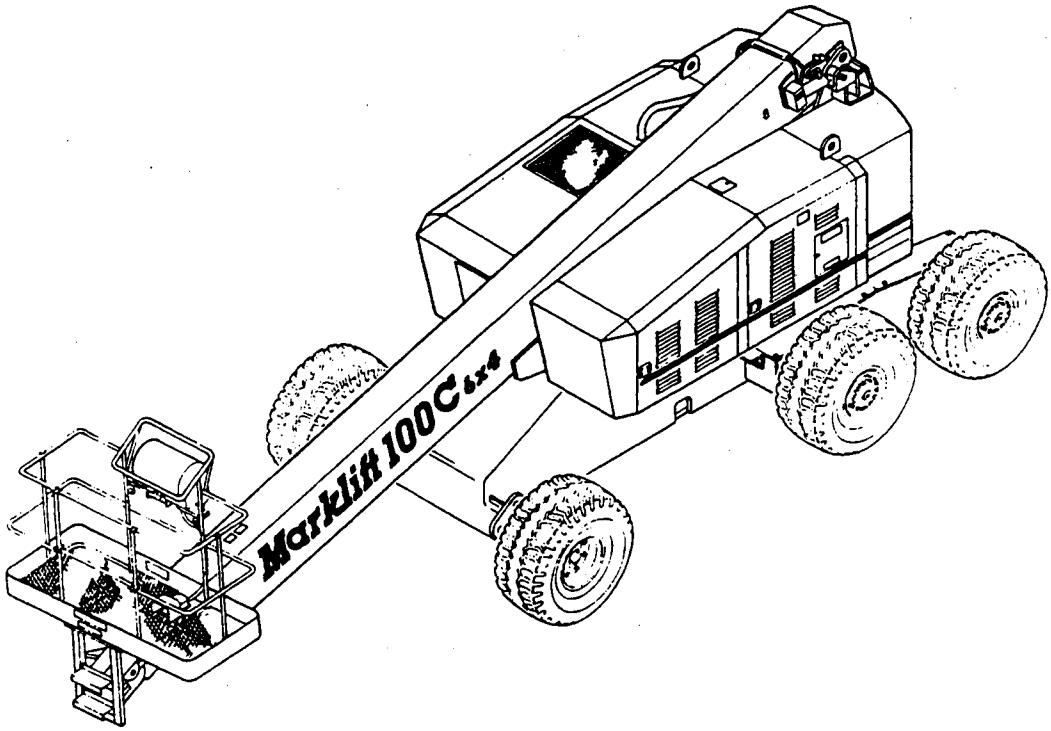
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED BOOM OPERATION MAINTENANCE AND PARTS MANUAL



Models: 80C (4X4), 80C (6X4), 100C (6X4)

FIRST EDITION: September 1989

Mark Industries

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17125

Mark Industries

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INTRODUCTION

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

Schematic and vendor information is also furnished. If additional information is needed, we urge the customer to contact the local dealer. If this is impossible, please contact the Mark Industries Service Department at (714) 879-6275 ext. 362.

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

The model capacity, pressure settings and serial number can be found on the ID plate mounted on the rear of the frame assembly. The serial number should be used when ordering parts. This will help our parts department give prompt and accurate service.

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

Description	Model		
	80C4x4	80C6x4	100C6x4
Height –			
Working (maximum)	86'4" (26.31m)	86'4"	106" (32.31m)
Platform (maximum)	80'4" (24.49m)	80'4"	100' (30.48m)
Load capacity (unrestricted)	500 lbs (226.8 kg)	500lbs (226.8kg)	500 lbs (226.80kg)
Stowed height	8'10" (2169m)	8'10" (2169m)	9" (2.74m)
Width	7'11 3/4" (2.41m)	7'11 3/4" (2.41m)	7"11.75" (2.43m)
Length (minimum)	32'10" (10m)	32'10" (10m)	34'6" (10.52m)
Wheelbase	12' (3.66m)	12' (3.66m)	10' (3.04m)
Wheel track	6'6" (1.98m)	6'6" (1.98m)	6'6" (1.98m)
Turning Radius (inside)	22'6" (6.86m)	22'6" (6.86m)	16'10" (5.13m)
Tires	4 (Monofilled) 18x19.5-16PR	4 (Monofilled) 18x19.5-16PR	6 (Monofilled) 18x19.5-16PR
	Super Single Traction	Super Single Traction	Super Single Traction
			Road Lug
Turret rotation	Continuous 360°	Continuous 360°	360° Continuous
Tailswing	35" (9m) beyond tires	35" (9m) beyond tires	35" beyond tires
Engine	65hp Wisconsin (gasoline)	65hp Wisconsin (gasoline)	Diesel /F3L912 Deutz
Drive Motors	Piston type with variable	Piston type with variable	Piston type with variable
	displacement and internal	displacement and internal	displacement and internal
	shifters	shifters	shifters
Four wheel drive		6 x4 with walking beam	6 x 4 with walking beam
Travel speed (proportional)	0-2 mph (0-3.218 km/hr)	0-2 mph (0-3.218 km/hr)	0 - 2.5 mph (0 - 3.6 km/hr)
Fuel Tank capacity	70 gal. (.265 liter)	70 gal. (.265 liter)	70 gal (265liter)
Controls	Proportional and solenoid	Proportional and solenoid	Proportional and Solenoid
Hydraulic system	Load sensing and	Load sensing and	Load sensing and pressure
	pressure compensated	pressure compensated	compensation
Hydraulic operating pressure	2500 psi max	2500 psi max	2500 psi max.
	(175.8 kg/sq cm)	(175.8 kg/sq cm)	(175.8 kg/sq cm)
Hydraulic reservoir capacity	40 gal. (151.40 liter)	40 gal. (151.40 liter)	70 gal. (151.40 liter)
Platform dimensions	72" x 36" x 42"	72" x 36" x 42"	72" x 36" x 42"
	(1.80m x .91m x 1.07m)	(1.80m x .91m x 1.07m)	(1.83 m x .91 m x 1.06m)
Horizontal reach	68'8" (20.93m)	68'8" (20.93m)	67'4" (20.52m)
Boom elevation	+ 75° above horizontal	+ 75° above horizontal	+75° above horizontal
	-15° below horizontal	-15° below horizontal	-15° below horizontal
Weight	32,000 lbs (14,515 kg)	34,260lbs	36,250 lbs 16,433kg)
Shipping cube	2,288.09 cu ft (64.8m^3)		2,700 cu. ft. (76.51m^3)

Filling in the Warranty: Please refer to the applicable decals on your machine for the figures and quantities needed to fill in the blanks below (Items 1, 24, 25, 26, 32, 33,39,40,41,42).

		YES	NO
1.	Platform capacity decal _____. lbs.	☐	☐
2.	All warning, caution and emergency decals installed	☐	☐
3.	Emergency descent valve functions properly	☐	☐
4.	Operation instructions properly installed	☐	☐
5.	Operation and safety handbook received	☐	☐
6.	Electrical schematic received	☐	☐
7.	All controls (aerial & ground) are identified and operate correctly	☐	☐
8.	Stop switches operate properly (aerial & ground)	☐	☐
9.	Platform guard rails, secure and undamaged	☐	☐
10.	Platform access gate works properly	☐	☐
11.	Horn and beacon operate properly (optional)	☐	☐
12.	Brakes adjusted and operate correctly	☐	☐
13.	Circuit breakers operate properly	☐	☐
14.	All Hydraulic cylinders free of gas	☐	☐
15.	All hydraulic cylinder rods free of paint or scratches	☐	☐
16.	Hydraulic pump free of leaks	☐	☐
17.	Hydraulic hoses and fittings free of leaks	☐	☐
18.	Hydraulic oil level	☐	☐
19.	Hydraulic tank and fittings free of leaks	☐	☐
20.	Drive motors free of leaks	☐	☐
21.	Battery water level	☐	☐
22.	Coolant hoses and fittings free of leaks	☐	☐
23.	Electric radiator fan operates properly	☐	☐
24.	System pressure _____. PSI	☐	☐
25.	Pilot pressure _____. PSI	☐	☐
26.	Tire pressure _____. PSI	☐	☐
27.	Manual overrides operate properly	☐	☐
28.	Muffler is tight and free of leaks	☐	☐
29.	All electrical connections tight	☐	☐
30.	Manifold valve and fittings free of leaks	☐	☐
31.	110V generator operates properly (optional)	☐	☐
32.	Wheel lug nuts torqued to _____. lbs	☐	☐
—Internal Combustion Units—			
33.	Engine _____ .R.P.M	☐	☐
34.	Engine coolant (radiator) level	☐	☐
35.	Fuel tank and fitting free of leaks	☐	☐
36.	Engine oil level	☐	☐
37.	Engine oil filter free of leaks	☐	☐
38.	Engine alternator functions properly	☐	☐
39.	Turret rotation gear box oil level _____.	☐	☐
40.	Turret ring gear bolts torqued to _____ Ft. lbs	☐	☐
41.	Drive wheel, torque hub oil level _____.	☐	☐
42.	Retraction cable tension _____ Ft. lbs	☐	☐

MODEL	SERIAL NUMBER
INSPECTOR	OPTIONS

MANUFACTURERS' LIMITED WARRANTY

Mark Industries makes no warranty, expressed or implied, on any product manufactured or sold by Mark Industries except for the following limited warranty against defect 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 one (1) year 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 on 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 on any product) manufactured by Mark Industries which, within one (1) year from the date of shipment, shall have been returned to the Mark Industries facility in Brea, California (or any other location within the United States as shall be designated by Mark Industries), at no expense to Mark Industries, and demonstrated to the satisfaction of Mark Industries as being defective in material or workmanship.

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

There are no other warranties, expressed or implied, in addition to this limited warranty. **This limited warranty is exclusive and in lieu of all other warranties, expressed 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, electrical components are specifically excluded from this limited warranty.

Mark Industries

P. O. Box 2255, Brea, CA 92622-2255
714-879-6275 800-448-MARK
TELEX 194402 FAX 1-714-879-8884

WARRANTY REGISTRATION

Purchaser

Company Name

Address

Telephone

Date shipment received

Date of invoice

Date unit put into service

Unit will be used

Unit will be sold

Unit will be used for:

- ☐ Inspection
- ☐ Mining
- ☐ Welding
- ☐ Construction
- ☐ Scaffolding
- ☐ Mechanical
- ☐ General maintenance
- ☐ Heating/Air conditioning
- ☐ Carpentry
- ☐ Plumbing
- ☐ Electrical
- ☐ Sprinkler
- ☐ Painting/Sandblast
- ☐ Steel fabrication
- ☐ Rigging
- ☐ Roofing
- ☐ Glazing
- ☐ Other

Comments

Inspection completed by: Title:

Warranty will be void unless this inspection report is postmarked to Mark Industries not more than fourteen (14) days from the date shipment is received.

REV

IMPORTANT: Due to the width of the Marklifts and the overall width of the flatbed trailer, **extreme caution must be taken when loading and unloading.**

When loading and unloading Marklifts onto flatbed trailers, it is necessary to use a combination of winching and driving the boom in low drive speed. The operator in the basket must wear a safety belt attached with lanyard to the safety rings provided.

1. Make sure that the parking brake is set to start braking immediately by opening the Parking brake control valve.

2. If the unit has the High/Low drive option, it must be in **LOW DRIVE** at all times when loading and unloading.

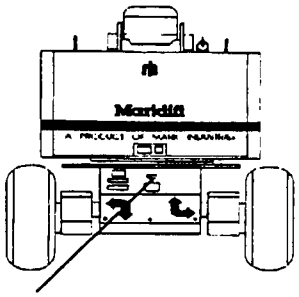


Figure 1: Parking Brake Control Valve

LOADING

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

2. Attach the winch cable to the boom at the drive wheel end of the base through the tow or lift eyes if provided. (See Figure 2.)

3. Use great care while driving and steering the unit up the ramp. Use low drive speed and keep all slack out of the winch cable. (If the ramp is too steep for the unit to climb, the winch will pull the unit up.) **You must keep the drive function engaged while winching, otherwise the brakes will prevent the machine from rolling.**

4. When the unit is on the truck and its weight has been properly distributed, tie the boom down as shown in Figure 3 of this instruction.

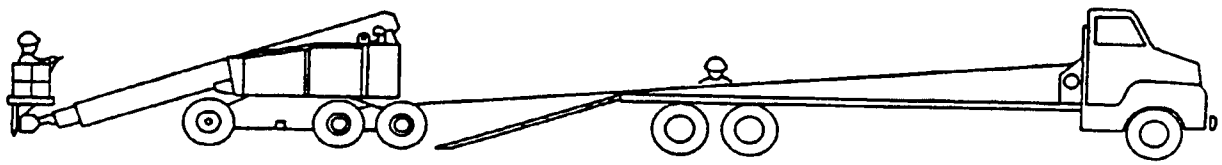
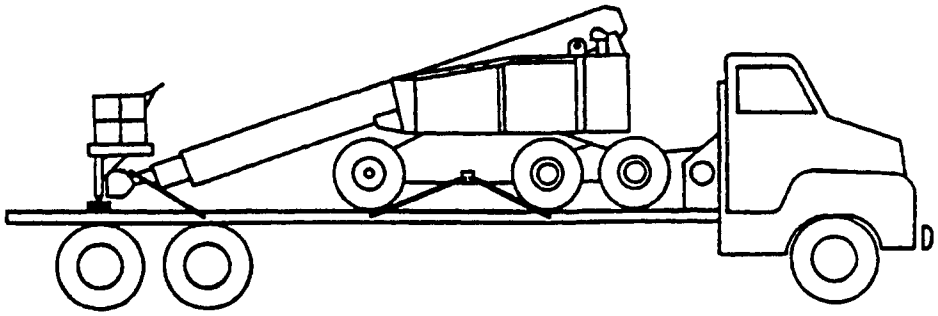


Figure 2: Loading the Marklift onto the truck



Note: Bottom of the basket weldment fork must not rest on the truck bed. Place a wooden block under the basket end of the boom arm.

Figure 3: Securing the Marklift to the Platform

UNLOADING

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

2. Select the low drive speed.

3. Use great care while driving and steering the unit off the trailer. Keep all slack out of the winch cable.

> **Warning:** **Do not** allow slack in the winch cable when going down the ramp, because of the possibility of snapping the cable if the unit descends too fast.

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

5. Readjust the boom parking brakes so that they start immediately after the dynamic brakes stop the unit. The procedure for re-adjusting the parking brakes is as follows: First close the needle valve completely. Open the valve 1/8 turn then place the unit on a flat surface, about 10' wide x 30' long. Position the boom slightly below horizontal and completely retract. Select "High" drive speed and "High" throttle at the

platform console. Drive the **MARKLIFT** with the controller handle in maximum position, approximately 15 feet, letting go of the controller when the wheel is next to a visual marker on the ground. A good deceleration and braking distance would be 3 feet measured from the marker to the center line of the same wheel when the unit has completely stopped. Adjust the needle valve on the parking brakes to reach this position. Repeat this procedure, driving in both directions until the **MARKLIFT** comes to a complete stop within 18" to 24". The deceleration valves have been set at the factory and should not be read-justed without first consulting **MARK INDUSTRIES** Customer Service Engineering Department. It is best to completely open the needle valve if the unit is to be used in a facility that has very steep slopes or inclines. However, very abrupt stops can be expected on flat surfaces if the drive controller is quickly set in a neutral position.

BEFORE OPERATING THE MARKLIFT, REVIEW THE FOLLOWING PROCEDURES:

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

2. Check hydraulic oil level.

3. Check engine oil level.

4. Fill the fuel tank. Use regular gasoline or switch to propane.

5. Check battery for 1200 ± 50 reading on the hydrometer. Charge battery if reading is below 1100 (see Battery Maintenance).

6. Check the hydraulic valve manifolds for leaks, loose fittings or loose wires.

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

8. After the ground control functions have been checked-out, position the selector switch to "Aerial" for operation at work platform. After entering the platform, depress the footswitch before using any control function switches. This increases engine RPM (if throttle HIGH-LOW selector is positioned to High) and electrically completes the circuit to the controls.

9. Your **MARKLIFT** is equipped with a proportional drive control. When using the proportional drive function, press the footswitch, raise the controller locking device, then gradually move the controller in the desired direction . The controller handle is spring-centered and self-locking to prevent accidental operation.

10. The travel or drive arrangement is located over the boom's steering wheels. This provides the best weight distribution for maximum traction. If the boom is rotated 180° the drive and steer decals read in reverse therefore the operator must reverse the drive and steer functions in order to continue in the direction. The forward arrow decals on each end of the base will show the drive direction correctly, regardless of the turret's position.

11. Brake adjustments may be made by turning a small needle valve. This valve is merely a time delay for applying the brakes. With the valve completely open, the time delay for applying the brakes is minimum. Set the delay valve to stop the machine in approximately three feet on level ground while driving in high speed.

The **MARKLIFT** conforms to specified **ANSI & OSHA** requirements, it is the responsibility of the owner to instruct the operators about 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.**

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. The operation of any new and unfamiliar equipment can be hazardous in the hands of untrained operators. **Every operator of the MARKLIFT must read, understand and follow the safety rules set forth herein.**

1. Inspect the machine periodically as specified in the Inspection and Checkout, and the Preventive Maintenance sections and as required by ANSI, OSHA, local safety boards and the owner. All unsafe items must be corrected by a qualified service person before use of the machine.

2. Only trained operators must be assigned to operate the **MARKLIFT.**

3. It is the responsibility of the operator to read and understand this manual and to follow all recommendations made.

4. Never exceed manufacturer's recommended platform load capacity. Remember, the load capacity of the **MARKLIFT** is the total combined weight of personnel and tools, fixtures, accessories, etc.

5. Always distribute load evenly over platform floor area.

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

7. The **MARKLIFT** platform is equipped with safety belt rings. **Each operator of the MARKLIFT must wear a body belt. The belt must be attached with lanyard to the provided anchor points.**

8. **Do Not** change, alter, or vary equipment in any way.

9. **Do Not** override any hydraulic, mechanical, or electrical safety devices.

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

11. **Do Not** work on the platform if your physical condition is such that you feel dizzy or unsteady in any way.

12. The **MARKLIFT** is a non-insulated personnel carrier and must not be operated within 10 feet of a 50,000 volt line. (See Division Of Industrial Safety.)

13. Under no circumstances should horseplay be tolerated on the **MARKLIFT.**

14. **Do Not** operate boom functions on more than a 5 degree front to rear or 3 degree side to side out-of-level condition.

15. **Do Not** drive the carriage or platform into objects.

16. **Do Not** lean over platform guard railings to perform work.

17. **Do Not** use ladders or scaffolding on the platform to obtain greater height.

18. **Do Not** raise or lower the boom into objects.

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

20. **Do Not** jump start other vehicles using the **MARKLIFT** battery.

21. **Do Not** drive on uneven, sloping or soft terrain, unless the boom is fully retracted and raised just above horizontal.

TITLE 8 DIVISION OF INDUSTRIAL SAFETY 358.38.113

(Register 73, No. 30—7-28-73)

Article 86. Provisions for Preventing accidents

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

2946. Provisions for Preventing Accidents Due toProximity 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 of such tool, machinery, equipment, apparatus, or buildng, or any part thereof, can come closer to high-voltage lines than the minmum 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.

(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.

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

(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.

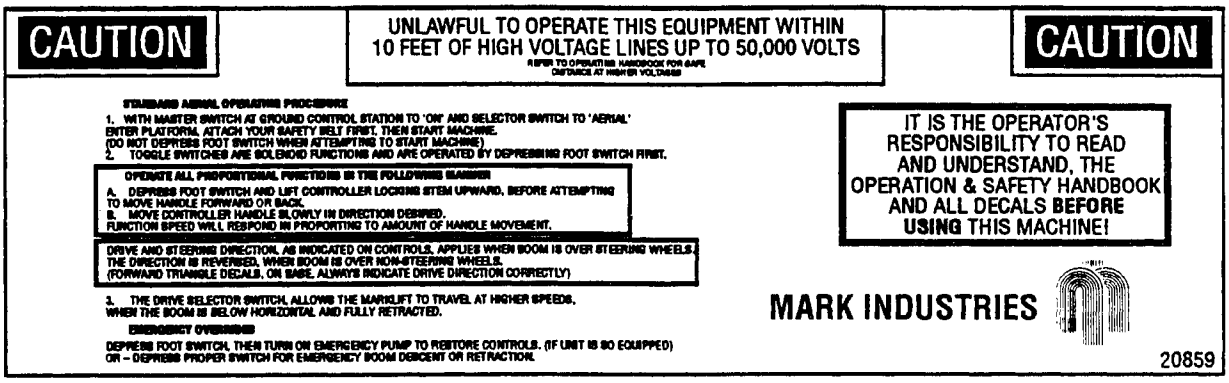
(E) Any overhead conductor shall be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized, and the line is visibly grounded at the work site.

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."**

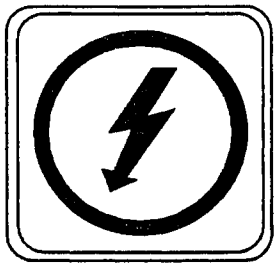
In addition to the above wording, the following statement in small lettering shall be provided on the warning sign: **"For Minimum Clearances of High-Voltage Lines in Excess of 50,000 Volts, See Article 86, Title 8, High-Voltage Electrical Safety Orders."**

OBSERVE ALL DANGER, WARNING, CAUTION AND EMERGENCY DECALS AT THE VARIOUS LOCATIONS ON THE **MARKLIFT** IN ORDER TO TAKE TIMELY PREVENTIVE AND CORRECTIVE ACTIONS.

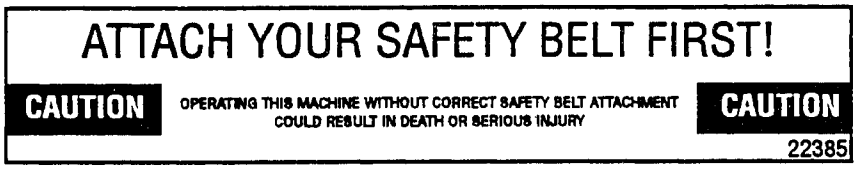
It is the primary responsibility of the user and operator to be thoroughly knowledgeable of all decal information, definition and location. The following page(s) illustrates a chart in which decals for the **MARKLIFT** can be replaced if the existing decal(s) is worn-out, torn, or illegible. This chart also refers to the decal's location and quantity used in that application.

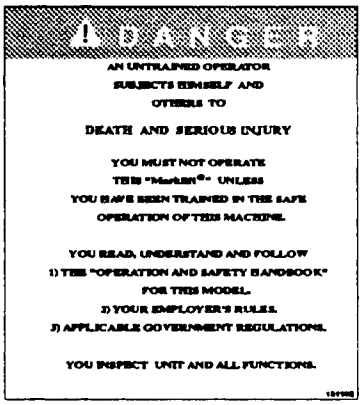








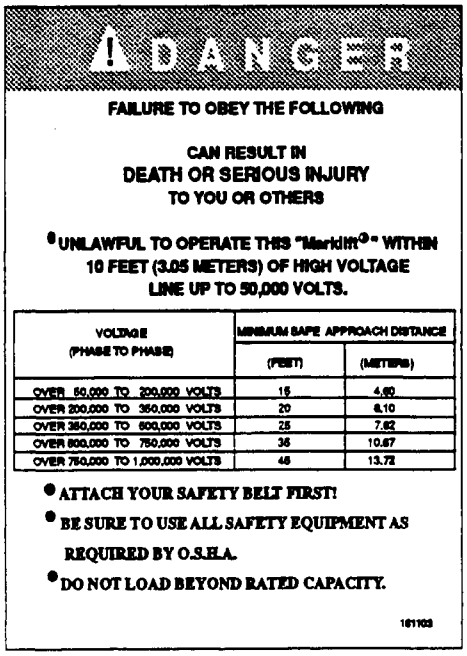


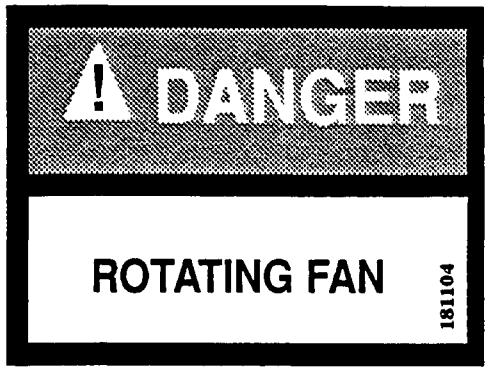




⇐100c Only

LOAD CAPACITY 500 LBS.
(EVENLY DISTRIBUTED LOAD) 2022









80c 4x4 and 80c 6x4 Only

DECAL P/N	DECAL DESCRIPTION 80C 4x4	LOCATION	QTY
67802	Decal Set	All Standard Decals	1
182103	Operation instructions	Final Assy	1
20460	Ground control console	Ground Control Box	1
182707	Aerial control box	Aerial control box	1
21236	Marklift Boom	Final Assy	2
22117	80 Marklift 80	Final Assy	2
181903	'C'	Final Assy	2
22740	4x4 4wd Booms	Final Assy	2
20409	Std. Pedestal	Final Assy	1
20410	Logo Mark Ind.	Final Assy	1
20411	Blue Stripe sq ends	Final Assy	6
20412	Blue stripe rd. ends	Final Assy	1
22386	'D' Ring Attach safety belt	Final Assy	2
2022	Load Cap. 500 lbs	Final Assy	2
181102	Danger, do not operate ...	Final Assy	2
181103	Danger, Obey the following	Final Assy	2
20419	Danger keep clear	Finaal Assy	3
182709	Directional arrow	Final Assy	2
182710	Directional arrow	Final Assy	2
20495	Emergency grd controls	Final Assy	1
20896	Brake	Final Assy	1
21235	Emergency Descent (valve type)	Final Assy	1
20508	Transportation	Final Assy	2
2017	Hydraulic system fluid	Final Assy	2
2020	Gasoline or Petrol	Final Assy	2
22385	Caution, Attach safety belt	Final Assy	1

DECAL P/N	DECAL DESCRIPTION 80C 4x4	LOCATION	QTY
20860	General checkout & operating instructions	Final Assy	1
21237	Grease fitting	Final Assy	3
22175	Caution monofilled tires	Final Assy	4
20660	Nameplate, ID	Final Assy	1
20662	Plate, patent no's - Booms	Final Assy	1
20661	Plate, ANSI A92	Final Assy	1
2003	Battery water level	Final Assy	1
20413	Engine Choke	Final Assy	1
130820	Operation & Safety Handbook	Final Assy	1

DECAL P/N	DECAL DESCRIPTION 80C 6x4	LOCATION	QTY
67803	Decal Set	All standard Decals	1
20413	Engine Choke	Final Assy	1
185702	Circuit Breaker 110 Vac	Final Assy	1
20460	Ground control console	Ground Control Box	1
182707	Aerial Control Box	Aerial Control Box	1
20860	General checkout & operating instructions	Final Assy	1
20508	Transportation	Final Assy	2
182710	Directional Arrow	Final Assy	2
20495	Emergency Ground controls	Final Assy	1
182709	Directional Arrow	Final Assy	2
20420	Tire Pressure 75 PSI	Final Assy	2
20419	Danger keep clear	Final Assy	3
181103	Danger, Obey the following	Final Assy	2
181102	Danger, Do not operate ...	Final Assy	2
20410	Logo, Mark Industries	Final Assy	1
21235	Emergency Descent (Valve Type)	Final Assy	1
22175	Caution, monofilled tires	Final Assy	4
21237	Grease Fitting	Final Assy	4
20896	Brake	Final Assy	1
20662	Plate, Patent no's - Booms	Final Assy	1
20661	Plate, ANSI A92	Final Assy	1
20660	Nameplate, ID	Final Assy	1
2020	Gasoline or Petrol	Final Assy	2
2017	Hydraulic System Fluid	Final Assy	1
2003	Battery Water Level	Final Assy	1
20409	STD Pedestal	Final Assy	1
20411	Blue Stripe Sq. Ends	Final Assy	5
20412	Blue Stripe Rnd Ends	Final Assy	1
20859	Caution, Aerial operating instructions	Aerial Control Box	1

DECAL P/N	DECAL DESCRIPTION 80C 6x4	LOCATION	QTY
22386	'D' Ring Attach Safety Belt	Final Assy	2
22117	80 MARKLIFT 80	Final Assy	2
21236	Marklift Boom	Final Assy	2
130820	Operating & Safety Handbook	Final Assy	1
181903	Decal 'C'	Final Assy	2
22385	Caution, Attach your safety belt	Final Assy	1
182103	Operation instruction & danger	Final Assy	1
181712	Close Cover	Final Assy	1
181104	Danger Rotating Fan	Final Assy	1
2022	Load Capacity 500 lbs	Final Assy	1

GENERAL DECALS

DECAL P/N	DECAL DESCRIPTION 100C	LOCATION	QTY
67804	Decal Set	All Standard Decals	1
182103	Operation Instr. Danger	Aerial Control Box	1
182707	Aerial Control Box	Aerial Control Box	1
21236	Marklift Boom	Final Assy	2
20409	Standard Pedestal	Final Assy	1
20410	Logo Mark Industries	Final Assy	1
20411	Blue Stripe Sq. Ends	Final Assy	4
20412	Blue Stripe Rd. Ends	Final Assy	1
2022	Load Cap. 500 lbs.	Final Assy	1
181102	Danger, Do not operate	Final Assy	2
181103	Danger, Obey the following	Final Assy	2
20419	Danger keep clear	Final Assy	3
20461	Forward arrow	Final Assy	1
20462	Forward arrow aft	Final Assy	1
20495	Emergency Grd. Controls	Final Assy	1
20896	Brake	Final Assy	1
22386	'D' Ring attach safety belt	Final Assy	2
21235	Emergency Descent (Valve type)	Final Assy	1
20508	Transportation	Final Assy	2
22910	100	Final Assy	2
2017	Hydraulic System Fluid	Final Assy	2
2033	Diesel Fuel Only	Final Assy	1
20859	Caution, Aerial Operating Instructions	Aerial Control Box	1
20860	General Checkout & Operating Instructions	Final Assy	1
21237	Grease Fitting	Final Assy	3
22175	Caution, Monofilled Tires Only	Final Assy	6

DECAL P/N	DECAL DESCRIPTION 100C	LOCATION	QTY
20660	Nameplate, ID	Final Assy	1
22739	6x4 4wd Booms	Final Assy	2
20662	Plate Patent Number Booms	Final Assy	1
20661	Plate, ANSI A92	Final Assy	1
181903	'C' (13" x 13")	Final Assy	2
24496	Reach Graph Marklift 100 6x4	Final Assy	1

The **MARKLIFT** may be towed for a distance no greater than one (1) mile at a speed not to exceed 8 mph. These instructions are for units equipped with a towing package.

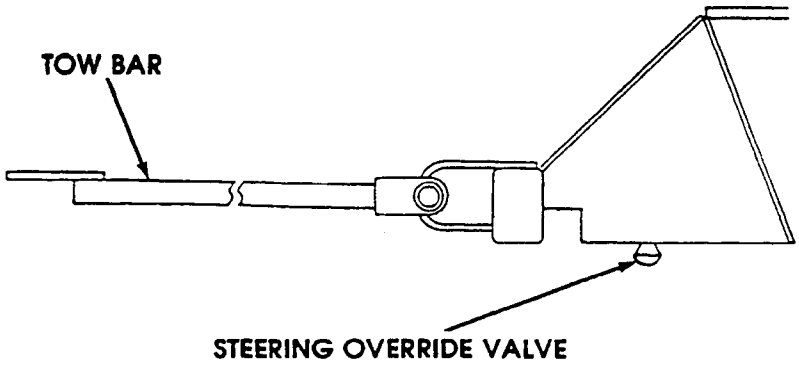
To tow the **MARKLIFT**:

1. Attach the tow bar from the **MARKLIFT** to the towing vehicle.

2. The torque hub **must** be disengaged.

   To disengage the torque hub, reverse the disconnect cap. The knob on the cap disengages the drive hub input shaft. **The brakes are also disengaged.**

3. The steering override valve **must** be pulled.



Caution: Brakes are disengaged.

Caution: Do not tow faster than 8 miles per hour.

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 supersede 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.

"EXTENSIBLE AND ARTICULATING BOOM PLATFORMS"

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

2. Only authorized persons shall operate an aerial lift.

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

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

5. A body belt shall be worn and a lanyard attached to the boom or basket when working from an aerial lift.

6. Boom and basket load limits specified by the manufacturer shall not be exceeded.

7. Articulating boom and extensible 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.

8. Climbers shall not be worn while performing work from aerial lift.

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

It shall be the responsibility of all **MARKLIFT** operators to read and act according to the following operating instructions. The purpose of these instructions are to promote safety and a better understanding of the functions of the **MARKLIFT** self-propelled boom.

DUAL FUEL SYSTEM

The 80c 4x4 and 80c 6x4 Booms are equipped with a dual fuel system which allows the operator to select gasoline or propane operation. The 3-position selector switch, located on the aerial control console, energizes solenoid valves which close one fuel line and open the other.

1. 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 running on propane and an attempt is made to start the machine using gasoline, more than normal cranking and battery drainage is required for the fuel pump to fill the lines and carburetor bowl with gasoline.

Turn the master switch at the ground control station to "ON". Position the selector switch to "Aerial". Enter the platform and **attach safety belt**. Pull open the red emergency stop switch cover located on the top right of the aerial control box. Pull down the toggle switch to the start position, **do not** depress the footswitch, when the engine starts, release the toggle switch.

Switching From Propane to Gasoline

With the engine running, step on the deadman footswitch and position the throttle switch to "HI" speed. Switch the fuel selector to gasoline. The engine will begin to stall as the carburetor bowl starts filling with gasoline. Switch back to propane until the engine resumes high speed. Switch back and forth from propane to gasoline until the engine is running smoothly on gasoline. (Do not stop at "OFF" position.)

Switching From Gasoline to Propane

With the engine running, step on the footswitch and position the throttle switch to "HI" speed. Set the 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 the throttle to "LOW" and release the footswitch. Let the engine idle for 20-30 seconds to completely burn up any remaining gasoline in the bowl.

2. DRIVE

Forward and reverse drive is achieved from the aerial control box only.

For the drive to function, the operator must use both the forward/reverse controller and the footswitch. The controller has a multi-axis and may be pushed in the desired direction.

3. STEERING

Steering the **MARKLIFT** is achieved by pressing the footswitch and operating the steering controller. While the engine is running, push the steering controller to the left or right to turn the wheels.

4. LIFT/LOWER

To raise or lower the boom from the ground control, set the selector switch to the "ground control" position, then push the toggle switch up or down.

To operate from the aerial control box, position the selector switch to the "Aerial" position. Raise or lower the platform by operating the "Lift/Lower" controller.

5. EXTENDING/RETRACTING

Extend or retract the boom from the ground control box by pushing the toggle switch in the direction desired.

To extend or retract the boom from the aerial control box, push the controller forward to extend or pull it back to retract.

6. TURRET ROTATION

The turret may be rotated from either the ground control or aerial control stations. Use the toggle switches at the ground control box and the controllers at the aerial control stations to rotate the turret in the desired direction.The turret may be rotated 360° continuously.

NOTE: As a safety feature, the "HI" throttle will not function if the boom is fifteen degrees above horizontal or if the boom is extended.

7. WARNING LIGHT AND BUZZER

As a special safety feature, the **MARKLIFT** is equipped with an "out-of- level" sensor that will disable the boom functions whenever the **MARKLIFT** is in an unsafe out-of-level position. An unsafe out-of-level condition is sensed by the level sensor when the machine is tilted 5° front to rear or 3° side to side.

The unsafe condition is indicated by a red warning light and buzzer, located on the top center of the aerial control box. When the warning light and buzzer are on, Lift/Lower, Extend/Retract, and Turret Rotation will not operate but the drive and steer functions will. Should the warning signals come on, maneuver the **MARKLIFT** until it is on a safe, level operating surface and all functions will be restored.

8. Engine Stopping

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

In Case of an Engine Failure Emergency, all boom hydraulic functions are operable with the emergency pump running. From the aerial platform, position the emergency pump switch to "ON". This will start the emergency pump. Continue normal operation by pressing the footswitch and moving the toggle switches in the desired direction of motion.

IMPORTANT: The aerial start switch must be set at the "ON" position in order for the emergency hydraulics to function. Emergency functions also apply to the ground control station.

The following preventive maintenance information is intended as a general guide. Please refer to the vendor section of this manual for detailed information on the engine, battery, etc.

MARK INDUSTRIES recommends that the following items be checked according to the schedules indicated. Any machine not in safe operating condition must be removed from service until it is repaired by a qualified service person.

DAILY (Before use on Each Work Shift)

1. Make sure that operation and safety decals are in place and readable.
2. Check the water level in the battery
3. Check for loose or worn hardware.
4. Check fuel level.
5. Make sure the operating controls perform correctly.
6. Check for and correct any hydraulic leaks.
7. Check for and correct any structural damage.
8. Check for wear on cables and hoses.

WEEKLY

1. Check the condition of the tires. Make sure they are free of serious cuts or defects.
2. Check that operation and safety decals are in place and readable.
3. Check for proper brake operation.
4. Make sure the battery is fully charged.

5. Clean unit by removing all dirt, oil, and grease. The machine may be washed with soap and water.

6. Check for and correct any hydraulic leaks.

7. Check for and correct any structural damage.

8. Check overall performance.

9. Check for wear on cables and hoses.

10. Check the air cleaner.

11. Check for proper hydraulic and engine oil level.

MONTHLY (or first 50 hours)

1. Check and lubricate, if necessary. (See lubrication instructions.)

2. Check battery condition.

3. Change the hydraulic oil return filter.

4. Grease ring gear, and rotation gear box worm gear.

5. Grease steering linkage.

6. Check and clean engine intake air cleaner.

7. Change engine oil filter.

8. Check torque hub oil filter.

9. Check retraction cables for proper tension:
   Extension - 22.0 ft lbs.
   Retraction - 22.0 ft lbs.

10. Check ring gear bolt for torque - 175 ft lbs. Turret, 85 ft lbs. base.

EVERY SIX MONTHS (or 100 hours)

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

EVERY YEAR

1. Re-pack all wheel bearings.
2. Change the hydraulic oil.
3. Change the hydraulic oil return filter.
4. Check the torque hub oil level.
5. Check the ring gear bolts for proper torque.
6. Change or clean air filter.

LUBRICATION INSTRUCTIONS

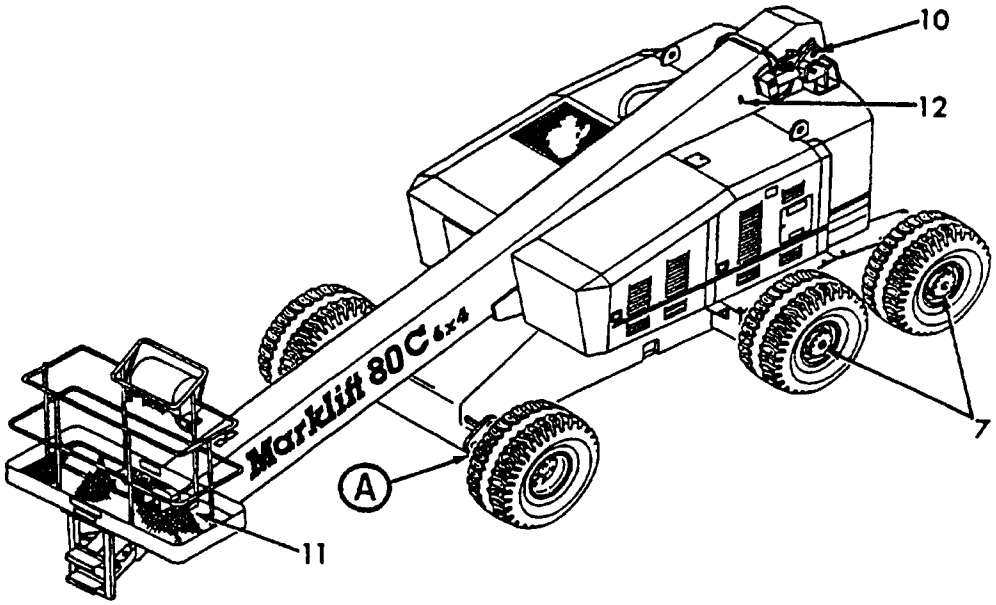
Item	Description*	Lubricant	Frequency
1	Rotation gear box bearing	Gear oil SAE EP 90	Monthly
2	Tie Rod Pin	Mobilcote Type - S Gear Grease	Monthly
3	Ring Gear	Mobilcote Type -S (4) Zerk Fittings Rotate Gear While Greasing	Monthly
4	Engine	SAE 30	See Wisconsin operating instructions (page 3 in Vendor Section)
5	Hydraulic Fluid	See Hydraulic Fluid Table	Clean yearly
6	Hydraulic Tank Strainer A-100-3	See Hydraulic Fluid Table	Clean yearly
7	Torque Hub	Type EP 90	Yearly
8	Hydraulic Tank Filter-UC-SE-1323		Clean yearly
9	Return Line Filter Element		Replace every 100 hours
10	Main Boom Pivot Pin	Mobilcote Type-S Gear Grease	Monthly
11	Extension sheaves Sheaves	Mobilcote Type-S Gear Grease	Monthly
12	Retraction Sheaves	Mobilcote Type-S Gear Grease	Monthly
13	Steering Yoke King Pins	Mobilcote Type-S Gear Grease	Monthly

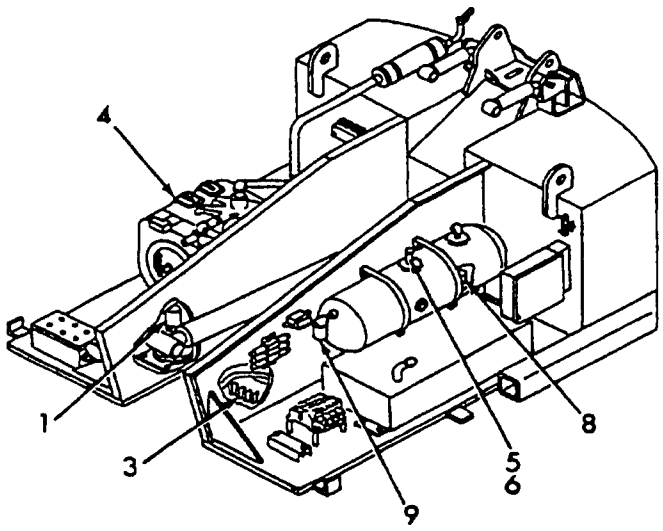
* See Following Page for Locations

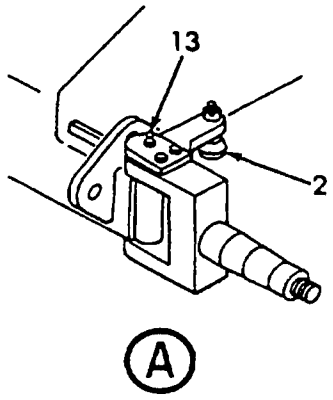
** Equivalent Bearing Grease: Union - Unoba EP-2, Shell - Alvinia EP-2

Lubrication Instructions

80C 4x4, 80C 6x4, 100C 6x4







Battery Fill Instructions

Water or Acid Loss to Batteries

Water loss from the battery is mainly due to evaporation brought on by temperature rises during heavy charging cycles. A very small amount of water is lost due to hydrogen and oxygen gases formed during charging. Acid is lost if the case becomes cracked or if the battery is allowed to tip over. Therefore, acid is seldom needed.

Checking the Water Level

When checking the water level, don't allow dirt to enter into the battery cells once the caps have been removed. Take particular care to avoid setting the caps down on a dirty surface. Replace the caps immediately after checking the water level.

Materials and Equipment Required

1. Battery Filler Bottle
2. Distilled Water (if available)
3. Hydrometer

Filling the Battery

Electric Scissor Lifts and Booms:
Use a hydrometer to see how much charge the battery has. A reading 1.260 and above in all cells indicates fully charged. (See chart on following page.) If the battery is fully charged, add water up to the level indicator.

If the battery's water level is far below the lead plates, add only enough water to barely cover the plates before charging. After the batteries are fully charged, add water up to the level indicator.

Gas or Diesel Scissor Lifts and Booms:
Gas and diesel powered machines have alternators that keep the batteries fully charged. For these units, add water to the level indicator.

Either excessive overcharge or moderate undercharge can shorten battery life. With proper attention to water level and charging time, compared to hydrometer readings, the batteries should give a long useful life.

TEMPERATURE/SPECIFIC GRAVITY CORRECTION TABLE FOR BATTERIES

ACTUAL HYDROMETER READING AT ACTUAL TEMPERATURE

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

Specific Gravity

Corrected to 80°F (17°C)	Freezing Temperature	
1,280	-90°F	-68°C
1.250	-62°F	-52°C
1.200	-16°F	-27°C
1.150	+ 5°F	-15°C
1.000	+19°F	- 7°C

Marklift Self-Propelled Boom
Model 80C 4x4, 80C 6x4, 100C 6x4

1. Type — EP 90

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

2. Oil Temperature

   Continuous — 160°F
   Intermittent — 200°F

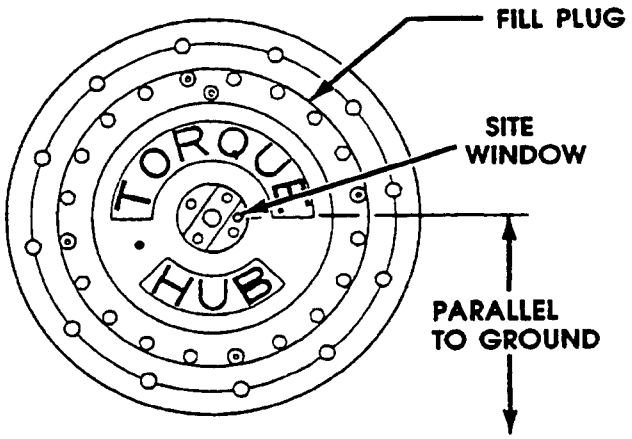
3. Oil Change

   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.

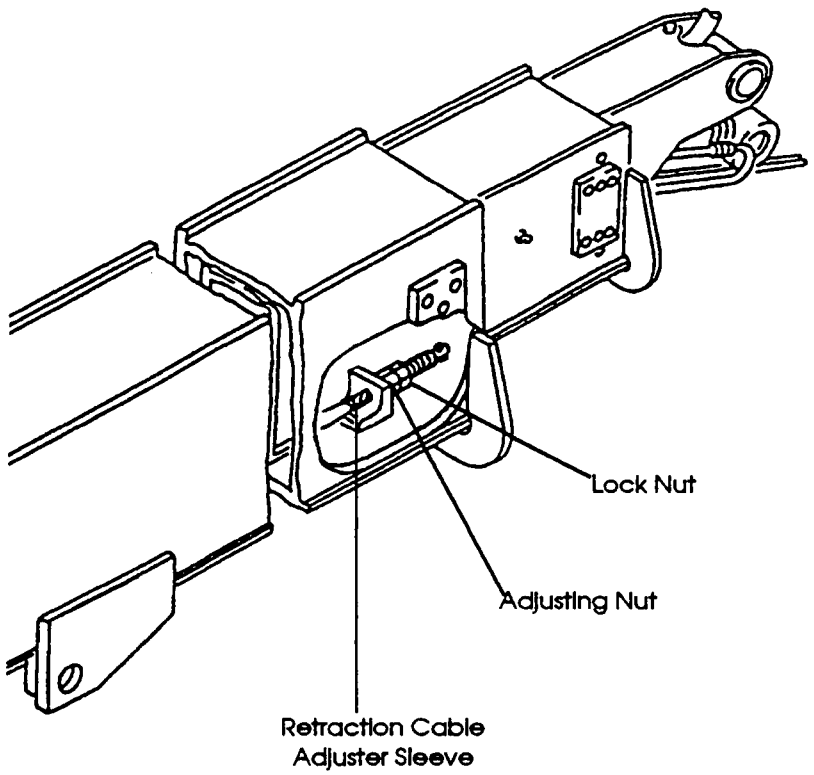
4. Oil Fill Level

   Unit mounted horizontal — half -full.
   Fill slowly to allow the air to escape.



Marklift Self-Propelled Boom
(Models 80C 4x4, 80C 6x4, 100C 6x4)

1. Elevate the boom until approximately horizontal above ground.
2. Extend the boom out approximately 3 to 4 feet.
3. It is necessary to have a crow's foot wrench or a special deep well socket.
4. Set torque wrench at 22.0 foot pounds.
5. Apply a few drops of oil or hydraulic fluid to the cable stud threads and nuts.
6. Loosen lock nut.
7. Tighten the adjusting nut until a torque of 22.0 foot pounds is registered.
8. Continue to extend the boom at one foot increments and torque the adjusting nut until the torque wrench registers ("releases") at 22.0 foot pounds. (The adjusting nut no longer turns on the adjuster sleeve.)
9. Tighten the lock nut when cable tensioning is completed.



Proportional Control Valve Operation

The following information will help the mechanic trouble shoot and make adjustments to the hydraulic system. It is the mechanic's responsibility to read and understand the given information.

The proportional control valve is comprised of four valve "segments" which provide individual control for each proportional function; drive (forward and reverse), boom (lift/lower and extend /retract), and turret rotation (right/left).

Flow from the hydraulic pump enters the valve at the inlet port of the inlet manifold and is introduced at the directional control spool of each valve segment across a "flow compensator valve". However, since no flow occurs across the valve spool until a function is operated, an internal passage inside the valve segment generates a pressure signal to the flow compensator causing it to be seated. Simultaneously, flow enters a parallel passage where it is directed across a 40 micron wire mesh screen or strainer, and encounters the "pilot relief valve". A proportionate amount of this flow is returned to the tank across the valve, thus generating a pilot pressure signal which is then supplied to the pilot valves.

The "pilot valves" are electromechanical valves which respond to a command signal generated by the electrical controller at the control station. Inside the pilot valve there is a plunger (which responds to the magnetic field generated by the valve coil whenever the controller is operated), a concave seat and a metering rod or needle. Operating the controller causes the plunger inside the pilot valve to lift off the concave seat which permits the seat to "snap" up off the metering rod or needle. This permits pilot flow to pass across an orifice in the valve seat (which is blocked by the metering rod when it is in contact with the seat), and through the pilot valve. This metered flow is directed through the valve segment into a "control" pasage for the directional control spool. Connected to the control passage is a tank return passage, pilot flow passing through the pilot valve is returned back to tank across a flow disc installed in the passage. This disc has a small orifice which meters the flow that is returned back to tank.

The rate at which the pilot valve opens and closes (the plunger releases the concave valve seat to permit it to lift up off the metering rod) determines the rate of flow through the pilot valve and into the control passage. As long as the valve is opened and closed at a minimum specific rate, the rate of flow into the control circuit is equal to the rate of flow

which can be returned to tank across the flow disc in the the tank return passage. Consequently there is no increase in pressure in the control passage. However as the controller is moved farther "on", the rate that the plunger releases the concave inlet disc, increases. This permits a greater volume of oil to pass across the valve and into the pilot valve body. This increased flow generates a pressure signal in the control passage (since only a finite amount of flow can be returned to tank across the flow disc at the base of the pilot valve in the tank return passage). This pressure signal is applied against the directional control spool and causes the spool to be "shifted" opposing a spring which normally maintains the spool in its centered state.

As the directional control spool is shifted off center, inlet flow from the pump is metered across tapered "lands" on the control spool and directed out the V1 or V2 ports, to the selected function. As the directional control spool shifts, a pressure drop occurs at the supply passage of the spool and results in a pressure "differential" across the flow compensator valve, this pressure difference causes the valve to open and regulates oil passed to the directional control spool based upon the difference in pressure created by the rate of flow out to the function being operated and the rate of flow being supplied by the pump. As flow out to the desired function encounters resistance, an internal passage parallel to the supply ports (V1 and V2) directs the corresponding pressure signal against a shuttle ball (located in the valve segment), which is connected in parallel to the other valve segments. This pressure signal is diverted by the shuttle ball out to the load sense port of the proportional control valve, where it is transmitted to the pump and instructs the pump to meet the flow requirements of the function being operated.

The speed at which the function operates is controlled by the metering effect across the valve spool (amount of shift determines the rate of flow), which is controlled by the operating rate (opening and closing) of the pilot valve. The load sense circuit is configured so that the pump receives the signal from whichever function has the highest flow requirement, even when multiple functions are selected.

Electrical System

The **MARKLIFT** electrical system is very straight forward and easy to trouble shoot because of 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 a proportional controller.

Whenever trouble shooting any problem, begin by checking the basics. This means checking to make sure that the batteries are in good shape and have at least a three quarter charge, determined by using a hydrometer and battery maintenance instructions. A large percentage of electrical problems are often due to poorly charged or defective batteries.

A. If a problem seems to be electrical, check the schematic, (see the SCHEMATIC chapter for more information) and use a volt/OHM meter to trace the power flow (electrical current) starting at the battery and continuing through the system until the problem is located.

B. Keep in mind, if you **DO NOT** have a good ground to a valve coil, relay, etc., then even if you have a proper electrical current to the coil or relay, the items will not function properly.

C. Diodes can be thought of as "One way electrical check valves" they permit current flow in one direction and stop it in the opposite direction.

D. The basic purpose of a relay is to remotely switch other electrical devices.

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 control console also contains a keyed ignition/start switch, as well as an engine stop switch, ammeter, and fuel gauge. When the selector switch is placed in the aerial position, the electrical source is routed to the aerial control box. The intent of the footswitch is to provide an additional safety

interlock in the control circuit to require foot as well as hand movement by the operator, thereby requiring maximum operator attention. The function of the footswitch only completes the electrical circuit to the aerial control console and engine throttle. **The footswitch is not directly connected to the drive braking system.**

The aerial control console is equipped with a controller and all 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 a proportional control valve for the drive function. The aerial control console contains an electrical controller complete with a manual lockout, for the drive function. The controller is spring-centered and is 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 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 low speed. This is accomplished through two limit switches sensing the altitude and extension positions of the boom, wired in series to a relay which connects the controller signal to a variable resistor (or potentiometer) that is connected to the ground and is parallel to the solenoid coil. This drains off some of the drive signal, limiting the speed when the machine is extended or raised above horizontal.

ENGINE

1. Unit will not start or run.

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

2. Unit dies under load.

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

3. Unit will not go into "HI" speed.

   A. Check the aerial HI/LO selector switch.
   B. Check the throttle solenoid valve.
   C. Check the linkage on the hydraulic or electric throttle.
   D. Refer to your local service facility.

4. Unit will not idle.

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

HYDRAULIC DRIVE MOTOR

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

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

Hydraulic Pump

Pump producing excessive noise.

A. Check hydraulic oil level (sight gauge on tank.)
B. Check oil. See hydraulic fluid table.
C. Check suction hose from tank to pump for kinks.
D. Check reservoir hydraulic oil level gauge.
E. Refer to your local service facility.

Lift

1. Functions will not operate from aerial control console.

A. Check Aerial/Ground selector switch.
B. Check footswitch continuity.
C. Check for loose wire in aerial control box.
D. Refer to your local service facility.

2. Functions will not operate from ground control box.

A. Check position of "Aerial/Ground" box selector switch.
B. Check the flow control needle supply pressure to the solenoid valve.
C. Refer to your local service facility.

Drive

Low torque drive.

A. Make sure hydraulic system is up to recommended pressure.
B. Check for extended or raised boom.
C. Refer to your local service facility.

Brakes

No brakes or low pressure.

A. Check the drive hub disengagement caps.
B. Check brake delay valve.
C. Refer to your local service facility.

HYDRAULIC FLUID TABLE

Milestone			Hydraulic fluid			
Oil company			Chevron	Gulf	Shell	Union
Brand Name			ATF Dextron II	ATF Dextron II	Donaz-T6	ATF Dextron
Viscosity	SUS AT 100°F (37.8°C)		187.4	195	200	200
	SUS AT 210°F (98.9°C)		49.2	50.4	50	52.3
	Index	°F	153°	155°	160°	172°
		°C	67.2°	68.3°	71.1°	77.8°
Flash point		°F	400°	405°	390°	395°
		°C	204.4°	207.2°	198.9°	201.7°
Pour point		°F	-40°	-50°	-50°	-45°
		°C	-40°	-45.6°	-45.6°	-42.8°

Mark Industries

MARKLIFT SERVICE MAINTENANCE CHECKLIST

MODEL NUMBER ______________ SERIAL NUMBER ______________ DATE SOLD ______________

DATE IN SERVICE ______________ OPTIONS ______________ WARRANTY PERIOD ______________

(shaded box) APPLIES TO MODELS WITH ENGINES ONLY

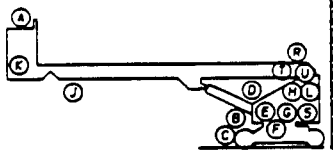
CODE:
C – CHECKED
A – ADJUSTED
R – REPAIRED
N – NEW PART
X – NEEDS REPAIR

Group	Items
PREVENTIVE MAINT.	OIL CHANGE, OIL FILTER, AIR FILTER, HYDRAULIC OIL CHANGE, HYDRAULIC OIL FILTER, WHEEL BEARING PACK, DRIVE MOTOR, PUMP MOTOR BRUSHES, ELECTRICAL CONTROLS, TRANS/DIFF OIL CHANGE
ELECTRICAL	TUNE UP SPARK PLUGS, GENERATOR, VOLTAGE REGULATOR, BATTERY, STARTER, POINTS / CONDENSER
HYDRAULIC	HYDRAULIC SYSTEM, LEV CYLINDER, LIFT CYLINDER SEALS, HYD CONTROL VALVE, HYDRAULIC PUMP, ROTARY MANIFOLD, LIFT ROLLERS, HYDRAULIC HOSES
	BRAKES
FUEL	FUEL SYSTEM, CARBURATOR, FUEL PUMP
STEER	STEERING, STEERING HOSES, STEER GEAR, STEER CYLINDER
TIRE	DRIVE TIRES, STEER TIRES
MAJ.	ENGINE OVERHAUL, DRIVE AXEL OVERHAUL
MISC.	

DATE	REMARKS	DATE	REMARKS	AGENCY

REV

ELECTRICAL SCHEMATIC-DEUTZ-100C 6X4-24302



ID	DESCRIPTION.	LOCATION
A	UPPER CONTROL BOX.	PLATFORM
B	LIMIT SWITCH # 1.	TURRET
C	NON-PROPORTIONAL VALVE.	CARRIAGE
D	PROPORTIONAL VALVE.	TURRET
E	EMERGENCY PUMP/MOTOR.	TURRET
F	GROUND CONTROL PANEL.	TURRET
G	BATTERIES.	TURRET
H	ENGINE.	TURRET
J	LIMIT SWITCH #2.	BOOM
K	FOOT SWITCH.	PLATFORM
L	POWER RELAY.	TURRET
M	SLOPE SENSOR.	TURRET

ID	DESCRIPTION.	LOCATION
N	AC. GENERATOR.	TURRET.
P	HORN.	TURRET
R	BEACON.	TURRET
S	HOURMETER.	TURRET
T	LIMIT SWITCH #3.	TURRET
U	LIMIT SWITCH #4.	TURRET

WIRING SCHEDULE

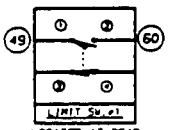
NO.	AWG	A	B	C	D	E	F	G	H	J	K	L	M	N
1	1						●							
1	12	●			●		●					●		
2	12	●					●					●		
3	12	●					●					●		
4	12	●					●							
5	12	●					●	S	P	A	R	E		
6	12	●					●	S	P	A	R	E		
7	18	●					●		●					
8	18	●					●		●					
9	18	●					●		●					
10	18	●					●							
11	18	●					●					●		
12	18	●		●			●							
13	18	●		●			●							
14	18	●		●			●							
15	18	●		●			●							
16	18	●			●		●							
17	18	●			●		●							
18	18	●			●		●							
19	18	●			●		●							
20	18	●			●		●							
21	18	●			●		●							
22	18	●			●		●							
23	18	●			●		●							
24	18	●					●		●					
25	18	●					●	S	P	A	R	E		
26	18	●				●	●							
27	18	●					●							
28	18	●					●							
29	18	●					●							
30	18	●					●							
31	18	●		●			●							
32	18	●		●			●							
33	18	●					●			●				
34	18	●					●	S	P	A	R	E		
35	18	●					●	S	P	A	R	E		
36	18	●					●	S	P	A	R	E		
37	18	●					●	S	P	A	R	E		
38	12	●					●							
39	12	●					●							
40	12	●					●							
41	18						●					●		

WIRING SCHEDULE

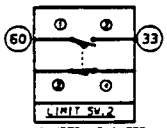
NO.	AWG	A	B	C	D	E	F	G	H	J	K	L	M	N	T	U
44	18						●									
45	18						●									
48	18					●										
49	18		●				●					●	●			
51	18						●						●			
52	18						●									
53	18						●		●			●				
55	12						●									
55	1					●		●	●							
56	18	●														
59	18								●							
60	18		●							●						
63	12						●									
64	12						●									
66	18						●									
67	12						●									
68	12						●		●							
69	12						●									
70	18	●									●					
72	18						●					●				
79	18								●							
80	18						●									
81	18						●									
82	18					●	●									
83	18					●	●									
84	18					●	●									
85	18					●	●									
86	18					●	●									
87	18					●	●									
88	18					●	●									
89	12						●									
99	12						●								●	●

NOTES:

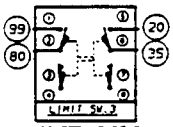
1. USE 1 AMP. 400V. MINIMUM DIODE.
2. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 20802.
3. ALL WIRES ARE 18 AWG. UNLESS OTHERWISE SPECIFIED.
4. USE 6A. 200V. DIODE P/N 4045.
5. WIRING SHOWN IN STOWED POSITION.
6. ALL WIRES FOR 110 A.C. ARE 12 AWG.
7. IDENTIFY EACH WIRE BY NUMBER FLAG AT THE ENDS WRAPPING COMPLETELY AROUND.
8. FOR 110V AC GEN. OPTION SEE DWG #24452.



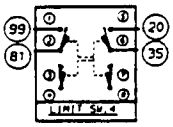
LOCATED AT REAR BOOM MOUNTING BRACKET. (BOTTOM) OPENS 15° AND ABOVE



MOUNTED AT INTERMEDIATE INNER BOOM. (BOTTOM) OPEN WHEN EXTENDED MORE THAN 1 FOOT

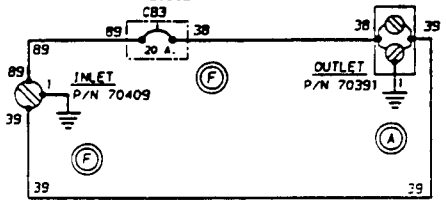


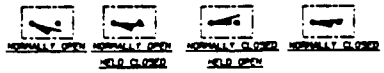
LOCATED AT REAR BOOM MOUNTING BRACKET. (RIGHT SIDE.) CLOSES WHEN OUTER-INTERMEDIATE TUBE IS RETRACTED



LOCATED AT THE CAR. ACTUATED FROM 55° TO 75° P/N 70468

CIRCUIT BREAKER
P/N 20562





LEGEND FOR LIMIT SWITCHES.

110 A.C. WIRING.



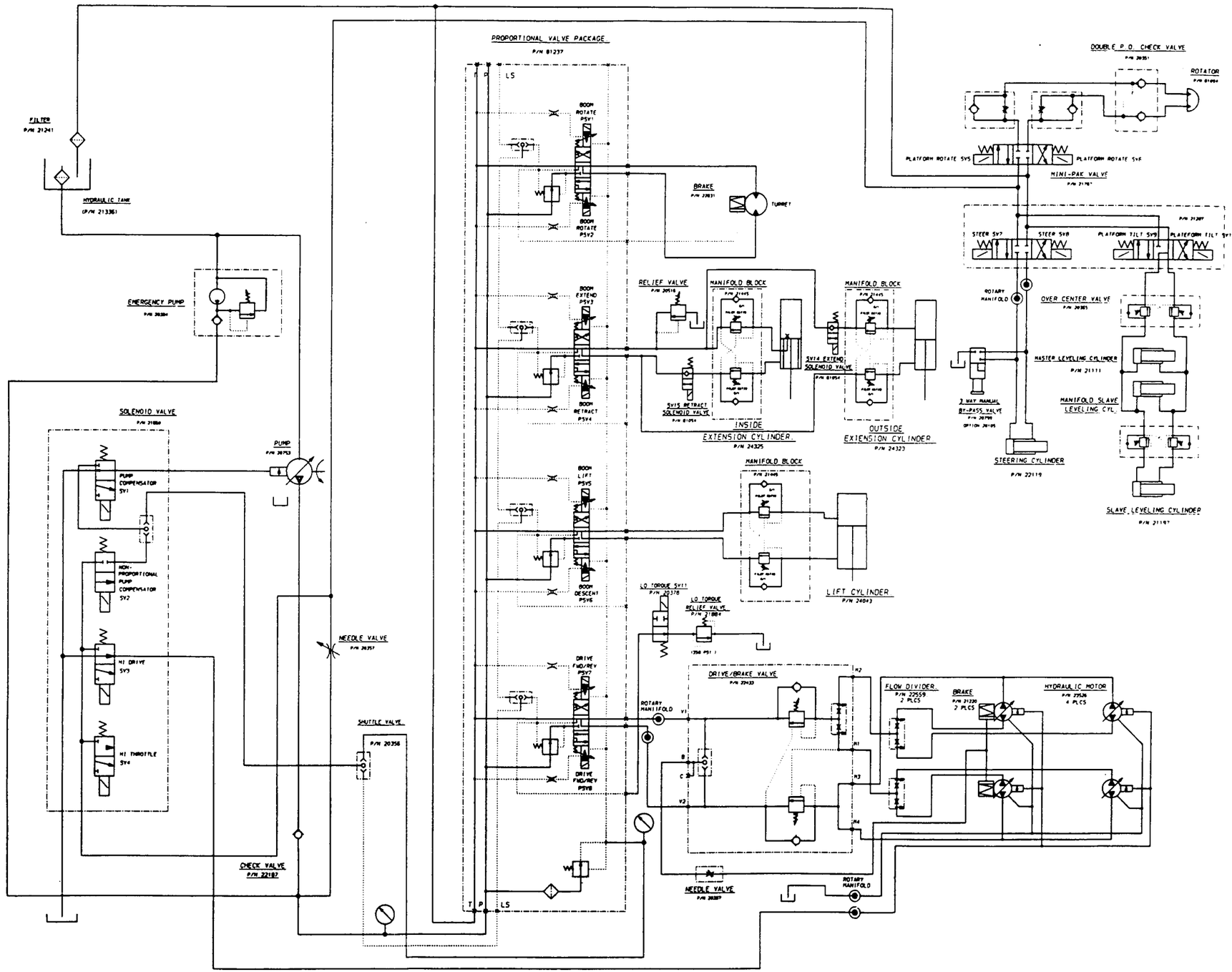
STARTER RELAY 1
P/N 70880.

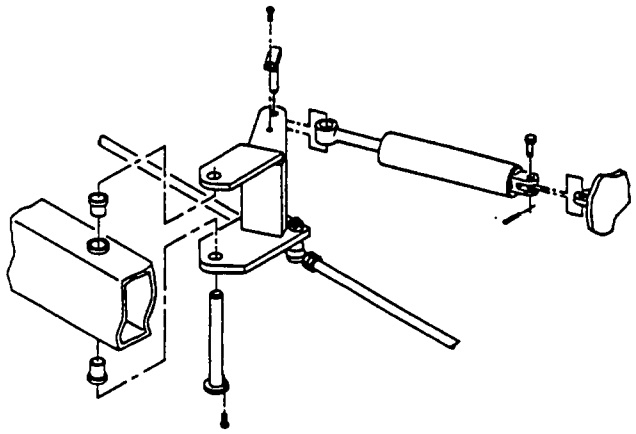


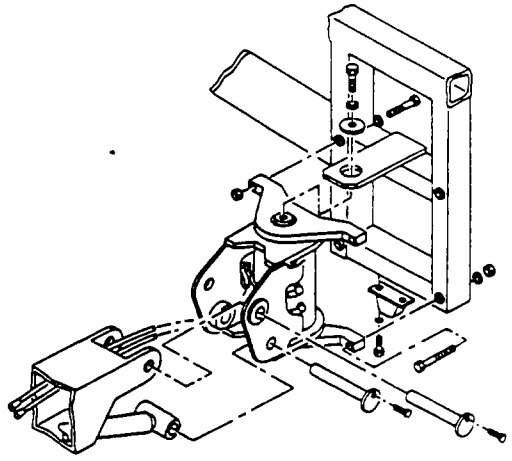
PUMP COMPENSATOR RELAY
P/N 70880.



EMERGENCY P. RELAY 6
P/N 70880.

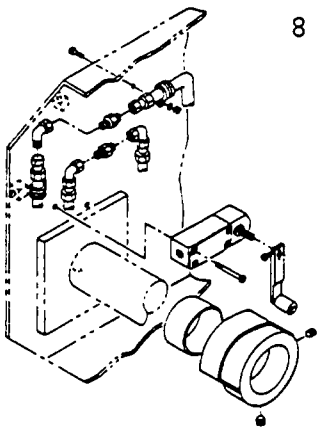

PROPORTIONAL VALVE PACKAGE
P/N 81237
P
LS
BOOM ROTATE PSV1
BOOM ROTATE PSV2
BOOM EXTEND PSV3
BOOM RETRACT PSV4
BOOM LIFT PSV5
BOOM DESCENT PSV6
DRIVE FWD/REV PSV7
DRIVE FWD/REV PSV8
BRAKE
P/N 23831
TURRET
RELIEF VALVE
P/N 20516
MANIFOLD BLOCK
P/N 21495
SV15 RETRACT SOLENOID VALVE
P/N 81054
INSIDE EXTENSION CYLINDER
P/N 24325
SV14 EXTEND SOLENOID VALVE
P/N 81054
MANIFOLD BLOCK
P/N 21495
OUTSIDE EXTENSION CYLINDER
P/N 24323
MANIFOLD BLOCK
P/N 21495
LIFT CYLINDER
P/N 24043
LO TORQUE SV11
P/N 20378
LO TORQUE RELIEF VALVE
P/N 21884
1250 PSI
DOUBLE P.O. CHECK VALVE
P/N 20351
ROTATOR
P/N 81054
PLATFORM ROTATE SV5
PLATFORM ROTATE SV6
MINI-PAK VALVE
P/N 21787
P/N 21289
STEER SV7
STEER SV8
PLATFORM TILT SV9
PLATFORM TILT SV10
ROTARY MANIFOLD
OVER CENTER VALVE
P/N 20385
MASTER LEVELING CYLINDER
P/N 21111
MANIFOLD SLAVE LEVELING CYL.
3 WAY MANUAL BY-PASS VALVE
P/N 20795
OPTION 20195
STEERING CYLINDER
P/N 22119
SLAVE LEVELING CYLINDER
P/N 21187
FILTER
P/N 21241
HYDRAULIC TANK
(P/N 213361
EMERGENCY PUMP
P/N 20284
SOLENOID VALVE
P/N 21886
PUMP
P/N 20753
PUMP COMPENSATOR SV1
NON-PROPORTIONAL PUMP COMPENSATOR SV2
HI DRIVE SV3
HI THROTTLE SV4
NEEDLE VALVE
P/N 20357
SHUTTLE VALVE
P/N 20356
CHECK VALVE
P/N 22187
T P LS
DRIVE/BRAKE VALVE
P/N 20433
ROTARY MANIFOLD
NEEDLE VALVE
P/N 20357
FLOW DIVIDER
P/N 22559
2 PLCS
BRAKE
P/N 21220
2 PLCS
HYDRAULIC MOTOR
P/N 22526
4 PLCS
ROTARY MANIFOLD

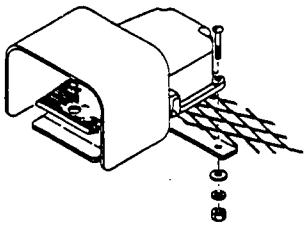


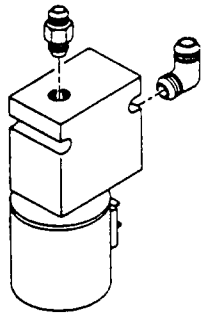


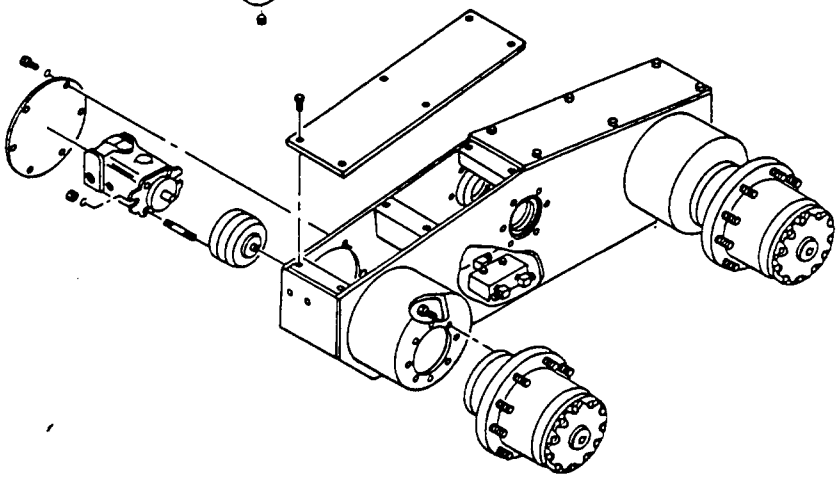
THIS SECTION 1 CONTAINS THE FOLLOWING MATTER:

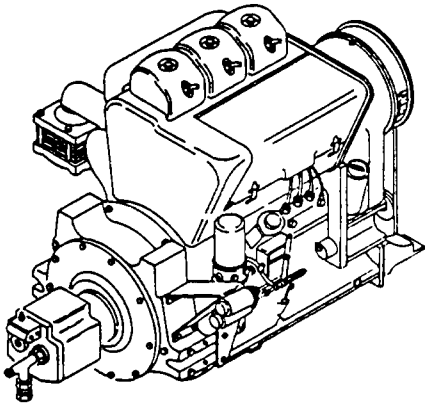
PAGE NO.	TITLE
1	TABLE OF CONTENTS
5	HOW TO USE PARTS CATALOG
8	HOW TO ORDER PARTS











SECTION 1	THE MARKLIFT PARTS CATALOG
PAGE NO.	TITLE
1	TABLE OF CONTENTS
4	HOW TO USE PARTS CATALOG
7	HOW TO ORDER PARTS

SECTION 2	FINAL ASSEMBLY
FIG. NO.	TITLE
1	FINAL ASSEMBLY (80C 4X4)
1A	FINAL ASSEMBLY (80C 6X4)
1B	FINAL ASSEMBLY (100C 6X4)
2	DECAL SET (80C 4X4)
2A	DECAL SET (80C 6X4)
2B	DECAL SET (100C 6X4)
3	AERIAL CONTROL BOX ASSEMBLY (ALL MODELS)
3A	AERIAL CONTROL BOX MULTI-AXIS CONTROL
3B	AERIAL CONTROL BOX MULTI-AXIS CONTROL
3C	AERIAL CONTROL BOX SINGLE-AXIS CONTROL
4	SHEET METAL KIT (ALL MODELS)
5	HYDRAULIC HOSE DIAGRAM (80C 4X4)
5A	HYDRAULIC HOSE DIAGRAM (80C 6X4)
5B	HYDRAULIC HOSE DIAGRAM (100C 6X4)
6	SLIDE BAR ASSEMBLY (ALL MODELS)
7	FOOT SWITCH ASSEMBLY (ALL MODELS)
8	PLATFORM ROTATOR ASSEMBLY (ALL MODELS)
8A	PLATFORM ROTATOR (ALL MODELS)

SECTION 3	CARRIAGE ASSEMBLY
FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY (80C 4X4)
1A	CARRIAGE ASSEMBLY (80C 6X4)
1B	CARRIAGE ASSEMBLY (100C 6X4)
2	WALKING BEAM ASSEMBLY (80C & 100C 6X4)
2A	WALKING BEAM SUB-ASSEMBLY (80C & 100C 6X4)
3	FLOW DIVIDER ASSEMBLY (ALL MODELS)

SECTION 3	CARRIAGE ASSEMBLY (CONT'D)
FIG. NO.	TITLE
4	DRIVE/BRAKE VALVE ASSEMBLY (ALL MODELS)
5	STEERING CYLINDER ASSEMBLY (ALL MODELS)
6	TIRE & RIM ASSEMBLY (ALL MODELS)
7	BRAKE ASSEMBLY (ALL MODELS)
8	TIE ROD ASSEMBLY (80C 6X4 & 100C 6X4)
9	DRIVE MOTOR ASSEMBLY (ALL MODELS)
10	TORQUE HUB (ALL MODELS)
10A	TORQUE HUB (80C & 100C 6X4)

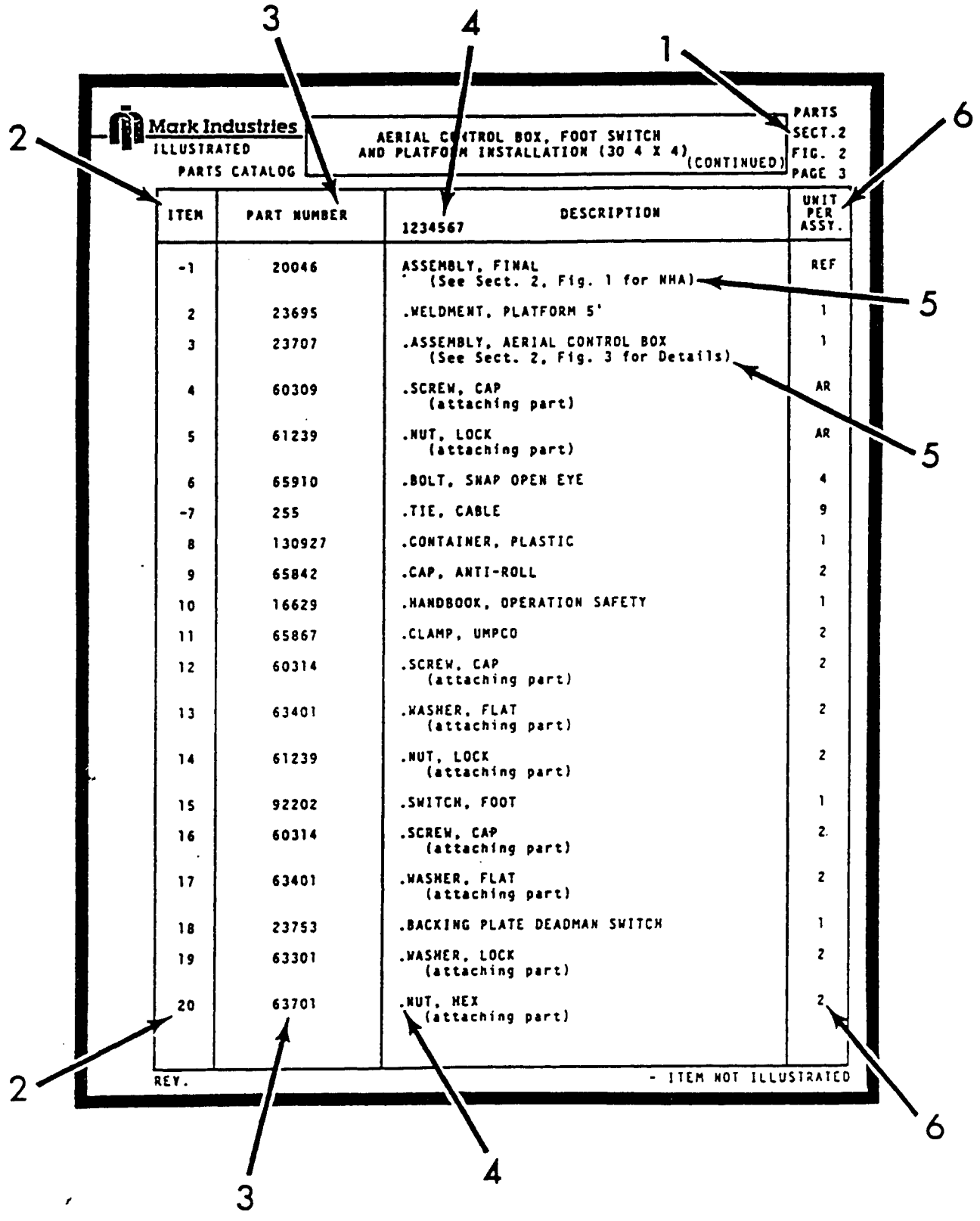
SECTION 4	TURRET ASSEMBLY
FIG. NO.	TITLE
1	TURRET ASSEMBLY (80C 4X4 & 6X4)
1A	TURRET ASSEMBLY (100C 6X4)
2	FUEL TANK ASSEMBLY (80C 4X4 & 6X4)
2A	DIESEL FUEL TANK ASSEMBLY (100C 6X4)
3	PROPORTIONAL VALVE ASSEMBLY (ALL MODELS)
4	HYDRAULIC TANK ASSEMBLY (80C 4X4 & 6X4)
4A	HYDRAULIC TANK ASSEMBLY (100C 6X4)
5	EMERGENCY DESCENT VALVE ASSEMBLY (80C 4X4 & 6X4)
6	GROUND CONTROL BOX ASSEMBLY (ALL MODELS)
7	MINIPAK ASSEMBLY (80C 4X4 & 6X4)
7A	MINIPAK ASSEMBLY (100C 6X4)
8	RELIEF VALVE ASSEMBLY (ALL MODELS)
9	DUAL OVERCENTER VALVE (ALL MODELS)
10	DUMP VALVE ASSEMBLY (ALL MODELS)
11	ROTATION GEARBOX ASSEMBLY (ALL MODELS)
11A	ROTATION GEARBOX BRAKE
11B	ROTATION GEARBOX HYDRAULIC MOTOR
12	ROTARY MANIFOLD ASSEMBLY (ALL MODELS)
13	ENGINE & PUMP ASSEMBLY (80C 4X4 & 6X4)
13A	ENGINE & PUMP ASSEMBLY (100C 6X4)
13B	ENGINE PUMP (ALL MODELS)
14	SOLENOID VALVE ASSEMBLY (ALL MODELS)

SECTION 4	TURRET ASSEMBLY (CONT'D)
FIG. NO.	TITLE
14A	SOLENOID VALVE ASSEMBLY (100C 6X4)
15	MASTER LEVELING CYLINDER ASSEMBLY (ALL MODELS)
16	LIFT CYLINDER ASSEMBLY (ALL MODELS)
17	EMERGENCY PUMP & MOTOR ASSEMBLY (ALL MODELS)
18	TORQUE HUB (ALL MODELS)

SECTION 5	BOOM ASSEMBLY
FIG. NO.	TITLE
1	FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)
1A	FINAL BOOM ASSEMBLY (100C 6X4)
2	INTERMEDIATE BOOM ASSEMBLY (80C 4X4 & 6X4)
2A	OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)
3	INNER BOOM ASSEMBLY (80C 4X4 & 6X4)
3A	INNER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)
4	INNER BOOM SUB-ASSEMBLY (100C 6X4)
5	BOOM EXTENSION CYLINDER ASSEMBLY (80C 4X4 & 6X4)
5A	BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)
5B	OUTSIDE BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)
6	SLAVE LEVELING CYLINDER ASSEMBLY (ALL MODELS)
7	CABLE SHEAVE ASSEMBLY (80C 4X4 & 6X4)
7A	CABLE SHEAVE ASSEMBLY (100C 6X4)
8	PLASTITRAK SUPPORT ROLLER ASSEMBLY (ALL MODELS)
8A	PLASTITRAK ASSEMBLY (100C 6X4)

SECTION 6	OPTIONS
FIG. NO.	TITLE
1	DUAL FUEL
2	TRAVEL WARNING HORN
3	ALL MOTION ALARM
4	ROTATING BEACON
5	(2) HEADLIGHTS & (2) REAR RED LIGHTS
6	STOP, TURN & CLEARANCE LIGHTS
7	12 VOLT PLATFORM WORK LIGHT

SECTION 6	OPTIONS (CONT'D)
FIG. NO.	TITLE
8	½" AIRLINE TO PLATFORM
9	½" HYDRAULIC LINE TO PLATFORM
10	SPARK ARRESTOR MUFFLER
11	CATALYTIC CONVERTER
12	2000 WATT GENERATOR
13	2500 WATT GENERATOR
14	HOSTILE ENVIRONMENT PACKAGE
15	TOW PACKAGE (8 MPH "IN-PLANT")
16	F3L912 DEUTZ DIESEL ENGINE
17	NISSAN DIESEL ENGINE
18	65 HP WISCONSIN GAS ENGINE



Mark Industries
ILLUSTRATED
PARTS CATALOG

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

PARTS SECT. 2
FIG. 2
PAGE 3

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

REV. - ITEM NOT ILLUSTRATED

1. This area refers to the corresponding illustration.

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

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

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

2. The **Item Number** corresponds to the item number shown for the part in the illustration. (Parts with item numbers preceded by a dash are not illustrated such as -1, -7, etc.)

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

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

   1 2 3 4 5 6 7

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

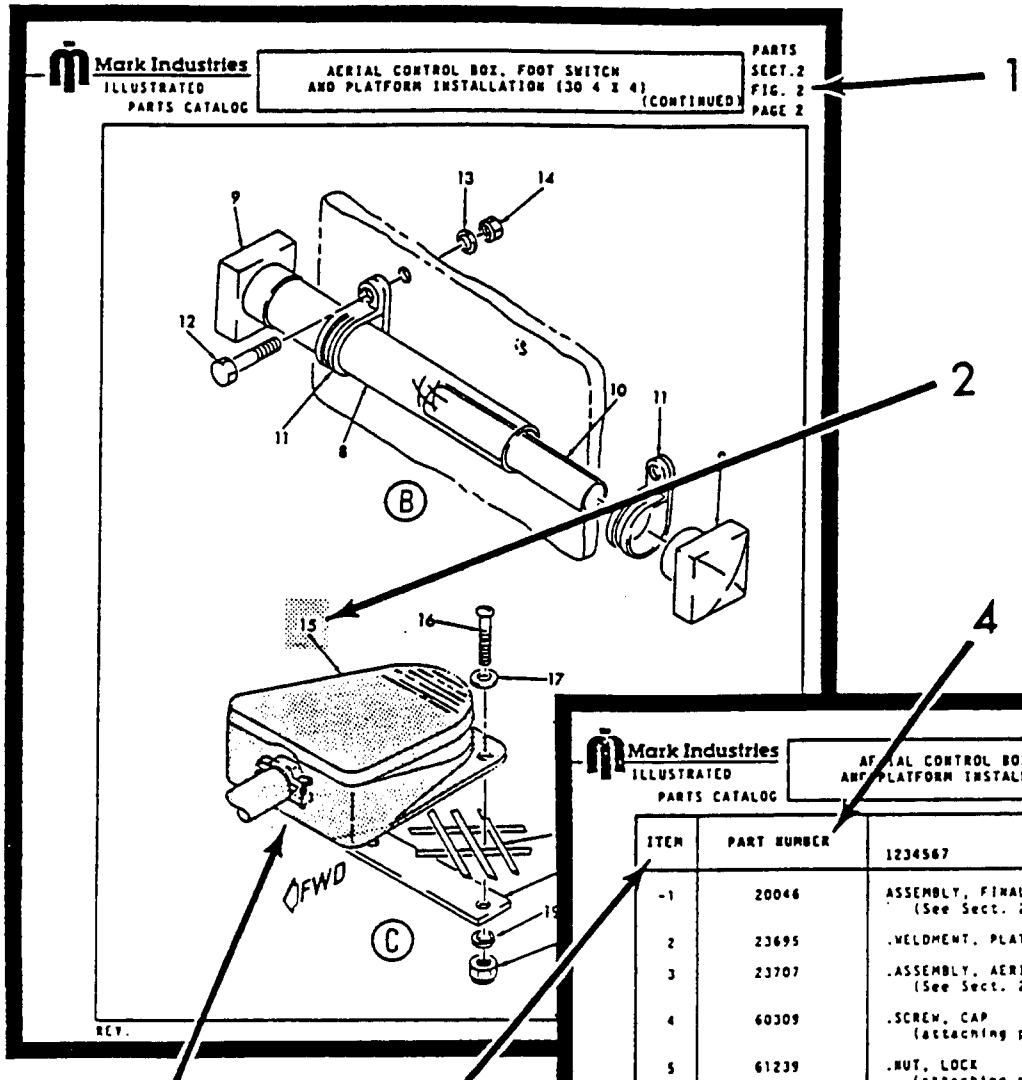
5. **NHA** (Next Higher Assembly) and **DETAILS** - Section and Figure reference catalog location indicates where the installation or assembly is listed under NHA and where illustrated for more detailed breakdown.

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

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

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

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



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

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

REV. - ITEM NOT ILLUSTRATED

1. PART NUMBER

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

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

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

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

2. TO ORDER:

By Phone: Service Department

(800) 448-MARK

or

(714) 879-MARK

By Fax: (714) 879-8884

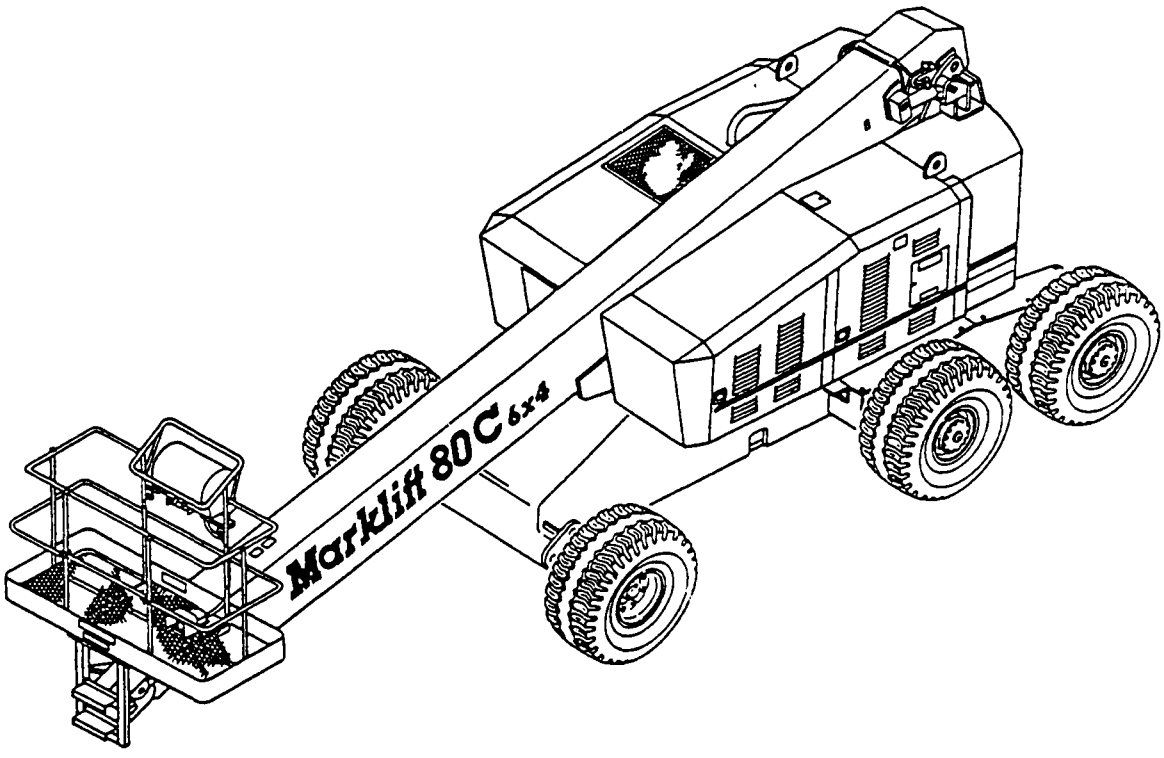
By Mail: Attention Service Department

MARK INDUSTRIES
Post Office Box 2255
Brea, California 92622

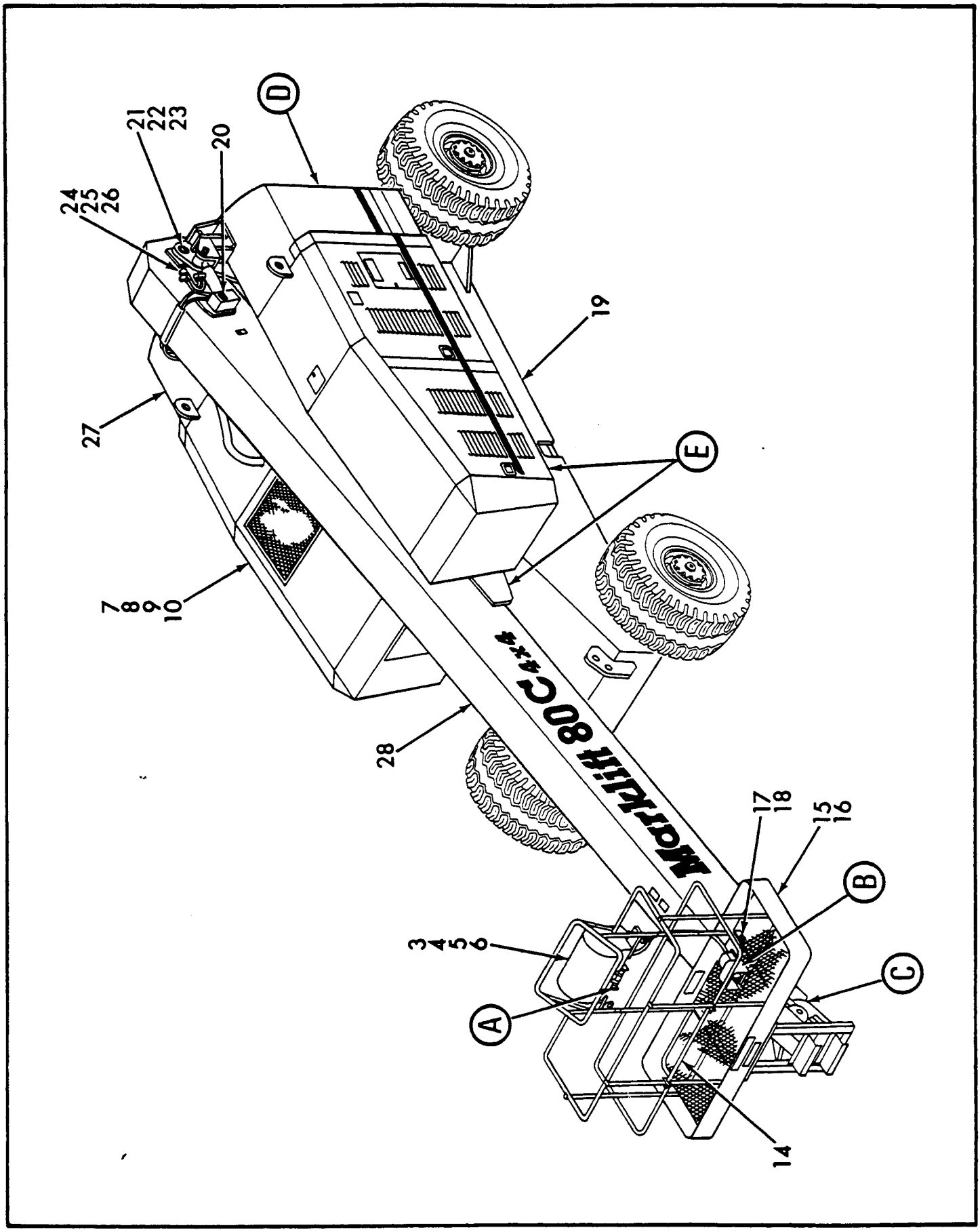
MARK INDUSTRIES
P.O. Box 2255
Brea, California 92622
205 South Puente Street, Brea, California 92621
(714)879-6275, FAX (714)879-8885

SECTION 2 CONTAINS:

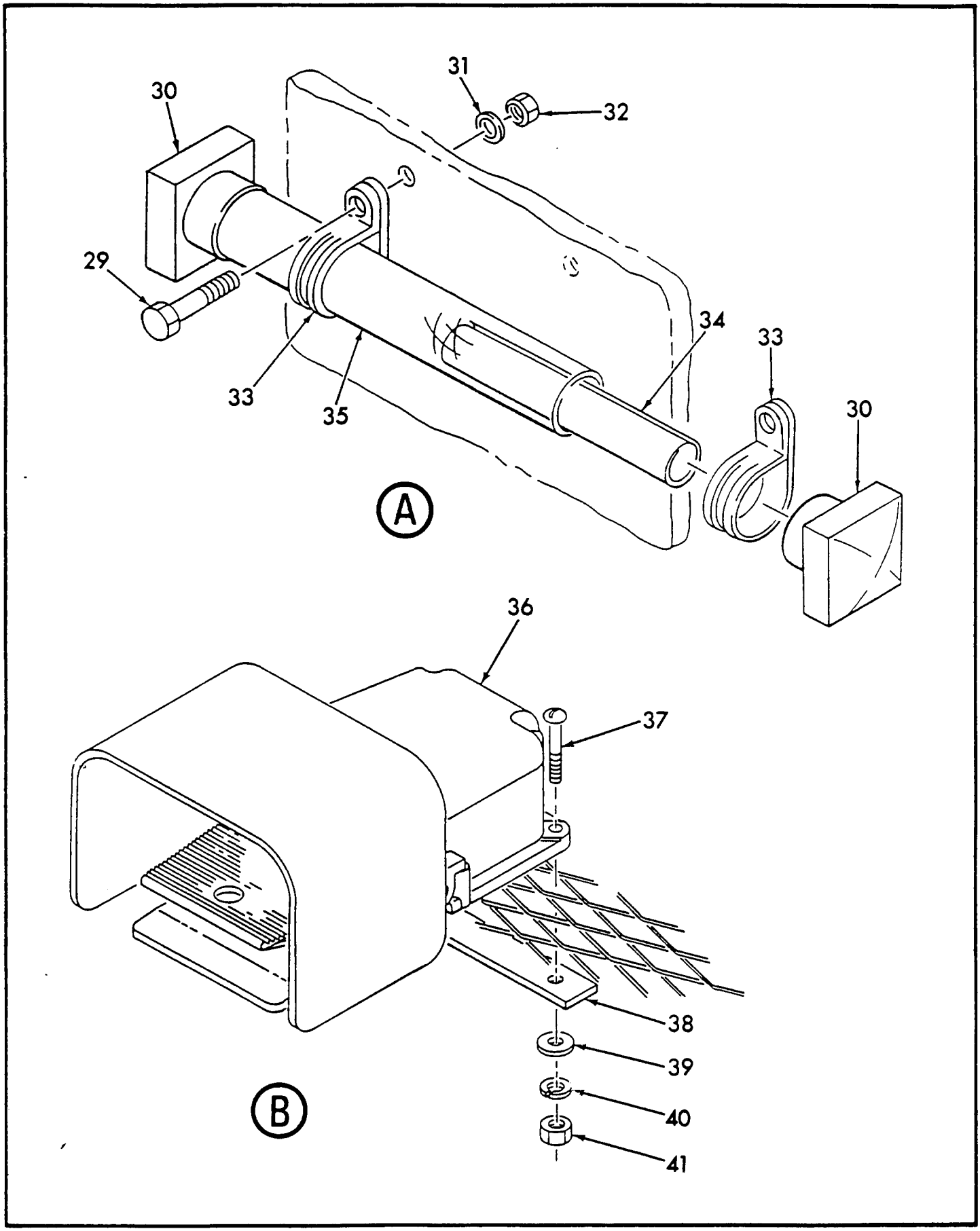
FIG. NO.	TITLE
1	FINAL ASSEMBLY (80C 4X4)
1A	FINAL ASSEMBLY (80C 6X4)
1B	FINAL ASSEMBLY (100C 6X4)
2	DECAL SET (80C 4X4)
2A	DECAL SET (80C 6X4)
2B	DECAL SET (100C 6X4)
3	AERIAL CONTROL BOX ASSEMBLY (ALL MODELS)
3A	AERIAL CONTROL BOX MULTI-AXIS CONTROL
3B	AERIAL CONTROL BOX MULTI-AXIS CONTROL
3C	AERIAL CONTROL BOX SINGLE-AXIS CONTROL
4	SHEET METAL KIT (ALL MODELS)
5	HYDRAULIC HOSE DIAGRAM (80C 4X4)
5A	HYDRAULIC HOSE DIAGRAM (80C 6X4)
5B	HYDRAULIC HOSE DIAGRAM (100C 6X4)
6	SLIDE BAR ASSEMBLY (ALL MODELS)
7	FOOT SWITCH ASSEMBLY (ALL MODELS)
8	PLATFORM ROTATOR ASSEMBLY (ALL MODELS)
8A	PLATFORM ROTATOR (ALL MODELS)



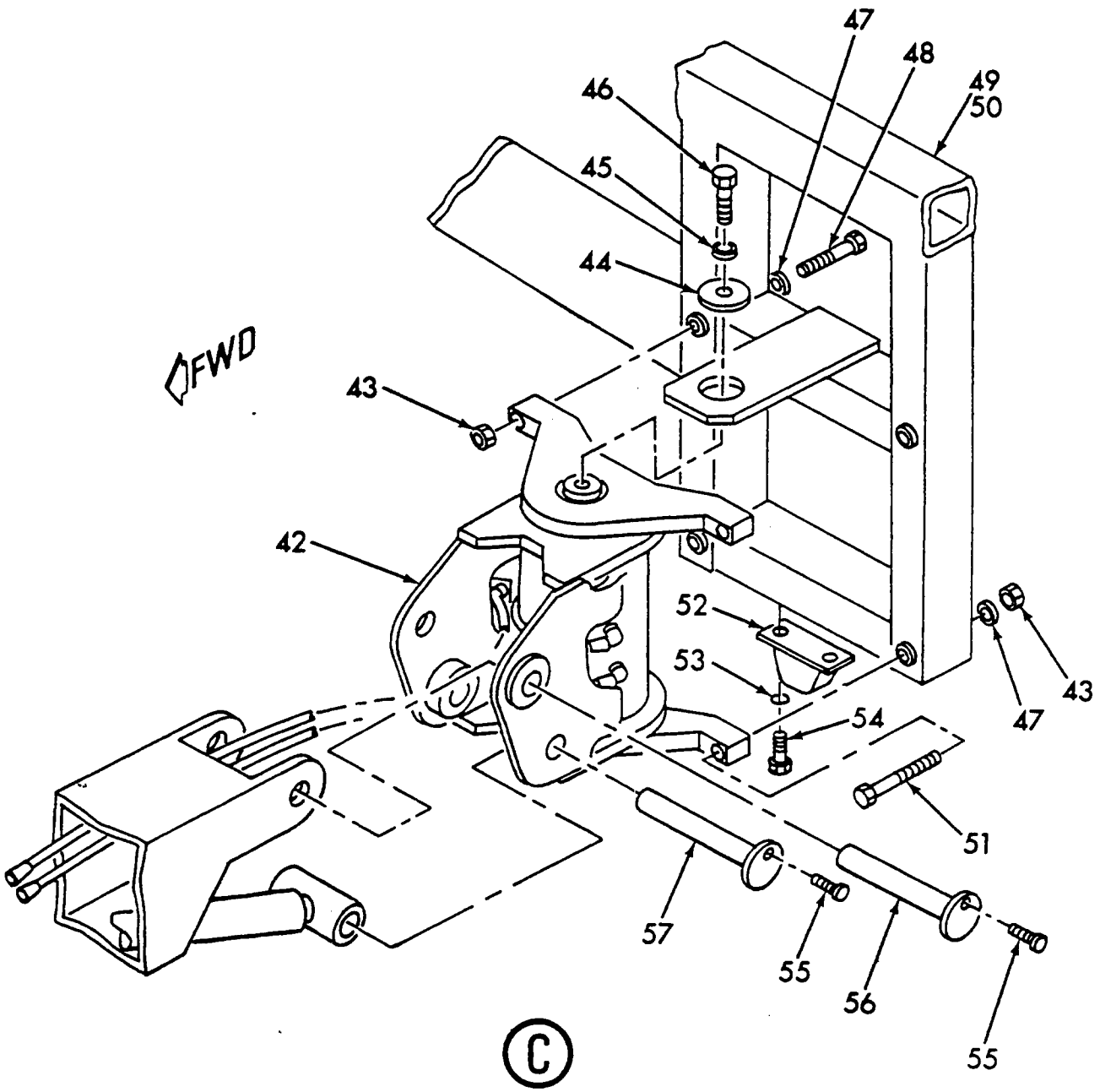
FINAL ASSEMBLY (80C 4X4)

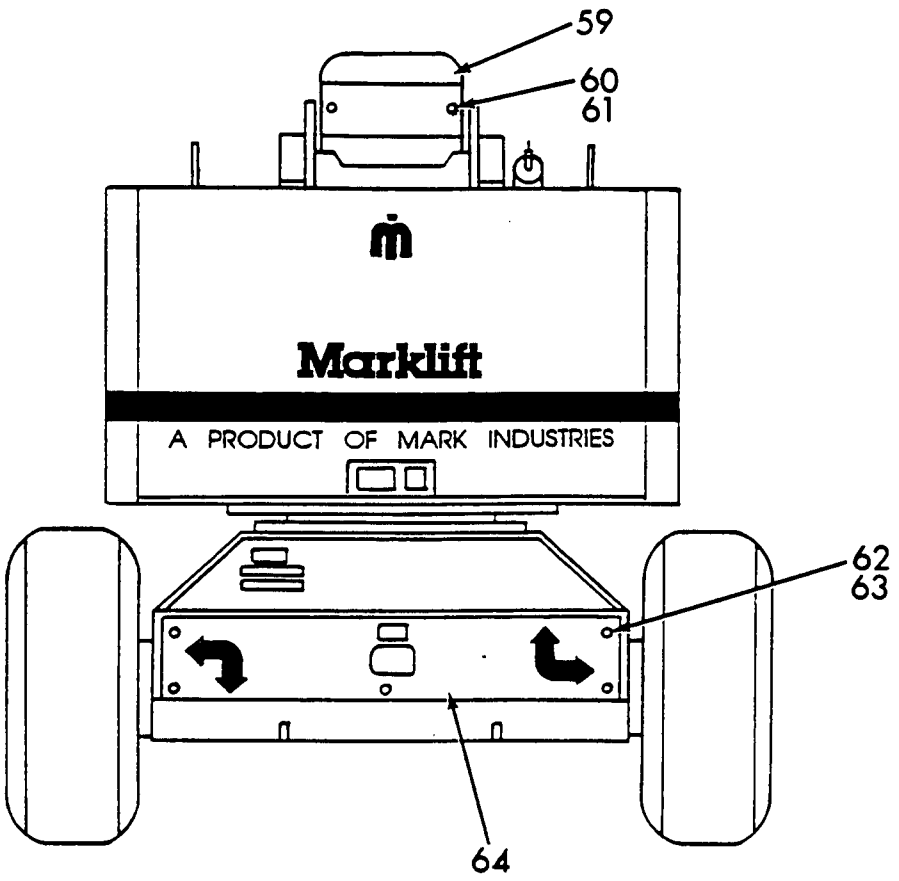


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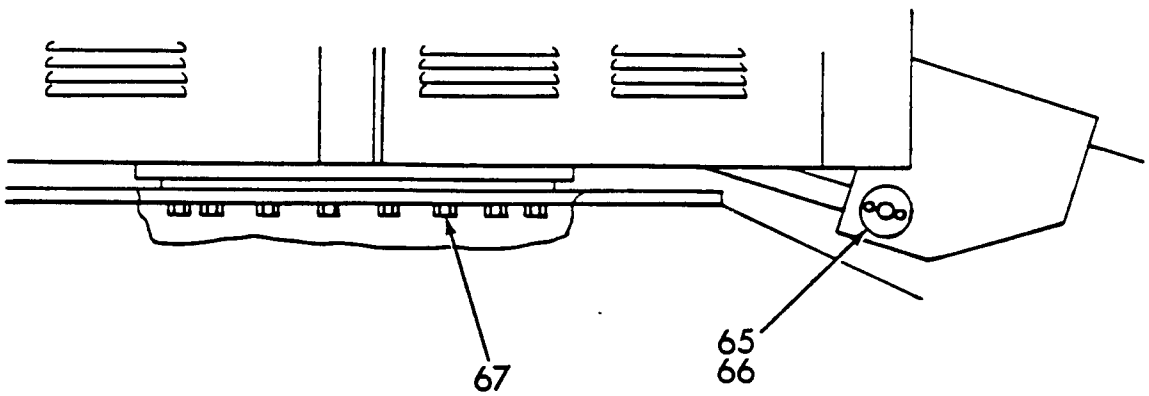

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FINAL ASSEMBLY (80C 4X4)




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A PRODUCT OF MARK INDUSTRIES
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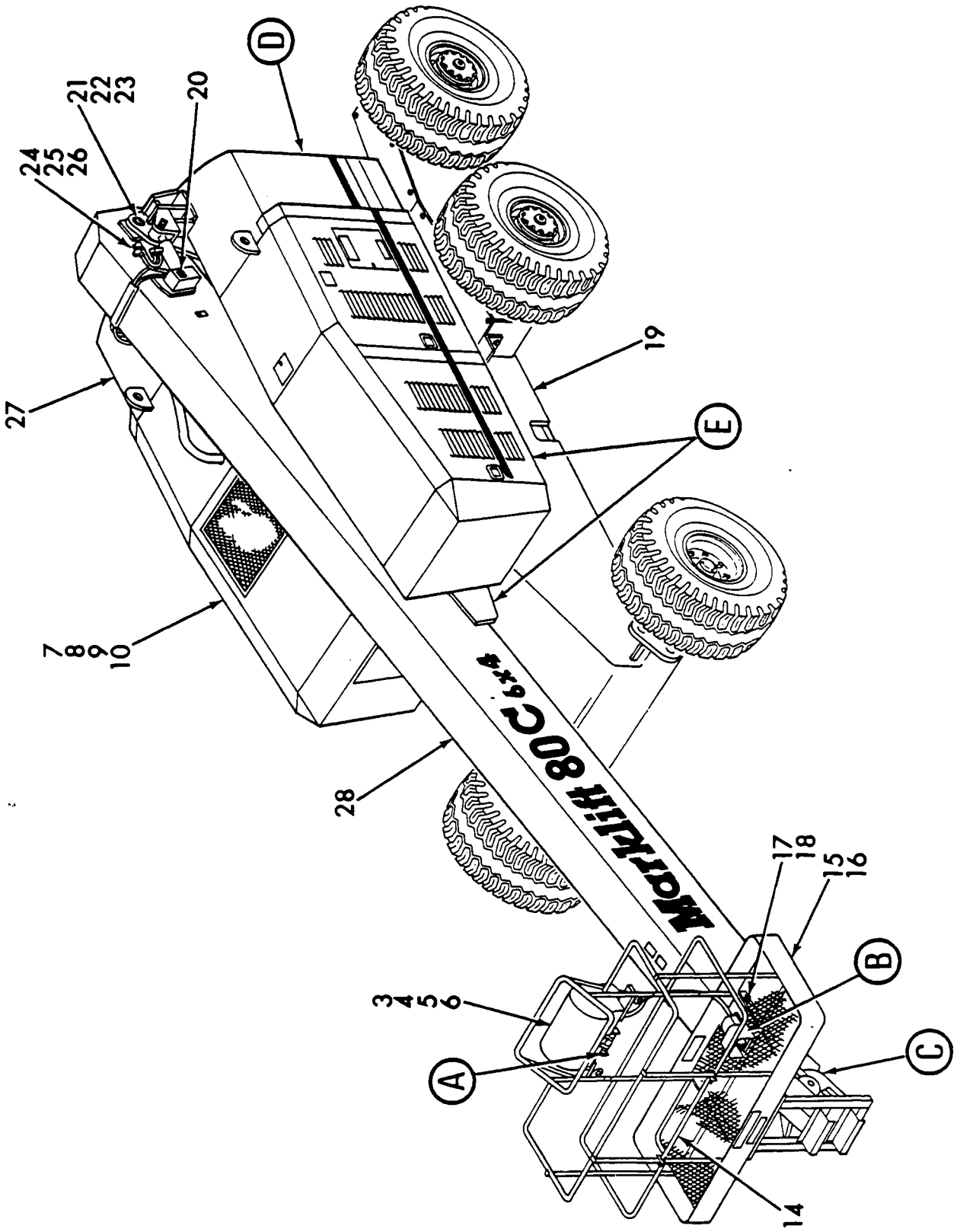


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20047	ASSEMBLY, FINAL	REF
-2	67802	.SET, DECAL (See Sect. 2, Fig. 2 for Details)	1
3	24118	.ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for Details)	1
4	60325	.SCREW, CAP	4
5	63403	.WASHER, FLAT	4
6	63319	.WASHER, LOCK	4
7	22009	.KIT, SHEET METAL (See Sect. 2, Fig. 4 for Details)	1
8	61902	.SCREW, CAP	54
9	63401	.WASHER, FLAT	34
10	60711	.NUT, WITH NYLON INSERT	24
-11	24650	.DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5 for Details)	1
-12	24443	.SCHEMATIC, ELECTRICAL (See Schematic Section)	1
-13	24279	.SCHEMATIC, HYDRAULIC (See Schematic Section)	1
14	24088	.ASSEMBLY, SLIDE BAR (See Sect. 2, Fig. 6 for Details)	1
15	24150	.WELDMENT, PLATFORM (6 FT.)	1
-16	16268	.CLAMP, HOSE	4
17	60515	.SCREW, CAP	4
18	61302	.NUT, HEX	4
19	23980	.ASSEMBLY, CARRIAGE (See Sect. 3, Fig. 1 for Details)	1
20	21334	.PIN, LEVELING CYLINDER TO BOOM	2
21	22053	.PIN, BOOM PIVOT	2
22	25360	.TUBE, ROUND	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23	60607	.SCREW, CAP	2
24	2594	.ELBOW, SWIVEL	2
25	2568-35	.HOSE, HYDRAULIC	1
26	2562	.FITTING, STRAIGHT SWIVEL	2
27	24477	.ASSEMBLY, TURRET (See Sect. 4, Fig. 1 for Details)	1
28	24136	.ASSEMBLY, BOOM (See Sect. 5, Fig. 1 for Details)	1
29	60309	.SCREW, CAP	2
30	65842	.CAP, ANTI-ROLL	2
31	63401	.WASHER, FLAT	2
32	61239	.NUT, LOCK	2
33	65867	.CLAMP	2
34	16629	.HANDBOOK, OPERATION SAFETY	1
35	130927	.CONTAINER, PLASTIC	1
36	20480	.ASSEMBLY, FOOT SWITCH (See Sect. 2, Fig. 7 for Details)	1
37	60346	.SCREW, CAP	2
38	22742	.PLATE, DEADMAN SWITCH BACKING	2
39	63402	.WASHER, FLAT	2
40	63302	.WASHER, LOCK	2
41	60702	.NUT, HEX	2
42	24444	.ASSEMBLY, PLATFORM ROTATOR (See Sect. 2, Fig. 8 for Details)	1
43	61305	.NUT, LOCK	4
44	63415	.WASHER, FLAT	1
45	63305	.WASHER, LOCK	1
46	60516	.SCREW, CAP	1

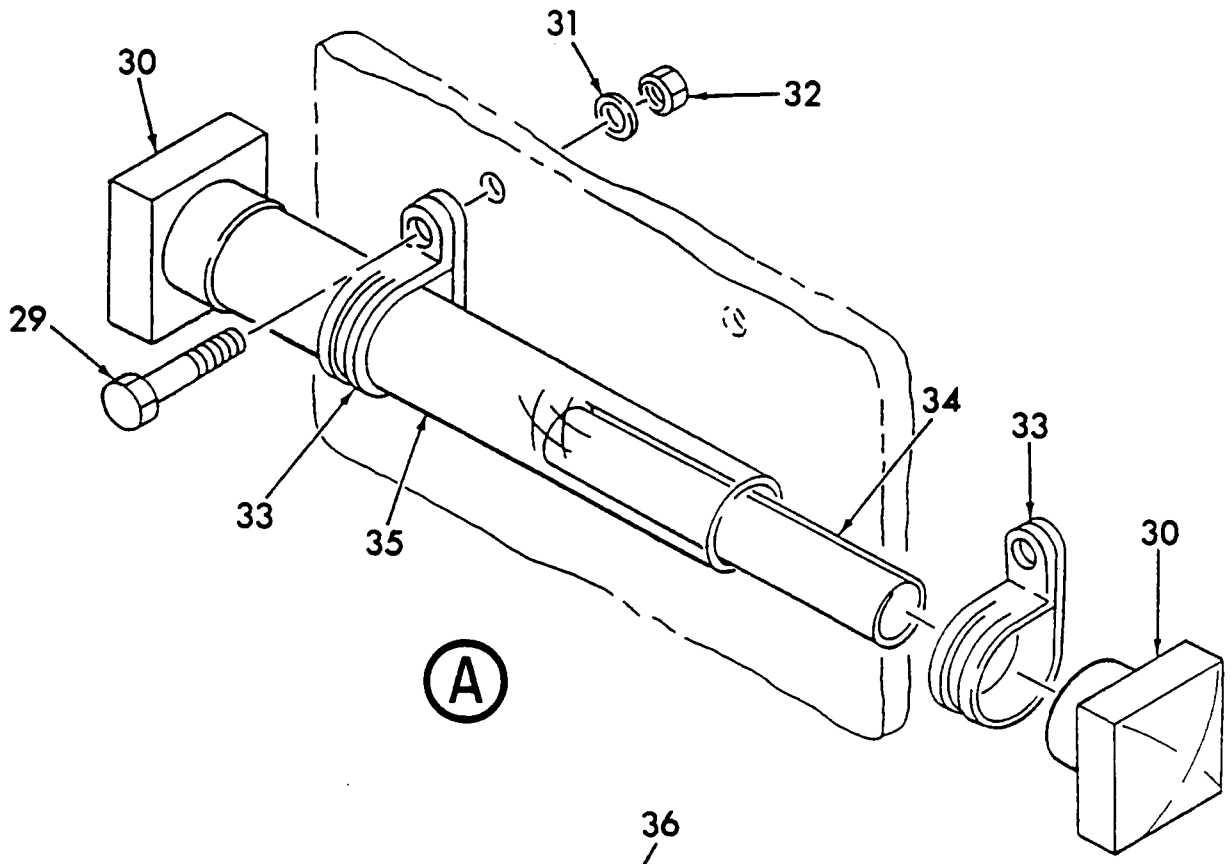
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
47	63415	.WASHER, FLAT	4
48	60540	.SCREW, CAP	2
49	24171	.WELDMENT, PLATFORM ROTATION FORK	1
-50	65321-42	.SLEEVE, PLASTIC COIL	1
51	60513	.SCREW, CAP	2
52	20552	.BUMPER, PLATFORM	1
53	63403	.WASHER, FLAT	2
54	60307	.SCREW, CAP	2
55	60607	.SCREW, CAP	2
56	20457	.PIN, BOOM TO ROTATION FORK	1
57	20261	.PIN, SLAVE CYLINDER TO ROTATION FORK	1
-58	16609	.PAINT, BLUE	1 GAL.
59	24382	.COVER, BOOM	1
60	60607	.SCREW, CAP	4
61	63319	.WASHER, LOCK	4
62	60325	.SCREW, CAP	4
63	63319	.WASHER, LOCK	4
64	24921	.COVER, REAR	1
65	22047	.PIN, LIFT CYLINDER TO BOOM	1
66	61813	.SCREW, CAP	2
67	60609	.SCREW, CAP	36
-68	16608	.PAINT, SPRAYLAT WHITE	10 GAL.
-69	65112	.PAINT, TANK WHITE	1½ GAL.
-70	65114	.GASOLINE	5 GAL.
-71	65116	.OIL, HYDRAULIC	60 GAL.

