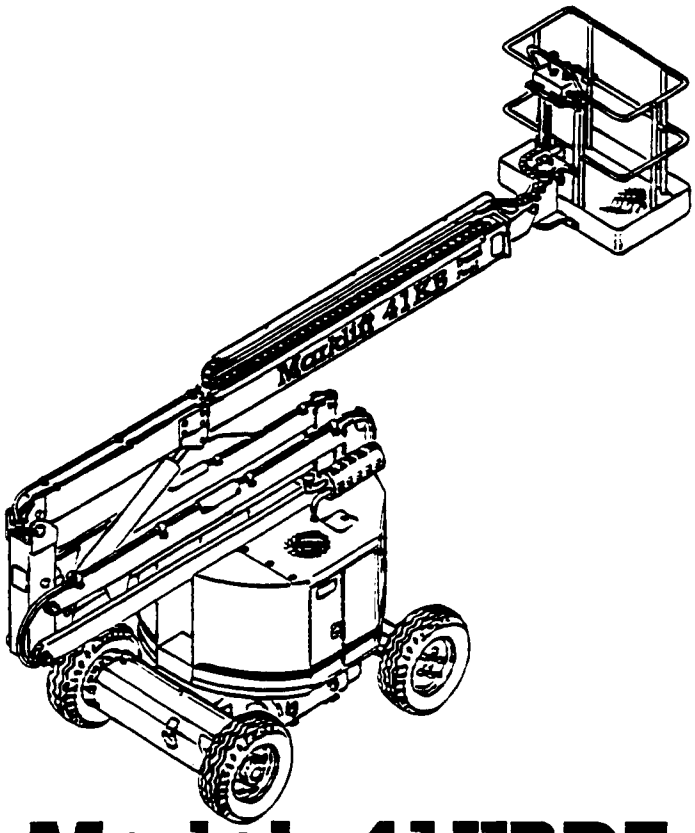
The Marklifts.®
A Product of Mark Industries

SELF-PROPELLED KNUCKLEBOOM OPERATION MAINTENANCE AND PARTS MANUAL



Model: 41KBDF

PRELIMINARY ISSUE: June 1990

Mark Industries

P.O. Box 2255
Brea, California 92622
205 South Puente Street, Brea, California 92621
(714) 879-MARK, FAX (714) 879-8884

17308

Mark Industries

TABLE OF CONTENTS

GENERAL

Introduction 3

Specifications 4

Warranty 5

Warranty Registration 6

New Equipment Condition 7

OPERATION

Loading/Unloading Instructions 8

Figure 1: Park Brake Control Valve 8
Figure 2: Securing the MARKLIFT 9

Inspection and Checkout 11

The MARKLIFT Safety 12

Division of Industrial Safety 14
Lead Counterweight Information 16
General Decal Listing 18

Operating Procedures 20

MAINTENANCE

Preventive Maintenance 23

Torque Hub Lubrication 25

Battery Maintenance 26

Battery Fill Instructions 26
Avoiding Battery Hazards 27
Battery Hydrometer Reading 28

Cold Weather Storage 29

Lubrication Chart 30

Trouble Shooting 32

Trouble Shooting Checklist 33

Equipment Maintenance Record 36

Hydraulic Fluid Table 37

Recommended Spare Parts List 38

TABLE OF CONTENTS (CONT.)

SCHEMATICS

Electrical Schematics — Page

41KBDF 1

Hydraulic Schematics

41KBDF 2

PARTS

The MARKLIFT Parts Catalog ..... Section 1

Final Assembly ..... Section 2

Carriage Assembly ..... Section 3

Turret Assembly ..... Section 4

Boom Assembly ..... Section 5

Platform Asssembly ..... Section 6

Options Assembly ..... Section 7

VENDOR

Fairfield Torque Hub Final Drives ..... Section 1

Mico Multiple Disc Brake ..... Section 2

Eaton Hydraulic Motor ..... Section 3

Nissan Engine ..... Section 4

Eaton Double Gear Pump ..... Section 5

Eaton Shift Cylinder ..... Section 6

SERVICE BULLETINS

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 not possible, please contact the Mark Industries Customer Service Engineering Department at (714) 879-MARK.

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 platform capacity, pressure settings and serial number can be found on the ID plate mounted on carriage assembly. The serial number should be used whenever 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.

MARK INDUSTRIES reserves the right to continually make product and safety improvements. Your participation in implementing such improvements will be required.

Description	Model
	41KBDF
Working Height	47' 0" (14.33m)
Platform Height	41' 0" (12.50m)
Load capacity	500 lbs. (226.8 kg)
Platform dimensions	30" x 48" (.76m x 1.22m)
Platform rotation	Manual - 180 °
Horizontal reach	
centerline rotation	28' 10" (8.79m)
clear reach	25' 11" (7.90m)
Length (stowed)	19' 1" (5.82m)
Width	5' 9" (1.75m)
Height (stowed)	6' 9" (2.06m)
Wheelbase	6' 0" (1.83m)
Tailswing	zero
Turret rotation	350° noncontinuous
Travel speed	0-3 mph (0-4.83 km/hr)
Controls	
function	Proportional / hydraulic
drive	Proportional / hydraulic
Turning radius	
inside	6' 8" (2.03m)
outside	13' 0" (3.96m)
Tires	8.75 X 16.5 (pneumatic)
Ground clearance	7" (.18m)
Power source	35 HP water cooled
Weight	13,320 lbs (6042 kg)
Shipping Cube	759.19 cu. ft. (21.5 m^3)

Specifications are nominal and are subject to change 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 or from date first put into service upon proper notification. 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.

Warranty effective as of 2/90

Mark Industries

P.O. Box 2255, Brea, CA 92622-2255

714-879-6275 800-448-MARK

TELEX 194402 FAX 1-714-879-8884

WARRANTY REGISTRATION

Purchaser/Dealer:

Company Name:

Address:

Telephone:

Date shipped (from invoice):

Date shipment received:

Date unit put into service:

Unit will be placed in rental fleet:

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.

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

MODES
SERIAL NUMBER
INSPECTOR

OPTIONS _____

When loading and unloading the **MARKLIFT**, it is necessary to use a combination of winching and driving the boom in low drive speed. <u>The operator in the basket must wear a safety belt attached with lanyard to the safety rings provided.</u>

Make sure that the parking brake is set for immediate braking by opening the parking brake control valve. (Seefigure 1.)

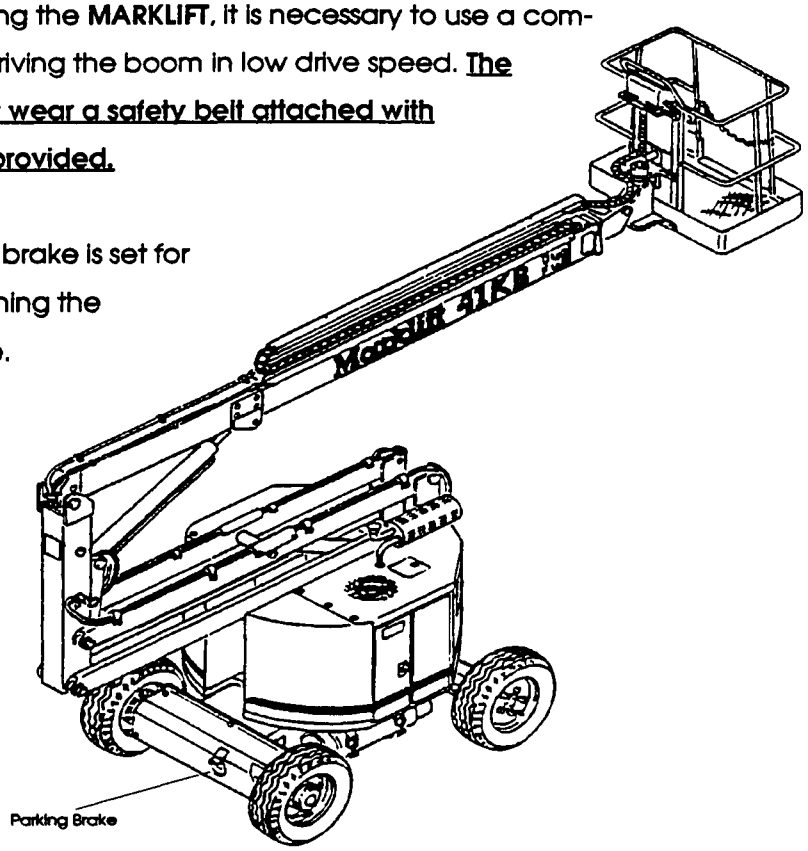


Figure 1: Parking Brake Control Valve

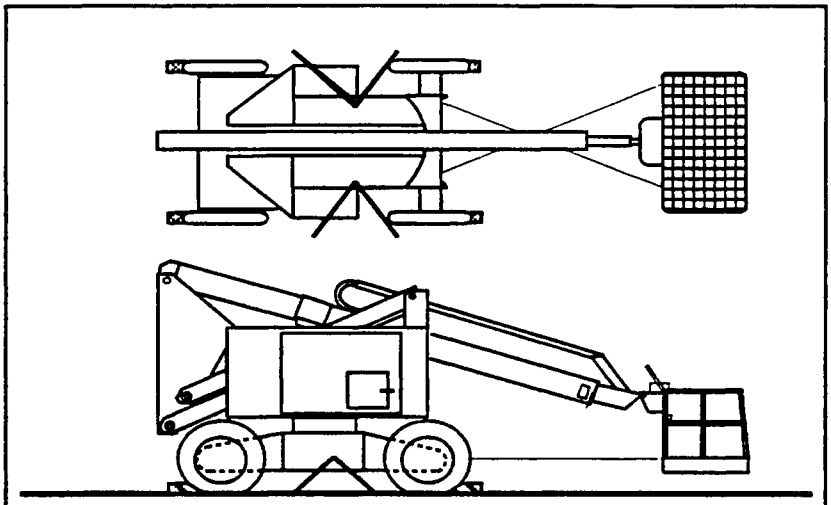
LOADING

1. With the trailer on level ground, align the tires of the **MARKLIFT** with the ramps of the trailer.

2. Attach the winch cable to the unit at the drive wheel end of the base through the tow eye.

3. Exercise great care while driving and steering the unit up the ramp, keeping all slack out of the winch cable. If the ramp is too steep for the unit to climb, the winch will pull the unit up. <u>You must keep the drive function engaged while winching, otherwise the brakes will prevent the wheels from rolling.</u>

4. When the **MARKLIFT** is on the truck and properly located, chain the boom down as shown in figure 2 of this instruction.



Recommended Tie Down Procedure for Gasoline Units. Note: Thin lines indicate individual tie lines.

Do not use binders on the machine's platform tie lines . Individual tie lines can be tensioned by extending the boom or tilting the platform up.

Figure 2: Securing the MARKLIFT to the platform

UNLOADING

1. With the trailer on level ground, disconnect the tie-down chains from the MARKLIFT and make sure that the winch cable is still properly attached to the unit.

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

Warning:	**Do Not** allow slack in the winch cable when going down the ramp, because of the possibility of snapping the cable should the unit descend the ramp too fast.

3. When all the wheels are on level ground, disconnect the winch cable from the unit.

4. Re-adjust the boom parking brakes as follows: First, close the needle valve completely. Open the valve 1/8 turn then place the unit on a flat surface, approximately 20 feet long. Position the boom in the cradle and completely retract the the boom to obtain high speed drive mode.

Drive the **MARKLIFT** approximately 15 feet with the controller handle in maximum position. Release the controller while the wheel is next to a visual marker on the ground. A good slowing and braking distance would be 3 feet measured from the marker to the center line of the same wheel after the unit has completely stopped. Adjust the needle valve on the parking brakes to achieve this distance.

Warning: Do Not drive on uneven, sloping, or soft terrain that sets the unit in an out-of-level condition.

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 batteries for 1.200 ± 50 reading on the hydrometer. Charge the batteries if the readings are below 1.100. 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 boom function switches. Check hoses for leaks.

6. After the ground control functions have been checked out, position the selector switch to "Aerial" for operation at the work platform. After entering the platform, depress the footswitch before using any control function switches. This electrically completes the circuit to the controls.

The **MARKLIFT** conforms to applicable ANSI and OSHA requirements at the time of shipment. 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 person before use of the machine.

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

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

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

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

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

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

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

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

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

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

14. **Do Not** operate boom functions in an out-of-level condition.

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

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

17. **Do Not** lean over platform rails to perform work.

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

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

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

21. **Do Not** jump start other vehicles using the **MARKLIFT** BATTERY.

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."**

Marklift Units With Lead Counterweight

If your MARKLIFT has lead counterweights, please refer to OSHA 29 CFR 19.10.1025 for requirements concerning occupational exposure to lead. It is your responsibility to obtain the regulations that pertain to lead usage for your place of employment and for the protection of your employees.

If you are unable to obtain said regulations, you may contact Mark Industries directly for assistance at (714) 879-MARK. You may also contact Mark Industries for a copy of the Material Safety Data Sheet for Lead.

DANGER, WARNING, EMERGENCY AND CAUTION DECALS

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** are listed. This will enable you to replace the existing decal(s) if they become worn-out, torn, or illegible. It is essential that all decals be in a readable condition for the safe operation of the **MARKLIFT**. It is therefore recommended that they be properly maintained.

Danger, Warning and Caution are used to identify levels of hazard seriousness. Given below is a definition of each term as it applies to the decals:

- Danger (indicated in red):
  Immediate hazards which **Will** result in severe personal injury or death.

- Warning (indicated in orange):
  Hazards or unsafe practices which **Could** result in severe personal injury or death.

- Caution (indicated in yellow):
  Hazards or unsafe practices which **Could** result in minor personal injury or product or property damage.

GENERAL DECALS
41KBDF

DECAL P/N	DECAL DESCRIPTION 41KBDF	ASSEMBLY	QTY
600254	Decal Set	All Standard Decals	1
140595	Tie Down Diagram	Final Assembly	2
23558	Liquid Tank Only	Final Assembly	1
20411	Blue Stripe Square End	Final Assembly	3
20409	Standard Pedestal	Final Assembly	1
181751	"41KB"	Final Assembly	2
140420	"Dual Fuel"	Final Assembly	2
182747	Upper Control	Final Assembly	1
182764	Aerial Control Switch	Final Assembly	1
20419	Danger Keep Clear	Final Assembly	2
185702	110 VAC Circuit Breaker	Final Assembly	1
20410	Mark Industries Logo	Final Assembly	1
20412	Blue Stripe Round Ends	Final Assembly	2
20420	Tire Pressure 75 PSI	Final Assembly	2
2022	Load Capacity 500 Lbs.	Final Assembly	2
130820	Operation & Safety Handbook	Final Assembly	1
22385	Caution Attach Your Safety...	Final Assembly	1
181103	Danger Obey the Following...	Final Assembly	4
22386	"D" Ring Attach Safety...	Final Assembly	2
181102	Danger Do Not Operate...	Final Assembly	2
182101	Danger & Aerial Operation...	Final Assembly	1
20461	Forward Arrow	Final Assembly	1
20462	Forward Arrow Aft	Final Assembly	1
2020	Gasoline or Petrol	Final Assembly	2
2017	Hydraulic System Fluid	Final Assembly	2
20896	Brake	Final Assembly	1
140496	Hand Pump	Final Assembly	1

DECAL P/N	DECAL DESCRIPTION 41KBDF	ASSEMBLY	QTY
140495	Emergency	Final Assembly	1
20860	General Checkout & Operating...	Final Assembly	1
183301	Warning Lead Paint...	Final Assembly	1
183302	Warning This Counterweight...	Final Assembly	1
20660	Identification Nameplate	Final Assembly	1
20661	ANSI A92 Plate	Final Assembly	1

OPERATION

The **MARKLIFT** may be operated from either the ground control or aerial control station. To operate from either station, the key switch must be in the "On" position.

Starting

Aerial Control

1. Position the selector switch (located on the ground control station) to "Aerial", then enter the aerial platform. **Attach safety belt after entering the platform.**

2. Select fuel, Propane or Gasoline, with the three-position switch on the aerial control station. The "Off" position allows for adjustments when switching from one fuel to the other.

3. Push the emergency stop switch to the "On" position.

4. Turn the anti-restart switch to start position and release after engine is started.

Ground Control

1. Set the selector switch (located on the ground control station) to "Ground".

2. Select fuel at the aerial control station to gas or propane.

3. Turn key switch to start position and release after engine is started.

Drive

The **MARKLIFT** knuckle Boom is driveable only from the aerial control station. The unit may be driven with the boom and/or turret in various positions.

1. While depressing the footswitch, lift the controller to unlock and then push forward or pull backward on the drive control lever to move the **MARKLIFT** forward or reverse. The directional arrow decals on each end of the base indicate drive direction when the turret is properly oriented (boom over the steering wheels).

2. The **MARKLIFT** may be driven at higher speeds when the boom is below horizontal and fully retracted (in the cradle). When the boom is out of cradle, the unit will travel at low speed only. Gradually increase speed, adjusting according to the conditions of the terrain.

3. Movement of the control lever automatically releases the brakes. When the drive controller is returned to the center position, the brakes will automatically apply.

STEERING

1. The **MARKLIFT** may be steered from the aerial control only. Make right and left turns by pressing the the footswitch and pushing the steering control on top of the drive pistol grip right or left. Avoid oversteering. The steering angle will remain in the last powered position until repositioned by the operator. The steering switch is a momentary switch and will return to the center when released.

2. Do Not continue to steer in the same direction after the steering cylinder has reached its extreme stroke.

BOOM

Boom functions are fully proportional and selected by toggle switches located on the left side of the aerial control station. Push and hold the desired operation, depress the footswitch, then lift the controller locking stem upward and push forward or backward.

TURRET ROTATION

Turret rotation is grouped with the boom controls and is operated in the same manner. The turret may be rotated 350° noncontinuously. When rotated, the "FORWARD" indicating decals on the base of the unit provide reference for the drive direction and platform orientation.

NOTE: If the turret is rotated 180°, the steering and drive orientation will be reversed!

PLATFORM LEVELLING

The **MARKLIFT** platform is automatically levelled as the boom is raised or lowered. However, the operator may want to adjust the platform while driving the unit on a slope for extended periods of time or to achieve a more natural position when the boom is extended horizontally.

To level the platform, first depress the footswitch then operate the "Platform Levelling" switch to the up or down position. The platform will maintain this attitude until repostioned by the operator. The Platform Levelling switch is a momentary switch which will return to neutral when released.

PLATFORM ROTATION

Toggle Operation (Optional)

The Knuckle Boom platform may be rotated 180° (90° either side of center) which allows access to a larger work area. To rotate the platform, push the toggle switch in the desired direction while depressing the footswitch. The toggle switch is a momentary switch which will return to neutral when released.

Manual Operation

Manual platform rotation is a standard feature of the **MARKLIFT.** The manual rotator is located below the aerial control station. Rotate the platform by lifting the lower part of the platform rotation handle, then rotate the handle to the right or left to obtain the desired position.

EMERGENCY GROUND CONTROL

1. On the ground control panel, select the boom and turret functions and activate switches in the desired directions.

2. To operate the handpump:

   A. Make sure that the master switch is still turned on.
   B. Set selector switch to "Ground".
   C. Push the Emergency Stop/Start switch to "Stop".
   D. Move the handle of the handpump forward and backward or up and down, while holding the selected function switch with the other hand, until the desired position is attained.

SHUTDOWN

1. Fully retract the boom, rotate the turret so that the boom is between the two rear wheels, and completely lower the riser.

2. Close the safety cover on the Emergency switch, placing the switch to "STOP".

3. Turn the master switch to "OFF" and remove the ignition key.

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

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

DAILY (Before use on each work shift)

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

WEEKLY

1. Check the condition of the tires. Make sure they are free of serious cuts or defects.
2. Check that operation and safety decals are in place and readable.
3. Check for proper brake operation.
4. Make sure the batteries are fully charged.
5. Clean the unit by removing all dirt, oil, and grease. The machine may be washed with soap and water.
6. Check for and correct any hydraulic leaks.
7. Check for and correct any structural damage.
8. Check overall performance.

9. Check for wear on cables and hoses.

10. Check for proper hydraulic and engine oil level.

MONTHLY (or first 100 hours)

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

2. Check condition of the batteries. (See Battery Maintenance.)

3. Change the hydraulic oil return filter.

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

5. Grease steering linkage.

6. Check torque hub oil level.

7. Check engine intake air cleaner.

8. Change engine oil filter.

YEARLY

1. Re-pack all wheel bearings.

2. Change the hydraulic oil.

3. Change the hydraulic oil return filter.

4. Change the torque hub oil.

5. Check the ring gear bolts for proper torque.

6. Change or clean air filter.

MARKLIFT SELF-PROPELLED BOOM
MODEL 41KB

1. Type — EP 90

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

2. Oil Temperature

   Continuous — 160° F
   Intermittent — 200° F

3. Oil Change

   Initial — After 50 hours or 50,000 revolutions of operation. Preferable in a loaded condition.

   Subsequent — 1000 hours or (1) year whichever comes first. Higher temperatures make it necessary to change oil more frequently.

4. Oil Fill Level

   To fill, open both fill plugs. Position one plug parallel to the ground. Pour oil into the top fill plug. Fill at slow pace to allow air to escape. When oil begins to leak from the fill plug which is parallel to the ground, stop filling. Close both fill plugs.

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

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

Avoid Battery Hazards !

- Batteries produce flammable and explosive gasses. Keep arcs, sparks, flames and lighted tabacco 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.

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

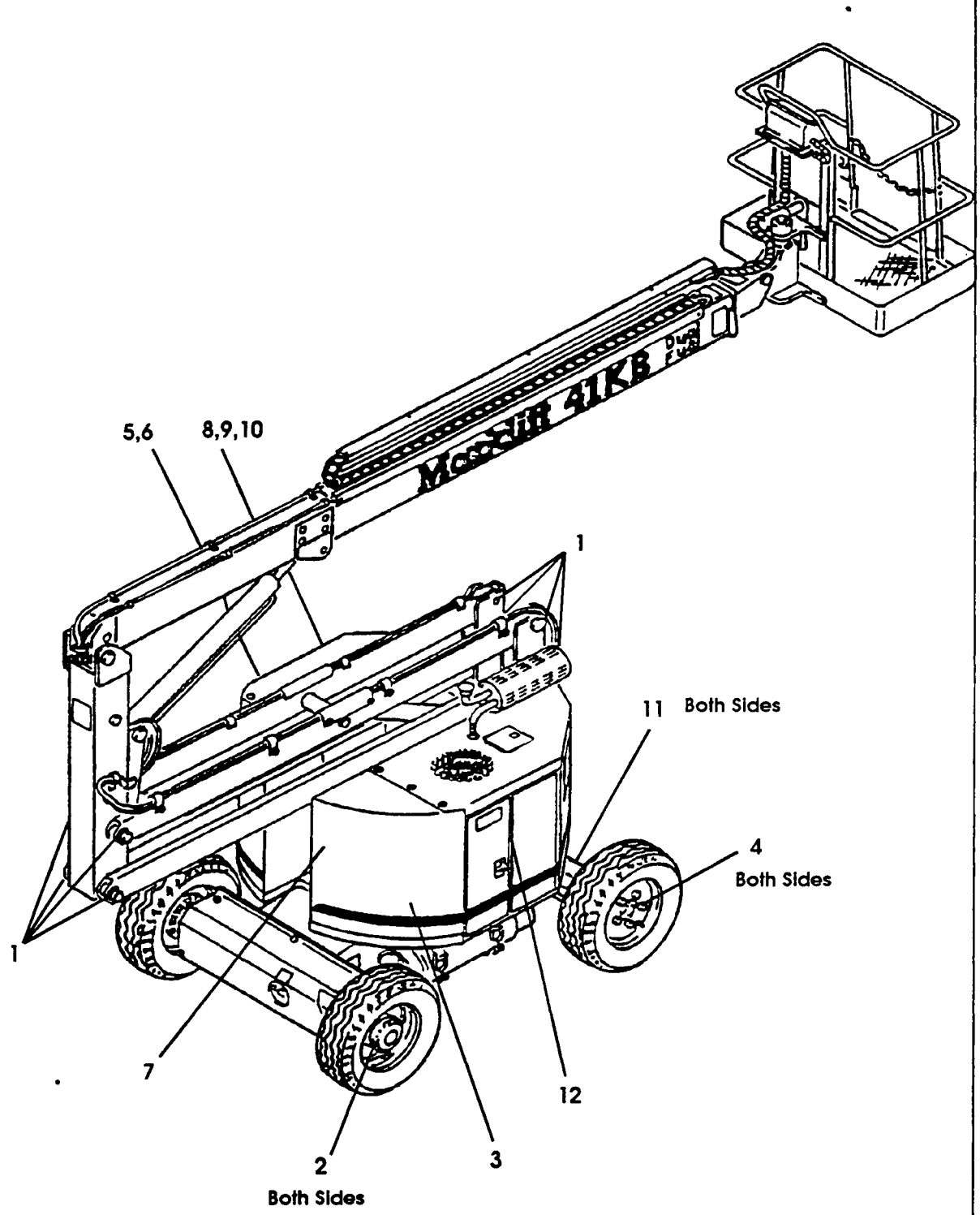
Corrected to 80°F (17°C)	Freezing Temperature	
1.280	-90°F	-68°C
1.250	-62°F	-52°C
1.200	-16°F	-27°C
1.150	+ 5°F	-15°C
1.000	+19°F	- 7°C

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.

Protecting Engines for Winter

To protect the cylinders, pistons, rings and valves from rusting and sticking, a half and half mixture of kerosene and good gas engine oil should be injected into the intake manifold while the engine is warm and running at moderate speed. Use one ounce per cylinder 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 will give a coating of oil on the above mentioned parts protecting them from the atmosphere.

If possible, store the machine inside a building. If there is no available building, the engine should be protected from the weather by a proper covering.


5,6
8,9,10
1
11 Both Sides
4
Both Sides
1
7
12
2
Both Sides
3

RECOMMENDED SERVICE CHART

ITEM	DESCRIPTION	LUBRICANT	FREQUENCY
1.	Pivot pin grease fittings [1]	Mobil - Grease VA6L36AG	Monthly
2.	Torque Hubs	Gear oil SAE 90	Yearly
3.	Ring gear [2]	Mobil - Grease VA6L36AG	Monthly
4.	Wheel Bearings	Mobil - Grease VA6L36AG	Yearly
5.	Hydraulic Return oil filter	21245 filter	100 hours
6.	Hydraulic oil	ATF Dextron II	Yearly
7.	Radiator [3]	50-50 Ratio coolant water	See manufacturer's operating instructions
8.	Battery	Add water and check level	See battery maintenance chart
9.	Engine oil	SAE 30	See manufacturer's operating instructions
10.	Engine oil filter	Recommended element	See manufacturer's operating instructions
11.	King Pins	Mobil grease VA6L36AG	Monthly
12.	Govenor	SAE 30	See manufacturer's instructions

1. Cycle arms and visually ensure bushings are accepting grease.

2. Lubricate entire radius of turntable bearing by rotating turret in 20° increments until one full rotaion (360°) has been completed.

3. Check coolant level at recovery tank. Do not open radiator cap if the engine has been operated less than one hour previously.

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. Determine the charge by using a hydrometer and following the 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 volt ohm meter to trace the power flow, 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 enough electrical power to operate the coil or relay), these items will not function properly.

HYDRAULIC

A. The various hydraulic boom functions are controlled by electric solenoid and proportional valves. When operating boom functions at a reduced speed, a portion of hydraulic fluid is routed back to the tank by the proportional unloading valve, reducing the speed of that function.

B. Directional control valves have two opposed electrical coils with a moveable spool between the coils.

C. Two-position valves are either normally open to allow hydraulic fluid to circulate through them until electrically closed, or normally closed to prevent passage of fluid when electrically energized.

Engine will not run.

1. Check position of fuel selector switch.
2. Check the batteries for proper charge. (See Battery Maintenance.)
3. Check battery connections.
4. Check circuit breaker.
5. Check for adequate fuel supply.
6. Check for water in gas tank.
7. Check for closed fuel shut-off valve.
8. Refer to your authorized MARKLIFT dealer.

HYDRAULIC PUMP

Hydraulic pump producing excessive noise.

1. Check hydraulic oil level.
2. Check suction line fittings for tightness.
3. Check suction hose from tank to pump for kinks.
4. Refer to your authorized MARKLIFT dealer.

BOOM LIFT / RISER

MARKLIFT lift function will not work.

1. Check electric connector to lift/riser solenoid valves for security.
2. Check lift/ riser solenoid valve coil for defect.
3. Check lift/ riser solenoid valve for defect.
4. Check lift/ riser cylinder holding valve for defect.
5. Slope sensor circuit inoperative.
6. Check lift / riser function selector switch.
7. Refer to your authorized MARKLIFT dealer.

BOOM

Problems extending and retracting.

1. Check electric connector to solenoid valves for good connecton.
2. Check solenoid valve for defect.
3. Check function selector switch.
4. Slope sensor circuit inoperative.
5. Check regenerative valve for mal-functions.
6. Refer to your authorized MARKLIFT dealer.

TURRET ROTATION

Turret will not rotate.

1. Check electric connection to solenoid valve for good connection.
2. Check solenoid valve for defects.
3. Check function selector switch.
4. Slope sensor circuit inoperative.
5. Inspect woodruff key between worm gear box and orbit motor.
6. Refer to your authorized MARKLIFT dealer.

STEERING

MARKLIFT steers in only one direction.

1. Check electrical wire connection at valve coils.

2. Check valve coils for defects.

3. Check valve cartridge for defects.

4. Check controller for proper electrical connection.

5. Refer to authorized MARKLIFT dealer.

DRIVE

No forward or reverse drive.

1. Check to see if drive controller output is in both directions.

2. Check directional control solenoid valve or valve coil.

3. Check for loose wire connections on drive/steer contol valve.

4. Refer to authorized MARKLIFT dealer.

No high speed.

1. Check to see if high speed limit switch arm is out of adjustment.

2. Check high speed limit switch for defects.

3. Check electrical connections at high/low speed (series/parallel) valve assembly.

No drive operation.

1. Make sure parking brake releases.

2. Check drive controller command output (LED illuminates).

3. Refer to authorized MARKLIFT dealer.

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

F = Filled
R = Repaired
C = Checked
A = Adjusted
X = Needs repair
NA = Not available

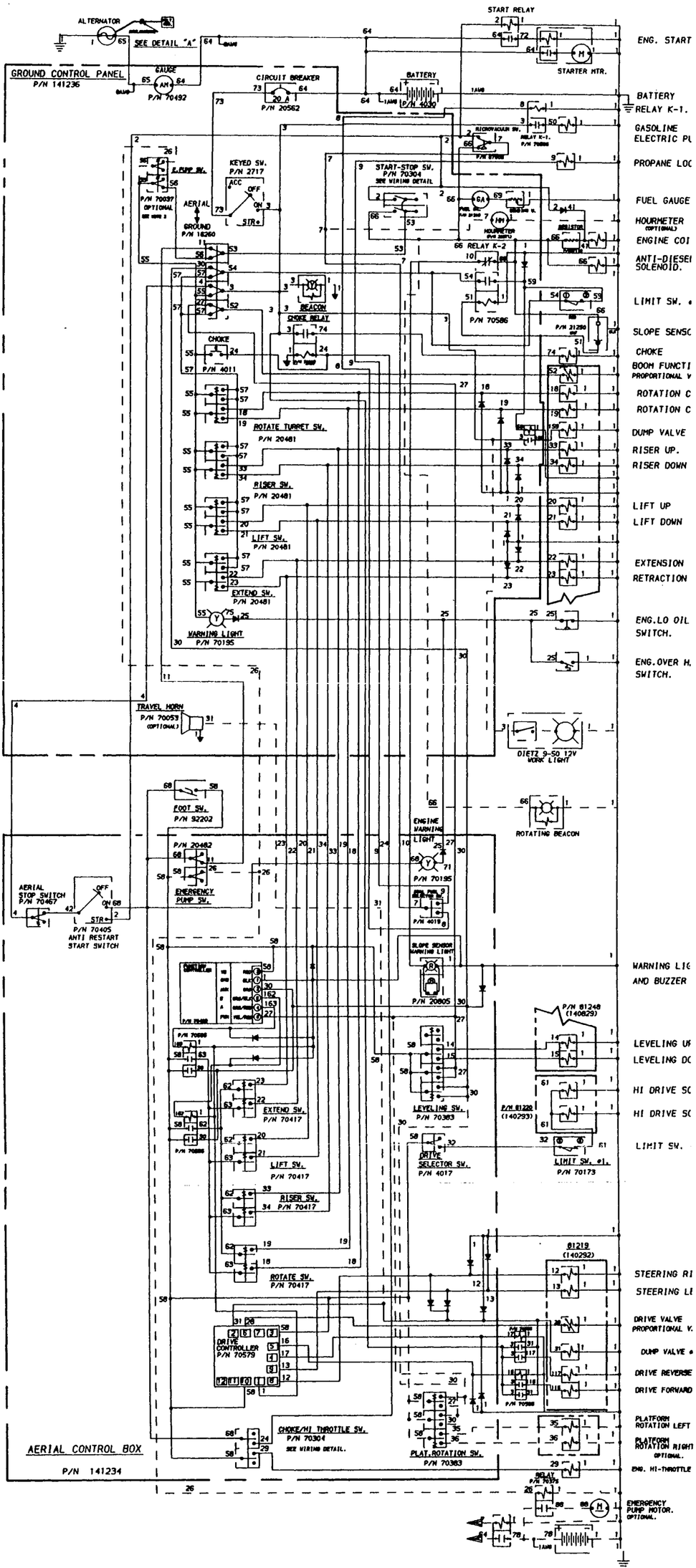
Comments

HYDRAULIC FLUID TABLE

Milestone			Hydraulic fluid			
Oil company			Chevron	Gulf	Shell	Union
Brand Name			ATF Dexron II	ATF Dexron II	Donaz-T6	ATF Dexron
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°

MODEL: 41KBDF

PART NO.	QTY.	DESCRIPTION
600254	2	DECAL SET
600219	2	SEAL KIT TORQUE HUB
66861	2	SEAL KIT STEERING CYLINDER SE
600033	2	SEAL KIT STEERING CYLINDER TH
67150	2	SEAL KIT BRAKES
66869	2	SEAL KIT ENGINE DRIVEN PUMP
600185	2	SEAL KIT RISER CYLINDER
600059	2	SEAL KIT EXTENSION CYLINDER
67997	2	SEAL KIT MASTER CYLINDER
67186	2	SEAL KIT EXTENSION CYLINDER
67357	2	SEAL KIT DRIVE MOTOR
21250	1	SLOPE SENSOR
70031	1	SWITCH LEVER
70107	1	LIMIT SWITCH
67213	6	ELEMENT RETURN FILTER
70173	2	LIMIT SWITCH
70148	1	SWITCH LEVER
21245	4	RETURN FILTER ELEMENT
70195	2	INDICATOR LIGHT
70361	2	CIRCUIT BREAKER
40111	1	PUSH BUTTON SWITCH
2717	1	IGNITION SWITCH
70170	1	RELAY
70479	10	DIODE
20562	2	CIRCUIT BREAKER
70303	1	SWITCH GUARD
70405	1	ANTI-RESTART SWITCH
20805	1	ALARM BUZZER
130927	2	CONTAINER, PLASTIC
65842	4	CAP, ANTI-ROLL
17407	2	HANDBOOK
20884	1	SWITCH GUARD

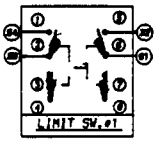


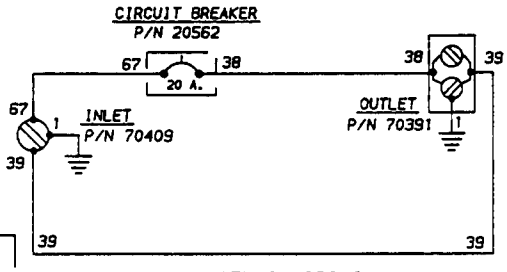
Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	41KBDF
NOTES	P/N 141370 REV.A

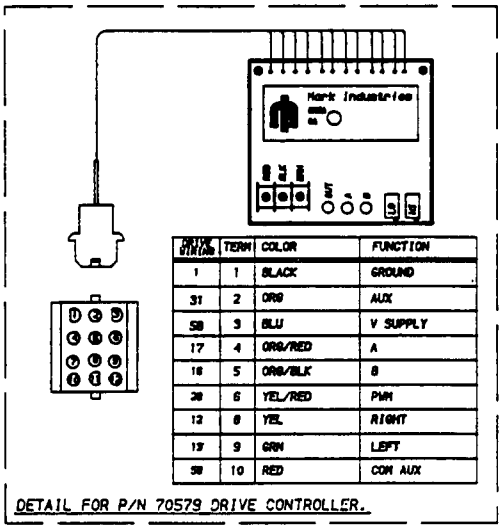
SCHEMATIC
PAGE 1

Mark Industries	TITLE	ELECTRICAL SCHEMATIC	SCHEMATIC
	MODEL	41KBDF	PAGE 1A
	NOTES	P/N 141370 REV.A	





115VAC WIRING.

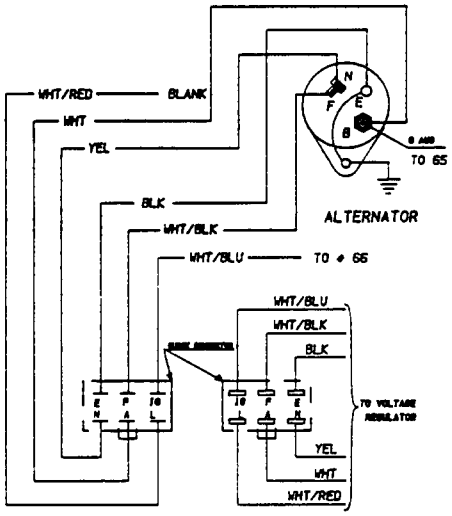


DRIVE WIRING	TERM	COLOR	FUNCTION
1	1	BLACK	GROUND
31	2	ORG	AUX
58	3	BLU	V SUPPLY
17	4	ORG/RED	A
18	5	ORG/BLK	B
30	6	YEL/RED	PWM
12	8	YEL	RIGHT
13	9	GRN	LEFT
59	10	RED	CON AUX

DETAIL FOR P/N 70579 DRIVE CONTROLLER.

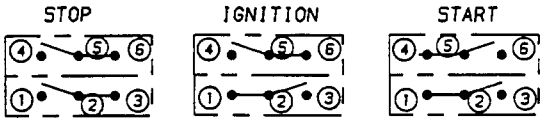


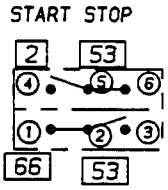
LEGEND FOR LIMIT SWITCHES.



DETAIL "A"

WIRING DETAIL

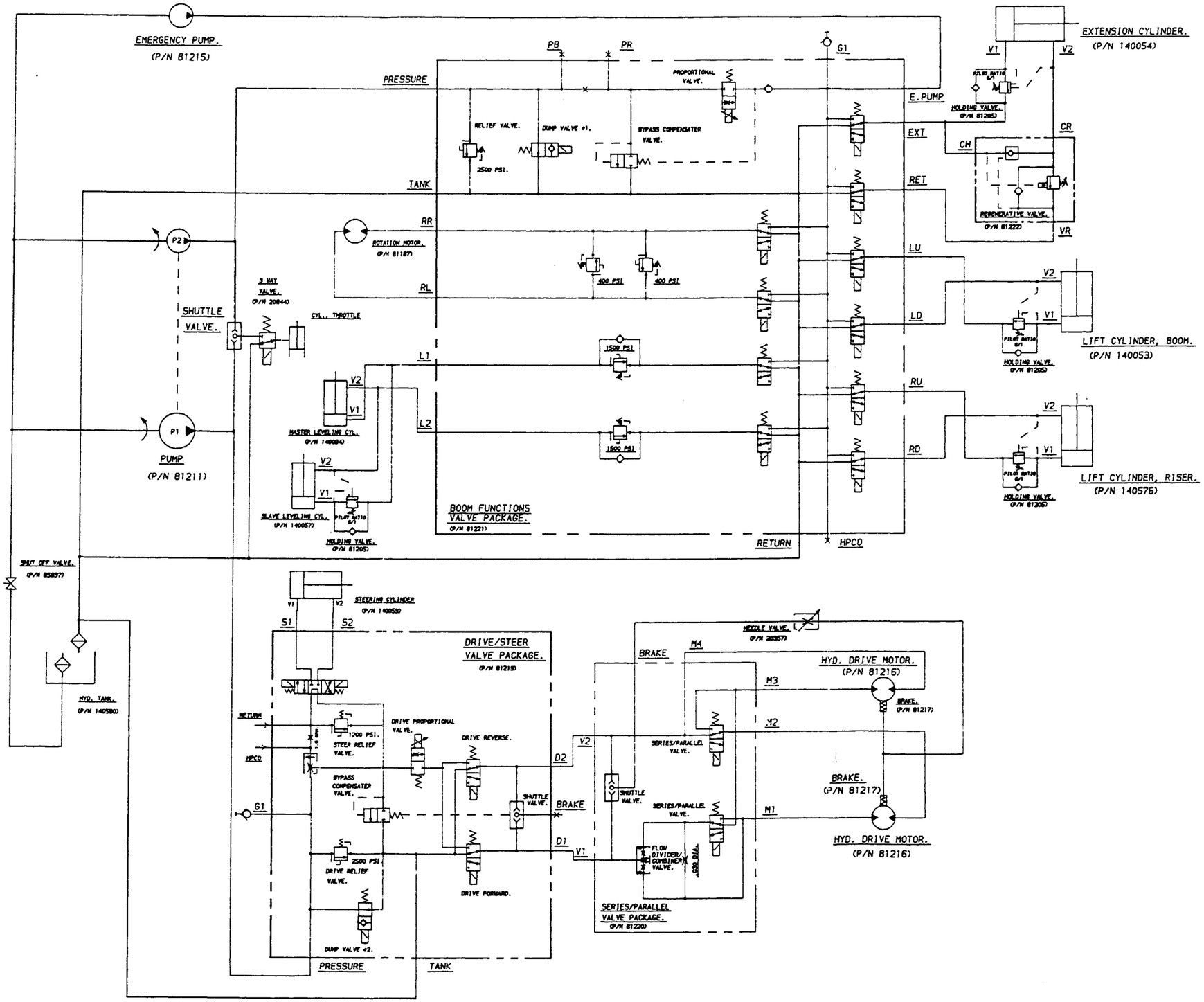




Mark Industries

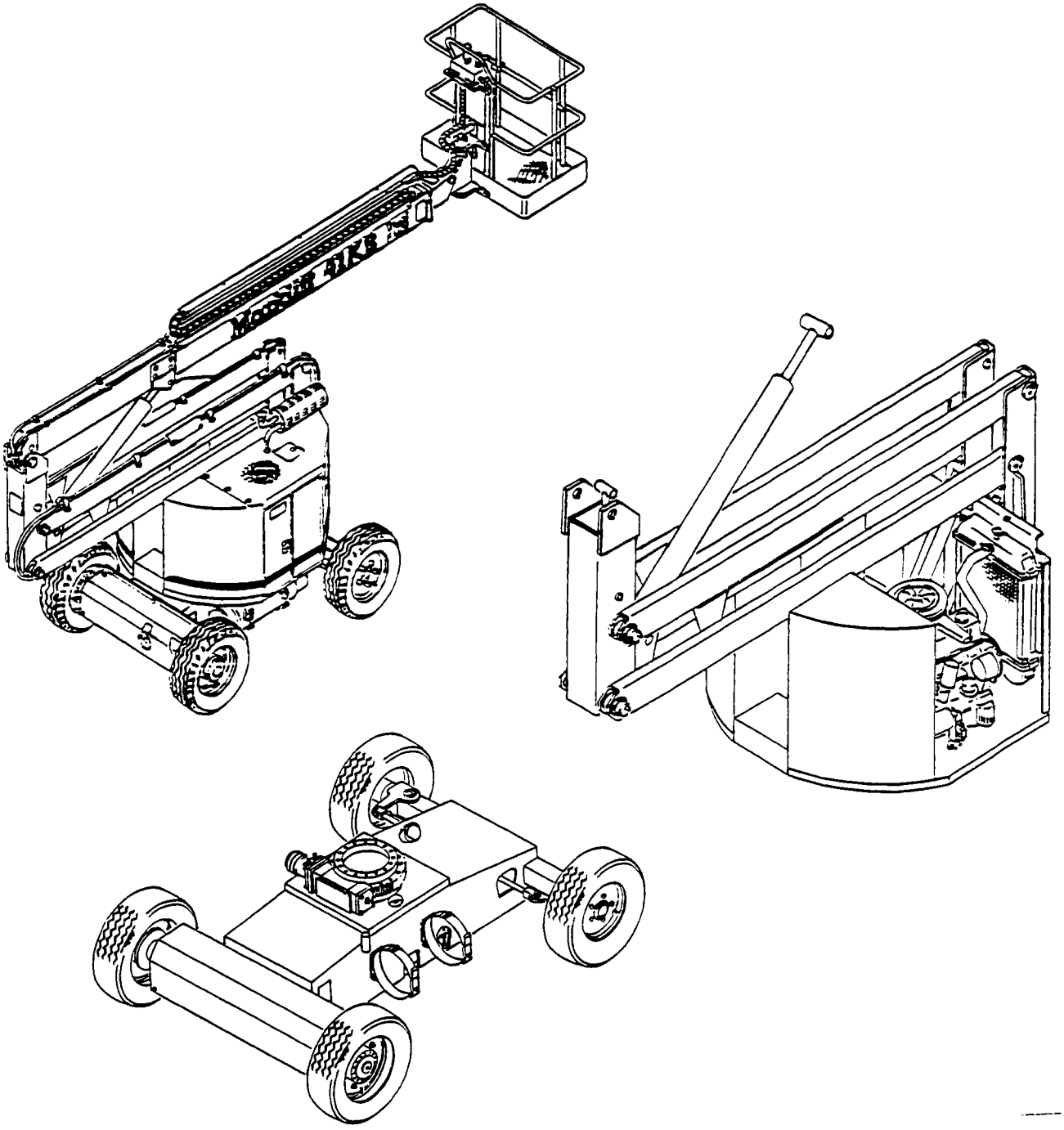
TITLE	HYDRAULIC SCHEMATIC
MODEL	41KBDF
NOTES	P/N 140503 REV.A

SCHEMATIC
PAGE 2



THIS SECTION 1 CONTAINS THE FOLLOWING MATTER:

PAGE NO.	TITLE
1	NOTICE TO USERS
2	TABLE OF CONTENTS
4	HOW TO USE THE PARTS CHAPTER
6	HOW TO ORDER PARTS



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.

THIS PARTS CHAPTER CONTAINS:

SECTION 1 INTRODUCTION TO THE PARTS CHAPTER

PAGE NO.	TITLE
1	NOTICE TO USERS
2	TABLE OF CONTENTS
4	HOW TO USE THE PARTS CHAPTER
6	HOW TO ORDER PARTS

SECTION 2 FINAL ASSEMBLY

FIG. NO.	TITLE
1	FINAL ASSEMBLY
2	DECAL SET
3	PLATFORM ASSEMBLY
4	AERIAL CONTROL BOX ASSEMBLY
5	GROUND CONTROL PANEL ASSEMBLY
6	TYPICAL MANUAL ROTATOR (FROM MID 1987 UNTIL EARLY 1990)
6A	PLATFORM MANUAL ROTATOR ASSEMBLY (SINCE EARLY 1990)
7	HYDRAULIC HOSE KIT DIAGRAM

SECTION 3 CARRIAGE ASSEMBLY

FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY
2	SERIES/PARALLEL VALVE ASSEMBLY
3	STEERING CYLINDER ASSEMBLY (SE)
3A	STEERING CYLINDER ASSEMBLY (TH)
4	SLEW DRIVE MOTOR/ROTATOR ASSEMBLY

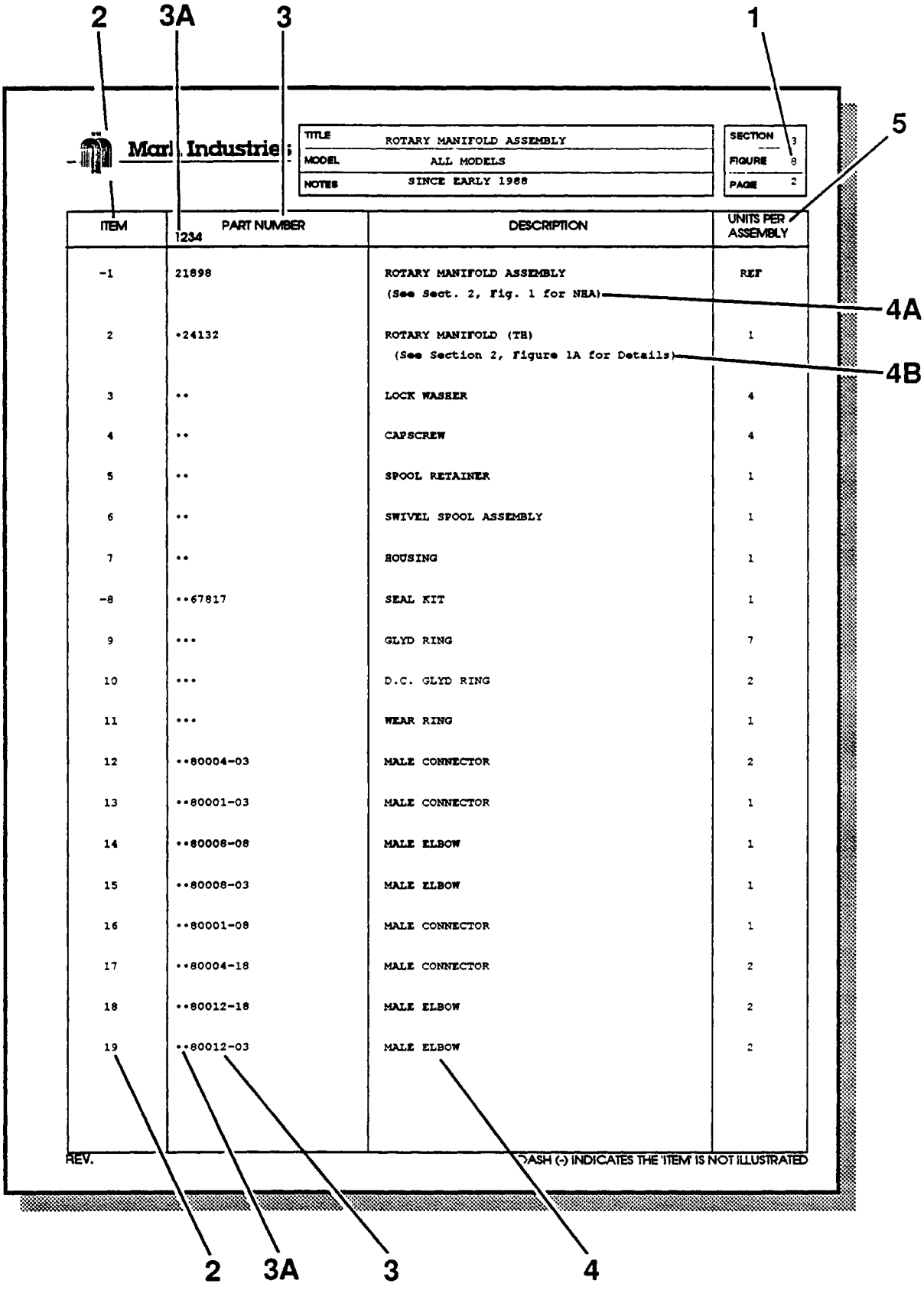
SECTION 4 TURRET ASSEMBLY

FIG. NO.	TITLE
1	TURRET ASSEMBLY
2	BOOM FUNCTION VALVE ASSEMBLY
3	ENGINE/PUMP ASSEMBLY
4	PROPORTIONAL DRIVE/STEER VALVE ASSEMBLY
5	COOLING SYSTEM ASSEMBLY

SECTION 4	TURRET ASSEMBLY (CONT'D)
FIG. NO.	TITLE
6	HYDRAULIC TANK ASSEMBLY
7	RISER LIFT CYLINDER ASSEMBLY (SE)
7A	RISER LIFT CYLINDER ASSEMBLY (TH)
8	MASTER CYLINDER SUB-ASSEMBLY (SE)
8A	MASTER CYLINDER ASSEMBLY (TH)

SECTION 5	BOOM ASSEMBLY
FIG. NO.	TITLE
1	FINAL BOOM ASSEMBLY
2	INNER BOOM ASSEMBLY
3	EXTENSION CYLINDER (SE)
3A	EXTENSION CYLINDER (GB)

SECTION 6	OPTIONS	
FIG. NO.	TITLE	PART NO.
1	LIFTING LUG	140021
2	POWERED PLATFORM ROTATOR ASSEMBLY	140853
3	MONOFILLED TIRES	140659
4	ALL MOTION ALARM	140660
5	TRAVEL WARNING HORN	140657
6	ROTATING AMBER BEACON	140866
7	SPARK ARRESTOR MUFFLER	140666
8	ALL FUNCTION AUXILIARY POWER	140676



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 (See Sect. 2, Fig. 1 for NHA)	REF
2	•24132	ROTARY MANIFOLD (TH) (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	••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**.

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

   Part Number

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

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

4. Elements of the **Description**.

   A. **NHA** (Next Higher Assembly) corresponds to the Section and Figure to be referred to for the major assembly that this item is part of.

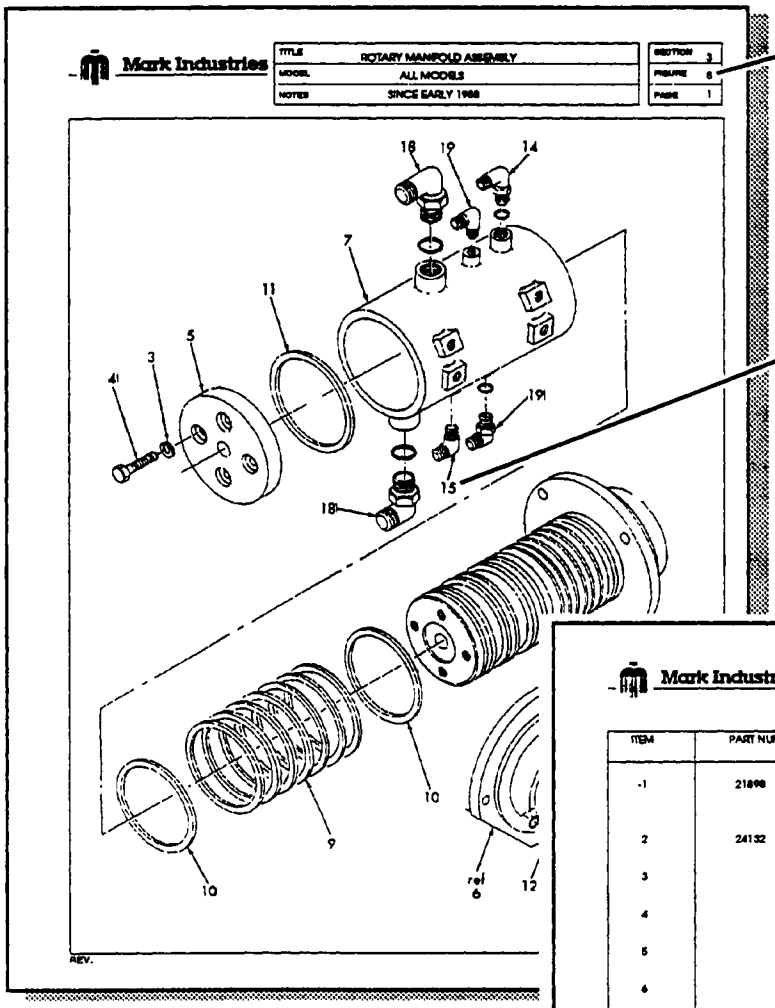
   B. **DETAILS** corresponds to the Section and Figure to be referred to for a more detailed breakdown of this item.

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.*

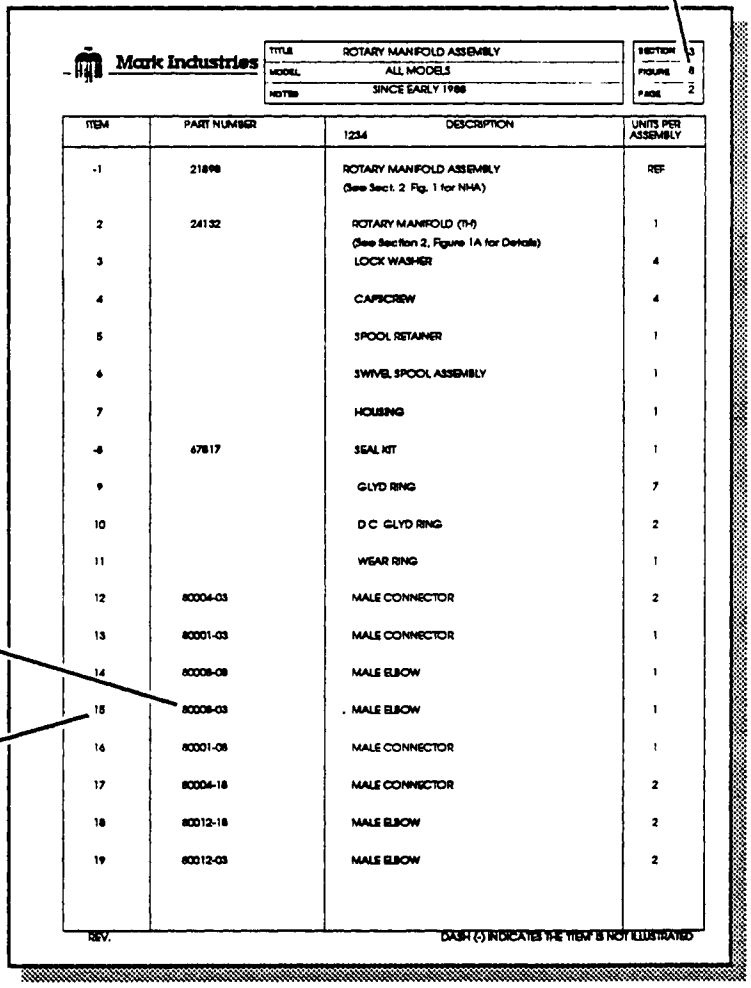
   C. A **number** indicates the *quantity* of the part used in the next higher assembly.



1A

1B

1A



ITEM	PART NUMBER	1234 DESCRIPTION	UNITS PER ASSEMBLY
-1	21898	ROTARY MANIFOLD ASSEMBLY (See Sect. 2 Fig. 1 for NHA)	REF
2	24132	ROTARY MANIFOLD (1-f) (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

1D

1C

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**.

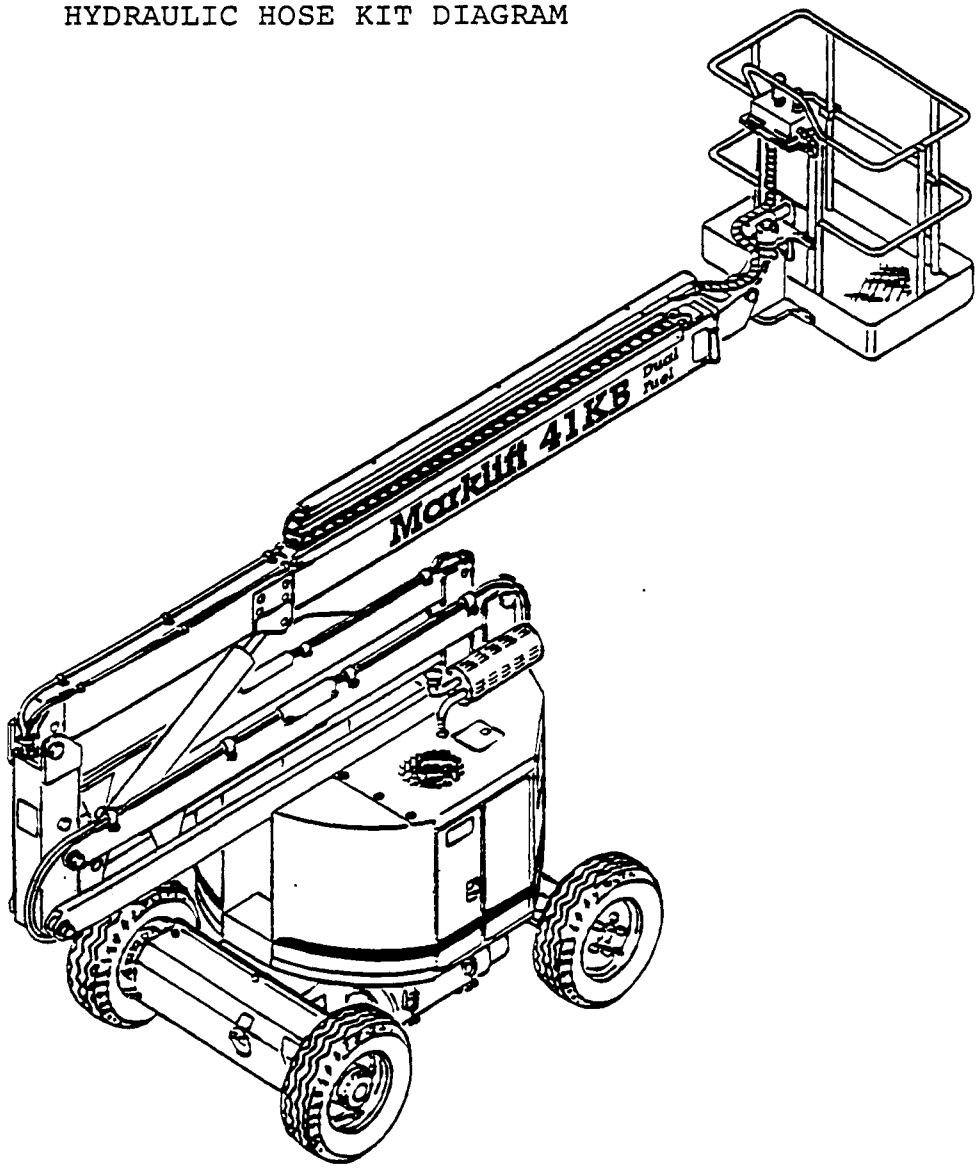
   A. By **FAX**: **(714) 879-8884**

   B. By Phone: (714) 879-MARK

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

SECTION 2 CONTAINS:

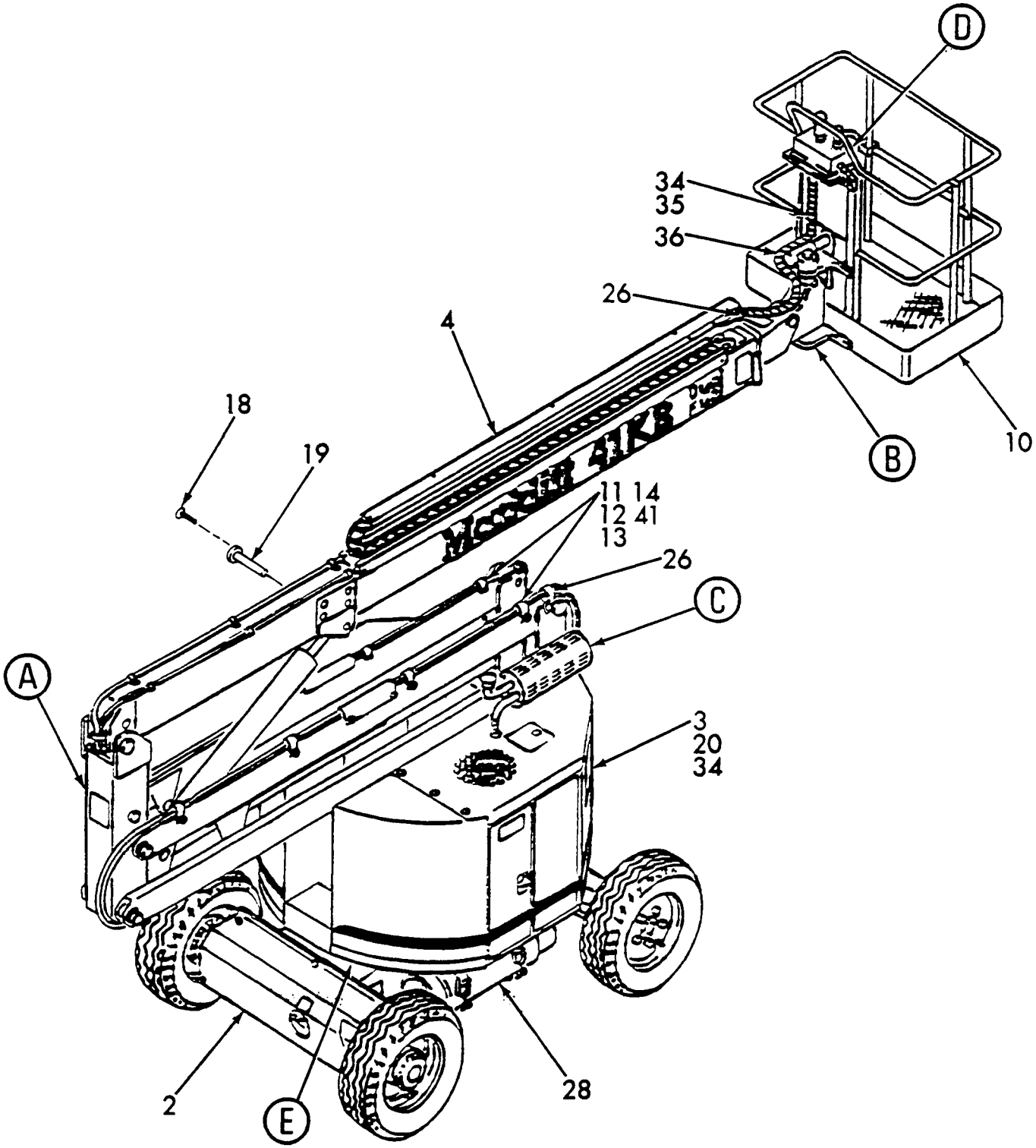
FIG. NO.	TITLE
1	FINAL ASSEMBLY
2	DECAL SET
3	PLATFORM ASSEMBLY
4	AERIAL CONTROL BOX ASSEMBLY
5	GROUND CONTROL PANEL ASSEMBLY
6	TYPICAL MANUAL ROTATOR (FROM MID 1987 UNTIL EARLY 1990)
6A	PLATFORM MANUAL ROTATOR ASSEMBLY (SINCE EARLY 1990)
7	HYDRAULIC HOSE KIT DIAGRAM



Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	1
PAGE	1

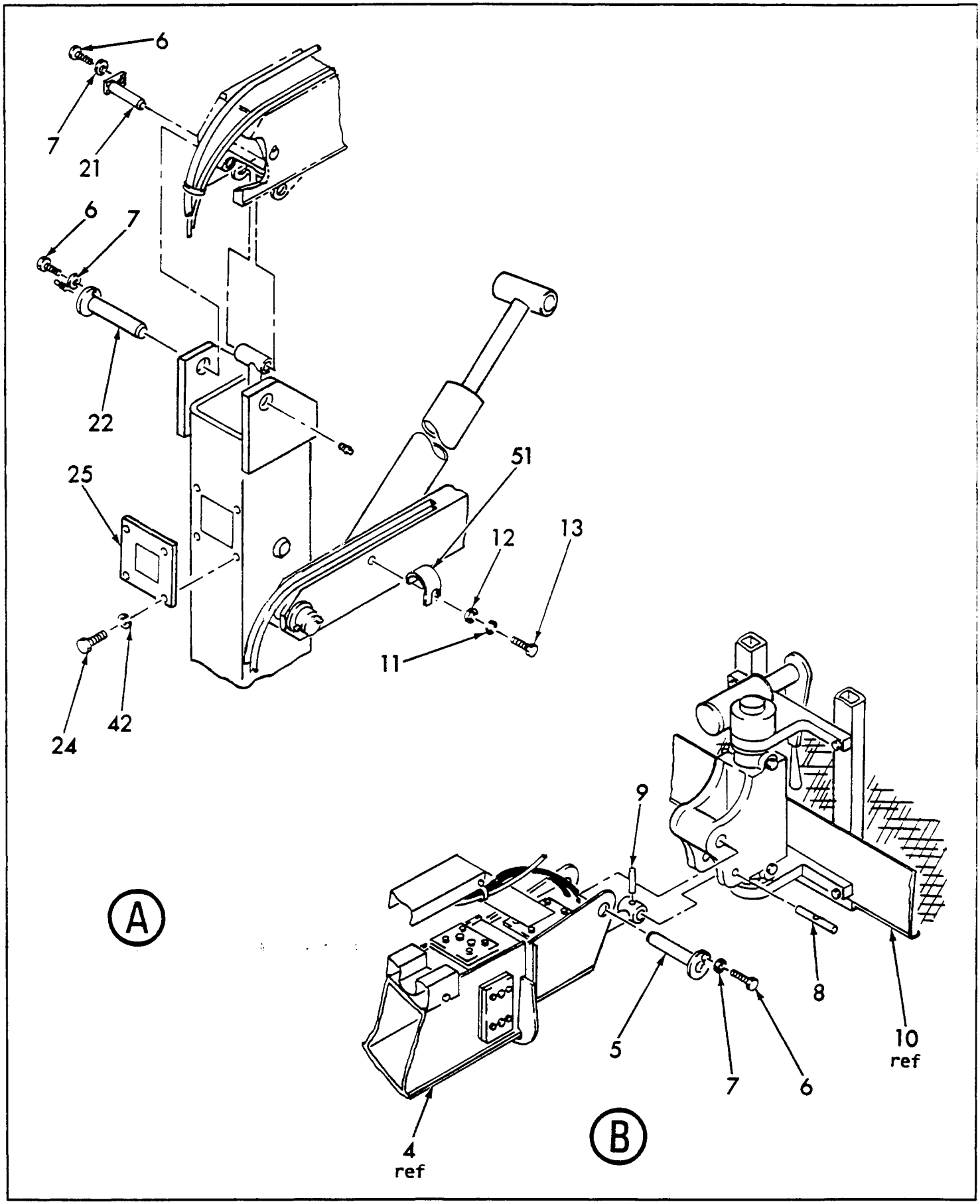


REV.

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	1
PAGE	2

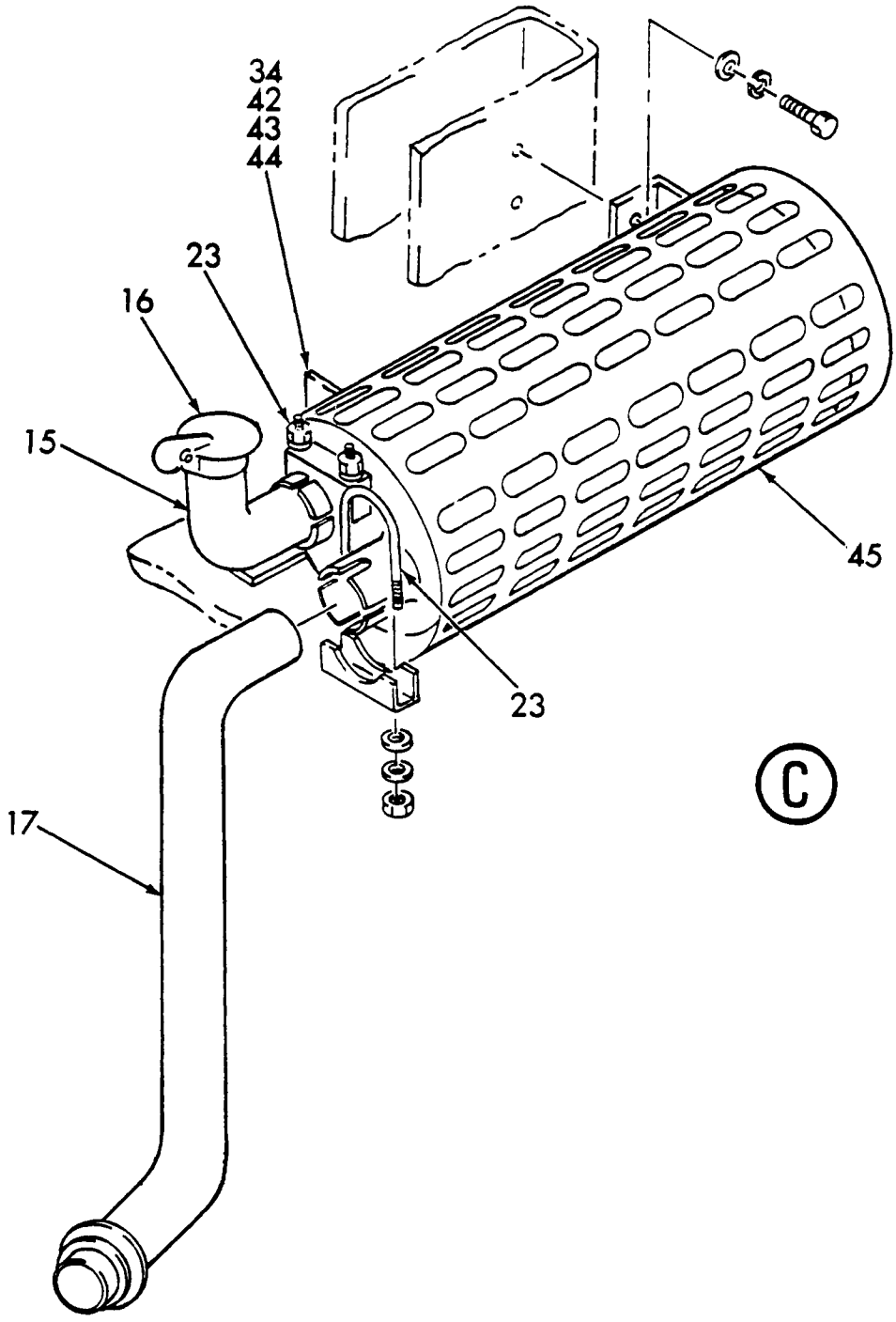


REV.

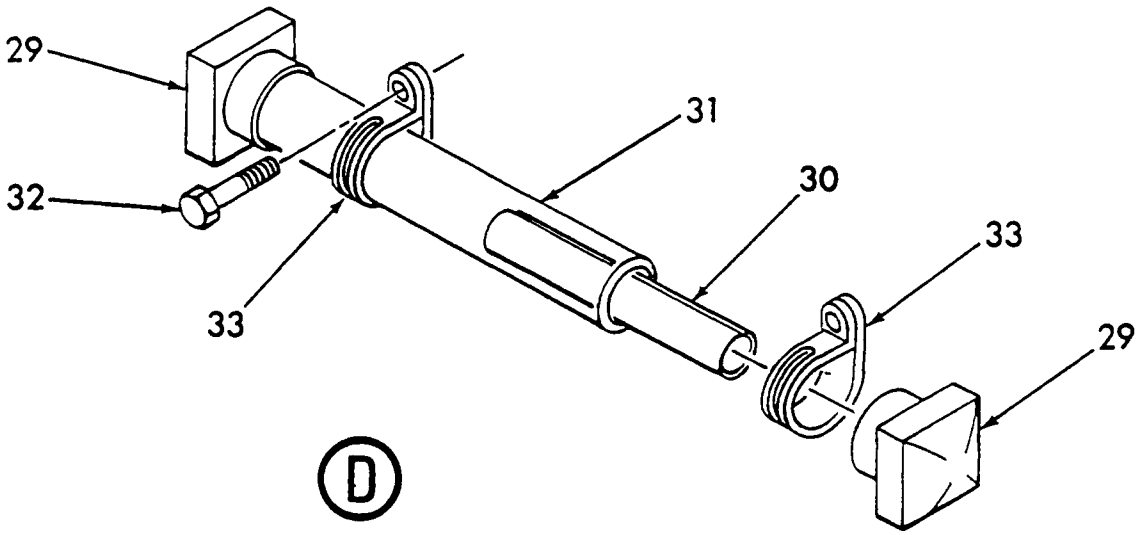
Mark Industries

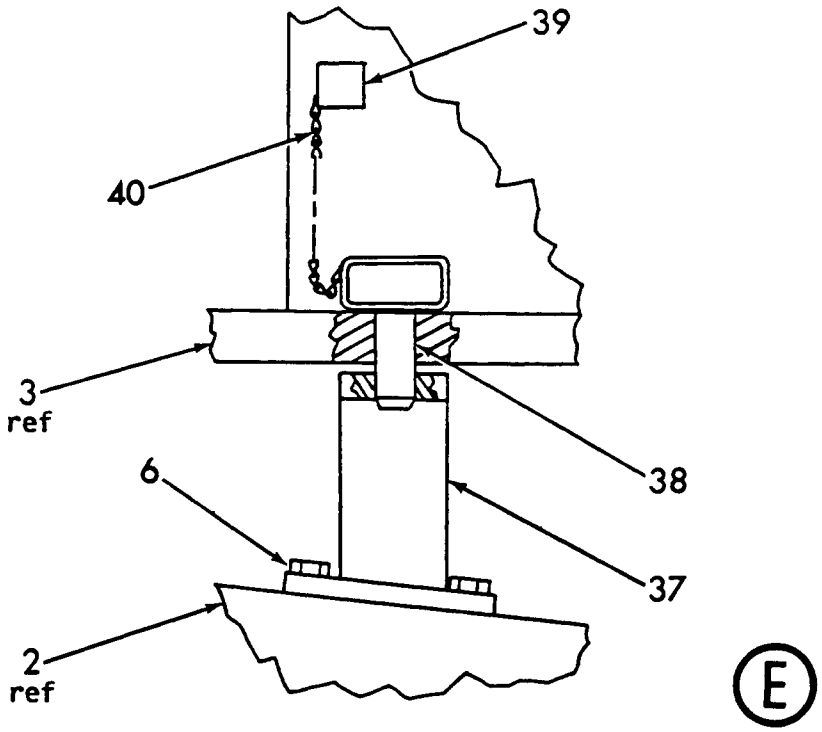
TITLE	FINAL ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	1
PAGE	3



REV.


