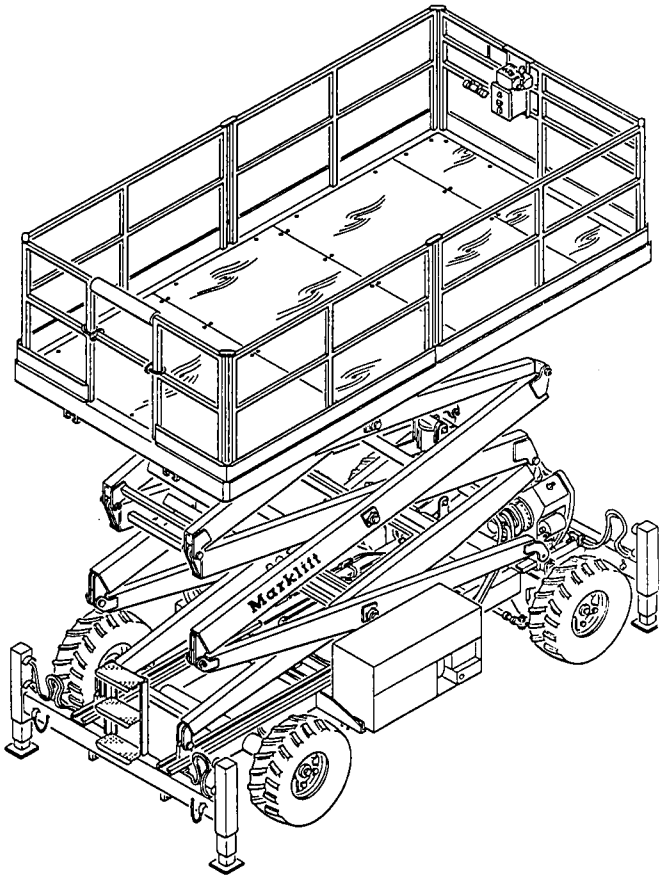
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED SCISSOR OPERATION MAINTENANCE AND PARTS MANUAL



MODELS:
MT31G & MT40G

FIRST EDITION: December,1989

Mark Industries

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Mark Industries

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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 Engineering Department at (714) 879-6275.

WARNING: IMPROPER USE OF THIS MACHINE WILL 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	Models	
	MT31G	MT40G
Height –		
Working (maximum)	37' (11.28m)	46' (14.02m)
Platform (maximum)	31' (9.45m)	40' (12.19m)
Platform (minimum)	59" (1.50m)	68" (1.73m)
Length (overall)	170"	170"
Width (overall)	87.5" (2.22m)	87.5" (2.22m)
Platform –		
Dimensions (inside)	80" x 164" (2.03m x 4.17m)	80" x 164" (2.03m x 4.17m)
Safety rail height	42" (1.06m)	42" (1.06m)
Toeplate height	6" (.15m)	6" (.15m)
Load capacity	2000 lbs (907.18 kg)	1500 lbs (680.40 kg)
Wheel base	110" (2.79m)	110" (2.79m)
Wheel track	75" (1.91m)	75" (1.91m)
Turning radius (inside)	13'6" (4.11m)	13'6" (4.11m)
Travel speed proportional drive	0-3 mph (0-4.82 km/hr)	0-3 mph (0-4.82 km/hr)
Lift speed (maximum load)	65 sec.	71 sec.
Lower speed (maximum load)	40 sec.	42 sec.
Power system (dual fuel)	29 HP Wisconsin	29 HP Wisconsin
Battery voltage	12 VDC	12VDC
Capacities		
Battery	90 amp/hr	90 amp/hr
Hydraulic tank	18 gal. (68.14L)	18 gal. (68.14L)
Fuel tank	15gal. (56.78L)	15 gal. (56.78L)
Alternator	30 amp	30 amp
Tire size	29 x 12.50 x 15 NHS	29 x 12.50 x 15 NHS
Optional sand tire	Super Terra Grip 11L -15 Rib	Super Terra Grip 11L - 15 Rib
Ground clearance	7" (.18m)	7" (.18m)
Shipping weight	5640 lbs. (2558.25 kg)	7510 lbs. (3406.5 kg)
Shipping cube	583.5 cu. ft. (16.52 m^3)	962.15 cu. ft. (27.25 m^3)

Specifications are nominal and are subject to change without prior notice due to continuous design improvements.

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

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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.

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).

		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	☐	☐

MODEL	SERIAL NUMBER
INSPECTOR	OPTIONS

The **MARKLIFT** conforms to applicable ANSI and OSHA requirements. Since the safety requirements made by ANSI, OSHA and the various safety boards in your area are subject to change, it is the responsibility of the owner to instruct the operators about all such current requirements.

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

1. Inspect the machine periodically as specified in the Inspection and Checkout, and 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 technician 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 the load evenly over the platform floor area.

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

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

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

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

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

11. 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 for required clearances from overhead high voltage lines.)

12. Under no circumstances should horse play be tolerated on the **MARKLIFT.**

13. **Do Not** drive on uneven, sloping or soft terrain that sets the unit in an out-of-level condition of more than 6 degrees fore and aft, or 3 degrees side to side.

14. **Do Not** drive the platform into objects.

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

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

17. **Do Not** raise or lower scissor into objects.

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

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

20. When a machine is not in use, remove the key from the ground control panel to prevent unauthorized use.

21. When working under the elevated platform, always remember to raise the **Safety Support Arm** to prevent accidental platform descent.

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 to Proximity to Overhead Lines.

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

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

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

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

TABLE X: Required Clearances from Overhead High-Voltage Lines

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

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

Article 86. Provisions for Preventing Accidents

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

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

Nominal Voltage (Phase to Phase)				Minimum Required Clearance (Feet)
	750	-	50,000	6
over	50,000	-	345,000	10
over	345,000	-	750,0000	16
over	750,000	-	1,000,000	20

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

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

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

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

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

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

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 illustrates a chart in which decals for the **MARKLIFT** can be replaced if the existing decal(s) is worn-out, torn, or illegible.

USE VAPOR TANK ONLY 2004

2020 **GASOLINE OR PETROL**

DO NOT LIFT FROM THIS END 2041

WARNING

DO NOT WORK UNDERNEATH THIS LIFT UNLESS IT IS MECHANICALLY LOCKED.

SEE SERVICE MANUAL FOR LOCATION AND USE OFMECHANICAL LOCKS 2016

LOAD CAPACITY 1500 LBS.
(EVENLY DISTRIBUTED LOAD) MT40G

LOAD CAPACITY 2000 LBS.
(EVENLY DISTRIBUTED LOAD) MT31G

GUARD RAILS ARE FOR YOUR SAFETY

CAUTION **DO NOT REMOVE** **CAUTION**

OPERATING THIS MACHINE WITHOUT GUARD RAILS COULD RESULT IN DEATH OR SERIOUS INJURY

31169

DECAL P/N	DECAL DESCRIPTION	ASSEMBLY	Qty
67784	Decal Set	All Standard Decals	1
185707	Power to platform 110 VAC	Final Assembly	1
32345	Ground control box	Lower control panel	1
182712	Aerial control box	Upper control panel	1
130938	MARK	Final Assembly	2
2017	Hydraulic system fluid	Final Assembly	2
2003	Battery water level	Final Assembly	1
2041	Do not lift	Final Assembly	2
2019	Emergency lowering valve	Final Assembly	1
2016	Do not work under	Final Assembly	2
2027	Load capacity 2000 lbs	Final Assembly	4
20661	Plate, ANSI A92	Final Assembly	1
182744	Operation instruction & danger	Final Assembly	1
31260	MARKLIFT	Final Assembly	2
2020	Gasoline or petrol	Final Assembly	2
2004	Vapor tank only	Final Assembly	1
20660	Nameplate, ID	Final Assembly	1
131061	Blue stripe	Final Assembly	2
130606	Freewheeling valve	Final Assembly	1
30520	Nameplate - pat. no.	Final Assembly	1
31109	Caution scissor guard rails	Final Assembly	2
130596	A Product of Mark Industries	Final Assembly	2
130820	Operation & Safety Handbook	Final Assembly	1
32369	MT-Series	Final Assembly	1
182714	Aerial control box	Upper control panel	1

DECAL P/N	DECAL DESCRIPTION	ASSEMBLY	Qty
67705	Decal Set	All Standard Decals	1
32345	Ground control box	Lower control panel	1
182712	Aerial control box	Final assembly	1
130938	MARK	Final assembly	2
2017	Hydraulic system fluid	Final assembly	1
2003	Battery water level	Final assembly	1
2041	Do not lift	Final assembly	2
2019	Emergency lowering valve	Final assembly	1
2016	Do not work under	Final assembly	1
2026	Load capacity 1500 lbs.	Final assembly	4
20661	Plate, ANSI A92	Final assembly	1
182744	Operation, Instruction & Danger	Final assembly	2
31260	Marklift (scissor machine)	Final assembly	2
2020	Gasoline or petrol	Final assembly	2
2004	Vapor tank only	Final assembly	1
20660	Nameplate, ID	Final assembly	1
131061	Blue stripe	Final assembly	2
130606	Freewheeling valve	Final assembly	1
30520	Nameplate, pat. no. (scissors)	Final assembly	1
31109	Caution scissor guard rails	Final assembly	2
130596	A Product of Mark Industries	Final assembly	1
130820	Operation & Safety handbook	Final assembly	1
32369	MT-Series	Final assembly	1
182714	Aerial control box	Upper control panel	1

Before unloading the **MARKLIFT**, inspect it for any physical damage. Note any damage on the freight bill and report it to the carrier.

FREEWHEELING

The **MARKLIFT** may be freewheeled for loading, unloading and towing for a very short distance (maximum of one (1) mile), at a speed no greater than five (5) mph.The brakes **must** be disengaged before the **MARKLIFT** can be freewheeled. Disengage the brakes by closing the freewheel valve and momentarily activating the drive control. (See illustration on the following page.)

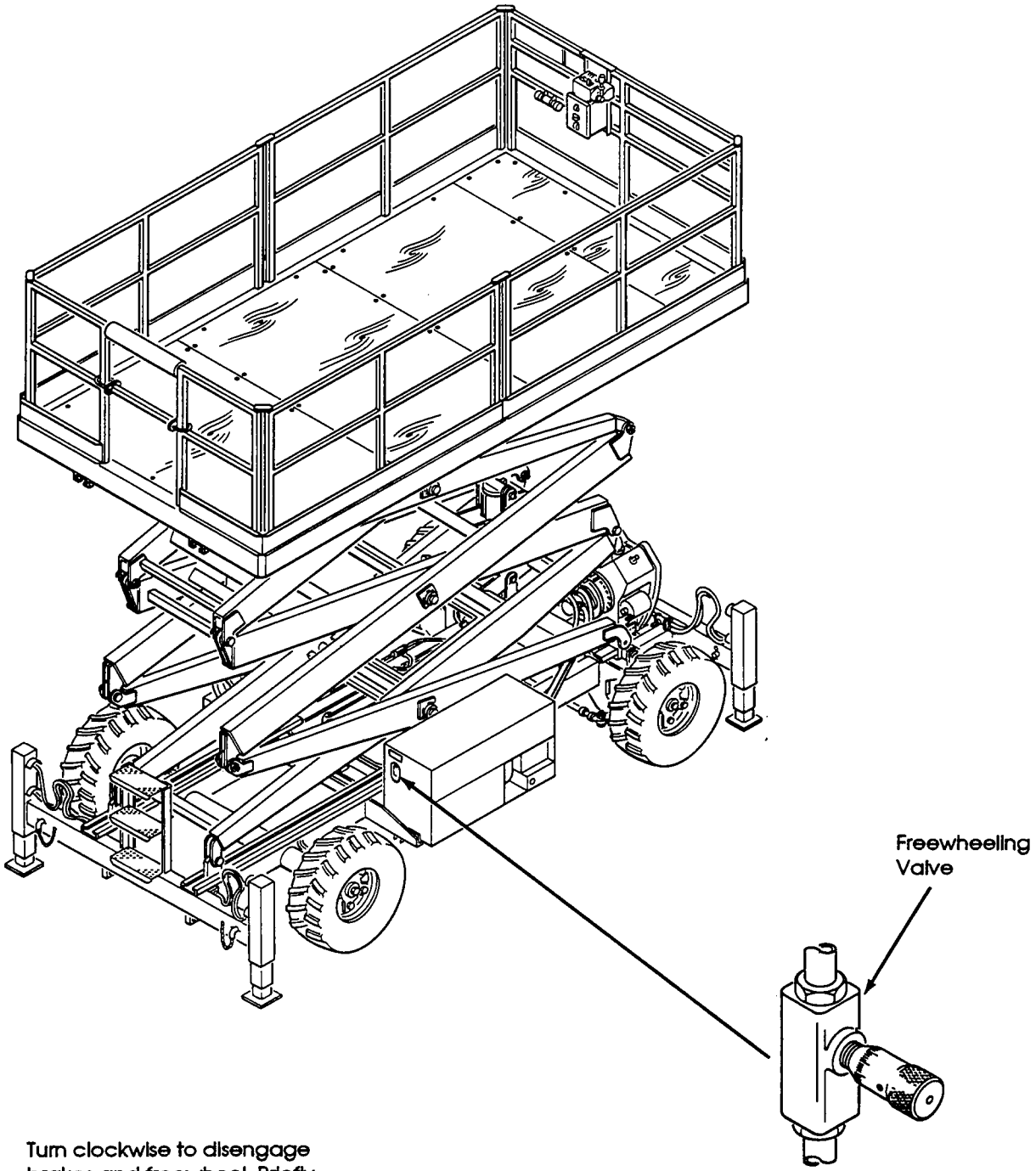
To transport the **MARKLIFT** over long distances, a truck or trailer must be used. If a rollback truck with a winch is used, attach the winch cable to the tiedown brackets and pull the **MARKLIFT** onto the truck. Keep the winch cable taut at all times. Be sure to open the freewheeling valve to set the brakes back into the normal mode.

MAKE SURE THE UNIT IS ON A LEVEL SURFACE BEFORE ATTEMPTING TO FREEWHEEL THE MARKLIFT.

USE CAUTION WHEN THE BRAKES ARE DISENGAGED ALWAYS REMEMBER TO OPEN THE FREEWHEELING VALVE TO RESTORE BRAKING.

TRUCK TRANSPORTING

When securing the **MARKLIFT** to the truck, put the chains or straps through the tiedown brackets only. **DO NOT CHAIN OR STRAP OVER THE THE PLATFORM OR GUARD RAILS.** Severe damage to the scissor arms may result from excess pressure caused by securing the machine over the top of the platform.



Turn clockwise to disengage brakes and freewheel. Briefly activate the drive.

Open the valve to restore the brakes. Turn counter-clockwise.

After the unit is delivered and unloaded, some minor inspections must be made before putting the unit into service. The following must be checked:

For All Units:

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 - sight gauge shows full with unit in stowed position.

3. Check battery for 1200 ± 50 reading on the hydrometer. Charge the battery if its reading is below 1100. If batteries require water, fill to proper level AFTER charging.

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

5. Position selector switch to ground, then operate switches. Check hose for leaks.

6. Make sure that the brakes will hold the unit on an incline of up to 3 degrees.

Gasoline Units:

1. Check oil level in the engine.

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

3. Start engine. Allow the engine to warm up.

4. After initial warm-up of gasoline engine, press engine stop button making sure the stop circuit is operational.

1. STARTING

The **MARKLIFT** may be started from either the aerial or ground control panels. Before either position will function, the power switch must be set at the "ON" position.

A. AERIAL CONTROL PANEL

Position the selector switch to "Aerial", then enter the platform. Be sure to secure the entry chain, gate or bar after entering the platform. Turn the power switch to "START", use choke if necessary, release when the engine starts.

B. GROUND CONTROL PANEL

Position the selector to "Ground". Rotate the ignition switch to "Start", use the choke if necessary. When the engine starts, release the key.

2. DUAL FUEL SYSTEM

A. SWITCHING FROM PROPANE TO GAS

With the engine running, 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 speed. Switch back and forth from propane to gasoline until the engine is running smoothly on gasoline.

B. SWITCHING FROM GAS TO PROPANE

With the engine running, switch the fuel selector to "OFF". The engine will continue to run until it uses all the fuel from the carburetor bowl. When the engine begins to run roughly, allow it to run several seconds and then switch to propane.

Let the engine idle for 20-30 seconds to completely burn off any remaining gasoline.

3. **DRIVE**

Forward and reverse drive of the MARKLIFT is done from the aerial control only. For best operation, place the thumb over the controller knob and wrap the fingers loosely around the locking stem. Pull the drive controller locking stem upward then move the controller handle in the desired direction. The drive speed will respond according to the amount of handle movements.

4. **STEERING**

The unit may be steered from the aerial control panel only. Push the toggle switch to the left to turn the front wheels to the left. Pushing the switch to the right will cause the wheels to turn to the right. The toggle switch is a momentary switch which will automatically return to the off position when released.

5. **RAISE PLATFORM**

To raise or lower the platform from the ground control, set 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" toggle switch. The toggle switch is self centering. When it is released it will automatically set itself to center (the neutral position). The unit will remain stationary.

6. WARNING LIGHT AND BUZZER

As a special safety feature, the **MARKLIFT** is equipped with an "out-of- level" sensor that will disable the scissor functions whenever the **MARKLIFT** is in an unsafe out-of-level position.

An unsafe out-of-level situation is sensed by the slope sensor when the machine is tilted 3° or more on either side or 6° front or rear. 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: UP/DOWN will not operate but the drive and steer functions will. **The platform will lower automatically.** Should the warning signals come on, maneuver the **MARKLIFT** until it is on a safe operating surface and all functions will be restored.

7. ALL MOTION ALARM (OPTION)

For some industrial applications, and to meet particular safety requirements, a warning horn may be needed. The warning horn option on the **MARKLIFT** can be used as an automatic movement indicator, or manually activated, as required. The horn is activated by a three-position switch on the aerial control panel. The middle position is "Off".

When the switch is positioned to the right, the horn will sound when either the drive or lift function is activated (forward and reverse, up and down).

There is also available a travel warning horn which sounds when the unit moves forward or reverse.

8. STABILIZERS

Stabilizers are standard equipment on the MT40G. The stabilizers are hydraulically driven and can only be operated from the aerial control panel. The momentary switch is located on the bottom center of the face of the control panel.

Position the switch to "DOWN" to lower the stabilizers and "UP" to retract. When the stabilizers are in the down position, drive is not active. On the MT40G, the lift is deactivated at 30 feet when the stabilizers are up. To regain the lift function to 40 feet, lower the stabilizers.

MARK INDUSTRIES recommends that the following items be checked periodically as stated below. Any machine not in safe operating condition must be removed from service until it is repaired by a qualified service person.

DAILY

1. Make sure that operation and safety decals are in place and easy to read.
2. Check hydraulic tank level.
3. Check gasoline tank level.
4. Check engine oil level.
5. Check the water level in the batteries.
6. Check for loose or worn hardware, wire connections, etc..
7. Inspect the controls for proper operation.
8. Check for and correct any hydraulic leaks.
9. Check for and correct any structural damage.

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 are easy to read.
3. Check for proper brake operation.
4. Record hour meter reading. (Optional)
5. Clean unit by removing all dirt, oil, and grease. The machine may be washed with soap and water. (Stay away from electrical panels and charging units.)
6. Check overall performance.
7. Check for wear on the electrical cables and hoses.

MONTHLY (or first 50 hours)

1. Check and lubricate, if necessary.

2. Check battery condition.

3. Change the hydraulic oil return filter.

EVERY SIX MONTHS (or 100 hours)

1. Check and lubricate, if necessary.

2. Change the hydraulic oil return filter.

EVERY YEAR

1, Re-pack all wheel bearings.

2. Change the hydraulic oil.

3. Change the hydraulic oil return filter.

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 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

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.

Gas or Diesel Scissor Lifts

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

Note: Cold temperatures have a numbing effect on the electromechanical action of the battery, greatly reducing its capacity. Therefore, it is highly recommended that the battery be kept in an almost fully charged condition during cold weather.

BATTERY HAZARDS

When handling batteries, please keep safety in mind and follow the guidlines below.

- Batteries produce flammable and explosive gases. Keep arcs, sparks, flames and lighted tobacco away from batteries.
- Battery acid will damage eyes or skin on contact. Always wear a face shield during battery maintenance to avoid acid in eyes. Also wear rubber gloves and protective clothing to keep acid off skin.
- Never check the battery by placing a metal object across the posts. Serious burns or an explosion can result.
- Charge batteries only in a well ventilated area.

1. ELECTRICAL

Whenever troubleshooting 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, refer to the schematic, (see the SCHEMATIC section for more information) and use a test light to trace 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., (even if you have a enough electrical power to operate the coil or relay), these 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 the relay is to remotely switch other electrical devices.

2. HYDRAULIC

A. The various hydraulic functions are controlled by electric solenoid valves. When a slower drive speed is needed, a portion of the hydraulic fluid is routed to the tank by the low speed priority valve, reducing the speed.

B. Directional valves (steering, drive etc.) have two electrical coils with a movable spool between the coils.

C. One way valves (lift, descent,and dump) are opened or closed to prevent or permit passage of fluid when electrically energized.

ENGINE

1. Will not start or run.

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

2. Can't get high speed.

A. Check aerial "High/Low" throttle switch.
B. Check throttle solenoid valve.
C. Refer to your local service facility.

3. No idle.

A. Check aerial "High/Low" throttle switch.
B. Check throttle solenoid valve.
C. Refer to your local service facility.

4. Dies under load.

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

HYDRAULIC WHEEL DRIVE MOTOR

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

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

HYDRAULIC PUMP

Pump producing excessive noise.

A. Check suction hose from tank to pump for kinks.
B. Check hydraulic oil level (sight gauge on tank.)
C. Check suction line fittings for tightness.
D. Check oil. See hydraulic fluid table.
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 for loose wire in aerial junction box.
C. Check pilot valve pressure.
D. Check solenoid dump valve.

2. Functions will not operate from ground control box.

A. Check position of "Aerial/Ground" box selector switch.
B. Check solenoid dump valve.
C. Check pilot valve pressure.
D. Refer to your local service facility.

3. Functions too slow or too fast.

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

DRIVE

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

NEW EQUIPMENT MAINTENANCE RECORD

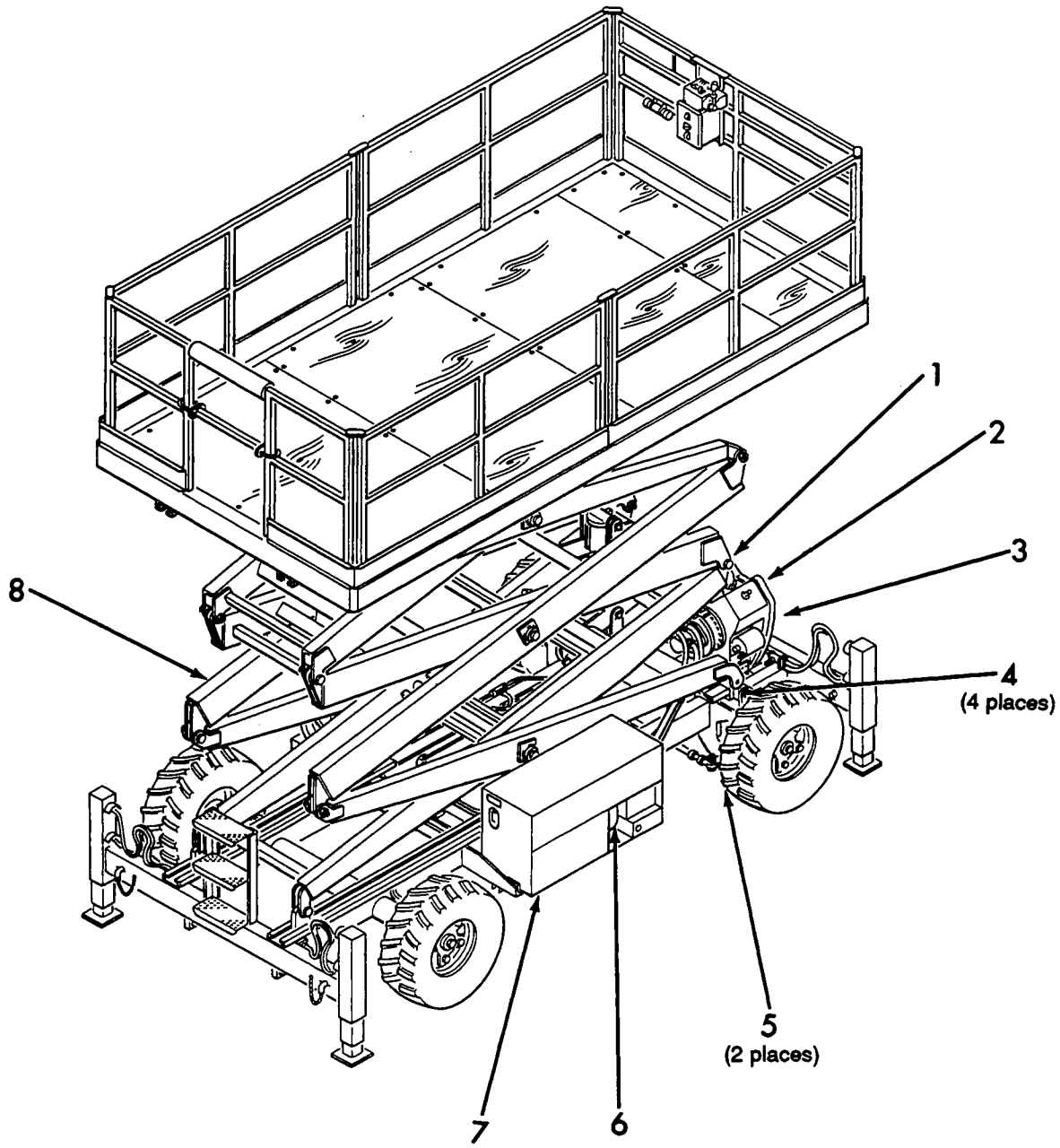
MODEL	SERIAL NUMBER
DATE	EQUIPMENT NUMBER
LOCATION	MECHANIC

ITEM	CODE	COMMENTS	ITEM	CODE	COMMENTS
Engine oil			Safety cut-outs		
Engine oil filter			Bushings		
Air filter			Rollers		
Fuel filter			Wear pad		
Tune-up			Front end assembly		
Choke			Tire pressure		
Engine RPM			Tire condition		
Charging system			Wheel nuts		
Fuel system LPG/gas			Wheel bearing		
Batteries			Nuts and bolts		
Battery terminals			Guard rails		
Motor brushes			Lubrication		
Hydraulic fluid			Warning decals		
Hydraulic oil filter			Operating inst.		
Hydraulic systems			General decals		
Hydraulic pressure			Paint		
Hydraulic hoses			All operations		
Cylinders			Lift		
Drive motors			Steering		
Brakes			Forward drive		
Aerial control box			Tilt switches		
Ground control box			Fuel level		
Relays			Literature		
Wire connections			Options		

Code	Comments
F = Filled R = Repaired C = Checked A = Adjusted X = Needs repair	

RECOMMENDED LUBRICATION AND SERVICE CHART

MT 31G and MT40G

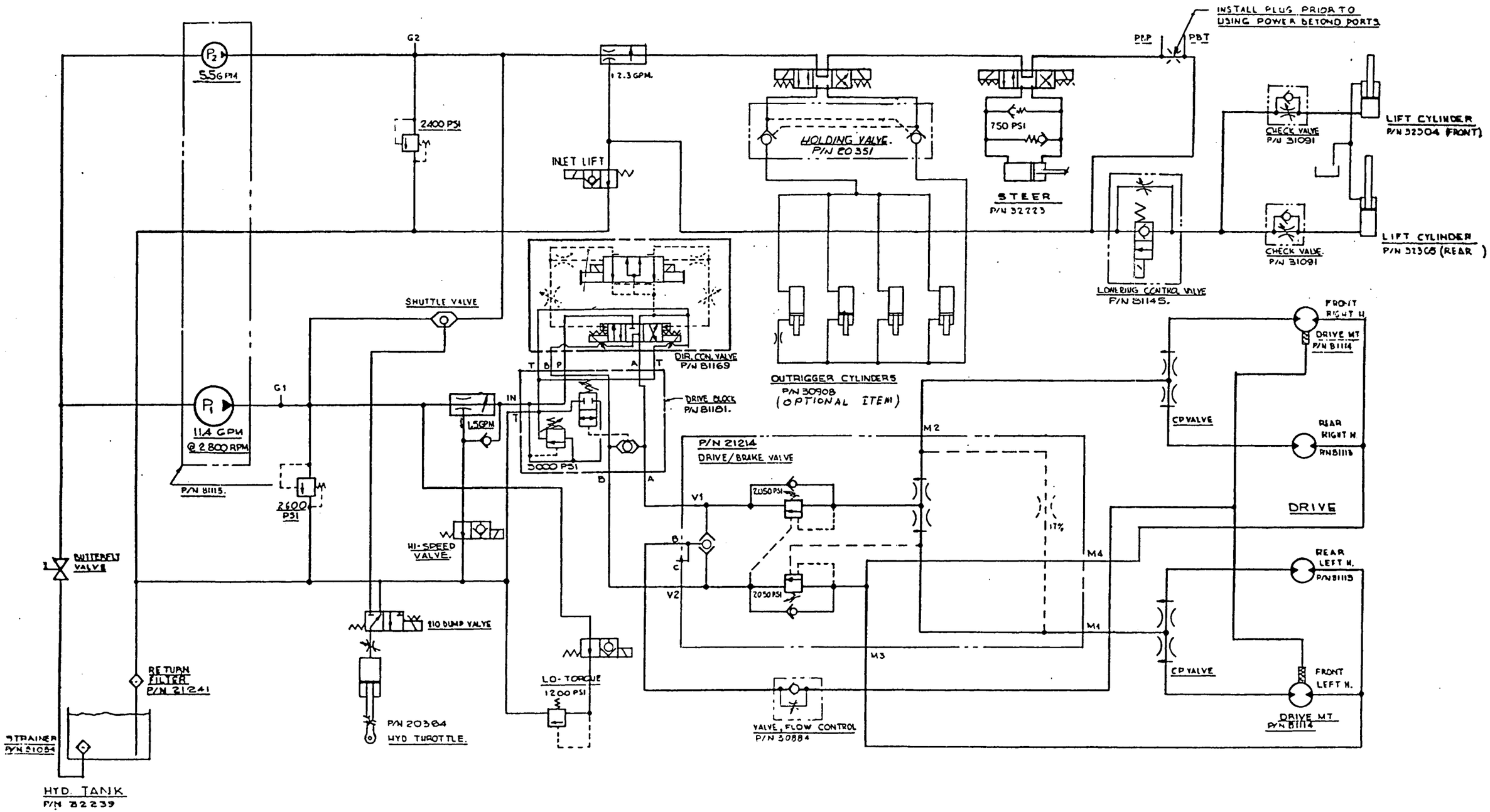


Shown: MT31G

RECOMMENDED LUBRICATION AND SERVICE CHART (con't)

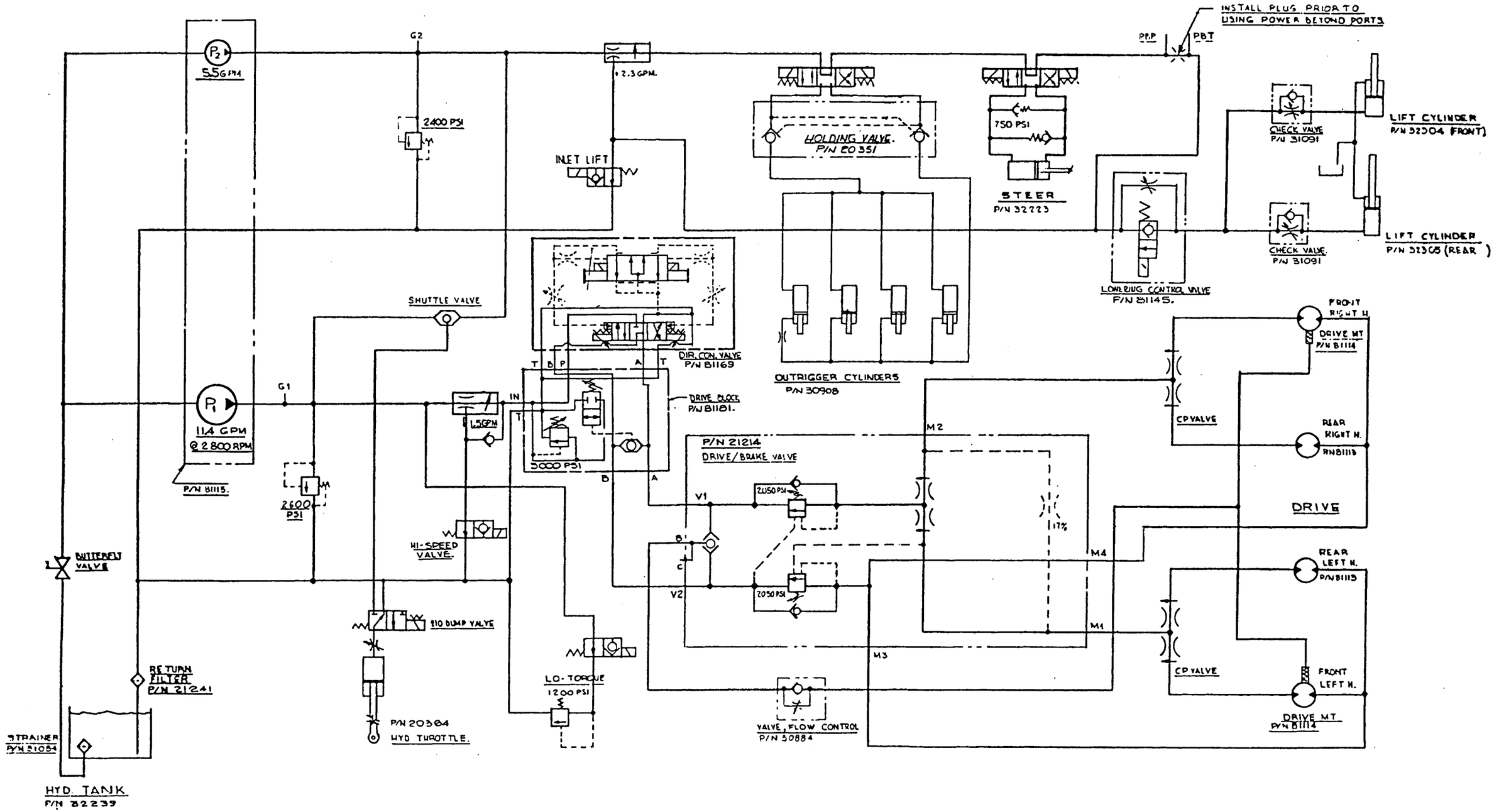
ITEM	DESCRIPTION	LUBRICANT	FREQUENCY
1.	Fuel Filter		Replace every 100 hrs.
2.	Air Cleaner element		Clean every 25 hrs. or as condition dictates
3.	Engine oil	Engine service (According to mfg. spec.)	Check daily
4.	Brake Trunnions or King pins	Mobile (VA6L36AG)	Grease monthly
5.	Brake output shaft bearing	Mobile (VA6L36AG)	Grease quarterly
6.	Hydraulic filter		Replace every 100 hrs.
7.	Inlet Strainer		Clean Yearly
8.	Batteries		Check Daily

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°



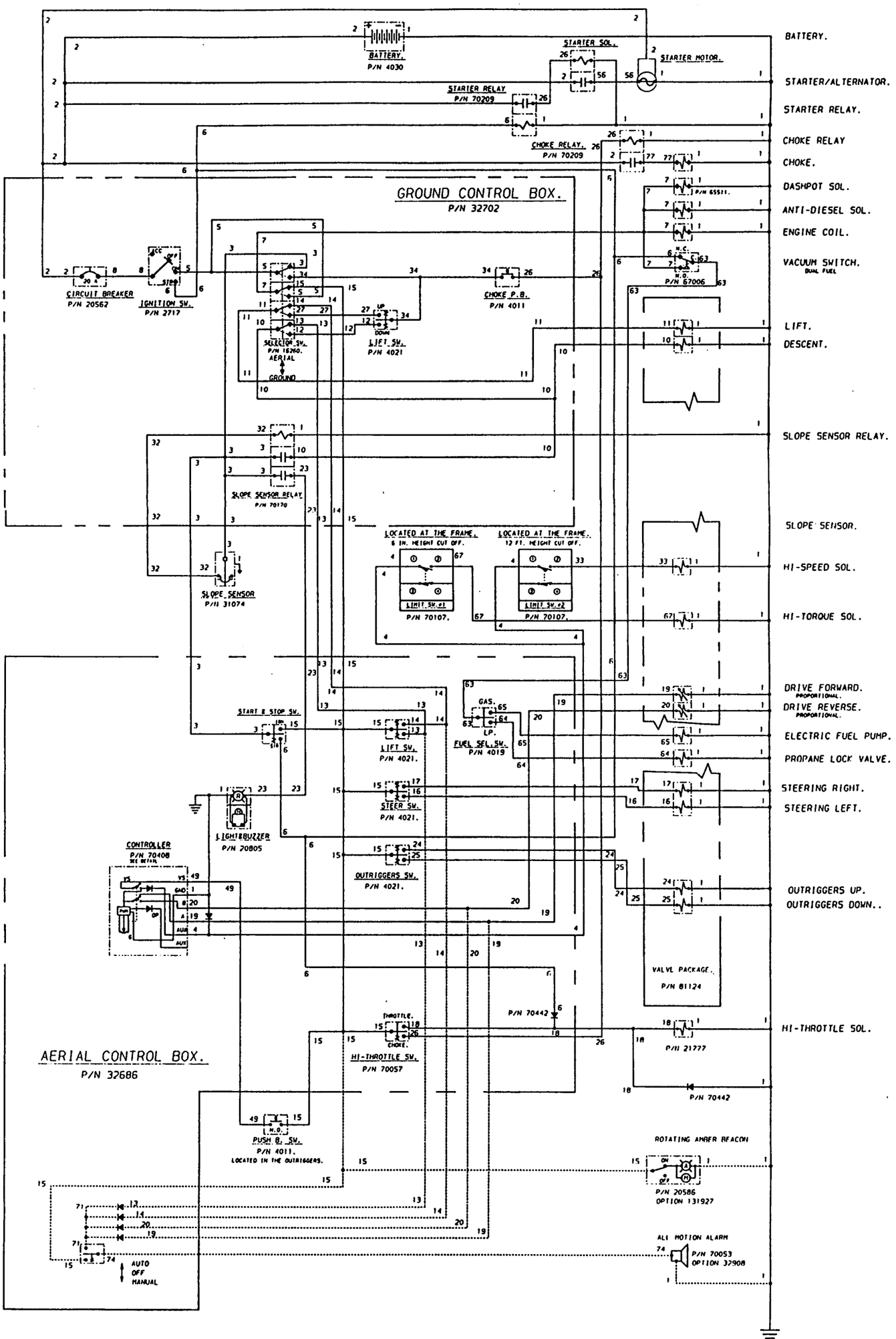
NOTES

1. USE P/N 81124 FOR VALVE PACKAGE.



NOTES

1. USE P/N 81124 FOR VALVE PACKAGE.



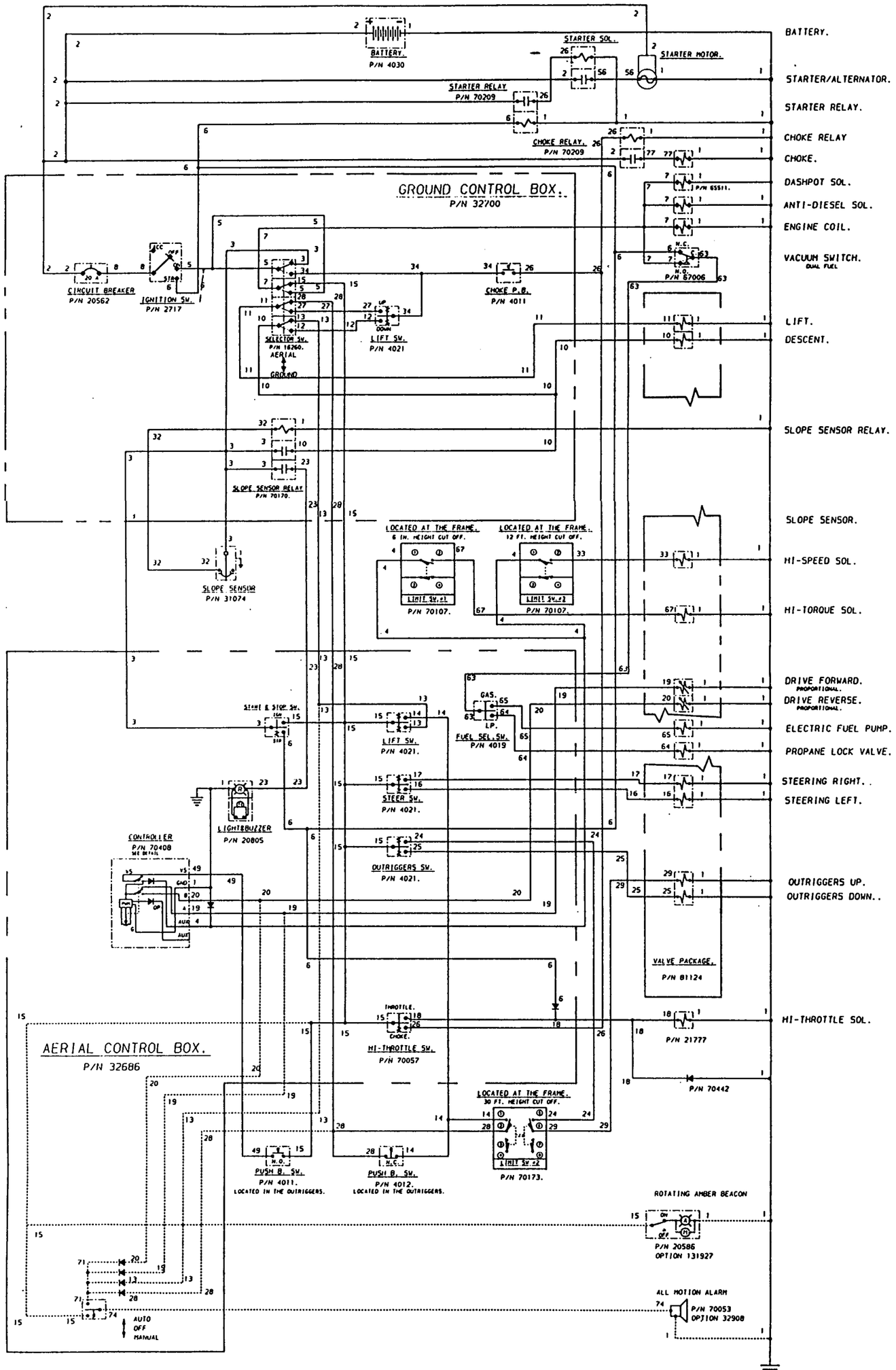
NORMALLY OPEN | NORMALLY OPEN HELD CLOSED | NORMALLY CLOSED | NORMALLY CLOSED HELD OPEN

LEGEND FOR LIMIT SWITCHES.

110 A.C. WIRING.

NOTES.

1. USE 1 AMP. 400V. MINIMUM DIODE. (PC-CONTROLLER).
2. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 130337.
3. ALL WIRES ARE 16 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.



NOTES:

1. USE 1 AMP. 400V. MINIMUM DIODE. (PQ-CONTROLLER).
2. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 130337.
3. ALL WIRES ARE 16 AWG. UNLESS OTHERWISE SPECIFIED.
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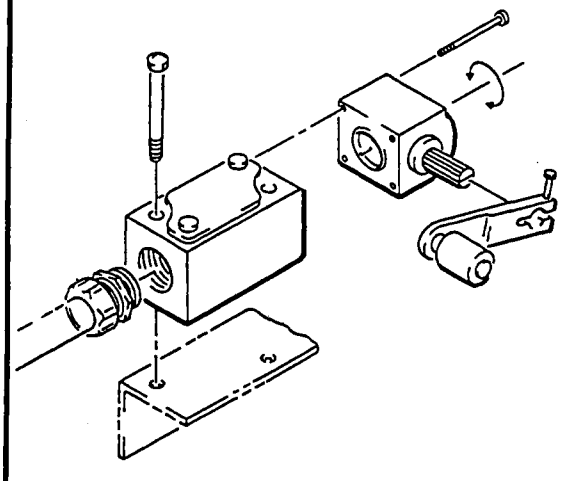

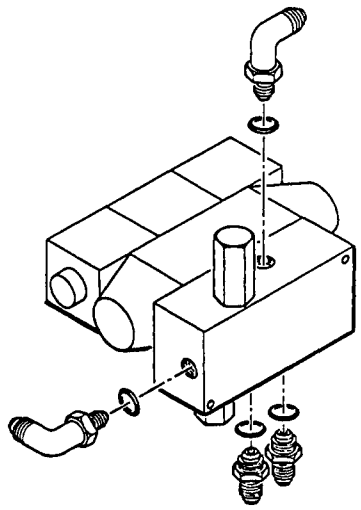

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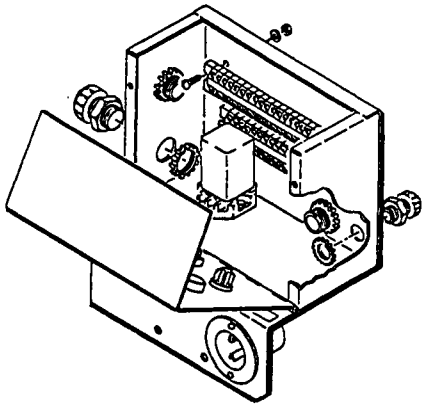

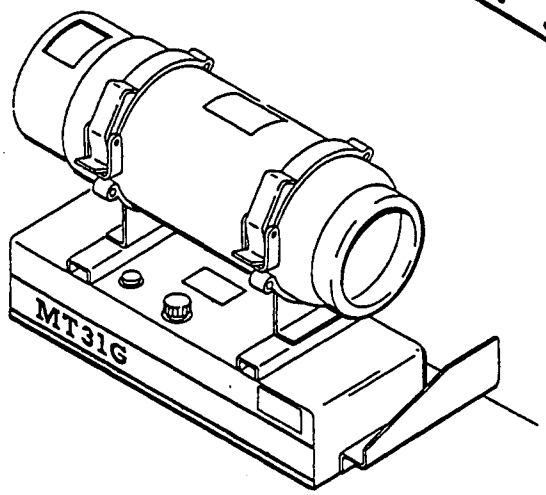

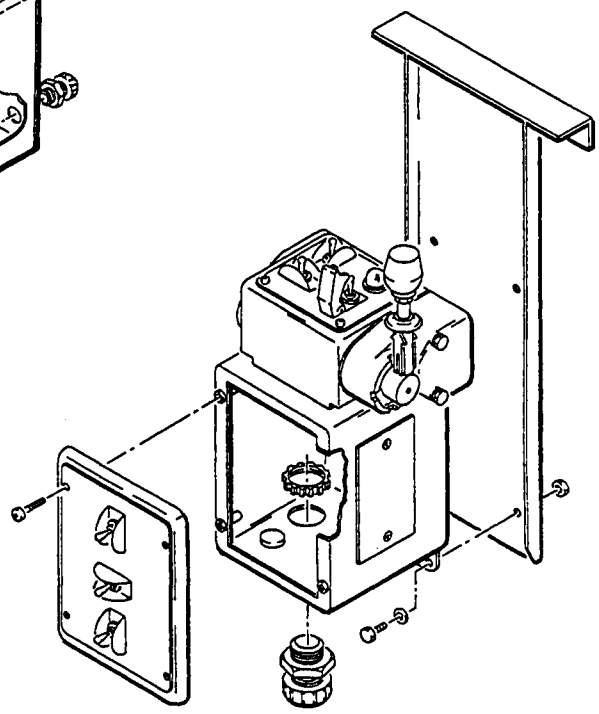

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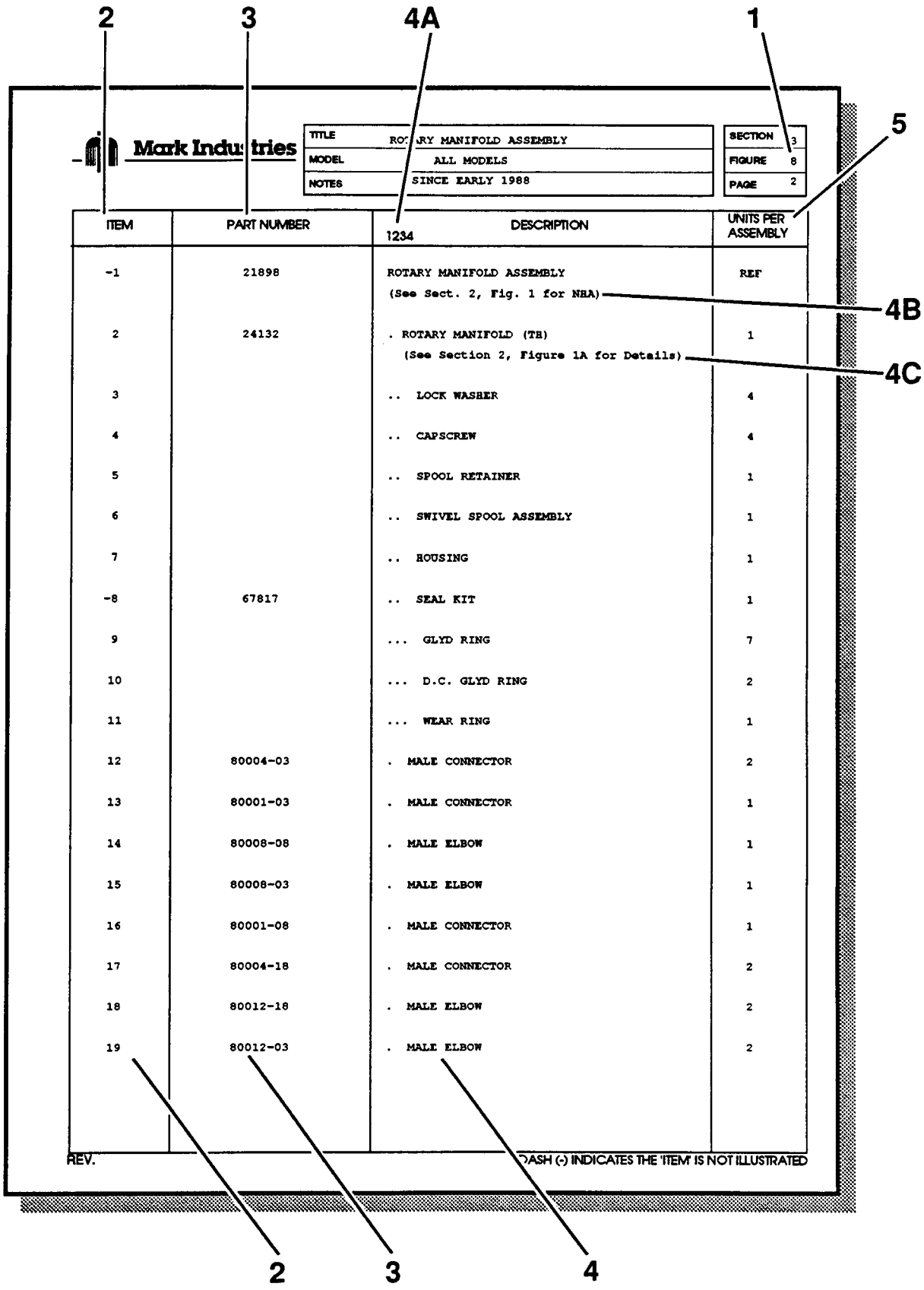


Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY
MODEL	ALL MODELS
NOTES	SINCE EARLY 1988

SECTION	3
FIGURE	8
PAGE	2

ITEM	PART NUMBER	1234 DESCRIPTION	UNITS PER ASSEMBLY
-1	21898	ROTARY MANIFOLD ASSEMBLY	REF
		(See Sect. 2, Fig. 1 for NHA)	
2	24132	. ROTARY MANIFOLD (TH)	1
		(See Section 2, Figure 1A for Details)	
3		.. LOCK WASHER	4
4		.. CAPSCREW	4
5		.. SPOOL RETAINER	1
6		.. SWIVEL SPOOL ASSEMBLY	1
7		.. HOUSING	1
-8	67817	.. SEAL KIT	1
9		... GLYD RING	7
10		... D.C. GLYD RING	2
11		... WEAR RING	1
12	80004-03	. MALE CONNECTOR	2
13	80001-03	. MALE CONNECTOR	1
14	80008-08	. MALE ELBOW	1
15	80008-03	. MALE ELBOW	1
16	80001-08	. MALE CONNECTOR	1
17	80004-18	. MALE CONNECTOR	2
18	80012-18	. MALE ELBOW	2
19	80012-03	. MALE ELBOW	2

REV.

DASH (-) INDICATES THE ITEM IS NOT ILLUSTRATED

1. The Parts Chapter Pagination.

   A. **SECTION** refers to the major divisions of the Parts Chapter.

   B. **FIGURE** refers to the items illustrated separately in each section.

   C. **PAGE** indicates the page number of the figure illustrated.

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.)

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

4. Elements of the **Description.**

   A. The **Indenture System** used in the Parts Chapter of this Technical Manual shows the relationship of one part to another.

   Figure Description

   1 2 3 4

   . Items ***included*** as part of the **figure.**

   . . Items ***included*** as part of the **single indentured** item listed directly above it.

   . . . Items ***included*** as part of the **double indentured** item listed directly above it.

   . . . . Items ***included*** as part of the **triple indentured** item listed directly above it.

   B. **NHA** (**N**ext **H**igher **A**ssembly) corresponds to the Section and Figure to be referred to for the major assembly that this item is part of.

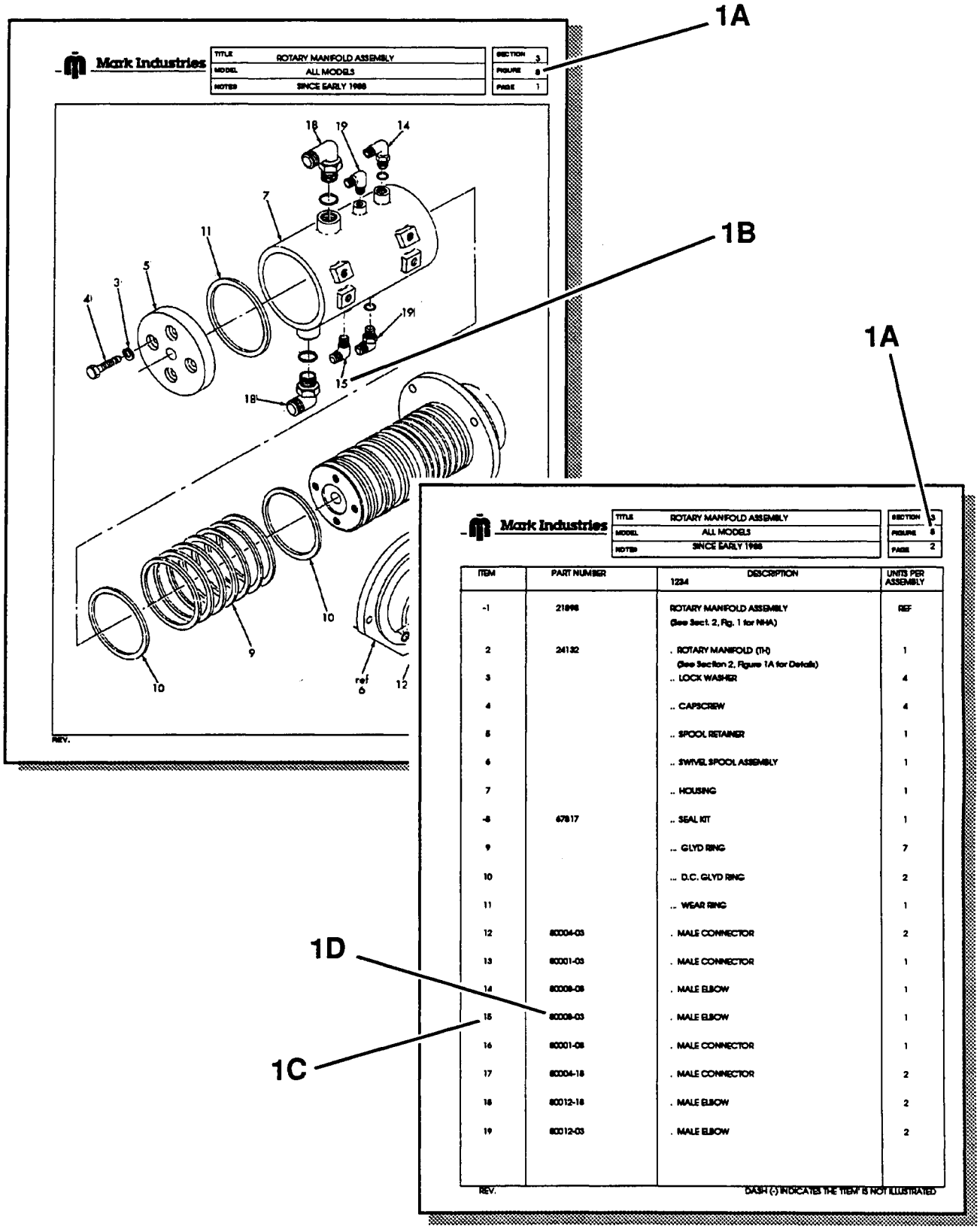
   C. **DETAILS** corresponds to the Section and Figure to be referred to for a more detailed breakdown of this item.

5. **UNITS PER ASSEMBLY** entries are as follows:

   A. **REF** indicates the item is already listed in the NHA figure.

   B. **AR** indicates the part is used in a quantity *As Required.*

   C. A **number** indicates the *quantity* of the part used in the next higher assembly.



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSEMBLY
-1	21898	ROTARY MANIFOLD ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	24132	. ROTARY MANIFOLD (TI-I) (See Section 2, Figure 1A for Details)	1
3		.. LOCK WASHER	4
4		.. CAPSCREW	4
5		.. SPOOL RETAINER	1
6		.. SWIVEL SPOOL ASSEMBLY	1
7		.. HOUSING	1
-8	67817	.. SEAL KIT	1
9		... GLYD RING	7
10		... D.C. GLYD RING	2
11		... WEAR RING	1
12	60004-03	. MALE CONNECTOR	2
13	60001-03	. MALE CONNECTOR	1
14	60008-08	. MALE ELBOW	1
15	60008-03	. MALE ELBOW	1
16	60001-08	. MALE CONNECTOR	1
17	60004-18	. MALE CONNECTOR	2
18	60012-18	. MALE ELBOW	2
19	60012-03	. MALE ELBOW	2

REV.

DASH (-) INDICATES THE ITEM IS NOT ILLUSTRATED

1. Finding the Mark Industries Part Number.

   A. Using the Table of Contents, find the Section and Figure Number. Locate the correct page by referencing these numbers.

   B. Match the required part to the figure illustration. Note the Item Number.

   C. Find the Item Number on the part listing that follows the figure.

   D. Use the Mark Industries Part Number listed next to the Item Number when ordering.

2. Ordering: Listed below are the methods of ordering parts. The **preferred** method of ordering parts is by **FAX**.

   A. By **FAX**: **(714) 879-8884**

   B. By Phone: (714) 879-MARK

   C. By Mail: MARK INDUSTRIES
   ATTENTION: PARTS DEPARTMENT
   P.O. BOX 2255
   BREA, CA. 92622

DISCLAIMER

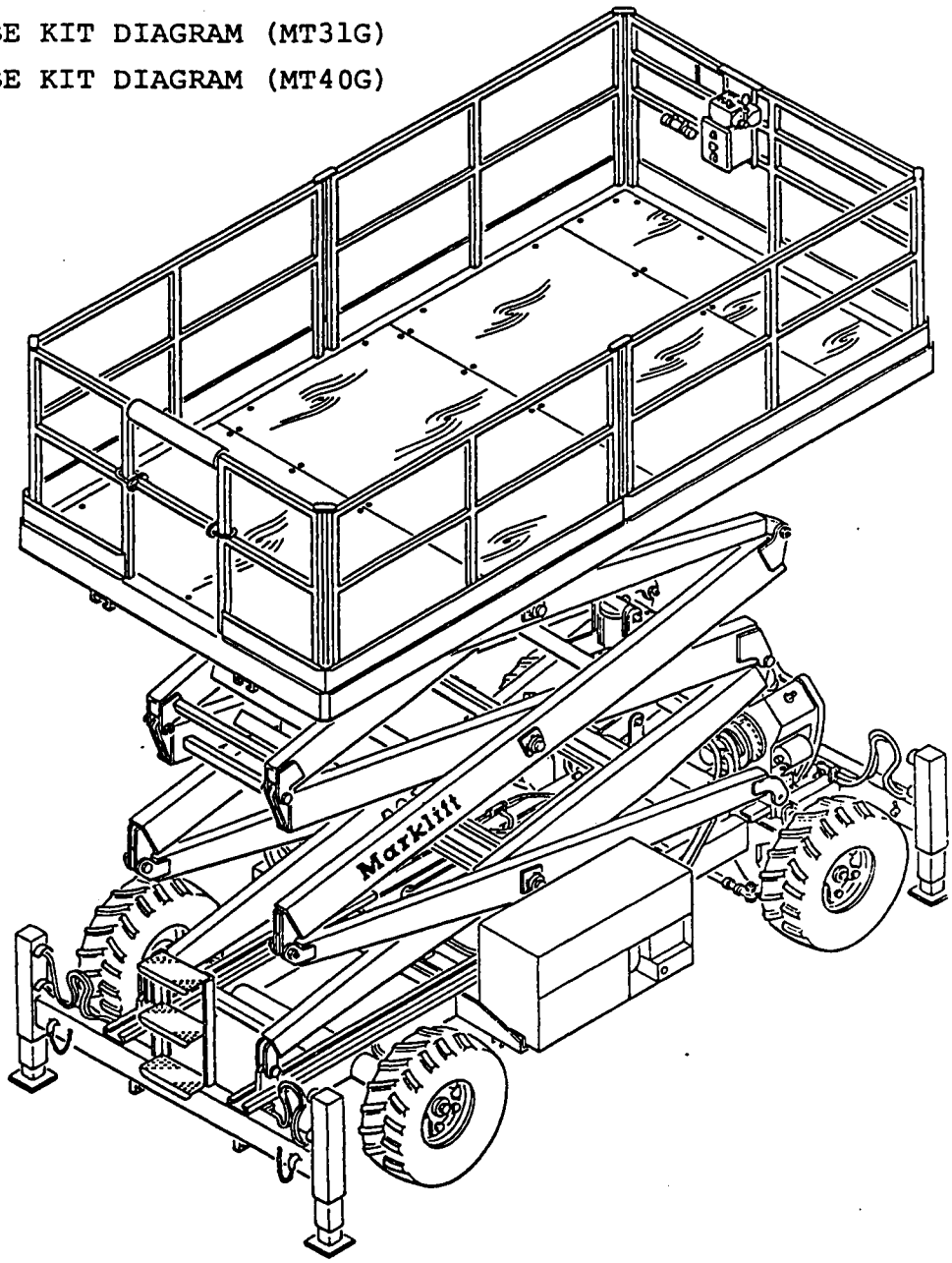
MARK INDUSTRIES strives to include in the Parts Chapter, information and illustrations that are accurate, complete, and current. Due to on-going changes and revisions by our many suppliers, it is often impossible to show all variations of a given assembly. Therefore, this information is subject to change without notice.

Despite the care and effort taken in preparing this Parts Chapter, MARK INDUSTRIES makes **no warranties** that the information and illustrations herein are totally accurate and complete.

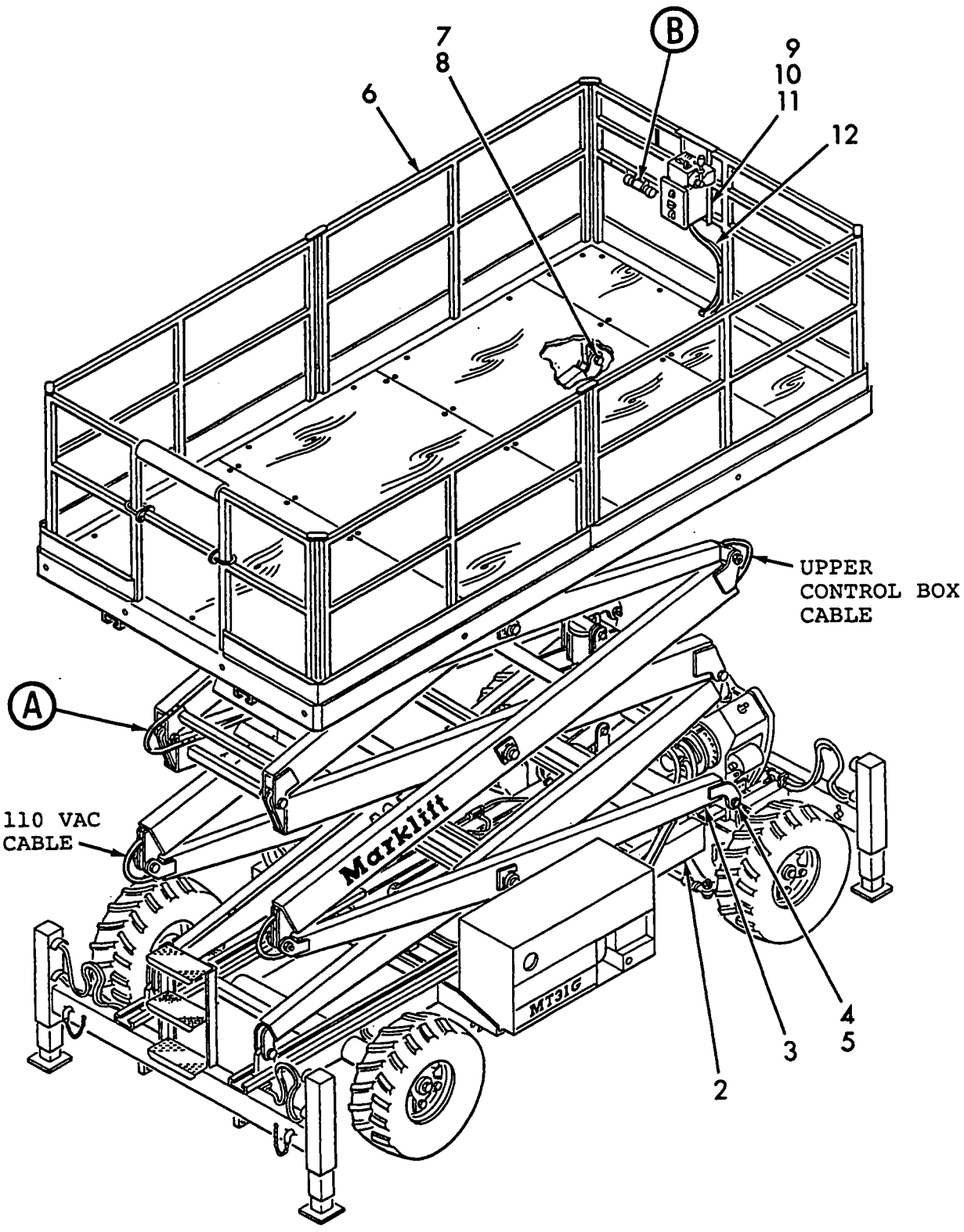
NOTICE

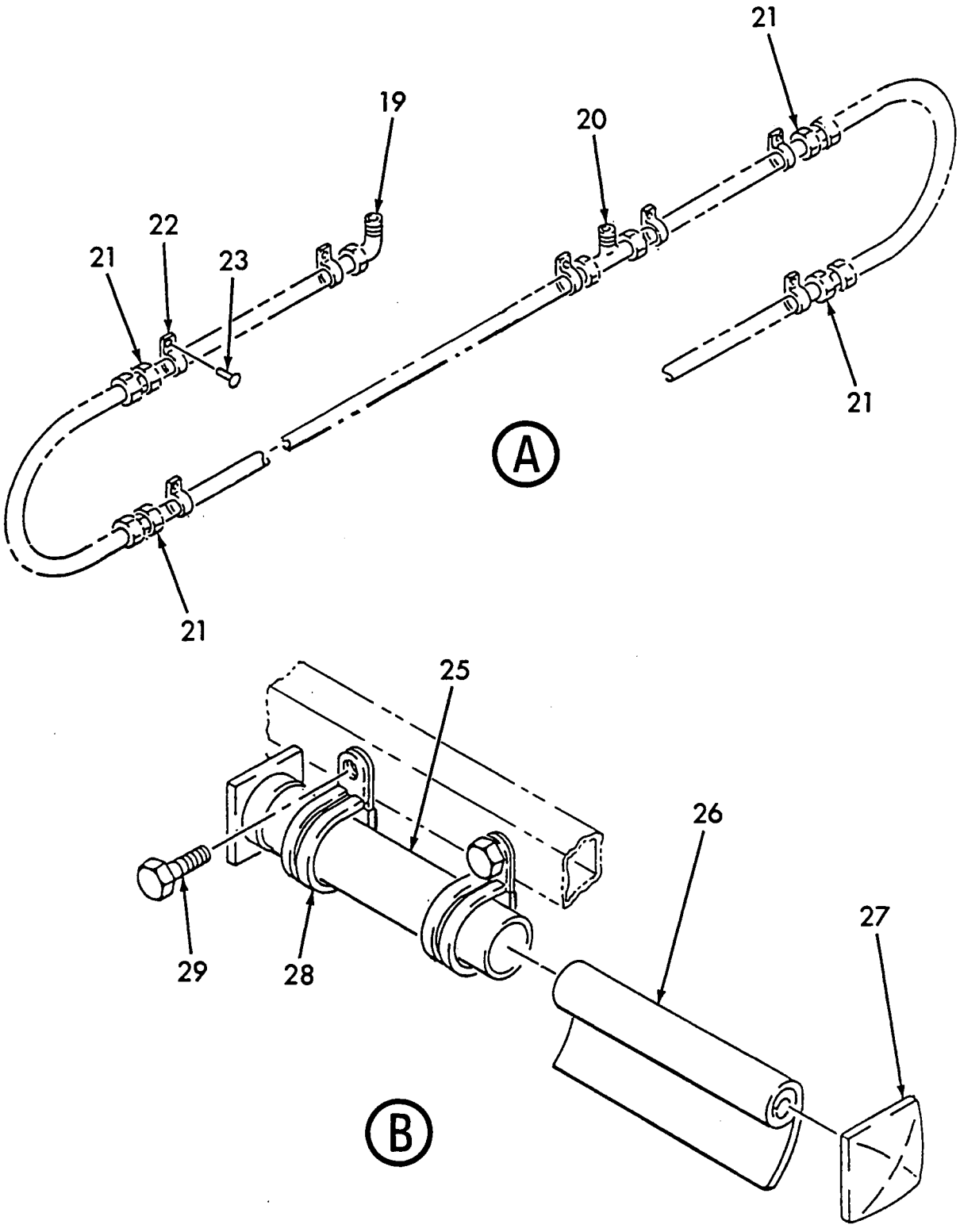
The Parts Chapter, though sometimes helpful in the process of assembly/disassembly, is **NOT** intended to be assembly/disassembly instructions.

SECTION 2 CONTAINS:



FINAL ASSEMBLY (MT31G)

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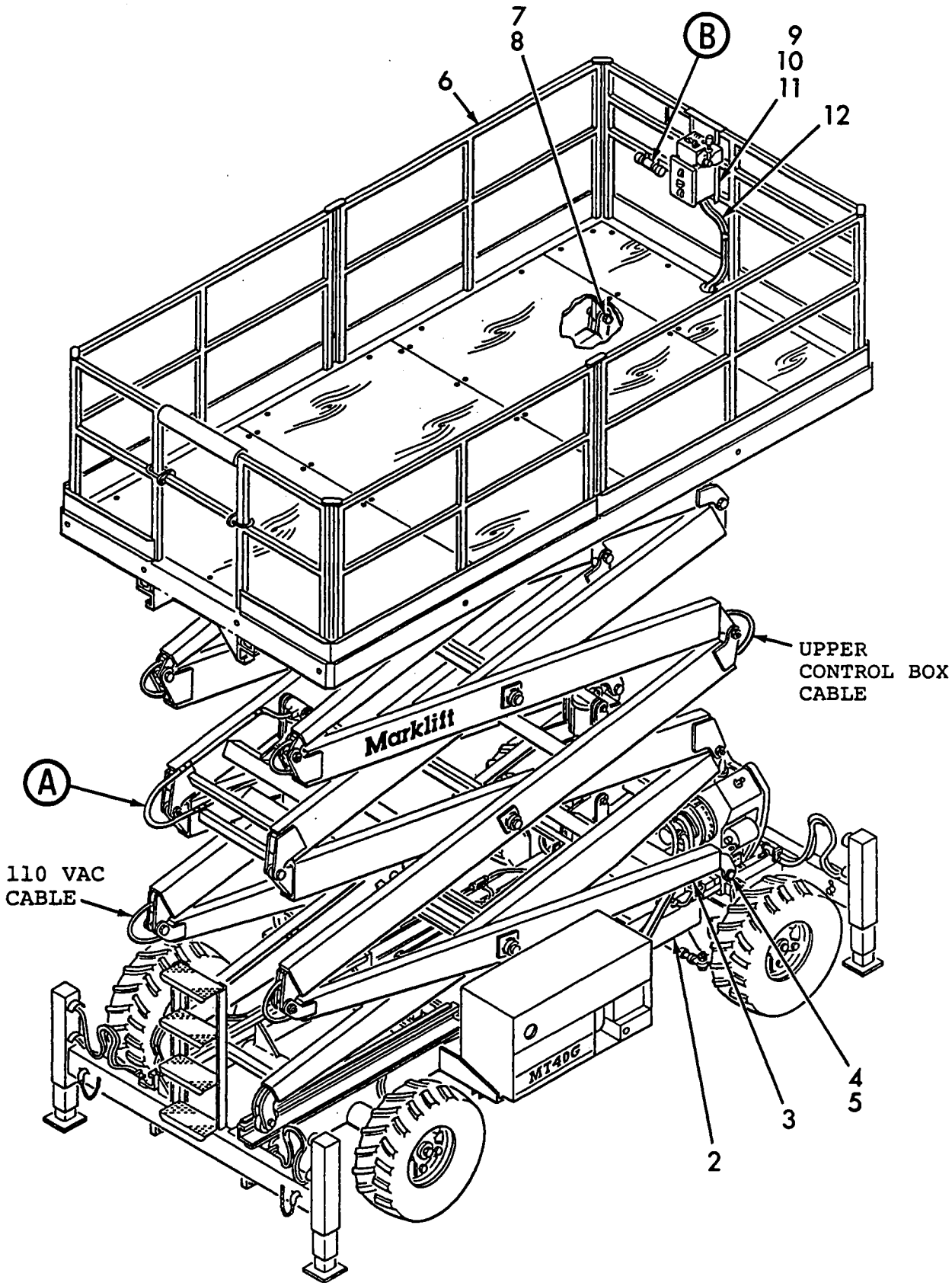
FINAL ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30044	ASSEMBLY, FINAL	REF
2	32603	. ASSEMBLY, FRAME (See Sect. 3, Fig. 1 for Details)	1
3	32653	. ASSEMBLY, SCISSORS (See Sect. 4, Fig. 1 for Details)	1
4	30890	. BOLT, EAR PIVOT	2
5	61310	. NUT, HEX LOCK	2
6	32642	. ASSEMBLY, PLATFORM (See Sect. 5, Fig. 1 for Details)	1
7	30890	. BOLT, EAR PIVOT	2
8	61310	. NUT, HEX LOCK	2
9	32686	. ASSEMBLY, UPPER CONTROL BOX (See Sect. 2, Fig. 2 for Details)	1
10	60340	. SCREW, CAP (attaching part)	4
11	60313	. NUT, HEX-SELF LOCKING (attaching part)	4
12	130337-75	. CABLE, CONDUCTOR	75 FT
-13	255	. TIE, CABLE	AR
-14	256	. TIE, CABLE	AR
-15	32684	. SCHEMATIC, HYDRAULIC (See Schematic Section, page 1)	1
-16	32701	. SCHEMATIC, ELECTRICAL (See Schematic Section, page 3)	1
-17	32695	. DIAGRAM, HYDRAULIC HOSE KIT (See Sect. 2, Fig. 4 for Details)	1
-18	32696	. DIAGRAM, TUBE KIT (See Sect. 2, Fig. 5 for Details)	1
19	80014-06	. ELBOW, UNION	1
20	80031-06	. TEE, UNION	1
21	80042-06	. UNION	4
22	764	. CLAMP	12

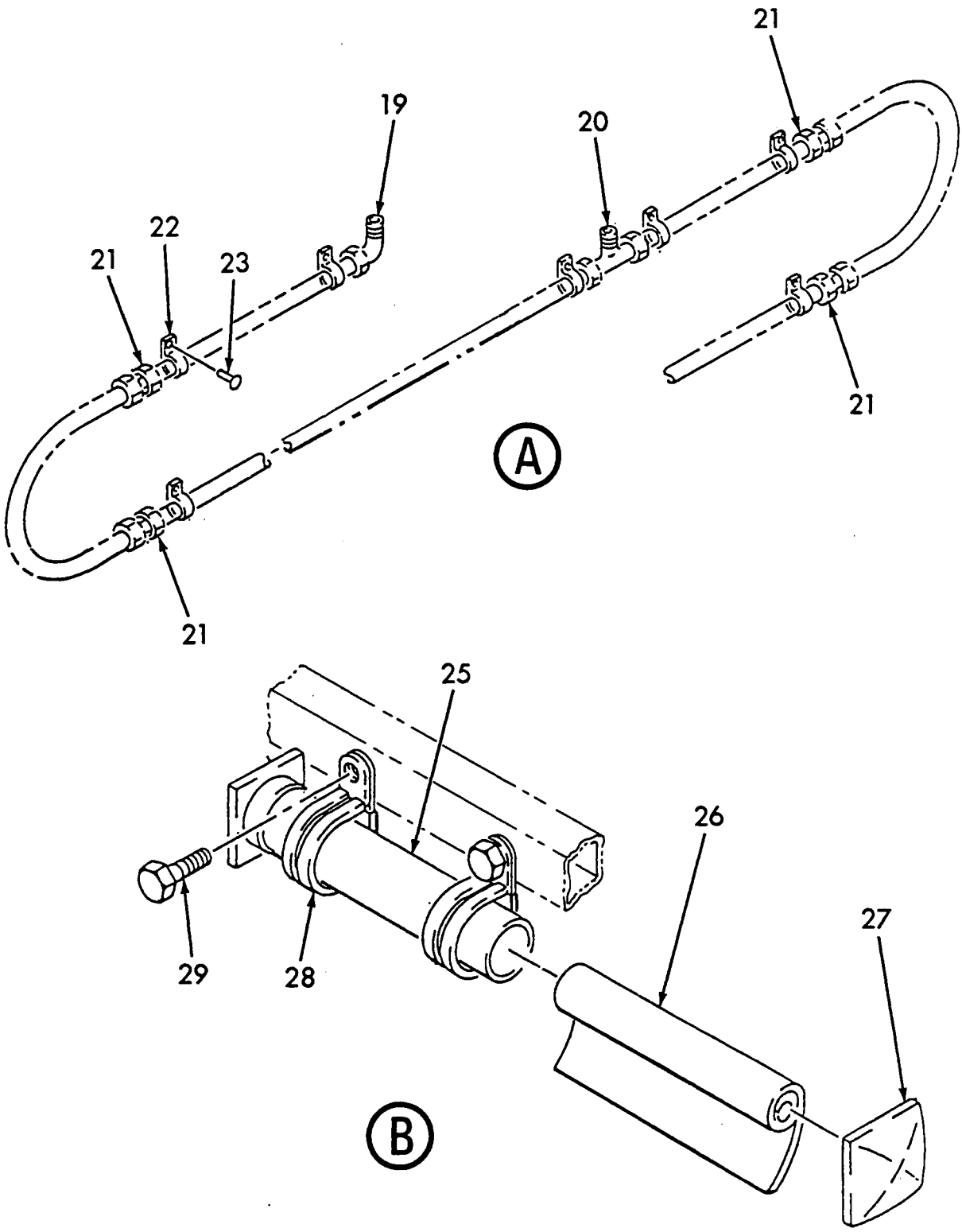
- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23	63651	. RIVET, POP	12
-24	65116	. OIL, HYDRAULIC	10 GAL
25	130927	. CONTAINER, PLASTIC	1
26	16628	. HANDBOOK, SCISSOR	1
27	65842	. CAP, ANTI ROLL	2
28	65867	. CLAMP	2
29	61711	. SCREW, SELF TAPPING	2
-30	16609	. PAINT, BLUE	2 GAL
-31	65368	. PAINT, BLUE	16 OZ
-32	16608	. PAINT, WHITE	6 GAL
-33	2673	. PAINT, WHITE	16 OZ
-34	2996	. OIL, MOTOR	.87 GAL
-35	65114	. GASOLINE	5 GAL
-36	17217	. CATALOG, MARKLIFT PARTS	1

FINAL ASSEMBLY (MT40G)



FINAL ASSEMBLY (MT40G)

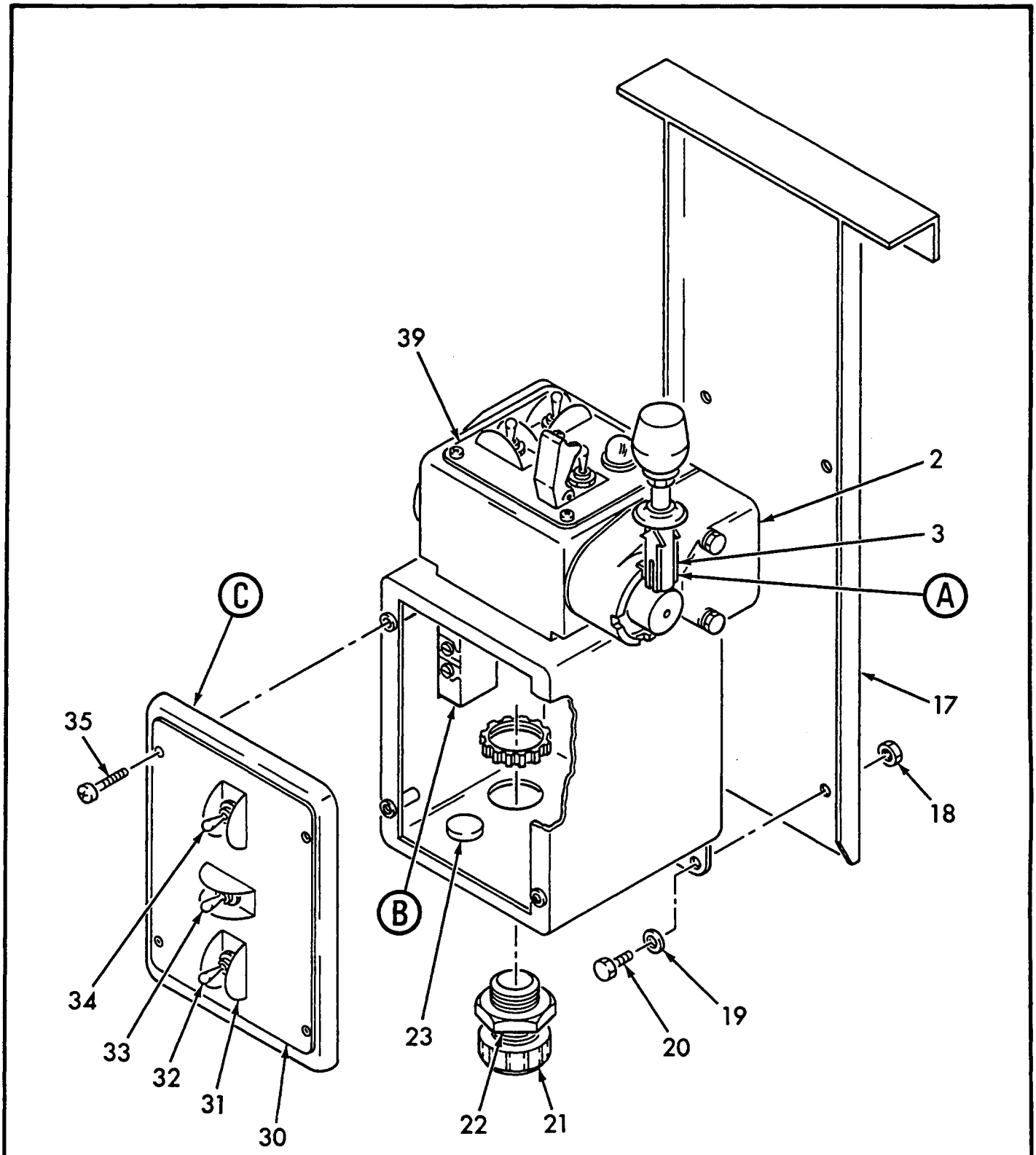


REV.

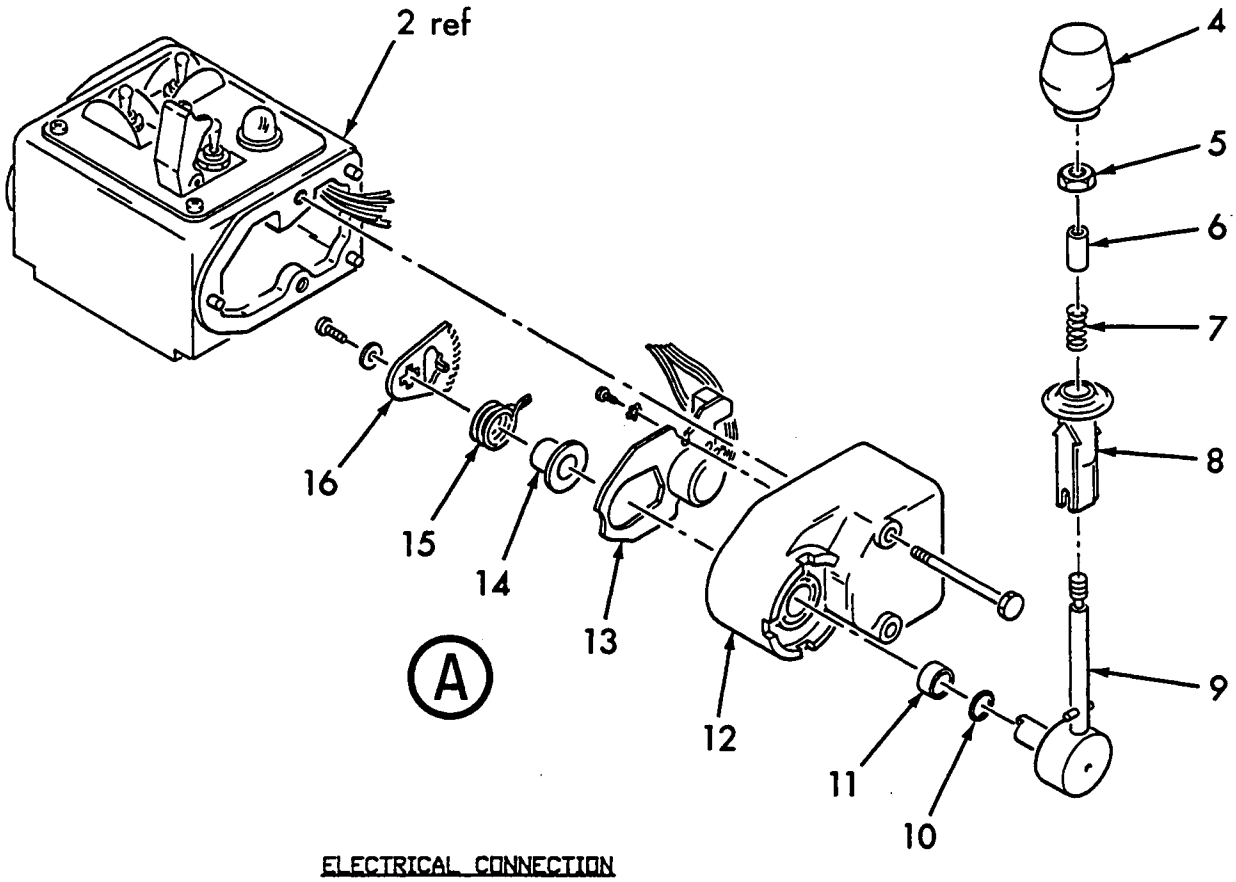
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30043	ASSEMBLY, FINAL	REF
2	32602	. ASSEMBLY, FRAME (See Sect. 3, Fig. 1 for Details)	1
3	32652	. ASSEMBLY, SCISSORS (See Sect. 4, Fig. 1 for Details)	1
4	30890	. BOLT, EAR PIVOT	2
5	61310	. NUT, HEX LOCK	2
6	32641	. ASSEMBLY, PLATFORM (See Sect. 5, Fig. 1 for Details)	1
7	30891	. BOLT, EAR PIVOT	2
8	61310	. NUT, HEX LOCK	2
9	32686	. ASSEMBLY, UPPER CONTROL BOX (See Sect. 5, Fig. 2 for Details)	1
10	60319	. SCREW, CAP	4
11	60313	. NUT, HEX-SELF LOCKING	4
12	130337-75	. CABLE, CONDUCTOR	75 FT
13	255	. TIE, CABLE	AR
14	256	. TIE, CABLE	AR
-15	32683	. SCHEMATIC, ELECTRICAL (See Schematic Section, page 2)	1
-16	32684	. SCHEMATIC, HYDRAULIC (See Schematic Section, page 4)	1
-17	32695	. DIAGRAM, HYDRAULIC HOSE KIT (See Sect. 2, Fig. 4A for Details)	1
-18	32696	. DIAGRAM, TUBE KIT (See Sect. 2, Fig. 5A for Details)	1
19	80014-06	. ELBOW, UNION	1
20	80031-06	. TEE, UNION	1
21	80042-06	. UNION	4
22	764	. CLAMP	12

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23	63651	. RIVET, POP	12
-24	65116	. OIL, HYDRAULIC	10 GAL
25	130927	. CONTAINER, PLASTIC	1
26	16628	. HANDBOOK, SCISSOR	1
27	65842	. CAP, ANTI ROLL	2
28	65867	. CLAMP	2
29	61711	. SCREW, SELF TAPPING	2
-30	16609	. PAINT, BLUE	2 GAL
-31	65368	. PAINT, BLUE	16 OZ
-32	16608	. PAINT, WHITE	6 GAL
-33	2673	. PAINT, WHITE	16 OZ
-34	2996	. OIL, MOTOR	.87 GAL
-35	65114	. GASOLINE	5 GAL
-36	17217	. CATALOG, MARKLIFT PARTS	1

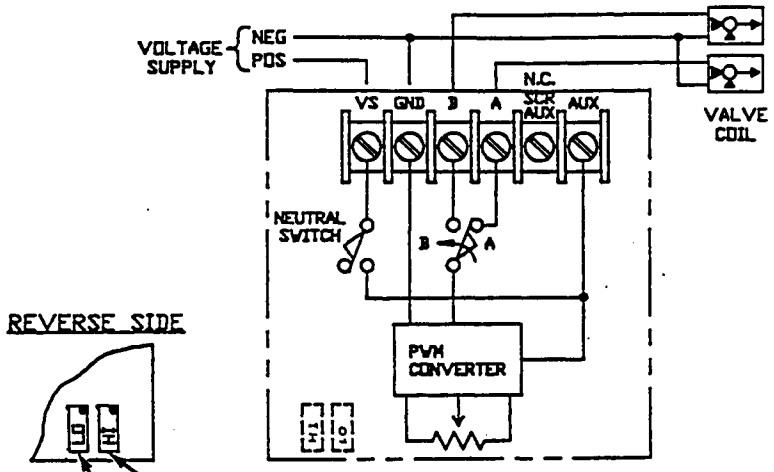
UPPER CONTROL BOX ASSEMBLY



REV.



ELECTRICAL CONNECTION

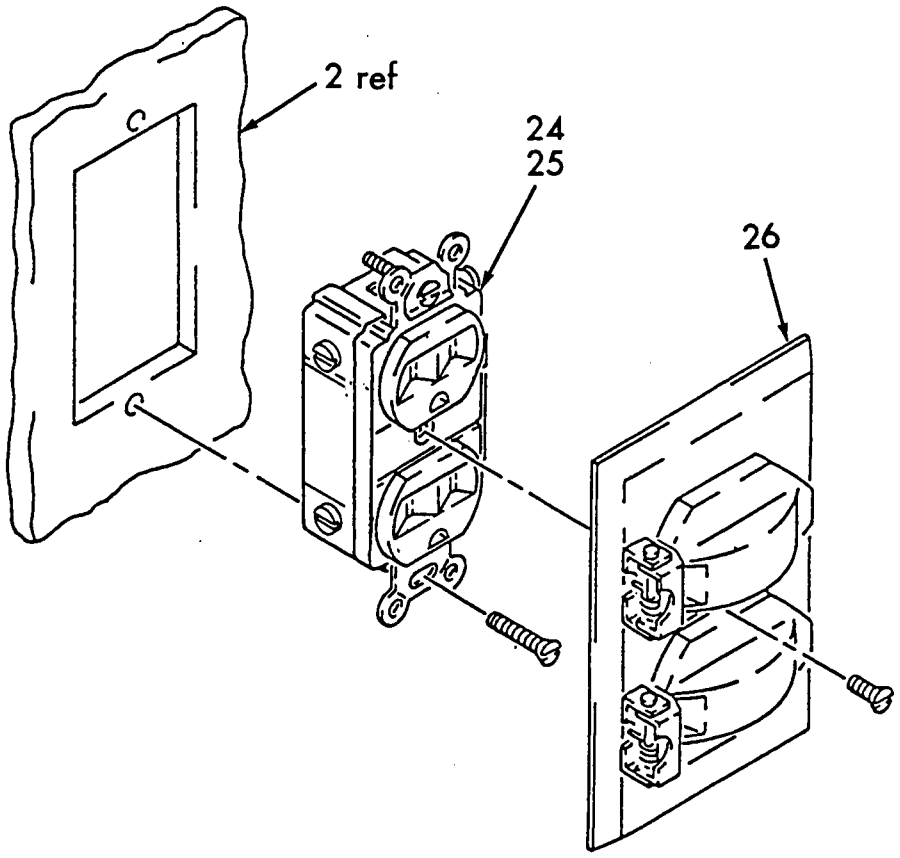


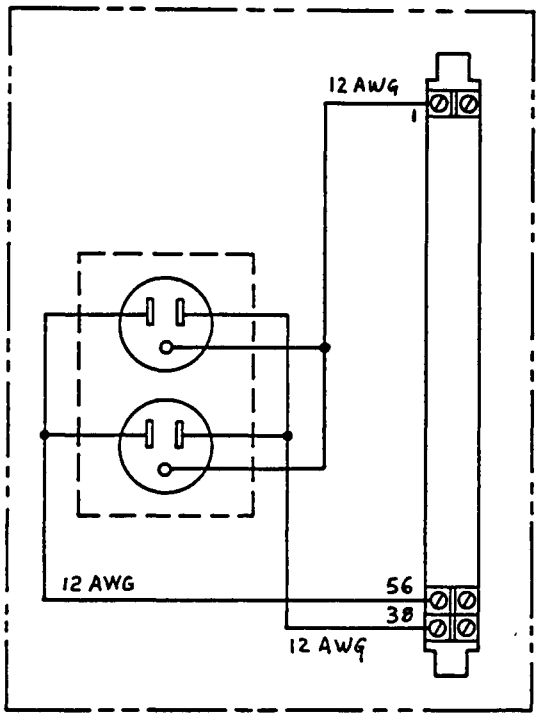
REVERSE SIDE

HI LIMIT ADJ
CW INCREASES

LO LIMIT ADJ
CW INCREASES

UPPER CONTROL BOX ASSEMBLY



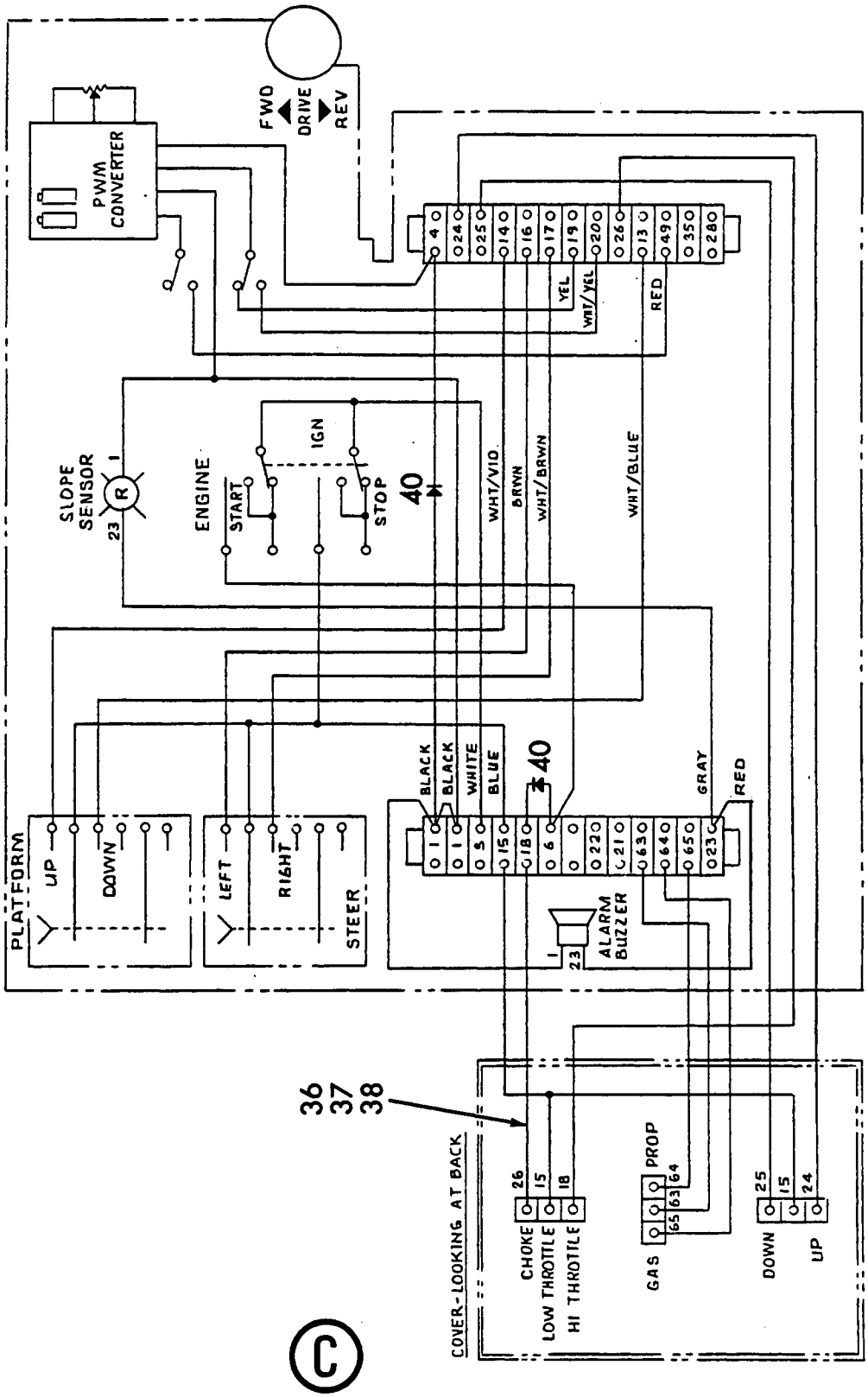


FWD

B

REV.

UPPER CONTROL BOX ASSEMBLY



UPPER CONTROL BOX ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32686	ASSEMBLY, UPPER CONTROL BOX (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	70408	. BOX, UPPER CONTROL	1
3	20539	. ASSEMBLY, CONTROLLER HANDLE	1
4	20479	. KNOB, CONTROLLER HANDLE	1
5	60708	. NUT, HEX	1
6	16916	. SPACER, SAFETY LOCK	1
7	16915	. SPRING, SAFETY LOCK	1
8	20581	. LOCK, SAFETY	1
9	16903	. HANDLE, CONTROLLER	1
10	66223	. "O" RING, HOUSING	1
11	66222	. BUSHING, HOUSING	1
12	16902	. HOUSING, CONTROLLER	1
13	67704	. ASSEMBLY, ELECTRICAL (BOARD ONLY)	1
14	16917	. SPACER, TORSION SPRING	1
15	16904	. SPRING, TORSION	1
16	16906	. GEAR, SELECTOR	1
17	32574	. PLATE, MOUNTING	1
18	61313	. NUT, HEX (self locking)	4
19		. WASHER	4
20	60309	. SCREW, CAP	4
21	2807	. RELIEF, STRAIN	1
22	61115	. NUT, LOCK	1
23	2219	. PLUG	2
24	70391	. RECEPTACLE, G.F. Cl	1
25	70394	. CONNECTOR, TWIST ON	2

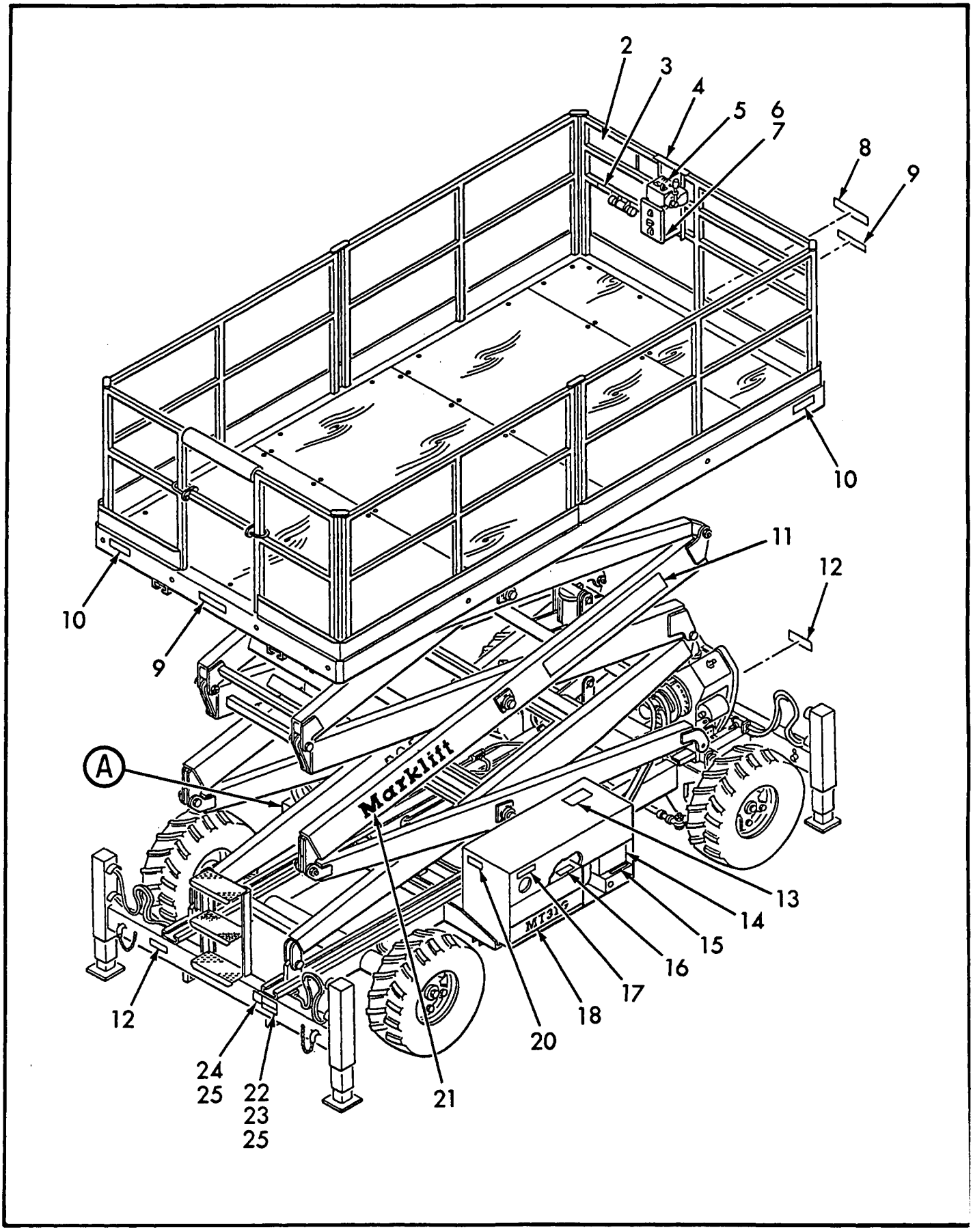
- ITEM NOT ILLUSTRATED

UPPER CONTROL BOX ASSEMBLY

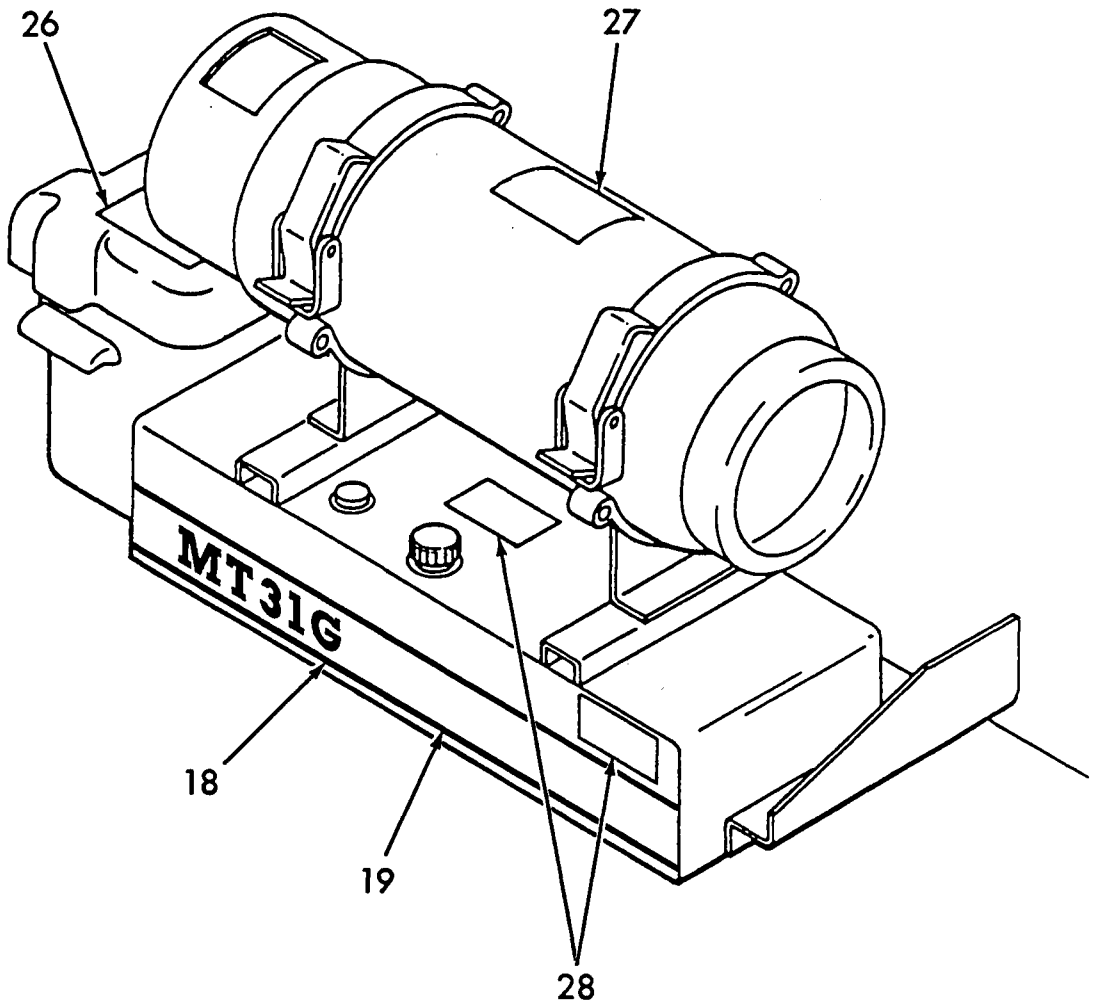
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	70392	. RECEPTACLE, COVER	1
27	63002	. SCREW, MACHINE	2
28	62636	. SCREW, MACHINE	4
29	61502	. NUT, HEX	4
30	182712	. DECAL, UPPER CONTROL BOX (FRONT COVER)	1
31	20884	. GUARD, SWITCH	3
32	4021	. SWITCH, TOGGLE	1
33	4019	. SWITCH, TOGGLE	1
34	70057	. SWITCH, TOGGLE	1
35		. SCREW	4
36	70232	. WIRE, WHITE (3 FT)	AR
37	117-C	. CONNECTOR, RING	10
38	256	. CABLE, TIE	5
39	182714	. DECAL, UPPER CONTROL BOX (TOP OF BOX)	1
40	70479	. DIODE	2

- ITEM NOT ILLUSTRATED

DECAL SET (MT31G)



DECAL SET (MT31G)



(A)

DECAL SET (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	67784	SET, DECAL	REF
2	182744	. DECAL, OPERATION INSTRUCTIONS	1
3	130820	. DECAL, OPERATION AND SAFETY HANDBOOK	1
4	2014	. DECAL, CAUTION HIGH VOLTAGE LINES	1
5	182714	. DECAL, UPPER CONTROL BOX (STEER) (See Sect. 2, Fig. 2 for NHA)	1
6	182712	. DECAL, UPPER CONTROL BOX (DRIVE) (See Sect. 2, Fig. 2 for NHA)	1
7		. DECAL, 110 VAC	1
8	32369	. DECAL, MT-SERIES	1
9	31109	. DECAL, CAUTION SCISSOR GUARD RAIL	2
10	2027	. DECAL, LOAD CAPACITY 2000 LBS.	4
11	130596	. DECAL, A PRODUCT OF MARK INDUSTRIES	2
12	2041	. DECAL, DO NOT LIFT	2
13	2016	. DECAL, DO NOT WORK UNDER	1
14	32345	. DECAL, GROUND CONTROL BOX (See Sect. 3, Fig. 22 for NHA)	1
15	185707	. DECAL, POWER TO PLATFORM 110 VAC (See Sect. 3, Fig. 22 for NHA)	1
16	2017	. DECAL, HYDRAULIC SYSTEM FLUID	1
17	2019	. DECAL, EMERGENCY LOWERING VALVE	1
18	181731	. DECAL, MT31G	2
19	181728	. DECAL, STRIPE	1
20	130606	. DECAL, FREEWHEELING VALVE	1
21	31260	. DECAL, MARKLIFT	2
22	30520	. PLATE, PATENT NUMBER SCISSORS	1
23	20661	. PLATE, ANSI A92	1
24	20660	. NAMEPLATE, IDENTIFICATION	1

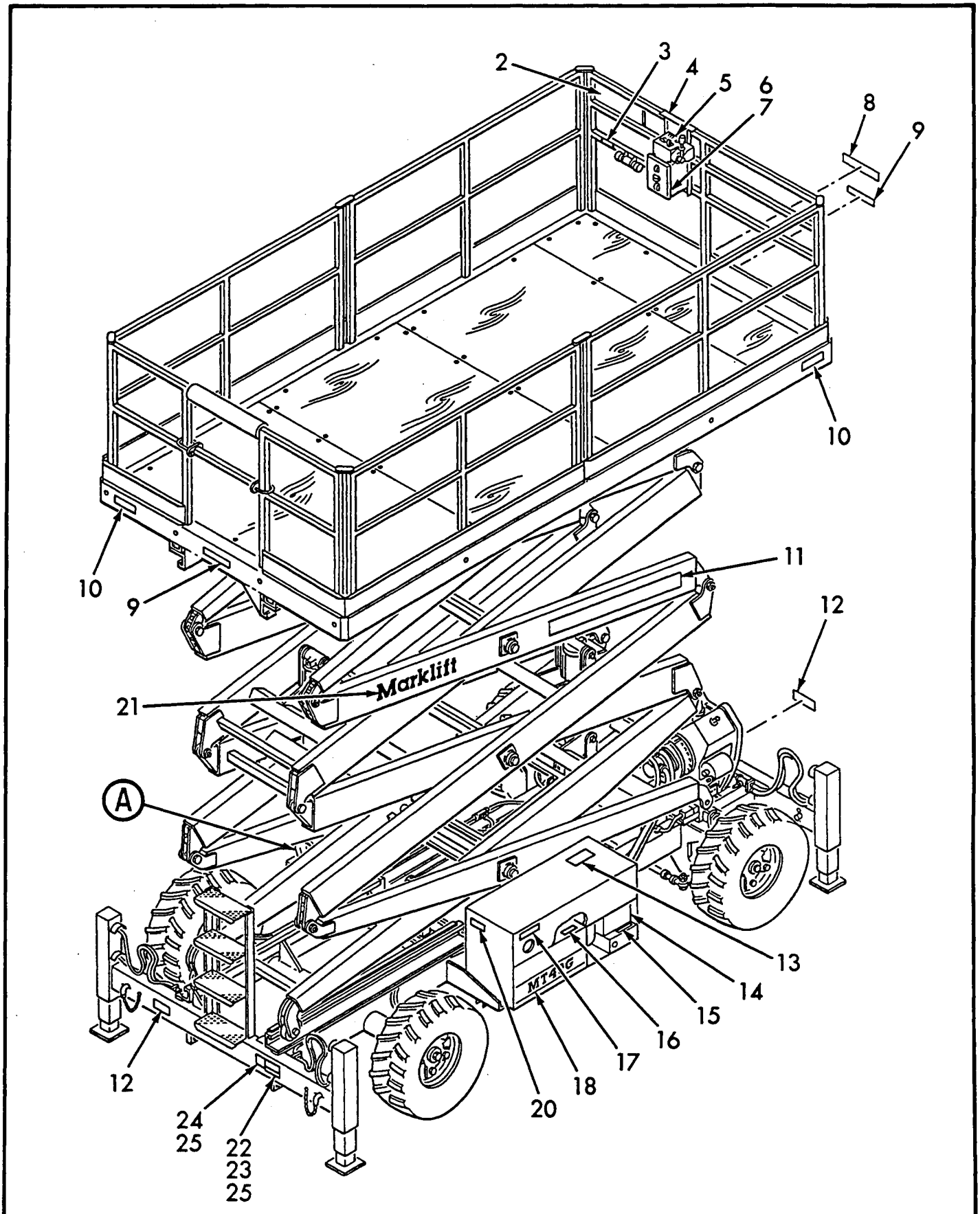
- ITEM NOT ILLUSTRATED

DECAL SET (MT31G)

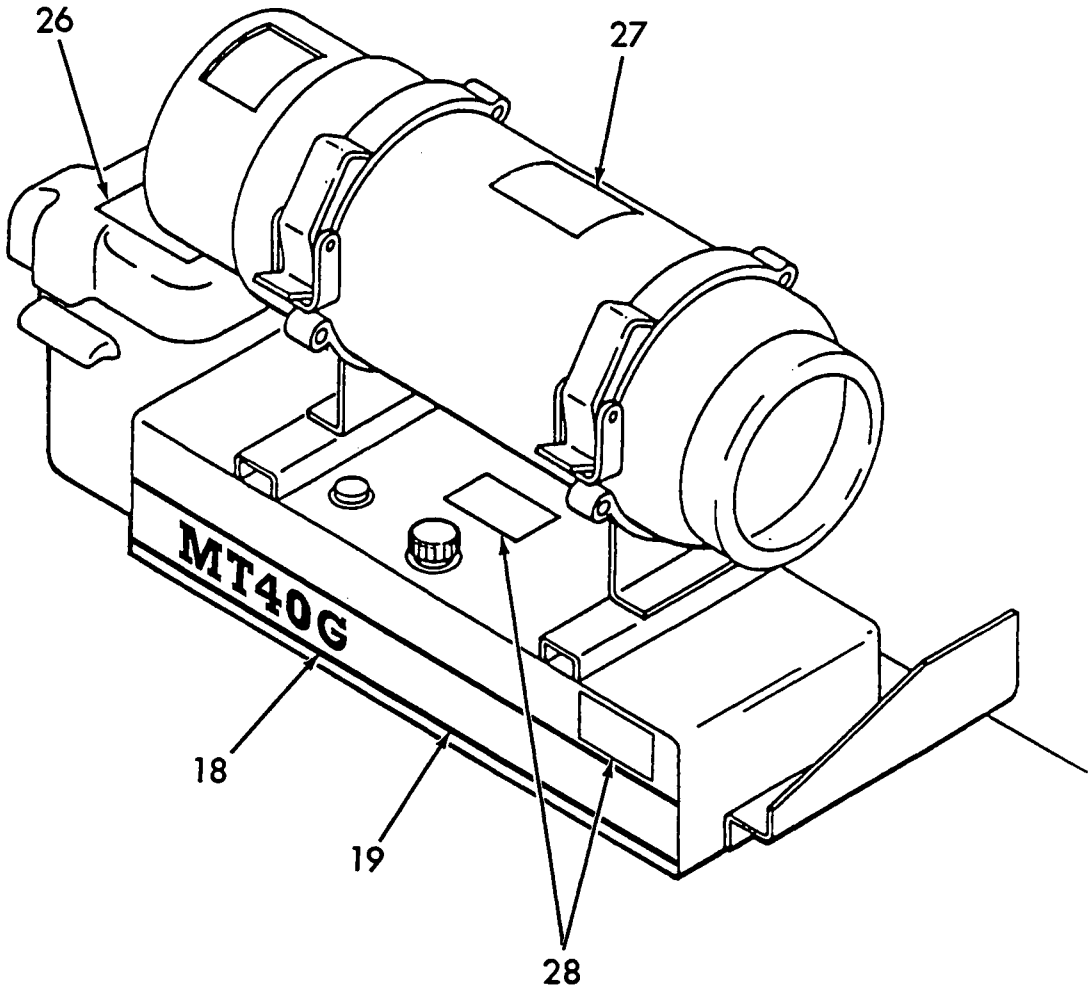
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	63653	. RIVET, POP	12
26	2003	. DECAL, BATTERY WATER LEVEL	1
27	2004	. DECAL, VAPOR TANK ONLY	1
28	2020	. DECAL, GASOLINE OR PETROL	2

- ITEM NOT ILLUSTRATED

DECAL SET (MT40G)



DECAL SET (MT40G)



(A)

DECAL SET (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	67705	SET, DECAL	REF
2	182744	. DECAL, OPERATION INSTRUCTIONS	1
3	130820	. DECAL, OPERATION AND SAFETY HANDBOOK	1
4	2014	. DECAL, CAUTION HIGH VOLTAGE LINES	1
5	182714	. DECAL, UPPER CONTROL BOX (STEER) (See Sect. 2, Fig. 2 for NHA)	1
6	182712	. DECAL, UPPER CONTROL BOX (DRIVE) (See Sect. 2, Fig. 2 for NHA)	1
7		. DECAL, 110 VAC	1
8	32369	. DECAL, MT-SERIES	1
9	31109	. DECAL, CAUTION SCISSOR GUARD RAIL	2
10	2026	. DECAL, LOAD CAPACITY 1500 LBS.	4
11	130596	. DECAL, A PRODUCT OF MARK INDUSTRIES	2
12	2041	. DECAL, DO NOT LIFT	2
13	2016	. DECAL, DO NOT WORK UNDER	1
14	32345	. DECAL, GROUND CONTROL BOX (See Sect. 3, Fig. 22A for NHA)	1
15	185707	. DECAL, POWER TO PLATFORM 110 VAC (See Sect. 3, Fig. 22A for NHA)	1
16	2017	. DECAL, HYDRAULIC SYSTEM FLUID	1
17	2019	. DECAL, EMERGENCY LOWERING VALVE	1
18	181732	. DECAL, MT40G	2
19	181728	. DECAL, STRIPE	1
20	130606	. DECAL, FREEWHEELING VALVE	1
21	31260	. DECAL, MARKLIFT	2
22	30520	. PLATE, PATENT NUMBER SCISSORS	1
23	20661	. PLATE, ANSI A92	1
24	20660	. NAMEPLATE, IDENTIFICATION	1

