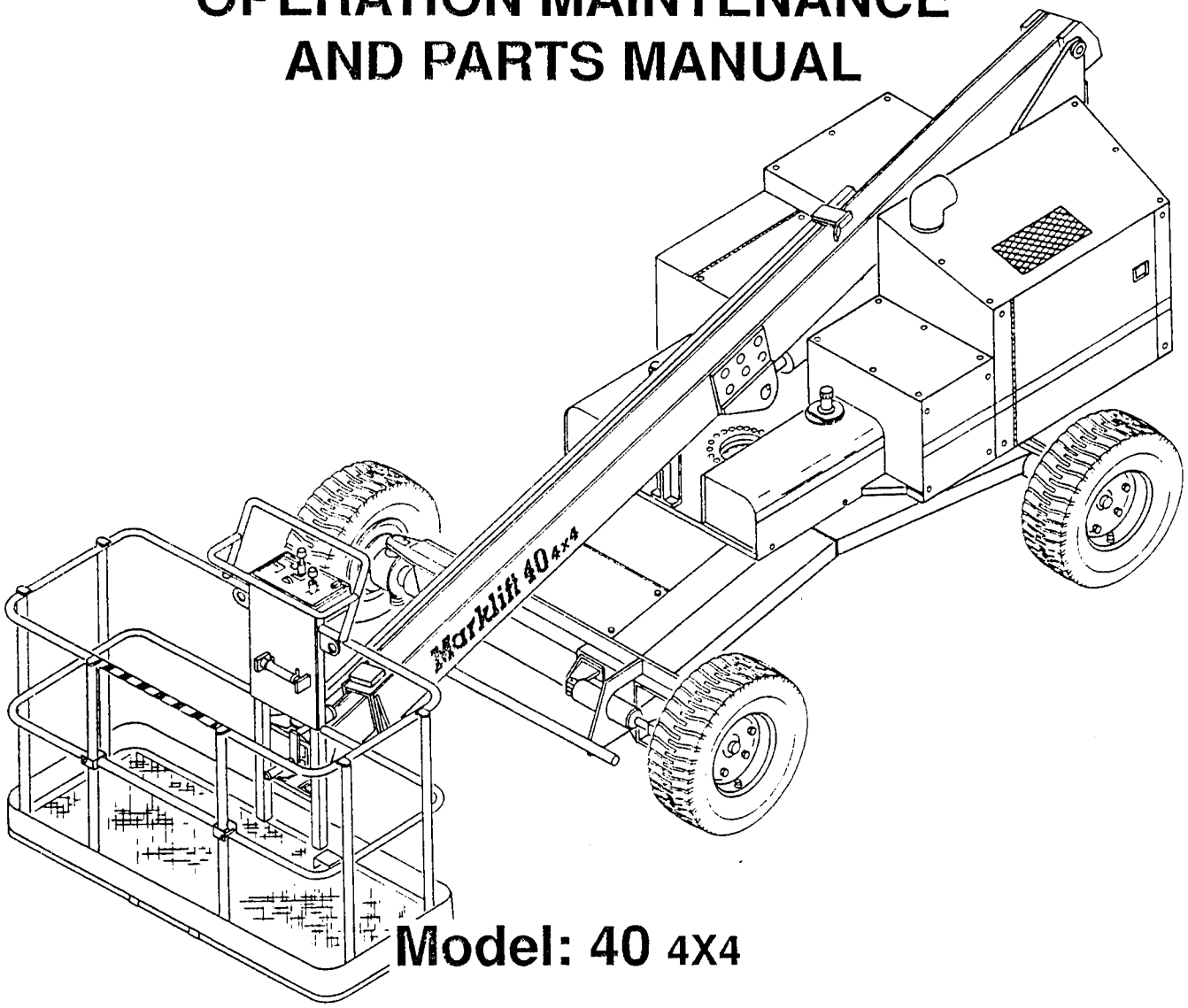
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED BOOM OPERATION MAINTENANCE AND PARTS MANUAL



Model: 40 4X4

FIRST EDITION: January 1990

Mark Industries

P.O. Box 2255
Brea, California 92622
205 South Puente Street, Brea, California 92621
(714) 879-6275, FAX (714) 879-8884

17129

Mark Industries

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Mark Industries

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INTRODUCTION

The purpose of this manual is to provide the customer with operation,safety, maintenance and parts information that will enhance the reliable performance of the **MARKLIFT.** Schematic and vendor information is also furnished. If additional information is needed, we urge the customer to contact the local dealer. If this is impossible, please contact the Mark Industries Service Department at (714) 879-6275.

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

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

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

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

Description	Model 40 4x4
Height –	
Working (maximum)	46'0"(14.02m)
Platform (maximum)	40'0"(12.19m)
Length (stowed)	24'8"(7.52m)
Width	8'0"(2.44m)
Platform dimensions	30"x 72"x 42"(.76m x1.83m x 1.07m)
Platform rotation	Manual - 180°
Horizontal reach	
centerline of rotation	33'6"(10.21m)
clear reach (curb)	29'6"(8.99m)
Load Capacity (unrestricted)	500 lbs.(226.8 kg)
Wheel Base	8'0"(2.44m)
Ground Clearance	14.5"(.37m)
Turning Radius (inside)	10'0"(.25m)
Power source	Wisconsin VH4D 30 HP Air Cooled
Hydraulic Tank Cap	20 gal (U.S.)
Tires	12x16.5 10 Ply Loader Lug
Weight	9,200 lbs.(4174.23 kg)
Hydraulic Pump	18.5 gal/min (4.89 liters/min)
Height (stowed)	6'10"(2.08m)
Turret rotation	Non-continuous 360°
Turret tailswing	26"(.66m)
Travel speed	3.5 mph(5.63 km/hr)
Controls	
Function	Solenoid
Drive	Proportional
Gradeability	21%

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

MANUFACTURERS' LIMITED WARRANTY

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

> Mark Industries warrants the products manufactured by Mark Industries to be free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment. This limited warranty does not extend to any product of another manufacturer or to any part, component, accessory or attachment not manufactured by Mark Industries. The warranty, if any, with respect to any product of another manufacturer or to any part, component, accessory or attachment not manufactured by Mark Industries is limited to the warranty, if any, extended to Mark Industries by the manufacturer of the other product, part, component, accessory or attachment.

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

The sole obligation and liability of Mark Industries under this limited warranty (and the exclusive remedy for any purchaser, owner or user of Mark Industries products) is limited to the repair or replacement, at the option of Mark Industries, of any product (or any part or parts on any product) manufactured by Mark Industries which, within one (1) year from the date of shipment, shall have been returned to the Mark Industries facility in Brea, California (or any other location within the United States as shall be designated by Mark Industries), at no expense to Mark Industries, and demonstrated to the satisfaction of Mark Industries as being defective in material or workmanship.

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

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

Mark Industries shall not be liable for any special, indirect or consequential damages. Further, no representation or warranty made by any person, including any representative of Mark Industries, which is inconsistent or in conflict with, or in addition to the terms of the foregoing limited warranty (or the limitations of the liability of Mark Industries as set forth above) shall be binding upon Mark Industries unless reduced to writing and approved by an officer of Mark Industries.

Tires, batteries, filter elements, electrical components are specifically excluded from this limited warranty.

Mark Industries

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

WARRANTY REGISTRATION

Purchaser

Company Name

Address

Telephone

Date shipment received

Date of invoice

Date unit put into service

Unit will be used

Unit will be sold

Unit will be used for:

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

Comments

Inspection completed by: Title:

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

NEW EQUIPMENT CONDITION REPORT

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

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

MODEL	SERIAL NUMBER
INSPECTOR	OPTIONS

CAUTION:	Due to the width of the **Marklift** as compared to the overall width of the trailer, extreme caution must be taken when loading and unloading.

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

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

2. Extend the boom in order to achieve the lowest travel speed. Use **LOW DRIVE** at all times when loading and unloading.

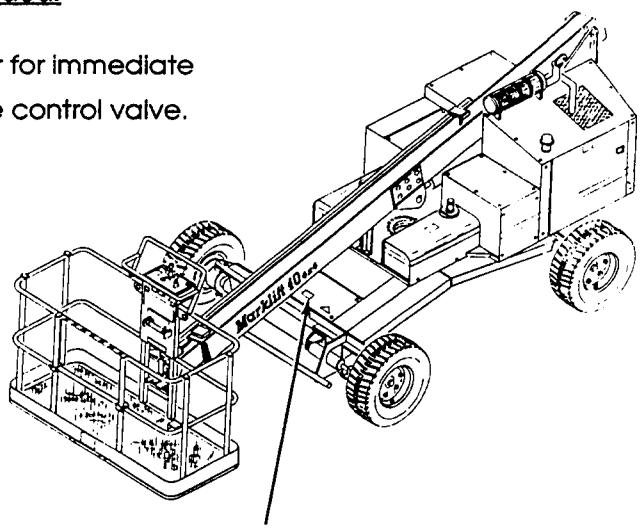


Figure 1: Parking Brake Control Valve

LOADING

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

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

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

4. When the Marklift is on the truck and properly located, chain the boom down as shown in Figure 3 of this instruction.



Figure 2: Loading the Marklift onto truck

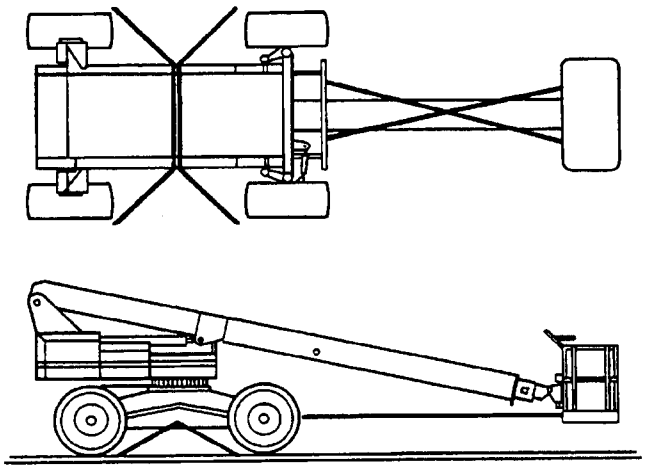


Figure 3: Securing the Marklift to the Platform

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. Select the low drive speed on the platform control console.

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

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

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

5. Re-adjust the boom parking brakes so that they apply immediately after the dynamic brakes stop the unit. The procedure for re-adjusting the parking brakes is as follows: First, close the needle valve completely. Open the valve 1/8 turn then place the unit on a flat surface, approximately 10 feet wide x 30 feet long. Position the boom slightly below horizontal and completely retract the boom. Select "High" drive speed at the platform controls. 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. Repeat this procedure, driving in both directions until the **MARKLIFT** comes to a complete stop within 18" to 24". The deceleration valves have been set at the factory and should not be readjusted without first consulting the **MARK INDUSTRIES** Customer Service Engineering Department. It is best to completely open the needle valve if the unit is to be driven on steep slopes or inclines.Very abrupt stops can be expected on flat surfaces if the drive controller is quickly released or returned to a neutral position.

WARNING: Do not drive on uneven, sloping or soft terrain unless the boom is fully retracted and raised just above horizontal.

BEFORE OPERATING THE MARKLIFT, REVIEW THE FOLLOWING PROCEDURES:

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

2. Check hydraulic oil level.

3. Check engine oil level.

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

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

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

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

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

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

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

11. The travel or drive arrangement is with the boom located over the boom's steering wheels. This provides the best weight distribution for maximum traction.

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

Every operator of the MARKLIFT must read, understand and follow the safety rules set forth herein. The **MARKLIFT** self-propelled aerial work platform is a personnel lifting device, and it is essential that it be properly maintained and operated to perform all functions with maximum safety and efficiency. The operation of any new and unfamiliar equipment can be hazardous in the hands of untrained operators.

1. Inspect the machine periodically as specified in the Inspection and Checkout, and Preventive Maintenance sections and as required by ANSI, OSHA, local safety boards and the owner. All unsafe items must be corrected by a qualified service 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. **Do Not** change, vary, or alter the equipment in any way.