29
31
32
30
33
33
29
D


39
40
3
ref
38
6
37
2
ref
E

Mark Industries

TITLE	FINAL ASSEMBLY	SECT. 2
MODEL	41KBDF	FIG. 1
NOTES		PAGE 5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140013	ASSEMBLY, FINAL	REF
2	.141127	ASSEMBLY, CARRIAGE (See Sect. 3, Fig. 1 for Details)	1
3	.141093	ASSEMBLY, TURRET (See Sect. 4, Fig. 1 for Details)	1
4	.140122	ASSEMBLY, FINAL BOOM (See Sect. 5, Fig. 1 for Details)	1
5	.140436	PIN, ROTATOR	1
6	.60539	SCREW, CAP	7
7	.63303	WASHER, LOCK	3
8	.140437	PIN, SLAVE CYLINDER ROTATOR	1
9	.64213	PIN, ROLL	1
10	.141232	ASSEMBLY, PLATFORM (See Sect. 2, Fig. 3 for Details)	1
11	.63302	WASHER, LOCK	18
12	.63402	WASHER, FLAT	16
13	.60324	SCREW, CAP	18
14	.140612	ASSEMBLY, ARM CABLE CLAMP	2
15	.23546	ELBOW, MODIFIED MUFFLER	3
16	.21288	CAP, MUFFLER RAIN	1
17	.140624	WELDMENT, EXHAUST	1
18	.61813	SCREW, CAP	1
19	.140428	PIN, BOOM LIFT	1
20	.140287	ASSEMBLY, GROUND CONTROL PANEL (See Sect. 2, Fig. 5 for Details)	1
21	.140431	PIN, MASTER CYLINDER/BOOM	1
22	.140860	PIN, BOOM PIVOT	1
23	.16230	CLAMP, MUFFLER	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.60353	SCREW, CAP	4
25	.140549	COVER, PLATE RISER	1
26	.65463	CLAMP	3
-27	.141149	DIAGRAM, HOSE KIT (See Sect. 2, Fig. 7 for Details)	1
28	.65937	TANK, LIQUID PROPANE	1
29	.65842	CAP, ANTI-ROLL	2
30	.17407	HANDBOOK, OPERATION & SAFETY	1
31	.130927	CONTAINER, PLASTIC	1
32	.61711	SCREW, SELF-TAPPING	2
33	.65867	CLAMP	2
34	.61921	SCREW, BUTTON HEAD	38
35	.16268	CLAMP, HOSE	4
36	.65322	COIL, PROTECTIVE PLASTIC	5 FT
37	.140918	WELDMENT, RETAINER ANTI-ROTATION	1
38	.140915	WELDMENT, TURRET PIN	1
39	.25315	TUBE, ROUND	1
40	.160173	CHAIN, TWIST	1
41	.140791	GUARD, ARM CABLE	2
42	.63301	WASHER, LOCK	6
43	.140381	BRACKET, MUFFLER	1
44	.60701	NUT, HEX	2
45	.65751	MUFFLER (WITH SHIELD)	1
-46	.2673	PAINT, WHITE TOUCH-UP	1 CAN
-47	.2675	PAINT, BLUE TOUCH-UP	1 CAN
-48	.16609	PAINT, BLUE	½ GAL

Mark Industries

TITLE	FINAL ASSEMBLY	SECT.	2
MODEL	41KBDF	FIG.	1
NOTES		PAGE	7

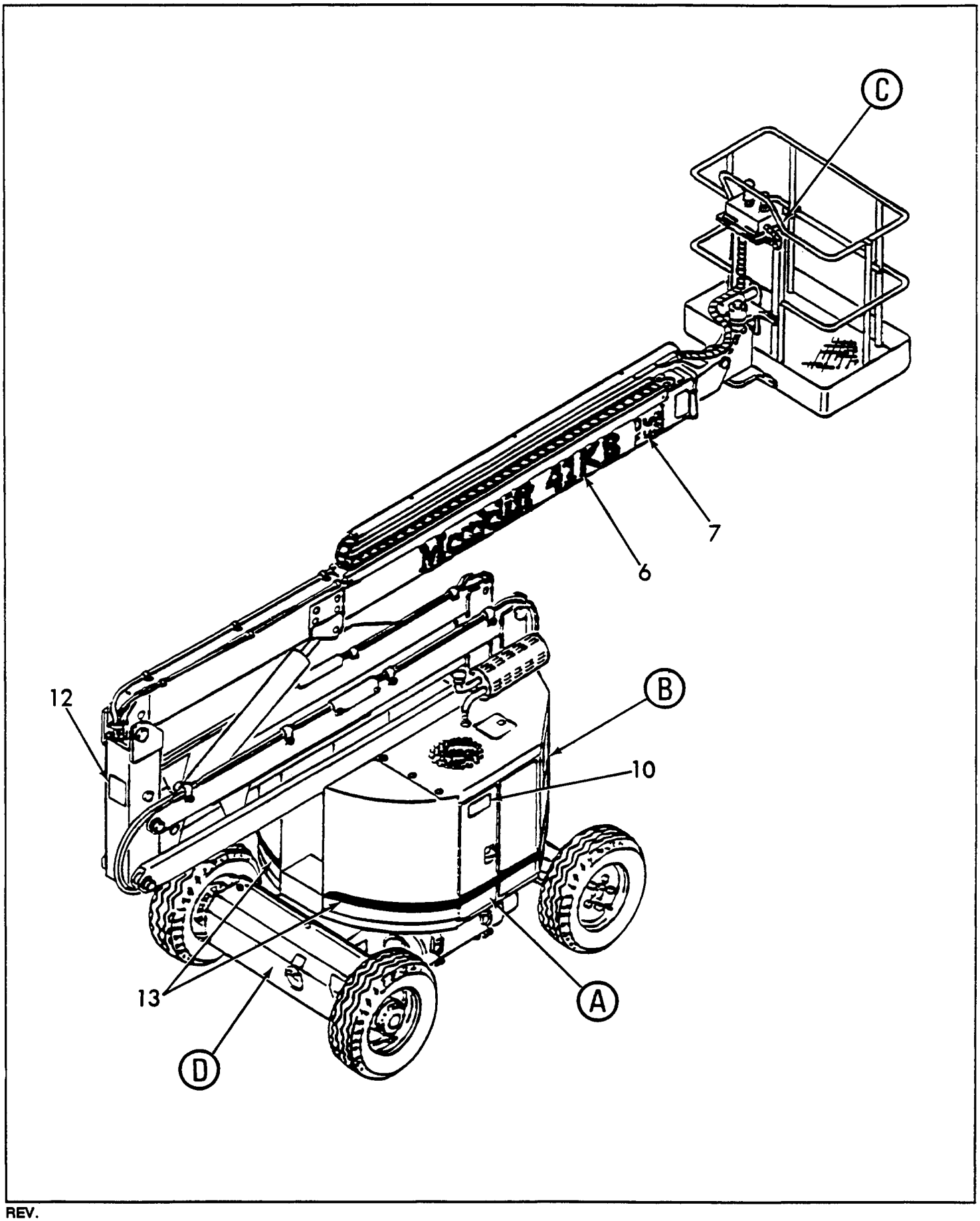
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-49	.16608	PAINT, WHITE	3 GAL
-50	.65116	OIL, HYDRAULIC	25 GAL
51	.140602	ASSEMBLY, CLAMP ARM CABLE	8

DASH (-) INDICATES THE ITEM IS NOT ILLUSTRATED

Mark Industries

TITLE	DECAL SET
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	2
PAGE	1

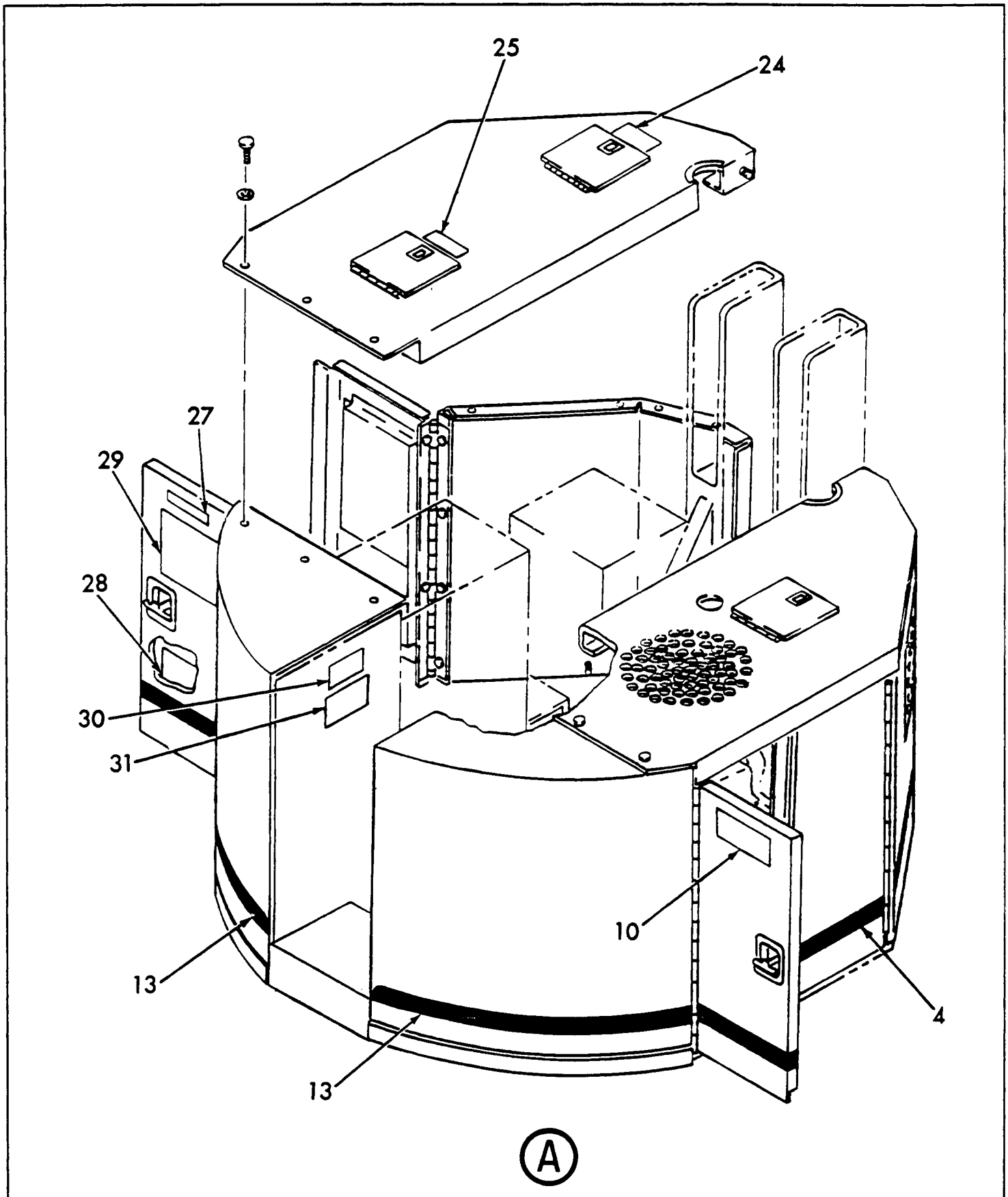


REV.

Mark Industries

TITLE	DECAL SET
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	2
PAGE	2

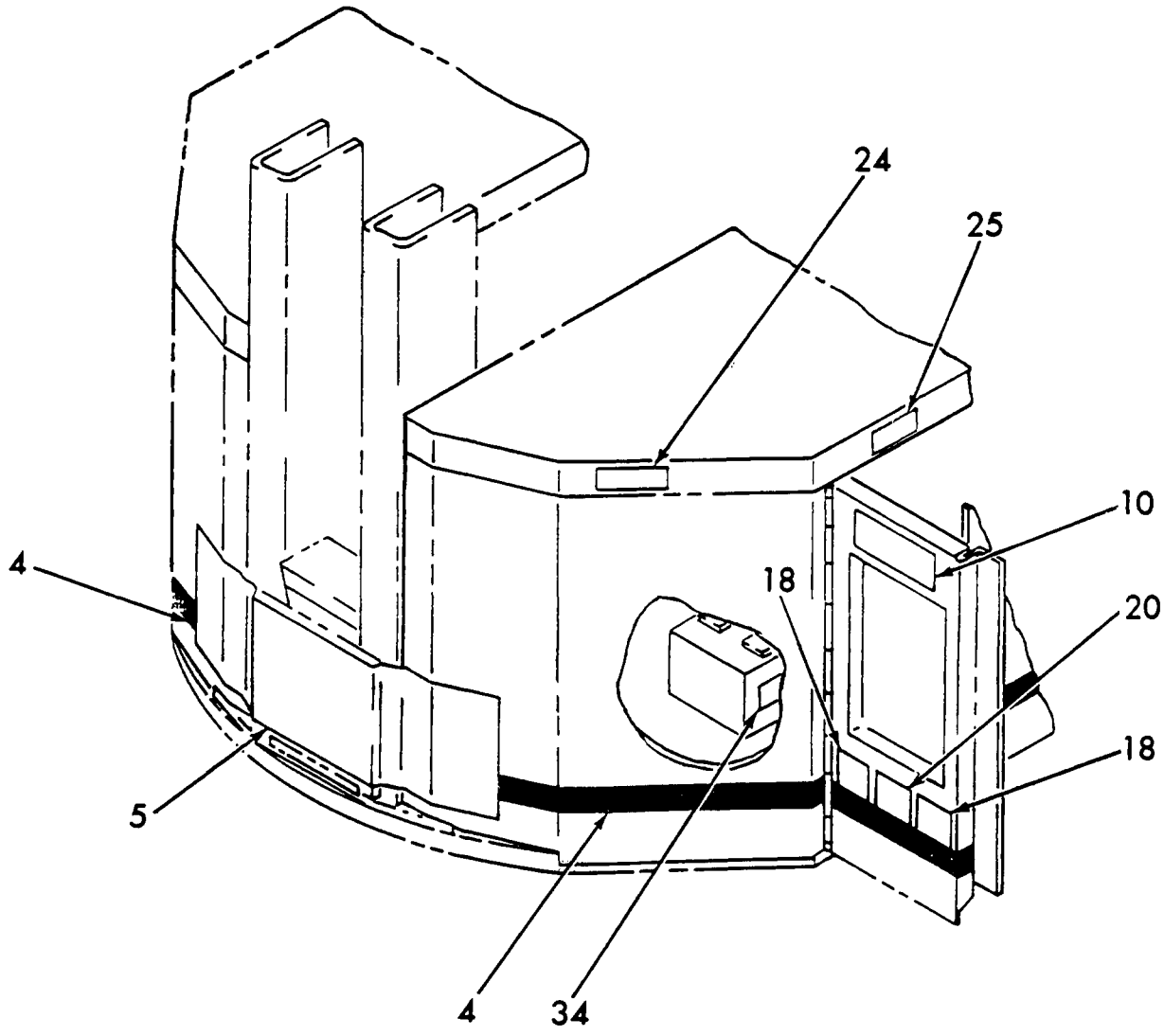


REV.

Mark Industries

TITLE	DECAL SET
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	2
PAGE	3



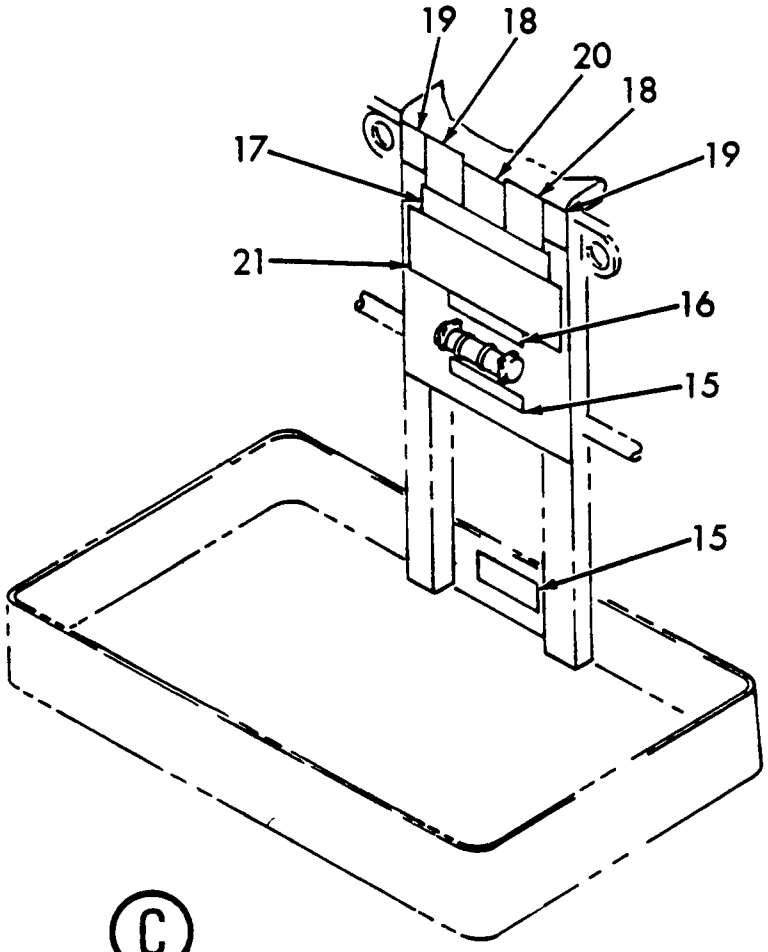
B

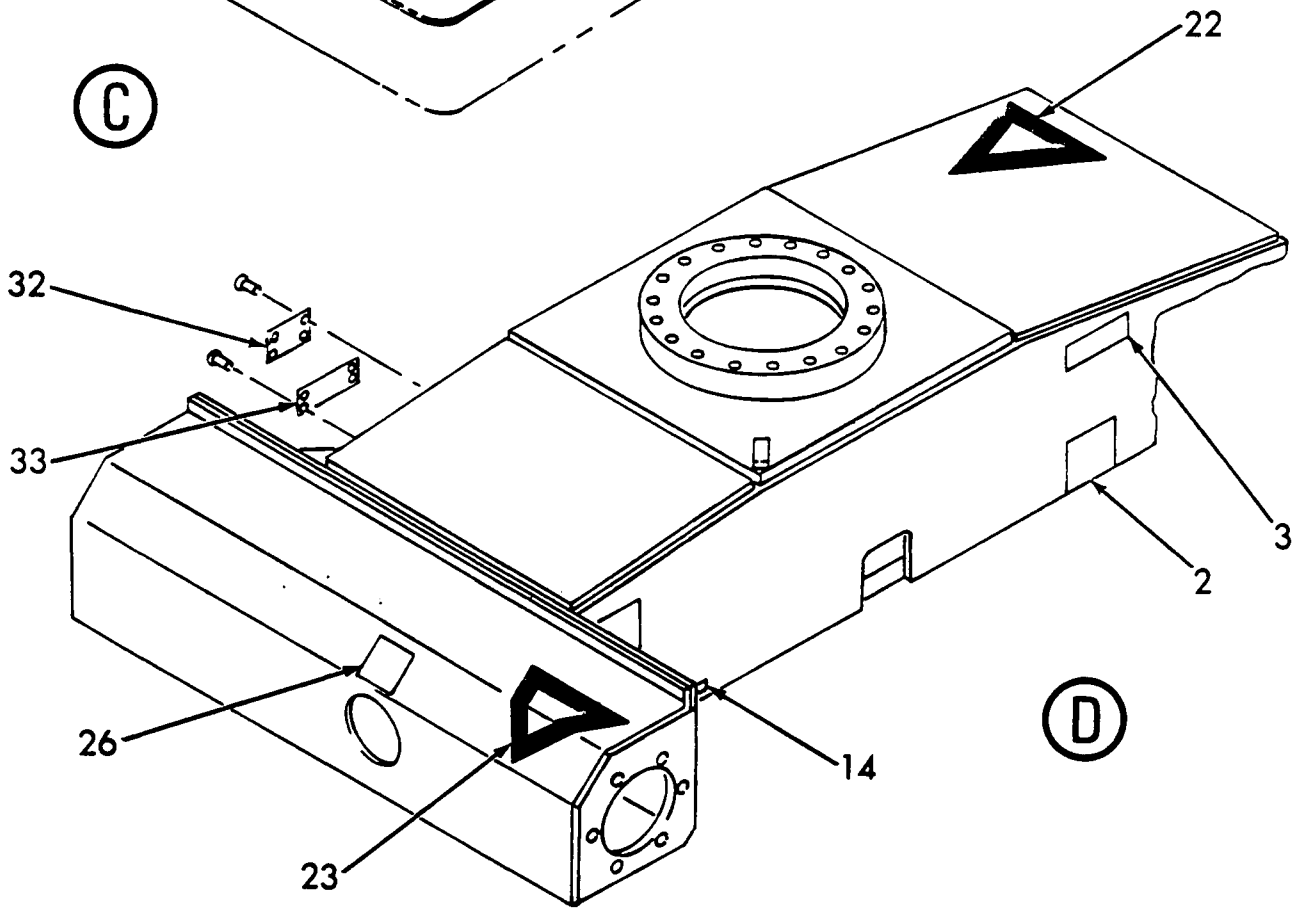
REV.

Mark Industries

TITLE	DECAL SET
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	2
PAGE	4





REV.

Mark Industries

TITLE	DECAL SET	SECT. 2
MODEL	41KBDF	FIG. 2
NOTES		PAGE 5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	600254	SET, DECAL	REF
2	.140595	DECAL, TIE DOWN DIAGRAM	2
3	.23558	DECAL, LIQUID TANK ONLY	1
4	.20411	DECAL, BLUE STRIPE SQUARE END	3
5	.20409	DECAL, STANDARD PEDESTAL	1
6	.181751	DECAL, "41KB"	2
7	.140420	DECAL, "DUAL FUEL"	2
-8	.182763	DECAL, UPPER CONTROL (See Sect. 2, Fig. 4 for Location)	1
-9	.182764	DECAL, AERIAL CONTROL SWITCH (See Sect. 2, Fig. 4 for Location)	1
10	.20419	DECAL, DANGER KEEP CLEAR	2
-11	.185702	DECAL, 110 VAC CIRCUIT BREAKER (See Sect. 2, Fig. 5 for Location)	1
12	.20410	DECAL, MARK INDUSTRIES LOGO	1
13	.20412	DECAL, BLUE STRIPE ROUND ENDS	2
14	.20420	DECAL, TIRE PRESSURE 75 PSI	2
15	.2022	DECAL, LOAD CAPACITY 500 LBS.	2
16	.130820	DECAL, OPERATION & SAFETY HANDBOOK	1
17	.22385	DECAL, CAUTION ATTACH YOUR SAFETY...	1
18	.181103	DECAL, DANGER OBEY THE FOLLOWING	4
19	.22386	DECAL, "D" RING ATTACH SAFETY...	2
20	.181102	DECAL, DANGER DO NOT OPERATE...	2
21	.182101	DECAL, DANGER & AERIAL OPERATION...	1
22	.20461	DECAL, FORWARD ARROW	1
23	.20462	DECAL, FORWARD ARROW AFT	1
24	.2020	DECAL, GASOLINE OR PETROL	2

DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	DECAL SET
MODEL	41KBDF
NOTES	

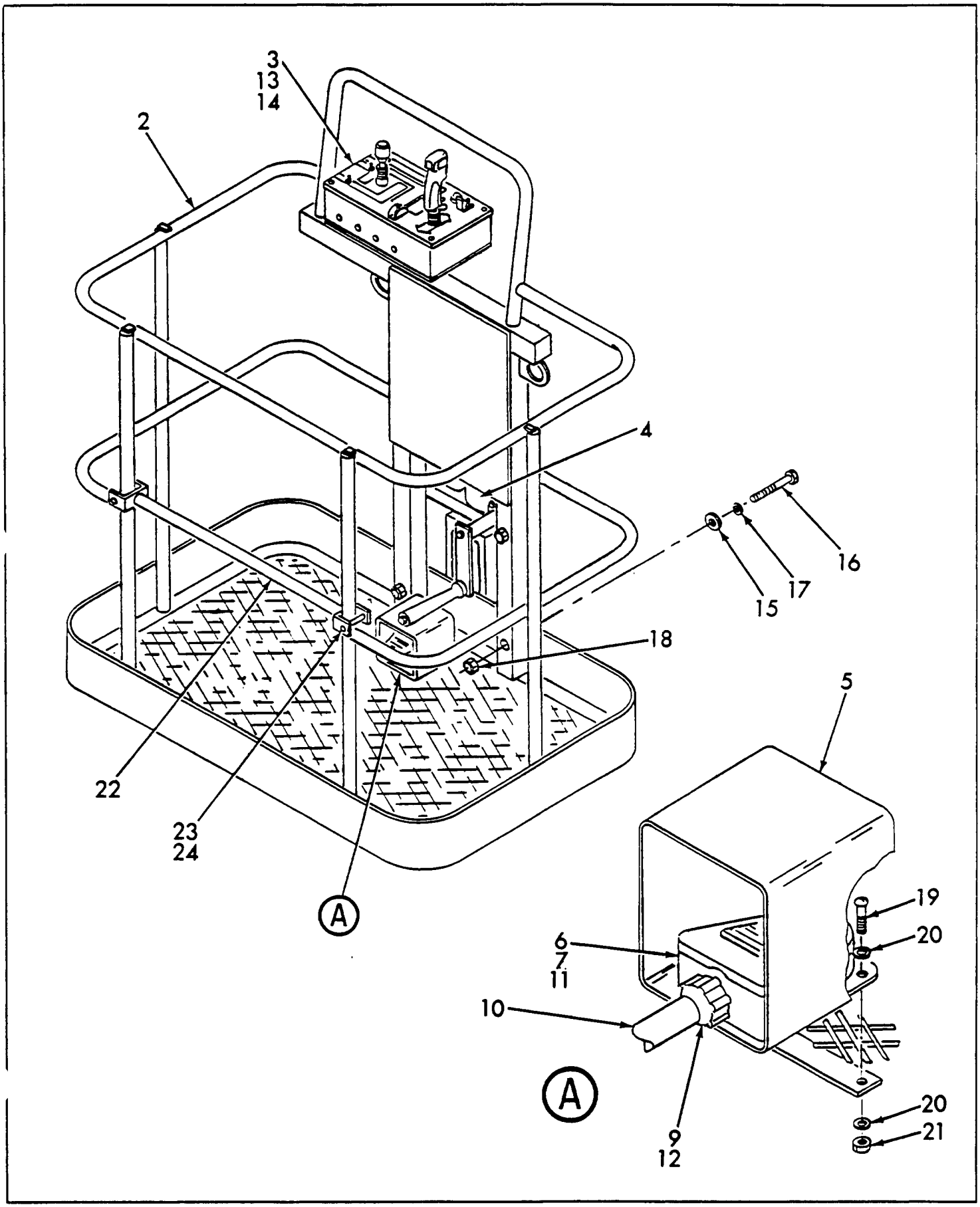
SECT.	2
FIG.	2
PAGE	6

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.2017	DECAL, HYDRAULIC SYSTEM FLUID	2
26	.20896	DECAL, BRAKE	1
27	.140496	DECAL, HAND PUMP	1
28	.140495	DECAL, EMERGENCY	1
29	.20860	DECAL, GENERAL CHECKOUT & OPERATING	1
30	.183301	DECAL, WARNING LEAD PAINT...	1
31	.183302	DECAL, WARNING THIS COUNTERWEIGHT...	1
32	.20660	NAMEPLATE, IDENTIFICATION	1
33	.20661	PLATE, ANSI A92	1
34	.2003	DECAL, BATTERY WATER	1

DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	PLATFORM ASSEMBLY	SECTION	2
MODEL	41KBDF	FIGURE	3
NOTES		PAGE	1



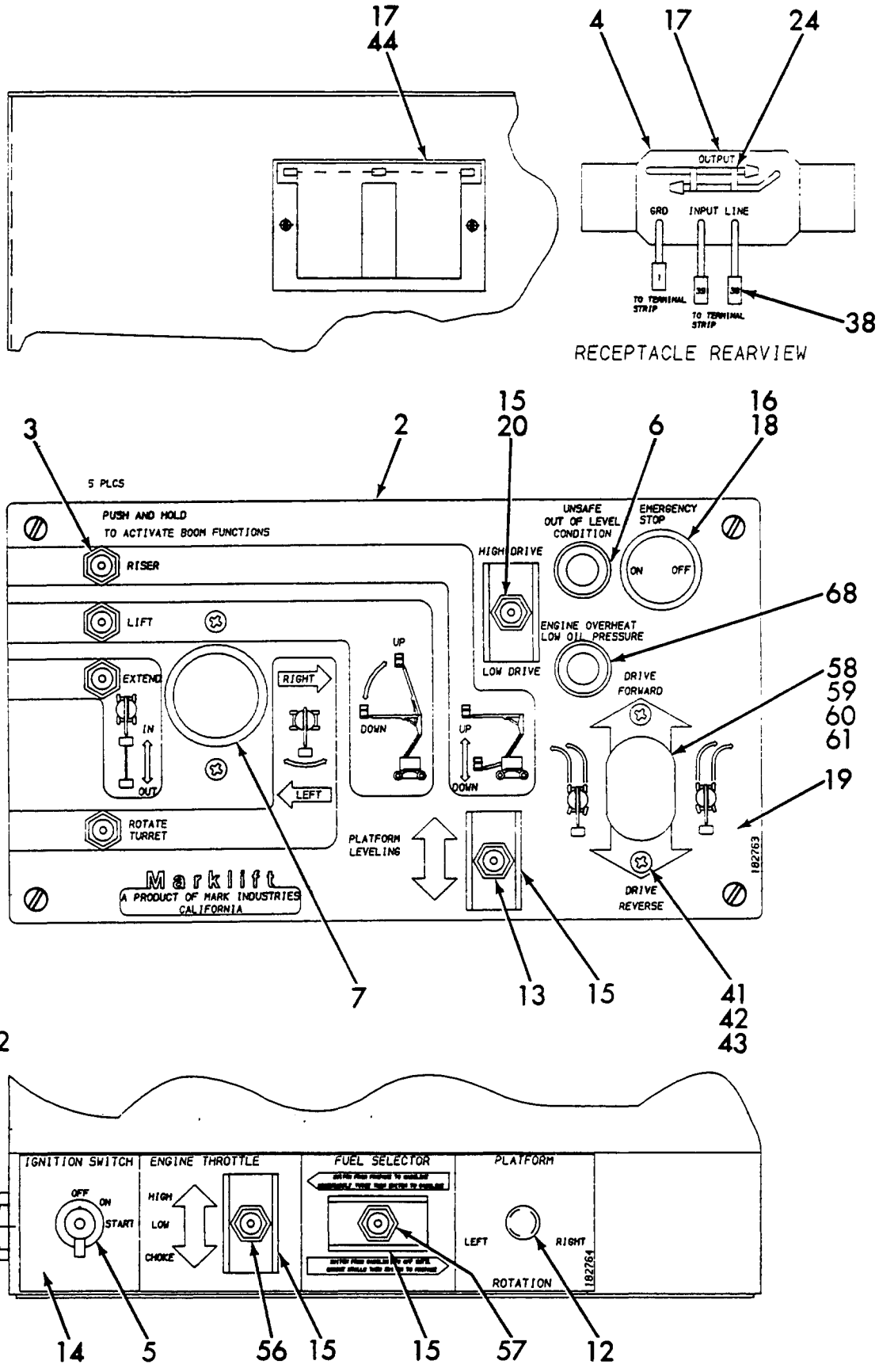
REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	141232	ASSEMBLY, PLATFORM (See Sect. 2, Fig. 1 for NHA)	REF
2	.140964	WELDMENT, PLATFORM	1
3	.141234	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 4 for Details)	1
4	.81373	ASSEMBLY, MANUAL ROTATOR (See Sect. 2, Fig. 6 & 6A for Details)	1
5	.23846	COVER, FOOT SWITCH	1
6	.141094	ASSEMBLY, FOOT SWITCH	1
7	..92202	SWITCH, FOOT	1
-8	...66336	MICROSWITCH	1
9	..2806	RELIEF, STRAIN	1
10	..4034	CABLE	6
11	..16213	CONNECTOR, RING	2
12	..2808	NUT, LOCK	1
13	.60353	SCREW, CAP	4
14	.63401	WASHER, FLAT	4
15	.141287	WASHER, PLATFORM/ROTATOR	4
16	.60549	SCREW, CAP	4
17	.63415	WASHER, FLAT	4
18	.61242	NUT, LOCK	4
19	.62714	SCREW, MACHINE	2
20	.63413	WASHER, FLAT	2
21	.61241	NUT, LOCK	2
22	.141080	WELDMENT, SLIDE BAR	1
23	.160212	PIN, CLEVIS	2
24	.160213	PIN, COTTER	2

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	4
PAGE	1

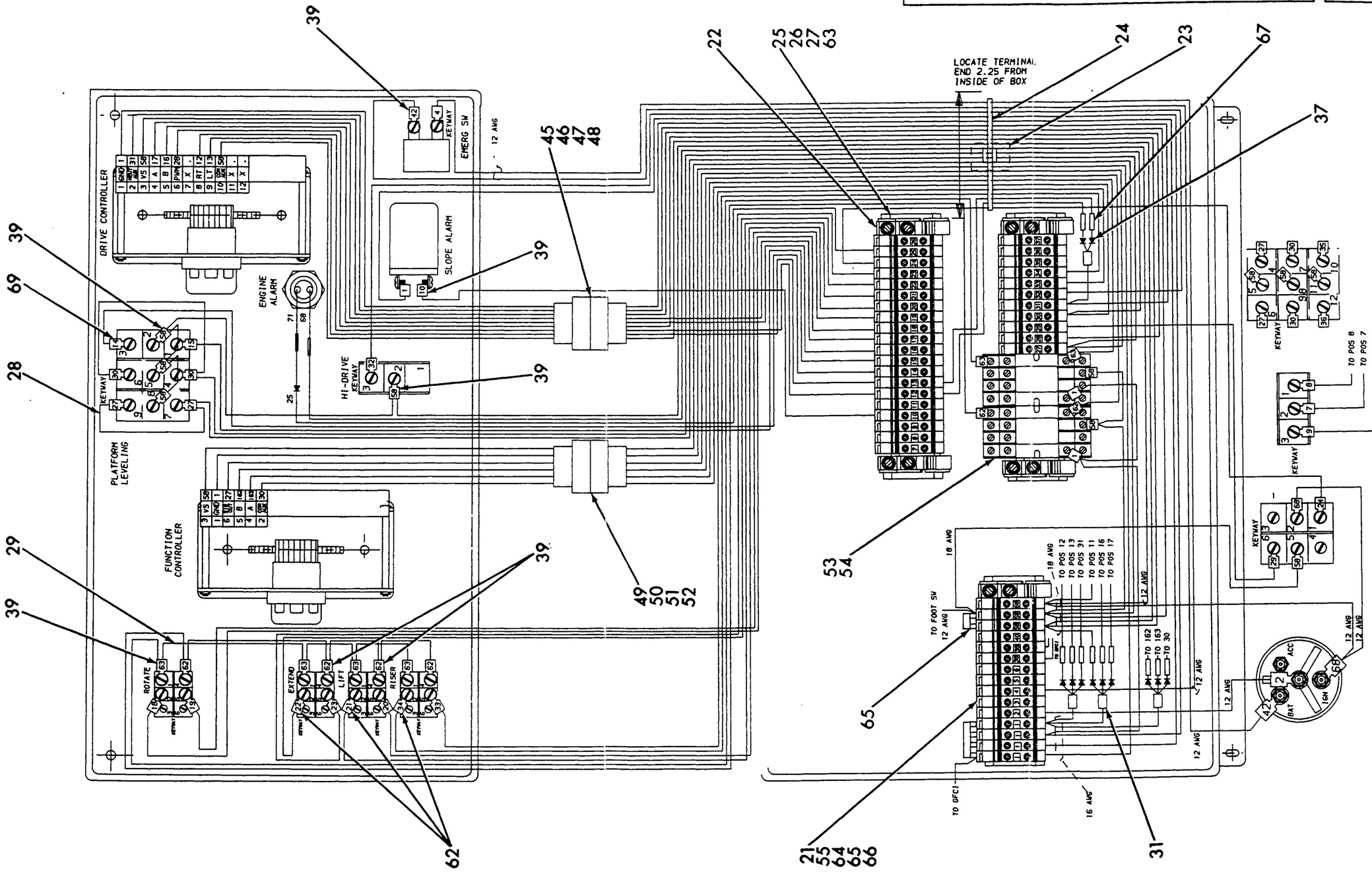


REV.

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	4
PAGE	2



Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	41KBDF
NOTES	

SECT.	2
FIG.	4
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	141234	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for NHA)	REF
2	.141296	MACHINING, AERIAL CONTROL BOX	1
3	.70417	SWITCH, TOGGLE	4
4	.70394	CONNECTOR, TWIST-ON WIRE	2
5	.70405	SWITCH, ANTI-RESTART IGNITION	1
6	.20805	ALARM, BUZZER	1
7	.70488	CONTROLLER	1
-8	..67812	BOARD, ENCAPSULATED CONTROLLER	1
-9	...600171	CAP, PLASTIC (MATES WITH P/N 70502)	1
-10	...600172	SOCKET (MATES WITH P/N 70517)	6
-11	..600006	POTENTIOMETER WITH WIRES	1
12	.771	PLUG	1
13	.70383	SWITCH, LEVELING	1
14	.182764	DECAL, AERIAL CONTROL SWITCH	1
15	.20884	GUARD, SWITCH	4
16	.31080	KNOB, EMERGENCY ON/OFF	1
17	.70391	RECEPTACLE, G.F.C.I.	1
18	.4018	SWITCH, PUSH/PULL	1
19	.182763	DECAL, UPPER CONTROL	1
20	.4017	SWITCH, TOGGLE	2
21	.70376	TERMINAL	46
22	.70377	STOP, END	5
23	.16214	MOUNTS	5
24	.256	TIE, CABLE	37
25	.62621	SCREW, MACHINE	6

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY	SECT.	2
MODEL	41KBDF	FIG.	4
NOTES		PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.61502	NUT, HEX	6
27	.63312	WASHER, LOCK	6
28	.2991	WIRE, WHITE (12 AWG)	1 FT
29	.2990	WIRE, WHITE (18 AWG)	7.5 FT
30	.70098	WIRE, YELLOW WITH GREEN STRIPE	0.5 FT
31	.117-D	CONNECTOR	4
32	.16215	RELIEF, STRAIN	1
33	.16105	NUT, LOCK	1
34	.2806	RELIEF, STRAIN	1
35	.2808	NUT, LOCK	1
36	.117-C	RING, CONNECTOR	3
37	.70479	DIODE	11
38	.70162	TERMINAL	3
39	.117-B	CONNECTOR	17
40	.70008	WIRE, YELLOW WITH GREEN (16 AWG)	1 FT
41	.62703	SCREW, MACHINE	4
42	.63313	WASHER, LOCK	4
43	.63413	WASHER, FLAT	4
44	.70392	COVER, RECEPTACLE	1
45	.141375	ASSEMBLY, DRIVE WIRE HARNESS	1
46	..70516	PLUG, CONNECTOR	1
47	..70517	PIN	12
48	..2990	WIRE, WHITE (18 AWG)	1.5 FT
49	.141144	ASSEMBLY, BOOM FUNCTION WIRE HARNESS	1
50	..70502	PLUG, CONNECTOR (6 PIN)	1

Mark Industries

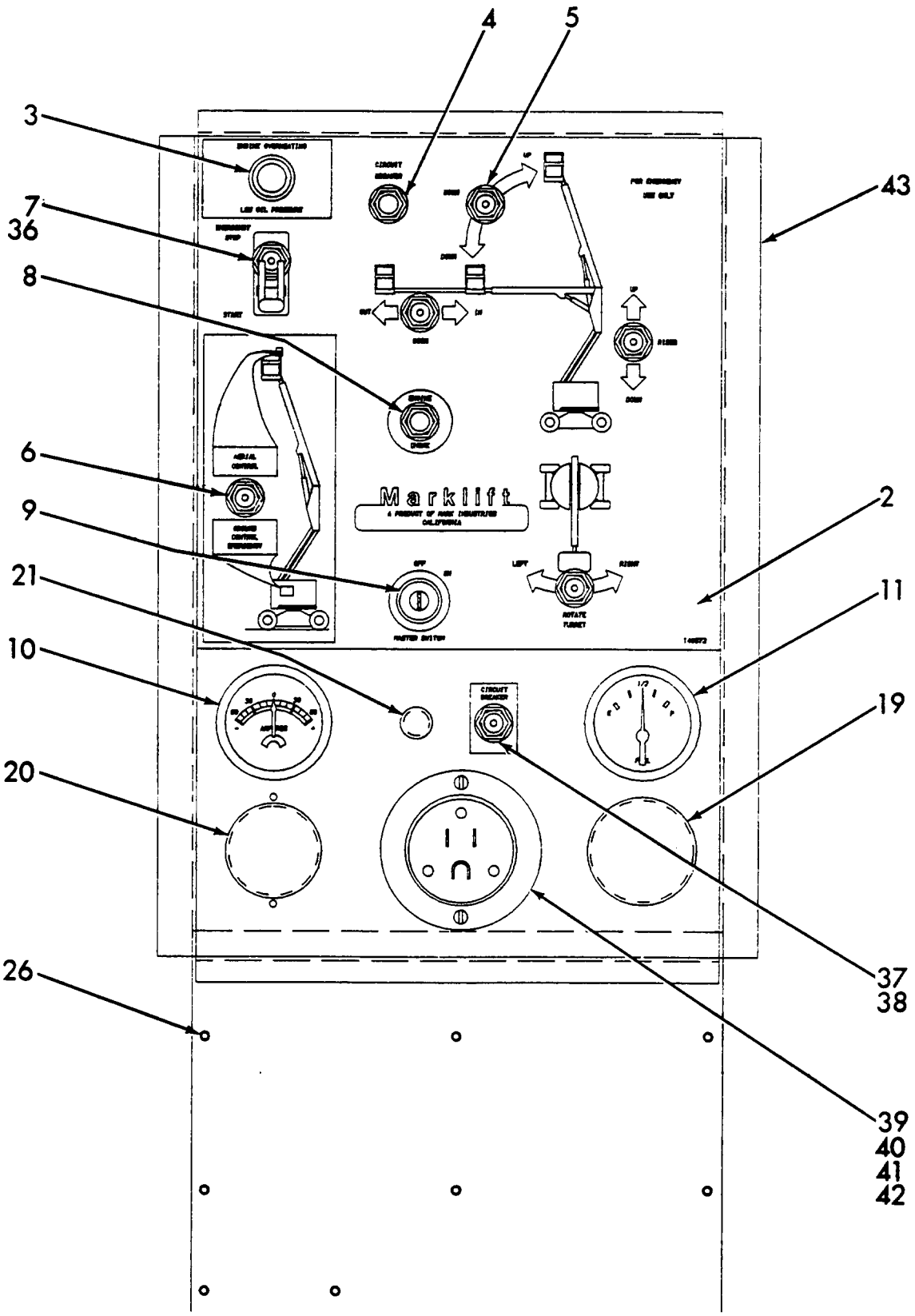
TITLE	AERIAL CONTROL BOX ASSEMBLY	SECT.	2
MODEL	41KBDF	FIG.	4
NOTES		PAGE	5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
51	..70503	PIN	6
52	..2990	WIRE, WHITE (18 AWG)	1 FT
53	.70586	RELAY	2
54	.70214	BASE, RELAY	2
55	.141373	RAIL, TERMINAL	1
56	.70304	SWITCH, TOGGLE	1
57	.4019	SWITCH	1
58	.70579	CONTROLLER	1
-59	..600244	BOARD, ENCAPSULATED CONTROLLER	1
-60	...600173	CAP, PLASTIC (MATES WITH P/N 70516)	1
-61	...600172	SOCKET (MATES WITH P/N 70502)	12
-62	...600349	BOARD, POTENTIOMETER	1
63	.141374	RAIL, TERMINAL	2
64	.70378	END, SECTION	3
65	.70570	BAR, JUMPER	1
66	.70381	MARKER (1-100)	1
67	.70069	CONNECTOR, BUTT	12
68	.70195	LIGHT, INDICATOR	1
69	.70149	CONNECTOR	19

Mark Industries

TITLE	GROUND CONTROL PANEL ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	5
PAGE	1



REV.

Mark Industries

TITLE	GROUND CONTROL PANEL ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	5
PAGE	2

Mark Industries

TITLE	GROUND CONTROL PANEL ASSEMBLY	SECT. 2
MODEL	41KBDF	FIG. 5
NOTES		PAGE 3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140287	ASSEMBLY, GROUND CONTROL PANEL (See Sect. 2, Fig. 1 for Details)	REF
2	.182716	DECAL, GROUND CONTROL PANEL	1
3	.70195	LIGHT, INDICATOR	1
4	.70361	BREAKER, CIRCUIT	1
5	.20481	SWITCH, TOGGLE	4
6	.16260	SWITCH, TOGGLE	1
7	.70304	SWITCH, TOGGLE	1
8	.4011	SWITCH, PUSH BUTTON	1
9	.2717	SWITCH, IGNITION	1
10	.20994	AMMETER (60 AMP)	1
11	.21219	GAUGE, FUEL	1
12	.70209	SOLENOID, 12 VDC	1
13	.30215	CLIP, RELAY HOLD DOWN	1
14	.70170	RELAY, 12 VDC	1
15	.117-A	BLOCK, TERMINAL END	3
16	.4027	BLOCK, TERMINAL	47
17	.117-C	RING, CONNECTOR	8
18	.16325	CONNECTOR, TERMINAL	2
19	.65244	PLUG	1
20	.65243	PLUG	1
21	.65240	PLUG	1
22	.117-D	CONNECTOR	10
23	.70479	DIODE	10
24	.256	TIE, CABLE	45
25	.16214	MOUNT	8

Mark Industries

TITLE	GROUND CONTROL PANEL ASSEMBLY
MODEL	41KBDF
NOTES	

SECT.	2
FIG.	5
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.61712	SCREW, CAP	8
27	.60342	SCREW, CAP	2
28	.60701	NUT, HEX	2
29	.63301	WASHER, LOCK	2
30	.63401	WASHER, FLAT	2
31	.2990	WIRE, WHITE (18 AWG)	7.5 FT
32	.70205	WIRE, BLACK (8 AWG)	1 FT
33	.70098	WIRE, YELLOW WITH GREEN STRIPE	0.5 FT
34	.61721	SCREW, SHEET METAL	4
35	.784-A	SOCKET, 8 PIN OCTAL	1
36	.70303	SWITCH, GUARD	1
37	.20562	BREAKER, CIRCUIT	1
38	.185702	DECAL, CIRCUIT BREAKER 110 VAC	1
39	.70409	RECEPTACLE	1
40	.62636	SCREW, MACHINE	2
41	.63312	WASHER, LOCK	2
42	.61502	NUT, HEX	2
43	.140238	PANEL, LOWER CONTROL	1
44	.70460	BASE, RELAY	5
45	.70459	RELAY	5
46	.70461	RAIL	1
47	.70462	CLIP	5
48	.70406	SPADE, SPRING	6
49	.117-B	CONNECTOR	22
50	.70149	CONNECTOR	22

Mark Industries

TITLE	GROUND CONTROL PANEL ASSEMBLY
MODEL	41KBDF
NOTES	

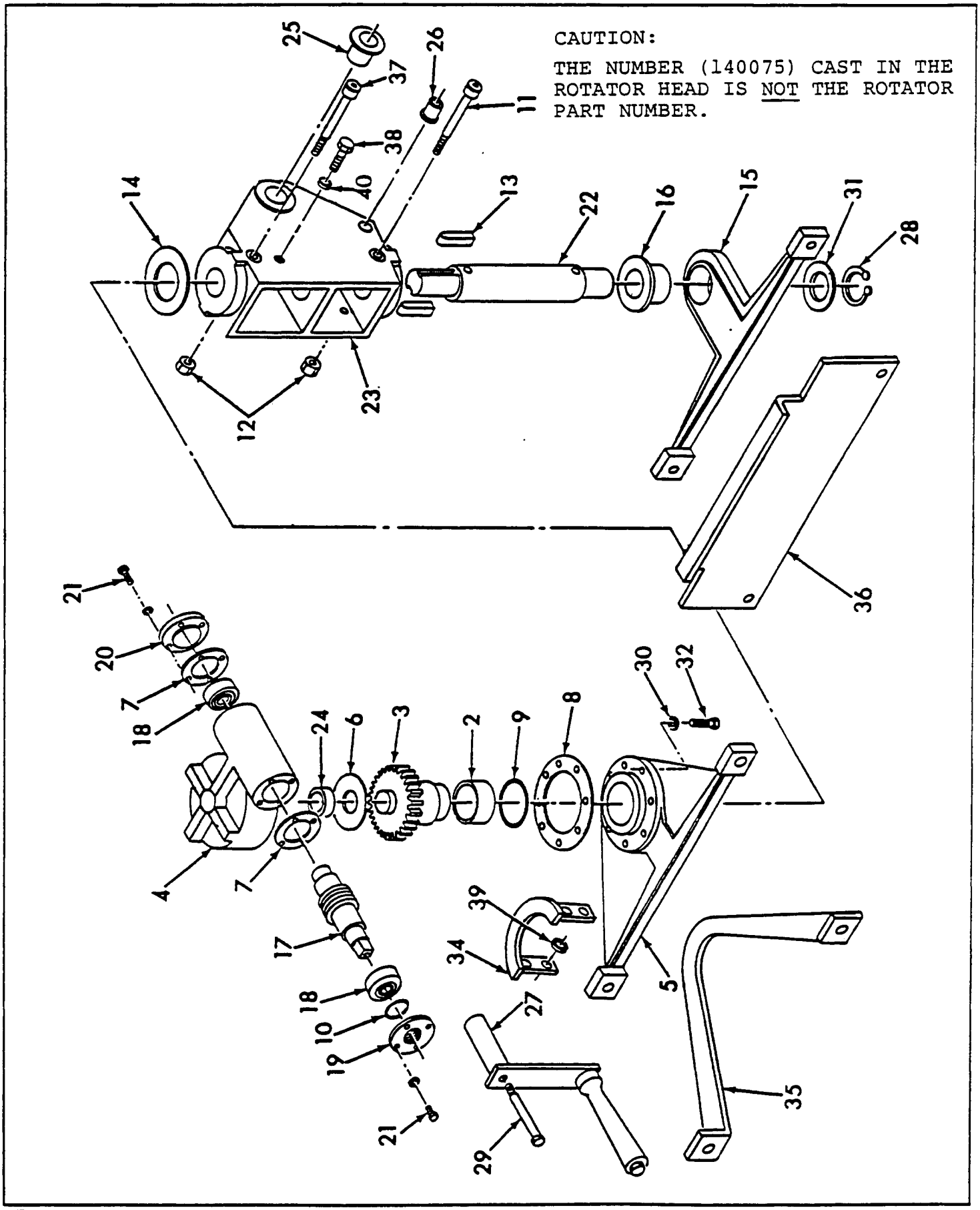
SECT.	2
FIG.	5
PAGE	5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
51	.70567	CONNECTOR, RING (RED)	3
52	.70566	SPADE, SPRING (RED)	4
53	.70568	STOP, TERMINAL	2

Mark Industries

TITLE	TYPICAL MANUAL ROTATOR
MODEL	41KBDF
NOTES	FROM MID 1987 UNTIL EARLY 1990

SECTION	2
FIGURE	6
PAGE	1



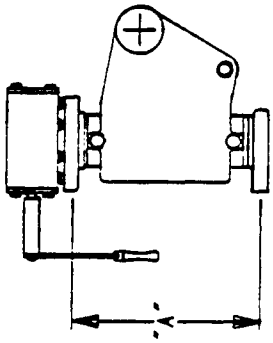
REV.

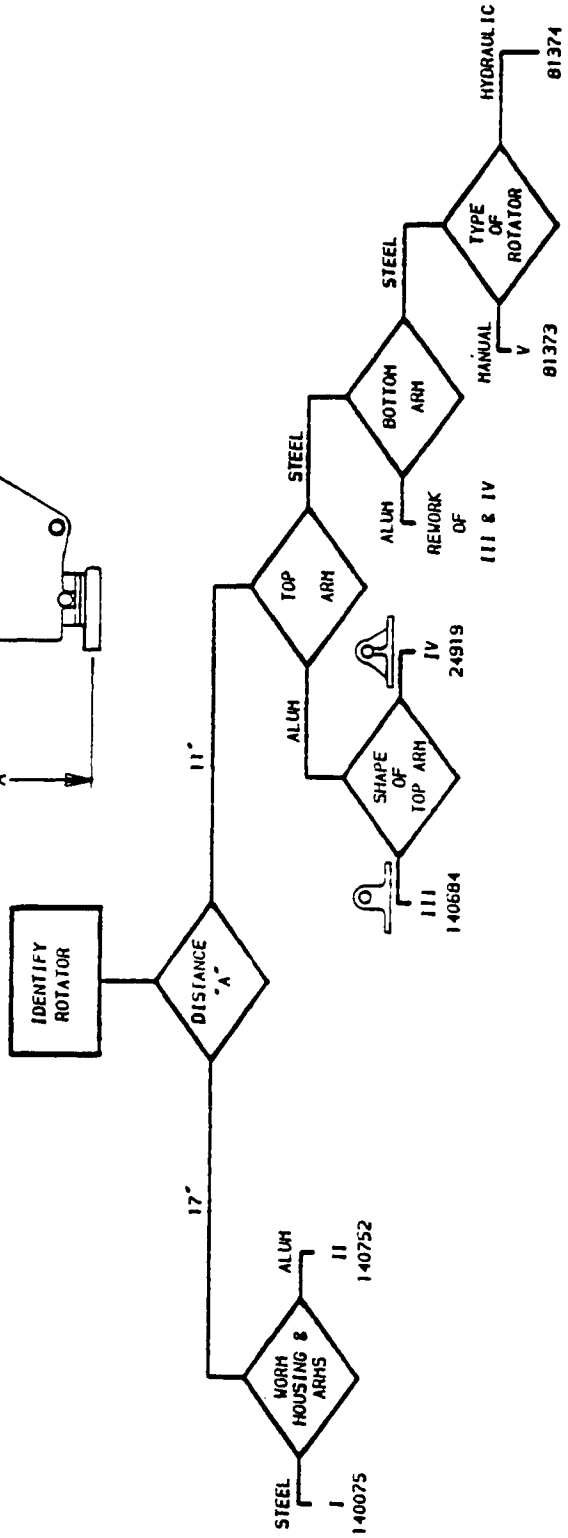
Mark Industries

TITLE	TYPICAL MANUAL ROTATOR
MODEL	41KBDF
NOTES	FROM MID 1987 UNTIL EARLY 1990

SECTION	2
FIGURE	6
PAGE	2

ROTATOR IDENTIFICATION FLOW CHART





REV.

ITEM	M.I.P/N (I)	M.I.P/N (II)	M.I.P/N (III)	M.I.P/N (IV)	DESCRIPTION	QTY
-1	140075	140752	140684	24919	ASSEMBLY, ROTATOR (SEE SEC 2 FIG 1 FOR NHA)	REF
2	68030	68030	68030	68030	BUSHING	1
3	** 600278	** 600279	** 600279	600280	GEAR, BULL	1
4	+ 68033	68032	68032	68032	HOUSING, GEAR	1
5	** 68036	* 81378	* 81378	* 81378	ARM, TOP	1
6	68037	68037	68037	68037	WASHER, THRUST	1
7	68038	68038	68038	68038	GASKET, END CAP	2
8	68039	68039	68039	68039	GASKET, GEARBOX	1
9	68040	68040	68040	68040	O-RING	1
10	68041	68041	68041	68041	O-RING	1
11	600187	600187	600187	600187	BOLT	1
12	600188	600188	600188	600188	NUT W/NYLOCK	2
13	600189	600189	600189	600189	KEY	2
14	68044	68043	68043	68042	WASHER, THRUST	1
15	** 600282	600283	600283	600283	ARM, BOTTOM	1
16	68045	68045	68045	68045	BUSHING, FLANGED	1
17	600284	600285	600286	600286	GEAR, WORM	1
18	68046	68046	68046	68046	BEARING, ROLLER	2
19	600287	* 600288	600288	600288	CAP, END (THRU)	1
20	68048	68047	68047	68047	CAP, END	1
21	600192	600190	600190	600190	BOLT	8
22	** 600289	** 600290	600291	600291	PIN, MAIN	1
23	++	++	++	++	YOKE	1
24	68049	68049	68049	68049	BUSHING	1
25	68050	68050	68050	68050	BUSHING, FLANGED	2
26	68051	68051	68051	68051	BUSHING, FLANGED	2
27	* 68052	* 68052	68052	68052	CRANK, HAND	1
28	N/A	N/A	68054	68054	RING, SNAP	1
29	* 600191	* 600191	600191	600191	BOLT	1
30	N/A	N/A	63302	63302	WASHER, LOCK	8
31	N/A	N/A	N/A	600292	WASHER, FLAT	1
32	600186	600186	600186	600186	BOLT	8
-33	600193	600193	600193	600193	KIT, PROD. IMPROVEMENT	REF
34	141342	141342	141342	141342	RETAINER, COLLAR	1
35	141341	141341	141341	141341	COLLAR, ROTATOR	1
36	141344	141344	141344	141344	BRACKET, ANGLE	1
37	60558	60558	60558	60558	SCREW, CAP	1
38	60338	60338	60338	60338	SCREW, CAP	2
39	63402	63402	63402	63402	WASHER, FLAT	4
40	63303	63303	63303	63303	WASHER, LOCK	2

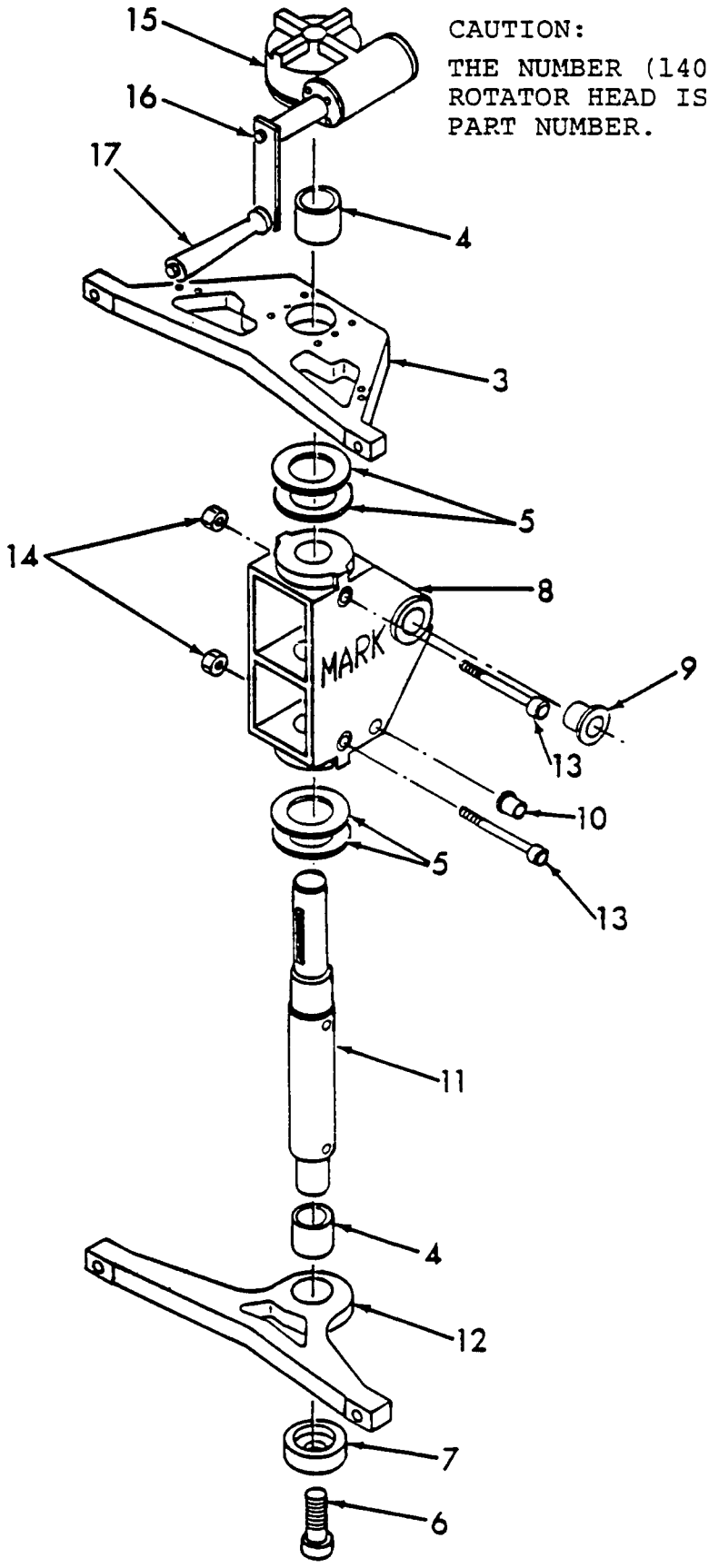
* Parts are not original, but are a newer "direct replacement."
** Special Order items; allow 90 days lead time.
\+ Originally made of "cast iron"; replacements are "aluminum".
++ If the yoke requires replacement, the ENTIRE rotator MUST be replaced W/81373. {Modification is necessary if the "original" rotator is P/N 140075 or 140752.}

NOTE: SEE THE "ROTATOR IDENTIFICATION FLOW CHART" TO DETERMINE WHICH ROTATOR IS APPLICABLE.

Mark Industries

TITLE	PLATFORM MANUAL ROTATOR ASSEMBLY
MODEL	41KBDF
NOTES	SINCE EARLY 1990

SECTION	2
FIGURE	6A
PAGE	1



CAUTION:

THE NUMBER (140075) CAST IN THE ROTATOR HEAD IS NOT THE ROTATOR PART NUMBER.

REV.

Mark Industries

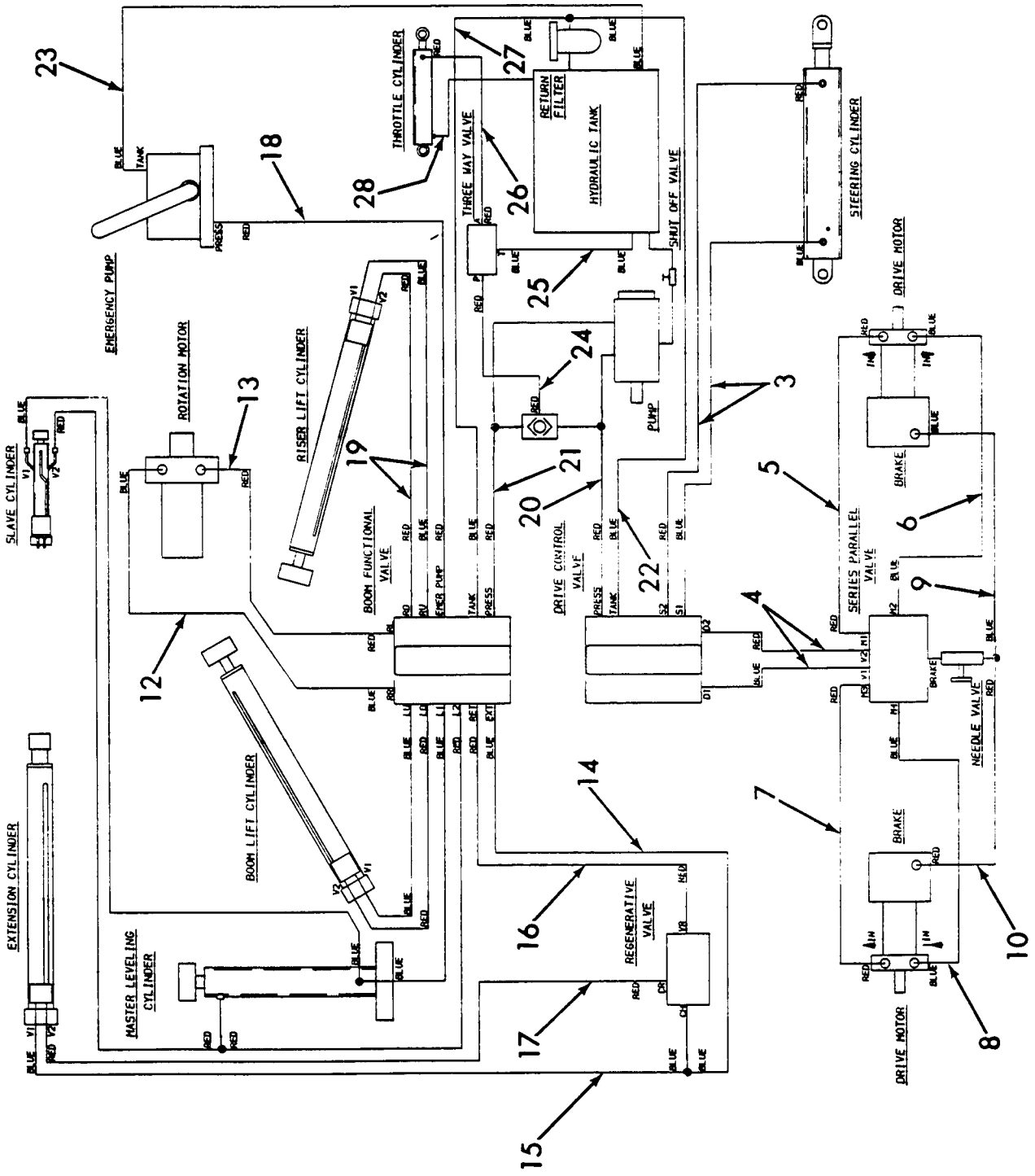
TITLE	PLATFORM MANUAL ROTATOR ASSEMBLY	SECT. 2
MODEL	41KBDF	FIG. 6A
NOTES	SINCE EARLY 1990	PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	81373	ROTATOR, MANUAL (See Sect. 2, Fig. 3 for NHA)	REF
-2	.81369	BASE, ROTATOR	REF
3	..600221	ARM, STEEL TOP	1
4	..600222	BUSHING	2
5	..600223	WASHER, THRUST	4
6	..600224	BOLT	1
7	..600225	WASHER, RETAINING	1
8	..	YOKE, ROTATOR	1
9	...68050	BUSHING, FLANGED	2
10	...68051	BUSHING, FLANGED	2
11	...600226	PIN, MAIN	1
12	...600227	ARM, STEEL BOTTOM	1
13	...600187	BOLT	2
14	...600188	NUT (WITH NYLOCK)	2
15	.81374	GEARHEAD	1
16	..600191	BOLT	1
17	..600281	HANDLE, CRANK	1

Mark Industries

TITLE	HOSE KIT DIAGRAM
MODEL	41KBDF
NOTES	

SECTION	2
FIGURE	7
PAGE	1



REV.

Mark Industries

TITLE	HOSE KIT DIAGRAM	SECT. 2
MODEL	41KBDF	FIG. 7
NOTES		PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	141149	DIAGRAM, HOSE KIT (See Sect. 2, Fig. 1 for NHA)	REF
-2	.141149 KIT-A	DIAGRAM, HOSE KIT (CARRIAGE)	1
3	..13213-04-1300	ASSEMBLY, HOSE	2
4	..13213-10-1300	ASSEMBLY, HOSE	2
5	..13212-08-0144	ASSEMBLY, HOSE	1
6	..13212-08-0120	ASSEMBLY, HOSE	1
7	..13213-08-0296	ASSEMBLY, HOSE	1
8	..13210-08-0250	ASSEMBLY, HOSE	1
9	..13210-04-0174	ASSEMBLY, HOSE	1
10	..13210-04-0244	ASSEMBLY, HOSE	1
-11	.141149 KIT-B	DIAGRAM HOSE KIT (TURRET)	1
12	..13215-06-0420	ASSEMBLY, HOSE	1
13	..13215-06-0390	ASSEMBLY, HOSE	1
14	..13231-08-0250	ASSEMBLY, HOSE	1
15	..13210-08-3040	ASSEMBLY, HOSE	1
16	..13212-08-0190	ASSEMBLY, HOSE	1
17	..13211-08-3040	ASSEMBLY, HOSE	1
18	..13213-04-0350	ASSEMBLY, HOSE	1
19	..13212-06-0870	ASSEMBLY, HOSE	2
20	..13213-10-0640	ASSEMBLY, HOSE	1
21	..13213-08-0770	ASSEMBLY, HOSE	1
22	..13214-12-0320	ASSEMBLY, HOSE	1
23	..13210-06-0400	ASSEMBLY, HOSE	1
24	..13210-04-0330	ASSEMBLY, HOSE	1
25	..13210-06-0510	ASSEMBLY, HOSE	1

Mark Industries

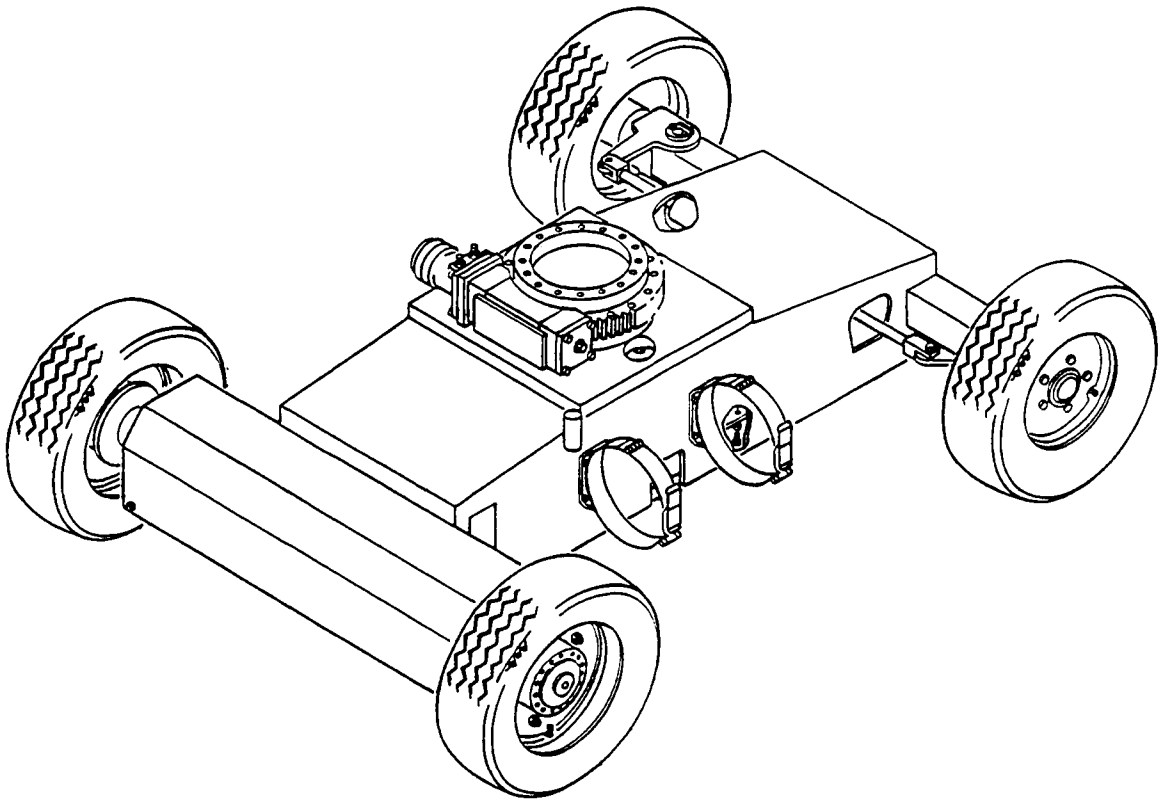
TITLE	HOSE KIT DIAGRAM
MODEL	41KBDF
NOTES	

SECT.	2
FIG.	7
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	..13210-04-0110	ASSEMBLY, HOSE	1
27	..13210-10-0870	ASSEMBLY, HOSE	1
28	..13210-04-1130	ASSEMBLY, HOSE	1

SECTION 3 CONTAINS:

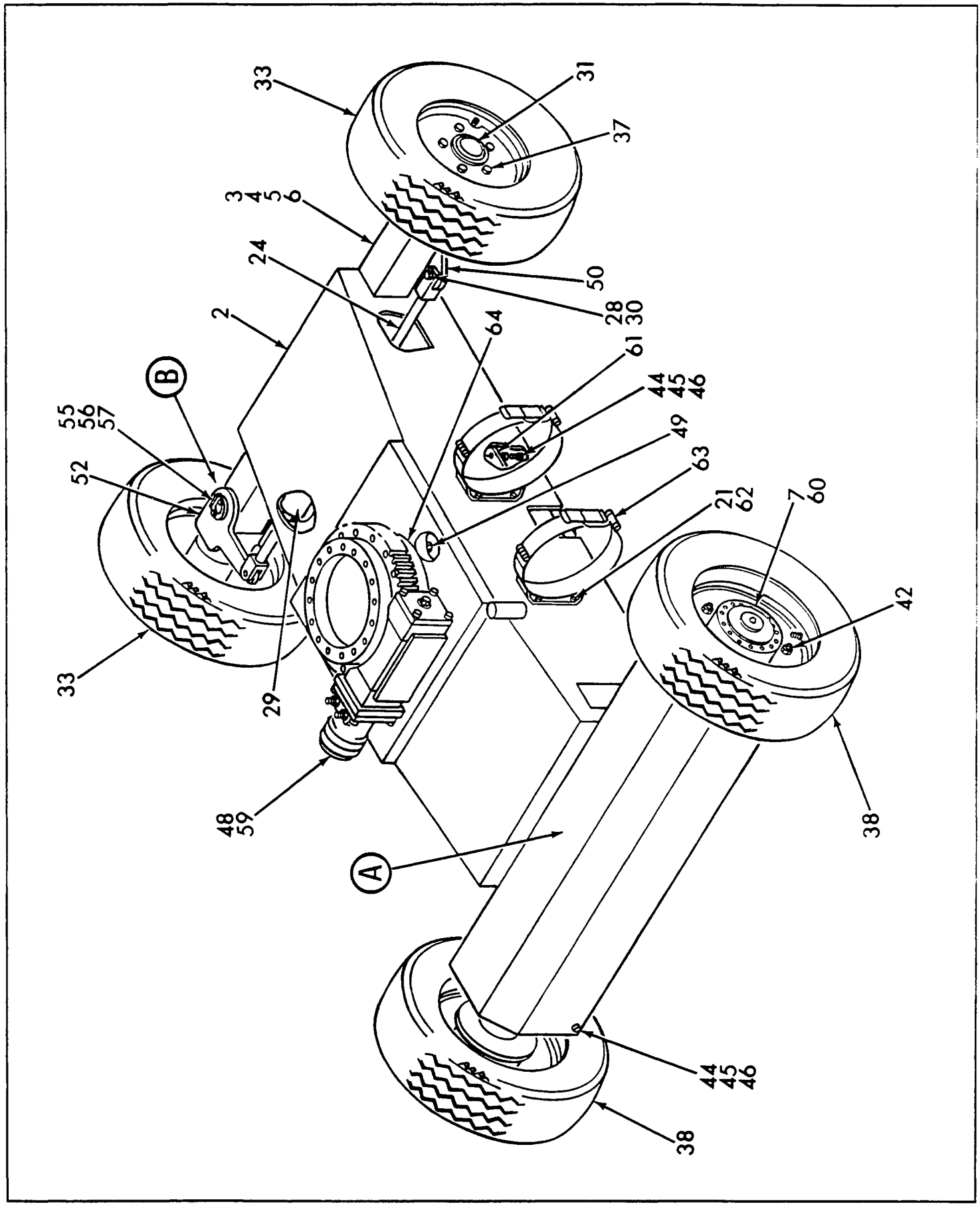
FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY
2	SERIES/PARALLEL VALVE ASSEMBLY
3	STEERING CYLINDER ASSEMBLY (SE)
3A	STEERING CYLINDER ASSEMBLY (TH)
4	SLEW DRIVE MOTOR/ROTATOR ASSEMBLY



Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	3
FIGURE	1
PAGE	1

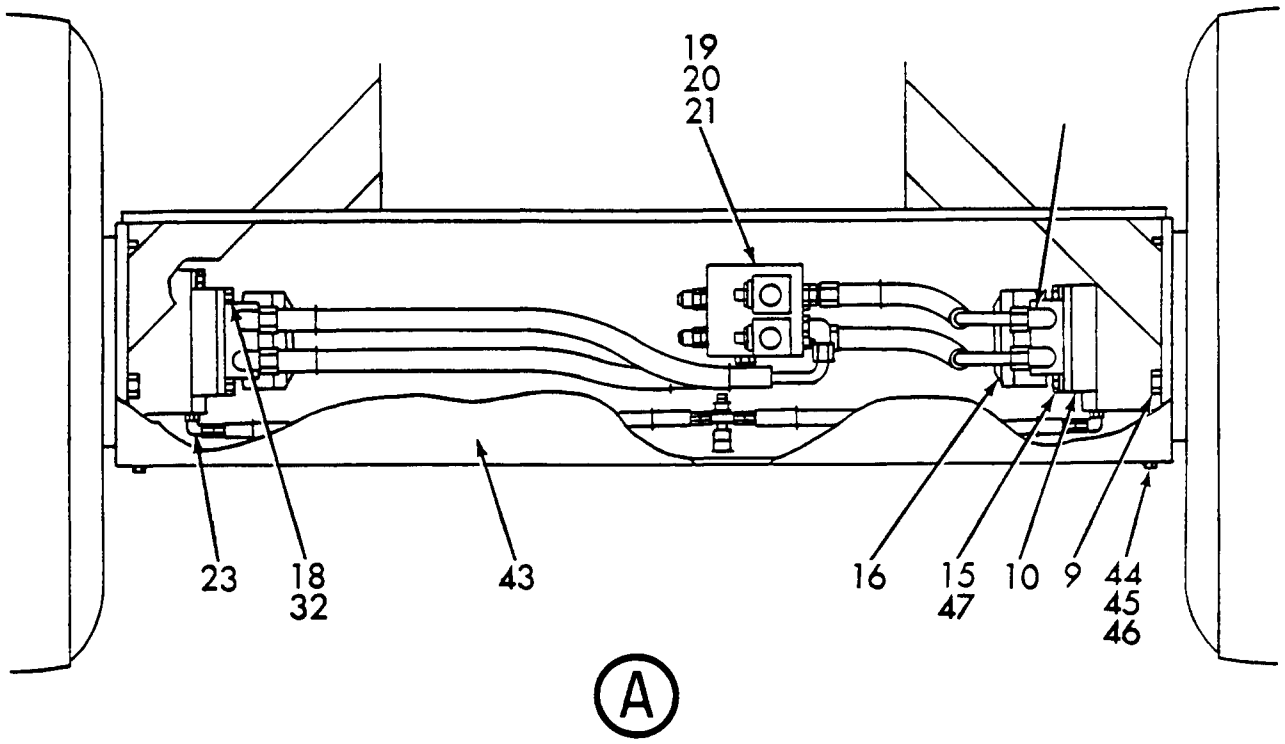


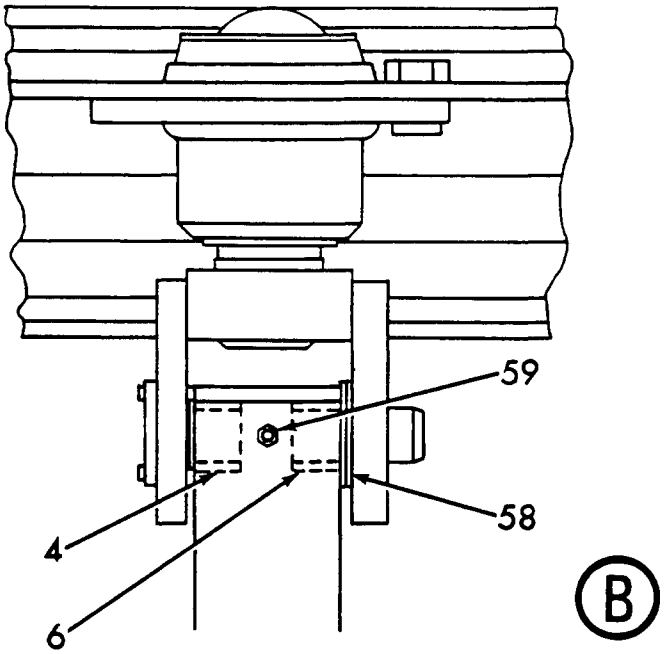
REV.

Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	3
FIGURE	1
PAGE	2



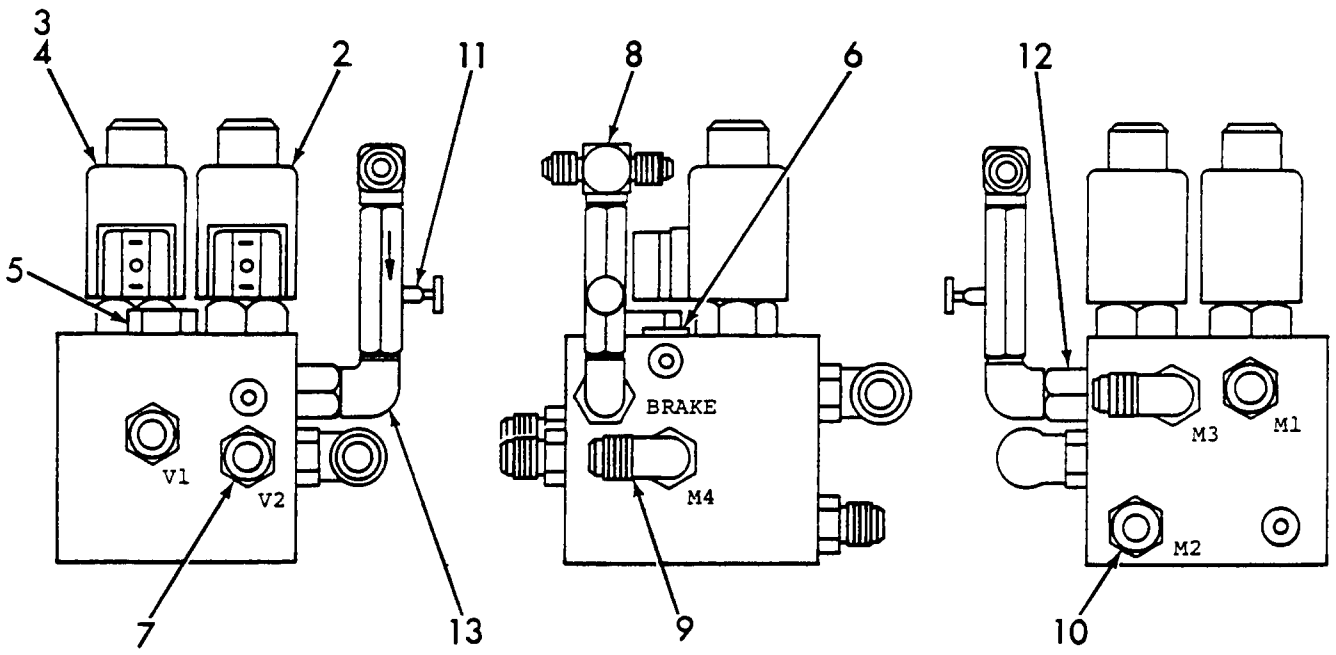


REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	141127	ASSEMBLY, CARRIAGE (See Sect. 2, Fig. 1 for NHA)	REF
2	.141117	WELDMENT, CARRIAGE	1
3	..140039	MACHINING, STEERING AXLE	1
4	...64910	BUSHING, FLANGED	2
5	...2265	BUSHING	1
6	...64934	BEARING, SLEEVE	2
7	.81218	HUB, TORQUE (See Vendor Chapter for Details)	2
-8	..600219	KIT, SEAL	1
9	.60604	SCREW, CAP	12
10	.81217	BRAKE (See Vendor Chapter for Details)	2
-11	..67150	KIT, SEAL	1
-12	..67657	KIT, BEARING	1
-13	..67650	KIT, SPRING	1
-14	..67645	KIT, LINING	1
15	.60610	SCREW, CAP	4
16	.81216	MOTOR, DRIVE	2
-17	..67357	KIT, SEAL	1
18	.65969	SCREW	4
19	.140293	ASSEMBLY, SERIES/PARALLEL VALVE (See Sect. 3, Fig. 2 for Details)	1
20	.60343	SCREW, CAP	3
21	.63319	WASHER, LOCK	15
22	.80012-13	ELBOW, STRAIGHT THREAD	4
23	.80012-03	ELBOW, STRAIGHT THREAD	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.140237	ASSEMBLY, STEERING TIE ROD	1
25	..140273	WELDMENT, STERING TIE ROD	1
26	..140270	YOKE, ADJUSTING TIE ROD	1
27	..60902	NUT, JAM	1
28	.65966	SCREW, SHOULDER	2
29	.140291	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 3 & 3A for Details)	1
30	.61236	NUT, LOCK	2
31	.140089	ASSEMBLY, HUB	2
32	.63305	WASHER, LOCK	4
33	.140167	ASSEMBLY, WHEEL	2
34	..140040	WHEEL	2
35	..140317	VALVE	2
36	..140165	TIRE	2
37	.65117	NUT, BALL	10
38	.140166	ASSEMBLY, FRONT AXLE WHEEL	2
39	..140280	WHEEL, FRONT AXLE	2
40	..140321	VALVE	2
41	..140165	TIRE	2
42	.65945	NUT, CONICAL	18
43	.140438	COVER	1
44	.60353	SCREW, CAP	9
45	.63401	WASHER, FLAT	9
46	.63301	WASHER, LOCK	9
47	.63405	WASHER, FLAT	4
48	.141271	ASSEMBLY, SLEW DRIVE MOTOR/ROTATOR (See Sect. 3, Fig. 4 for Details)	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
49	.60636	SCREW, CAP	18
50	.140329	ASSEMBLY, L.H. SPINDLE & YOKE	1
51	..2265	BUSHING	1
52	.140328	ASSEMBLY, R.H. SPINDLE & YOKE	1
53	..2265	BUSHING	1
54	..64935	BEARING, SLEEVE	1
55	.140338	PIN, KING	2
56	.60338	SCREW, CAP	4
57	.63302	WASHER, LOCK	4
58	.140759	SPACER (STEERING YOKE)	2
59	.65103	FITTING, GREASE	4
60	.65106	OIL, GEAR (90 WT.)	2
61	.140472	COVER, CARRIAGE PLATE BOTTOM	1
62	.60325	SCREW, CAP	8
63	.486-A	BRACKET, TANK	2
64	.141333	SPACER, TURRET PLATE	1

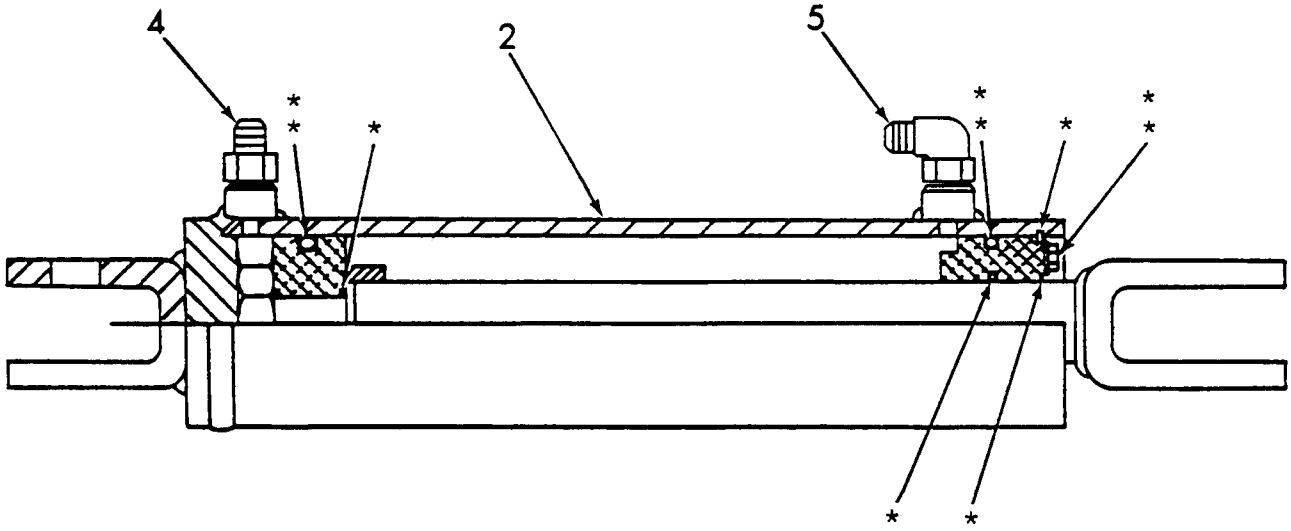


ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140293	ASSEMBLY, SERIES/PARALLEL VALVE (See Sect. 3, Fig. 1 for NHA)	REF
2	.81220	VALVE, SERIES/PARALLEL	1
3	..67221	VALVE, SOLENOID	2
4	...66913	COIL, 12 VOLT (D01)	1
5	..67228	DIVIDER/COMBINER, FLOW	1
6	..600023	VALVE, SHUTTLE	1
7	.80004-15	CONNECTOR, STRAIGHT THREAD	2
8	.80034-04	TEE, MALE BRANCH	1
9	.80012-13	ELBOW, STRAIGHT THREAD	2
10	.80004-13	CONNECTOR, STRAIGHT THREAD	2
11	.20357	VALVE, NEEDLE	1
12	.51903	ADAPTER, FEMALE PIPE	1
13	.80022-03	ELBOW, MALE PIPE	1

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY (SE)
MODEL	41KBDF
NOTES	BEFORE LATE 1989

SECTION	3
FIGURE	3
PAGE	1



NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

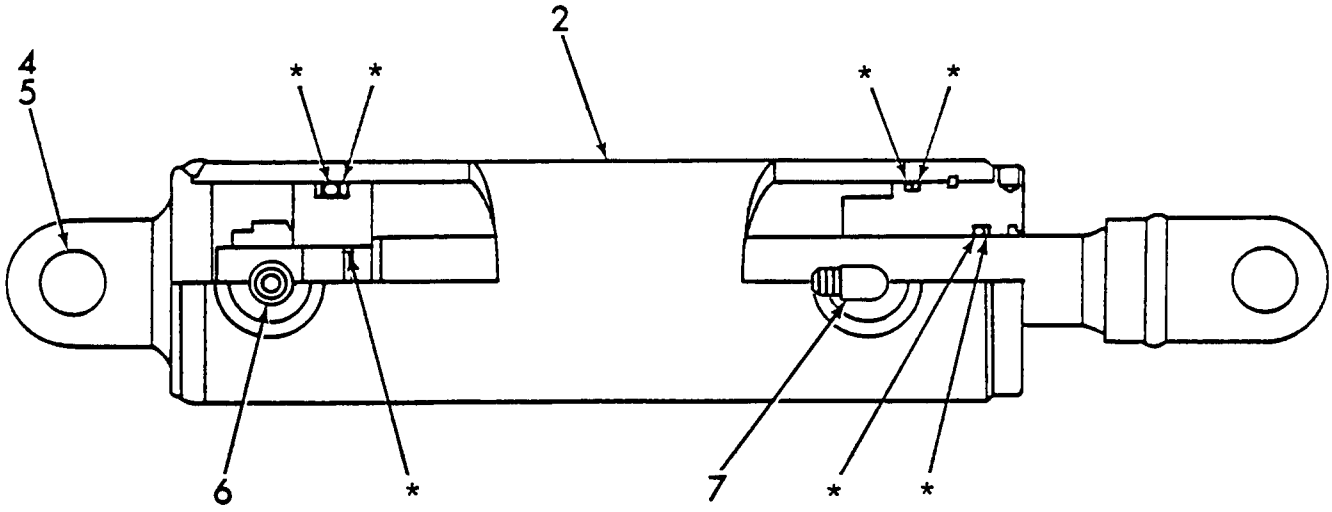
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140291	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 for NHA)	REF
2	.140059	CYLINDER, STEERING (SE)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..66861	KIT, SEAL (SE)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	.80004-03	CONNECTOR, STRAIGHT THREAD	1
5	.80012-03	ELBOW, STRAIGHT THREAD	1

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY (TH)
MODEL	41KBDF
NOTES	AFTER LATE 1989

SECTION	3
FIGURE	3A
PAGE	1



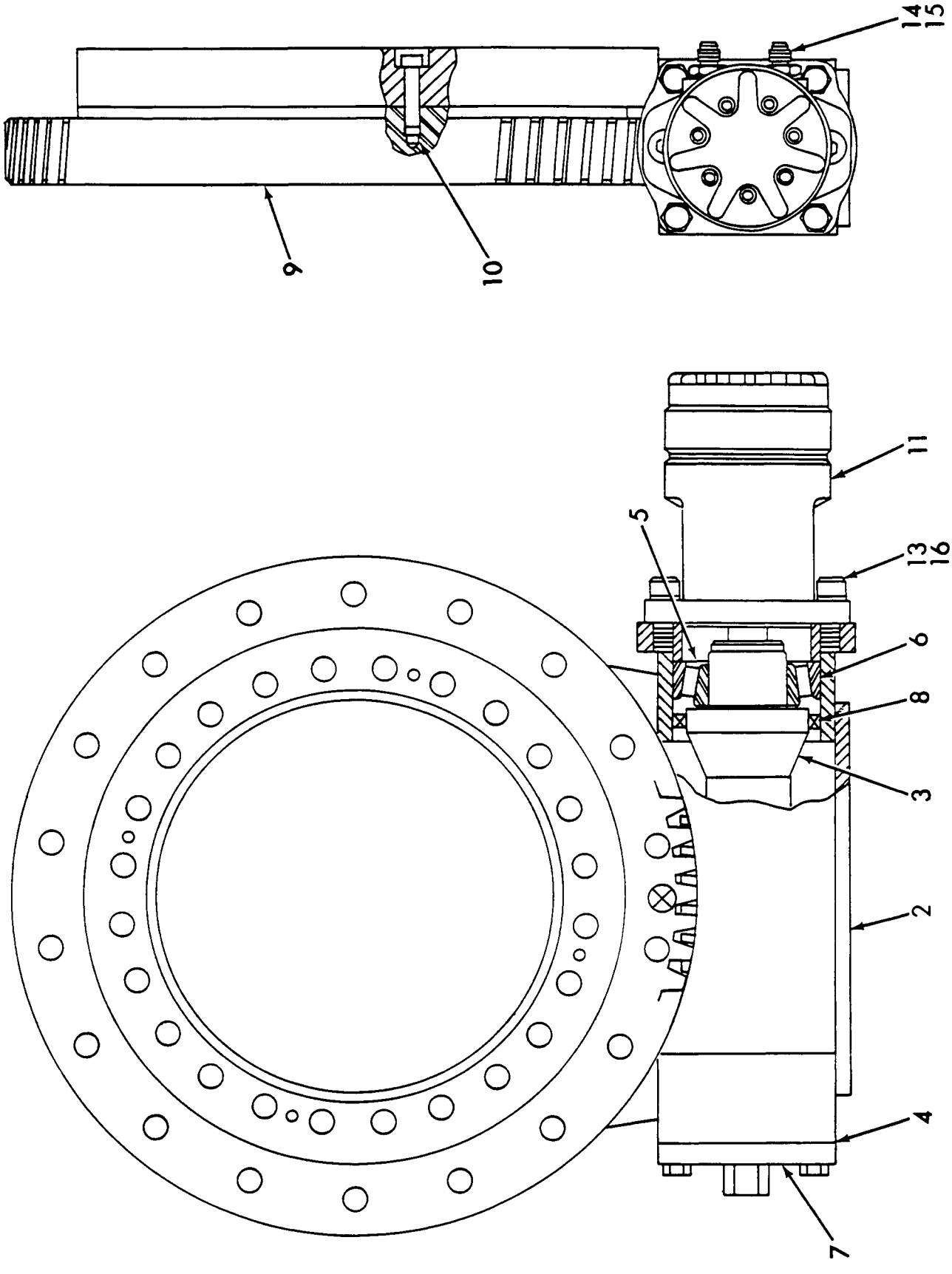
NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140291	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 for NHA)	REF
2	.140059	CYLINDER, STEERING (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..600033	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..68005	PIN, CLEVIS	2
5	..68006	PIN, CLIP	4
6	.80004-03	CONNECTOR, STRAIGHT THREAD	1
7	.80012-03	ELBOW, STRAIGHT THREAD	1

Mark Industries

TITLE	SLEW DRIVE MOTOR/ROTATOR ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	3
FIGURE	4
PAGE	1

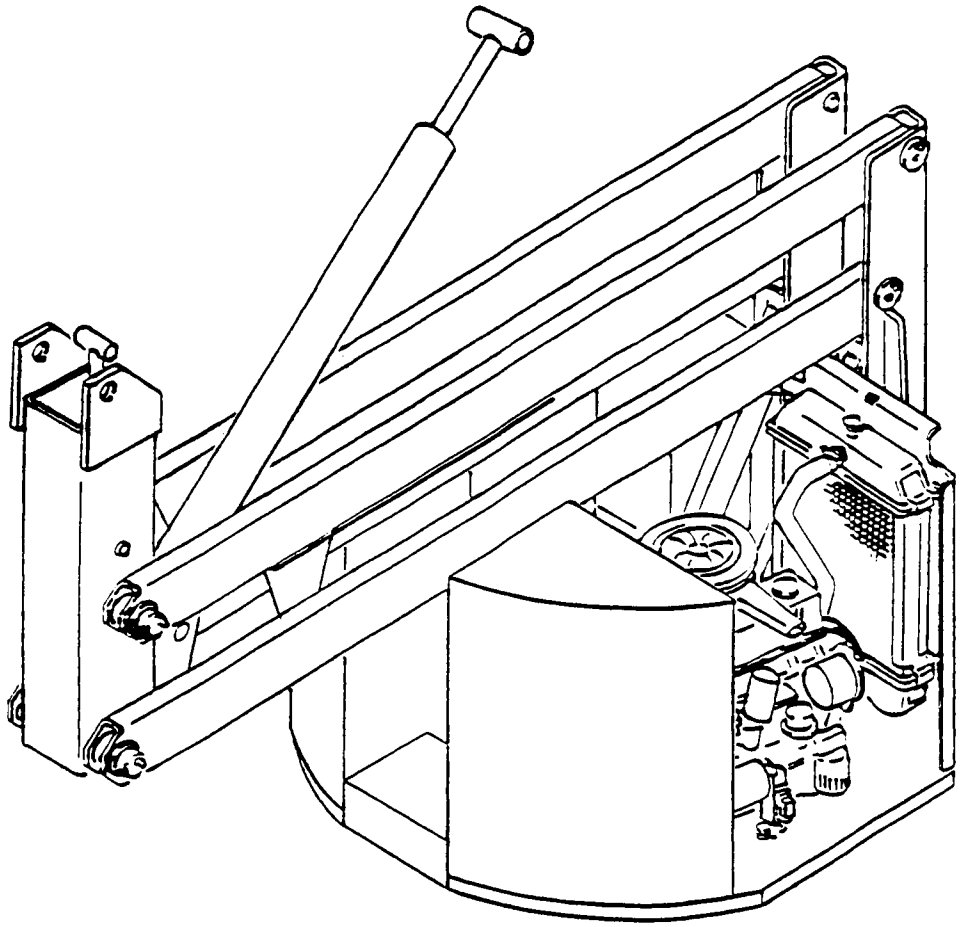


REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	141271	ASSEMBLY, SLEW DRIVE MOTOR/ROTATOR (See Sect. 3, Fig. 1 for NHA)	REF
2	.141277	ASSEMBLY, WORM BOX	1
3	..600117	SHAFT	1
4	..600118	SET, SHIM	1
5	..600121	CONE, BEARING	2
6	..600122	CUP, BEARING	2
7	..600120	SEAL, OUTBOARD	1
8	..600119	SEAL, INBOARD	1
9	.23722	GEAR, RING	1
10	.62017	SCREW, CAP	2
11	.81362	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	1
-12	..600123	KIT, SEAL	1
13	.62011	SCREW, CAP	2
14	.80001-11	CONNECTOR, MALE	2
15	.65781	PLUG, CAP	2
16	.63305	WASHER, LOCK	2

SECTION 4 CONTAINS:

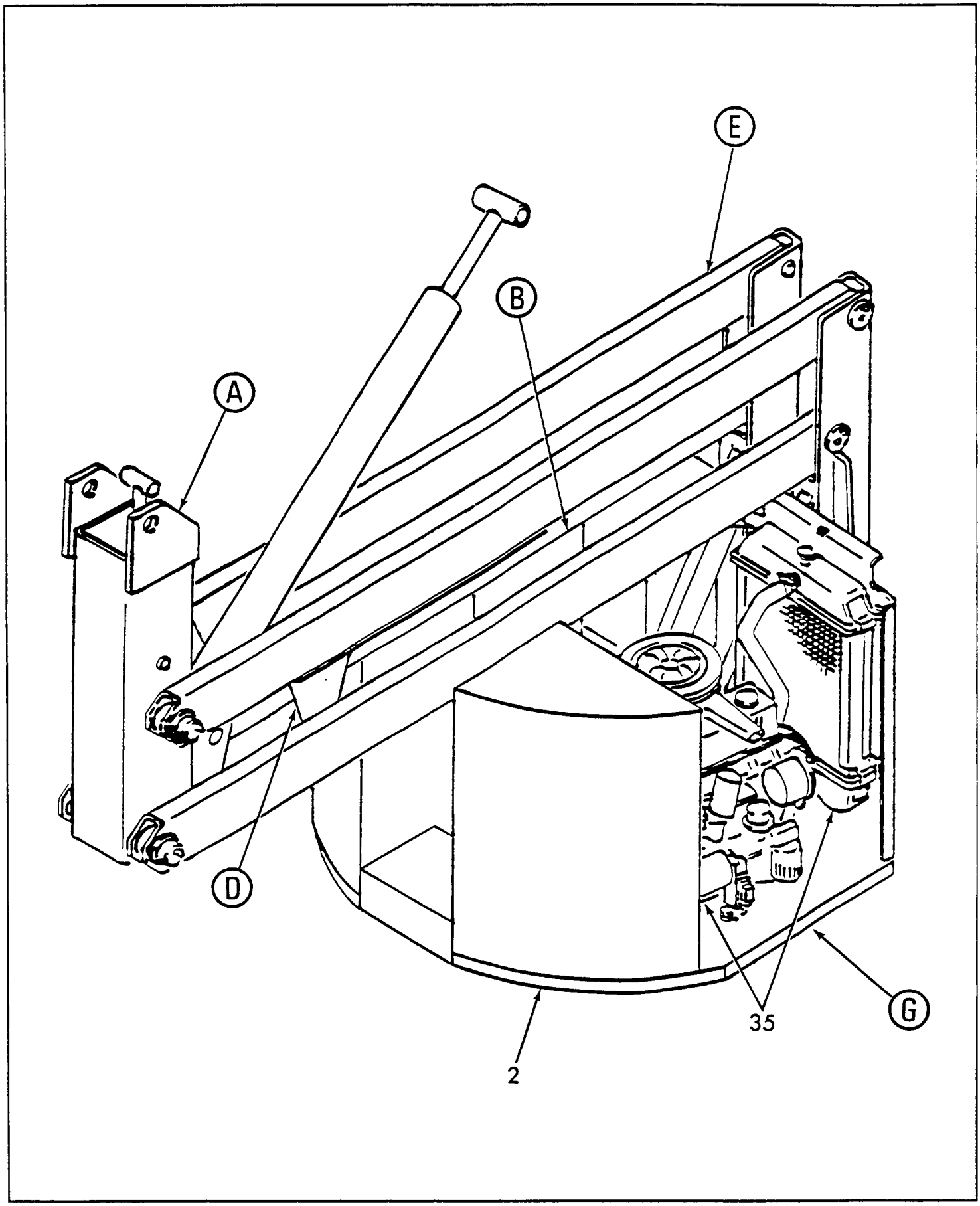
FIG. NO.	TITLE
1	TURRET ASSEMBLY
2	BOOM FUNCTION VALVE ASSEMBLY
3	ENGINE/PUMP ASSEMBLY
4	PROPORTIONAL DRIVE/STEER VALVE ASSEMBLY
5	COOLING SYSTEM ASSEMBLY
6	HYDRAULIC TANK ASSEMBLY
7	RISER LIFT CYLINDER ASSEMBLY (SE)
7A	RISER LIFT CYLINDER ASSEMBLY (TH)
8	MASTER CYLINDER SUB-ASSEMBLY (SE)
8A	MASTER CYLINDER ASSEMBLY (TH)



Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	1
PAGE	1

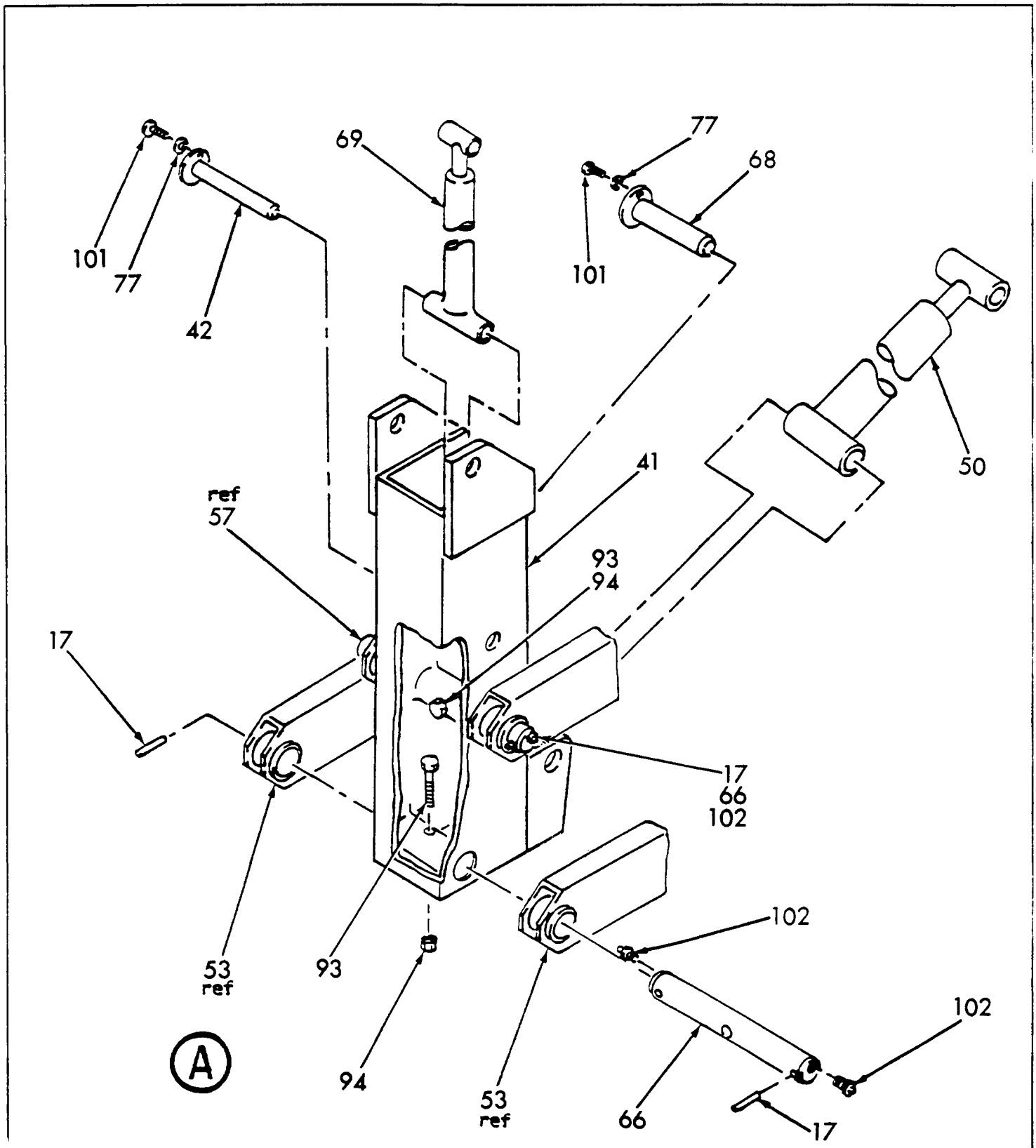


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	1
PAGE	2

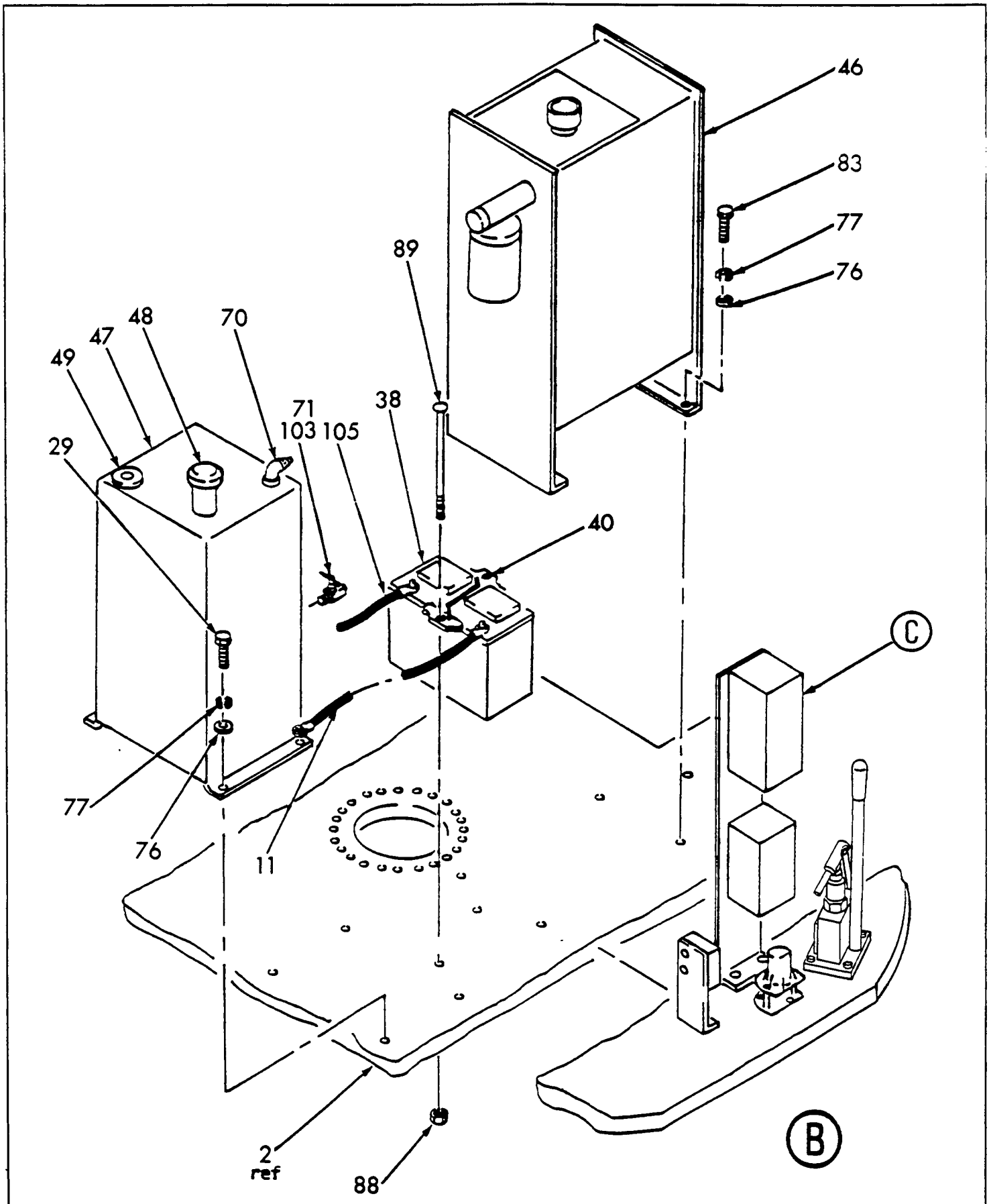


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	1
PAGE	3

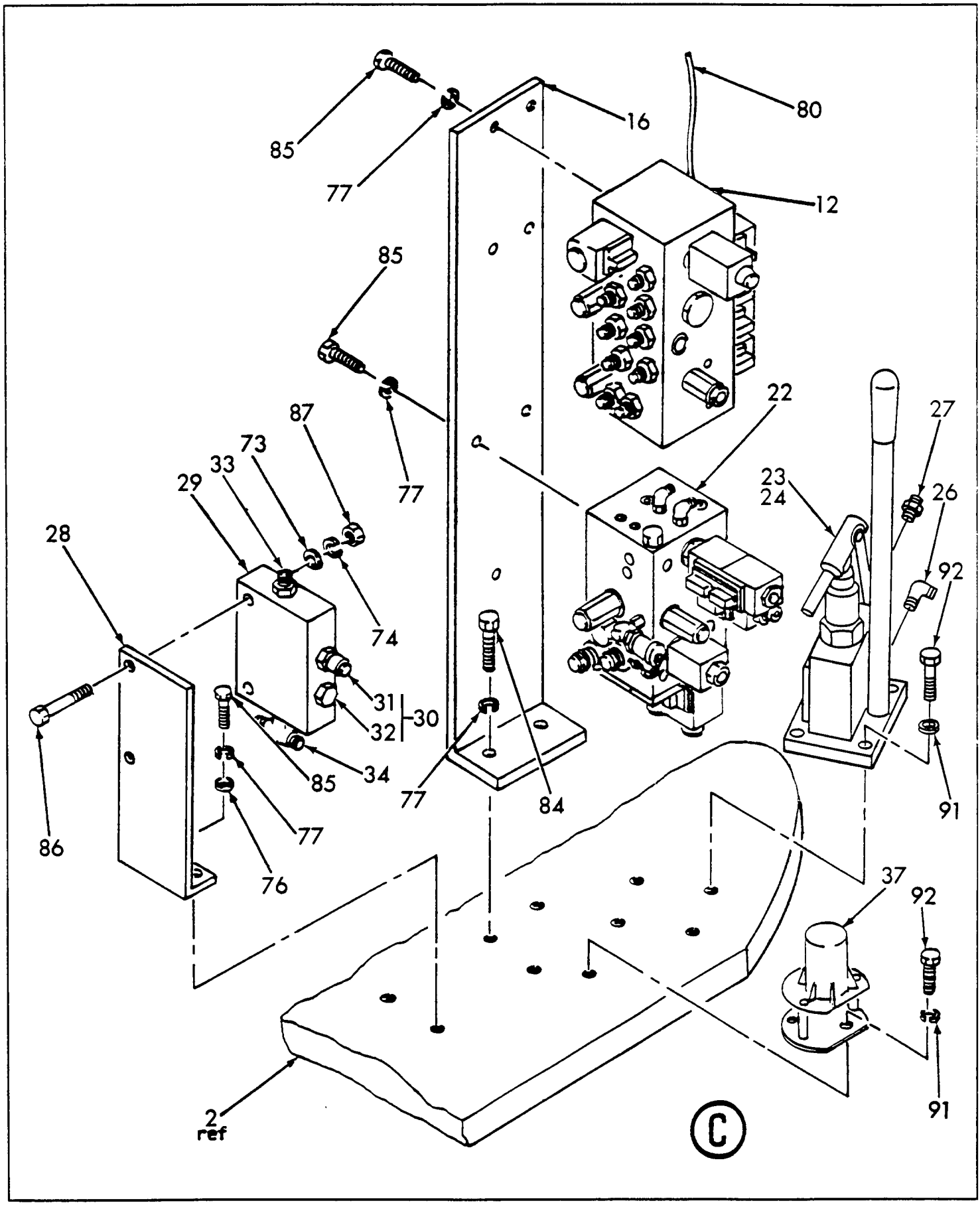


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	1
PAGE	4

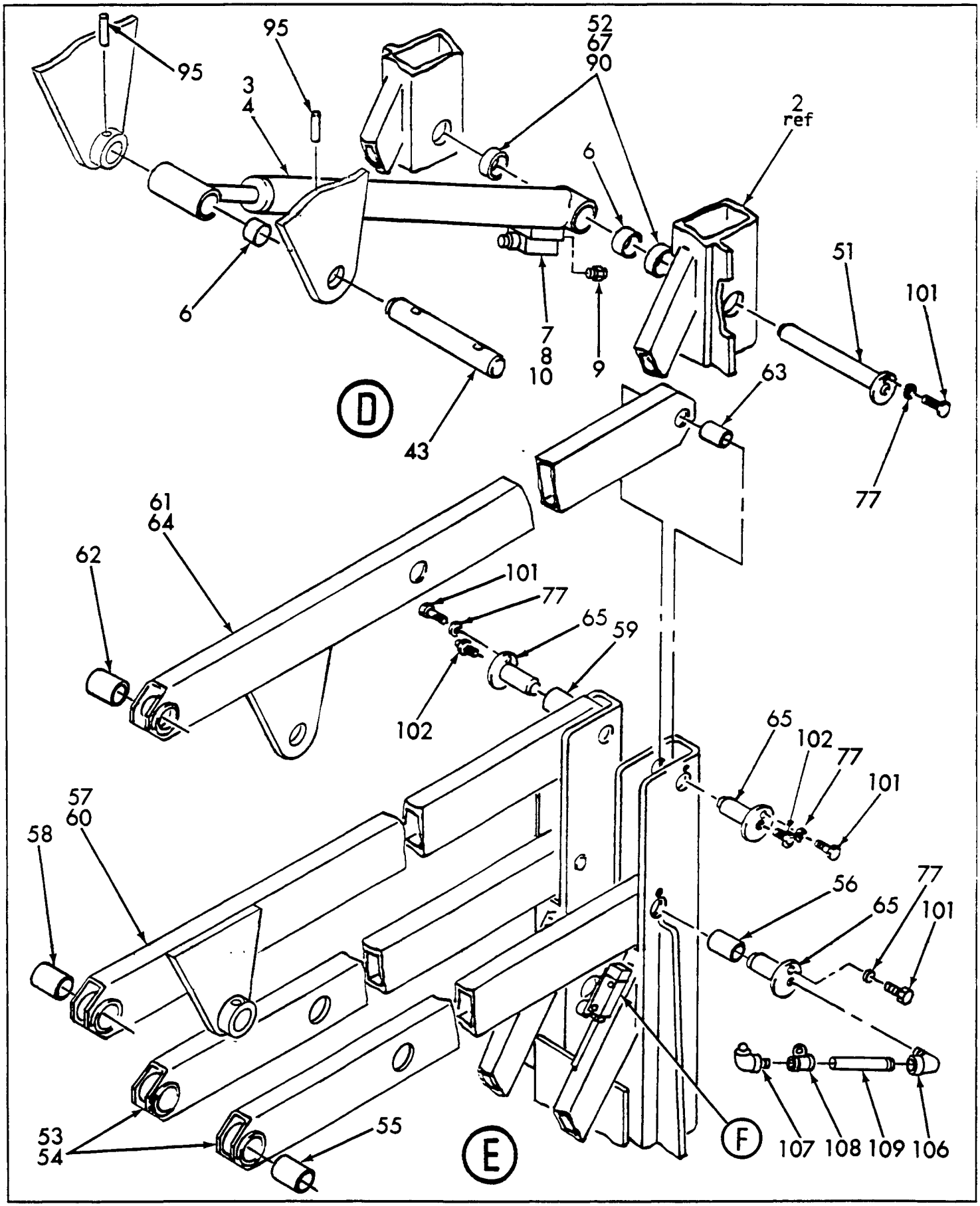


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	1
PAGE	5

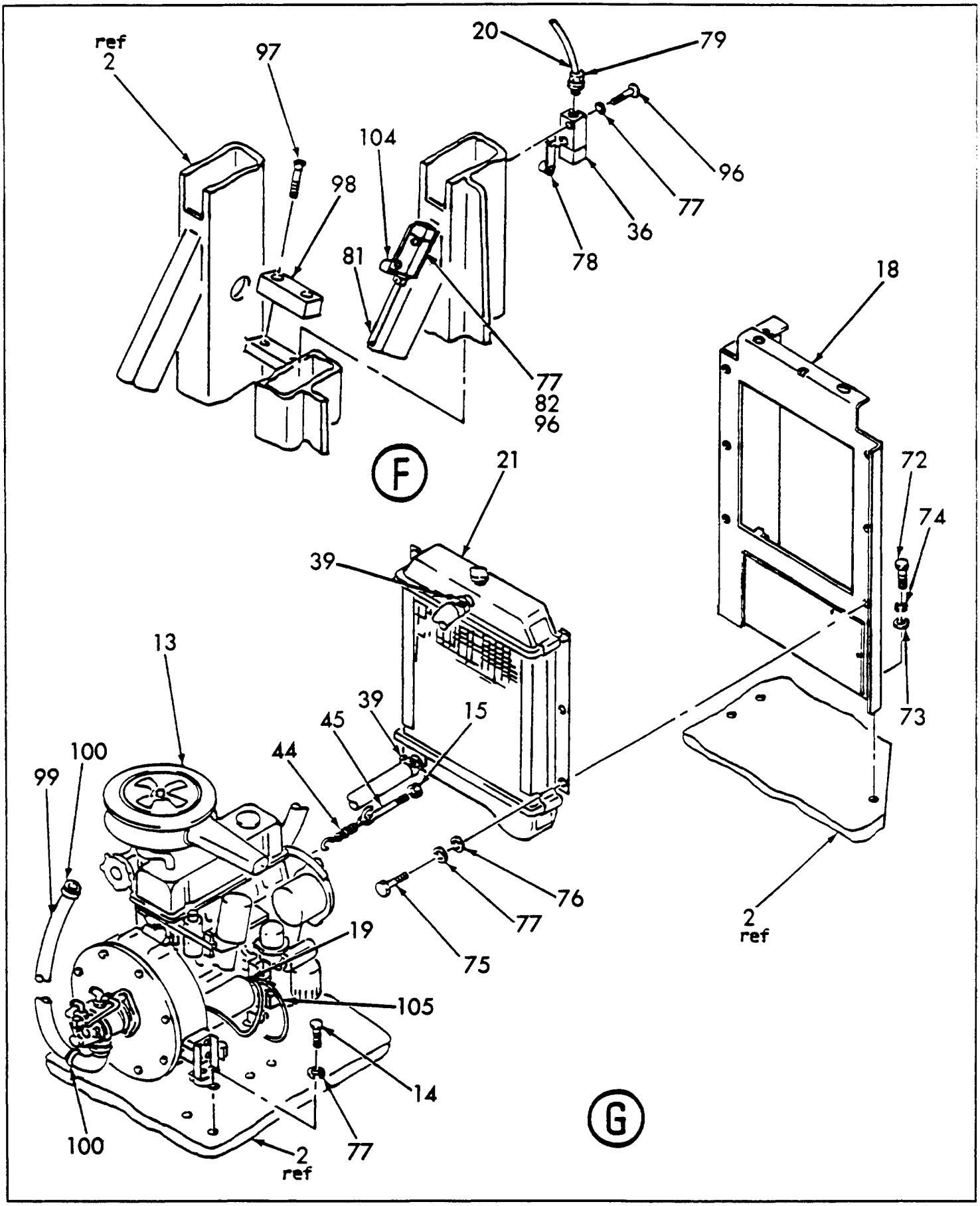


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	1
PAGE	6



REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECT.	4
FIG.	1
PAGE	7

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	141093	ASSEMBLY, TURRET (See Sect. 2, Fig. 1 for NHA)	REF
2	.140147	WELDMENT, TURRET PLATE	1
3	.141085	ASSEMBLY, RISER CYLINDER	1
4	..141084	CYLINDER, RISER (TH)	1
-5	...600185	KIT, SEAL (TH)	1
6	...600062	BUSHING	4
7	..60319	SCREW, CAP	3
8	..63301	WASHER, LOCK	3
9	..80004-08	CONNECTOR, STRAIGHT THREAD	2
10	..81205	VALVE, HOLDING	1
11	.13226-0180	ASSEMBLY, BATTERY CABLE (1.5 FT)	1
12	.140829	ASSEMBLY, BOOM FUNCTION VALVE (See Sect. 4, Fig. 2 for Details)	1
13	.140064	ASSEMBLY, ENGINE/PUMP (See Sect. 4, Fig. 3 for Details)	1
14	.60325	SCREW, CAP	18
15	.60703	NUT, HEX	2
16	.140478	WELDMENT, MANIFOLD BRACKET	1
17	.65967	PIN, ROLL	4
18	.140571	BRACKET, RADIATOR	1
19	.70386-1440	CABLE	12 FT
20	.2912-1560	CABLE	13 FT
21	.140587	RADIATOR	1
22	.140292	ASSEMBLY, PROPORTIONAL DRIVE/STEER (See Sect. 4, Fig. 4 for Details)	1
23	.140806	ASSEMBLY, EMERGENCY PUMP	1

DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	..81281	PUMP, EMERGENCY	1
-25	...600031	KIT, SEAL	1
26	..80008-04	ELBOW, MALE	1
27	..80001-04	CONNECTOR, MALE	1
28	.140476	WELDMENT, BRACKET REGENERATIVE	1
29	.140313	ASSEMBLY, REGENERATIVE VALVE	1
30	..81222	VALVE, REGENERATIVE	1
31	...67360	VALVE, COUNTERBALANCE	1
32	...67361	VALVE, CHECK	1
33	..80004-13	CONNECTOR, STRAIGHT THREAD	3
34	..80030-06	TEE, SWIVEL NUT	1
35	.140857	ASSEMBLY, COOLING SYSTEM (See Sect. 4, Fig. 5 for Details)	1
36	.70173	SWITCH, LIMIT	1
37	.21250	SENSOR, SLOPE	1
38	.4030	BATTERY (12 VOLT, 95 AMP)	1
39	.16288	CLAMP, HOSE	4
40	.20375	CLAMP, BATTERY	1
41	.141082	MACHINING, RISER	1
42	.140548	PIN, MASTER CYLINDER/RISER	1
43	.141113	PIN, ARM/CYLINDER	1
44	.65839	SPRING, EXTENSION	1
45	.65959	EYEBOLT	1
46	.140580	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 6 for Details)	1
47	.140239	TANK, FUEL	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
48	..81150	CAP, FILLER/BREATHER	1
49	..65811	UNIT, SENDING	1
50	.140814	ASSEMBLY, RISER LIFT CYLINDER (See Sect. 4, Fig. 7 & 7A for Details)	1
51	.140421	PIN, ARM/CYLINDER COLUMN	1
52	.27095	TUBE	2
53	.141168	ASSEMBLY, RISER ARM/LOWER	2
54	..141167	WELDMENT, RISER ARM/LOWER	2
55	..140385	BUSHING, RISER	2
56	..140386	BUSHING, COLUMN	2
57	.141092	ASSEMBLY, RISER ARM/UPPER (R.H.)	1
58	..140385	BUSHING, RISER	1
59	..140386	BUSHING, COLUMN	1
60	..141090	WELDMENT, RISER ARM/UPPER (R.H.)	1
61	.141091	ASSEMBLY, RISER ARM/UPPER (L.H.)	1
62	..140385	BUSHING, RISER	1
63	..140386	BUSHING, COLUMN	1
64	..141089	WELDMENT, RISER ARM/UPPER (L.H.)	1
65	.140423	PIN, ARM/COLUMN	4
66	.140422	PIN, ARM/RISER	2
67	.28174	TUBE	6
68	.140430	PIN, BOOM LIFT/RISER	1
69	.140947	ASSEMBLY, MASTER CYLINDER (See Sect. 4, Fig. 8 & 8A for Details)	1
70	.160093	HOSE, BARB	1
71	.160092	HOSE, BARB	1

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	41KBDF
NOTES	

SECT.	4
FIG.	1
PAGE	10

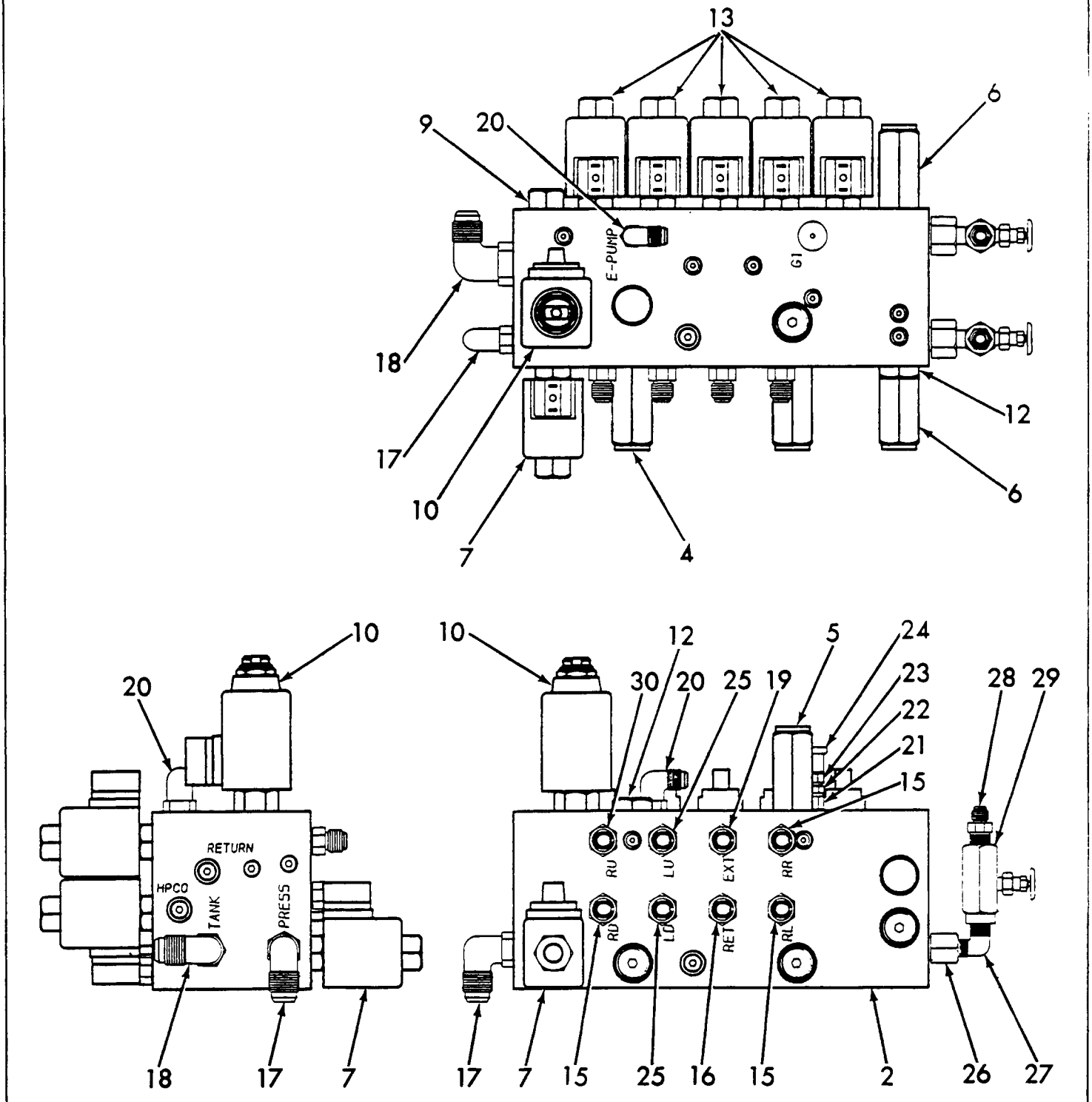
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
72	.60322	SCREW, CAP	5
73	.63402	WASHER, FLAT	5
74	.63302	WASHER, LOCK	7
75	.60320	SCREW, CAP	14
76	.63403	WASHER, FLAT	14
77	.63319	WASHER, LOCK	45
78	.70031	LEVER, SWITCH	1
79	.2806	RELIEF, STRAIN	2
80	.70384-1200	CABLE	10 FT
81	.2912-1200	CABLE	10 FT
82	.70107	SWITCH, LIMIT	1
83	.60372	SCREW, CAP	8
84	.60331	SCREW, CAP	4
85	.60343	SCREW, CAP	5
86	.60329	SCREW, CAP	2
87	.60702	NUT, HEX	2
88	.61246	NUT (WITH NYLOCK)	2
89	.65108	BOLT, HOLD DOWN	2
90	.28175	TUBE	8
91	.63301	WASHER, LOCK	8
92	.60342	SCREW, CAP	6
93	.60614	SCREW, CAP	2
94	.61301	NUT, LOCK	2
95	.64216	PIN, ROLL	2
96	.62704	SCREW, MACHINE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
97	.61832	SCREW, CAP	2
98	.141114	PAD, BOOM REST	1
99	.140553	HOSE, HYDRAULIC	2.5 FT
100	.55	CLAMP, HOSE	2
101	.65984	SCREW, CAP	7
102	.65103	FITTING, GREASE	6
103	.12000	VALVE, NEEDLE	1
104	.70148	ARM, LEVER SWITCH	1
105	.13226-0760	ASSEMBLY, BATTERY CABLE (6.3 FT)	1
106	.160332	ELBOW, STREET	2
107	.160329	FITTING, GREASE	2
108	.764	CLAMP, RUBBER	2
109	.28862	TUBE (31" LONG)	2

Mark Industries

TITLE	BOOM FUNCTION VALVE ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	2
PAGE	1

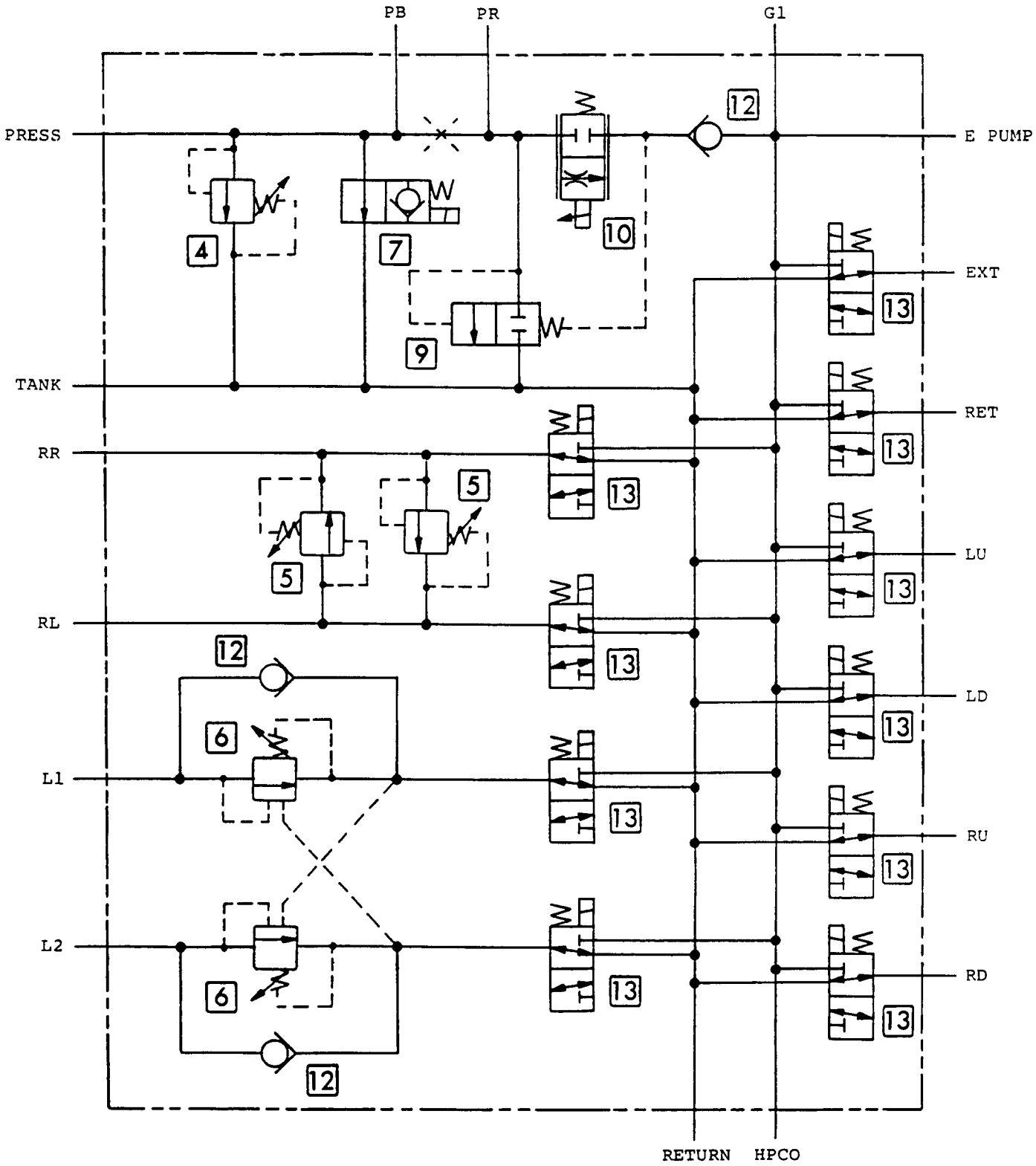


REV.

Mark Industries

TITLE	BOOM FUNCTION VALVE ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	2
PAGE	2



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140829	ASSEMBLY, BOOM FUNCTION VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	.81248	VALVE, BOOM FUNCTION	1
-3	..600026	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
*4	..68060	VALVE, RELIEF	1
*5	..67218	VALVE, RELIEF	2
*6	..68057	VALVE, RELIEF	2
7	..66920	VALVE, SOLENOID	1
-8	...66914	COIL, 12 VOLT (SMALL)	1
9	..67338	VALVE, DIFFERENTIAL SENSING	1
10	..600027	SOLENOID, PROPORTIONAL	1
-11	...600111	COIL, 12 VOLT (LARGE)	1
12	..66674	VALVE, CHECK	3
13	..66923	VALVE, SOLENOID	10
-14	...66914	COIL, 12 VOLT (SMALL)	1
15	.80004-08	CONNECTOR, STRAIGHT THREAD	3
16	.80004-12	CONNECTOR, STRAIGHT THREAD	1
17	.80012-12	ELBOW, STRAIGHT THREAD	1
18	.80012-15	ELBOW, STRAIGHT THREAD	1
19	.80004-11	CONNECTOR, STRAIGHT THREAD	1
20	.80012-03	ELBOW, STRAIGHT THREAD	1
21	.51903	ADAPTER, FEMALE PIPE	1
22	.80052-03	NIPPLE, PIPE	1
		NOTE: PRIOR TO USE, RELIEF VALVES WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

Mark Industries

TITLE	BOOM FUNCTION VALVE ASSEMBLY
MODEL	41KBDF
NOTES	

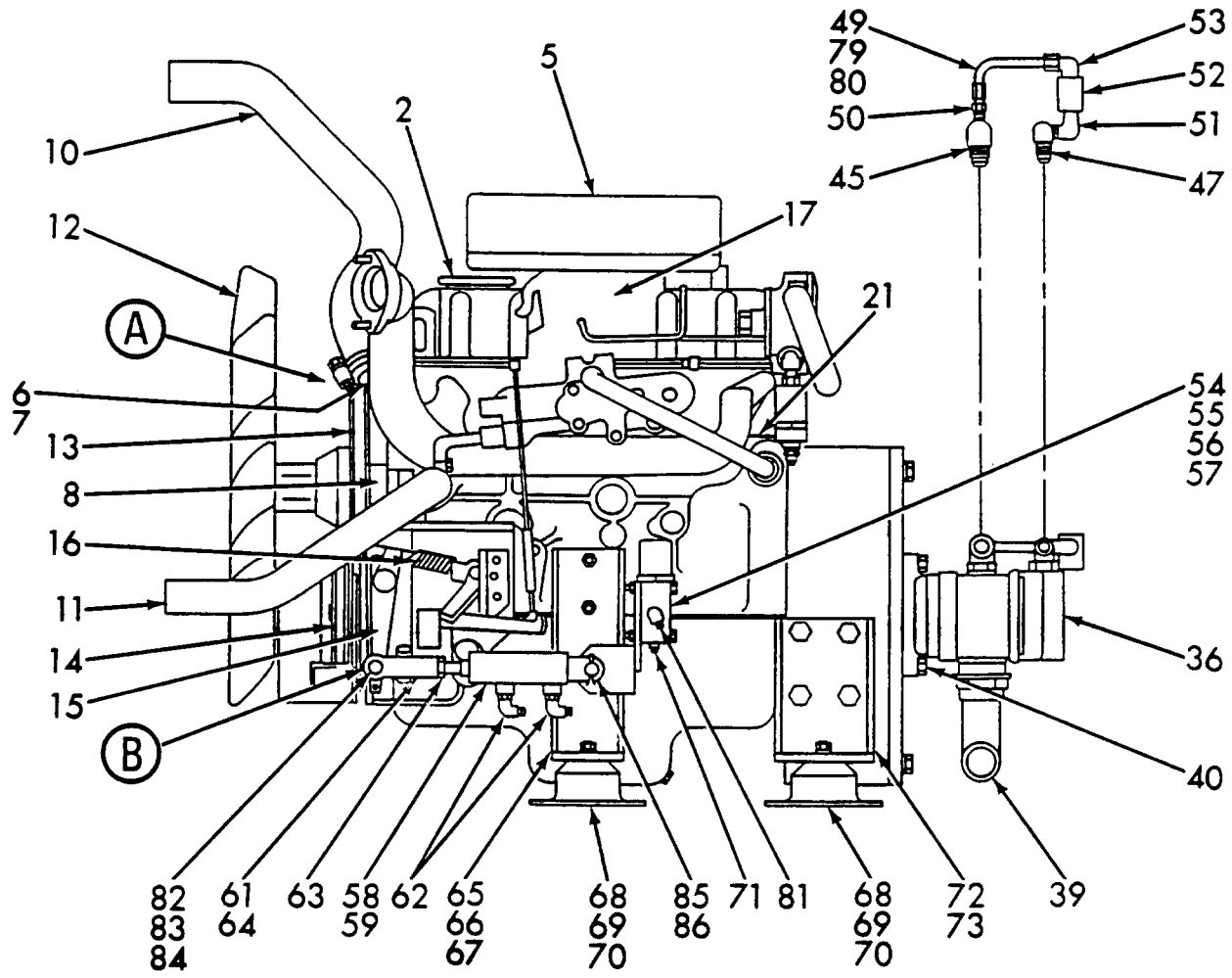
SECT.	4
FIG.	2
PAGE	4

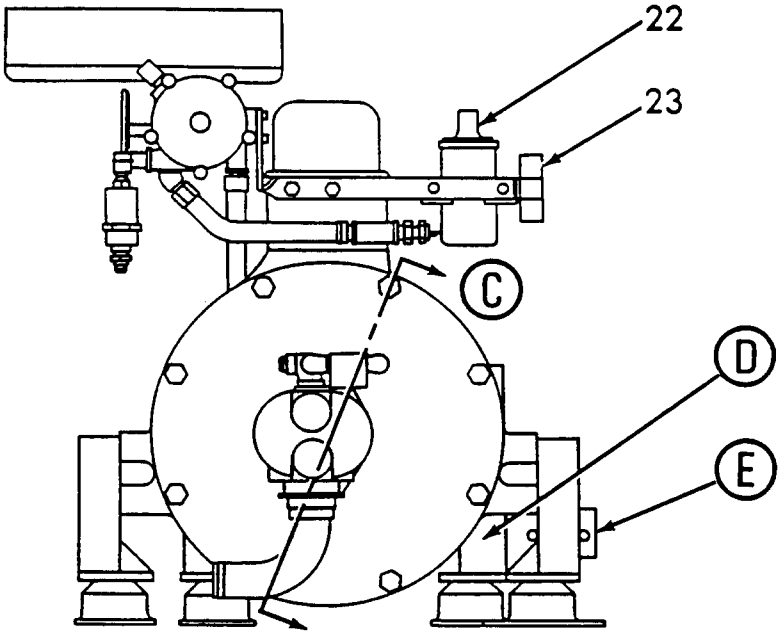
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.2527	COUPLING, QUICK DISCONNECT	1
24	.845	CAP, QUICK DISCONNECT	1
25	.80004-05	CONNECTOR, STRAIGHT THREAD	2
26	.80063-01	ADAPTER, FEMALE PIPE	2
27	.80022-04	ELBOW, MALE PIPE	2
28	.80001-04	CONNECTOR, MALE	2
29	.20357	VALVE, NEEDLE	2
30	.140765	CONNECTOR, MODIFIED	

Mark Industries

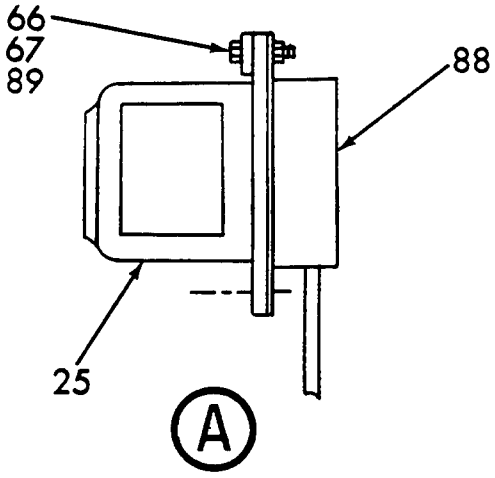
TITLE	ENGINE/PUMP ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	3
PAGE	1

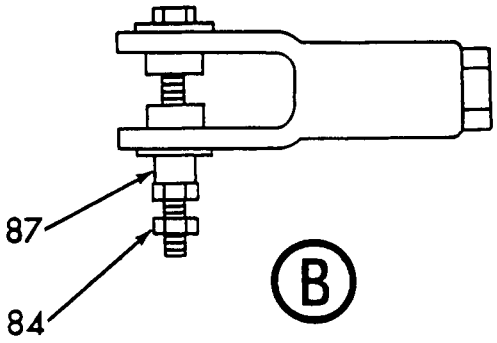




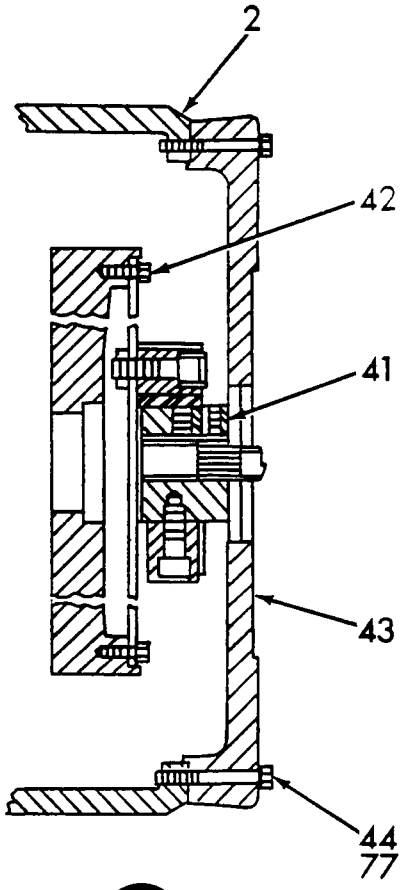
REV.



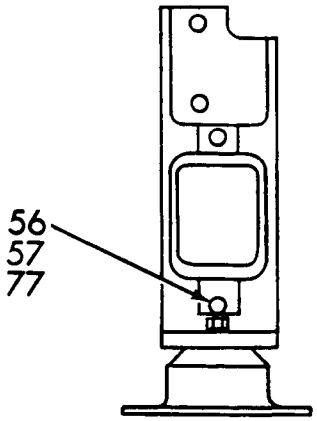
A



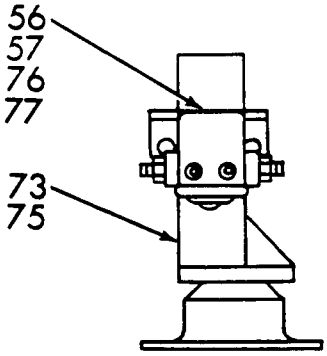
B



C



D



E

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140064	ASSEMBLY, ENGINE/PUMP (See Sect. 4, Fig. 1 for NHA)	REF
2	.21049	ENGINE, NISSAN (A-15 GAS) (See Vendor Chapter for Details)	1
-3	..600040	KIT, TUNE-UP	1
-4	..67334	FILTER, OIL	1
5	..600047	ELEMENT, AIR FILTER	1
6	..67468	THERMOSTAT	1
7	..600041	GASKET, THERMOSTAT	1
8	..67464	PUMP, WATER	1
-9	..67456	SENDER, TEMPERATURE	1
10	..160103	HOSE, UPPER RADIATOR	1
11	..160104	HOSE, LOWER RADIATOR	1
12	..160102	FAN, RADIATOR	1
13	..67465	BELT, FAN	1
14	..67457	BELT, GOVERNOR	1
15	..67114	GOVERNOR, MECHANICAL	1
16	..67442	SPRING, GOVERNOR	1
17	..67460	CARBURETOR	1
-18	...600049	KIT, CARBURETOR REBUILD	1
-19	..66953	SOLENOID, CHOKE	1
20	..67461	INSULATOR, CARBURETOR	1
21	..600042	GASKET, VALVE COVER	1
22	..67075	COIL, IGNITION	1
23	..67120	RESISTOR, BALLAST	1
-24	..67469	DISTRIBUTOR	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	..67076	ALTERNATOR	1
-26	..67079	REGULATOR, VOLTAGE	1
-27	..67470	STARTER	1
-28	..67082	DIPSTICK	1
-29	..67453	PUMP, ELECTRIC FUEL	1
-30	..67103	FLYWHEEL	1
-31	...68063	GEAR, RING	1
-32	..67436	SWITCH, OIL PRESSURE	1
-33	..67083	KIT, DUAL FUEL	1
-34	...16923	SWITCH, VACUUM SAFETY	1
-35	16919	KIT, VACUUM SAFETY SWITCH REPAIR	1
36	.81115	ASSEMBLY, DOUBLE GEAR PUMP (See Vendor Chapter for Details)	1
-37	..66869	KIT, SEAL	1
-38	...600162	SEAL, SHAFT	1
39	.81197	TUBE, ELBOW	1
40	.65950	SCREW, CAP	2
41	.140242	COUPLING	1
42	.65949	SCREW, CAP	8
43	.140241	ADAPTER, PUMP	1
44	.60354	SCREW, CAP	8
45	.140507	ELBOW, PUMP I	1
-46	..80012-15	ELBOW, STRAIGHT THREAD	1
47	.140508	ELBOW, PUMP II	1
-48	..80012-13	ELBOW, STRAIGHT THREAD	1
49	.27329	TUBE	1

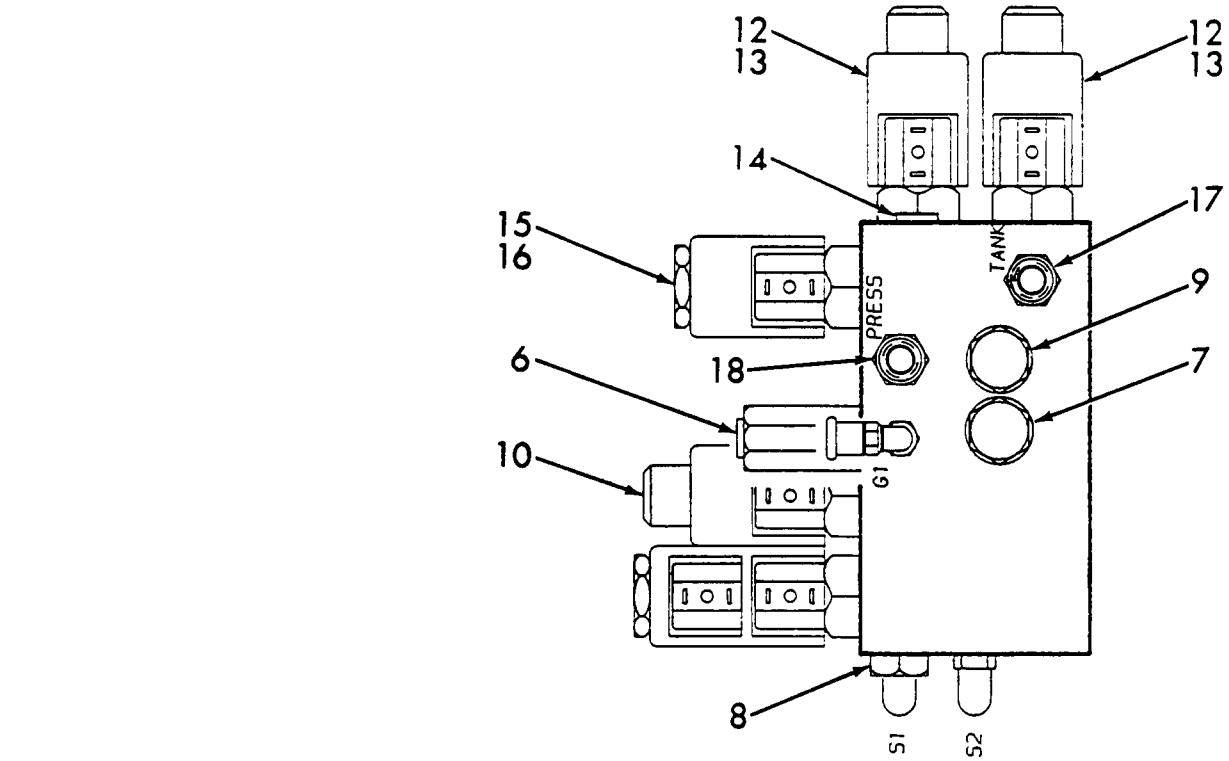
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
50	.80001-04	CONNECTOR, MALE	1
51	.80022-04	ELBOW, MALE PIPE	1
52	.20356	VALVE, SHUTTLE	1
53	.80008-04	ELBOW, MALE	1
54	.20844	VALVE, SOLENOID	1
55	.60340	SCREW, CAP	2
56	.63301	WASHER, LOCK	6
57	.63701	NUT, HEX	6
58	.140578	ASSEMBLY, SHIFT CYLINDER	1
59	..20719	CYLINDER, SHIFT (See Vendor Chapter for Details)	1
-60	...66793	KIT, SEAL	1
61	..20789	CLEVIS, SHIFTING	1
62	..80012-03	ELBOW, STRAIGHT THREAD	2
63	..60901	NUT, JAM	1
64	..37292	TUBE	1
65	.140319	MOUNT,(L.H.) REAR ENGINE	1
66	.63442	WASHER, LOCK	5
67	.65357	NUT, HEX	5
68	.65858	MOUNT, FRONT MOTOR	4
69	.63326	WASHER, LOCK	4
70	.60719	NUT, HEX	4
71	.80004-05	CONNECTOR, STRAIGHT THREAD	1
72	.140320	MOUNT, FRONT ENGINE	1
73	.65976	SCREW, CAP	8
74	.140318	MOUNT, (R.H.) REAR ENGINE	1

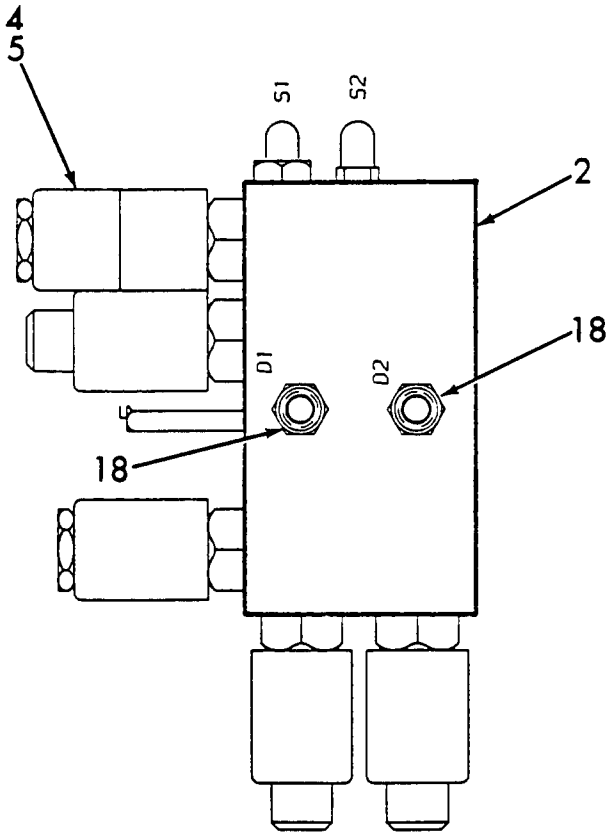
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
75	.140556	MOUNT, FRONT ENGINE	1
76	.70209	SOLENOID, 12 VDC	1
77	.60342	SCREW, CAP	4
78	.63319	WASHER, LOCK	8
79	.80060-04	NUT	2
80	.80062-03	SLEEVE	2
81	.80012-05	ELBOW, STRAIGHT THREAD	2
82	.60341	SCREW, CAP	1
83	.63041	WASHER, FLAT	2
84	.61227	NUT, HEX WITH NYLOCK	2
85	.64108	PIN, CLEVIS	1
86	.64317	PIN, COTTER	1
87	.35715	TUBE	1
88	.140911	GUARD, ENGINE ALTERNATOR	1
89	.67061	SCREW, CAP	1

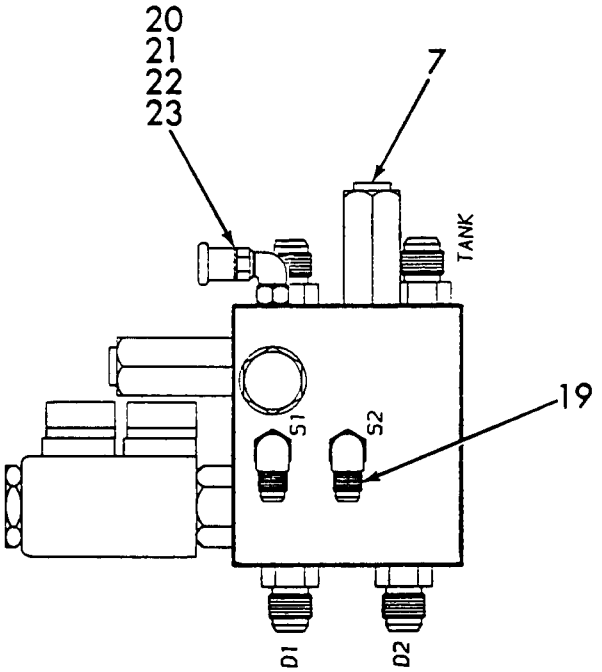
Mark Industries

TITLE	PROPORTIONAL DRIVE/STEER VALVE ASSY
MODEL	41KBDF
NOTES	

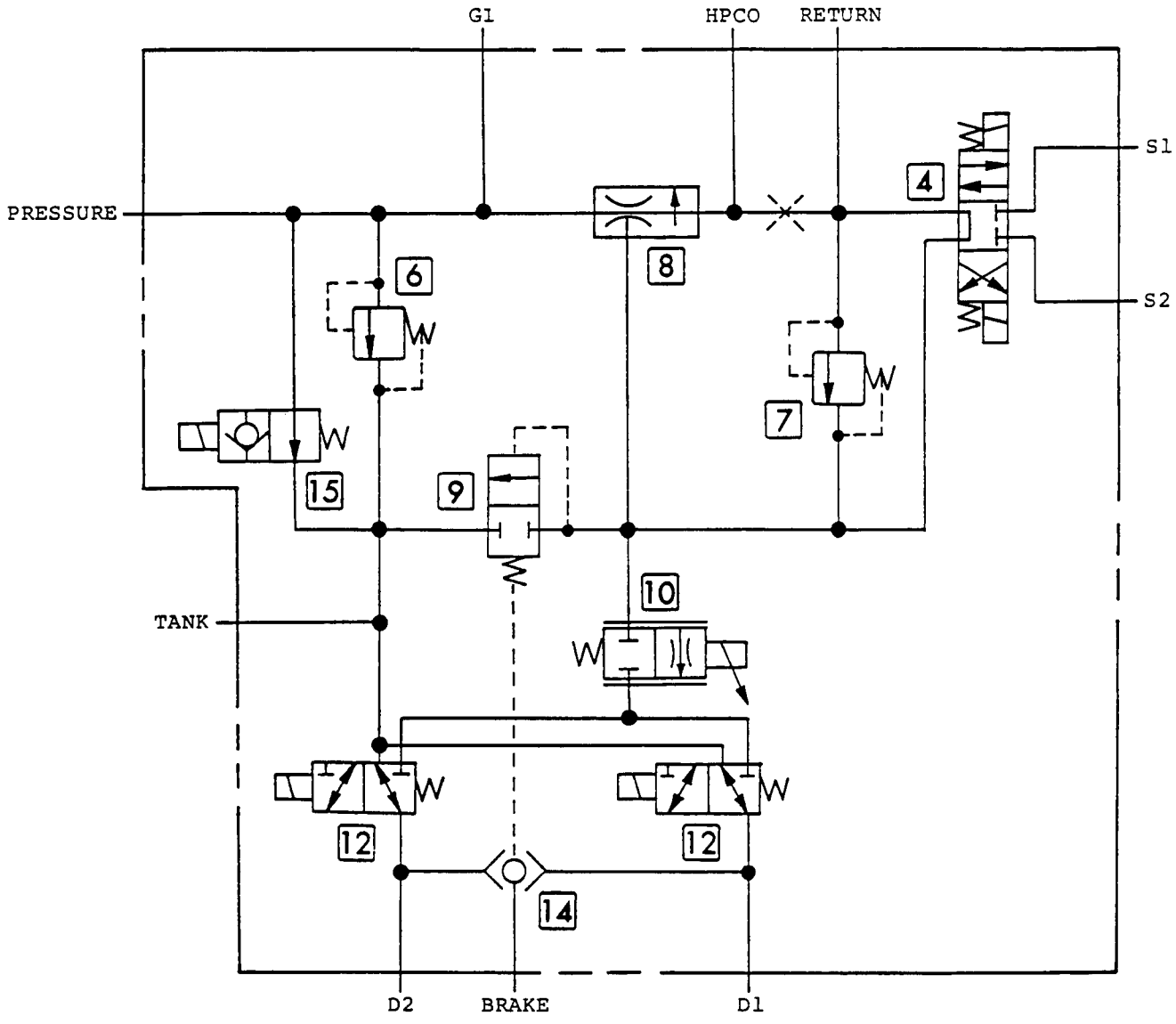
SECTION	4
FIGURE	4
PAGE	1







REV.

