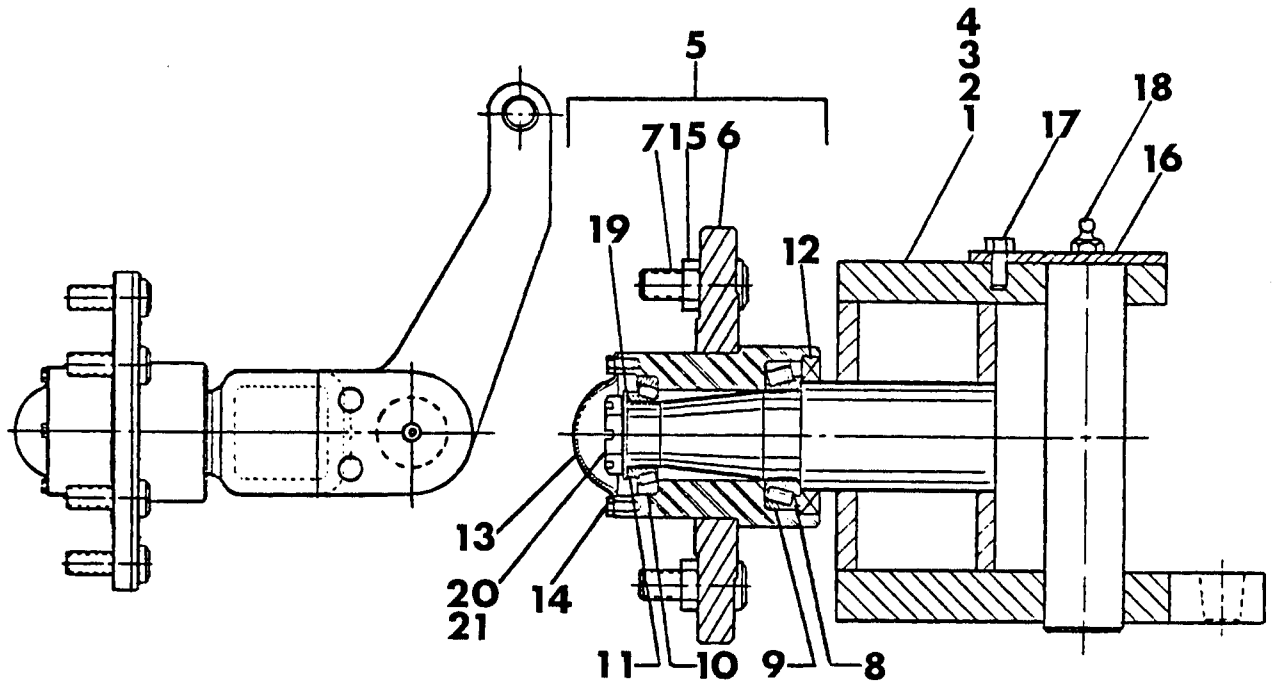
ITEM	PART NUMBER	DESCRIPTION	QTY
3-	21327	STEERING ARM ASSEMBLY	1
-1	20717	STEERING ARM	1
-2	21326	STEERING BRACKET	1
-3	64901	BUSHING --2 O.D. X 1 1/2 I.D. X 1	2
-4		HEX HEAD CAPSCREW-BOWMALOK 41039	2

FIGURE 3.1 -- STEERING ARM ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
3.1-	21289	STEERING ARM ASSEMBLY	1
-1	21299	STEERING ARM	1
-2	21326	SUPPORT BRACKET	1
-3	64901	BUSHING--2 O.D. X 1 1/2 I.D. X 1	2
-4	60506	HEX HEAD CAPSCREW-3/4-10UNC X 2 ¼ GR.8	2
-5	61304	LOCK NUT 3/4-10UNC BOWMAGRIP 36787	2

FIGURE 4 - HUB & YOKE ASSEMBLY

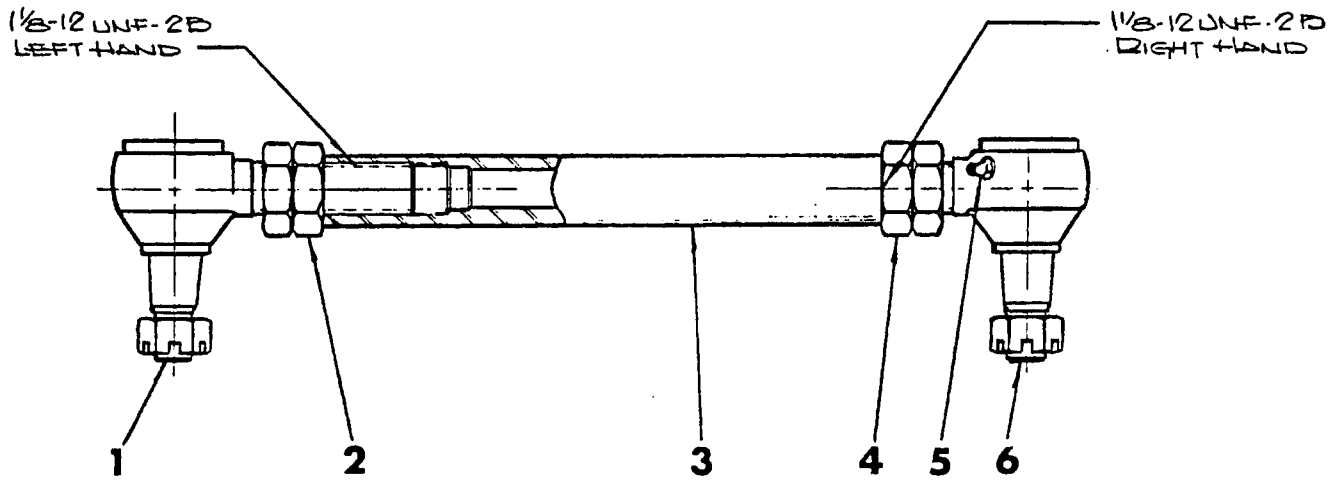


ITEM	PART NUMBER	DESCRIPTION	QTY
-1	21107	HUB & YOKE ASSEMBLY (R.H.) (SHOWN)	1
-2	21106	HUB & YOKE ASSEMBLY (L.H.) (OPPOSITE)	1
-3	21119	YOKE SPINDLE WELDMENT (L.H.)	1
-4	21120	YOKE SPINDLE WELDMENT (R.H.)	1
-5	21791	HUB ASSEMBLY	1
-6	21792	MACHINED HUB	1
-7	65351	WHEEL BOLT	6
-8	21795	INNER CUP	1
-9	21794	INNER CONE	1
-10	21797	OUTER CUP	1
-11	21796	OUTER CONE	1
-12	21798	GREASE SEAL	1
-13	21799	DUST CAP	1
-14	60309	HEX HEAD CAP SCREW - 1/4-20UNC X 3/4	4
-15	65117	BALL NUT - 3/4-16UNF	6
-16	21344	KING PIN	1
-17	60618	HEX HEAD CAP SCREW - 3/8-16UNC X 1 1/4 (BOWMALOK 41014)	2

FIGURE 4 - HUB & YOKE ASSEMBLY

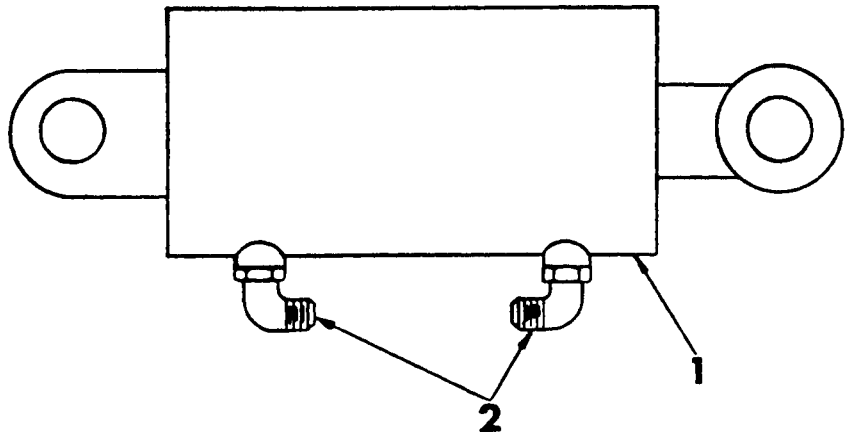
ITEM	PART NUMBER	DESCRIPTION	QTY
-18	65103	GREASE FITTING - 1/8NPT	1
-19	63454	KEY WASHER - 2 1/4 O.D. X 1 I.D. X 1/8 THICK (GR. 8)	1
-20	61004	CASTLE JAM NUT	1
-21	16244	COTTER PIN - 1/8 DIA. X 1 1/2	1

FIGURE 5 - TIE ROD ASSEMBLY



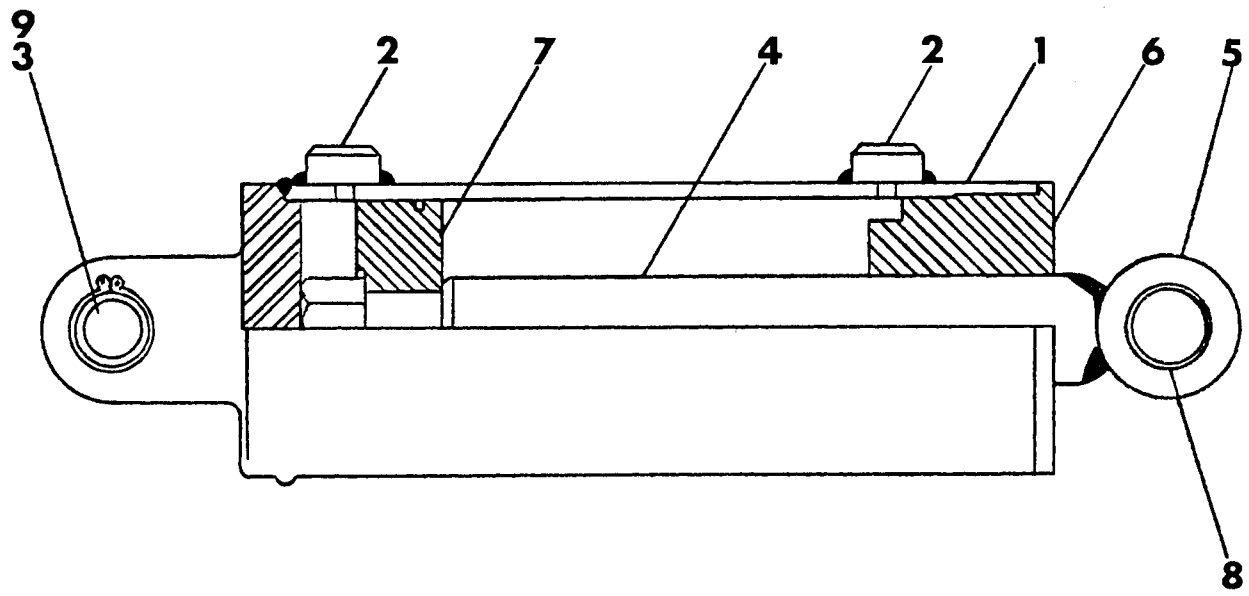
ITEM	PART NUMBER	DESCRIPTION	QTY
5-	21354	TIE ROD ASSEMBLY	1
-1	20569	TIE ROD END	1
-2	20567	JAM NUT - 11/8-12UNF (L.H. THREAD)	2
-3	25071	ROUND TUBING - 11/2 O.D. X 5/16W X 23	1
-4	20566	JAM NUT - 11/8-12UNF (R.H. THREAD)	2
-5	65103	GREASE FITTING - 1/8NPT	2
-6	20568	TIE ROD END	1

FIGURE 6 - STEERING CYLINDER ASSEMBLY



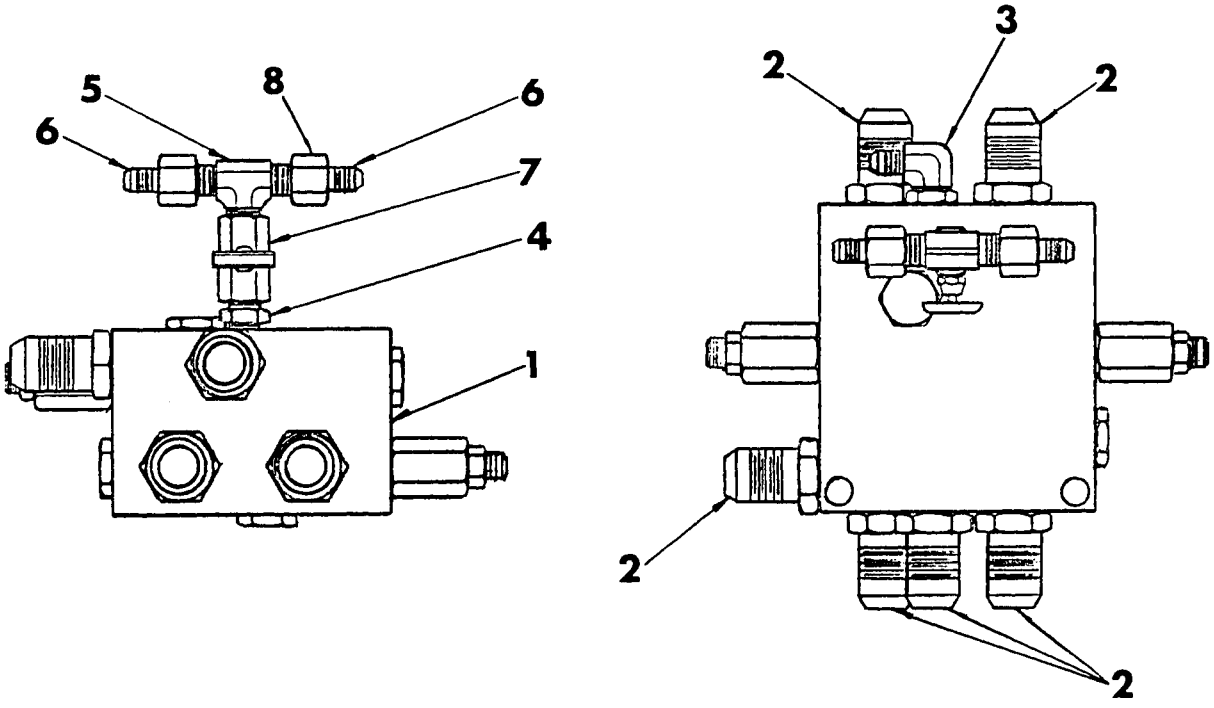
ITEM	PART NUMBER	DESCRIPTION	QTY
6-	21663	STEERING CYLINDER ASSEMBLY	1
-1	21239	STEERING CYLINDER	1
-2	2532	STRAIGHT THREAD ELBOW	2

FIGURE 6.1 - STEERING CYLINDER



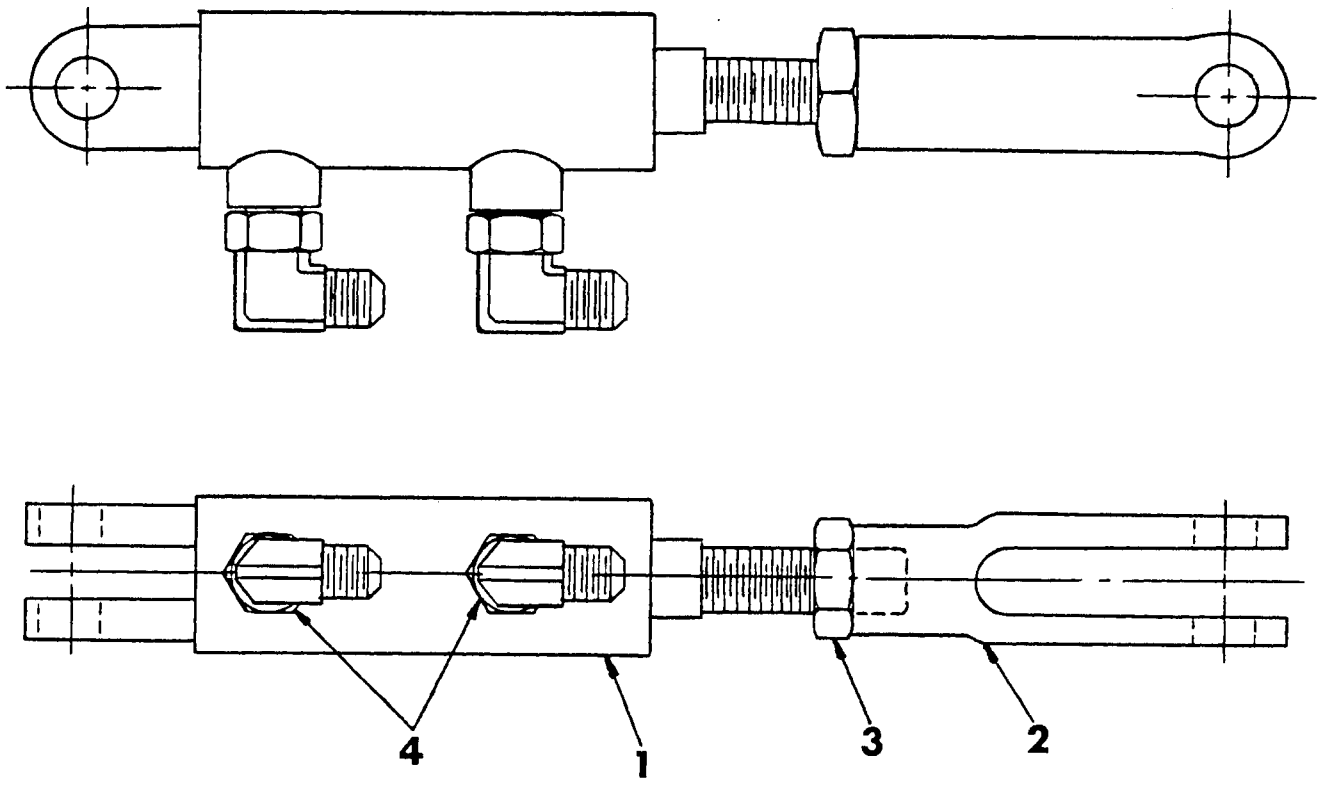
ITEM	PART NUMBER	DESCRIPTION	QTY
6.1-	21239	STEERING CYLINDER	1
-1		BARREL - SE00239B	1
-2		PORT - 9885	2
-3		BASE CLEVIS ASSEMBLY - 19314	1
-4	66466	ROD - SE00239R	1
-5		ROD PINEYE - 18213	1
-6	66200	"S"T" HEAD - 13128	1
-7	66199	PISTON - 14214	1
-8	66485	16 DU 24 BUSHING - 9506	2
-9		CLEVIS PIN - 9221	1
-10	66041	SEAL KIT - 25421	1

FIGURE 7 - DRIVE/BRAKE VALVE ASSEMBLY



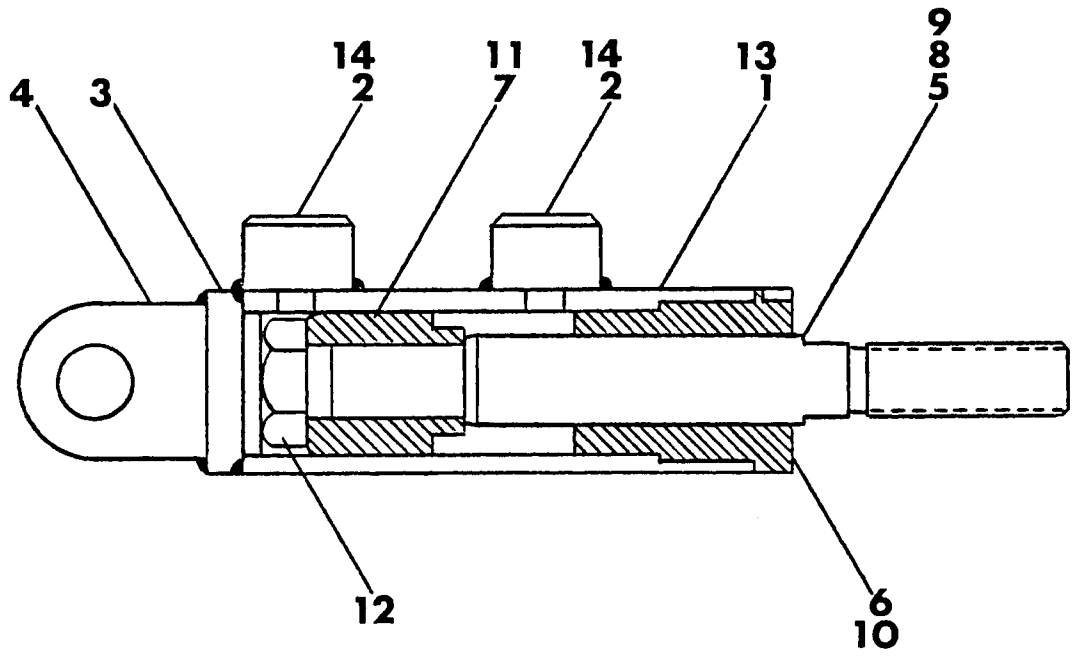
ITEM	PART NUMBER	DESCRIPTION	QTY
7-	21082	DRIVE/BRAKE VALVE ASSEMBLY	1
-1	21214	VALVE	1
-2	80004-19	STRAIGHT THREAD CONNECTOR (2544 old no.)	6
-3	80012-03	90° STRAIGHT THREAD ELBOW (2532 old no.)	1
-4	80052-04	PIPE NIPPLE (2475 old no.)	1
-5	80034-08	MALE BRANCH TEE (2490 old no.)	1
-6	80056-01	TUBE END REDUCER (2496 Old no.)	2
-7	20357	NEEDLE VALVE (FOR BRAKE ADJUSTMENT)	1
-8	80060-05	NUT - 6 - BTX - S	2

FIGURE 8 - 2-SPEED SHIFT CYLINDER ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
8-	22604	2-SPEED SHIFT CYLINDER ASSEMBLY	1
-1	20719	2-SPEED SHIFT CYLINDER (SEE FIG. 8.1)	1
-2	20789	SHIFT CLEVIS	1
-3	60901	JAM NUT - 1/2-20UNF	1
-4	80012-03	STRAIGHT THREAD ELBOW	2

FIGURE 8.1 - 2-SPEED SHIFT CYLINDER



ITEM	PART NUMBER	DESCRIPTION	QTY
8.1-	20719	2-SPEED SHIFT CYLINDER	1
-1		BARREL - SE00719	1
-2		PORT - 9885	2
-3		BASE - 16001	1
-4		CLEVIS EAR - 15155	2
-5		ROD - SE00719R	1
-6		TEE HEAD - 13110	1
-7		"U" PISTON - 14207	1
-8		ROD WIPER - 10605	1
-9		ROD SEAL - 10051	1
-10		HEAD SEAL - 10151	1
-11		PISTON SEAL - 10436	1
-12		HEX NUT - 11015	1
-13		MARK NAMEPLATE - 9303	1
-14		PORT PLUG - 9810	2
-15	20035	SEAL KIT - 25303	1

FIGURE 9 - TURRET ASSEMBLY

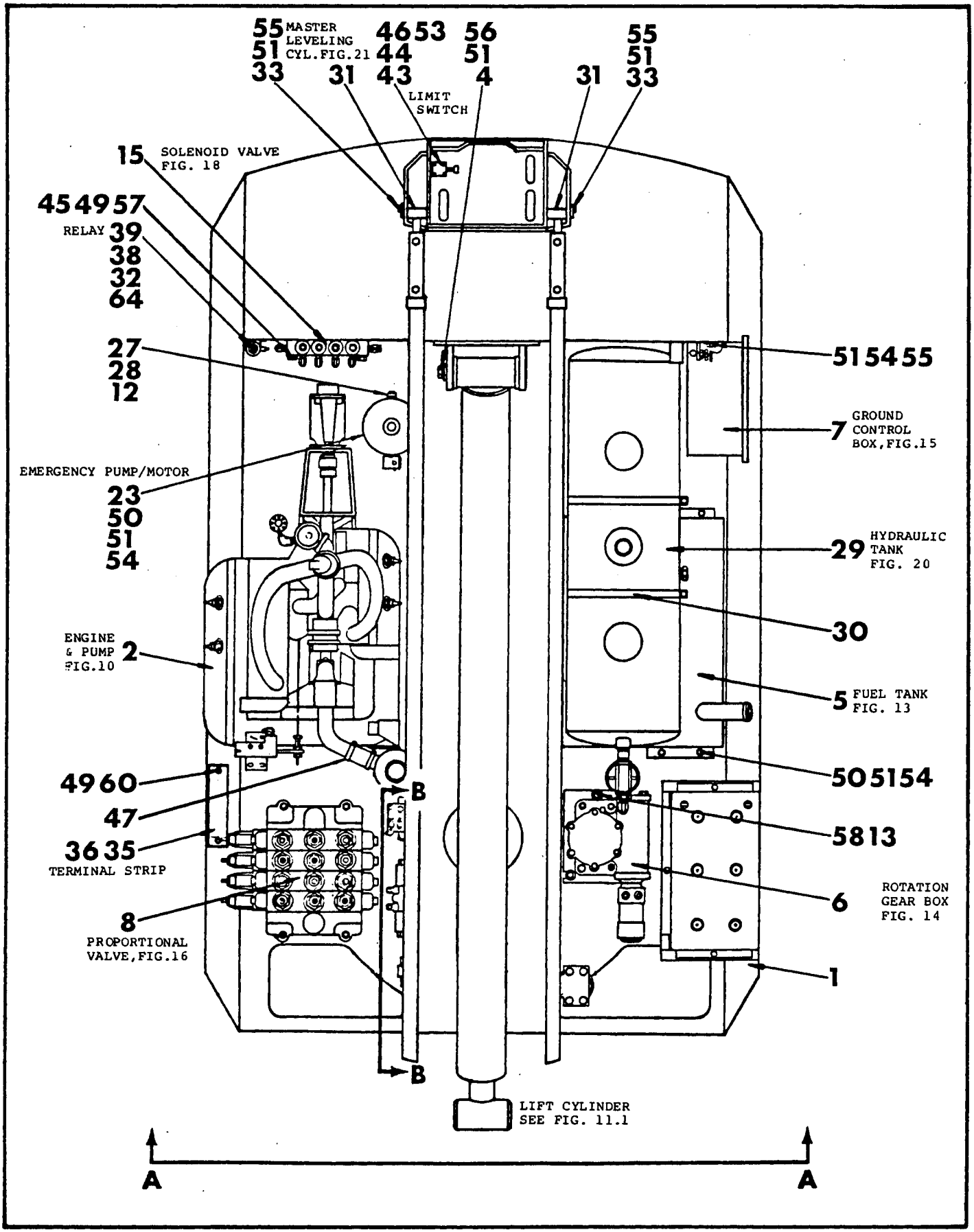


FIGURE 9 - TURRET ASSEMBLY

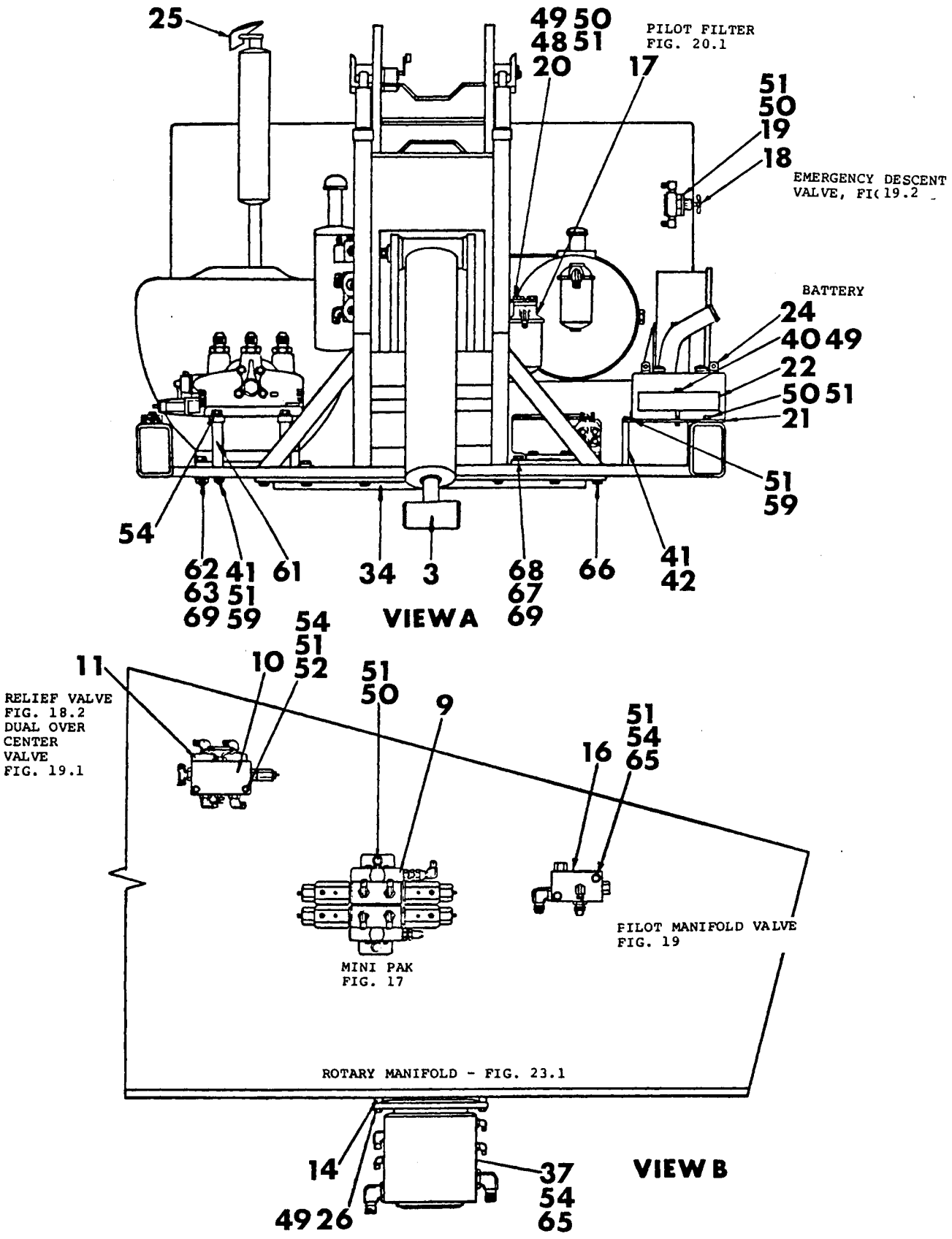


FIGURE 9 - TURRET ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
9-	21940	TURRET ASSEMBLY (21051 OLD NO.)	1
-1	22616	TURRET WELDMENT (21104 old no.)	1
-2	21083	ENGINE & PUMP ASSEMBLY (SEE FIG. 10)	1
-3	21894	LIFT CYLINDER ASSEMBLY (SEE FIG. 11.1)	1
-4	21330	LIFT CYLINDER PIN	1
-5	21076	FUEL TANK ASSEMBLY (SEE FIG. 13)	1
-6	2 21972	ROTATION GEAR BOX ASSEMBLY (SEE FIG. 14)(21078 OLD NO.)	1
-7	21703	GROUND CONTROL BOX ASSEMBLY (SEE FIG. 15)	1
-8	22519	PROPORTIONAL VALVE ASSEMBLY (SEE FIG. 16)	1
-9	21088	MINIPAK SUB-ASSEMBLY (SEE FIG. 17)	1
-10	22144	RELIEF VALVE ASSEMBLY (SEE FIG. 18.2)	1
-11	21584	DUAL OVER CENTER VALVE ASSEMBLY (SEE FIG. 19.1)	1
-12	80012-08	STRAIGHT THREAD ELBOW	1
-13	63503	HEAVY DUTY FLAT WASHER - 3/4 (GR. B)	1
-14	20445	SPACER	4
-15	21692	SOLENOID VALVE ASSEMBLY (SEE FIG. 18)	1
-16	21472	PILOT MANIFOLD VALVE ASSEMBLY (SEE FIG. 19)	1
-17	22963(22146)	PILOT FILTER ASSEMBLY (SEE FIG. 20.1)	1
-18	22189	EMERGENCY DESCENT VALVE ASSEMBLY (SEE FIG. 19.2)	1
-19	21279	NEEDLE VALVE BRACKET	1
-20	20333	FILTER MOUNTING BRACKET	1
-21	21284	BATTERY TRAY	1
-22	21286	HOLD DOWN BRACKET	2
-23	21229	EMERGENCY PUMP/MOTOR PUMP -66781 MOTOR-66783	1
-24	21244	BATTERY	1
-25	21288	MUFFLER RAIN CAP	1
-26	60330	HEX HEAD CAP SCREW - 5/16-18UNC X 2 3/4	4
-27	80004-19	STRAIGHT THREAD CONNECTOR	1
-28	80004-08	STRAIGHT THREAD CONNECTOR	1

ITEM	PART NUMBER	DESCRIPTION	QTY
-29	21937	HYDRAULIC TANK ASSEMBLY (SEE FIG. 20)	1
-30	21387	HYDRAULIC TANK BRACKET (21077 old no.)	2
-31	21084	MASTER LEVELING CYLINDER ASSEMBLY (SEE FIG. 21)	2
-32	60309	HEX HEAD CAP SCREW - 1/4-20UNC X 3/4	2
-33	21337	MASTER LEVELING CYLINDER TO TURRET PIN	2
-34	21200	SLEWING RING	1
-35	21217	TERMINAL STRIP	1
-36	21386	TERMINAL STRIP COVER	1
-37	21898	ROTARY MANIFOLD ASSEMBLY (MARCH 1983) (SEE FIG. 23.1)	1
-38	63301	SPLIT LOCK WASHER - 1/4	2
-39	4082	RELAY	1
-40	60307	HEX HEAD CAP SCREW - 5/16-18UNC X 4 1/2	2
-41	63619	THREADED ROD - 3/8-16UNC X 7 1/2	5
-42	25314	ROUND TUBING	1
-43	70107	LIMIT SWITCH	1
-44	70031	LEVER ARM (70032 OLD NO.)	1
-45	63402	FLAT WASHER - 5/16	2
-46	62704	ROUND HEAD SLOTTED MACHINE SCREW - NO. 10-32UNF X 2	2
-47	16288	HOSE CLAMP	2
-48	60322	HEX HEAD CAP SCREW - 5/16-18UNC X 3/4	2
-49	63302	SPLIT LOCK WASHER - 5/16	12
-50	60343	HEX HEAD CAP SCREW - 3/8-16UNC X 1	16
-51	63303	SPLIT LOCK WASHER - 3/8	39
-52	60356	HEX HEAD CAP SCREW - 3/8-16UNC X 4 1/2	2
-53	63313	SPLIT LOCK WASHER - NO. 10	2
-54	63403	FLAT WASHER - 3/8	21
-55	60607	HEX HEAD CAP SCREW - 3/8-16UNC X 3/4 (BOWMALOK)	5
-56	60612	HEX HEAD CAP SCREW - 3/8-16UNC X 1 1/2 (BOWMALOK)	4
-57	60339	HEX HEAD CAP SCREW - 5/16-16UNC X 3	2

FIGURE 9 - TURRET ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
-58	60601	HEX HEAD CAP SCREW - 3/4-10UNC X 1 1/2 (BOWMALOK 41039)	1
-59	60703	HEX NUT - 3/8-16UNC	10

FIGURE 9.1 - TURRET ASSEMBLY - 21940

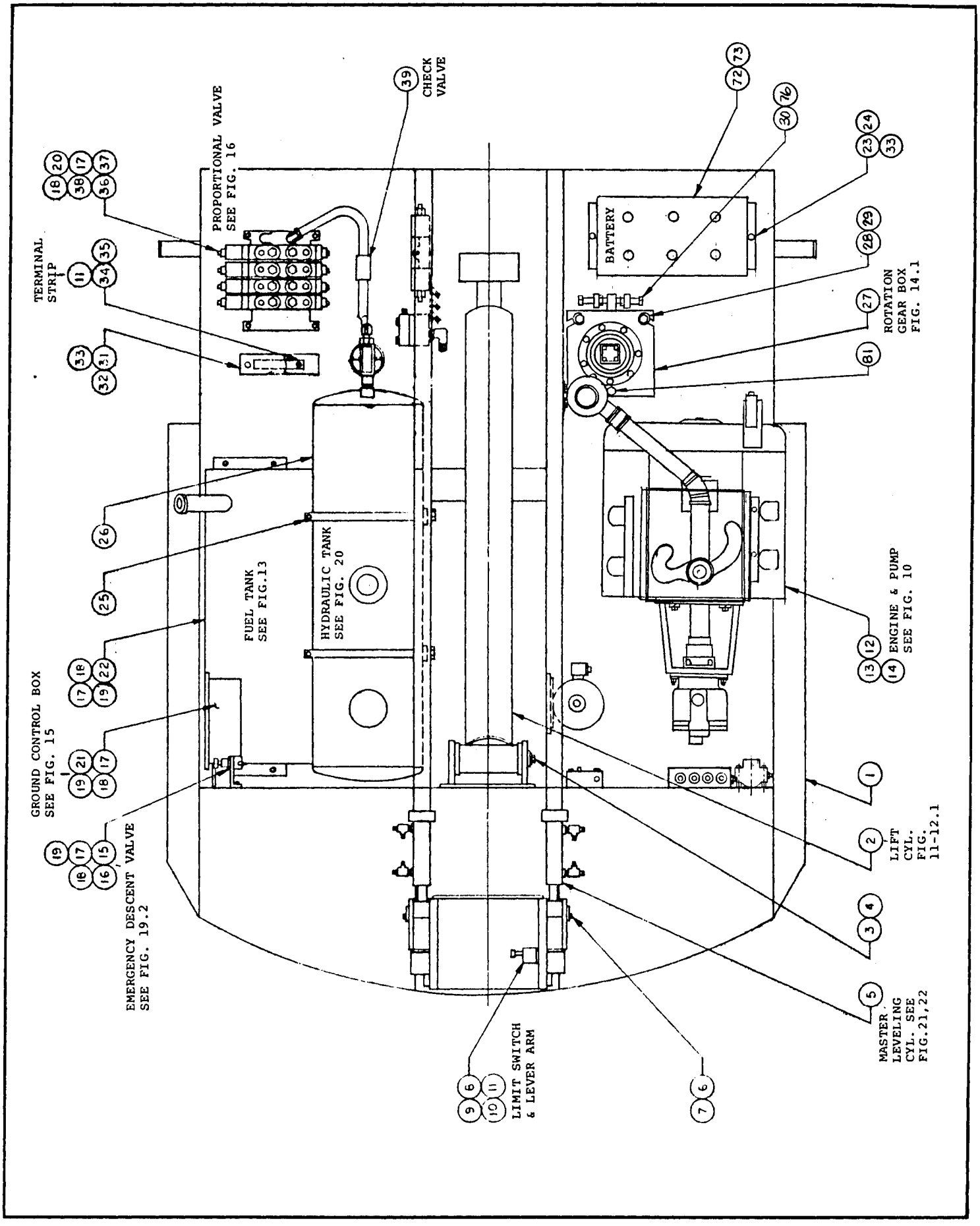
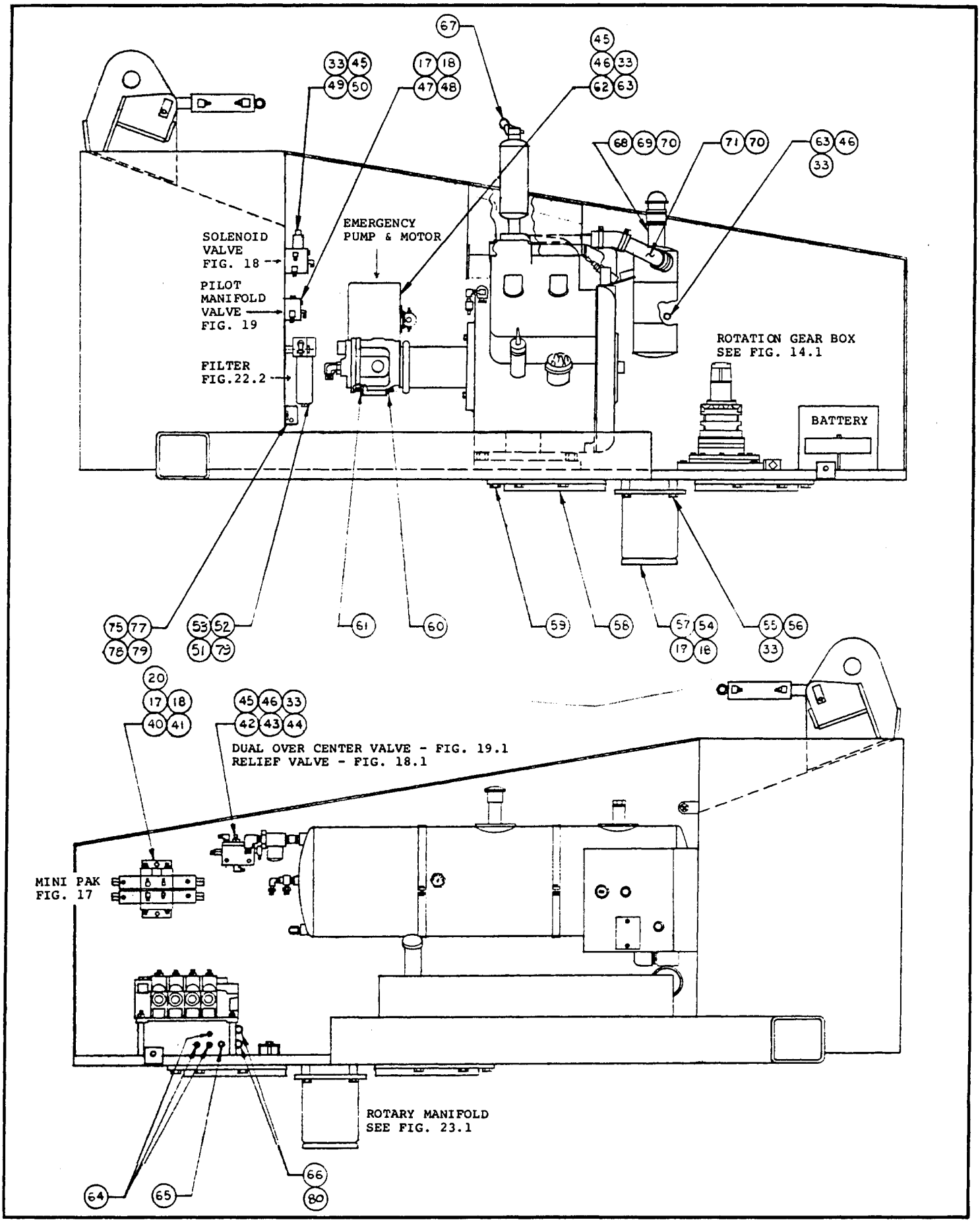


FIGURE 9.1 - TURRET ASSEMBLY - 21940



ITEM	QTY	PART NO.	DESCRIPTION
35	2	62607	SCREW, MACHINE
36	1	22519	ASSY., PROPORTIONAL VAVLE
37	4	25324	TUBE, ROUND
38	4	63619	ROD, THREADED
39	1	22187	VALVE, CHECK
40	1	21088	ASSY., MINIPAK
41	2	60343	SCREW, CAP
42	1	21584	ASSY., DUAL OVER CENTER VALVE
43	1	22144	ASSY., RELIEF VALVE
44	2	60316	SCREW, CAP
45	2	63402	WASHER, FLAT
46	6	60702	NUT, HEX
47	1	21472	ASSY., PILOT MANIFOLD VALVE
48	2	60317	SCREW, CAP
49	1	21692	ASSY., SOLENOID VALVE
50	2	60339	SCREW, CAP
51	2	26055	TUBE, ROUND
52	2	60377	SCREW, CAP
53	1	22963	ASSY., FILTER
54	2	60612	SCREW, CAP
55	4	20445	SPACER
56	4	60511	SCREW, CAP
57	1	21898	ASSY., ROTARY MANIFOLD
58	1	21200	RING, SLEWING
59	16	60604	SCREW, CAP
60	2	80004-08	CONNECTOR, STRAIGHT THREAD
61	1	80004-18	CONNECTOR, STRAIGHT THREAD
62	1	21229	EMERGENCY, PUMP AND MOTOR
63	4	60338	SCREW, CAP
64	3	80017-03	ELBOW, BULKHEAD 45° UNION
65	1	80017-05	ELBOW, BULKHEAD 45° UNION
66	2	80011-08	ELBOW, BULKHEAD UNION
67	1	21288	CAP, RAIN MUFFLER
68	1	26015	TUBE, ROUND

ITEM	QTY	PART NO.	DESCRIPTION
1	1	22616	WELDMENT, TURRET
2	1	21894	ASSY., LIFT CYLINDER
3	1	21330	PIN, LIFT CYLINDER
4	2	60618	SCREW, CAP
5	2	21084	ASSY., MASTER LEVELING CYLINDER
6	2	21337	PIN, MASTER LEVELING CYLINDER ROD END
7	2	60607	SCREW, CAP
8	1	70107	SWITCH, LIMIT
9	1	70031	ARM, LEVER
10	2	62704	SCREW, MACHINE
11	4	63313	WASHER, LOCK
12	1	21083	ASSY., ENGINE & PUMP
13	4	60635	SCREW, CAP
14	4	60715	NUT, HEX
15	4	22189	ASSY., EMERGENCY DESCENT VALVE
16	1	21279	BRACKET, EMERGENCY DESCENT VALVE
17	12	63403	WASHER, FLAT
18	12	63303	WASHER, LOCK
19	5	60325	SCREW, CAP
20	6	60703	NUT, HEX
21	1	21703	ASSY., GROUND CONTROL BOX
22	1	21076	ASSY., FUEL TANK
23	2	21286	BRACKET, BATTERY HOLD DOWN
24	2	60316	SCREW, CAP
25	2	21387	BRACKET, HYDRAULIC TANK
26	1	21937	ASSY., HYDRAULIC TANK
27	1	21972	ASSY., ROTATION GEAR BOX
28	2	60637	SCREW, CAP
29	2	22169	WASHER, GEAR BOX
30	2	62222	SET SCREW, CUP POINT
31	1	21386	COVER, TERMINAL STRIP
32	2	60323	SCREW, CAP
33	18	63302	WASHER, LOCK
34	1	21217	STRIP, TERMINAL

ITEM	QTY	PART NO.	DESCRIPTION
69	1	65561	HOSE, RUBBER PLAIN
70	4	16288	CLAMP, HOSE
71	1	26014	TUBE, ROUND
72	1	21244	BATTERY
73	1	20673	KIT, BATTERY CABLE
74	1	21956	CHIMNEY
75	1	70201	RELAY
76	2	60910	NUT, JAM
77	2	60353	SCREW, CAP
78	2	63301	WASHER, FLAT
79	4	63401	WASHER, LOCK
80	2	65352	WASHER, LOCK
81	1	60601	SCREW, CAP

FIGURE 10 - ENGINE & PUMP ASSEMBLY

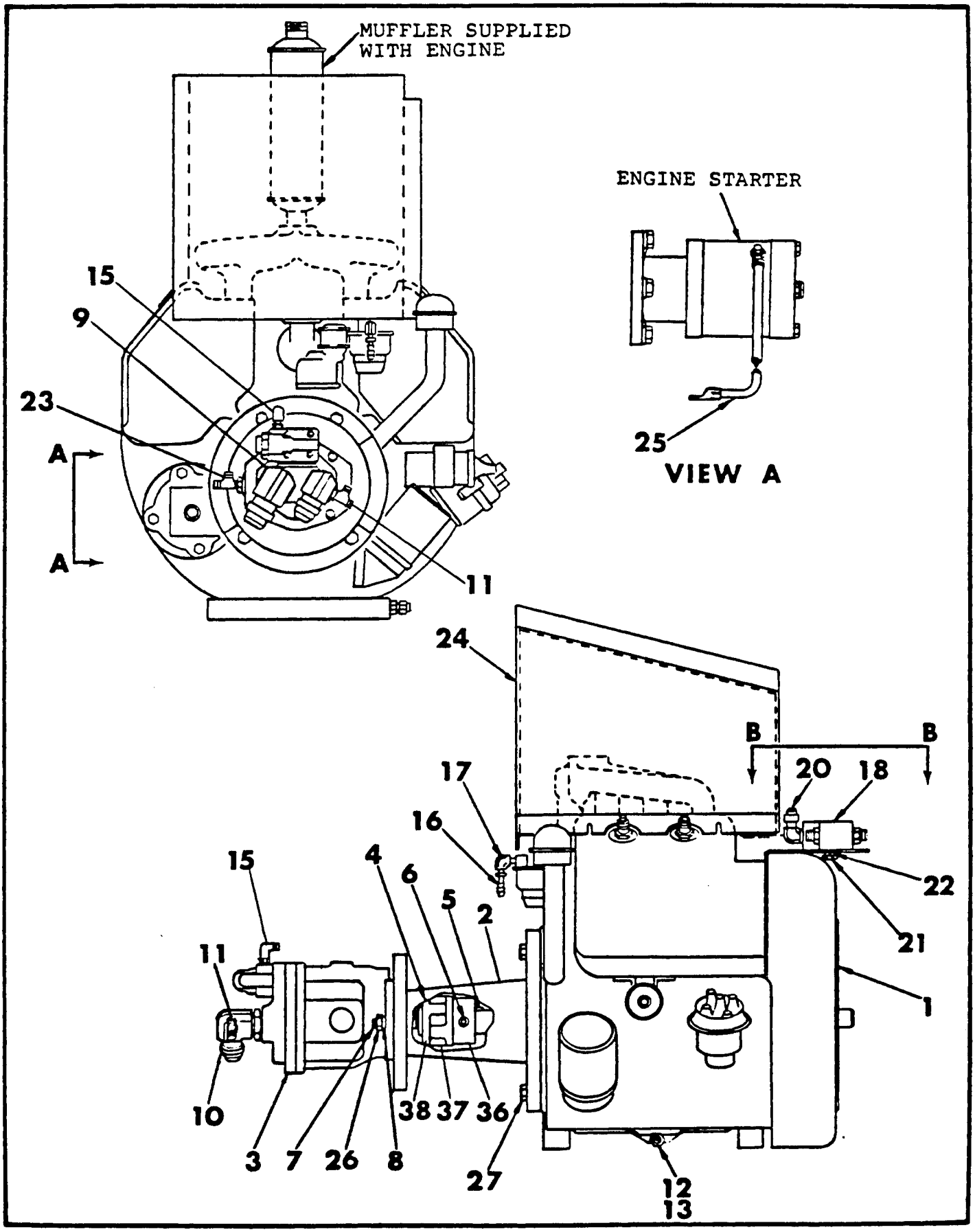


FIGURE 10 - ENGINE & PUMP ASSEMBLY

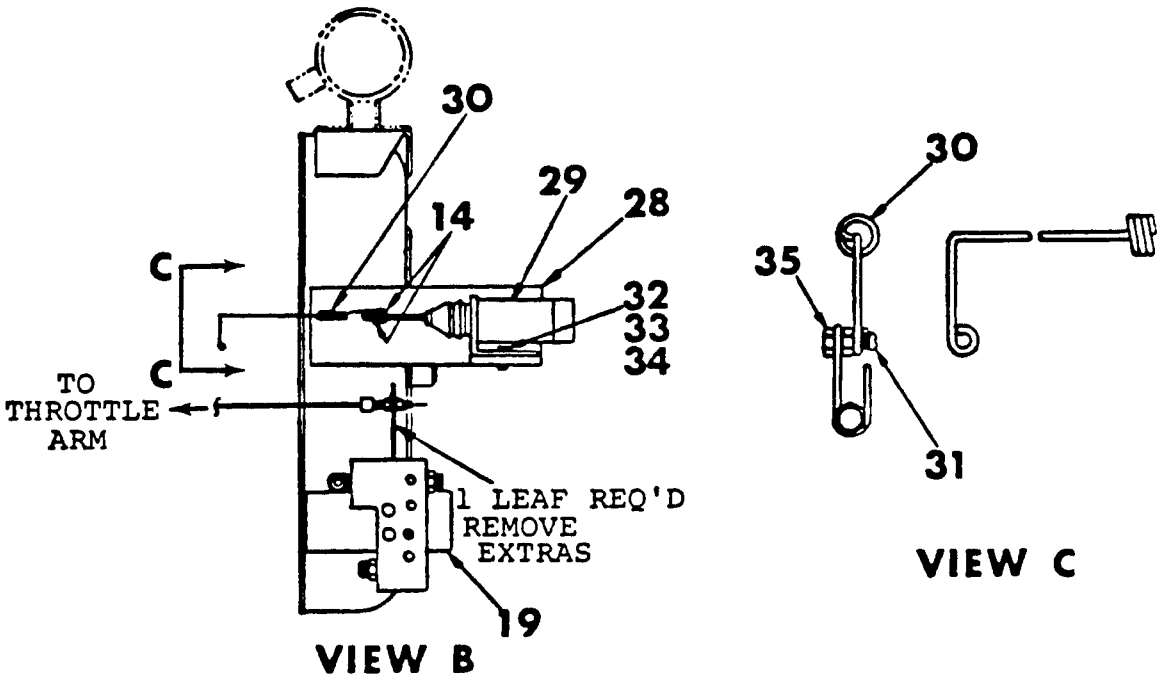


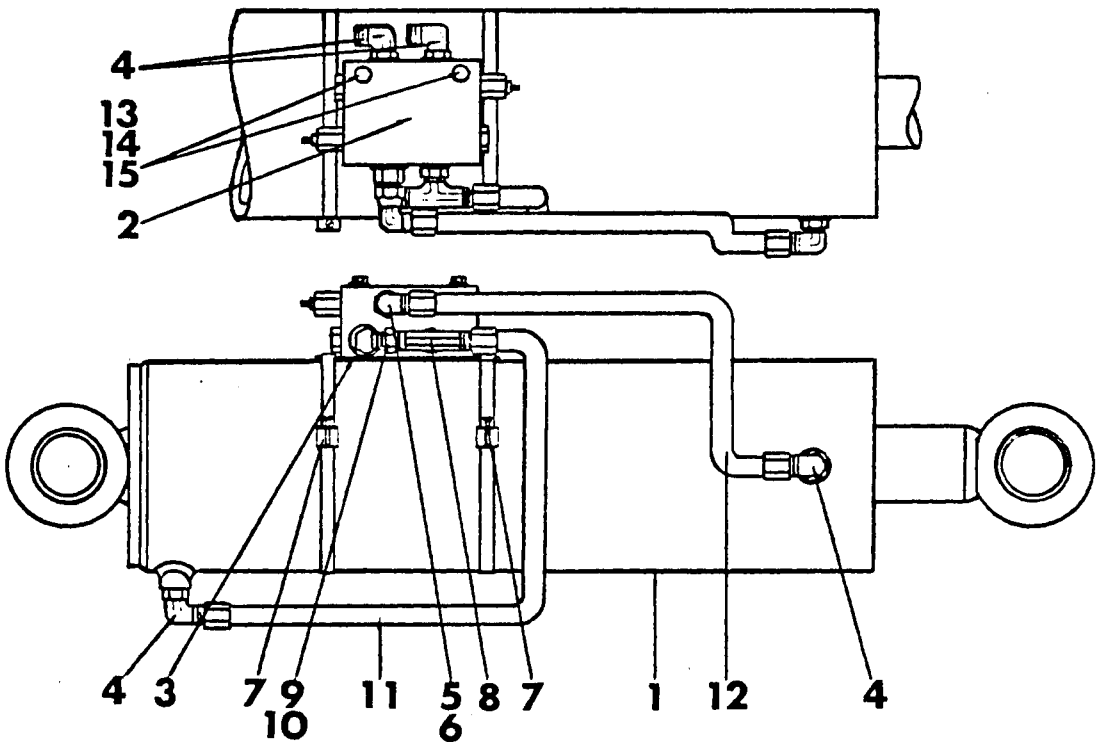
FIGURE 10 - ENGINE & PUMP ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
1-	21083	ENGINE & PUMP ASSEMBLY	1
-1	21215	ENGINE	1
-2	21389	PUMP ADAPTER	1
-3	20753	PUMP	1
-4	21306	COUPLING ASSEMBLY	1
-5	25005	KEY - 3/8 SQ. X 2	1
-6	62201	SET SCREW - 1/4-20UNC X 1/2	2
-7	63613	STUD - 1/2-13UNC X 2 1/2 (GR. 5)	2
-8	63305	SPLIT LOCK WASHER - 1/2	2
-9	80012-28	STRAIGHT THREAD ELBOW	1
-10	20798	MODIFIED STRAIGHT THREAD ELBOW	1
-11	80037-08	MALE RUN TEE	1
-12	80059-06	CAP	1
-13	80001-14	CONNECTOR	1
-14	60805	HEX NUT - 1/4-28UNF	2
-15	80012-03	STRAIGHT THREAD ELBOW	1
-16	240	HOSE BARB	1
-17	16500	90° STREET ELBOW	1
-18	20364	HYDRAULIC THROTTLE	1
-19	20811	THROTTLE BRACKET	1
-20	80012-04	STRAIGHT THREAD ELBOW	1
-21	60404	HEX HEAD CAP SCREW - 5/16-24UNF X 1	2
-22	63302	SPLIT LOCK WASHER - 5/16	2
-23	80033-08	STRAIGHT THREAD RUN TEE	1
-24	21397	EXHAUST CHIMNEY	1
-25	4103-48	CABLE ASSEMBLY - 1 AWG X 48	1
-26	60705	HEX NUT - 1/2-13UNC	2
-27	60604	HEX HEAD CAP SCREW - 5/8-11UNC X 1 1/2	4
-28	21097	SYNCHRO START BRACKET (BOWMALOK 41032)	1
-29	21777	SYNCHRO START	1
-30	65199	SYNCHRO START SPRING	1
-31	62609	ROUND HEAD MACHINE SCREW - NO. 6-32UNC X 1/2	1

FIGURE 10 - ENGINE & PUMP ASSEMBLY

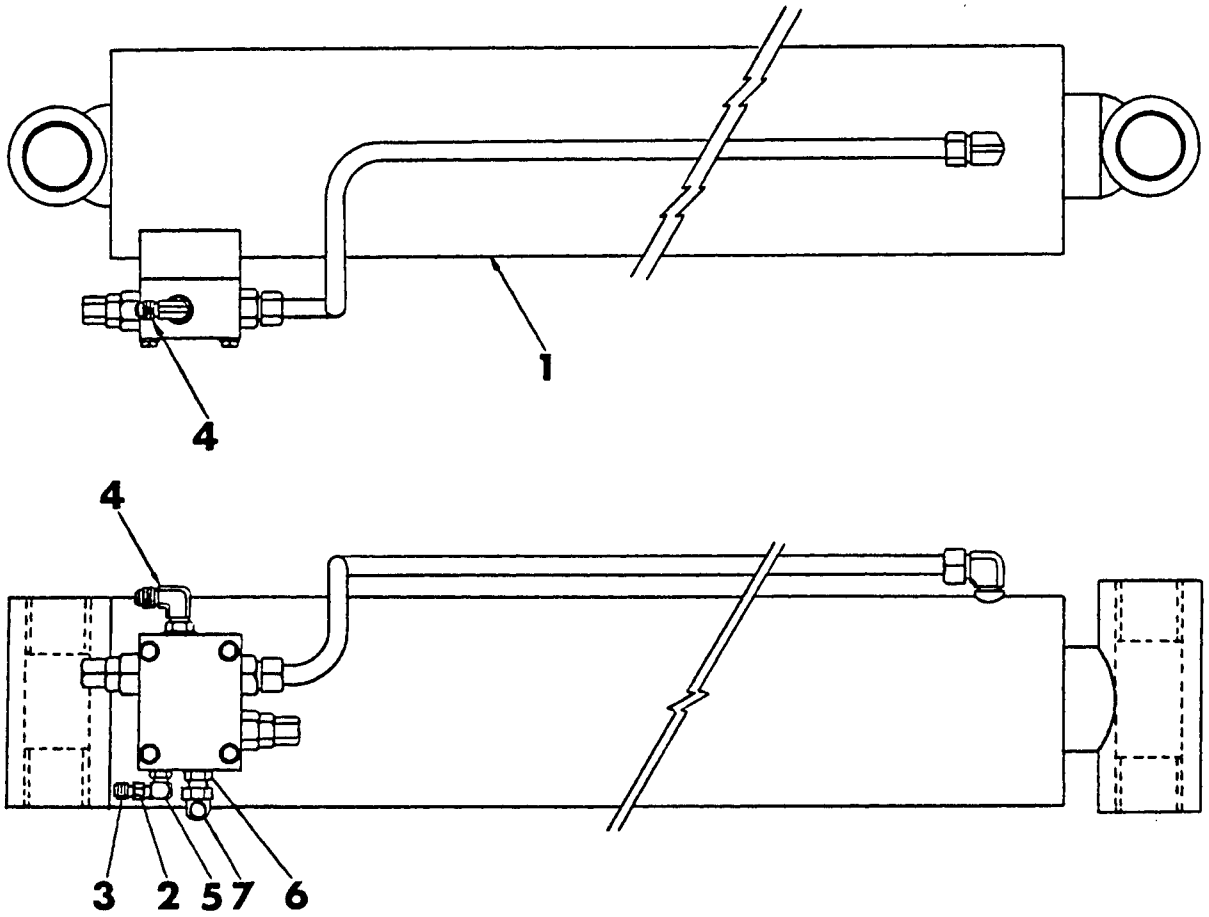
ITEM	PART NUMBER	DESCRIPTION	QTY
-32	60353	HEX HEAD CAP SCREW - 1/4-20UNC X 1/2	2
-33	63301	SPLIT LOCK WASHER - 1/4	2
-34	60701	HEX NUT - 1/4-20UNC	2
-35	61501	HEX NUT - NO. 6-32UNC	2
-36	20928	3 - JAW COUPLING	1
-37	20930	INSERT	1
-38	20925	3 - JAW COUPLING	1
-39	66741	SHAFT SEAL	1

FIGURE 11--LIFT CYLINDER ASSEMBLY



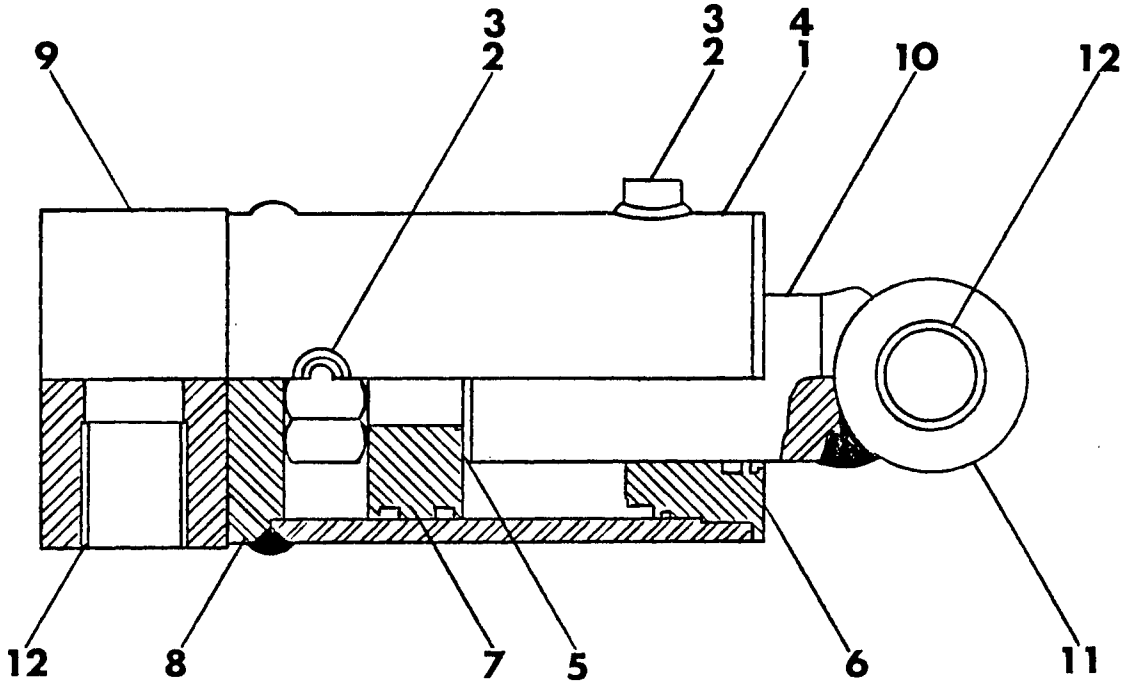
ITEM	PART NUMBER	DESCRIPTION	QTY
11-	21075	LIFT CYLINDER ASSEMBLY	1
-1	21112	LIFT CYLINDER (SEE FIG. 12)	1
-2	21223	HOLDING VALVE	1
-3	20210	HOLDING VALVE MOUNTING PLATE	1
-4	80012-11	90° O-RING ELBOW	4
-5	80004-11	CONNECTOR	5
-6	80015-06	90° SWIVEL ELBOW	1
-7	24166	STRAP	2
-8	80036-11	BRANCH TEE (2546 old no.)	1
-9	2501	NUT	1
-10	21385	BLEED DOWN ORIFICE	1
-11	20628	TUBING ASSEMBLY	1
-12	20627	TUBING ASSEMBLY	1
-13	60344	HEX HEAD CAP SCREW - 3/8-16UNC X 3	2
-14	63303	LOCK WASHER - 3/8	2
-15	63428	FLAT WASHER - 3/8	2

FIGURE 11.1 - LIFT CYLINDER ASSEMBLY (INTEGRAL HOLDING VALVE)



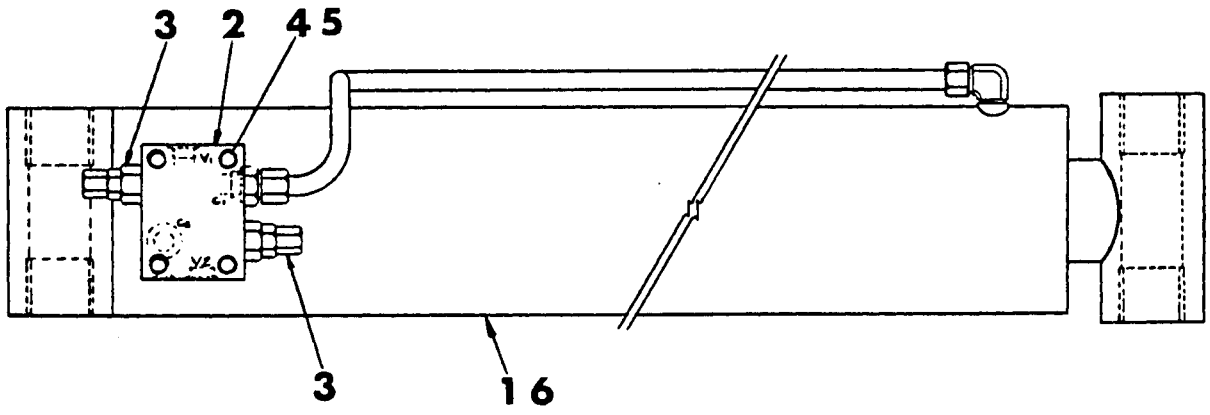
ITEM	PART NUMBER	DESCRIPTION	QTY
11-	21894	LIFT CYLINDER ASSEMBLY	1
-1	21257	LIFT CYLINDER SUB-ASSEMBLY (SEE FIG. 12)	1
-2	80060-05	NUT	1
-3	20348	BLEED DOWN ORIFICE	1
-4	80012-11	STRAIGHT THREAD ELBOW	1
-5	50900	STRAIGHT THREAD ELBOW	1
-6	80004-11	STRAIGHT THREAD CONNECTOR	1

FIGURE 12--LIFT CYLINDER



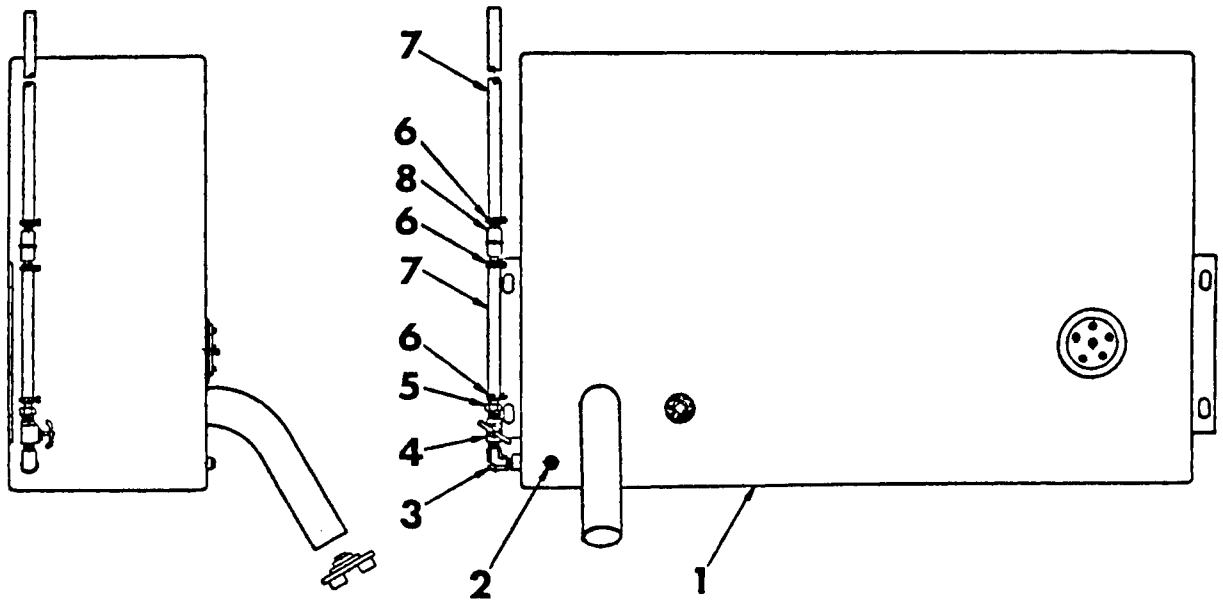
ITEM	PART NUMBER	DESCRIPTION	QTY
12-	21112	LIFT CYLINDER	1
-1		BARREL -SE00212B	1
-2		PORT - 9888	2
-3		CAP PLUG - 9813	3
-4		MARK NAME PLATE - 9303	1
-5		STOP TUBE - 18913	1
-6	66550	TEE HEAD - 13206	1
-7		"U" PISTON - 14136	1
-8		PLAIN BASE - 17021	1
-9		BASE PINEYE - 18458	1
-10		ROD - SE00212R	1
-11		ROD PINEYE - 18459	1
-12		32 DU 32 BEARING - 9507	4
-13	66043	SEAL KIT - 25368	1