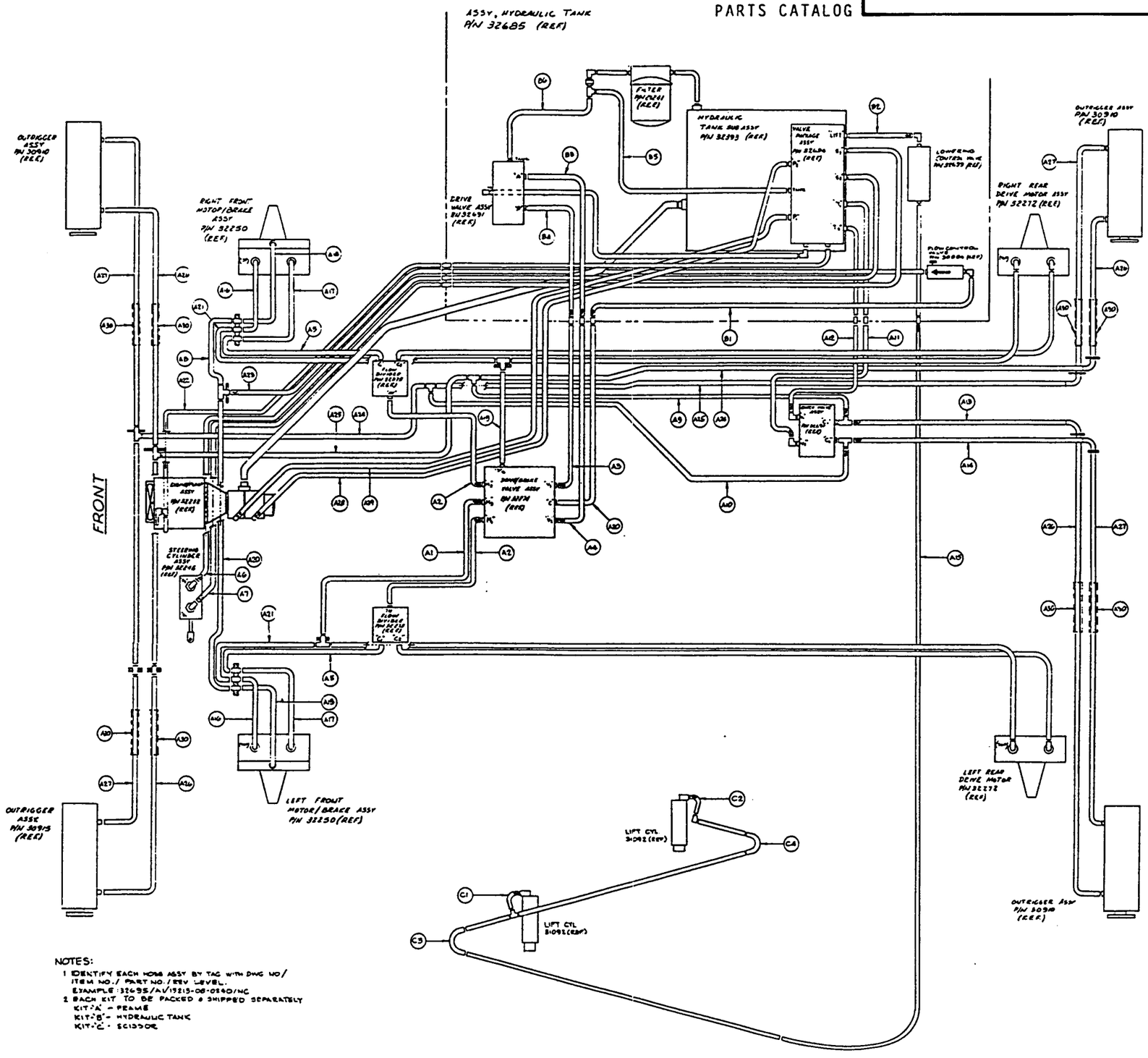
- ITEM NOT ILLUSTRATED

DECAL SET (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
25	63653	. RIVET, POP	12
26	2003	. DECAL, BATTERY WATER LEVEL	1
27	2004	. DECAL, VAPOR TANK ONLY	1
28	2020	. DECAL, GASOLINE OR PETROL	2

- ITEM NOT ILLUSTRATED

HYDRAULIC HOSE KIT DIAGRAM (MT31G)



NOTES:

1 IDENTIFY EACH HOSE ASSY BY TAG WITH DWG NO/ ITEM NO./ PART NO./ REV LEVEL.
EXAMPLE: 32695/A1/19215-08-0540/NC
2 EACH KIT TO BE PACKED & SHIPPED SEPARATELY
KIT 'A' - FRAME
KIT 'B' - HYDRAULIC TANK
KIT 'C' - SCISSOR

HOSE KIT DIAGRAM (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567		UNIT PER ASSY.
-1	32695	DIAGRAM, HOSE KIT		REF
A1	13213-08-0240	. HOSE ASSEMBLY	KIT "A"	1
A2	13213-08-0220	.		2
A3	13213-10-0304	.		1
A4	13213-10-0342	.		1
A5	13213-08-0440	.		2
A6	13213-06-0770	.		1
A7	13213-06-0860	.		1
A8	13213-04-0246	.		1
A9	13213-06-0290	.		1
A10	13213-06-0374	.		1
A11	13213-06-0340	.		1
A12	13213-06-0320	.		1
A13	13213-06-1140	.		1
A14	13213-06-1100	.		1
A15	13213-08-1080	.		1
A16	13210-08-0330	.		2
A17	13210-08-0350	.		2
A18	13210-04-0380	.		2
A19	13210-08-0224	.		1
A20	13210-04-0340	.		2
A21	13210-08-0520	.		2
A22	13210-04-1190	.		1
A23	13213-04-0540	.		1
A24	13210-06-0860	.		2
A25	13210-06-0810	. HOSE ASSEMBLY		2

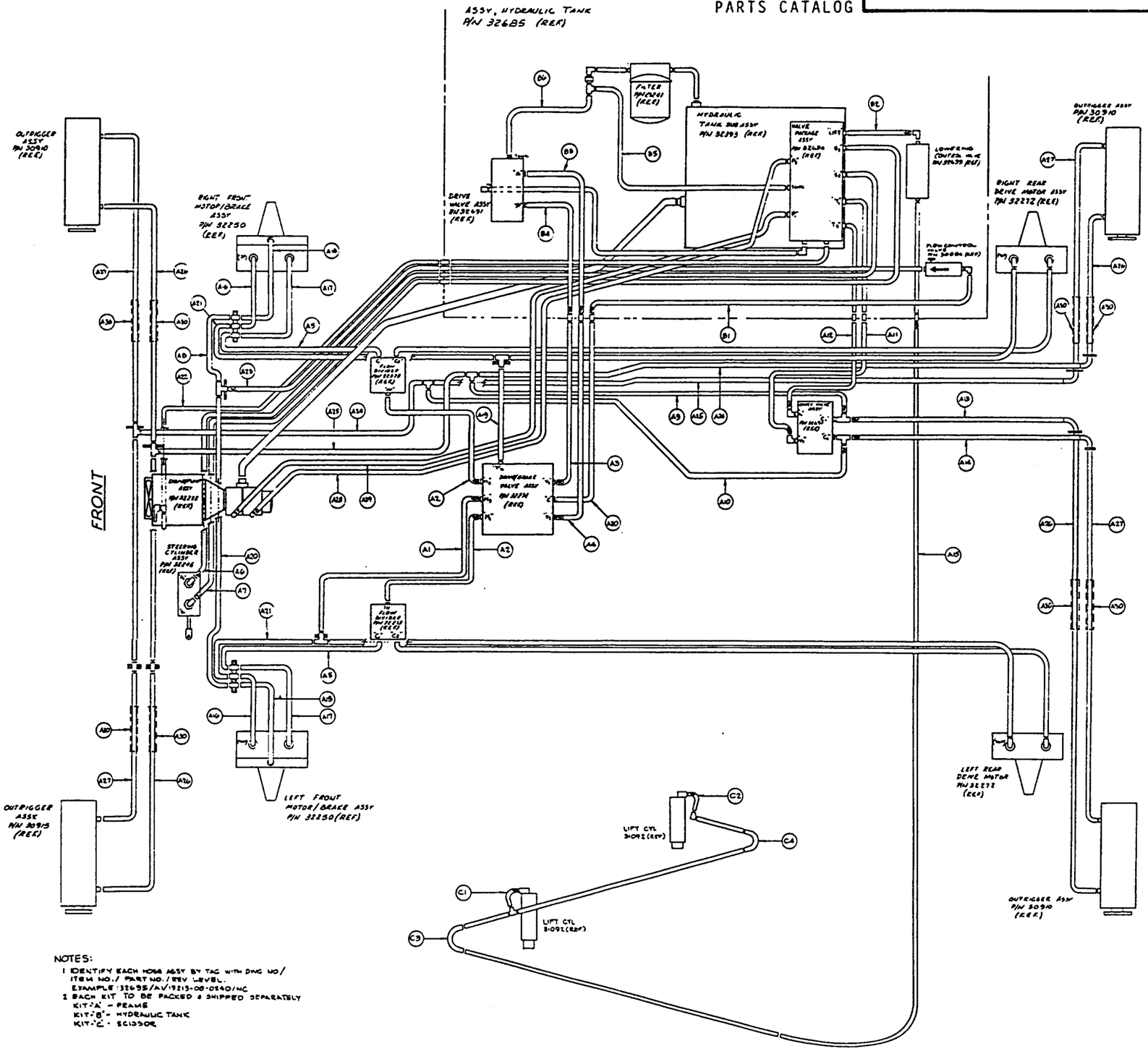
- ITEM NOT ILLUSTRATED

HOSE KIT DIAGRAM (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567		UNIT PER ASSY.
A26	13210-06-0500	. HOSE ASSEMBLY	KIT "A"	4
A27	13210-06-0620	.		4
A28	13212-08-0900	.		1
A29	13212-10-0890	. HOSE ASSEMBLY		1
A30	2662	. HOSE GUARD		11 FT
B1	13213-04-0280	. HOSE ASSEMBLY	KIT "B"	1
B2	13213-08-0134	.		1
B3	13213-10-0370	.		1
B4	13213-10-0350	.		1
B5	13205-12-0150	.		1
B6	13205-12-0170	. HOSE ASSEMBLY		1
C1	13213-08-0200	. HOSE ASSEMBLY	KIT "C"	1
C2	13213-08-0210	.		1
C3	13210-08-0270	.		1
C4	13210-08-0310	. HOSE ASSEMBLY		1

- ITEM NOT ILLUSTRATED

HYDRAULIC HOSE KIT DIAGRAM (MT40G)



NOTES:

1. IDENTIFY EACH HOSE ASSY BY TAG WITH DWG NO/ ITEM NO./ PART NO./ REV LEVEL.
   EXAMPLE: 32695/A1/19215-08-0540/NC
2. EACH KIT TO BE PACKED & SHIPPED SEPARATELY
   KIT 'A' - FRAME
   KIT 'B' - HYDRAULIC TANK
   KIT 'C' - SCISSOR

HOSE KIT DIAGRAM (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567		UNIT PER ASSY.
-1	32695	DIAGRAM, HOSE KIT		REF
A1	13213-08-0240	. HOSE ASSEMBLY	KIT "A"	1
A2	13213-08-0220	.		2
A3	13213-10-0304	.		1
A4	13213-10-0342	.		1
A5	13213-08-0440	.		2
A6	13213-06-0770	.		1
A7	13213-06-0860	.		1
A8	13213-04-0246	.		1
A9	13213-06-0290	.		1
A10	13213-06-0374	.		1
A11	13213-06-0340	.		1
A12	13213-06-0320	.		1
A13	13213-06-1140	.		1
A14	13213-06-1100	.		1
A15	13213-08-1080	.		1
A16	13210-08-0330	.		2
A17	13210-08-0350	.		2
A18	13210-04-0380	.		2
A19	13210-08-0224	.		1
A20	13210-04-0340	.		2
A21	13210-08-0520	.		2
A22	13210-04-1190	.		1
A23	13213-04-0540	.		1
A24	13210-06-0860	.		2
A25	13210-06-0810	HOSE ASSEMBLY		2

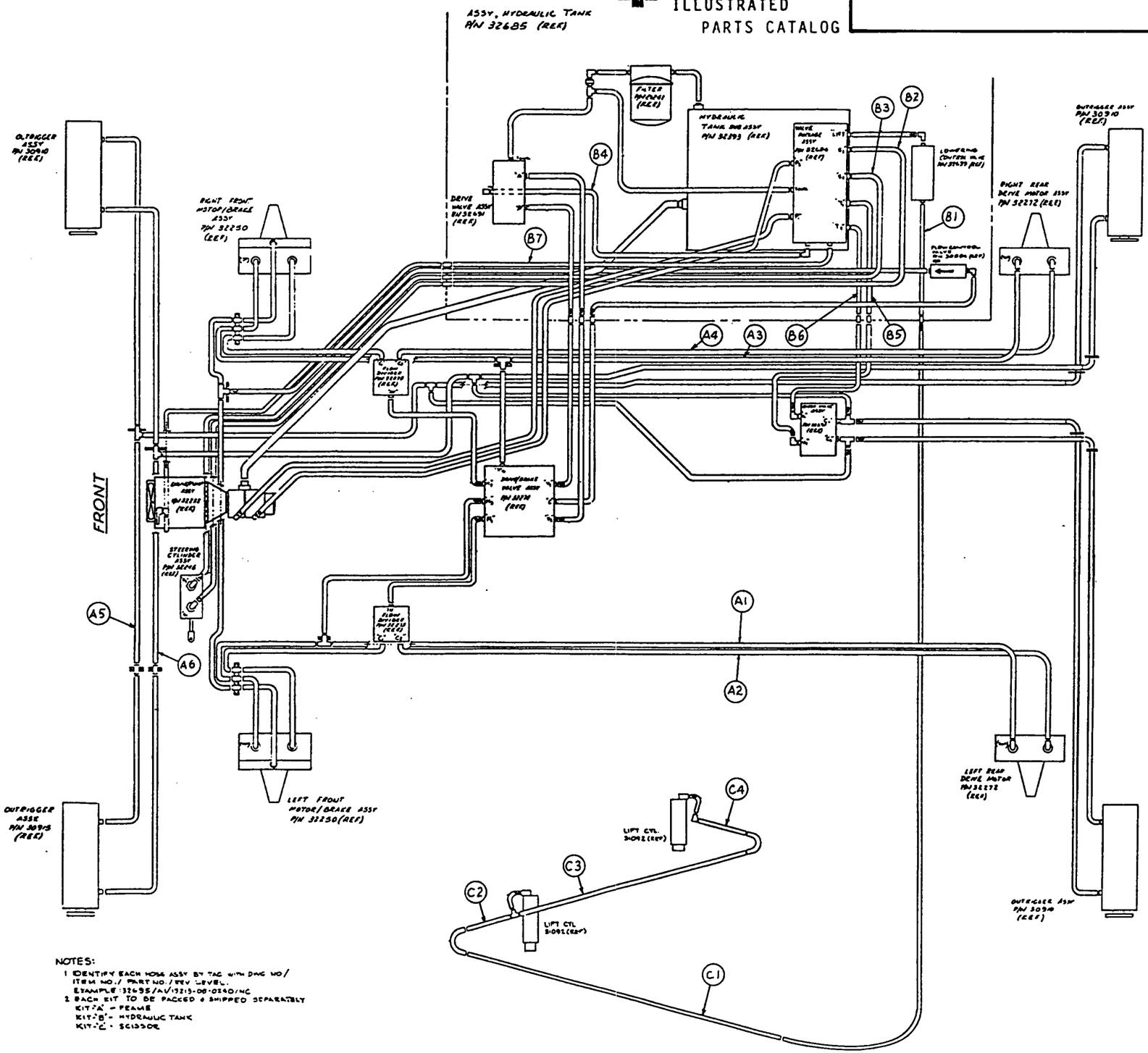
- ITEM NOT ILLUSTRATED

HOSE KIT DIAGRAM (MT40G)

ITEM	PART NUMBER	1234567 DESCRIPTION		UNIT PER ASSY.
A26	13210-06-0500	. HOSE ASSEMBLY	KIT "A"	4
A27	13210-06-0620	.		4
A28	13212-08-0900	.		1
A29	13212-10-0890	. HOSE ASSEMBLY		1
A30	2662	. HOSE GUARD		11 FT
B1	13213-04-0280	. HOSE ASSEMBLY	KIT "B"	1
B2	13213-08-0134	.		1
B3	13213-10-0370	.		1
B4	13213-10-0350	.		1
B5	13205-12-0150	.		1
B6	13205-12-0170	. HOSE ASSEMBLY		1
C1	13213-08-0200	. HOSE ASSEMBLY	KIT "C"	1
C2	13213-08-0210	.		1
C3	13210-08-0270	.		1
C4	13210-08-0310	. HOSE ASSEMBLY		1

- ITEM NOT ILLUSTRATED

TUBE KIT DIAGRAM (MT31G)



NOTES:

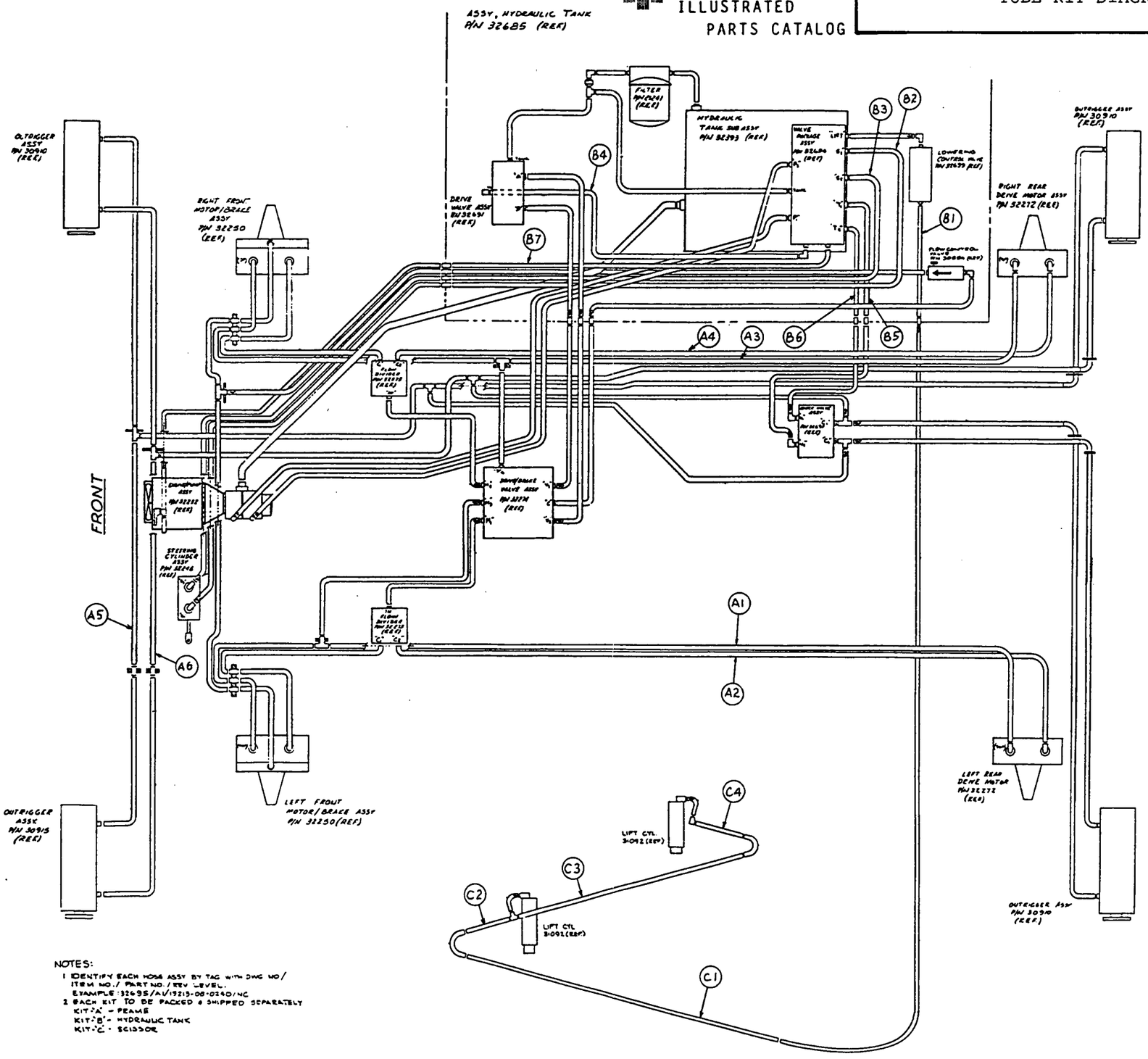
1 IDENTIFY EACH HOSE ASSY BY TAG WITH DWG NO/ ITEM NO./ PART NO./ REV LEVEL.
EXAMPLE: 32695/A/1321-08-0240/NC
2 EACH KIT TO BE PACKED & SHIPPED SEPARATELY
KIT-'A' - FRAME
KIT-'B' - HYDRAULIC TANK
KIT-'C' - SCISSOR

TUBE KIT DIAGRAM (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32696	DIAGRAM, TUBE KIT	REF
A1	32696-A1	. TUBE ASSEMBLY	1
A2	32696-A2	.	1
A3	32696-A3	.	1
A4	32696-A4	. KIT "A"	1
A5	32696-A5	.	1
A6	32696-A6	. TUBE ASSEMBLY	1
B1	32696-B1	. TUBE ASSEMBLY	1
B2	32696-B2	.	1
B3	32696-B3	.	1
B4	32696-B4	. KIT "B"	1
B5	32696-B5	.	1
B6	32696-B6	.	1
B7	32696-B7	. TUBE ASSEMBLY	1
C1	32696-C1	. TUBE ASSEMBLY	1
C2	32696-C2	.	1
C3	32696-C3	. KIT "C"	1
C4	32696-C4	. TUBE ASSEMBLY	1

- ITEM NOT ILLUSTRATED

TUBE KIT DIAGRAM (MT40G)



NOTES:

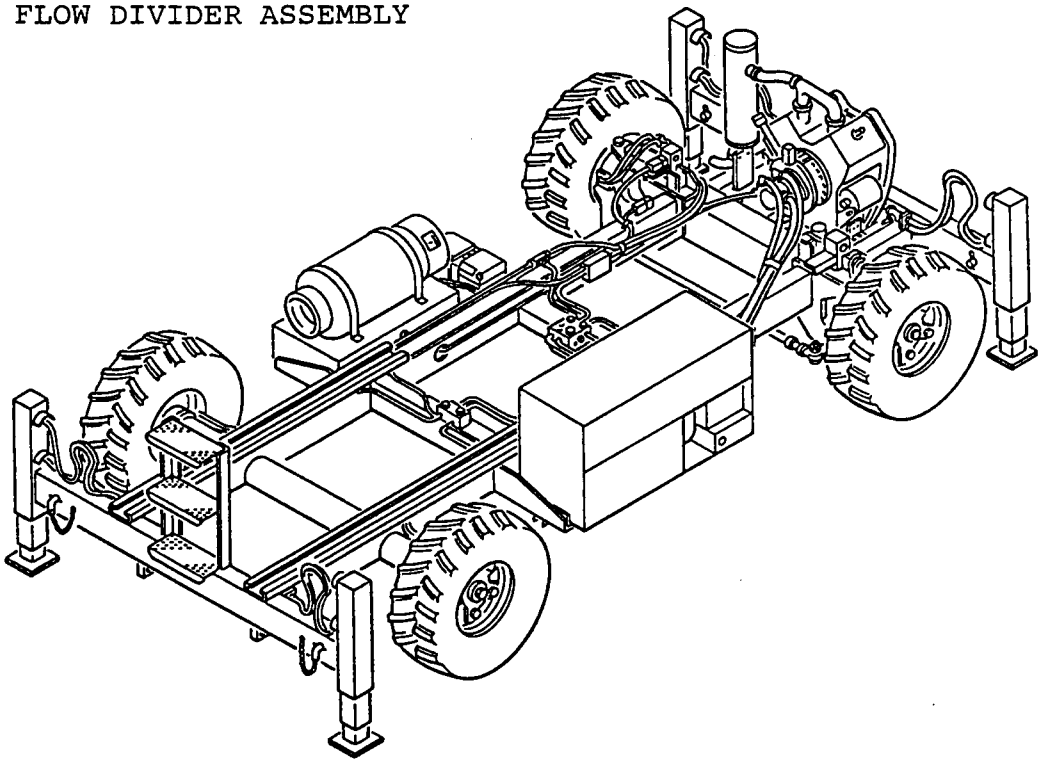
1 IDENTIFY EACH HOSE ASSY BY TAG WITH DWG NO/ ITEM NO./ PART NO./ REV LEVEL.
EXAMPLE: 32695/A1/19215-08-0260/NC
2 EACH KIT TO BE PACKED & SHIPPED SEPARATELY
KIT 'A' - FRAME
KIT 'B' - HYDRAULIC TANK
KIT 'C' - SCISSOR

TUBE KIT DIAGRAM (MT40G)

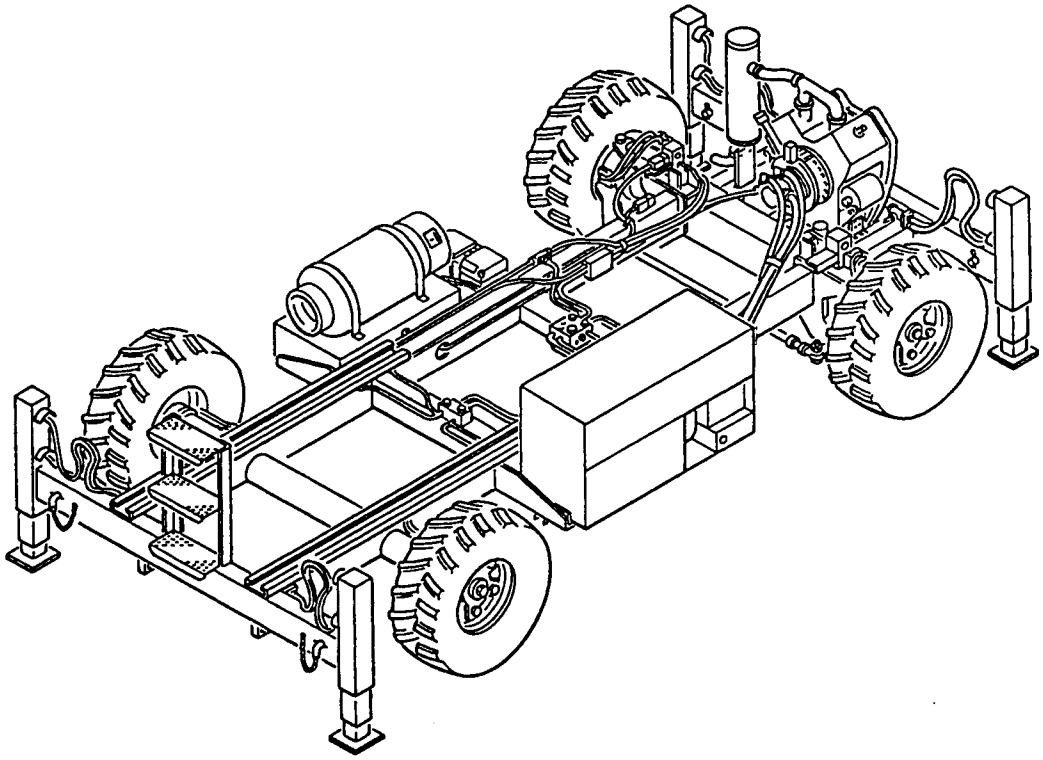
ITEM	PART NUMBER	DESCRIPTION 1234567		UNIT PER ASSY.
-1	32696	DIAGRAM, TUBE KIT		REF
A1	32696-A1	. TUBE ASSEMBLY	KIT "A"	1
A2	32696-A2	.		1
A3	32696-A3	.		1
A4	32696-A4	.		1
A5	32696-A5	.		1
A6	32696-A6	. TUBE ASSEMBLY		1
B1	32696-B1	. TUBE ASSEMBLY	KIT "B"	1
B2	32696-B2	.		1
B3	32696-B3	.		1
B4	32696-B4	.		1
B5	32696-B5	.		1
B6	32696-B6	.		1
B7	32696-B7	. TUBE ASSEMBLY		1
C1	32696-C1	. TUBE ASSEMBLY	KIT "C"	1
C2	32696-C2	.		1
C3	32696-C3	.		1
C4	32696-C4	. TUBE ASSEMBLY		1

REV.

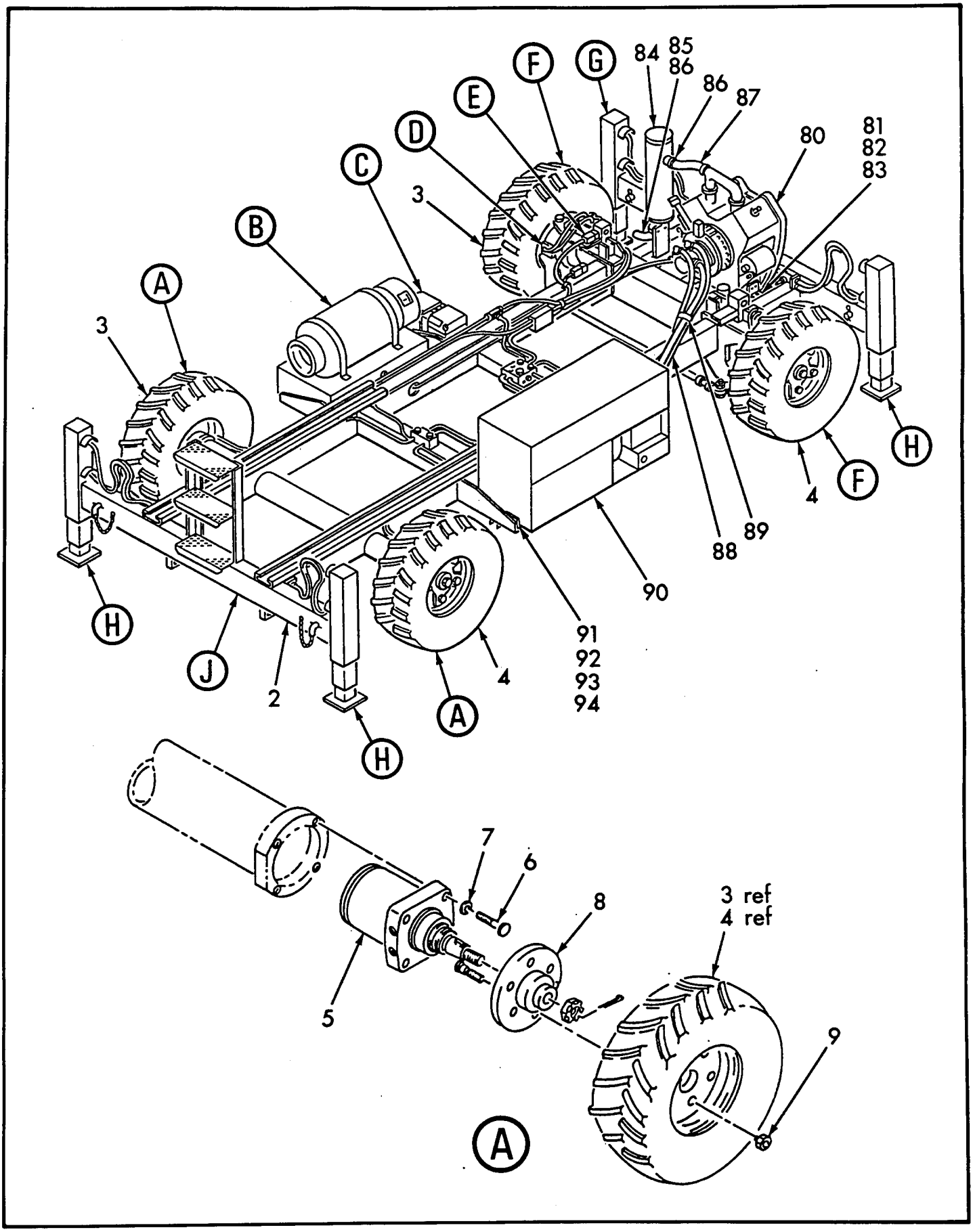
SECTION 3 CONTAINS:



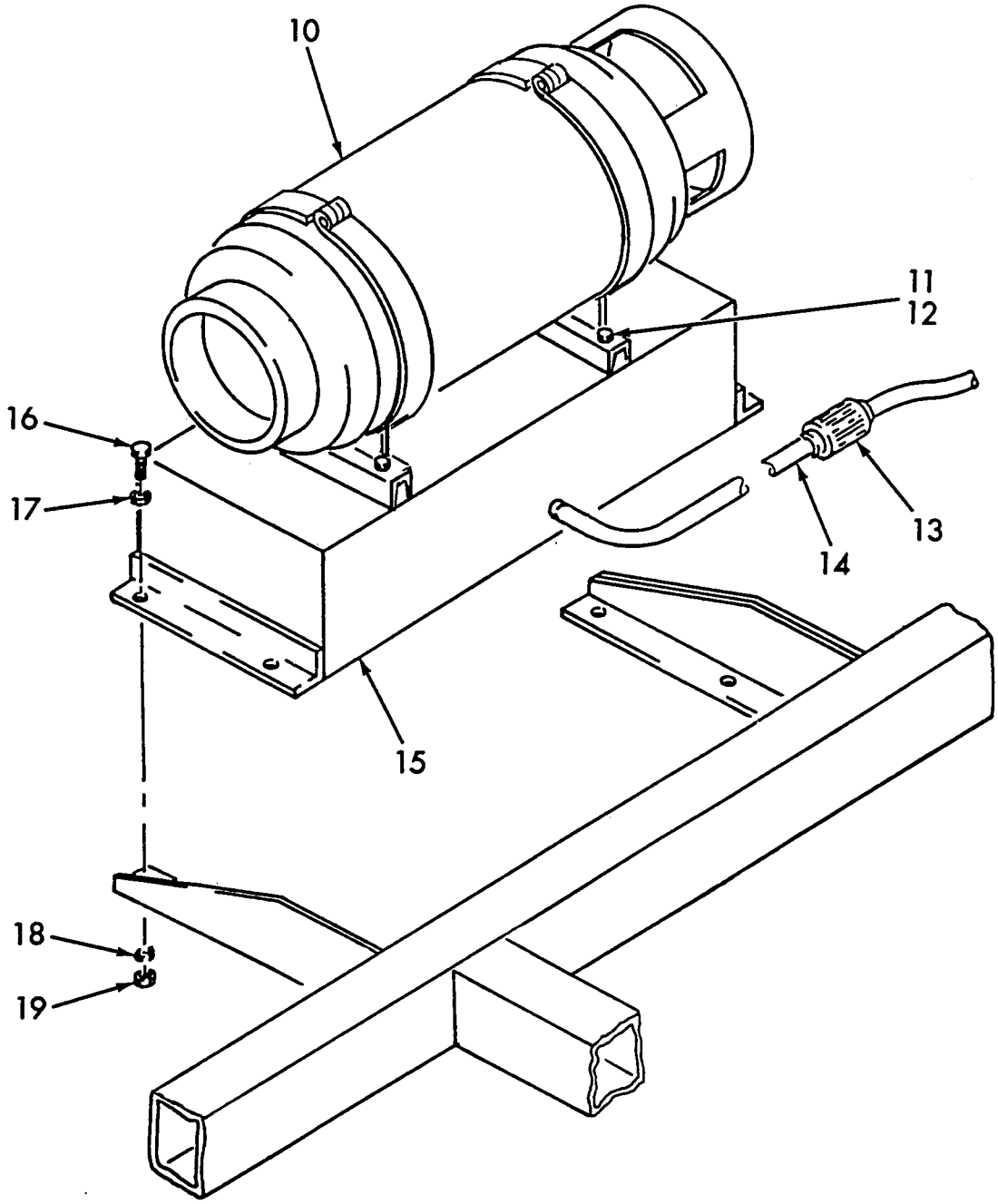
SECTION 3 CONTAINS: (CONT'D)



FRAME ASSEMBLY (MT31G)



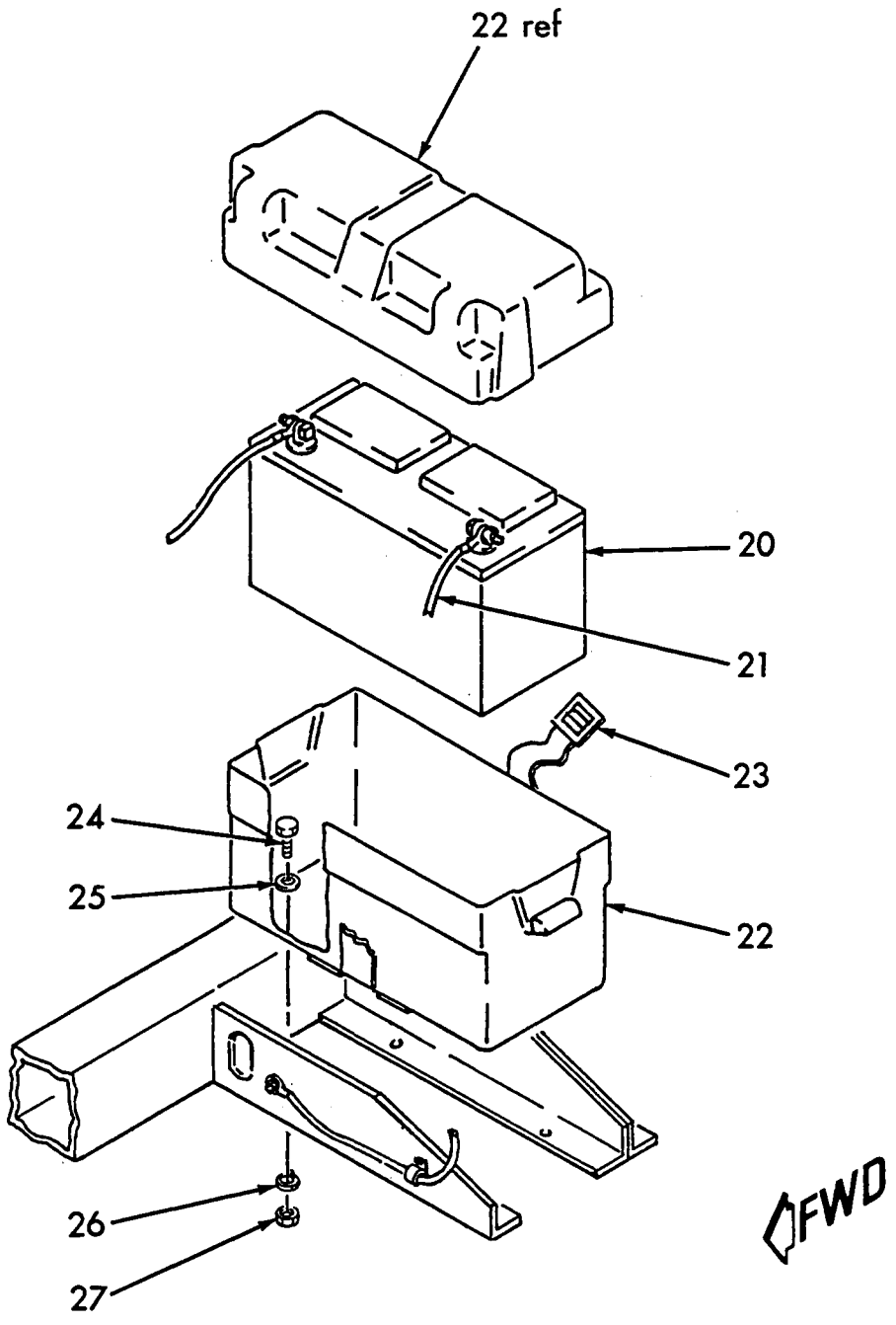
FRAME ASSEMBLY (MT31G)



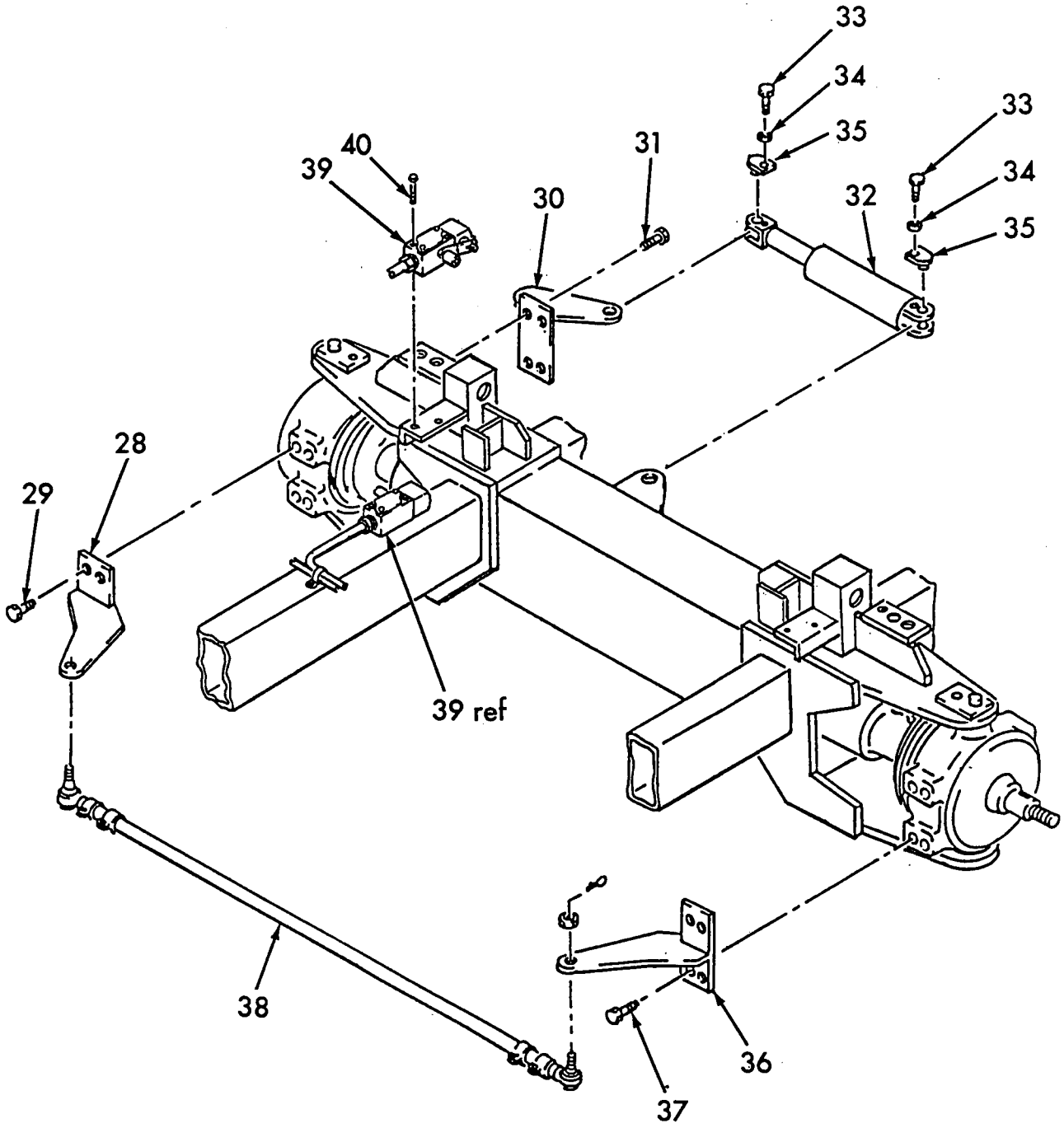
B

REV.

FRAME ASSEMBLY (MT31G)

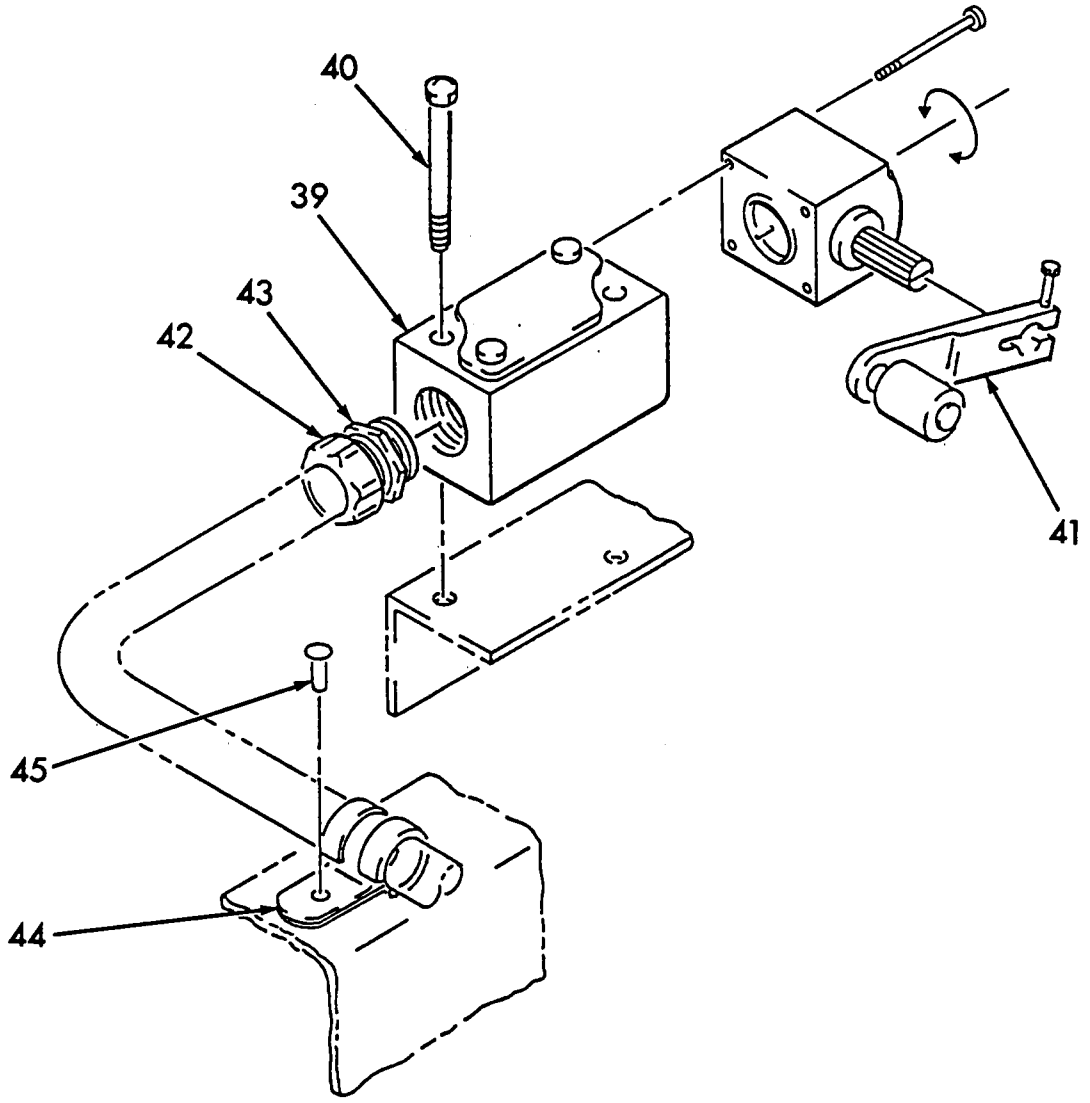


FRAME ASSEMBLY (MT31G)



D

FRAME ASSEMBLY (MT31G)



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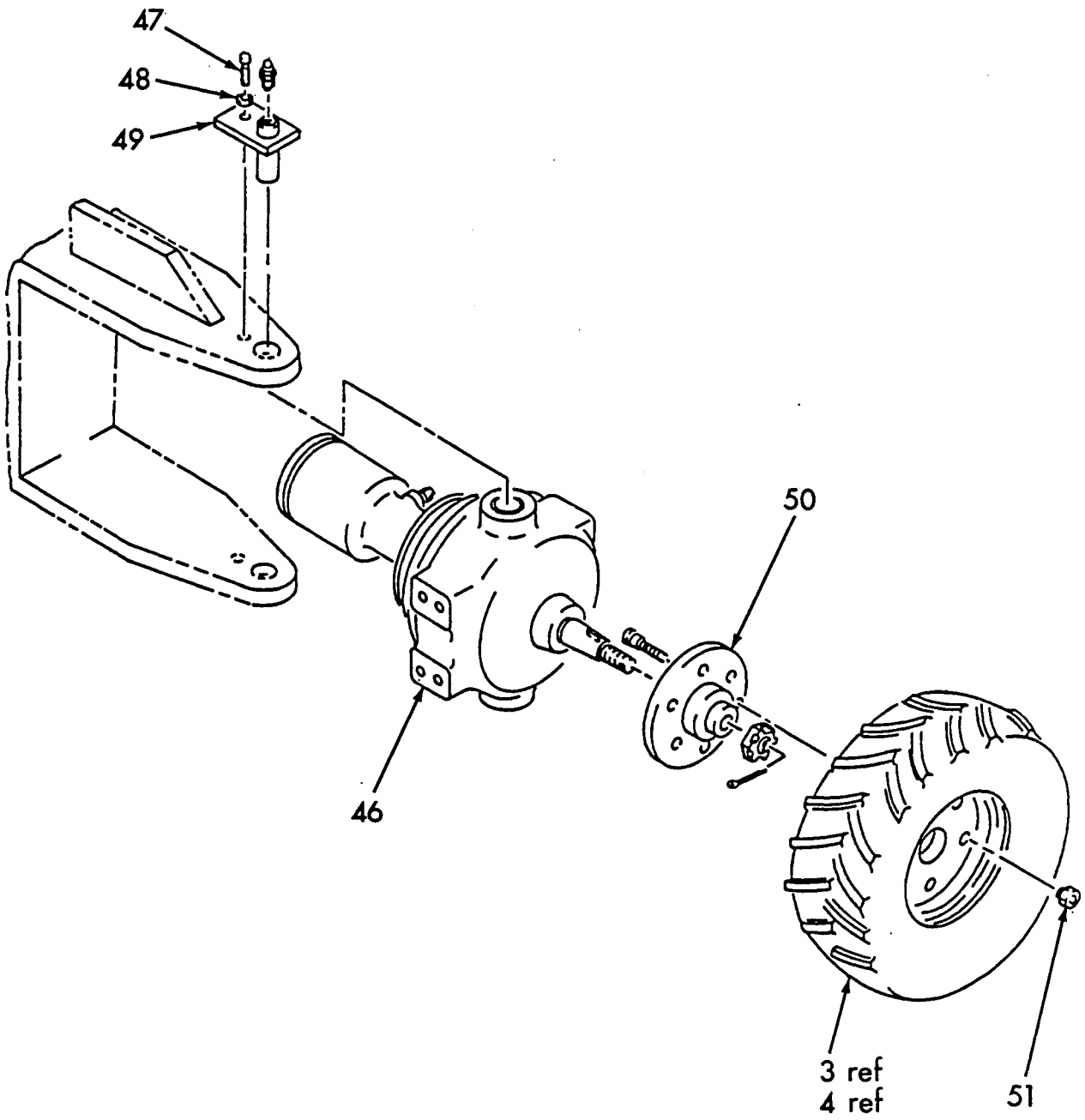
FRAME ASSEMBLY (MT31G)



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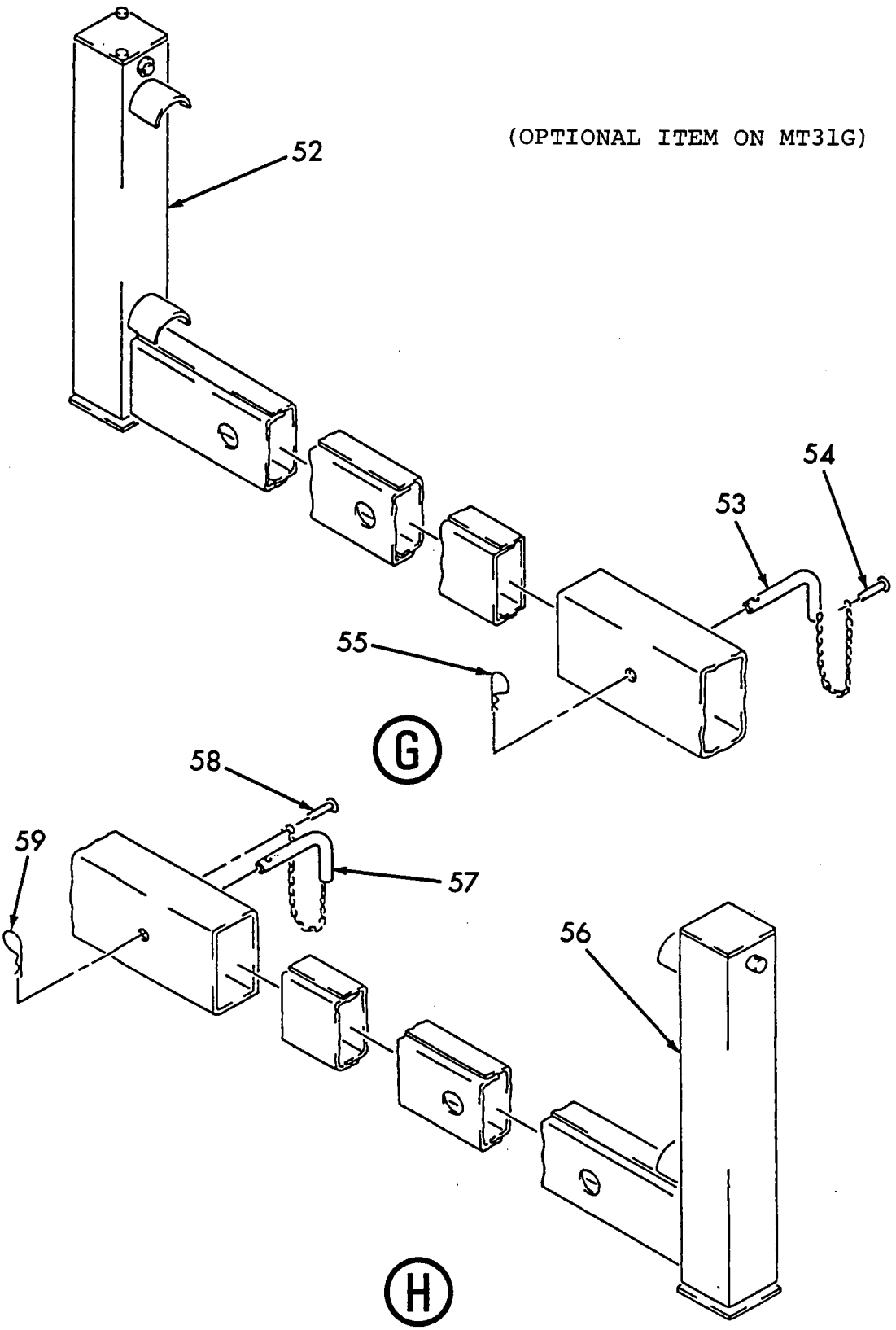
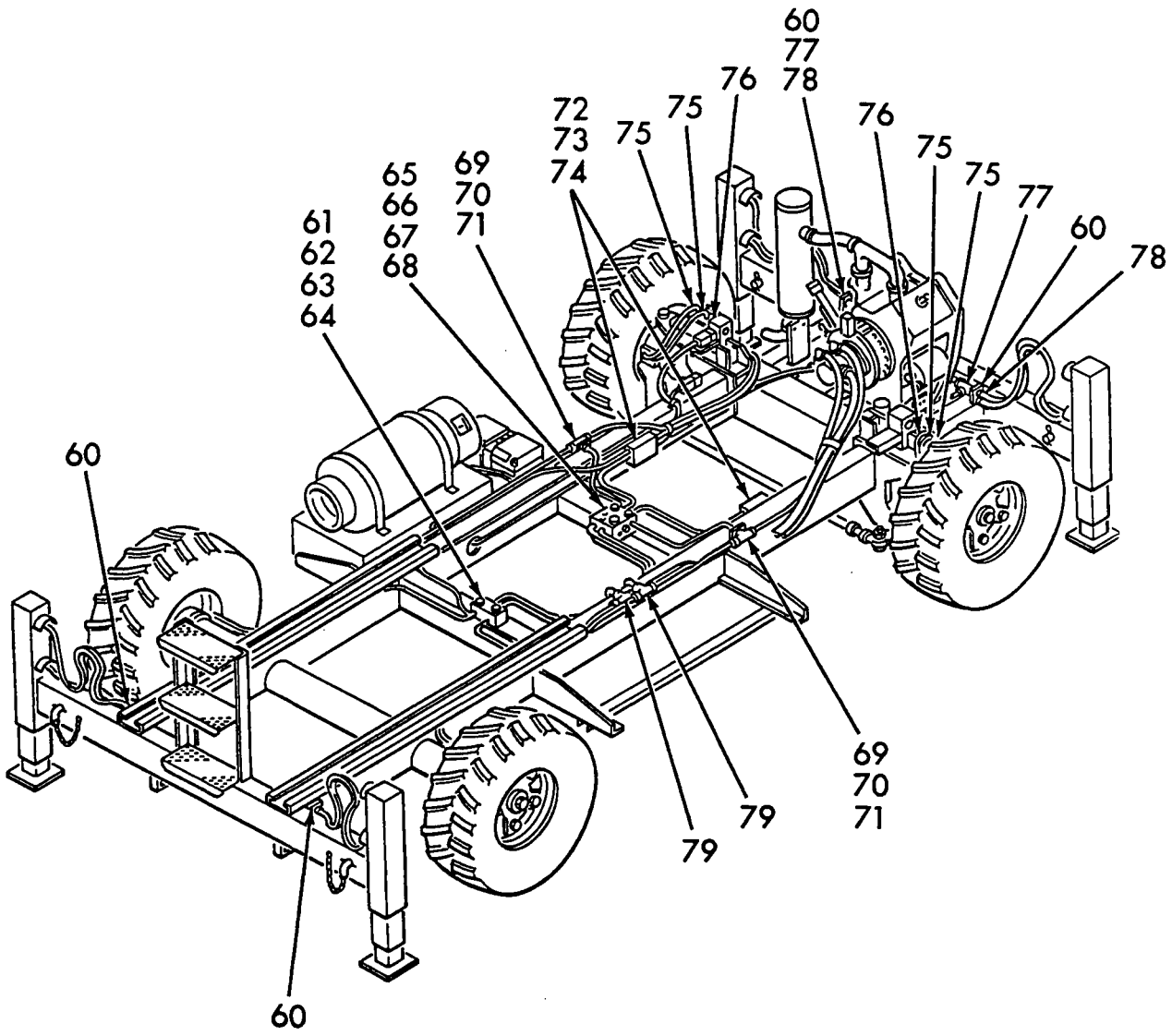
FRAME ASSEMBLY (MT31G)



FRAME ASSEMBLY (MT31G)



J

REV.

FRAME ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32603	ASSEMBLY, FRAME (See Sect. 2, Fig. 1 for NHA)	REF
2	32601	. WELDMENT, FRAME	1
3	32259	. ASSEMBLY, TIRE AND WHEEL (R.H.) (See Sect. 3, Fig. 2 for Details)	2
4	32166	. ASSEMBLY, TIRE AND WHEEL (L.H.) (See Sect. 3, Fig. 3 for Details)	2
5	32272	. ASSEMBLY, REAR DRIVE MOTOR (See Sect. 3, Fig. 4 for Details)	2
6	60521	. SCREW, CAP	8
7	63327	. WASHER, LOCK	8
8	32167	. HUB, DRIVE	2
9	65156	. NUT, WHEEL	12
10	486-C	. TANK, LPG	1
11	60324	. SCREW, CAP	4
12	63402	. WASHER, FLAT	4
13	160	. FILTER, FUEL	1
14	160-B	. HOSE, FUEL (12 FT)	AR
15	30285	. ASSEMBLY, FUEL TANK (See Sect. 3, Fig. 5 for Details)	1
16	60309	. SCREW, CAP	4
17	63401	. WASHER, FLAT	4
18	63301	. WASHER, LOCK	4
19	60701	. NUT, HEX	4
20	4030	. BATTERY (12 VOLT, 95 AMP) (See Vendor for more Information)	1
21	31238-L	. KIT, BATTERY CABLE	1
22	782	. BOX, BATTERY	1
23	16935	.. BELT	1

- ITEM NOT ILLUSTRATED

FRAME ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	60309	. SCREW, CAP	4
25	63401	. WASHER, FLAT	4
26	63301	. WASHER, LOCK	4
27	60701	. NUT, HEX	4
28	32194	. ARM, STEERING (L.H.)	1
29	60370	. SCREW, CAP	4
30	32222	. BRACKET, STEERING CYLINDER	1
31	60370	. SCREW, CAP	4
32	32246	. ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 6 for Details)	1
33	60353	. SCREW, CAP	2
34	63301	. WASHER, LOCK	2
35	20252	. PIN, STEERING	2
36	32170	. ARM, STEERING (R.H.)	1
37	60370	. SCREW, CAP	4
38	32648	. ASSEMBLY, TIE ROD (See Sect. 3, Fig. 7 for Details)	1
39	70173	. SWITCH, LIMIT	2
40	62708	. SCREW, MACHINE	4
41	70032	. LEVER, OPERATING	2
42	2806	. RELIEF, STRAIN	2
43	2808	. NUT, LOCK	2
44	764	. CLAMP, RUBBER	1
45	63654	. RIVET, POP	1
46	32250	. ASSEMBLY, MOTOR AND BRAKE (STEER) (See Sect. 3, Fig. 8 for Details)	2
47	60322	. SCREW, CAP	4

- ITEM NOT ILLUSTRATED

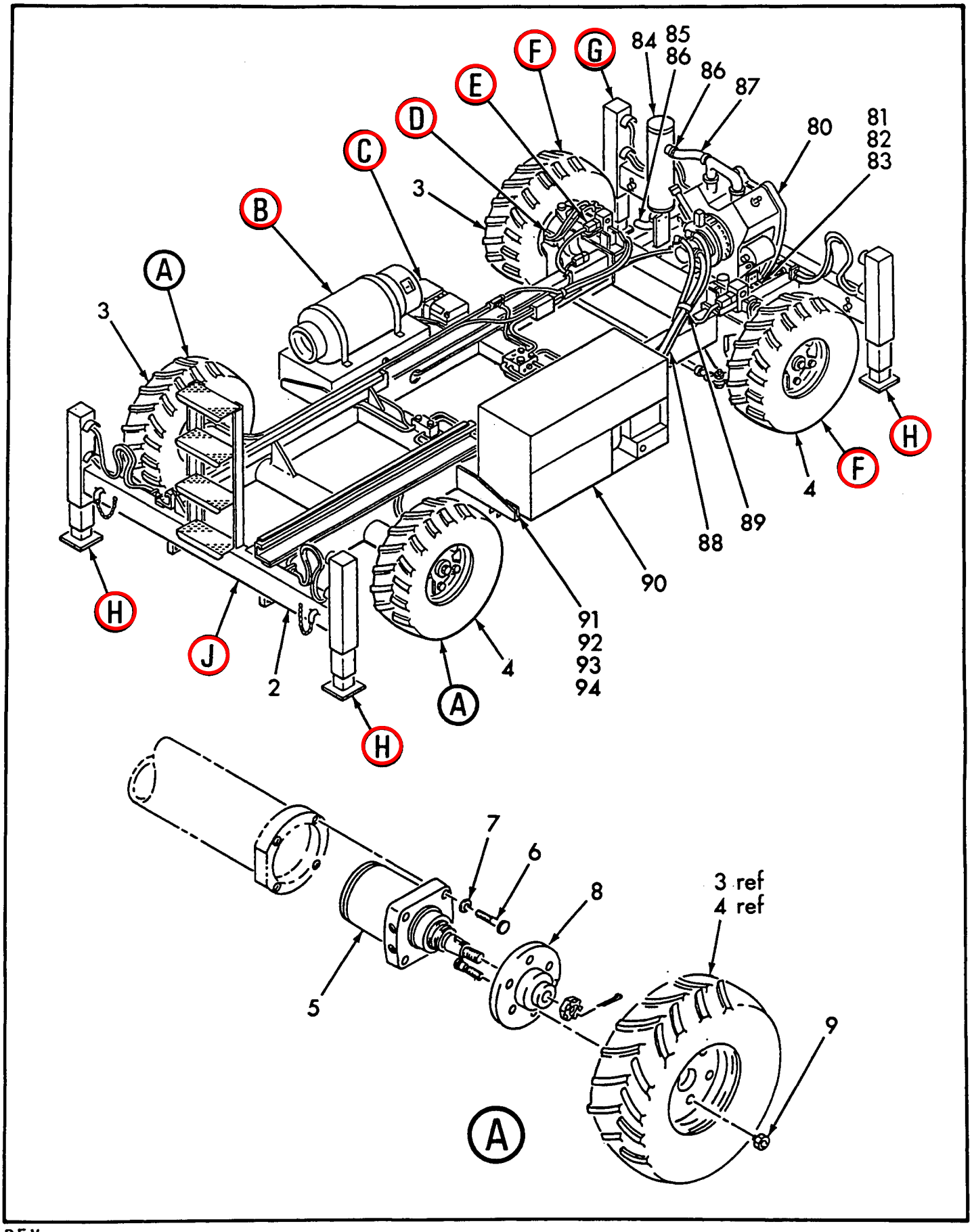
FRAME ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
48	63302	. WASHER, LOCK	4
49	32748	. WELDMENT, KING PIN	4
50	32167	. HUB, DRIVE	2
51	65156	. NUT, WHEEL	12
52	30915	. ASSEMBLY, HYDRAULIC OUTRIGGER (OPTIONAL ITEM ON MT31G) (See Sect. 3, Fig. 11 for Details)	1
53	29-B	. PIN	1
54	63654	. RIVET, POP	1
55	721	. PIN, COTTER	1
56	30910	. ASSEMBLY, HYDRAULIC OUTRIGGER (OPTIONAL ITEM ON MT31G) (See Sect. 3, Fig. 12 for Details)	3
57	29-B	. PIN	3
58	63654	. RIVET, POP	3
59	721	. PIN, COTTER	3
60	80011-05	. UNION, ELBOW BULKHEAD	4
61	32697	. ASSEMBLY, CHECK VALVE (See Sect. 3, Fig. 14 for Details)	1
62	60354	. SCREW, CAP	2
63	63319	. WASHER, LOCK	2
64	63403	. WASHER, FLAT	2
65	32274	. ASSEMBLY, DRIVE AND BRAKE VALVE (See Sect. 3, Fig. 15 for Details)	1
66	60361	. SCREW, CAP	2
67	63319	. WASHER, LOCK	2
68	60703	. NUT, HEX	2
69	80035-06	. TEE, BULKHEAD	2
70	60309	. SCREW, CAP	4

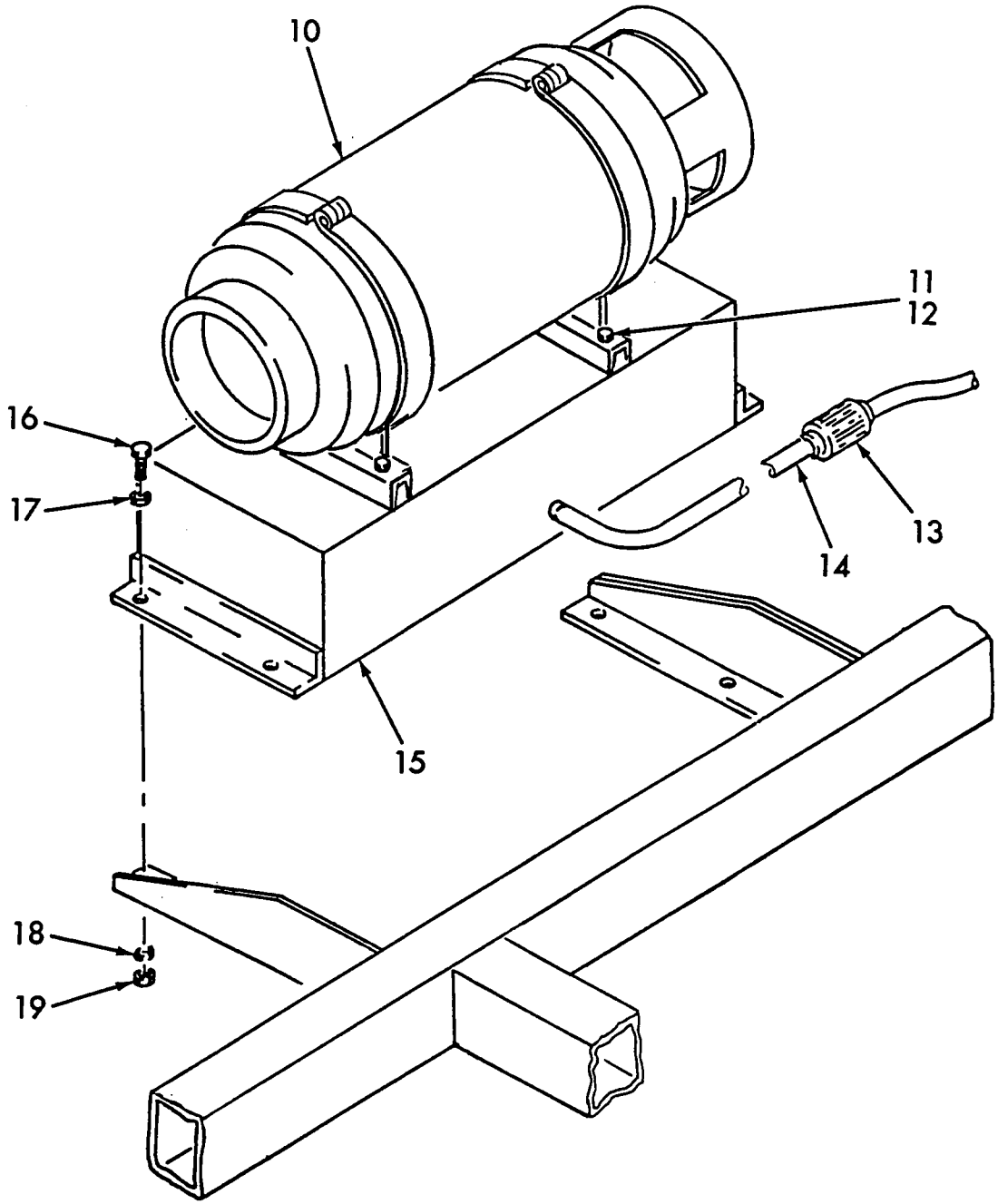
- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
71	63301	. WASHER, LOCK	4
72	32273	. ASSEMBLY, FLOW DIVIDER (See Sect. 3, Fig. 16 for Details)	2
73	60319	. SCREW, CAP	4
74	63301	. WASHER, LOCK	4
75	80011-06	. UNION, ELBOW BULKHEAD	4
76	80045-03	. UNION, BULKHEAD	2
77	80032-05	. TEE, BULKHEAD	2
78	80045-05	. UNION, BULKHEAD	2
79	80031-05	. TEE, UNION	2
80	32720	. ASSEMBLY, ENGINE AND PUMP (See Sect. 3, Fig. 17 for Details)	1
81	60308	. SCREW, CAP	4
82	63305	. WASHER, LOCK	4
83	60705	. NUT, HEX	4
84	65772	. MUFFLER	1
85	32515	. SPOUT, TAIL	1
86	65791	. CLAMP, MUFFLER	2
87	65885	. CONNECTOR, EXHAUST	1
88	81245	. HOSE, SUCTION	1
89	55	. CLAMP, HOSE	2
90	32738	. ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 19 for Details)	1
91	60309	. SCREW, CAP	4
92	63401	. WASHER, FLAT	4
93	63301	. WASHER, LOCK	4
94	60701	. NUT, HEX	4

FRAME ASSEMBLY (MT40G)



FRAME ASSEMBLY (MT40G)



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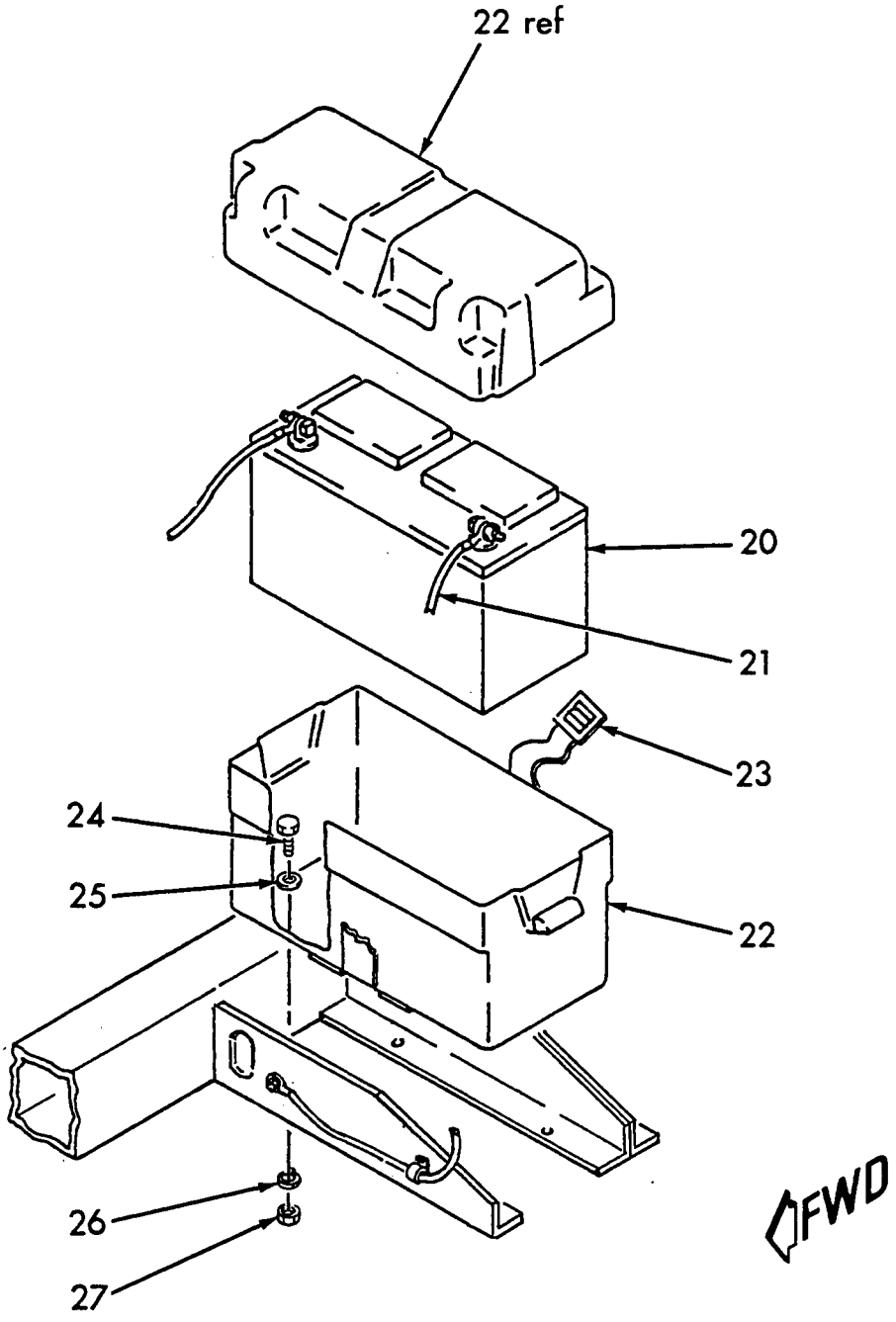
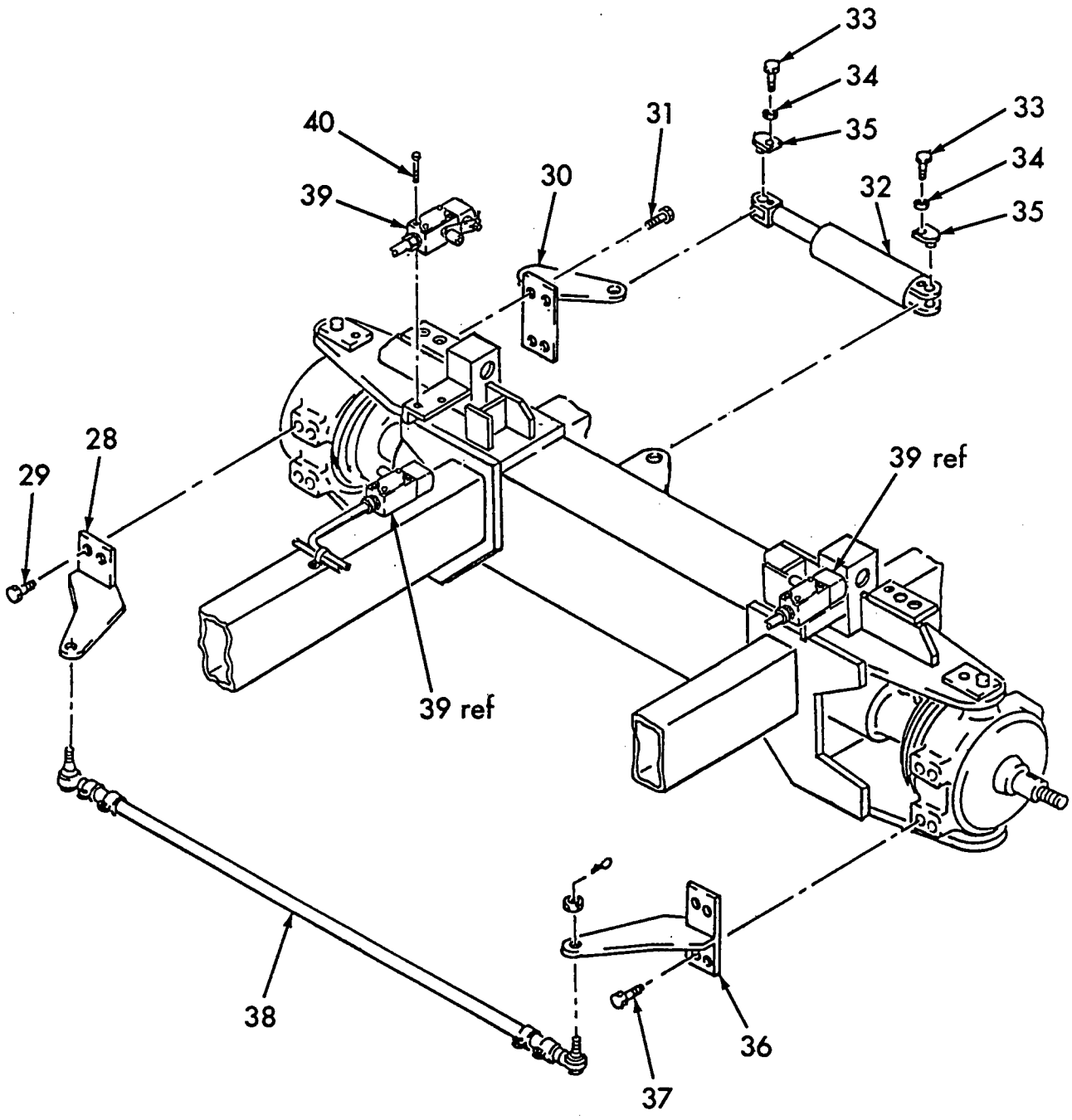
FRAME ASSEMBLY (MT40G)



FRAME ASSEMBLY (MT40G)



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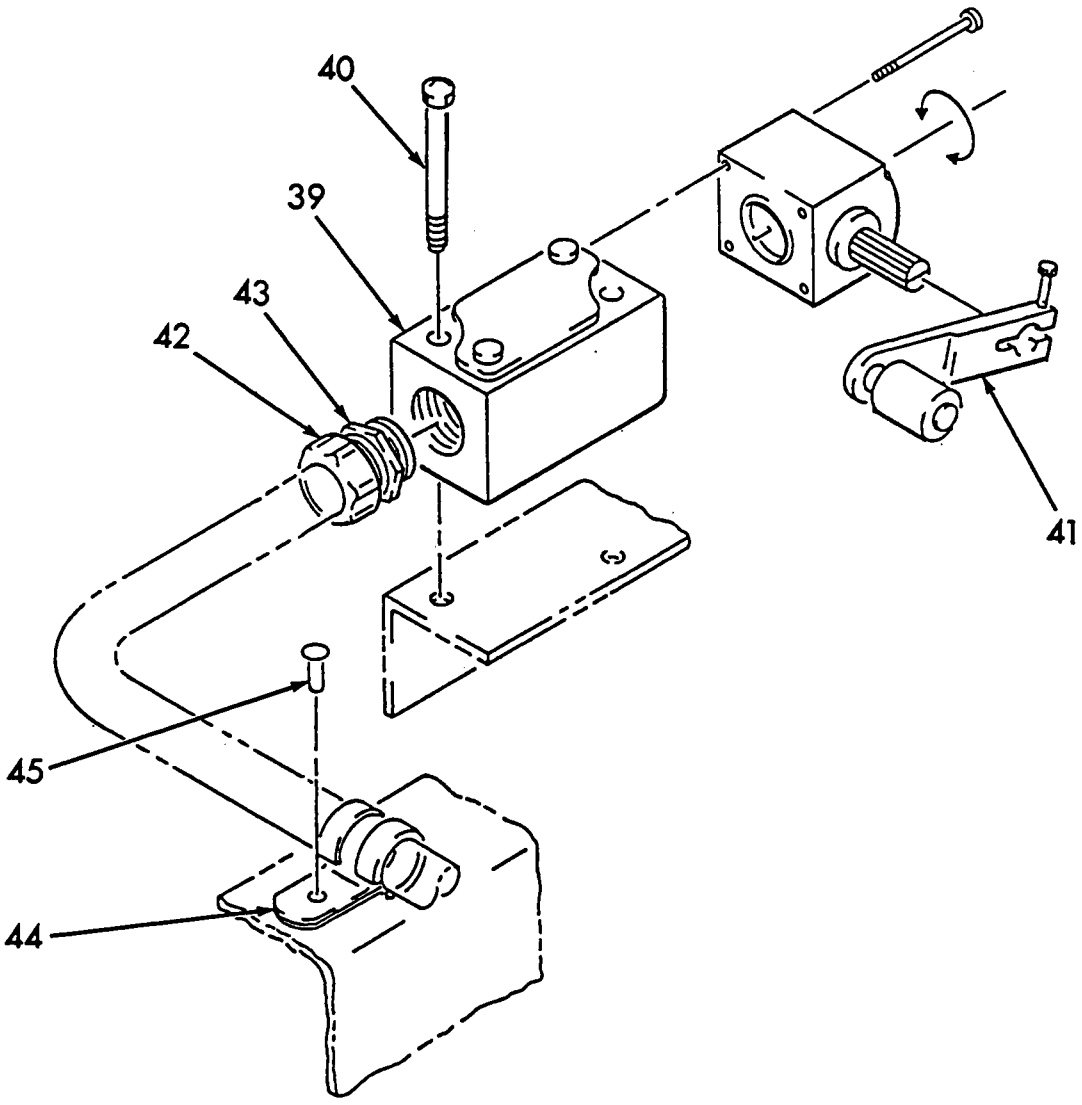
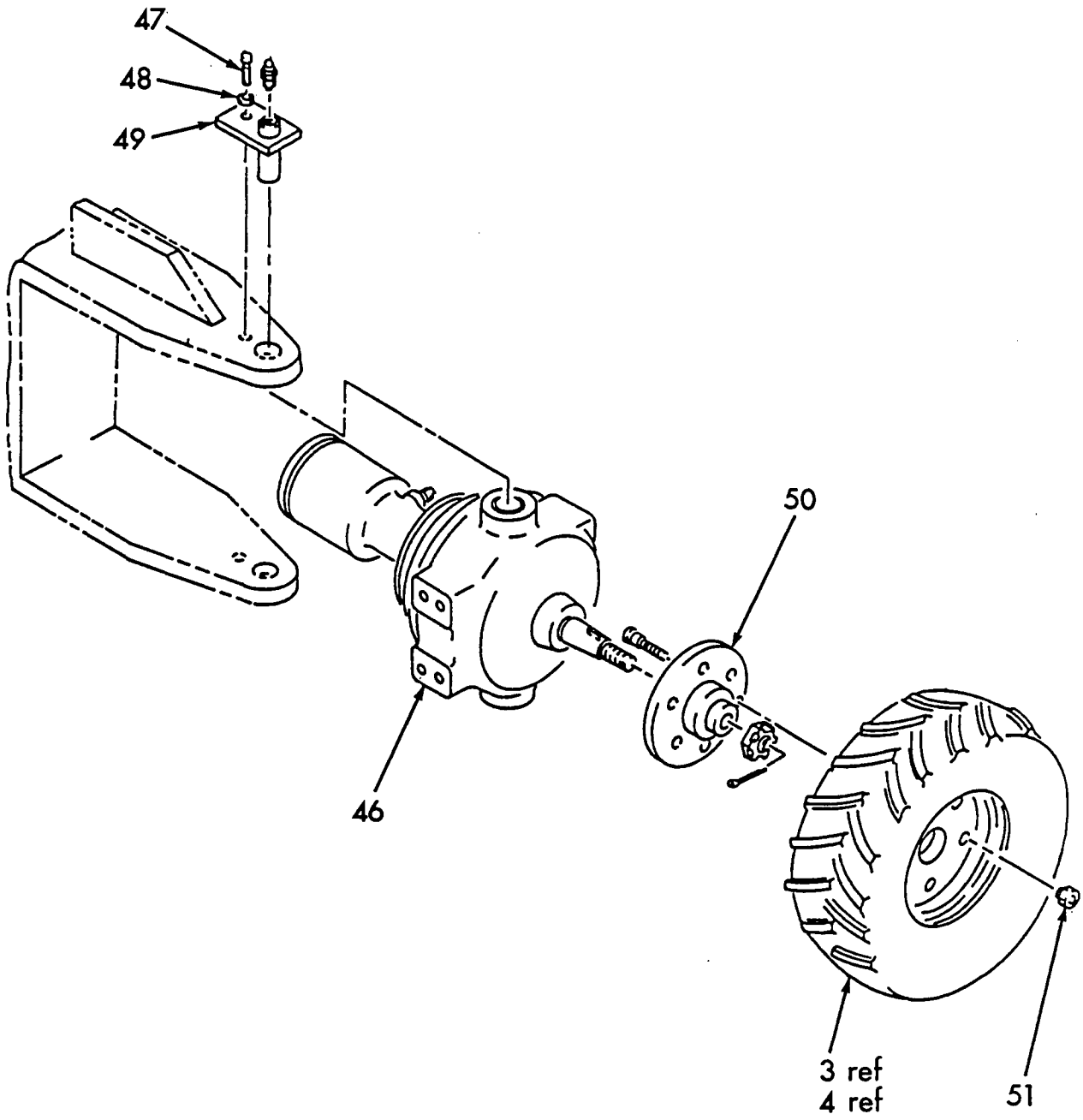
FRAME ASSEMBLY (MT40G)



E

FRAME ASSEMBLY (MT40G)



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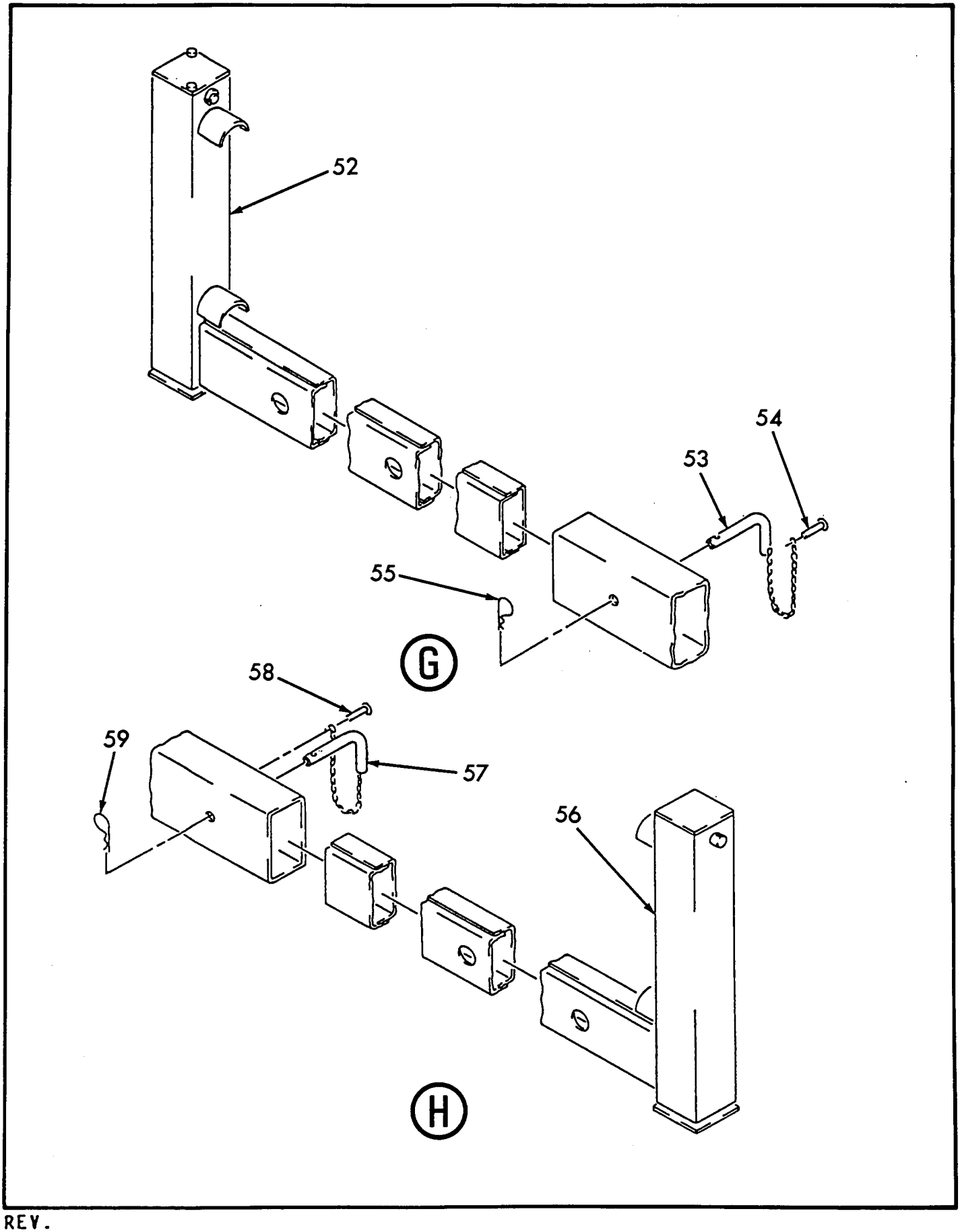
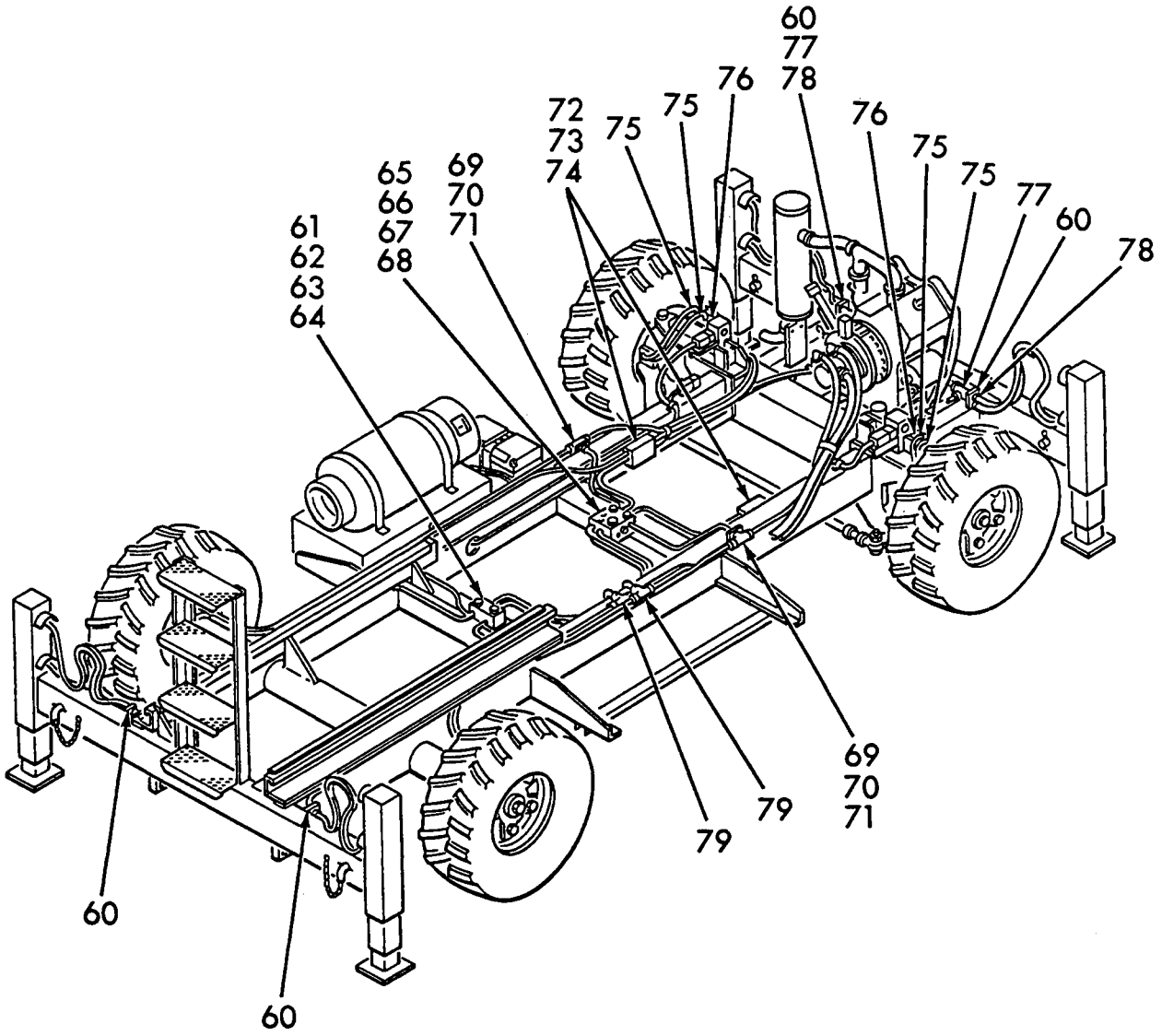
FRAME ASSEMBLY (MT40G)



FRAME ASSEMBLY (MT40G)



J

FRAME ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32602	ASSEMBLY, FRAME (See Sect. 2, Fig. 1A for NHA)	REF
2	32600	. WELDMENT, FRAME	1
3	32259	. ASSEMBLY, TIRE AND WHEEL (R.H.) (See Sect. 3, Fig. 2 for Details)	2
4	32166	. ASSEMBLY, TIRE AND WHEEL (L.H.) (See Sect. 3, Fig. 3 for Details)	2
5	32272	. ASSEMBLY, REAR DRIVE MOTOR (See Sect. 3, Fig. 4 for Details)	2
6	60521	. SCREW, CAP	8
7	63327	. WASHER, LOCK	8
8	32167	. HUB, DRIVE	2
9	65156	. NUT, WHEEL	12
10	486-C	. TANK, LPG	1
11	60324	. SCREW, CAP	4
12	63402	. WASHER, FLAT	4
13	160	. FILTER, FUEL	1
14	160-B	. HOSE, FUEL (12 FT)	AR
15	30285	. ASSEMBLY, FUEL TANK (See Sect. 3, Fig. 5 for Details)	1
16	60309	. SCREW, CAP	4
17	63401	. WASHER, FLAT	4
18	63301	. WASHER, LOCK	4
19	60701	. NUT, HEX	4
20	4030	. BATTERY (12 VOLT, 95 AMP) (See Vendor for more Information)	1
21	31238-L	. KIT, BATTERY CABLE	1
22	782	. BOX, BATTERY	1
23	16935	.. BELT	1

- ITEM NOT ILLUSTRATED

FRAME ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	60309	. SCREW, CAP	4
25	63401	. WASHER, FLAT	4
26	63301	. WASHER, LOCK	4
27	60701	. NUT, HEX	4
28	32194	. ARM, STEERING (L.H.)	1
29	60370	. SCREW, CAP	4
30	32222	. BRACKET, STEERING CYLINDER	1
31	60370	. SCREW, CAP	4
32	32246	. ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 6 for Details)	1
33	60353	. SCREW, CAP	2
34	63301	. WASHER, LOCK	2
35	20252	. PIN, STEERING	2
36	32170	. ARM, STEERING (R.H.)	1
37	60370	. SCREW, CAP	4
38	32648	. ASSEMBLY, TIE ROD (See Sect. 3, Fig. 7 for Details)	1
39	70173	. SWITCH, LIMIT	3
40	62708	. SCREW, MACHINE	6
41	70032	. LEVER, OPERATING	3
42	2806	. RELIEF, STRAIN	3
43	2808	. NUT, LOCK	3
44	764	. CLAMP, RUBBER	2
45	63654	. RIVET, POP	2
46	32250	. ASSEMBLY, MOTOR AND BRAKE (STEER) (See Sect. 3, Fig. 8 for Details)	2
47	60322	. SCREW, CAP	4

- ITEM NOT ILLUSTRATED

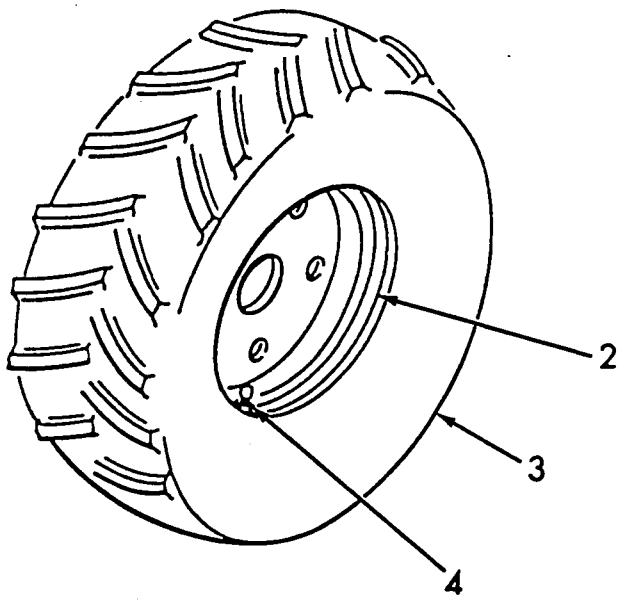
FRAME ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
48	63302	. WASHER, LOCK	4
49	32748	. WELDMENT, KING PIN	4
50	32167	. HUB, DRIVE	2
51	65156	. NUT, WHEEL	12
52	30915	. ASSEMBLY, HYDRAULIC OUTRIGGER (See Sect. 3, Fig. 11 for Details)	1
53	29-B	. PIN	1
54	63654	. RIVET, POP	1
55	721	. PIN, COTTER	1
56	30910	. ASSEMBLY, HYDRAULIC OUTRIGGER (See Sect. 3, Fig. 12 for Details)	3
57	29-B	. PIN	3
58	63654	. RIVET, POP	3
59	721	. PIN, COTTER	3
60	80011-05	. UNION, ELBOW BULKHEAD	4
61	32697	. ASSEMBLY, CHECK VALVE (See Sect. 3, Fig. 14 for Details)	1
62	60354	. SCREW, CAP	2
63	63319	. WASHER, LOCK	2
64	63403	. WASHER, FLAT	2
65	32274	. ASSEMBLY, DRIVE AND BRAKE VALVE (See Sect. 3, Fig. 15 for Details)	1
66	60361	. SCREW, CAP	2
67	63319	. WASHER, LOCK	2
68	60703	. NUT, HEX	2
69	80035-06	. TEE, BULKHEAD	2
70	60309	. SCREW, CAP	4
71	63301	. WASHER, LOCK	4

- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
72	32273	. ASSEMBLY, FLOW DIVIDER (See Sect. 3, Fig. 16 for Details)	2
73	60319	. SCREW, CAP	4
74	63301	. WASHER, LOCK	4
75	80011-06	. UNION, ELBOW BULKHEAD	4
76	80045-03	. UNION, BULKHEAD	2
77	80032-05	. TEE, BULKHEAD	2
78	80045-05	. UNION, BULKHEAD	2
79	80031-05	. TEE, UNION	2
80	32720	. ASSEMBLY, ENGINE AND PUMP (See Sect. 3, Fig. 17 for Details)	1
81	60308	. SCREW, CAP	4
82	63305	. WASHER, LOCK	4
83	60705	. NUT, HEX	4
84	65772	. MUFFLER	1
85	32515	. SPOUT, TAIL	1
86	65791	. CLAMP, MUFFLER	2
87	65885	. CONNECTOR, EXHAUST	1
88	81245	. HOSE, SUCTION	1
89	55	. CLAMP, HOSE	2
90	32738	. ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 19A for Details)	1
91	60309	. SCREW, CAP	4
92	63401	. WASHER, FLAT	4
93	63301	. WASHER, LOCK	4
94	60701	. NUT, HEX	4

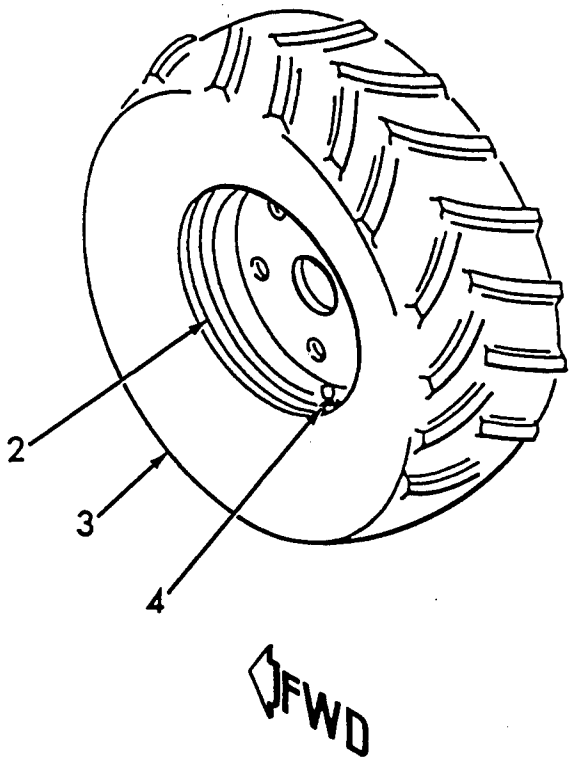
TIRE AND WHEEL ASSEMBLY (R.H.)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32259	ASSEMBLY, TIRE AND WHEEL (R.H.) (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32157	. WHEEL	1
3	30526	. TIRE	1
4	2252	. STEM, VALVE	1

REV.

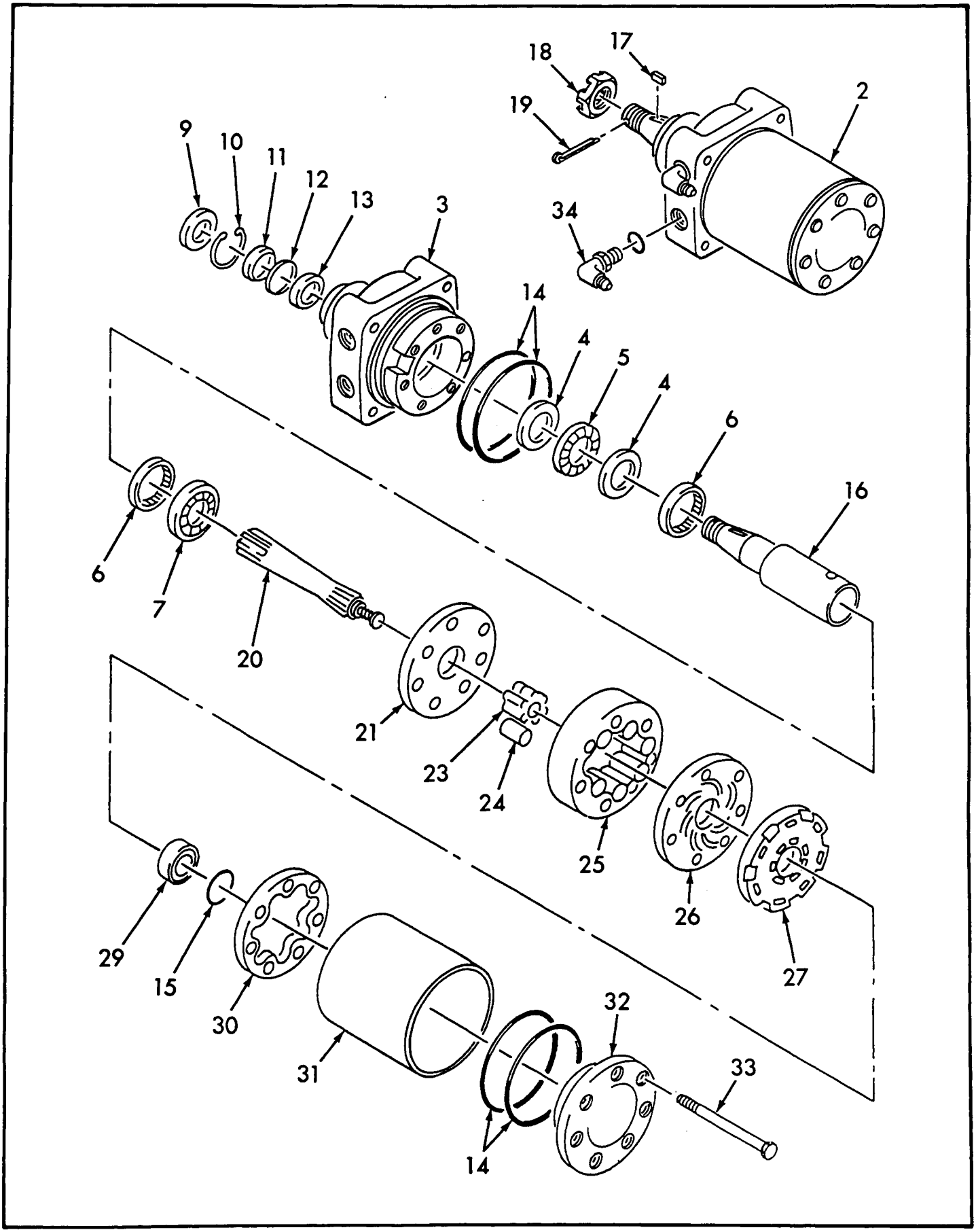
TIRE AND WHEEL ASSEMBLY (L.H.)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32166	ASSEMBLY, TIRE AND WHEEL (L.H.) (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32157	. WHEEL	1
3	30526	. TIRE	1
4	2252	. STEM, VALVE	1

REV.

REAR DRIVE MOTOR ASSEMBLY



REAR DRIVE MOTOR ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32272	ASSEMBLY, REAR DRIVE MOTOR (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	81113	. MOTOR, DRIVE	1
3		.. HOUSING	1
4		... WASHER, THRUST	2
5		... BEARING, THRUST	1
6		... BEARING	2
7		... BEARING, THRUST	1
-8	66162	.. KIT, SEAL	1
9		... SEAL	1
10		... RING, RETAINER	1
11		... WASHER, BACK-UP	1
12		... WASHER	1
13		... SEAL, SHAFT	1
14		... RING, SEAL	4
15		... RING, SEAL (COMMUTATOR)	1
16	67980	.. SHAFT, COUPLING	1
17		.. KEY	1
18		.. NUT, CASTLE	1
19		.. PIN, COTTER	1
20	67979	.. LINK, DRIVE	1
21		.. PLATE, WEAR	1
-22		.. SET, ROTOR (MATCHED SET)	1
23		... ROTOR	1
24		... VANE	7
25		... STATOR	1
26		.. PLATE, MANIFOLD	1

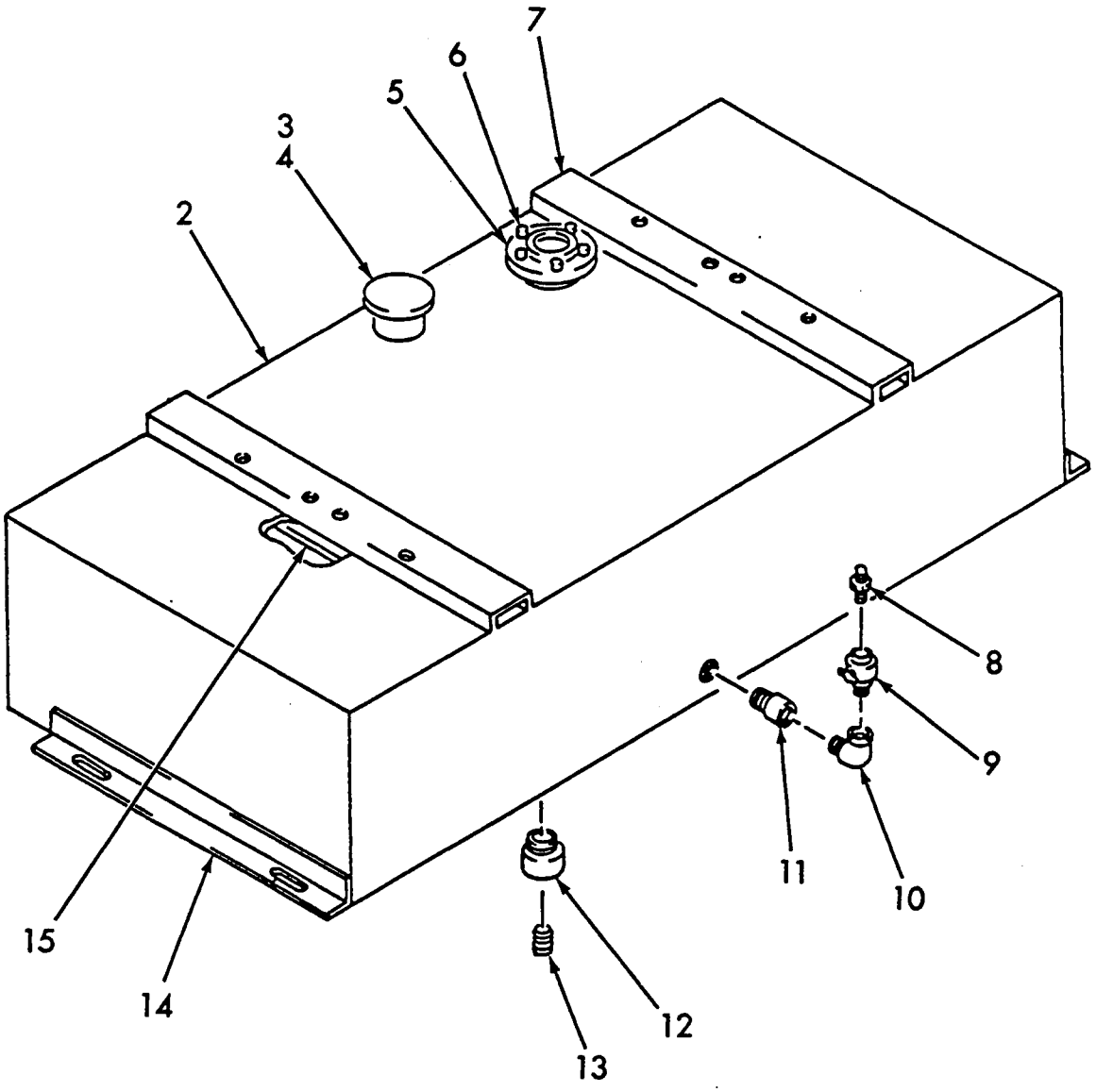
- ITEM NOT ILLUSTRATED

REAR DRIVE MOTOR ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
27		.. MANIFOLD	1
-28		.. SET, COMMUTATOR	1
29		... COMMUTATOR	1
30		... RING, COMMUTATOR	1
31		.. SLEEVE	1
32		.. COVER, END	1
33		.. BOLT, SPECIAL	7
34	80012-13	. ELBOW, STRAIGHT THREAD	2

- ITEM NOT ILLUSTRATED

FUEL TANK ASSEMBLY

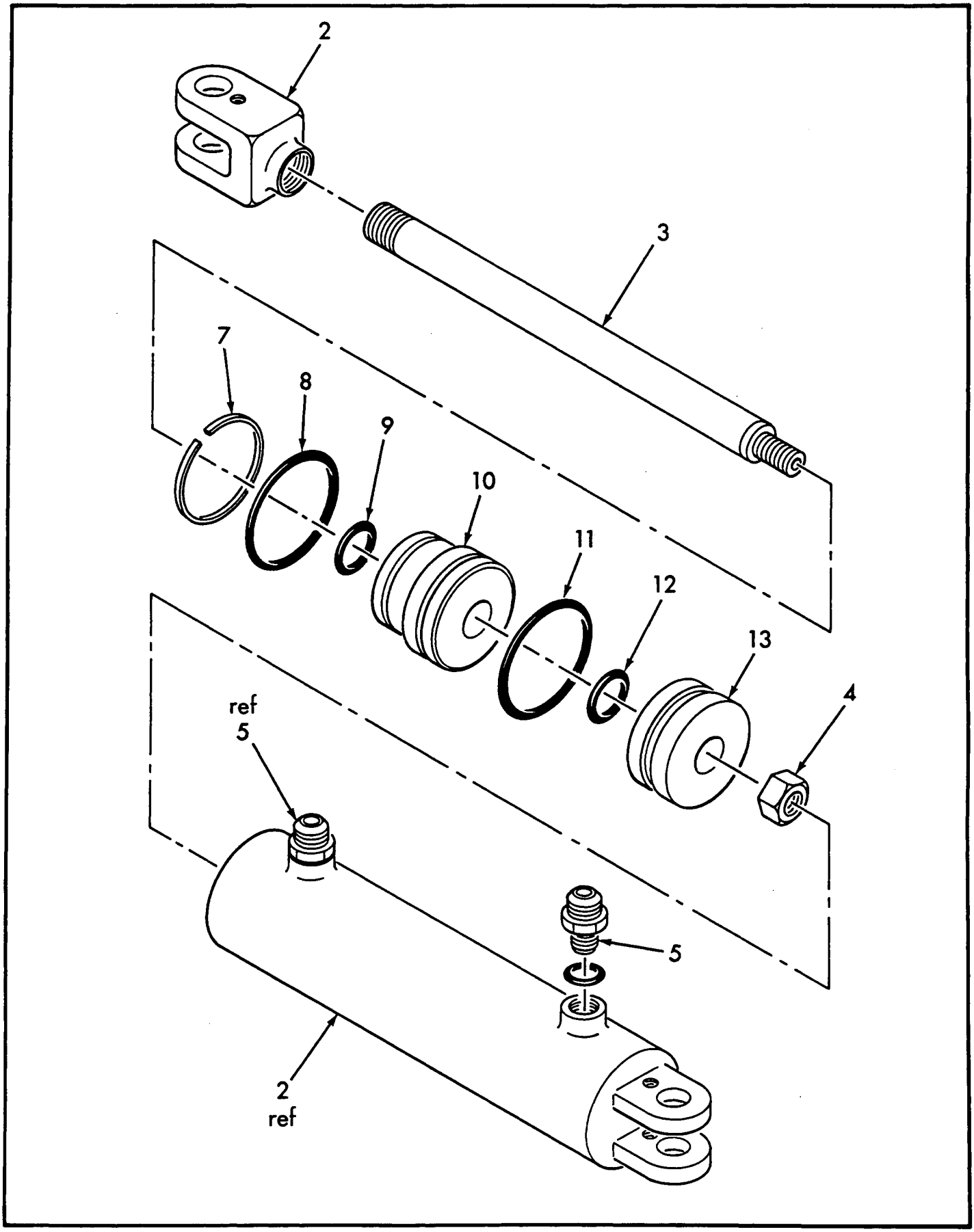


FUEL TANK ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30285	ASSEMBLY, FUEL TANK (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32538	. WELDMENT, TANK	1
3	3005	. ASSEMBLY, BREATHER CAP	1
-4		.. FILTER, ELEMENT	1
5	3017	. GAUGE, LIQUID LEVEL	1
6	61729	. SCREW	5
7	37112	. BAR CHANNEL	2
8	80001-04	. CONNECTOR, MALE	1
9	12000	. VALVE, NEEDLE	1
10	80021-03	. ELBOW, STREET	1
11	54807	. COUPLING HALF	1
12	54806	. COUPLING HALF	1
13	3027	. PLUG, MAGNETIC DRAIN	1
14	37110	. BAR ANGLE	2
15	37111	. BAR ANGLE	2

- ITEM NOT ILLUSTRATED

STEERING CYLINDER ASSEMBLY

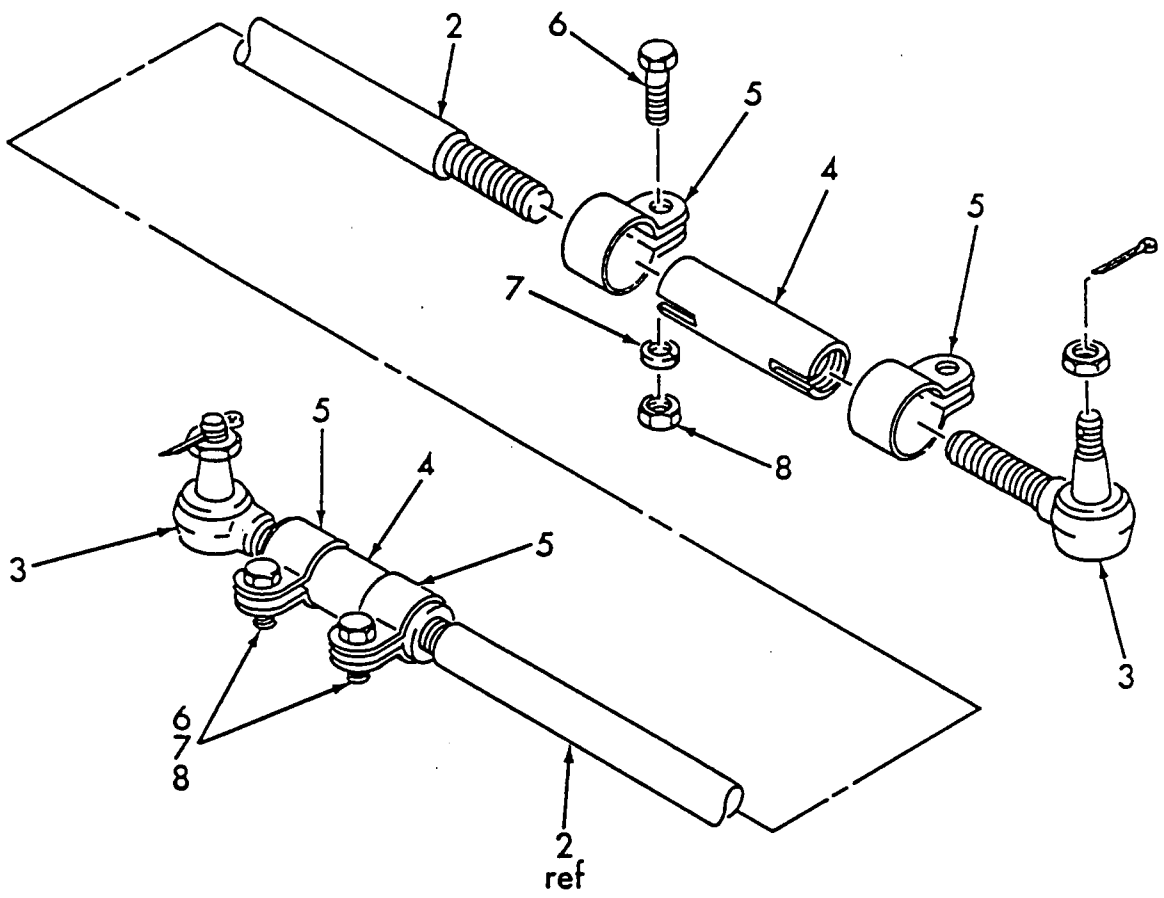


STEERING CYLINDER ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32246	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32223	. CYLINDER, STEERING	1
3	67238	. ROD, CHROME PLATED ASSEMBLY	1
4		. NUT, LOCK	1
5	81149	. ADAPTER (SAE O-RING)	2
-6	66861	.. KIT, SEAL	1
7		... WASHER, BACKUP	1
8		... "O" RING	1
9		... "O" RING	1
10	67195	... GLAND, HEAD	1
11		... "O" RING	1
12		... "O" RING	1
13	67194	... PISTON	1

- ITEM NOT ILLUSTRATED

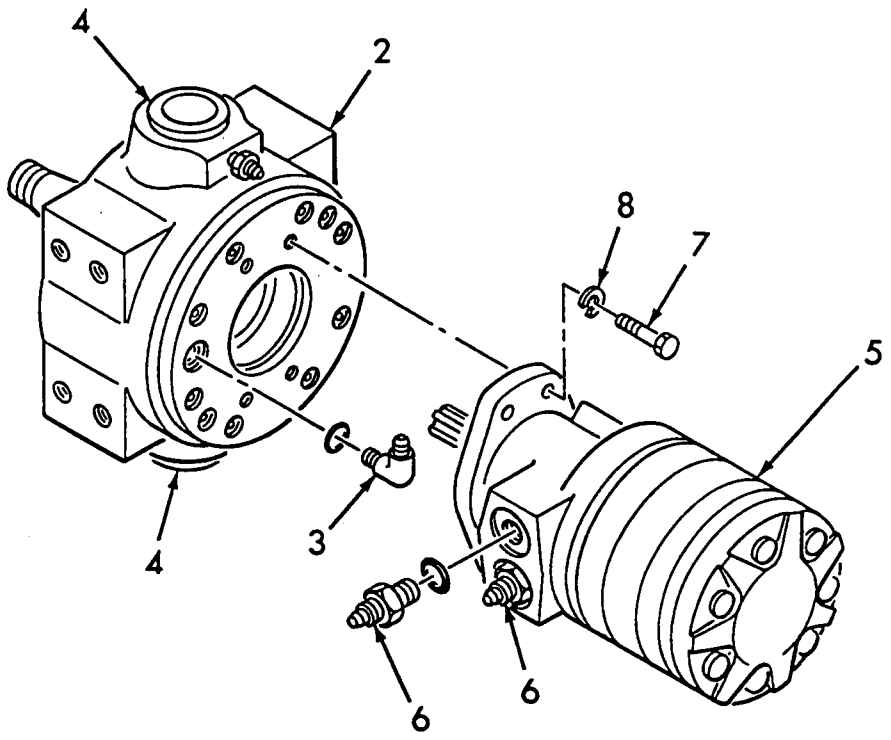
TIE ROD ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32648	ASSEMBLY, TIE ROD (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32647	. TIE ROD	1
3	66037	. TIE ROD END	2
4	32212	. TURN BUCKLE	2
5	66239	. CLAMP	4
6	60415	. SCREW, CAP	4
7	63303	. WASHER, LOCK	4
8	60803	. NUT, HEX	4

REV.