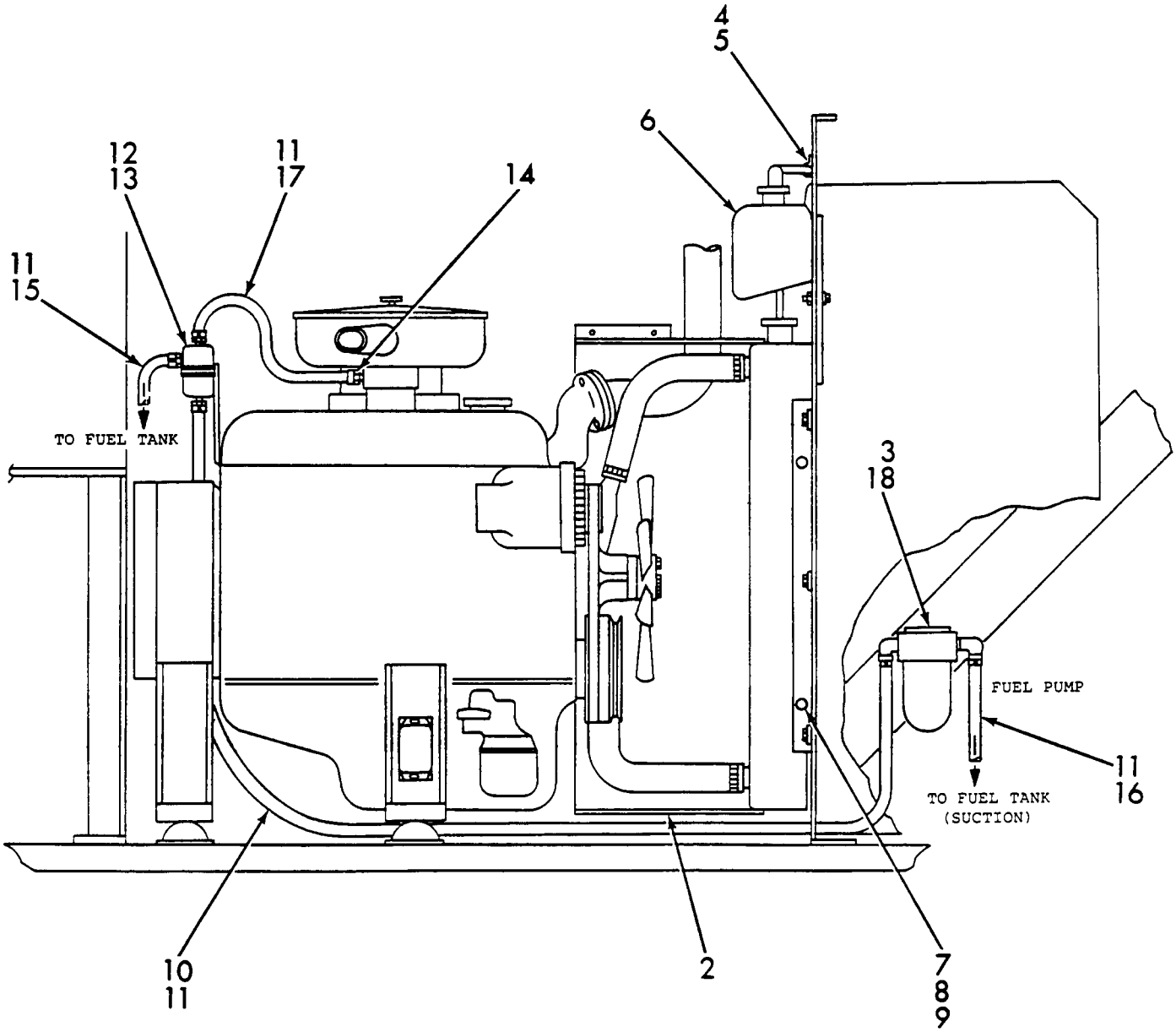

G1
HPCO
RETURN
S1
S2
PRESSURE
4
8
6
7
15
9
10
TANK
12
12
14
D2
BRAKE
D1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140292	ASSEMBLY, PROPORTIONAL DRIVE/STEER VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	.81219	PACKAGE, PROPORTIONAL DRIVE VALVE	1
-3	..600025	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
4	..67223	VALVE, 3 POSITION 4 WAY	1
5	...66914	COIL, 12 VOLT (SMALL)	2
*6	..68060	VALVE, RELIEF	1
*7	..68057	VALVE, RELIEF	1
8	..67229	REGULATOR, FLOW	1
9	..600024	VALVE, DIFFERENTIAL SENSING	1
10	..67345	VALVE, PROPORTIONAL SOLENOID	1
11	...600111	COIL, 12 VOLT (LARGE)	1
12	..67221	VALVE, SOLENOID	2
13	...66913	COIL, 12 VOLT (MEDIUM)	1
14	..600023	VALVE, SHUTTLE	1
15	..66920	VALVE, SOLENOID	1
16	...66914	COIL, 12 VOLT (SMALL)	1
17	.80004-18	CONNECTOR, STRAIGHT THREAD	1
18	.80004-15	CONNECTOR, STRAIGHT THREAD	3
19	.80012-03	ELBOW, STRAIGHT THREAD	2
20	.51903	ADAPTER, FEMALE PIPE	1
21	.80022-03	ELBOW, MALE PIPE	1
22	.2527	COUPLING, QUICK DISCONNECT	1
23	.845	CAP, QUICK DISCONNECT	1
		NOTE: PRIOR TO USE, RELIEF VALVES WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

Mark Industries

TITLE	COOLING SYSTEM ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	5
PAGE	1



REV.

Mark Industries

TITLE	COOLING SYSTEM ASSEMBLY
MODEL	41KBDF
NOTES	

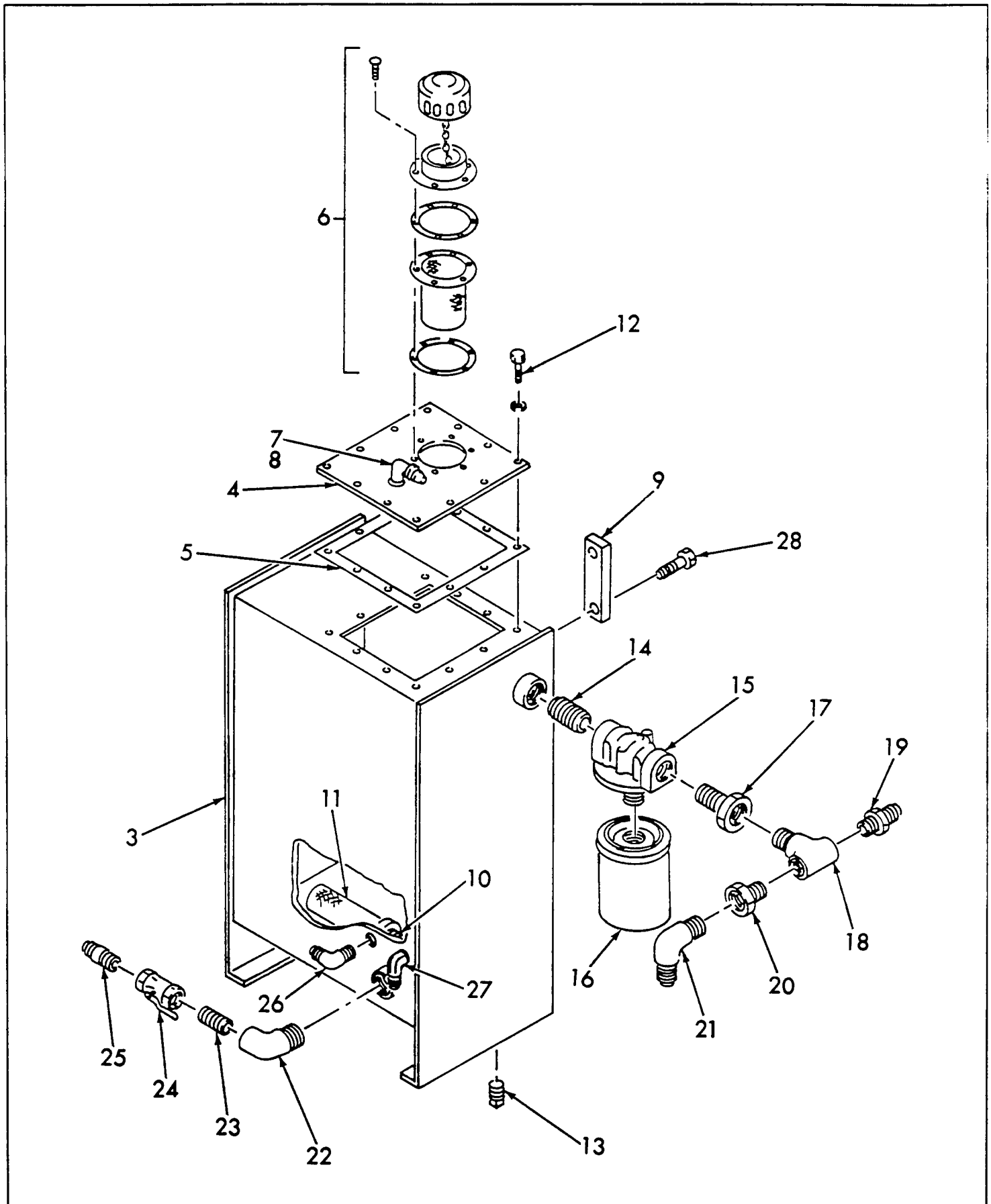
SECT.	4
FIG.	5
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140857	ASSEMBLY, COOLING SYSTEM (See Sect. 4, Fig. 1 for NHA)	REF
2	.140847	SHROUD, RADIATOR	1
3	.140884	BRACKET, FUEL PUMP MOUNTING	1
4	.764	CLAMP, RUBBER	2
5	.61725	SCREW, SELF-TAP	2
6	.160105	SYSTEM, COOLANT RECOVERY	1
7	.60309	SCREW, CAP	4
8	.60701	NUT, HEX	4
9	.63301	WASHER, LOCK	4
10	.160146	HOSE, FUEL (5/16 I.D.)	6.75 FT
11	.161-A	CLAMP, HOSE	8
12	.160061	FILTER, FUEL (WITH BYPASS)	1
13	.30355	CLAMP, CUSHIONED	1
14	.160059	NIPPLE, BRASS HOSE	1
15	.160149	HOSE, FUEL (¼ I.D.)	5 FT
16	.160147	HOSE, FUEL (5/16 I.D.)	3.3 FT
17	.160148	HOSE, FUEL (5/16 I.D.)	1 FT
18	67453	PUMP, FUEL	REF

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	4
FIGURE	6
PAGE	1



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140580	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 1 for NHA)	REF
-2	.140125	SUB-ASSEMBLY, HYDRAULIC TANK	1
3	..140087	TANK, HYDRAULIC	1
4	..140126	COVER, HYDRAULIC TANK	1
5	..140127	GASKET, HYDRAULIC TANK COVER	1
6	..3005	ASSEMBLY, BREATHER CAP	1
7	..80021-03	ELBOW, STREET	1
8	..65213	CAP, BREATHER	1
9	..81184	GAUGE, FLUID LEVEL	1
10	..16553	NIPPLE	1
11	..81183	STRAINER, SUCTION	1
12	..60342	SCREW, CAP	12
13	..3027	PLUG, MAGNETIC DRAIN	1
14	.16552	NIPPLE	1
15	.21241	FILTER, RETURN LINE	1
16	..21245	ELEMENT, (REPLACEMENT) FILTER	1
17	.53801	REDUCER, PIPE	1
18	.80040-18	TEE, MALE	1
19	.80001-21	CONNECTOR, MALE	1
20	.65972	REDUCER, PIPE THREAD	1
21	.80008-18	ELBOW, MALE	1
22	.52307	ELBOW, STREET	1
23	.65803	NIPPLE	1
24	.65837	VALVE, BUTTERFLY	1
25	.65831	NIPPLE, COMBINATION	1

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	41KBDF
NOTES	

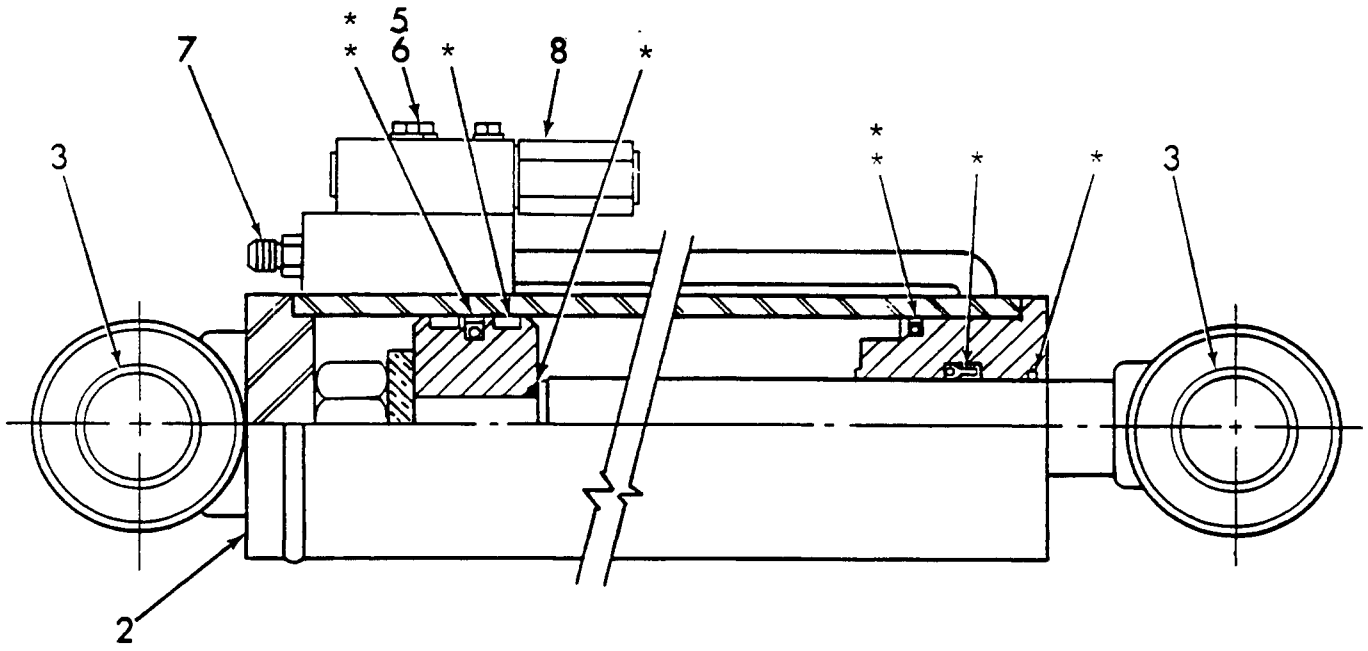
SECT.	4
FIG.	6
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.80008-10	ELBOW, MALE	1
27	.80008-11	ELBOW, MALE	1
28		SCREW, SELF-TAPPING	2

Mark Industries

TITLE	RISER LIFT CYLINDER ASSEMBLY (SE)
MODEL	41KBDF
NOTES	UNTIL MID 1989

SECTION	4
FIGURE	7
PAGE	1



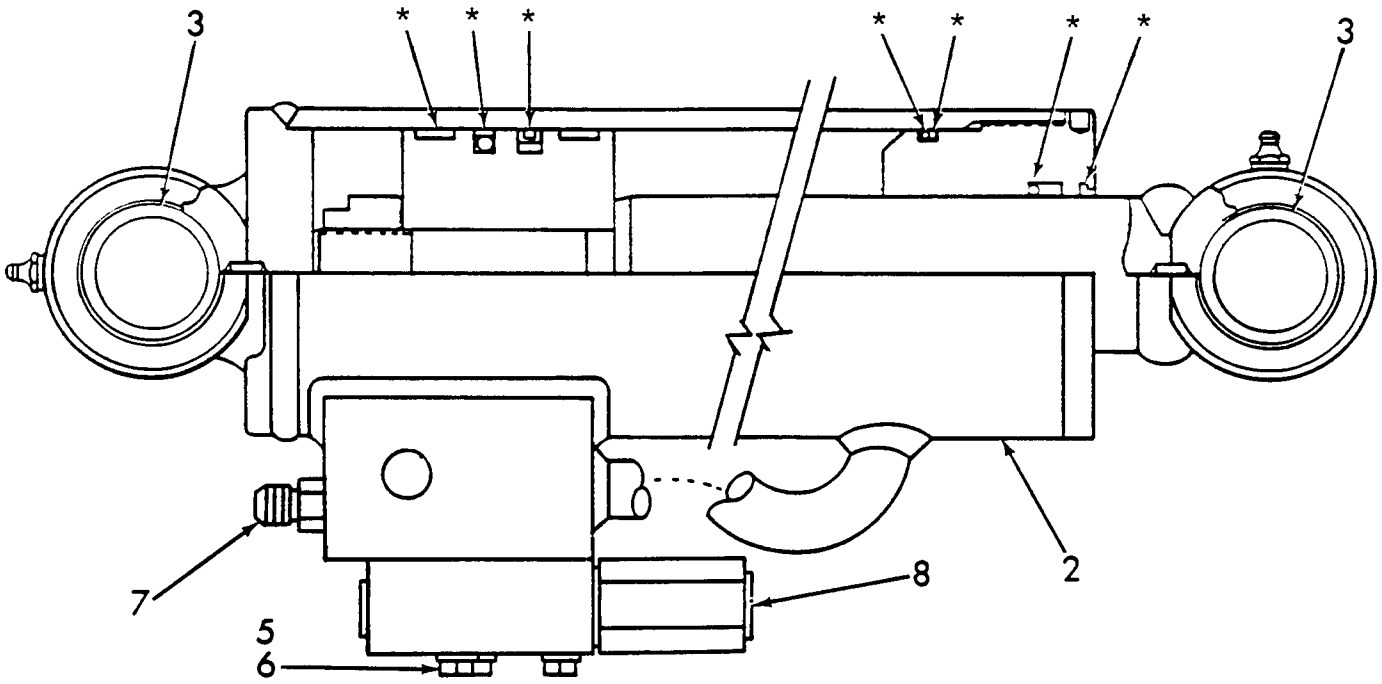
NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140814	ASSEMBLY, RISER LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.140813	CYLINDER, RISER LIFT (SE)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
3	..66882	BUSHING	4
-4	..67230	KIT, SEAL (SE)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	.60319	SCREW, CAP	3
6	.63301	WASHER, LOCK	3
7	.80004-08	CONNECTOR, STRAIGHT THREAD	2
8	.81205	VALVE, HOLDING	1

Mark Industries

TITLE	RISER LIFT CYLINDER ASSEMBLY (TH)
MODEL	41KBDF
NOTES	SINCE MID 1989

SECTION	4
FIGURE	7A
PAGE	1



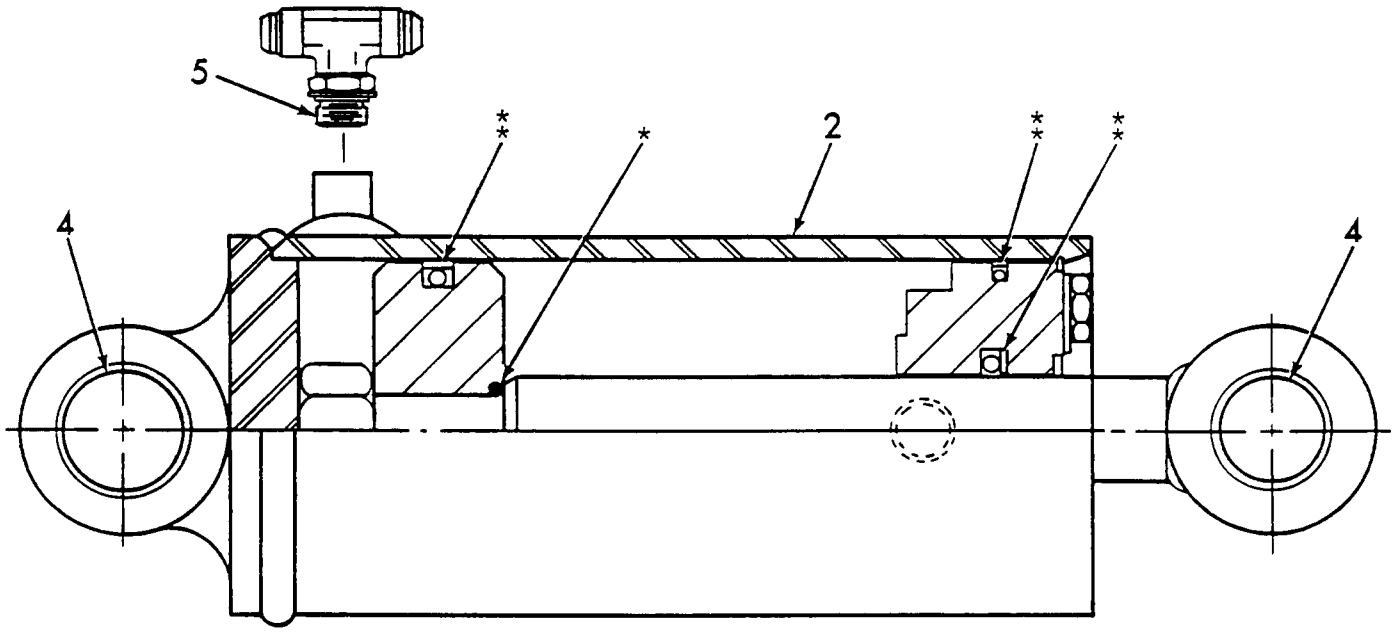
NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140814	ASSEMBLY, RISER LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.140813	CYLINDER, RISER LIFT (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
3	..600062	BUSHING	4
-4	..600059	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	.60319	SCREW, CAP	3
6	.63301	WASHER, LOCK	3
7	.80004-08	CONNECTOR, STRAIGHT THREAD	2
8	.81205	VALVE, HOLDING	1

Mark Industries

TITLE	MASTER CYLINDER SUB-ASSEMBLY (SE)
MODEL	41KBDF
NOTES	UNTIL LATE 1989

SECTION	4
FIGURE	8
PAGE	1



NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

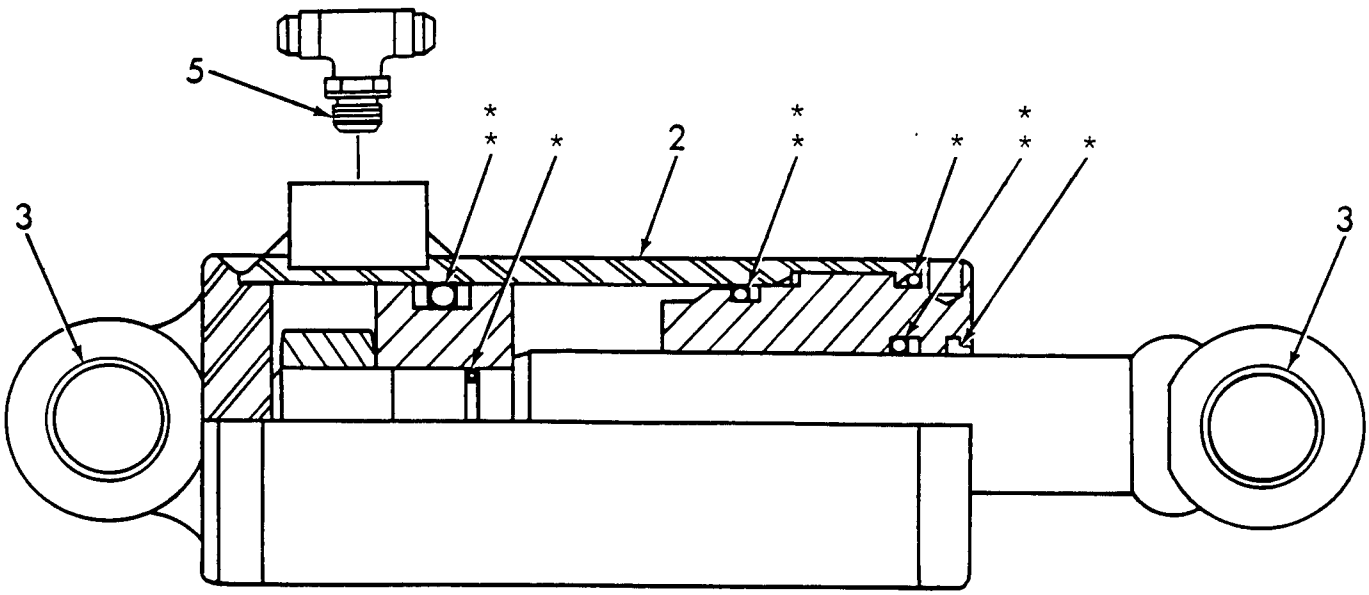
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140062	SUB-ASSEMBLY, MASTER CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.140094	CYLINDER, MASTER (SE)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..67130	KIT, SEAL	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..67191	BUSHING	1
5	.80036-03	TEE, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	MASTER CYLINDER ASSEMBLY (TH)
MODEL	41KBDF
NOTES	SINCE LATE 1989

SECTION	4
FIGURE	8A
PAGE	1



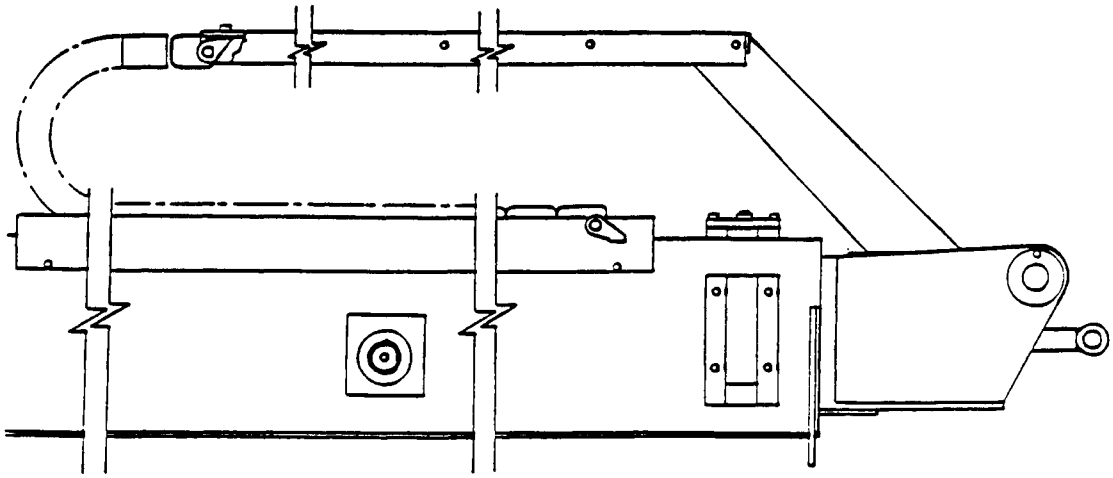
NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

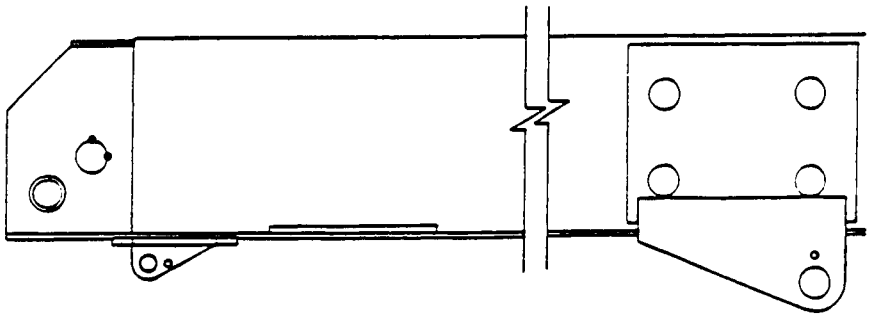
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140947	ASSEMBLY, MASTER CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.140896	CYLINDER, MASTER (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
3	..67999	BUSHING	4
-4	..67997	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	.80036-03	TEE, STRAIGHT THREAD	2

REV.

SECTION 5 CONTAINS:

FIG. NO.	TITLE
1	FINAL BOOM ASSEMBLY
2	INNER BOOM ASSEMBLY
3	EXTENSION CYLINDER (SE)
3A	EXTENSION CYLINDER (GB)

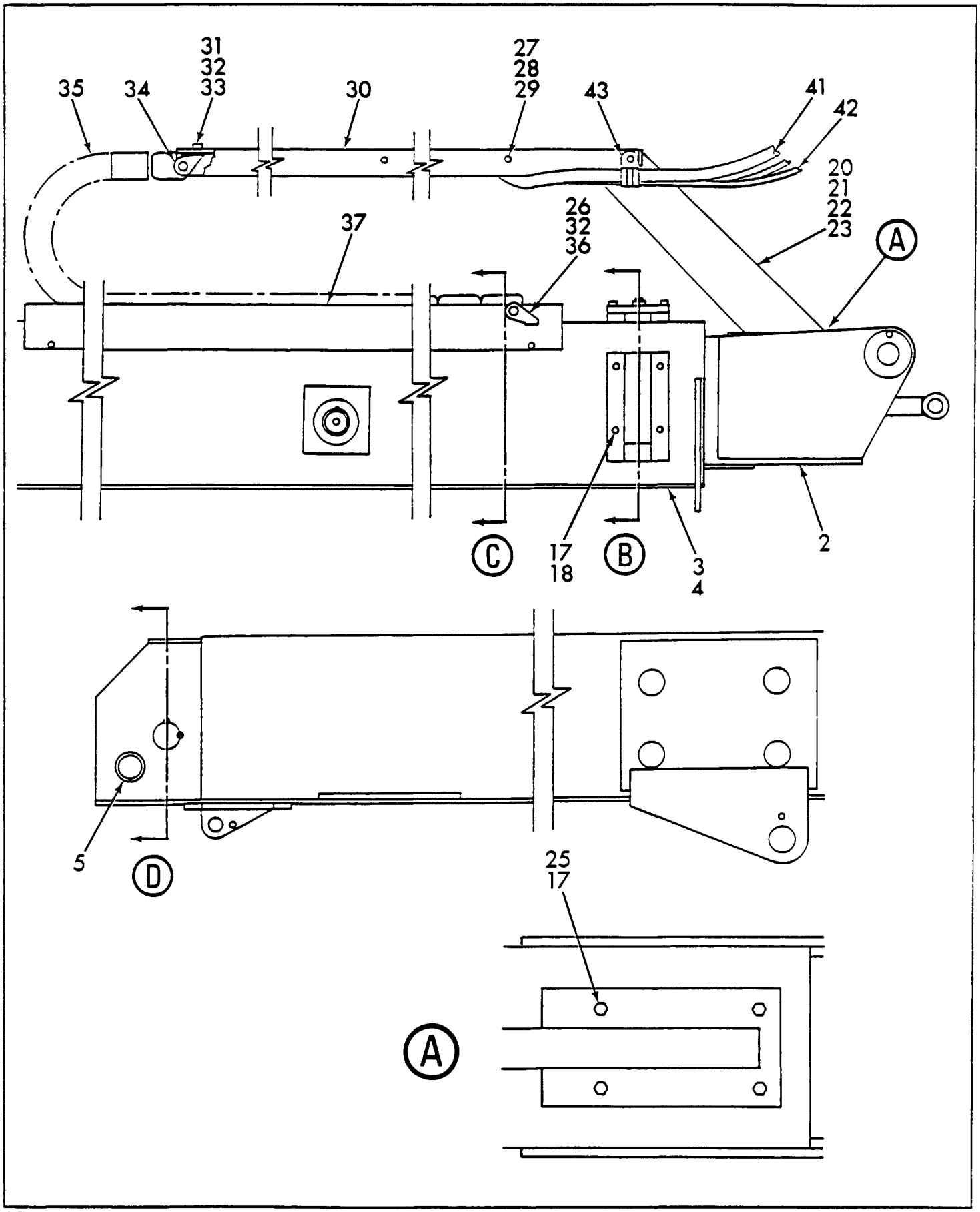




Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	5
FIGURE	1
PAGE	1

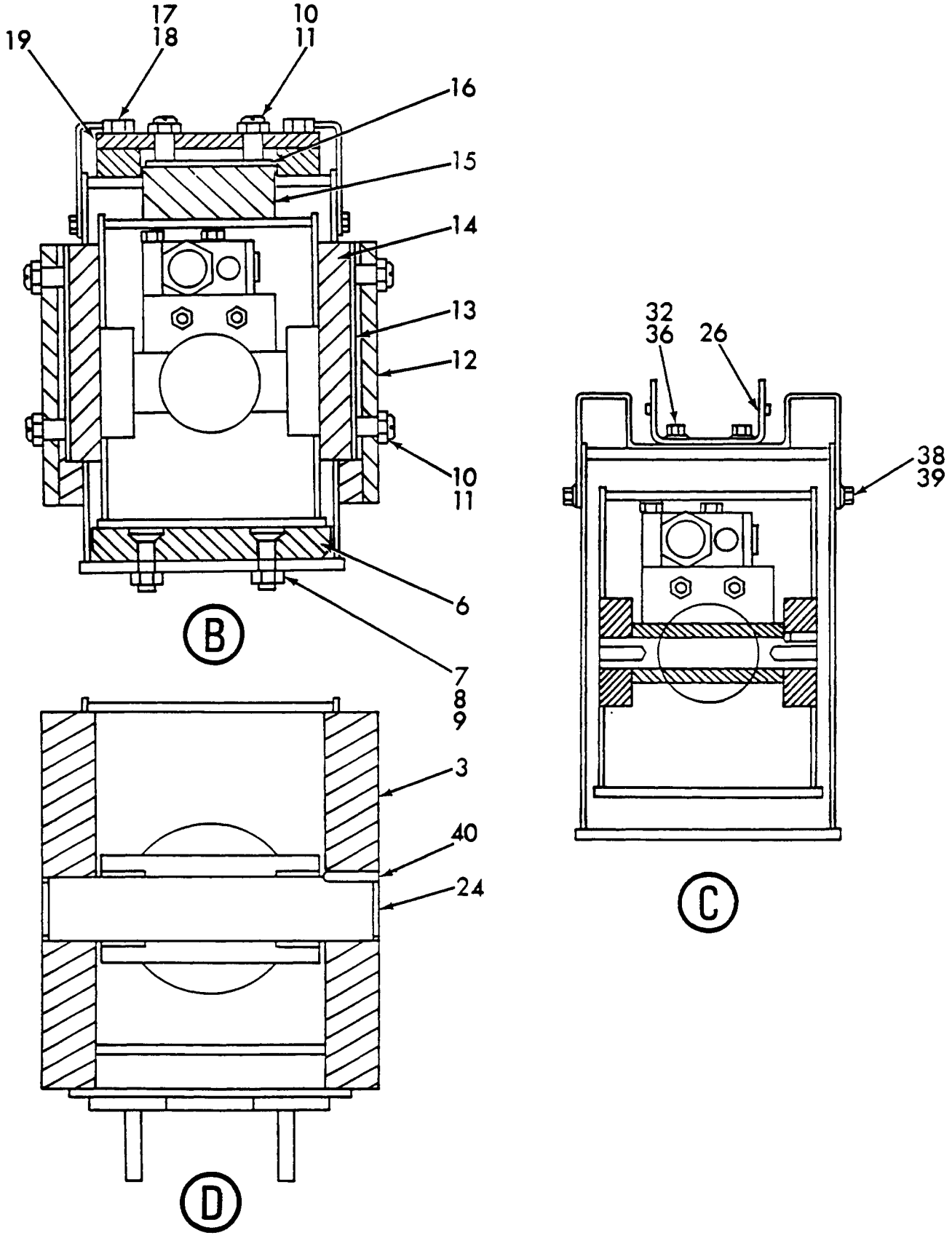


REV.

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	41KBDF
NOTES	

SECTION	5
FIGURE	1
PAGE	2



REV.

Mark Industries

TITLE	FINAL BOOM ASSEMBLY	SECT.	5
MODEL	41KBDF	FIG.	1
NOTES		PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140122	ASSEMBLY, FINAL BOOM (See Sect. 2, Fig. 1 for NHA)	REF
2	.140120	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 2 for Details)	1
3	.140029	MACHINING, OUTER BOOM	1
4	..140031	WELDMENT, OUTER BOOM	1
5	..140121	BUSHING	2
6	.140396	PAD, WEAR (OUTER BOOM BOTTOM)	1
7	.61821	SCREW, CAP	4
8	.63319	WASHER, LOCK	4
9	.60703	NUT, HEX	4
10	.62210	SCREW, SET	6
11	.60901	NUT, JAM	6
12	.140402	PLATE, SIDE COVER	2
13	.27258	STRIP	2
14	.140403	PAD, WEAR (SIDE)	2
15	.140405	PAD, WEAR (TOP)	1
16	.27259	STRIP	1
17	.63302	WASHER, LOCK	12
18	.60338	SCREW, CAP	12
19	.140406	PLATE, TOP COVER	1
20	.140399	WELDMENT, POWER TRACK BRACKET	1
21	..140400	SPACER, TUBE	1
22	..140784	TUBE, MOUNTING	1
23	..140340	BRACKET, POWER TRACK	1
24	.140429	PIN, EXTENSION CYLINDER (CAP END)	1

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	41KBDF
NOTES	

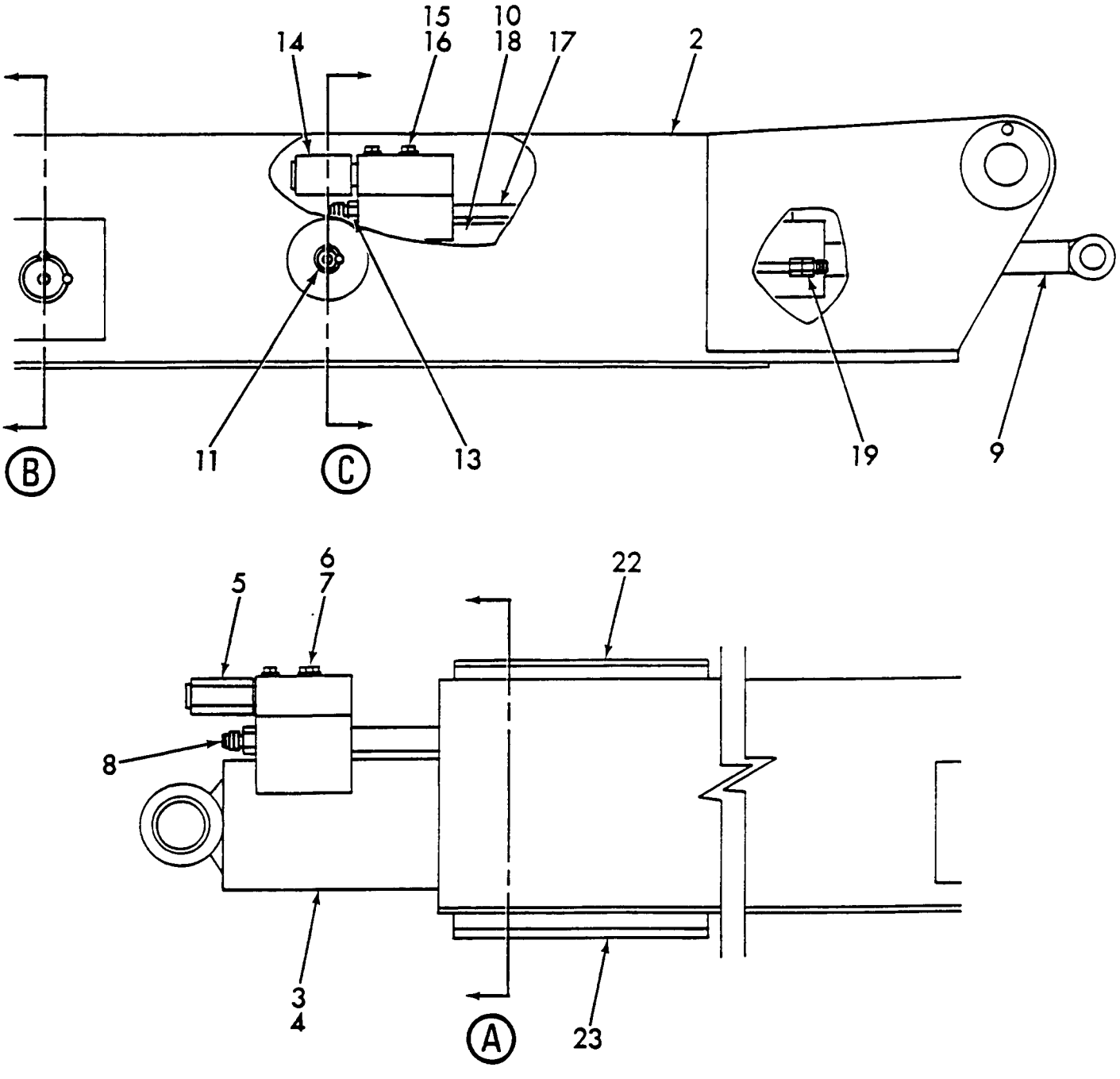
SECT.	5
FIG.	1
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.60367	SCREW, CAP	4
26	.23875	BRACKET, STATIONARY (MALE)	1
27	.60429	SCREW, CAP	3
28	.61322	NUT, LOCK	3
29	.63429	WASHER, FLAT	3
30	.140347	SUPPORT, POWER TRACK	1
31	.60353	SCREW, CAP	2
32	.63433	WASHER, FLAT	4
33	.60711	NUT, LOCK	2
34	.23874	BRACKET, MOVABLE (FEMALE)	1
35	.23824	TRACK, POWER	45
36	.60422	SCREW, CAP	2
37	.140201	GUIDE, POWER TRACK	1
38	.61729	SCREW, MACHINE	4
39	.63313	WASHER, LOCK	4
40	.62229	SCREW, SET	2
41	.70528	CABLE, CONDUCTOR (65 FT)	1
42	.2568	HOSE, HYDRAULIC (50 FT)	2
43	.65867	CLAMP	3

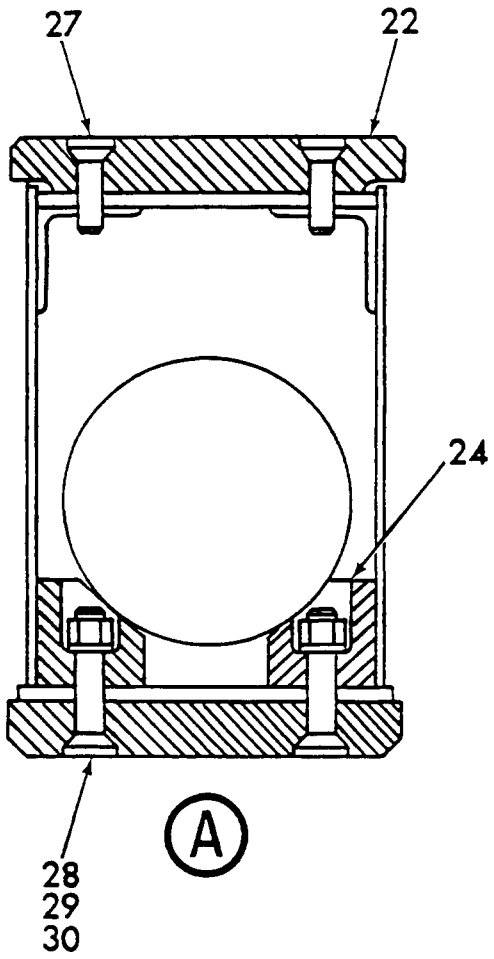
Mark Industries

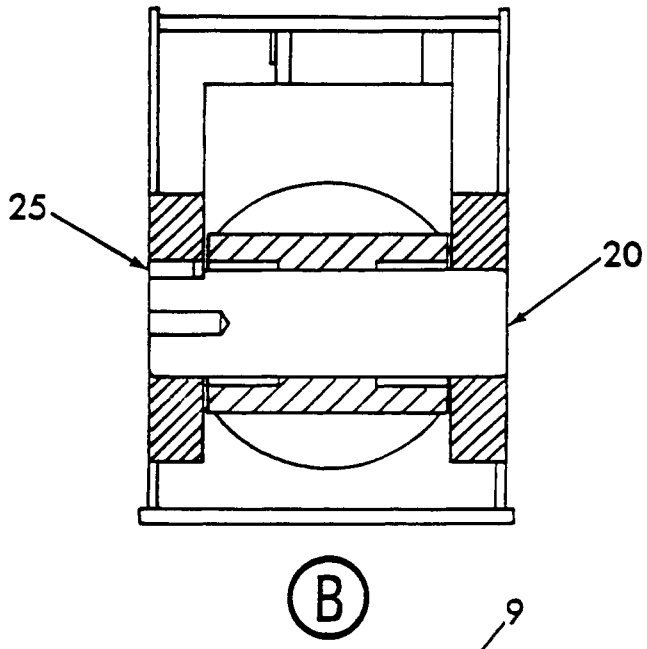
TITLE	INNER BOOM ASSEMBLY
MODEL	41KBDF
NOTES	

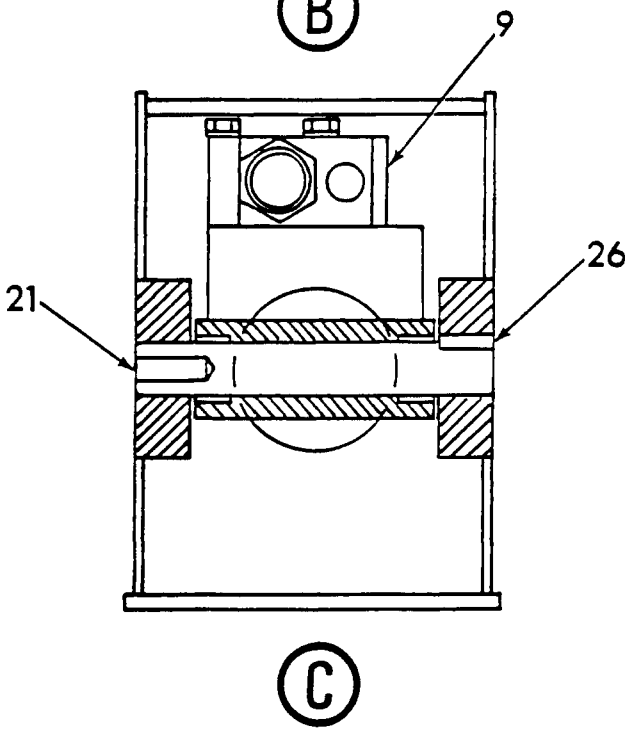
SECTION	5
FIGURE	2
PAGE	1



REV.


27
22
24
28
29
30
A


25
20
B


9
26
21
C

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140120	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 1 for NHA)	REF
2	.140124	MACHINING, INNER BOOM	1
3	.140055	ASSEMBLY, EXTENSION CYLINDER	1
4	..140054	CYLINDER, EXTENSION (See Sect. 5, Fig. 3 for Details)	1
5	..81205	VALVE, HOLDING	1
6	..60319	SCREW, CAP	3
7	..63301	WASHER, LOCK	3
8	..80004-11	CONNECTOR, STRAIGHT THREAD	2
9	.140946	SUB-ASSEMBLY, SLAVE CYLINDER	1
10	..140890	CYLINDER, SLAVE (TH)	1
11	...67999	BUSHING	4
-12	...67997	KIT, SEAL	1
13	..80004-03	CONNECTOR, STRAIGHT THREAD	2
14	..81205	VALVE, HOLDING	1
15	..60319	SCREW, CAP	3
16	..63301	WASHER, LOCK	3
17	..140058-6	ASSEMBLY, TUBE	2
18	..65111	STRAP	1
19	..80042-03	CONNECTOR, UNION	2
20	.140424	PIN, EXTENSION CYLINDER (ROD END)	1
21	.140415	PIN, SLAVE CYLINDER (CAP END)	1
22	.140398	PAD, WEAR (INNER BOOM TOP)	1
23	.140397	PAD, WEAR (INNER BOOM BOTTOM)	1
24	.140395	PAD, WEAR (EXTENSION CYLINDER)	2

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	41KBDF
NOTES	

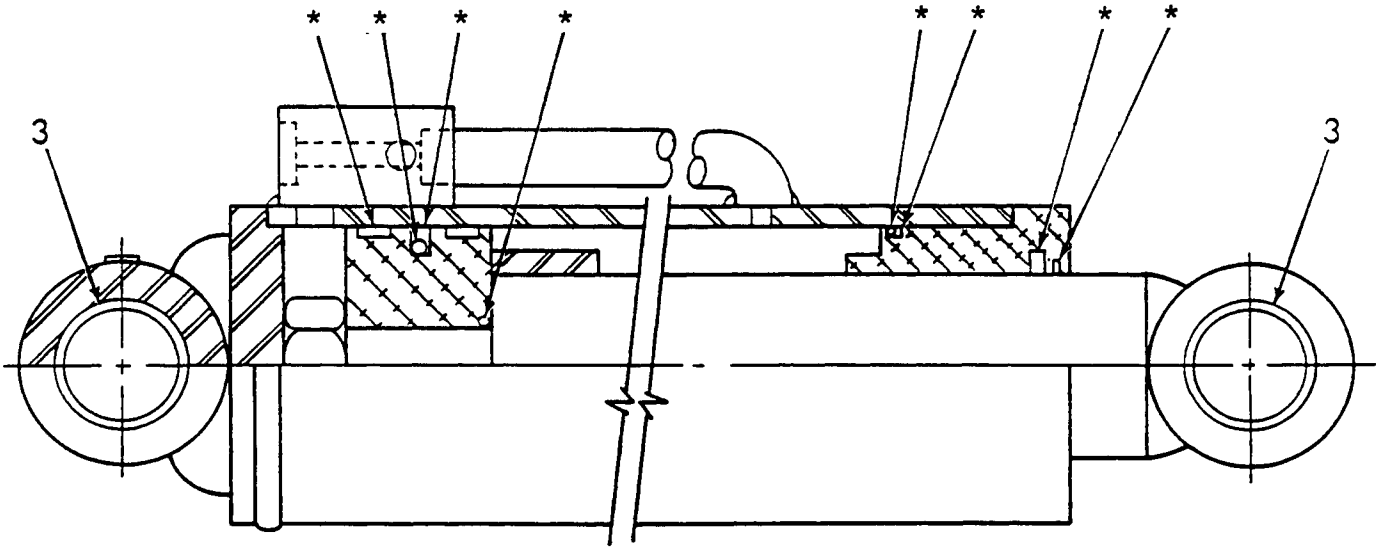
SECT.	5
FIG.	2
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.62239	SCREW, SET	2
26	.62235	SCREW, SET	2
27	.61829	SCREW, CAP	4
28	.61824	SCREW, CAP	4
29	.61318	NUT, LOCK	4
30	.63403	WASHER, FLAT	4

Mark Industries

TITLE	EXTENSION CYLINDER (SE)
MODEL	41KBDF
NOTES	BEFORE LATE 1989

SECTION	5
FIGURE	3
PAGE	1



NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

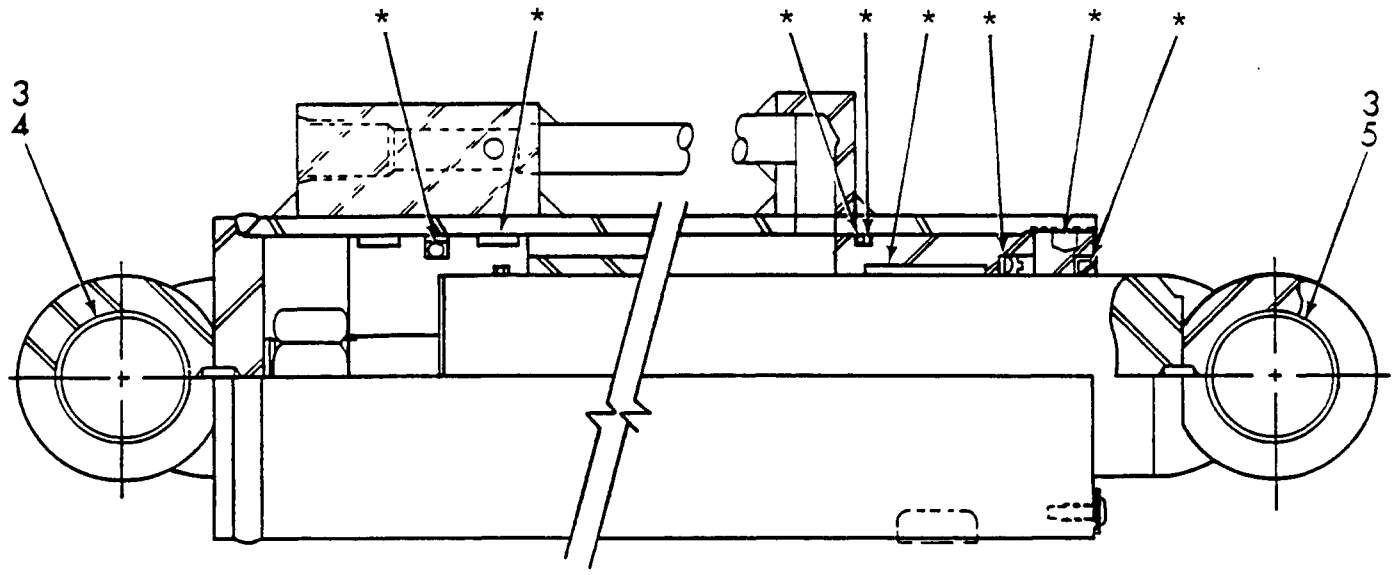
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140054	CYLINDER, EXTENSION (SE) (See Sect. 5, Fig. 2 for NHA) NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	REF
-2	.67186	KIT, SEAL NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	1
3	.67180	BUSHING	4

REV.

Mark Industries

TITLE	EXTENSION CYLINDER (GB)
MODEL	41KBDF
NOTES	AFTER LATE 1989

SECTION	5
FIGURE	3A
PAGE	1



NOTE 1: DUE TO ONGOING VENDOR/MFG. REVISIONS, WHEN POSSIBLE, PROVIDE ALL NUMBERS FROM THE CYLINDER I.D. TAG.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140054	CYLINDER, EXTENSION (GB) (See Sect. 5, Fig. 2 for NHA) NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	REF
-2	.600084	KIT, SEAL NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	1
3	.67180	BUSHING	4
4	.600160	SPACER, PINEYE (BARREL END)	1
5	.600103	SPACER, PINEYE (ROD END)	1

REV.

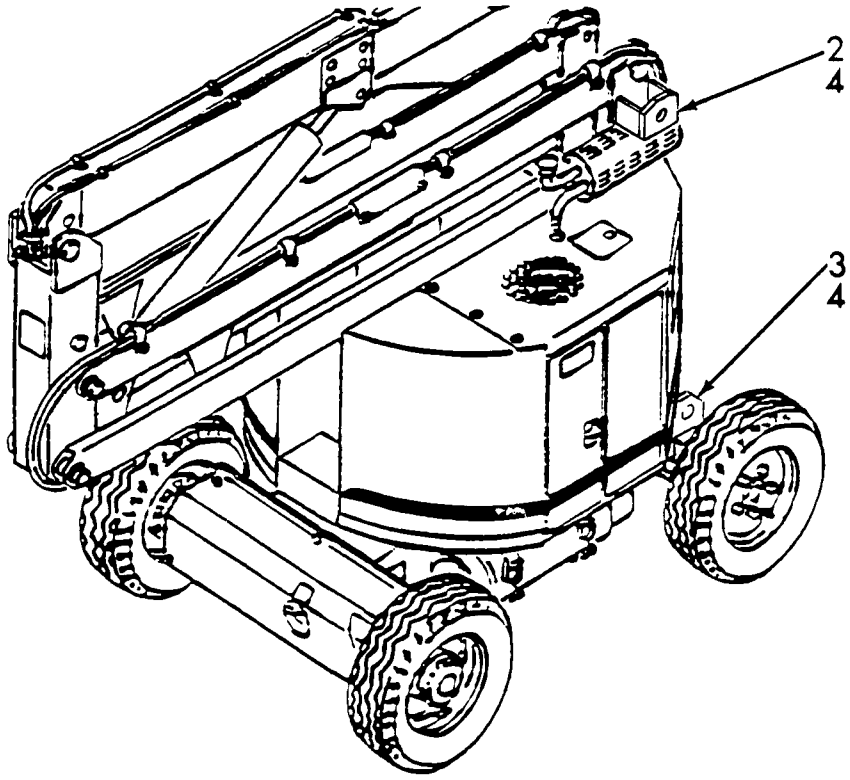
SECTION 6 CONTAINS:

FIG. NO.	TITLE	PART NO.
1	LIFTING LUGS	140021
2	POWERED PLATFORM ROTATOR	140853
3	MONOFILLED TIRES	140659
4	ALL MOTION ALARM	140660
5	TRAVEL WARNING HORN	140657
6	ROTATING AMBER BEACON	140866
7	SPARK ARRESTOR MUFFLER	140666
8	ALL FUNCTION AUXILIARY POWER	140676

Mark Industries

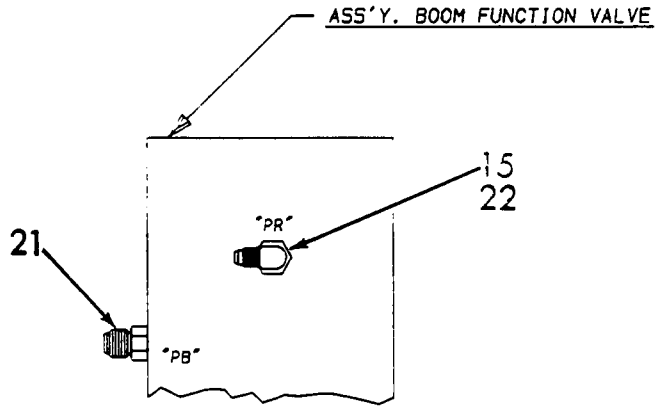
TITLE	LIFTING LUGS
MODEL	41KBDF
NOTES	

SECTION	6
FIGURE	1
PAGE	1

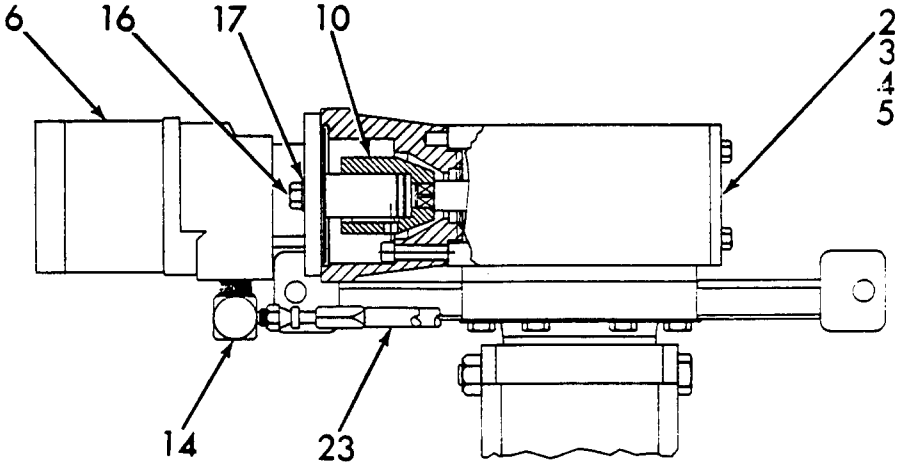


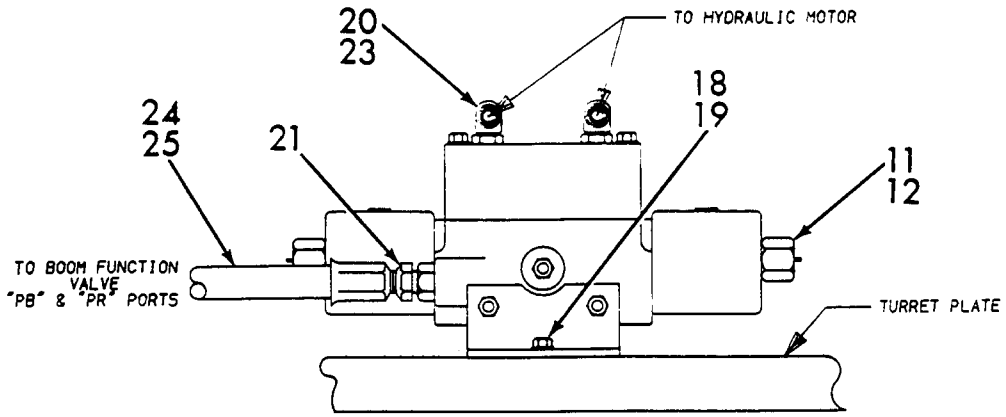
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140021	LUGS, LIFTING	REF
2	.140644	WELDMENT, LIFTING LUG	2
3	.21759	LUG, LIFTING (BASE)	2
4	.181501	DECAL, CAUTION LIFTING LUGS	4

REV.



BOOM FUNCTION VALVE MODIFICATION





INSTALLATION

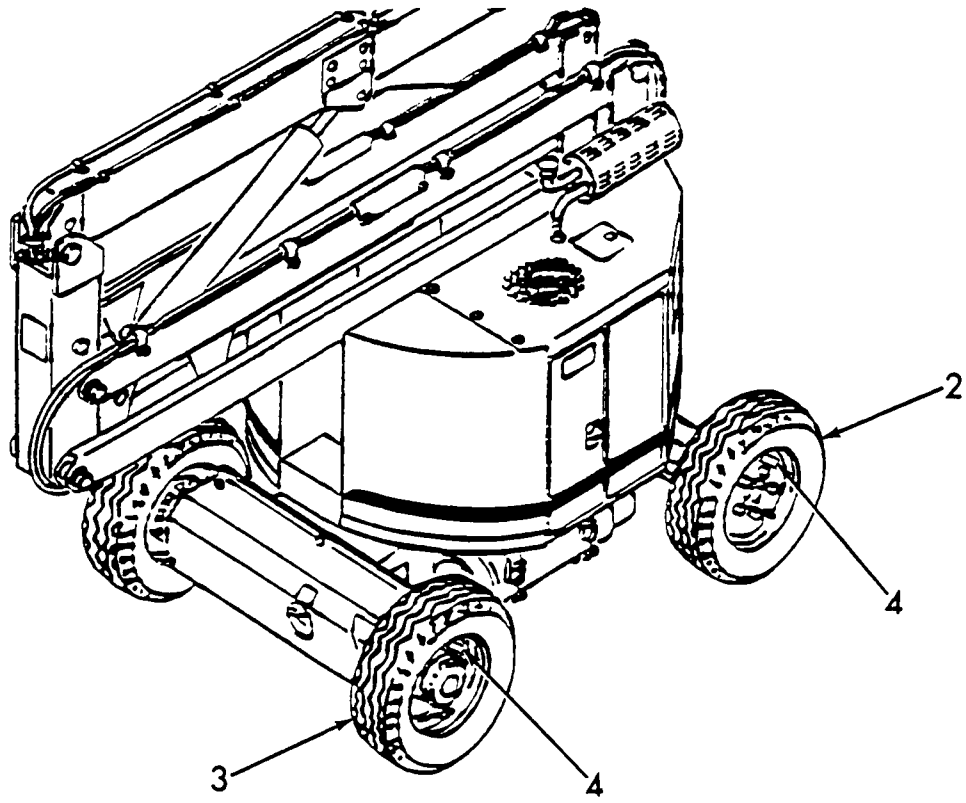
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140853	ROTATOR, POWERED PLATFORM	REF
2	.141136	SUB-ASSEMBLY, HYDRAULIC POWERED ROTATOR	1
3	..24919	ROTATOR, MANUAL (See Sect. 2, Fig. 6 for Details)	1
4	..140818	ADAPTER, MOTOR	1
5	..62017	SCREW, CAP	4
6	.81274	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	1
-7	..67688	KIT, SEAL	1
-8	..67690	SHAFT, COUPLING	1
-9	..67698	LINK, DRIVE	1
10	.140819	COUPLING, SHAFT	1
11	.81239	VALVE (WITH CROSSOVER RELIEF) (See Vendor Chapter for Details)	1
12	..16953	COIL, 12 VDC	2
-13	..67825	KIT, SEAL (UP TO 3 BANK VALVE)	1
14	.80008-05	ELBOW, MALE	2
15	.80048-02	PLUG, HOLLOW HEX	2
16	.60308	SCREW, CAP	2
17	.63305	WASHER, LOCK	2
18	.60325	SCREW, CAP	2
19	.62319	WASHER, LOCK	2
20	.80012-05	ELBOW, STRAIGHT THREAD	2
21	.80004-08	CONNECTOR, STRAIGHT THREAD	3
22	.80012-08	ELBOW, STRAIGHT THREAD	1
23	.13232-04-7920	ASSEMBLY, HOSE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.13213-06-0710	ASSEMBLY, HOSE	1
25	.13212-06-0710	ASSEMBLY, HOSE	1

Mark Industries

TITLE	MONOFILLED TIRES
MODEL	41KBDF
NOTES	

SECTION	6
FIGURE	3
PAGE	1



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140659	TIRES, MONOFILLED (IN LIEU OF STANDARD)	REF
2	.141137	ASSEMBLY, MONOFILLED WHEEL (REAR AXLE)	2
3	.141138	ASSEMBLY, MONOFILLED FRONT WHEEL	2
4	.22175	DECAL, CAUTION MONOFILLED TIRES ONLY	4
		NOTE: DUE TO THEIR CRITICAL EFFECT ON INSURING MACHINE STABILITY, MONO-FILLED TIRES CAN ONLY BE PURCHASED AS THE COMPLETE TIRE/WHEEL ASSEMBLY.	

REV.

Mark Industries

TITLE	ALL MOTION ALARM
MODEL	41KBDF
NOTES	

SECTION	6
FIGURE	4
PAGE	1

ILLUSTRATION NOT AVAILABLE

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140660	ALARM, ALL MOTION	1
-2	.70053	HORN, WARNING	1
-3	.60312	SCREW, CAP	2
-4	.63301	WASHER, LOCK	2
-5	.60701	NUT, HEX	2
-6	.4045	DIODE (6 AMP, 200 VOLT)	2

REV.

Mark Industries

TITLE	TRAVEL WARNING HORN
MODEL	41KBDF
NOTES	

SECTION	6
FIGURE	5
PAGE	1

ILLUSTRATION NOT AVAILABLE

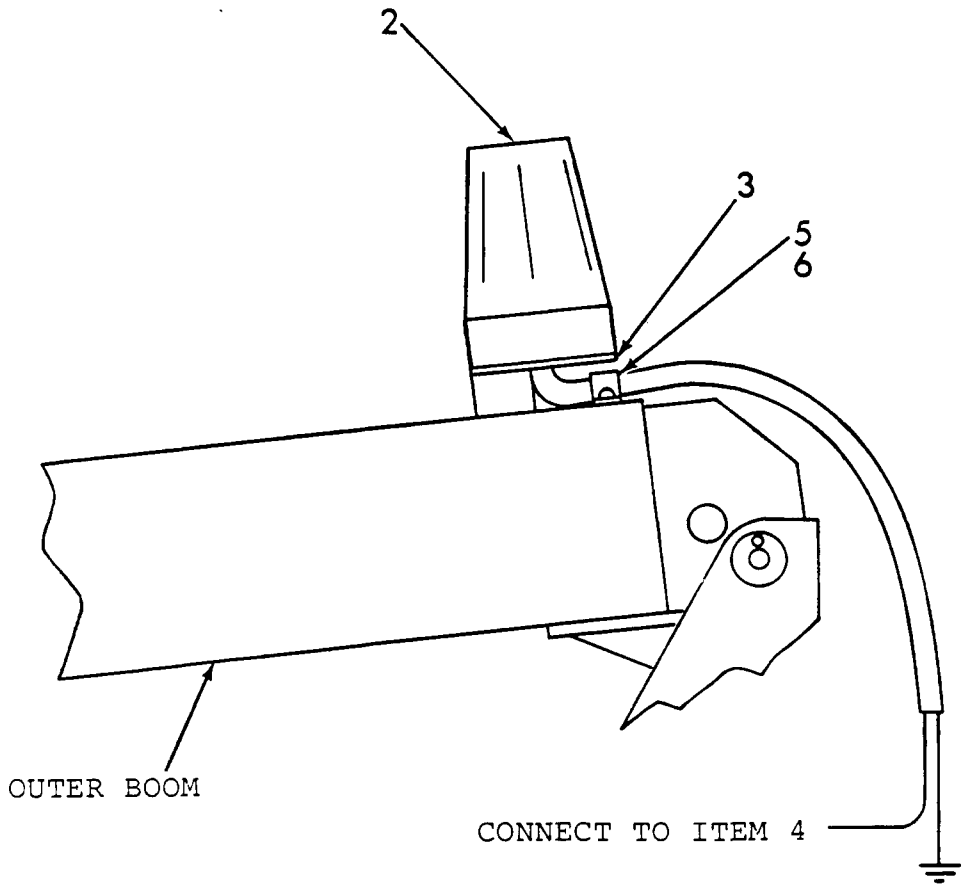
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140657	HORN, TRAVEL WARNING	1
-2	.70053	HORN, WARNING	2
-3	.60312	SCREW, CAP	2
-4	.63301	WASHER, LOCK	2
-5	.60701	NUT, HEX	2

REV.

Mark Industries

TITLE	ROTATING AMBER BEACON
MODEL	41KBDF
NOTES	

SECTION	6
FIGURE	6
PAGE	1



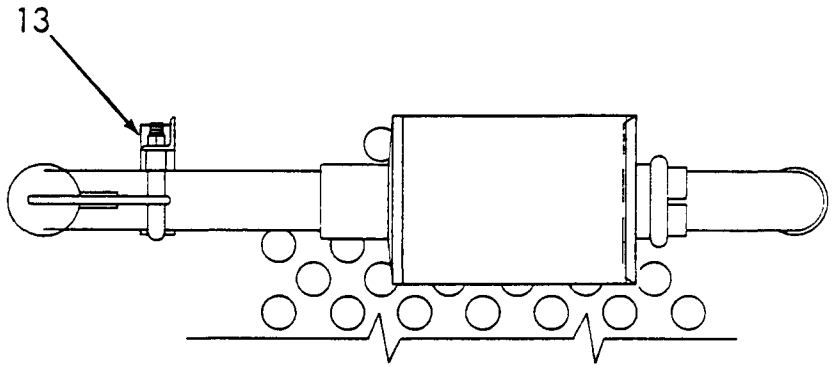
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140866	BEACON, ROTATING AMBER	REF
2	.20863	BEACON, ROTATING	1
3	.140865	WELDMENT, MOUNTING BRACKET	1
4	.2768	CABLE (18 AWG)	20 FT
5	.764	CLAMP, RUBBER	6
6	.63657	RIVET, POP	6

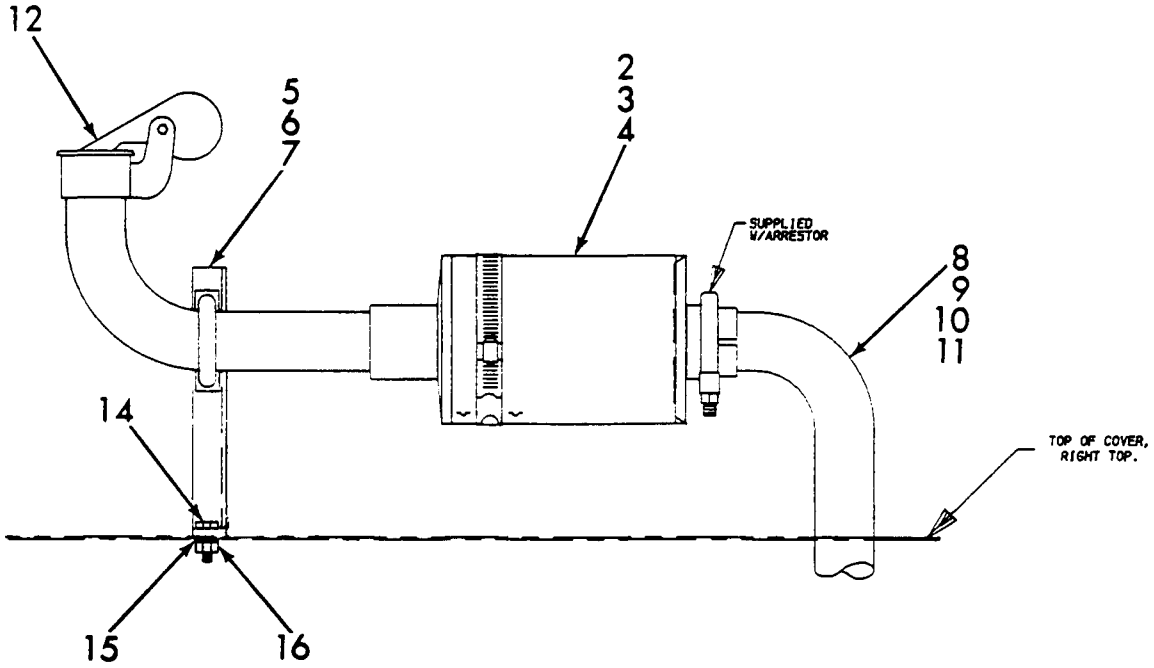
REV.