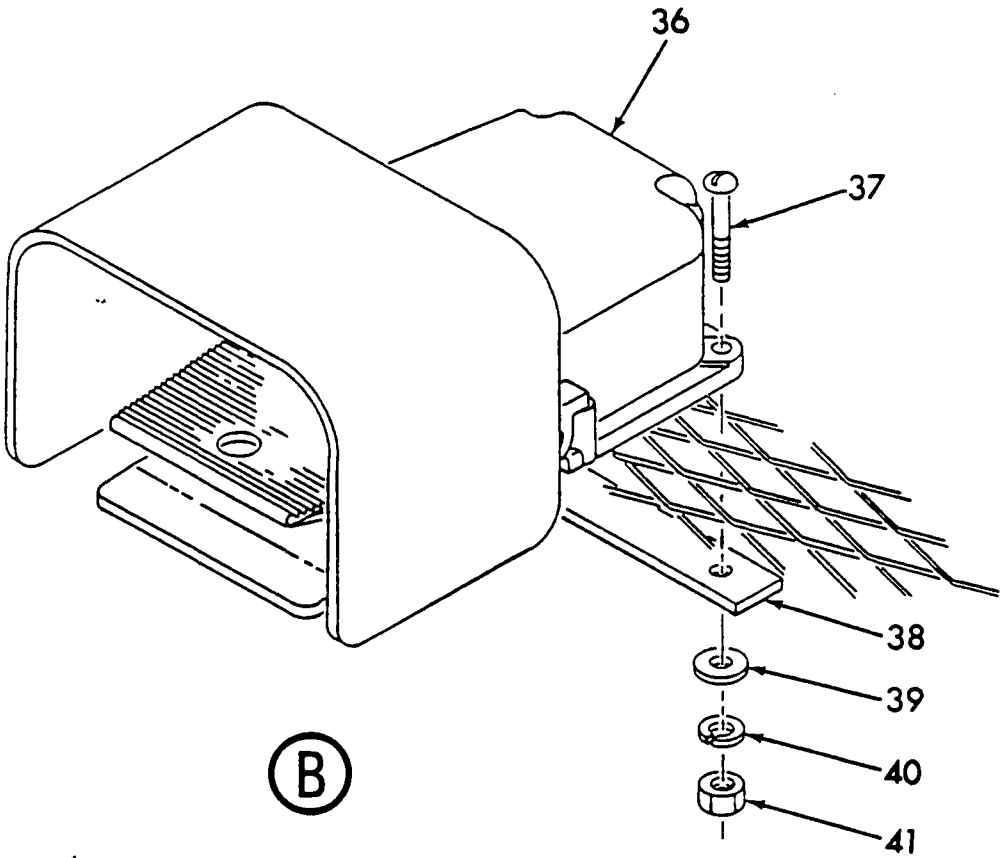
FINAL ASSEMBLY (80C 6X4)



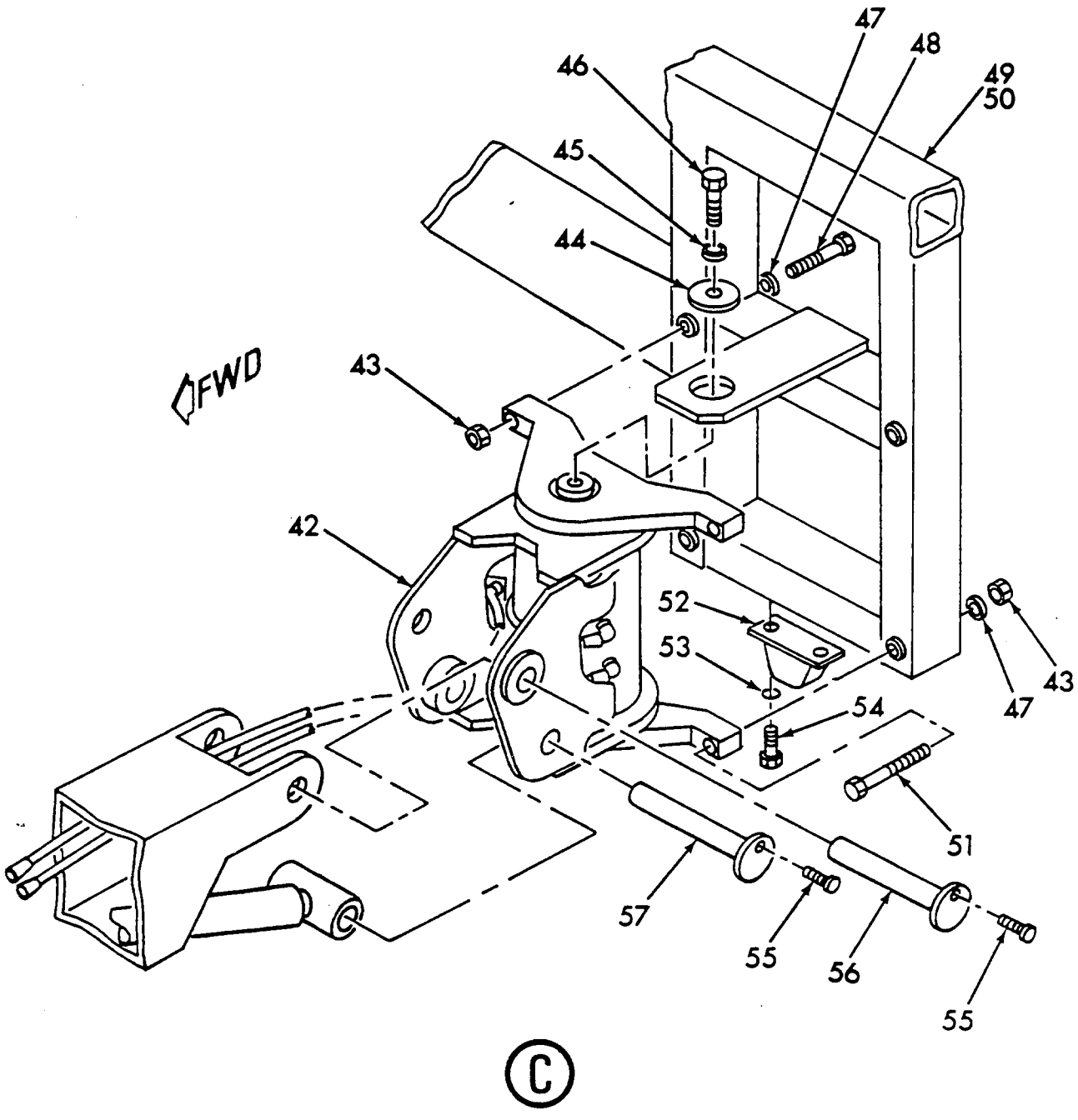
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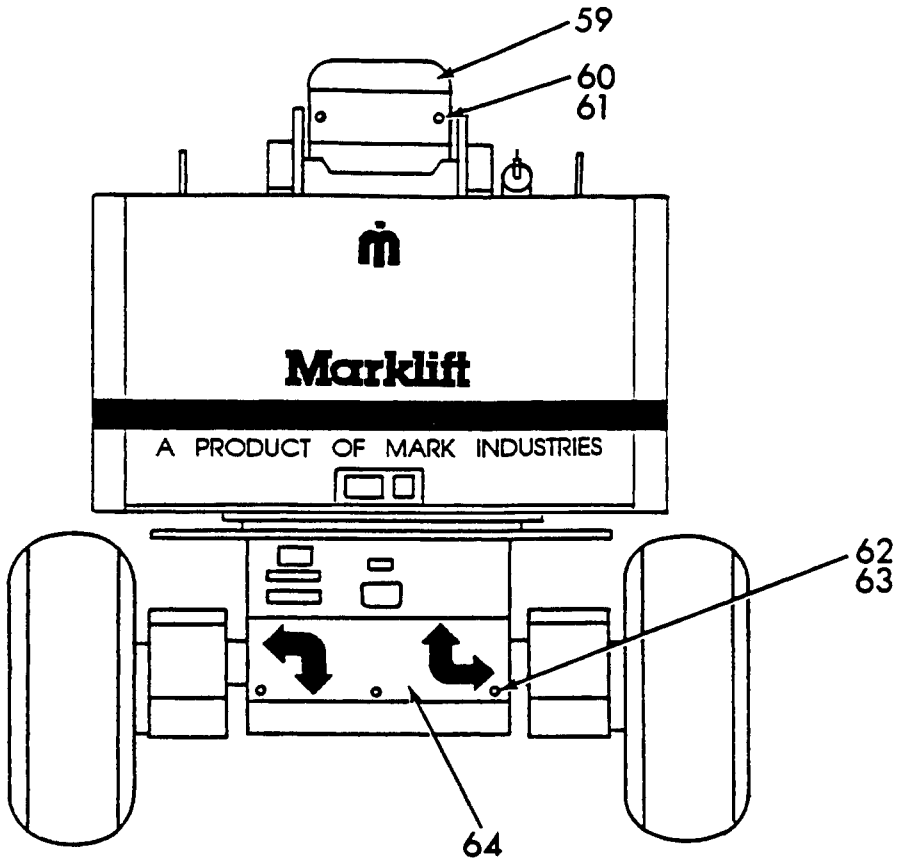
FINAL ASSEMBLY (80C 6X4)



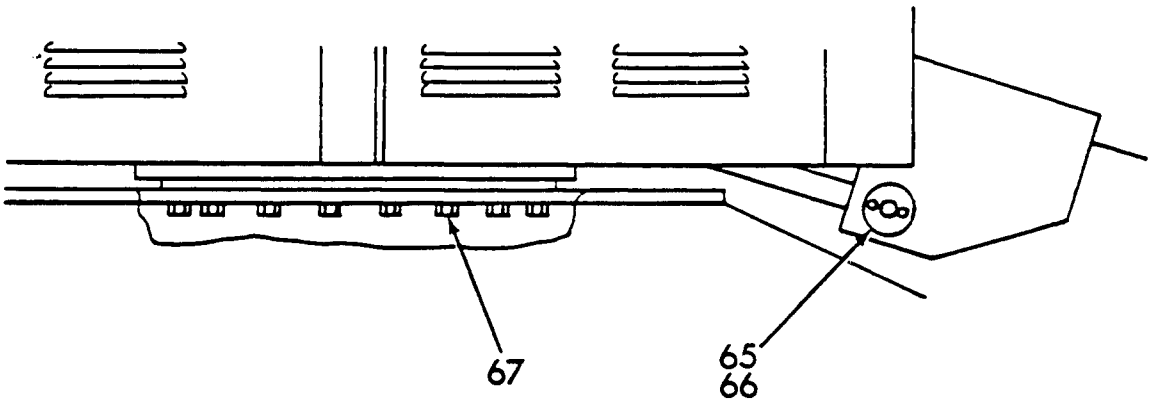


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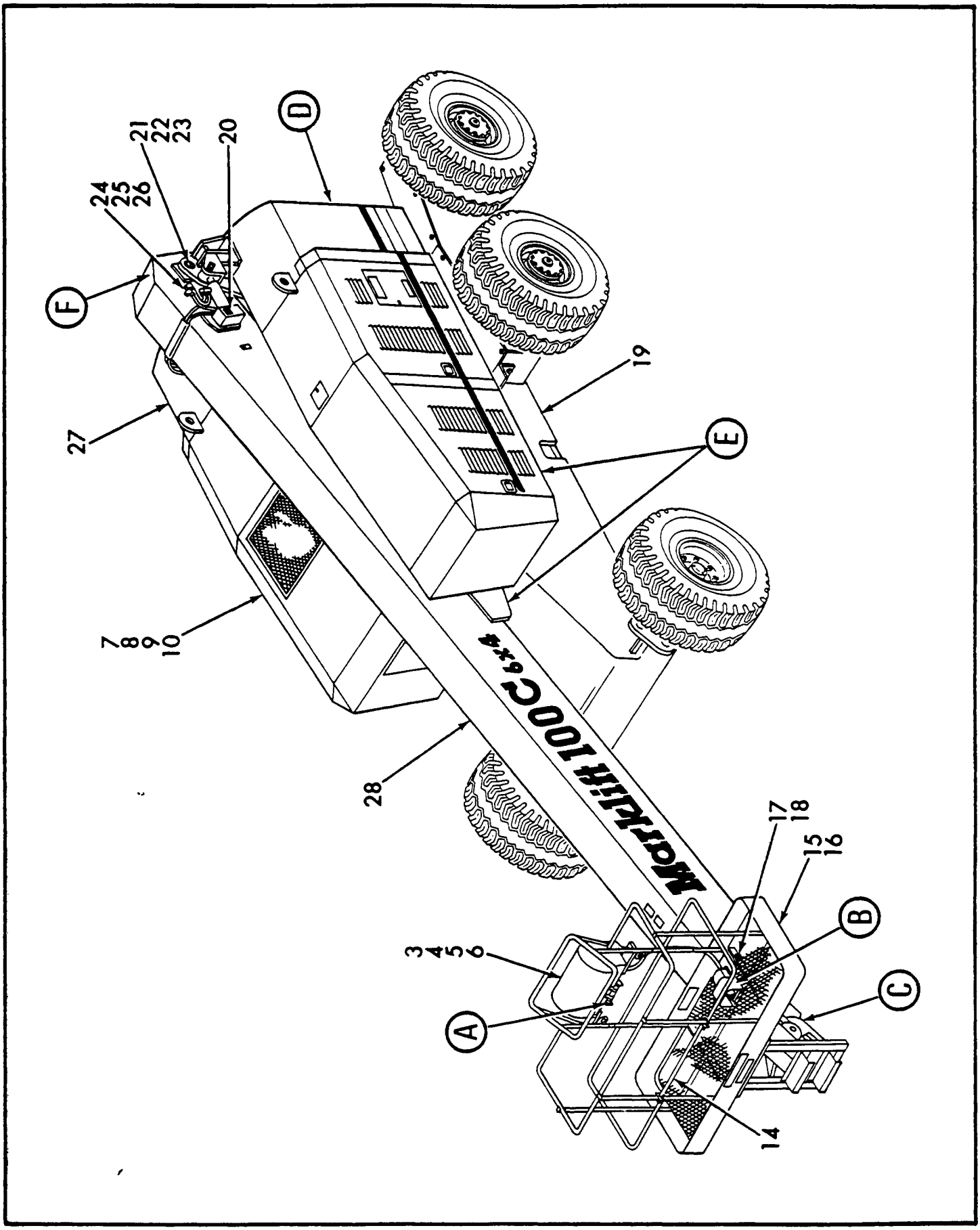


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20063	ASSEMBLY, FINAL	REF
-2	67803	.SET, DECAL (See Sect. 2, Fig. 2A for Details)	1
3	24118	.ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for Details)	1
4	60325	.SCREW, CAP	4
5	63403	.WASHER, FLAT	4
6	63319	.WASHER, LOCK	4
7	22009	.KIT, SHEET METAL (See Sect. 2, Fig. 4 for Details)	1
8	61902	.SCREW, CAP	54
9	63401	.WASHER, FLAT	34
10	60711	.NUT, WITH NYLON INSERT	24
-11	SKP-0817-KTC	.DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5A for Details)	1
-12	24443	.SCHEMATIC, ELECTRICAL (See Schematic Section)	1
-13		.SCHEMATIC, HYDRAULIC (See Schematic Section)	1
14	24088	.ASSEMBLY, SLIDE BAR (See Sect. 2, Fig. 6 for Details)	1
15	24150	.WELDMENT, PLATFORM (6 FT.)	1
-16	16268	.CLAMP, HOSE	4
17	60515	.SCREW, CAP	4
18	61302	.NUT, HEX	4
19	22118	.ASSEMBLY, CARRIAGE (See Sect. 3, Fig. 1A for Details)	1
20	21334	.PIN, LEVELING CYLINDER TO BOOM	2
21	22053	.PIN, BOOM PIVOT	2
22	25360	.TUBE, ROUND	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23	60607	.SCREW, CAP	2
24	2594	.ELBOW, SWIVEL	2
25	2568-35	.HOSE, HYDRAULIC	1
26	2562	.FITTING, STRAIGHT SWIVEL	2
27	24477	.ASSEMBLY, TURRET (See Sect. 4, Fig. 1 for Details)	1
28	24136	.ASSEMBLY, BOOM (See Sect. 5, Fig. 1 for Details)	1
29	60325	.SCREW, CAP	2
30	65842	.CAP, ANTI-ROLL	2
31	63401	.WASHER, FLAT	2
32	61239	.NUT, LOCK	2
33	65867	.CLAMP	2
34	17409	.HANDBOOK, OPERATION SAFETY	1
35	130927	.CONTAINER, PLASTIC	1
36	20480	.ASSEMBLY, FOOT SWITCH (See Sect. 2, Fig. 7 for Details)	1
37	60346	.SCREW, CAP	2
38	22742	.PLATE, DEADMAN SWITCH BACKING	2
39	63402	.WASHER, FLAT	2
40	63302	.WASHER, LOCK	2
41	60702	.NUT, HEX	2
42	24444	.ASSEMBLY, PLATFORM ROTATOR (See Sect. 2, Fig. 8 for Details)	1
43	61305	.NUT, LOCK	4
44	23565	.WASHER, FLAT	1
45	63305	.WASHER, LOCK	1
46	60516	.SCREW, CAP	1

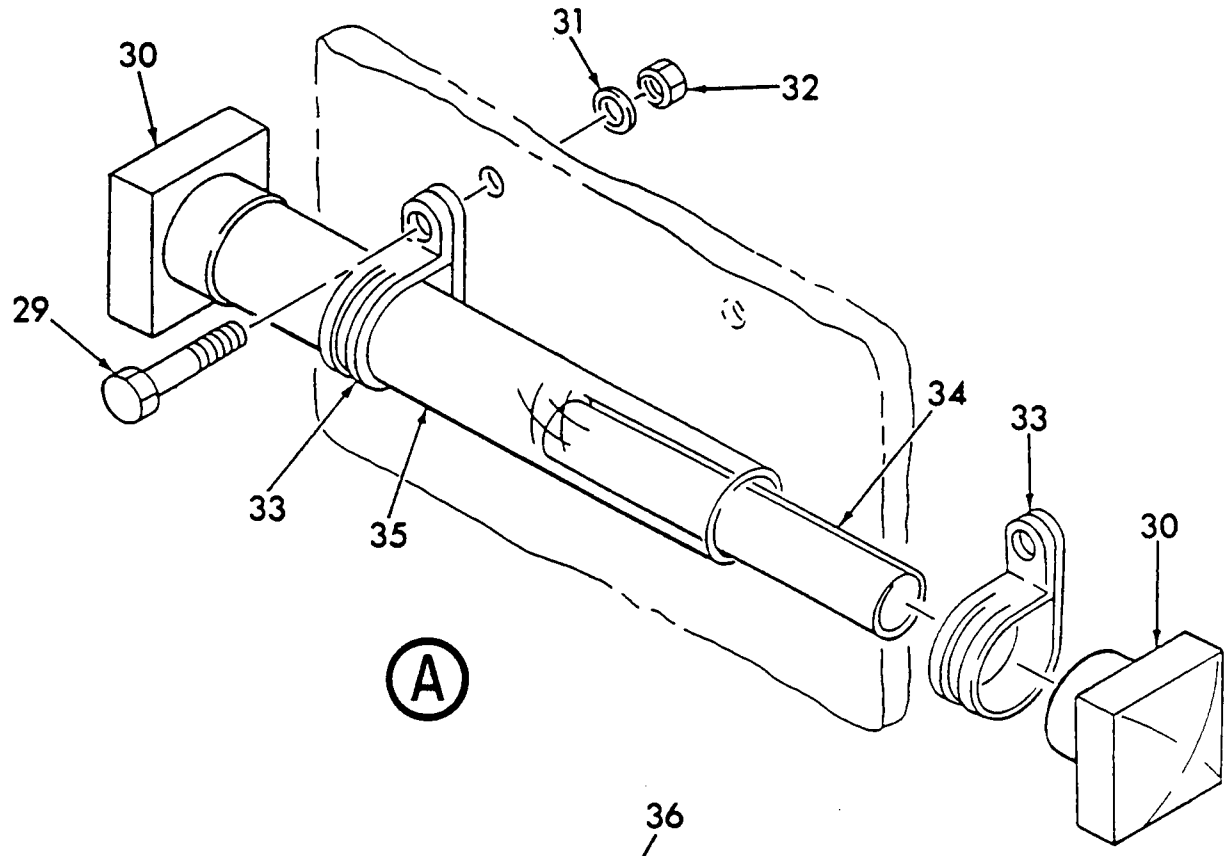
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
47	63415	.WASHER, FLAT	4
48	60540	.SCREW, CAP	2
49	24171	.WELDMENT, PLATFORM ROTATION FORK	1
-50	65321-42	.SLEEVE, PLASTIC COIL	1
51	60513	.SCREW, CAP	2
52	20552	.BUMPER, PLATFORM	1
53	63403	.WASHER, FLAT	2
54	60307	.SCREW, CAP	2
55	60607	.SCREW, CAP	2
56	20457	.PIN, BOOM TO ROTATION FORK	1
57	20261	.PIN, SLAVE CYLINDER TO ROTATION FORK	1
-58	16609	.PAINT, BLUE	1 GAL.
59	24382	.COVER, BOOM	1
60	60325	.SCREW, CAP	4
61	63319	.WASHER, LOCK	4
62	60325	.SCREW, CAP	4
63	63319	.WASHER, LOCK	4
64	22098	.COVER, REAR	1
65	22047	.PIN, LIFT CYLINDER TO BOOM	1
66	60607	.SCREW, CAP	2
67	60609	.SCREW, CAP	36
-68	16608	.PAINT, SPRAYLAT WHITE	10 GAL.
-69	65112	.PAINT, TANK WHITE	1½ GAL.
-70	65114	.GASOLINE (REGULAR)	5 GAL.
-71	65116	.OIL, HYDRAULIC	60 GAL.

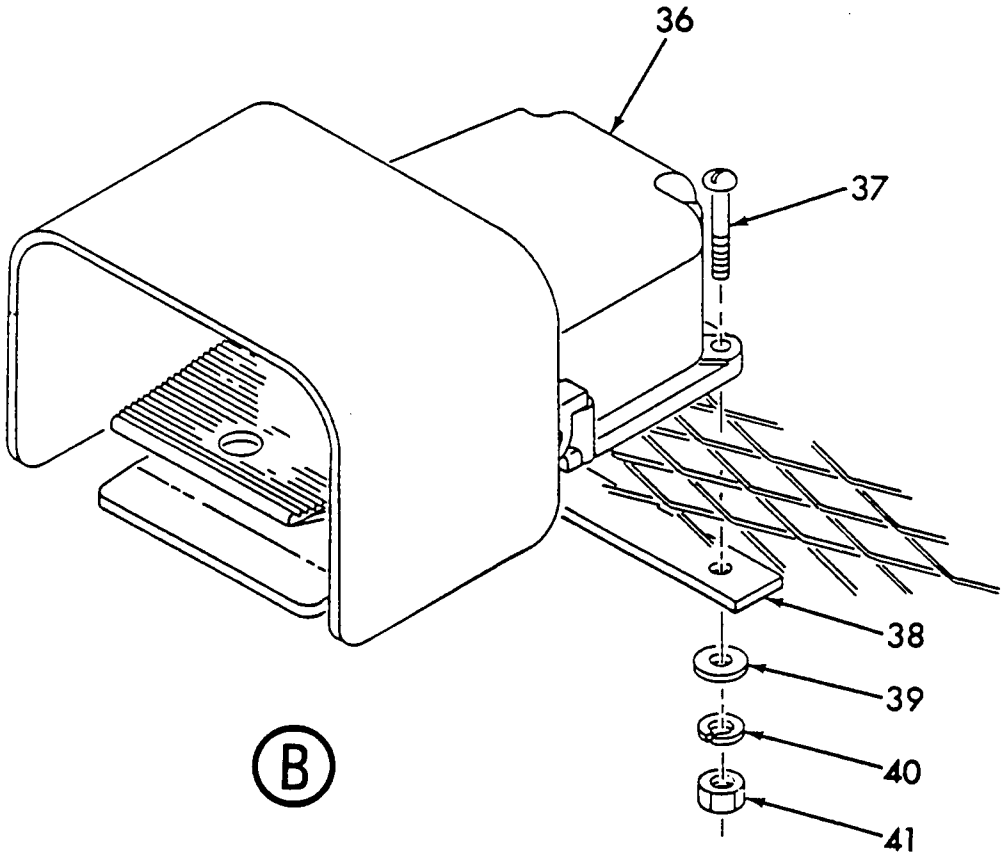
FINAL ASSEMBLY (100C 6X4)



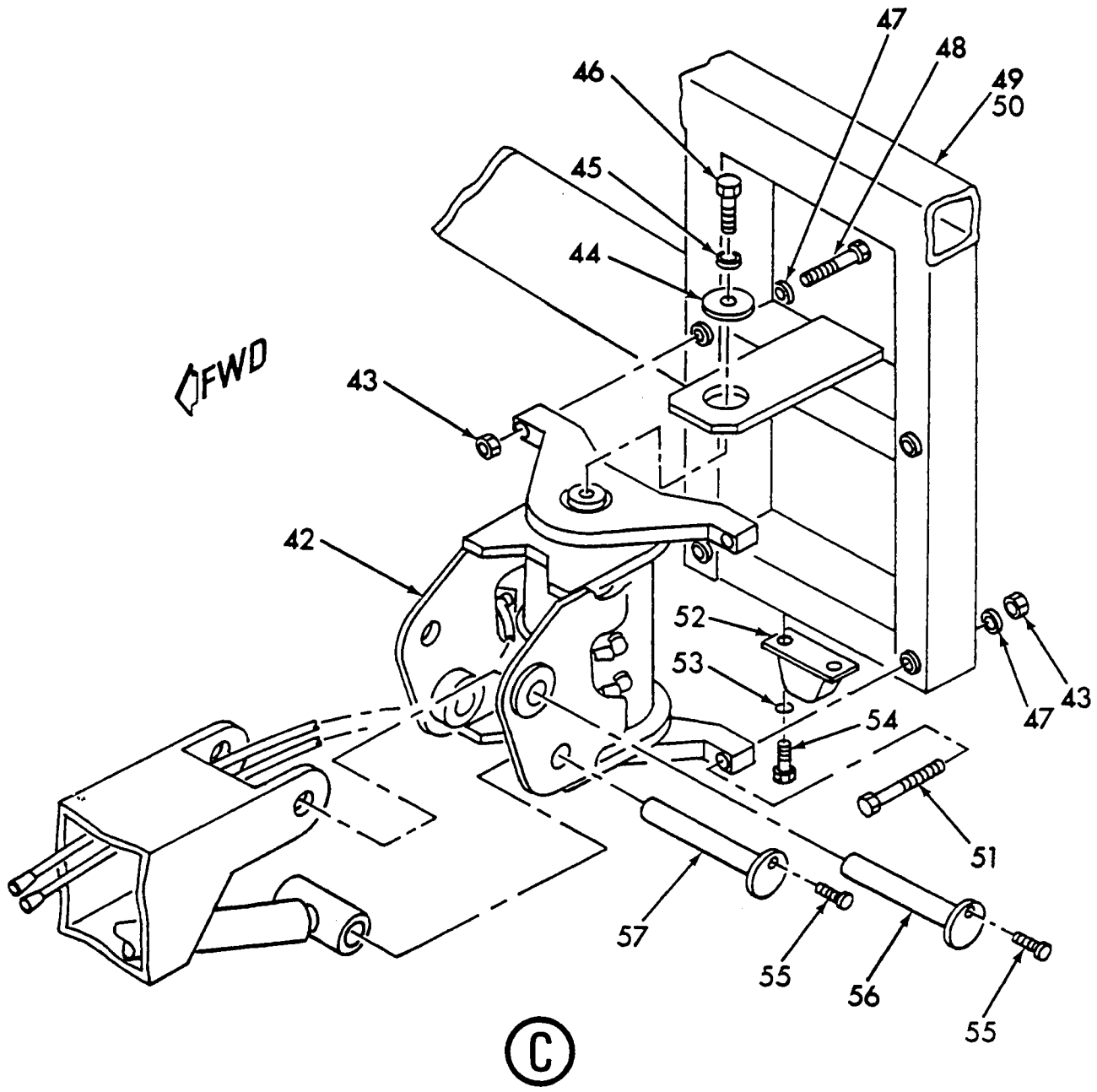
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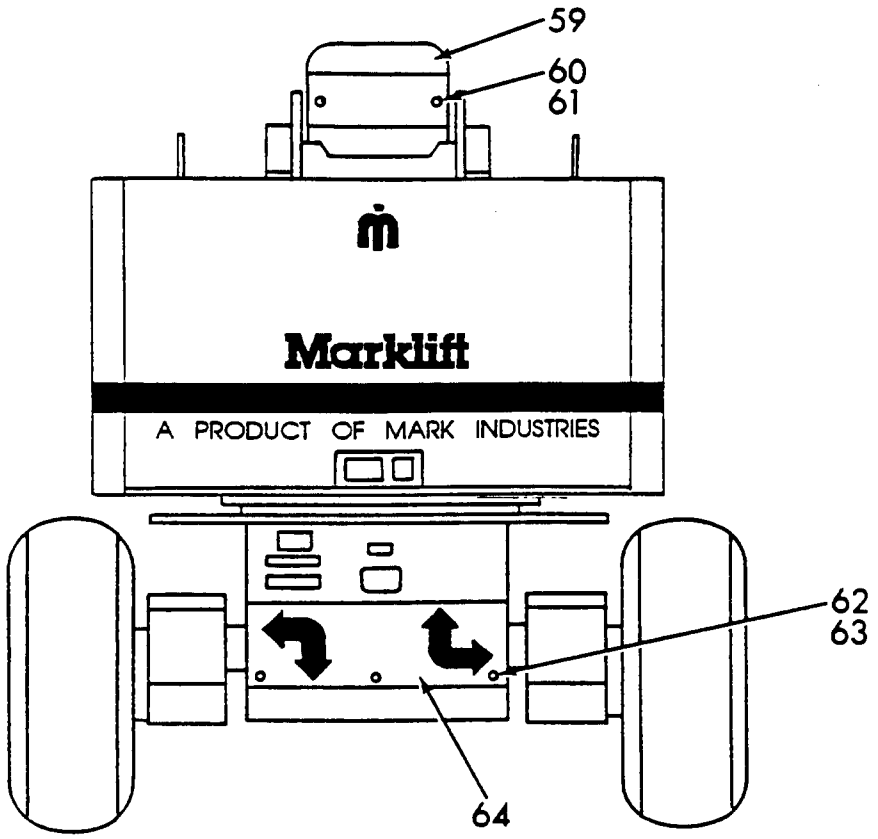
FINAL ASSEMBLY (100C 6X4)



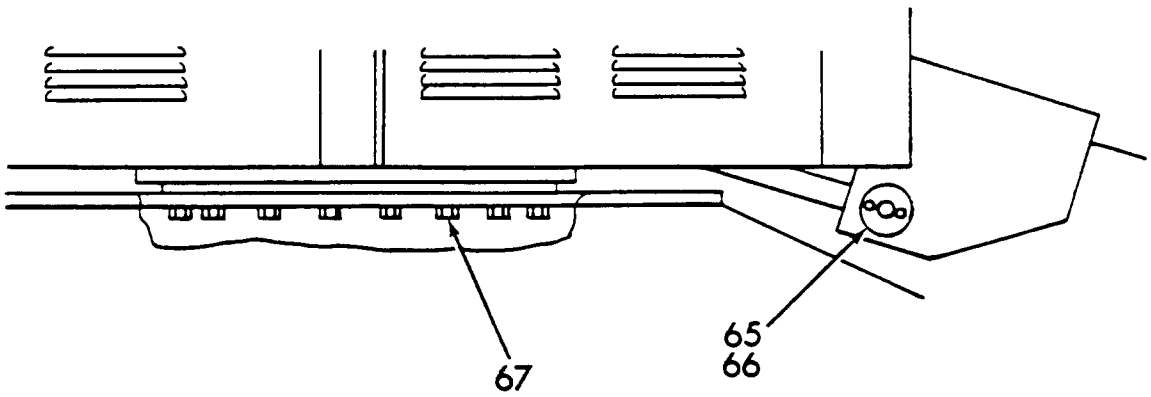


FINAL ASSEMBLY (100C 6X4)




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Marklift
A PRODUCT OF MARK INDUSTRIES
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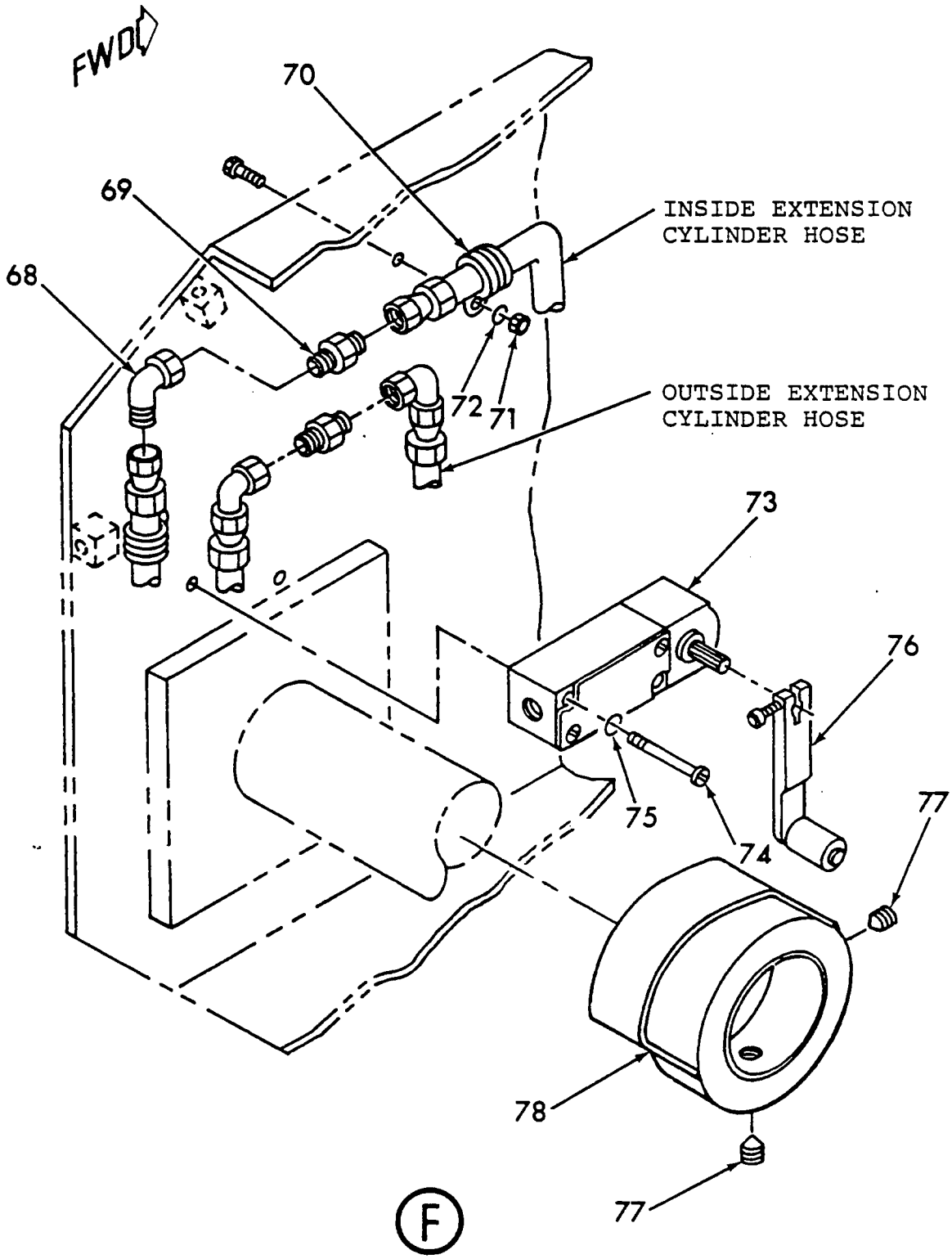
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E



FINAL ASSEMBLY (100C 6X4)



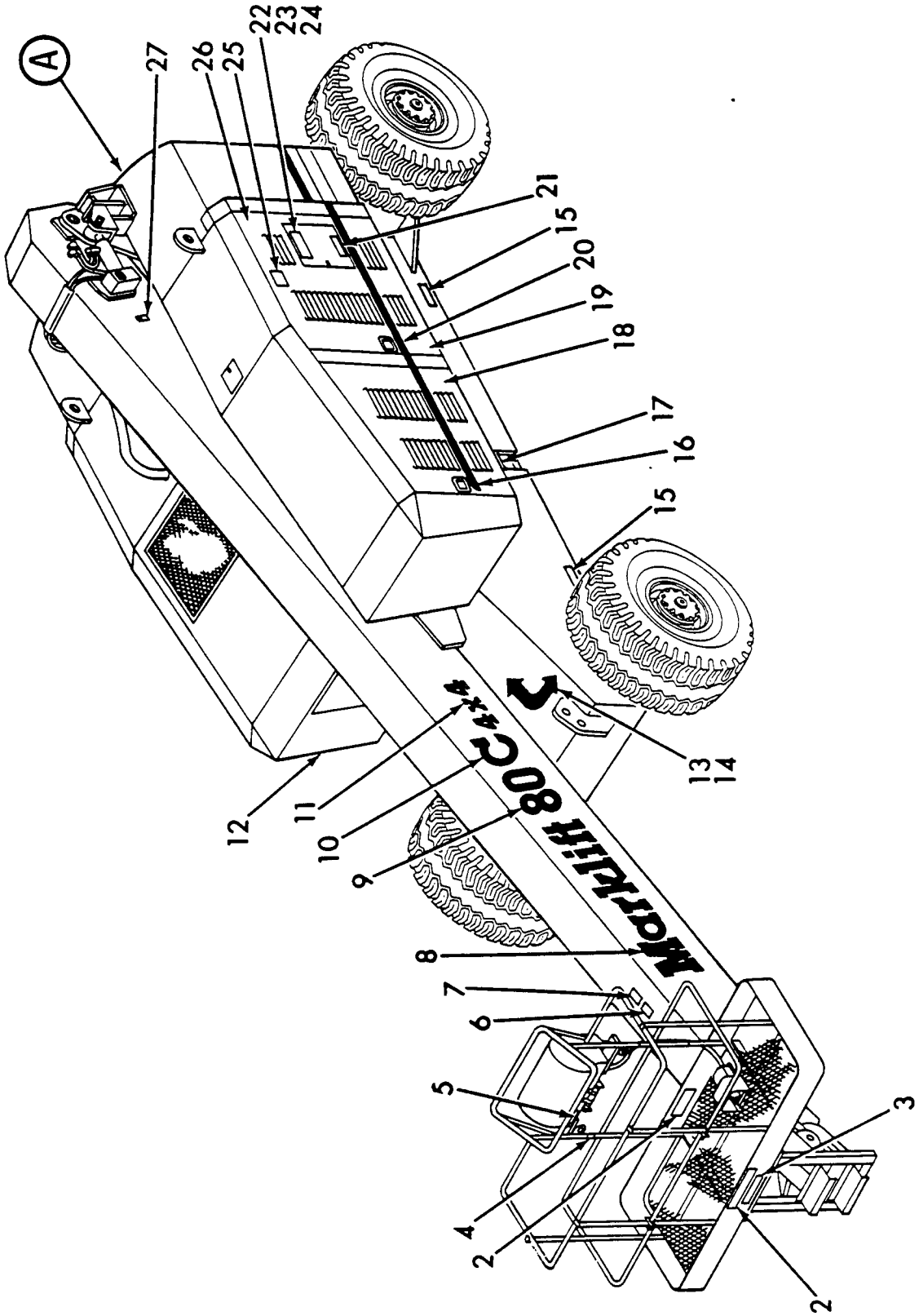
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20062	ASSEMBLY, FINAL	REF
-2	67804	.SET, DECAL (See Sect. 2, Fig. 2B for Details)	1
3	24118	.ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for Details)	1
4	60325	.SCREW, CAP	4
5	63403	.WASHER, FLAT	4
6	63319	.WASHER, LOCK	4
7	22009	.KIT, SHEET METAL (See Sect. 2, Fig. 4 for Details)	1
8	61902	.SCREW, CAP	54
9	63401	.WASHER, FLAT	34
10	60711	.NUT, WITH NYLON INSERT	24
-11	24616	.DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5B for Details)	1
-12	24302	.SCHEMATIC, ELECTRICAL (See Schematic Section)	1
-13	24301	.SCHEMATIC, HYDRAULIC (See Schematic Section)	1
14	24088	.ASSEMBLY, SLIDE BAR (See Sect. 2, Fig. 6 for Details)	1
15	24150	.WELDMENT, PLATFORM (6 FT.)	1
-16	16268	.CLAMP, HOSE	4
17	60515	.SCREW, CAP	4
18	61302	.NUT, HEX	4
19	24499	.ASSEMBLY, CARRIAGE (See Sect. 3, Fig. 1B for Details)	1
20	21334	.PIN, LEVELING CYLINDER TO BOOM	2
21	23456	.PIN, BOOM PIVOT	2
22	28157	.TUBE, ROUND	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23	60607	.SCREW, CAP	2
24	2594	.ELBOW, SWIVEL	2
25	2568-35	.HOSE, HYDRAULIC	1
26	2562	.FITTING, STRAIGHT SWIVEL	2
27	24485	.ASSEMBLY, TURRET (See Sect. 4, Fig. 1A for Details)	1
28	24310	.ASSEMBLY, BOOM (See Sect. 5, Fig. 1A for Details)	1
29	60325	.SCREW, CAP	2
30	65842	.CAP, ANTI-ROLL	2
31	63401	.WASHER, FLAT	2
32	61239	.NUT, LOCK	2
33	65867	.CLAMP	2
34	16629	.HANDBOOK, OPERATION SAFETY	1
35	130927	.CONTAINER, PLASTIC	1
36	20480	.ASSEMBLY, FOOT SWITCH (See Sect. 2, Fig. 7 for Details)	1
37	60346	.SCREW, CAP	2
38	22742	.PLATE, DEADMAN SWITCH BACKING	2
39	63402	.WASHER, FLAT	2
40	63302	.WASHER, LOCK	2
41	60702	.NUT, HEX	2
42	24444	.ASSEMBLY, PLATFORM ROTATOR (See Sect. 2, Fig. 8 for Details)	1
43	61305	.NUT, LOCK	4
44	23565	.WASHER, FLAT	1
45	63305	.WASHER, LOCK	1
46	60516	.SCREW, CAP	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
47	63415	.WASHER, FLAT	4
48	60540	.SCREW, CAP	2
49	24171	.WELDMENT, PLATFORM ROTATION FORK	1
-50	65321-42	.SLEEVE, PLASTIC COIL	1
51	60513	.SCREW, CAP	2
52	20552	.BUMPER, PLATFORM	1
53	63403	.WASHER, FLAT	2
54	60307	.SCREW, CAP	2
55	60607	.SCREW, CAP	2
56	20457	.PIN, BOOM TO ROTATION FORK	1
57	20261	.PIN, SLAVE CYLINDER TO ROTATION FORK	1
-58	16609	.PAINT, BLUE	1 GAL.
59	24393	.COVER, BOOM	1
60	60325	.SCREW, CAP	4
61	63319	.WASHER, LOCK	4
62	60325	.SCREW, CAP	4
63	63319	.WASHER, LOCK	4
64	22098	.COVER, REAR	1
65	24364	.PIN, LIFT CYLINDER TO BOOM	1
66	60607	.SCREW, CAP	2
67	60609	.SCREW, CAP	36
68	80015-06	.ELBOW, SWIVEL NUT	6
69	80042-06	.UNION	4
70	16268	.CLAMP, HOSE	4
71	61239	.NUT, LOCK	4
72	63301	.WASHER, LOCK	4

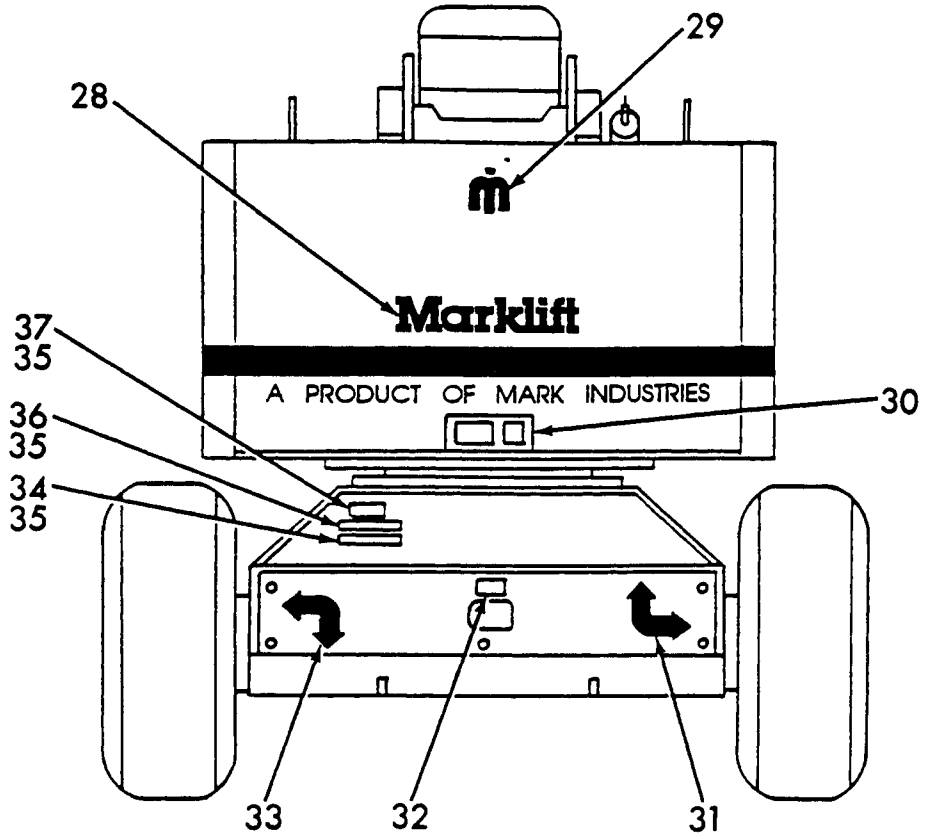
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
73	70468	.SWITCH, LIMIT	1
74	62704	.SCREW, SLOTTED MACHINE	2
75	63313	.WASHER, LOCK	2
76	70032	.LEVER, SWITCH	1
77		.SCREW, SET (FURNISHED WITH CAM WELDMENT)	2
78	24615	.WELDMENT, CAM	1
-79	16608	.PAINT, SPRAYLAT WHITE	10 GAL.
-80	65112	.PAINT, TANK WHITE	1½ GAL.
-81	65115	.FUEL, DIESEL	5 GAL.
-82	65116	.OIL, HYDRAULIC	60 GAL.

DECAL SET (80C 4X4)



REV.

DECAL SET (80C 4X4)



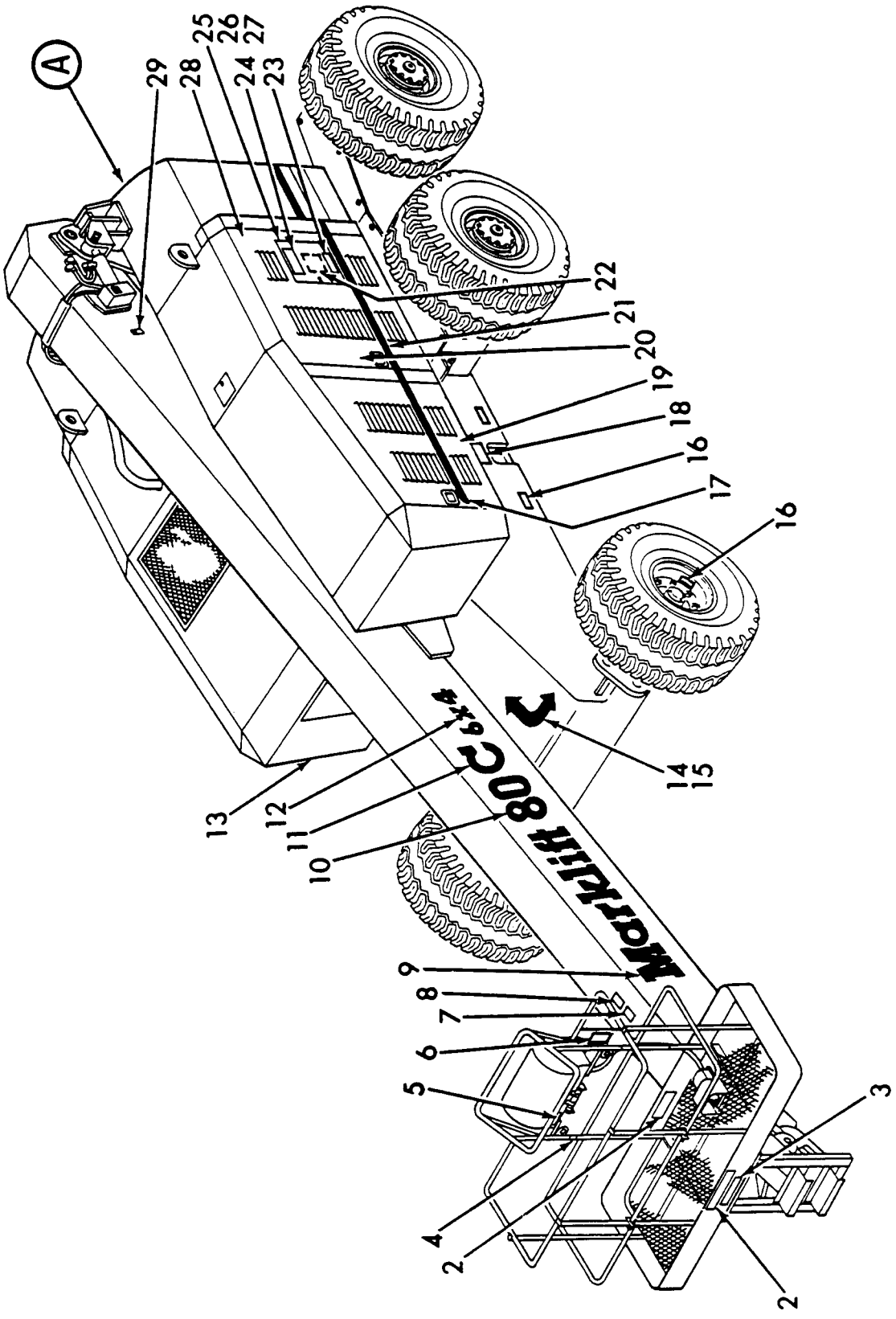
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	67802	SET, DECAL (See Sect. 2, Fig. 1 for NHA)	REF
2	2022	.DECAL, LOAD CAPACITY 500 LBS.	2
3	22385	.DECAL, ATTACH SAFETY BELT	1
4	22386	.DECAL, "D" RING ATTACH SAFETY BELT	2
5	130820	.DECAL, OPERATION & SAFETY HANDBOOK	1
6	181103	.DECAL, DANGER OBEY THE FOLLOWING	1
7	181102	.DECAL, DANGER DO NOT OPERATE UNLESS	1
8	21236	.DECAL, MARKLIFT BOOM	2
9	22117	.DECAL, "80"	2
10	181903	.DECAL, "C"	2
11	22740	.DECAL, "4X4"	2

REV.

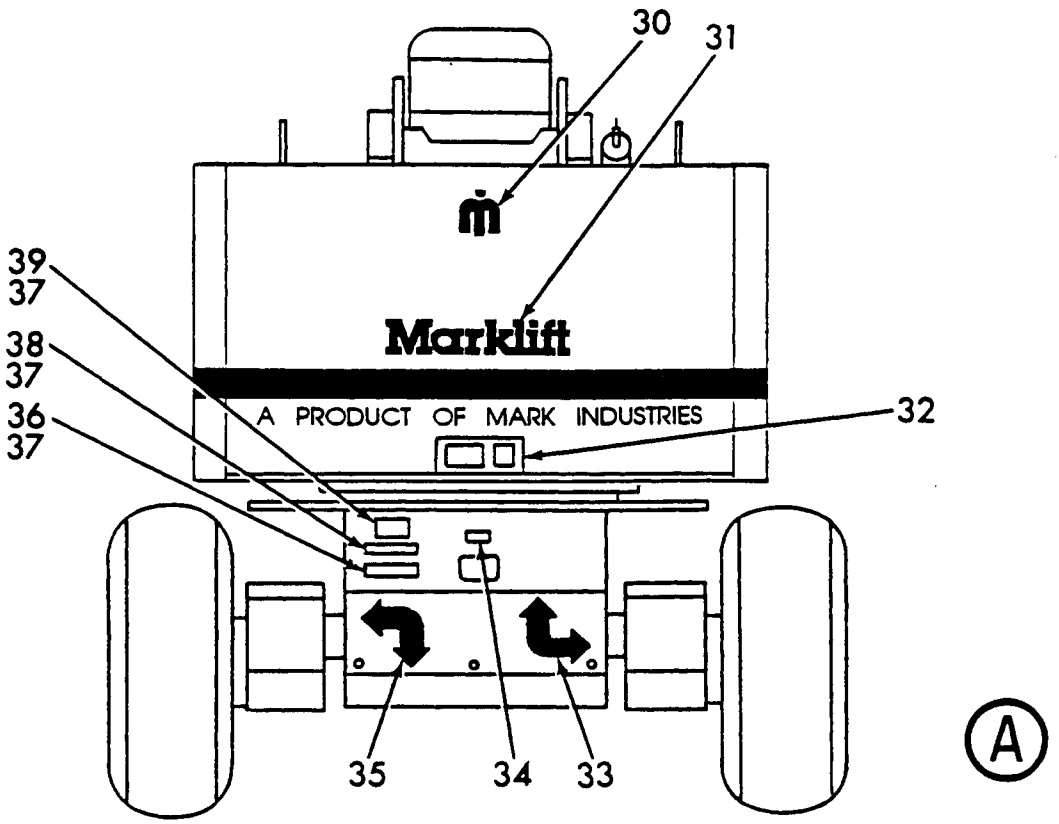
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
12	2003	.DECAL, BATTERY	1
13	182709	.DECAL, DIRECTIONAL ARROW	1
14	182710	.DECAL, DIRECTIONAL ARROW	1
15	22175	.DECAL, CAUTION MONOFILLED TIRES ONLY	4
16	20412	.BLUE STRIP ROUND ENDS (½ REQUIRED EACH SIDE)	1
17	20508	.DECAL, TRANSPORTATION	2
18	2020	.DECAL, GASOLINE (ONE ON GAS TANK)	2
19	2017	.DECAL, HYDRAULIC SYSTEM (ONE ON HYDRAULIC TANK)	2
20	20411	.DECAL, BLUE STRIP SQUARE ENDS (3 REQUIRED EACH SIDE)	6
21	20495	.DECAL, EMERGENCY GROUND CONTROLS	1
22	181102	.DECAL, DANGER DO NOT OPERATE UNLESS	1
23	181103	.DECAL, DANGER OBEY THE FOLLOWING	1
24	20860	.DECAL, GENERAL CHECKOUT & OPERATION INSTRUCTIONS	1
25	20419	.DECAL, DANGER KEEP CLEAR	2
26	21235	.DECAL, EMERGENCY DESCENT	1
27	21237	.DECAL, GREASE FITTING	3
28	20409	.DECAL, MARKLIFT PEDESTAL	1
29	20410	.DECAL, MARK INDUSTRIES LOGO	1
30	20419	.DECAL, DANGER KEEP CLEAR	1
31	182710	.DECAL, DIRECTIONAL ARROW	1
32	20896	.DECAL, BRAKE	1
33	182709	.DECAL, DIRECTIONAL ARROW	1
34	20661	.DECAL PLATE, ANSI-A92	1

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
35	63653	.RIVET, POP	12
36	20662	.DECAL PLATE, PATENT NUMBERS	1
37	20660	.NAMEPLATE, I.D.	1

DECAL SET (80C 6X4)



DECAL SET (80C 6X4)



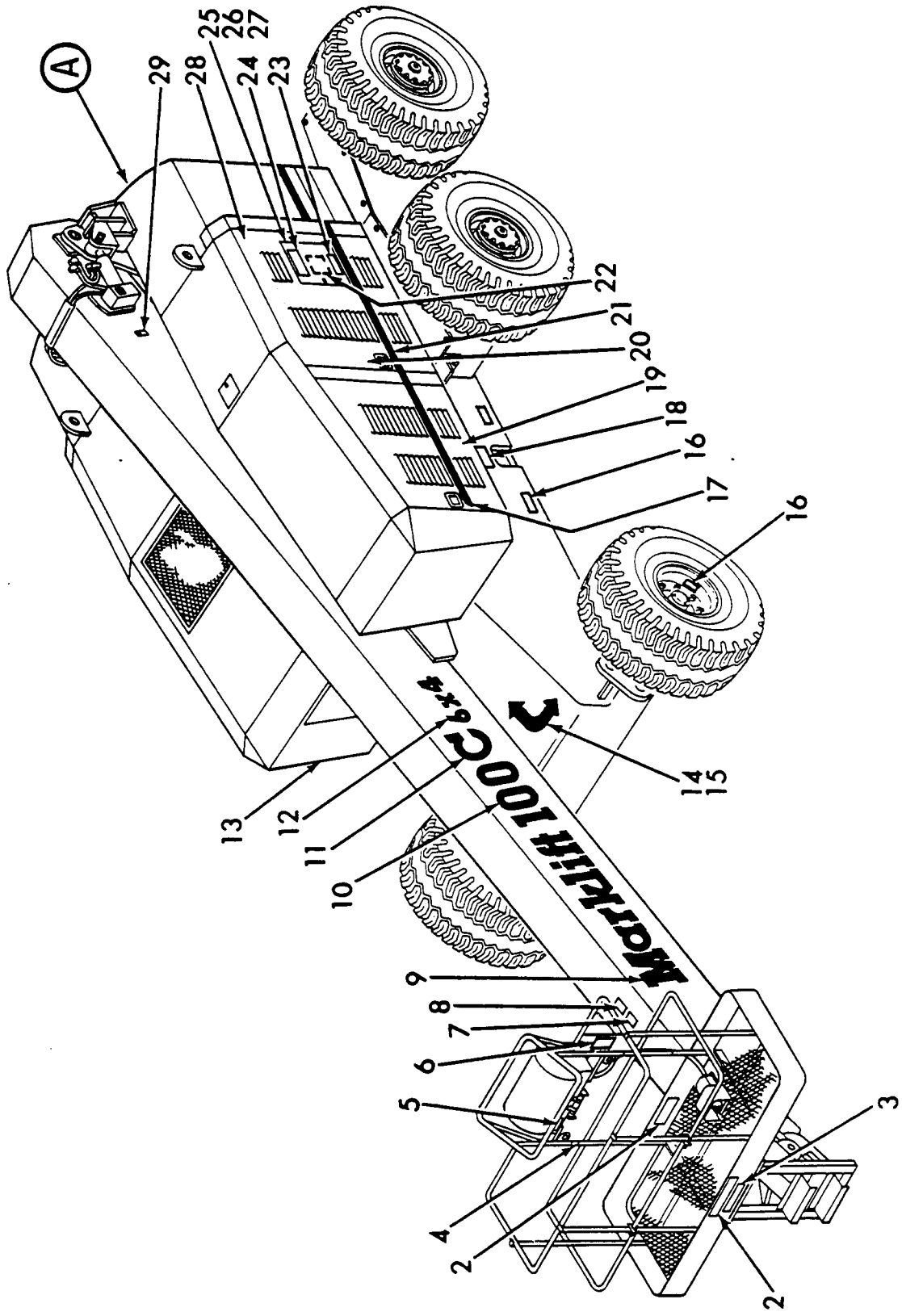
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	67803	SET, DECAL (See Sect. 2, Fig. 1A for NHA)	REF
2	2022	.DECAL, LOAD CAPACITY 500 LBS.	2
3	22385	.DECAL, ATTACH SAFETY BELT	1
4	22386	.DECAL, "D" RING ATTACH SAFETY BELT	2
5	130820	.DECAL, OPERATION & SAFETY HANDBOOK	1
6	24496	.DECAL, REACH GRAPH	1
7	181103	.DECAL, DANGER OBEY THE FOLLOWING	1
8	181102	.DECAL, DANGER DO NOT OPERATE UNLESS	1
9	21236	.DECAL, MARKLIFT BOOM	2
10	22117	.DECAL, "80"	2
11	181903	.DECAL, "C"	2
12	22739	.DECAL, "6X4"	2

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
13	2003	.DECAL, BATTERY	1
14	182709	.DECAL, DIRECTIONAL ARROW	1
15	182710	.DECAL, DIRECTIONAL ARROW	1
16	22175	.DECAL, CAUTION MONOFILLED TIRES ONLY	6
17	20412	.BLUE STRIP ROUND ENDS (½ REQUIRED EACH SIDE)	1
18	20508	.DECAL, TRANSPORTATION	2
19	2017	.DECAL, HYDRAULIC SYSTEM (ONE ON HYDRAULIC TANK)	2
20	2020	.DECAL, GASOLINE (ONE ON GAS TANK)	2
21	20411	.DECAL, BLUE STRIP SQUARE ENDS (3 REQUIRED EACH SIDE)	6
22	24496	.DECAL, REACH GRAPH	1
23	20495	.DECAL, EMERGENCY GROUND CONTROLS	1
24	20419	.DECAL, DANGER KEEP CLEAR	3
25	181102	.DECAL, DANGER DO NOT OPERATE UNLESS	1
26	181103	.DECAL, DANGER OBEY THE FOLLOWING	1
27	20860	.DECAL, GENERAL CHECKOUT & OPERATION INSTRUCTIONS	1
28	21235	.DECAL, EMERGENCY DESCENT	1
29	21237	.DECAL, GREASE FITTING	3
30	20410	.DECAL, MARK INDUSTRIES LOGO	1
31	20409	.DECAL, MARK PEDESTAL	1
32	20419	.DECAL, DANGER KEEP CLEAR	1
33	182710	.DECAL, DIRECTIONAL ARROW	1
34	20896	.DECAL, BRAKE	1
35	182709	.DECAL, DIRECTIONAL ARROW	1

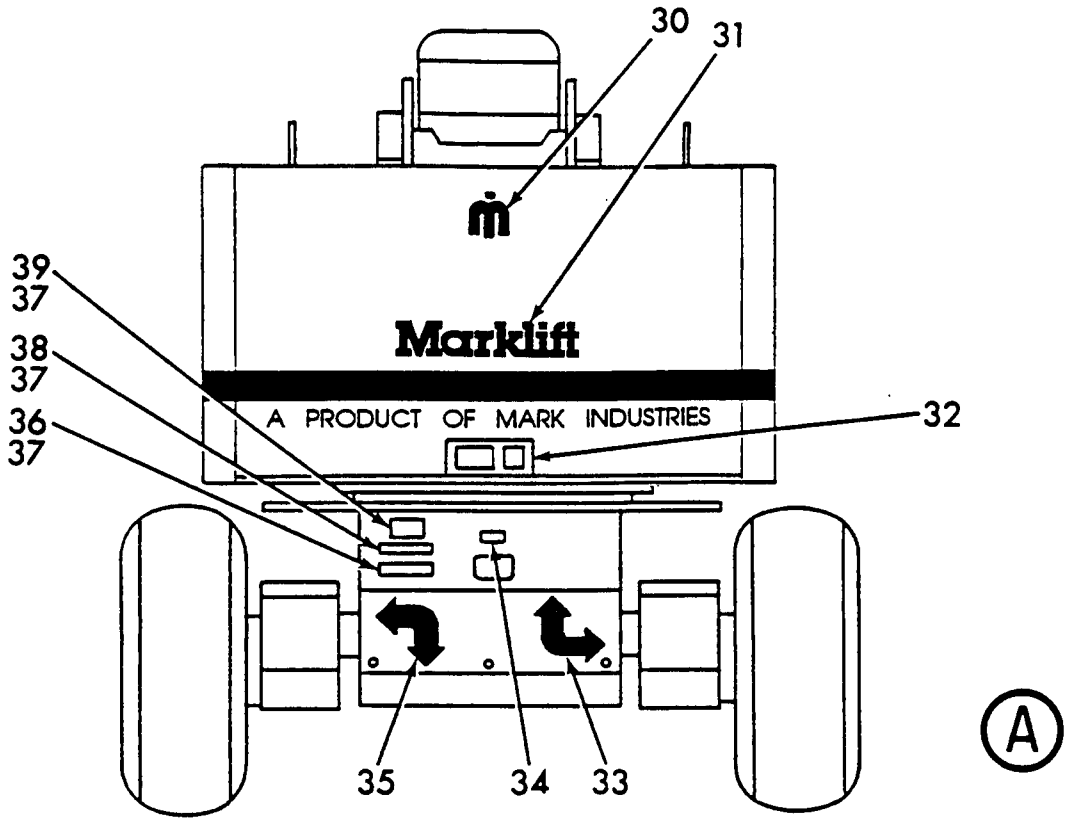
DECAL SET (80C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
36	20661	.DECAL PLATE, ANSI-A92	1
37	63653	.RIVET, POP	12
38	20662	.DECAL PLATE, PATENT NUMBERS	1
39	20660	.NAMEPLATE, I.D.	1

DECAL SET (100C 6X4)



DECAL SET (100C 6X4)

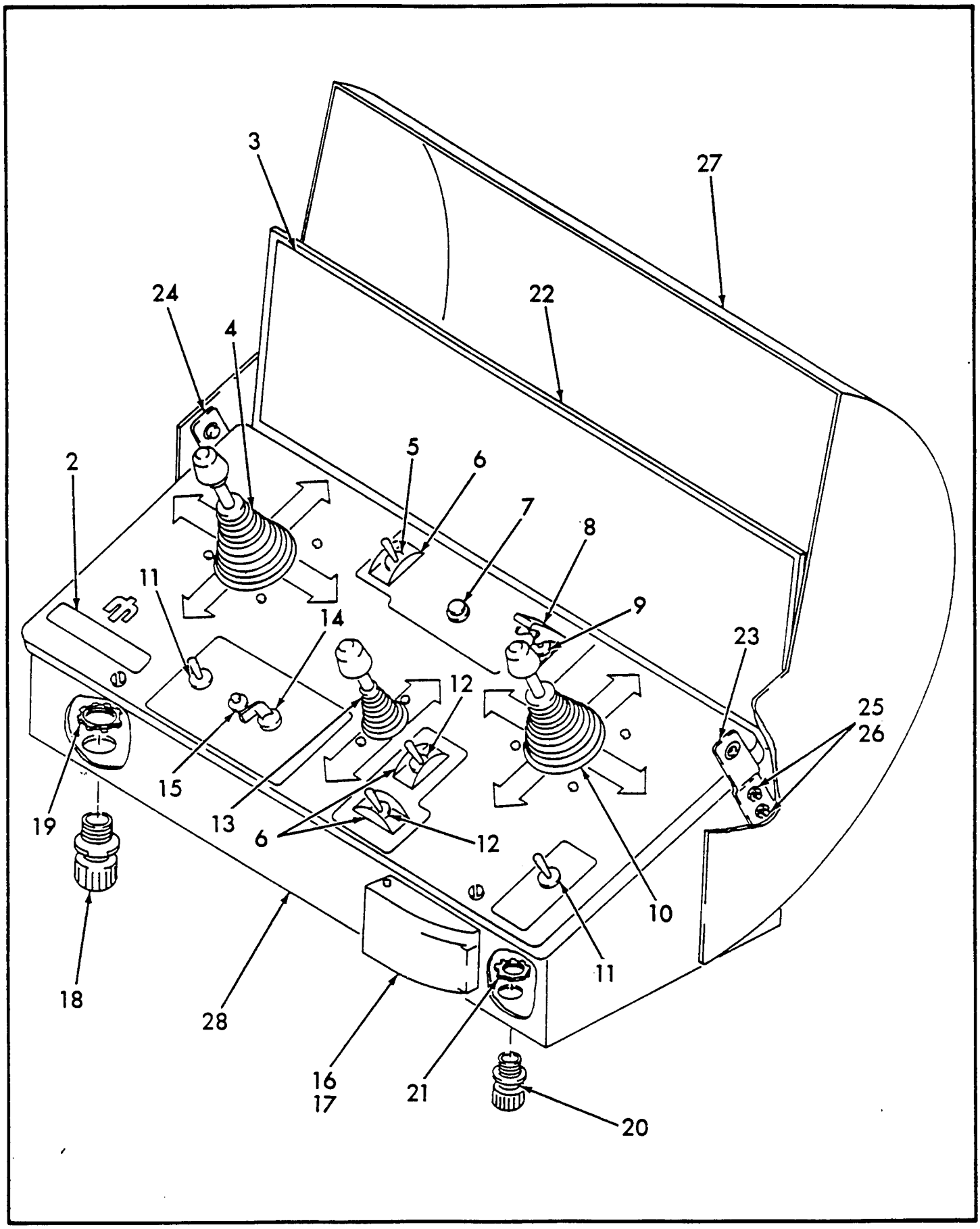


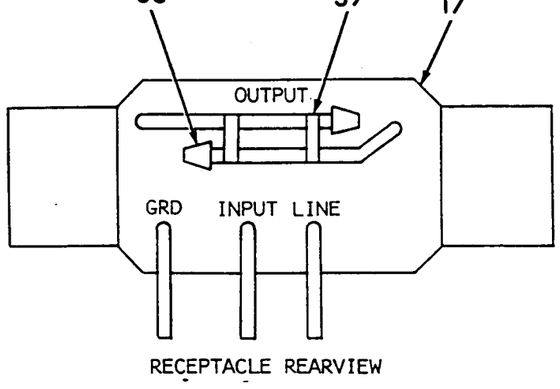
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	67804	SET, DECAL (See Sect. 2, Fig. 1 for NHA)	REF
2	2022	.DECAL, LOAD CAPACITY 500 LBS.	2
3	22385	.DECAL, ATTACH SAFETY BELT	1
4	22386	.DECAL, "D" RING ATTACH SAFETY BELT	2
5	130820	.DECAL, OPERATION & SAFETY HANDBOOK	1
6	24496	.DECAL, REACH GRAPH	1
7	181103	.DECAL, DANGER OBEY THE FOLLOWING	1
8	181102	.DECAL, DANGER DO NOT OPERATE UNLESS	1
9	21236	.DECAL, MARKLIFT BOOM	2
10	22910	.DECAL, "100"	2
11	181903	.DECAL, "C"	2
12	22739	.DECAL, "6X4"	2

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
13	2003	.DECAL, BATTERY	1
14	182709	.DECAL, DIRECTIONAL ARROW	1
15	182710	.DECAL, DIRECTIONAL ARROW	1
16	22175	.DECAL, CAUTION MONOFILLED TIRES ONLY	6
17	20412	.BLUE STRIP ROUND ENDS (½ REQUIRED EACH SIDE)	1
18	20508	.DECAL, TRANSPORTATION	2
19	2017	.DECAL, HYDRAULIC SYSTEM (ONE ON HYDRAULIC TANK)	2
20	2033	.DECAL, DIESEL FUEL ONLY	2
21	20411	.DECAL, BLUE STRIP SQUARE ENDS (3 REQUIRED EACH SIDE)	6
22	24496	.DECAL, REACH GRAPH	1
23	20495	.DECAL, EMERGENCY GROUND CONTROLS	1
24	20419	.DECAL, DANGER KEEP CLEAR	3
25	181102	.DECAL, DANGER DO NOT OPERATE UNLESS	1
26	181103	.DECAL, DANGER OBEY THE FOLLOWING	1
27	20860	.DECAL, GENERAL CHECKOUT & OPERATION INSTRUCTIONS	1
28	21235	.DECAL, EMERGENCY DESCENT	1
29	21237	.DECAL, GREASE FITTING	3
30	20410	.DECAL, MARK INDUSTRIES LOGO	1
31	20409	.DECAL, MARK PEDESTAL	1
32	20419	.DECAL, DANGER KEEP CLEAR	1
33	182710	.DECAL, DIRECTIONAL ARROW	1
34	20896	.DECAL, BRAKE	1
35	182709	.DECAL, DIRECTIONAL ARROW	1
36	20661	.DECAL PLATE, ANSI-A92	1

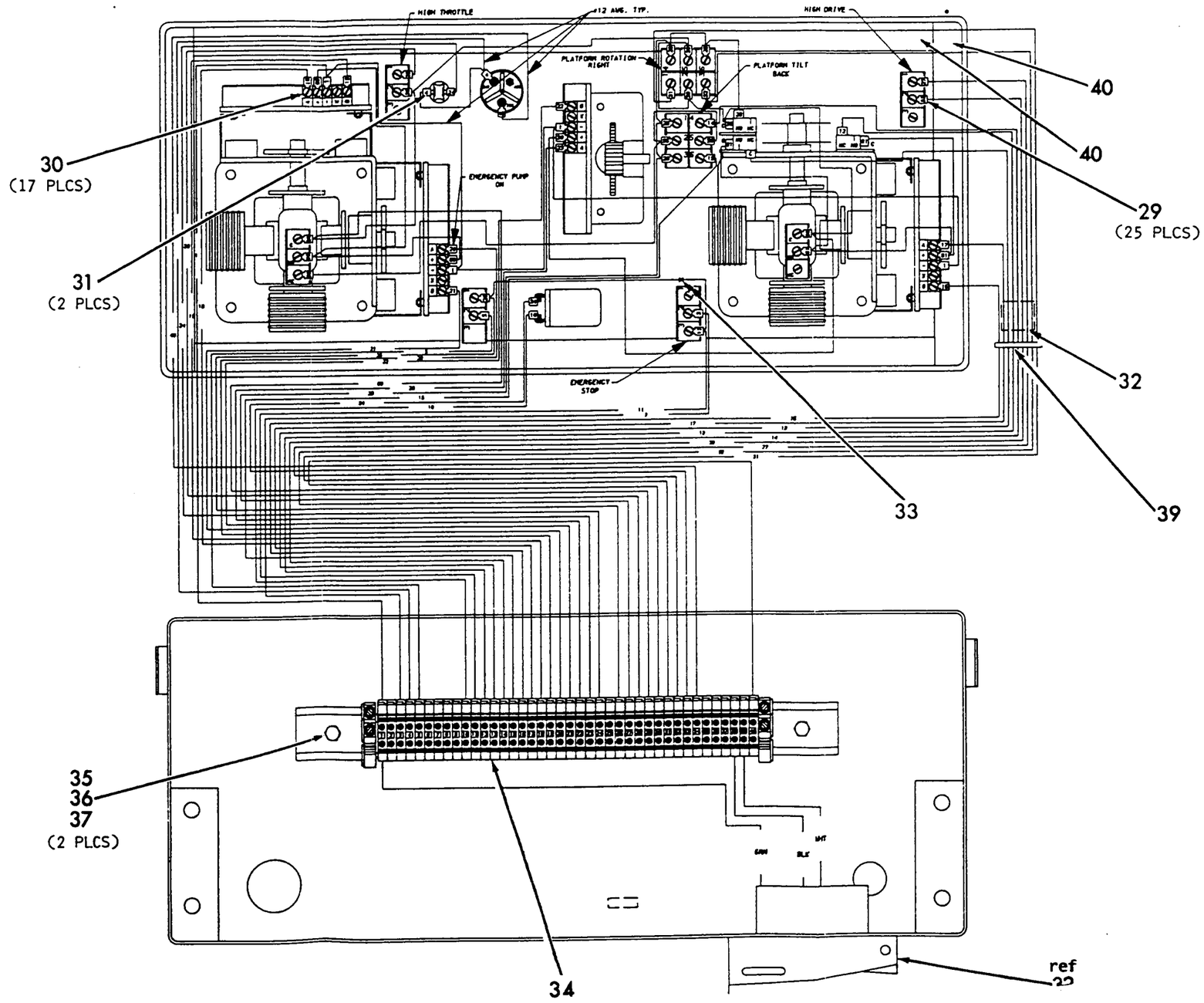
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
37	63653	.RIVET, POP	12
38	20662	.DECAL PLATE, PATENT NUMBERS	1
39	20660	.NAMEPLATE, I.D.	1

AERIAL CONTROL BOX ASSEMBLY (ALL MODELS)





RECEPTACLE REARVIEW



WIRING DIAGRAM

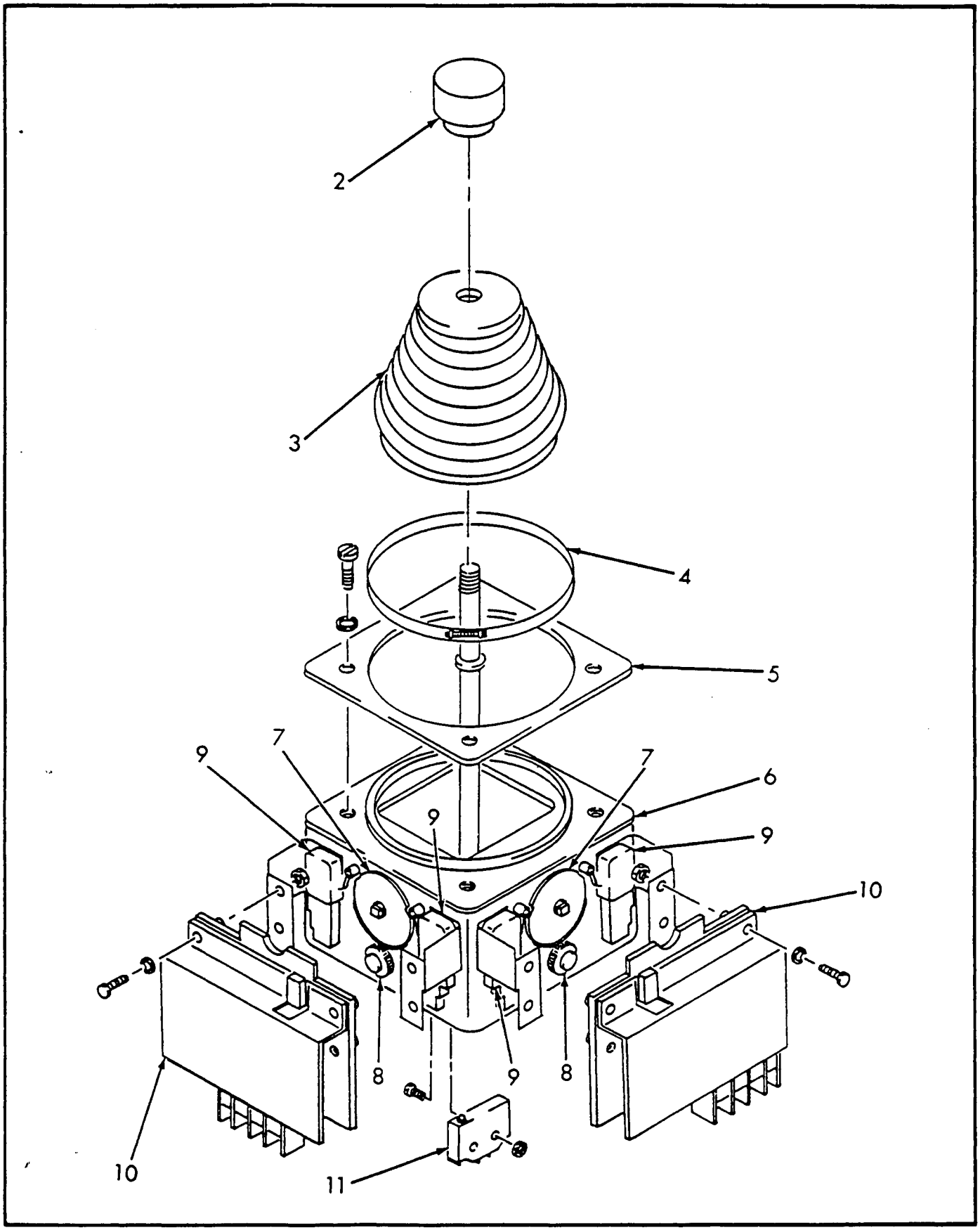
AERIAL CONTROL BOX ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24118	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 1, 1A or 1B for NHA)	REF
2	182707	.DECAL, AERIAL CONTROL BOX	1
3	182103	.DECAL, OPERATING INSTRUCTIONS	1
4	70457	.CONTROL, MULTI-AXIS (See Sect. 2, Fig. 3A for Details)	1
5	70291	.SWITCH, TOGGLE	1
6	20884	.GUARD, SWITCH	3
7	20805	.BUZZER, ALARM	1
8	70407	.GUARD, SWITCH	1
9	4021	.SWITCH, TOGGLE	1
10	70455	.CONTROL, MULTI-AXIS (See Sect. 2, Fig. 3B for Details)	1
11	70313	.SWITCH, TOGGLE	2
12	20481	.SWITCH, TOGGLE	2
13	70453	.CONTROL, SINGLE AXIS (See Sect. 2, Fig. 3C for Details)	1
14	70405	.SWITCH, ANTI-RESTART IGNITION	1
15	4011	.SWITCH, PUSH BUTTON	1
16	70392	.COVER, RECEPTACLE	1
17	70391	.RECEPTACLE, G.F.C.I.	1
18	16215	.RELIEF, STRAIN	1
19	16005	.NUT, LOCK	1
20	2806	.REFIEF, STRAIN	1
21	2808	.NUT, LOCK	1
22	24122	.PLATE, BACK	1
23	24121	.BRACKET, RIGHT SIDE MOUNTING	1
24	24120	.BRACKET, LEFT SIDE MOUNTING	1

AERIAL CONTROL BOX ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	60701	.NUT, HEX	7
26	63301	.WASHER, LOCK	7
27	24123	.WELDMENT, COVER	1
28	24119	.BOX, AERIAL CONTROL	1
29	2859	.TONGUE, RING	25
30	70406	.SPRING, SPADE	17
31	117-E	.TERMINAL, PUSH IN	2
32	16214	.MOUNTS	5
33	4045	.DIODE	1
34	24127	.ASSEMBLY, TERMINAL BLOCK	1
35	63401	.WASHER, FLAT	2
36	63301	.WASHER, LOCK	2
37	60701	.NUT, HEX	2
38	70394	.CONNECTOR, TWIST-ON WIRE	2
39	256	.TIE, CABLE	50
40	160015	.EXTRUSION, NEOPRENE BLACK	4

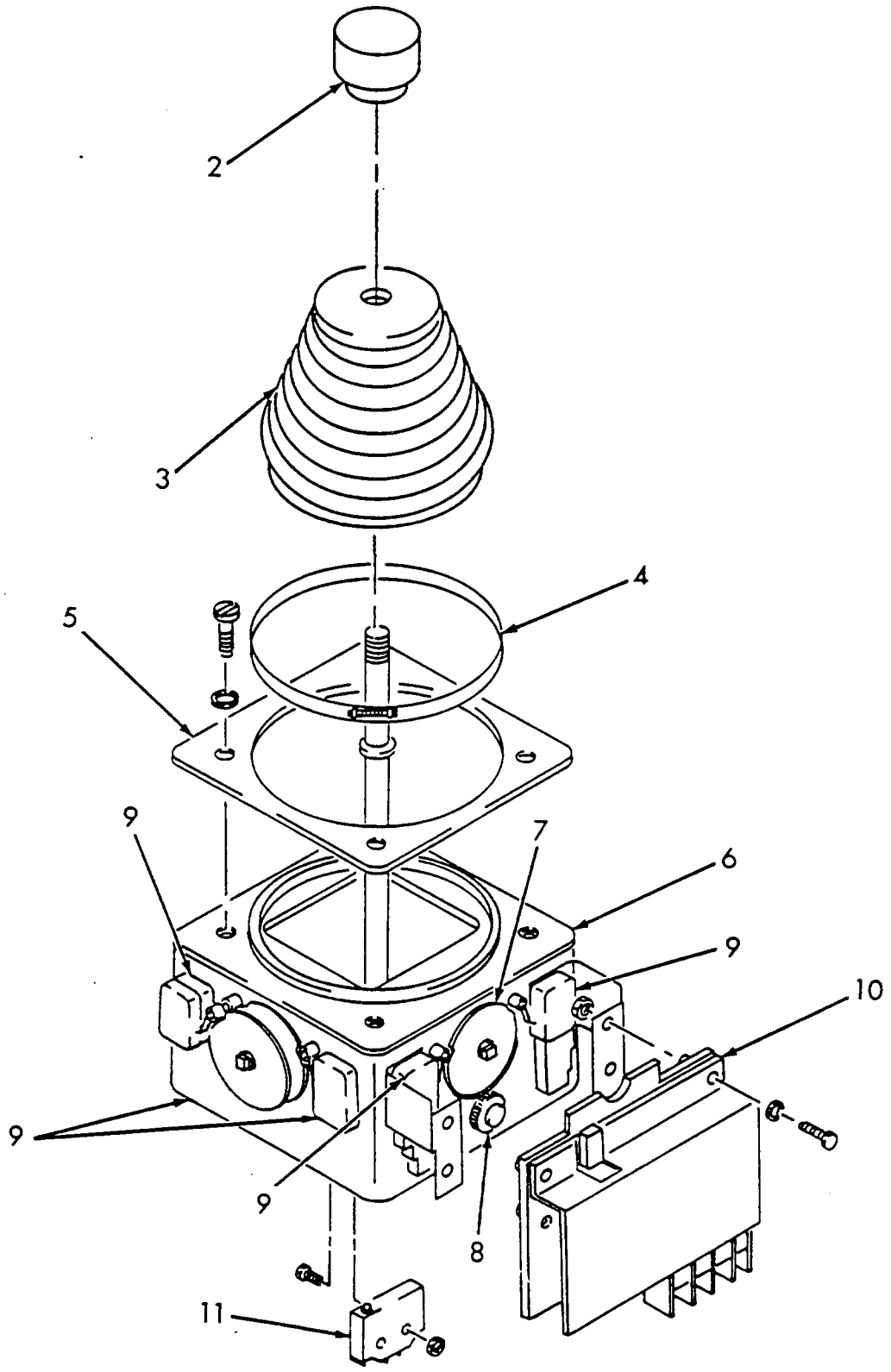
AERIAL CONTROL BOX MULTI-AXIS CONTROL (LIFT/LOWER AND TURRET ROTATION)



AERIAL CONTROL BOX MULTI-AXIS CONTROL

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	70457	CONTROL, MULTI-AXIS (See Sect. 2, Fig. 3 for NHA)	REF
2		.KNOB	1
3	67482	.BOOT	1
4	67483	.CLAMP, BOOT	1
5	67481	.GASKET, MOUNTING	1
6	67491	.ASSEMBLY, POTENTIOMETER	1
7	67484	.GEAR, CAM	2
8	67485	.GEAR, SLAVE	2
9	67486	.SWITCH, MICRO	4
10	67490	.BOARD, CIRCUIT	2
11	67487	.BRACKET, AUXILIARY CONTACT	2

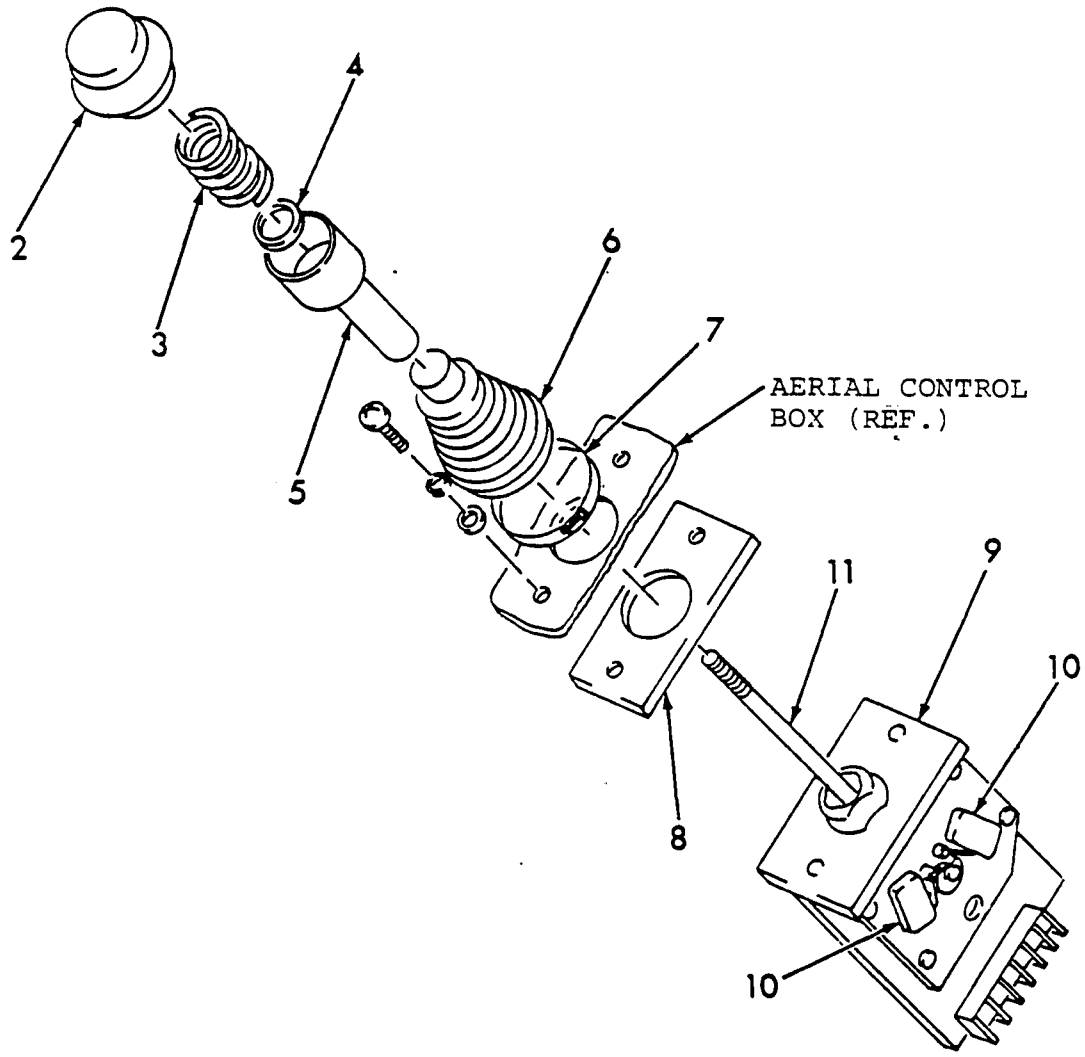
AERIAL CONTROL BOX MULTI-AXIS CONTROL (DRIVE/STEER)



AERIAL CONTROL BOX MULTI-AXIS CONTROL

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	70455	CONTROL, MULTI-AXIS (See Sect. 2, Fig. 3 for NHA)	REF
2		.KNOB	1
3	67482	.BOOT	1
4	67483	.CLAMP, BOOT	1
5	67481	.GASKET, MOUNTING	1
6	67491	.ASSEMBLY, POTENTIOMETER	1
7	67484	.GEAR, CAM	1
8	67485	.GEAR, SLAVE	1
9	67486	.SWITCH, MICRO	5
10	67490	.BOARD, CIRCUIT	1
11	67487	.BRACKET, AUXILIARY CONTACT	1

AERIAL CONTROL BOX SINGLE-AXIS CONTROL (EXTEND/RETRACT)

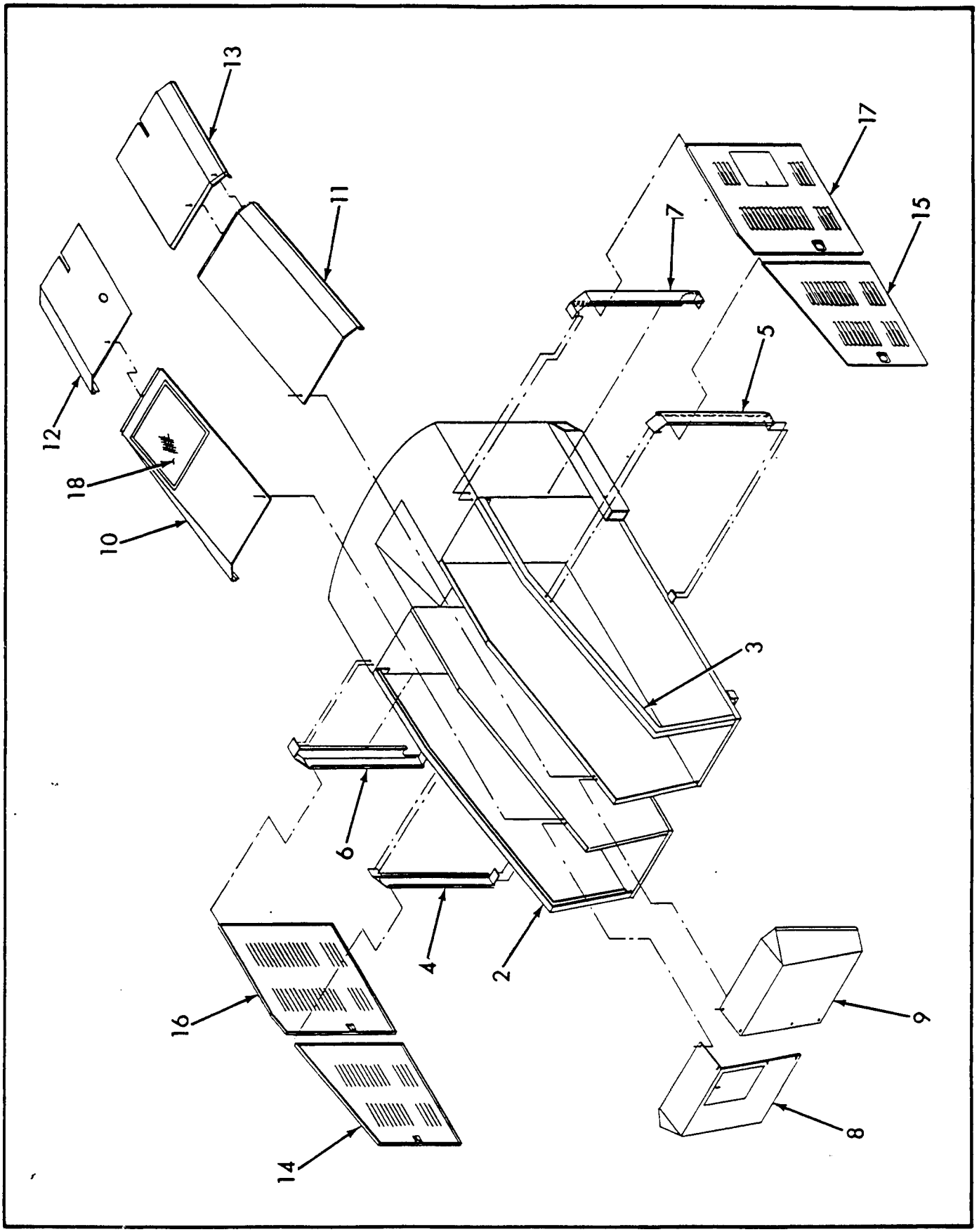


REV.

AERIAL CONTROL BOX SINGLE-AXIS CONTROL

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	70453	CONTROL, SINGLE AXIS (See Sect. 2, Fig. 3 for NHA)	REF
2	67499	.CAP, UPPER	1
3	67498	.SPRING, HANDLE	1
4	67497	.RING, RETAINING	1
5	67488	.HANDLE, LOWER	1
6	67496	.BOOT	1
7	67495	.CLAMP, BOOT	1
8	67493	.GASKET	1
9	67492	.POTENTIOMETER, CIRCUIT BOARD	1
10	67486	.SWITCH, MICRO	2
11	67494	.TUBE, MECHANICAL INTERLOCK	1

SHEET METAL KIT (ALL MODELS)

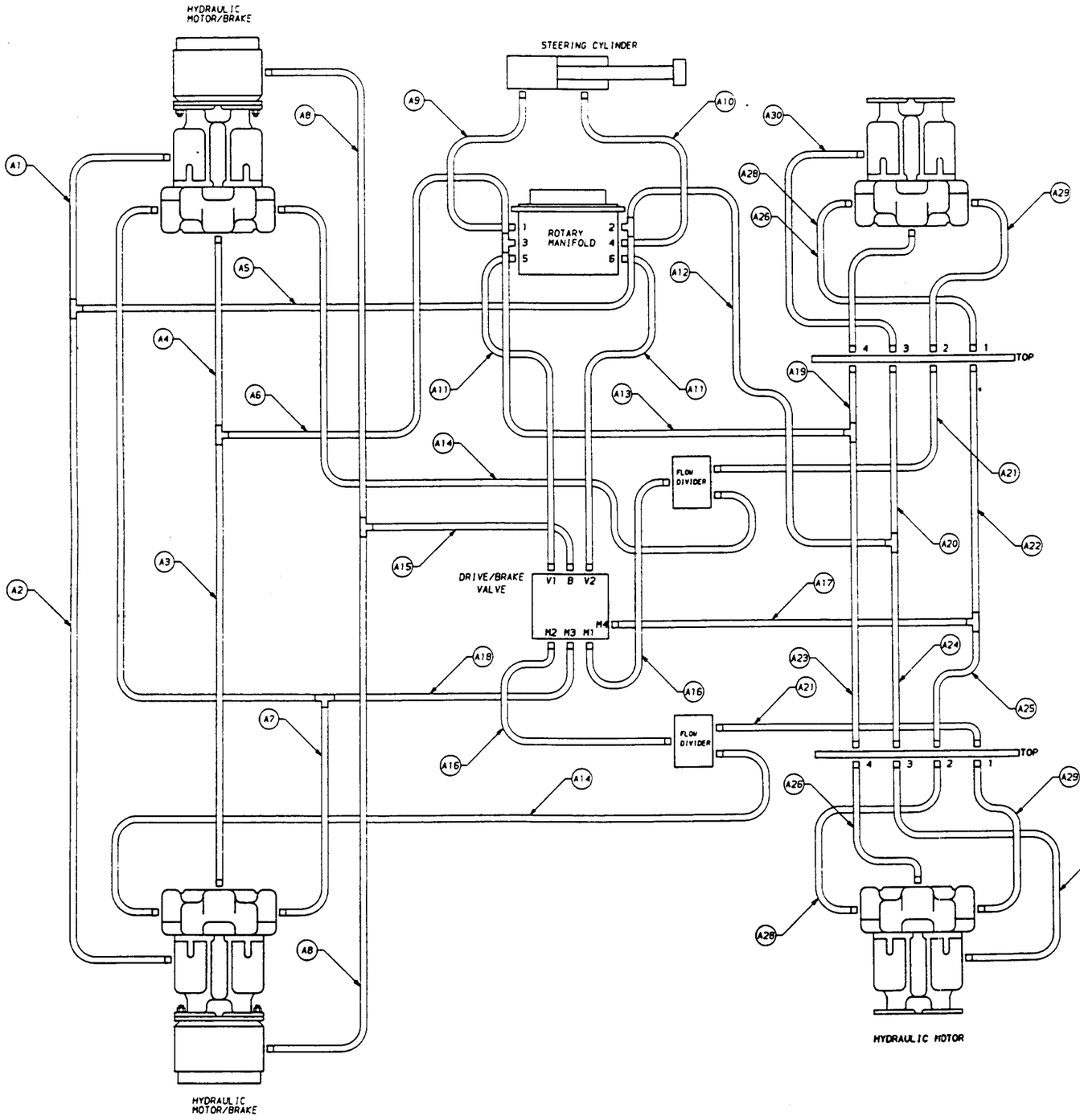


REV.

SHEET METAL KIT (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22009	KIT, SHEET METAL (See Sect. 2, Fig. 1, 1A or 1B for NHA)	REF
2	22336	.RAIL, FRAME (LEFT)	1
3	22337	.RAIL, FRAME (RIGHT)	1
4	22338	.SUPPORT, MID (LEFT)	1
5	22339	.SUPPORT, MID (RIGHT)	1
6	22340	.SUPPORT, FRONT (LEFT)	1
7	22341	.SUPPORT, FRONT (RIGHT)	1
8	22342	.COVER, NOSE (LEFT)	1
9	22343	.COVER, NOSE (RIGHT)	1
10	22344	.COVER, MID (LEFT)	1
11	22345	.COVER, MID (RIGHT)	1
12	22346	.COVER, TOP (LEFT)	1
13	22347	.COVER, TOP (RIGHT)	1
14	22348	.DOOR, REAR (LEFT)	1
15	22349	.DOOR, REAR (RIGHT)	1
16	22350	.DOOR, FRONT (LEFT)	1
17	22351	.DOOR, FRONT (RIGHT)	1
18	22352	.SCREEN	1

HYDRAULIC HOSE DIAGRAM (80C 4X4)

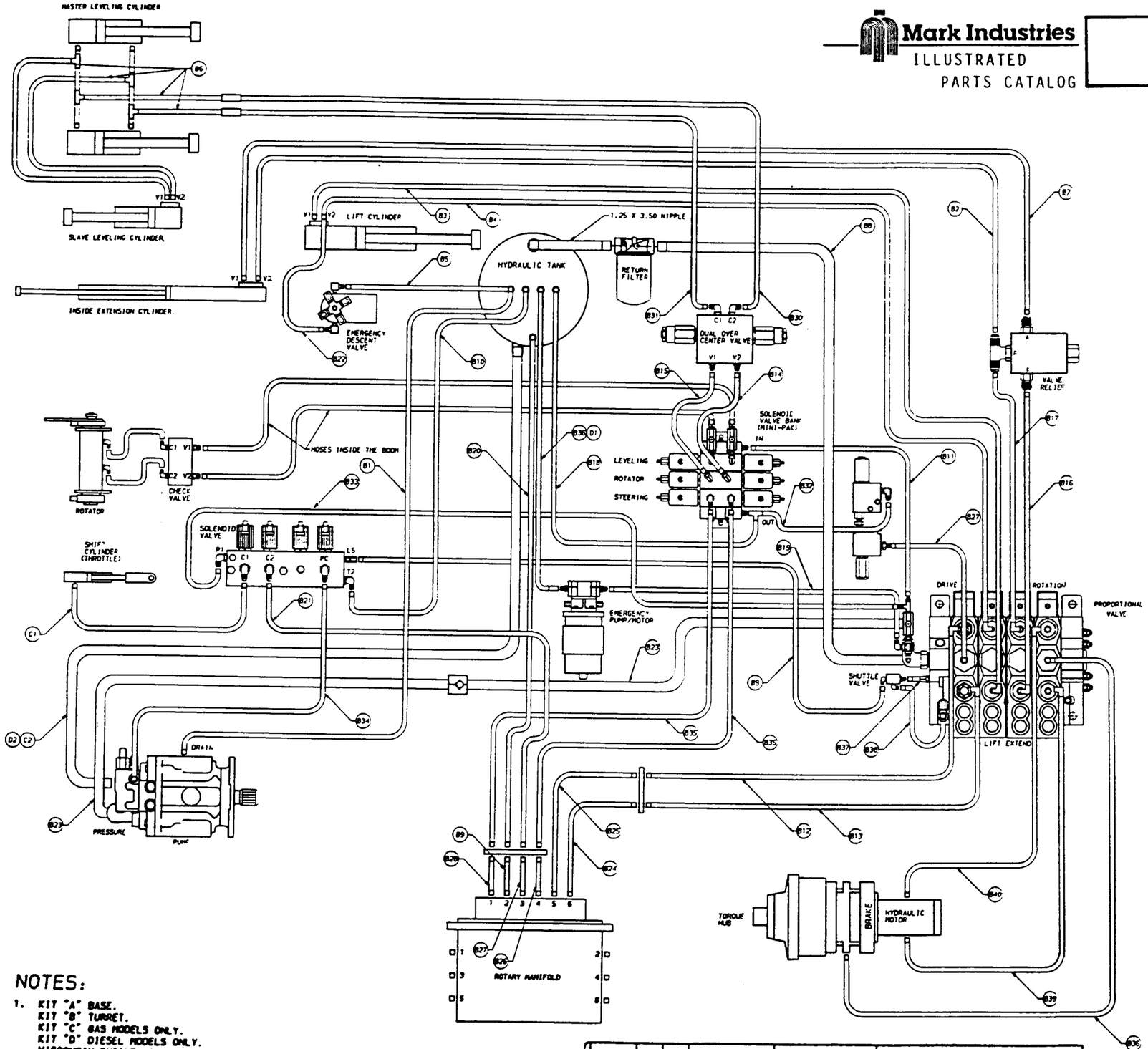


KIT "A"

CODE IDENT NO	QTY. REQ'D	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	DATA: SPECIFICATIONS SIZES, NOTES, SUPPLIERS
BILL OF MATERIAL					
.	1	A30	13215-06-0554-5*	ASSEMBLY , HOSE.	.
.	2	A29	13213-12-0450	.	.
.	2	A28	13215-12-0510-5*	.	.
.	1	A27	13213-06-0490	.	.
.	2	A26	13213-04-0520	.	.
.	1	A25	13210-12-0090	.	.
.	1	A24	13210-06-0204	.	.
.	1	A23	13210-04-0204	.	.
.	1	A22	13210-12-0200	.	.
.	2	A21	13212-12-0580	.	.
.	1	A20	13210-06-0100	.	.
.	1	A19	13210-04-0104	.	.
.	1	A18	13210-12-0680	.	.
.	1	A17	13213-12-0750	.	.
.	2	A16	13213-12-0340	.	.
.	1	A15	13210-04-0680	.	.
.	2	A14	13210-12-1110	.	.
.	1	A13	13210-04-0650	.	.
.	1	A12	13210-06-0680	.	.
.	2	A11	13213-12-0274	.	.
.	1	A10	13210-04-0800	.	.
.	1	A9	13210-04-0710	.	.
.	2	A8	13213-04-0344	.	.
.	1	A7	13210-12-0214	.	.
.	1	A6	13210-04-0750	.	.
.	1	A5	13210-06-0800	.	.
.	1	A4	13213-04-0240	.	.
.	1	A3	13213-04-0254	.	.
.	1	A2	13210-06-0330	.	.
.	1	A1	13210-06-0290	ASSEMBLY , HOSE.	.

DWG NO. 24650

HYDRAULIC HOSE DIAGRAM (80C 4X4)



NOTES:

1. KIT "A" BASE.
   KIT "B" TURRET.
   KIT "C" GAS MODELS ONLY.
   KIT "D" DIESEL MODELS ONLY.
   WISCONSIN ENGINE WILL REQUIRE KITS A,B,& C.
   LISTER & DEUTZ ENGINE WILL REQUIRE KITS A,B,& D.
   EACH TO BE PACKED & SHIPPED SEPARATELY.
2. TAG EACH ITEM WITH PART NUMBER
   EXAMPLE. 13213-12-0230.
3. TAG EACH KIT WITH DRAWING NUMBER/KIT LETTER/REVISION LEVEL
   EXAMPLE. 24650 A/C

KIT "B"

.	1	840	13213-08-0940		
.	1	839	13212-08-0950	ASSEMBLY , HOSE.	
.	1	838	13213-04-0150	ASSEMBLY , HOSE	
.	1	837	13213-04-0060		
.	1	836	13213-04-1000		
.	2	835	13213-04-0210		
.	1	834	13210-04-0200		
.	1	833	13213-06-1450		
.	1	832	13210-04-0140		
.	1	831	13213-04-1240		
.	1	830	13213-04-1220		
.	1	829	13213-04-0200		
.	1	828	13213-06-0210		
.	2	827	13213-04-0230		
.	1	826	13213-04-0260		
.	1	825	13213-12-0280		
.	1	824	13213-12-0220		
.	1	823	13210-16-0600		
.	1	822	13210-04-0600		
.	1	821	13213-04-1250		
.	1	820	13213-06-0320		
.	1	819	13213-06-1080		
.	1	818	13210-06-0280		
.	1	817	13212-08-0310		
.	1	816	13213-08-0274		
.	1	815	13213-04-0190		
.	1	814	13213-04-0160		
.	1	813	13212-12-0290		
.	4	812	13213-12-0230		
.	1	811	13212-06-0280		
.	1	810	13210-06-1300		
.	1	89	13210-04-1300		
.	1	88	13210-16-0290		
.	1	87	13210-08-1180		
.	4	86	13211-04-0150		
.	1	85	13210-04-1150		
.	1	84	13213-08-1300		
.	1	83	13212-08-1250		
.	1	82	13213-08-1160		
.	1	81	13210-06-0850	ASSEMBLY , HOSE	

KIT "D"

.	1	D2	13205-20-0590	ASSEMBLY , HOSE.	
.	1	D1	13213-06-1000		

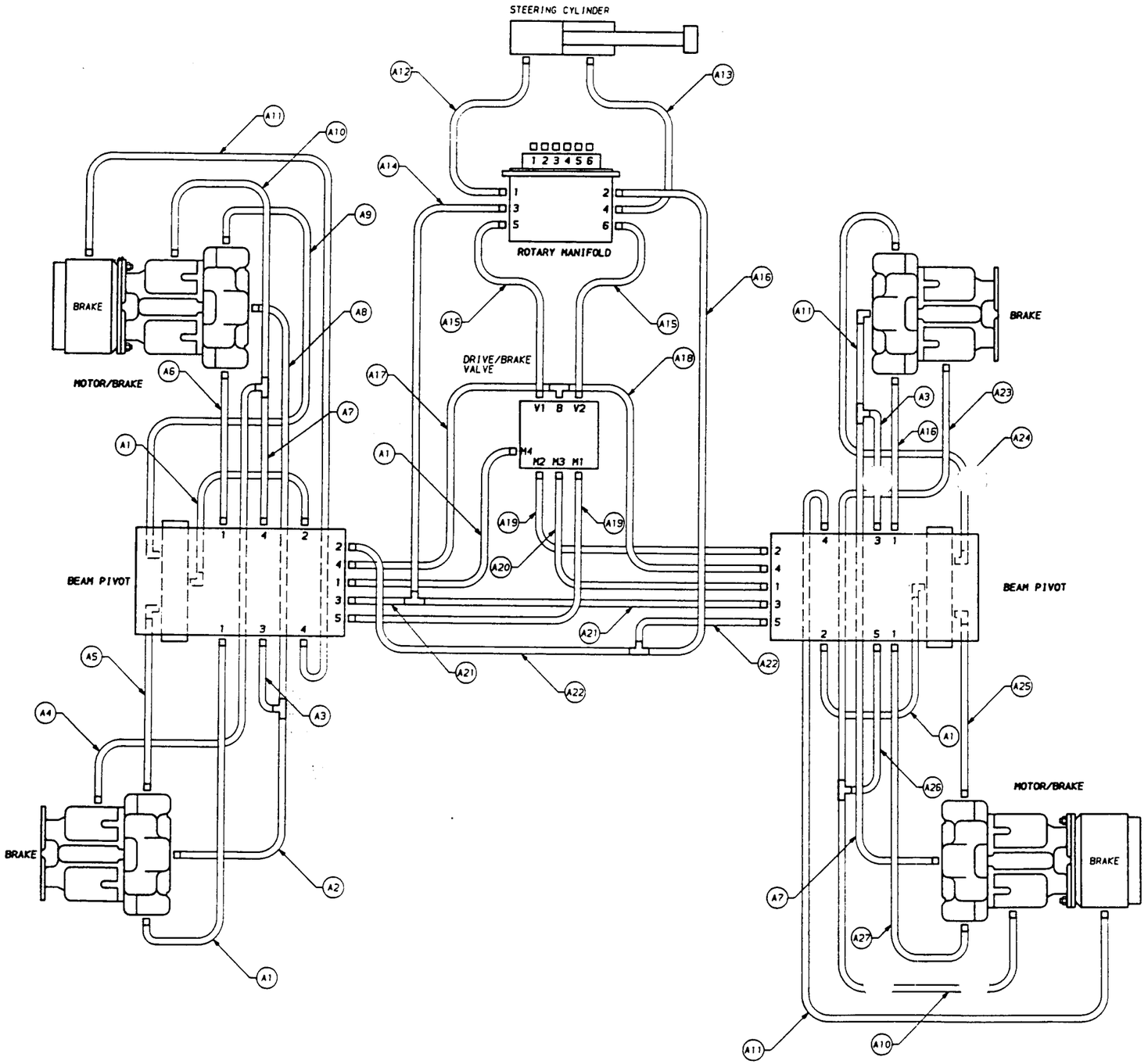
KIT "C"

.	1	C2	13205-20-0540		
.	1	C1	13210-04-1060		

DWG NO. 24650

HYDRAULIC HOSE DIAGRAM (80C 6X4)
(TO BE FURNISHED WHEN AVAILABLE)

DWG NO. SKP-0817-KT-C



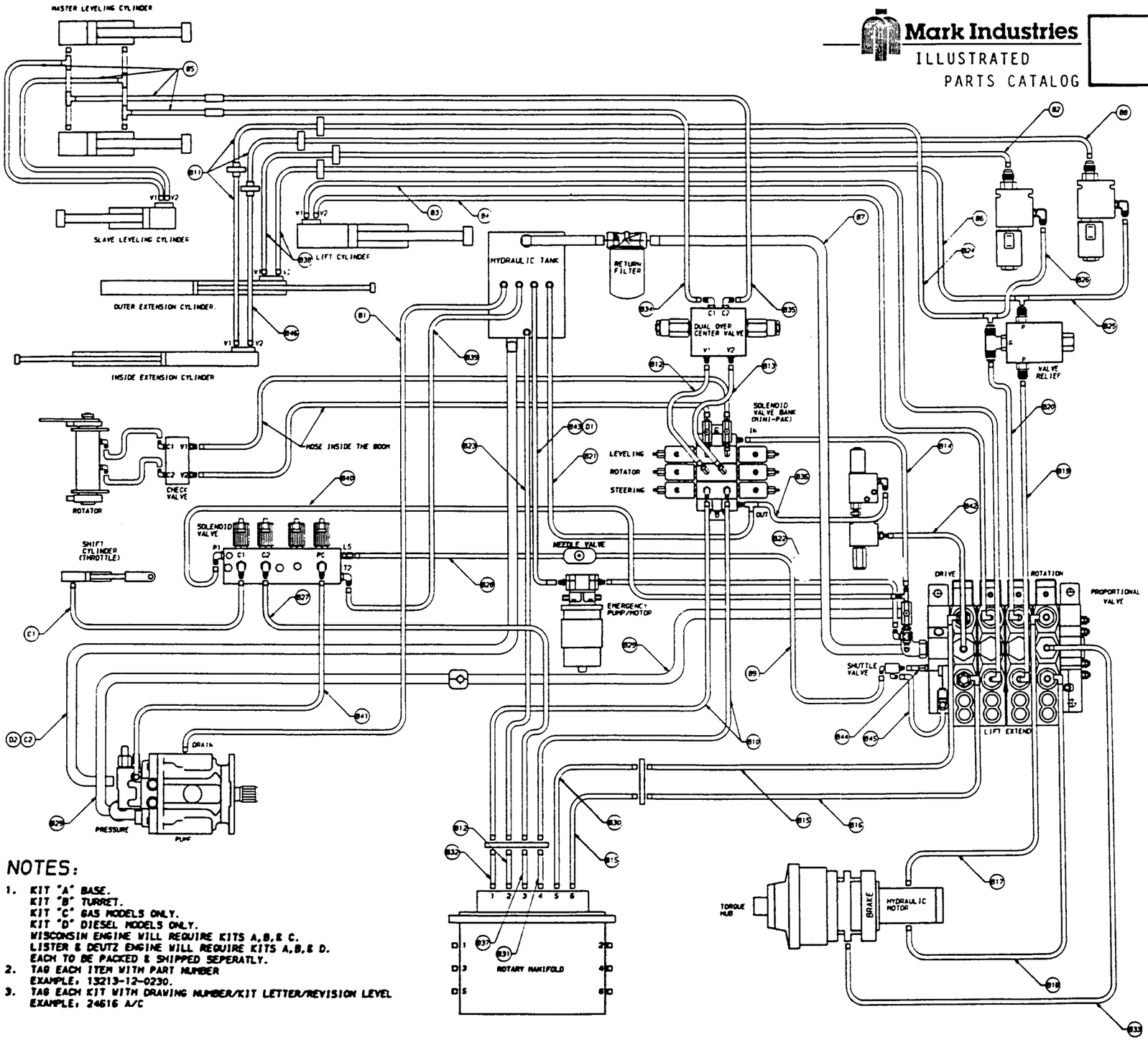
KIT "A"

CODE IDENT NO	QTY REQ'D	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	DATA: SPECIFICATIONS SIZES, NOTES, SUPPLIERS
.	4	A1	13213-12-0270	ASSEMBLY , HOSE.	.
.	1	A2	13213-04-0280	.	.
.	2	A3	13210-04-0160	.	.
.	1	A4	13223-12-0280	.	.
.	1	A5	13210-12-0170	.	.
.	2	A6	13210-12-0160	.	.
.	2	A7	13213-04-0220	.	.
.	1	A8	13213-04-0270	.	.
.	1	A9	13212-12-0300	.	.
.	2	A10	13213-08-0290	.	.
.	3	A11	13213-04-0380	.	.
.	1	A12	13210-04-0650	.	.
.	1	A13	13210-04-0680	.	.
.	1	A14	13210-04-0950	.	.
.	2	A15	13223-12-0800	.	.
.	1	A16	13210-08-0950	.	.
.	1	A17	13213-04-0200	.	.
.	1	A18	13213-04-0120	.	.
.	2	A19	13214-12-0270	.	.
.	1	A20	13214-12-0230	.	.
.	2	A21	13213-04-0154	.	.
.	2	A22	13213-08-0130	.	.
.	1	A23	13213-08-0470	.	.
.	1	A24	13213-12-0280	.	.
.	1	A25	13210-12-0180	.	.
.	1	A26	13210-08-0190	.	.
.	1	A27	13212-12-0270	ASSEMBLY , HOSE.	.

BILL OF MATERIAL

DWG NO. 24616

HYDRAULIC HOSE DIAGRAM (100C 6X4)



NOTES:

1. KIT "A" BASE.
   KIT "B" TURRET.
   KIT "C" GAS MODELS ONLY.
   KIT "D" DIESEL MODELS ONLY.
   WISCONSIN ENGINE WILL REQUIRE KITS A,B,& C.
   LISTER & DEUTZ ENGINE WILL REQUIRE KITS A,B,& D.
   EACH TO BE PACKED & SHIPPED SEPERATLY.
2. TAG EACH ITEM WITH PART NUMBER
   EXAMPLE: 13213-12-0230.
3. TAG EACH KIT WITH DRAWING NUMBER/KIT LETTER/REVISION LEVEL
   EXAMPLE: 24616 A/C

KIT "D"

.	1	D2	13205-20-0600	ASSEMBLY ,HOSE.		.
.	1	D1	13213-06-0990	.		.

KIT "C"

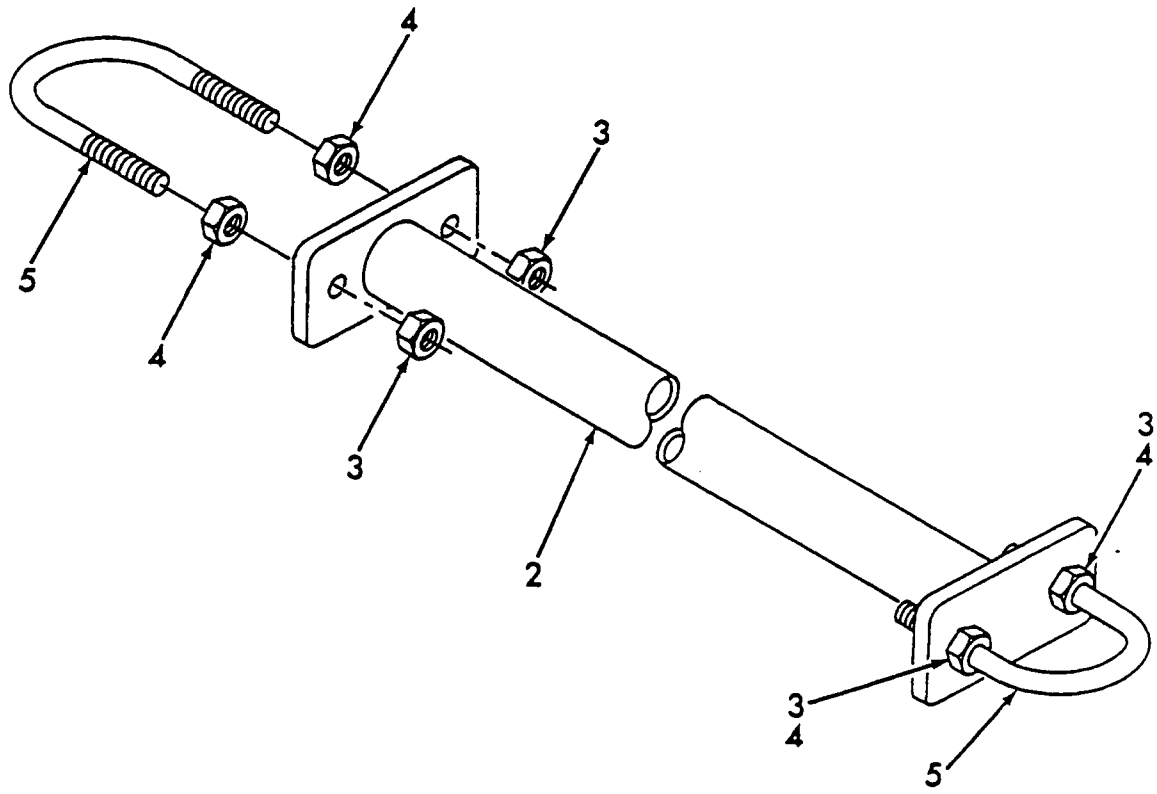
.	1	C2	13205-20-0540	.		.
.	1	C1	13210-04-1060	.		.

.	1	B46	13213-08-3100	.		.
.	1	B45	13213-04-0150	.		.
.	1	B44	13213-04-0060	.		.
.	1	B43	13213-06-1000	ASSEMBLY ,HOSE.		.

KIT "B"

.	1	B42	13213-04-0200	ASSEMBLY ,HOSE.		.
.	1	B41	13213-06-1450	.		.
.	1	B40	13210-06-1190	.		.
.	2	B39	13210-08-0850	.		.
.	1	B38	13210-04-1000	.		.
.	1	B37	13213-04-0230	.		.
.	1	B36	13210-04-0110	.		.
.	1	B35	13213-04-1220	ASSEMBLY ,HOSE.		.
.	1	A34	13213-04-1240	ASSEMBLY ,HOSE.		.
.	1	A33	13213-04-1000	.		.
.	1	A32	13213-06-0210	.		.
.	1	B31	13213-04-0260	.		.
.	1	B30	13213-12-0280	.		.
.	2	B29	13213-16-0600	.		.
.	1	B28	13210-04-0100	.		.
.	1	B27	13213-04-1200	.		.
.	2	B26	13210-08-0360	.		.
.	1	B25	13210-08-0270	.		.
.	1	B24	13213-08-1160	.		.
.	1	B23	13213-06-0320	.		.
.	1	B22	13213-06-1080	.		.
.	1	B21	13213-08-0280	.		.
.	1	B20	13212-08-0310	.		.
.	1	B19	13213-08-0270	.		.
.	1	B18	13212-08-0950	.		.
.	1	B17	13213-08-0940	.		.
.	1	B16	13212-12-0260	.		.
.	2	B15	13213-12-0230	.		.
.	1	B14	13213-06-0200	.		.
.	1	B13	13213-04-0160	.		.
.	2	B12	13213-04-0190	.		.
.	3	B11	13213-08-3120	.		.
.	1	B10	13210-04-0190	.		.
.	1	B9	13213-04-1330	.		.
.	1	B8	13210-08-1480	.		.
.	1	B7	13210-16-0290	.		.
.	1	B6	13210-08-1180	.		.
.	4	B5	13211-04-0150	.		.
.	1	B4	13213-08-1300	.		.
.	1	B3	13212-08-1250	.		.
.	1	B2	13210-08-1540	.		.
.	1	B1	13210-06-0850	ASSEMBLY ,HOSE.		.

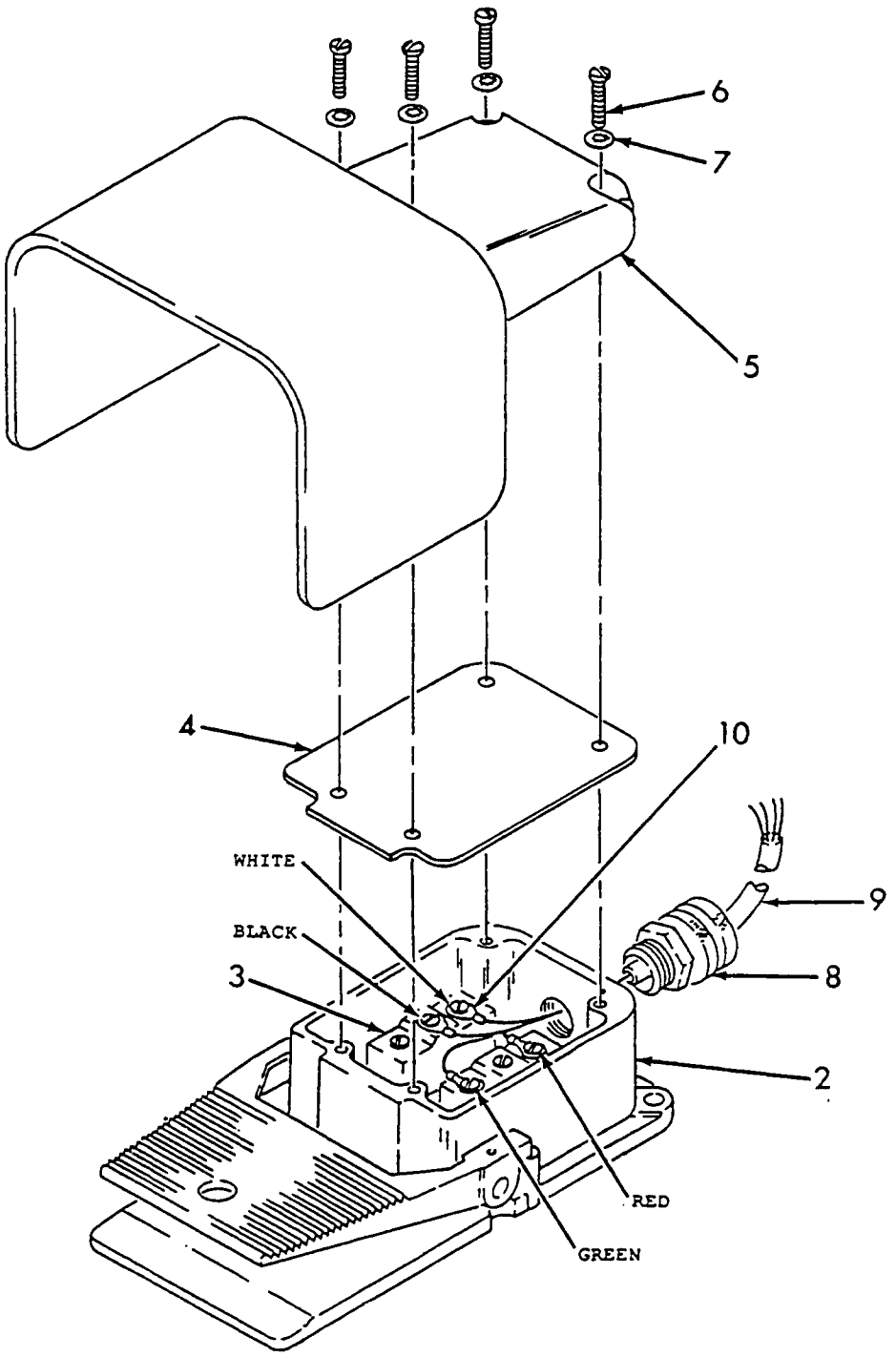
SLIDE BAR ASSEMBLY (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24088	ASSEMBLY, SLIDE BAR (See Sect. 2, Fig. 1, 1A or 1B for NHA)	REF
2	24167	.WELDMENT, SLIDE BAR	1
3	61318	.NUT, HEX LOCK	4
4	60703	.NUT, HEX	4
5	160017	.U-BOLT	2

REV.

FOOT SWITCH ASSEMBLY (ALL MODELS) (SINCE MID 1985)

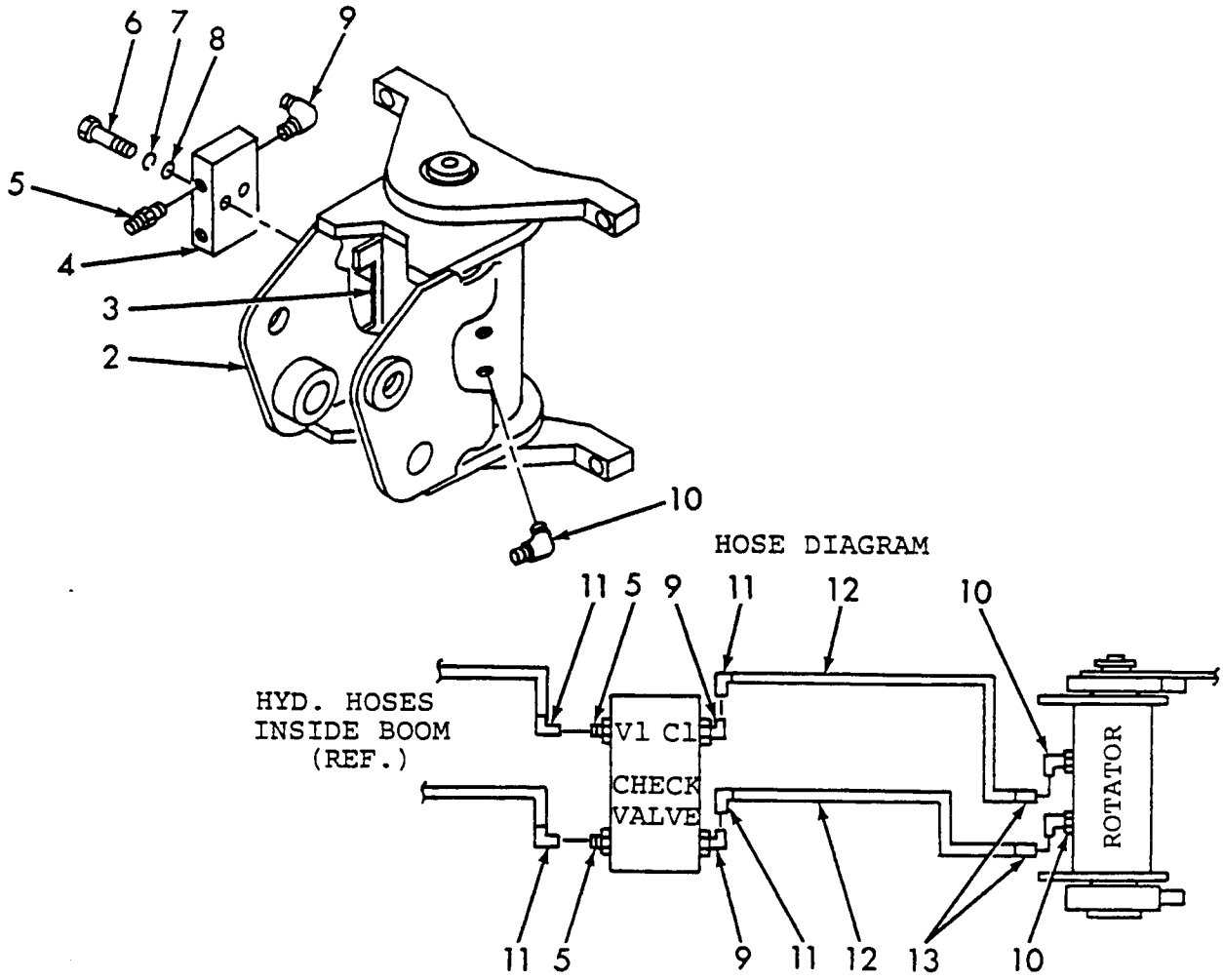


FOOT SWITCH ASSEMBLY (ALL MODELS) (SINCE MID 1985)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20480	ASSEMBLY, FOOT SWITCH (See Sect. 2, Fig. 1, 1A or 1B for NHA)	REF
2	70212	.SWITCH, FOOT (HERCULES)	1
3	66336	..MICROSWITCH	2
4		..GASKET	1
5		..COVER	1
6		..SCREW	4
7		..WASHER, STAR	4
8	2531	.RELIEF, STRAIN	1
9	2912	.CABLE, 18 GA/4 CONDUCTOR	6 FT.
10	117C	.CONNECTOR, RING	4

- ITEM NOT ILLUSTRATED

PLATFORM ROTATOR ASSEMBLY (ALL MODELS)



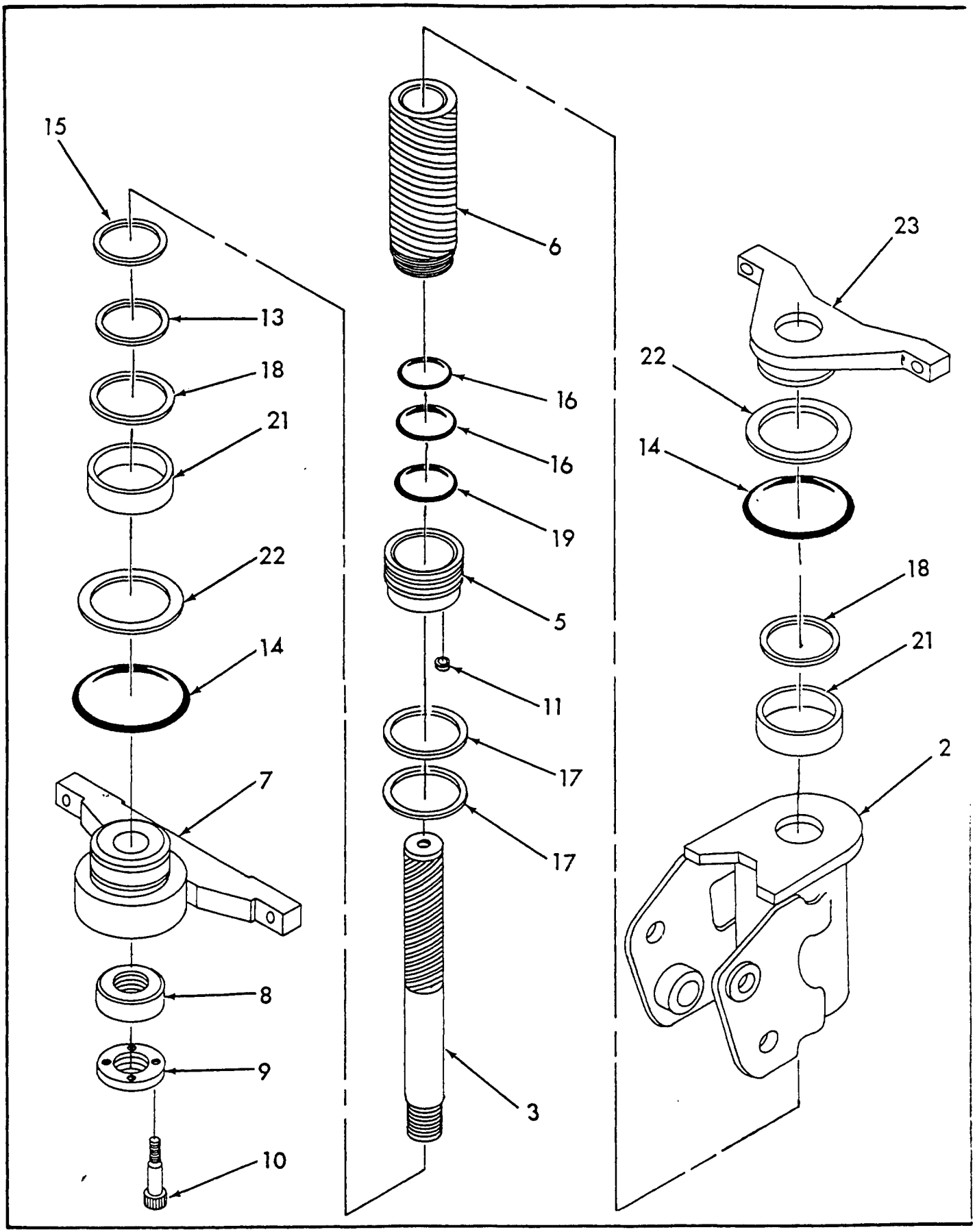
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24444	ASSEMBLY, PLATFORM ROTATOR (See Sect. 2, Fig. 1, 1A or 1B for NHA)	REF
2	81094	.ROTATOR, PLATFORM (See Sect. 2, Fig. 8A for Details)	1
3	23197	.BRACKET, CHECK VALVE	1
4	20351	.VALVE, CHECK	1
5	80004-05	.CONNECTOR, STRAIGHT THREAD	2
6	60360	.SCREW, CAP	2
7	63302	.WASHER, LOCK	2
8	63402	.WASHER, FLAT	2

PLATFORM ROTATOR ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
9	80012-05	.ELBOW, STRAIGHT THREAD	2
10	80012-03	.ELBOW, STRAIGHT THREAD	2
11	2594	.ELBOW, SWIVEL	4
12	2568-0144	.HOSE, HYDRAULIC	2
13	2562	.FITTING, STRAIGHT SWIVEL HOSE	2

- ITEM NOT ILLUSTRATED

PLATFORM ROTATOR (ALL MODELS)



REV.