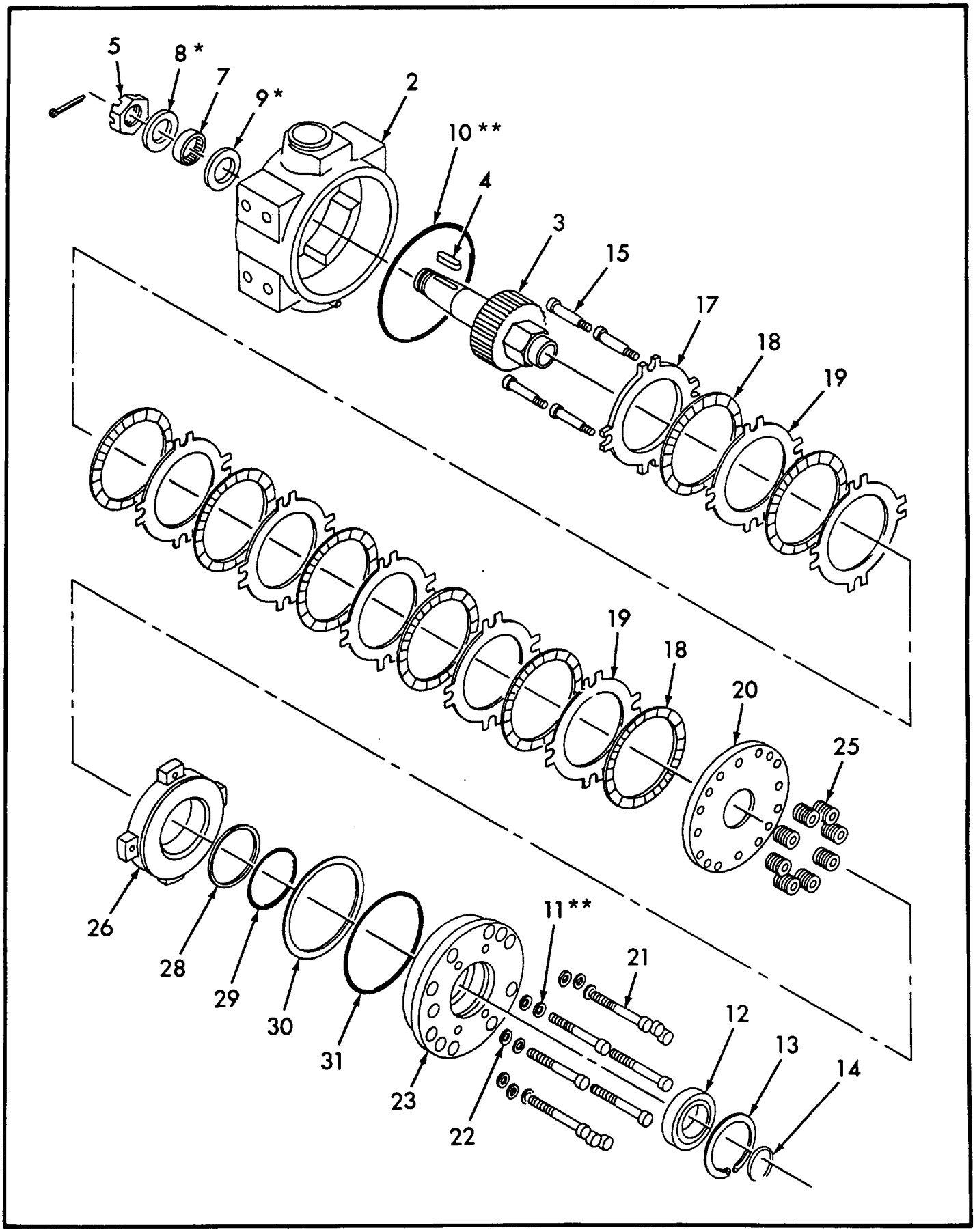
DRIVE MOTOR & BRAKE ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32250	ASSEMBLY, DRIVE MOTOR & BRAKE (See Sect. 3, Fig. 1 thru 1A for NHA)	REF
2	81116	. BRAKE, MULTIPLE DISC (BEFORE FEB. 1989) (See Sect. 3, Fig. 9 for Details)	1
2	81289	. BRAKE, MULTIPLE DISC (AFTER FEB. 1989) (See Sect. 3, Fig. 9A for Details)	1
3	80012-03	. ELBOW, STRAIGHT THREAD	1
4	67638	. BUSHING	2
5	81114	. MOTOR, DRIVE (STEER)(BEFORE FEB. 1989) (See Sect. 3, Fig. 10 for Details)	1
5	81271	. MOTOR, DRIVE (STEER)(AFTER FEB. 1989) (See Sect. 3, Fig. 10A for Details)	1
6	80004-13	. CONNECTOR, STRAIGHT THREAD	2
7	60622	. SCREW, CAP	4
8	63327	. WASHER, LOCK	4

REV.

MULTIPLE DISC BRAKE
(BEFORE FEB. 1989)



REV.

MULTIPLE DISC BRAKE
(BEFORE FEB. 1989)

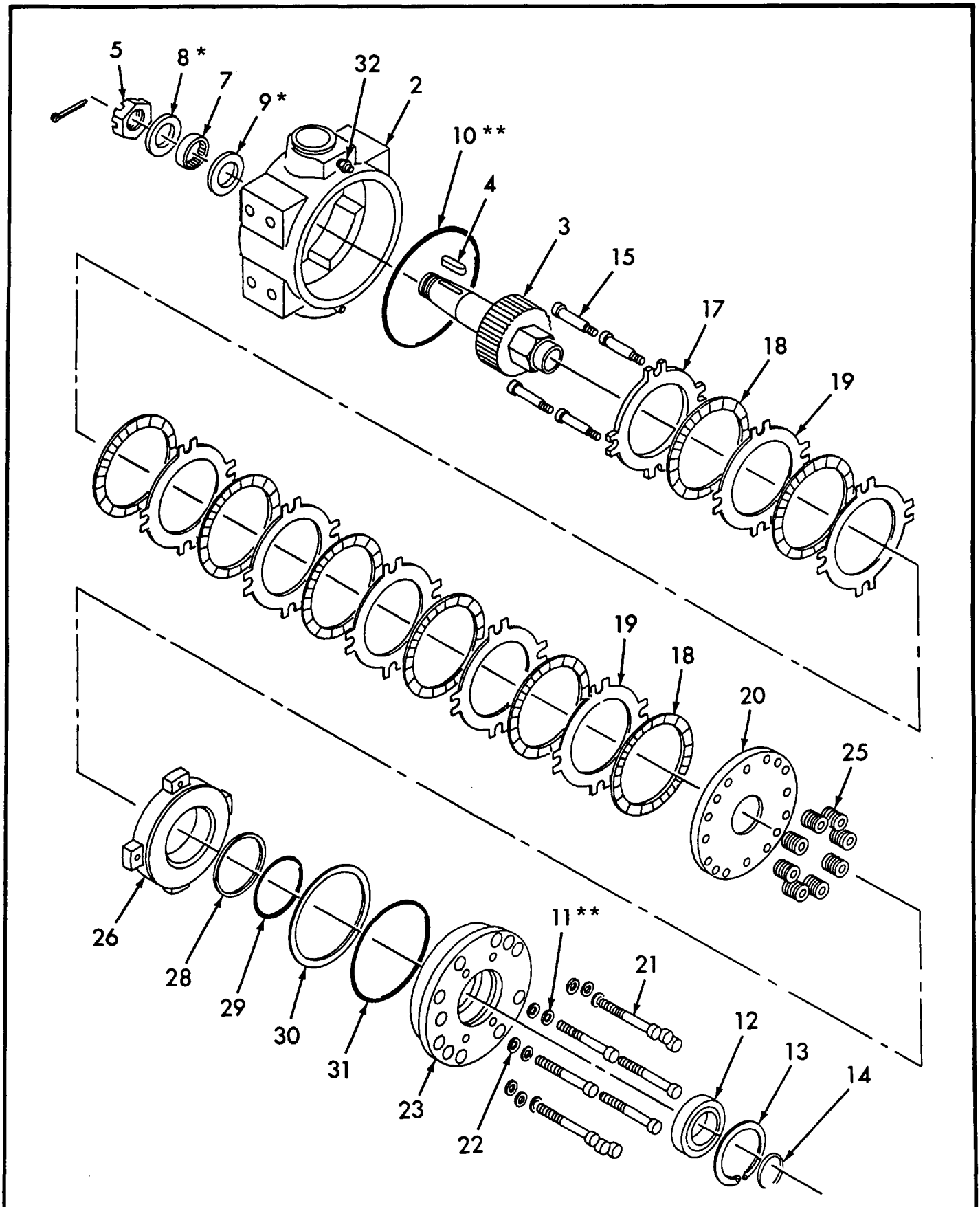
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81116	BRAKE, MULTIPLE DISC (See Sect. 3, Fig. 8 for NHA)	REF
2		. HOUSING, TRUNNION	1
3		. ASSEMBLY, SPLINE SHAFT	1
4		. KEY	1
5		. NUT, CASTLE	1
-6	67659	. KIT, BEARING	1
7		.. BEARING, NEEDLE	1
8		.. SEAL*	1
9		.. SEAL*	1
10		.. O-RING**	1
11		.. WASHER, SEALING**	10
12		.. BEARING	1
13		. RING, RETAINING	1
14		. RING, RETAINING	1
15		. BOLT, SHOULDER (TENSION PIN)	4
-16	67646	. KIT, LINING	1
17		.. DISC, PRIMARY	1
18		.. DISC, ROTOR	8
19		.. DISC, STATOR	7
10		.. O-RING**	1
11		.. WASHER, SEALING**	1
20		. PLATE, SPRING	1
21		. SCREW, CAP (ASSEMBLY BOLT)	10
22		. WASHER, FLAT	10
		NOTE: *COMES IN BEARING KIT & SEAL KIT **COMES WITH ALL KITS	

MULTIPLE DISC BRAKE
(BEFORE FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23		. PLATE, PRESSURE	1
-24	67653	. KIT, SPRING	1
25		.. SPRING - RED	10
10		.. O-RING**	1
11		.. WASHER, SEALING**	10
26		. PISTON	1
-27	66971	. KIT, SEAL	1
28		.. RING, BACK-UP (I.D.)	1
29		.. O-RING (I.D.)	1
30		.. RING, BACK-UP (O.D.)	1
31		.. O-RING (O.D.)	1
8		.. SEAL*	1
9		.. SEAL*	1
10		.. O-RING**	1
11		.. WASHER, SEALING**	10

NOTE:
*COMES IN BEARING KIT & SEAL KIT
**COMES WITH ALL KITS

MULTIPLE DISC BRAKE
(AFTER FEB. 1989)



REV.

MULTIPLE DISC BRAKE
(AFTER FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81289	BRAKE, MULTIPLE DISC (See Sect. 3, Fig. 8 for NHA)	REF
2		. HOUSING, TRUNNION	1
3		. ASSEMBLY, SPLINE SHAFT	1
4		. KEY	1
5		. NUT, CASTLE	1
-6	67659	. KIT, BEARING	1
7		.. BEARING, NEEDLE	1
8		.. SEAL*	1
9		.. SEAL*	1
10		.. O-RING**	1
11		.. WASHER, SEALING**	10
12		.. BEARING	1
13		. RING, RETAINING	1
14		. RING, RETAINING	1
15		. BOLT, SHOULDER (TENSION PIN)	4
-16	67646	. KIT, LINING	1
17		.. DISC, PRIMARY	1
18		.. DISC, ROTOR	8
19		.. DISC, STATOR	7
10		.. O-RING**	1
11		.. WASHER, SEALING**	1
20		. PLATE, SPRING	1
21		. SCREW, CAP (ASSEMBLY BOLT)	10
22		. WASHER, FLAT	10
		NOTE: *COMES IN BEARING KIT & SEAL KIT **COMES WITH ALL KITS	

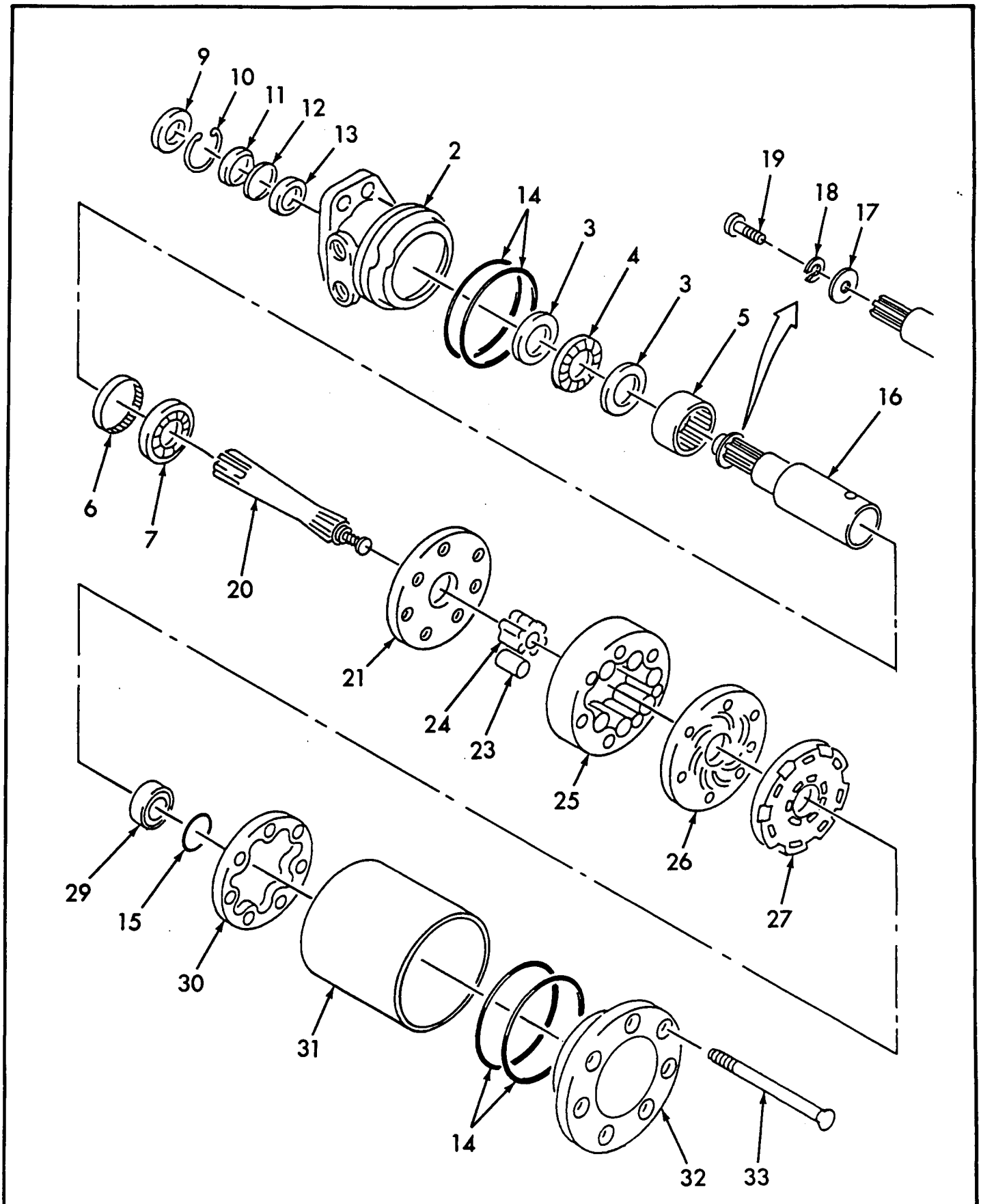
MULTIPLE DISC BRAKE
(AFTER FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
23		. PLATE, PRESSURE	1
-24	67653	. KIT, SPRING	1
25		.. SPRING - RED	10
10		.. O-RING**	1
11		.. WASHER, SEALING**	10
26		. PISTON	1
-27	66971	. KIT, SEAL	1
28		.. RING, BACK-UP (I.D.)	1
29		.. O-RING (I.D.)	1
30		.. RING, BACK-UP (O.D.)	1
31		.. O-RING (O.D.)	1
8		.. SEAL*	1
9		.. SEAL*	1
10		.. O-RING**	1
11		.. WASHER, SEALING**	10
32		. FITTING	1

NOTE:
*COMES IN BEARING KIT & SEAL KIT
**COMES WITH ALL KITS

- ITEM NOT ILLUSTRATED

DRIVE MOTOR (STEER)
(BEFORE FEB. 1989)



DRIVE MOTOR (STEER)
(BEFORE FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81114	MOTOR, DRIVE (STEER) (See Sect. 3, Fig. 8 for NHA)	REF
2		. HOUSING	1
3		.. WASHER, THRUST	2
4		.. BEARING, THRUST	1
5		.. BEARING	1
6		.. BEARING	1
7		.. BEARING, THRUST	1
-8	3036-A	. KIT, SEAL	1
9		.. SEAL	5
10		.. RING, RETAINING	1
11		.. WASHER, BACK-UP	1
12		.. WASHER	1
13		.. SEAL	1
14		.. RING, SEAL	4
15		.. RING, SEAL	1
16		. SHAFT, COUPLING	1
17		. WASHER	1
18		. WASHER, LOCK	1
19		. BOLT	1
20	67979	. LINK, DRIVE	1
21		. PLATE, WEAR	1
-22		. SET, ROTOR (MATCHED SET)	1
23		.. VANE	7
24		.. ROTOR	1
25		.. STATOR	1

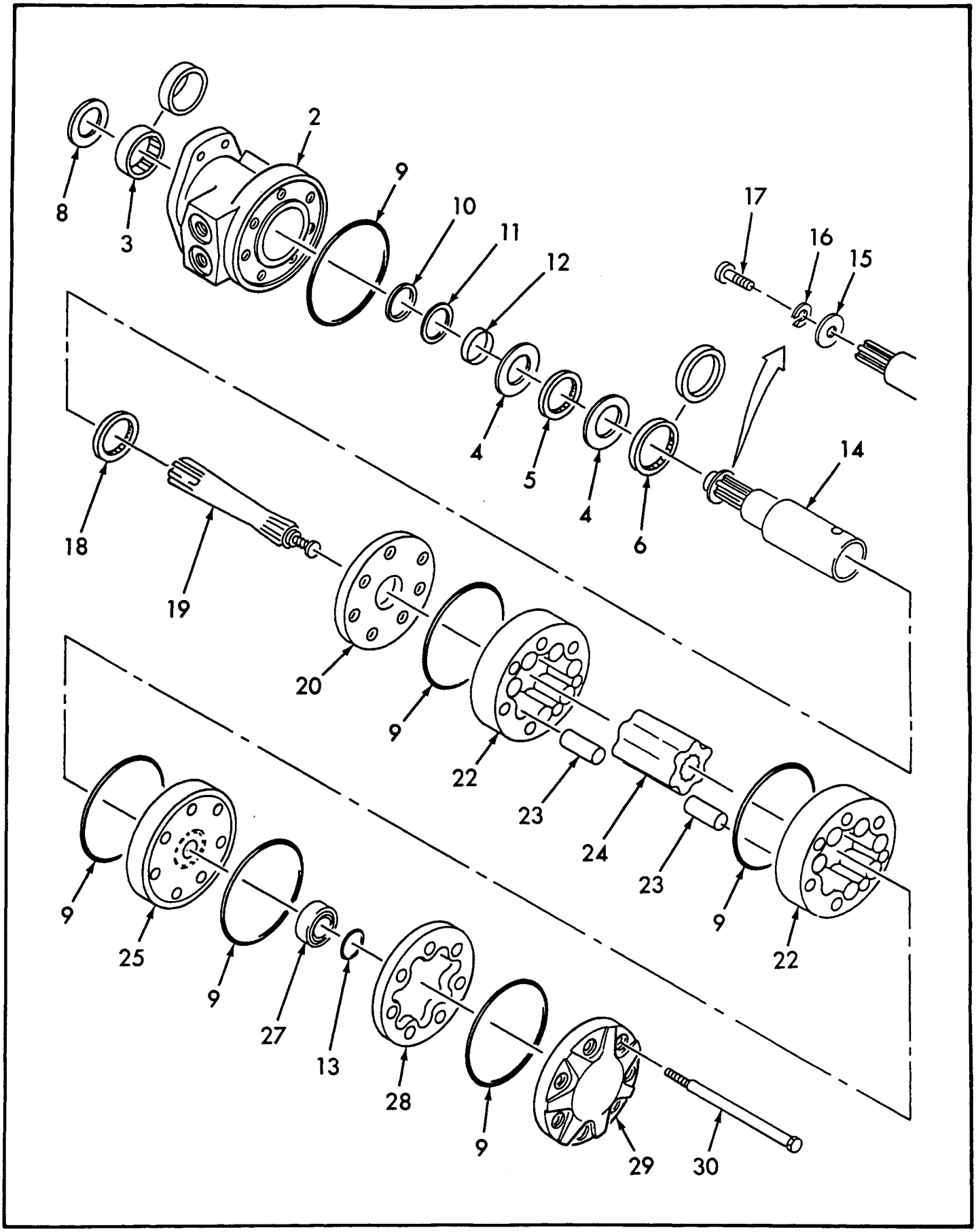
- ITEM NOT ILLUSTRATED

DRIVE MOTOR (STEER)
(BEFORE FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26		. PLATE, MANIFOLD	1
27		. MANIFOLD	1
-28		. SET, COMMUTATOR (MATCHED SET)	1
29		.. COMMUTATOR	1
30		.. RING, COMMUTATOR	1
31		. SLEEVE	1
32		. COVER, END	1
33		. BOLT, SPECIAL	7

- ITEM NOT ILLUSTRATED

DRIVE MOTOR (STEER)
(AFTER FEB. 1989)



DRIVE MOTOR (STEER)
(AFTER FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81271	MOTOR, DRIVE (STEER) (See Sect. 3, Fig. 8 for NHA)	REF
2		. HOUSING	1
3		.. BEARING/BUSHING, OUTER	1
4		.. WASHER, THRUST	2
5		.. BEARING, THRUST	1
6		.. BEARING/BUSHING, INNER	1
-7	67689	. KIT, SEAL	1
8		.. SEAL, DIRT & WATER	1
9		.. RING, SEAL	5
10		.. WASHER, BACK-UP	1
11		.. WASHER, BACK-UP	1
12		.. SEAL	1
13		.. RING, COMMUTATOR SEAL	1
14	67702	. SHAFT, COUPLING	1
15		. WASHER	1
16		. WASHER, LOCK	1
17		. BOLT	1
18		. BEARING, THRUST	1
19	67696	. LINK, DRIVE	1
20		. PLATE, WEAR	1
-21		. SET, ROTOR (MATCHED)	1
22		.. STATOR (HALF)	2
23		.. VANE	14
24		.. ROTOR	1
25		. MANIFOLD	1

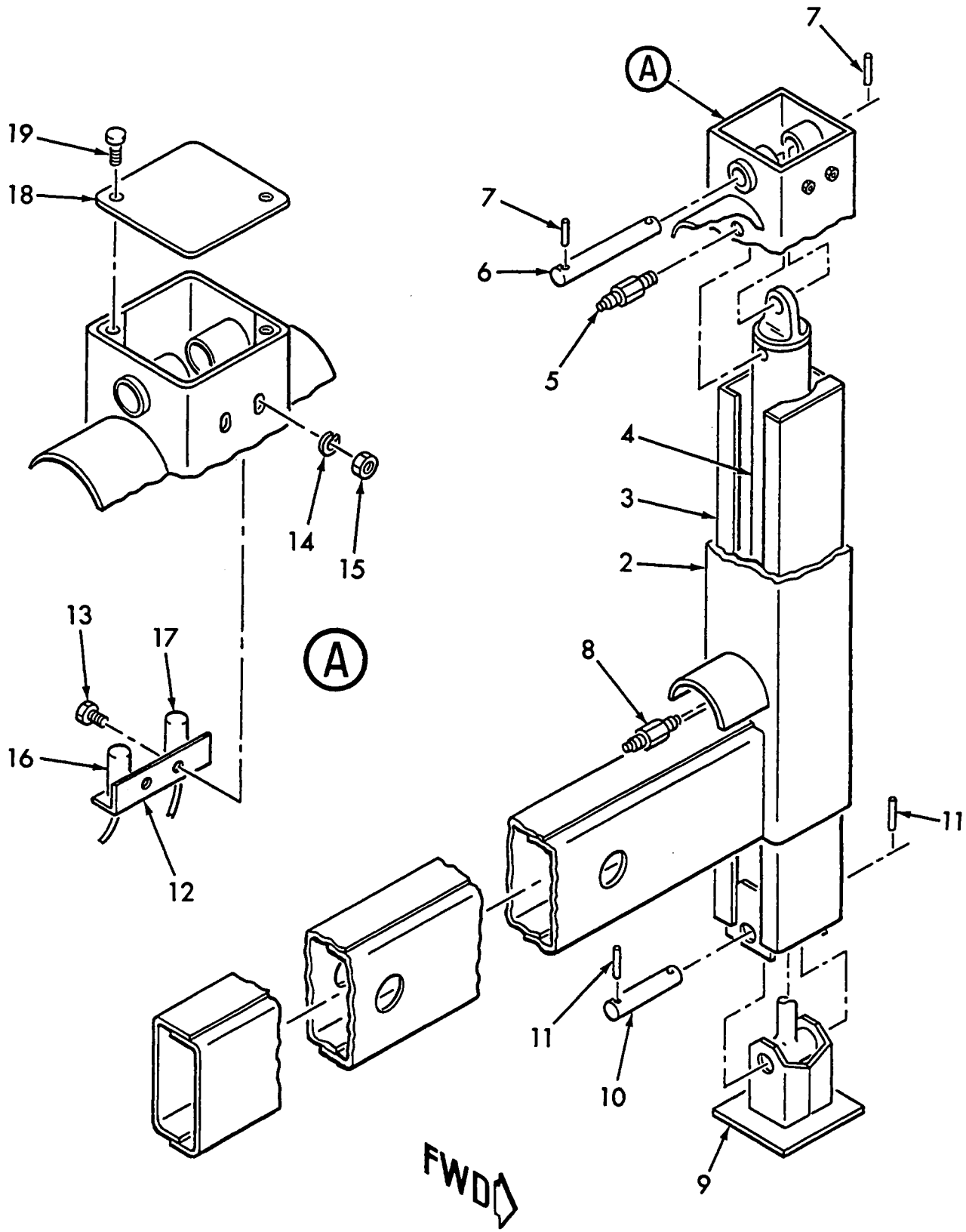
- ITEM NOT ILLUSTRATED

DRIVE MOTOR (STEER)
(AFTER FEB. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-26		. ASSEMBLY, COMMUTATOR	1
27		.. COMMUTATOR	1
28		.. RING, COMMUTATOR	1
29		. COVER, END	1
30		. BOLT, SPECIAL	7

- ITEM NOT ILLUSTRATED

HYDRAULIC OUTRIGGER ASSEMBLY

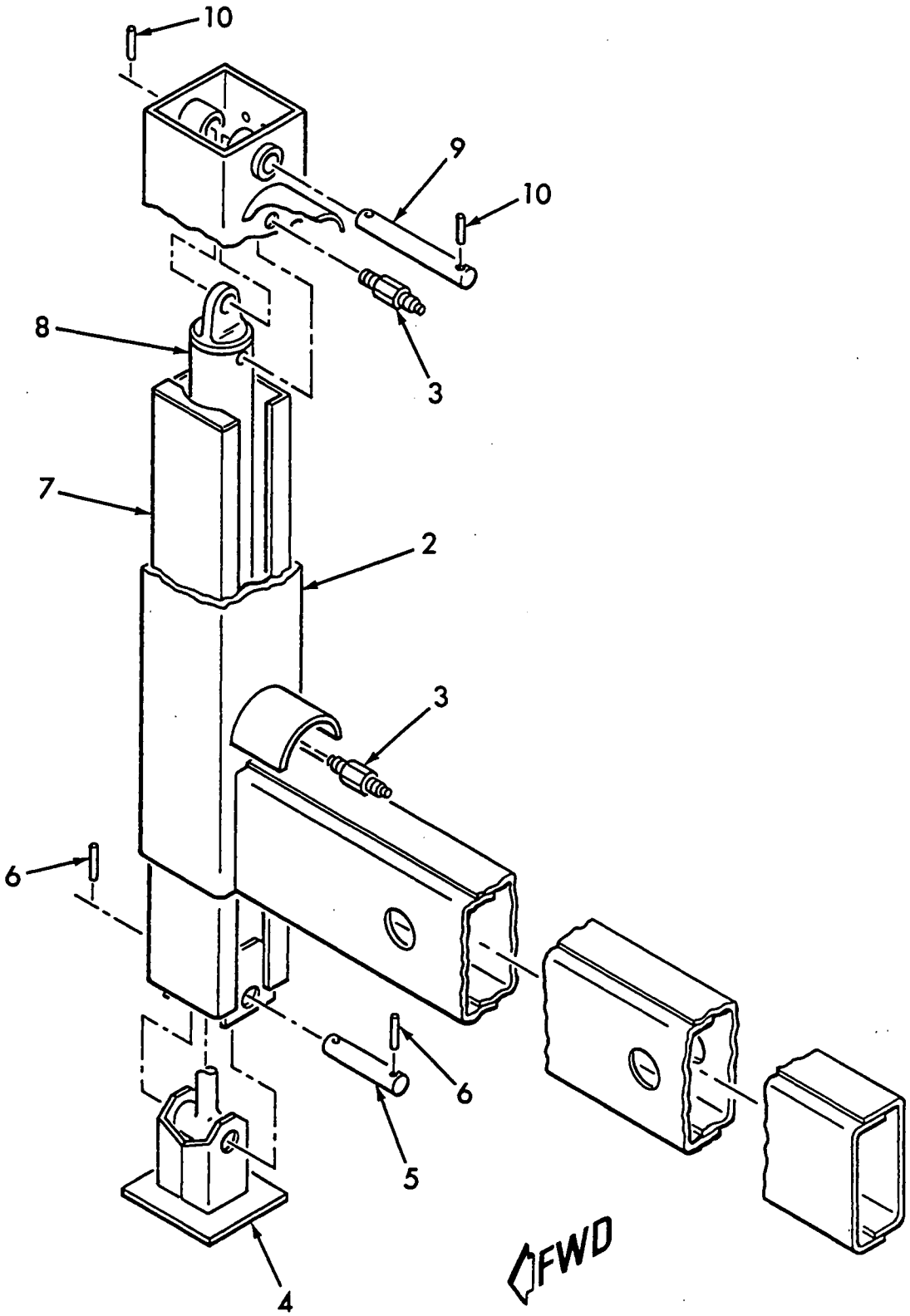


HYDRAULIC OUTRIGGER ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30915	ASSEMBLY, HYDRAULIC OUTRIGGER (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	30919	. WELDMENT, HYDRAULIC OUTRIGGER	1
3	30917	. TUBE, SLIDING	1
4	30908	. CYLINDER, HYDRAULIC OUTRIGGER (See Sect. 3, Fig. 13 for Details)	1
5	2592	. CONNECTOR, ORIFICED LONG MALE	1
6	30902	. PIN, UPPER	1
7	16220	. PIN, ROLL	2
8	2487	. CONNECTOR, LONG MALE	1
9	30903	. SUPPORT, SLIDING TUBE	1
10	30904	. PIN, LOWER	1
11	16220	. PIN, ROLL	2
12	30901	. BRACKET, SWITCH	1
13	60309	. SCREW, CAP	2
14	63301	. WASHER, LOCK	2
15	60701	. NUT, HEX	2
16	4011	. SWITCH, PUSH BUTTON	1
17	4012	. SWITCH, PUSH BUTTON	1
18	30900	. CAP, END	1
19	60309	. SCREW, CAP	2

- ITEM NOT ILLUSTRATED

HYDRAULIC OUTRIGGER ASSEMBLY

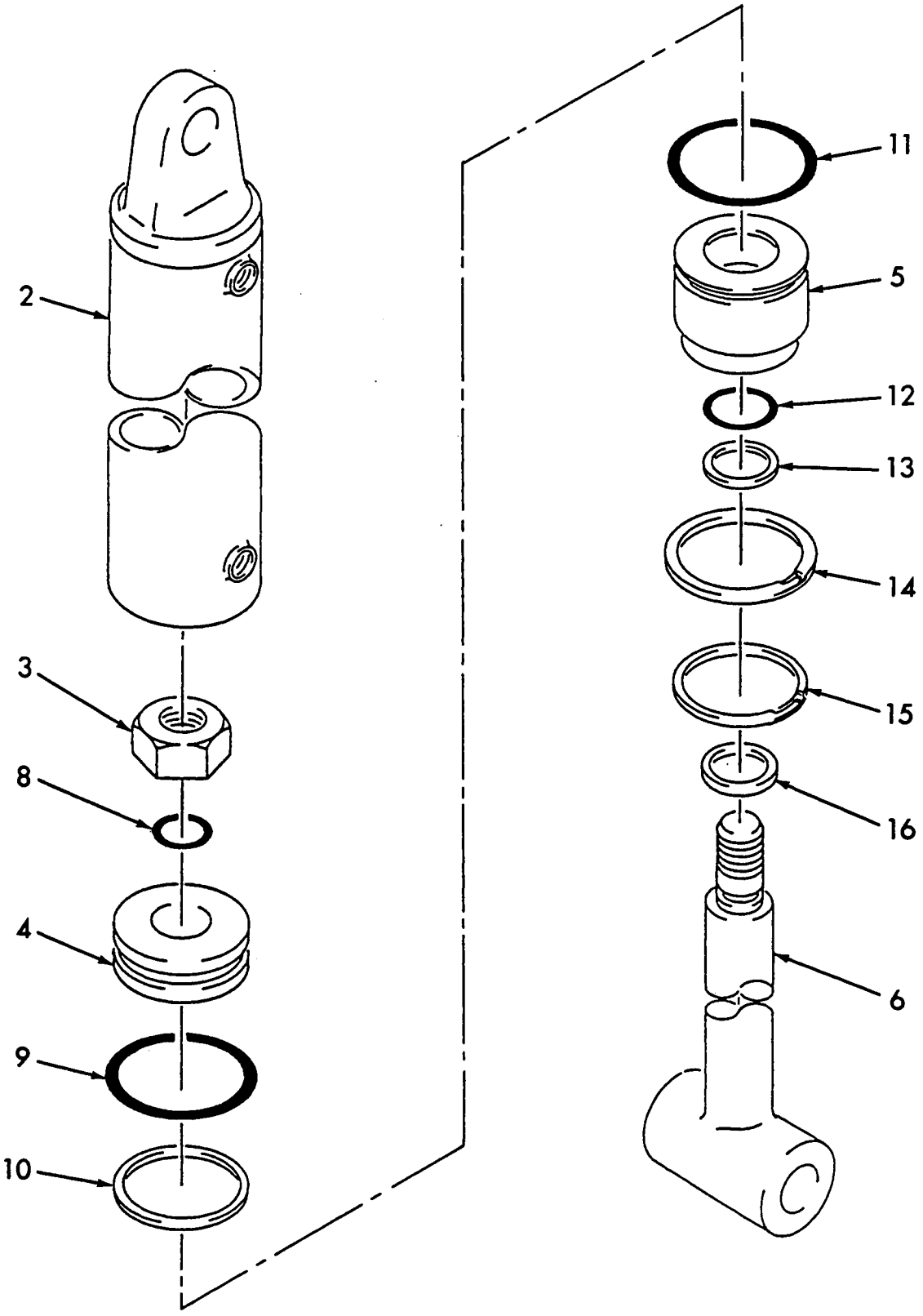


HYDRAULIC OUTRIGGER ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30910	ASSEMBLY, HYDRAULIC OUTRIGGER (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	30911	. WELDMENT, HYDRAULIC OUTRIGGER	1
3	2487	. CONNECTOR, LONG MALE	2
4	30903	. SUPPORT, SLIDING TUBE	1
5	30904	. PIN, LOWER	1
6	16220	. PIN, ROLL	2
7	30748	. TUBE, SLIDING	1
8	30908	. CYLINDER, HYDRAULIC OUTRIGGER (See Sect. 3, Fig. 13 for Details)	1
9	30902	. PIN, UPPER	1
10	16220	. PIN, ROLL	2

- ITEM NOT ILLUSTRATED

HYDRAULIC OUTRIGGER CYLINDER ASSEMBLY

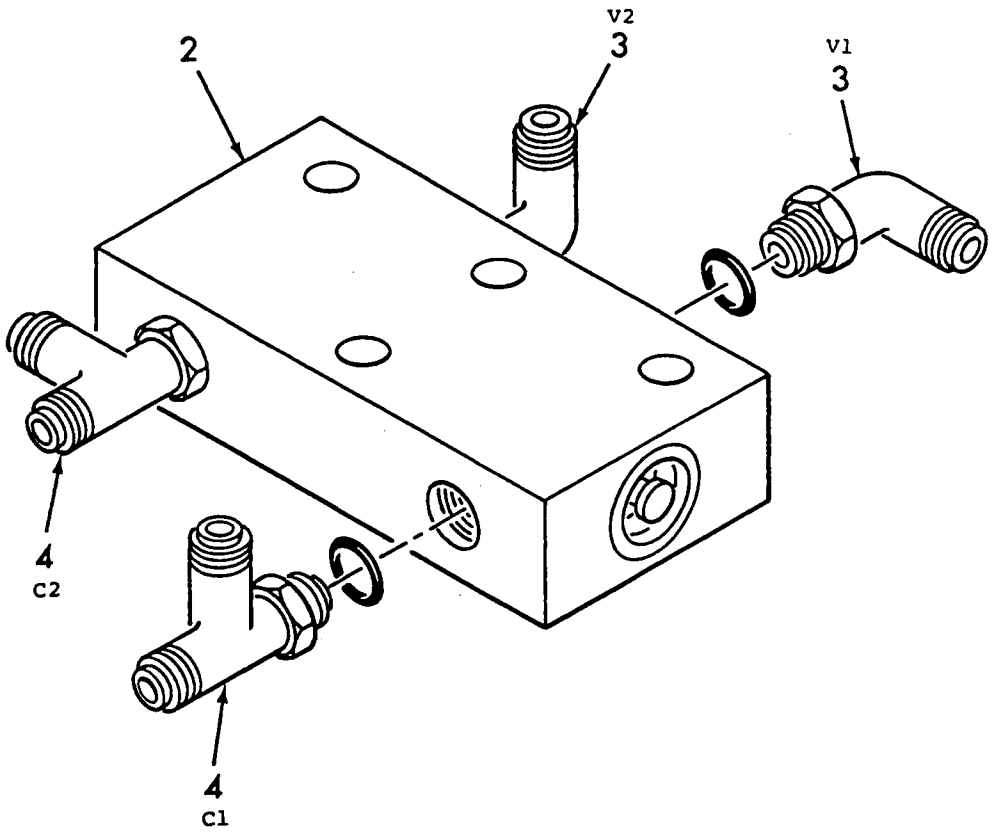


HYDRAULIC OUTRIGGER CYLINDER ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30908	ASSEMBLY, HYDRAULIC OUTRIGGER CYLINDER (See Sect. 3, Fig. 11 or 12 for NHA)	REF
2		. BODY (BARREL)	1
3		. NUT, PISTON	1
4		. PISTON	1
5		. GLAND (HEAD)	1
6		. ROD	1
-7	244-A	. KIT, SEAL	1
8		.. O-RING	1
9		.. O-RING (PISTON)	1
10		.. RING, BACK-UP (PISTON)	1
11		.. O-RING (GLAND)	1
12		.. O-RING	1
13		.. RING, BACK-UP	1
14		.. RING, RETAINING (LARGE)	1
15		.. RING, RETAINING (SMALL)	1
16		.. WIPER, ROD	1

- ITEM NOT ILLUSTRATED

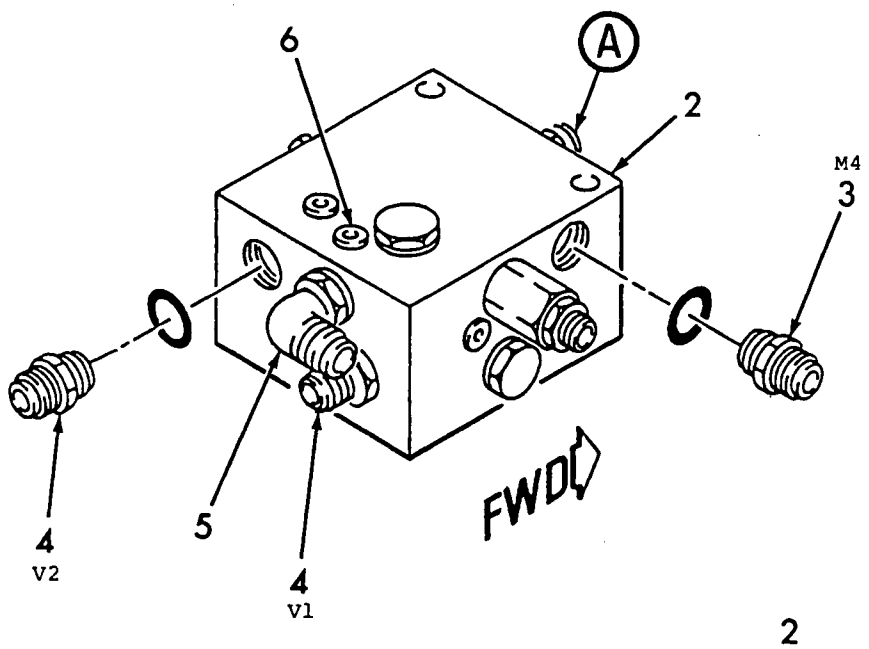
OUTRIGGER CHECK VALVE

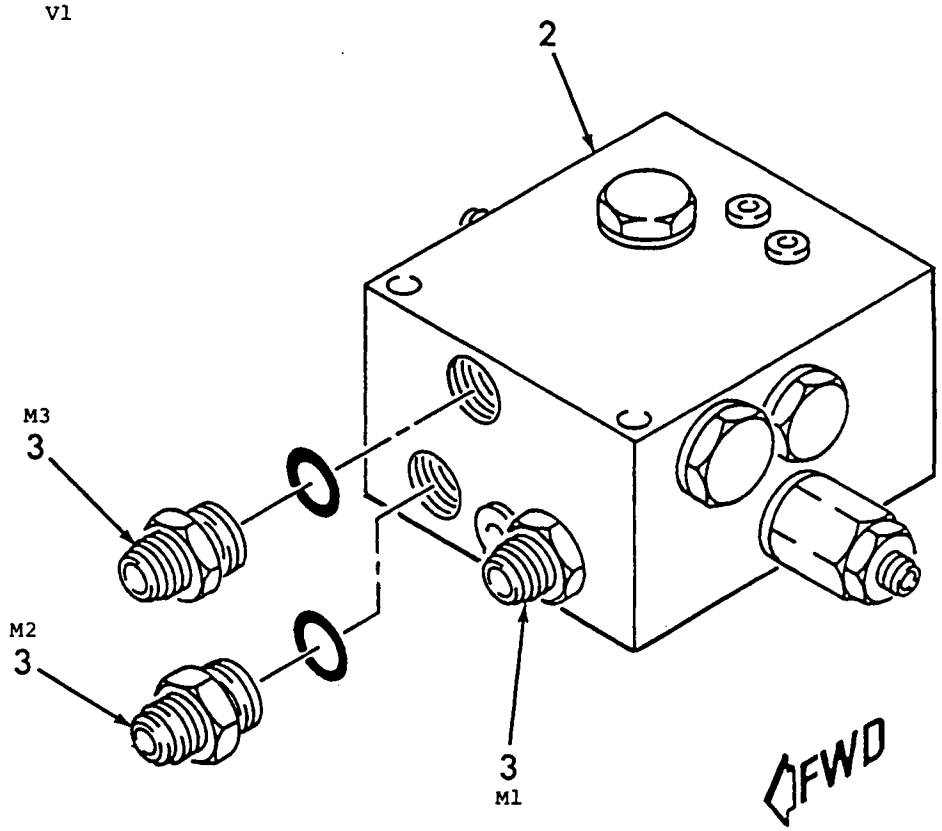


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32697	ASSEMBLY, OUTRIGGER CHECK VALVE (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	20351	. VALVE, CHECK	1
3	80033-08	. TEE, MALE RUN	2
4	80012-08	. ELBOW, STRAIGHT THREAD	2

REV.

DRIVE AND BRAKE VALVE ASSEMBLY





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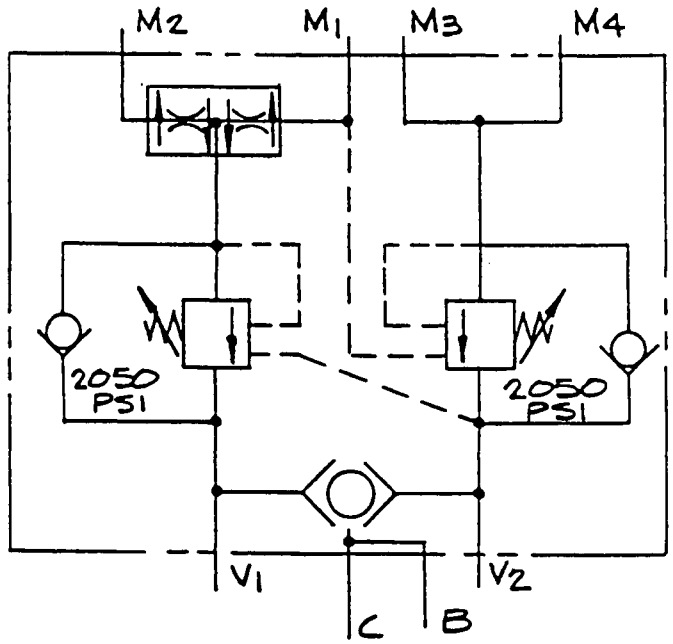
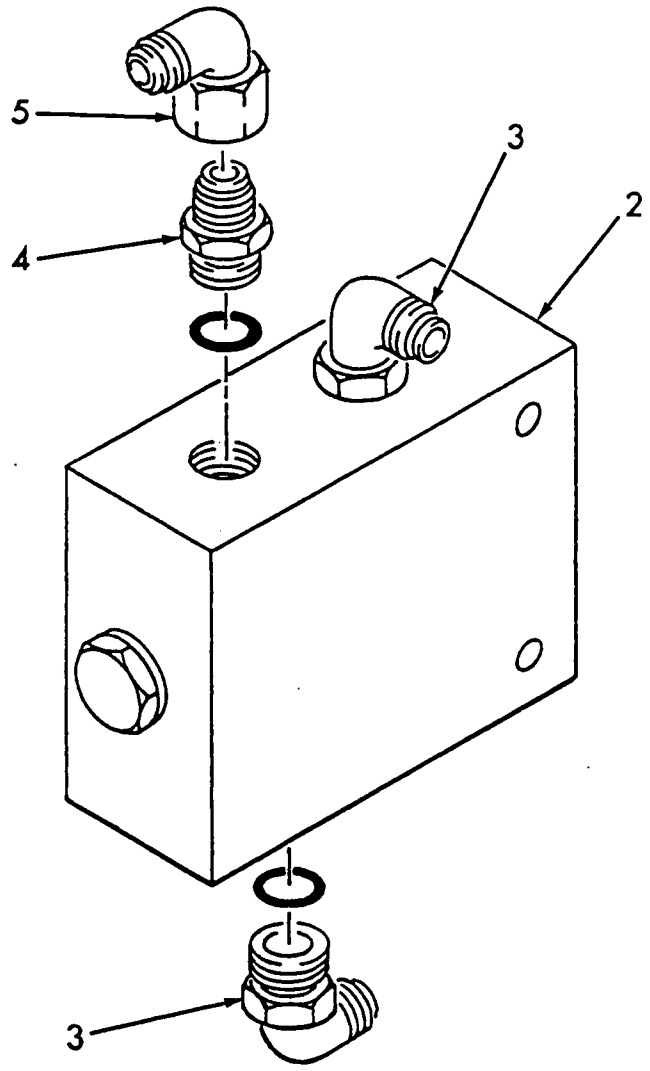


SCHEMATIC

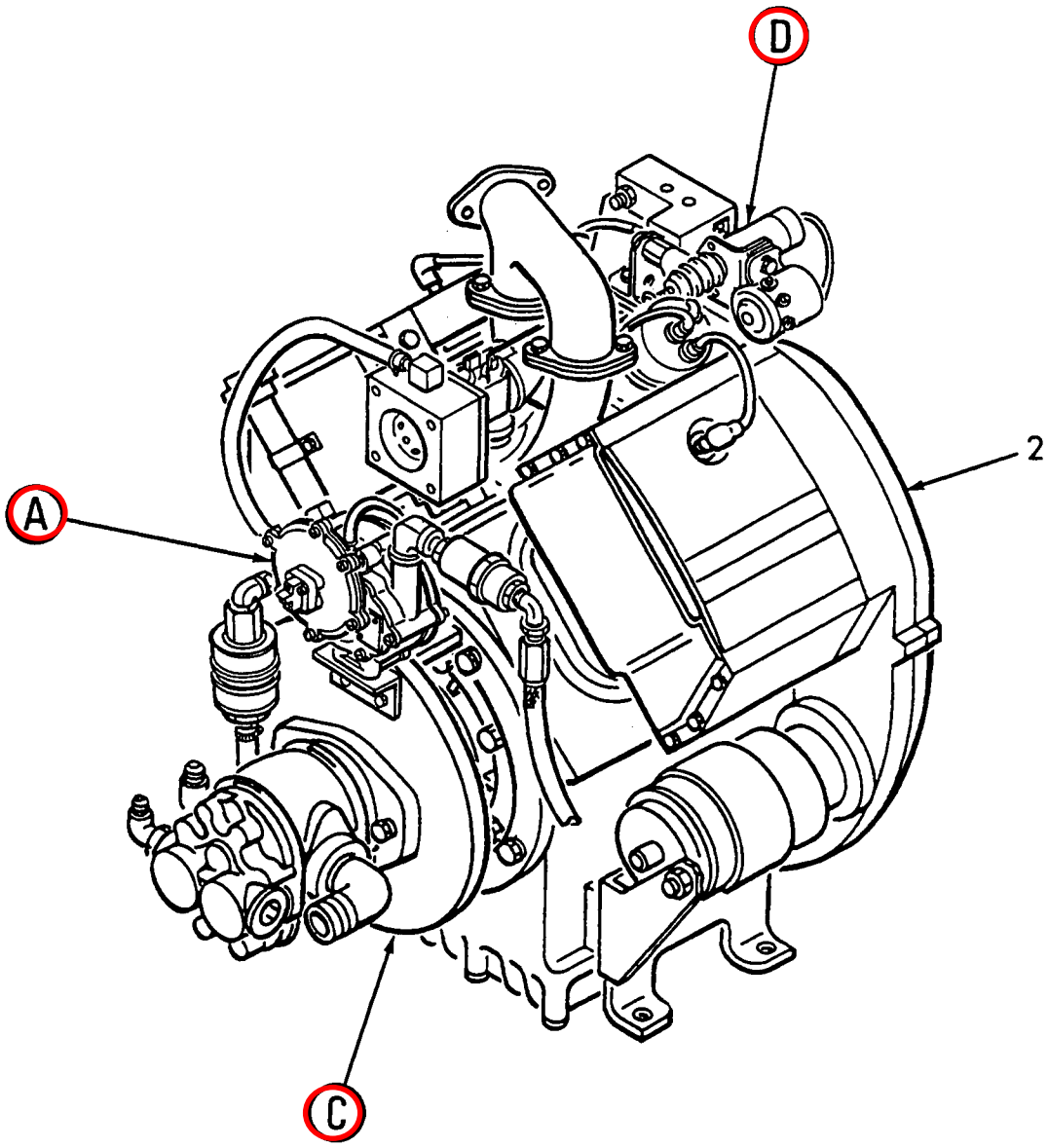
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32274	ASSEMBLY, DRIVE AND BRAKE VALVE (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	21214	. VALVE, DRIVE/BRAKE	1
3	80004-11	. CONNECTOR, STRAIGHT THREAD (M1, M2, M3, M4)	4
4	80004-16	. CONNECTOR, STRAIGHT THREAD (V1, V2)	2
5	80012-05	. ELBOW, STRAIGHT THREAD	1
6	80048-03	. PLUG, HOLLOW HEX	1

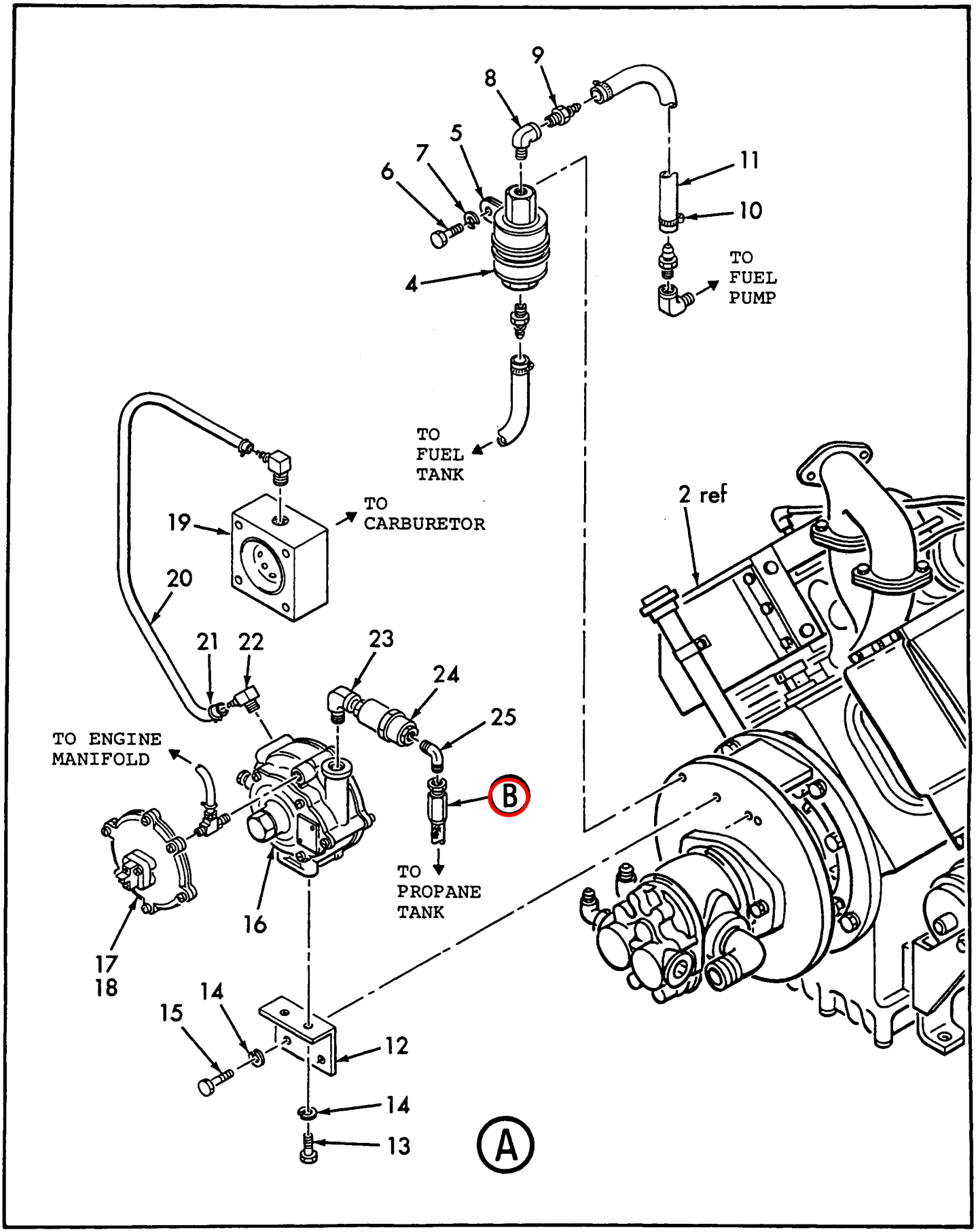
FLOW DIVIDER ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32273	ASSEMBLY, FLOW DIVIDER (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	81125	. DIVIDER, FLOW	1
3	80012-11	. ELBOW, STRAIGHT THREAD	2
4	80004-11	. CONNECTOR, STRAIGHT THREAD	1
5	80015-06	. ELBOW, SWIVEL NUT	1

ENGINE AND PUMP ASSEMBLY

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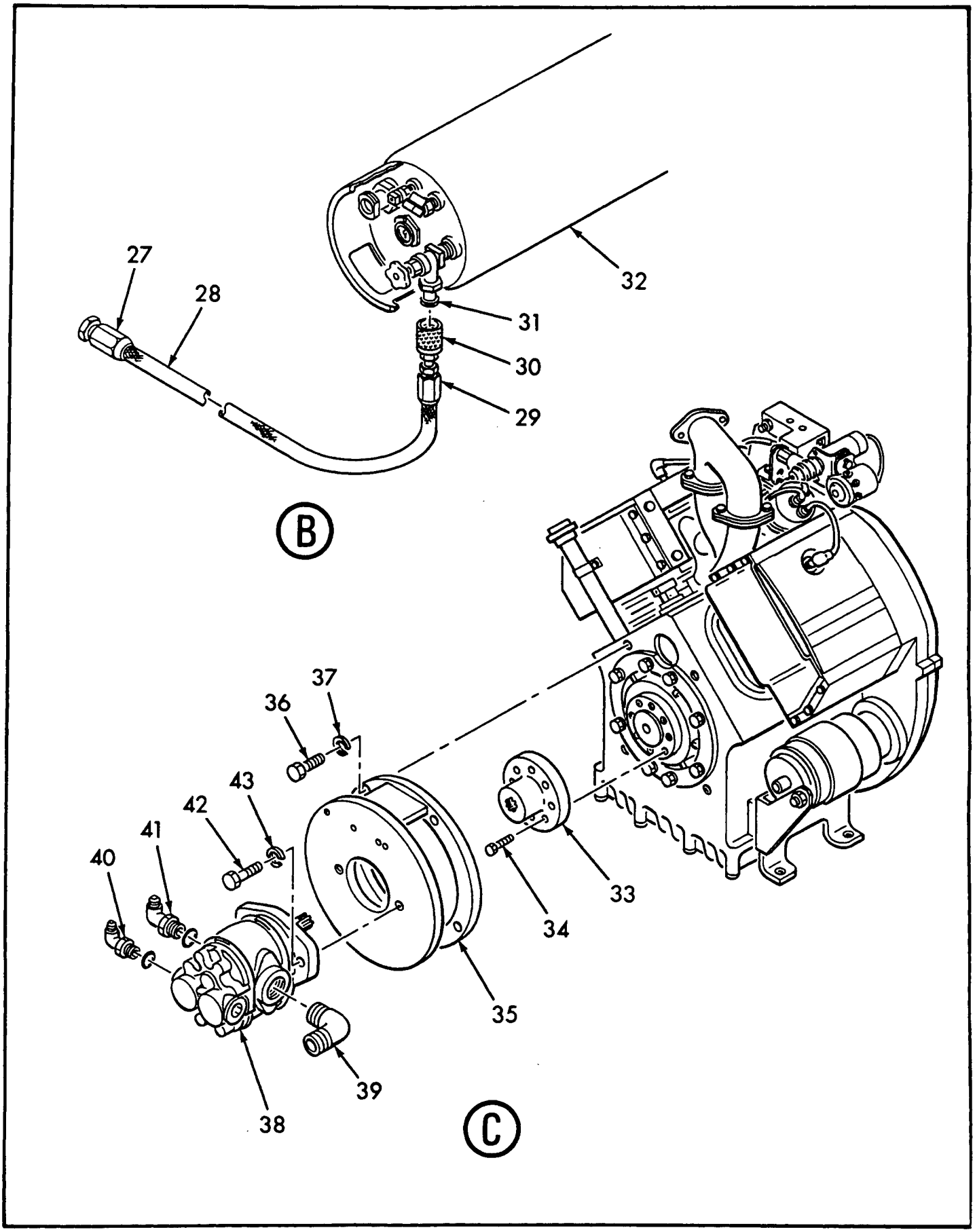
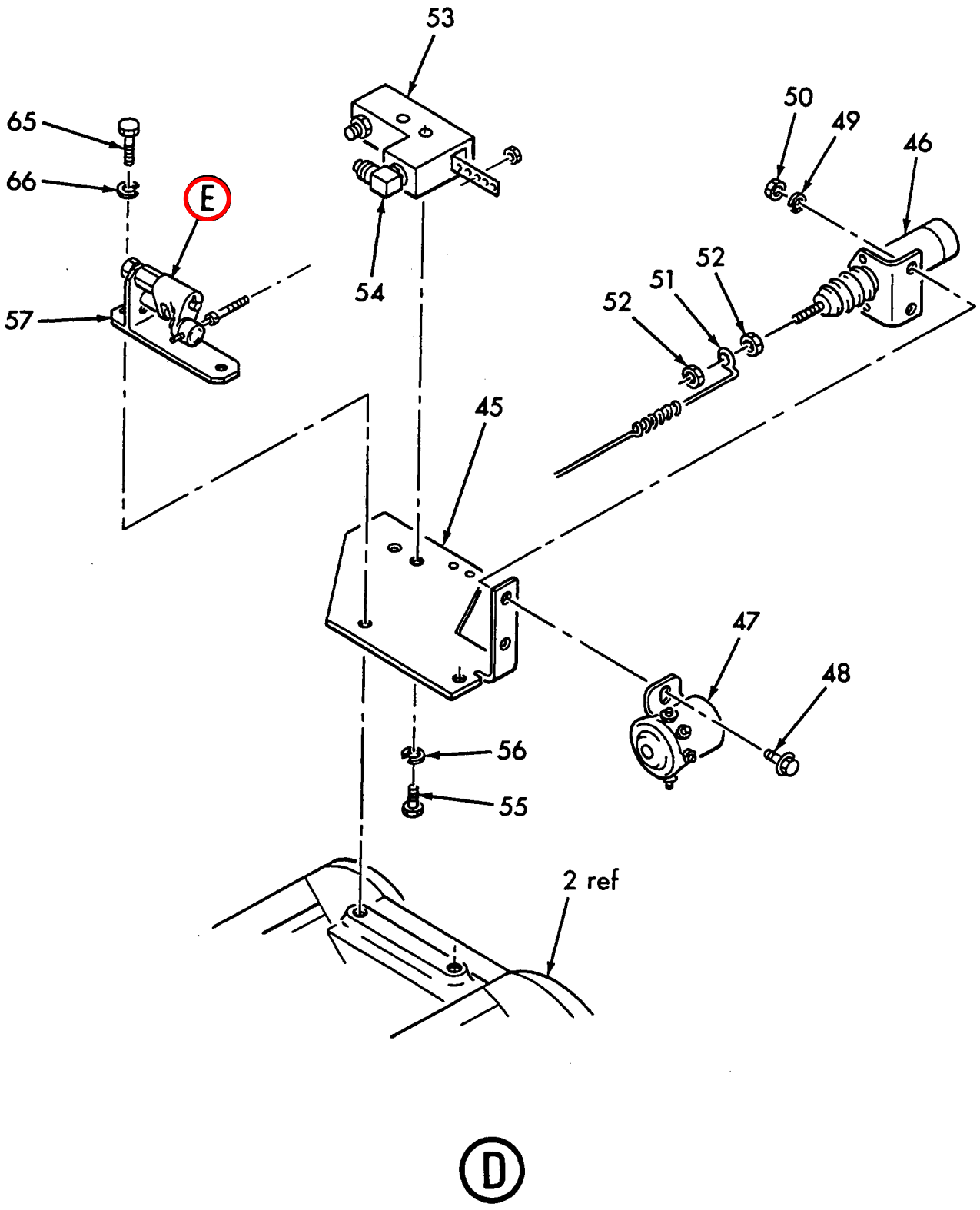
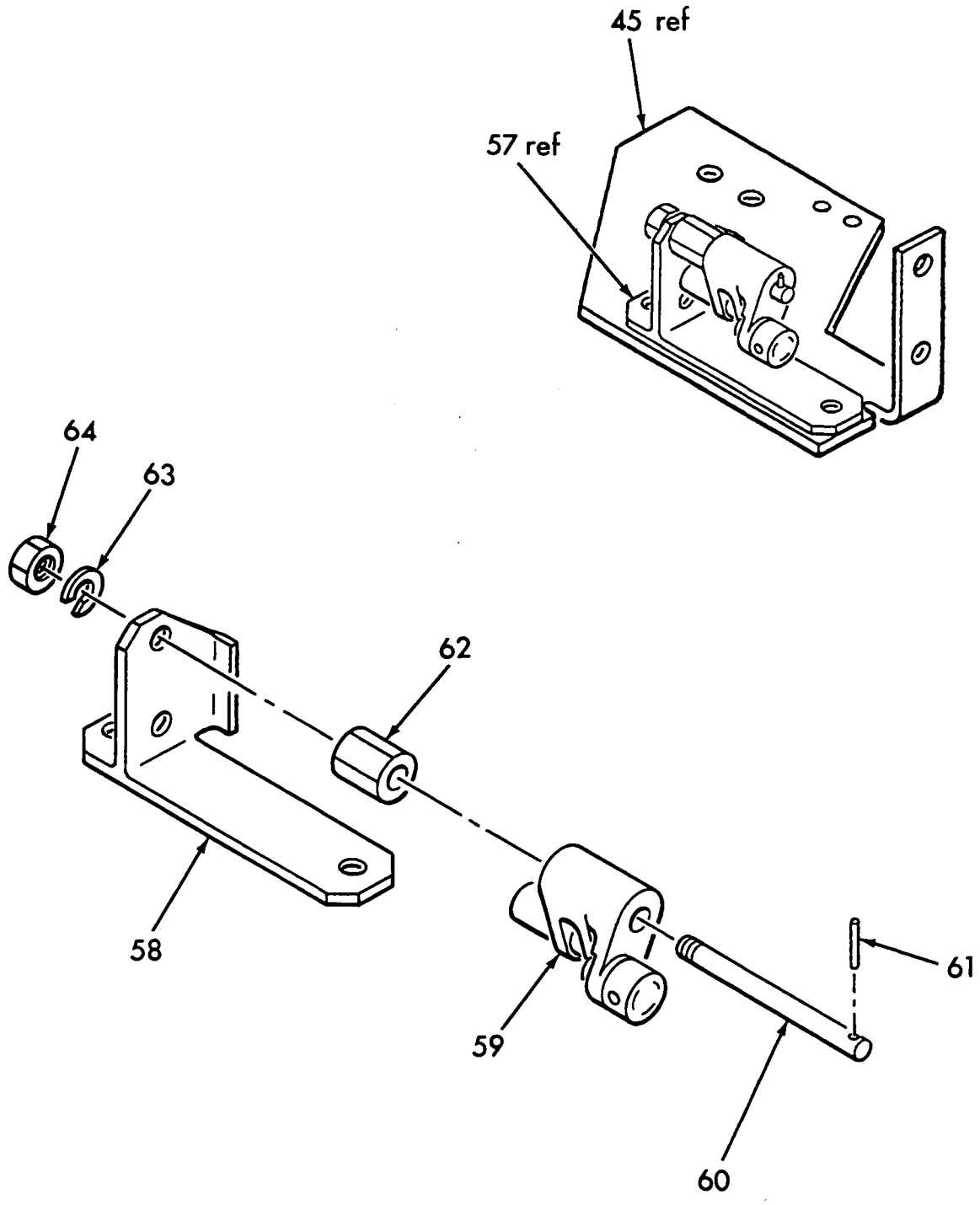
ENGINE AND PUMP ASSEMBLY



ENGINE AND PUMP ASSEMBLY

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ENGINE AND PUMP ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32720	ASSEMBLY, ENGINE AND PUMP (See Sect. 3, Fig. 1 & 1A for NHA)	REF
2	32550	. ENGINE, GASOLINE	1
-3	32354	. KIT, DUAL FUEL	1
4	20832	.. VALVE, FUEL SHUT-OFF	1
5	65867	.. CLAMP	1
6	60353	.. SCREW, CAP	1
7	63301	.. WASHER, LOCK	1
8	66196	.. ELBOW, STREET	2
9	240	.. BARB, HOSE	3
10	161-A	.. CLAMP, HOSE	4
11	160-B	.. HOSE, FUEL	1.75 FT
12	32454	.. BRACKET, DUAL FUEL	1
13	60353	.. SCREW, CAP	2
14	63301	.. WASHER, LOCK	4
15	60309	.. SCREW, CAP	2
16	16921	.. REGULATOR	1
17	16975	.. KIT, VACUUM SAFETY SWITCH	1
-18	16919	... KIT, REPAIR	1
19	160068	.. ADAPTER, CARBURETOR	1
20	65485-24	.. HOSE	1
21	2713	.. CLAMP, HOSE	2
22	65532	.. BARB, HOSE	2
23	16519	.. ELBOW, STREET	1
24	16925	.. LOCK, PROPANE FILTER	1
25	80008-08	.. ELBOW, MALE	1

- ITEM NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-26	32517	.. ASSEMBLY, PROPANE HOSE	1
27	16451	... FITTING, HOSE	1
28	2616	... HOSE	12 FT
29	16452	... FITTING, HOSE	1
30	65142	... SOCKET, QUICK DISCONNECT	1
31	65141	.. NIPPLE	1
32	486-C	.. TANK, PROPANE	1
33	32217	. SHAFT, STUB	1
34	60625	. SCREW, CAP	8
35	32219	. ADAPTER, PUMP	1
36	60630	. SCREW, CAP	4
37	63304	. WASHER, LOCK	4
38	81256	. ASSEMBLY, DOUBLE GEAR PUMP (See Sect. 3, Fig. 18 for Details)	1
39	81197	. TUBE, ELBOW	1
40	80012-15	. ELBOW, STRAIGHT THREAD	1
41	80012-13	. ELBOW, STRAIGHT THREAD	1
42	60630	. SCREW, CAP	2
43	63304	. WASHER, LOCK	2
-44		. ASSEMBLY, THROTTLE (BEFORE DEC. 1988) (See Sect. 3, Fig. 17A for Details)	1
-44	SKP-0848	. ASSEMBLY, THROTTLE (KIT) (AFTER DEC. 1988 - BEFORE SEPT. 1989) (See Sect. 3, Fig. 17B for Details)	1
-44		. ASSEMBLY, THROTTLE (AFTER SEPT. 1989) (Shown in this Figure)	1
45	22521	. BRACKET, MOUNTING SOLENOID VALVE AND HYDRAULIC THROTTLE	1

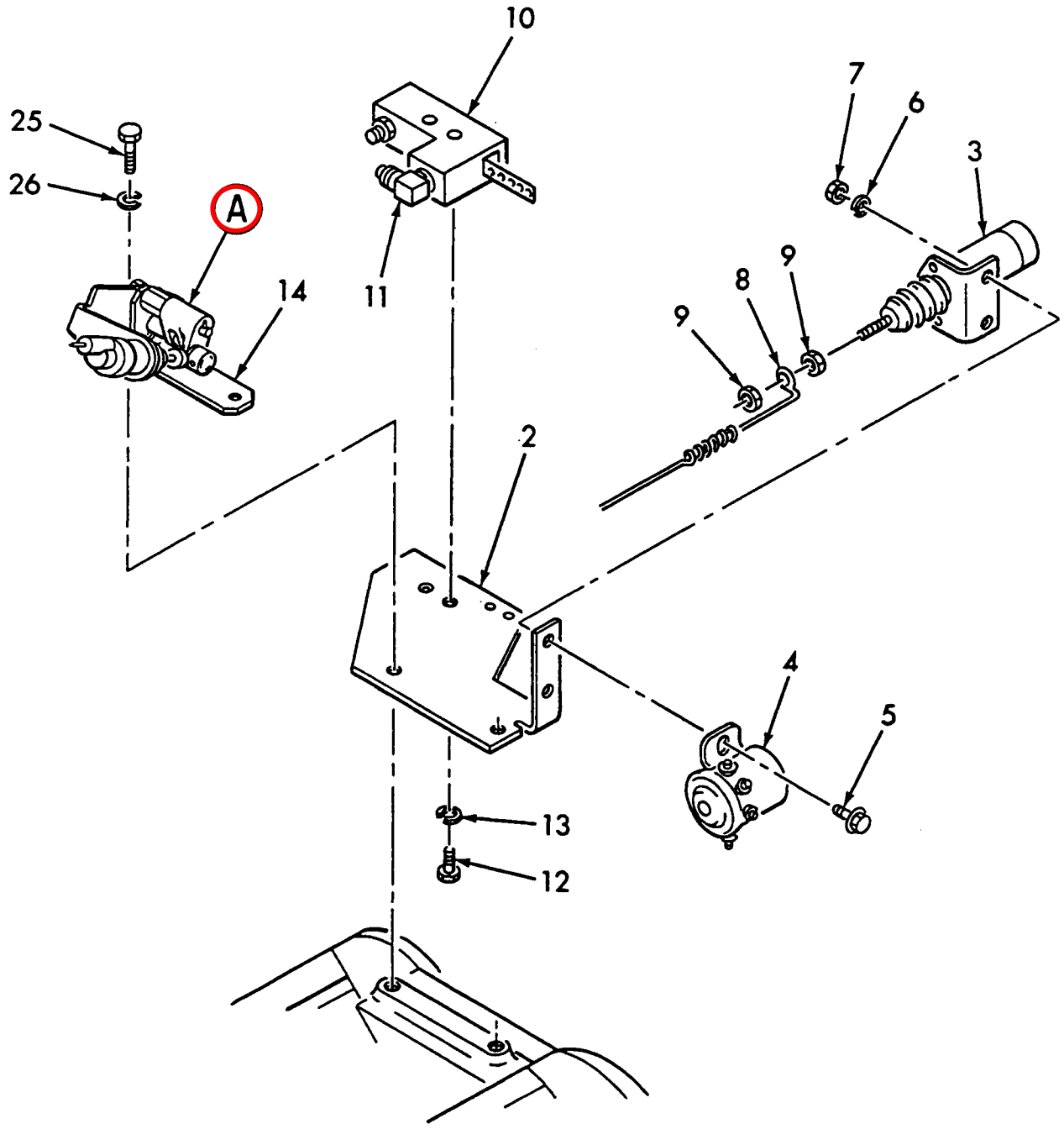
ENGINE AND PUMP ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
46	21777	. SYNCHRO, START	1
47	70209	. RELAY, SOLENOID (12V)	1
48	60309	. SCREW, CAP	2
49	63301	. WASHER, LOCK	2
50	60701	. NUT, HEX	2
51	133100	. LINKAGE, THROTTLE	1
52	60805	. NUT, HEX	2
53	20364	. THROTTLE, HYDRAULIC	1
54	80008-04	. ELBOW, MALE	1
55	60404	. SCREW, CAP	2
56	63302	. WASHER, LOCK	2
57		. ASSEMBLY, GOVERNOR CONTROL*	1
58		.. BRACKET, GOVERNOR CONTROL	1
59		.. ARM, GOVERNOR CONTROL	1
60		.. PIN	1
61		.. PIN, ROLLER	1
62		.. SPACER	1
63		.. WASHER, LOCK	1
64		.. NUT, HEX	1
65	60404	. SCREW, CAP	2
66	63302	. WASHER, LOCK	2

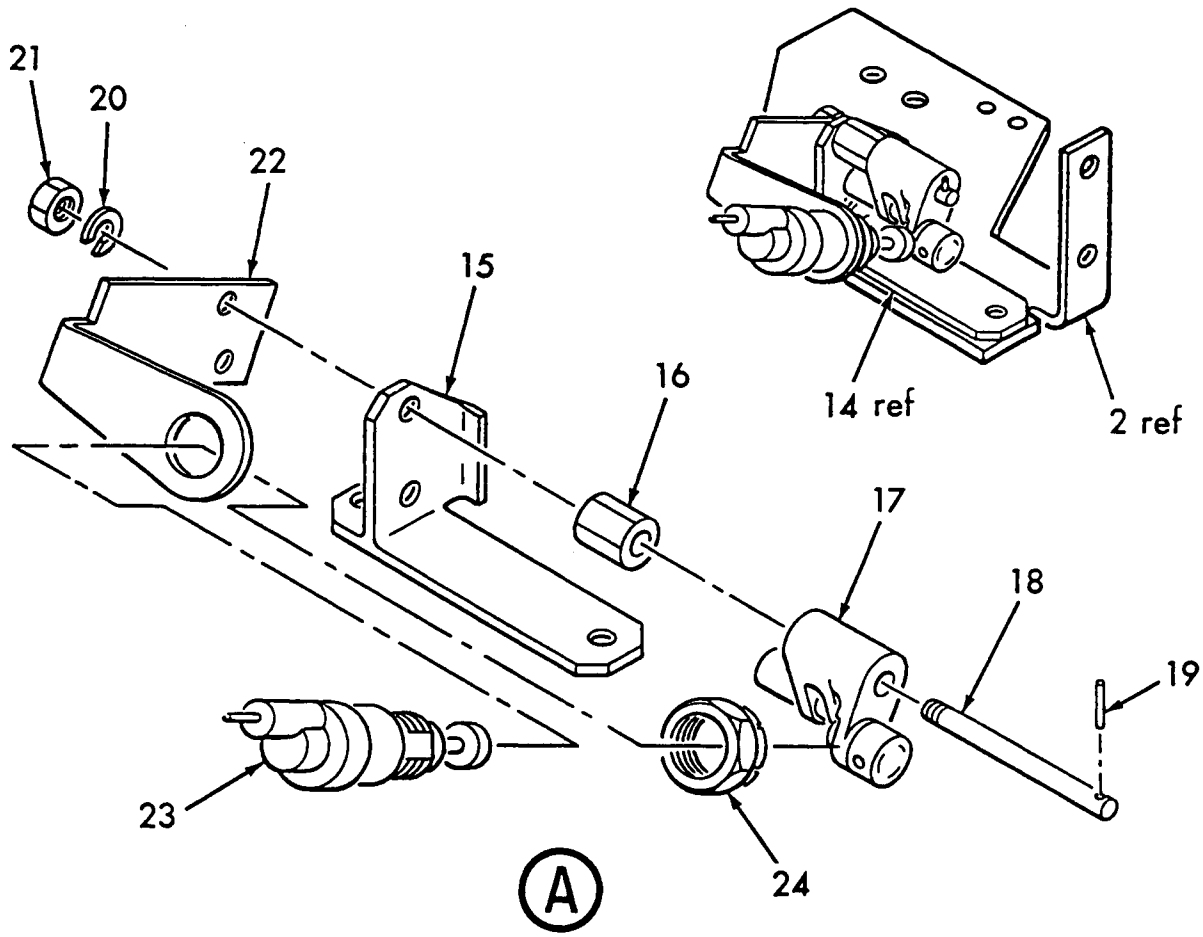
*PART OF ENGINE ASSEMBLY:
PROVIDED BY MANUFACTURER.

- ITEM NOT ILLUSTRATED

ENGINE AND PUMP ASSEMBLY
Throttle Assembly Only
(BEFORE DEC. 1988)



ENGINE AND PUMP ASSEMBLY
Throttle Assembly Only
(BEFORE DEC. 1988)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32720	ASSEMBLY, ENGINE & PUMP (See Sect. 3, Fig. 15 for NHA)	REF
2	22521	. BRACKET, MOUNTING SOLENOID VALVE AND HYDRAULIC THROTTLE	1
3	21777	. SYNCHRO, START	1
4	70209	. RELAY, SOLENOID (12V)	1
5	60309	. SCREW, CAP	2
6	63301	. WASHER, LOCK	2
7	60701	. NUT, HEX	2

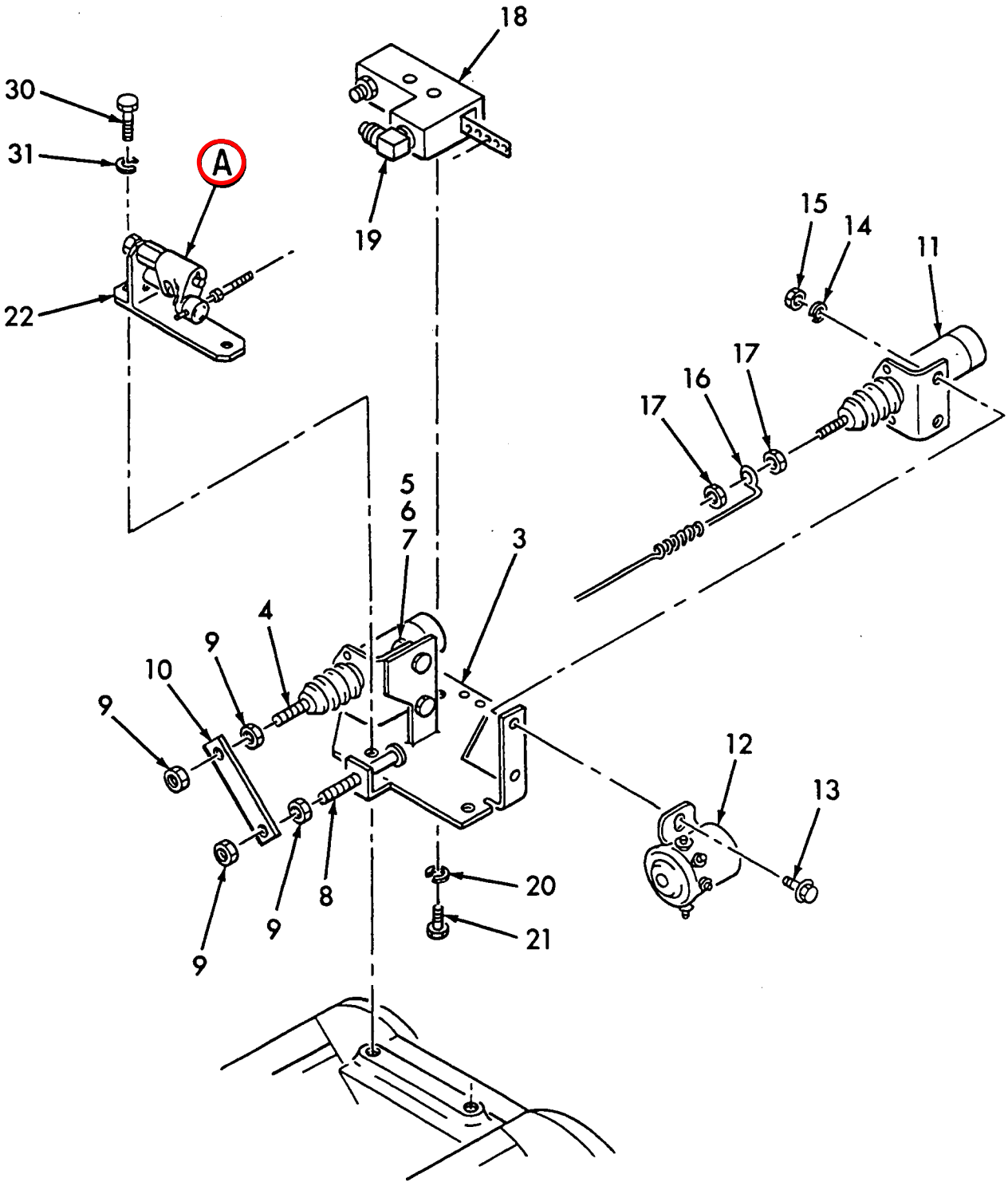
ENGINE AND PUMP ASSEMBLY
Throttle Assembly Only
(BEFORE DEC. 1988)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
8	65199	. SPRING, UNIVERSAL THROTTLE	1
9	60805	. NUT, HEX	2
10	20364	. THROTTLE, HYDRAULIC	1
11	80008-04	. ELBOW, MALE	1
12	60404	. SCREW, CAP	2
13	63302	. WASHER, LOCK	2
-14		. ASSEMBLY, GOVERNOR CONTROL*	1
15		.. BRACKET, GOVERNOR CONTROL	1
16		.. SPACER	1
17		.. ARM, GOVERNOR CONTROL	1
18		.. PIN, PIVOT	1
19		.. PIN, ROLLER	1
20		.. WASHER, LOCK	1
21		.. NUT, HEX FLEX	1
22	22663	. BRACKET, DASHPOT	1
23	65511	. DASHPOT	1
24	61232	. NUT, THIN FLEX	1
25	60322	. SCREW, CAP	2
26	63302	. WASHER, LOCK	2

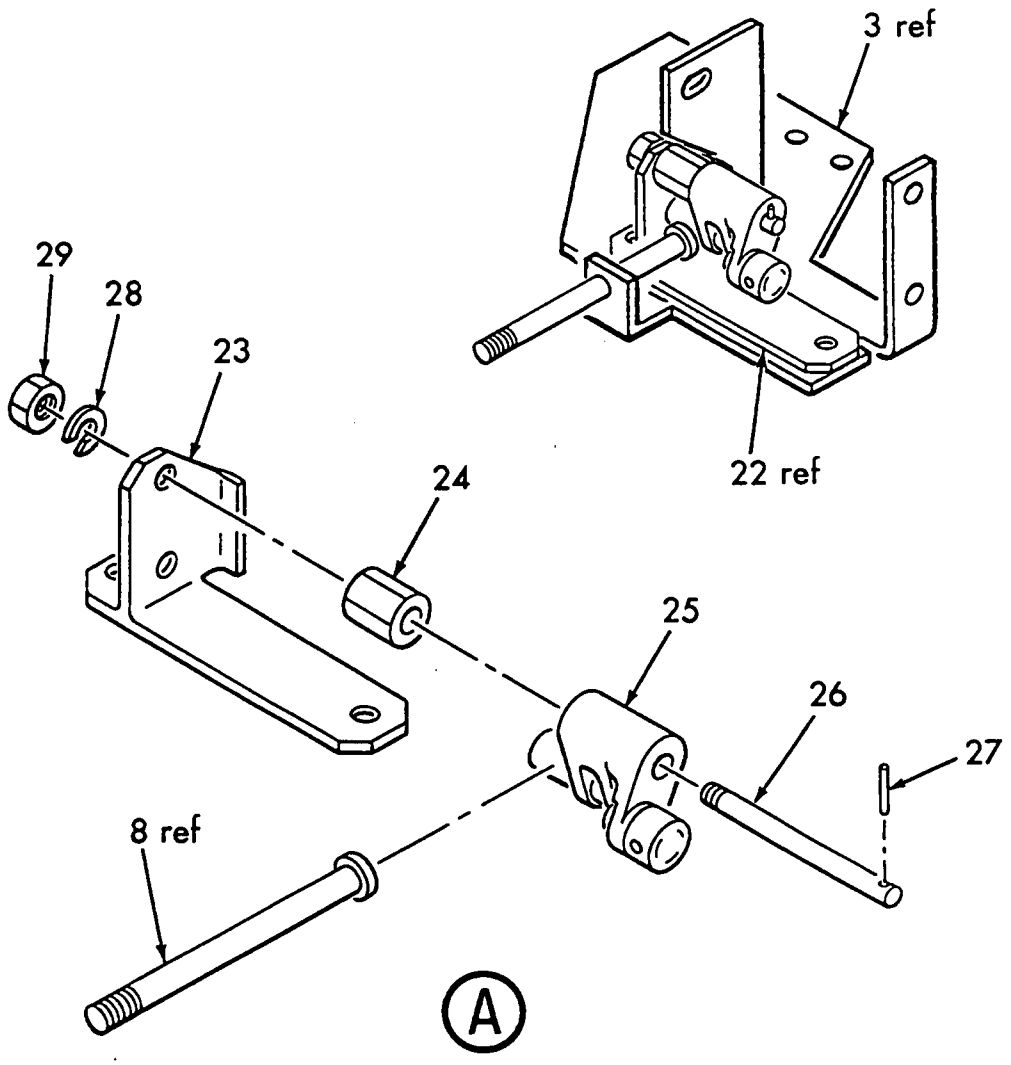
*PART OF ENGINE ASSEMBLY:
PROVIDED BY MANUFACTURER.

- ITEM NOT ILLUSTRATED

ENGINE AND PUMP ASSEMBLY
Throttle Assembly Only
(AFTER DEC. 1988 - BEFORE SEPT. 1989)



ENGINE AND PUMP ASSEMBLY
Throttle Assembly Only
(AFTER DEC. 1988 - BEFORE SEPT. 1989)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32720	ASSEMBLY, ENGINE AND PUMP (See Sect. 3, Fig. 17 for NHA)	REF
-2	SKP-0848	. KIT, LOW THROTTLE INSTALLATION	
3	SKP-0871	.. BRACKET, THROTTLE MOUNTING	1
4	21777	.. SOLENOID	1
5	60309	.. SCREW, CAP	2
6	63301	.. WASHER, LOCK	4
7	60701	.. NUT, HEX	2

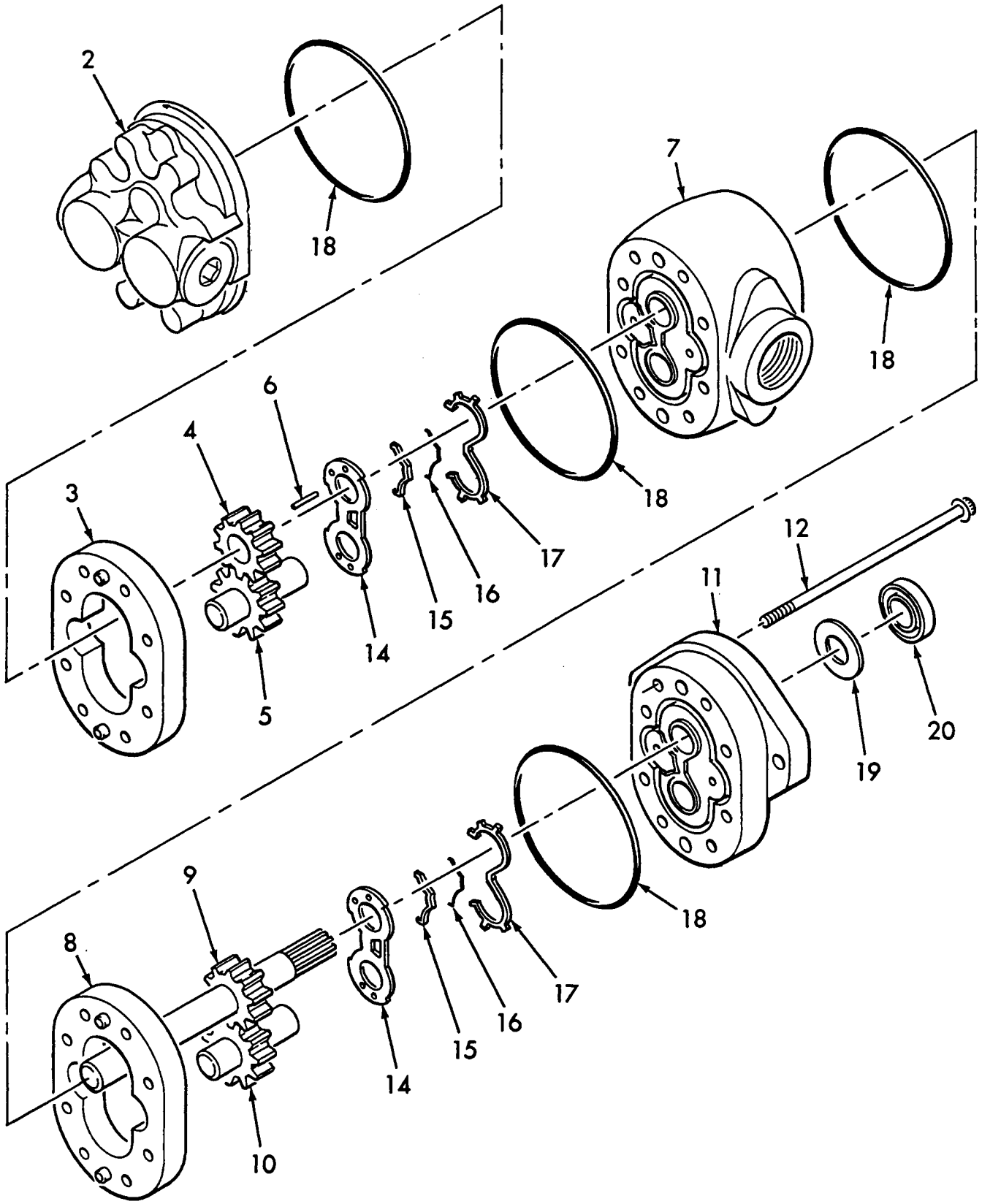
REV.

ENGINE AND PUMP ASSEMBLY
Throttle Assembly Only
(AFTER DEC. 1988 - BEFORE SEPT. 1989)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
8	60352	.. ROD, ACTUATOR	1
9	60701	.. NUT, HEX	4
10	SKP-0868	.. LEAF, THROTTLE	1
11	21777	. SYNCHRO, START	1
12	70209	. RELAY, SOLENOID	1
13	60309	. SCREW, CAP	2
14	63301	. WASHER, LOCK	2
15	60701	. NUT, HEX	2
16	65199	. SPRING, UNIVERSAL THROTTLE	1
17	60805	. NUT, HEX	2
18	20364	. THROTTLE, HYDRAULIC	1
19	80008-04	. ELBOW, MALE	1
20	63302	. WASHER, LOCK	2
21	60404	. SCREW, CAP	2
22		. ASSEMBLY, GOVERNOR CONTROL*	1
23		.. BRACKET, GOVERNOR CONTROL	1
24		.. SPACER	1
25		.. ARM, GOVERNOR CONTROL	1
26		.. PIN, PIVOT	1
27		.. PIN, ROLLER	1
28		.. WASHER, LOCK	1
29		.. NUT, HEX	1
30	60322	. SCREW, CAP	2
31	63302	. WASHER, LOCK	2
		*PART OF ENGINE ASSEMBLY; PROVIDED BY MANUFACTURER.	

- ITEM NOT ILLUSTRATED

DOUBLE GEAR PUMP ASSEMBLY



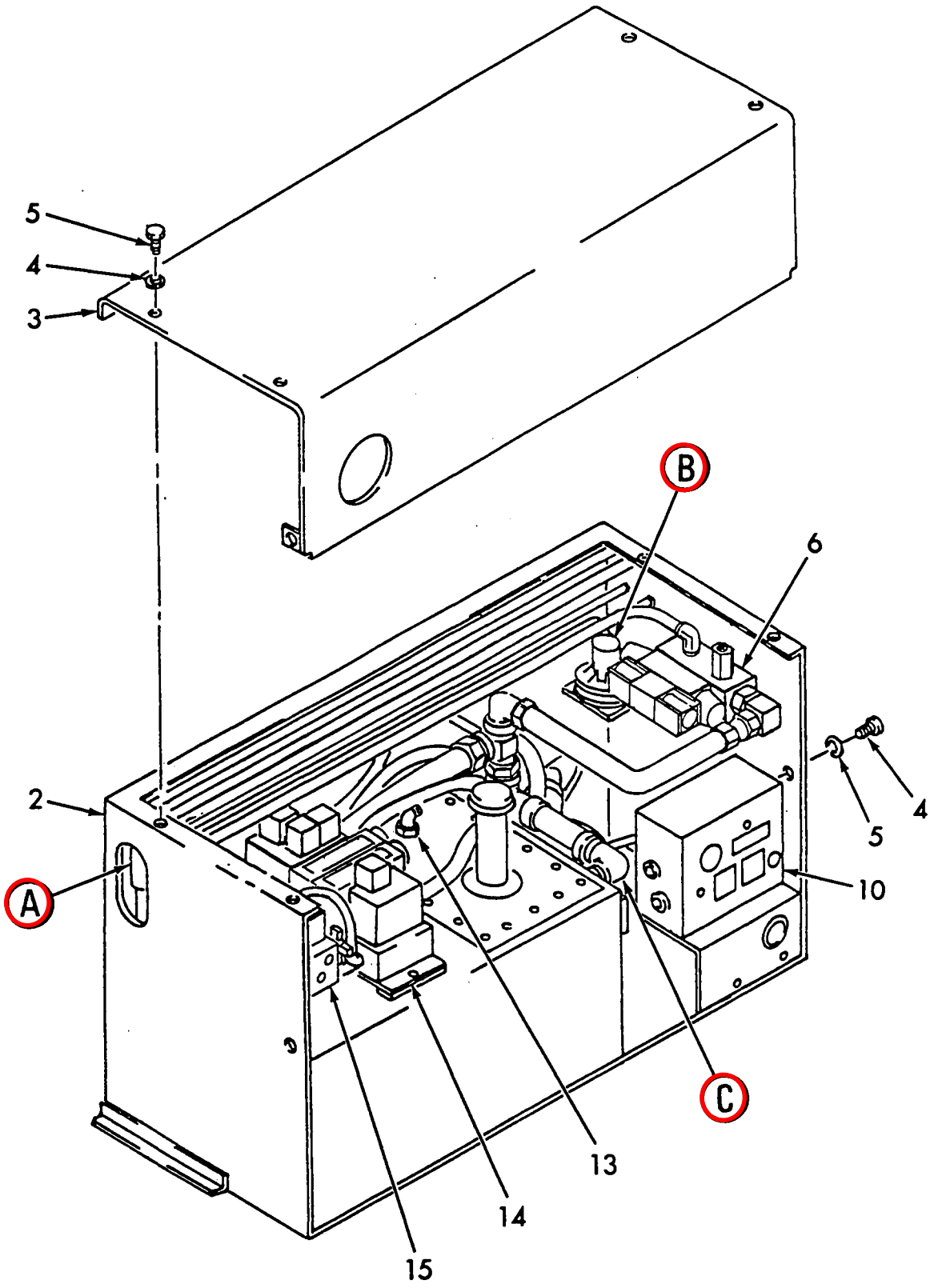
REV.

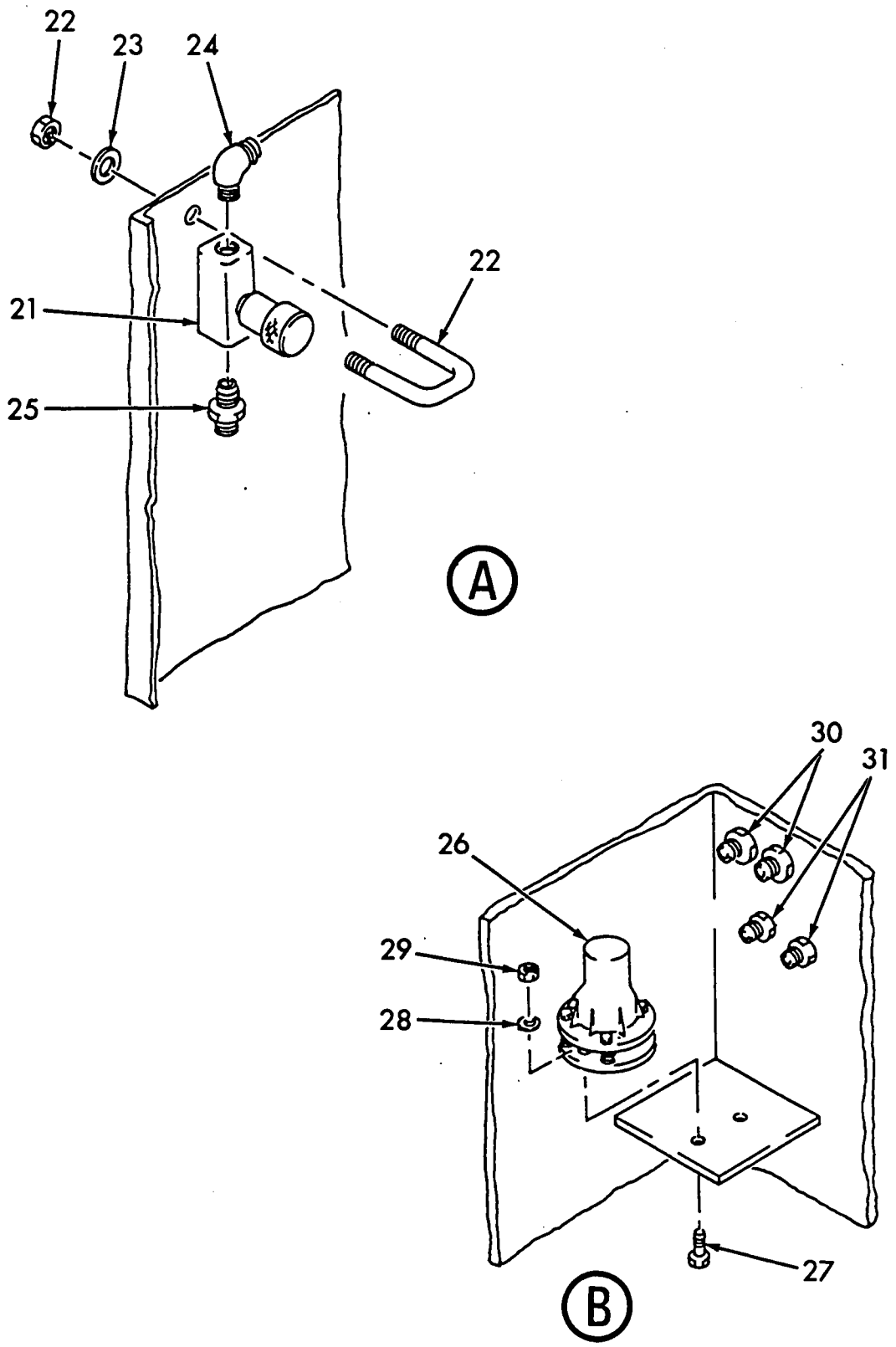
DOUBLE GEAR PUMP ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	81256	ASSEMBLY, DOUBLE GEAR PUMP (See Sect. 3, Fig. 17 for NHA)	REF
2	67501	. ASSEMBLY, BACK PLATE	1
3		. BODY, REAR	1
4	66993	. GEAR, SLIP FIT	1
5	66996	. GEAR, IDLER	1
6	66990	. KEY, ROUND	1
7	67504	. PLATE, ADAPTER	1
8		. BODY, FRONT	1
9	67505	. ASSEMBLY, DRIVE SHAFT	1
10	67503	. ASSEMBLY, IDLER GEAR	1
11	67502	. ASSEMBLY, FRONT PLATE	1
12		. SCREW, CAP	8
-13	66869	. KIT, SEAL	1
14		.. PLATE, WEAR	2
15		.. SEAL, BEARING	2
16		.. O-RING, MOLDED	2
17		.. GASKET, BACK-UP	2
18		.. O-RING	4
19		.. WASHER	1
20		.. SEAL, SHAFT	1

- ITEM NOT ILLUSTRATED

HYDRAULIC TANK ASSEMBLY (MT31G)




22
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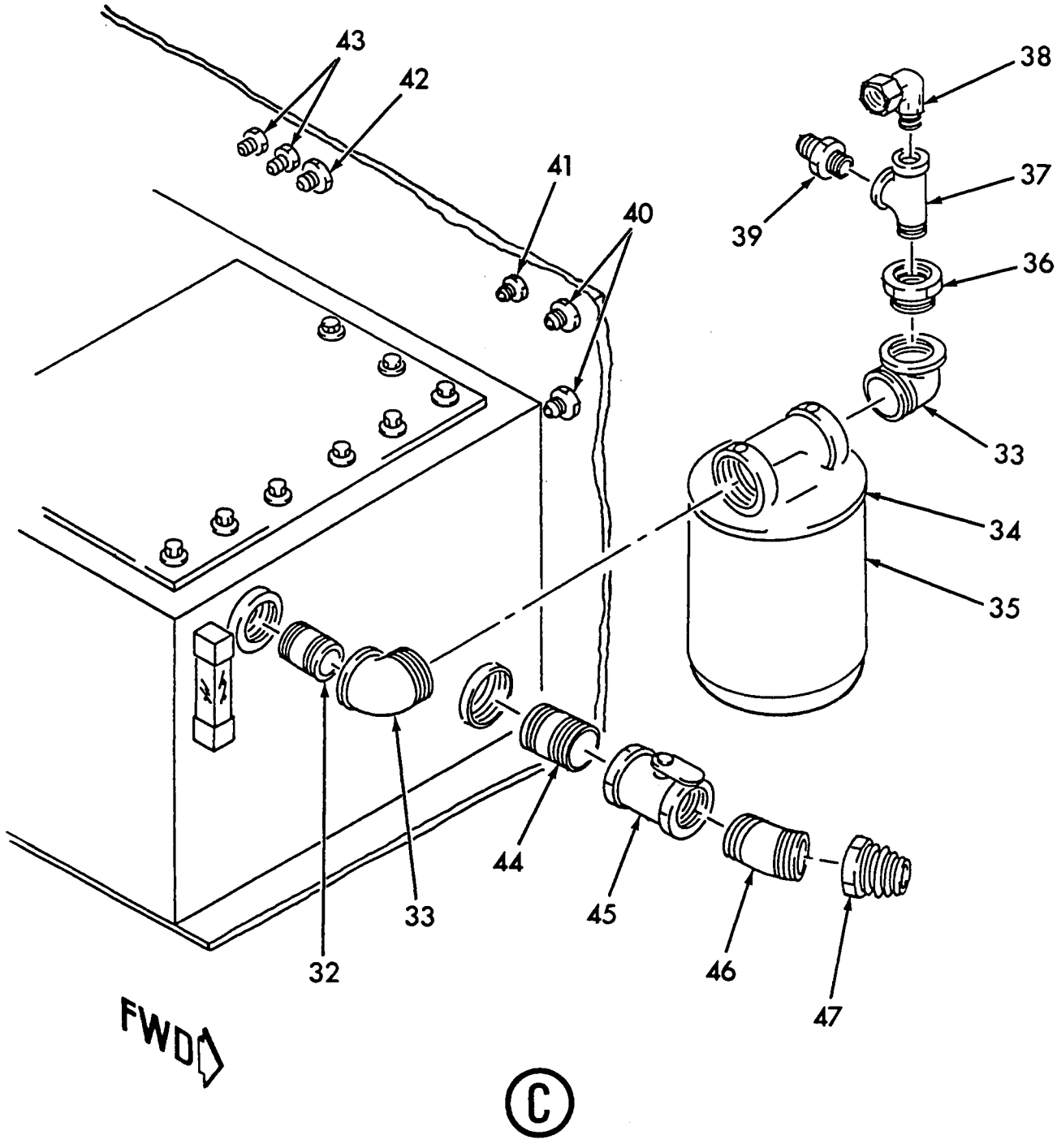
HYDRAULIC TANK ASSEMBLY (MT31G)



HYDRAULIC TANK ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32738	ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 1 for NHA)	REF
2	32393	. SUB-ASSEMBLY, HOUSING TANK (See Sect. 3, Fig. 20 for Details)	1
3	32171	. COVER, HYDRAULIC TANK	1
4	60353	. SCREW, CAP	6
5	63301	. WASHER, LOCK	6
6	32691	. ASSEMBLY, DRIVE BLOCK VALVE (See Sect. 3, Fig. 21 for Details)	1
-7	60352	. SCREW, CAP	3
-8	63301	. WASHER, LOCK	6
-9	60701	. NUT, HEX	3
10	32702	. ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 22 for Details)	1
-11	60324	. SCREW, CAP	3
-12	63302	. WASHER, LOCK	3
13	80008-04	. ELBOW, MALE	1
14	32694	. ASSEMBLY, VALVE PACKAGE (See Sect. 3, Fig. 23 for Details)	1
-15	60322	. SCREW, CAP	2
-16	63302	. WASHER, LOCK	2
17	32699	. ASSEMBLY, LOWERING CONTROL VALVE (See Sect. 3, Fig. 24 for Details)	1
-18	60337	. SCREW, CAP	2
-19	63301	. WASHER, LOCK	2
-20	60701	. NUT, HEX	2
21	30884	. VALVE, FLOW CONTROL	1
22	65365	. U-BOLT (WITH NUTS)	1
23	63301	. WASHER, LOCK	2

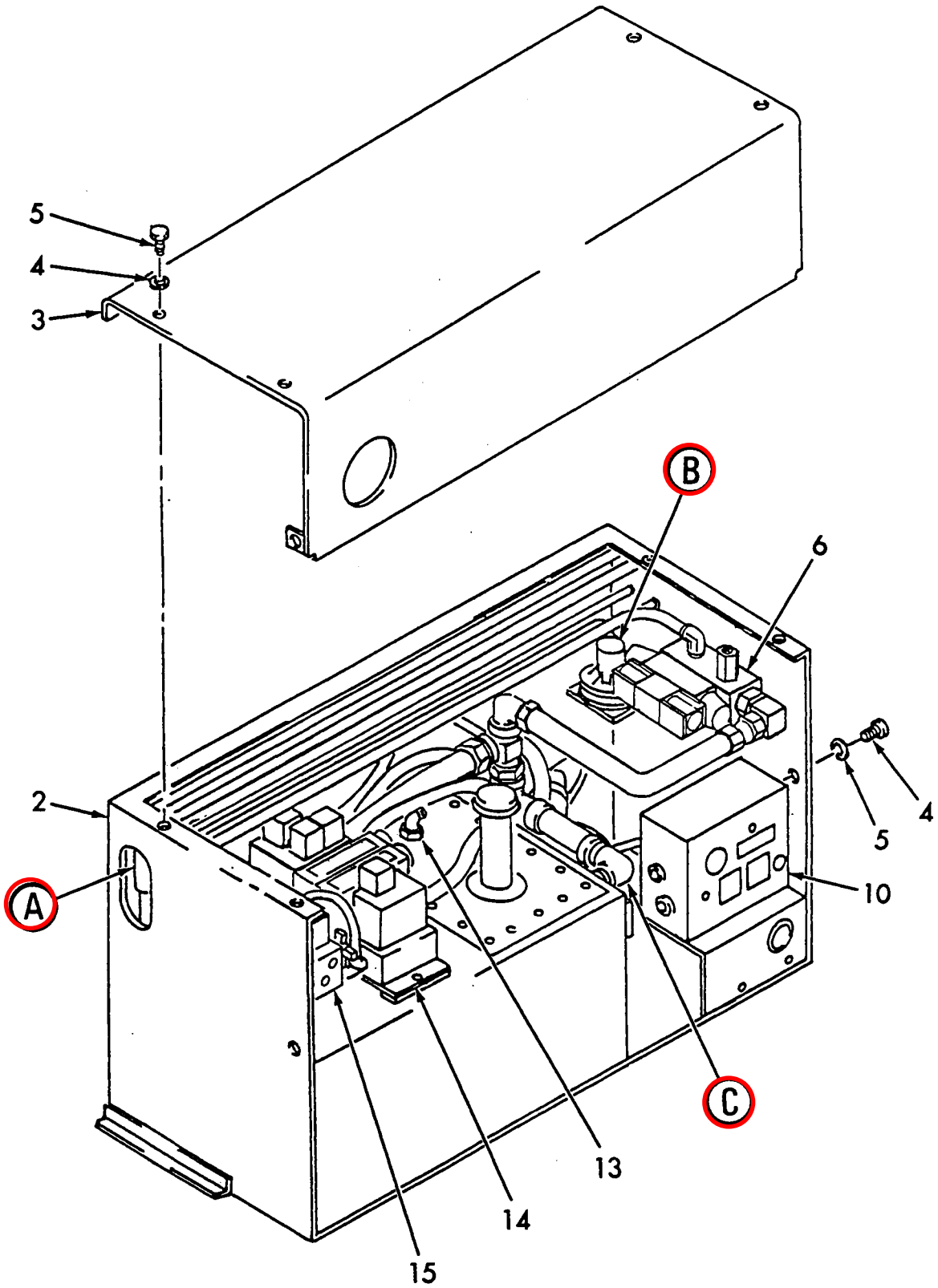
- ITEM NOT ILLUSTRATED

HYDRAULIC TANK ASSEMBLY (MT31G)

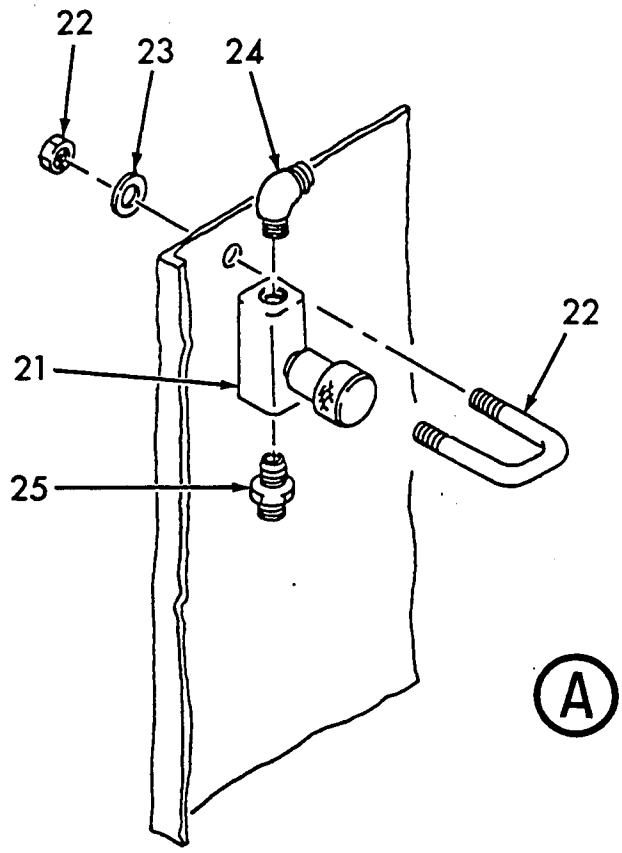
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	80008-03	. ELBOW, MALE	1
25	80001-03	. CONNECTOR, MALE	1
26	31074	. SENSOR, SLOPE	1
27	60309	. SCREW, CAP	2
28	63301	. WASHER, LOCK	2
29	60701	. NUT, HEX	2
30	80011-05	. ELBOW, BULKHEAD UNION	2
31	80011-03	. ELBOW, BULKHEAD UNION	2
32	65864	. NIPPLE	1
33	16503	. ELBOW, STREET	2
34	21241	. FILTER, RETURN	1
35	21245	.. ELEMENT	1
36	80057-19	. REDUCER, PIPE THREAD	1
37	80041-14	. TEE, STREET	1
38	80008-19	. ELBOW, MALE	1
39	80001-19	. CONNECTOR, MALE	1
40	80011-07	. ELBOW, BULKHEAD UNION	2
41	80011-03	. ELBOW, BULKHEAD UNION	1
42	80011-06	. ELBOW, BULKHEAD UNION	1
43	80011-05	. ELBOW, BULKHEAD UNION	2
44	16551	. NIPPLE	1
45	65837	. VALVE, BUTTERFLY	1
46	55201	. ELBOW, STREET	1
47	65831	. NIPPLE COMBINATION	1
-48	70029	. CONNECTOR	AR
-49	70271	. CONNECTOR	AR

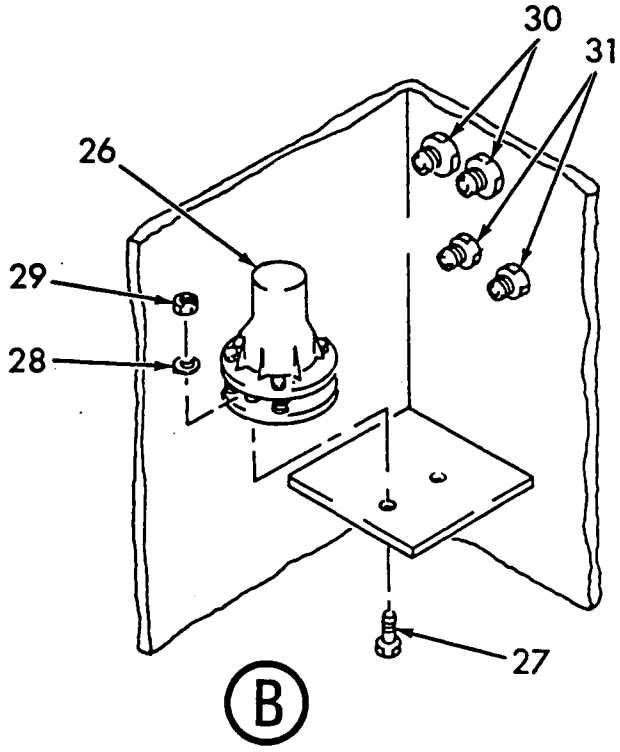
- ITEM NOT ILLUSTRATED

HYDRAULIC TANK ASSEMBLY (MT40G)

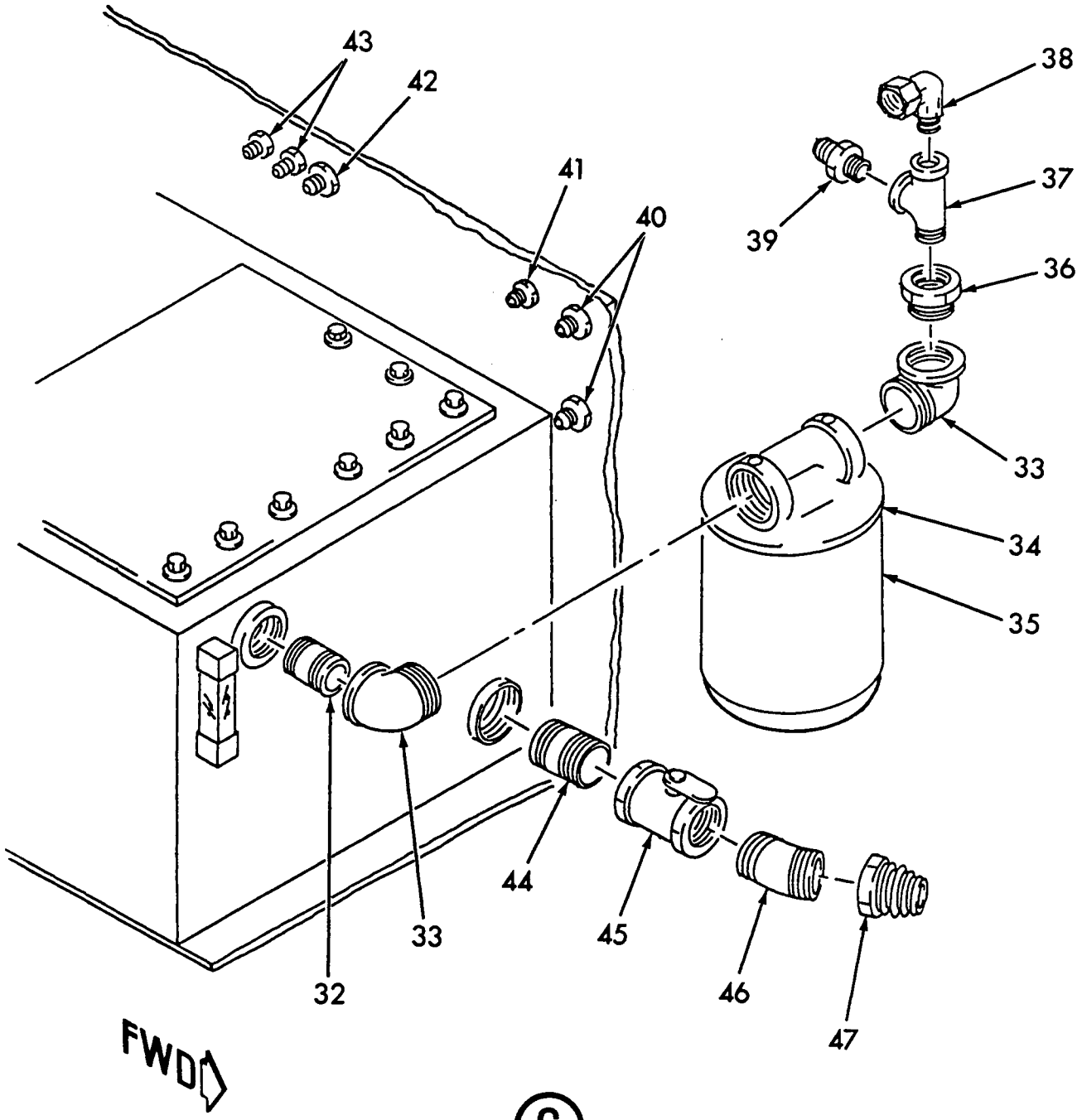


HYDRAULIC TANK ASSEMBLY (MT40G)





HYDRAULIC TANK ASSEMBLY (MT40G)



HYDRAULIC TANK ASSEMBLY (MT40G)

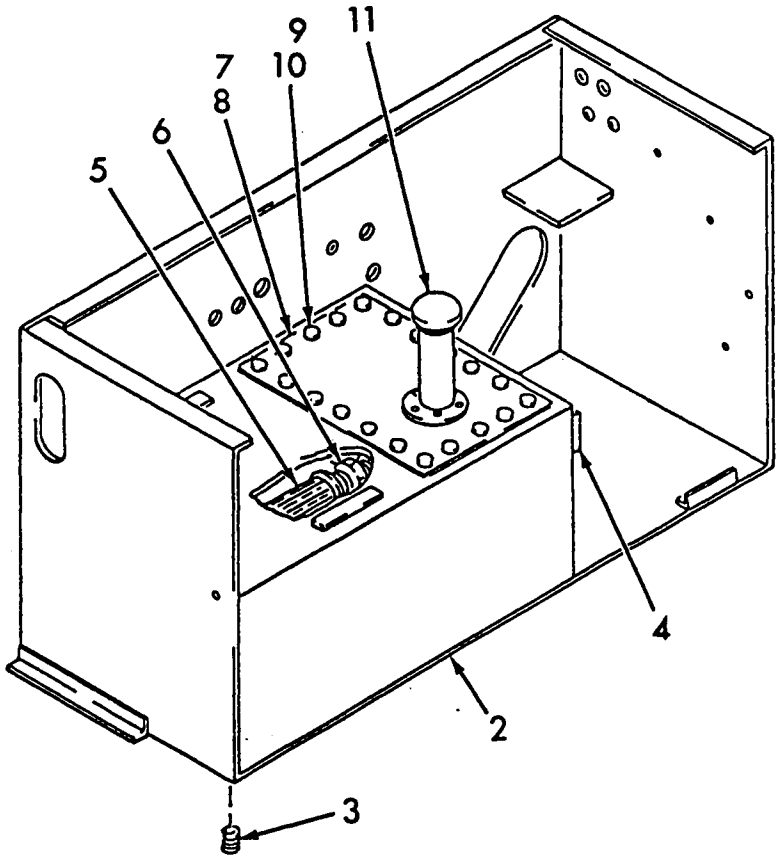
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32685	ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 1A for NHA)	REF
2	32393	. SUB-ASSEMBLY, HOUSING TANK (See Sect. 3, Fig. 20 for Details)	1
3	32171	. COVER, HYDRAULIC TANK	1
4	60353	. SCREW, CAP	6
5	63301	. WASHER, LOCK	6
6	32691	. ASSEMBLY, DRIVE BLOCK (See Sect. 3, Fig. 21 for Details)	1
-7	60352	. SCREW, CAP	3
-8	63301	. WASHER, LOCK	6
-9	60701	. NUT, HEX	3
10	32700	. ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 22A for Details)	1
-11	60324	. SCREW, CAP	3
-12	63302	. WASHER, LOCK	3
13	80008-04	. ELBOW, MALE	1
14	32694	. ASSEMBLY, VALVE PACKAGE (See Sect. 3, Fig. 23 for Details)	1
-15	60322	. SCREW, CAP	2
-16	63302	. WASHER, LOCK	2
17	32699	. ASSEMBLY, LOWERING CONTROL VALVE (See Sect. 3, Fig. 24 for Details)	1
-18	60337	. SCREW, CAP	2
-19	63301	. WASHER, LOCK	2
-20	60701	. NUT, HEX	2
21	30884	. VALVE, FLOW CONTROL	1
22	65365	. U-BOLT (WITH NUTS)	1
23	63301	. WASHER, LOCK	2

HYDRAULIC TANK ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
24	80008-03	. ELBOW, MALE	1
25	80001-03	. CONNECTOR, MALE	1
26	31074	. SENSOR, SLOPE	1
27	60309	. SCREW, CAP	2
28	63301	. WASHER, LOCK	2
29	60701	. NUT, HEX	2
30	80011-05	. ELBOW, BULKHEAD UNION	2
31	80011-03	. ELBOW, BULKHEAD UNION	2
32	65864	. NIPPLE	1
33	16503	. ELBOW, STREET	2
34	21241	. FILTER, RETURN	1
35	21245	.. ELEMENT	1
36	80057-19	. REDUCER, PIPE THREAD	1
37	80041-14	. TEE, STREET	1
38	80008-19	. ELBOW, MALE	1
39	80001-19	. CONNECTOR, MALE	1
40	80011-07	. ELBOW, BULKHEAD UNION	2
41	80011-03	. ELBOW, BULKHEAD UNION	1
42	80011-06	. ELBOW, BULKHEAD UNION	1
43	80011-05	. ELBOW, BULKHEAD UNION	2
44	16551	. NIPPLE	1
45	65837	. VALVE, BUTTERFLY	1
46	55201	. ELBOW, STREET	1
47	65831	. NIPPLE COMBINATION	1
-48	70029	. CONNECTOR	AR
-49	70271	. CONNECTOR	AR

- ITEM NOT ILLUSTRATED

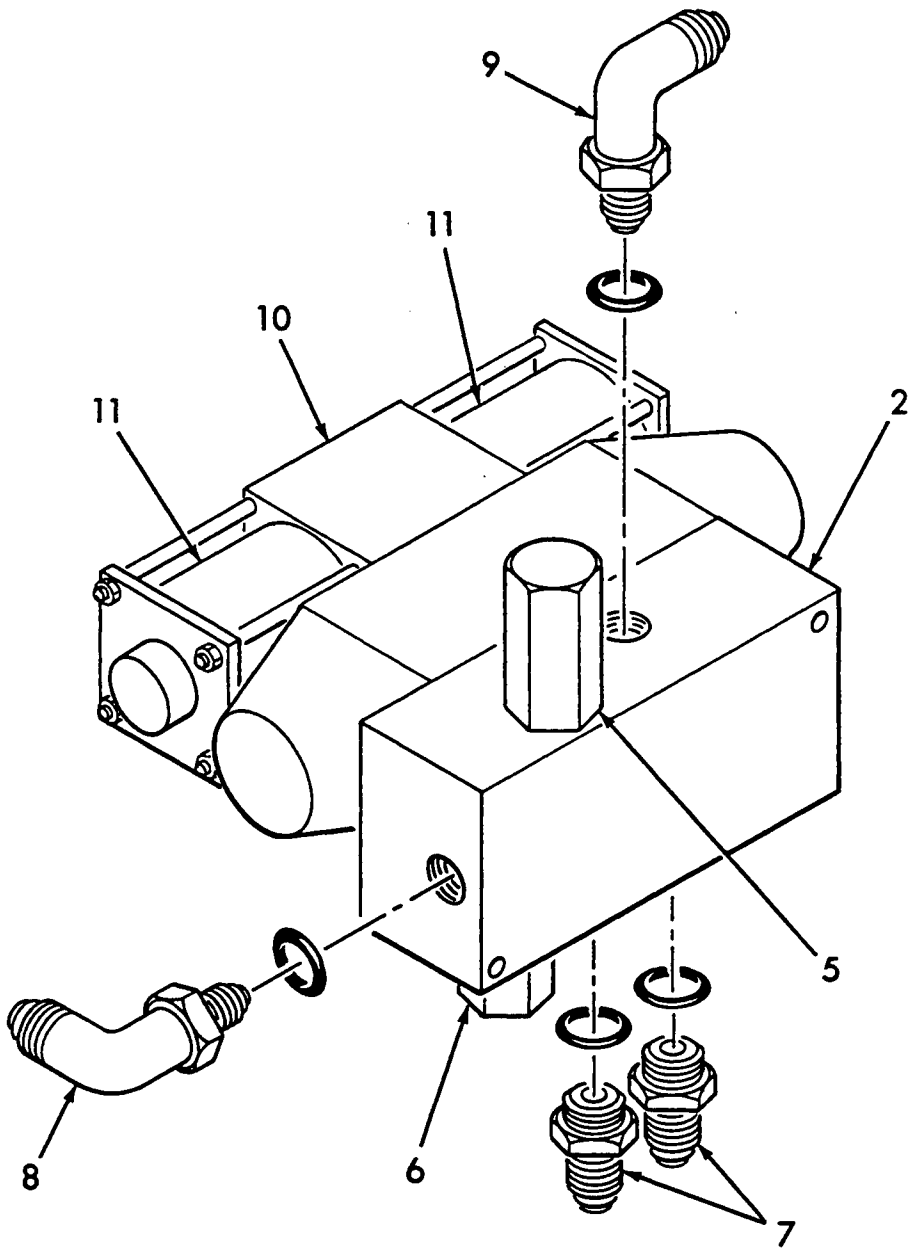
HOUSING TANK SUB-ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32393	SUB-ASSEMBLY, HOUSING TANK (See Sect. 3, Fig. 19 or 19A for NHA)	REF
2	32189	. WELDMENT, HYDRAULIC HOUSING	1
3	3027	. PLUG, MAGNETIC	1
4	3018	. GUAGE, FLUID LEVEL	1
5	81171	. STRAINER	1
6	80052-15	. NIPPLE, PIPE	1
7	32173	. COVER, HYDRAULIC TANK	1
8	32175	. GASKET, HYDRAULIC TANK	1
9	60353	. SCREW, CAP	20
10	63301	. WASHER, LOCK	20
11	81123	. ASSEMBLY, FILLER NECK	1

REV.