Mark Industries

TITLE	SPARK ARRESTOR MUFFLER
MODEL	41KBDF
NOTES	

SECTION	6
FIGURE	7
PAGE	1





REV.

Mark Industries

TITLE	SPARK ARRESTOR MUFFLER
MODEL	41KBDF
NOTES	

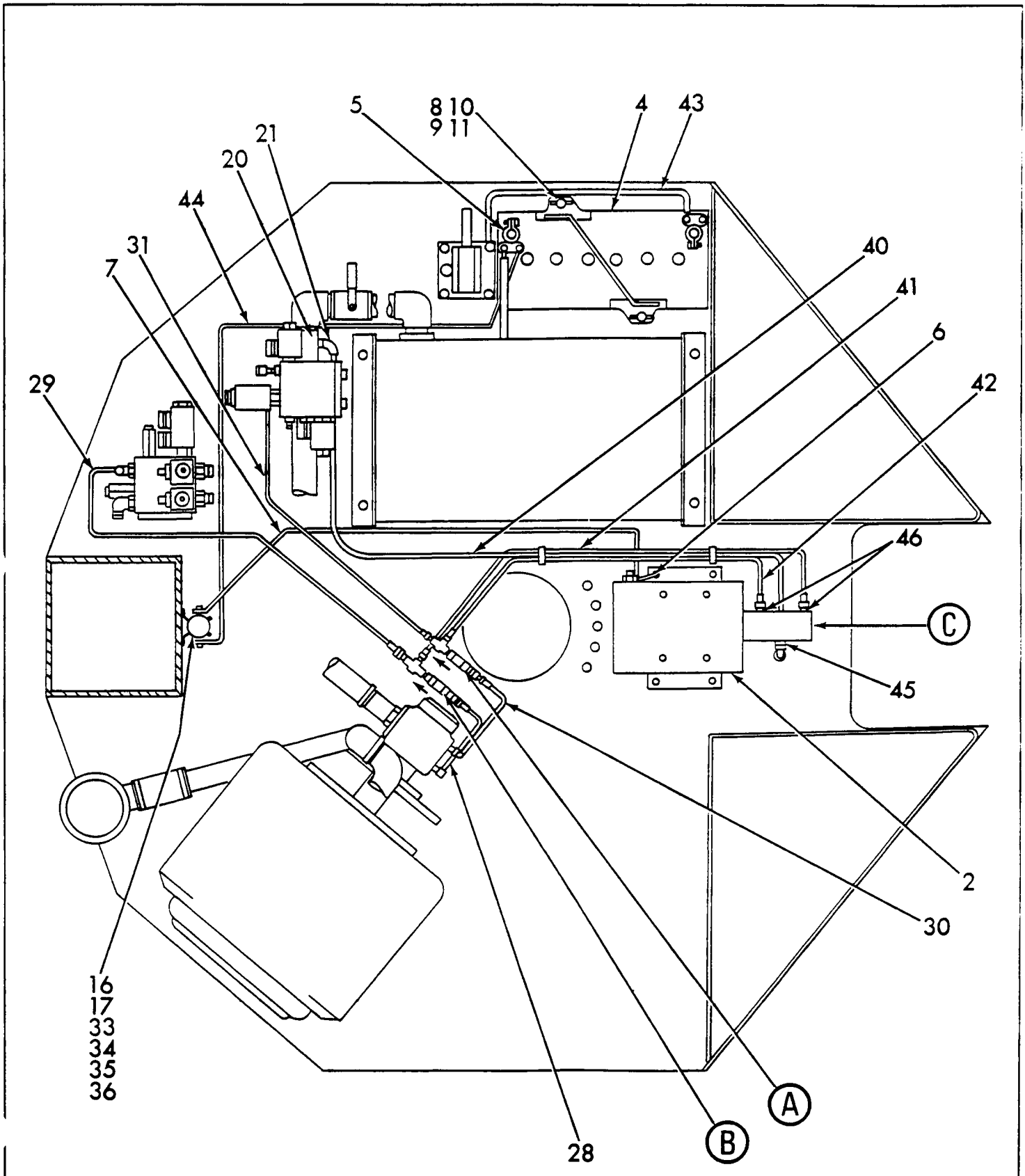
SECT.	6
FIG.	7
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140666	MUFFLER, SPARK ARRESTOR (NISSAN)	REF
2	.140810	WELDMENT, SPARK ARRESTOR	1
3	..23546	ELBOW, MODIFIED MUFFLER	1
4	..160106	MUFFLER, SPARK ARRESTOR	1
5	.140812	WELDMENT, BRACKET MUFFLER	1
6	..140811	BRACKET, MUFFLER	1
7	..140392	BRACKET, MUFFLER	1
8	.140817	WELDMENT, EXHAUST TUBE	1
9	..140816	TUBE, EXHAUST	1
10	..65987	FERRULE, EXHAUST TUBE	1
11	..65988	FLANGE, EXHAUST	1
12	.21288	CAP, MUFFLER RAIN	1
13	.16230	CLAMP, MUFFLER	1
14	.60312	SCREW, CAP	2
15	.63301	WASHER, LOCK	2
16	.60701	NUT, HEX	2

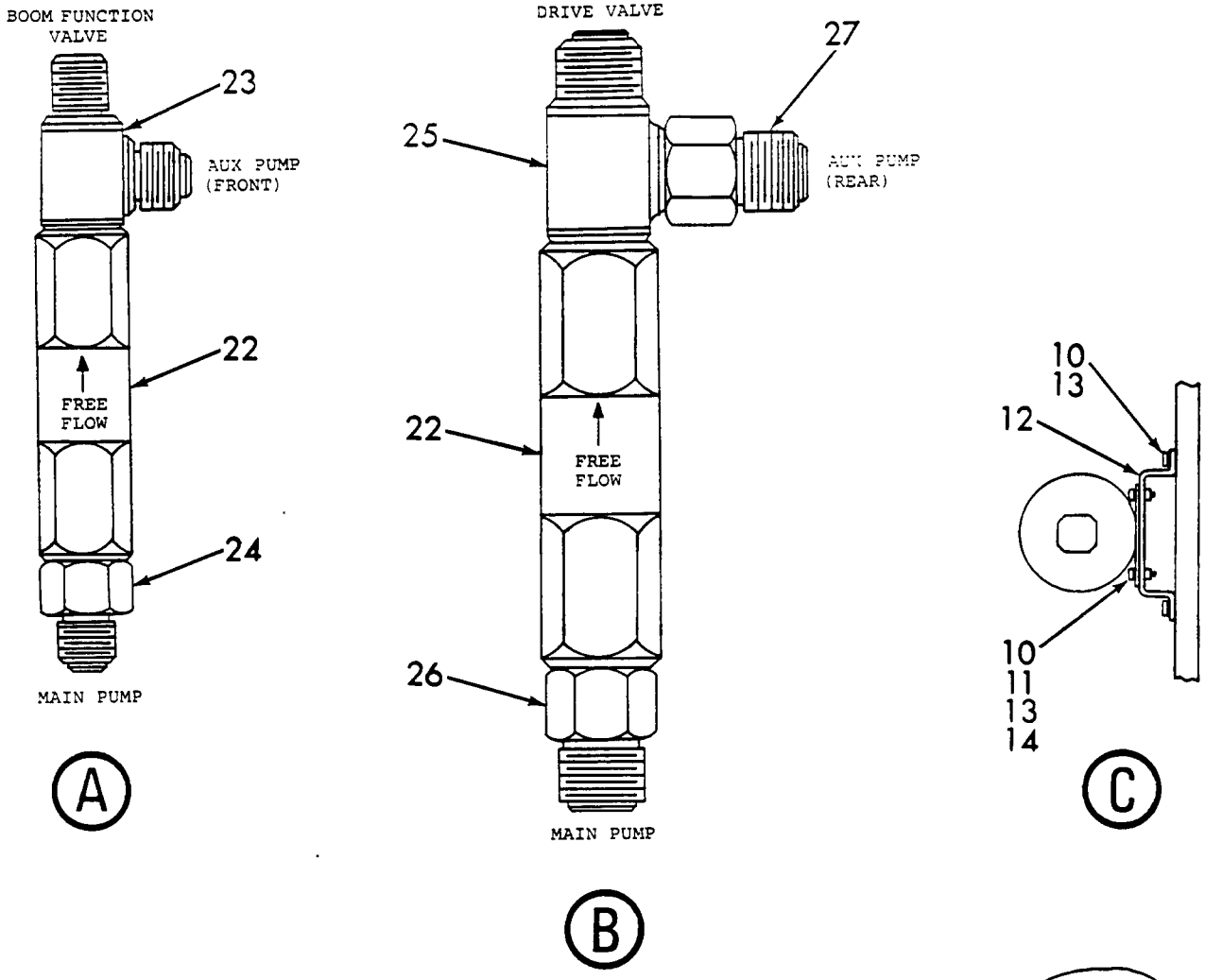
Mark Industries

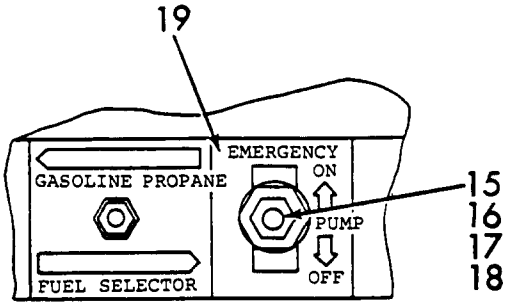
TITLE	ALL FUNCTION AUXILIARY POWER
MODEL	41KBDF
NOTES	TYPICAL

SECTION	6
FIGURE	8
PAGE	1

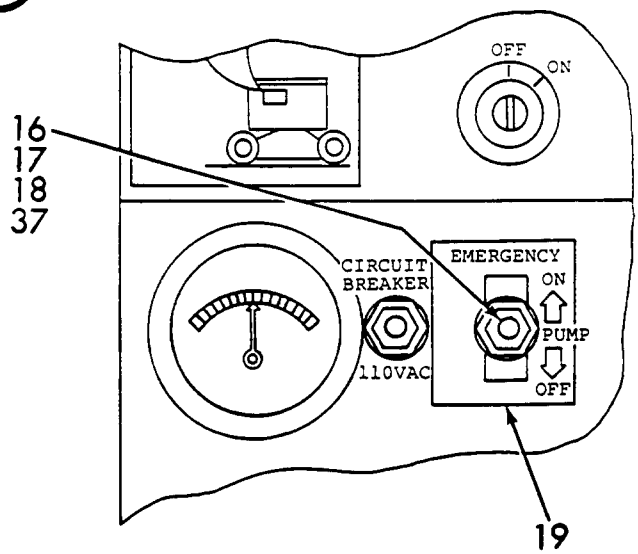


REV.





AERIAL CONTROL BOX



GROUND CONTROL PANEL

Mark Industries

TITLE	ALL FUNCTION AUXILIARY POWER
MODEL	41KBDF
NOTES	TYPICAL

SECT.	6
FIG.	8
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	140676	POWER, ALL FUNCTION AUXILIARY	REF
2	.21229	PUMP, EMERGENCY	1
-3	..66858	KIT, SEAL (WEB)	1
4	.70458	BATTERY, 12 VOLT	1
5	.160116	TERMINAL, BATTERY	2
6	.13226-0130	ASSEMBLY, BATTERY CABLE	1
7	.13226-0550	ASSEMBLY, ELECTRICAL CABLE	1
8	.160125	ROD, THREADED	2
9	.61615	NUT, WING	2
10	.63302	WASHER, LOCK	10
11	.63402	WASHER, FLAT	6
12	.140861	SUPPORT, EMERGENCY PUMP	1
13	.60338	SCREW, CAP	8
14	.60702	NUT, HEX	4
15	.70037	SWITCH, TOGGLE	1
16	.2990	WIRE, WHITE (18 AWG)	20 FT
17	.117-C	RING, CONNECTOR	12
18	.70303	SWITCH, GUARD	2
19	.182702	DECAL, EMERGENCY PUMP SWITCH	2
20	.140856	WELDMENT, SUCTION	1
21	.80008-12	ELBOW, MALE	1
22	.81189	VALVE, IN-LINE CHECK	2
23	.80037-14	TEE, MALE	1
24	.80001-14	CONNECTOR, MALE	1
25	.80037-16	TEE, MALE	1

Mark Industries

TITLE	ALL FUNCTION AUXILIARY POWER
MODEL	41KBDF
NOTES	TYPICAL

SECT.	6
FIG.	8
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.80001-16	CONNECTOR, MALE	1
27	.80056-06	REDUCER, TUBE END	1
28	.13212-10-0110	ASSEMBLY, HOSE	1
29	.13210-10-0400	ASSEMBLY, HOSE	1
30	.13213-08-0104	ASSEMBLY, HOSE	1
31	.13210-08-0380	ASSEMBLY, HOSE	1
32	.13213-08-065	ASSEMBLY, HOSE	1
33	.70209	SOLENOID, 12 VDC	1
34	.60342	SCREW, CAP	2
35	.63401	WASHER, FLAT	2
36	.63301	WASHER, LOCK	2
37	.20482	SWITCH, TOGGLE	2
38	.2991	WIRE, WHITE (12 AWG)	10 FT
39	.70008	WIRE, YELLOW WITH GREEN (16 AWG)	10 FT
40	.13213-08-0620	ASSEMBLY, HOSE	1
41	.13213-08-0420	ASSEMBLY, HOSE	1
42	.13213-08-0300	ASSEMBLY, HOSE	1
43	.13226-0350	ASSEMBLY, ELECTRICAL CABLE	1
44	.13226-0720	ASSEMBLY, ELECTRICAL CABLE	1
45	.80001-15	CONNECTOR, MALE	1
46	.80004-12	CONNECTOR, STRAIGHT THREAD	2

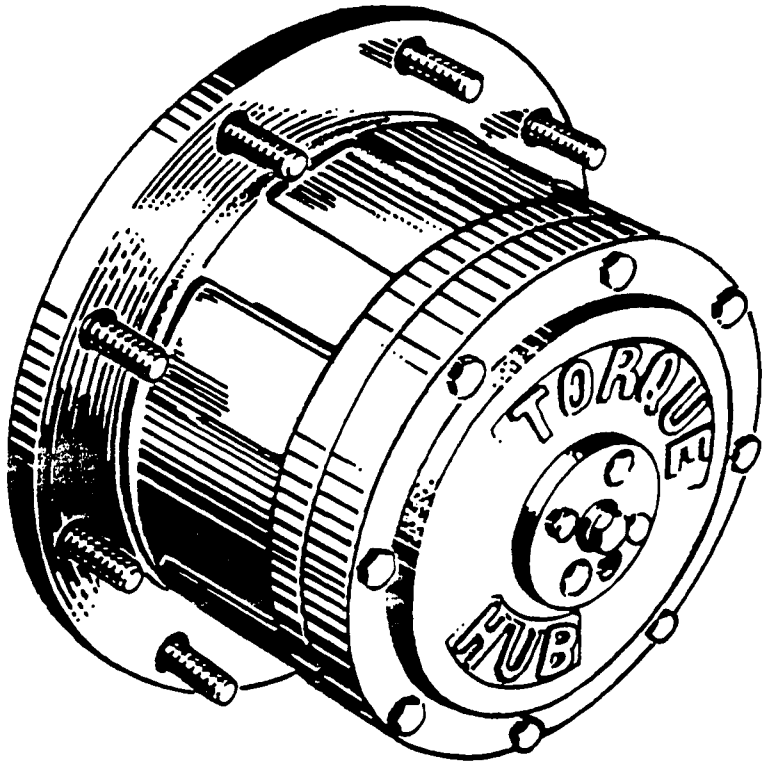
Mark Industries

TITLE	VENDOR CHAPTER
MODEL	41KBDF

SECTION	DESCRIPTION	PART NO.
1	FAIRFIELD TORQUE-HUB FINAL DRIVES	81218
2	MICO MULTIPLE DISC BRAKE	81217
3	EATON HYDRAULIC MOTOR	81362
4	NISSAN ENGINE	21049
5	EATON DOUBLE GEAR PUMP	81115
6	EATON SHIFT CYLINDER	20719
7	TRW TORQMOTOR	81274

Torque-Hub® Final Drives

Service Manual



Fairfield

THE DRIVE PEOPLE

REV.

Introduction

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

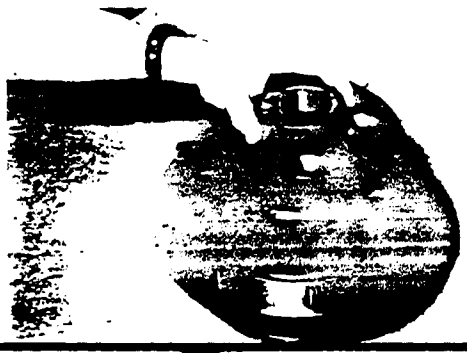
Included are —

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

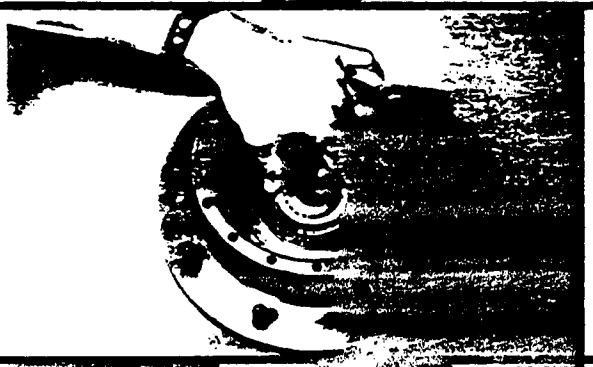
At the time of printing, this Manual was complete for the specific Torque-Hub model designated. However, Fairfield Manufacturing Co., Inc., reserves the right to update and improve its products at any time. All specifications and procedures are therefore subject to change without notice.

Safety

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



5. Place Bearing Cone #JM205149 over end of Spindle and into Bearing cup.



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

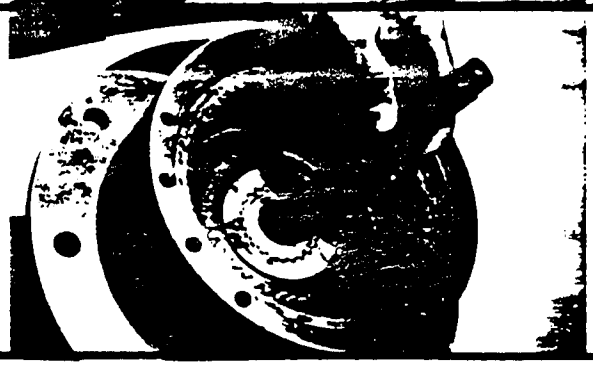


7. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

   ⚠ Eye protection should be worn during Retaining Ring installation.



8. Place Internal Gear onto end of Spindle.



9. Place Input Shaft Assembly into Spindle bore with unsplined end facing out.

W1A-W1B
Disassembly Procedure

1. Loosen all 16 Cover Bolts and drain the oil from the unit.

2. Remove the 16 Cover Bolts and lift off the Cover Sub-Assembly. Discard the 'O' ring Seal from the Cover counterbore.

3. Lift out the Carrier Sub-Assembly and the top Thrust Washer. The Thrust Washer may stick inside the Cover.

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

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

6. Lift out the Internal Gear and Thrust Washer. The Thrust Washer may stick to the bottom of the Carrier.

7. Remove the Retaining Ring from the Spindle and discard; then lift the hub off the Spindle.

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

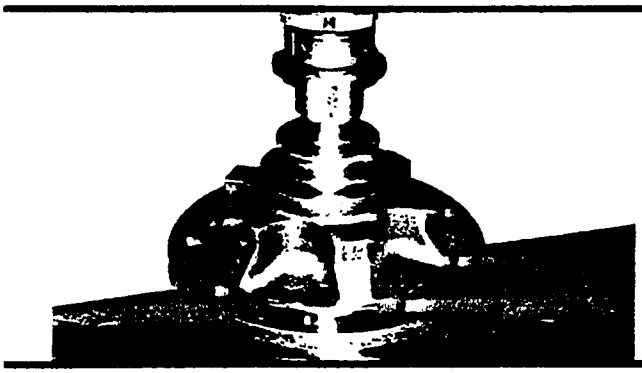
9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

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

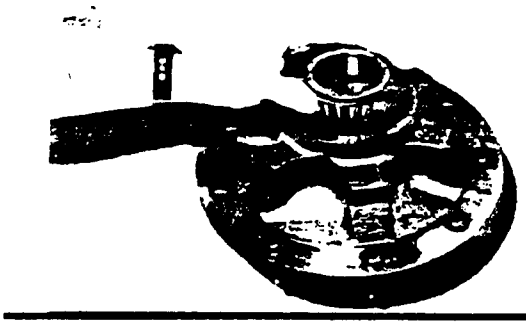
10. To remove the Cluster Gears from the Carrier, drive the anti-roll pin into the Planet Shaft of the Cluster Gear. After the Planet Shaft is removed the roll pin should be driven out of the Planet Shaft.

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

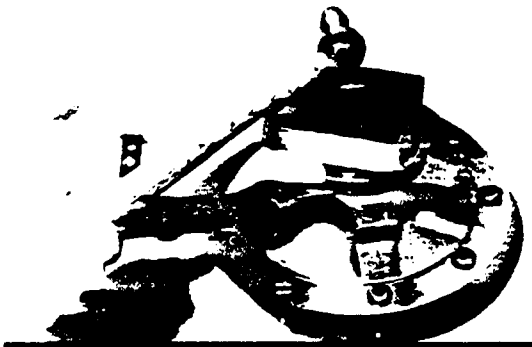
Main Assembly Procedure



1. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JLM506810 will go into small end of Hub, and Cup #JM205110 will go into large end of Hub. If Studs are being used, they can be pressed in at this time. Solid support must be used in this operation.



2. Place Bearing cone #JLM506849 into Bearing Cup in small end of Hub.



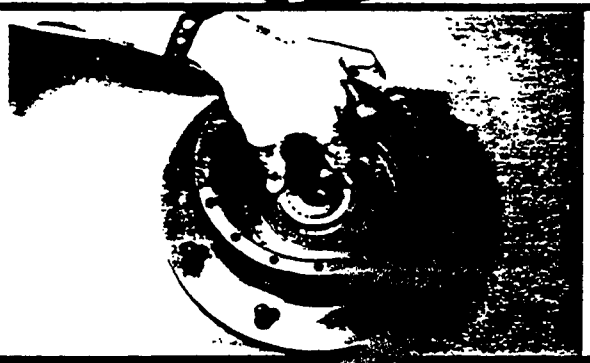
3. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.



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



5. Place Bearing Cone #JM205149 over end of Spindle and into Bearing cup.

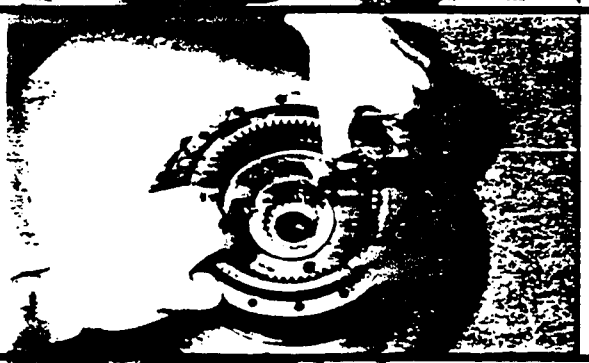


6. Place Bearing Shim over end of Spindle and against Bearing Cone.

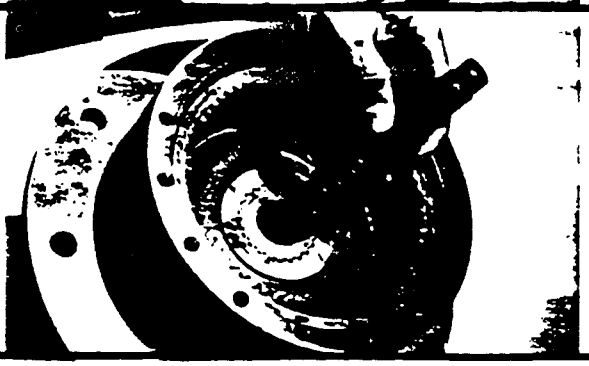


7. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

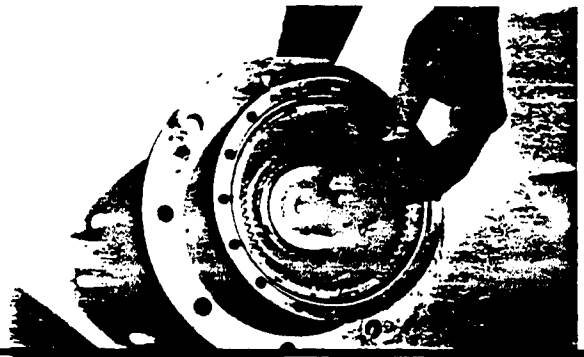
   ⚠ Eye protection should be worn during Retaining Ring installation.



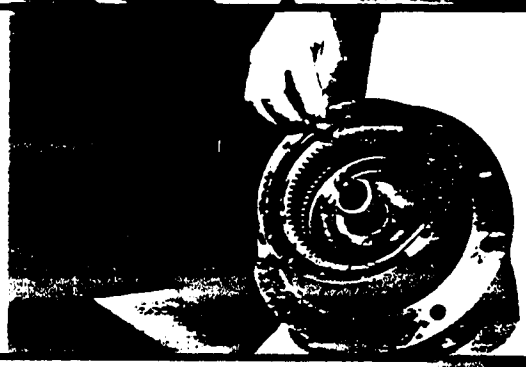
8. Place Internal Gear onto end of Spindle.



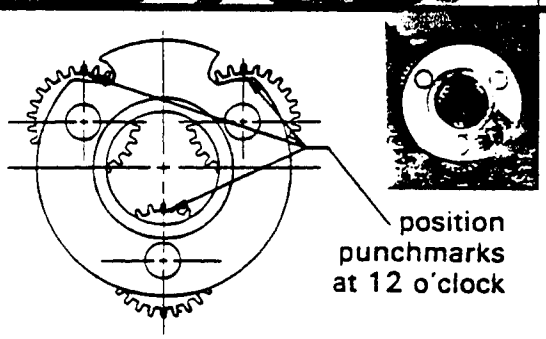
9. Place Input Shaft Assembly into Spindle bore with unsplined end facing out.



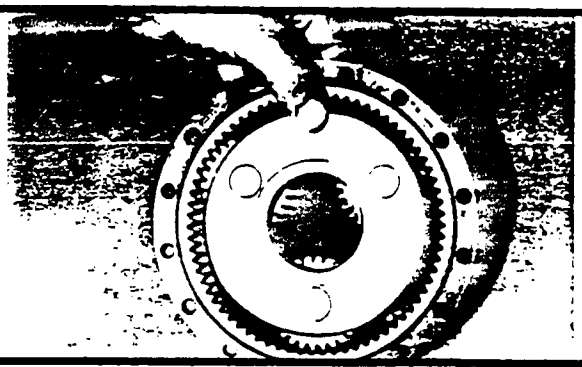
10. Place narrow Thrust Spacer over Input Shaft with counterbore side facing Spindle.



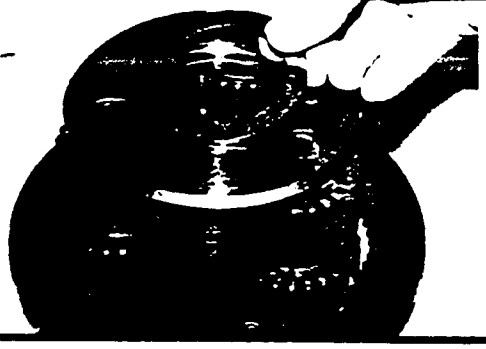
11. Place 'O' Ring into Hub counterbore. Use petroleum jelly or grease to hold 'O' Ring in place. Slight stretching of the 'O' Ring may be necessary to insure proper seating.



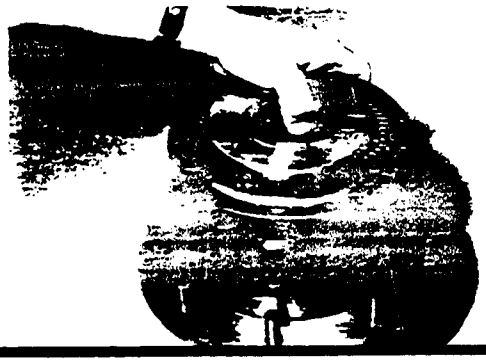
12. Place Carrier Assembly on a flat surface with the large gears up and positioned as shown. Find the punch marked tooth on each large gear and locate at 12 o'clock (straight-up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears.



13. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation.

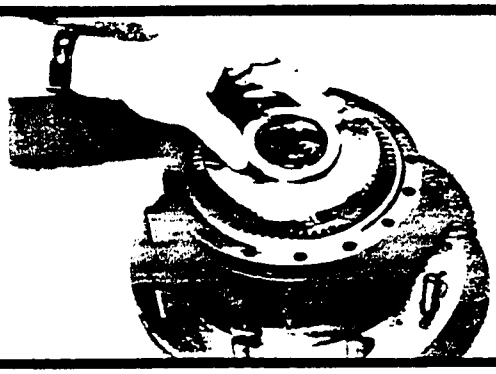


14. Turn over Carrier Assembly and Ring Gear while keeping gears in mesh. Place Thrust Washer into Carrier counterbore. Use petroleum jelly or grease to hold washer in place.



15. While holding Ring Gear, Input Gear and Cluster Gears in mesh, place small side of Cluster Gears into mesh with the Internal Gear. On the Ring Gear locate the hole marked "X" over one of the counterbored holes in Hub. Mark these holes on outside diameter for later use.

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

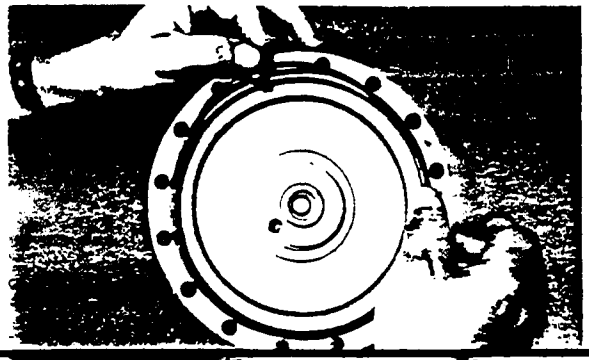


16. Place Thrust Washer into Carrier counterbore.

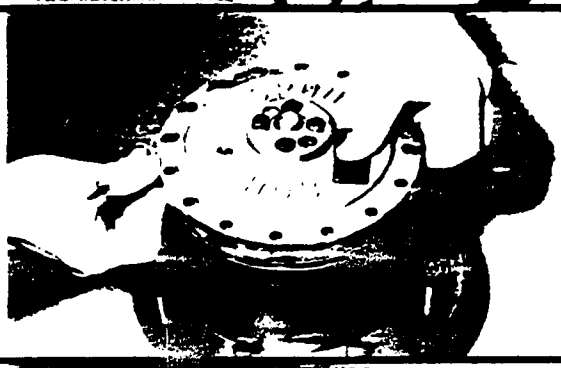


17. The Input Gear is now installed into the carrier meshing with the large diameter cluster gear. The counterbore in the bore of the Input Gear must be to the inside of this assembly.

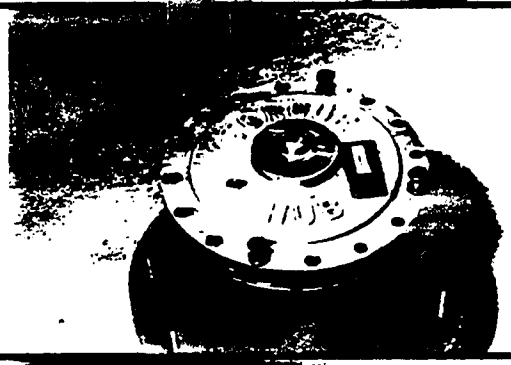




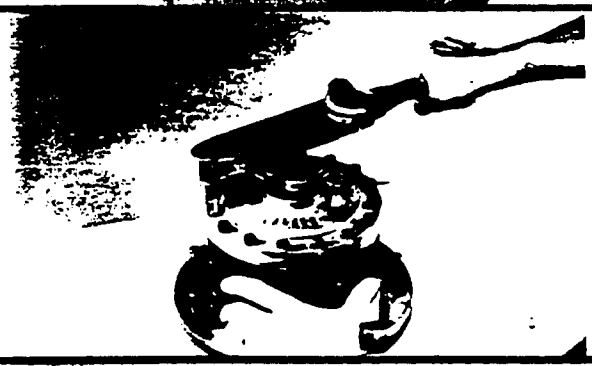
19. Place 'O' Ring into Cover Assembly counterbore. Use petroleum jelly or grease to hold 'O' Ring in place.



20. Place Cover Assembly over Ring Gear with oil level check plug in Cover located approximately 90° from oil fill plug in Hub.



21. Locate four Shoulder Bolts with flat washers, 90° apart into counterbored holes in Hub marked in step 16. Torque Shoulder Bolts to 23-27 ft. lbs.



22. Use standard grade 8-5/16-18x2¼ bolts with flat washers in remaining holes. Torque to 23-27 ft. lbs.



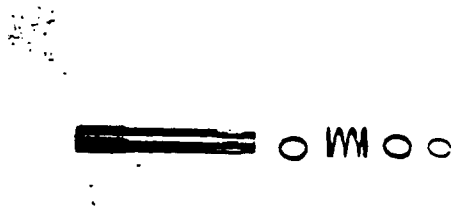
23. Place Coupling into Spindle and onto Input Shaft.

This completes the Torque-Hub Assembly. The unit must be filled one-half full of EP90 lubricant before operation.

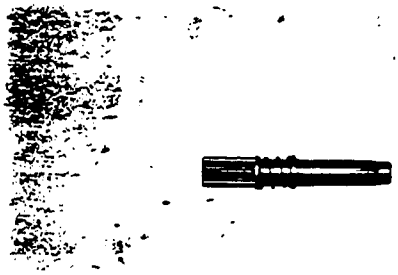
Assembly Procedure

For Sub-Assemblies

Input Shaft Sub-Assembly



1. Place Washer, Spring and Washer, in that order, onto Input Shaft.



2. Install Retaining Ring into Input Shaft groove to secure Spacers and Spring to shaft.

   ⚠ Eye protection should be worn during Retaining Ring installation.

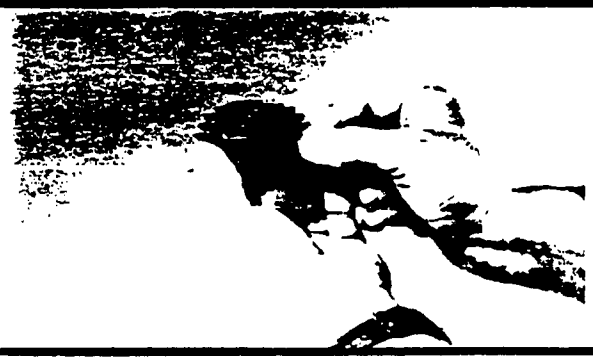
Carrier Sub-Assembly



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



2. Place sixteen Needle Rollers into Cluster Gear bore.



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

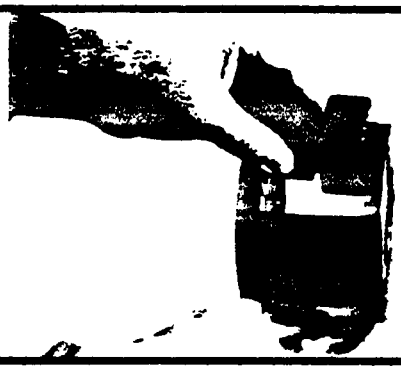


4. Place second set of sixteen Needle Rollers into Cluster Gear.

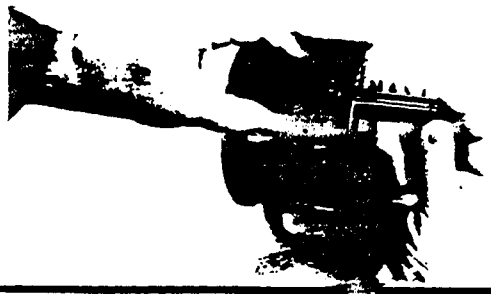


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

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



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



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

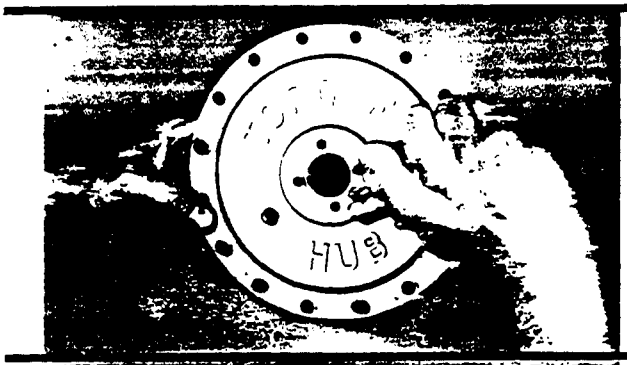


8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

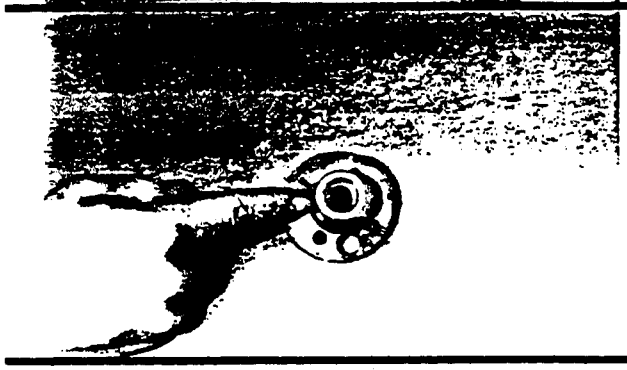
   Repeat these steps for remaining two Cluster Gears to complete Carrier Sub Assembly.

Carrier Sub-Assembly

Cover Sub-Assembly



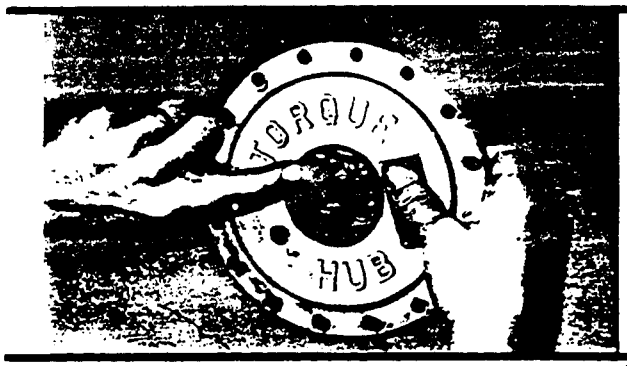
1. Screw Pipe Plug into Cover.



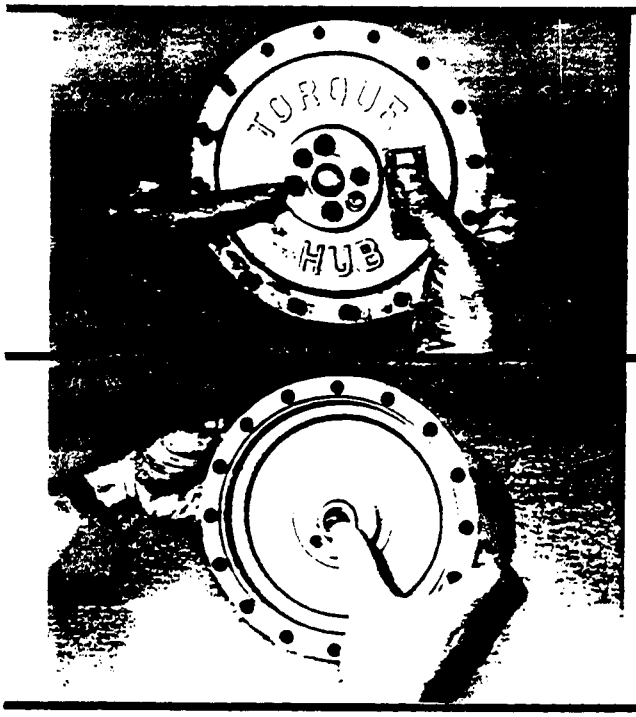
2. Slip 'O' Ring over Cover Cap and against face.



3. Place 'O' Ring into Cover Cap internal groove. The Disconnect Rod may be used to push 'O' Ring into groove.



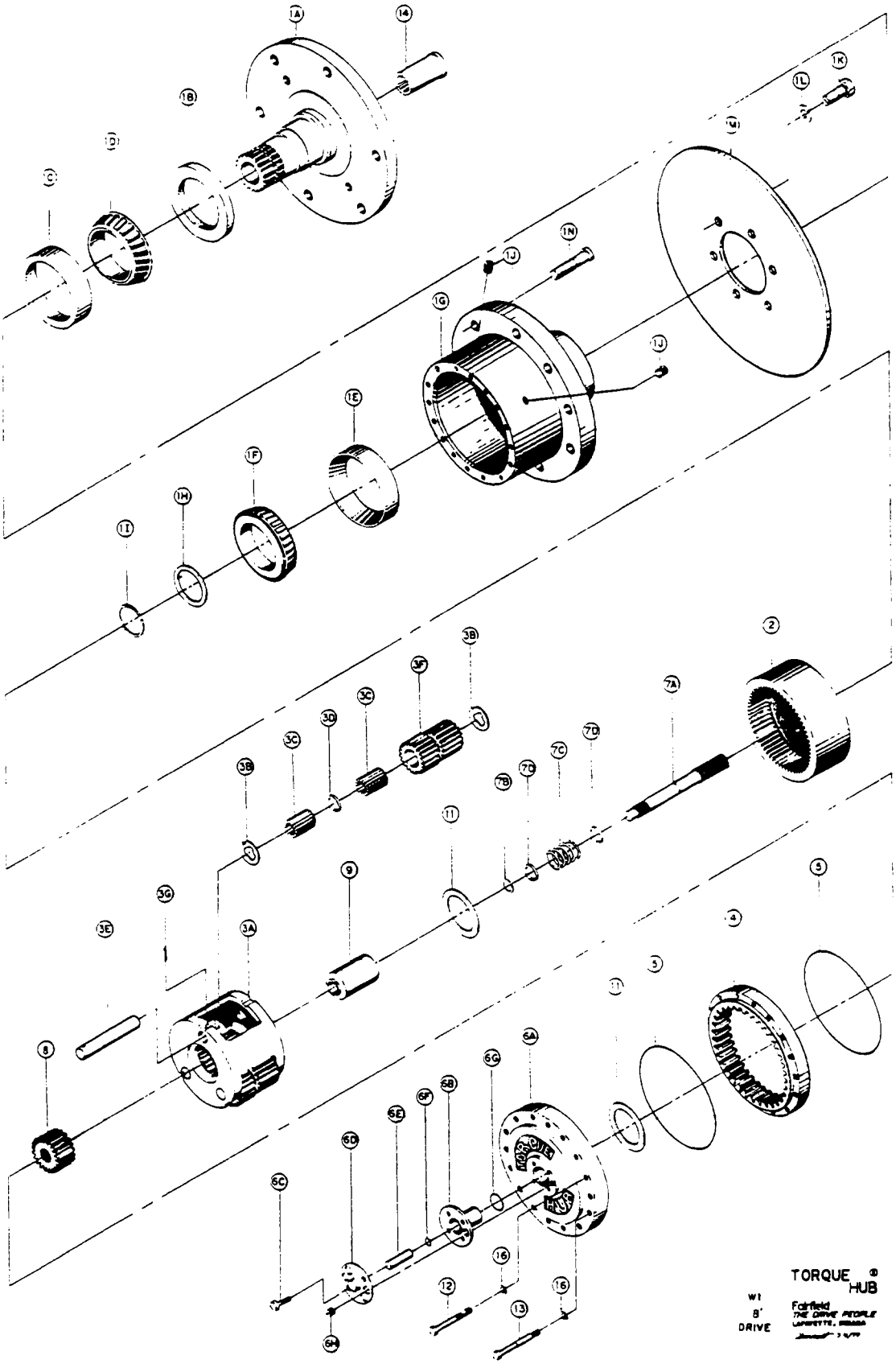
4. Place Cover Cap into Cover with large hole located over Pipe Plug. Secure Cover Cap to Cover with two ¼-20x¾ bolts. Torque bolts to 70-80 in. lbs.



5. Place Disconnect Cap over Cover Cap with nipple facing out. Secure Disconnect Cap to Cover with two ¼-20x¾ bolts. Torque bolts 70-80 in. lbs.

6. Turn Cover over and push Disconnect Rod into Cover Cap. Rod will be held in place by friction from the 'O' Ring.

Cover Sub-Assembly

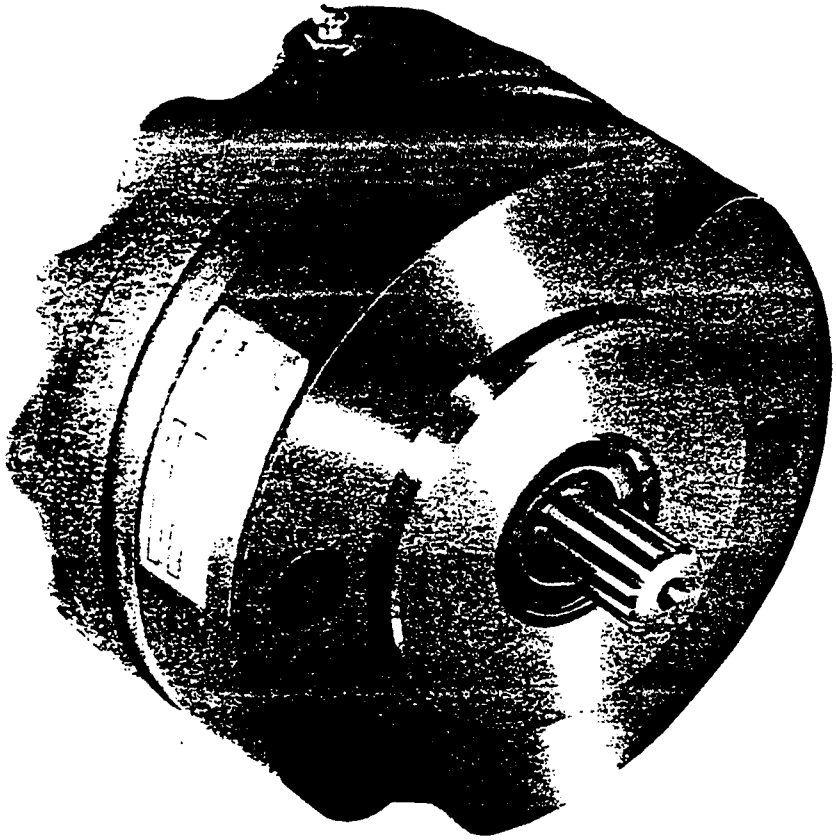

TORQUE HUB
W1
8'
DRIVE
Fairfield

SY·TEC SERIES

MULTIPLE DISC BRAKE

(dry design - SAE B size)

SERVICE MANUAL



TYPICAL BRAKE

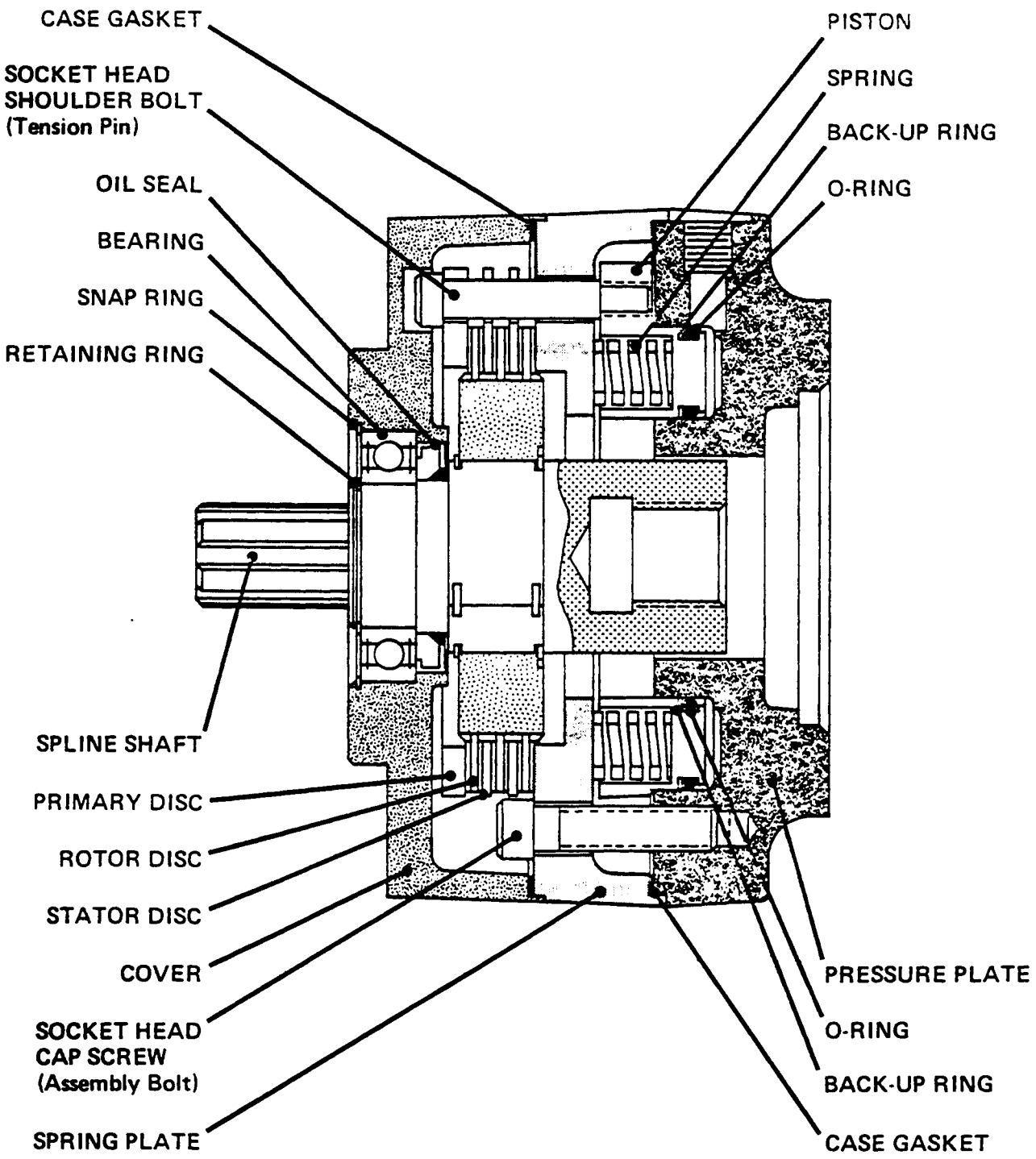


FIGURE 1

PRINCIPLES OF OPERATION

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

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

Two application examples.

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

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

DESCRIPTION OF MODEL NUMBERS



SERIES
S - Sy-Tec

OUTPUT FACE
B - SAE B-Mount 2-Bolt

OUTPUT SPLINE
13 - 13T 16/32
06 - 1.0 Dia. 6B
25 - 1.25 Dia. Keyed
10 - 1.0 Dia. Keyed
14 - 14T 12/24 Spline
15 - 15T 16/32 Spline

INPUT SPLINE
13 - 13T 16/32
06 - 1.0 Dia. 6B
25 - 1.25 Dia. Keyed
10 - 1.00 Dia. Keyed
14 - 14T 12/24 Spline
15 - 15T 16/32
12 - 12T 12/24
used with L
Input Face only

TORQUE

1 psi = 06895 bar

Code	Standard (In. lbs.)	High (In. lbs.)	Release Pressure (psi)	Full Release Pressure (psi)
90 *		9000	300	330
70 *		7000	250	280
40		4000	190	220
28	2800		190	220
35		3500	150	180
24	2400		150	180
29		2900	135	165
19	1900		135	165
25		2500	120	150
16	1600		120	150
18		1800	100	130
12	1200		100	130

For use with input spline codes 14 and 25 only.

INPUT FACE
B - SAE B-Mount 2-Bolt
A - MAB 4-Bolt and SAE A 2-Bolt
L - Charlynn Bearingless 2000
R - Closed
A4 - Charlynn Standard 2000

OPTIONS
(Available separately or in combination)
S - Speed Sensor - High torque models only
Z - Oil Cooled
D - Double Bearing

DISASSEMBLY

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

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

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

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

ASSEMBLY

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

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

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

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

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

REV.

FOR REPAIR KIT INFORMATION REFER TO PAGE 7.

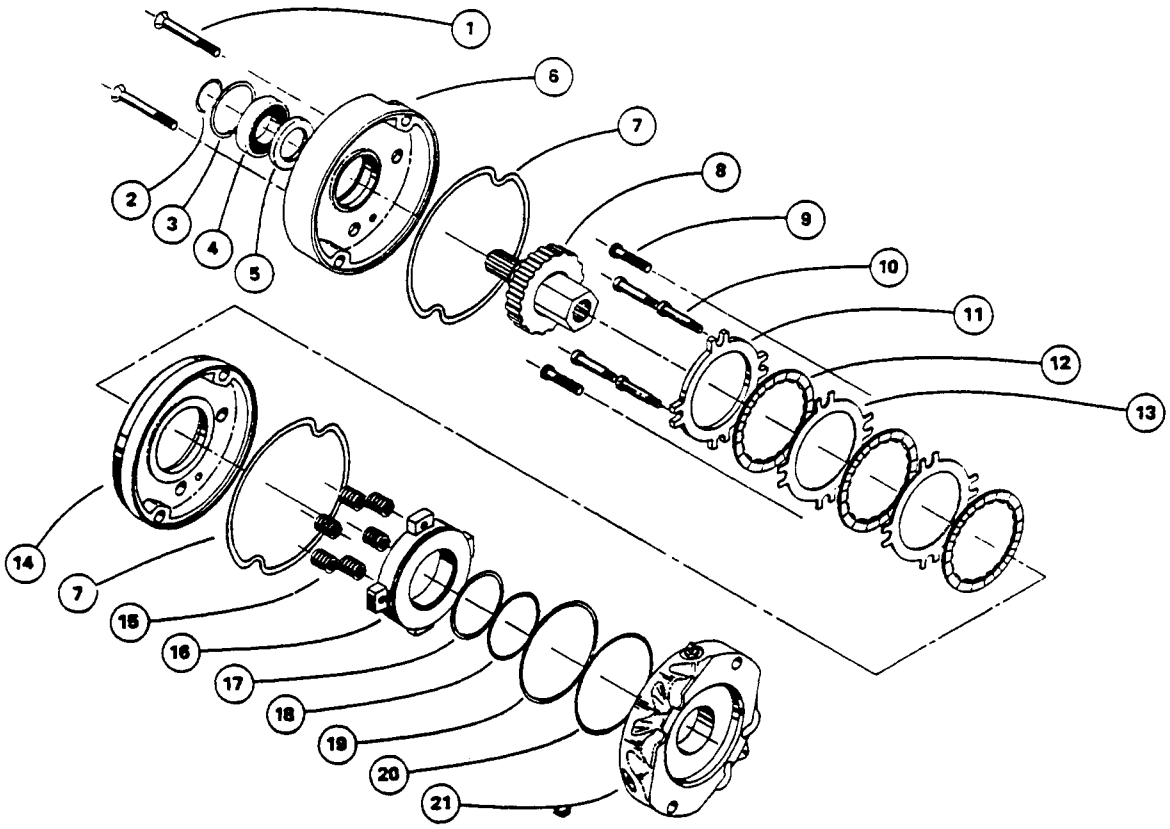


FIGURE 2

PARTS LIST

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

BLEEDING

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

SERVICE DIAGNOSIS

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

REPAIR KITS

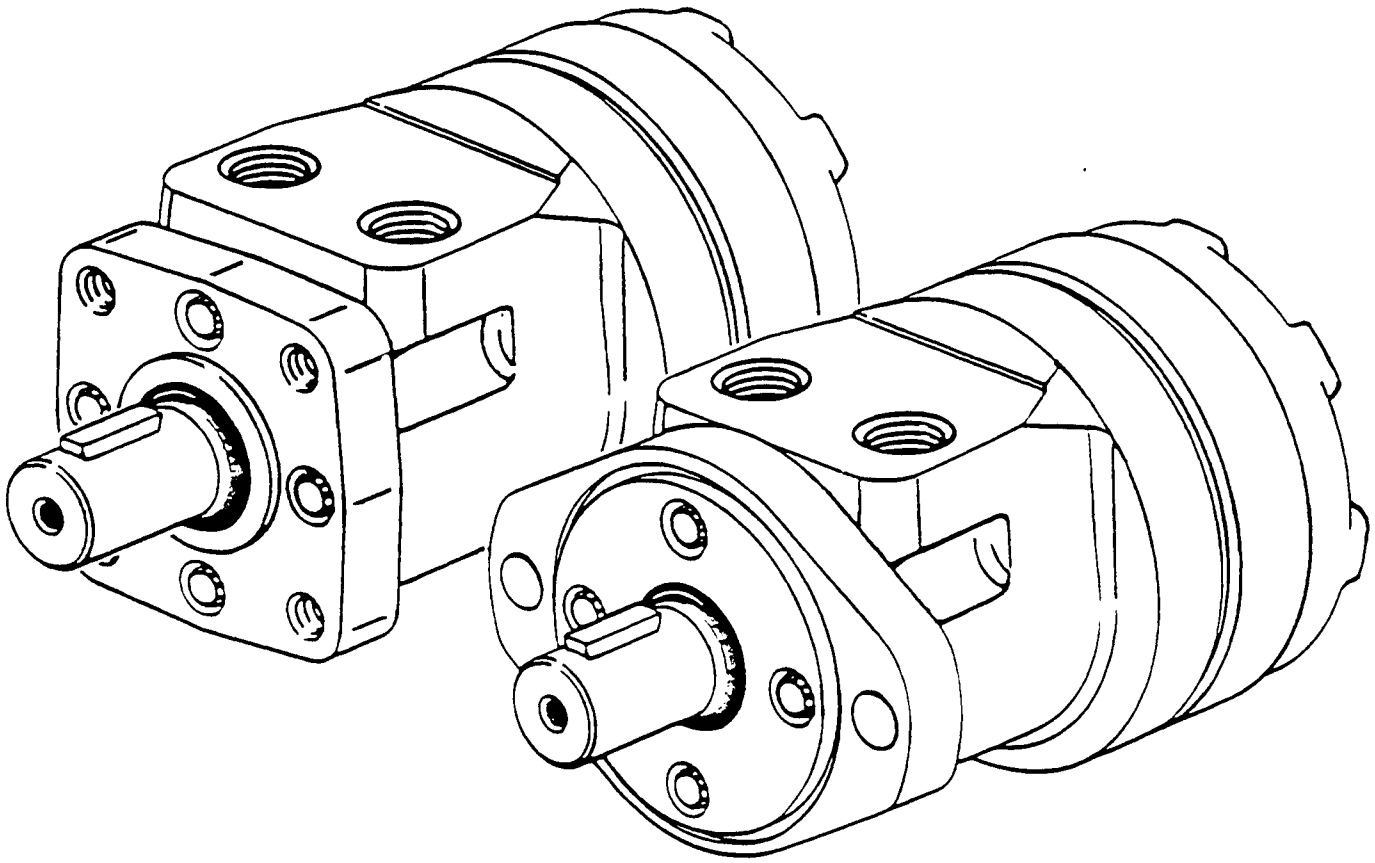
(Refer to Page 5 for item numbers)

NUMBER	DESCRIPTION	INCLUDES
67150	O-ring and Back-up Ring Kit	Case Gaskets (item 7) Face Gasket (not shown) Face Seal (not shown) Oil Seal (item 5) Back-up Rings (items 17 & 19) O-rings (items 18 & 20) Loc-tite
N/A	High Torque Lining Kit	Case Gaskets (item 7) Face Gasket (not shown) Face Seal (not shown) Primary Disc (item 11) Stator Discs (item 13) Rotor Discs (item 12) Loc-tite
67657	Bearing Kit	Case Gaskets (item 7) Face Gasket (not shown) Face Seal (not shown) Oil Seal (item 5) Bearing (item 4) Loc-tite
67650	Spring Kit	Case Gaskets (item 7) Face Gasket (not shown) Face Seal (not shown) Springs - red (item 15) Springs - blue (item 15) Loc-tite
67645	Standard Lining Kit	Case Gaskets (item 7) Face Gasket (not shown) Face Seal (not shown) Primary Disc (item 11) Stator Discs (item 13) Rotor Discs (item 12) Loc-tite

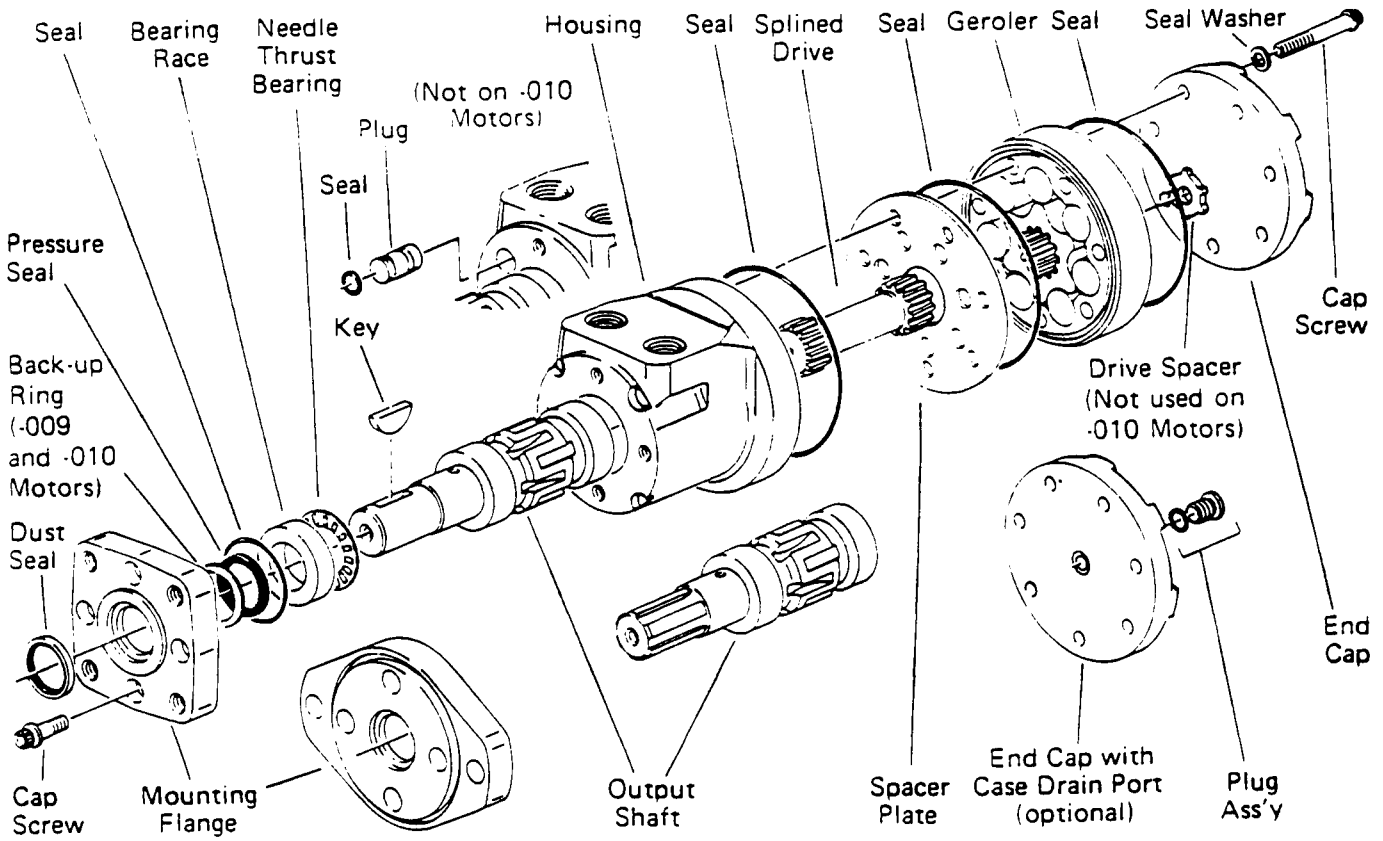
Eaton
Hydraulics
Division

Repair Information

S Series Char-Lynn® Motors 008 009 010



EATON



Tools required for disassembly and reassembly.

- Torque wrench (300 lb-in [34Nm] capacity)
- 12-16 in. [300-400mm] breaker bar
- *5/16 in.–12 point socket no. 5422 (Heavy Duty–500 lb-in [56Nm] Capacity)
- Small screwdriver (6-8x1/4 in. [150-200x6mm] flat blade), see page 6 for tooling information.
- 3/16 in. [5mm] hex key
- *Shaft pressure seal installation tool for 008 motor P/N 600470
- *Shaft pressure seal installation tool for 009 and 010 motors P/N 600523
- Seal sleeve or bullet P/N 600304 (1 in. dia. shaft), P/N 600466 (7/8 in. dia. shaft)

The following tools are not necessary for disassembly and reassembly but are extremely helpful.

- Small propane torch

* Tools available–by special order–through our service department.

Disassembly

Instructions in this manual are for "S" Series motors (103-xxxx-008. 009 and 010).

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting the lines. clean port area of motor. Remove key when used. Check shaft and key slot, remove burrs, nicks or sharp edges and polish around the key slot. Before starting disassembly, drain oil from motor, then plug ports and thoroughly clean exterior of motor.

Although not all drawings show the motor in a vise, we recommend that you keep the motor in the vise during disassembly. Follow the clamping procedures explained throughout the manual.

Geroler End



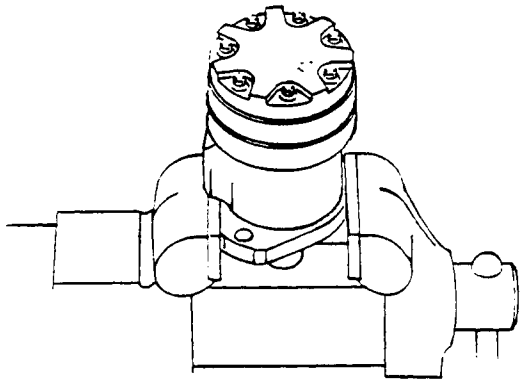


Figure 1

1 Place motor in vise, clamp across edge of flange with output shaft down. When clamping, use protective device on vise, such as special soft jaws, pieces of hard rubber or board, see Fig. 1.

2 Some motors may have a case drain plug in the end cap. If external case drain is not used, it is not necessary to replace the seal unless leakage occurs.

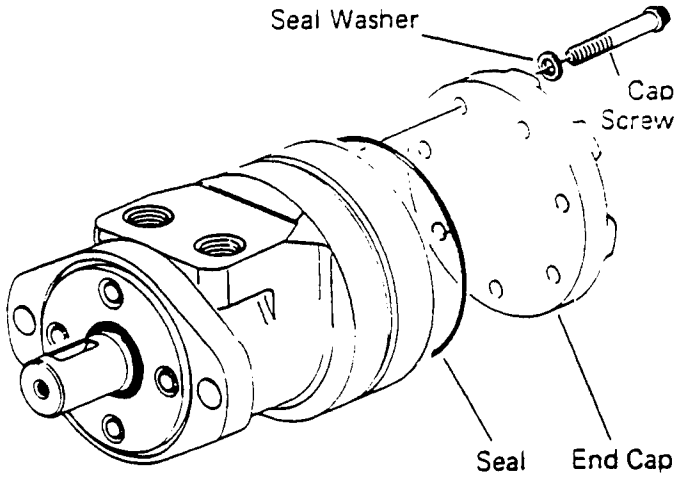


Figure 2

3 Remove cap screws and seal washers from end cap (seal washers used on 3.6, 4 2 and 5.8 cu. in. [59, 69 and 95 cu. cm.] displacement motors only).

4 Remove end cap.

5 Remove seal from Geroler.

6 Remove Geroler—retain rollers in the outer Geroler ring, see Fig. 3.

7 Remove seal from Geroler. see Fig. 3.

8 Remove drive spacer (not used on 5.8 and 9.7 cu. in. [95 and 159 cu. cm.] displacement motors for the 008 and 009 motors and not used at all on 010 motors).

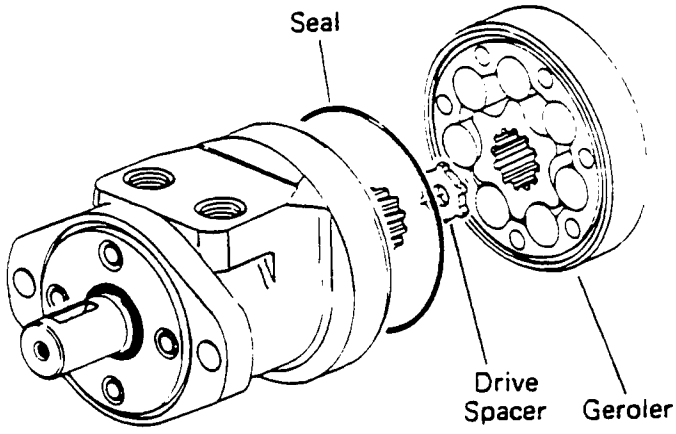


Figure 3

Disassembly

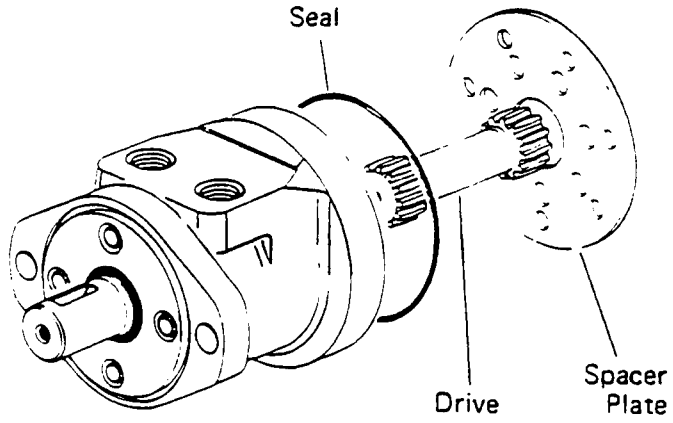


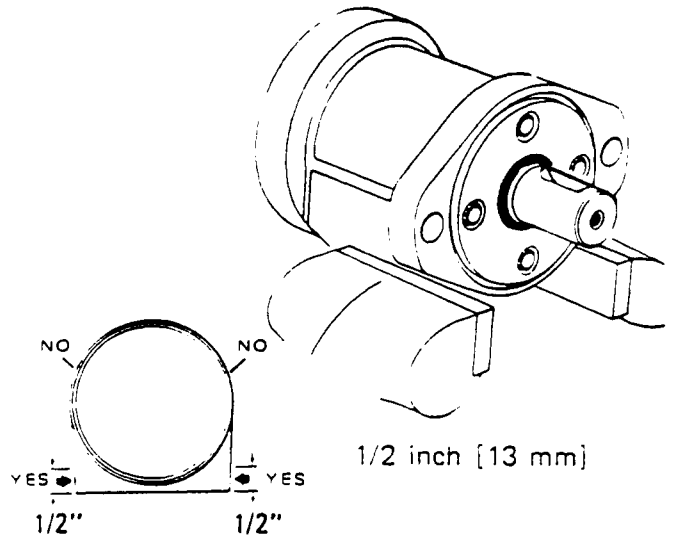
Figure 4

9 Remove spacer plate.

10 Remove drive, see Fig. 4.

11 Remove seal from housing.

Shaft End



Clamp across ports not across housing. Excessive clamping pressure causes distortion.

Figure 5

12 Reposition motor in vise. Clamp across ports as shown in Fig. 5, not on side of housing. Do not over tighten jaws. Excessive clamping force may distort housing.

13 Remove the 4 cap screws from the mounting flange. These motors are assembled using Loctite on the screws to hold them in place.

The screws will require approximately 300-400 lb-in [34-45Nm] of torque to break loose and approximately 100 lb-in [11Nm] torque to remove after they are broken loose. Do not use an impact wrench on Loctited screws. this may result in rounded heads or broken sockets.

Note: If higher torque than given above is required to break the screws loose, apply heat according to the following instructions. When heated the Loctite partially melts and the torque required to remove the screw is greatly reduced. Follow the instructions carefully, and be careful not to overheat and cause damage to the motor. Use a small flame propane torch to heat a small area of the housing, where the screw enters, see Fig. 6. Apply torque to the screw with a **socket** wrench gradually as heat is applied for 8 to 10 seconds. As soon as the screw breaks loose, remove heat from the housing and continue turning the screw until it is completely removed.

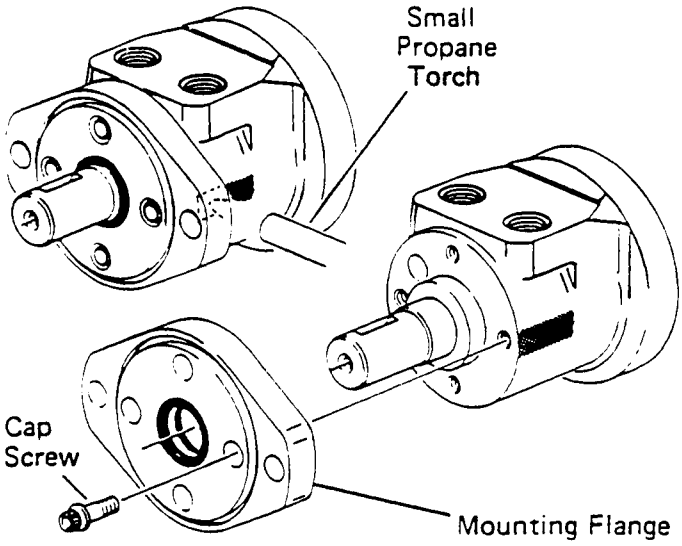


Figure 6

14 Remove motor from vise. Place on clean flat surface. Carefully lift flange from housing with a twisting motion.

Disassembly

15 The dust seal, pressure seal and oil seal will come off with the flange. Use a seal remover tool, like the one shown in Fig. 7, to remove the dust seal and pressure seal, as shown in Fig. 8 and 9.

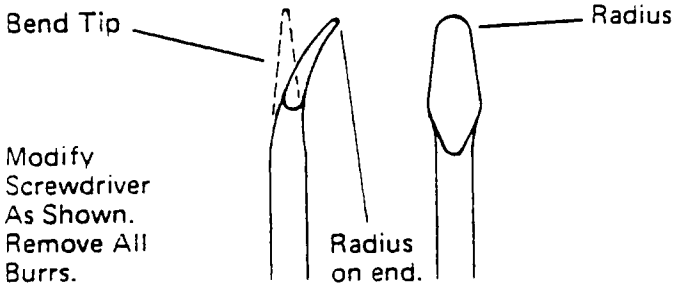
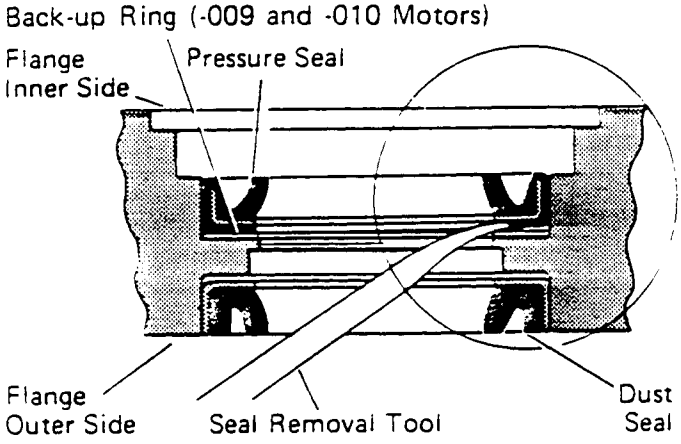


Figure 7



Work from outer side for both (either) seals.

Figure 8

Work nose of tool between pressure seal and flange. Pry seal partway. Remove tool and repeat at a point 180° away. Push seal completely out of cavity, see Fig. 8.

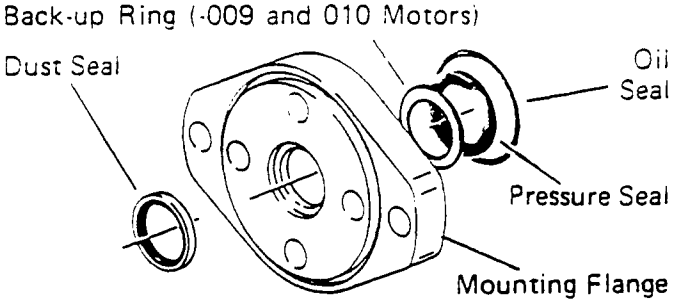


Figure 9

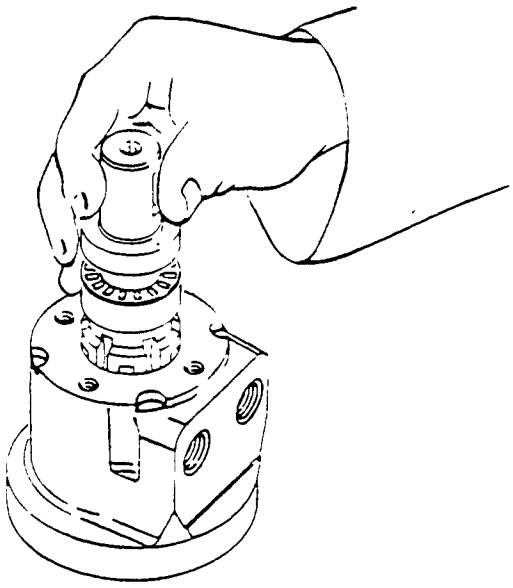


Figure 10

16 Remove output shaft from housing.

17 Remove bearing race and needle thrust bearing from shaft.

18 Some older housings have plugs. To remove the plug, use a 3/16 in. [5mm] hex key, inserted through port opening, to push them out.