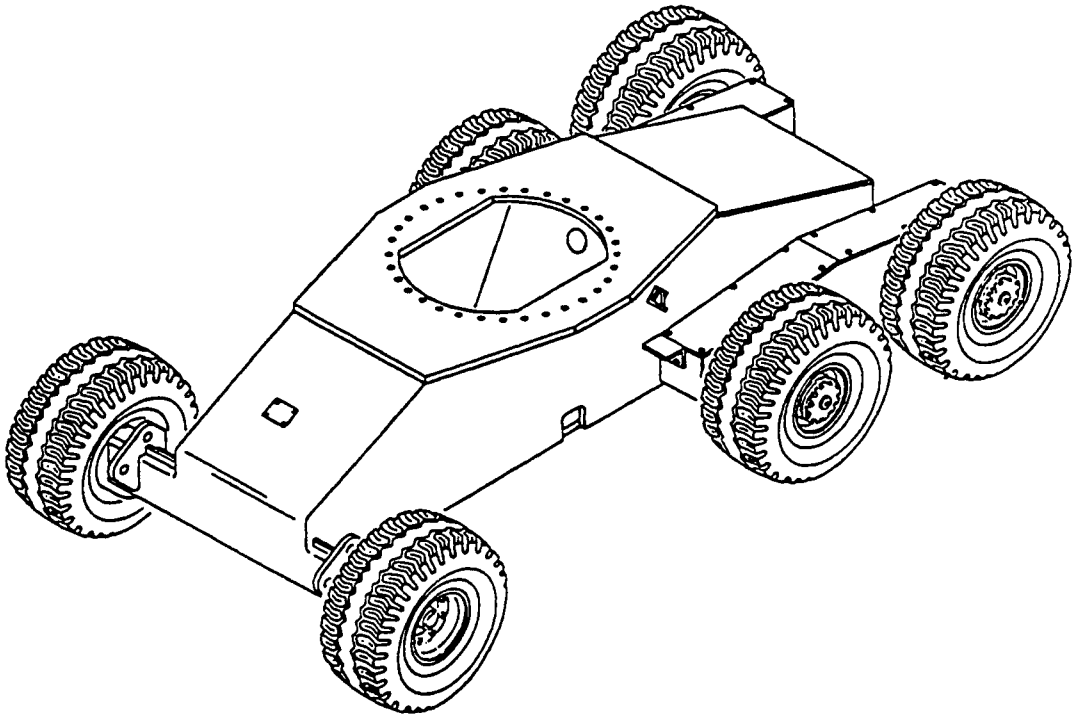
PLATFORM ROTATOR (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81094	ROTATOR, PLATFORM (See Sect. 2, Fig. 8 for NHA)	REF
2		.ASSEMBLY, HOUSING	1
3	67764	.ASSEMBLY, SHAFT	1
-4	67766	.SUB-ASSEMBLY, PISTON & SLEEVE	1
5		..PISTON	1
6		..SLEEVE	1
7	67767	.WELDMENT, END CAP	1
8		.NUT	1
9		.LOCKNUT	1
10		.CAPSCREW	4
11		.SETSCREW	2
-12	67770 67214	.KIT, SEAL (AFTER ROTATOR S.N. 8307) KIT, SEAL (PRIOR TO ROTATOR S.N. 8307)	1 1
13		..SEAL, END CAP (O-RING)	1
14		..SEAL, EXCLUDER (O-RING)	2
15		..B/U RING, END CAP	1
16		..PACKING, ROD (POLYPAK)	2
17		..PACKING, PISTON (POLYPAK)	2
18		..PACKING, SHAFT & CAP (POLYPAK)	2
19		..SEAL, PISTON (O-RING)	1
-20	67771 67777	.KIT, BEARING (AFTER ROTATOR S.N. 8307) KIT, BEARING (PRIOR TO ROTATOR S.N. 8307)	1 1
21		..BEARING	2
22		..BEARING, THRUST	2
23		.END, CAP FOOT	1

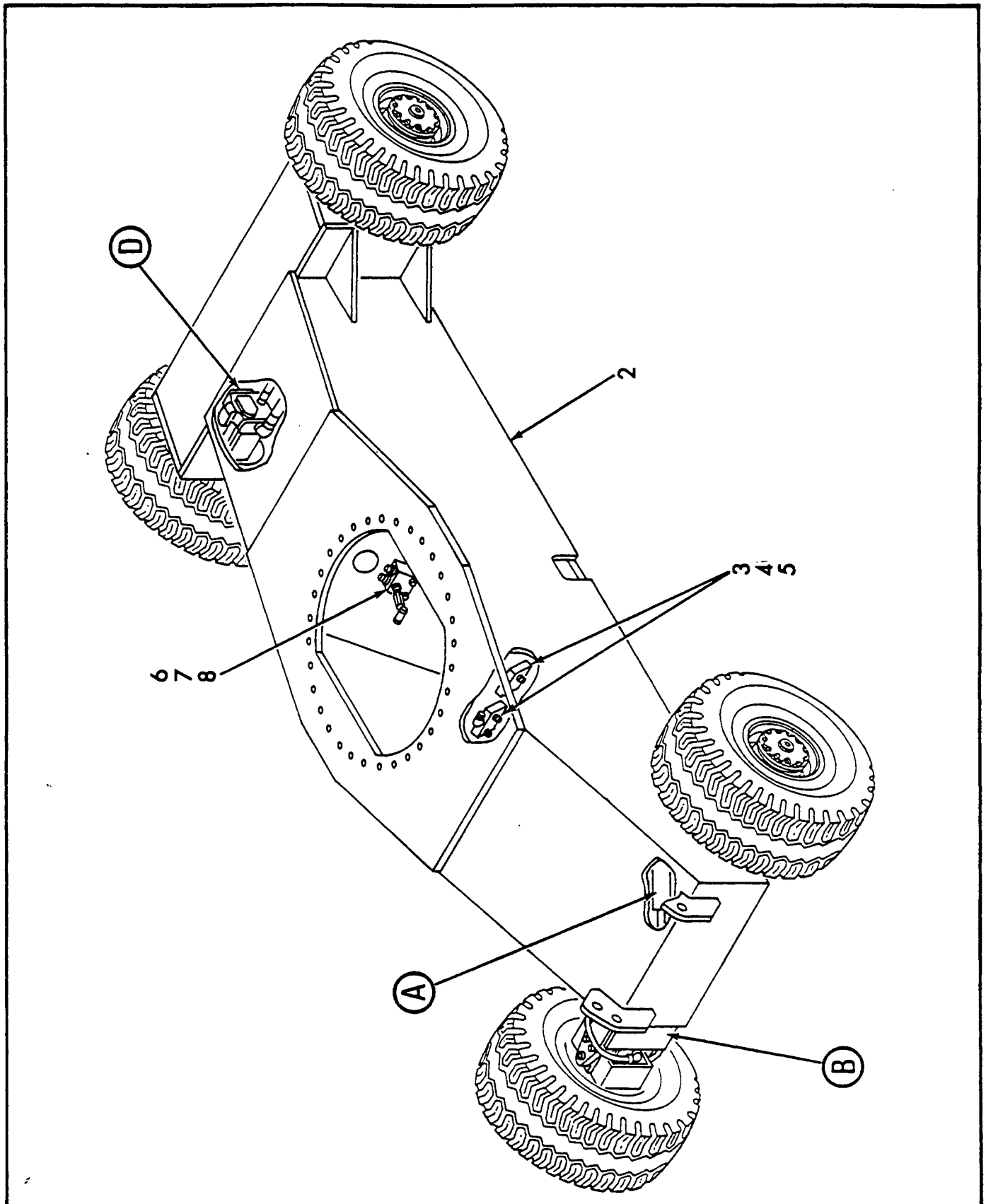
- ITEM NOT ILLUSTRATED

SECTION 3 CONTAINS:

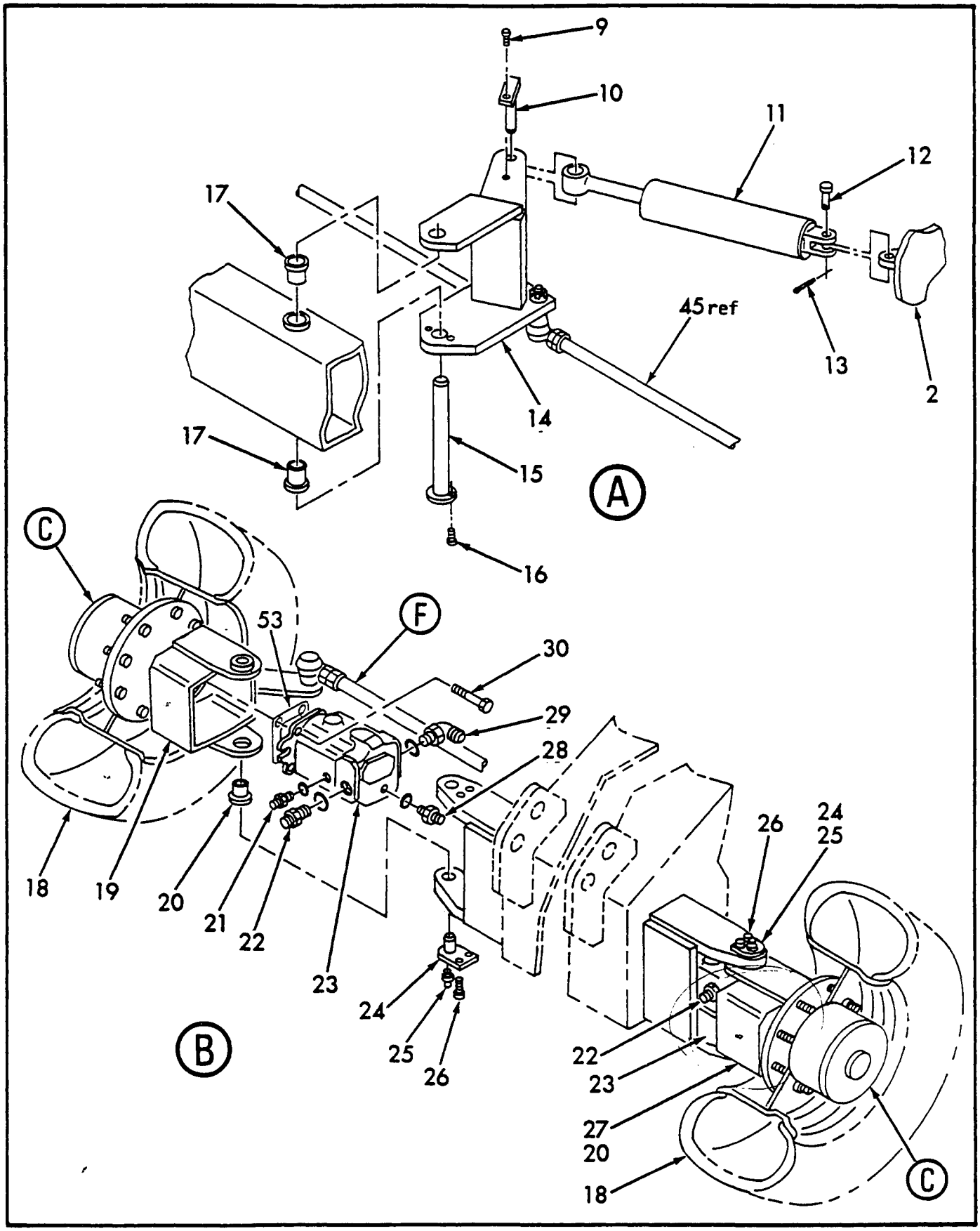
FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY (80C 4X4)
1A	CARRIAGE ASSEMBLY (80C 6X4)
1B	CARRIAGE ASSEMBLY (100C 6X4)
2	WALKING BEAM ASSEMBLY (80C & 100C 6X4)
2A	WALKING BEAM SUB-ASSEMBLY (80C & 100C 6X4)
3	FLOW DIVIDER ASSEMBLY (ALL MODELS)
4	DRIVE/BRAKE VALVE ASSEMBLY (ALL MODELS)
5	STEERING CYLINDER ASSEMBLY (ALL MODELS)
6	TIRE & RIM ASSEMBLY (ALL MODELS)
7	BRAKE ASSEMBLY (ALL MODELS)
8	TIE ROD ASSEMBLY (80C 4X4 & 100C 6X4)
8A	TIE ROD ASSEMBLY (80C 6X4)
9	DRIVE MOTOR ASSEMBLY (ALL MODELS)
10	TORQUE HUB (ALL MODELS)
10A	TORQUE HUB (80C & 100C 6X4)



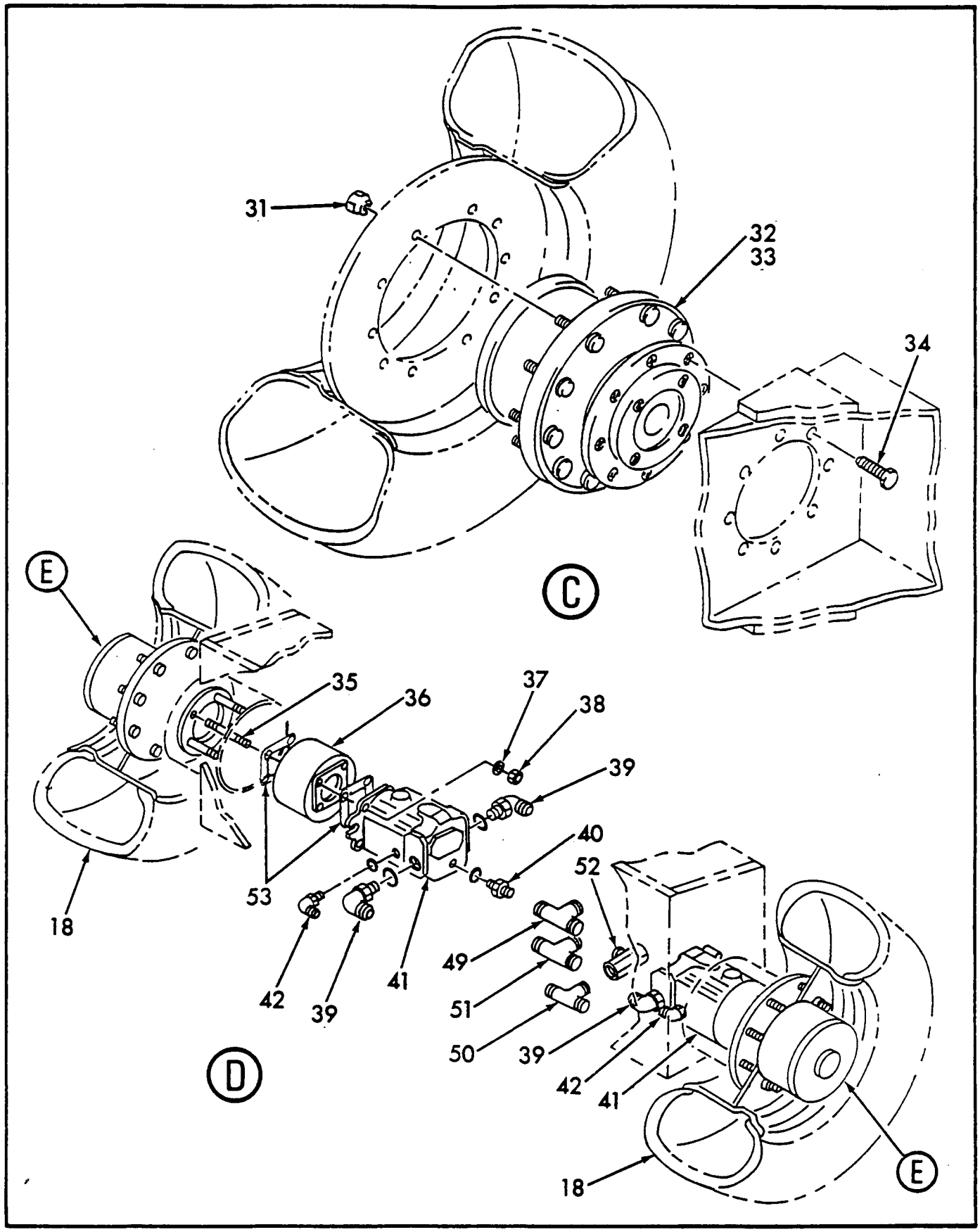
CARRIAGE ASSEMBLY (80C 4X4)



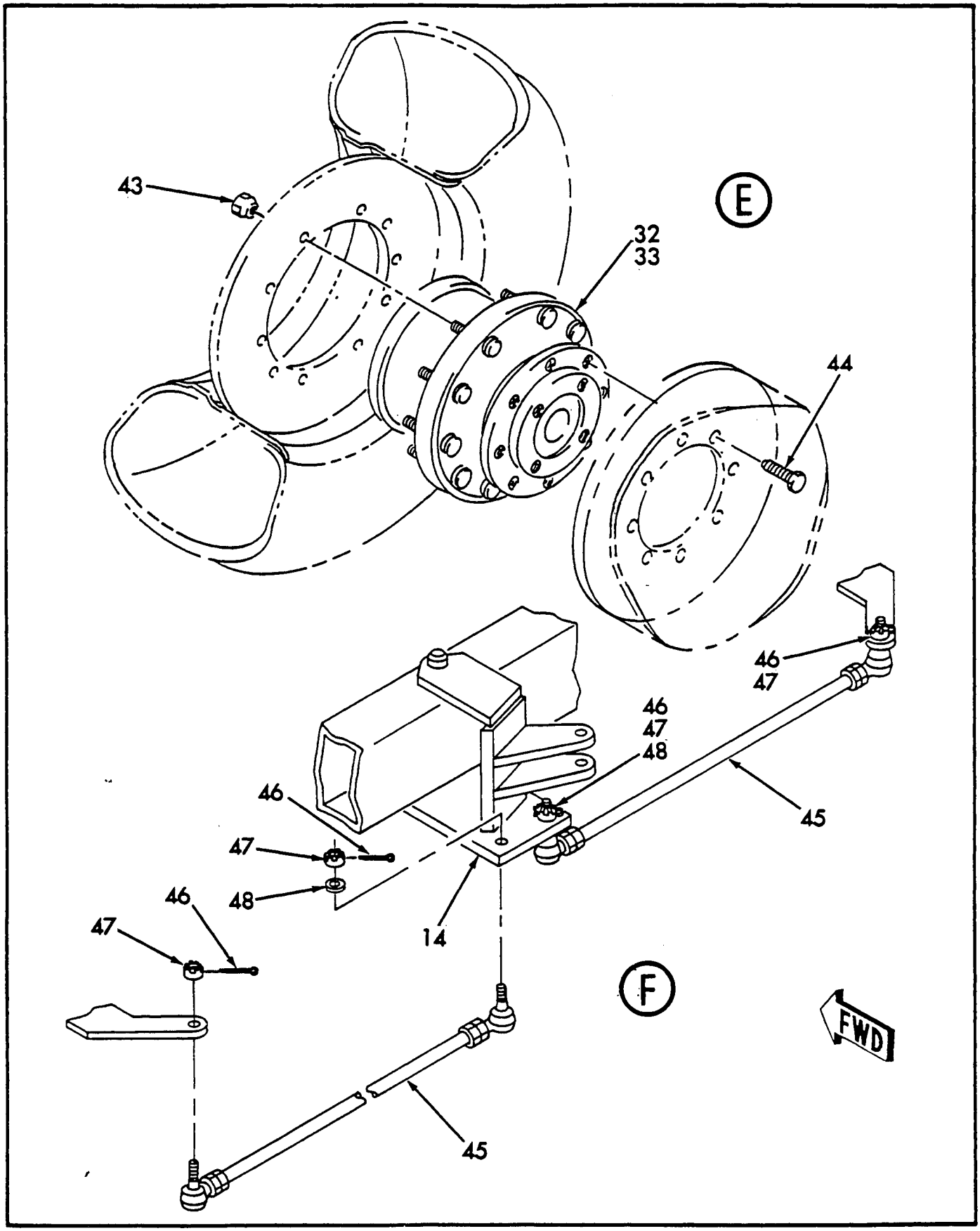
CARRIAGE ASSEMBLY (80C 4X4)



CARRIAGE ASSEMBLY (80C 4X4)



CARRIAGE ASSEMBLY (80C 4X4)



REV.

CARRIAGE ASSEMBLY (80C 4X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23980	ASSEMBLY, CARRIAGE (See Sect. 2, Fig. 1 for NHA)	REF
2	23967	.WELDMENT, CARRIAGE	1
3	22579	.ASSEMBLY, FLOW DIVIDER (See Sect. 3, Fig. 3 for Details)	1
4	60317	.SCREW, CAP	4
5	63303	.WASHER, LOCK	4
6	22501	.ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 4 for Details)	1
7	60356	.SCREW, CAP	2
8	63303	.WASHER, LOCK	2
9	60607	.SCREW, CAP	1
10	22214	.PIN, STEERING CYLINDER	1
11	22212	.ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 5 for Details)	1
12		.PIN, CLEVIS	1
13	64310	.PIN, COTTER	1
14	22043	.WELDMENT, STEERING ARM	1
15	22045	.PIN, STEERING ARM	1
16	65949	.SCREW, CAP	2
17	64910	.BUSHING, STEERING ARM PIN	2
18	22094	.ASSEMBLY, TIRE & RIM (See Sect. 3, Fig. 6 for Details)	4
19	23982	.YOKE, LEFT HAND STEERING	1
20	21906	.BUSHING, FLANGE	2
21	80004-03	.CONNECTOR, STRAIGHT THREAD	4
22	80004-21	.CONNECTOR, STRAIGHT THREAD	2
23	23526	.ASSEMBLY, DRIVE MOTOR (See Sect. 3, Fig. 9 for Details)	2

- ITEM NOT ILLUSTRATED

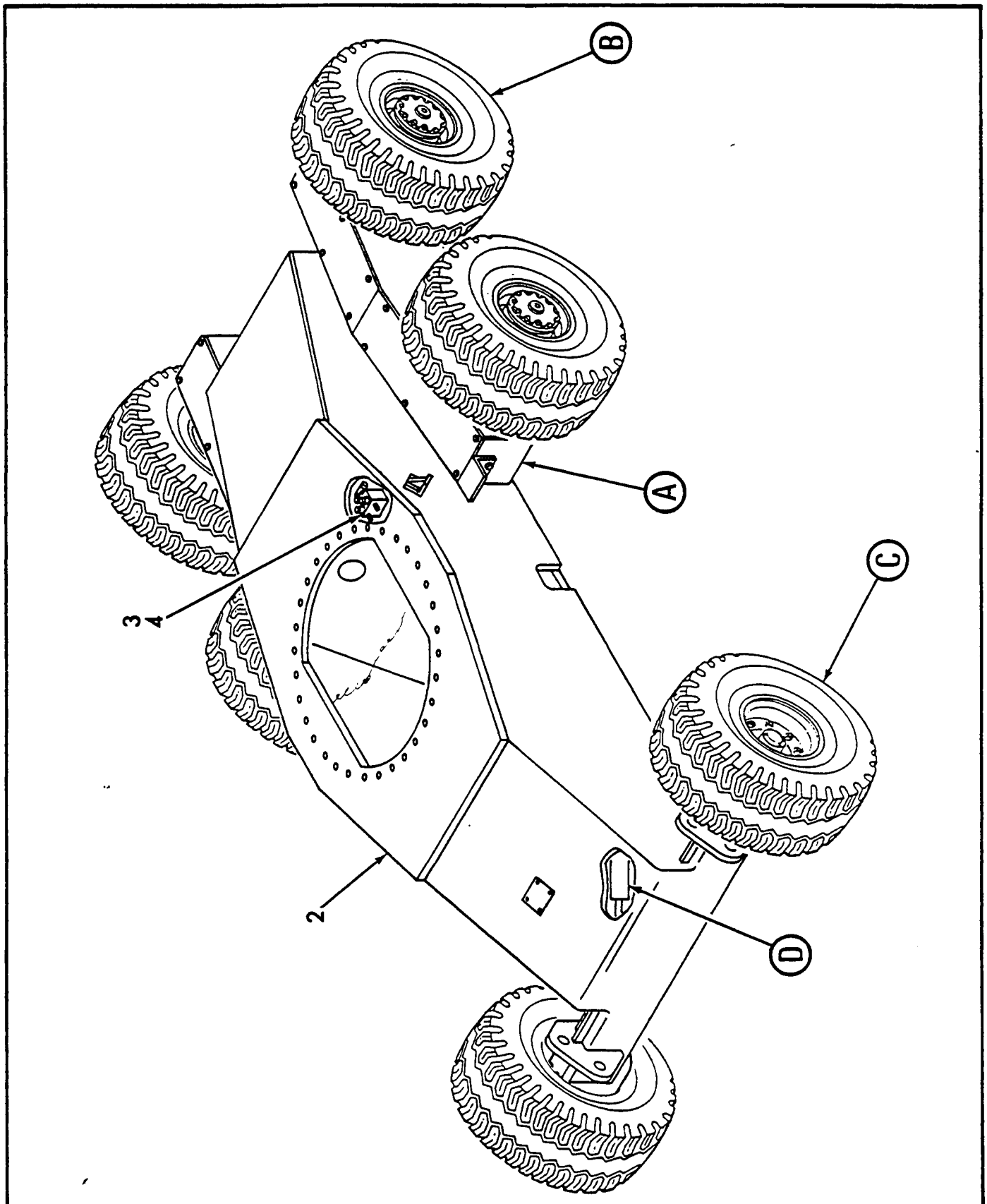
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	23984	.PIN, KING	4
25	65103	.FITTING, GREASE	4
26	60610	.SCREW, CAP	8
27	23981	.YOKE, RIGHT HAND STEERING	2
28	80004-03	.CONNECTOR, STRAIGHT THREAD	2
29	80012-21	.ELBOW, STRAIGHT THREAD	2
30	60604	.SCREW, CAP	32
31	65117	.NUT, BALL	20
32	21222	.HUB, TORQUE (See Sect. 3, Fig. 10 for Details)	4
-33	65106	.OIL, GEAR	4 PTS.
34	160002	.SCREW, CAP	16
35	63633	.STUD	8
36	21659	.ASSEMBLY, BRAKE (See Sect. 3, Fig. 7 for Details)	2
37	63305	.WASHER, LOCK	8
38	60705	.NUT, HEX	8
39	80012-21	.ELBOW, STRAIGHT THREAD	4
40		.CONNECTOR, STRAIGHT THREAD	2
41	23526	.ASSEMBLY, DRIVE MOTOR (See Sect. 3, Fig. 9 for Details)	2
42	80012-13	.ELBOW, STRAIGHT THREAD	4
43	65117	.NUT, BALL	20
44	160002	.SCREW, CAP	16
45	24157	.ASSEMBLY, TIE ROD (See Sect. 3, Fig. 8 for Details)	2
46	64310	.PIN, COTTER	4
47	16101	.NUT, LOCK	4

CARRIAGE ASSEMBLY (80C 4X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
48	63432	.WASHER, FLAT	2
49	80045-08	.TEE, BULKHEAD UNION	1
50	80045-03	.TEE, BULKHEAD UNION	1
51	80045-05	.TEE, BULKHEAD UNION	1
52	20357	.VALVE, NEEDLE	1
53	66847	.GASKET	6

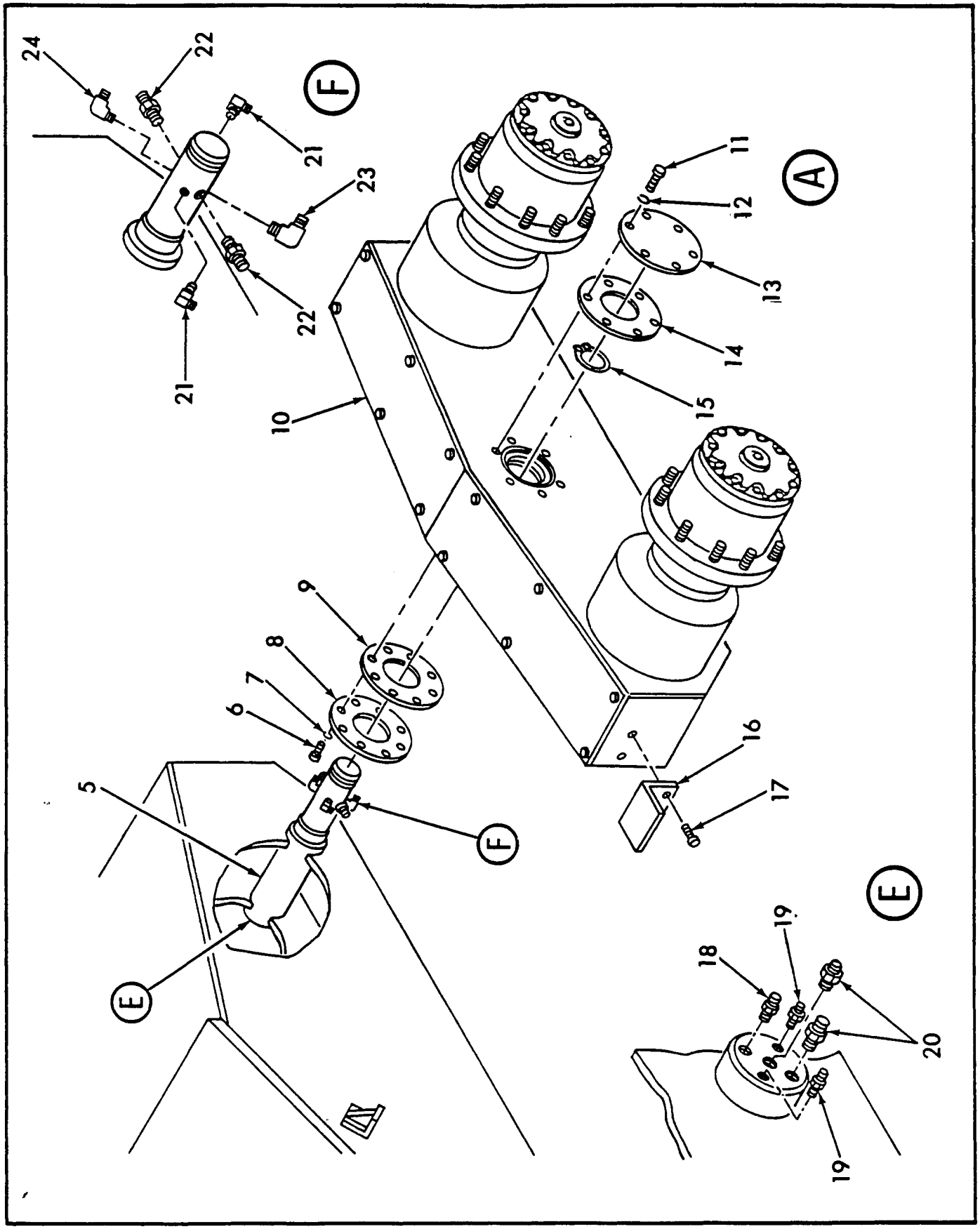
- ITEM NOT ILLUSTRATED

CARRIAGE ASSEMBLY (80C 6X4)

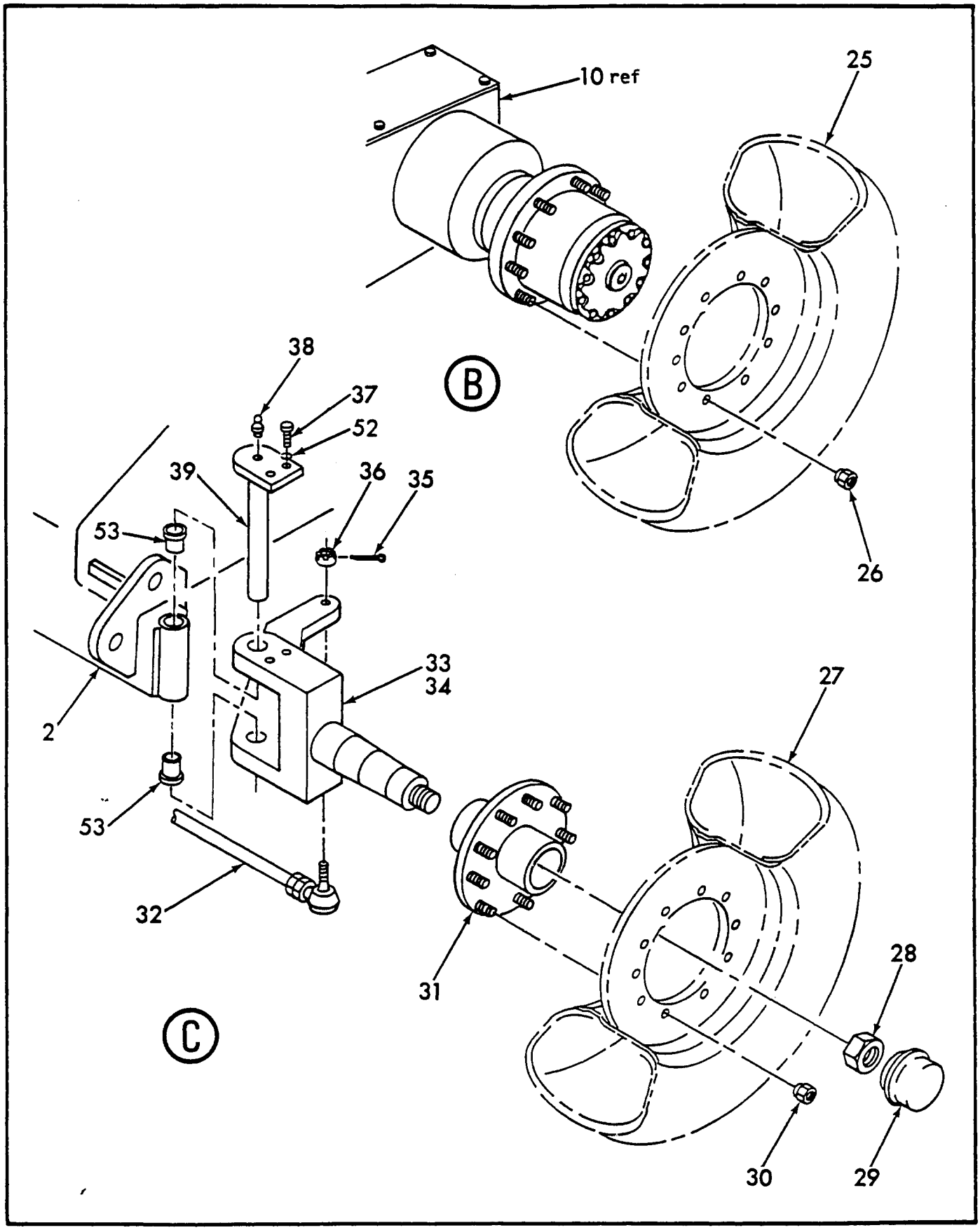


REV.

CARRIAGE ASSEMBLY (80C 6X4)

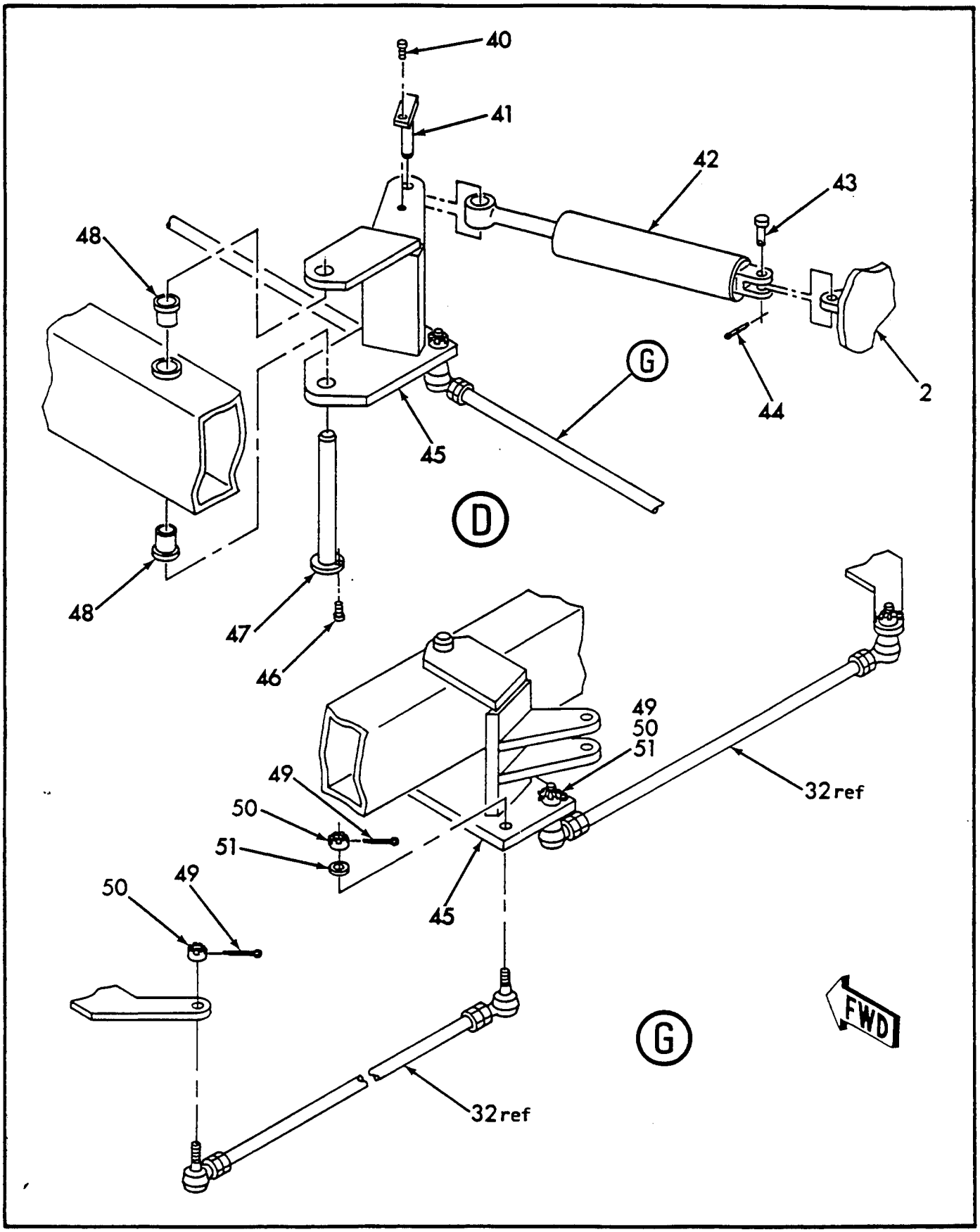


CARRIAGE ASSEMBLY (80C 6X4)



REV.

CARRIAGE ASSEMBLY (80C 6X4)



REV.

CARRIAGE ASSEMBLY (80C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22118	ASSEMBLY, CARRIAGE (See Sect. 2, Fig. 1A for NHA)	REF
2	22033	.WELDMENT, CARRIAGE	1
3	22501	.ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 4 for Details)	1
4	60373	.SCREW, CAP	2
5	22090	.PIVOT, BEAM (WELDED IN PLACE)	REF
6	60309	.SCREW, CAP	16
7	63301	.LOCKWASHER, SPLIT	16
8	21644	.RETAINER, SEAL	2
9	21645	.BEARING, SEAL	2
10	21628	.ASSEMBLY, WALKING BEAM (See Sect. 3, Fig. 2 for Details)	2
11	60322	.SCREW, CAP	12
12	63302	.LOCKWASHER, SPLIT	12
13	21632	.COVER	2
14	21121	.BEARING, SEAL	2
15	21642	.RING, RETAINING	2
16	21654	.STOP, WALKING BEAM	2
17	60601	.SCREW, CAP	4
18	80001-12	.CONNECTOR, MALE	1
19	51008	.CONNECTOR, MALE	2
20	80001-20	.CONNECTOR, MALE	2
21	51107	.ELBOW, MALE	2
22	80001-20	.CONNECTOR, MALE	2
23	80008-20	.ELBOW, MALE	1
24	80008-12	.ELBOW, MALE	1

- ITEM NOT ILLUSTRATED

CARRIAGE ASSEMBLY (80C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	22094	.ASSEMBLY, TIRE & RIM (See Sect. 3, Fig. 6 for Details)	4
26	65117	.NUT, BALL	40
27	22094	.ASSEMBLY, TIRE & WHEEL (See Sect. 3, Fig. 6 for Details)	2
28	61004	.NUT, STEERING YOKE	2
29	21799	.CAP, DUST	2
30	65117	.NUT, BALL	20
31	22039	.HUB, STEERING	2
32	22034	.ASSEMBLY, TIE ROD (See Sect. 3, Fig. 8A for Details)	2
33	22042	.YOKE, STEERING (L.H.)	1
34	22041	.YOKE, STEERING (R.H.)	1
35	64310	.PIN, COTTER	4
36	16101	.NUT, LOCK	4
37	60610	.SCREW, CAP	4
38	65103	.FITTING, GREASE	2
39	22044	.PIN, KING	2
40	60607	.SCREW, CAP	1
41	22214	.PIN, STEERING CYLINDER	1
42	22212	.ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 5 for Details)	1
43		.PIN, CLEVIS (PART OF ITEM 42)	1
44		.PIN, COTTER (PART OF ITEM 42)	1
45	22043	.WELDMENT, STEERING ARM	1
46	65949	.SCREW, CAP	2
47	22045	.PIN, STEERING ARM	1
48	21098	.BUSHING, STEERING ARM PIN	2

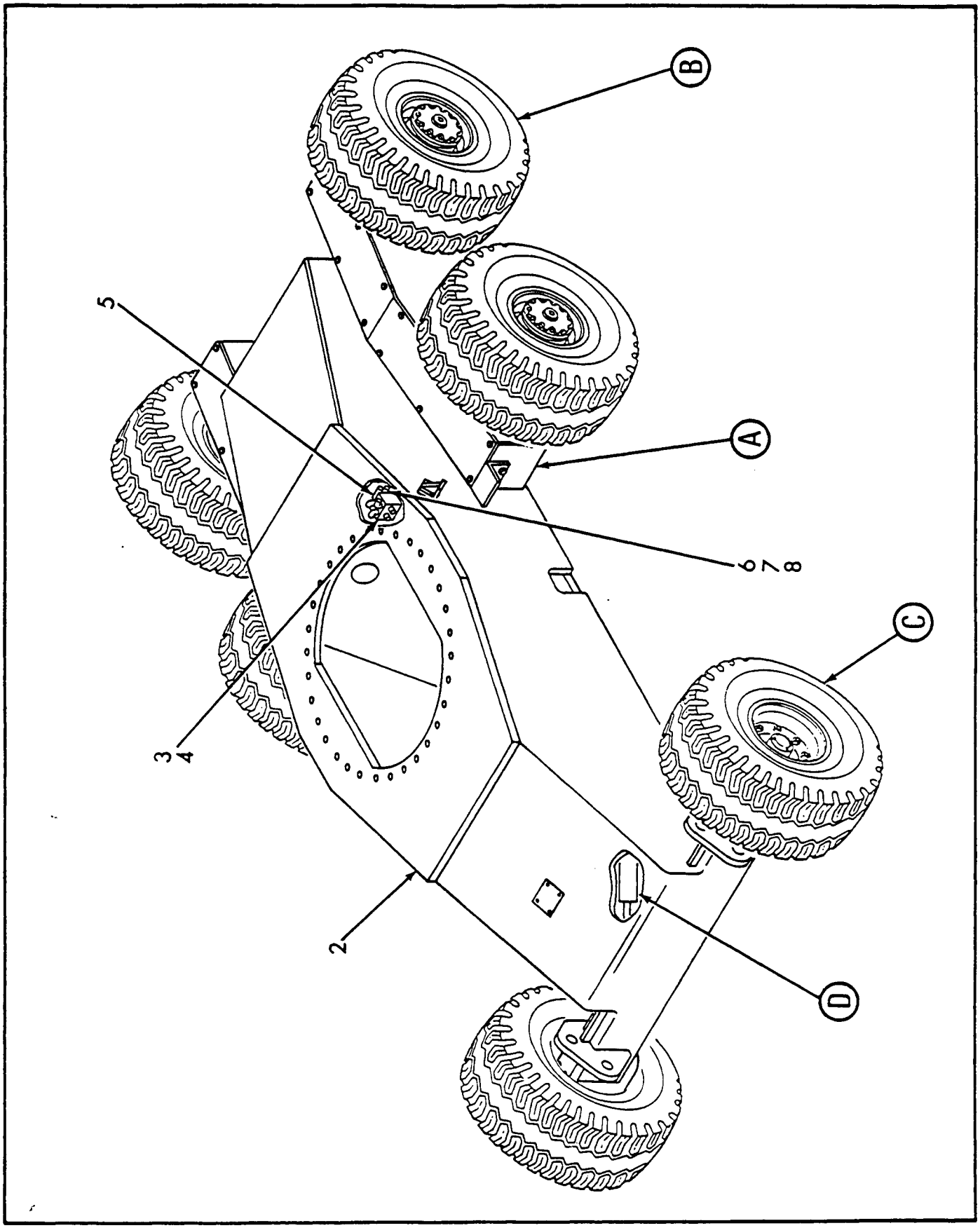
- ITEM NOT ILLUSTRATED

CARRIAGE ASSEMBLY (80C 6X4)

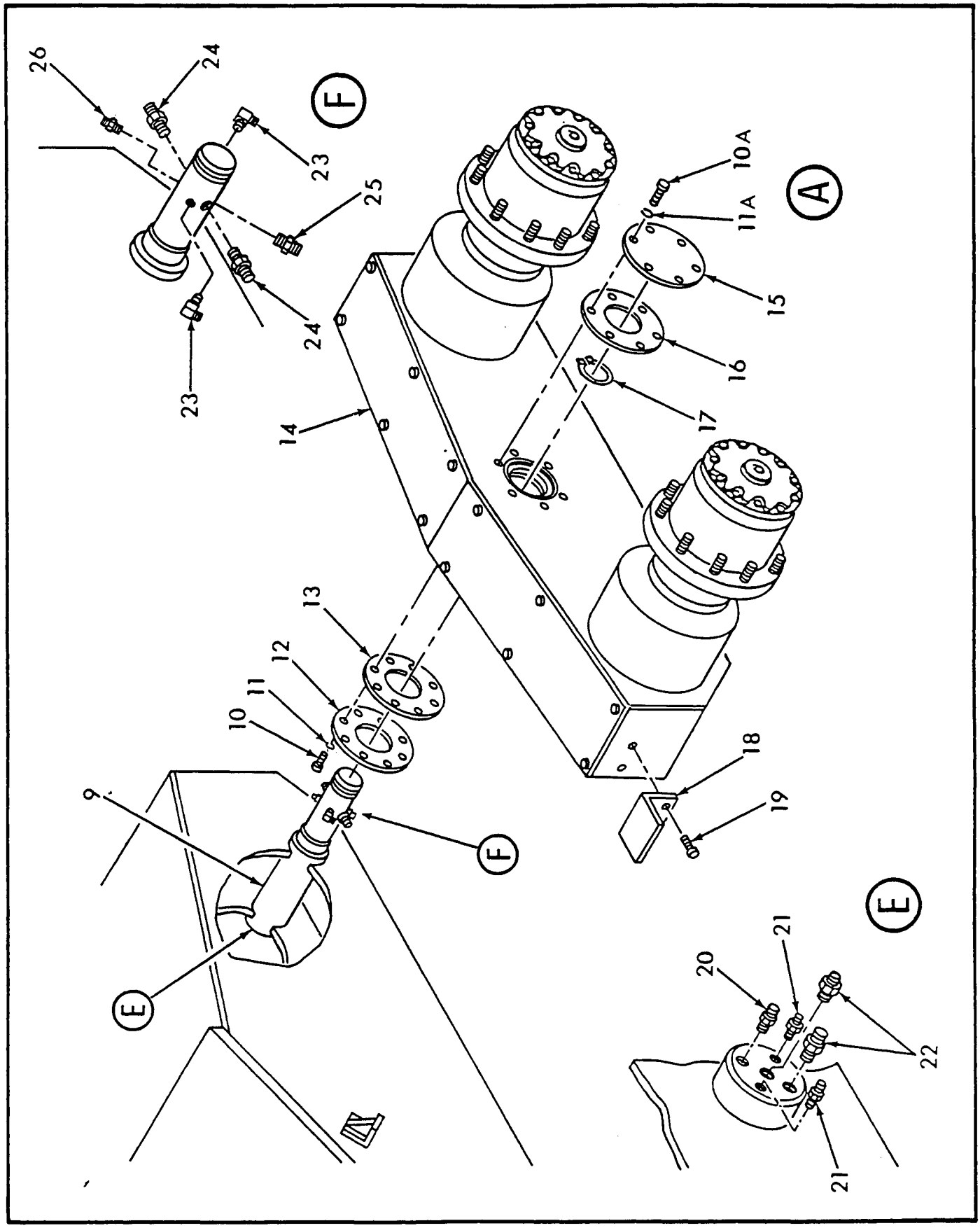
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
49	64310	.PIN, COTTER	4
50	16101	.NUT, LOCK	4
51	63432	.WASHER, FLAT	2
52	63305	.WASHER, LOCK	4
53	23983	.BUSHING	4

- ITEM NOT ILLUSTRATED

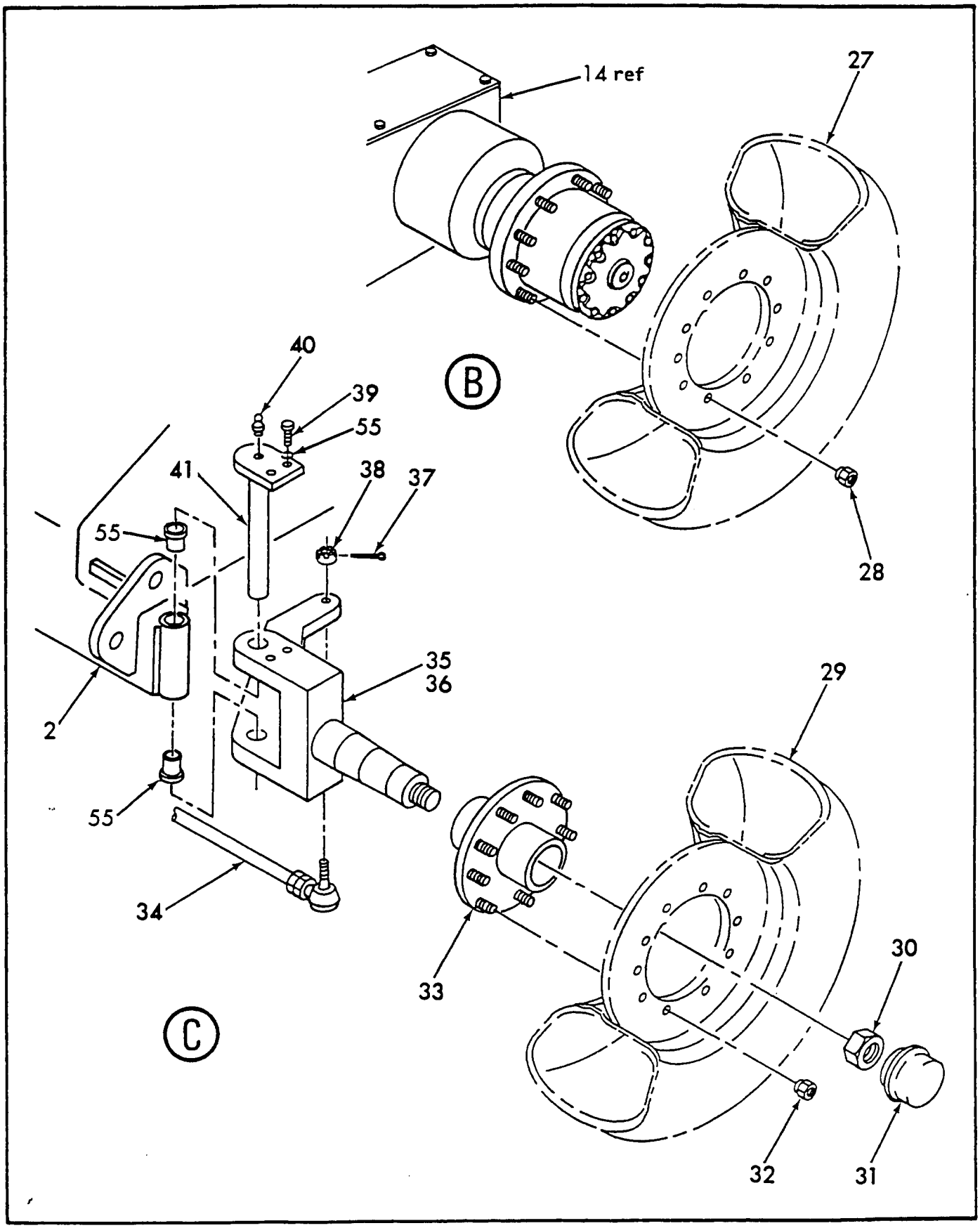
CARRIAGE ASSEMBLY (100C 6X4)



CARRIAGE ASSEMBLY (100C 6X4)

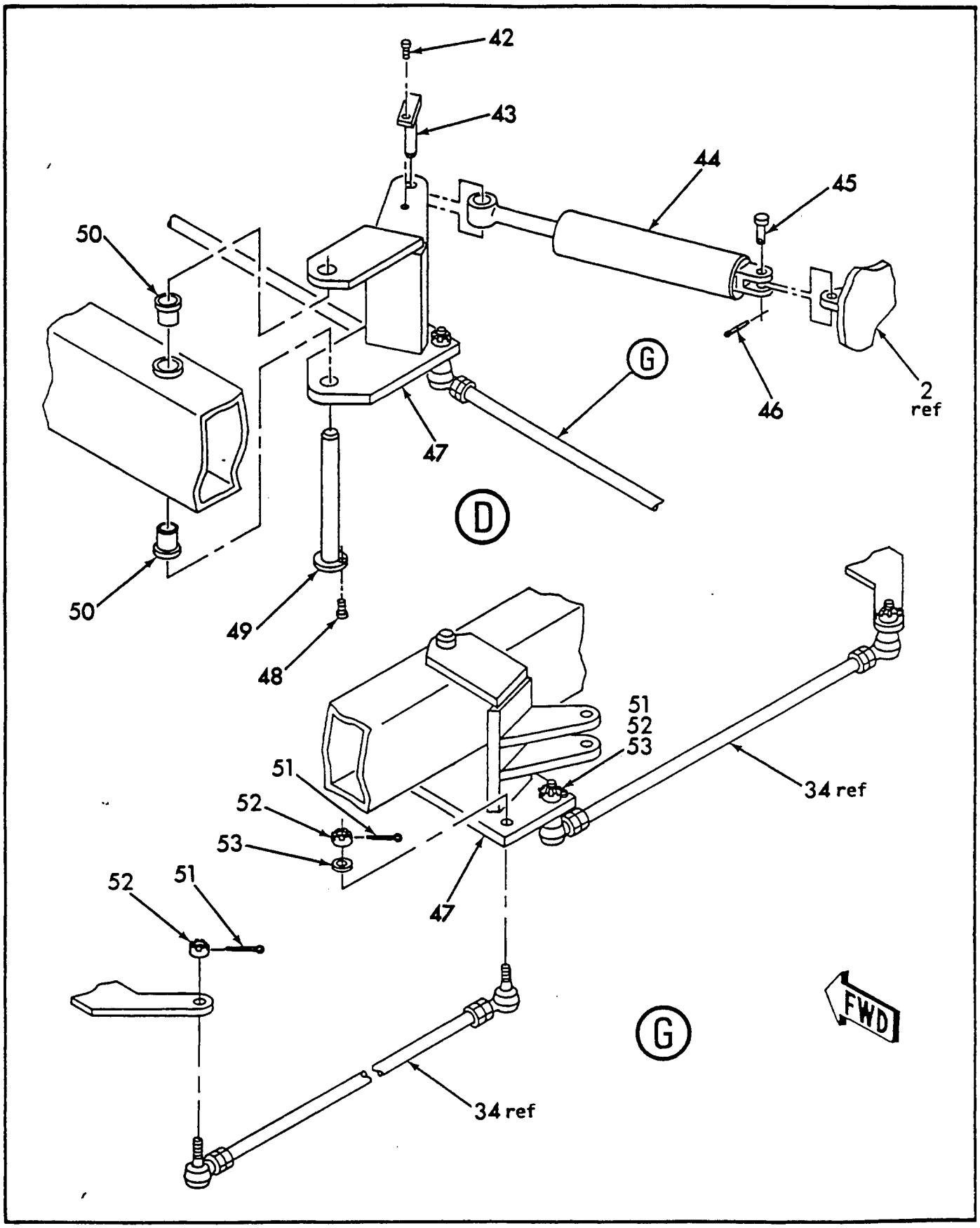


CARRIAGE ASSEMBLY (100C 6X4)



REV.

CARRIAGE ASSEMBLY (100C 6X4)



CARRIAGE ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24499	ASSEMBLY, CARRIAGE (See Sect. 2, Fig. 1B for NHA)	REF
2	24498	.WELDMENT, CARRIAGE	1
3	25501	.ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 4 for Details)	1
4	60362	.SCREW, CAP	2
5	20357	.VALVE, NEEDLE	1
6	80045-03	.TEE, BULKHEAD UNION	1
7	80045-05	.TEE, BULKHEAD UNION	1
8	80045-08	.TEE, BULKHEAD UNION	1
9	22090	.PIVOT, BEAM (WELDED IN PLACE)	REF
10	60309	.SCREW, CAP	16
10A	60322	.SCREW, CAP	12
11	63301	.WASHER, LOCK	16
11A	63302	.WASHER, LOCK	12
12	21644	.RETAINER, SEAL	2
13	21645	.BEARING, SEAL	2
14	21628	.ASSEMBLY, WALKING BEAM (See Sect. 3, Fig. 2 for Details)	2
15	21632	.COVER, WALKING BEAM	2
16	21121	.BEARING, SEAL	2
17	21642	.RING, RETAINING	2
18	21654	.STOP, WALKING BEAM	2
19	60601	.SCREW, CAP	4
20	80004-03	.CONNECTOR, STRAIGHT THREAD	2
21	51008	.CONNECTOR, MALE	4
22	80004-21	.CONNECTOR, MALE	4
23	51007	.ELBOW, MALE	4

- ITEM NOT ILLUSTRATED

CARRIAGE ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	80004-21	.CONNECTOR, MALE	4
25	80012-21	.CONNECTOR, STRAIGHT THREAD	2
26	80012-13	.CONNECTOR, STRAIGHT THREAD	2
27	22094	.ASSEMBLY, TIRE AND RIM (See Sect. 3, Fig. 6 for Details)	4
28	65117	.NUT, BALL	40
29	22094	.ASSEMBLY, TIRE & RIM (See Sect. 3, Fig. 6 for Details)	2
30	61004	.NUT, STEERING YOKE	2
31	21799	.CAP, DUST	2
32	65117	.NUT, BALL	20
33	22039	.HUB, STEERING	2
34	24157	.ASSEMBLY, TIE ROD (See Sect. 3, Fig. 8 for Details)	2
35	22042	.YOKE, STEERING (L.H.)	1
36	22041	.YOKE, STEERING (R.H.)	1
37	64310	.PIN, COTTER	4
38	16101	.NUT, LOCK	4
39	60610	.SCREW, CAP	4
40	65103	.FITTING, GREASE	2
41	23984	.PIN, KING	2
42	60607	.SCREW, CAP	1
43	22214	.PIN, STEERING CYLINDER	1
44	22212	.ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 5 for Details)	1
45		.PIN, CLEVIS (PART OF ITEM 44)	1
46		.PIN, COTTER (PART OF ITEM 44)	1
47	22043	.WELDMENT, STEERING ARM	1

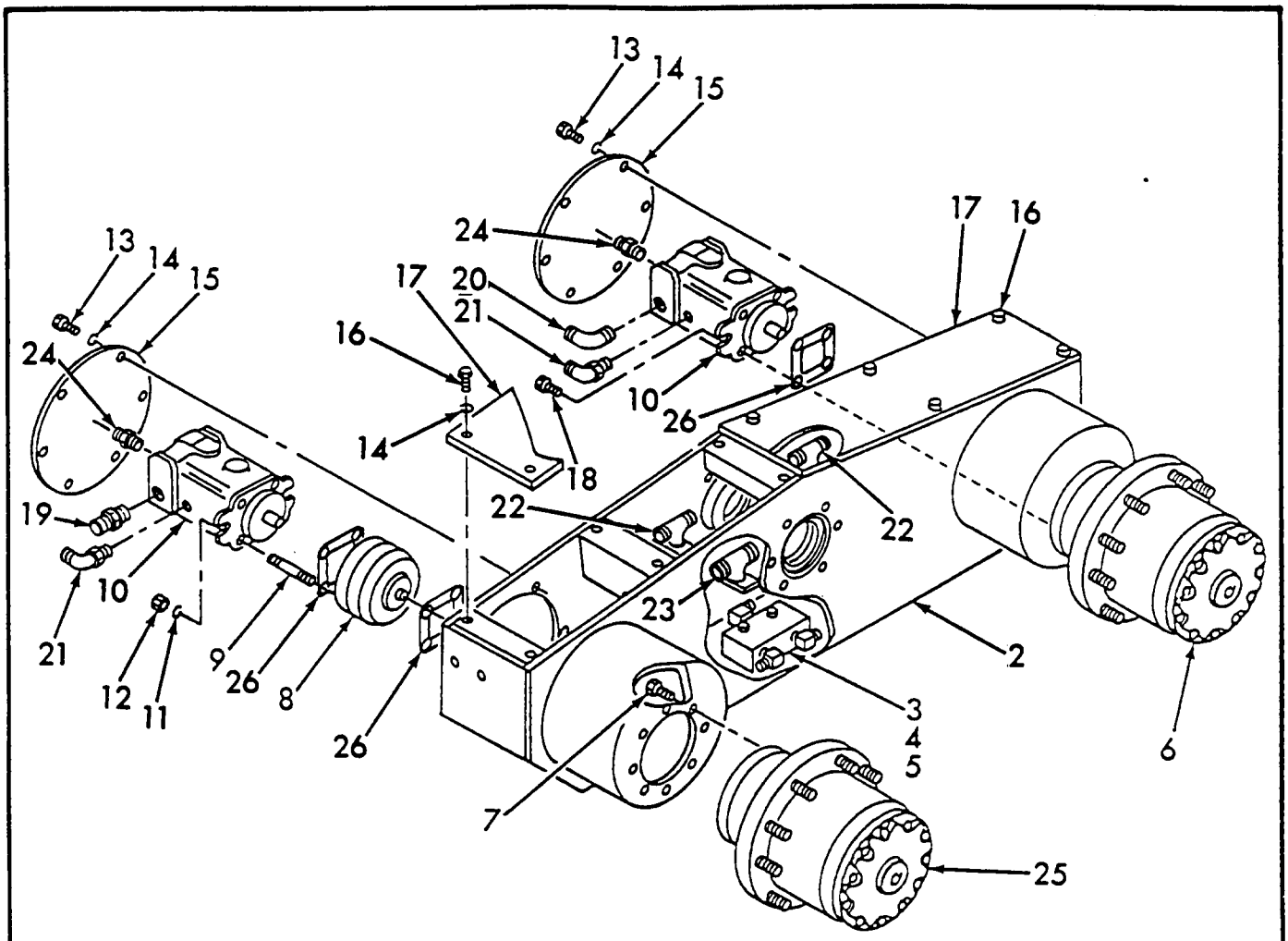
- ITEM NOT ILLUSTRATED

CARRIAGE ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
48	65949	.SCREW, CAP	2
49	22045	.PIN, STEERING ARM	1
50	21098	.BUSHING, STEERING ARM PIN	2
51	64310	.PIN, COTTER	4
52	16101	.NUT, LOCK	4
53	63432	.WASHER, FLAT	2
54	63305	.WASHER, LOCK	4
55	23983	.BUSHING	4

- ITEM NOT ILLUSTRATED

WALKING BEAM ASSEMBLY (80C & 100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21628	ASSEMBLY, WALKING BEAM (See Sect. 3, Fig. 1A or 1B for NHA)	REF
2	21883	.SUB-ASSEMBLY, WALKING BEAM (See Sect. 3, Fig. 2A for Details)	1
3	22579	.ASSEMBLY, FLOW DIVIDER (See Sect. 3, Fig. 3 for Details)	1
4	60317	.SCREW, CAP	2
5	63319	.LOCKWASHER, SPLIT	2
6	21222	.HUB, TORQUE (See Sect. 3, Fig. 10 for Details)	1
7	60604	.SCREW, CAP	16

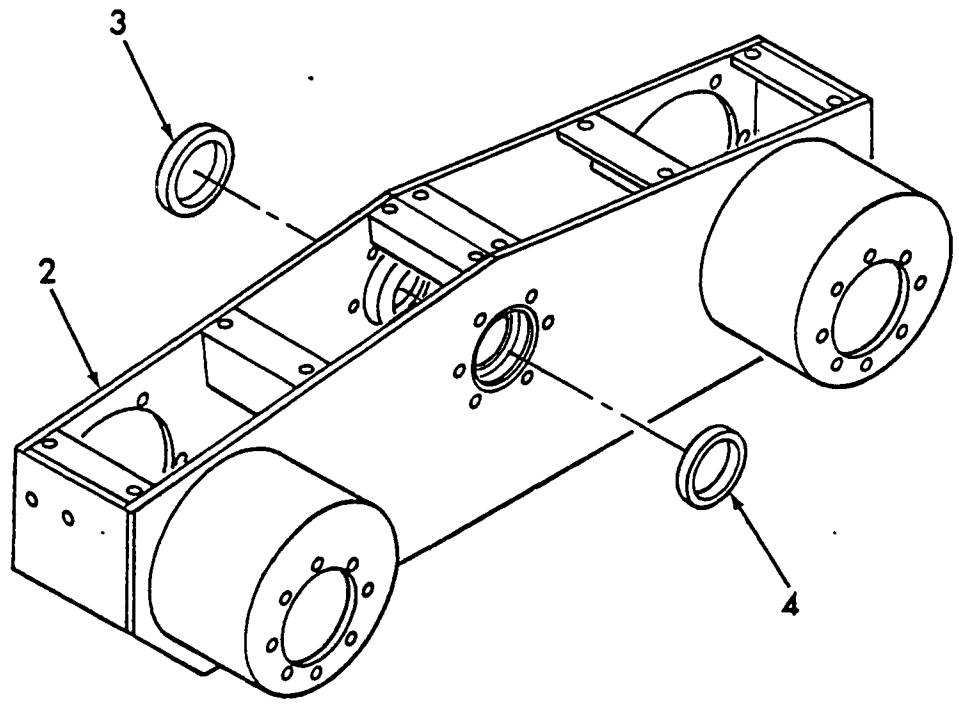
REV.

WALKING BEAM ASSEMBLY (80C & 100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
8	21659	.ASSEMBLY, BRAKE (See Sect. 3, Fig. 7 for Details)	1
9	63633	.ROD, THREADED	4
10	23526	.ASSEMBLY, DRIVE MOTOR (WITH INTERNAL SHIFT) (See Sect. 3, Fig. 9 for Details)	2
11	63305	.LOCKWASHER, SPLIT	4
12	60705	.NUT, HEX	4
13	60322	.SCREW, CAP	12
14	63302	.LOCKWASHER, SPLIT	24
15	21631	.COVER	2
16	60322	.SCREW, CAP	12
17	21639	. COVER	2
18	60602	.SCREW, CAP	4
19	80004-21	.CONNECTOR, STRAIGHT THREAD	2
20	80012-21	.ELBOW, STRAIGHT THREAD	2
21	80012-13	.ELBOW, STRAIGHT THREAD	2
22	80035-03	.TEE, BULKHEAD BRANCH	2
23	80035-06	.TEE, BULKHEAD BRANCH	1
24	80004-03	.CONNECTOR, STRAIGHT THREAD	2
25	24201	.HUB, TORQUE (WITH STEEL SPINDLE) (See Sect. 3, Fig. 10A for Details)	1
26	66847	.GASKET	3

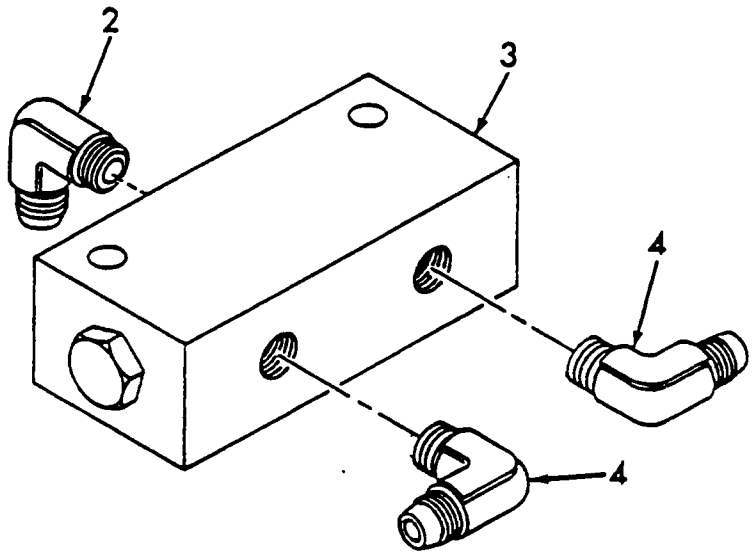
- ITEM NOT ILLUSTRATED

WALKING BEAM SUB-ASSEMBLY (80C & 100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21883	SUB-ASSEMBLY, WALKING BEAM (See Sect. 3, Fig. 2 for NHA)	REF
2	21627	.WELDMENT, WALKING BEAM	1
3	21640	.BEARING	1
4	21641	.BEARING	1

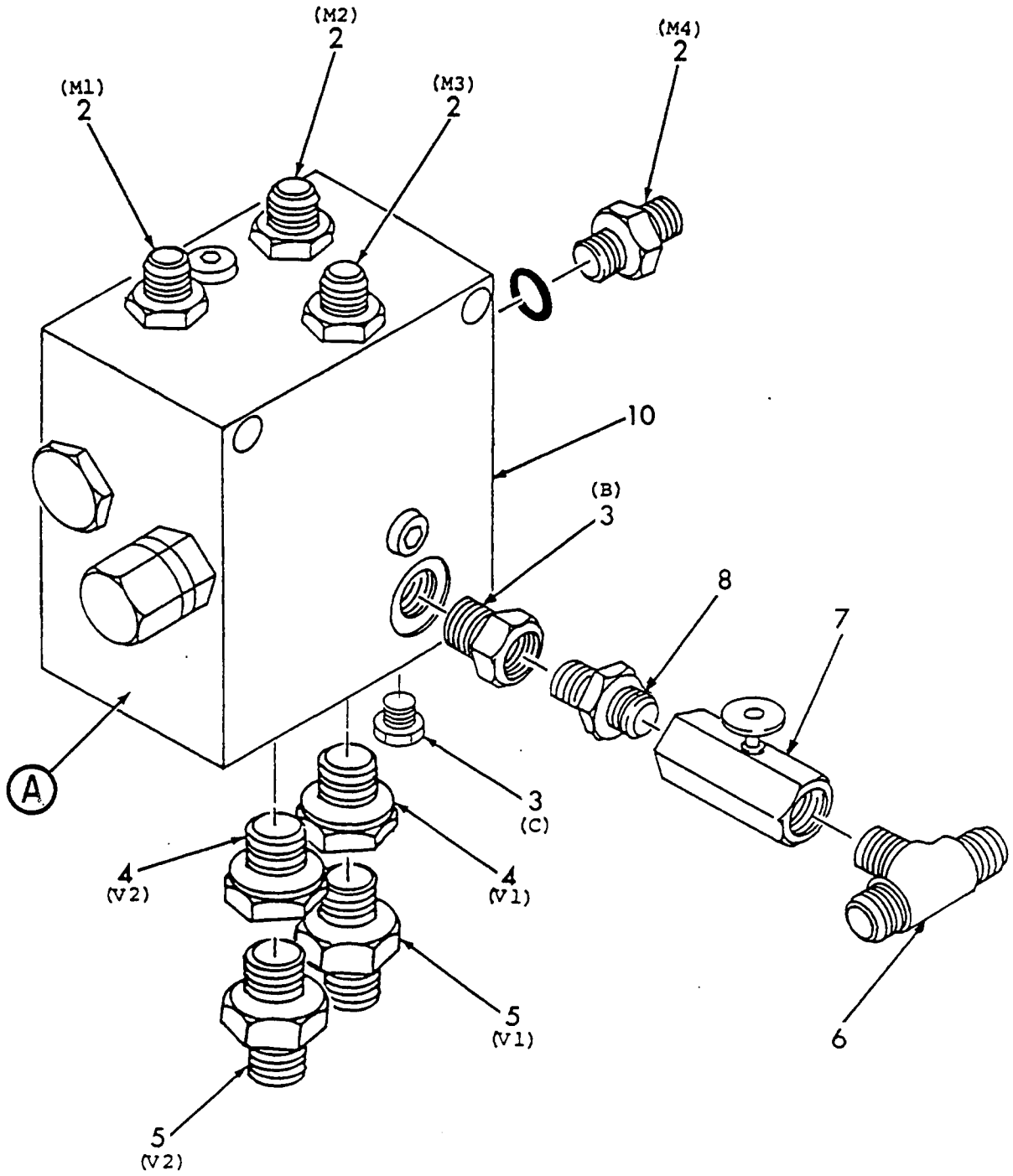
FLOW DIVIDER ASSEMBLY (ALL MODELS)



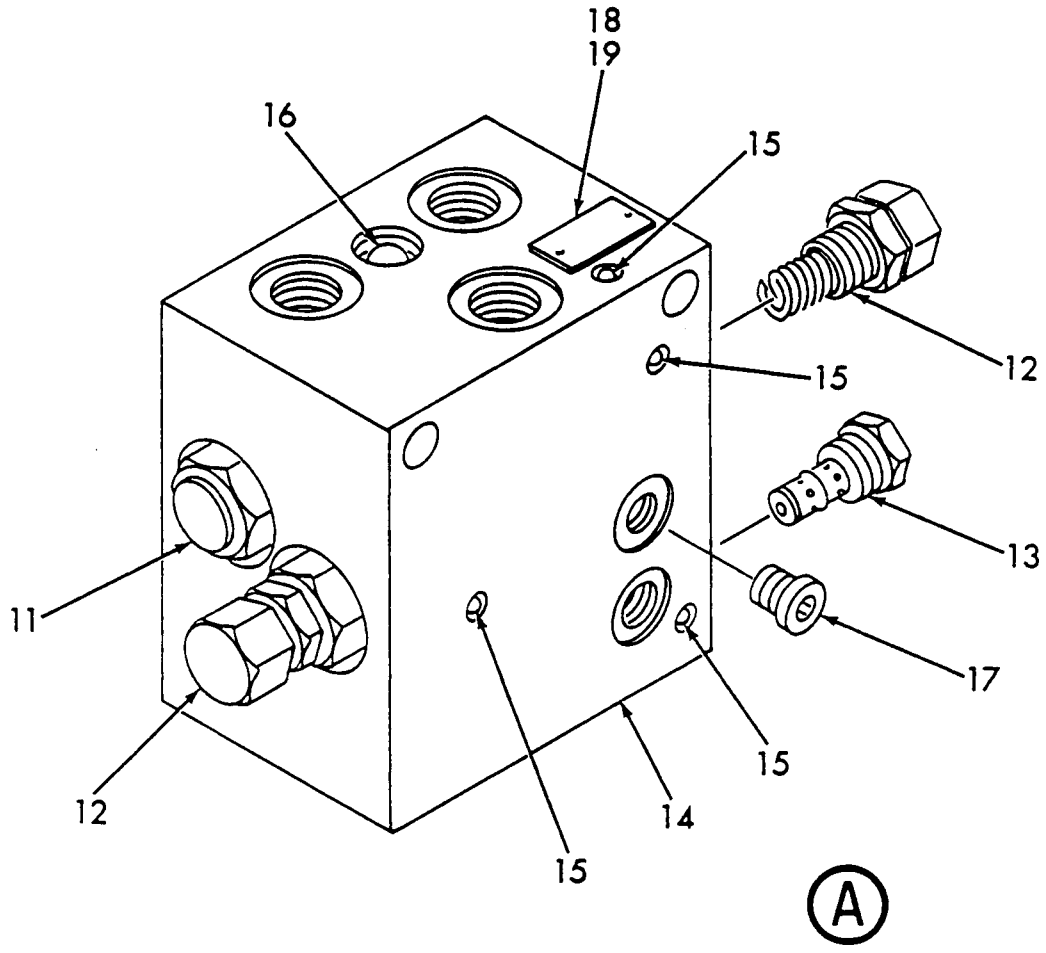
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22579	ASSEMBLY, FLOW DIVIDER (See Sect. 3, Fig. 1 for 80C 4X4 NHA) (See Sect. 3, Fig. 2 for 80C & 100C 6X4 NHA)	REF
2	80008-23	.ELBOW, MALE	1
3	81296	.DIVIDER, FLOW	1
4	80008-19	.ELBOW, MALE	2

REV.

DRIVE/BRAKE VALVE ASSEMBLY (ALL MODELS)



DRIVE/BRAKE VALVE ASSEMBLY (ALL MODELS)

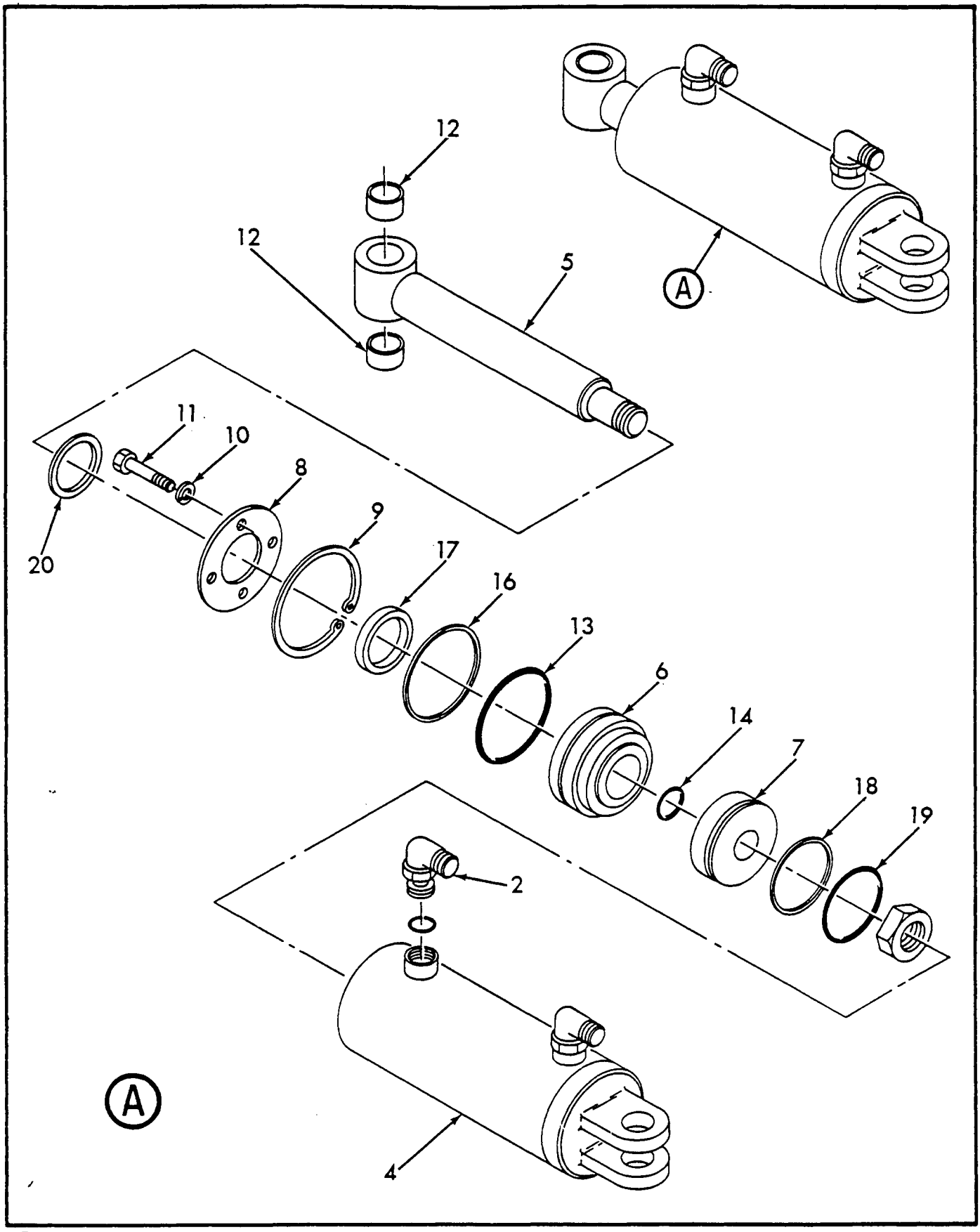


DRIVE/BRAKE VALVE ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22501	ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 1, 1A or 1B for NHA)	REF
2	80004-18	.CONNECTOR, STRAIGHT THREAD (M1, M2, M3, M4)	4
3	80050-05	.PLUG, STRAIGHT THREAD (B)	1
4	80063-16	.ADAPTER, FEMALE PIPE (V1, V2)	2
5	80001-21	.CONNECTOR, MALE	2
6	80034-04	.TEE, MALE BRANCH	1
7	20357	.VALVE, NEEDLE	1
8	80052-04	.NIPPLE, PIPE	1
9	80063-01	.ADAPTER, FEMALE	1
10	22433	.VALVE, DRIVE/BRAKE	1
11	67711	..VALVE, POSITIVE TRACTION	1
12	67712	..VALVE, COUNTER BALANCE	2
13	67713	..VALVE, SHUTTLE	1
14	67714	..VALVE, MANIFOLD	1
15	67715	..PLUG, EXPANDER	4
16	67716	..PLUG, EXPANDER	1
17	67717	..PLUG, S.A.E.	1
18		..NAMEPLATE	1
19		..RIVET	2

- ITEM NOT ILLUSTRATED

STEERING CYLINDER ASSEMBLY (ALL MODELS)



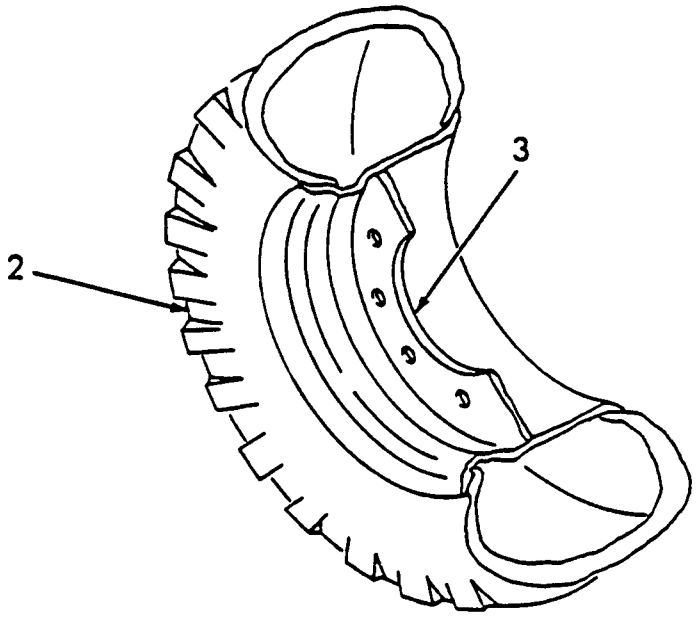
REV.

STEERING CYLINDER ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22212	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1, 1A or 1B for NHA)	REF
2	80012-03	.ELBOW, STRAIGHT THREAD	2
-3	22119	.CYLINDER, STEERING	1
4		..BARREL	1
5		..ROD	1
6		..HEAD	1
7		..PISTON	1
8		..PLATE, HEAD	1
9		..RING, SNAP	1
10		..WASHER, LOCK	4
11		..SCREW, CAP	4
12		..BUSHING	2
-13	66361	..KIT, SEAL	1
14		...O-RING, STATIC	1
15		...O-RING, HEAD	1
16		...B/U RING, HEAD	1
17		...SEAL, ROD (POLYPAK)	1
18		...RING, SERVON	1
19		...O-RING	1
20		...WIPER, ROD	1

- ITEM NOT ILLUSTRATED

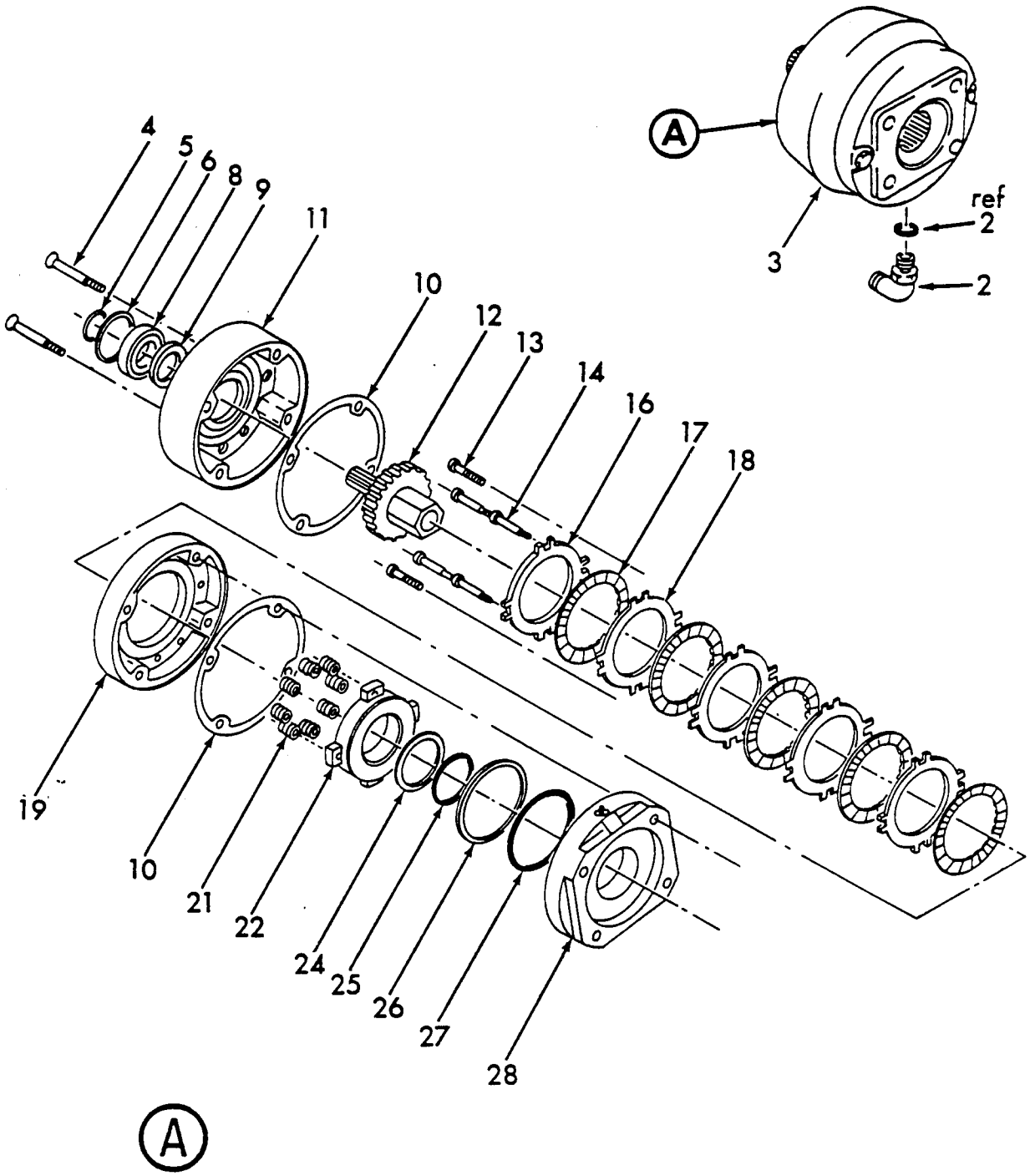
TIRE AND RIM ASSEMBLY (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22094	ASSEMBLY, TIRE AND RIM (See Sect. 3, Fig. 1, 1A or 1B for NHA)	REF
2	66570	.TIRE	1
3	66569	.RIM	1

REV.

BRAKE ASSEMBLY (ALL MODELS)



BRAKE ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21659	ASSEMBLY, BRAKE (See Sect. 3, Fig. 1 for 80C 4X4 NHA) (See Sect. 3, Fig. 2 for 80C & 100C 6X4 NHA)	REF
2	80012-03	.ELBOW, STRAIGHT THREAD	1
3	21220	.BRAKE	1
4		.SCREW, FLAT HEAD SOCKET CAP	2
5		.RING, RETAINING	1
6		.RING, SNAP	1
-7	67656	.KIT, BEARING	REF
8		..BEARING	1
9		..SEAL, OIL	1
10		..SEAL, CASE	2
11		.PLATE, COVER	1
12		.ASSEMBLY, SPLINE SHAFT	1
13		.SCREW, SOCKET HEAD CAP	2
14		.BOLT, SOCKET HEAD SHOULDER	4
-15	66972	.KIT, LINING	REF
*10		..SEAL, CASE	2
16		..DISC, PRIMARY	1
17		..DISC, ROTOR	5
18		..DISC, STATOR	4
19		.PLATE, SPRING	1
-20	67649	.KIT, SPRING	REF
*10		..SEAL, CASE	2
21		..SPRING (RED) ..SPRING (BLUE)	6 2
22	67661	.PISTON	1

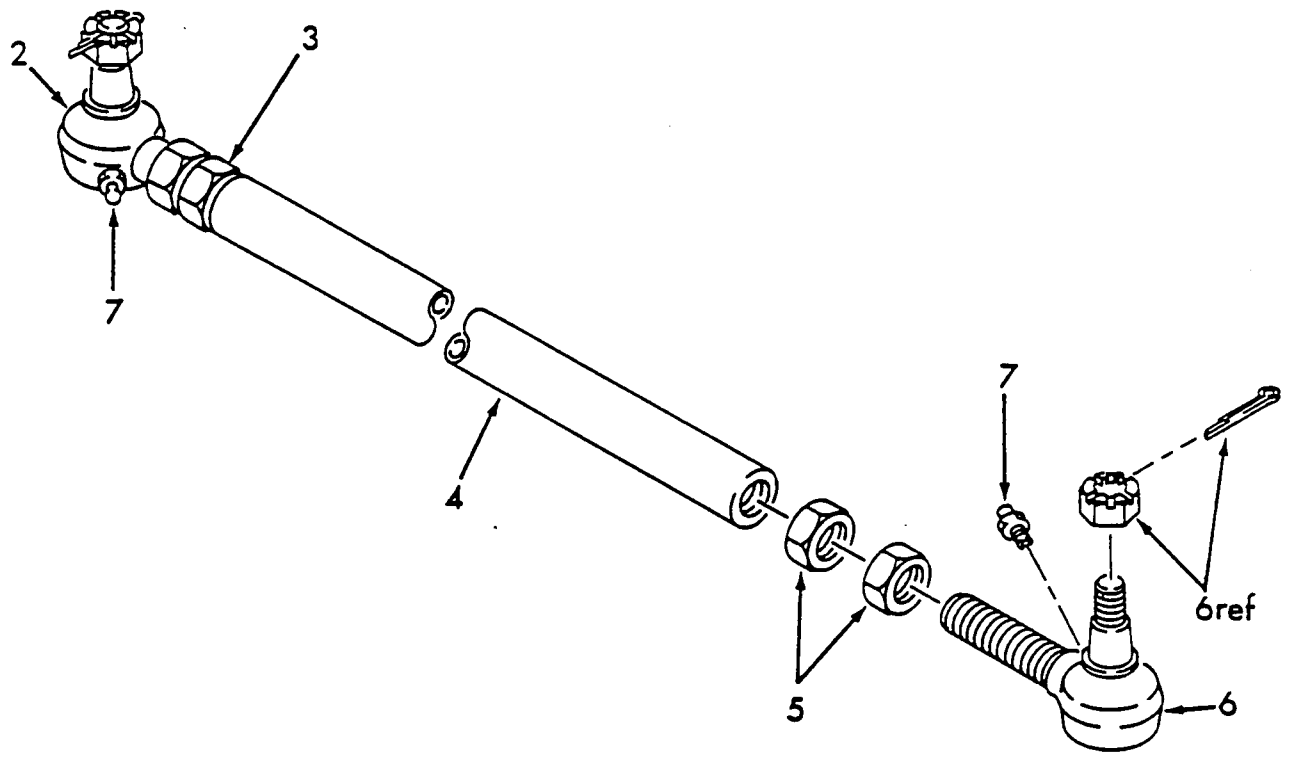
- ITEM NOT ILLUSTRATED

BRAKE ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-23	66972	.KIT, SEAL	REF
*10		..SEAL, CASE	1
24		..RING, BACK-UP (I.D.)	1
25		..O-RING (I.D.)	1
26		..RING, BACK-UP (O.D.)	1
27		..O-RING (O.D.)	1
28		.PLATE, PRESSURE	1
		NOTE: ASTERISK (*) INDICATES THE ITEM HAS BEEN PREVIOUSLY LISTED.	

- ITEM NOT ILLUSTRATED

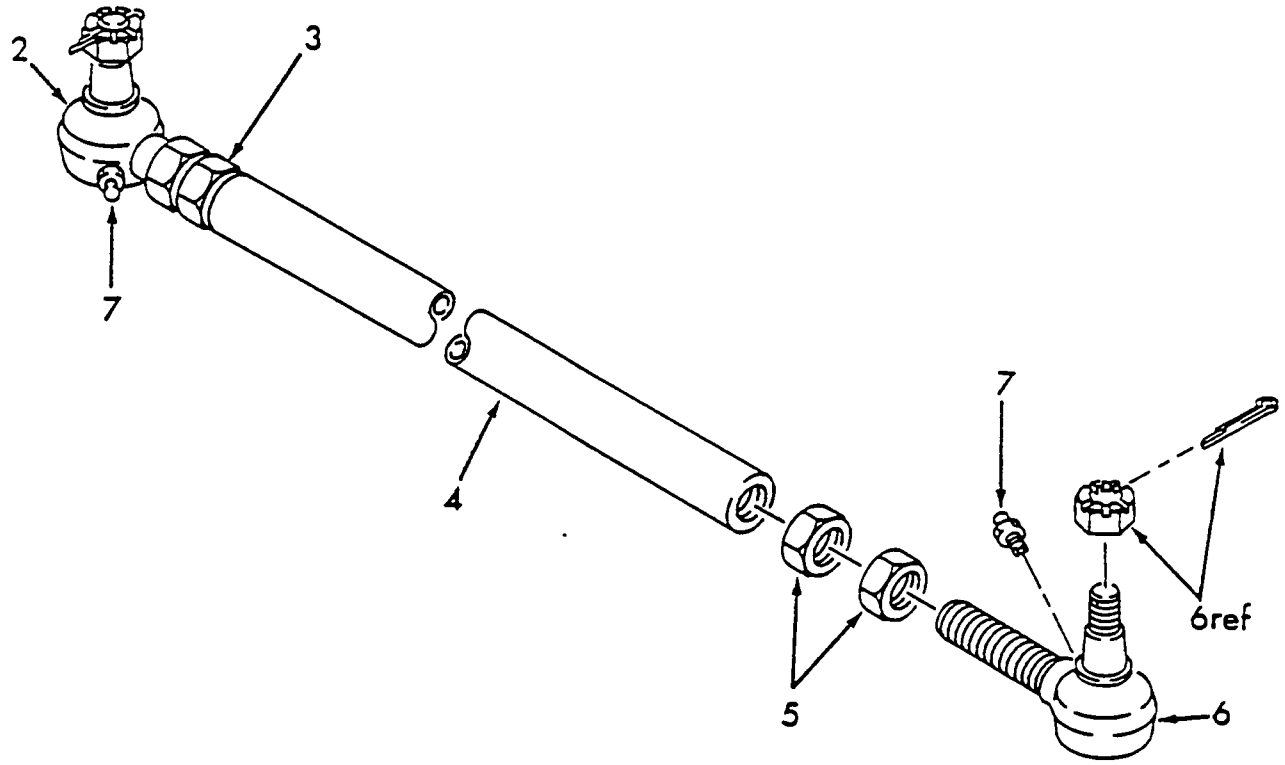
TIE ROD ASSEMBLY (80C 4X4 & 100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24157	ASSEMBLY, TIE ROD (See Sect. 3, Fig. 1 or 1B for NHA)	REF
2	20569	.END, TIE ROD	1
3	20567	.NUT, HEX JAM (LEFT HAND THREAD)	2
4	27410	.TUBE, ROUND	1
5	20566	.NUT, HEX JAM (RIGHT HAND THREAD)	2
6	20568	.END, TIE ROD	1
7	65103	.FITTING, GREASE	2

REV.

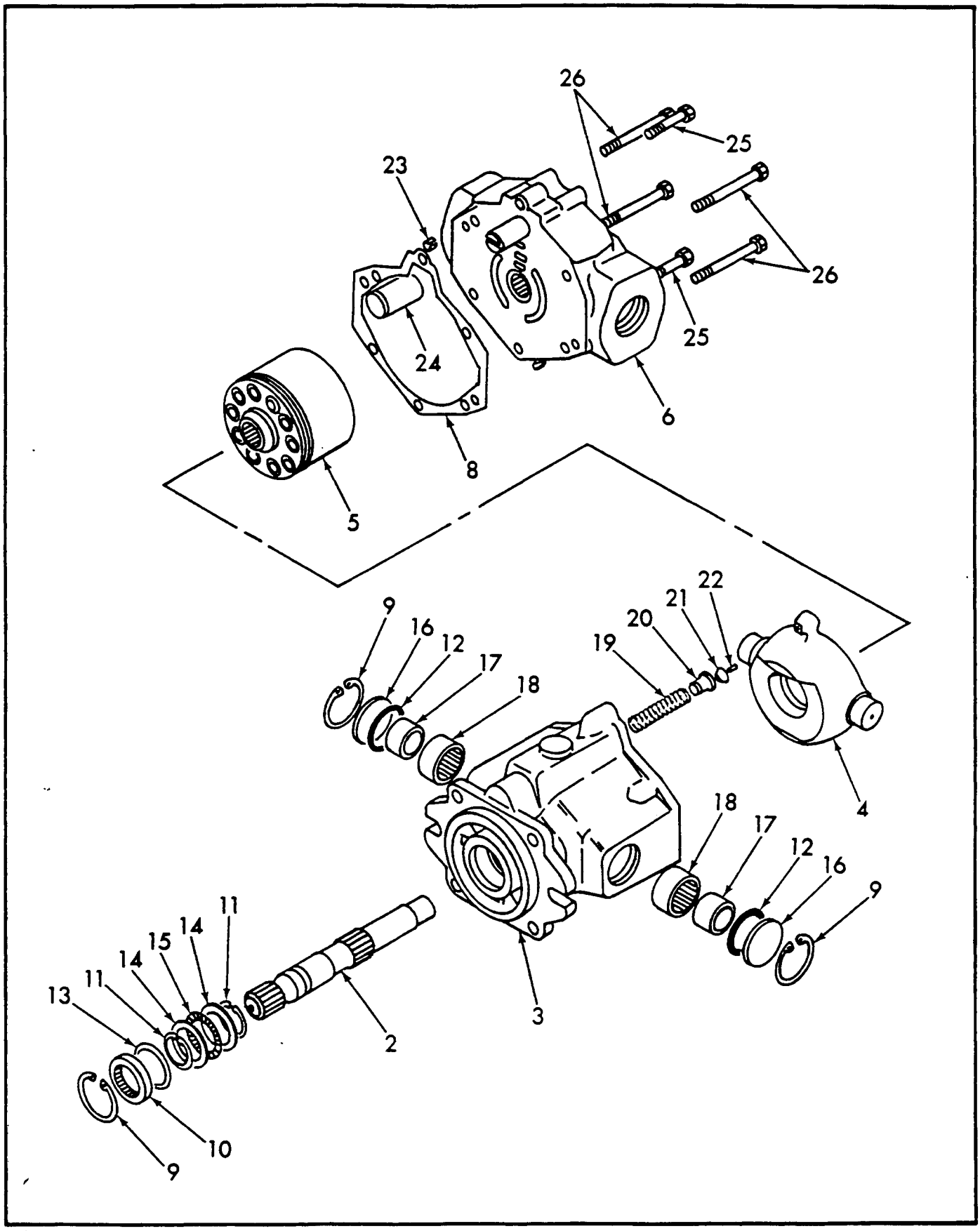
TIE ROD ASSEMBLY (80C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22034	ASSEMBLY, TIE ROD (See Sect. 3, Fig. 1A for NHA)	REF
2	20569	.END, TIE ROD	1
3	20567	.NUT, HEX JAM (LEFT HAND THREAD)	2
4	24479	.ROD, TIE	1
5	20566	.NUT, HEX JAM (RIGHT HAND THREAD)	2
6	20568	.END, TIE ROD	1
7	65103	.FITTING, GREASE	2

REV.

DRIVE MOTOR ASSEMBLY (ALL MODELS)



REV.

DRIVE MOTOR ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23526	ASSEMBLY, DRIVE MOTOR (See Sect. 3, Fig. 1 or 2 for NHA)	REF
2		.SHAFT, DRIVE	1
3		.ASSEMBLY, HOUSING	1
4		.ASSEMBLY, CAM PLATE	1
5		.ASSEMBLY, ROTATING KIT	1
6		.ASSEMBLY, BACKPLATE	1
-7	67632	.KIT, SEAL	1
8		..GASKET	1
9		..RING, RETAINING	3
10		..SEAL, SHAFT	1
11		..RING, RETAINING	2
12		..O-RING	2
13		.WASHER	1
14		.RACE, THRUST	2
15		.BEARING, THRUST	1
16		.COVER, TRUNNION	2
17		.RACE, TRUNNION	2
18		.BEARING, TRUNNION	2
19		.SPRING	1
20		.COLLAR, SPRING	1
21		.BUTTON, PIVOT	1
22		.PIN, ROLL	1
23		.PIN, DOWEL	2
24		.PISTON, CONTROL	1

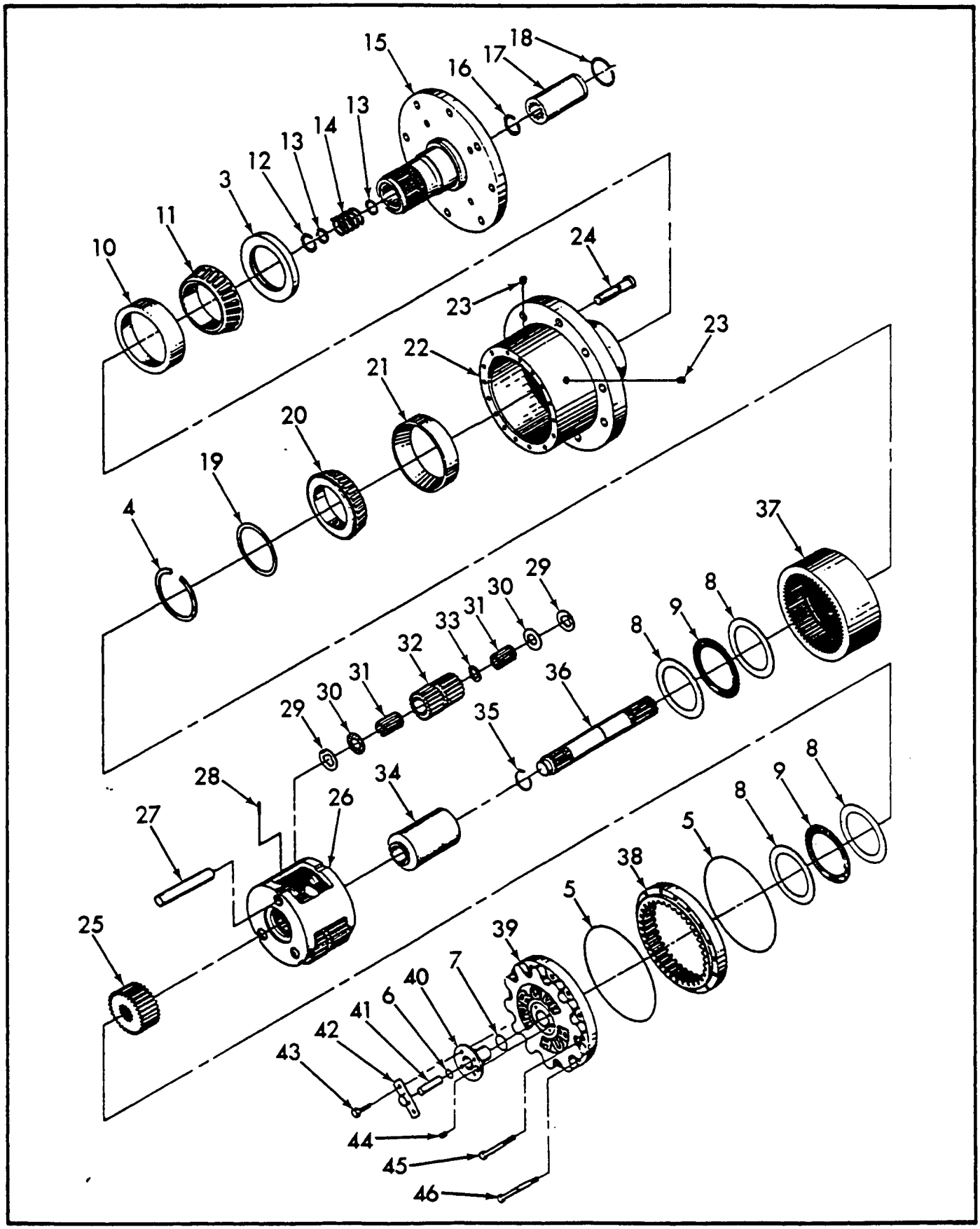
- ITEM NOT ILLUSTRATED

DRIVE MOTOR ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25		.SCREW, CAP	2
26		.SCREW, CAP	4

- ITEM NOT ILLUSTRATED

TORQUE HUB (ALL MODELS)



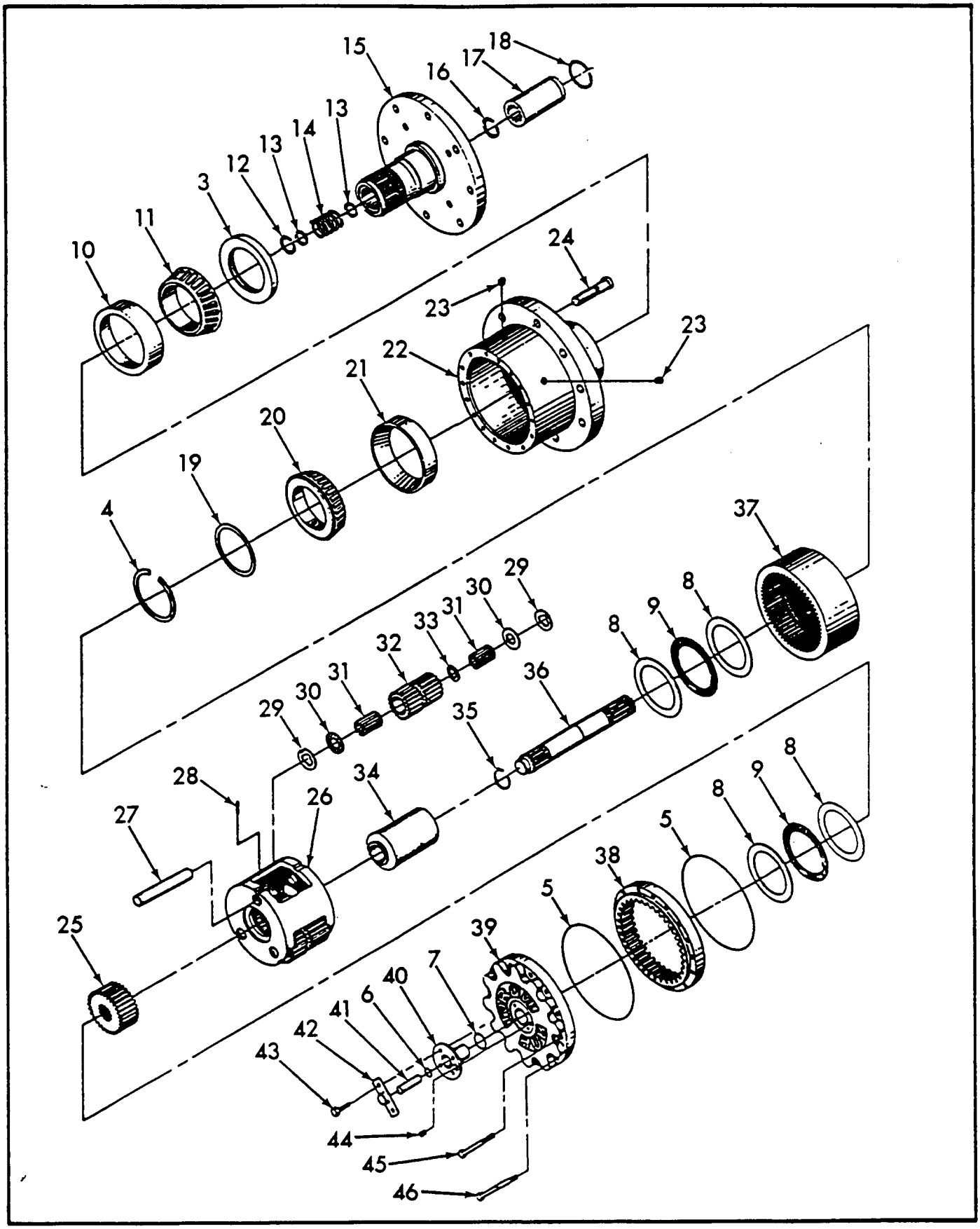
TORQUE HUB (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21222	HUB, TORQUE (See Sect. 3, Fig. 1 or 2 for NHA)	REF
-2	67870	.KIT, SEAL	1
3	66397	..SEAL	1
4		..RING, RETAINING	1
5		..O-RING	2
6		..O-RING	1
7		..O-RING	1
8		..WASHER, THRUST	4
9		..BEARING, THRUST	2
10	67912	.CUP, BEARING	1
11	67920	.CONE, BEARING	1
12	67888	.RING, RETAINING	1
13	67892	.WASHER	2
14		.SPRING	1
15		.SPINDLE	1
16	67890	.RING, RETAINING	1
17	67880	.COUPLING	1
18	67891	.RING, RETAINING	1
19	67903	.SPACER	1
20	67921	.CONE, BEARING	1
21	67913	.CUP, BEARING	1
22		.HUB	1
23		.PLUG, PIPE	2
24	67884	.STUD	10
25		.GEAR, INPUT	1

TORQUE HUB (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26		.CARRIER	1
27	66431	.SHAFT, PLANET	3
28		.PIN, ROLL	3
29	66430	.WASHER, THRUST	6
30	67894	.WASHER, THRUST	6
31	66423	.ROLLER, NEEDLE	84
32		.GEAR, CLUSTER	3
33	67904	.SPACER	3
34	67905	.SPACER, THRUST	1
35	67889	.RING, RETAINING	1
36		.SHAFT, INPUT	1
37		.GEAR, INTERNAL	1
38		.GEAR, RING	1
39	66724	.COVER	1
40	66341	.CAP, COVER	1
41	66230	.ROD, DISCONNECT	1
42	66115	.CAP, DISCONNECT	1
43	67928	.BOLT	4
44		.PLUG, PIPE	1
45	67929	.BOLT	8
46	67930	.BOLT, SHOULDER	4

TORQUE HUB (80C & 100C 6X4)



TORQUE HUB (80C & 100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24201	HUB, TORQUE (See Sect. 3, Fig. 2 for NHA)	REF
-2	67870	.KIT, SEAL	1
3	66397	..SEAL	1
4		..RING, RETAINING	1
5		..O-RING	2
6		..O-RING	1
7		..O-RING	1
8		..WASHER, THRUST	4
9		..BEARING, THRUST	2
10	67912	.CUP, BEARING	1
11	67920	.CONE, BEARING	1
12	67888	.RING, RETAINING	1
13	67892	.WASHER	2
14		.SPRING	1
15		.SPINDLE	1
16	67890	.RING, RETAINING	1
17	67880	.COUPLING	1
18	67891	.RING, RETAINING	1
19	67903	.SPACER	1
20	67921	.CONE, BEARING	1
21	67913	.CUP, BEARING	1
22		.HUB	1
23		.PLUG, PIPE	2
24	67884	.STUD	10
25		.GEAR, INPUT	1

TORQUE HUB (80C & 100C 6X4)

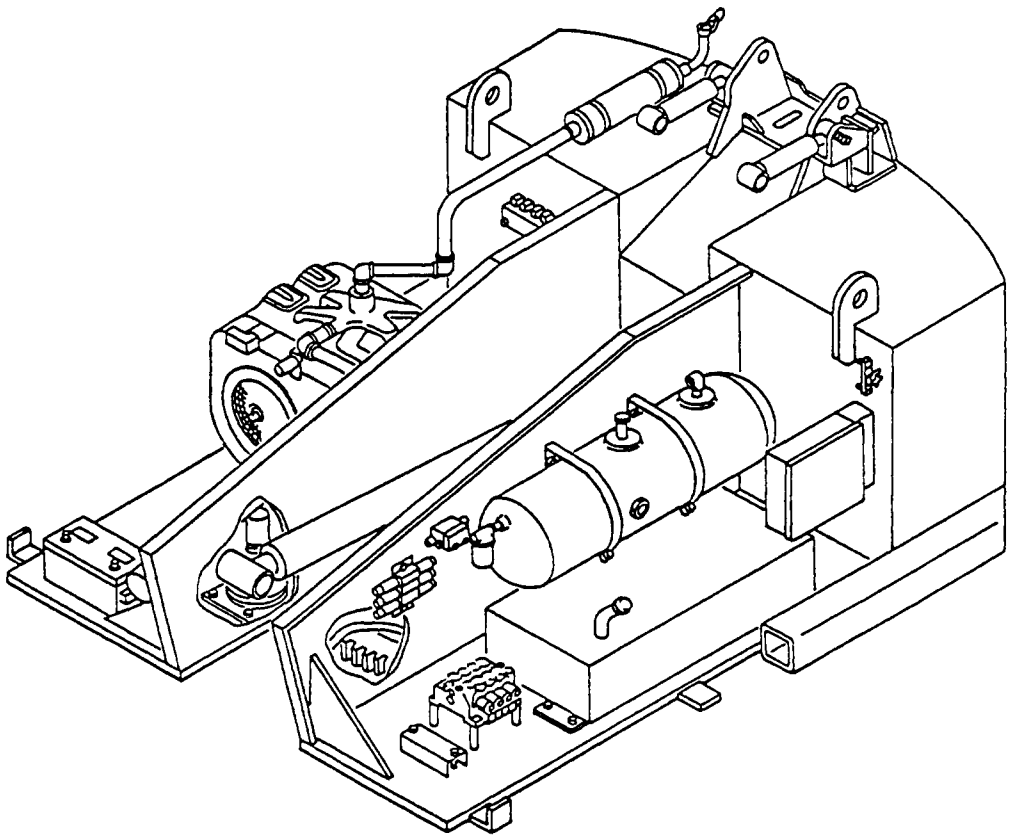
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26		.CARRIER	1
27	66431	.SHAFT, PLANET	3
28		.PIN, ROLL	3
29	66430	.WASHER, THRUST	6
30	67894	.WASHER, THRUST	6
31	66423	.ROLLER, NEEDLE	84
32		.GEAR, CLUSTER	3
33	67904	.SPACER	3
34	67905	.SPACER, THRUST	1
35	67889	.RING, RETAINING	1
36		.SHAFT, INPUT	1
37		.GEAR, INTERNAL	1
38		.GEAR, RING	1
39	66724	.COVER	1
40	66341	.CAP, COVER	1
41	66230	.ROD, DISCONNECT	1
42	66115	.CAP, DISCONNECT	1
43	67928	.BOLT	4
44		.PLUG, PIPE	1
45	67929	.BOLT	8
46	67930	.BOLT, SHOULDER	4

- ITEM NOT ILLUSTRATED

SECTION 4 CONTAINS:

FIG. NO.	TITLE
1	TURRET ASSEMBLY (80C 4X4 & 6X4)
1A	TURRET ASSEMBLY (100C 6X4)
2	FUEL TANK ASSEMBLY (80C 4X4 & 6X4)
2A	DIESEL FUEL TANK ASSEMBLY (100C 6X4)
3	PROPORTIONAL VALVE ASSEMBLY (ALL MODELS)
4	HYDRAULIC TANK ASSEMBLY (80C 4X4 & 6X4)
4A	HYDRAULIC TANK ASSEMBLY (100C 6X4)
5	EMERGENCY DESCENT VALVE ASSEMBLY (80C 4X4 & 6X4)
6	GROUND CONTROL BOX ASSEMBLY (ALL MODELS)
7	MINIPAK ASSEMBLY (80C 4X4 & 6X4)
7A	MINIPAK ASSEMBLY (100C 6X4)
8	RELIEF VALVE ASSEMBLY (ALL MODELS)

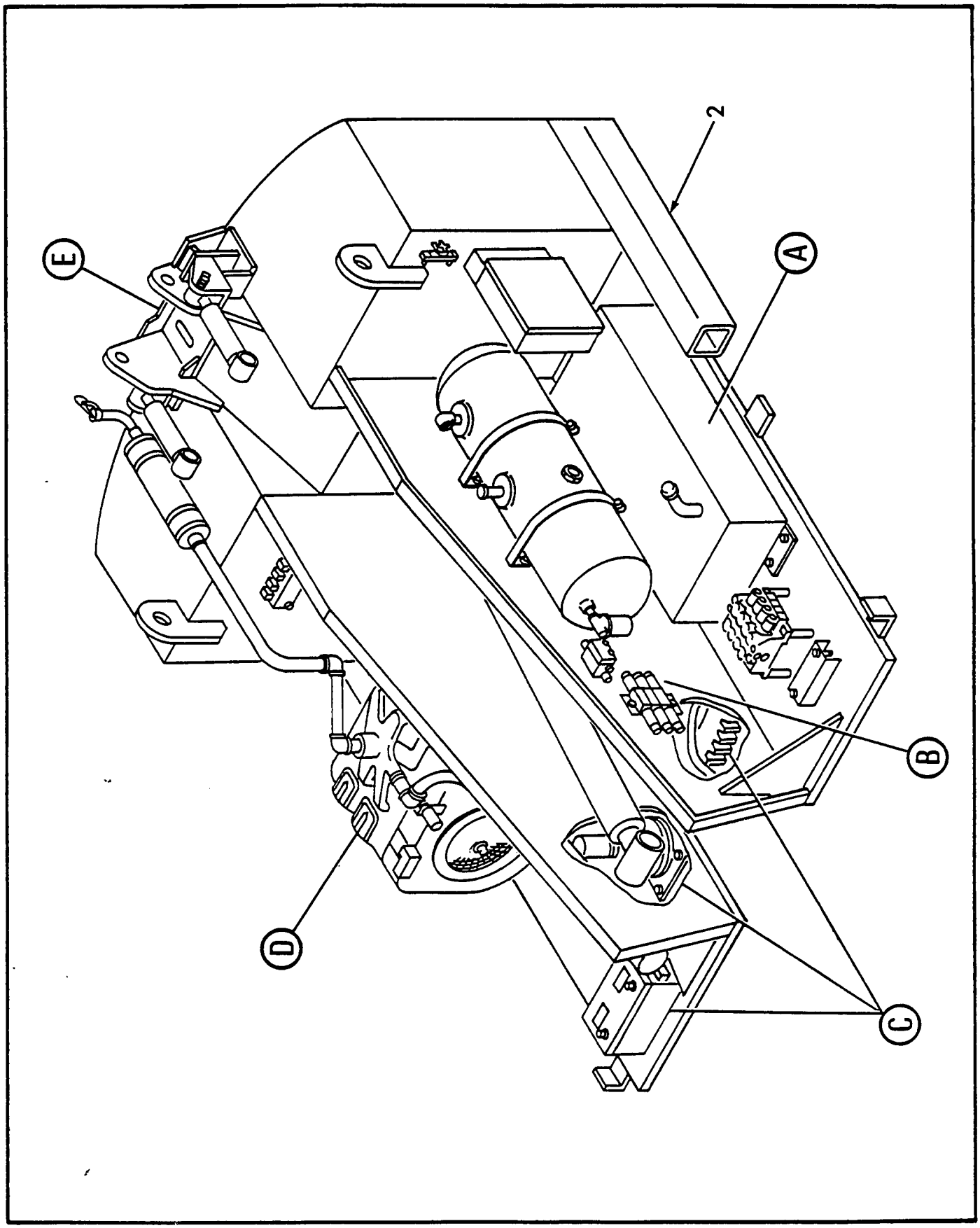
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SECTION 4 CONTAINS: (CONTINUED)

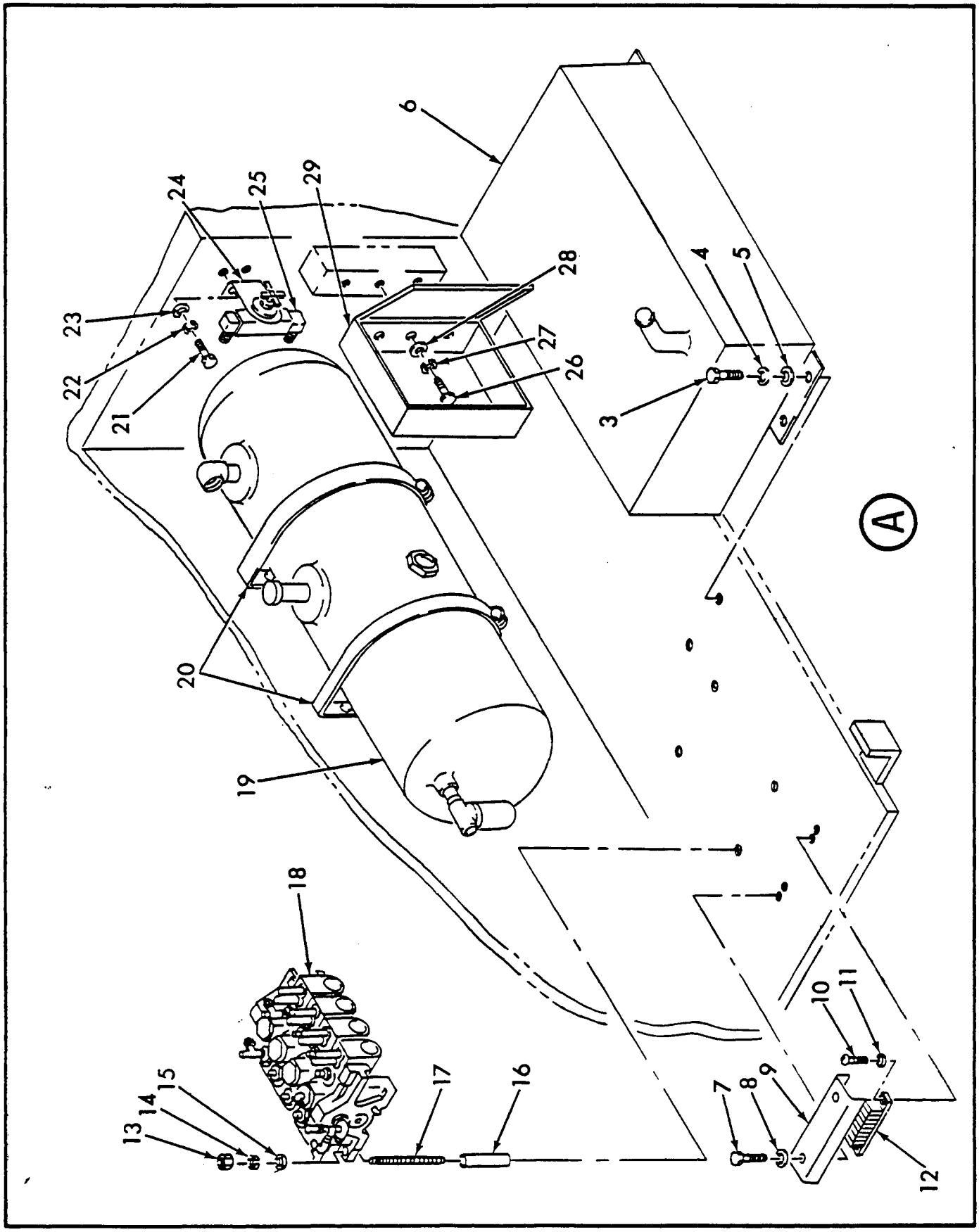
FIG. NO.	TITLE
9	DUAL OVERCENTER VALVE (ALL MODELS)
10	DUMP VALVE ASSEMBLY (ALL MODELS)
11	ROTATION GEARBOX ASSEMBLY (ALL MODELS)
11A	ROTATION GEARBOX BRAKE
11B	ROTATION GEARBOX HYDRAULIC MOTOR
12	ROTARY MANIFOLD ASSEMBLY (ALL MODELS)
13	ENGINE & PUMP ASSEMBLY (80C 4X4 & 6X4)
13A	ENGINE & PUMP ASSEMBLY (100C 6X4)
13B	ENGINE PUMP (ALL MODELS)
14	SOLENOID VALVE ASSEMBLY (ALL MODELS)
14A	SOLENOID VALVE ASSEMBLY (100C 6X4)
15	MASTER LEVELING CYLINDER ASSEMBLY (ALL MODELS)
16	LIFT CYLINDER ASSEMBLY (ALL MODELS)
17	EMERGENCY PUMP & MOTOR ASSEMBLY (ALL MODELS)
18	TORQUE HUB (ALL MODELS)

TURRET ASSEMBLY (80C 4X4 & 6X4)



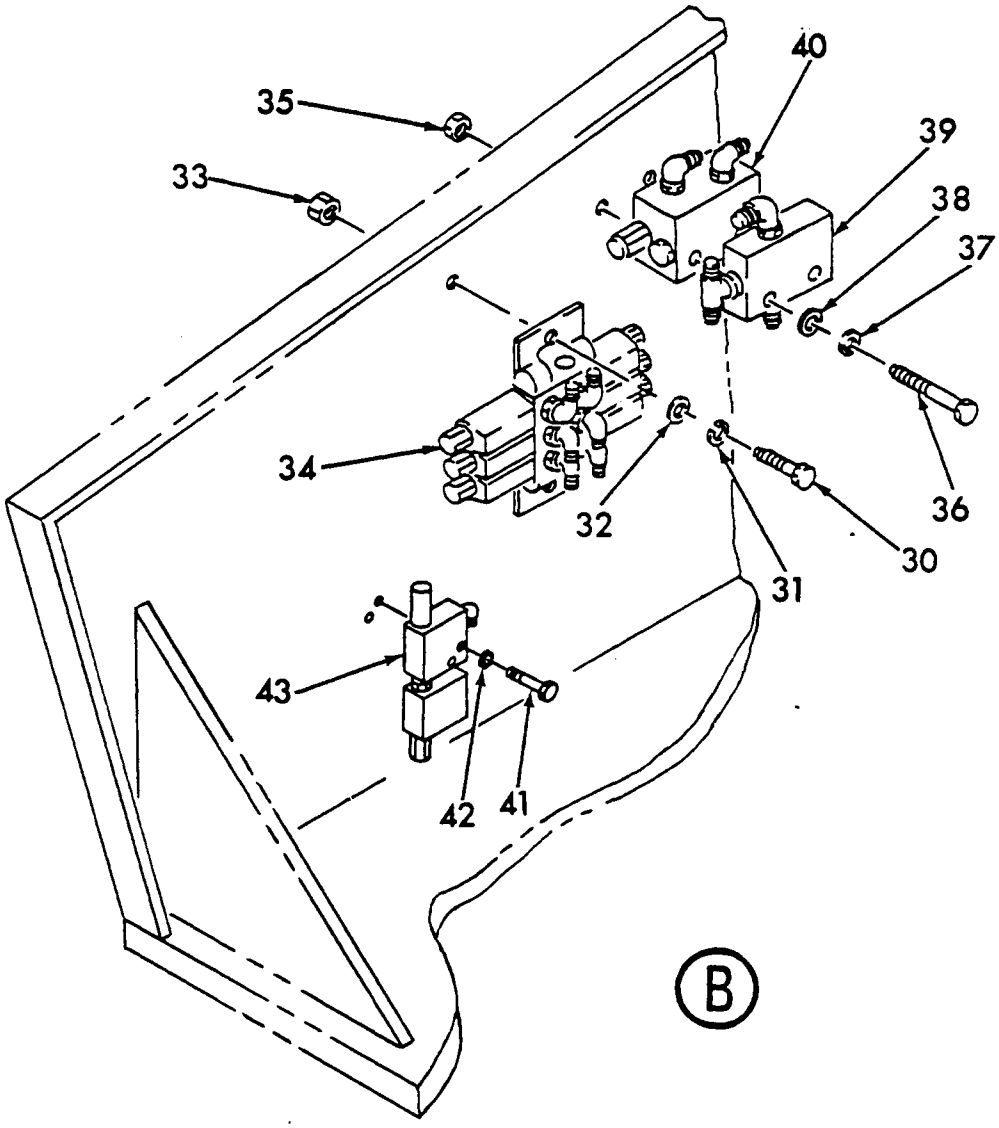
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TURRET ASSEMBLY (80C 4X4 & 6X4)

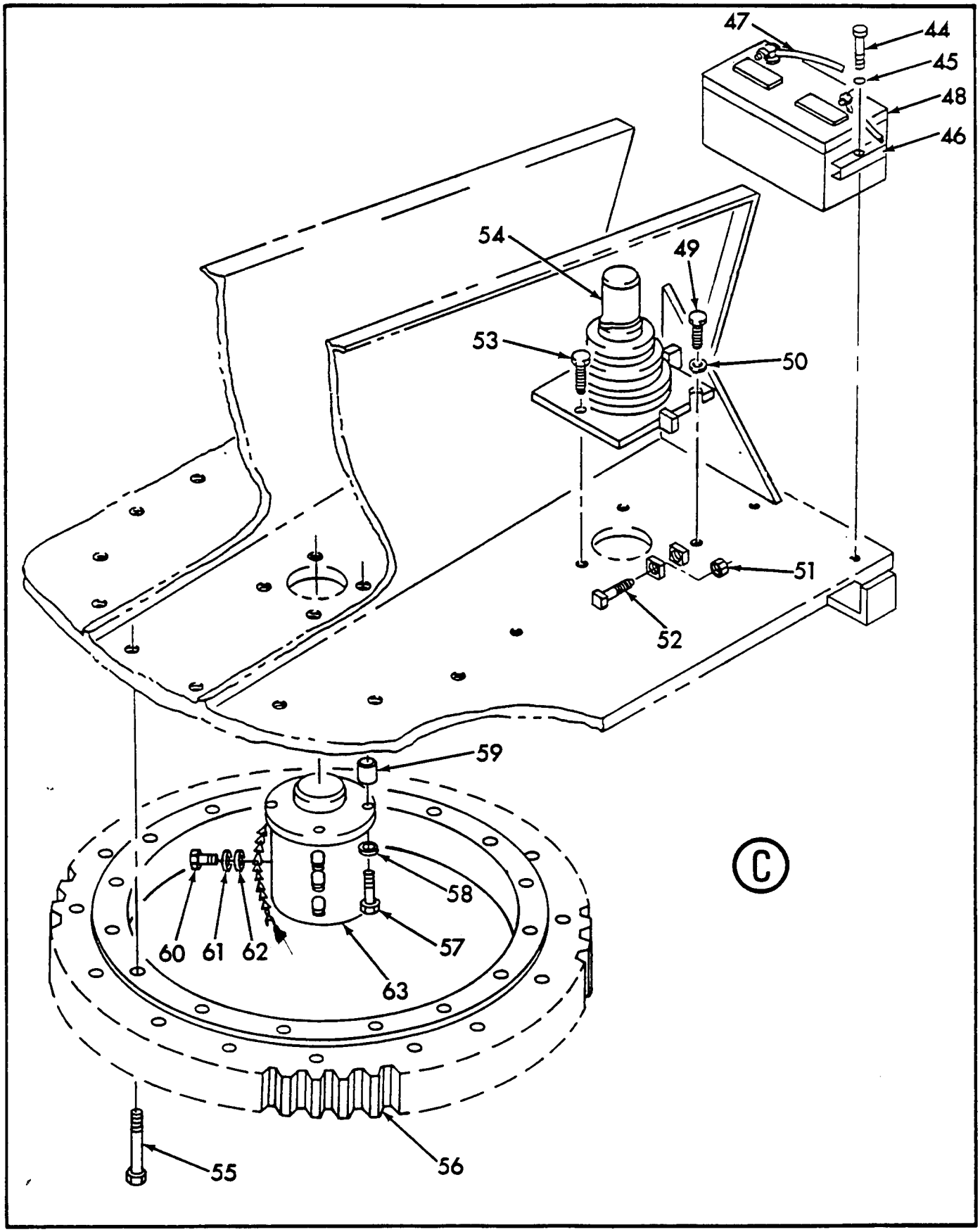


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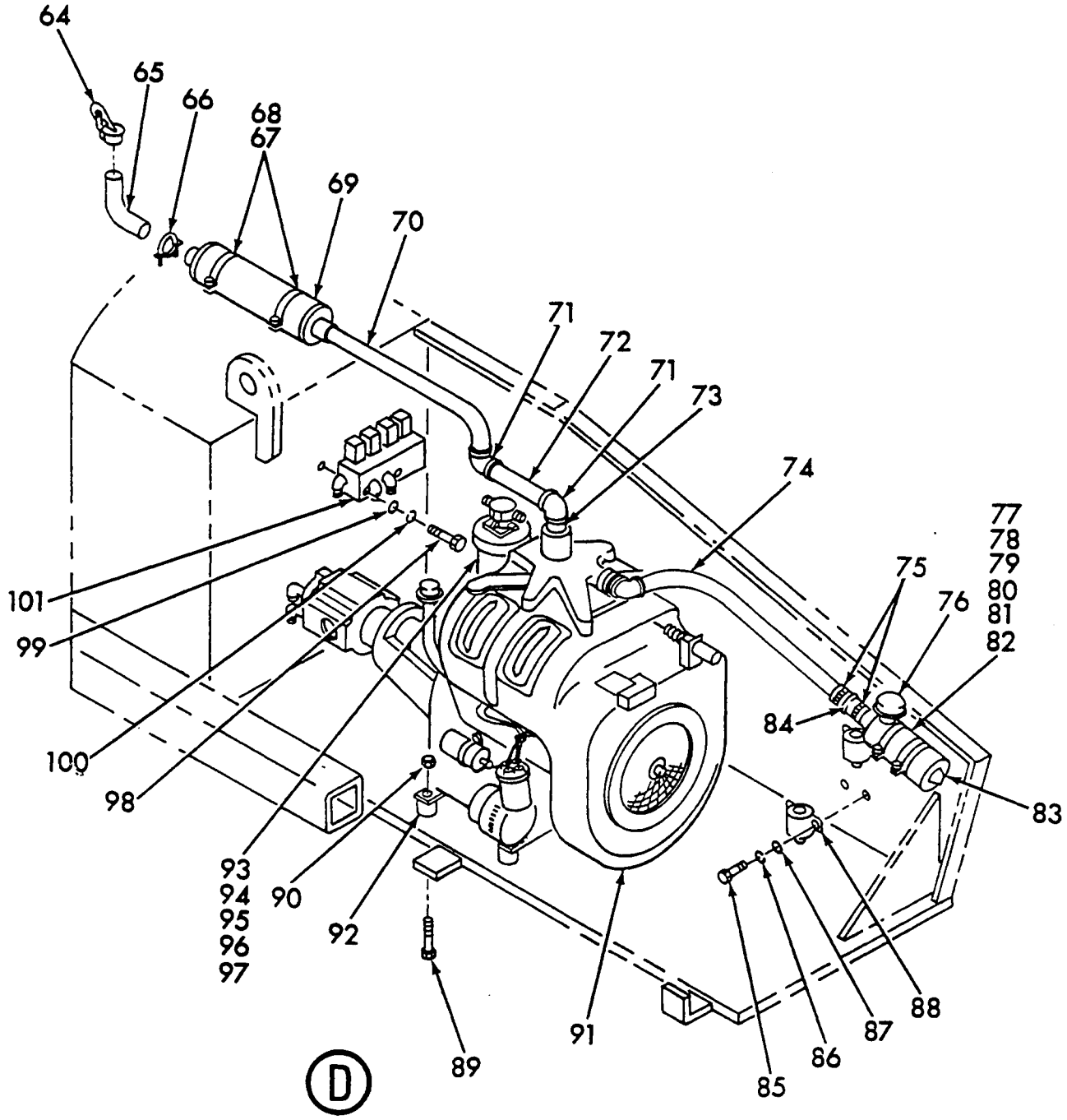
TURRET ASSEMBLY (80C 4X4 & 6X4)



TURRET ASSEMBLY (80C 4X4 & 6X4)

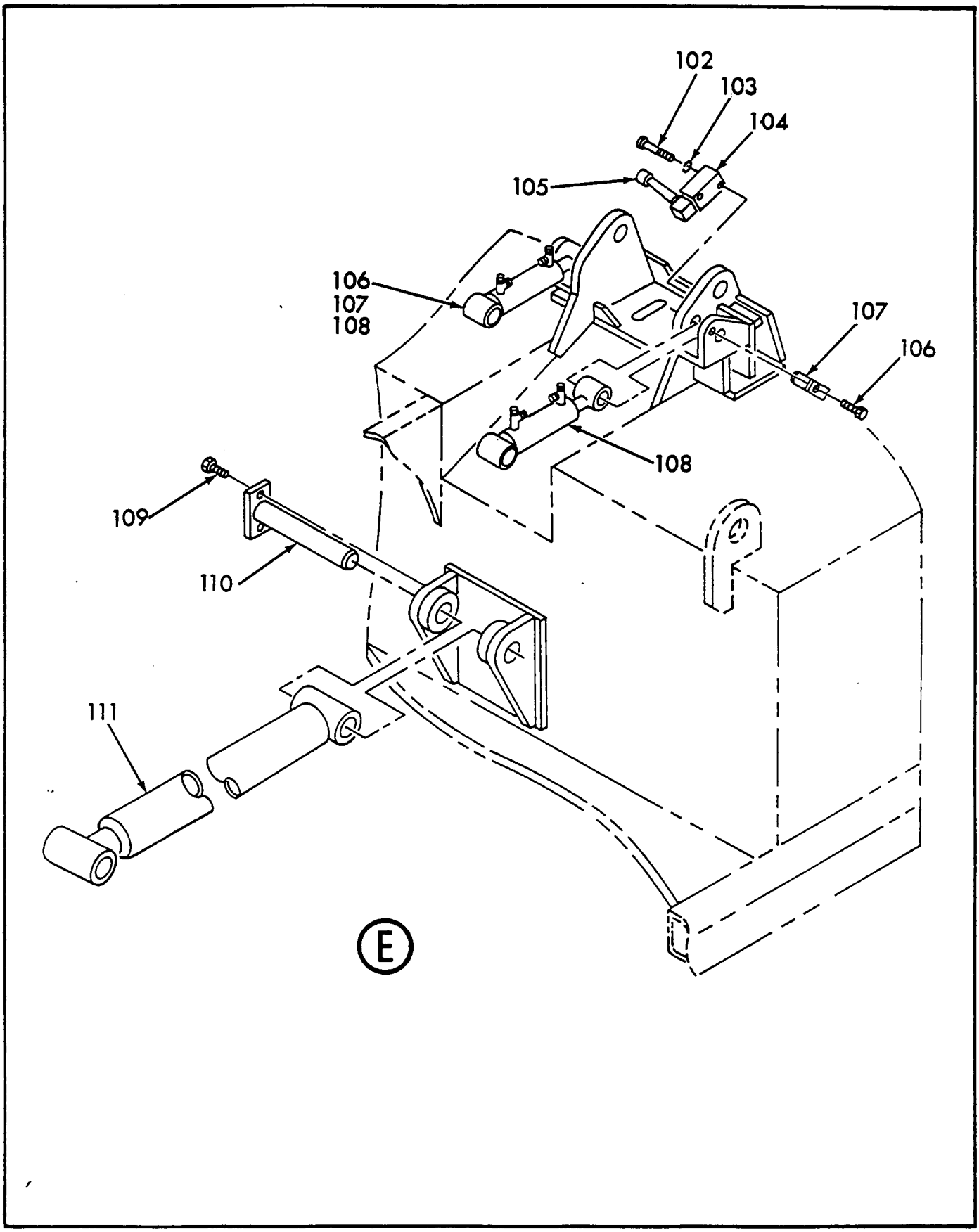


TURRET ASSEMBLY (80C 4X4 & 6X4)



REV.