DRIVE BLOCK ASSEMBLY



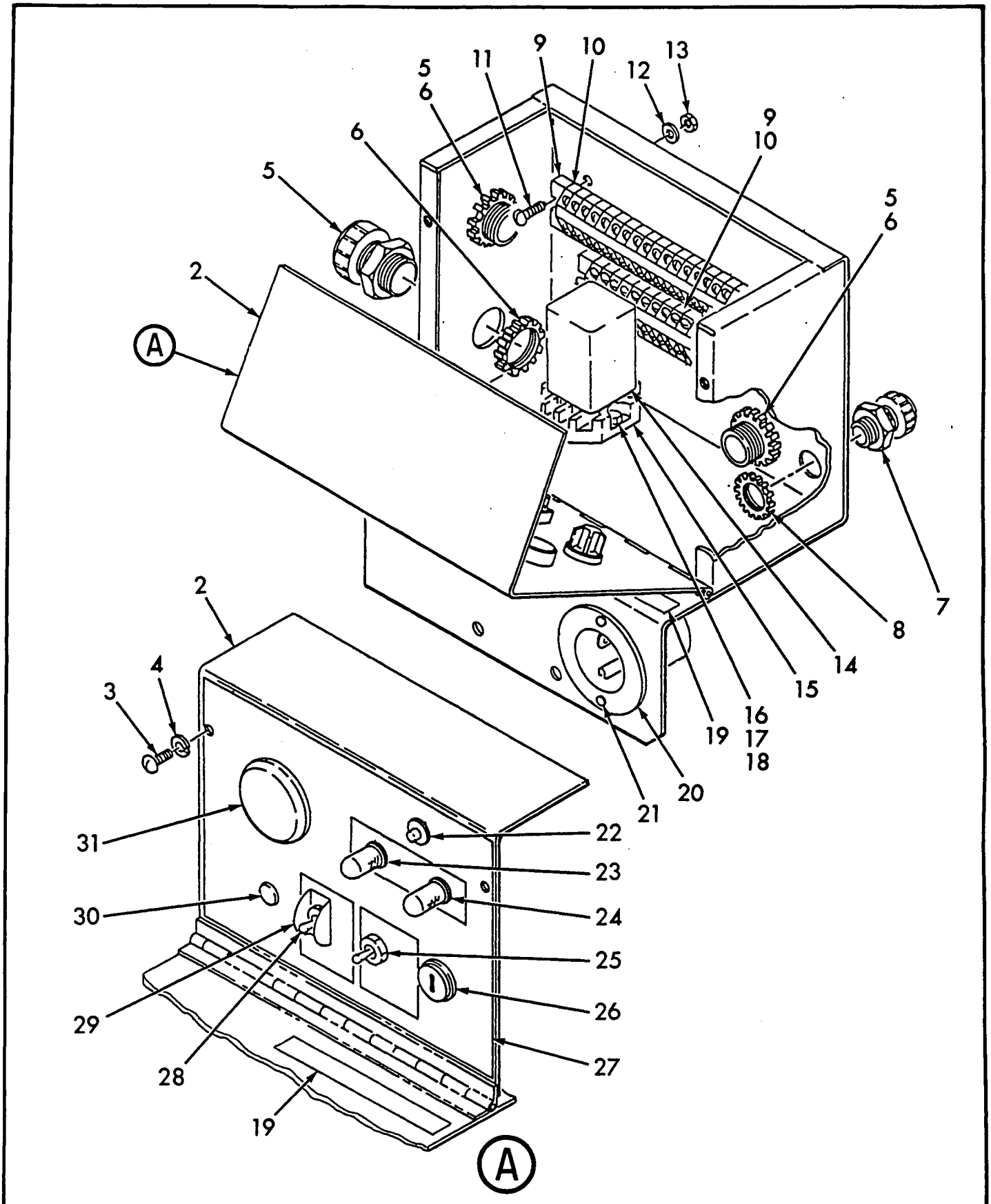
DRIVE BLOCK ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32691	ASSEMBLY, DRIVE BLOCK VALVE (See Sect. 3, Fig. 19 or 19A for NHA)	REF
2	81255	. VALVE, DRIVE BLOCK	1
-3	68058	.. KIT, SEAL	1
-4	600023	.. VALVE, SHUTTLE	1
5	68060	.. VALVE, RELIEF*	1
6	67229	.. REGULATOR, FLOW	1
7	80004-16	. CONNECTOR, STRAIGHT THREAD	2
8	80012-19	. ELBOW, STRAIGHT THREAD	1
9	80012-16	. ELBOW, STRAIGHT THREAD	1
10	81169	. VALVE, DIRECTION CONTROL	1
11	66749	.. COIL, 12V	2

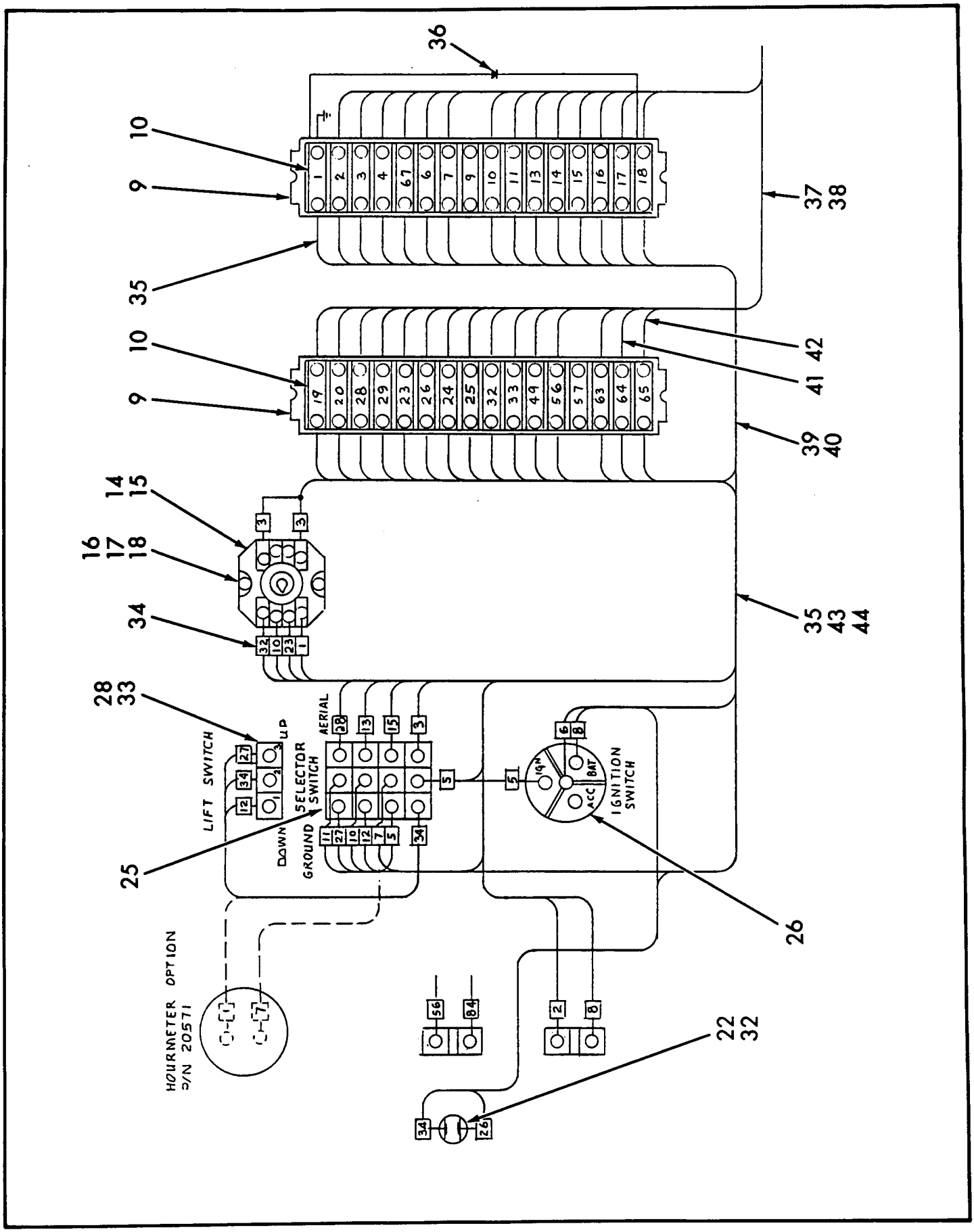
NOTE:
PRIOR TO USE, ITEMS WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE LISTED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.

- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY (MT31G)



GROUND CONTROL BOX ASSEMBLY (MT31G)



GROUND CONTROL BOX ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32702	ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 19 for NHA)	REF
2	32390	. BOX, GROUND CONTROL	1
3	62612	. SCREW, CAP	2
4	63312	. WASHER, LOCK	2
5	2807	. RELIEF, STRAIN	3
6	2809	. NUT, LOCK	3
7	2806	. RELIEF, STRAIN	1
8	2808	. NUT, LOCK	1
9	117-A	. END, TERMINAL BLOCK	2
10	4027	. BLOCK, TERMINAL	32
11	62612	. SCREW, CAP	4
12	63312	. WASHER, LOCK	4
13	61502	. NUT, HEX	4
14	70170	. RELAY	1
15	70239	. SOCKET	1
16	62623	. SCREW, CAP	2
17	63312	. WASHER, LOCK	2
18	61502	. NUT, HEX	2
19	185707	. DECAL, POWER TO PLATFORM 110 VAC	1
20	70409	. RECEPTACLE	1
21	61502	. NUT, HEX	2
22	4011	. SWITCH, PUSH BUTTON	1
23	20562	. BREAKER, CIRCUIT	1
24	20562	. BREAKER, CIRCUIT	1
25	16260	. SWITCH, TOGGLE (SELECTOR)	1

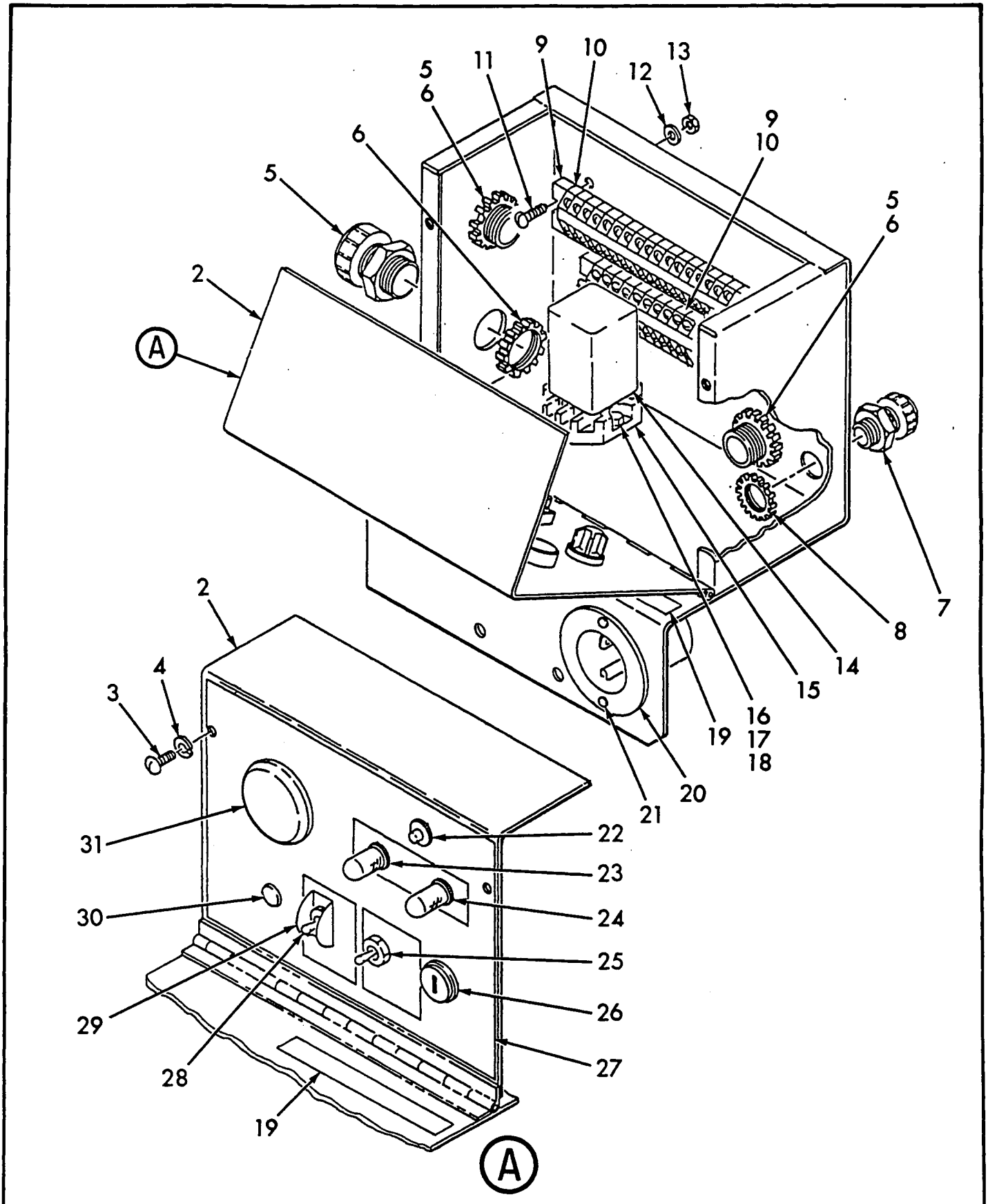
- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY (MT31G)

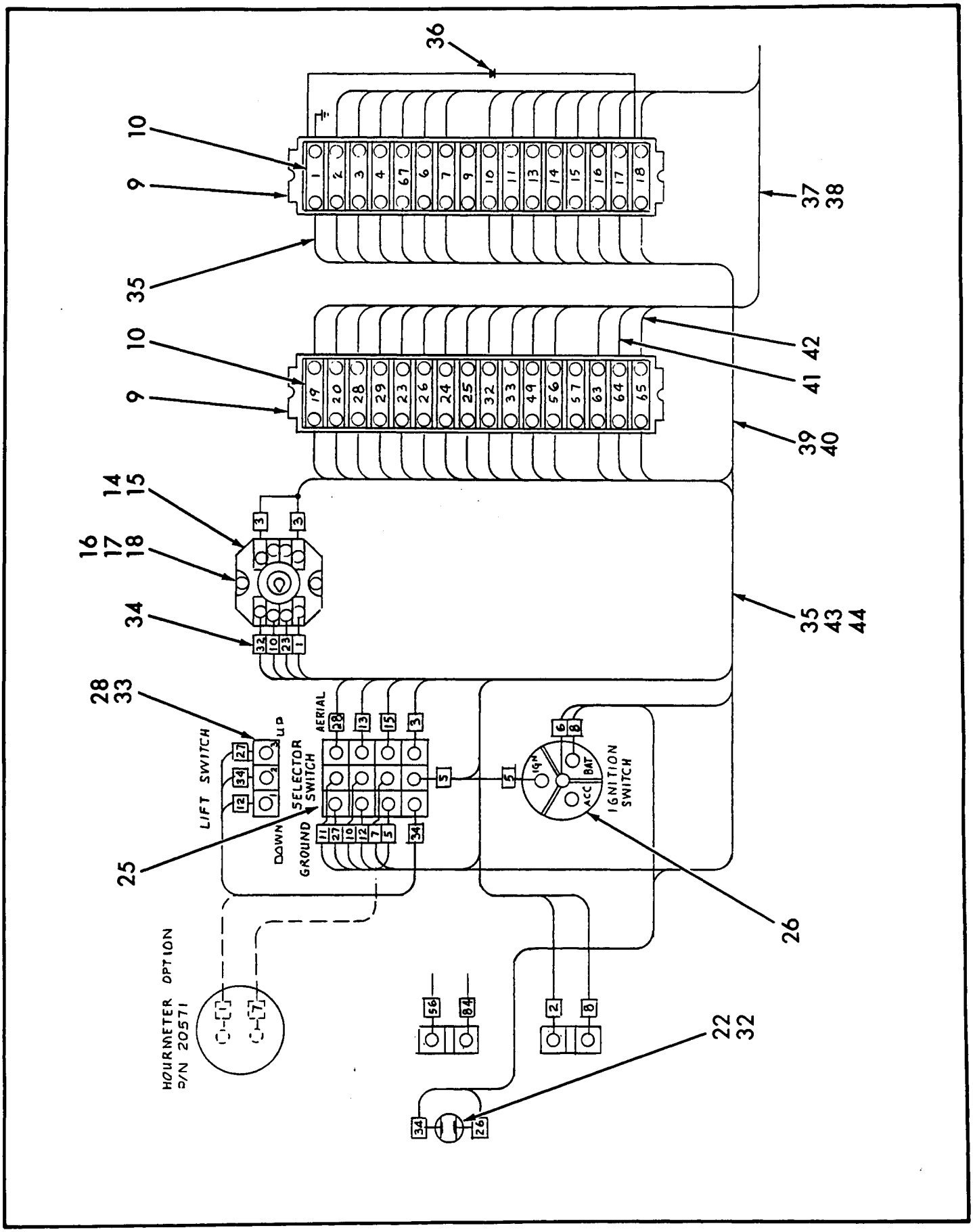
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	2717	. SWITCH, IGNITION	1
27	32345	. DECAL, GROUND CONTROL	1
28	4021	. SWITCH, TOGGLE (LIFT)	1
29	20884	. GUARD, SWITCH	1
30	771	. PLUG, WHITE	1
31	65244	. PLUG, WHITE	2
32	117-E	. TERMINAL, PUSH-ON	2
33	117-C	. RING, CONNECTOR	33
34	16213	. CONNECTOR	6
35	70006	. WIRE, GREEN (15 FT)	AR
36	70442	. DIODE	1
37	70009	. WIRE, RED (15 FT)	AR
38	2991	. WIRE, WHITE (1 FT)	AR
39	70232	. WIRE, WHITE (9 FT)	AR
40	2990	. WIRE, WHITE (12 FT)	AR
41	70007	. WIRE, YELLOW (15 FT)	AR
42	70004	. WIRE, BLUE (15 FT)	AR
43	70008	. WIRE, YELLOW (3 FT)	AR
44	4034	. CABLE (12 FT)	AR
-45	6K	. WIRE, BLACK (4 FT)	AR

- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY (MT40G)



GROUND CONTROL BOX ASSEMBLY (MT40G)



GROUND CONTROL BOX ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32700	ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 19A for NHA)	REF
2	32390	. BOX, GROUND CONTROL	1
3	62612	. SCREW, CAP	2
4	63312	. WASHER, LOCK	2
5	2807	. RELIEF, STRAIN	3
6	2809	. NUT, LOCK	3
7	2806	. RELIEF, STRAIN	1
8	2808	. NUT, LOCK	1
9	117-A	. END, TERMINAL BLOCK	2
10	4027	. BLOCK, TERMINAL	32
11	62612	. SCREW, CAP	4
12	63312	. WASHER, LOCK	4
13	61502	. NUT, HEX	4
14	70170	. RELAY	1
15	70239	. SOCKET	1
16	62623	. SCREW, CAP	2
17	63312	. WASHER, LOCK	2
18	61502	. NUT, HEX	2
19	185707	. DECAL, POWER TO PLATFORM 110 VAC	1
20	70409	. RECEPTACLE	1
21	61502	. NUT, HEX	2
22	4011	. SWITCH, PUSH BUTTON	1
23	20562	. BREAKER, CIRCUIT	1
24	20562	. BREAKER, CIRCUIT	1
25	16260	. SWITCH, TOGGLE (SELECTOR)	1

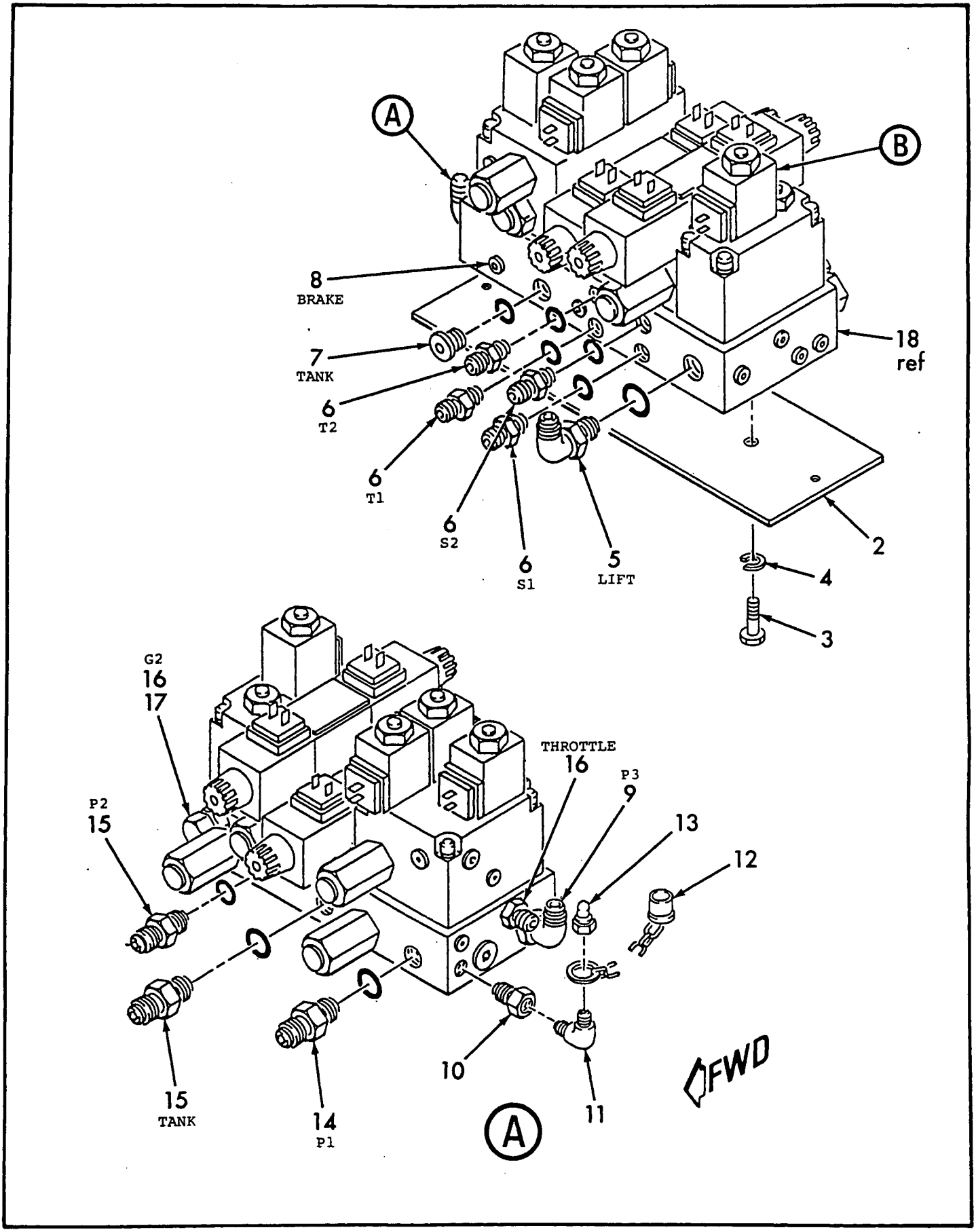
- ITEM NOT ILLUSTRATED

GROUND CONTROL BOX ASSEMBLY (MT40G)

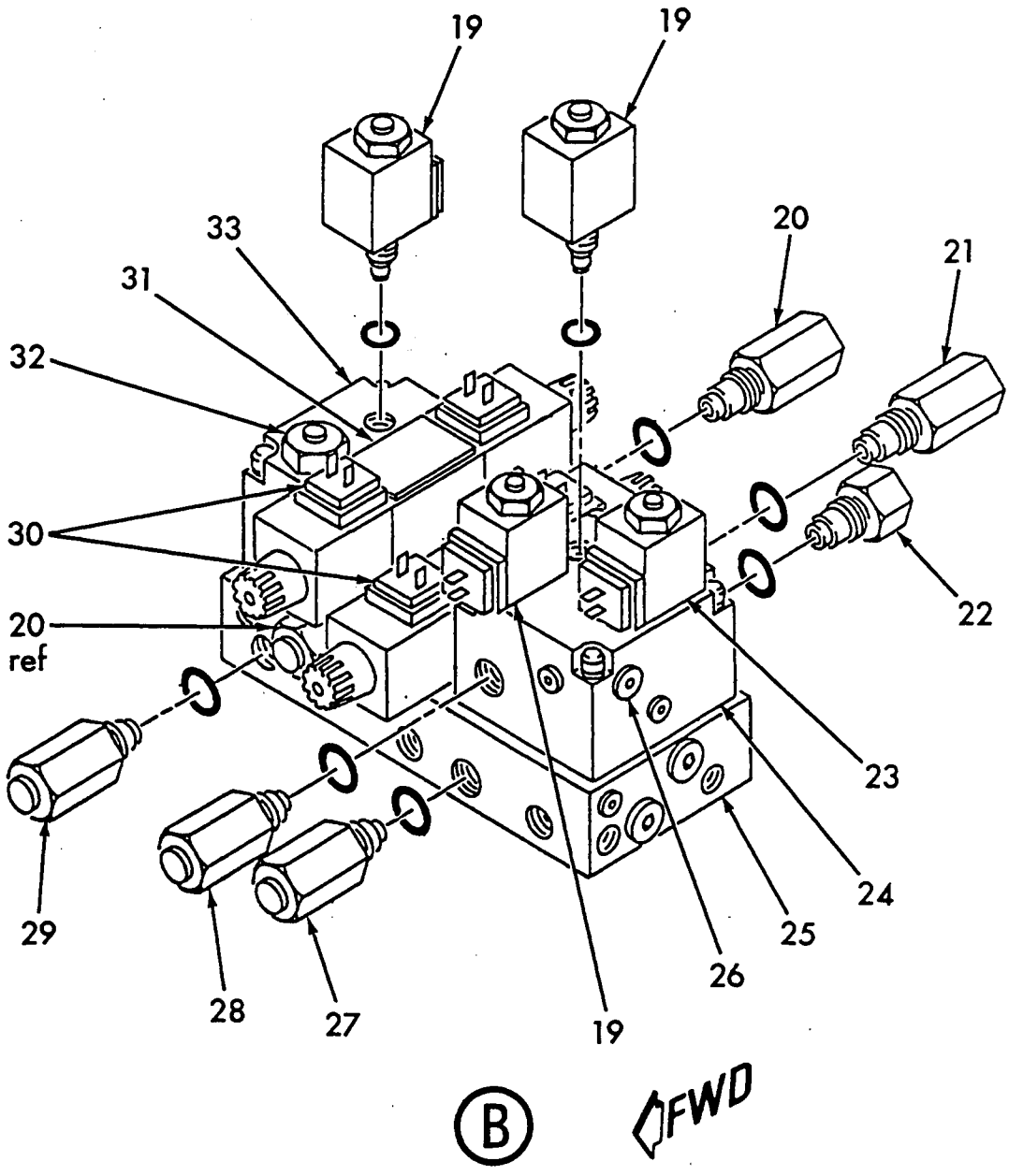
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	2717	. SWITCH, IGNITION	1
27	32345	. DECAL, GROUND CONTROL	1
28	4021	. SWITCH, TOGGLE (LIFT)	1
29	20884	. GUARD, SWITCH	1
30	771	. PLUG, WHITE	1
31	65244	. PLUG, WHITE	2
32	117-E	. TERMINAL, PUSH-ON	2
33	117-C	. RING, CONNECTOR	33
34	16213	. CONNECTOR	6
35	70006	. WIRE, GREEN (15 FT)	AR
36	70442	. DIODE	1
37	70009	. WIRE, RED (15 FT)	AR
38	2991	. WIRE, WHITE (1 FT)	AR
39	70232	. WIRE, WHITE (9 FT)	AR
40	2990	. WIRE, WHITE (12 FT)	AR
41	70007	. WIRE, YELLOW (15 FT)	AR
42	70004	. WIRE, BLUE (15 FT)	AR
43	70008	. WIRE, YELLOW (3 FT)	AR
44	4034	. CABLE (12 FT)	AR
-45	6K	. WIRE, BLACK (4 FT)	AR

- ITEM NOT ILLUSTRATED

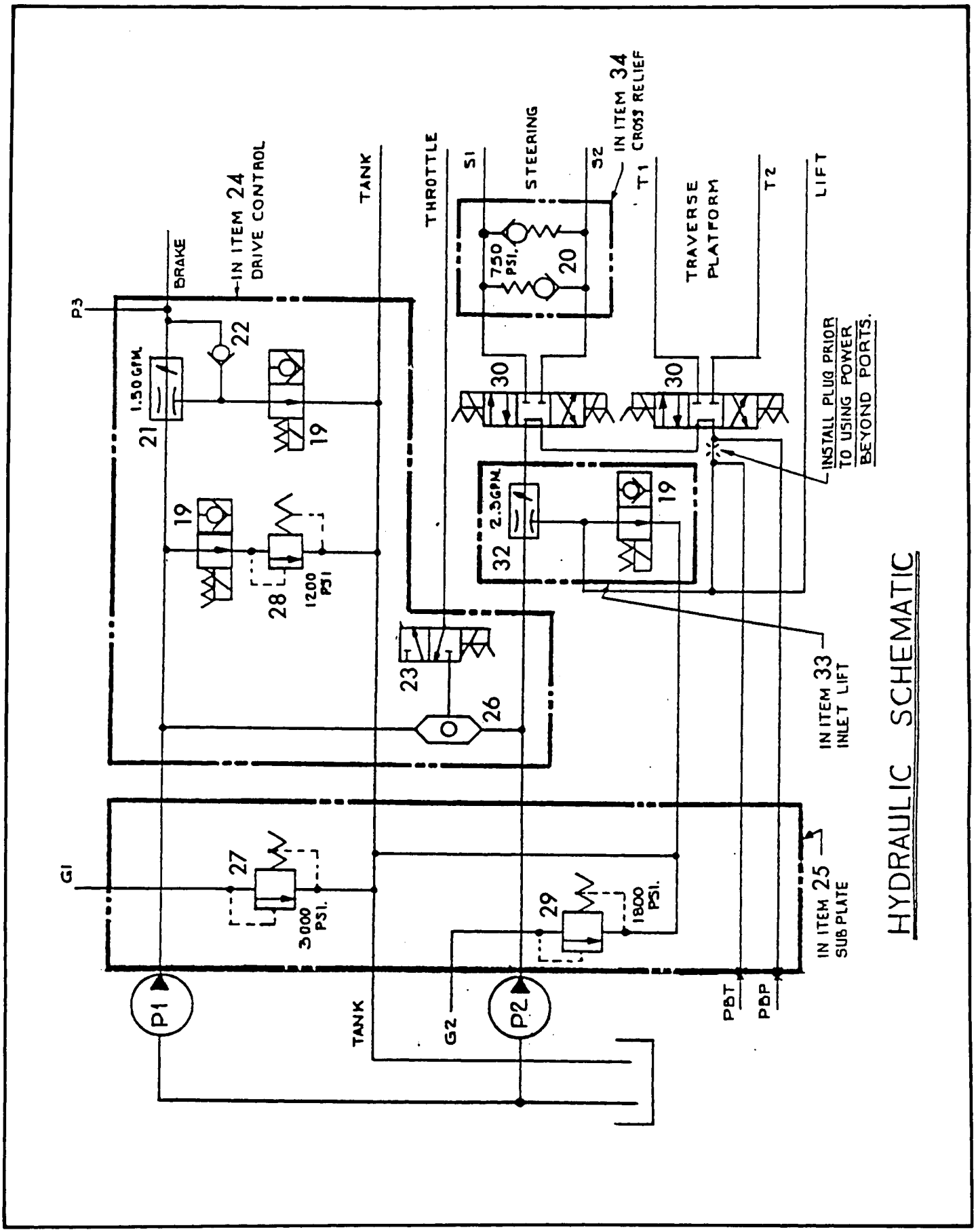
VALVE PACKAGE ASSEMBLY



VALVE PACKAGE ASSEMBLY



VALVE PACKAGE ASSEMBLY



VALVE PACKAGE ASSEMBLY

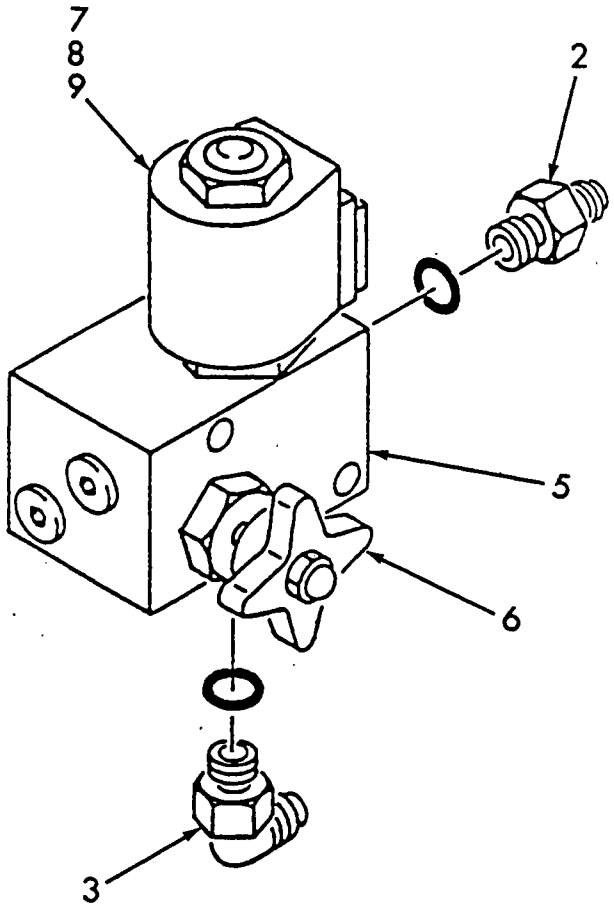
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32694	ASSEMBLY, VALVE PACKAGE (See Sect. 3, Fig. 19 or 19A for Details)	REF
2	32190	. PLATE, MOUNTING	1
3	60325	. SCREW, CAP	2
4	63319	. WASHER, LOCK	2
5	80012-11	. ELBOW (LIFT)	1
6	81149	. ADAPTER (S1, S2, T1, T2)	4
7	80051-06	. PLUG, HEX (TANK)	1
8	80051-03	. PLUG, HEX (BRAKE)	1
9	80012-16	. ELBOW (P3)	1
10	51903	. ADAPTER, FEMALE (G1)	1
11	80022-03	. ELBOW, MALE	1
12	845	. CAP, QUICK DISCONNECT	1
13	2527	. COUPLING, QUICK DISCONNECT	1
14	80012-09	. CONNECTOR (P1)	1
15	80004-16	. CONNECTOR (P2, TANK)	2
16	80004-03	. CONNECTOR (G2, THROTTLE)	2
17	80059-03	. CAP (G2)	1
-18	81124	. PACKAGE, VALVE	1
19	66920	.. SOLENOID, 2 WAY N.O.	3
20	66926	.. VALVE, RELIEF	2
21	66921	.. DIVIDER, FLOW	1
22	66674	.. VALVE, CHECK	1
23	66923	.. SOLENOID, 2 POS. 3 WAY	1
24	66931	.. CONTROL, DRIVE	1
25	66898	.. SUB-PLATE	1

- ITEM NOT ILLUSTRATED

VALVE PACKAGE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
26	66664	.. VALVE, SHUTTLE	1
27	66919	.. VALVE, RELIEF	1
28	66922	.. VALVE, RELIEF	1
29	66927	.. VALVE, RELIEF	1
30	66925	.. VALVE, DO1	2
31	66853	.. PLATE, COVER	2
32	66677	.. REGULATOR, FLOW	1
33	66899	.. SECTION, INLET	1
-34	66930	.. RELIEF, CROSS	1
-35	66913	.. COIL, 12V D.C.V.	1
-36	66914	.. COIL, 12V	1
-37	67018	.. KIT, SEAL	1

- ITEM NOT ILLUSTRATED


7
8
9
2
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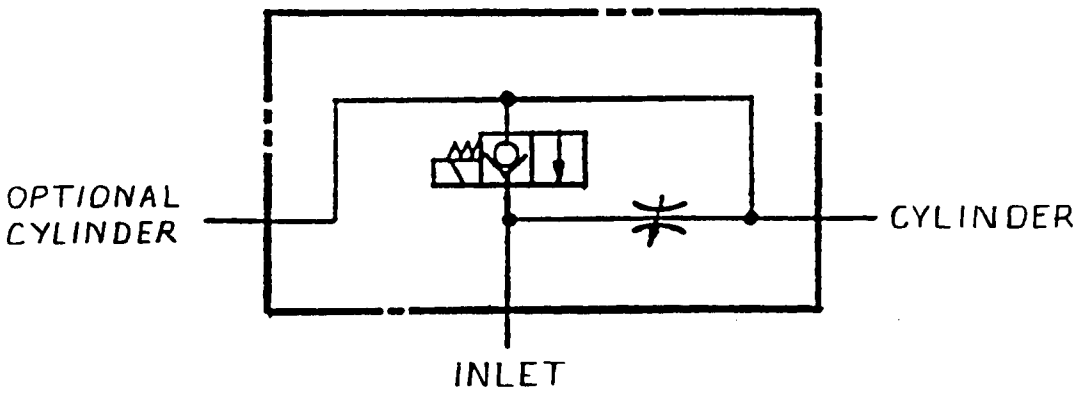
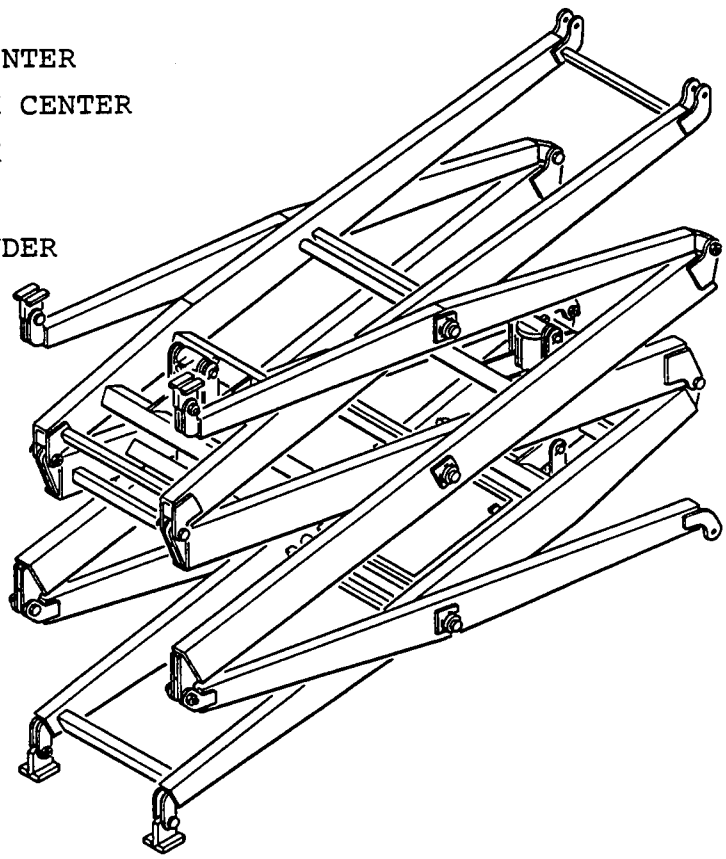

OPTIONAL
CYLINDER
CYLINDER
INLET

LOWERING PACKAGE ASSEMBLY

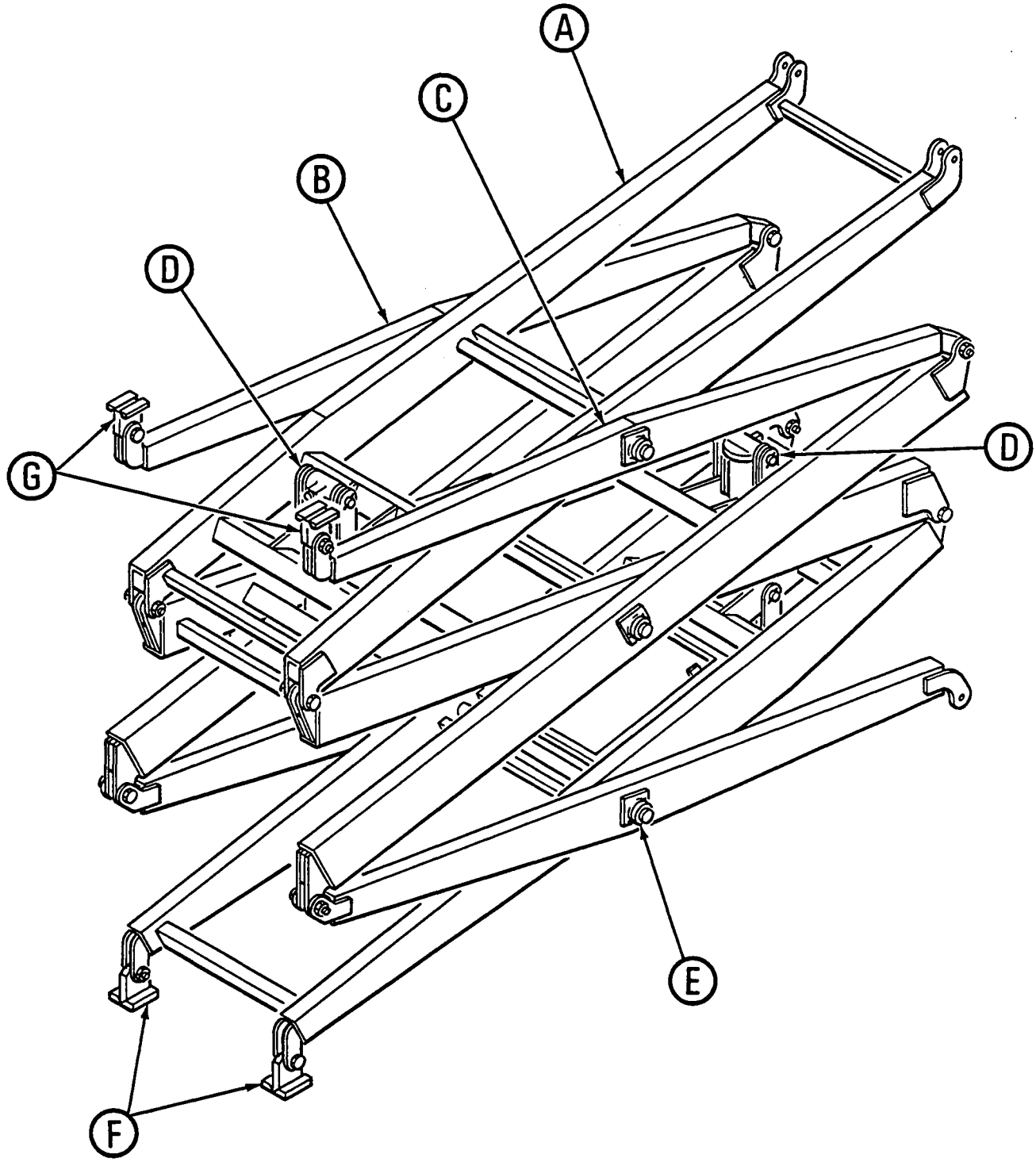
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32700	ASSEMBLY, LOWERING CONTROL VALVE (See Sect. 3, Fig. 19 or 19A for Details)	REF
2	80004-11	. CONNECTOR (CYL.)	1
3	80012-11	. ELBOW (INLET)	1
-4	81145	. VALVE, LOWERING CONTROL	1
5	67010	.. VALVE, NEEDLE (WITH HANDLE)	1
6	67009	.. HANDLE (ONLY)	1
7	67011	.. VALVE, SOLENOID	1
-8	67013	... KIT, SEAL	1
9	66914	.... COIL (ONLY)	1

- ITEM NOT ILLUSTRATED

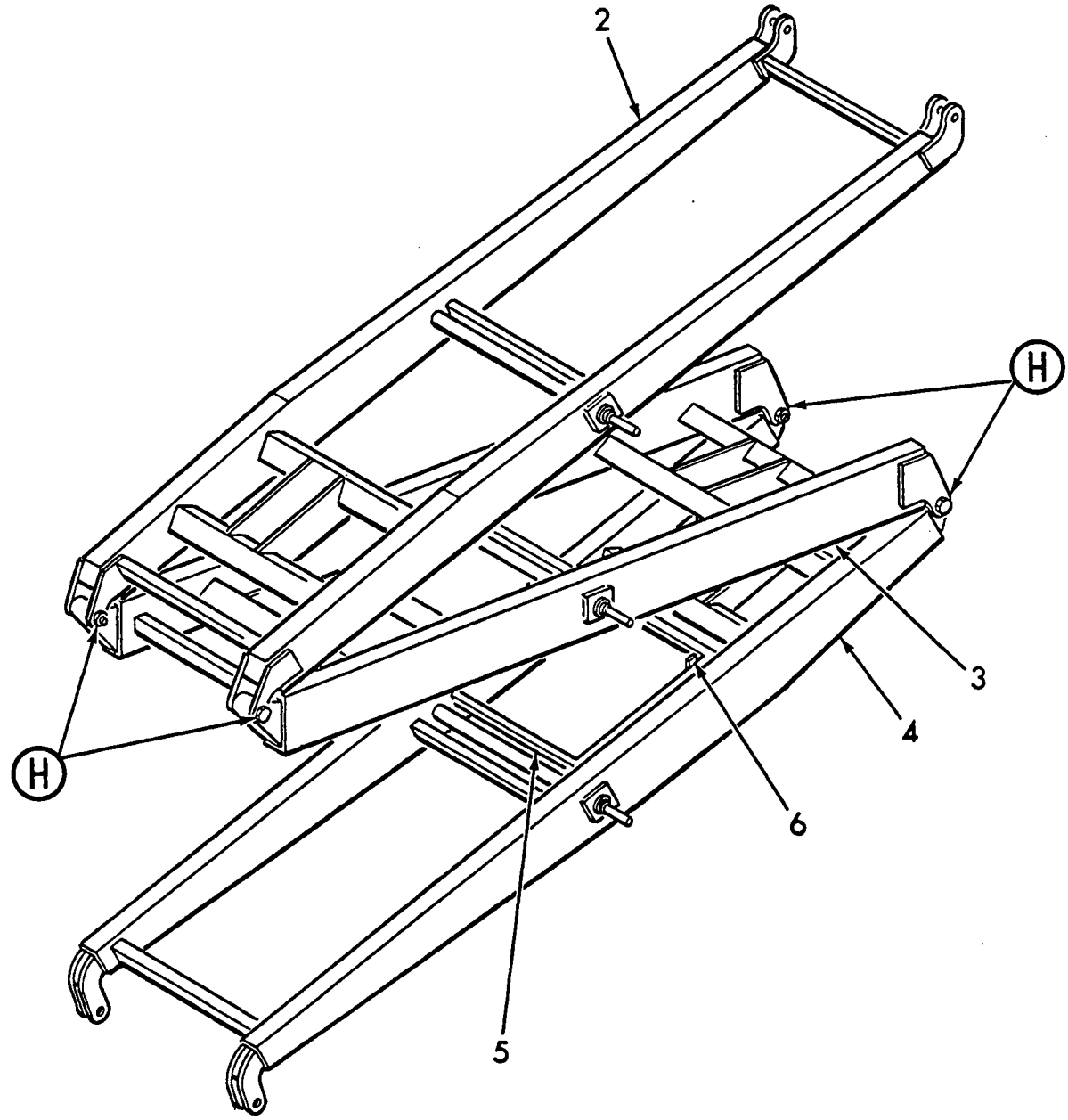
SECTION 4 CONTAINS:



SCISSOR ASSEMBLY (MT31G)

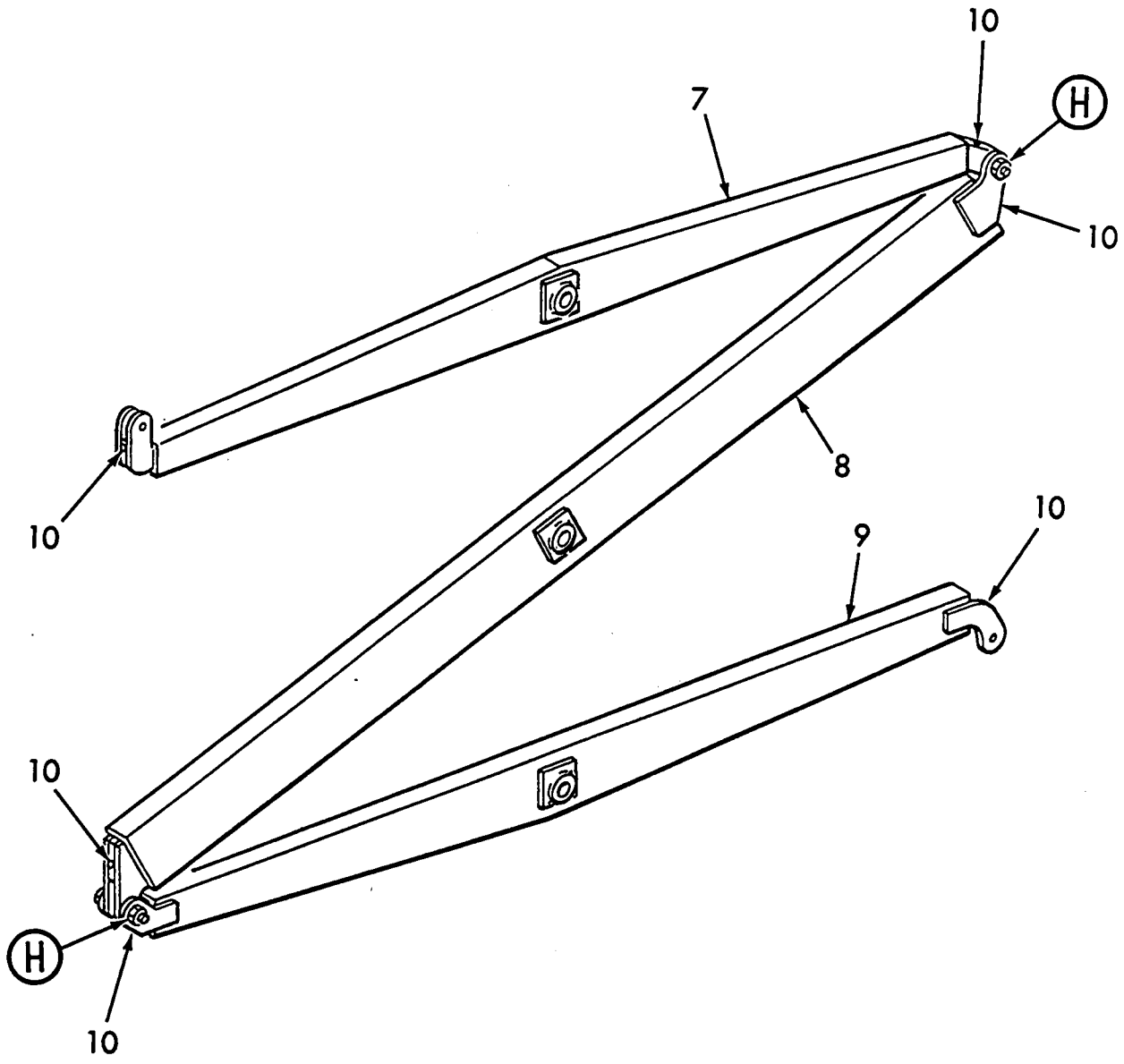


SCISSOR ASSEMBLY (MT31G)



A

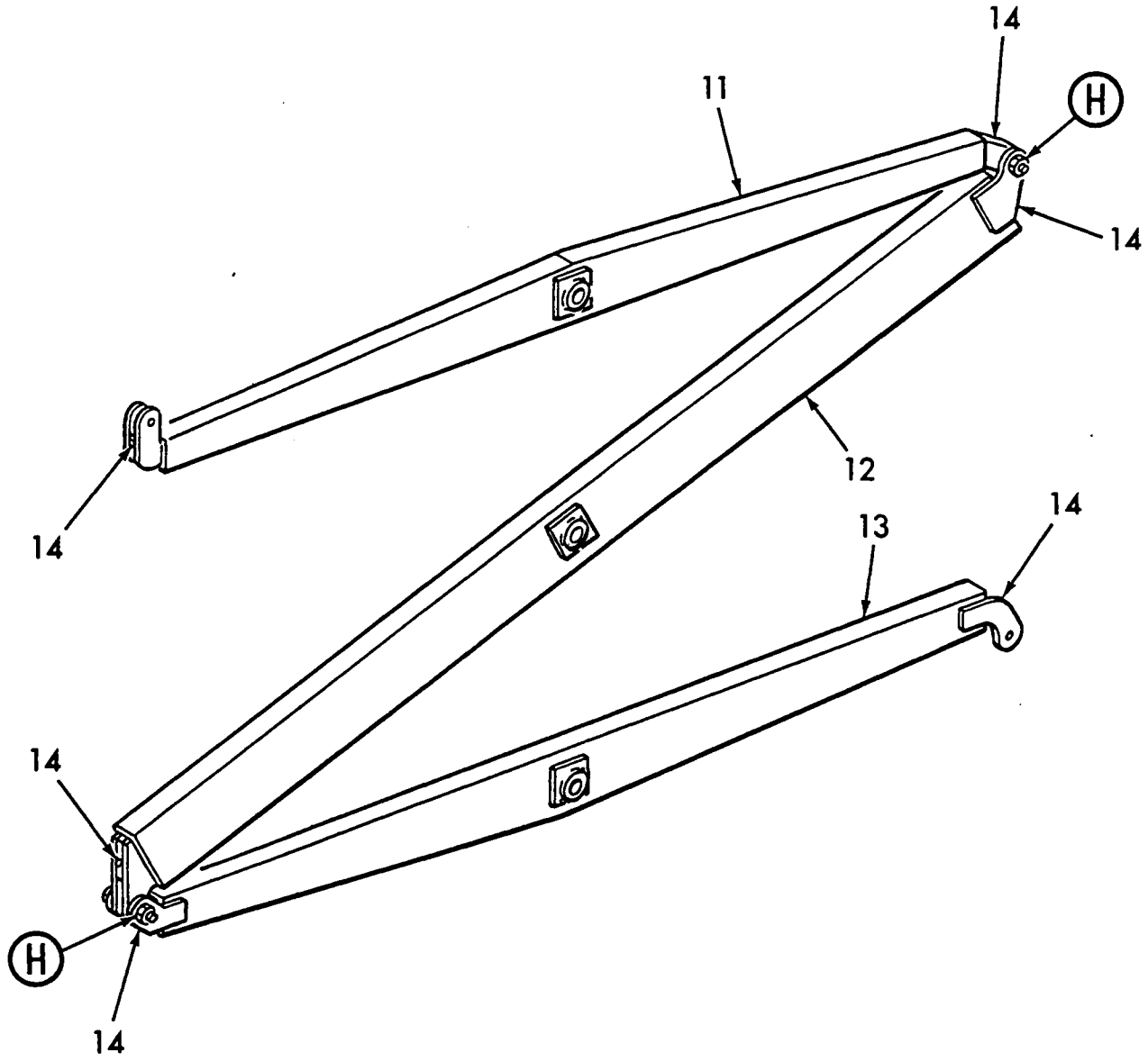
SCISSOR ASSEMBLY (MT31G)



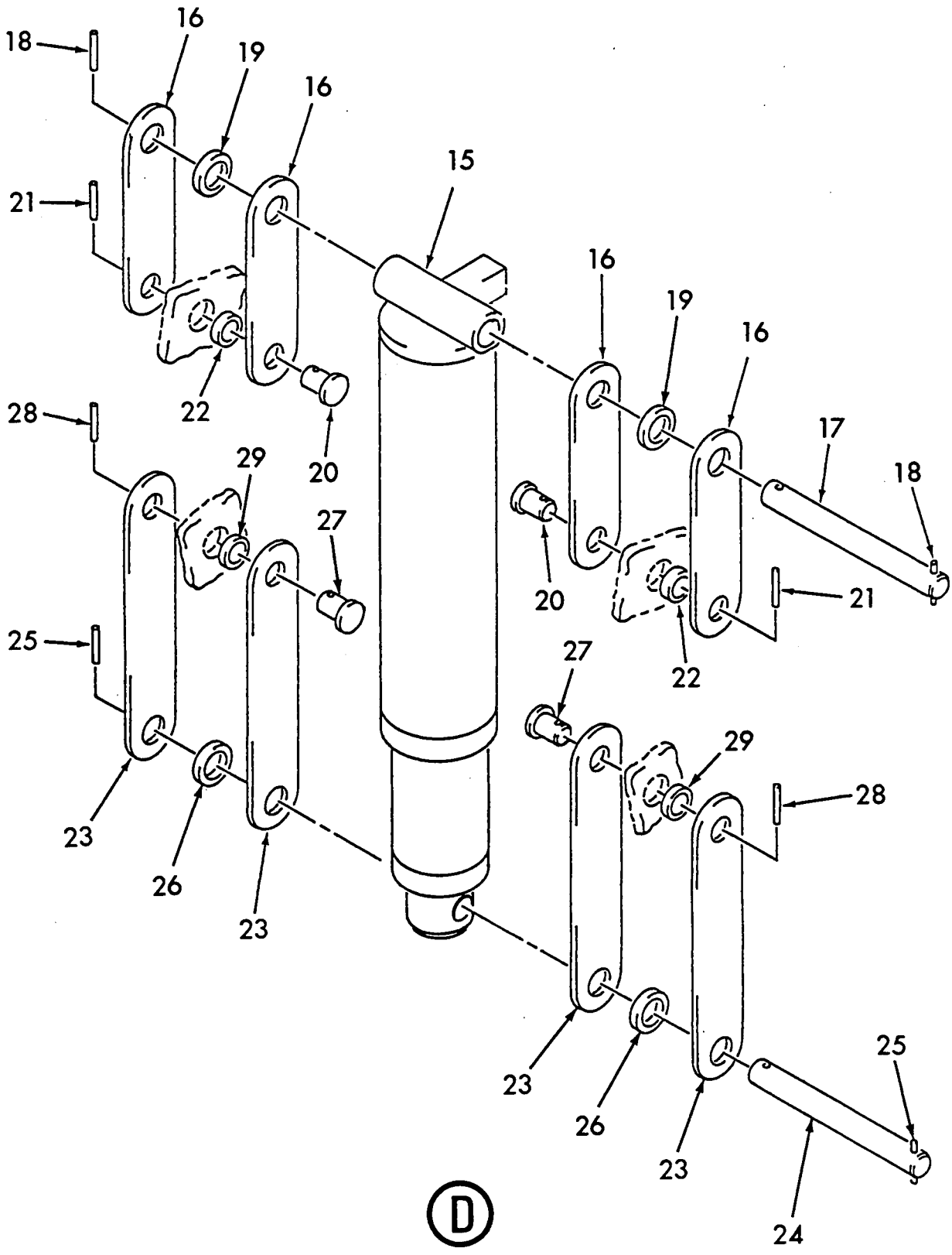
B

REV.

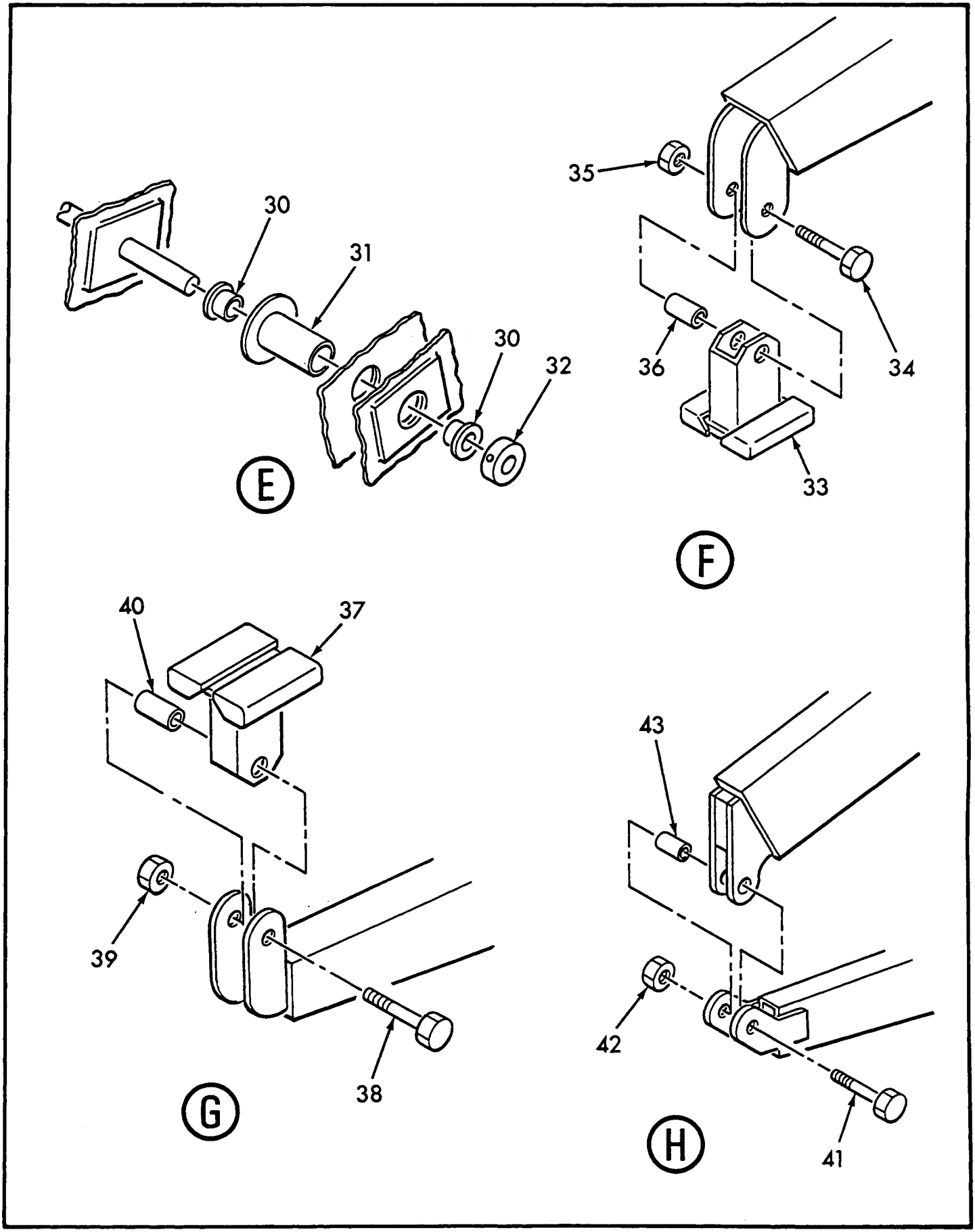
SCISSOR ASSEMBLY (MT31G)



SCISSOR ASSEMBLY (MT31G)



SCISSOR ASSEMBLY (MT31G)



REV.

SCISSOR ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32653	ASSEMBLY, SCISSOR (See Sect. 2, Fig. 1 for NHA)	REF
2	8021	. ASSEMBLY, INNER ARM-TOP (See Sect. 4, Fig. 2 for Details)	1
3	8022	. ASSEMBLY, INNER ARM-CENTER (See Sect. 4, Fig. 3 for Details)	1
4	8023	. ASSEMBLY, INNER ARM-BOTTOM (See Sect. 4, Fig. 4 for Details)	1
5	30338	. ASSEMBLY, INNER ARM SUPPORT (See Sect. 4, Fig. 5 for Details)	1
6	30701	. PIN, QUICK RELEASE	1
7	8025-1	. ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 6 for Details)	1
8	8026-1	. ASSEMBLY, OUTER ARM-CENTER (See Sect. 4, Fig. 7 for Details)	1
9	8027-1	. ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 8 for Details)	1
10	117-G	. CONNECTOR, STRAIN RELIEF	8
11	8025-2	. ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 6 for Details)	1
12	8026-2	. ASSEMBLY, OUTER ARM-CENTER (See Sect. 4, Fig. 7 for Details)	1
13	8027-2	. ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 8 for Details)	1
14	117-G	. CONNECTOR, STRAIN RELIEF	8
15	31092	. ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 9 for Details)	2
16	8304	. STRAP, CYLINDER	8
17	8303	. PIN, CYLINDER PIVOT	2
18	377	. PIN, ROLLER	4
19	8321	. COLLAR, CYLINDER PIVOT PIN	4
20	9033	. PIN, CYLINDER STRAP PIVOT	4

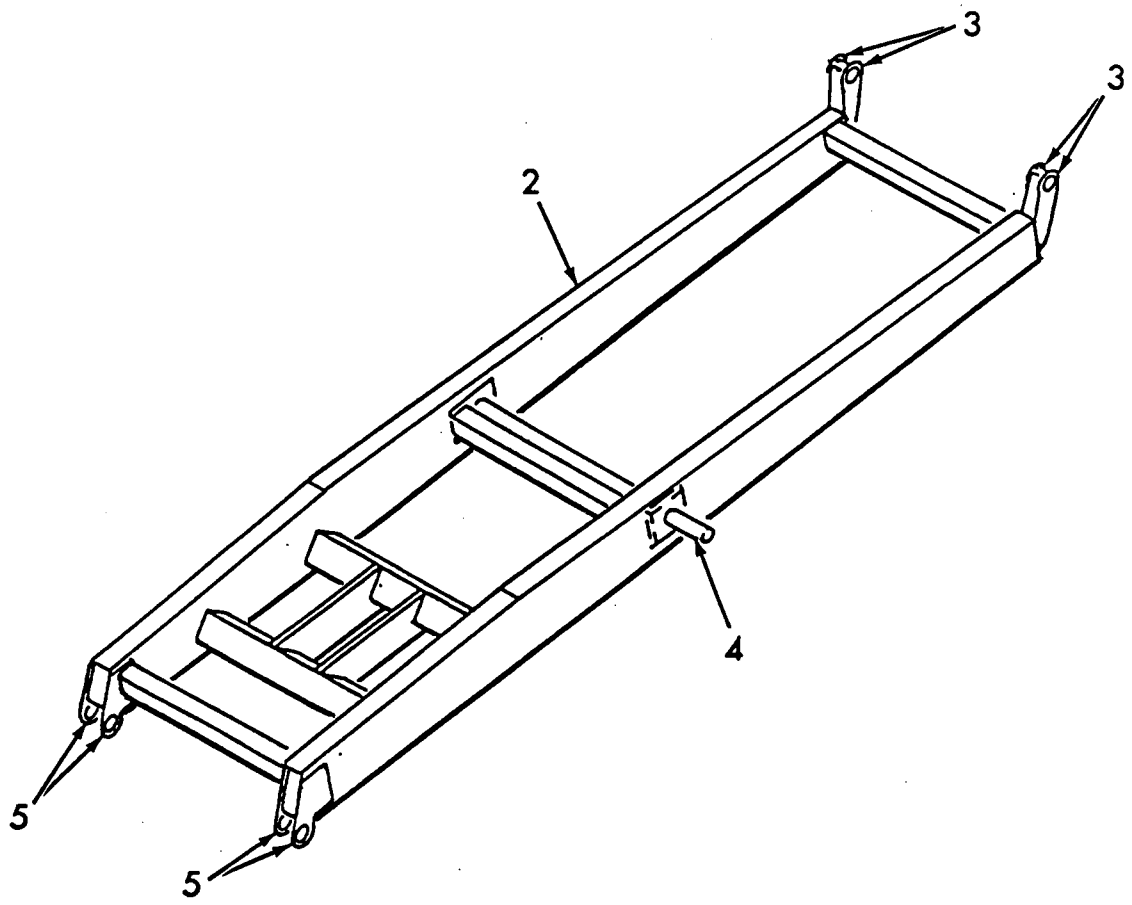
- ITEM NOT ILLUSTRATED

SCISSOR ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
21	377	. PIN, ROLLER	4
22	2279	. BUSHING	4
23	8305	. STRAP, CYLINDER	8
24	8302	. PIN, CYLINDER PIVOT	2
25	377	. PIN, ROLLER	4
26	8321	. COLLAR, CYLINDER PIVOT PIN	4
27	9033	. PIN, CYLINDER STRAP PIVOT	4
28	377	. PIN, ROLLER	4
29	2279	. BUSHING	4
30	2282	. BEARING, FLANGED	12
31	23823	. SPACER	6
32	2214	. COLLAR, SHAFT	6
33	32687	. SHOE, SLIDING	2
34	30296	. BOLT, EAR PIVOT	2
35	61304	. NUT, LOCK	2
36	65661	. SLEAVE, BEARING	2
37	32731	. SHOE, SLIDING	2
38	30296	. BOLT, EAR PIVOT	2
39	61304	. NUT, LOCK	2
40	65661	. SLEAVE, BEARING	2
41	30890	. BOLT, EAR PIVOT	8
42	61310	. NUT, LOCK	8
43	2284	. BEARING, SLEEVE	8

- ITEM NOT ILLUSTRATED

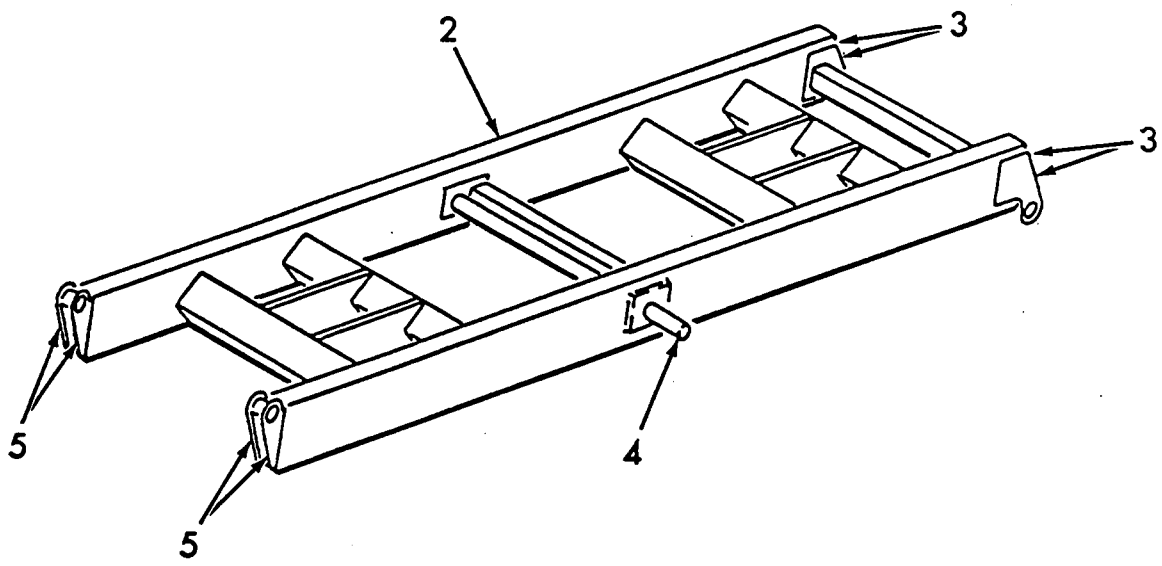
INNER ARM-TOP ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8023	ASSEMBLY, INNER ARM-TOP	REF
2	8069	. ARM, LIFT	1
3	8098	. EAR, ARM END	4
4	8074	. SHAFT, CENTER PIVOT	1
5	8077-1	. EAR, ARM END	4

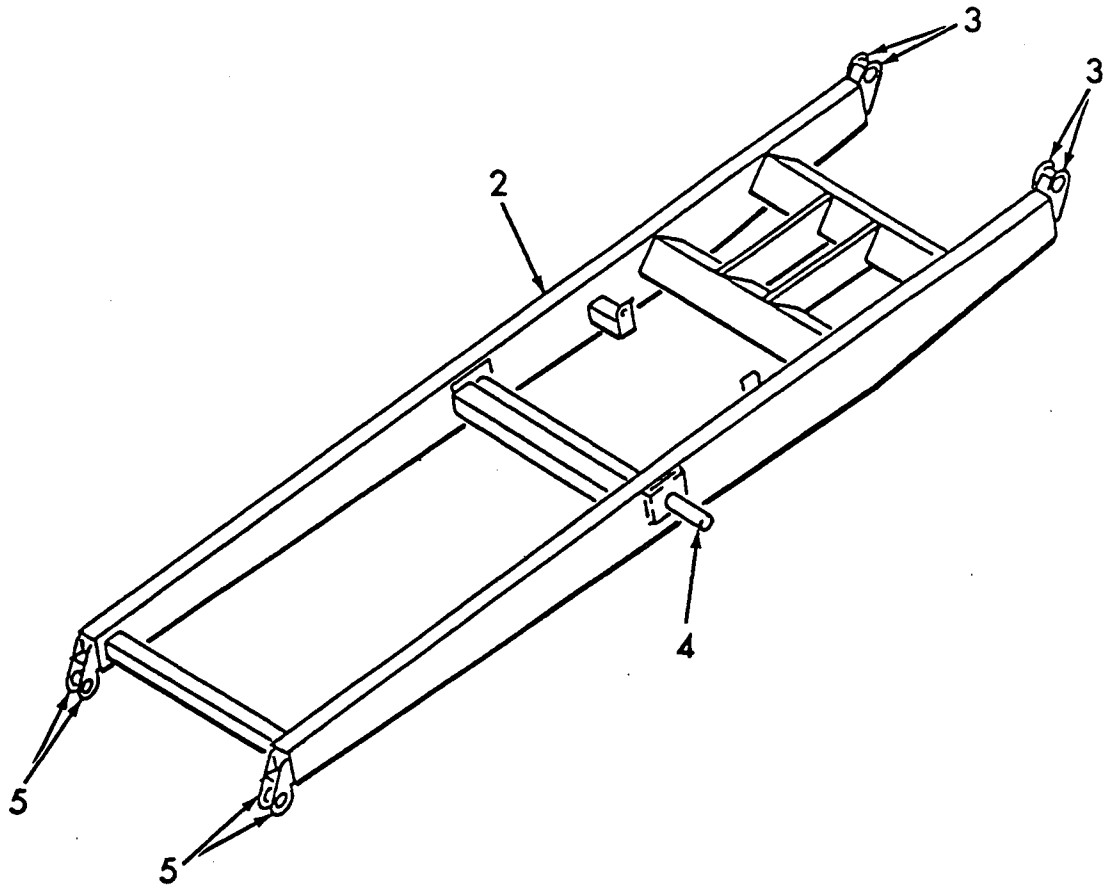
REV.

INNER ARM-CENTER ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8022	ASSEMBLY, INNER ARM-CENTER	REF
2	8071	. ARM, LIFT	1
3	8076-3	. EAR, ARM END	4
4	8074	. SHAFT, CENTER PIVOT	1
5	8076-1	. EAR, ARM END	4

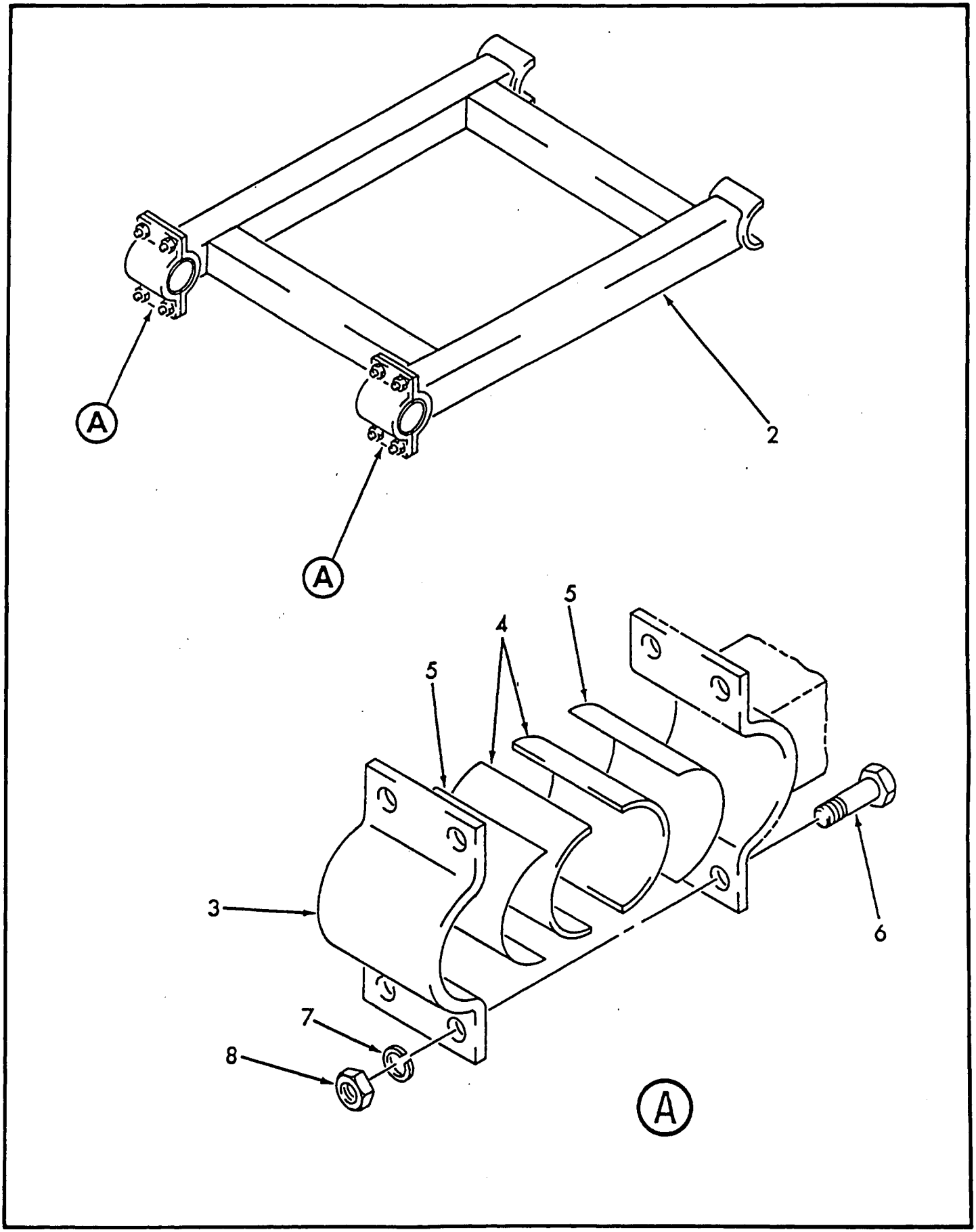
INNER ARM-BOTTOM ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8021	ASSEMBLY, INNER ARM-BOTTOM	REF
2	8069	. ARM, LIFT	1
3	8077-3	. EAR, ARM END	4
4	8074	. SHAFT, CENTER PIVOT	1
5	8078	. EAR, ARM END	4

REV.

INNER ARM SUPPORT ASSEMBLY



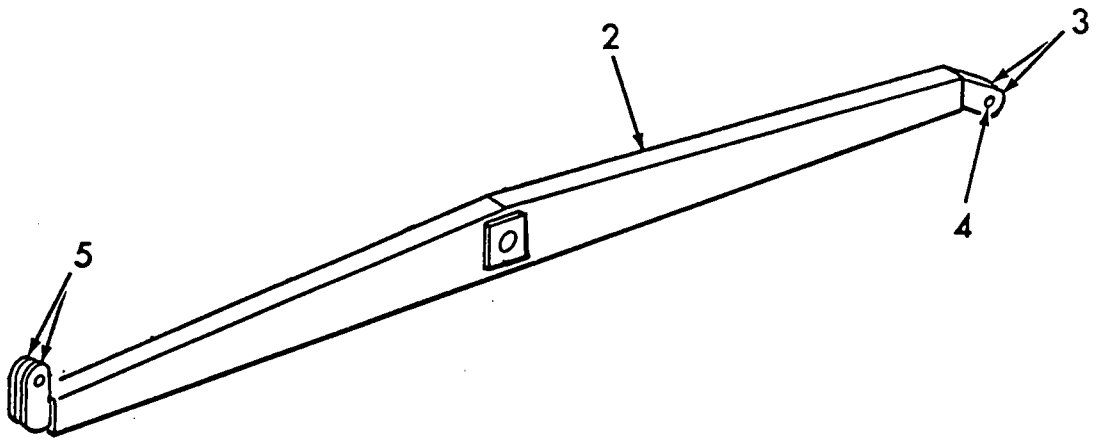
REV.

INNER ARM SUPPORT ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30338	ASSEMBLY, INNER ARM SUPPORT (See Sect. 4, Fig. 1 for NHA)	REF
2	30308	. WELDMENT, INNER ARM SUPPORT	1
3	30335	. CLAMP, INNER ARM SUPPORT	2
4	65792	. PAD, SPRING	4
5	65192	. ADHESIVE	AR
6	60343	. SCREW, CAP (attaching part)	8
7	63303	. WASHER, LOCK (attaching part)	8
8	60703	. NUT, HEX (attaching part)	8

- ITEM NOT ILLUSTRATED

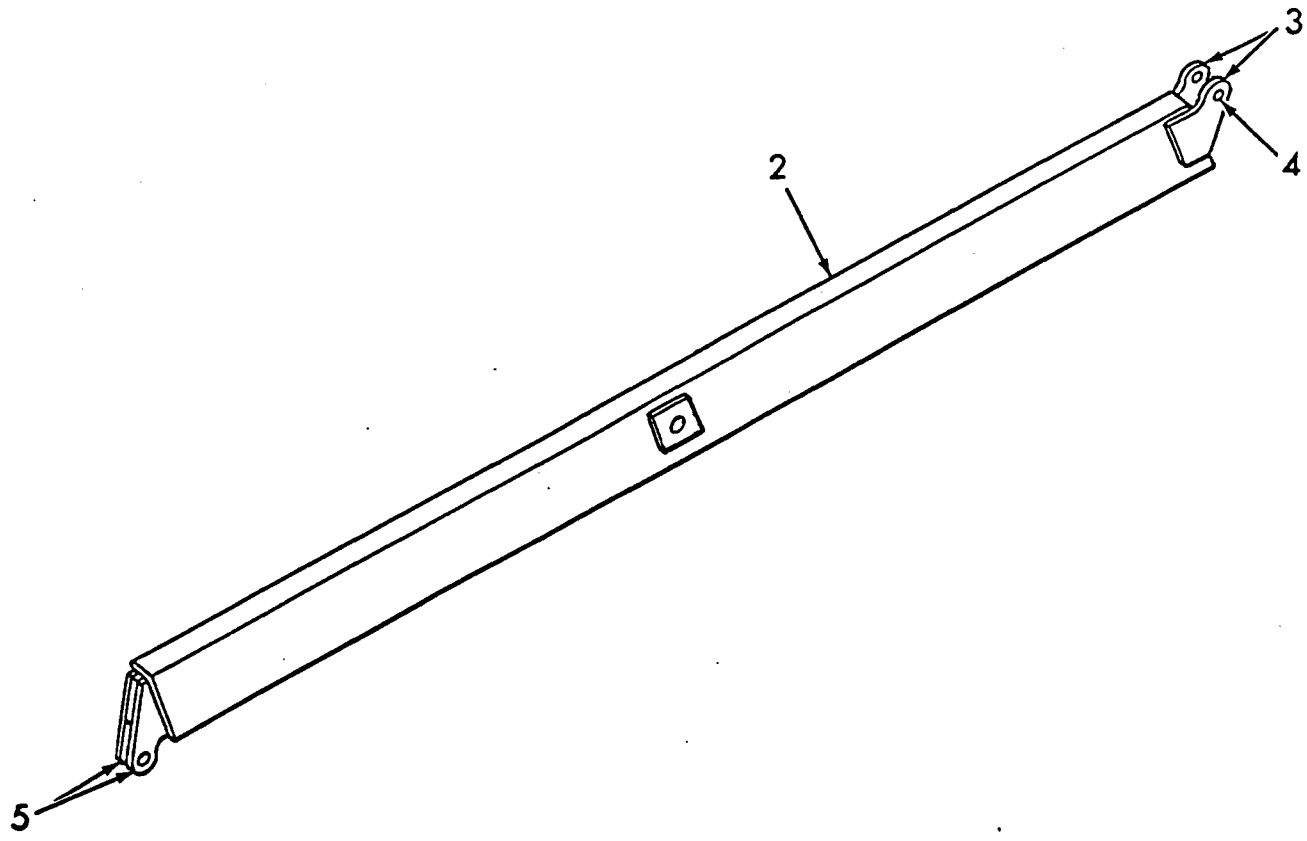
OUTER ARM-TOP ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION . 1234567	UNIT PER ASSY.
-1	8025-1	ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 1 for NHA)	REF
-1	8025-2	ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 1 for NHA)	REF
2	8070	. ARM	1
3	8079-3	. EAR, ARM END	2
4	35430	. TUBE, ROUND	1
5	8098	. EAR, ARM END	2

REV.

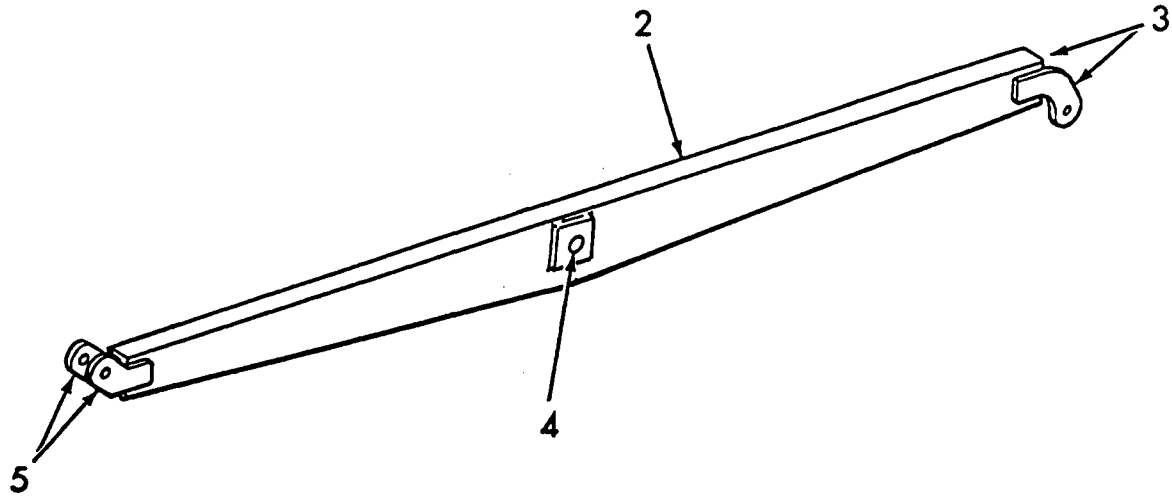
OUTER ARM-CENTER ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8026-1	ASSEMBLY, OUTER ARM-CENTER (See Sect. 4, Fig. 1 for NHA)	REF
-1	8026-2	ASSEMBLY, OUTER ARM-CENTER (See Sect. 4, Fig. 1 for NHA)	REF
2	8071	. ARM	1
3	8076-1	. EAR, ARM END	2
4	35430	. TUBE, ROUND	1
5	8076-3	. EAR, ARM END	2

REV.

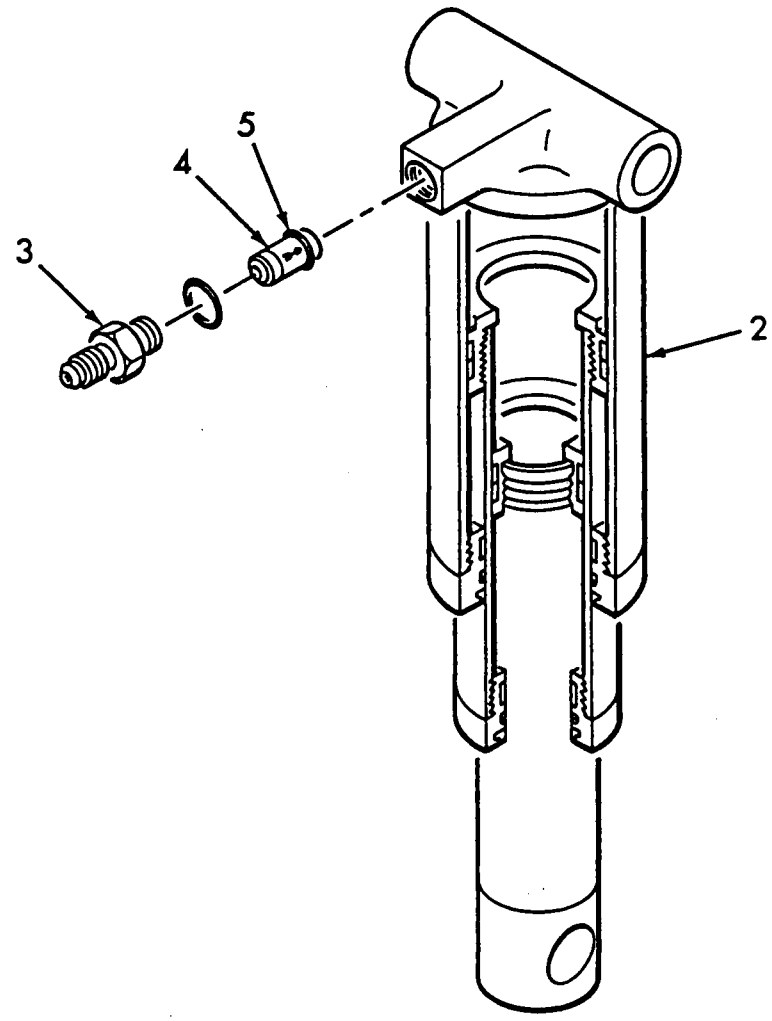
OUTER ARM-BOTTOM ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8027-1	ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 1 for NHA)	REF
-1	8027-2	ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 1 for NHA)	REF
2	8070	. ARM	1
3	8079-1	. EAR, ARM END	2
4	8073	. BUSHING, RETAINER	1
5	8098	. EAR, ARM END	2

REV.

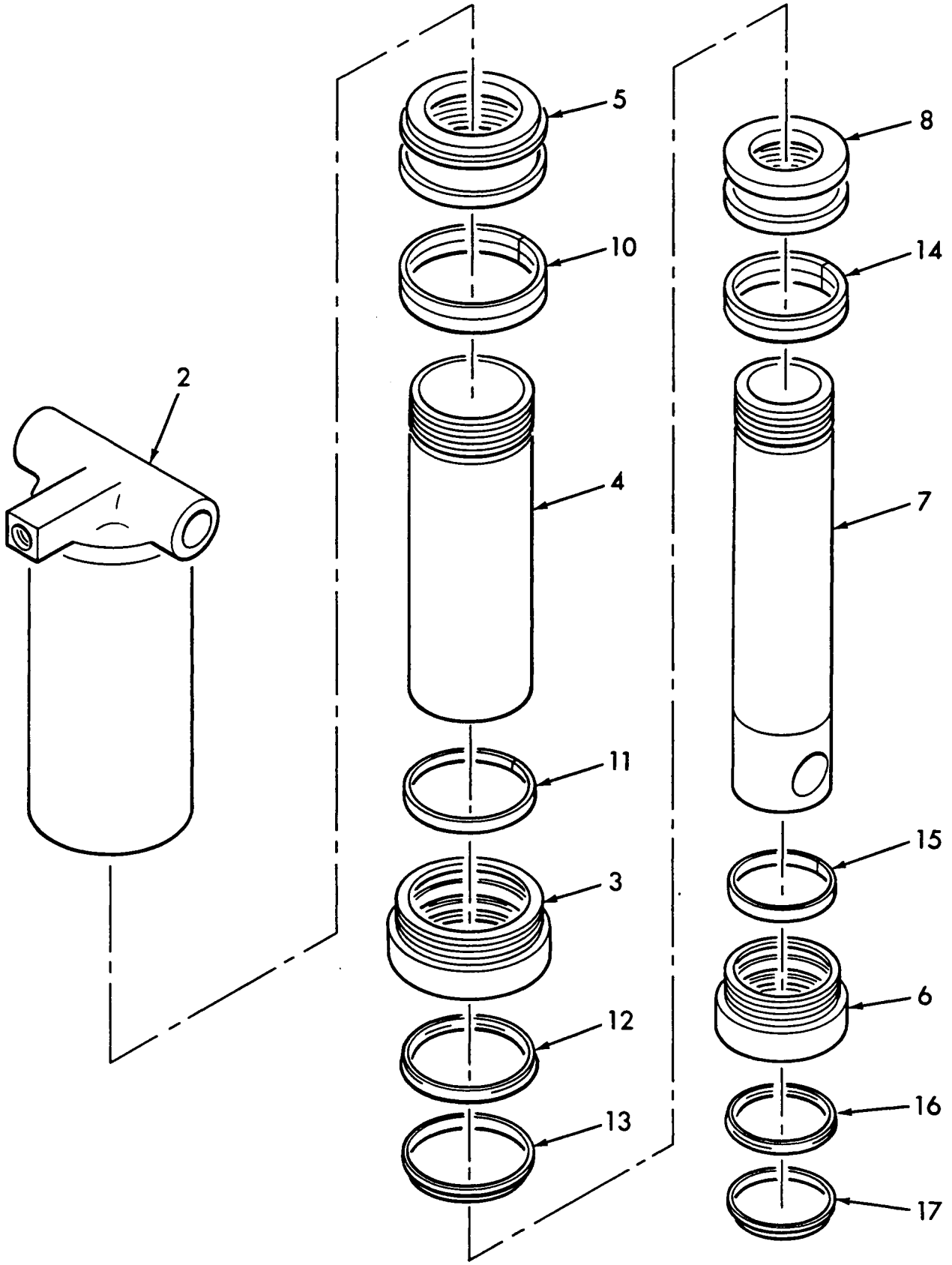
LIFT CYLINDER ASSEMBLY (MT31G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	31092	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	30809	. CYLINDER, TELESCOPIC (See Sect. 4, Fig. 10 for Details)	1
3	80004-14	. CONNECTOR, STRAIGHT THREAD	1
4	31091	. VALVE, CHECK	1
5	880	. O-RING	1
-6	67043	.. KIT, SEAL (5X4)	1
-6	67042	.. KIT, SEAL (5½X4½)	1

REV.

TELESCOPIC CYLINDER ASSEMBLY

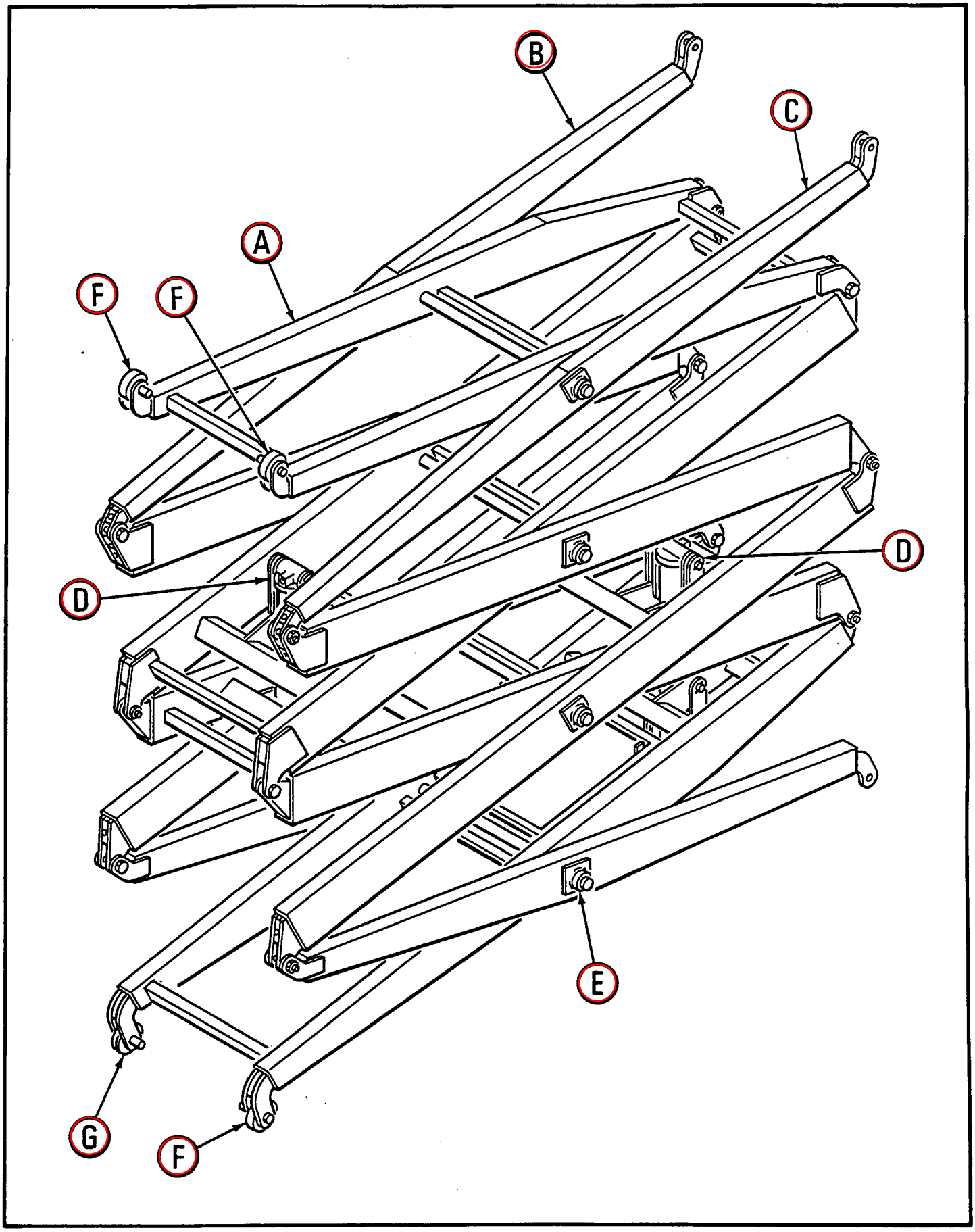


TELESCOPIC CYLINDER ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	31092	ASSEMBLY, TELESCOPIC CYLINDER (See Sect. 4, Fig. 9 for NHA)	REF
2		. BARREL	1
3		. HEAD, OUTER	1
4		. ROD, OUTER	1
5		. PISTON, OUTER	1
6		. HEAD, INTER	1
7		. ROD, INTER	1
8		. PISTON, INTER	1
-9	67043	. KIT, SEAL (5X4)	1
-9	67042	. KIT, SEAL (5½X4½) (SHOWN)	1
10		.. RING, WEAR	2
11		.. RING, WEAR	1
12		.. SEAL, ROD	1
13		.. WIPER, ROD	1
14		.. RING, WEAR	2
15		.. RING, WEAR	1
16		.. SEAL, ROD	1
17		.. WIPER, ROD	1

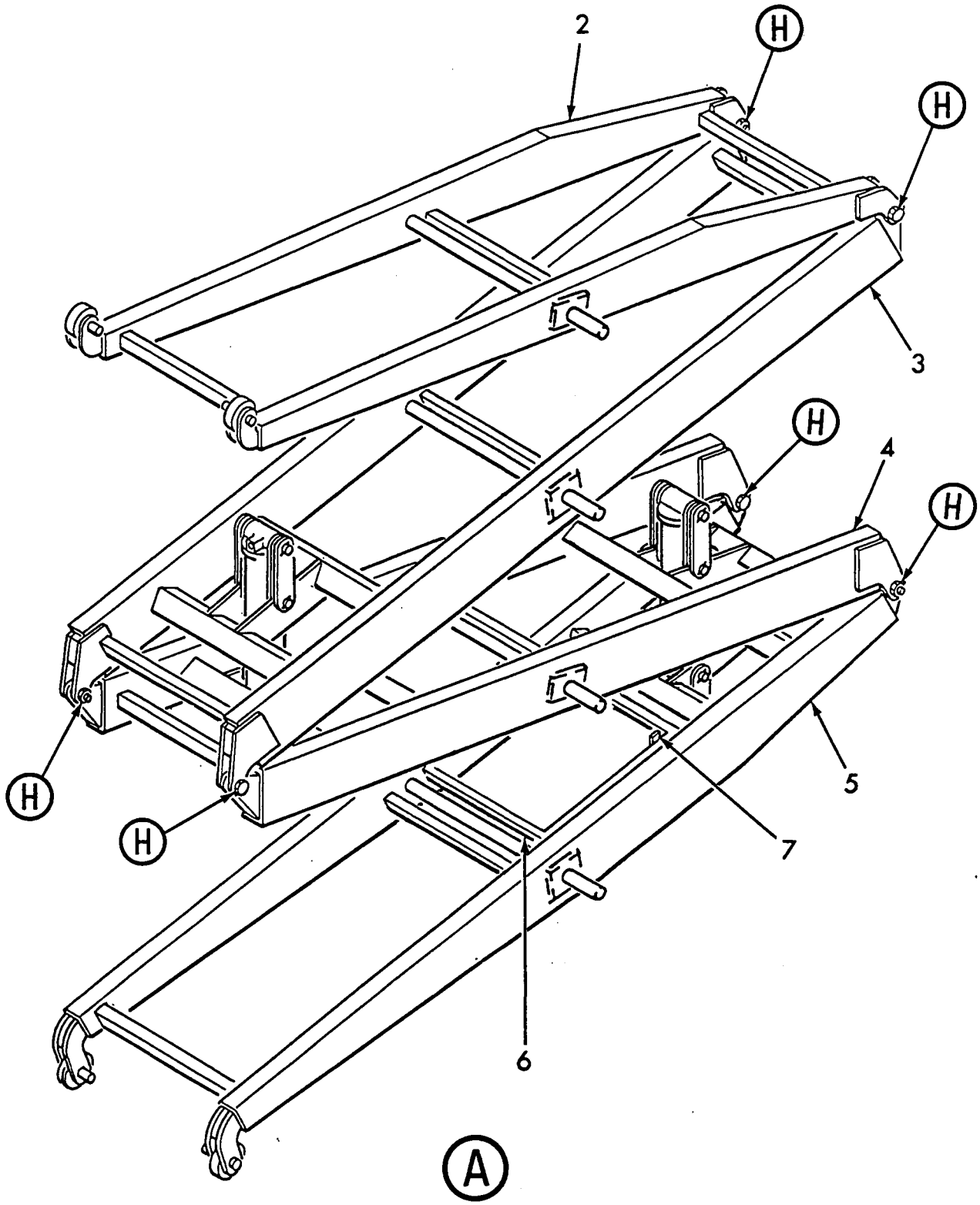
- ITEM NOT ILLUSTRATED

SCISSOR ASSEMBLY (MT40G)



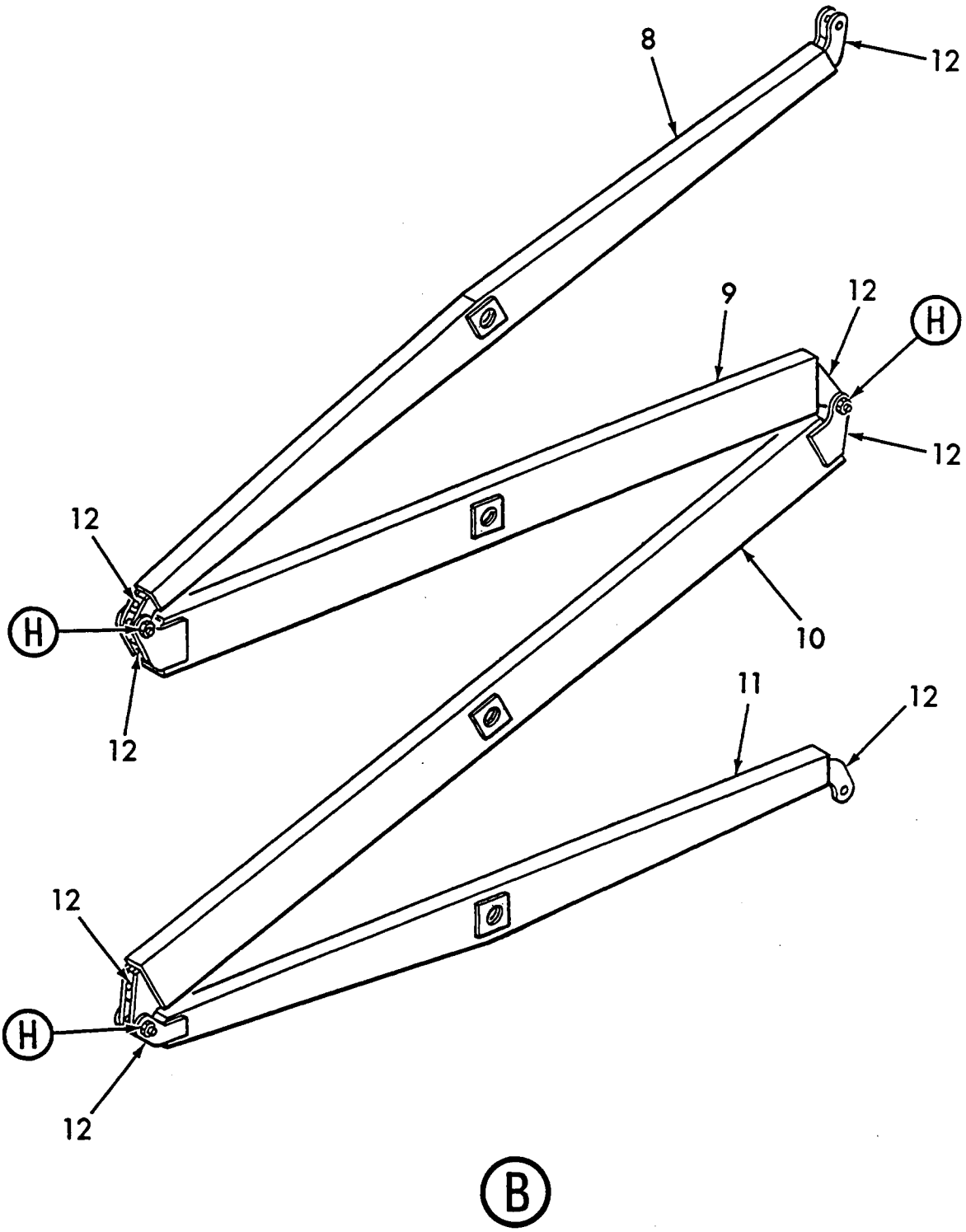
REV.

SCISSOR ASSEMBLY (MT40G)



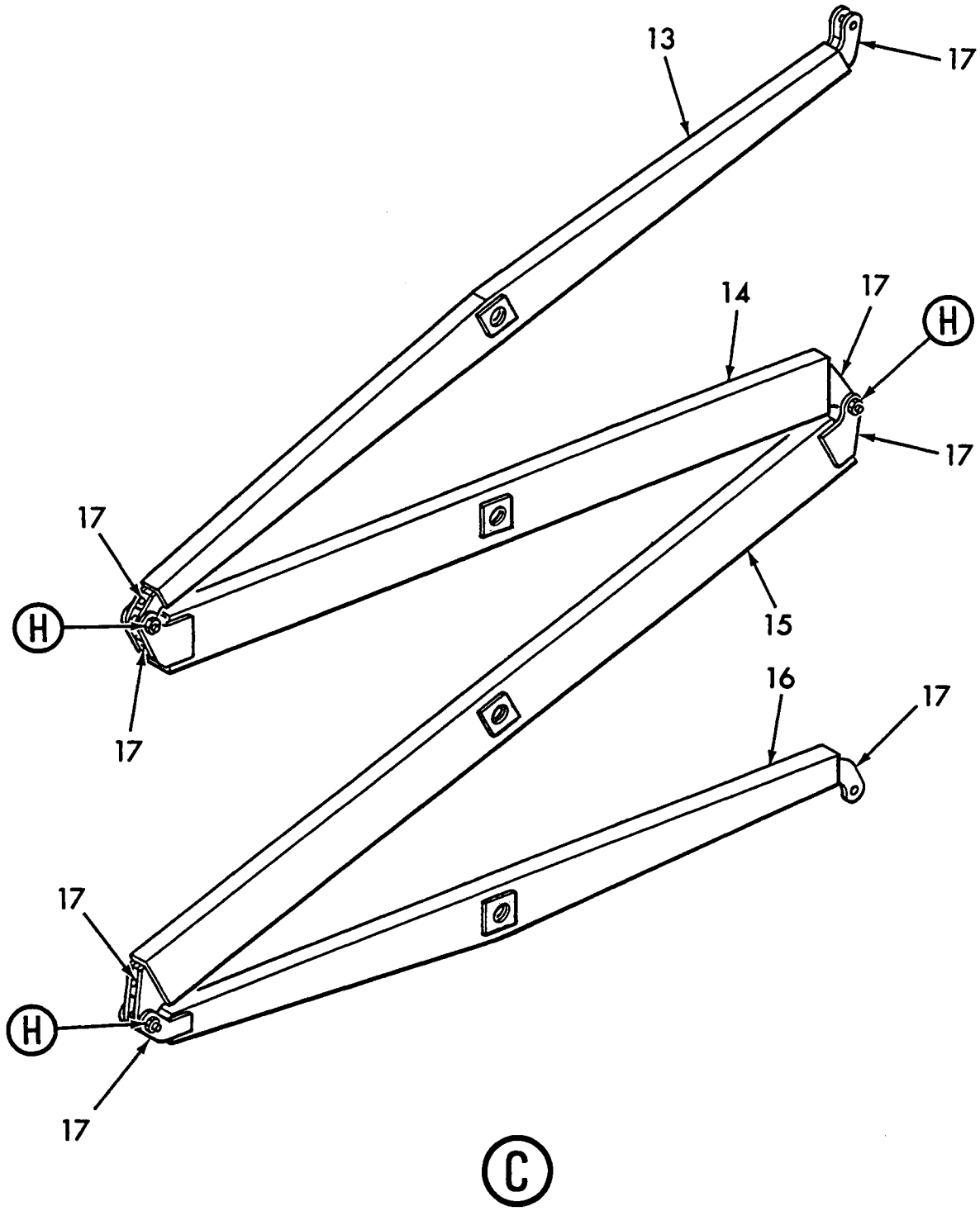
REV.