FIGURE 12.1 - LIFT CYLINDER SUB-ASSEMBLY (INTEGRAL HOLDING VALVE)



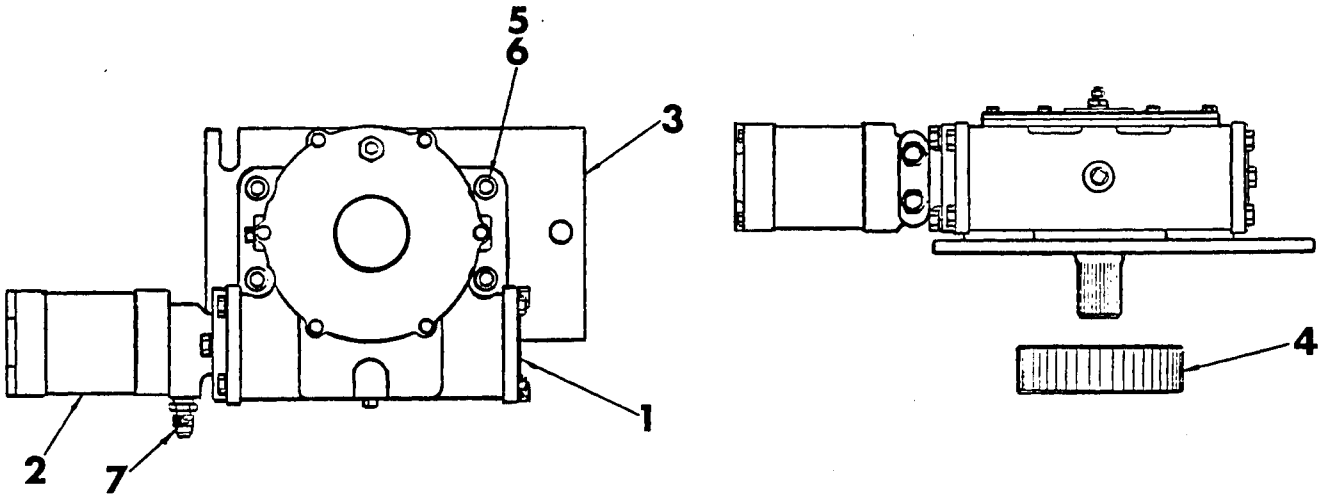
ITEM	PART NUMBER	DESCRIPTION	QTY
12-	21257	LIFT CYLINDER SUB-ASSEMBLY	1
-1	21199	LIFT CYLINDER	1
-2	21445	BOOM CYLINDER VALVE BLOCK	1
-3	21580	OVER CENTER CARTRIDGE OLD 81006	2
-4	61820	SOCKET HEAD CAP SCREW - 5/16-24UNF X 2	4
-5	63302	SPLIT LOCK WASHER - 5/16	4
-6	66043 66721	SEAL KIT	1

FIGURE 13 - FUEL TANK ASSEMBLY



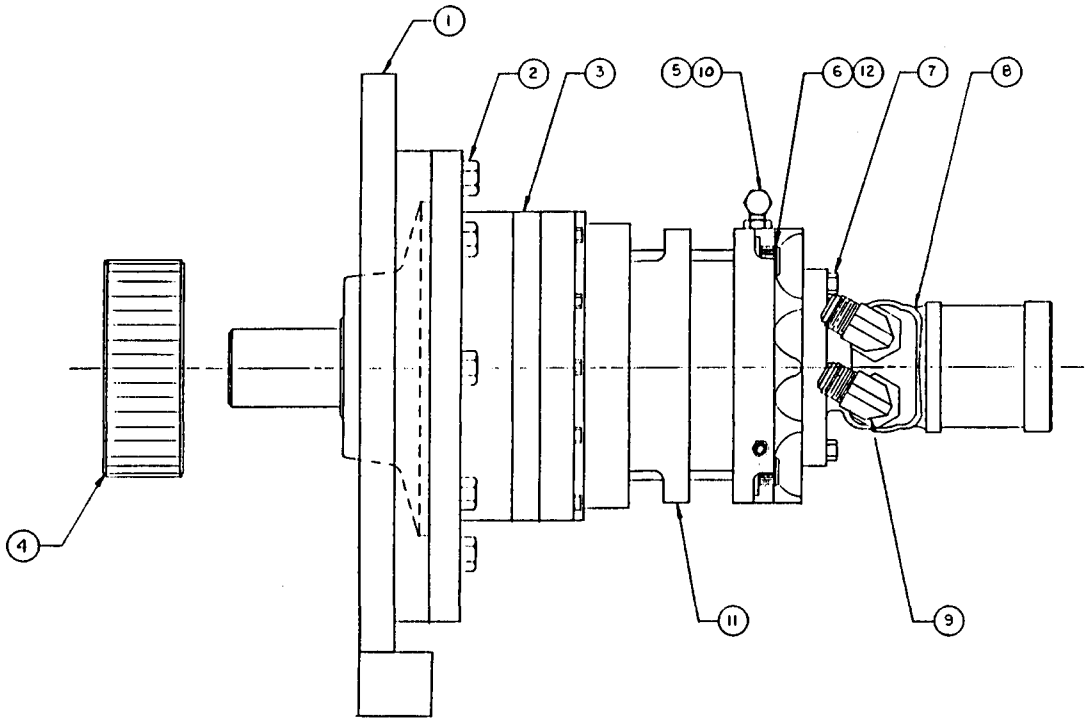
ITEM	PART NUMBER	DESCRIPTION	QTY
13-	21076	FUEL TANK ASSEMBLY	1
-1	21335	FUEL TANK	1
-2	80048-03	PIPE PLUG	1
-3	80021-03	STREET ELBOW	1
-4	12000	NEEDLE VALVE	1
-5	2589	MALE CONNECTOR	1
-6	161A	HOSE CLAMP	4
-7	160B	HOSE	1
-8	160	FUEL FILTER	1

FIGURE 14--ROTATION GEAR BOX ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
14-	21078	ROTATION GEAR BOX ASSEMBLY	1
-1	20726	ROTATION GEAR BOX	1
-2	20520	MOTOR	1
-3	20736	SUB PLATE	1
-4	21201	PINION GEAR	1
-5	61901	SOCKET HEAD CAPSCREW--5/8-11UNC X 2	4
-6	63306	LOCKWASHER--5/8	4
-7	80001-12	CONNECTOR	4

FIGURE 14.1- ROTATION GEAR BOX ASSEMBLY - 21972



ITEM	QTY	PART NO.	DESCRIPTION
1	1	22997	MTG. PLATE WELDMENT
2	9	60602	CAP SCREW
3	1	22830	TORQUE HUB
4	1	21974	PINION
5	1	80036-03	BRANCH STRAIGHT THREAD TEE
6	2	61940	CAP SCREW
7	2	60622	CAP SCREW
8	1	81080	HYDRAULIC MOTOR
9	2	80018-13	STRAIGHT THREAD 45° ELBOW
10	1	80059-03	CAP
11	1	22831	BRAKE
12	2	63305	LOCK WASHER
13	1	67150	SEAL KIT

FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

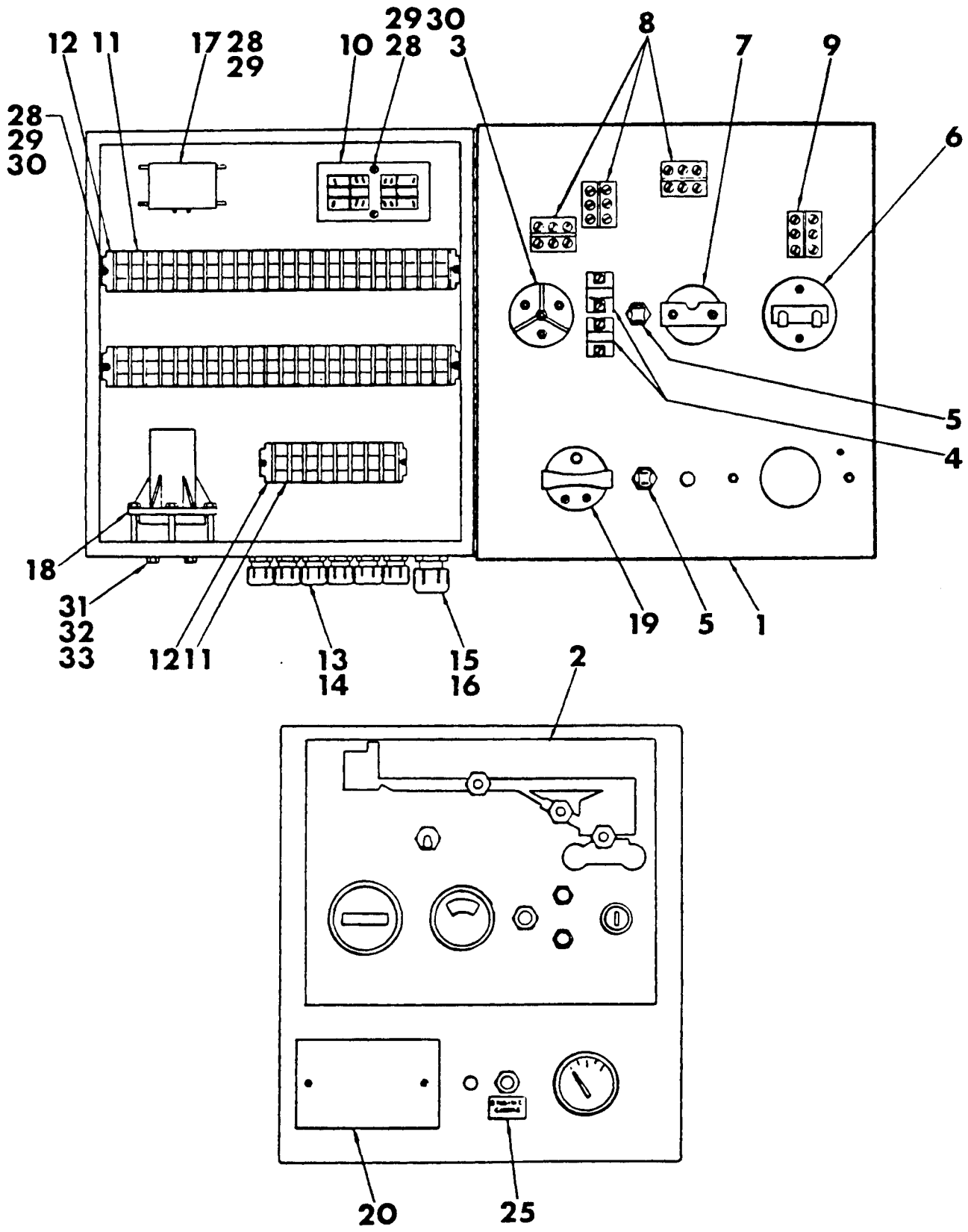
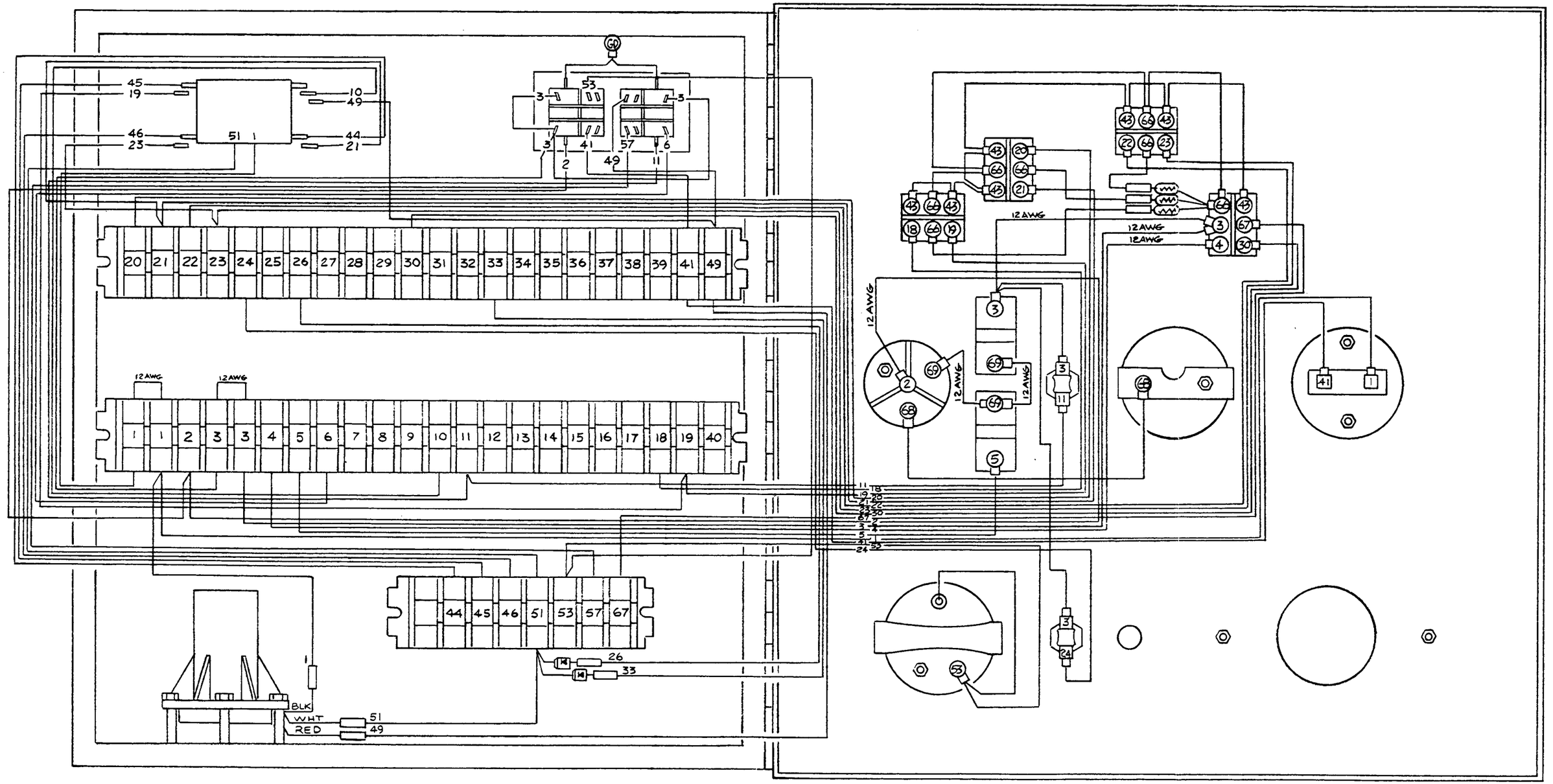


FIGURE 15 - GROUND CONTROL BOX ASSEMBLY



WIRING DIAGRAM LEGEND

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

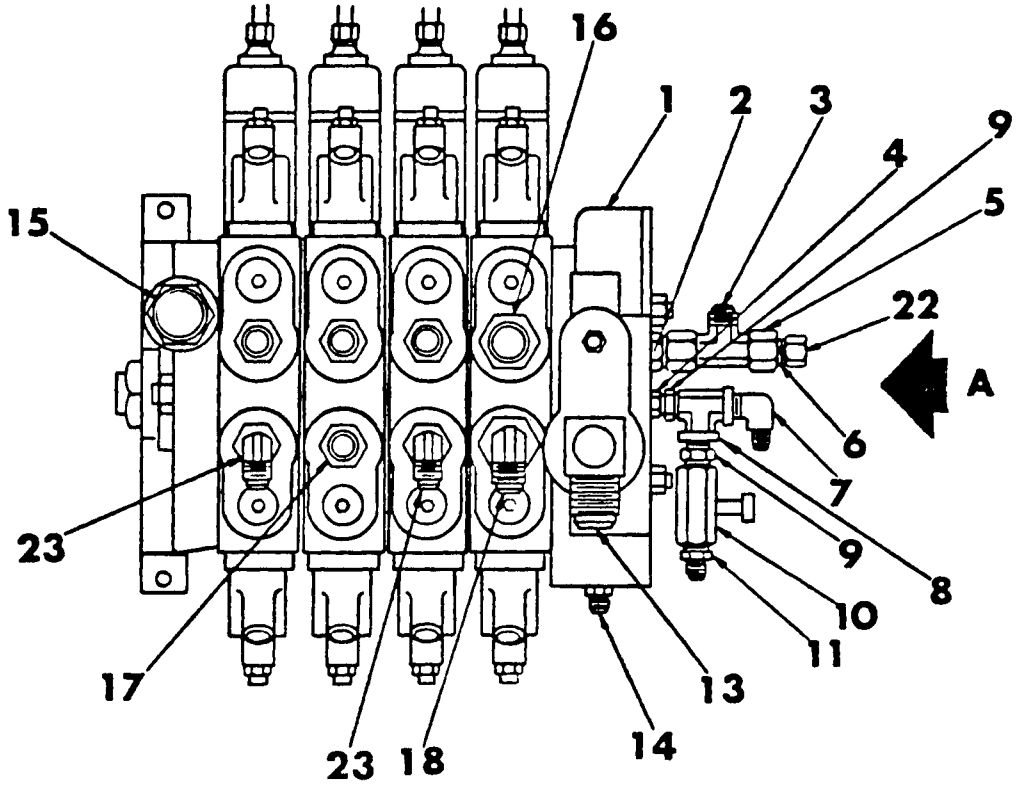
FIGURE 15 - GROUND CONTROL BOX ASSEMBLY

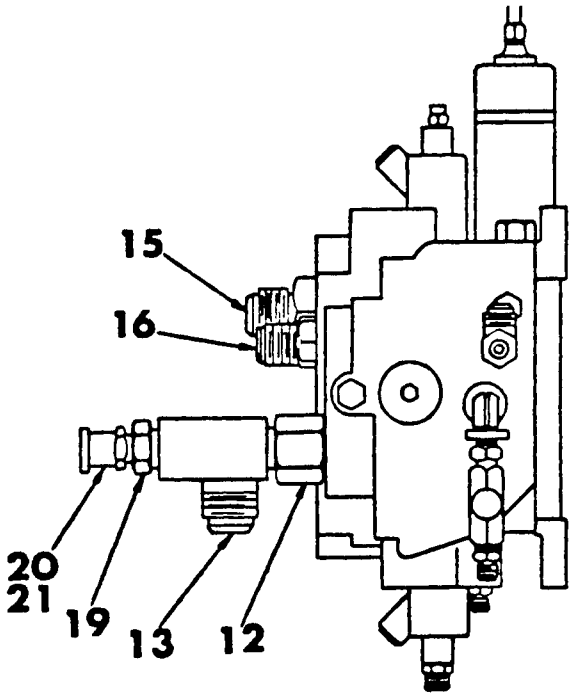
ITEM	PART NUMBER	DESCRIPTION	QTY
15-	21703	GROUND CONTROL BOX ASSEMBLY	1
-1	20977	ENCLOSURE	1
-2	20460	DECAL - COVER	1
-3	2717	IGNITION SWITCH	1
-4	20562	CIRCUIT BREAKER	2
-5	4011	PUSH BUTTON SWITCH	2
-6	20571	HOUR METER	1
-7	20572	AMMETER	1
-8	20481	TOGGLE SWITCH	3
-9	20482	TOGGLE SWITCH	1
-10	20573	LATCHING RELAY	1
-11	4027	TERMINAL BLOCK	52
-12	117A	TERMINAL BLOCK END	3
-13	2806	STRAIN RELIEF	6
-14	2808	LOCK NUT	6
-15	2807	STRAIN RELIEF	1
-16	2809	LOCK NUT	1
-17	21253	RELAY T-BAR SEE 34 & 35	1
-18	21250	SLOPE SENSOR	1
-19	21219	FUEL GAUGE	1
-20	902	COVER PLATE	1
-21	4045	DIODE	2
-22	70142	RESISTOR	3
-23	117D	BUTT CONNECTOR	8
-24	117E	PUSH ON TERMINAL	6
-25	20413	DECAL-"ENGINE CHOKE"	1
-26	2859	RING TONGUE	25
-27	876	RING TONGUE	10
-28	62609	ROUND HEAD SLOTTED CAPSCREW NO. 6-32UNC X 1/2	14
-29	63311	LOCKWASHER - No. 6	14
-30	61501	HEX NUT - NO. 6-32UNC	12
-31	60116	HEX HEAD CAPSCREW - 3/8-16UNC X 3/4	4

REV.3 4-84	FIGURE 15 - GROUND CONTROL BOX ASSEMBLY	28.1

ITEM	PART NUMBER	DESCRIPTION	QTY
-32	63303	LOCKWASHER - 3/8	4
-33	60703	HEX NUT - 3/8-16UNC	4
-34	70213	RELAY	1
-35	70214	RELAY BASE	1

FIGURE 16 - PROPORTIONAL VALVE ASSEMBLY



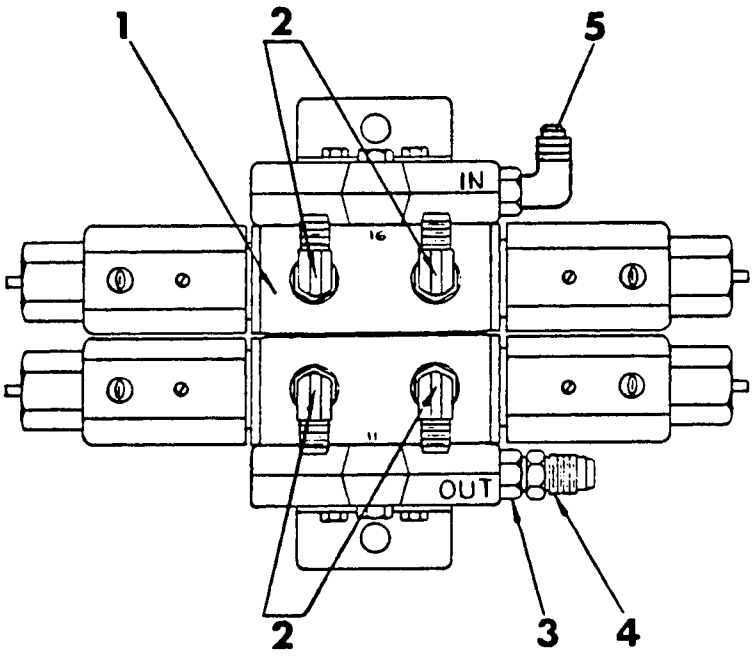


VIEW A

FIGURE 16 - PROPORTIONAL VALVE ASSEMBLY

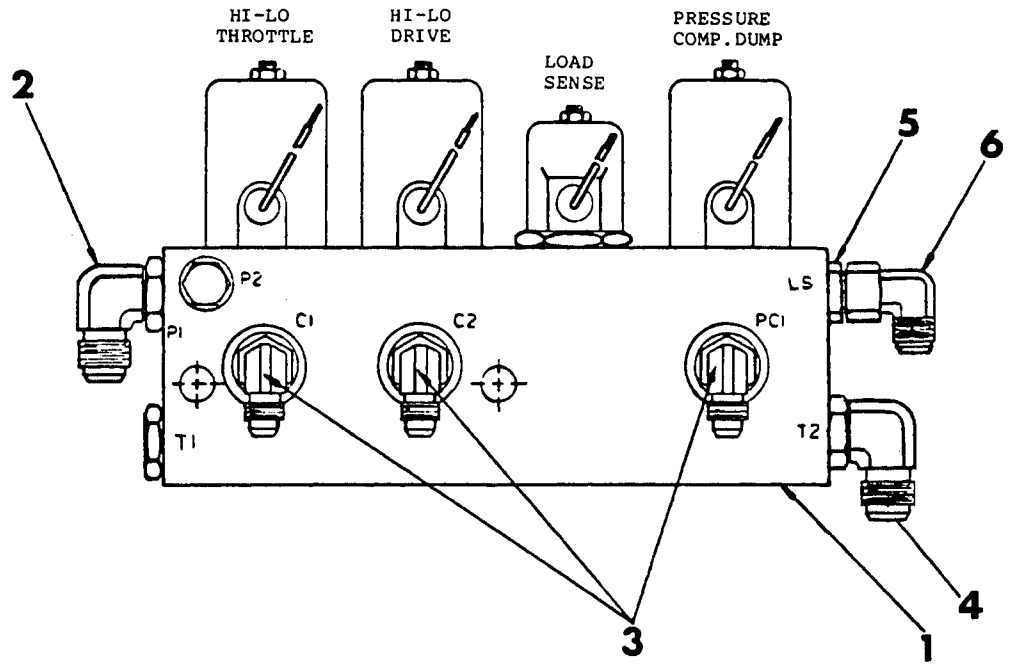
ITEM	PART NUMBER	DESCRIPTION	QTY
16.1-	22519	PROPORTIONAL VALVE ASSEMBLY	1
-1	21776	PROPORTIONAL VALVE	1
-2	80004-09	STRAIGHT THREAD CONNECTOR	1
-3	80028-05	SWIVEL NUT RUN TEE	1
-4	80058-03	FEMALE PIPE ADAPTER	1
-5	80060-05	NUT	1
-6	80056-01	TUBE END REDUCER	1
-7	80008-08	MALE ELBOW	1
-8	80039-04	FEMALE TEE	1
-9	80052-04	PIPE NIPPLE	2
-10	20357	NEEDLE VALVE	1
-11	80001-08	MALE CONNECTOR	1
-12	80063-15	FEMALE PIPE ADAPTER	1
-13	55300	TEE	1
-14	80004-03	STRAIGHT THREAD CONNECTOR	1
-15	80004-24	STRAIGHT THREAD CONNECTOR	1
-16	80004-18	STRAIGHT THREAD CONNECTOR	1
-17	80004-14	STRAIGHT THREAD CONNECTOR	4
-18	80012-18	STRAIGHT THREAD ELBOW	1
-19	54709	HEX REDUCING NIPPLE	1
-20	2527	QUICK DISCONNECT COUPLING	1
-21	845	CAP	1
-22	80059-03	CAP	1
-23	80012-14	STRAIGHT THREAD ELBOW	2

FIGURE 17 - MINIPAK SUB-ASSEMBLY



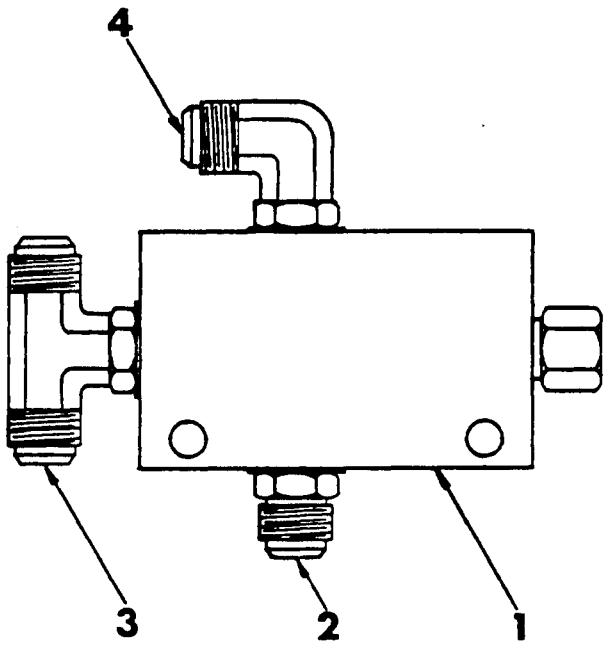
ITEM	PART NUMBER	DESCRIPTION	QTY
17-	21088	MINIPAK SUB-ASSEMBLY	1
-1	21207	SOLENOID VALVE BANK	1
-2	80012-05	90° STRAIGHT THREAD ELBOW	4
-3	80063-01	FEMALE PIPE ADAPTER	1
-4	80001-08	MALE CONNECTOR	1
-5	80012-08	STRAIGHT THREAD ELBOW	1

FIGURE 18 - SOLENOID VALVE ASSEMBLY



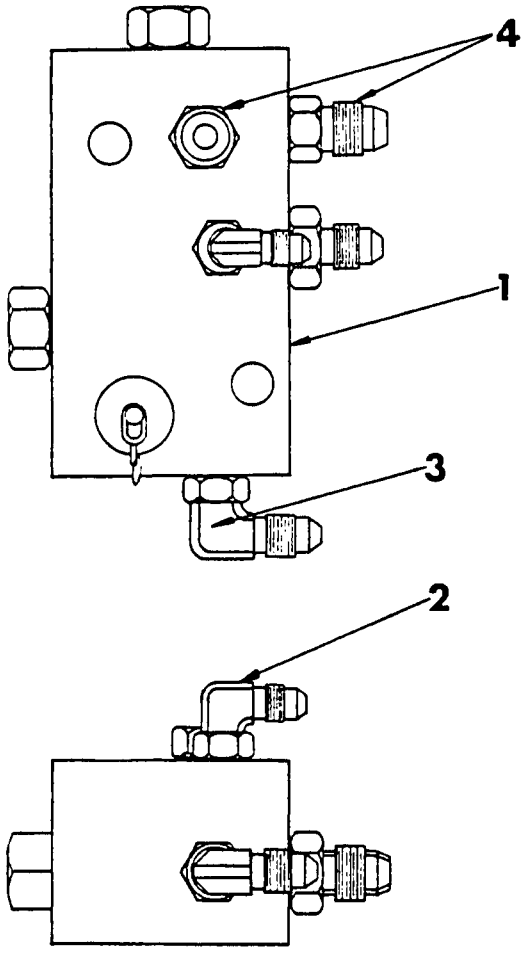
ITEM	PART NUMBER	DESCRIPTION	QTY
18-	21692	SOLENOID VALVE ASSEMBLY	1
-1	21860	SOLENOID VALVE	1
-2	50900	STRAIGHT THREAD ELBOW	1
-3	80012-03	90° STRAIGHT THREAD ELBOW	3
-4	80012-08	90° STRAIGHT THREAD ELBOW	1
-5	80004-03	STRAIGHT THREAD CONNECTOR	1
-6	80015-03	SWIVEL NUT ELBOW	1

FIGURE 18.1 - RELIEF VALVE ASSEMBLY



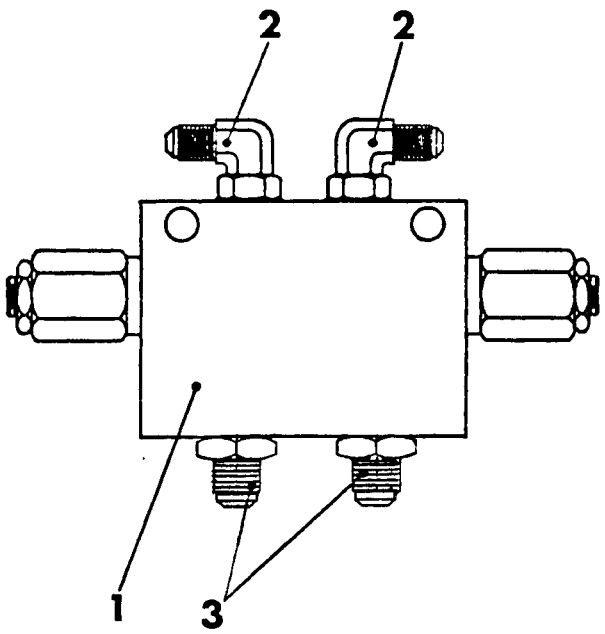
ITEM	PART NUMBER	DESCRIPTION	QTY
18.1-	22144	RELIEF VALVE ASSEMBLY	1
-1	20564	RELIEF VALVE REWORK	1
-2	80004-11	STRAIGHT THREAD CONNECTOR	1
-3	80036-11	STRAIGHT THREAD BRANCH TEE	1
-4	80012-11	STRAIGHT THREAD ELBOW	1

FIGURE 19 - PILOT VALVE MANIFOLD ASSEMBLY



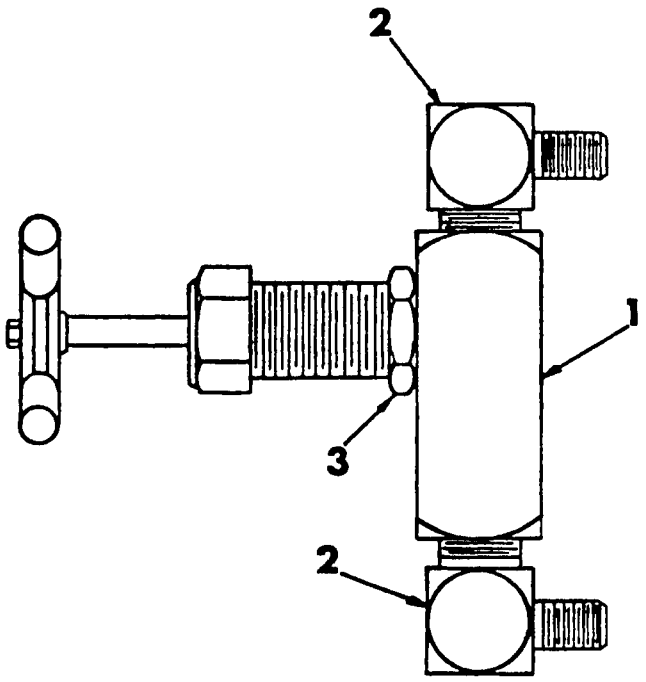
ITEM	PART NUMBER	DESCRIPTION	QTY
19-	21472	PILOT VALVE MANIFOLD ASSEMBLY	1
-1	21448	PILOT VALVE MANIFOLD	1
-2	80012-03	90° STRAIGHT THREAD ELBOW	1
-3	80012-08	90° STRAIGHT THREAD ELBOW	1
-4	80004-08	STRAIGHT THREAD CONNECTOR	2
-5	66905	BLOCK, MANIFOLD	
-6	66906	CARTRIDGE, PRIORITY	
-7	66907	CARTRIDGE, CHECK	
-8	66908	CARTRIDGE, SHUTTLE	
-9	67116	SEAL KIT (FOR 66906 & 66907)	
-10	67117	SEAL KIT (FOR 66908)	

FIGURE 19.1 - DUAL OVER CENTER VALVE ASSEMBLY



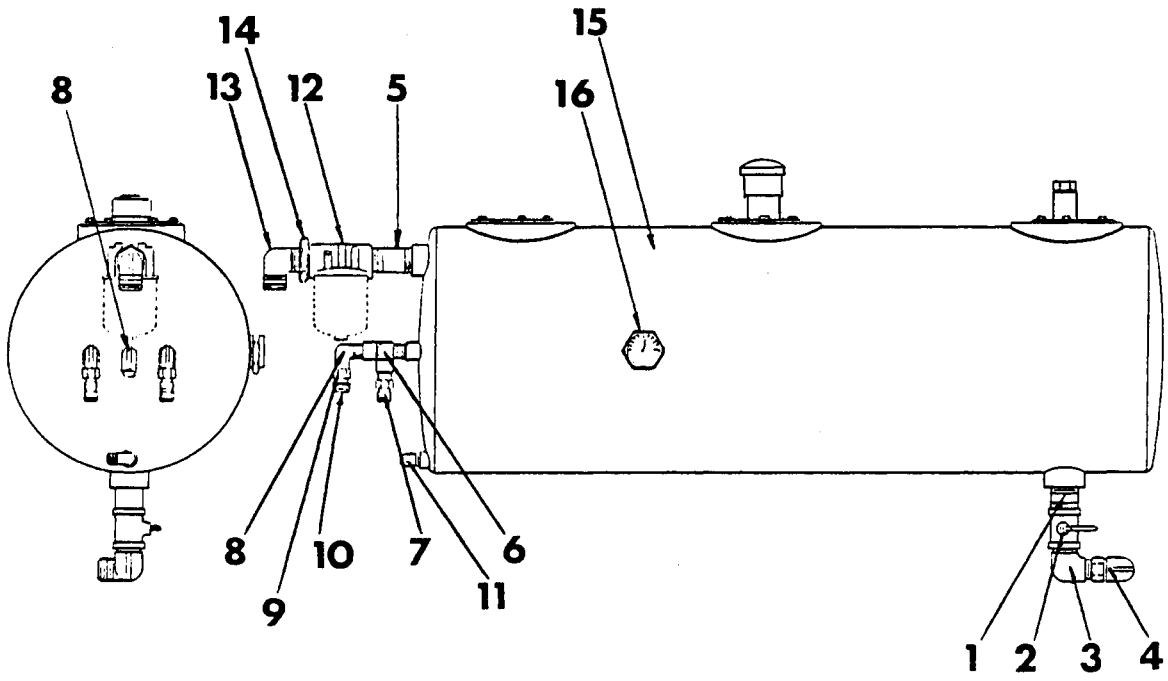
ITEM	PART NUMBER	DESCRIPTION	QTY
19.1-	21584	DUAL OVER CENTER VALVE ASSEMBLY	1
-1	20365	DUAL OVER CENTER VALVE	1
-2	80012-05	90° STRAIGHT THREAD ELBOW	2
-3	80004-05	STRAIGHT THREAD CONNECTOR	2

FIGURE 19.2 - MANUAL DESCENT VALVE ASSEMBLY



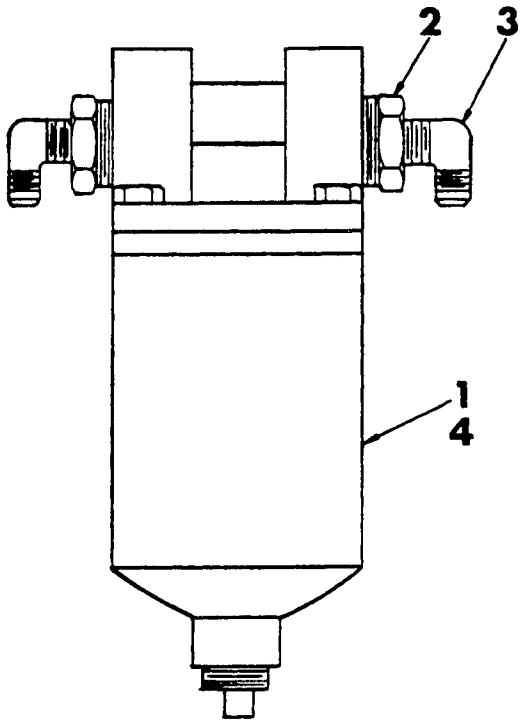
ITEM	PART NUMBER	DESCRIPTION	QTY
19.2-	22189	MANUAL DESCENT VALVE ASSEMBLY	1
-1	20436	NEEDLE VALVE	1
-2	51107	MALE ELBOW	2
-3	60911	JAM NUT - 15/16-20UNEF	1

FIGURE 20 - HYDRAULIC TANK ASSEMBLY



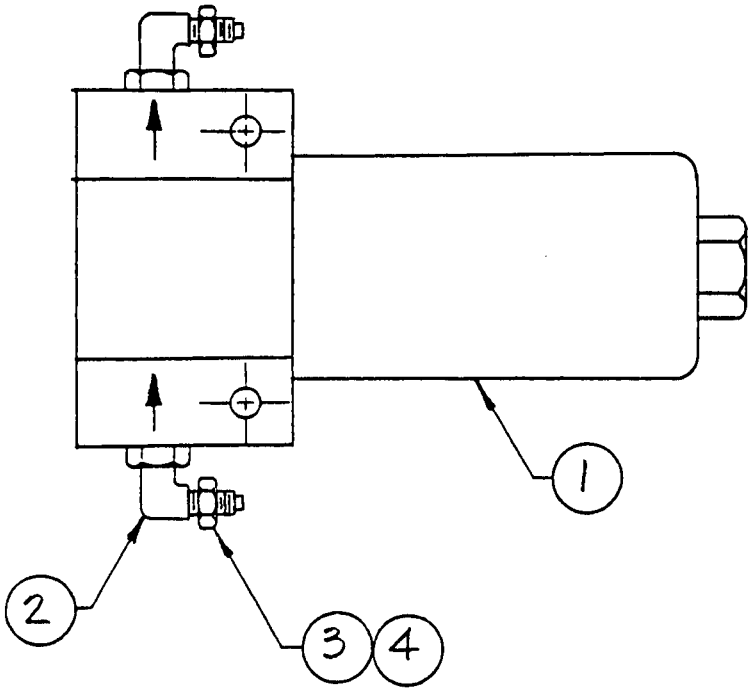
ITEM	PART NUMBER	DESCRIPTION	QTY
25-	21077	HYDRAULIC TANK ASSEMBLY	1
-1	16553	NIPPLE 1½ NPT SCH'D 40 BLK PIPE	1
-2	20050	BUTTERBALL VALVE 1½ NPT	1
-3	2551	ELBOW	1
-4	80015-11	SWIVEL NUT ELBOW	1
-5	16558	NIPPLE 1¼ NPT X 3½ LG. BLK PIPE	1
-6	2586	TEE	2
-7	80001-10	MALE CONNECTOR	2
-8	80008-10	MALE ELBOW	3
-9	80060-05	NUT	2
-10	80056-01	TUBE END REDUCER	2
-11	80008-20	MALE ELBOW	1
-12	21241	RETURN LINE FILTER	1
-13	80008-23	MALE ELBOW	1
-14	16705	BUSHING 1 1/4 X 1 NPT BLK. PIPE	1
-15	21336	HYDRAULIC TANK	1
-16		GAUGE (REF.)	1

FIGURE 20.1 - PILOT FILTER ASSEMBLY



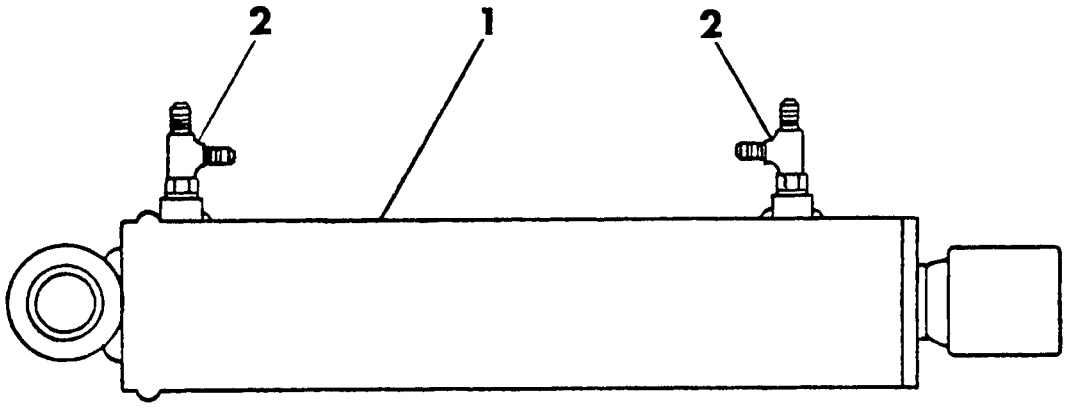
ITEM	PART NUMBER	DESCRIPTION	QTY
20.1-	22146	PILOT FILTER ASSEMBLY	1
-1	20368	FILTER	1
-2	80057-11	REDUCER	2
-3	80008-08	90° MALE ELBOW	2
-4	20472	FILTER ELEMENT	1

FIGURE 20.2- FILTER ASSEMBLY - 22963



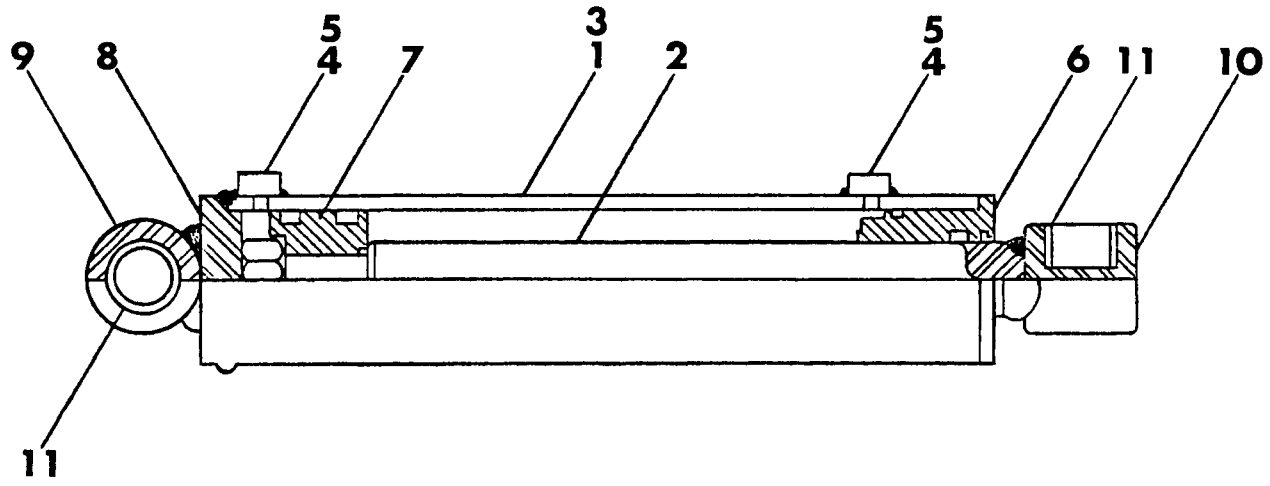
ITEM	QTY	PART NO.	DESCRIPTION
1	1	81076	FILTER
2	2	80012-14	STRAIGHT THREAD ELBOW
3	1	80056-03	TUBE END REDUCER
4	1	80060-06	NUT

FIGURE 21 - MASTER LEVELING CYLINDER ASSEMBLY



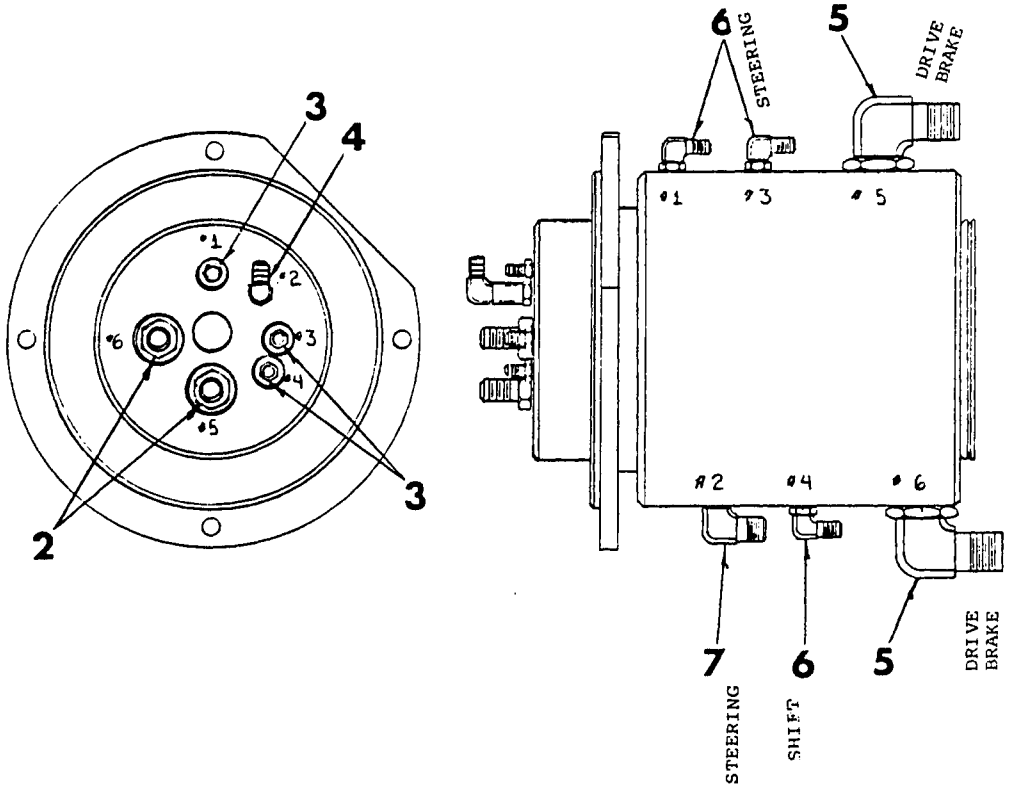
ITEM	PART NUMBER	DESCRIPTION	QTY
21-	21084	MASTER LEVELING CYLINDER ASSEMBLY	1
-1	21111	MASTER LEVELING CYLINDER (SEE FIG. 27)	1
-2	80033-03	STRAIGHT THREAD RUN TEE	2

FIGURE 22--MASTER LEVELING CYLINDER



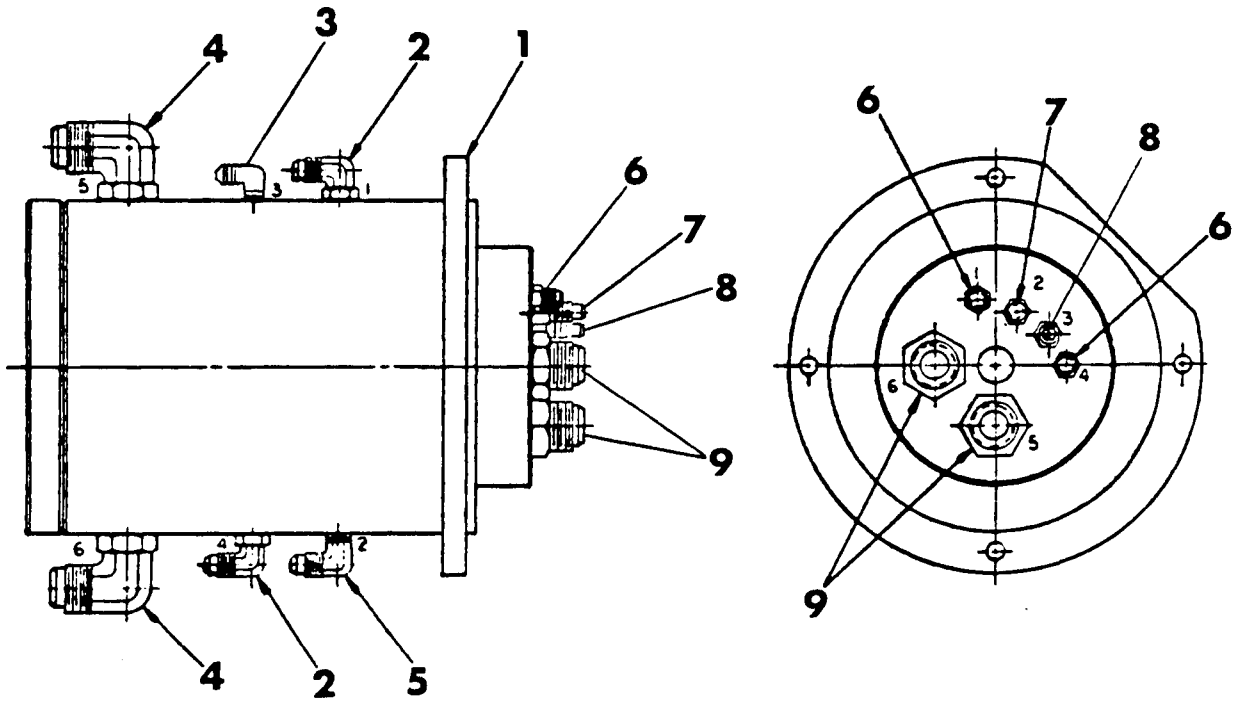
ITEM	PART NUMBER	DESCRIPTION	QTY
22-	21111	MASTER LEVELING CYLINDER	1
-1		BARREL - SE00211B	1
-2		ROD - SE00211R	1
-3		MARK NAMEPLATE - 9303	1
-4		PORT - 9885	2
-5		CAP PLUG - 9810	2
-6		TEE HEAD - 13204	1
-7		PISTON - 14139	1
-8		PLAIN BASE - 16011	1
-9		BASE PINEYE - 18609	1
-10		ROD PINEYE - 18610	1
-11		DUIZ BEARING - 9506	4
-12	66044	SEAL KIT - 25138	1

FIGURE 23- ROTARY MANIFOLD ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION	QTY
23-	20793	ROTARY MANIFOLD ASSEMBLY	1
-1	20324	HYDRAULIC ROTARY MANIFOLD	1
-2	80004-18	STRAIGHT THREAD CONNECTOR	2
-3	80004-03	STRAIGHT THREAD CONNECTOR	3
-4	80013-08	EXTRA LONG MALE ELBOW	1
-5	80012-18	STRAIGHT THREAD ELBOW	2
-6	80012-03	STRAIGHT THREAD ELBOW	3
-7	80008-08	MALE ELBOW	1
-8	66561	SEAL KIT (RA)	1

FIGURE 23.1- ROTARY MANIFOLD ASSEMBLY
(MARCH 1983)



ITEM	PART NUMBER	DESCRIPTION	QTY
23.1-	21898	ROTARY MANIFOLD ASSEMBLY	1
-1	21895	ROTARY MANIFOLD	1
-2	80012-03	STRAIGHT THREAD ELBOW	2
-3	80008-03	MALE ELBOW	1
-4	80012-18	STRAIGHT THREAD ELBOW	2
-5	80008-08	MALE ELBOW	1
-6	80004-03	STRAIGHT THREAD CONNECTOR	2
-7	80001-08	MALE CONNECTOR	1
-8	80001-08	MALE CONNECTOR	1
-9	80004-18	STRAIGHT THREAD CONNECTOR	2
-10	66561	SEAL KIT (RA)	1

FIGURE 24- SHEET METAL COVER KIT

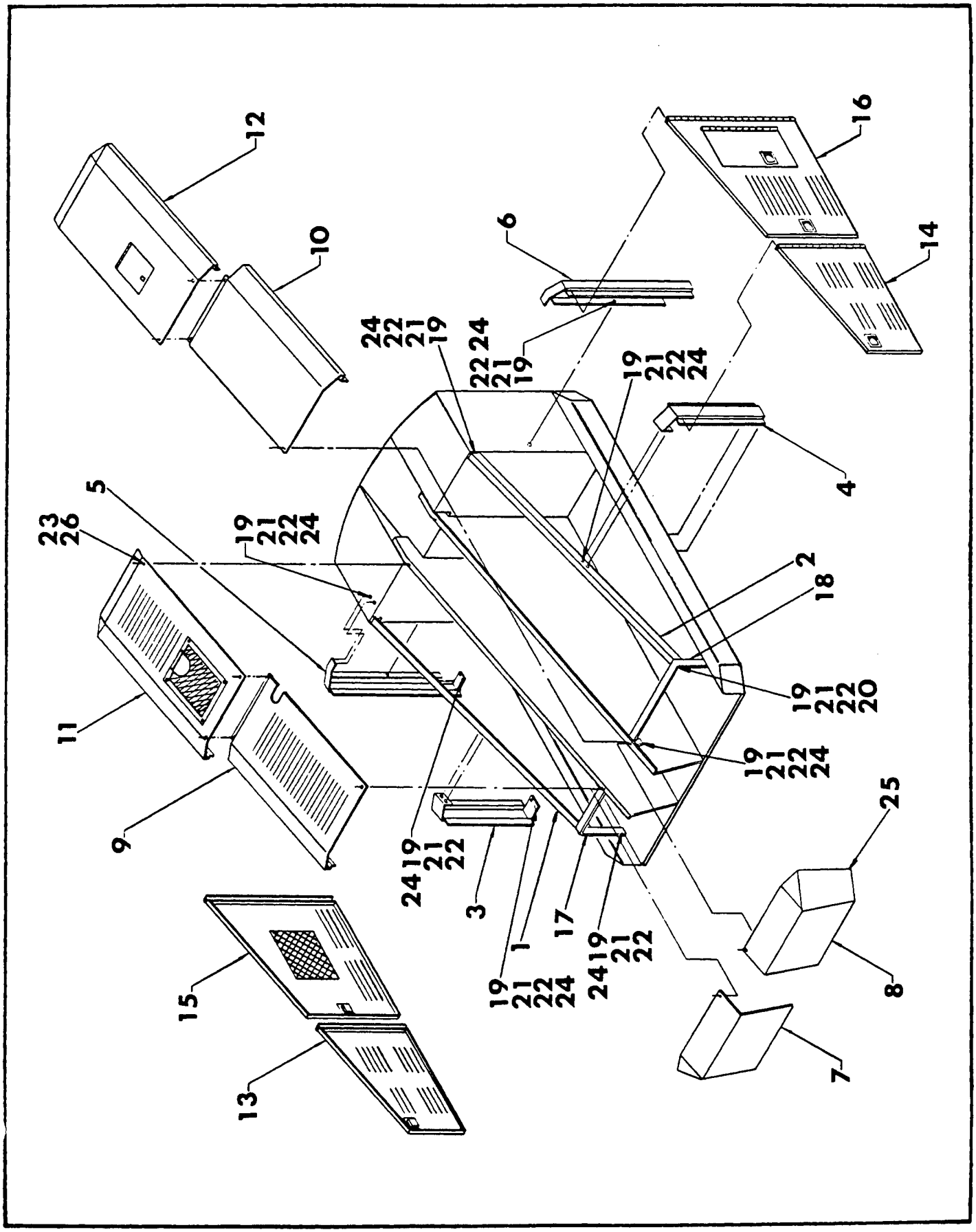
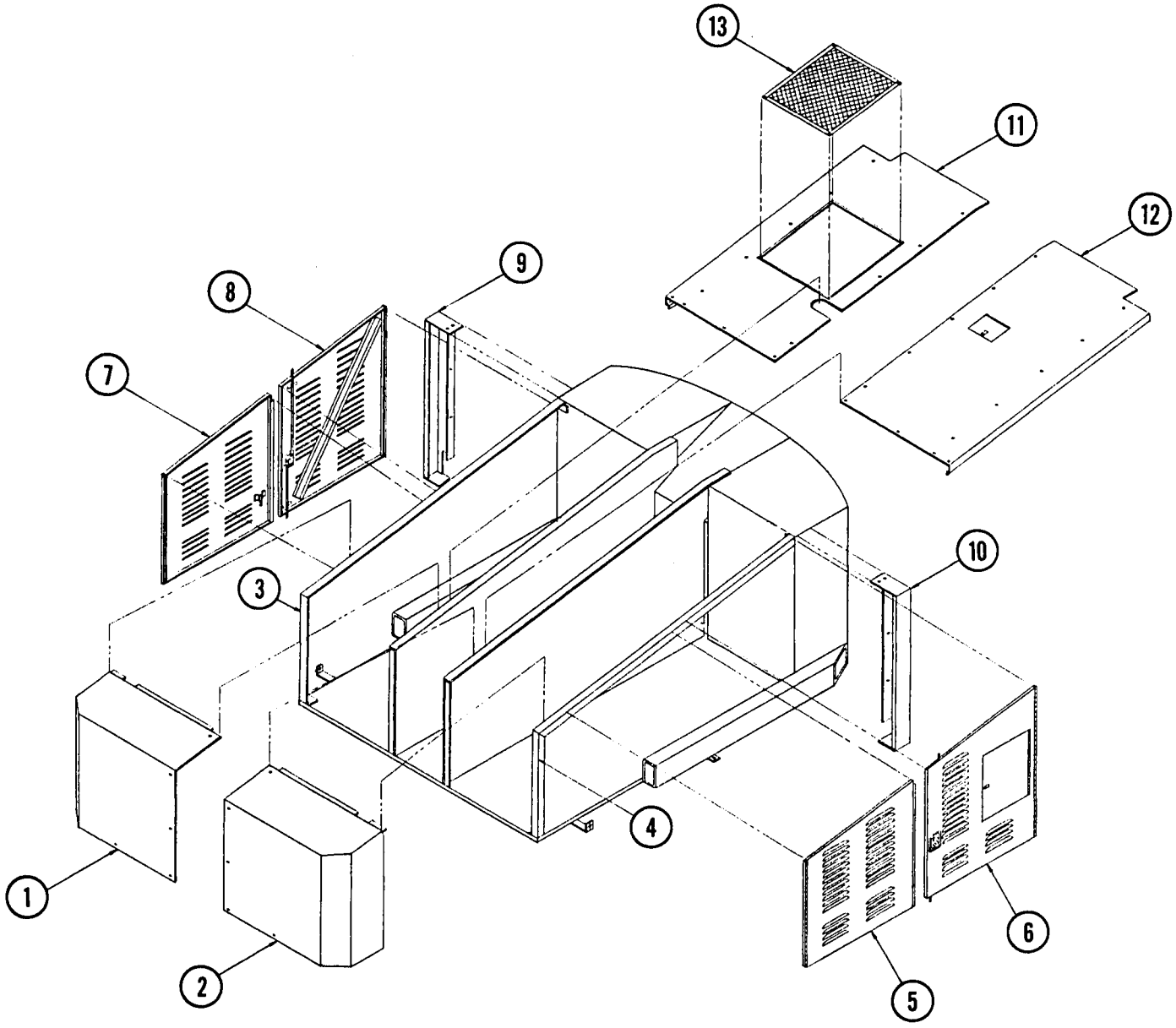


FIGURE 24 - SHEET METAL COVER KIT

ITEM	PART NUMBER	DESCRIPTION	QTY
24-	21224	SHEET METAL COVER KIT	1
-1	21362	LEFT FRAME RAIL	1
-2	21363	RIGHT FRAME RAIL	1
-3	21364	LEFT MID SUPPORT	1
-4	21365	RIGHT MID SUPPORT	1
-5	21366	LEFT FRONT SUPPORT	1
-6	21367	RIGHT FRONT SUPPORT	1
-7	21368	LEFT NOSE PIECE	1
-8	21369	RIGHT NOSE PIECE	1
-9	21370	LEFT MID COVER	1
-10	21371	RIGHT MID COVER	1
-11	21396	LEFT FRONT COVER	1
-12	21373	RIGHT FRONT COVER	1
-13	21374	LEFT REAR DOOR	1
-14	21375	RIGHT REAR DOOR	1
-15	21393	LEFT FRONT DOOR	1
-16	21377	RIGHT FRONT DOOR	1
-17	21378	LEFT REAR SUPPORT	1
-18	21379	RIGHT REAR SUPPORT	1
-19	60343	HEX HEAD CAPSCREW - 3/8-16UNC X 1	34
-20	60703	HEX NUT - 3/8-16UNC	4
-21	63403	FLAT WASHER - 3/8	34
-22	63303	SPLIT LOCKWASHER - 3/8	34
-23	61902	HEX SOCKET ROUND HEAD CAPSCREW - 1/4-20UNC X 3/4 (BOWMAN 40877)	52
-24	61313	LOCK NUT - 1/4-20UNC	30
-25	62401	FLAT HEAD CAPSCREW - 1/4-20 X 3/4	2
-26	63401	FLAT WASHER - 1/4	52



ITEM	QTY	PART NO.	DESCRIPTION
1	1	22630	LEFT NOSE COVER
2	1	22631	RIGHT NOSE COVER
3	1	22659	LEFT SUPPORT
4	1	22660	RIGHT SUPPORT
5	1	22628	RIGHT REAR DOOR
6	1	22629	RIGHT FRONT DOOR
7	1	22627	LEFT REAR DOOR
8	1	22626	LEFT FRONT DOOR
9	1	22661	LEFT FRONT SUPPORT
10	1	22662	RIGHT FRONT SUPPORT
11	1	22633	TOP LEFT COVER
12	1	22632	TOP RIGHT COVER
13	1	22634	EXPANDED METAL SCREEN

FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY

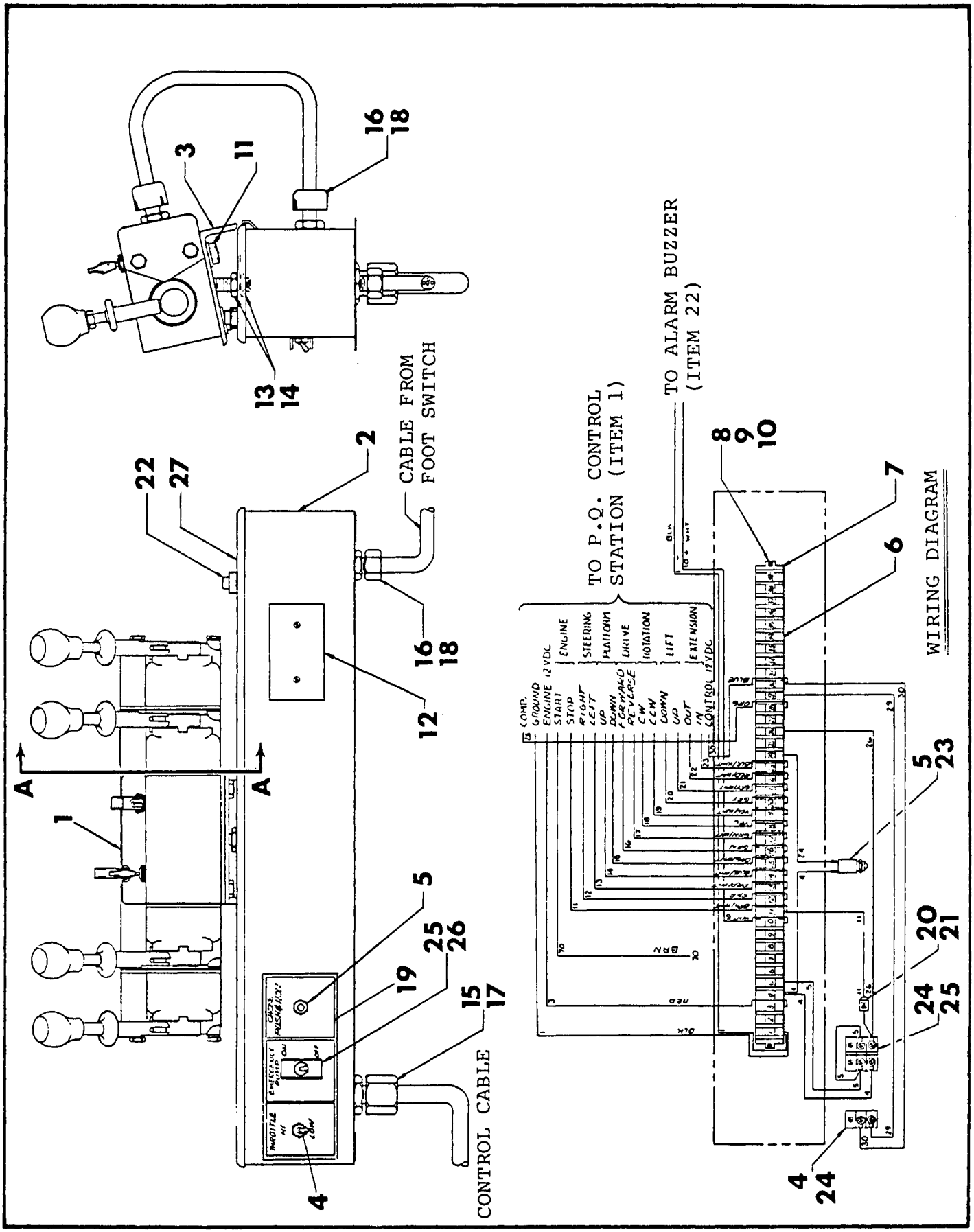
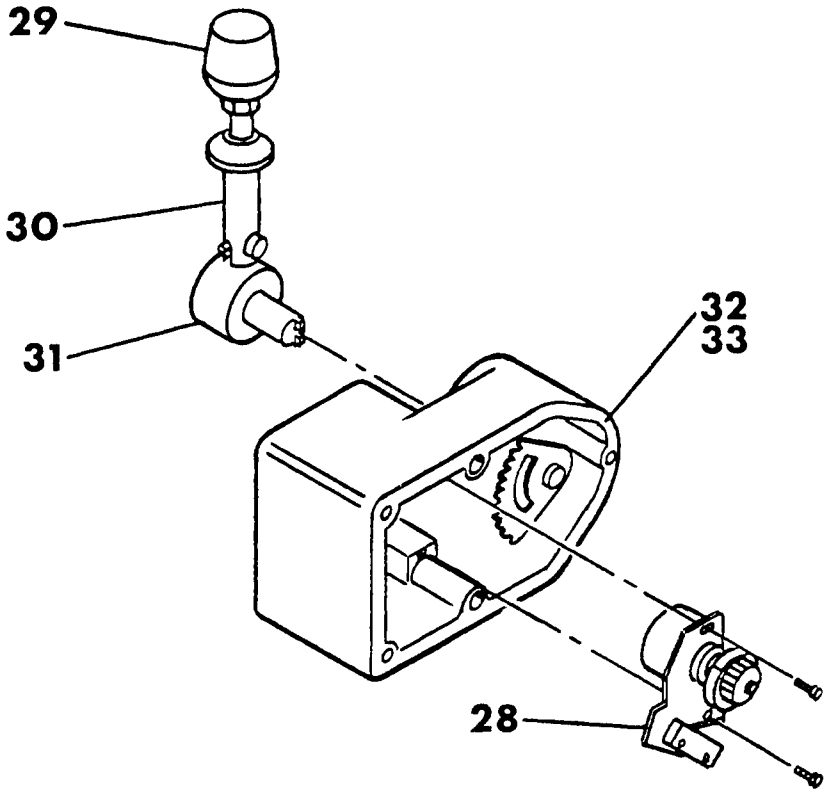