Reassembly

Shaft End

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage or damage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe parts with cloth or paper towel, lint or other matter can get into the hydraulic system and cause damage. Check around the key slot and chamfered area of the shaft for burrs, nicks or sharp edges that can damage the seals when reassembling. Remove nicks or burrs with a hard smooth stone (such as an Arkansas stone). Do not try to file or grind motor parts.

Note: Lubricate all seals with petroleum jelly such as Vaseline. Use new seals when reassembling the motor. Refer to parts list (6-125) for proper seal kit number.

Important: Do not stretch seals before installing.

Cleanliness is extremely important in the successful application of Loctite. Use the following procedures to properly clean all parts.

A. Wash the housing with non-petroleum base solvent to remove oil, grease and debris. Petroleum base solvents may leave residue detrimental to successful Loctiting. Pay particular attention to 4 tapped holes on the flange end.

Note: Fully cured Loctite resists most solvents, oils, gasoline, kerosene, and is not affected by cleaning operations.

B. Blow dry with compressed air. Clean and dry the tapped holes.

Note: It is not necessary to remove the cured Loctite that is securely bonded in the tapped holes; however, any loose particles of cured Loctite should be removed.

C. Wire brush the screw threads to remove cured Loctite and other debris. Discard any screws that have damaged threads or a corroded, damaged, or rounded head.

D. Wash the screws with non-petroleum base solvent. Blow dry with compressed air jet.

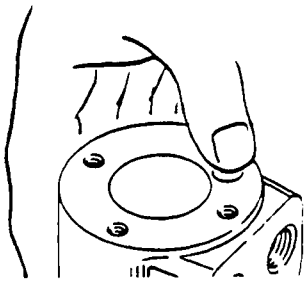


Figure 11

19 If you removed check valves, or plug(s), replace seal(s). Lubricate new seal(s). Install on check valves, or plug(s). Carefully push check valves, or plug(s), in housing until flush with housing face. Do not damage seal(s).

20 Lubricate output shaft with clean hydraulic oil, then install shaft in housing.

Important: Do not permit oil to get into the 4 tapped holes.

Note: To help with timing procedures, a timing dot is machined on output shaft. See figures 18 and 19.

Reassembly

21 Install needle thrust bearing then bearing race on shaft. Pull shaft partially out of housing, then push all three parts in housing together. The bearing race must rotate freely when in position.

Important Note: Prior to installing high pressure shaft seal it is necessary to break the sharp corner of the flange seal seat, see Fig. 12. Use 400 grit paper to break corner.

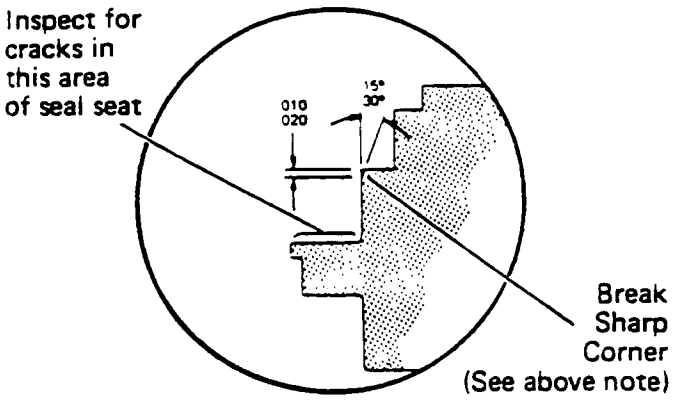


Figure 12

22 Clean mounting flange of all loose metallic chips, particles, dirt or other contamination, including oil. During cleaning, visually check seal seat in mounting flange for scratches or other marks that might damage the pressure seal. Check for cracks in flange that might cause leakage, see Fig. 12.

Important: If a pressure seal installation tool isn't available, temporarily install flange without seals. Then install 2 cap screws to secure flange to housing. Install seals in flange, and apply loctite, after you reassemble Gerotor end of motor (see step 41 thru 45 page 11).

Note: If you have a pressure seal installation tool, continue reassembly, starting with step 23.

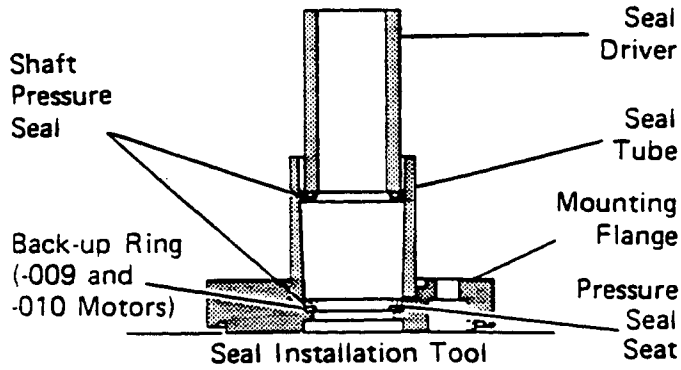


Figure 13

23 Lubricate I.D. of seal tube and O.D. of shaft pressure seal with a light film of clean petroleum jelly. Align small I.D. end of seal tube with seal seat in mounting flange. Install back-up ring and pressure seal in tube—lips of seal face up—see above. Then insert seal driver in tube to firmly push (by hand with rotating action) seal in seal seat.

Important: After installing seal in flange, examine seal condition. If cut, damaged, or improperly installed, you must replace it before continuing reassembly.

24 Install dust seal in flange, see Fig. 15. Press the dust seal into place carefully. To eliminate damage to rubber portion or distortion of metal container, use a tool (flat-round face 1-3/8 to 1-5/8 in. [35-41mm] diameter) which provides proper guiding and positioning.

25 Install 1-15/16 in. [50mm] I.D. seal in flange.

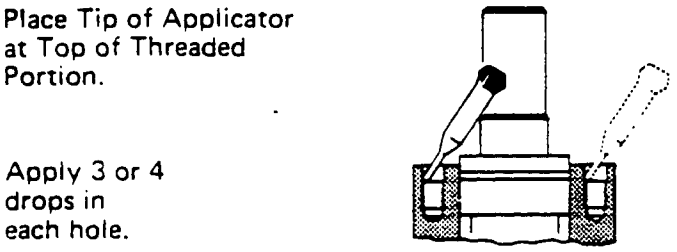


Figure 14

Caution: Do not use excessive amount of Loctite.

26 Apply 3 or 4 drops of Loctite adhesive (Loctite no. 601 sealant) at top of threads in each of 4 holes in housing, see Fig. 14. Do not allow parts with Loctite applied to surface to contact any metal parts other than their proper assembly. Wipe off excess Loctite from housing face, using a non-petroleum base solvent. Do not apply Loctite to threads more than 15 minutes before installing screws. If housing stands for more than 15 minutes, repeat application. No additional cleaning or removal of previous Loctite is necessary.

Reassembly

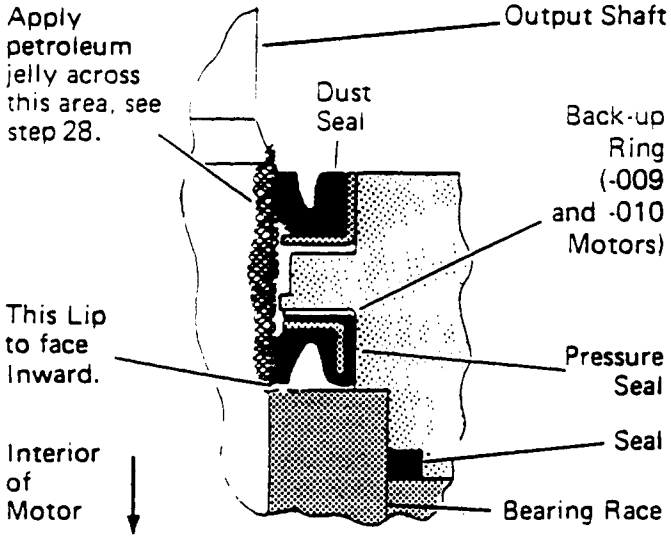


Figure 15

27 Before installing the flange and seal assembly over the shaft, place a protective sleeve or bullet over the shaft. Then, lubricate space between dust seal and pressure seal, as well as lips of both seals, see Fig. 15. Install flange. Rotate flange slowly while pushing down over shaft. Be careful not to invert or damage the seals.

28 Clamp motor in vise as shown in Fig. 5, then install dry screws and alternately torque immediately to 250 lb-in [28Nm]. If you use primer, allow to cure for 10-15 minutes, without primer, allow 6 hours before subjecting motor to high torque reversals. On all other applications you can run the motor immediately. If you use new bolts, make sure they are the correct length, 7/8 in. [22mm] under head length, see parts list for correct part number. Longer screws will not permit proper seal between the flange and housing. Install key in key slot of shaft.

Geroler End

29 Clamp housing in a vise, Gerotor end up. See Step 1 for correct clamping procedure.

Important Note: To aid installation of seals, apply light coating of clean petroleum jelly, such as Vaseline, to seals before installing.

Important: Do not stretch seals before installing.

30 Pour approximately 35 cc of clean hydraulic oil in output shaft cavity.

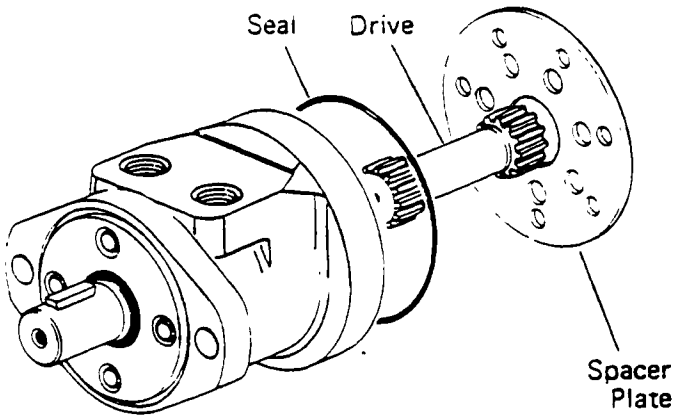


Figure 16

31 Install 3-19/32 in. [90mm] I.D. seal in housing seal groove. Avoid twisting seal.

32 Install drive, observe proper timing procedure (Fig. 18).

33 Place spacer plate carefully on the housing, align bolt holes.

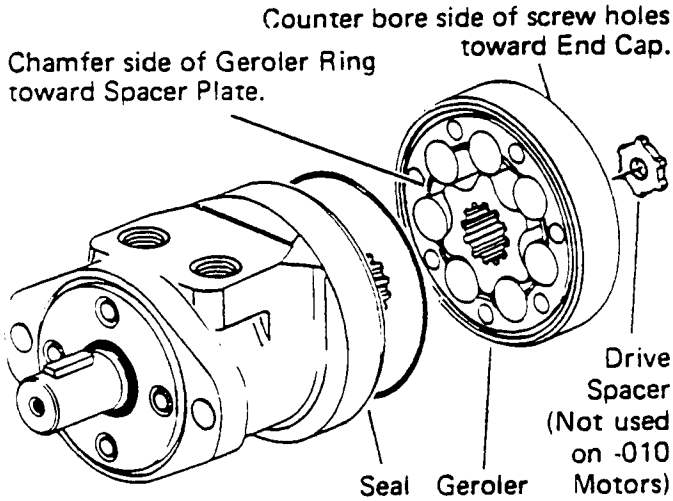


Figure 17

34 Install 3-19/32 in. [90mm] I.D. seal in Gerotor seal groove, see Fig. 17. Avoid twisting seal.

35 Carefully place Gerotor on the spacer plate, see Fig. 17. Observe proper timing procedure, see Fig. 18.

Reassembly

Timing Procedure

A. Align shaft timing dot with any bolt hole.

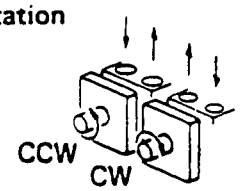
B. Install drive. For the 3.6 and 4.5 cu. in. [59 and 74 cu. cm.] displacements on the 010 motors, install the wide end of the drive in the output shaft. Install either end of the drive in the output shaft for the 010 motor displacements ranging from 5.9 to 22.6 cu. in. [97 to 370 cu. cm.].

C. Install spacer plate. Remember which bolt hole was aligned with the shaft timing dot.

D. Place gerotor on wear plate, positioning any star point over the bolt hole aligned with the timing dot.

E. Rotate gerotor to line up bolt holes. Be careful not to disengage star from drive or disturb gerotor seal.

Standard Rotation



When timing is orientated as shown.

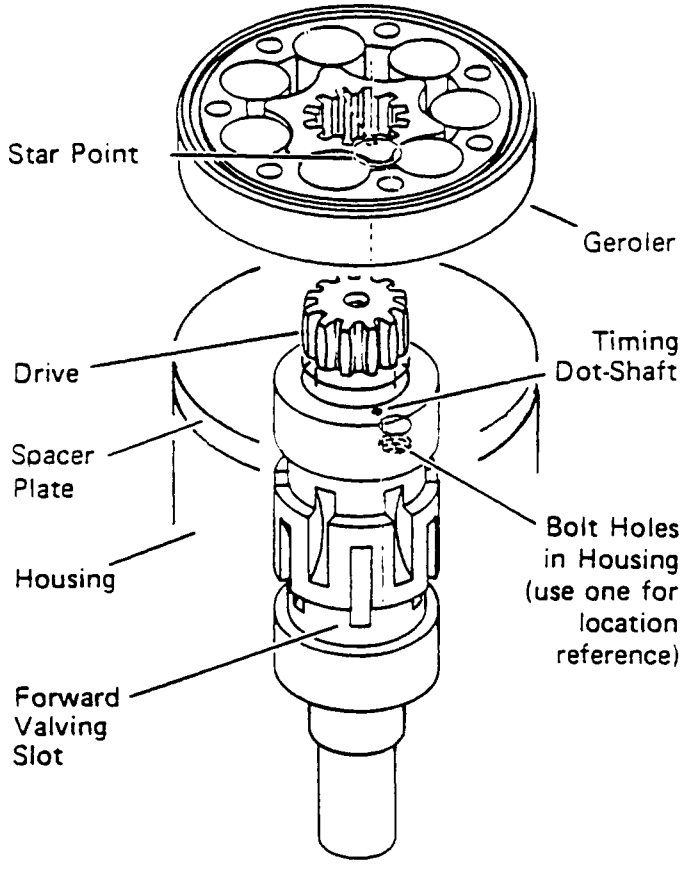
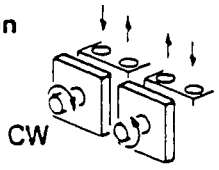


Figure 18

Reverse rotation is obtained by positioning any star valley, rather than any star point, over the aligned bolt hole.

Reverse Rotation



When timing is orientated as shown.

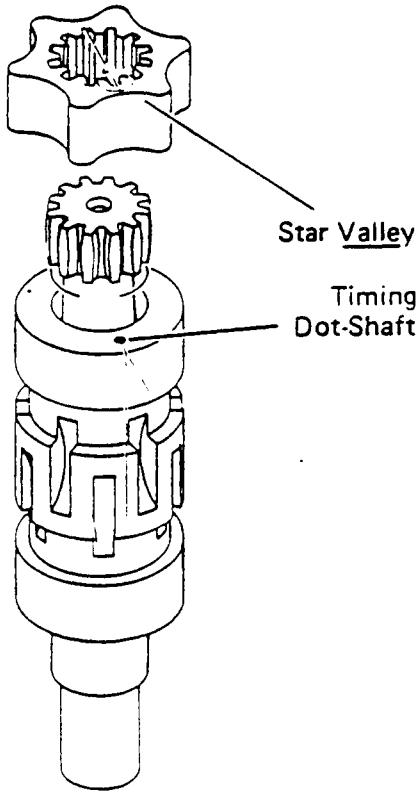


Figure 19

36 Install drive spacer (not used on 5.8 and 9.7 cu. in. [97 and 159 cu. cm] displacements on the 008 and 009 motors and not used at all on 010 motors). See figure 17.

37 Install 3-19/32 in. [90mm] I.D. seal in Geroler seal groove. Avoid twisting seal.

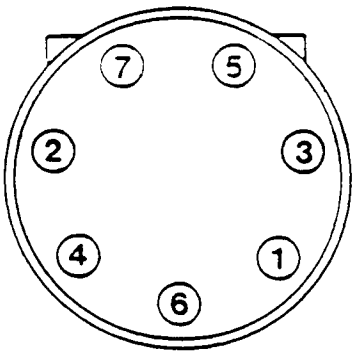
38 Install end cap, see Figs. 20 and 21.

Reassembly

39 Install cap screws (and seal washers when required, see information below) in end cap.

On 5.9 cu. in. displacement motors or less, use seal washers. Pre-tighten all screws to 15-40 lb-in[2-5Nm]. Make sure Geroler section seals are properly seated before torquing screws. Then torque screws to 200 lb-in[23Nm] in sequence, as shown in Fig. 21.

On 7.3 cu. in. displacement motors or larger, omit seal washers. Pretighten all screws to 15-40 lb-in[2-5Nm]. Make sure Geroler section seals are properly seated before torquing screws. Then torque screws to 300 lb-in[34Nm] in sequence, as shown in Fig. 21.



Bolt Torquing Sequence

Figure 21

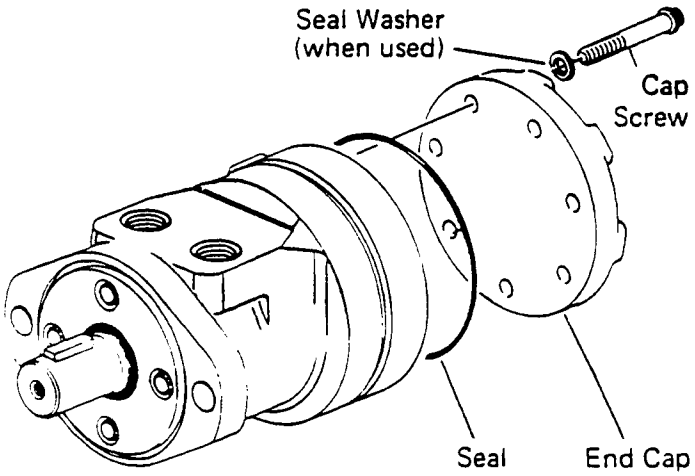


Figure 20

Note: Steps 41 through 45 cover mounting flange seal installation without using a seal installation tool.

40 Clamp motor in vise with output shaft up, see Fig. 23. Remove cap screws and flange.

41 Prepare seal seat of flange, see step 22.

42 Lubricate dust seal O.D. Then install dust seal in flange. Make sure dust seal is flush with flange, see step 24.

Reassembly

43 Install pressure seal flush against bearing race, see Fig. 22. Lightly lubricate pressure seal O.D.

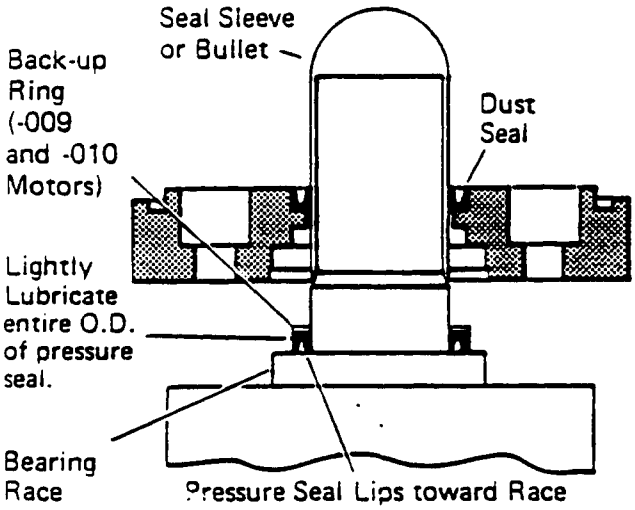


Figure 22

44 Place a seal sleeve or bullet over shaft. Twist flange down shaft until flush against pressure seal. The pressure seal must enter into seat evenly and gradually. Install 4 cap screws. Gradually and evenly finger tighten cap screws (criss-cross pattern). Then use a hand socket wrench to lightly snug tighten screws until flange is flush against housing. DON'T TIGHTEN SCREWS MORE THAN 1 FULL ROTATION AT A TIME–(criss-cross pattern).

45 Use a hand torque wrench to gradually and evenly tighten cap screws (criss-cross pattern) until they reach 250 lb-in[28Nm]. See caution and important notes below.

Caution: Do not use air socket wrench on cap screws for this type of seal installation.

Important: Proper pressure seal installation is important. You must remove cap screws and flange to examine seal condition. If you've cut or damaged the pressure seal, you must replace it with a new one. If seal is in good condition continue flange reassembly–starting with procedure step 24, page 8.

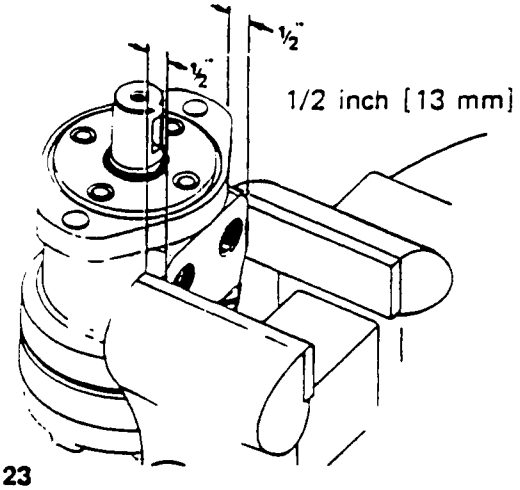


Figure 23

NISSAN ENGINE

OPERATION & MAINTENANCE MANUAL

MODEL A SERIES

NISSAN MOTOR CO., LTD.
Tokyo, Japan

A12/15-A

Foreword

This booklet has been prepared to provide the necessary information for the operation, inspection and maintenance of the Nissan Engine.

We urge you to follow the recommendations contained in this booklet, so that the Nissan Engine will remain free of trouble throughout its working life. Please familiarize yourself with this booklet, and refer to it when necessary

If you encounter any problems with your Nissan Engine, contact the authorized Nissan dealer in your area.

All information, specifications and illustrations in this manual are on a basis of the latest data obtainable at the time of the publication. Nissan reserves the right to make changes or improvements at any time without notice.

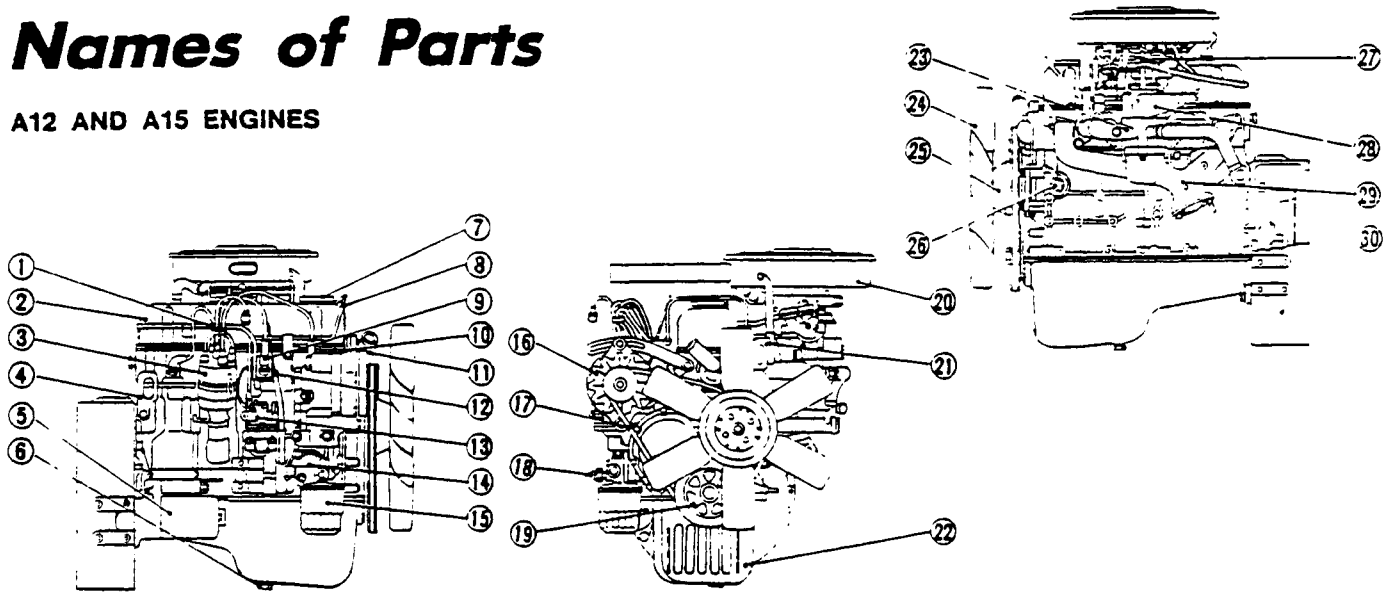
NISSAN

Contents

Names of Parts 1
Operation 1
Other Handling and Operations 2
Daily Care 5
Maintenance 6
Trouble Diagnosis and Corrections 13
Recommended Lubricant 20
System Diagram 20
Engine Serial Number 22
Specifications 23

Names of Parts

A12 AND A15 ENGINES



1. High tension cable
2. Rocker cover
3. Distributor
4. Rear engine slinger
5. Starter motor
6. Oil drain plug
7. Oil filler cap
8. Fuel pipe
9. Spark plug
10. Thermo sender
11. Water outlet
12. Oil level gauge
13. Fuel pump
14. Oil pump
15. Oil filter
16. Alternator
17. Fan belt
18. Oil pressure switch
19. Crank pulley
20. Air cleaner
21. Front engine slinger
22. Oil pan
23. Intake manifold
24. Cooling fan
25. Water pump
26. Water outlet
27. Carburetor
28. Governor
29. Exhaust manifold
30. Flywheel housing

Operation

HANDLING OF NEW ENGINE

The life and performance of an engine are greatly influenced by how it is handled and serviced during the initial period.

Operate the engine by observing the following the precautions during the initial 100 hours of operation.

Cautions in operation

1. After starting, warm the engine thoroughly by means of warming-up operation until the cooling water temperature rises above 50°C (122°F)
2. Never attempt to race the engine under non-loaded conditions.
3. Always maintain the operating speed of the engine below 70% of the maximum engine rpm.
4. Avoid overloading.

ENGINE HANDLING PRECAUTIONS

When handling the engine, be sure to observe the following precautions:

When starting the engine

1 Check the engine oil and coolant level, and refill if necessary.

2. After the engine starts, make sure that the oil and charge warning lamps are off.
3. Warm up the engine until it runs smoothly, emitting normal exhaust gases.
4 During this warming up operation, or when the cooling water the cooling water temperature is still low, never attempt to race the engine.

During engine operation

1. During operation, always make sure that the cooling water temperature and lubricating oil pressure are both normal. Normal cooling water temperature is 75 to 85°C (167 to 185°F).

   Oil pressure is normal if the "OIL" warning lamp remains OFF during engine operation.
2. Always be aware of the condition of the engine, paying attention to any abnormal vibration, noise or other unusual circumstances. If any abnormality is found, immediately stop the operation, examine the cause, and make the necessary correction.

When stopping the engine

Upon completion of operation, idle the engine for some time to lower its temperature before stopping. This procedure will help to extend the engine life.

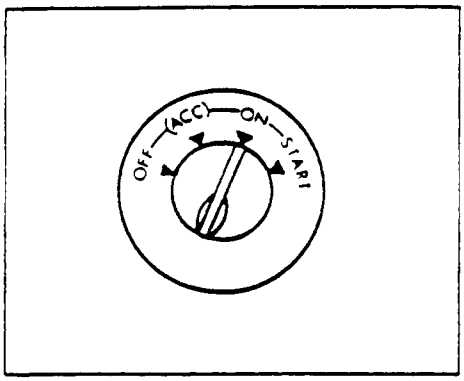
Note that stopping the engine immediately after heavily loaded operation will deteriorate the engine because it is still in a very hot state.

Others

Perform periodical inspection and replacement of the following items:

Engine oil, oil filter, air cleaner element, fuel filter element.

STARTING AND OPERATING



Starting

1 Pull out the choke control knob.

2. Turn the ignition key to the extreme right. Release the key as soon as the engine starts.

Do not turn the starting motor for more than 10 seconds at any time. It is not good for starter motor to run for long time.

3. Push in the choke control knob after the warming-up operation is over.
   Never race the engine during this warming-up period.

Stopping

To stop the engine, idle the engine, turn the ignition key to the "OFF" position, then the engine will stop.

Except in an emergency, be sure to turn the ignition key of only after the engine speed has returned to idle.

CAUTIONS DURING OPERATION

During engine operation, the warning light should remain OFF. If it comes ON, immediately stop operation, and take the actions that are described below.

If any other abnormalities such as unusual noise, vibration, or shocks are observed again stop the operation, and make the necessary inspection and repair

At completion of the day's operations

1. Make sure that there is no oil leak, water leak, or any other defects.
2. Clean the exterior of the engine so that any oil leak, water leak, fuel leak or other defect may be easily detected.
3. If antifreeze is not used in the cooling system in cold weather, be sure to discharge the cooling water to prevent damage to the engine and/or radiator due to freezing water
4 Repair any faulty parts detected during operation.

Other Handling and Operations

AGAINST COLD AND HOT WEATHER

In cold weather

● Oil

Use engine oil suitable for ambient temperature. (Refer to RECOMMENDED LUBRICANTS)

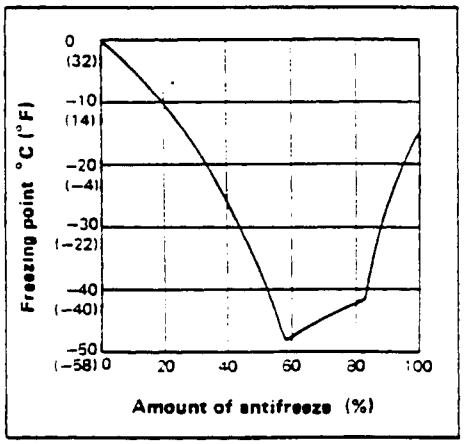
● Coolant

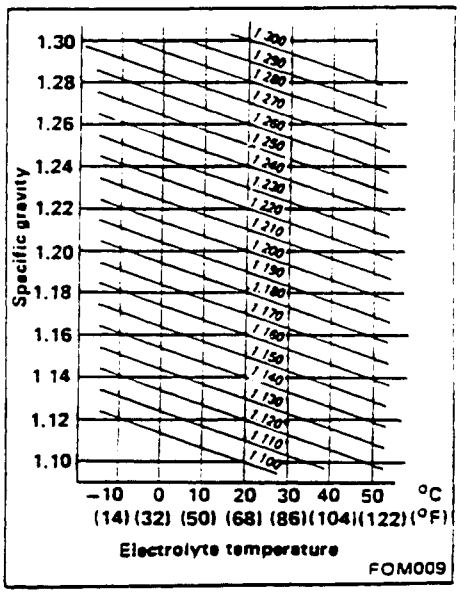
When coolant might freeze under low ambient temperature, drain out the coolant completely.

In such a cold weather, it is recommended to mix anti-freeze solution into cooling system because it make you free from draining coolant.

Coolant capacity (Engine proper):
2.7 ℓ (2-7/8 US qt, 2-3/8 Imp qt)

Coolant mixture ratio





● Battery

Battery should not be left in discharged state. When battery performance becomes questionable, check the specific gravity of the electrolyte, terminals of battery and alternator for looseness.

The normal specific gravity is 1.260 as corrected at 20°C (68°F) If changes about

0.0007 for every 1°C (1.8°F). If the specific gravity of electrolyte does not reach the desirable value, charge the battery soon.

In hot weather

- **Oil**

Engine oil should be changed to summer type oil. (Refer to RECOMMENDED LUBRICANTS)

- **Coolant**

Because the engine is more likely to overheat in hot weather, the engine should be placed in the shade. Overheating sometimes comes from defective hoses, connections, loosened radiator cap, or defective fan belt. So check carefully the cooling system to maintain the best cooling effect.

It is recommended to add antifreeze solution into the cooling system because it increases the coolant boiling point.

- **Battery**

Since the battery electrolyte evaporates much in hot weather, it is necessary to top up distilled water frequently.

WHEN USING THE ENGINE ONLY DURING A PARTICULAR PERIOD OF THE YEAR

When the engine is to be used only in a particular period of the year, such as summer or winter, the service life of the engine will be determined by how it is maintained during the out-of-use period. Follow the procedures below when preparing the engine.

During in-use period

Follow the normal handling procedures during this period. However, it will be necessary to shorten the oil replacement internal and other service intervals, because the engine will often be operated for a longer than normal period of time during a single day and the load applied will often be greater than usual.

During out-of-use period

During the out-of-use period, perform the following maintenance procedures for the engine. If it is impossible to perform these operations, refer to "Long Term Storage".

1 Perform loaded operation once a month

- Run the engine and perform checks set forth in item 1 above.
- Apply a load in excess of 50% of the rated load to the engine, and operate it for more than 10 minutes. Make sure that no abnormal noise or vibration is produced.

2. Perform the following inspection and adjustment before placing the engine in use period.

- Drain sediment from the fuel system (fuel filter and fuel tank)
- Change engine oil and oil filter element
- Check and adjust valve clearance.
- Check and adjust fan and governor belt tension.
- Check battery electrolyte level and specific gravity.
- Change air cleaner element.
- Check cooling water
- Check exhaust leakage

PROCEDURES FOR PLACING THE ENGINE IN LONG-TERM STORAGE

Before storing the engine for a long period of time (more than 3 months), perform the following procedures to prevent formation of rust. If the storage period is short, follow the maintenance procedures for the engine as described in the previous paragraph.

Lubricating system

Drain the engine oil, pour the specified amount of rust preventive oil into the oil pan, and then run the engine under no load at approximately 1,500 rpm for about 10 minutes. Stop the engine, and seal all the openings of the lubricating system with sealing tape.

For a greater rust preventing effect, perform this operation in combination with the rust preventing procedure for the fuel system and cooling system

Fuel system

Drain fuel from the fuel system, and pour the mixed fuel (the ratio of fuel to rust preventing oil should be 1 · 1) into the fuel tank. Operate the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, drain the mixed fuel, and then seal all of the openings in the fuel system (such as the breather of the fuel tank) with sealing tape.

Cooling system

Flush the cooling system, and pour antifreeze or an anti-rust agent into the cooling water. Run the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, and seal all of the openings in the cooling system (such as overflow pipe, etc.) with sealing tape. If antifreeze is used, keep the cooling water in the system. If an anti-rust agent is used, thoroughly drain the cooling water before sealing.

When using antifreeze, pay attention to the freezing point of coolant and choose a mixing ratio of at least 30%. a mixing ratio of less than 30% provides only a limited rust preventing effect. Note that the anti-rust agent will freeze when the temperature falls below 0°C (32°F). In such event, either thoroughly drain the cooling water or use antifreeze.

Combustion chamber

After completing the rust preventive procedure, allow the engine temperature to drop to room temperature. Then disconnect the air cleaner from the carburetor, and spray or pour rust preventing oil into the combustion chamber. Next, disconnect the high tension cable from the spark plugs, turn the ignition switch to the "START" position, and crank the engine five to ten times, and than install the high tension cables and air cleaner.

Engine exterior

Using a petroleum solvent, remove dirt and oil from the uncoated metal surfaces of the engine (intake manifold, exhaust manifold rocker cover, fan and governor belt grooves of pulleys, etc.) Spray or apply anti-rust agent to the cleaned surfaced. Do not apply any type mineral or vegetable oil to the fan and governor belt grooves of pulleys.

Others

1 Remove the fan and governor belt or keep it loosened.

2. Seal the air intake hole of the air cleaner and air outlet hole of the exhaust tube with adhesive tape.
3. Wrap the open type generator with a porous bag, and fasten the bag with a rubber band or similar item.

4 If the engine is equipped with a clutch, spray an evaporative anti-rust agent into the clutch housing, and seal the opening with adhesive tape.

5. When storing the engine as a complete assembly outdoors, cover it fully with a porous water-proof sheet.
   Do not use a vinyl sheet, because it lacks porosity and retains water inside.

Preparations for operation after long-term storage

1 Remove all adhesive sealing tapes from the openings of the engine.

2. Drain the rust preventing oil and anti-rust agent by using the following procedure, and replace it with the specified amount of engine oil, fuel and cooling water.

Lubricating system:
Drain oil through the drain plug of oil pan and oil filter.

Fuel system:
First operate the engine with the mixed fuel that is used in the rust preventing operation, and then drain the fuel.

Cooling system:
If antifreeze is used, drain cooling water from the drain valves on each of the radiator and cylinder block, and flush the cooling system.
If an anti-rust agent is used, flush the cooling system.

Exterior of engine:
Clean the exterior surfaces of the engine with a petroleum solvent (Trichlene).

3. Replace the elements of the oil filter, the air cleaner and the fuel filter with new ones.

4. Adjust the fan and governor belt for proper tension.

5. Check and adjust valve clearance. Apply engine oil to the rocker arm and other valve mechanism.

6. Check the battery electrolyte level and specific gravity. Refill and/or recharge if it is necessary.

7. Before the engine starts, disconnect the high tension cables from the spark plugs.

8. Set the ignition switch at the "START" position, and crank the engine for about 10 seconds. Repeat this cranking operation two or three times in order to disperse engine oil to every portion of the engine, and then install the high tension cable.

9. Start the engine, and let it idle for about 5 minutes.

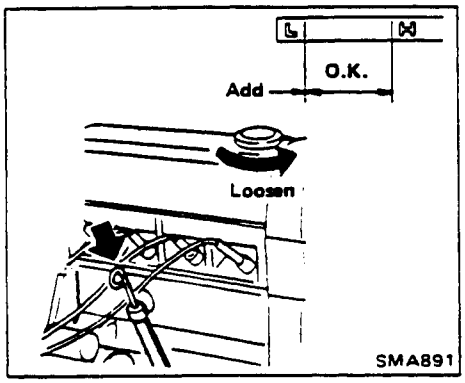
10. Gradually increase the engine speed to the rated rpm, and run the engine for about 10 minutes under no load. Make sure that the charge warning lamp and oil warning lamp are off and cooling water temperature are normal, and that the engine does not produced any abnormal vibration or noise.

Daily Care

In order to prevent trouble in daily operation, it is necessary that the operator be constantly aware of the condition of the engine. To achieve this awareness, the operator must personally inspect the engine before starting the day's activities.

If you note any defects, notify your authorized NISSAN dealer

CHECK ENGINE OIL LEVEL



To check the oil level, pull out the level gauge, wipe it clean and reinsert it; remove it again to read the oil level The level should be between the "L" and "H" marks.

CHECK COOLING WATER LEVEL

Remove the radiator cap, and check the cooling water level. Also check the cap and determine if it functions correctly. The cooling water level is correct if it is near to the filler neck of radiator. Insufficient water level may be caused by leakage from the engine or radiator. Check carefully for any sign of leakage; if no leaks are discovered, add water to the filler neck portion.

If cooling water is dirty, flush the cooling system.

When replacing the radiator cap, be sure to fit it securely. If replaced loosely or improperly, the cooling water will quickly evaporate, causing the engine to overheat.

CHECKING THE ENGINE FOR LEAKAGE

1 Insure that the engine, radiator and hoses are not leaking.
2. Check each portion of the engine, and make sure that there is no sign of an oil leak.
3. Check the fuel system to make sure that there is no sign of fuel leaking from the fuel pipe and hose.

CHECKING THE ENGINE OPERATION DURING BOTH IDLING AND ACCELERATION

Make sure that the engine runs normally at idling speed, and that engine rpm increases smoothly as it is accelerated.

OTHERS

Correct all of the faults and problems that were observed during the previous day's operation.

If any faults are discovered during the daily inspection, contact an authorized NISSAN dealer for additional inspection, adjustment or repair. Always maintain the engine in its top condition.

PERIODIC MAINTENANCE AND LUBRICANT SCHEDULE

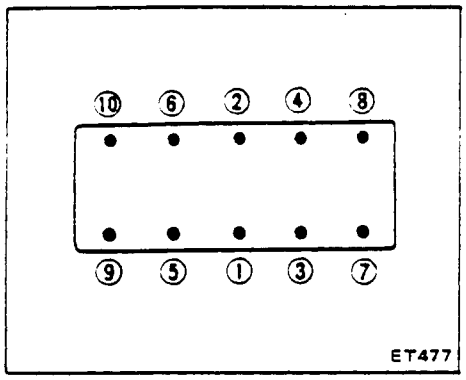
The following table lists the servicing required to keep your engine operating in top mechanical condition, and should be attended to as indicated, preferably by an authorized NISSAN dealer.

MAINTENANCE OPERATION			MAINTENANCE INTERVAL											
Periodic maintenance should be performed after specified intervals have elapsed in month or hours, whichever comes first.	Months		1	2	3	4	5	6	7	8	9	10	11	12
	Hundreds of hours		2	4	6	8	10	12	14	16	18	20	22	24
Retighten cylinder head bolts, manifolds & exhaust tube nuts & carburetor attaching nuts			X											
Adjust intake & exhaust valve clearance			X		X			X			X			X
Check drive belts for cracks, fraying, wear and tension			X	X	X	X	X	X	X	X	X	X	X	X
Change engine oil		(1)	X	X	X	X	X	X	X	X	X	X	X	X
Replace engine oil filter		(1)	X		X			X			X			X
Change engine anti-freeze coolant (L.L.C., Ethylene glycol base)														X
Change engine coolant (Soft water)														X
Clean radiator outside		(2)												
Check cooling system hoses & connections		(2)												
Clean or replace fuel strainer element		(2)												
Check or replace fuel strainer		(2)												
Check fuel lines (Hoses, piping, connections, etc.)		(2)												
Clean & replace air cleaner element (Dry paper type)	(1)	Clean	X	X	X	X	X		X	X	X	X	X	
		Replace						X						X
Check crankcase ventilation hose														X
Check & replace spark plugs		Check	X	X	X	X	X	X	X	X	X	X	X	
		Replace												X
Check distributor point, cap and rotor			X	X	X	X	X	X	X	X	X	X	X	X
Check ignition wiring														X
Adjust ignition timing			X	X	X	X	X	X	X	X	X	X	X	X
Adjust engine idle rpm			X	X	X	X	X	X	X	X	X	X	X	X
Check battery specific gravity								X						X

Notes: **(1) Under dusty or other dirty operating conditions, more frequent maintenance should be necessary.**
(2) Follow the original equipment manufacturer's (O.E.M.) instructions.

Check: Check, correct and replace if necessary.

MAINTENANCE OPERATION



Retightening cylinder head

1 Warm up engine sufficiently.

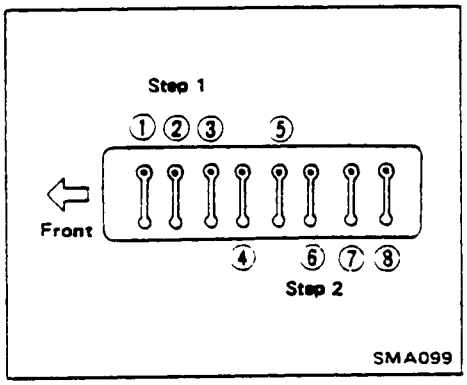
2. Tightening should be made in the sequence shown.

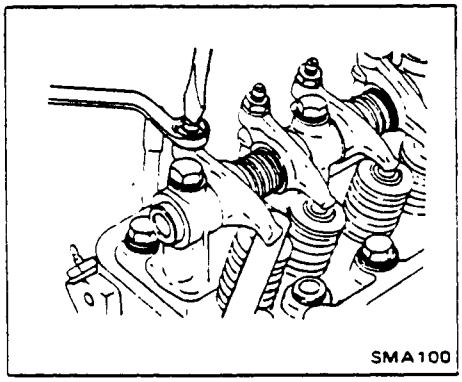
Ⓣ : **69 to 74 N•m (7.0 to 7.5 kg-m, 51 to 54 ft-lb)**

Retightening manifold, carburetor and exhaust tube

Intake and exhaust manifold bolts and nuts. and carburetor nuts should be retightened to prevent air and/or exhaust gas leakage

Ⓣ : **Manifold nut and bolt**
9 to 14 N•m (0.9 to 1.4 kg-m, 6.5 to 10.1 ft-lb)
Carburetor nut
5 to 7 N•m (0.5 to 0.7 kg-m, 3.6 to 5.1 ft-lb)
Exhaust tube nut
20 to 25 N•m (2.0 to 2.6 kg-m, 14 to 19 ft-lb)





Adjusting intake and exhaust valve clearance

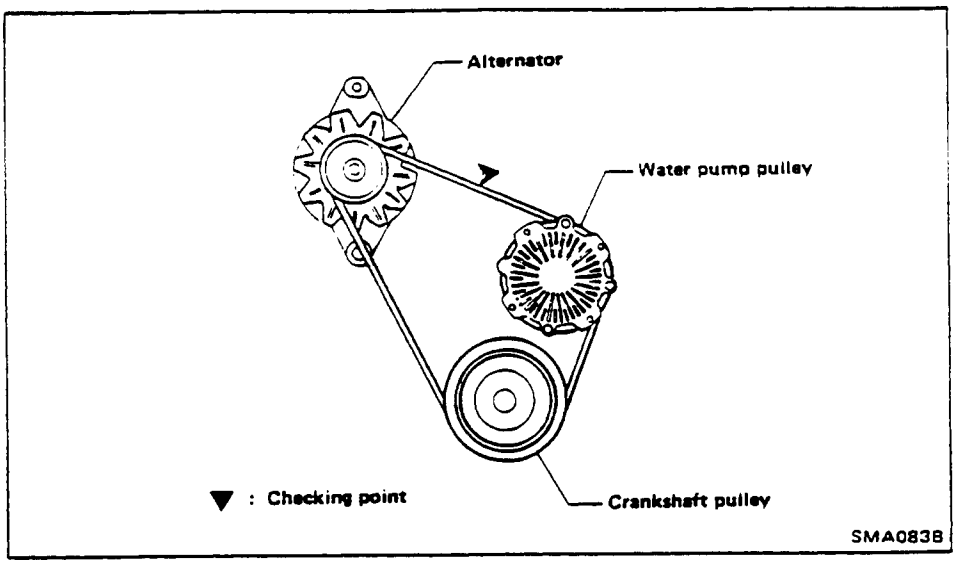
Adjustment should be made while engine is warm but not running.

1. Start engine and warm it up sufficiently. Then turn off engine.
2. Remove valve rocker cover.
3. Rotate crankshaft.

(1) Set No. 1 cylinder in top dead center on its compression stroke. and adjust valve clearances ①, ②, ③ and ⑤.

(2) Set No. 4 cylinder in top dead center on its compression stroke and adjust valve clearances ④, ⑥, ⑦ and ⑧.

Valve clearance (Hot):
Intake & exhaust:
0.35 mm (0.014 in)



Checking and adjusting drive belts

1. Visually inspect for cracks, fraying, wear or oiliness.

The belts should not touch the bottom of the pulley groove.

2. Check belt tension by pushing midway between pulleys.

Drive belt deflection:
8 to 12 mm (0.31 to 0.47 in)
Pushing force:
98 N (10 kg, 22 lb)

Changing engine oil and oil filter

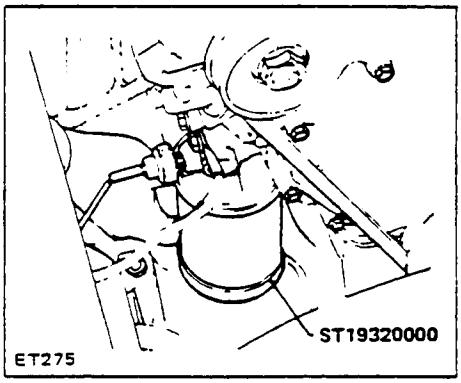
1. Start engine and warm up engine sufficiently, then stop engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

WARNING:
Be careful not to burn yourself, as the engine oil may be hot.

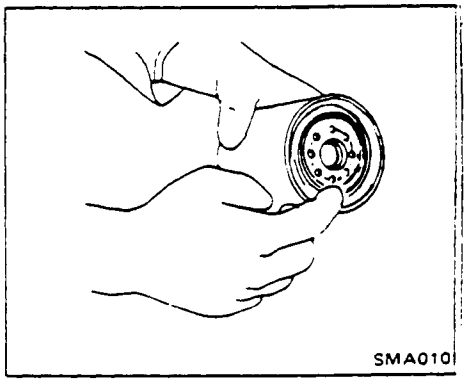
- **A milky oil indicates the presence of cooling water. Isolate the cause and take corrective measure.**
- **An oil with extremely low viscosity indicates dilution with fuel.**

3. Clean and install oil pan drain plug with washer.

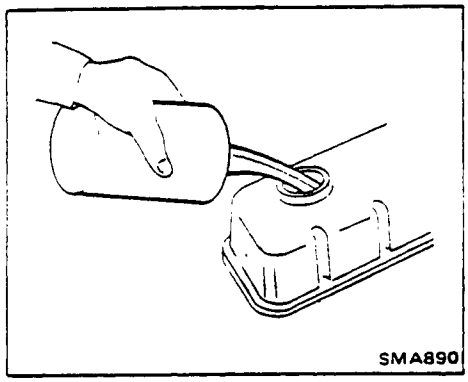
Ⓣ : **Oil pan drain plug**
20 to 29 N·m
(2.0 to 3.0 kg-m, 14 to 22 ft-lb)

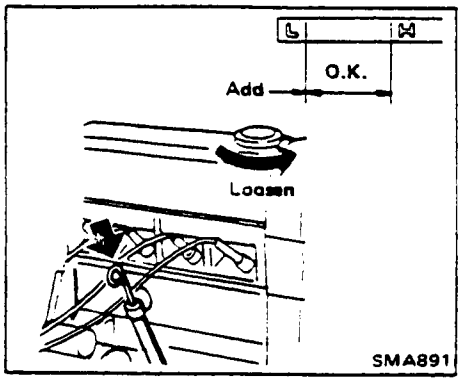


4 Using Tool, remove oil filter.
5. Wipe oil filter mounting surface with a clean rag.



6. Smear a little engine oil on rubber gasket of new oil filter
7 Install new oil filter. Handtighten ONLY DO NOT use a wrench to tighten the filter


SMA890



SMA891

8. Refill engine with new recommended engine oil, referring to Recommended Lubricants.

Check oil level with dipstick.

Oil capacity:

	Unit: liter (US qt, Imp qt)
With oil filter	3.2 (3-3/8, 2-7/8)
Without oil filter	2.7 (2-7/8, 2-3/8)

9. Start engine. Check area around drain plug and oil filter for any sign of oil leakage.

If any leakage is evident, these parts have not been properly installed.

10. Warm up engine sufficiently. Then stop engine and wait a few minutes. Check oil level. If necessary, add engine oil.

When checking oil level, set engine at level.

Changing engine coolant

WARNING:

To avoid the danger of being scalded, never attempt to change the coolant when the engine is hot.

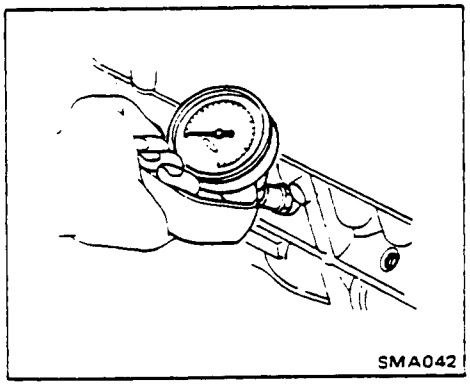
When using antifreeze coolant, mix the antifreeze coolant with water, observing instructions attached to antifreeze container

Cleaning radiator outside

Clean outside of radiator with dry compressed air

Checking cooling system, hoses and connections

Check hoses and fittings for loose connections or deterioration. Retighten or replace if necessary.


SMA042

Checking engine compression pressure

1. Warm up engine sufficiently, then stop engine.
2. Remove all spark plugs.
3. Properly attach a compression tester to spark plug hole in cylinder being tested.
4. Set carburetor throttle valve at fully-open position.
5. Crank engine and read gauge indication.

- Engine compression measurement should be made as quickly as possible.

Compression pressure:

Standard
1,245 kPa (12.45 bar, 12.7 kg/cm², 181 psi)/350 rpm

Minimum
981 kPa (9.81 bar, 10.0 kg/cm², 142 psi)/350 rpm

6. Cylinder compression in cylinders should not be less than 80% of the highest reading.

If cylinder compression in one of more cylinders is low, pour a small quantity of engine oil into cylinders through the spark plug holes and retest compression.

- If adding oil helps the compression pressure, chances are that piston rings are worn or damaged.
- If pressure stays low, valve may be sticking or seating improperly.
- If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression, there is leakage past the gasketed surface.

Oil and water in combustion chambers can result from this problem.

Cleaning or replacing fuel strainer element

The fuel strainer or fuel strainer element should be checked, cleaned or replaced periodically.

Refer to Periodic Maintenance Recommended by Original Equipment Manufacturers (O.E.M.)

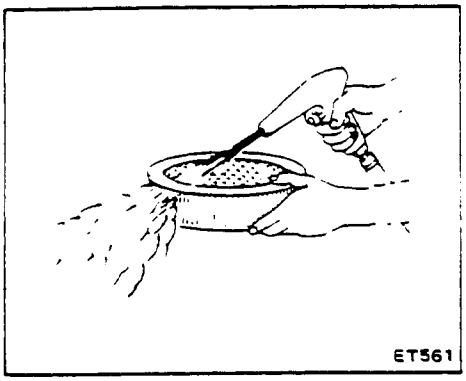
Checking fuel lines (Hoses, piping, connections, etc.)

Check fuel lines for proper attachment, leaks, cracks, damage, loose connections, chaffing and deterioration. If necessary, replace any damaged or defective parts.

Adjusting choke mechanism (Choke valve and linkage)

1. Check choke valve and mechanism for free operation, and clean or replace if necessary. Binding can result from petroleum gum formation on choke shaft or from damage.
2. Check for smooth operation of choke control wire. Ascertain that choke valve is fully opened when choke control knob is depressed fully

Adjust stroke if necessary.

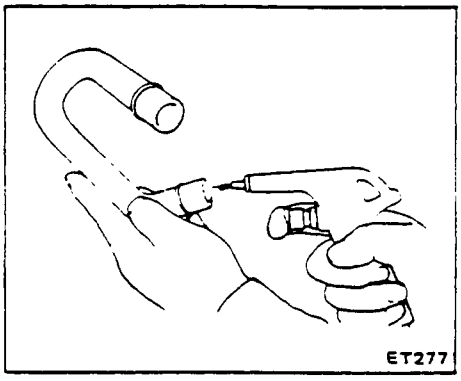


Cleaning and replacing air cleaner element (Dry paper type)

1. Remove air cleaner cover and filter element.
2. Blow dust off inner side of element with dry compressed air.
3. Wipe inside of air cleaner housing and cover with damp cloth.

Be careful not to drop into carburetor.

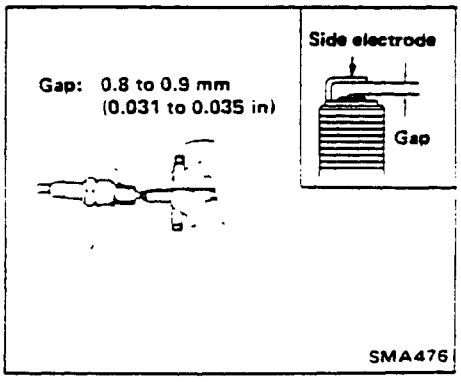
4 Install element and air cleaner cover



Checking crankcase ventilation hose

1. Check hoses and hose connections for leaks.
2. Check each hose for cracks or distortion.
3. Disconnect all hoses and blow them out with dry compressed air.

If any hose cannot be made free of obstructions, replace with a new one.



Checking and replacing spark plugs

1. Disconnect the high tension cables from the spark plugs.

Do not pull on the cable.

2. Remove spark plugs with spark plug wrench
3. Clean plugs in sand blast cleaner.
4 Inspect insulator for cracks or chips, gasket for damage or deterioration and electrode for wear or burning. If they are excessively worn, replace with new ones.
5. Check spark plug gap.

Spark plug type:
B4ES

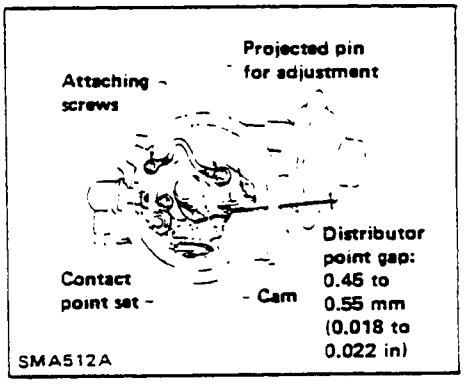
Gap:
0.8 to 0.9 mm
(0.031 to 0.035 in)
Ⓣ: **15 to 20 N·m**
(1.5 to 2.0 kg-m, 11 to 14 ft-lb)

Checking distributor point cap and rotor

Visual check

1 Inspect point, cap and rotor for excessive burning or pitting.
2. Use a point file to clean contact area and remove scale from point.

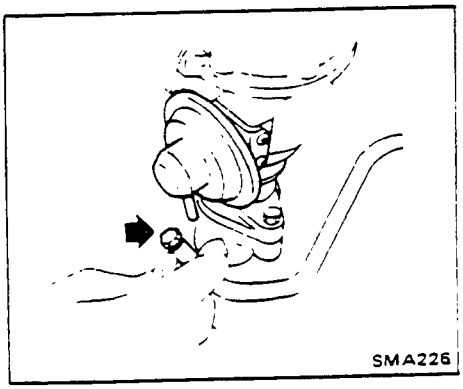
Do not attempt to remove all roughness.



Checking point gap

Set contact point on the nose of cam, and check point gap with oilless thickness gauge.

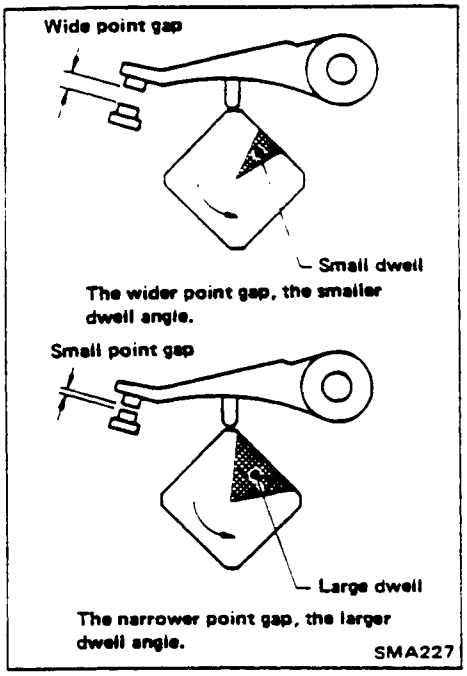
If the gap is out of specification, loosen contact point plate attaching screws and adjust point gap by pivoting projected pin.



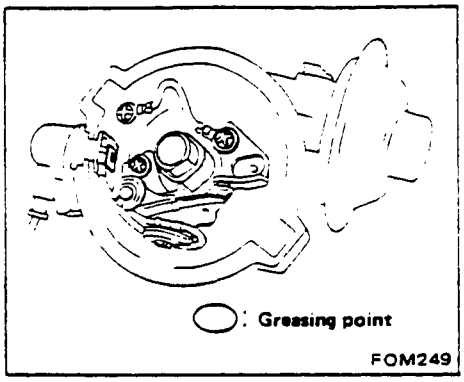
Checking dwell angle

1 Start engine and warm it up.
2. Disconnect distributor vacuum hose from distributor vacuum controller, and plug the hose with proper plug.
3. Run engine at idle speed and measure dwell angle with a dwell meter.

Dwell angle:
49° to 55°

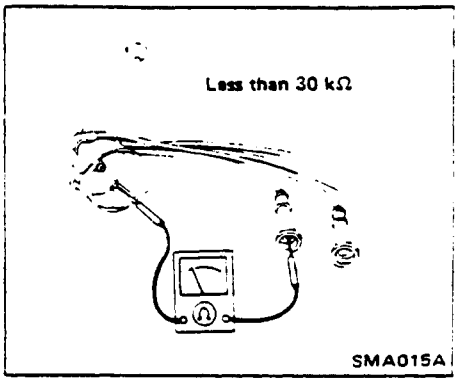


4. If dwell angle is not within the specified value turn off engine and adjust point gap.
5. If dwell angle is not within the specified value when point gap is correct, cam lobe is worn Replace cam.



Greasing distributor cam and cam heel

When checking distributor point, clean and apply the specified grease to cam and cam heel.



Checking ignition high tension cable

1. Visually check the cable for cracks, and damaged and burned terminals.
2. Using an ohmmeter, measure the resistance between cable terminal on the spark plug side and corresponding electrode inside cap.

Shake the cable while measuring resistance to check for intermittent brakes.

Checking and adjusting ignition timing, idle-rpm and mixture ratio

CAUTION:

a. Idle mixture ratio is adjusted at factory and requires no further adjustment. If it becomes necessary to adjust it, proceed with the following steps.

b. Do not attempt to screw the idle adjusting screw down completely. Doing so could cause damage to screw tip, which in turn will tend to cause malfunctions.

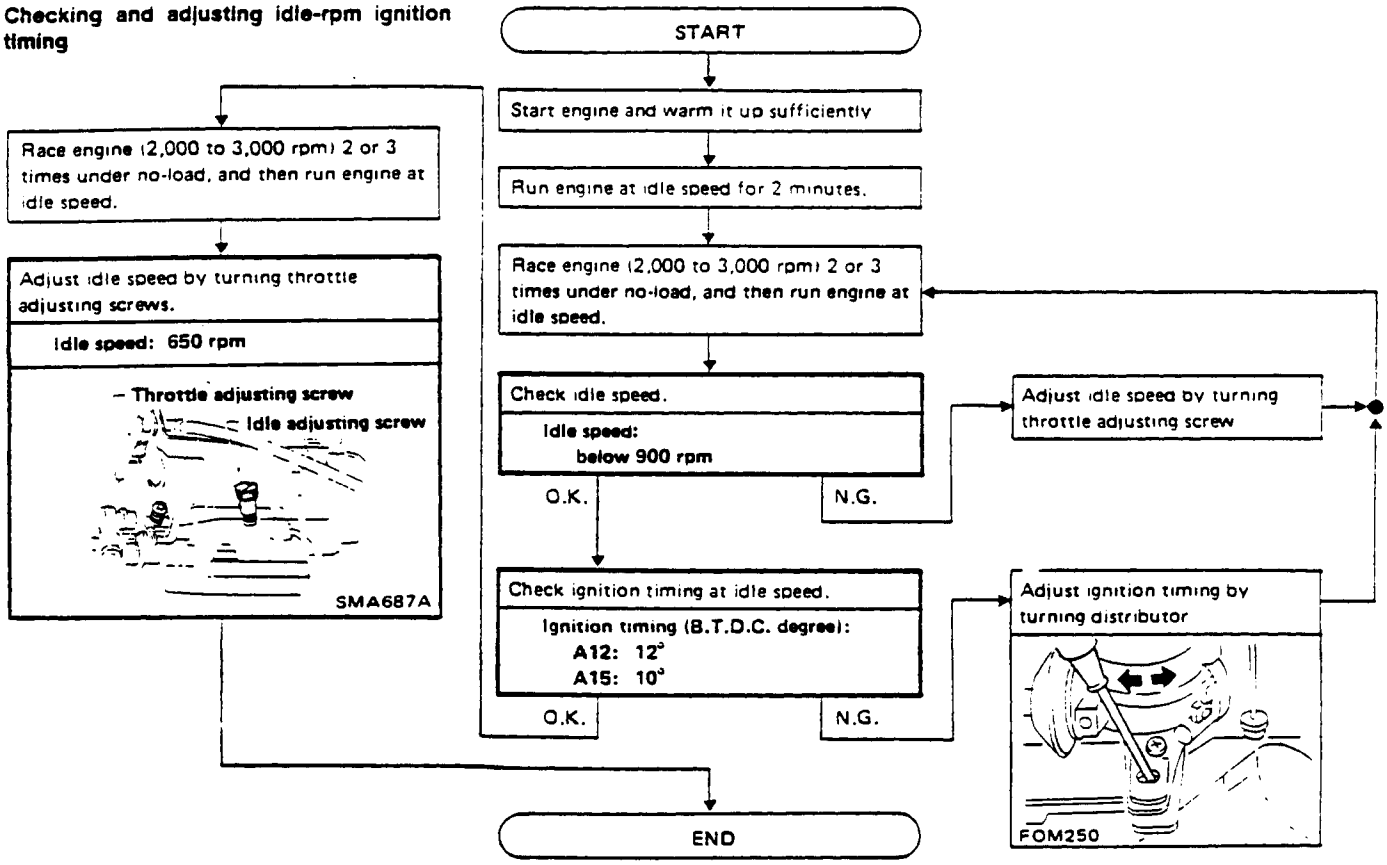
Preparation

1. Make sure that the following parts are in good order.

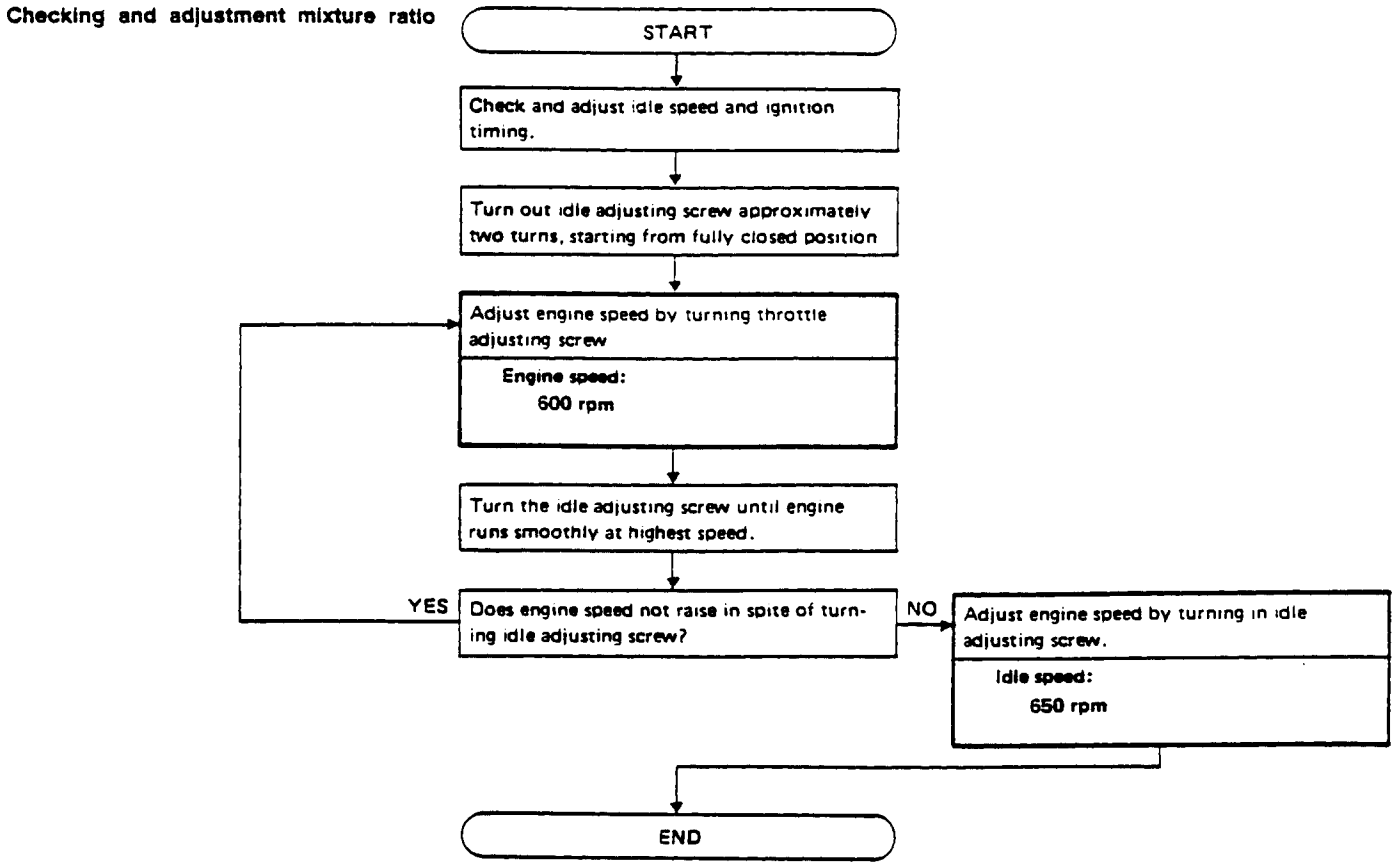
- **Ignition system**
- **Engine oil and coolant levels**
- **Valve clearance**
- **Float level at idling speed**

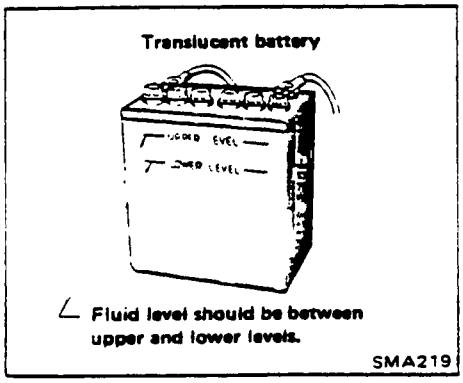
2. Set shift lever in "Neutral" position.

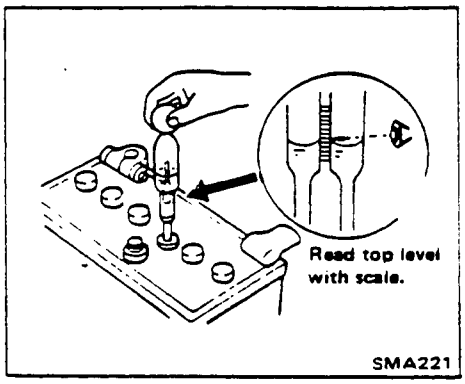
Checking and adjusting idle-rpm ignition timing



Checking and adjustment mixture ratio







Checking electrolyte level

Check the fluid level in each filler. If necessary, add only distilled water.

Do not overfill.

Checking electrolyte gravity

1. Place the hydrometer in the cell.
   Be sure the float is not in contact with the cylinder wall.
2. Take in enough electrolyte into the hydrometer to allow the float to suspend freely between the top and bottom of the cylinder
3. Read indication.

	Permissible value	Fully charged value (at 20°C (68°F))
Other climates	Over 1.20	1.26
Frigid climate	Over 1.22	1.28
Tropical climate	Over 1.18	1.24

Trouble Diagnosis and Corrections

Condition	Probable cause	Corrective action
CANNOT CRANK ENGINE OR SLOW CRANKING	Improper grade oil.	Replace with proper grade oil.
	Partially discharged battery.	Charge battery.
	Malfunctioning battery.	Replace.
	Loose alternator belt.	Adjust.
	Trouble in charging system.	Inspect.
	Wiring connection trouble in starting circuit.	Correct.
	Malfunctioning ignition switch.	Repair or replace.
	Malfunctioning starting motor.	Repair or replace.

ENGINE WILL CRANK NORMALLY BUT WILL NOT START

In this case, the following trouble causes may exist, but in many cases ignition system or fuel system is in trouble.

Ignition system in trouble
Fuel system in trouble
Valve mechanism does not work properly
Low compression

(Trouble-shooting procedure)
Check spark plug firstly by following procedure.
Disconnect high tension cable from one spark plug and hold it about 10 mm (0.39 in) from the engine metal part and crank the engine.

Condition	Probable cause	Corrective action
	Good spark occurs. a. Check spark plug. b. Check ignition timing. c. Check fuel system. d. Check cylinder compression.	
	No spark occurs. Very high current.	Check the current flow in primary circuit. Inspect primary circuit for short. Check breaker point operation.
	Low or no current.	Check for loose terminal or disconnection in primary circuit.
Ignition system out of order	Burned distributor point.	Repair or replace.
	Improper point gap.	Adjust.
	Faulty condenser.	Replace.
	Leak at rotor cap and rotor.	Clean or replace.
	Faulty spark plug.	Clean, adjust plug gap or replace.
	Improper ignition timing.	Adjust.
	Faulty ignition coil.	Replace.

Condition	Probable cause	Corrective action
Ignition system out of order	Disconnection of high tension cable.	Replace.
	Loose connection or disconnection in primary circuit.	Repair or replace.
Fuel system out of order	Lack of fuel	Supply.
	Dirty fuel filter.	Replace.
	Dirty or clogged fuel pipe.	Clean.
	Fuel pump will not work properly.	Repair or replace.
	Carburetor choke will not work properly.	Check and adjust.
	Improper adjustment of float level.	Correct.
	Improper idling.	Adjust.
	Dirty or clogged carburetor.	Disassemble and clean.
	Clogged breather pipe of fuel tank.	Repair and clean.
Low compression	Incorrect spark plug tightening or faulty gasket.	Tighten to normal torque or replace gasket.
	Improper grade engine oil or low viscosity.	Replace with proper grade oil.
	Incorrect valve clearance.	Adjust.
	Compression leak from valve seat.	Remove cylinder head and lap valves.
	Sticky valve stem.	Correct or replace valve and valve guide.

Condition	Probable cause	Corrective action
Low compression	Weak or damaged valve springs.	Replace.
	Compression leak at cylinder head gasket.	Replace gasket.
	Sticking damaged piston ring.	Replace piston rings.
	Worn piston ring or cylinder.	Overhaul engine.

(Trouble-shooting procedure)
Inject a small quantity of engine oil in spark plug hole, and then measure cylinder compression.

Compression increases.	Malfunctioning cylinder or piston ring.
Compression does not change.	Compression leaks from valve, cylinder head or head gasket.

Condition	Probable cause	Corrective action
IMPROPER ENGINE IDLING (Low engine idle speed)	Clogged or damaged carburetor jets.	Clean or replace.
	Incorrect idle adjustment.	Adjust.
	Clogged air cleaner filter.	Clean or replace filter.
Fuel system out of order	Damaged manifold gaskets or carburetor insulator.	Replace gasket or insulator.
	Improper float level adjustment.	Adjust.
	Loose or cracked vacuum hoses or air hoses from carburetor and intake manifold.	Check for loose connections or cracks.
	Malfunctioning carburetor choke.	Check and adjust.
Low compression		Previously mentioned.

Condition	Probable cause	Corrective action
Others	Incorrect valve clearance.	Adjust.
	Extremely low revolution.	Adjust.
	Malfunction of the ignition system (spark plug, high tension cable, ignition coil, etc.)	Replace.
	Incorrect basic ignition timing.	Adjust.
	Faulty P.C.V. valve.	Replace.
	Malfunction of choke valve or linkage.	Adjust.
	Incorrect idle adjustment.	Adjust idle speed.
	Clogged air cleaner filter.	Replace air cleaner filter.
	Loose manifold and cylinder head bolts.	Retighten bolts.
IMPROPER ENGINE IDLING (High engine idle speed)	Binding accelerator linkage.	Check and correct accelerator linkage.
	Incorrect idle adjustment.	Adjust.
	Malfunctioning carburetor choke.	Check and adjust.
	Malfunction of governor.	Adjust governor or replace it, if necessary.

Condition	Probable cause	Corrective action
ENGINE POWER NOT UP TO NORMAL		
Low compression		Previousiy mentioned.
Ignition system out of order	Incorrect ignition timing.	Adjust.
	Damaged spark plugs.	Clean, adjust or replace plugs.
	Worn distributor points.	Dress, or replace points. Also check condenser.
	Damaged spark plugs.	Clean, adjust ore replace plugs.
Fuel system out of order	Malfunction of choke system.	Adjust.
	Clogged fuel pipe or needle valve.	Clean.
	Dirty or clogged fuel filter.	Replace.
	Fuel pump will not work properly.	Repair or replace.
	Clogged carburetor jets.	Disassemble and clean.
	Throttle valve does not open fully.	Readjust.
Air intake system out of order	Clogged air cleaner.	Clean or replace filter.
	Air inhaling from manifold gasket or carburetor gasket.	Replace gasket.
	Faulty P.C.V. valve.	Replace.

Condition	Probable cause	Corrective action
Overheating	Insufficient coolant.	Replenish.
	Loose fan belt.	Adjust fan belt.
	Worn or oiled fan belt.	Replace.
	Inoperative thermostat.	Replace.
	Worn water pump.	Replace.
	Clogged or leaky radiator.	Flush, repair or replace.
	Faulty radiator filler cap.	Replace.
	Air in cooling system.	Retighten each part of cooling system.
	Improper engine oil grade.	Replace with proper grade oil.
	Incorrect ignition timing.	Adjust.
	Clogged carburetor (lean mixture).	Overhaul carburetor.
Overcooling	Inoperative thermostat.	Replace.
Others	Improper governor adjustment.	Adjust governor to the specified conditions.

Condition	Probable cause	Corrective action
NOISY ENGINE		
Engine knocking	Overloaded engine.	Use right gear in driving.
	Carbon knocking.	Disassemble cylinder head and remove carbon.
	Timing knocking.	Adjust ignition timing.
	Fuel knocking.	Use specified octane fuel.
	Preignition (misusing of spark plug).	Use specified spark plug.
Mechanical knocking		
Crankshaft bearing knocking	This strong dull noise increases when engine is accelerated. To locate the place, cause a misfire in each cylinder. If the noise stops by the misfire, this cylinder generates the noise.	This caused by worn or damaged bearings, or unevenly worn crankshaft. Renew bearings and adjust or change crankshaft. Check lubrication system.
Connecting rod bearing knocking	This is a little higher-pitched noise than the crankshaft knocking, and also increases when engine is accelerated. Cause a misfire in each cylinder and if the noise diminishes almost completely, this crankshaft bearing generates the noise.	Same as the case of crankshaft bearings.