TURRET ASSEMBLY (80C 4X4 & 6X4)



REV.

TURRET ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24477	ASSEMBLY, TURRET (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	22150	.WELDMENT, TURRET	1
3	60325	.SCREW, CAP	4
4	63303	.WASHER, LOCK	4
5	63403	.WASHER, FLAT	4
6	22136	.ASSEMBLY, FUEL TANK (See Sect. 4, Fig. 2 for Details)	1
7	60323	.SCREW, CAP	2
8	63302	.WASHER, LOCK	2
9	21386	.COVER, TERMINAL STRIP	1
10	62607	.SCREW, MACHINE	2
11	63313	.WASHER, LOCK	2
12	21217	.STRIP, TERMINAL	1
13	60705	.NUT, HEX	3
14	63305	.WASHER, LOCK	3
15	63405	.WASHER, FLAT	3
16	27527	.TUBE, ROUND	3
17	63633	.ROD, THREADED	3
18	24145	.ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 3 for Details)	1
19	21387	.BRACKET, HYDRAULIC TANK	2
20	21937	.ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 4 for Details)	1
21	60325	.SCREW, CAP	2
22	63303	.WASHER, LOCK	2
23	63403	.WASHER, FLAT	2
24	21279	.BRACKET, EMERGENCY DESCENT VALVE	1

- ITEM NOT ILLUSTRATED

TURRET ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	21279	.ASSEMBLY, EMERGENCY DESCENT VALVE (See Sect. 4, Fig. 5 for Details)	1
26	60325	.SCREW, CAP	3
27	63303	.WASHER, LOCK	3
28	63403	.WASHER, FLAT	3
29	24298	.ASSEMBLY, GROUND CONTROL BOX (See Sect. 4, Fig. 6 for Details)	1
30	60343	.SCREW, CAP	2
31	63303	.WASHER, LOCK	2
32	63403	.WASHER, FLAT	2
33	60703	.NUT, HEX	2
34	22607	.ASSEMBLY, MINIPAK (See Sect. 4, Fig. 7 for Details)	1
35	60702	.NUT, HEX	2
36	60316	.SCREW, CAP	2
37	63302	.WASHER, LOCK	2
38	63402	.WASHER, FLAT	2
39	22144	.ASSEMBLY, RELIEF VALVE (See Sect. 4, Fig. 8 for Details)	1
40	22510	.ASSEMBLY, DUAL OVER CENTER VALVE (See Sect. 4, Fig. 9 for Details)	1
41	60340	.SCREW, CAP	2
42	63301	.WASHER, LOCK	2
43	22204	.ASSEMBLY, DUMP VALVE (See Sect. 4, Fig. 10 for Details)	1
44	60316	.SCREW, CAP	2
45	63302	.WASHER, LOCK	2
46	21286	.BRACKET, BATTERY HOLD DOWN	2
47	24637	.KIT, BATTERY CABLE	1

- ITEM NOT ILLUSTRATED

TURRET ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
48	21244	.BATTERY, 12 VOLT	1
49	60637	.SCREW, CAP	2
50	22169	.WASHER, GEARBOX	2
51	60910	.NUT, JAM	2
52	62222	.SCREW, SET CUP POINT	2
53	60601	.SCREW, CAP	1
54	22789	.ASSEMBLY, ROTATION GEARBOX (See Sect. 4, Fig. 11 for Details)	1
55	60604	.SCREW, CAP	16
56	22021	.RING, SLEWING	1
57	60511	.SCREW, CAP	4
58	63302	.WASHER, LOCK	4
59	20445	.SPACER, MANIFOLD	4
60	60612	.SCREW, CAP	2
61	63303	.WASHER, LOCK	2
62	63403	.WASHER, FLAT	2
63	21898	.MANIFOLD, ROTARY (See Sect. 4, Fig. 12 for Details)	1
64	21288	.CAP, MUFFLER RAIN	1
65	65337	.ELBOW, MUFFLER	1
66	16288	.CLAMP, HOSE	1
67	60322	.SCREW, CAP	4
68	65336	.BRACKET, MUFFLER	2
69	65328	.MUFFLER	1
70	22185	.EXHAUST, 2SS INTERLOCK	1
71	62345	.90° FEMALE ELBOW	4
72	65347	.NIPPLE	1

- ITEM NOT ILLUSTRATED

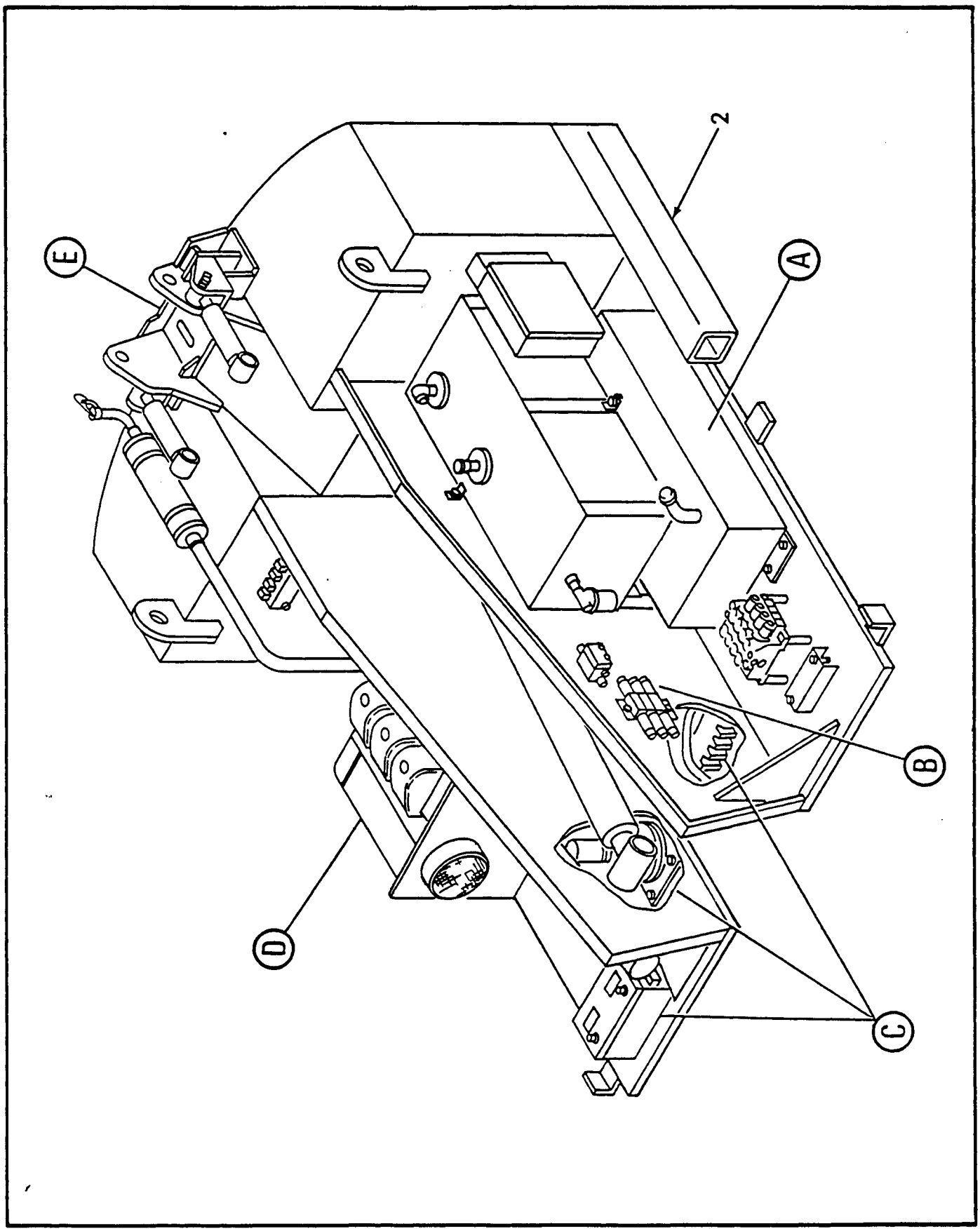
TURRET ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
73	65346	.NIPPLE	1
74	24586	.TUBE, AIR INTAKE	1
75	65417	.CLAMP, HOSE	2
76	160083	.HOOD, AIR INLET	1
77	22208	.BRACKET, AIR CLEANER MOUNTING	2
78	60338	.SCREW, CAP	10
79	63402	.WASHER, FLAT	8
80	65412	.BAND, MOUNTING	2
81	63302	.WASHER, LOCK	2
82	60702	.NUT, HEX	2
83	160082	.CLEANER, AIR	1
84	160086	.REDUCER	1
85	60318	.SCREW, CAP	4
86	63301	.WASHER, LOCK	4
87	63401	.WASHER, FLAT	4
88	70209	.RELAY, SOLENOID	2
89	60635	.SCREW, CAP	4
90	60715	.NUT, HEX	4
91	24593	.ASSEMBLY, ENGINE & PUMP (See Sect. 4, Fig. 13 for Details)	1
92	22133	.SPACER, ENGINE	4
93	60338	.SCREW, CAP	4
94	60702	.NUT, HEX	4
95	63402	.WASHER, FLAT	4
96	63302	.WASHER, LOCK	4
97	22390	.ASSEMBLY, EMERGENCY PUMP & MOTOR (See Sect. 4, Fig. 17 for Details)	4

- ITEM NOT ILLUSTRATED

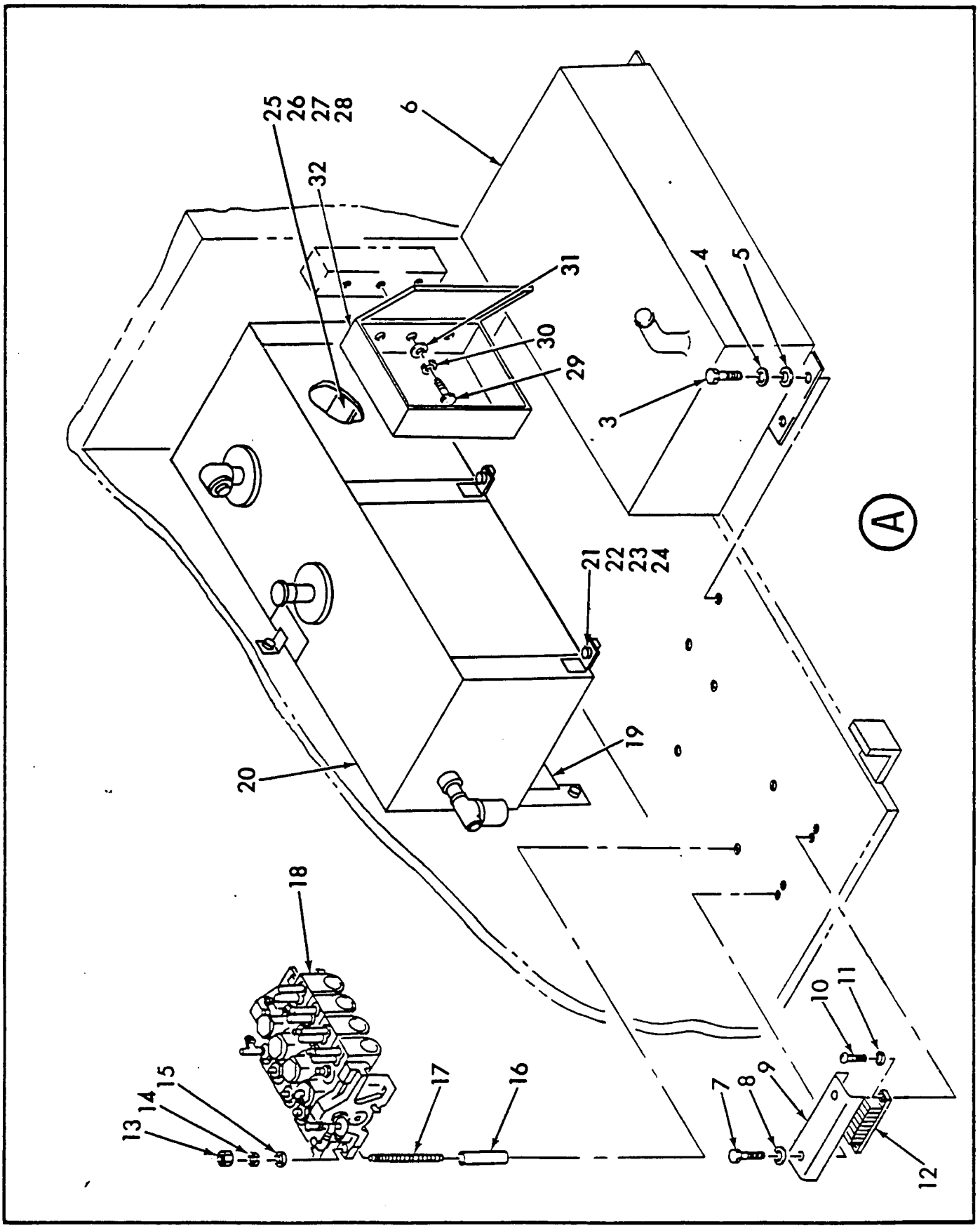
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
98	60329	.SCREW, CAP	2
99	63402	.WASHER, FLAT	2
100	63302	.WASHER, LOCK	2
101	22609	.ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 14 for Details)	1
102	62704	.SCREW, MACHINE	2
103	63313	.WASHER, LOCK	2
104	70107	.SWITCH, LIMIT	1
105	70031	.ARM, LEVER	1
106	60607	.SCREW, CAP	2
107	21337	.PIN, MASTER LEVELING CYLINDER	2
108	21084	.ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 15 for Details)	2
109	60618	.SCREW, CAP	2
110	22046	.PIN, LIFT CYLINDER	1
111	24056	.ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 16 for Details)	1

TURRET ASSEMBLY (100C 6X4)

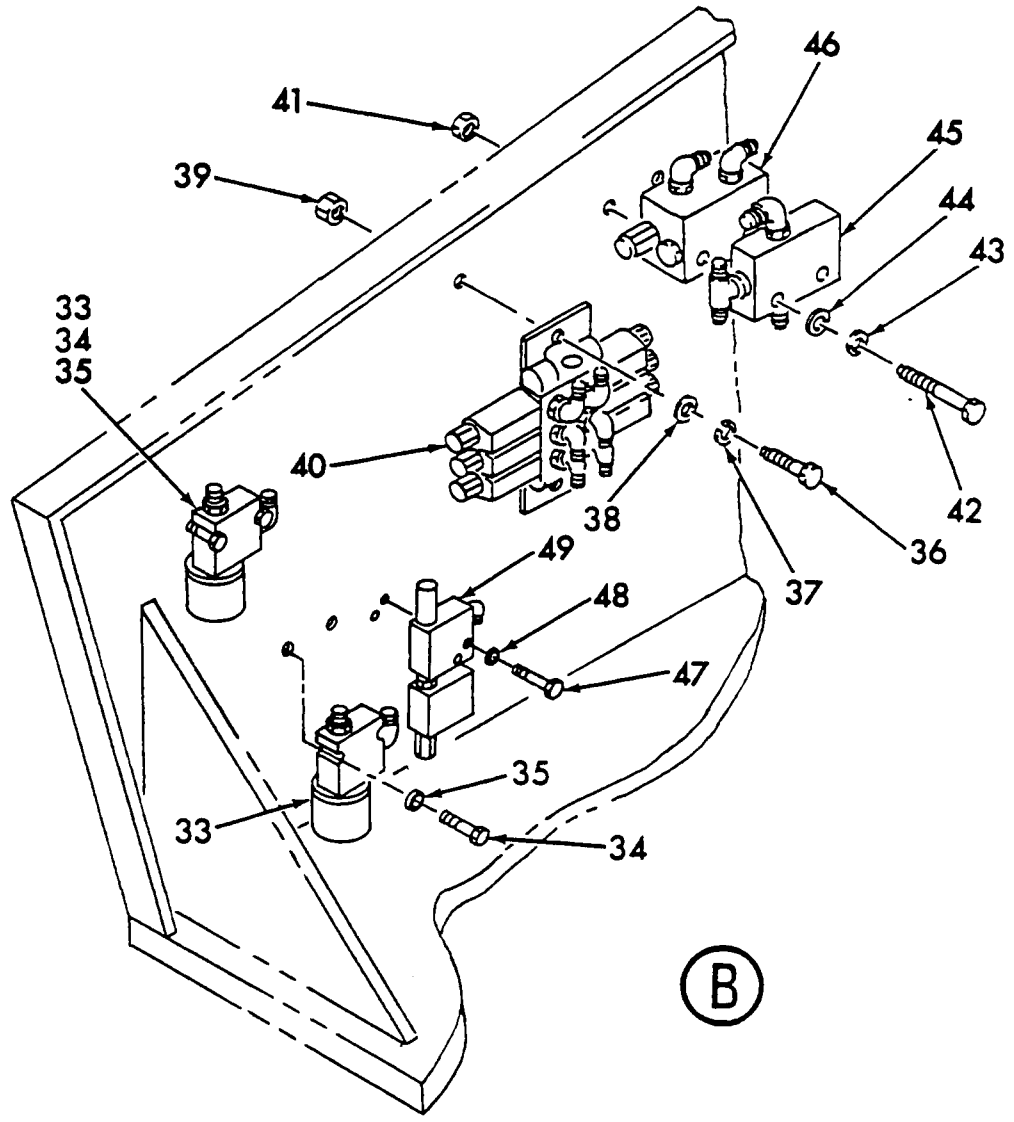


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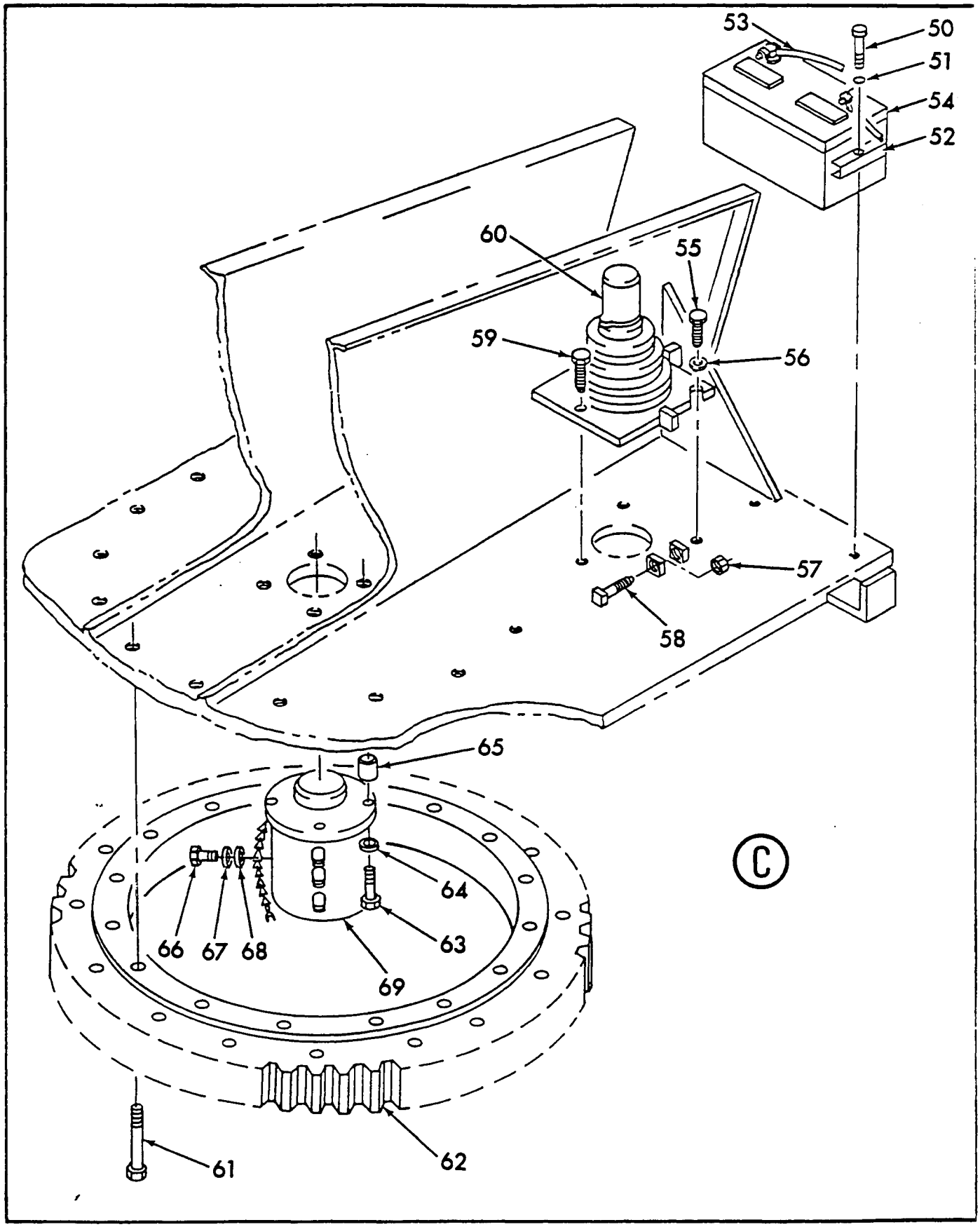
TURRET ASSEMBLY (100C 6X4)



TURRET ASSEMBLY (100C 6X4)

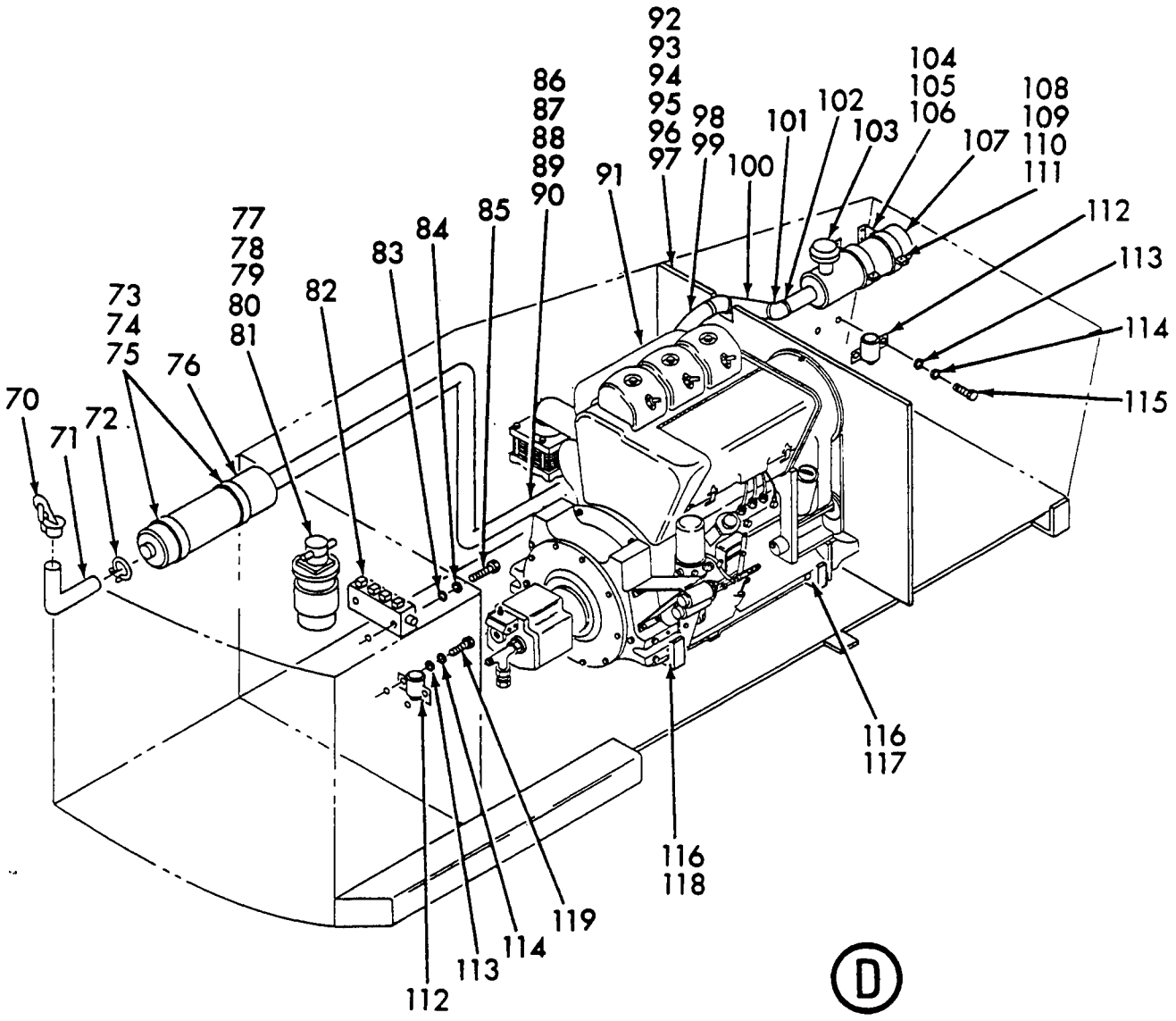


TURRET ASSEMBLY (100C 6X4)

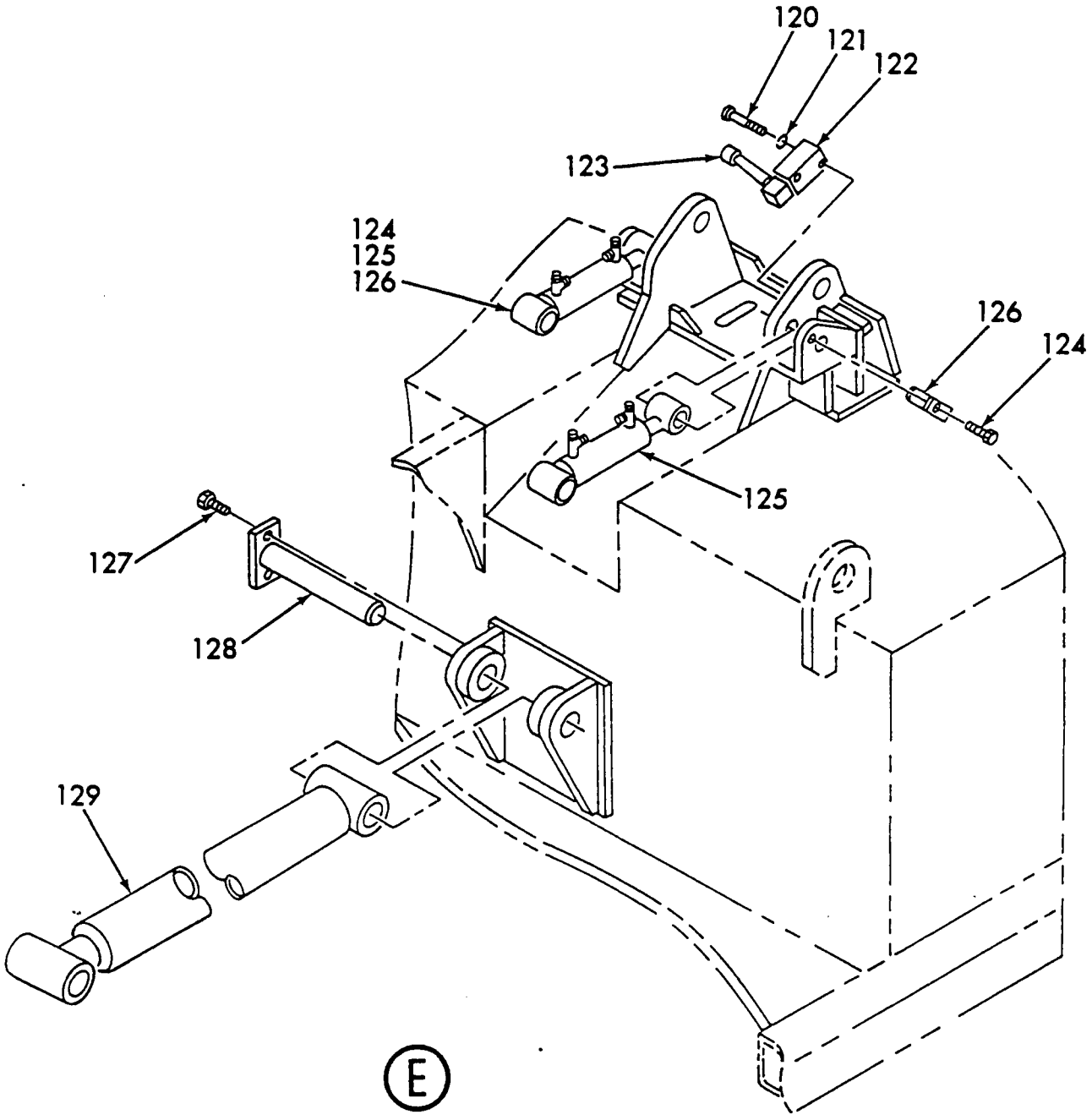


REV.

TURRET ASSEMBLY (100C 6X4)



TURRET ASSEMBLY (100C 6X4)



TURRET ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24485	ASSEMBLY, TURRET (See Sect. 2, Fig. 1A for NHA)	REF
2	24482	.WELDMENT, TURRET	1
3	60325	.SCREW, CAP	4
4	63303	.WASHER, LOCK	4
5	63403	.WASHER, FLAT	4
6	22197	.ASSEMBLY, DIESEL FUEL TANK (See Sect. 4, Fig. 2A for Details)	1
7	60323	.SCREW, CAP	2
8	63302	.WASHER, LOCK	2
9	21386	.COVER, TERMINAL STRIP	1
10	62607	.SCREW, MACHINE	2
11	63313	.WASHER, LOCK	2
12	21217	.STRIP, TERMINAL	1
13	60705	.NUT, HEX	3
14	63305	.WASHER, LOCK	3
15	63405	.WASHER, FLAT	3
16	27527	.TUBE, ROUND	3
17	63633	.STUD	3
18	24145	.ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 3 for Details)	1
19	24513	.WELDMENT, HYDRAULIC TANK BRACKET	2
20	24504	.ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 4A for Details)	1
21	60346	.SCREW, CAP	4
22	63302	.WASHER, LOCK	4
23	63402	.WASHER, FLAT	4
24	60708	.NUT, HEX	4

- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	24517	.SUPPORT, HYDRAULIC TANK	1
26	60331	.SCREW, CAP	2
27	63303	.WASHER, LOCK	2
28	63403	.WASHER, FLAT	2
29	60325	.SCREW, CAP	3
30	63303	.WASHER, LOCK	3
31	63403	.WASHER, FLAT	3
32	24298	.ASSEMBLY, GROUND CONTROL BOX (See Sect. 4, Fig. 6 for Details)	1
33	22909	.ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 14A for Details)	2
34	60319	.SCREW, CAP	4
35	63301	.WASHER, LOCK	4
36	60343	.SCREW, CAP	2
37	63303	.WASHER, LOCK	2
38	63403	.WASHER, FLAT	2
39	60703	.NUT, HEX	2
40	22607	.ASSEMBLY, MINIPAK (See Sect. 4, Fig. 7A for Details)	1
41	60702	.NUT, HEX	2
42	60316	.SCREW, CAP	2
43	63302	.WASHER, LOCK	2
44	63402	.WASHER, FLAT	2
45	22144	.ASSEMBLY, RELIEF VALVE (See Sect. 4, Fig. 8 for Details)	1
46	22510	.ASSEMBLY, DUAL OVERCENTER VALVE (See Sect. 4, Fig. 9 for Details)	1
47	60340	.SCREW, CAP	2

TURRET ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
48	63301	.WASHER, LOCK	2
49	22204	.ASSEMBLY, DUMP VALVE (See Sect. 4, Fig. 10 for Details)	1
50	60316	.SCREW, CAP	2
51	63302	.WASHER, LOCK	2
52	21286	.BRACKET, BATTERY HOLD DOWN	2
53	24638	.KIT, BATTERY CABLE	1
54	21244	.BATTERY, 12 VOLT	1
55	60637	.SCREW, CAP	2
56	22169	.WASHER, GEARBOX	2
57	60910	.NUT, JAM	2
58	62222	.SCREW, SET CUP POINT	2
59	60601	.SCREW, CAP	1
60	22789	.ASSEMBLY, ROTATION GEARBOX (See Sect. 4, Fig. 11 for Details)	1
61	60604	.SCREW, CAP	16
62	22021	.RING, SLEWING	1
63	60511	.SCREW, CAP	4
64	63302	.WASHER, LOCK	4
65	20445	.SPACER, MANIFOLD	4
66	60612	.SCREW, CAP	2
67	63303	.WASHER, LOCK	2
68	63403	.WASHER, FLAT	2
69	21898	.MANIFOLD, RCTARY (See Sect. 4, Fig. 12 for Details)	1
70	21288	.CAP, MUFFLER RAIN	1
71	65337	.ELBOW, MUFFLER	1

TURRET ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
72	16288	.CLAMP, HOSE	1
73	65336	.BRACKET, MUFFLER	2
74	60322	.SCREW, CAP	4
75	63302	.WASHER, LOCK	4
76	65328	.MUFFLER	1
77	22390	.ASSEMBLY, EMERGENCY PUMP & MOTOR (See Sect. 4, Fig. 17 for Details)	1
78	60338	.SCREW, CAP	4
79	63302	.WASHER, LOCK	4
80	63402	.WASHER, FLAT	4
81	60702	.NUT, HEX	4
82	22609	.ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 14 for Details)	1
83	63402	.WASHER, FLAT	2
84	63302	.WASHER, LOCK	2
85	60329	.SCREW, CAP	2
86	65330	.GASKET	1
87	65329	.FLANGE, EXHAUST	1
88	65331	.SCREW, CAP	3
89	22186	.EXHAUST, 2SS INTERLOCK	1
90	65332	.NUT, HEX	3
91	22201	.ASSEMBLY, ENGINE & PUMP (See Sect. 4, Fig. 13A for Details)	1
92	22179	.BAFFLE, UPPER	1
93	22211	.BAFFLE, LOWER	1
94	22287	.STIFFENER, BAFFLE	1
95	60312	.SCREW, CAP	19

- ITEM NOT ILLUSTRATED

TURRET ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
96	63301	.WASHER, LOCK	19
97	60701	.NUT, HEX	19
98	25380	.TUBE, ROUND	1
99	65327	.HOSE, RUBBER	1
100	25377	.TUBE, ROUND	1
101	65344	.ELBOW, RUBBER AIR INLET	2
102	65326	.CLAMP, AIR INLET	6
103	65348	.HOOD, AIR INLET	1
104	22208	.BRACKET, AIR CLEANER MOUNTING	2
105	60338	.SCREW, CAP	8
106	63402	.WASHER, FLAT	8
107	65324	.CLEANER, AIR	1
108	65325	.BAND, MOUNTING	2
109	60338	.SCREW, CAP	2
110	63302	.WASHER, LOCK	2
111	60702	.NUT, HEX	2
112-	70209	.SOLENOID	3
113	63301	.WASHER, LOCK	6
114	63401	.WASHER, FLAT	6
115	60318	.SCREW, CAP	4
116	22802	.STAND OFF	4
117	22202	.SUPPORT, FRONT	1
118	22205	.SUPPORT, REAR	1
119	60353	.SCREW, CAP	2
120	62704	.SCREW, MACHINE	2
121	63313	.WASHER, LOCK	2

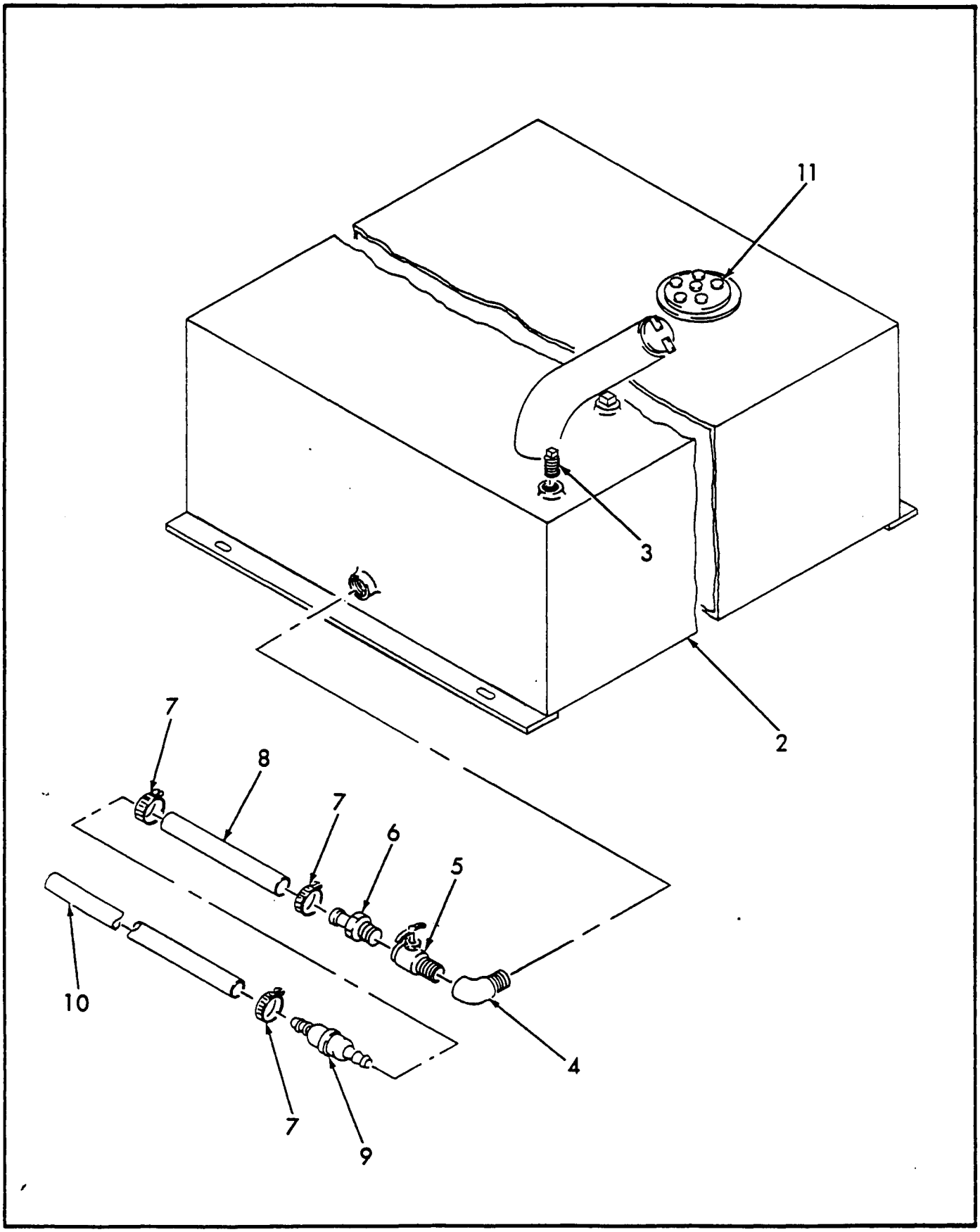
- ITEM NOT ILLUSTRATED

TURRET ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
122	70107	.SWITCH, LIMIT	1
123	70031	.ARM, LEVER	1
124	60607	.SCREW, CAP	2
125	21337	.PIN, MASTER LEVELING CYLINDER	2
126	21084	.ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 15 for Details)	2
127	60618	.SCREW, CAP	2
128	22046	.PIN, LIFT CYLINDER	1
129	24056	.ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 16 for Details)	1

- ITEM NOT ILLUSTRATED

FUEL TANK ASSEMBLY (80C 4X4 & 6X4)

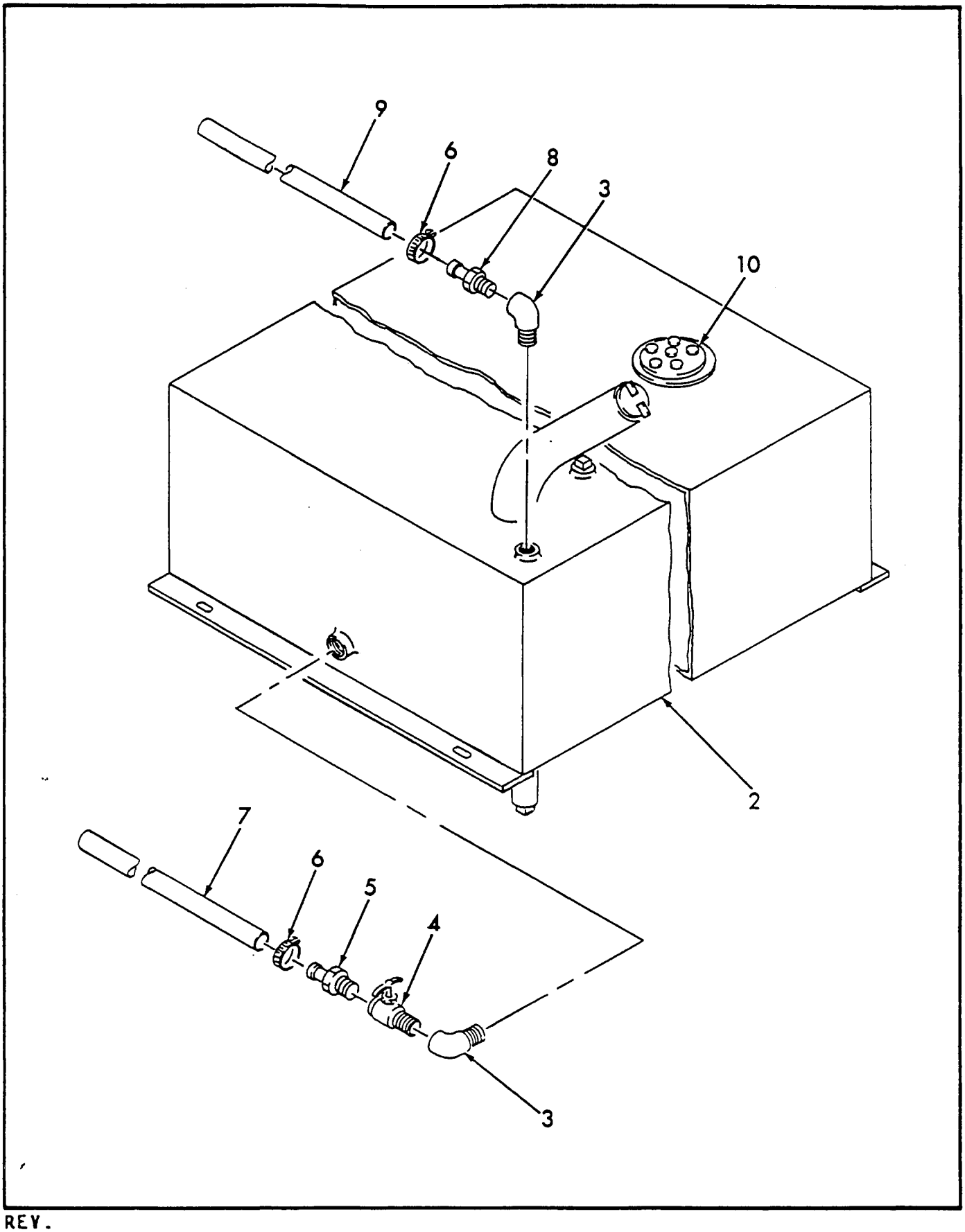


FUEL TANK ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22136	ASSEMBLY, FUEL TANK (See Sect. 4, Fig. 1 for NHA)	REF
2	22024	.TANK, FUEL	1
3	53911	.PLUG, PIPE	1
4	80021-03	.ELBOW, STREET	1
5	12000	.VALVE, SHUT OFF	1
6	2589	.FITTING, HOSE	1
7	161-A	.CLAMP, HOSE	3
8	160-B-0040	.HOSE	1
9	160	.FILTER, FUEL	1
10	160-B-1000	.HOSE	1
11	20041	.UNIT, TRANSMITTING	1

- ITEM NOT ILLUSTRATED

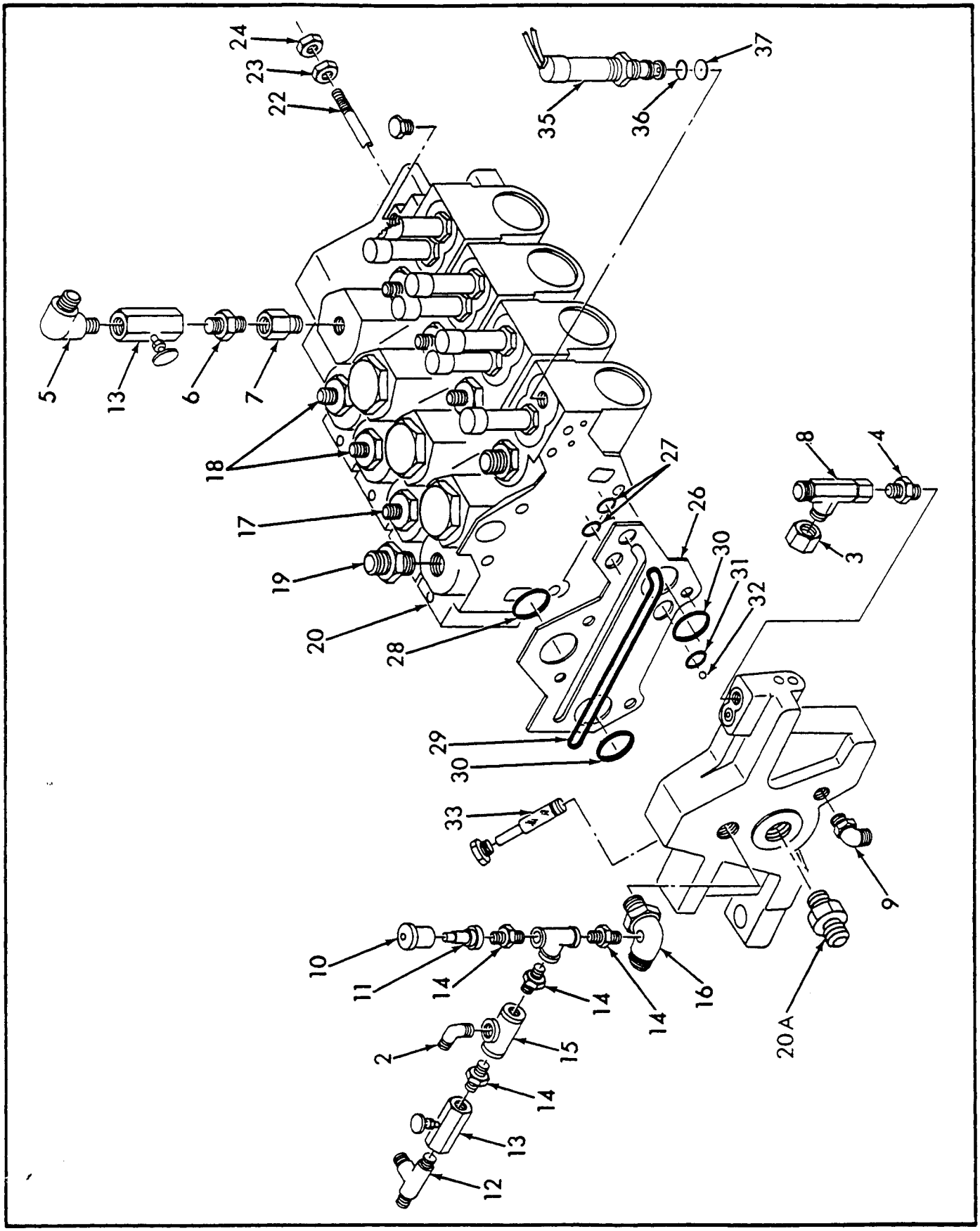
DIESEL FUEL TANK ASSEMBLY (100C 6X4)



DIESEL FUEL TANK ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22197	ASSEMBLY, DIESEL FUEL TANK (See Sect. 4, Fig. 1A for NHA)	REF
2	22024	.TANK, FUEL	1
3	2450	.ELBOW, STREET	2
4	12000	.VALVE, SHUT OFF	1
5	2589	.FITTING, HOSE	1
6	161-A	.CLAMP, HOSE	2
7	65227	.HOSE, FUEL	1
8	864	.FITTING, HOSE	1
9	65226	.HOSE, FUEL	1
10	20041	.UNIT, TRANSMITTING	1

PROPORTIONAL VALVE ASSEMBLY (ALL MODELS)



REV.

PROPORTIONAL VALVE ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24145	ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	80008-08	.ELBOW, MALE	1
3	80059-03	.CAP	1
4	80004-03	.CONNECTOR, STRAIGHT THREAD	1
5	80008-04	.ELBOW, MALE	1
6	80052-03	.NIPPLE, PIPE	1
7	51903	.ADAPTER, FEMALE PIPE	1
8	80028-03	.TEE, SWIVEL NUT RUN	1
9	80012-03	.ELBOW, STRAIGHT THREAD	1
10	845	.CAP, QUICK DISCONNECT	1
11	2527	.COUPLING, QUICK DISCONNECT	1
12	80037-08	.TEE, MALE RUN	1
13	20357	.VALVE, NEEDLE	2
14	80052-04	.NIPPLE, PIPE	4
15	80039-04	.TEE, FEMALE PIPE	2
16	24181	.ELBOW, MODIFIED STRAIGHT THREAD	1
17	50844	.CONNECTOR, STRAIGHT THREAD	2
18	80004-14	.CONNECTOR, STRAIGHT THREAD	4
19	80004-18	.CONNECTOR, STRAIGHT THREAD	2
20	81315	.VALVE, PROPORTIONAL	1
20A	80004-24	.CONNECTOR, STRAIGHT THREAD	1
-21	67379	..KIT, TIE ROD	1
22		...ROD, TIE	4
23		...NUT, HEX	4
24		...NUT, LOCK	4

- ITEM NOT ILLUSTRATED

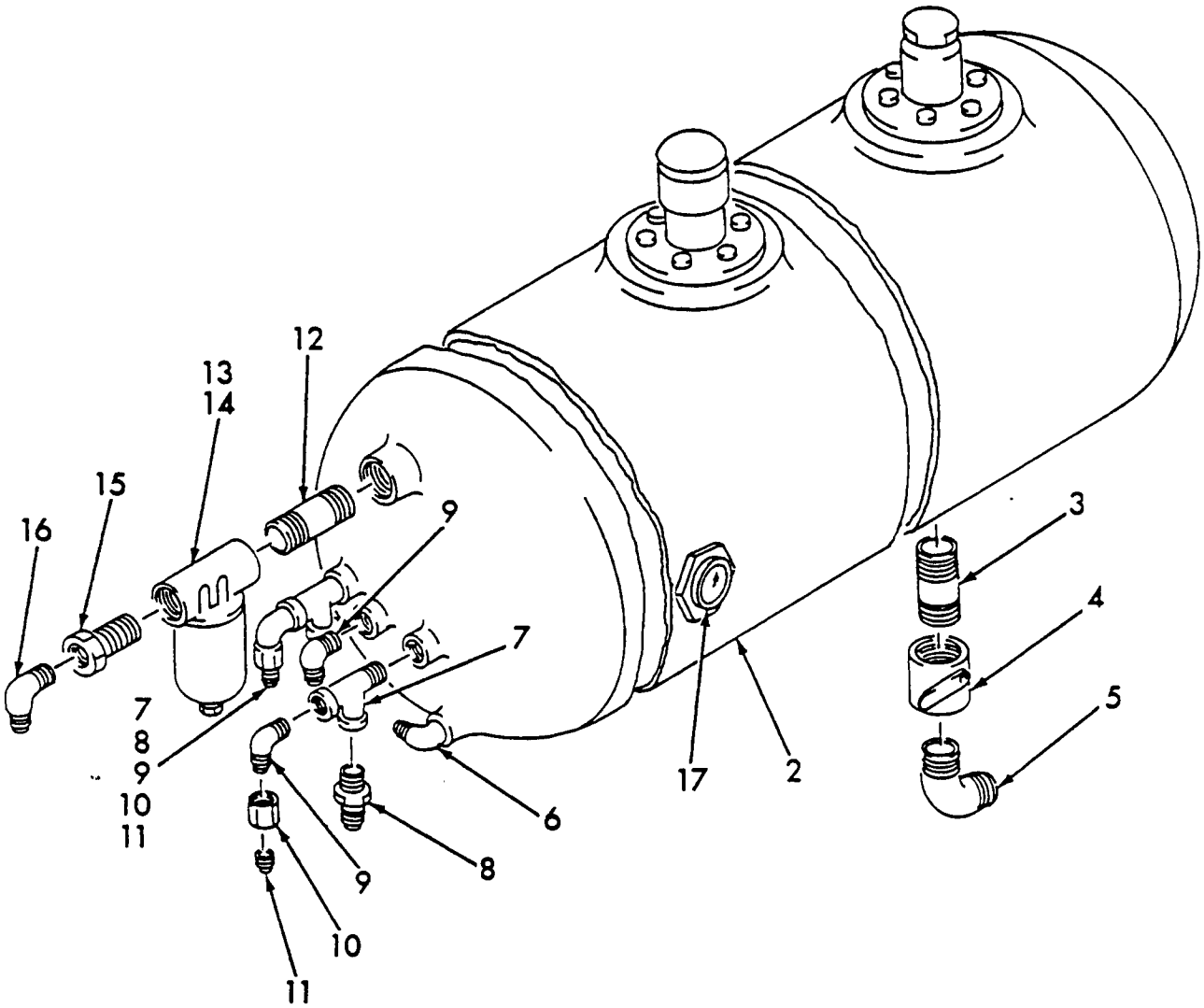
PROPORTIONAL VALVE ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-25	67378	..KIT, SEAL PLATE	5
26		...PLATE, SEAL	1
27		...O-RING	2
28		...O-RING	1
29		...O-RING	1
30		...O-RING	2
31		...O-RING	1
32		...BALL	1
33	67382	..STRAINER, INLET L.S. PILOT FILTER	1
-34	67380	..KIT, SOLENOID CARTRIDGE	8
* 35		...CARTRIDGE, SOLENOID	1
36		...O-RING	1
* 37		...DISK	1

*ITEMS 35 AND 37 ARE MATCH SETS AND SHOULD NOT BE REPLACED INDIVIDUALLY.

- ITEM NOT ILLUSTRATED

HYDRAULIC TANK ASSEMBLY (80C 4X4 & 6X4)

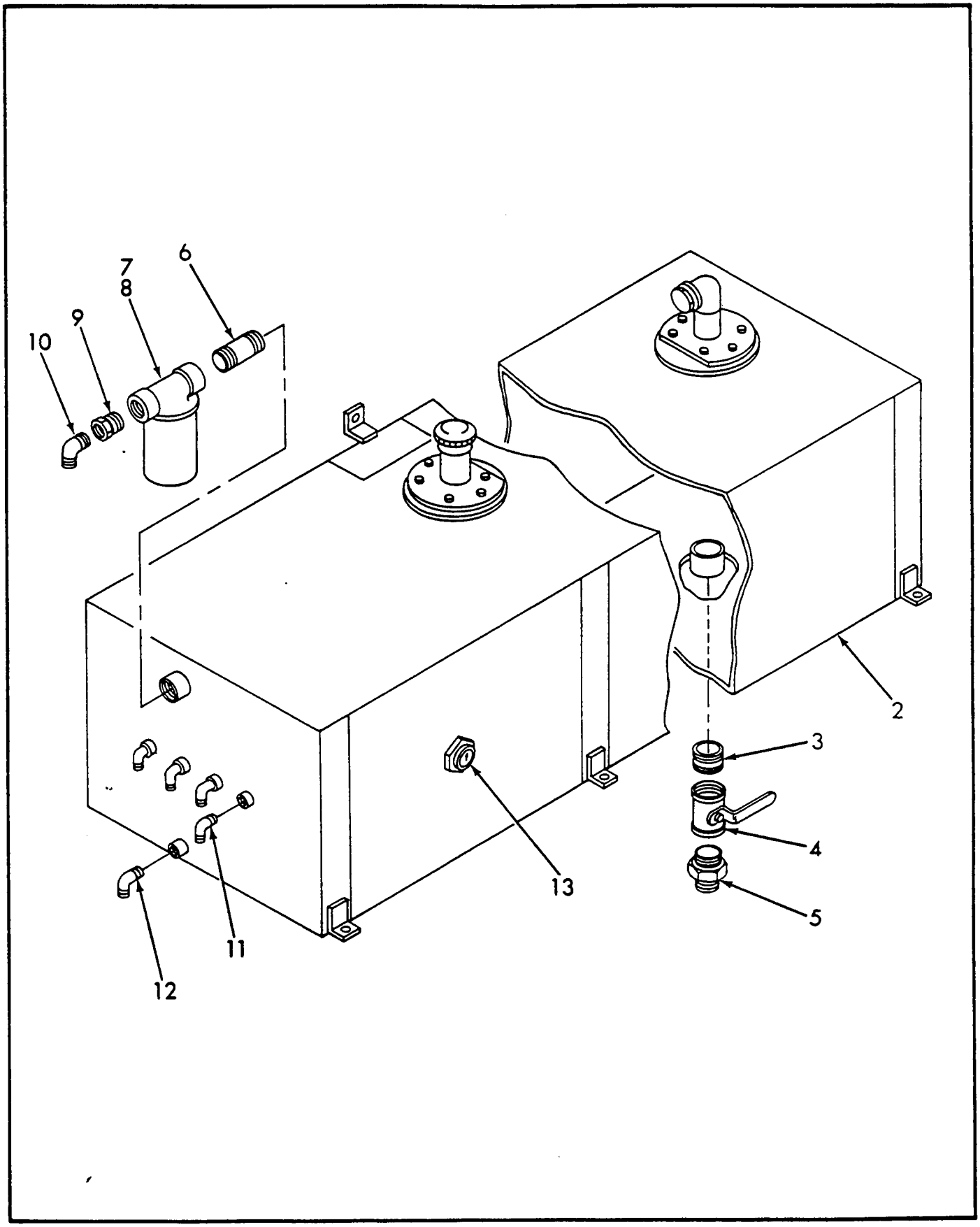


HYDRAULIC TANK ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21937	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 1 for NHA)	REF
2	21336	.TANK, HYDRAULIC	1
3	16553	.NIPPLE	1
4	20050	.VALVE, BUTTERBALL	1
5	2551	.ELBOW	1
6	80008-20	.ELBOW, MALE	1
7	80041-06	.TEE, STREET	2
8	80001-10	.CONNECTOR, MALE	2
9	80008-10	.ELBOW, MALE	3
10	80060-05	.NUT	2
11	80056-01	.REDUCER, TUBE END	2
12	16557	.NIPPLE	1
13	21241	.FILTER, RETURN LINE	1
14	21245	..ELEMENT, FILTER	1
15	80057-20	.REDUCER, PIPE THREAD	1
16	80008-23	.ELBOW, MALE	1
17	65130A	.GAUGE	1

- ITEM NOT ILLUSTRATED

HYDRAULIC TANK ASSEMBLY (100C 6X4)

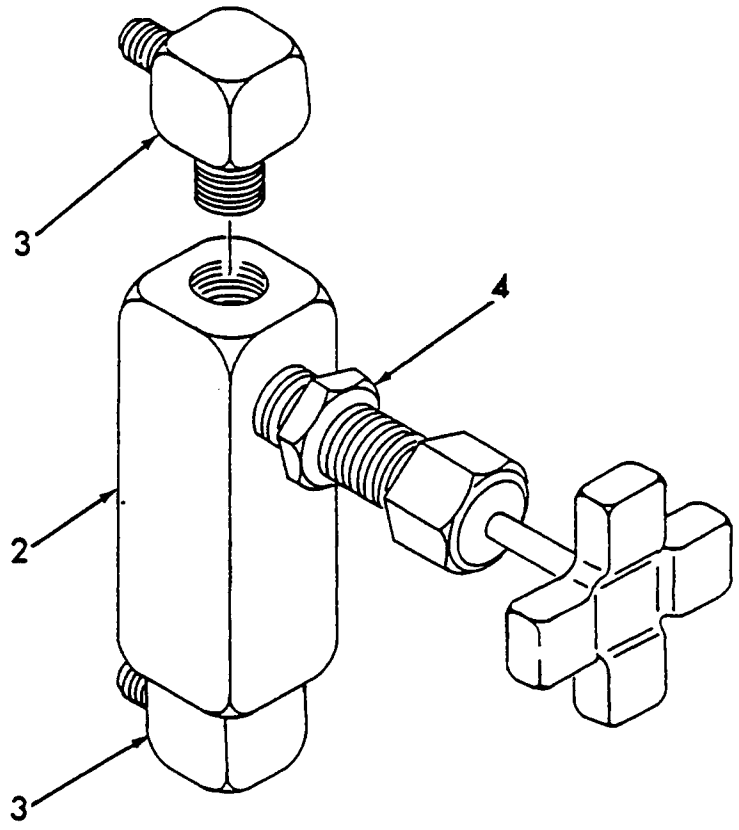


HYDRAULIC TANK ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24504	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 1A for NHA)	REF
2	24503	.TANK, HYDRAULIC	1
3	16553	.NIPPLE	1
4	20050	.VALVE, BUTTERBALL	1
5	2968	.CONNECTOR, MALE	1
6	16558	.NIPPLE	1
7	21241	.FILTER, RETURN LINE	1
8	21245	..ELEMENT, FILTER	1
9	53801	.REDUCER, PIPE	1
10	80008-23	.ELBOW, MALE	1
11	80008-10	.ELBOW, MALE	4
12	80008-11	.ELBOW, MALE	1
13	81122	.GAUGE	1

- ITEM NOT ILLUSTRATED

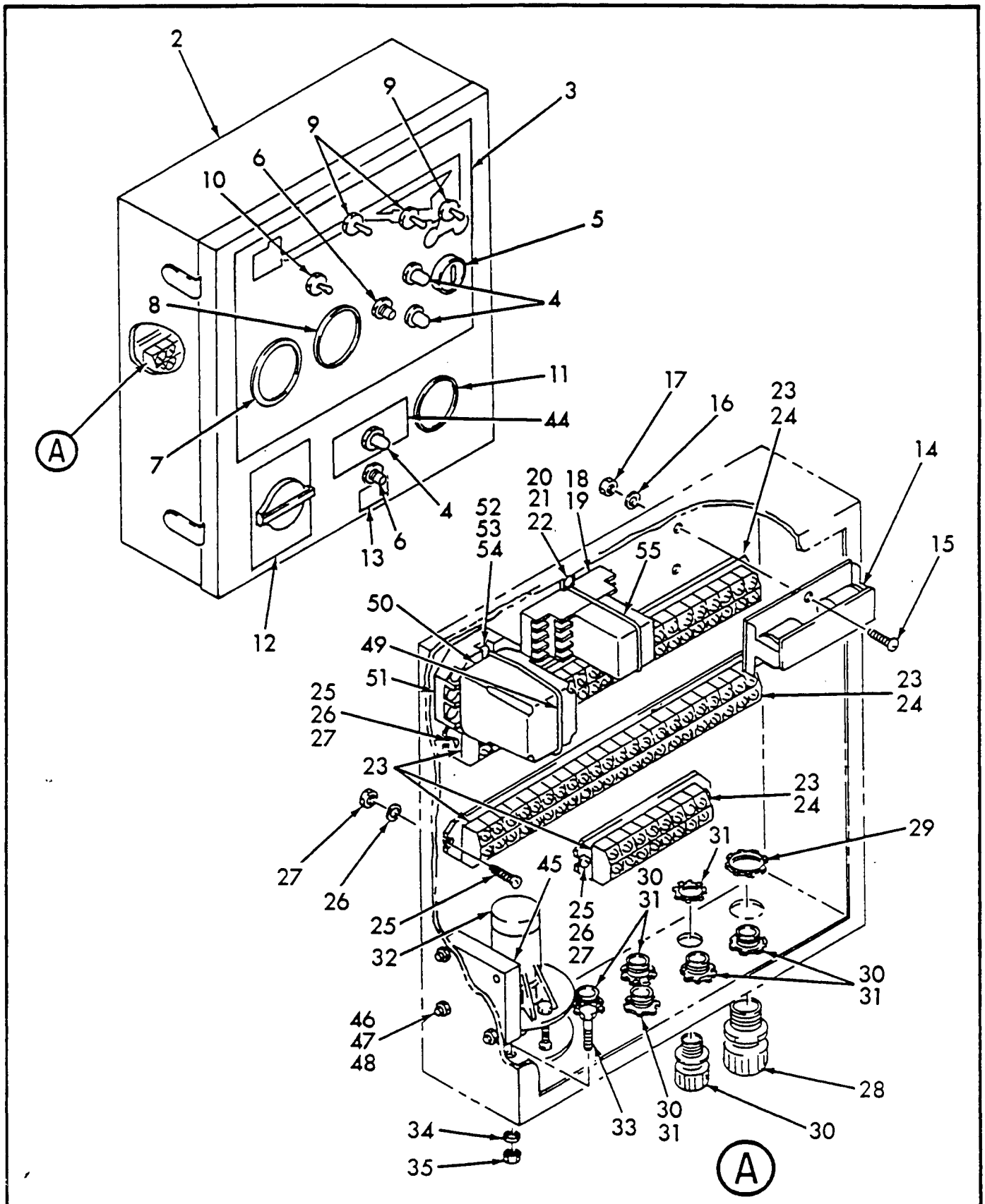
EMERGENCY DESCENT VALVE ASSEMBLY (80C 4X4 & 6X4)



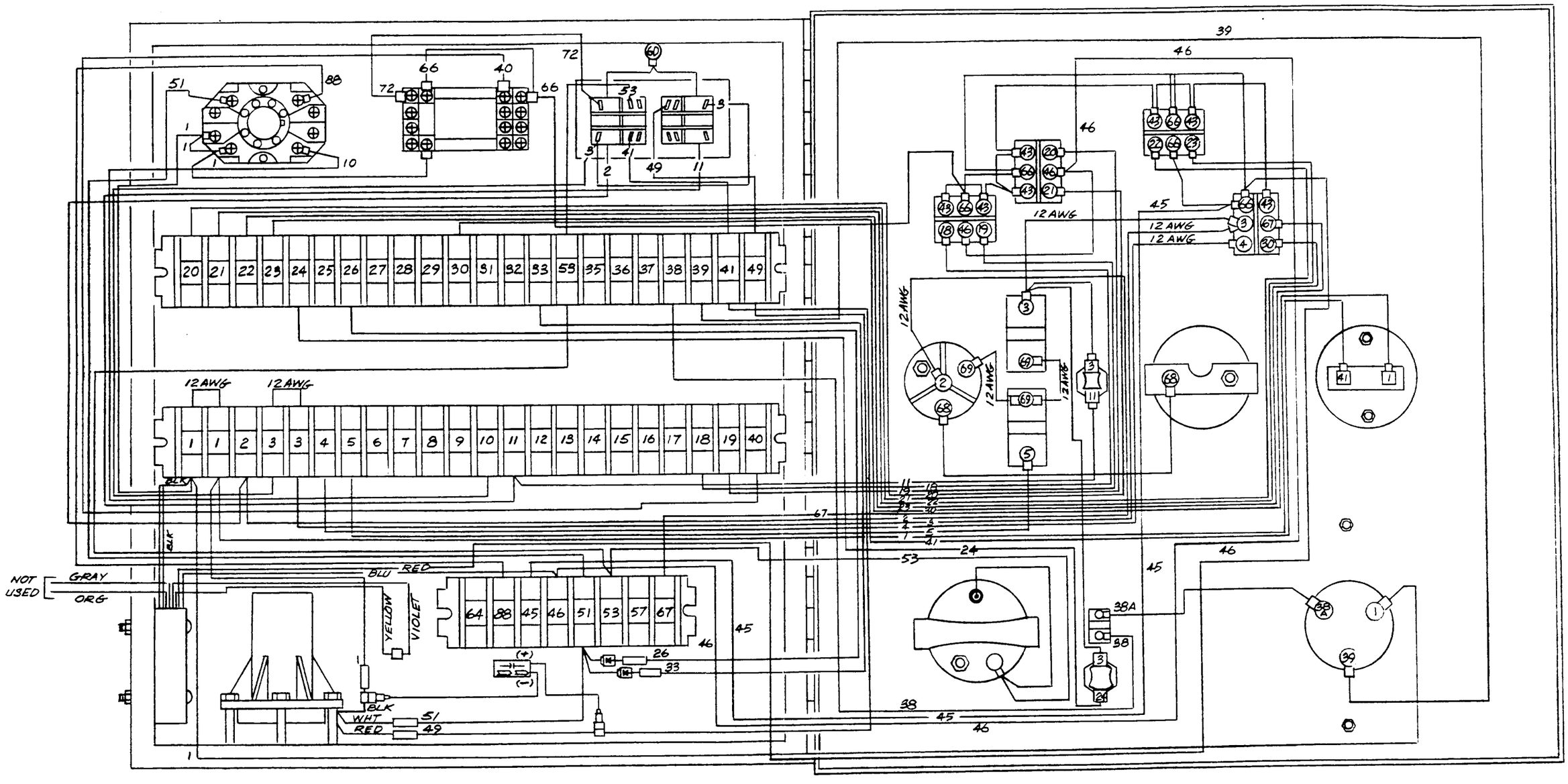
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22189	ASSEMBLY, EMERGENCY DESCENT VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	20436	.VALVE, NEEDLE	1
3	51107	.ELBOW, MALE	2
4	60911	.NUT, JAM	1

REV.

GROUND CONTROL BOX ASSEMBLY (ALL MODELS)



REV.



WIRING DIAGRAM

ITEM		ITEM	
36		40	
37		41	
38		42	
39		42	

GROUND CONTROL BOX ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24298	ASSEMBLY, GROUND CONTROL BOX (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	20977	.ENCLOSURE	1
3	20460	.DECAL	1
4	20562	.BREAKER, CIRCUIT	3
5	2717	.SWITCH, IGNITION	1
6	4011	.SWITCH, PUSH BUTTON	2
7	20571	.METER, HOUR	1
8	20572	.AMMETER	1
9	20481	.SWITCH, TOGGLE	3
10	20482	.SWITCH, SELECTOR	1
11	21219	.GAUGE, FUEL	1
12	70119	.PLATE, MALE RECEPTACLE COVER	1
13	20413	.DECAL, ENGINE CHOKE	1
14	20573	.RELAY, LATCHING	1
15	62609	.SCREW, CAP	2
16	63311	.WASHER, LOCK	2
17	61501	.NUT, HEX	2
18	70213	.RELAY	1
19	70214	.BASE, RELAY	1
20	62630	.SCREW, MACHINE	2
21	63311	.WASHER, LOCK	2
22	61501	.NUT, HEX	2
23	4027	.BLOCK, TERMINAL	52
24	117-A	.END, TERMINAL BLOCK	3
25	62609	.SCREW, CAP	6

- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	63311	.WASHER, LOCK	6
27	61501	.NUT, HEX	6
28	2807	.RELIEF, STRAIN	1
29	2809	.NUT, LOCK	1
30	2806	.RELIEF, STRAIN	6
31	2808	.NUT, LOCK	6
32	21250	.SENSOR, SLOPE	1
33	60325	.SCREW, CAP	4
34	63303	.WASHER, LOCK	4
35	60703	.NUT, HEX	4
36	4045	.DIODE	3
37	117-D	.CONNECTOR, BUTT	5
38	117-E	.TERMINAL, PUSH-ON	6
39	70029	.CONNECTOR, FEMALE	2
40	117-CC	.CONNECTOR, FEMALE	2
41	2859	.RING, TONGUE	25
42	876	.RING, TERMINAL	10
43	70147	.CAPACITOR	1
44	185702	.DECAL, CIRCUIT BREAKER, 110 V.A.C.	1
45	70413	.VALVE, ENERPAC #MC31000036 CIRCUIT BOARD (100C ONLY)	1
46	62630	.SCREW, CAP	4
47	63311	.WASHER, LOCK	4
48	61501	.NUT, HEX	4
49	30215	.CLIP, RELAY HOLD DOWN	1
50	70145	.RELAY, 12 VDC	1
51	784-A	.SOCKET, 8 PIN OCTAL	1

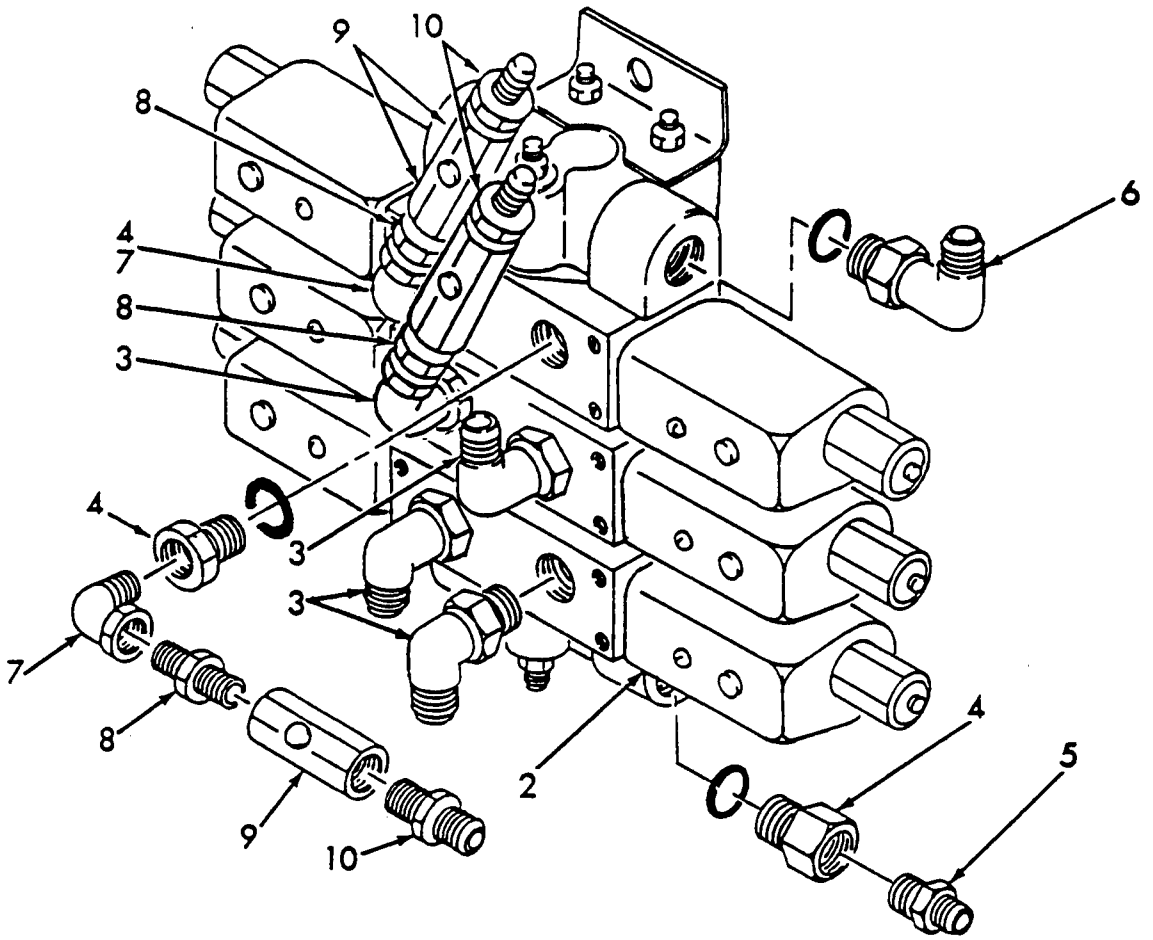
- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
52	62609	.SCREW, CAP	2
53	63311	.WASHER, LOCK	2
54	61501	.NUT, HEX	2
55		.CLIP, RELAY HOLD DOWN (FURNISHED WITH ITEM 19 RELAY BASE)	1

- ITEM NOT ILLUSTRATED

MINIPAK ASSEMBLY (80C 4X4 & 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21088	ASSEMBLY, MINIPAK (See Sect. 4, Fig. 1 for NHA)	REF
2	21787	.VALVE,SOLENOID (See Vendor Chap. for more Information)	1
3	80012-05	.ELBOW, STRAIGHT THREAD	4
4	80063-01	.ADAPTER, FEMALE PIPE	3
5	80001-08	.CONNECTOR, MALE	1
6	80012-08	.ELBOW, STRAIGHT THREAD	1

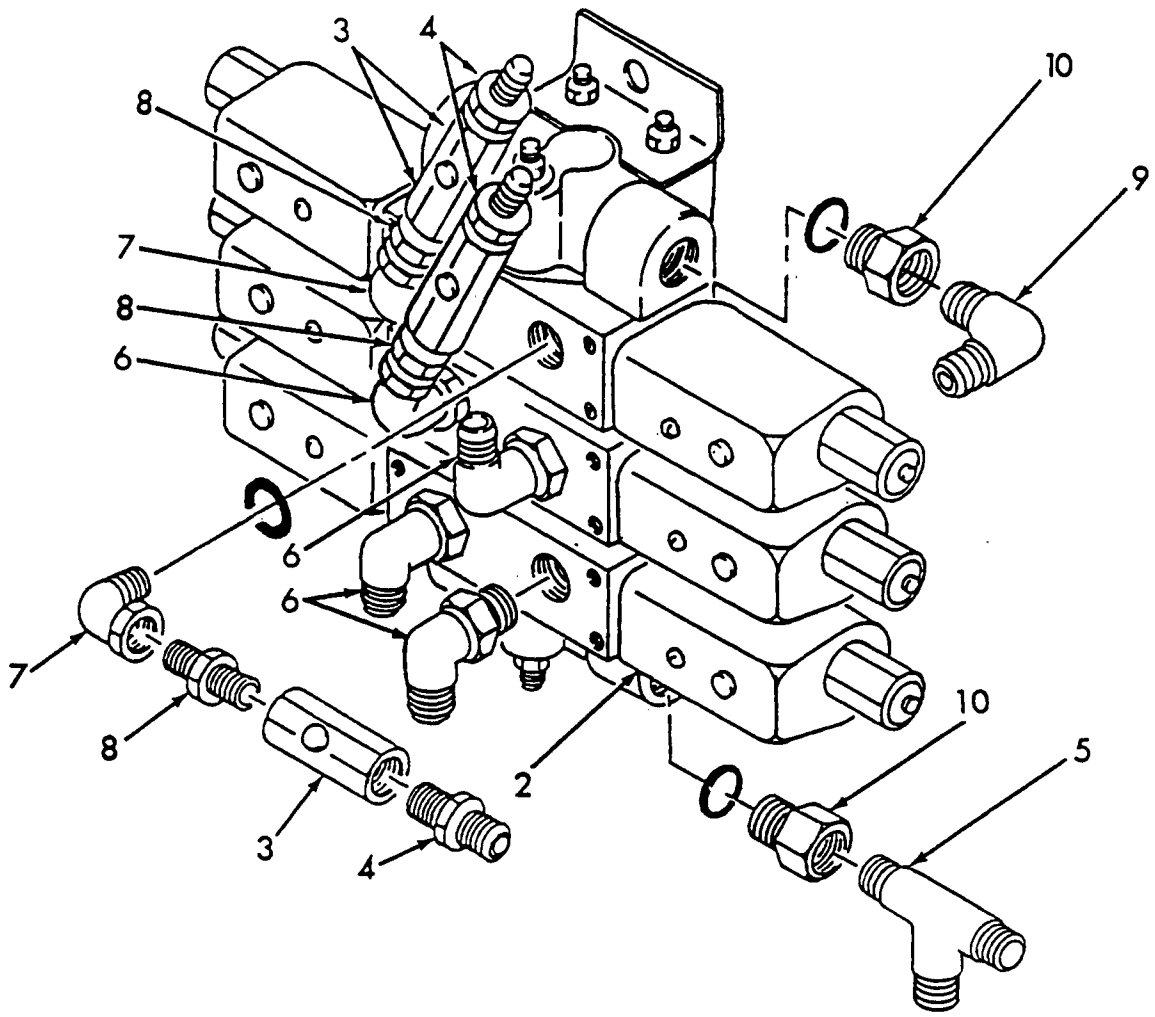
REV.

MINIPAK ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
7	80021-03	.ELBOW, STREET	2
8	80052-04	.NIPPLE, PIPE	4
9	20370	.VALVE, NEEDLE	4
10	80001-04	.CONNECTOR	4
-11	67825	.KIT, SEAL	1

- ITEM NOT ILLUSTRATED

MINIPAK ASSEMBLY (100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22607	ASSEMBLY, MINIPAK (See Sect. 4, Fig. 1A for NHA)	REF
2	21787	.VALVE, SOLENOID	1
3	20370	.VALVE, NEEDLE	4
4	80001-04	.CONNECTOR, MALE	4
5	80037-08	.TEE, MALE RUN	1

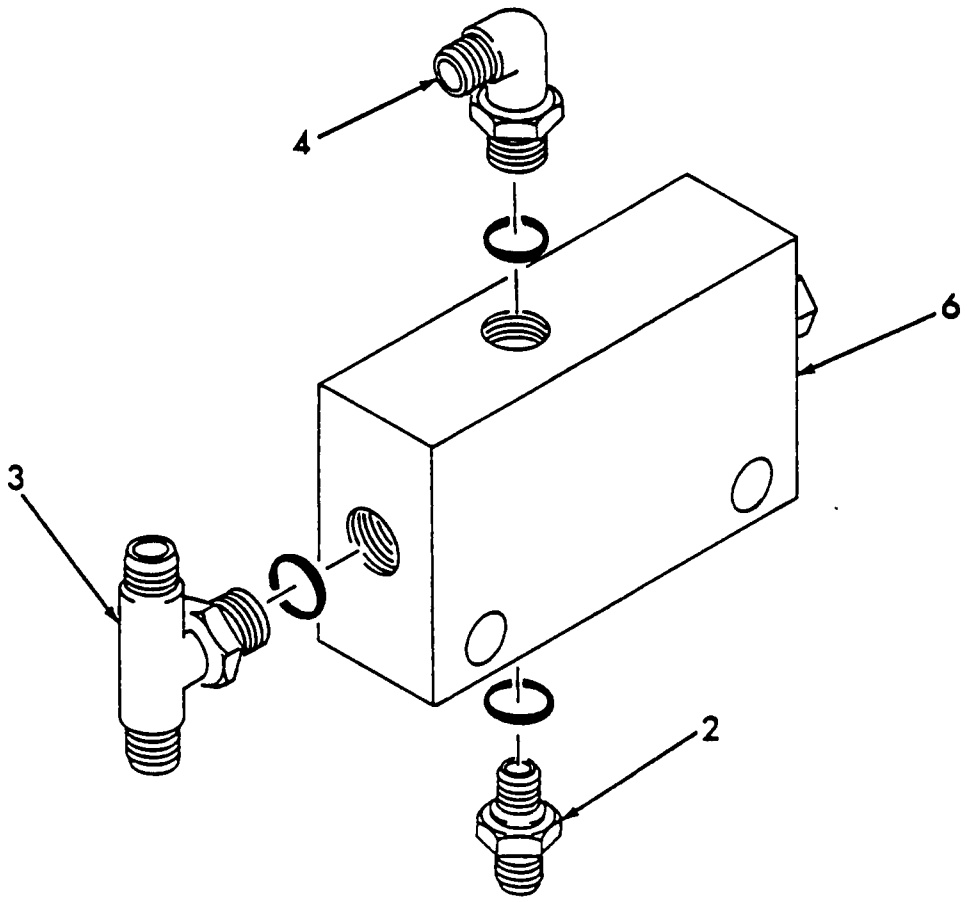
REV.

MINIPAK ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
6	80012-05	.ELBOW, STRAIGHT THREAD	4
7	80021-03	.ELBOW, STREET	2
8	80052-04	.NIPPLE, PIPE	4
9	80008-08	.ELBOW, MALE	1
10	80063-01	.ADAPTER, FEMALE PIPE	2
-11	67825	.KIT, SEAL	1

- ITEM NOT ILLUSTRATED

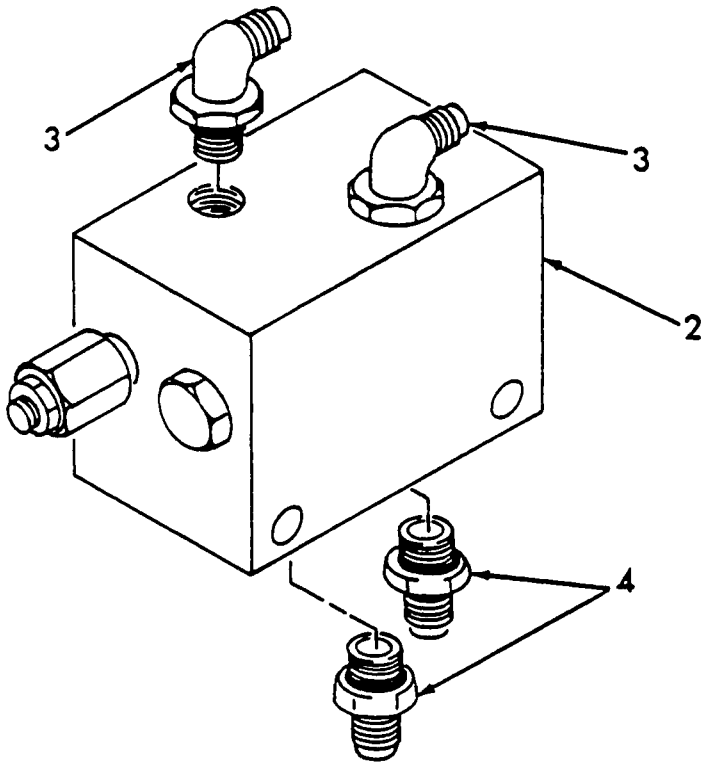
RELIEF VALVE ASSEMBLY (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22144	ASSEMBLY, RELIEF VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	80004-11	.CONNECTOR, STRAIGHT THREAD	1
3	80036-11	.TEE, STRAIGHT THREAD BRANCH	1
4	80012-11	.ELBOW, STRAIGHT THREAD	1
-5	20564	.VALVE, RELIEF REWORK	1
6	20516	..VALVE, RELIEF	1

REV.

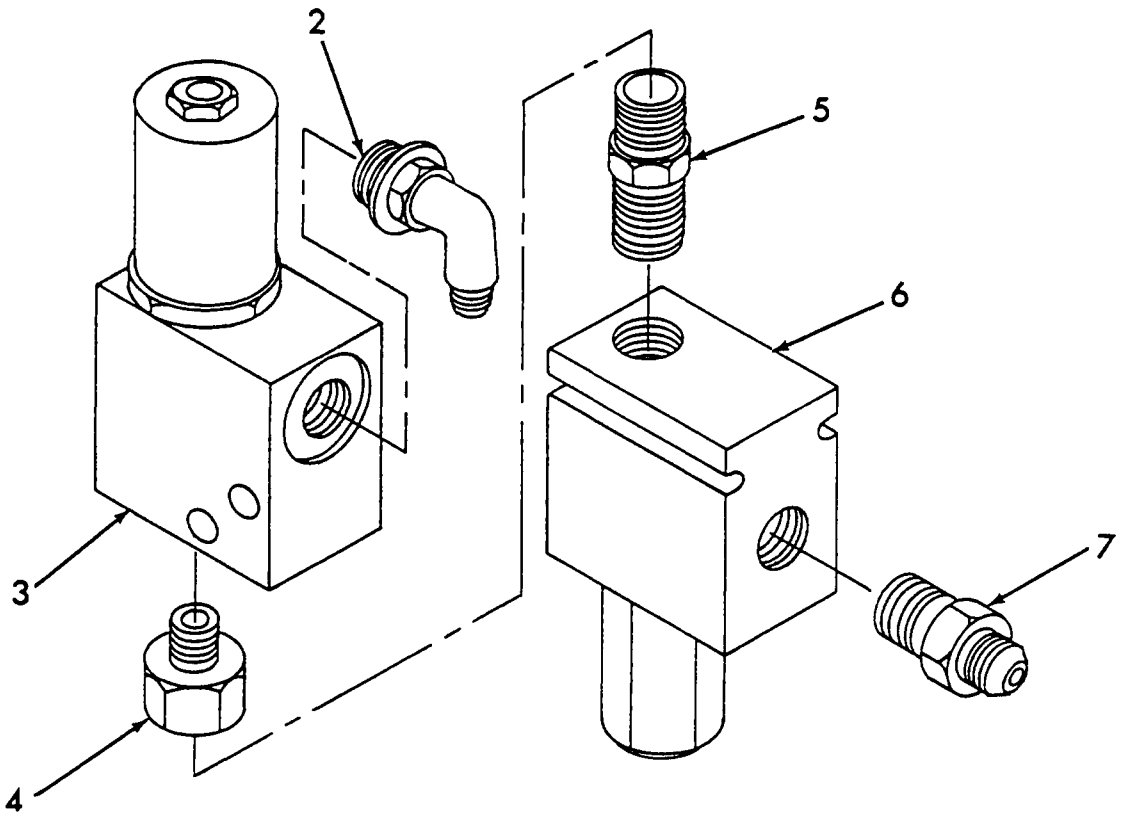
DUAL OVERCENTER VALVE (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22510	ASSEMBLY, DUAL OVERCENTER VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	20365	.VALVE, DUAL OVERCENTER	1
3	80012-05	.ELBOW, STRAIGHT THREAD	2
4	80004-05	.CONNECTOR, STRAIGHT THREAD	2

REV.

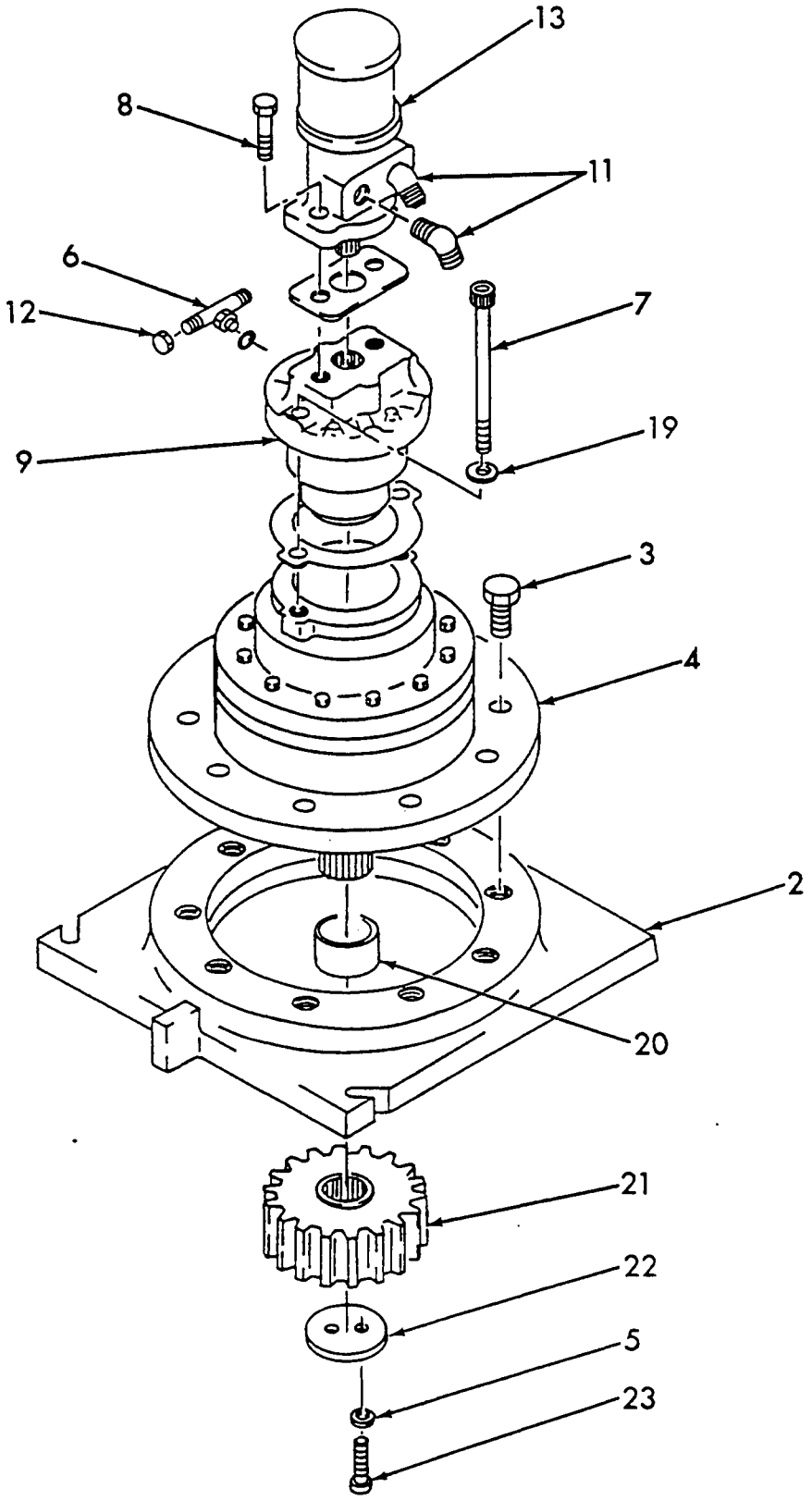
DUMP VALVE ASSEMBLY (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22204	ASSEMBLY, DUMP VALVE	REF
2	80012-05	.ELBOW, STRAIGHT THREAD	1
3	410	.VALVE, SOLENOID	1
4	80063-01	.ADAPTER, FEMALE PIPE	1
5	80052-04	.NIPPLE, PIPE	1
6	21882	.VALVE, RELIEF	1
7	80001-04	.CONNECTOR, MALE	1

REV.

ROTATION GEARBOX ASSEMBLY (ALL MODELS)

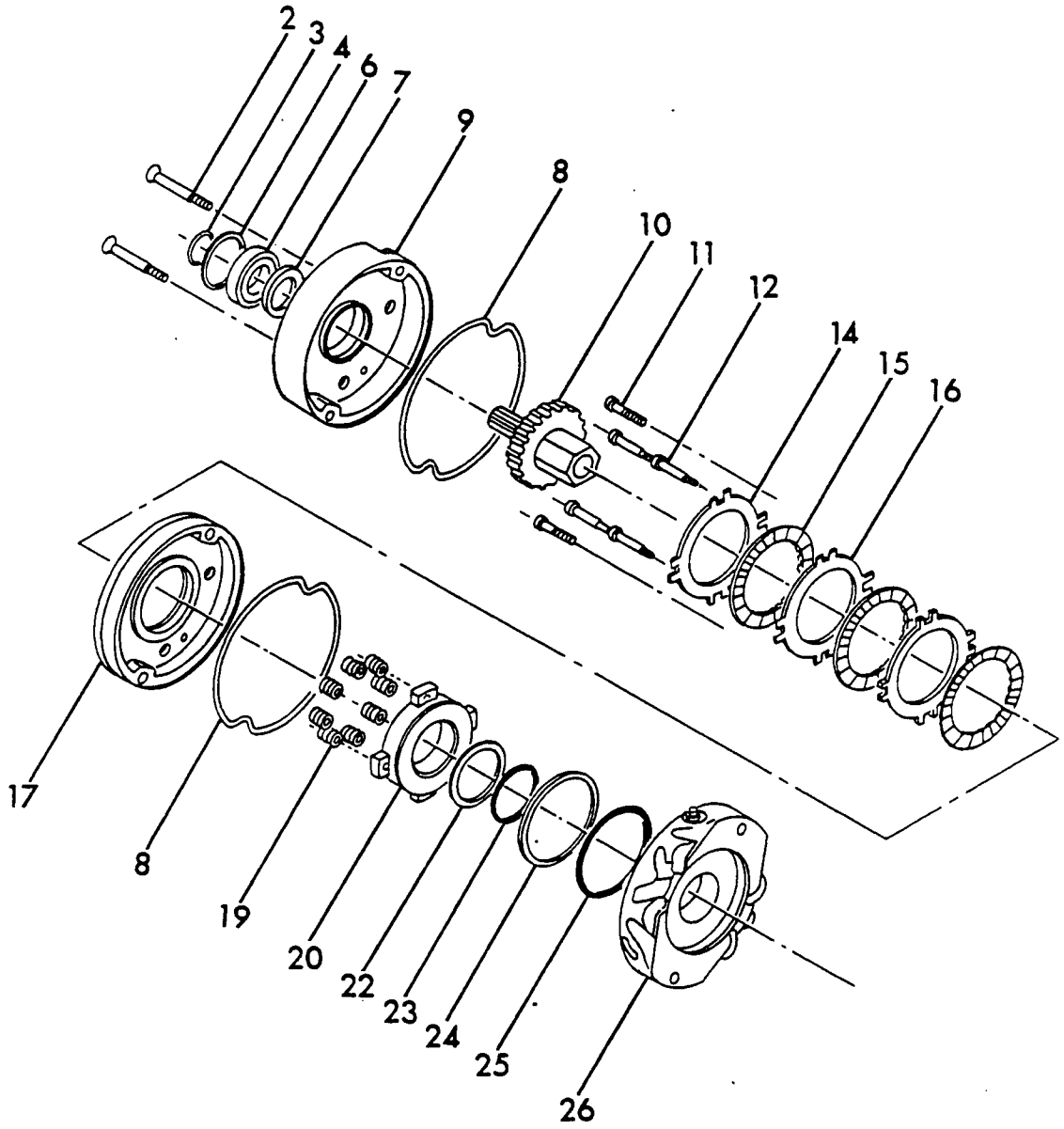


ROTATION GEARBOX ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22789	ASSEMBLY, ROTATION GEARBOX (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	22998	.WELDMENT, MOUNTING PLATE	1
3	60602	.SCREW, CAP	9
4	22830	.HUB, TORQUE (See Sect. 4, Fig. 18 for Details)	1
5	63303	.WASHER, LOCK	2
6	80036-03	.TEE, STRAIGHT THREAD BRANCH	1
7	61940	.SCREW, CAP	2
8	60622	.SCREW, CAP	2
9	22831	.BRAKE (See Sect. 4, Fig. 11A for Details)	1
-10	67688	..KIT, SEAL (FOR 81275)	1
11	80018-13	.ELBOW, 45° STRAIGHT THREAD	2
12	80059-03	.CAP	1
13	81275	.MOTOR, HYDRAULIC (See Sect. 4, Fig. 11B for Details)	1
-14	67150	..KIT, SEAL (FOR 22831)	1
-15	67644	..KIT, LINING (FOR 22831)	1
-16	67650	..KIT, SPRING (FOR 22831)	1
-17	67657	..KIT, BEARING (FOR 22831)	1
-18	67660	..PISTON (FOR 22831)	1
19	63305	.WASHER, LOCK	2
20	22099	.SPACER, PINION	1
21	22828	.PINION	1
22	22829	.RETAINER, PINION	1
23	61919	.SCREW, CAP	2

- ITEM NOT ILLUSTRATED

ROTATION GEARBOX BRAKE



REV.

ROTATION GEARBOX BRAKE

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22831	BRAKE, ROTATION GEARBOX (See Sect. 4, Fig. 11 for NHA)	REF
2		.SCREW, FLAT HEAD SOCKET CAP	2
3		.RING, RETAINING	1
4		.RING, SNAP	1
-5	67657	.KIT, BEARING	1
6		..BEARING	1
7		..SEAL, OIL	1
8		..SEAL, CASE	2
9		.PLATE, COVER	1
10		.ASSEMBLY, SPLINE SHAFT	1
11		.SCREW, SOCKET HEAD CAP	2
12		.BOLT, SOCKET HEAD SHOULDER	4
-13	67644	.KIT, LINING	1
*8		..SEAL, CASE	2
14		..DISC, PRIMARY	1
15		..DISC, ROTOR	3
16		..DISC STATOR	2
17		.PLATE, SPRING	1
-18	67650	.KIT, SPRING	1
*8		..SEAL, CASE	2
19		..SPRING (RED) ..SPRING (BLUE)	4 2
20	67660	.PISTON	1
21	67150	.KIT, SEAL	1
*7		..SEAL, OIL	1
*8		..SEAL, CASE	2

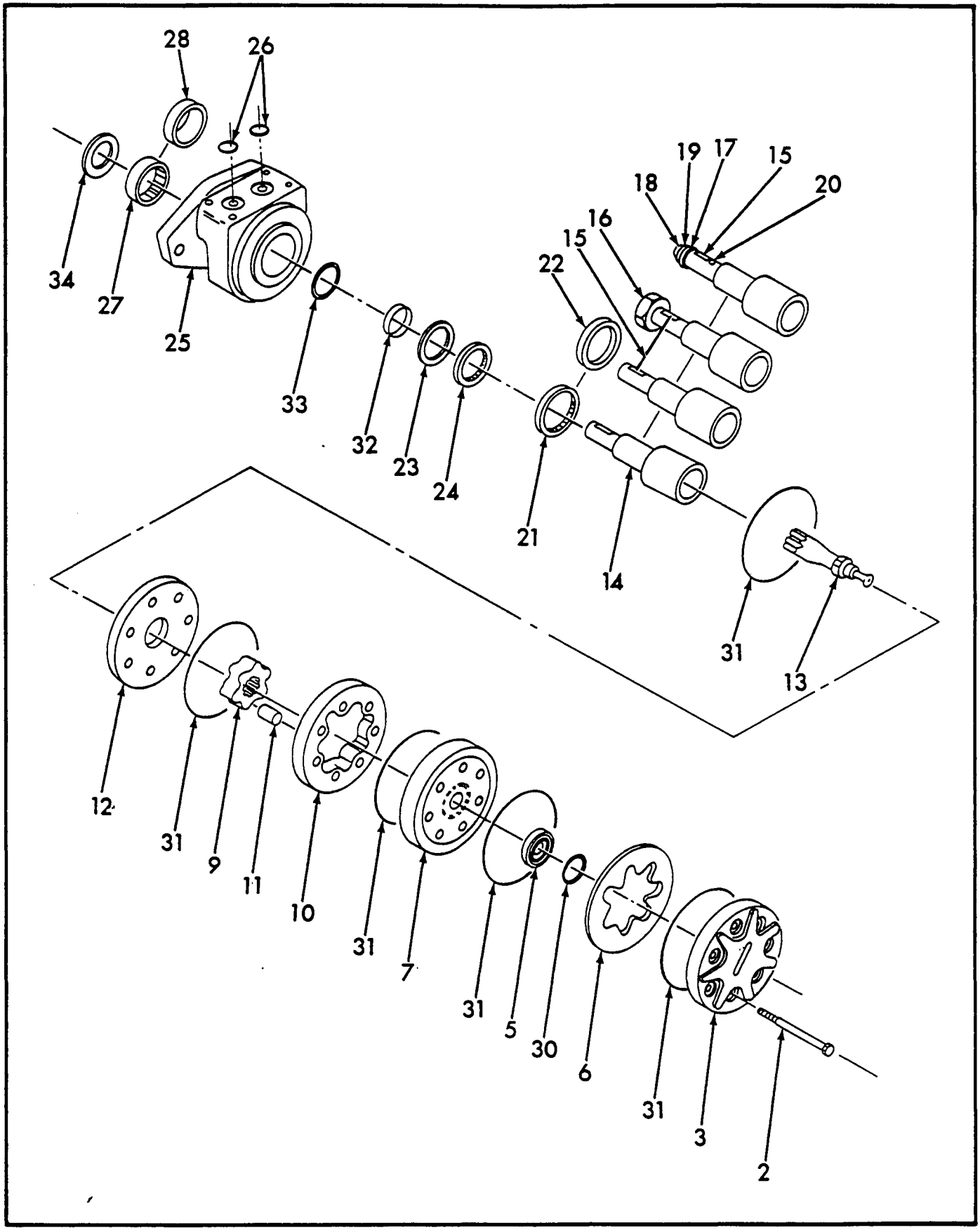
- ITEM NOT ILLUSTRATED

ROTATION GEARBOX BRAKE

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
22		..RING, BACK-UP (I.D.)	1
23		..O-RING (I.D.)	1
24		.RING, BACK-UP (O.D.)	1
25		..O-RING (O.D.)	1
26		.PLATE, PRESSURE	1

- ITEM NOT ILLUSTRATED

ROTATION GEARBOX HYDRAULIC MOTOR



REV.

ROTATION GEARBOX HYDRAULIC MOTOR

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81276	MOTOR, ROTATION GEARBOX HYDRAULIC (See Sect. 4, Fig. 11 for NHA)	REF
2		.BOLT, SPECIAL	5
3		.COVER, END	1
-4		.ASSEMBLY, COMMUTATOR & RING (MATCHED SET)	1
5		..COMMUTATOR	1
6		..RING, COMMUTATOR	1
7		.MANIFOLD	1
-8		.SET, ROTOR (MATCHED SET)	1
9		..ROTOR	1
10		..STATOR	1
11		..VANE	7
12		.PLATE, WEAR	1
13	67692	.LINK, DRIVE	1
14	67699	.SHAFT, COUPLING	1
15		.KEY	1
16		.NUT	1
17		.WASHER	1
18		.BOLT	1
19		.WASHER, LOCK	1
20		.RING, RETAINER	1
21		.BEARING, INNER	1
22		.BUSHING, INNER	1
23		.WASHER, THRUST	1
24		.BEARING, THRUST	1
25		.HOUSING	1

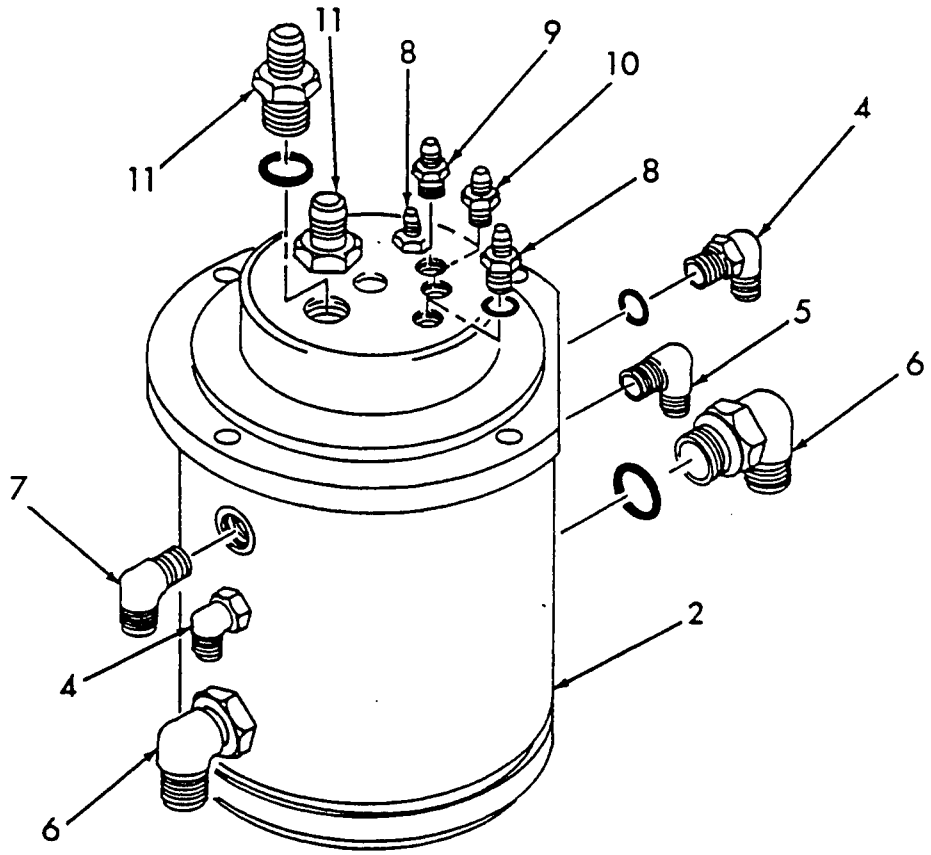
- ITEM NOT ILLUSTRATED

ROTATION GEARBOX HYDRAULIC MOTOR

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26		.O-RING	2
27		.BEARING, OUTER	1
28		.BUSHING, OUTER	1
-29	67688	.KIT, SEAL	1
30		..RING, COMMUTATOR SEAL	1
31		..RING, SEAL	5
32		..SEAL	1
33		..RING, BACK-UP	1
34		..SEAL, DIRT & WATER	1

- ITEM NOT ILLUSTRATED

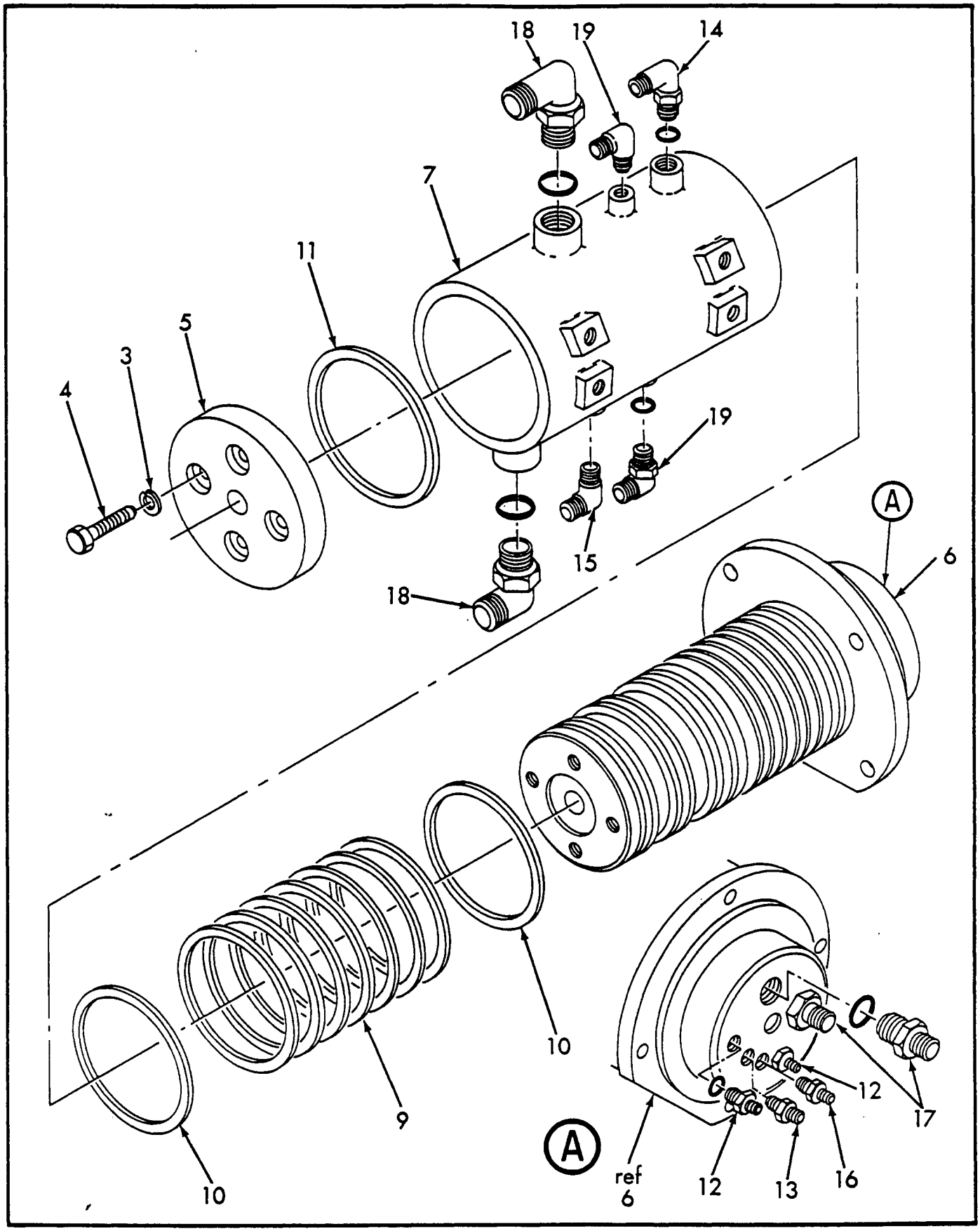
ROTARY MANIFOLD ASSEMBLY (ALL MODELS) (TO EARLY 1988)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21898	ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 1 or 1A for NHA)	REF
-2	21895	.MANIFOLD, ROTARY (RA)	1
-3	66561	..KIT, SEAL	1
4	80012-03	.ELBOW, STRAIGHT THREAD	2
5	80008-03	.ELBOW, MALE	1
6	80012-18	.ELBOW, STRAIGHT THREAD	2
7	80008-08	.ELBOW, MALE	1
8	80004-03	.CONNECTOR, STRAIGHT THREAD	2
9	80001-08	.CONNECTOR, MALE	1
10	80001-03	.CONNECTOR, MALE	1
11	80004-18	.CONNECTOR, STRAIGHT THREAD	2

REV.