FIGURE 25- AERIAL CONTROL CONSOLE ASSEMBLY



VIEW A

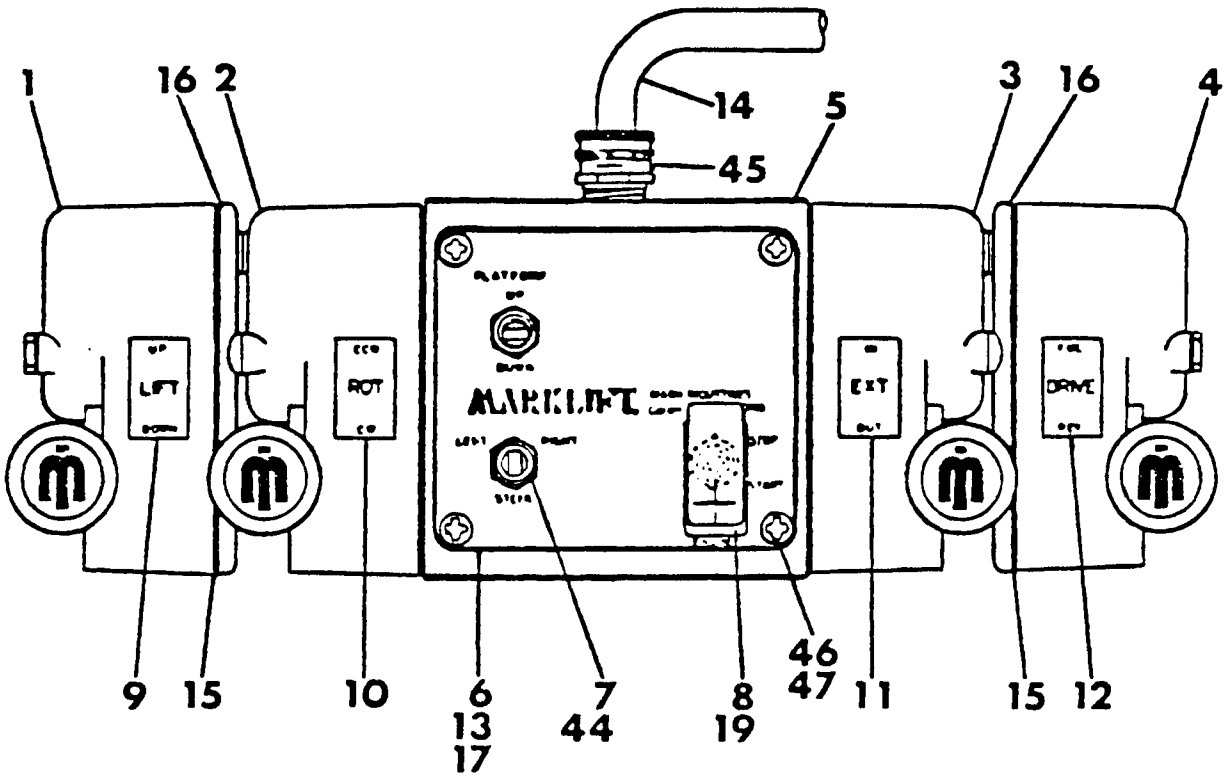
FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
25-	21090	AERIAL CONTROL CONSOLE ASSEMBLY	1
-1	20392	AERIAL CONTROL STATION (SEE FIG. 25.2)	1
-2	20311	ENCLOSURE 4 X 4 X 24	1
-3	20217	CONTROL STATION MOUNTING BRACKET	1
-4	4017	TOGGLE SWITCH	1
-5	4011	PUSH BUTTON SWITCH	1
-6	4027	TERMINAL BLOCK	39
-7	117A	TERMINAL BLOCK END	1
-8	62624	TRUSS HEAD CAP SCREW - NO. 6-32UNC X 3/8	5
-9	60710	HEX NUT - NO. 6-32UNC	5
-10	63311	LOCK WASHER - NO. 6	5
-11	60633	HEX HEAD CAP SCREW - 1/4-20UNC X 1/2 (BOWMALOK 41000)	4
-12	902	COVER PLATE	1
-13	60702	HEX NUT - 5/16-18UNC	4
-14	63302	LOCK WASHER - 5/16	4
-15	16215	STRAIN RELIEF	1
-16	2806	STRAIN RELIEF	2
-17	16105	LOCK NUT	1
-18	2808	LOCK NUT	2
-19	22571	DECAL	1
-20	4045	DIODE	1
-21	877	BUTT CONNECTOR	1
-22	20805	ALARM BUZZER	1
-23	117E	PUSH ON TERMINAL	2
-24	2859	RING TONGUE	8
-25	70037	TOGGLE SWITCH	1
-26	20884	SWITCH GUARD	1
-27	20444	DECAL (5^{O} SLOPE)	1
-28	20580	POTENTIOMETER ASSEMBLY	1
-29	20479	KNOB	1
-30	20581	CONTROLLER LOCK-OUT	1
-31	20539	CONTROLLER HANDLE ASSEMBLY	1

FIGURE 25 - AERIAL CONTROL CONSOLE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
-32	20597	GASKET	1
-33	20598	GASKET - CENTER COVER	1

FIGURE 25.1 - AERIAL CONTROL STATION ASSEMBLY



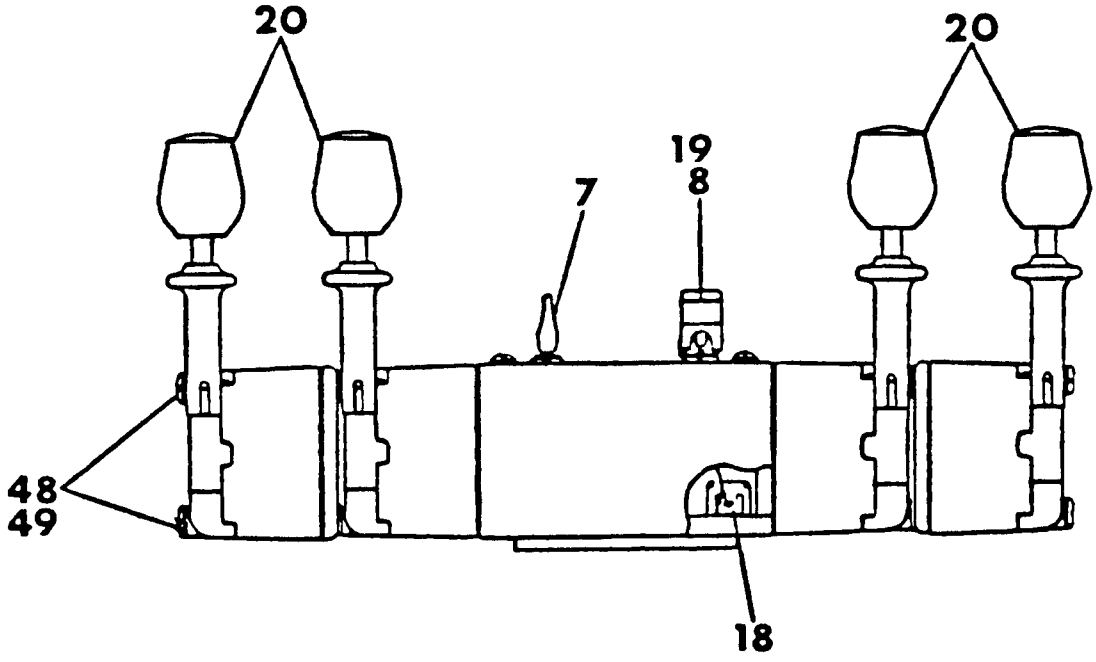


FIGURE 25.1- AERIAL CONTROL STATION ASSEMBLY

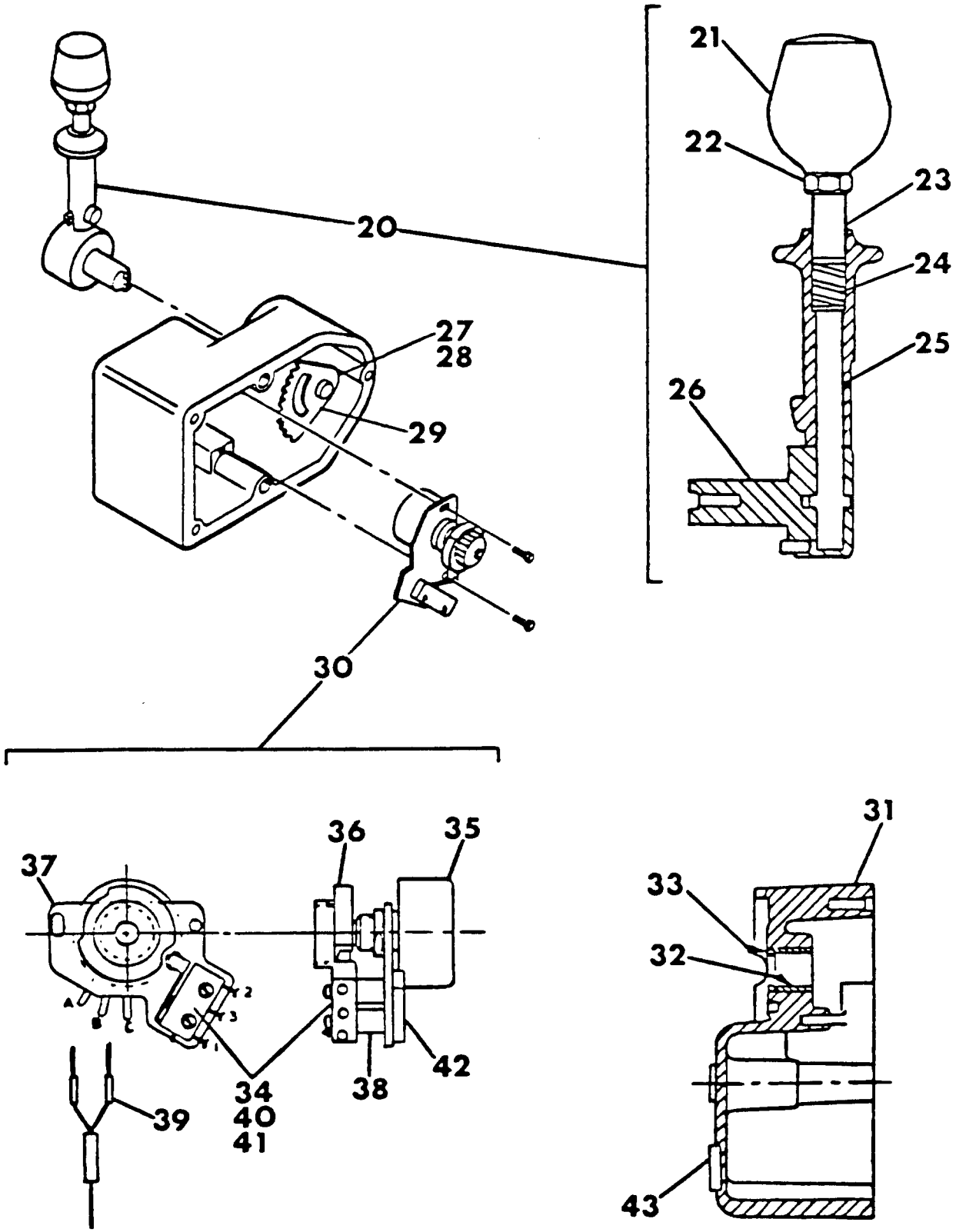


FIGURE 25.1- AERIAL CONTROL STATION ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
25.1-	20392	AERIAL CONTROL STATION ASSEMBLY (PQ)	1
-1	2962	LIFT CONTROLLER ASSEMBLY	1
-2	2959	ROTATION CONTROLLER ASSEMBLY	1
-3	2960	EXTENSION CONTROLLER ASSEMBLY	1
-4	2963	DRIVE CONTROLLER ASSEMBLY	1
-5	16907	CENTER HOUSING	1
-6	16908	SWITCH MOUNTING PLATE	1
-7	20618	MOMENTARY SWITCH	2
-8	16912	SWITCH GUARD (RED)	1
-9	16901	LIFT METAL DECAL	1
-10	16910	ROTATION METAL DECAL	1
-11	16905	EXTENSION METAL DECAL	1
-12	16909	DRIVE METAL DECAL	1
-13	16913	SWITCH MOUNTING PLATE (USED ON S21 ONLY)	1
-14	16914	CONTROLLER CABLE	1
-15	20597	CONTROLLER HOUSING GASKET	4
-16	16900	CONTROLLER HOUSING COVER PLATE	2
-17	20598	SWITCH PLATE MOUNTING GASKET	1
-18	66161	TERMINAL STRIP	2
-19	4021	START/STOP SWITCH	1
-20	20539	CONTROLLER HANDLE ASSEMBLY	4
-21	20479	CONTROLLER KNOB W/LOGO	4
-22	60708	5/16" HEX NUT	4
-23	16916	SAFETY LOCK SPACER	4
-24	16915	SAFETY LOCK SPRING	4
-25	20581	SAFETY LOCK	4
-26	16903	CONTROLLER HANDLE	4
-27	16904	TORSION SPRING	4
-28	16917	TORSION SPRING SPACER	4
-29	16906	SELECTOR GEAR	4
-30	20580	POTENTIOMETER ASSEMBLY	4
-31	* 16902	CONTROLLER HOUSING	4
-32	66222	BUSHING-CONTROLLER HOUSING	4

FIGURE 25.1 - AERIAL CONTROL STATION ASSEMBLY

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

FIGURE 26 - FINAL BOOM ASSEMBLY

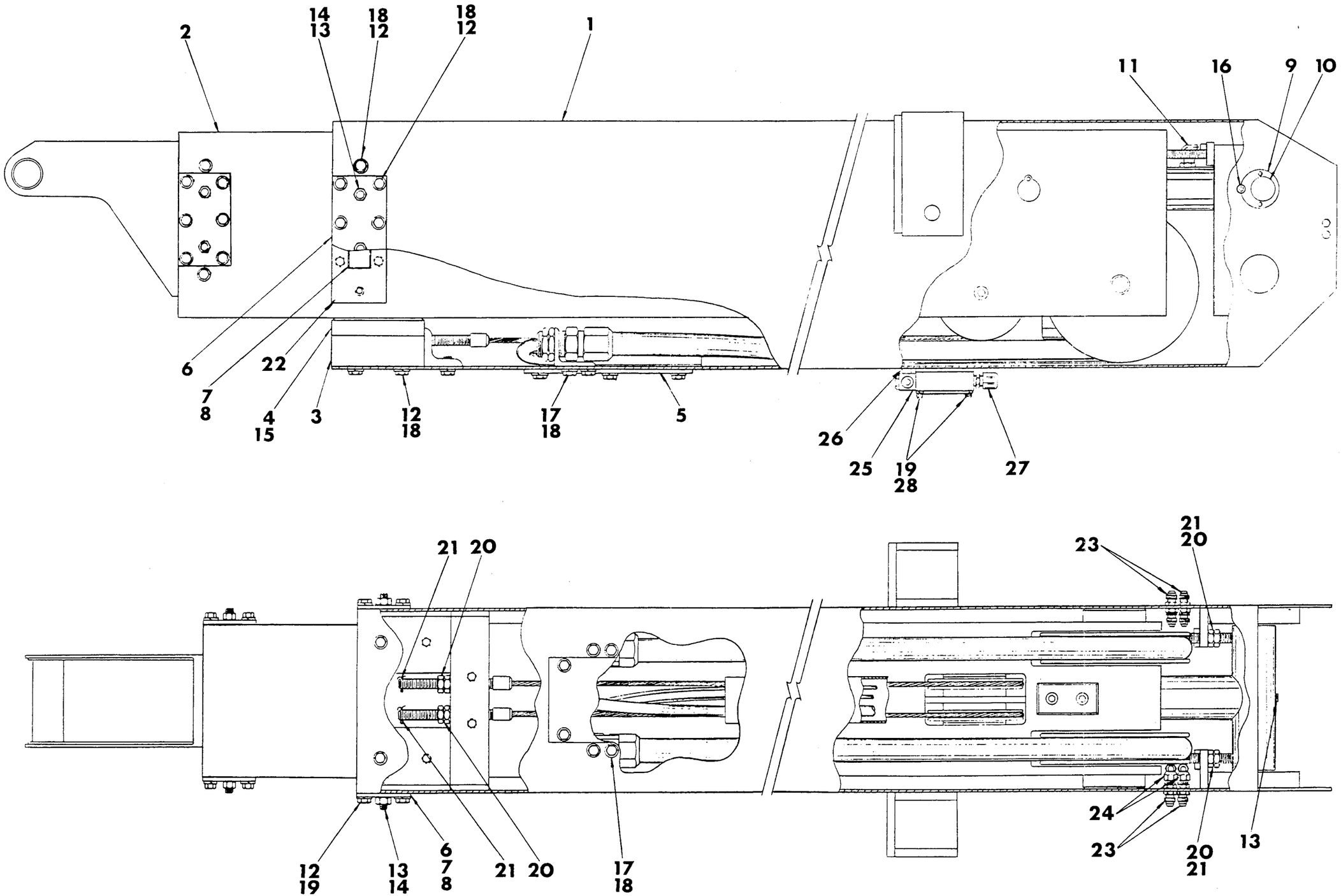


FIGURE 26 - FINAL BOOM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
31-	21052	FINAL BOOM ASSEMBLY	1
-1	21101	OUTER BOOM MACHINING	1
-2	21053	INTERMEDIATE BOOM ASSEMBLY (SEE FIG. 27)	1
-3	21310	END BRACKET	1
-4	21311	WEAR PAD	2
-5	21320	ACCESS COVER PLATE	1
-6	21321	COVER PLATE	2
-7	20453	PAD PRESSURE PLATE	2
-8	21315	WEAR PAD	2
-9	21353	ECCENTRIC BUSHING	2
-10	21340	PIN	1
-11	80012-11	STRAIGHT THREAD ELBOW	2
-12	60343	HEX HEAD CAP SCREW - 3/8-16UNC X 1	22
-13	62204	HEX SOCKET HEAD SET-SCREW - 1/2-13UNC X 1	5
-14	61101	JAM NUT - 1/2-13UNC	4
-15	61806	HEX SOCKET FLAT HEAD CAP SCREW - 3/8-24UNF X 1 1/4	4
-16	62203	HEX SOCKET HEAD SET-SCREW - 3/8-16UNC X 3/8	2
-17	60607	HEX HEAD CAP SCREW - 3/8-16UNC X 3/4 (BOWMALOK 41012)	4
-18	63303	SPLIT LOCK WASHER - 3/8	26
-19	63313	SPLIT LOCK WASHER - NO. 10	2
-20	61102	JAM NUT - 5/8-11UNC	8
-21	64301	COTTER PIN - 1/8 DIA. X 1	4
-22	21358	WEAR PAD RETAINER	2
-23	80045-03	BULKHEAD UNION	4
-24	2594	90° ELBOW SWIVEL HOSE FITTING	2
-25	70107	LIMIT SWITCH	1
-26	20804	ACTUATOR ARM	1
-27	2806	STRAIN RELIEF	1

ITEM	PART NUMBER	DESCRIPTION	QTY
-28	61916	HEX SOCKET HEAD CAP SCREW - NO. 10-32 UNC X 2	2

FIGURE 26.1 - FINAL BOOM ASSEMBLY (MARK TRACK)

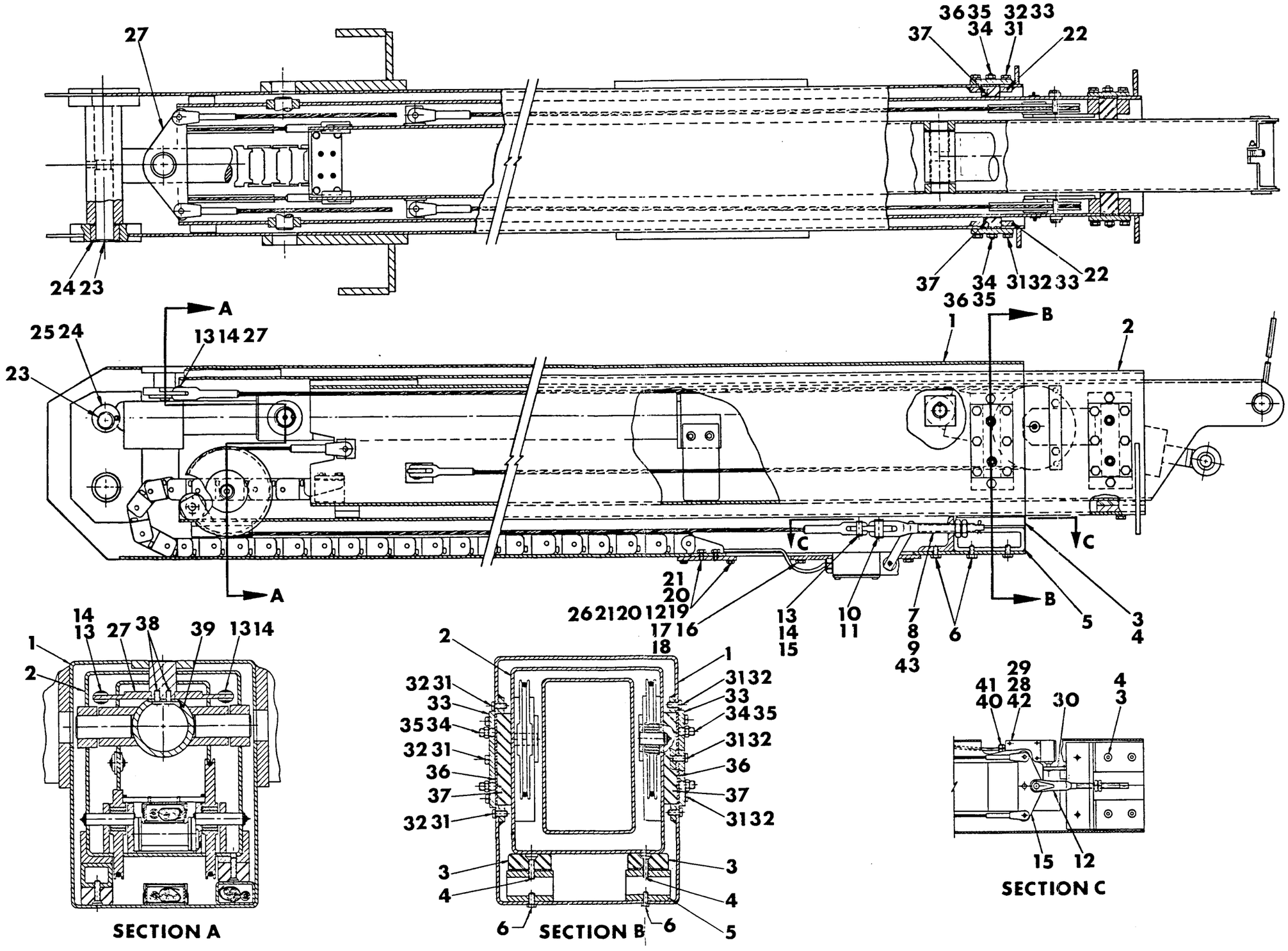
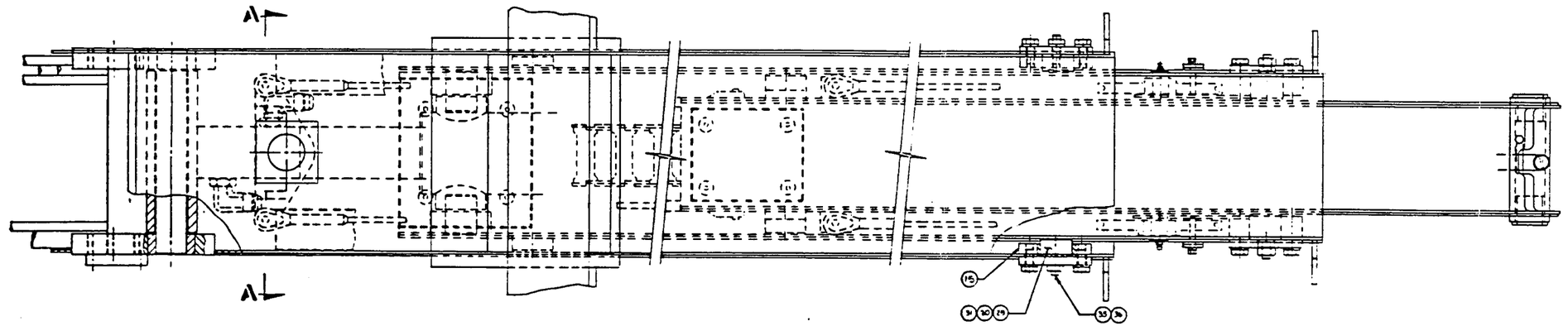


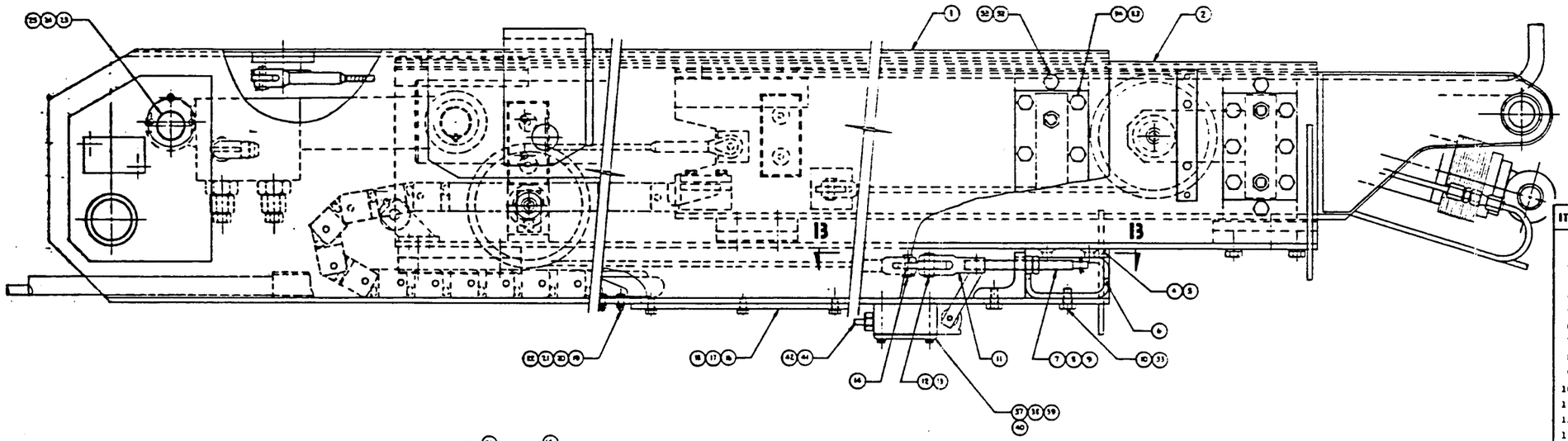
FIGURE 26.1 - FINAL BOOM ASSEMBLY (MARK TRACK)

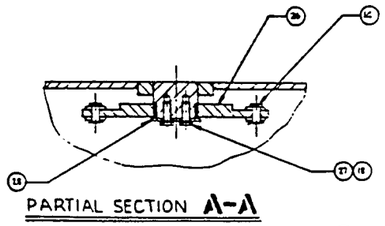
ITEM	PART NUMBER	DESCRIPTION	QTY
26.1-	22700	FINAL BOOM ASSEMBLY	1
-1	22694	OUTER BOOM MACHINING	1
-2	22699	INTERMEDIATE BOOM ASSEMBLY (SEE FIG. 27.1)	1
-3	22696	WEAR PAD	2
-4	61806	FLAT SOCKET HEAD CAP SCREW - 3/8-24UNF X 1 1/4	4
-5	22706	BOOM END BRACKET	1
-6	60607	HEX HEAD CAP SCREW - 3/8-16UNC X 3/4 (BOWMALOK 41012)	6
-7	22710	THREADED SLEEVE - 3/4-10UNC	1
-8	60910	JAM NUT - 3/4-10UNC	2
-9	64301	COTTER PIN - 1/8 DIA. X 1	1
-10	22708	PIN	1
-11	65076	SNAP RING	2
-12	63301	SPLIT LOCK WASHER - 1/4	4
-13	22703	PIN	4
-14	65082	SNAP RING	8
-15	22707	RETRACTION LEVER CABLE	1
-16	60367	HEX HEAD CAP SCREW - 5/16-18UNC X 5/8 (GR. 5)	6
-17	63302	SPLIT LOCK WASHER - 5/16	6
-18	21320	ACCESS COVER	1
-19	60617	HEX HEAD CAP SCREW - 1/4-20UNC X 1 (BOWMALOK 41002)	4
-20	22586	STATIONARY MOUNTING BRACKET (L.H.)	1
-21	22585	STATIONARY MOUNTING BRACKET (R.H.)	1
-22	21358	WEAR PAD RETAINER	2
-23	21340	BOOM EXTENSION CYLINDER PIN	1
-24	21353	ECCENTRIC BUSHING	2
-25	62203	SOCKET HEAD SET SCREW - 3/8-16UNC X 3/8	2
-26	60701	HEX NUT - 1/4-20UNC	8
-27	22709	EXTENSION CABLE LEVER	1
-28	62704	ROUND SLOTTED HEAD MACHINE SCREW - NO. 10-32UNF	2

FIGURE 26.1 - FINAL BOOM ASSEMBLY
(MARK TRACK)

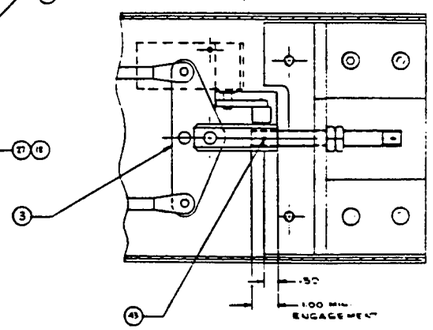
ITEM	PART NUMBER	DESCRIPTION	QTY
-29	63313	SPLIT LOCK WASHER - NO. 10	2
-30	70148	LEVER ARM	1
-31	60325	HEX HEAD CAP SCREW - 3/8-16UNC X 1 (GR. 5)	16
-32	63303	SPLIT LOCK WASHER - 3/8	16
-33	21321	COVER PLATE	2
-34	62204	SOCKET HEAD SET SCREW - 1/2-13UNC X 1	4
-35	61101	JAM NUT - 1/2-13UNC	4
-36	20453	PAD PRESSURE PLATE	2
-37	21315	WEAR PAD	2
-38	60603	HEX HEAD CAP SCREW - 5/16-18UNC X 3/4 (BOWMALOK 41006)	2
-39	22593	RETAINER	1
-40	2806	STRAIN RELIEF	1
-41	2768-385	ELECTRICAL CABLE - 18-2 AWG X 385	1
-42	70107	LIMIT SWITCH	1
-43	64301	COTTER PIN - 1/8 DIA. X 1	1







PARTIAL SECTION A-A



SECTION 13-13

ITEM	QTY	PART NO.	DESCRIPTION
35	4	62204	SCREW, SET
36	4	61101	NUT, JAM
37	1	70107	SWITCH, LIMIT
38	2	62615	SCREW, MACHINE
39	2	63313	WASHER, LOCK
40	1	70148	LEVER, ARM
41	1	2806	RELIEF, STRAIN
42	1	70036-385	CABLE, ELECTRICAL
43	1	64204	PIN, ROLL

ITEM	QTY	PART NO.	DESCRIPTION
1	1	21055	MACHINING, OUTER BOOM
2	1	22063	ASSY., INTERMEDIATE BOOM
3	1	23210	LEVER, RETRACTION CABLE
4	2	23208	PAD, WEAR
5	4	61801	SCREW, CAP
6	1	23212	BRACKET, BOOM END
7	1	22594	SLEEVE, THREADED
8	2	60801	NUT, HEX
9	1	64301	PIN, COTTER
10	4	60542	SCREW, CAP
11	1	23269	TERMINAL, CABLE
12	1	22548	PIN
13	2	65081	RING, SNAP
14	4	23544	PIN, CLEVIS
15	2	23158	RETAINER
16	1	21320	COVER, PLATE
17	6	60367	SCREW, CAP
18	6	63302	WASHER, LOCK
19	4	60581	SCREW, CAP
20	1	22586	BRACKET, MOUNTING STATIONARY LEFT HAND
21	1	22585	BRACKET, MOUNTING STATIONARY RIGHT HAND
22	4	63301	WASHER, LOCK
23	1	23213	PIN, BOOM EXTENSION CYLINDER
24	2	21353	BUSHING, ECCENTRIC
25	2	62203	SCREW, SET
26	1	23209	LEVER, EXTENSION CABLE
27	2	60533	SCREW, CAP
28	1	22593	RETAINER
29	2	23170	PAD, WEAR
30	2	20453	PLATE, PAD PRESSURE
31	2	21321	PLATE, COVER
32	4	60395	SCREW, CAP
33	20	63303	WASHER, LOCK
34	12	60343	SCREW, CAP

FIGURE 27 - INTERMEDIATE BOOM ASSEMBLY

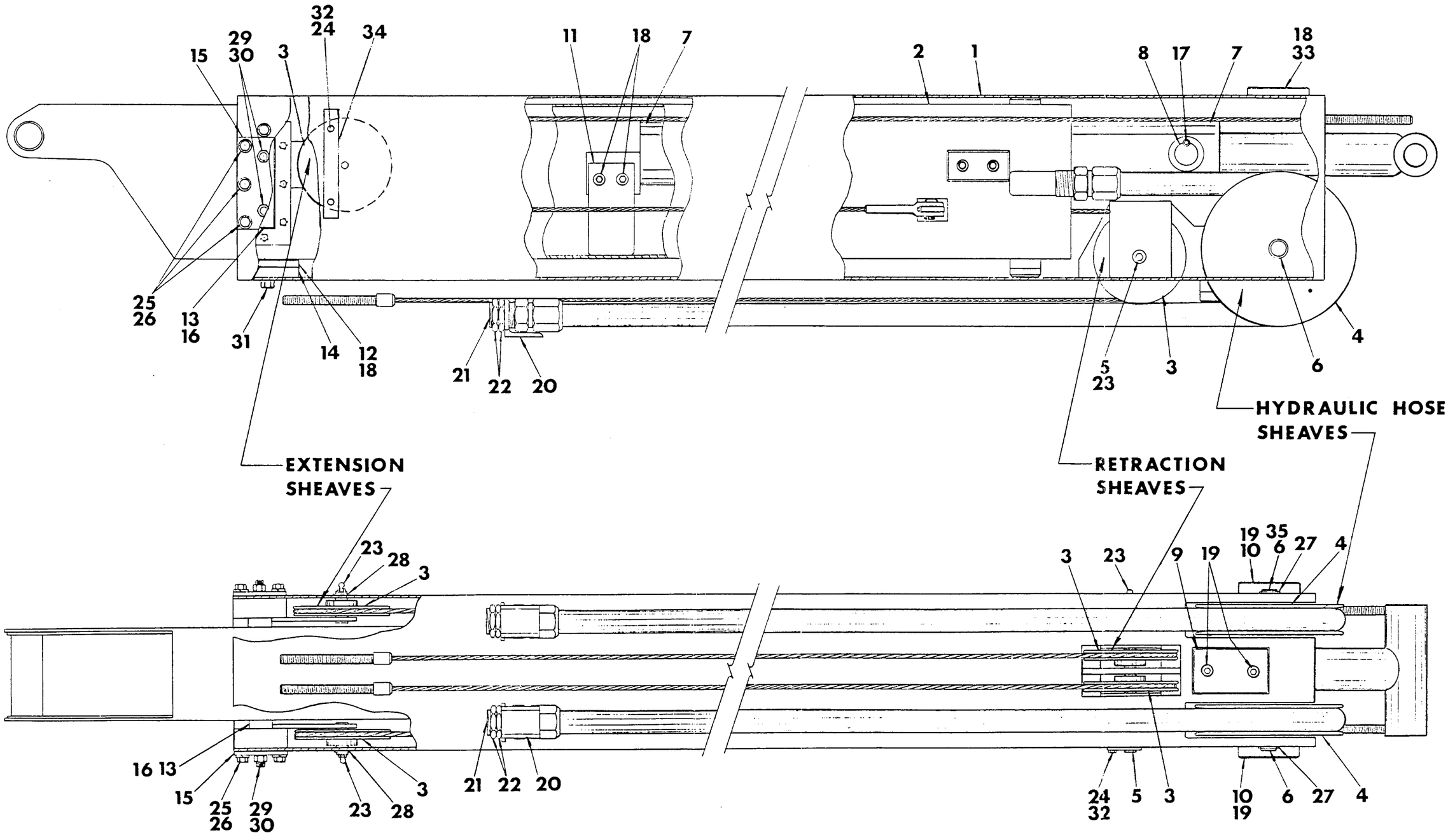


FIGURE 27 - INTERMEDIATE BOOM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	QTY
32-	21053	INTERMEDIATE BOOM ASSEMBLY	1
-1	21102	INTERMEDIATE BOOM MACHINING	1
-2	21054	INNER BOOM ASSEMBLY (SEE FIG. 28)	1
-3	21303	CABLE SHEAVE ASSEMBLY	4
-4	20247	HOSE SHEAVE	2
-5	21302	CABLE SHEAVE SHAFT	1
-6	21300	HOSE SHEAVE PIN	1
-7	21893	BOOM EXTENSION CYLINDER ASSEMBLY (SEE FIG. 31.1)	1
-8	21338	TRUNNION PIN	2
-9	20284	WEAR PAD	1
-10	21317	WEAR PAD	2
-11	21312	WEAR PAD	2
-12	21391	WEAR PAD	1
-13	21314	WEAR PAD	2
-14	21343	WEAR PAD SUPPORT PLATE	1
-15	21321	COVER PLATE	2
-16	20453	PAD PRESSURE PLATE	2
-17	62203	HEX SOCKET HEAD SETSCREW - 3/8-16UNC X 3/8	2
-18	61801	HEX SOCKET FLAT HEAD CAPSCREW - 3/8-24UNF X 3/4	12
-19	61805	HEX SOCKET FLAT HEAD CAPSCREW - 3/8-24UNF X 1	6
-20	20298	RETRACTION HOSE BRACKET	2
-21	20211	HOSE ADAPTER	2
-22	80061-11	BULKHEAD LOCKNUT	4
-23	65103	GREASE FITTING - 1/8NPT	3
-24	60627	HEX HEAD CAPSCREW - 5/16-18UNC X 1/2 (BOWMALOK 41005)	5
-25	60307	HEX HEAD CAPSCREW - 3/8-16UNC X 1 1/2 (GR. 5)	12
-26	63303	SPLIT LOCKWASHER - 3/8	12
-27	65075	SNAP RING	2
-28	65076	SNAP RING	2

ITEM	PART NUMBER	DESCRIPTION	QTY
-29	62204	HEX SOCKET HEAD SETSCREW - 1/2-13UNC X 1	4
-30	61101	JAM NUT - 1/2-13UNC	4
-31	60613	HEX HEAD CAPSCREW - 3/8-16UNC X 1 (BOWMALOK 41013)	2
-32	63302	SPLIT LOCKWASHER - 5/16	5
-33	21316	WEAR PAD	2
-34	21287	CABLE KEEPER	2
-35	25397	SPACER	2

FIGURE 27.1 - INTERMEDIATE BOOM ASSEMBLY (MARK TRACK)

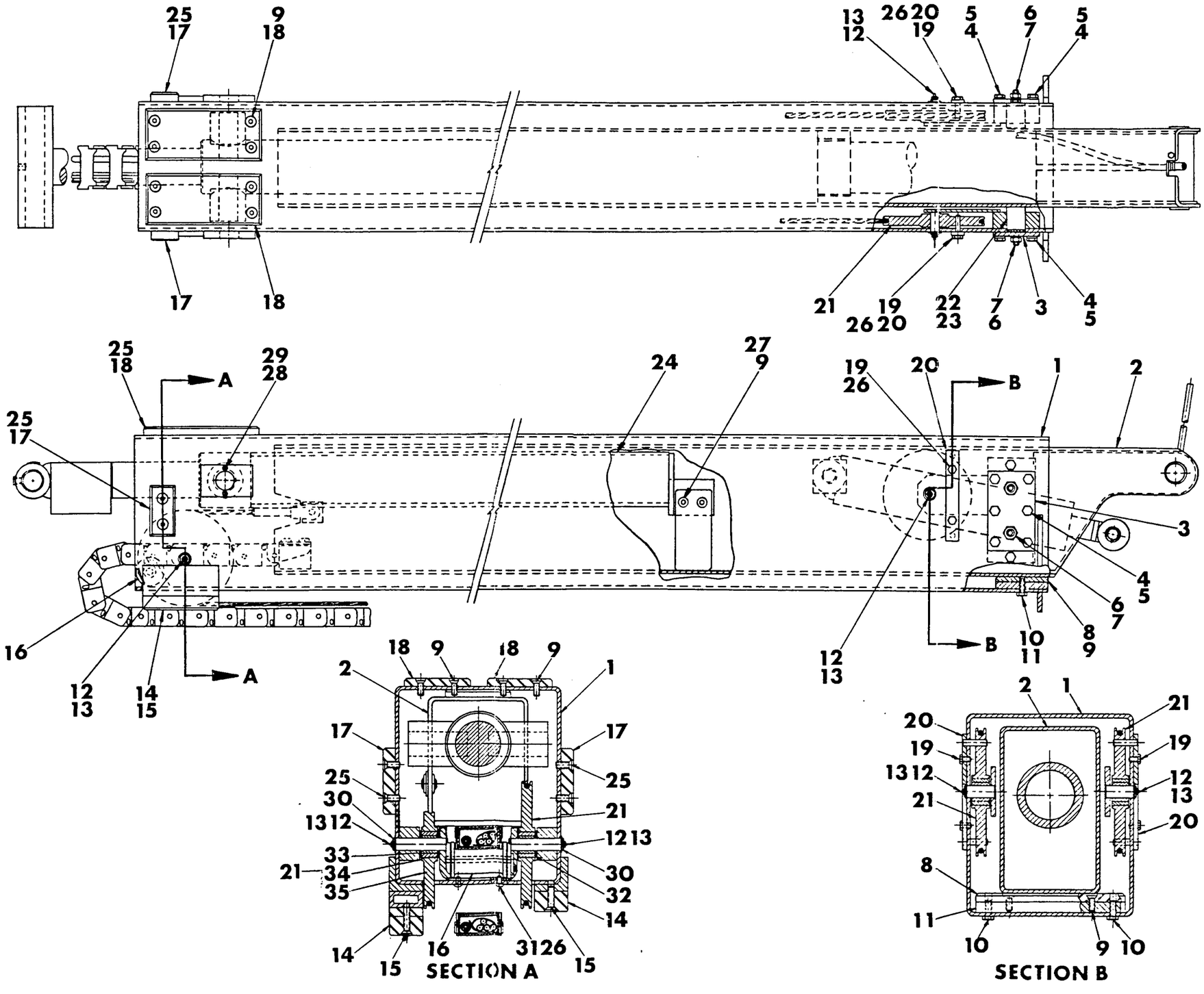


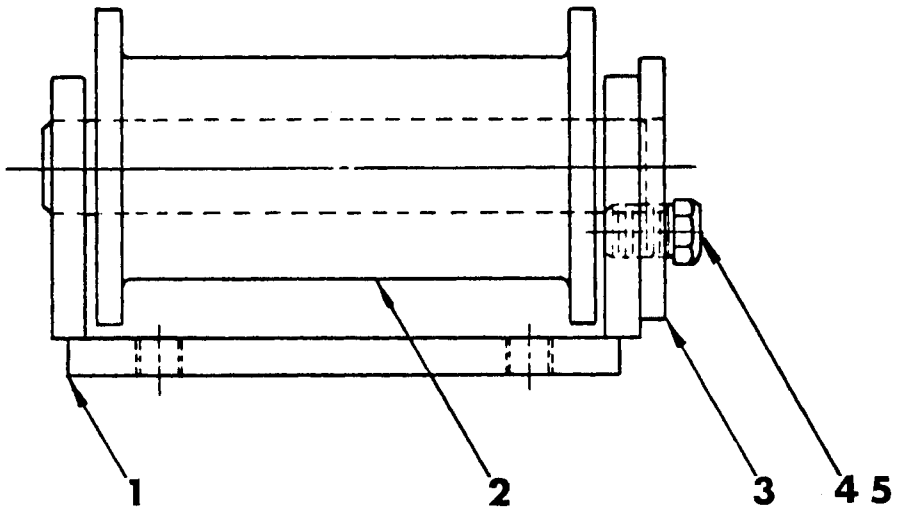
FIGURE 27.1 - INTERMEDIATE BOOM ASSEMBLY
(MARK TRACK)

ITEM	PART NUMBER	DESCRIPTION	QTY
27.1-	22699	INTERMEDIATE BOOM ASSEMBLY	1
-1	22689	INTERMEDIATE BOOM MACHINING	1
-2	22698	INNER BOOM ASSEMBLY (SEE FIG. 28.1)	1
-3	21321	COVER PLATE	2
-4	60307	HEX HEAD CAP SCREW - 3/8-16UNC X 1 1/2 (GR. 5)	12
-5	63303	SPLIT LOCK WASHER - 3/8	12
-6	61101	JAM NUT - 1/2-13UNC	4
-7	62204	SOCKET HEAD SET SCREW - 1/2-13UNC X 1	4
-8	21391	WEAR PAD	1
-9	61801	FLAT SOCKET HEAD CAP SCREW - 3/8-24UNF X 3/4	16
-10	60613	HEX HEAD CAP SCREW - 3/8-16UNC X 1 (BOWMALOK 41013)	2
-11	21343	WEAR PAD SUPPORT PLATE	1
-12	65103	GREASE FITTING	4
-13	65076	SNAP RING	6
-14	22697	WEAR PAD	2
-15	61802	FLAT SOCKET HEAD CAP SCREW - 3/8-24UNF X 1 1/2	4
-16	22704	PLASTITRAK ROLLER SUPPORT ASSEMBLY (SEE FIG. 27.2)	1
-17	21317	WEAR PAD	2
-18	21316	WEAR PAD	2
-19	60527	HEX HEAD CAP SCREW - 5/16-18UNC X 5/8 (GR. 8)	4
-20	21287	CABLE KEEPER WELDMENT	2
-21	22705	CABLE SHEAVE ASSEMBLY	4
-22	21314	WEAR PAD	2
-23	20453	PAD PRESSURE PLATE	2
-24	21893	BOOM EXTENSION CYLINDER ASSEMBLY (SEE FIG. 31.1)	1
-25	61805	FLAT SOCKET HEAD CAP SCREW - 3/8-24UNF X 1	4
-26	63302	SPLIT LOCK WASHER - 5/16	8
-27	21312	WEAR PAD	2

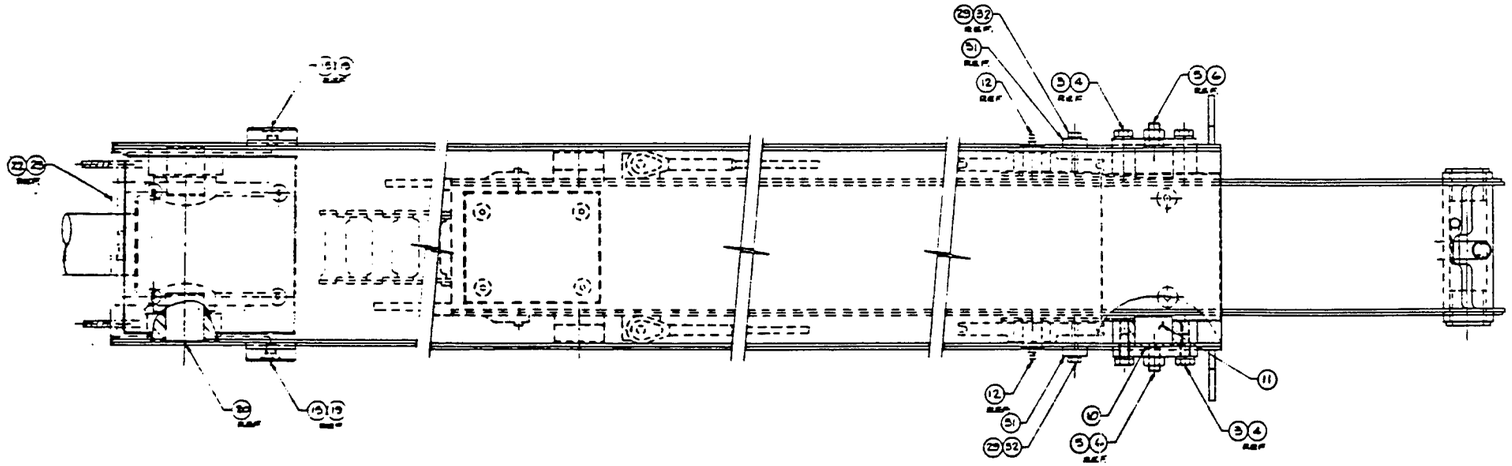
FIGURE 27.1 - INTERMEDIATE BOOM ASSEMBLY
(MARK TRACK)

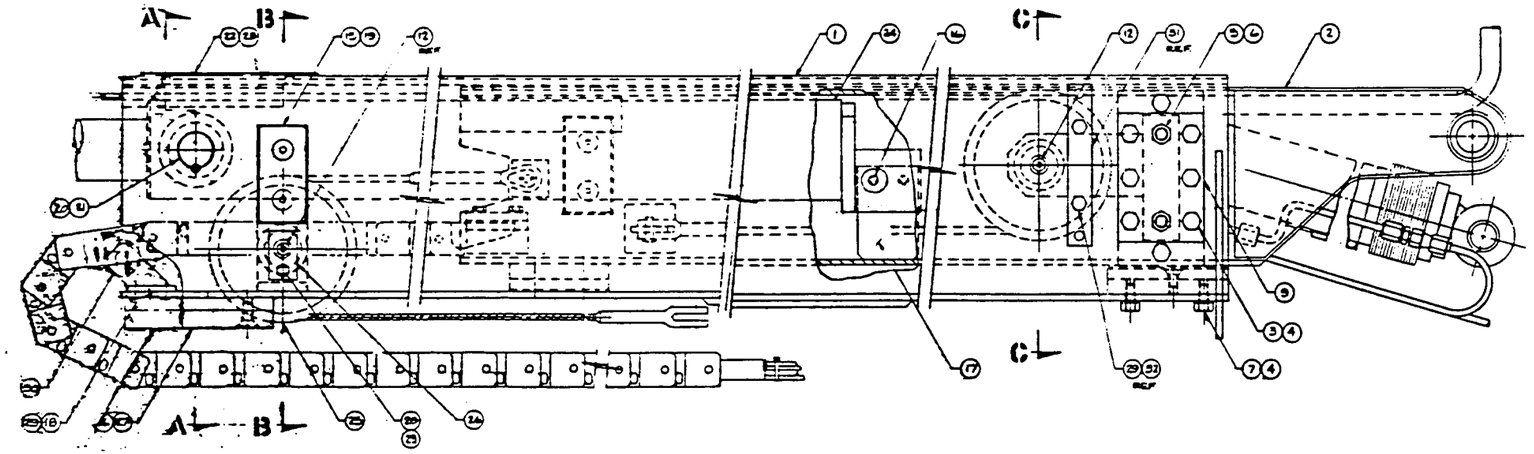
ITEM	PART NUMBER	DESCRIPTION	QTY
-28	21338	TRUNNION PIN	2
-29	62203	SOCKET HEAD SET SCREW - 3/8-16UNC X 3/8	2
-30	22729	SHEAVE PIN	2
-31	61931	BUTTON HEAD SOCKET CAP SCREW - 5/16-18UNC X 5/8	4
-32	65534	THRUST WASHER	8
-33	65061	INNER RING	1
-34	65062	OUTER RING	1
-35	25910	PLATE	1
-36	21319-122	SHIVE AND WARE PAD BRACKET	1

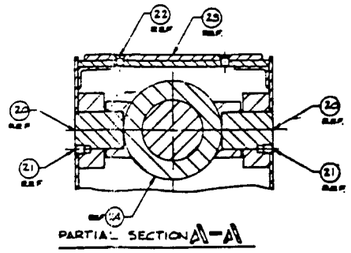
FIGURE 27.2 - INTERMEDIATE BOOM PLASTITRAK ROLLER SUPPORT ASSEMBLY

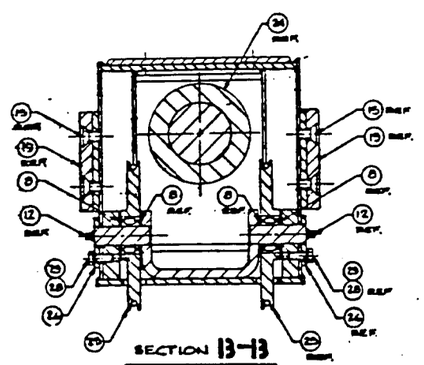


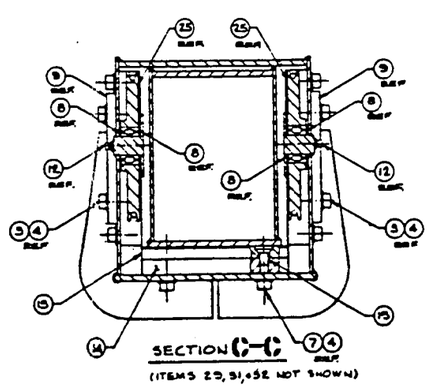
ITEM	PART NUMBER	DESCRIPTION	QTY
27.2-	22704	INTERMEDIATE BOOM PLASTITRAK ROLLER SUPPORT ASSEMBLY	1
-1	22715	BRACKET WELDMENT	1
-2	22717	PLASTITRACK ROLLER	1
-3	22716	PLASTITRACK ROLLER PIN	1
-4	60527	HEX HEAD CAP SCREW - 5/16-18UNC X 5/8 (GR. 5)	1
-5	63302	SPLIT LOCK WASHER - 5/16	1











ITEM	QTY	PART NO.	DESCRIPTION
1	1	23058	MACHINING, INTERMEDIATE BOOM
2	1	23064	ASSY., INNER BOOM
3	12	60541	SCREW, CAP
4	16	63303	WASHER, LOCK
5	4	61101	NUT, JAM
6	4	62204	SCREW, SET
7	4	60325	SCREW, CAP
8	8	65534	WASHER, THRUST
9	2	21321	COVER, PRESSURE PAD
10	2	20453	PLATE, PRESSURE PAD
11	2	23200	PAD, WEAR
12	4	65103	FITTING, GREASE
13	1	23206	PAD, WEAR
14	1	23207	SUPPORT, WEAR PAD
15	6	61801	SCREW, CAP
16	8	61805	SCREW, CAP
17	2	23201	PAD, WEAR
18	4	61931	SCREW, CAP
19	2	22567	PAD, WEAR
20	2	23211	PIN, TRUNNION
21	2	62203	SCREW, SET
22	4	61822	SCREW, CAP
23	1	23204	PAD, WEAR
24	1	23188	ASSY., BOOM EXT. CYLINDER
25	4	23543	ASSY., CABLE SHEAVE
26	2	23144	PIN, CABLE SHEAVE
27	2	23202	PAD, WEAR
28	2	60553	SCREW, CAP
29	10	63302	WASHER, LOCK
30	1	22704	ASSY., PLASTITRAK SUPPORT ROLLER
31	2	23215	WELDMENT, CABLE KEEPER
32	2	60527	SCREW, CAP

FIGURE 28 - INNER BOOM ASSEMBLY

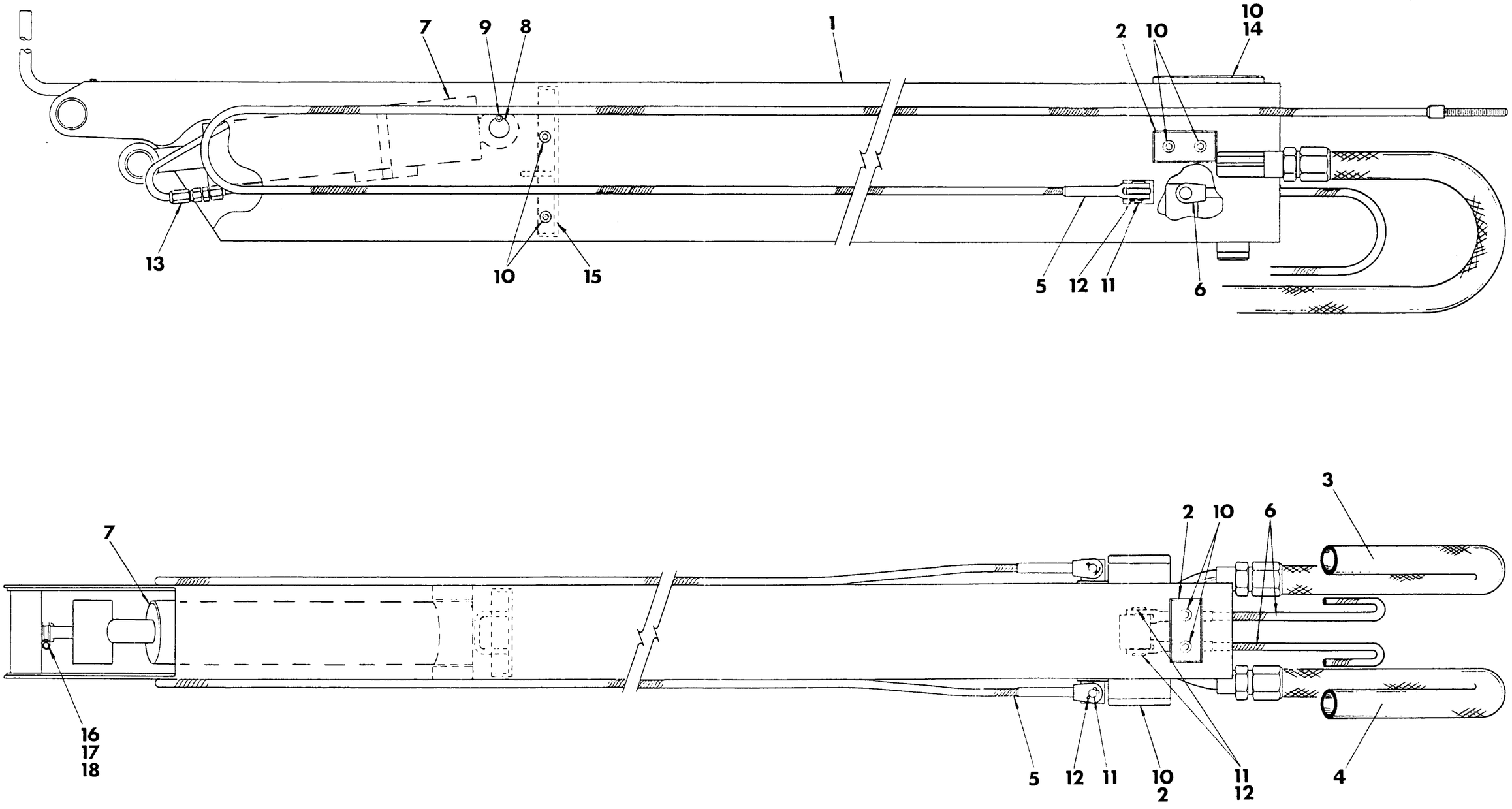
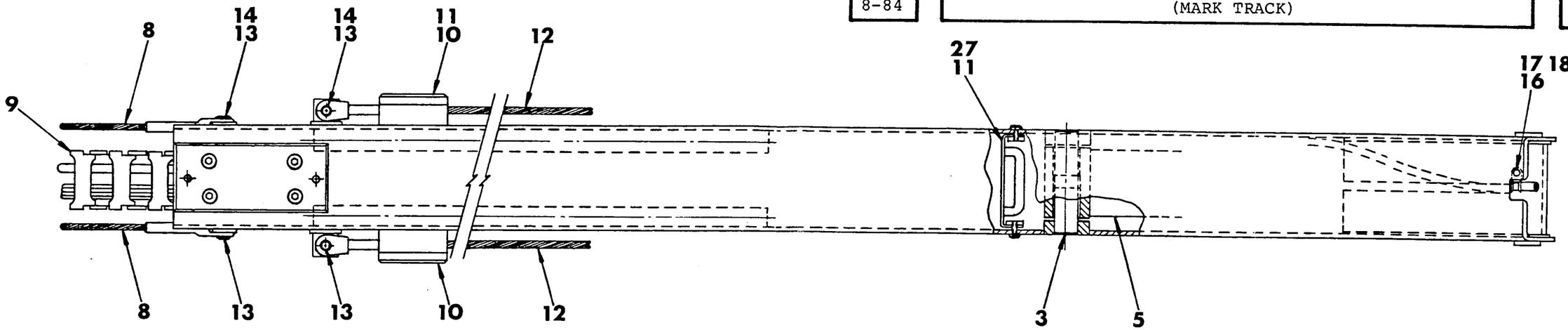


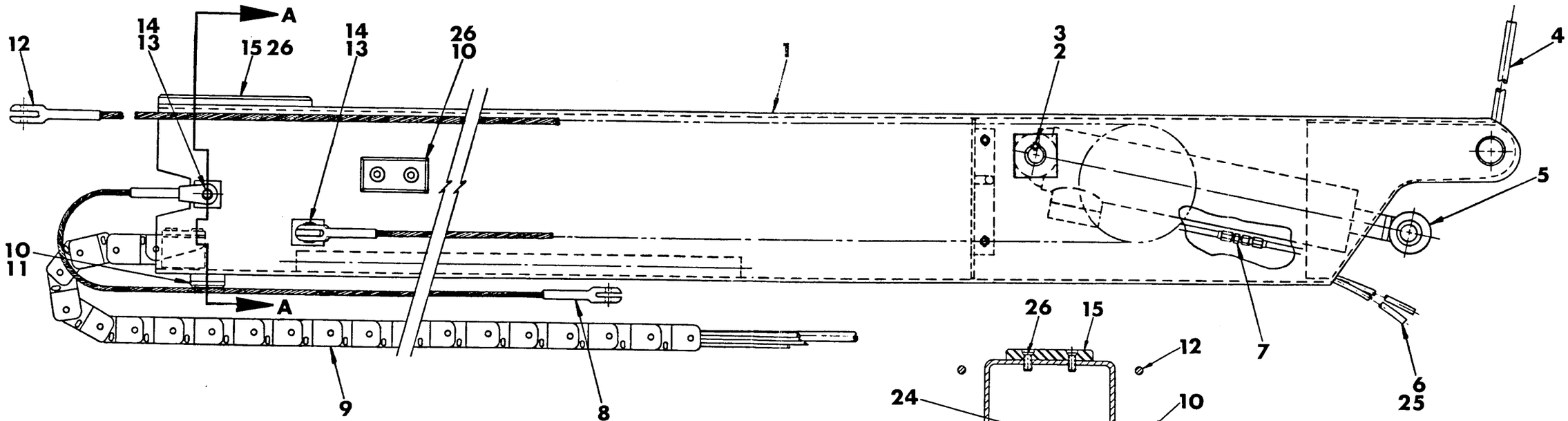
FIGURE 28 - INNER BOOM ASSEMBLY

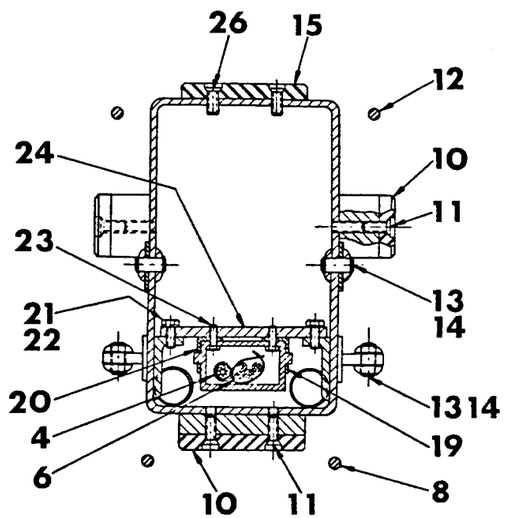
ITEM	PART NUMBER	DESCRIPTION	QTY
33-	21054	INNER BOOM ASSEMBLY	1
-1	21103	INNER BOOM MACHINING	1
-2	21313	WEAR PAD	3
-3	21081	HYDRAULIC HOSE ASSEMBLY	1
-4	21080	ELECTRICAL HOSE ASSEMBLY	1
-5	21323	EXTENSION CABLE ASSEMBLY	2
-6	21322	RETRACTION CABLE ASSEMBLY	2
-7	21094	SLAVE LEVELING CYLINDER ASSEMBLY (SEE FIG.	1
-8	20262	LEVELING CYLINDER PIN	1
-9	62203	HEX SOCKET HEAD SETSCREW - 3/8-16UNC X 3/8	2
-10	61801	HEX SOCKET FLAT HEAD CAPSCREW - 3/8-24UNF X 3/4	14
-11	21318	CLEVIS PIN - 7/16 DIA X 1 1/4	4
-12	64302	COTTER PIN - 3/32 DIA X 1	4
-13	2562	STRAIGHT SWIVEL HOSE FITTING	2
-14	21391	WEAR PAD	1
-15	21350	BULKHEAD PLATE	1
-16	16268	HOSE CLAMP	1
-17	60309	HEX HEAD CAPSCREW - 1/4-20UNC X 3/4 (GR. 5)	1
-18	60701	HEX NUT - 1/4-20UNC	1

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FIGURE 28.1 - INNER BOOM ASSEMBLY
(MARK TRACK)



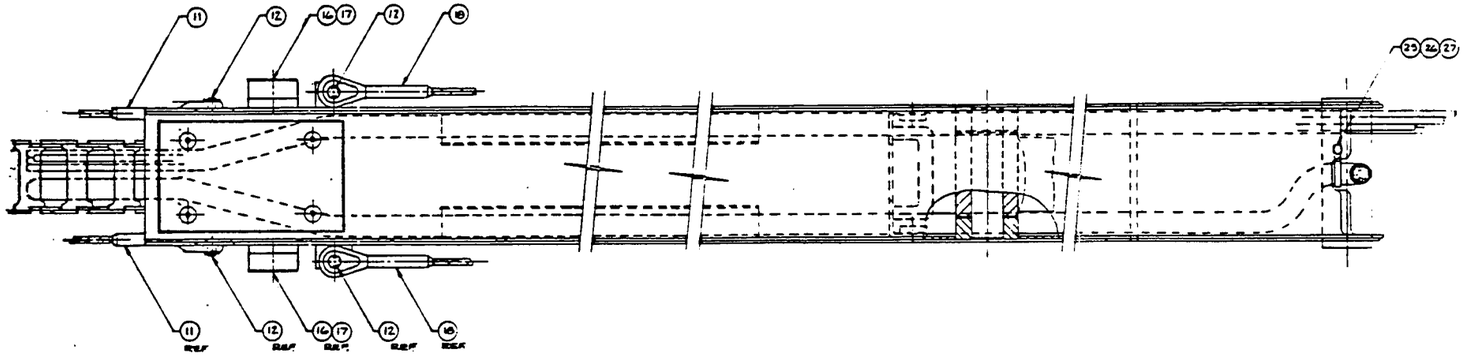


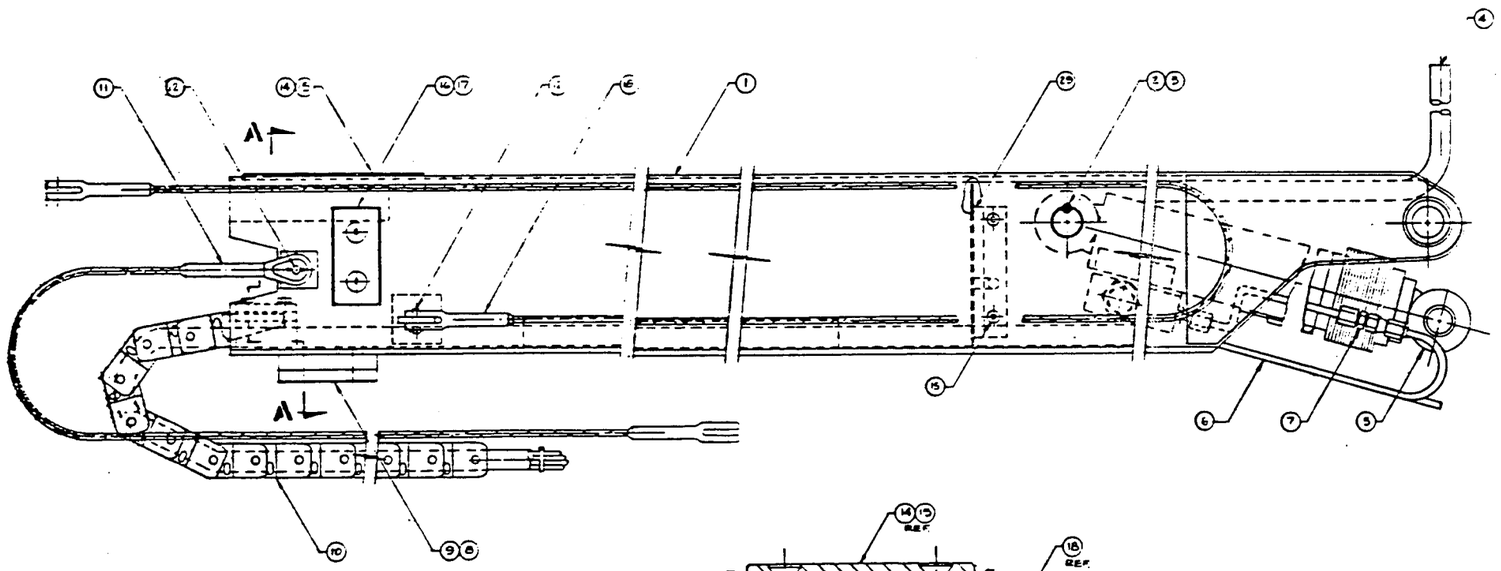


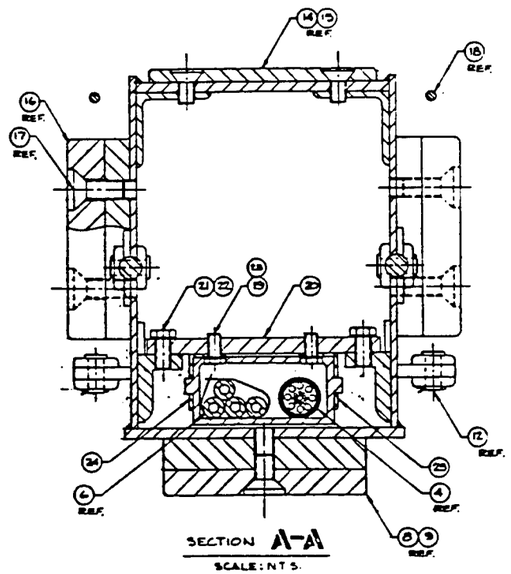
SECTION A

FIGURE 28.1 - INNER BOOM ASSEMBLY
(MARK TRACK)

ITEM	PART NUMBER	DESCRIPTION	QTY
28.1	22698	INNER BOOM ASSEMBLY	1
-1	22687	INNER BOOM MACHINING	1
-2	62203	SOCKET HEAD SET SCREW - 3/8-16UNC X 3/8	1
-3	20262	SLAVE LEVELING CYLINDER PIN	1
-4	20802-1020	ELECTRICAL CABLE	1
-5	21094	SLAVE LEVELING CYLINDER ASSEMBLY (SEE FIG. 29.1)	1
-6	2568-900	HYDRAULIC HOSE	2
-7	2562	STRAIGHT SWIVEL FITTING	2
-8	22701	RETRACTION CABLE 247 OLD NUMBER	2
-9	**22695	PLASTITRAK - SEE BELOW	
-10	21313	WEAR PAD	3
-11	61801	FLAT SOCKET HEAD CAP SCREW - 3/8-24UNF X 3/4	10
-12	22702	EXTENSION CABLE 489 OLD NUMBER JULY TO AUG. OF 84 #491	2
-13	22703	CABLE PIN	4
-14	65082	SNAP RING	8
-15	21391	WEAR PAD	1
-16	60309	HEX HEAD CAP SCREW -1/4 -20UNC X 3/4 (GR. 5)	1
-17	60711	HEX NUT - 1/4-20UNC (WITH NYLON INSERT)	1
-18	16268	RUBBER CLAMP	1
-19	22588	MOVEABLE MOUNTING BRACKET (L.H.)	1
-20	22587	MOVEABLE MOUNTING BRACKET (R.H.)	1
-21	60322	HEX HEAD CAP SCREW - 5/16-18UNC X 3/4 (GR. 5)	4
-22	63302	SPLIT LOCK WASHER - 5/16	4
-23	60633	HEX HEAD CAP SCREW - 1/4-20UNC X 1/2	4
-24	22730	PLASTITRAK MOUNTING PLATE	1
-25	2568-780	HYDRAULIC HOSE	2
-26	61811	FLAT SOCKET HEAD CAP SCREW - 3/8-24UNF X 5/8	4
-27	21350	BULKHEAD PLATE	1
	** 21933	MARKTRAC 110 PIECES (17.7 ft.) COMPLETE ASSEMBLIES ONLY!	