Condition	Probable cause	Corrective action
Mechanical knocking		
Piston cylinder noise	When you hear an overlapping metallic noise which increases its magnitude with the revolution of engine and which decreases as engine is warmed up, this noise is caused by piston and cylinder. To locate the place, cause a misfire in each cylinder.	This may cause an abnormal wearing of cylinder and lower compression which in turn will cause a lower out-put power and excessive consumption of oil. Overhaul engine.
Piston pin noise	This noise is heard at each highest and lowest dead end of piston. To locate the place, cause a misfire in each cylinder.	This may cause a wear on piston pin, or piston pin hole. Renew piston and piston pin assembly.
Water pump noise	This noise may be caused by worn or damaged bearings, or by the uneven surface of sliding parts.	Replace water pump with a new one.
Others	An improper adjustment of valve clearance.	Adjust.
	Noise of timing chain.	Adjust the tension of chain.
	An excessive end-play on crankshaft.	Disassemble engine and renew main bearing.

Condition	Probable cause	Corrective action
ABNORMAL COMBUSTION (Backfire, afterfire, run-on, etc.)		
Improper ignition timing	Improper ignition timing.	Adjust.
	Improper heat range of spark plugs.	Use specified spark plugs.
Fuel system out of order	Improper idle adjustment.	Adjust.
	Damaged carburetor or manifold gasket (backfire, afterfire).	Replace them with new parts.
	Clogged carburetor jet.	Disassemble carburetor and check it.
	Improper function of the float.	Adjust the level, and check needle valve.
Faulty cylinder head, etc.	Improperly adjusted valve clearance.	Adjust.
	Excess carbon in combustion chamber.	Remove head and get rid of carbon.
	Damaged valve spring (backfire, afterfire).	Replace it with a new one.

Condition	Probable cause	Corrective action
EXCESSIVE OIL CONSUMPTION		
Oil leakage	Loose oil drain plug.	Tighten it.
	Loose or damaged oil pan gasket.	Renew gasket or tighten it.
	Loose or damaged chain cover gasket.	Renew gasket or tighten it.
	Worn oil seal in front and rear of crankshaft.	Renew oil seal.
	Loose or damaged rocker cover gasket.	Renew gasket or tighten it (but not too much).
	Improper tightening of oil filter.	Renew gasket and tighten it with the proper torque.
	Loose or damaged oil pressure switch.	Renew oil pressure switch or tighten it.
Excessive oil consumption	Cylinder and piston wear.	Overhaul cylinder and renew piston.
	Improper location of piston ring gap or reversely assembled piston ring.	Remount piston rings.
	Damaged piston rings.	Renew rings. Repair or renew piston and cylinder.
	Worn piston ring groove and ring.	Renew piston and piston ring.
	Fatigue of valve oil seal lip.	Replace seal lip with a new one.
	Worn valve stem.	Renew valve or guide.

Condition	Probable cause	Corrective action
Others	Inadequate quality of engine oil.	Use the designated oil.
	Engine overheat.	Previously mentioned.
	Malfunction of P.C.V. system.	Check or replace.
POOR FUEL ECONOMY		
See the explanation of the power decrease		
Others	Improper idle adjustment (Idle speed, ignition timing, mixture ratio).	Adjust it to the designated rpm.
	Fuel leakage.	Repair or tighten the connection of fuel pipes.
	Improper governor adjustment.	Adjust it to the designated rpm.
TROUBLE IN OTHER FUNCTIONS		
Decreased oil pressure	Improper grade oil.	Replace with proper grade oil.
	Overheat.	Previously mentioned.
	Malfunctioning oil pump regulator valve.	Disassemble oil pump and repair or replace it.

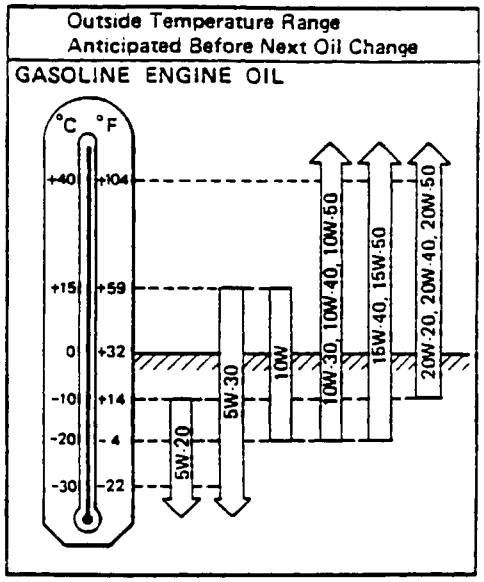
Condition	Probable cause	Corrective action
Decreased oil pressure	Functional deterioration of oil pump.	Repair or replace it with a new one.
	Blocked oil filter.	Replace with a new one.
	Increased clearance in various sliding parts.	Disassemble and replace the worn parts with new ones.
	Blocked oil strainer.	Clean it.
	Malfunctioning oil gauge pressure switch.	Replace it with a new one.
Excessive wear on the sliding parts	Oil pressure decreases.	Previously mentioned.
	Damaged quality or contamination of oil.	Exchange the oil with proper one and change oil filter.
	Clogged air cleaner filter.	Clean or replace filter
	Overheat or overcool.	Previously mentioned.
	Improper fuel mixture.	Check the fuel system.
Scuffing of sliding parts	Decrease of oil pressure.	Previously mentioned.
	Insufficient clearances.	Adjust to the sufficient clearances.
	Overheat.	Previously mentioned.
	Improper fuel mixture.	Check the fuel system.
	Improper ignition timing.	Adjust.

Recommended Lubricant

LUBRICANT

Lubricant	Specifications	Remarks
Gasoline engine oil	API SD or SE	For further details, refer to the recommended SAE viscosity chart.
Antifreeze	–	Ethylene glycol base

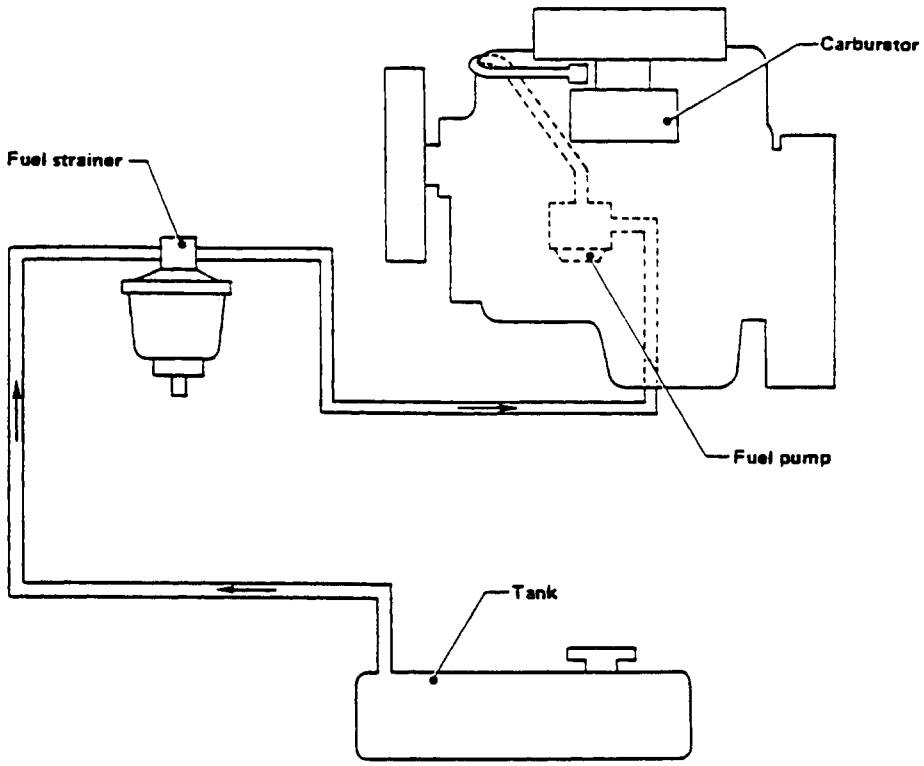
SAE VISCOSITY NUMBER



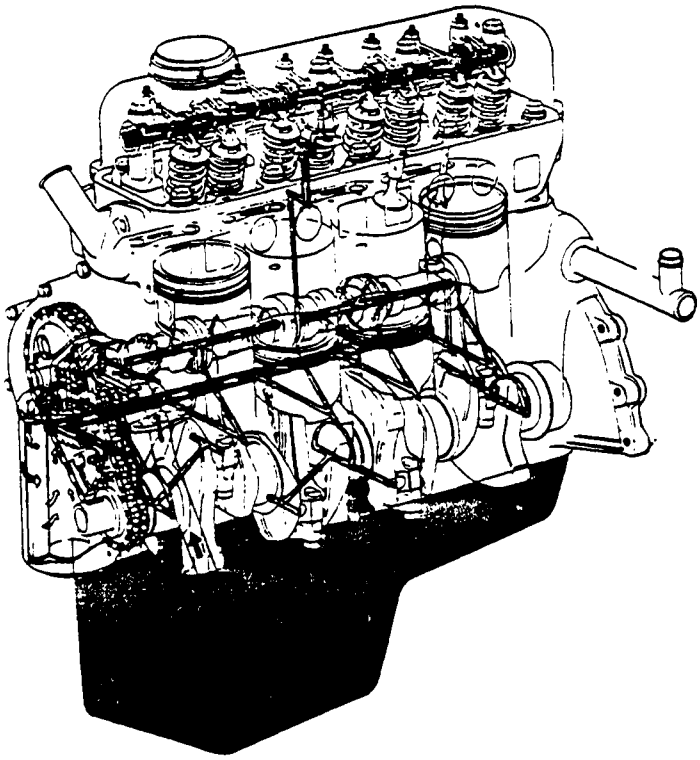
TI0005

System Diagram

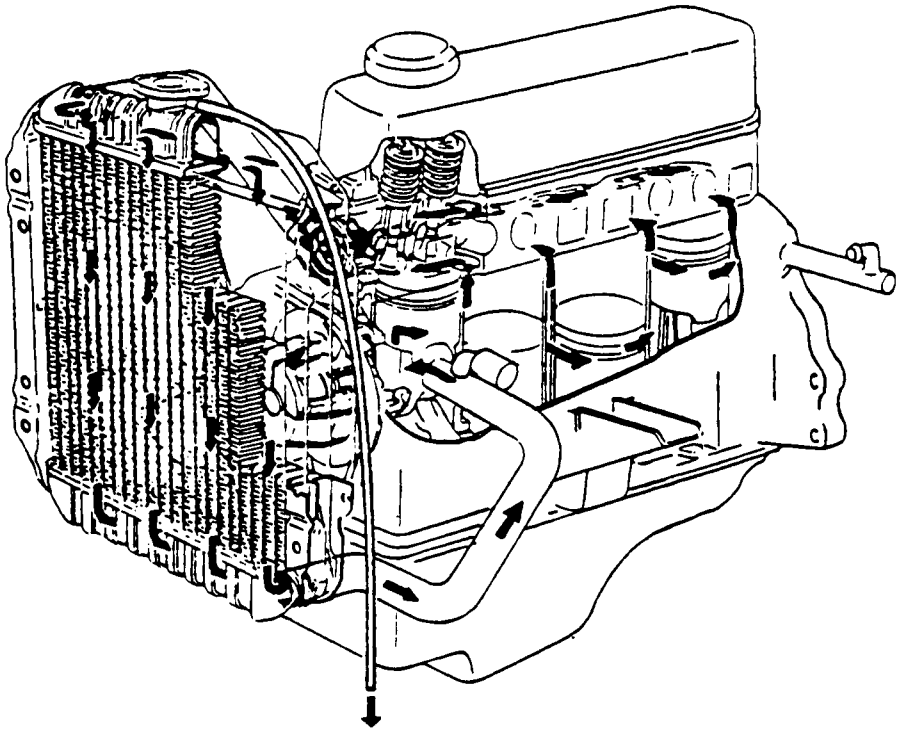
FUEL SYSTEM DIAGRAM



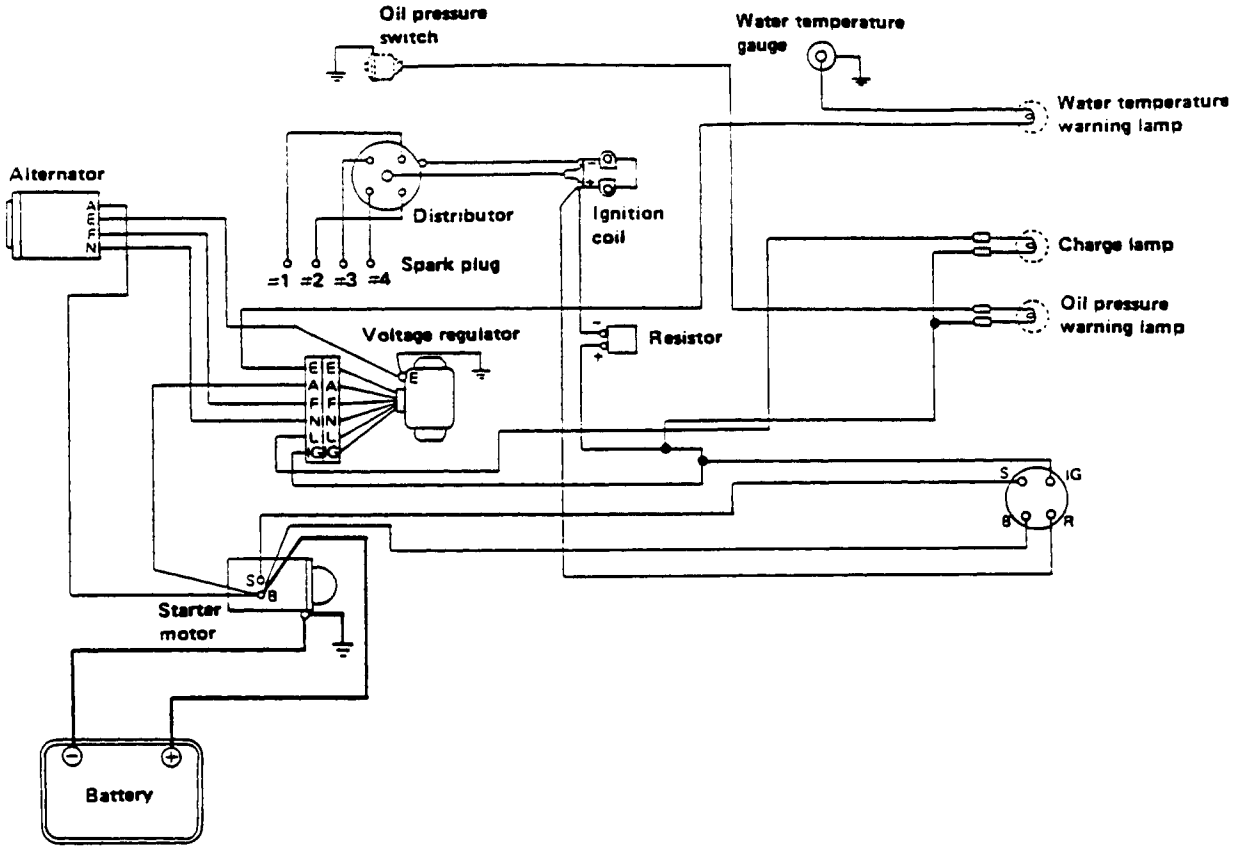
LUBRICATION SYSTEM DIAGRAM



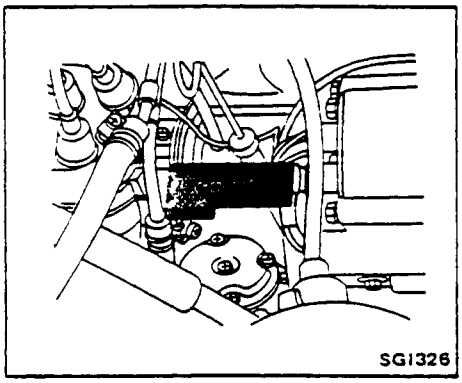
COOLING SYSTEM DIAGRAM



ELECTRICAL SYSTEM DIAGRAM



Engine Serial Number



The engine serial number is stamped on the right side of cylinder block.

A12-xxxxxx x

A15-xxxxxx x

- Serial No.
- Engine model

Specifications

ENGINE GENERAL

Item \ Engine model	A12	A15
Engine general specifications Classification	Gasoline	
Cycle	4	
No. of cylinders and arrangement	4, in-line	
Valve arrangement	O.H.V. (Overhead valve)	
Bore x stroke mm (in)	73 x 70 (2.87 x 2.76)	76 x 82 (2.99 x 3.23)
Displacement cm^3 (cu in)	1,171 (71.45)	1,488 (90.80)
Compression ratio	9.0	
Number of piston rings Compression	2	
Oil	1	
Number of main bearings	5	
Firing order	1-3-4-2	

INSPECTION AND ADJUSTMENT

Valve clearance (Hot) mm (in) Intake Exhaust	0.35 (0.014)
Drive belt deflection mm (in)	8 to 12 (0.31 to 0.47)
Applied pushing force N (kg, lb)	98 (10, 22)
Engine oil capacity ℓ (US qt, Imp qt) With oil filter	3.2 (3-3/8, 2-7/8)
Without oil filter	2.7 (2-7/8, 2-3/8)
Engine compression pressure kPa (bar, kg/cm^2, psi)/rpm Standard	1,245 (12.45, 12.7, 181)/350
Minimum	981 (9.81, 10.0, 142)/350
Spark plug Type	B4ES
Gap mm (in)	0.8 to 0.9 (0.031 to 0.035)
Distributor Point gap mm (in)	0.45 to 0.55 (0.018 to 0.022)
Dwell angle (degree)	49 to 55°
High tension cable resistance (Ohm)	Less than 30,000

Ignition timing idle speed B.T.D.C. degree/rpm	A12	A15
	12°/650	10°/650

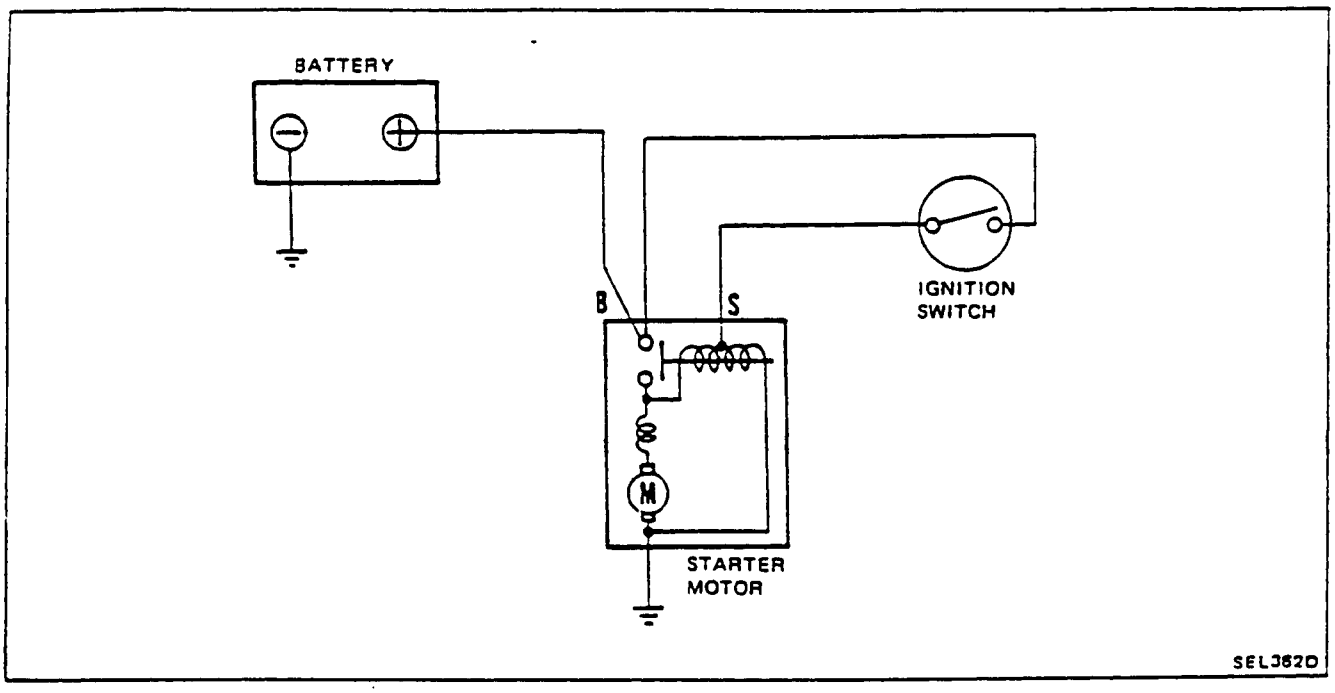
TIGHTENING TORQUE

Unit	N-m	kg-m	ft-lb
Cylinder head bolt	69 - 74	7.0 - 7.5	51 - 54
Rocker shaft bracket bolt	20 - 25	2.0 - 2.5	14 - 18
Main bearing cap bolt	49 - 59	5.0 - 6.0	36 - 43
Flywheel fixing bolt	78 - 88	8.0 - 9.0	58 - 65
Connecting rod cap nut	31 - 37	3.2 - 3.8	23 - 27
Camshaft sprocket bolt	39 - 47	4.0 - 4.8	29 - 35
Locating plate bolt	5 - 8	0.5 - 0.8	3.6 - 5.8
Valve rocker adjusting nut	16 - 22	1.6 - 2.2	12 - 16
Oil strainer bolt	9 - 14	0.9 - 1.4	6.5 - 10.1
Oil pan bolt	4 - 6	0.4 - 0.6	2.9 - 4.3
Oil pan drain plug	20 - 29	2.0 - 3.0	14 - 22
Timing chain cover bolt	5 - 7	0.5 - 0.7	3.6 - 5.1
Crank pulley bolt	147 - 196	15 - 20	108 - 145
Water pump bolt	9 - 14	0.9 - 1.4	6.5 - 10.1
Fuel pump nut	9 - 14	0.9 - 1.4	6.5 - 10.1
Spark plug	15 - 20	1.5 - 2.0	11 - 14

STARTING SYSTEM

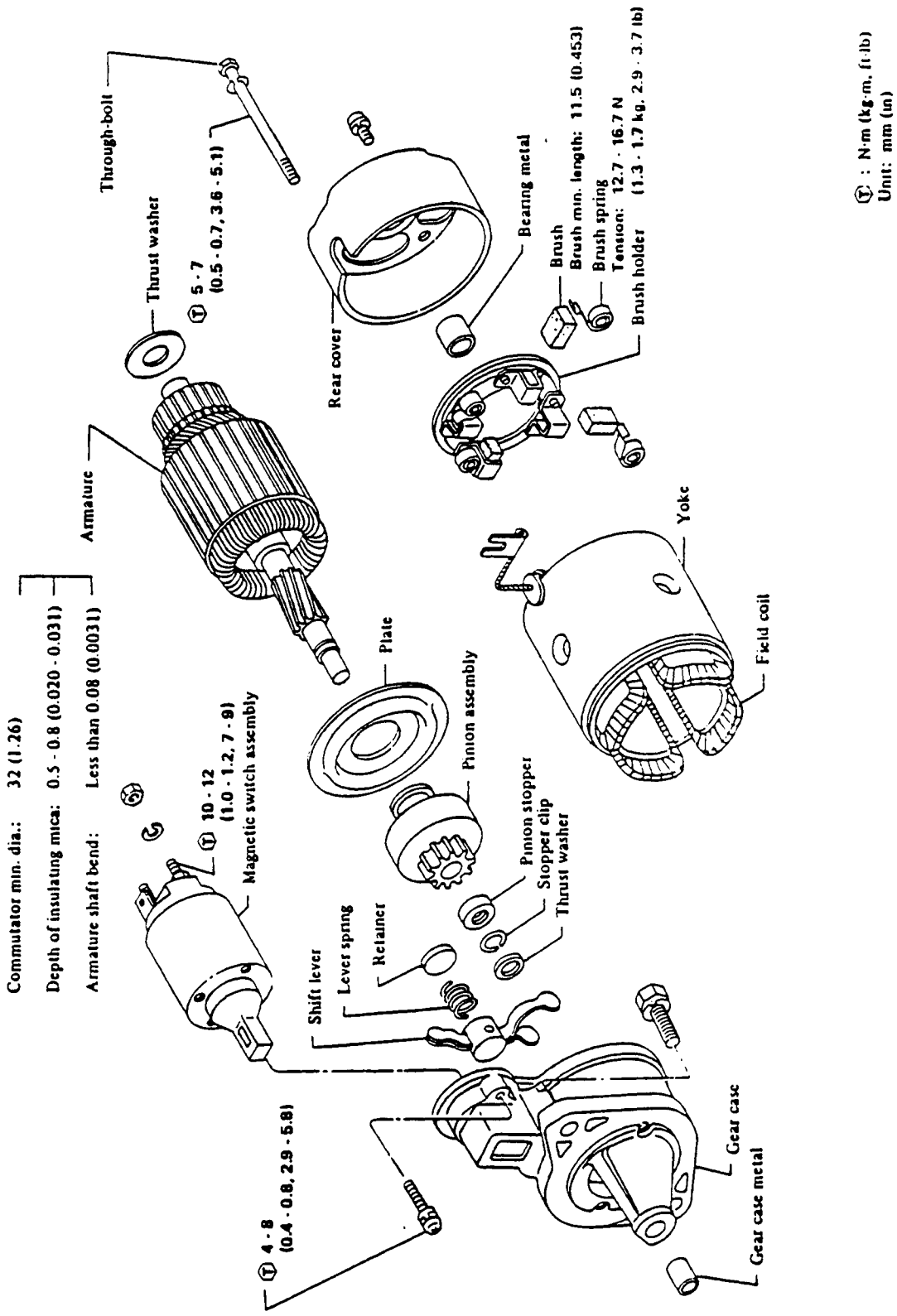
CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

SCHEMATIC



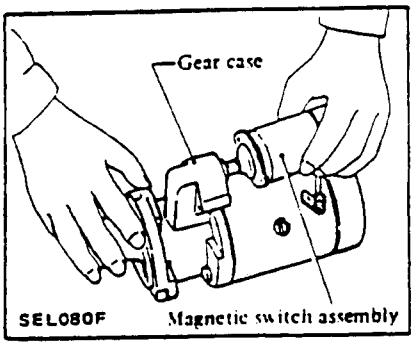
STARTER MOTOR

M2T20181

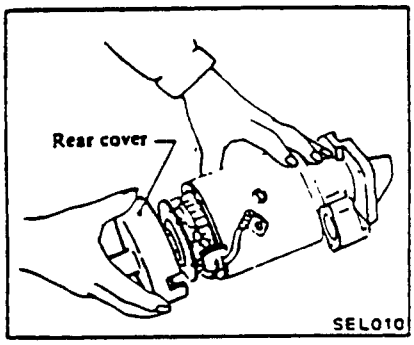


DISASSEMBLY

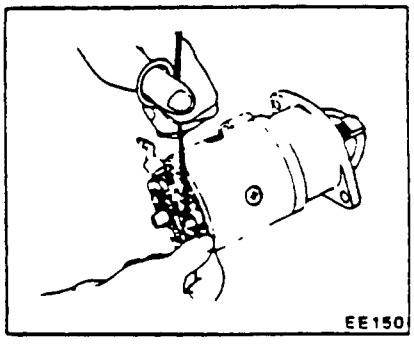
1. Remove magnetic switch.



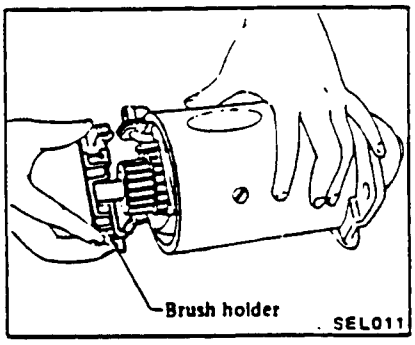
2. Remove rear cover.



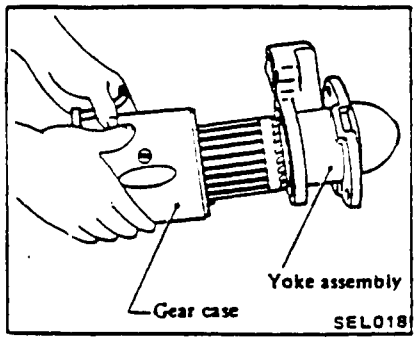
3. Lift up brush springs.



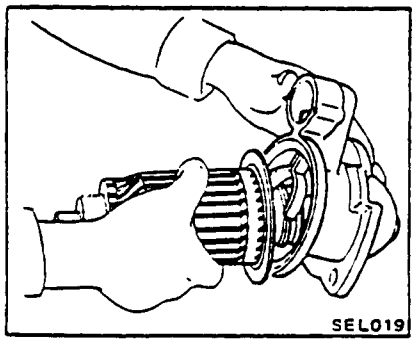
4. Remove brush holder



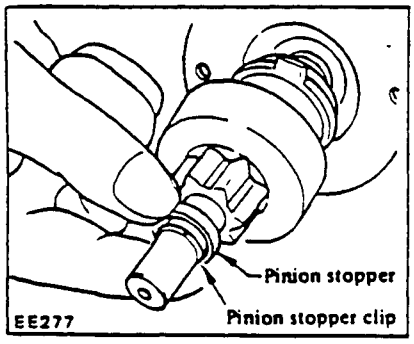
5. Remove yoke.



6. Withdraw armature and shift lever.



7. Remove overrunning clutch.
- Remove pinion stopper clip, pushing pinion stopper toward clutch side.

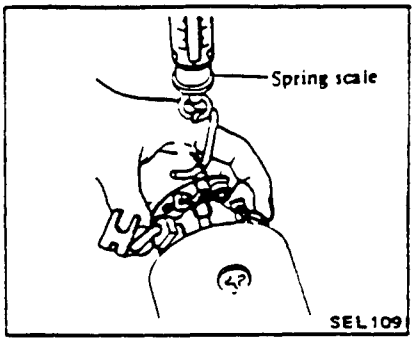


Brush spring

Check brush spring tension.

Spring tension:
13.7 - 17.7 N
(1.4 - 1.8 kg,
3.1 - 4.0 lb)

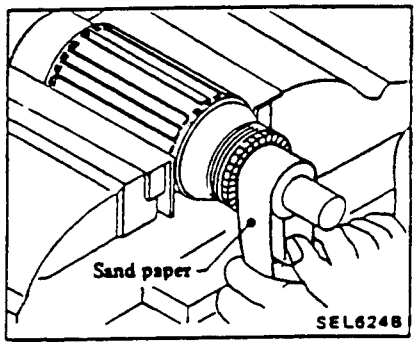
- Not in the specified value. ... Repair or replace.



INSPECTION

Armature assembly

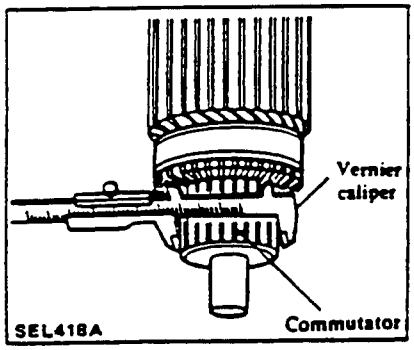
1. Check commutator surface.
- Rough ... Sand lightly with No. 500 ~600 sandpaper.



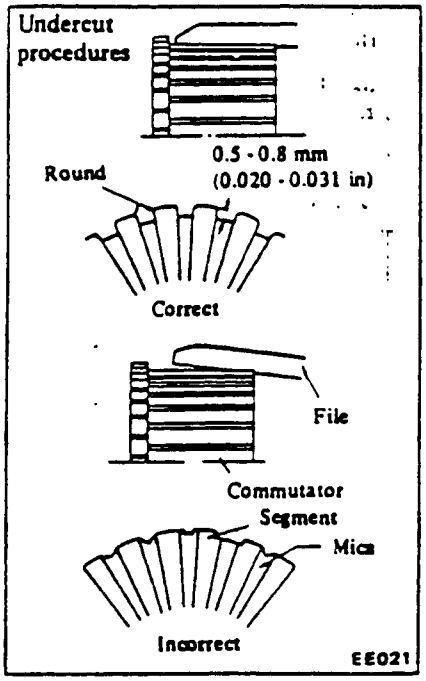
2. Check diameter of commutator.

Commutator minimum diameter:
Refer to S.D.S.

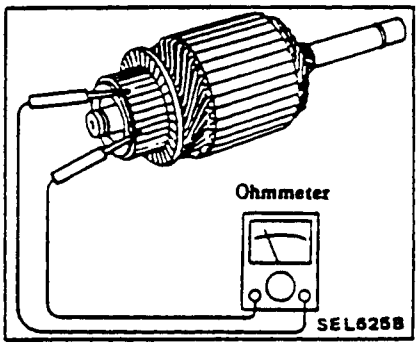
- Less than specified value ... Replace.



3. Check depth of insulating mica from commutator surface.
- Less than 0.2 mm (0.008 in) ... Undercut to 0.5 - 0.8 mm (0.020 - 0.031 in)

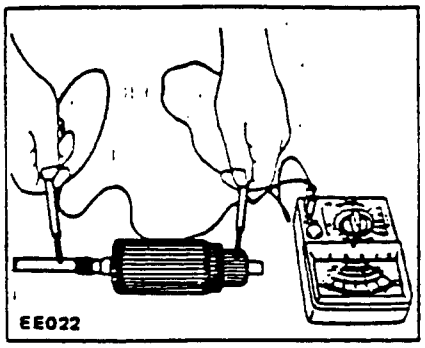


4. Continuity test (between two segments side by side).



- No continuity ... Replace.

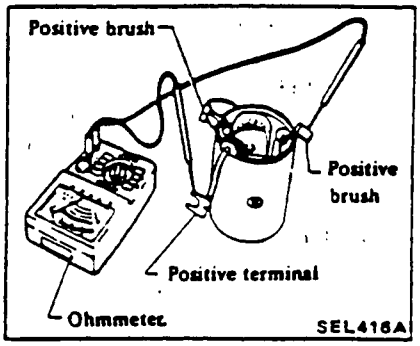
5. Insulation test (between each commutator bar and shaft).



- Continuity exists ... Replace.

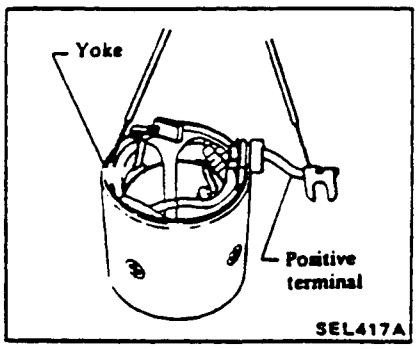
Field coil

1. Continuity test (between field coil positive terminal and positive brushes).



- No continuity ... Replace field coil.

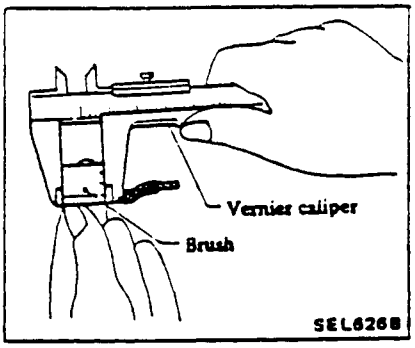
2. Insulation test (between field coil positive terminal and yoke).



- Continuity exists ... Replace field coil.

Brush

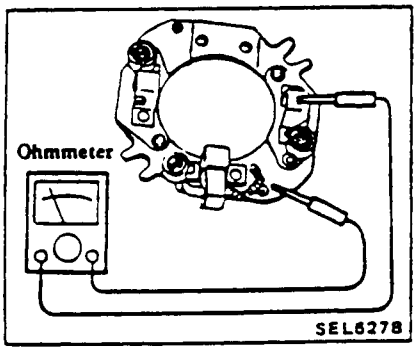
Check wear of brush.
Wear limit length: Refer to S.D.S.



- Excessive wear ... Replace.

Brush holder

1. Perform insulation test between brush holder (positive side) and its base (negative side).

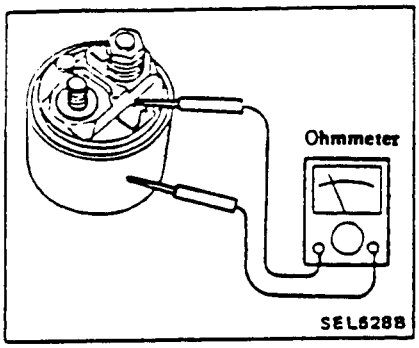


- Continuity exists ... Replace.

2. Check brush holder to see if it moves smoothly.
- If brush holder is bent, replace it; if sliding surface is dirty, clean.

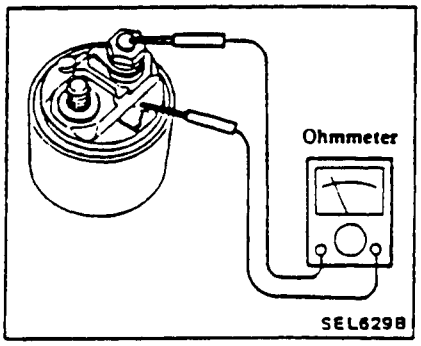
Magnetic switch

1. Continuity test (between "S" terminal and switch body).



- No continuity ... Replace.

2. Continuity test (between "S" terminal and "M" terminal).

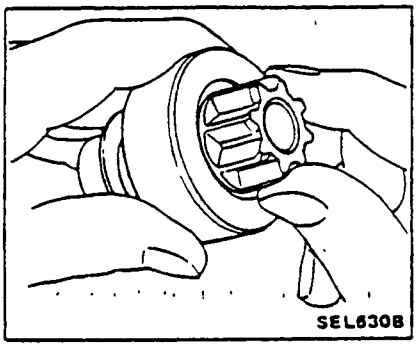


- No continuity ... Replace.

Pinion assembly

1. Check clutch.

Check pinion to see that it locks properly when turned in "drive" direction and rotates smoothly when turned in reverse.



- Pinion does not lock in either direction or unusual resistance is evident ... Replace.

2. Inspect pinion teeth.

- Replace pinion if teeth are worn or damaged. (Also check condition of ring gear teeth.)

ASSEMBLY

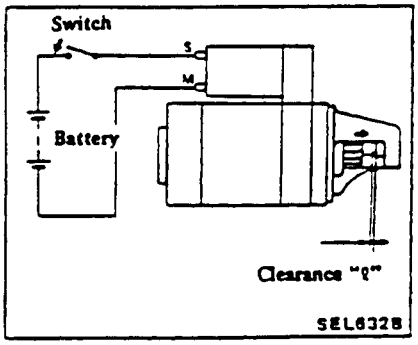
a. Apply grease to:

- Rear cover metal
- Gear case metal
- Frictional surface of pinion
- Moving portion of shift lever
- Plunger of magnetic switch

b. Check pinion to see if its engagement length is correct.

With pinion driven out by magnetic switch, push pinion back to remove slack and measure clearance "ℓ" between the front edge of the pinion and the pinion stopper.

Clearance "ℓ":
Refer to S.D.S.



CHARGING SYSTEM

CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

DESCRIPTION

The charging circuit consists of the battery, alternator, regulator and necessary wiring to connect these, parts.

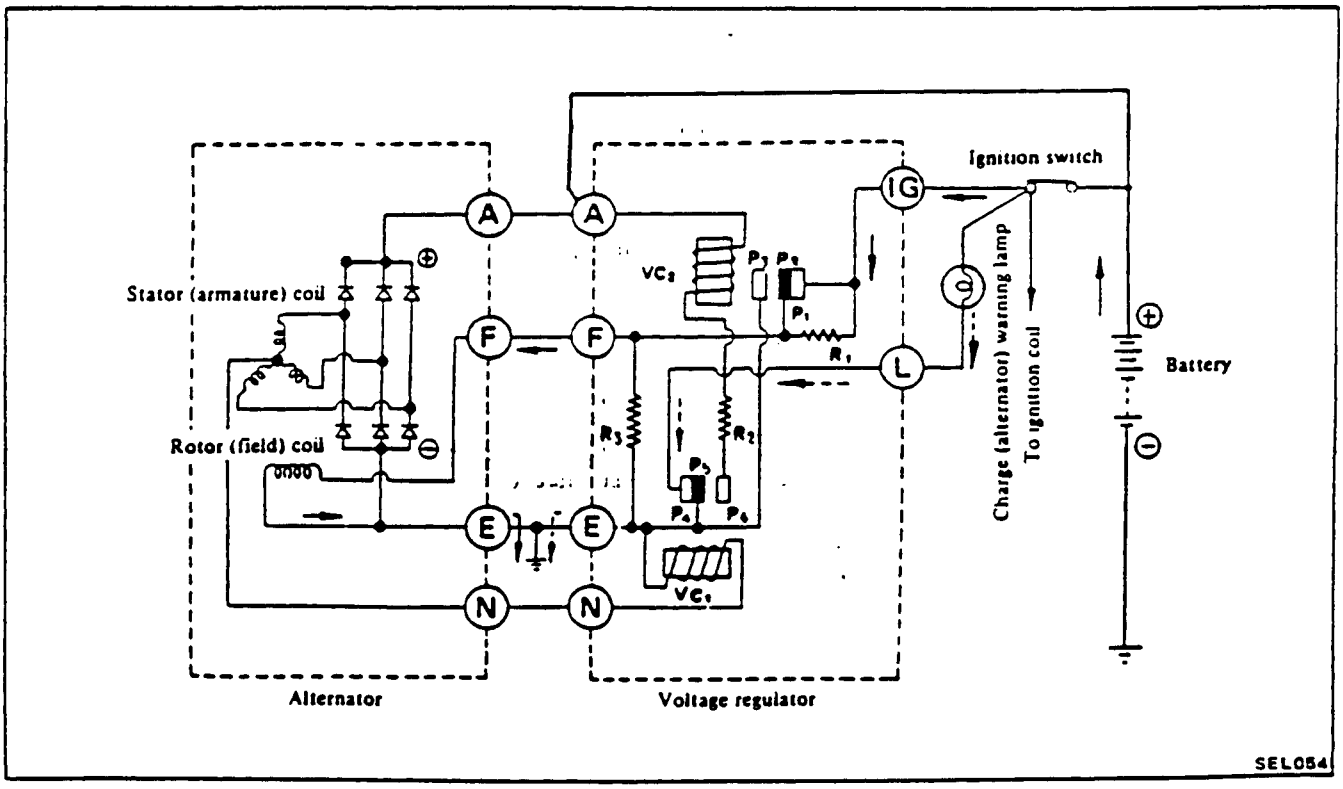
When the ignition switch is set to "ON", current flows from the battery to ground through the ignition switch, voltage regulator IG terminal, primary side contact point "P1", movable contact point "P2", voltage regulator "F" terminal, alternator "F" terminal, rotor (field) coil and alternator "E" terminal, as shown in Figure by full line arrow marks. Then the rotor in the alternator is excited. On the other hand, current flows from the battery to ground through the ignition switch, warning lamp, voltage regulator "L" terminal, lamp side contact point "P4", movable contact point "P5", and voltage regulator "E" terminal, as shown by dotted line arrow marks. Then, the warning lamp lights.

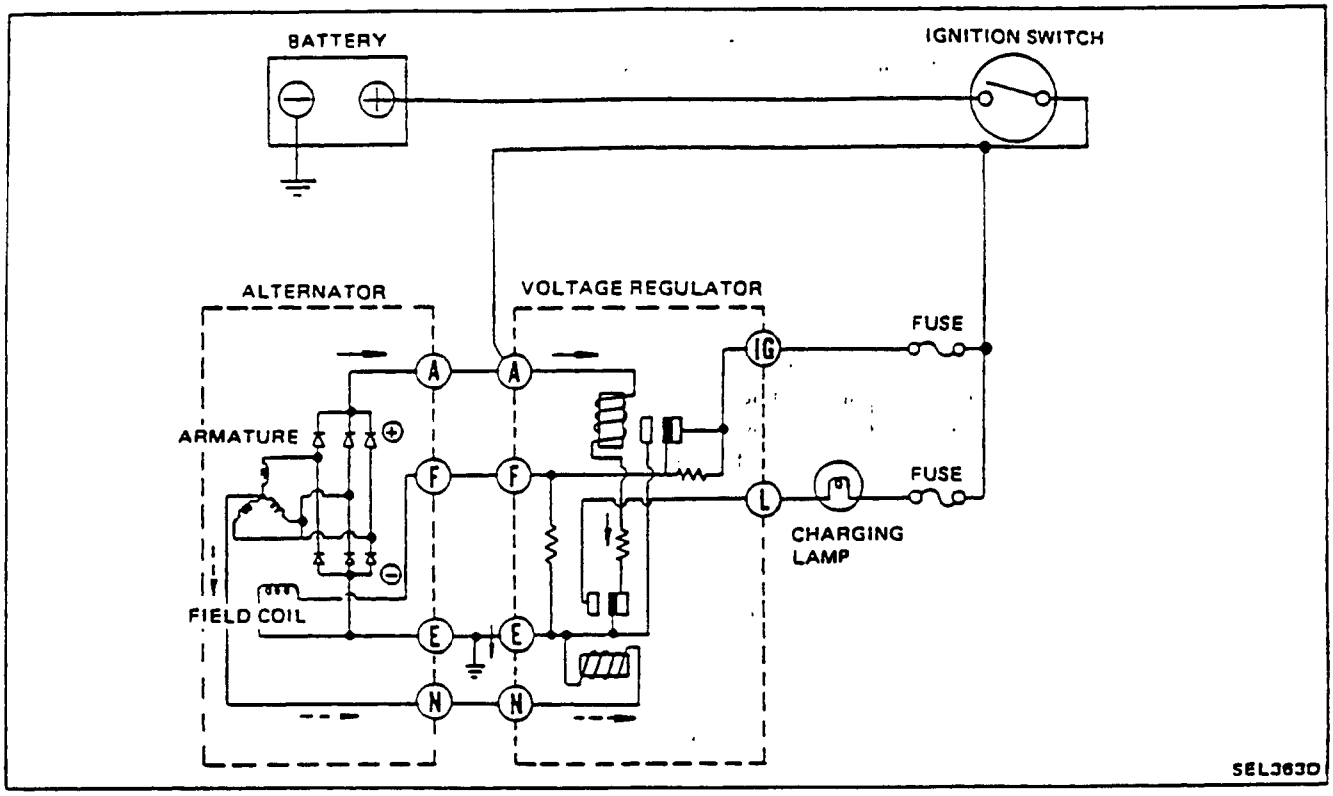
When the alternator begins to operate, three-phase alternating current is induced in the stator (armature) coil. This alternating current is rectified by the positive and negative silicon diodes. The rectified direct current output reaches the alternator "A" and "E" terminals.

On the other hand, the neutral point voltage reaches "N" and "E" terminals (nearly a half of the output voltage), and current flows from voltage regulator "N" terminal to "E" terminal or ground through the coil "VC1" by the dotted line arrow marks. Then, the coil "VC1" is excited, and the movable contact point "P5" comes into contact with voltage winding side contact point "P6". This action turns off the warning lamp and completes the voltage winding circuit, as shown by the full line arrow marks.

When the alternator speed is increased or the voltage starts to rise excessively, the movable contact point "P2" is separated from the primary side contact "P1" by the magnetic force of coil "VC2". Therefore, register "R1" is applied into the rotor circuit and output voltage is decreased. As the output voltage is decreased, the movable contact point "P2" and primary side contact "P1" comes into contact once again, and the alternator voltage increases. Thus, the rapid vibration of the movable contact point "P2", maintains an alternator output voltage contact.

When the alternator speed is further increased or the voltage starts to rise excessively, the movable contact point "P2" comes into contact with secondary side contact point "P3". Then, the rotor current is shut off and alternator output voltage is decreased immediately. This action separates movable contact "P2" from secondary contact "P3". Thus, the rapid vibration of the movable contact point "P2" or breaking and completing the rotor circuit maintains constant alternator output voltage.





CHARGING SYSTEM TROUBLE-SHOOTING

Before conducting an alternator test, make sure battery is fully charged.

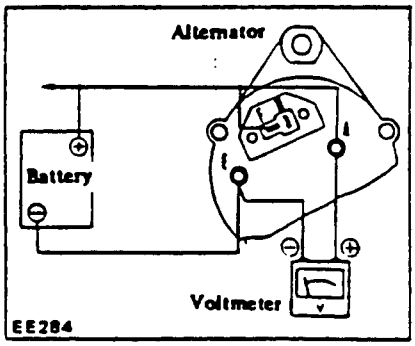
To conduct test, it is necessary to use a 30-volt voltmeter and suitable test probes.

Set up a test circuit as shown in Figure and test alternator in manner indicated in flow chart below:

1. Disconnect connectors at alternator.
2. Connect "A" terminal to "F" terminal.
3. Connect one test probe from voltmeter positive terminal to "A" terminal. Connect the other test probe to ground. Make sure that voltmeter registers battery voltage.
4. Turn on headlights and switch to High Beam.
5. Start engine.
6. Increase engine speed gradually until it is approximately 1,100 rpm, and take the voltmeter reading.

Measured value: Below 12.5 volts
Alternator is run-down. Remove and check it for condition.

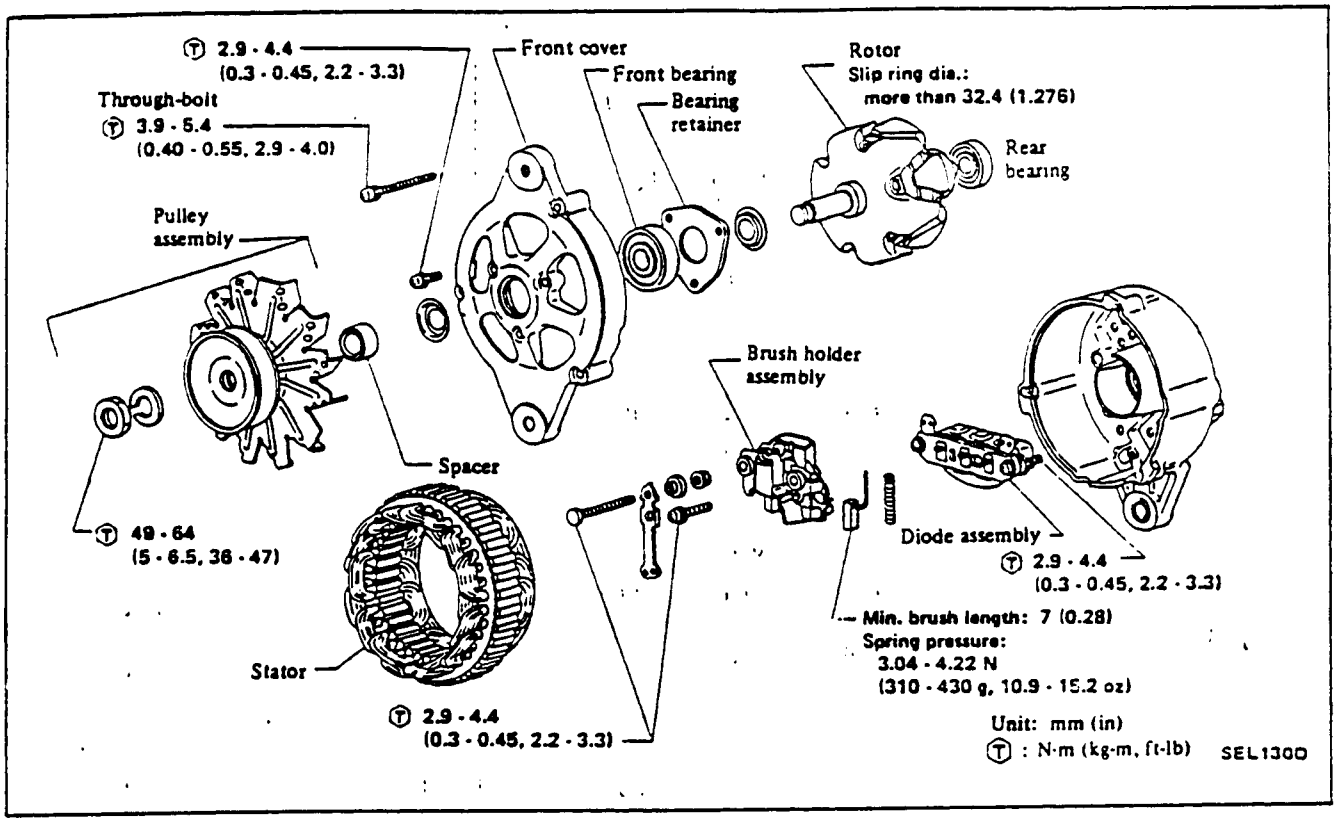
Measured value: Over 12.5 volts
Alternator is in good condition.



a. Do not run engine at more than 1,100 rpm while test is being conducted on alternator.

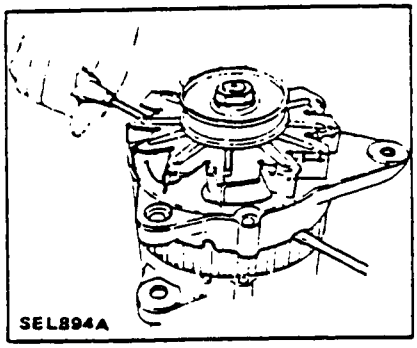
b. Do not race engine.

ALTERNATOR

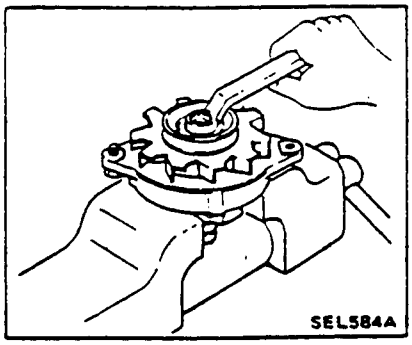


DISASSEMBLY

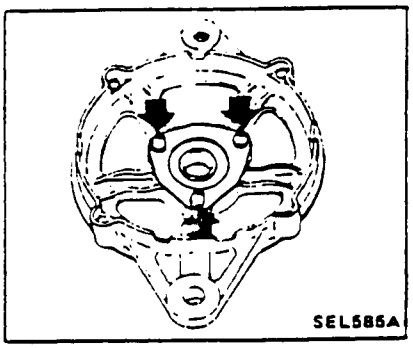
1. Remove through-bolts.
2. Separate front cover and rear cover.

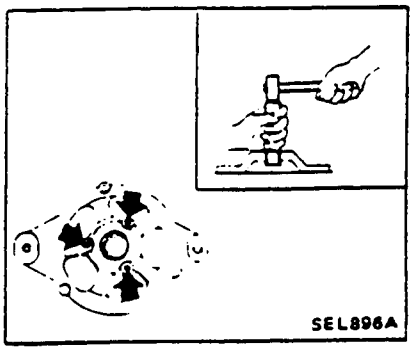


3. Separate front cover and rotor shaft.
(1) Place rear cover side of rotor in a vice.
(2) Remove pulley nut.
(3) Take out pulley, fan and front cover.



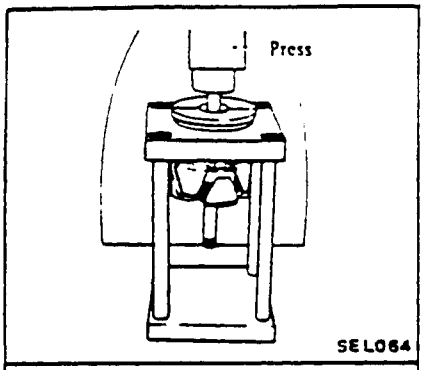
4. Remove bearing retainer and take out bearing.

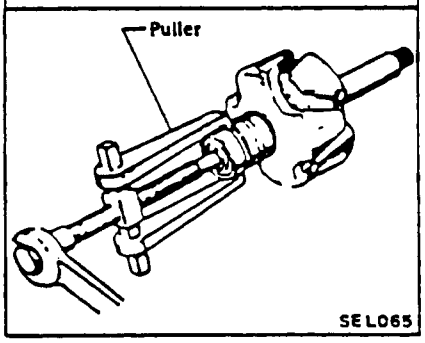




Rotor

Pull rear bearing off rotor assembly.

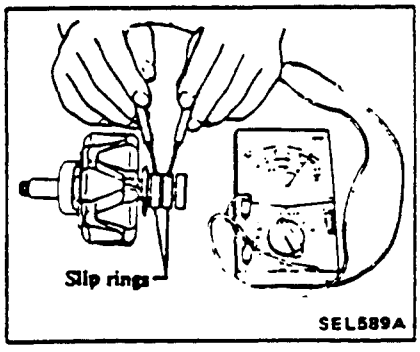




INSPECTION

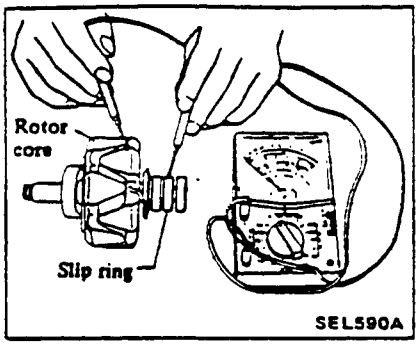
Rotor

1. Continuity test.



- No continuity ... Replace rotor.

2. Insulation test.



- Continuity exists ... Replace rotor.

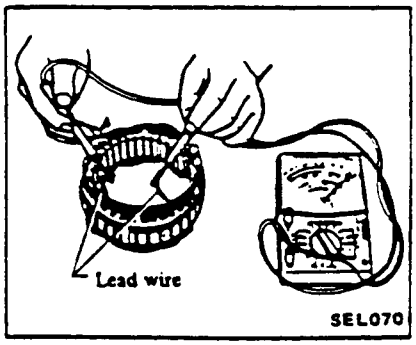
3. Check slip ring for wear.

Slip ring outer diameter:
Refer to S.D.S.

If necessary, replace rotor assembly.

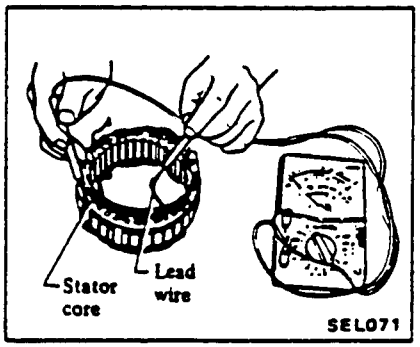
Stator

1. Continuity test



- No continuity ... Replace stator.

2. Insulation test



- Continuity exists ... Replace stator.

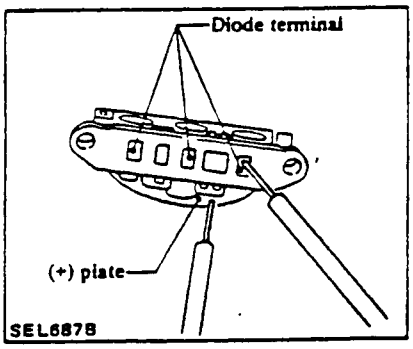
Diode

Perform a continuity test on diodes in both directions, using an ohmmeter.

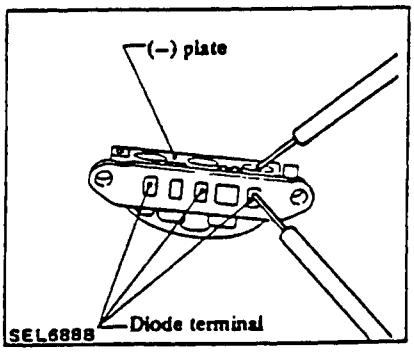
Circuit tester terminal		Conduction
Positive	Negative	
(+) plate Holder plate	Diode terminal	Yes
Diode terminal	(+) plate Holder plate	No
(−) plate	Diode terminal	No
Diode terminal	(−) plate	Yes

Some ohmmeters use a reverse polarity, in which case continuity will be exactly opposite from the chart above.

Positive diode



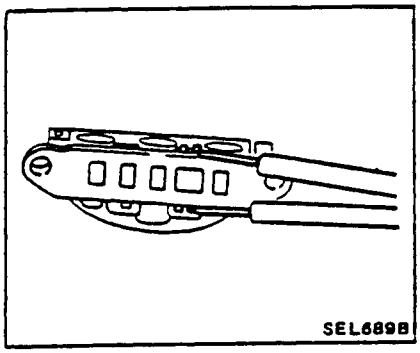
Negative diode



- If a diode is faulty, replace all diodes as a unit.

Sub-diode

Perform a continuity test on sub-diodes by attaching probes of an ohmmeter to diode terminals.
If continuity exists or does not exist in both directions, diode is faulty and all diodes should be replaced as a unit.

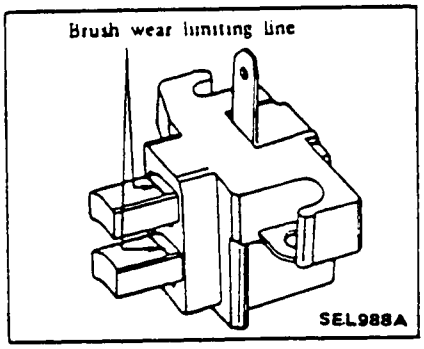


Brush

1. Check smooth movement of brush.
- Not smooth ... Check brush holder and clean.

2. Check brush for wear.

Min. brush length:
8.0 mm (0.315 in)



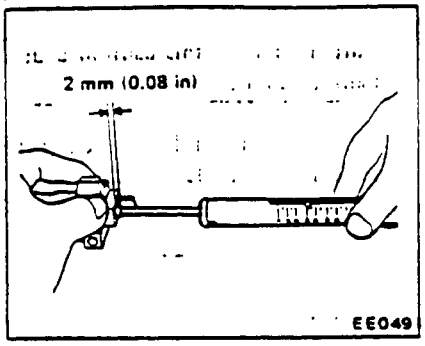
- Less than the specified value ... Replace.

3. Check brush pig tail for damage.
- Damaged ... Replace.

4. Check brush spring pressure.
Measure brush spring pressure with brush projected approximately 2 mm (0.08 in) from brush holder.

Spring pressure:
3.040 - 4.217 N
(310 - 430 g,
10.93 - 15.17 oz)

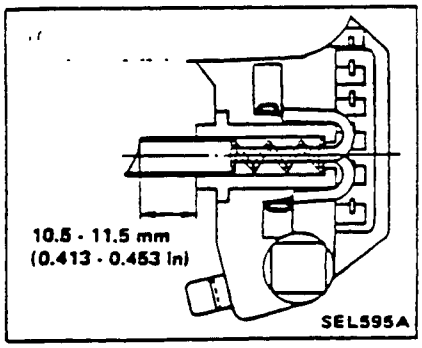
When brush is worn, pressure decreases approximately 0.196 N (20 g, 0.71 oz) per 1 mm (0.04 in) wear.



- Not in the specified value ... Replace.

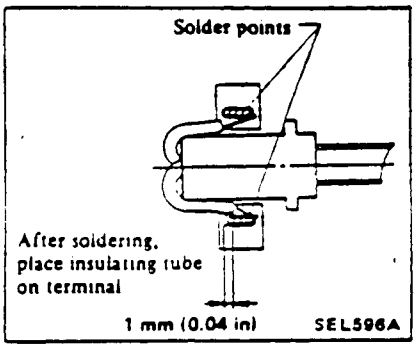
ASSEMBLY

1. When soldering each stator coil lead wire to diode assembly terminal, carry out the operation as fast as possible.
2. When soldering brush lead wire, observe the following.
(1) Position brush so that it extends 11 mm (0.43 in) from brush holder.

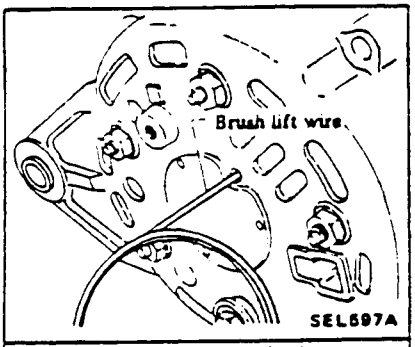


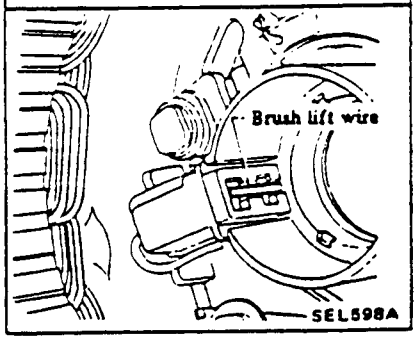
(2) Coil lead wire 1.5 times around terminal groove. Solder outside of terminal.

When soldering, be careful not to let solder adhere to insulating tube as it will weaken the tube and cause it to break.



3. Tighten pulley nut and make sure that deflection of V-groove is proper.
4. Before installing front and rear sides of alternator, push brush up with fingers and retain brush, by inserting brush lift wire into brush lift hole from outside.





5. After installing front and rear sides of alternator, pull brush lift wire by pushing toward center.

Do not pull brush lift by pushing toward outside of cover as it will damage slip ring sliding surface.

6. Tighten through-bolts.

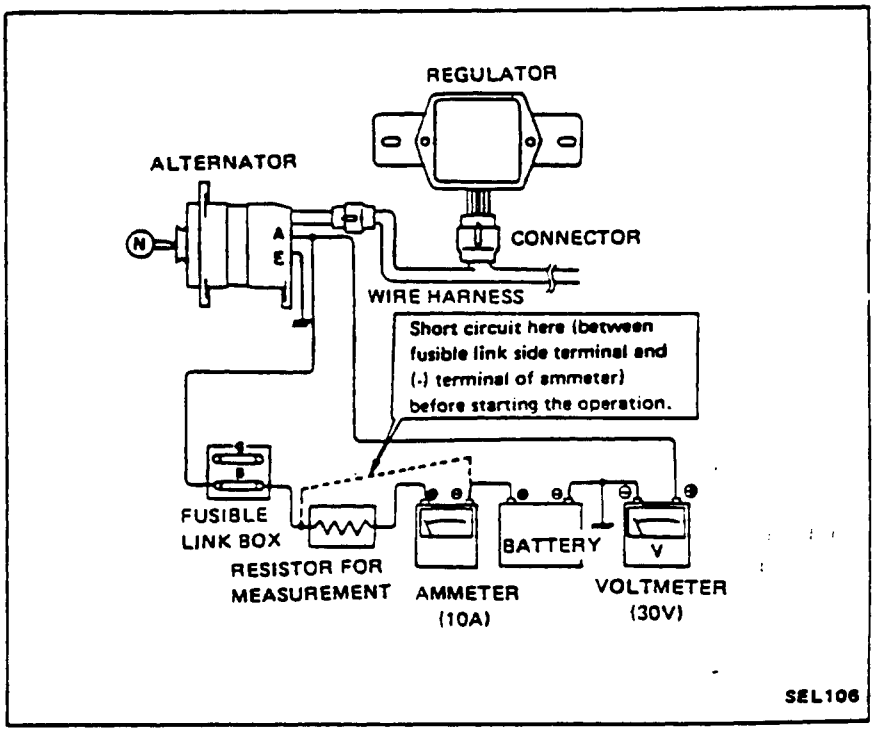
VOLTAGE REGULATOR

MEASUREMENT OF REGULATING VOLTAGE

1. Connect DC voltmeter (15-30V), DC ammeter (15-30A), battery and resistor (0.25Ω) with cables as shown. **Check to be sure that all electrical loads such as lamps, air conditioner, radio, etc. are turned off.**

CAUTION:
Before starting engine, be sure to make short circuit with a cable as shown in Figure.
Failure to follow this caution causes a damaged ammeter.

2. Refer to the following chart to determine if regulator and relative parts are in good condition:



1. Start engine.
2. Rotate engine at 2,500 rpm for several minutes.

After racing for several minutes, ammeter reading – below 5A.

After racing for several minutes, ammeter reading – over 5A.

Fully charged battery available.
1. Replace with fully charged battery.
2. Check to see if current falls below 5A.

Fully charged battery not available.
1. Connect a 0.25Ω resistor in series.

Current falls below 5A.

Current does not fall below 5A.

Recharge battery and see if current falls below 5A.

Reduce engine speed to idling and then raise it to 2,500 rpm while observing needle of voltmeter.

Needle of voltmeter held within limits shown in the table below.
Regulator functioning properly.

Needle of voltmeter out of limits shown in the following chart.
Regulator out of order. Have it repaired at authorized shop.

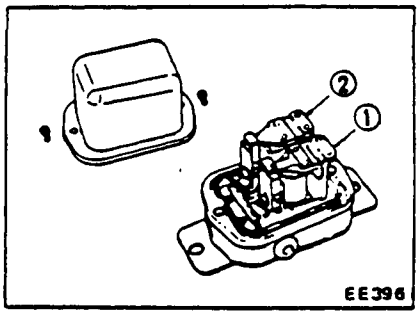
Temperature °C (°F)	Voltage V (RQB2220B)
−10 (14)	14.75 - 15.25
0 (32)	14.60 - 15.10
10 (50)	14.45 - 14.95
20 (68)	14.30 - 14.80
30 (86)	14.15 - 14.65
40 (104)	14.00 - 14.50

a. Do not measure voltage immediately after driving. Do this while regulator is cold.
b. To measure voltage, raise engine speed gradually from idling to rated speed.
c. Voltage may be approximately 0.3V higher than the rated for two to three minutes after engine is started, or more specifically, when regulator becomes self-heated. Measurements should then be made within one minute after starting engine, or when regulator is cold.
d. The regulator is of a temperature-compensating type. Before measuring voltage, be sure to measure surrounding temperature.

ADJUSTMENT

Voltage regulator

Adjusting regulating voltage

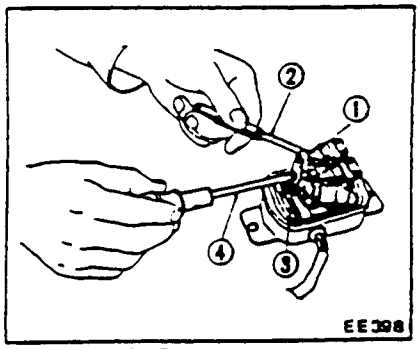


1 Charge relay
2 Voltage regulator

1. Inspect contact surface.
Rough ... Lightly polish with sand paper (#500 or 600).

2. Measure each gap. Adjust core gap and point gap in that order. No adjustment is required for yoke gap.
3. Adjusting core gap
Loosen screw which is used to secure contact set on yoke, and move contact upward or downward properly.

Core gap:
Refer to S.D.S.

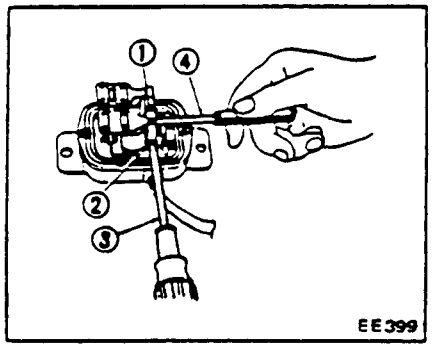


1 Contact set
2 Thickness gauge
3 4 mm (0.16 in) dia. screw
4 Crosshead screwdriver

4. Adjusting point gap

Loosen screw used to secure upper contact, and move upper contact upward or downward adequately.

Point gap:
Refer to S.D.S.

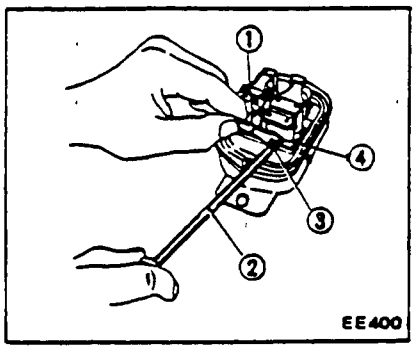


1 Thickness gauge
2 3 mm (0.12 in) dia. screw
3 Crosshead screwdriver
4 Upper contact

5. Adjusting voltage

Adjust regulating voltage as follows:

Loosen lock nut securing adjusting screw. Turn this screw clockwise to increase, or counterclockwise to decrease, regulating voltage.

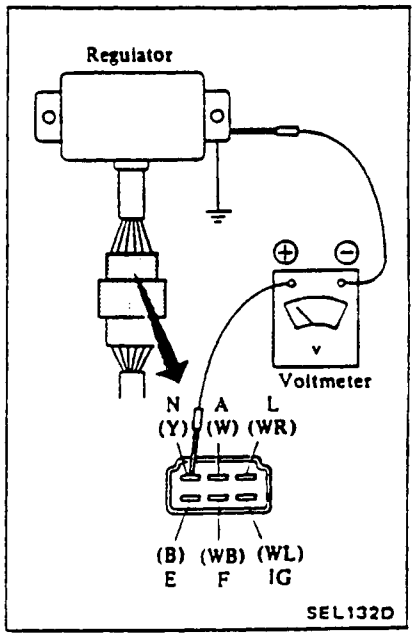


1 Wrench
2 Crosshead screwdriver
3 Adjusting screw
4 Lock nut

Charge relay

Normal relay operating voltage is 8 to 10V as measured at alternator "A" terminal. Relay itself, however, operates at 4 to 5V.

Use a DC voltmeter, and set up a circuit as shown in Figure.



1. Connect positive terminal of voltmeter of regulator lead connector "N" terminal with negative terminal grounded.
2. Start engine and keep it idle.
3. Take voltmeter reading.

0 volts
1. Check for continuity between "N" terminals of regulator and alternator.
2. Alternator circuit defective if continuity exists.

Below 5.2 volts
(Pilot lamp remains lit.)
1. Check fan belt tension.
2. If correct, remove regulator and adjust as necessary.

Over 5.2 volts
(Pilot lamp remains lit.)
Pilot lamp relay coil or contact points out of order.
Replace regulator.

Over 5.2 volts
(Pilot lamp does not light.)
Pilot lamp relay assembly is in good condition.

CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

DESCRIPTION

The ignition circuit consists of the ignition switch, coil, distributor, wiring, spark plugs and battery.

The circuit is equipped with a resistor. During cranking, electrical current bypasses the resistor, thereby connecting the ignition coil directly to battery. This provides full battery voltage at coil and keeps ignition voltage as high as possible.

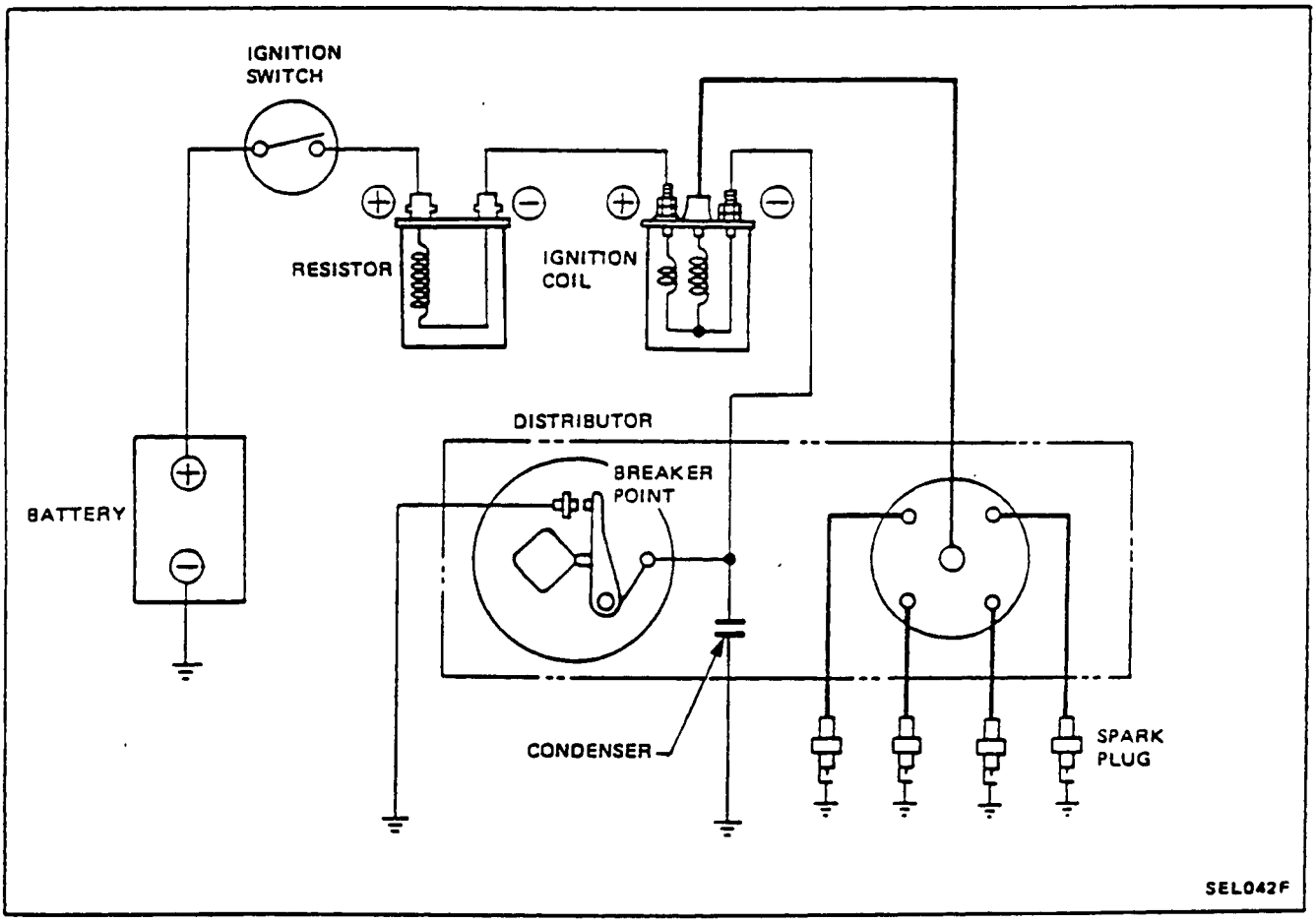
Low voltage current is supplied by the battery or alternator and flows through the primary circuit. It consists of the ignition switch, resistor, primary winding of the ignition coil, distributor contact points, condenser and all connecting low tension wiring.

High voltage current is produced by the ignition coil and flows through the secondary circuit, resulting in high voltage spark between the electrodes of the spark plugs in engine cylinders. This circuit contains the secondary winding of the ignition coil, high tension wiring, distributor rotor and cap.