ROTARY MANIFOLD ASSEMBLY (ALL MODELS) (SINCE EARLY 1988)

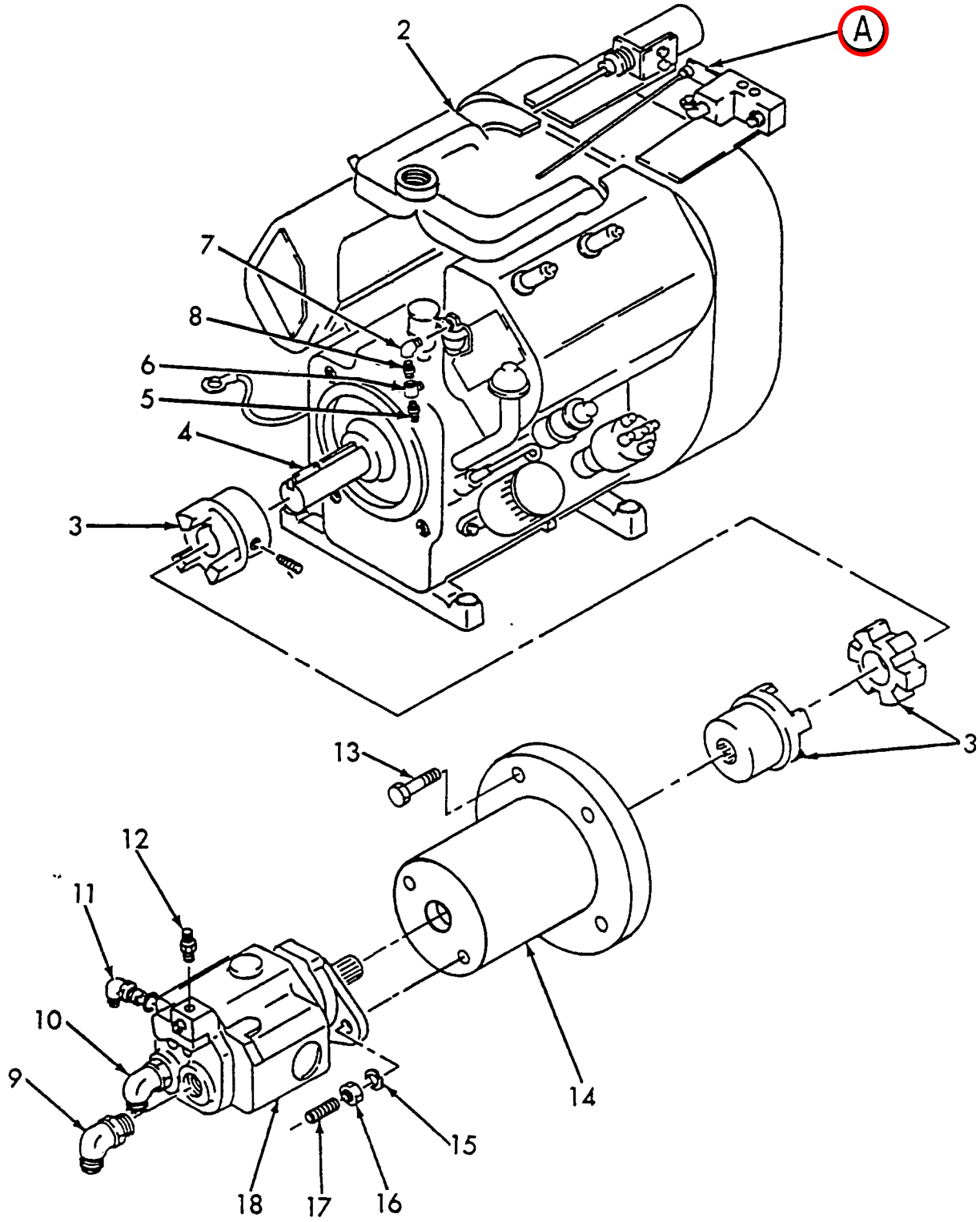


ROTARY MANIFOLD ASSEMBLY (ALL MODELS)
(SINCE EARLY 1988)

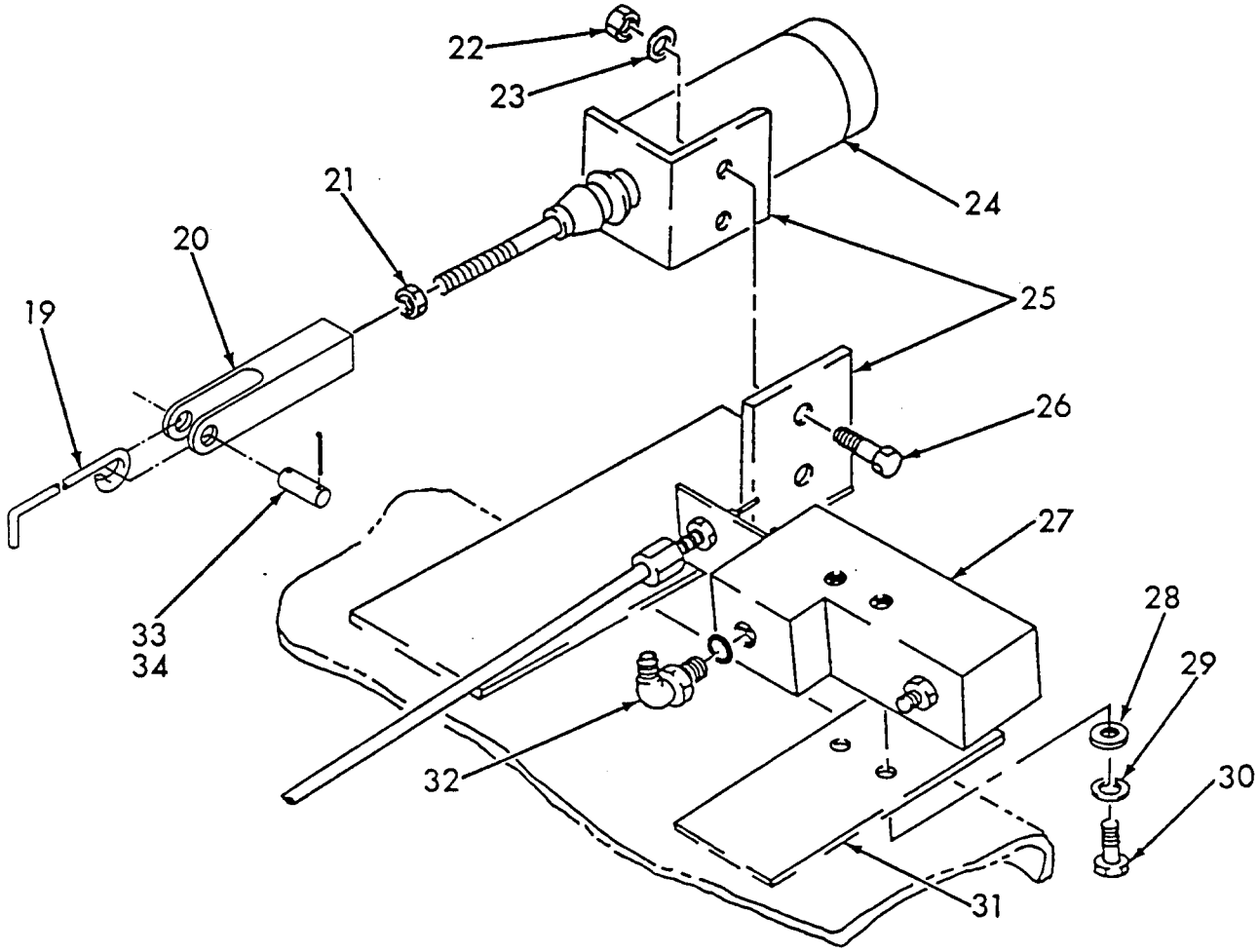
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21898	ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 1 or 1A for NHA)	REF
-2	24132	.MANIFOLD, ROTARY (TH)	1
3		..WASHER, LOCK	4
4		..SCREW, CAP	4
5		..RETAINER, SPOOL	1
6		..ASSEMBLY, SWIVEL SPOOL	1
7		..HOUSING	1
-8	67817	..KIT, SEAL	1
9		...RING, GLYD	7
10		...RING, D.C. GLYD	2
11		...RING, WEAR	1
12	80004-03	.CONNECTOR, MALE	2
13	80001-03	.CONNECTOR, MALE	1
14	80008-08	.ELBOW, MALE	1
15	80008-03	.ELBOW, MALE	1
16	80001-08	.CONNECTOR, MALE	1
17	80004-18	.CONNECTOR, MALE	2
18	80012-18	.ELBOW, MALE	2
19	80012-03	.ELBOW, MALE	2

- ITEM NOT ILLUSTRATED

ENGINE & PUMP ASSEMBLY (80C 4X4 & 6X4)



ENGINE & PUMP ASSEMBLY (80C 4X4 & 6X4)



ENGINE & PUMP ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24593	ASSEMBLY, ENGINE & PUMP (See Sect. 4, Fig. 1 for NHA)	REF
2	24309	.ENGINE, WISCONSIN	1
3	22173	.ASSEMBLY, COUPLING	1
4	25253	.KEY	1
5	240	.BARB, HOSE	1
6	20832	.VALVE, FUEL SHUT OFF	1
7	66196	.ELBOW, STREET	2
8	16550	.NIPPLE, PIPE	1
9	80012-24	.ELBOW, STRAIGHT THREAD	1
10	80012-28	.ELBOW, STRAIGHT THREAD	1
11	80012-08	.ELBOW, STRAIGHT THREAD	1
12	80004-03	.CONNECTOR, STRAIGHT THREAD	1
13	60604	.SCREW, CAP	4
14	22101	.ADAPTER, PUMP MACHINING	1
15	63305	.WASHER, LOCK	2
16	60705	.NUT, HEX	2
17	63613	.STUD	2
18	21638	.PUMP, ENGINE (See Sect. 4, Fig. 13B for Details)	1
19	24609	.LINKAGE, CHOKE	1
20	67432	.YOKE, HIGH SPEED	1
21	60805	.NUT, HEX	1
22	60701	.NUT, HEX	2
23	63301	.WASHER, LOCK	2
24	21777	.SOLENOID, D.C.	1
25	22194	.BRACKET, SOLENOID	1

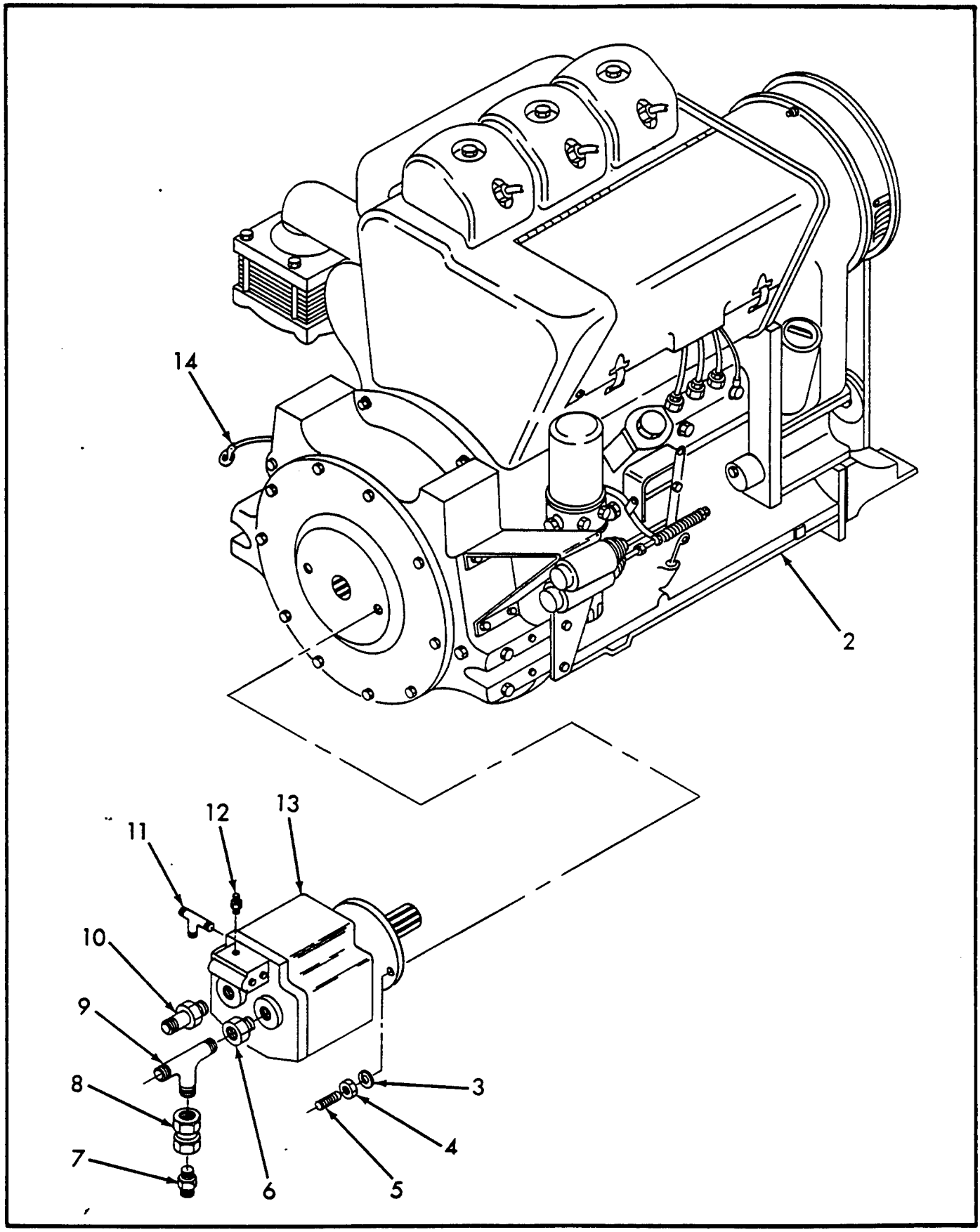
- ITEM NOT ILLUSTRATED

ENGINE & PUMP ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	60309	.SCREW, CAP	2
27	20364	.THROTTLE, HYDRAULIC	1
28	63402	.WASHER, FLAT	2
29	63302	.WASHER, LOCK	2
30	60404	.SCREW, CAP	2
31	22209	.BRACKET, MOUNTING THROTTLE	1
32	80008-04	.ELBOW, MALE	1
33	64313	.PIN, COTTER	2
34	67793	.PIN, YOKE	1

- ITEM NOT ILLUSTRATED

ENGINE & PUMP ASSEMBLY (100C 6X4)



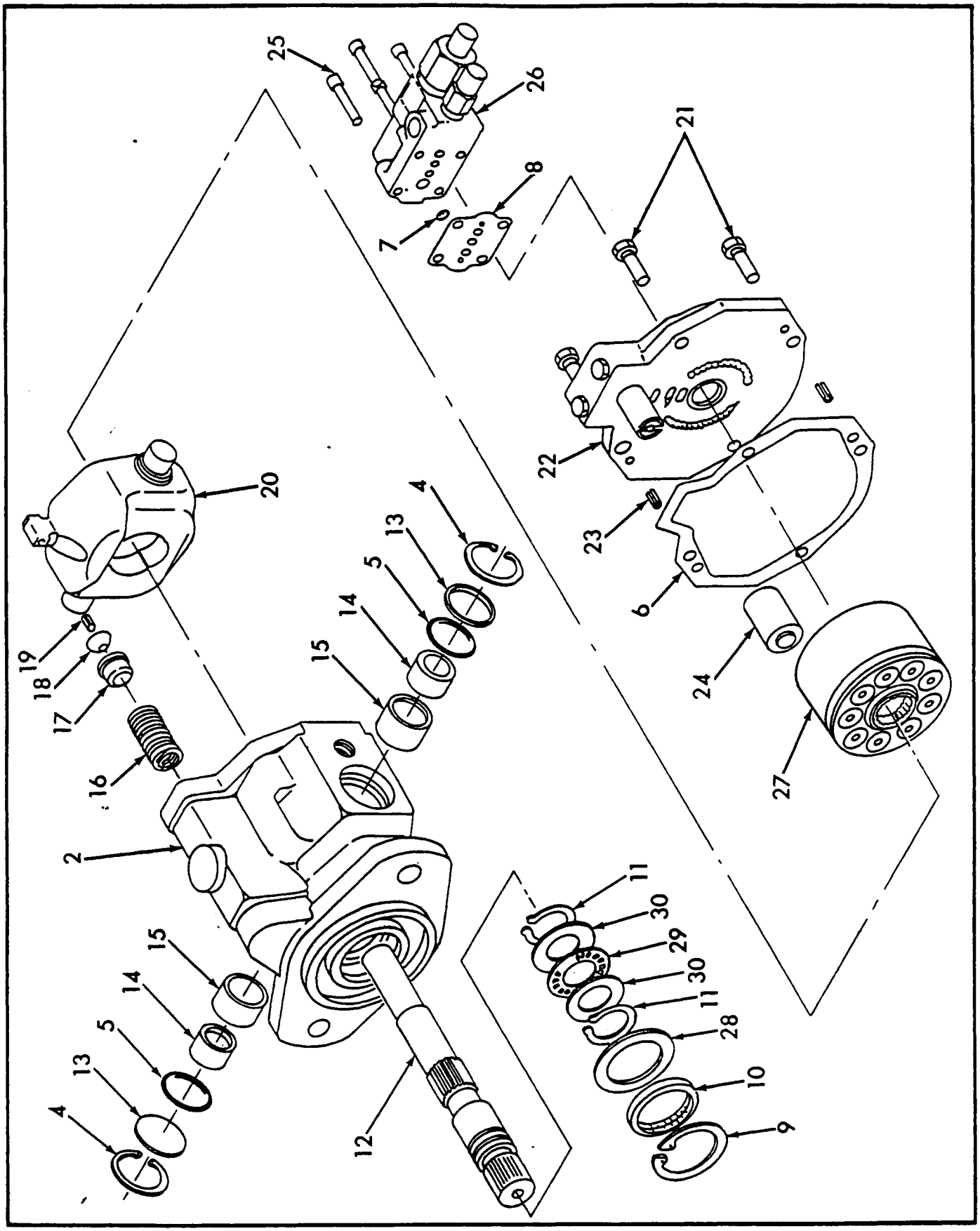
REV.

ENGINE & PUMP ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22201	ASSEMBLY, DEUTZ ENGINE-PUMP (See Sect. 4, Fig. 1A for NHA)	REF
2	22200	.ENGINE, DEUTZ DIESEL	1
3	63305	.WASHER, LOCK	2
4	60705	.NUT, HEX	2
5	63613	.STUD	2
6	52002	.ADAPTER, FEMALE PIPE	1
7	51007	.CONNECTOR, MALE	1
8	54809	.COUPLING, HEX REDUCING	1
9	55302	.TEE, EXTERNAL PIPE	1
10	50838	.CONNECTOR, STRAIGHT THREAD	1
11	53202	.TEE, STRAIGHT THREAD RUN	1
12	50801	.CONNECTOR, STRAIGHT THREAD	1
13	21638	.PUMP, ENGINE (See Sect. 4, Fig. 13B for Details)	1
14	13226-54	.ASSEMBLY, CABLE-1 AWG	54 IN.

- ITEM NOT ILLUSTRATED

ENGINE PUMP (ALL MODELS)



REV.

ENGINE PUMP (ALL MODELS)

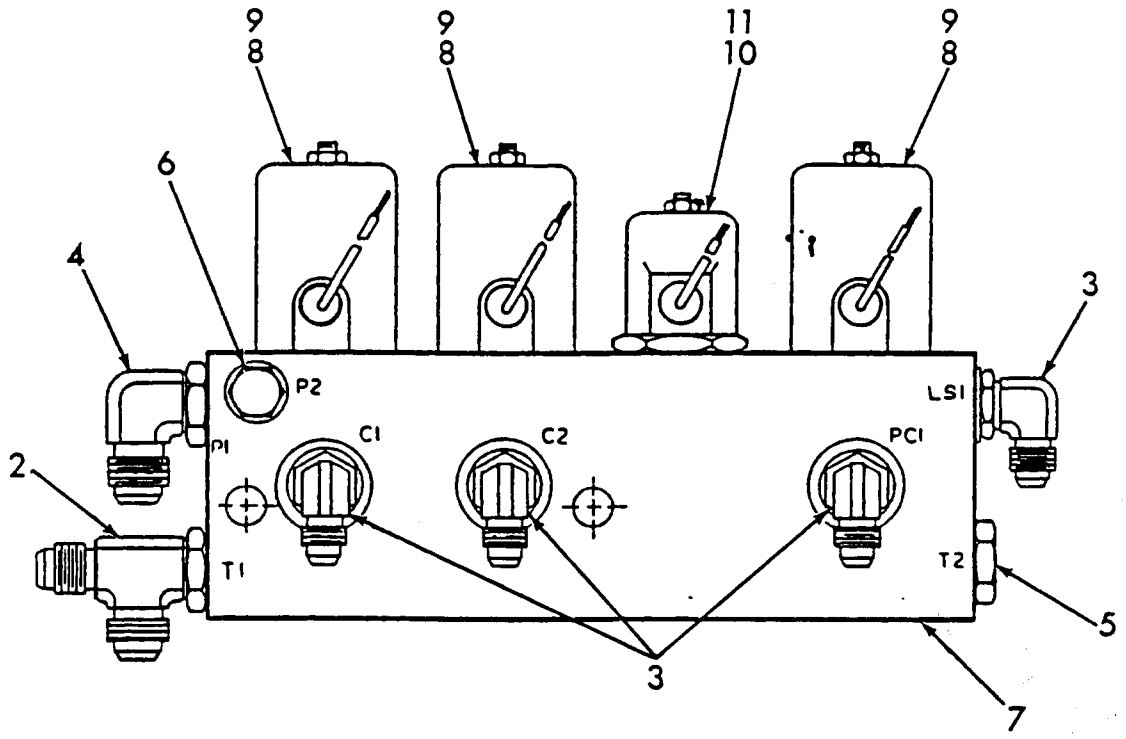
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21638	PUMP, ENGINE (See Sect. 4, Fig. 13 or 13A for NHA)	REF
2		.ASSEMBLY, HOUSING	1
-3	16964	.KIT, SEAL	1
4		..RING, RETAINING	2
5		..O-RING	2
6		..GASKET	1
7		..O-RING	1
8		..GASKET, COMPENSATOR	1
9		..RING, RETAINING	1
10	66741	..SEAL, SHAFT	1
11		..RING, RETAINING	2
12		.SHAFT, DRIVE	1
13		.COVER, TRUNNION	2
14		.RACE, INNER	2
15		.BEARING, NEEDLE	2
16		.SPRING, CAMPLATE CONTROL	1
17		.COLLAR, SPRING	1
18		.BUTTON, PIVOT	1
19		.PIN, ROLL	1
20		.CAMPLATE	1
21		.CAPSCREW, BACKPLATE	4
22		.ASSEMBLY, BACKPLATE	1
23		.PIN, ROLL	2
24		.PISTON, CONTROL	1
25		.SCREW, COMPENSATOR CAP	4

ENGINE PUMP (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	21757	.ASSEMBLY, COMPENSATOR	1
27		.ASSEMBLY, ROTATING KIT	1
28		.WASHER	1
29		.BEARING, THRUST	1
30		.WASHER, THRUST	2

- ITEM NOT ILLUSTRATED

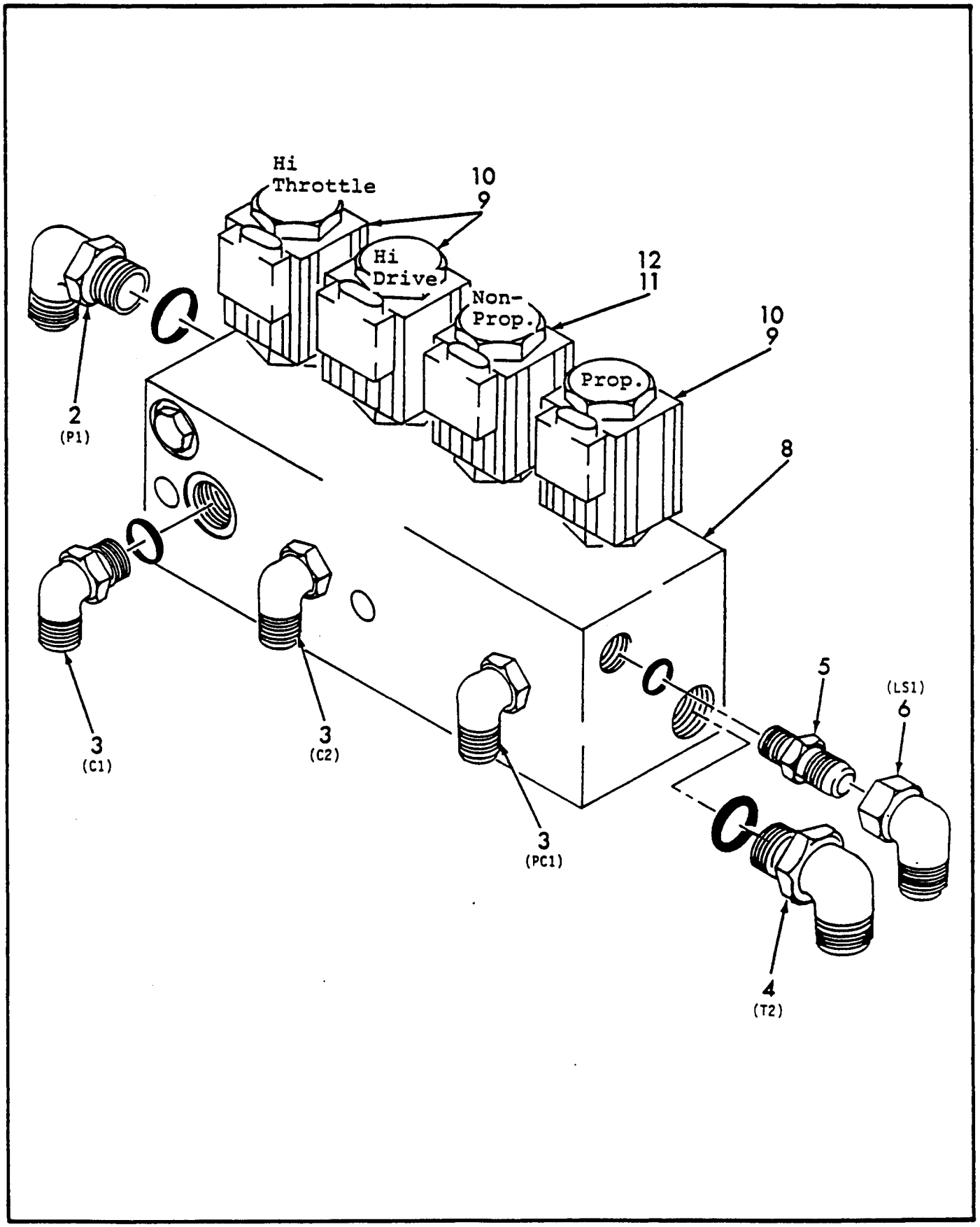
SOLENOID VALVE ASSEMBLY (ALL MODELS) (TO LATE 1986)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21692	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	53201	.TEE	1
3	2532	.ELBOW, 90°	4
4	2447	.ELBOW, 90°	1
5	2405	.PLUG, HEX HEAD	1
6	53900	.PLUG, HOLLOW HEX	1
7	21860	.BLOCK, MANIFOLD	1
8	66201	..COIL, LARGE ROUND (ONLY)	3
9	66245	..CARTRIDGE, 3-WAY (ONLY)	3
10	66202	..COIL, SMALL ROUND (ONLY)	1
11	66246	..CARTRIDGE, 2-WAY (ONLY)	1

REV.

SOLENOID VALVE ASSEMBLY (ALL MODELS)
(FROM LATE 1986 TO LATE 1988)

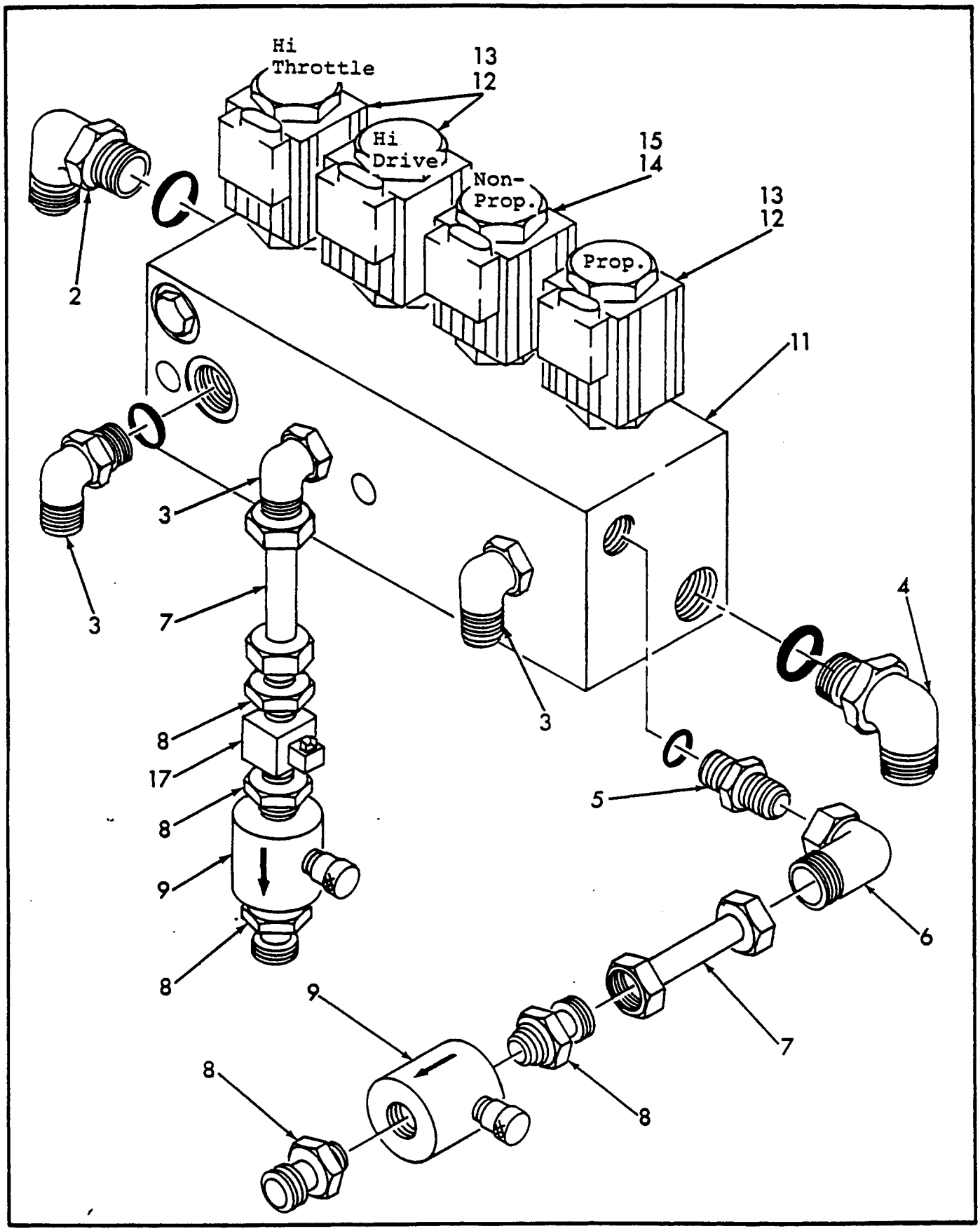


SOLENOID VALVE ASSEMBLY (ALL MODELS)
(FROM LATE 1986 TO LATE 1988)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21692	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	50900	.ELBOW, STRAIGHT THREAD	1
3	80012-03	.ELBOW, STRAIGHT THREAD	3
4	80012-08	.ELBOW, STRAIGHT THREAD	1
5	80004-03	.CONNECTOR, STRAIGHT THREAD	1
6	80015-03	.ELBOW, SWIVEL NUT	1
-7	21860	.VALVE, SOLENOID	1
8	66885	..BLOCK, MANIFOLD	1
9	66884	..COIL (SQUARE) & CARTRIDGE	3
10	67249	...COIL (ONLY) (SQUARE)	3
11	66883	..COIL (SQUARE) & CARTRIDGE	1
12	67249	...COIL (ONLY) (SQUARE)	1
-13	67248	..KIT, SEAL	1

- ITEM NOT ILLUSTRATED

SOLENOID VALVE ASSEMBLY (ALL MODELS) (SINCE LATE 1988)



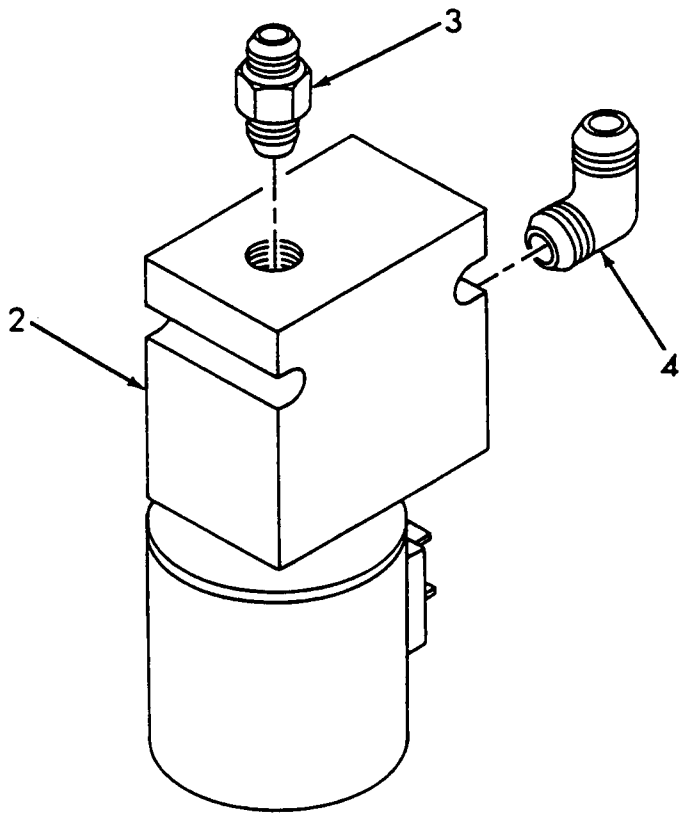
REV.

SOLENOID VALVE ASSEMBLY (ALL MODELS)
(SINCE LATE 1988)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22609	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	50900	.ELBOW, STRAIGHT THREAD	1
3	80012-03	.ELBOW, STRAIGHT THREAD	3
4	80012-08	.ELBOW, STRAIGHT THREAD	1
5	80004-03	.CONNECTOR, STRAIGHT THREAD	1
6	80015-03	.ELBOW, SWIVEL NUT	1
7	22609-9	.ASSEMBLY, TUBE	2
8	80001-03	.CONNECTOR, MALE	4
9	30884	.VALVE, FLOW CONTROL	2
-10	21860	.VALVE, SOLENOID	1
11	66885	..BLOCK, MANIFOLD	1
12	66884	..COIL (SQUARE) & CARTRIDGE	3
13	67249	...COIL (ONLY)(SQUARE)	3
14	66883	..COIL (SQUARE) & CARTRIDGE	1
15	67249	...COIL (ONLY)(SQUARE)	1
-16	67248	..KIT, SEAL	1
17	81258	.VALVE, ELECTRICAL CHECK	1

- ITEM NOT ILLUSTRATED

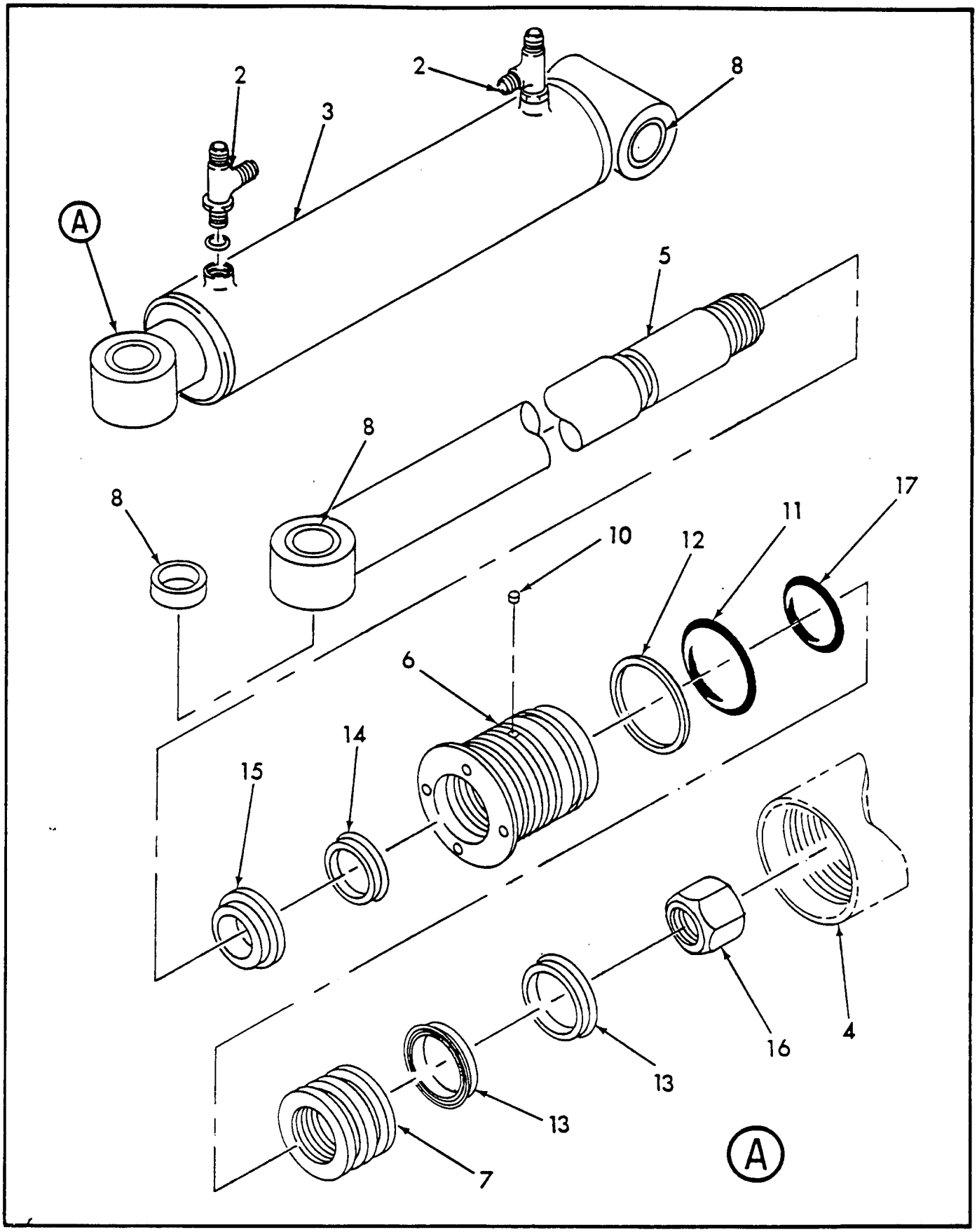
SOLENOID VALVE ASSEMBLY (100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22909	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1A for NHA)	REF
2	81054	.VALVE, SOLENOID	1
3	80004-11	.CONNECTOR, STRAIGHT THREAD	1
4	80012-11	.ELBOW, STRAIGHT THREAD	1

REV.

MASTER LEVELING CYLINDER ASSEMBLY (ALL MODELS)



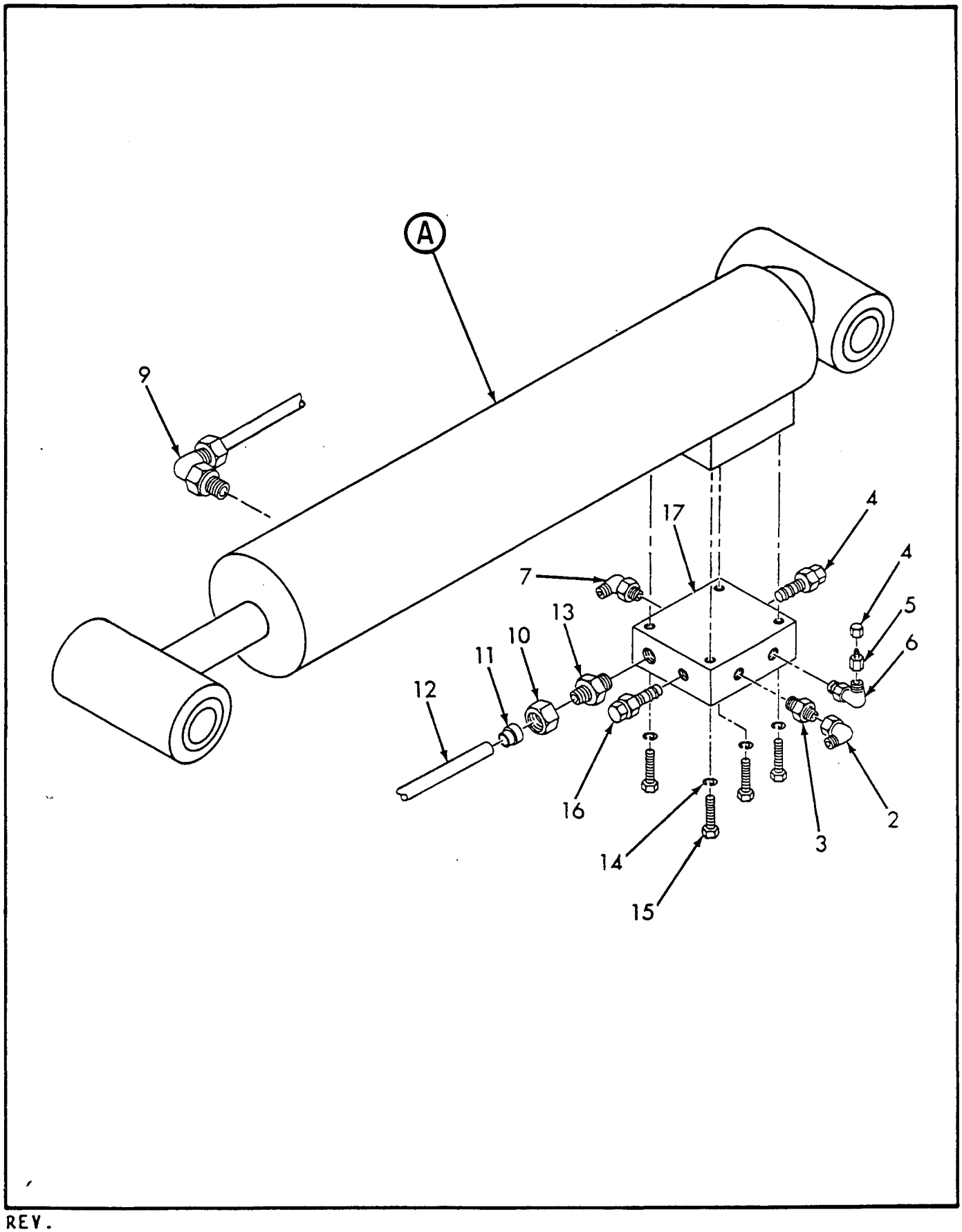
REV.

MASTER LEVELING CYLINDER ASSEMBLY (ALL MODELS)

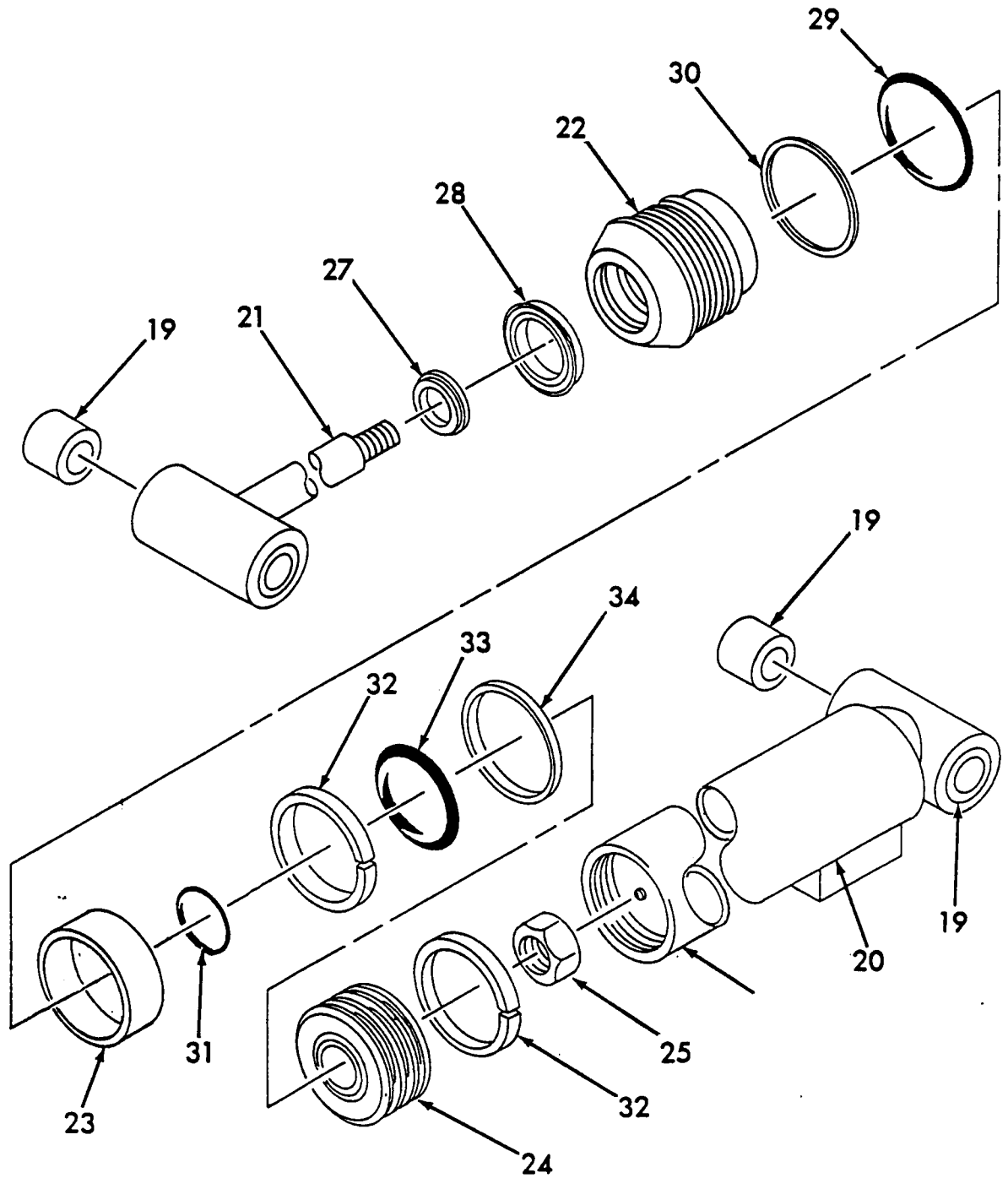
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21084	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	80033-03	.TEE, STRAIGHT THREAD RUN	2
3	21111	.CYLINDER, MASTER LEVELING	1
4		..BARREL	1
5		..ROD	1
6		..NUT, GLAND	1
7		..PISTON	1
8	67671	..BUSHING	4
-9	66044	..KIT, SEAL	1
10		...PELLET, LOCK	1
11		...O-RING, GLAND NUT	1
12		...B/U RING, GLAND NUT	1
13		...SEAL, PISTON (POLYPAK)	2
14		...SEAL, ROD (POLYPAK)	1
15		...WIPER, ROD	1
16		...NUT, ROD	1
17		...O-RING, STATIC	1

- ITEM NOT ILLUSTRATED

LIFT CYLINDER ASSEMBLY (ALL MODELS)



LIFT CYLINDER ASSEMBLY (ALL MODELS)



LIFT CYLINDER ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24056	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	80015-06	.ELBOW, SWIVEL NUT	1
3	80004-11	.CONNECTOR, STRAIGHT THREAD	1
4	20348	.ORIFICE, BLEED DOWN	1
5	80060-05	.NUT	1
6	50900	.ELBOW, STRAIGHT THREAD	1
7	80012-11	.ELBOW, STRAIGHT THREAD	1
-8	24094	.SUB-ASSEMBLY, LIFT CYLINDER	1
9	80012-18	..ELBOW, STRAIGHT THREAD	1
10	80060-08	..NUT	2
11	80062-08	..SLEEVE	2
12	26379	..TUBING, HYDRAULIC	1
13	80004-19	..CONNECTOR, STRAIGHT THREAD	1
14	63302	..WASHER, LOCK	4
15	61943	..SCREW, ROUND SOCKET HEAD	4
16	81006	..CARTRIDGE, OVERCENTER	2
17	21445	..BLOCK, BOOM CYLINDER VALVE	1
-18	24043	..CYLINDER, LIFT	1
19		...BUSHING	4
20		...BARREL	1
21		...ROD	1
22		...NUT, GLAND	1
23		...TUBE, STOP	1
24		...PISTON	1
25		...NUT, ROD	1

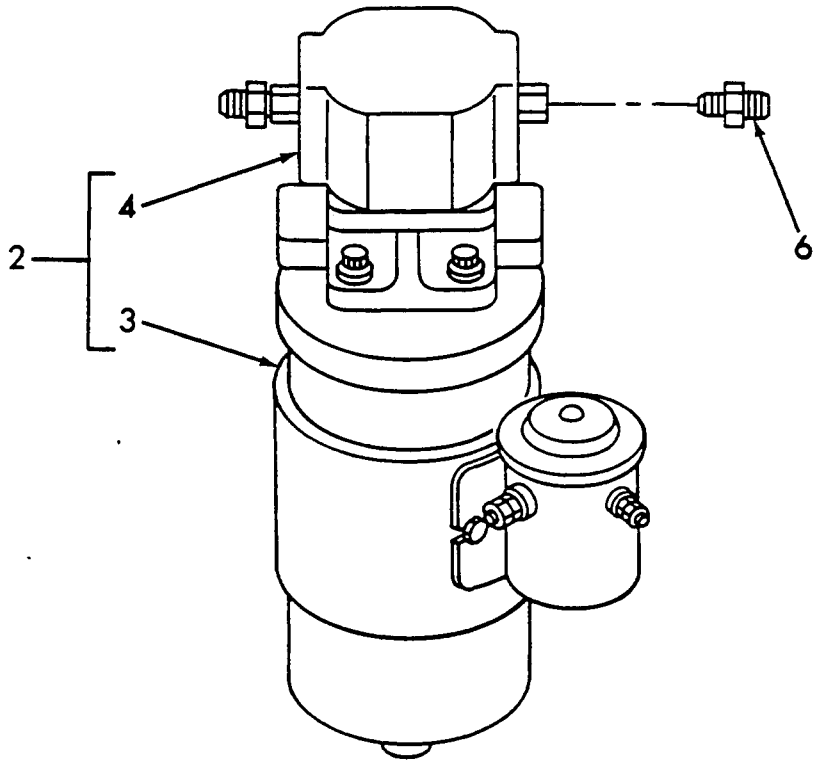
- ITEM NOT ILLUSTRATED

LIFT CYLINDER ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-26	67776	...KIT, SEAL	1
27		....WIPER, ROD	1
28		....SEAL, ROD	1
29		....O-RING, HEAD	1
30		....B/U RING, HEAD	1
31		....O-RING, STATIC	1
32		....RING, WEAR	2
33		....O-RING, PISTON	1
34		....RING, GLYD	1

- ITEM NOT ILLUSTRATED

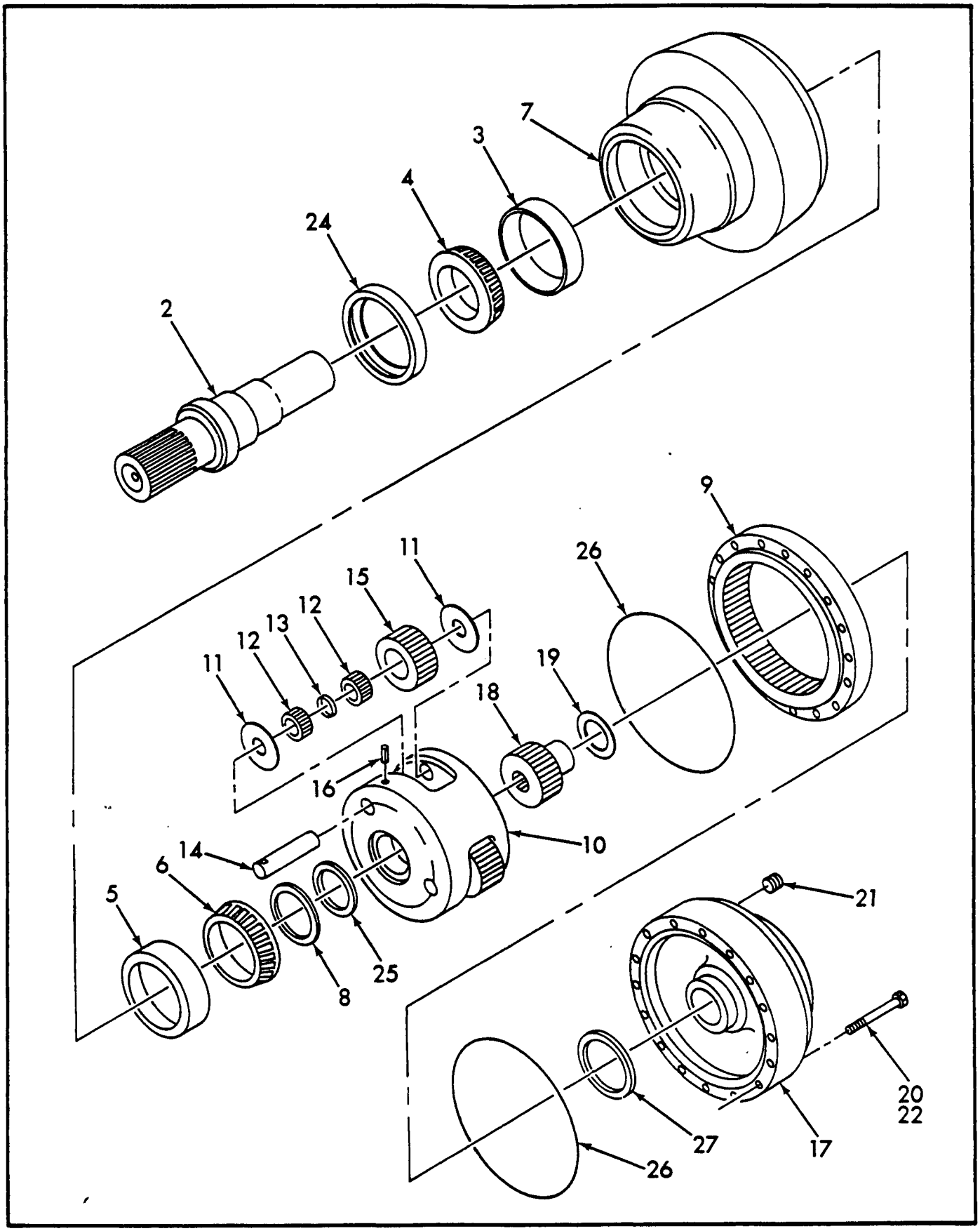
EMERGENCY PUMP & MOTOR ASSEMBLY (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22390	ASSEMBLY, EMERGENCY PUMP & MOTOR (See Sect. 4, Fig. 1 or 1A for NHA)	REF
2	20384	.PUMP & MOTOR, EMERGENCY	1
3	67940	..MOTOR	1
4	66402	..PUMP	1
-5	67935	...KIT, SEAL	1
6	80001-08	.CONNECTOR, MALE	2

REV.

TORQUE HUB (ALL MODELS)



REV.

TORQUE HUB (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22830	HUB, TORQUE (See Sect. 4, Fig. 11 for NHA)	REF
2	67877	.SHAFT, OUTPUT	1
3	67917	.CUP, BEARING	1
4	67924	.CONE, BEARING	1
5	67915	.CUP, BEARING	1
6	67923	.CONE, BEARING	1
7		.HUB	1
8	67911	.SPACER	1
9		.GEAR, RING	1
10		.CARRIER	1
11	67898	.WASHER, THRUST	6
12	67918	.ROLLER, NEEDLE	96
13	67907	.SPACER	3
14		.SHAFT, PLANET	3
15		.GEAR, PLANET	3
16		.PIN, ROLL	3
17		.COVER	1
18		.GEAR, INPUT	1
19	67899	.WASHER, THRUST	1
20	67931	.BOLT	8
21		.PLUG, PIPE	1
22	67932	.BOLT, SHOULDER	4
-23	67871	.KIT, SEAL	1
24	66508	..SEAL, SHAFT	1
25		..RING, RETAINING	1

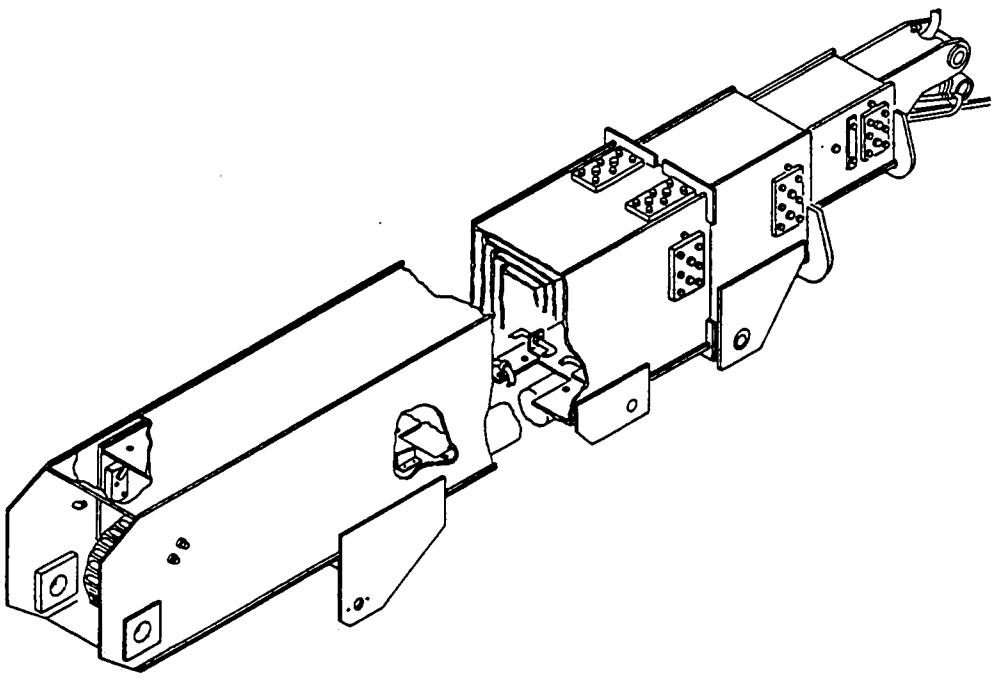
TORQUE HUB (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26		..O-RING	2
27		..WASHER, THRUST	1

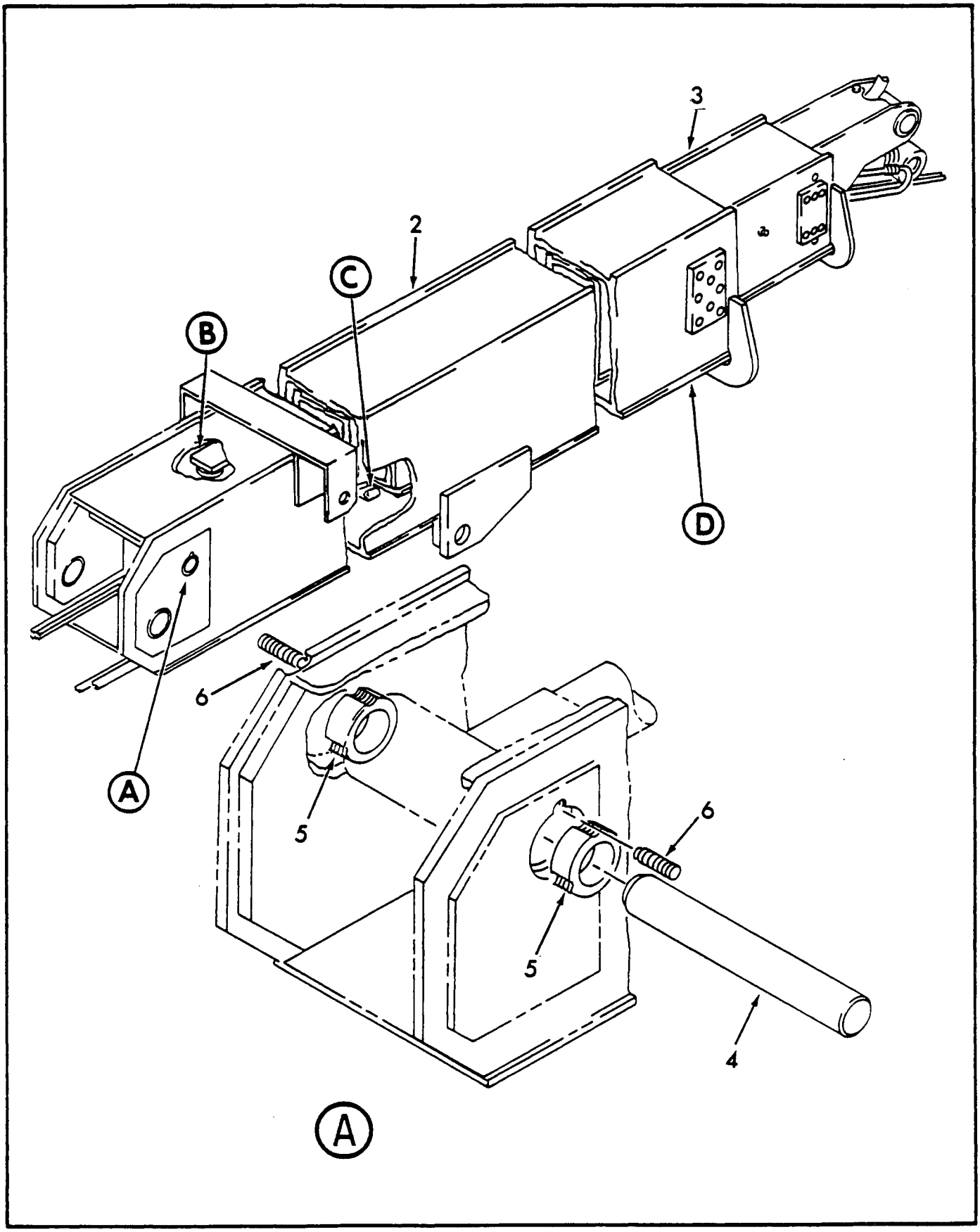
- ITEM NOT ILLUSTRATED

SECTION 5 CONTAINS:

FIG. NO.	TITLE
1	FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)
1A	FINAL BOOM ASSEMBLY (100C 6X4)
2	INTERMEDIATE BOOM ASSEMBLY (80C 4X4 & 6X4)
2A	OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)
3	INNER BOOM ASSEMBLY (80C 4X4 & 6X4)
3A	INNER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)
4	INNER BOOM SUB-ASSEMBLY (100C 6X4)
5	BOOM EXTENSION CYLINDER ASSEMBLY (80C 4X4 & 6X4)
5A	BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)
5B	OUTSIDE BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)
6	SLAVE LEVELING CYLINDER ASSEMBLY (ALL MODELS)
7	CABLE SHEAVE ASSEMBLY (80C 4X4 & 6X4)
7A	CABLE SHEAVE ASSEMBLY (100C 6X4)
8	PLASTITRAK SUPPORT ROLLER ASSEMBLY (ALL MODELS)
8A	PLASTITRAK ASSEMBLY (100C 6X4)

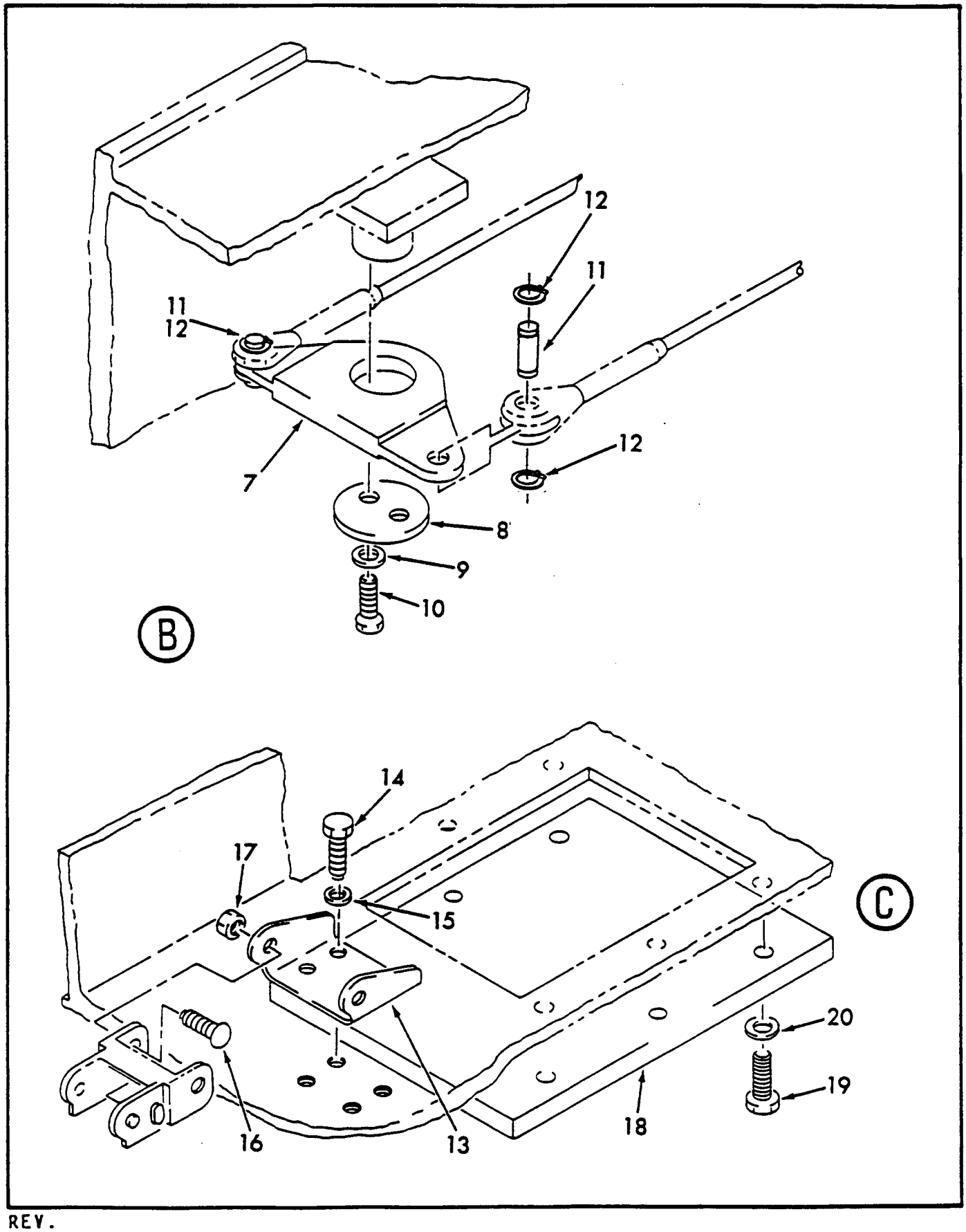


FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)

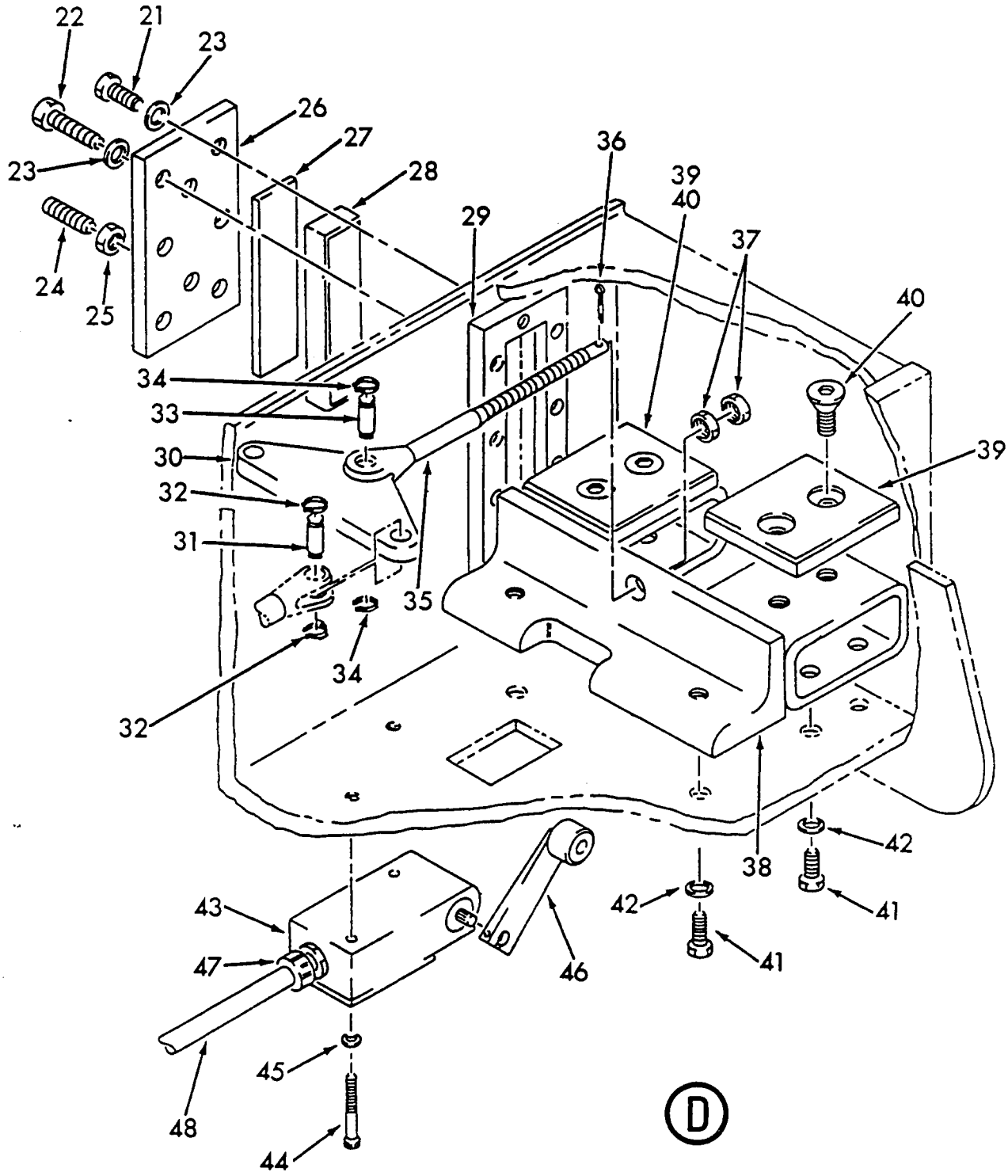


REV.

FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)



FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)



FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24136	ASSEMBLY, FINAL BOOM (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	23640	.MACHINING, OUTER BOOM	1
3	24135	.ASSEMBLY, INTERMEDIATE BOOM (See Sect. 5, Fig. 2 for Details)	1
4	23966	.PIN, BOOM EXTENSION CYLINDER	1
5	21353	..BUSHING, ECCENTRIC	2
6	62229	.SCREW, SET	4
7	23964	.LEVER, EXTENSION CABLE	1
8	22593	.RETAINER	1
9	63302	.WASHER, LOCK	2
10	60533	.SCREW, CAP	2
11	22703	.PIN, CABLE	2
12	65082	.RING, SNAP	4
13	23894	.BRACKET, STATIONARY (PLASTITRAK)	1
14	60501	.SCREW, CAP	4
15	63301	.WASHER, LOCK	4
16	61931	.SCREW, CAP	2
17	61322	.NUT, LOCK	2
18	22121	.PLATE, ACCESS COVER	1
19	60367	.SCREW, CAP	6
20	63302	.WASHER, LOCK	6
21	60395	.SCREW, CAP	4
22	60343	.SCREW, CAP	12
23	63303	.WASHER, LOCK	16
24	62204	.SCREW, SET	4
25	61101	.NUT, JAM	4

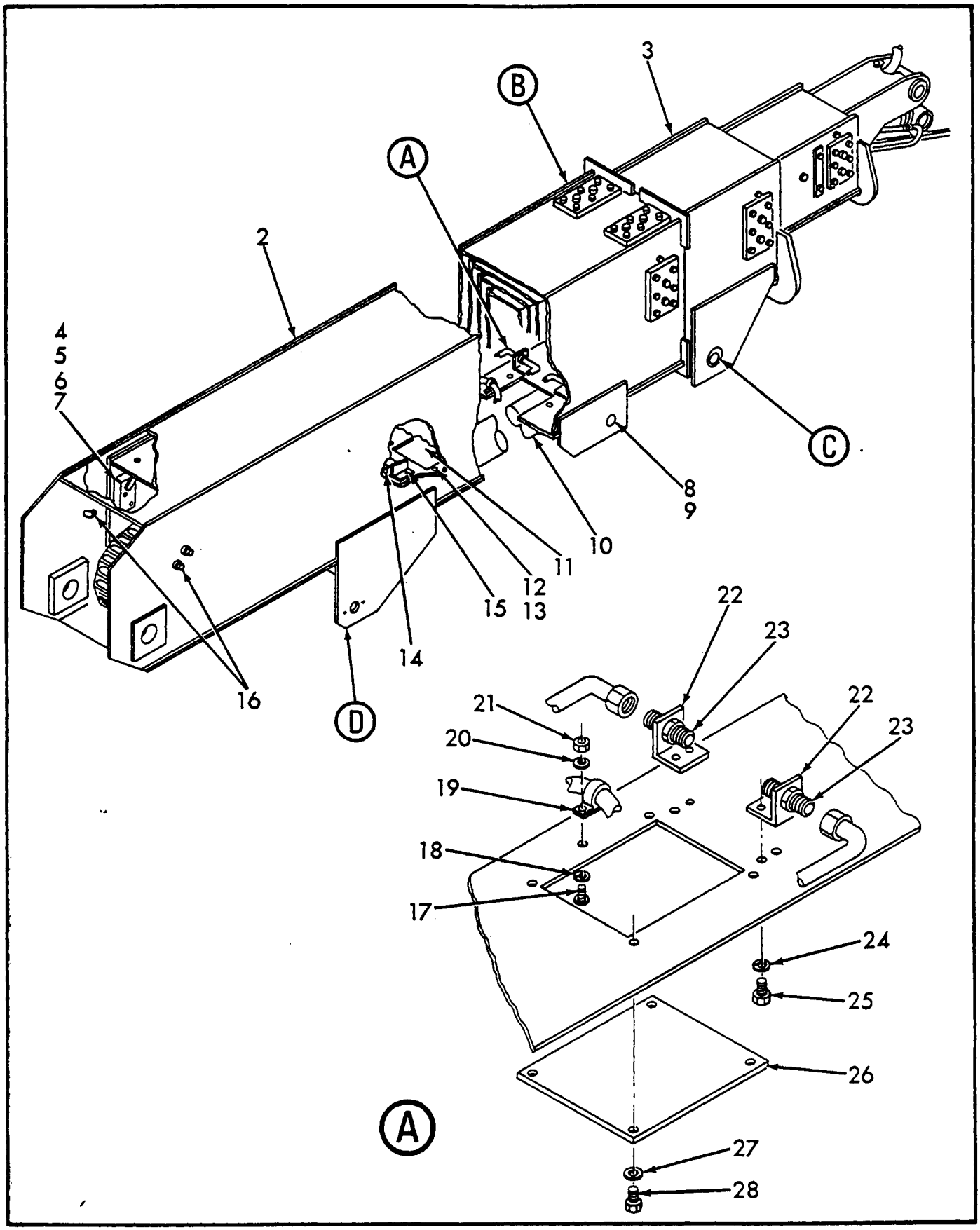
- ITEM NOT ILLUSTRATED

FINAL BOOM ASSEMBLY (80C 4X4 & 6X4)

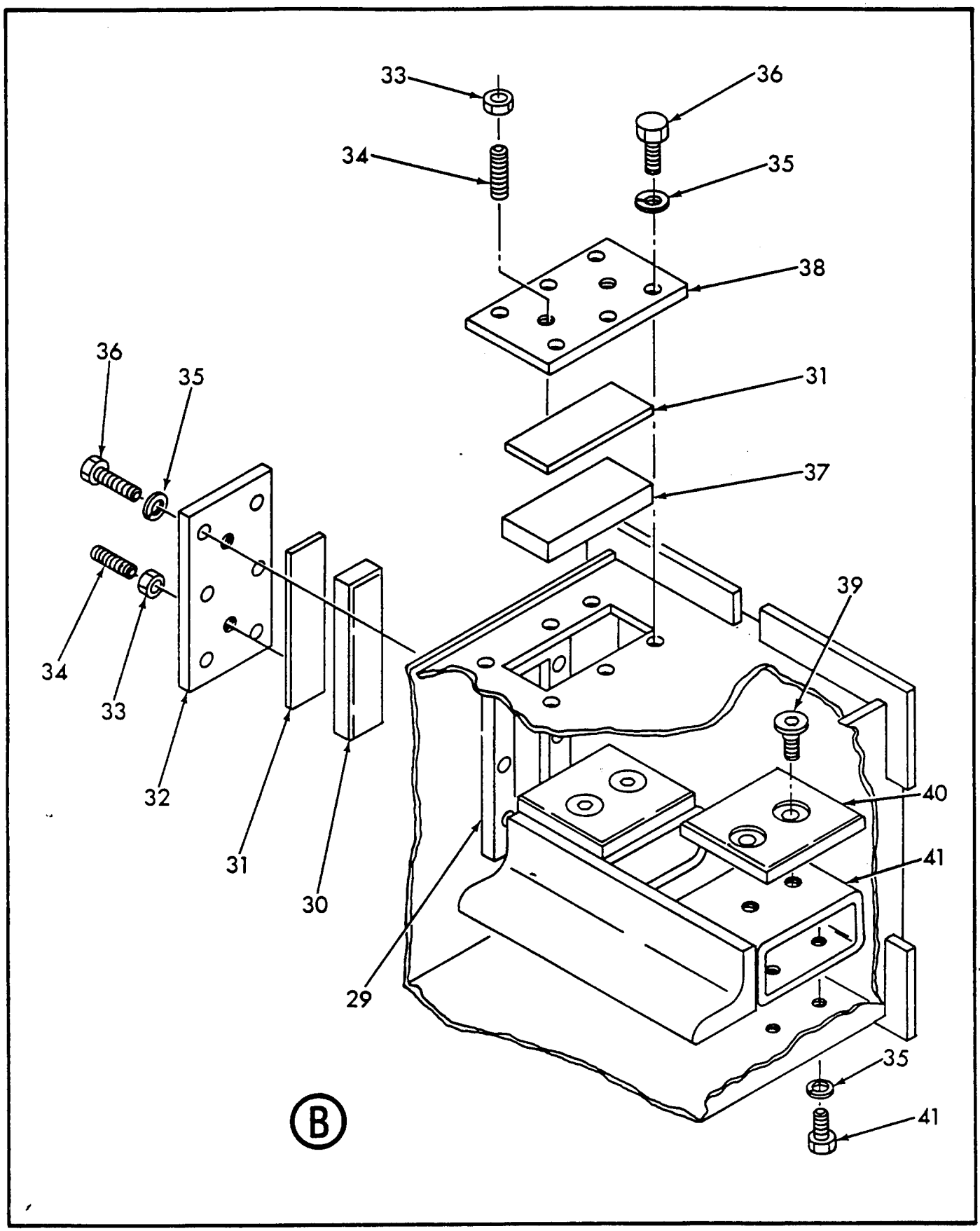
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	21321	.PLATE, WEAR PAD COVER	2
27	20453	.PLATE, PRESSURE PAD	2
28	24016	.PAD, WEAR	2
29	21358	.RETAINER, WEAR PAD	2
30	23965	.LEVER, RETRACTION CABLE	1
31	22703	..PIN, CABLE	2
32	65082	.RING, SNAP	4
33	22708	.PIN, CABLE	1
34	65076	.RING, SNAP	2
35	22710	.CLEVIS	1
36	64301	.PIN, COTTER	1
37	60910	.NUT, JAM	2
38	23842	.BRACKET, BOOM END	1
39	23958	.PAD, WEAR	2
40	61806	.SCREW, CAP	4
41	60542	.SCREW, CAP	4
42	63303	.WASHER, LOCK	4
43	70107	.SWITCH, LIMIT	1
44	62615	.SCREW, MACHINE	2
45	63313	.WASHER, LOCK	2
46	70148	.LEVER, ARM	1
47	2806	.RELIEF, STRAIN	1
48	70036	.CABLE, ELECTRICAL (400 IN.)	1

- ITEM NOT ILLUSTRATED

FINAL BOOM ASSEMBLY (100C 6X4)

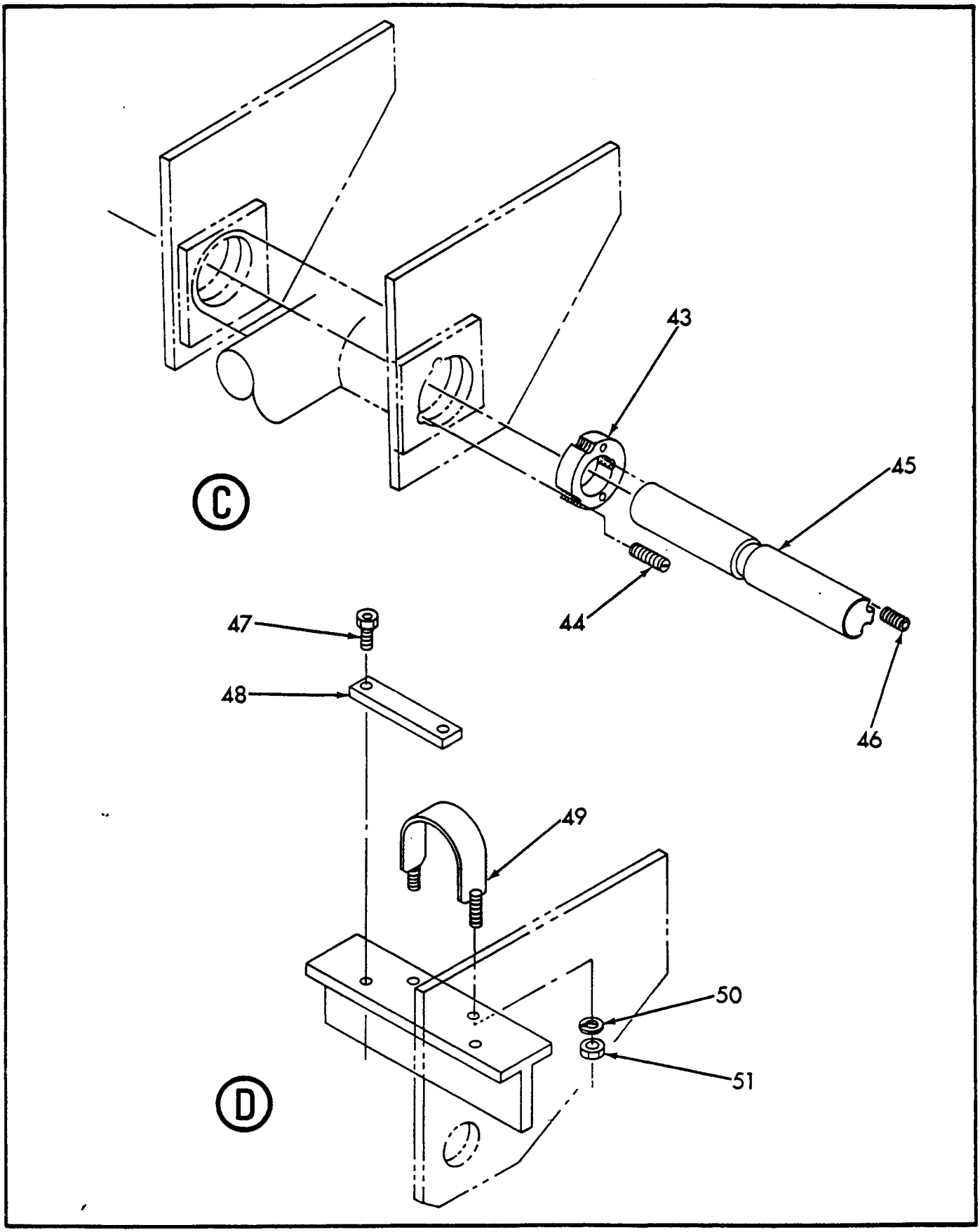


FINAL BOOM ASSEMBLY (100C 6X4)



REV.

FINAL BOOM ASSEMBLY (100C 6X4)



REV.

FINAL BOOM ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24310	ASSEMBLY, FINAL BOOM (See Sect. 2, Fig. 1B for NHA)	REF
2	24072	.MACHINING, OUTER BOOM	1
3	24311	.ASSEMBLY, OUTER/INTERMEDIATE BOOM (See Sect. 5, Fig. 2A for Details)	1
4	70107	.SWITCH, LIMIT	1
5	70032	.LEVER, SWITCH	1
6	62704	.SCREW, MACHINED SLOTTED	2
7	63313	.WASHER, LOCK	2
8	24228	.PIN, TRUNNION	2
9	62221	.SCREW, SET	2
10	24328	.ASSEMBLY, OUTSIDE BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 5B for Details)	1
11	22121	.PLATE, ACCESS COVER	1
12	63303	.WASHER, LOCK	4
13	60408	.SCREW, CAP	4
14	24401	.ASSEMBLY, PLASTITRAK (See Sect. 5, Fig. 8A for Details)	1
15	60625	.SCREW, CAP	4
16	80011-03	.ELBOW, BULKHEAD UNION	4
17	60534	.SCREW, CAP	1
18	63301	.WASHER, LOCK	1
19	16268	.CLAMP, HOSE	1
20	63401	.WASHER, FLAT	1
21	60701	.NUT, HEX	1
22	22207	.BRACKET, BULKHEAD FITTING	2
23	80045-06	.UNION, BULKHEAD	2
24	63302	.WASHER, LOCK	4

- ITEM NOT ILLUSTRATED

FINAL BOOM ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	60603	.SCREW, CAP	4
26	24480	.PLATE, ACCESS COVER	1
27	63303	.WASHER, LOCK	4
28	60408	.SCREW, CAP	4
29	31358	.RETAINER	2
30	23170	.PAD, WEAR	2
31	20453	.PLATE, PRESSURE PAD	4
32	21321	.PLATE, COVER	2
33	61101	.NUT, JAM	8
34	62204	.SCREW, SET	8
35	63303	.WASHER, LOCK	28
36	60325	.SCREW, CAP	24
37	24242	.PAD, WEAR	2
38	22171	.PLATE, COVER	2
39	61805	.SCREW, FLAT SOCKET HEAD CAP	4
40	24225	.PAD, WEAR	2
41	24226	.BRACKET, WEAR PAD	2
42	60416	.SCREW, CAP	4
43	24454	.BUSHING, ECCENTRIC	2
44	62229	.SCREW, SET	4
45	24227	.PIN, ANCHOR	1
46	62229	.SCREW, SET	2
47	61821	.SCREW, CAP	2
48	22125	.PAD, WEAR-OUTSIDE EXTENSION CYLINDER	1
49	24402	.CLAMP, OUTSIDE EXTENSION CYLINDER	1

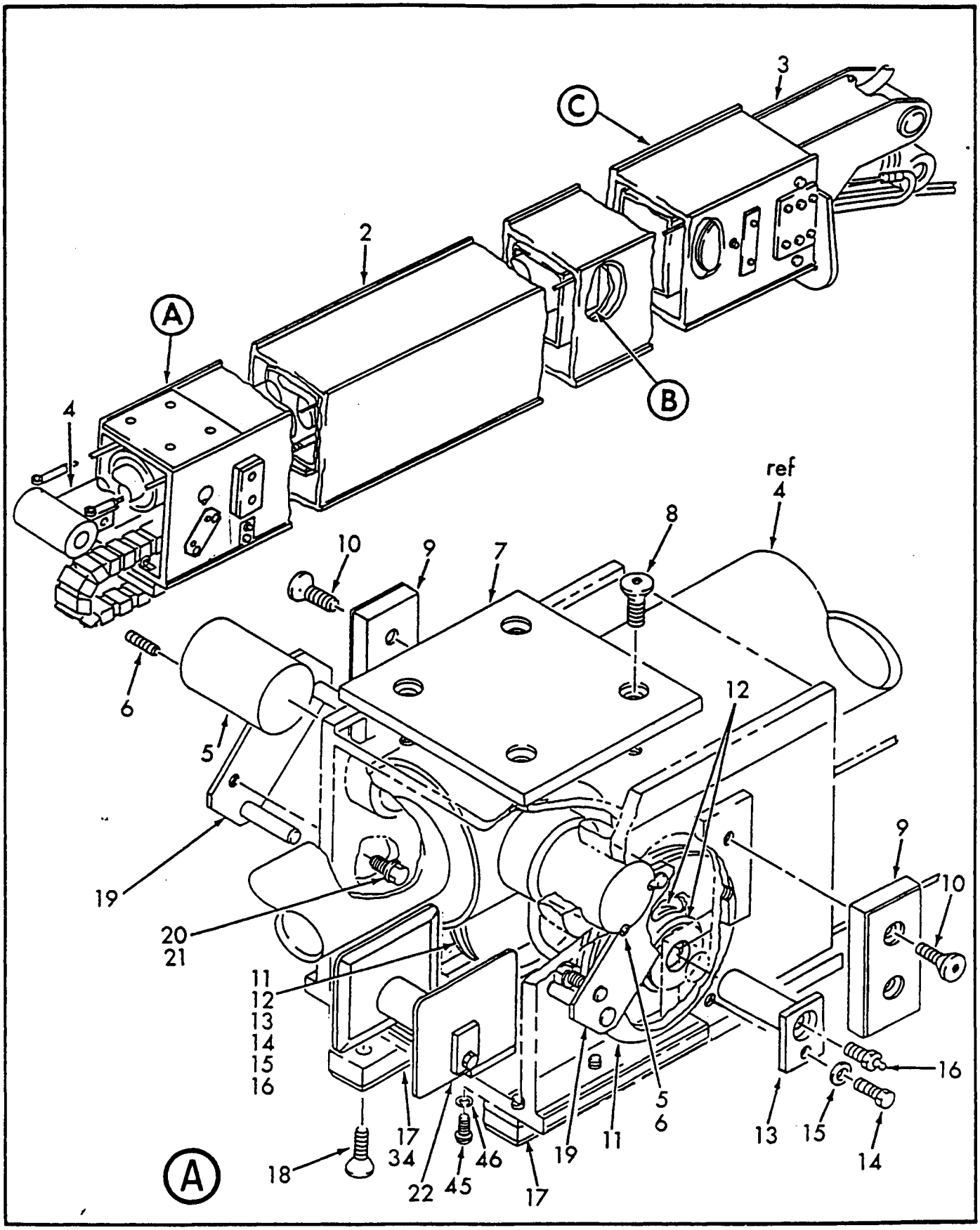
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FINAL BOOM ASSEMBLY (100C 6X4)

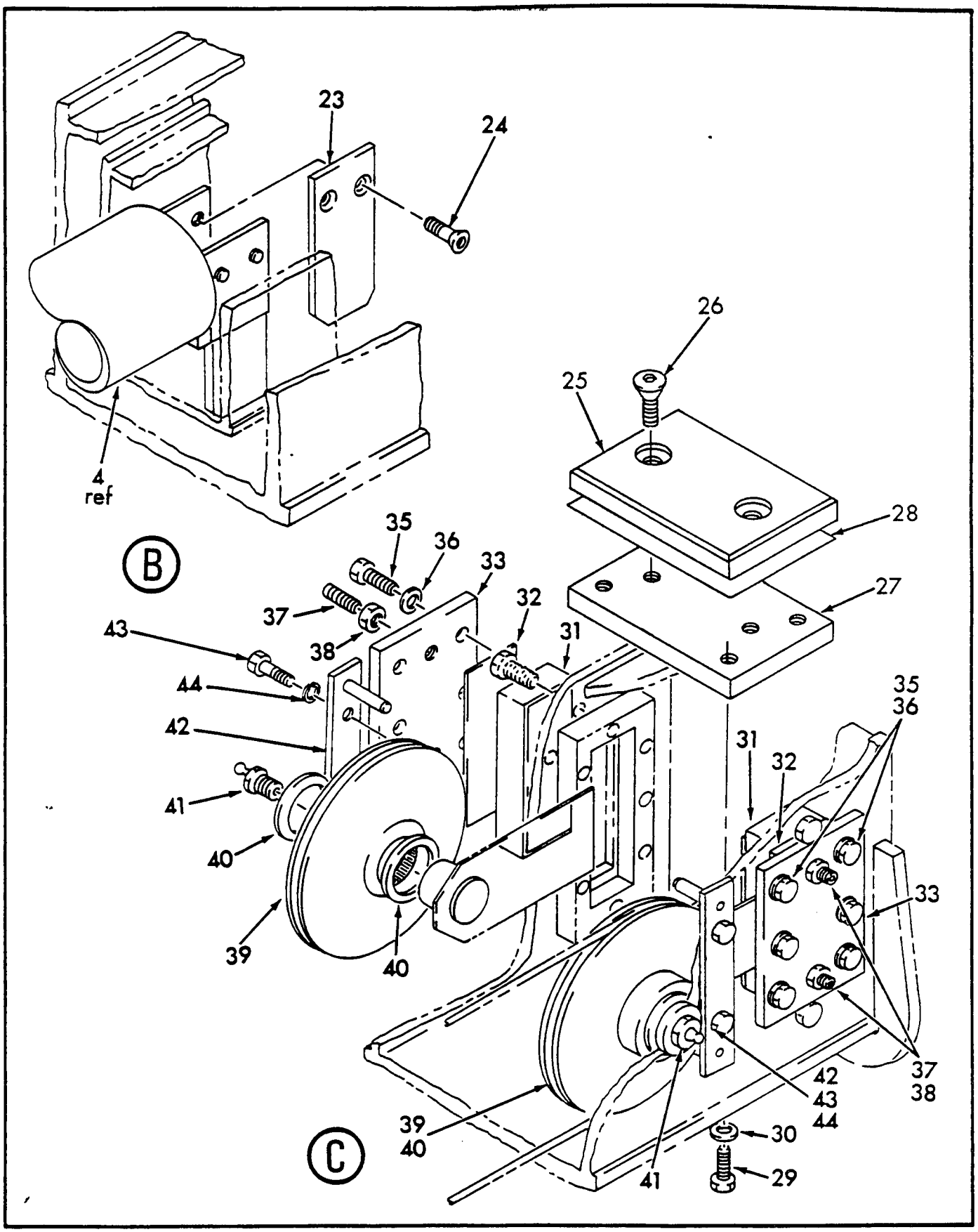
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
50	63303	.WASHER, LOCK	2
51	60703	.NUT, HEX	2

- ITEM NOT ILLUSTRATED

INTERMEDIATE BOOM ASSEMBLY (80C 4X4 & 6X4)



INTERMEDIATE BOOM ASSEMBLY (80C 4X4 & 6X4)



REV.

INTERMEDIATE BOOM ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24135	ASSEMBLY, INTERMEDIATE BOOM (See Sect. 5, Fig. 1 for NHA)	REF
2	23638	.MACHINING, INTERMEDIATE BOOM	1
3	24134	.ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 3 for Details)	1
4	23836	.ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 5 for Details)	1
5	24017	.PIN, TRUNNION	2
6	62229	.SCREW, SET	3
7	23954	.PAD, WEAR	1
8	61826	.SCREW, CAP	4
9	23955	.PAD, WEAR	2
10	61801	.SCREW, CAP	4
11	22705	.ASSEMBLY, CABLE SHEAVE (See Sect. 5, Fig. 7 for Details)	2
12	65534	.WASHER, THRUST	4
13	23845	.PIN, CABLE SHEAVE	2
14	60553	.SCREW, CAP	2
15	63302	.WASHER, LOCK	2
16	65103	.FITTING, GREASE	2
17	23957	.PAD, WEAR	2
18	61806	.SCREW, CAP	4
19	23749	.WELDMENT, CABLE KEEPER	2
20	60527	.SCREW, CAP	4
21	63302	.WASHER, LOCK	4
22	24510	.ASSEMBLY, PLASTITRAK SUPPORT ROLLER (See Sect. 5, Fig. 8 for Details)	1
23	23956	.PAD, WEAR	2

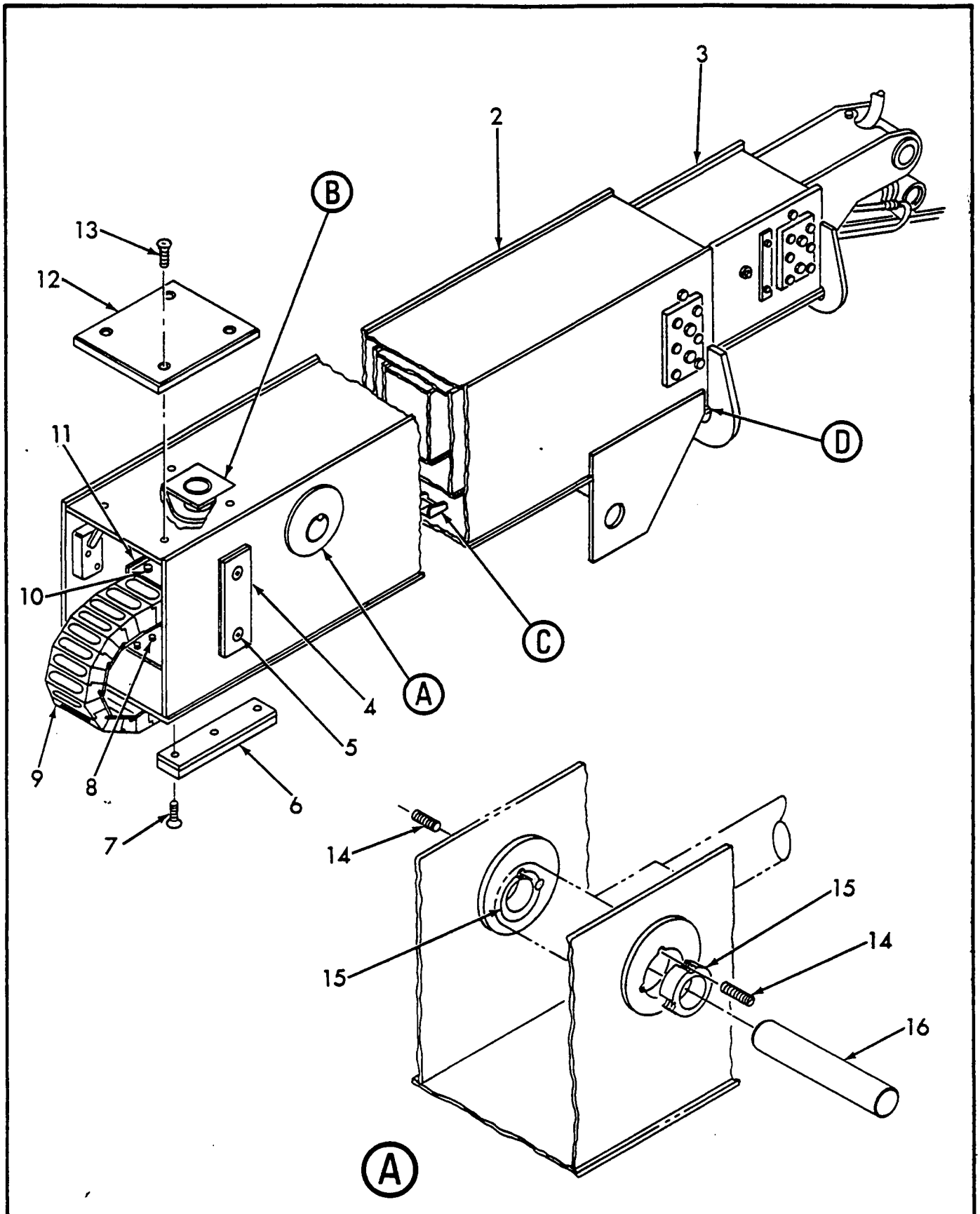
- ITEM NOT ILLUSTRATED

INTERMEDIATE BOOM ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	61805	.SCREW, CAP	6
25	23953	.PAD, WEAR	1
26	61801	.SCREW, CAP	2
27	23844	.SUPPORT, WEAR PAD	1
28	23962	.SHIM	1
29	60325	.SCREW, CAP	4
30	63303	.WASHER, LOCK	4
31	23952	.PAD, WEAR	2
32	20453	.PLATE, PRESSURE PAD	2
33	21321	.COVER, PRESSURE PAD	2
34	23963	.SHIM	2
35	60541	.SCREW, CAP	12
36	63303	.WASHER, LOCK	12
37	62204	.SCREW, SET	4
38	61101	.NUT, JAM	4
39	22705	.ASSEMBLY, CABLE SHEAVE (See Sect. 5, Fig. 6 for Details)	2
40	65534	.WASHER, THRUST	4
41	65103	.FITTING, GREASE	2
42	21287	.WELDMENT, CABLE KEEPER	2
43	60527	.SCREW, CAP	4
44	63302	.WASHER, LOCK	4
45	61931	.SCREW, CAP	4
46	63302	.WASHER, LOCK	4

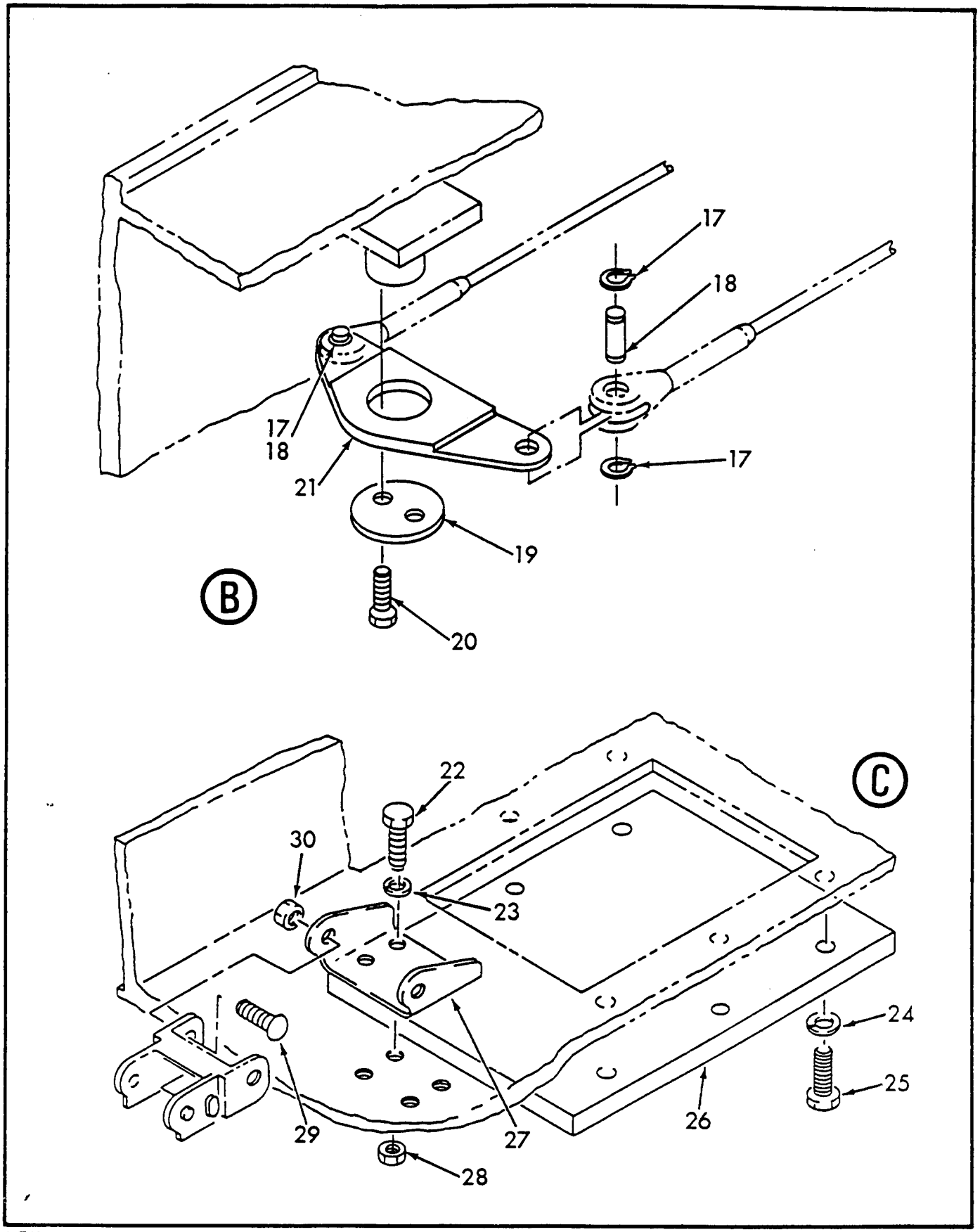
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OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)



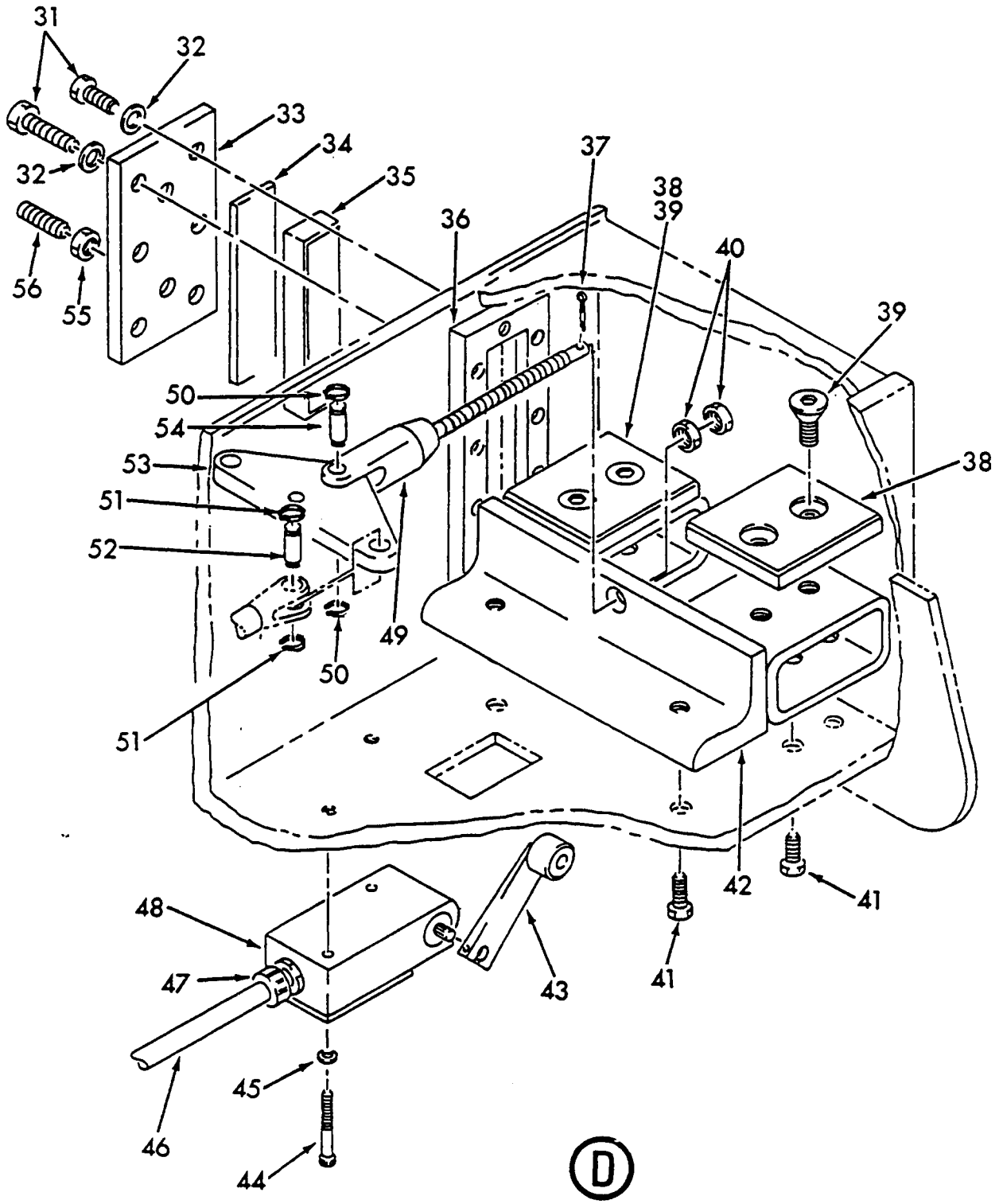
REV.

OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)



REV.

OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)



OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24311	SUB-ASSEMBLY, OUTER/INTERMEDIATE BOOM (See Sect. 5, Fig. 1A for NHA)	REF
2	24074	.MACHINING, OUTER/INTERMEDIATE BOOM	1
3	24312	.SUB-ASSEMBLY, INNER/INTERMEDIATE BOOM (See Sect. 5, Fig. 3A for Details)	1
4	24241	.PAD, WEAR	2
5	61801	.SCREW, CAP	4
6	24240	.PAD, WEAR	2
7	61805	.SCREW, CAP	6
8	60607	.SCREW, CAP	4
9	24401	.ASSEMBLY, PLASTITRAK (See Sect. 5, Fig. 8A for Details)	1
10	60625	.SCREW, CAP	4
11	22031	.BRACKET, PLASTITRAK	1
12	24239	.PAD, WEAR	1
13	61827	.SCREW, CAP	4
14	62229	.SCREW, SET	4
15	21353	.BUSHING, ECCENTRIC	2
16	23213	.PIN, BOOM EXTENSION	1
17	65082	.RING, SNAP	4
18	22703	.PIN	2
19	22593	.RETAINER	1
20	60603	.SCREW, CAP	2
21	24229	.LEVER, EXTENSION CABLE	1
22	60644	.SCREW, CAP	4
23	63301	.WASHER, LOCK	4
24	63302	.WASHER, LOCK	6

- ITEM NOT ILLUSTRATED

OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)

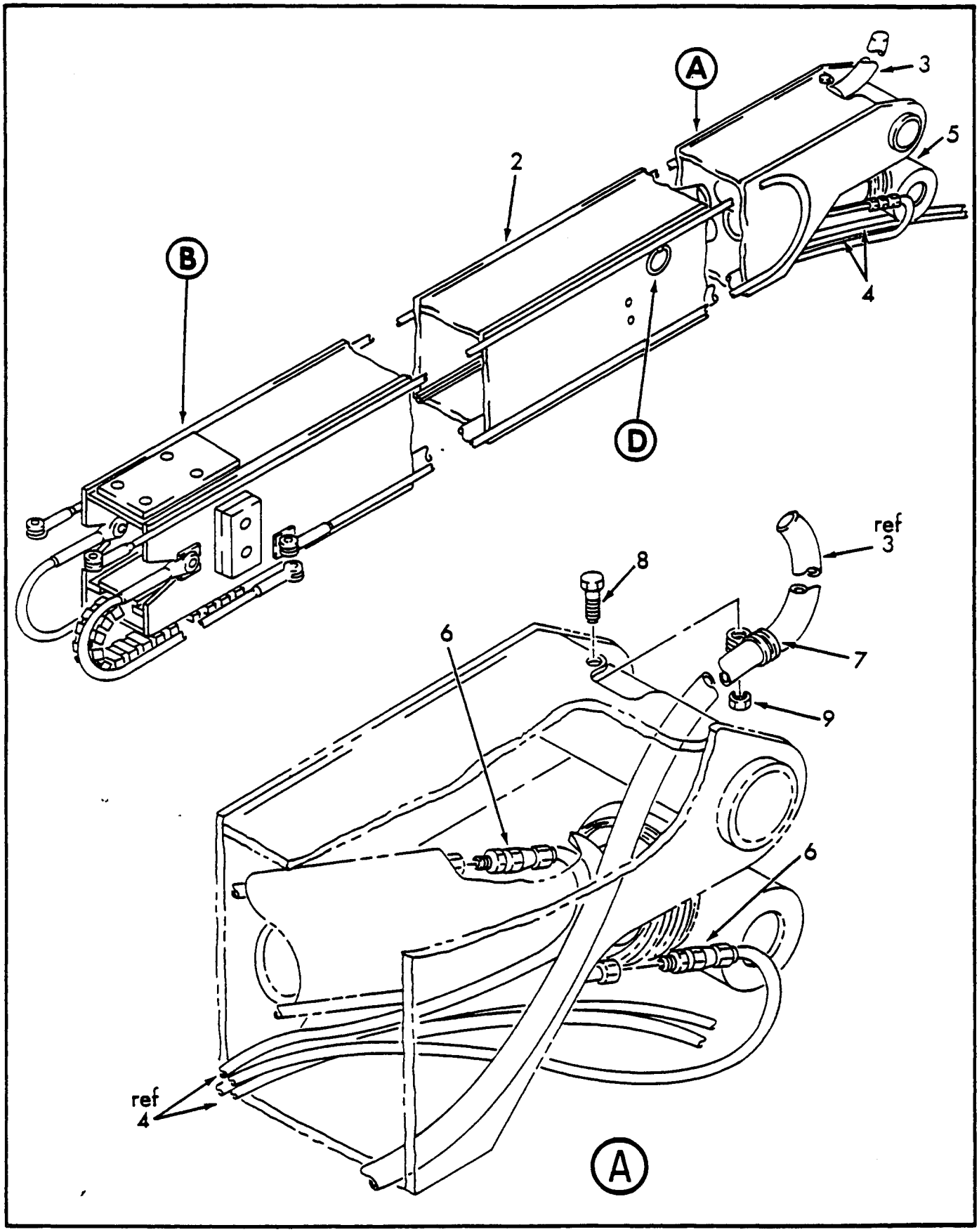
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	60367	.SCREW, CAP	6
26	24230	.PLATE, COVER	1
27	23894	.BRACKET, STATIONARY (PLASTITRAK)	1
28	60701	.NUT, HEX	4
29	61931	.SCREW, CAP	2
30	61322	.NUT, LOCK	2
31	60325	.SCREW, CAP	16
32	63303	.WASHER, LOCK	16
33	21321	.PLATE, WEAR PAD COVER	2
34	20453	.PLATE, PAD PRESSURE	2
35	23170	.PAD, WEAR	2
36	21358	.RETAINER, WEAR PAD	2
37	64301	.PIN, COTTER	1
38	24392	.PAD, WEAR	2
39	61806	.SCREW, FLAT SOCKET HEAD CAP	4
40	60910	.NUT, JAM	2
41	60607	.SCREW, CAP	6
42	24224	.BRACKET, BOOM END	1
43	70148	.LEVER, ARM	1
44	62704	.SCREW, MACHINE	2
45	63313	.WASHER, LOCK	2
46	2768	.CABLE, ELECTRICAL (25 FT.)	1
47	2806	.RELIEF, STRAIN	1
48	70107	.SWITCH, LIMIT	1
49	22710	.CLEVIS	1
50	65076	.RING, SNAP	2

OUTER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)

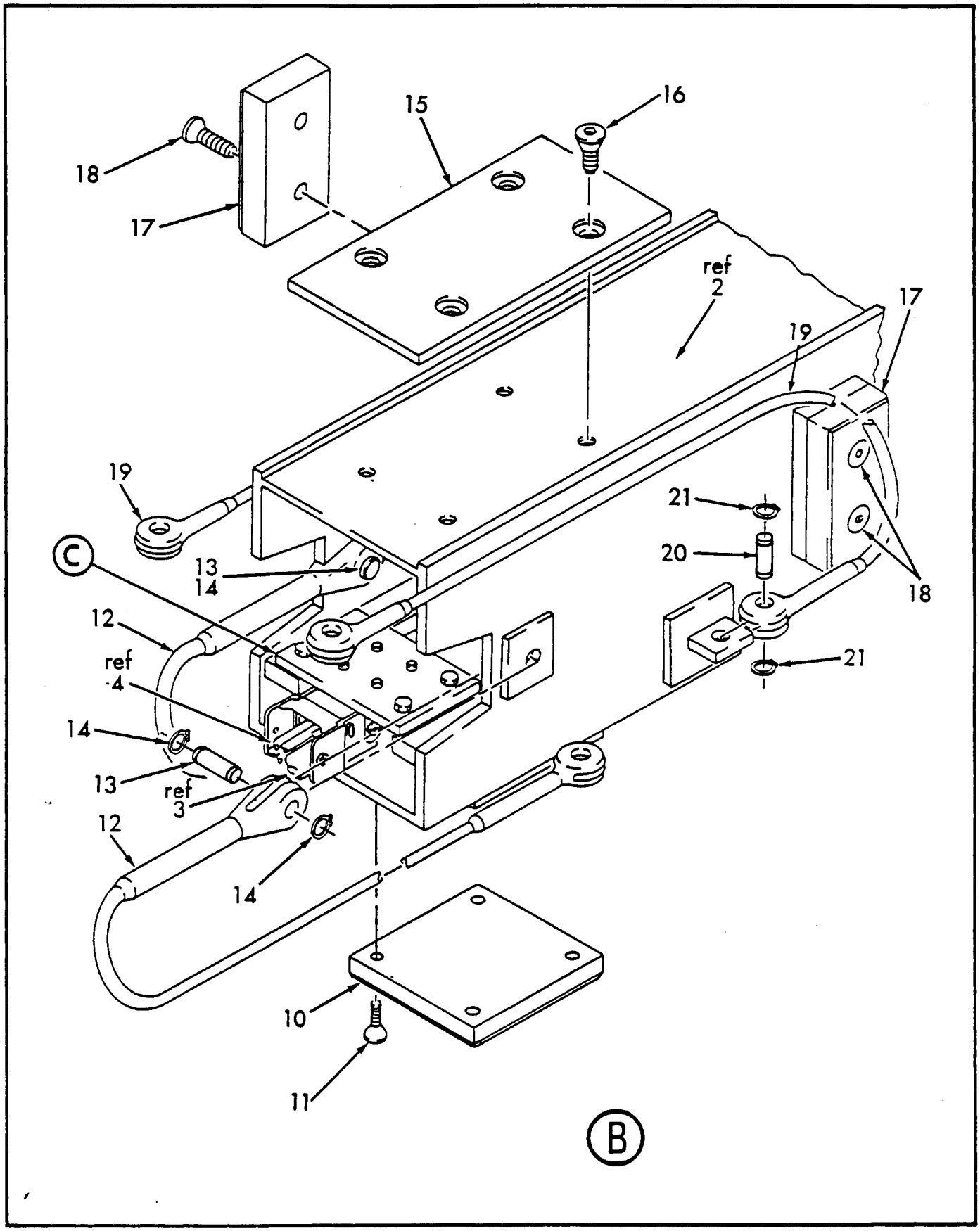
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
51	65082	.RING, SNAP	4
52	22703	.PIN	2
53	24238	.LEVER, RETRACTION CABLE	1
54	22708	.PIN	1
55	61101	.NUT, JAM	4
56	62204	.SCREW, SET	4
57	60617	.SCREW, CAP	4

- ITEM NOT ILLUSTRATED

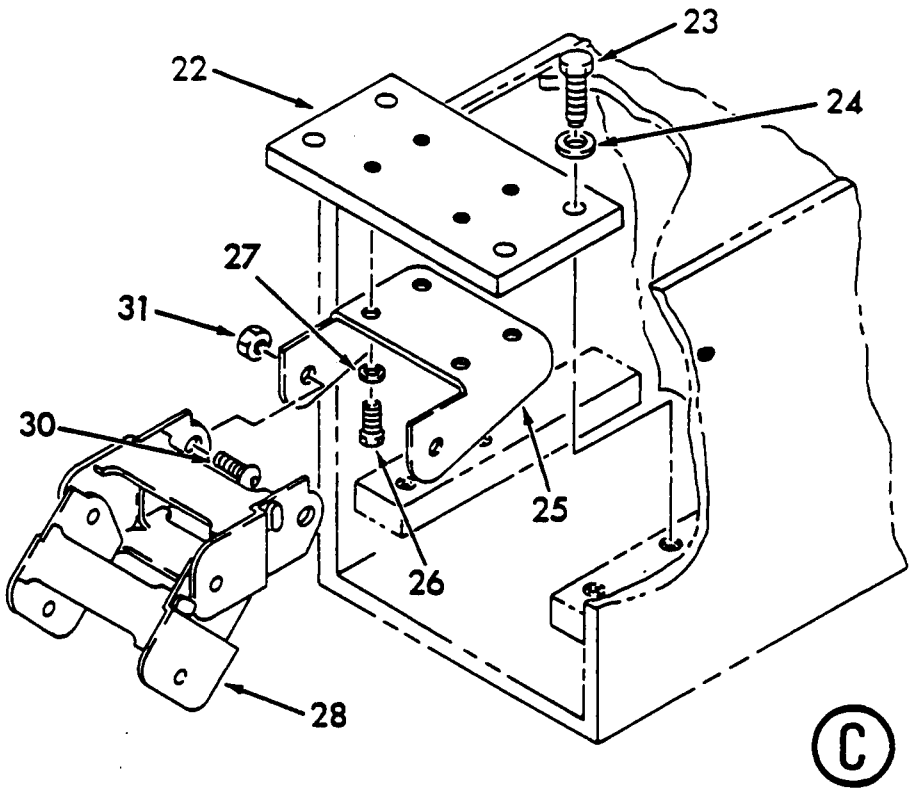
INNER BOOM ASSEMBLY (80C 4X4 & 6X4)

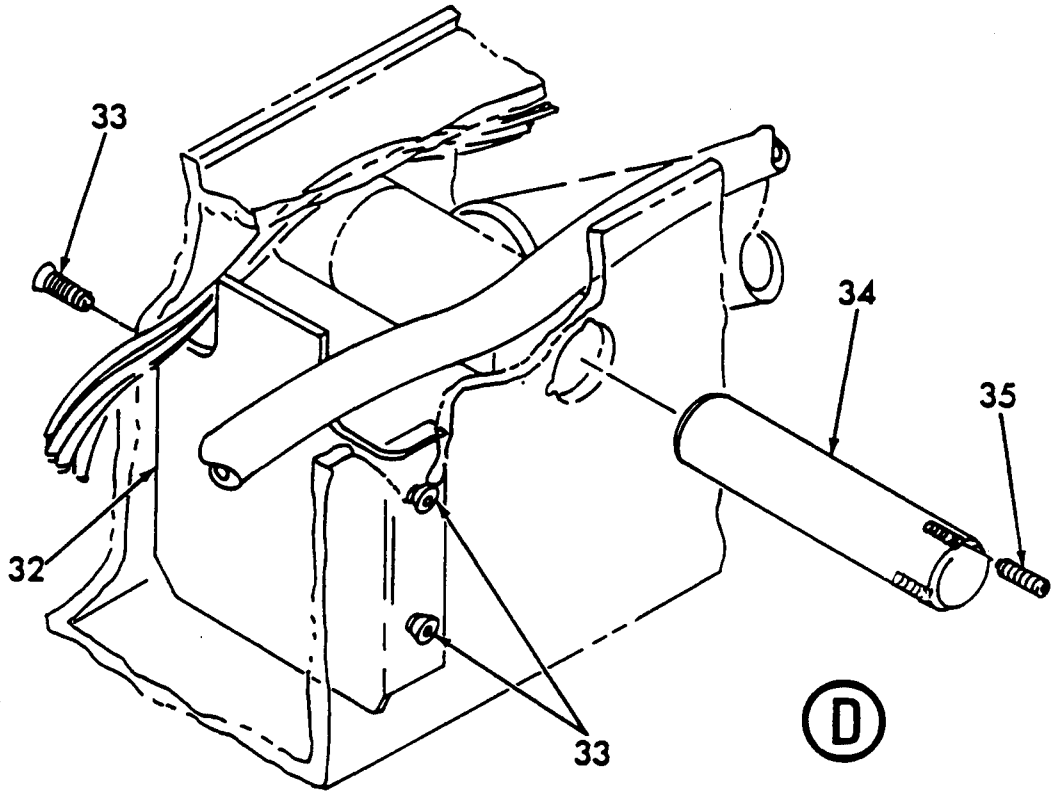


INNER BOOM ASSEMBLY (80C 4X4 & 6X4)



INNER BOOM ASSEMBLY (80C 4X4 & 6X4)





INNER BOOM ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24134	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 1 for NHA)	REF
2	23635	.MACHINING, INNER BOOM	1
3	20802	.CABLE, ELECTRIC (1620 IN.)	1
4	2568	.HOSE, HYDRAULIC (1440 IN.)	4
5	21094	.ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 6 for Details)	1
6	2562	.FITTING, STRAIGHT SWIVEL	2
7	16268	.CLAMP, HOSE	1
8	60309	.SCREW, CAP	1
9	60711	.NUT, HEX	1
10	23949	.PAD, WEAR	1
11	61805	.SCREW, CAP	4
12	23960	.CABLE, RETRACTION	2
13	22703	.PIN, CABLE	2
14	65082	.RING, SNAP	4
15	23950	.PAD, WEAR	1
16	61833	.SCREW, CAP	4
17	23951	.PAD, WEAR	2
18	61806	.SCREW, CAP	4
19	23959	.CABLE, EXTENSION	2
20	22703	.PIN, CABLE	2
21	65082	.RING, SNAP	4
22	24133	.PLATE, MOUNTING PLASTITRAK	1
23	60322	.SCREW, CAP	4
24	63302	.WASHER, LOCK	4
25	23895	.BRACKET, MOVABLE PLASTITRAK	1

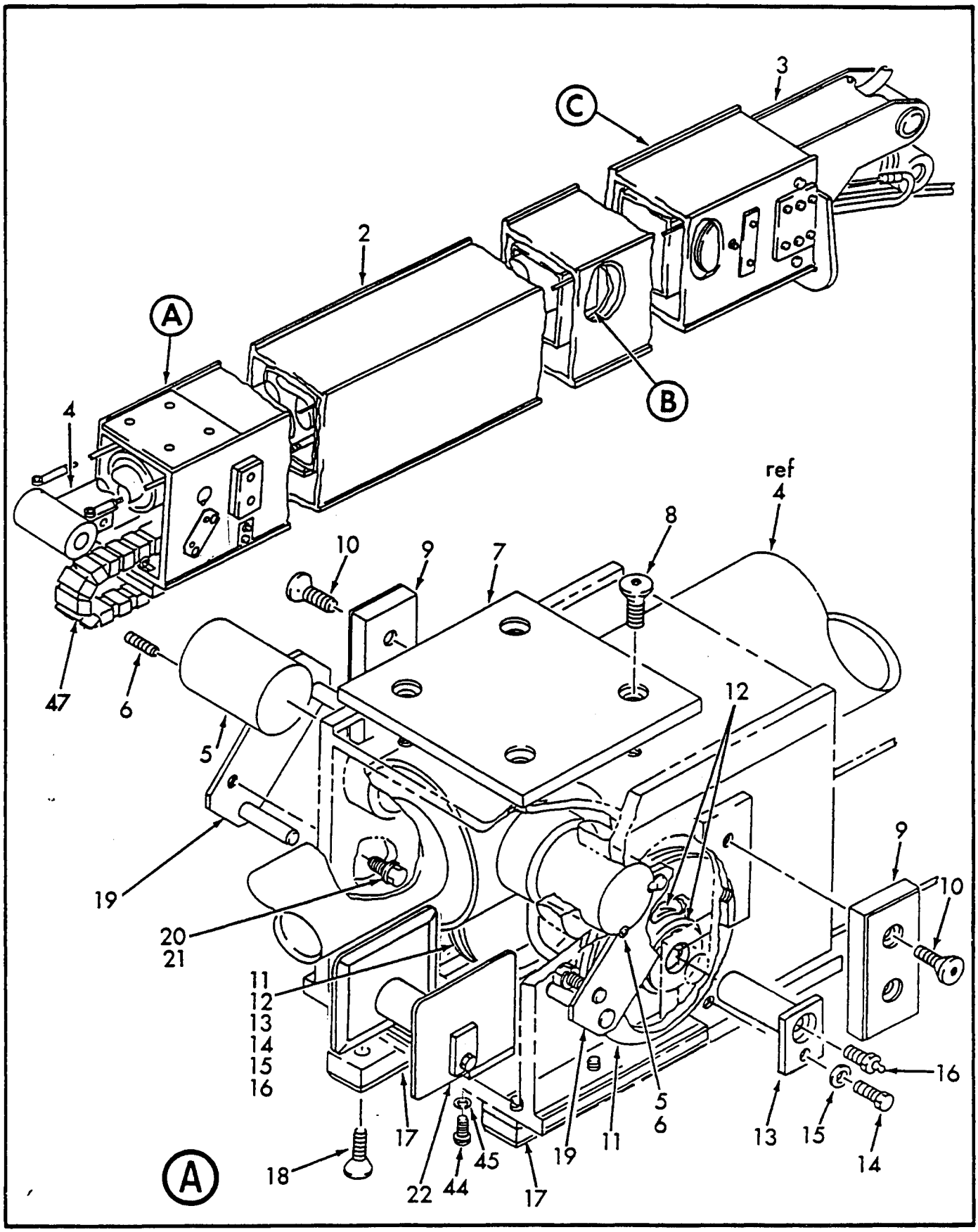
- ITEM NOT ILLUSTRATED

INNER BOOM ASSEMBLY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	60543	.SCREW, CAP	4
27	63301	.WASHER, LOCK	4
28	23824	.TRACK, POWER (See Note)	165 PCS
-29	21933	..TRACK, MARK 21933 Superceded by....(See Note)	REF
30	61931	.SCREW, CAP	2
31	61322	.NUT, LOCK	2
32	24014	.PLATE, BULKHEAD	1
33	61833	.SCREW, CAP	4
34	23961	.PIN, SLAVE LEVELING CYLINDER	1
35	62229	.SCREW, SET	2

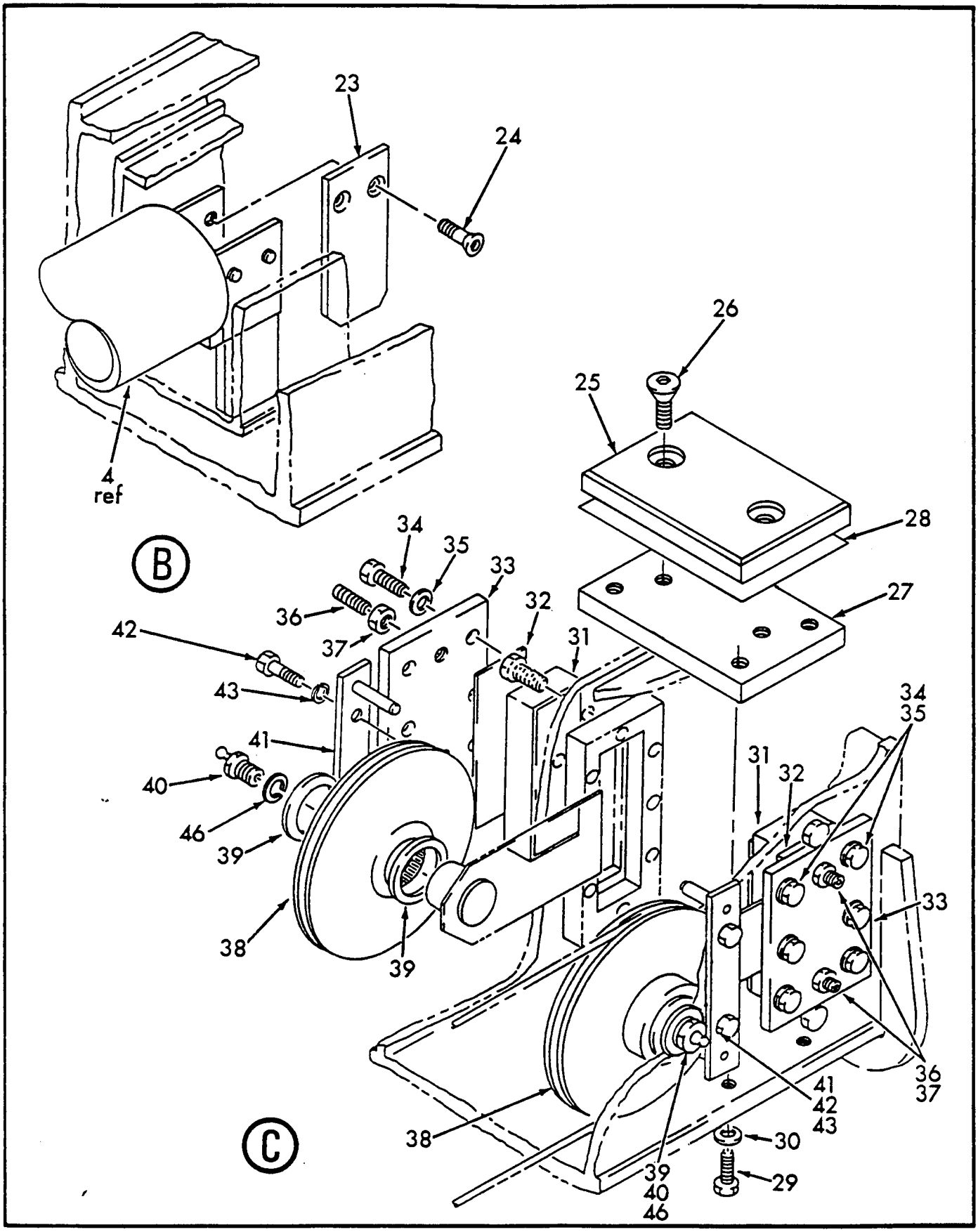
Note: 21933 superceded by SKP-0435 Plastitrak, Gleason Reel
1. 21933-Mark Track, Superceded by
2. SKP-0435 Plastitrak, Gleason Reel Type 1023 Superceded by
3. 23824-Power Trak, Gleason Series-P type 162P-11-1.9 Color Blue

INNER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)



REV.