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

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

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

11. The **MARKLIFT** is a non-insulated personnel carrier and must not be operated within 10 feet of a 50,000 volt line. (See Division Of Industrial Safety for required clearances from overhead high voltage lines.)

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

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

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

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

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

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

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

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

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

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 Y

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

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

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

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

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

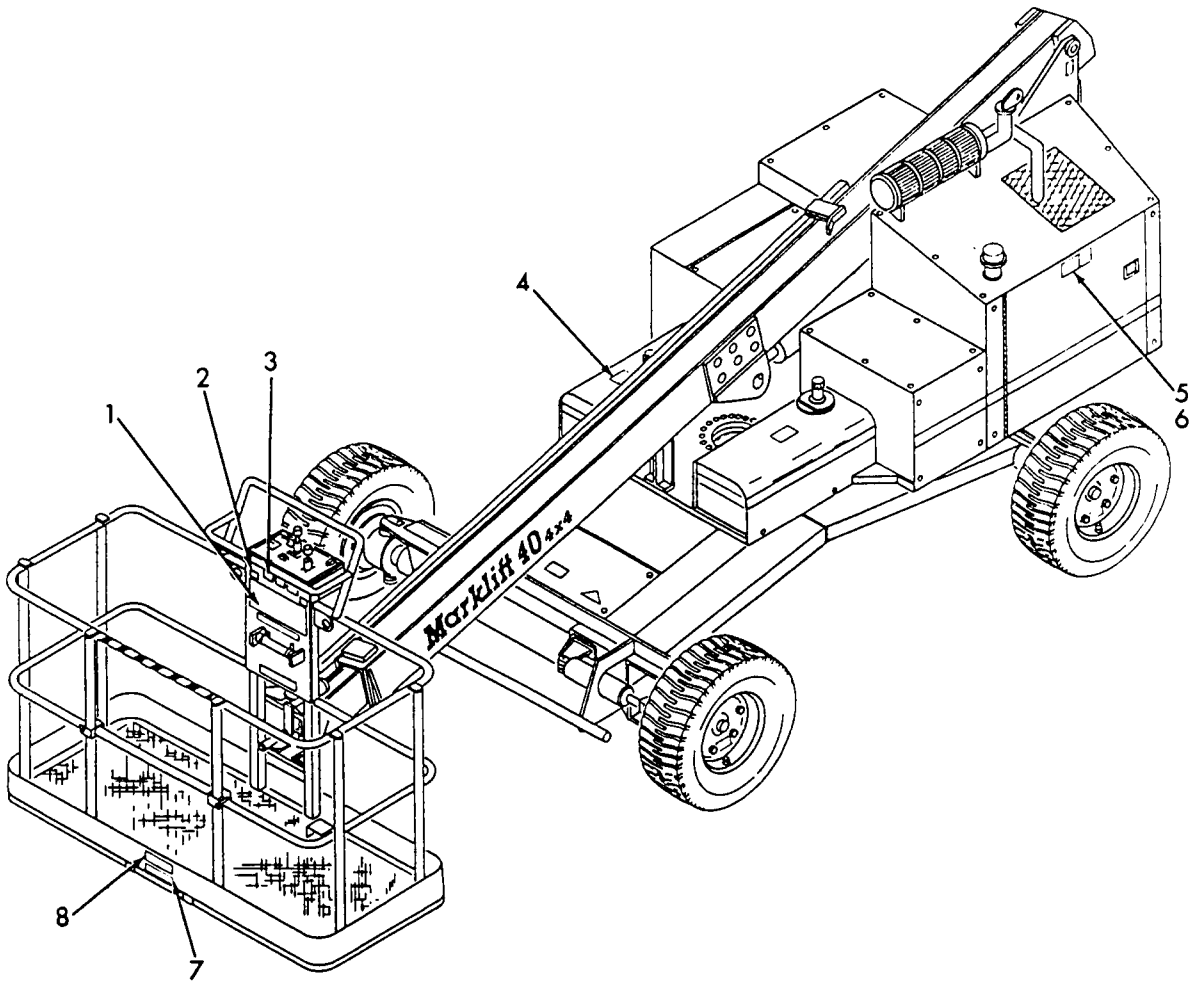
2947. **Warning Signs Required.** The owner, agent, or employer responsible for the operations of equipment shall post and maintain in plain view of the operator and driver on each crane, derrick, power shovel, drilling rig, hay loader, hay stacker, pile driver, or similar apparatus, a durable warning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

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

DANGER, WARNING, CAUTION AND EMERGENCY 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(s) illustrates a chart in which decals for the **MARKLIFT** can be replaced if the existing decal(s) is worn-out, torn, or illegible. This chart also refers to the decal's location and quantity used in that application.



CAUTION

UNLAWFUL TO OPERATE THIS EQUIPMENT WITHIN 10 FEET OF HIGH VOLTAGE LINES UP TO 50,000 VOLTS

REFER TO OPERATING HANDBOOK FOR SAFE DISTANCES AT HIGHER VOLTAGES

CAUTION

STANDARD AERIAL OPERATING PROCEDURE

1. WITH MASTER SWITCH AT GROUND CONTROL STATION TO 'ON' AND SELECTOR SWITCH TO 'AERIAL' ENTER PLATFORM, ATTACH YOUR SAFETY BELT FIRST, THEN START MACHINE. (DO NOT DEPRESS FOOT SWITCH WHEN ATTEMPTING TO START MACHINE)
2. TOGGLE SWITCHES ARE SOLENOID FUNCTIONS AND ARE OPERATED BY DEPRESSING FOOT SWITCH FIRST.

OPERATE ALL PROPORTIONAL FUNCTIONS IN THE FOLLOWING MANNER

A. DEPRESS FOOT SWITCH AND LIFT CONTROLLER LOCKING STEM UPWARD, BEFORE ATTEMPTING TO MOVE HANDLE FORWARD OR BACK.
B. MOVE CONTROLLER HANDLE SLOWLY IN DIRECTION DESIRED. FUNCTION SPEED WILL RESPOND IN PROPORTING TO AMOUNT OF HANDLE MOVEMENT.

DRIVE AND STEERING DIRECTION, AS INDICATED ON CONTROLS, APPLIES WHEN BOOM IS OVER STEERING WHEELS. THE DIRECTION IS REVERSED, WHEN BOOM IS OVER NON-STEERING WHEELS. (FORWARD TRIANGLE DECALS, ON BASE, ALWAYS INDICATE DRIVE DIRECTION CORRECTLY)

3. THE DRIVE SELECTOR SWITCH, ALLOWS THE MARKLIFT TO TRAVEL AT HIGHER SPEEDS, WHEN THE BOOM IS BELOW HORIZONTAL AND FULLY RETRACTED.

EMERGENCY OVERRIDE

DEPRESS FOOT SWITCH, THEN TURN ON EMERGENCY PUMP TO RESTORE CONTROLS. (IF UNIT IS SO EQUIPPED) OR – DEPRESS PROPER SWITCH FOR EMERGENCY BOOM DESCENT OR RETRACTION.

IT IS THE OPERATOR'S RESPONSIBILITY TO READ AND UNDERSTAND, THE OPERATION & SAFETY HANDBOOK AND ALL DECALS **BEFORE USING** THIS MACHINE!

MARK INDUSTRIES

20859

1

ATTACH SAFETY BELT

22386

2

⚠ DANGER

AN UNTRAINED OPERATOR
SUBJECTS HIMSELF AND
OTHERS TO

DEATH AND SERIOUS INJURY

YOU MUST NOT OPERATE
THIS "Marklift©" UNLESS
YOU HAVE BEEN TRAINED IN THE SAFE
OPERATION OF THIS MACHINE.

YOU READ, UNDERSTAND AND FOLLOW
1) THE "OPERATION AND SAFETY HANDBOOK"
FOR THIS MODEL.
2) YOUR EMPLOYER'S RULES.
3) APPLICABLE GOVERNMENT REGULATIONS.

YOU INSPECT UNIT AND ALL FUNCTIONS.

101102

3

2020

GASOLINE OR PETROL

4

DANGER

ELECTROCUTION HAZARD
KEEP CLEAR

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

20419

5

⚠ DANGER

FAILURE TO OBEY THE FOLLOWING

CAN RESULT IN
DEATH OR SERIOUS INJURY
TO YOU OR OTHERS

- UNLAWFUL TO OPERATE THIS "Marklift©" WITHIN 10 FEET (3.05 METERS) OF HIGH VOLTAGE LINE UP TO 50,000 VOLTS.

VOLTAGE (PHASE TO PHASE)	MINIMUM SAFE APPROACH DISTANCE	
	(FEET)	(METERS)
OVER 50,000 TO 200,000 VOLTS	10	4.92
OVER 200,000 TO 350,000 VOLTS	20	6.10
OVER 350,000 TO 500,000 VOLTS	25	7.62
OVER 500,000 TO 750,000 VOLTS	35	10.67
OVER 750,000 TO 1,000,000 VOLTS	45	13.72

- ATTACH YOUR SAFETY BELT FIRST!
- BE SURE TO USE ALL SAFETY EQUIPMENT AS REQUIRED BY O.S.H.A.
- DO NOT LOAD BEYOND RATED CAPACITY.

101103

6

ATTACH YOUR SAFETY BELT FIRST!

CAUTION — OPERATING THIS MACHINE WITHOUT CORRECT SAFETY BELT ATTACHMENT COULD RESULT IN DEATH OR SERIOUS INJURY — CAUTION

22385

7

LOAD CAPACITY 500 LBS.
(EVENLY DISTRIBUTED LOAD)

2022

8

GENERAL DECALS
40 4x4

DECAL P/N	DECAL DESCRIPTION 40 4X4	ASSEMBLY	QTY
67960	All Standard Decals	Final Assembly	1
23721	Ground Control Console	Lower Control Panel	1
185707	Power to Platform 110 VAC	Final Assembly	1
20412	Blue Stripes - Round Ends	Final Assembly	1
182748	Cover, Aerial Control Box	Final Assembly	1
182749	Rear Side, Aerial Control Box	Final Assembly	1
20660	Nameplate, Identification	Final Assembly	1
20661	Plate, ANSI A92	Final Assembly	1
20408	Boom Marklift	Final Assembly	2
20872	40	Final Assembly	2
22740	4X4 4WD Booms	Final Assembly	2
21237	Grease Fitting	Final Assembly	2
181102	Danger, Do Not Operate Unless...	Final Assembly	2
181103	Danger, Obey The Following	Final Assembly	2
20508	Transportation	Final Assembly	2
2017	Hydraulic System Fluid	Final Assembly	2
2020	Gasoline or Petrol	Final Assembly	2
20461	Forward Arrow	Final Assembly	1
20462	Forward Arrow Aft	Final Assembly	1
20409	Standard Pedestal (Marklift)	Final Assembly	1
20410	Logo Mark Industries	Final Assembly	1
23195	A Product Of Mark Industries	Final Assembly	1
2003	Battery Water Level	Final Assembly	1
20859	Caution: Aerial Operation Instructions	Final Assembly	1
22386	"D" Ring, Attach Safety Belt	Final Assembly	2
22385	Caution Attach Your Safety Belt	Final Assembly	1
20411	Blue Stripe Square End	Final Assembly	1
2022	Load Capacity 500 lbs.	Final Assembly	1
22959	Tire Pressure 50 PSI	Final Assembly	8
130820	Operation & Safety Handbook	Final Assembly	1
20860	General Checkout & Operation Instr.	Final Assembly	1
20419	Danger Keep Clear	Final Assembly	2
20879	Dipstick	Final Assembly	1
182302	Light and buzzer indicate danger...	Final Assembly	1

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

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

"EXTENSIBLE AND ARTICULATING BOOM PLATFORMS"

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

2. Only authorized persons shall operate an aerial lift.

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

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

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

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

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

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

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

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

DUAL FUEL SYSTEM (Optional)

The 40 4x4 **MARKLIFT** is equipped with a dual fuel system which allows the operator to select gasoline or propane operation. The 3-position selector switch, located on the aerial control console, energizes solenoid valves which close one fuel line and open the other.