SCISSOR ASSEMBLY (MT40G)



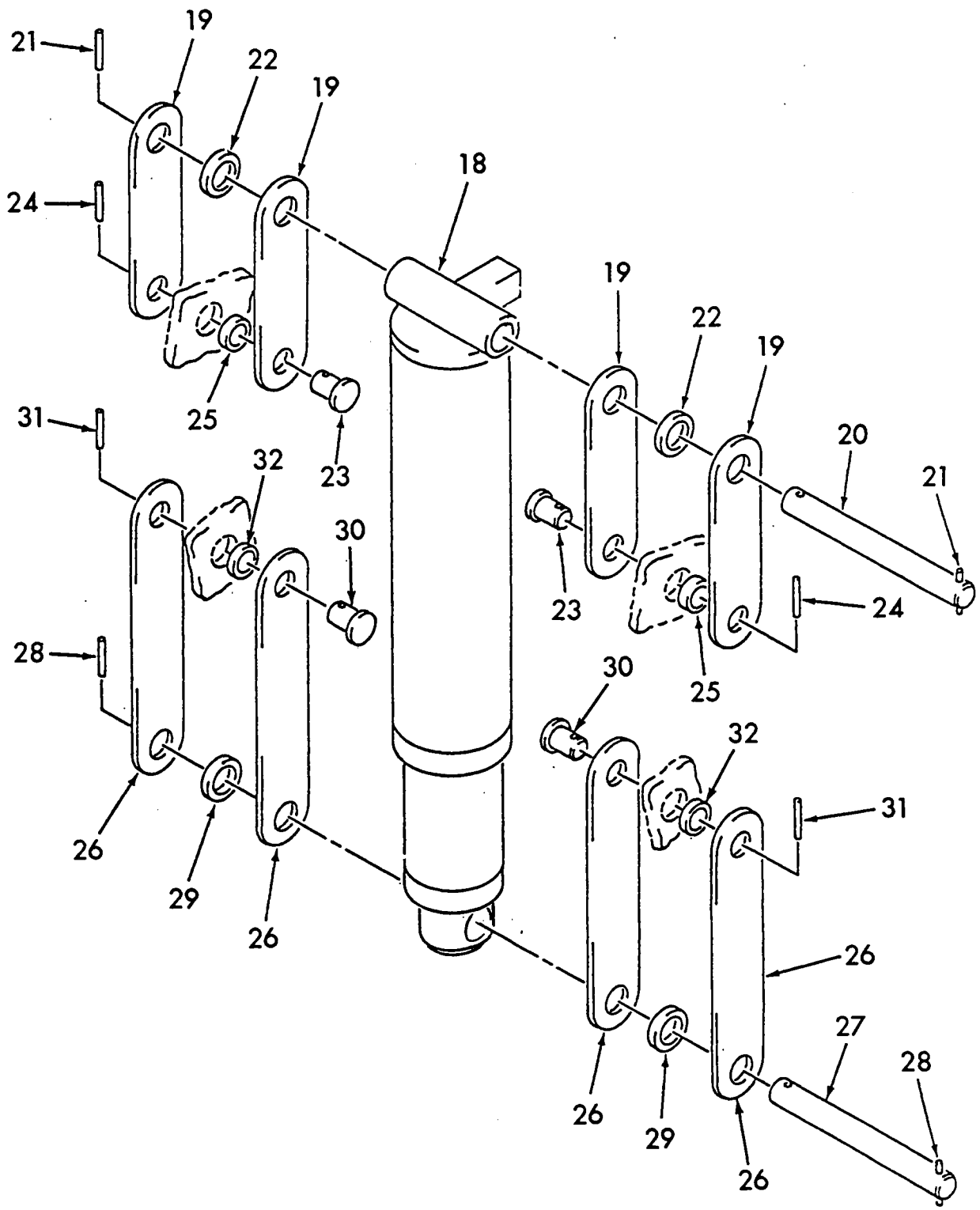
REV.

SCISSOR ASSEMBLY (MT40G)

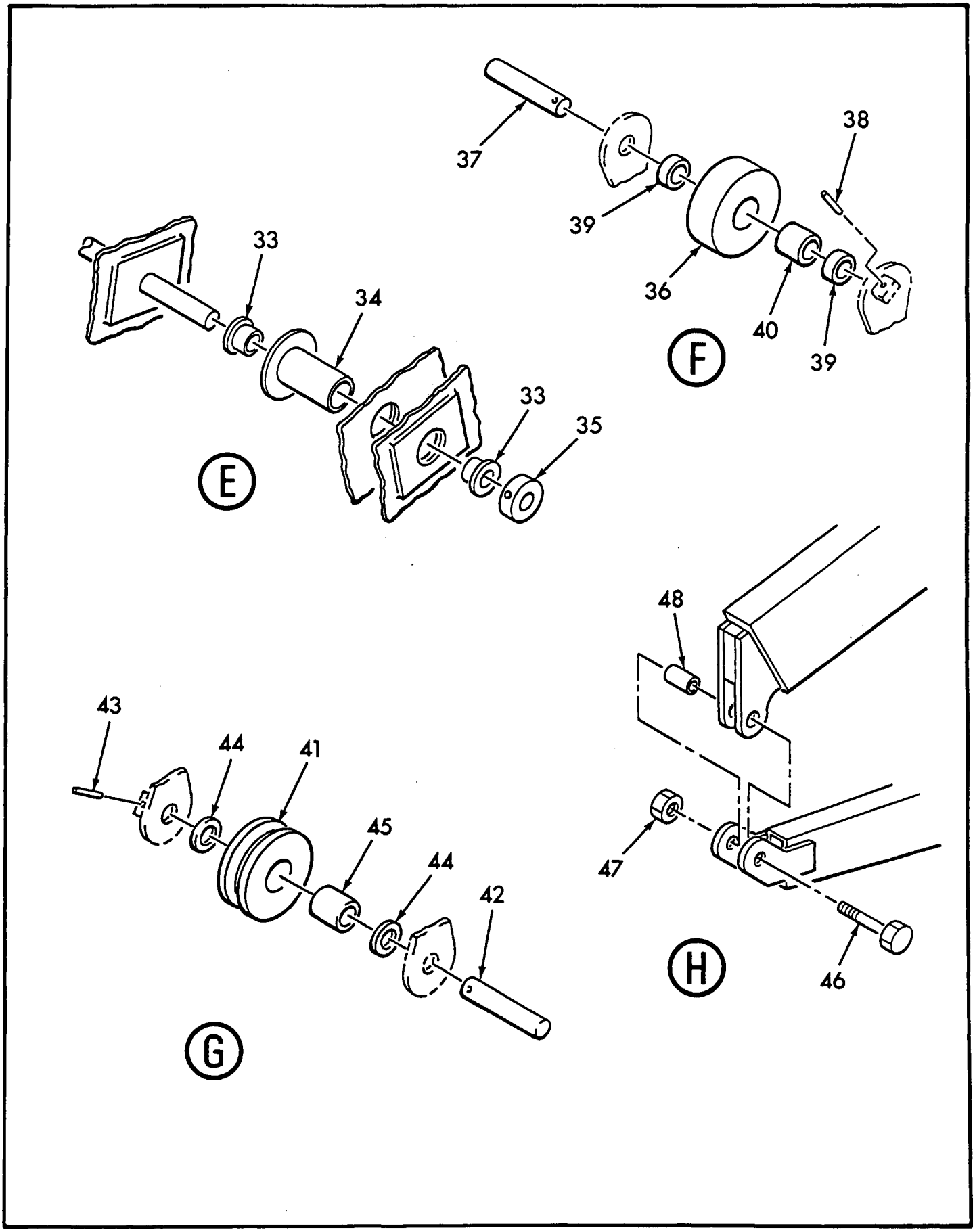


REV.

SCISSOR ASSEMBLY (MT40G)



SCISSOR ASSEMBLY (MT40G)



REV.

SCISSOR ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32652	ASSEMBLY, SCISSOR (See Sect. 2, Fig. 1A for NHA)	REF
2	32717	. ASSEMBLY, INNER ARM-TOP (See Sect. 4, Fig. 2A for Details)	1
3	8066	. ASSEMBLY, INNER ARM-TOP CENTER (See Sect. 4, Fig. 3A for Details)	1
4	8064	. ASSEMBLY, INNER ARM-BOTTOM CENTER (See Sect. 4, Fig. 4A for Details)	1
5	32716	. ASSEMBLY, INNER ARM-BOTTOM (See Sect. 4, Fig. 5A for Details)	1
6	30338	. ASSEMBLY, INNER ARM SUPPORT (See Sect. 4, Fig. 6A for Details)	1
7	30701	. PIN, QUICK RELEASE	1
8	8067-2	. ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 7A for Details)	1
9	32730-1	. ASSEMBLY, OUTER ARM-TOP CENTER (See Sect. 4, Fig. 8A for Details)	1
10	8063-1	. ASSEMBLY, OUTER ARM-BOTTOM CENTER (See Sect. 4, Fig. 9A for Details)	1
11	8062-1	. ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 10A for Details)	1
12	117-G	. CONNECTOR, STRAIN RELIEF	8
13	8067-1	. ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 7A for Details)	1
14	32730-2	. ASSEMBLY, OUTER ARM-TOP CENTER (See Sect. 4, Fig. 8A for Details)	1
15	8063-2	. ASSEMBLY, OUTER ARM-BOTTOM CENTER (See Sect. 4, Fig. 9A for Details)	1
16	8062-2	. ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 10A for Details)	1
17	117-G	. CONNECTOR, STRAIN RELIEF	8
18	31092	. ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 11A for Details)	2

SCISSOR ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
19	8304	. STRAP, CYLINDER	8
20	8303	. PIN, CYLINDER PIVOT	2
21	377	. PIN, ROLLER	4
22	8321	. COLLAR, CYLINDER PIVOT PIN	4
23	9033	. PIN, CYLINDER STRAP PIVOT	4
24	377	. PIN, ROLLER	4
25	2279	. BUSHING	4
26	8305	. STRAP, CYLINDER	8
27	8302	. PIN, CYLINDER PIVOT	2
28	377	. PIN, ROLLER	4
29	8321	. COLLAR, CYLINDER PIVOT PIN	4
30	9033	. PIN, CYLINDER STRAP PIVOT	4
31	377	. PIN, ROLLER	4
32	2279	. BUSHING	4
33	2283	. BEARING, FLANGED	16
34	23823	. SPACER	8
35	2214	. COLLAR, SHAFT	8
36	2361	. ROLLER, DECK	3
37	35806	. BAR, ROUND	3
38	377	. PIN, ROLLER	3
39	63416	. WASHER, FLAT	6
40	2287	. BEARING, SLEEVE	3
41	2362	. ROLLER, V-DECK	1
42	35806	. BAR, ROUND	1
43	377	. PIN, ROLLER	1
44	63416	. WASHER, FLAT	2

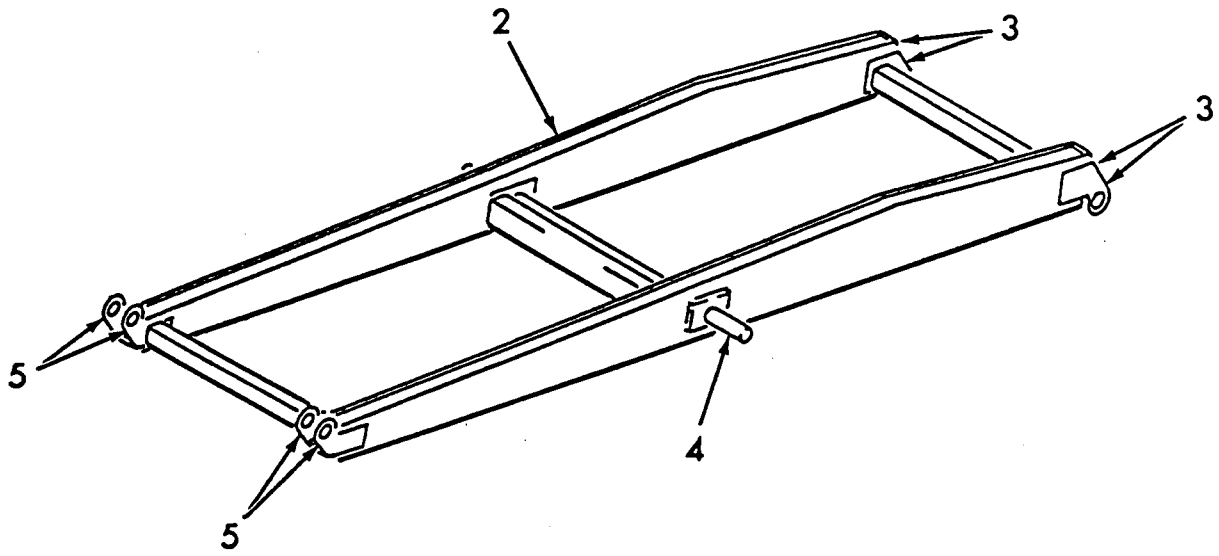
- ITEM NOT ILLUSTRATED

SCISSOR ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
45	2287	. BEARING, SLEEVE	1
46	30890	. BOLT, EAR PIVOT	12
47	61310	. NUT, LOCK	12
48	2284	. BEARING, SLEEVE	12
-49	2282	. BUSHING, LIGHT OIL	12

- ITEM NOT ILLUSTRATED

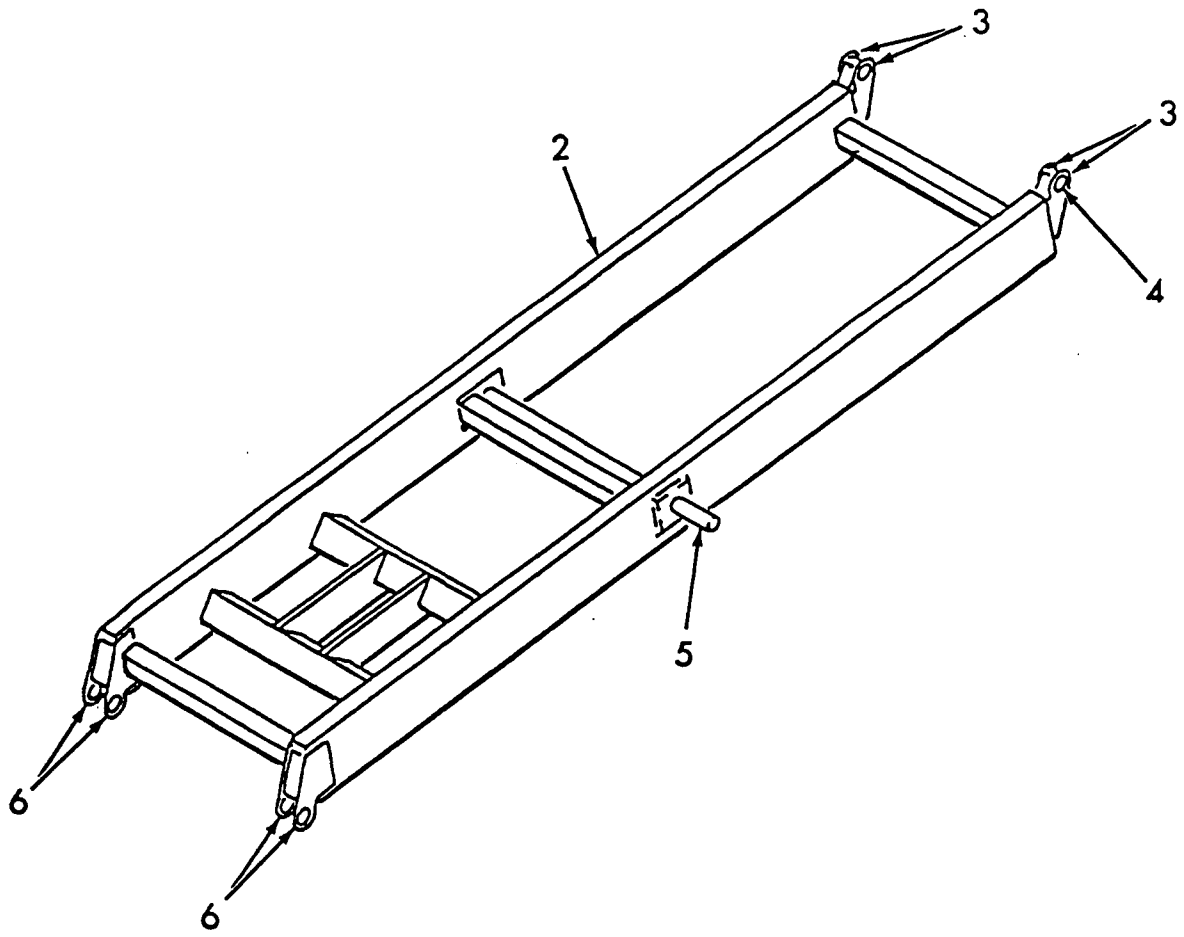
INNER ARM-TOP ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32717	ASSEMBLY, INNER ARM-TOP (See Sect. 4, Fig. 1A for NHA)	REF
2	8069	. ARM	2
3	8077-1	. EAR, ARM END	4
4	874	. SHAFT, CENTER PIVOT	1
5	32719	. EAR, ARM END	4

REV.

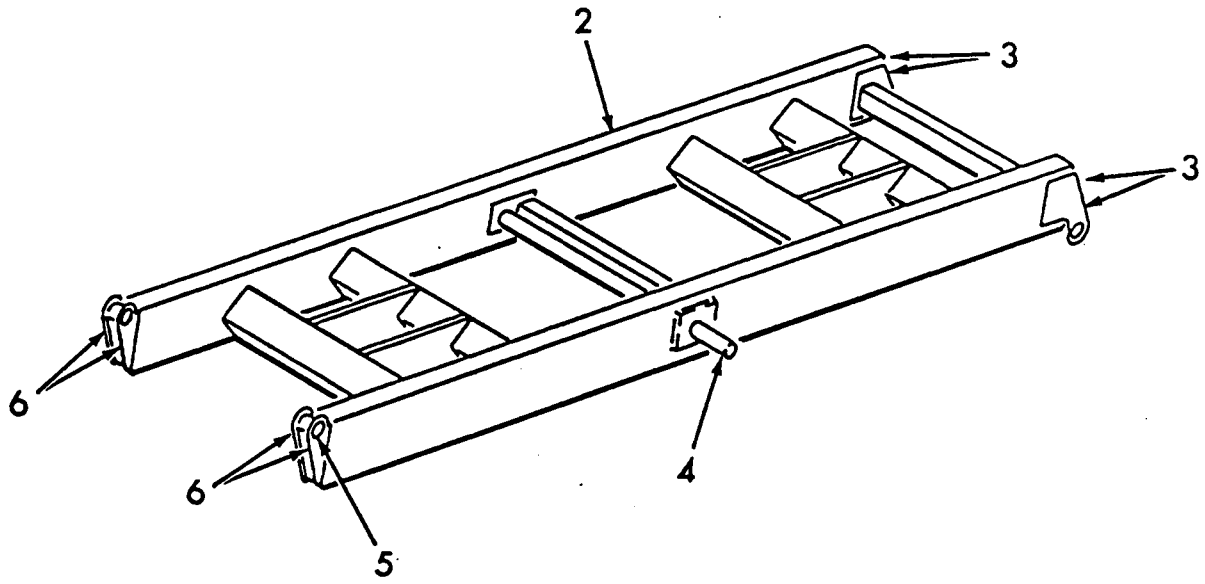
INNER ARM-TOP CENTER ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8066	ASSEMBLY, INNER ARM-TOP CENTER (See Sect. 4, Fig. 1A for NHA)	REF
2	8071	. ARM	2
3	8076-3	. EAR, ARM END	4
4	35430	. TUBE, ROUND	2
5	8074	. SHAFT, CENTER PIVOT	1
6	8076-1	. EAR, ARM END	4

REV.

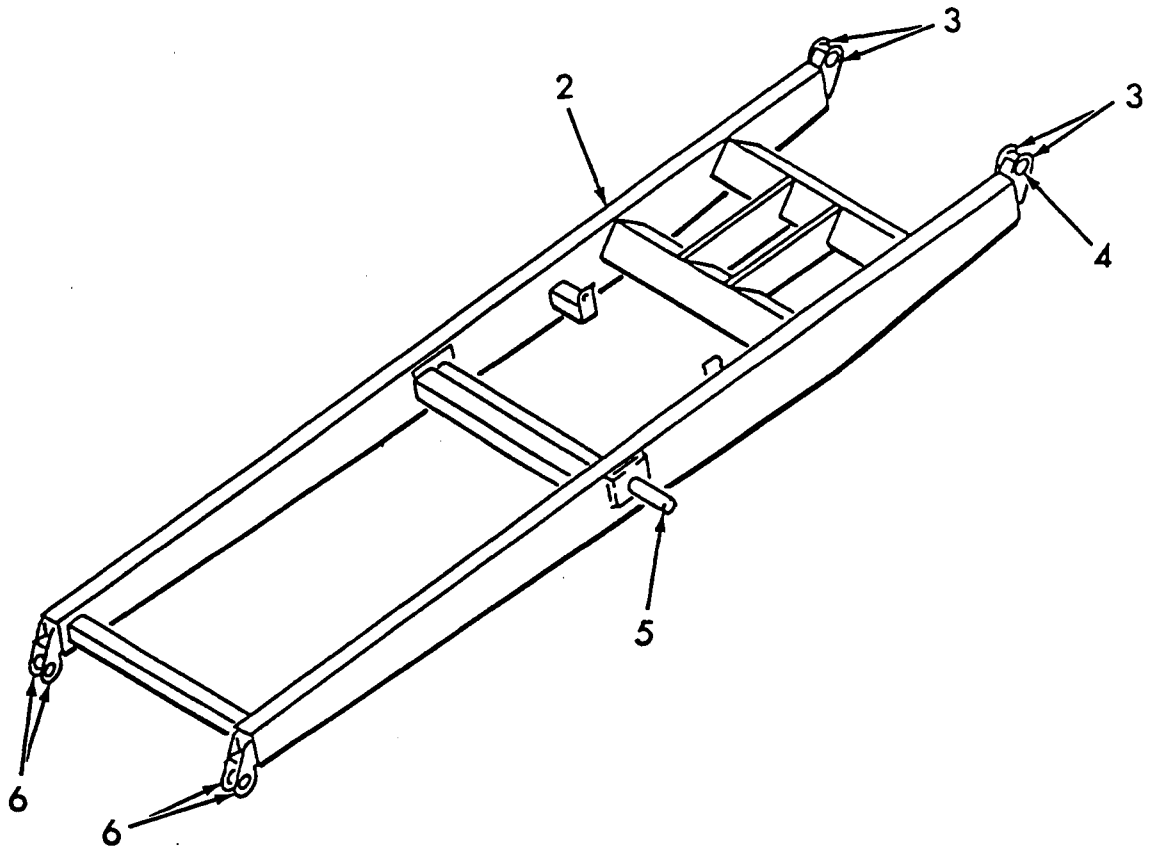
INNER ARM-BOTTOM CENTER ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8064	ASSEMBLY, INNER ARM-BOTTOM CENTER (See Sect. 4, Fig. 1A for NHA)	REF
2	8071	. ARM	2
3	8076-1	. EAR, ARM END	4
4	8074	. SHAFT, CENTER PIVOT	1
5	35430	. TUBE, ROUND	2
6	8076-3	. EAR, ARM END	4

REV.

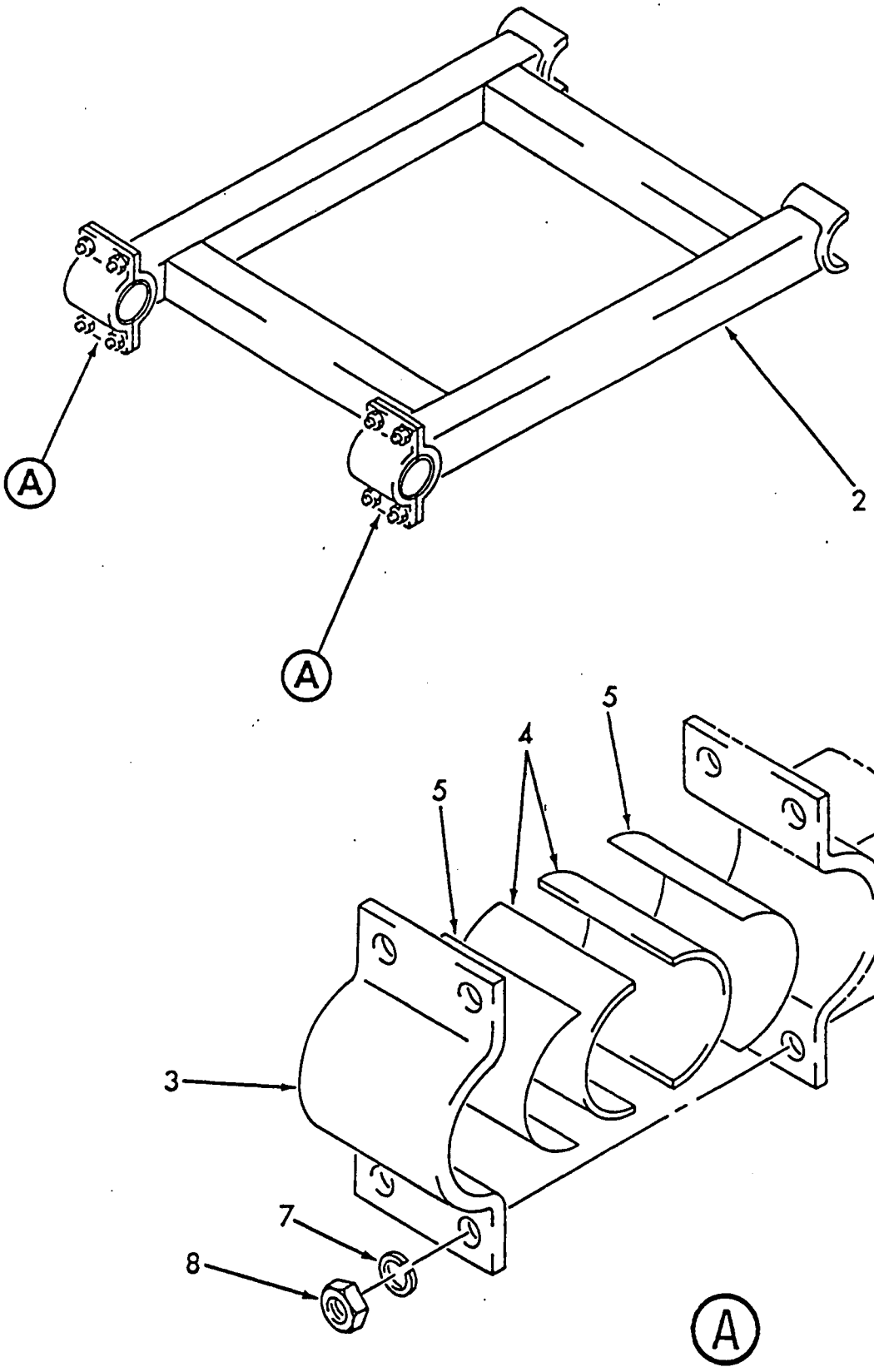
INNER ARM-BOTTOM ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32716	ASSEMBLY, INNER ARM-BOTTOM (See Sect. 4, Fig. 1A for NHA)	REF
2	8069	. ARM	2
3	8077-3	. EAR, ARM END	4
4	35430	. TUBE, ROUND	2
5	8074	. SHAFT, CENTER PIVOT	1
6	32718	. EAR, ARM END	4

REV.

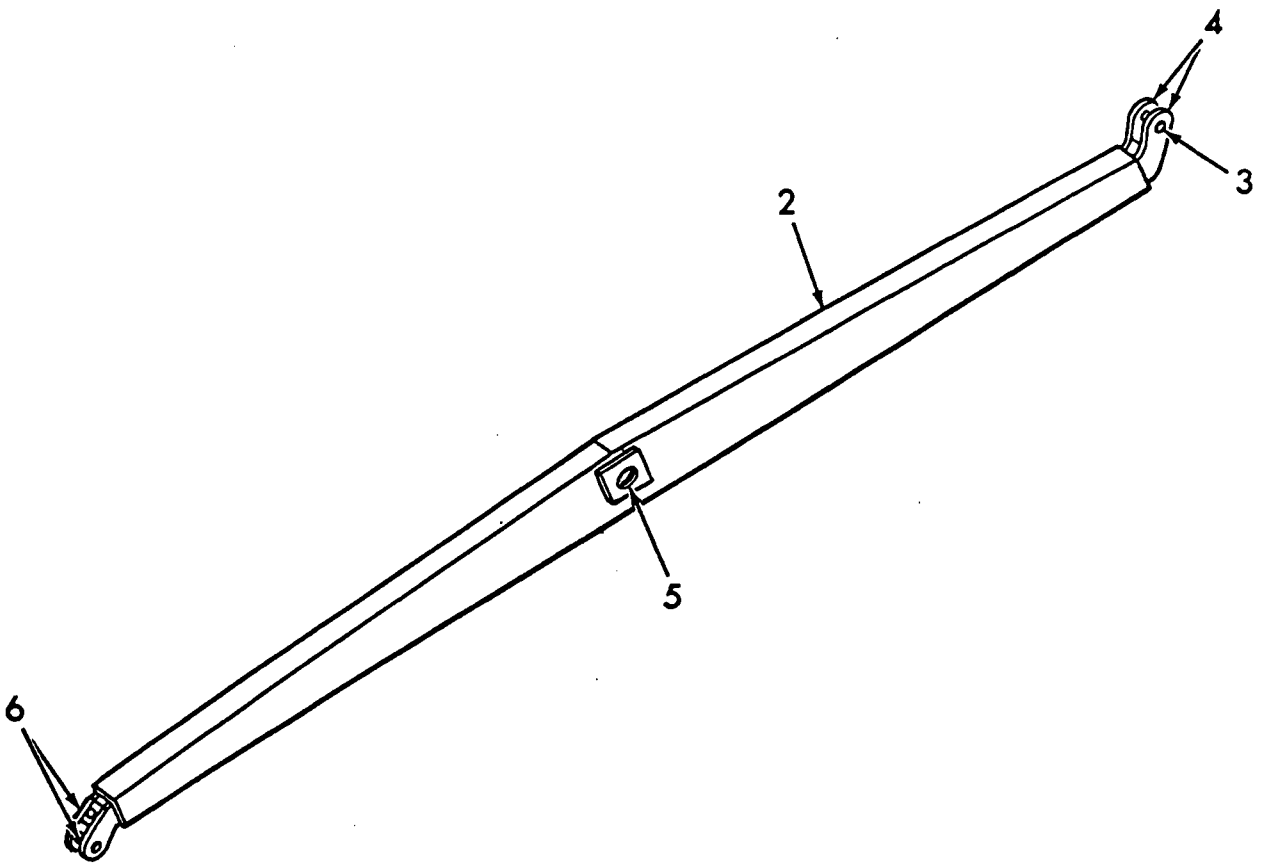
INNER ARM SUPPORT ASSEMBLY



INNER ARM SUPPORT ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	30338	ASSEMBLY, INNER ARM SUPPORT (See Sect. 4, Fig. 1A for NHA)	REF
2	30308	. WELDMENT, INNER ARM SUPPORT	1
3	30335	. CLAMP, INNER ARM SUPPORT	2
4	65792	. PAD, SPRING	4
5	65192	. ADHESIVE	AR
6	60343	. SCREW, CAP	8
7	63303	. WASHER, LOCK	8
8	60703	. NUT, HEX	8

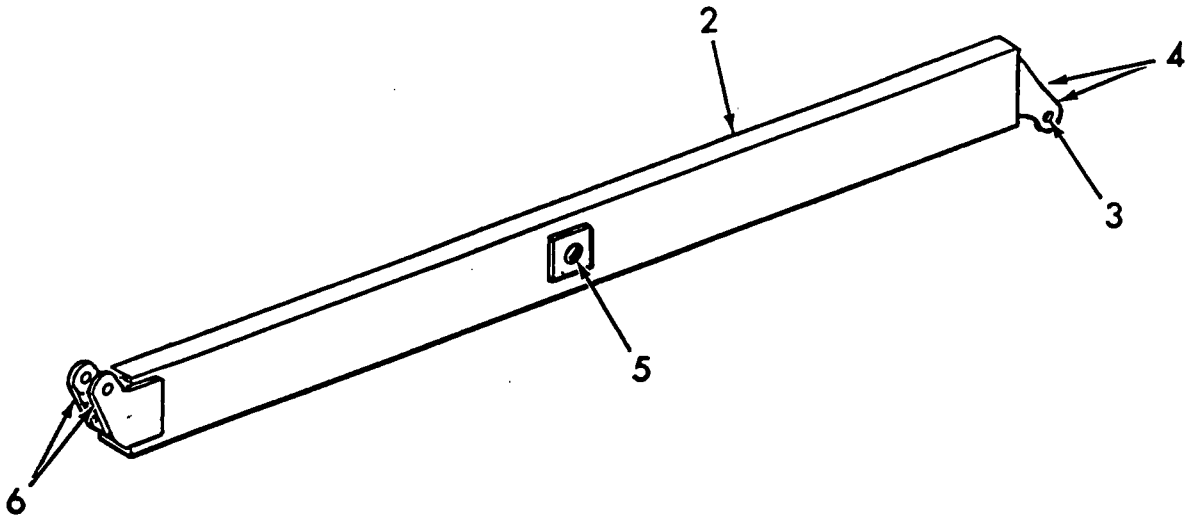
OUTER ARM-TOP ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8067-2	ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 1A for NHA)	REF
-1	8067-1	ASSEMBLY, OUTER ARM-TOP (See Sect. 4, Fig. 1A for NHA)	REF
2	8070	. ARM	1
3	35430	. TUBE, ROUND	1
4	8098	. EAR, ARM END	2
5	8073	. BUSHING, RETAINER	1
6	8079-3	. EAR, ARM END	2

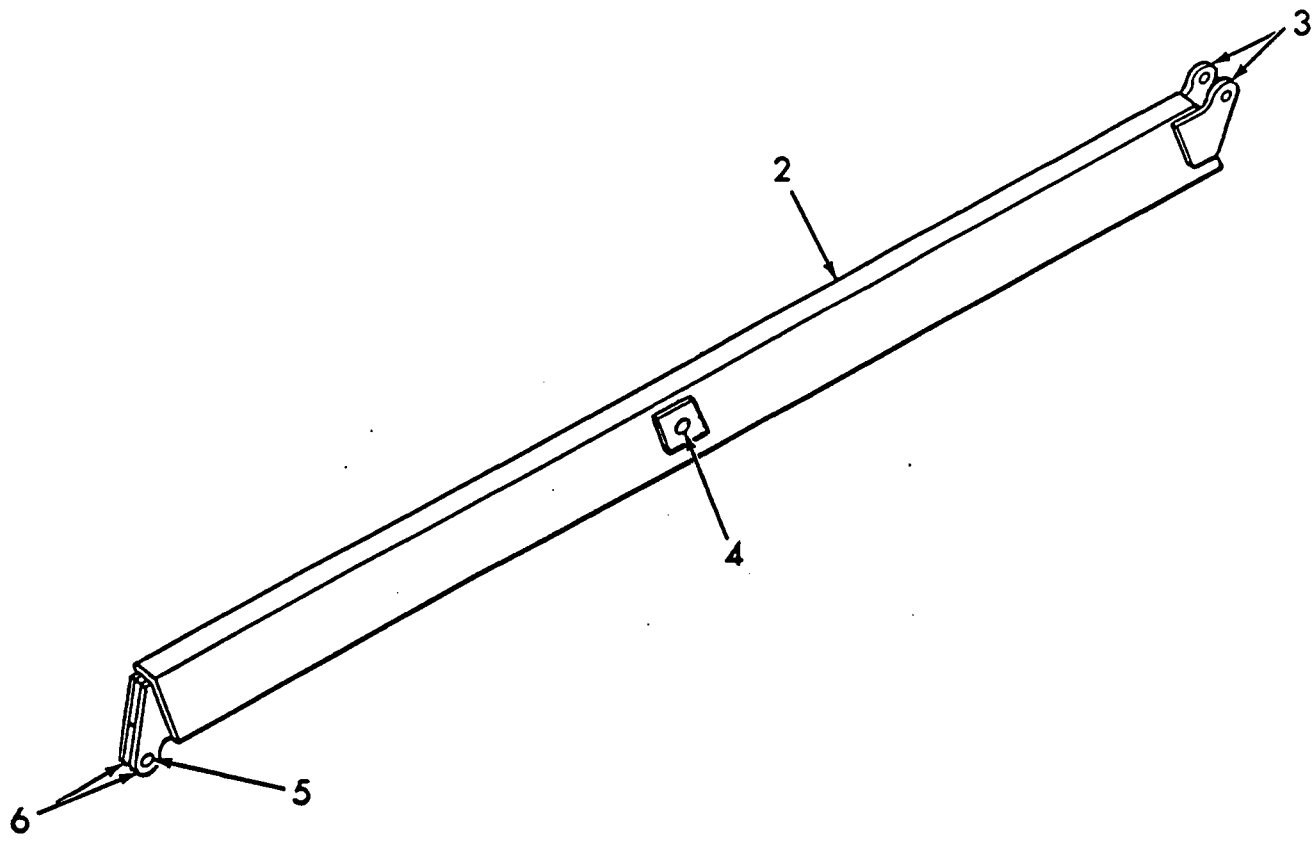
REV.

OUTER ARM-TOP CENTER ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32730-1	ASSEMBLY, OUTER ARM-TOP CENTER (See Sect. 4, Fig. 1A for NHA)	REF
-1	32730-2	ASSEMBLY, OUTER ARM-TOP CENTER (See Sect. 4, Fig. 1A for NHA)	REF
2	8071	. ARM	1
3	35430	. TUBE, ROUND	1
4	8076-1	. EAR, ARM END	2
5	8073	. BUSHING, RETAINER	1
6	8076-3	. EAR, ARM END	2

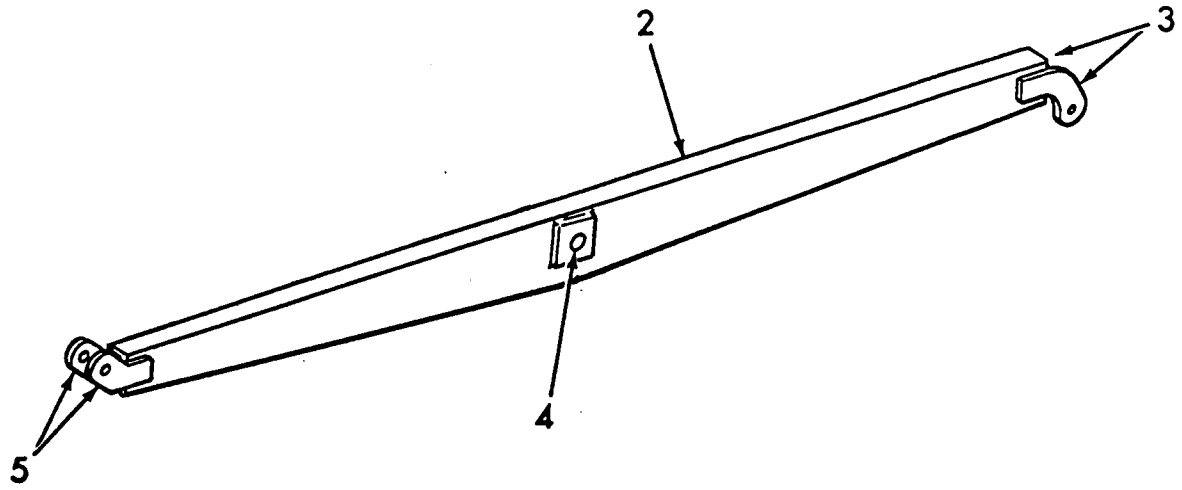
OUTER ARM-BOTTOM CENTER ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8063-1	ASSEMBLY, OUTER ARM-BOTTOM CENTER (See Sect. 4, Fig. 1A for NHA)	REF
-1	8063-2	ASSEMBLY, OUTER ARM-BOTTOM CENTER (See Sect. 4, Fig. 1A for NHA)	REF
2	871	. ARM	1
3	8076-1	. EAR, ARM END	2
4	8073	. BUSHING, RETAINER	1
5	35430	. TUBE, ROUND	1
6	8076-3	. EAR, ARM END	2

REV.

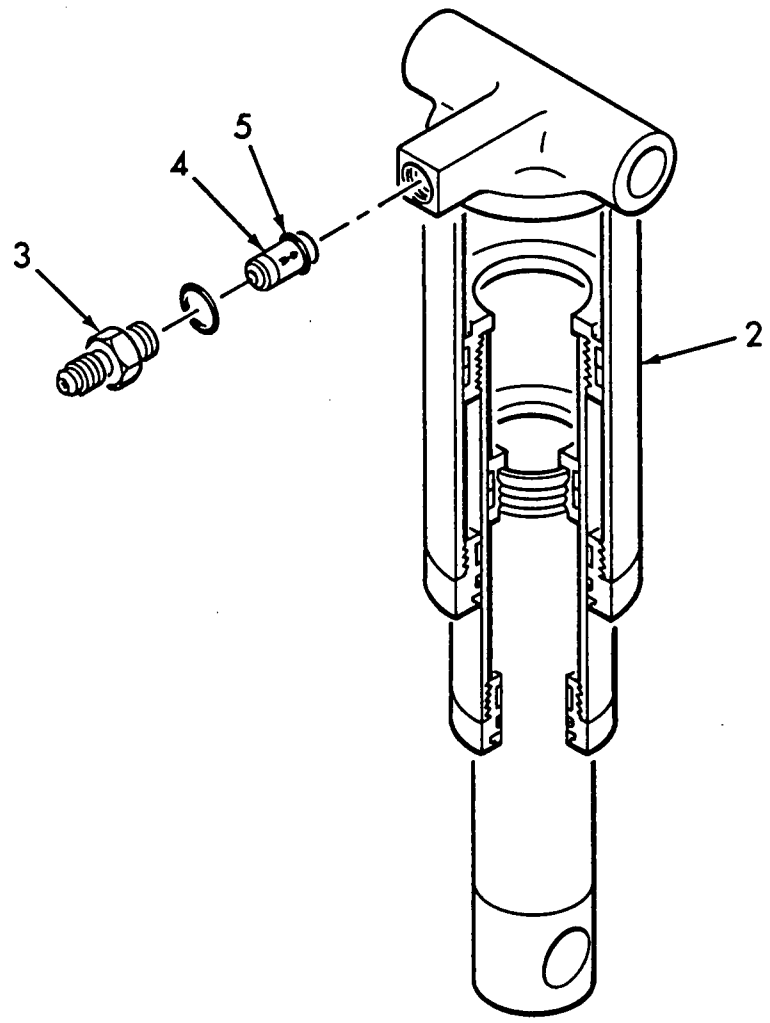
OUTER ARM-BOTTOM ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	8062-1	ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 1A for NHA)	REF
-1	8062-2	ASSEMBLY, OUTER ARM-BOTTOM (See Sect. 4, Fig. 1A for NHA)	REF
2	8070	. ARM	1
3	8098	. EAR, ARM END	2
4	8073	. BUSHING, RETAINER	1
5	8079-1	. EAR, ARM END	2

REV.

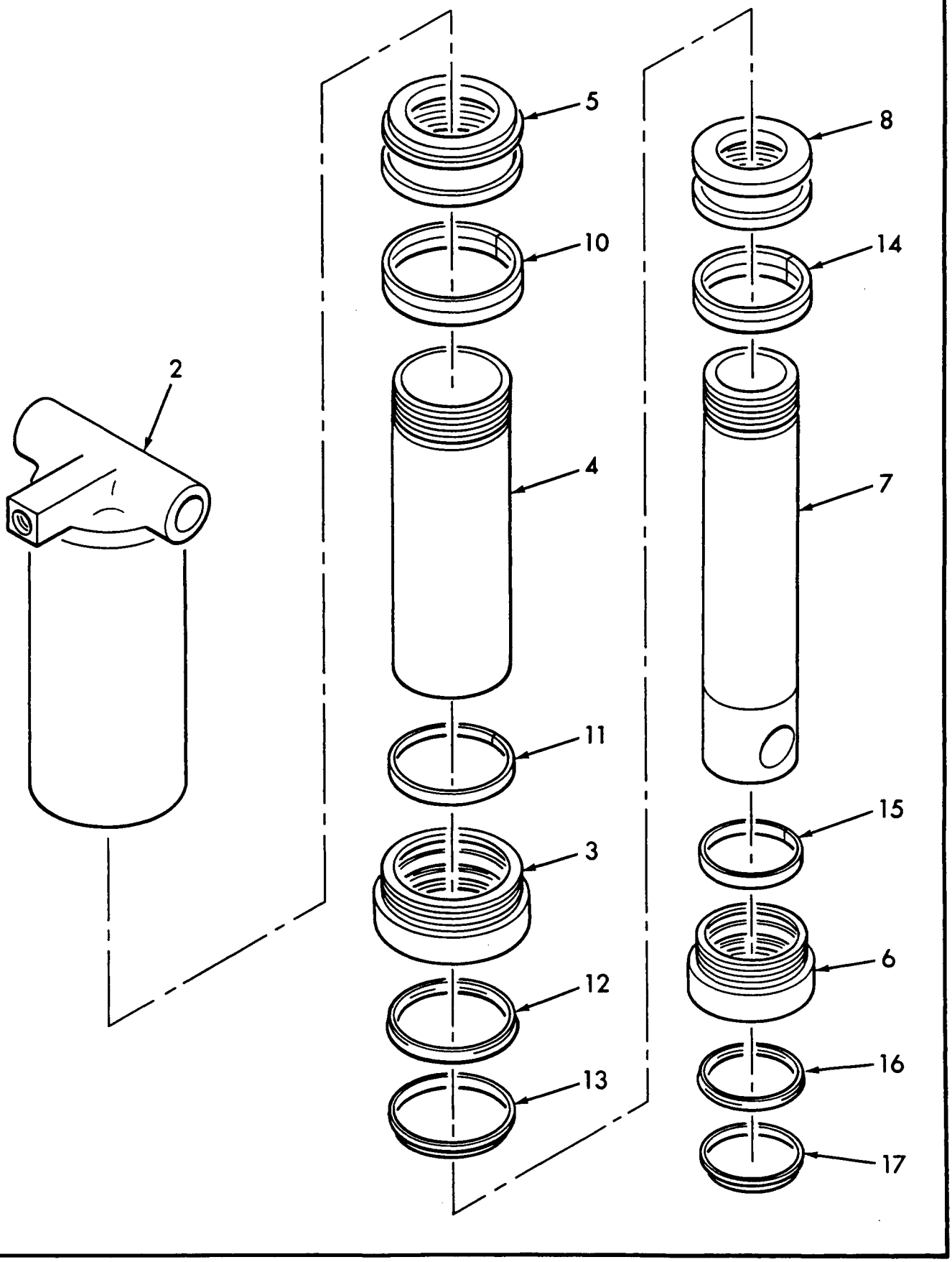
LIFT CYLINDER ASSEMBLY (MT40G)



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	31092	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1A for NHA)	REF
2	30809	. CYLINDER TELESCOPIC (See Sect. 4, Fig. 12A for Details)	1
3	80004-14	. CONNECTOR, STRAIGHT THREAD	1
4	31091	. VALVE, CHECK	1
5	880	. O-RING	1
-6	67043	.. KIT, SEAL (5X4)	1
-6	67042	.. KIT, SEAL (5½X4½)	1

REV.

TELESCOPIC CYLINDER ASSEMBLY

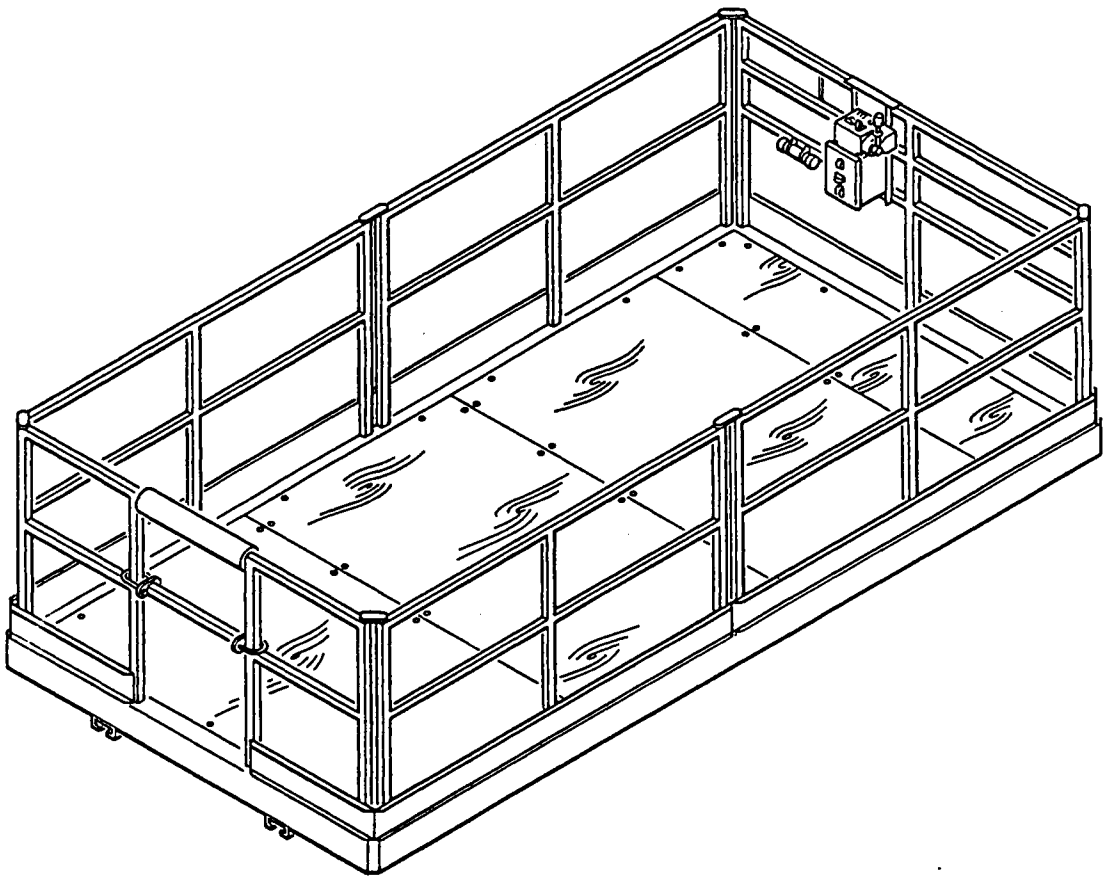


TELESCOPIC CYLINDER ASSEMBLY

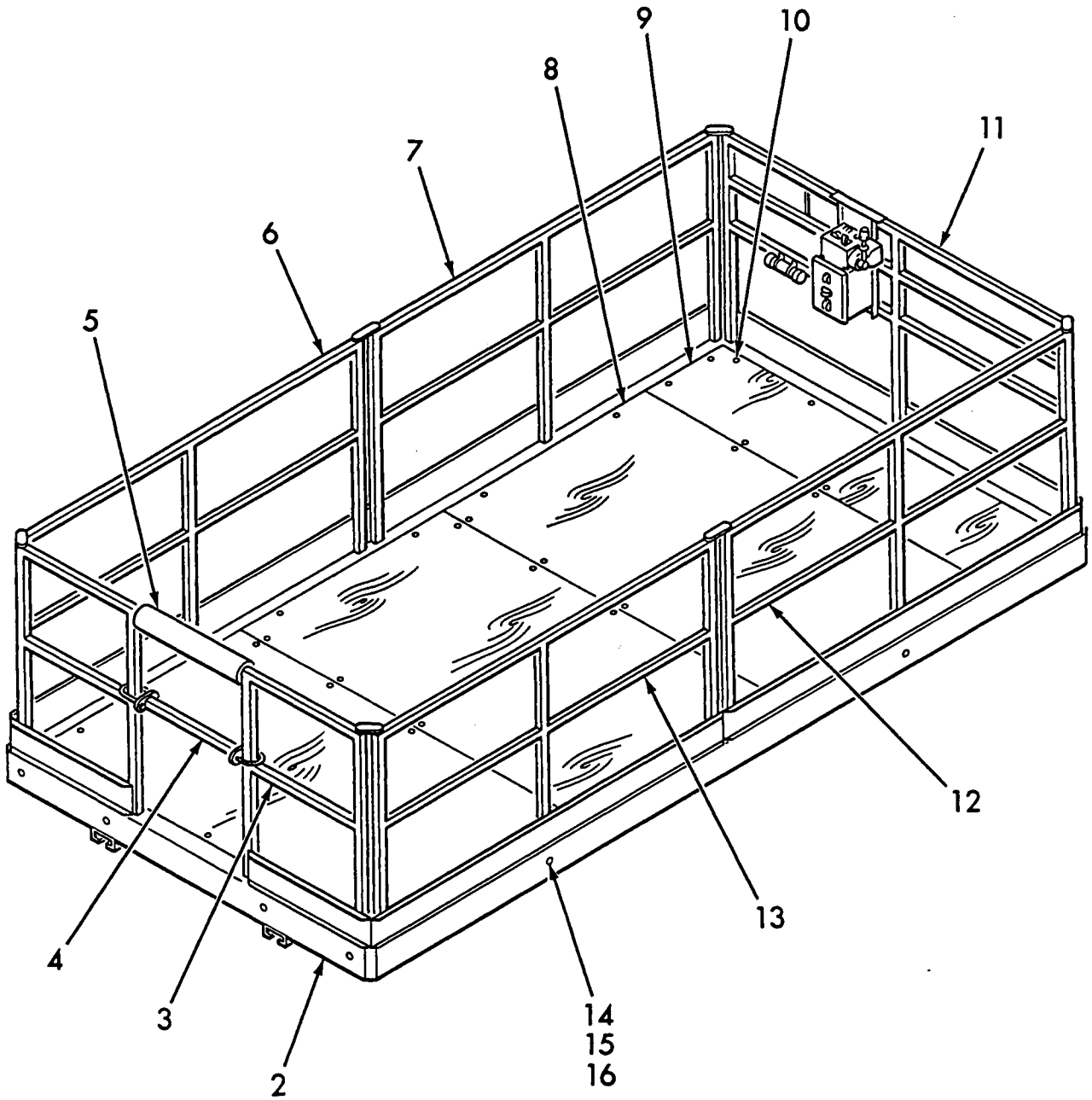
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	31092	ASSEMBLY, TELESCOPIC CYLINDER (See Sect. 4, Fig. 11A for NHA)	REF
2		. BARREL	1
3		. HEAD, OUTER	1
4		. ROD, OUTER	1
5		. PISTON, OUTER	1
6		. HEAD, INTER	1
7		. ROD, INTER	1
8		. PISTON, INTER	1
-9	67043	. KIT, SEAL (5X4)	1
-9	67042	. KIT, SEAL (5½X4½)(SHOWN)	1
10		.. RING, WEAR	2
11		.. RING, WEAR	1
12		.. SEAL, ROD	1
13		.. WIPER, ROD	1
14		.. RING, WEAR	2
15		.. RING, WEAR	1
16		.. SEAL, ROD	1
17		.. WIPER, ROD	1

- ITEM NOT ILLUSTRATED

SECTION 5 CONTAINS:



PLATFORM ASSEMBLY (MT31G)



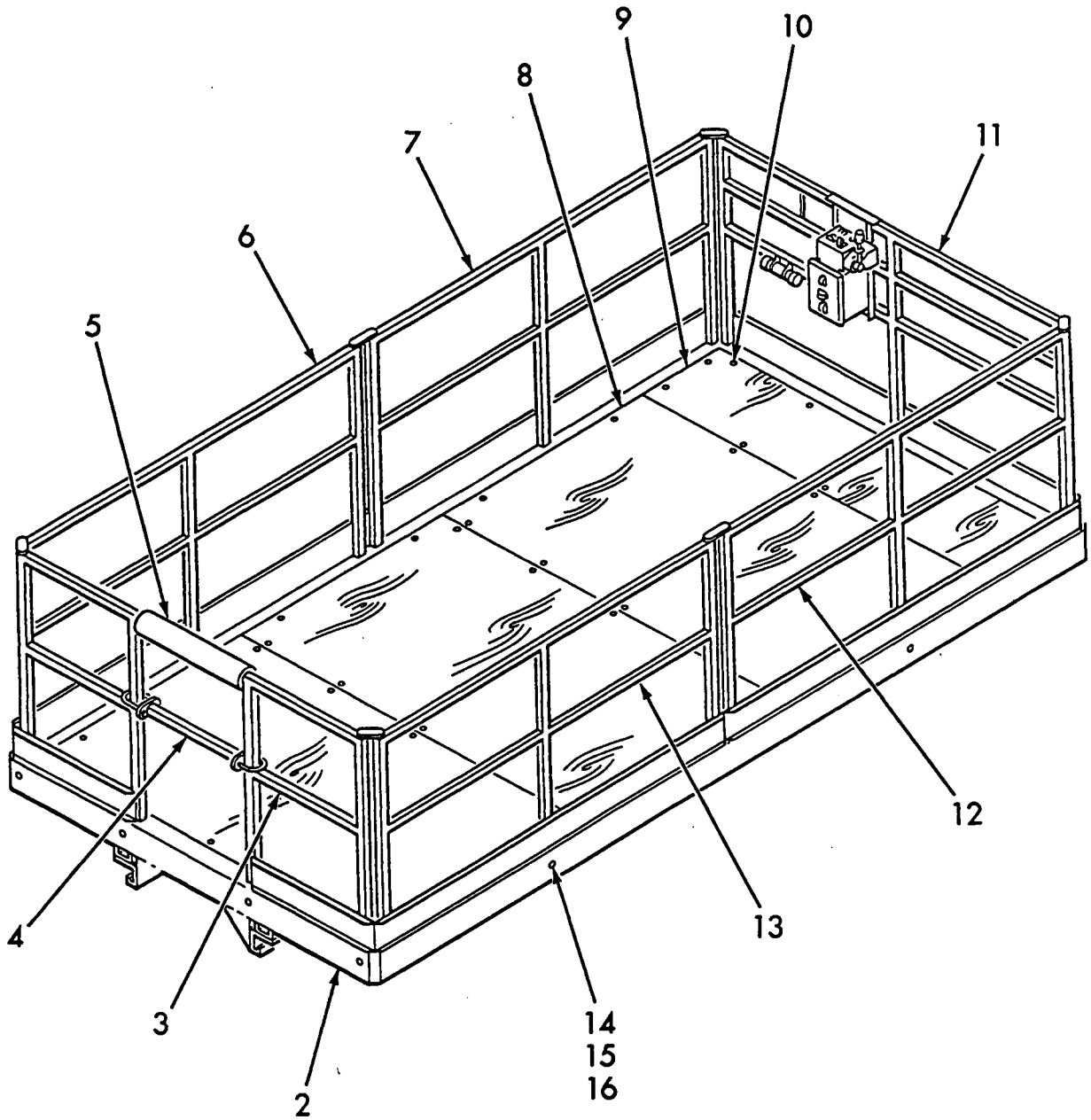
REV.

PLATFORM ASSEMBLY (MT31G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32642	ASSEMBLY, PLATFORM (See Sect. 2, Fig. 1 for NHA)	REF
2	32624	. WELDMENT, PLATFORM	1
3	32640	. RAIL, GUARD-REAR	1
4	32741	. BAR, SLIDE	1
5	160054	. BUMPER, RAIL	1
6	32637	. RAIL, GUARD-L.H. REAR	1
7	32638	. RAIL, GUARD-L.H. FRONT	1
8	32643	. PLYWOOD, PLATFORM	3
9	32644	. PLYWOOD, PLATFORM	1
10	61706	. SCREW, CAP	62
11	32639	. RAIL, GUARD-FRONT	1
12	32635	. RAIL, GUARD-R.H. FRONT	1
13	32636	. RAIL, GUARD-R.H. REAR	1
14	60341	. SCREW, CAP (HEX HEAD)	9
15	63301	. WASHER, LOCK	9
16	60701	. NUT, HEX	9

- ITEM NOT ILLUSTRATED

PLATFORM ASSEMBLY (MT40G)



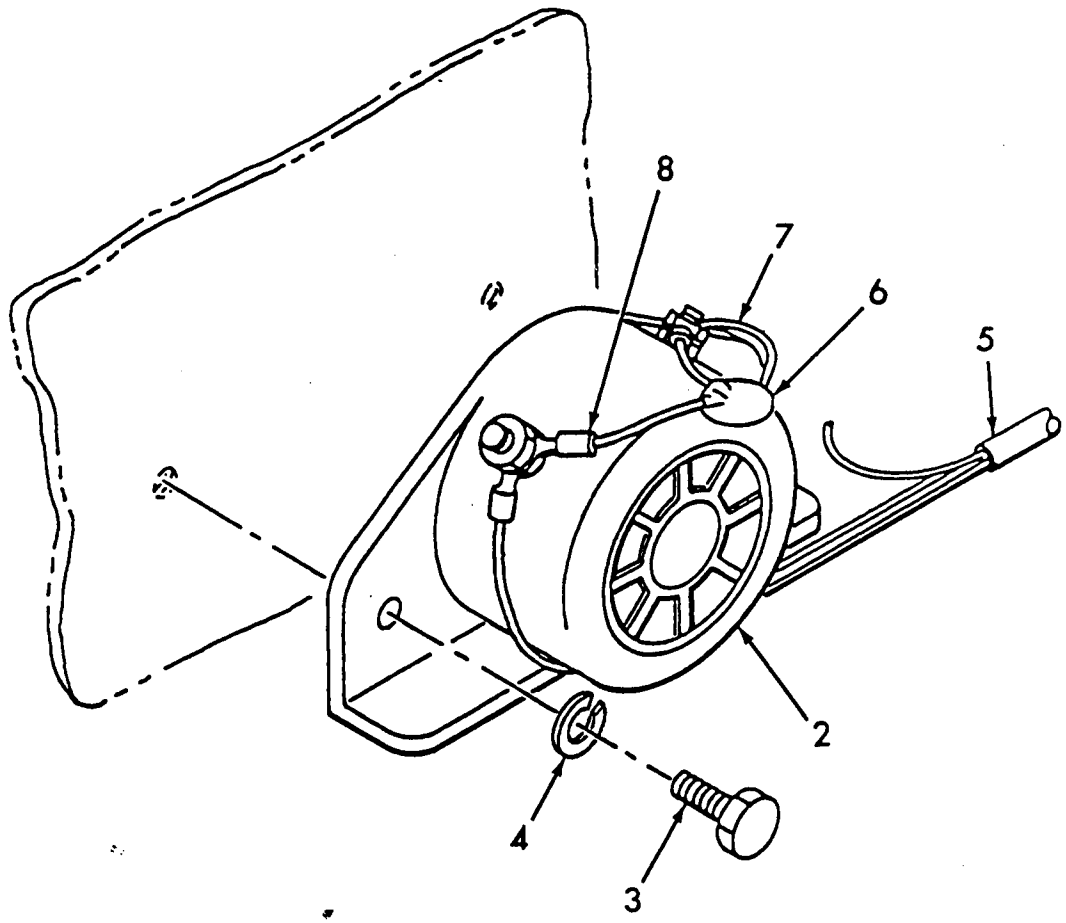
PLATFORM ASSEMBLY (MT40G)

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32641	ASSEMBLY, PLATFORM (See Sect. 2, Fig. 1A for NHA)	REF
2	32623	. WELDMENT, PLATFORM	1
3	32640	. RAIL, GUARD-REAR	1
4	32741	. BAR, SLIDE	1
5	160054	. BUMPER, RAIL	1
6	32637	. RAIL, GUARD-L.H. REAR	1
7	32638	. RAIL, GUARD-L.H. FRONT	1
8	32643	. PLYWOOD, PLATFORM	3
9	32644	. PLYWOOD, PLATFORM	1
10	61706	. SCREW, CAP	62
11	32639	. RAIL, GUARD-FRONT	1
12	32635	. RAIL, GUARD-R.H. FRONT	1
13	32636	. RAIL, GUARD-R.H. REAR	1
14	60341	. SCREW, CAP (HEX HEAD)	9
15	63301	. WASHER, LOCK	9
16	60701	. NUT, HEX	9

- ITEM NOT ILLUSTRATED

SECTION 6 CONTAINS:

TRAVEL WARNING HORN ASSEMBLY

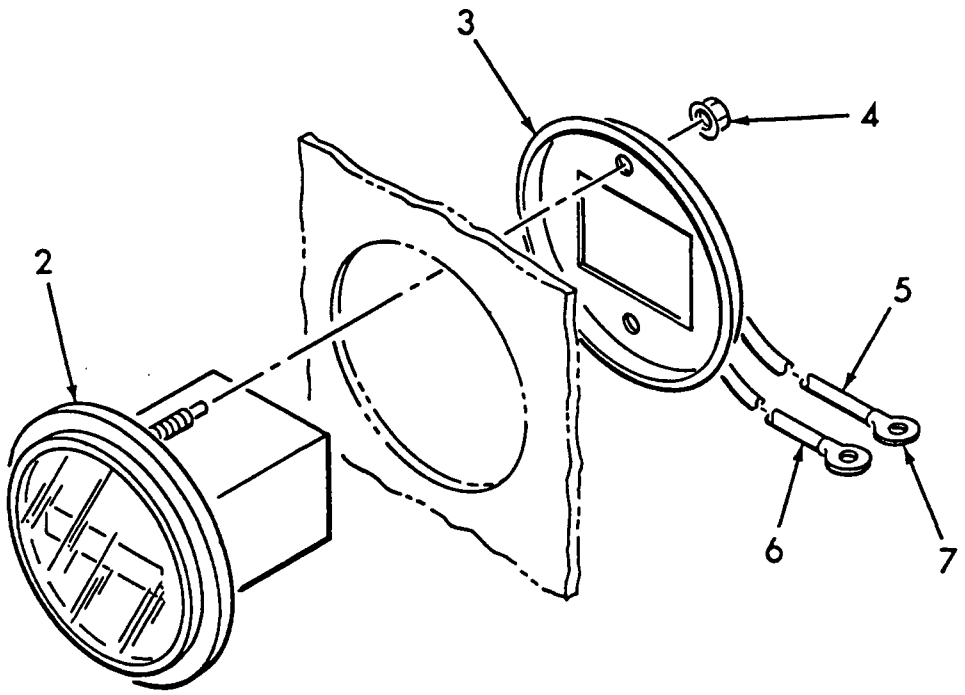


ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	131912	ASSEMBLY, TRAVEL WARNING HORN	REF
2	70053	. HORN, WARNING	1
3	60309	. SCREW, CAP	2
4	63301	. WASHER, LOCK	2
5	16201	. WIRE	3 FT
6	130705	. VARISTOR	1
7	70007	. WIRE, YELLOW	6 IN
8	117-C	. CONNECTOR, RING	10

REV.

Drawing for **Mark Industries**
Part No. 32908 was not
available this edition

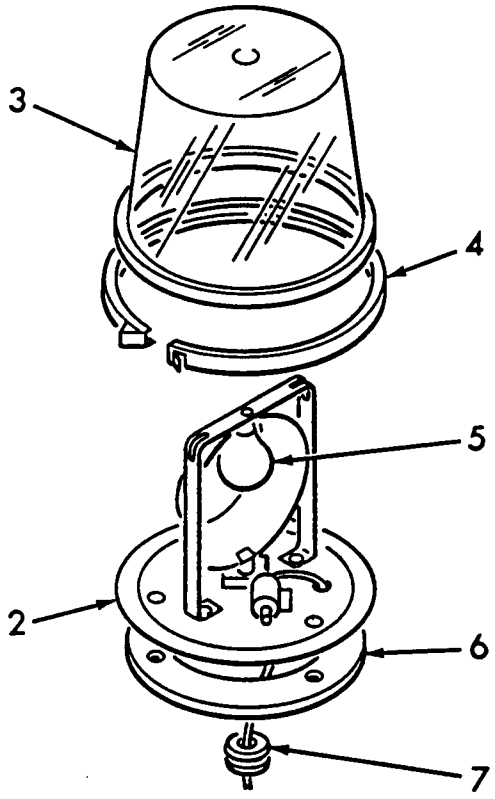
HOURMETER ASSEMBLY



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	131065	ASSEMBLY, HOURMETER	REF
2	20571	. HOURMETER	1
3		. COVER, BACK	1
4		. NUT, LOCK	2
5	70232	. WIRE, WHITE	1.5 FT
6	70008	. WIRE, YELLOW/GREEN	1.5 FT
7	117-C	. RING, CONNECTOR	2

REV.

ROTATING AMBER BEACON ASSEMBLY



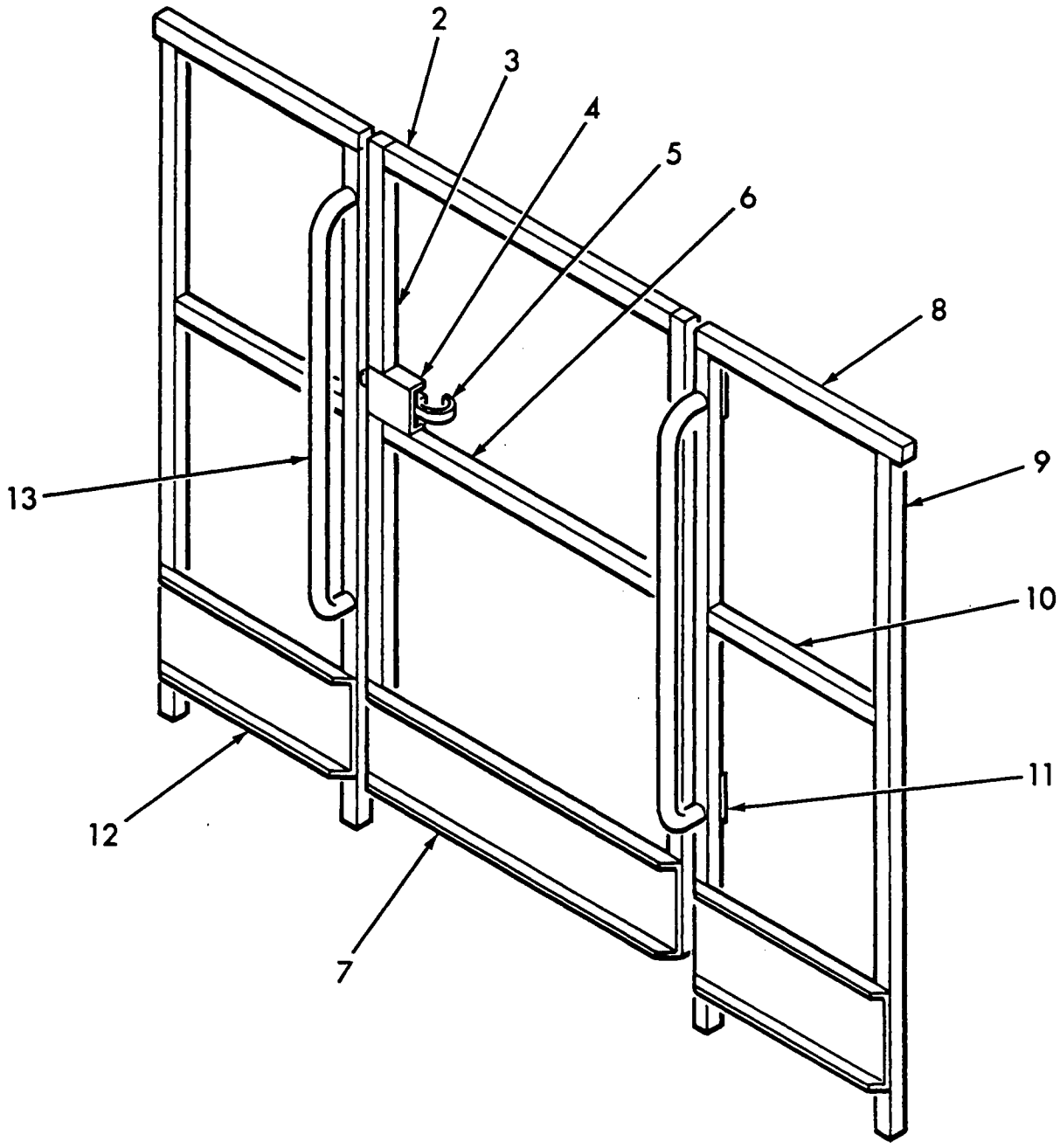
ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	131927	ASSEMBLY, ROTATING AMBER BEACON	REF
2		. BODY	1
3		. BULB	1
4		. CLAMP	1
5		. CAP	1
6		. GASKET	1
7	729	. GROMMET	1

REV.

12 VOLT PLATFORM WORK LIGHT

Drawing for **Mark Industries**
Part No. 131928 was not
available this edition

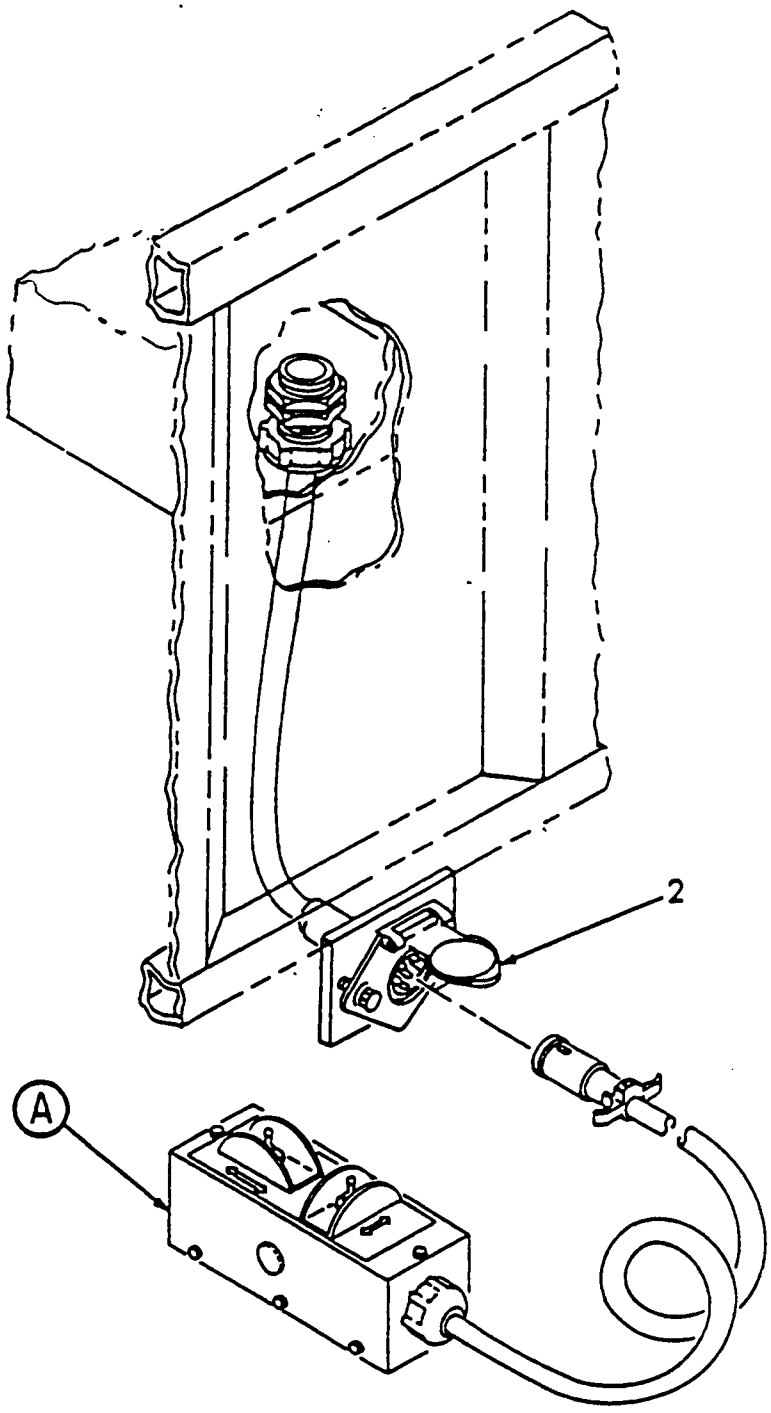
SWING GATE ASSEMBLY



SWING GATE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32914	WELDMENT, REAR GUARD RAIL	REF
2	36310	. TUBE, RECTANGULAR	1
3	36247	. TUBE, SQUARE	1
4	35015	. CHANNEL	1
5	16231	. BOLT, LATCH	1
6	36315	. TUBE, SQUARE	1
7	30149-23.0	. PLATE, TOE	1
8	37197	. TUBE, RECTANGULAR	2
9	36305	. TUBE, SQUARE	4
10	37196	. TUBE, SQUARE	2
11	12005	. HINGE, SPRING	2
12	30149-28.1	. PLATE, TOE	2
13	32031	. RAIL, HAND	2

- ITEM NOT ILLUSTRATED


2
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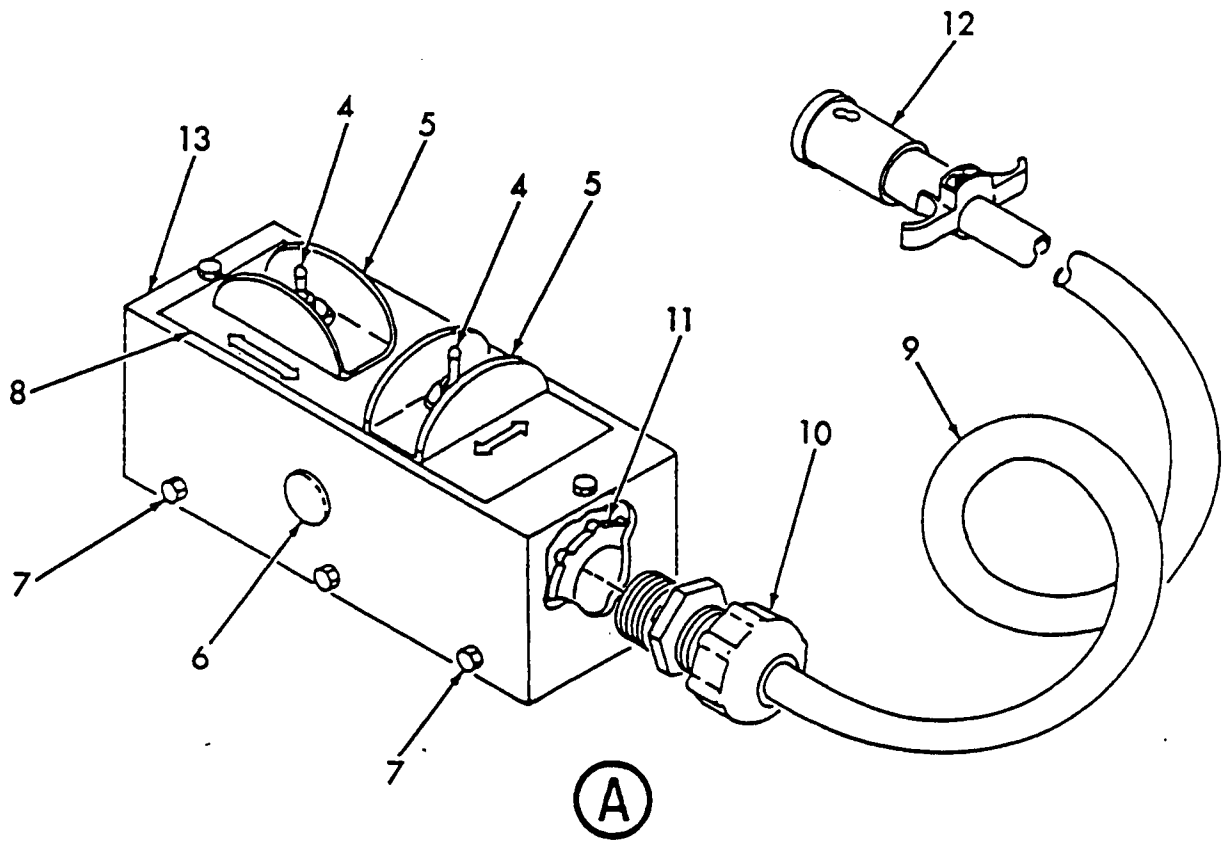
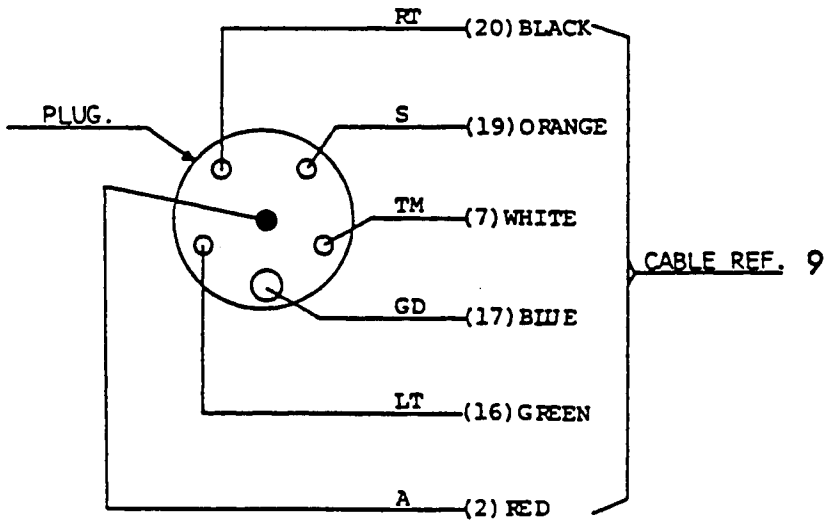




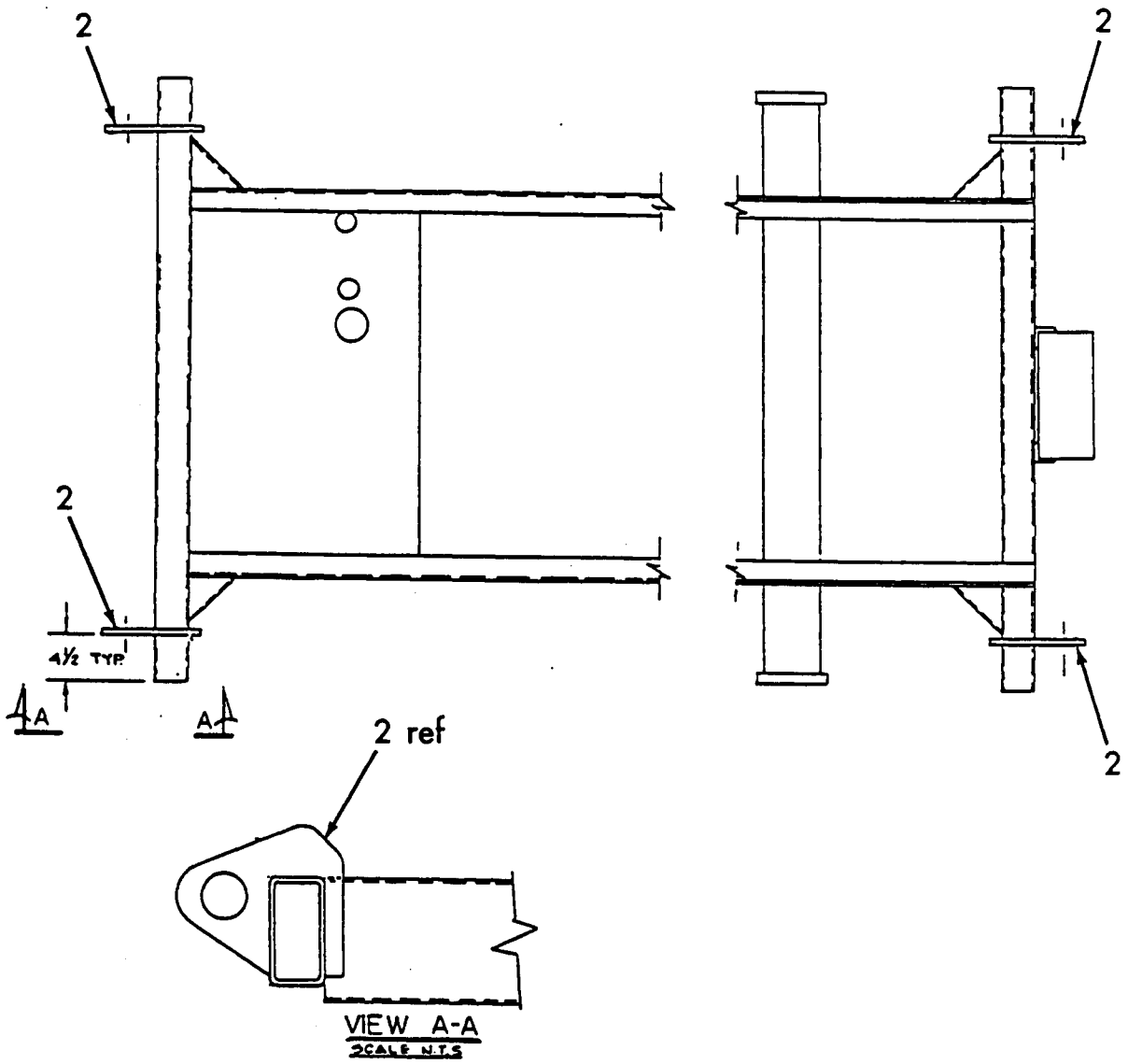
PLUG WIRING DIAGRAM

REMOTE DRIVE KIT

ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	131916	KIT, REMOTE DRIVE	REF
2	131940	. PLUG, FEMALE REMOTE DRIVE & STEER	1
-3	130911	. ASSEMBLY, REMOTE DRIVE LANYARD/CONTROL	1
4	20481	.. SWITCH, TOGGLE	2
5	20884	.. GUARD, SWITCH	2
6	771	.. PLUG, WHITE	1
7	61726	.. SCREW, SELF TAPPING	8
8	130906	.. DECAL, R. CONTROL DRIVE & STEER	1
9	130902-08	.. CABLE, CONDUCTOR	1
10	70281	.. RELIEF, STRAIN	1
11	2808	.. NUT, LOCK	1
12	70266	.. PLUG (6-POLE)	1
13	130901	.. ASSEMBLY, ELECTRICAL	1

- ITEM NOT ILLUSTRATED

LIFTING LUGS



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	31010	LUGS, LIFTING	REF
2	30920	. LUG, LIFTING	4

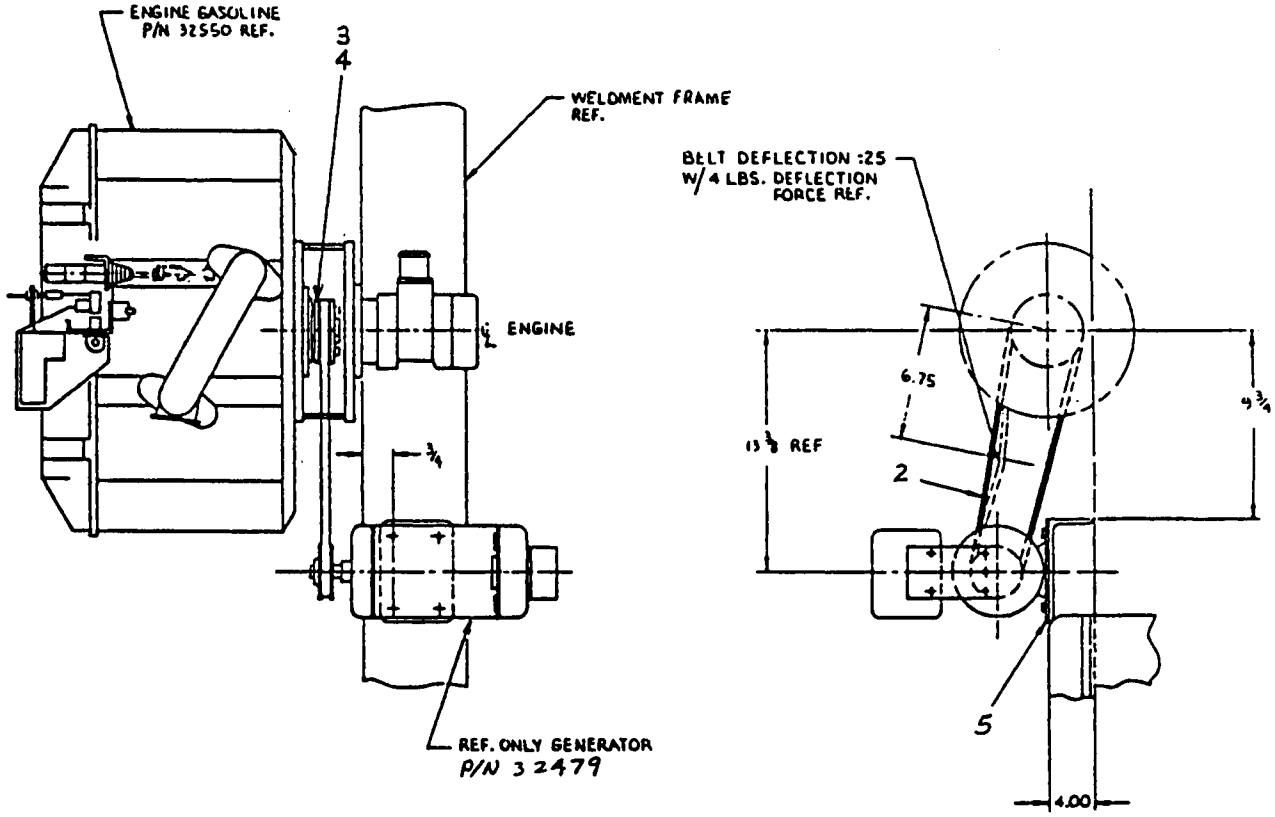
REV.

CATALYTIC CONVERTER

Drawing for **Mark Industries**
Part No. 32922 was not
available this edition

Drawing for **Mark Industries**
Part No. 32479 was not
available this edition

GENERATOR BRACKET PULLEY & BELT



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32931	GENERATOR BRACKET PULLEY AND BELT	REF
2	65874	. BELT	1
3	32459	. SHAFT, PULLEY AND STUB	1
4	60323	. SCREW, CAP	8
5	32737	. BRACKET, GENERATOR MOUNTING	1

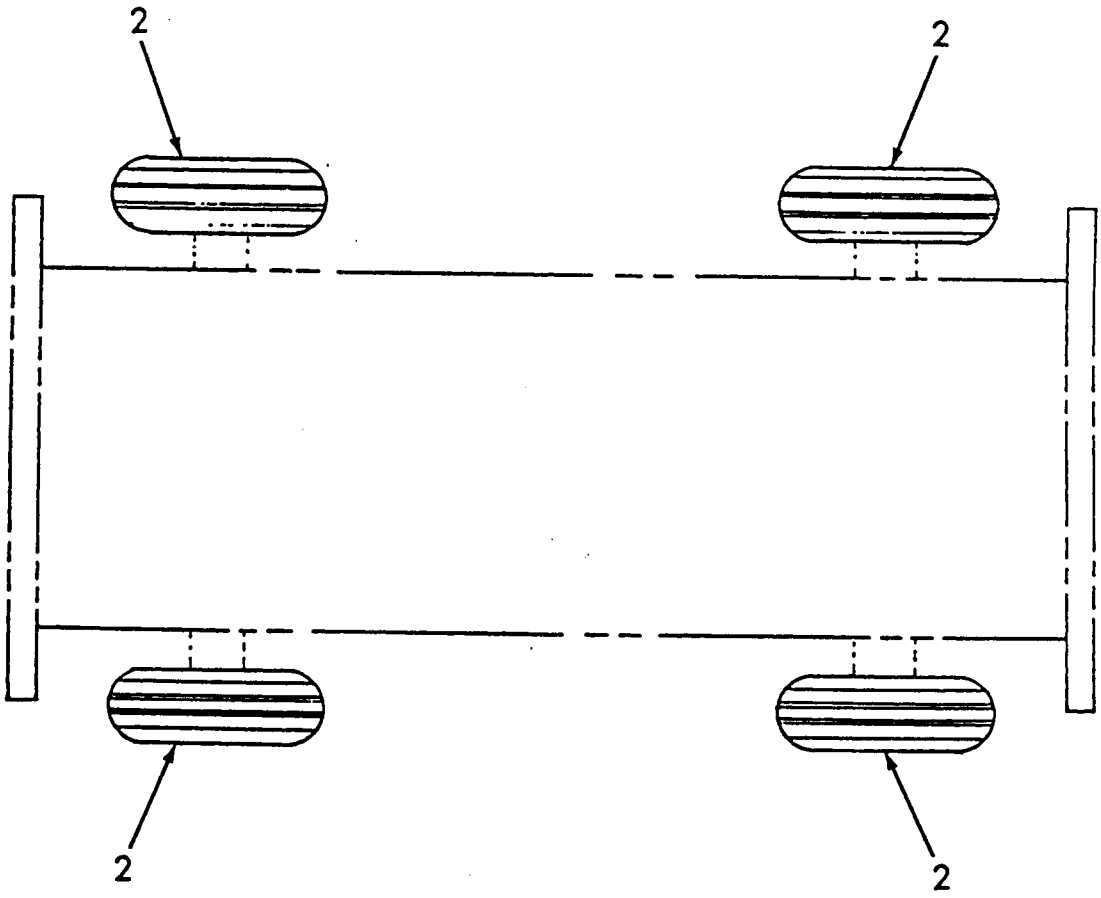
REV.

SPARK ARRESTOR MUFFLER

Drawing for **Mark Industries**
Part No. 32924 was not
available this edition

Drawing for **Mark Industries**
Part No. 32935 was not
available this edition

SAND TIRES



ITEM	PART NUMBER	DESCRIPTION 1234567	UNIT PER ASSY.
-1	32415	TIRE, SAND	REF
2	32440	. ASSEMBLY, SAND TIRE AND WHEEL	4

REV.

VENDOR CHAPTER CONTAINS:

SECTION 1	WISCONSIN ENGINE	P/N 32550
PAGE NO.	TITLE	
1-53	REPAIR MANUAL	
1	TABLE OF CONTENTS	

SECTION 2	DOUBLE GEAR PUMP	P/N 81256
PAGE NO.	TITLE	
1-8	SERVICE MANUAL	

SECTION 3	DISC BRAKE	P/N 81116
PAGE NO.	TITLE	
1-7	SERVICE MANUAL	

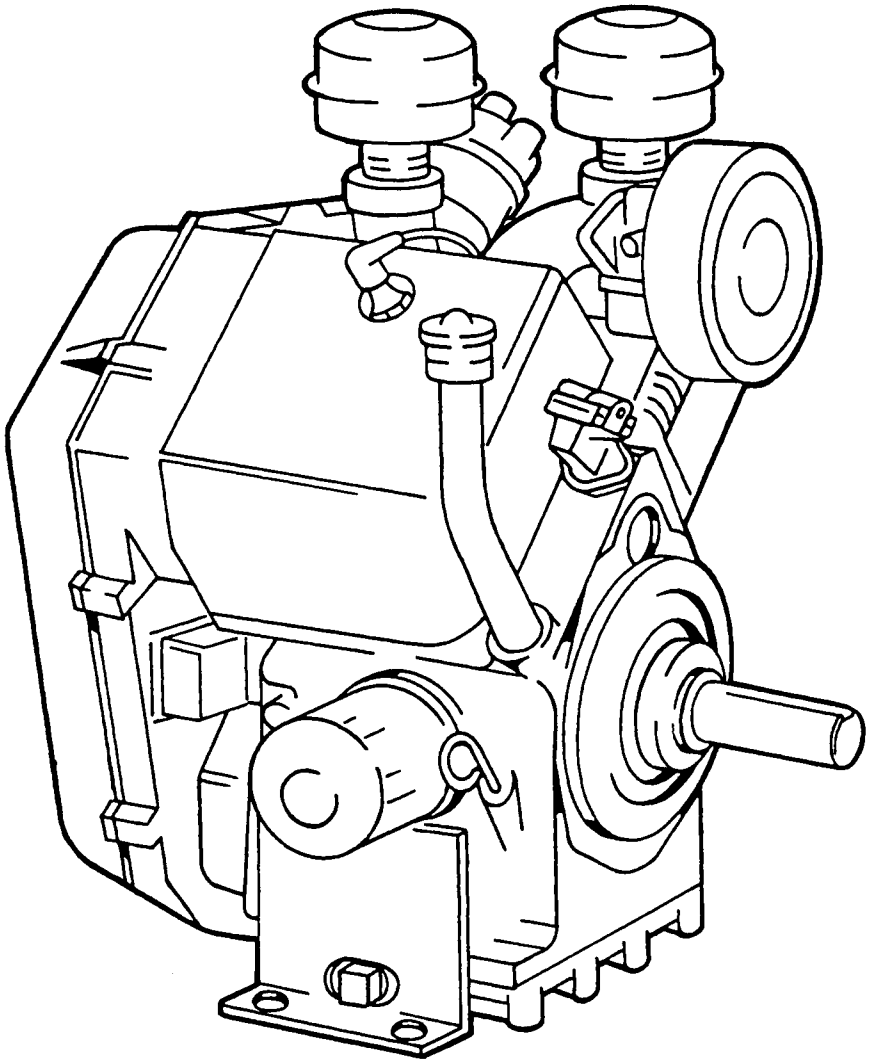
SECTION 4	DRIVE MOTOR	P/N 81271
PAGE NO.	TITLE	
1-33	SERVICE PROCEDURE	
5	TABLE OF CONTENTS	

SECTION 5	DRIVE MOTOR	P/N 81113
PAGE NO.	TITLE	
1-13	SERVICE PROCEDURE	
2	TABLE OF CONTENTS	

INFORMATION PROVIDED IN THIS VENDOR CHAPTER IS BEING FORWARDED AS A COURTESY.
MARK INDUSTRIES IS NOT RESPONSIBLE FOR ANY VARIATIONS IN THE INFORMATION PROVIDED HEREIN.

REPAIR MANUAL

WISCONSIN ENGINE



gasoline
air cooled
2 cylinder

Model

W2-1250

MAY BE USED FOR
MODELS W2-1230
AND W2-1235

TABLE OF CONTENTS

SPECIFICATIONS

MODELS W2-1230 and W2-1235

Bore ..... 3.75 in. (95.25 mm)
Stroke ..... 3.40 in. (86.36 mm)
Piston displacement ..... 75 cu. in. (1230 cc)
Compression ratio 6.8:1

Horsepower

Continuous duty operation is recommended at 80% of horsepower shown.

Engine rated performance is documented to Engine Test Code — S.A.E. J-1349.

Model W2-1230 .....25 hp at 3600 rpm
Model W2-1235 .....30 hp at 3600 rpm

Horsepower specified in the accompanying chart is for an atmospheric temperature of 77°F (25°C) at sea level and at a dry Barometric pressure of 29.31 inches (744.5 mm) of mercury.

For each inch (25.4 mm) lower the Barometric pressure drops, there will be a loss in horsepower of 3½%.

For each 10°F (5.5°C) temperature rise there will be a reduction in horsepower of 1%.

For each 1000 ft. (305 m) altitude above sea level there will be a reduction in horsepower of 3½%.

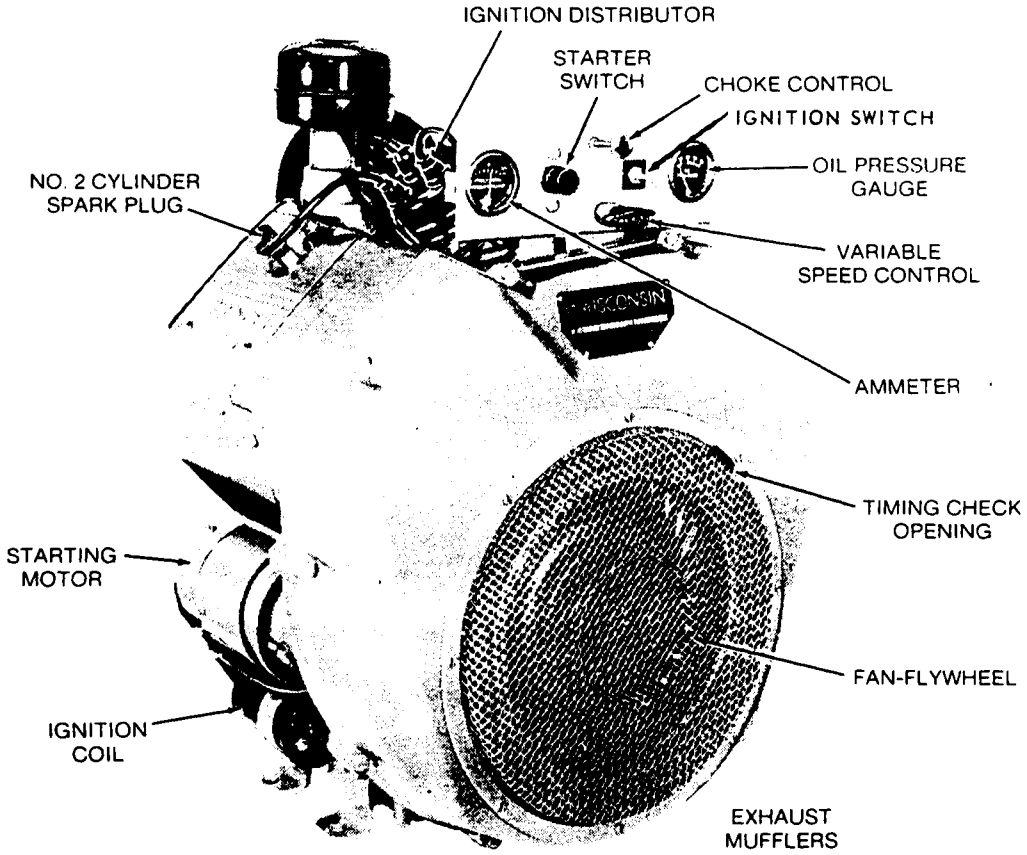
The friction in new engines cannot be reduced to the ultimate minimum during the regular block test, but engines are guaranteed to develop at least 85 per cent of maximum power when shipped from the factory. The power will increase as friction is reduced during the first few days of operation. The engine will develop at least 95% of maximum horsepower when friction is reduced to a minimum.

SAFETY PRECAUTIONS

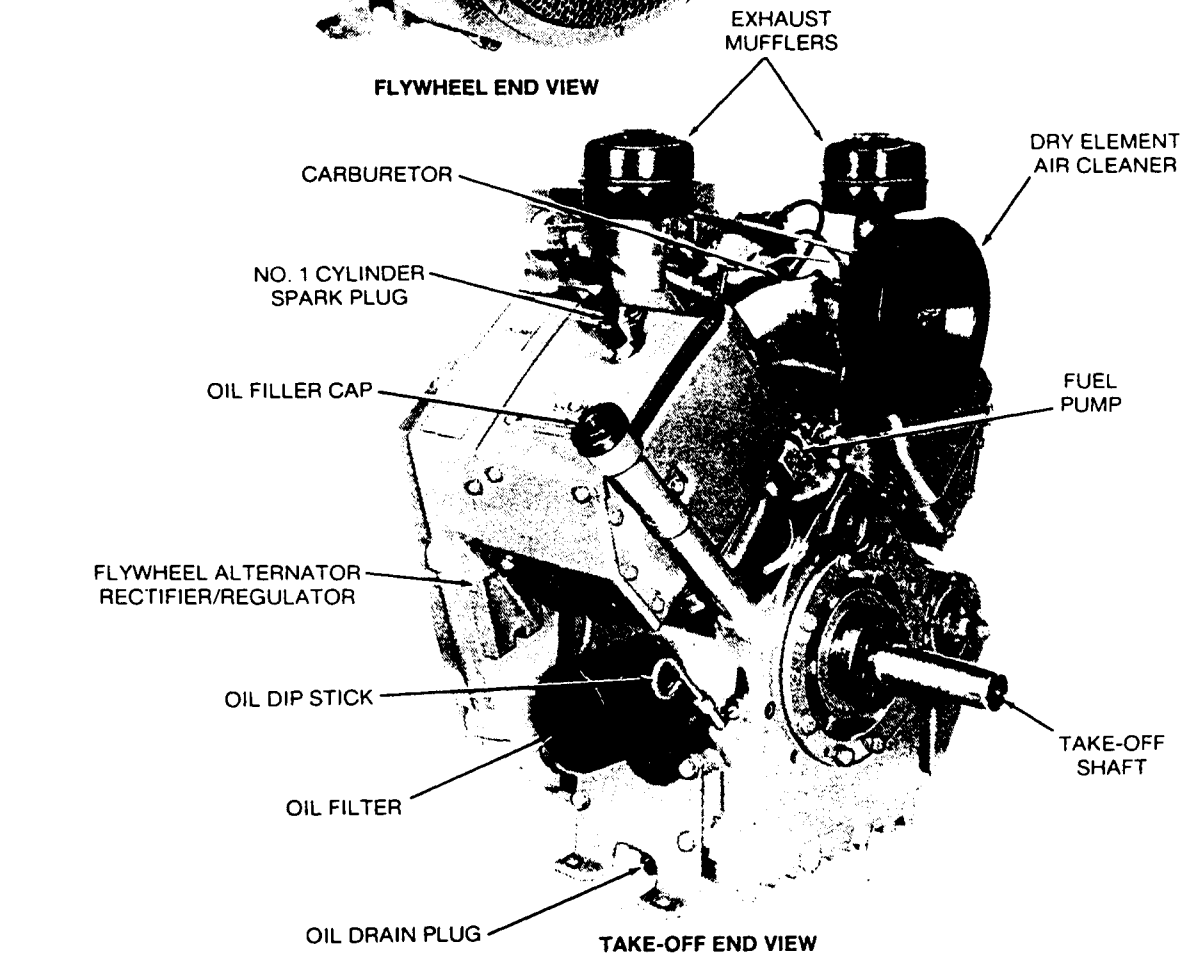
Careless use of the engine causes a high percentage of accidents. Avoid serious injury by being alert, use common sense and be safety minded. Observe the following precautions and carefully enforce them when operating your ***Wisconsin Engine***. Read operating instructions thoroughly — Know how to stop the engine in case of emergency.

⚠ This symbol indicates important safety messages throughout this Repair Manual — ***Read Them Carefully.***

- Engine should be operated only by qualified persons.
- 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 can cause serious illness and possible death.
- Keep exhaust connection tight and components in good condition; noise from a faulty exhaust system can also be harmful.
- Exhaust system parts get very hot — avoid touching these parts until the engine has stopped and has sufficiently cooled off.
- Never refuel a hot or running engine. Do not smoke while filling fuel tank or servicing fuel system.
- Always refuel slowly to avoid spillage.
- Make sure all fuel lines and connections are tight and in good condition.
- Handle batteries carefully; battery acid will burn skin and can cause blindness if it contacts the eyes.
- Avoid sparks near battery. Gas given off by battery is explosive.
- Keep engine and surrounding area clean and clear of trash.
- When starting engine maintain a safe distance from moving parts of equipment. Be sure all rotating parts are secure and in good condition.
- Do not start engine with clutch engaged.
- Never run engine with governor linkage disconnected, or operate at speeds in excess of 3600 R.P.M. load.
- Never make adjustments on machinery while it is connected to the engine, without first disconnecting 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.
- Never run engine while safety switches are disconnected, or protective screening is removed from unit.
- Do not leave engine running while lubricating, making adjustments or repairs unless specifically recommended.
- Never leave engine unattended while it is running.
- Keep hands, feet and clothing away from all moving parts.
- Mount a fire extinguisher close to the engine. Maintain extinguisher properly and be familiar with its use.
- Precaution is the best insurance against accidents.



FLYWHEEL END VIEW



TAKE-OFF END VIEW

Fig. 1

REV

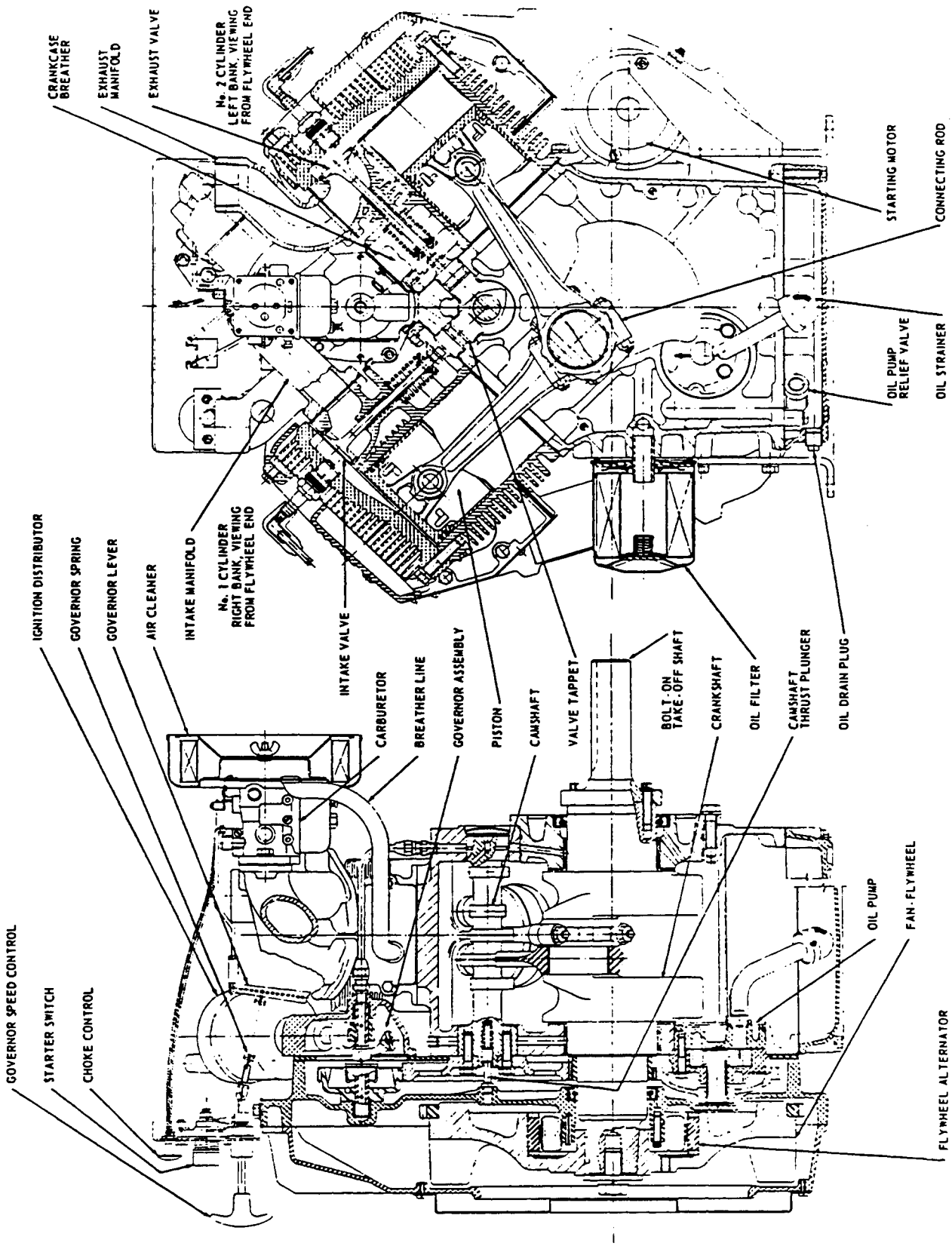


Fig. 2 ENGINE SECTIONAL VIEWS

GENERAL INFORMATION and DESIGN

Wisconsin engines are of the ***four cycle*** type, in which each of the four operations of ***intake, compression, expansion*** and ***exhaust*** requires 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, by a combination fan-flywheel encased in a cast aluminum shroud. The air is divided and directed by ducts and baffles to achieve maximum cooling efficiency.

Never operate an engine with any part of the shrouding removed — this will retard air cooling.

Keep the cylinder and head fins free from dirt and chaff. Improper circulation of cooling air will cause engine to overheat.

CARBURETOR

The proper combustible mixture of gasoline and air is furnished by a calaberated carburetor, with a fixed main metering jet, that provides correct fuel to air ratios for all speeds and loads.

IGNITION SYSTEM

The spark for ignition of the fuel mixture is directed from the coil to the spark plugs, at the proper time, by ***Battery Ignition*** (12 volt) ***Distributor.*** The distributor is mounted to the governor housing and is easily accessible for timing.

CHARGING SYSTEM

10 amp or 30 amp Flywheel Alternator Circuits are furnished as optional equipment. Stub shaft drive at flywheel end is also available for an automotive type belt driven alternator. Battery is not furnished by Teledyne Wisconsin Motor.

LUBRICATION SYSTEM, Fig. 11

A Gerotor type oil pump provides pressurized lubrication through passages in the crankcase and crankshaft to the main bearings, connecting rods and camshaft bearings. Oil expelled from these areas forms a mist which lubricates the cylinder walls, valves and tappets. An external oil line from above the camshaft provides lubrication to the governor and gear train. All of the circulated oil passes through a ***full-flow*** oil filter.

GOVERNOR

A mechanical flyweight type governor maintains engine speed by varying the throttle opening to suit the load imposed upon the engine. Options available are either a ***fixed speed*** governor, a ***variable speed control*** to regulate the governed speed of the engine, or an ***idle control.***

ROTATION

The rotation of the crankshaft is clockwise when viewing the flywheel or cranking end of the engine. This gives ***counterclockwise rotation*** when viewing the power take-off end of the crankshaft. The flywheel end of the engine is designated the ***front end,*** and the power take-off end, the ***rear end*** of the engine.

Full power take-off from the flywheel end of engine is also optionally available.

BEFORE STARTING ENGINE

1. FUEL

Fill fuel tank with a reputable well known brand of ***Regular Grade*** gasoline. ***Leaded*** gasoline is preferred with an *Anti-knock Index of ***87 minimum.*** Unleaded regular gasoline may be used, although shorter valve life may be experienced.
Note: *minimum Motor octane number must be 82.

Caution: Refuel slowly to avoid spillage. Do not smoke when filling tank.

Be sure that vent hole in fuel tank cap is clean and free of any obstruction.

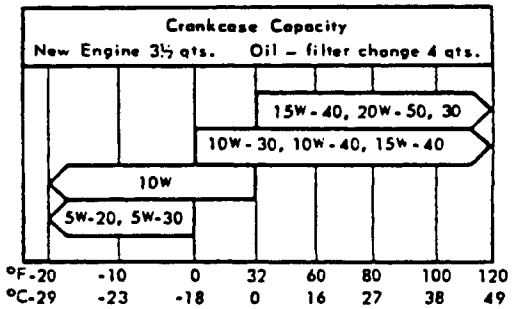
2. LUBRICATION

Fill crankcase base with the proper grade of engine oil as specified in ***"Grade Of Oil"*** chart. Fill through the oil filler tube opening to the level indicated by the ***Full Mark*** on ***Dipstick.*** Approximately 3½ quarts are required in a new engine — 4 quarts with oil and filter change.

IMPORTANT

Do not overfill crankcase. ***Do not*** allow oil level to go below ***Add*** mark on dip stick.

RECOMMENDED SAE VISCOSITY GRADES
Use oil Designation as Service SE or SF



If engine is used at near maximum performance, it is recommended that a single-viscosity oil of SF Quality be used; either grade SAE 30 or SAE 10W.

Proven synthetic oils give superior service in air cooled gasoline engines and can be used, but the recommended oil change interval remains at 100 nours.

With reference to *Fig. 3* and *Fig. 4*, 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.

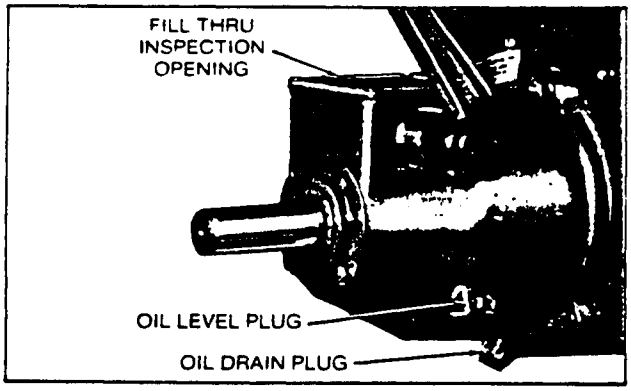


Fig. 3

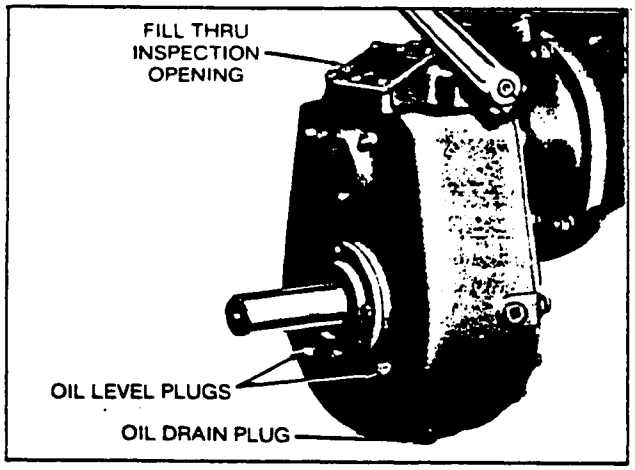


Fig. 4

NOTE: Automotive Dry Plate Clutch and Clutch Reduction assemblies should be lubricated per instructions on inspection plate attached to clutch housing.

STARTING

⚠ ***Caution:*** Maintain a safe distance from moving parts of equipment. Know how to stop the engine quickly in case of emergency.

⚠ ***Caution:*** Do not operate engine in a closed building unless it is properly ventilated.

STARTING PROCEDURE, Fig. 5

1. Check crankcase oil level and gasoline supply. Open fuel shut-off valve in fuel strainer or tank.
2. Disengage clutch, if furnished.
3. Pull variable speed control 'T' handle out about halfway and lock in place. With a two speed (idle control), start in full load position — idle after engine starts.
4. Close choke by pulling choke button to extreme out position.
5. Pull out ignition switch button, tag reads *'To Stop Push In'*.
6. Depress starter switch to start engine.

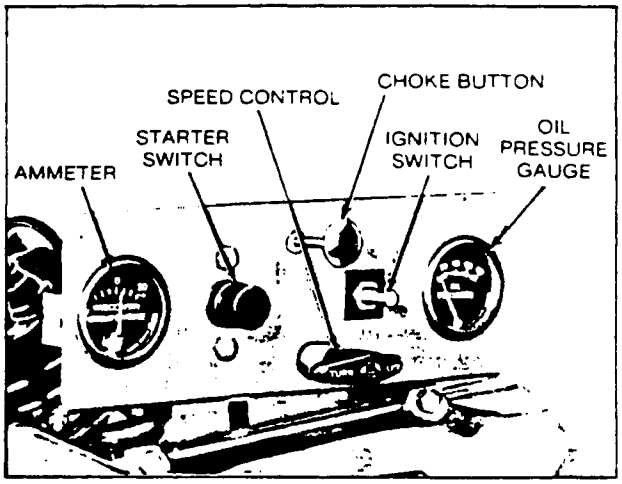


Fig. 5 CONTROL PANEL

IMPORTANT

Do not crank engine for more than 30 seconds at a time if engine fails to start, wait about 2 minutes between cranking periods to prevent starter from over-heating.

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

If flooding should occur, open choke fully by pushing choke button in and continue cranking. Less choking is necessary in warm weather or when engine is warm, than when cold.

WARM-UP

After engine starts, allow it to warm up a few minutes before applying load. ***Do not race or gun engine*** to hurry WARM-UP. The proper oil film on various surfaces of the pistons, cylinders, bearings, etc., cannot be established until the oil has warmed up and become sufficiently fluid.

⚠ ***Caution: Racing an engine by disconnecting the governor,*** or by doing anything to interfere with the governor controlled engine speed, ***is extremely dangerous.***

The governor is provided as a means for controlling the engine speed to suit the load applied, and also as a safety measure to guard against excessive speeds, which not only overstrain all working parts, but which might cause wrecking of the engine and possible injury to bystanders.

TO STOP ENGINE

Depress ignition switch button, tag reads *'To Stop Push In'*.

If the engine has been running hard and is hot, do not stop it abruptly from full load, but remove the load and allow engine to run idle at 1000 to 1200 R.P.M. for three to five minutes. This will reduce the internal temperature of the engine much faster, minimize valve warping, and of course the external temperature, including the manifold and carburetor will also reduce faster, due to air circulation

from the flywheel. Thus, the problems of ***vapor lock*** and ***dieseling***, or ***run-on***, will also be minimized by this continued practice.

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 on remote or side mounted air cleaners.

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

DRY TYPE AIR CLEANER, Fig. 6

The dry element air cleaner mounted directly to the carburetor is standard equipment on this model engine. ***Do not*** oil element, and ***do not*** use gasoline or kerosene for cleaning.

Service Daily; or twice a day if engine is operating in very dusty conditions. Remove element and shake out the accumulated dust and dirt. Wipe out dirt from inside cover and from housing.

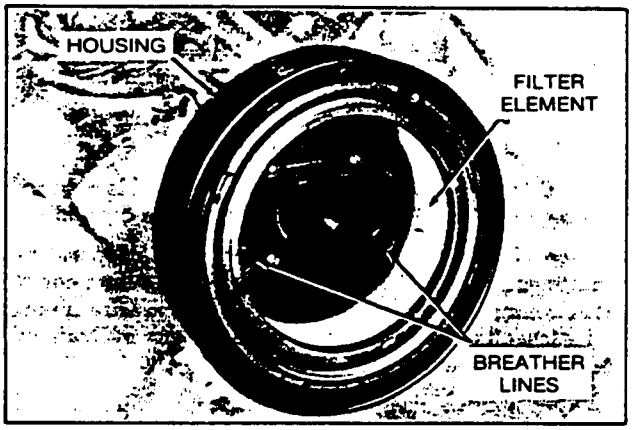


Fig. 6 DRY ELEMENT AIR CLEANER

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 installing in air cleaner. In cold weather, protect element from freezing until dry.

After five washings or one year of service, whichever comes first, replace cartridge element. New filter elements are available from all Teledyne Wisconsin Motor Distributors and Service Centers.