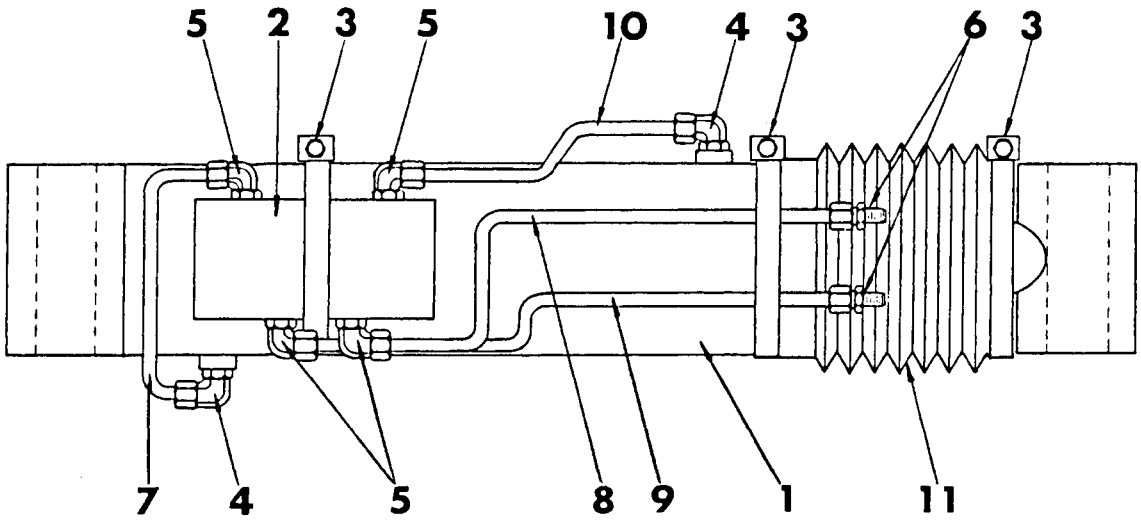






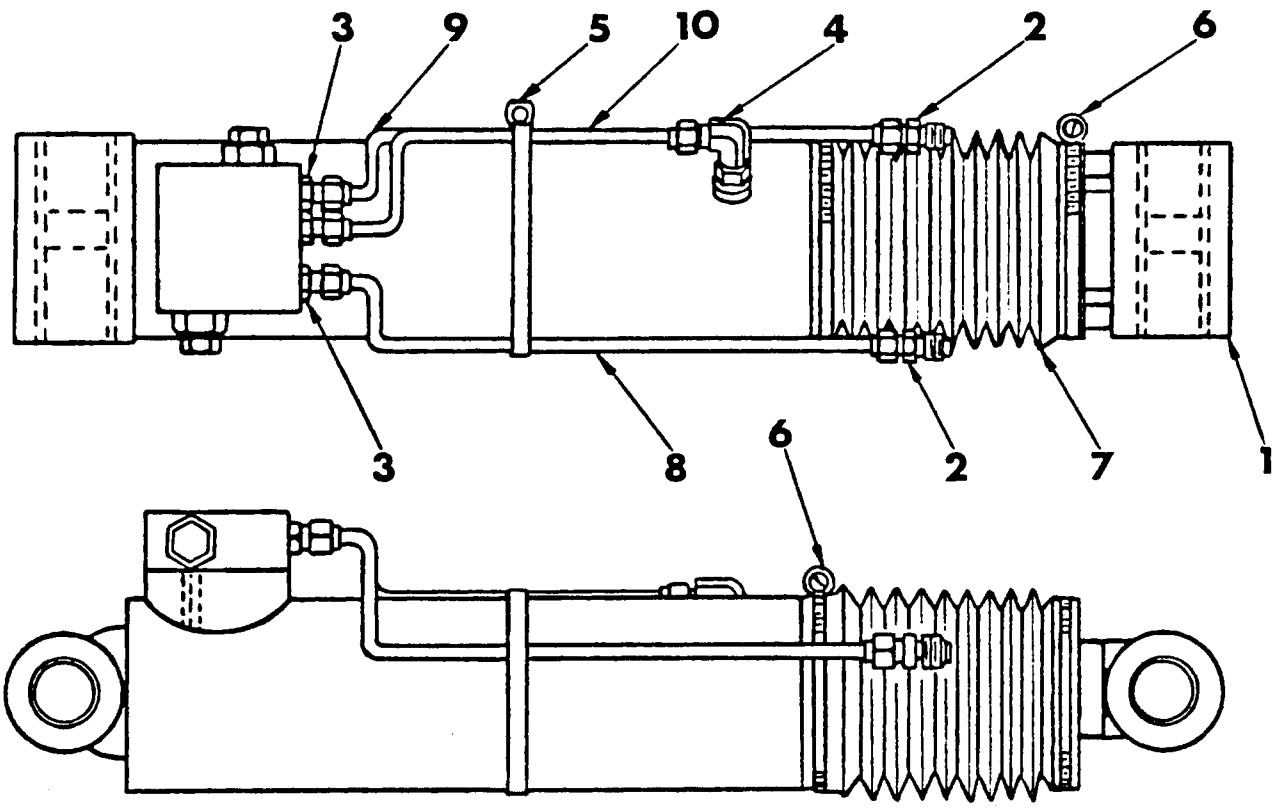
ITEM	QTY	PART NO.	DESCRIPTION
1	1	23061	MACHINING INNER BOOM
2	1	62203	SCREW, SET
3	1	23218	PIN, SLAVE LEVELING CYLINDER
4	1	20802-1020	CABLE, ELECTRICAL
5	1	21094	ASSY., SLAVE LEVELING CYLINDER
6	4	2568-900	HOSE, HYDRAULIC
7	2	2562	FITTING, STR. SWIVEL
8	1	23083	PAD, WEAR
9	2	61827	SCREW, CAP
10	1	22695	ASSY., MARK TRACK
11	2	23217	CABLE, RETRACTION
12	4	23544	PIN, CLEVIS
13			
14	1	23203	PAD, WEAR
15	8	61822	SCREW, CAP
16	2	22569	PAD, WEAR
17	4	61805	SCREW, CAP
18	2	23216	CABLE, EXTENSION
19	4	60543	SCREW, CAP
20	1	22730	PLATE, MTG. PLASTITRAK
21	4	60322	SCREW, CAP
22	4	63302	WASHER, LOCK
23	1	22588	BRACKET, MTG. MOVABLE L.H.
24	1	22587	BRACKET, MTG. MOVABLE R.H.
25	1	60309	SCREW, CAP
26	1	60711	NUT, HEX
27	1	16268	CLAMP, RUBBER
28	4	63301	WASHER, LOCK
29	1	23214	PLATE, BULKHEAD

FIGURE 29--SLAVE LEVELING CYLINDER ASSEMBLY



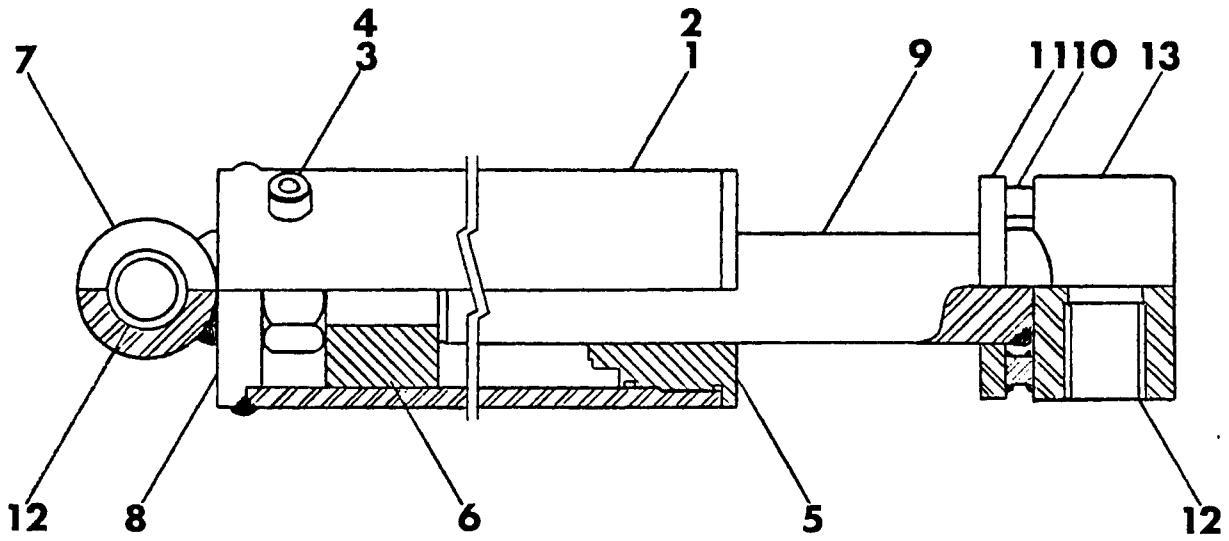
ITEM	PART NUMBER	DESCRIPTION	QTY
29-	21079	SLAVE LEVELING CYLINDER ASSEMBLY	1
-1	21110	SLAVE LEVELING CYLINDER (SEE FIG. 30)	1
-2	20351	PILOT CHECK VALVE	1
-3	65111	STRAP-BOWMAN 24166 PU	3
-4	80012-03	90° ELBOW	2
-5	80012-05	90° ELBOW	4
-6	80042-03	CONNECTOR	2
-7	20600	TUBE ASSEMBLY	1
-8	20601	TUBE ASSEMBLY	1
-9	20602	TUBE ASSEMBLY	1
-10	20603	TUBE ASSEMBLY	1
-11	21388	CONVOLUTED TUBING	1

FIGURE 29.1 - SLAVE LEVELING CYLINDER ASSEMBLY (INTEGRAL HOLDING VALVE)



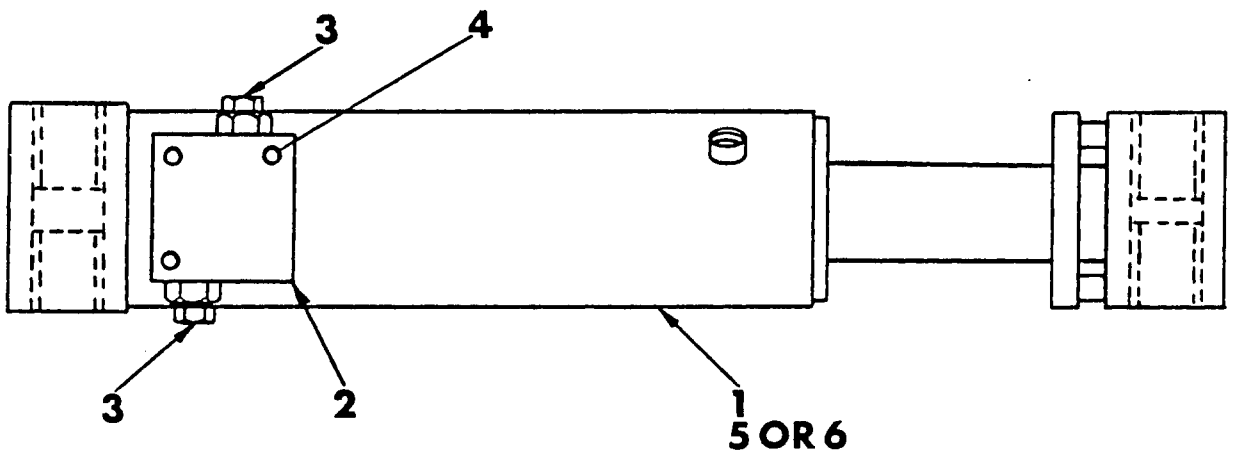
ITEM	PART NUMBER	DESCRIPTION	QTY
29.1-	21094	SLAVE LEVELING CYLINDER ASSEMBLY	1
-1	21263	SLAVE LEVELING CYLINDER SUB-ASSEMBLY (SEE FIG. 30.1)	1
-2	80042-03	UNION CONNECTOR	2
-3	80004-03	STRAIGHT THREAD CONNECTOR	3
-4	80012-03	STRAIGHT THREAD ELBOW	1
-5	16206	STRAP	1
-6	16318	CLAMP	2
-7	21388	CONVOLUTED TUBING	1
-8	21094-8	TUBE ASSEMBLY - 1/4	1
-9	21094-9	TUBE ASSEMBLY - 1/4	1
-10	21094-10	TUBE ASSEMBLY - 1/4	1

FIGURE 30--SLAVE LEVELING CYLINDER



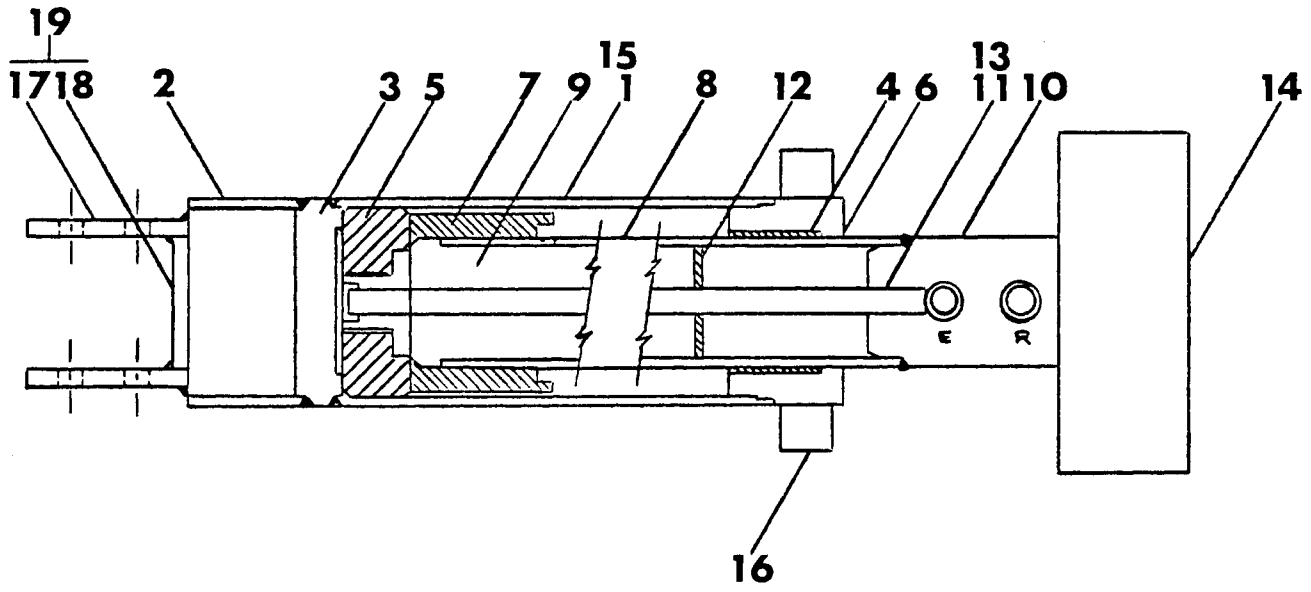
ITEM	PART NUMBER	DESCRIPTION	QTY
30-	21110	SLAVE LEVELING CYLINDER	1
-1		BARREL - SE00210B	1
-2		MARK NAMEPLATE - 9303	1
-3		PORT - 9885	2
-4		CAP PLUG - 9810	2
-5		TEE HEAD - 13041	1
-6		PISTON - 14134	1
-7		BASE PINEYE - 18460	1
-8		PLAIN BASE - 17011	1
-9		ROD - SE00210R	1
-10		SPACER - 15164	2
-11		ROD STOP - 16148	1
-12		20 DU 28 GARLOCK - 9502	4
-13		ROD PINEYE - 18143	1
-14	66045	SEAL KIT - 25137	1
-15	66048	SEAL KIT - 25360 OLD STYLE FOR 2 GROOVE PISTON w/S A C O M A PISTION SEALS	1

FIGURE 30.1 - SLAVE LEVELING CYLINDER SUB-ASSEMBLY (INTEGRAL HOLDING VALVE)



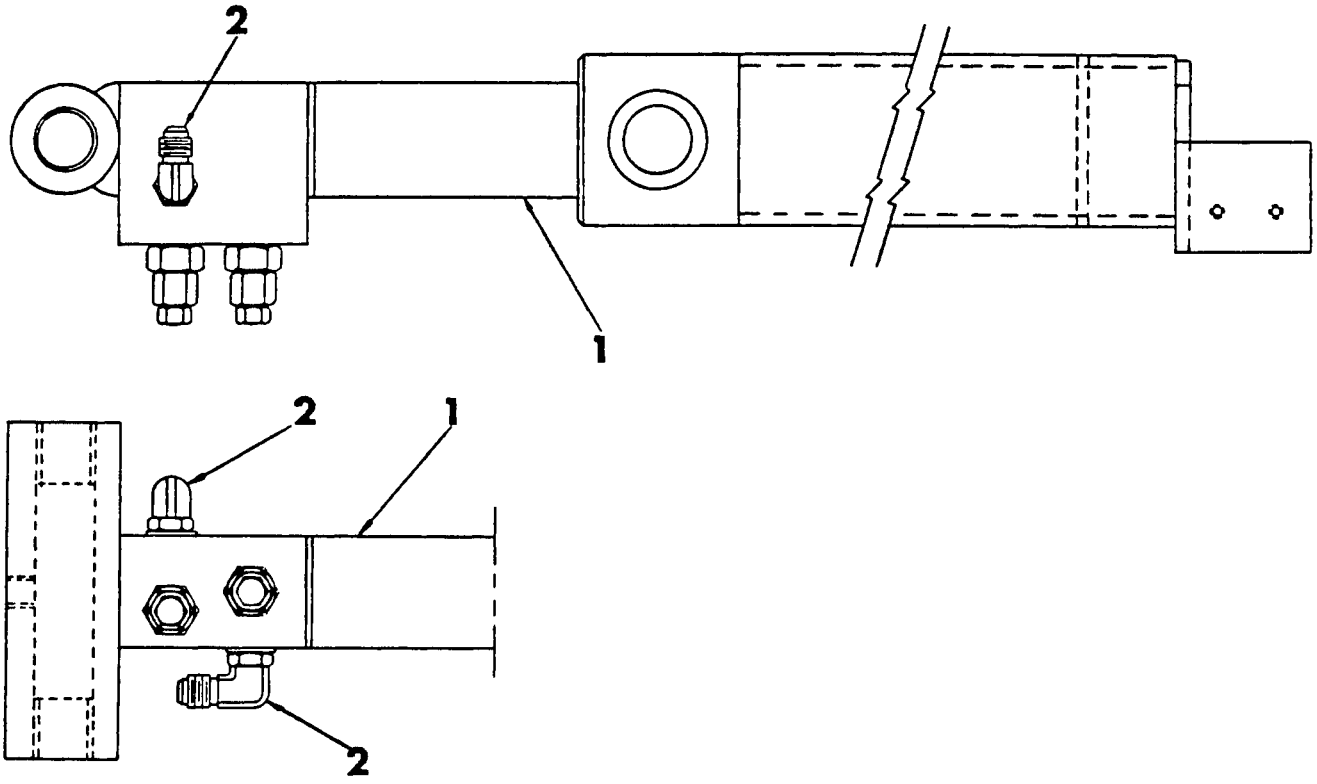
ITEM	PART NUMBER	DESCRIPTION	QTY
30.1-	21263	SLAVE LEVELING CYLINDER SUB-ASSEMBLY	1
-1	21197	SLAVE LEVELING CYLINDER	1
-2	21447	MANIFOLD BLOCK	1
-3	21267	OVERCENTER CARTRIDGE	2
-4	61903	ROUND SOCKET HEAD CAP SCREW - 3/8-16UNC X 1 1/2	3
-5	66045 OR	SEAL KIT (SE)	1
-6	66563	SEAL KIT (RA)	1

FIGURE 31--BOOM EXTENSION CYLINDER



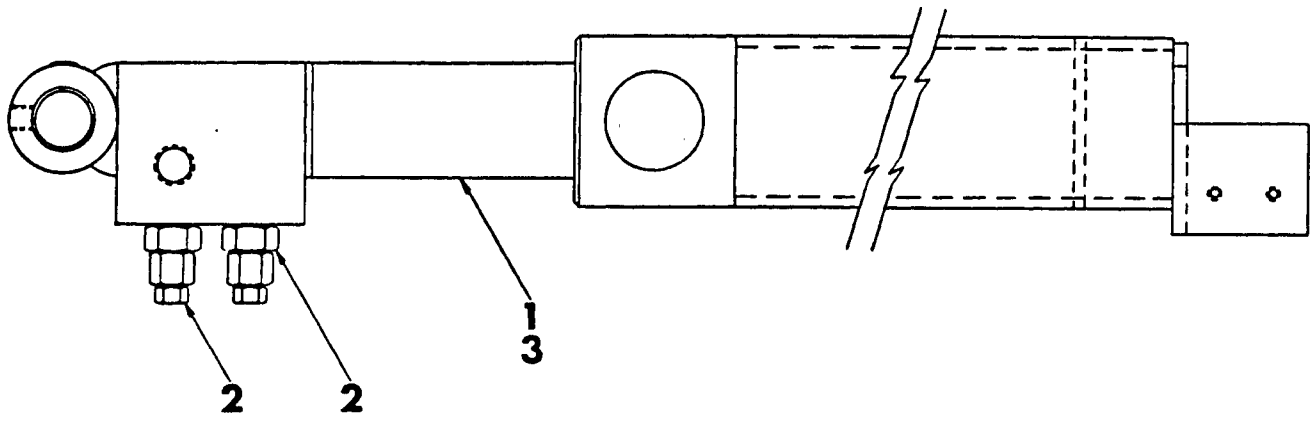
ITEM	PART NUMBER	DESCRIPTION	QTY
31-	21213	BOOM EXTENSION CYLINDER	1
-1		MAIN BARREL - SE00213B	1
-2		EXTENSION BARREL - 18807	1
-3		BARREL END PLATE - 16051	1
-4		BRONZE BUSHING - 9621	1
-5		PISTON - 14211	1
-6		HEAD - 13307	1
-7		STOP TUBE - 18611	1
-8		ROD TUBE - 5221	1
-9		REAR ROD TIP - 17902	1
-10		FRONT ROD TIP - 17901	1
-11		FLUID LINE - 18025	1
-12		TUBE SUPPORT - 7009	8
-13		FLUID LINE ASSEMBLY - 20148	1
-14		ROD PINEYE - 18026	1
-15		MARK NAMEPLATE - 9303	1
-16		TRUNION - 18304	2
-17		FLANGE - 16142	2
-18		FLANGE BASE - 16143	1
-19		FLANGE ASSEMBLY - 26143	1
-20	66048	SEAL KIT - 25360	1

FIGURE 31.1 - BOOM EXTENSION CYLINDER ASSEMBLY (INTERNAL HOLDING VALVE)



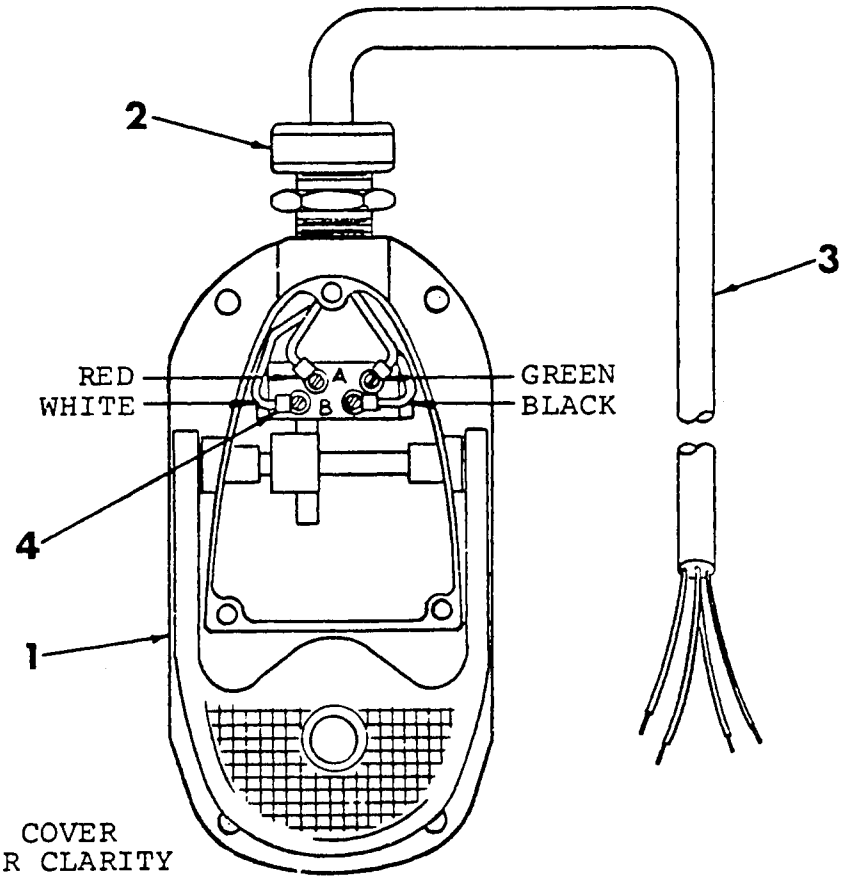
ITEM	PART NUMBER	DESCRIPTION	QTY
31.1-	21893	BOOM EXTENSION CYLINDER ASSEMBLY	1
-1	21261	BOOM EXTENSION CYLINDER SUB-ASSEMBLY (SEE FIG. 37)	1
-2	80012-11	STRAIGHT THREAD ELBOW	2

FIGURE 31.2 - BOOM EXTENSION CYLINDER SUB-ASSEMBLY (INTERNAL HOLDING VALVE)



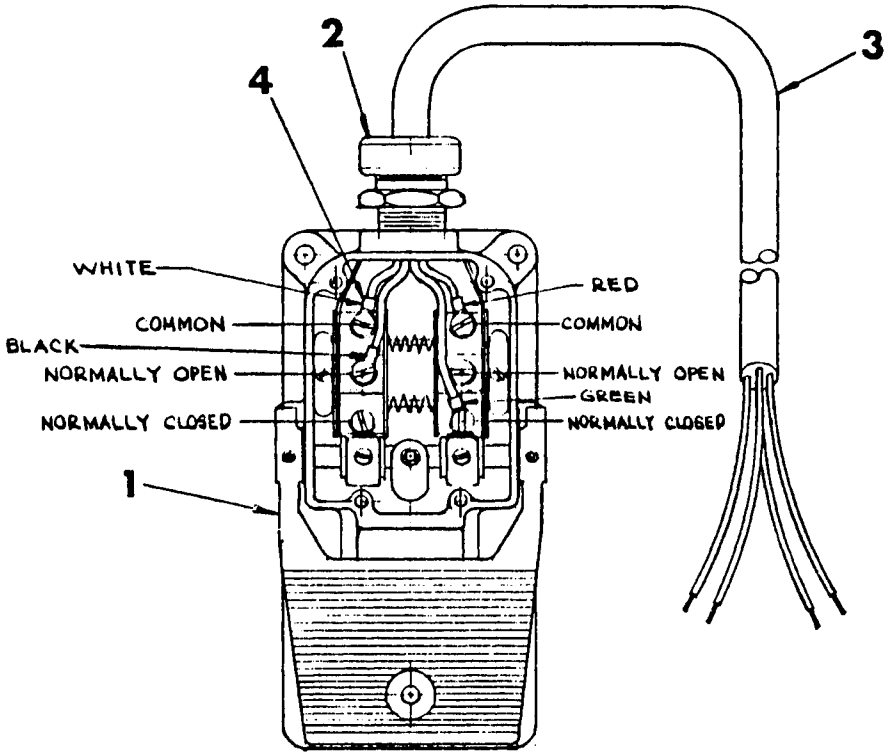
ITEM	PART NUMBER	DESCRIPTION	QTY
31.2-	21261	BOOM EXTENSION CYLINDER SUB-ASSEMBLY	1
-1	21892	BOOM EXTENSION CYLINDER	1
-2	21580	OVER CENTER CARTRIDGE	2
-3	66048	SEAL KIT (SE)	1

FIGURE 32 - FOOT SWITCH ASSEMBLY



NOTE:
SHOWN WITH COVER
REMOVED FOR CLARITY

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



NOTE:
SHOWN WITH COVER
REMOVED FOR CLARITY

ITEM	PART NUMBER	DESCRIPTION	QTY
63-	20480	FOOT SWITCH ASSEMBLY	1
-1	70212	FOOT SWITCH	1
-2	2531	STRAIN RELIEF	1
-3	2912	CABLE - 18/4 SJO OIL RESISTANT X 60'	1
-4	876	TERMINAL RING	1

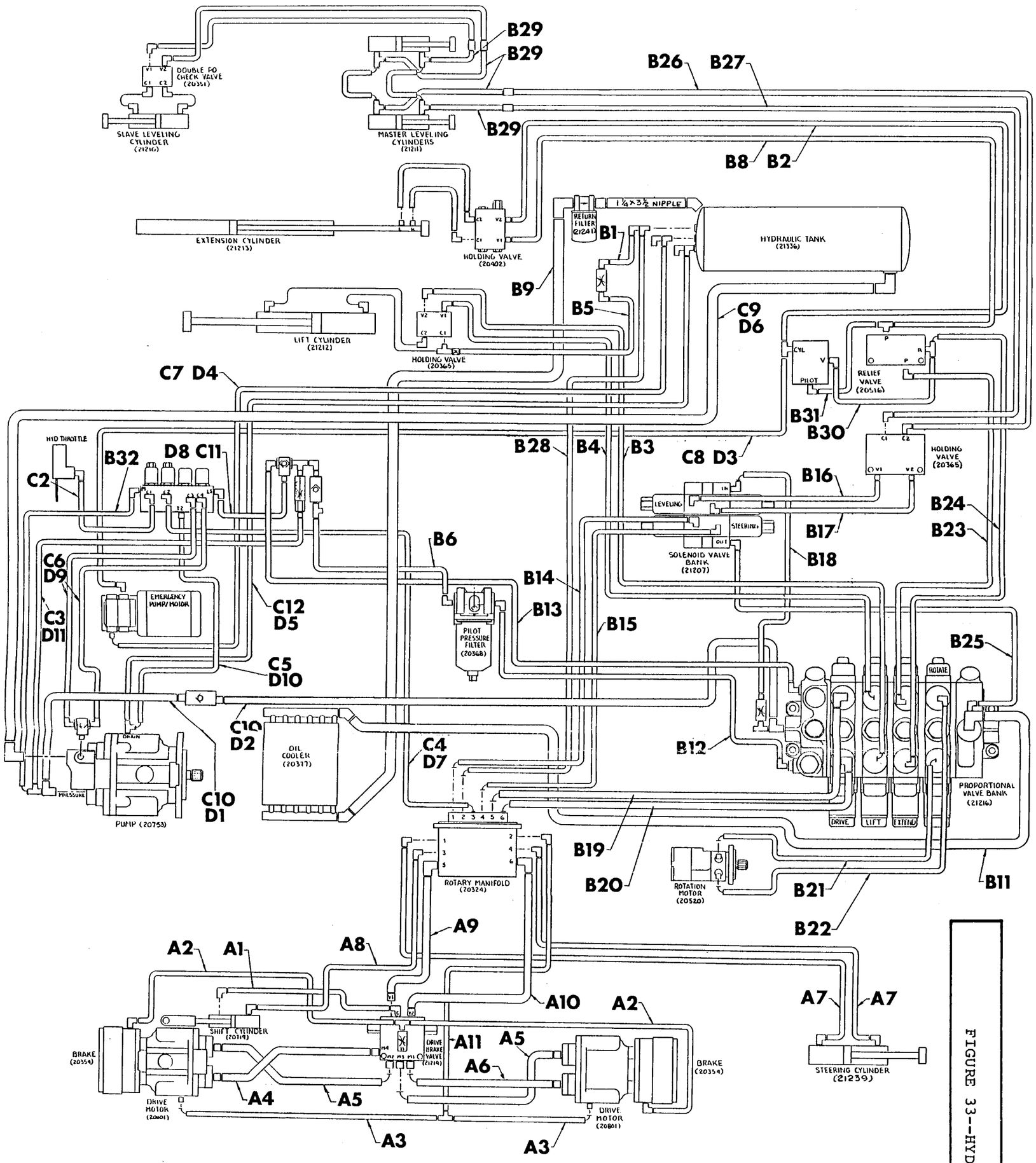


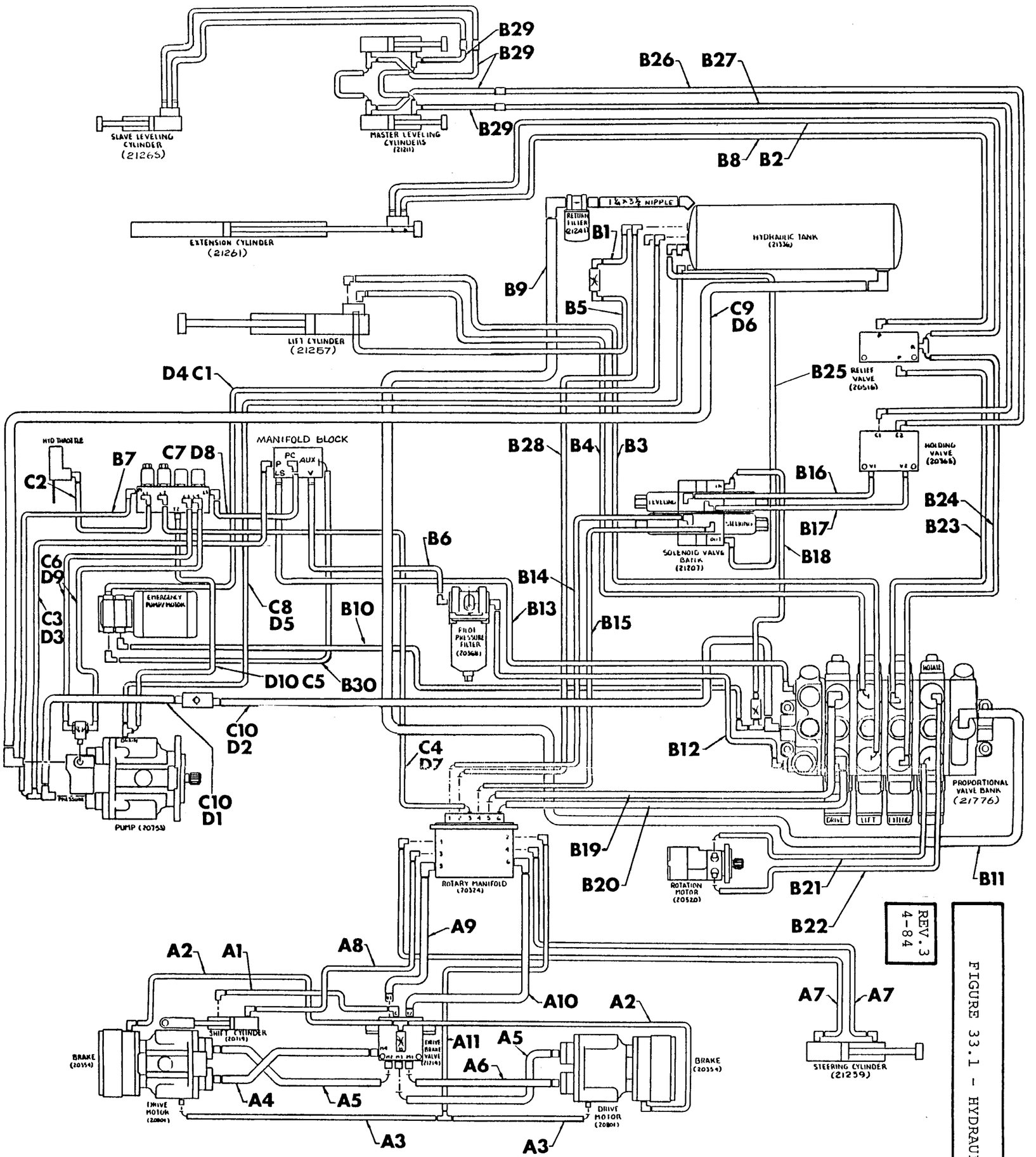
FIGURE 33--HYDRAULIC HOSE KIT

FIGURE 33--HYDRAULIC HOSE KIT

ITEM	PART NUMBER	DESCRIPTION	QTY
	NOTE:	KIT "A" - BASE KIT "B" - TURRET KIT "C" - GAS MODELS ONLY KIT "D" - DIESEL MODELS ONLY	
33-	21055	HYDRAULIC HOSE KIT	1
-A1	13210-04-0230	HOSE ASSEMBLY	1
-A2	13213-04-0340	" "	2
-A3	13213-06-0270	" "	2
-A4	13220-12-0204	" "	1
-A5	13223-12-0240	" "	2
-A6	13223-12-0260	" "	1
-A7	13210-04-0600	" "	2
-A8	13210-04-0700	" "	1
-A9	13220-12-0540	" "	1
-A10	13220-12-0560	" "	1
-A11	13210-06-0650	" "	1
-B1	13210-04-0900	" "	1
-B2	13210-08-0950	" "	1
-B3	13213-08-1250	" "	1
-B4	13213-08-1310	" "	1
-B5	13210-04-0600	" "	1
-B6	13210-06-0900	" "	1
-B8	13210-08-0920	" "	1
-B9	13205-16-0500	" "	1
-B11	13205-16-0520	" "	1
-B12	13213-06-0660	" "	1
-B13	13210-04-0380	" "	1
-B14	13213-04-0360	" "	1
-B15	13213-04-0300	" "	1
-B16	13213-04-0110	" "	1
-B17	13213-04-0120	" "	1
-B18	13213-06-0380	" "	1
-B19	13223-12-0340	" "	1
-B20	13223-12-0400	" "	1

FIGURE 33--HYDRAULIC HOSE KIT

ITEM	PART NUMBER	DESCRIPTION	QTY
-B21	13214-08-0680	HOSE ASSEMBLY	1
-B22	13213-08-0630	" "	1
-B23	13210-08-0200	" "	1
-B24	13213-08-0294	" "	1
-B25	13213-06-0170	" "	1
-B26	13210-04-0940	" "	1
-B27	13210-04-0960	" "	1
-B28	13213-06-0390	" "	1
-B29	13213-04-0150	" "	4
-B30	13213-08-0130	" "	1
-B31	13210-04-0250	" "	1
-B32	13210-06-0200	" "	1
-C2	13210-04-0960	" "	1
-C3	13210-06-0900	" "	1
-C4	13213-04-1050	" "	1
-C5	13213-06-0220	" "	1
-C6	13210-04-0110	" "	2
-C7	13213-06-1000	" "	1
-C8	13210-06-0550	" "	1
-C9	13203-20-0340	" "	1
-C10	13220-12-0310	" "	2
-C11	13210-04-1050	" "	1
-C12	13210-06-0900	" "	1
-D1	13220-12-0130	" "	1
-D2	13220-12-0160	" "	1
-D3	13213-06-0220	" "	1
-D4	13213-06-1170	" "	1
-D5	13210-06-1200	" "	1
-D6	13203-20-0760	" "	1
-D7	13213-04-0410	" "	1
-D8	13210-04-0600	" "	1
-D9	13210-04-0190	" "	2
-D10	13213-06-0350	" "	1
-D11	13213-06-0500	" "	1



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FIGURE 33.1 - HYDRAULIC HOSE KIT (NOV. 1983)

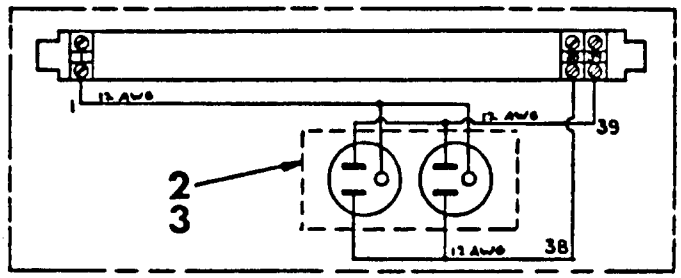
FIGURE 33 - HYDRAULIC HOSE KIT (NOV. 1983)

ITEM	PART NUMBER	DESCRIPTION	QTY
	NOTE:	KIT "A" - BASE KIT "B" - TURRET KIT "C" - GAS MODELS ONLY KIT "D" - DIESEL MODELS ONLY	
33-	21055	HYDRAULIC HOSE KIT	1
-A1	13210-04-0230	HOSE ASSEMBLY	1
-A2	13213-04-0340	" "	2
-A3	13213-06-0270	" "	2
-A4	13220-12-0204	" "	1
-A5	13223-12-0240	" "	2
-A6	13223-12-0260	" "	1
-A7	13210-04-0600	" "	2
-A8	13210-04-0700	" "	1
-A9	13220-12-0540	" "	1
-A10	13220-12-0560	" "	1
-A11	13210-06-0650	" "	1
-B1	13210-04-0900	" "	1
-B2	13210-08-0950	" "	1
-B3	13213-08-1260	" "	1
-B4	13213-08-1190	" "	1
-B5	13210-04-0600	" "	1
-B6	13210-06-0900	" "	1
-B7	13213-06-0220	" "	1
-B8	13210-08-0920	" "	1
-B9	13205-16-0700	" "	1
-B10	13210-06-0550	" "	1
-B11	13213-06-0710	" "	1
-B12	13213-06-0660	" "	1
-B13	13210-04-0380	" "	1
-B14	13213-04-0360	" "	1
-B15	13213-04-0300	" "	1
-B16	13213-04-0110	" "	1
-B17	13213-04-0120	" "	1

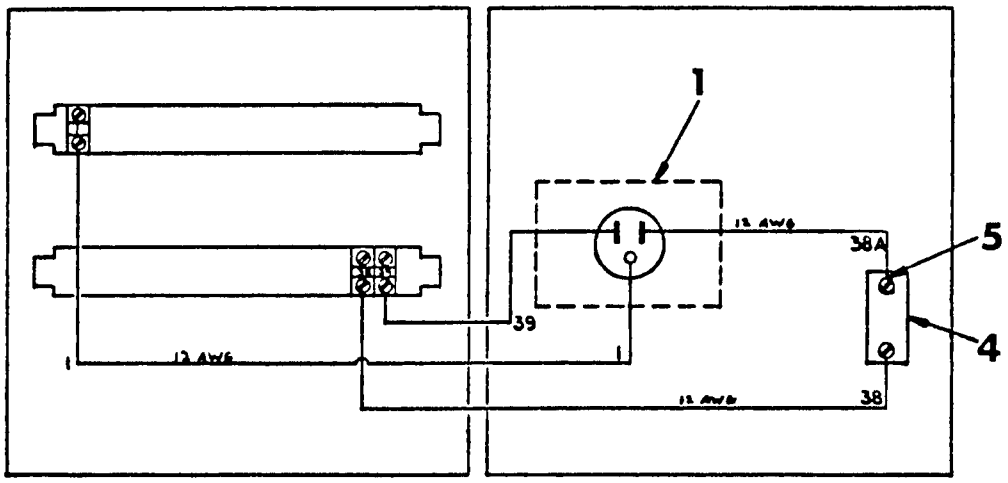
FIGURE 33 - HYDRAULIC HOSE KIT (NOV. 1983)

ITEM	PART NUMBER	DESCRIPTION	QTY
-B18	13213-06-0380	HOSE ASSEMBLY	1
-B19	13214-12-0340-45	" "	1
-B20	13215-12-0440-45	" "	1
-B21	13214-08-0610	" "	1
-B22	13213-08-0590	" "	1
-B23	13210-08-0250	" "	1
-B24	13213-08-0310	" "	1
-B25	13213-06-0610	" "	1
-B26	13210-04-0940	" "	1
-B27	13210-04-0960	" "	1
-B28	13213-06-0390	" "	1
-B29	13213-04-0150	" "	4
-C1	13205-12-0850	" "	1
-C2	13210-04-0960	" "	1
-C3	13210-06-0900	" "	1
-C4	13213-04-1050	" "	1
-C5	13213-06-0220	" "	1
-C6	13210-04-0140	" "	2
-C7	13210-04-1050	" "	1
-C8	13210-06-0990	" "	1
-C9	13203-20-0340	" "	1
-C10	13220-12-0320	" "	2
-D1	13220-16-0130	" "	1
-D2	13220-16-0180	" "	1
-D3	13213-06-0500	" "	1
-D4	13213-12-1050	" "	1
-D5	13210-06-1200	" "	1
-D6	13203-20-0760	" "	1
-D7	13213-04-0410	" "	1
-D8	13210-04-0600	" "	1
-D9	13210-04-0190	" "	2
-D10	13213-06-0350	" "	1

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



AERIAL CONTROL CONSOLE



GROUND CONTROL CONSOLE

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

FIGURE 35- TOWING KIT INSTALLATION (OPTION)

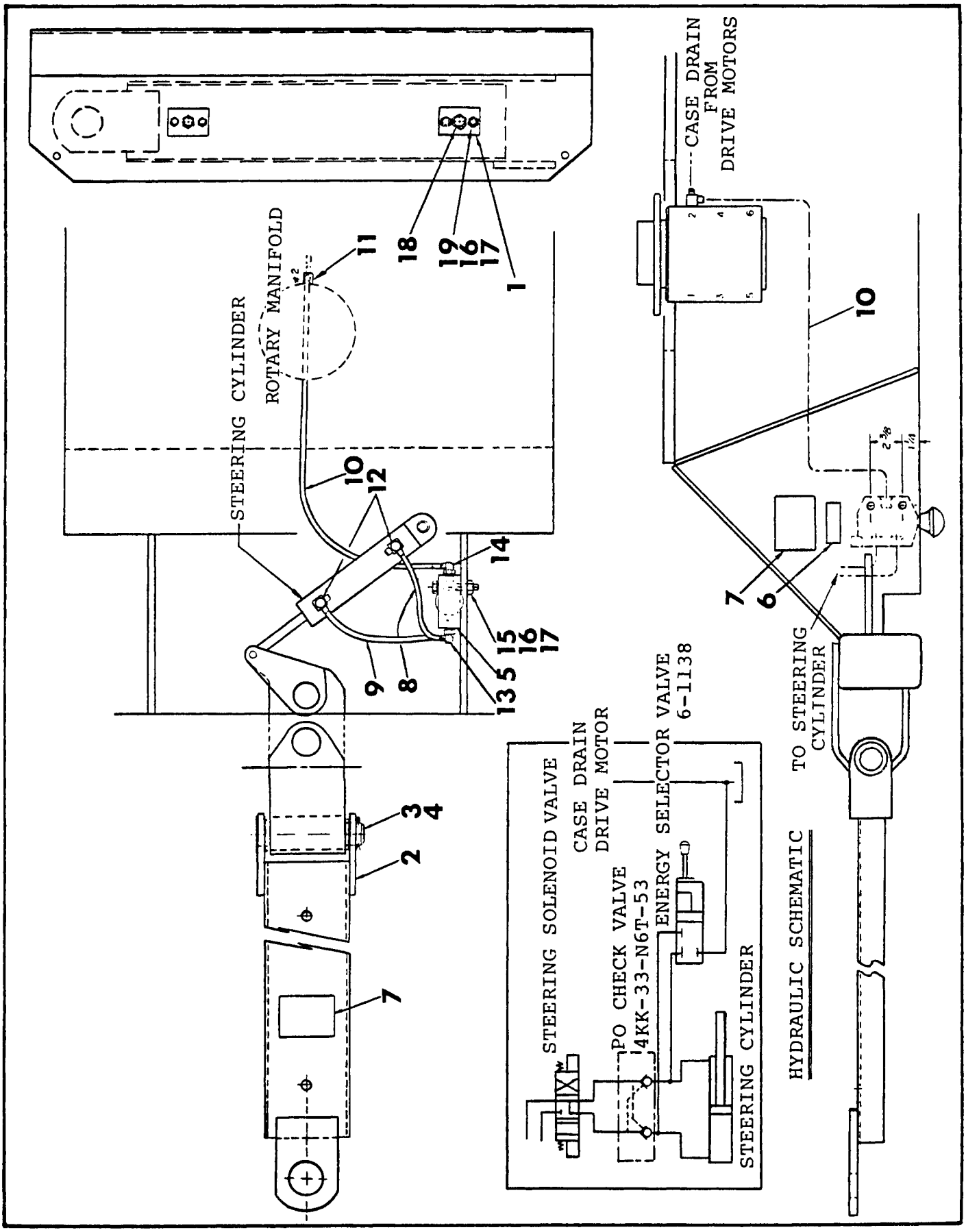
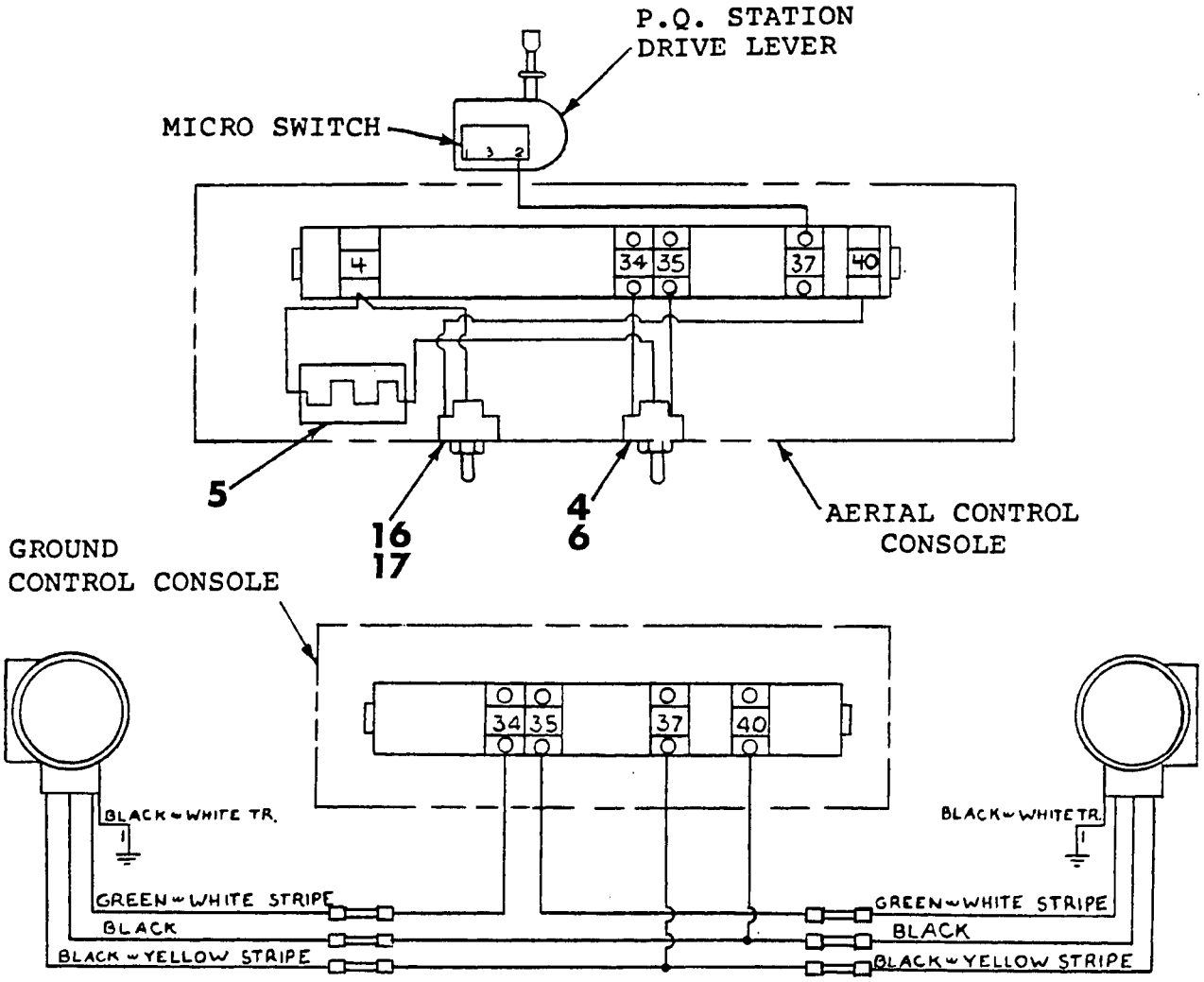


FIGURE 35 - TOWING KIT INSTALLATION (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
35-	20081	TOWING KIT INSTALLATION	1
-1	20837	FLANGED STUD	2
-2	20425	TOWING BAR	1
-3	20426	PIN	1
-4	64314	COTTER PIN - 1/4 X 2 1/2	1
-5	20799	BY-PASS VALVE	1
-6	20492	STEERING OVERRIDE DECAL	1
-7	20491	TOWING INSTRUCTIONS DECAL	2
-8	13210-04-0220	HOSE ASSEMBLY	1
-9	13210-04-0300	HOSE ASSEMBLY	1
-10	13210-06-0800	HOSE ASSEMBLY	1
-11	80037-08	MALE RUN TEE	1
-12	80033-03	STRAIGHT THREAD RUN TEE	2
-13	80008-05	MALE ELBOW	2
-14	80008-11	MALE ELBOW	1
-15	60317	HEX HEAD CAP SCREW - 3/8-16UNC X 2 1/2	2
-16	60703	HEX NUT - 3/8-16UNC	6
-17	63303	LOCK WASHER - 3/8	6
-18	60705	HEX NUT - 1/2-13UNC	2
-19	60343	HEX HEAD CAP SCREW - 3/8-16UNC X 1	4

FIGURE 36 - CLEARANCE, STOP AND TURNING LIGHTS (OPTION)



ELECTRICAL DIAGRAM

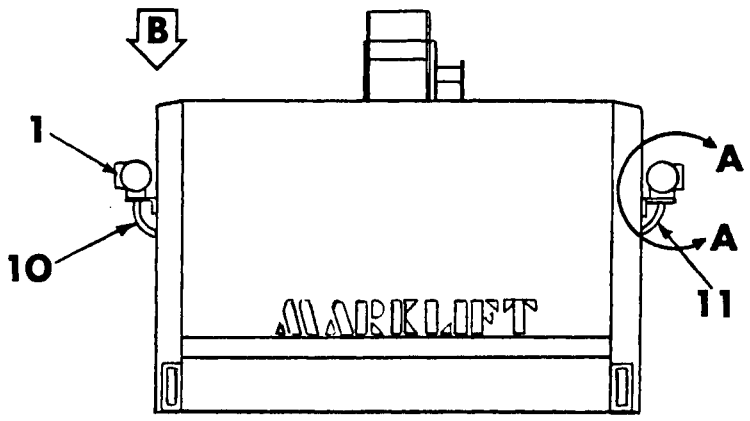


FIGURE 36 - CLEARANCE, STOP AND TURNING LIGHTS
(OPTION)

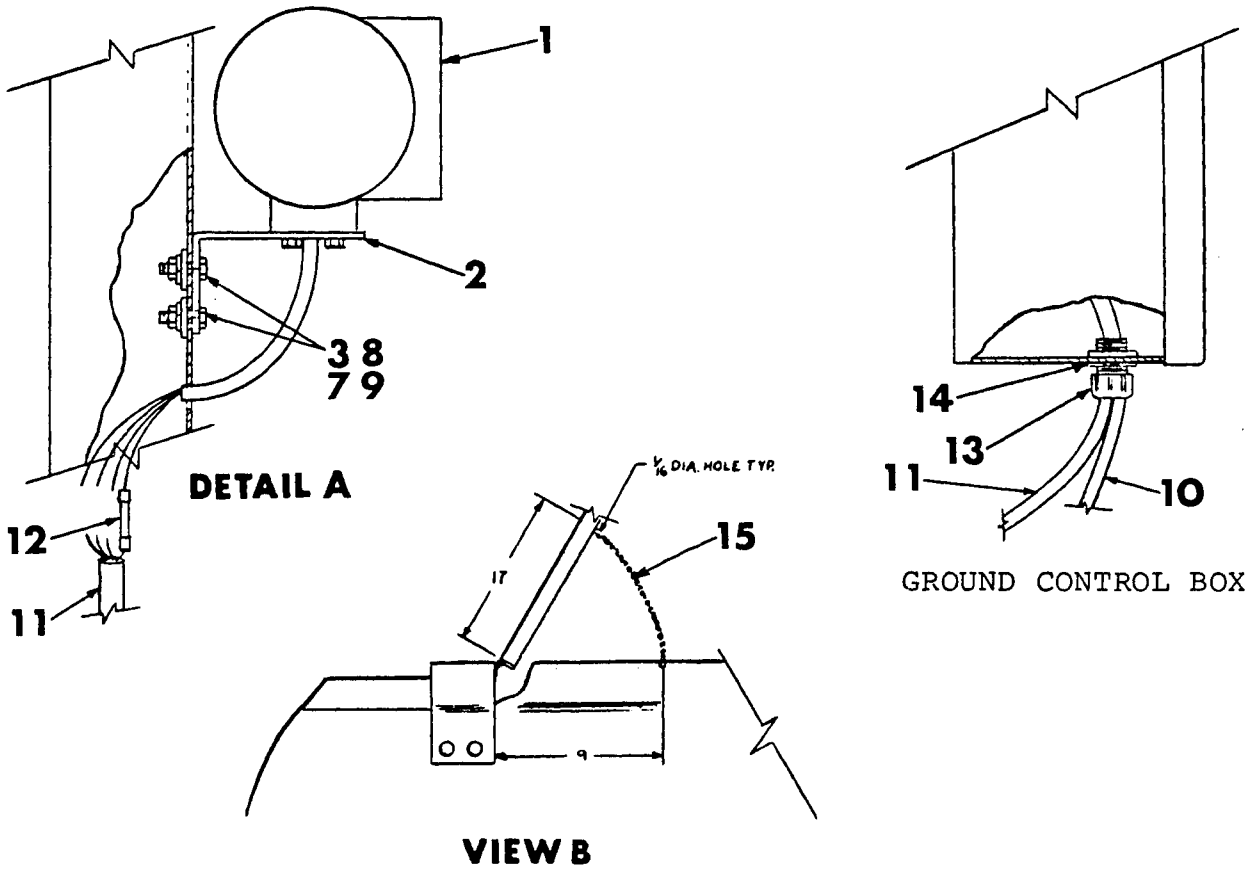
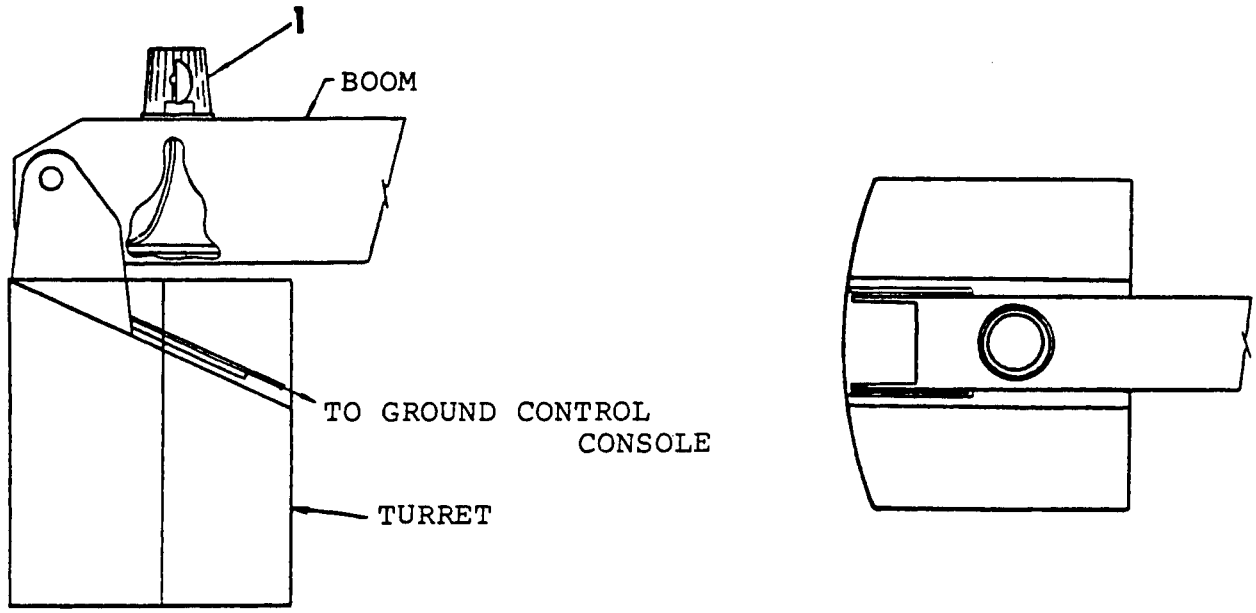


FIGURE 36 - CLEARANCE, STOP AND TURNING LIGHTS (OPTION)

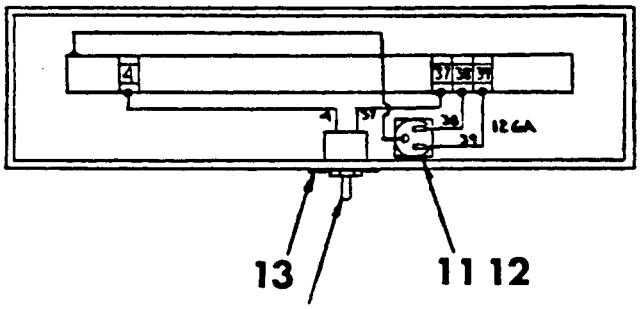
ITEM	PART NUMBER	DESCRIPTION	QTY
36-	20079	CLEARANCE, STOP AND TURNING LIGHTS	1
-1	20838	CLEARANCE LIGHT	2
-2	20864	MOUNTING BRACKET	2
-3	63403	FLAT WASHER - 3/8	4
-4	4019	TOGGLE SWITCH	1
-5	448-A	FLASHER	1
-6	20866	TURN INDICATOR DECAL	1
-7	60331	HEX HEAD CAP SCREW - 3/8-16UNC X 1 1/4	4
-8	60703	HEX NUT - 3/8-16UNC	4
-9	63303	SPLIT LOCK WASHER - 3/8	4
-10	2912	CABLE - 18 AWG 4 COND X 24	1
-11	2912	CABLE - 18 AWG 4 COND X 120	1
-12	117-D	BUTT CONNECTOR	8
-13	2806	STRAIN RELIEF	2
-14	2808	LOCK NUT	2
-15	3B	SINGLE JACK CHAIN	2
-16	4017	TOGGLE SWITCH	1
-17	20509	LIGHTS DECAL	1

FIGURE 37 - ROTATING BEACON INSTALLATION (OPTION)

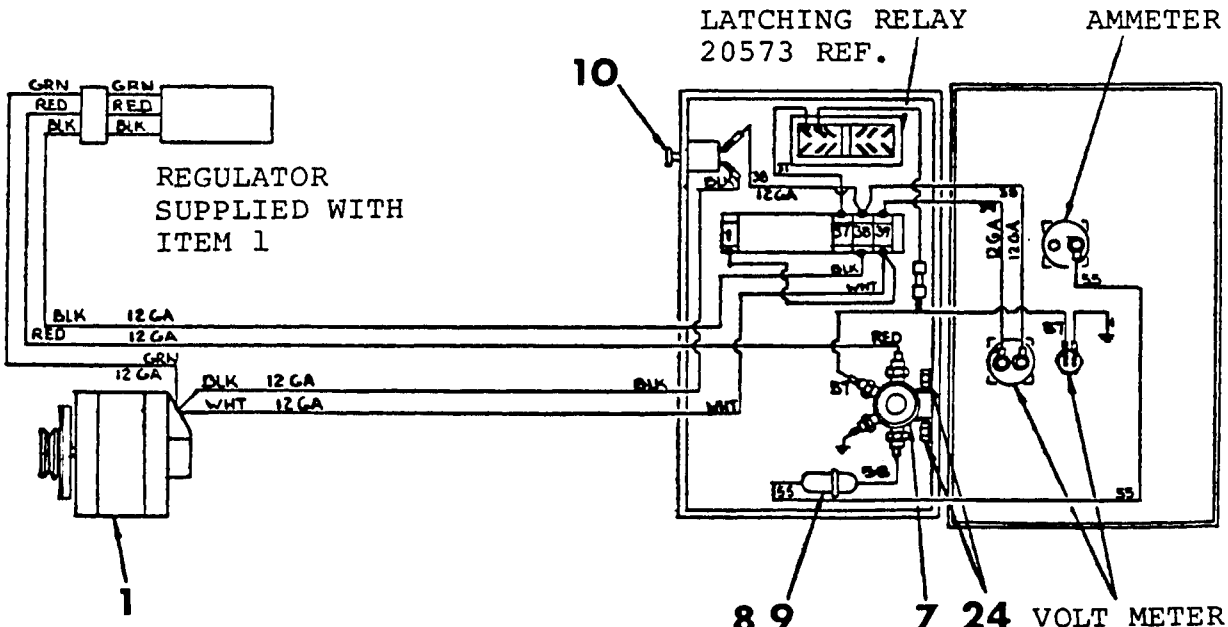


ITEM	PART NUMBER	DESCRIPTION	QTY
37 -	20107	ROTATING BEACON INSTALLATION	1
-1	20863	ROTATING BEACON -- YELLOW, RED OR BLUE	1

FIGURE 38 - ALTERNATOR FOR WISCONSIN VG4D (OPTION)

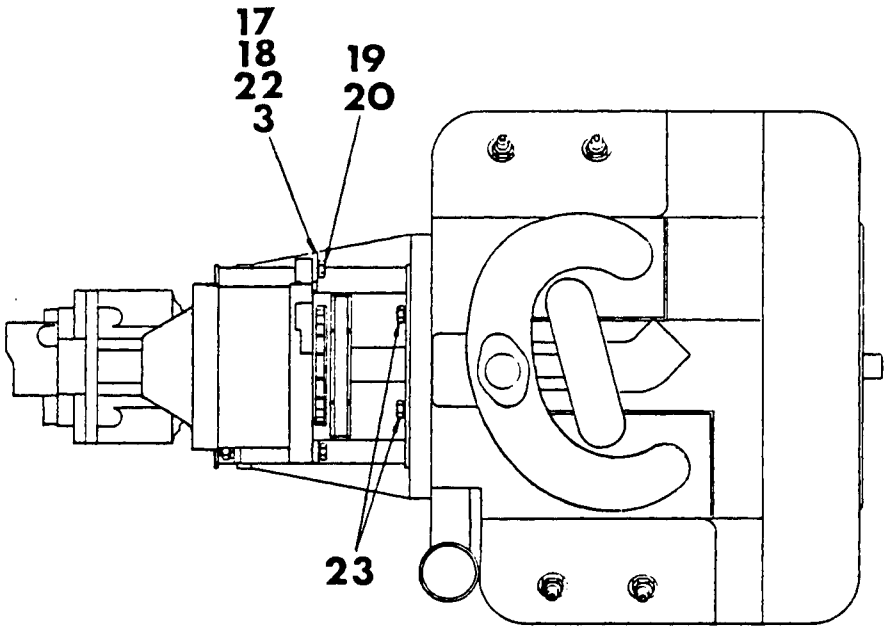


AERIAL CONTROL CONSOLE



ELECTRICAL DIAGRAM

FIGURE 38 - ALTERNATOR FOR
WISCONSIN VG4D (OPTION)



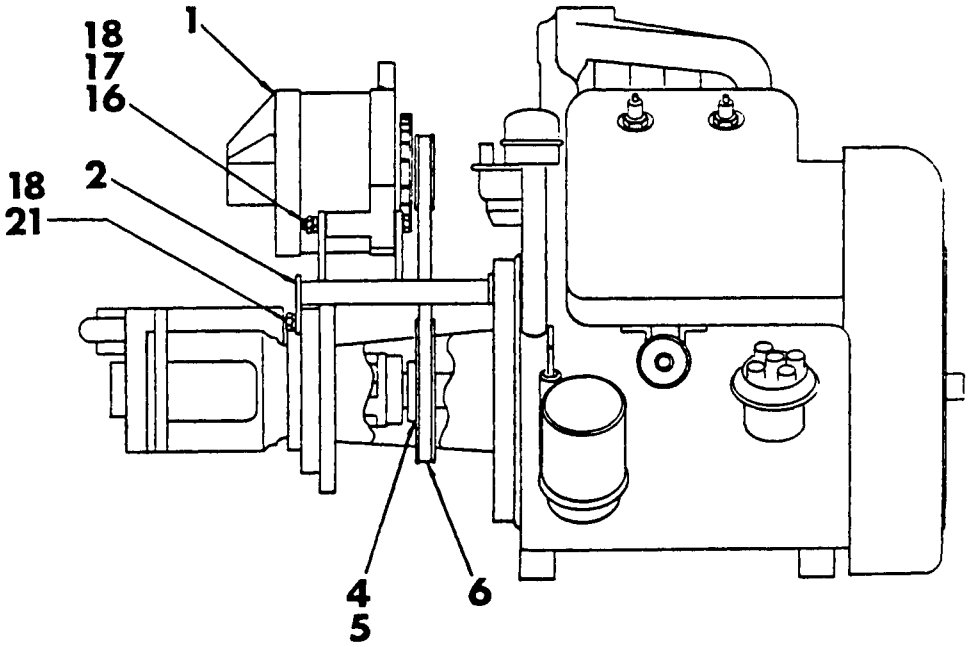


FIGURE 38 - ALTERNATOR FOR WISCONSIN VG4D (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
38 -	20159	ALTERNATOR FOR WISCONSIN VG4D	1
-1	20907	ALTERNATOR	1
-2	21381	MOUNTING BRACKET	1
-3	20900	TENSIONER	1
-4	65001	PULLY	1
-5	65005	TAPER BUSHING	1
-6	16303	V-BELT	1
-7	4082	RELAY	1
-8	131	FUSE HOLDER	1
-9	16310	FUSE (30 AMP)	1
-10	20562	CIRCUIT BREAKER	1
-11	20515	RECEPTACLE	1
-12	356	COVER PLATE	1
-13	20494	DECAL (110 VAC)	1
-14	2806	STRAIN RELIEF	1
-15	2808	LOCK NUT	1
-16	60347	HEX HEAD CAPSCREW 3/8-16UNC X 4	1
-17	60703	HEX NUT-3/8-16UNC	2
-18	63303	LOCKWASHER-3/8 SPLIT	4
-19	60338	HEX HEAD CAPSCREW-5/16-18UNC X 1	1
-20	63302	LOCKWASHER-5/16 SPLIT	1
-21	60325	HEX HEAD CAPSCREW-3/8-16UNC X 3/4	2
-22	60343	HEX HEAD CAPSCREW-3/8-16UNC X 1	1
-23	60624	HEX HEAD CAPSCREW-7/16-14UNC X 1 3/4 BOMALOK 41021-1	2
-24	60150	HEX HEAD CAPSCREW-1/4-20UNC X 1/2	2
-25	60701	HEX NUT-1/4-20UNC	2