1. STARTING

The engine should be started with propane. The propane system bypasses the fuel pump and carburetor bowl and supplies fuel directly into the carburetor for quick starting. If the engine has been running on propane and an attempt is made to start the machine using gasoline, more than normal cranking and battery drainage is required for the fuel pump to fill the lines and carburetor bowl with gasoline.

Turn the master switch at the ground control station to "ON". Position the selector switch to "Aerial". Enter the platform and **attach safety belt**. Pull open the red emergency stop switch cover located on the top right of the aerial control box. Turn the anti-restart switch counter-clockwise to "Off" then clockwise to the "Start" position. Release the anti-restart switch after the engine has started.

Switching From Propane to Gasoline

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

Switching From Gasoline to Propane

With the engine running, step on the footswitch and position the throttle switch to "HI" speed. Set the fuel selector to "OFF". The engine will continue to run as it uses fuel from the carburetor bowl. When the engine begins to stall, allow it to run several

seconds and then switch to propane. Switch the throttle to "LOW" and release the footswitch. Let the engine idle for 20-30 seconds to completely burn up any remaining gasoline in the bowl.

2. **DRIVE**

Forward and reverse drive is achieved from the aerial control box only.
For the drive to function, the operator must use both the forward/reverse controller and the footswitch. The controller has a single-axis and must be pushed in the desired direction.

3. **STEERING**

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

4. **LIFT/LOWER**

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

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

5. **EXTENDING/RETRACTING**

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

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

6. **TURRET ROTATION**

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

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

7. WARNING LIGHT AND BUZZER

As a special safety feature, the **MARKLIFT** is equipped with an "out-of- level" sensor that will alert the operator whenever the **MARKLIFT** is in an unsafe out-of-level position. An unsafe out-of-level condition is sensed by the level sensor when the machine is tilted 5° in any direction.

The unsafe condition is indicated by a red warning light and buzzer which act as a warning device only. When the warning light and buzzer are on, boom functions will not cutout. Should the warning signals come on, maneuver the MARKLIFT until it is on a flat, level operating surface.

8. Engine Stopping

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

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

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

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

DAILY (BEFORE USE ON EACH WORK SHIFT)

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

WEEKLY

1. Check the condition of the tires. Make sure they are free of serious cuts or defects.
2. Check that operation and safety decals are in place and readable.
3. Check for proper brake operation.
4. Optional Record hour meter reading.
5. Clean unit by removing all dirt, oil, and grease. The machine may be washed with soap and water.
6. Check for and correct any hydraulic leaks.

7. Check for and correct any structural damage.

8. Check overall performance.

9. Check for wear on cables and hoses.

MONTHLY (or first 50 hours)

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

2. Check battery condition.

3. Change the hydraulic oil return filter.

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

5. Grease steering linkage.

EVERY SIX MONTHS (or 100 hours)

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

2. Change pilot filter element. (See lubrication instructions.)

3. Change the hydraulic oil return filter.

EVERY YEAR

1. Re-pack all wheel bearings.

2. Change the hydraulic oil.

3. Change the hydraulic oil return filter.

LUBRICATION INSTRUCTIONS

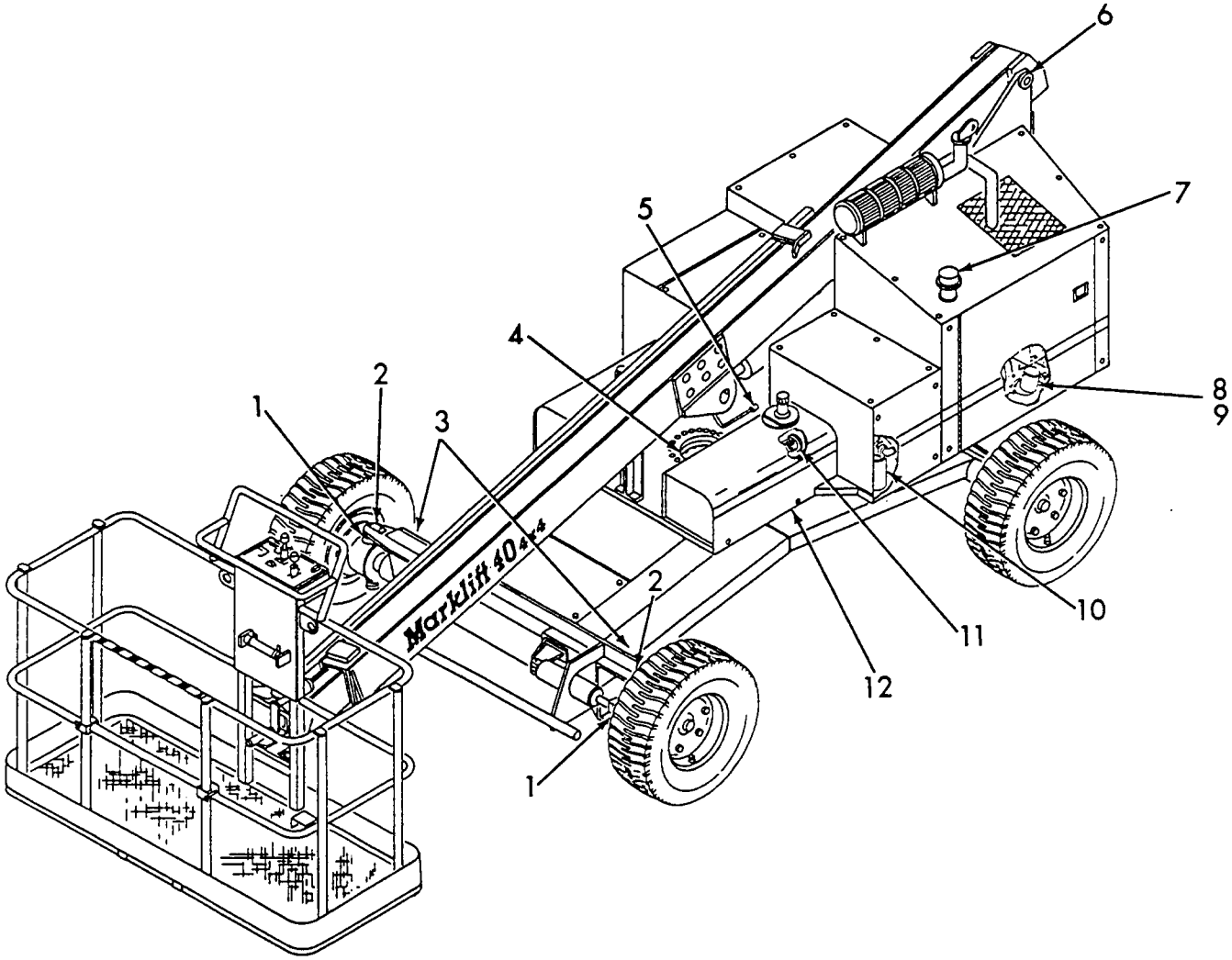
Item	Description*	Lubricant	Frequency
1.	Brake Carrier	Grease-Mobil VA6L36AG	Quarterly
2.	King Pins	Grease-Mobil VA6L36AG	Monthly
3.	Tie Rod Ends	Grease-Mobil VA6L36AG	Monthly
4.	Ring Gear	Grease-Mobil	Monthly
5.	Fuel Filter	Change (160061) M I VA6L36AG or Equivalent**	Every 100 hrs.
6.	Pivot Pin	Grease-Mobil VA6L36AG	Monthly
7.	Air Cleaner	Clean	Weekly or as needed
8.	Engine Oil Filter	Change	As Eng. Mfg. Recommends
9.	Engine Oil	Change	As Eng. Mfg. Recommends
10.	Hydraulic Oil Filter	Change (21245) M I	Every 100 hrs.
11.	Hydraulic Tank Strainer	Clean (81183) M I	Yearly
12.	Hydraulic Oil	Change (ATF Dexron II)	Yearly

* See Following Page for Locations

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

Lubrication Instructions

40 4x4



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

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

TEMPERATURE/SPECIFIC GRAVITY CORRECTION TABLE FOR BATTERIES

ACTUAL HYDROMETER READING AT ACTUAL TEMPERATURE

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

Specific Gravity

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

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.

AVOID BATTERY HAZARDS !

Batteries produce flammable and explosive gasses. Keep arcs, sparks, flames and lighted tobacco away.

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.

Protecting Engines for Winter

To protect the cylinderss, 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.

HYDRAULIC SYSTEM

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

The **MARKLIFT** employs the latest components in mobile hydraulic equipment. The hydraulic circuit contains 2 two-stage engine driven hydraulic pumps. One stage is for the drive function only, the other stage is for the steer and boom functions. The drive stage of the pump supplies the drive manifold. The drive manifold contains a bypass compensator, a load sense shuttle, a relief valve, and a proportional control valve. The bypass compensator acts as a dump valve, returning all of the drive pump output back to the hydraulic tank when the pump is running and the proportional drive valve is not energized. As the drive controller is moved, flow is automatically diverted proportionally from the tank to the drive motors. The relief valve insures that the pressure will not exceed the drive system requirement and damage the pump.

Manifold Relief Valve

The manifold pressure relief valve insures that the manifold pressure does not exceed the maximum pressure rating for the pump.

Dump Valve

The dump valve allows all of the flow from the secondary stage pump to free flow back to the hydraulic tank. The dump valve closes to pressurize the manifold when any function is activated. This provides fuel economy, over-all efficiency and minimizes oil heat build up.

Directional Control Valve

The directional control valves for the steer and rotation functions provide flow in the proper direction upon demand.

Three Way Valves

The three way valves provide flow to the function when electrically activated. They are normally closed in design allowing the function to be connected to tank in a neutral or a de-energized condition.

Crossover Relief Valves

The cross over relief valves for the rotation function limit the pressure which limits the force of the boom rotation function. This limits the possibility of damage to the boom if rotated into an obstacle.

Extension Relief Valve

The extension relief valve limits the force of the extension cylinder when it is being extended. This provides protection from damage to the extension cylinder rod if the boom is extended into an obstacle.

Over-center Valves

The over-center valves in the slave leveling circuit provide protection to the circuit from over pressure when the slave leveling cylinder is bottomed out and the boom is being lifted or lowered (the movement of the boom drives the master leveling cylinder which would cause the pressure to rise to the over-center relief setting).

Electrical System

The **MARKLIFT** electrical system is very straight forward and easy to trouble shoot because of it's simplicity. There are two major junction boxes which also serve as the ground and aerial control consoles. The source for the electrical system is a 12 volt battery with a negative ground. All electrical components operate directly from the source through either switches or a proportional controller.

The ground control console houses the necessary switches for starting and stopping the engine; a selector switch for isolating either the ground or aerial control console, and the required toggle switches for moving the boom. The ground control console also contains a keyed ignition/start switch, as well as an engine stop switch, ammeter, and fuel gauge. When the selector switch is placed in the aerial position, the electrical source is routed to the aerial control junction box. The intent of the footswitch is to provide an additional safety interlock in the control circuit to produce foot as well as hand movement by the operator, thereby requiring maximum operator attention. The function of the footswitch only completes the electrical circuit to the aerial control console and engine throttle. **The footswitch is not directly connected to the drive braking system.**

The aerial control console is equipped with a controller and all switches necessary to operate the boom functions, as well as drive and steer. It also contains a start/stop and an emergency pump switch. Your **MARKLIFT** is equipped with a proportional control valve for turret rotation and the drive function. The aerial control console contains electrical controllers complete with manual lockout rotation for the drive function. The controllers are spring-centered and are designed to produce a variable output signal to the control valve. The output signal is directly proportional to the handle movement on the controller. The valve is electrically coupled to the controller and responds only to the signal level transmitted to it by the operator.

The operator must learn how to move the controller slowly to obtain a smooth transition from start up to wide open and back to neutral.