HEAVY DUTY AIR CLEANERS, Fig. 7

Dry element, or oil bath heavy duty type air cleaners are optionally used, and are mounted either to the left hand side of the engine, or to the customer equipment structure.

DRY TYPE Heavy Duty Air Cleaner

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.

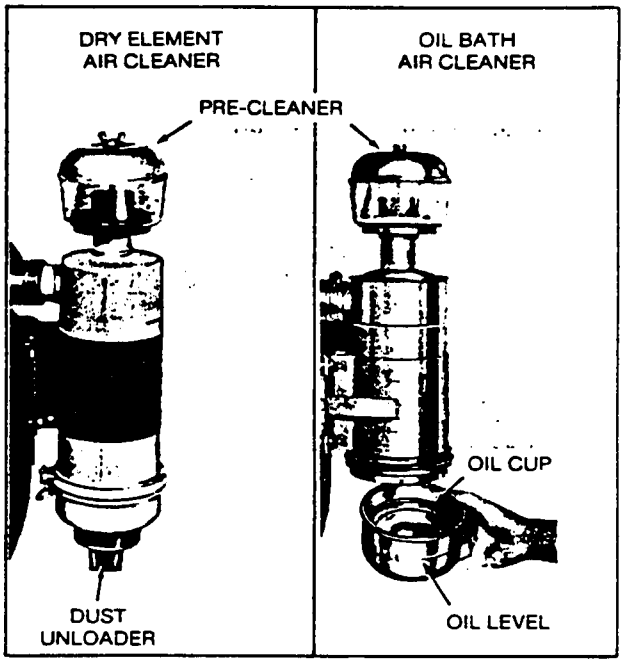


Fig. 7 HEAVY DUTY AIR CLEANERS

Do Not Use Gasoline, Kerosene or Solvent for Cleaning —Do Not Oil Element.

After ten washings or one year of service, replace cartridge. New cartridges are available at all ***Wisconsin Distributors*** and ***Service Centers***.

OIL BATH Heavy Duty Air Cleaner

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.

IMPORTANT

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 more often 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.

PRE-CLEANER

The optionally furnished collector type pre-cleaner, mounted to the top of the air cleaner as illustrated in Fig. 7, 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 SYSTEM, Fig. 8, Fig. 9

The crankcase is ventilated by means of a closed breather system, controlled by ***Reed Type Breather Valves***. The breather valve is an integral part of each of the two valve chamber inspection covers, as illustrated in Fig. 9.

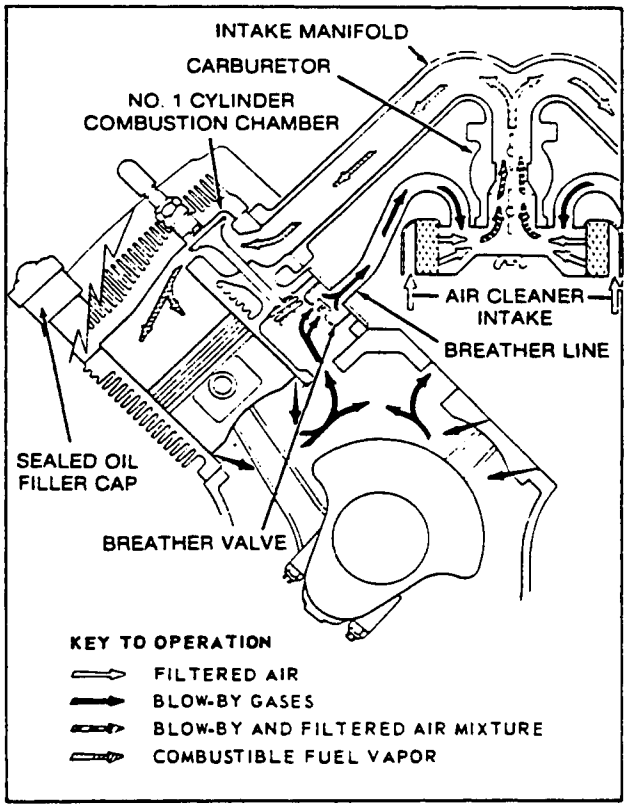


Fig. 8

Oil and fuel vapors (blow-by) in the crankcase is released through the breather valves to the air cleaner, carburetor and intake manifold, where it is mixed with fresh fuel vapor and burned in the combustion chamber. See Fig. 8.

IMPORTANT

It is necessary that the breather valves be kept clean and operable, and the breather lines free of any obstruction. The operation of the breather valves is also important in maintaining a partial vacuum in the crankcase to prevent oil leaks at seal and gasket surfaces.

Every 100 Hours; Inspect breather lines for breaks or obstruction.

Every 250 Hours; Remove inspection covers and clean breather valves with a solvent.

⚠ ***Caution:*** Do not use gasoline, naptha, or benzine. They are highly flammable.

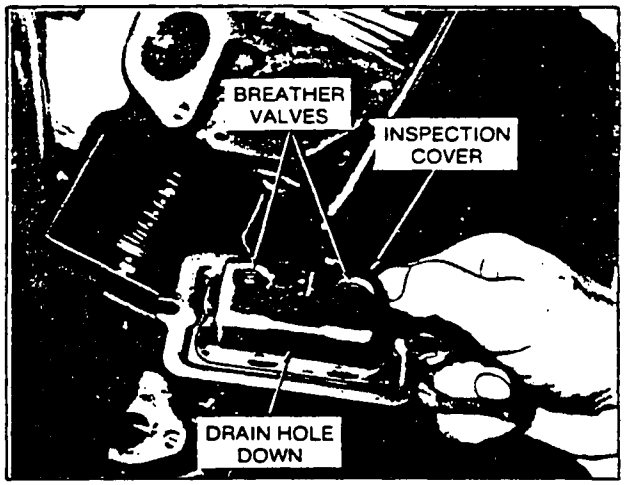


Fig. 9 BREATHER VALVE

CRANKCASE OIL, Fig. 10

Check Oil Level Every 8 Hours. One quart of oil is required to raise the oil level from ***Add*** to ***Full*** mark on dipstick.

Change Oil Every 100 Hours under normal operating conditions. In extreme dusty and extensive idling conditions, change oil at 50 hour intervals. Remove drain plug and allow oil to drain into a suitable container. Drain oil while engine is hot — it will flow more freely.

⚠ ***Caution:*** Wear gloves when removing drain plug from hot engine.

IMPORTANT

Do not overfill crankcase. ***Do not allow*** oil level to go below ***Add*** mark on dipstick.

Refer to ***Recommended Grades of Oil chart***, Page 5, for type and quantity of oil to be used.

OIL FILTER, Fig. 10, Fig. 11

Under ordinary conditions, all of the engine oil is circulated through a ***full-flow*** 25 micron oil filter. But, when the filter element becomes extremely dirty, the oil bypasses the filter material through a relief valve within the oil filter. As a result, there is no variation in oil pressure to indicate that the oil filter is clogged and requires replace-

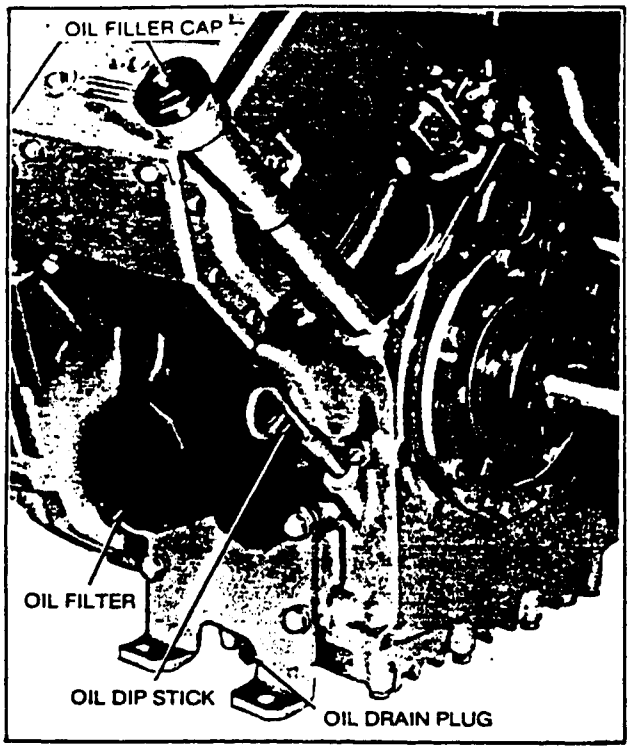


Fig. 10

ment. Because clean oil is so essential for the friction free operation of all bearing surfaces, it is very important that the oil filter be changed at the recommended interval.

Every 100 hours of operation, or at every oil change, replace oil filter.

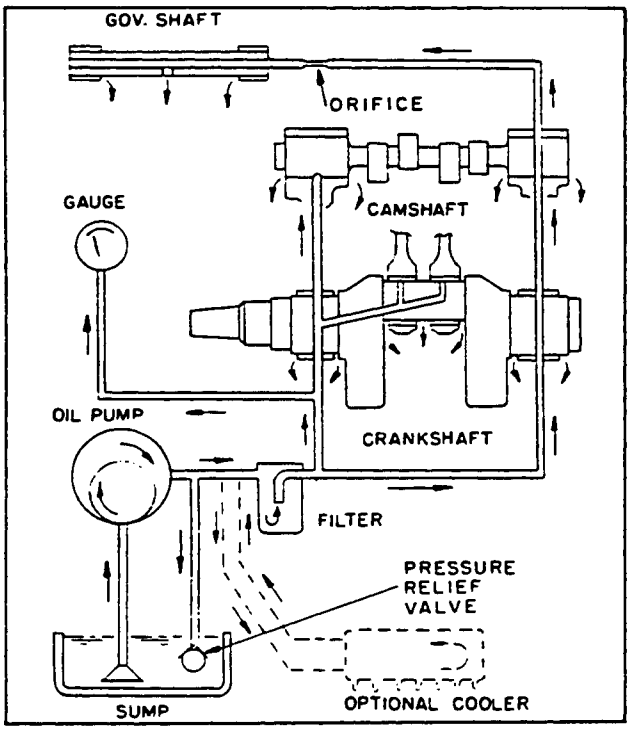


Fig. 11 LUBRICATION SYSTEM

For replacement, use only a Wisconsin ***Micro-Fine*** oil filter, specifically designed for this model engine.

When reassembling new filter, add a film of clean oil to the face of the base gasket. Turn filter to a snug fit, then ½ turn more. ***Do not overtighten.***

OIL PRESSURE, Fig. 11

Oil pressure is controlled by a non-adjustable relief valve mounted in the crankcase below the oil pump. With engine oil hot, gauge pressure will be from 30 to 50 p.s.i. at engine speeds of 1600 to 3600 r.p.m. If pressure falls below 15 p.s.i., refer to ***'trouble shooting'***, page 23, for possible causes.

FUEL FILTER, Fig. 12

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. A glass bowl fuel filter should be connected into the fuel system between the tank and fuel pump.

Inspect glass filter bowl daily, and clean if dirt or water are visible. To remove sediment bowl, loosen nut below glass bowl and swing bail to one side. Twist bowl as it is being removed to prevent gasket from sticking to bowl and breaking. Clean screen and glass thoroughly — replace gasket if it is damaged or hardened. ***Repair Kits*** are available for service replacement.

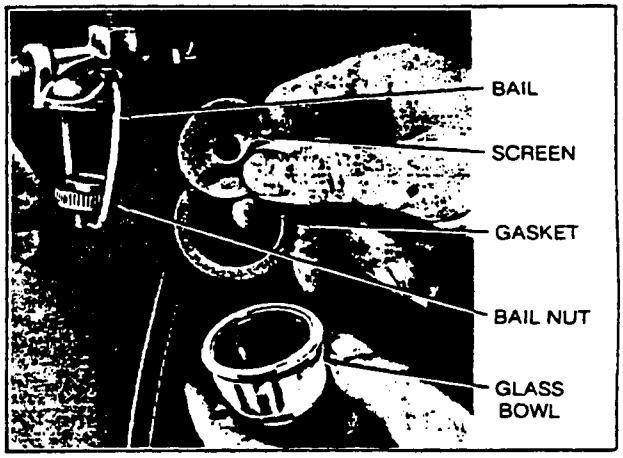


Fig. 12

IGNITION DISTRIBUTOR, Fig. 18

Check for faulty and loose fitting wires, for cracks in distributor cover, and for corroded or burned terminals.

Every 250 Hours; apply 1 drop of light engine oil (10W) to 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.

Inspect condition of breaker points for cleaning, adjustment or replacement.

SPARK PLUGS, Fig. 13

Incorrect gap, fouled or worn spark plug electrodes, will have an adverse effect on engine operation.

NOTE: Beginning with engine serial number 5996538, model W2-1230 is equipped with 14 mm spark plugs, Champion N6 (std.), or RN6 (resistor type), in place of 18 mm spark plugs (Champion D-16J). The 14 mm spark plugs always were original equipment on engine model W2-1235.

Every 250 Hours; remove spark plugs — clean, regap or replace if necessary.

Spark plug gap — ***0.035 inch*** (std. 14 mm)
0.030 inch (resistor type)
0.030 inch (18 mm plug)

Replacement plugs must be of the same heat range as those removed. ***In reassembly***; tighten spark plugs ***18*** to ***22 foot pounds torque*** (dry).

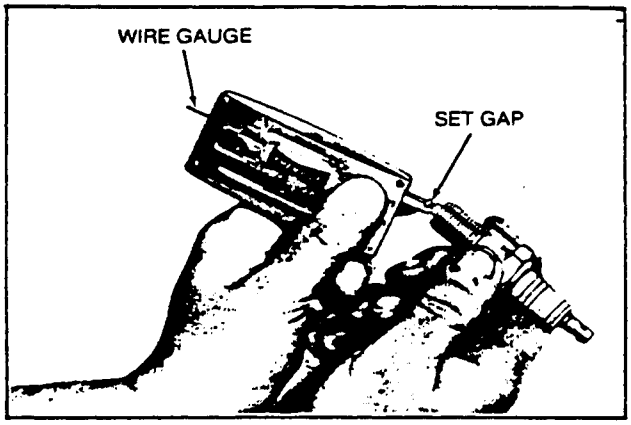


Fig. 13 SPARK PLUG

STARTING MOTOR, Fig. 1

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 drive — if necessary lubricate with powdered graphite.

KEEP ENGINE CLEAN, Fig. 14

This engine is cooled by blasts of air which must be allowed to circulate all around the cylinders and cylinder heads to properly cool the engine and thereby keep it in good running condition. If ***dust, dirt or chaff is allowed to collect in the cylinder shrouding or in the V between the cylinders***, it will retard the flow of air and cause the engine to overheat. Keep ***flywheel screen*** clean, so as not to restrict the intake of cooling air.

IMPORTANT

Do not operate engine with damaged or badly dented shrouding.

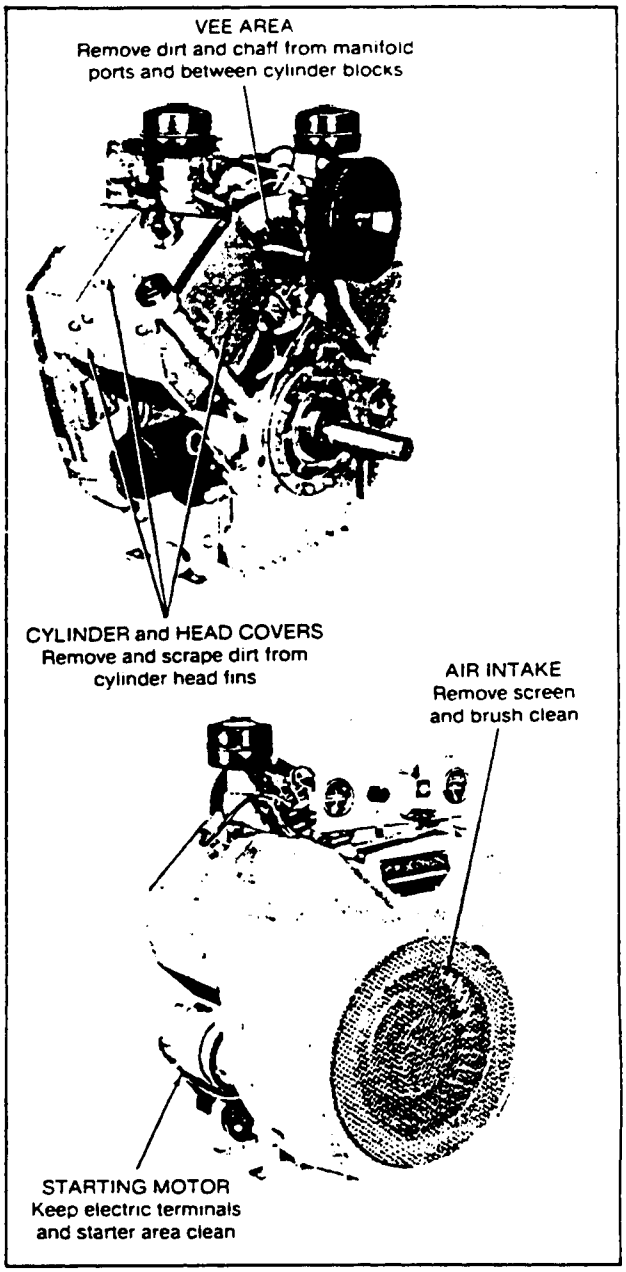


Fig. 14

Do not operate engine with any part of the shrouding removed.

Do not allow warm air to recirculate back through the cooling system.

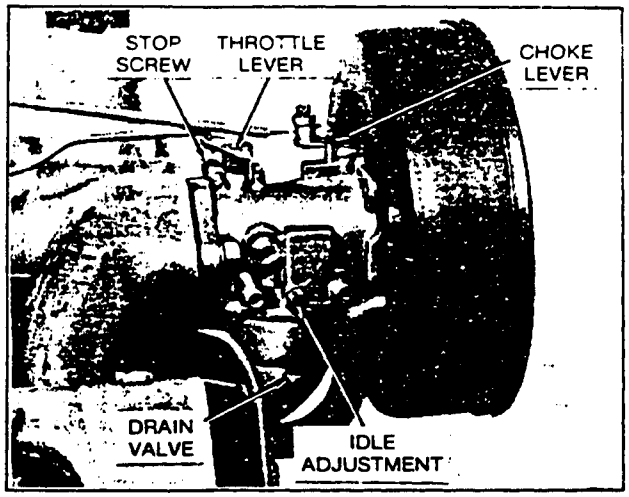


Fig. 15 CARBURETOR ADJUSTMENT

ADJUSTMENTS

CARBURETOR, Fig. 15

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 engine running at idle speed (throttle valve closed). Initial setting is approximately ***1 turn open.***

Refer to *'CARBURETOR'* section, *Page 46*, for further Adjustment and Repair Information.

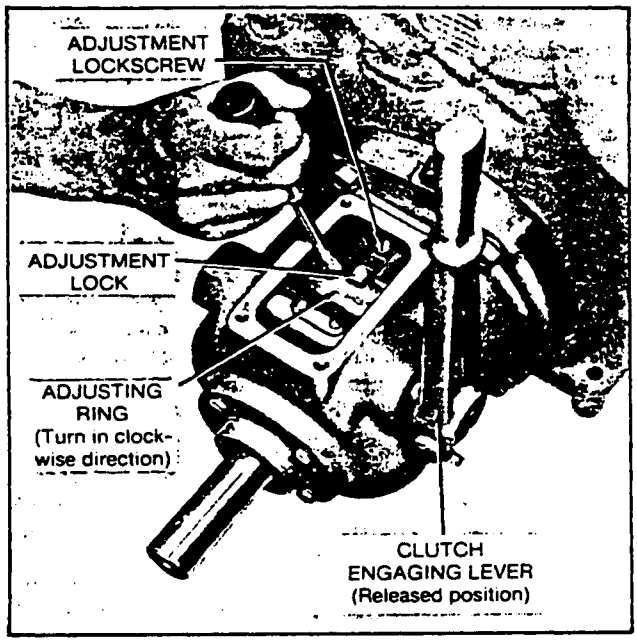


Fig. 16

CLUTCH ADJUSTMENT, Fig. 16

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

Turn engine over; by means of a 15/16 inch socket wrench fitted to the flywheel retainer screw, until clutch ***adjustment lock*** is visible through the inspection opening. Loosen ***adjustment lockscrew*** one full turn. Keep clutch from turning by securing the crankshaft at flywheel end. Then, by means of a screwdriver, turn ***adjusting ring*** one notch at a time in a clockwise direction, until a very firm pressure (100 ft. lbs. torque), is required to snap the clutch into engaged position by means of the clutch shifter lever. Securely tighten adjustment lockscrew. Assemble the inspection plate, being sure the gasket fits properly and is not broken.

CLUTCH REDUCTION ADJUSTMENT, Fig. 17

The clutch in the clutch reduction unit is the same as used in the power take-off unit and is adjusted through ***two pipe tap openings***; one for the ***adjustment lockscrew*** and the other for turning the ***adjusting ring***. There are ***four adjusting plugs*** in the housing to provide a means of adjusting the clutch regardless of what position the unit is mounted in.

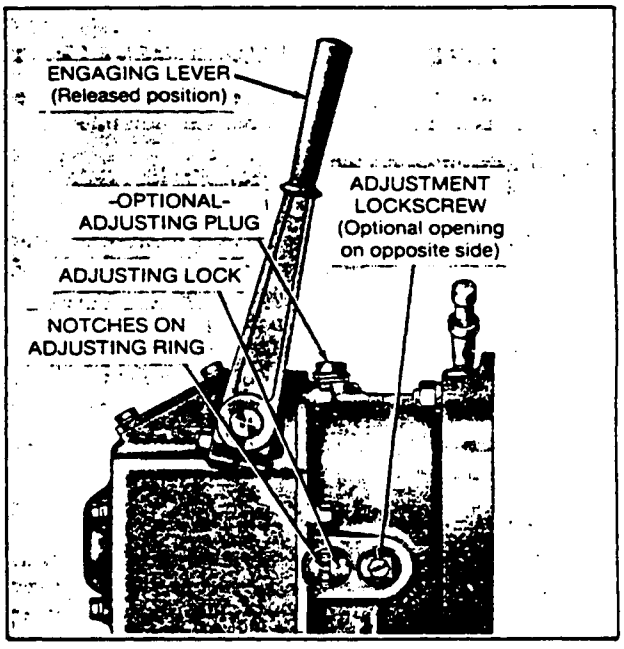


Fig. 17

Remove the two pipe plugs on the side of the housing (if not accessible, use the two optional taps). Disengage the clutch and turn engine over slowly with socket wrench until the ***adjustment lockscrew*** is visible through the pipe plug opening nearest to the engine. Loosen ***lockscrew*** one full turn, or enough to relieve the tension of the lock against the notches on the ***adjusting ring***. Then, turn engine over slightly to expose the ***notches*** on ***adjusting ring***. Keep engine crankshaft from turning, while through

the adjacent pipe plug opening, turn the ***adjusting ring*** with a screwdriver, one notch at a time in a clockwise direction (viewing from take-off end), until a very firm pressure (100 ft. lbs. torque), is required to snap the clutch into engaged position by means of the clutch shifter lever. Tighten adjustment lockscrew and install pipe plugs when adjustment is completed.

Automotive Type Clutch should be adjusted per manufacturer's instruction on inspection plate attached to clutch housing.

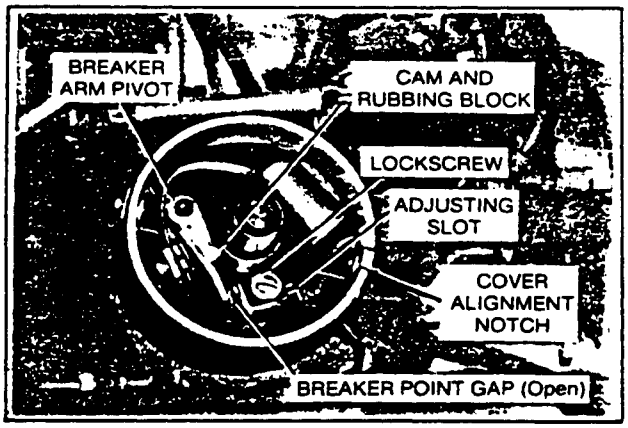


Fig. 18 DISTRIBUTOR BREAKER POINTS

DISTRIBUTOR BRK'R. POINT ADJUSTMENT, Fig. 18

Remove distributor cap, rotor and dust cover. Examine cap for cracks and for corroded or burned terminals.

The breaker point gap should be:

.020 inch at full separation

To readjust point gap, turn engine over slowly 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 screwdriver, turn ***Adjusting Screw*** until a slight drag is felt when sliding the feeler gauge from between the points. Tighten lockscrew and recheck point gap.

Points that are badly pitted or worn should be replaced and properly adjusted.

GOVERNOR — OPERATION, Fig. 19

The centrifugal flyweight type governor rotates on a shaft, supported by bearings in the upper part of the gear cover and governor housing, and is driven off the camshaft gear at ***crankshaft speed***. The governor shaft and housing also provide an integral drive for the Battery Ignition Distributor.

Four sintered iron flyweights are contained in pockets of the governor drive gear. The toe end of the flyweights bear against a thrust sleeve and bearing assembly that moves back and forth as the flyweights move in and out. The motion of the thrust sleeve and bearing is transmitted to the governor lever which in turn is linked to the carburetor throttle lever.

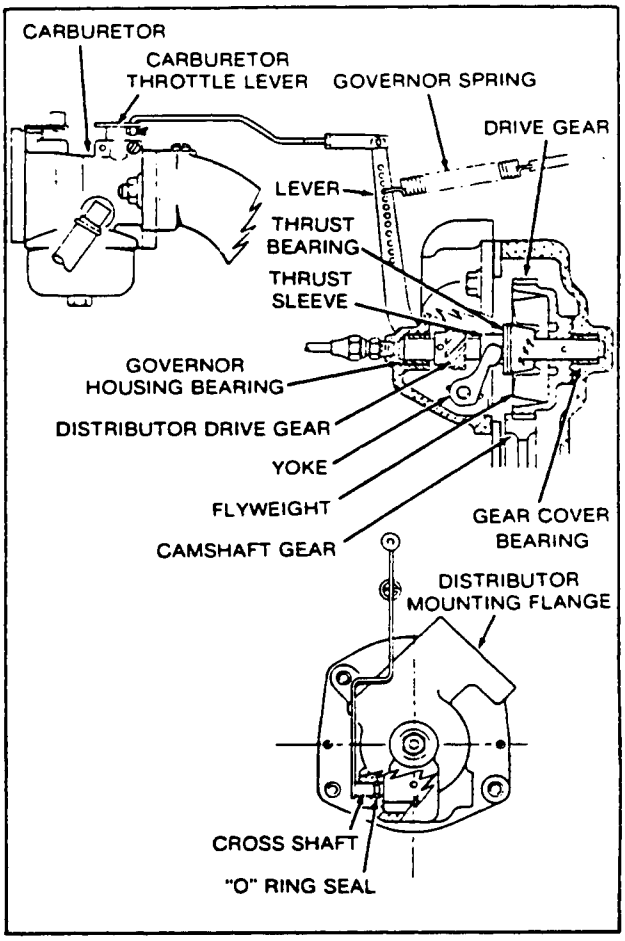


Fig. 19

A spring connected to the governor lever tends to hold the governor flyweights to their ***inner*** position, also to hold the carburetor throttle open. As the engine speed increases, the centrifugal force in the flyweights acts against the spring and closes the throttle to a point where the engine speed will be maintained practically constant under varying load conditions. This speed can be varied to suit conditions by adjusting the governor spring tension to suit.

GOVERNOR ADJUSTMENT, Fig. 20, Fig. 21

The throttle rod connection to the carburetor must be very carefully adjusted for length, otherwise the governor will not function properly and cause the engine to surge badly. With the engine at rest, the governor spring will keep the flyweights ***in***, and the throttle rod must be of such length as to hold the carburetor throttle wide open at that point.

With reference to Fig. 20, disconnect the ***throttle rod*** from the carburetor, and loosen the ***locknut*** at the ***connector*** on the ***governor lever***. Place the governor lever in a ***stopped position*** against the governor housing, and the carburetor throttle lever in the ***wide open*** position, in same direction as governor lever. With both levers in this position, screw the throttle rod into the connector until the 90° bent end of

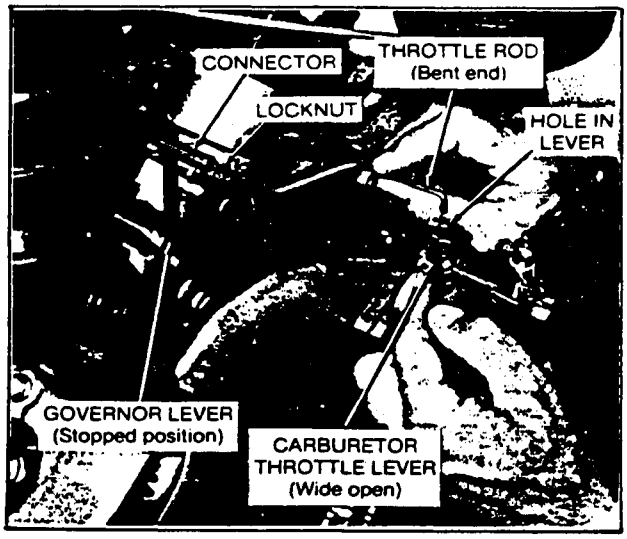


Fig. 20

Load R.P.M.	No Load R.P.M.	Hole No.	Spring	Fly-Weight
1600	1650	5	Light	Heavy
1700	1770	5		
1800	1880	6		
1900	2000	7		
2000	2420	2	Std.	
2100	2450	2		
2200	2475	2		
2300	2550	2		
2400	2620	2		
2500	2700	2		
2600	2770	2		Std.
2700	2850	3		
2800	2925	4		
2900	3050	4		
3000	3130	5		
3100	3200	5		
3200	3300	6		
3300	3410	6		
3400	3520	7		
3500	3630	9		
3600	3740	11		

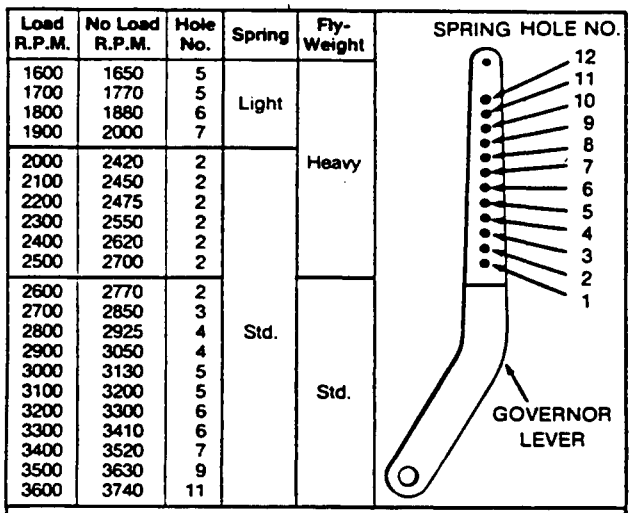


Fig. 21

the rod will register with the hole in the carburetor throttle lever. Then, screw throttle rod ***in one more turn*** to shorten linkage slightly. Tighten throttle rod locknut and assemble cotter pin to carburetor end of throttle rod.

NOTE: Heavy flyweight governor with a light tension spring is used in place of standard, when minimum overrun is required, i.e., generator set.

The governor lever is furnished with 12 holes, as shown in *Fig. 21*, for attaching the governor spring. It is very important that the spring is hooked into the proper hole to suit the speed at which the engine is to be operated. The Governor Lever Chart, *Fig. 21*, shows the ***full load*** and ***no load*** speeds of the engine and the hole corresponding thereto. Note that the ***full load*** speed is less than the ***no load*** speed and this must be taken into consideration when readjusting the governor. As an example; if the engine is to be operated at ***3200*** revolutions per minute under load, the spring should be hooked into the ***6th*** hole in the governor lever, and the spring tension adjusted to run ***3300 r.p.m.*** at ***no load***. When load is applied, the engine will run at approximately ***3200 r.p.m.***

⚠ ***Caution: Do not*** operate engine above 3600 r.p.m. load. ***Do not*** operate with governor disconnected.

GOVERNOR-SPRING TENSION ADJUSTMENT, Fig. 22

With engine running and warmed up, use a tachometer or revolution counter against crankshaft to observe the engine r.p.m. while adjusting the governor spring tension.

Variable Speed Control:

Pull *'T'* handle control outward and turn clockwise to lock in place when desired operating speed is obtained. Move ***collar*** on speed control rod to a ***stop position*** against ***threaded ferrule*** and lock in place with ***allen set screw.***

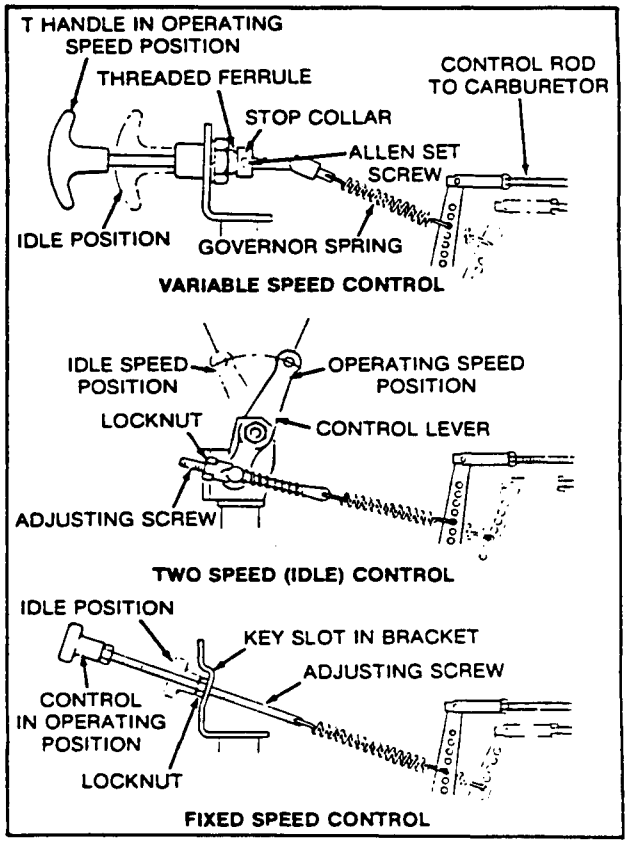


Fig. 22

Two Speed (Idle), or Fixed Speed Control

Place ***control*** in operating speed position. Turn ***adjusting screw locknut***, to obtain desired No Load operating

r.p.m. — clockwise to increase speed, counterclockwise to decrease speed.

VALVE TAPPET ADJUSTMENT, Fig. 23

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

Intake — .007 inch ***Exhaust — .020 inch***

The ***intake valve*** is to the ***left*** in the cylinder block, facing the valve chamber opening. The ***exhaust valve*** is to the ***right***. Place a feeler gauge of proper clearance between the valve stem and tappet screw. Adjust clearance by means of two 1/2 or 7/16 inch tappet wrenches.

For ease in adjusting the tappets, disconnect the oil line to governor housing, and remove the intake manifold.

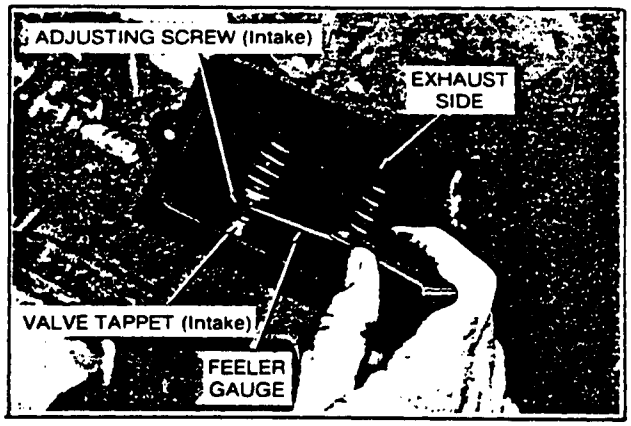


Fig. 23 VALVE TAPPET ADJUSTMENT

TIMING

FIRING ORDER

The firing interval (crankshaft degrees), between No. 1 cylinder and No. 2 is 270° — from No. 2 cylinder to No. 1, 450°.

The ***No. 1 cylinder*** is on the ***Right Hand Side***, when viewed from flywheel end of engine. No. 2 cylinder is on the ***Left Hand Side***, nearest to the flywheel.

NOTE: This differs from other Wisconsin Vee type engines where the No. 1 cylinder is in the left hand cylinder bank, nearest to the flywheel.

DISTRIBUTOR

The distributor is of the mechanical advance type and it is driven off an engine speed governor shaft through a pair of 2:1 ratio gears. Thus, the distributor operates at ***one-half*** engine speed in a ***clockwise direction***, when viewed from above.

DISTRIBUTOR TIMING PROCEDURE, Fig's. 24, 25, 26, 27, 28

⚠ ***Caution:*** Disconnect battery leads to engine, to prevent engine from accidently starting.

IMPORTANT

It is necessary that the distributor breaker point gap be ***.020 inch***, because any change in gap opening will affect the ignition timing. Check, and adjust if necessary per

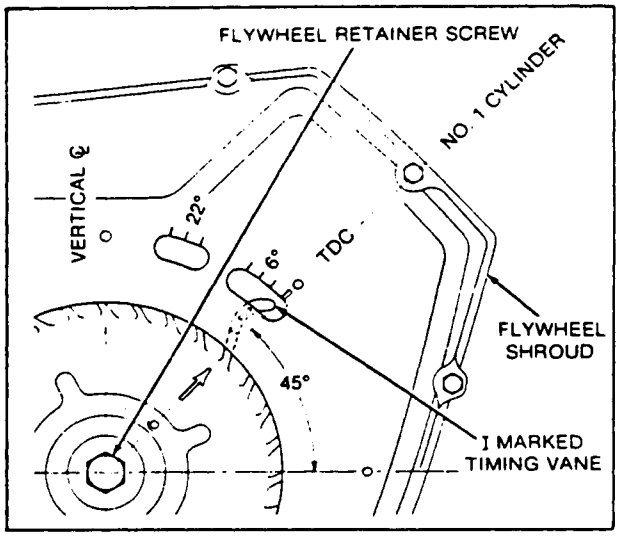


Fig. 24

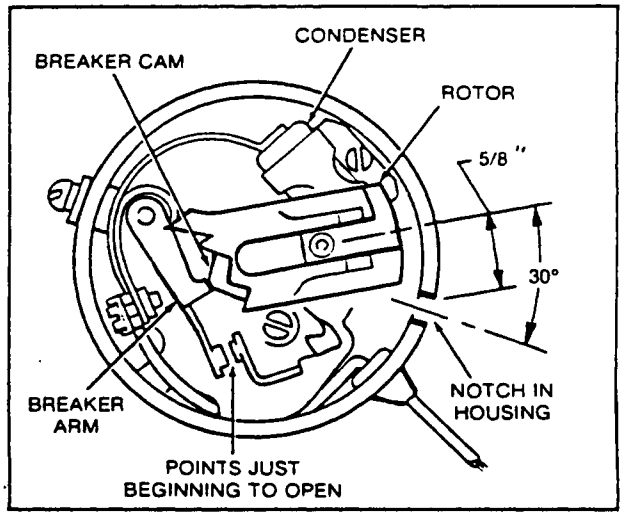


Fig. 25

Distributor Breaker Point Adjustment paragraphs, Page 12, before timing distributor to engine.

DISTRIBUTOR MOUNTING

Assuming the distributor was removed from the engine; take off the screen over the flywheel air intake opening. This will more clearly expose the timing marks on flywheel shroud, and also the flywheel T.D.C. ***Timing Vane*** located by an ***Arrow*** and identified through the timing opening by a vertical *(I)* cast depression on the top of the vane, see Fig. 24. Next, remove spark plug from No. 1 cylinder, on right hand side of engine. By means of a 15/16 inch socket wrench fitted to the flywheel retainer screw, turn the engine over slowly, and at the same time hold a finger or thumb over the spark plug hole to determine the compression stroke.

Upon reaching the compression stroke, continue turning flywheel until the ***vertical mark (I)*** on the top of the ***Timing Vane*** is in line with ***T.D.C. mark*** on the flywheel shroud. The No. 1 piston is now on top dead center with timing marks positioned as illustrated in Fig. 24. Reassemble spark plug.

NOTE: At this time, paint the ***'I' mark*** on the timing vane ***white***, so that it will be clearly visible for checking with a ***Timing Light***.

With the No. 1 piston now on ***TDC*** and on compression stroke, take off cap, rotor and dust shield from distributor and mount to adapter housing in the following manner:

1. With reference to Fig. 25, place ***rotor*** on distributor shaft and turn shaft clockwise until center of ***rotor contact*** is about 5/8" from ***outer edge of notch*** in distributor housing, or about 30° from center of notch. A ***slight resistance*** will be felt as the breaker cam contacts the breaker arm.
2. With ***advance arm*** in place and tightened to adapter housing, assemble distributor to adapter with ***rotor*** pointing in an approximate ***3 o'clock position***, which would place the ***notch*** in housing and ***No. 1 terminal*** in about a ***4 o'clock position***, see Fig. 26. It may be necessary to rotate shaft slightly by means of the rotor to mesh distributor gear with governor accessory drive gear.
3. With the ***distributor clamp screw*** loose, turn the distributor body slightly in a clockwise direction until the breaker points are firmly closed. Then turn the distributor body in a counterclockwise direction until the ***breaker points*** are just ***beginning to open***. At this point a slight resistance can be felt as the breaker point cam strikes the breaker point arm.

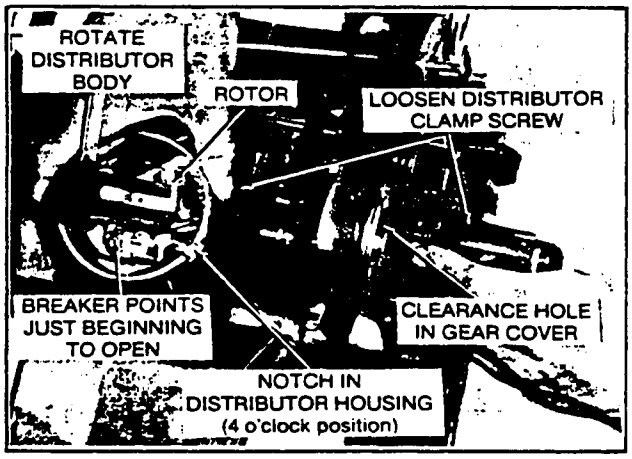


Fig. 26

4. Tighten ***advance arm clamp screw*** through hole in gear cover. Number 1 cylinder is now ready to fire in the retarded position.
5. Assemble dust cover and distributor cap. Connect ignition wires from distributor to spark plugs and coil per Fig. 27 and wiring diagram Fig. 30.

If care is exercised in the preceding instructions, the spark timing should be accurate enough for satisfactory starting, however, ***checking spark advance*** with a Timing Light, as described in the following ***'Timing Check'*** paragraphs, is necessary.

SPARK ADVANCE

The running spark advance is 6° before Top Dead Center (T.D.C.) at 1800 r.p.m., with the distributor ***fully advanced*** to ***22°*** before T.D.C. at ***3400 r.p.m.*** Engines are properly adjusted at the factory for accurate timing and peak dependable performance for the complete operating range of speeds from 1600 through 3600 r.p.m. Future timing can be checked and adjusted in the following manner:

TIMING MARKS

Two timing slots are provided on the right hand side of the front face of flywheel shroud:

1. ***For timing variable high speed engines to 22° at 3400 r.p.m.***, refer to Fig. 28 which illustrates 25°, 22°, 19° and T.D.C. timing marks. A ***cast arrow*** identifies the ***"I" marked*** flywheel vane that is visible through the opening at the 22° mark.
2. ***For fixed speed engines***, particularly those operating at ***1800 r.p.m.***, refer to Fig. 28A which illustrates 9°, 6°, 3° and T.D.C. timing marks. The ***cast arrow*** identifies the ***"I" marked*** flywheel vane that is visible through the opening at the ***6° mark***.

NOTE: Read ****Important Note*** on Page 16, with reference to Fig. 15 on Page 11, for adjusting engine speed to 1800 r.p.m. for 6° advance timing.

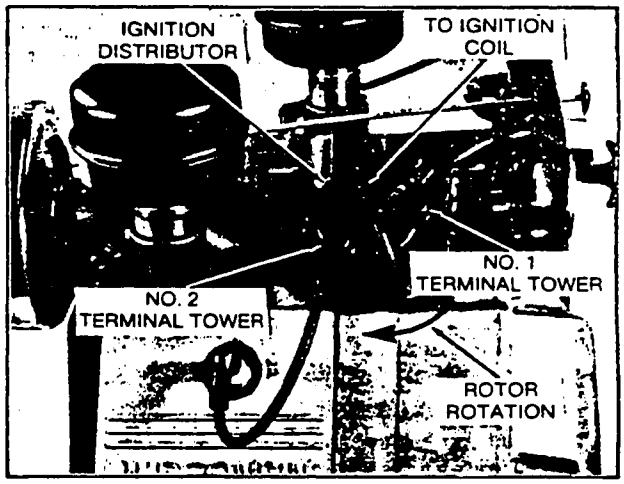


Fig. 27

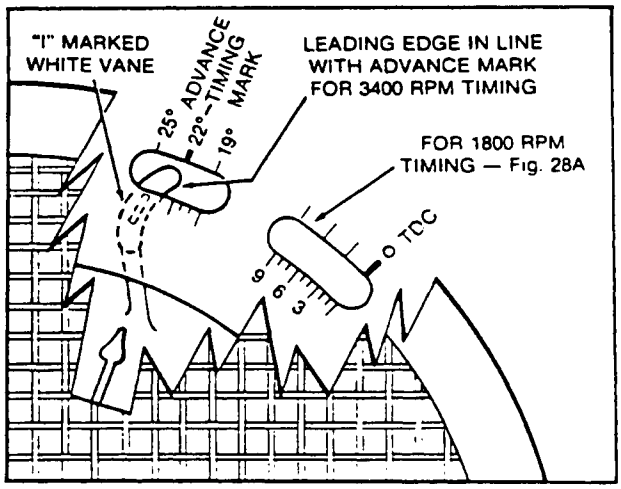


Fig. 28 SPARK ADVANCE VARIABLE HIGH SPEED

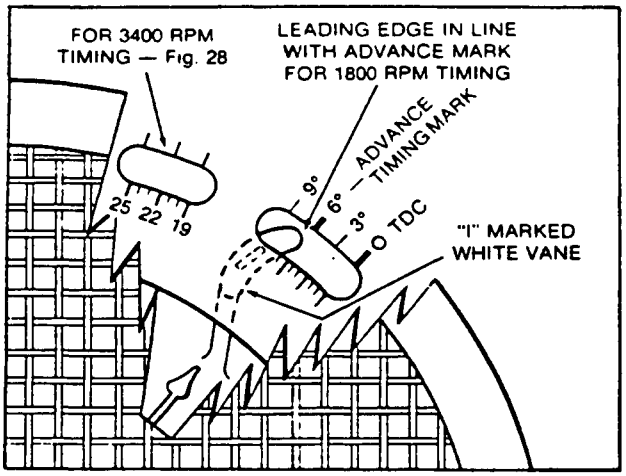


Fig. 28A SPARK ADVANCE
FIXED LOW SPEED

TIMING CHECK AND ADJUSTMENT

It is necessary that the distributor breaker point gap be *.020 inch*, because any change in gap opening will affect the ignition advance. Check and adjust if necessary, per Distributor Breaker Point Adjustment paragraphs, before timing.

A *slotted opening* is provided on the rim of the flywheel screen so that timing can be checked without removing the screen.

⚠ *Caution: Do not* operate engine with screen removed from front face of shroud.

NOTE: Paint the *"I" marked* flywheel vane *white*, so that it will be clearly visible for checking with a *Timing Light.*

1. With reference to Fig. 29, connect the inductive clamp of a conventional automotive type *Timing Light* to the *No. 1* spark plug cable. Clip the red marked clamp of the timing light to the battery positive terminal, and the black marked clip to ground.
2. With reference to Figs. 28, 29, and the engine operating at *3400 r.p.m.*, allow the flash from the timing light to illuminate the *"I" whitened* flywheel vane. At the time of the flash the *leading edge* of the vane should line up with the *22° Timing Mark* on the flywheel shroud.

2a. For fixed *low speed* applications, operate the engine at *1800 r.p.m.* and allow the flash from the timing light to illuminate the *"I" whitened* flywheel vane. At the time of the flash the leading edge of the vane should line up with the *6° Timing Mark* on flywheel shroud, as illustrated in Fig. 28A.

3. If timing is incorrect, loosen the advance arm *clamp screw* at the base of the distributor. A screwdriver clearance hole is provided in the flywheel shroud as shown in Fig. 26.

   With the engine again running at timing speed turn the distributor body *very slightly* clockwise or counterclockwise as required, until *white vane* and *Timing Mark* do match up. Securely tighten clamp screw when satisfactory timing is accomplished.

*IMPORTANT

On fixed low speed applications timing should be adjusted to 6° before T.D.C. at 1800 r.p.m.

For engines where the governor is set to operate at speeds other than 1800 r.p.m., a tachometer will have to be used, and the speed adjusted to 1800 r.p.m. in the following manner, and with reference to Fig. 15.

1. Run engine at idle speed, *1000 r.p.m.*
2. Turn *Stop Screw* on carburetor throttle lever clockwise until engine speed reaches *1800 r.p.m.*
3. Proceed to check and adjust timing.
4. After timing is accomplished, turn stop screw on carburetor throttle lever counterclockwise until original idle speed of *1000 r.p.m.* is obtained.

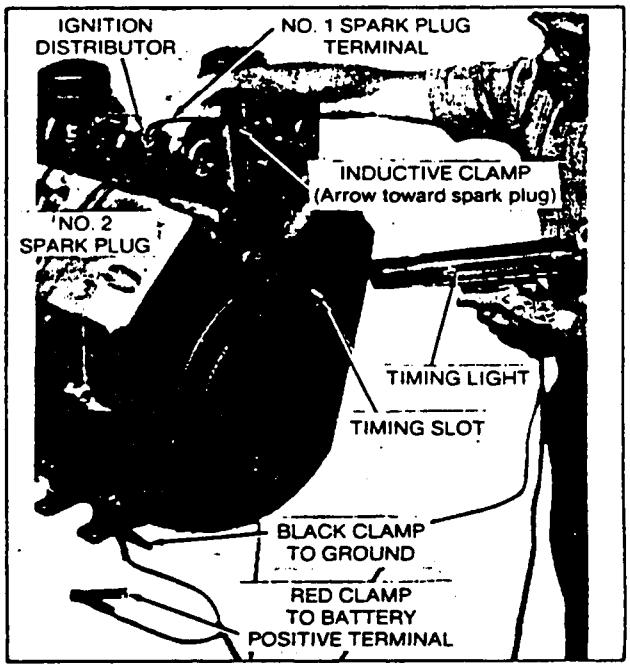


Fig. 29

ELECTRICAL EQUIPMENT

The *12 volt* Battery Ignition Distributor with Coil and Starting Motor, Fig. 30, are standard equipment. Options include: 30 amp or 10 amp Flywheel Alternator, Electric Fuel Pump, Instrument Panel, High-Temperature Safety Switch and Solenoid Starting. ***Battery is not furnished by Teledyne Wisconsin Motor.***

⚠ *Caution:* Stop engine when checking battery terminals or electrical connections. High voltage in starter and ignition cables will cause shock if touched with bare hands.

FLYWHEEL ALTERNATOR, Fig. 31, Fig. 31A

This flywheel alternator is of the permanent magnet type and has ***no brushes, commutator, belts*** or ***adjustments***. A series of coils (stator) is mounted to the engine gear cover,

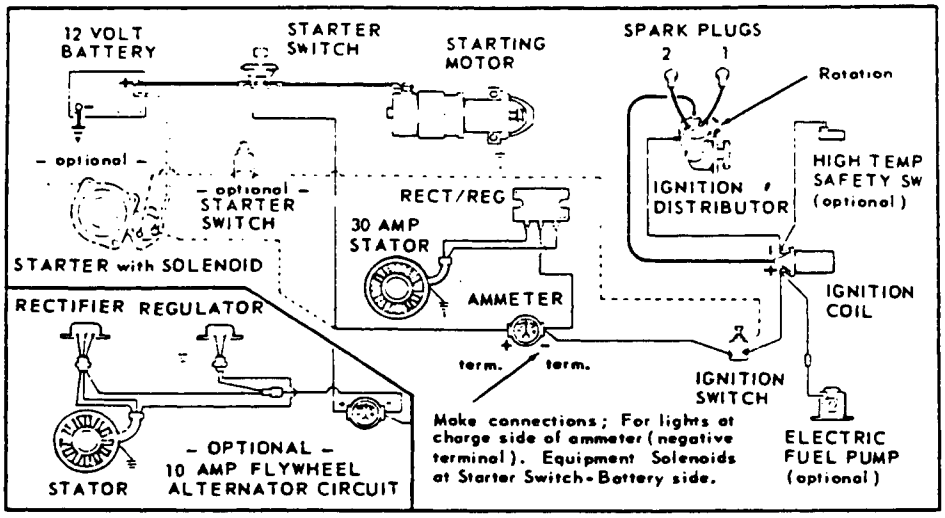


Fig. 30 WIRING DIAGRAM ELECTRICAL SYSTEM WITH FLYWHEEL ALTERNATOR

and the magnetic flux is provided by a permanent magnet in the flywheel which rotates around these stationary coils.

IMPORTANT

This is a ***Negative Ground*** system. Charging components will be damaged if grounded wrong in connecting or jumping batteries.

⚠ ***Caution:*** Handle battery carefully to prevent acid burns. Avoid sparks near battery — gas given off by battery is explosive.

Both ***10 amp*** and ***30 amp Flywheel 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 30 amp circuit. Also, the 30 amp system has a ***single unit Rectifier/Regulator*** mounted to a cavity on the right hand side of the gear cover. The 10 amp system has ***separate Rectifier/Regulator modules*** mounted to a cover in the same location.

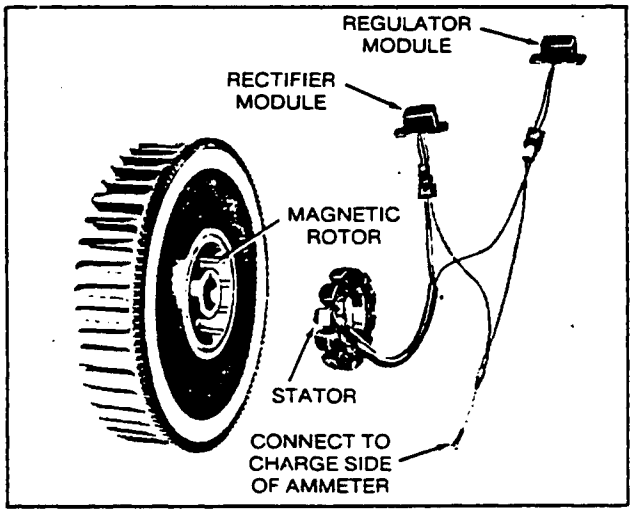


Fig. 31 10 AMP FLYWHEEL ALTERNATOR

IMPORTANT

While welding is being done on equipment or machinery

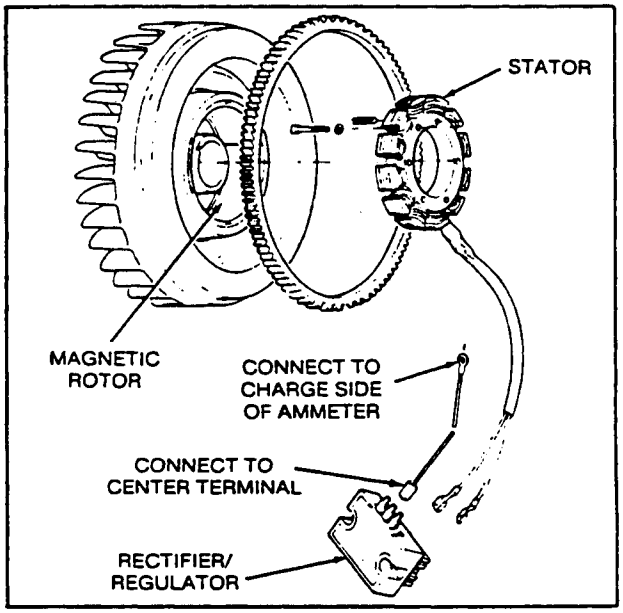


Fig. 31A 30 AMP FLYWHEEL ALTERNATOR

equipped with a Wisconsin engine, furnished with a flywheel alternator, disconnect battery completely from the electrical circuit (remove cables from positive and negative terminals of battery). This is a precautionary measure, since high electric current and voltage may appear during the welding process and damage the regulator.

PRECAUTIONS to be exercised in the use of both 10 amp and 30 amp Flywheel Alternators.

1. ***Do not*** reverse battery connections. Negative battery terminal must be grounded. Reverse polarity will damage rectifier.
2. Connect booster batteries — positive to positive and negative to negative.
3. ***Do not*** ground any wires from stator or modules which terminate at connectors.
4. ***Do not*** operate engine with battery disconnected, or disconnect the alternator output lead while the alter-

nator 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.

5. Disconnect ground battery lead if a battery charger is used.
6. ***Do not*** polarize the Rectifier/Regulator.

WIRING CIRCUITS, Fig. 30, 31, 31A

These are ***negative ground circuits***. Connect ground strap from negative post of battery to starting motor flange, or good clean grounding surface on engine.

10 Amp System, Fig. 31

The *fool-proof* type connectors are used to prevent incorrect wiring from the stator to the rectifier and regulator modules. To disconnect plugs, squeeze outer ends of recepticle and pull apart.

The rectifier is insulated from ground, but the stator and regulator module are grounded to the engine through their mounting surface. The regulator module therefore should not be removed and mounted at some remote location.

30 Amp System, Fig. 31A

The single module ***rectifier/regulator*** is grounded through its mounting surface. Ease in making wire connections is provided by spade type terminals.

The two lead wires from the stator are connected to ***either*** of the two ***outer terminals*** on the regulator/rectifier. The ***center terminal*** on the regulator/rectifier ***must*** be connected to the ***negative terminal*** on the ammeter.

FLYWHEEL ALTERNATOR SERVICE PROCEDURE:

PRELIMINARY TESTS

1. ***Visual Inspection*** should be made to eliminate conditions that may be interpreted as a defective alternator. Examine leads for broken or loose connections, and make sure modules are securely mounted. The ***regulator module*** must be mounted to a metal surface for grounding purposes, (Test 5.0) for 10 amp alternator system.

   The ***rectifier module***, although insulated electrically from ground, should be securely mounted for heat dissipation. The mounting surfaces must be clean and free of contaminants, oil, grease, etc.

   The rectifier/regulator module for the 30 amp system is cooled by air circulation through body fins which extend into the flywheel air shroud. ***Do not*** allow fins to get clogged with dirt.

2. ***Check Battery.*** Use a Automotive battery in good condition, fully charged and with clean, tight terminal connections.

3. ***Check Ammeter.*** Be certain the ammeter is functioning correctly. Amperage output is regulated by engine speed. The rated ***amperage*** output is

Maximum RPM	10 AMP System	30 AMP System
3600	10 amps	30 amps

When assured that the problem is with the alternator, follow the tests outlined in *'Trouble Shooting'*.

TROUBLE SHOOTING

FLYWHEEL ALTERNATOR
12 VOLT — 10 AMP and 30 AMP Systems

Trouble Shooting Procedure is a guide showing methods of testing the charging components. The following chart of ***Tests 1.0*** to ***4.3*** are with the ***engine running***, and substituting known good components in place of suspected faulty components. ***Static Tests 5.0*** through ***7.2***, following the ***Running Tests***, are more conclusive but some tests require special Wisconsin Test Lights.

RUNNING TESTS

Problem: Battery Overcharge	Possible Cause & Remedy
Test 1.0 Engine *not* running check battery with DC Voltmeter.	
1.1 If voltage is greater than 13.5 volts	1.1 Place 12 volt light bulb or carbon pile across battery to reduce voltage to below 13.5 volts.
1.2 With engine running at full RPM, check battery voltage with ***DC Voltmeter.***	
1.3 If the charge increases beyond 13.5 volts.	1.3 ***For 10 amp circuit*** Faulty Regulator. Replace. — static check regulator per Test No. 5.1. for 10 amp system. ***For 30 amp system*** Faulty Rectifier/Regulator. Replace
1.4 If the charge remains under 13.5 volts.	1.4 Alternator functioning properly. Check battery condition.

Problem: Low/No Charge	Possible Cause & Remedy
Test 2.0 Proceed with Test 1.0 and 1.1. It is necessary to slightly discharge battery to make system work.	
2.1 With engine running at full RPM, check battery voltage with DC Voltmeter.	
2.2 If the charge rate increases —	2.2 Alternator functioning properly. Battery was fully charged.
For 10 amp system	
2.3 If system does not charge.	2.3 Operate engine with regulator disconnected (continue with Test 2.4).
2.4 If charge rate increased with regulator disconnected.	2.4 Regulator was at fault. Replace regulator module. — static check regulator per Test No. 5.1.
2.5 If the charge rate does not increase with regulator disconnected.	2.5 Regulator is not at fault ***Check Rectifier*** per Test 3.0, 3.1 or static check per Test 6.0.
For 30 amp system	
2.6 If system does not charge.	2.6 Temporarily substitute another Rectifier/Regulator. Be sure to ground case to engine.
2.7 If charge rate increases with substitute Rectifier/Regulator.	2.7 Rectifier/Regulator at fault — repiace.
2.8 If no charge.	2.8 Rectifier/Regulator not at fault — check stator per Test 4.2.

Problem: Low/No Charge	Possible Cause & Remedy
Test 3.0 Test conditions and procedure the same as 1.0 and 1.1. It is necessary to slightly discharge battery to make system work.	
3.1 Plug *new Rectifier in* system. Run engine at full RPM.	
For 10 amp system only	
3.2 If the charge rate increases with new rectifier in system.	3.2 Rectifier module at fault. Permanently install new rectifier module.
3.3 If the charge rate does not increase with new Rectifier —	3.3 Rectifier not at fault. *Check Stator* per Test 4.0.

Problem: Low/No Charge	Possible Cause & Remedy
For 10 amp system	
Test 4.0 With engine stopped, unplug all connectors between modules and stator. Start engine and run at 2400 RPM. *With AC voltmeter* check voltage between each of the black stator leads and ground.	
4.1 If one of the two voltages is zero or they are over 10% apart. —	4.1 The stator is defective and should be replaced. Static check stator per Tests 7.0, 7.1, 7.2.
For 30 amp system	
4.2 With engine stopped, unplug both AC leads at Rectifier/Regulator. Connect AC voltmeter to leads from stator. Start engine and check voltage.	4.2
4.3 If AC voltage does not increase with engine speed.	4.3 The stator is defective and should be replaced.

Open Circuit AC Voltage	
RPM	Volts ± 10%
3600	50
3200	44
2800	39
2400	33
2000	28
1600	22

FLYWHEEL ALTERNATOR COMPONENTS

STATIC TESTS

The following test equipment is required:

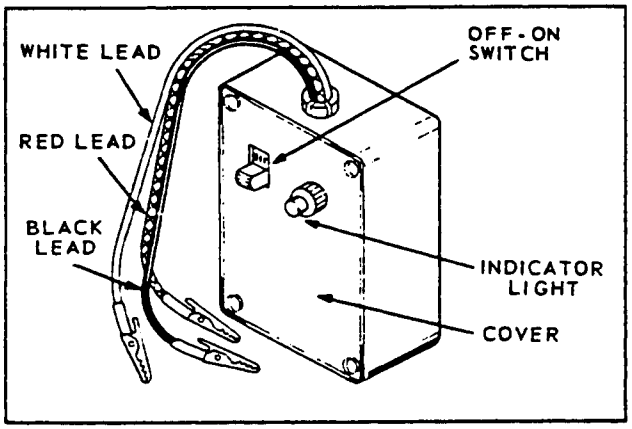


Fig. 32, DF83 ANALYZER

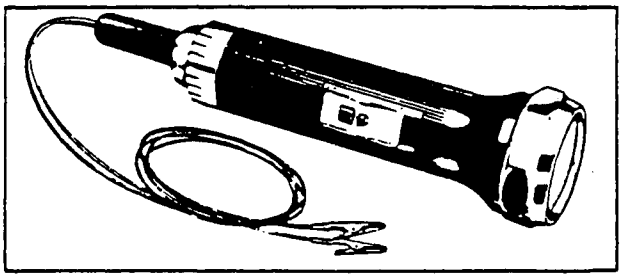


Fig. 32A, DF81 FLASHLITE TESTER

DF 83 Analyzer — Wisconsin Part, *Fig. 32.*
DF 81 Flashlite Tester — Wisconsin Part, *Fig. 32A.*
VOLT-OHM-MILLIAMMETER Simpson 260 or equal.

The DF 83 Analyzer was developed for testing the solid state ignition and flywheel alternator components as furnished on ***Wisconsin*** engines. It is very efficiently and economically powered by four transistor radio type 9 volt batteries. The DF 81 Flashlite Tester is used primarily for checking continuity.

REGULATOR TESTS (10 Amp System)

Test 5.0 REGULATOR GROUND

The YJ 60 Regulator module must be mounted to a metal surface for grounding purposes. Check for continuity with a VOM (R x 1 scale) or test light.

TESTER RED LEAD	TESTER BLACK LEAD	RESULT
To Regulator Body	To Ground	DF 83 - Light On DF 81 - Light On VOM - Continuity

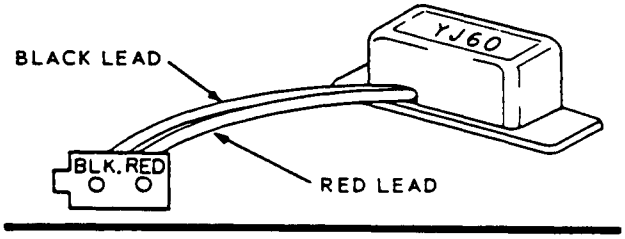
Test 5.1 REGULATOR STATIC CHECK

This test is an alternative or in addition to running tests 2.3 and 2.4 (omitting regulator). The *DF 83* Analyzer is used.

YJ 60 REGULATOR

NOTE: Module is ***defective*** if light indication ***is not as shown.***

TEST NO.	ANALYZER RED LEAD TO:	ANALYZER BLACK LEAD TO:	ANALYZER WHITE LEAD TO:	LIGHT INDICATION
1	Module Base Plate	Module Red Lead	-	OFF
2	Module Red Lead	Module Base Plate	-	OFF
3	Module Red Lead	Module Base Plate	Module Black Lead Then Remove	On And Remain On



RECTIFIER TESTS (10 Amp System)

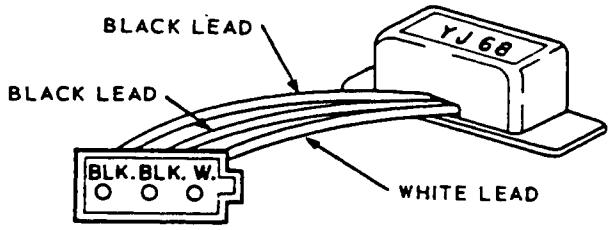
Test 6.0 RECTIFIER STATIC CHECK

The diodes in the Rectifier module can be checked with any continuity device such as the DF 83 analyzer, DF 81 Flashlite or VOM. Since various testing devices will differ in their operation, it should be noted in the following three Rectifier test charts that the results in tests 1 and 2 should always be opposite to the results of tests 3 and 4.

YJ 68 RECTIFIER (using DF 83 Analyzer)

Module is defective if light indication is not as shown.

TEST NO.	ANALYZER RED LEAD TO:	ANALYZER BLACK LEAD TO:	ANALYZER WHITE LEAD TO:	LIGHT INDICATION
1	Module White Lead	Either Module Black Lead	-	OFF
2	Module White Lead	Other Module Black Lead	-	OFF
3	Either Module Black Lead	Module White Lead	-	ON
4	Other Module Black Lead	Module White Lead	-	ON



YJ 68 RECTIFIER (using DF 81 Flashlite)

TEST NO.	TESTER RED LEAD TO:	TESTER BLACK LEAD TO:	LIGHT INDICATION
1	Module White Lead	Either Module Black Lead	ON
2	Module White Lead	Other Module Black Lead	ON
3	Either Module Black Lead	Module White Lead	OFF
4	Other Module Black Lead	Module White Lead	OFF

YJ 68 RECTIFIER (using VOM equipment)

Note: Continuity shall be in one direction only. If readings are not as indicated, replace module.

TEST NO.	VOM RED LEAD TO:	VOM BLACK LEAD TO:	METER INDICATION
1	Module White Lead	Either Module Black Lead	No Continuity
2	Module White Lead	Other Module Black Lead	No Continuity
3	Either Module Black Lead	Module White Lead	Continuity
4	Other Module Black Lead	Module White Lead	Continuity

RECTIFIER/REGULATOR TESTS (30 Amp System)

NOTE: Static check of Rectifier/Regulator module is not available — direct substitution is the only means of checking. Follow engine running test procedures beginning with Test No. 2.0 and for 30 amp system.

STATOR TESTS

YB 81 10 amp STATOR **YB 84 30 amp STATOR**

The continuity tests for stators is not a 100% method of checking. However, if the stator fails the continuity tests, it is definitely defective. If it passes the tests but all other components have also checked out O.K., the stator may be the defective part of the system and should be replaced. Test can be made with Stator on engine.

Test 7.0 STATOR GROUND

Like the Regulator, the YB 81 and YB 84 Stators must be grounded. Stator ground can be checked with any type continuity device.

TEST NO.	TESTER RED LEAD	TESTER BLACK LEAD	RESULT
1	To Stator Black Lead	To Ground	DF 83 - Light On DF 81 - Light On VOM - Continuity
2	To Other Black Lead	To Ground	

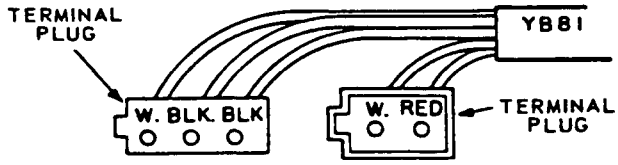
Test 7.1 STATOR CONTINUITY

This test should be performed after 7.0 stator ground test. Use continuity equipment such as DF 81 Flashlite or VOM. ***Results other than specified indicate a defective stator.***

TEST NO.	TESTER RED LEAD	TESTER BLACK LEAD	RESULT
1	To Ground	To Stator Red Lead	DF 81 - Light On VOM - Continuity
2	To Ground	To Stator Black Lead	
3	To Ground	To Other Black Lead	

Test 7.2 CONTINUITY with DF 83 Analyzer (applies to 10 amp system only)

TEST NO.	ANALYZER RED LEAD TO:	ANALYZER BLACK LEAD TO:	ANALYZER WHITE LEAD TO:	LIGHT INDICATION
1	Stator Black Lead	Ground	–	On
2	Stator Other Black Lead	Ground	–	On
3	Ground	Stator Red Lead	–	On
4	Ground	Stator Black Lead	–	On
5	Ground	Stator Other Black Lead	–	On



For 30 amp system

1. Connect analyzer Red and Black leads to stator leads — Light "ON."
2. From either stator lead to ground — Light "OFF."

If light indication is other than shown, for either 10 amp or 30 amp systems, stator is defective. If stator checks out good, perform voltage test 7.3.

Test 7.3 STATOR RUNNING VOLTAGE For 10 amp system

With the engine stopped, unplug all connectors between modules and stator. Start the engine and run at operating speed. Perform the following tests with an AC voltmeter:

TEST NO.	METER RED LEAD	METER BLACK LEAD	STATOR DEFECTIVE IF:
1	To Stator Black Lead	To Ground	Either Reading is 0 or Readings Vary more than 10%
2	To Other Stator Black Lead	To Ground	

For 30 amp system refer to test 4.2.

HIGH TEMPERATURE SAFETY SWITCH, Fig. 33

As a safety precaution against overheating, engines are optionally equipped with a high temperature switch mounted to the cylinder head opposite the ***No. 1*** spark plug toward take-off end. ***Do not*** locate switch at any other location.

When cylinder head temperature becomes critically high, the safety switch will automatically stop the engine by shorting out the ignition system. A waiting period of ***5 to 10 minutes*** will be required before the switch has cooled off sufficiently to re-start the engine. An overheated engine will score the cylinder walls, burn out connecting rod and crankshaft bearings, also warp pistons and valves. The cause of the overheating condition will have to be remedied before the engine is re-started. *See **Engine Overheats** paragraph in Troubles, Causes and Remedies section.*

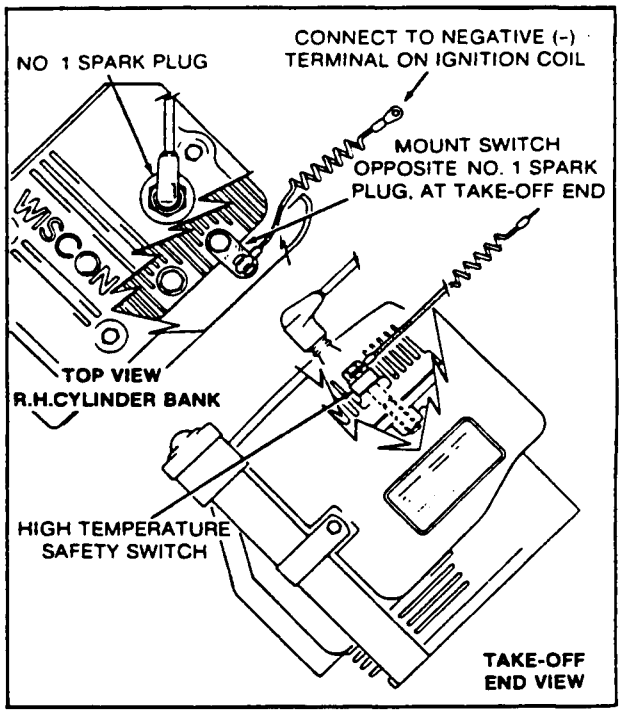


Fig. 33

ENGINE TROUBLES CAUSES AND REMEDIES

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. There are other factors which will contribute to hard starting; such as, too heavy a load for the engine to turn over at a low starting speed, a long exhaust pipe with high back pressure, etc. These conditions may affect the starting but do not indicate that the engine is improperly adjusted.

As a guide to locating starting difficulties which might arise, the following causes are listed under the three headings: ***Fuel Mixture, Compression,*** and ***Ignition.***

In each case, the causes of trouble are given in the order in which they are most apt to occur. If the remedy is apparent, no further remedies are suggested.

Starting Difficulties

FUEL MIXTURE

No fuel in tank or fuel shut-off valve closed.

Plugged vent hole in fuel tank cap.

Faulty fuel pump. Diaphragm in pump worn or punctured.

Carburetor not choked sufficiently, especially if engine is cold.

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

Poor grade or stale gasoline that will not vaporize sufficiently to form the proper fuel mixture.

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

Dirt or gum holding float needle valve in carburetor open. This condition would be indicated if fuel continues to drip from carburetor with engine standing idle. Often tapping the float chamber of the carburetor very lightly with the handle of a screwdriver or similar tool will remedy this trouble.

Restricted or dirty air cleaner.

Faulty carburetor — requires overhaul.

To test for clogged fuel line, loosen fuel line nut at carburetor slightly. If line is open, fuel should drip out at loosened nut.

COMPRESSION

⚠ ***Caution:*** Disconnect spark plug wires to prevent engine from accidentally starting.

If the engine has proper compression, considerable resistance will be encountered on the compression stroke when turning engine crankshaft over slowly by hand. If resistance is not encountered compression is faulty.

Restore Compression to an engine that has been out of operation for a period of time, in which the oil has drained off the cylinders, by removing the spark plugs and pour about a fluid ounce of crankcase oil through the spark plug hole in each cylinder. Turn engine crankshaft over several times to distribute the oil over the cylinder walls, then reassemble spark plugs and compression should be satisfactory.

Compression Check using a commercial compression test gauge; T.W.M. does not consider it practical to publish a p.s.i. compression figure because of the variables involved; engine condition, method of testing, and rpm of test. Our recommendation is that whatever gauge test is performed, a variation of more than 10 p.s.i. between cylinders would indicate leaking rings, valves or any of the following:

Valve stuck open due to carbon and gum on valve stem, or leaking valve seat, *see 'Valves', Page 35.*

Valve tappets adjusted with insufficient clearance under valve stems. *See 'Valve Tappets,' Page 14.*

Piston rings worn, broken, or stuck in piston due to carbon accumulation. *See 'Connecting Rods and Pistons', Page 31.*

Loose spark plugs or broken spark plug. In this case a hissing noise will be heard when cranking engine, 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.

IGNITION

Check Distributor *'Ignition spark'* per instructions on *Page 23.* No spark or weak spark may be attributed to the following:

Ignition cable loose or disconnected at coil, distributor or magneto, or spark plugs.

Broken or frayed ignition wires.

Spark plug insulator broken.

Spark plugs wet or dirty.

Spark plug gap incorrect. *See Page 10.*

Condensation on spark plug electrodes.

Breaker point gap incorrect. *See Page 12.*

Breaker points pitted or fused.

Breaker arm sticking.

Condenser leaking or grounded.

Spark timing wrong. *See Page 16.*

Weak battery. Faulty ignition coil.

ENGINE MISSES

Spark plug gap incorrect. *See Page 10.*

Worn, leaking or loose ignition cables.

Weak spark or no spark in one of the cylinders. *See 'Ignition', test for spark, Page 23.*

Loose connections at ignition cables.

Breaker points pitted or worn.

Water in gasoline.

Poor compression. *See 'Compression', Page 22.*

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', Page 6.*

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

Air vent hole in fuel tank cap plugged.

Engine scored or stuck due to lack of oil.

Ignition troubles. *See 'Ignition', Page 22.*

ENGINE OVERHEATS

Crankcase oil supply low. Replenish immediately.

Ignition spark timed wrong. *See 'Timing', Page 14.*

Low grade of gasoline.

Engine overloaded.

Restricted cooling air circulation.

Part of air shroud removed from engine.

Dirt between cooling fins on cylinder or head.

Intake screen clogged with dirt.

Engine operated in confined space where cooling air is continually recirculated.

Carbon in engine.

Dirty or incorrect grade of crankcase oil.

Restricted exhaust.

Engine operated while detonating due to low octane gasoline or heavy load at low speed.

ENGINE SURGES OR GALLOPS

Carburetor flooding.

Governor spring hooked into wrong hole in lever. *See 'Governor Adjustment', Page 12.*

Governor spring tension incorrectly adjusted.

Governor or throttle linkage binding, worn or disconnected.

ENGINE KNOCKS

Poor grade of gasoline or of low octane rating.

Engine operating under heavy load at low speed.

Carbon or lead deposits in cylinder head.

Spark advanced too far. *See 'Timing', Page 14.*

Loose or burnt out connecting rod bearing.

Engine overheated due to causes under previous heading.

Worn or loose piston pin.

ENGINE BACKFIRES THROUGH CARBURETOR

Water or dirt in gasoline.

Engine cold.

Poor grade of gasoline.

Sticky inlet valves.

Overheated valves.

Spark plug heat range incorrect (too hot).

Hot carbon particles in engine.

HIGH OIL PRESSURE

Oil pressure gauge defective.

Oil too heavy.

Faulty relief valve.

Clogged pressure line.

LOW or NO OIL PRESSURE

Oil pressure gauge defective.

Oil line to gauge clogged up.

Crankcase oil supply low.

Faulty oil pump.
- Gears worn or broken.
- Cover worn.
- Loose cover.
- Body worn.

Faulty relief valve.

Clogged or leaky oil line connections.

Strainer screen clogged up.

Oil too thin due to dilution or too light of grade used.

Worn rod bearings, or main bearings.

IGNITION SPARK

If difficulty is experienced in starting the engine or if engine misses firing, the strength of the ignition spark should be tested as follows: ***Disconnect*** the No. 1 and No. 2 spark plug cables from distributor towers. Leave the cable from the center tower to the coil in place. Insert a stiff piece of wire or metal rod into one of the sockets. Use an insulated pliers and hold cable terminal of that tower about 1/8 inch from the stiff wire or rod. Then, with the ignition switch on, turn the engine over by depressing the starter button and watch for a spark to discharge during the cranking cycle.

⚠ ***Caution:*** There is high voltage in ignition cables. Hold with insulated pliers to prevent receiving an electric shock.

Repeat this check with the other ignition cable. A good spark from each of the towers will eliminate the ignition coil and distributor as the source of trouble. If there is a weak spark, or no spark at all, check ***breaker point gap, condenser*** and ***ignition coil.***

ENGINE DISASSEMBLY and REASSEMBLY

OVERHAUL

An engine overhaul shall be deemed necessary if at least one of the following occur:

1. A ***10%*** loss in horsepower.
2. Oil consumption of ***one quart*** or more every 12 hours of operation.
3. A major engine part failure.

Under normal operating conditions and with scheduled maintenance, a suggested period between ***overhaul;***

2000 Hours: For ***intermittent load*** applications using 65 to 85% of horsepower at 1500 to 3600 r.p.m.

1500 Hours: For ***continuous load*** applications using 85 to 95% of horsepower at 2400 to 3600 r.p.m.

SAFETY NOTICE

Correct repair and adjustment are very important for safe and reliable engine operation. It is impossible to evaluate and advise of all the conceivable ways in which service work should be done, or of the unsafe consequences of each

way. Use common sense and satisfy yourself that what you are doing will not jeopardize your safety, the safety of others, or cause damage to the engine.

⚠ ***Caution:***

1. Engine repairs should be made only by an experienced mechanic.
2. Wear safety glasses and safety shoes.
3. Do not clean parts with gasoline — use a commercial petroleum solvent, or 'degreaser', according to instructions.
4. When using air pressure for cleaning, wear safety glasses and protective clothing.
5. Keep work area clean of spilled fuel and oil.
6. Store oily rags in a fireproof container.
7. Do not smoke in work area or where batteries are stored.
8. Comply with recommended torque valves when tightening screws and nuts.
9. Replacement screws must be of equal or better grade of steel.

PREPARATION and SUGGESTIONS

Clean the engine before attempting to repair it. Remove as much dirt and grime as possible before removing any parts. This will make the repair job much cleaner and reduce the possibility of getting harmful dirt particles inside the engine.

Provide a well lighted working area with enough space for parts and tools to be spread out. A work stand is essential for holding the engine securely while removing or tightening parts.

When disassembling the engine, lay the parts out in the order that they were removed. Have several boxes available so that parts belonging to certain groups can be kept together. Tag parts if there is a possibility of confusion.

It is suggested that reference also be made to engine PARTS MANUAL for reassembly. The exploded illustrations will help in identifying parts, show the components of individual assembly groups and presents a visual order of reassembly.

Drain Oil From Crankcase
Before Disassembly

All parts should be thoroughly cleaned and inspected for possible replacement. ***Use new gaskets, crankshaft oil seals*** and ***'o' ring seals*** in reassembly and lubricate all bearing surfaces.

TOOL REQUIREMENTS

Other than the conventional socket wrenches, screwdrivers, pliers, hammer, etc., the following tools may also be required.

Compressor, piston ring.

Dial Indicators.

Driver, insert (Wisconsin DF 69).

Driver, valve guide (Wisconsin DF 72).

Expander, piston ring.

Micrometers.

Oil Seal and Bearing Tool Kit (Wis. TW1001) Fig. 34.

Puller, flywheel.

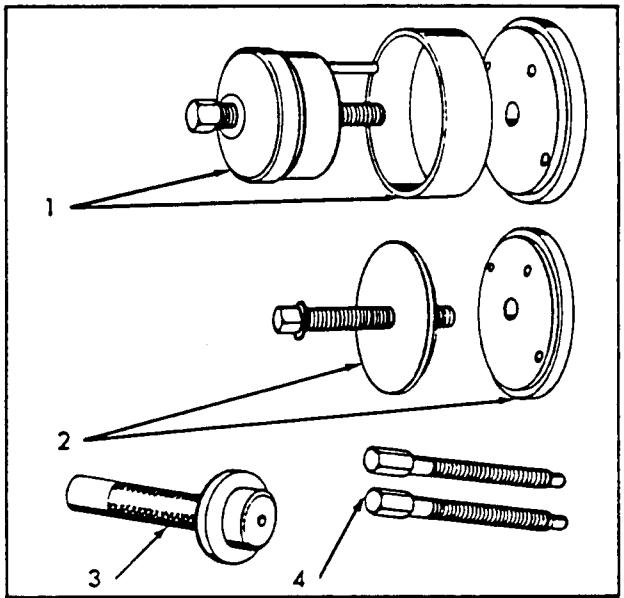
Puller, insert (Wisconsin DF 66A).

Puller, idler shaft (Wisconsin DF 67).

Torque wrench (0-75 in. lbs.).

Torque wrench (0-50 ft. lbs.).

Valve spring compressor.



1	**CRANKSHAFT MAIN BEARING TOOL:** Used to install and remove main bearings. Aligns oil holes of bearings with oil passages in crankcase.
2	**CRANKSHAFT SEAL INSTALLER:** Used to install crankshaft oil seal in bearing retainer (take off end).
3	**SEAL DRIVER:** Used to install crankshaft oil seal in gear cover.
4	**FORCING SCREWS:** Used to remove main bearing retainer plate from crankcase.

Fig. 34 SERVICE TOOL KIT TW1001

DISASSEMBLY and REASSEMBLY PROCEDURES

With the disassembly operations, instructions on reassembly are also given, as often it will not be necessary to disassemble the entire engine. If it is desired to disassemble the entire engine, the reassembly instructions can be looked up under the headings of the various parts.

ACCESSORIES

Remove ***clutch*** or ***clutch reduction*** unit if engine is equipped with either of these accessories.

AIR CLEANER, if mounted to left hand side of engine; disconnect breather lines and loosen adapter elbow at carburetor. Remove complete air cleaner and bracket assembly from side of cylinder shroud.

CONTROL PANEL can be removed to prevent being damaged. Disconnect: ignition wires, choke wire at carburetor, oil pressure line to gauge and variable speed control if furnished.

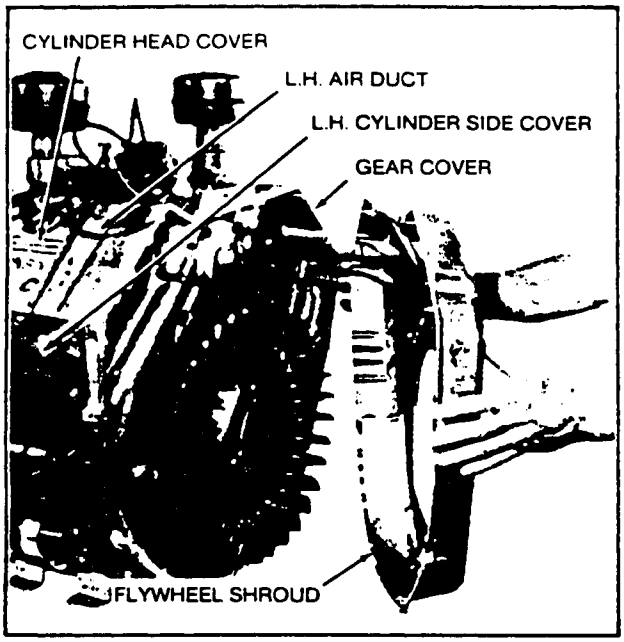


Fig. 35

FLYWHEEL SHROUD, Fig. 35

Remove eight pan head screws and take off screen from front face of flywheel shroud. Remove ten hex head screws and take off flywheel shroud.

In Reassembly; tighten flywheel shroud to gear cover screws ***48 inch lbs. torque.***

POWER TAKE-OFF STUB SHAFT, Fig. 36

The stub shaft mounted to the back-end of the crankshaft must be removed if main bearing plate or crankshaft is to be disassembled. Use a 5/16 inch 12 point socket wrench to remove the eight mounting screws.

The stub shaft mounting holes are equally spaced, so scribe crankshaft with a ***locating mark*** on hub of stub shaft if it is an installation requirement that the keyway in the stub shaft be mounted in the same position it was removed from.

In Reassembly; tighten the 12 point capscrews alternately to ***24 ft. lbs. torque.*** Keep flywheel from turning by applying a 15/16 inch wrench to the flywheel retainer screw while tightening stub shaft capscrews.

FLYWHEEL, Fig. 37

By means of a 15/16 inch offset box wrench, loosen flywheel screw by striking the handle of wrench a sharp blow with a soft hammer. Remove retainer screw with washers and keep nearby for use after flywheel is taken off.

⚠ ***Caution:*** Wear safety glasses when using a hammer to loosen flywheel retainer screw and for all other phases of overhaul where eye injuries are possible.

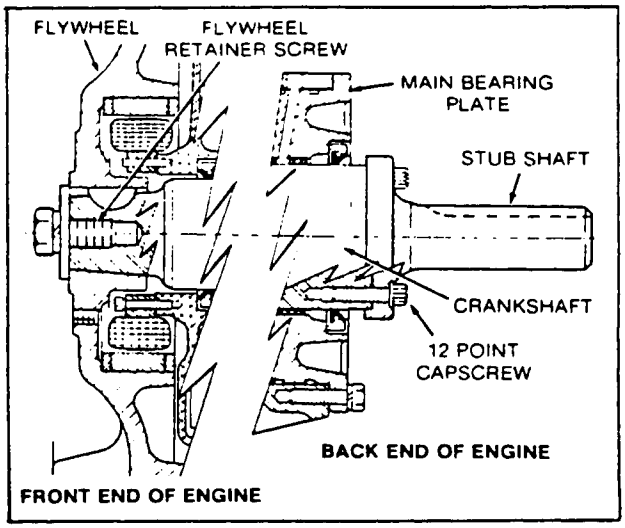


Fig. 36

The flywheel is mounted to a taper on the crankshaft and is further secured in place by a Woodruff key. The flywheel is provided with at least two 5/16-18 tapped holes on a 3-3/4 inch bolt circle for removal by means of a wheel puller as illustrated in Fig. 37.

Important: Avoid striking end of crankshaft with a hammer to loosen flywheel from taper — damage to the retainer screw threads and crankshaft could result.

Important: Carefully remove and reassemble flywheel so as not to damage flywheel alternator rotor and stator.

⚠ ***Caution:*** Handle flywheel with care — check condition of cooling fins. Operating an engine with damaged or broken off fins will damage the engine and could seriously injure the operator or bystanders

NOTE: The flywheel retainer screw can be put back into the end of the crankshaft and used with a 15/16 inch socket wrench to turn crankshaft during overhaul procedures.

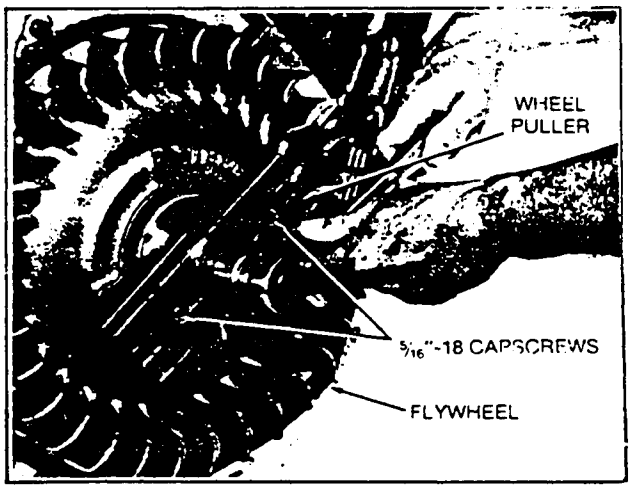


Fig. 37

In Reassembly; be sure the Woodruff key is in position on the shaft and that the keyway in the flywheel is lined up accurately with the key. After mounting; seat flywheel on crankshaft taper by slipping a piece of pipe over the end of the crankshaft and against the hub of the flywheel, and striking the end of the pipe a sharp blow with a hammer.

Mount plain washer, lockwasher and retainer screw — tighten to ***115 ft. lbs. torque.***

FLYWHEEL RING GEAR, Fig. 38

If ring gear is damaged, it can be removed by sawing partway through the ring gear, then breaking it using a hammer and chisel.

In Reassembly; oven heat new ring gear 380° to 400°F for 30 to 40 minutes. ***Do not heat with a torch.***

When properly heated, ring will fall into place on flywheel (chamfer on inside of ring toward flywheel). If necessary, tap into place with a hammer, but ***work fast.*** If ring gear shrinks to the flywheel before it is properly in place, it will have to be removed and replaced with another new ring gear.

INTAKE MANIFOLD and CARBURETOR, Fig. 39

Disconnect fuel line at carburetor, breather lines at air cleaner, and unhook throttle rod from carburetor lever. By removing 4 capscrews and lockwashers, complete air cleaner, carburetor and intake manifold can be removed from cylinder blocks as a complete unit.

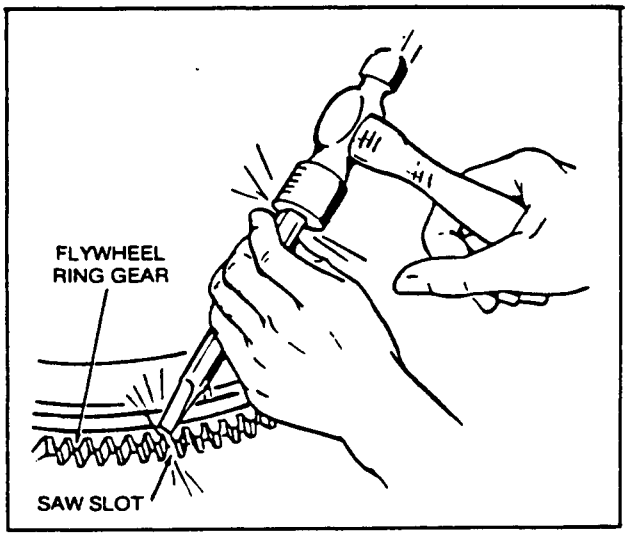


Fig. 38 RING GEAR REMOVAL

In Reassembly; if cylinder blocks were removed — spacing between intake port flanges of both cylinder blocks must be accurate to provide a secure fit to the intake manifold flanges. Use manifold as a gauge when tightening cylinder blocks to crankcase — refer to Fig. 65, Page 35.

With gaskets in place, mount and tighten manifold screws ***alternately,*** from one side to the other, to ***18 ft. lbs. torque.***

Refer to Accessories in rear section of manual for Carburetor Repair. Tighten carburetor to manifold locknuts to ***24 ft. lbs. torque.***

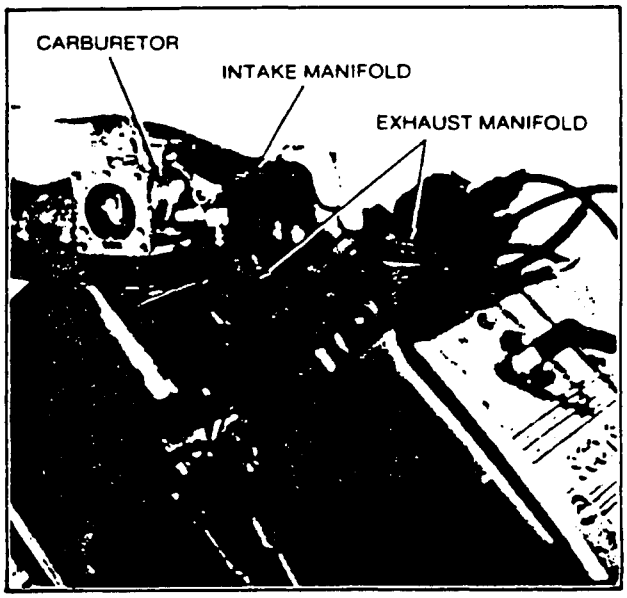


Fig. 39

EXHAUST MANIFOLDS, Fig. 39

Remove the twin exhaust manifolds, or if optional single branch exhaust system was furnished — this can be removed as a complete unit.

In Reassembly; with gaskets in place, tighten manifold to cylinder block flange screws to ***18 ft. lbs. torque.*** The optional single exhaust manifold branch is mounted to the twin side branches and tightened to ***31 ft. lbs. torque.***

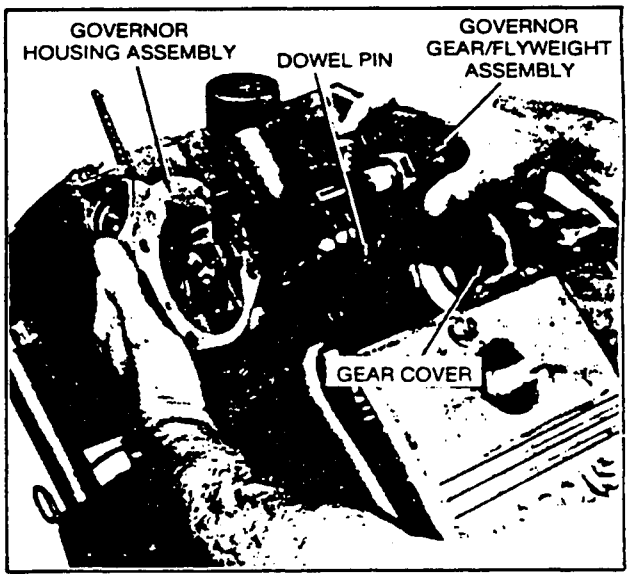


Fig. 40

GOVERNOR and DISTRIBUTOR, Figs. 40, 41, 42

Remove breather lines from valve chambers, and disconnect ignition wires at spark plugs and coil. Take out

distributor advance arm mounting screw and remove distributor. Loosen governor oil line at crankcase and take out the 4 governor housing capscrews and lockwashers from inside of the gear cover. Pull housing free from dowel pins, then twist slightly to disengage governor gear from cam gear. Remove governor housing and gear/flyweight assemblies from gear cover, see *Fig. 40.*

In Reassembly; clean and lubricate all bearing surfaces. Replace parts that are damaged or if there is excessive wear, *see Chart, Fig. 41 and Governor Illustration, Fig. 42.* Mount distributor per *Timing Instructions, Page 14.*

With housing gasket in place on spacer plate, mount governor assembly (less distributor), carefully engaging governor gear with camshaft gear, and aligning holes in

GOVERNOR— CLEARANCE and WEAR LIMITS (inches)

Description	Original Dimension	Clearance	Wear Limit
Cross Shaft Diameter	.309/.310		.002
Cross Shaft Hole dia. in Housing	.312/.313	.002/.004	.002
Gear Shaft Diameter	.5000/.4996		.002
Gear Shaft Bearing I.D.	.501/.502	.0024/.0010	.002
Thrust Sleeve I.D.	.503/.505	.0030/.0054	.003

Fig. 41

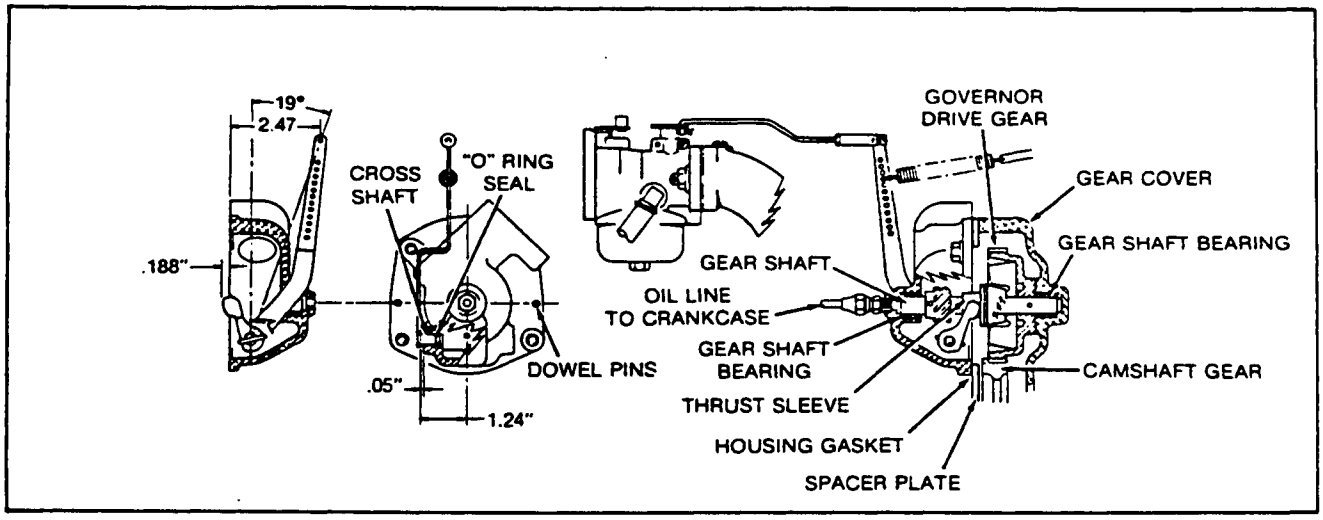


Fig. 42

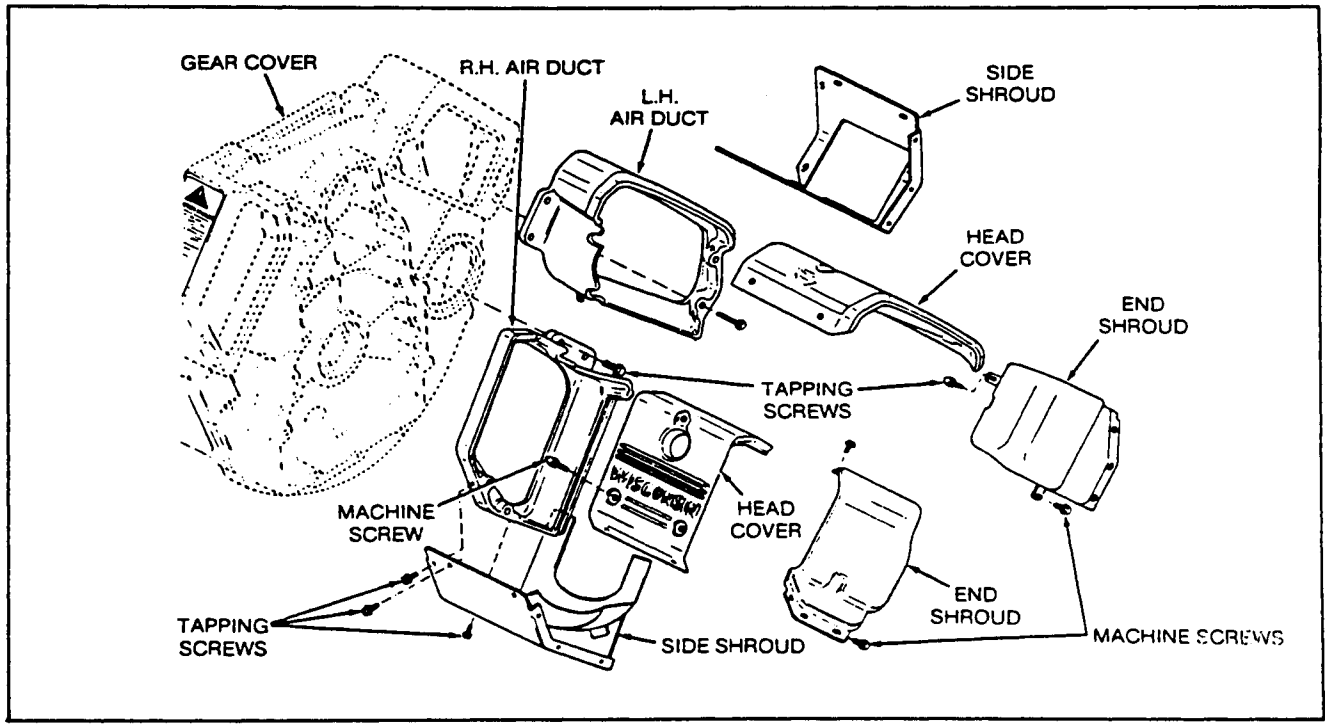


Fig. 43

governor housing with dowel pins in gear cover. Tighten housing mounting screws to ***84 inch lbs. torque***, then connect oil line to crankcase.

Mount ignition distributor to governor housing per ***'Timing Procedure'***, Page 14, Figures 23, 24, 25, 26.

AIR SHROUDING, Fig. 43

Remove shrouding in the following sequence, noting that some of the mounting screws are hex head machine thread with an attached external lockwasher, and others are self-tapping thread with a hex washer head.

1. Cylinder end shrouds and oil filler tube support strap.
2. Cylinder side shrouds.
3. Cylinder head covers.
4. Air duct from right hand side. Air duct on left hand side can remain attached to the gear cover.

In Reassembly; tighten machine thread screws to ***108 inch lbs. torque***, and the self-tapping thread screws to ***48 inch lbs. torque***.

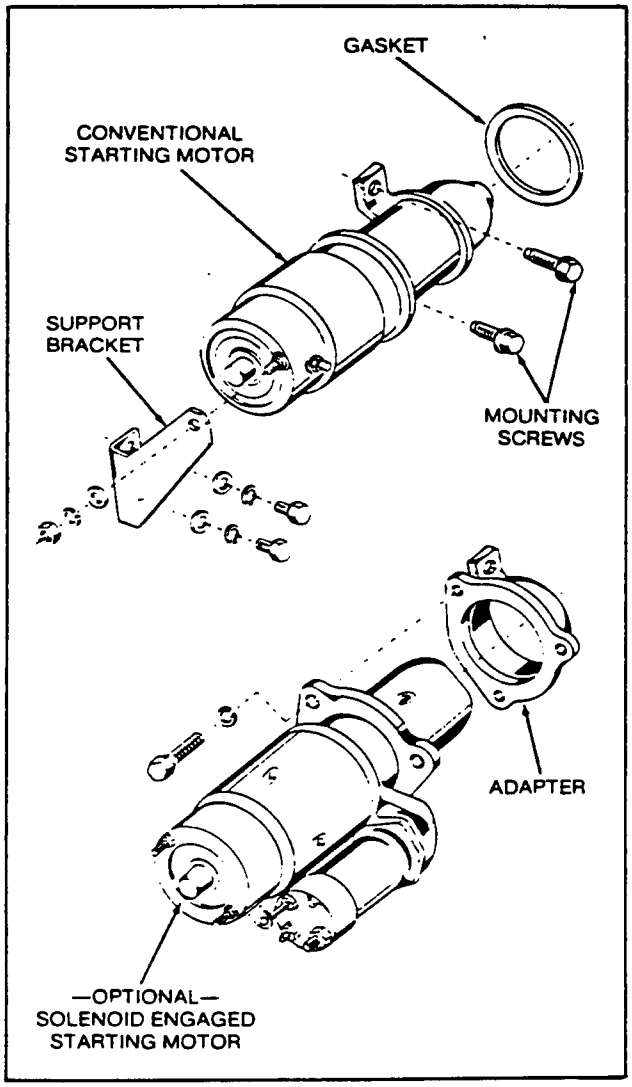


Fig. 44

STARTING MOTOR, Fig. 44

The ***conventional type*** standard starting motor is *"Inertia Engaged"*, with a *FOLO-THRU* bendix to protect against damages caused by false starts.

Optionally furnished is a "Solenoid Engaged" starting motor containing an overrunning clutch type drive that provides positive engagement. The ***Solenoid Starting Motor*** is mounted to an adapter attached to the engine gear cover, and is removed and reassembled in the same manner as the conventional starting motor.

First remove the ignition coil, which is usually mounted to the engine support below the starting motor. Disconnect starter cable, then loosen and remove nut and washers from starting motor to support bracket. Take off support bracket after removing the 2 mounting screws and washers.

Caution: Starting motor is not held in place by a pilot flange — ***hold starter firmly*** while removing mounting screws. By means of a 9/16 inch socket wrench, take out the 2 capscrews that support starting motor to gear cover.

In Reassembly; thoroughly clean terminals and exterior of motor body. Clean bendix with Kerosene — ***Do not*** oil bendix — if necessary, lubricate with powdered graphite.

When remounting starter, be sure flange gasket is in place. Its purpose is to prevent dirt and moisture from entering into the gear cover and starter bendix. Tighten starter to gear cover screws to ***144 inch lbs. torque — Do not*** overtorque — screw threads are in aluminum material. Tighten bracket and support screws and nut to ***108 inch lbs. torque***.

CYLINDER HEADS and SPARK PLUGS, Fig. 45

Caution: Beginning with engine serial No. 5996538 the cylinder head was changed to accommodate a 14 mm spark plug in place of an 18 mm plug. If a cylinder head using an 18 mm plug is to be replaced with a new head, both heads must be changed using 14 mm spark plugs. ***Do not*** use cylinder heads with two different spark plug sizes on the same engine. Refer to Page 10 for spark plug part numbers and gap setting.

Remove spark plug, three studs, five capscrews and washers from each of the two cylinder heads. Take off heads and discard head gaskets. Clean carbon from the combustion chamber and dirt from between cooling fins. Check cylinder head mounting face for distortion — if ***warpage*** is evident, replace head. The cylinder head should be flat within .005 inch.

In Reassembly; mount new gaskets with gasket face in either direction. Apply a mixture of graphite and oil to the threads of the mounting screws and studs to prevent them from rusting tight against the cylinder block. Screw the studs for attaching the cylinder head covers in their correct location on cylinder heads. Then, tighten the studs and screws to ***36 ft. lbs. torque***, in the sequence shown in *Fig 45*. After engine is ***run-in***, retorque to ***36 ft. lbs.***

Hi-temp Safety Switch, optionally furnished, is mounted to the cylinder head opposite the No. 1 spark plug, at take-off end. Switch must be remounted in this same location or it will not function properly. See Fig. 33.

Spark plugs can be left out temporarily for ease in turning engine over for remainder of assembly and for timing adjustments. When mounting spark plugs, tighten ***18 to 22 ft. lbs. torque*** (dry).

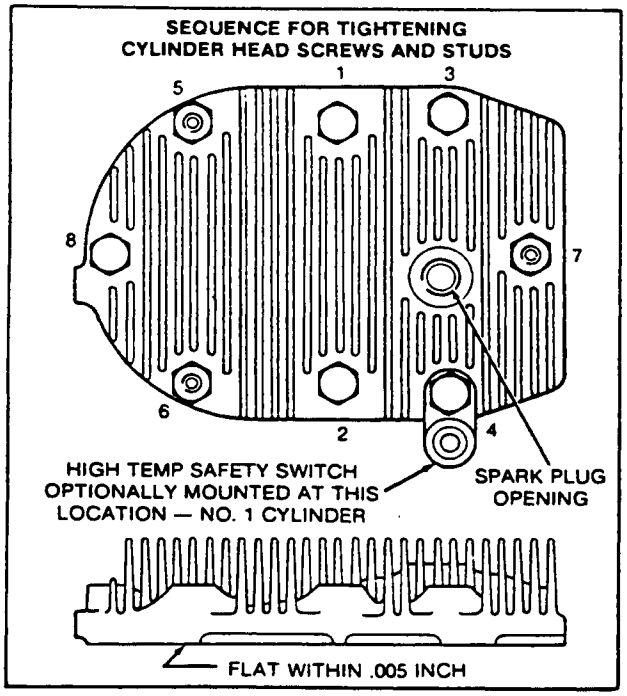


Fig. 45

FLYWHEEL ALTERNATOR — STATOR, Fig. 46

Stator can be left on gear cover and removed as a complete unit as illustrated in *Fig. 47*. If stator is to be replaced because of malfunction, first remove the four #10-32 screws by means of a 5/32 inch Allen wrench. Then, place a pry bar alternately in the area behind the two stator dowel pins, and pry stator mounting surface loose. Then, take off stator wire cavity cover from gear cover, disconnect wire from rectifier/regulator module terminals — remove stator assembly.

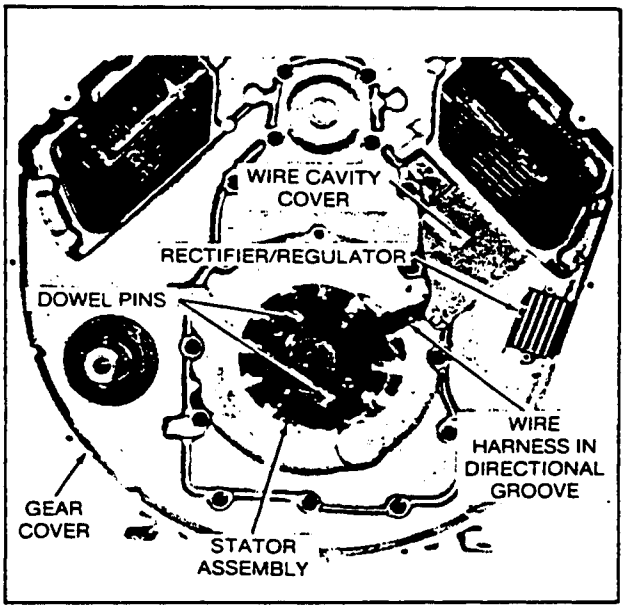


Fig. 46

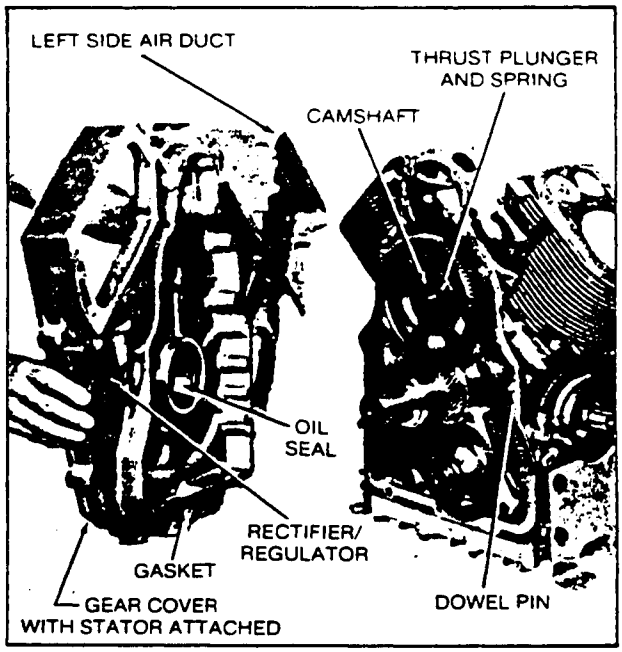


Fig. 47

In Reassembly of new stator, point wire harness in line with directional groove in gear cover, place stator mounting surface over dowel pins and gently tap in place. Apply #242 ***Loctite*** to the four #10-32 screw threads and tighten to ***18 inch lbs. torque.*** Connect wire harness to rectifier/regulator module and remount wire cavity cover.

GEAR COVER, Fig's. 47, 48, 49

Disassemble air duct from gear cover on right hand side by removing four hex head screws. Air duct on left hand side can remain attached to gear cover.

Remove eleven 5/16"-18 x 2" long capscrews and lockwashers that mount the gear cover to crankcase. With the rectifier/regulator disconnected from the stator, pull gear cover free from crankcase dowel pins.

Remove thrust plunger and spring from end of camshaft to prevent them from falling out and being lost.

With reference to Fig. 49, check condition of governor shaft bearing and oil seal. Crankshaft oil seals are included as part of the engine gasket set and should be replaced if engine is rebuilt. The oil seal is assembled to the gear cover with the ***lip pointing inward*** toward the engine crankshaft gear, see Fig. 49.

Install Gear Cover Oil Seal as illustrated in *Fig. 48*, by using seal driver tool #208200 contained in TW1001 Tool Kit.

1. Slide oil seal onto driver with open lip toward the tool. ***Note:*** This is opposite of the main bearing plate oil seal.
2. While supporting and cushioning the gear cover assembly, place the oil seal and driver into the gear cover recess.

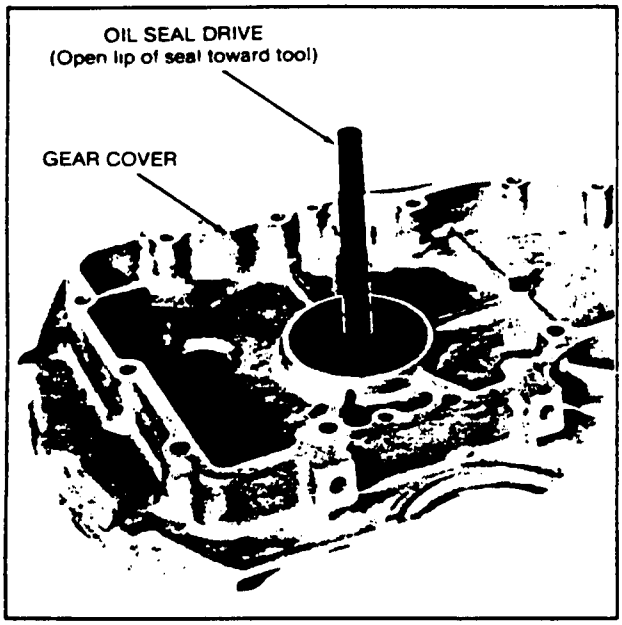


Fig. 48

3. Squarely hit the seal driver with a hammer until the seal is fully seated in the gear cover.

The governor shaft to bearing clearance is .001 to .0024 inch. When the clearance becomes .0044 inch, replace bearing and, or shaft.

In Reassembly; insert thrust plunger and spring into end of camshaft. Mount gasket to spacer plate face, using a thin coat of oil or grease to hold it in place. Assemble gear cover being careful not to damage or fold lip of oil seal when contacting shoulder on crankshaft. Engage crankcase dowel pins and lightly tap gear cover in place. Assemble the 11 capscrews and lockwashers, tighten to ***18 ft. lbs. torque.***

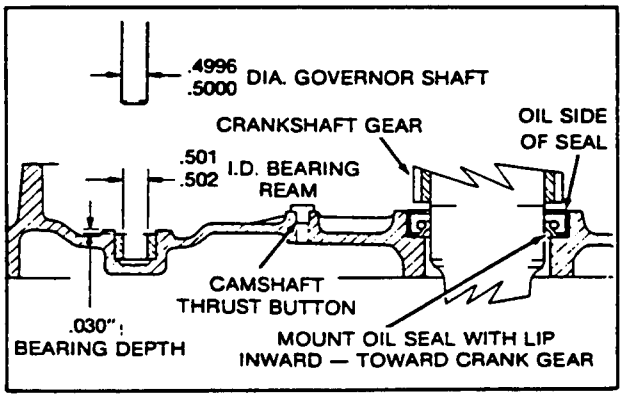


Fig. 49

GEAR TRAIN, Fig. 50

With the removal of gear cover, the gear train will be exposed as shown in *Fig. 50.* Remove camshaft thrust plunger and spring to prevent their being lost.

Future reference can be made to *Fig. 50* when assembling crankshaft and camshaft, as accurate location of the timing marks is essential for proper engine operation.

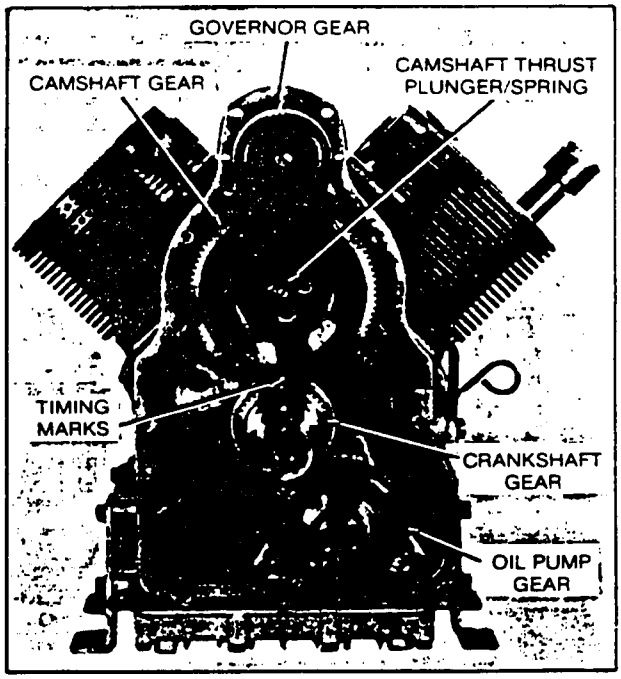


Fig. 50

OIL PAN, Fig. 51

Invert engine to a position where the bottom of the crankcase will be accessible. Take off oil pan and gasket, using a 1/2 inch socket wrench to remove 12 capscrews and lockwashers.

In Reassembly; use a new oil pan gasket, and mount oil pan with oil drain to either side — oil filter side is standard. Use Perma-tex on screw threads and tighten to ***18 ft. lbs. torque.***

OIL PUMP, Fig's. 51, 52, 53

Remove 3 capscrews and lockwashers through the openings in the oil pump drive gear at the gear cover face of the crankcase. The complete oil pump assembly can then be pushed out from inside the crankcase.