FIGURE 39 - RAISED PLATFORM ROTATION (OPTION)

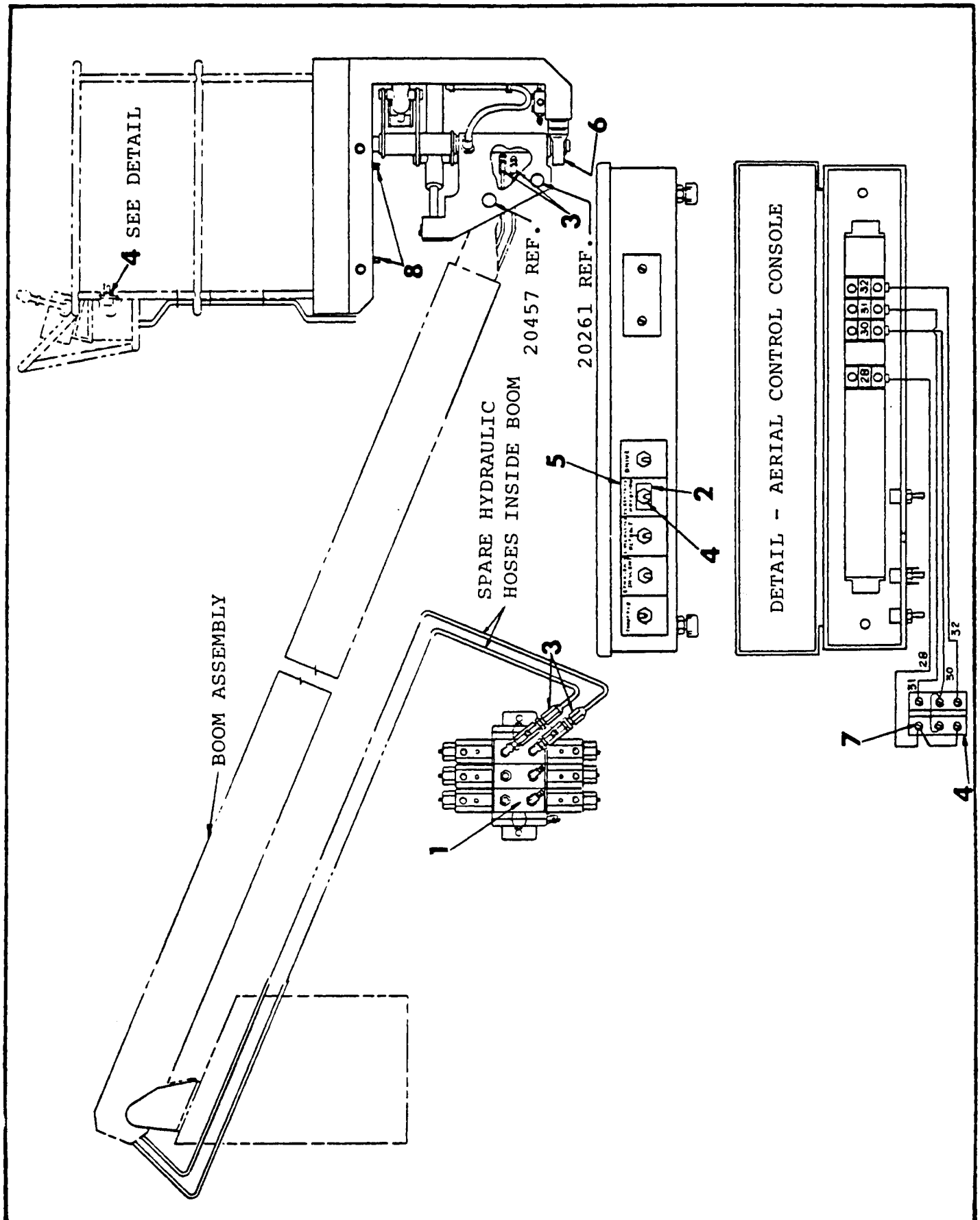


FIGURE 39 - RAISED PLATFORM ROTATION (OPTION)

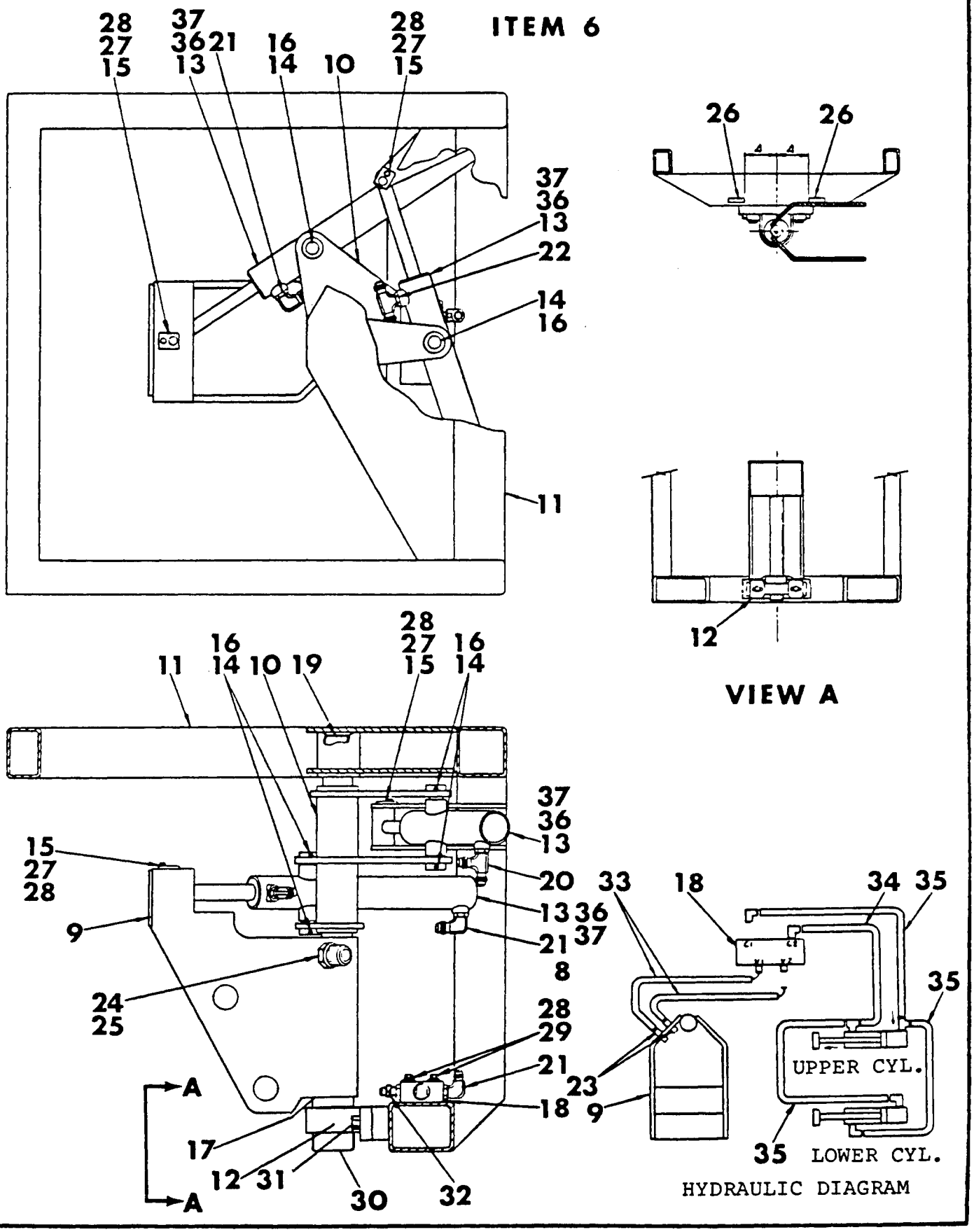


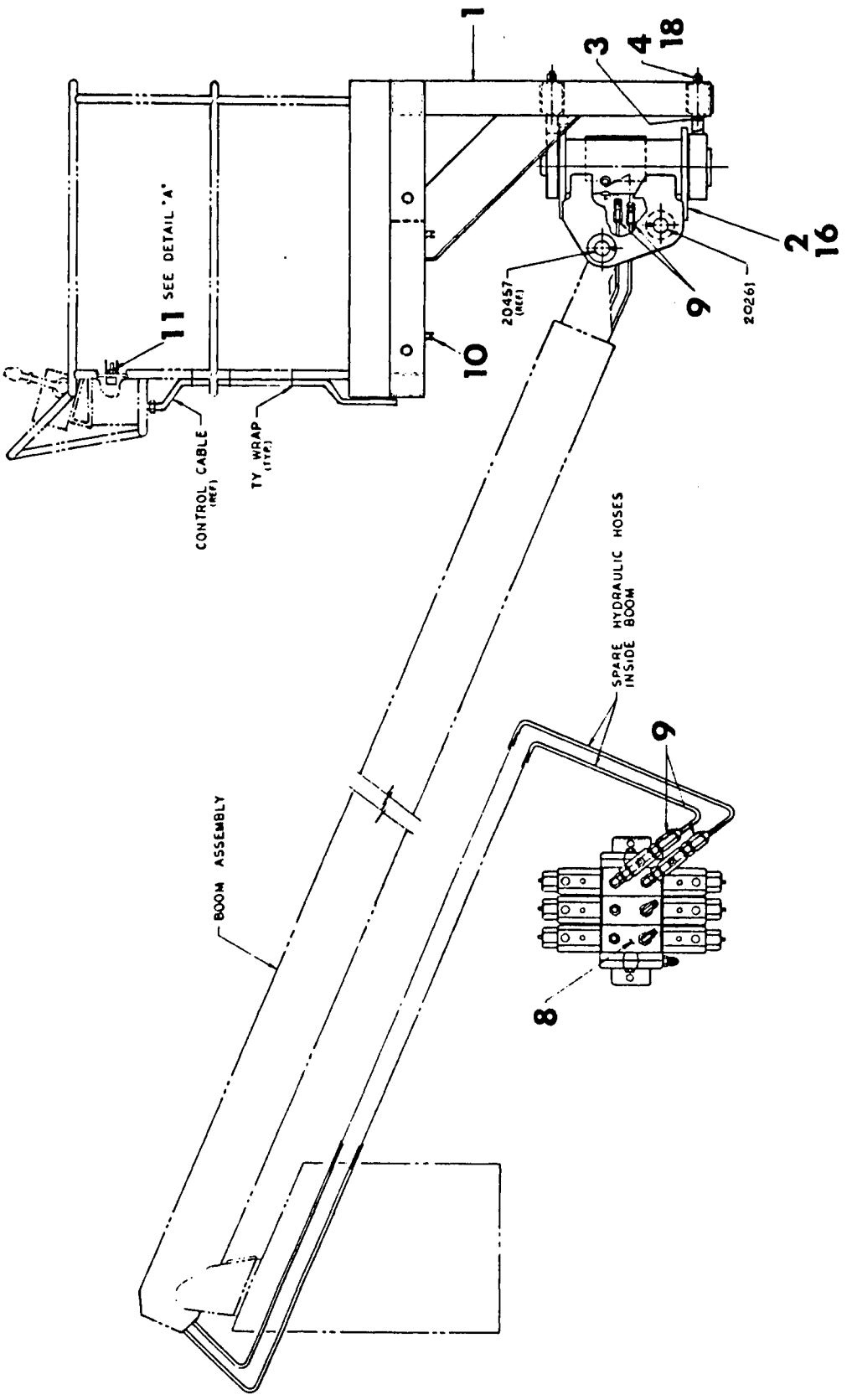
FIGURE 39 - RAISED PLATFORM ROTATION (OPTION)

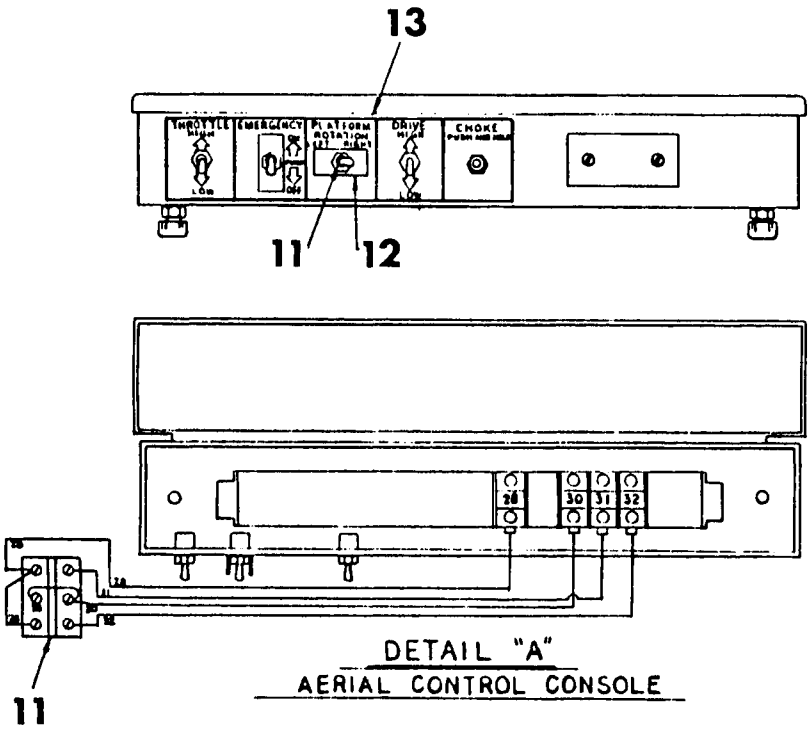
ITEM	PART NUMBER	DESCRIPTION	QTY
39-	20097	PLATFORM ROTATION	1
-1	21713	MINI-PAK SUB ASSEMBLY	1
-2	20884	SWITCH GUARD	1
-3	2562	STRAIGHT SWIVEL HOSE FITTING	4
-4	4021	TOGGLE SWITCH	1
-5	22571	DECAL - AERIAL CONTROL SWITCHES	1
-6	20960	PLATFORM ROTATION ASSEMBLY	1
-7	117B	RING TONGUE	6
-8	16268	HOSE CLAMP	4
-9	20818	LEVELING SKIRT	1
-10	20985	IDLER WELDMENT	1
-11	20997	FORK WELDMENT	1
-12	22481	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 - 5/32 X 1 1/4	4
-17	20914	SPACER	1
-18	20351	DOUBLE P.O. CHECK VALVE	1
-19	20846	THRUST WASHER	1
-20	16400	RUN TEE	1
-21	80012-03	90° ELBOW	4
-22	80036-03	BRANCH TEE	1
-23	80017-03	BULKHEAD UNION	2
-24	30038	STRAIN RELIEF	1
-25	61120	CONDUIT NUT	1
-26	25253	KEYSTOCK	2
-27	60121	HEX HEAD CAPSCREW - 5/16 - 18 UNC X 3/8	2
-28	63302	SPLIT LOCK WASHER - 5/16	4
-29	60329	HEX HEAD CAPSCREW - 5/16 - 18 UNC X 2	2
-30	65454	COLLAR	1
-31	60602	HEX HEAD CAPSCREW - 1/2 - 13 UNC X 1 1/2 BOWMALOK	2
-32	80004-03	STRAIGHT THREAD CONNECTOR	2

FIGURE 39 - RAISED PLATFORM ROTATION (OPTION)

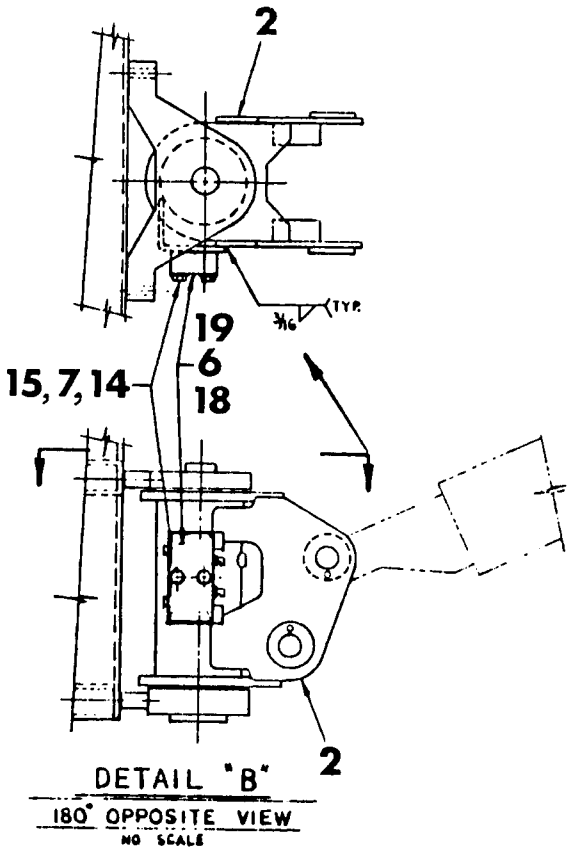
ITEM	PART NUMBER	DESCRIPTION	QTY
-33	13213-04-0200	HOSE ASSEMBLY	2
-34	13210-04-0240	HOSE ASSEMBLY	1
-35	13210-04-0220	HOSE ASSEMBLY	3
-36	66255 OR	PLATFORM ROTATION CYLINDER SEAL KIT(SE)	1
-37	66568	PLATFORM ROTATION CYLINDER SEAL KIT(RA)	1
-38	64905	SEAL KIT	1
-39	2112-1	OILITE BUSHING	1

FIGURE 39.1 PLATFORM ROTATION (OPTION)

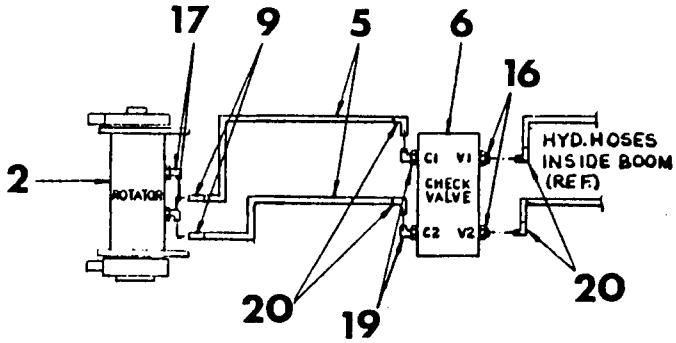




DETAIL "A"
AERIAL CONTROL CONSOLE



DETAIL "B"
180° OPPOSITE VIEW
NO SCALE

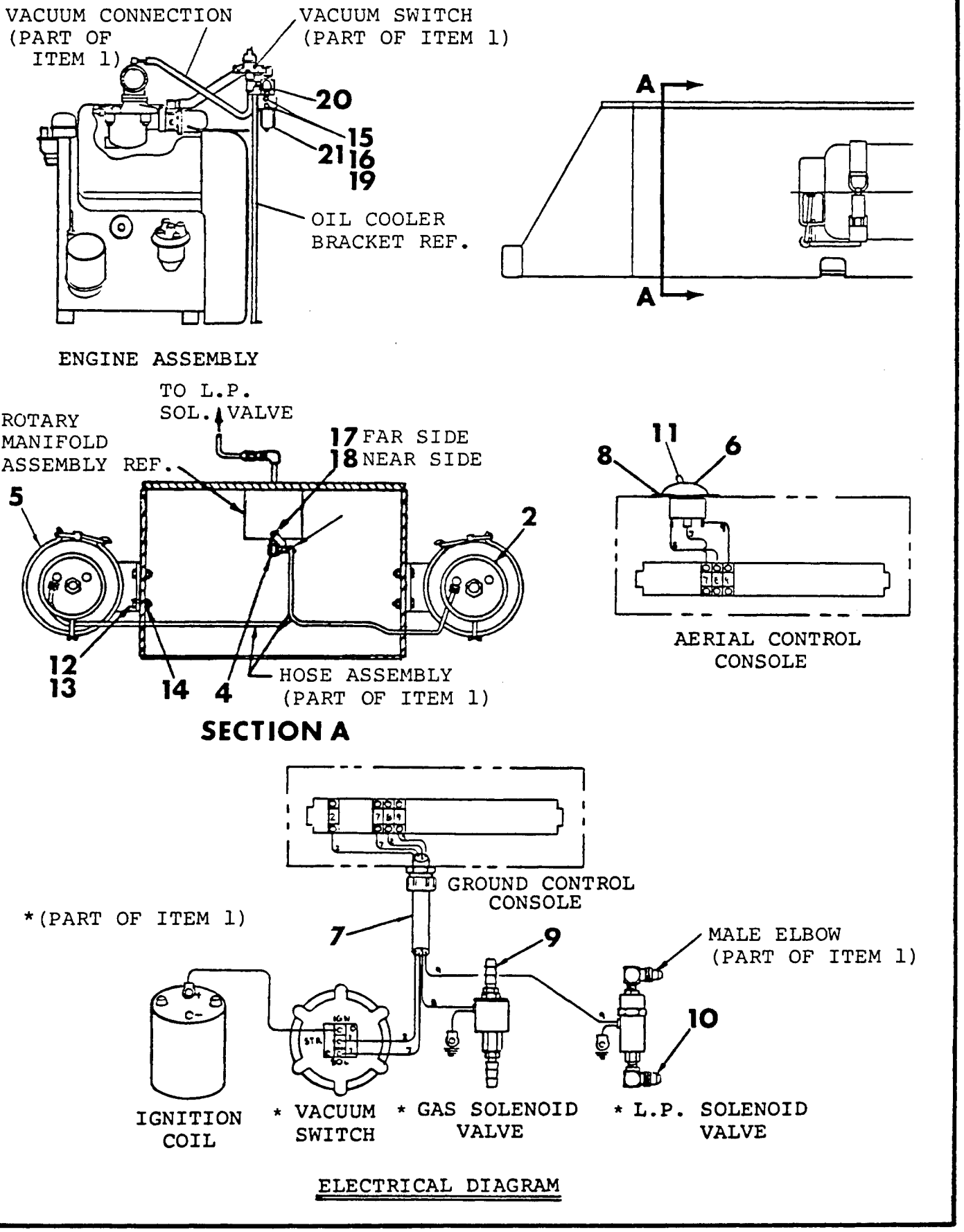


HOSE DIAGRAM

FIGURE 39.1 · PLATFORM ROTATION (OPTION)

ITEM	QTY	PART NO.	DESCRIPTION
	1	22279	PLATFORM ROTATION (OPTION)
1	1	23065	WELDMENT, FORK PLATFORM ROTATION
2	1	81094	ROTATOR, HELAC
3	4	60540	SCREW, CAP
4	4	61305	NUT, LOCK
5	2	2568-0144	HOSE, HYDRAULIC
6	1	20351	VALVE, CHECK
7	2	60360	SCREW, CAP
8	1	21713	SUB-ASSEMBLY, MINI-PAK
9	4	2562	FITTING, STRAIGHT SWIVEL HOSE
10	4	16268	CLAMP, HOSE
11	1	4021	SWITCH, TOGGLE
12	1	20884	GUARD, SWITCH
13	1	22571	DECAL
14	2	63302	WASHER, LOCK
15	2	63402	WASHER, FLAT
16	2	80004-05	CONNECTOR, STRAIGHT THREAD
17	2	80012-03	ELBOW, STRAIGHT THREAD
18	8	63415	WASHER, FLAT
19	2	80012-05	ELBOW, STRAIGHT THREAD
20	4	2594	ELBOW, SWIVEL

FIGURE 40 - DUAL FUEL (OPTION)

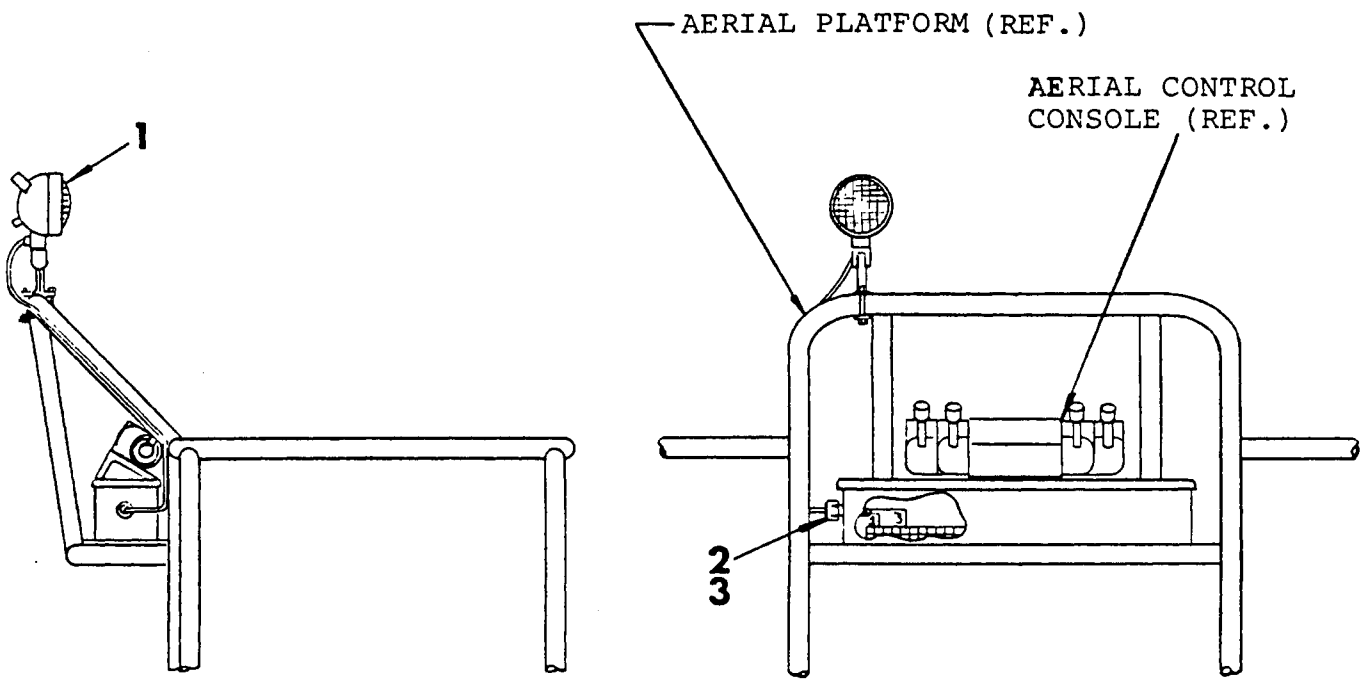


ELECTRICAL DIAGRAM

FIGURE 40 - DUAL FUEL (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
40-	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	80029-07	FEMALE BRANCH TEE	1
-4	21897	SWIVEL JOINT ASSEMBLY	1
-5	486-A	TANK BRACKET	2
-6	20884	SWITCHGUARD	1
-7	2912	ELECTRICAL CABLE - 18 AWG 4	1
-8	20543	DECAL - DUAL FUEL	1
-9	65209	HOSE BARB - 1/8 NPT X 1/4 HOSE	2
-10	80009-07	FEMALE ELBOW	1
-11	4019	TOGGLE SWITCH	1
-12	63303	SPLIT LOCK WASHER - 3/8	8
-13	60307	HEX HEAD CAP SCREW - 3/8-16UNC X 1 1/2	8
-14	60703	HEX NUT - 3/8-16UNC	8
-15	60312	HEX HEAD CAP SCREW - 1/4-20UNC X 1	2
-16	60701	HEX NUT	2
-17	60612	CAP SCREW - 3/8-16UNC X 1 (BOWMALOK 41015)	1
-18	60613	CAP SCREW - 3/8-16UNC X 1 (BOWMALOK 41013)	1
-19	63401	FLAT WASHER - 1/4	4
-20	80001-08	MALE CONNECTOR	1
-21	20886	MOUNTING BRACKET	1

FIGURE 41 - PLATFORM 12 VOLT WORKLIGHT (OPTION)



ITEM	PART NUMBER	DESCRIPTION	QTY
41 -	20139	12V PLATFORM WORKLIGHT	1
-1	20862	WORKLIGHT	1
-2	2522	STRAIN RELIEF	1
-3	141	LOCK NUT	1

FIGURE 42 - FORK GROUND SENSOR (OPTION)

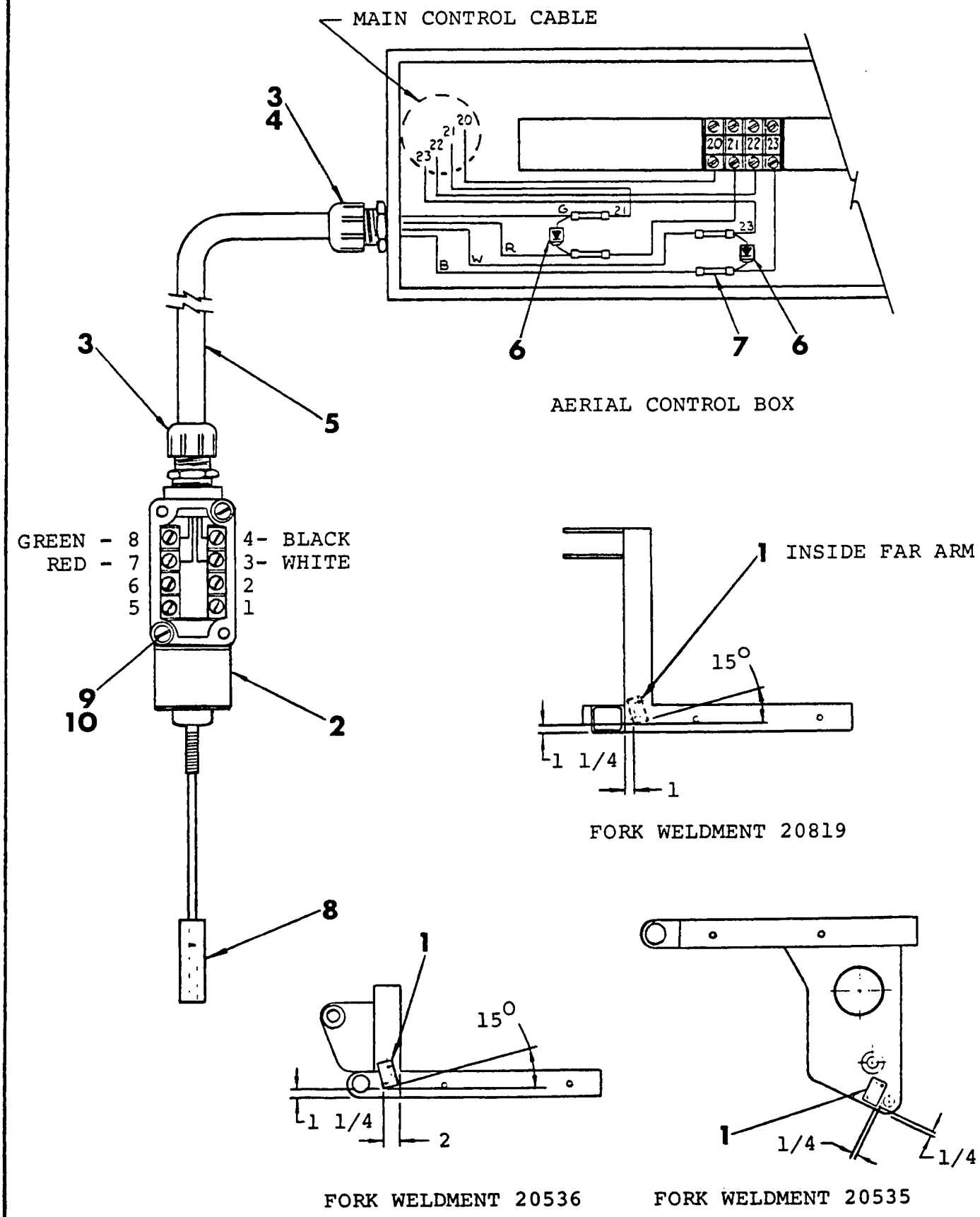
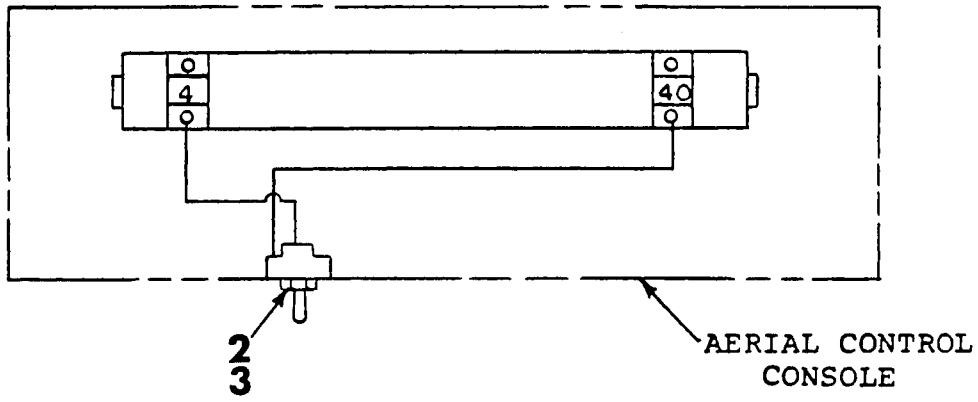
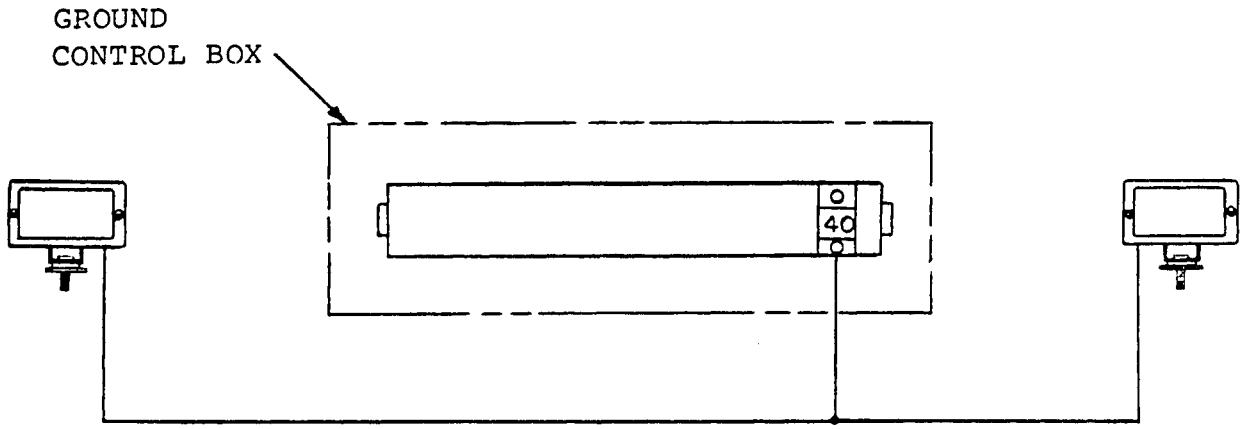


FIGURE 42 -FORK GROUND SENSOR (OPTION)

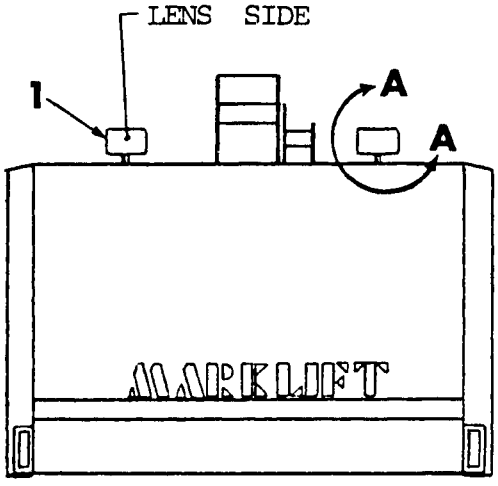
ITEM	PART NUMBER	DESCRIPTION	QTY
42-	20164	FORK GROUND SENSOR	1
-1	20761	MOUNTING PLATE	1
-2	20919	LIMIT SWITCH	1
-3	2806	STRAIN RELIEF	1
-4	2808	LOCK NUT	1
-5	70019	CABLE--4 COND 18GA X 60	1
-6	4045	DIODE	2
-7	117D	BUTT CONNECTOR	4
-8		HOSE--3/16 ID X 2	1
-9		HEX HEAD CAPSCREW--10-32UNF X 2	2
-10	63310	SPLIT LOCKWASHER	2

FIGURE 43 - HEADLIGHTS (OPTION)





ELECTRICAL DIAGRAM



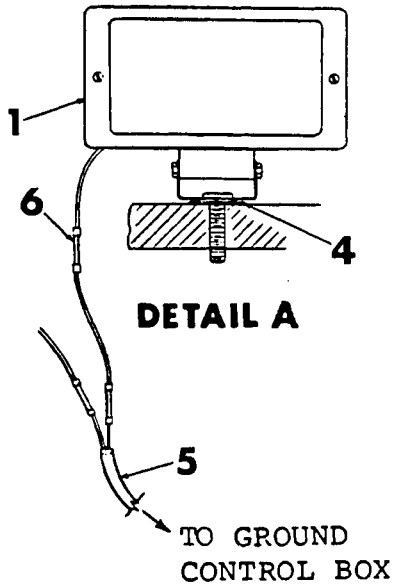


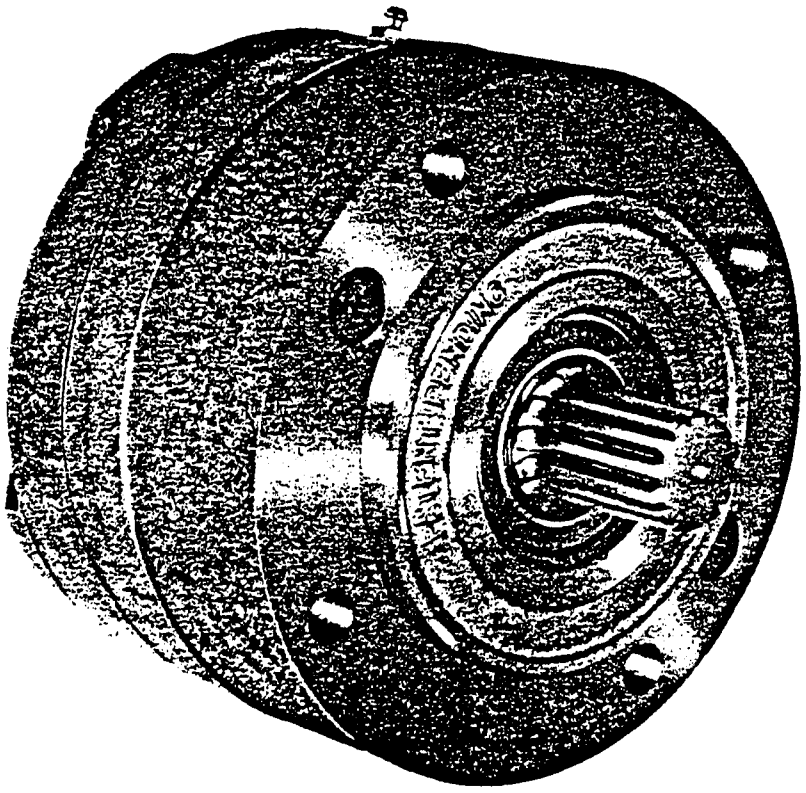
FIGURE 43 - HEADLIGHTS (OPTION)

ITEM	PART NUMBER	DESCRIPTION	QTY
-43	20078	HEADLIGHTS	1
-1	20971	HEADLIGHT	2
-2	4017	TOGGLE SWITCH	1
-3	20509	LIGHTS DECAL	1
-4	63403	FLAT WASHER - 3/8	1
-5	2991	CABLE - 12 AWG 2 COND X 72	1
-6	117-D	BUTT CONNECTOR	4

MULTIPLE DISC BRAKE

(SAE C size)

SERVICE MANUAL MICO



MICO INCORPORATED
MICO WEST / SY TEC

MICO, INC.
1911 Lee Blvd., P.O. Box 2118, No. Mankato, MN U.S.A. 56002-2118
Phone. (507) 625-6426 / TELEX 910-565-2444

MICO WEST / SY TEC
701 East Francis St., P.O. Box 9058, Ontario, CA U.S.A. 91762-9058
Phone. (714) 947-4077 / TELEX 510-600-0132

Form No. 81-950-050 2/86

Printed in U.S.A.

TYPICAL BRAKE

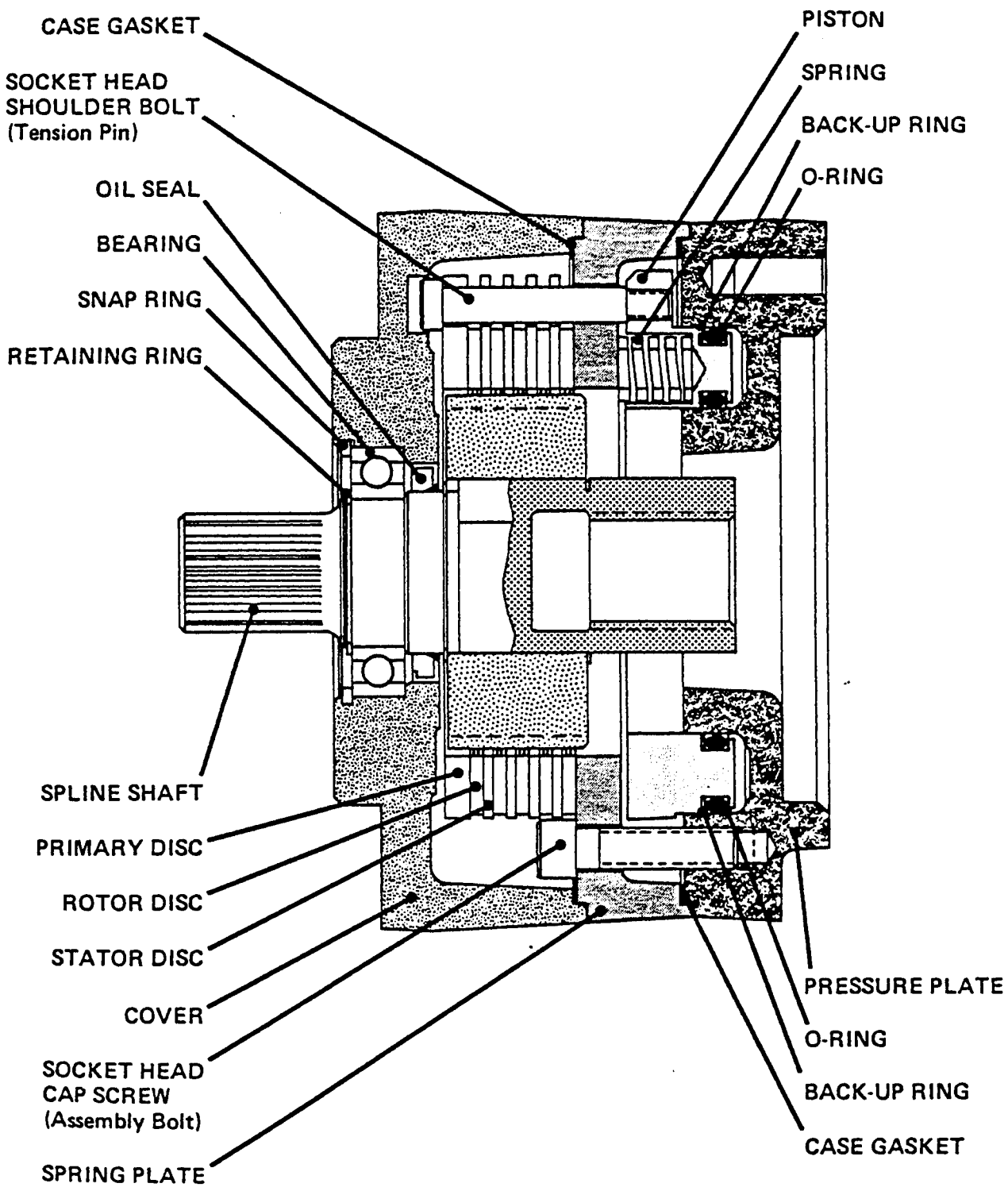


FIGURE 1

PRINCIPLES OF OPERATION

These brakes are spring-set, hydraulically release, multi-disc brakes. They are used primarily for holding loads, vehicles, conveyors, etc. in place when the hydraulic drive system is shut down or fails. Although the brakes are rated at 3,000 psi, they only require from 100 psi to 220 psi to make them function normally. The exact pressure required for operation is dependent upon the number of springs used to generate the torque necessary to hold the designed load. Thus, a brake with a full compliment of springs, will generate the highest level of torque and require approximately 220 psi to fully release the brake and provide adequate running clearance for the individual discs. A brake with 1/2 of the full spring compliment will have 1/2 as much torque and will require only 100 psi to fully release the brake. Consult catalog to choose the torque which best suits your design parameters.

It is very important to remember that any pressure on the brake's release piston will directly effect the level of torque.

Two application examples:

1. The brake has a release pressure of 200 psi. The actuation pressure is provided by a charge pump. During certain phases of the machine's operation, the charge pump pressure dips from 200 psi to 100 psi. At 200 psi, the brake runs free (zero torque) but at 100 psi the brake will generate slightly less than half of its rated torque. The brake will drag — failure may occur. In this case, a brake should be selected which has a lower release pressure.
2. A brake has a release pressure of 200 psi. The system is set up to hold a load when a variable pump is shifted into neutral. Everything is running fine until the filter clogs, causing a build-up of back pressure in the return line to the tank. At a pressure of 60 psi, the brake will lose 25% of its holding torque; thus the load may slip. The situation can be corrected by replacing the filter or adding an extra margin of safety to your required brake torque in the initial design.

These brake are designed to give thousands of trouble-free hours of service when set up correctly in the hydraulic circuit.

DESCRIPTION OF MODEL NUMBERS

C - ** ** ** ** - * *

OUTPUT FACE
SAE C Mt. (4) Bolt

OUTPUT SPLINE
04 — 14T 12/24 (internal)
14 — 14T 12/24 (external)
17 — 17T 12/24

INPUT SPLINE
14 — 14T 12/24
17 — 17T 12/24
06 — 1.0–6B

TORQUE

Code	Std.	High	Release
12		12000	200
98	9800		200
10		10000	170
80	8000		170
85		8500	150
70	7000		150
66		6600	125
55	5500		125
54		5400	105
45	4500		105
Short 42	4200		150
Short 28	2800		150
Short 22	2200		125

INPUT FACE
C — SAE 4 Bolt C Mt.
M — MAB & SAE A
B — SAE B Mt.
E — Char-lynn 4000

OPTIONS
S — Speed Sensor
Z — Wet Brake
D — Double Bearing
2 — 2 Bolt C Mt.

DISASSEMBLY

1. Remove 2 flat head assembly bolts (items 1). A suitable holding fixtue is useful to keep brake in position.
2. Tap female end of spline shaft assembly (item 8) and spring plate (item 14) with soft mallet to separate cover. If sections will not separate, use a screwdriver to carefully pry sections apart.
3. Remove case gasket. (item 7) from cover (item 6).
4. Remove retaining ring (item 2) from spline shaft assembly (item 8).
5. Remove spline shaft assembly (item 8) from cover (item 6) by tapping male end of spline shaft assembly with soft mallet.
6. Remove snap ring (item 3) from cover (item 6) and press out oil seal (item 5) and bearing (item 4) if required.
7. Remove four socket head shoulder bolts (items 10). A suitable holding fixture is useful to hold brake in position.

   CAUTION: Do not remove shoulder bolts without pressurization of brake (approx. 200 psi) or damage may result.

8. Remove primary disc (item 11), five rotor discs (items 12) and four stator discs (items 13).
9. Remove 2 socket head cap screws (items 9).
10. Remove spring plate (item 14).
11. Remove case gasket (item 7) from spring plate (item 14).
12. Before removing springs (items 15), note pattern for reassembly purposes.
13. Remove piston (item 16) by carefully exerting hydraulic pressure through brake release port on pressure plate (item 21).
14. Remove outside and inside o-rings (items 18 & 20) and outside and inside back-up rings (items 17 & 19) from piston (item 16).

    CAUTION: Care must be taken so as not to scratch or mar piston.

ASSEMBLY

LUBRICATE ALL RUBBER COMPONENTS FROM REPAIR KIT WITH CLEAN TYPE FLUID USED IN THE SYSTEM.

1. Use an alkaline wash to clean parts before assembly.
2. Press oil seal (item 5) into bore until it is flush with bearing shoulder. Open side of oil seal must face toward the front side of cover (item 6).
3. Press bearing (item 4) into position until it bottoms out on oil seal borestep.
4. Install snap ring (item 3) into cover (item 6).
5. Press spline shaft assembly (item 8) into bearing (item 4) until shaft bottoms on shaft shoulder. Bearing innner race must be supported during this operation.
6. Install retaining ring (item 2) on spline shaft assembly (item 8).
7. Install back-up rings (items 17 & 19) on piston (item 16) toward spring pockets.
8. Install o-rings (items 18 & 20) on piston (item 16). Be sure o-rings are flat and all twists removed.

   CAUTION: Care must be taken so as not to scratch or mar piston.

9. Lubricate piston (item 16) with type fluid used in the system. Carefully press piston into pressure plate (item 21). Be sure piston is aligned correctly at all times and that there are no extrusions. Press piston until it bottoms on pressure plate (item 21).
10. Install eight springs (item 15) according to pattern noted during disassembly. Different colored springs must be alternated.
11. Apply a bead of 3M-08001 adhesive on the spring plate (item 14), pressure plate (item 21) and cover (item 6) sealing surfaces. Affix case gaskets (item 7) to cover (item 6) and spring plate (item 14).
12. Place unit on a press. Using fixture, depress and install two oil dipped, socket head assembly bolts (item 9). Torque bolts to 40 ft. lbs. A suitable holding fixture is useful to hold brake in position.
13. Install stator discs (item 13) and rotor discs (item 12). Begin with a rotor disc (item 12) and alternate with stator discs (item 13).
14. Install primary disc (item 11).
15. Align discs and partially screw in four oil-dipped, socket head shoulder bolts (item 10). Inspect for free movement of stack. Pressurize brake release port (approx. 200 psi) to release discs. Torque shoulder bolts to 20 ft. lbs. and release pressure. A suitable holding fixture is useful to hold brake in position.
16. Install cover (item 6) using flat head assembly bolts (item 1). Torque bolts to 45 ft. lbs.

BLEEDING

1. Install brake in system and connect pressure lines.
2. Bleed pressure release section of brake by pressurizing side inlet port and allowing air to escape from top port. Pressure should not exceed 100 psi during bleeding.
3. Apply sufficient pressure to release brake and check for proper operation in system.

SERVICE DIAGNOSIS

(Numbers shown refer to Figures 2 and 3)

PROBLEM	CAUSE	EXPLANATION	ACTION
Brake slips	A. Excessive pressure in hydraulic system	If there is back pressure in the brakes actuation line, the holding torque of the brakes is reduced.	Check filters, hose size, restrictions in other hydraulic components.
	B. Oil in brake if designed for dry use	Dry linings generate 66% more torque than linings saturated with oil. If the brake has oil in it, check the type of pil hydraulic or gearbox. 1. Gearbox oil 2. Hydraulic oil 3. Hydraulic oil	Replace oil seal in brake Check motor seal Check piston seals Note: Internal components will need to be inspected, cleaned and replaced as required.
	C. Disc plates worn	The thickness of the disc stack sets the torque level. A thin stack reduces torque.	Check disc thickness (see inspection procedures)
	D. Springs broken or have taken a permanent set	Broken or set springs can cause reduced torque - a rare occurrence	Check release pressure (see spring replacement)
Brake drags or runs hot	A. Low actuation pressure	The brake should be pressurized to minimum of 20 psi over the specified release pressure under normal operating conditions. Lower pressures will cause the brake to drag thus generating heat.	Place pressure gauge in bleed port & check pressure with system on
	B. Bearing failure	If the bearing should fail, a large amount of drag can be generated	Replace bearing
	C. Oil in brake	Excess fill of oil in sump condition thru wet brakes can cause the unit to run hot. Also excessive rpm in sump condition.	Drain oil and refill as specified for brakes Switch to flow thru cooling.
Brake will not release	A. Stuck valve or clogged	Brakes are designed to come on when system pressure drops below stated release pressure. If pressure cannot get to brake, the brake will not release.	Place pressure gauge in bleed port - check for adequate pressure - Replace defective line or component
	B. Bad o-rings	If release piston will not hold pressure, brake will not release.	See section 1-B-3
	C. Discs frozen	Sy-Tec brakes are designed for only limited dynamic braking. A severe emergency stop or prolonged reduced release pressure operation may result in this type of damage.	Replace disc stack (see inspection procedures)

FOR REPAIR KIT INFORMATION REFER TO PAGE 7.

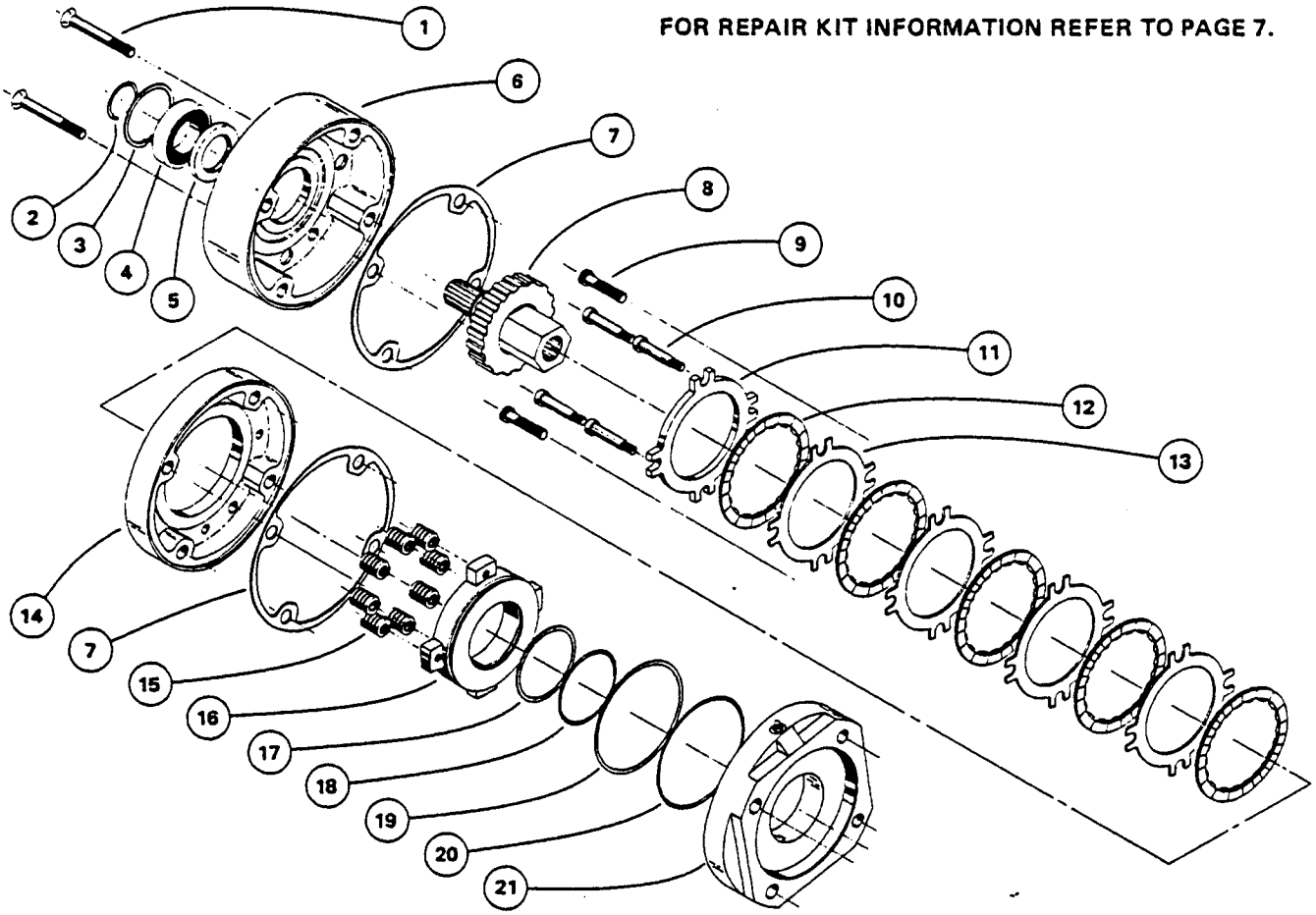


FIGURE 2

PARTS LIST

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	FLAT HEAD ASSEMBLY BOLTS	11	PRIMARY DISC
2	RETAINING RING	12	ROTOR DISCS
3	SNAP RING	13	STATOR DISCS
4	BEARING	14	SPRING PLATE
5	OIL SEAL	15	SPRINGS
6	COVER	16	PISTON
7	CASE GASKETS	17	BACK-UP RING
8	SPLINE SHAFT ASSEMBLY	18	O-RING
9	SOCKET HEAD CAP SCREWS (Assembly Bolts)	19	BACK-UP RING
		20	O-RING
10	SOCKET HEAD SHOULDER BOLTS (Tension Pins)	21	PRESSURE PLATE

REPLACEMENT KITS

PART NUMBER	KIT DESCRIPTION	KIT INCLUDES
RK-1 plus your brake model number	Inspection Kit	Face Gaskets Case Gaskets
RK-2 plus your brake model number	Oil Seal & Gasket Replacement Kit	Face Gaskets Case Gaskets Oil Seal
RK-3 plus your brake model number	O-ring & Back-up Ring Replacement Kit	Face Gaskets Case Gaskets Oil Seal O-Rings Back-up Rings Loc-tite
RK-4 plus your brake model number	Lining Replacement Kit	Face Gaskets Case Gaskets Primary Disc Stator Discs Rotor Discs
RK-5 plus your brake model number	Bearing Replacement Kit	Face Gaskets Case Gaskets Bearing Oil Seal
RK-6 plus your brake model number	Spring Replacement Kit	Face Gaskets Case Gaskets Springs
RK-7 plus your brake model number	Pressure Override Seal Replacement Kit	Face Gaskets Case Gaskets Oil Seal

AUSCO BOOM WHEEL BRAKES

BRAKE FUNCTION

The Failsafe Brake is spring loaded to apply the brake and hydraulic pressure is required to release or "hold off" the brake. Normal operation is to have the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the hydraulic system pressure below the release pressure of the brake, will cause a brake application.

The brake is designed to fit with a gear reducer and a hydraulic motor. The common mounting surfaces of the brake, the motor, and the gear reducer are machined to close tolerances and should be protected from damage during installation and removal.

INSTALLATION INSTRUCTIONS (Ref: Fig. 1)

1. Place the gasket onto the mounting face of the brake.
2. Place the brake shaft into the gear reducer with the brake bleeder screw in the vertical position.
3. Move the brake into position with gear reducer assuring proper gasket location. Align the mounting bolt holes by rotating the engaged brake into position. If this is not possible, the brake may be rotated after pressure has been applied to the brake inlet. This will release the brake and allow it to be rotated into position.
4. Similarly place a gasket onto the flange of the motor.
5. Insert the shaft of the motor into the brake and push into position, assuring proper gasket location.
6. Insert the two half-inch bolts (Grade 5) thru the motor flange, the gasket, the brake, the second gasket, and into the threaded hole in the gear reducer mounting flange. Insure that the bolts are not too long so that they do not bottom out in the reducer before clamping.
7. Run bolts in alternately to prevent binding, until snug. Then torque the bolts to 75-85 lb. ft.
   Note: Both Shafts must slide together freely - DO NOT use bolts to force the units together.
8. With motor and brake bolted into position, remove cap plug and connect "inlet" hydraulic line to brake. (If not done for shaft alignment - Step 3). Brake inlet is .250 tubing O.D., Straight thread O-ring boss (.438-20, UNF 2B Thd.)
9. Bleed air from brake via bleeder screw.
   Note: Maximum pressure to brake is 3000 psi.

BRAKE DISASSEMBLY PROCEDURE: (Ref. Fig. 2)

1. With shaft protrusion downward, disassemble in the following order:
2. Bolts (24) alternately, Power Plate (22), O-ring (6), Stationary Discs (15), Springs (13), Rotating Discs (14), Primary Disc (12), Pins (11), Springs (8 & 9), Spring Retainer (7).
3. Further disassembly is not recommended and should not be attempted unless necessary for the replacement of specific

parts, i.e., Snap Rings (1 & 2), Bearing (3) and Shaft (10) from Housing (5), if necessary: proceed as follows:

A) Remove Snap Rings (1 & 2), then remove Shaft (10) from Bearing (3) by lightly tapping shaft with a plastic mallet.
B) Remove bearing from housing.
C) Brake 33451 and 34535: After removal of shaft and bearing, inspect Seal (4) for damage of sealing lip. If damaged, press seal from housing and replace per reassembly instructions.

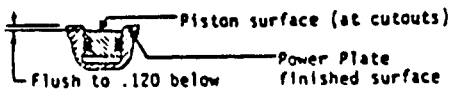
4. Remove the Piston (16) from the Power Plate (22) by introducing low pressure air - 15 psi - into the hydraulic inlet. Make sure piston is directed away from the operator. Remove O-rings (18 & 20, and Back-up Rings (17 & 19) from the piston O.D. and I.D. grooves. Back-up Rings will be damaged and should not be removed if replacement is not planned.
5. Pressure Relief Valve (26) can be removed and inspected to assure spring-loaded ball moves freely and is free of contamination.

ASSEMBLY PROCEDURE

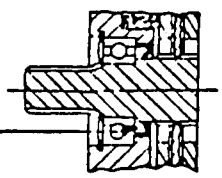
IMPORTANT: There may be more parts in a service kit than your brake requires. Check the parts list carefully for the exact quantity. In the case of springs, space the required quantity equally.
All parts must be thoroughly clean prior to reassembly.
Use the reverse of the disassembly procedure with the following notes and additions:

1. Worn O-rings and damaged or worn teflon back-up rings must be replaced prior to reassembly.
2. Cylinder of the Power Plate, Piston and O-rings must be clean prior to assembly, and pre-lubed with the system hydraulic fluid.
3. If replacement of Pressure Relief Valve (26) is necessary, install 1/2 to 3/4 turns beyond finger tight.
4. Assembly Piston (16) into Power Plate (22) using a shop press, being careful not to damage the O-rings or teflon back-up rings. Visually align the center of the cut-outs in the Piston with the Torque Pin (11) holes in the Power Plate (22).

   Depth of piston installation into the power plate is critical. DO NOT exceed .120 depth or piston will cock, resulting in a complete loss of braking.



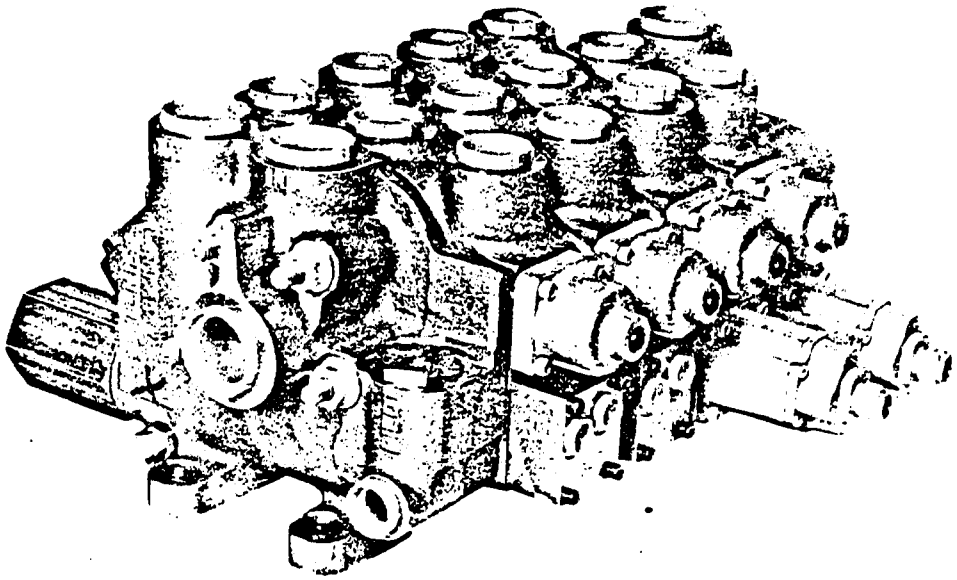
5. Replacement of Seal (4) Brakes 31131,33451, 34535, 35410, 36400 & 36415:
   A) Install Bearing (3) & Snap Ring (1) into Housing (5).
   B) Press Seal (4) into housing with lip facing bearing.
   C) Apply small amount of grease in cavity between bearing & seal.



JULY 1977

SERVICE MANUAL

LOAD SENSING PRESSURE COMPENSATING PROPORTIONAL DIRECTIONAL VALVE



MODEL NO. 269300

BERTEA / INDUSTRIAL PRODUCTS

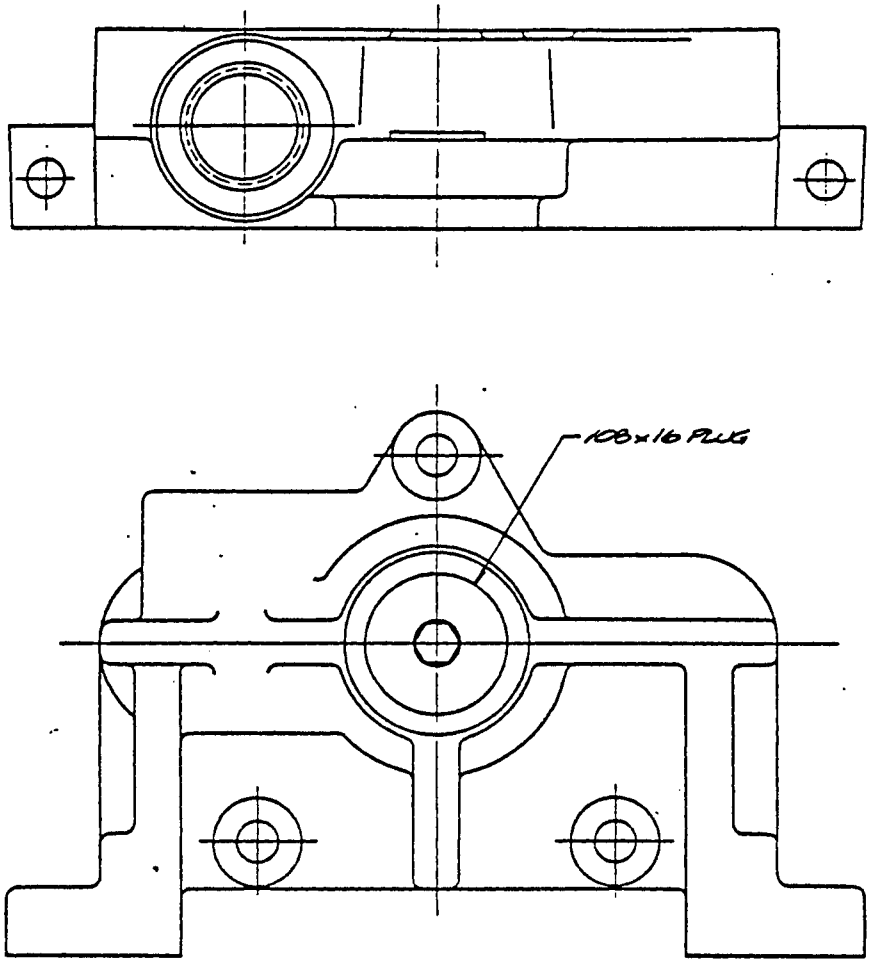
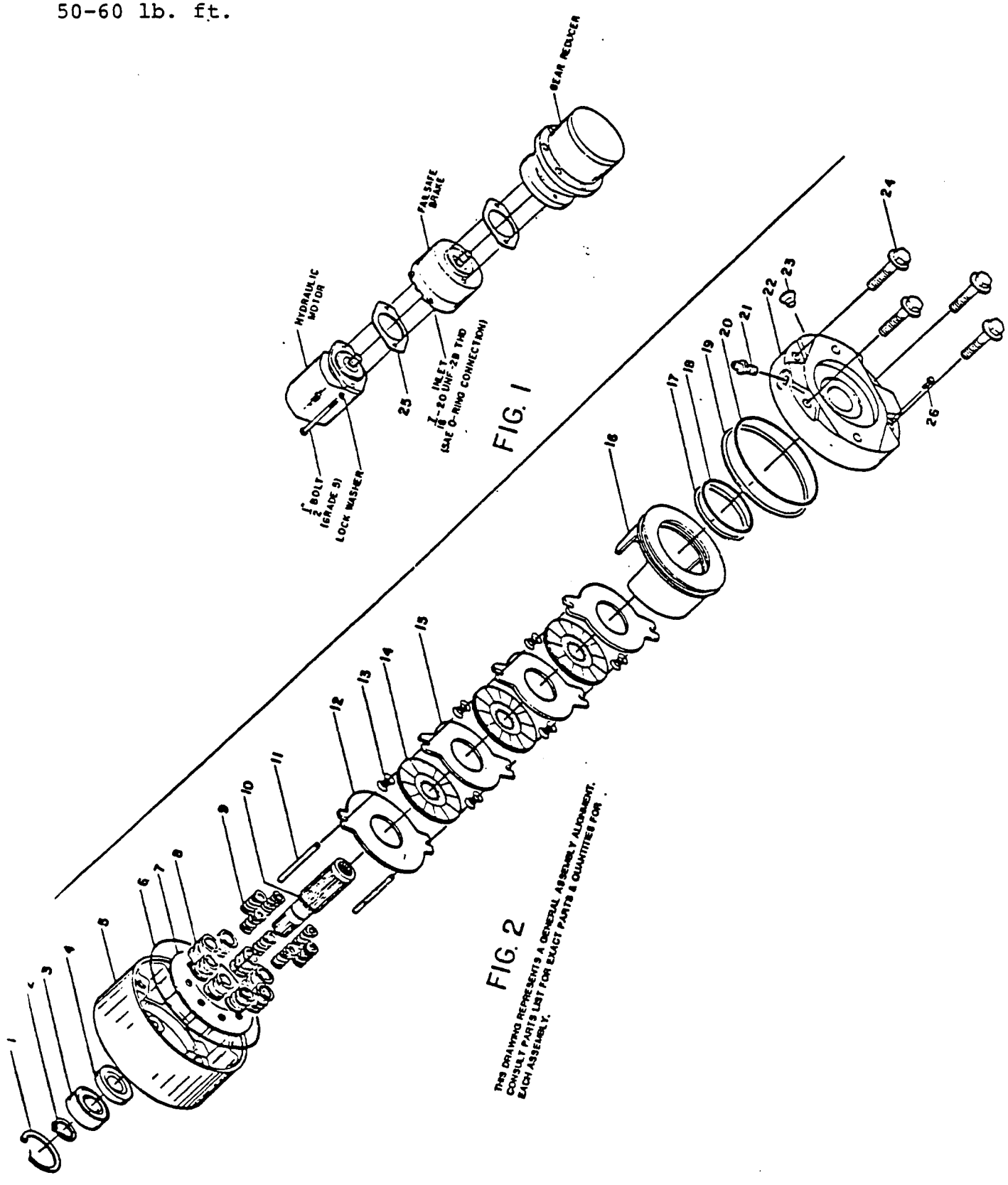


FIGURE 11

OUTLET ASS'Y
MODEL V530-700250

D) Press Shaft (10) into Bearing (3).
Install Snap Ring (2) onto shaft.