The **MARKLIFT** boom unit has additional safety systems for driving. When the unit is driven with the boom extended or raised above horizontal, the unit is automatically shifted into low speed. This is accomplished through two limit switches sensing the altitude and extension

positions of the boom, wired in series to the controller "Hi/Lo" circuitry. This prevents the controller from supplying maximum rated electrical output to the proportional valve whereby reduced speed is obtained when the boom is extended or raised above horizontal.

Hydraulic Pump

Pump producing excessive noise.

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

Lift

1. Functions will not operate from aerial control console.

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

2. Functions will not operate from ground control box.

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

Drive

Low torque drive.

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

Brakes

No brakes or low pressure.

A. Check brake delay valve.
B. Refer to your local service facility.

ENGINE

1. Unit will not start or run.

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

2. Unit dies under load.

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

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

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

4. Unit will not idle.

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

HYDRAULIC DRIVE MOTOR

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

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

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°

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	40 4X4 (WISC.)
NOTES	24927 C

SCHEMATIC

PAGE 1

AERIAL CONTROL BOX.
P/N 24918

GROUND CONTROL BOX
P/N 24949

DUAL FUEL OPTION

115 A.C. WIRING.

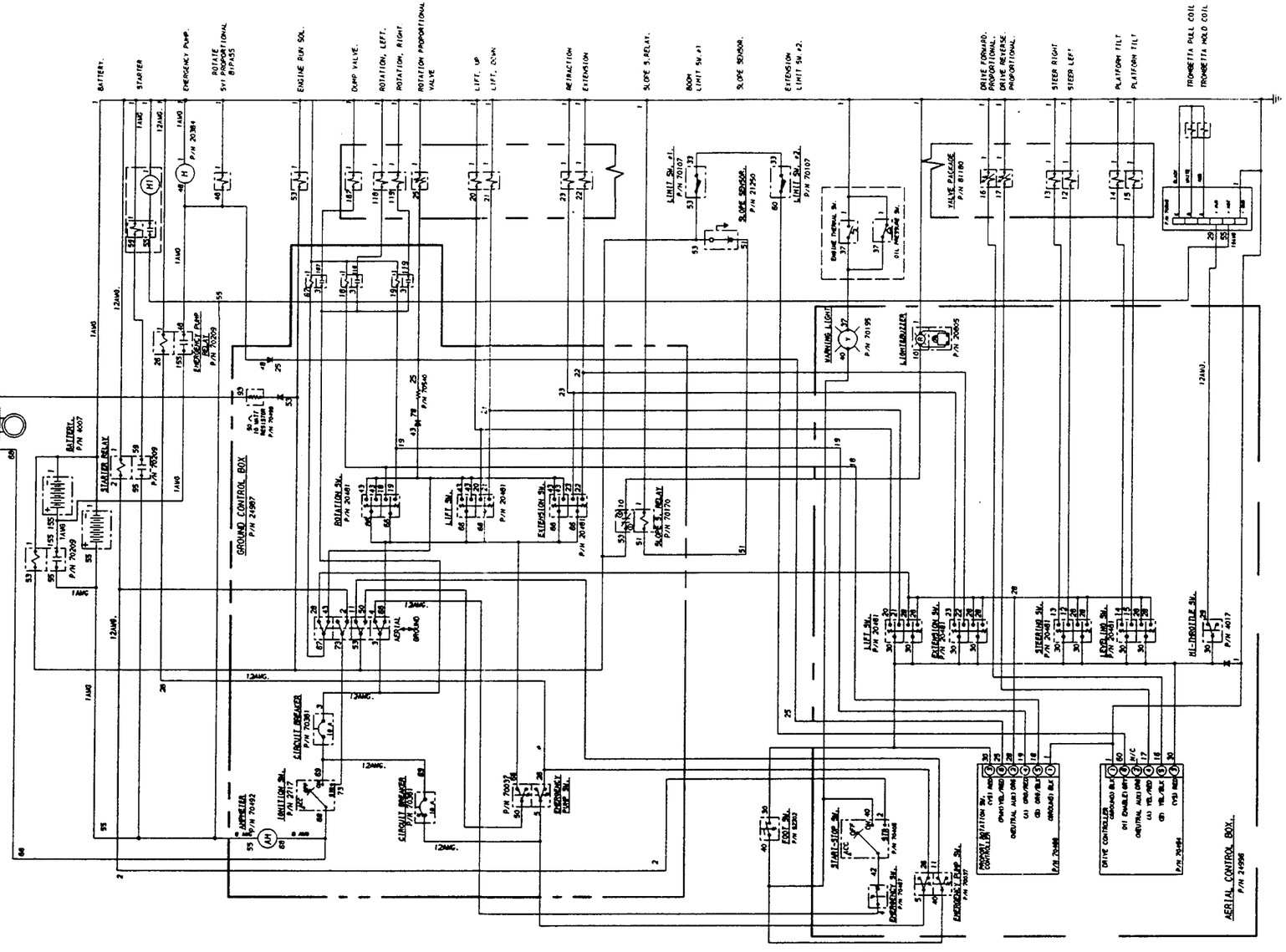
NOTES:

1. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE 14H CABLE P/N 70528.
2. ALL WIRES ARE 18 AWG UNLESS OTHERWISE SPECIFIED.
3. USE 6A. 1000V. DIODE P/N 70479.
4. WIRING AND SWITCHES ARE SHOWN IN STOWN POSITION.
5. ALL WIRES FOR 115VAC. ARE 12 AWG.
6. IDENTIFY EACH WIRE BY NUMBER FLAG AT BOTH ENDS
7. WHERE TWO WIRES (14AWG.) CABLE TO WIRE #4, AND RUN THIS WIRE IN PARALLEL WITH #4.

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	40 4X4 (DEUTZ)
NOTES	24985 B

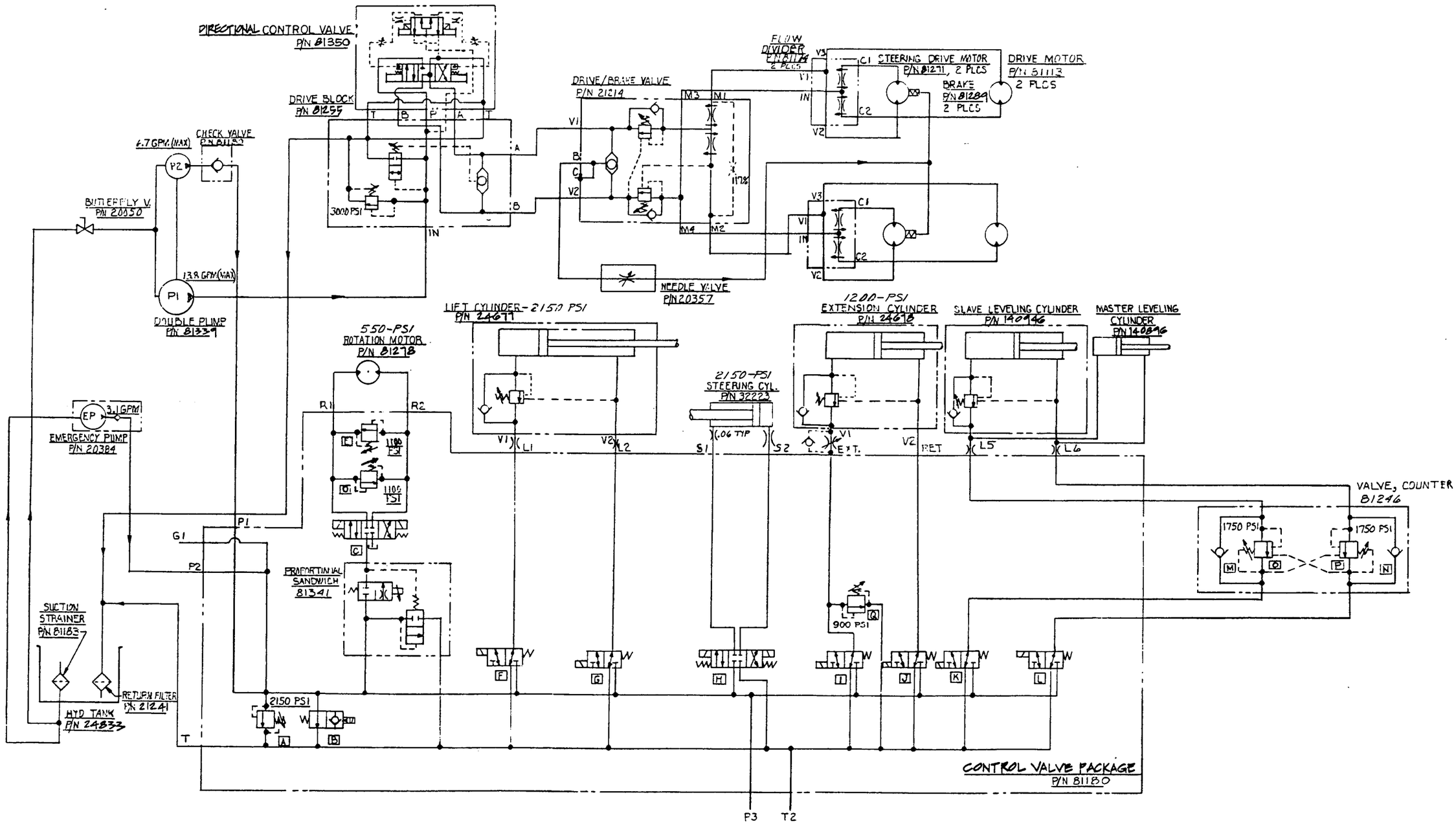
SCHEMATIC
PAGE
2



Mark Industries

TITLE	HYDRAULIC SCHEMATIC
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	210219 NC