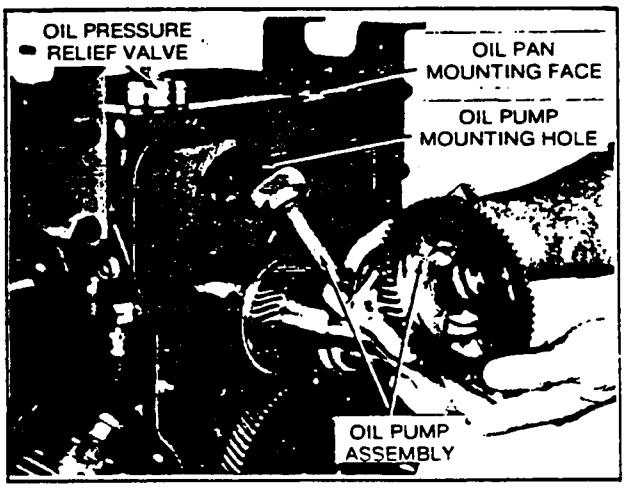


Fig. 51

Oil pump disassembly; is required for inspection and cleaning if faulty pump operation is suspected. The cover and pick-up tube assembly can be removed by taking out the pump mounting screws through openings in the drive gear. A puller is required to remove drive gear from shaft. Wash all parts in a cleaning solvent and dry with compressed air.

Replace oil pump or related parts if any of the following conditions exist.

1. Cracks or excessive wear in pump body.
2. Excessive wear or damage to gears. (Gears are replaced as a matched set.)

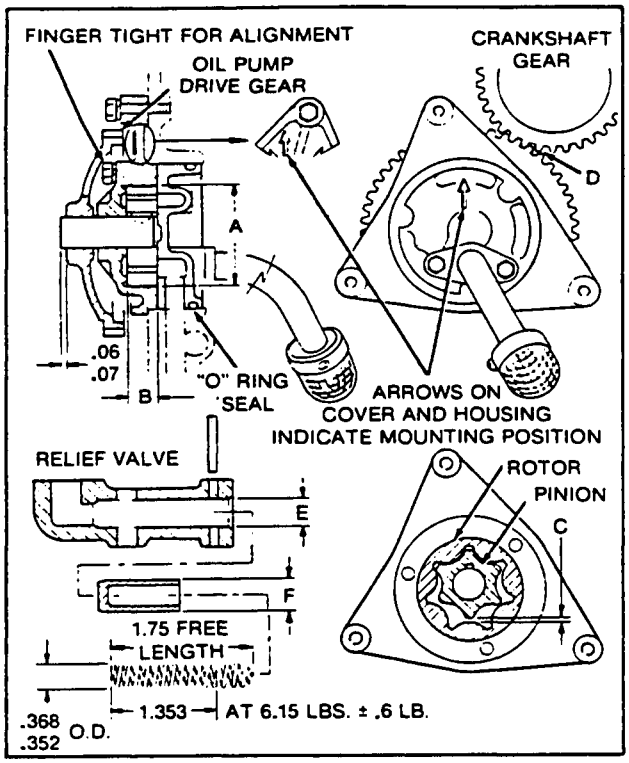


Fig. 52 OIL PUMP

OIL PUMP— CLEARANCE and WEAR LIMITS (inches)

	Description	Original Dimension	Clearance	Wear Limit
A	Pump Housing I.D.	2.2555/2.2575	.0055/.0105	.003
	Rotor O. Dia.	2.2500/2.2470		
B	Pump Housing Depth	.6905/.6925	.003/.006	.002
	Rotor Width	.6875/.6865		
C	Rotor Tip Clearance		.004/.006	.003
D	Backlash-Pump Gear to Crankshaft Gear		.003/.006	
E	Relief Valve Body I.D.	.4375/.4385	.0015/.0030	.001
F	Piston O. Dia.	.4360/.4355		

Fig. 53

3. Drive shaft loose in pump body.
4. Wear in cover that allows oil to leak past the face of rotor and pinion.
5. Damage to oil pick-up tube or screen.

Refer to *Fig. 53* for size, clearance and wear limits of oil pump parts.

Relief Valve; for oil pump pressure, is mounted to the bottom of the crankcase, as illustrated in *Fig 51.* Remove, clean and inspect for faulty operation. Refer to *Fig. 53* for relief valve clearance and wear limits.

In Reassembly; press drive gear onto shaft before mounting cover, and per dimensions in *Fig. 52.* ***Note:*** Thoroughly oil pinion and rotor gears as a pump prime for initial starting.

Mount housing and cover with cast ***arrow pointing upward.*** Tighten cover screws only ***fingertight*** to allow for alignment of cover and body assembly to crankcase.

Place a new 'O' ring seal on cover. Push oil pump into crankcase bore, being sure that body is aligned with cover, and shoulders firmly against crankcase face. Check to be sure that ***arrows*** on cover, and on the opposite side of body, are pointing in the same ***upward direction, see Fig. 52.***

Tighten cover mounting screws and pick-up tube screws to ***48 inch lbs. torque,*** and body flange screws to crankcase, ***108 inch lbs. torque.***

Spin oil pump drive gear counterclockwise to check for free movement of internal gears.

PISTONS and CONNECTING RODS

REMOVAL

Rotate crankshaft to bring connecting rod down to a convenient position for removal of cap. By means of a 9/16 inch socket wrench, loosen and remove locknuts from connecting rod bolts. By tapping the end of the bolts lightly, the connecting rod cap will break loose from the bolts. Tape or cap ends of connecting rod bolts to prevent them from scratching cylinder walls and crank pins when removing.

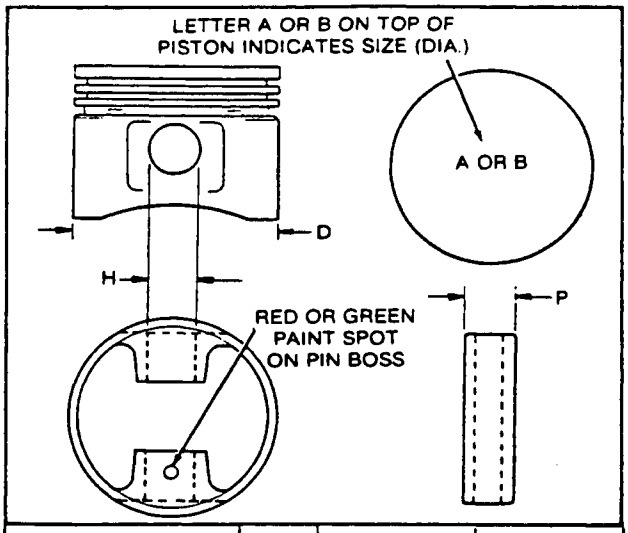
Scrape off all carbon deposits that might interfere with removal of pistons from upper end of cylinder. Turn crankshaft until piston is at top, then push connecting rod and piston assembly upward and out through top of cylinder. Be careful not to scrape rod against crank pin and cylinder wall. Place caps on rods immediately so that they will not be mismatched in reassembly. ***Note:*** Tag connecting rod and piston assemblies so that they can be reassembled into the same cylinder that they were removed from.

Replace connecting rods that are damaged. Check for twisted or bent rods, and inspect for nicks and cracks.

DISASSEMBLY

Piston Pin should be removed using a hydraulic press. The pin is a select clearance fit to the piston, and an interference press fit to the connecting rod. ***Do not*** interchange piston pins. Pistons are matched with pins to obtain a clearance of .0005 to .0008 inch. ***Pins are not serviced separately. For Service Replacement;*** pin is furnished with

piston and ***color coded*** Red and Green to match corresponding color spot on piston pin boss in piston, *see Fig. 54.*



	Description		Size (inches)	Clearance
D	Piston Diameter at Skirt Thrust Faces	A	3.7465/3.7470	.0035/.0025
		B	3.7471/3.7475	.0034/.0026
H	Piston Pin Hole Dia. in Piston	Red	.87530/.87515	
		Green	.87515/.87500	
P	Piston Pin Diameter	Red	.8746/.8745	.00080/.00055
		Green	.8745/.8744	.00075/.00050

Fig. 54

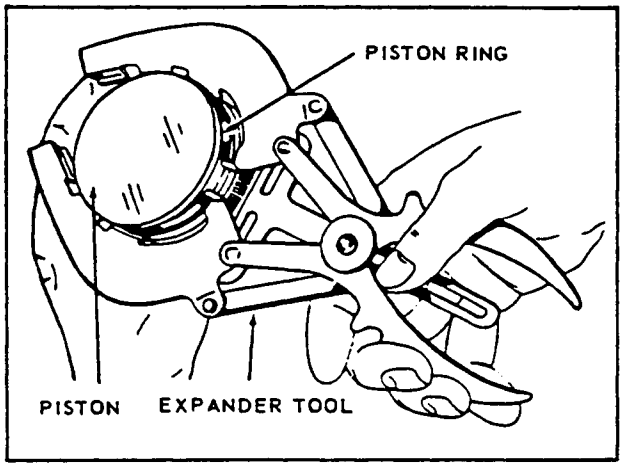


Fig. 55

Piston Rings; if they are to be replaced, should be removed by means of a ring expander, *see Fig. 55,* so as not to damage piston.

Pistons; should be thoroughly cleaned of carbon and varnish accumulations using a cleaning solvent, ***do not use a wire brush.*** Clean oil ring slots and oil holes in piston pin bosses.

Check for cracked or worn ring lands, scuffed or cracked skirt or pin holes and eroded areas at top of piston. Replace pistons that are damaged or show excessive wear.

PISTON, RING, ROD CLEARANCES and WEAR LIMITS (inches)

Cylinder Bore	A	3.7500/3.7495	
	B	3.7505/3.7501	
Cyl. Out of Round		.0005	
Cyl. Taper		.003	
Piston Dia. at Bottom of Skirt, Thrust Faces	A	3.7465/3.7470	
	B	3.7471/3.7475	
		Clearance	**Wear Limits**
Piston to Cylinder at Piston Skirt Thrust Face	A	.0035/.0025	.003
	B	.0034/.0026	.003
Piston Ring Gap		.010/.020	.005
Piston Ring Side Clearance in Grooves	Top Ring	.002/.004	.002
	Scraper Ring	.002/.004	.002
	Oil Ring	.0015/.0035	.002
Piston Pin to Connecting Rod-Small End (1500 lb. min. for assembly)		.0006/.0015 Tight	
Piston Pin to Piston	Red	.00080/.00055	.001
	Green	.00075/.00050	.001
Connecting Rod to Crank Pin - Side Clearance		.009/.018	.005
Connecting Rod **Shell Bearing** to Crank Pin Dia. (Vertical)		.0011/.0036	.003

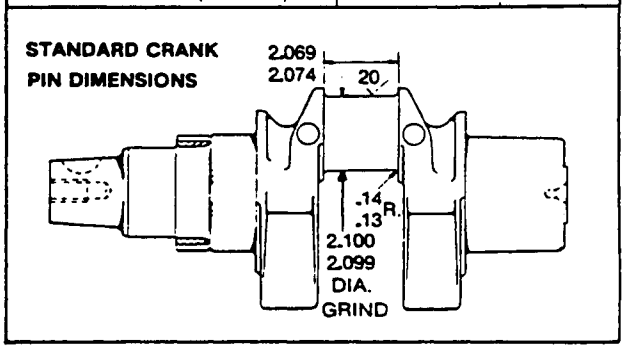


Fig. 56

REASSEMBLY/PISTONS and CONNECTING RODS

Shell Bearings must be correctly mounted to the connecting rod ***in reassembly.*** The cap should be mounted to the rod so that the ***locating lug*** of both bearing halves are on the same side as illustrated in *Fig. 57.* Spread a film of oil on back of shell bearing before mounting to help hold them in place during assembly. Refer to chart, *Fig. 56,* for clearance between bearing and crank pin.

The precision shell bearings do not utilize shims for adjustment. Check crank pin for out-of-round or taper, then use a commercial ***Plastic Gage*** to check clearance between crank pin and rod bearing. If clearance is excessive — .010 and .020 inch undersize shell bearings are available for reconditioned crank pins.

Piston skirt is ***cam-ground*** to an elliptical contour. Clearance between the piston and cylinder must be determined from the center of the thrust face at the bottom of the piston skirt. Refer to Chart, *Fig. 56*, for proper clearance. The thrust face on the piston are the wide section of the piston, 90° from the axis of the piston pin hole, on both sides of the piston.

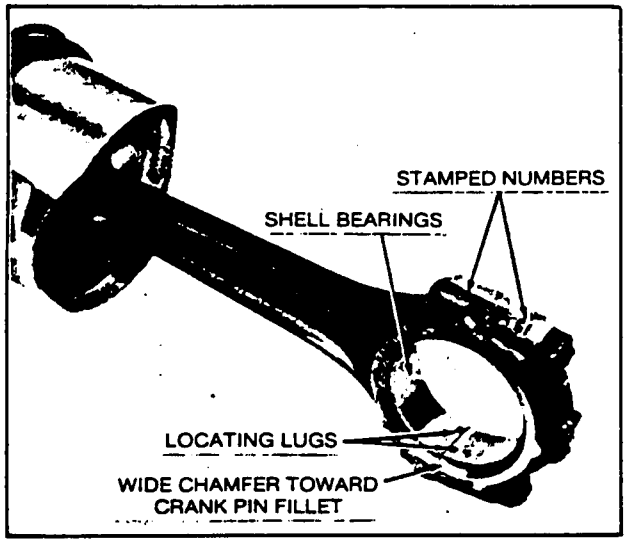


Fig. 57

IMPORTANT

When measuring pistons, pins and cylinder bores, it is important that these parts be at room temperature. If any parts are hotter or colder than the others, improper fitting will result.

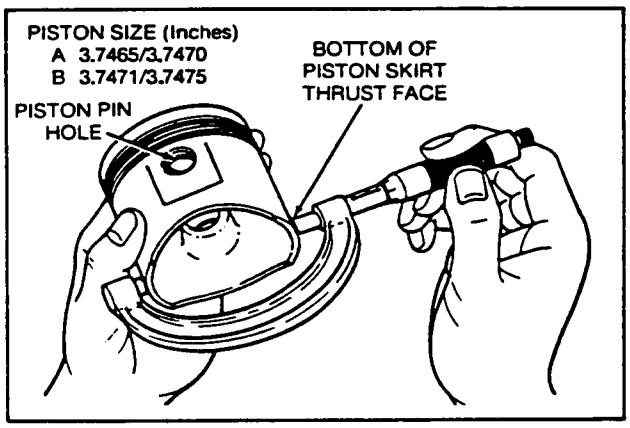


Fig. 58

With reference to *Fig. 58*, measure piston at bottom of piston skirt thrust faces, 90° from pin hole. For service, standard pistons are marked on top in ***A*** and ***B*** sizes, as illustrated. For reboring, .010, .020 and .030 inch oversize pistons are also available.

Piston Pin is a press fit into the connecting rod. Lubricate pin hole in piston and rod — use a hydraulic press to facilitate assembly of pin. Properly support piston to prevent skirt from being crushed. Press pin into a depth of about .015 inch below outer surface of piston, using a minimum force of 1500 lbs. to obtain functional pin operation. See *Fig. 62*.

Optionally; a rod heater can be used to induction heat and expand pin hole in connecting rod so that piston pin can be hand pressed in place.

Caution: Do not use a torch for heating — connecting rod might warp.

Piston Ring gap and side clearance should be checked before installing onto piston.

With reference to *Fig. 59*, insert ring into cylinder bore below ring travel. Square ring in bore by pushing it in position with head of piston. The ring gap as measured with a feeler gauge should be .010 to .020 inches for each of the three rings. With new rings, incorrect gap usually indicates wrong size rings. It should not be necessary to alter gap by filing ends of new rings.

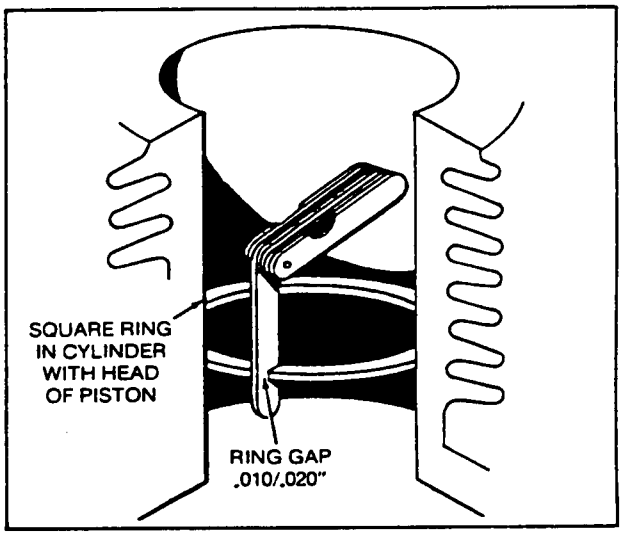


Fig. 59 RING GAP

Side Clearance of the compression, scraper and oil rings, should be measured before installing rings on piston. The clearances indicated in *Fig. 60* are with new piston and rings. If clearance is more than .002 inch over the high limit with new rings and original piston, replace piston assembly.

PISTON RINGS, Fig's. 59, 60, 61, 62

If a ring expander tool, *Fig. 55*, is not available, install rings by placing the open end of ring on piston first, as shown in *Fig. 61*. Spread ring only far enough to slip over piston and into correct groove, being careful not to distort ring. Install bottom ring first and work toward the head of the piston, installing top ring last. The word ***'TOP'*** on compression and scraper rings indicates direction of ring placement on piston.

Note: Be sure Expander Ring is in place in 3rd groove before mounting oil control ring.

The outer diameter of the compression ring is ***chrome plated***. Mount scraper ring with scraper edge down,

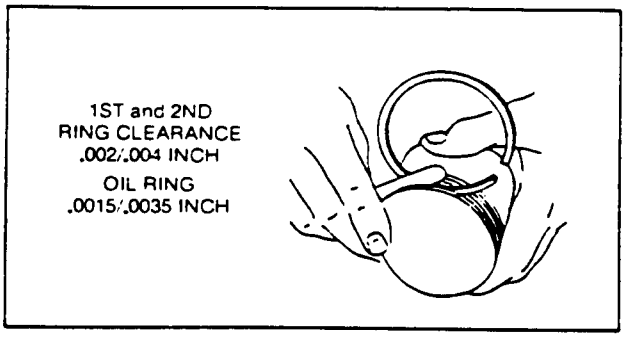


Fig. 60 RING SIDE CLEARANCE

otherwise oil pumping and excessive oil consumption will result. Refer to *Fig. 62* for the correct placement of piston rings.

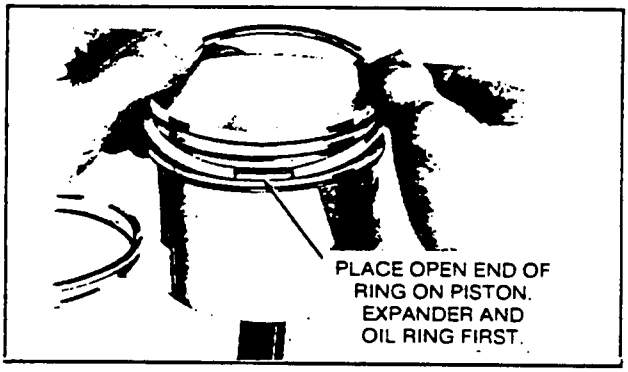


Fig. 61

Connecting Rod/Piston Assemblies should be put back into the same cylinder bore from which they were removed. Stagger the piston ring gaps as follows:

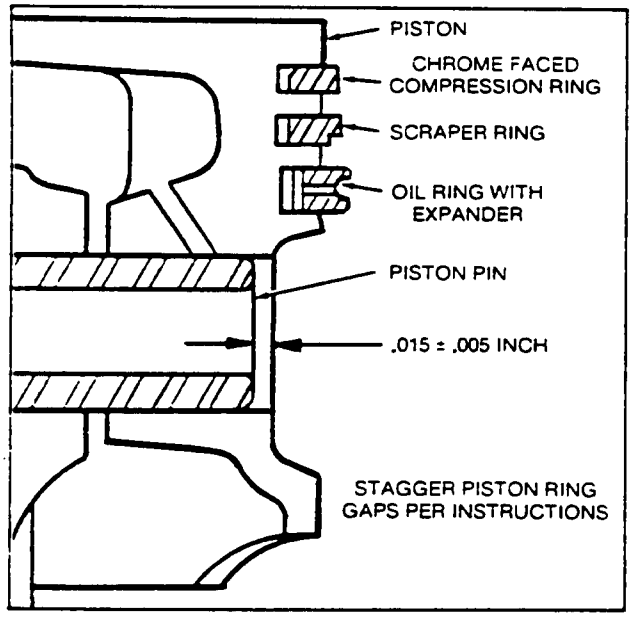


Fig. 62

1. 180° between top and 2nd ring.
2. 90°, oil ring expander from 2nd ring.
3. 90°, oil ring from expander, and at least 30° from top and 2nd ring gaps.

Lubricate rings, pistons, cylinder walls and crank pin with SAE 30 grade oil.

IMPORTANT

Assemble with rod bearing parallel to crank pin, and chamfer in bearing bore away from vertical center of crank pin. The large outer vertical flat surfaces of both rods are facing each other when rods are attached to crank pin as illustrated in Fig's. 63 and 64.

Tape or cap ends of connecting rod bolts to prevent them from scratching cylinder walls and crank pins when assembling. Use an automotive ring compressor over piston and insert rod into cylinder from cylinder head end. Use the wooden handle end of hammer and gently tap piston into cylinder until the connecting rod bearing contacts the crank pin.

Note: Identical numbers are stamped on one side of the bearing end of connecting rod and its corresponding cap, *see Fig. 63.* These numbers must be on the same side of each individual rod when mounted in engine. This is for identification and correct assembly. The numbers for No. 1 cylinder rod are on a side opposite those of No. 2.

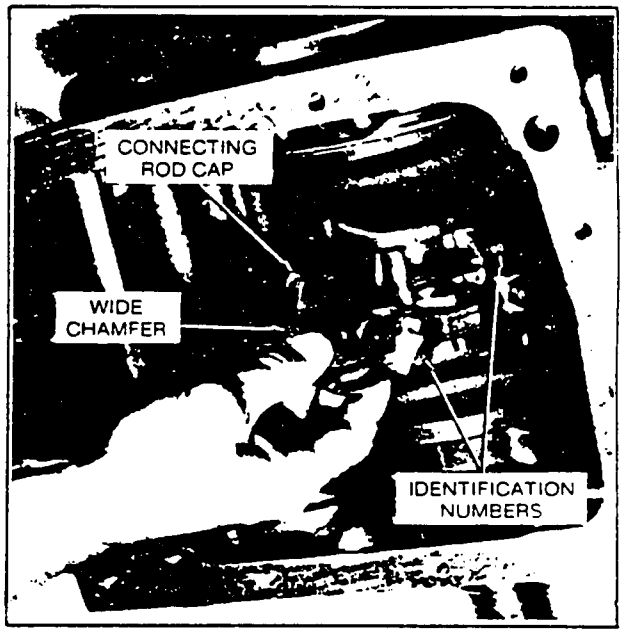


Fig. 63

Install ***new locknuts*** on connecting rod bolts and tighten to ***36 ft. lbs. torque.*** Total ***side clearance*** of both rods to the crankshaft is .009 to .018 inches. Evenly distributed this is approximately .003 to .006 inch between the two rods and to each side of the crank pin cheeks. If there is no clearance to either of the sides, then one of the rods is incorrectly mounted. *see Fig. 64.*

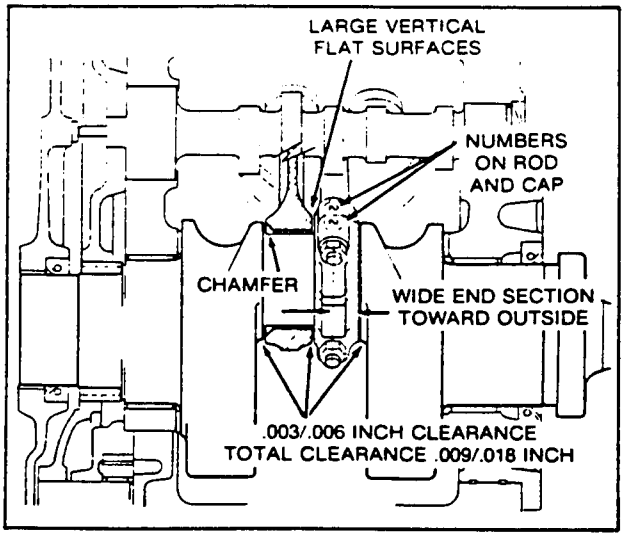


Fig. 64 CONNECTING ROD ASSEMBLY

FUEL PUMP, Fig. 65

The mechanical fuel pump illustrated in *Fig. 65* is standard equipment on these models of engines. The pump is driven off the camshaft — has a lift of 4 feet, and static pressure of 1 to 1½ lbs. above the outlet port when engine is operating at 1800 rpm.

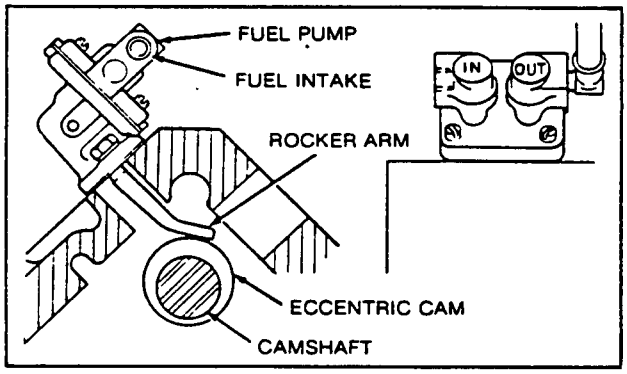


Fig. 65 FUEL PUMP

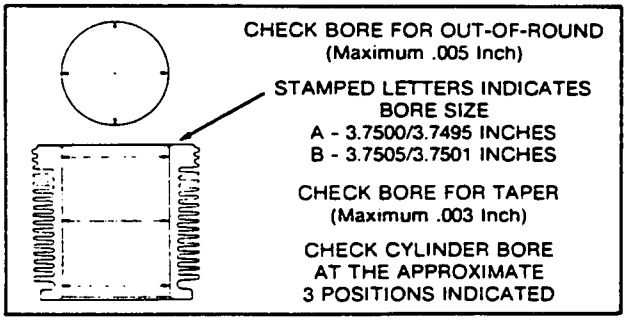


Fig. 66

After 500 hours of operation the efficiency of the pump may decrease. Check for rocker arm or cam wear, and inspect diaphragm for possible replacement. Refer to *Repair Instructions* in *Accessories Section* for further information.

Electric Fuel Pump rated at 2 to 3.5 *psi* at zero delivery is optionally available in place of mechanical pump. The pump is wired into the circuit per wiring diagram, *Fig. 30*.

CYLINDER BLOCKS, Fig's. 66, 67

Clean all dirt and foreign deposits from between the cylinder fins and manifold ports.

The cylinder blocks do not have to be removed unless the cylinder bore is scored, out-of-round, or worn oversize more than ***0.005*** inch. The standard cylinder bore sizes are as follows (inches):

A 3.7500/3.7495 dia.
B 3.7505/3.7501 dia.

For service replacement, cylinder blocks are stamped ***A*** and ***B***, on top between bore and valve ports, for selection with A and B marked pistons.

Cylinder blocks can be rebored and fitted with pistons and ring of .010", .020" and .030" oversize. It is recommended that this work be done by an authorized Teledyne Wisconsin Motor Distributor or Service Center.

In Reassembly; spacing and parallel alignment between intake port flanges of both cylinder blocks must be accurate enough to provide a secure fit to the intake manifold.

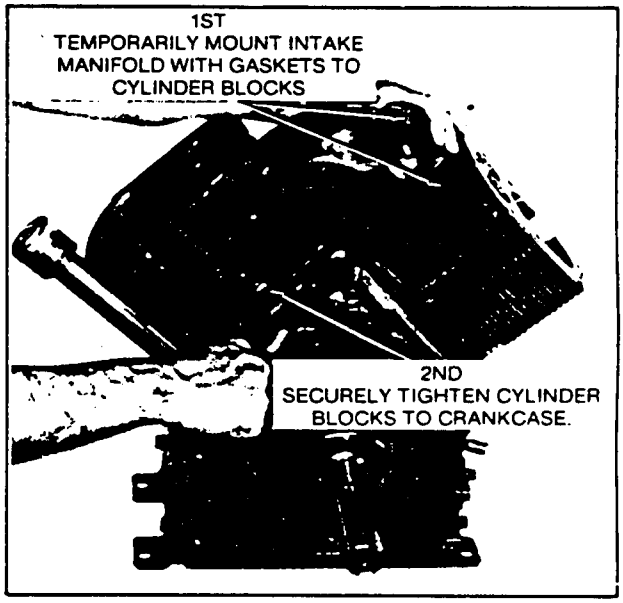


Fig. 67

With reference to *Fig. 67*, use manifold and gaskets as a gauge. Hand tighten manifold to cylinder block screws for alignment, then tighten the four cylinder block holddown nuts to ***47 ft. lbs. torque***. Tighten the cap screw in valve spring compartment to ***31 ft. lbs. torque***.

After securely mounting both cylinder blocks, remove manifold and gaskets for convenience in tappet adjustment and further parts assembly in the valley area.

VALVES and SEAT INSERTS

Take off the combination valve inspection cover and

breather assemblies from cylinder blocks. Insert a rag in the opening at the bottom of valve chamber so the retainer locks do not fall into the engine crankcase. By means of a standard automotive valve spring compressor as illustrated in *Fig. 68*, remove retainer locks. Release compressor tension lever and remove seat, spring and valve. Follow the same procedure for the other valves.

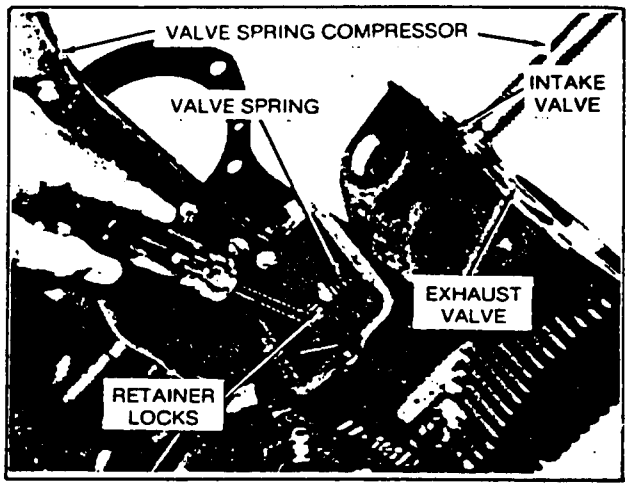


Fig. 68

Clean all parts, as well as the cylinder ports and guides, of all carbon and gum deposits. Tag each reusable valve so that they will be put back into the same guide they were removed from, in reassembly. Replace valves that are badly burned, pitted or warped.

Valve springs that are weak will spoil a good overhaul if they are not replaced. With reference to *Fig. 69*, check free length, compression strength and if both ends are parallel. Replace springs that are not within ***5 lbs.*** of the amount shown, when compressed to length when ***valve is open.*** Discard springs that show evidence of rust, and if they are not within 1/16 inch of being square.

In Reassembly: Mount valve springs with the damper coils against the cylinder block.

NOTE: Both ends of spring are ground square with 1.5 ***damper coils*** on one end only.

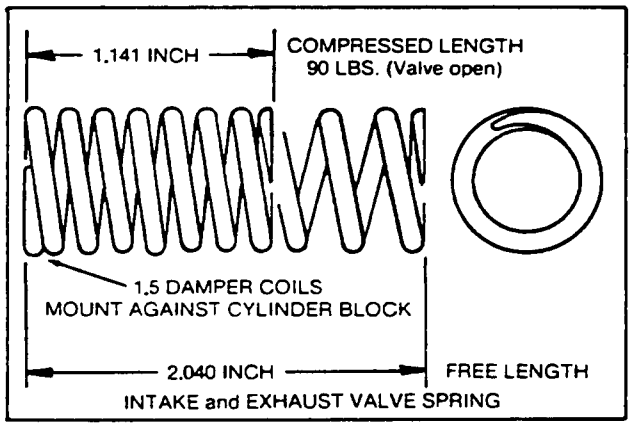


Fig. 69

Valve Rotators are furnished on the ***exhaust valves*** in place of the conventional valve seat. On some applications rotators are also furnished on the ***intake valves***. The same valve spring is used with or without valve rotator. The action of the rotator is to rotate the valve slightly each time the valve opens, helps prevent sticky valves and will impart a wiping action between the valve face and valve seat, thereby preventing the build-up of foreign deposits. Valve rotation will also avoid prolonged exposure of any one sector of the valve face to a local hot spot on the seat which will result in lower and more uniform valve face-seat temperatures. Clean and inspect operation of rotators — replace if faulty.

Seat Inserts for both intake and exhaust valves can be removed when replacement becomes necessary by means of a Wisconsin ***DF 68A*** insert puller, *See Fig. 70.* Maximum recommended seat width for replacement is .087 inches, *See Fig. 71.* The intake and exhaust seat inserts are identical in size, but the materials are different. The exhaust seat inserts are of a special ***long life*** heat resistant steel. For mounting seat inserts use Wisconsin ***DF 69*** insert driver.

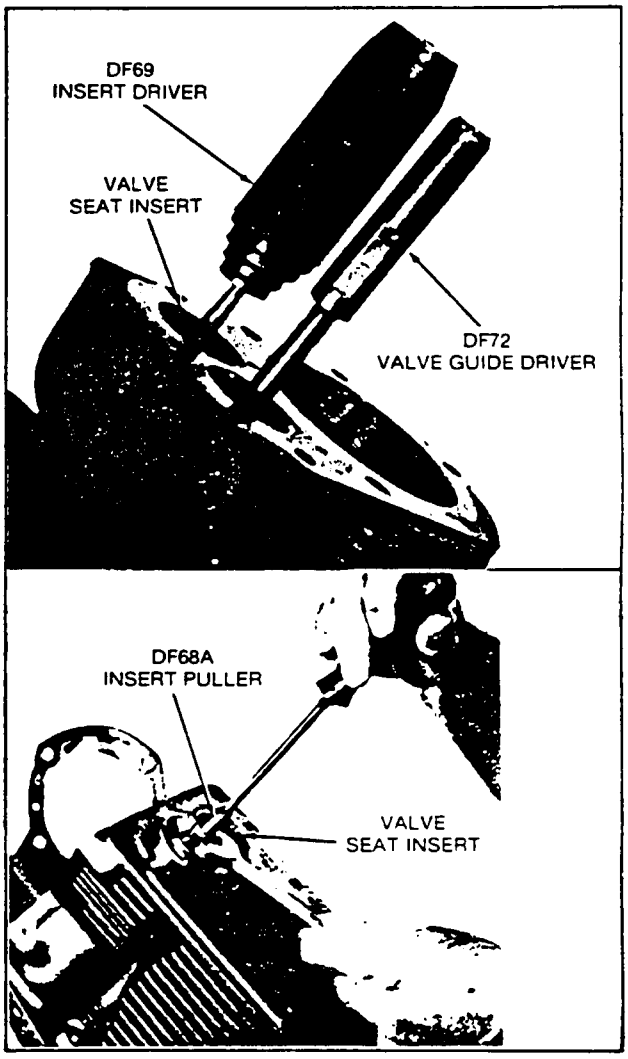
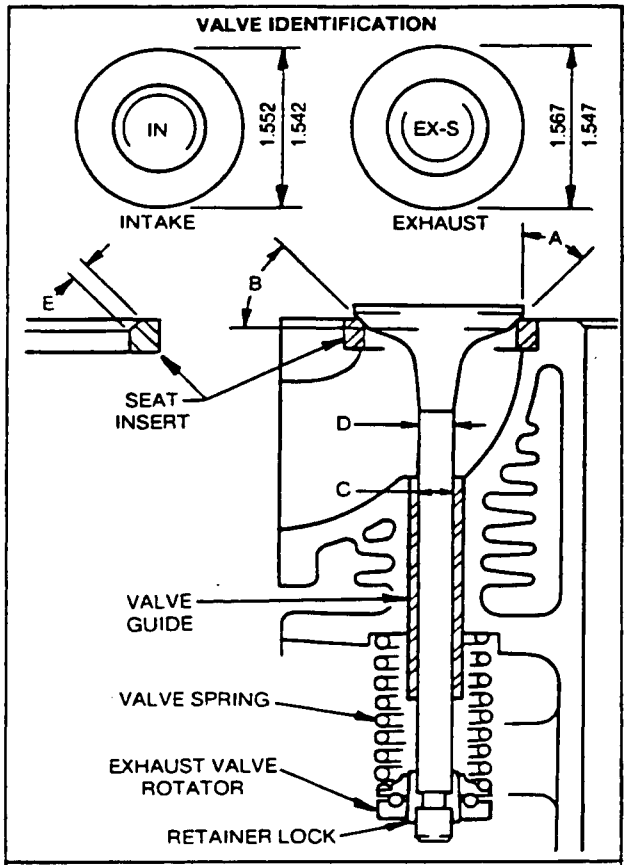


Fig. 70

Before grinding valves, inspect valve guides for possible replacement. Refer to *Valve Guide* paragraph. The valve face is ground at 45° to the vertical center line of the valve stem and the valve seat insert should also be ground at a 45° angle. ***After grinding***, lap valves in place until a uniform ring will show entirely around the face of the valve. Clean valves and wash block thoroughly with a hot solution of soap and water. Wipe cylinder walls with clean lint free rags and light engine oil, especially if cylinders were rebored and honed.



SPECIFICATIONS ARE FOR BOTH INTAKE AND EXHAUST		
A - Valve Face Angle	45°	
B - Seat Insert Angle	45°	
C - Guide Inside Diameter	.312/.313"	
D - Valve Stem Diameter	**Clearance**	**Wear Limit**
Intake - .310/.311"	.001/.003"	.002"
Exhaust - Lock End .308/.309"	.003/.005"	.002"
Exhaust - Head End .308/.307"	.004/.006"	.002"
E - Valve Insert Face	**Width** .057/.072"	**Max.** .087"

Fig. 71 VALVE and SEAT SPECIFICATIONS

Valves are approximately identical in size, but the material specifications are considerably different. The exhaust valves have a special ***long life*** heat resistant steel seat face, and is identified by the cast letters ***EX-S*** on the head. The intake valve has ***IN*** cast on the face and is to the left in the cylinder block — the exhaust valve is to the right. *See Fig's. 68 and 71.*

Valve guides in the cylinder block are easily replaceable by use of Wisconsin ***DF 72 driver tool.***

In Reassembly; mount guides as illustrated in *Fig. 71.* Maximum allowable clearance between valve stem and guide is .005 inch for intake valve, and .007 inch for exhaust valve. The inside diameter of the unassembled valve guide is .313/.314 inch. When pressed into the cylinder block, using DF-72 driver tool, the inside diameter should compress to an operating diameter of .312/.313 inches — ***if necessary ream to obtain the proper I.D.***

CAMSHAFT and VALVE TAPPETS

The valve tappets are cylindrical shaped and can be taken out from the top of the crankcase before the camshaft is removed. Tag tappets so that they can be reassembled back into the same holes that they were removed from. Camshaft and gear assembly can be taken out as a complete unit from the gear cover end of the crankcase as illustrated in *Fig. 72.*

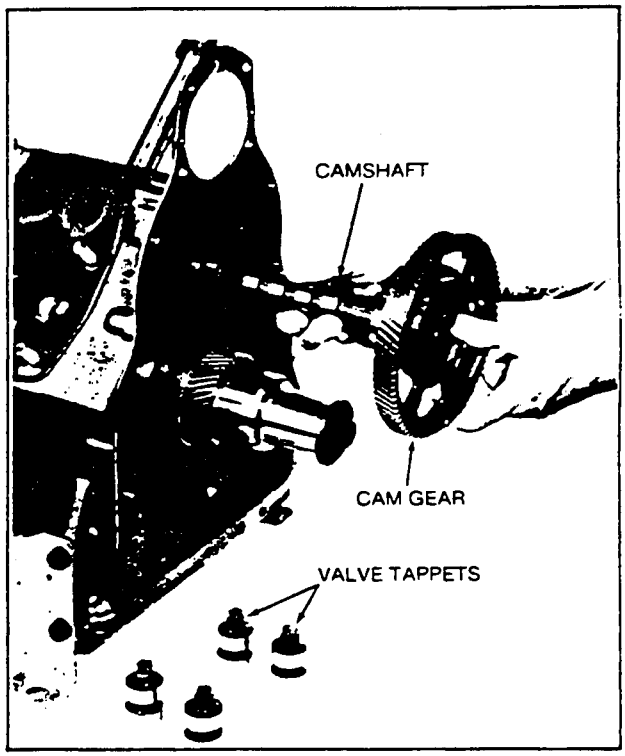


Fig. 72

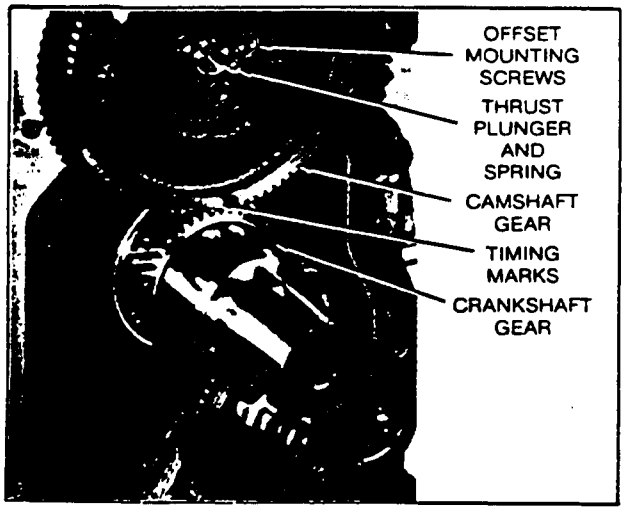


Fig. 73

In Reassembly; check tappets, camshaft and gear for damage or excessive wear, replace if necessary. Refer to clearance and wear limits chart, *Fig. 74*. Check cam gear teeth backlash with a dial indicator as illustrated in *Fig. 75*. The backlash should not be less than .003 inch nor more than .006 inch.

Camshaft Gear can be removed if necessary by taking out the three mounting screws and applying a gear puller. ***In Reassembly;*** align the gear mounting holes with the camshaft tapped holes (offset spacing for accurate mounting). Thread mounting screws, with lockwashers, in place and alternately turn them down to draw cam gear in place on camshaft. Tighten screws to ***18 ft. lbs. torque.***

Timing Mark (drill point) in space between gear teeth on cam gear must match up with a similar ***marked gear tooth*** on crankshaft gear for accurate timing. Assemble accordingly and per *Fig. 73* illustration.

CAMSHAFT and VALVE TAPPETS CLEARANCE and WEAR LIMITS (inches)

Description		Original Dimension	Clearance	Wear Limit
Tappet Diameter		1.1247/1.1237	.0003/.0021	.001
Tappet Hole Diameter in Crankcase		1.1258/1.1250		
Camshaft Bearing Diameter-Small End		1.4980/1.4974	.0002/.0036	.002
Bearing Hole Diameter in Crankcase-Small End		1.501/1.500 (Fig. 80)		
Camshaft Bearing Diameter-Large End		2.0600/2.0593	.0025/.0044	.002
Bearing Hole Dia. in Crankcase-Large End		2.0637/2.0625 (Fig. 80)		
Cam Lift In. and Exh.	W2-1230	.331		±.005
	W2-1235	.370		
Tappet Screw Adjustment Torque 35 in. lbs. min.				

Fig. 74

Tappet Adjustment should be made after the cylinder block assemblies are in place, and before manifolding is mounted.

The clearance between valve stem and tappet adjusting screw should be:

Intake - .007 inch ***Exhaust - .020 inch***

Refer to page 13 and Fig. 23 for valve tappet adjustment procedure.

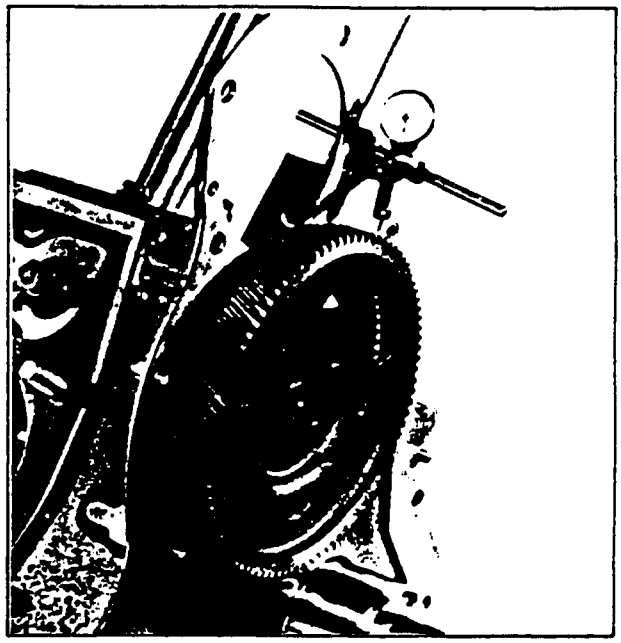


Fig. 75 CHECKING CAMSHAFT GEAR BACKLASH

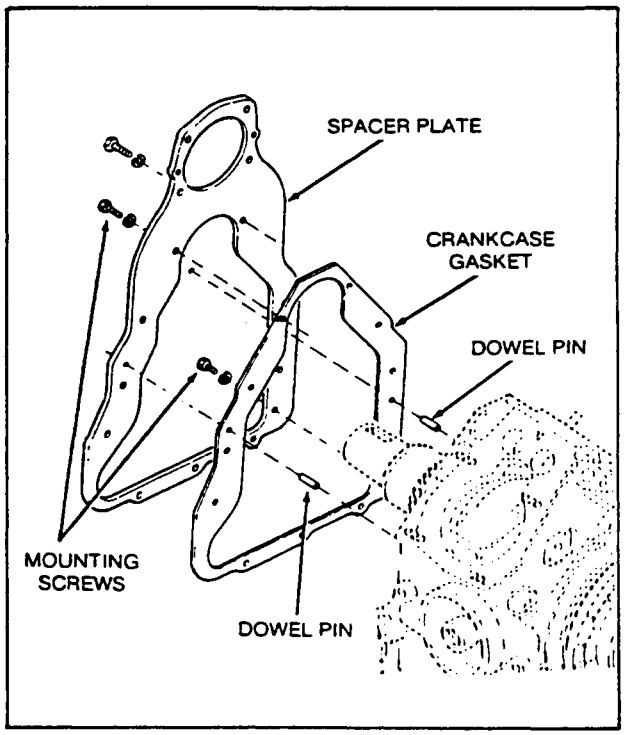


Fig. 76

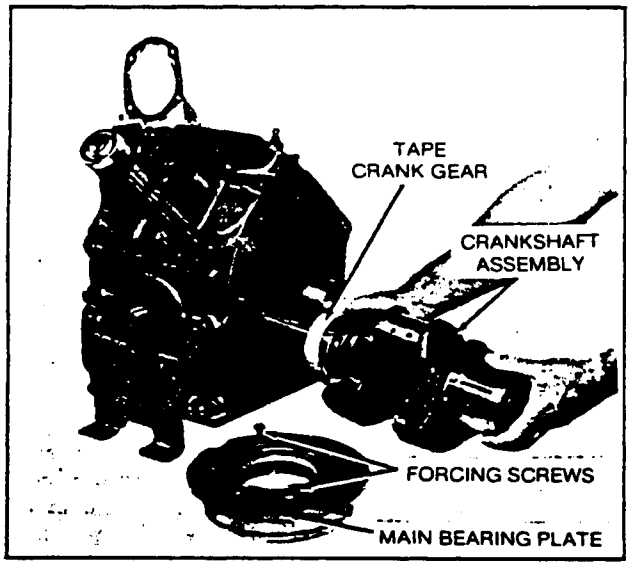


Fig. 77

SPACER PLATE, Fig. 76

If it is necessary to remove or replace the spacer plate; it is fastened to the crankcase with three capscrews, two at the cam gear location, and one in the lower left hand side.

In Reassembly; use a new gasket and hold in place on crankcase with a few dabs of grease. Tighten mounting screws to ***18 ft. lbs. torque.***

MAIN BEARING PLATE — Removal, Fig. 77

The power take-off shaft mounted to the rear end of the crankshaft must be removed before taking off the main bearing plate. Refer to *Fig. 36, page 25,* for stub shaft disassembly and reassembly procedures.

The bearing plate is doweled to the crankcase for bearing alignment. After removing the eight mounting screws and lockwashers, thread a 5/16"-18 x 1½" long capscrew into the two tapped holes in the face of the bearing plate. Alternately tighten them to loosen bearing plate from dowel pins. Take off main bearing plate along with crankshaft shims (if any), and thrust bearing. Check main bearing and thrust bearing for scuffing or excessive wear, see chart *Fig. 80.*

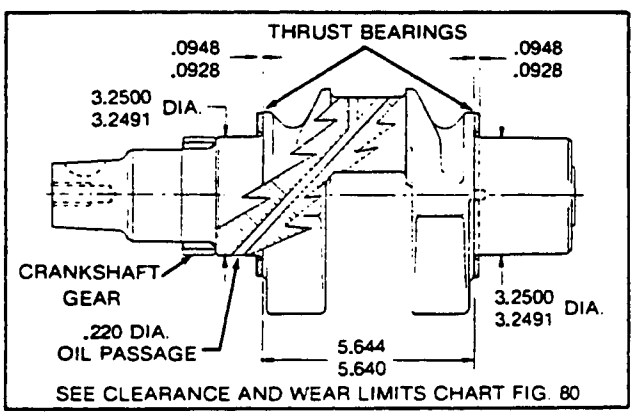


Fig. 78

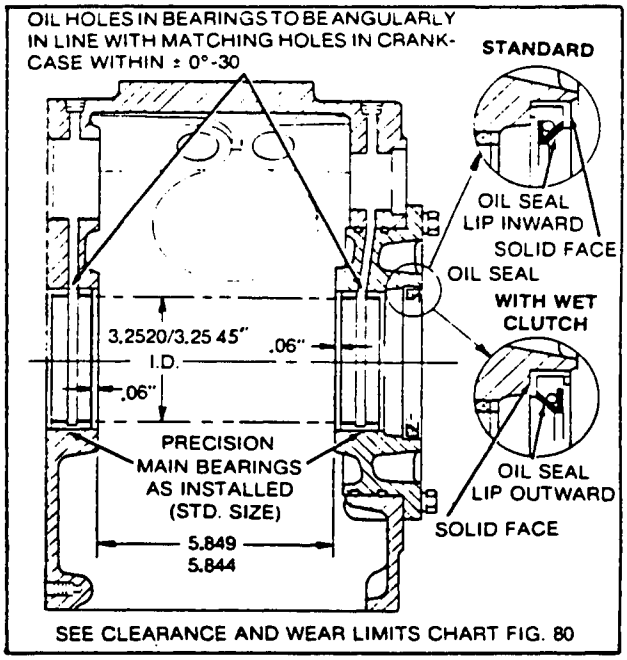


Fig. 79

CRANKSHAFT — Removal, Fig's. 77, 78

Wrap tape around crank gear teeth, and then remove crankshaft from crankcase being very careful not to damage main bearing in crankcase. Inspect connecting rod bearings per *Fig. 56, page 32,* and main bearings per *Fig. 79.* Clean out oil passages at main bearing, up and through to crank pin.

Remove thrust bearing from inside crankcase, inspect for scuffing or excessive wear.

CRANKCASE, Fig. 79

Clean out all oil passages to camshaft and main bearings. Check ***camshaft*** bearings for excessive wear per chart *Fig. 74* and illustration *Fig. 82.* Inspect ***main bearings*** in crankcase and bearing plate for wear and alignment per *Fig. 79* and specification chart *Fig. 80.*

For Service Replacement; standard size and .005 inch undersize bearings are available. These precision bearings do not require any machining after bearings are pressed in place.

IMPORTANT: The two oil holes in the main bearings must be aligned with the oil passages in crankcase and main bearing plate to within ±0°-30'.

The *Main Bearing Tool* included in *Kit TW1001* (Ref. 1, Fig. 34), is used to conveniently remove and install main bearings in both crankcase and main bearing plate.

Because the alignment of the main bearings is critical, the crankcase and main bearing plate for production engines are sub-assembled and the holes for the main bearings are line bored for accuracy. For ***service replacement of crankcase,*** a matched production engine bearing plate and crankcase complete with bearings is furnished.

To replace main bearing plate only, a semi-finished bearing plate can be furnished for ***line-boring*** with an existing crankcase, if machining facilities of this type are available. Oil seal counter-bore and pilot diameter machining are also required, and oversize dowel pins must be used. Refer to ***Main Bearing Plate*** paragraphs on *page 39*.

BEARING PLATE/CRANKCASE MAIN BEARING CLEARANCE and WEAR LIMITS (inches)

Description	Original Dimension	Clearance	Wear Limit
Crankshaft Main Bearing Diameter	3.2500/3.2491	.002/.005	.001
Crankcase Main Bearing Diameter	3.2520/3.2541		
Crankshaft Thrust Surface Length	5.644/5.640		
Crankcase/Thrust Brg. Surface Length	5.654/5.663	.010/.023	
*Available Shim Sizes to Obtain Proper Clearance (End Play)	.004/.006 and .010/.012	.005/.012 End Play	

Fig. 80

CRANKSHAFT/GEAR — Reassembly, Fig. 81

To replace crank gear — drill and chisel to split gear, being careful not to damage oil seal or main bearing surfaces on crankshaft. Scribe a mark on the crankshaft, not more than 9/16 inch long, from end of oil seal surface, and in line with center of flywheel keyway in shaft. ***Do not*** scribe into area where oil seal lips contact crankshaft — remove any scribe burrs.

Press new gear onto shaft, chamfer end forward, with the vertical centerline of any ***tooth exactly in line with scribe mark*** on oil seal surface and vertical centerline of engine crank pin. Add a prick punch ***Timing Mark*** to base of tooth face on vertical centerline, *see Fig. 81*.

IMPORTANT

Marked gear tooth must be in line with vertical centerline of crank pin to within .020 inch, or valve timing will be inaccurate for satisfactory engine operation.

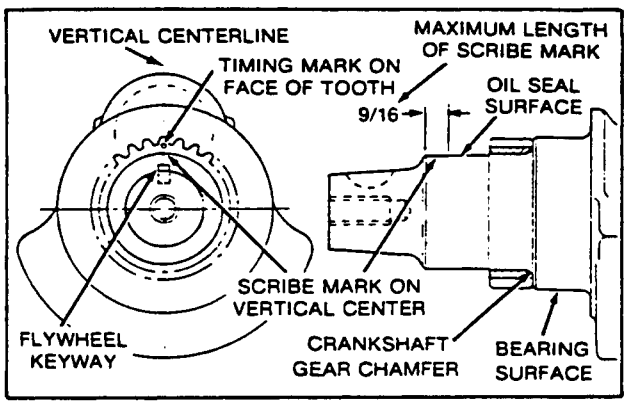


Fig. 81 CRANKSHAFT GEAR ASSEMBLY

Mount flywheel end thrust bearing with tabs inserted into retainer holes in crankcase. Apply oil to thrust bearing and crankshaft main bearing surfaces.

Wrap outside of crank gear teeth with tape, and then assemble crankshaft to crankcase through main bearing plate opening, being careful not to damage crankcase bearing, or scratch oil seal surface on crankshaft.

MAIN BEARING PLATE — Reassembly

Note: Finished bearing plates are not available for service replacement because of bearing alignment. Semi-finished bearing plates, which can be mounted to an existing crankcase and ***line-bored***, are available. See ***New Bearing Plate*** instructions following the next two paragraphs.

The main bearing plate oil seal and sleeve bearing, if replaced, are mounted per illustration *Fig. 79*. ***Oil Seal*** is normally assembled (standard), with ***lip inward*** and solid face toward the outside. On engines equipped with an oil operated clutch, the oil seal is reversed, with the lip facing outward. The same standard size and .005 inch undersize bearings used in the crankcase are also used in the main bearing plate. No machining is required after bearings are pressed in place.

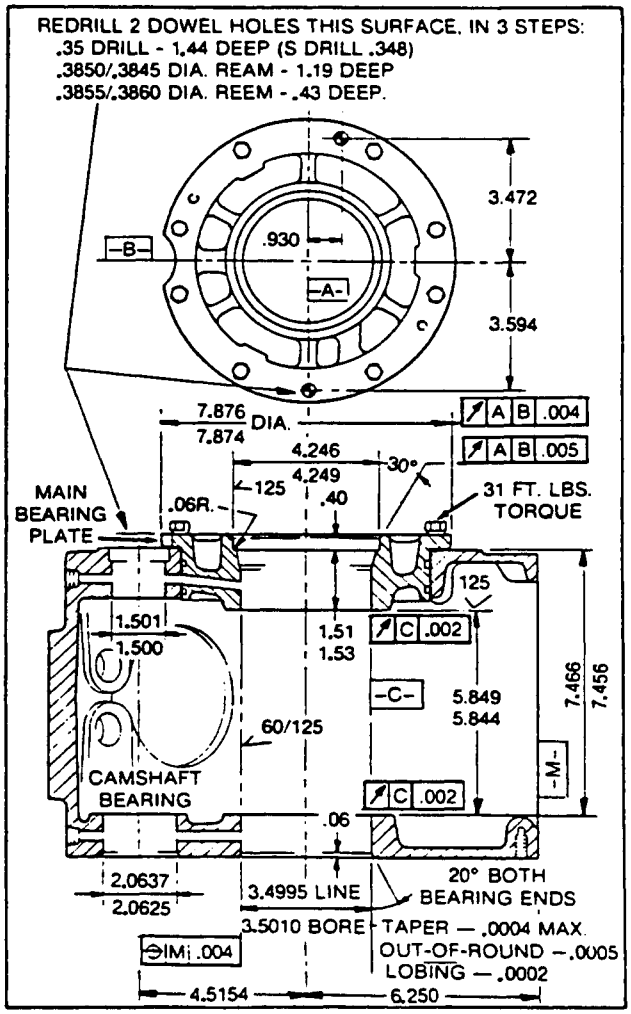


Fig. 82

Service Tool Kit TW 1001 (Fig. 34) contains tools for conveniently removing and installing main bearing and oil seal in the main bearing plate.

Temporarily mount bearing plate with shims (if used), and thrust bearing attached, but leave the two 'o' ring seals off. Torque mounting screws to ***31 ft. lbs.*** and proceed with *Crankshaft End Play* instructions.

New Bearing Plate (furnished semi-finished), used with an existing crankcase will have to be line-bored so that bearings are in complete alignment. With reference to *Fig. 82*:

1. Align the 2 drilled holes in semi-finished bearing plate with current reamed dowel holes in crankcase — mount bearing plate to case, less 'o' ring seals and shaft oil seal. Torque mounting screws to ***31 ft. lbs.***
2. Redrill the 2 dowel holes in three steps as follows (in inches):
   .35 dia. drill — 1.44 deep (S drill .348 dia.)
   .3850/.3845 dia. ream — 1.19 deep
   .3855/.3860 dia. ream — .43 deep
3. Tap two new PA-475 service dowel pins in place (.3853/.3851 dia. x 1¼ long).
4. Line-bore bearing plate with crankcase.
   3.4995/3.5010" Diameter.

Taper, hour glass or barrel	.0004" max.
Out-of-round	.0005" max.
Lobing	.0002" max.

5. Machine inside thrust face of bearing plate, counterbore for oil seal, and turn outside pilot diameter per dimensions shown in *Fig. 82*.
6. Clean crankcase/bearing plate and press in place the appropriate size main bearings and oil seal per *Fig. 79*. Check bearing alignment.
7. Remove bearing plate from crankcase. Add thrust bearings and assemble the crankshaft into crankcase. Remount bearing plate, less 'o' ring seals, and proceed to ***check end play***.

Crankshaft End Play is .005 to .012 inch with the engine at normal room temperature. Adjustment is made by the addition or removal of steel shims between the crankshaft thrust bearing and main bearing plate.

With reference to *Fig. 83*, check and adjust end play in the following manner.

1. Rap crankshaft from take-off end with a soft hammer so that crankshaft will shoulder against main bearing at gear cover end.
2. Rap crankshaft in the opposite end (from gear cover end) to seat against main bearing at take-off end.
3. Attach a Dial Indicator to the crankcase at the take-off end, and against the end of the crankshaft. Set dial at 0.
4. With a pry bar, wedge crankshaft toward gear cover end of crankcase — the movement of the crankshaft will register as end play on the indicator dial. Confirm the end play figures by repeating this sequence several times.

The end play adjustment shims are of two thicknesses —.010 to .012 inch and .004 to .006 inch. If end play is ***more than .012 inch***, add a corresponding thickness of shim —***less than .005 inch*** end play, remove shim.

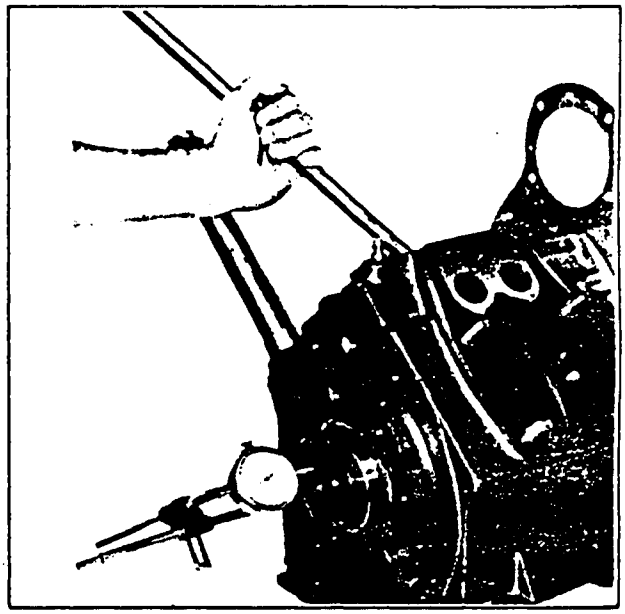


Fig. 83

After end play is finalized, remove bearing plate one more time and mount two new ***'o' ring oil seals*** to the outer body diameter. Gently tap bearing plate over the dowel pins to the crankcase face, being careful not to damage the 'o' ring seals and crankshaft oil seal. Mount capscrews with lockwashers and tighten to ***31 ft. lbs. torque***.

TESTING REBUILT ENGINE

An engine that has been rebuilt with new main bearings, connecting rod shell bearings and having cylinders re-bored or replaced, and fitted with new pistons, rings and valves, should go through a thorough "run-in" period before any load is applied to it.

The engine should be started and allowed to run for about one-half hour at about 1200 to 1400 R.P.M. without load. The R.P.M. should then be increased to engine operating speed, still without load, for an additional three and one-half to four hours.

The proper "running-in" of the engine will help to establish polished bearing surfaces and proper clearances between the friction areas of the newly replaced parts.

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. Replace oil filter and fill crankcase to proper level with the recommended grade of lubricating oil.

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.

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.	5	●				
CHECK AIR CLEANER. Shake out accumulated dirt from dry element cleaner - Maintain oil level in oil bath type cleaner.	7	●				
CLEAN AIR INTAKE SCREEN. Clean cooling fins if necessary.	10	●				
CLEAN AIR FILTER ELEMENT. Dry Element and Oil Bath types.	7		●			
CHANGE CRANKCASE OIL. Use grade and classification of oil recommended. In adverse conditions change oil every 50 hours of operation.	8			●		
REPLACE OIL FILTER every oil change.	8			●		
INSPECT CRANKCASE BREATHER SYSTEM. Clean if necessary.	8			●		
CHECK COMPRESSION. Pressure should not vary more than 10 p.s.i. between cylinders. Remove head - clean out carbon deposits. Reseat valves if necessary	22				●	
INSPECT SPARK PLUGS and BREAKER POINTS. Replace if necessary and regap to specification.	10 12				●	
INSPECT FUEL FILTER. Clean filter screen and glass bowl.	9				●	
LUBRICATE DISTRIBUTOR breaker arm pivot.	9				●	
INSPECT COOLING SYSTEM. Remove shrouding and scrape off dirt from between fins, around cylinders and from shrouding.	10				●	
INSPECT STARTING MOTOR. Check for loose mounting and cable connections.	10				●	
CHANGE OIL IN CLUTCH and REDUCTION GEAR HOUSINGS.	5,6					●

CLEARANCE and WEAR LIMITS (Inches) for Models W2-1230 and W2-1235

Description			Tolerance	Wear Limit
Cylinder Bore	A size		3.7500 3.7495	.005
	B size		3.7505 3.7501	
	Out of round		.0005	
	Taper		.003	
Cylinder Head	Flatness		.005	
Pistons	A size at skirt		3.7470 3.7465	.002
	B size at skirt		3.7475 3.7471	
	Clearance to bore		.0025 .0035	.003
Piston Pins	Red-dia. of pin		.8746 .8745	Clearance .0005 .0008
	Green-dia. of pin		.8745 .8744	
	Red-bore in piston		.87530 .87515	Wear limit .001
	Green-bore in piston		.87515 .87500	
	Piston pin to con. rod		.0006/.0015 tight	
Piston Rings side clearance in grooves	Top ring		.002/.004	.002
	Scraper ring		.002/.004	.002
	Oil ring		.0015/.0035	.002
	Ring gap		.010/.020	.005
Connecting Rods	Bearing to crank pin		.0011/.0036	.003
	Side clearance		.009/.018	.005
	Bore centers		7.559/7.555	—
	Bore align. (parallel)		.002	.004
Crankshaft	Crank pin diameter		2.100/2.099	.002
	Crank pin width		2.074/2.069	.003
	Main bearing dia.		3.2500/3.2491	.001
	Bearings parallel		.0002	.0004
	End play		.005/.012	Adj.
Crankcase	Main bearing I.D.		3.2541/3.2520	
	Clearance to crankshaft		.002/.005	.001
	Camshaft brg.-large		2.0637/2.0625	
	Camshaft brg.-small		1.501/1.500	
	Bearings out of round		.0005	
Camshaft	Bearing dia.-large		2.0600/2.0593	
	Clearance to case bore		.0025/.0044	.002
	Bearing dia.-small		1.4980/1.4970	
	Clearance to case bore		.0020/.0036	.002
	Cam lift	W2-1230	.331	±.005
		W2-1235	.370	

Description		Tolerance	Wear Limit
Governor	Gear shaft dia.	.5000/.4996	.002
	Shaft bearing I.D.	.501/.502	.002
	Clearance, shaft/brg.	.0010/.0024	.003
	Cross shaft dia.	.310/.309	.002
	Shaft bearing I.D.	.312/.313	.002
	Clearance, shaft/brg.	.002/.004	.003
	Thrust sleeve I.D.	.503/.505	.003
	Clearance to shaft	.0030/.0054	.006
Oil Pump	Pump housing I.D.	2.2555/2.2575	.002
	Rotor outside dia.	2.2500/2.2470	.002
	Clearance, rotor/hsg.	.0055/.0105	.003
	Pump housing depth	.6905/.6925	.002
	Rotor width	.6875/.6865	.001
	Clearance, rotor width	.003/.006	.002
	Clearance, rotor tip	.004/.006	.003
Tappets	Tappet diameter	1.1247/1.1237	.0005
	Bore in crankcase	1.1250/1.1258	.0005
	Clearance, tappet/bore	.0003/.0021	.001
	Valve stem to tappet clearance	IN. .007 EX. .020	Adj.
Valves	Valve guide I.D.	.312/.313	
	Stem dia.-INTAKE	.311/.310	
	Stem clearance, IN.	.001/.003	.002
	Stem diameter-EXH. lock end	.308/.309	
	Stem diameter-EXH. head end	.307/.308	
	EXH.-Stem clearance Lock end Head end	 .003/.005 .004/.006	.002
	Valve/Seat angle	45°	
	Insert face width	.057/.072	.015
	Valve spring	1.141 at 90 lbs.	-5 lbs.
Ignition	Distributor Breaker point gap	.020	Adj.
	Running spark advance B.T.D.C.	6° at 1800 rpm 22° at 3400 rpm	Adj.
	Spark plug gap Regular	.035	Adj.
	Spark plug gap Resistor	.030	

TORQUE SPECIFICATIONS FOR MACHINE HARDWARE
For Engine Models W2-1230 and W2-1235
Torque Values — Maximum Foot Pounds (Dry)

Wisconsin Part Number	Size Capscrew Unless Specified	Qty.	Application	Torque Foot Pounds
XB 114	#10-32 x 1¼ (socket head)	4	Alternator Stator to Gear Cover	1.5
XD 157	¼-20 x ½	4	Breather Cover Assembly to Cylinder Block	9
		8	Cylinder End Cover to Cylinder Cover	9
XD 188	¼-20 x ⅜ (self-tapping)	2	End Cover to Cylinder Head Cover	4
XD 180	¼-20 x ½ (self-tapping)	8	Cylinder Cover to Air Duct and Cylinder Head	4
XD 14	¼-20 x ⅝	1	Coil to Engine Support	9
XD 6	¼-20 x ¾	2	Starting Motor Bracket to Crankcase	9
		2	Fuel Pump to Crankcase	9
		2	Oil Pump Pick Up Tube to Cover	4
XD 184	¼-20 x ¾ (self-tapping)	10	Flywheel Shroud to Gear Cover	4
XD 186	¼-20 x ⅞	6	Cylinder Head Cover to Special Studs	9
XD 7	¼-20 x 1	3	Oil Pump to Crankcase	9
XD 8	¼-20 x 1¼	2	Oil Pump Relief Valve to Crankcase	9
XD 152	¼-20 x 1⅜	3	Oil Pump Cover to Body	4
PD 77	¼-20 Nut	1	Starting Motor Bracket to Starting Motor Stud	9
XD 15 B	5/16-18 x ¾	3	Spacer Plate to Crankcase	18
XD 181	5/16-18 x ¾ (self-tapping)	4	Air Duct to Gear Cover	7
		2	Instrument Panel Mounting	7
XD 19	5/16-18 x 1¼	3	Camshaft Gear to Camshaft	18
		6	Intake and Exhaust Manifolds to Cylinder Block	18
XD 182	5/16-18 x 1¼ (self-tapping)	4	Air Duct to Gear Cover	7
XB 116	5/16-18 x 1¼ (12 point drive)	8	Crankshaft Extension (stub shaft)	24
XD 22	5/16-18 x 1¾	12	Oil Pan to Crankcase	18
XD 23	5/16-18 x 2	9	Gear Cover to Crankcase	18
		2	Spacer to Gear Cover	18
XD 140	5/16-18 x 2¼	4	Governor Housing to Gear Cover	7
		2	Exhaust Manifold to Cylinder	18
PD 256	5/16-24 Nut (tensilock)	2	Carburetor to Intake Manifold	24
XD 27 A	⅜-16 x 1	8	Engine Supports to Crankcase	31
XD 29	⅜-16 x 1¼	8	Bearing Plate to Crankcase	31
		2	Cylinder Block Hold Down	31
		6	Optional Single Outlet Exhaust Manifold	31
XD 185	⅜-16 x 1¼ (self-tapping)	2	Starting Motor to Gear Cover	12
XD 31	⅜-16 x 1¾	10	Cylinder Head to Cylinder Block	36
PC 638	⅜-16 Stud	6	Cylinder Head to Cylinder Block	36
PD 247	⅜-24 Nut	4	Connecting Rod	36
PD 12	7/16-20 Nut	8	Cylinder Block Hold Down	47
XD 51	⅝-11 x 1¼	1	Flywheel to Crankshaft	115
YD 369 YD 369 A	M14 x 1.25	2	Spark Plug to Cylinder Head	18-22

ACCESSORIES

OPERATION and SERVICE INSTRUCTION

CARBURETOR

FUEL PUMP

Major repairs of Industrial Clutches, Transmissions, Ignition Distributor and Starting Motor require special tools and testing equipment. It is suggested that these repairs be done at either a Teledyne Wisconsin Motor Distributor, or the Accessory Manufacturer's dealer.

CARBURETOR OPERATION, REPAIR and SERVICE PARTS

WISCONSIN No. L118 WALBRO LHM-43 For Engine Model W2-1235
WISCONSIN No. L119 WALBRO LMH-44 For Engine Model W2-1230

NOTE: For obsolete L115 (LMH-34) refer to page 48.

OPERATION, Fig. 1

Fuel from supply tank flows to **float valve seat** (1), through **fuel valve** (2) and into **fuel bowl** (3). As the level in fuel bowl increases, the **float** (4) rises, shutting off fuel supply by forcing **fuel valve** (2) into seat. As fuel is being used, the float lowers and allows additional fuel to enter bowl through the fuel valve.

Fuel from the bowl enters the **main fuel jet** (5), then through and up to the **main nozzle** (7). At full throttle, fuel passes through **main nozzle** (7) where it is mixed with air from **nozzle air bleed** (8) and enters into **venturi** (9). At low idle speeds, fuel flows through the **idle jet** (10), up the **idle channel** (11), around **idle adjustment** (12) and into the **emulsion chamber** (13), where it is mixed with air entering the **idle air vent** (14). This air-fuel mixture then enters the throttle bore of carburetor through the outer **idle hole** (15). As the throttle is gradually opened, the inner hole starts to feed the throttle bore, and assists the **main nozzle** (7) in taking over the full throttle range.

When starting, the **choke valve** is closed and the **throttle valve** (16) is opened causing an abnormally high suction on both idle and main systems, thus providing a rich mixture for starting.

CARBURETOR TROUBLES — CAUSES AND REMEDIES

Dirt is the major cause of field service carburetor problems. An adequate Fuel Filter must be used between the tank and carburetor, and should be serviced frequently. Service Air Filter daily — Keep carburetor and linkage free of dirt.

FUEL LEAKS FROM CARBURETOR

Float level too high: See Fig. 2 and Float Setting Instructions page 47.

Dirt under inlet needle valve: Remove inlet valve, clean seat by rinsing in mild solvent or clean fuel, blow off with compressed air.

Bowl vent plugged: Remove bowl and blow thru body vent hole with compressed air.

Collapsed float, caused by blowing assembled carburetor with compressed air: Replace float.

Carburetor gummed from storage - float stuck: Remove fuel bowl and clean.

ENGINE SMOKES AND RUNS RICH

Dirty air filter: Clean per instructions.

Improper adjustment: Set Idle Needle 1 turn open from seat. Refer to Adjustment Instruction, page 47.

Bowl retainer gasket leaks: Tighten securely, or replace.

Air bleed in carburetor plugged: Remove fuel bowl and idle needle. Clean thoroughly with compressed air

ENGINE RUNS LEAN

Improper adjustment: Set Idle Needle 1 turn open from seat. Refer to Adjustment Instructions, page 47.

Idle holes plugged. Dirt in fuel delivery channels: Remove fuel bowl and idle needle. Clean thoroughly with compressed air

Low fuel level: See Fig. 2 and Float Setting Instructions, page 47.

Fuel filter plugged: Remove and clean.

ENGINE STARTS HARD

Improper adjustment: Set Idle Needle 1 turn open from seat. Refer to Adjustment Instructions, page 47.

No fuel in carburetor: Check carburetor drain valve. Clean tank, filter and carburetor. Check fuel lines for obstructions, and test fuel pump

Choke valve not closing: Check linkage for proper travel.

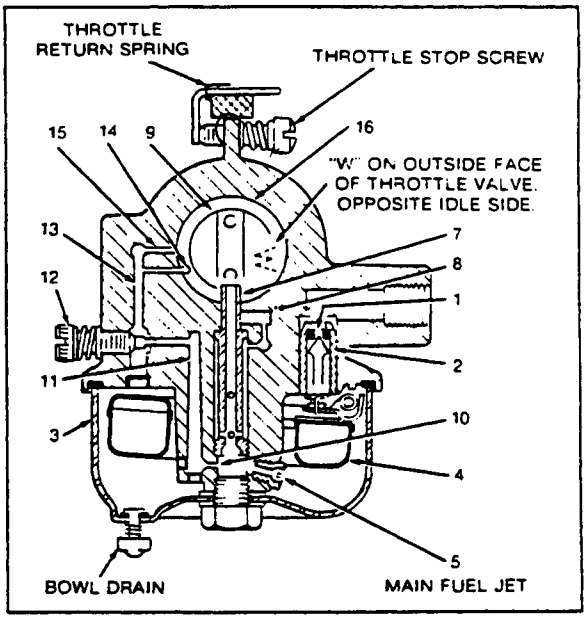


Fig. 1

GOVERNOR SURGE

Governor sticking: Check linkage for binding.

Throttle shaft and valve binding: Remove and replace shaft if worn. Clean carburetor body and reassemble throttle shaft.

DISASSEMBLY

Before disassembling: Clean outside of carburetor from all foreign material.

CAUTION: When cleaning a completely assembled carburetor, **do not** blow with compressed air, you may collapse the float.

DO NOT soak or boil carburetor or body in chemical solutions. Idle channel is permanently sealed — solution will seep in and cause corrosion. Use a mild solvent, fuel oil or kerosene.

Disassemble parts in the following sequence: Refer to exploded view, page 47.

1 Bowl retainer screw	(4)	10 Choke valve screws	(18)
2 Retainer gasket	(5)	11 Choke valve	(22)
3 Fuel bowl	(2)	12 Choke shaft	(19)
4 Fuel bowl gasket	(3)	13 Throttle valve screws	(18)
5 Float shaft	(7)	14 Throttle valve	(17)
6 Float and spring	(6 8)	15 Throttle shaft	(14)
7 Fuel valve-spring	(9)	16 Throttle shaft seal	(16)
8 Idle needle assembly	(11)	17 Throttle return spring	(15)
9 Throttle stop screw	(13)		

Viton seal for fuel valve can be replaced if necessary. Pull out by means of a small hook on the end of a wire paper clip

Clean throttle shaft seal in fuel oil or kerosene and dry. Re-oil with No. 30 weight oil or equivalent

REASSEMBLY

Wash all other parts with carburetor cleaning solvent and blow off with compressed air

Install choke shaft and valve. Mount valve with part number toward the outside with the valve in a closed position.

Mount throttle valve, with letter "W" on valve facing outward and opposite idle side of carburetor. Make certain valve plate does not bind when opening and closing throttle. Be sure that return spring tension holds throttle valve closed.

Viton fuel valve seat; press firmly in place with groove end toward seat hole.

Tighten main fuel jet (25) to 12-16 inch pounds torque and Bowl Screw (4), to 30-35 inch pounds.

FLOAT SETTING, Fig. 2

Mount all other parts in reverse order of disassembly. Hook fuel valve spring under float adjustment tab, and float support spring as illustrated in fig. 2. Float should be .030/.070 inch from top of body casting rim — bend adjustment tab to raise or lower fuel level — Float drop should be ± .060 inch from end of nozzle boss.

ADJUSTMENTS, Fig. 3

Turn idle speed screw (13) in, until throttle valve is slightly open. With engine warmed up and running, turn adjusting screw in or out as required to obtain desired low idle speed (1000 to 1200 r.p.m.).

The idle adjusting needle (11) should be seated lightly (clockwise), then backed out 1 ± 1/8 turns as a preliminary setting. With engine warmed up and running at about 1200 R.P.M., fine tune idle mixture for smooth steady running.

The Main Metering Jet (25) for high speed operation is fixed (not adjustable).

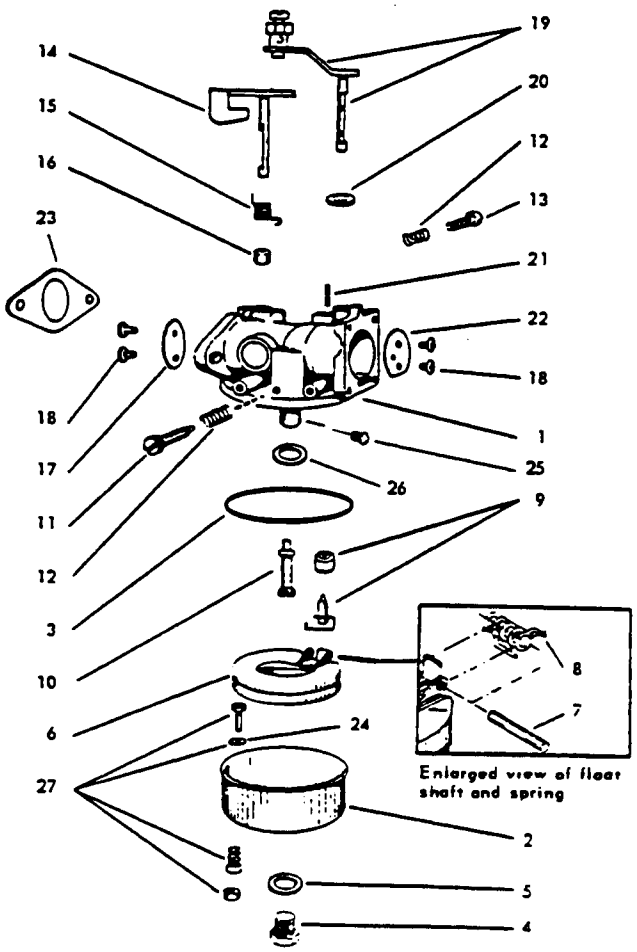


Fig. 3, EXPLODED VIEW

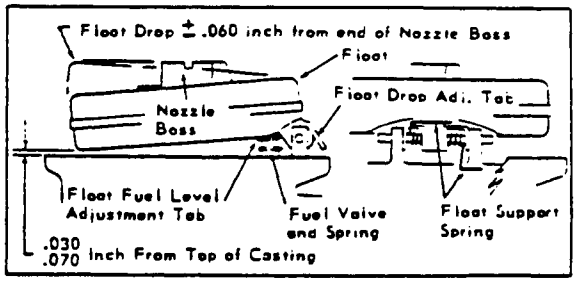


Fig. 2, FLOAT SETTING

ADJUSTABLE MAIN JET for high altitude operation is available for service.

Part No. *83-100-540*

Includes: (1) Fiber washer
(1) Adjustable needle assembly

Remove and discard gasket (5) and screw (4). Replace with 83-100-540 Adjustable Needle Assembly.

SERVICE PARTS LIST

Wisconsin Part No's. L 118 (LMH-43) and L 119 (LMH-44).
Parts are identical for both carburetors except where noted

Item No.	Part Number	Description	Qty.
1		THROTTLE BODY (not served)	1
2	83-20-513	FUEL BOWL with drain assembly	1
3	*	GASKET - fuel bowl	1
4	83-96-155	SCREW - fuel bowl retainer	1
5	*	GASKET - fuel bowl retainer (outer)	1
6	83-75-502	FLOAT - assembly	1
7	†	SHAFT - float	1
8	†	SPRING - float support	1
9	†	FUEL VALVE and VITON SEAT	1
10	83-86-244	NOZZLE - main, for L118	1
	83-86-261	NOZZLE - main, for L119	1
11	†	NEEDLE - idle	1
12	†	SPRING - idle needle, and stop (1 in Kit)	2
13	83-96-18	SCREW - throttle stop, 10-32 x 5/8 Fill. hd.	1
14	83-30-887	THROTTLE SHAFT assy — incl. items 15, 16	1
15	83-98-240	SPRING - throttle return	1
16	83-156-18	SEAL - throttle shaft	1
17	83-34-18	VALVE - throttle	1
18	83-96-263	SCREW - throttle and choke valve No. 4-40 x 3/16 Pan head	4
19	83-40-796	CHOKE SHAFT - assembly with swivel	1
20	83-156-21	SEAL - choke shaft	1
21	83-98-13	SPRING - choke stop	1
22	83-62-50	VALVE - choke	1
23	*	GASKET - flange	1
24	*	GASKET - bowl drain	1
25	83-114-0740†	JET - main fuel, for L118 (LQ57)	1
	83-114-0700†	JET - main fuel, for L119 (LQ58)	1
26	*	GASKET - fuel bowl to body (inner)	1
27	83-154-503	KIT - bowl drain	1
	Q51†	GASKET SET (also included in Repair Kit) *Parts included in Q51 Gasket Set	
	LQ57	REPAIR KIT, for L118	1
	LQ58	REPAIR KIT, for L119 †Parts included in Repair Kit	1

CARBURETOR OPERATION, REPAIR and SERVICE PARTS

WISCONSIN No. L 115 WALBRO No. LMH-34 For Engine Model W2-1230

(OBSOLETE) Replaced by L 119, interchangeable as a complete unit.

CAUTION Do not remove nozzle (Ref. 10) from carburetor unless replacing it with a new **service nozzle** — idle holes will not line up. Tighten 15 to 20 inch pounds torque. Use a proper fitted tool to prevent damage to slot in nozzle head.

Mount throttle valve, with letter "W" on valve facing outward and opposite idle side of carburetor. Make certain valve plate does not bind when opening and closing throttle. Be sure that return spring tension holds throttle valve closed.

Viton fuel valve seat; press firmly in place with groove end toward seat hole.

Tighten **main fuel jet** (4), to 35 inch pounds torque.

FLOAT SETTING, Fig. 2

Mount all other parts in reverse order of disassembly. Hook fuel valve spring under float adjustment tab, and float support spring as illustrated in fig. 2. Float should be .030/.070 inch from top of body casting rim — bend adjustment tab to raise or lower fuel level.

ADJUSTMENTS, Fig. 3

Turn **idle speed screw** (13) in, until throttle valve is slightly open. With engine warmed up and running, turn adjusting screw in or out as required to obtain desired low idle speed (1000 to 1200 r.p.m.)

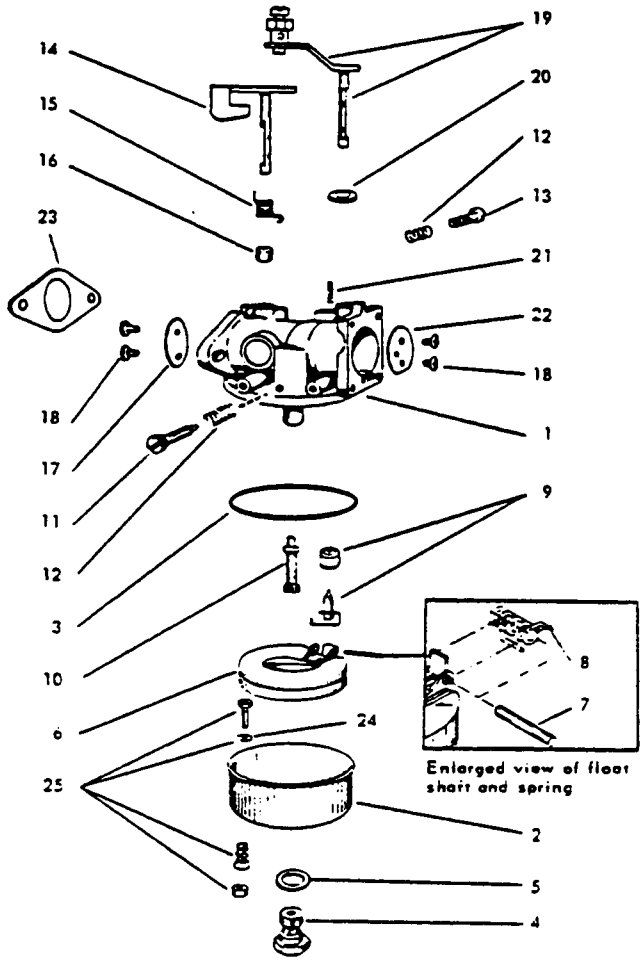


Fig. 3, EXPLODED VIEW

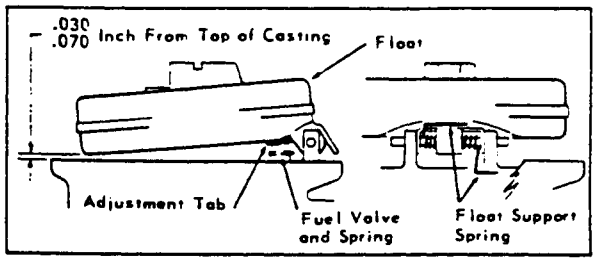


Fig. 2, FLOAT SETTING

The **idle adjusting needle** (11) should be seated lightly (clockwise), then backed out 1 ± 1/8 turn as a preliminary setting. With engine warmed up and running at about 1200 R.P.M., fine tune idle mixture for smooth steady running.

The **Main Metering Jet** (4), for high speed operation is fixed (not adjustable).

SERVICE PARTS LIST

Item No.	WISCONSIN PART NO. L 115	Description	Qty.
		WLBRO PART NO. LMH-34	
1		**THROTTLE BODY** (not serviced)	1
2	83-20-513	**FUEL BOWL** with drain assembly	1
3	*	**GASKET** — fuel bowl	1
4	83-112-6661	**MAIN FUEL JET** (.066)	1
5	*	**GASKET** — main jet, bowl retainer	1
6	83-75-502	**FLOAT** — assembly	1
7	†	**SHAFT** — float	1
8	†	**SPRING** — float support	1
9	†	**FUEL VALVE and VITON SEAT**	1
10	83-86-174	**NOZZLE** — main (service)	1
11	†	**NEEDLE** — idle	1
12	†	**SPRING** — idle needle and stop (1 in Kit)	2
13	83-96-18	**SCREW** — throttle stop 10-32 × .. Fil. hd.	1
14	83-30-887	**THROTTLE SHAFT** assy — incl. items 15, 16	1
15	83-98-240	**SPRING** — throttle return	1
16	83-156-18	**SEAL** — throttle shaft	1
17	83-34-18	**VALVE** — throttle	1
18	83-96-263	**SCREW** — throttle and choke valve No. 6-32 × 3/16 Pan head	4
19	83-40-796	**CHOKE SHAFT** — assembly with swivel	*
20	83-156-21	**SEAL** — choke shaft	1
21	83-98-13	**SPRING** — choke stop	*
22	83-62-70	**VALVE** — choke	*
23	*	**GASKET** — flange	*
24	*	**GASKET** — bowl drain	*
25	83-154-503	**KIT** — bowl drain	*
	† Q 50	**GASKET SET** (also includes * Repair Kit) * Parts included in Q 50 Gasket Set.	
	LQ 56	**REPAIR KIT** * Parts included in LQ 56 Repair Kit.	

LP-62 series FUEL PUMP

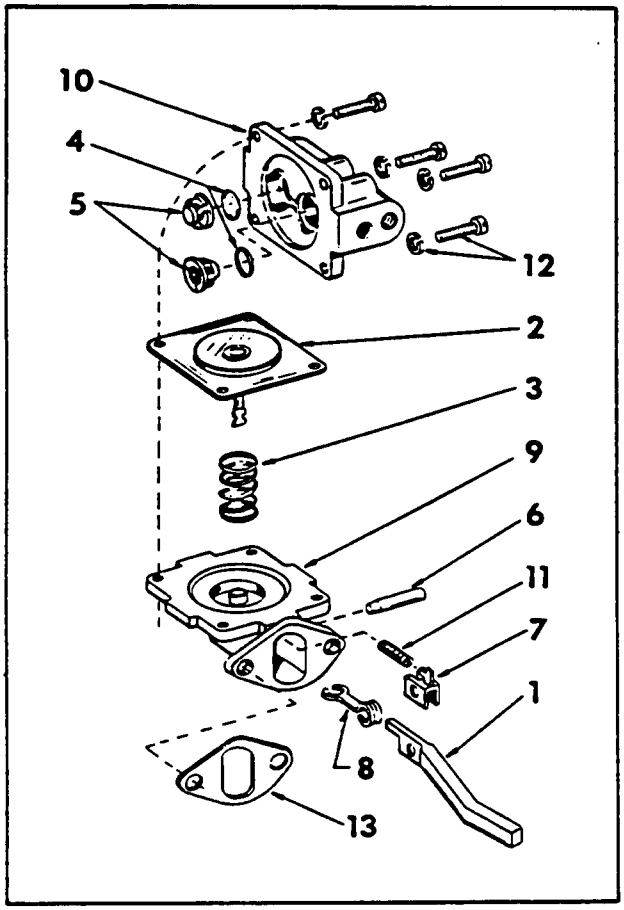
REPAIR INSTRUCTIONS

For single and two cylinder engine models

PART NO.	ENGINE USED ON
LP 62 A	THD, TJD
LP 62 B	ACN, BKN, AENL
LP 62 C	MTHD
LP 62 D	AGND
LP 62 E	S-7D
LP 62 F	S-10D, S-12D, S-14D
LP 62 G	S-8D, TRA-10D, TRA-12D
LP 62 A4	W2-1230, W2-1235

The fuel pump, like all other parts of the engine, is subject to wear and you will find that any time after 500 hours of use, its efficiency will gradually decrease. This is indictated by the engines faltering at high speeds or when heavy loads are suddenly applied. The pump can easily be restored to its normal efficiency by the installation of a Wisconsin LQ-51 Diaphragm Kit.

1. Disconnect fuel lines from pump and remove fuel strainer if mounted to pump. Remove fuel pump from engine housing by taking out the two mounting screws.
2. File a groove across a point at the union of castings (9 and 10). This is a positive location of the fuel INLET and OUTLET positions when reassembling. Remove four head to bracket screws (12) and remove fuel head (10).
3. Turn fuel head (10) over, remove and discard both valve assemblies, noting their positions.
4. Clean fuel head thoroughly with kerosene or diesel fuel and a fine wire brush.



5. Hold fuel head (10), with diaphragm surface up, place two valve gaskets (4) into covities where valves were removed. Press valve assemblies (5) in evenly without distortion, and stake in place.
6. Set fuel head assembly aside and proceed to rebuild lower diaphragm section.
7. Insert the end of a small screw driver into the coils of rocker arm spring (11), remove and save.
8. Hold mounting bracket (9) in the left hand, with the rocker arm toward your body and the thumb nail on the end of link (8). With the heel of right hand on diaphragm (2), compress the diaphragm spring (3), and at the same time turn in a clockwise direction 90°. This will unhook the diaphragm from link (8) so it can be removed.
9. Clean the mounting bracket (9) with kerosene or diesel fuel and a fine wire brush.
10. Place the new diaphragm operating spring (3) into bracket (9). Repeat in reverse order paragraph eight, using the new diaphragm. Replace rocker arm spring (11) removed in paragraph seven.
11. Mount this assembly back on the engine in the position from which it was removed, using the new flange gasket (13), which is the last piece of the repair kit.
12. Crank the engine over to a position where the diaphragm (2) is laying flat on the mounting bracket (9). Place the fuel head (10) back in position so that the indicating marks of step one are in line, and start the four head screws approximately three turns. Again, crank the engine over to a position where diaphragm (2) is pulled down into mounting bracket (9) to its lowest position. Securely tighten the four head screws (12).
13. Mount fuel strainer to fuel pump, if applicable, and connect fuel lines.

NOTE: The LQ-51 Diaphragm Kit and the parts included therein, which are identified by an asterisk (*), are the only parts of the fuel pump available for service.

Ref. No.	Description	No. Req.
1	ROCKER ARM	1
* 2	DIAPHRAGM ASSEMBLY	1
* 3	DIAPHRAGM SPRING	1
* 4	VALVE GASKETS	2
* 5	VALVE and CAGE ASSEMBLY	2
6	PIN for rocker arm	1
7	SPRING CLIP for rocker arm	1
8	LINK for diaphragm spring	1
9	MOUNTING BRACKET	1
10	FUEL HEAD	1
11	SPRING for rocker arm	1
12	SCREW and WASHER for head mounting	4
*13	GASKET for mounting flange	1

INSTALLATION INSTRUCTIONS (Solid State Ignition)

PRE-INSTALLATION CHECKS

1. Visually inspect plug wires, coil wire, distributor cap and rotor. Replace any components that show deterioration. It is especially important that the cap and plug wires be in good condition if a high output coil is used.
2. Check for loose or poor connections in ignition circuit. Check battery terminals for corrosion and loose connections.
3. Check battery voltage with engine off. It should be in the area of 12 to 14 volts.
4. The following procedure applies only to those installations where an external ballast resistor or resistance wire is used in the primary ignition circuit. Using a jumper wire, or clip lead, connect the minus (−) side of the coil to ground. Turn the ignition switch on. Read the voltage from the positive (+) side of the coil to ground. This voltage must not be less than 6.0 volts. If it is less than 6.0 volts the red or white wire from the module will have to be connected to the ignition switch side of the ballast resistor (Point A in Figure 2).

NOTE: In most circuits that use an external ballast resistor, this resistor is bypassed during starting putting the full battery voltage to the positive (+) terminal of the coil. ***In those cases where an external ballast resistor is used and it is not bypassed during starting, the red or white wire from the module will have to be connected to the ignition switch side of the ballast resistor (Point A in Figure 2) regardless of the voltage read at the positive (+) terminal of the ignition coil in the procedure above.*** In all cases the black wire remains connected to the minus (−) side of the ignition coil.

1. Make sure ignition switch is off. For added safety disconnect negative terminal from battery.
2. Remove distributor cap and gasket from distributor (1). Leave high voltage wires connected in the distributor cap.
3. Check side play in top distributor bearing. Excessive side play will cause erratic performance and must be corrected before installing IGNITOR.
4. Install adapter plate (5) in the same holes where the points were located. Using the flat head screw (6) provided, secure the adapter plate. ***DO NOT TIGHTEN.*** The Pan Head screw (7) is to hold the ground strap and the adapter plate. Leave both screws snug, not tight.
5. Install wire harness. For part number MIC0065600 the wire must be laced back under the breaker plate. Figure (1). For part number MIC0065650, the wires are to be looped around the inside diameter of the Distributor. In both cases, the grommet is to be inserted in the slot (8) in the distributor case. The wire length inside the distributor can be adjusted by pulling one wire at a time through the grommet.

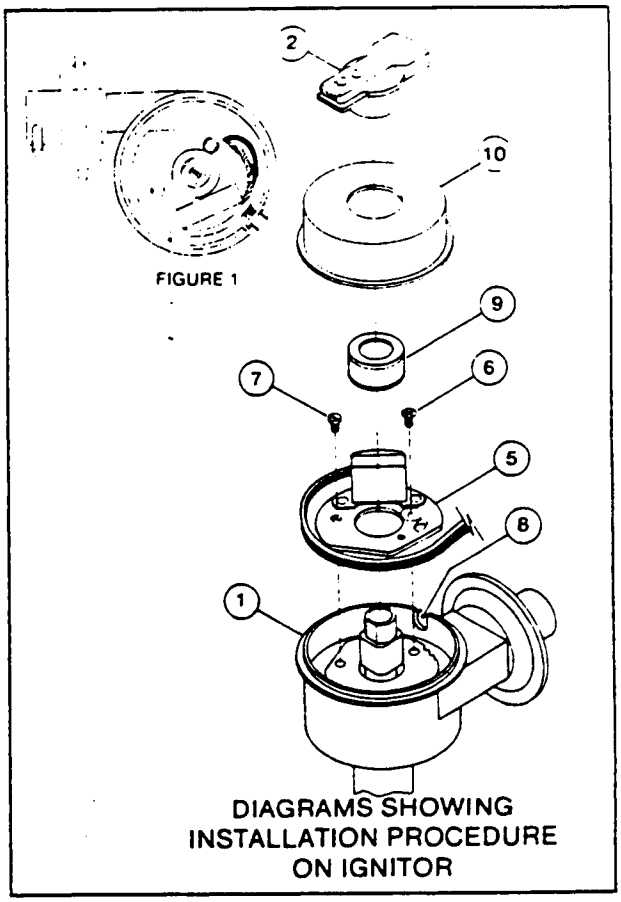


Fig. 1

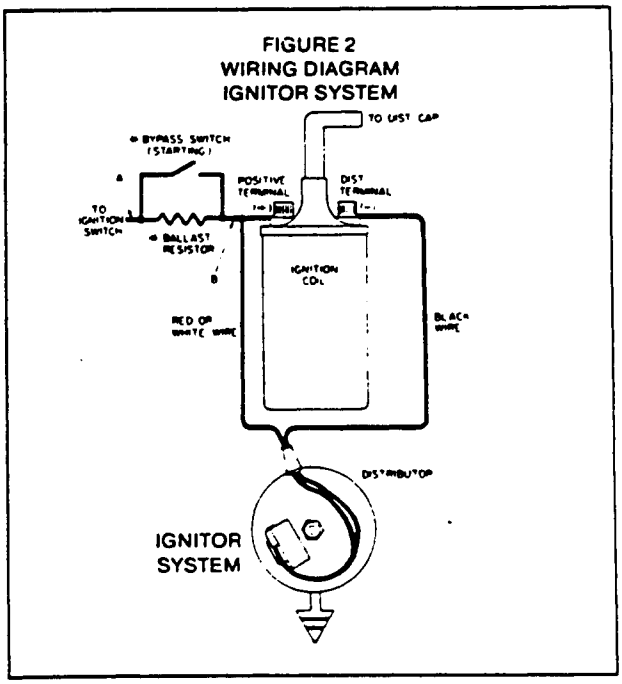


Fig. 2

6. Install IGNITOR magnet sleeve (9) over cam on distributor shaft. Locate on cam and press firmly into position. NOTE: Sleeve fits tightly over cam. It may be necessary to use the rotor to press over cam (rotate it until a slight locating position can be felt) before pressing it into place. Press all the way on until fully seated.

7. With magnet sleeve installed, adjust gap between magnet sleeve and module. This is done by pulling the module away from magnet sleeve. A gap of .015" to .030" is desirable. ***Make sure IGNITOR module does not hit magnet sleeve.*** Once gap is correct, tighten the two screws.

8. Install dust cap (10) making sure step in dust cover is locked into detent in distributor where wire harness goes through housing wall (8) and reinstall rotor (2).

9. Replace distributor cap and gasket. Make sure all high voltage wires are securely seated.

10. Connect the black wire to the distributor (−) side of the ignition coil. For installations that do not use a primary ballast resistor, connect the white wire to the ignition (+) side of the ignition coil. For installations that use a primary ballast resistor, it is preferable to connect the white wire to the ignition switch side of the resistor, rather than to the ignition (+) side of the coil. For installations that use a primary ballast resistor, AND THIS RESISTOR IS NOT BY-PASSED DURING STARTING, the white wire must be connected to the ignition switch side of the ballast resistor.

11. The engine can now be started. Let the engine run for a few minutes and then set the timing in the conventional manner. It will be worth the time to set the timing exactly, as it will never have to be reset.

TESTING

If the vehicle will not start after installation or vehicle quits after starting, the following test may be done to check the system.

1. Connect the positive (+) lead of a voltmeter to the negative (−) side of the ignition coil. Connect the negative (−) lead of the voltmeter to ground. Set the voltmeter to DC volts on at least a 15 volt scale.
2. Disconnect the high voltage wire from the center of the distributor cap and ***ground*** it to the engine block or chassis.
3. Crank engine.
4. The voltmeter should fluctuate from a range of 1 to 2 volts to a range of 10 to 12 volts as the engine is cranked.
5. If the voltmeter does not fluctuate, one of the following problems exist:
   a. If the voltmeter shows a constant 0 reading, there is an open circuit somewhere in the primary ignition circuit.
   b. If the voltmeter shows a constant voltage in the 1.0 to 3.5 volts range, the power transistor is shorted out.
   c. If the voltmeter shows a constant voltage equal to the battery voltage, there is an open circuit in the Ignitor or the Hall cell is not operating.

FOREWORD

This Repair Manual includes operating instructions, maintenance, adjustments, disassembly and reassembly procedures for the basic engine and accessories. Application of this information will help to obtain maximum engine performance, keep repair costs to a minimum and add years of service to the life of your **Wisconsin** engine.

Because **Wisconsin** engines are used on so many different types of equipment, and built to such a variety of specifications, the illustrations and information contained may not exactly suit all applications, but are typical for this particular model. Also, continued engineering for the improvement of our product may reflect changes in your engine which may not have been included at the time of this publication.

Teledyne Wisconsin Motor stands behind its engines with a world-wide network of more than 2200 Engine Distributors and Service Centers in over 90 countries. Should there be a need for specific data relative to the service of your engine, contact your nearest Teledyne Wisconsin Motor Distributor or Service Center — he is listed in the Yellow Pages of the Telephone Directory under ENGINES — GASOLINE.

MODEL	
SPEC NO.	
SERIAL NO.	

Copy this info from the Engine Name Plate. The Model, Spec No. and Serial No. must be given when requesting specific engine information and when ordering Service Replacement Parts.

MM-396 **Parts Catalog** should be used in conjunction with this Repair Manual. The exploded illustrations will help to identify parts and will present a visual order of reassembly.

IMPORTANT SAFETY NOTICE

Proper maintenance, adjustments and repair are very important for safety and reliable engine operation. It is impossible to evaluate and advise of all the conceivable ways in which service work should be done, or of the unsafe consequences of each way. Use common sense, and satisfy yourself that what you are doing will not jeopardize your safety, the safety of others, or damage to the engine.

Read instructions thoroughly before making any adjustments and repairs. Acquaint yourself with the parts and how they operate. When operating the engine, strictly follow the **Safety Precautions** on page 2, and any additional safety measures suggested by the manufacturer of the equipment the engine is used on.

Limited Engine Warranty

TELEDYNE WISCONSIN MOTOR, herein referred to as 'Teledyne Wisconsin , warrants each new Wisconsin 4-cycle air-cooled engine sold by Teledyne Wisconsin 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 Teledyne Wisconsin will, at its option, replace or repair, at one of Teledyne Wisconsin's factories, or at a point designated by Teledyne Wisconsin, any part or parts which shall appear to the satisfaction of Teledyne Wisconsin upon inspection at such point, to have been defective in material or workmanship. This warranty does not obligate Teledyne Wisconsin 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 used in a manner not recommended by Teledyne Wisconsin, nor to any engine which shall have been repaired, altered, used in any type of competition, nor operated other than within Teledyne Wisconsin Motor specified limits, neglected or used in any way which, in Teledyne Wisconsin's opinion, adversely affects its performance: nor to any engine in which parts not supplied or approved by Teledyne Wisconsin 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.

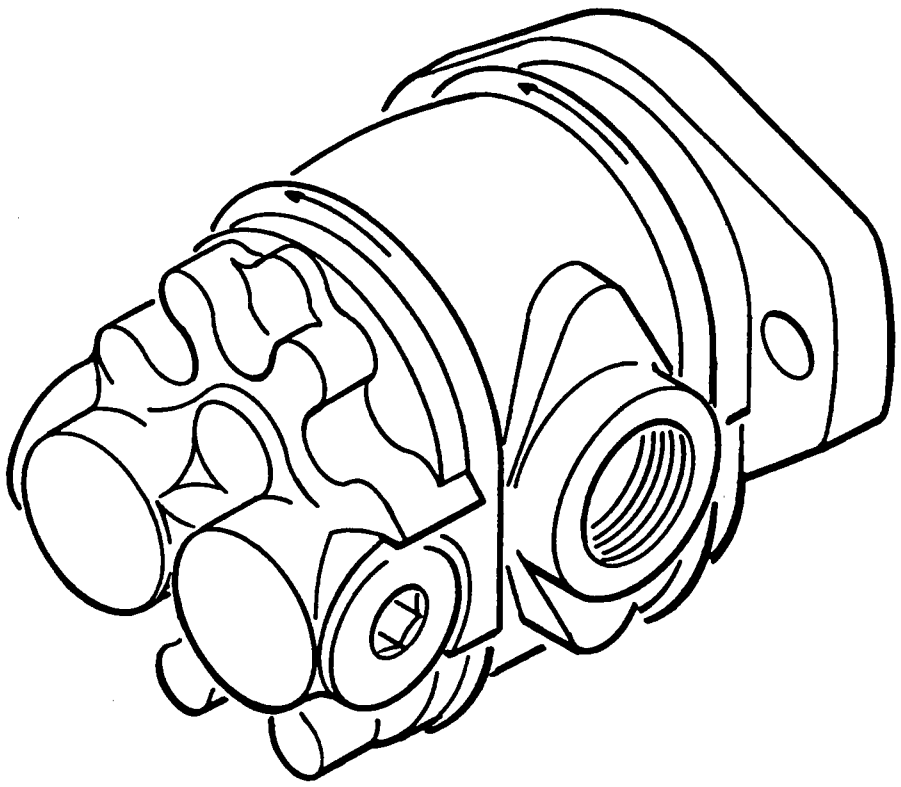
Teledyne Wisconsin reserves the right to modify, alter, and improve any engine or parts without incurring any obligation to replace any engine or parts previously sold with such modified, altered, or improved engine or parts.

THIS WARRANTY, AND TELEDYNE WISCONSIN'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 Teledyne Wisconsin's behalf unless made in writing and signed by an officer of Teledyne Wisconsin.

TELEDYNE WISCONSIN MOTOR

MILWAUKEE, WISCONSIN 53219

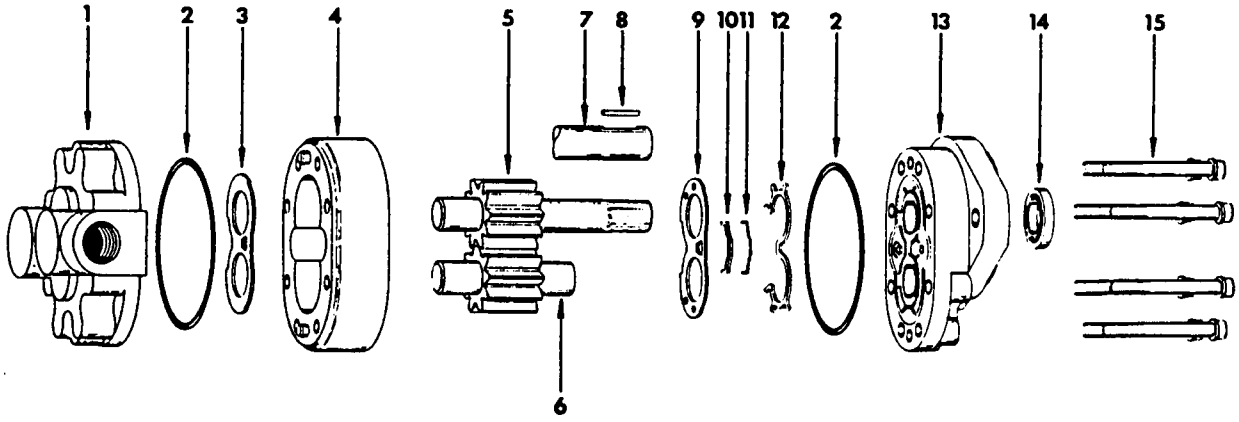
Service Manual



Model 25300 High Pressure Gear Pump

Inspection/Servicing

SINGLE PUMP



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.	REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Back plate assembly	1	9	Wear plate	1
2	O-ring	2	10	Bearing seal	1
3	Optional thrust plate	1	11	Molded o-ring	1
4	Body	1	12	Back-up gasket	1
5	Spline drive gear assy.	1	13	Front plate assy.	1
6	Idler gear assy.	1	14	Shaft seal	1
7	Keyed drive gear assy.	1	15	Cap screw	8
8	Key	1			

Note: For pumps with Flow Divider, Flow Control or Relief Valve backplates refer to page 7.

DISASSEMBLY

1. Remove key (8) from drive shaft if keyed drive gear assembly (7) is used.
2. Thoroughly clean outside of pump.
3. Use sharp tool to mark across front plate, body and backplate. This will assure proper reassembly.
4. Clamp pump in vise, shaft up.
5. Remove cap screws (15) eight each.
6. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front plate (13) from back plate (1). Body (4) will remain with either front plate or backplate.
7. If backplate was removed first, remove optional thrust plate (3) from body gear pockets (4). If the front plate was removed first, remove wear plate (9) from body gear pockets (4).
8. Remove drive gear assembly (5) or (7) and idler gear assembly (6) from body (4).
9. To separate body (4) from the plate it remains with, place drive gear assembly (5) or (7) in bushing and tap protruding end with plastic hammer or rawhide mallet.
10. Remove o-ring (2) from front plate (13) and backplate (1).
11. Remove back-up gasket (12) from front plate (13) by prying with a sharp tool.
12. Remove bearing seal (10) from front plate (13) by prying with a sharp tool.
13. Remove molded o-ring (11) from front plate (13).
14. Remove shaft seal (14) from front plate (13) by prying with a screwdriver.

INSPECT PARTS FOR WEAR

GENERAL

1. Clean and dry all parts.
2. Remove all nicks and burrs from all parts with emery cloth.

GEAR ASSEMBLY

1. Check drive shaft spline for twisted or broken teeth or check keyed drive shaft for broken or chipped keyway.
2. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.
3. If shaft measures less than .748 in bushing area, the gear assembly should be replaced. (one gear assembly may be replaced separately; shafts and gears are available as assemblies only.)
4. Inspect gear face for scoring and excessive wear.
5. If gear width is below the following figures — the gear assembly should be replaced.

Pump Disp.	.50	.66	.84	1.02	1.20	1.37	1.54	1.69	1.87
Gear Width	.384	.510	.636	.762	.888	1.014	1.140	1.266	1.392

6. Be sure snap rings are in grooves on either side of drive and idler gears.
7. If edge of gear teeth are sharp, break edge with emery cloth.

FRONT AND BACKPLATE

1. Oil groove in bushings in both front plate and backplate should be in line with dowel pin holes and 180° apart. This positions the oil grooves closest to respective dowel pin holes.
2. If I.D. of bushings in front plate or backplate exceed .755 front or backplate should be replaced. (Bushings are not available as separate items.)
3. Bushings in front plate should be flush with face of front plate.
4. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.

BODY

1. Check inside gear pockets for excessive scoring or wear.
2. Body should be replaced if I.D. of gear pockets exceeds 1.713.

GENERAL INFORMATION

It is important that the relationship of the backplate, thrust plate, body, wear plate and front plate is correct. You will note two half moon cavities in the body which must face away from the front plate. Note: The smaller half moon port cavity must be on the pressure side of the pump. Side of thrust plate and wear plate with mid section cut out must be on suction side of pump. Suction side of backplate is always side with larger port boss.

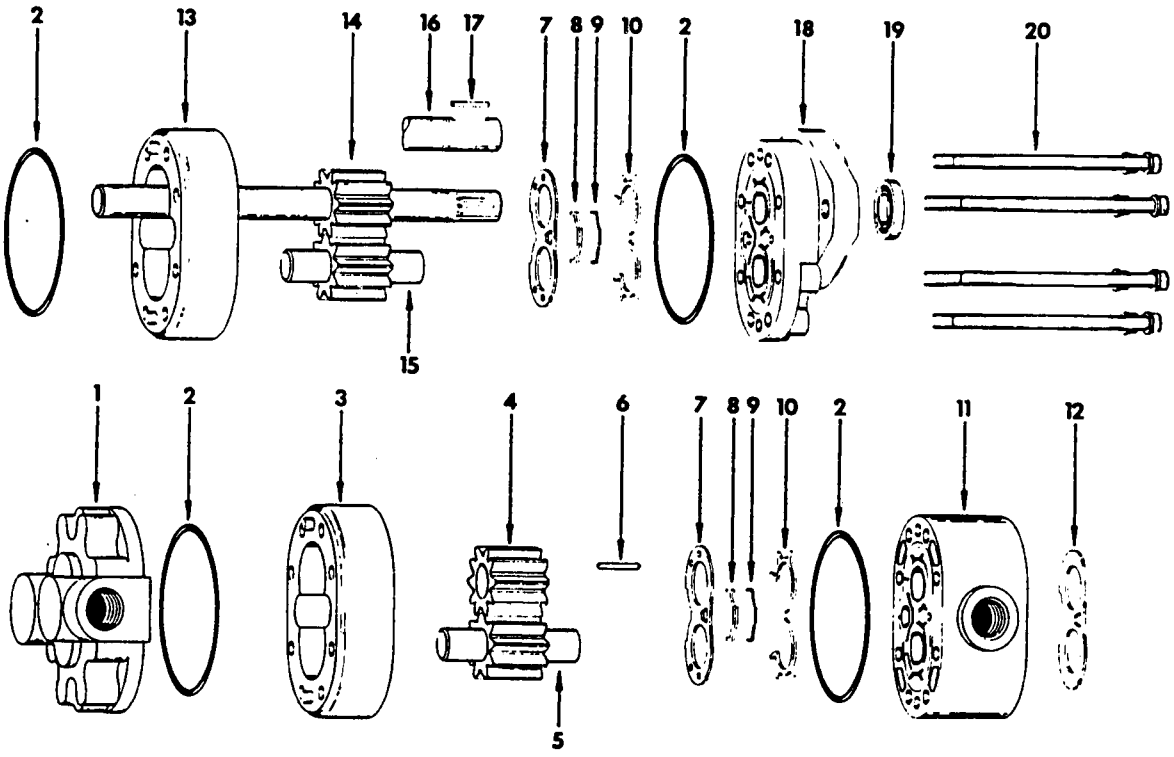
REASSEMBLY

1. The optional thrust plate, wear plate, bearing seal, molded o-ring, back-up gasket, shaft seal and o-rings should be replaced as new parts.
2. Install o-ring (2) in groove of front plate (13).
3. Tuck back-up gasket (12) into groove in front plate (13) with open part of "V" section down.
4. Place molded o-ring (11) in groove in front plate. Place bearing seal (10) over molded o-ring — groove side down.
5. Apply a thin coat of heavy grease to both milled faces of body. Slip body onto front plate — half moon port cavities in body must face away from front plate.

   Note: The small half moon port cavity must be on the pressure side of pump.
6. Place wear plate (9) on top of back-up gasket with bronze face up. The side with the mid section cut away must be on suction side of pump. (Be sure to note difference between wear plate (9) and optional thrust plate (3).
7. Dip gear assemblies into oil and slip into front plate bushings.
8. Install optional thrust plate (3) — bronze face toward gears. The side with mid section cut out must be on suction side of pump. Thrust plate must fit inside gear pockets.
9. Install o-ring (2) in groove in backplate (1).
10. Slide backplate (1) over gear shafts until dowel pins are engaged.
11. Install bolts (15). Tighten evenly to 25/28 ft. lbs. torque.
12. Liberally oil shaft seal (14) and carefully work over drive shaft being careful not to cut rubber sealing lip.
13. Place 1-5/16" O.D. sleeve over shaft and press in shaft seal (14) until flush with front surface of front plate.
14. Install key (8) on keyed shaft (7).

Note: Refer to Trouble Shooting and Start-up Procedure on page 6.

DOUBLE PUMP



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.	REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Back plate assembly	1	11	Adapter plate	1
2	O-ring	4	12	Optional thrust plate	1
3	Rear body	1	13	Front body	1
4	Gear (slip fit)	1	14	Spline drive gear assy.	1
5	Idler gear assy. (rear)	1	15	Idler gear assy. (front)	1
6	Round key	1	16	Keyed drive gear assy.	1
7	Wear plate	2	17	Key	1
8	Bearing seal	2	18	Front plate assy.	1
9	Molded o-ring	2	19	Shaft seal	1
10	Back-up gasket	2	20	Cap screw	8

Note: For pumps with Flow Divider, Flow Control or Relief Valve backplates refer to page 7.

DISASSEMBLY

1. Remove key (17) if keyed drive gear assembly (16) is used.
2. Clean outside of pump thoroughly.
3. Use sharp tool to scribe a mark across all sections of the pump. This will assure proper reassembly.
4. Clamp pump in vise, shaft up and remove cap screws (20) eight each.
5. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front pump sections. Body (13) will remain with either front plate (18) or adapter plate (11).
6. Remove idler gear (15) from either front plate or adapter plate.
7. Remove backplate (1) from body (3) by tapping on backplate with plastic hammer or rawhide mallet.
8. Remove idler gear (5), slip fit gear (4) and key (6). Remove drive gear assembly (14 or 16) from adapter plate. Remove optional thrust plate (12) from adaptor plate (11).
9. Place drive gear assembly in bushing and tap protruding end with plastic hammer or rawhide mallet to remove bodies (3) or (13) from plates they remained with.
10. Remove wear plate (7) from front plate (18).
11. Remove wear plate (7) from adapter plate (11).
12. Remove o-rings (2) from front plate (18), adapter plate (11), and backplate (1).
13. Remove back-up gasket (10), bearing seal (8) and molded o-ring (9) from front plate (18) and adapter plate (11) by prying out with a sharp tool.
14. Remove shaft seal (19) from front plate (18) by prying with a screwdriver.

INSPECT PARTS FOR WEAR

GENERAL

1. Clean and dry all parts.
2. Remove nicks and burrs from all parts with emery cloth.

GEAR ASSEMBLY

1. Check drive shaft spline (14) for twisted or broken teeth or check keyed drive shaft (16) for broken or chipped keyway. Check for broken keyway in shaft where slip fit gear is installed for double pump.
2. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.
3. If shaft measures less than .748 in bushing area, the gear assembly should be replaced. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only. The slip fit gear is available separately).
4. Inspect gear face for scoring and excessive wear.
5. If gear widths are below the following figures the gear assembly should be replaced.

Pump Disp.	.50	.66	.84	1.02	1.20	1.37	1.54	1.69	1.87
Gear Width	.384	.510	.636	.762	.888	1.014	1.140	1.266	1.392

6. Be sure retaining rings are in grooves on either side of drive and idler gears.
7. If edge of gear teeth are sharp, break edge with emery cloth.