6. Rotating Discs must be clean and dry. There should be no presence of oil on any lining material or mating surfaces of the Stationary Discs.
7. Install Bolts (24). Tighten sequentially, one turn at a time, until Power Plate (22) is properly seated. Torque 50-60 lb. ft.



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

MODEL 269300 SERIES

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FIGURE IDENTIFICATION

Figure #1 - Module Assembly

Figure #2 - Circuit Schematic

Figure #3 - Remote Electro-Hydraulic Control Schematic

Figure #4 - Remote Pilot Oil Control Schematic

Figure #5 - Dual Port Inlet Manifold

Figure #6 - Directional Valve Manifold

Figure #7 - Manual Override End Cap

Figure #8 - Single Port Inlet Manifold

Figure #9 - Basic Shuttle

Figure #10 - Adjustable Shuttle

Figure #11 - Purge Manifold Assembly

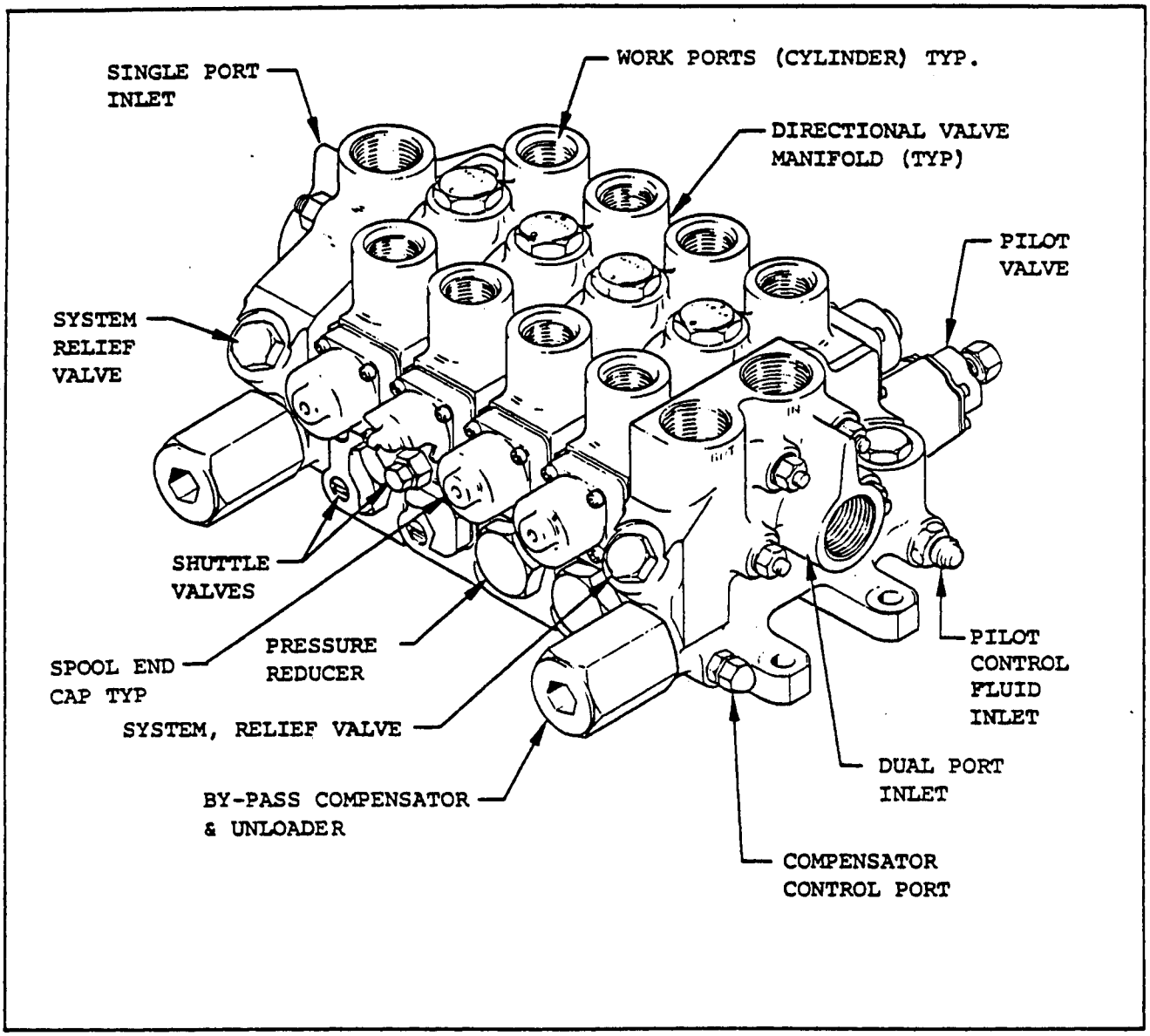
Figure #12 - Bertea Valve Installation

Figure #13 - Remote Purge System Schematic

Figure #14 - Installation Drawing 269300

Figure #15 - Pilot Valve Installation

BERTEA LOAD SENSING - PRESSURE COMPENSATING
PROPORTIONAL DIRECTIONAL VALVE



MODULE ASSEMBLY
FIGURE 1

I INTRODUCTION

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

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

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

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

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

II SYSTEM DESCRIPTION

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

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

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

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

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

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

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

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

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

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

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

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

Directional Valve Manifold Assemblies with shuttles and pressure reducers.

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

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

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

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

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

III OPERATION (Figure #2)

A. LOAD SENSING & PRESSURE COMPENSATING

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

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

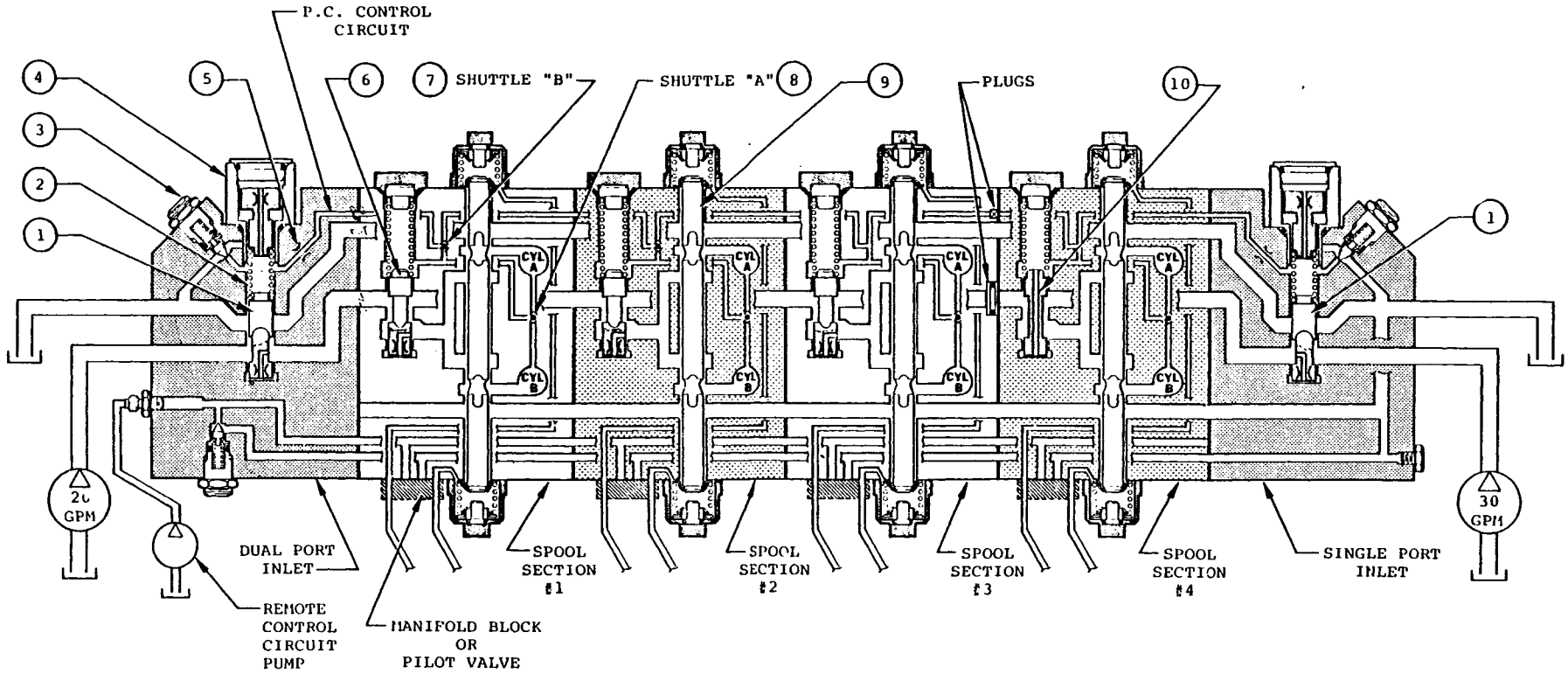
The directional valve spool (Item 9) is spring caged to the center position with a 19# preload. As the remote control system builds up a differential pressure across the spool - ie increases the pressure in one end cap and lowers the pressure in the other end cap - the spool will move out of center detent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

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

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

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

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



LOAD SENSING - PRESSURE COMPENSATING CIRCUIT SCHEMATIC
FIGURE 2

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

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

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

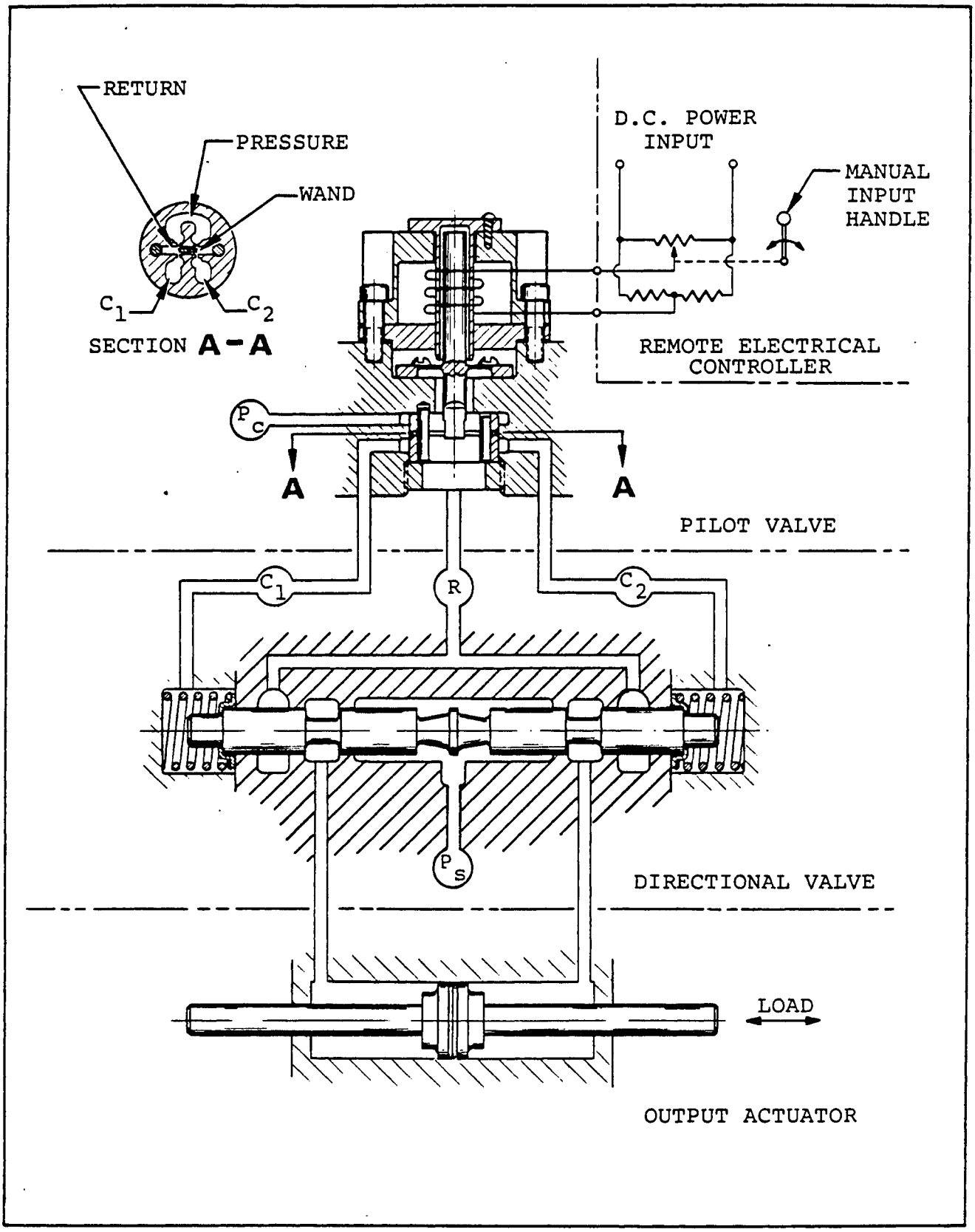
Since the 30 gpm pump supplies fluid to only spool section #4, it is not required to use a pressure reducer spool in the manifold, because the by-pass compensator (Item 1) of the single port inlet will hold 150 psi differential pressure across the directional valve spool. This 150 psi will maintain constant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

B. REMOTE CONTROL OF DIRECTIONAL VALVE SPOOL

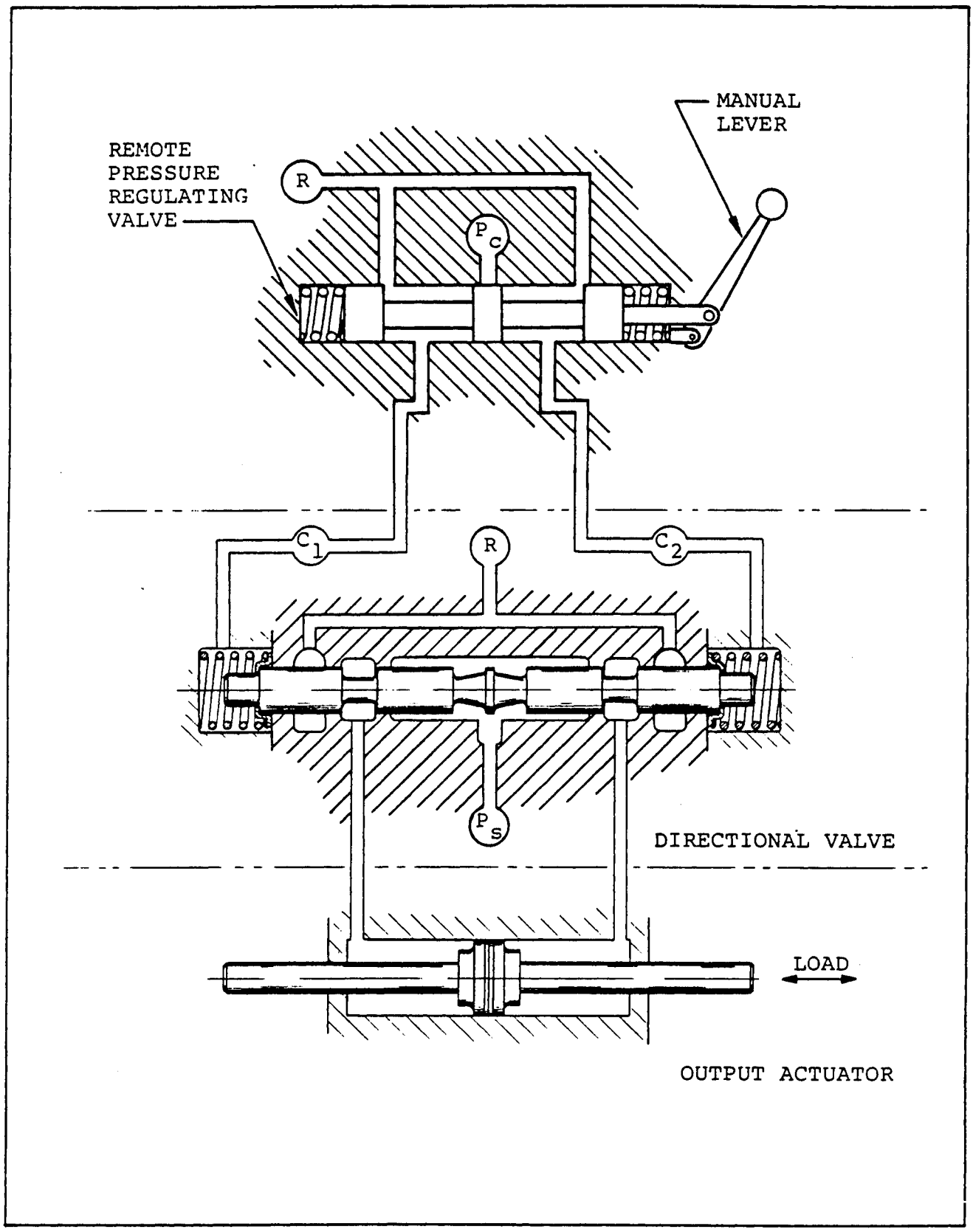
The two basic systems used to control the position of the directional valve spool, and thus control the speed or position of the function are (1) Electro-Hydraulic or (2) Remote Pilot Oil. Each system varies the differential pressure in the end caps to position the spool proportional to input command!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

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

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



REMOTE ELECTRO-HYDRAULIC CONTROL
FIGURE 3



REMOTE PILOT OIL CONTROL
FIGURE 4

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

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

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

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

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

IV ASSEMBLY & SERVICE

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

Dual Port Inlet Manifold Assembly Figure #5

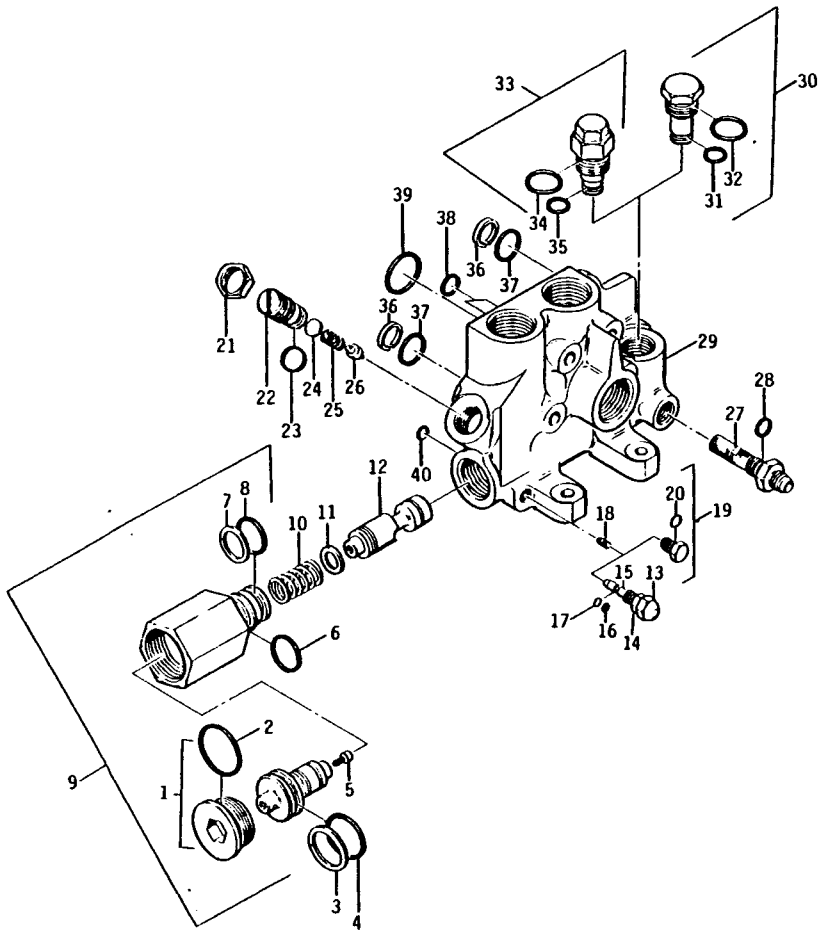
The dual port manifold assembly provides inlet porting for both the power fluid circuit and, also, the pilot valve control fluid circuit. The power fluid circuit contains both inlet and outlet porting, but the control fluid circuit is inlet porting only. The system relief valve (Item 21 thru 26) is adjustable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

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

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

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	269342-20	HEX. PLUG
2	1	3-920N552-90	"O" RING
3	1	261895-5	GLYD RING
4	1	2-122N674-70	"O" RING
5	1	269341-3	ORIFICE PLUG
6	1	3-916N552-90	"O" RING
7	1	3-922N300-90	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

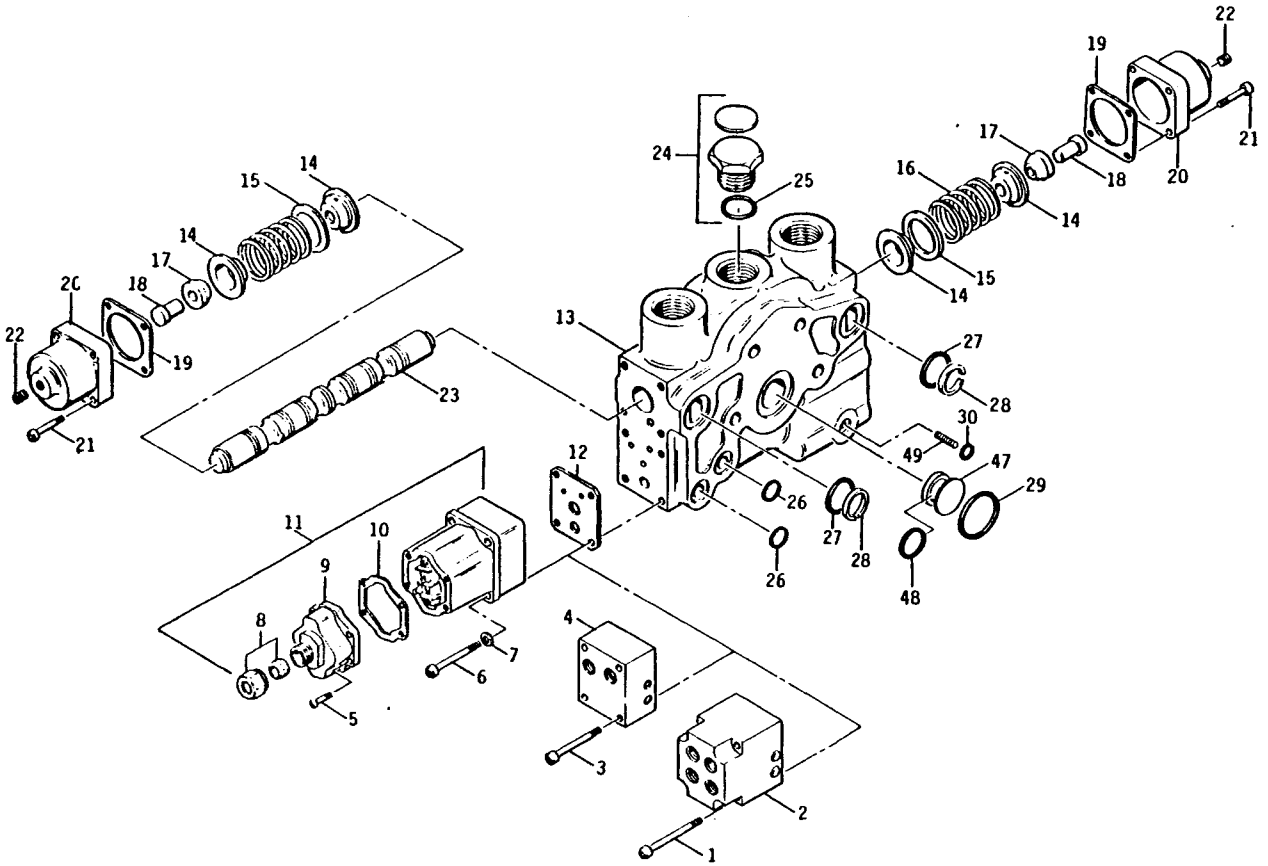
Δ 269344-1 "O" RING KIT



DUAL PORT INLET MANIFOLD
FIGURE 5

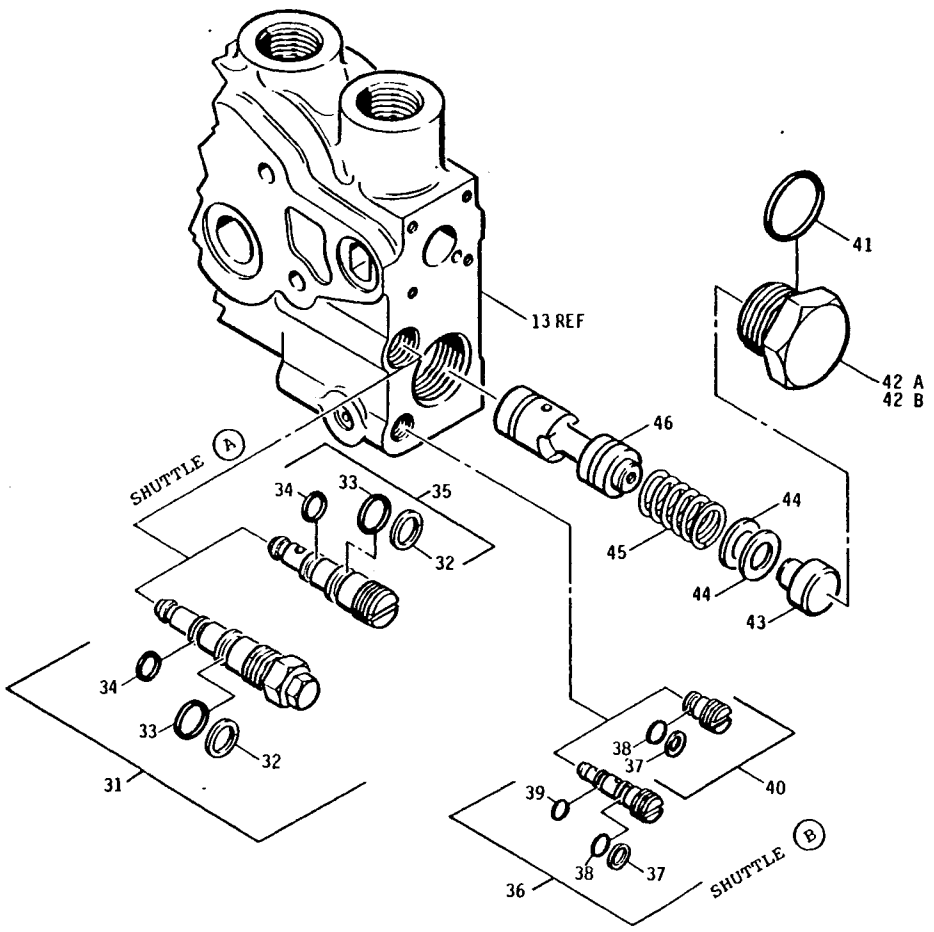
ITEM NO.	QTY	PART NUMBER	DESCRIPTION
1	4	10-24x1 3/4	SCREW-SOC. HEAD
2	1	269357-1	MANIFILD ASSY.-PURGE & SHUTTLE VALVE
3	4	10-24x1 1/2	SCREW-SOC. HEAD
4	1	269327-1	MANIFOLD ASSY.-PURGE CIRCUIT
5	4	#6-32x1/2	SCREW-PHILLIPS HD.
6	4	234980	SCREW-SOC. HEAD
7	4	234959	WASHER
8	1	249896	SEAL KIT
9	1	242933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

12

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.

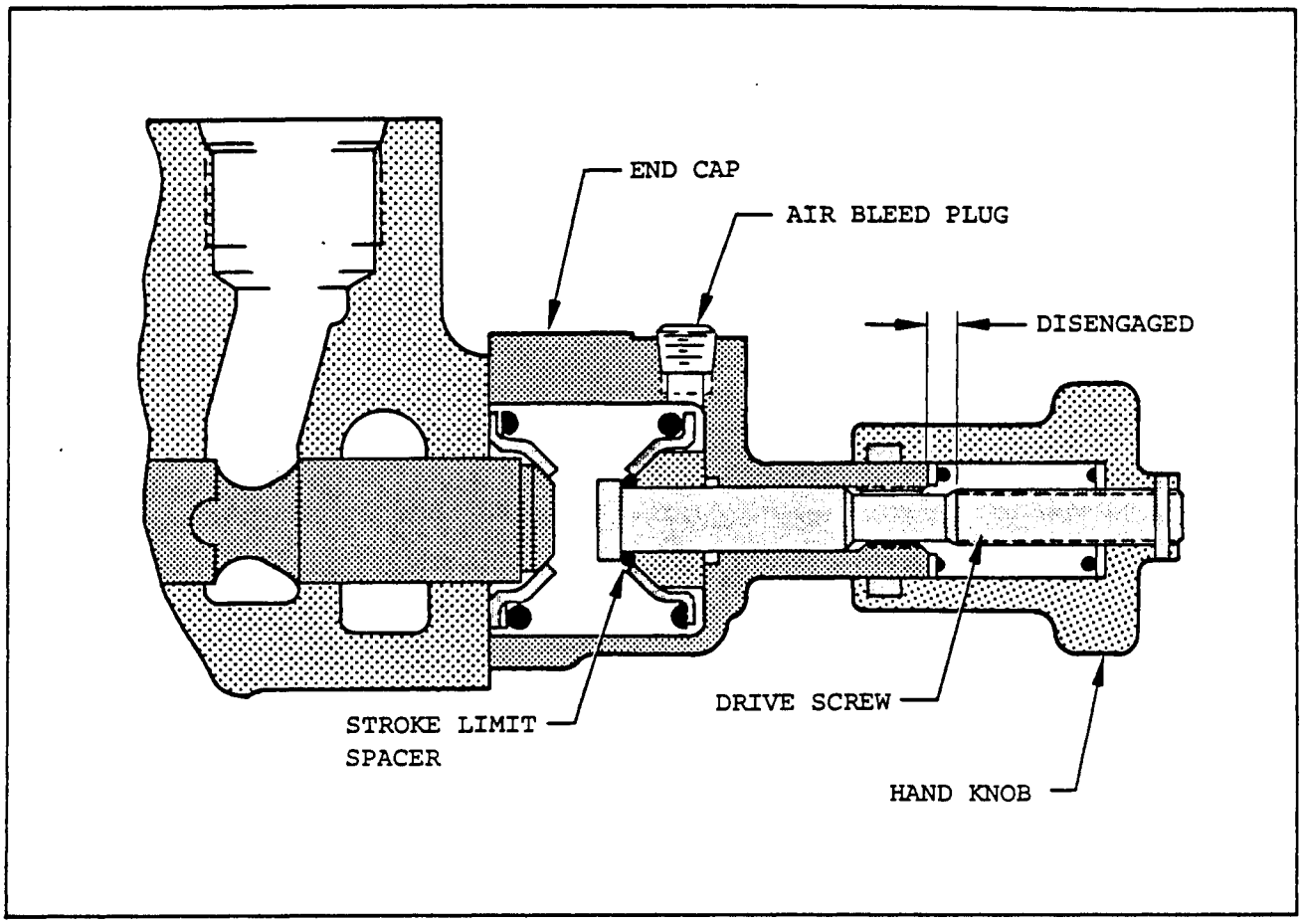
The hand knob is held in the thread disengaged position by a light spring to prevent inadvertent operation. Press the knob inward while rotating to engage the threads in the cap and the drive screw. Continued rotation clockwise will move the spool from center and will provide flow from the cylinder port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

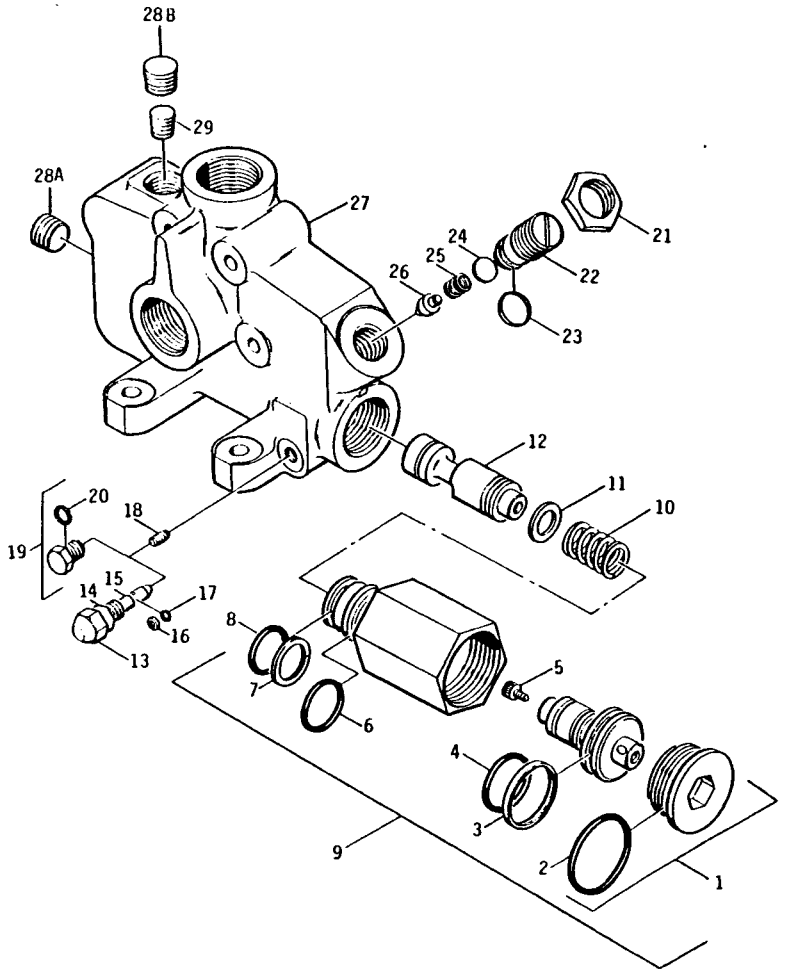
The system relief valve (21 thru 26) is adjustable up to 3000 psi. The orifice (Item 18) limits the flow into the compensator spring cavity, permitting the relief valve to limit system pressure by porting this fluid to tank.

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

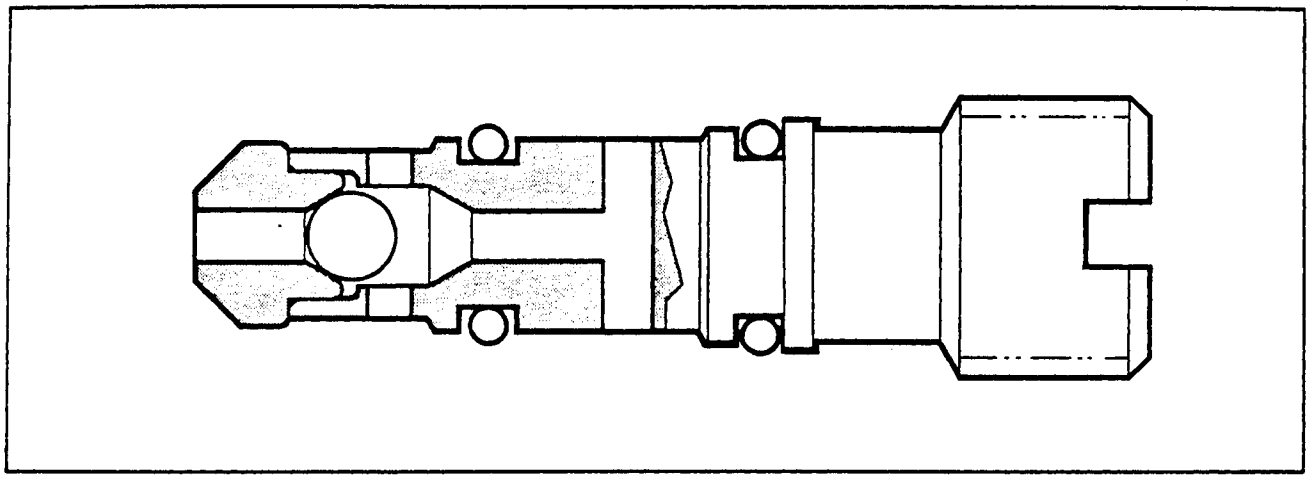
The electro-hydraulic pilot valve is a separate, replaceable assembly as shown on Figure #6 and #15. Each valve has 150 micron filter, installed beneath the roll pin that is used for installation orientation.

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

15

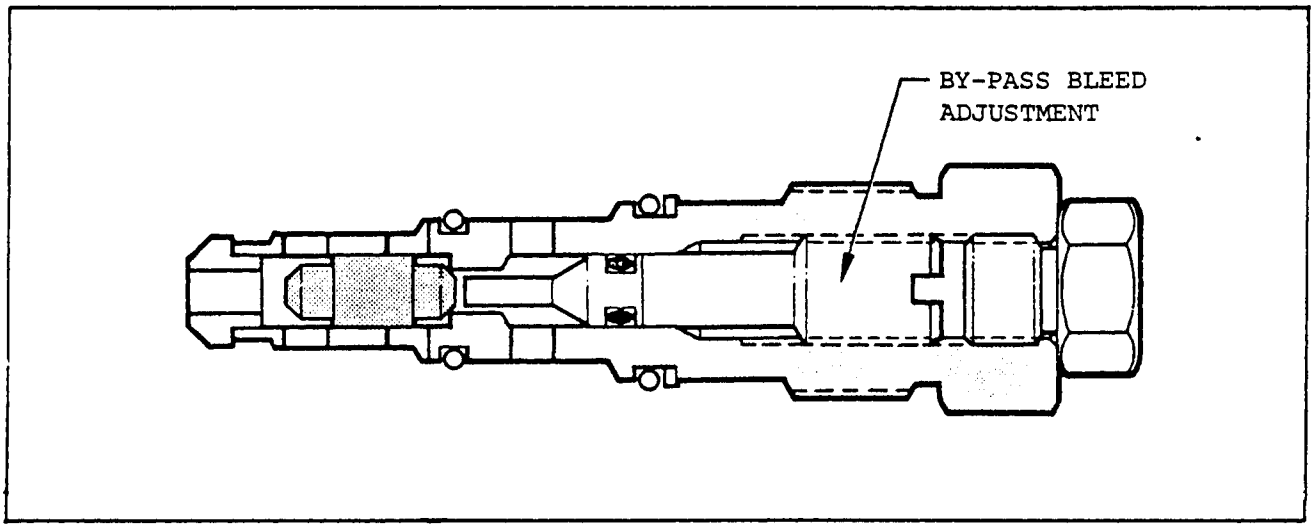


BASIC SHUTTLE
FIGURE 9

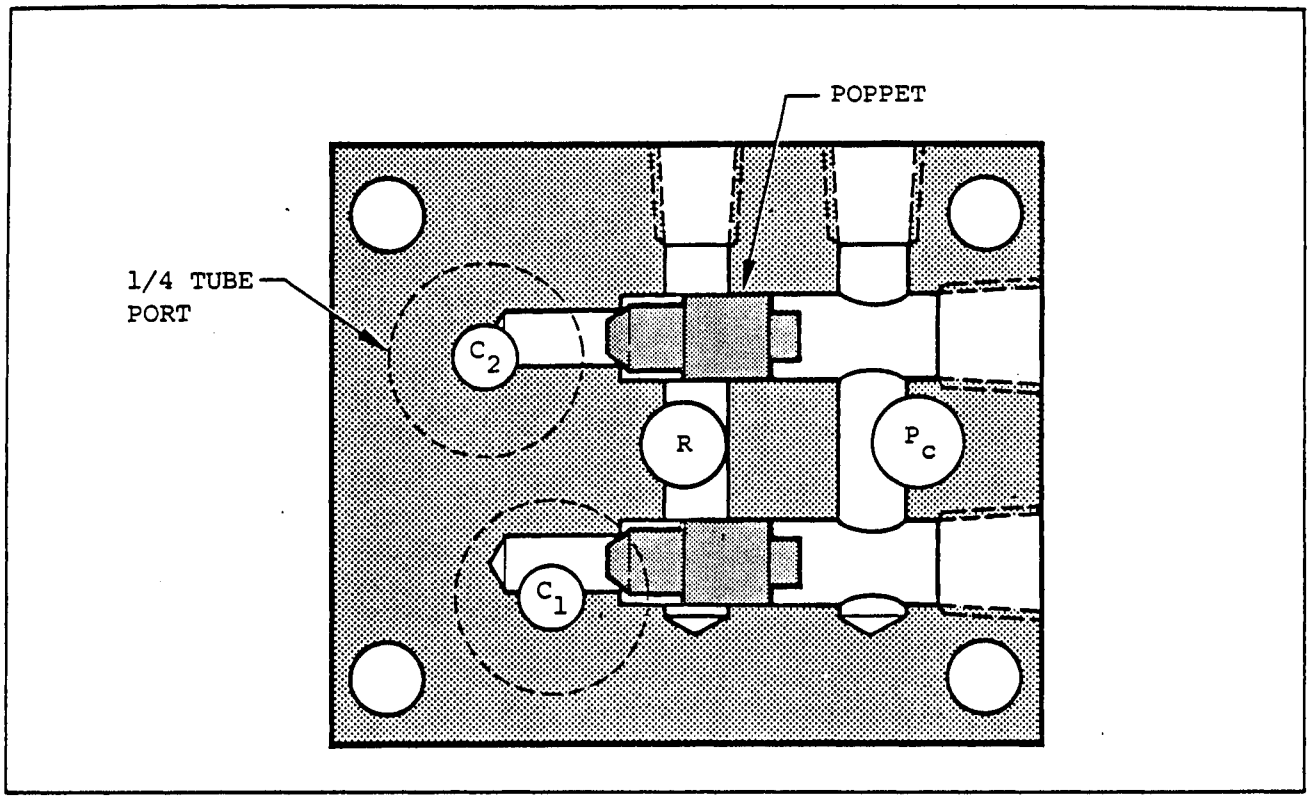
Shuttle Assemblies

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

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



ADJUSTABLE BY-PASS SHUTTLE
FIGURE 10



PURGE MANIFOLD ASSEMBLY
FIGURE 11

Purge Manifold Assembly

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

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

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

V INSTALLATION

A. FILTRATION & HYDRAULIC SYSTEM PREPARATION

The life of any hydraulic system is sensitive to the cleanliness of the fluid stream. It is recommended that good cleaning and flushing procedures be followed in the assembly and test of the system.

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

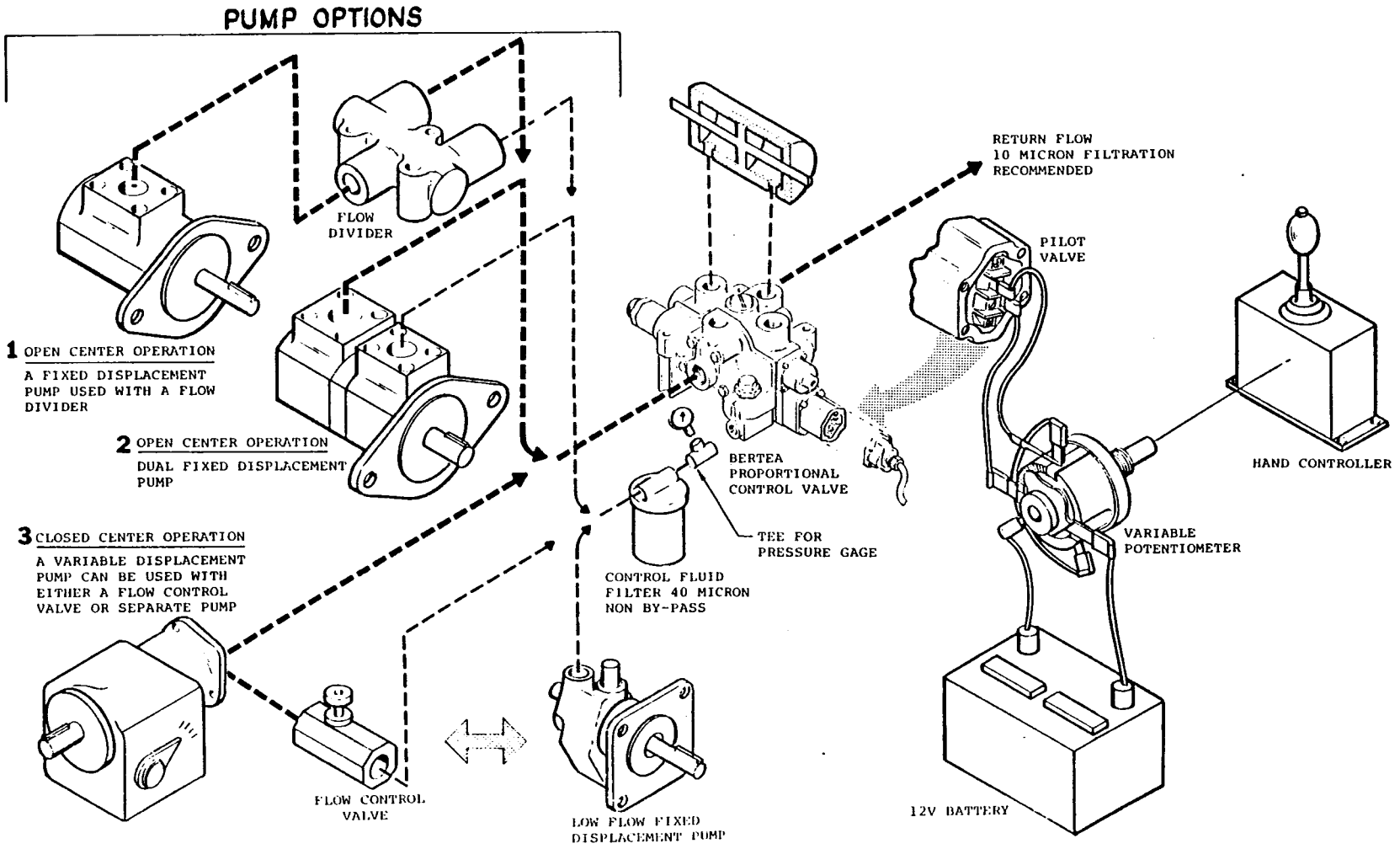
Since this pilot circuit is a constant flow, if the filter is the same micron size as the system filter, it will have a short life. The small tube type filter in the inlet manifold (234950, Figure #5) is 100 micron rating and is only intended for coarse material. Each pilot valve has a 150 micron filter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

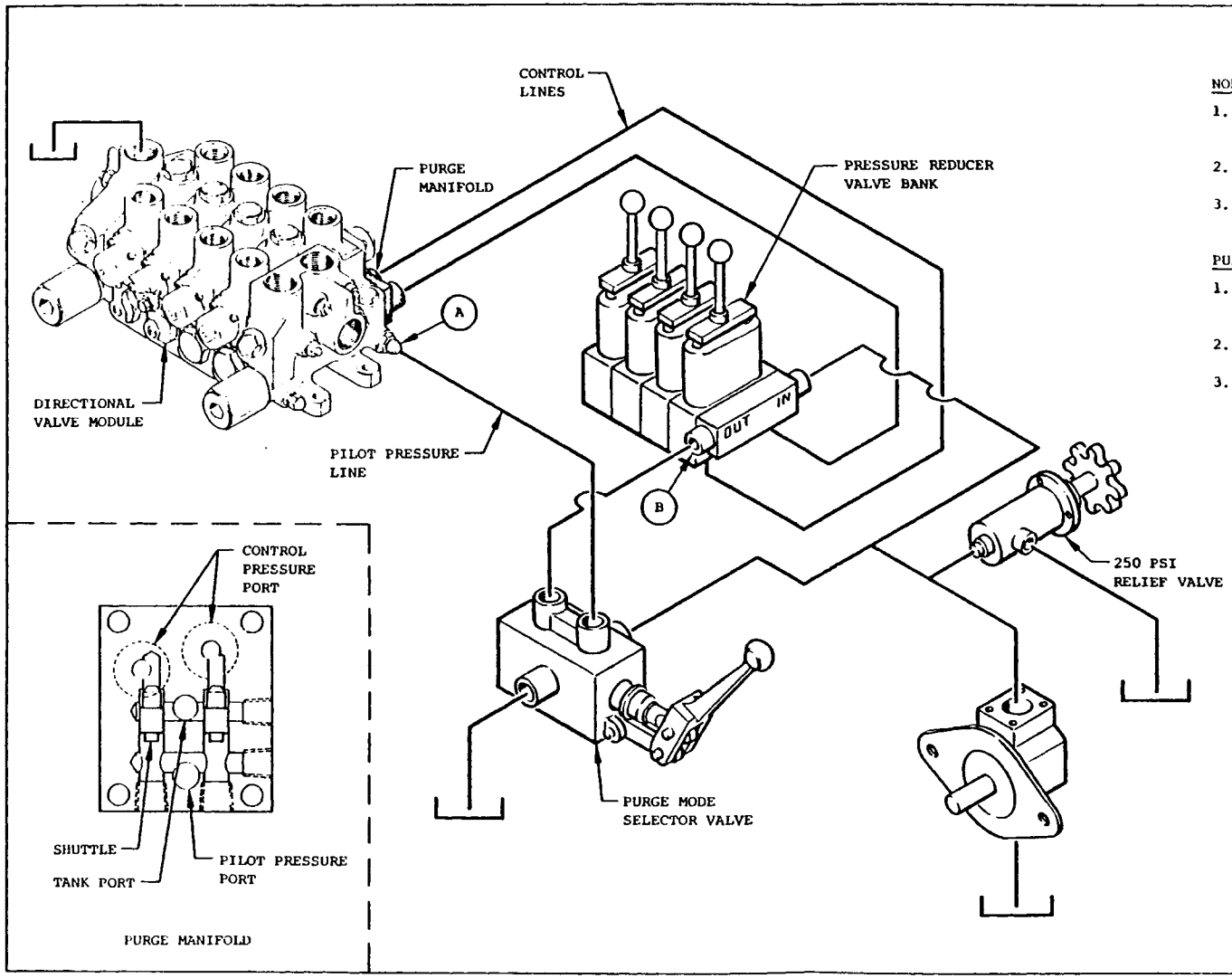
B. PILOT FLUID CIRCUIT

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

When using electro-hydraulic pilot valves, (Ref: Figure #12), a differential pressure of 300 to 350 psi is required across the module. If the return line pressure is 50 psi, an inlet pressure of 350 psi would be required. Each standard pilot valve requires a continous flow of 0.5 to 0.6 gpm and the pilot pressure relief valve is set to flow 0.5 gpm at 300 psi 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.


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



REMOTE PURGE SYSTEM SCHEMATIC
FIGURE 13

PURGE "ON DEMAND" SYSTEM OPERATION

NORMAL OPERATING MODE

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

PURGE MODE OPERATION

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

20

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

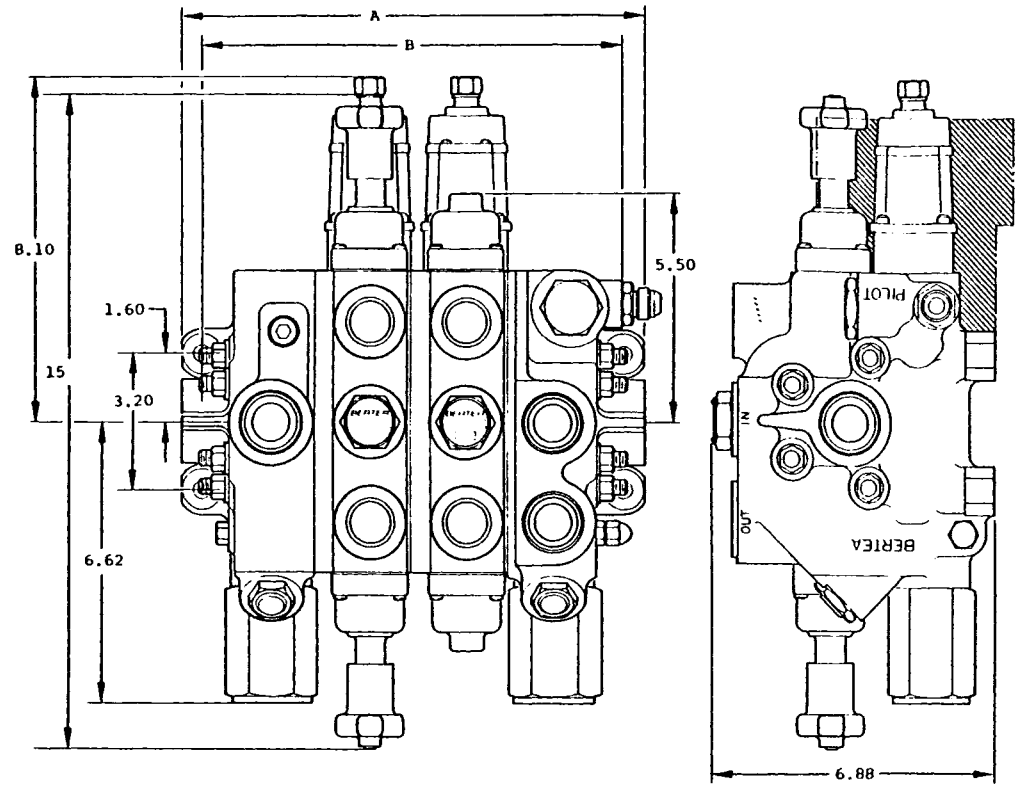
Inlet - 1 5/16-12 (1" Tube)
Cylinder - 1 1/16-12 (3/4" Tube)
Outlet - 1 5/16-12 (1" Tube)
Pilot Control - 3/8 Flared Tube Male
Purge Manifolds - 7/16-20 (1/4" Tube)

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.

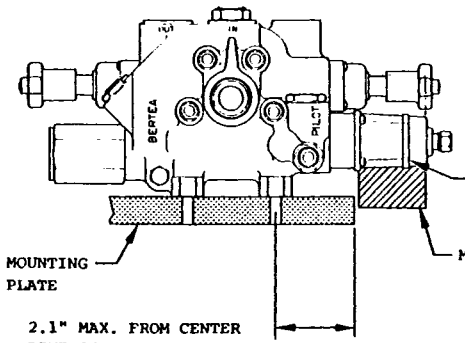


⚠ CAUTION: NO MAGNETIC METAL WITHIN 1.5 OF PILOT VALVE AS SHOWN.

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

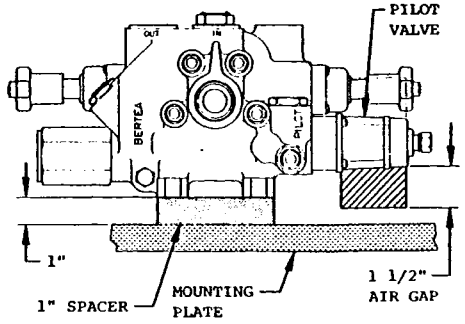
INSTALLATION
FIGURE 14

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



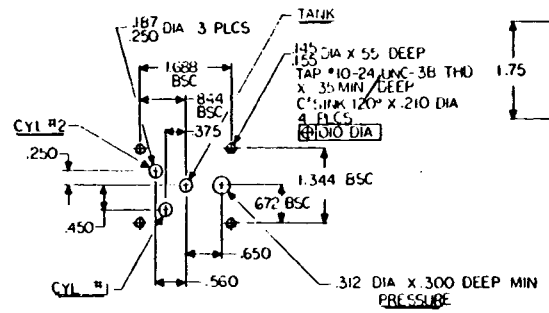
If the mounting plate extends underneath the pilot valve magnet the module must be raised at least one (1) inch in order to provide an air gap of 1-1/2 inch beneath the pilot valve.

FIGURE 2

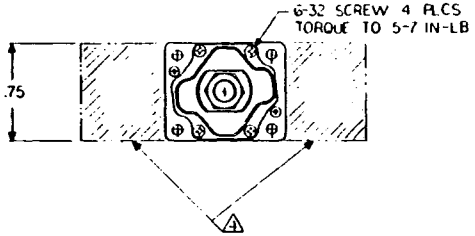
26

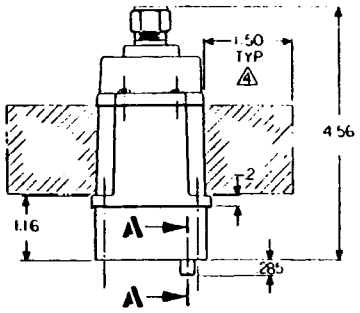
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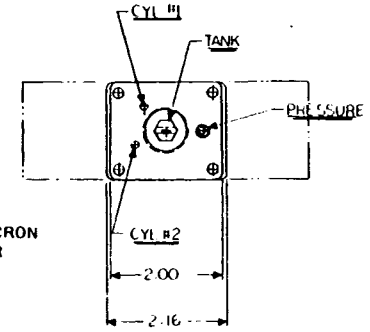
REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
C	SEE E O	4-26-77	

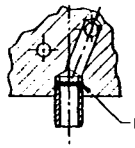


MOUNTING FACE
(REQ'D FOR MOUNTING MANIFOLD)









SECTION A-A

NOTES:

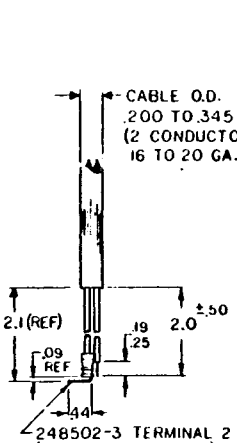
1. TECHNICAL DATA

DIFFERENTIAL PRESSURE	300 PSI
QUIESCENT FLOW	.5 TO 6 GPM
COIL RESISTANCE	60 OHMS
RATED CURRENT	60 MA
FILTRATION	25 MICRON
RATED VOLTAGE @ 60 MA	3.6 VOLTS DC
FLUID	PETROLEUM OIL
WEIGHT	.85 LB/385 GM

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

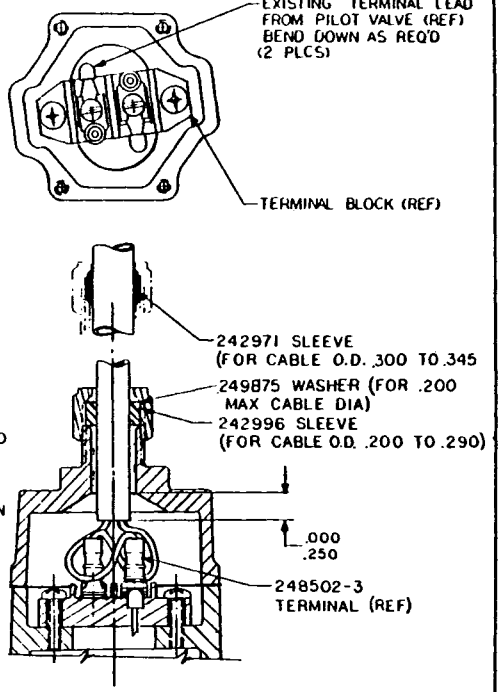
4. CAUTION: NO MAGNETIC MATERIAL ALLOWED WITHIN AREA SHOWN.

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



248502-3 TERMINAL 2 REQ'D
(BERTEA FURNISHED)
(AMP SPECIAL IND.
P/N 327043 BEFORE BEND).
STRIP INSULATION AS SHOWN
AND CRIMP WITH ONE OF
THE FOLLOWING CRIMPING
TOOL:
AMP SPEC. IND. NO. 29564
VACO CORP. NO. 1902
THOMAS & BETTS
NO. WT1000
HOLLINGSWORTH
SOLDERLESS TERMINAL CO
NO. H2A
OR EQUIV. TOOL

CUSTOMER'S CABLE



TERMINAL CONNECTIONS
2X SIZE

PART NO & NAME	MATERIAL	MATERIAL SPEC	HEAT TREATMENT	FINISH	SHT
QUANTITY REQUIRED FOR NOTED ASSEMBLY					

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
TOLERANCE ON:
LINEAR DIMENSIONS: XXX ± .010; XX ± .040; X ± .100
ANGLES: XX.XX ± 0.50°; XX.X ± 1.0°; XX ± 5.0°
DRAWING SYMBOLS & TOLERANCE PER USASI Y14.5
125 MAX SURFACE ROUGHNESS PER USASI B46.1
STRAIGHT THREADS PER MIL S 8879
MFG PRACTICES PER USM 5103

DRAWN	L LAMBERT	7-2-74
CHECKED	MD	8-15-74
APPROVED	ACW	8/16/74

BERTEA / CORPORATION IRVINE - CALIFORNIA

INSTALLATION DRAWING - FOR
234912 PILOT VALVE

SIZE	CODE IDENT NO	
D	82106	242980

SCALE: 1/1 E NOTED | SHEET 1 OF 1

PILOT VALVE INSTALLATION
FIGURE 15

nload sensing systems limit the maximum pressure ependent o: the load requirement. Often there is a difference which results in wasted power. Load sing minimizes this loss by limiting the pump let pressure to a fixed amount above the load uirement.

he system shown below, this feature is applied to a d pump using a bypass compensator. The compen- or works in two conditions:

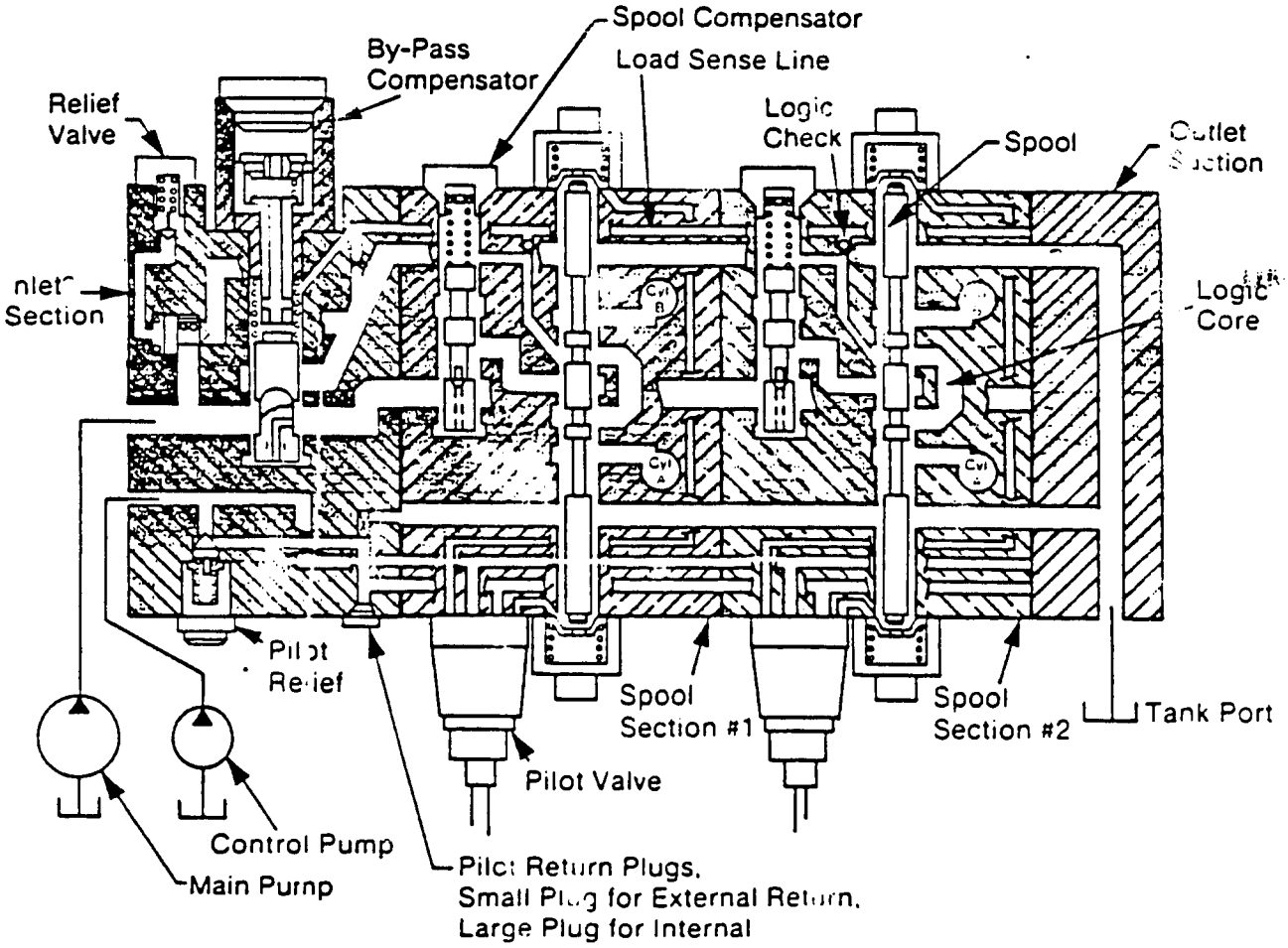
(1) With no signal from the load sense line, the npensator opens allowing full pump flow to tank at ut 50 PSI (all spools centered).

(2) With a load signal present, the compensator ains closed until the pump outlet pressure reac- PSI above the load. Flow not required for w s to tank at load plus 150 PSI.

A maximum limit is maintained by the relief valve.

The load signal is sent to the compensator through the load sense circuit comprised of logic checks and a logic core in each work section. If spool #1 is shifted downward in the sketch, the small land would open Cyl. B to the inlet and the logic core. This pressure would be communicated through the logic check to the sense line and the compensator. If more than one spool is actuated at the same time, the logic checks select the higher load level as the signal to the compensator.

Further refinement is obtained by the addition of spool compensators. These reduce the speed fluctuations that would exist during simultaneous operation of functions requiring different pressure levels. They are standard on all load sense modules.



The load pressure can also be used to control the compensator on a variable pressure compensated pump. As on the previous page, the load signal comes from the sensing circuit. The logic core in combination with the logic checks select the highest load requirement as the signal to the pump compensator. The pump than reacts to two possible conditions:

(1) (all spools centered) No load signal is present so the pump goes to minimum flow at 150-250 PSI which is the value of the compensator spring.

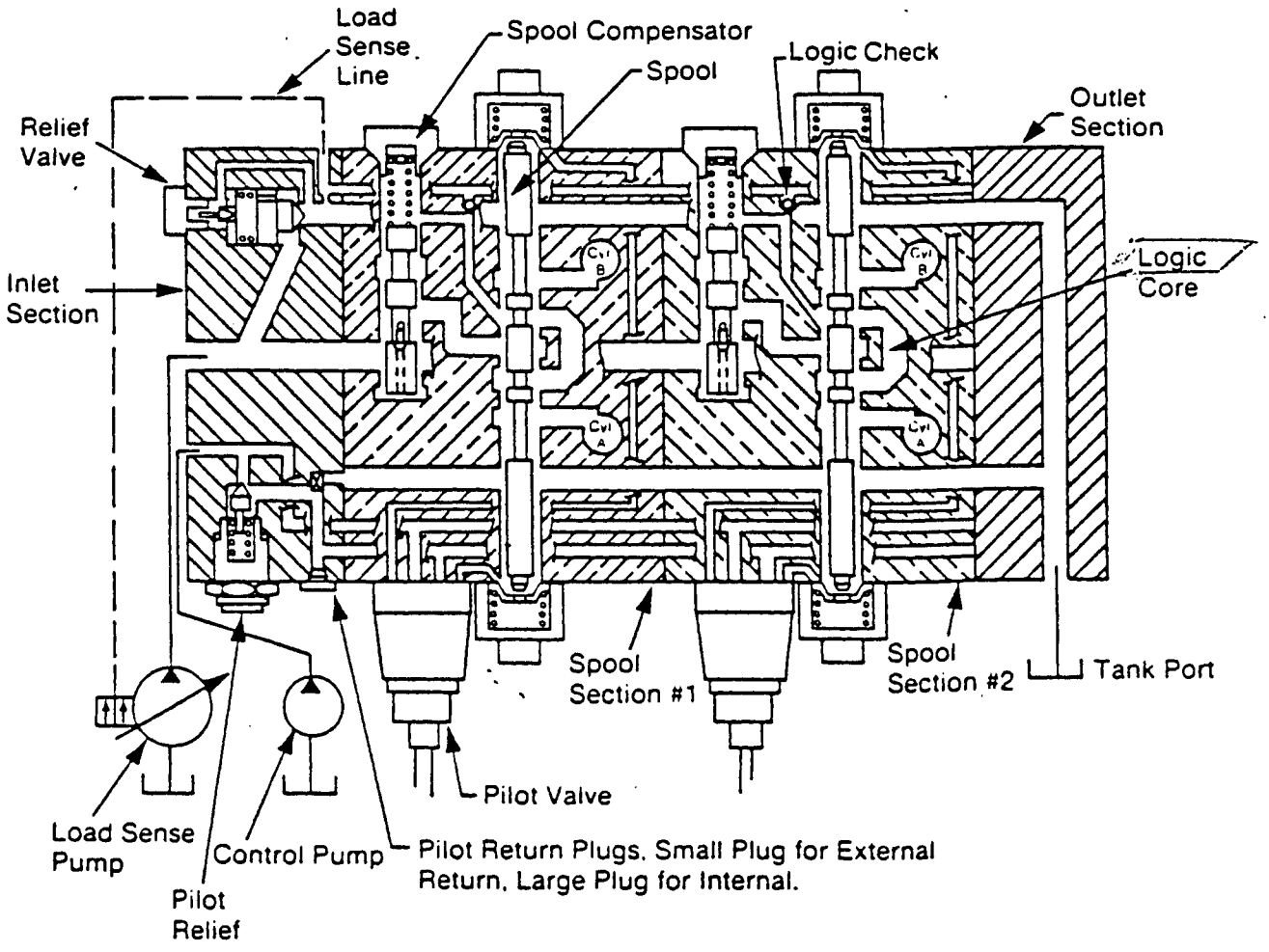
(2) (spool actuated) The highest load signals the pump to build to load pressure plus the 150-250 PSI requirement of the spring.