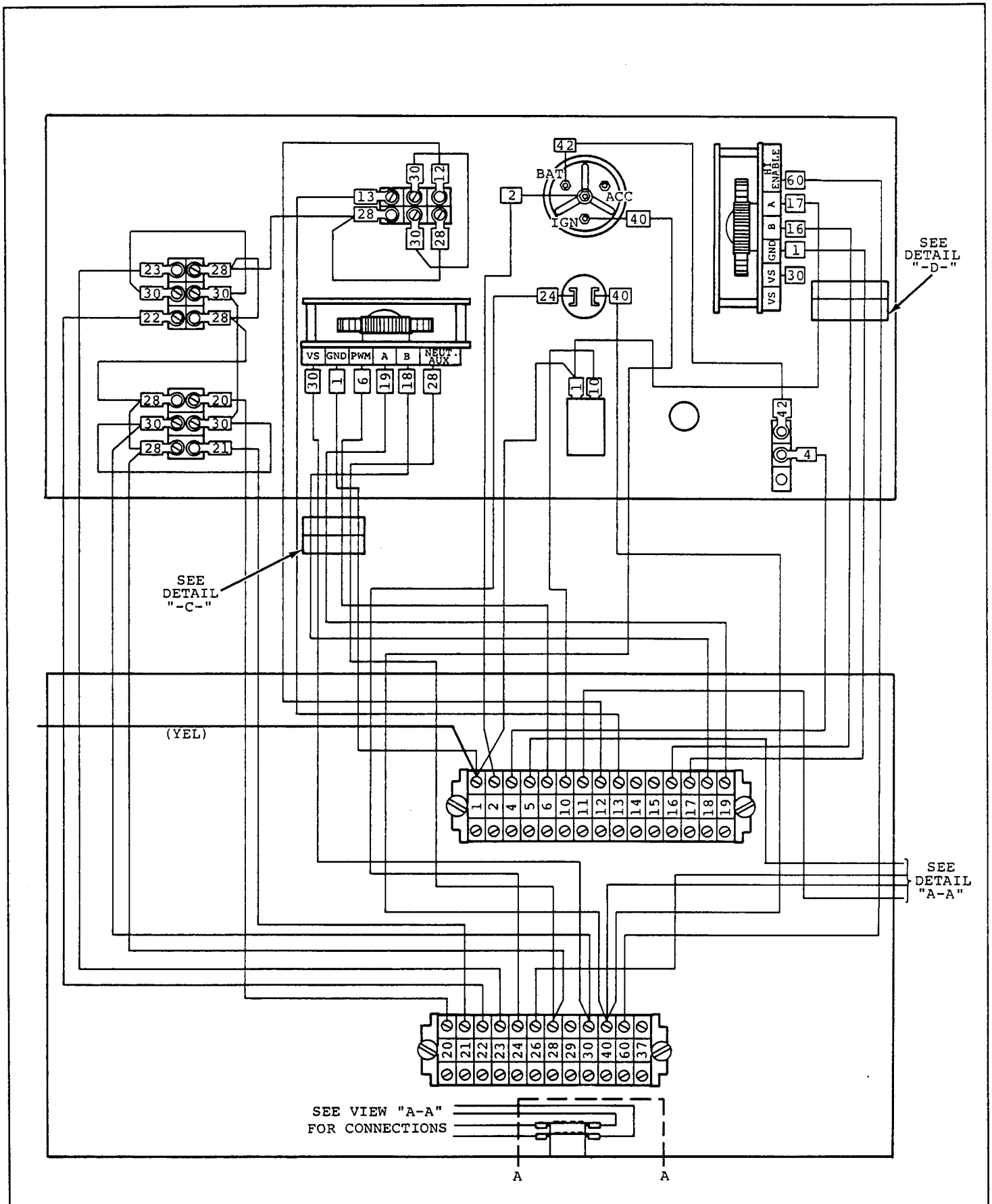
SCHEMATIC
PAGE 3



Mark Industries

TITLE	AERIAL CONTROL BOX SCHEMATIC
MODEL	40 4X4 (WISC.)
NOTES	24918 NC

SCHEMATIC
PAGE
4

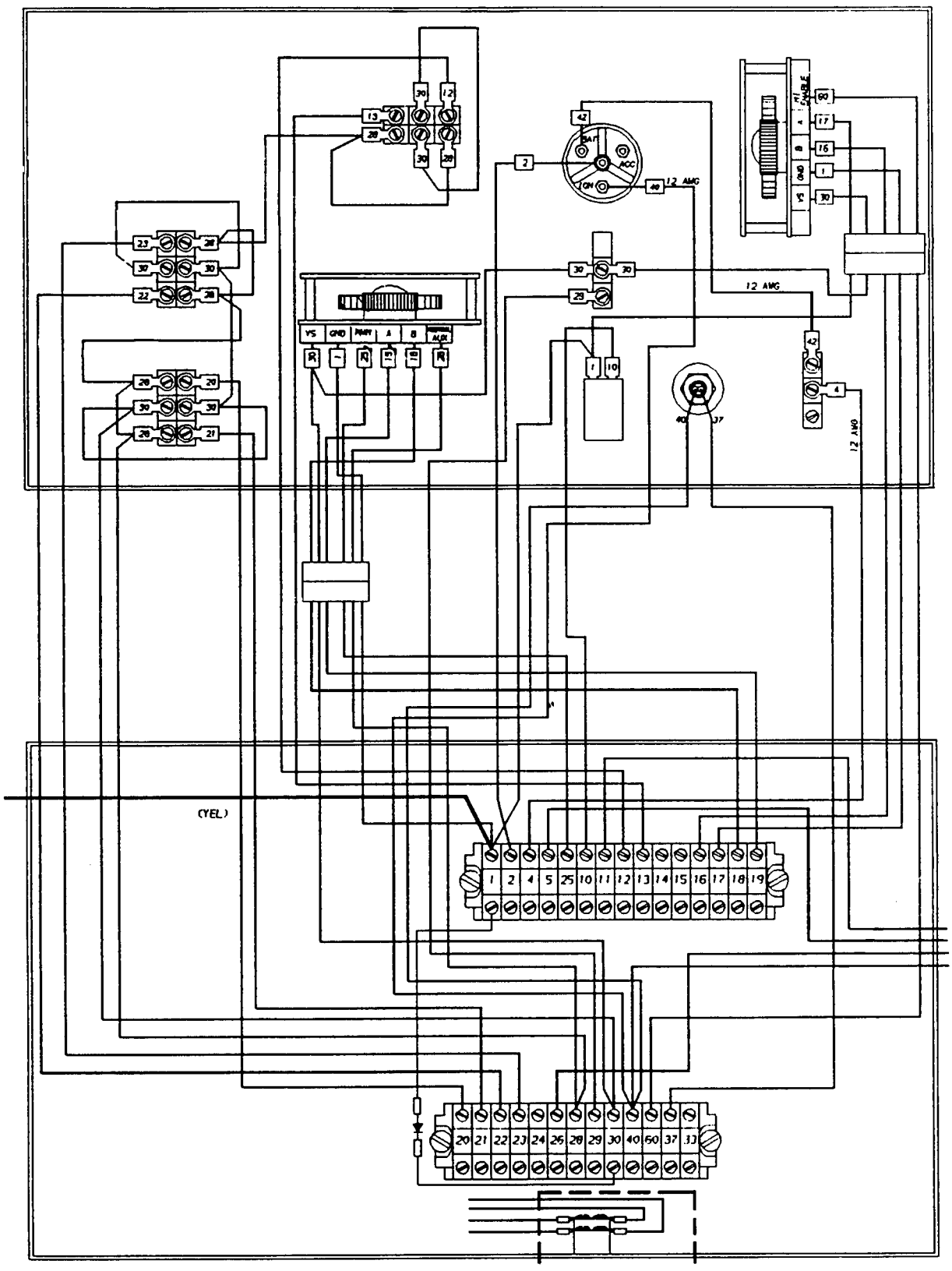


REV.

Mark Industries

TITLE	AERIAL CONTROL BOX SCHEMATIC
MODEL	40 4X4 (DEUTZ)
NOTES	24996 B

SCHEMATIC
PAGE
5

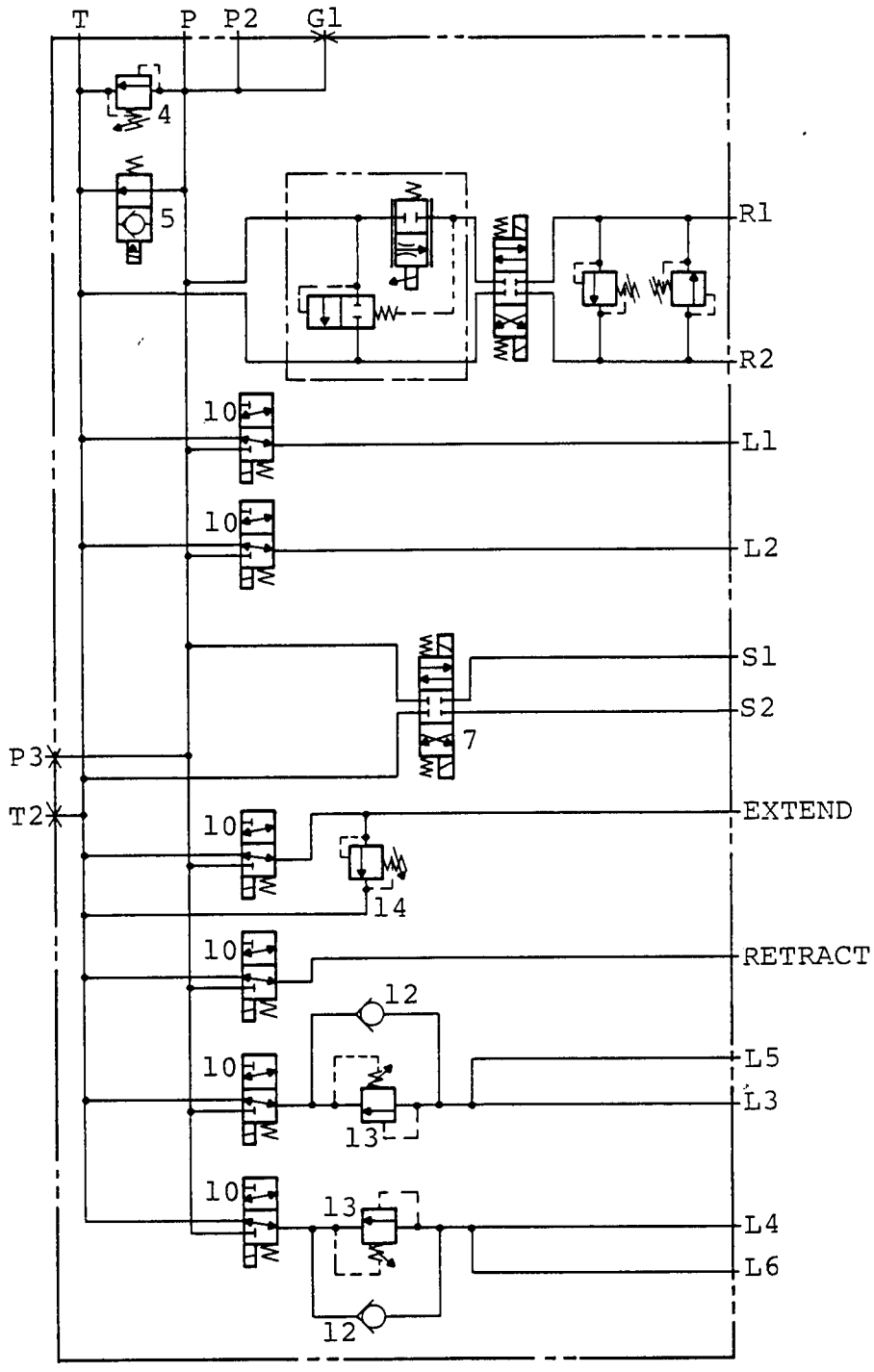


REV.

Mark Industries

TITLE	CONTROL VALVE SCHEMATIC
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	24977 A

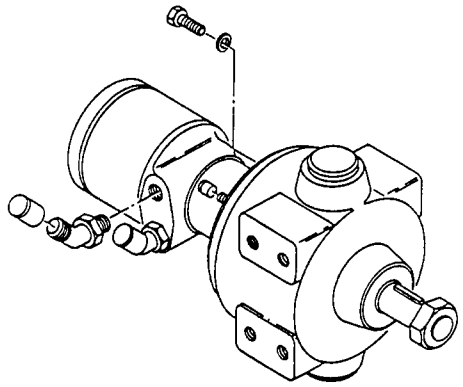
SCHEMATIC
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6

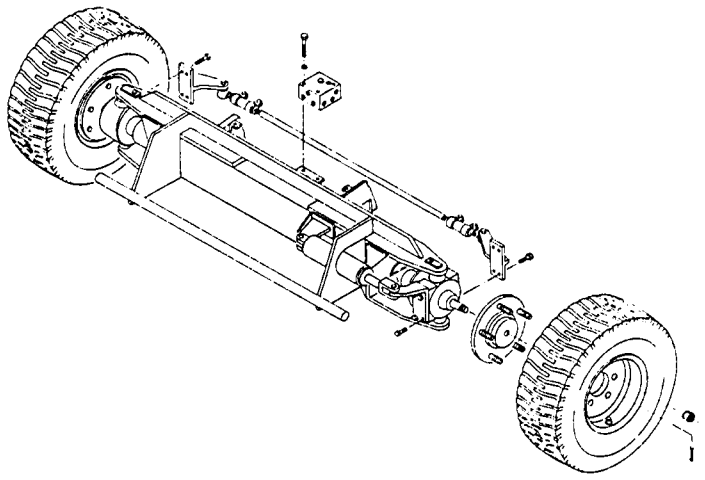


NOTE:

PRIOR TO USE, RELIEF VALVES WITH ASTERISK(*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON SPECIFIC MACHINES HYDRAULIC SCHEMATIC.

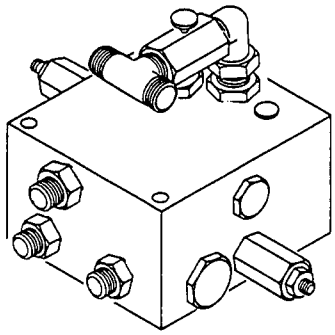
REV.