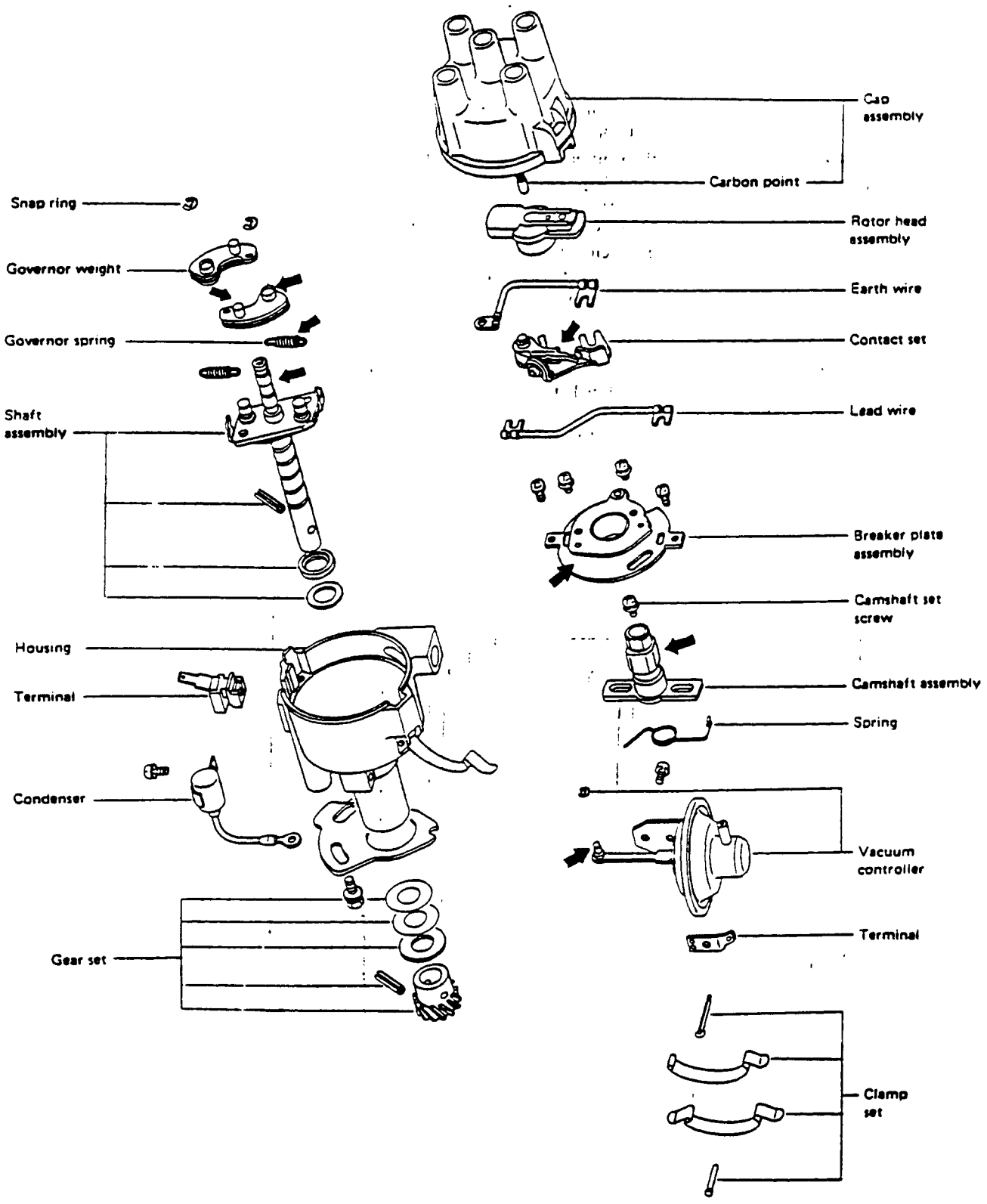
When the ignition switch is turned on and the distributor contact points are closed, the primary current flows through the primary winding of the coil and through the contact points to ground.

When the contact points are opened by the revolving distributor cam, the magnetic field built up in the primary winding of the coil moves through the secondary winding of the coil inducing high voltage. The high voltage is produced every time the contact points open. The high voltage current flows through the high tension wire to the distributor cap. Then the rotor distributes the current to one of the spark plug terminals in the distributor cap.

The spark is obtained when the high voltage current jumps the gap between the insulated electrode and the ground side electrode of the spark plug. This process is repeated for each power stroke of the engine.



DISTRIBUTOR



CHECKING AND ADJUSTMENT

Cap and rotor head

Check cap and rotor head for dust, carbon deposits and cracks.

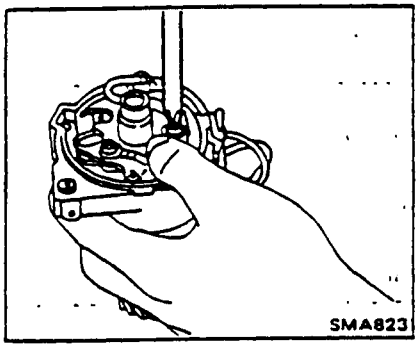
Contact point

1. Check the point surface.

Take off any irregularities with fine sandpaper (No. 500 or 600) or with oil stone.

2. Adjust point gap.

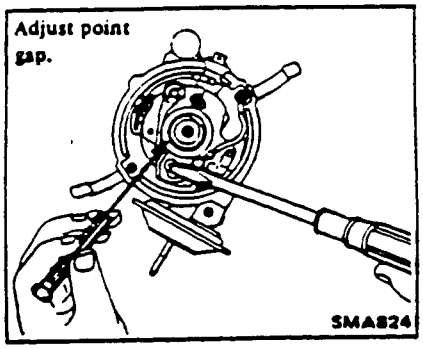
Loosen breaker plate set screws.



Move breaker plate by pivoting around projected pin so that contact point gap can be adjusted to the specified value.

Turning breaker plate clockwise will decrease contact point gap, and turning counterclockwise will increase contact point gap.

Point gap:
Refer to S.D.S.



Tighten breaker plate set screws.

Condenser

Checking of condenser is made by a capacity tester. This can also be made by a circuit tester with its range set to high resistance reading. When needle of tester swings violently and then moves back to infinite gradually, it is an indication that condenser is in good condition.

If needle shows any steady reading or if it registers zero, the likelihood is that transformer is out of order, calling for replacement.

Condenser capacity:
0.2 - 0.24 μF

Condenser insulation resistance:
More than 5MΩ

Advance mechanism

Specifications

Refer to S.D.S.

Vacuum advance mechanism mechanical parts

1. Check vacuum inlet for signs of leakage at its connection.
2. Check vacuum diaphragm for air leak.

If leak is found, replace vacuum controller assembly.

3. Inspect breaker plate for smooth moving.

If plate does not move smoothly, this condition could be due to sticky steel balls or pivot. Apply grease to steel balls or, if necessary, replace breaker plate as an assembly.

Centrifugal advance mechanical parts

When cause of engine malfunction is traced to centrifugal advance mechanical part, use distributor tester to check its characteristic.

When nothing is wrong with its characteristic, conceivable causes are breakdown or abnormal wearing-out of driving part or others. So do not disassemble it.

In case of improper characteristic, take off contact breaker assembly part and check closely cam assembly, governor weight, shaft and governor spring, etc.

In case centrifugal advance mechanical part is reassembled, be sure to check advance characteristic with distributor tester.

DISASSEMBLY

Disassemble distributor, noting the following especially.

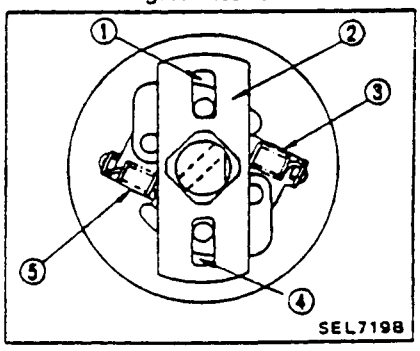
CAUTION:
Put match mark across cam and shaft so that original combination can be restored at assembly.

CAUTION:
Inscribe a match mark across spring and mating part so that spring can be replaced in its original position during assembly.
Be careful not to stretch or deform governor spring.

ASSEMBLY

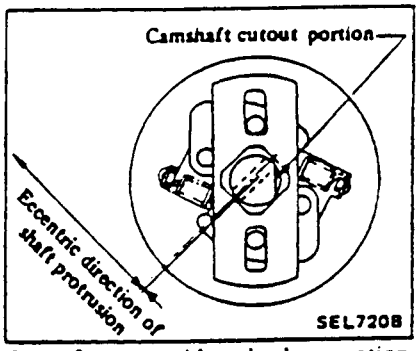
Carefully observe the following instructions.

1. Install governor spring to shaft so that relative positions of the two are as shown in figure below.



1 Short rectangular
2 Cam shaft
3 Governor spring "B" (Rectangular hook type)
4 Long rectangular hole
5 Governor spring "A" (Circular hook type)

2. Install camshaft to shaft so that relative positions of notch in camshaft and protrusion on lower end of shaft are as shown in figure below.



3. After assembly, check operation of governor before installing it on engine.
4. Ignition timing should be tested with unit mounted on engine.

SERVICE DATA AND SPECIFICATIONS

STARTER MOTOR

Model		MITSUBISHI M2T20181
Nominal output	kW	0.8
System voltage	V	12
Weight	kg (lb)	4.2 (9.3)
No load		
Terminal voltage	V	11.5
Current	A	Less than 50
Revolution	rpm	More than 7,400
Minimum length of brush	mm (in)	11.5 (0.45)
Brush spring tension	N (kg, lb)	12.7 - 16.7 (1.3 - 1.7, 2.9 - 3.7)
Outer diameter of commutator	mm (in)	32 (1.26)
Depth of mica		
Wear limit	mm (in)	0.2 (0.008)
Repair accuracy	mm (in)	0.5 - 0.8 (0.020 - 0.031)
Clearance between armature shaft and bearing		
Wear limit	mm (in)	0.2 (0.008)
Repair accuracy	mm (in)	0.03 - 0.10 (0.0012 - 0.0039)
Gap "g" between pinion front edge and pinion stopper	mm (in)	0.5 - 2.0 (0.020 - 0.079)

ALTERNATOR

Model		MITSUBISHI A1T24371
Nominal rating	V-A	12 - 35
Ground polarity		Negative
Minimum revolution under no load (When 14 volts is applied)	rpm	Less than 1,000
Hot output current	A/rpm	More than 27.5/2,500 More than 35/5,000
Pulley ratio		2.25
Minimum length of brush	mm (in)	More than 7 (0.28)
Brush spring pressure	N (g, oz)	3.040 - 4 217 (310 - 430, 10 93 - 15.17)
Slip ring outer diameter	mm (in)	More than 32.4 (1.276)

VOLTAGE REGULATOR

Model		MITSUBISHI RQB222085
Regulator voltage [at 20°C (68°F)] (With fully charged battery)	V	14.3 - 15.3
Voltage coil resistance [at 20°C (68°F)]	Ω	23.6
Rotor coil inserting resistance [at 20°C (68°F)]	Ω	10
Voltage coil series resistance [at 20°C (68°F)]	Ω	38
Core gap	mm (in)	0.7 - 1.3 (0.028 - 0.051)
Point gap	mm (in)	0.3 - 0.45 (0.012 - 0.018)
Charge relay		
Release voltage at "N" terminal	V	4.2 - 5.2
Voltage coil resistance	Ω	23.6
Core gap	mm (in)	0.9 - 1.4 (0.035 - 0.055)
Point gap	mm (in)	0.7 - 1.1 (0.028 - 0.043)

DISTRIBUTOR

Model	A12	A15
	MITSUBISHI T3T03571	MITSUBISHI T3T03581
Firing order	1-3-4-2	
Rotating direction	Counterclockwise	
Dwell angle at point gap 0.5 mm (0.020 in) degree	49° - 55°	
Point gap mm (in)	0.45 - 0.55 (0.018 - 0.022)	
Cap insulation resistance MΩ	50	
Rotor head insulation resistance MΩ	50	
Cap carbon point length mm (in)	More than 3 (0.12)	
Vacuum advance (Distributor degree/ distributor kPa (mbar, mmHg, inHg))	0° /18.7 - 21.3 (187 - 213, 140 - 160, 5.51 - 6.30) 7.5° - 9.5°/ 36.0 - 40.0 (360 - 400, 270 - 300, 10.63 - 11.81)	0°/12.7 - 15.3 (127 - 153, 95 - 115, 3.74 - 4.53) 11° - 13°/ 37.3 - 42.7 (373 - 427, 280 - 320, 11.02 - 12.60)
Centrifugal advance (Distributor degree/ distributor rpm)	0°/470 - 625 10.5° - 12.5°/2,400	0°/500 - 620 10.5° - 12.5°/2,400

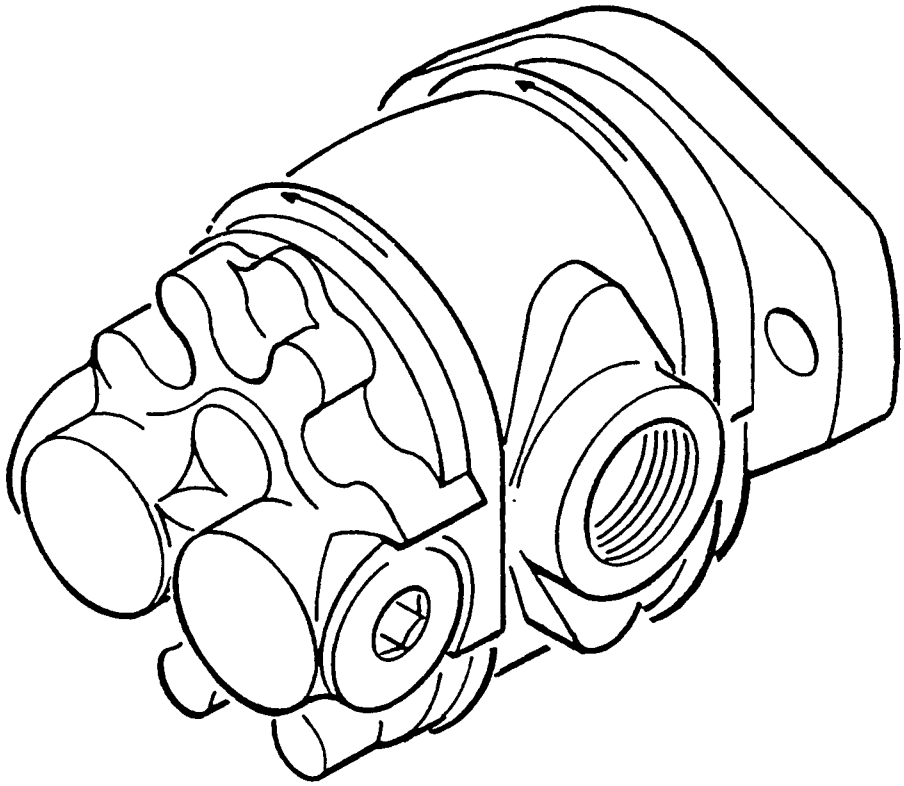
IGNITION COIL

Model		MITSUBISHI HPS-13E10
Primary voltage	V	12
Spark gap	mm (in)	More than 7 (0.28)
Primary resistance (at 20°C (68°F))	Ω	1.5±10%

SPARK PLUG

Size (Screw dia. x reach) mm (in)	14 x 19 (0.55 x 0.75)
Plug gap mm (in)	0.8 - 0.9 (0.031 - 0.035)
Tightening torque N·m (kg-m, ft-lb)	15 - 20 (1.5 - 2.0, 11 - 14)

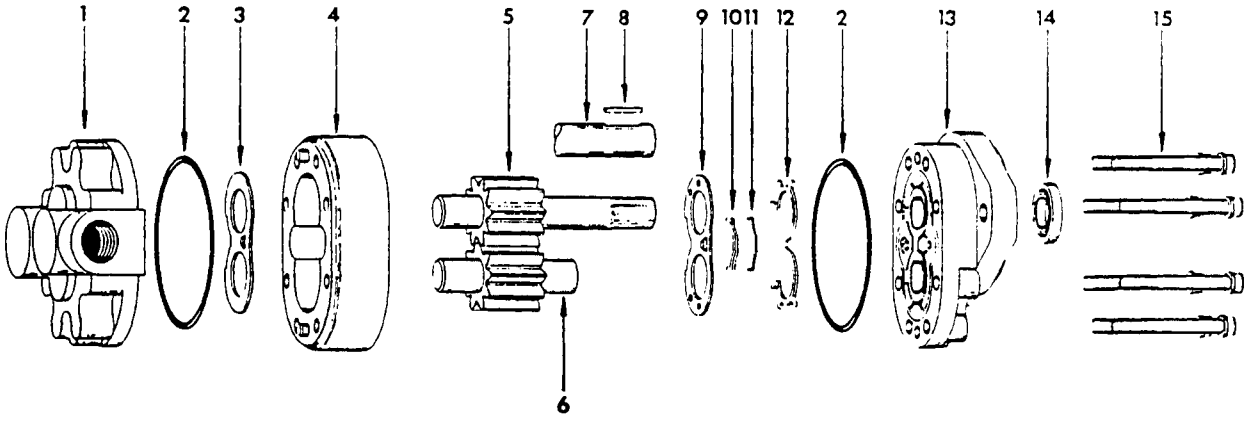
Service Manual



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.

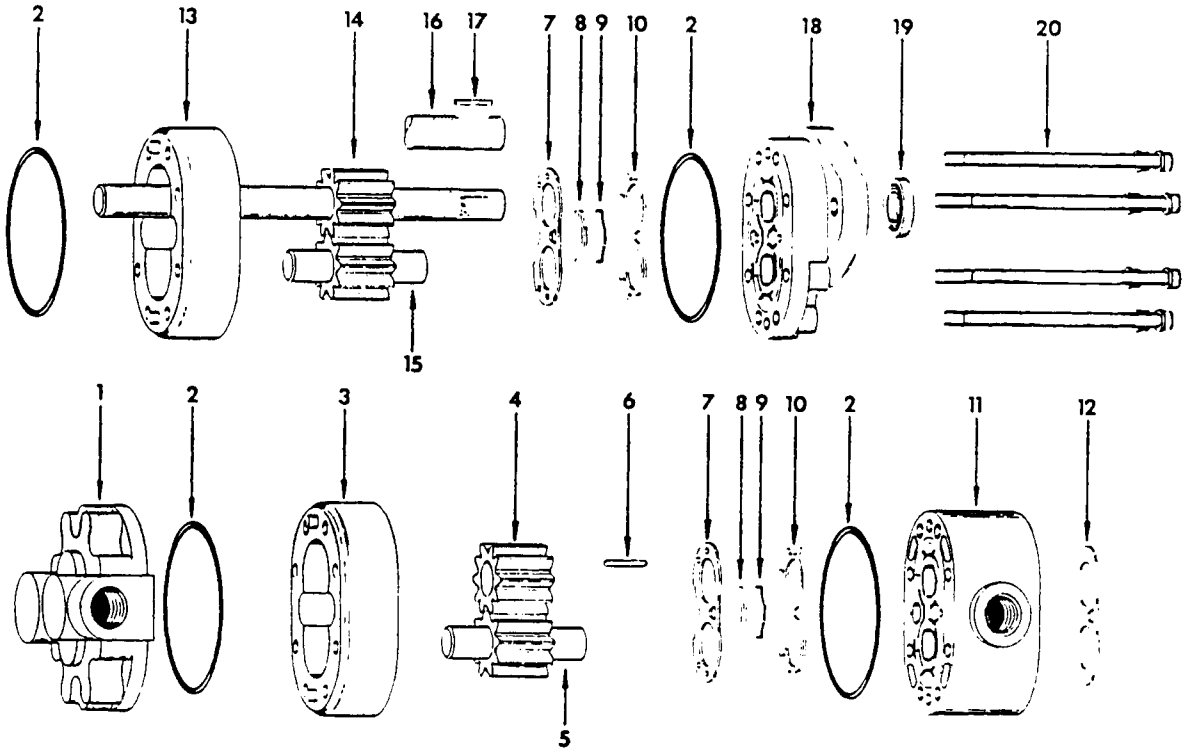
12. Liberally oil shaft seal (14) and carefully work over drive shaft being careful not to cut rubber sealing lip.

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)

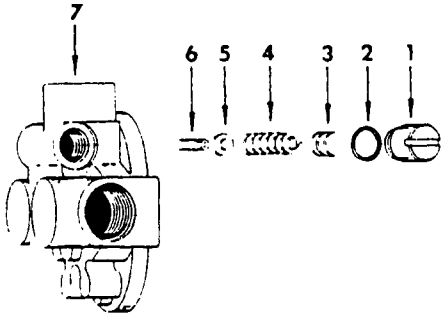
PLACING PUMP BACK INTO SERVICE

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

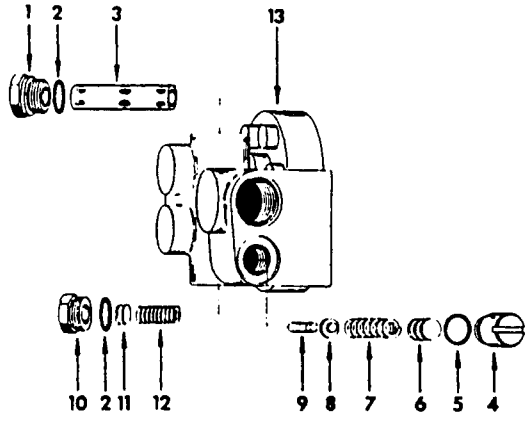
8. Check spring (4) for weakness or breakage.

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 INSTRUCTIONS

SHIFT CYLINDER

M.I. P/N 20719
Seal Kit P/N 66793

Disassembly

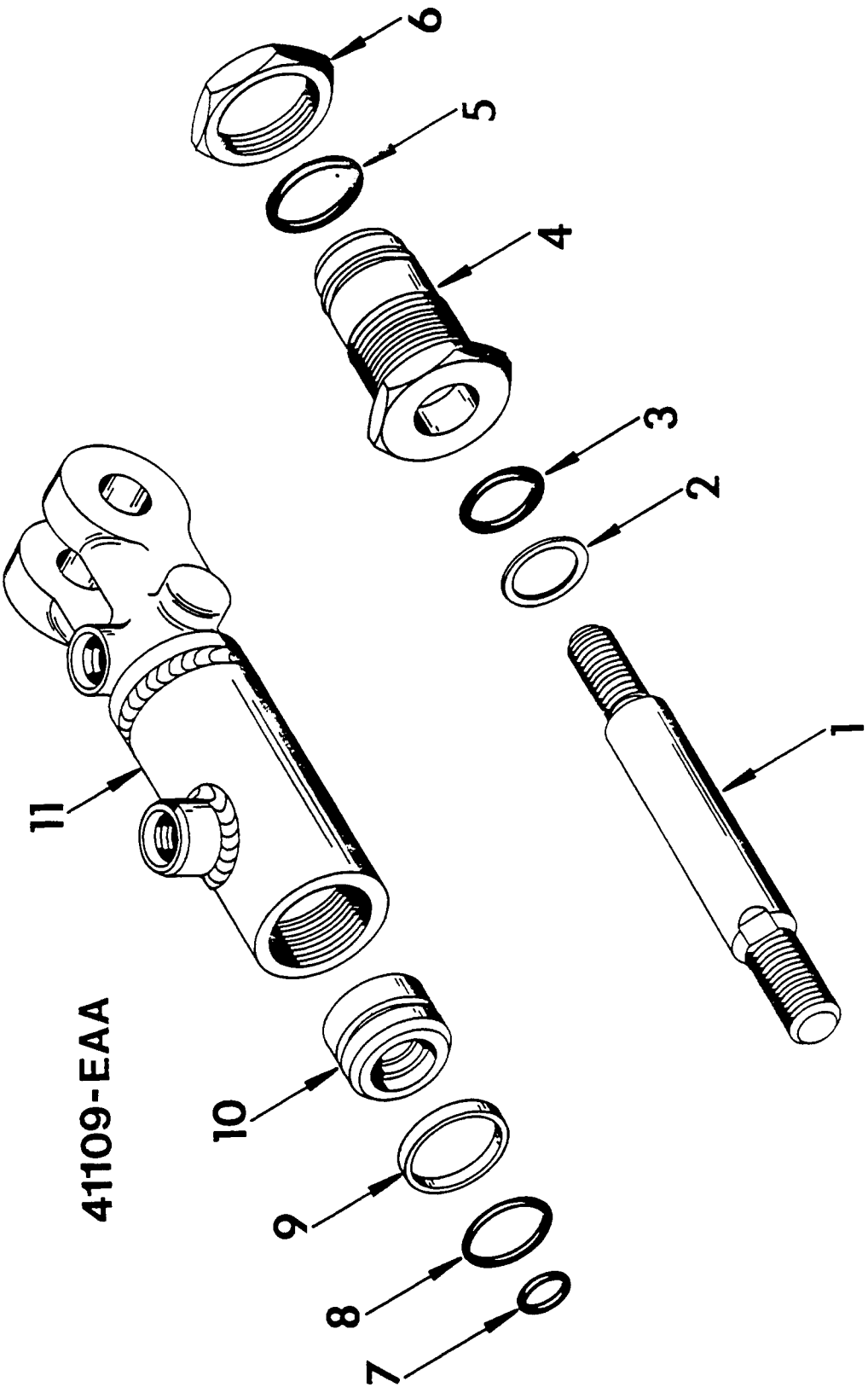
1. Thoroughly clean the outside of the cylinder.
2. Loosen bearing nut (6); unscrew and remove bearing (4).
3. Remove piston & rod assembly from the barrel (11).
4. Remove piston (10) from rod (1).
5. Remove all o-rings, back-up washers, and Teflon piston ring from all parts. These items should be replaced with the new items supplied in the cylinder seal kit.
6. Thoroughly clean and dry all parts.

Inspection

1. Remove nicks and burrs from all parts using emery cloth.
2. Inspect the I.D. of the barrel for excessive scoring and wear.
3. Inspect the rod for scratches and nicks.
4. Inspect the I.D. of the bearing for scoring and excessive wear.

Reassembly

1. All parts should be cleaned and thoroughly dried. Metal parts should be lightly oiled prior to reassembly.
2. Install new o-ring (3) and back-up washer (2) in the I.D. of bearing (4).
3. Install bearing nut (6) on bearing (4).
4. Install new o-ring (5) on O.D. of bearing (4).
5. Install new o-ring (7) on rod (1); install piston (10); then, torque to 14-16 ft/lbs.
6. Install new o-ring (8) and Teflon slipper ring (9) on O.D. of piston (10). The Teflon ring will stretch as it is installed on the piston and it must be compressed after installation, to help it return to its original size.
   Suggestion: A hose clamp could be used as a field tool to compress the Teflon piston ring.
7. Install bearing (4) on piston rod assembly.
8. Oil the piston liberally, then insert it in the barrel I.D. Push the bearing down until threads are engaged. Push the piston rod down its' full travel. Continue turning bearing in, until the distance from the top of the bearing to the end of the rod is 1.62 inches. Stop, and tighten the bearing nut (6) to 12-17 ft/lbs.
9. Cycle the cylinder and check for leaks.


6
5
4
3
2
1
11
10
9
8
7
41109-EAA

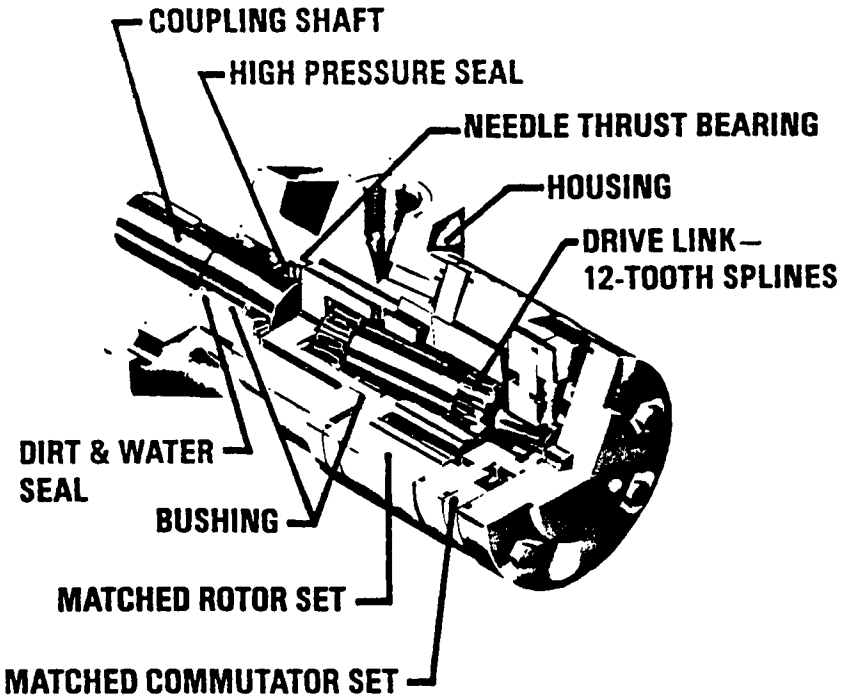
Torqmotor™

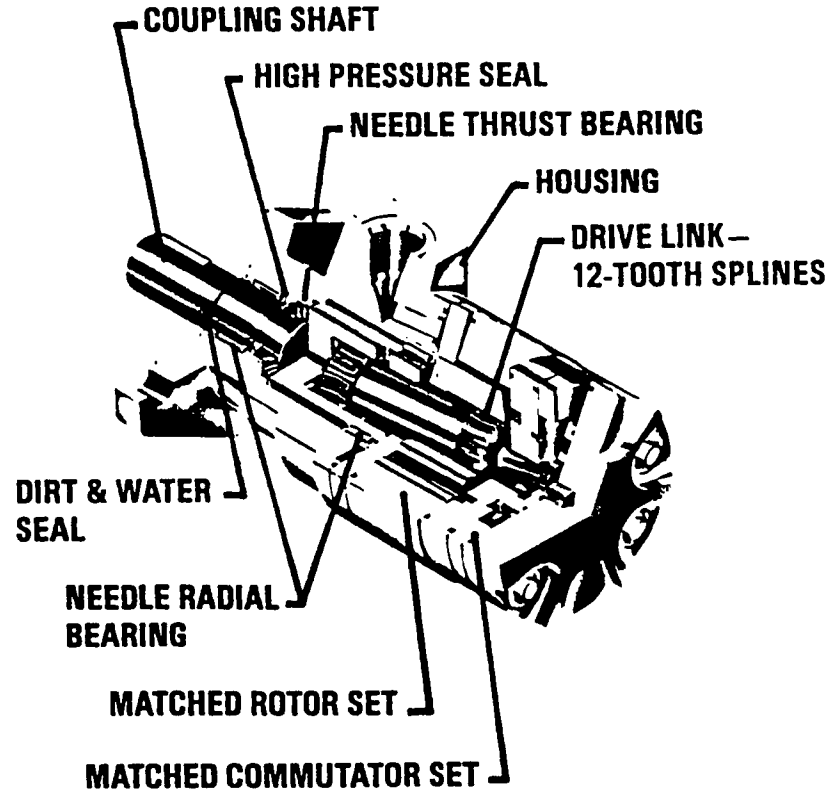
Service Procedure

MG, MF, MB, ME Series

REV.

Torqmotor™ Design Features





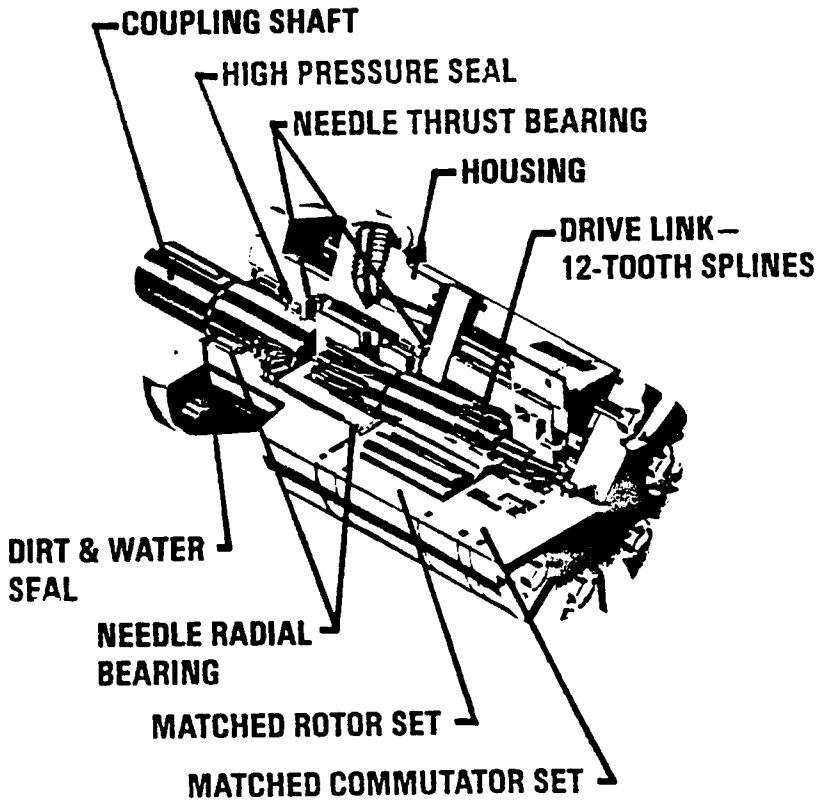
Torqmotor™ MG Series features include:

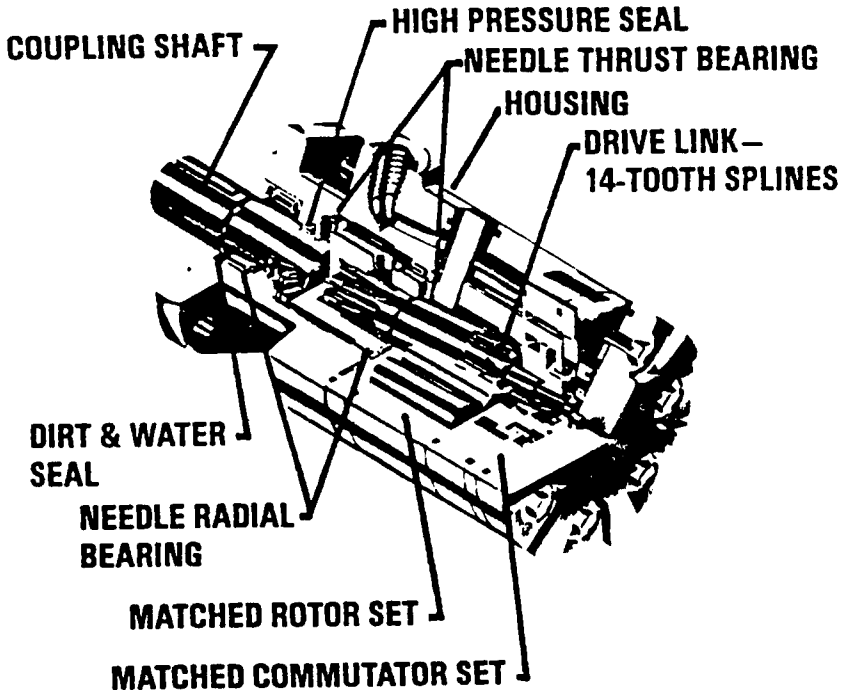
- The roller vane rotor set design offers a low-friction, wear compensation which maximizes the useful performance life of the motor
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency
- Design flexibility MG offers the widest selection of shaft options, displacements 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

	Page
Design Features	2 & 3
Definitions	4
Introduction	6
Troubleshooting Guide	7
Troubleshooting Check List	8
Tools and Material Required for Servicing	9
Bolt Torque	9
Exploded Assembly View	10
Dissassembly & Inspection	11
Assembly	19
Rotor Set Component Assembly Procedure (One Piece Stator)	29
Rotor Set Component Assembly Procedure (Two Piece Stator)	30
Final Checks	32
Hydraulic Fluids	32
Filtration, Operating Temperature	32
Tips for Maintaining the System	33

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.

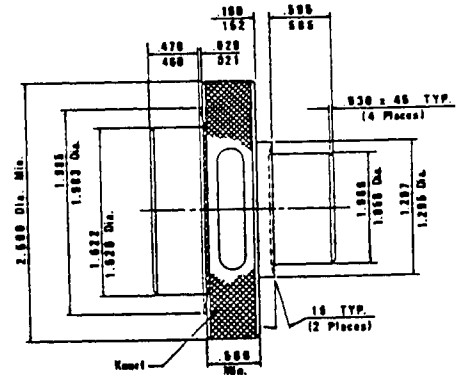
Clean corrosion resistant grease. Recommended grease is E/M Lubricant #K-70M, Ross Gear Specification #045236

NOTE: The available service seal kits include the recommended grease as a grease pack #406018

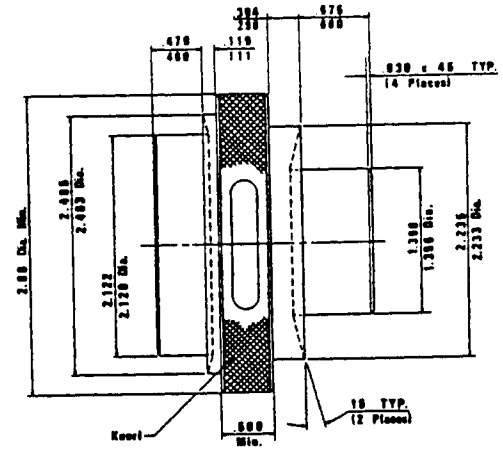
CAUTION: Mixing greases that have different bases can be detrimental to bearing life.

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

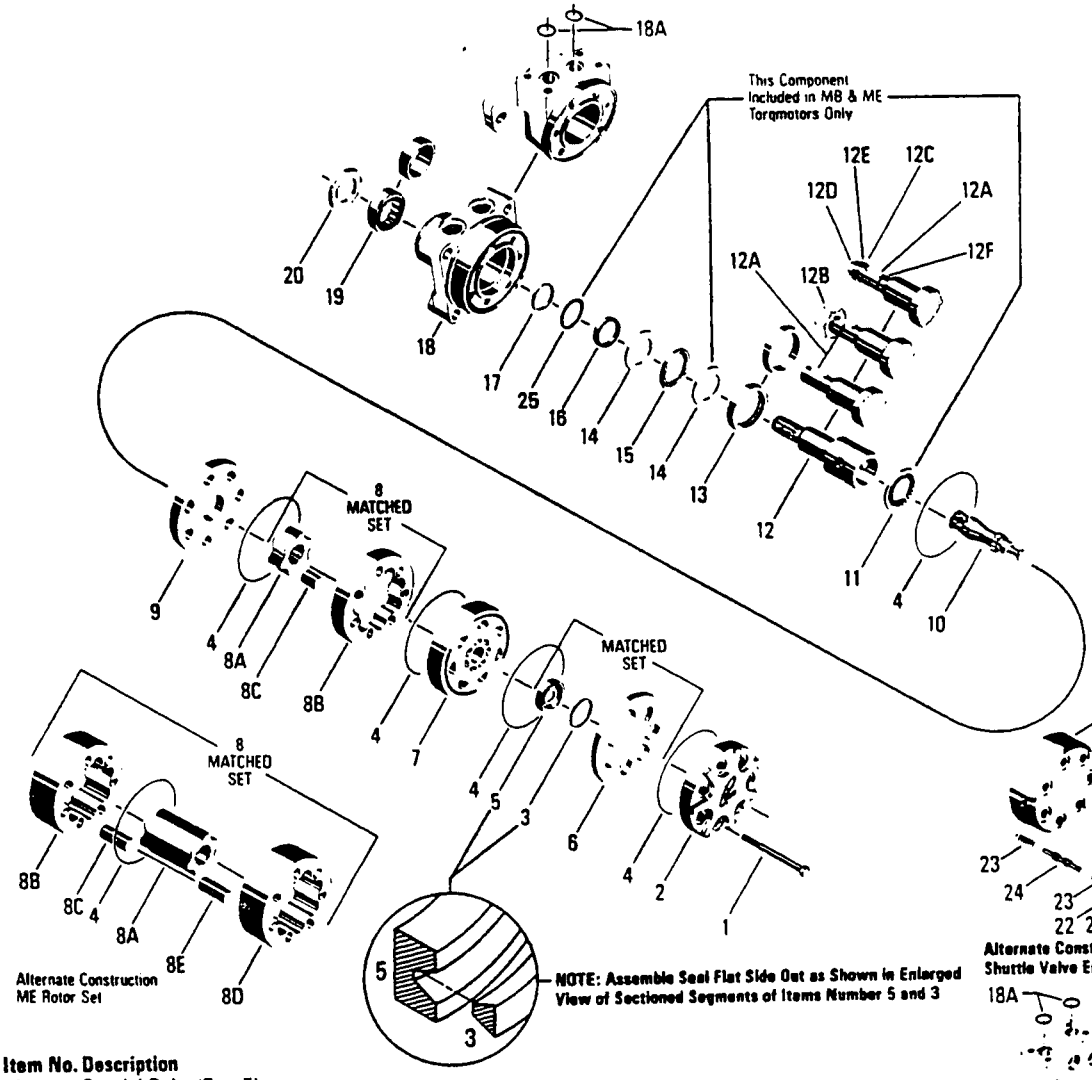


(Fabricate if considered necessary)
FIGURE 2—MB & ME

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



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.

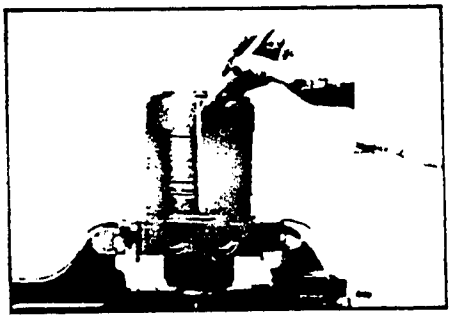


Figure 3

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.

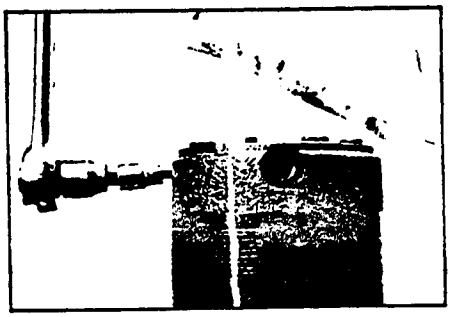


Figure 4

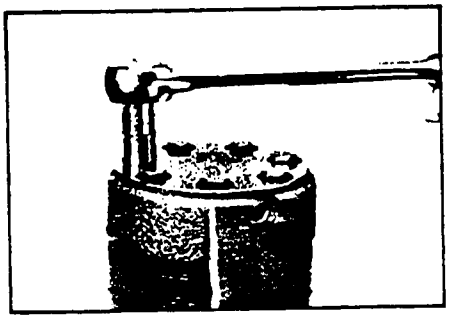


Figure 5

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.

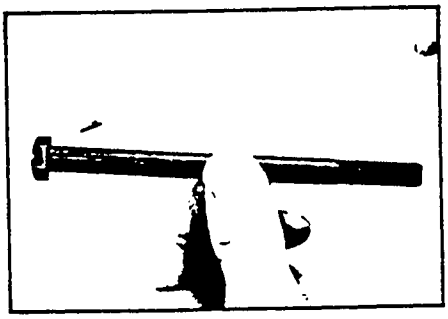


Figure 6

remove end cover & inspect bolts

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

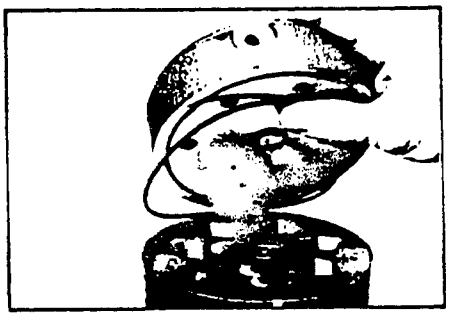


Figure 7

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.

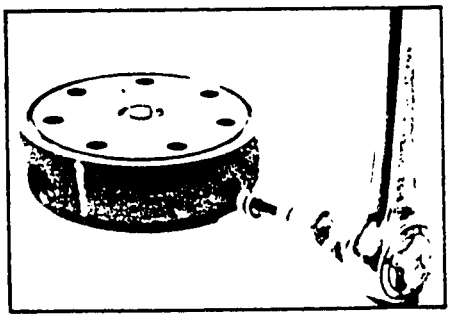


Figure 8

NOTE

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

NOTE

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

wash & inspect end cover

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

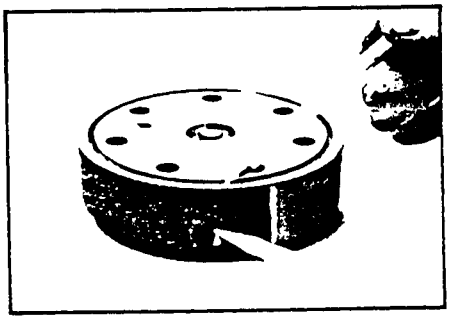


Figure 9

NOTE

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

remove & inspect commutator ring

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

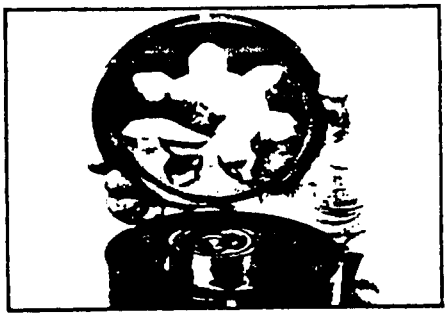


Figure 10

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.

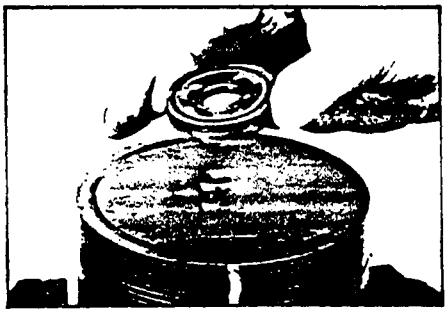


Figure 11

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.

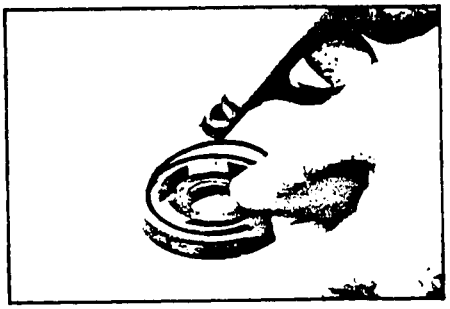


Figure 12

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

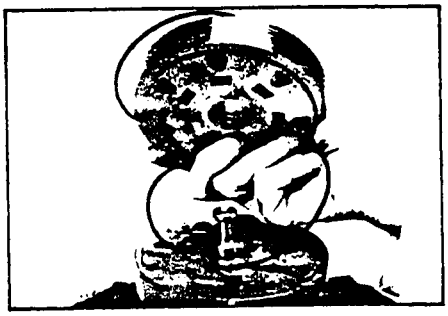


Figure 13

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.

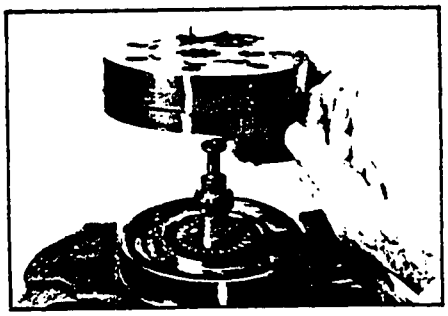


Figure 14

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.

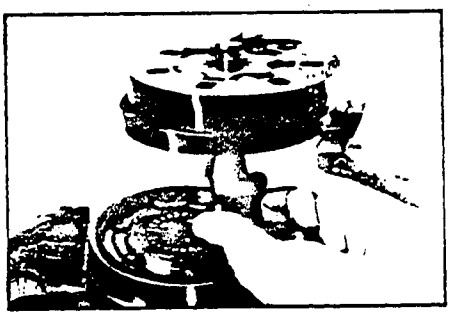


Figure 15

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.

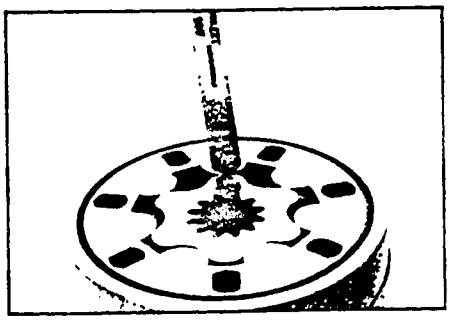


Figure 16

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)

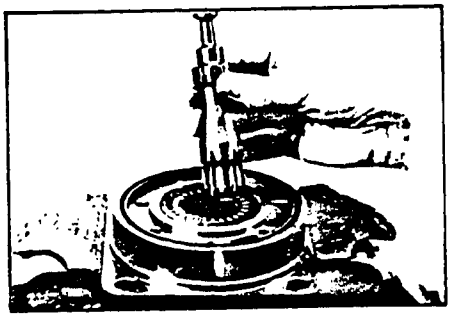


Figure 17

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.

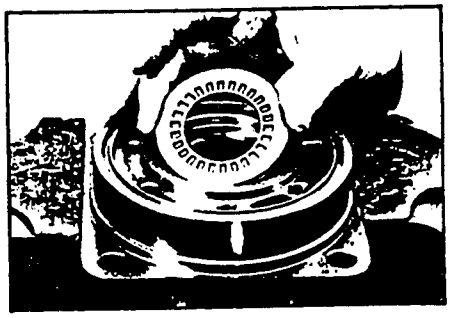


Figure 18

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).

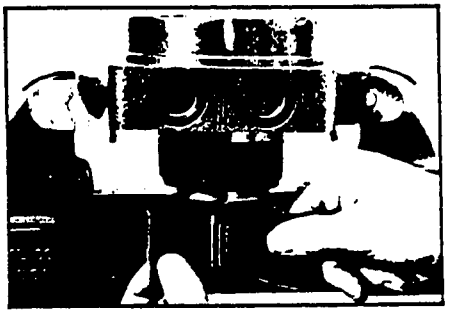


Figure 19

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.

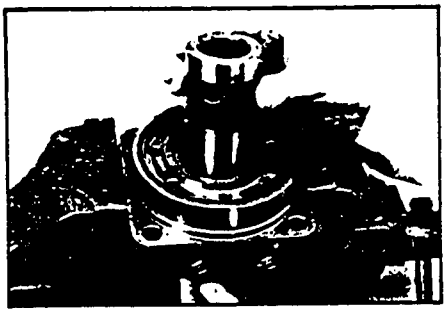


Figure 20

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.

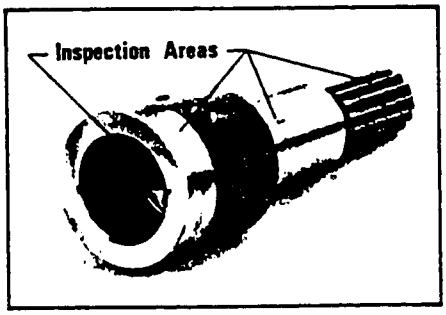


Figure 21

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.

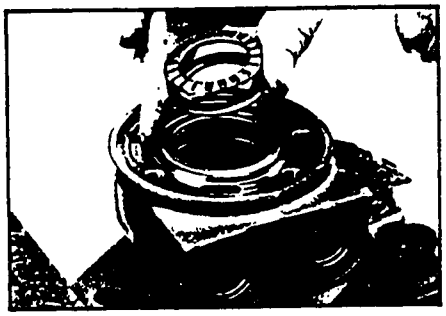


Figure 22

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.

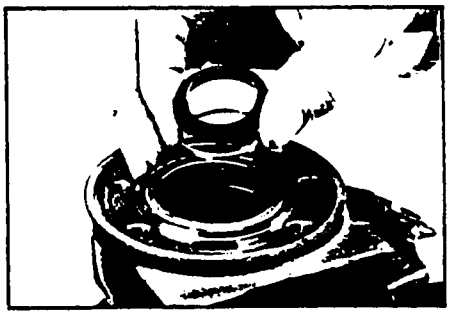


Figure 23

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.

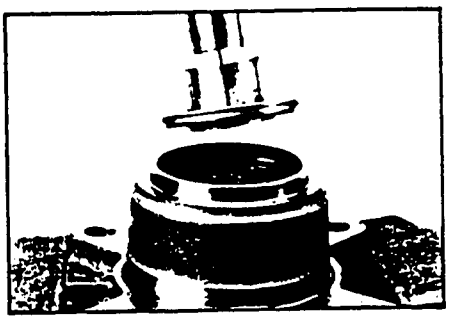


Figure 25

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.

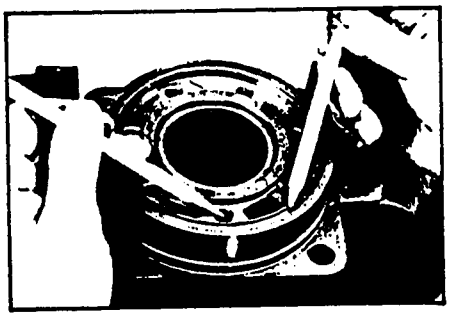


Figure 26

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.

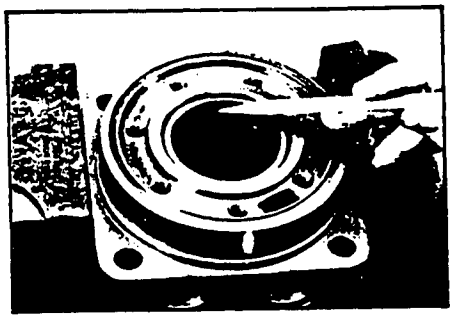


Figure 27

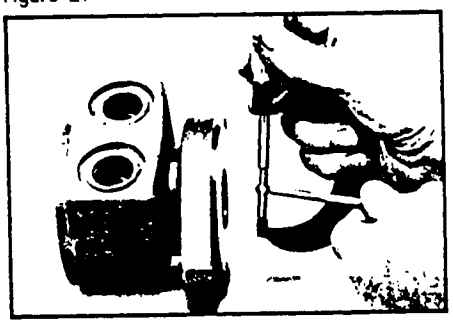


Figure 28

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.

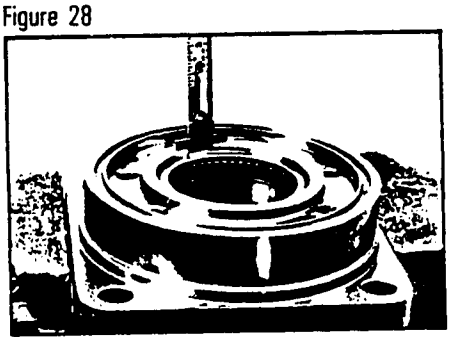


Figure 29

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.

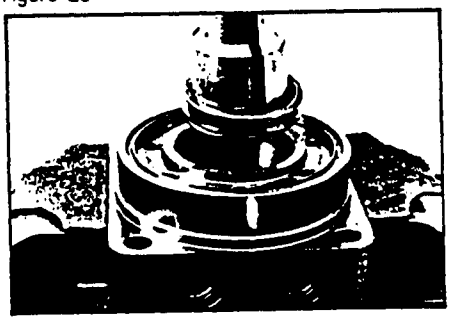


Figure 30

THE DISASSEMBLY OF TORQMOTOR IS COMPLETED.

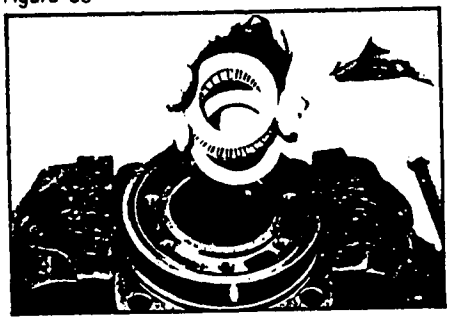


Figure 31

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.

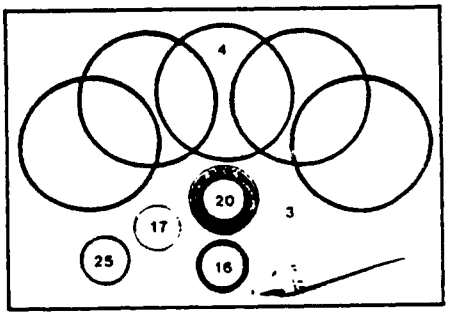


Figure 32 MB, ME seal kit

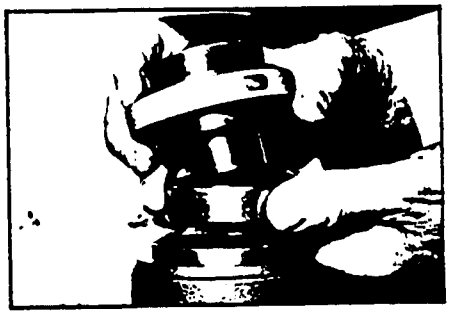
press in outer bearing/bushing

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.

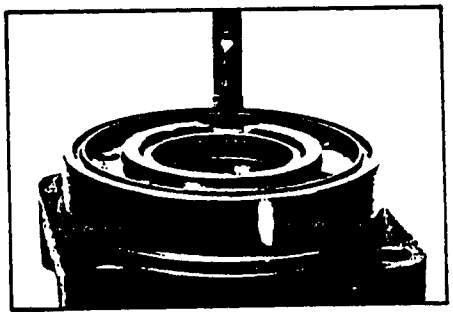


Figure 35

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.

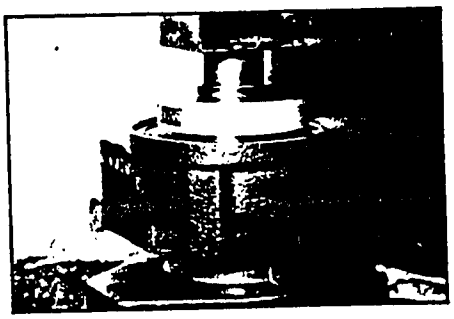


Figure 36

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.

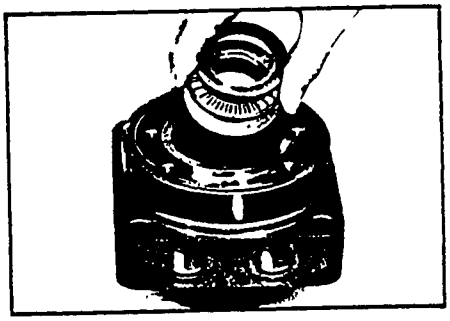


Figure 38

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

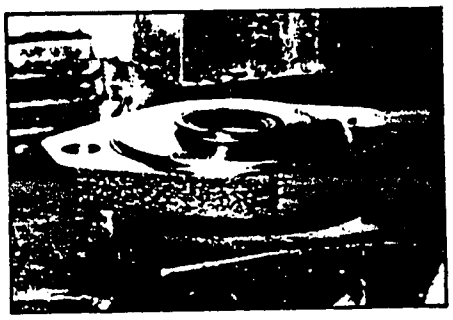


Figure 40

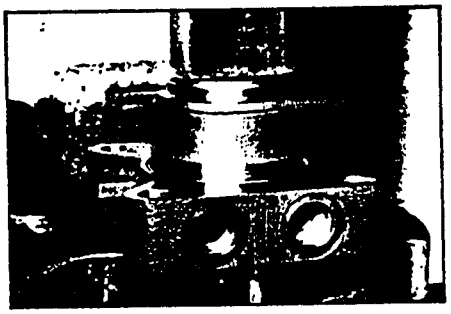


Figure 41

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.

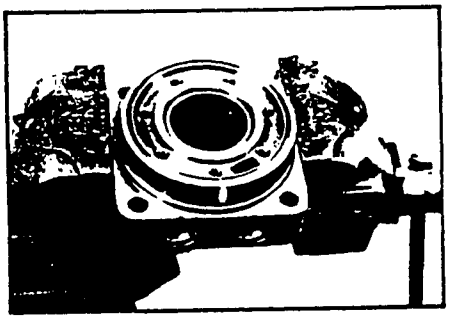


Figure 42

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.

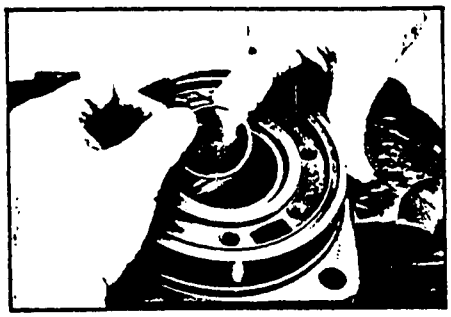


Figure 43

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).

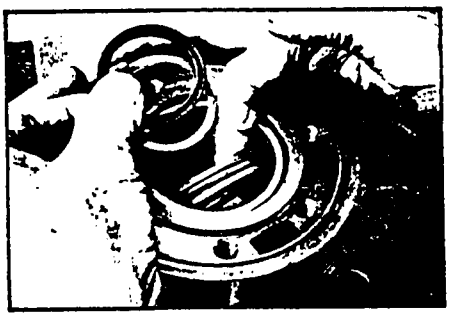


Figure 44

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.

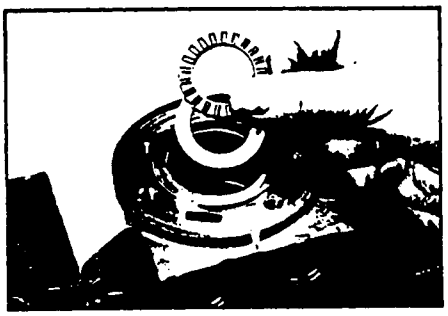


Figure 45

apply masking tape to shaft

7. Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal. SEE FIGURE 46.

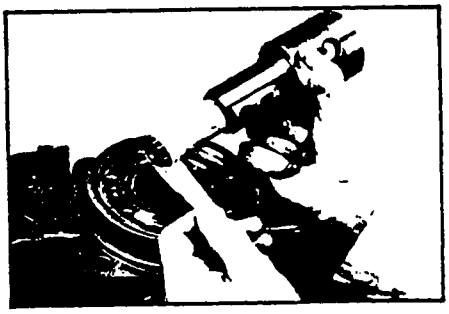


Figure 46

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.

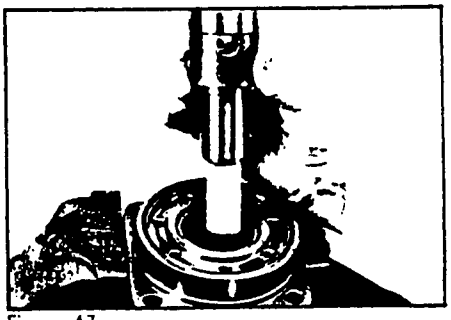


Figure 47

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.

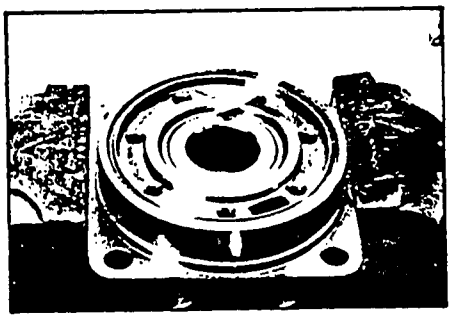


Figure 48

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.

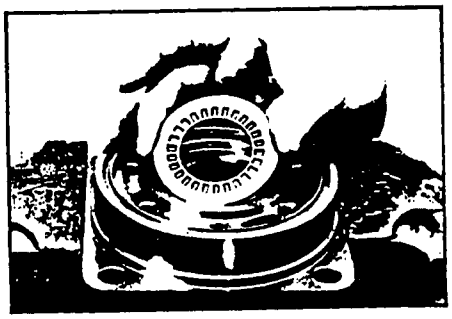


Figure 49

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.

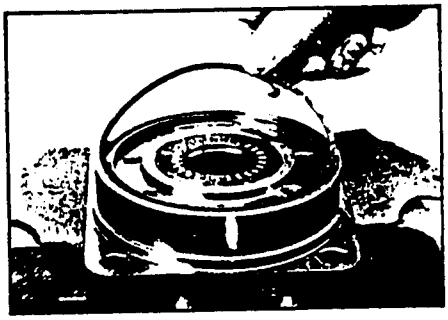


Figure 50

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.

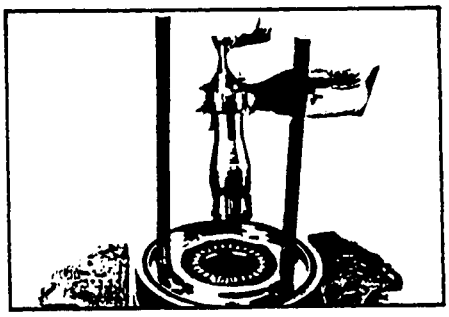


Figure 51

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.

assemble wear plate

12. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18). SEE FIGURE 52.

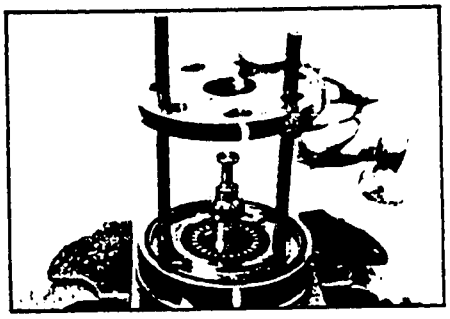


Figure 52

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.

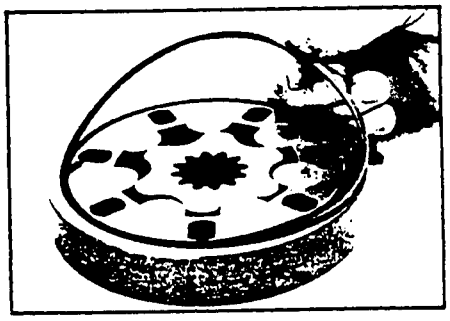


Figure 53

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.

NOTE

NOTE: If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure," on page 30 or 31.

NOTE

NOTE: The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down. The rotor set has a seal ring groove on the wear plate contact side of the stator (8B).

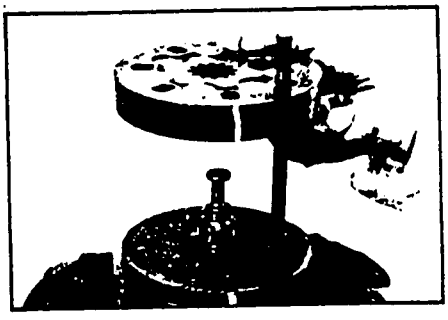


Figure 54

assemble seal ring in manifold

15. Apply clean grease to a **new** seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7). SEE FIGURE 55



Figure 55

NOTE

NOTE: The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.

assemble manifold

16. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set. SEE FIGURE 56.

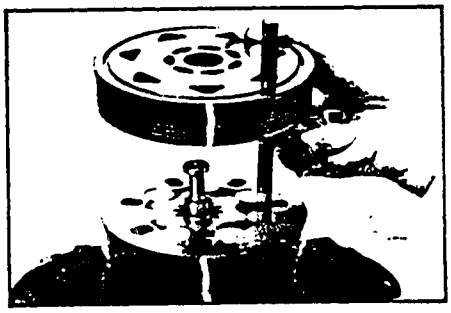


Figure 56

insert a seal in manifold

17. Apply grease to a **new** seal ring (4) and insert it in the seal ring groove exposed on the manifold. SEE FIGURE 57.

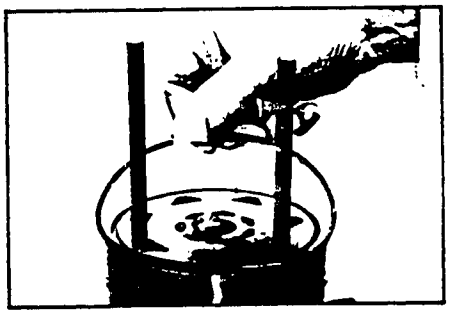


Figure 57

assemble commutator ring

18. Assemble the commutator ring (6) over alignment studs onto the manifold. SEE FIGURE 58.

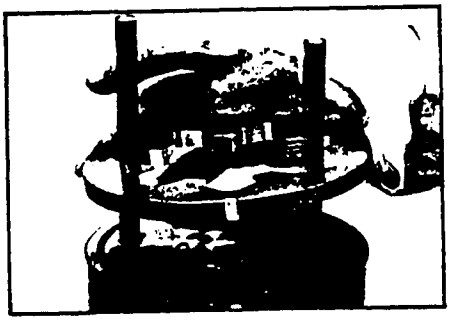


Figure 58

assemble seal & commutator

19. Assemble a **new** seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up. SEE FIGURE 59, 60.

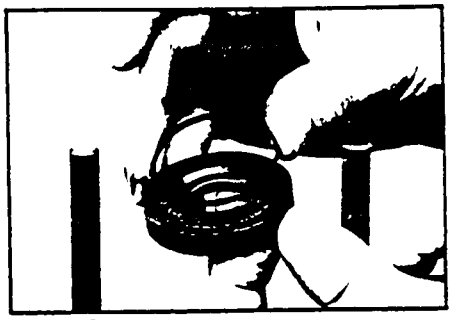


Figure 59

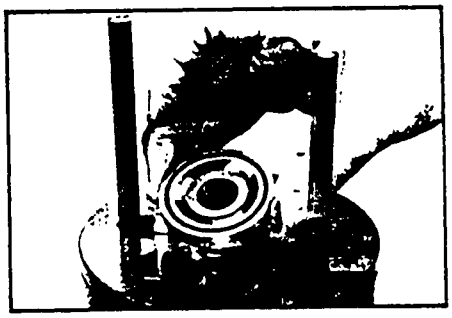


Figure 60

assemble shuttle valve parts into end cover

20. If shuttle valve components items #21, #22, #23, #24 were removed from the end cover (2) turn a plug (21) with a **new** o-ring (22), loosely into one end of the valve cavity in the end cover. Insert a spring (23) the valve (24) and the second spring (23) into the other end of the valve cavity. Turn the second plug (21) with a **new** o-ring (22) loosely into the end cover valve cavity. 3/16 inch Allen wrench required. SEE FIGURE 61.

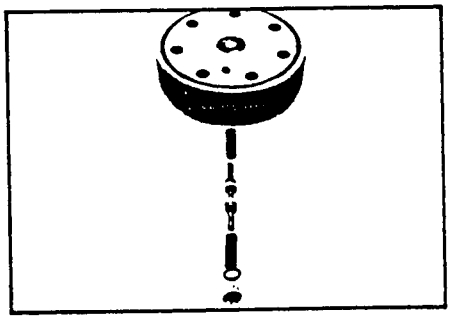


Figure 61

assemble relief valve parts in end cover

21. If relief valve components items #21, #22, #24 were removed from the end cover (2) assemble a **new** o-ring (22) on the two plugs (21). Assemble a two piece relief valve (24) in each of the plugs, with the large end of the conical spring into the plug first and the small nut of the other valve piece in the small end of the conical spring. Turn each of the plug and relief valve assemblies into the end cover loosely to be torqued later. 3/8 inch Allen or 1 inch Hex socket required. SEE FIGURE 62.

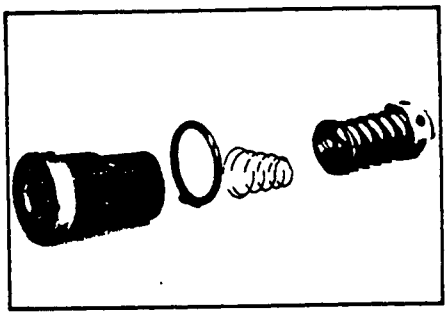


Figure 62

assemble seal ring & end cover

22. Assemble a **new** seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. SEE FIGURE 63, 64. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to housing port bosses is shown in FIGURE 65.

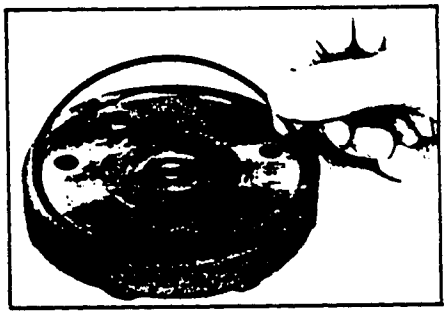


Figure 63

NOTE

NOTE: If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.

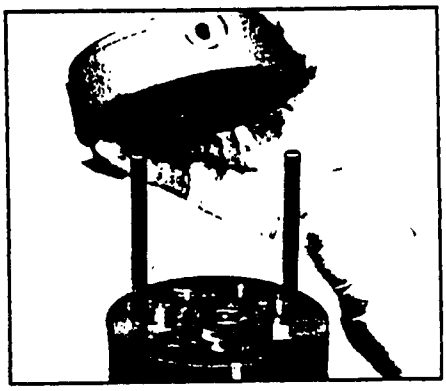


Figure 64

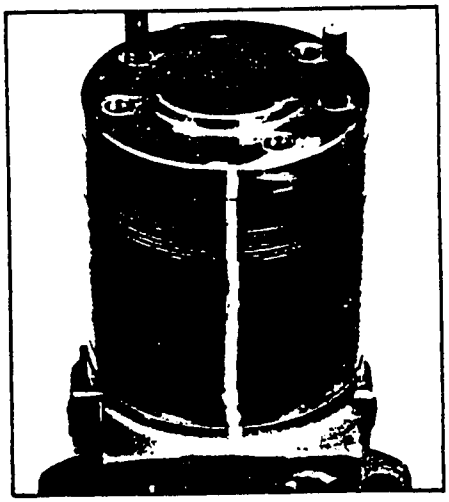


Figure 65

assemble cover bolts

23. Assemble the 5 or 7 special bolts (1, 1A, 1B or 1C) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 22-26 ft. lbs. (30-35 N m) for the five MG & MF Series 5/16 24 threaded bolts or 45-55 ft. lbs. (61-75 N m) for the seven MB & ME Series 3/8-24 threaded bolts. SEE FIGURE 66, 67, 68.

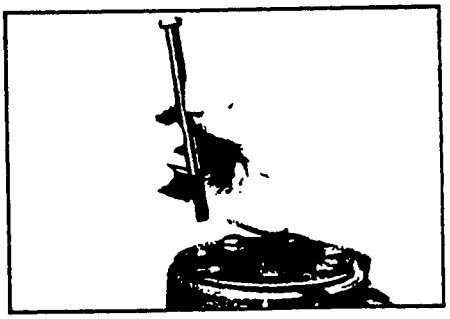


Figure 66

NOTE

NOTE: The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard end cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.

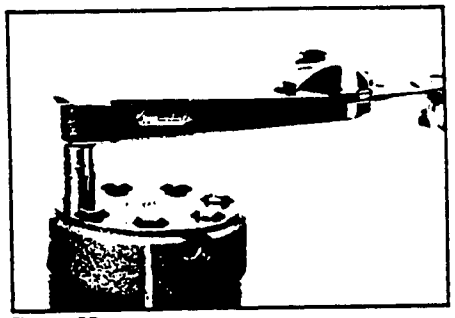


Figure 67

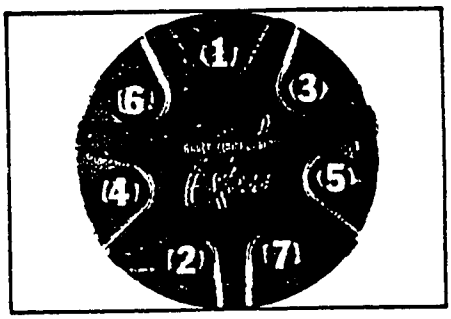


Figure 68

torque the valve plugs

24. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 N m) if cover is so equipped. SEE FIGURE 69.

    Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs. (61-75 N m) if cover is so equipped.

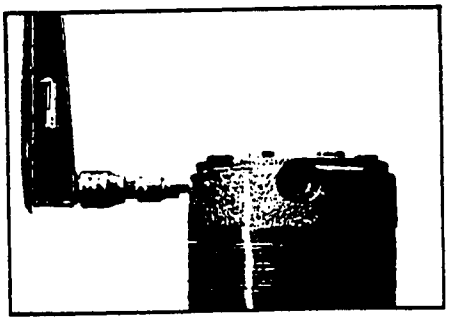


Figure 69

THE ASSEMBLY OF THE TORQMOTOR IS NOW COMPLETE EXCEPT FOR WOODRUFF KEY (12A), NUT (12B), WASHER (12C), BOLT (12D), LOCKWASHER (12E), RETAINER RING (12F) or PORT O-RINGS (18A) AT INSTALLATION IF APPLICABLE. SEE PAGE 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.

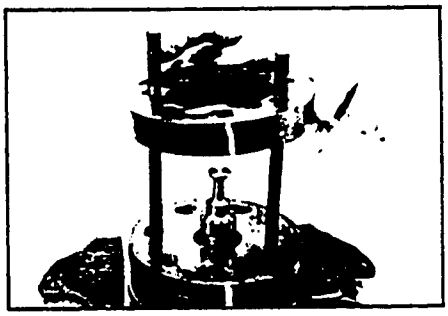


Figure 70

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.

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.

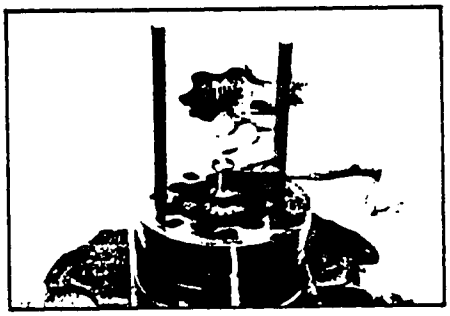


Figure 71

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.

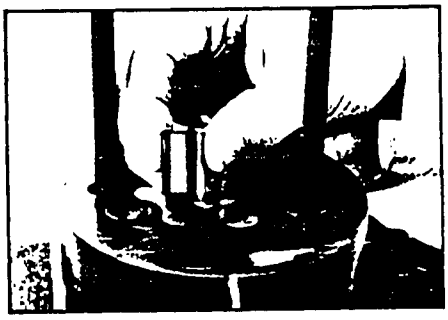


Figure 72

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.

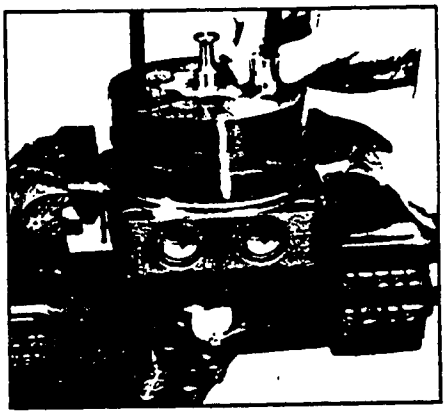


Figure 73

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.

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.