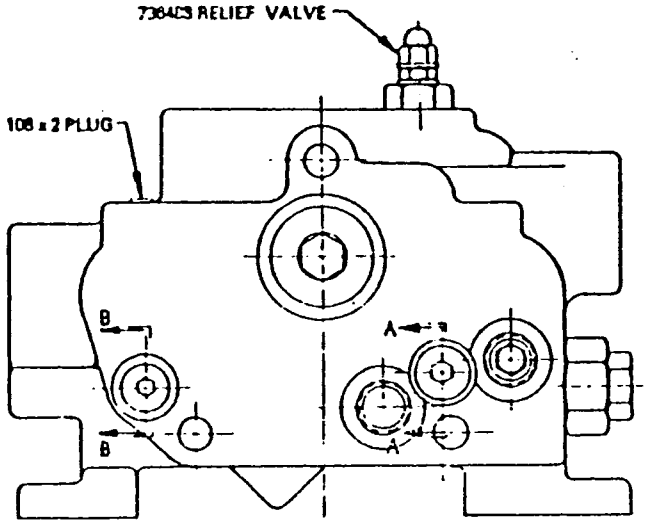
Thus under any load condition, the pump provides the flow demand at a pressure equal to 150-250 PSI above the load. This 150-250 PSI will vary with each manufacturer's pump. A system pressure limit is provided by the integral relief in the Parker inlet section.

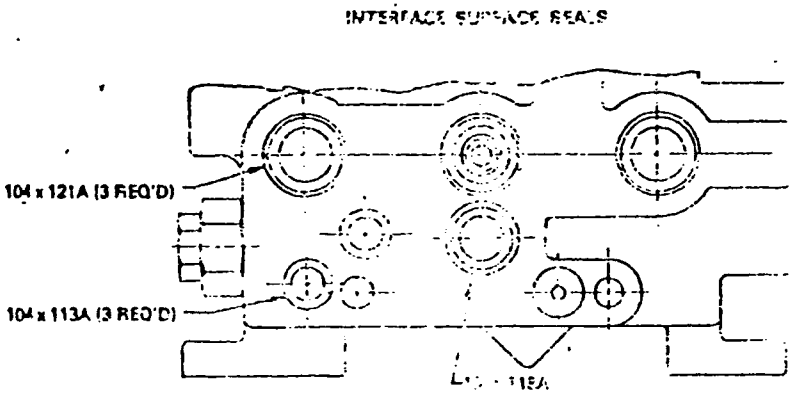
In multiple operation, speed fluctuation due to different pressure requirements are minimized by the spool compensators which are standard on the Parker load sensing work modules.

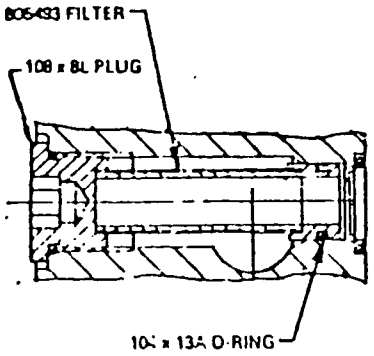
In addition to full four way proportional operation, the Parker sectional valves are available with these options:

(1) cylinder port reliefs
(2) anti-cavitation checks
(3) manual override end caps
(4) solenoid dump for integral relief

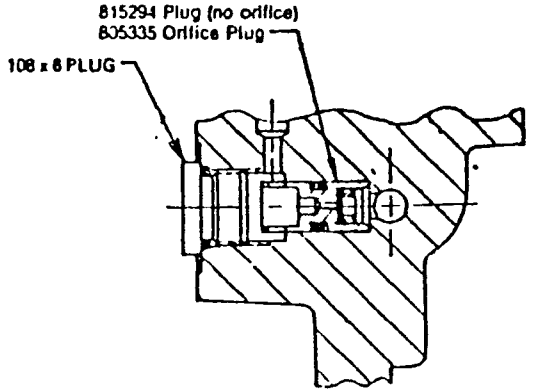






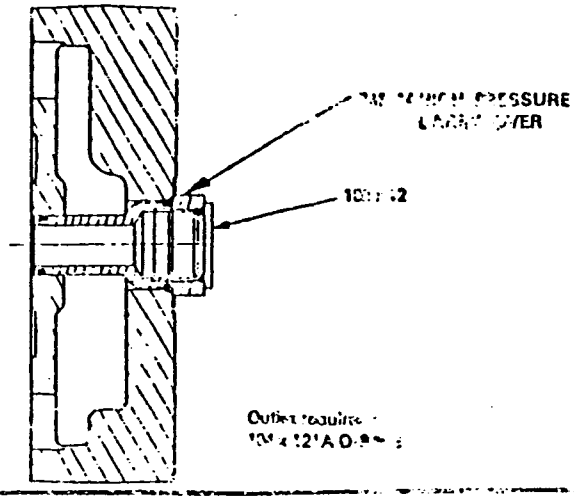


A–A



B–B

VS 30 OUTLET SECTION



Parker Hannifin Corporation
Mobile Hydraulic Division
17325 Euclid Ave., Cleveland OH 44112

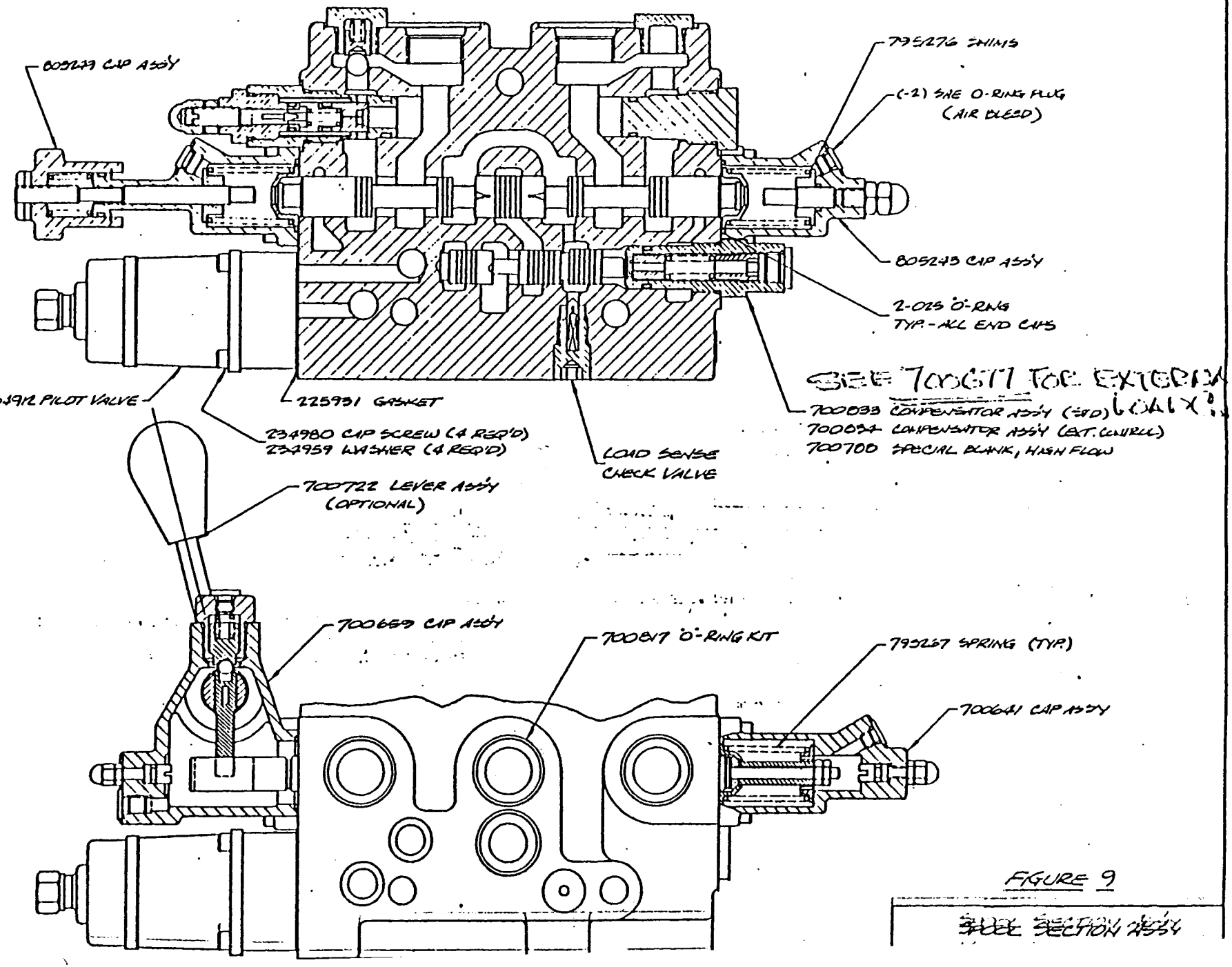


FIGURE 9

SEE SECTION 2554

Pilot Valve

OPERATION

The pilot valve is a highly reliable, dirt tolerant, four port valve, with supply, return, and two control ports C_1 & C_2. C_1 and C_2 are connected to the ends of the main spool as was shown in the sketches on the previous three pages. A proportional (0-60ma) and reversible (+ or -) current signal produces a portportional and reversible pressure differential (0-240 PSI) between C_1 & C_2. This differential is used to move the main spool. The higher the differential the greater the movement of the main spool and the greater is the flow through main valve.

A detailed description of the pilot valve is in bulletin 1400. It is enough here to show the basic principle. Pilot pressure is contained in the supply cavity of the diverter plate (part in pilot valve where differential originates). This fluid escapes as two jets from the diverter inlet orifices. With the blade centered (Fig.1) these jets cannot enter the two receiving orifices. If the blade moves to the right (Fig. 2) the jet directed to C_1 is uninterrupted while C_2 is still blocked. C_1 will develop a greater pressure than C_2. Fig. 3 shows the reverse, C_2 greater than C_1.

Application data for the pilot is shown below. These figures are to be used for application of the pilot integral to the values described in the catalog. If required as a separate unit contact your Parker representative.

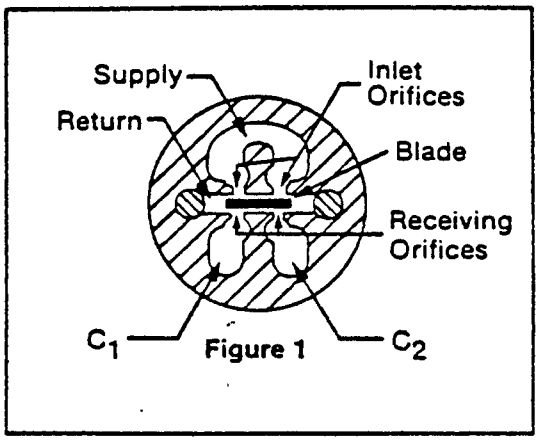


Figure 1

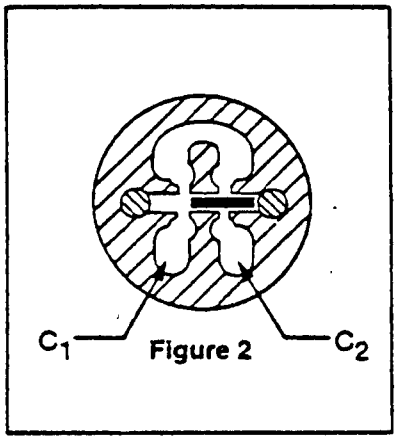


Figure 2

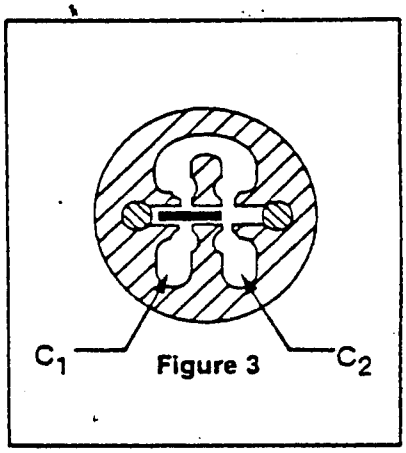


Figure 3

APPLICATION REQUIREMENTS

Maximum Supply Pressure	500 PSI
Maximum Return Pressure	100 PSI
Filtration Required	25 micron
Input Flow Required	@300 PSID
Standard Model	.55 GPM
High Flow Model	1.0 GPM
Coil Resistance	60 ohms
Control Current	60 ma
Control Voltage @ 60 ma	3.6 volts

NOTE: No magnetic material allowed in shaded area as shown.

Fluid Selection — Petroleum Base

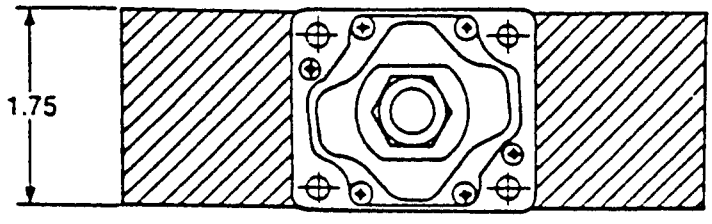
Consult Parker for other fluids.

Viscosity Range

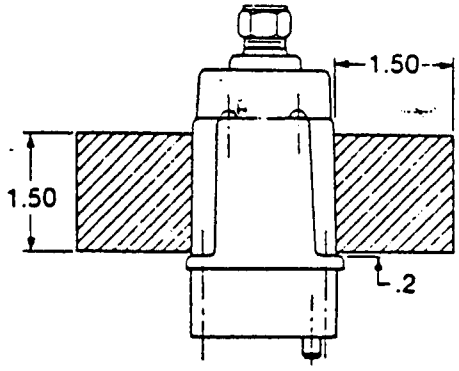
Minimum (running)	50 SSU
Maximum (start-up)	
@ 300 PSID pilot	1800 SSU
@ 400 PSID pilot	2200 SSU

Temperature Range

Maximum (running)	225° F
Minimum (start-up)	start-up temperature cannot cause viscosity to exceed above limits.



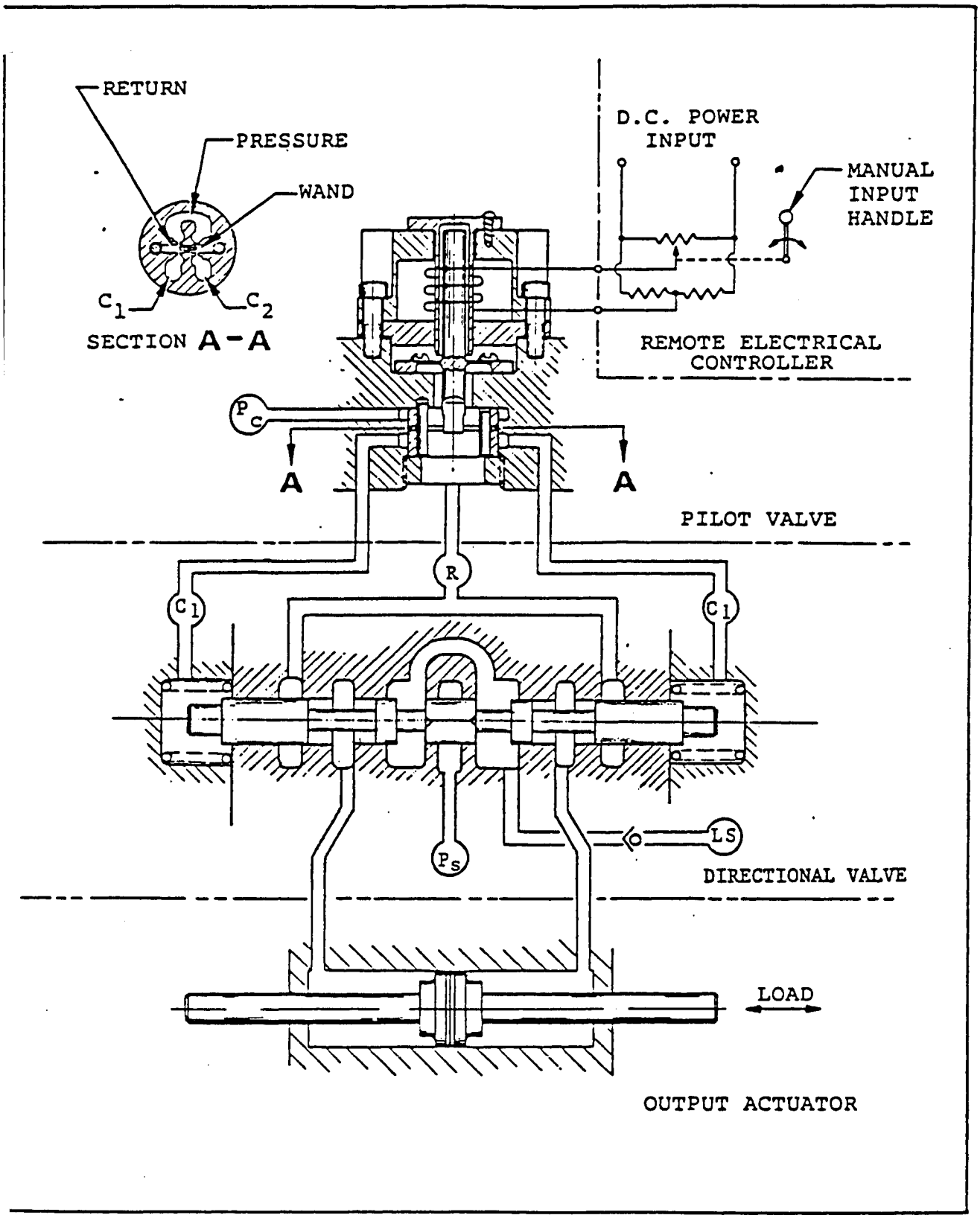
Top View



Parker Hannifin Corporation
Mobile Hydraulic Division
17325 Euclid Ave.
Cleveland, Ohio 44112

Parker Fluidpower

Service Manual Series VS30-700250 new



SCHEMATIC
SINGLE FUNCTION LOAD SENSE REMOTE CONTROL VALVE
FIGURE 2

Parker Fluidpower

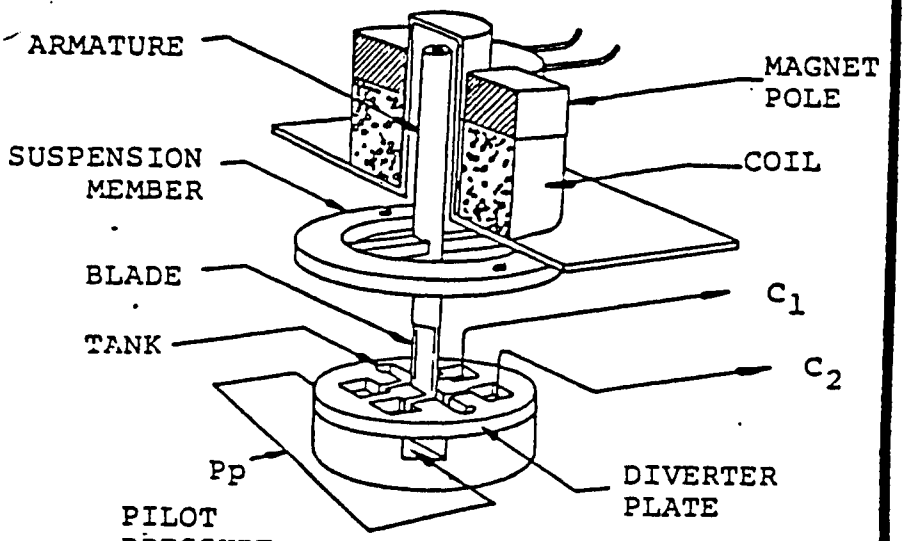


FIGURE 3

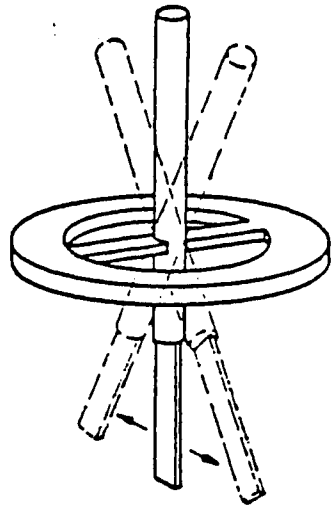


FIGURE 4
(Armature Motion)

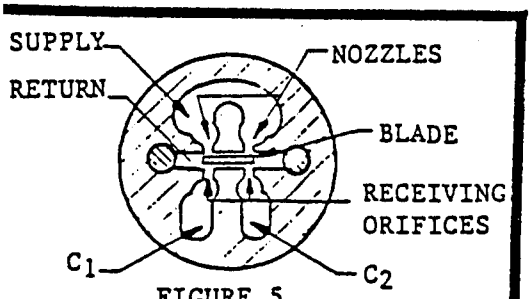


FIGURE 5
DIVERTER PLATE
$C_1 = C_2$

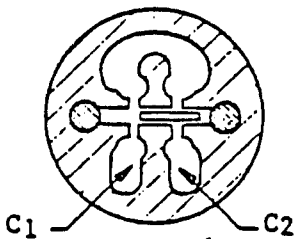


FIGURE 6
C_1 PRESSURE
GREATER THAN C_2

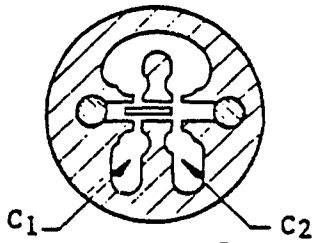


FIGURE 7
C_2 PRESSURE
GREATER THAN C_1

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

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

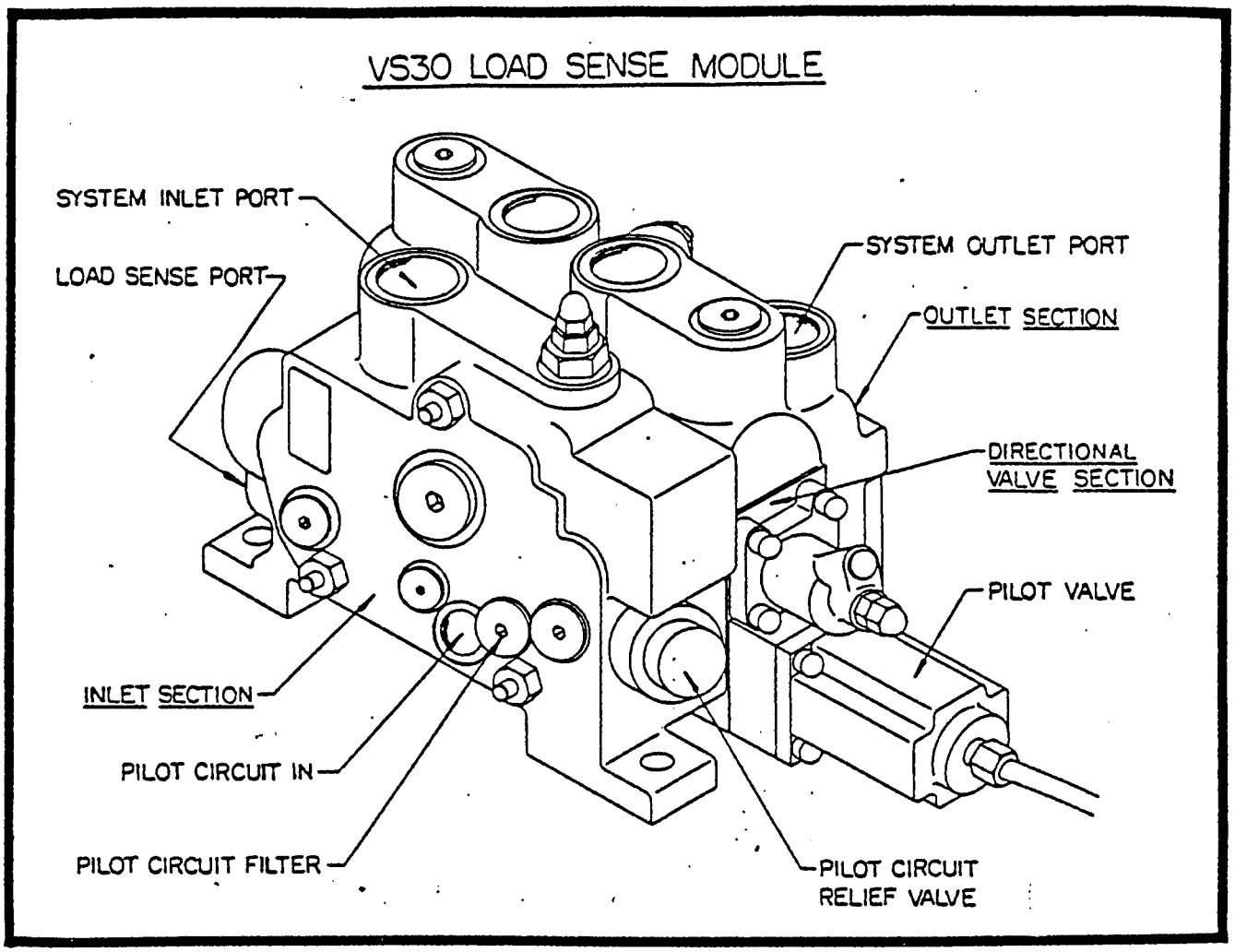


FIGURE 1

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

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

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

OPERATION (Figure 2)

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

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

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

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

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

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

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

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

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

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

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

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

FILTRATION AND HYDRAULIC SYSTEM PREPARATION

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

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

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

A 100 micron strainer is installed into each inlet manifold (Figure 3) to provide second level protection in case of debris in tubing, etc.

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

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

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

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

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

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

ASSEMBLY AND SERVICE

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

A. Inlet Manifold Assembly (Figure 8)

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

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

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

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

B. Directional Valve Section (Figure 9)

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

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

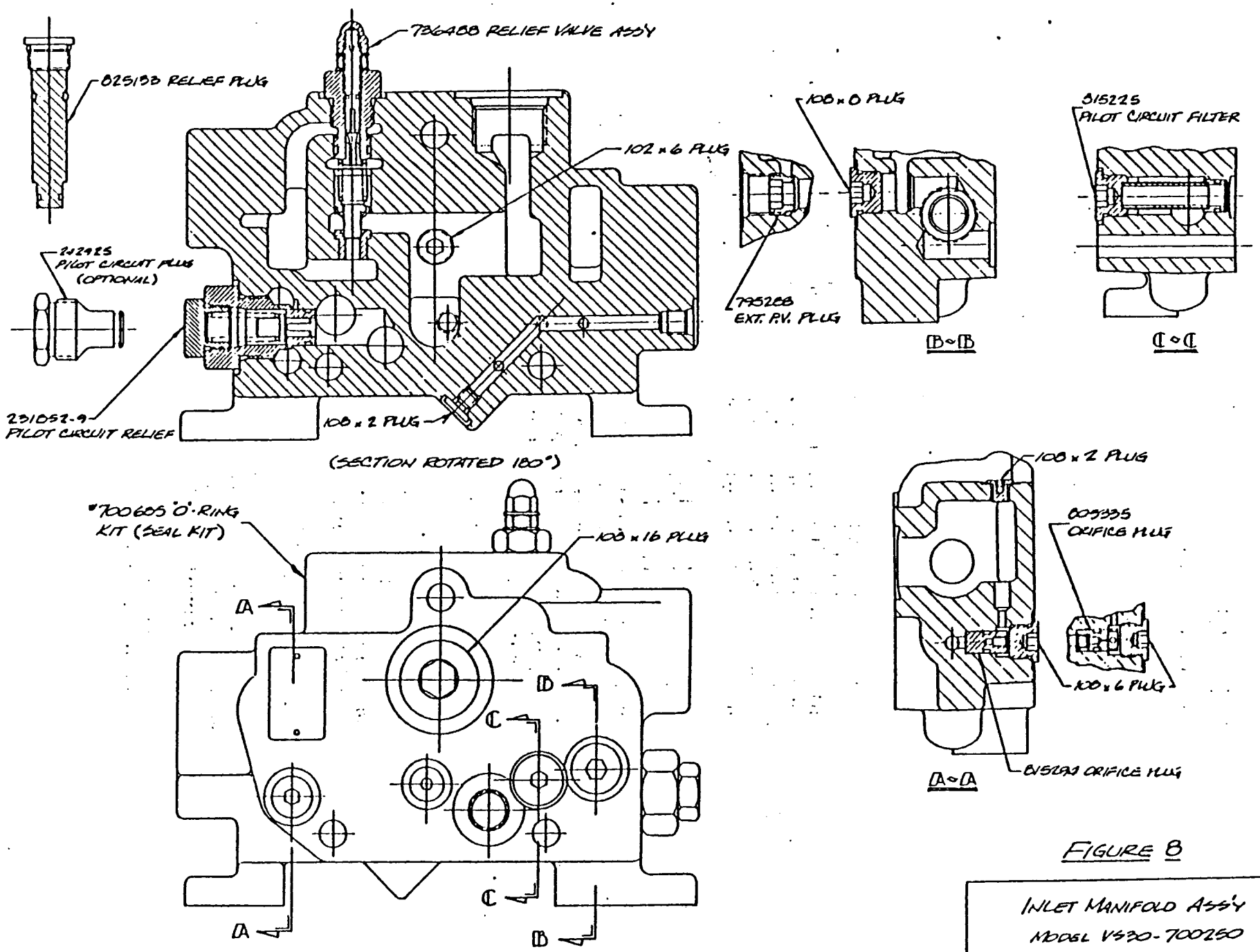


FIGURE 8

INLET MANIFOLD ASS'Y
MODEL VS30-700250

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

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

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

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

#700833 Standard Compensator

#700834 Compensator, External Control

#700788 Special Blank, High Flow

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

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

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

C. Outlet Manifold (Figure 11)

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

LOAD SENSE PUMP

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

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

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

COMPENSATED PUMPS

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

LOAD SENSE VALVE MODULE (VARIABLE PUMPS)

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

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

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

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TROUBLE SHOOTING

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

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

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

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

ELECTRICAL PROBLEMS

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

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

HYDRAULIC PROBLEMS

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

1. Poor Metering Control

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

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

TROUBLE SHOOTING CHART

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

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

2. LOW FUNCTION SPEED

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

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

3. NULL SHIFT

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

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

4. ENGINE START MOTION

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

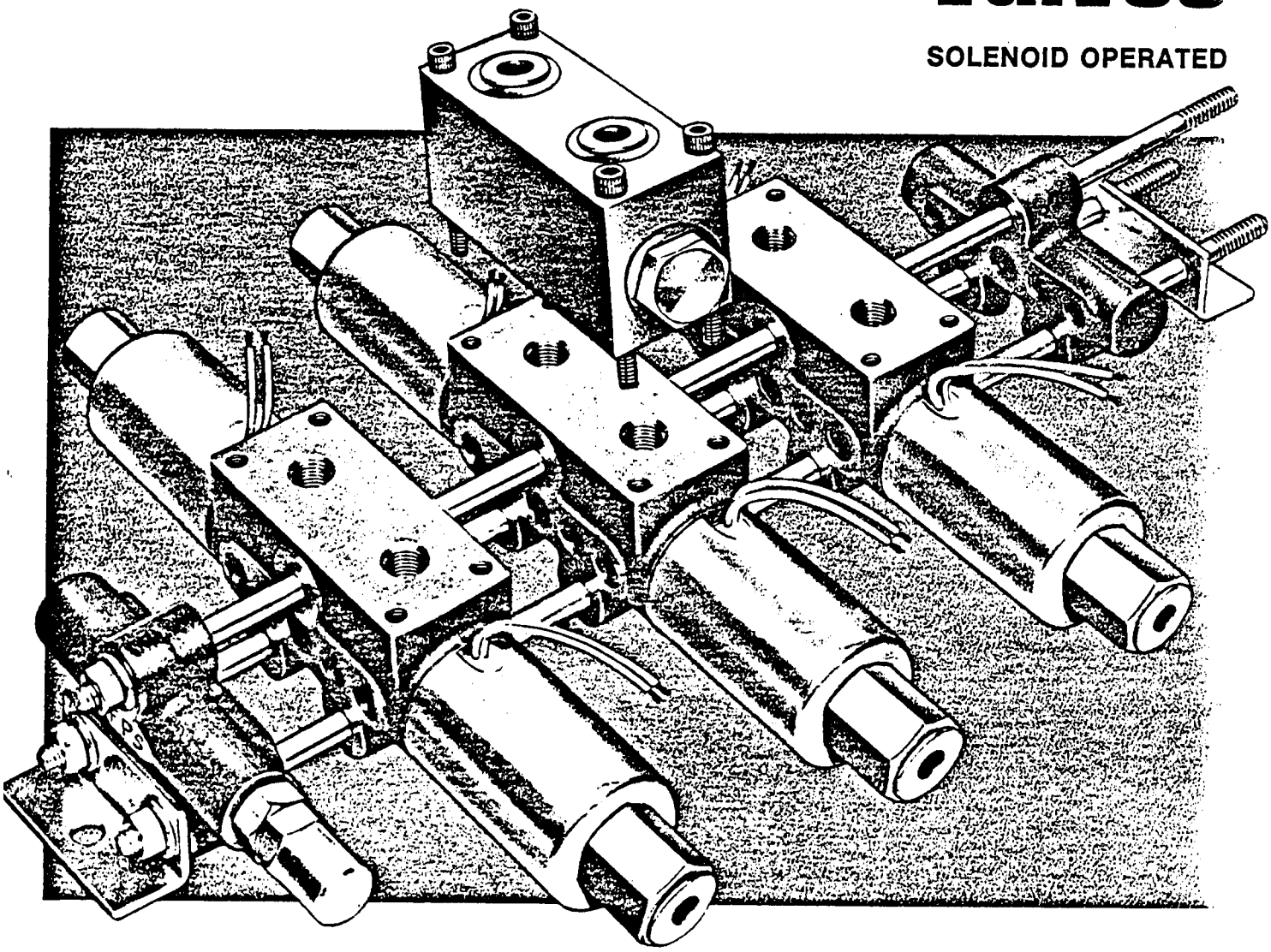
The electromechanical operation of the pilot valve can be checked by removing the valve and observing the motion of the end of the diverter blade while moving the remote control lever. The end of the blade is visible in the center slot of the gasket face of the valve.

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

Bulletin No. 5-2360-4

mini-pak valves

SOLENOID OPERATED



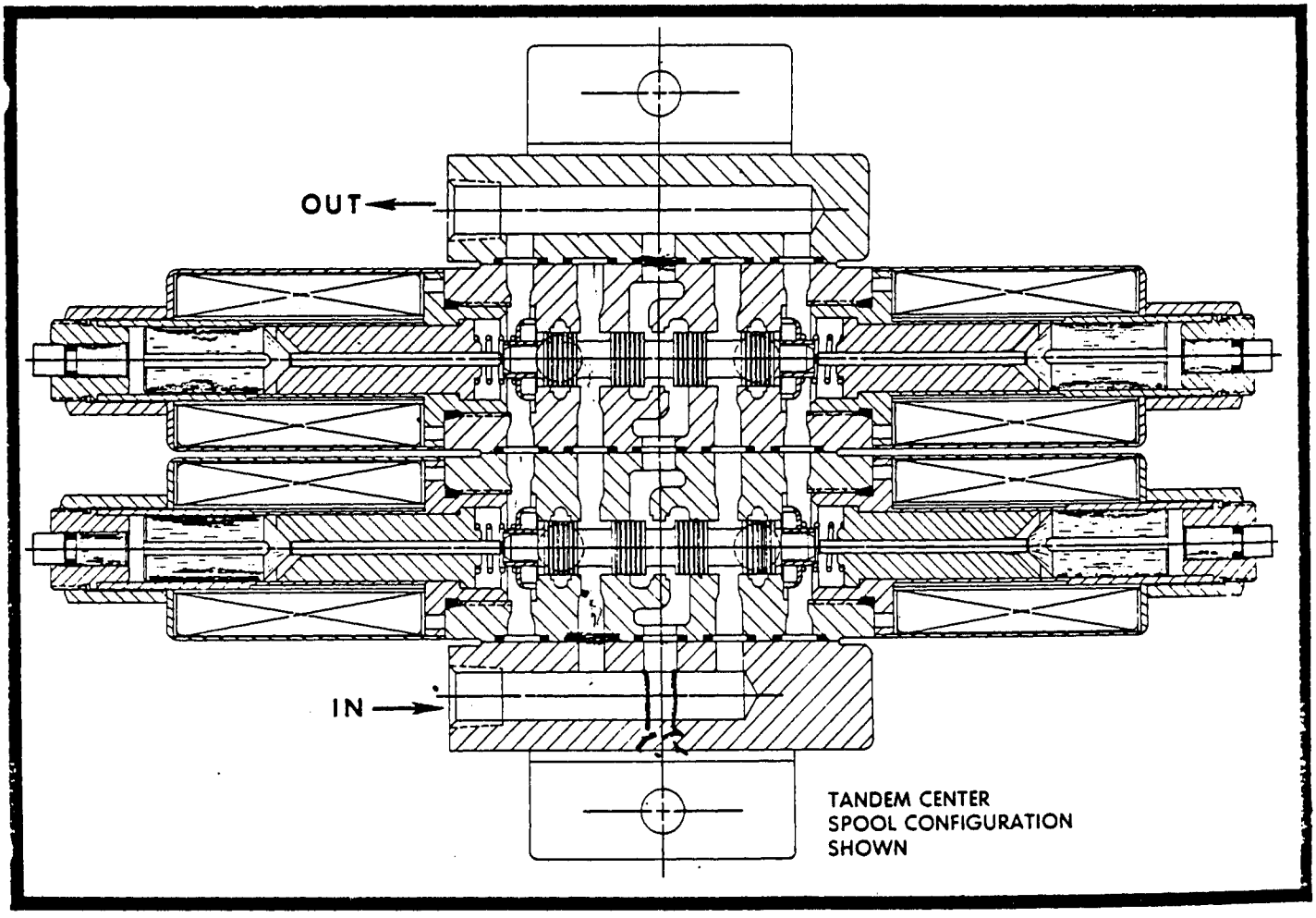
- maximum flow rate 19 L/min (5 gpm)
- working pressures to 207 BAR (3000 psi)
- direct solenoid operated — dc
- series-parallel circuit

AMBAC Industries Incorporated
FLUID POWER SYSTEMS DIVISION

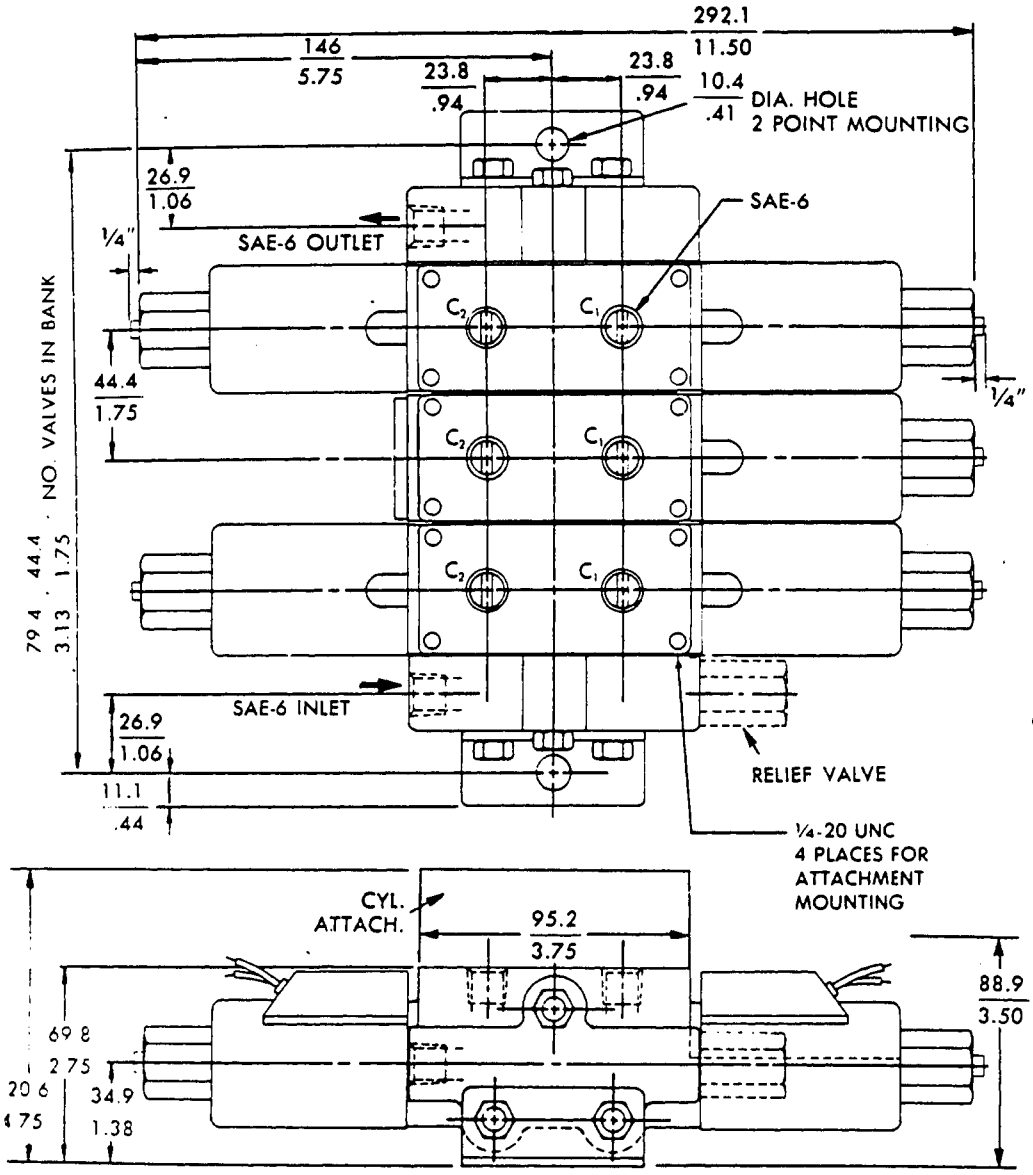
mini-pak
solenoid valve features

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

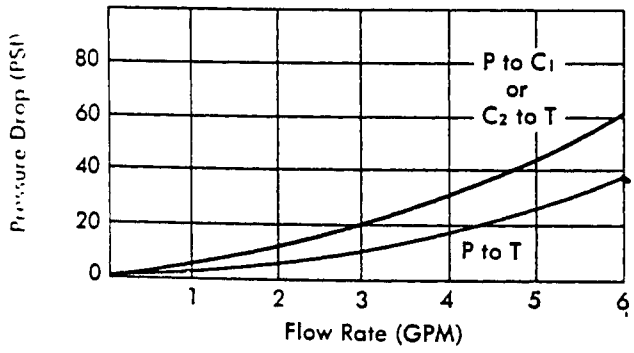


- Two position and Three Position Spools Available—Spool Types, Page 4.
- Rated Pressure 207 BAR (3000 PSI).
- Rated Oil Temperature 74°C (165°F).
- Available Voltages 12, 24 and 36 VDC.
- Current Draw 2.8 amp. @ 12 VDC @ 21°C (70°F).
- Can Be Mounted In Any Position.
- Weight 3.6 kg (8 lbs.) Per Section.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

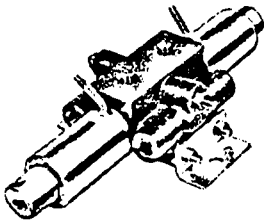
$\frac{MM}{INCH} = MM/INCH.$

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

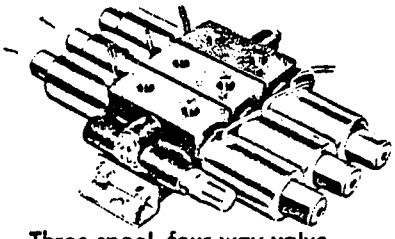
Pressure drop data for valve Model 56-10 (Tandem center 3 position 4-way, pressure to tank open — C_1 and C_2 blocked.) Maximum flow rate 19L/min (5 GPM). 150 SSU oil at 38°C (100°F).



Available options (consult factory).



Four-way, three position double solenoid valve.

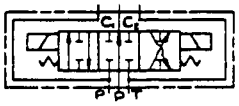
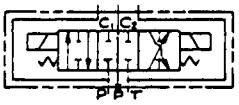
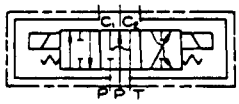
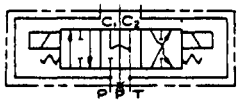
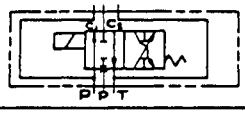
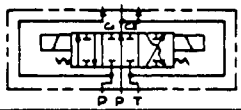


Three spool, four-way valve assembly with relief valve at inlet.



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

spool type (flow pattern) — TABLE I

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

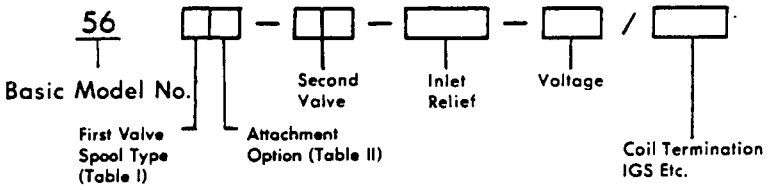
For spool configurations other than shown consult factory.

cylinder attachment valves — C_1C_2 — TABLE II

A.S.A. Symbol	Valve Type	Code	Description	
	Lock Valve	A	Without Thermal Reliefs	
		B	One Thermal Relief	241 BAR (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	

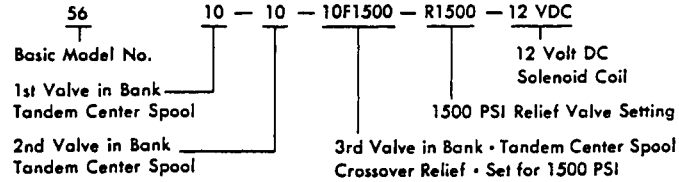
Code letter JJ indicates Palm Button Manual Override

ordering information



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

example of three bank assembly

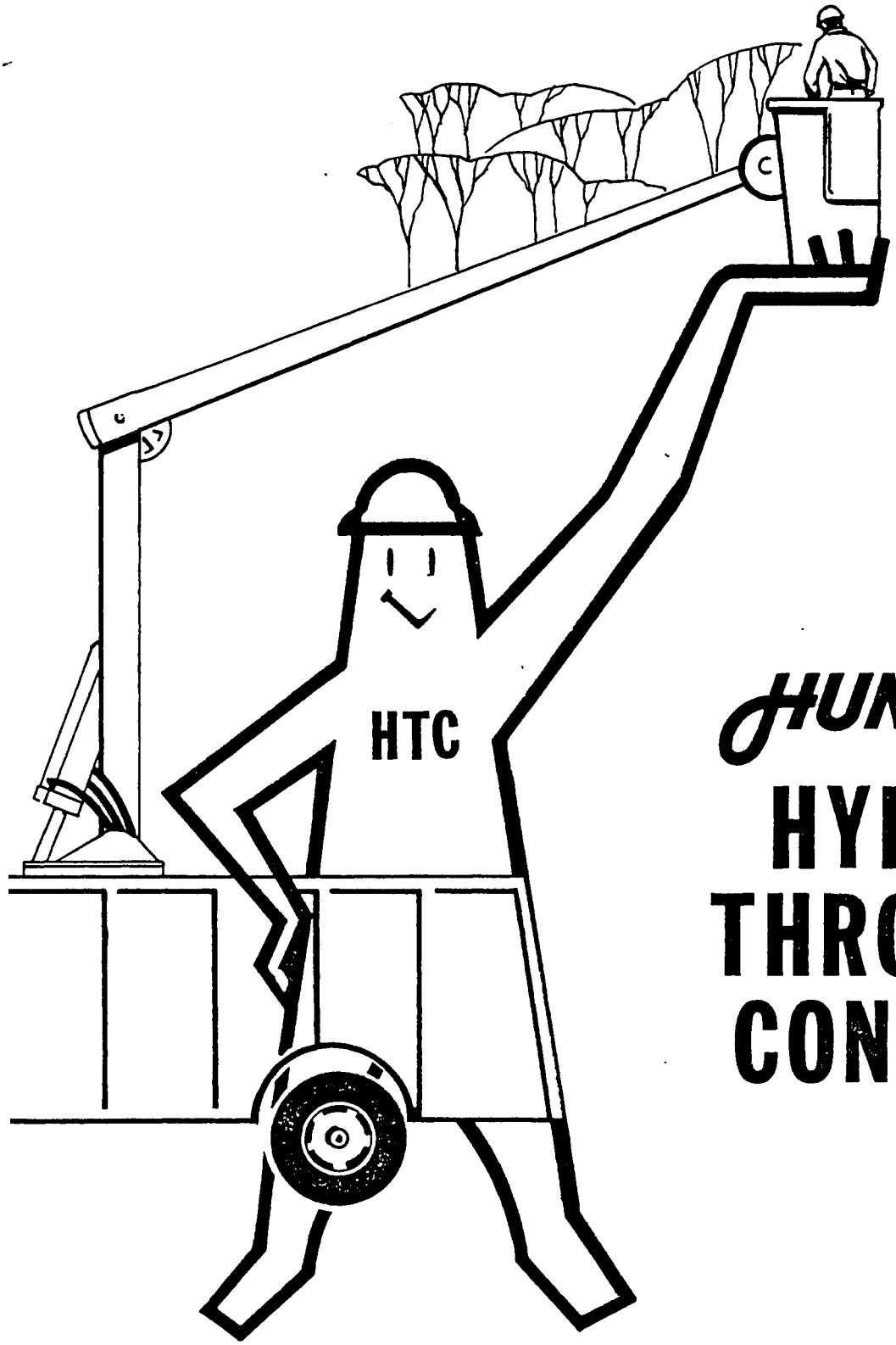


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Phone: 312-541-3000

FO-LC-5M-3 78

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INSTALLATION INSTRUCTIONS



HUNTER

HYDRO-THROTTLE CONTROL

MUNCIE PARTS MFG. CO., INC.

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

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

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

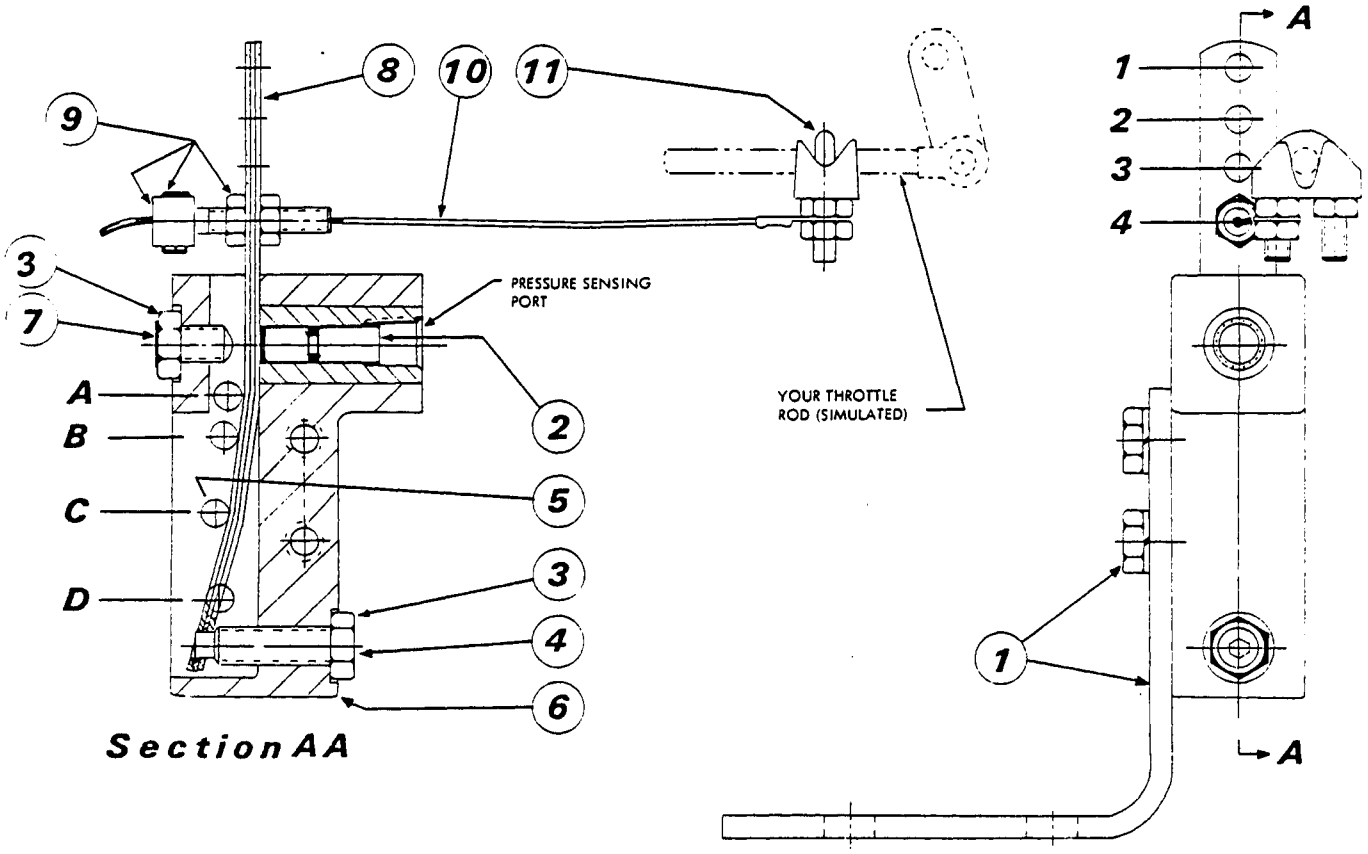
TOLEDO DIVISION
P.O. Box 6593 • Toledo, Ohio 43612
Phone (419) 729-3861

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

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

PARTS LIST

SERIES 90 THROTTLE CONTROL



Model 1-9010

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

I. INSTALLATION OF THE THROTTLE CONTROL

A. Introduction

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

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

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

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

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

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

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

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

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

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

B. Mounting Bracket

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

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

C. Pressure Connection to Pump Discharge Line

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

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

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

D. Engine Throttle Linkage Check

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

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

E. Cable Slack Adjustment

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

Secure the clamp (11) to the throttle rod. Engage the cable (10) eyelet to one of the clamp studs. Thread the cable through the hole in the rod, remove almost all slack, and secure it with the set screws.

Finalize the cable slack adjustment with the nuts provided on the actuating rod (9). The cable should have some slack but not excessive. Check to make sure the engine returns to idle after operating the accelerator.

F. Adjusting Procedure

The spring rate is adjustable by moving the fulcrum screw (5) and changing the number of leaf springs (8). See table below for the possible variations. The spring rate increases as the variation number decreases. For instance, the table indicates the spring will be three (3) times stiffer with variation No. 2 than No. 3.

Variation Number	No. of Springs	Fulcrum Hole	Spring Tension			Actuating Rod Hole Location
			*Turns	*Pressure	Rate	
1	3	A	3	1100	11X	4
2	3	B	3	780	3X	4
3	3	C	2-1/2	640	Normal	4
4	2	C	2	370	3/4X	4
5	2	D	5/8	300	1/4X	4

* Note: Apply turns from when the screw (4) just begins to deflect the spring at zero load. Pressure is approximate when piston will begin to move.

The control was shipped with variation 3. Try it first. The adjusting procedure will direct you to another variation, if another is needed.

1. Disengage PTO. Turn in speed screw (7) until it touches spring (8). Then turn out one turn, temporarily, to limit stroke and prevent accidental racing of engine.

2. Engage PTO. Air bleed sensing line by cracking fitting at Throttle Control. Proceed after oil warms up to within normal operating temperature range.

3. Operate a highly loaded circuit valve lever. Bottom out a cylinder to obtain system relief valve pressure if this is easier. The throttle will open.

4. Make speed adjustment. Turn speed screw (7) in or out with the circuit loaded. Use the nut (3) to lock it when it regulates your desired speed. Move actuating rod from hole 4 to hole 3, only if the spring should stop on the housing instead of the screw.

5. Return lever to neutral. The throttle must close and the engine must return to idle. Check Trouble Shooting section, Part II, Section C. If unsuccessful, increase the spring rate, see table above. Repeat entire procedure.

F. Adjusting Procedure (Continued)

6. Determine which of the circuits produce the lowest pressure. Operate it and decide which of the following applies, paragraph 6a, 6b, or 6c.

a. Throttle Opens and Closes Properly From Idle

(1) Finalize engine speed screw (7) adjustment by alternately operating the lowest and the highest loaded circuits. Lock nut (3) securely.

(2) Operate and check all other circuits. They should operate because they are loaded between the highest and lowest circuits used for adjustments.

(3) Installation is now complete.

b. Throttle Does Not Open From Idle Speed, but Will at Higher Speed

Check if it will open at higher engine speeds.

(1) Operate a higher pressure circuit lever to open the throttle and bring the engine up to speed, then operate the lowest pressure circuit lever.

(2) If it stays open, after the higher pressure lever is returned, decide whether the required sequence of operation is acceptable. It usually is acceptable. It now contains the highest spring setting.

(3) If not acceptable, or if it did not stay open, proceed with step (c) below.

c. Throttle Will Not Open at All

Make spring tension adjustment. Proceed as follows:

(1) Disengage PTO. Turn out screw (4) until leaf spring (8) is loose. Then turn it in until the spring just begins to deflect and is at zero load.

(2) Engage PTO. The throttle will open.

(3) Turn screw (4) in gradually. Count turns, and record as "B", until the throttle just closes. Do not overshoot and leave the screw at this point. Note how the throttle closed. If it closed suddenly, increase the spring rate, see table above. Repeat adjustment from paragraph c (1).

6c. (Continued)

(4) Operate the lowest pressure circuit. The throttle must open. If it opened, proceed directly to step 5. Otherwise, choose between (a) and (b) below.

(a) If it did not open, the motivating force is below zero. Revise the plumbing to increase the amount the pressure will increase when the circuit is operated. See Section A.

(b) Operate the next higher loaded circuit, etc. until you find a circuit that does operate from idle. Use this circuit for the adjustments specified in paragraph 5 below. You will find out later whether the lower pressure circuits, that did not operate from idle, will become operable at a higher speed.

(5) Turn in on screw (4) in small increments equal to approximately 10% of the total turns given in the table above.

After each increment, operate the lowest pressure circuit lever from neutral to fully open the throttle, and then return it to neutral to fully close the throttle.

Wait for the engine to idle before repeating.

Count, and record as "C", the number of turns to exactly when the throttle no longer opens from idle.

Note: Increase the spring rate, see table above, if the total turns counted (B plus C), exceeds by more than 20% the number of turns noted in the table above.

Decrease your spring rate if you observed the throttle will no longer fully open.

Repeat adjustment from paragraph c(1), if spring rate was changed.

(6) Turn screw (4) out 1/8 turn or 1/4 times "C" turns whichever is greater to provide an operating margin between the lowest circuit pressure and the final spring tension.

(7) Check operation as per paragraph F6a or F6b. If the lighter loaded circuits do not operate, revise the plumbing to increase the amount the pressure will increase when these circuits are operated. See Section A.

II. TROUBLE SHOOTING HINTS

A. Problem: Engine Does Not Idle But Speeds Up When PTO Is Engaged

Probable Cause	Remedy
1. Control lever stuck open.	1. Return all valves to neutral.
2. Low leaf spring tension.	2. Repeat calibration.
3. Cold Oil.	3. Warm oil. Also check Part I, Section "C".

B. Problem: Engine Does Not Speed Up When Light Load Is Applied

Probable Cause	Remedy
1. PTO not engaged.	1. Engage PTO.
2. Air in sensing line.	2. Bleed line. Crack fitting at control.
3. Connecting cable.	3. Reduce slack to minimum.
4. Stops on speed screw.	4. Adjust screw.
5. Hot oil.	5. Allow oil to cool.
6. Your engine throttle linkage.	6. Oil and repair. Check manufacturer for lighter spring if it is excessive.
7. Circuit pressure is too low.	7. Revise plumbing to increase spread between your circuit and by-passing pressures. See Part I, Section "A".
8. Excessive leaf spring tension.	8. Repeat calibration.
9. Excessive leaf spring rate.	9. Reduce spring rate. See table in Part I, Section "F".

C. Problem: Engine Does Not Return To Idle After A Load Is Applied

Probable Cause	Remedy
1. Engine speed excessive.	1. Reset speed screw adjustment.
2. Your engine.	2. Make sure it can idle.
3. Connecting cable.	3. Check for slack.
4. Low leaf spring rate.	4. Increase spring rate. See table in Part I, Section "F".
5. Low leaf spring rate.	5. Repeat calibration.
6. Excessive by-passing pressure.	6. Remove "bottlenecks" or increase line size downstream of the control connection.

STARTING and OPERATING INSTRUCTIONS

ISSUE MM-357

WISCONSIN

Air-Cooled Engines



Four Cylinder Engine Models

VH4D • VG4D • V-465D

TELEDYNE WISCONSIN MOTOR

WORLD'S FOREMOST SOURCE FOR HEAVY DUTY AIR COOLED ENGINES

INTRODUCTION

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

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

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

SPECIFICATIONS

MODEL VH4D		MODEL VG4D		MODEL V-465D	
Bore	3¼"	Bore	3½"	Bore	3¾"
Stroke	3¼"	Stroke	4 "	Stroke	4 "
Piston Displacement — cu. in.	107.7	Piston Displacement — cu. in.	154	Piston Displacement — cu. in.	177
Horsepower — 1400 R.P.M.	17.2	Horsepower — 1400 R.P.M.	25	Horsepower — 1600 R.P.M.	41.6
1600 R.P.M.	20.0	1600 R.P.M.	29	1800 R.P.M.	47.5
1800 R.P.M.	22.5	1800 R.P.M.	32	2000 R.P.M.	52.4
2000 R.P.M.	24.7	2000 R.P.M.	34	2200 R.P.M.	56.7
2200 R.P.M.	26.5	2200 R.P.M.	36	2400 R.P.M.	60.0
2400 R.P.M.	28.0	2400 R.P.M.	37	2600 R.P.M.	63.0
2600 R.P.M.	29.2			2800 R.P.M.	64.5
2800 R.P.M.	30.0			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

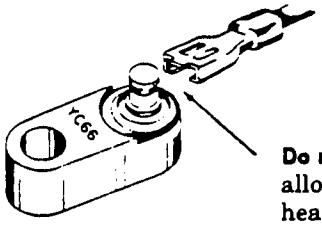
, if engine is equipped with STARTING MOTOR, DISTRIBUTOR IGNITION and FLYWHEEL ALTERNATOR, or GENERATOR.



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



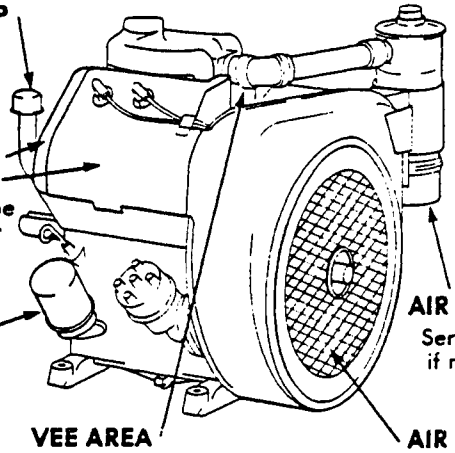
Temperature Safety Switch

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.



BREATHER CAP
Clean at every oil change

CYLINDER and HEAD COVERS
Remove and scrape dirt from cylinder and head fins.

OIL FILTER
Replace at least every other oil change.

AIR CLEANER
Service daily if necessary

VEE AREA
Remove dirt and chaff from manifold ports and space between CYL. blocks.

AIR INTAKE
Remove screen and brush clean.

• 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.

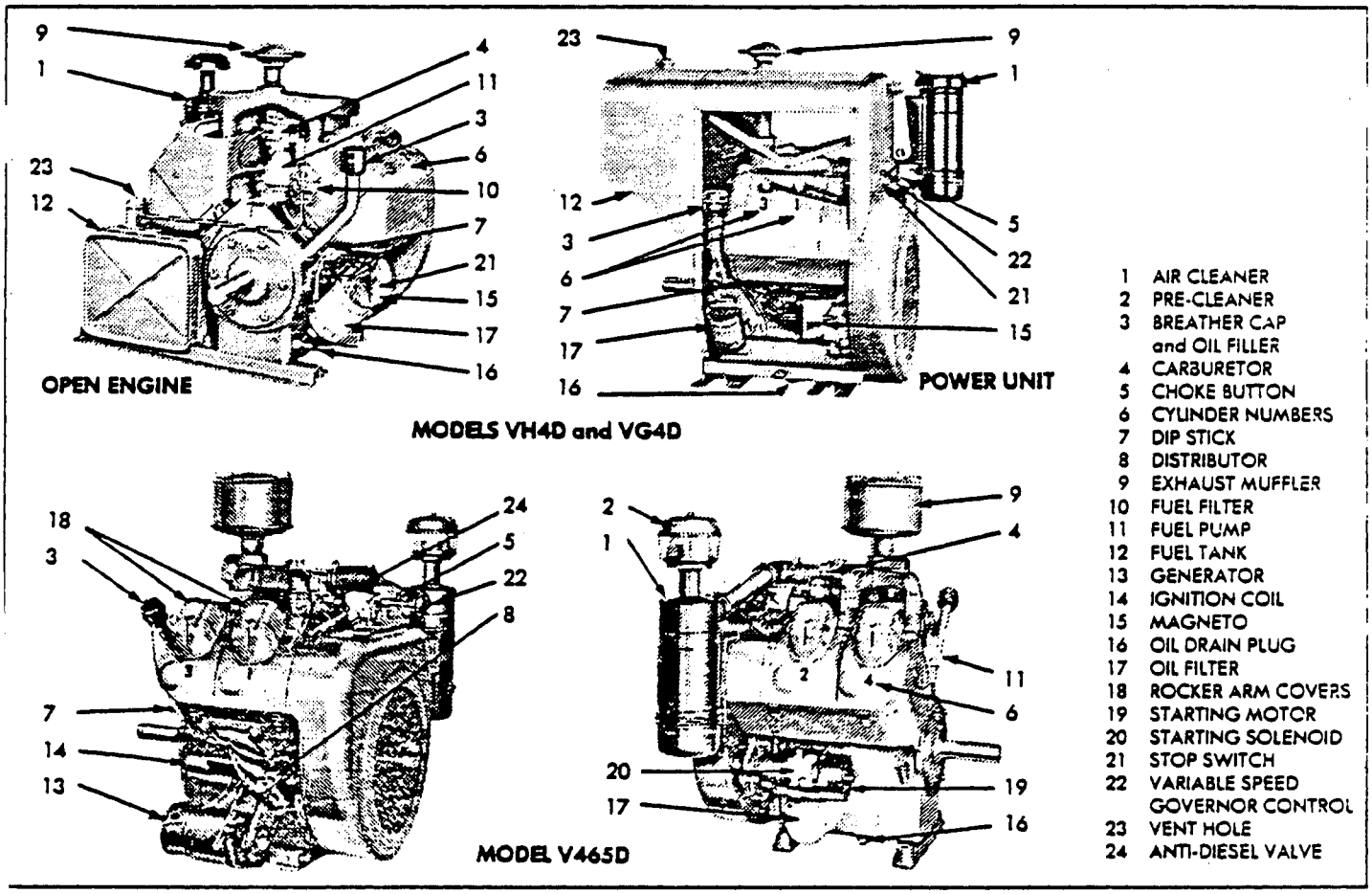


Fig. 1, REFERENCE VIEWS

GENERAL INFORMATION

hese engines are of the four cycle type, in hich each of the four operations of suc- ion, compression, expansion and exhaust onstitutes a complete stroke. This gives ne power stroke per cylinder for each two evolutions of the crankshaft.

OOLING

ooling is accomplished by a flow of air cir- ulated over the cylinders and heads of the ngine from a combination fan-flywheel en- ased in a sheet metal shroud. The air is di- ided and directed by ducts and baffles to sure uniform cooling of all parts.

EVER OPERATE AN ENGINE WITH NY PART OF THE SHROUDING RE- OVED — this will retard air cooling.

GNITION

he spark for ignition of the fuel mixture is rnished by a high tension magneto iven by the timing gears at crankshaft eed (models VH4D and VG4D).

attery ignition (12 volt) distributor, is fur- shed in place of magneto on engines uipped with flywheel alternator, or as op- nal ignition (Std. on model V-465D).

OTATION

rotation of the crankshaft is clockwise en viewing from the flywheel or front d of the engine, and counterclockwise ro- tion of the power takeoff or rear end of e 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.