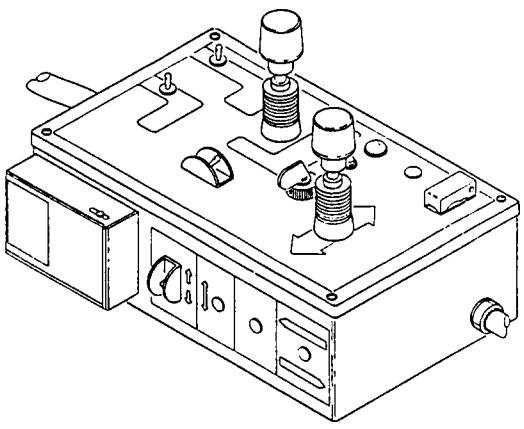


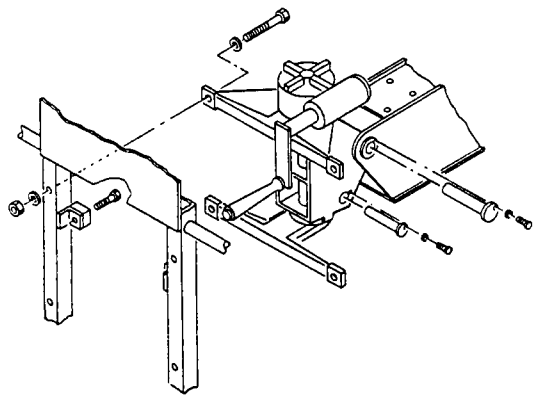


THIS SECTION 1 CONTAINS THE FOLLOWING MATTER:

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.

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

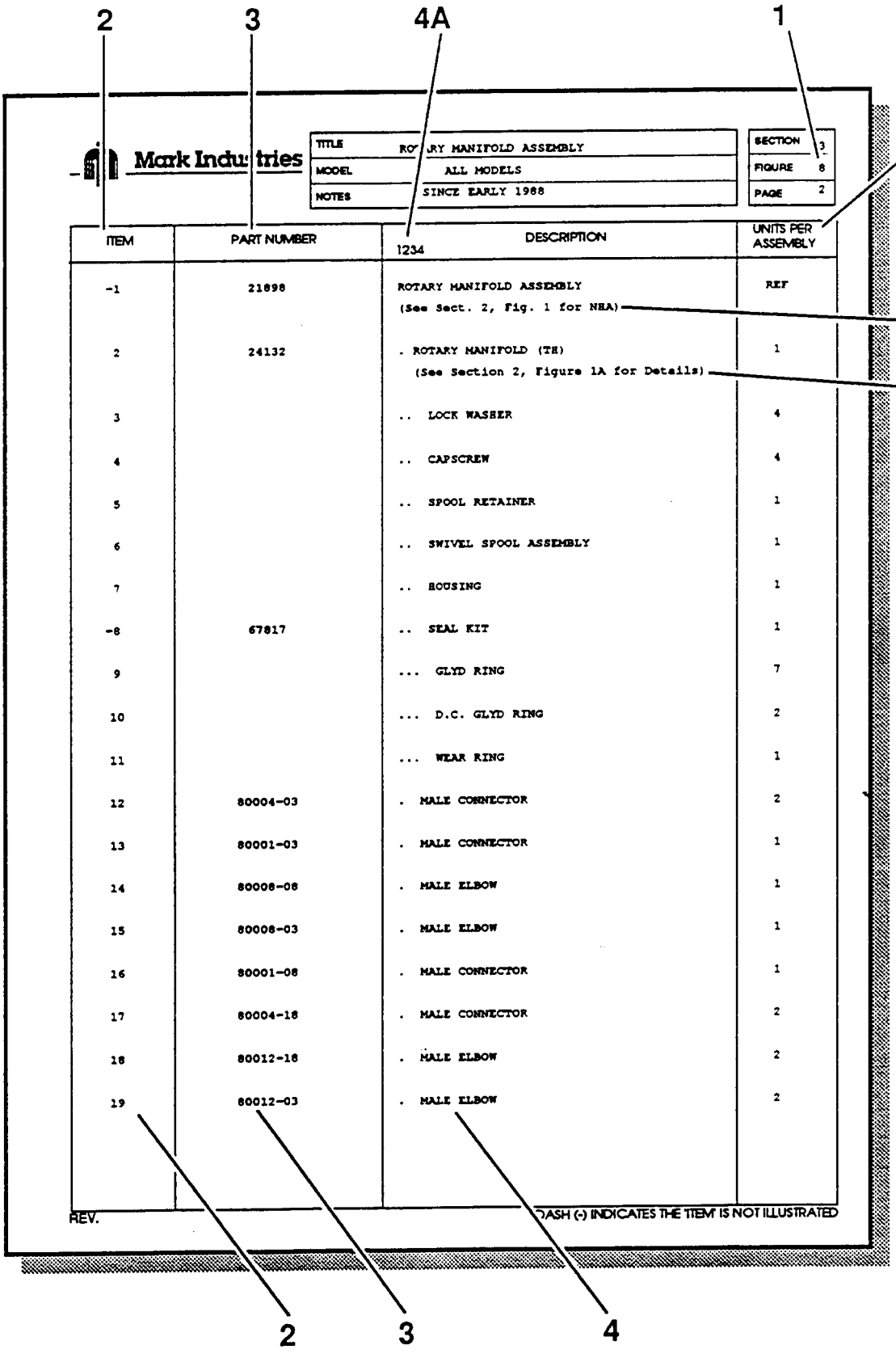
SECTION 2	FINAL ASSEMBLY
FIG. NO.	TITLE
1	FINAL ASSEMBLY (WISC.)
2	FINAL ASSEMBLY (DEUTZ)
3	SHEET METAL KIT (WISC.)
4	SHEET METAL KIT (DEUTZ)
5	AERIAL CONTROL BOX ASSEMBLY (WISC.)
6	AERIAL CONTROL BOX ASSEMBLY (DEUTZ)
7	DECAL SET (DEUTZ & WISC.)
8	MANUAL ROTATOR (DEUTZ & WISC.)(USED UNTIL MID JULY 1989)
8A	MANUAL ROTATOR (DEUTZ & WISC.)(MID JULY 1989-DEC. 1989)
8B	MANUAL ROTATOR (DEUTZ & WISC.)(SINCE DEC. 1989)
9	CONTROLLER (DRIVE)(DEUTZ & WISC.)
10	CONTROLLER (ROTATE)(DEUTZ & WISC.)
11	HYDRAULIC DIAGRAM (DEUTZ & WISC.)

SECTION 3	CARRIAGE ASSEMBLY
FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY (DEUTZ & WISC.)
2	FLOW DIVIDER ASSEMBLY (DEUTZ & WISC.)
3	DRIVE/BRAKE VALVE ASSEMBLY (DEUTZ & WISC.)
4	TIRE & WHEEL ASSEMBLY (L.H.)(DEUTZ & WISC.)
5	TIE ROD ASSEMBLY (DEUTZ & WISC.)
6	TIRE & WHEEL ASSEMBLY (R.H.)(DEUTZ & WISC.)
7	STEERING CYLINDER ASSEMBLY (TH)(DEUTZ & WISC.)
7A	STEERING CYLINDER ASSEMBLY (SE)(DEUTZ & WISC.)

SECTION 4	TURRET ASSEMBLY
FIG. NO.	TITLE
1	TURRET ASSEMBLY (WISC.)
2	TURRET ASSEMBLY (DEUTZ)
3	ENGINE & PUMP ASSEMBLY (WISC.)
4	ENGINE & PUMP ASSEMBLY (DEUTZ)
5	MASTER LEVELING CYLINDER ASSEMBLY (DEUTZ & WISC.)
6	LIFT CYLINDER ASSEMBLY (DEUTZ & WISC.)
7	COUNTERBALANCE ASSEMBLY (DEUTZ & WISC.)
8	EMERGENCY PUMP ASSEMBLY (DEUTZ & WISC.)
9	CONTROL VALVE ASSEMBLY (DEUTZ & WISC.)
10	LOWER CONTROL PANEL ASSEMBLY (WISC.)
11	LOWER CONTROL PANEL ASSEMBLY (DEUTZ)
12	DRIVE BLOCK VALVE ASSEMBLY (DEUTZ & WISC.)
13	HYDRAULIC TANK ASSEMBLY (DEUTZ & WISC.)
14	ROTATION GEARBOX ASSEMBLY (DEUTZ & WISC.)
15	FUEL TANK ASSEMBLY (DEUTZ & WISC.)

SECTION 5	BOOM ASSEMBLY
FIG. NO.	TITLE
1	BOOM ASSEMBLY (DEUTZ & WISC.)
2	INNER BOOM ASSEMBLY (DEUTZ & WISC.)
3	EXTENSION CYLINDER ASSEMBLY (DEUTZ & WISC.)
4	SLAVE CYLINDER ASSEMBLY (DEUTZ & WISC.)

SECTION 6	OPTIONS
FIG. NO.	TITLE
1	DUAL FUEL KIT
2	LIFTING LUGS
3	HYDRAULIC PLATFORM ROTATION
4	SAND TIRES
5	2K WATT GENERATOR
6	CONTINUOUS TURRET ROTATION


2
3
4A
1
5
Mark Industries
TITLE ROTARY MANIFOLD ASSEMBLY
MODEL ALL MODELS
NOTES SINCE EARLY 1988
SECTION 3
FIGURE 8
PAGE 2
ITEM
PART NUMBER
1234 DESCRIPTION
UNITS PER ASSEMBLY
-1 21898 ROTARY MANIFOLD ASSEMBLY REF
(See Sect. 2, Fig. 1 for NHA)
2 24132 . ROTARY MANIFOLD (TH) 1
(See Section 2, Figure 1A for Details)
3 .. LOCK WASHER 4
4 .. CAPSCREW 4
5 .. SPOOL RETAINER 1
6 .. SWIVEL SPOOL ASSEMBLY 1
7 .. HOUSING 1
-8 67817 .. SEAL KIT 1
9 ... GLYD RING 7
10 ... D.C. GLYD RING 2
11 ... WEAR RING 1
12 80004-03 . MALE CONNECTOR 2
13 80001-03 . MALE CONNECTOR 1
14 80008-08 . MALE ELBOW 1
15 80008-03 . MALE ELBOW 1
16 80001-08 . MALE CONNECTOR 1
17 80004-16 . MALE CONNECTOR 2
18 80012-16 . MALE ELBOW 2
19 80012-03 . MALE ELBOW 2
REV.
DASH (-) INDICATES THE ITEM IS NOT ILLUSTRATED
4B
4C
2
3
4