FRONT PLATE, BACKPLATE & ADAPTER PLATE

1. Oil gooves in bushing in both front plate, backplate and adapter plate should be in line with dowel pin holes and 180° apart. This positions the oil grooves closest to the respective dowel pin holes.
2. If I.D. of bushings in front plate, backplate or adapter plate exceed .755 the front plate, backplate, or adapter plate should be replaced. (Bushings are not available as separate items).
3. Bushings in front plate and back-up gasket side of adapter plate should be flush with face.
4. If optional thrust plates are not used check for scoring on face of backplate and adapter plate. If wear exceeds .0015 backplate or adapter plate should be replaced.

BODY

1. Check inside gear pockets for excessive scoring or wear.
2. Body should be replaced if I.D. of gear pockets exceed 1.713.

GENERAL INFORMATION

It is important that relationship of the backplate, body, wear plate and front plate is correct. You will note two half moon cavities in the body which must face away from the front plate. Note: The smaller half moon port cavity must be on the pressure side of the pump. Side of thrust plate and wear plate with mid section cut out must be on suction side of pump. Suction side of backplate is always side with larger port boss.

REASSEMBLY

1. Optional thrust plate, wear plates, bearing seals, molded o-rings, back-up gaskets, shaft seal and o-rings should be replaced as new parts.
2. Install o-rings (2) in groove of front plate (18), adapter plate (11), and backplate (1) with a small amount of grease to hold in place.
3. Tuck back-up gasket (10) in front plate (18) and adapter plate (11) with open part of "V" section down.
4. Place molded o-ring (9) in groove in front plate and adapter plate. Place bearing seal (8) over molded o-ring, groove side down.
5. Apply a thin coat of heavy grease to both milled faces of body. Slip body onto front plate-half moon port cavities in body must face away from front plate. Note: The small half moon port cavity must be on the pressure side of pump.
6. Place wear plate (7) on top of back-up gasket with bronze face up. The side with the mid section cut away must be on suction side of pump.
7. Dip drive gear assembly (14 or 16) and idler gear assembly (15) into oil. Slip both gear assemblies into gear pocket of body and into front plate bushings.
8. Install optional thrust plate (12) into body (13) bronze face toward gears with mid section cut away towards suction side of pump.
9. Install adapter plate (11) in place on front body (13). Check positioning mark on all sections of pump.
10. Install second body (3) onto adapter plate (11) and install wear plate (7).
11. Install key (6) in slot of drive gear assembly shaft (14 or 16). Dip slip fit gear (4) in oil and slip on shaft and into gear pocket of body. Check key for proper location.
12. Dip idler gear (5) in oil and install in gear pocket of body (3).
13. Position backplate (1) over shafts until dowel pins in body are engaged.
14. Install cap screws (20). Tighten evenly to 25/28 ft. lbs. torque.
15. Work shaft seal (19) over drive gear shaft, being careful to not cut rubber sealing lip. (Oil seal liberally before installing). Place 1-5/16 O.D. sleeve over shaft and press in shaft seal (19) until flush with front surface of front plate.
16. Install key (17) on keyed shaft (16).

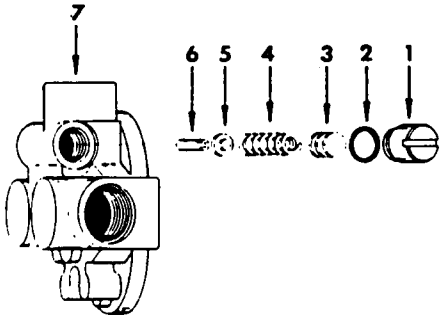
PLACING PUMP BACK INTO SERVICE

1. If shop test stand is available, the following procedure for testing rebuilt pumps is recommended:
   - A. Mount pump on test stand making sure that the proper level of clean oil is available in the reservoir. Check suction line for leaks and obstructions.
   - B. Start pump and run for three minutes at zero pressure.
   - C. Intermittently load pump to 500 P.S.I. for three minutes.
   - D. Intermittently load pump to 1000 P.S.I. for three minutes.
   - E. Intermittently load pump to 2000 P.S.I. for three minutes.
   - F. Remove pump from test stand and check for freeness of drive shaft. Check for leaks.
2. If shop test stand is not available, the following procedure for testing rebuilt pumps is recommended:
   - A. Mount pump on equipment and run pump at 1/2 engine speed at zero pressure.
   - B. By operating control valve build pressure intermittently for three minutes.
   - C. Increase engine speed to full throttle and build pressure intermittently for three minutes.
   - D. Idle engine and check for leaks.

SINGLE OR DOUBLE PUMP TROUBLE SHOOTING

PUMP TROUBLE	PROBABLE CAUSE	REMEDY
1. Noisy pump caused by cavitation.	a. Oil too heavy. b. Oil filter plugged. c. Suction line plugged or too small.	a. Change to proper viscosity b. Clean filters. c. Clean line and check for size.
2. Oil heating	a. Oil supply low. b. Contaminated oil. c. Setting of relief valve too high or too low. d. Oil in system too light.	a. Fill reservoir. b. Drain reservoir and refill with clean oil. c. Set to correct pressure. d. Drain reservoir and refill with proper viscosity oil.
3. Shaft seal leakage	a. Worn shaft seal. b. Worn shaft in seal area c. Broken bearing seal or back-up gasket d. Bushings out of position. e. Excessive internal wear.	a. Replace shaft seal. b. Replace drive shaft c. If replacing the shaft and shaft seal does not stop seal leakage, the pump should be disassembled and checked for items 3, c. & d. d. Disassemble pump and replace front plate. e. Disassemble pump inspect parts and replace as needed
4. Foaming oil	a. Low oil level. b. Air leaking into suction line. c. Wrong kind of oil.	a. Fill reservoir. b. Tighten fittings. c. Drain and fill reservoir with non-foaming oil.

RELIEF VALVE BACKPLATE



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Slotted plug	1
2	O-ring	1
3	Shims	As Reqd.
4	Spring, Relief Valve	1
5	Plug Seat	1
6	Seat	1
7	Backplate	1

DISASSEMBLY

1. Use slotted socket and remove relief valve plug (1), shims (3), spring (4), plug seat (5) and seat (6) from backplate (7).

Note: Do not remove internal relief valve cartridge assembly. Cartridge assembly has been set to a predetermined depth with locktite applied.

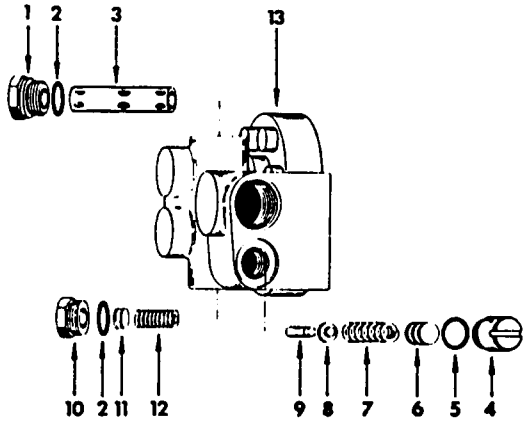
INSPECTION

1. Clean and dry all parts.
2. The o-rings need not be inspected as they should be replaced as new items.
3. Remove all nicks and burrs from all parts with emery cloth.
4. Oil grooves in bushings should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to the respective pin holes.
5. If I.D. of bushings in backplate exceed .755, the backplate should be replaced. (Bushings are not available as separate items).
6. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.
7. Check shims (3) for wear.
8. Check spring (4) for weakness or breakage.
9. Wash backplate in clean solvent, direct compressed air into relief valve cavity in backplate to dry relief valve cartridge assembly. The procedure removes any trapped contamination.

REASSEMBLY

1. Install relief valve parts in backplate (7), seat (6), plug seat (5), spring (4), same number of shims (3), new o-ring (2) on plug (1) and torque plug to 21 to 24 ft. lbs.

FLOW DIVIDER/FLOW CONTROL BACKPLATE



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Hex Plug	1
2	O-ring	2
3	Flow Divider Spool	1
4	Slotted Plug	1
5	O-ring	1
6	Shims	As Req'd
7	Spring, Relief Valve	1
8	Plug Seat	1
9	Seat	1
10	Hex Plug	1
11	Shims	As Req'd
12	Spring, Flow Divider	1
13	Backplate	1

DISASSEMBLY

1. Use slotted socket and remove relief valve plug (4), shims (6), spring (7), plug seat (8) and seat (9) from backplate (13).
   Note: Do not remove internal relief valve cartridge assembly. Cartridge assembly has been set to a predetermined depth with locktite applied.
2. Remove plug (1), spool (3), plug (10), shims (11) and spring (12) from backplate (13).

INSPECTION

1. Clean and dry all parts.
2. The o-rings need not be inspected as they should be replaced as new items.
3. Remove all nicks and burrs from all parts with emery cloth.
4. Oil grooves in bushings should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to the respective pin holes.
5. If I.D. of bushings in backplate exceed .755 the backplate should be replaced. (Bushings are not available as separate items).
6. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.
7. Inspect backplate spool bore for scoring or contamination.
8. Inspect spool O.D. for scratches, it should be smooth and free of nicks and burrs. Spool should slide freely inside backplate bore.
9. Check shims (6) and (11) for wear.
10. Check springs (7) and (12) for weakness or breakage.
11. Wash backplate in clean solvent, direct compressed air into relief valve cavity in backplate to dry relief valve cartridge assembly. The procedure removes any trapped contamination.

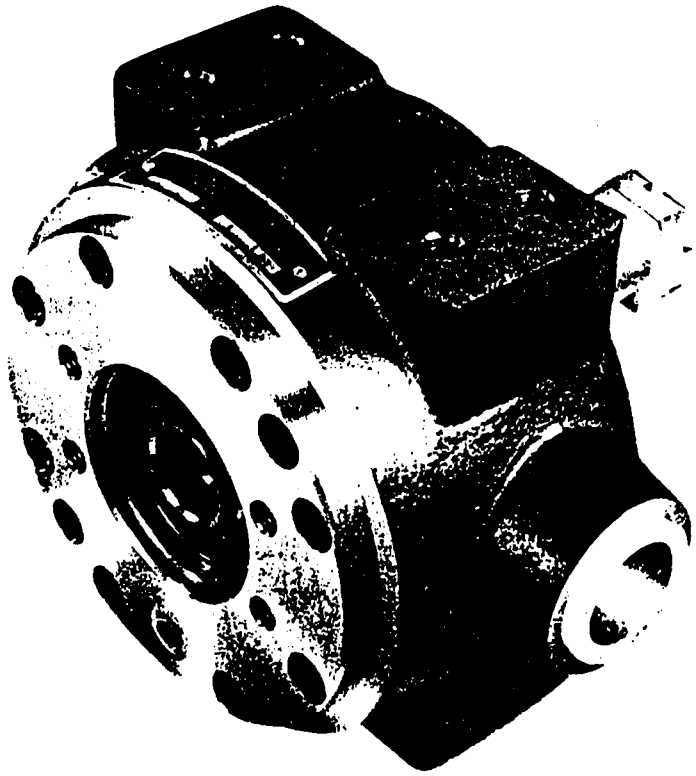
REASSEMBLY

1. Install relief valve parts in backplate (13), seat (9), plug seat (8), spring (7), same number of shims (6), new o-ring (5) on plug (4) and torque plug (4) to 21 to 24 ft. lbs.
2. Install flow divider parts in backplate (13) spool (3), spring (12), same number of shims (11), new o-rings (2) on plugs (1) and (10) and torque plugs (1) and (10) to 27 to 30 ft. lbs.

FLOW DIVIDER/FLOW CONTROL TROUBLE SHOOTING

FLOW DIVIDER TROUBLE	PROBABLE CAUSE	REMEDY
1. External leakage.	a. Spool plug o-ring. b. Relief valve plug o-ring.	a. Remove spool plug and replace o-ring. b. Remove relief valve plug and replace o-ring.
2. Low priority pressure.	a. Low relief valve setting.	a. Replace weak or broken spring. b. Shim as required. c. Replace backplate assy.
3. Low priority flow.	a. Relief valve open or leaking. b. Scratched machined sealing surface in relief valve. (Either in seat or poppet within cartridge) c. Contaminant lodged in relief valve. d. Missing spring shims. e. Weak Spool spring.	a. Replace weak or broken spring. b. Replace parts as required. c. Clean relief valve cavity. d. Add shims as required. e. Replace spool spring.
4. No priority flow.	a. Broken spool spring. b. Orifice inside spool plugged.	a. Replace spool spring. b. Check for contaminant lodged in orifice.
5. No secondary flow.	a. Spool sticking.	a. Remove and clean spool bore.
6. Low secondary flow.	a. Pump flow degradation due to wear.	a. Check pump for worn parts and replace.

SERVICE MANUAL mico



SY·TEC SERIES

MULTIPLE DISC BRAKE

(trunnion)

TYPICAL BRAKE

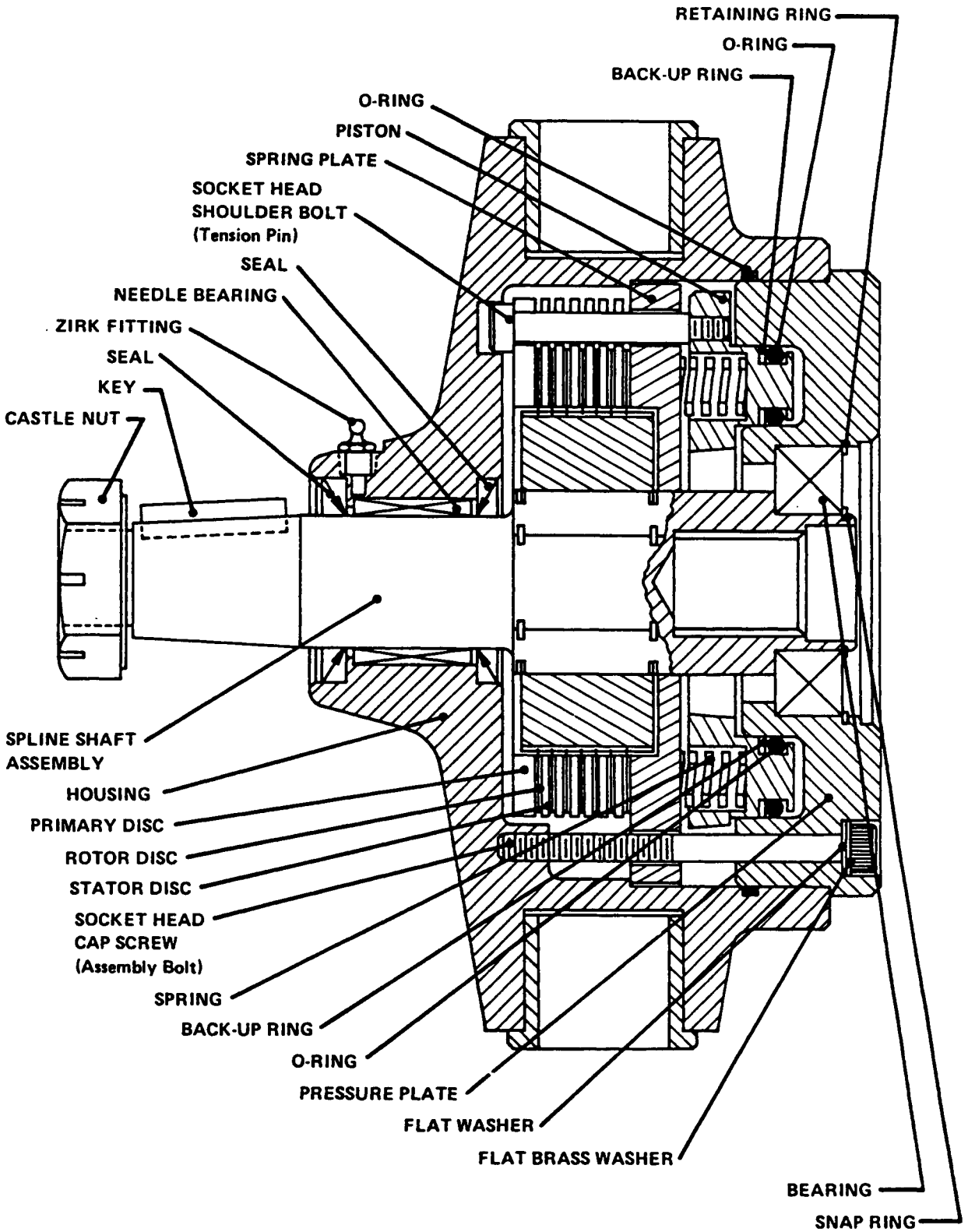


FIGURE 1

REV.

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 300 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 300 psi to fully release the brake and provide adequate running clearance for the individual discs.

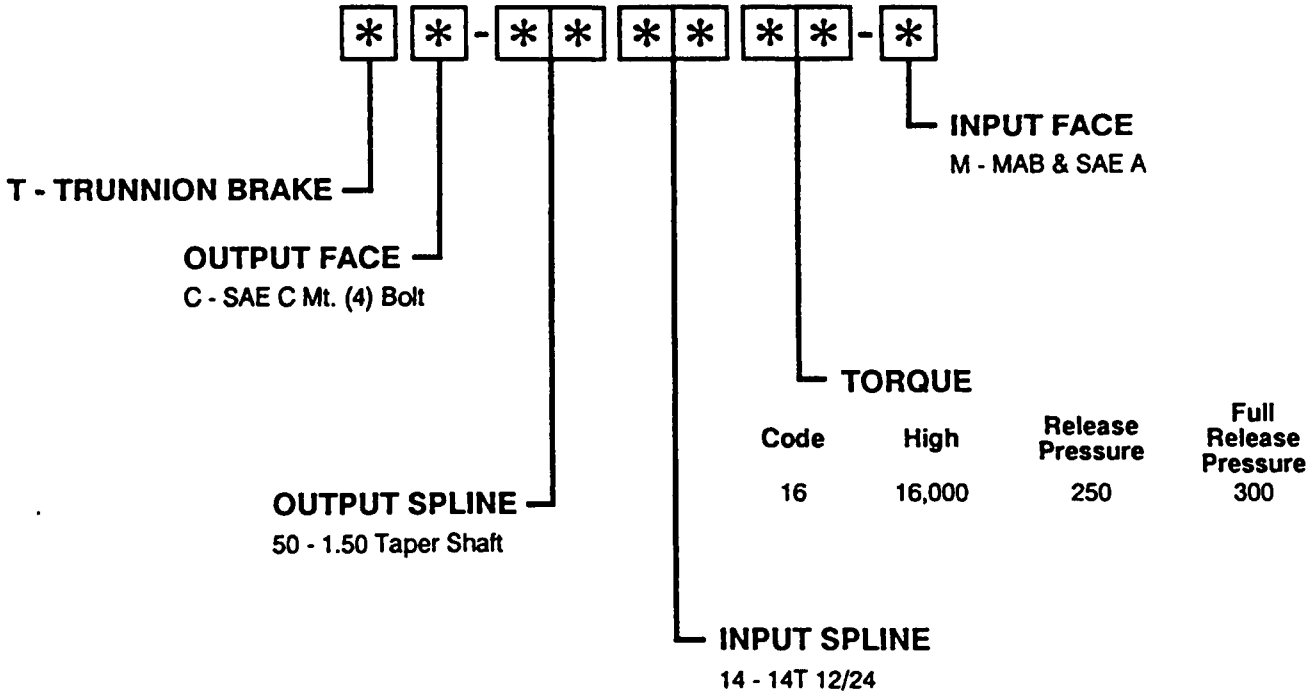
It is very important to remember that any pressure on the brake's release piston will directly effect the level of torque.

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



Code	High	Release Pressure	Full Release Pressure
16	16,000	250	300

DISASSEMBLY

1. Remove castle nut (26) and key (20) from output end of spline shaft assembly (19).
2. Remove 10 socket head assembly bolts (4) and flat washers (5 & 6). Washers (5) are brass. A suitable holding fixture is useful to keep brake in position.
3. Tap output end of spline shaft assembly (19) with a soft mallet to separate housing (22) from internal parts assembly.
4. Remove o-ring (21) from housing (22).
5. Needle bearing (24) and seals (23 & 25) will remain in housing (22). Inspect parts for wear and remove only if necessary.
6. Remove snap ring (1) from input end of spline shaft assembly (19).
7. Tap input end of spline shaft assembly (19) with a soft mallet to separate spline shaft from internal parts assembly. Bearing (3) and retaining ring (2) will remain in pressure plate (7).
8. Remove both and inspect for wear.
9. Remove four socket head shoulder bolts (18). A suitable holding fixture is useful to hold brake in position.
   CAUTION: Do not remove shoulder bolts without pressurization of brake (approx. 300 psi) or damage may result.
10. Remove primary disc (17), seven rotor discs (16) and six stator discs (15).
11. Remove spring plate (14).
12. Before removing spring (13), note pattern for reassembly purposes.
13. Separate piston (12) and pressure plate (7) by carefully exerting hydraulic pressure through brake release port on pressure plate.
14. Remove outside and inside o-rings (8 & 10) and outside and inside back-up rings (9 & 11) from piston (12).
    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 SYSTEM.

1. Use an alkaline wash to clean parts before assembly.
2. Install back-up rings (9 & 11) on piston (12) toward spring pockets.
3. Install o-rings (8 & 10) on piston (12). Be sure o-rings are flat and all twists removed.
   CAUTION: Care must be taken so as not to scratch or mar piston.
4. Lubricate piston (12) with type fluid found in the system. Carefully press piston into pressure plate (7). Be sure piston is aligned correctly at all times and that there are no extrusions. Press piston until it bottoms on pressure plate (7).
5. Install springs (13) according to pattern noted during disassembly.
6. Place spring plate (14) over springs (13).
7. Install stator discs (15) and rotor discs (16). Begin with a rotor disc (16) and alternate with stator discs (15).
8. Install primary disc (17).
9. Align discs and partially screw in four socket head shoulder bolts (18).
   NOTE: Socket head shoulder bolts (18) should have loctite applied. Apply one or two drops of Loctite to the threads.
   Inspect for free movement of stack. Align and center internal splined teeth such that shaft assembly (19) will engage rotors properly. Pressurize brake release port (approx. 300 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.
10. Install spline shaft assembly (19) through stack input end first and out pressure plate (7).
11. Install bearing (3) and retaining ring (2) in pressure plate (7).
12. Install snap ring (1) on input end of spline shaft assembly (19).
13. If seals (23 & 25) and needle bearing (24) were removed from housing (22) they must be installed. Note direction of both seals.
14. Install o-ring (21) in housing (22).
15. Install housing (22) with the internal parts assembly using 10 socket head assembly bolts (4) and flat washers (5 & 6).
    NOTE: The ten socket head assembly bolts (4) should have Loctite applied. Apply one or two drops of Loctite to the threads.
    Washers (5) are brass and should be installed first on the bolts. Torque bolts to 35 ft. lbs.
16. Install castle nut (26) and key (20) on output end of spline shaft assembly (19).

FOR REPAIR KIT INFORMATION REFER TO PAGE 7

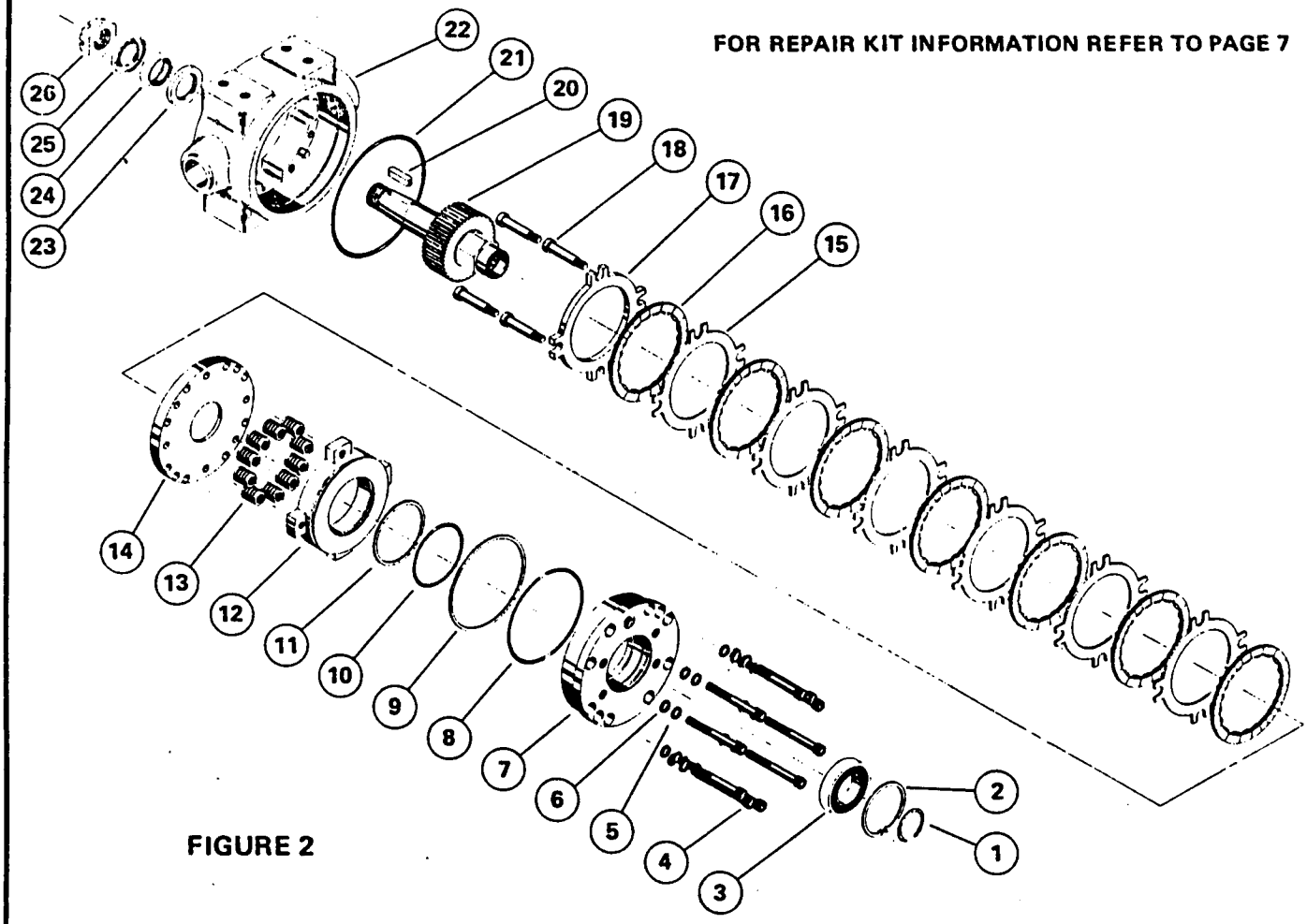


FIGURE 2

PARTS LIST

ITEM	DESCRIPTION
1	SNAP RING
2	RETAINING RING
3	BEARING
4	SOCKET HEAD CAP SCREWS (10) (Assembly Bolts)
5	FLAT BRASS WASHERS (10)
6	FLAT WASHERS (10)
7	PRESSURE PLATE
8	O-RING
9	BACK-UP RING
10	O-RING
11	BACK-UP RING
12	PISTON
13	SPRINGS (10)
14	SPRING PLATE
15	STATOR DISCS (6)
16	ROTOR DISCS (7)
17	PRIMARY DISC
18	SOCKET HEAD SHOULDER BOLTS (4) (Tension Pins)
19	SPLINE SHAFT ASSEMBLY
20	KEY
21	O-RING
22	HOUSING
23	SEAL
24	NEEDLE BEARING
25	SEAL
26	CASTLE NUT

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 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. Spring 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 components
	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

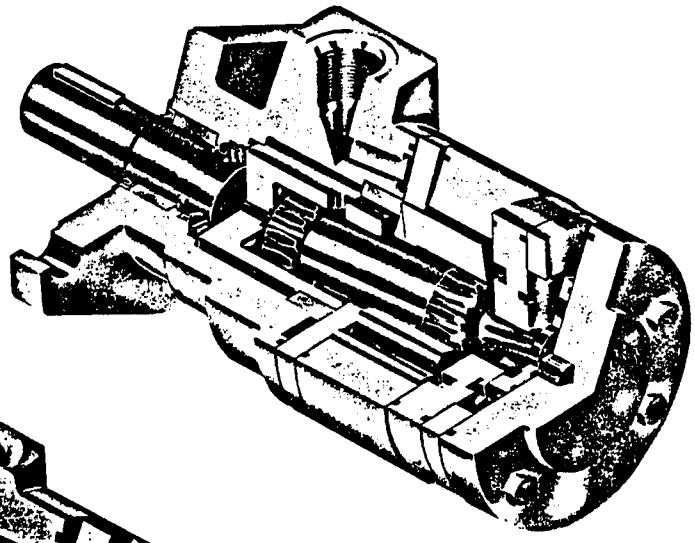
REPAIR KITS

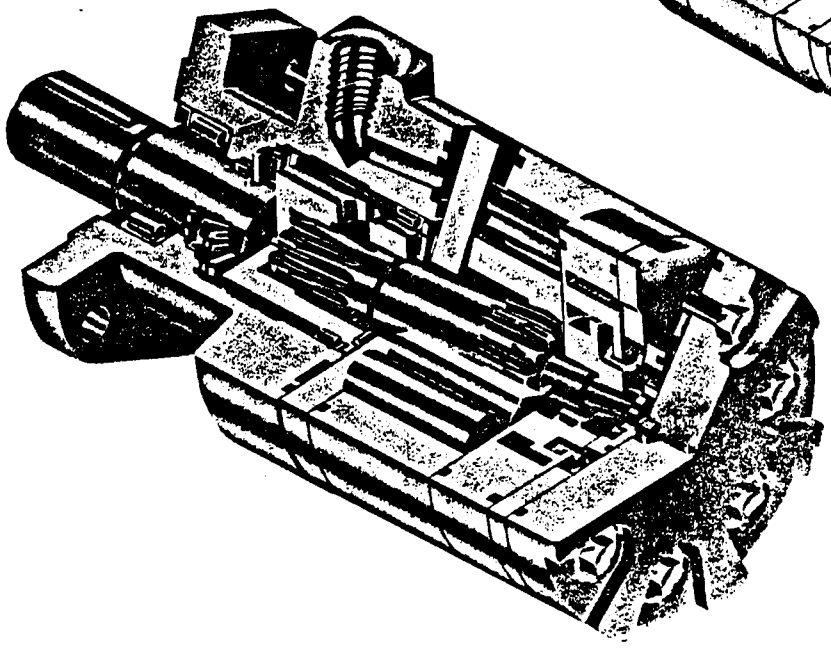
(Refer to Page 5 for item numbers)

NUMBER	DESCRIPTION	INCLUDES
12-501-026	O-ring and Back-up Ring Kit	Flat Brass Washers (items 5) Seals (items 23 & 25) O-rings (items 8, 10, & 21) Back-up Rings (items 9 & 11) Loctite
12-501-106	Lining Kit	Flat Brass Washers (items 5) O-ring (item 21) Primary Disc (item 17) Stator Discs (items 15) Rotor Discs (items 16) Loctite
12-501-108	Bearing Kit	Flat Brass Washers (items 5) O-ring (item 21) Seals (items 23 & 25) Bearings (items 3 & 24) Loctite
12-501-114	Spring Kit	Flat Brass Washers (items 5) O-ring (item 21) Springs (items 13) Loctite

Torqmotor™

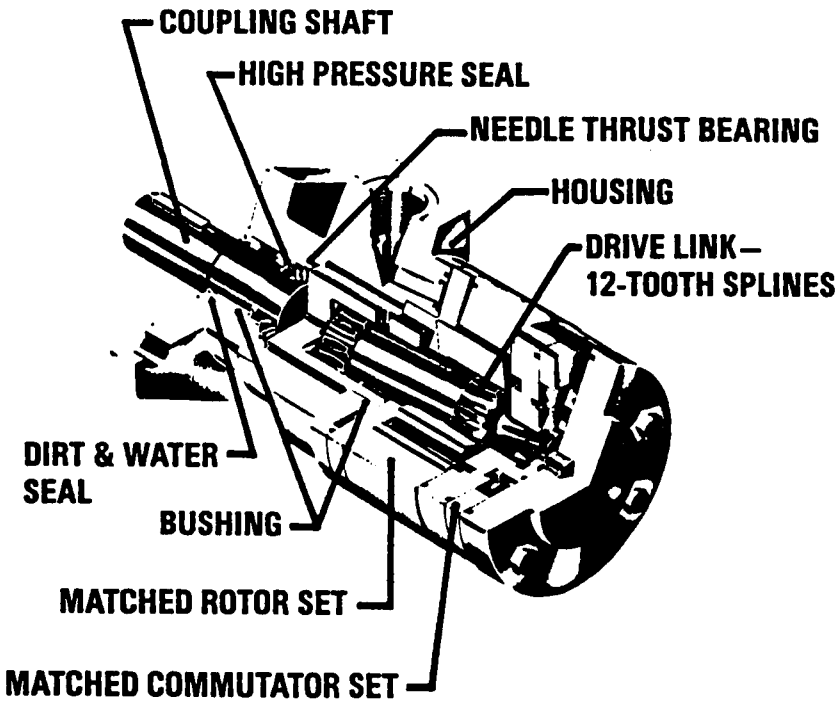
Service Procedure





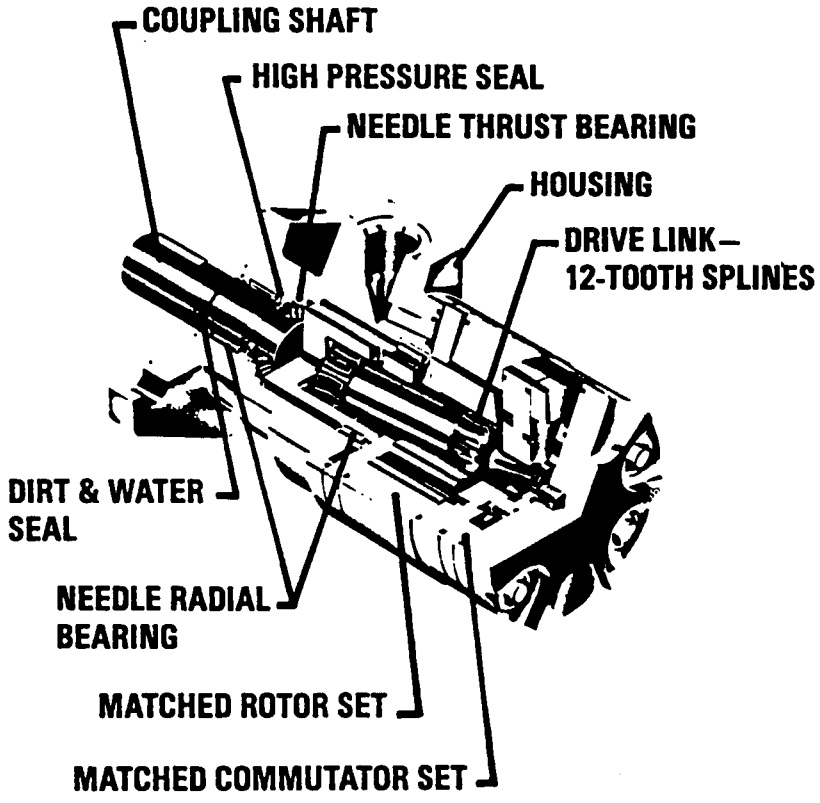
MG, MF, MB, ME Series

Torqmotor™ Design Features



Torqmotor™ MG Series features include:

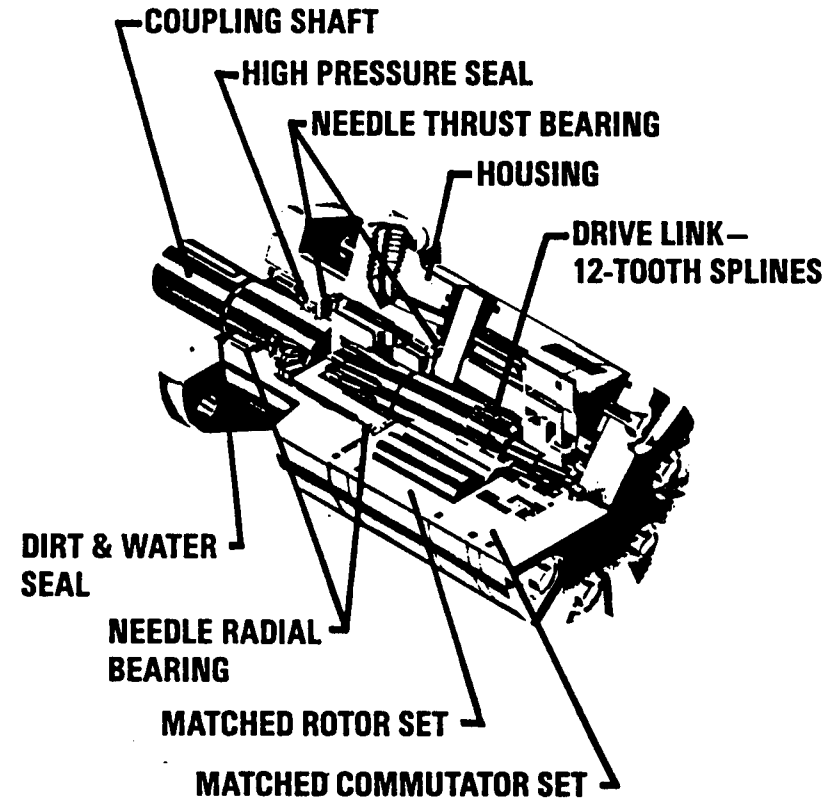
- The roller vane rotor set design offers a low-friction, wear compensation which maximizes the useful performance life of the motor.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.
- Design flexibility - MG offers the widest selection of shaft options, displacements and mounting flanges in the industry.
- Patented 60-40 spline member arrangement transmits more torque with less weight.
- Full flow lubrication maximizes cooling and may provide up to 50% longer life than motors not having this feature.
- Higher pressure ratings provide greater torque than competitive brands.
- Full interchangeability with other motors which are designed according to industry standards.
- Compatible with most hydraulic systems with regard to pressure, torque and speed.
- A unique high-pressure shaft seal that eliminates the need for case drains.
- Up to 13 horse power output.

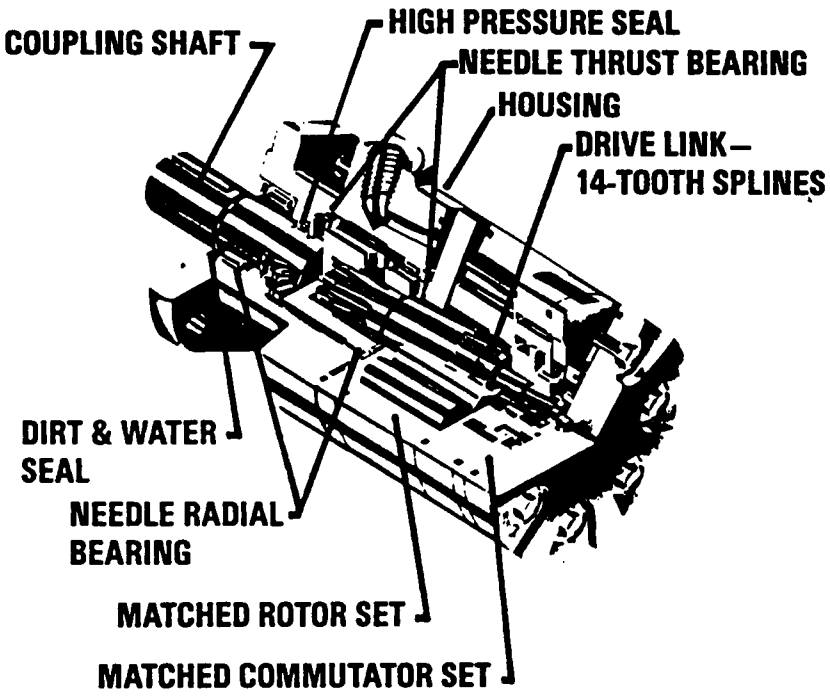


Torqmotor™ MF Series features include:

- Roller vanes to reduce friction and internal leakage and to maintain efficiency.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.
- Wheel mount version available.
- More starting torque than competitive motors in applications where the shaft is side loaded. (Competitive brands require more pressure to start the motor.)
- A needle roller mounted coupling shaft and steel-caged thrust bearing which can withstand 1000-pound thrust loads.
- Side load capacity is 1600 lbs (727.3 kg) maximum at center of output shaft.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- Up to 17 horsepower output.
- Greater durability due to superior lubrication and minimum drive spline wear.
- Patented 60-40 spline member arrangement transmits more torque with less weight.

Torqmotor™ Design Features





Torqmotor™ MB Series features include:

- Heavy-duty thrust and roller bearings for up to twice side-load capacity to the previous motor.
- Roller vanes to reduce friction and internal leakage, and to maintain efficiency.
- A patented orbiting commutation system for less wear and longer life.
- A patented 60:40 arrangement of internal and external spline members to transmit more torque with less weight.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- A unique manifold designed to improve operating efficiency.
- Up to 1000 lbs (453.6 kg) end-thrust capacity in either direction.
- A design that is less sensitive to contamination than competitive motors.
- Up to 36 horsepower output.
- Greater durability because of superior lubrication and minimum drive spline wear.
- Superior low speed performance.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.

Torqmotor™ ME Series features include:

- Roller vanes to reduce friction and internal leakage and to maintain efficiency.
- A patented orbiting commutation system for less wear and longer life.
- A patented 60:40 arrangement of internal and external spline members to transmit more torque with less weight.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- A manifold designed to improve operating efficiency.
- Heavy-duty thrust and roller bearings for up to twice the side-load capacity to the previous motor.
- Up to 1000 lbs (453.6 kg) end-thrust capacity in either direction.
- A design that is less sensitive to contamination than competitive motors.
- Up to 49 horsepower output.
- Greater durability because of superior lubrication and minimum drive spline wear.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.

Definitions

NOTE: **A NOTE provides key information to make a procedure easier or quicker to complete.**

CAUTION: **A CAUTION refers to procedure that must be followed to avoid damaging the Torqmotor™ or other system components.**

WARNING: **A WARNING REFERS TO PROCEDURES THAT MUST BE FOLLOWED FOR THE SAFETY OF THE EQUIPMENT OPERATOR AND THE PERSON INSPECTING OR REPAIRING THE TORQMOTOR™**

Disclaimer

This Service Manual has been prepared by TRW Ross Gear Division for reference and use by mechanics who have been trained to repair and service hydraulic motors and systems on commercial and non-commercial equipment applications. TRW Ross Gear Division has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the techniques and tools required for maintaining, repairing and servicing the complete line of TRW Ross Gear MG, MF, MB & ME Torqmotor Units. However, despite the care and effort taken in preparing this general Service Manual, TRW **makes no warranties** that (a) the Service Manual or any explanations, illustrations, information, techniques or tools described herein are either accurate, complete or correct as applied to a specific Torqmotor unit, or (b) any repairs or service of a particular Torqmotor unit will result in a properly functioning Torqmotor unit.

If inspection or testing reveals evidence of abnormal wear or damage to the Torqmotor unit or if you encounter circumstances not covered in the Manual, STOP — CONSULT THE EQUIPMENT MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE A TORQMOTOR UNIT WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL TRW REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO TRW'S SPECIFICATIONS FOR THE TORQMOTOR UNIT.

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular Torqmotor unit to (a) inspect the unit for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the equipment, or the safe operation of the Torqmotor, and (c) fully inspect and test the Torqmotor unit and the hydraulic system to insure that the repair or service of the Torqmotor unit has been properly performed and that the Torqmotor and hydraulic system will function properly.

Patents

Ross Gear Division products and systems described in this manual are protected by one or more of the following United States patents: 3,606,601. In addition, foreign patents have been issued in Canada, the United Kingdom, and West Germany.

Table of Contents

Introduction

Service Manual for Series MG, MF, MB, ME

This service manual has one purpose: to guide you in maintaining, troubleshooting, and servicing the MG, MF, MB & ME Torqmotor (low-speed, high-torque hydraulic motor).

Material in this manual is organized so you can work on the Torqmotor and get results without wasting time or being confused. To get these results, you should read this entire manual before you begin any work on the Torqmotor.

This manual also contains troubleshooting information and checklist. If you must service the Torqmotor, the checklist will help you to determine where the problem may be.

The three-column format of the Disassembly and Inspection, and Assembly sections will make it easier for you to conduct major work on the Torqmotor. Column 1 gives a brief key for each procedure. Column 2 explains in detail the procedure you should follow. Column 3 illustrates this procedure with photographs. Read all material carefully and pay special attention to the notes, cautions, and warnings.

A foldout page with the same Torqmotor exploded assembly view on both sides is provided in this manual. The component part names and item numbers assigned on this exploded assembly view correspond with names and item numbers (in parentheses) used in the disassembly and assembly procedures set forth in this manual. When this exploded assembly view page is folded out, you can easily identify components and locate their relative position on the exploded assembly view as you follow the disassembly and assembly procedures.

Service part list charts are also provided in this manual with the part names and exploded view item numbers cross referenced to Ross Gear service part numbers.

Service parts are available through the Original Equipment Manufacturer or Ross approved MG, MF, MB & ME Distributors.

As you gain experience in servicing the Torqmotor, you may find that some information in this manual could be clearer or more complete. If so, let us know about it. Do not try to second guess the manual. If you are stuck, contact us. Servicing the Torqmotor should be a safe and productive procedure, in order for the unit to deliver the reliable, long-life operation engineered into it.

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.

Tools and Materials Required for Servicing

MG, MF, MB, ME Series Service Manual

Clean, petroleum-based solvent

Emery paper

Vise with soft jaws

Air pressure source

Arbor press

Screw driver

Masking tape

Breaker bar

Torque wrench—ft. lbs. (N m)

Sockets: 1/2 or 9/16 inch thin wall, 1 inch

Allen Sockets: 3/16, 3/8 inch

Adjustable crescent wrench or hose fitting wrenches

SAE 10W40 SE or SF oil

Special bearing mandrel for MG & MF Torqmotors (SEE FIGURE 1)

Special bearing mandrel for MB & ME Torqmotors (SEE FIGURE 2)

Feeler gage .005 inch (.13 mm)

MG & MF Torqmotors require blind hole bearing puller for 1.06 inch (26.9 mm) and 1.62 inch (41.1 mm) diameter bearing/bushing.

MB & ME Torqmotors require blind hole bearing puller for 1.40 inch dia. (35.6 mm) and 2.130 inch dia. (54.1 mm) bearing.

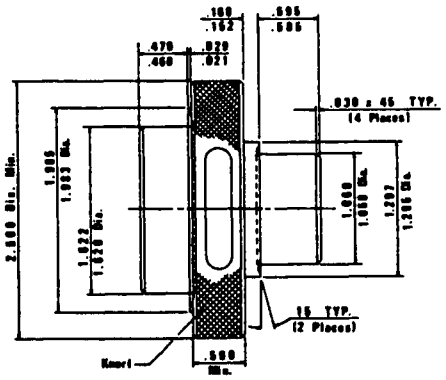
Clean corrosion resistant grease. Recommended grease is E/M Lubricant #K-70M, Ross Gear Specification #045236

NOTE: The available service seal kits include the recommended grease as a grease pack #406018

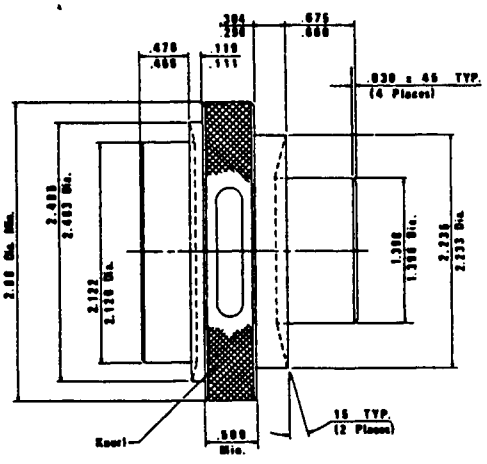
CAUTION: Mixing greases that have different bases can be detrimental to bearing life.

CONVERSIONS

INCHES	mm	INCHES	mm
.020	.51	1.060	26.92
.021	.53	1.295	32.89
.029	.74	1.297	32.94
.030	.76	1.396	35.46
.111	2.81	1.398	35.51
.119	3.02	1.620	41.15
.152	3.86	1.622	41.20
.160	4.06	1.983	50.37
.296	7.52	1.985	50.42
.304	7.72	2.120	53.85
.460	11.68	2.122	53.90
.470	11.94	2.233	56.72
.500	12.70	2.235	56.77
.585	14.86	2.483	63.07
.595	15.11	2.485	63.12
.660	16.76	2.500	63.5
.675	17.15	2.88	73.2
1.058	26.87		



(Fabricate if considered necessary)
FIGURE 1—MG & MF

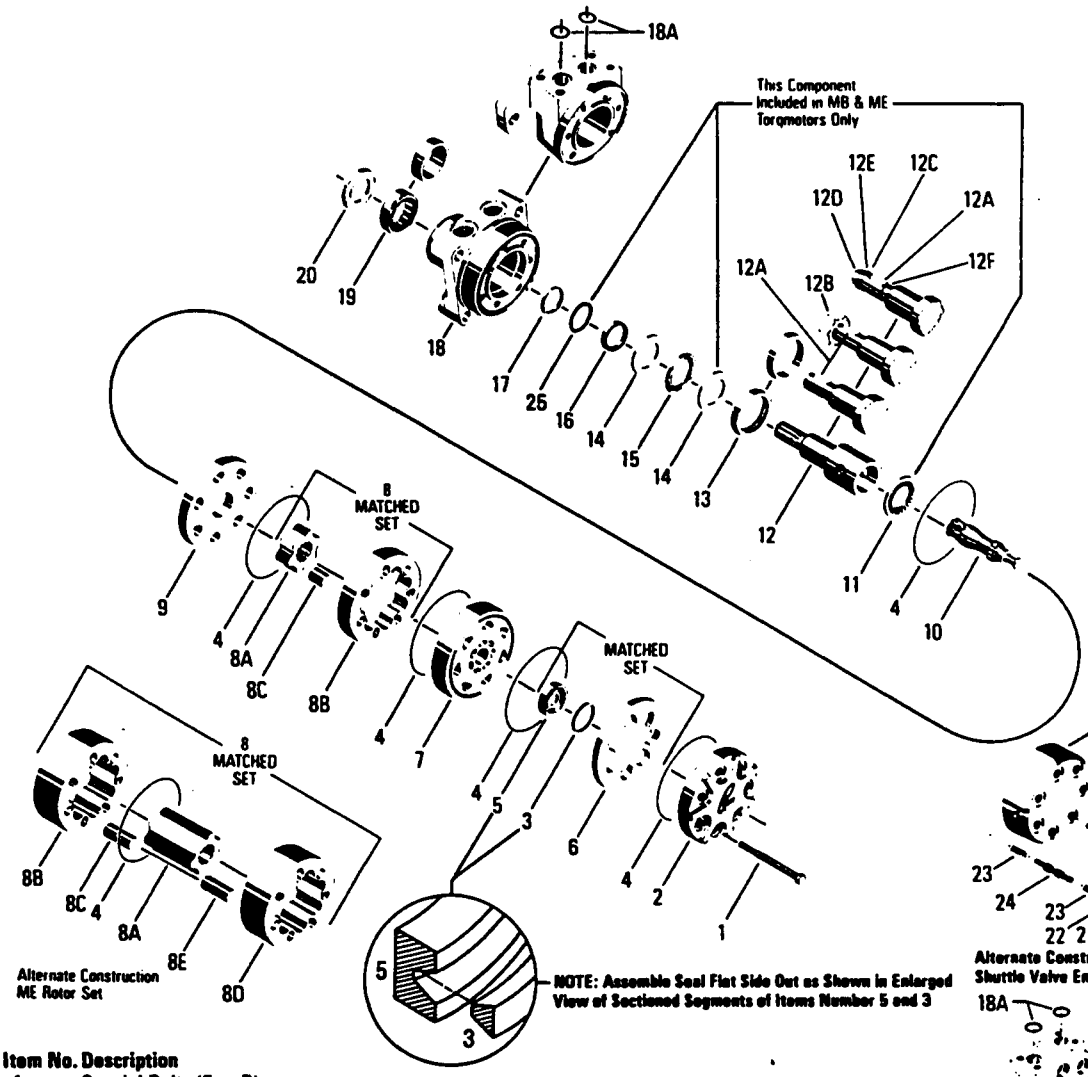


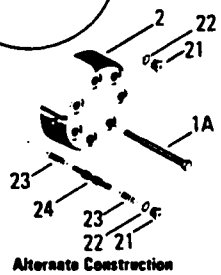
(Fabricate if considered necessary)
FIGURE 2—MB & ME

Torque Chart

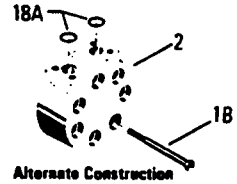
Part Name	Item Number	Torque
bolt 5/16 24 UNF 2A	1, 1A, 1B or 1C	22-26 ft. lbs. (30-35 N m)
bolt 3/8 24 UNF 2A	1, 1A, 1B or 1C	45-55 ft. lbs. (60-76 N m)
bolt 5/8 18 UNF 2A	12D	140-180 ft. lbs. (190-244 N m)
nut 3/4 16 UNF 2B	12B (MG, MF)	175-255 ft. lbs. (237-305 N m)
nut 1 20 UNEF 2B	12B (MB, ME)	300-400 ft. lbs. (407-542 N m)
nut 1-1/8 18 UNEF 2B	12B (ME)	300-400 ft. lbs. (407-542 N m)

Torqmotor™ Exploded Assembly View—Typical

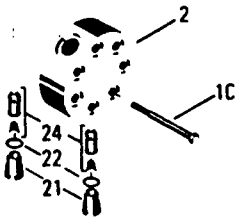




Alternate Construction Shuttle Valve End Cover



Alternate Construction Manifold Port End Cover



Alternate Construction Relief Valve End Cover

Item No.	Description				
1.	Special Bolts (5 or 7)				
1A.	Special Bolts (7)				
1B.	Special Bolts (7)	11.	Thrust Bearing	20.	Dirt & Water Seal
1C.	Special Bolts (7)	12.	Coupling Shaft	21.	Plug (2)
2.	End Cover	12A.	Key	22.	O-Ring (2)
3.	Seal Ring-Commutator	12B.	Nut	23.	Spring
4.	Seal Ring (5)	12C.	Washer	24.	Valve (Shuttle or Relief)
5.	Commutator	12D.	Bolt	25.	Backup Washer
6.	Commutator Ring	12E.	Lockwasher		
7.	Manifold	12F.	Retaining Ring		
8.	Rotor Set	13.	Bearing/Bushing, Inner		
8A.	Rotor	14.	Thrust Washer		
8B.	Stator or Stator Half	15	Thrust Bearing		
8C.	Vane (7)	16.	Seal		
8D.	Stator Half	17.	Backup Washer		
8E.	Vane (7)	18	Housing		
9.	Wear Plate	18A.	O-Ring (2)		
10.	Drive Link	19.	Bearing/Bushing, Outer		

Disassembly and Inspection

(Preparation Before Disassembly)

- Before you disassemble the Torqmotor unit or any of its components read this entire manual. It provides important information on parts and procedures you will need to know to service the Torqmotor.
- Determine whether the Torqmotor you are about to disassemble is the Small Frame Series MG or MF or the Large Frame Series MB or ME so you can follow those procedures that pertain to that Series Torqmotor. The first two letters of the "spec" number on the Torqmotor identification tag is the Series designation. Also determine the type of end cover construction from the alternate views shown on page 7A and 7B.
- The Small Frame Series MG & MF Torqmotors will have a 3.66 inch (92.9 mm) main body outside diameter and five 5/16-24 UNF 2A cover bolts. The Large Frame Series MB & ME Torqmotors will have a 5 inch (127.0 mm) main body outside diameter and seven 3/8 24 UNF 2A cover bolts.
- Refer to page 7 for tools and other items required to service the Torqmotor and have them available.
- Thoroughly clean off all outside dirt, especially from around fittings and hose connections, before disconnecting and removing the Torqmotor. Remove rust or corrosion from coupling shaft.
- Remove coupling shaft connections and hose fittings and immediately plug port holes and fluid lines.
- Remove the Torqmotor from system, drain it of fluid and take it to a clean work surface. (A piece of wrapping paper makes an excellent disposable top.)
- Clean and dry the Torqmotor before you start to disassemble the unit.
- As you disassemble the Torqmotor clean all parts, except seals, in clean petroleum-based solvent, and blow them dry.

WARNING: SINCE THEY 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 OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

CAUTION: Never steam or high pressure wash hydraulic components. Do not force or abuse closely fitted parts.

- Keep parts separate to avoid nicks and burrs.
- Discard all seals and seal rings as they are removed from the Torqmotor. Replace all seals, seal rings and any damaged or worn parts with genuine Ross or OEM approved service parts.

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.

WARNING

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

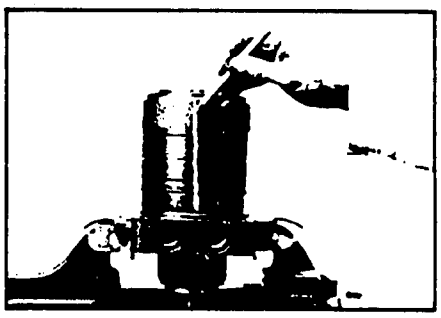


Figure 3

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.

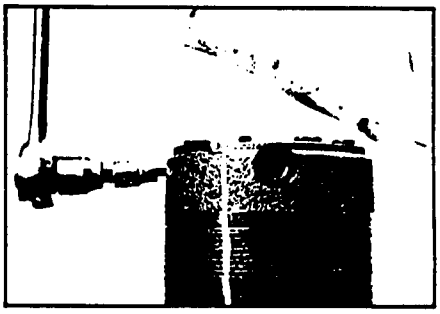


Figure 4

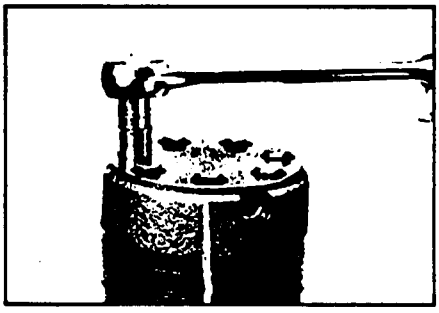


Figure 5

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.

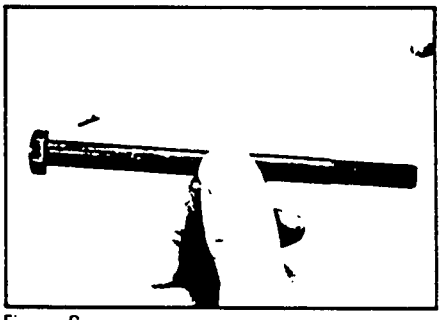


Figure 6

remove end cover & inspect bolts

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

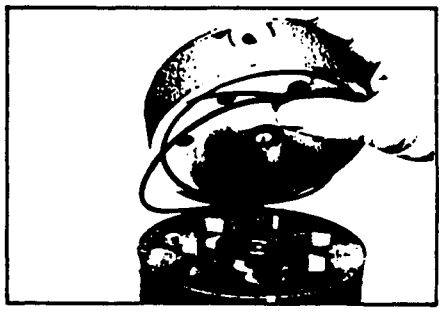


Figure 7

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.

NOTE

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

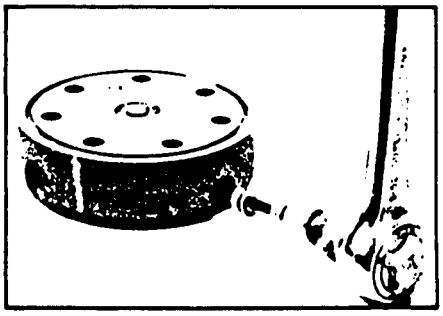


Figure 8

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.

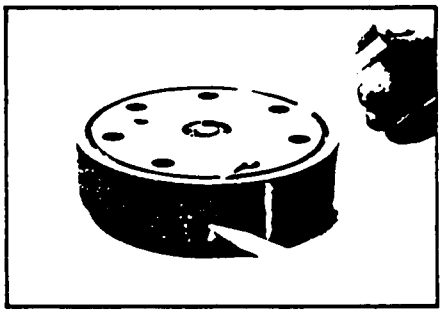


Figure 9

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.

remove & inspect commutator ring

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

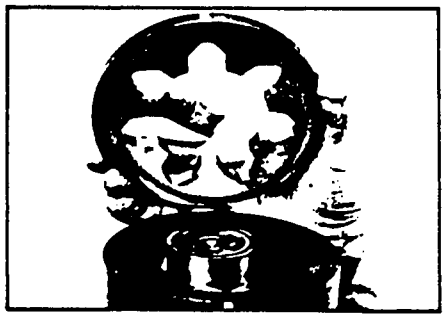


Figure 10

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.

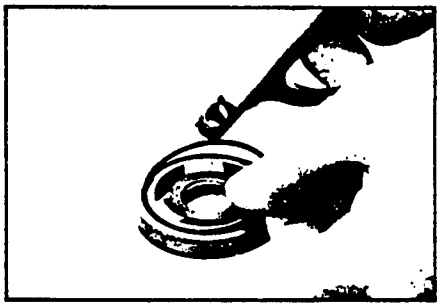


Figure 12

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 15. 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.

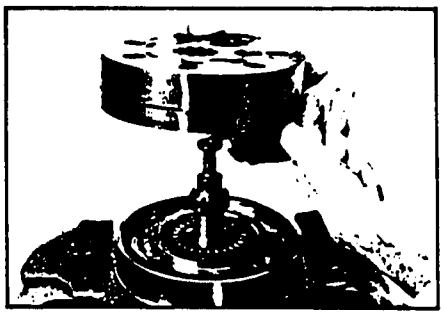


Figure 14

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.

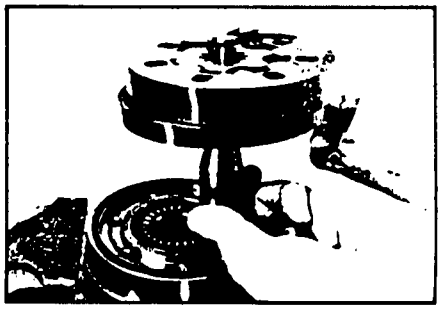


Figure 15

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.

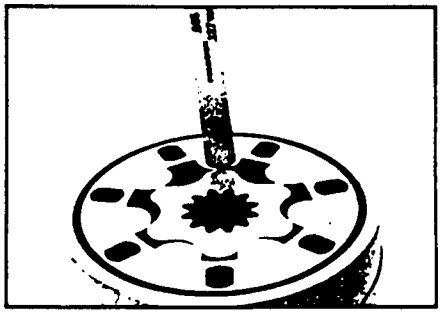


Figure 16

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).

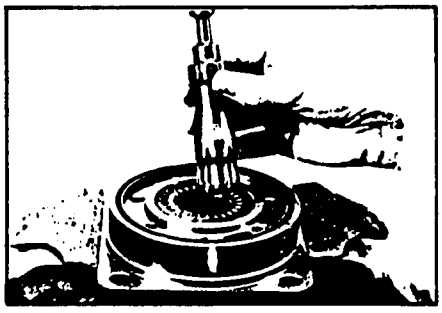


Figure 17

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).

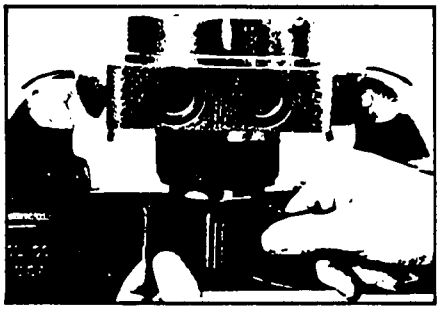


Figure 19

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.

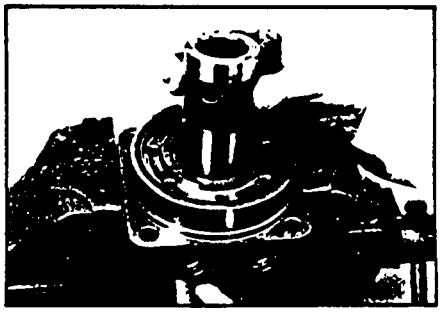


Figure 20

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.

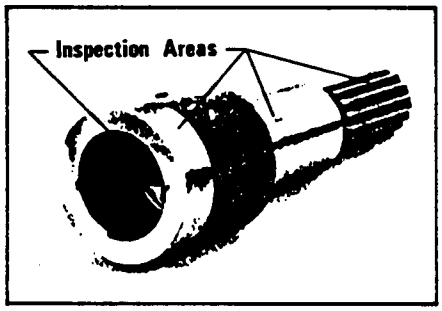


Figure 21

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.

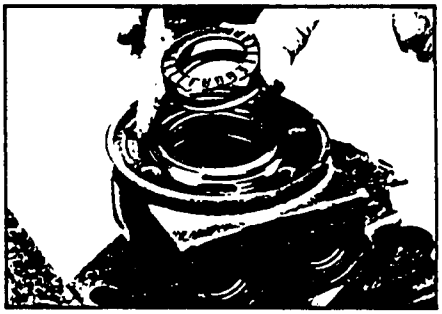


Figure 22

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.

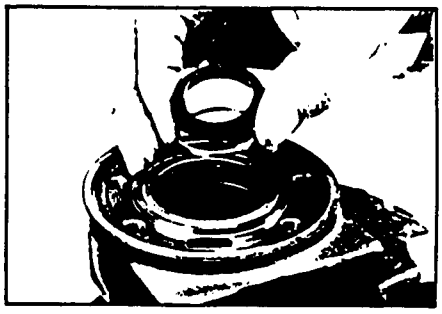


Figure 23

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.

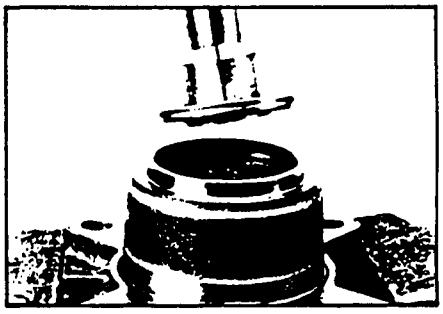


Figure 25

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.

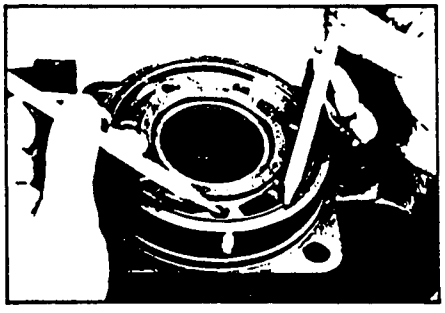


Figure 26

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.

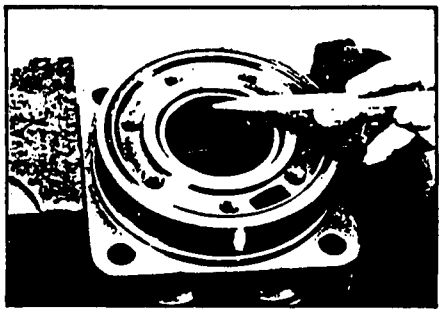


Figure 27

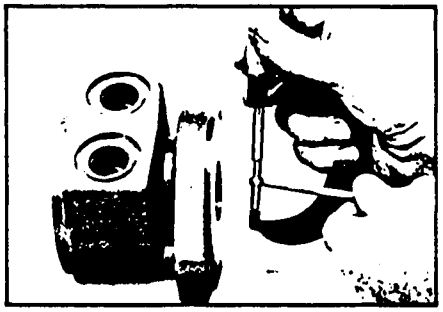


Figure 28

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.

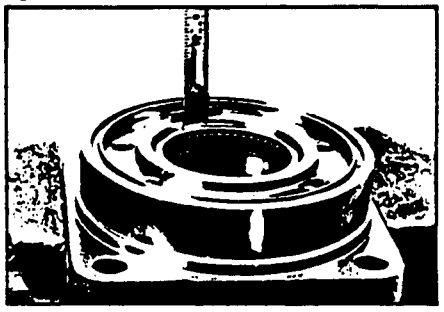


Figure 29

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.

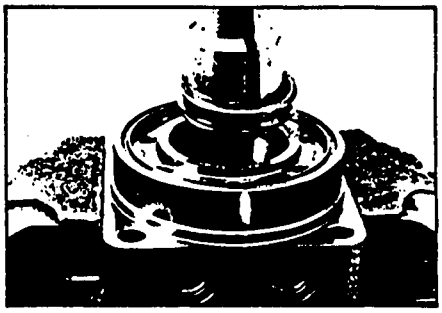


Figure 30

THE DISASSEMBLY OF TORQMOTOR IS COMPLETED.

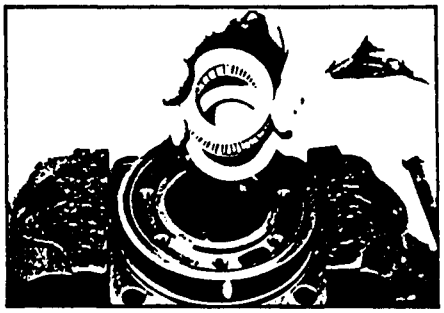


Figure 31

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.

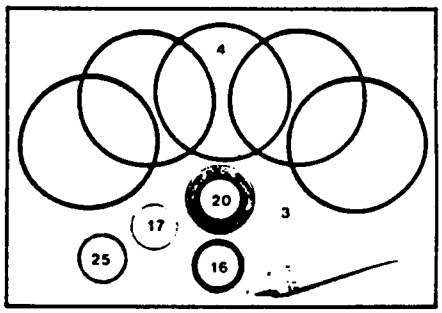


Figure 32 MB, ME seal kit

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.

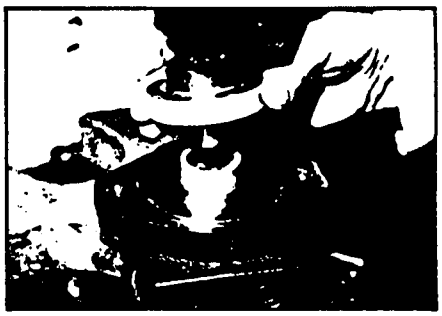


Figure 33

   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.

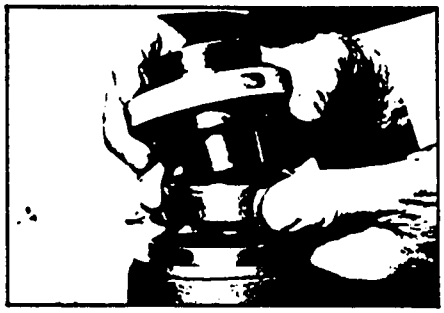


Figure 34

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.

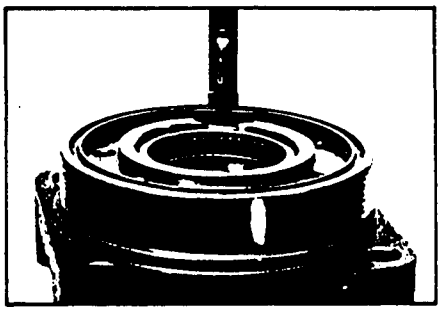


Figure 35

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.

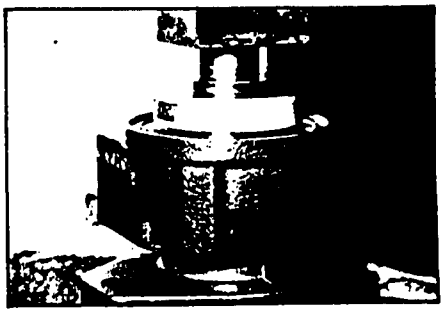


Figure 36

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.

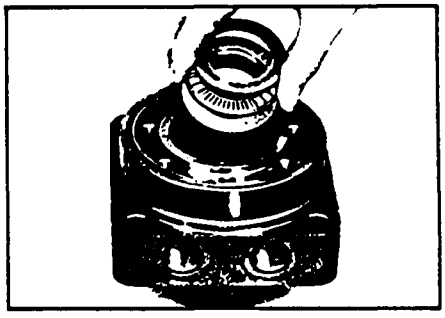


Figure 38

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

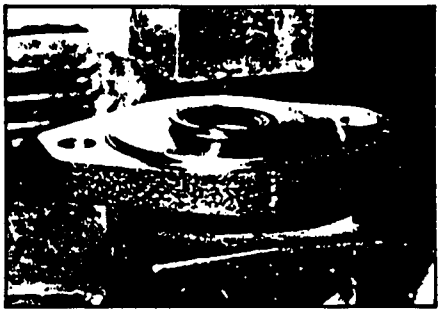


Figure 40

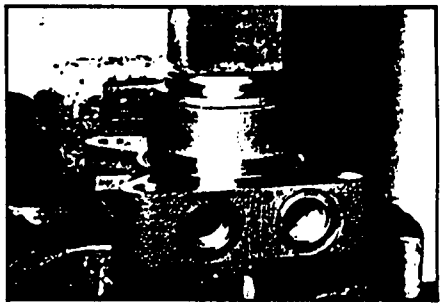


Figure 41

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.

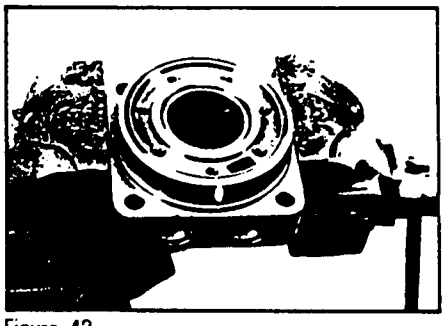


Figure 42

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.

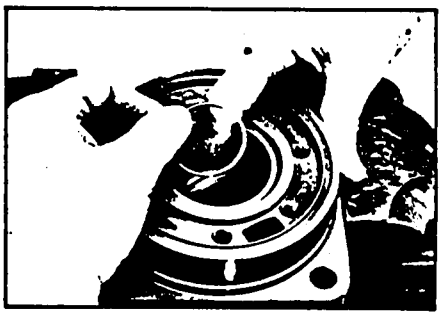


Figure 43

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).

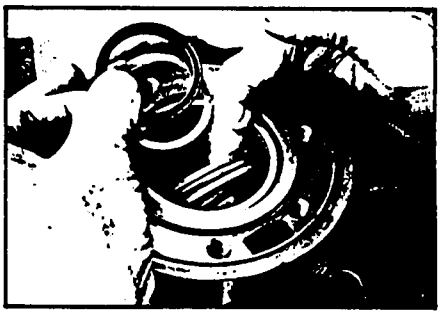


Figure 44

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.

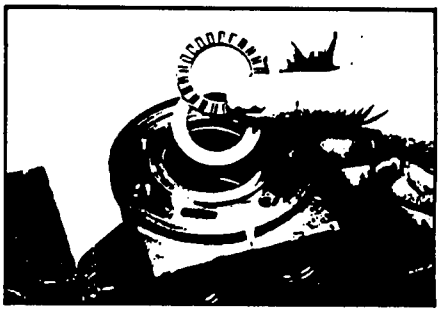


Figure 45

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.

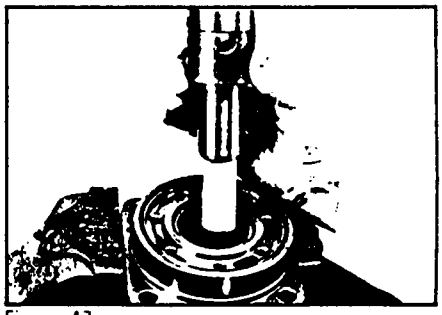


Figure 47

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.

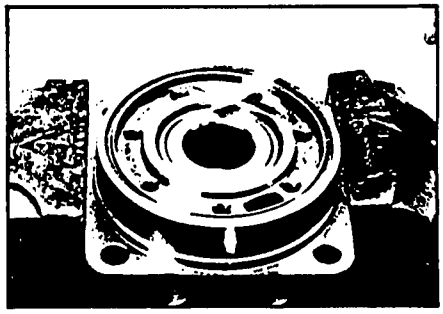


Figure 48

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.

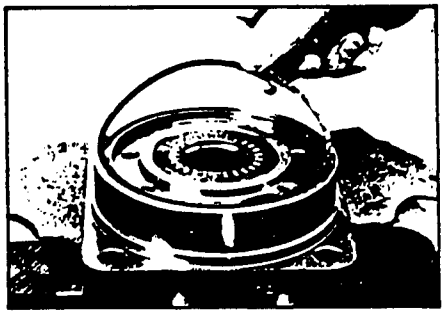


Figure 50

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.

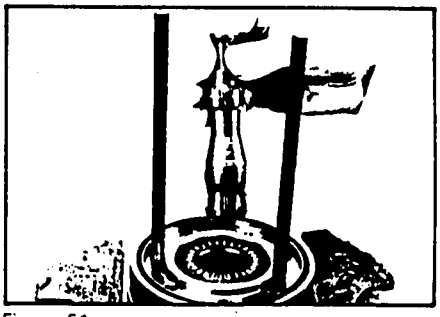


Figure 51

assemble wear plate

12. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18). SEE FIGURE 52.

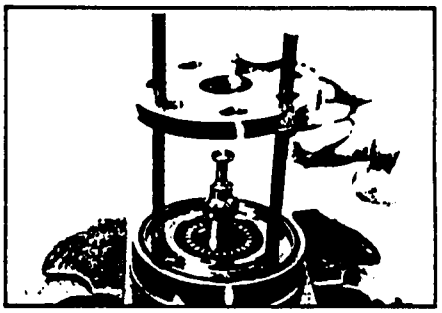


Figure 52

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.

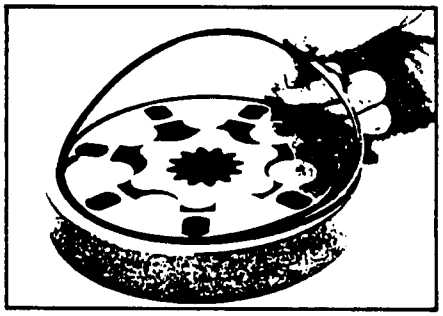


Figure 53

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).

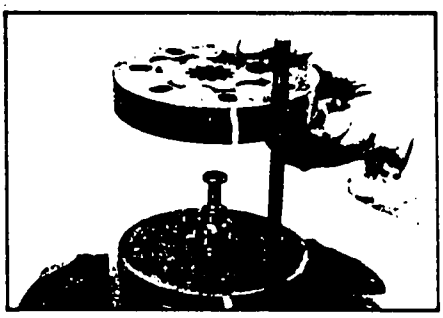


Figure 54

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.

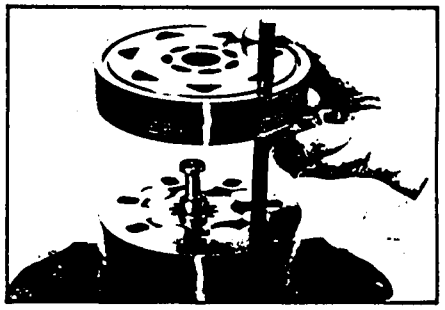


Figure 56

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.

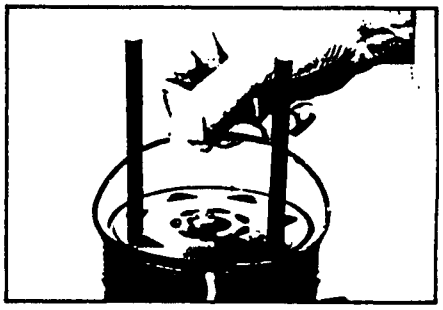


Figure 57

assemble commutator ring

18. Assemble the commutator ring (6) over alignment studs onto the manifold. SEE FIGURE 58.

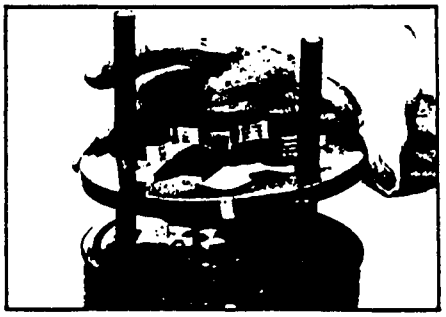


Figure 58

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.

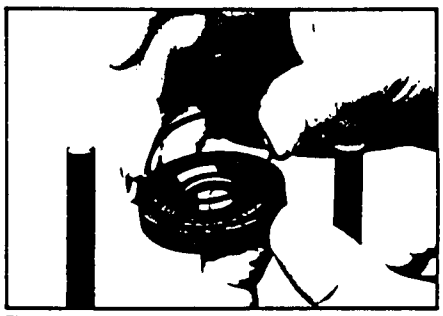


Figure 59

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.

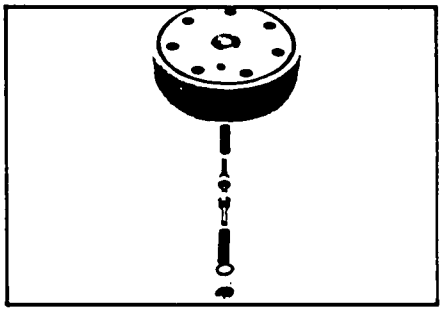


Figure 61

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.

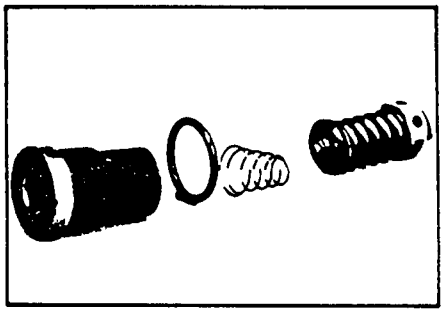


Figure 62

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.

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.

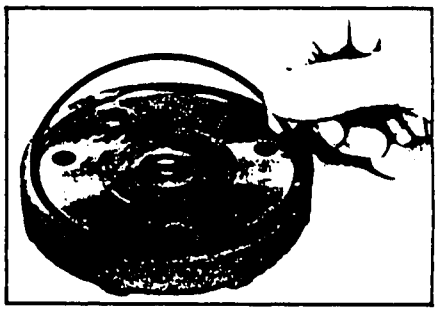


Figure 63

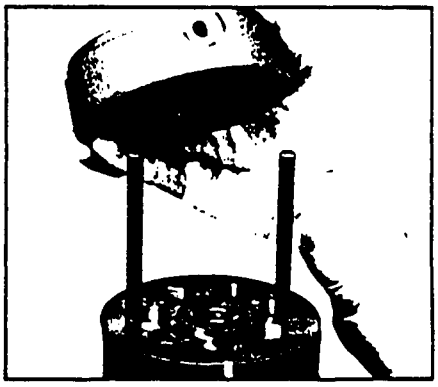


Figure 64

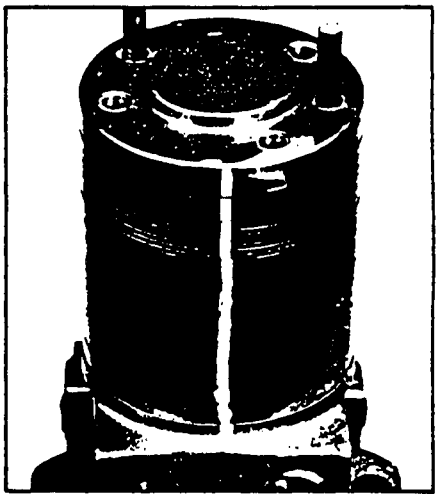


Figure 65

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.

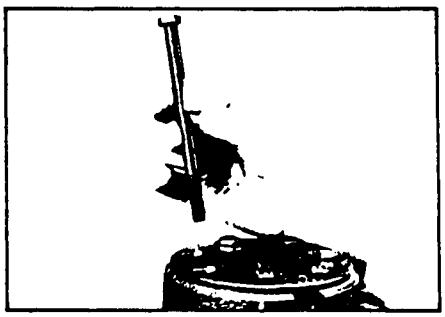


Figure 66

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.

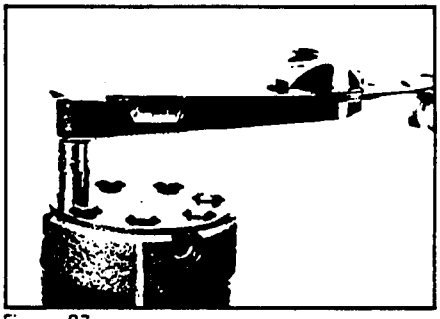


Figure 67

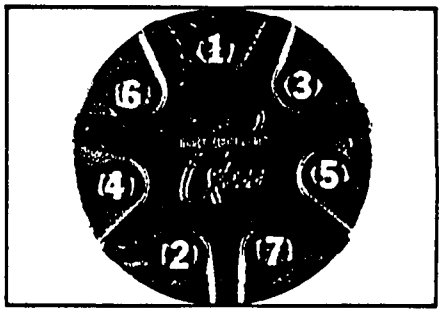


Figure 68

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.

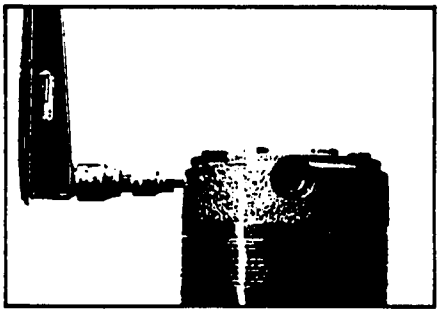


Figure 69

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 32 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.

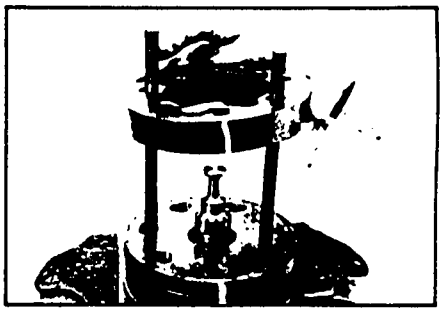


Figure 70

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.

assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets. SEE FIGURE 72.

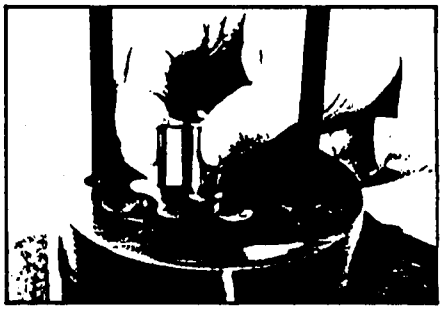


Figure 72

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.

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 25 to continue Torqmotor assembly.

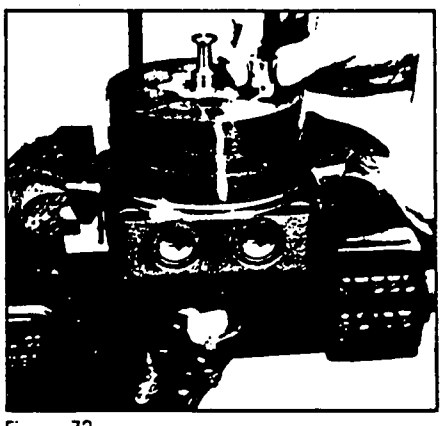


Figure 73

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.

assemble second stator half

7. Assemble the second stator half (8D) over the two alignment studs and rotor (8A) with seal ring side down onto the first stator half (8B) aligning any timing marks applied for this purpose.

CAUTION

CAUTION: If the stator half (8B) is a different height (thickness) than stator half (8D) the stator vanes (8C) or (8E) of the same length (height) as the stator half must be reassembled in their respective stator half for the rotor set to function properly.

assemble vanes

8. Assemble six vanes (8E), or as many vanes that will readily assemble into the stator vane pockets.

assemble full complement of vanes

9. 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 (8E) into stator (8D), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

Go to Torqmotor assembly procedure #15, page 25 to continue Torqmotor assembly.

Final Checks

Final Checks

- Pressurize the Torqmotor™ with 100 p.s.i. dry air or nitrogen and submerge in solvent to check for external leaks.
- Check Torqmotor™ for rotation. Torque required to rotate coupling shaft should not be more than 50 ft. lbs. (68 N m)
- On MG & MF Series Torqmotors, pressure port with "A" cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "B" cast under it is for counter clockwise coupling shaft rotation.
- On MB & ME Series Torqmotors, pressure port with "B" cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "A" case under it is for counter clockwise coupling shaft rotation.
- Use test stand if available, to check operation of the Torqmotor™.

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

- 10W40 SE or SF manufacturers suggested oil.
- Hydraulic fluid as recommended by equipment manufacturer, but the viscosity should not drop below 50 SSU or contain less than .125% zinc anti-wear additives.

CAUTION: Do not mix oil types. Any mixture, or an unapproved oil, could deteriorate the seals. Maintain the proper fluid level in the reservoir. When changing fluid, completely drain old oil from the system. It is suggested also that you flush the system with clean oil.

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

Maximum operating temperature 200°F (93.3°C).

Tips for Maintaining the Torqmotor™ Hydraulic System

- Adjust fluid level in reservoir as necessary.
- Encourage all operators to report any malfunction or accident that may have damaged the hydraulic system or component.
- Do not attempt to weld any broken Torqmotor™ component. Replace the component with original equipment only.
- Do not cold straighten, hot straighten, or bend any Torqmotor™ part.
- Prevent dirt or other foreign matter from entering the hydraulic system. Clean the area around and the filler caps before checking oil level.
- Investigate and correct any external leak in the hydraulic system, no matter how minor the leak.
- Comply with manufacturer's specifications for cleaning or replacing the filter.

CAUTION: Do not weld, braze, solder or any way alter any Torqmotor™ component.

CAUTION: Maximum operating pressure must not exceed recommended Torqmotor™ pressure capacity.

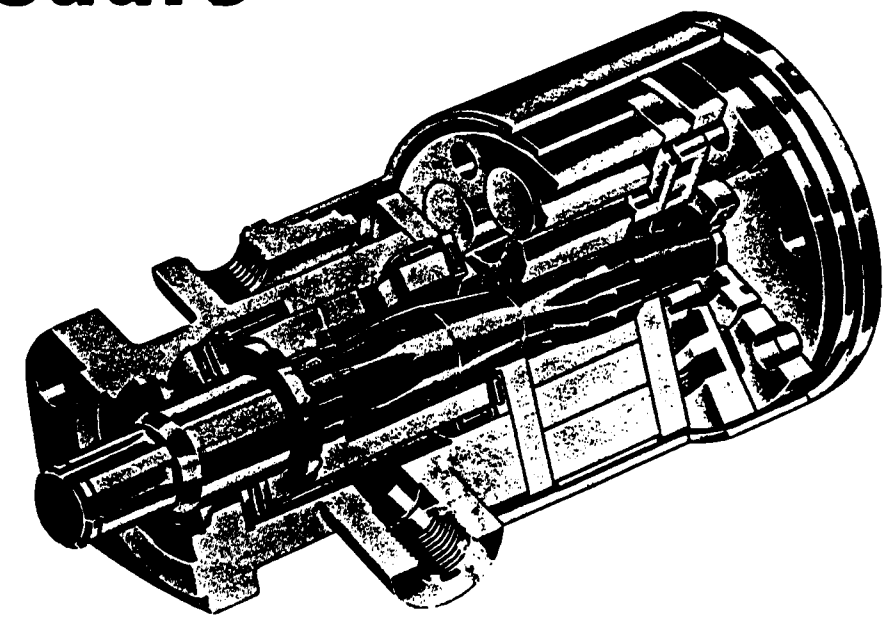
CAUTION: Always carefully inspect any system component that may have been struck or damaged during operation or in an accident. Replace any component that is damaged or that is questionable.

CAUTION: Do not force any coupling onto the Torqmotor™ coupling shaft as this could damage the unit internally.

Ross Gear extends close technical cooperation and assistance. If problems occur which you cannot solve, please contact our Ross Service Department or local Ross approved Distributor. Our phone number and telex number and address are on the back cover of this manual.

Torqmotor™

Service Procedure



MAB and MAE Series

Table of Contents

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 MAB or MAE 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 THEY 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 OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

Preliminary Checks

Hydraulic systems are often trouble-free. 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 MAB and MAE system.

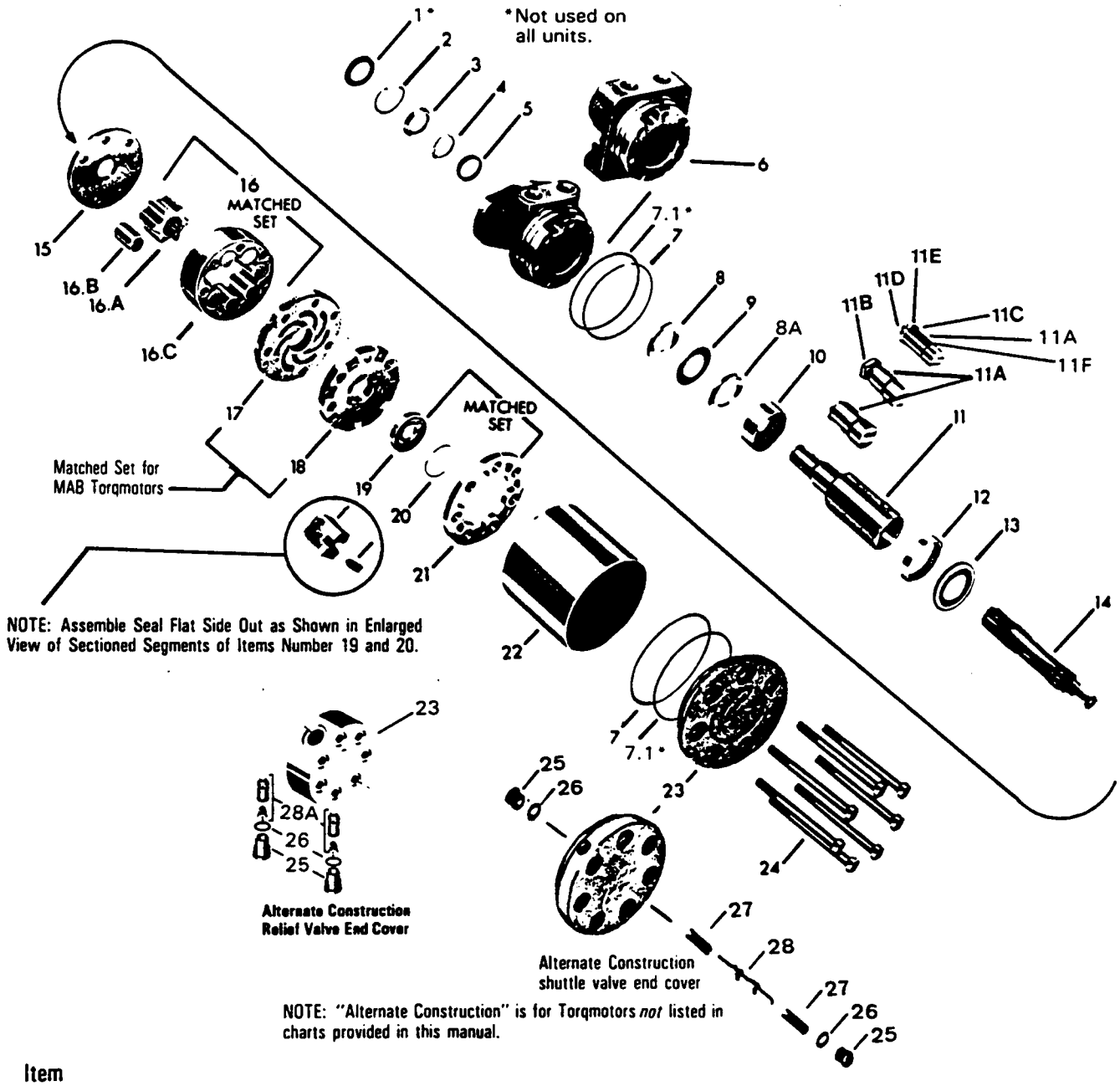
Visually check other components to see if they are loosely mounted, show signs of leaks, or other damage or wear.

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 MAB and MAE are not recommended for hydraulic systems with maximum temperatures above 200°F (93.3°C).

MAB/MAE Torqmotor™ Exploded Assembly View—Typical



Item No.

*1.	Seal	9.	Thrust Bearing	13.	Thrust Bearing	20.	Seal Ring
2.	Retaining Ring	10.	Bearing	14.	Drive Link	21.	Commutator Ring
3.	Back-Up Washer	11.	Coupling Shaft	15.	Wear Plate	22.	Sleeve
4.	Washer	11A.	Key	16.	Rotor Set	23.	End Cover Assembly
5.	Seal	11B.	Nut	16A.	Rotor	24.	Special Bolt (7)
6.	Housing	11C.	Washer	16B.	Vane (7)	25.	Plug
7.	Seal Ring (2)	11D.	Bolt	16C.	Stator	26.	O-Ring
*7.1	Back Up Ring (2)	11E.	Lock Washer	17.	Manifold Plate	27.	Spring (2)
8.	Thrust Washer	11F.	Retaining Ring	18.	Manifold	28.	Valve (Shuttle)
8A.	Thrust Washer	12.	Bearing	19.	Commutator	28A.	Relief Valve (2) (Two piece)

Troubleshooting Checklist

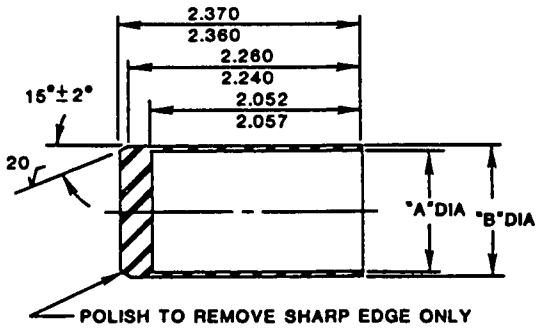
Trouble	Cause	Remedy
Oil Leakage	1. Hose fittings loose, worn or damaged	Check & replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings (7) deteriorated by excess heat	Replace oil seal rings by disassembling Torqmotor™ unit.
	3. Special bolt (24) loose or its sealing area deteriorated by corrosion	(a) Loosen then tighten single bolt to 45-55 ft.lbs. (60-76 N m)
		(b) Replace bolt.
	4. Internal shaft seal (5) worn or damaged	Replace seal. Disassembly of Torqmotor™ unit not necessary.
	5. Worn coupling shaft (11) and internal seal (5)	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 MAB/MAE 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.

Patents

Ross Gear Division products and systems described in this manual are protected by one or more of the following United States patents: 3,289,602; 3,288,034; 3,452,680 and 3,606,601. In addition, patent applications have been filed in Brazil, Canada, Denmark, France, Italy, Japan, Sweden, the United Kingdom, and West Germany.

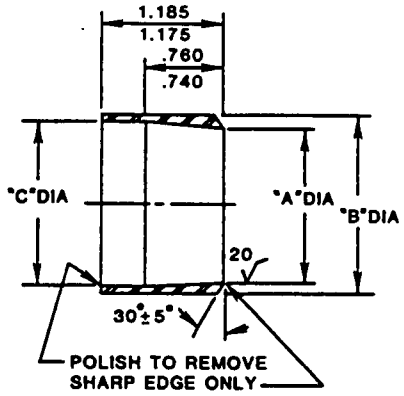
Seal Installation Tools



Dimensions Shown in Inches

Tool No.	Shaft Seal Dia.	Dim. "A"	Dim. "B"
J26751	1¼	1.252/1.258	1.290/1.280
J33074-1	1½	1.502/1.508	1.540/1.530

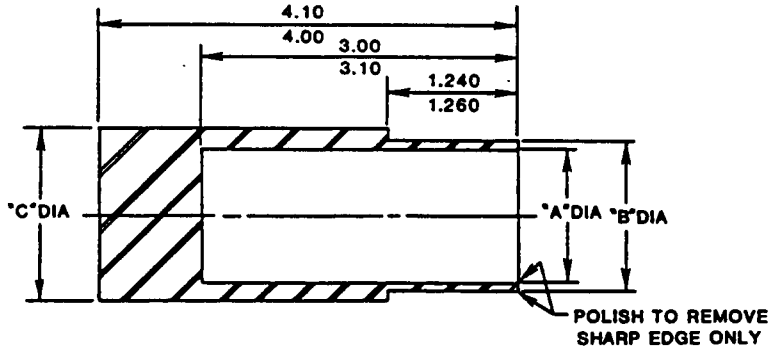
Seal Thimble
Figure 1.



Dimensions Shown in Inches

Tool No.	Shaft Seal Dia.	Dim. "A"	Dim. "B"	Dim. "C"
J26753	1¼	1.502/1.504	1.735/1.715	1.590/1.610
J33074-3	1½	1.751/1.753	1.985/1.965	1.840/1.860

Seal Compression Ring
Figure 3.



Dimensions Shown in Inches

Tool No.	Shaft Seal Dia.	Dim. "A"	Dim. "B"	Dim. "C"
J26752	1¼	1.300/1.350	1.500/1.498	1.600/1.600
J33074-2	1½	1.550/1.600	1.747/1.745	2.400/2.200

Seal Driver
Figure 2.

CONVERSIONS

Inches	mm	Inches	mm
.740	18.80	1.610	40.89
.760	19.30	1.715	43.55
1.175	29.85	1.735	44.07
1.185	30.10	1.745	44.32
1.240	31.50	1.747	44.37
1.252	31.80	1.751	44.48
1.258	31.95	1.753	44.53
1.260	32.00	1.800	45.72
1.280	32.51	1.840	46.74
1.290	32.77	1.860	47.24
1.300	33.02	2.052	52.12
1.350	34.29	2.057	52.25
1.498	38.05	2.200	55.88
1.500	38.10	2.240	56.90
1.502	38.15	2.260	57.40
1.504	38.20	2.360	59.94
1.508	38.30	2.370	60.20
1.530	38.87	2.400	60.96
1.540	39.12	3.00	76.2
1.550	39.37	3.10	78.7
1.590	40.39	4.00	101.6
1.600	40.46	4.10	104.1

NOTE: Tool Kit J26905 for 1¼ inch (32 mm) seal diameter coupling shaft includes tools J26751, J26752 and J26753.

Tool Kit J33074 for 1½ inch (38 mm) seal diameter coupling shaft includes tools J33074-1, J33074-2 and J33074-3.

Tool Kits available from: Kent-Moore, 29784 Little Mack, Roseville, Michigan 46066, Phone (313) 774-9500.

Disassembly and Inspection Procedures

PREPARATION BEFORE DISASSEMBLY

Before disconnecting hoses, thoroughly clean off all outside dirt around fittings. (After disconnecting hoses and before removing from vehicle, IMMEDIATELY plug portholes.) Drain fluid and finish cleaning and drying assembly before placing on a clean work surface. (A piece of clean paper makes an excellent disposable top.) All disassembled parts should be cleaned separately in clean petroleum-based solvent and blown dry with air to avoid nicks and burrs. Discard all seal and seal rings as they are removed from Torqmotor. Use Ross Gear Division or OEM approved service parts.

WARNING: SINCE THEY 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 OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

CAUTION: Never steam or high pressure wash hydraulic components. Do not force or abuse closely fitted parts.

REPLACEMENT OF HIGH PRESSURE SEAL (5) WITHOUT COMPLETE TORQMOTOR™ DISASSEMBLY

(Reference Exploded Assembly View)

1. Remove and discard dirt seal (1) and retaining ring (2) from Torqmotor. (Some applications may not require dirt seal (1).)
2. Completely fill Torqmotor with oil. Plug "A" and "B" ports and set Torqmotor in a clean pan. Place a clean rag around the coupling shaft seal area of the housing to prevent oil spray. Carefully grip coupling shaft with appropriate wrench and rotate coupling shaft rapidly in a counter-clockwise direction. Oil pressure generated by Torqmotor will eject backup washer (3), washer (4) and seal (5).
3. Select the proper seal assembly tools for the 1¼ inch (31.8 mm) or 1½ inch (38.1 mm) seal diameter coupling shaft involved. See Figures 1, 2 and 3, page 2.

   Insert the selected seal compression ring tool (Figure 3), with chamfered end inward, into housing (6) until it bottoms out. Assemble the selected seal thimble tool (Figure 1) over coupling shaft (11). Coat new seal (5) with clean grease and assemble over seal thimble with lip side inward. Push new seal (5) into housing (6) with the appropriate seal driver tool (Figure 2). Remove seal driver, thimble and compression tools.
4. Hold washer (4) between thumb and index finger and slightly collapse washer and assemble into housing (6). Assemble back-up washer (3) tab side out, and retaining ring (2). Be sure rounded edge of retaining ring is faced inward, and that back-up washer tab is between ends of retaining ring. Be sure the new retaining ring (2) is the same thickness as the one removed. (Seal kit contains two retaining rings to select from.) Apply a small amount of clean grease to the back side of new seal (1) and assemble into housing (6) if required.

TORQMOTOR DISASSEMBLY

(Reference Exploded Assembly View)

1. Place Torqmotor in a vise, clamping down on the housing (6) port bosses with the coupling shaft (11) pointed down.

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

2. If the end cover assembly (23) has a shuttle valve (28), scribe a line on housing (6) in some manner in line with the port in the end cover for reassembly orientation. Loosen the two plugs (25) with a 3/16 or 3/8 inch Allen wrench, for later disassembly. Remove the seven special bolts (24) using a 9/16 inch thin wall socket. Inspect bolts for damaged threads, or the sealing ring under the bolt head. Replace damaged bolts.
3. Remove end cover assembly (23) and seal ring (7) and back up ring (7.1) if included by inserting screwdriver between end cover assembly and sleeve (22). Pry up end cover assembly and lift from unit with rings attached. Discard seal ring and back up ring. It may be necessary to use a chisel and hammer to break the end cover loose.
4. If the end cover (23) has shuttle valve (28) or relief valve (28A) and the previously loosened plugs (25), remove the two plugs and o-rings (26).

   CAUTION: Be ready to catch two springs (27) and shuttle valve (28) or relief valve (28A) that will fall out of the end cover valve cavity when the plug assemblies are removed.

   Thoroughly wash cover in proper solvent and blow dry. Be sure the 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 cover as necessary.

   NOTE: O-ring (26) is not included in seal kits but is serviced separately if required.
5. Remove commutator ring (21), commutator (19), seal ring (20), and manifold (18) by using two of the special bolts (24) as a lifting tool—insert the two special bolts into two holes and lift out the previously mentioned parts.
6. Remove seal ring (20) from commutator (19), using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator and commutator ring (21) for cracks or burrs. Inspect commutator for wear, scoring, spalling or brinelling. If

any of these conditions exist, replace commutator and commutator ring as a matched set.

7. Remove manifold plate (17) by again using two special bolts (24) as a lifting tool. Inspect manifold (18) and manifold plate (17) for cracks, surface scoring, brinelling or spalling. Replace manifold or manifold plate that exhibits any of these conditions. A polished pattern on the ground surfaces from commutator or rotor rotation is normal.

8. Remove rotor set (16) and wear plate (15), by again using the two bolts as a lifting tool. Retain rotor set in its assembled form, if possible, to maintain the same rotor vane to stator contact surfaces. Inspect the rotor set in its assembled form for nicks, scoring, or spalling, on any surface and broken or worn rotor splines. If any rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the wear plate for cracks, brinelling, or scoring.

9. Place rotor set on a flat surface and center rotor (16A) in stator (16C) such that two rotor lobes (180° apart) and a roller vane (16B) 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.

10. Remove drive link (14) from coupling shaft (11) if it was not removed with rotor set and wear plate. Inspect drivelink for cracks and for worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts.

11. Remove thrust bearing (13) and inspect for wear, brinelling, corrosion, and a full complement of retained rollers.

12. Remove coupling shaft (11) by pushing on the output end of shaft. 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. Replace coupling shaft if any of these conditions exist.

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

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

13. Remove sleeve (22) by inserting screwdriver between sleeve and housing (6) and pry up. Inspect sleeve for deformation from the original cylindrical shape to a "barrel" or "hour glass" shape. Inspect sleeve ends for severe nicks, burrs or corrosion. Replace sleeve if any of these conditions exist.

    NOTE: Minor burrs and corrision that would damage new seal rings during assembly can be removed from sleeve ends.

14. Remove seal ring (7) and back up ring (7.1) if included from housing (6) and discard seal and back up ring.

15. Remove housing (6) from vise, turn over and reclamp in vise with dirt seal (1) end pointed up.

16. Remove dirt seal (1), retaining ring (2), back-up washer (3), washer (4), and seal (5) from housing (6). Discard seals and washers but keep retaining ring (2) for comparison when selecting new retaining ring from seal kit. If burr exists on retaining ring groove, remove with a scraping tool.

17. Inspect housing (6) 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. If the housing is defective in these areas, discard the housing assembly and the disassembly of the Torqmotor is complete.

18. If the housing assembly (6) has passed inspection to this point, inspect the bearings (9), (10), (12) and thrust washers (8) and (8A). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and the thrust washers must be free of brinelling and corrosion. If the housing has passed this inspection the disassembly of the Torqmotor is completed.

19. If only the outer bearing (12) requires replacement, carefully use a suitable bearing puller to remove bearing so the housing is not damaged.

20. If bearing (10) requires replacement, use a 1.488 inch (37.80mm) maximum diameter shaft or a 1.745 inch (44.32 mm) maximum diameter shaft based on the internal seal (5) bore diameter and press out thrust washers (8), (8A), thrust bearing (9), and bearings (10) and (12). The housing wearplate face should be placed on a block of wood during the pressing operation to protect it. Discard thrust washers (8) and (8A), thrust bearings (9), and bearings (10) and (12) and replace with new parts, as parts will have been damaged when being pressed out.

    NOTE: The depth or location of bearings (10) and (12) in relation to the housing wearplate face should be measured and noted before pressing the bearings out. This will facilitate the correct reassembly of new bearings.

The disassembly of Torqmotor is completed.

TORQMOTOR ASSEMBLY PROCEDURES

(Reference Exploded Assembly View)

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. 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, sleeve, and housing and from port and sealing areas.

HOUSING BEARING REPLACEMENT PROCEDURES

1. If bearing components were removed for replacement, assemble new thrust washer (8), new thrust bearing (9) and new thrust washer (8A) in that order into housing (6) bearing cavity. If thrust washer (8A) has a chamfer on the inside diameter, the chamfered side must face away from thrust bearing (9).

   NOTE: Thrust washer (8A) will be identical to thrust washer (8) unless a chamfered inside diameter is required because of coupling shaft design.

   NOTE: An appropriate size piloted bearing mandrel is required to press in housing bearings.

2. If bearings (10) and (12) required are for a 2.25 inch (57.2 mm) diameter (nominal) housing bearing bore, press in new bearing (10) which is 1.0 inch (25.4 mm) long, into housing (6) bearing bore to a depth of 2.410 ± .010 inch (61.2 ± 0.254 mm), measured from the housing wear plate contact surface. Then, press in new bearing (12) which is .5 inch (12.7 mm) long into housing bearing bore to a depth of .115 ± .010 inch (2.92 ± 0.254 mm) measured from the housing wear plate contact surface.

   NOTE: Press against the lettered end of bearing cage when pressing in a roller bearing assembly.

3. If the bearings (10) and (12) required are for a 2.50 inch (63.5 mm) diameter (nominal) bearing bore, press in new bearing (10) which is 1.0 inch (25.4 mm) long into housing (6) bearing bore to a depth of 2.379 ± .010 inch (60.43 ± 0.254 mm) measured from housing wear plate contact surface. Press new bearing (12) which is identical to bearing (10) into housing bearing bore to a depth of .115 ± .010 inch (2.92 ± 0.254 mm) measured from the housing wear plate contact surface.

   NOTE: The bearings (10) and (12) must be assembled to the correct depths to assure the necessary clearance for thrust washer (8A) and thrust bearing (13) and to assure required bearing support.

TORQMOTOR ASSEMBLY

If the sealing diameter of the coupling shaft (11) is larger than any other diameter on the output end of the coupling shaft, begin the Torqmotor assembly procedures with Step 1 below. If there is a diameter on the output end of the coupling shaft equal to the sealing diameter of the coupling shaft begin the procedures with Step 6 below.

1. Place housing (6) in a vise and clamp down on housing port bosses with small bore end pointed up. Apply clean grease to new seal (5) and assemble into housing with seal lip pointed inward.
2. Hold washer (4) between thumb and index finger and slightly collapse to facilitate assembly into housing (6).
3. Assemble back-up washer (3) into housing (6) with the anti-rotation tab facing out.
4. Select a new retaining ring (2) from the seal kit, that is the same thickness as the retaining ring removed. Assemble the new retaining ring into housing (6). Be sure rounded edge of retaining ring is faced inward and that back-up washer tab is between ends of retaining ring.
5. Apply a small amount of clean grease to back side of new seal (1) and assemble into housing (6), if a seal (1) is required.
6. Invert housing (6) in vise so that the large bore end is up.
7. Apply cellophane tape around splines or keyway on coupling shaft (11) to prevent damaging seals.
8. Lubricate and assemble coupling shaft (11), firmly seating it against thrust washer (8A).
9. Assemble thrust bearing (13) onto end of coupling shaft (11).
10. Assemble drive link (14) into coupling shaft (11) with their splines in mesh. (Align hole in drive link with hole in coupling shaft (11), if applicable.)

NOTE: Two alignment studs screwed finger tight into housing (6) bolt holes, approximately 180° 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 3/8-24 UNF 2A bolts that are over .5 inch (12.7 mm) longer than the bolts (24) used in the Torqmotor.

11. Assemble wear plate (15) over drive link (14) and studs onto housing (6).
12. Install assembled rotor set (16) with counterbore in rotor (16A) down, if applicable, and splines in mesh with drive link splines.

    NOTE: If necessary, go to "Rotor, Stator, Vane Assembly" procedures on page 9.

13. Assemble manifold plate (17), manifold (18) and then the commutator ring (21) over the drive link (14) onto rotor set (16) per the exploded assembly view. Be sure swirls in manifold and manifold plate are faced together.

14. Assemble a new seal ring (20), flat side up, into commutator (19) and assemble commutator over end of drive link (14) onto manifold (18) with seal side up.

15. Assembly new back up ring (7.1) if required and new seal ring (7) on housing (6), apply a generous amount of SAE 10W40 to both ends of sleeve (22) and assemble onto housing. Make sure sleeve is sitting in a non-cocked position.

16. Turn a plug (25) with a new O-ring (26) loosely onto each end of cover (23) valve cavity if shuttle valve (28) is required.

17. Then insert a spring (27), the valve (28) and another spring (27) into the other end of the valve cavity. Turn another plug (25) with new O-ring (26) loosely into cover valve cavity.

    If relief valve (28A) components were removed from the end cover, assemble new O-ring (26) onto the relief valve plugs (25). Assemble the two piece relief valve (28A) with large end of conical spring into the plug first and the small nut of the other valve piece in the small end of the conical spring. Turn these plug and relief valve assemblies into the end cover loosely to be torqued later.

18. Assemble a new back up ring (7.1) if required and a new seal ring (7) onto end cover and assemble end cover onto sleeve (22) in a non-cocked position.

    NOTE: If the end cover has a valve (28) or (28A) use the line you previously scribed on the housing (6) to radially align the end cover port into its original position.

19. Assemble seven special bolts (24) and screw in finger tight. Removal of the two alignment studs should be made after at least two bolts have been assembled. Alternately and progressively tighten the bolts to pull end cover assembly (23) and sleeve (22) into place with a final torque of 50 ± 5 ft.lbs. (68 ± 8 N m).

    Tightening sequence:

    NOTE: The special bolt (24) required for use with the shuttle valve (28) end cover assembly (23) is longer than the bolt required with the standard end cover assembly. Refer to the individual service parts list for correct service part number.

20. Torque the two shuttle plug valve assemblies (25) into a end cover assemble to 12-19 ft.lbs. (16-26 N m). Torque the relief valve plug assemblies (25) into an end cover assembly to 45-55 ft.lbs. (61-75 N m).

21. If seal (5), washer (4), back-up washer (3), snap ring (2) and seal (1) have not yet been assembled, invert housing in vise so the coupling shaft (11) is pointing up and follow procedures #3 and #4 under "Replacement of High Pressure Seal" on page 6 to assemble these components.

The assembly of Torqmotor is now complete except for woodruff key (11A), nut (11B), washer (11C), bolt (11D), lock washer (11E) or retaining ring (11F) if applicable at Torqmotor installation. See final checks. All ports should be plugged until Torqmotor is installed in system.

ROTOR, STATOR, VANE ASSEMBLY PROCEDURE

A disassembled rotor (16A), stator (16C) and vanes (16B) that cannot be readily assembled by hand can be assembled by the following procedures.

1. Place stator (16C) onto wear plate (15) after following Torqmotor assembly procedures 1 through 11.
2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate bolt holes and turn two bolts (24) finger tight into bolt holes 180° apart to retain stator and wear plate stationary.
3. Assemble six vanes (16B) into the stator vane pockets.
4. Assemble rotor (16A), counterbore down, if applicable, into stator (16C) and onto wear plate (15) with rotor splines in mesh with drive link splines.
5. Grasp the output end of coupling shaft (11) with locking pliers or other appropriate turning devices and rotate coupling shaft, drive link and rotor to seat the rotor and assembled vanes into stator, creating necessary clearance to assemble seventh vane. Assemble the seven vanes using minimum force.
6. Remove the two assembled bolts if used to retain stator and wear plate.

Final Checks

Final Checks

- Pressurize the Torqmotor™ with 100 p.s.i. (6.9 BAR) dry nitrogen and submerge in solvent to check for external leaks.
- Check Torqmotor™ for rotation. Torque required to rotate coupling shaft should not be more than 50 ft.lbs. (68 N m)
- Pressure port with "A" cast under it on housing (6) is for counter-clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "B" cast under it is for clockwise coupling shaft rotation.
- Use test stand if available, to check operation of the Torqmotor™.

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

- 10W40 SE or SF manufacturers suggested oil.
- Hydraulic fluid as recommended by equipment manufacturer, but the viscosity should not drop below 50 SSU or contain less than .125% zinc anti-wear additives.

  CAUTION: Do not mix oil types. Any mixture, or an unapproved oil, could deteriorate the seals. Maintain the proper fluid level in the reservoir. When changing fluid, completely drain old oil from the system. It is suggested also that you flush the system with clean oil.

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

Maximum operating temperature 200°F (93.3°C).

Tips for Maintaining the Torqmotor™ Hydraulic System

- Adjust fluid level in reservoir as necessary.
- Encourage all operators to report any malfunction or accident that may have damaged the hydraulic system or component.
- Do not attempt to weld any broken Torqmotor™ component. Replace the component with original equipment only.
- Do not cold straighten, hot straighten, or bend any Torqmotor™ part.
- Prevent dirt or other foreign matter from entering the hydraulic system. Clean the area around and the filler caps before checking oil level.
- Investigate and correct any external leak in the hydraulic system, no matter how minor the leak.
- Comply with manufacturer's specifications for cleaning or replacing the filter.

CAUTION: Do not weld, braze, solder or any way alter any Torqmotor™ component.

CAUTION: Maximum operating pressure must not exceed recommended Torqmotor™ pressure capacity.

CAUTION: Always carefully inspect any system component that may have been struck or damaged during operation or in an accident. Replace any component that is damaged or that is questionable.

CAUTION: Do not force any coupling onto the Torqmotor™ coupling shaft as this could damage the unit internally.

Ross Gear extends close technical cooperation and assistance. If problems occur which you cannot solve, please contact our Ross Service Department or local Ross approved Distributor. Our phone number and telex number and address are on the back cover of this manual.

Disclaimer

This Service Manual has been prepared by TRW Ross Gear Division for reference and use by mechanics who have been trained to repair and service hydraulic motors and systems on commercial and non-commercial equipment applications. TRW Ross Gear Division has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the techniques and tools required for maintaining, repairing and servicing the complete line of TRW Ross Gear MAB & MAE Torqmotor Units. However, despite the care and effort taken in preparing this general Service Manual, TRW **makes no warranties** that (a) the Service Manual or any explanations, illustrations, information, techniques or tools described herein are either accurate, complete or correct as applied to a specific Torqmotor unit, or (b) any repairs or service of a particular Torqmotor unit will result in a properly functioning Torqmotor unit.

If inspection or testing reveals evidence of abnormal wear or damage to the Torqmotor unit or if you encounter circumstances not covered in the Manual, STOP – CONSULT THE EQUIPMENT MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE A TORQMOTOR UNIT WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL TRW REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO TRW'S SPECIFICATIONS FOR THE TORQMOTOR UNIT.

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular Torqmotor unit to (a) inspect the unit for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the equipment, or the safe operation of the Torqmotor, and (c) fully inspect and test the Torqmotor unit and the hydraulic system to insure that the repair or service of the Torqmotor unit has been properly performed and that the Torqmotor and hydraulic system will function properly.

SERVICE BULLETINS

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

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