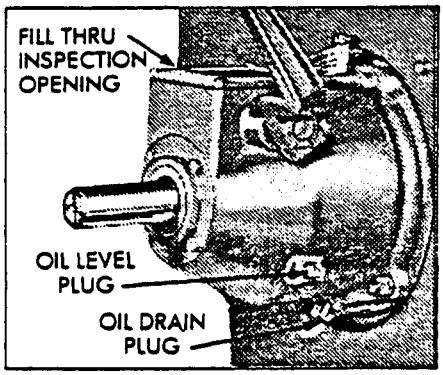


Fig. 2, VH4D
CLUTCH LUBRICATION

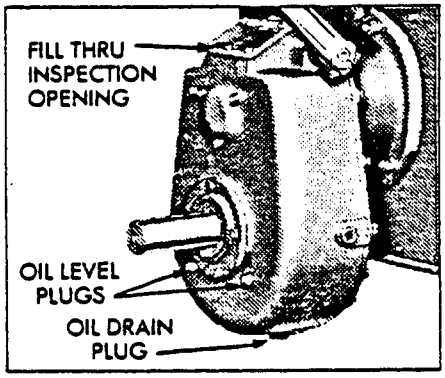


Fig. 3, VH4D
CLUTCH REDUCTION LUBRICATION

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

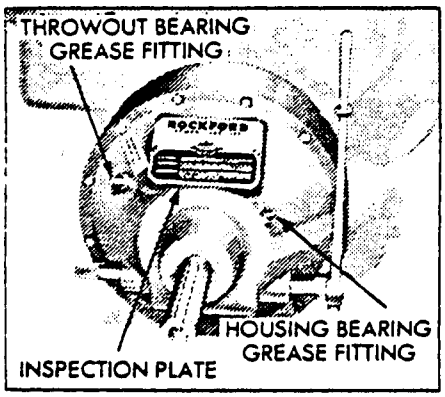


Fig. 4, VG4D, V465D
CLUTCH LUBRICATION

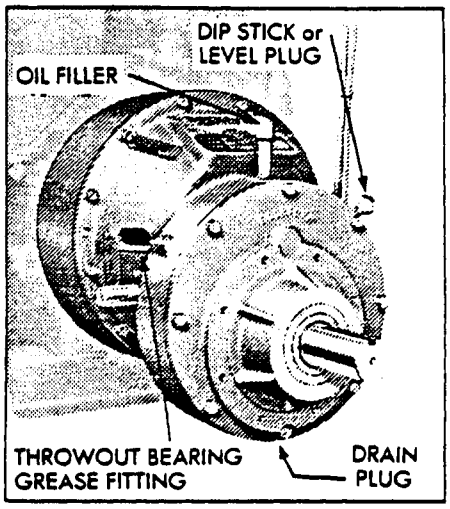


Fig. 5, VG4D, V465D
CLUTCH REDUCTION LUBRICATION

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.

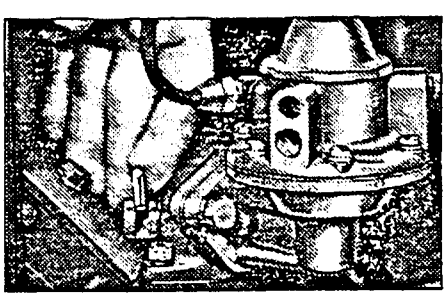


Fig. 6, FUEL PUMP PRIMER

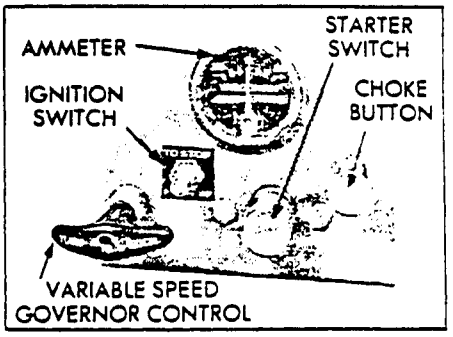


Fig. 7, VH4D, VG4D
CONTROL PANEL

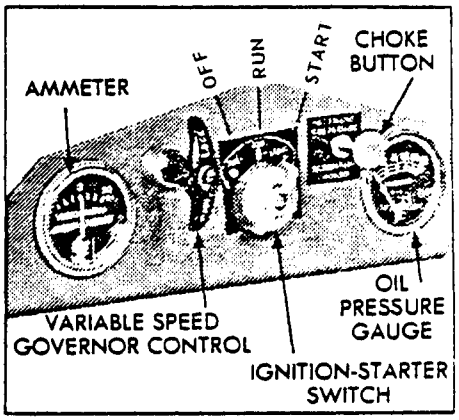


Fig. 8, V465D
CONTROL PANEL

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.

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

WARM-UP

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

TO STOP ENGINE

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

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

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

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

MAINTENANCE

AIR CLEANERS

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

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

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

OIL BATH AIR CLEANER, Fig. 9

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

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

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

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

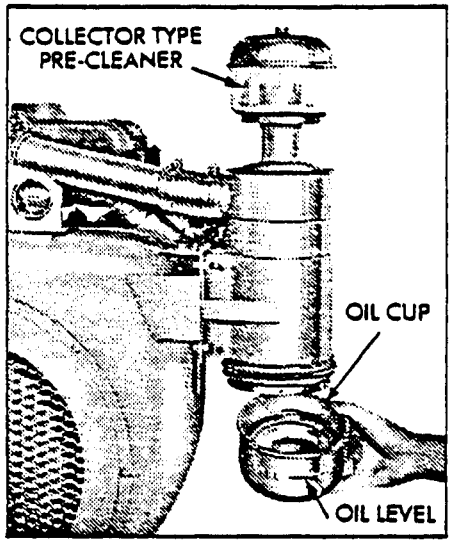


Fig. 9 OIL BATH AIR CLEANER

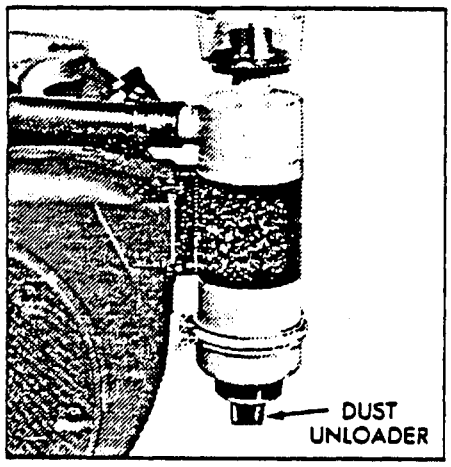


Fig. 10, DRY TYPE AIR CLEANER

DRY TYPE AIR CLEANER, Fig. 10

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

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

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

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

PRE-CLEANER

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

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

BREATHER CAP, Fig. 1, Ref. 3

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

DISTRIBUTOR, Fig. 1, Ref. 8

If engine is equipped with battery ignition distributor:

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

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

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

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

GENERATOR - Belt Driver, Fig. 1, Ref 13

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

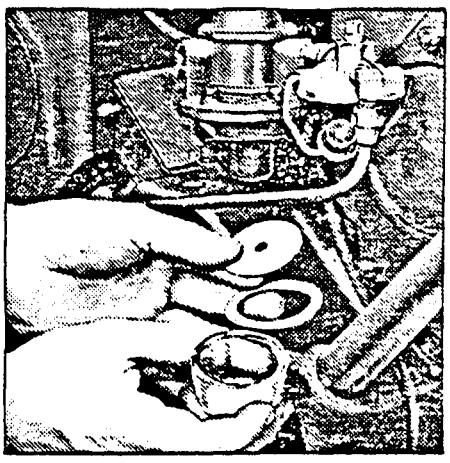
FUEL FILTER, Fig. 11

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

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

OIL FILTER, Fig. 1, Ref. 17

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


Fig. 11, FUEL FILTER

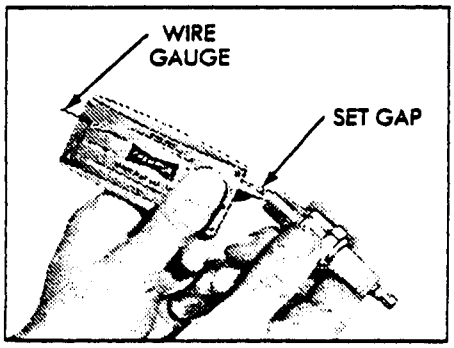


Fig. 12

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

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

SPARK PLUGS, Fig. 12

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

Spark plug gap - .030 inch.

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

Model	Thread Size	Make
VH4D 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

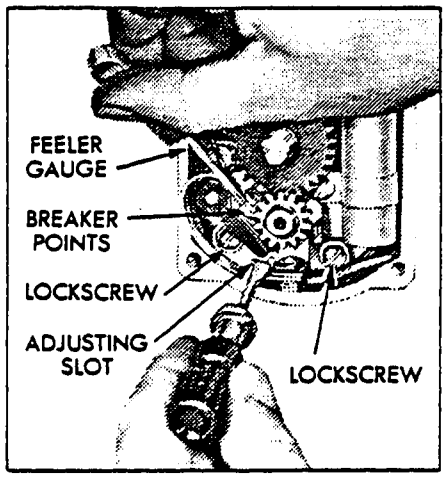


Fig. 13

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.

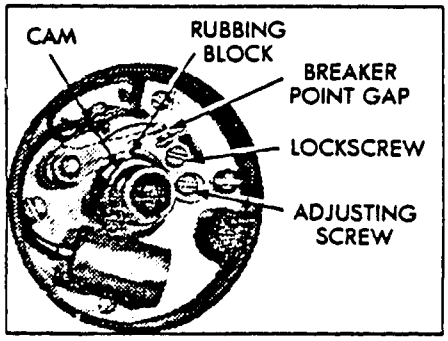


Fig. 14

Points that are badly pitted or worn should be replaced.

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

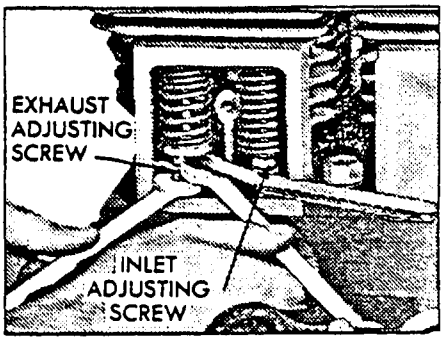


Fig. 15, VH4D, VG4D
VALVE TAPPET ADJUSTMENT

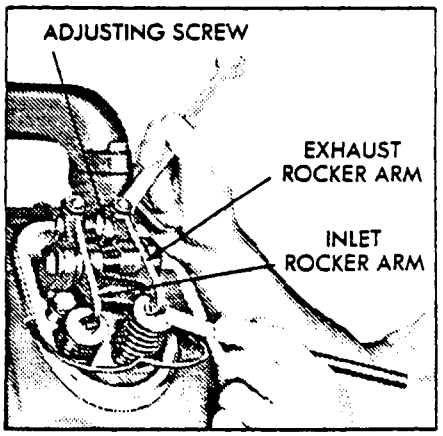


Fig. 16, V465D
VALVE TAPPET ADJUSTMENT

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.

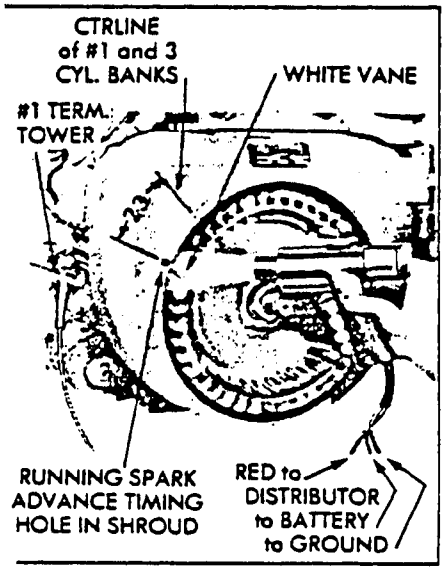


Fig. 17

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 ¼" 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.

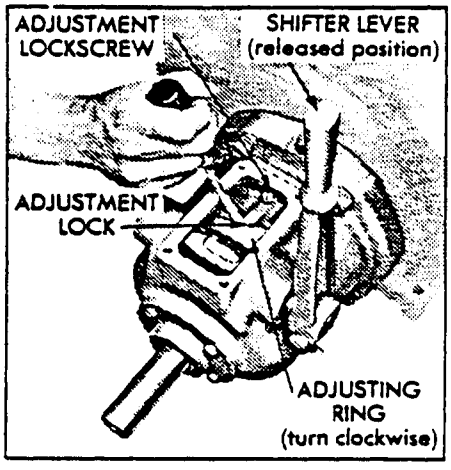


Fig. 18, VH4D
CLUTCH ADJUSTMENT

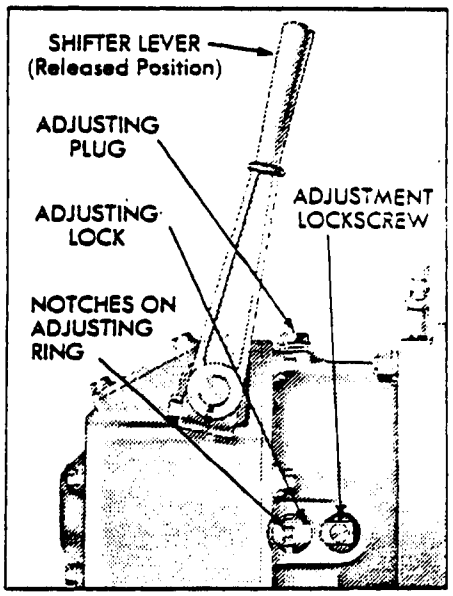


Fig. 19, VH4D
CLUTCH REDUCTION ADJUSTMENT

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

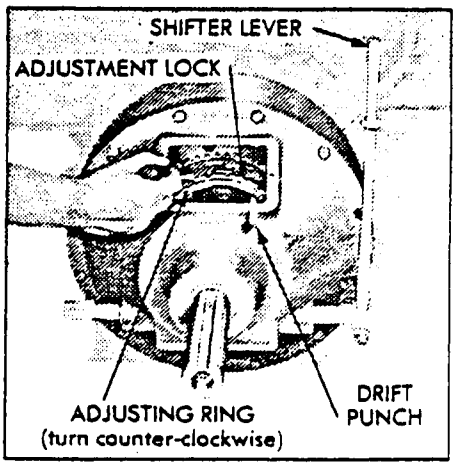


Fig. 20, VG4D, V465D
ROCKFORD CLUTCH ADJUSTMENT

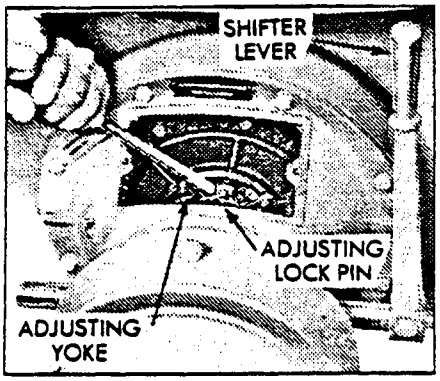


Fig. 21, VG4D, V465D
TWIN DISC CLUTCH ADJUSTMENT

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 lockpin and turn adjusting yoke slightly, to allow lockpin to snap into hole in floating plate. .

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

FLYWHEEL ALTERNATOR

Fig. 22 and Fig. 23

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

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

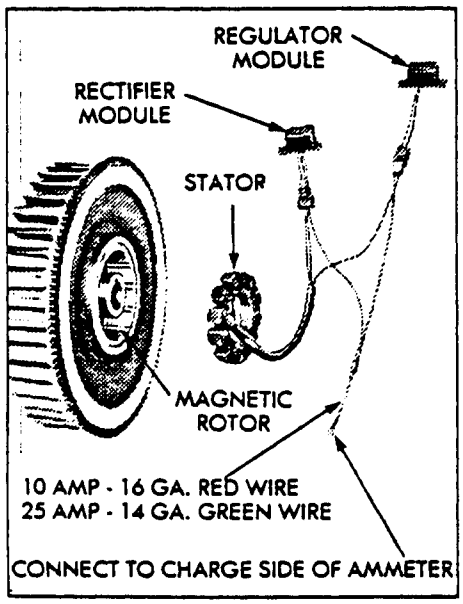


Fig. 22, FLYWHEEL ALTERNATOR

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

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

GENERATOR — WIRING CIRCUIT, Fig. 24

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

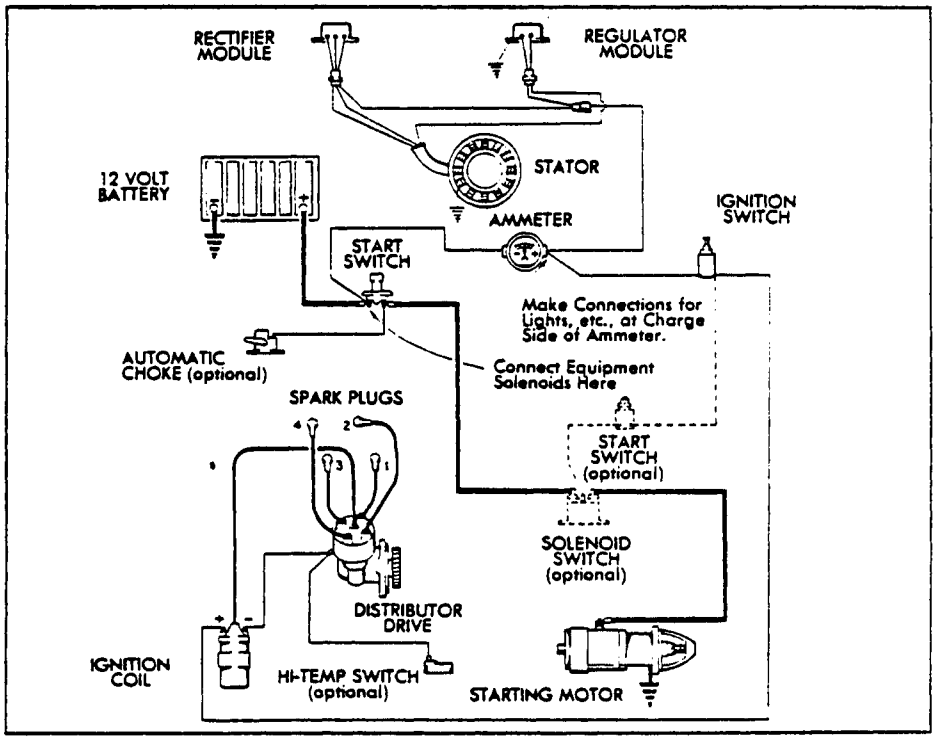


Fig. 23, WIRING DIAGRAM, Flywheel Alternator and Battery Ignition, Models VH4D, VG4D

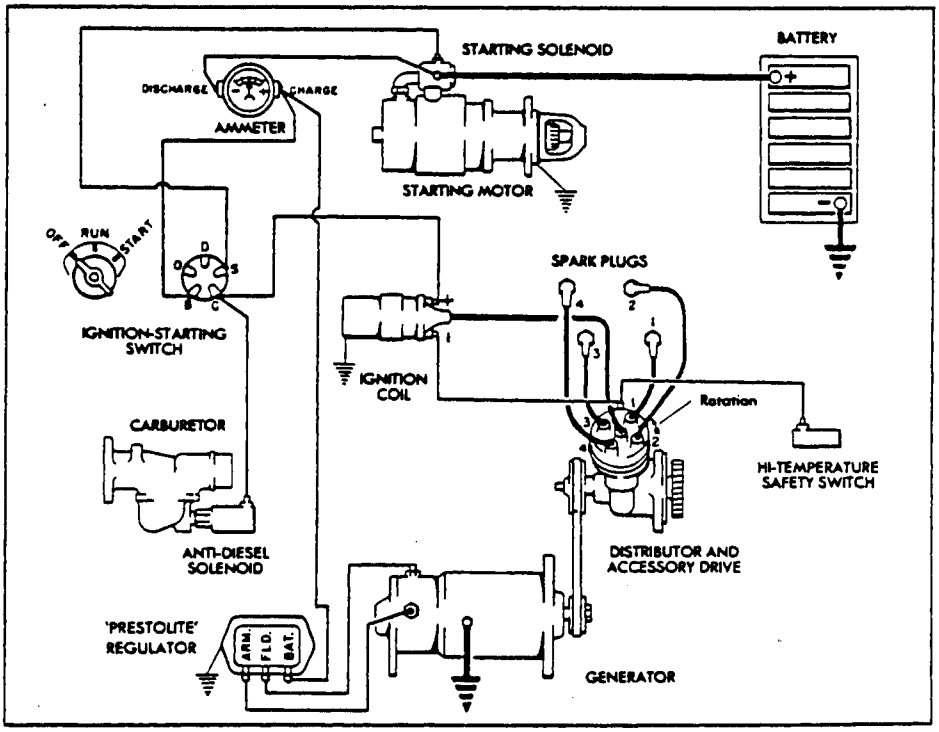


Fig. 24, WIRING DIAGRAM, Generator and Battery Ignition, Model V465D

TROUBLE SHOOTING

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

A proper fuel mixture in the cylinder.

Good compression in the cylinder.

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.

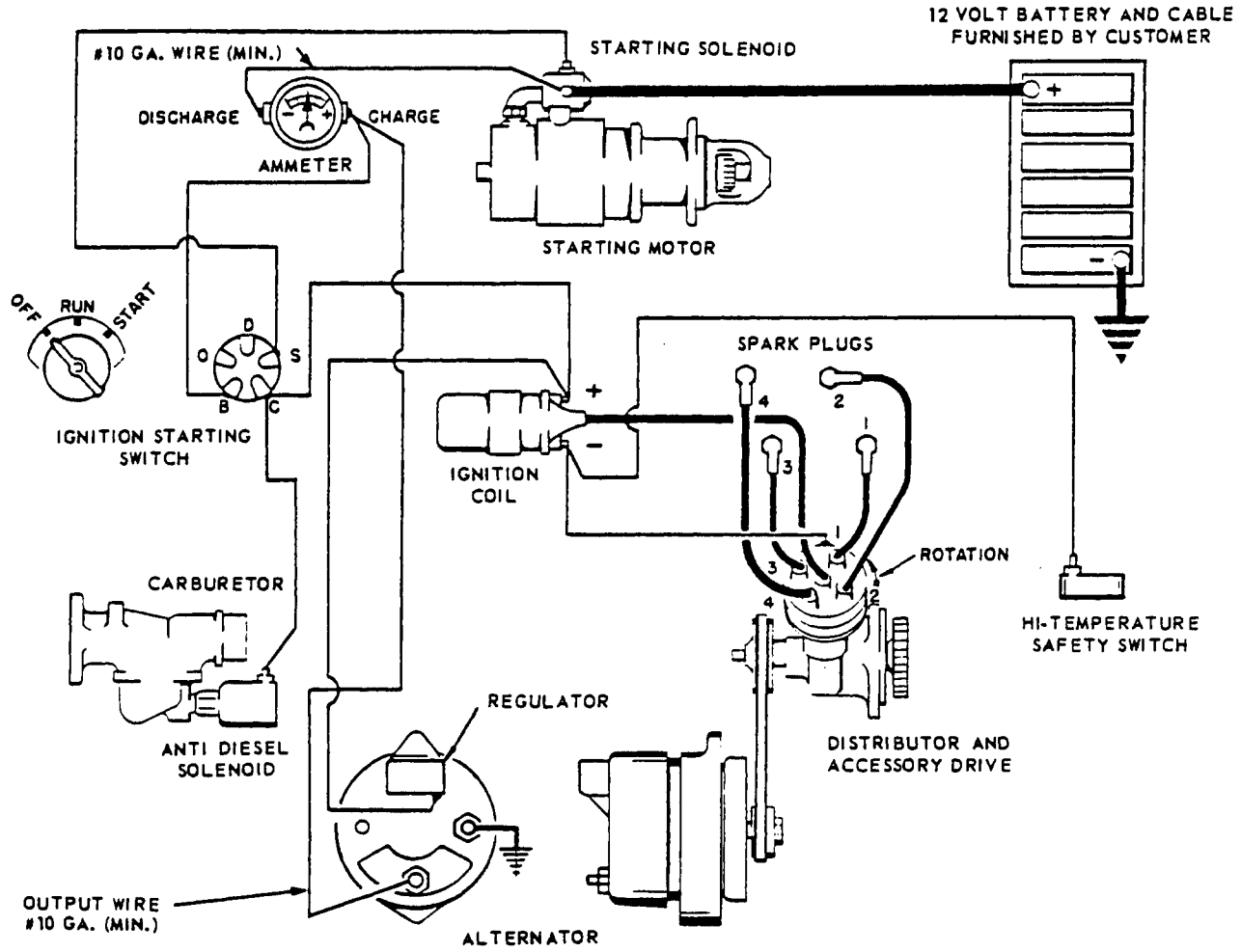
Do Not, remove the alternator from the vehicle without first disconnecting the grounded battery cable.

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



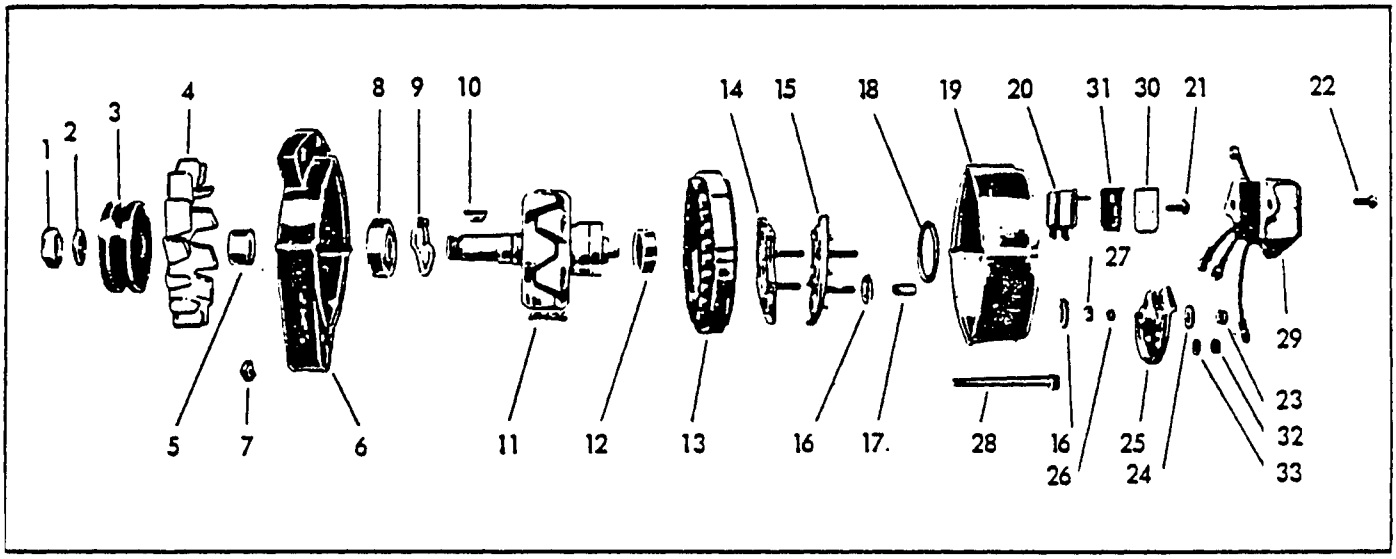
TELEDYNE WISCONSIN MOTOR MILWAUKEE, WISCONSIN 53219

YB 69 ALTERNATOR

MOTOROLA Part No. RA 12N 451

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 20 11 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

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

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

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

E ABOVE INFORMATION, WHICH WILL BE FOUND ON THE AME PLATE ATTACHED TO THE AIR SHROUD OF THE ENGINE, IOULD BE FILLED IN. YOUR PROMPT ATTENTION TO THIS ATTER WILL MAKE IT CONVENIENT FOR YOU IN THE FUTURE, THIS INFORMATION MUST BE GIVEN WHEN ORDERING RVICE PARTS, OR WHEN ADVICE TO AN ENGINE PROBLEM IS QUESTED.

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.

MAINTENANCE MANUAL

FOR

"HELAC" PIVOT-TYPE

ROTARY ACTUATORS

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I. THEORY OF OPERATION
II. HYDRAULIC LINE ATTACHMENT
III. DISASSEMBLY AND INSPECTION
IV. ASSEMBLY AND TESTING

HP - 384

I. THEORY OF OPERATION

In reference to Fig. I, fluid entering Port E2 under pressure will bear on piston (5) and force piston sleeve (6) upwards. The left-handed spline of piston sleeve (6) will combine with the right-handed spline of shaft (1) and cause rapid CW rotation of shaft (1) and flange (2) (looking down). Fluid entering Port E1 will reverse this rotation.

Displacement and torque are identical for CW and CCW rotation.

Shaft (1) is integral with shaft flange (2) and bearing tube (3). The shaft is supported radially by the large upper radial bearing (9) and the lower radial bearing (10). Axially, the shaft is separated from the housing by upper and lower thrust rings (8). End cap (7) is adjusted for axial clearance and locked in position by cap screw (11).

II. HYDRAULIC LINE ATTACHMENT

Ports E1 and E2 are provided with either NPT or SAE threads. The hydraulic lines from the control valve to the actuator should be as short as possible. If the lines are too long, the actuator cycles the fluid back and forth, not allowing sufficient fluid to reach the continuous flow circuit for filtering.

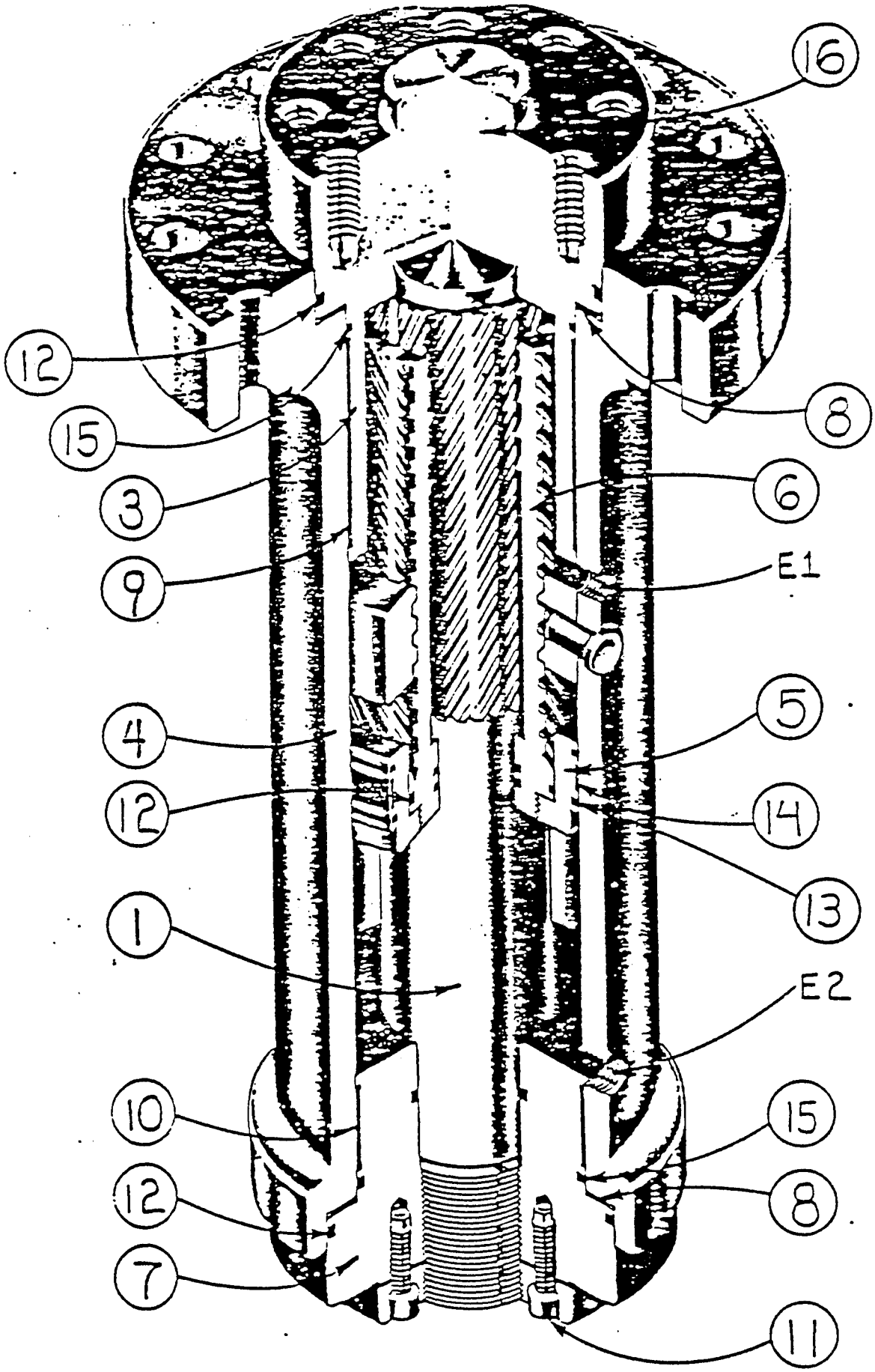


FIG. I - FLANGE MOUNTED HELAC PIVOT ACTUATOR

III. DISASSEMBLY AND INSPECTION

Place on clean work bench with room to place the internal parts as they are removed. Remove all hydraulic fittings. Loosen cap screws (11) and unscrew end cap (7). The shaft is now free to slide up and out of engagement with the piston sleeve (6). Note the orientation (see Fig. II). between the spline teeth, as this will greatly facilitate actuator timing upon reassembly.

After removing the shaft, the piston sleeve and piston, assembly can now be moved down and out of the housing. Remove all seals and wear strips from their grooves, except static piston seal (12). Seal (12) generally does not require replacement. Clean all parts thoroughly and inspect for wear. A small amount of wear on the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about .005 per mating set. After long service, a backlash of .015 per set may still be acceptable in most cases, depending on the required accuracy of the application.

Item 4 is the intregral housing and ring. Check the ring gear for wear and weld damage to the pins. Inspect the cylinder bore for wear and scratches. The surface finish should be 32 RMS or better, rehone if necessary. The radial bearing (9) & (10) and the piston wear strip (14) should have maximum radial clearance of

III. DISASSEMBLY AND INSPECTION (CONT'D)

.006. A clearance in excess of .008 calls for replacement of the bearings. Rough and grooved shaft journals require shaft replacement.

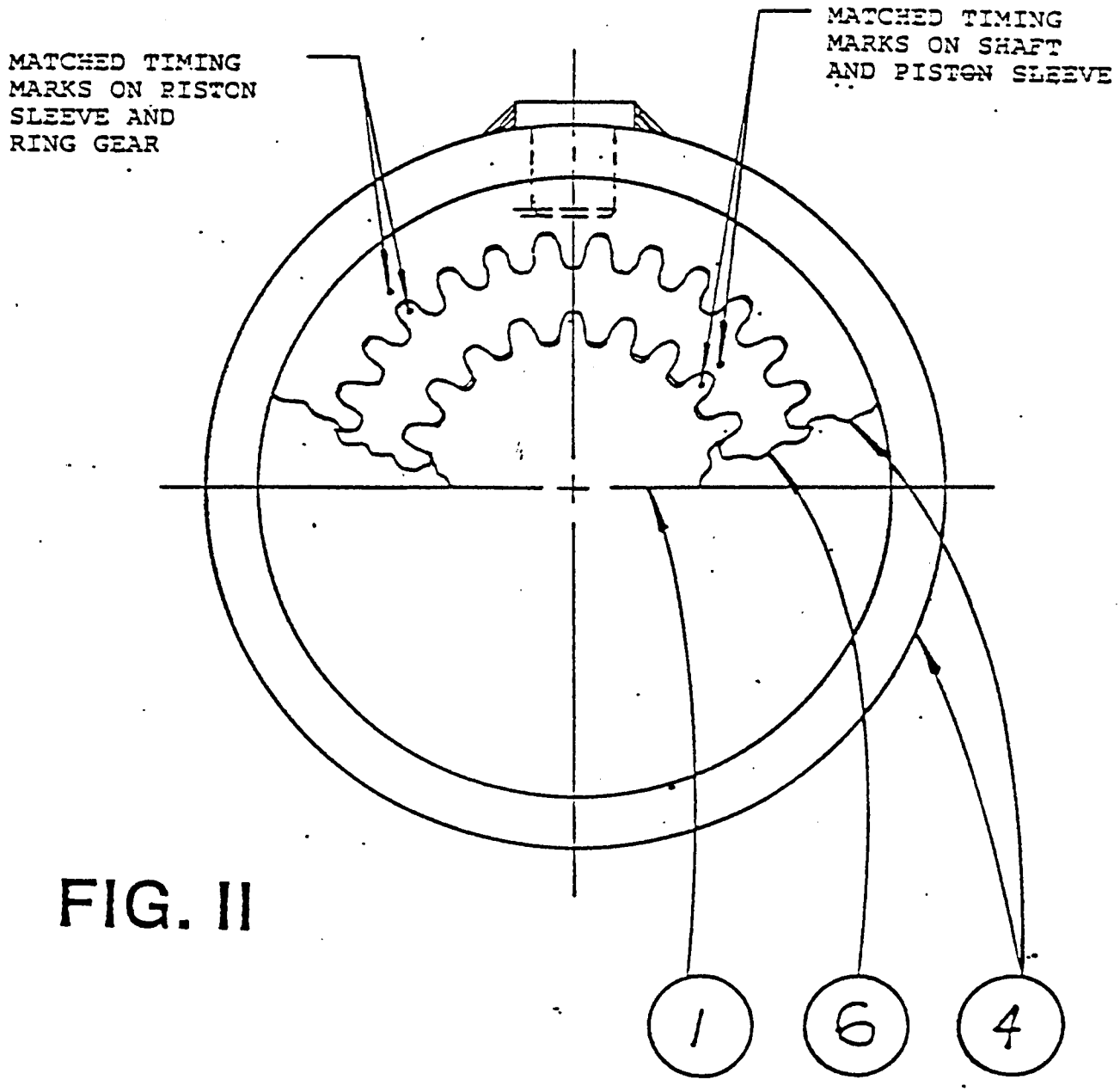


FIG. II

IV. ASSEMBLY AND TESTING

Wash all parts thoroughly in cleaning solvent and blow dry. Coat all sealing and working surfaces with a good grade hydraulic oil. Install seals in piston sleeve, piston and end caps. The lips of exclusion seals (12) face outward, and the lips of high pressure seals (15) face inwards.

Place the actuator in a vertical position, install the piston sleeve (6) in timed relation to the housing, applying firm pressure as the new seals and wear strip enter the housing and become compressed by the housing chamber. (CAUTION: Do not cock the sleeve too much any one way, for it will mar the cylinder bore). The timing marks (small punch marks on the face of each gear), must be lined up for proper shaft orientation (Fig. II).

Thrust rings (8) are coated with good grease before sliding on the shaft and end cap. The shaft is installed by again aligning the proper punched timing marks (Fig. II). Temporary taping (masking tape works well) of threaded portion of shaft will help installation past the shaft seals. Apply antiseize to threaded and surrounding areas of end caps. Also depending on the size of the actuator (some 60KS & up), the end cap may need to be installed with the actuator in a vertical position.

IV. ASSEMBLY & TESTING (CONT'D)

End cap (7) is torque to 40-80 ft-lb depending on the actuator size, such that the actuator begins rotation at approximately 100 psi pressure. The torque flange cannot be rotated by hand. The combined back-drive efficiency and friction prevent manual rotation. If the end cap is torqued too high, the actuator may take as much as 300 psi to rotate. If end cap is not torqued high enough, shaft axial motion in excess of .015 will occur and damage to the ring gear, piston, sleeve and/or shaft can result. The end cap must be secured against the shaft by tightening cap screws (11). Apply hydraulic pressure and check for shaft axial motion.

To test for leakage, pressurize port E2 to 3000 psi. No oil should seep from port E1 or from around end cap (7). Repeat test for pressurizing port E1 and check for leakage out of port E2 and around shaft flange (2).

Note: End cap torque should be checked at least every 800 hours or once a year. If end play is observed, (the torque flange moving out of the housing), tighten end cap.

TESTING & STORAGE

All Helac Corp. actuators have been tested and operated through at least twenty-five (25) full cycles. Test pressure is normally 3000 psi, except where working pressures have been designated higher, then testing is done above the required working pressure.

Helac Corp. actuators are normally shipped filled with petroleum base hydraulic oil, and the ports are plugged with the proper high strength steel plugs to prevent leakage during shipment.

If Helac Corp. actuators are not placed into service immediately, they should be stored in an even temperature location to avoid condensation moisture from forming and the hydraulic port plugs must be left in place to prevent oil loss from the cylinder and possible contamination.

LIMITED WARRANTY

HELAC CORPORATION warrants equipment manufactured by it to be free from defective material and defective factory workmanship. HELAC CORPORATION shall replace or repair such equipment, which under normal use and service discloses such defects. Equipment under warranty shall be returned to our factory at 1462 Blake St., Enumclaw, Washington 98022, transportation prepaid by the purchaser, for inspection by HELAC CORPORATION whose opinion as to defects shall be conclusive.

The warranty period shall be 12 months from the date of shipment from the HELAC plant or 6 months from the time of final installation within the application assembly, whichever occurs first. This warranty shall be voided as to any products which have been repaired, worked upon or altered by persons not authorized by HELAC CORPORATION, or which have been subject to misuse, negligence or accident.

HELAC CORPORATION, reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligations to make changes or alterations in products previously sold.

This warranty is in lieu of all other warranties, expressed or implied and no company or person is authorized to represent or assume for HELAC CORPORATION any liability in connection with the sale of HELAC products other than set forth herein. In no event shall HELAC be liable for any incidental or consequential damages. This includes, but is not limited to, operator use and/or neglect, incorrect design application and structural failure of any components attached to the HELAC CORPORATION product.

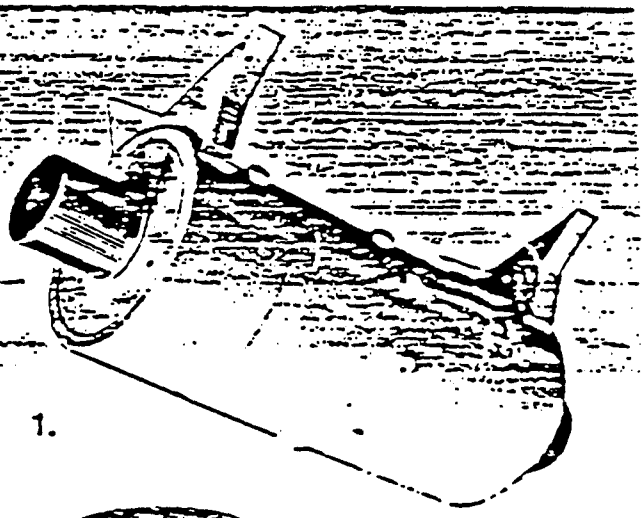
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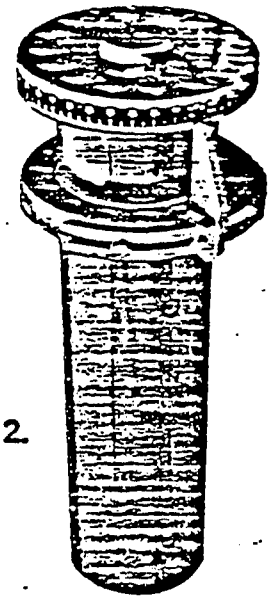
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WESEL SOLUTIONS

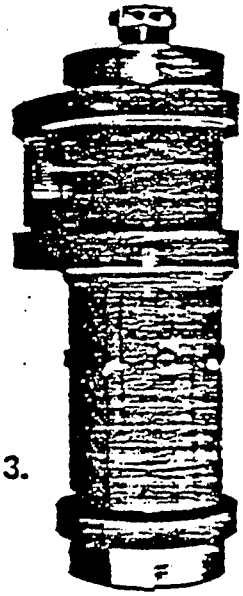


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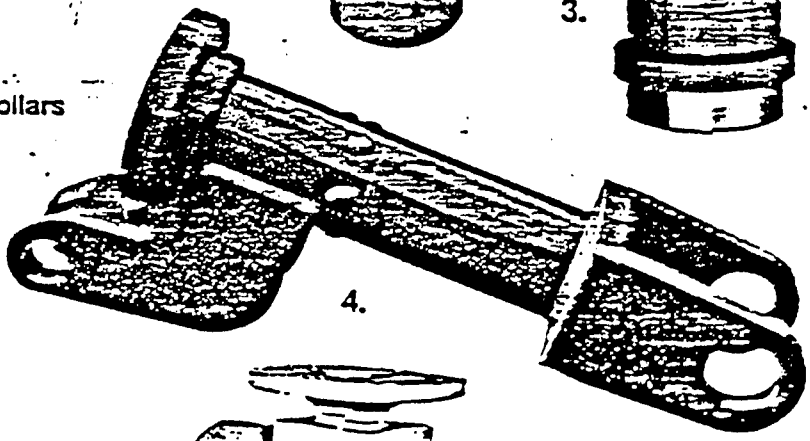
1. Offshore pipe handler with S.S. shaft and weld-on mounting brackets;
   380,000 in-lb x 100° rotation
2. Drill boom positioner with adjustable angle indicator;
   110,000 in-lb x 360° rotation
3. Actuator for the positioning of tunnel support sections. Shaft has gundrilled oil passages and counterbalance valve, body rotates;
   120,000 in-lb x 220° rotation
4. Drill positioner with body and cylinder mounting clevices for underground mining machine;
   80,000 in-lb x 270° rotation
5. Stainless steel shipboard actuator with non-rotating body, rotating output flange, and non-rotating inner shaft;
   28,000 in-lb x 240° rotation
6. Rotator for narrow aisle lift trucks. Set of inner mounting feet is stationary, outer feet rotate;
   15,000 in-lb x 190° rotation
7. Rack and pinion actuator with weld-on collars for basket rotation;
   16,000 in-lb x 180° rotation



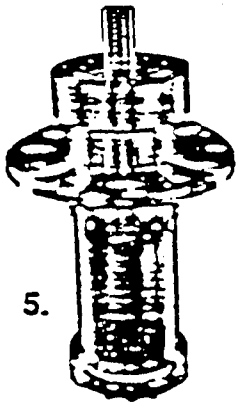
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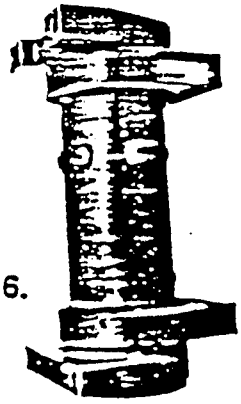
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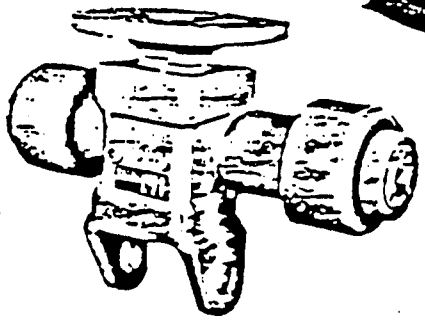
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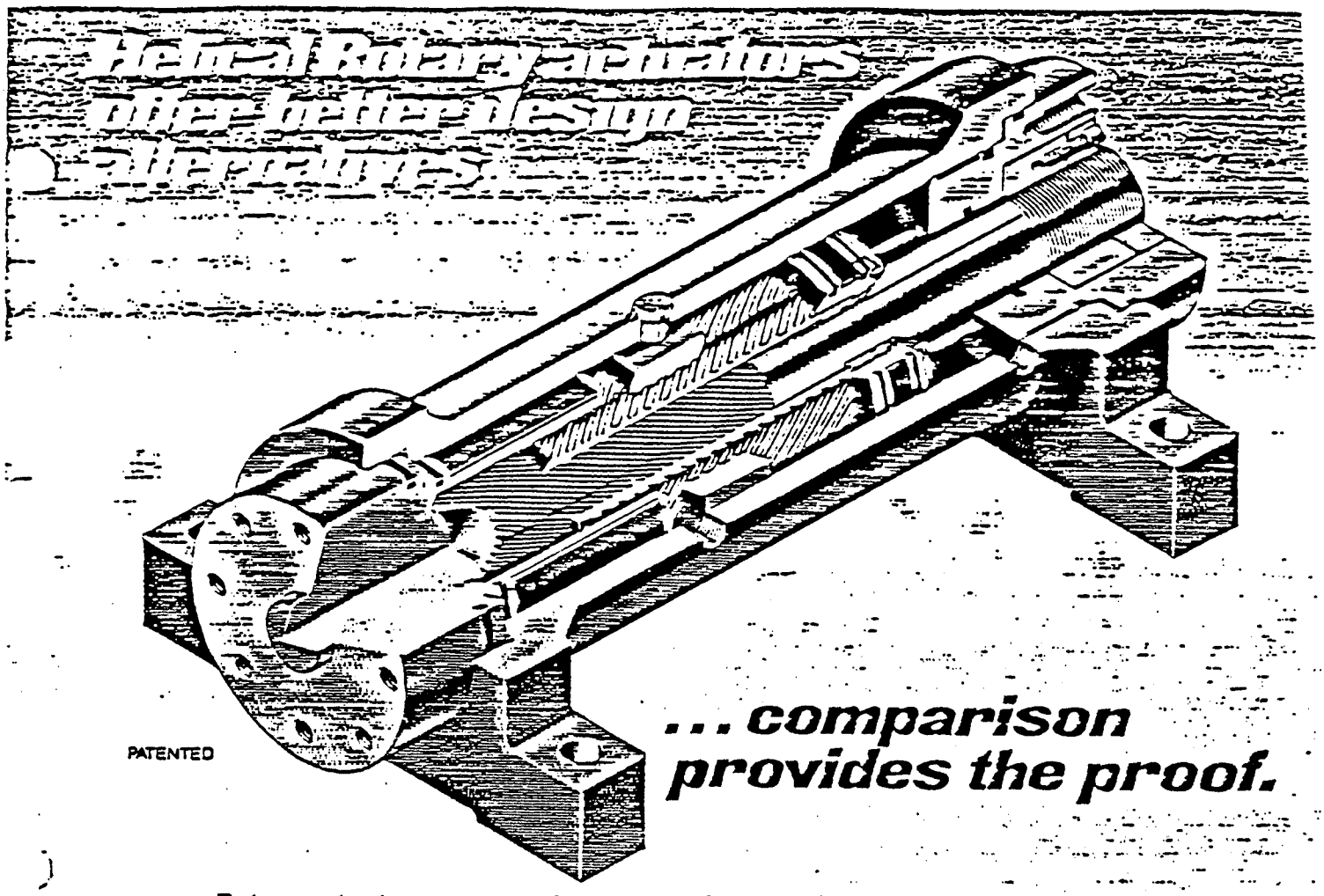
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HELAC

Helac Corporation

1462 BLAKE STREET • ENUMCLAW, WA 98022, USA

Phone (206) 825-1601
Telex: 469363



PATENTED

...comparison provides the proof.

Rotary actuators convert the energy of pressurized fluids into oscillating rotation. The design concept determines the critical operating characteristics such as holding ability, external loads, cushioning, etc.

Vane actuators are compact and convenient to use. Fluid pressure is converted directly into torque without intermediate elements. There is no backlash. The sealing surfaces are rectangular and cannot be sealed well for holding applications. Vane actuators leak internally. Rotation is limited to about 100° for double vane units and 270° for single vane actuators.

Rack-and-Pinion actuators seal the fluid in honed cylinders without leakage. They hold position. The piston force is transmitted to the pinion by two gear teeth. Torque output and shock resistance are limited by the gear teeth strength. Without special provisions, there is some backlash. The gear chamber is lubricated by oil or grease and requires service. Cushioning is simple and rotation readily adjustable. Helac Corp. manufactures the RH-Series of Rack-and-Pinion actuators.

Helical Rotary actuators have ideal circular sealing surfaces and do not drift or leak. Torque is transmitted through a full complement of spline teeth. Strength is superior. There is a small amount of backlash between the sliding teeth, which can be eliminated through special provisions. The helical design is produced in two basic configurations: the HELAC Shaft actuators, and the HELAC Pivot actuators. HELAC Pivot actuators (illustrated) feature large integral shaft flanges and large bearings for direct mounting of heavy loads. Torques range from 2,000 to 380,000 in-lb with standard rotation of 90,° 180,° and 360.° Most U.S. manufacturers of mining machinery have now standardized on HELAC Pivot actuators. We are also strong in construction and materials handling equipment. Request our brochure.

HELAC

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CUSTOM ENGINEERED ROTARY ACTUATORS

OEM's of many industries are blending HELAC's custom-engineered rotary actuators into their machines, and save on structure, bearings, and assembly time.

The HELAC Pivot actuators are particularly well suited to combine the advantages of large output flanges and huge bearings with customized body configurations. We can incorporate clevises for auxiliary hydraulic cylinders, or combine a body mounting clevis with a cylinder clevis for universal positioning within two planes.

We can offer alternate port sizes and port locations, or provide machined mounting pads for counterbalance valves.

In some cases our customers prefer to keep the shaft stationary and rotate the body. Then we offer gundrilled shafts for simplified plumbing.

For marine applications we can furnish the body and all exposed surfaces made from stainless steel, and the shafts can be sealed against external pressures.

Helac Corporation has the experience and flexibility to custom-engineer rotary actuators for all requirements. Our customers usually value the unique "HELAC" solutions because of their economy.

Helac Corporation
1452 Blake Street • Enumclaw, Washington 98022 U.S.A.
Phone (206) 825-1601 Telex: ESL 52101240

ROTARY ACTUATOR SHIPMENT INSTRUCTIONS

This shipment of HELAC Corporation rotary actuators have been tested to 4500 psi and operated through five (5) full rotation cycles. These actuators are shipped with a standard petroleum based hydraulic fluid (unless an alternate fluid and seals are specified).

If this (these) actuator(s) are not installed for use immediately, they should be stored in a dry, even temperature location to prevent moisture internally. The hydraulic ports are plugged with either plastic threaded or metal plugs and should be left in place until final assembly in the system.

Hydraulic lines to the actuators should be purged before attachment to the actuator. The hydraulic fluid in the actuator and lines between the control valve and actuator will cycle the majority of the fluid in and out of the actuator without returning through the filter. Contaminated fluid will cause rapid deterioration of actuator seals and cylinder walls. If the possibility of contaminated hydraulic fluid exists, in line high pressure filters should be installed in both hydraulic lines at the actuator.

If you have any questions concerning storage or installation of these HELAC Corp. actuators, please contact HELAC Corporation, Enumclaw, Washington, U.S.A., phone 206/825-1601, Telex 469363.

SERVICE BULLETIN NO: 3455

PREVENTATIVE MAINTENANCE AND CABLE TENSIONING

Three-Section Boom Assemblies

On three section boom assemblies, the inner boom section (or fly section) is cable actuated by a series of two extension cables, and two retraction cables. There are two extension sheaves and two retraction sheaves as well, which need to be greased periodically. (See Figure 1). The extension sheaves are attached on the aerial platform end of the middle boom assembly, and are greased at points "A" and "B". The retraction sheaves are attached on the opposite end of the middle boom assembly, and are greased at point "C". However, in order to gain access to point "C", the boom assembly must be in the fully retracted position, so that the retraction sheave grease zerk will align with a hole in the outer boom assembly. Both the retraction and extension sheaves should be greased every 100 hours of operation.

All of the telescopic sections are painted with an epoxy type paint, and are supported on nylon type wear pads. Therefore, greasing the boom assemblies themselves is not recommended. However, the surface of the boom assemblies should be free of any build-up of paint, concrete, tar etc.

On both figures 1 and 2, there are two housings and housing sheaves. Each of these housings contain either the electrical control cable, or the four hydraulic hoses for the aerial platform leveling and rotation.

BOOM ADJUSTING PROCEDURE

There are three parts in adjusting the cable tension. One, is checking the housing tension. Two, is adjusting the inner boom out to achieve the proper housing tension, and three, is adjusting the extension and retraction cables themselves to their proper tension.

Housing Tension Check

1. Extend boom fully (See Figure 2).

2. Place spotlight "A" to shine down inside the outer boom, over the top of the housing sheaves, and light up area of the housings.

3. Look between the inner and middle booms at point "B", to observe the housing slack. This slack should not be any closer than two inches from the bottom surface of the middle boom. (See Figure 2).

I HOUSING TENSIONING

1. Loosen retraction cables approximately ten turns, then tighten the extension cables to 25 ft. lbs. (See Figure 1). Note: In order to tighten the cables you will need a special cable tensioning wrench P/N: 20053. This wrench has a inner portion which connects to the end of the cable, and holds it stationary while turning the outer portion, which tightens the cable retaining nut. A 15/16" crowsfoot will have to be attached to the torque wrench in order to turn the outer shell of the cable tensioning wrench. Also there is a jam nut which is tightened against the adjusting nut. Loosen the jam nut approximately one turn then slide the wrench past the jam nut onto the adjusting nut.

2. Retract boom fully and measure the distance as indicated in item D of Figure 1. This distance should not exceed 14 inches.

3. Recheck housing tension. If housings are still too loose, repeat procedure, but insure that boom measurement does not exceed 14 inches.

4. Tension cables to 25 ft. lbs. as prescribed in Part II.

II CABLE TENSIONING

1. Retract boom assembly fully.

2. Torque extension cables to 25 ft. lbs. (See Figure 1).

3. Check measurement D to insure that this measurement does not exceed 14 inches.

4. Torque retraction cables to 25 ft. lbs.

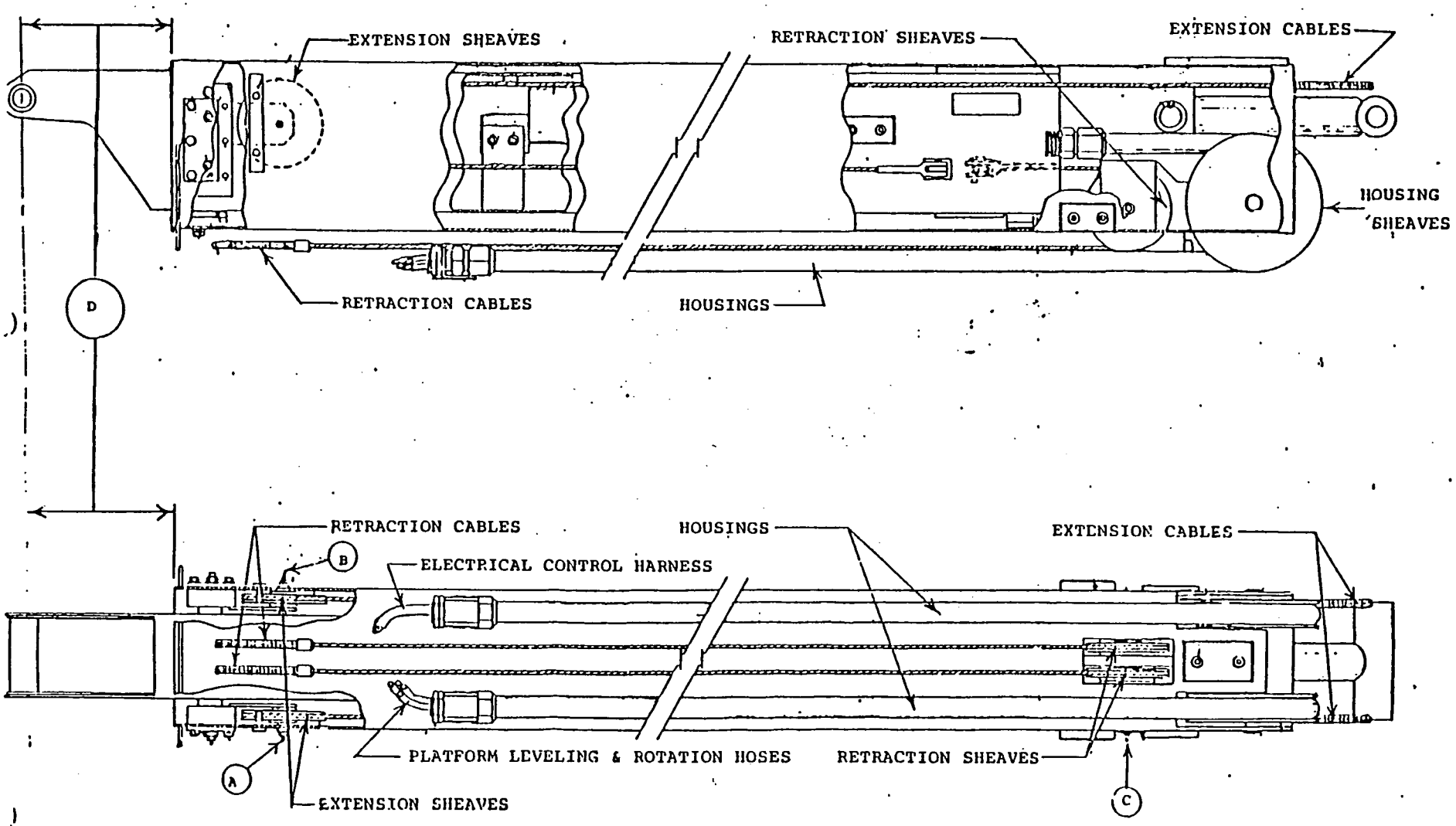

EXTENSION SHEAVES
RETRACTION SHEAVES
EXTENSION CABLES
HOUSING SHEAVES
RETRACTION CABLES
HOUSINGS
D
RETRACTION CABLES
HOUSINGS
EXTENSION CABLES
B
ELECTRICAL CONTROL HARNESS
PLATFORM LEVELING & ROTATION HOSES
RETRACTION SHEAVES
A
EXTENSION SHEAVES
C

FIGURE ONE

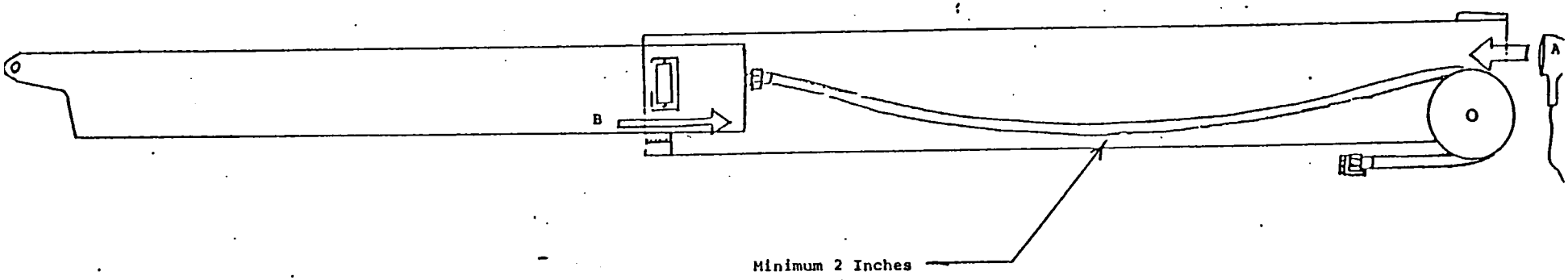


FIGURE TWO

SERVICE BULLETIN NO: 3455

NEW EVENER BAR CONFIGURATION

The models 62 and 30I (three section) boom has incorporated a Fixed Evener Bar between the two extension cables, and an Adjustable Evener Bar between the two retraction cables. The Evener Bar equalizes the tension uniformally between the cables. Therefore, separate cable adjustments are no longer needed.

Another improvement is the elimination of the housing hoses and housing hose sheaves. This new system eliminates the need for housing tensioning.

The Adjustable Evener Bar on the retraction cables is the only adjustment required. (See Figure #3).

Below are the torque settings for adjusting the Evener Bar tensioning nut.

30I	15 ft. lbs.
62	20 ft. lbs.

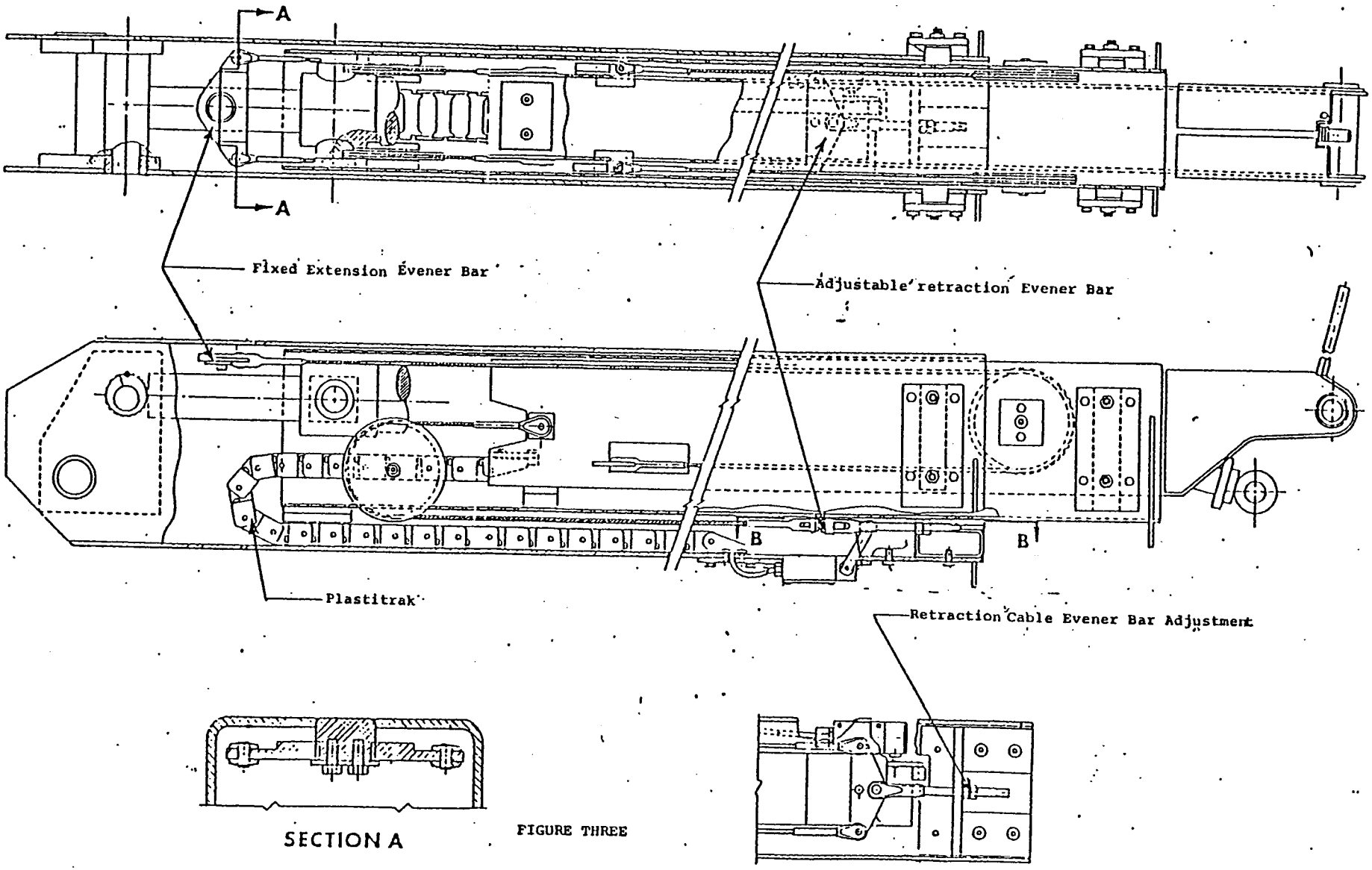


FIGURE THREE

RECOMMENDED LUBRICATED TORQUE VALUE
ALL BOOM MODELS

BOOM MODELS	TORQUE HUB MOUNTING BOLT Bowmalok	STEERING TIRE LUG NUT	DRIVE TIRE LUG NUT	RING GEAR TOP Bowmalok	RING GEAR BOTTOM Bowmalok	ROTATION GEAR BOX Bowmalok	RETRACTION CABLE EXTENSION TORQUE SPECS.
21RT - 21S	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	1/2-13X2	5/8-11X1-1/4	3/4-10X1-1/2 1/2-13X2	NA
30L	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	1/2-13X2	5/8-11X1-1/4	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
30H	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	1/2-13X2	5/8-11X1-1/4	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
30RT	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	1/2-13X2	5/8-11X1-1/4	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
2 section 30I 3 section	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	5/8-11X1-1/4	1/2-13X1-3/4	3/4-10X1-1/2 1/2-13X2	15 in. lbs. 15 ft. lbs.
30EB	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	5/8-11X1-1/4	1/2-13X1-3/4	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
32	5/8-11X1-1/4	1/2-20 UNF	1/2-20 UNF	5/8-11X1-1/4	1/2-13X1-3/4	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
40	5/8-11X1-1/4	3/4-16 Ballnut	3/4-16 Ballnut	5/8-11X1-1/4	1/2-13X2	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
40RT	5/8-11X1-1/4	3/4-16 Ballnut	3/4-16 Ballnut	5/8-11X1-1/4	1/2-13X2	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
2 section 40I 3 section	5/8-11X1-1/4	3/4-16 Ballnut	3/4-16 Ballnut	1/2-13X2	5/8-11X1-1/4	3/4-10X1-1/2 5/8-11X1-1/2	15 in. lbs. 15 ft. lbs. NEW
2 section 40EB 3 section	5/8-11X1-1/4	3/4-16 Ballnut	3/4-16 Ballnut	5/8-11X1-1/4	1/2-13X2	3/4-10X1-1/2 1/2-13X2	15 in. lbs. 15 ft. lbs. NEW
42 & 42-4*	5/8-11X1-1/2 5/8-11X1-1/4*	3/4-16Ballnut 1/2-20 UNF*	3/4-16Ballnut 1/2-20 UNF*	5/8-11X1-1/4	1/2-13X2	3/4-10X1-1/2 1/2-13X2	15 in. lbs.
62 & 62-4*	5/8-11X1-1/2	3/4-16 Ballnut	3/4-16 Ballnut	5/8-11X1-1/2	1/2-13X2	3/4-10X1-1/2 1/2-13X2	25 ft. lbs. OLD 20-22 ft. lbs. NEW
80 & 80-4*	5/8-11X1-1/2	3/4-16 Ballnut	3/4-16 Ballnut	5/8-11X1-1/2	1/2-13X2	3/4-10X3	25 ft. lbs. OLD 20-22 ft. lbs. NEW

TORQUE SPECS BOOM	
1/2-20 UNF Bowma-Grip 53 ft. lbs.	
3/4-16 Ballnut 188 ft. lbs.	
1/2-13X2 Bowmalok 87 ft. lbs.	
5/8-11X1-1/4 Bowmalok 175 ft. lbs.	
5/8-11X1-1/2 Bowmalok 175 ft. lbs.	
3/4-10X1-1/2 Bowmalok 310 ft. lbs.	

TORQUE SPECS
SCISSORS

ALL MODELS

WHEEL LUG NUTS
1/2-20 UNF Bowma-Grip
53 ft. lbs.

DRIVE HUB RETAINING FASTENERS

ALL SLAB MODELS
1-20 Castelated Jam Nut
180 ft. lbs.

Straight Axle Models (Gear Box)
1/4-10X1-1/2 Bowmalok
310 ft. lbs.

Large RT Models (No Gear Box)
1-1/4X18 Castelated Nut
390 to 400 ft. lbs.

* Identifys 4X4 on Booms Models