INNER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)



INNER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)

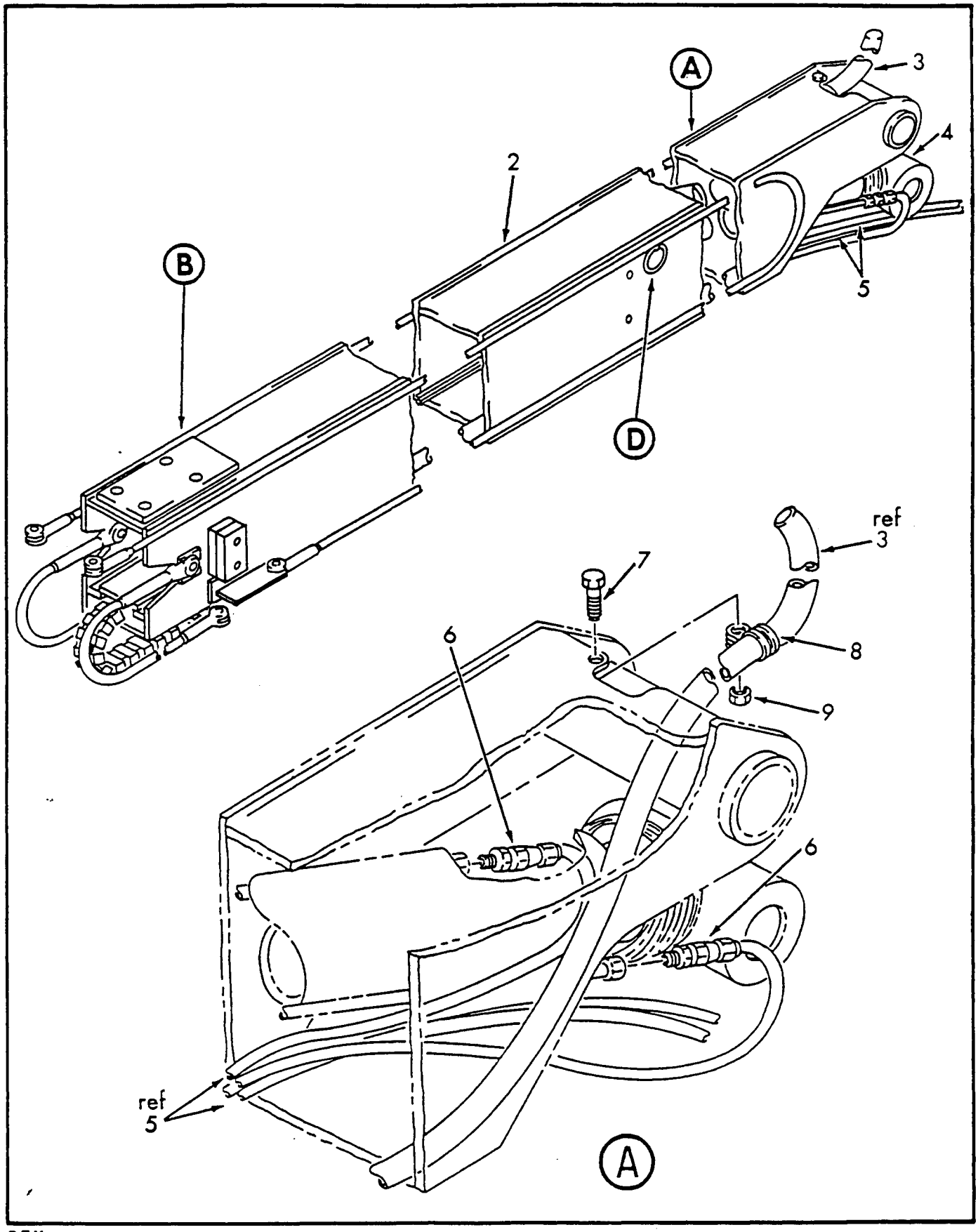
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24312	SUB-ASSEMBLY, INNER/INTERMEDIATE BOOM (See Sect. 5, Fig. 2A for NHA)	REF
2	24076	.MACHINING, INTERMEDIATE BOOM	1
3	24313	.SUB-ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 4 for Details)	1
4	24329	.ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 5A for Details)	1
5	24231	.PIN, TRUNNION	2
6	62229	.SCREW, SET	3
7	23204	.PAD, WEAR	1
8	61822	.SCREW, FLAT SOCKET HEAD CAP	4
9	22567	.PAD, WEAR	2
10	61801	.SCREW, FLAT SOCKET HEAD CAP	4
11	24222	.ASSEMBLY, CABLE SHEAVE (See Sect. 5, Fig. 7A for Details)	2
12	65534	.WASHER, THRUST	4
13	24221	.PIN, CABLE SHEAVE	2
14	60553	.SCREW, CAP	2
15	63302	.WASHER, LOCK	2
16	65103	.FITTING, GREASE	2
17	24223	.PAD, WEAR	2
18	61805	.SCREW, FLAT SOCKET HEAD CAP	4
19	24474	.WELDMENT, CABLE KEEPER	2
20	60527	.SCREW, CAP	4
21	63302	.WASHER, LOCK	4
22	24510	.ASSEMBLY, PLASTITRAK SUPPORT ROLLER (See Sect. 5, Fig. 8 for Details)	1
23	24400	.PAD, WEAR	2

INNER/INTERMEDIATE BOOM SUB-ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	21805	.SCREW, FLAT SOCKET HEAD CAP	4
25	23206	.PAD, WEAR	1
26	61801	.SCREW, FLAT SOCKET HEAD CAP	2
27	23207	.SUPPORT, WEAR PAD	1
28	23620	.SHIM	1
29	60325	.SCREW, CAP	4
30	63303	.WASHER, LOCK	4
31	23200	.PAD, WEAR	2
32	20453	.PLATE, PAD PRESSURE	2
33	21321	.PLATE, WEAR PAD COVER	2
34	60541	.SCREW, CAP	12
35	63303	.WASHER, LOCK	12
36	62204	.SCREW, SET	4
37	61101	.NUT, JAM	4
38	24222	.ASSEMBLY, CABLE SHEAVE (See Sect. 5, Fig. 7A for Details)	2
39	65534	.WASHER, THRUST	4
40	65103	.FITTING, GREASE	2
41	24474	.WELDMENT, CABLE KEEPER	2
42	60527	.SCREW, CAP	4
43	63302	.WASHER, LOCK	4
44	61931	.SCREW, BUTTON HEAD SOCKET CAP	4
45	63302	.WASHER, LOCK	4
46	65076	.RING, SNAP	2
47	24401	.ASSEMBLY, PLASTITRAK (See Sect. 5, Fig. 8A for Details)	1

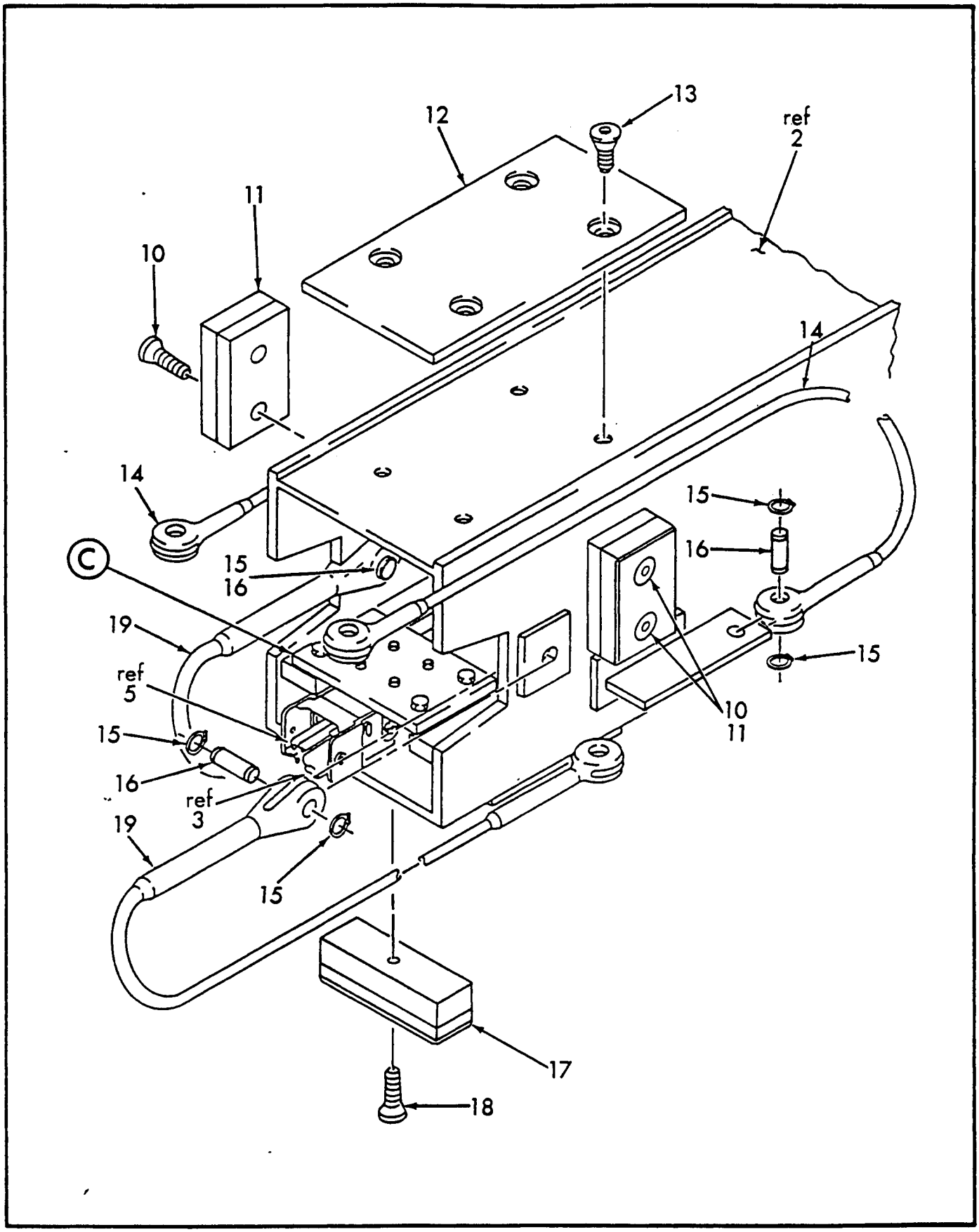
ITEM NOT ILLUSTRATED

INNER BOOM SUB-ASSEMBLY (100C 6X4)

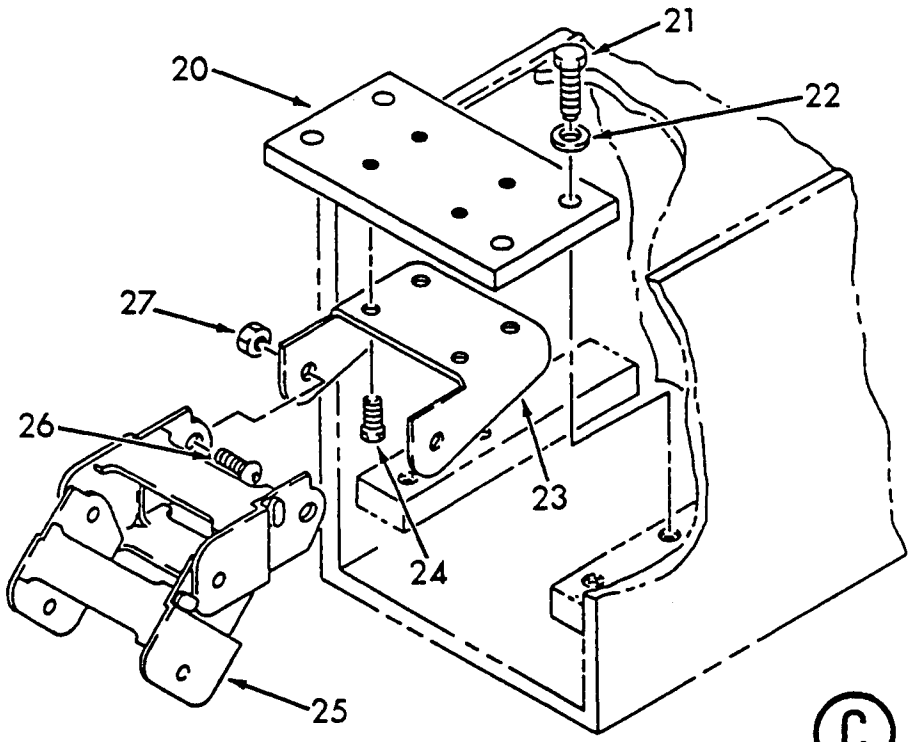


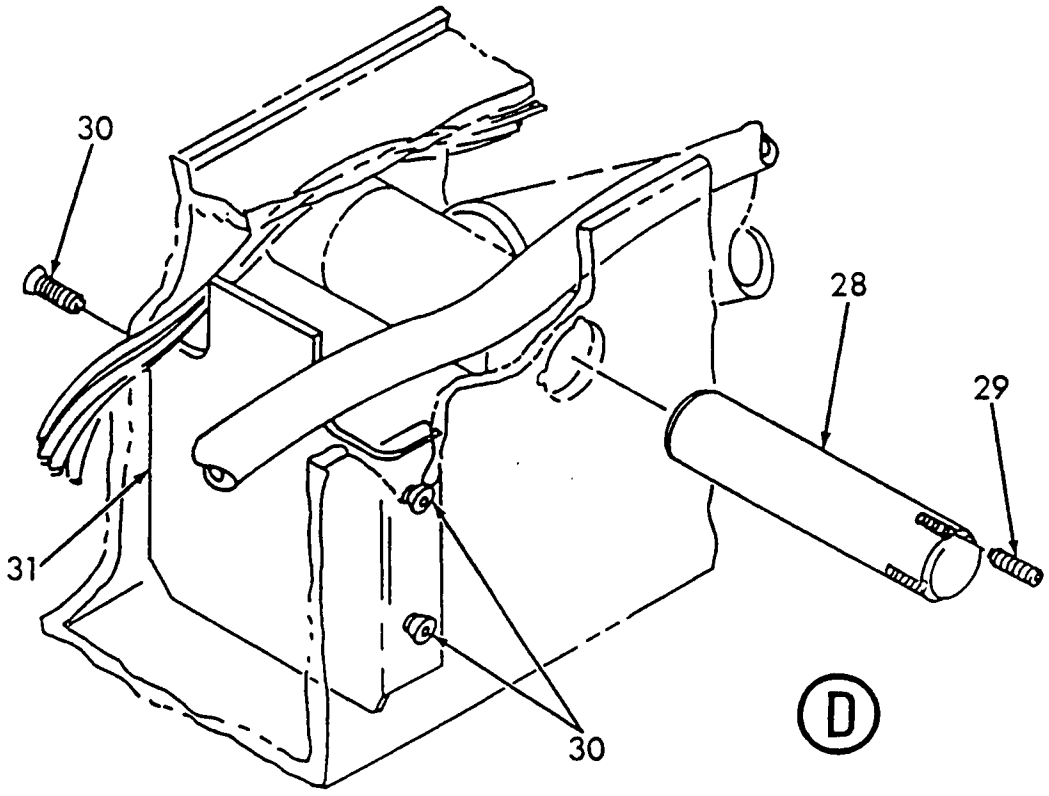
REV.

INNER BOOM SUB-ASSEMBLY (100C 6X4)



INNER BOOM SUB-ASSEMBLY (100C 6X4)





REV.

INNER BOOM SUB-ASSEMBLY (100C 6X4)

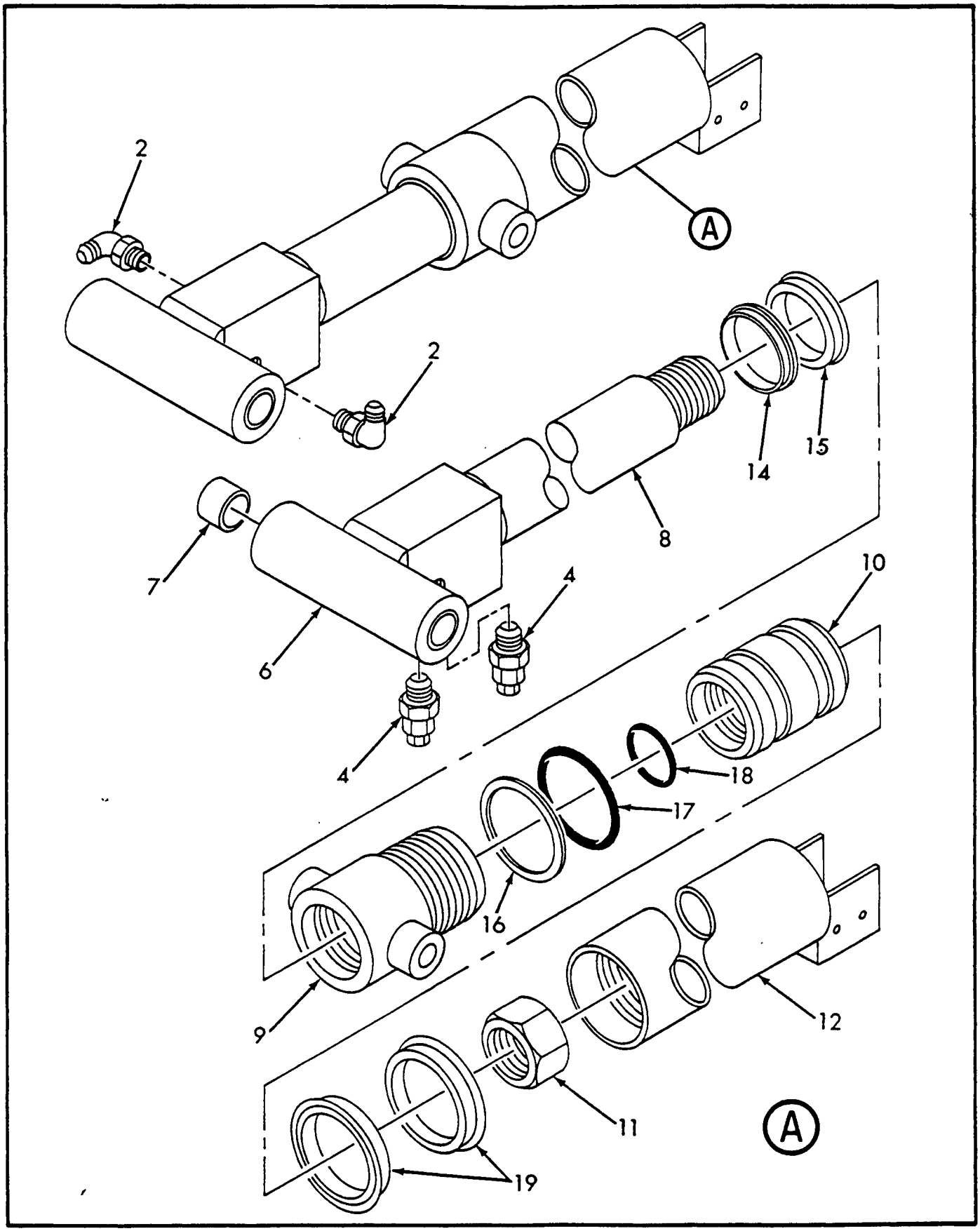
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24313	ASSEMBLY, INNER BOOM SUB-ASSEMBLY (See Sect. 5, Fig. 3A for NHA)	REF
2	24078	.MACHINING, INNER BOOM	1
3	20802	.CABLE, ELECTRICAL (155 FT.)	1
4	21094	.ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 6 for Details)	1
5	2568	.HOSE, HYDRAULIC (150 FT.)	1
6	2562	.FITTING, STRAIGHT SWIVEL	2
7	60309	.SCREW, CAP	1
8	16268	.CLAMP, HOSE	1
9	60711	.NUT, HEX	1
10	61805	.SCREW, FLAT SOCKET HEAD CAP	4
11	22569	.PAD, WEAR	2
12	23203	.PAD, WEAR	1
13	61822	.SCREW, FLAT SOCKET HEAD CAP	4
14	24399	.CABLE, EXTENSION	2
15	65082	.RING, SNAP	8
16	22703	.PIN, CABLE	4
17	23083	.PAD, WEAR	1
18	60403	.SCREW, FLAT SOCKET HEAD CAP	1
19	24398	.CABLE, RETRACTION	2
20	22730	.PLATE, PLASTITRAK MOUNTING	1
21	60322	.SCREW, CAP	4
22	63302	.WASHER, LOCK	4
23	23895	.BRACKET, MOVABLE PLASTITRAK	1
24	60543	.SCREW, CAP	4
25	23824	.TRACK, POWER	159 PCS

INNER BOOM SUB-ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	61931	.SCREW, BUTTON HEAD SOCKET CAP	2
27	61322	.NUT, LOCK	2
28	23218	.PIN, SLAVE LEVELING CYLINDER	1
29	62229	.SCREW, SET	2
30	61822	.SCREW, CAP	4
31	23214	.PLATE, BULKHEAD	1

- ITEM NOT ILLUSTRATED

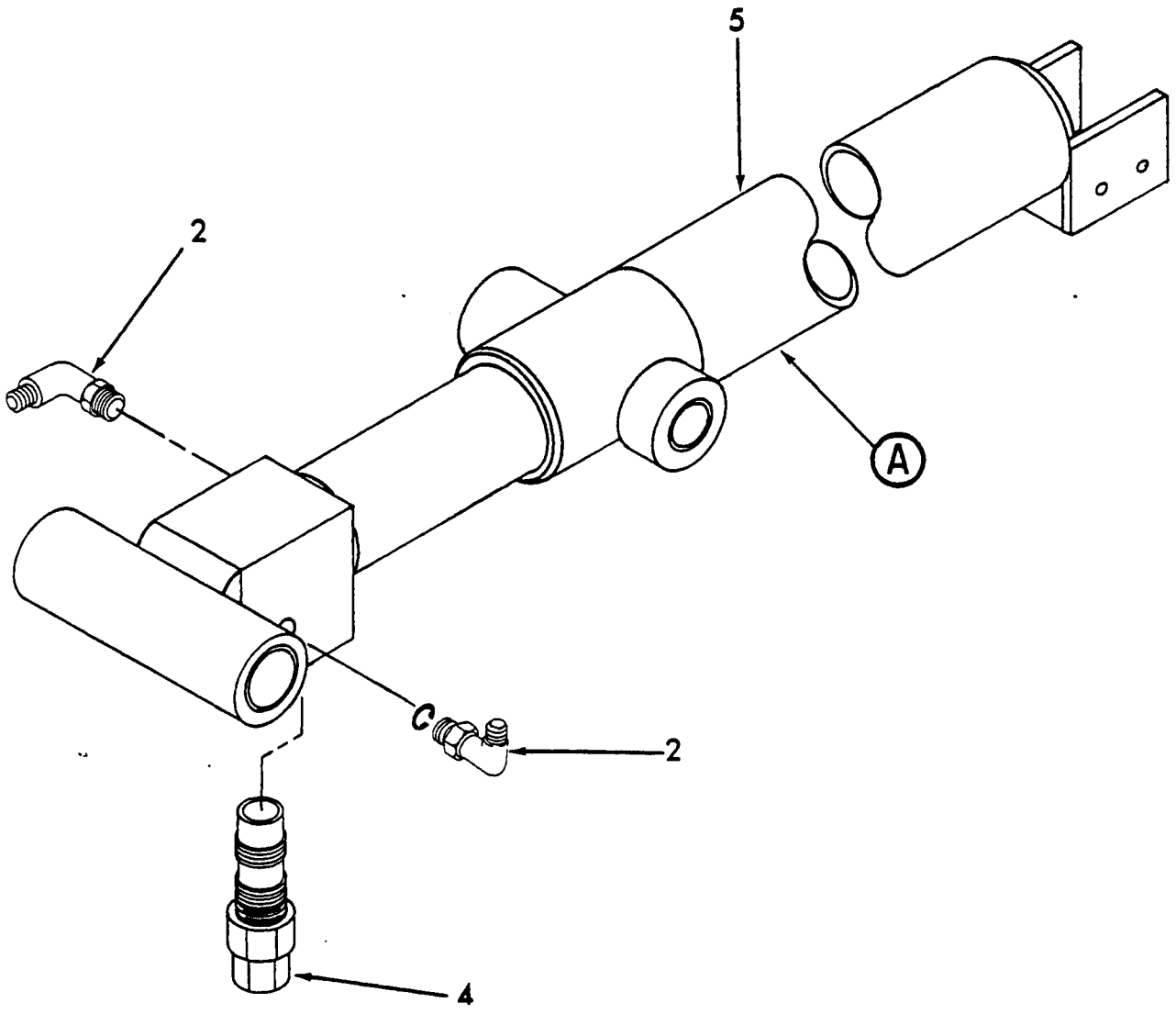
BOOM EXTENSION CYLINDER ASSEMBLY (80C 4X4 & 6X4)



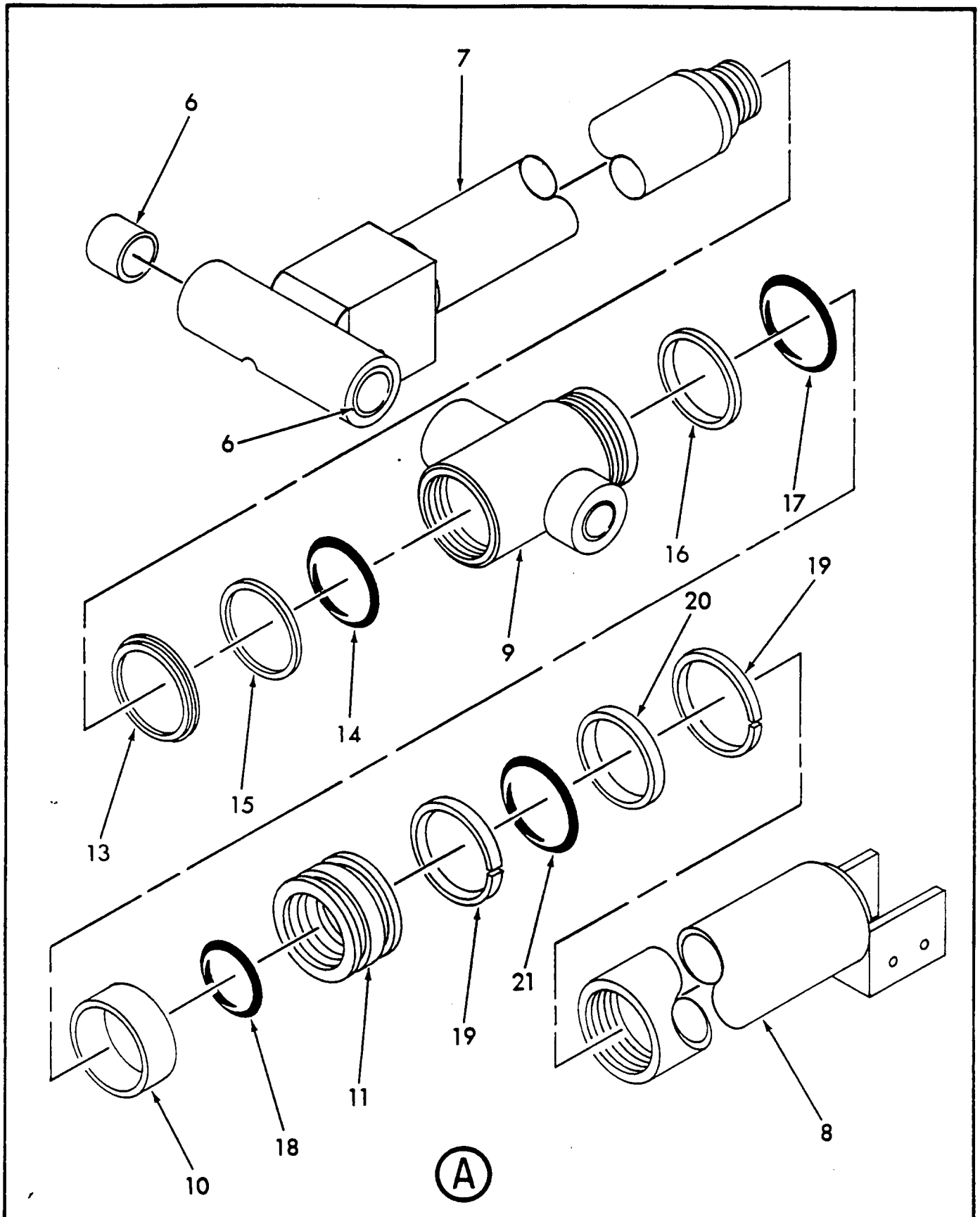
BOOM EXTENSION CYLINDER ASSEMLBY (80C 4X4 & 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	23836	ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 2 for NHA)	REF
2	80012-11	.ELBOW, STRAIGHT THREAD	2
-3	23835	.SUB-ASSEMBLY, BOOM EXTENSION CYLINDER	1
4	81006	..CARTRIDGE, OVER CENTER	2
-5	23825	..CYLINDER, BOOM EXTENSION	1
6		...END, ROD	1
7		...BUSHING, D.U.	2
8		...ROD	1
9		...NUT, GLAND	1
10		...PISTON	1
11		...NUT, LOCK	1
12		...BARREL	1
-13	67243	...KIT, SEAL	1
14		....WIPER, ROD	1
15		....SEAL, POLY-PAK	1
16		....RING, BACK-UP	1
17		....O-RING	1
18		....O-RING	1
19		...SEAL, POLY-PAK	2

BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)



BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)

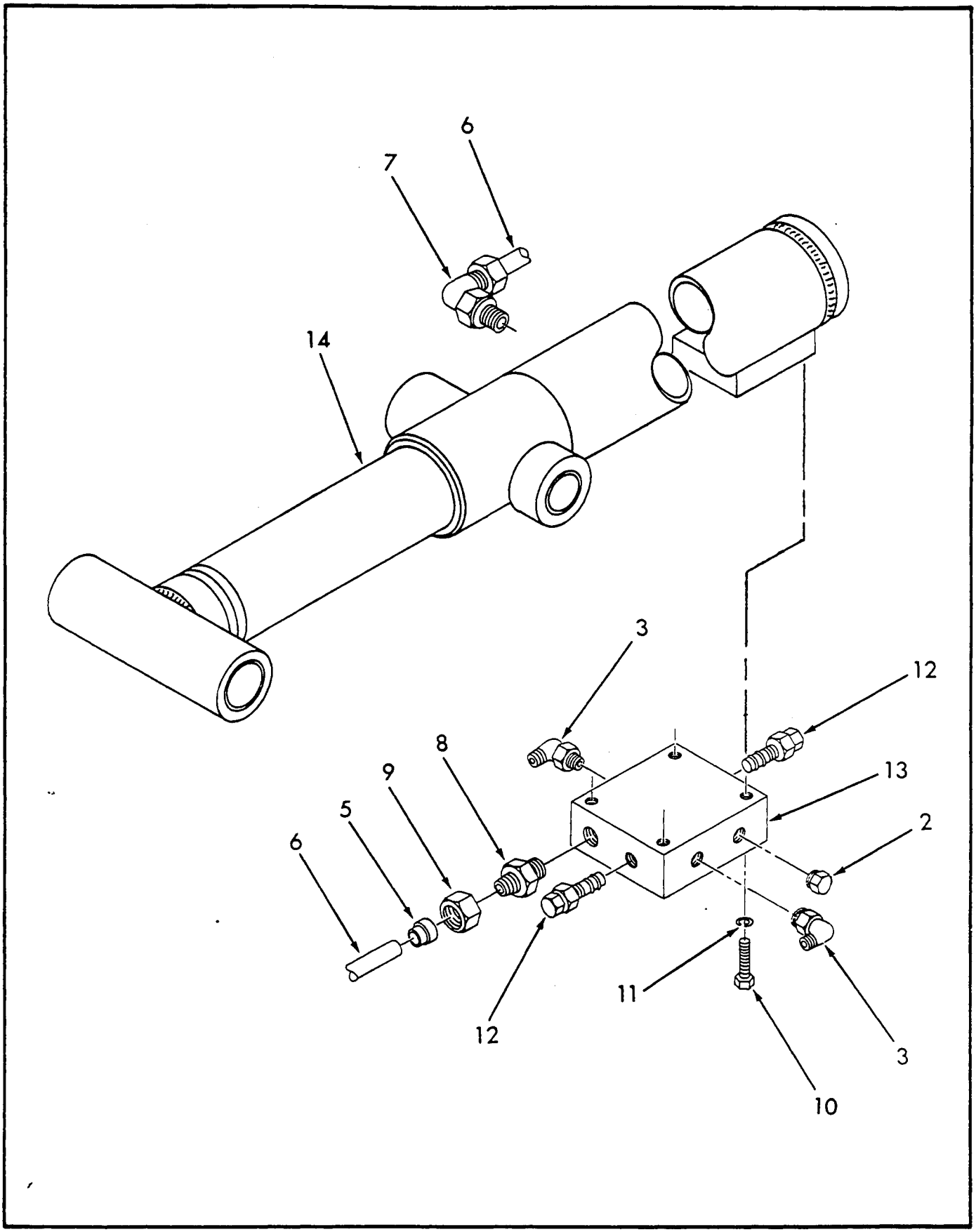


BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24329	ASSEMBLY, BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 3A for NHA)	REF
2	80012-11	.ELBOW, STRAIGHT THREAD	2
-3	24326	.SUB-ASSEMBLY, BOOM EXTENSION CYLINDER	1
4	81006	..CARTRIDGE, OVERCENTER	2
5	24325	..CYLINDER, BOOM EXTENSION	1
6		...BUSHING	2
7		...ROD	1
8		...BARREL	1
9		...HEAD	1
10		...TUBE, STOP	1
11		...PISTON	1
-12	67131	...KIT, SEAL	1
13		....WIPER, ROD	1
14		....O-RING	1
15		....SEAL, STEP	1
16		....B/U RING, HEAD	1
17		....O-RING, HEAD	1
18		....O-RING, STATIC	1
19		....RING, WEAR	2
20		....SEAL, PISTON	1
21		....RING, GLYD	1

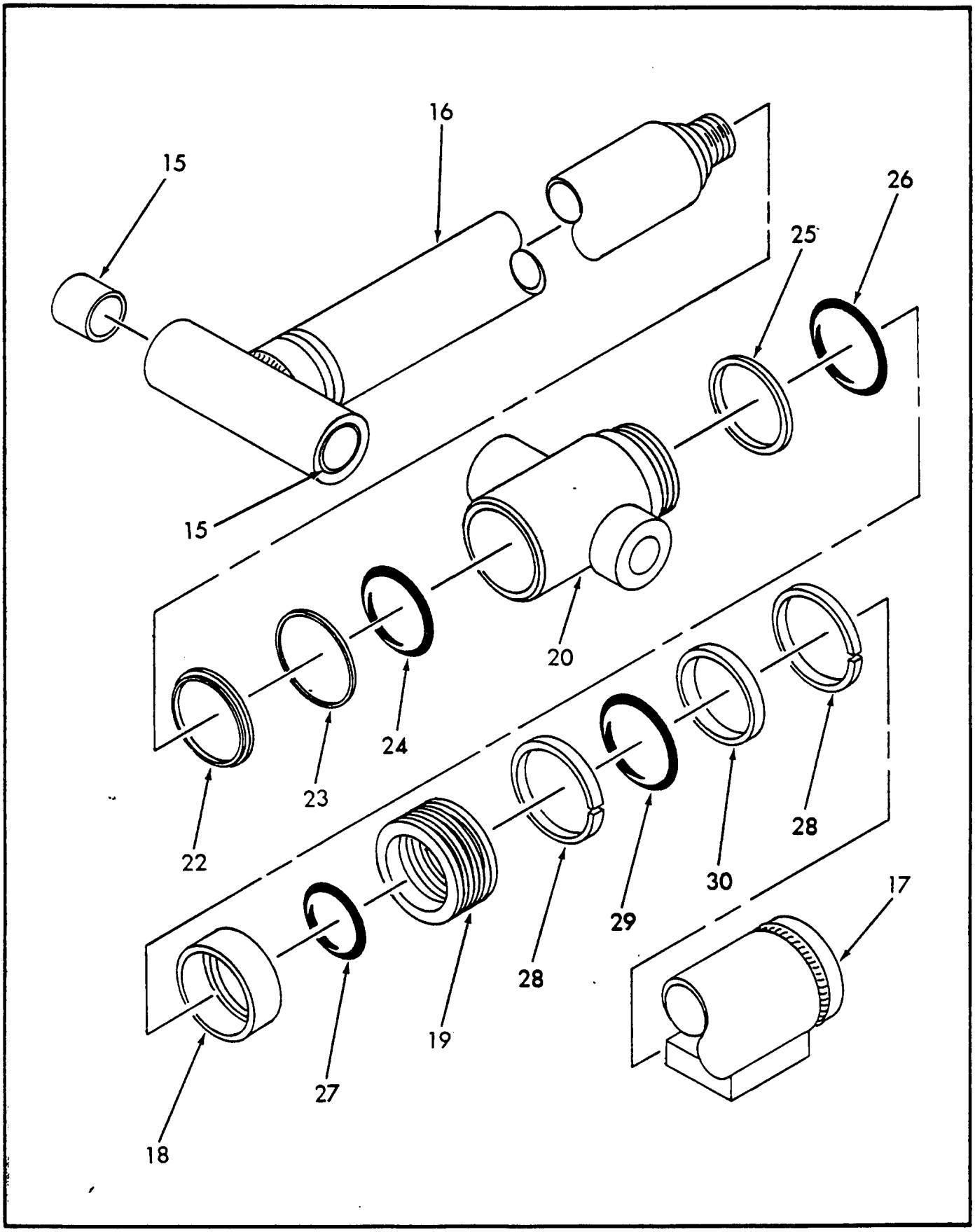
- ITEM NOT ILLUSTRATED

OUTSIDE BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)



REV.

OUTSIDE BOOM EXTENSION CYLINDER ASSEMBLY (100C 6X4)



OUTSIDE BOOM EXTENSION CYLINDER (100C 6X4)

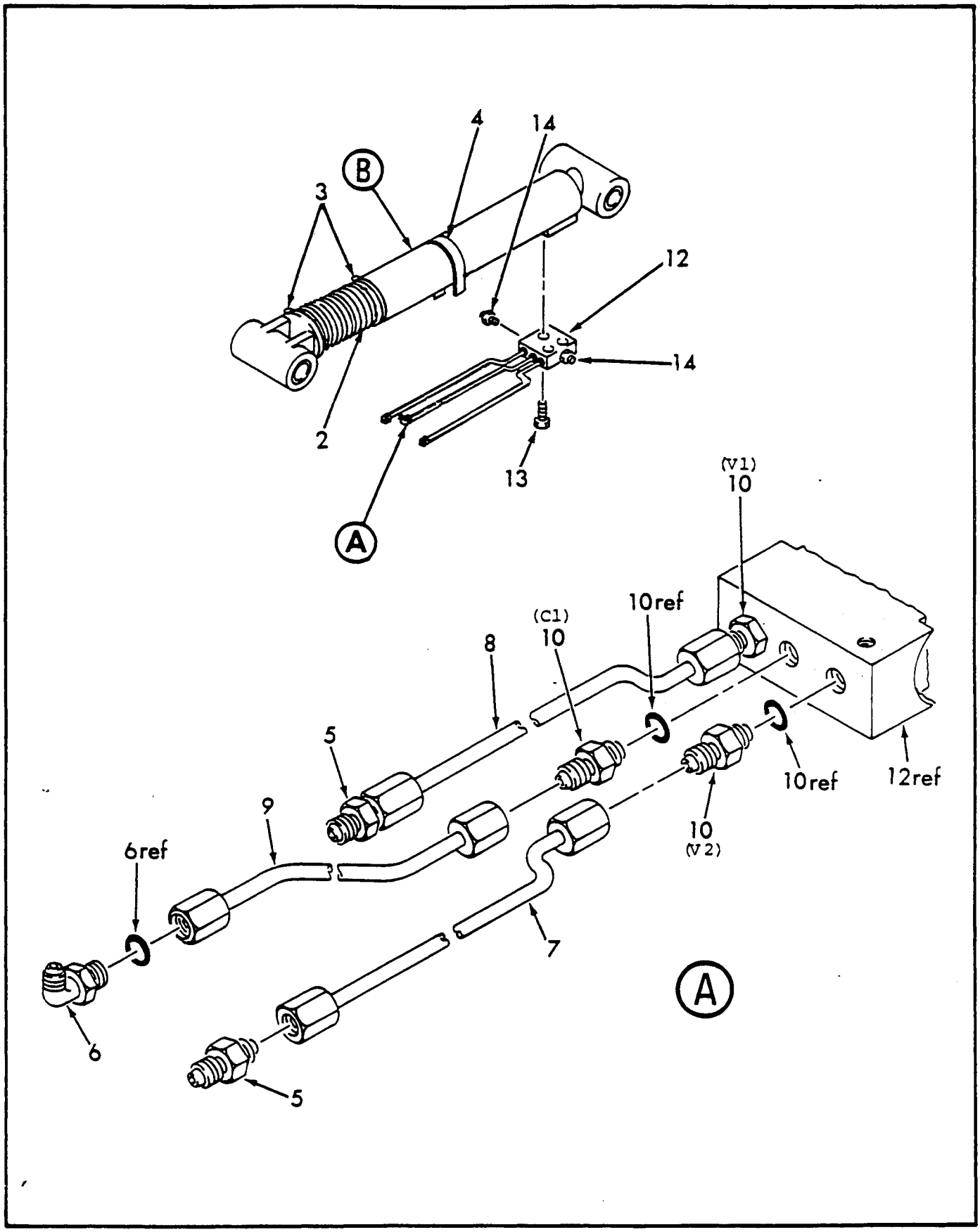
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24328	ASSEMBLY, OUTSIDE BOOM EXTENSION CYLINDER (See Sect. 5, Fig. 1A for NHA)	REF
2	80050-03	.PLUG, HEX HEAD STRAIGHT THREAD	1
3	80012-11	.ELBOW, STRAIGHT THREAD	2
-4	24327	.SUB-ASSEMBLY, OUTSIDE EXTENSION CYLINDER	1
5	80062-08	..SLEEVE	2
6	27735	..TUBING, HYDRAULIC	1
7	80012-19	..ELBOW, STRAIGHT THREAD	1
8	80004-19	..CONNECTOR, STRAIGHT THREAD	1
9	80060-06	..NUT	2
10	61820	..SCREW, CAP	4
11	63302	..WASHER, LOCK	4
12	81006	..CARTRIDGE, OVERCENTER	2
13	21445	..VALVE BLOCK, BOOM CYLINDER	1
14	24323	..CYLINDER, OUTSIDE EXTENSION	1
15		...BUSHING	2
16		...ROD	1
17		...BARREL	1
18		...TUBE, STOP	1
19		...PISTON	1
20		...HEAD	1
-21	67131	...KIT, SEAL	1
22		....WIPER, ROD	1
23		....SEAL, STEP	1
24		....O-RING	1
25		....B/U RING, HEAD	1

OUTSIDE BOOM EXTENSION CYLINDER (100C 6X4)

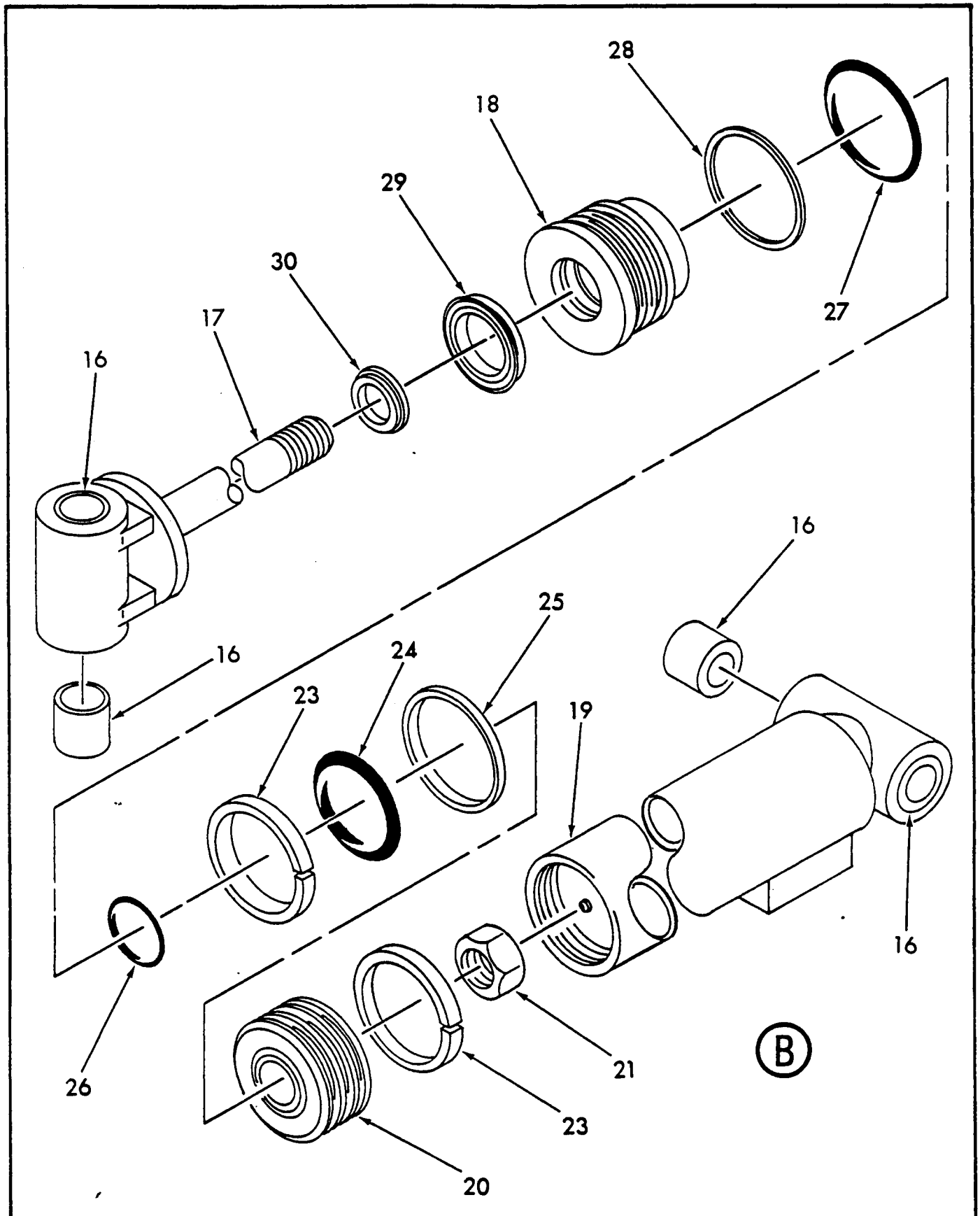
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26		....O-RING, HEAD	1
27		....O-RING, STATIC	1
28		....RING, WEAR	2
29		....SEAL, PISTON	1
30		....RING, GLYD	1

- ITEM NOT ILLUSTRATED

SLAVE LEVELING CYLINDER ASSEMBLY (ALL MODELS)



SLAVE LEVELING CYLINDER ASSEMBLY (ALL MODELS)



SLAVE LEVELING CYLINDER ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	21094	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 3 or 4 for NHA)	REF
2	21388	.TUBING, CONVOLUTED	1
3	16318	.CLAMP	2
4	16206	.STRAP	1
5	80042-03	.CONNECTOR, UNION	2
6	80012-03	.ELBOW, STRAIGHT THREAD	1
7	21094-8	.ASSEMBLY, TUBE	1
8	21094-9	.ASSEMBLY, TUBE	1
9	21094-10	.ASSEMBLY, TUBE	1
10	80004-03	.CONNECTOR, STRAIGHT THREAD (V1, V2, C1)	3
-11	21263	.SUB-ASSEMBLY, SLAVE LEVELING CYLINDER	1
12	21447	..BLOCK, MANIFOLD	1
13	61903	..CAPSCREW	3
14	21267	..CARTRIDGE, OVERCENTER	2
15	21197	..CYLINDER, SLAVE LEVELING	1
16		...BUSHING	4
17		...ROD	1
18		...NUT, GLAND	1
19		...BARREL	1
20		...PISTON	1
21		...NUT	1
-22	67040	...KIT, SEAL (SE) (S PISTON RING)(SINCE EARLY 1987)	1
	66045	...KIT, SEAL (SE)(POLYPAK)(TO EARLY 1987)	
	66563	...KIT, SEAL (RA)(O-RING)(TO EARLY 1987)	
23		....RING, SLYD	2

REV

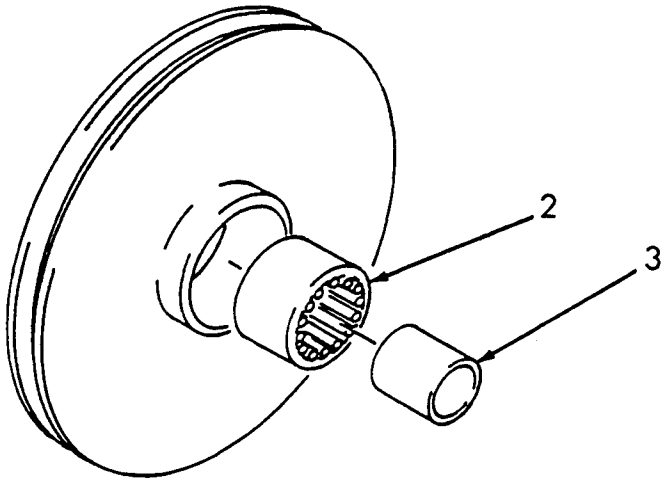
- ITEM NOT ILLUSTRATED

SLAVE LEVELING CYLINDER ASSEMBLY (ALL MODELS)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24		....O-RING, B/U	1
25		....RING, GLYD	1
26		....O-RING, STATIC	1
27		....O-RING, GLAND NUT	1
28		....B/U RING, GLAND NUT	1
29		....SEAL, ROD (POLYPAK)	1
30		....WIPER, ROD	1
		NOTE: SEAL KIT ITEMS ILLUSTRATED ARE FOR SEAL KIT PART NO. 67040.	

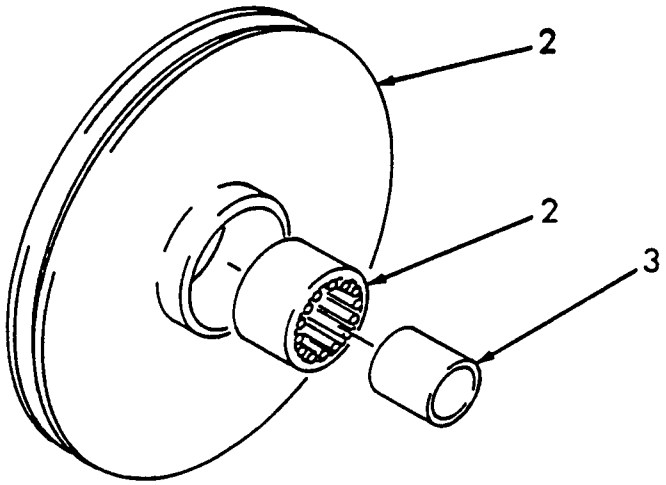
- ITEM NOT ILLUSTRATED

CABLE SHEAVE ASSEMBLY (80C 4X4 & 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	22705	ASSEMBLY, CABLE SHEAVE (See Sect. 5, Fig. 2 for NHA)	REF
2	65064	.ASSEMBLY, OUTER RING AND ROLLER	1
3	65063	.RING, INNER	1

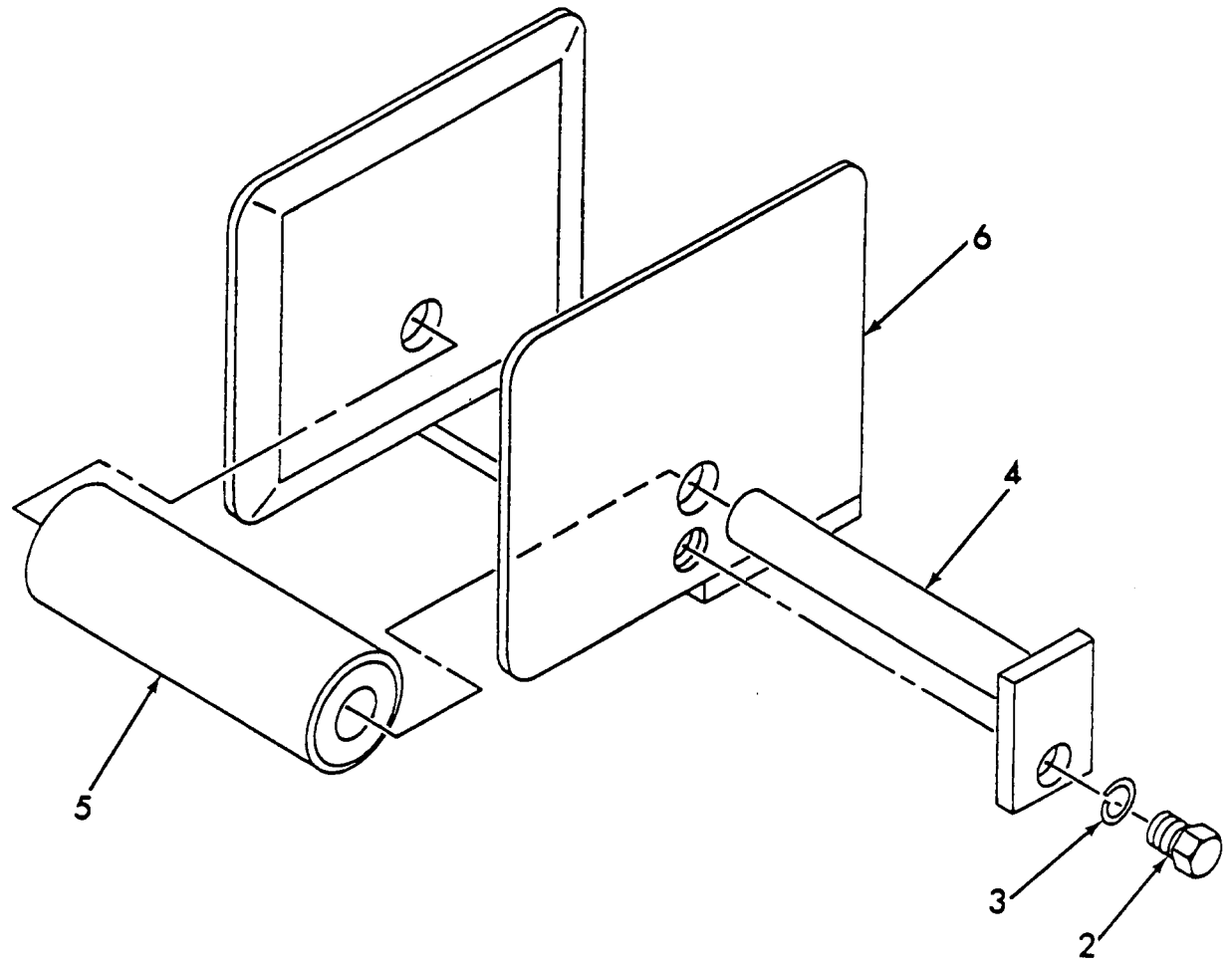
CABLE SHEAVE ASSEMBLY (100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24222	ASSEMBLY, CABLE SHEAVE (See Sect. 5, Fig. 3A for NHA)	REF
2	65064	.RING, OUTER	1
3	65063	.RING, INNER	1

REV.

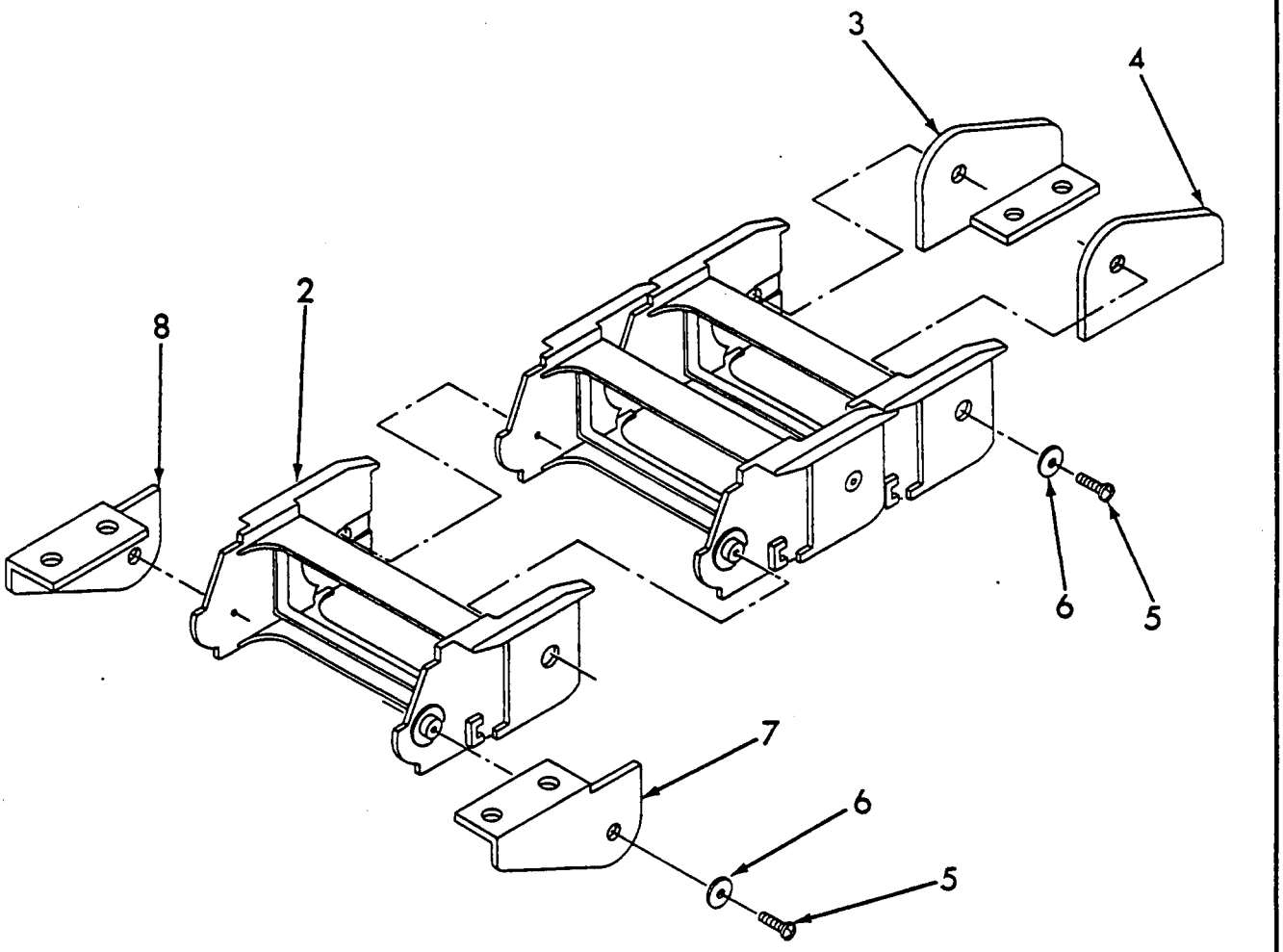
PLASTITRAK SUPPORT ROLLER ASSEMBLY (ALL MODELS)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24510	ASSEMBLY, PLASTITRAK SUPPORT ROLLER (See Sect. 5, Fig. 2 or 2A for NHA)	REF
2	60324	.SCREW, CAP	1
3	63302	.WASHER, LOCK	1
4	22716	.PIN, PLASTITRAK ROLLER	1
5	24508	.ROLLER, PLASTITRAK	1
6	24509	.WELDMENT, ROLLER BRACKET	1

REV.

PLASTITRAK ASSEMBLY (100C 6X4)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	24401	ASSEMBLY, PLASTITRAK (See Sect. 5, Fig. 1A for NHA)	REF
2	24403	.PLASTITRAK	60
3	22126	.BRACKET, L.H.-PLASTITRAK STATIONARY	1
4	22128	.BRACKET, R.H.-PLASTITRAK STATIONARY	1
5	22165	.SCREW	4
6	22164	.WASHER, PLASTIC	4
7	22129	.BRACKET, R.H.-PLASTITRAK MOVABLE	1
8	22093	.BRACKET, L.H.-PLASTITRAK MOVABLE	1

REV.

SECTION 6 CONTAINS:

FIG. NO.	TITLE	PART NO. (80C 4X4)	PART NO. (80C 6X4)	PART NO. (100C 6X4)
1	DUAL FUEL	23391	23391	*23391
2	TRAVEL WARNING HORN	20108	20108	20108
3	ALL MOTION ALARM	23392	23392	23392
4	ROTATING BEACON	20107	20107	20107
5	(2) HEADLIGHTS & (2) REAR RED LIGHTS	20078	20078	20078
6	STOP, TURN & CLEARANCE LIGHTS	20106	20106	20106
7	12 VOLT PLATFORM WORK LIGHT	20139	20139	20139
8	½" AIRLINE TO PLATFORM	23374	23374	23381
9	½" HYDRAULIC LINE TO PLATFORM	23376	23376	23382
10	SPARK ARRESTOR MUFFLER	22253	22253	22253
11	CATALYTIC CONVERTER	23335	23335	23335
12	2000 WATT GENERATOR	23396	23396	23396
13	2500 WATT GENERATOR	20330	20330	20330
14	HOSTILE ENVIRONMENT PACKAGE	23398	23398	23397
15	TOW PACKAGE (8 MPH "IN-PLANT")	22277	22277	22277
16	F3L912 DEUTZ DIESEL ENGINE	23347	23347	STD
17	NISSAN DIESEL ENGINE	23406	23407	23408
18	65 HP WISCONSIN GAS ENGINE	STD	STD	23444
-	5' PLATFORM	24149	24149	24149
-	6' PLATFORM	24150	24150	24150
-	8' PLATFORM	23359	23359	23359
-	10' PLATFORM			
	PARTS & SERVICE MANUAL	17125	17125	17125

- OPTION NOT ILLUSTRATED

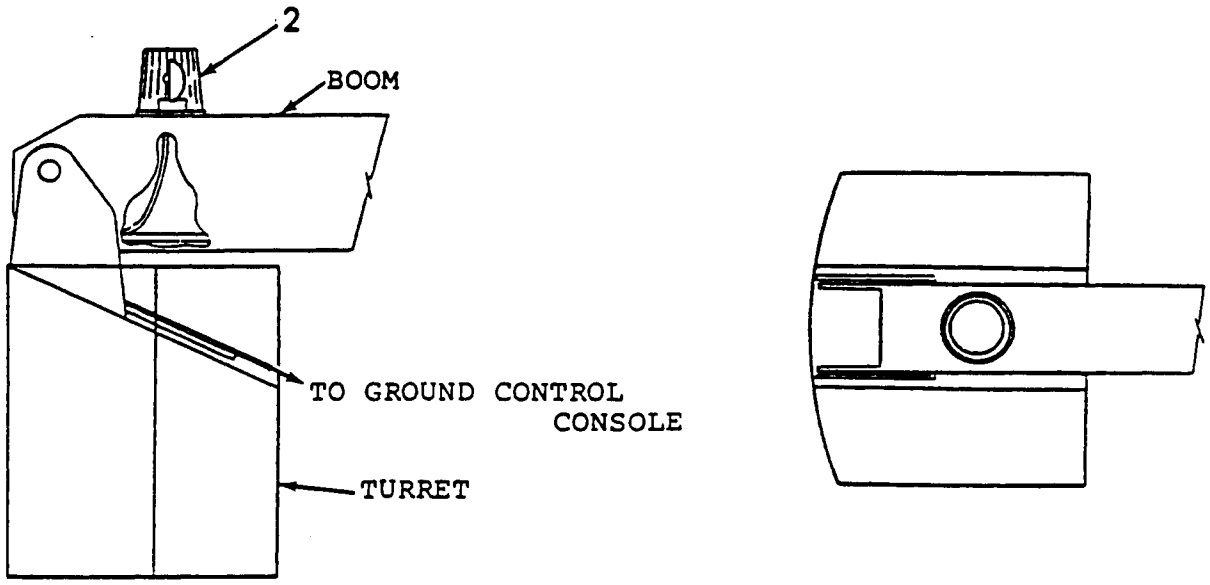
*ONLY W/65 HP AIR COOLED ENGINE

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ROTATING BEACON

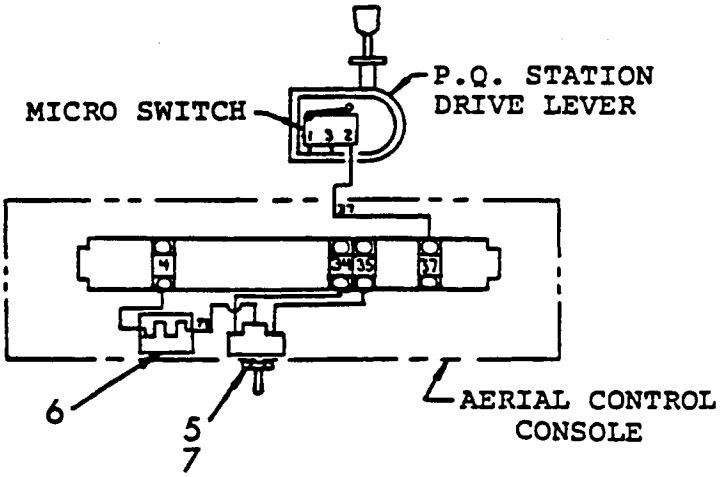


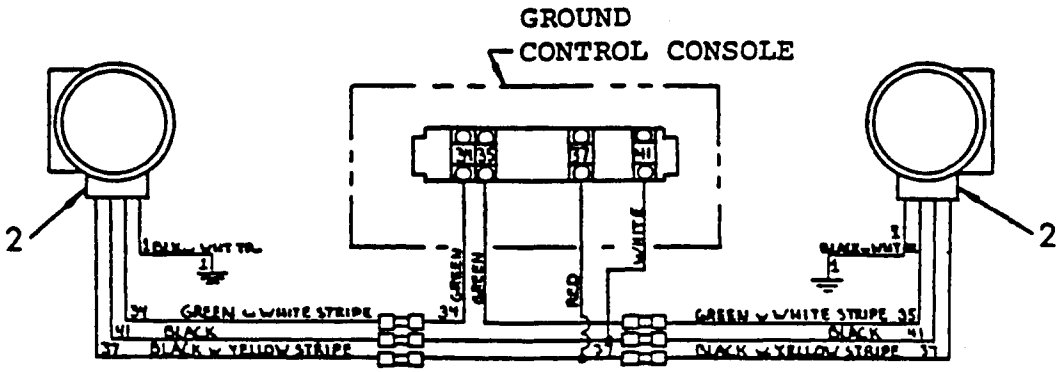
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20107	.INSTALLATION, ROTATING BEACON	REF
2	20863	.BEACON, ROTATING (YELLOW, RED OR BLUE)	1

REV.

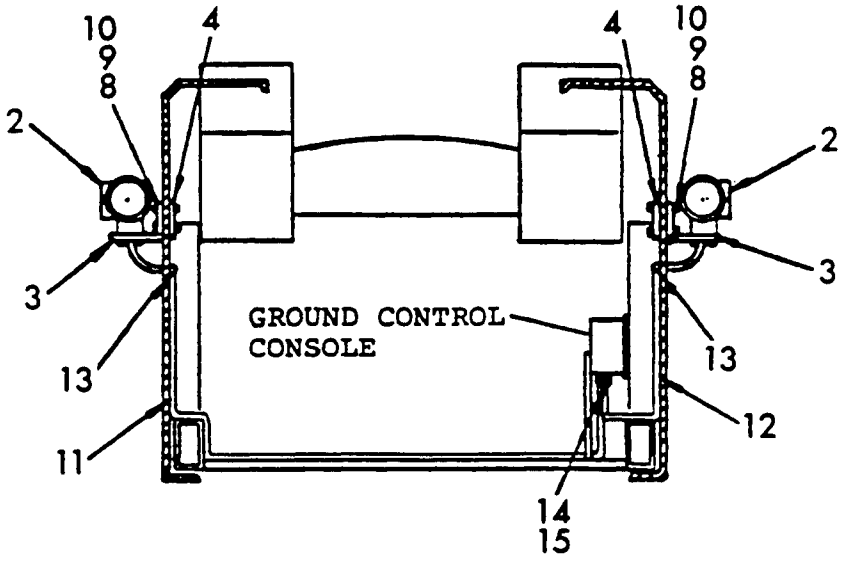
(2) HEADLIGHTS & (2) REAR RED LIGHTS

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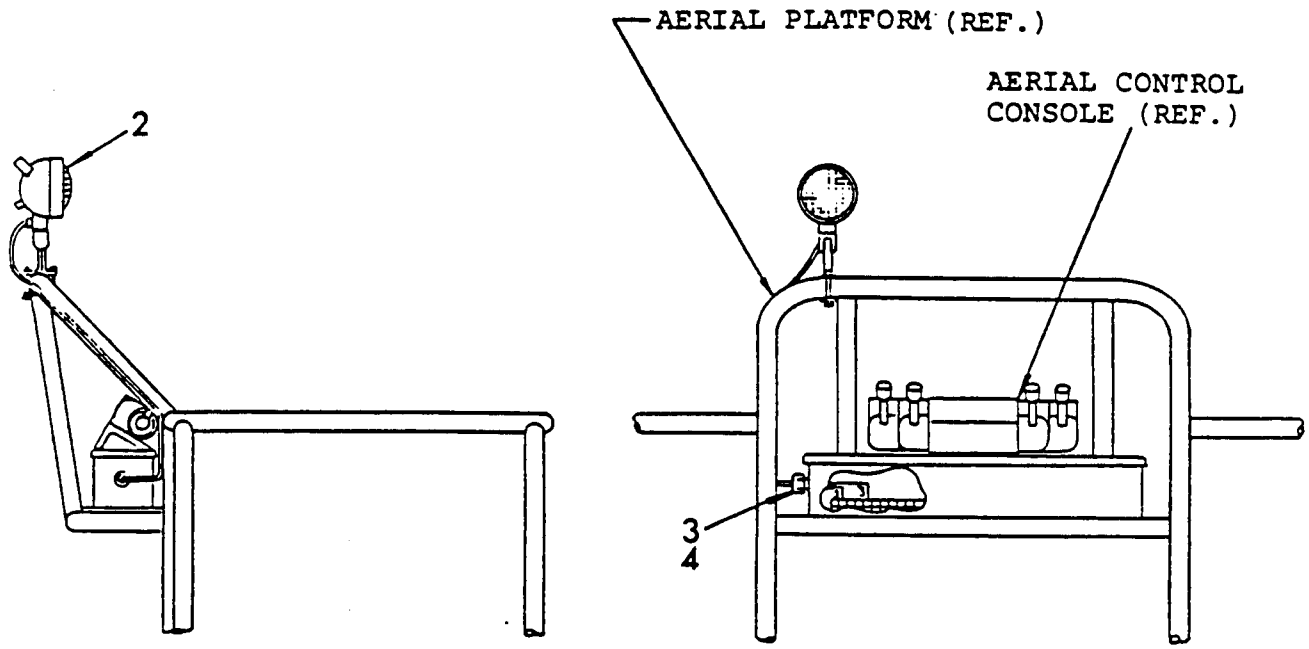
ELECTRICAL DIAGRAM



STOP, TURN & CLEARANCE LIGHTS

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	20106	.LIGHTS, STOP TURN & CLEARANCE	REF
2	20838	.LIGHT, CLEARANCE	2
3	20864	.BRACKET, MOUNTING	2
4	20865	.PLATE, BACK-UP	2
5	4019	.SWITCH, TOGGLE	1
6	448-A	.FLASHER	2
7	20866	.DECAL, TURN INDICATOR	1
8	60331	.SCREW, HEX HEAD	4
9	60703	.NUT, HEX	4
10	63303	.WASHER, SPLIT LOCK	4
11	2912	.CABLE (18AWG 4 COND X A/R)	1
12	2912	.CABLE (18AWG 4 COND X A/R)	1
13	117-0	.CONNECTOR, BUTT	8
14	2806	.RELIEF, STRAIN	2
15	2808	.NUT, LOCK	2

12 VOLT PLATFORM WORKLIGHT



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

REV.

½" AIRLINE TO PLATFORM (80C 4X4 & 6X4)

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THIS SECTION 6 - OPTION ASSEMBLY
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½" HYDRAULIC LINE TO PLATFORM (80C 4X4 & 6X4)

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½" HYDRAULIC LINE TO PLATFORM (100C 6X4)

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SPARK ARRESTER MUFFLER

THIS SECTION 6 - OPTION ASSEMBLY
PRINT NO. 22253
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THIS SECTION 6 - OPTION ASSEMBLY
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TOW PACKAGE (8 MPH "IN-PLANT")

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THIS SECTION 6 - OPTION ASSEMBLY
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THIS SECTION 6 - OPTION ASSEMBLY
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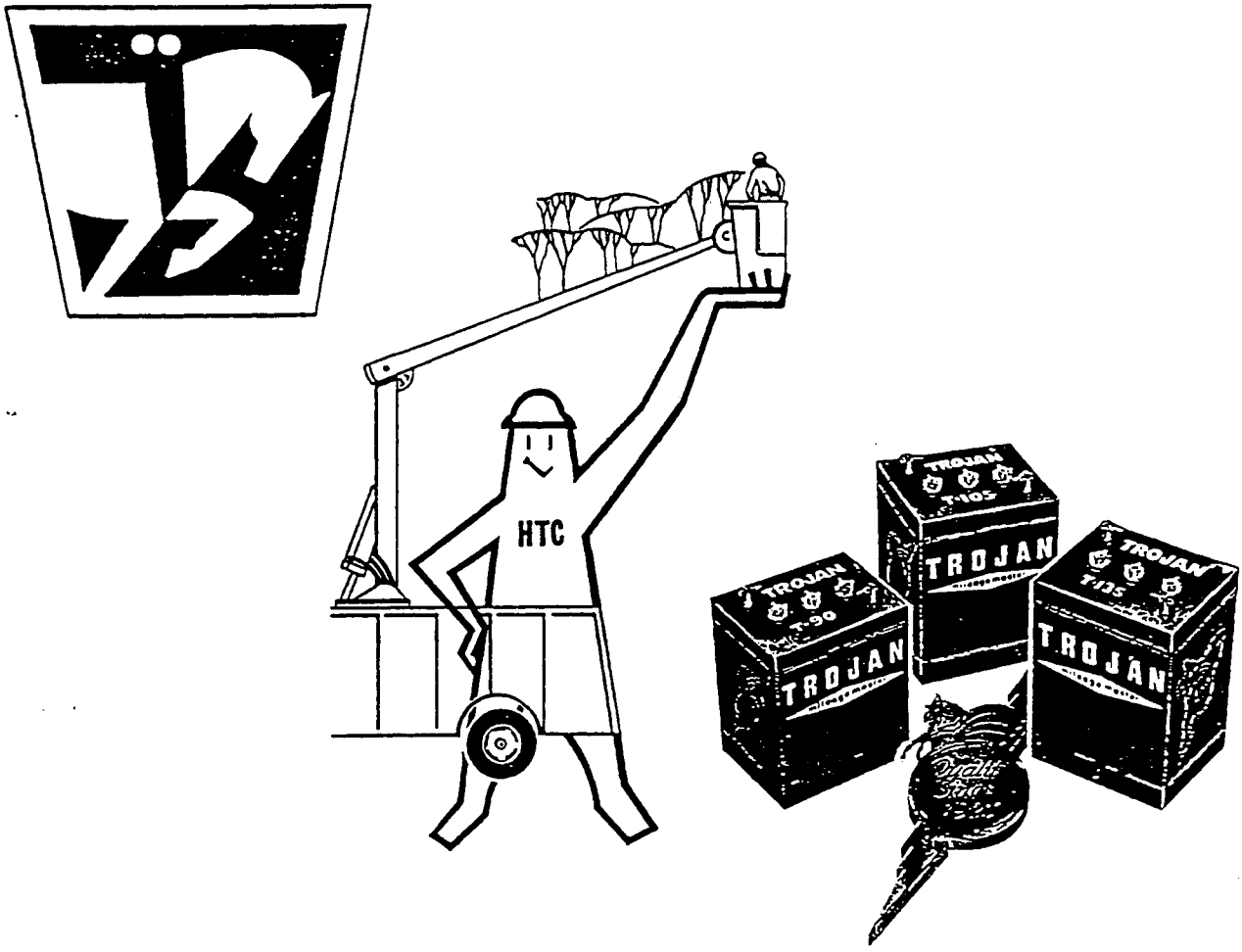
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THIS SECTION 6 - OPTION ASSEMBLY
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SECTION 7 CONTAINS:

PAGE NO.	TITLE
1	WISCONSIN ENGINE
15	HUNTER HYDRO-THROTTLE CONTROL
23	TROJAN BATTERY
27	FAIRFIELD TORQUE HUB - W3-P
43	FAIRFIELD TORQUE HUB - S1C
67	MICO MULTIPLE DISC BRAKE - SAE C
74	MICO MULTIPLE DISC BRAKE - SAE B
81	TRW TORQMOTOR
103	PULSAR, VP SERIES: PROPORTIONAL VALVE
119	MINI-PAK: SOLENOID OPERATED VALVE
125	HELAC PIVOT ROTARY ACTUATORS



STARTING and OPERATING INSTRUCTIONS

ISSUE MM-357

W I S C O N S I N

Air-Cooled Engines

Four Cylinder Engine Models

VH4D • VG4D • V-465D

TELEDYNE WISCONSIN MOTOR

WORLD'S FOREMOST SOURCE FOR HEAVY DUTY AIR COOLED ENGINES

INTRODUCTION

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

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

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

SPECIFICATIONS

MODEL VH4D

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

MODEL VG4D

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

MODEL V-465D

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

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

SAFETY PRECAUTIONS

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

NEW ENGINE Instructions

• LUBRICATION

Operating without oil will ruin engine.

IMPORTANT

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

Refer to *GRADE OF OIL* chart page 3, 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

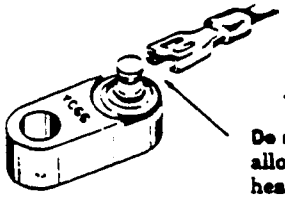
, if engine is equipped with STARTING MOTOR, DISTRIBUTOR IGNITION and FLYWHEEL ALTERNATOR, or GENERATOR.



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



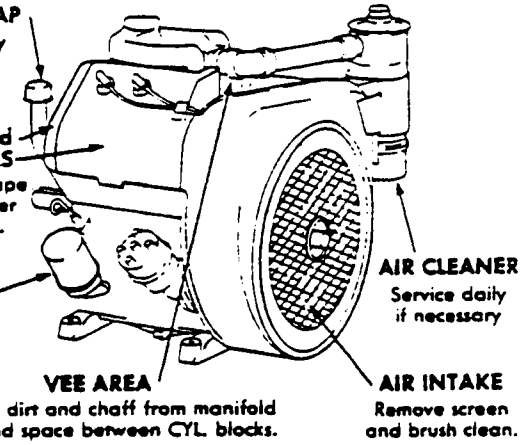
Temperature Safety Switch

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.

STARTING AND OPERATING INSTRUCTIONS

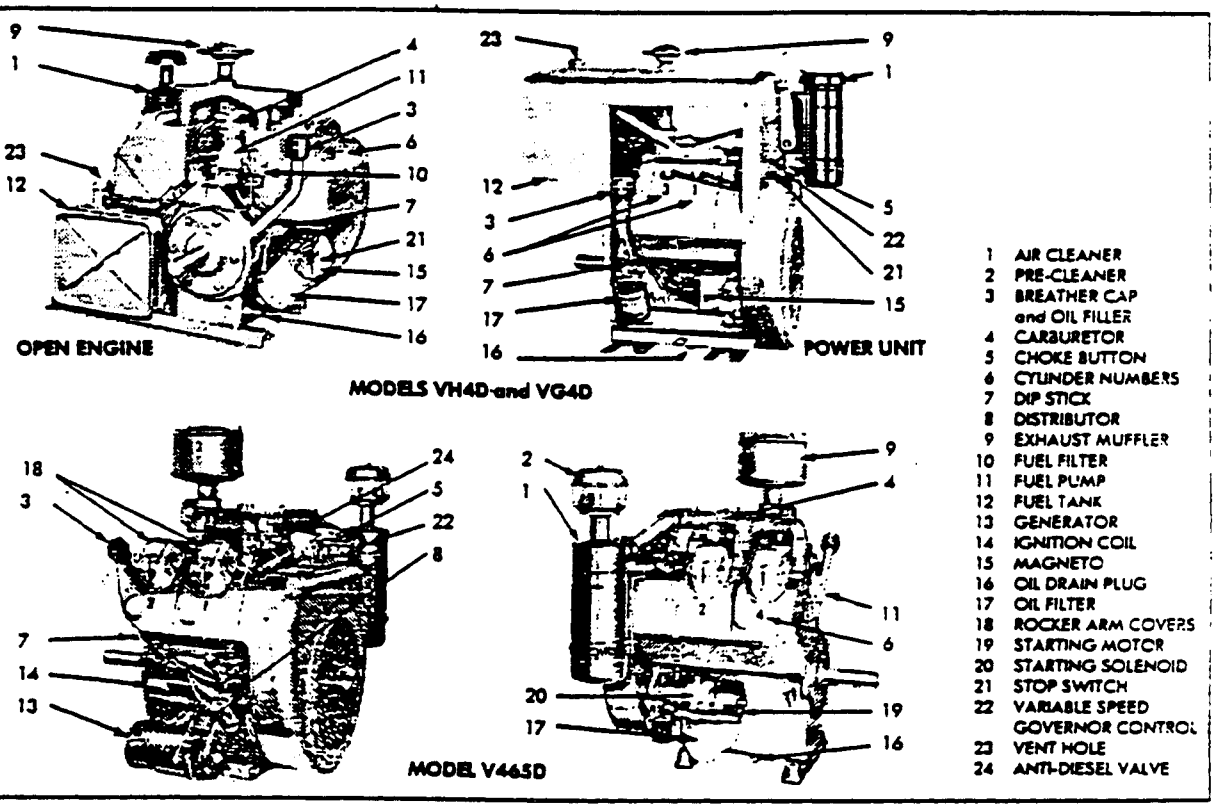


Fig. 1, REFERENCE VIEWS

GENERAL INFORMATION

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

COOLING

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

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

IGNITION

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

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

ROTATION

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

BEFORE STARTING NEW ENGINE

1. Fill tank with Regular grade gasoline.

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

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

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

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

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

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

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

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

GRADE OF OIL

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

Crankcase Capacity	VH4D	VG4D	V465D
New Engine	3½ qts.	4½ qts.	6 qts.
Oil and filter change	4 qts.	5 qts.	7 qts.
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.

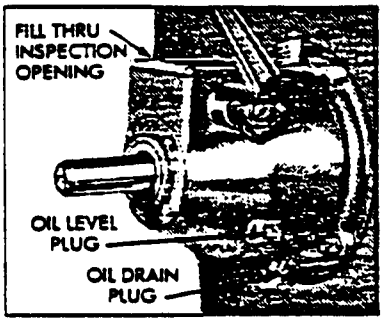


Fig. 2, VH4D
CLUTCH LUBRICATION

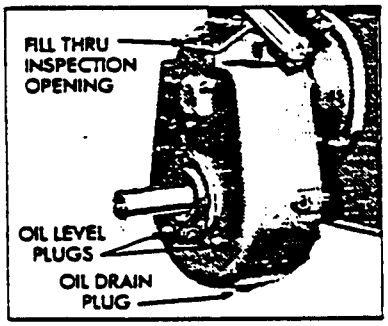


Fig. 3, VH4D
CLUTCH REDUCTION LUBRICATION

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

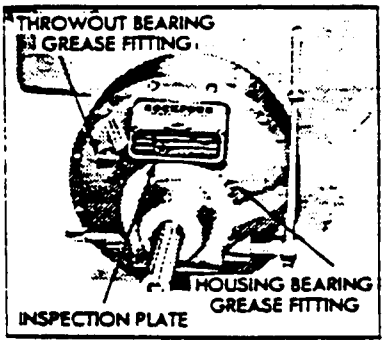


Fig. 4, VG4D, V465D
CLUTCH LUBRICATION

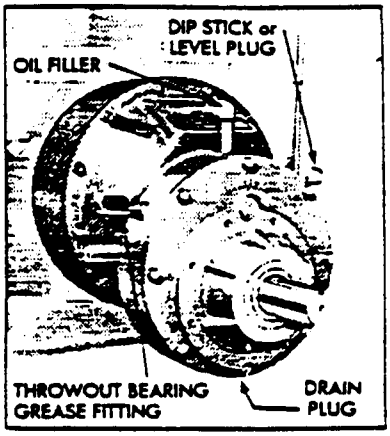


Fig. 5, VG4D, V465D
CLUTCH REDUCTION LUBRICATION

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.

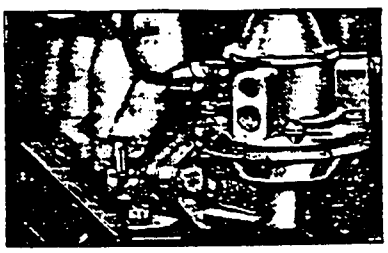


Fig. 6, FUEL PUMP PRIMER

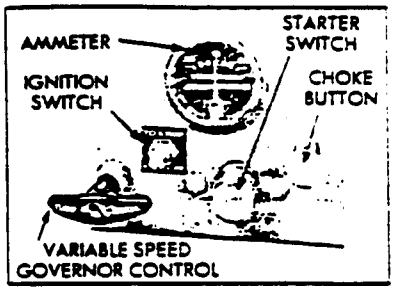


Fig. 7, VH4D, VG4D
CONTROL PANEL

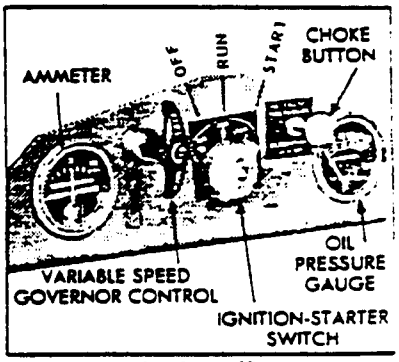


Fig. 8, V465D
CONTROL PANEL

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 'PUN' position.

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

WARM-UP

If all conditions are right, engine will start promptly in one or two attempts. After engine starts, allow it to warm up a few minutes before applying load. Do not race or run 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.

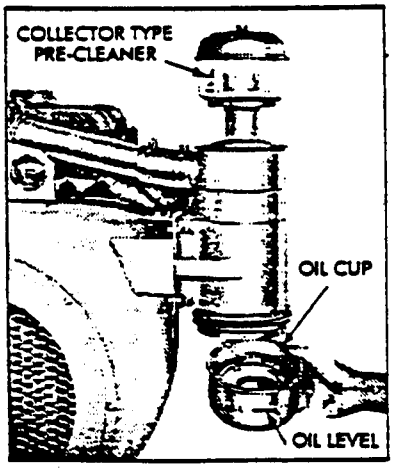


Fig. 9 OIL BATH AIR CLEANER

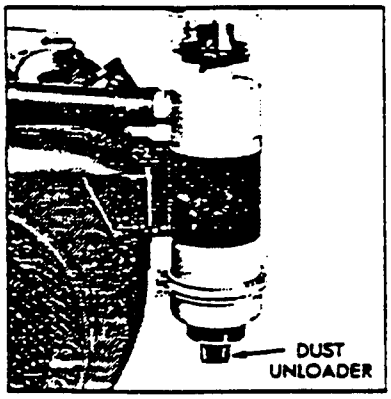


Fig. 10, DRY TYPE AIR CLEANER

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 on 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.

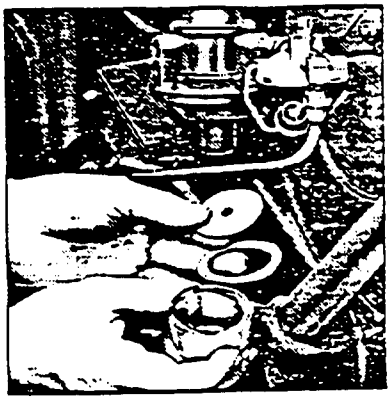


Fig. 11, FUEL FILTER

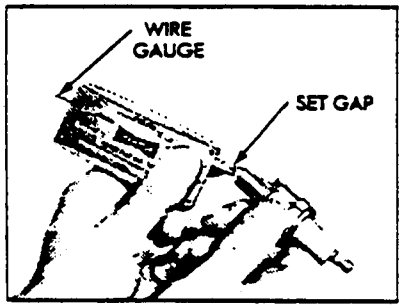


Fig. 12

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 so that no immediate adjustment is necessary. The IDLE ADJUSTMENT is for smooth low speed operation and this adjustment, if necessary, must be made with the carburetor throttle lever closed. Initial setting is approximately 1½ turns open.

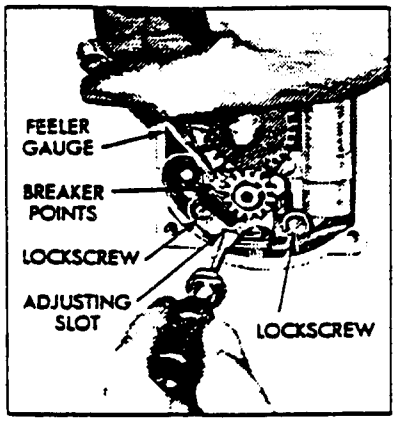


Fig. 13

MAGNETO BREAKER POINTS, Fig. 13

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

.015 inch at full separation.

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

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

DISTRIBUTOR (Battery Ignition), Fig. 14

The breaker point gap should be:

.020 inch at full separation.

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

Points that are badly pitted or worn should be replaced.

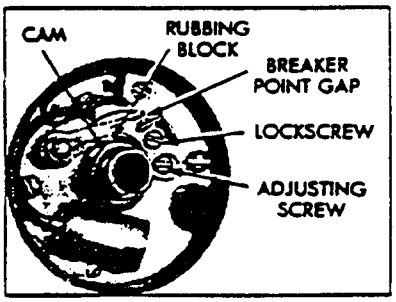


Fig. 14

VALVE TAPPET ADJUSTMENT

Models VH4D, VG4D, Fig. 15

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

Inlet - .008" Exhaust - .016"

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

Model V465D, Fig. 16

The clearance between the valve and rocker 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

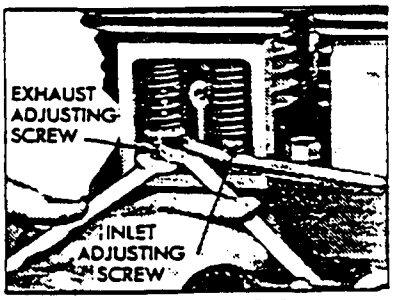


Fig. 15, VH4D, VG4D
VALVE TAPPET ADJUSTMENT

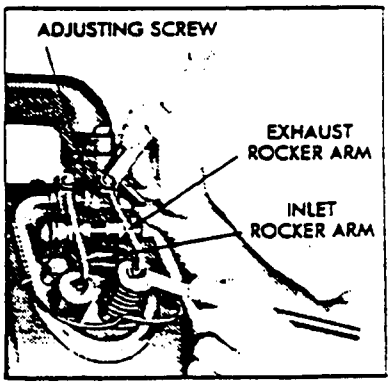


Fig. 16, V465D
VALVE TAPPET ADJUSTMENT

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.

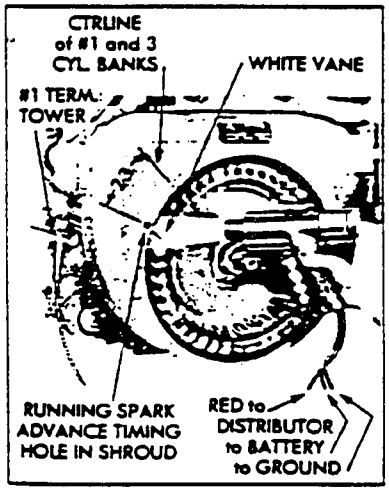


Fig. 17

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 ¾" diameter hole in rim face of flywheel screen.

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

CLUTCH ADJUSTMENT

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

VH4D Clutch, Fig. 18

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

VH4D CLUTCH REDUCTION, Fig. 19

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

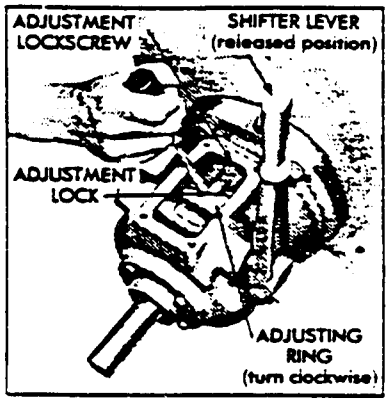


Fig. 18, VH4D
CLUTCH ADJUSTMENT

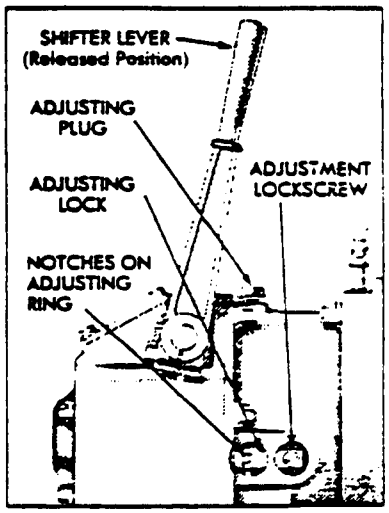


Fig. 19, VH4D
CLUTCH REDUCTION ADJUSTMENT

VG4D, V465D CLUTCH ADJUSTMENT

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

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

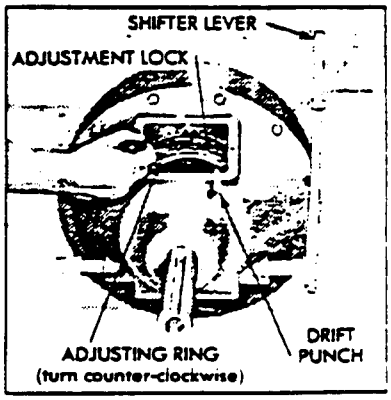


Fig. 20, VG4D, V465D
ROCKFORD CLUTCH ADJUSTMENT

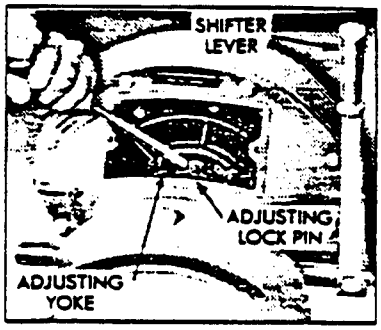


Fig. 21, VG4D, V465D
TWIN DISC CLUTCH ADJUSTMENT

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

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

FLYWHEEL ALTERNATOR

Fig. 22 and Fig. 23

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

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

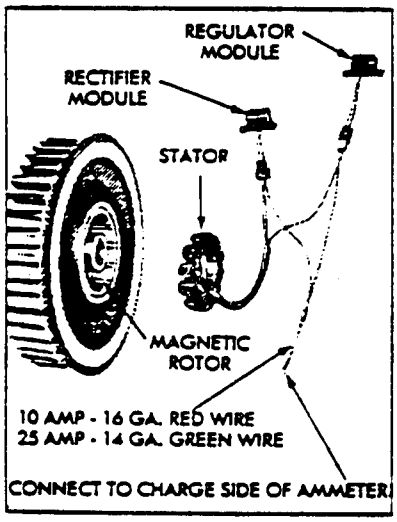


Fig. 22, FLYWHEEL ALTERNATOR

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

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

GENERATOR — WIRING CIRCUIT, Fig. 24

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

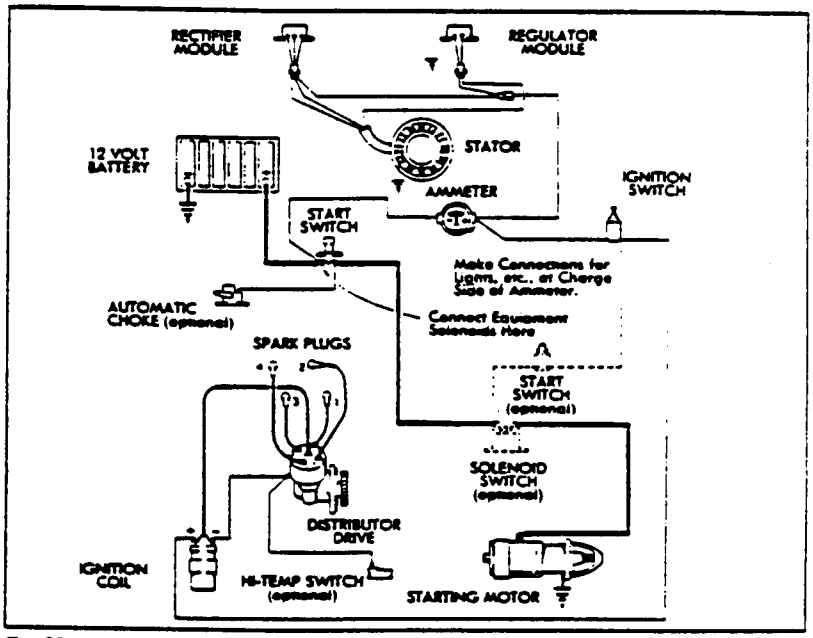


Fig. 23, WIRING DIAGRAM, Flywheel Alternator and Battery Ignition, Models VH4D, VG4D

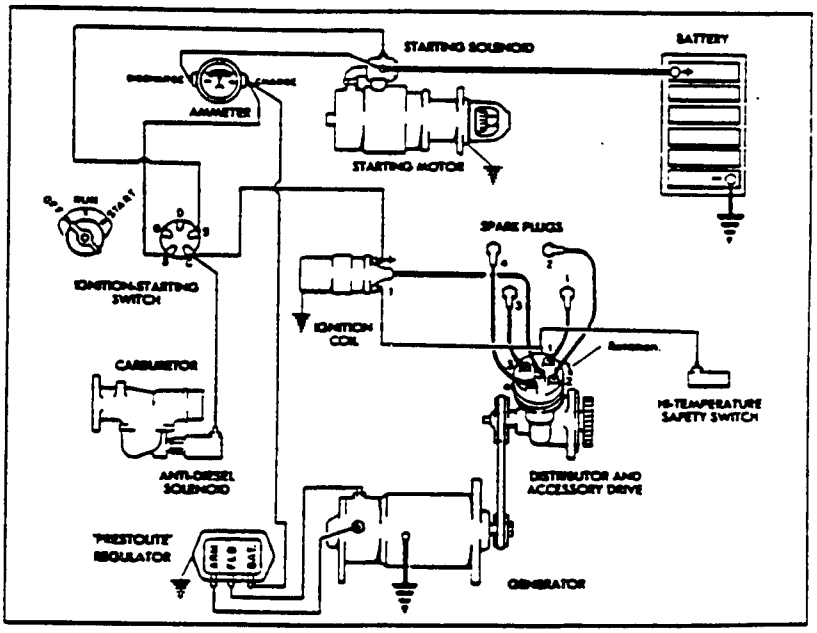


Fig. 24, WIRING DIAGRAM, Generator and Battery Ignition, Model V465D

TROUBLE SHOOTING

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

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

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

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

FUEL MIXTURE

No fuel in tank or fuel valve closed.

Plugged vent hole in fuel tank cap.

Fuel line clogged.

Fuel pump diaphragm worn or punctured.

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

Carburetor not choked sufficiently, especially if engine is cold.

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

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

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

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

COMPRESSION

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

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

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

Valve stuck open. Piston rings stuck or worn.

Valves adjusted with insufficient clearance.

IGNITION

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

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

Broken or frayed ignition wires.

Spark plug insulator broken.

Spark plugs wet or dirty.

Spark plug gap incorrect.

Condensation on spark plug electrodes.

Breaker point gap incorrect.

Breaker points pitted or fused.

Breaker arm sticking.

Condenser leaking or grounded.

Spark timing wrong.

Weak battery. Faulty ignition coil.

ENGINE MISSES

Spark plug gap incorrect.

Worn, leaking or loose ignition cables.

Weak spark. See 'Ignition' test for spark.

Breaker points pitted or worn.

Water in gasoline.

Poor compression. See 'Compression'.

Sticky valves.

ENGINE STOPS

Fuel tank empty.

Water, dirt or gum in gasoline.

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

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

Air vent hole in fuel tank cap plugged.

Ignition troubles. See 'Ignition'.

OVERHEATING

Crankcase oil supply low.

Ignition timing wrong.

Low grade of gasoline.

Engine overloaded.

Restricted cooling air circulation.

Part of air shroud removed from engine.

Dirt between cooling fins.

Intake or rotating screen clogged with dirt.

Restricted exhaust.

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

YB-69 ALTERNATOR

WISCONSIN Engine Model V-465D

SPECIFICATIONS

VOLTS – 12 VENTILATED – Yes RATED OUTPUT – 37 Amperes

BRUSHES – 2 CONTROL – Voltage Regulator ROTATION – Clockwise at drive end

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

PRECAUTIONS:

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

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

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

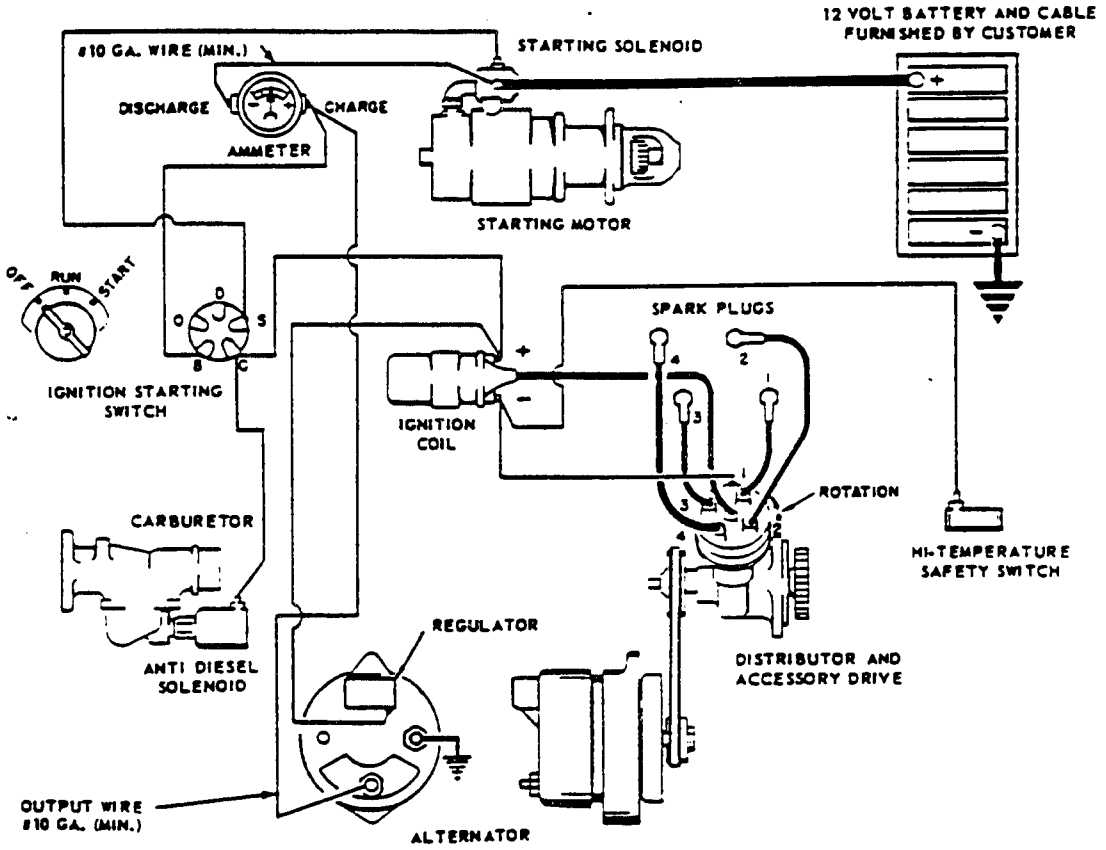
Do Not, remove the alternator from the vehicle without first disconnecting the grounded battery cable.

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

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

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

WIRING DIAGRAM



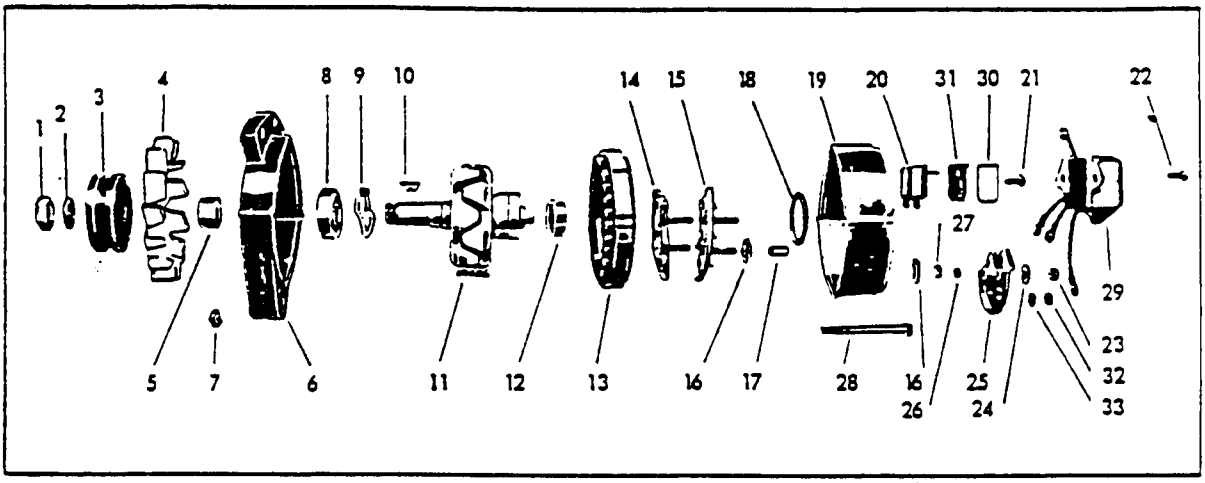
TELEDYNE WISCONSIN MOTOR MILWAUKEE, WISCONSIN· 53219

YB 69 ALTERNATOR

MOTOROLA Part No. RA 12N451

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

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



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

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

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

Limited Engine Warranty

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

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

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

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

TELEDYNE WISCONSIN MOTOR
MILWAUKEE, WISCONSIN 53219

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

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

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

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

cut along dotted line

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

Dear Customer:

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

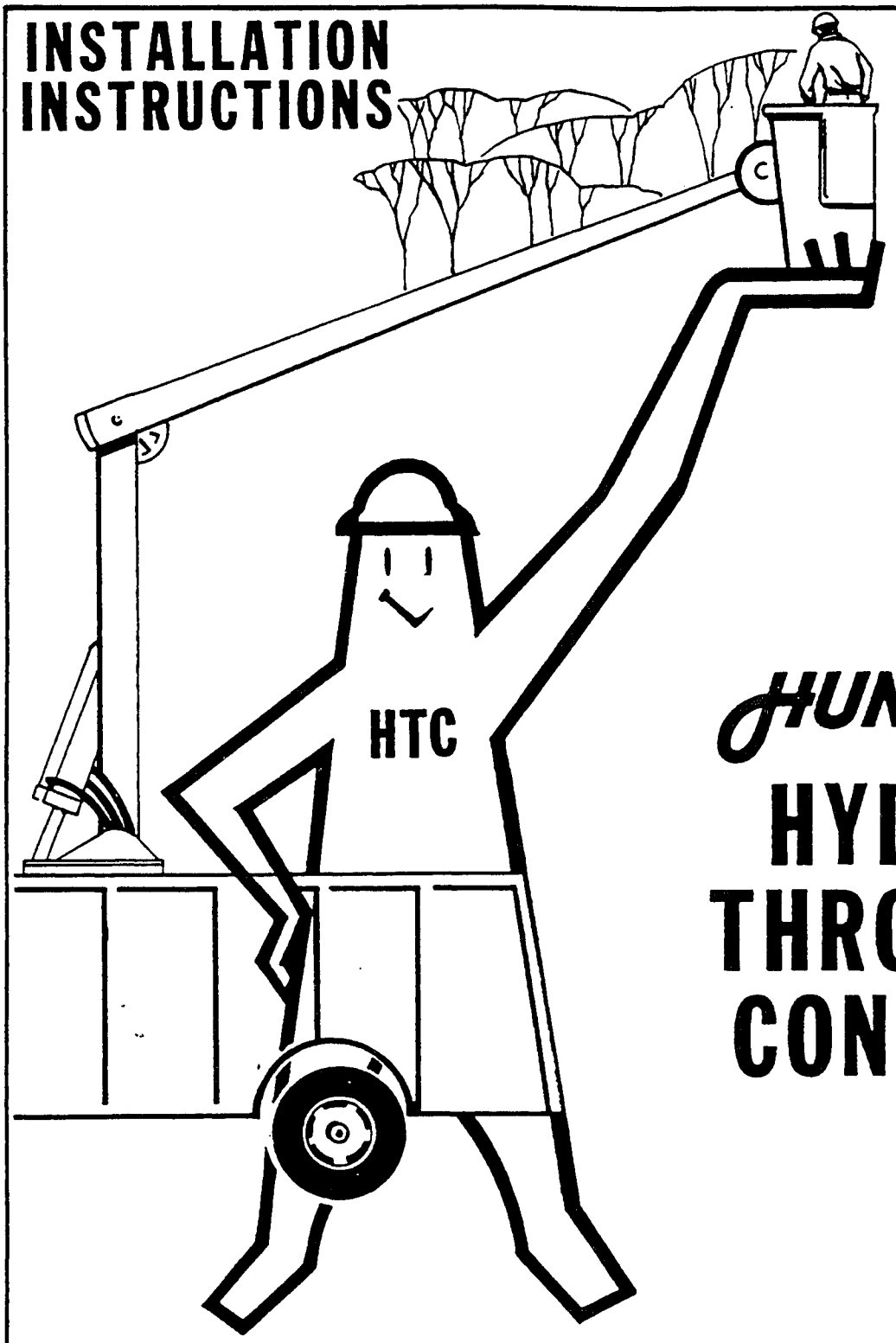
NAME _____

STREET _____

CITY _____ STATE _____ ZIP _____

ENGINE MODEL _____ SERIAL NO. _____

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

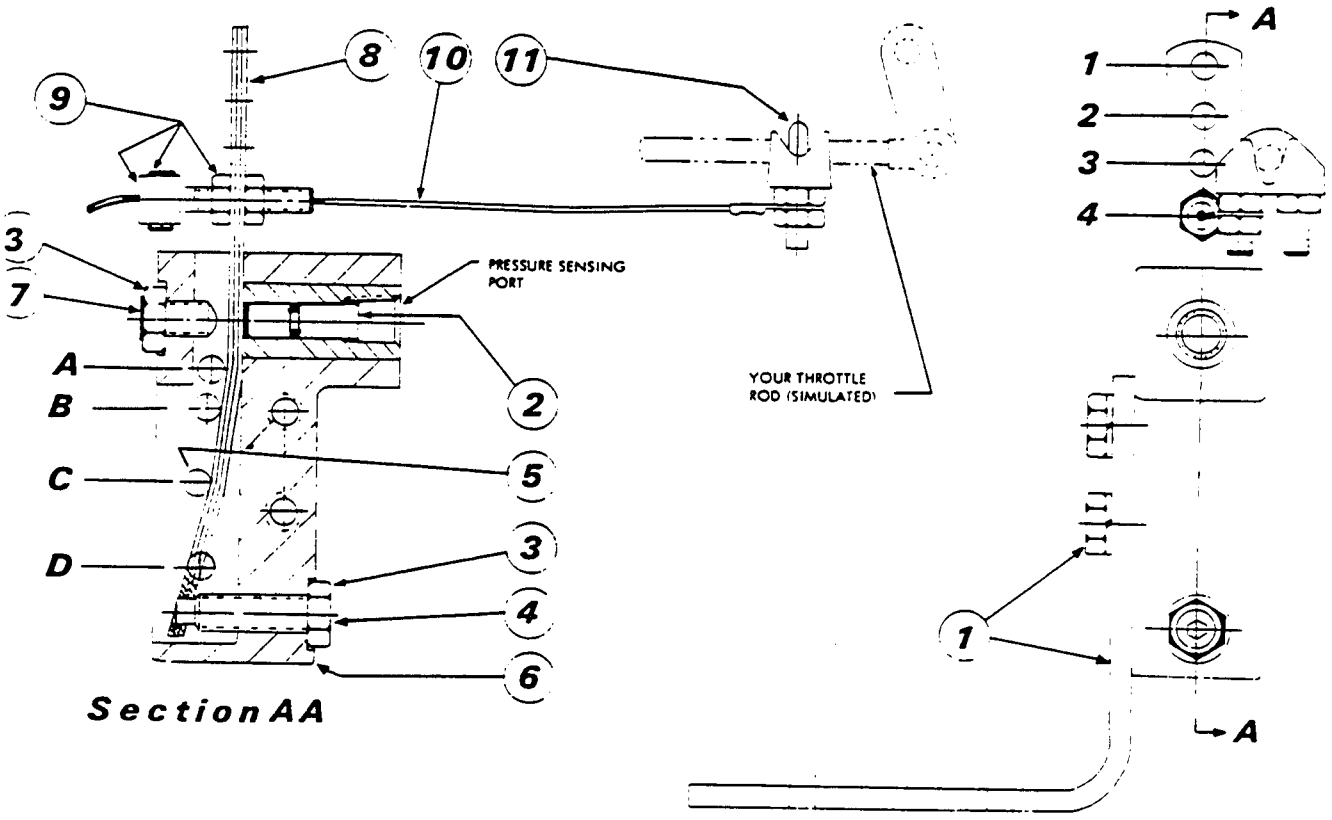
TOLEDO DIVISION
P O. Box 6593 • Toledo, Ohio 43612
Phone (419) 729-3861

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.

TROJAN MILEAGE MASTER BATTERIES



TROJAN BATTERY COMPANY

12380 CLARK STREET • SANTA FE SPRINGS, CA 90670

(213) 946-8381 • (714) 521-8215 Toll Free (Outside Calif.) (800) 423-6563 (Excluding Alaska and Hawaii)

proper care and maintenance of electric vehicle

1. NEW BATTERY RECEIVAL AND INSTALLATION

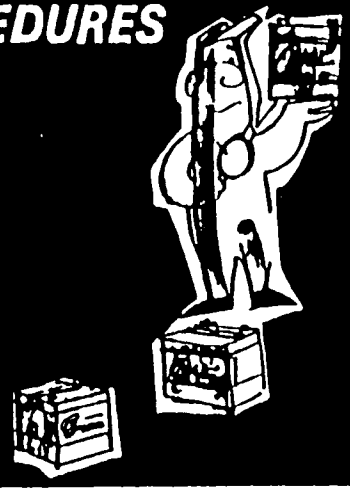


1. Always inspect incoming shipments of batteries for damage. Look for and pay particular attention for damage to or wet spots on the shipping cartons, examine those batteries for signs of breakage.
2. If damaged batteries are found secure acknowledgment of the damage from the carrier's representative and file a claim against the transportation company. Contact your supplier for battery replacement.
3. If batteries are received wet and not immediately placed in service, they must be charged at regular intervals as follows:

Storage Temperature	Charge
Below 40° F	None required
40° F to 60° F	Every 2 months
60° F and above	Once a month

4. Never stack one battery directly on top of another. Post damage and/or container damage can occur from improper stacking. If batteries are stored individually, place supporting boards between layers. Do not stack layers more than three (3) high and rotate stock so that the oldest batteries can be used first.
5. Dry charge batteries should be activated in accordance with instructions of the battery manufacturer.
6. Batteries should be installed in accordance with the vehicle manufacturer's instructions. Connections should be made tight enabling good contact between connector lugs and battery terminals. Always charge sets of batteries immediately after installation into the car.

2. MAINTENANCE-INSPECTION PROCEDURES



1. Water batteries at least once a week.
   a. Add only approved water to the cells. Distilled water is recommended, high mineral content water must not be used. Maximum allowable impurities in percent-iron (.003), chloride (.004), fixed residue (.076).
   b. Remove vent caps and water batteries preferably after charging to prevent over flow of acid due to expansion.
   c. Fill all cells to the proper level. Do not overfill cells. Fill to level indicator or ⅛ inch over the top of the separators if there is no level indicator. Do not use a hose to water batteries.
   d. Spot check cells between weekly waterings to assure electrolyte is above separators. Excess water usage indicates the presence of any one or all of the following conditions which should be checked.
      1. Overcharging
      2. High temperature operation
      3. Nearing end of service life
   e. Do not allow the electrolyte level to drop below the top of the separators since this will lead to shortened battery life.
2. Clean batteries after weekly watering or when washing cars.
   a. Wash the tops of the batteries making sure the vent caps are in place. Do not allow water or other foreign matter to enter the cells.
   b. Use a solution of bicarbonate of soda and water to wash batteries if there is an accumulation of acid.
3. Inspection to insure good conditions which will give better battery service.
   a. When watering batteries inspect battery and other terminal connections for:
      1. Corrosion — If any exists, clean connection and apply a non-metallic grease or protective spray to retard further corrosion.
      2. Loose Connections — Be sure all connections are tight and that good contact is made between terminals.
      3. Broken or Frayed Cables — Be sure all cable connections are good and that no loose or broken wires are exposed. Replace any which look suspicious.
   b. Once a week after the batteries have been charged, spot check two (2) or more cells for specific gravity reading. Gravity should be 1.250 - 1.280. If low readings are noted:
      1. Check charger to insure that proper charge is being returned to the batteries.
      2. Check connections as specified under Inspection 3a.
      3. Check all cells to determine if batteries are near the end of life. This should be done to the same procedure as called for under Section IV covering "Trouble Shooting" of batteries.
   c. On a regular interval, check car as outlined in the instruction manual for:
      1. Brake drag
      2. Proper tire pressure
      3. Proper alignment
      4. Proper lubrication
      5. Proper operation of electrical system
      6. Proper operation of drive and transmission system
      7. Condition of charger plug and receptacle in car

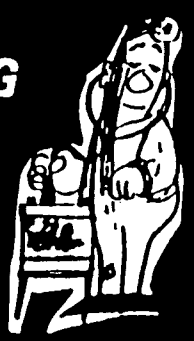
      Any of these conditions which are detrimental to car operation will shorten battery life.

3. CHARGING PROCEDURE



1. Become familiar with instructions issued with the charger or car manual.
2. Batteries are to be charged after each day's use as soon as play has been completed. Charging between rounds is permissible if it is determined feasible to do so.
3. Do not charge batteries if car was not used that day.
4. Do not allow batteries to sit in discharged condition for prolonged periods of time.
5. Always be sure batteries are fully charged each day prior to starting play.

4. TROUBLE SHOOTING FOR WEAK OR BAD BATTERIES



When a car fails to operate properly performing less than one round of golf, the car is to be brought into the shop and the batteries examined as follows:

1. Check terminal connections for corrosion, loose connections and broken or frayed cables.
2. If terminal connections appear to be in good condition, check all cells with a hydrometer for variation in specific gravity among cells. A variation of .030 points or more between cells of a battery is cause for suspect. Mark the low cells.
3. Recharge the batteries as recommended by the manufacturer.
4. Read all gravities again after recharge. Be sure that batteries are fully charged at gravities of 1.260 to 1.280. If cells vary by .030 points or more it is an indication of possible trouble within that battery.
5. Connect a load tester to the set of batteries and discharge the batteries at 75 Amps and record the time to a terminal voltage of 31.5 volts. Testers are now available having an automatic Shut-Off at this voltage. New batteries should run a minimum of 75 minutes on this test.
   a. If the batteries run less than 40 minutes they have either reached the end of life or a defective battery is in the circuit. Battery replacement is then necessary.
   b. If batteries run 40-50 minutes they have lost capacity and may be nearing the end of their useful life. In golf car service one round of golf may be expected on an average golf course.
   c. If batteries run more than 50 minutes, they are in good condition and satisfactory for continued service. Prior to putting the car back in service it should be checkud for the existence of other trouble as outlined in the instruction manual.

5. BATTERY REPLACEMENT



Defective Batteries (Premature Failures)

1. Defective battery can be determined either by observation of gravity variance at the end of the 75 Amp discharge (.030 or more points between cells of a battery) or by turning the discharge tester back on and determining the battery or cell which is defective by use of a voltmeter.
2. Mark the defective battery.
3. Recharge the batteries with the defective battery in the circuit.
4. Remove the defective battery and replace with new battery or battery of comparable age which is fully charged.

Worn Out Batteries

1. Remove old set of batteries.
2. Clean and recondition battery trays, holddowns and cables.
3. Inspect new batteries for broken containers and proper electrolyte level before installing in the car.
4. Install batteries in car being sure that they are properly held down, firm but not too tight.
5. Replace cables, being sure terminals and connectors are clean and connections are tight.
6. Apply a light coating of non-metallic grease or protective coating.

6. WINTER STORAGE OF WET BATTERIES



1. Prior to storing car, batteries should be cleaned, fully charged and properly leveled.
2. While in storage the batteries should be recharged to full charge at time intervals shown below:

Storage Temperature	Charge
Below 40° F	None required
40° F to 80° F	Every 2 months
80° F and above	Once a month

3. Check batteries after car has been removed from storage and before service begins. Follow inspection and trouble shooting procedures to determine the condition of the batteries.

Battery Council International

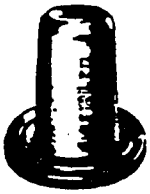
TROJAN MILEAGE MASTER BATTERIES

GROUP NUMBER	TYPE	VOLTS	REF. 20 HOUR RATE A.H.	75 AMPS TO 5.25 VOLTS AT 80° F MINUTES	OVERALL DIMENSIONS LENGTH	WIDTH	*HEIGHT	WEIGHT
GC-2	T-90	6	185	90	10-3/8	7-1/8	10-3/4	56
GC-2H	T-105	6	217	105	10-3/8	7-1/8	10-3/4	61
GC-2H	T-135	6	244	135	10-3/8	7-1/16	11-1/2	72

OTHER SPECIAL BATTERIES AVAILABLE FOR ELECTRIC VEHICLES.

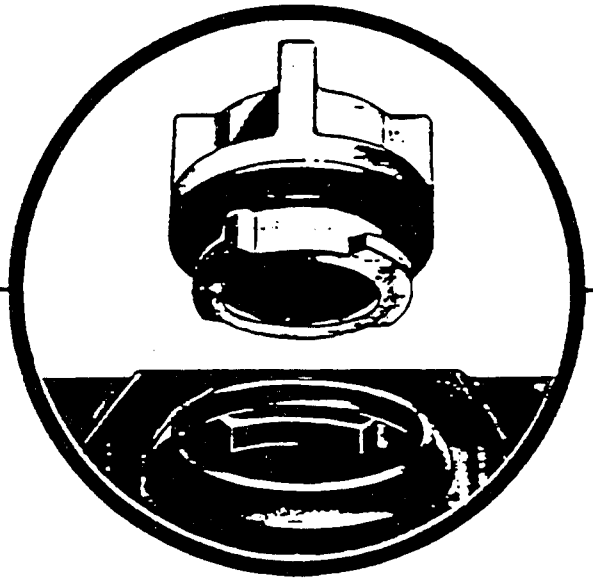
*TYPE OR TERMINAL WILL VARY HEIGHT SLIGHTLY

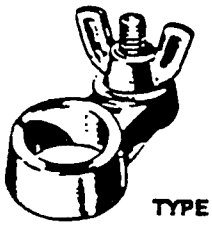
TROJAN "MILEAGE MASTER" TYPES FEATURE QUARTER-TURN VENT CAPS REDUCING SERVICE TIME 75%



TYPE AP

STRAIGHT POST



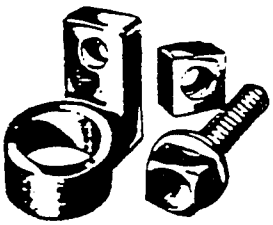


TYPE WT

WING NUT TERMINAL
3/16 or 5/16 Stud

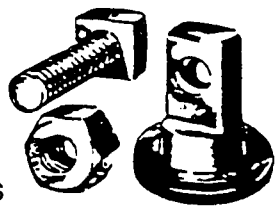
TYPE LT

ANGLE TERMINAL
5/16 Lead coated bolt



TYPE UT

UNIVERSAL TERMINAL



ALL BATTERIES COME WITH UNIVERSAL TERMINALS
UNLESS OTHERWISE SPECIFIED

DISTRIBUTED BY

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TROJAN BATTERY COMPANY

12380 CLARK STREET • SANTA FE SPRINGS, CA 90670

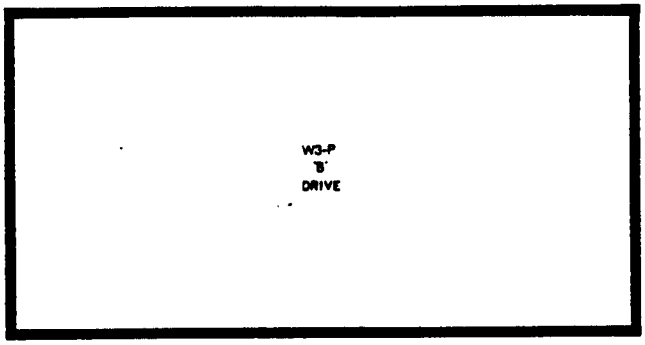
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REV.

FOR CARRIAGE TORQUE HUBS - 21222
& 24201 (WITH STEEL SPINDLE)

Torque-Hub® Final Drives

Service Manual



Fairfield Manufacturing Company, Inc.
2300 South Concord Road, Lafayette, Indiana 47903, 317/474-3474
FAX 317/477-7342
Subsidiary of Rexnord Inc.

Fairfield

THE DRIVE PEOPLE

Introduction

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

Included are —

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

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

Safety

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

W3-P "B" Drive Disassembly Procedure

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

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

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

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

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

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

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

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

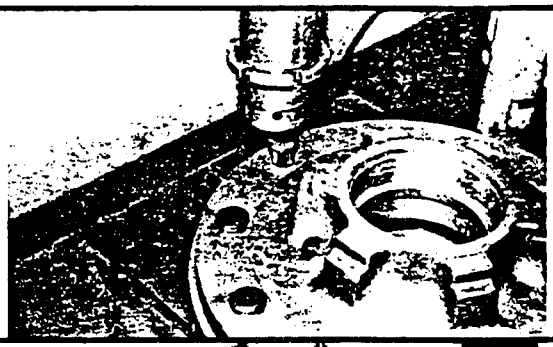
9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

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

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

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

Main Assembly Procedure

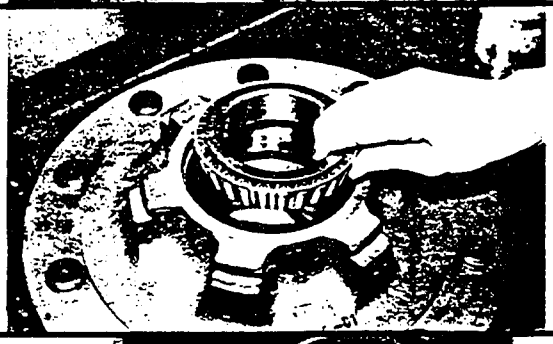


1. Using an arbor type press if available, (if not, a hammer may be used), install the wheel studs. The hub flange should be supported from the underside during this operation.

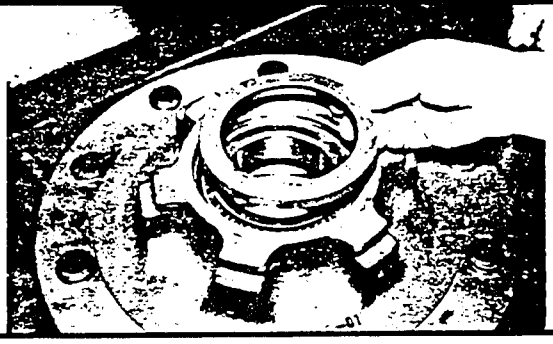
   Note: Wheel studs are optional.



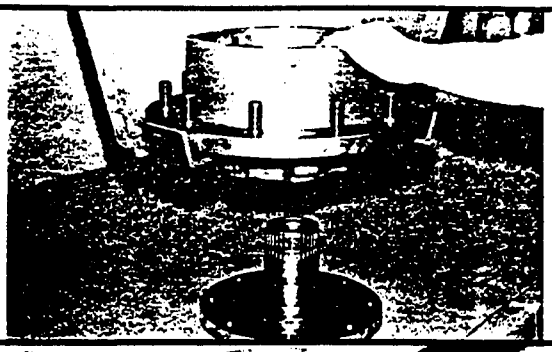
2. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JM716610 will go into small end of Hub, and Cup #JM515610 will go into large end of Hub.



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



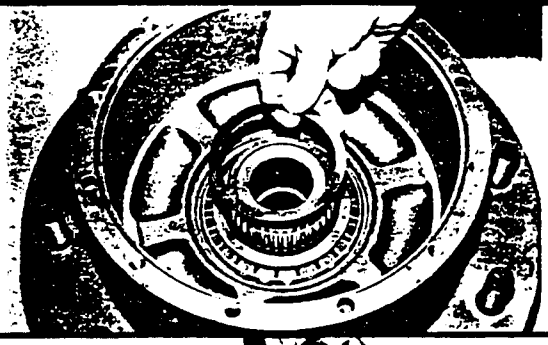
4. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.



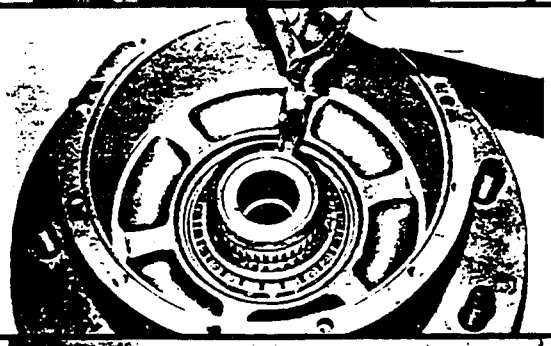
5. Lower Hub onto Spindle with large open end up.



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

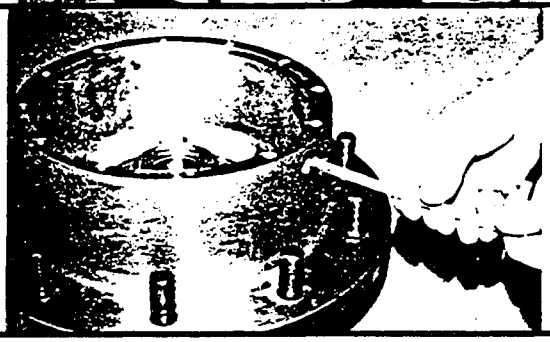


7. Place Bearing Shim over end of Spindle and against Bearing Cone.

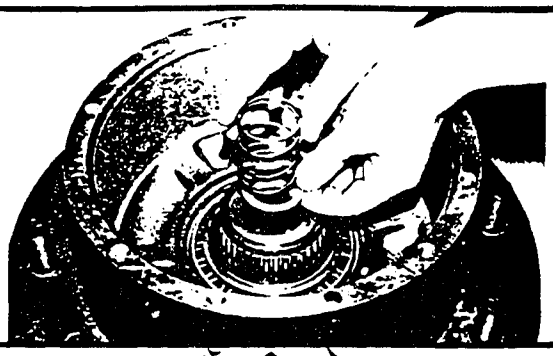


8. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

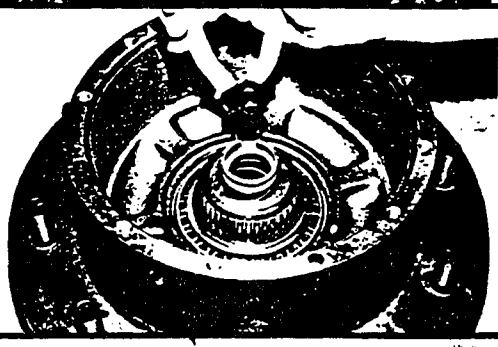
⚠ Eye protection should be worn during Retaining Ring installation.



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

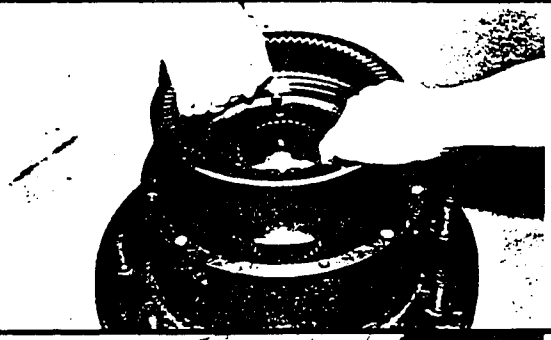


10. The disengage spacer and spring are installed into the co'bore of the Spindle.

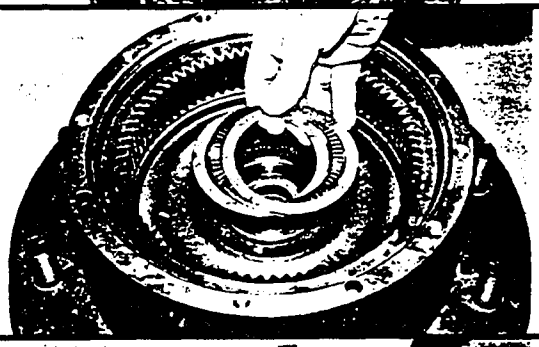


11. Another spacer and the correct Retaining Ring are installed into the Spindle co'bore and Retaining Ring groove provided.

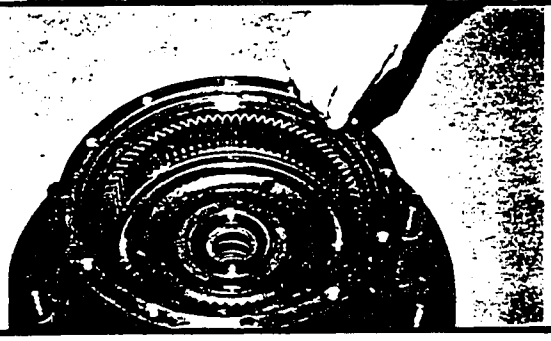
⚠ Eye protection should be worn during Retaining Ring installation.



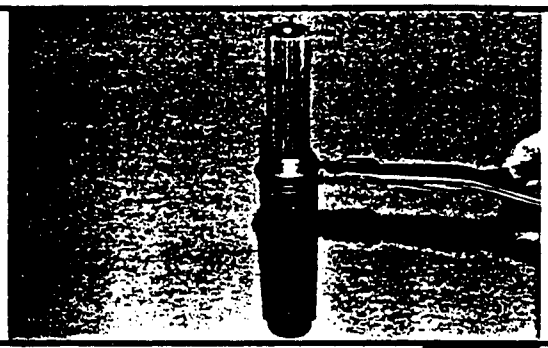
12. The internal gear is installed matching the Bore Spline the Spindle Spline.



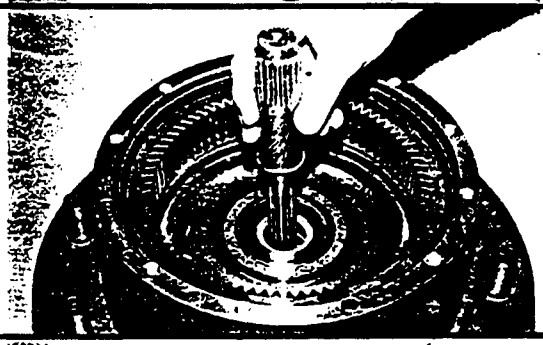
13. The thrust washer/thrust bearing set is installed on the portion of the Spindle which extends into the internal gear.



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



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

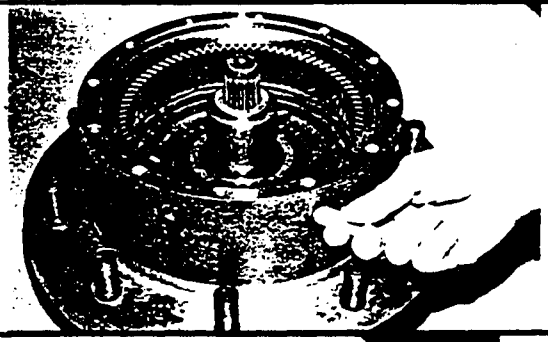


16. The input shaft is installed into the spindle.

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

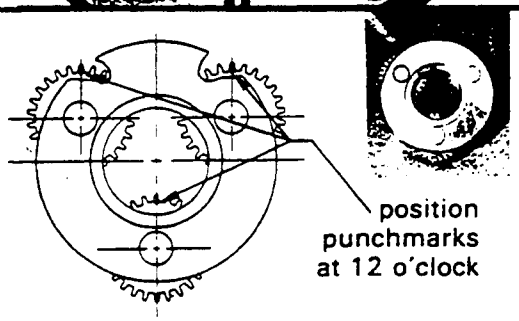


17. The thrust spacer is installed on the input shaft.

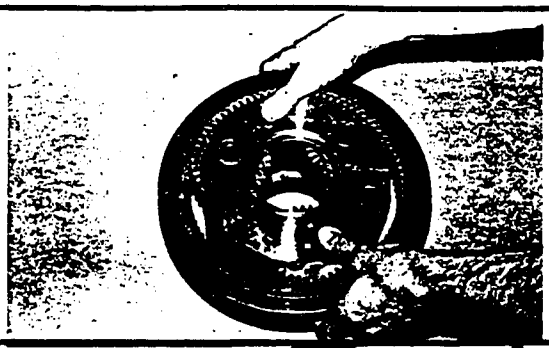


18. Locating the four counter reamed holes in the face of the hub, mark them for later identification.

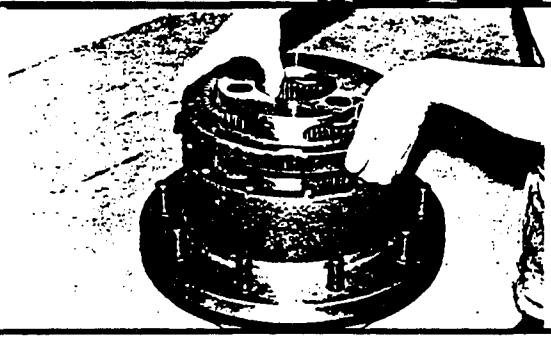
    These holes are reamed to accept the shoulder bolts.



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

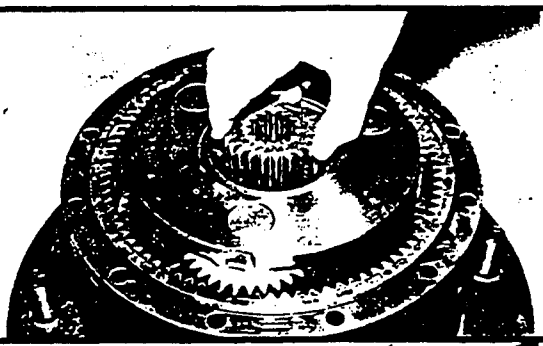


20. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation. The side of the Ring Gear with an "X" stamped on it should be up.

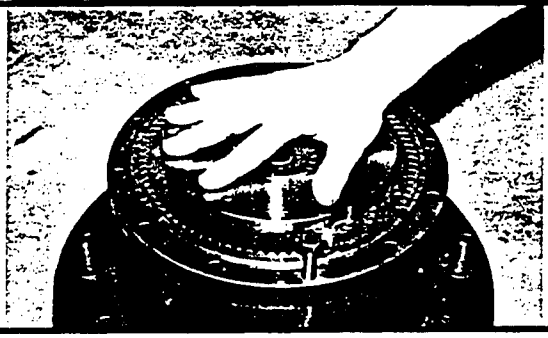


21. While holding Ring Gear and Cluster Gears in mesh, place small side of Cluster Gear into mesh with the Internal Gear. On the Ring Gear locate the hole marked "X" over one of the marked counterbored holes in Hub.

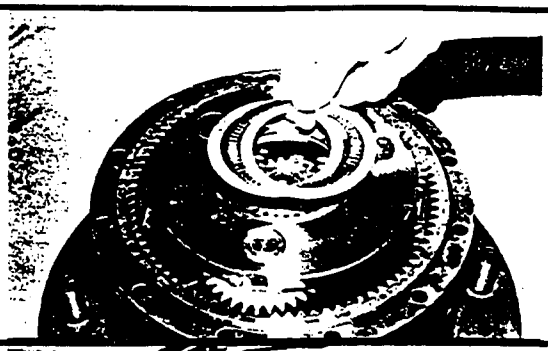
Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.



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



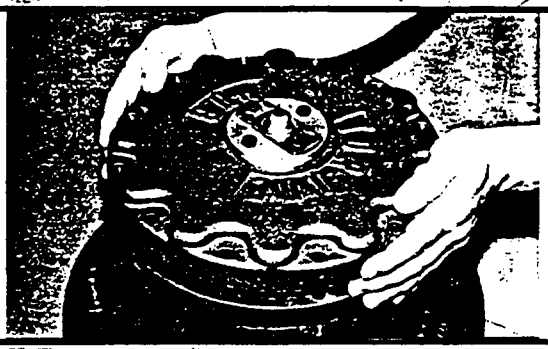
23. After inserting at least one shoulder bolt in the proper location, rotate the carrier. This is to check freedom of rotation and recheck timing.



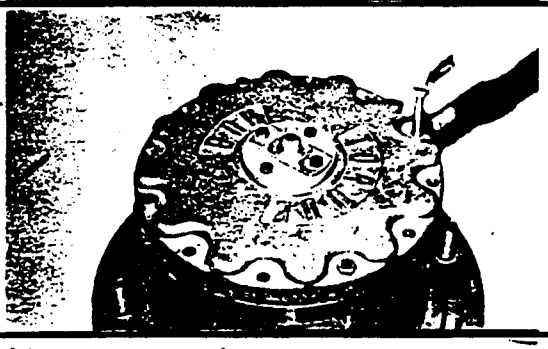
24. Another thrust washer/thrust bearing set is now installed into the counterbore in the face of the carrier.



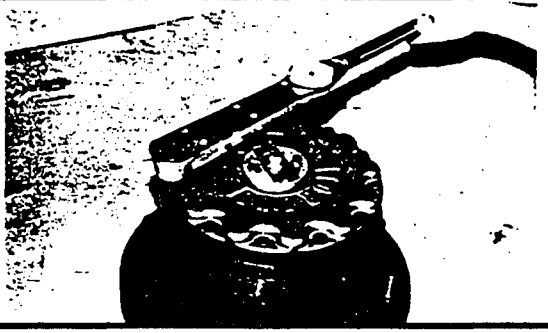
25. Place O'Ring into cover assembly counterbore. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.



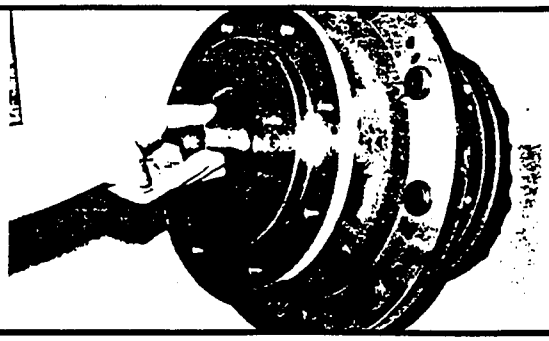
26. Place cover assembly on Ring Gear with oil level, check plug in cover located approximately 90° from oil fill plug in Hub.



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



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

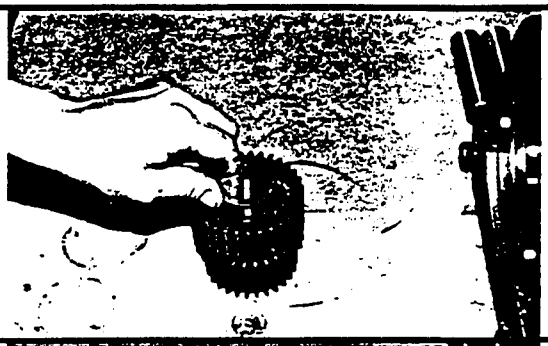


29. Place Coupling into the Spindle and onto the Input Shaft.

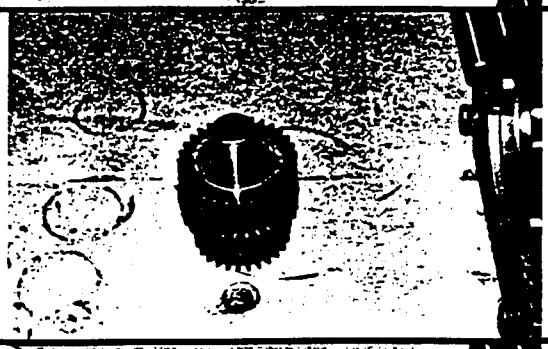
    Note: W3C units must have one external and one internal Snap Ring installed. All units with a "X" on the end of the model number must have two internal Snap Rings with a spacer between them installed in the Coupling.

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

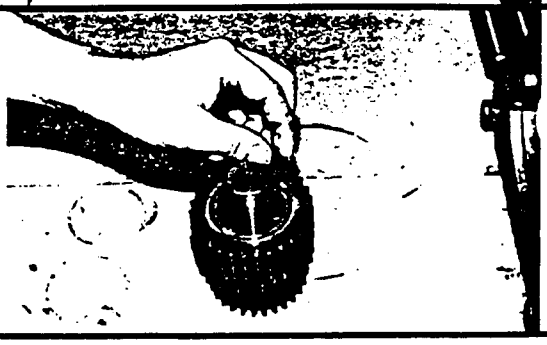
Carrier Sub-Assembly (Bronze Washers)



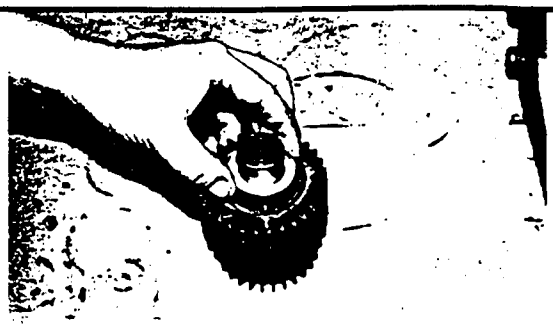
1. To aid in centering Planet Pin (3E) use an extra Spacer (3D) inserted into the bore of Cluster Gear (3F) which has been positioned on a flat surface, small diameter Cluster Gear down.



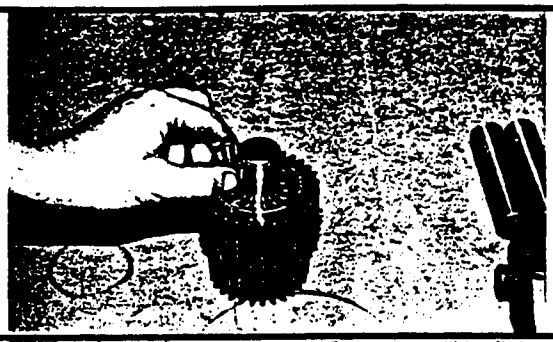
2. Position Planet Pin (3E) in the bore of Cluster Gear (3F) locating in Spacer (3D).



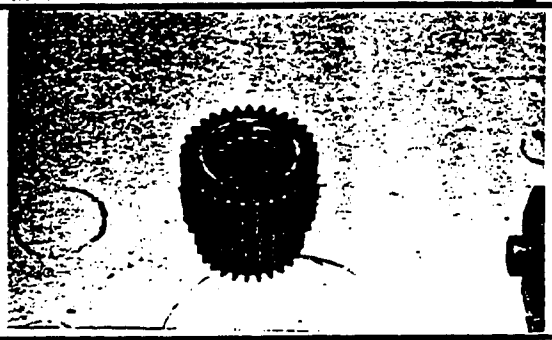
3. Install 14 Needle Rollers (3C) into lower half of Cluster Gear (3F) using sufficient grease or petroleum jelly to assist in holding Needle Rollers (3C).



4. Install Spacer (3D) onto Planet Pin (3E) locating on inboard end of Needle Rollers (3C).



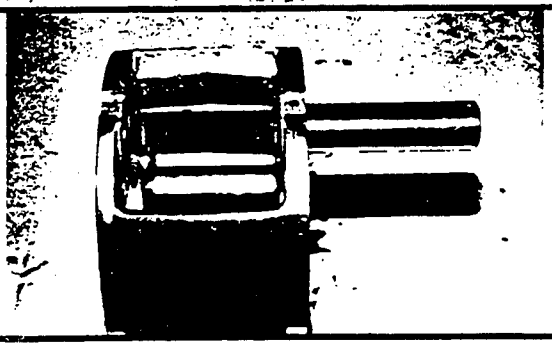
5. Install another 14 Needle Rollers (3C) into the remaining half of Cluster Gear (3F) using sufficient grease or petroleum jelly to assist in holding Needle Rollers (3C) in place once Planet Pin (3E) is removed.



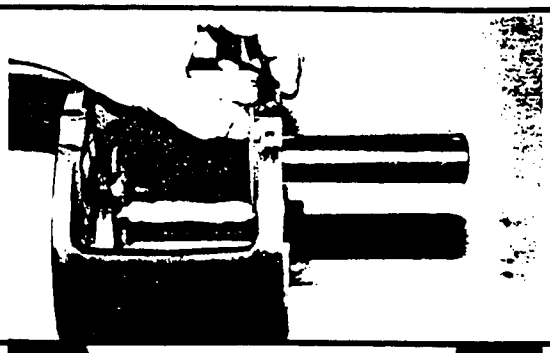
6. Planet Pin (3E) may be removed from the bore of Cluster Gear (3F).



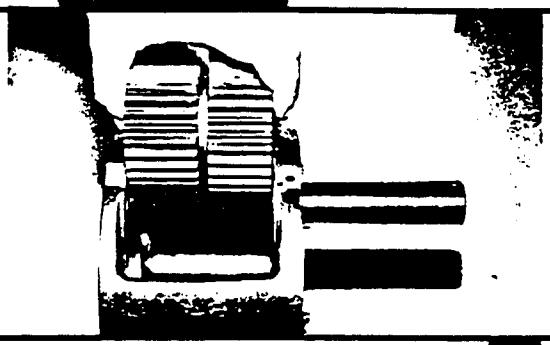
7. Thrust Washers (3H) are installed into the counterbores of each end of the Cluster Gear (3F). Care is to be taken to install the smooth side of Thrust Washer (3H) into the counterbore of Cluster Gear (3F).



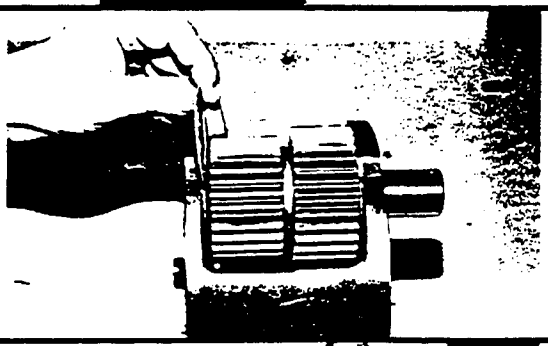
8. Insert Planet Pin (3E) into the Planet Pin hole of Carrier (3A) from the Roll Pin hole side. Care is to be taken to align Planet Pin (3E) with the chamfered end of the Roll Pin hole up. This chamfered hole is to assist in aligning the Roll Pin holes in the Carrier (3A) and Planet Pin (3E) as Roll Pin (3G) is tapped into location.



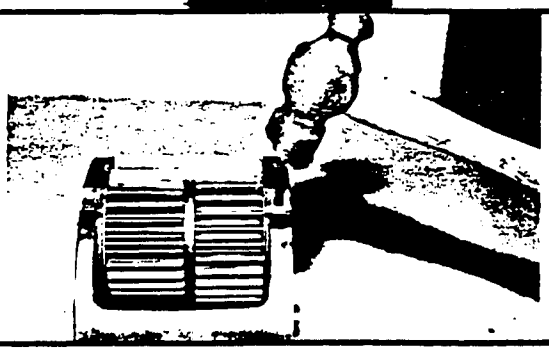
9. Using sufficient grease or petroleum jelly to assist in holding in position. Thrust Washer (3B) is installed onto Planet Pin (3E). Care is to be taken to install Thrust Washer (3B) with the tang positioned in the slot provided.



10. Cluster Gear (3F) with Thrust Washers (3H), Needle Rollers (3C) and Spacer (3D) installed is positioned into Carrier (3A) and aligned with Planet Pin (3E). Care is to be taken to insure Cluster Gear (3F) is installed with the large diameter end to the Roll Pin (3G) side of Carrier (3A).

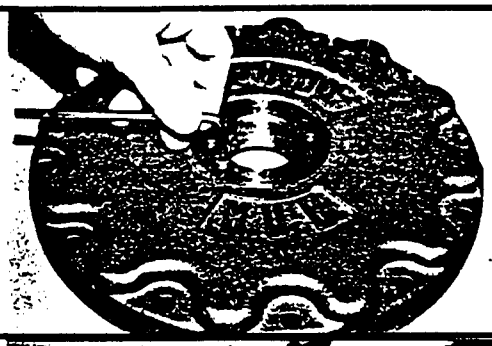


11. A second Thrust Washer (3B) is installed on the small diameter end of Cluster Gear (3F) using sufficient grease or petroleum jelly to assist in holding position as Planet Pin (3E) is fully extended through Carrier (3A).

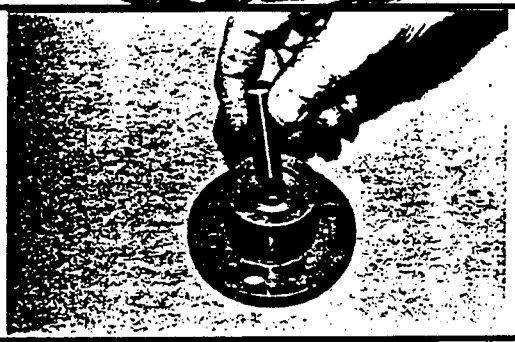


12. Upon checking alignment of the Roll Pin holes in Carrier (3A) and Planet Pin (3E), Roll Pin (3G) is tapped into location. Care is to be taken to insure that the external end of Roll Pin (3G) is below the outer diameter of Carrier (3A).

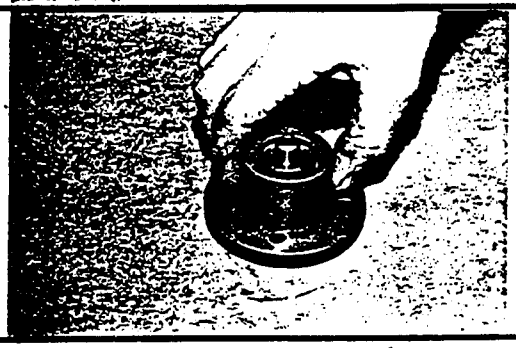
Cover Sub-Assembly



1. Screw Pipe Plug into Cover.



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



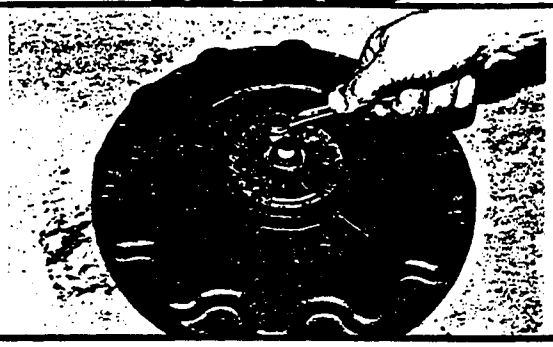
3. Slip 'O' Ring over Cover Cap and against face.



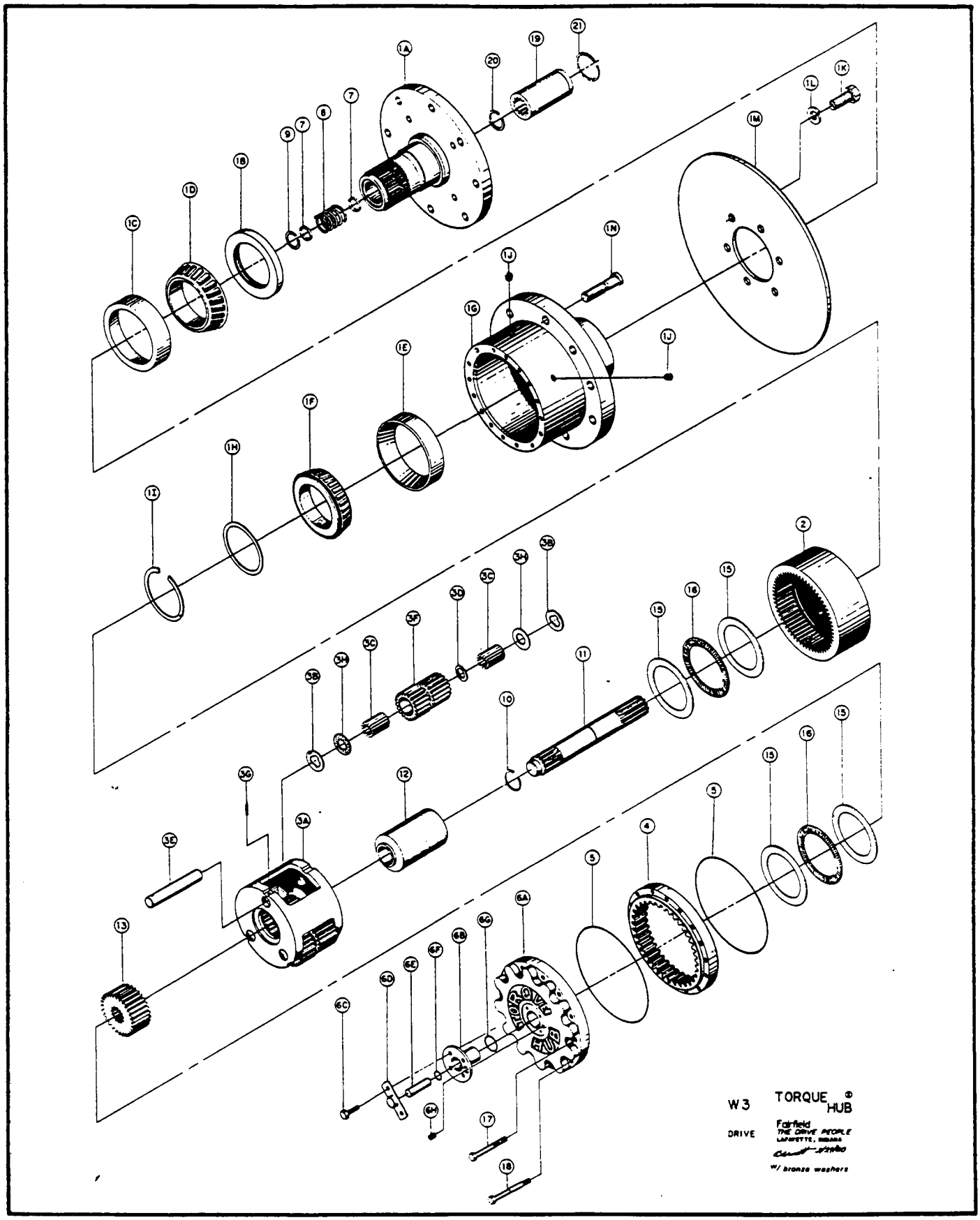
4. Place Cover Cap into Cover with large hole located over Pipe Plug.

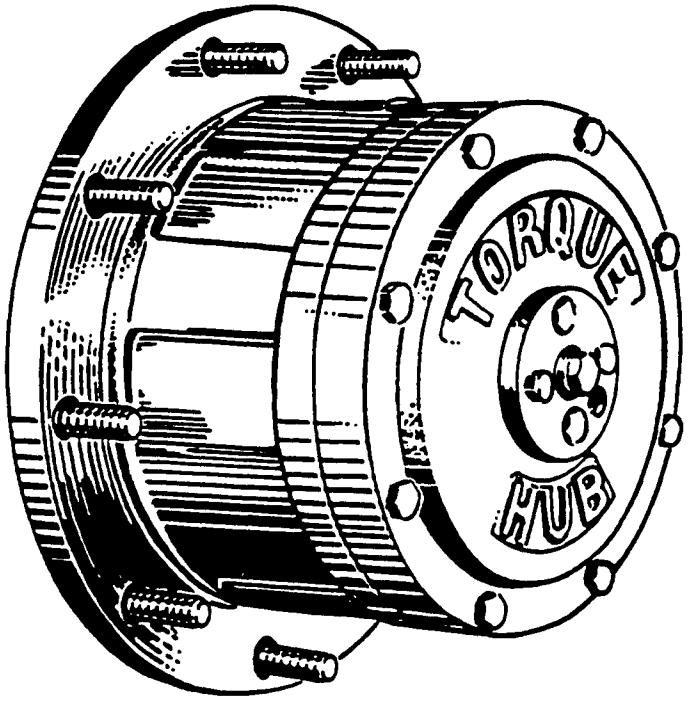


5. Install two 1/4 × 20 × 3/4 bolts 180° apart and torque to 70 - 80 in. lbs.



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


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LAFAYETTE, INDIANA
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THE DRIVE PEOPLE

TORQUE-HUB®

FOR ROTATION GEARBOX TORQUE HUB - 22830

Final Drives

ASSEMBLY-DISASSEMBLY MANUAL

FOR THE

S1C

UNIT

Fairfield
Manufacturing Company, Inc.

INTRODUCTION

This manual is a step-by-step guide to assembly and disassembly of torque-hub units. It is designed for the customer or shop mechanic who is repairing a particular model of torque-hub final drive.

Users of this manual should note that each part mentioned is followed by an indentification number enclosed in parentheses. These part numbers may be referred to in the Parts List section of this manual and on the cross-sectional view of this unit.

Any specialized tools normally used to assemble this unit are noted in the assembly procedures and diagrammed in the tooling section. However, it is not mandatory that these tools be used in this unit's assembly. Bearing cups and cones can be pressed using a punch and hammer along their top edges. Seals can be pressed by laying a board flat on top of the seal and then hammering the board down until it meets the hub. Studs can be hammered into stud holes. Should you use these methods, be very careful not to damage parts when using a punch and/or hammer.

Users should familiarize themselves with the procedures for roll and leak testing and bolt tightening and torquing found on the following pages before getting started.

SAFETY

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

ROLL and LEAK TESTING

Torque-hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

The Roll Test

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for improper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

The Leak Test

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at the main seal or wherever "O" rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where "O" rings or gaskets meet the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, "O" ring, or gasket, the part must be replaced.

TIGHTENING and TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to insure that the bolts are not tightened beyond their specified torque. Never use an impact wrench to tighten shoulder bolts. All shoulder bolts should be tightened by hand.

The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.

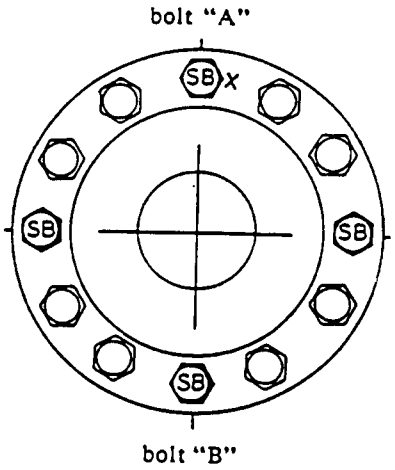
1. Tighten (but do not torque) bolt "A" until snug.

2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.

3. Continue around the bolt circle and tighten the remaining bolts.

4. Now use a torque wrench to apply the specified torque to bolt "A".

5. Continue around the bolt circle and apply an equal torque to the remaining bolts.



CONTENTS

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Roll and Leak Testing I
Tightening and Torquing Bolts II

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2

MAIN DISASSEMBLY

1. Remove the two pipe plugs (13) in cover (6) and drain the oil from the unit.

2. Loosen and remove the four shoulder bolts (14) and eight grade 8 bolts (12) from cover (6).

3. Remove cover (6) from hub (1G).

4. Remove "O" ring (5) from the counterbore in cover (6) and discard.

5. Remove thrust washer (11) from the counterbore in carrier housing (3A).

6. Remove input gear (9) from mesh with planet gears (3F).

CAUTION: Safety glasses should be worn during this step:
7. Using a punch, remove retaining ring (20) from the groove around the inside of input gear (9) and discard.

8. Lift carrier sub-assembly (3) out of hub (1G).

9. Lift ring gear (2) off of hub (1G).

10. Remove "O" ring (5) from the counterbore in hub (1G) and discard.

11. Remove the three pipe plugs (1J) from side of hub (1G).

12. Apply a preload to output shaft(1A) in order to remove retaining ring(1I). To do this, follow steps a-b:

a. Place bearing cone pressing tool (T-116407) on top of retaining ring (1I).

b. Apply pressure to the fixture using a hydraulic ram or by striking the fixture with a soft face hammer. Pressure should be applied until the hub rotates with difficulty.

CAUTION: Safety glasses should be worn during this step:
13. Using retaining ring pliers, remove retaining ring (1I) and discard.

14. Remove spacer (1H) from output shaft (1A).

15. Raise hub (1G) above your work surface and place a support underneath it in such a manner that output shaft (1A) will be able to fall through the bottom when pressed in next step.

16. Press output shaft (1A) out of hub (1G). The output shaft may come out with bearing cone (1D) and seal (1B) attached. If so, remove seal (1B) from output shaft and discard. Use a soft punch and hammer to remove bearing cone (1D) from the shaft. Be very careful not to strike the shaft when using the punch.

[More Main Disassembly on page 3] →

17. If **seal (1B)** and **bearing cone (1D)** remain in the hub, press the seal and bearing cone out using a bearing cone pressing tool (T-116407). Discard the seal.

18. Lift **bearing cone (1F)** out of **hub (1G)**.

19. Stand **hub(1G)** on its small diameter end. Using a soft punch and hammer, remove **bearing cup (1C)** from the counterbore of **hub (1G)**. Be very careful not to strike the counterbore when using the punch.

20. Turn **hub (1G)** over so that it rests on its large end. Using a soft punch and hammer, remove **bearing cup (1E)** from the counterbore of **hub (1G)**. Be very careful not to strike the counterbore when using the **punch.**

21. At this point the main disassembly is complete.

CARRIER DISASSEMBLY

1. Locate **roll pin (3G)** which holds **planet shaft (3E)** in the **carrier housing (3A).**

2. Drive the **roll pin (3G)** down into **planet shaft (3E)** until it bottoms against the carrier housing. If the roll pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

3. Remove **planet shaft (3E)** from **carrier housing (3A).** The two **thrust washers (3B)** and **planet gear (3F)** will slide off.

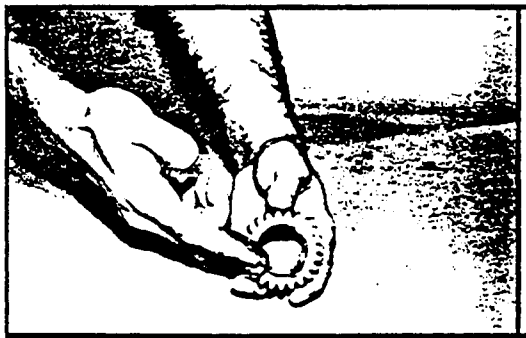
4. Place **planet shaft (3E)** in a vise and drive **roll pin (3G)** out through the roll pin hole.

5. Remove the **needle rollers (3C)** and **spacer (3D)** from inside **planet gear (3F).**

6. Repeat steps 1-5 to remove and disassemble the two remaining planet gears.

7. At this point the carrier disassembly is complete.

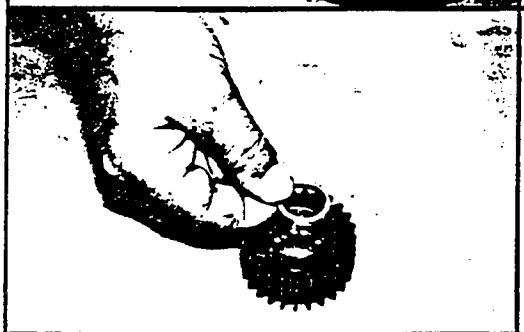
CARRIER SUB-ASSEMBLY



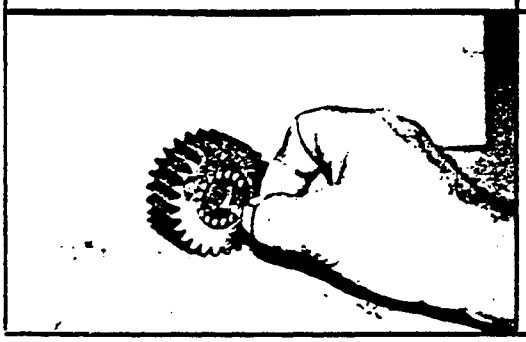
1. Apply grease to the inside of one **planet gear (3F).**



2. Line one half of **planet gear (2F)** with **16 needle rollers (3C).**

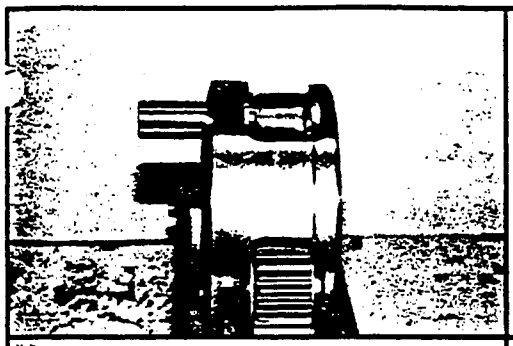


3. Place one **spacer (3D)** inside **planet gear (3F)** so that it rests on top of the **needle rollers (3C).**

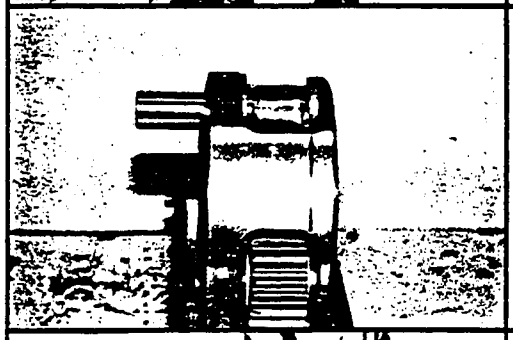


4. Line the remaining half of **planet gear (3F)** with **16 needle rollers (3C).**

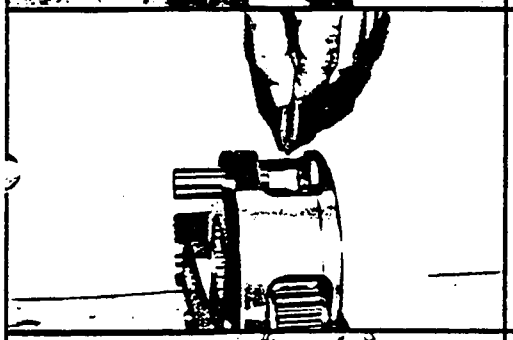
Carrier Sub-Assembly 5



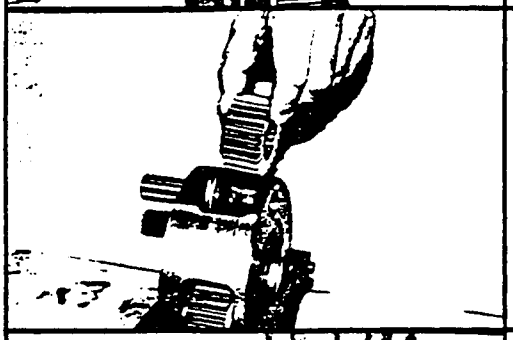
5. Stand **carrier housing** (3A) in an upright position.



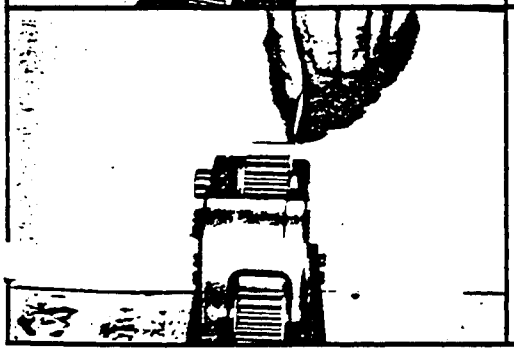
6. Insert a **planet shaft** (3E) into one of the planet shaft holes which also has a roll pin hole on **carrier housing** (3A). The end of the planet shaft that does <u>not</u> have the roll pin hole should be inserted into the carrier housing <u>first</u>.



7. Place one **thrust washer** (3B) onto the end of **planet shaft** (3E) which has been inserted through the planet shaft hole. Notice that the thrust washer has a tang on it: the tang should point straight down so as to fit within the space in the raised inside edge of the planet shaft hole.

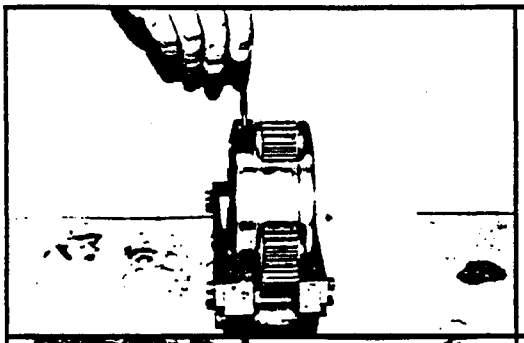


8. Following the thrust washer, place assembled **planet gear** (3F) onto **planet shaft** (3E).

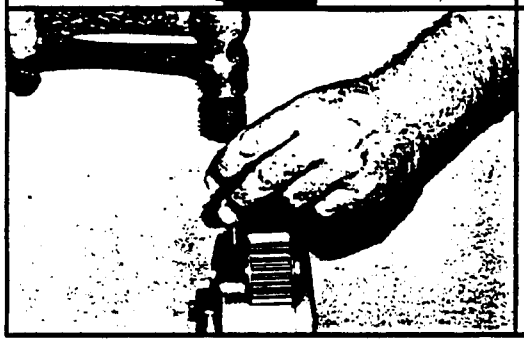


9. Following the planet gear, place one more **thrust washer** (3B) onto **planet shaft** (3E). Now insert **planet shaft** (3E) through the opposite planet shaft hole on **carrier housing** (3A).

6 Carrier Sub-Assembly



10. Use an alignment punch or similar tool to align the roll pin holes on the **carrier housing (3A)** and **planet shaft (3E).**

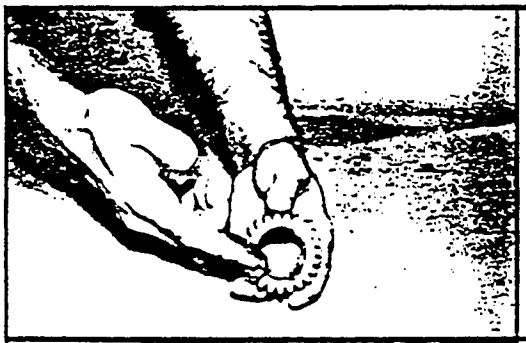


11. Drive **roll pin (3G)** down into the aligned roll pin holes.

12. Repeat steps 1-11 to assemble and install the two remaining planet gears.

13. At this point the carrier sub-assembly is complete.

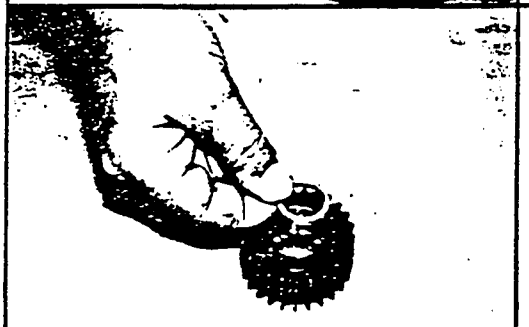
CARRIER SUB-ASSEMBLY



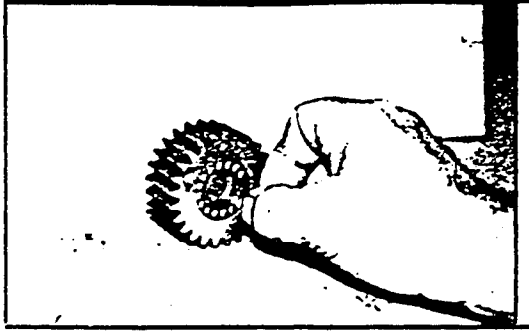
1. Apply grease to the inside of one **planet gear (3F).**



2. Line one half of **planet gear (2F)** with **16 needle rollers (3C).**



3. Place one **spacer (3D)** inside **planet gear (3F)** so that it rests on top of the **needle rollers (3C).**



4. Line the remaining half of planet gear (3F) with 16 needle rollers (3C).

17. If **seal (1B)** and **bearing cone (1D)** remain in the hub, press the seal and bearing cone out using a bearing cone pressing tool (T-116407). Discard the seal.

18. Lift **bearing cone (1F)** out of **hub (1G)**.

19. Stand **hub(1G)** on its small diameter end. Using a soft punch and hammer, remove **bearing cup (1C)** from the counterbore of **hub (1G)**. Be very careful not to strike the counterbore when using the punch.

20. Turn **hub (1G)** over so that it rests on its large end. Using a soft punch and hammer, remove **bearing cup (1E)** from the counterbore of **hub (1G)**. Be very careful not to strike the counterbore when using the punch.

21. At this point the main disassembly is complete.

CARRIER DISASSEMBLY

1. Locate **roll pin (3G)** which holds **planet shaft (3E)** in the **carrier housing (3A)**.

2. Drive the **roll pin (3G)** down into **planet shaft (3E)** until it bottoms against the carrier housing. If the roll pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

3. Remove **planet shaft (3E)** from **carrier housing (3A)**. The two **thrust washers (3B)** and **planet gear (3F)** will slide off.

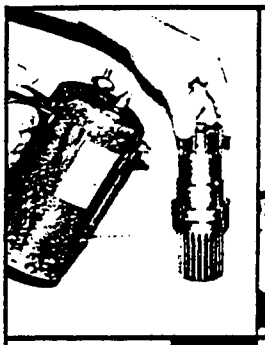
4. Place **planet shaft (3E)** in a vise and drive **roll pin (3G)** out through the roll pin hole.

5. Remove the **needle rollers (3C)** and **spacer (3D)** from inside **planet gear (3F)**.

6. Repeat steps 1-5 to remove and disassemble the two remaining planet gears.

7. At this point the carrier disassembly is complete.

HUB-SHAFT SUB-ASSEMBLY



1. Oil **output shaft** (1A) and **bearing cone** (1D).



2. Using bearing cone pressing tool (T-116407), press **bearing cone** (1D) onto the end of **output shaft** (1A) that has the retaining ring groove.



3. Stand **hub** (1G) on its small end. Using bearing cup pressing tool (T-116412), press **bearing cup** (1E) down into **hub** (1G).

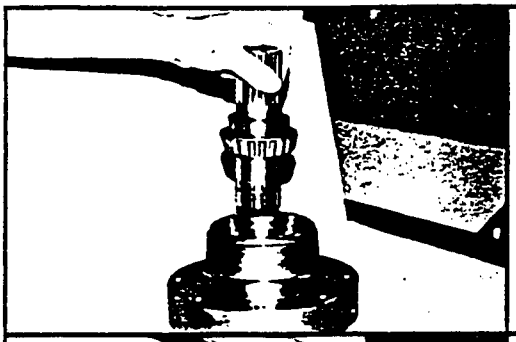
NOTE: Make sure that the cup sits square with the counterbore before pressing.



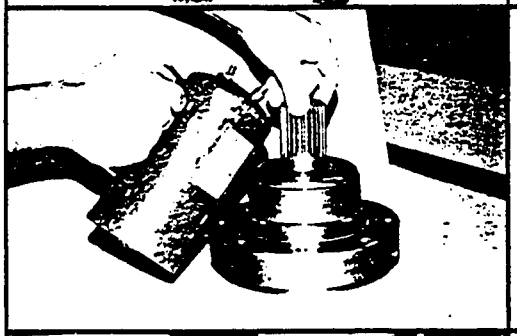
4. Turn **hub** (1G) over so that it rests on its large diameter end. Using bearing cup pressing tool (T-116412), press **bearing cup** (1C) into the small end of **hub** (1G).

NOTE: Make sure that the cup sits square with the counterbore before pressing.

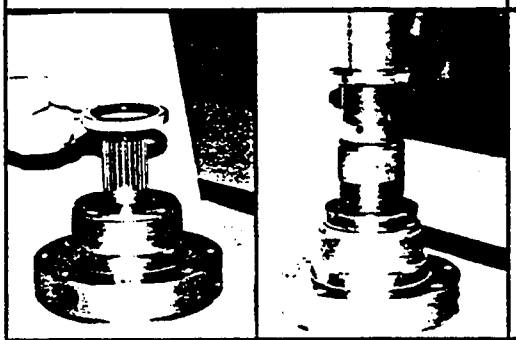
8 Hub-Shaft Sub-Assembly



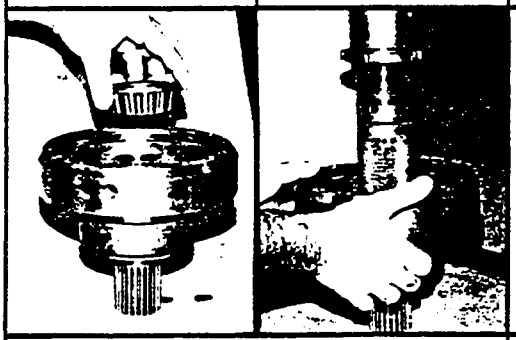
5. With **hub (1G)** still standing on its large end, place **output shaft (1A)** into **hub (1G)** so that the end of the shaft with the retaining ring groove points down.



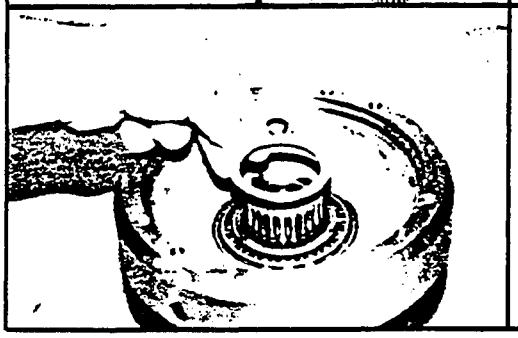
6. Oil **output shaft (1A)**.



7. Using seal pressing tool (T-116402), press **seal (1B)** into the counterbore in the small end of **hub (1G)**. The closed face of the seal should be up.

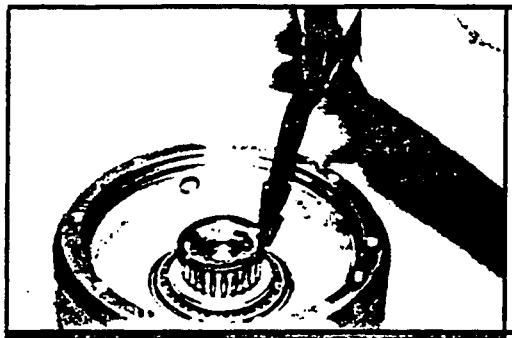


8. Turn **hub(1G)** over so that its small end points down. Using bearing cone pressing tool (T-116407), press **bearing cone (1F)** onto **output shaft (1A)**. Rotate the hub while pressing the bearing. Stop pressing when the hub starts to resist rotating.

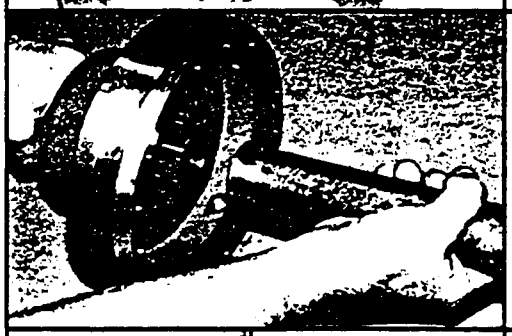


9. Place spacer (1H) onto **output shaft (1A)** so that it rests on top of bearing cone (1F).

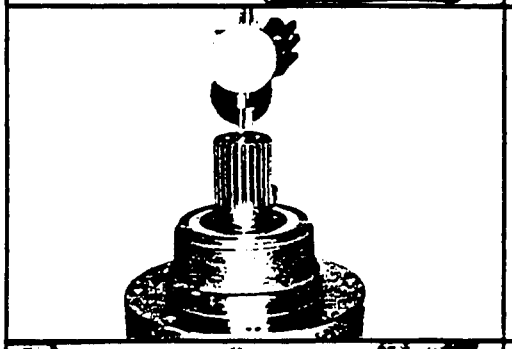
Hub-Shaft Sub-Assembly 9



CAUTION: Safety glasses should be worn during this step:
10. Using retaining ring pliers, place **retaining ring (1I)** into the groove on **output shaft (1A)**. Use a soft punch against the retaining ring to make sure that it is seated.

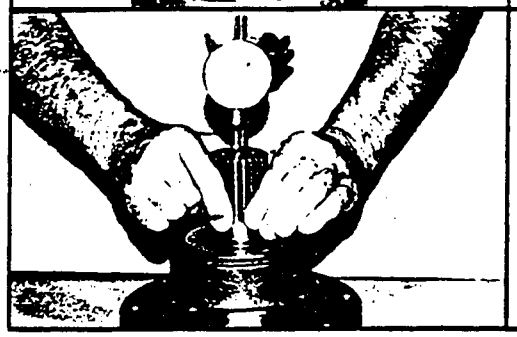


11. Hit the end of **output shaft (1A)** once or twice with a soft face hammer. Turn the shaft in both clockwise and counter clockwise directions while hitting. This will seat the bearing cone against the spacer and retaining ring, allowing necessary endplay in the hub-shaft sub-assembly.



12. Turn **hub (1G)** over so that it rests on its large end. Measure the endplay in the hub-shaft sub-assembly. To do this, follow steps a-c:

a. Mount a dial indicator on **hub (1G)**.Locate the dial rod on top of **output shaft (1A)**.

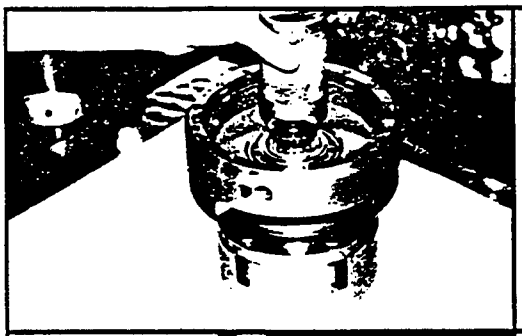


b. Lift up on the output shaft until the needle on the dial stops moving.

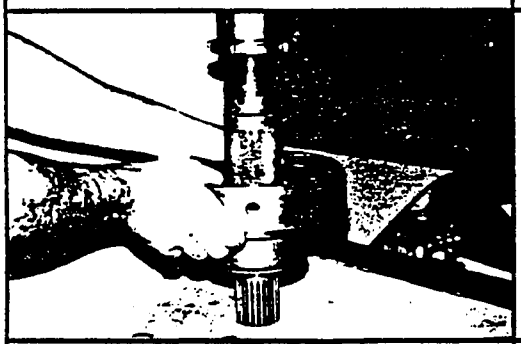
NOTE: Before doing step c, be aware that some applications of this unit may require an endplay of 0.000 in. to 0.003 in. If this is the case, installation of shims on bearing cone (1F) may be necessary to achieve this endplay. Contact your original equipment manufacturer (OEM) for the endplay information on your unit.

c. Read the dial. The reading on the dial should be no greater than 0.008 in.
- If the reading is less than 0.008 in., go to step 13.
- If the reading is above 0.008 in., continue to do steps d-h.

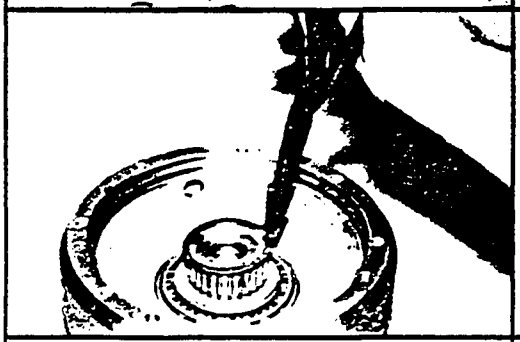
10 Hub-Shaft Sub-Assembly



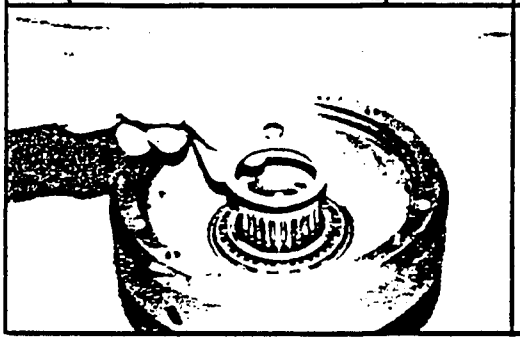
d. Place a bearing cone pressing tool (T-116407) on top of retaining ring (1I).



e. Press the fixture with a hydraulic ram or by striking it with a soft face hammer. Pressure should be applied until the hub rotates with difficulty. This step is necessary in order to remove the preload against the retaining ring.



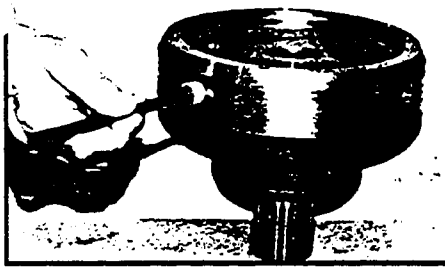
CAUTION: Safety glasses should be worn during this procedure.
f. Using retaining ring pliers, remove retaining ring (1I) and discard.
NOTE: Do not reuse the retaining ring.



g. Remove spacer (1H) and replace it on the output shaft with an SK91 spacer. This spacer is thicker and will reduce the endplay.

h. Repeat steps 8-12 to reassemble the shaft and remeasure the endplay.

Hub-Shaft Sub-Assembly 11

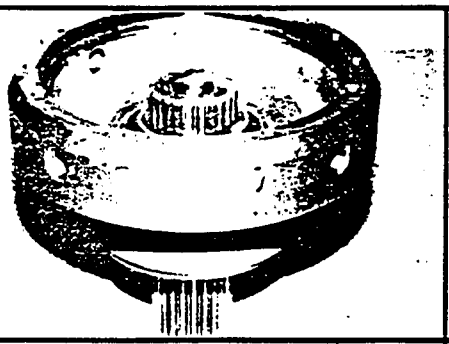


13. Apply a light coat of "Never-Seize" to the three **pipe plugs (1J)**. Tighten **pipe plugs (1J)** into the three pipe plug **holes on hub (1G)**.

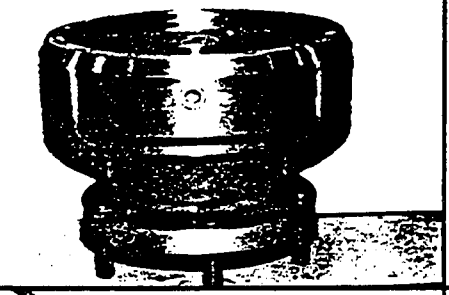
14. At this point the hub-shaft sub-assembly is complete.

12

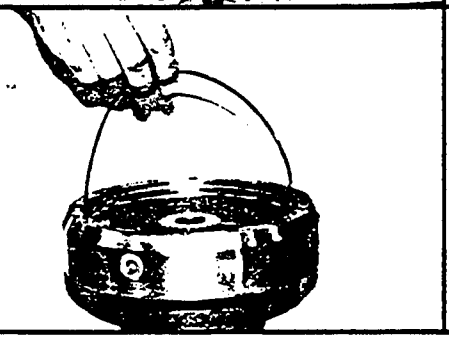
MAIN ASSEMBLY



1. Position hub (1G) on its output shaft (1A) so that the hub's small diameter end points down.



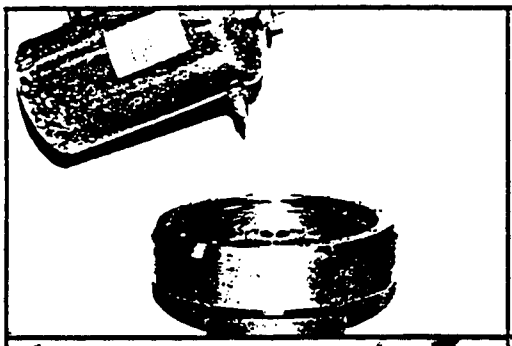
2. Mark the four shoulder bolt holes in hub (1G) with chalk or marker so that they can be aligned with the shoulder bolt holes in the ring gear (2) in a later step.



3. Grease "O" ring (5). Place "O" ring (5) into the counterbore of hub (1G).

CAUTION: Beware of sharp edges and burrs around the counterbore when installing the "O" ring.

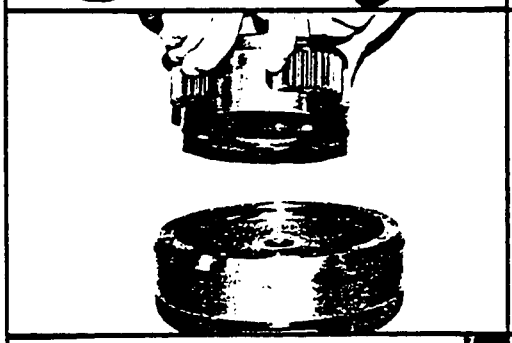
NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



4. Oil all exposed surfaces inside hub (1G).



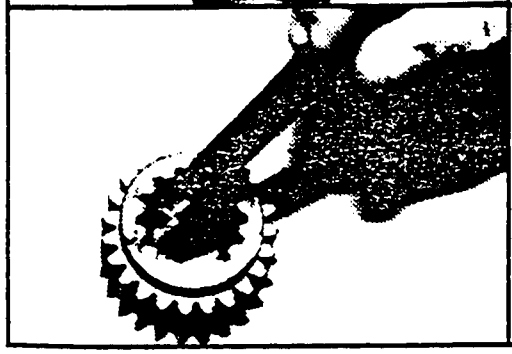
5. Oil carrier sub-assembly (3).



6. Place carrier sub-assembly (3), with spline connections down, into mesh with output shaft (1A).

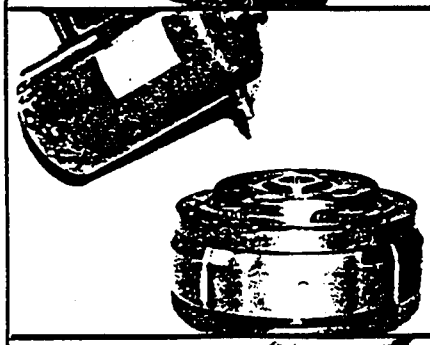


7. Place ring gear (2), with squared shoulder side down, into mesh with the planet gears (3F) of the carrier sub-assembly. Make sure that the shoulder bolt hole that is marked with an "X" on the ring gear aligns with any one of the marked shoulder bolt holes on the hub. The "X" should be on the cover side the ring gear.

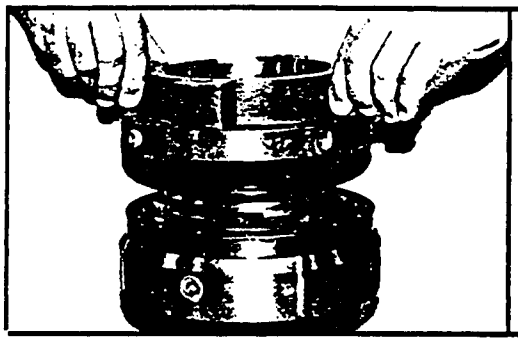


8. Start one half of retaining ring (20) into the groove inside input gear (9). Use a soft punch to press the remaining half of the retaining ring into the groove.

14 Main Assembly

	9. Insert input gear (9), with large diameter end down, into mesh with planet gears (3F).
	10. Place large thrust washer (11) over input gear (9) so that it rests on carrier housing (3A).
	11. Oil all exposed surfaces inside hub (1G).
	12. Grease "O" ring (5). Place "O" ring (5) into the counterbore of cover (6). CAUTION: Beware of sharp edges and burrs around the counterbore when installing "O" ring.

NOTE: "O" rings may be stretched to fit counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



14. Place cover (6) on top of ring gear (2) so that the two pipe plug holes in the cover line up between the pipe plug holes in the hub as shown in Diagram 1: pipe plug timing.

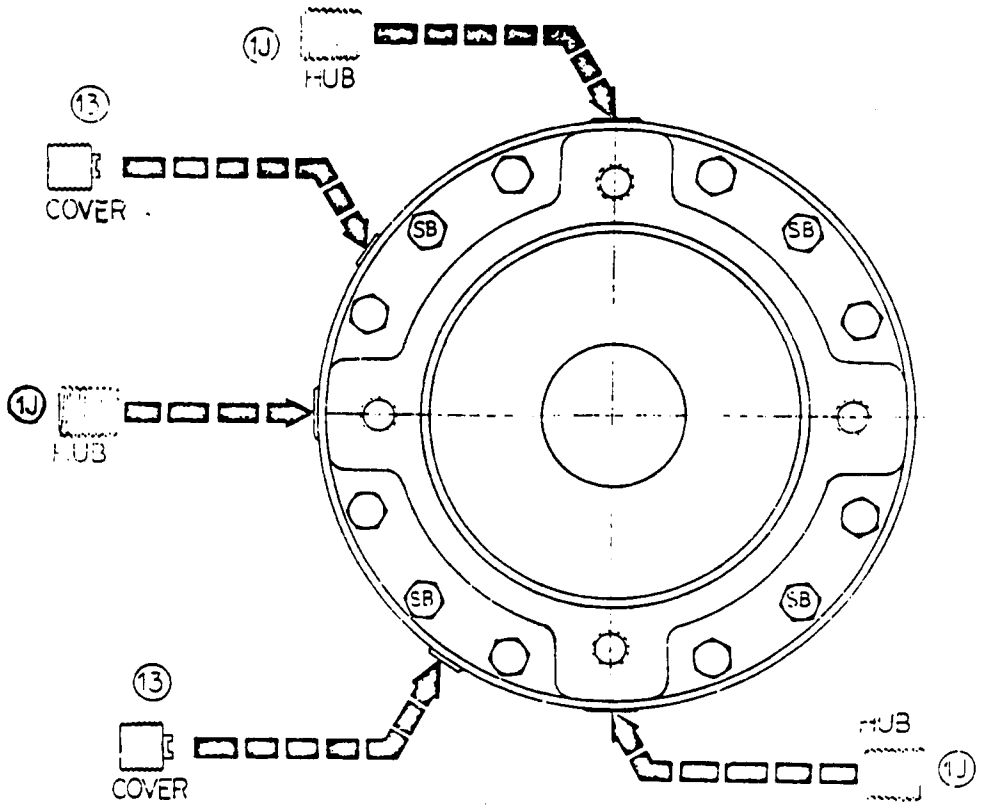
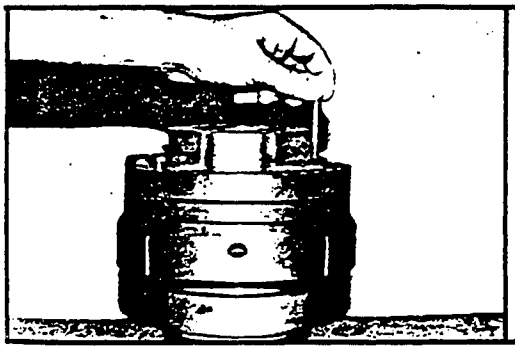
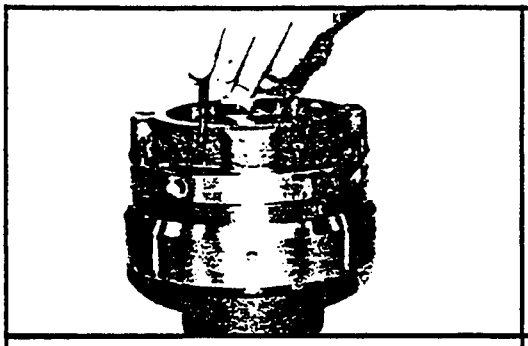


DIAGRAM 1: Pipe plug timing.



15. Place the four shoulder bolts (14) into the shoulder bolt holes marked on the hub and tighten.

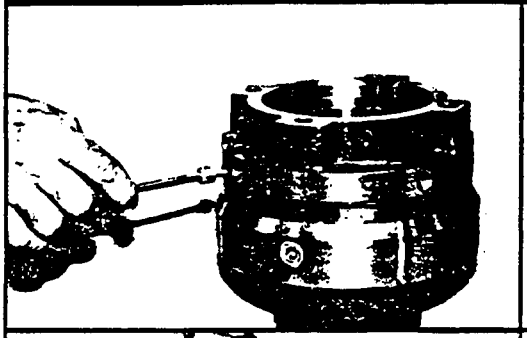
16 Main Assembly



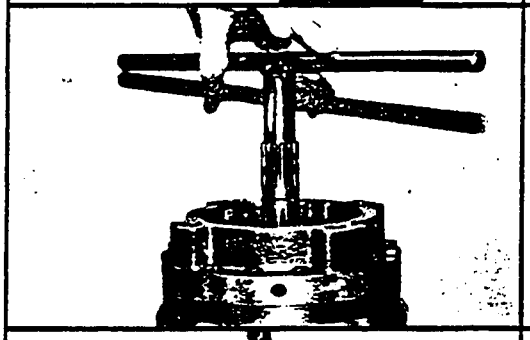
16. Place the eight grade 8 bolts (12) into the remaining bolt holes and tighten.



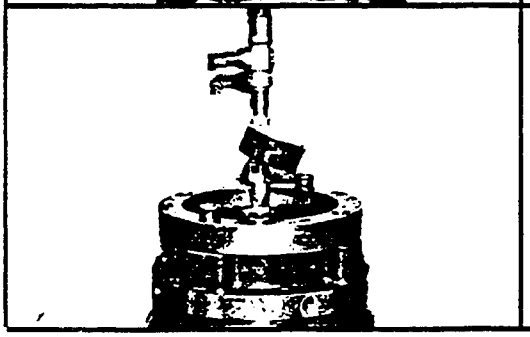
17. Apply 23-27 ft.-lbs. of torque to all bolts.



18. Apply a light coat of "Never-Seize" to both **pipe plugs (13)**. Tighten **pipe plugs (13)** into the two pipe plug holes on **cover (6)**.



19. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns as the ratio of the unit. The ratio is the last two digits of the model number found on the unit's ID tag. For example, unit S1C544S4 should be rolled 4 times in each direction.



20. Leak test the unit at a pressure of 5 psi for 2-3 minutes.

21. At this point the main assembly is complete.

17

TOOLING

The following specialized tools are used in the assembly of this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools exist as one piece and must be made from mild steel. All dimensions are given in inches.

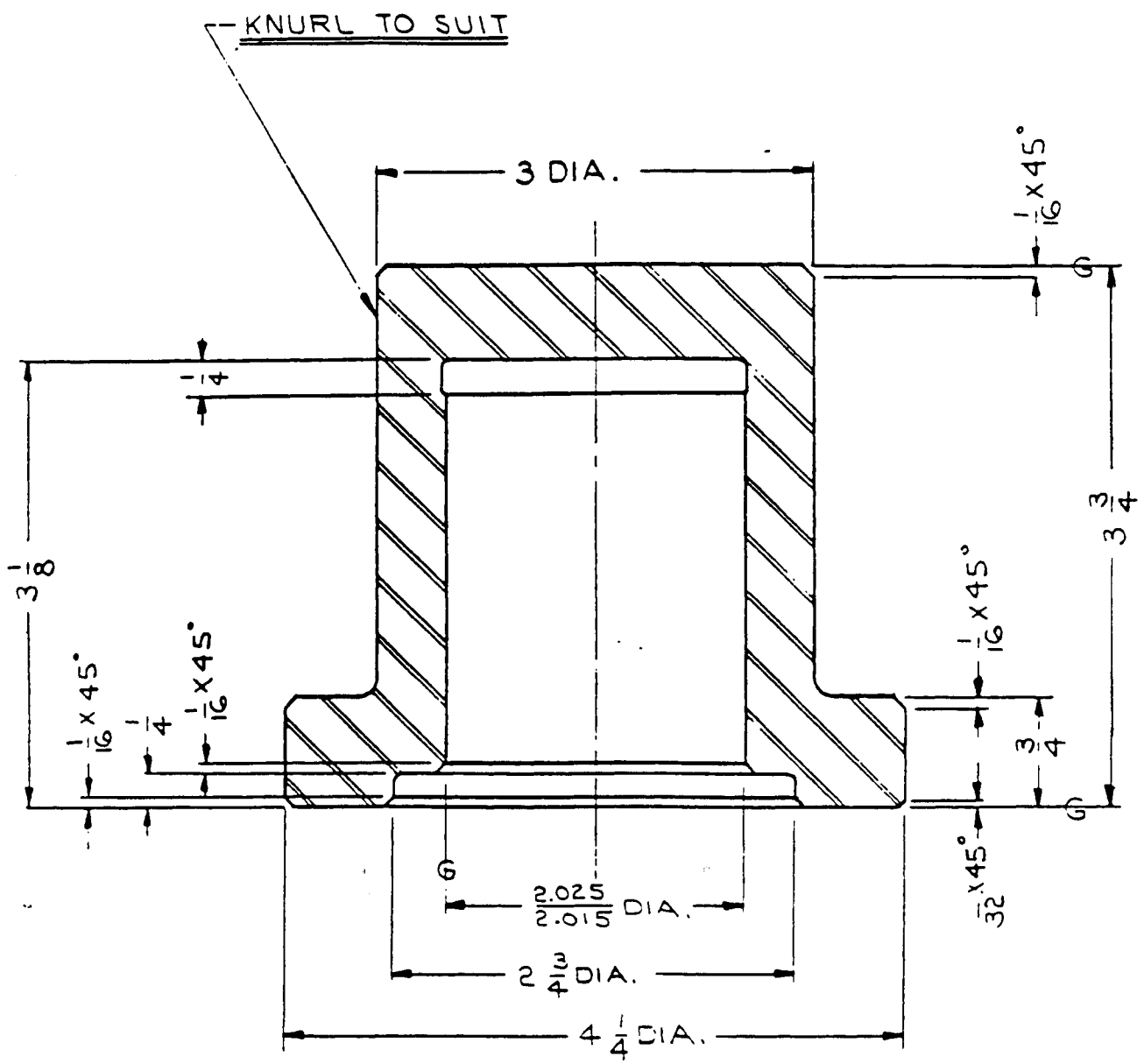
OPTIONAL: In order to improve tool life, tools may be carburized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a "G" on the tool diagram.

1.) T-116402
SEAL PRESSING FIXTURE for SEAL (1B)

2.) T-116407
ASSEMBLY PRESSING TOOL for BEARING CONES (1D) and (1F)

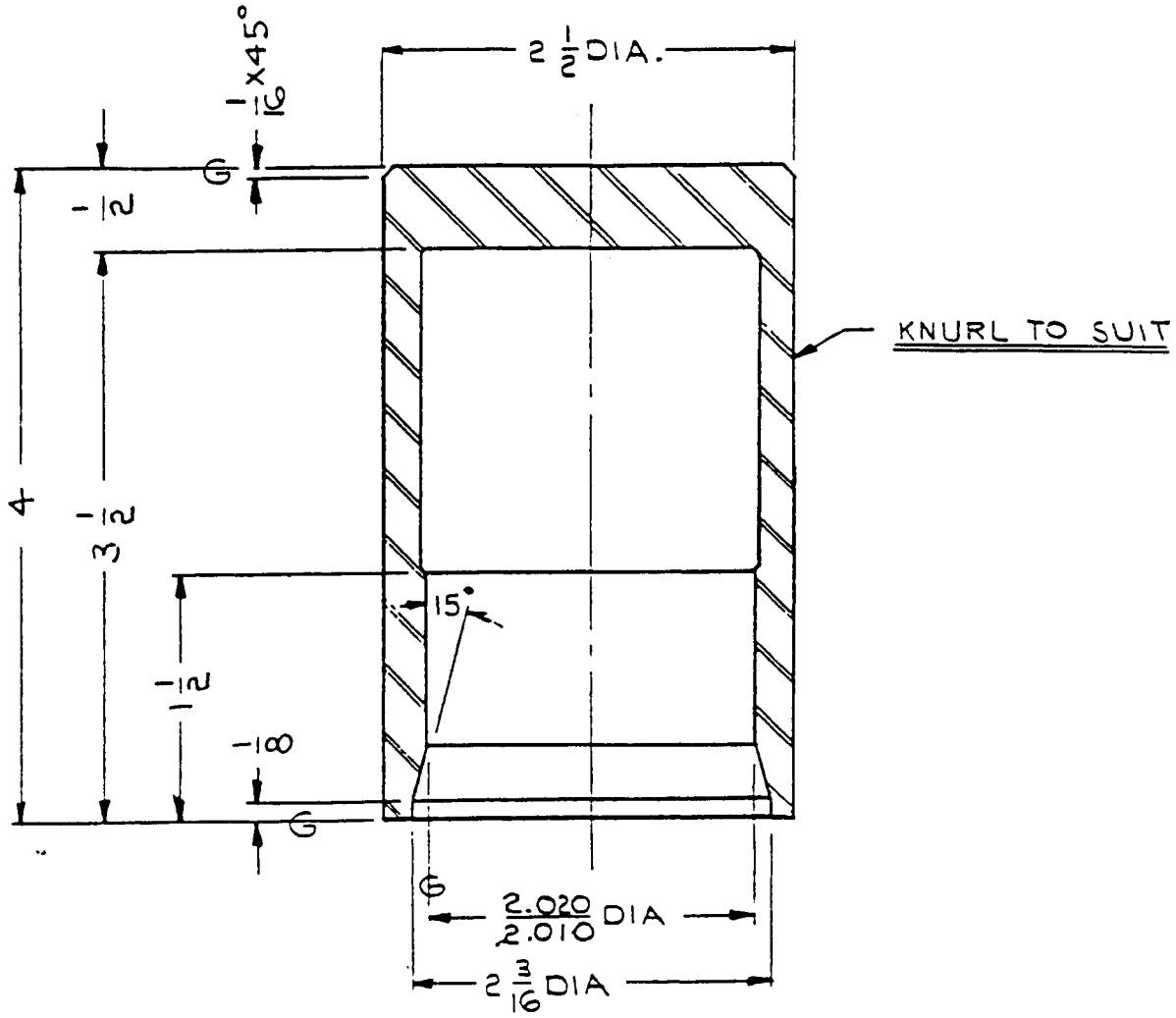
3.) T-116412
ASSEMBLY PRESSING TOOL for BEARING CUPS (1C) and (1E)

18



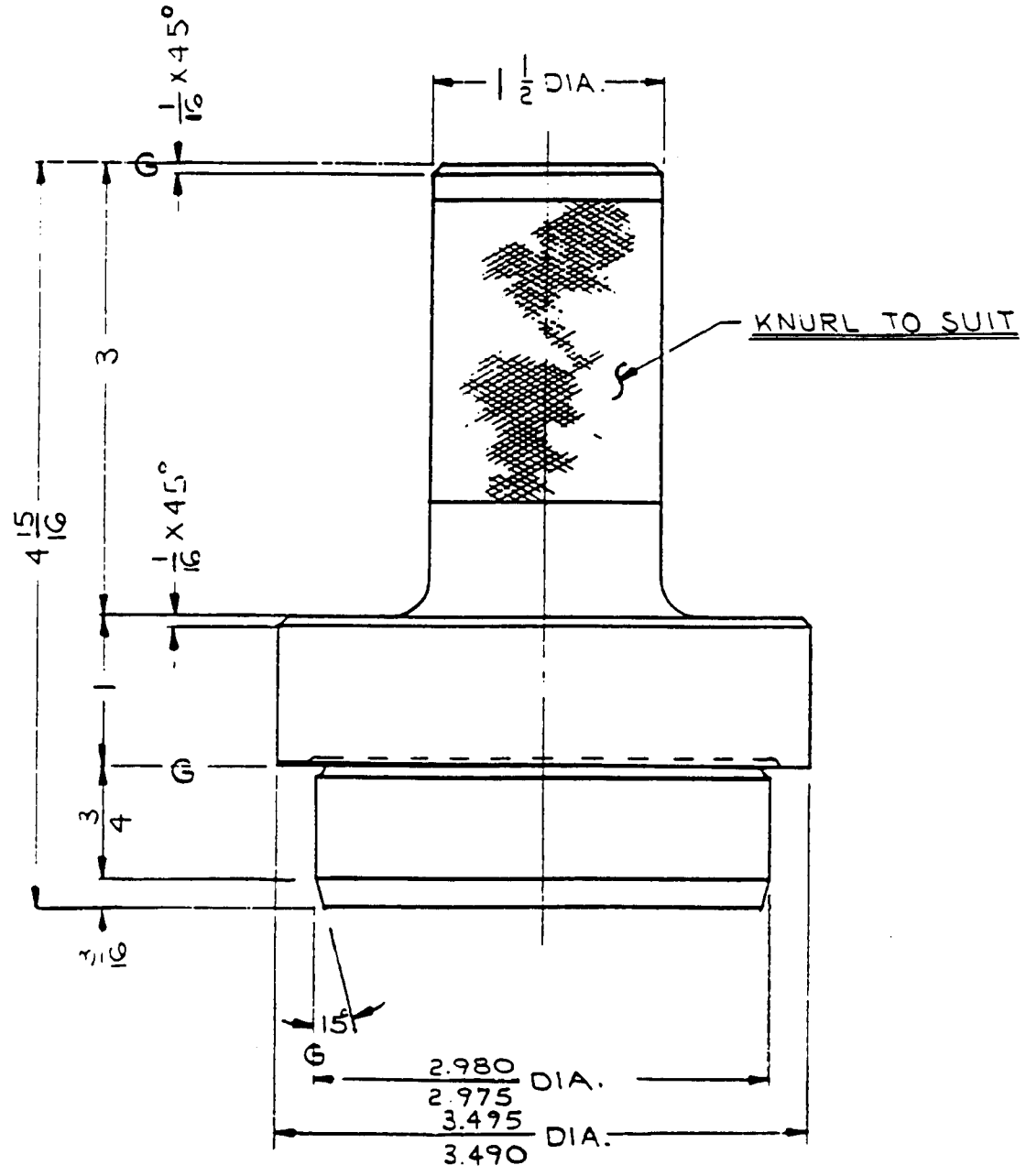
TOOL NO. T-116402

SEAL PRESSING FIXTURE
Used with seal(1B)



TOOL NO. T-116407

BEARING CONE PRESSING FIXTURE
Used with bearing cones(1D) and (1F)



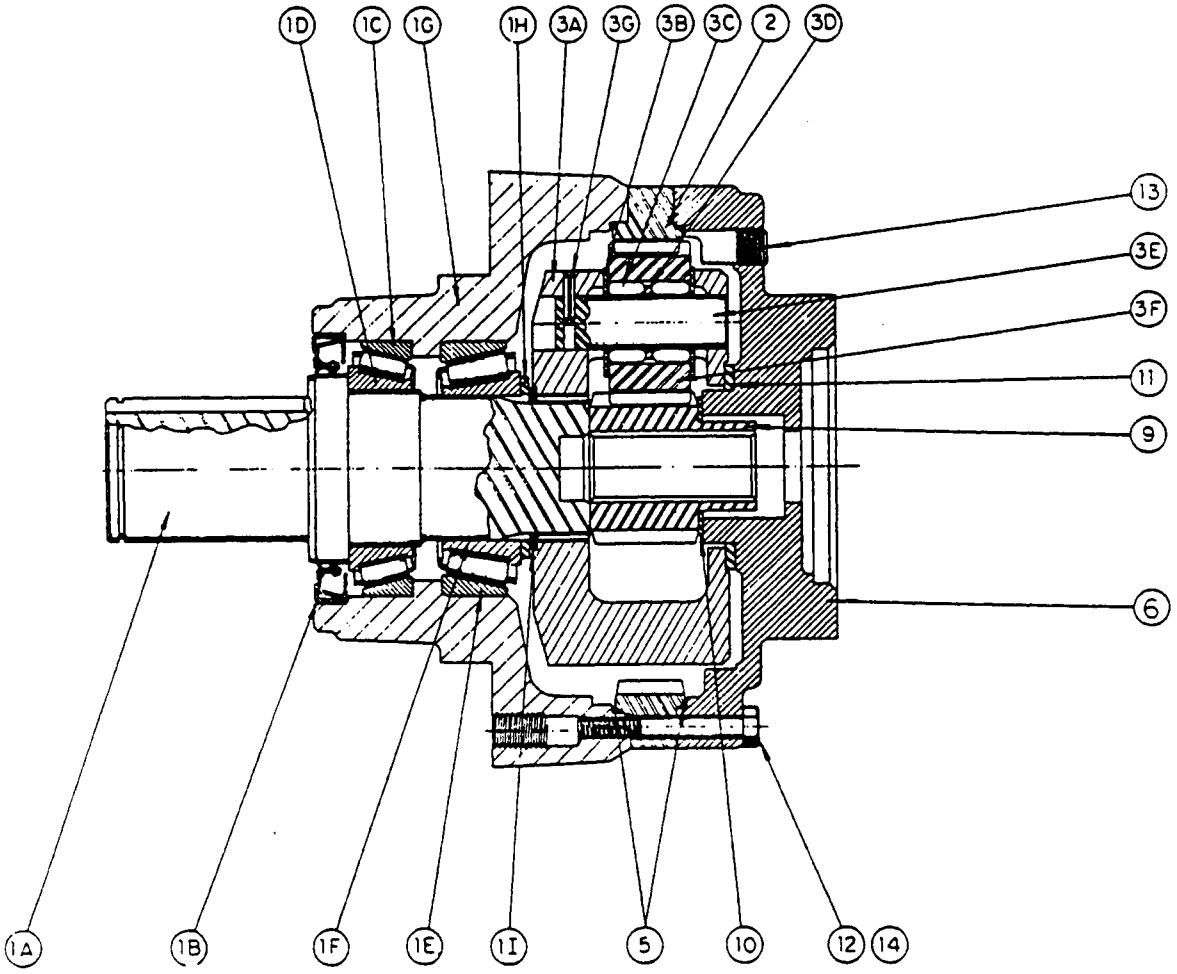
TOOL NO. T-116412

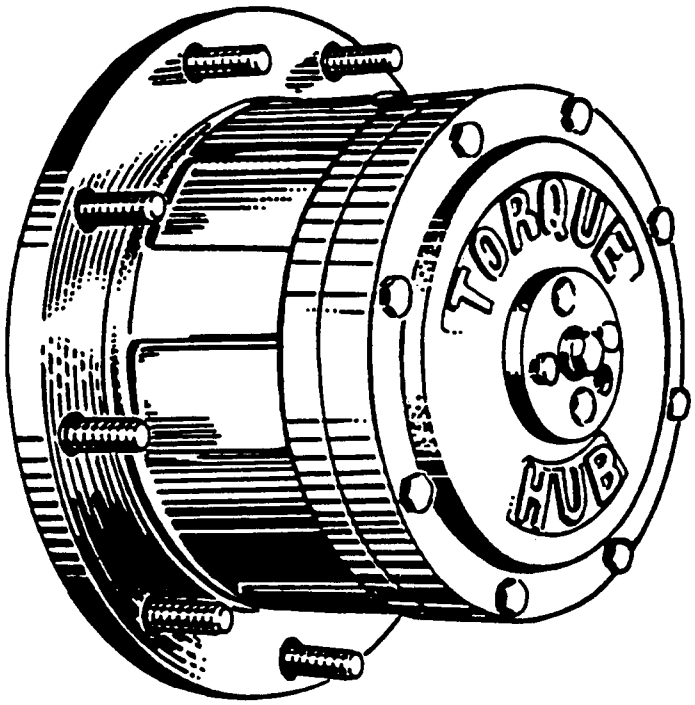
BEARING CUP PRESSING FIXTURE
Used with bearing cups(1C) and (1E)

PARTS LIST

ITEM	QUANTITY	DESCRIPTION
1	1	Hub-Spindle Sub-Assembly
1A	1	output shaft
1B	1	seal
1C	1	bearing cup
1D	1	bearing cone
1E	1	bearing cup
1F	1	bearing cone
1G	1	hub
1H	1	spacer
1I	1	retaining ring
1J	3	pipe plug
2	1	ring gear
3	1	carrier assembly
3A	1	carrier
3B	6	thrust washer
3C	96	needle roller
3D	3	spacer
3E	3	planet shaft
3F	3	planet gear
3G	3	roll pin
5	2	"O" ring
6	1	cover
9	1	input gear
11	1	thrust washer
12	8	bolt
13	2	magnetic pipe plug
14	4	shoulder bolt
20	1	retaining ring
24	1	ID plate
25	4	drive screw

CROSS SECTIONAL VIEW of the S1C





**The best answer
in hydrostatic drives
from the leader in
transmission components**

Fairfield
Manufacturing Company, Inc.

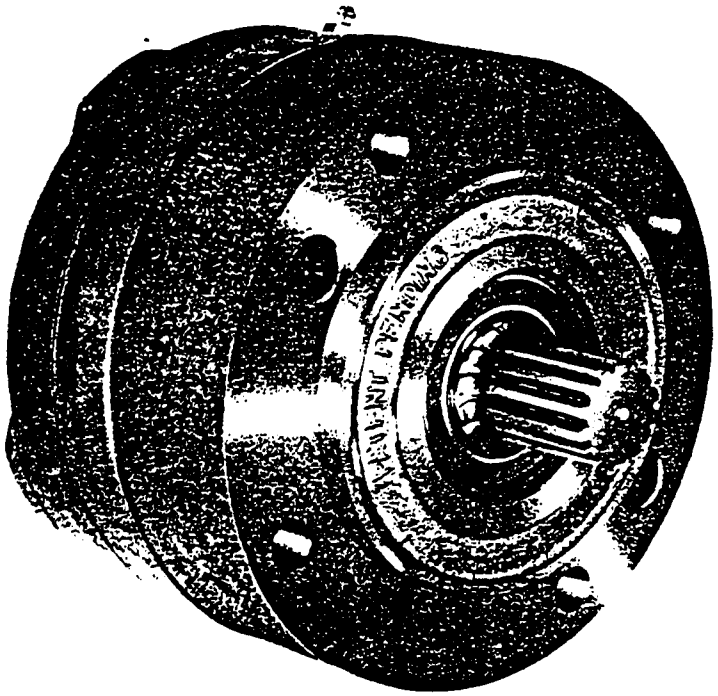
SY·TEC SERIES

MULTIPLE DISC BRAKE

(dry design - SAE C size)

SERVICE MANUAL

FOR TORQUE HUB BRAKE - 21220



MICO INCORPORATED
MICO WEST / SY·TEC

Form No. 81-950-050 9/87

REV.

TYPICAL BRAKE

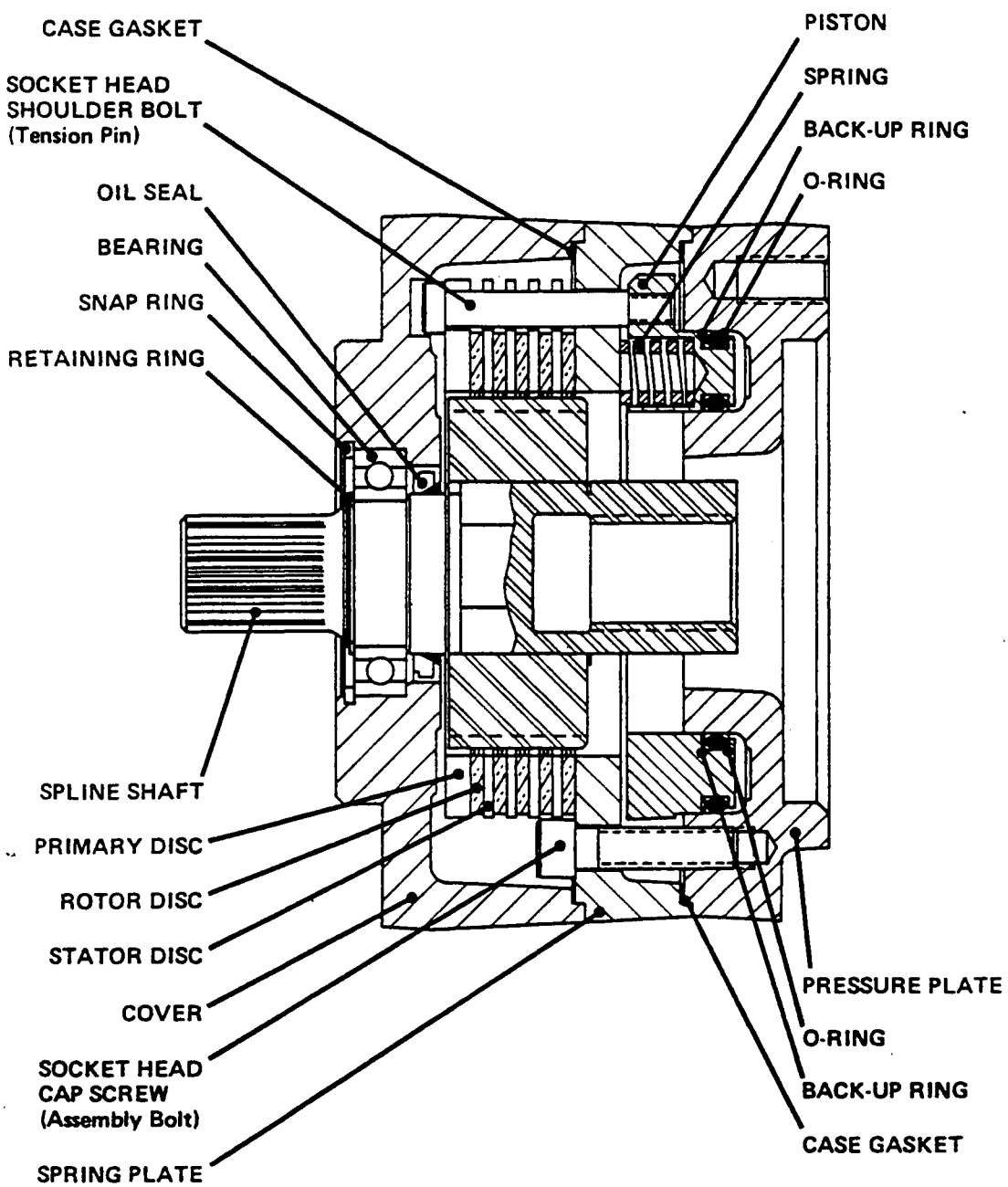


FIGURE 1

PRINCIPLES OF OPERATION

These brakes are spring-set, hydraulically released, 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 brakes are designed to give thousands of trouble-free hours of service when set up correctly in the hydraulic circuit.

DESCRIPTION OF MODEL NUMBERS



SERIES
S - Sy-Tec

OUTPUT FACE
C - SAE C-Mount 4-Bolt

OUTPUT SPLINE
04 - 14T 12/24 (internal)
14 - 14T 12/24 (external)
17 - 17T 12/24
25 - 1.25 Dia. Keyed
10 - 1.0 Dia. Keyed

INPUT SPLINE
14 - 14T 12/24
17 - 17T 12/24
06 - 1.0 Dia. 6B
25 - 1.25 Dia. Keyed
10 - 1.0 Dia. Keyed
21 - 21T 16/32
12 - 12T 12/24
13 - 13T 16/32

TORQUE

INPUT FACE
C - SAE C-Mount 4-Bolt
A - MAB 4-Bolt and SAE A 2-Bolt
R - Closed
B - SAE B-Mount 2-Bolt
A4 - Char-lynn Standard 4000
L - Char-lynn 4000 Bearingless

OPTIONS *
S - Speed Sensor
Z - Oil Cooled
D - Double Bearing
2 - SAE C-Mount 2-Bolt Thru
24 - 2-Bolt Offset C-Mount

* (Available separately or in combination)

1 psi = .06895 bar

Code	Standard (In. lbs.)	High (In. lbs.)	Release Pressure (psi)	Full Release Pressure (psi)
12		12,000	200	230
98	9800		200	230
10		10,000	170	200
80	8000		170	200
85		8500	150	180
70	7000		150	180
66		6600	125	155
55	5500		125	155
54		5400	105	135
45	4500		105	135

Lower torques available on request.

DISASSEMBLY

1. Remove 2 flat head assembly bolts (items 1). A suitable holding fixture 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

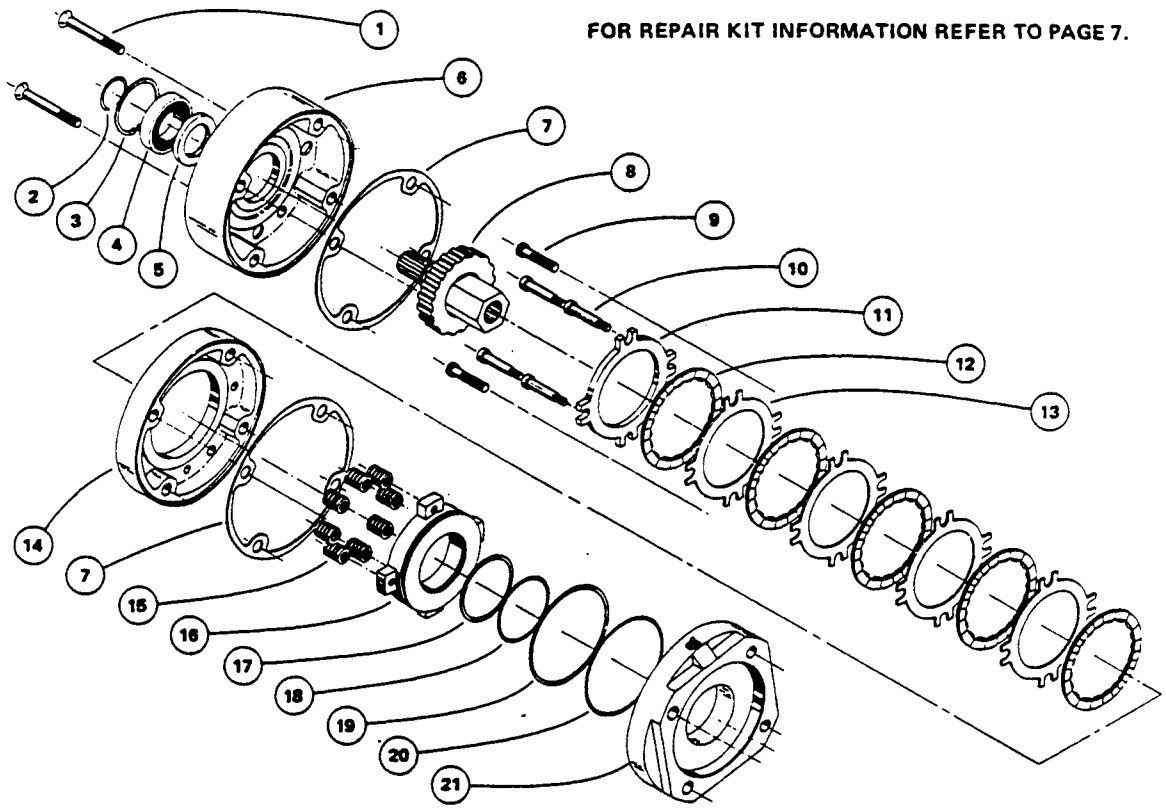
LUBRICATE ALL RUBBER COMPONENTS FROM REPAIR KIT WITH CLEAN TYPE FLUID USED IN THE SYSTEM.

1. Clean all parts thoroughly before assembling.
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 socket head assembly bolts (item 9). **SEE NOTE BELOW.** 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 socket head shoulder bolts (item 10). **SEE NOTE BELOW.** 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). **SEE NOTE BELOW.** Torque bolts to 45 ft. lbs.

NOTE: Bolts should have Loctite applied. Place one or two drops of Loctite to the threads.



FOR REPAIR KIT INFORMATION REFER TO PAGE 7.

FIGURE 2

PARTS LIST

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

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 Figure 2)

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 oil hydraulic or gearbox. 1. Gearbox oil 2. 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
	D. Springs broken or have taken a permanent set	Broken or set springs can cause reduced torque - a rare occurrence	Check release pressure
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.	Replace o-rings
	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

REPAIR KITS

(Refer to Page 5 for item numbers)

NUMBER	DESCRIPTION	INCLUDES
12-501-002	O-ring and Back-up Ring Kit	Case Gaskets (item 7) Face Gasket (not shown) Oil Seal (item 5) O-rings (items 18 & 20) Back-up Rings (items 17 & 19) Loc-tite
12-501-004	Lining Kit	Case Gaskets (item 7) Face Gasket (not shown) Primary Disc (item 11) Stator Discs (item 13) Rotor Discs (item 12) Loc-tite
12-501-006	Bearing Kit	Case Gaskets (item 7) Face Gasket (not shown) Bearing (item 4) Loc-tite
12-501-008	Spring Kit	Case Gaskets (item 7) Face Gasket (not shown) Springs - red (item 15) Springs - blue (item 15) Loc-tite
12-501-014	High Torque Lining Kit	Case Gaskets (item 7) Face Gasket (not shown) Primary Disc (item 11) Stator Discs (item 13) Rotor Discs - thick (item 12) Rotor Discs - thin (item 12) Loc-tite

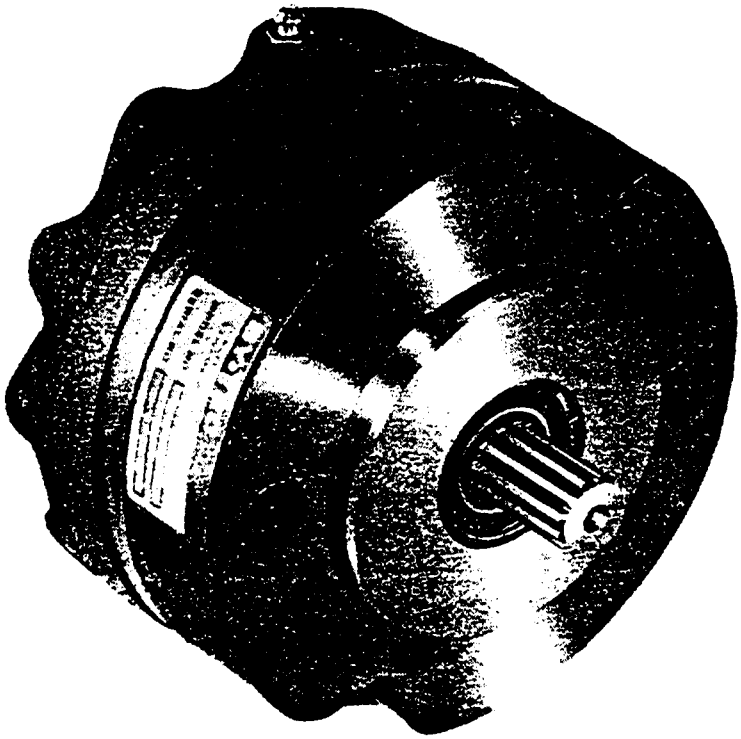
SY·TEC SERIES

MULTIPLE DISC BRAKE

(dry design - SAE B size)

SERVICE MANUAL mico

FOR ROTATION GEARBOX BRAKE - 22831



mico INCORPORATED
mico WEST / SY·TEC

FORM NO. 81-950-051 5/86

REV.

TYPICAL BRAKE

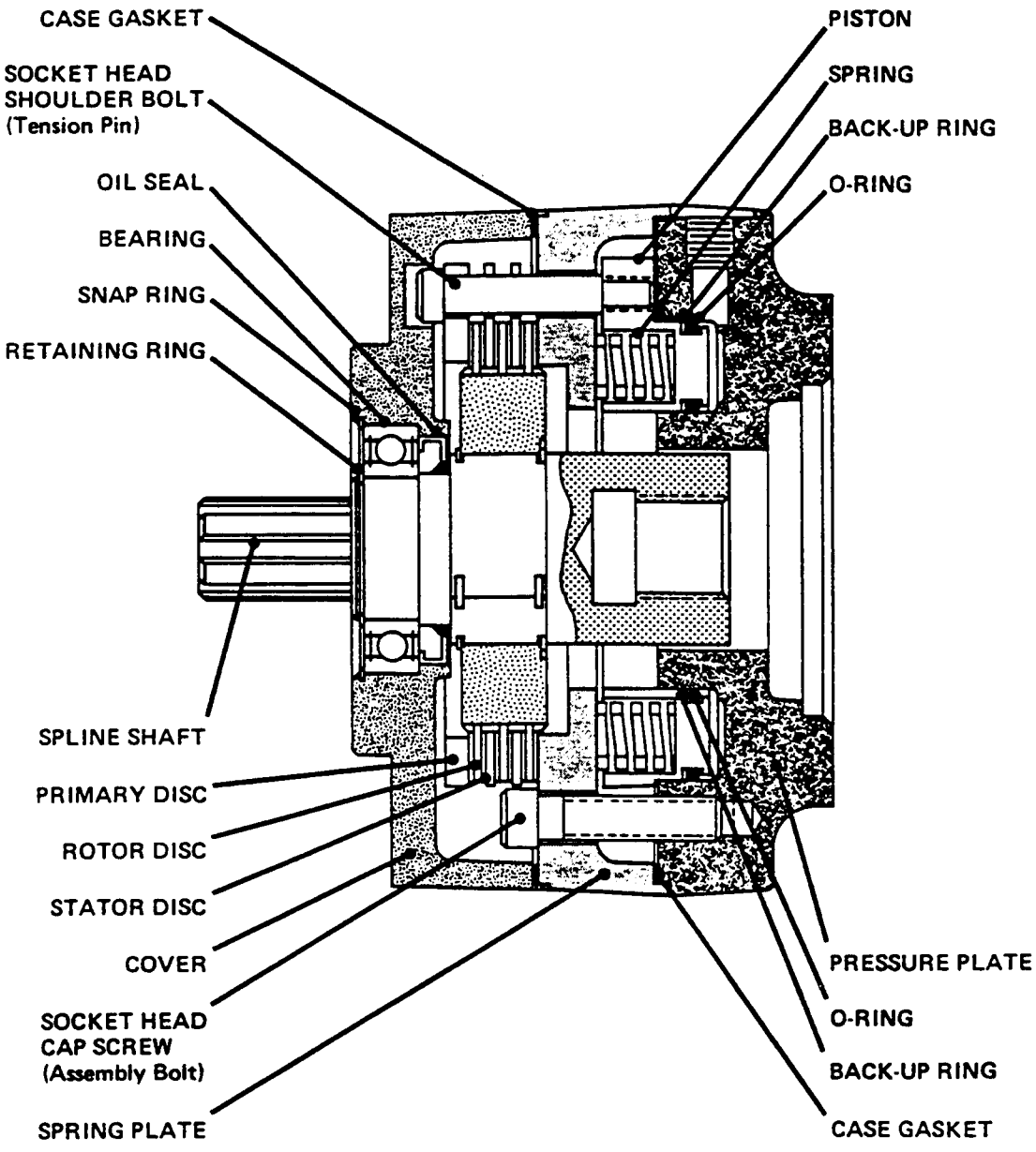


FIGURE 1

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.

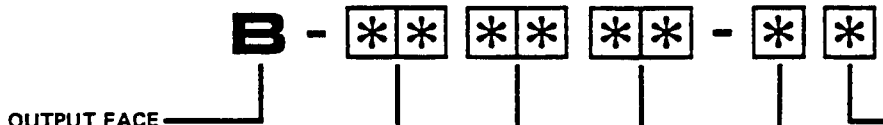
It is very important to remember that any pressure on the brake's release piston will directly effect the level of torque.

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



OUTPUT FACE
SAE B Mt. (2) Bolt

OUTPUT SPLINE
13–13T 16/32
06–1.0 Dia. 6B
25–1.25 Dia. Keyed

INPUT SPLINE
13–13T 16/32
06–1.0 Dia. 6B
25–1.25 Dia. Keyed

TORQUE

Code	Std.	High	Release
40		4000	190
28	2800		190
35		3500	150
24	2400		150
29		2900	135
19	1900		135
25		2500	120
16	1600		120
18		1800	100
12	1200		100

INPUT FACE
B–2-Bolt Mt.
A–MAB (4) Bolt &
SAE A2 Bolt

OPTIONS
S–Speed Sensor
Z–Wet
D–Double Bearing

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), three rotor discs (items 12) and two 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 six springs (items 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.

FOR REPAIR KIT INFORMATION REFER TO PAGE 7.

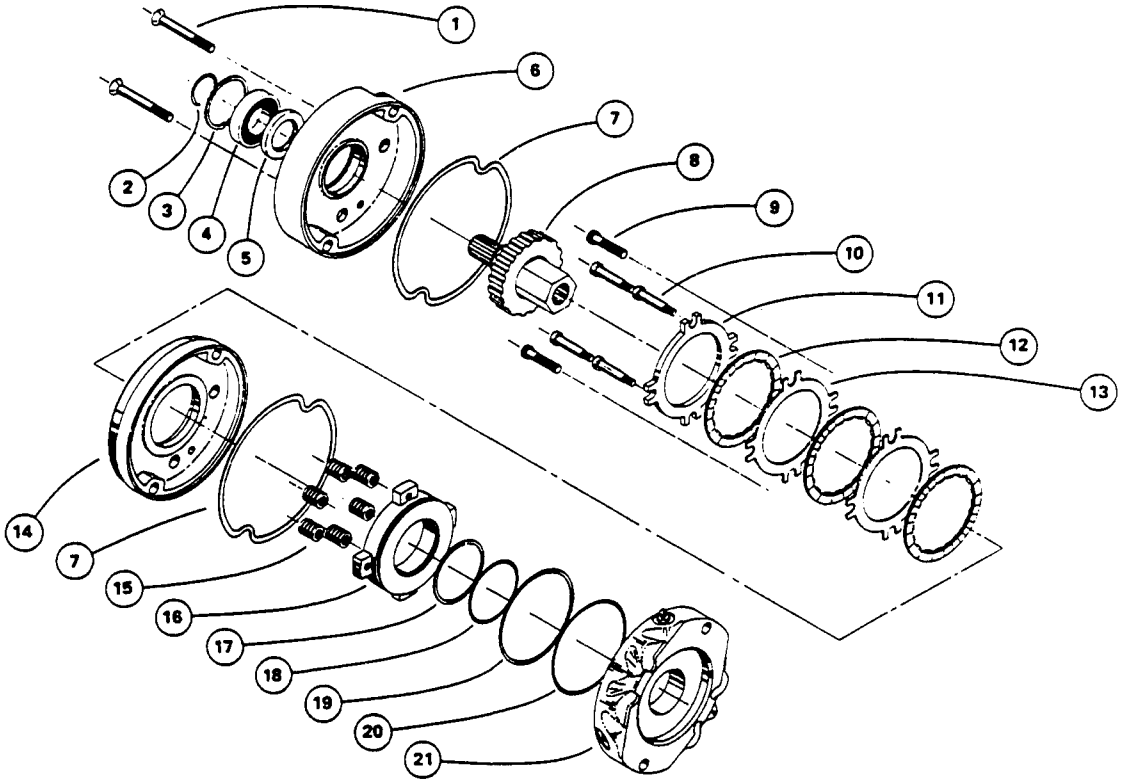


FIGURE 2

PARTS LIST

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

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

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
	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.	
	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

REPLACEMENT KITS

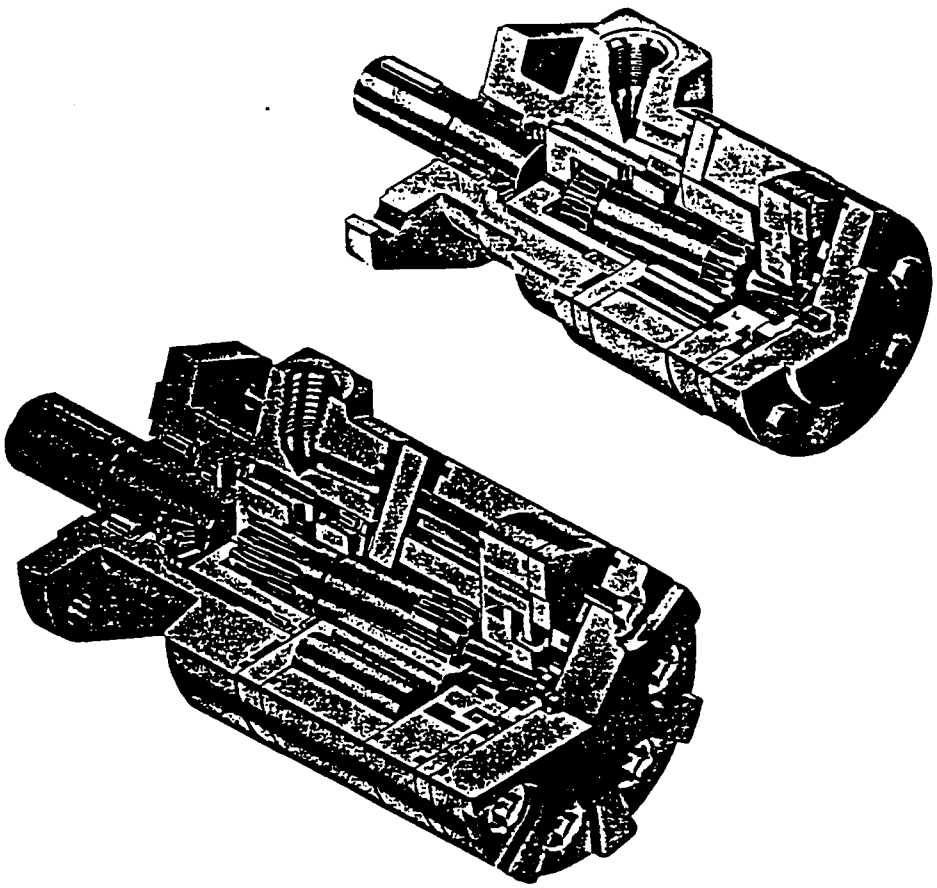
PART NUMBER	KIT DESCRIPTION	KIT INCLUDES
RK-1 plus your brake model number	Inspection Kit	Face Gaskets Case Gaskets
RK-2 plus your brake model number	Oil Seal & Gasket Replacement Kit	Face Gaskets Case Gaskets Oil Seal
RK-3 plus your brake model number	O-ring & Back-up Ring Replacement Kit	Face Gaskets 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

TRW

Torqmotor™

FOR ROTATION GEARBOX
HYDRAULIC MOTOR - 81276

MG, MF, MB, ME Series Service Procedure



TRW Ross Gear Division

Troubleshooting Guide

NOTE: Before troubleshooting any system problem, check service literature published by the equipment and/or component manufacturers. Follow their instructions, if given, for checking any component other than the Torqmotor™ unit.

Preparation

Make your troubleshooting easier by preparing as follows:

- work in a clean, well-lighted place;
- have proper tools and materials nearby;
- have an adequate supply of clean petroleum-based solvent.

WARNING: SINCE SOLVENTS ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT, EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA AND OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

Preliminary Checks

Hydraulic systems are often trouble-free. Hence, the problem an operator complains of could be caused by something other than the hydraulic components.

Thus, once you have determined that a problem exists, start with the easy-to-check items, such as:

- parts damaged from impact that were not properly repaired, or that should have been replaced; and
- improper replacement parts used in previous servicing
- mechanical linkage problems such as binding, broken, or loose parts or slipping belts.

Hydraulic Components

If you think the problem is caused by a hydraulic component, start by checking the easy-to-reach items.

Check all hoses and lines for cracks, hardening, or other signs of wear. Reroute any useable hoses that are kinked, severely bent, or that rest against hot engine parts. Look for leaks, especially at couplings and fittings. Replace any hoses or lines that don't meet system flow and pressure ratings.

Next, go to the reservoir and filter or filters. Check fluid level and look for air bubbles. Check the filter(s). A filter with a maximum 50 micron filtration is recommended for the Torqmotor system.

Visually check other components to see if they are loosely mounted, show signs of leaks, or other damage or wear.

Excessive heat in a hydraulic system can create problems that can easily be overlooked. Every system has its limitation for the maximum amount of temperature. After the temperature is attained and passed, the following can occur:

- oil seal leaks
- loss of efficiency such as speed and torque
- pump loss of efficiency
- pump failure
- hoses become hard and brittle
- hose failure

A normal temperature range means an efficient hydraulic system. Consult the manuals published by equipment and/or component manufacturers for maximum allowable temperatures and hydraulic tests that may be necessary to run on the performance of the hydraulic components. The Torqmotor™ is not recommended for hydraulic systems with maximum temperatures above 200°F (93.3°C).

Troubleshooting Checklist

Trouble	Cause	Remedy
Oil Leakage	1. Hose fittings loose, worn or damaged	Check & replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings (4) deteriorated by excess heat	Replace oil seal rings by disassembling Torqmotor™ unit.
	3. Special bolt (1, 1A, 1B or 1C) loose or its sealing area deteriorated by corrosion	(a) Loosen then tighten single bolt to torque specification. (b) Replace bolt.
	4. Internal shaft seal (16) worn or damaged	Replace seal. Disassembly of Torqmotor™ unit necessary.
	5. Worn coupling shaft (12) and internal seal (16)	Replace coupling shaft and seal by disassembling Torqmotor™ unit.
Significant loss of speed under load	1. Lack of sufficient oil supply	(a) Check for faulty relief valve and adjust or replace as required. (b) Check for and repair worn pump. (c) Check for and use correct oil for temperature of operation.
	2. High internal motor leakage	(a) Replace worn rotor set by disassembling Torqmotor™ unit.
	3. Severely worn or damaged internal splines	Replace rotor set, drive link and coupling shaft by disassembling Torqmotor™ unit.
	4. Excessive heat	Locate excessive heat source (usually a restriction) in the system and correct the condition.
Low mechanical efficiency or undue high pressure required to operate Torqmotor™ unit	1. Line blockage	Locate blockage source and repair or replace.
	2. Internal interference	Disassemble Torqmotor™ unit, identify and remedy cause and repair, replacing parts as necessary.
	3. Lack of pumping pressure	Check for and repair worn pump.
	4. Excessive binding or loading in system external to Torqmotor™ unit.	Locate source and eliminate cause.

CAUTION: If the hydraulic system fluid becomes overheated [in excess of 200°F (93.3°C)], seals in the system can shrink, harden or crack, thus losing their sealing ability.

Disassembly and Inspection

(Reference Exploded Assembly View)

place Torqmotor in a vise

1. Place the Torqmotor in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

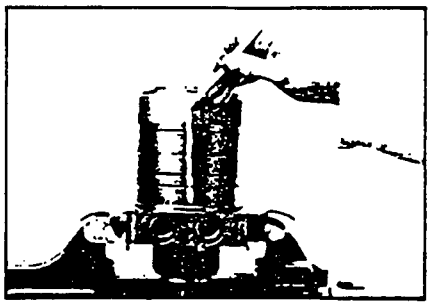


Figure 3

WARNING

WARNING: IF THE TORQMOTOR IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURING THE SERVICE PROCEDURES, CAUSING INJURY.

scribe alignment mark & loosen valve plugs

2. Scribe an alignment mark down and across the Torqmotor components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch allen wrench or 1 inch hex socket required. SEE FIGURE 3 & 4.

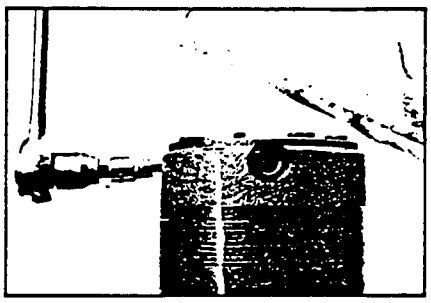


Figure 4

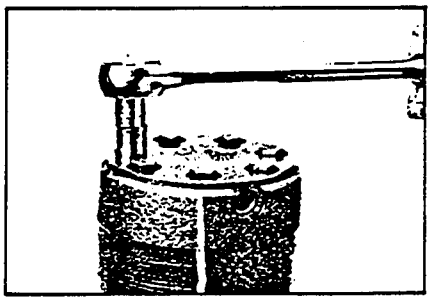


Figure 5

remove special bolts & inspect bolts

3. Remove the five or seven special ring head bolts (1, 1A, 1B, or 1C) using an appropriate 1/2 or 9/16 inch size socket. SEE FIGURE 5. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts. SEE FIGURE 6.

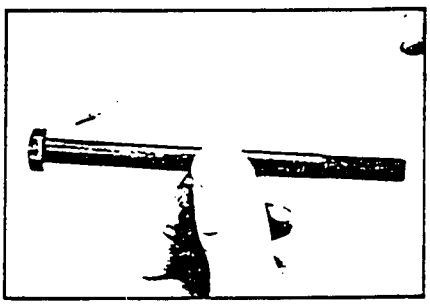


Figure 6

remove end cover & inspect bolts

4. Remove end cover assembly (2) and seal ring (4). Discard seal ring. SEE FIGURE 7.

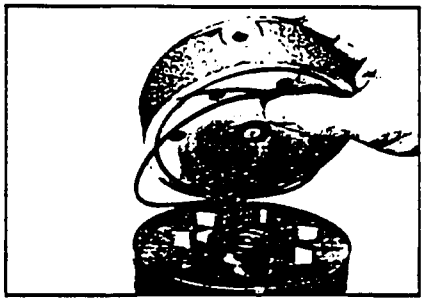


Figure 7

NOTE

NOTE: Refer to the appropriate "alternate cover construction" on page 7A or 7B to determine the end cover construction being serviced.

remove plugs and valves

5. If the end cover (2) is equipped with shuttle valve or relief valve (24) components, remove the two previously loosened plugs (21) and o-rings (22). SEE FIGURE 8.

CAUTION

CAUTION: Be ready to catch the shuttle valve or relief valve components that will fall out of the end cover valve cavity when the plugs are removed.

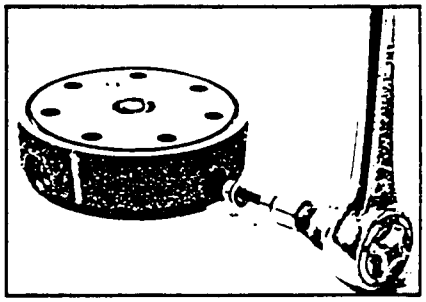


Figure 8

NOTE

NOTE: O-ring (22) is not included in seal kits but serviced separately if required.

NOTE

NOTE: The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.

wash & inspect end cover

6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary. SEE FIGURE 9.

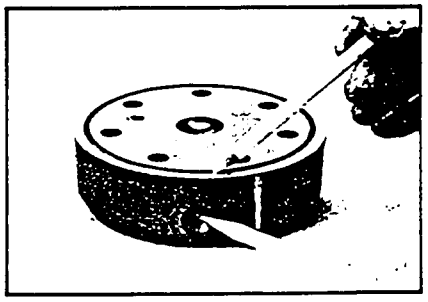


Figure 9

NOTE

NOTE: A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.



Figure 10

remove & inspect commutator ring

7. Remove commutator ring (6). SEE FIGURE 10. Inspect commutator ring for cracks, or burrs.

remove & inspect commutator

8. Remove commutator (5) and seal ring (3). Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator and commutator ring as a matched set. SEE FIGURE 11 & 12.

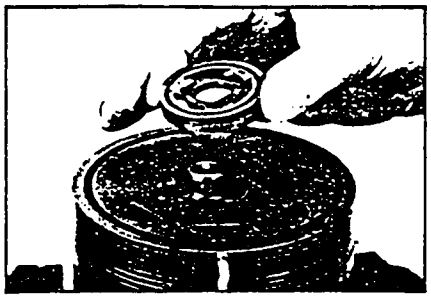


Figure 11

remove manifold

9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. SEE FIGURE 13. A polished pattern on the ground surfaces from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

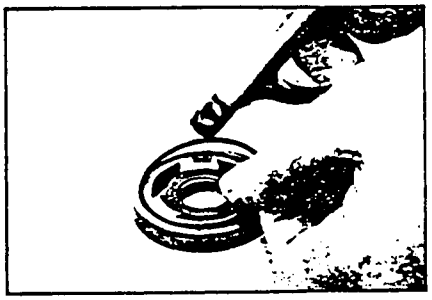


Figure 12

NOTE

NOTE: The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to ensure that same surface is reassembled against the rotor set.

remove & inspect rotor set & wearplate

10. Remove rotor set (8) and wearplate (9) together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. SEE FIGURE 14. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wearplate. You may have to shift the rotor set on the wearplate to work the drive link out of the rotor (8A) and wearplate. SEE FIGURE 15, Page 16. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the wearplate for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wearplate.

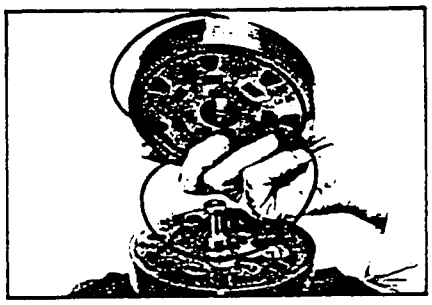


Figure 13

NOTE

NOTE: The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqmotor will ensure correct reassembly of rotor into stator and rotor set into Torqmotor. Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and Torqmotor.

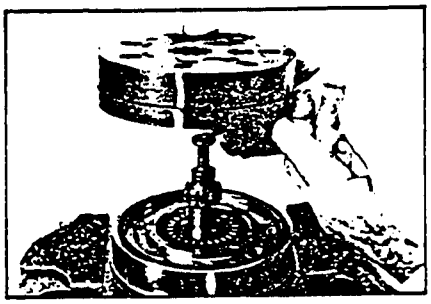


Figure 14

NOTE

NOTE: Series ME Torqmotors may have a rotor set with two stator halfs (8B & 8D) with a seal ring (4) between them and two sets of seven vanes (8C & 8E). Discard seal ring only if stator halfs become disassembled during the service procedures.

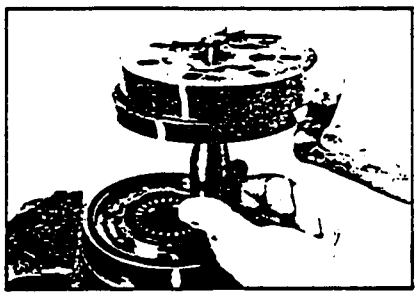


Figure 15

NOTE

NOTE: A polished pattern on the wear plate from rotor rotation is normal.

check rotor, vane clearance

11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than .005 inches (0.13 mm) of clearance, replace rotor set. SEE FIGURE 16.

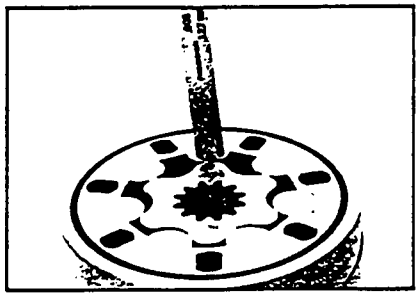


Figure 16

NOTE

NOTE: If rotor set (8) has two stator halfs (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction ME rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.

remove & inspect drive link

12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. SEE FIGURE 17. Remove and discard seal ring (4) from housing (18).

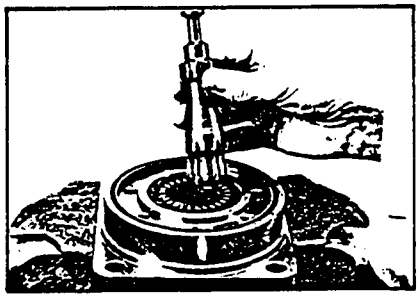


Figure 17

remove thrust bearing

13. Remove thrust bearing (11) from top of coupling shaft (12) if Torqmotor is a Series MB or ME. Inspect for wear, brinelling, corrosion and a full complement of retained rollers. SEE FIGURE 18.



Figure 18

check coupling shaft for rust or corrosion

14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used. SEE FIGURE 19. Remove any key (12A), nut (12B), washer (12C), bolt (12D), lock washer (12E), or retaining ring (12F).

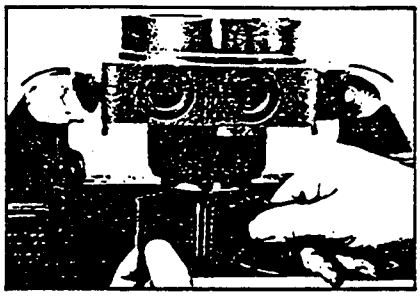


Figure 19

remove & inspect coupling shaft

15. Remove coupling shaft (12), by pushing on the output end of shaft. SEE FIGURE 20. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. SEE FIGURE 21. Replace coupling shaft if any of these conditions exist.

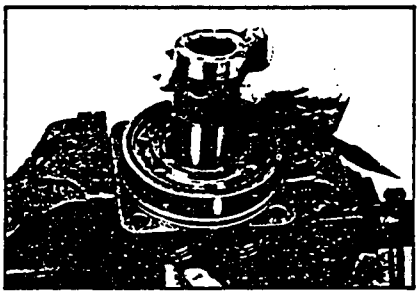


Figure 20

NOTE

NOTE: Minor shaft wear in seal area is permissible. If wear exceeds .020 inches (0.51 mm) diametrically, replace coupling shaft.

NOTE

NOTE: A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.

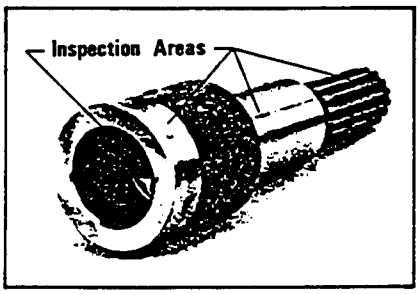


Figure 21

remove seal ring from housing

16. Remove and discard seal ring (4) from housing (18).

remove & inspect thrust washer & thrust bearing

17. Remove thrust bearing (15) and thrust washer (14) if the unit is a Series MG or MF. Inspect for wear, brinelling, corrosion and a full complement of retained rollers. SEE FIGURE 22.

NOTE

NOTE: Large Frame Series MB & ME Torqmotors have a thrust bearing (15) sandwiched between two thrust washers (14) that cannot be removed from housing (18) unless bearing (13) is removed for replacement.

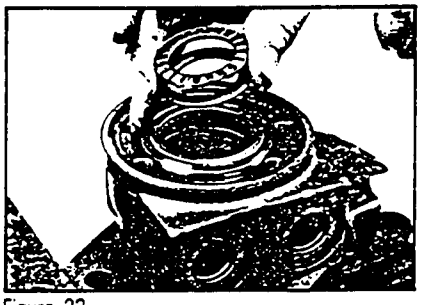


Figure 22

remove seal & washer or washers

18. Remove seal (16) and back up washer (17) from Small Frame, MG & MF housing (18). Discard both. SEE FIGURE 23.

Remove seal (16), backup washer (17), and backup washer (25) from Large Frame, Series MB & ME Torqmotor housing by working them around unseated thrust washers (14) and thrust bearing (15) and out of the housing. Discard seal and washers. SEE FIGURE 24.

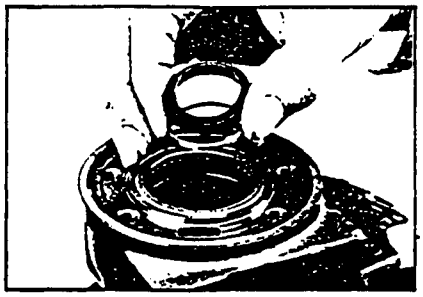


Figure 23

NOTE

NOTE: The original design units of Large Frame, Series MB & ME Torqmotors did not include backup washer (25), but must include backup washer (25) when reassembled for service.

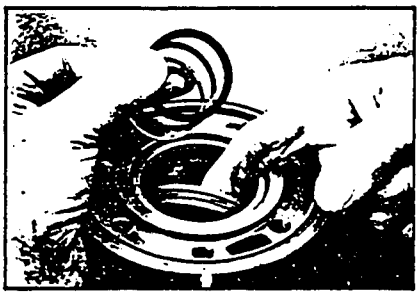


Figure 24

remove seal

19. Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller required. SEE FIGURE 25.

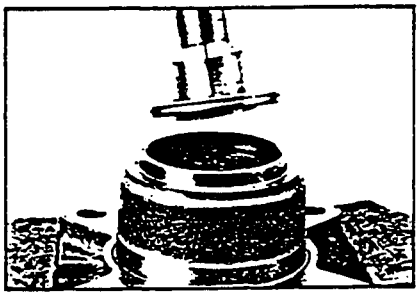


Figure 25

inspect housing assembly

20. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. SEE FIGURE 26. If the housing is defective in these areas, discard the housing assembly.

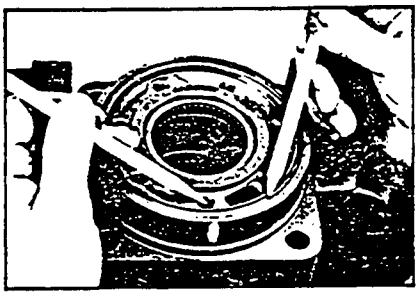


Figure 26

inspect housing bearing/bushing

21. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. SEE FIGURE 27. The MG Series bushing (19) or (13) to coupling shaft diametral clearance must not exceed .010 inch (.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced. SEE FIGURE 28. If the housing has passed this inspection the disassembly of the Torqmotor is completed.

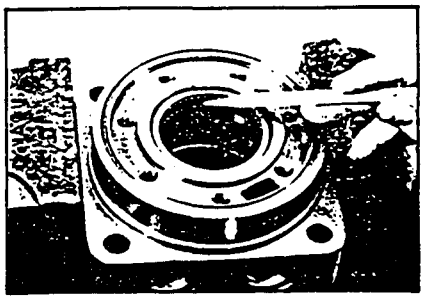


Figure 27

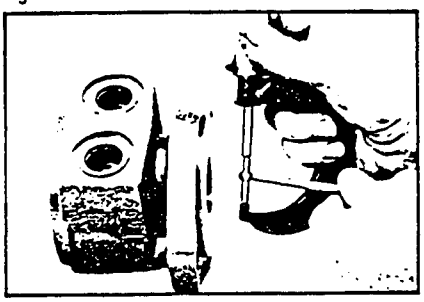


Figure 28

NOTE

NOTE: The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/bushings. This will facilitate the correct reassembly of new bearings/bushings. SEE FIGURE 29.

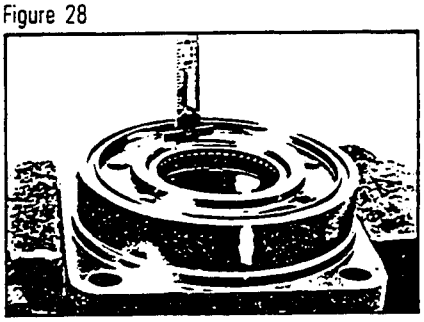


Figure 29

remove bearings or bushings & thrust washers

22. If the bearings, bushing or thrust washers must be replaced use a suitable size bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13). SEE FIGURES 30 & 31.

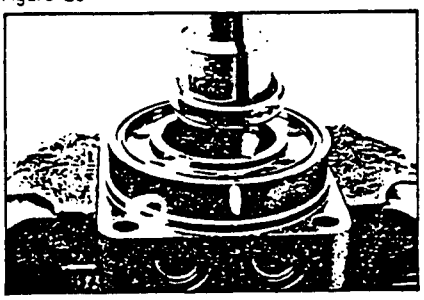


Figure 30

THE DISASSEMBLY OF TORQMOTOR IS COMPLETED.



Figure 31

Torqmotor™ Assembly

- Replace all seals and seal rings with new ones each time you reassemble the Torqmotor unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly. .
- **NOTE: Individual seals and seal rings as well as a complete seal kit are available. SEE FIGURE 32. The parts should be available through most OEM parts distributors or Ross approved Torqmotor™ distributors. (Contact your local dealer for availability).**
- **NOTE: Unless otherwise indicated, do not oil or grease parts before assembly.**
- Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing areas.

WARNING

WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

WARNING

WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

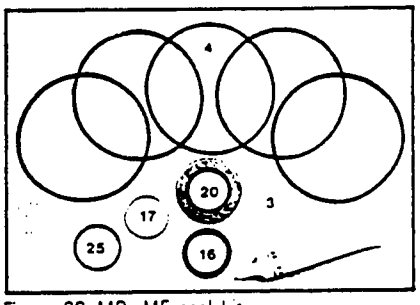
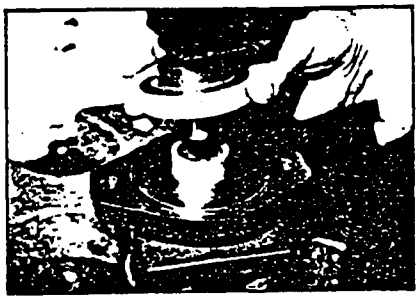


Figure 32 MB, ME seal kit

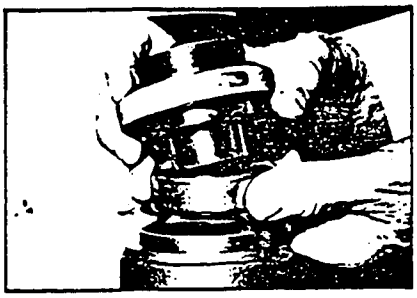
press in outer bearing/bushing

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a **new** outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section on page 7. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel such as described in figure 1 or figure 2 on page 7 which will control the bearing/bushing depth.

   Small Frame Series MG and MF Torqmotor housings require the use of bearing mandrel shown in figure 1 on page 7 to press bearing/bushing (19) into the housing to a required depth of .151/.161 inches (3.84/4.09 mm) from the end of the bearing counterbore. SEE FIGURE 33.


Figure 33

   Large Frame Series MB and ME Torqmotor housings require the use of the bearing mandrel shown in figure 2 on page 7 to press bearing (19) into the housing to a required depth of .290/.310 inches (7.37/7,87 mm) from the outside end of the bearing counterbore. SEE FIGURE 34.


Figure 34

NOTE

NOTE: Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.

CAUTION

CAUTION: If the bearing mandrel specified on page 7 is not available and alternate methods are used to press in bearing/bushing (13) and (19) the bearing/bushing depths specified must be achieved to insure adequate bearing support and correct relationship to adjacent components when assembled. SEE FIGURE 35.

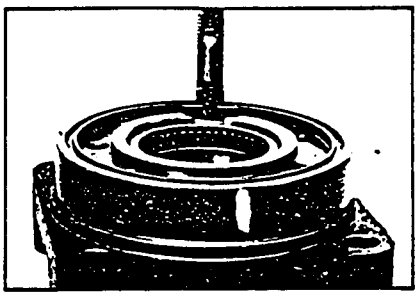


Figure 35

CAUTION

CAUTION: Because the bearing/bushings (13) and (19) have a press fit into the housing they must be discarded when removed. They must not be reused.

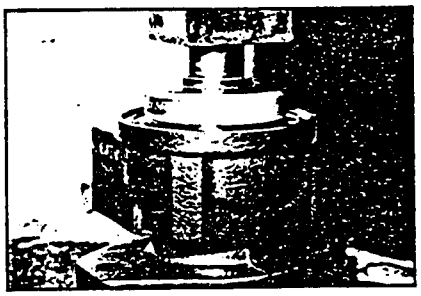


Figure 36

press in inner bearing/bushing

2. The Small Frame Series MG and MF Torqmotor inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to .03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19). Reference figure 1, page 7. SEE FIGURE 36.

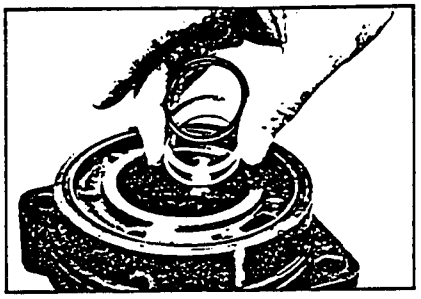


Figure 37

The Large Frame Series MB and ME Torqmotor housing (18) requires that you assemble a new backup washer (17), new backup washer (25), new seal (16), with the lip facing out, new thrust washer (14), new thrust bearing (15) and a new second thrust washer (14) in that order before pressing in the inner housing bearing (13). SEE FIGURE 37 & 38. When these components are in place, press new bearing (13) into the housing (18) to a depth of .105/.125 inches (2.67/3.18) below the housing wear plate contact face. Use the opposite end of the bearing mandrel used to press in outer bearing (19). Reference figure 2, page 7. SEE FIGURE 39.

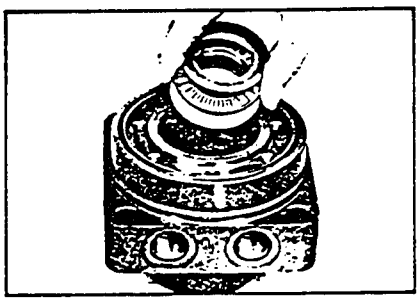


Figure 38

press in dirt & water seal

3. Apply a small amount of clean grease to a new dirt and water seal (20) and press it into the housing (18) outer bearing counterbore.

The Small Frame Series MG and MF Torqmotor dirt and water seal (20) must be pressed in until its' flange is flush against the housing. SEE FIGURE 40.

The Large Frame Series MB and ME Torqmotor dirt and water seal (20) must be pressed in with the lip facing out and until the seal is flush to .020 inches (.51 mm) below the end of housing. SEE FIGURE 41.



Figure 39



Figure 40

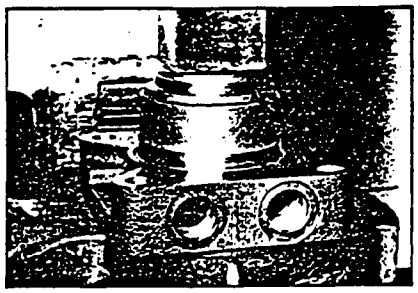


Figure 41

place housing assembly into vise

4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange. SEE FIGURE 42.

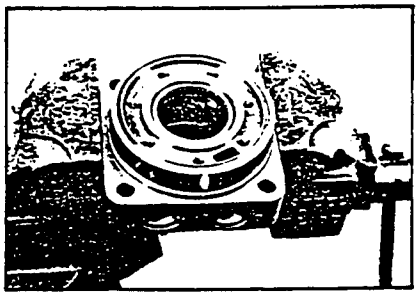


Figure 42

assemble backup washer & seal

5. On Small Frame, Series MG & MF Torqmotors assemble a new backup washer (17) and new seal (16) with the seal lip facing out, into their respective counterbores in housing (18) if they were not assembled in procedure 2.

Large Frame, Series MB and ME Torqmotor housing (18) that did not require replacement of the bearing package will require that the two "captured" thrust washers (14) and thrust bearing (15) be unseated and vertical to the counterbore and the new backup washer (17), new backup washer (25), and new seal (16) be worked around the thrust bearing package and placed into their respective counterbores. The seal lip must face out of the seal counterbore. Be sure the thrust bearing package is reseated correctly after assembly of the seal and backup washer. SEE FIGURE 43 & 44.

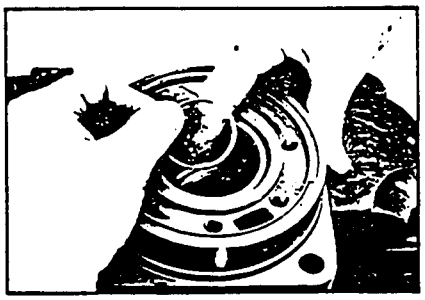


Figure 43

CAUTION

CAUTION: Original design Large Frame, MB & ME Torqmotors that do not have backup washer (25) when disassembled must be assembled with a new backup washer (17), new backup washer (25), and new seal (16).

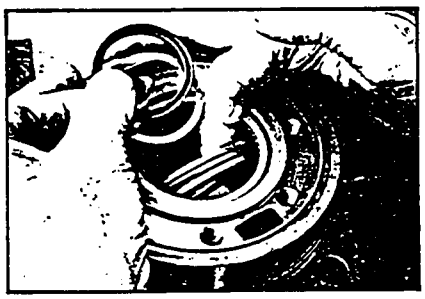


Figure 44

assemble thrust washer & bearing

6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Series MG or MF Torqmotor. SEE FIGURE 45.

NOTE

NOTE: Small Frame Series MG and MF Torqmotors require one thrust washer (14) with thrust bearing (15). The coupling shaft will be seated directly against the thrust bearing.

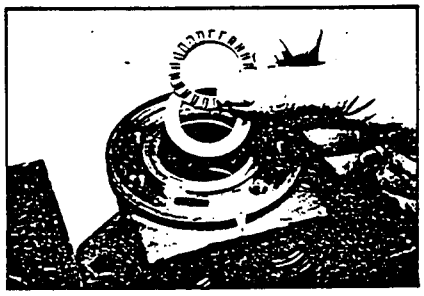


Figure 45

apply masking tape to shaft

7. Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal. SEE FIGURE 46.

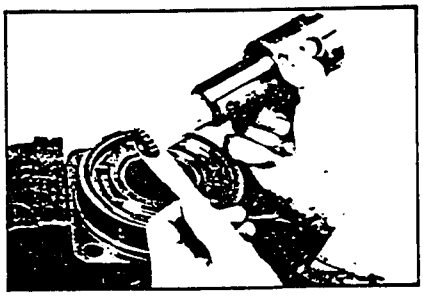


Figure 46

install coupling shaft

8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in MG and MF Series housings and against the second thrust washer (14) in MB and ME Series housings. SEE FIGURE 47.

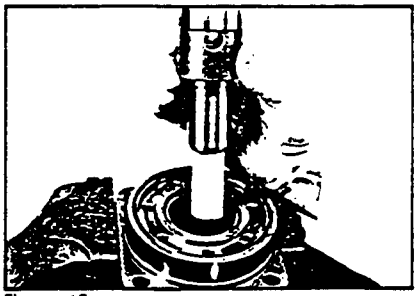


Figure 47

CAUTION

CAUTION: The outer bearing (19) is not lubricated by the system's hydraulic fluid. Be sure it is thoroughly packed with the recommended grease, Ross Gear grease specification #045236, E/M Lubricant #K-70M.

NOTE

NOTE: The coupling shaft (12) will be flush or just below the housing wear plate surface on Small Frame, Series MG and MF Torqmotors when properly seated while the coupling shaft (12) on Large Frame, Series MB and ME Torqmotors will be approximately .10 inch (2.54 mm) below the housing wear plate surface to allow the assembly of thrust bearing (11). The coupling shaft must rotate smoothly on the thrust bearing package. SEE FIGURE 48.

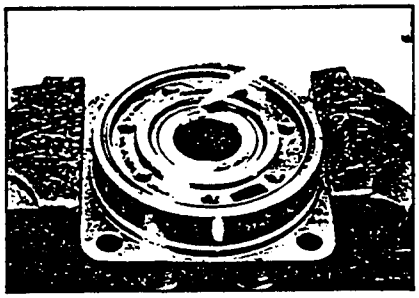


Figure 48

install thrust bearing

9. Install thrust bearing (11) onto the end of coupling shaft (12) only if you are servicing an MB or ME Series Torqmotor. SEE FIGURE 49.



Figure 49

insert seal ring

10. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove. SEE FIGURE 50.

NOTE

NOTE: One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over .5 inch (12.7 mm) longer than the bolts (1, 1A, 1B or 1C) used in the Torqmotor.

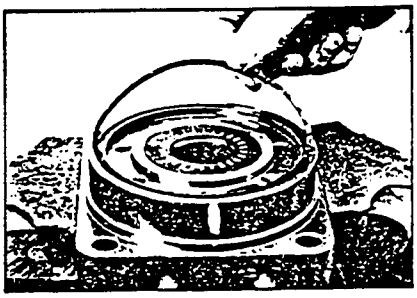


Figure 50

install drive link

11. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines. SEE FIGURE 51.

NOTE

NOTE: Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.

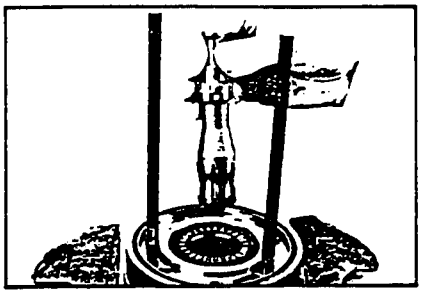


Figure 51

assemble wear plate

12. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18). SEE FIGURE 52.

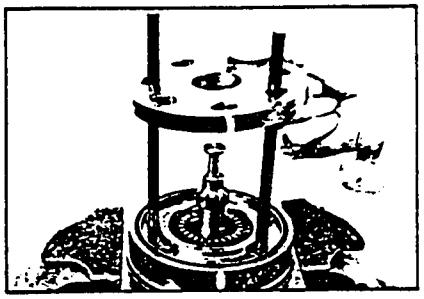


Figure 52

assemble seal ring

13. Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B). SEE FIGURE 53.

install the assembled rotor set

14. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines. SEE FIGURE 54.

NOTE

NOTE: It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.

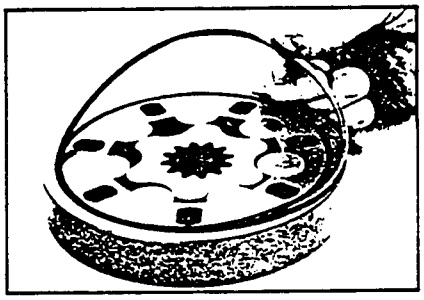


Figure 53

NOTE

NOTE: If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure," on page 30 or 31.

NOTE

NOTE: The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down. The rotor set has a seal ring groove on the wear plate contact side of the stator (8B).

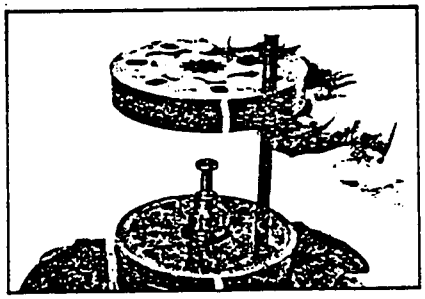


Figure 54

assemble seal ring in manifold

15. Apply clean grease to a new seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7). SEE FIGURE 55.

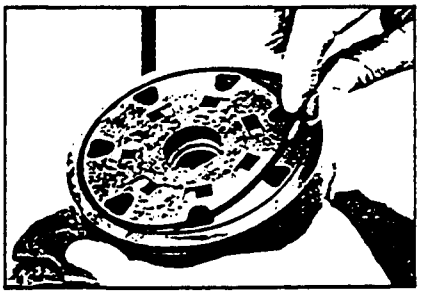


Figure 55

NOTE

NOTE: The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.

assemble manifold

16. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set. SEE FIGURE 56.

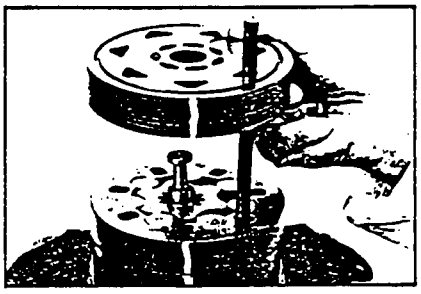


Figure 56

insert a seal in manifold

17. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold. SEE FIGURE 57.

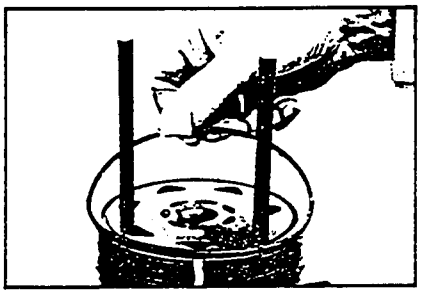


Figure 57

assemble commutator ring

18. Assemble the commutator ring (6) over alignment studs onto the manifold. SEE FIGURE 58.

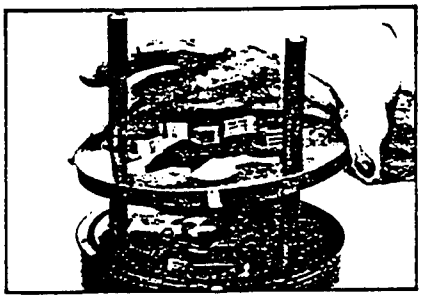


Figure 58

assemble seal & commutator

19. Assemble a **new** seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up. SEE FIGURE 59, 60.

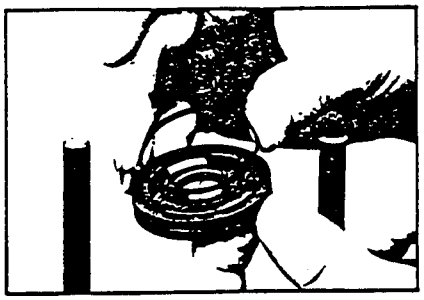


Figure 59

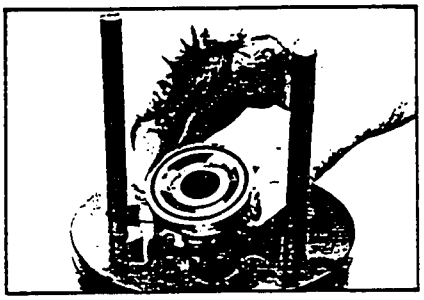


Figure 60

assemble shuttle valve parts into end cover

20. If shuttle valve components items #21, #22, #23, #24 were removed from the end cover (2) turn a plug (21) with a **new** o-ring (22), loosely into one end of the valve cavity in the end cover. Insert a spring (23) the valve (24) and the second spring (23) into the other end of the valve cavity. Turn the second plug (21) with a **new** o-ring (22) loosely into the end cover valve cavity. 3/16 inch Allen wrench required. SEE FIGURE 61.

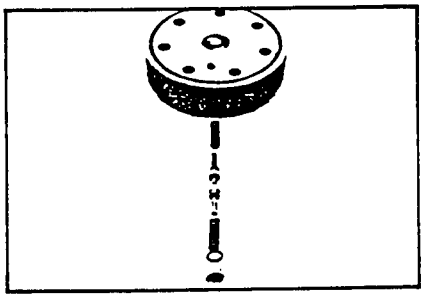


Figure 61

assemble relief valve parts in end cover

21. If relief valve components items #21, #22, #24 were removed from the end cover (2) assemble a **new** o-ring (22) on the two plugs (21). Assemble a two piece relief valve (24) in each of the plugs, with the large end of the conical spring into the plug first and the small nut of the other valve piece in the small end of the conical spring. Turn each of the plug and relief valve assemblies into the end cover loosely to be torqued later. 3/8 inch Allen or 1 inch Hex socket required. SEE FIGURE 62.

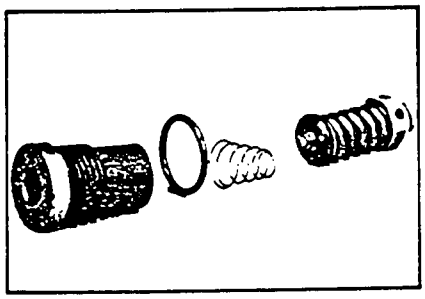


Figure 62

assemble seal ring & end cover

22. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. SEE FIGURE 63, 64. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to housing port bosses is shown in FIGURE 65.

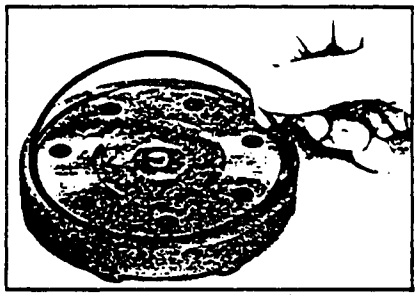


Figure 63

NOTE

NOTE: If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.

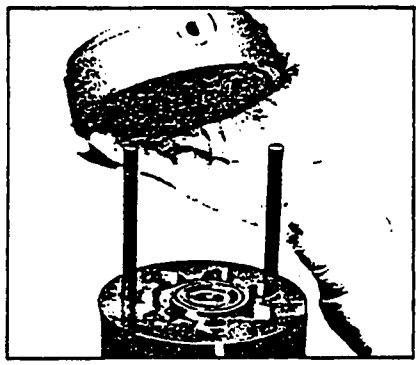


Figure 64

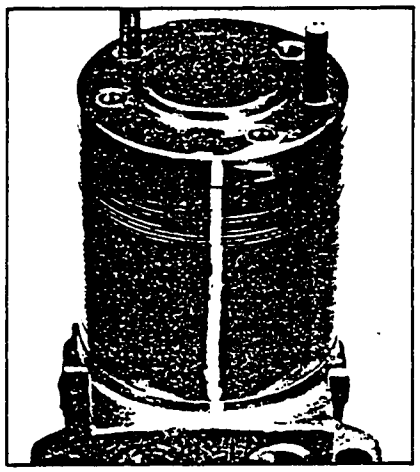


Figure 65

assemble cover bolts

23. Assemble the 5 or 7 special bolts (1, 1A, 1B or 1C) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 22-26 ft. lbs. (30-35 N m) for the five MG & MF Series 5/16 24 threaded bolts or 45-55 ft. lbs. (61-75 N m) for the seven MB & ME Series 3/8-24 threaded bolts. SEE FIGURE 66, 67, 68.

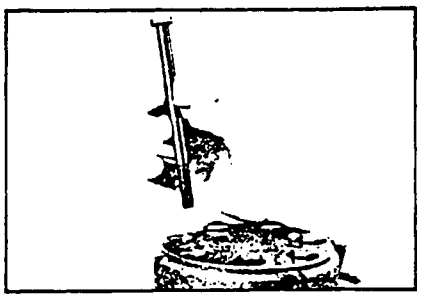


Figure 66

NOTE

NOTE: The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard end cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.

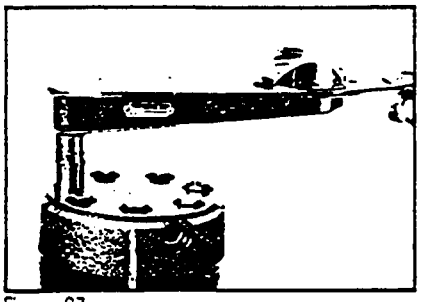


Figure 67

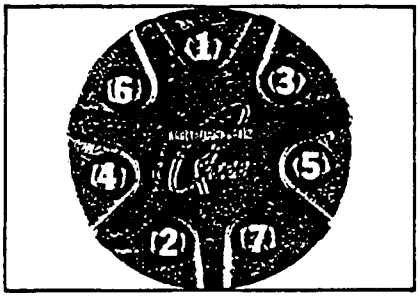


Figure 68

torque the valve plugs

24. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 N m) if cover is so equipped. SEE FIGURE 69.

Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs. (61-75 N m) if cover is so equipped.

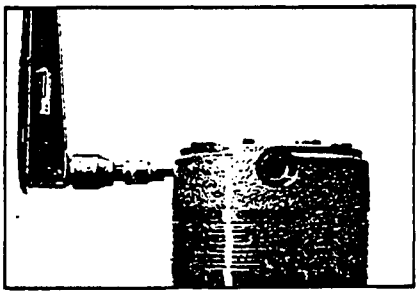


Figure 69

THE ASSEMBLY OF THE TORQMOTOR IS NOW COMPLETE EXCEPT FOR WOODRUFF KEY (12A), NUT (12B), WASHER (12C), BOLT (12D), LOCKWASHER (12E), RETAINER RING (12F) or PORT O-RINGS (18A) AT INSTALLATION IF APPLICABLE. SEE PAGE 33 FOR FINAL CHECKS.

Rotor Set Component Assembly Procedure

One Piece Stator Construction

A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

assemble stator

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqmotor assembly procedures 1 through 13. Be sure the seal ring is in place. SEE FIGURE 70.

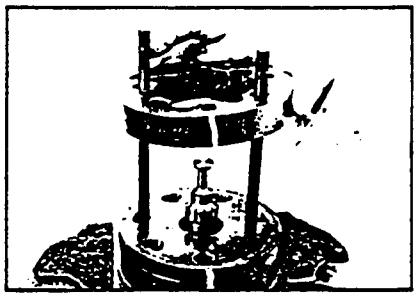


Figure 70

insert two bolts

2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

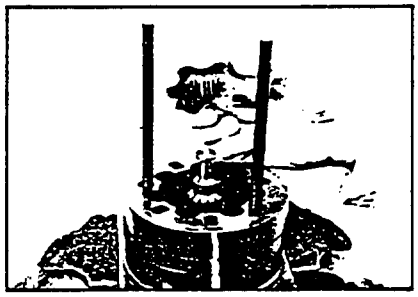


Figure 71

assemble rotor

3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines. SEE FIGURE 71.

NOTE

NOTE: If the manifold side of the rotor was etched during Torqmotor disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.

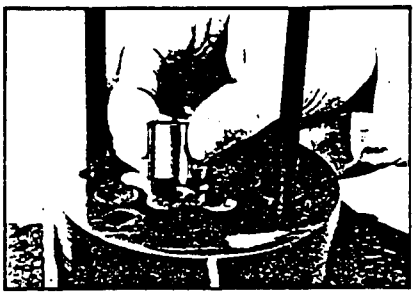


Figure 72

assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets. SEE FIGURE 72.

CAUTION

CAUTION: Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

assemble full complement of vanes

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force. SEE FIGURE 73.

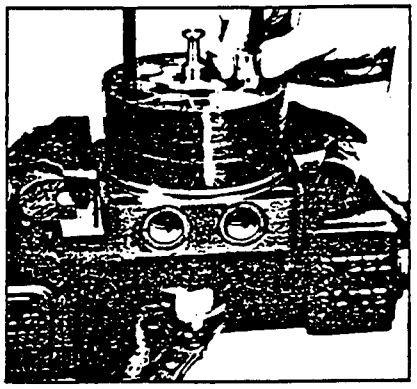


Figure 73

remove two assembled bolts

6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

Go to Torqmotor assembly procedure #15, page 26 to continue Torqmotor assembly.

Rotor Set Component Assembly Procedure

Two Piece Stator Construction

A disassembled rotor set (8) that cannot be readily assembled by hand and has a two piece stator can be assembled by the following procedures.

assemble stator halfs

1. Place stator half (8B) onto wear plate (9) with seal ring (4) side down, after following Torqmotor assembly procedures 1 through 13. Be sure the seal ring is in place.

insert two alignment studs

2. Align stator bolt holes with wear plate and housing bolt holes and turn two alignment studs finger tight into bolt holes approximately 180 degrees apart to retain stator half and wear plate stationary.

assemble rotor

3. Assemble rotor (8A), counterbore down if applicable, into stator half (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.

NOTE

NOTE: Use any marking you applied to rotor set components to reassemble the components in their original relationship to ensure ultimate wear life and performance.

assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.

CAUTION

CAUTION: Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

assemble full complement of vanes

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator half (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

assemble seal ring in stator half

6. Place second stator half (8D) on a flat surface with seal ring groove up. Apply a small amount of grease to a new seal ring (4) and assemble it into stator half ring groove.

DESCRIPTION

The **PULSAR™** VP Series electrohydraulic valves by **ENERPAC** are designed for remote directional control for proportional flow control. Both linear and rotary functions are common applications for controlling position and/or velocity. The spools of the main valve are piloted by the patented technology of the VS Series **PULSAR** cartridge, which uses pulse-width modulated excitation to provide proportional control.

INLETS

Standard to each inlet section in the VP Series is a stainless steel wire cloth pilot supply filter of 43 microns, absolute.

Also standard is a pressure reducing valve designed to provide oil to each **PULSAR** pilot stage with the required 200 PSI pressure supply.

Load Sensing

In a load sensing circuit, pressure and flow compensation is accomplished at the pump. Therefore, the inlet section for a load sensing circuit acts primarily as a manifold to inlet the main oil supply and to connect the load sensed signal back to the pump, and to outlet the tank line to reservoir.

END COVER

The end cover section is essentially a manifold connecting the two separate tank flow passages and serves to complete the sectional valve stacking. Optionally it may also be equipped with a load sensing port. This port is used as an extra shuttle port in circuits where multiple stacks are connected to the same load sensing pump or to the same pressure compensated bypass inlet.

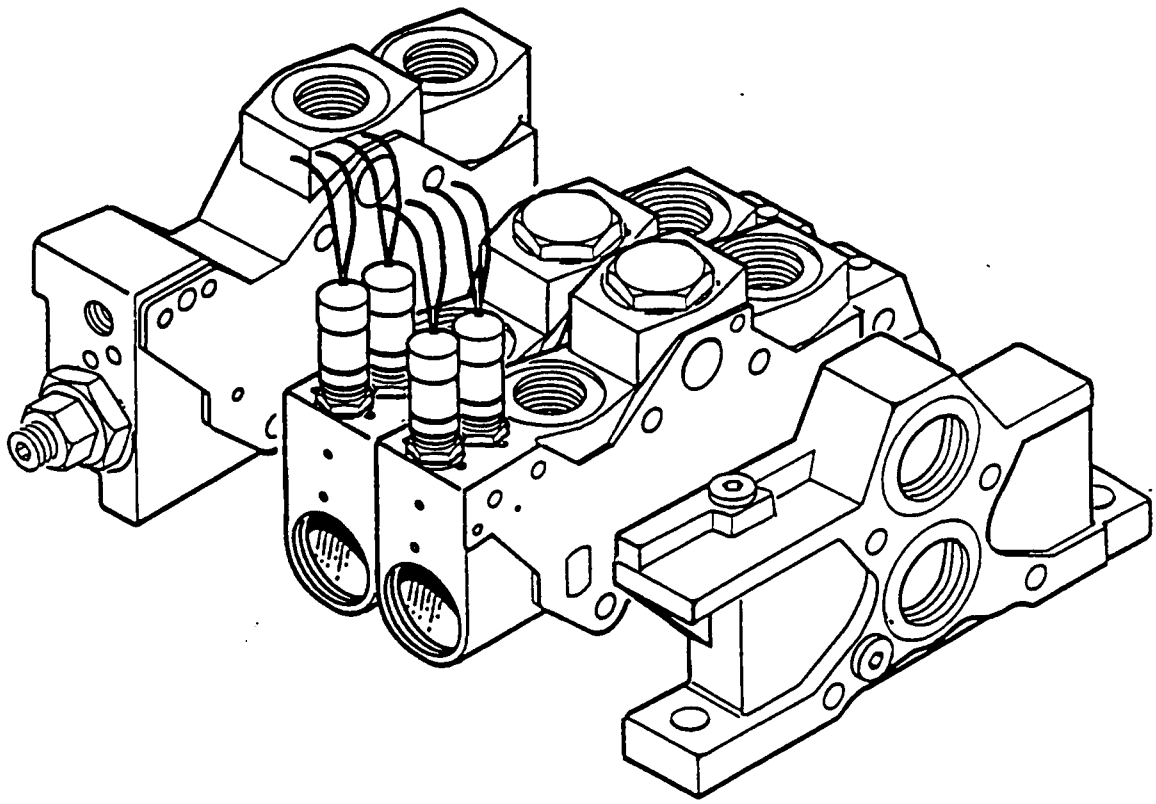


FIGURE 1, VALVE STACKING

WORKING SECTIONS

All standard VP Series valve working section bodies are the same; each accommodates a 7/8 inch diameter main spool to meter flow. Since maximum flow capacity through the section is determined by the angle on the spool land, it is possible to change a 5 GPM section to a 20 GPM section by replacing only the main spool. Spool sizes available for the **PULSAR** VP Series are from 2.5 to 40 GPM.

All valve stacks feature internal load sensing shuttle logic. A shuttle ball lays in a cavity between working sections and allows the highest working pressure to be transmitted through the inlet load sensing port to the pump compensator.

Individual Compensation

Primary flow past the main spool in each working section is governed by, (a) main spool position, and (b) the pressure difference across the main spool metering land. While the **PULSAR** pilot section controls main spool position, the pressure difference across the metering land is subjected to upstream system pressure variations. Available to VP Series working sections, the individual compensator spool labeled in Figure 3, serves as a flow regulator during such pressure changes. It consists of a two-land spool with equal diameters, a plug, a 50 PSI spring, and an internal sensing passage.

Oil supply enters between the two lands, and is separated from sensing pressure by the sliding spool land within the bore. As the main spool opens, load pressure is sensed on the spring chamber side of the compensator spool causing this spool to open. As the regulator spool opens increasing flow to the main spool area, an increasing pressure drop results across the main spool metering region. When this pressure drop across the main spool is equal to the spring force "pressure", the compensator spool meters about a steady state position in response to system pressure variations. Thus, the compensator spool positions itself such that the regulated pressure below the spool equals the combined load pressure plus spring force pressure above. In this way the individual compensator reacts to throttle system pressure variations prior to the main spool metering area. Such compensation is particularly useful when sections and their functions must operate simultaneously.

Dual Angle Spools

Optional main spool lands are profiled with two angles to give two distinct metering capabilities. This feature is advantageous where more precise control is desirable in the low flow region for.

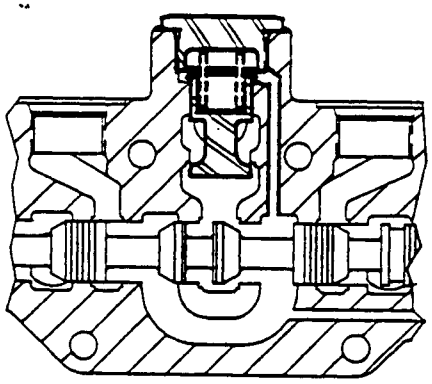


FIGURE 2, INDIVIDUAL
PRESSURE COMPENSATION

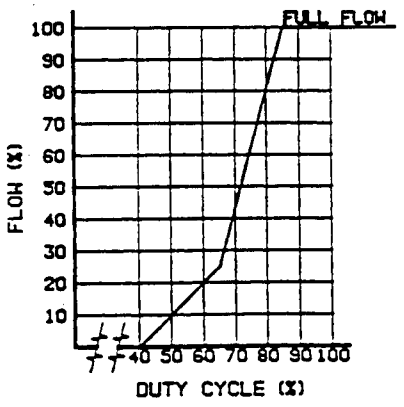


FIGURE 3, DUAL ANGLE SPOOL

OPERATION

PULSAR VP SERIES VALVE

Pilot Stage

The **PULSAR** VS Series pressure control valve is a normally closed, spring-biased, solenoid-actuated, high speed, digital (on/off) valve. It consists of a removable, replaceable cartridge assembly specifically matched with an separate orifice plate and O-ring seal. To generate a proportional control pressure, the coil inside the cartridge is energized 33 times per second with a pulse-width modulated (PWM) electrical signal. The resulting control pressure is directly proportional to the duty cycle, or percent of "ON" time per cycle of this electrical excitation. Oil exiting the cartridge is restricted by the 0.024 inch fixed orifice plate; the resulting back pressure is proportional to the operator-regulated duty cycle. This pressure is then routed within the working section to the end of the main spool to furnish the control pressure.

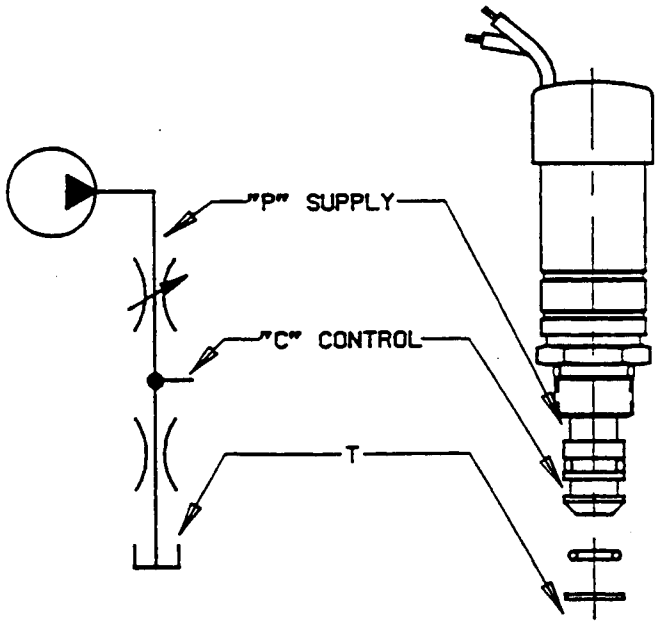


FIGURE 4, "VS" SERIES PULSAR™ CARTRIDGE

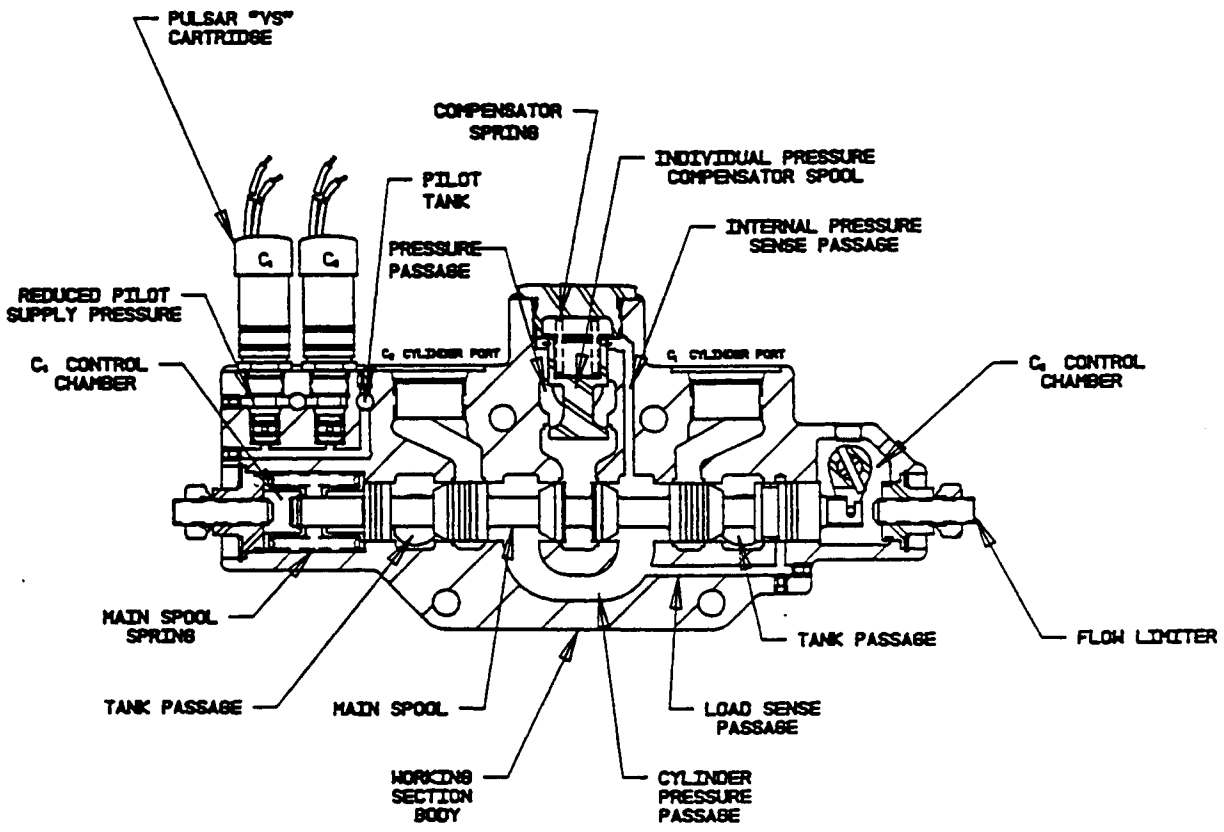


FIGURE 5, WORKING SECTION FEATURES

Main Stage

The cross-sectional diagram shows a VP Series valve section equipped with the standard spring centered, 4-way, 3-position, closed cylinder main spool. The position of the spool is determined by the centering spring and the differential pressure between the two control chambers at either end of the spool.

In the centered position, both control chambers are at tank pressure as are the tank passage and cylinder pressure passage. The result is that no differential pressure exists, the spool centers to neutral position and there is no flow to or from either cylinder port. If this condition exists throughout the stack, then the load sensing pressure is vented back to tank in each section. This causes the inlet compensator flow to be bypassed directly to tank at approximately 200 PSI for fixed displacement pumps, or allows a load sensing pump to destroke and remain at standby pressure.

When one of the pilot cartridges is activated by the operator, as the cartridge labeled C_2 in FIGURE 11, a pressure differential is produced. As the main spool shifts to the left, the load sensing flow passage and sensing line are exposed to load pressure, while the tank passage and left control chamber receive tank pressure. However, the right control chamber (shaded) receives pilot control pressure, thus shifting the spool to the left, as shown. Due to designed overlap and centering spring preload, first flow occurs at a 50 PSI pressure differential with full flow at 135 PSI. Within this metering range, oil flows past the valve spool and out the C_2 cylinder port. Since the inlet pressure compensator/load sensing pump receives load sense pressure, the compensator/pump is able to furnish the appropriate supply pressure and flow.

Additionally, the VP Series valve simultaneously meters flow in and out of the working section. In FIGURE 11, this occurs at each metering land where flow is shown leaving and entering the working section. This dual metering enhances the valve's overall metering capability resulting in smoother performance.

Finally, it can be noted the main spool is without O-ring seals. This design feature coupled with the associated PWM control significantly reduces spool resistance, thereby minimizing hysteresis to ± 1% (TYP.)

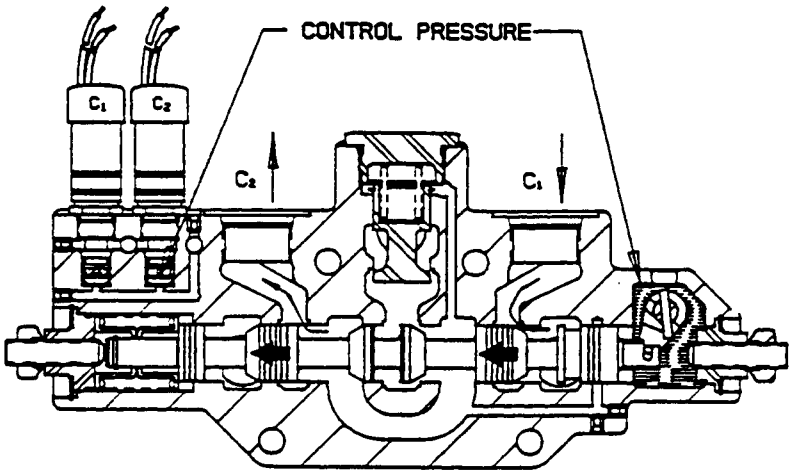


FIGURE 6, WORKING SECTION, MAIN SPOOL, SHIFTED

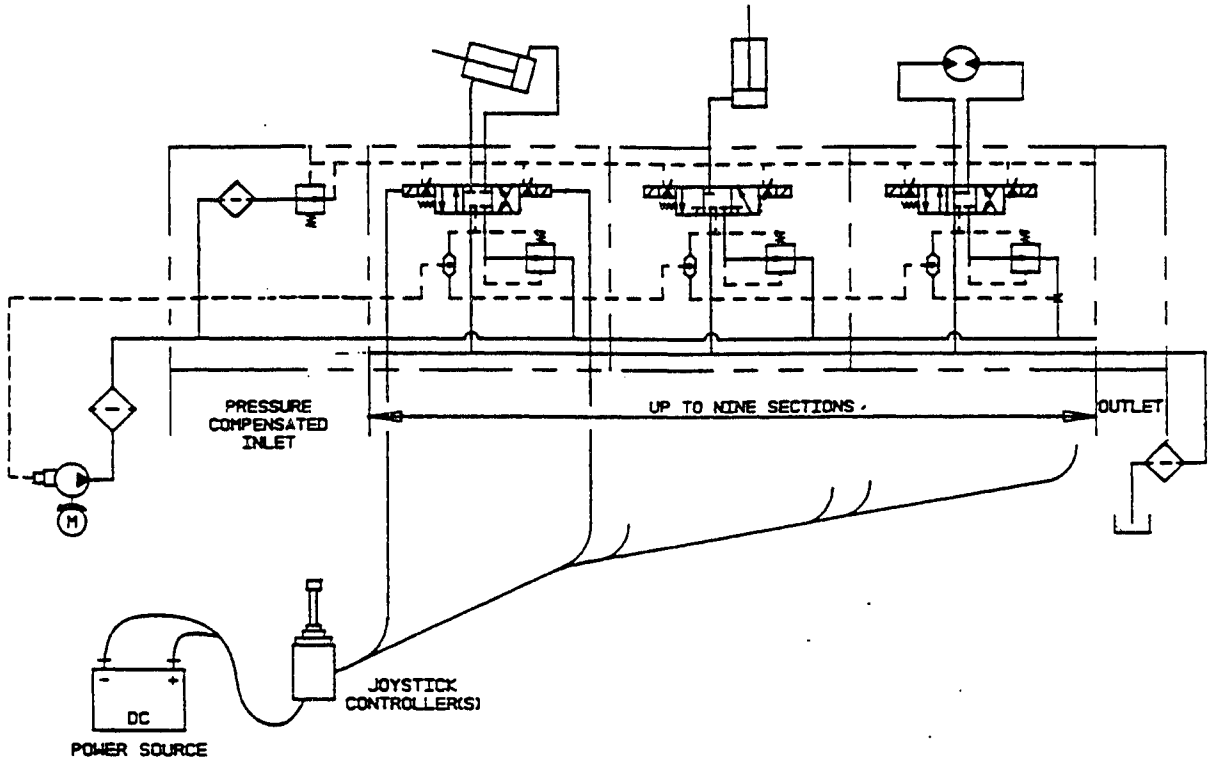


FIGURE 7, SAMPLE SYSTEM CONFIGURATION

SAMPLE SYSTEM CONFIGURATION

FIGURE 12, illustrates the assocation of the VP Series valve stack to other typical circuit components. Also, it helps visualize the activation sequence from operator to actuator.

For proportional electrohydraulic control (EHC), the electrical control module is supplied with 12 VDC power. During remote, man-in-the-loop operation, the operator moves a control lever to initiate the electrical signal transmitted to the VS Series **PULSAR** cartridge. The operator positions the control lever regulating the duty cycle. In this way he regulates the pilot control pressure and flow through the main section. The further the control lever is moved, the higher the main control flow that results. Generally, individual functions are controlled by one valve section.

PRE-OPERATION CHECKLIST

The following check is performed to identify and eliminate inferior operating conditions, both those capable of preventing a successful system start-up and those which may deteriorate producing similar results. In addition to performing this inspection upon initial start-up, **ENERPAC** also recommends this checklist be applied periodically as other system components are routinely maintained or inspected.

Electrical Circuit - Wire Check

Contact surfaces should be free of oxidation or corrosion, and sealed against moisture. Visually inspect all wires and connectors. Correct signs of loose or impeded connections as well as exposed or severely crimped wires. Inspect the following:

1) Power supply connection of 12-VDC, ground
2) Power cable and connectors from power source to joystick controller
3) Power cable and connectors between joystick controller and valve cartridges/coils

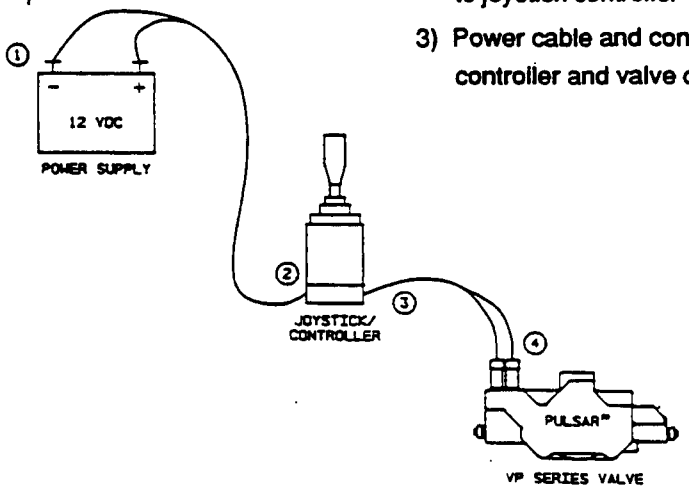


FIGURE 8, SAMPLE ELECTRICAL CIRCUIT

Hydraulic Circuit - Line Check

Inspect hydraulic lines and connections for signs of looseness or obstruction. Tighten loose fittings and correct any crimped hoses or tubes, including as follows:

1) From pump, through pressure filter, to valve stack
2) For load sensing circuits, check sensing line to pump
3) Lines between valve stack and reservoir
4) All hoses to actuators, i.e., cylinders, motors
5) Tie-downs of hoses and tubing

NOTE - Entrapped air in hydraulic lines is common upon start-up and may result in temporary irregular motion. However, if after a reasonable operating period this condition persists, hydraulic lines should be bled to remove entrapped air and carefully inspected for leaks, starting with the pump suction line.

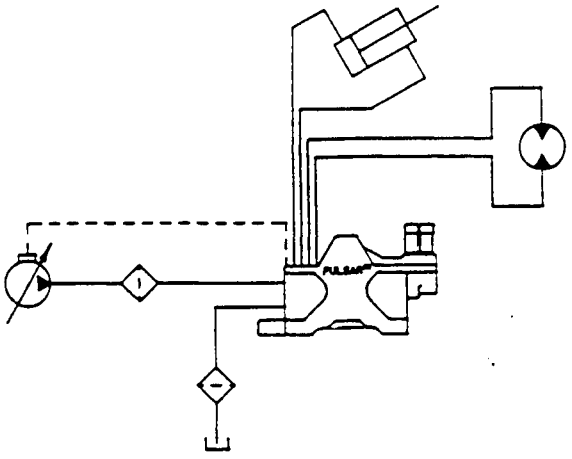


FIGURE 9, SAMPLE HYDRAULIC CIRCUIT

BASIC SYSTEM DIAGNOSIS

The following troubleshooting scheme is provided to determine if the VP Series valve requires off-vehicle service. To accomplish this the remainder of the electrohydraulic system is sequentially examined to eliminate other possible actuation interruptions. Since an assortment of symptoms are possible, this troubleshooting guide should be supplemented with reasonable on-site observation and judgement.

In order to perform this diagnosis two instruments are required, an analog DC voltmeter and a pressure gauge capable of reading maximum system pressure.

To make a voltage reading connect the positive lead from the voltmeter to the positive terminal at the specified location. Connect the negative lead from the meter to any electrical ground. Make the reading and proceed.

NOTE - A considerable number of electrically-related problems are due to contaminated connectors. To avoid an early reoccurrence, each time a connector is separated and checked, clean both leads with an appropriate contact cleaner, containing a de-greasing agent if possible. This precaution can avoid wrongly identifying an electrical component(s) as faulty.

CAUTION - Obstructions which contaminate filter elements in many cases are not easily visible. Therefore, disassembled filters should be cleaned particularly if the system has (1) been recently started, (2) operated in a dirty environment, (3) operated for some time without maintenance.

NOTE - For systems sending load sensing signals back to the pump, it is possible for such communication to result in instability, e.g., excessive vibration or irregular actuation. Such interaction may be alleviated by changing the length, diameter, or type of hydraulic line (hose or tube) between the pump and the VP Series valve. Also, in load sensing applications where other valves operate from a common pump it is best to systematically isolate sensing signals during diagnosis. To accomplish this disconnect and cap ALL BUT ONE of the load sensing lines from returning to the pump. Further, remove any participating logic check valves. Operate the offending function(s). Continue in this manner, checking one input at a time, to identify which signal(s) contributes to the instability and requires further attention.

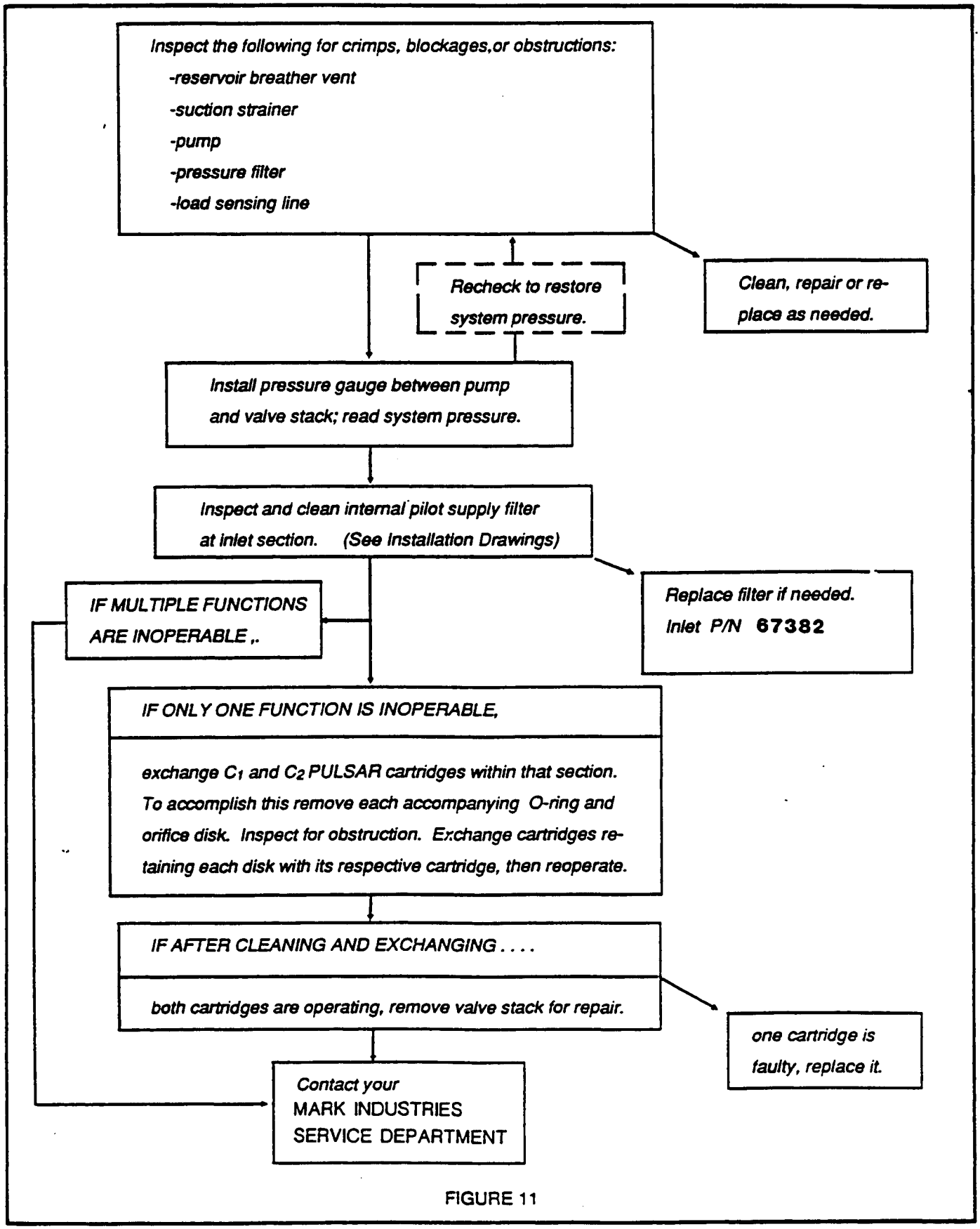

Inspect the following for crimps, blockages,or obstructions:
-reservoir breather vent
-suction strainer
-pump
-pressure filter
-load sensing line
Recheck to restore system pressure.
Clean, repair or replace as needed.
Install pressure gauge between pump and valve stack; read system pressure.
Inspect and clean internal pilot supply filter at inlet section. (See Installation Drawings)
Replace filter if needed.
Inlet P/N 67382
IF MULTIPLE FUNCTIONS ARE INOPERABLE,.
IF ONLY ONE FUNCTION IS INOPERABLE,
exchange C1 and C2 PULSAR cartridges within that section. To accomplish this remove each accompanying O-ring and orifice disk. Inspect for obstruction. Exchange cartridges retaining each disk with its respective cartridge, then reoperate.
IF AFTER CLEANING AND EXCHANGING . . . .
both cartridges are operating, remove valve stack for repair.
one cartridge is faulty, replace it.
Contact your MARK INDUSTRIES SERVICE DEPARTMENT

FIGURE 11

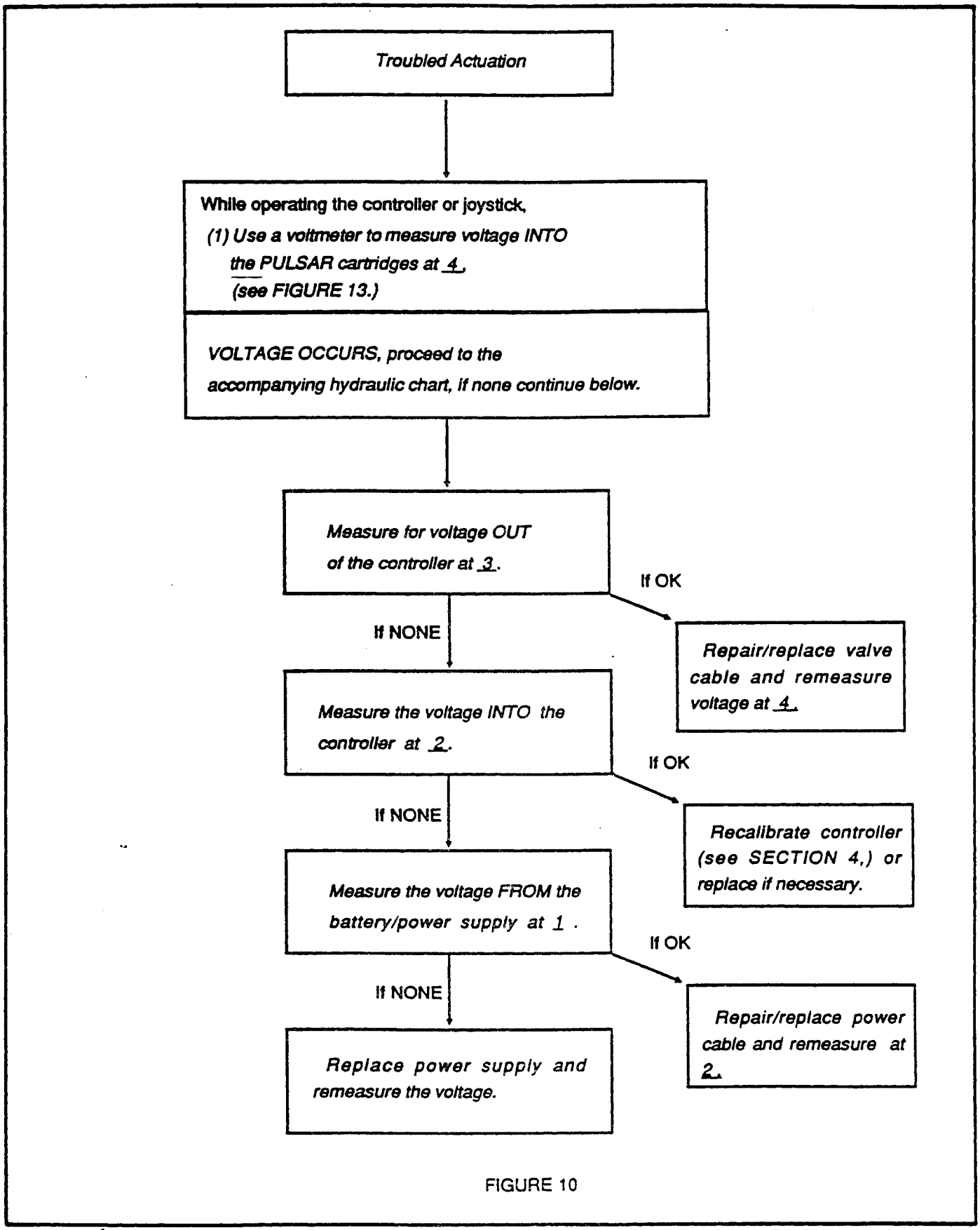

Troubled Actuation
While operating the controller or joystick,
(1) Use a voltmeter to measure voltage INTO the PULSAR cartridges at 4,
(see FIGURE 13.)
VOLTAGE OCCURS, proceed to the accompanying hydraulic chart, if none continue below.
Measure for voltage OUT of the controller at 3.
If OK
Repair/replace valve cable and remeasure voltage at 4.
If NONE
Measure the voltage INTO the controller at 2.
If OK
Recalibrate controller (see SECTION 4,) or replace if necessary.
If NONE
Measure the voltage FROM the battery/power supply at 1.
If OK
Repair/replace power cable and remeasure at 2.
If NONE
Replace power supply and remeasure the voltage.

FIGURE 10

MAINTENANCE

SYSTEM

Hydraulic systems containing the **PULSAR** VP Series valve have no preventive maintenance requirements beyond those of other fluid power systems. However, since the valve operates within a system **ENERPAC** recommends a comprehensive program of maintenance be applied. Minimally, such a program should include periodic attention to the pump, reservoir, in-line filter and hydraulic fluid, as well as the VP Series valve. Refer to manual for maintenance specifications.

Particularly important to valve operation is the condition of the hydraulic fluid, including its specification, operating level, and purity.

- Regardless of the maintenance schedule, if the oil level is found to be outside the normal operating range correction should be made at once. Oil added to the system must be compatible and clean.
- Check the system returned filter as programmed maintenance specifies, replace as needed.
- Remove and inspect the pump suction strainer. Blow out contaminants with compressed air.
- Inspect the reservoir breather element and clean as required.

VP SERIES VALVE

The valve contains two (2) filter elements of which one (1) requires maintenance. See the appropriate drawing for the location of the pilot supply filter on the inlet section. The plug is an SAE 4 (9/16 inch, ext. hex.) fitting. Remove, and clean trapped contaminants using compressed air from the inside out. Damaged filter elements should be replaced with **MARK INDUSTRIES part number 67382**

CONTROLLER ADJUSTMENT NOTES

- Should proportional sections experience slight shifting in the Lo Threshold over time, repeat the Controller Adjustment Procedure found in the Electrical portion of SECTION 4. Such shifting would be characterized by delayed flow as the jovstick is actuated.
- It is very important that neutral joystick position coincide with NO flow through the valve. If flow does occur and the Controller Adjustment Procedure in SECTION 4 has been completed, contact;
  MARK INDUSTRIES Service Dept.

INSTALLATION

GENERAL CONSIDERATIONS

- The valve is stacked and performance tested prior to shipment. Each is capped and carefully packed to ensure a clean, operation-ready condition. Allow port caps to remain in place until hoses and other hookups have been prepared.
- The valve is not attitude sensitive and can be mounted in any orientation without affecting performance.

- *Primary consideration is recommended in regard to mounting for the following maintenance items: accessibility, proximity to other hydraulic components, and routing of hydraulic lines and wiring.*
- *Also, main spools can ONLY be removed toward the cartridge side of the valve section. Consequently, if there is a possibility main spools might later be exchanged to affect flow, sufficient clearance (9.5 inches min.) must be available.*

- The mounting surface must be sufficiently flat to avoid excessive distortion upon tightening. Three (3) mounting holes are provided.
- **CAUTION** - The VP Series **PULSAR** valve is compatible with ONLY a 0 to 12 VDC peak-to-peak, 33 Hertz, pulse-width modulated controller signal output. In addition, an inductive turn-off spike of approximately 18 V. IS REQUIRED for proper operation.

RECOMMENDED PRACTICE

Proper start-up and function of a hydraulic system is often dependent on the quality of its installation. Following are some basic installation recommendations.

Cleanliness

- Installation operations such as cutting, threading, flaring result in debris capable of contaminating a hydraulic circuit. Care should be taken to prevent such debris from entering the system.
- All hoses should be flushed with appropriate degreasing solution prior to installation. Tubing may be blown out with compressed air or flushed.
- Care should be taken to ensure that sealing compounds are unable to enter the hydraulic system. Do not apply teflon tape to the first few connector threads.
- Be certain hydraulic oil is clean before adding it to the system.

NOTE - If there is no high pressure filter installed preceding the valve, it is recommended upon start-up that the valve supply line be connected to the return line for several minutes to allow the new oil to pass through the return line filter.

Hoses and Lines

- For maximum performance hydraulic lines should be sufficiently large in diameter, yet short in length as possible. Also, avoid bends, keep the number of fittings to a minimum, and otherwise limit restrictions.
- For cylinders with differential areas, it is recommended that the higher flow be connected to the C_1 port, whenever possible.
- To enhance metering, lines between valves and actuators should be short and reasonably rigid.
- For circuits employing the load sensing feature, effort should be made to restrict the length and diameter of the sensing line returned to the pump. Lengths in excess of six (6) feet slow response time and increase the opportunity for instability.
- Provide sufficient slack in hoses to relieve potential strain.
- Flexible hoses require kink free movement throughout the machine range.
- Hoses subjected to rubbing should be covered with protective sheathing.
- Keep hoses away from hot spots. Install insulation if this is not possible.
- Provide support to hydraulic lines which become necessarily long. Vibrating lines are capable of loosening sufficiently to result in oil leaks.
- Leakage at the inlet side of the pump cannot be allowed. Such leaks permit air to enter the system which can be responsible for an assortment of system difficulties.

HYDRAULIC

*Hydraulic oil specifications:

Petroleum base,

Viscosity range--- 1500 to 30 SUS,

Temperature range- -40 to 250 degrees F.

Specific operating conditions will determine the final selection.

CAUTION - For hydraulic circuits returning a load sensing signal to the pump and incorporating fluid logic from other component valves, verify their compatibility. The VP Series valve sections use the free-floating shuttle ball style and will ONLY be compatible with this shuttle style.

NOTE - The VP Series valve spool is designed to meter flow in and out of the section. Consequently, it is recommended to route the return line from the actuator back through the valve then to tank, to take advantage of this meter-out capability. This is particularly beneficial in the case of a motor function where the motor shaft is allowed to freewheel or coast.

Hydraulic Fitting Sizes

Fitting	Inches	SAE	Tube Size
Cylinder ports	1-1/4 ext.hex.	12	3/4 "
Inlet & outlet ports	1-1/2 ext.hex.	16	1 "
External drain (L.S.)	9/16 ext.hex.	4	1/4 "
Flow limiter: adjust.	3/16 int. hex.		
lockdown	11/16 ext. hex.		
Pressure comp. inlet:			
Bypass: adjust.	3/16 int. hex.		
seal nut	11/16 ext.hex.		
Full flow: adjust.	1-3/8 ext.hex.		
locknut	1-1/2 ext.hex.		

ELECTRICAL

- It is reemphasized that appropriate (see Basic Considerations) pulse-width modulated excitation must be provided for proportional flow control.
- Solenoid coil current draw is less than 500 mA, however a minimum of 18 GA wire is recommended for strength and durability.
- There is no polarity requirement.
- Special shielding is usually NOT required. However,

CAUTION - If the wiring configuration requires a common solenoid return path, ensure that the signal conductor is of sufficient gauge to carry the combined coil currents.

Controller Adjustment Procedure

The purpose in adjusting the controller is to obtain effective metering capability throughout the range of the control stick. This is achieved by adjusting two potentiometers (trim pots) on the controller.

- The "Lo Range" or "Lo Threshold" is the null adjustment which sets the turn-on or first flow point of the valve being controlled. This is adjusted to compensate for mechanical deadband in the valve. The Lo Threshold pot is turned clockwise (CW) to set a minimum voltage just below the valve's first flow point. The first flow point is so labeled in FIGURE 17. This ensures the valve will start flow soon after the controller is displaced, and will shut off when returned to neutral.
- The right pot is the "Hi Range" or "Hi Threshold". It determines the point at which maximum valve flow rate is achieved compared to control stick position. FIGURE 17 shows the Hi Threshold adjustment varies the rate of change in flow with respect to controller displacement, or the slope of the curve. When the Hi Threshold is properly adjusted maximum flow through the valve coincides with full control stick displacement.

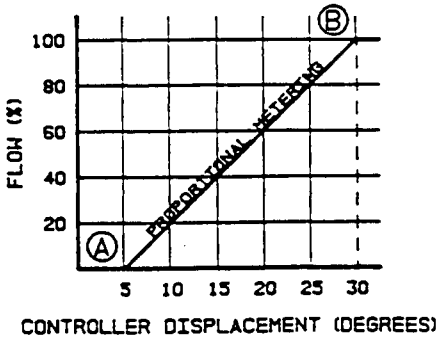


FIGURE 12
PERCENT FLOW vs.
CONTROLLER DISPLACEMENT

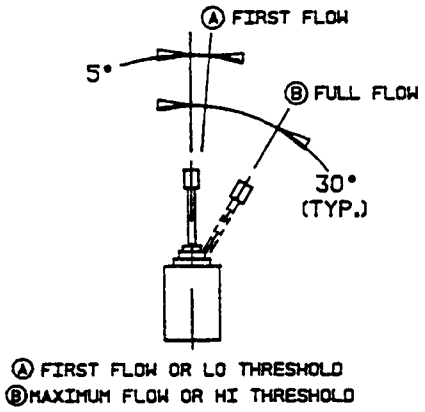


FIGURE 13, JOYSTICK CONTROLLER

Numerous controller adjustments are possible, however most precise metering is obtained when controller displacement corresponds to the valve flow range. This adjusted condition is achieved by the following procedure:

1) Set the controller to a position approximately 5 degrees from the neutral position, FIGURE 18.
2) Turn the Lo Threshold pot sufficiently to permit first flow. Clockwise (CW) increases flow, counter-clockwise (CCW) reduces flow.
3) Actuate the controller to full displacement, approximately 30 degrees.
4) Turn the Hi Threshold pot to just permit maximum needed flow. CW increases, CCW reduces flow. Care should be taken to ensure that the trim pot is not rotated past full flow. If turned too high, full flow will occur at a lesser control position and some controllability will be lost.
5) Return the controller to neutral. The valve should turn off, no flow.
6) If some flow occurs, the Lo Threshold pot should be turned down CCW a very small amount until flow ceases. However, if this final adjustment does not halt flow, consult the supplier of the controller regarding signal interruption at the neutral controller position.

When installation is complete it is possible to proceed with the system check. Please refer to the Pre-Operation Check found in SECTION 2 of this manual.

VP SERIES PROPORTIONAL VALVE
SERVICE PARTS LIST

		PART NUMBER
INLETS:	-Load Sensing	VL1110-0001P
	-Pressure Compensating (* * * = relief setting/10)	VB2213--***1P
	-Pressure Compensating with Power Beyond	VP2413--***1P
WORKING SECTIONS:		See Chart *
TIE ROD KITS: (include tie rods, hex nut and lock nut)		
	1 Section	VOTR1K1
	2 Section	VOTR2K1
	3 Section	VOTR3K1
	4 Section	VOTR4K1
	5 Section	VOTR5K1
	6 Section	VOTR6K1
	7 Section	VOTR7K1
	8 Section	VOTR8K1
	9 Section	VOTR9K1
END COVERS:	-with Ports (P,T,LS)	VO-1111K1
	-without Ports	VO-0001K1
SERVICE PARTS/KITS:		
SPOOL KITS		See Chart * *
FLOW LIMITER KIT (Both Spool Ends)		VPFL1K1
SEAL KIT (O-rings, Seal Plate, Shuttle Ball)		VOSPK1

INLET PILOT FILTER
- Load Sensing VLPFK1
- Pressure Compensating VBPFK1

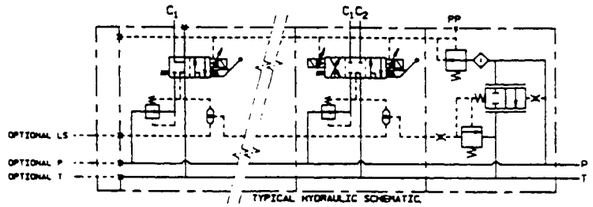
SOLENOID PLUGS (2) VNPK1
SOLENOID CARTRIDGE VS1320-0011P
PILOT OIL FITTING KIT VWFK1
VP SERIES HANDLE FOR MANUAL OVERRIDE, 6 Inch VPH6K1
ON/OFF (Low Leak) SPOOL KIT
- 4-Way VQ024K1
- 3-Way VQ033K1

* PROPORTIONAL WORKING SECTION (with individual pressure compensation and manual override without handle)

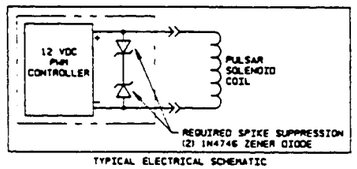
FLOW RATING (GPM)	3-POS. 3-WAY(C.C.)	3-POS. 4-WAY (C.C.)	3-POS. 4-WAY (O.C.)
2.5	VP1333-3211P	VP1243-3211P	VP1143-3211P
3.5	VP2333-3211P	VP2243-3211P	VP2143-3211P
5.0	VP3333-3211P	VP3243-3211P	VP3143-3211P
7.0	VP4333-3211P	VP4243-3211P	VP4143-3211P
10.0	VP5333-3211P	VP5243-3211P	VP5143-3211P
14.0	VP6333-3211P	VP6243-3211P	VP6143-3211P
20.0	VP7333-3211P	VP7243-3211P	VP7143-3211P
28.0	VP8333-3211P	VP8243-3211P	VP8143-3211P
40.0	VP9333-3211P	VP9243-3211P	VP9143-3211P

* * SPOOL KITS

FLOW RATING (GPM)	3-POS. 3-WAY (C.C.)	3-POS. 4-WAY (C.C.)	3-POS. 4-WAY (O.C.)
2.5	VP133K1	VP124K1	VP114K1
3.5	VP233K1	VP224K1	VP214K1
5.0	VP333K1	VP324K1	VP314K1
7.0	VP433K1	VP424K1	VP414K1
10.0	VP533K1	VP524K1	VP514K1
14.0	VP633K1	VP624K1	VP614K1
20.0	VP733K1	VP724K1	VP714K1
28.0	VP833K1	VP824K1	VP814K1
40.0	VP933K1	VP924K1	VP914K1



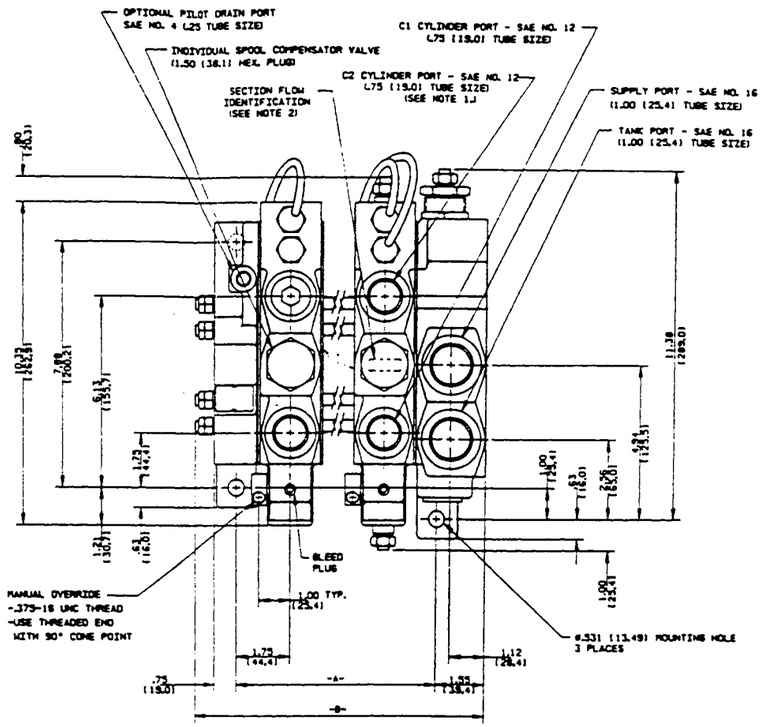
TYPICAL HYDRAULIC SCHEMATIC



TYPICAL ELECTRICAL SCHEMATIC

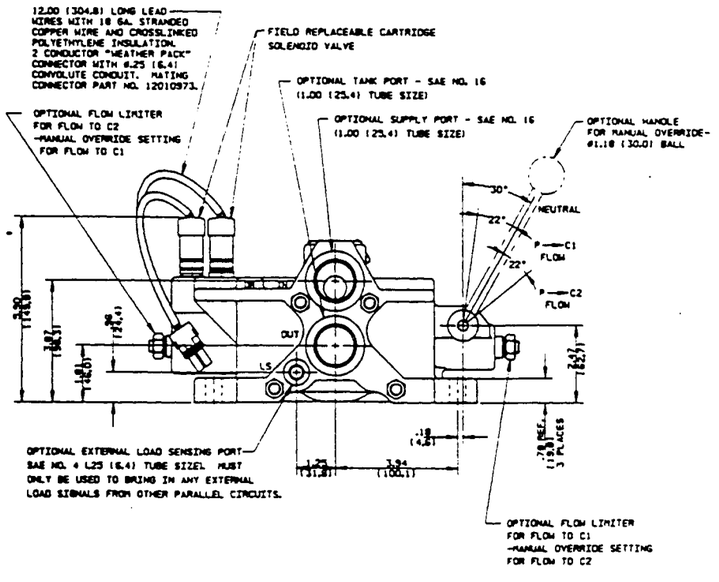
NOTES:
1.) RECOMMEND STRAIGHT THREAD, LONG CONNECTOR FITTING BE USED IN C2 PORT.
2.) IDENTIFICATION MARKED AS: FLOW (IN GPM)/CYLINDER PORT CONFIGURATION (O=OPEN, C=CLOSED).
3.) FLOW DIRECTION IS REVERSED IF VALVE HAS HIGH RESPONSE OPTION.
4.) WHEN PRESSURE COMPENSATOR ADJUSTMENT IS REQUIRED TO CHANGE FULL FLOW BYPASS PRESSURE ADJUSMENT MUST BE BACKED OUT BEFORE SETTING FULL FLOW, THEN MUST BE RESET FOR 200 PSI (13.8 BAR) IP——TL

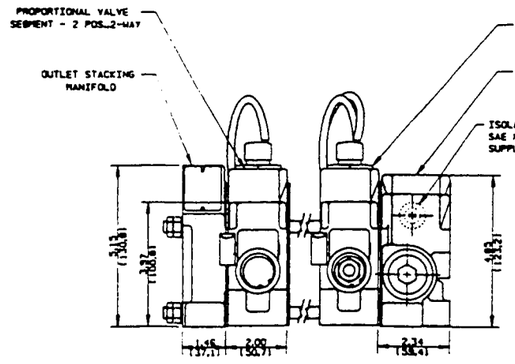
NUMBER OF SEGMENTS	A	B
1	3.50 (88.9)	6.50 (165.1)
2	5.50 (139.7)	8.50 (215.9)
3	7.50 (190.5)	10.50 (266.7)
4	9.50 (241.3)	12.50 (317.5)
5	11.50 (292.1)	14.50 (368.3)
6	13.50 (342.9)	16.50 (419.1)
7	15.50 (393.7)	18.50 (469.9)
8	17.50 (444.3)	20.50 (520.7)
9	19.50 (495.3)	22.50 (571.5)

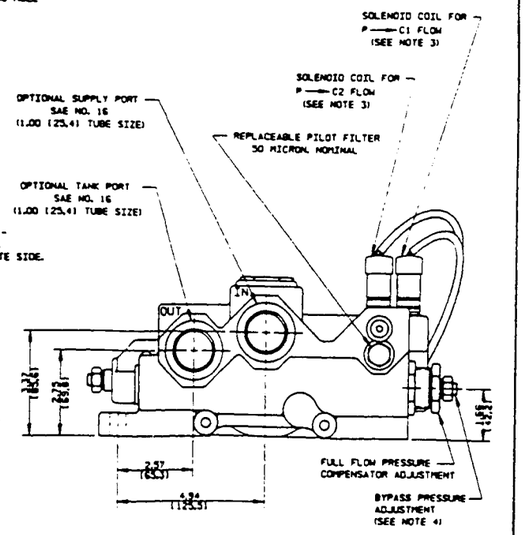


VALVE SPECIFICATIONS

OPERATING PRESSURE:	
PRESSURE SUPPLY PORT	3500 PSI [241.4 BAR]
CYLINDER PORTS	3500 PSI [241.4 BAR]
TANK PORTS	500 PSI [35.5 BAR]
PILOT SUPPLY PRESSURE	200 PSI [13.8 BAR] (PLUS TANK PSI)
RELIEF VALVE SETTING	500-3500 PSI [34.5-241.4 BAR]
SPOOL FLOW RATINGS (AT 100 PSI LOOP DROP)	2.5, 3.5, 5, 7, 10, 14, 20, 28, & 40 GPM
SPOOL/CYLINDER PORT CONFIGURATION	-2 POS., 2 WAY/OPEN OR CLOSED CYLINDER PORTS (P——C1)
	-2 POS., 4 WAY/OPEN OR CLOSED CYLINDER PORTS (P——C1, C2——T)
	-3 POS., 3 WAY/OPEN OR CLOSED CYLINDER PORTS (P——C1 & C1——T)
	-3 POS., 4 WAY/OPEN OR CLOSED CYLINDER PORTS
SPOOL DEADBAND	25% OF STROKE
ELECTRICAL DEADBAND (FROM NULL)	40% ±10% MODULATION RATIO
DEADBAND SYMMETRY	±5% OF MODULATION RATIO
NEUTRAL LEAKAGE (PER SECTION)	0.01 GPM (TYP.) AT 200 PSI
RECOMMENDED FILTRATION	SAE CLASS 5 (17/14 - ISO 4406)
MAXIMUM FLUID TEMPERATURE	250°F [121°C]
AMBIENT TEMPERATURE RANGE	-40°F TO 180°F [-40°C TO 82°C]
STEP RESPONSE:	
0% TO 100% (PROPORTIONAL)	600 MILLISECONDS (TYP.)
0% TO 100% (ON/OFF)	300 MILLISECONDS (TYP.)
100% TO 0% (EITHER)	300 MILLISECONDS (TYP.)
0% TO 100% (HIGH RESPONSE)	80 MILLISECONDS (TYP.)
100% TO 0% (HIGH RESPONSE)	60 MILLISECONDS (TYP.)
HYSTERESIS	±1% (TYP.)
COIL RESISTANCE	28.0 OHMS @ 70°F [21°C]
RATED OPERATING VOLTAGE	12±3 VDC
CURRENT DRAW	430 MA AT 12 VDC & 70°F [21°C]
PWM FREQUENCY	33 HZ (SQUARE WAVE)
SEAL MATERIAL	BUNA-N
MOUNTING ATTITUDE	UNRESTRICTED
WEIGHT (APPROX)	10 LBS. (MANIFOLDS)
	13 LBS. (WORKING SECTIONS)
	15 LBS. (INLET VALVE)







NOTE: ALL DIMENSIONS ARE NOMINAL.

ENERPAC

Specification Sheet

DESCRIPTION: PROPORTIONAL VALVE WITH P.C. BYPASS INLET

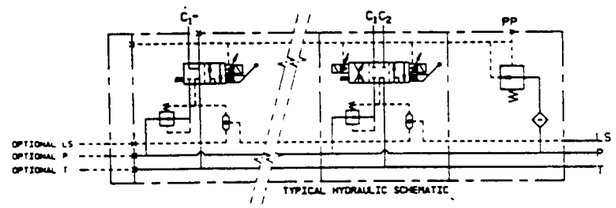
MODEL NO. VA1888-8888-888

DRAWING NO. VA1888-8888-888

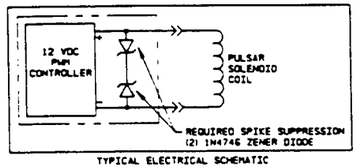
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A1

Instruction Drawing



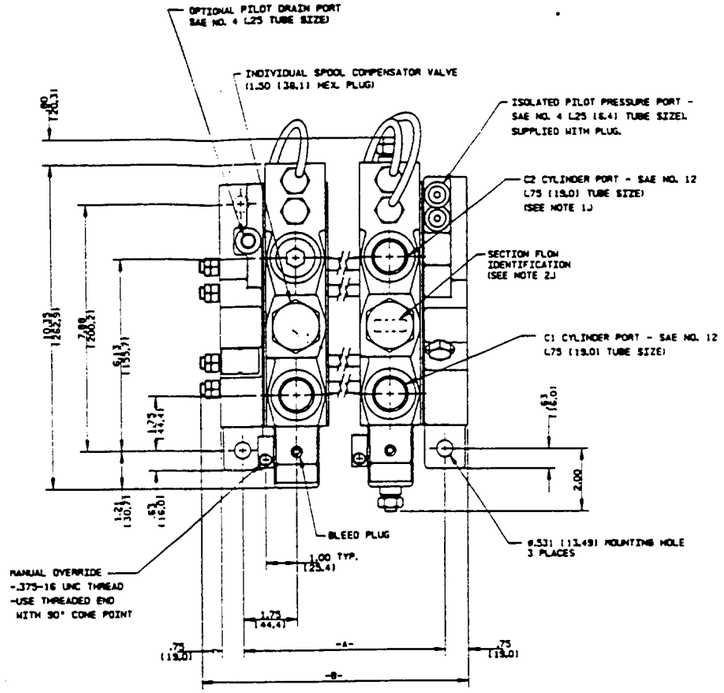
TYPICAL HYDRAULIC SCHEMATIC



TYPICAL ELECTRICAL SCHEMATIC

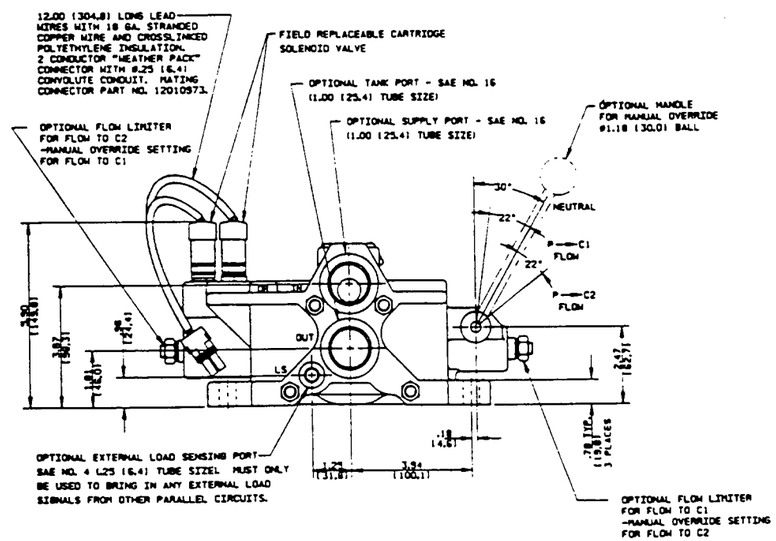
NOTES:
1. RECOMMEND STRAIGHT THREAD, LONG CONNECTOR FITTING BE USED IN C2 PORT.
2. IDENTIFICATION MARKED AS: FLOW (IN GPM)/CYLINDER PORT CONFIGURATION (O=OPEN, C=CLOSED).
3. FLOW DIRECTION IS REVERSED IF VALVE HAS HIGH RESPONSE OPTION.

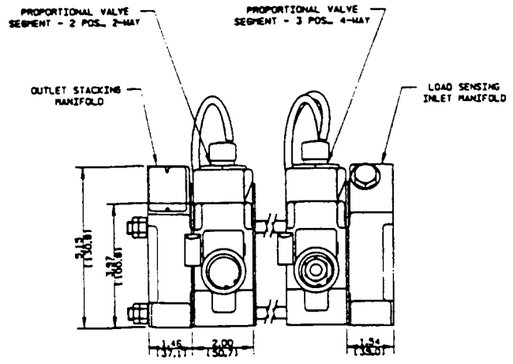
NUMBER OF SEGMENTS	A	B
1	3.50 [88.9]	5.75 [146.0]
2	5.50 [139.7]	7.75 [196.8]
3	7.50 [190.5]	9.75 [247.6]
4	9.50 [241.3]	11.75 [298.4]
5	11.50 [292.1]	13.75 [349.2]
6	13.50 [342.9]	15.75 [400.0]
7	15.50 [393.7]	17.75 [450.8]
8	17.50 [444.5]	19.75 [501.6]
9	19.50 [495.3]	21.75 [552.4]

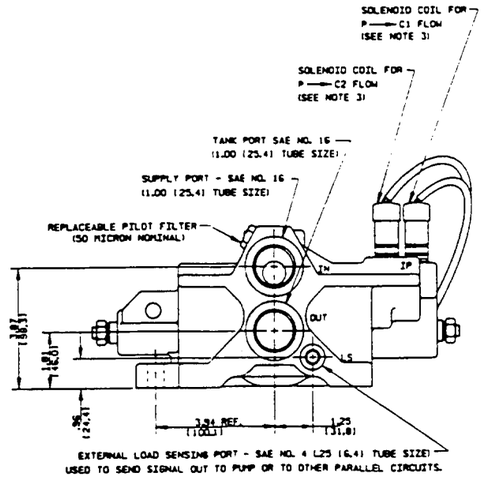


VALVE SPECIFICATIONS

OPERATING PRESSURE	
PRESSURE SUPPLY PORT	3500 PSI (241.4 BAR)
LOAD SENSING PORT	3500 PSI (241.4 BAR)
CYLINDER PORTS	3500 PSI (241.4 BAR)
TANK PORTS	500 PSI (35.5 BAR)
PILOT SUPPLY PRESSURE	200 PSI (13.8 BAR) PLUS TANK PSI.
SPOOL FLOW RATINGS	2.5, 3.5, 5, 7, 10, 14, 20,
(AT 100 PSI LOOP DROP)	28, & 40 GPM
SPOOL/CYLINDER PORT	-2 POS., 2 WAY/OPEN OR CLOSED
CONFIGURATION	CYLINDER PORTS (P⟷C1)
	-2 POS., 4 WAY/OPEN OR CLOSED
	CYLINDER PORTS (P⟷C1, C2⟷T)
	-3 POS., 3 WAY/OPEN OR CLOSED
	CYLINDER PORTS (P⟷C1 & C1⟷T)
	-3 POS., 4 WAY/OPEN OR CLOSED
	CYLINDER PORTS
SPOOL DEADBAND	25% OF STROKE
ELECTRICAL DEADBAND (FROM NULL)	40% ±10% MODULATION RATIO
DEADBAND SYMMETRY	±5% OF MODULATION RATIO
NEUTRAL LEAKAGE (PER SECTION)	0.01 GPM (TYP.) AT 200 PSI
RECOMMENDED FILTRATION	SAE CLASS 5 (17/14 - ISO 4406
MAXIMUM FLUID TEMPERATURE	250°F (121°C)
AMBIENT TEMPERATURE RANGE	-40°F TO 180°F (-40°C TO 82°C.
STEP RESPONSE:	
0% TO 100% (PROPORTIONAL)	600 MILLISECONDS (TYP.)
0% TO 100% (ON/OFF)	300 MILLISECONDS (TYP.)
100% TO 0% (EITHER)	300 MILLISECONDS (TYP.)
0% TO 100% (HIGH RESPONSE)	80 MILLISECONDS (TYP.)
100% TO 0% (HIGH RESPONSE)	60 MILLISECONDS (TYP.)
HYSTERESIS	1% (TYP.)
COIL RESISTANCE	2.8Ω OHMS @ 70°F (21°C)
RATED OPERATING VOLTAGE	12±3 VDC
CURRENT DRAW	430 MA AT 12 VDC & 70°F (21°C)
PWM FREQUENCY	33 HZ (SQUARE WAVE)
SEAL MATERIAL	BUNA-N
MOUNTING ATTITUDE	UNRESTRICTED
WEIGHT (APPROX)	10 LBS. (MANIFOLDS)
	15 LBS. (WORKING SECTIONS)







NOTE: ALL DIMENSIONS ARE NOMINAL.

ENERPAC.

Specification Sheet

MODEL NO. VA3000-0000-000

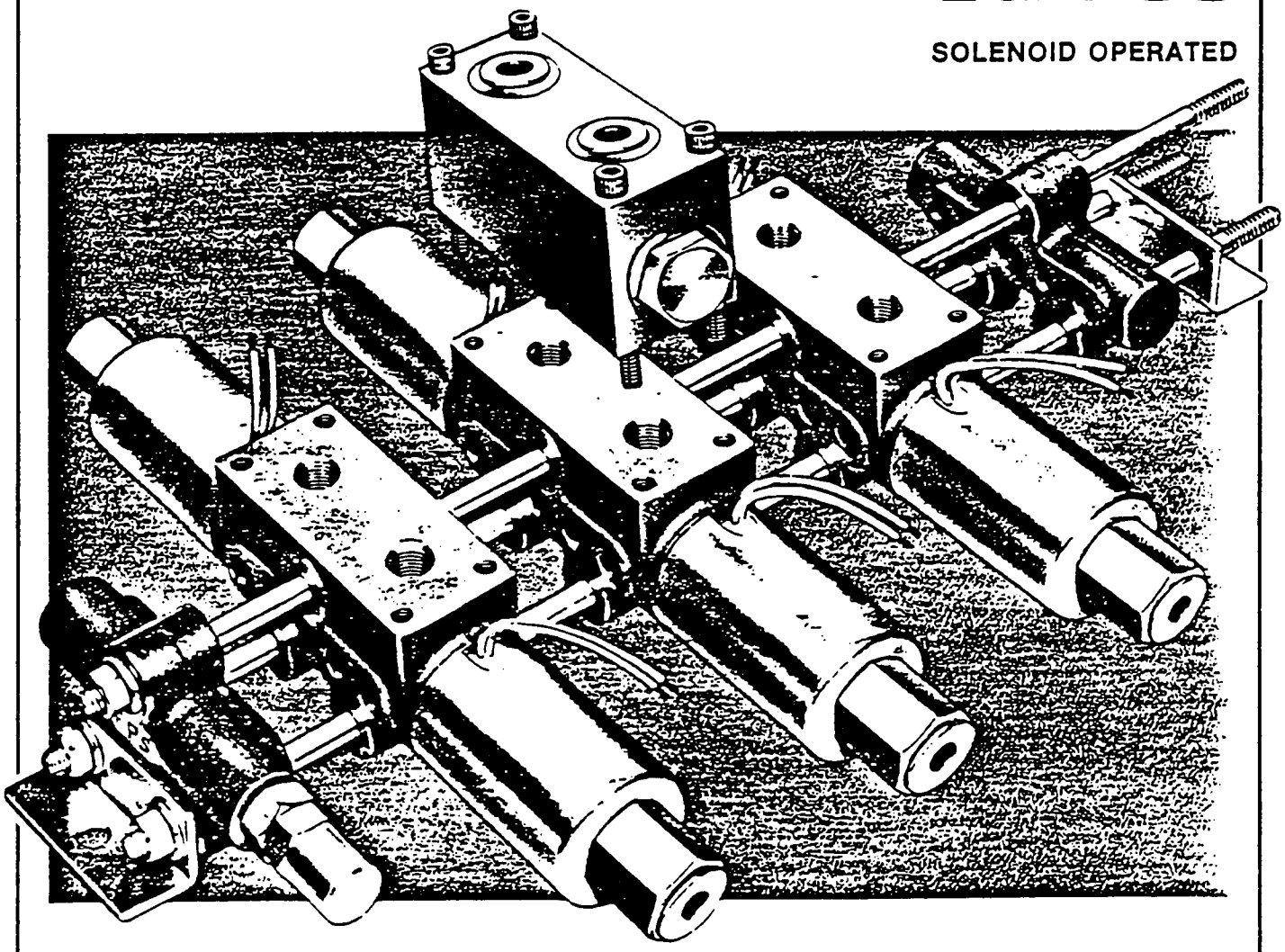
DESCRIPTION: PROPORTIONAL VALVE WITH LOAD SENSING INLET

VA3000-0000-000 D

Instruction Drawing

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

FPS Mini Pak Valves

Maintenance and service bulletin

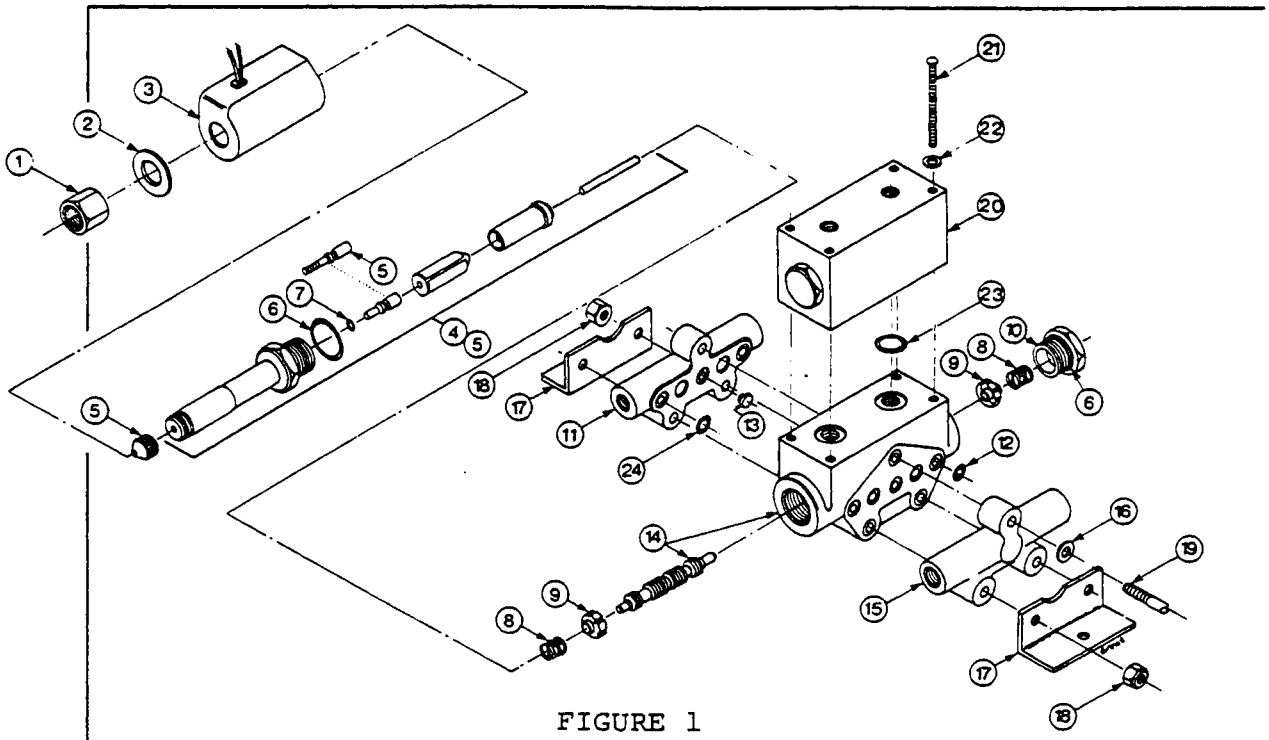


FIGURE 1

Parts List

Item	Description	Item	Description	Item	Description
1.	Nut	9.	Spring retainer	18.	Nut
2.	Nameplate	10.	Plug	19.	Tie rod
3.	Solenoid coil	11.	Outlet section	20.	Attachment (optional)
4.	Tube S/A (standard)	12.	O-ring (5)		
5.	Tube S/A (palm button)	13.	Closed center plug	21.	Bolt
		14.	Body & spool	22.	Washer
6.	O-ring	15.	Inlet section	23.	O-ring
7.	O-ring	16.	Washer	24.	O-ring (5)
8.	Spring	17.	Mounting bracket		

UNITED TECHNOLOGIES AUTOMOTIVE

COMPONENTS DIVISION

FLUID POWER SYSTEMS

Disassembly: (See Figure 1)

Note: Before attempting to disassemble this or any other hydraulic component, prepare a CLEAN work area.

1. Remove coil nut (1) and slide coil (3) off tube (4).
2. Remove nuts (18), mounting bracket (17) and washer (16) from the inlet end of the valve bank.
3. Remove inlet (15), attachments (20) as necessary, and O-rings.
4. Remove valve sections (14), one at a time, removing O-rings (12) or (13) between each section. Remove only those sections to be repaired or replaced.
5. Use a 1½" box or open end wrench to loosen tubes (4) from body.

CAUTION: Use proper tools to avoid damaging tube subassembly.

6. Remove tube subassembly by hand. Spring (8) and spring retainer (9) may fall from valve body.
7. Slide pin, plug and plunger out of tube.

NOTE: Pin, plug and plunger are a matched set. Do NOT mix parts.

8. Use a small punch to gently push manual override pin into tube until it is free and falls out.
9. If valve has manual override option "JJ", use a screwdriver inside the tube to hold pin (5) from turning while removing the palm button.
10. Repeat steps 5 through 8 to remove tubes on the opposite side of the valve.
11. Gently slide spool (14) from valve body. Make note of its position in the valve body. Spool cannot be turned around. It must slide into the body in the same position it came out.

CAUTION: BODY AND SPOOL ARE A MATCHED SET. If either one is damaged, BOTH must be replaced.

12. Wash all parts in cleaning solvent and dry with air gun. Be sure to remove all traces of solvent.

Assembly:

Note: Before re-assembly, discard all used O-rings.

1. All parts should be individually inspected to verify they are free from wear, burrs, nicks, scratches or any other defect that could cause poor performance.

2. Lubricate all system parts and O-rings with clean system oil before assembly.

3. Lubricate spool (14) and valve body and carefully slide spool into body making sure it is in the same position as when it was removed. Spool should slide freely in body.

4. Install O-ring (7) on manual override pin. Lubricate inside of tube where pin is installed. Carefully push pin into place. Install O-ring (6) on tube. Install plunger, plug and pin. Make sure that these parts are lubricated with oil. Pin should slide freely in plug.

5. Place spring retainer (9) onto spool with prongs towards spool. Place spring (8) over retainer and install tube subassembly into valve body by hand.

6. Repeat steps 4 and 5 for the opposite side of the valve.

7. Install one nut (18) on each tie rod (19). Place two tie rods through the mounting bracket (17). Place one flat washer (16) on the third tie rod. Place outlet section (11) over the tie rods. An aid in banking sections is to place the mounting bracket in a vice or on the edge of a flat surface with the tie rods in a vertical position. Place five O-rings (24). Install a valve section over the tie rods. Place the O-rings (12) on this section. Replace remaining sections as above.

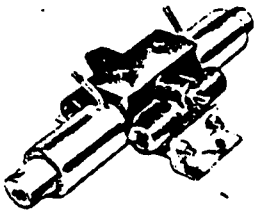
8. Install inlet section (15). Place mounting bracket (17) over lower tie rods and install two nuts (18). Place a flat washer (16) over top tie rod only.

9. Torque tie rods in three steps of 50 in./lbs., 90 in./lbs., and finally 115 in./lbs. THIS IS VERY IMPORTANT! OVERTORQUEING WILL CAUSE BORE DISTORTION & MAY CAUSE SPOOL BINDING OR INCREASED LEAKAGE.

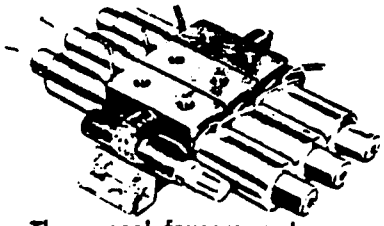
Assembly continued:

10. In order to set the relief, if installed, the complete valve must be placed on a test stand capable of flow from 1 to 5 GPM. Remove the cap over the adjustment screw and loosen the lock nut (see below). Set incoming pressure on test stand to desired valve setting and adjust screw in to increase relief setting or out to decrease relief setting. Setting is correct when .25 GPM flows out of valve at desired pressure.

11. If painting is required make sure all ports are plugged and electrical connections are masked.



Four-way, three position double solenoid valve.

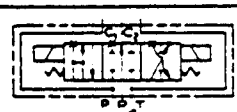
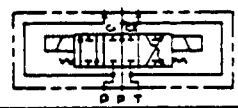


Three spool, four-way valve assembly with relief valve at inlet.



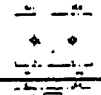
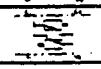
Three spool, four-way valve assembly with relief valve (Manual-Solenoid-Solenoid).

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

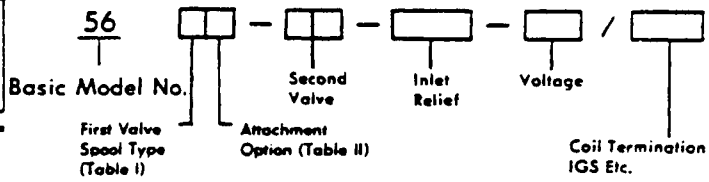
For spool configurations other than shown consult factory.

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

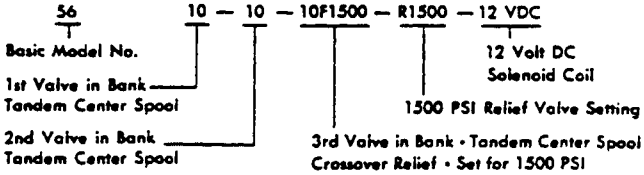
Code letter JJ indicates Palm Button Manual Override

ordering information



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

example of three bank assembly



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HELAC

MAINTENANCE MANUAL

FOR

"HELAC" PIVOT

ROTARY ACTUATORS

HP-SERIES

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HP-286

I. THEORY OF OPERATION

In reference to Fig. I, fluid entering Port E2 under pressure will bear on piston (4) and force piston sleeve (3) upwards. The left-handed spline of piston sleeve (3) will combine with the right-handed spline of shaft (2) and cause rapid CW rotation of shaft and flange (2) (looking down). Fluid entering Port E1 will reverse this rotation.

Displacement and torque are identical for CW and CCW rotation.

Shaft (2A) is integral with shaft flange (2B) and bearing tube (2C). The shaft is supported radially by the large upper radial bearing (19) and the lower radial bearing (18). Axially, the shaft is separated from the housing by upper and lower thrust rings (20). End cap (5) is adjusted for axial clearance and locked in position by cap screw (7).

II. HYDRAULIC LINE ATTACHMENT

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

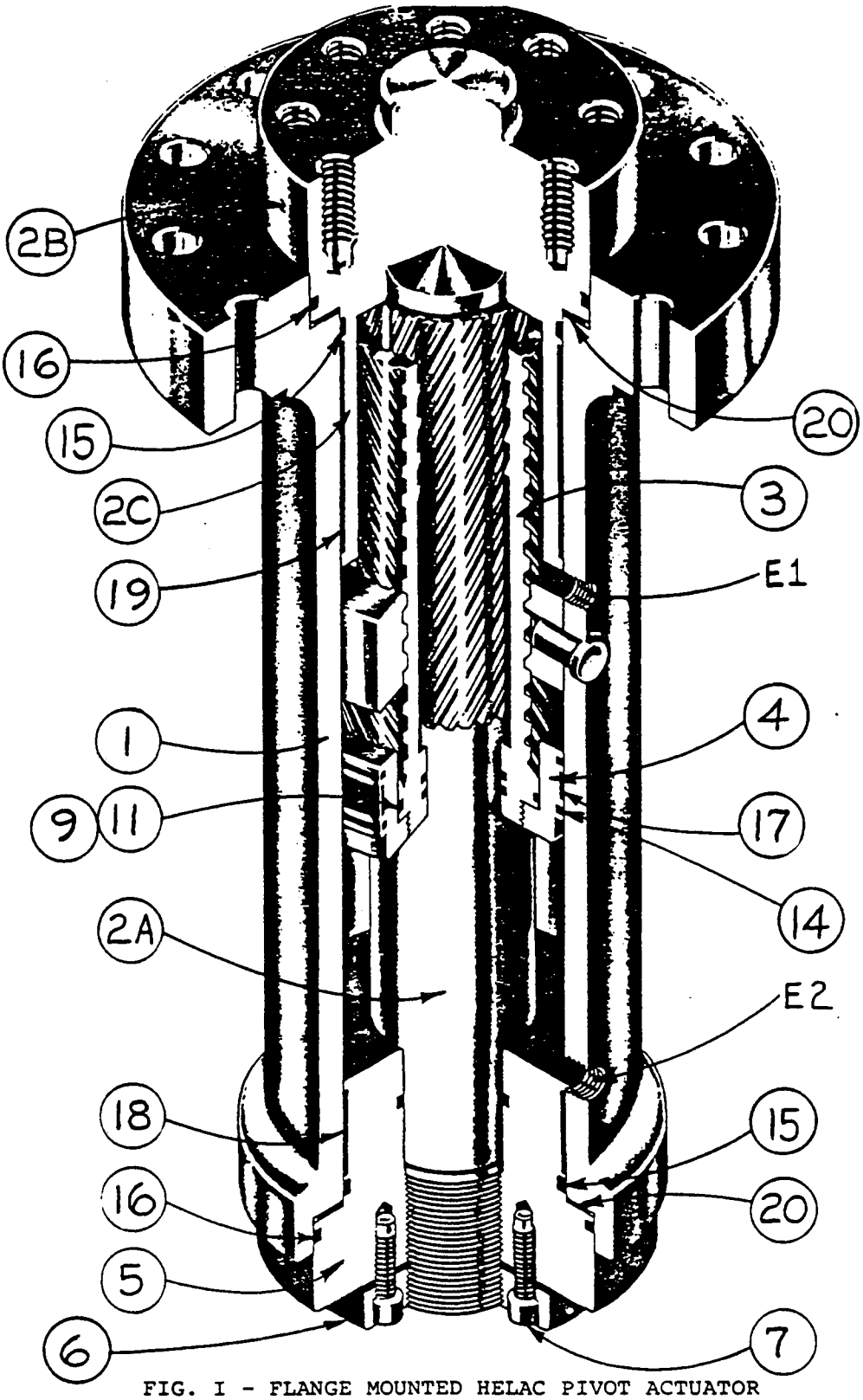


FIG. I - FLANGE MOUNTED HELAC PIVOT ACTUATOR

III. DISASSEMBLY AND INSPECTION

Place on clean work bench with room to place the internal parts as they are removed. Remove all hydraulic fittings. Loosen cap screws (7) and unscrew locknut (6) and end cap (5). The shaft is now free to slide up and out of engagement with the piston sleeve (3). Note the orientation (see Fig. II) between the spline teeth, as this will greatly simplify actuator timing upon reassembly.

After removing the shaft, the piston sleeve and the piston assembly can now be moved down and out of the housing. Remove all seals and wear strips from their grooves, except static piston seals (9) and (11). These seals generally do not require replacement. Clean all parts thoroughly and inspect for wear. A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about .005 per mating set. After long service, a backlash of about .015 per set may still be acceptable in most cases, depending on the required accuracy of the application.

Item (1) is the integral housing and ring. Check the ring gear for wear and weld damage to the pins. Inspect the cylinder bore for wear and scratches. The surface finish should be 32 RMS or better, rehone if necessary. The radial bearing (18) and (19) and the piston wear strip (17) should have maximum radial clearance of

III. DISASSEMBLY AND INSPECTION (CONT'D)

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

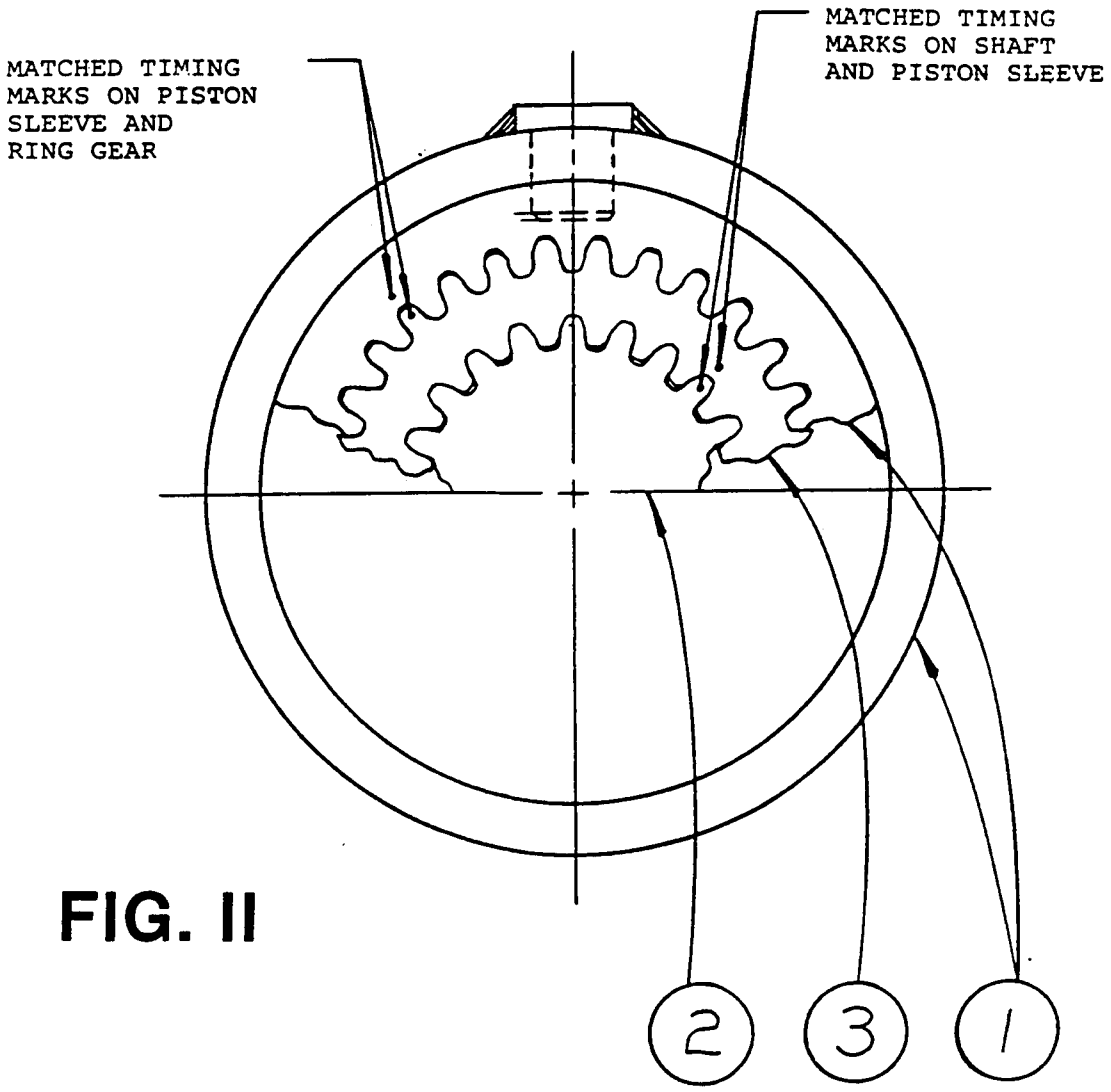


FIG. II

IV. ASSEMBLY AND TESTING

Wash all parts thoroughly in cleaning solvent and blow dry. Coat all sealing and working surfaces with a good grade hydraulic oil. Install seals in piston sleeve, piston and end caps. The lips of exclusion seals (16) face outward, and the lips of high pressure seals (15) face inwards.

Place the actuator in a vertical position, install the piston sleeve (3) in timed relation to the housing, applying firm pressure as the new seals and wear strip enter the housing and become compressed by the housing chamber. (CAUTION: Do not cock the sleeve too much any one way, for it will mar the cylinder bore). The timing marks (small punch marks on the face of each gear), must be lined up for proper shaft orientation. (Fig. II).

Thrust rings (20) are coated with good grease before sliding on the shaft and end cap. The shaft is installed by again aligning the proper punched timing marks (Fig. II). Temporary taping (masking tape works well) of threaded portion of shaft will help installation past the shaft seals. Apply antiseize to threaded and surrounding areas of end caps. Also depending on the size of the actuator (some 60K's& up), the end cap may need to be installed with the actuator in a vertical position.

IV. ASSEMBLY AND TESTING (CONT'D)

End cap (5) is torque to 40-80 ft-lb depending on the actuator size, such that the actuator begins rotation at approximately 100 PSI pressure. The torque flange cannot be rotated by hand. The combined back-drive efficiency and friction prevent manual rotation. If the end cap is torqued too high, the actuator may take as much as 300 PSI to rotate. If end cap is not torqued high enough, shaft axial motion in excess of .015 will occur and damage the ring gear, piston, sleeve and/or shaft can result. The end cap must be secured against the shaft by tightening cap screws (7). Apply hydraulic pressure and check for shaft axial motion.

To test for leakage, pressurize port E2 to 3000 PSI. No oil should seep from port E1 or from around end cap (5). Repeat test for pressurizing port E1 and check for leakage out of port E2 and around shaft flange (2B).

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

TESTING & STORAGE

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

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

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

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