1. The Parts Chapter Pagination.

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

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

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

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

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

4. Elements of the **Description**.

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

      Figure Description

      1 2 3 4

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

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

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

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

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

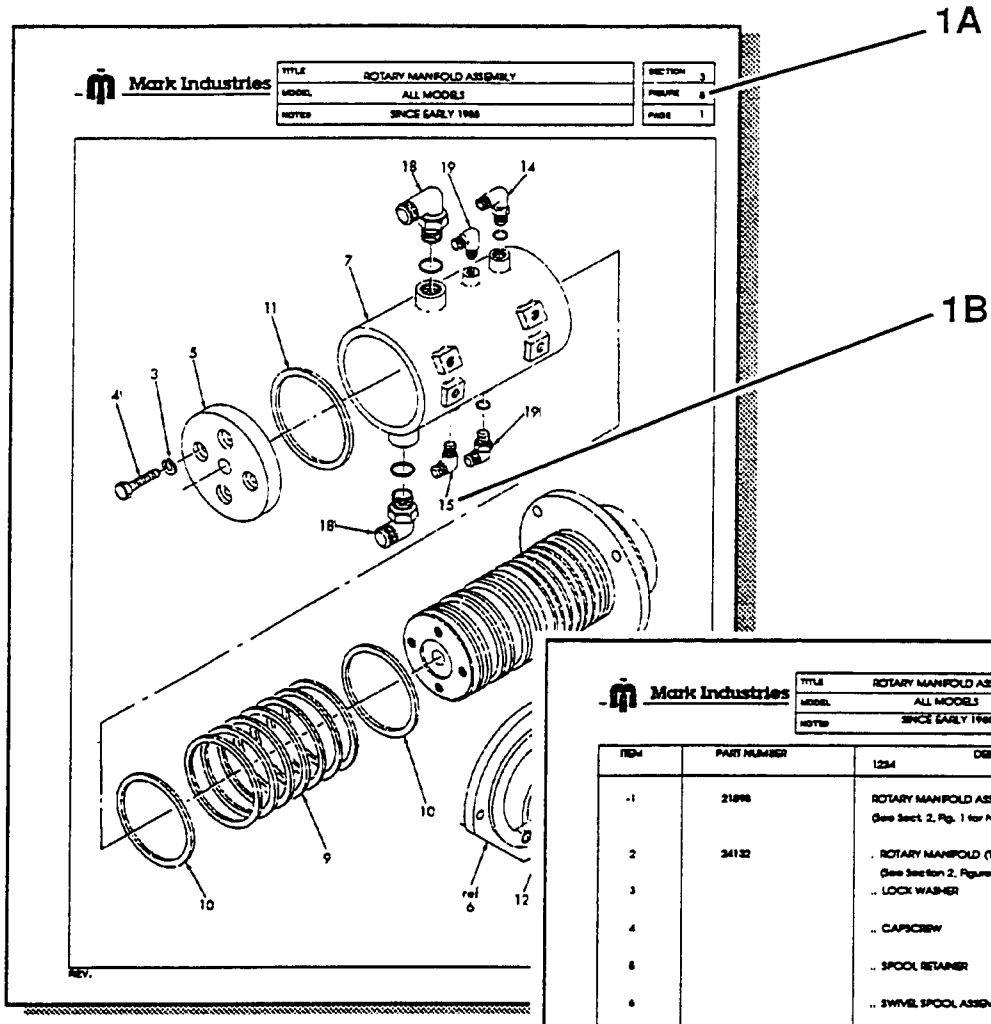
   C. **DETAILS** corresponds to the Section and Figure to be referred to for a more detailed breakdown of this item.

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

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

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

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



Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY	SECTION	3
MODEL	ALL MODELS	FIGURE	8
NOTES	SINCE EARLY 1988	PAGE	2

ITEM	PART NUMBER	1234 DESCRIPTION	UNITS PER ASSEMBLY
-1	21898	ROTARY MANIFOLD ASSEMBLY (See Sect. 2, Pg. 1 for NHA)	REF
2	34132	. 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	60004-08	. MALE CONNECTOR	2
13	60001-08	. MALE CONNECTOR	1
14	60008-08	. MALE ELBOW	1
15	60008-08	. MALE ELBOW	1
16	60001-08	. MALE CONNECTOR	1
17	60004-16	. MALE CONNECTOR	2
18	60013-16	. MALE ELBOW	2
19	60013-08	. MALE ELBOW	2

REV.

DASH (-) INDICATES THE ITEM IS NOT ILLUSTRATED

1. Finding the Mark Industries Part Number.

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

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

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

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

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

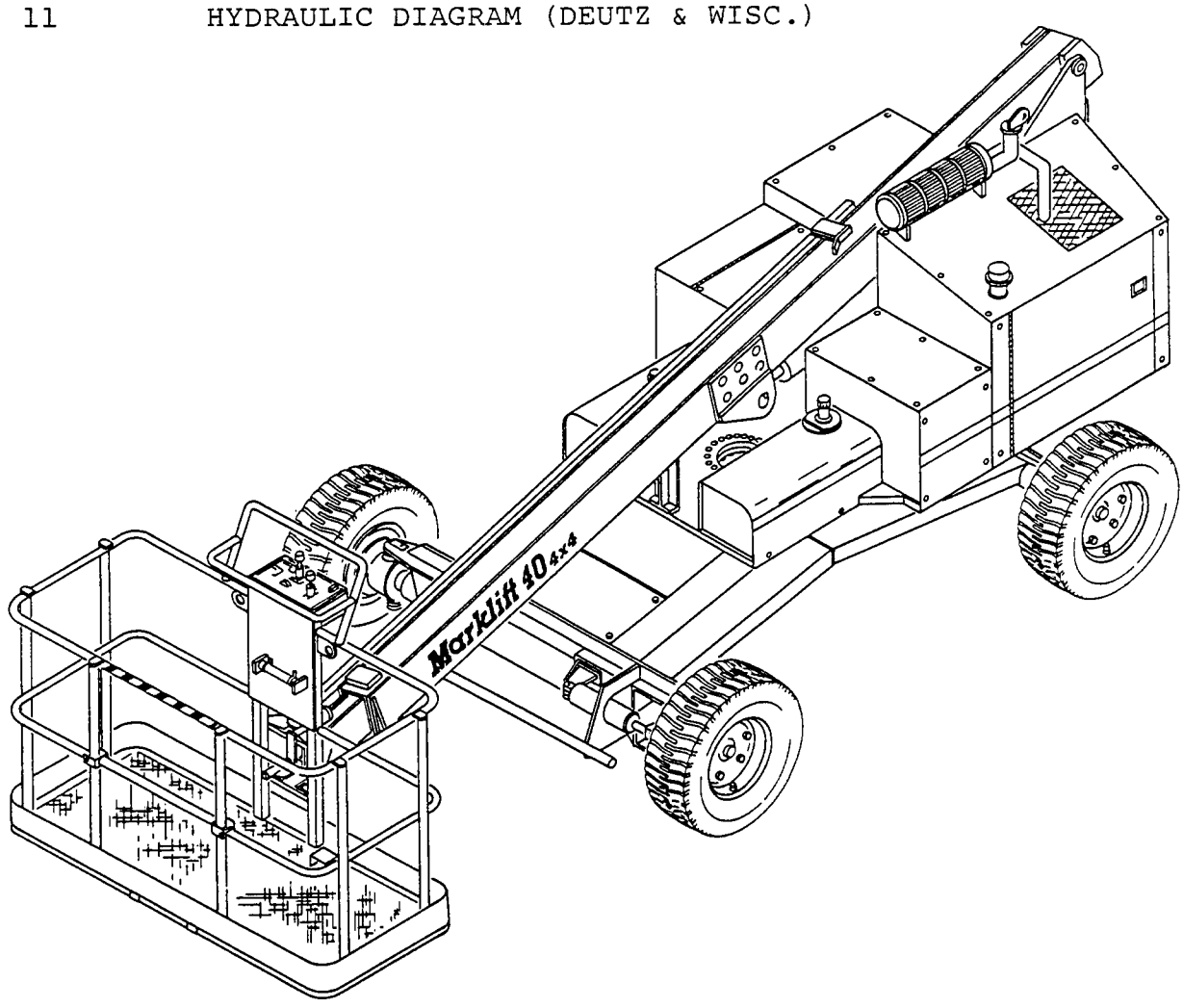
   A. By **FAX**: **(714) 879-8884**

   B. By Phone: (714) 879-MARK

   C. By Mail: MARK INDUSTRIES
   ATTENTION: PARTS DEPARTMENT
   P.O. BOX 2225
   BREA, CA. 92622

SECTION 2 CONTAINS:

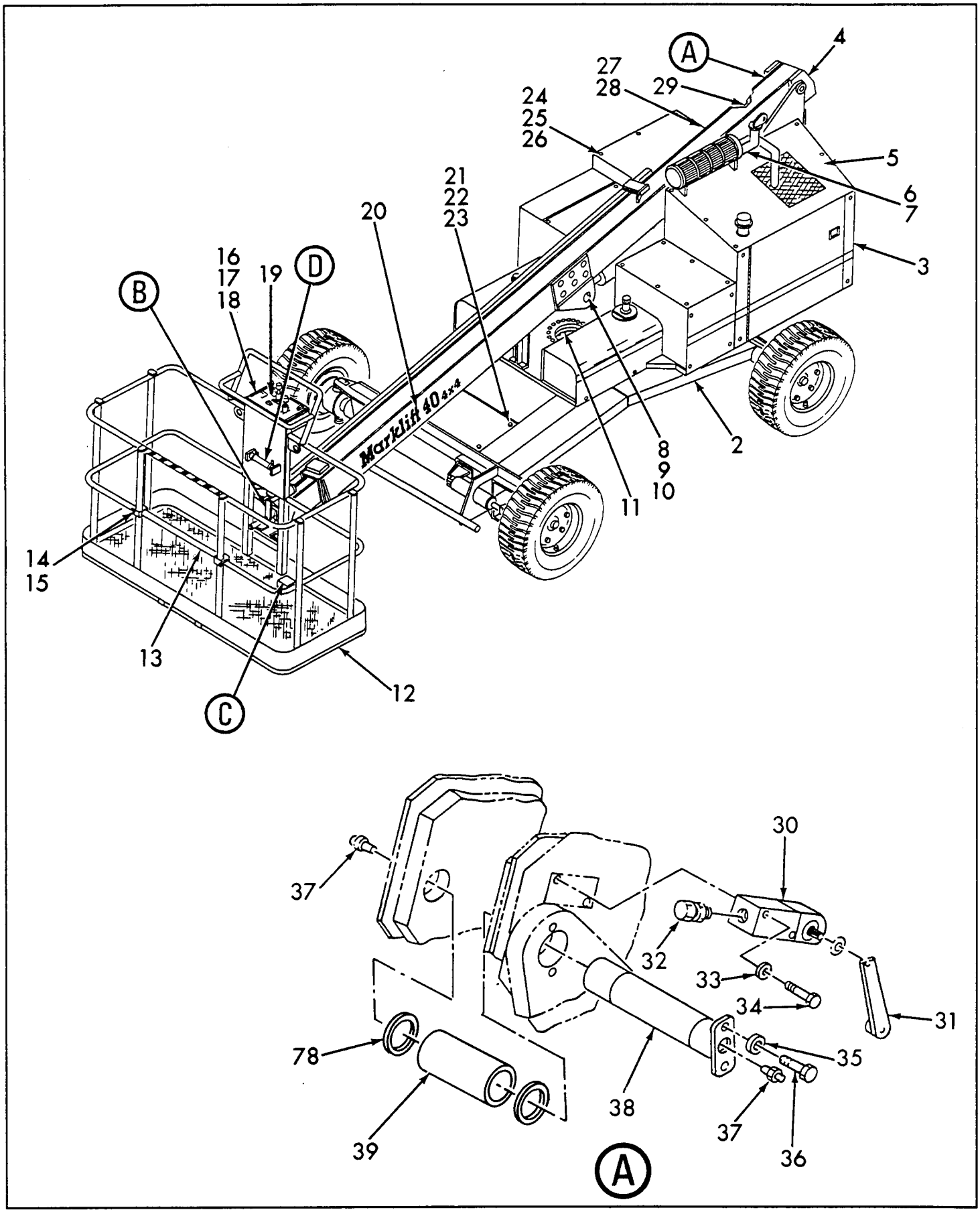
FIG. NO.	TITLE
1	FINAL ASSEMBLY (WISC.)
2	FINAL ASSEMBLY (DEUTZ)
3	SHEET METAL KIT (WISC.)
4	SHEET METAL KIT (DEUTZ)
5	AERIAL CONTROL BOX ASSEMBLY (WISC.)
6	AERIAL CONTROL BOX ASSEMBLY (DEUTZ)
7	DECAL SET (DEUTZ & WISC.)
8	MANUAL ROTATOR (DEUTZ & WISC.)(USED UNTIL MID JULY 1989)
8A	MANUAL ROTATOR (DEUTZ & WISC.)(MID JULY 1989-DEC. 1989)
8B	MANUAL ROTATOR (DEUTZ & WISC.)(SINCE DEC. 1989)
9	CONTROLLER (DRIVE)(DEUTZ & WISC.)
10	CONTROLLER (ROTATE)(DEUTZ & WISC.)
11	HYDRAULIC DIAGRAM (DEUTZ & WISC.)



Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	40 4X4(WISC.)
NOTES	

SECTION	2
FIGURE	1
PAGE	1

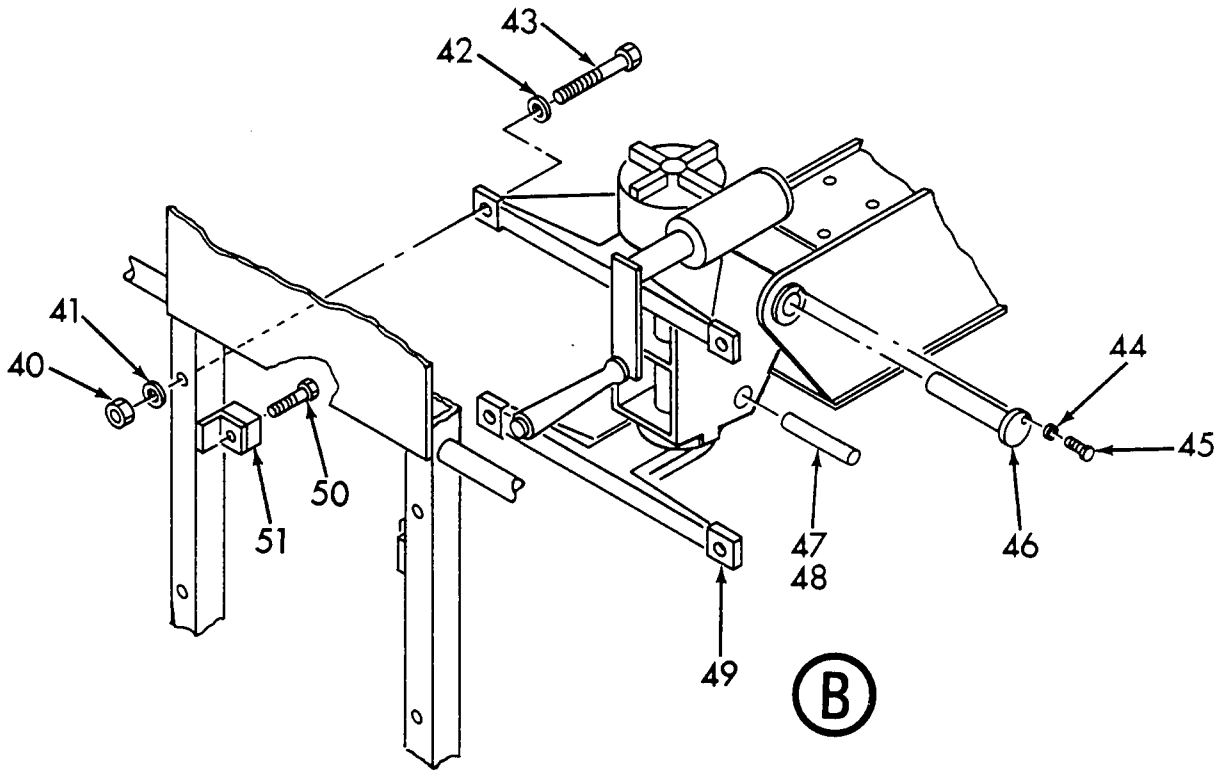


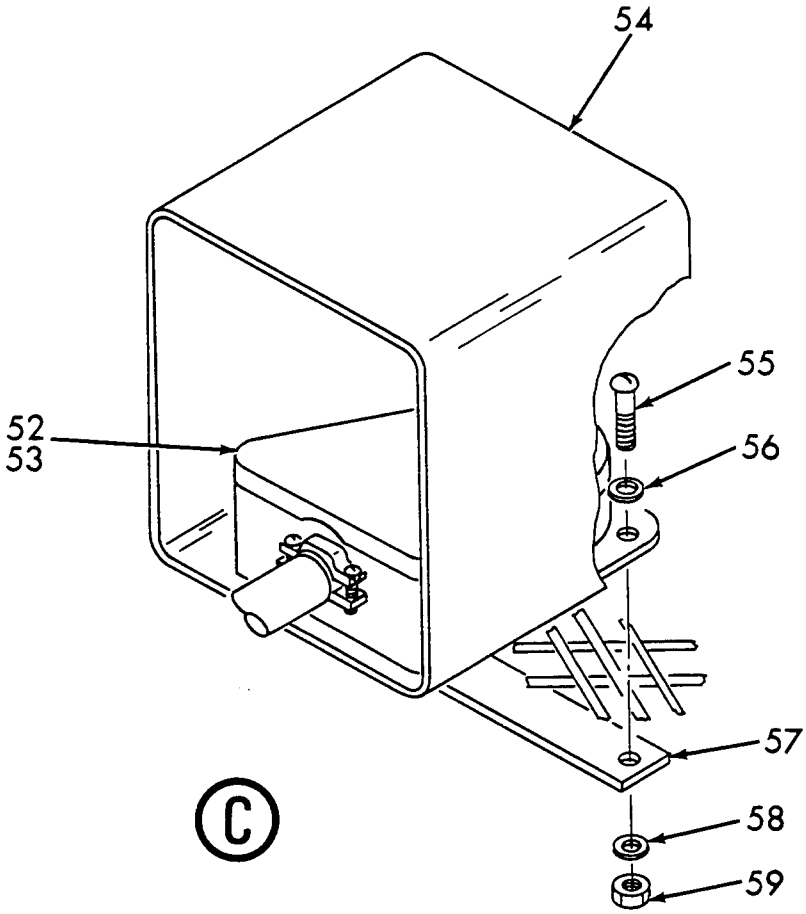
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Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

SECTION	2
FIGURE	1
PAGE	2



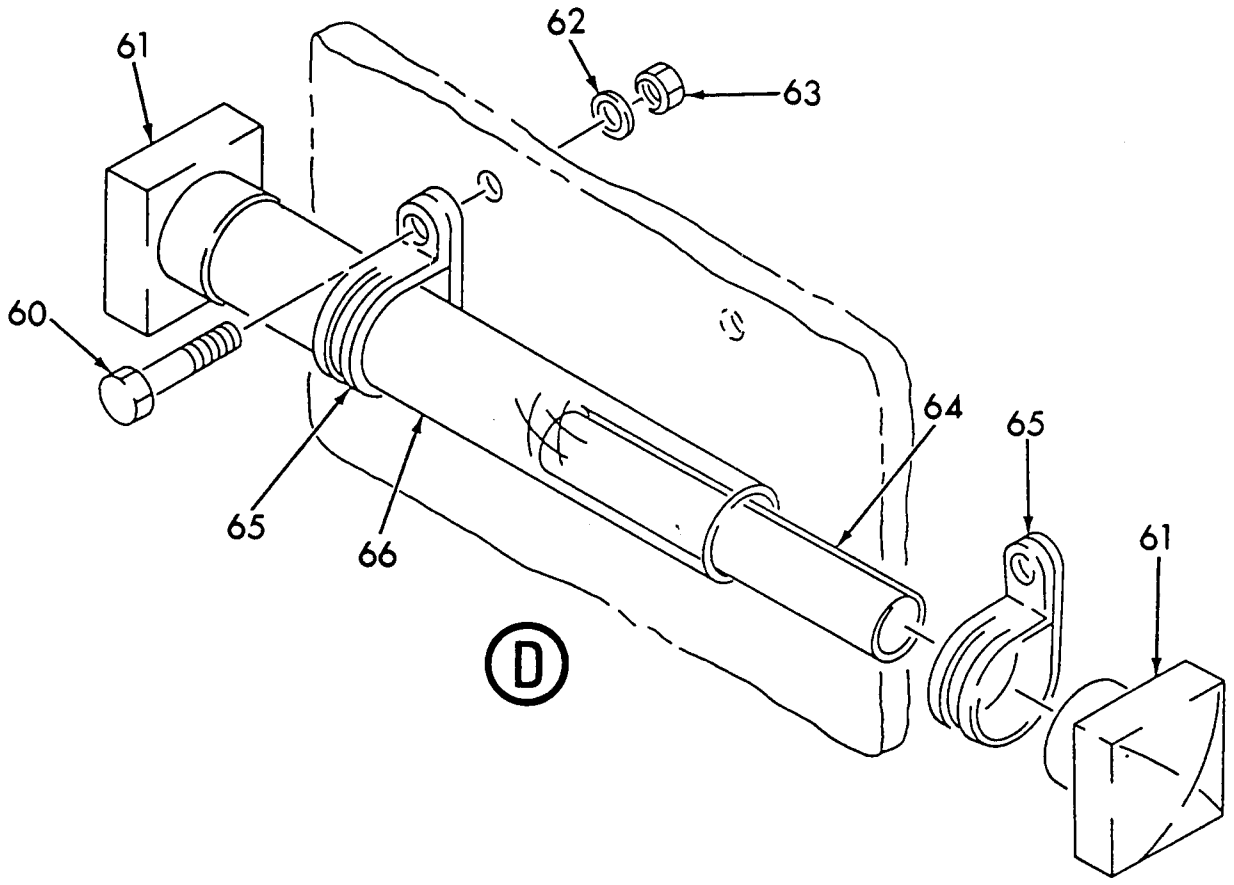


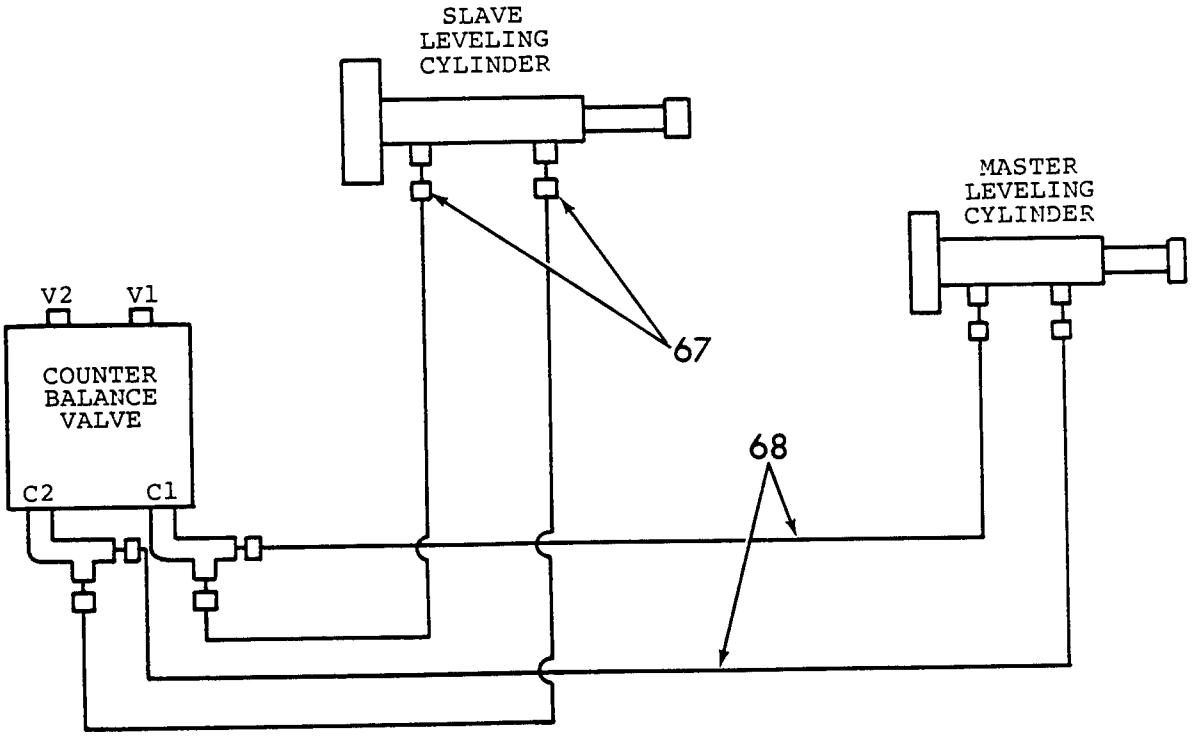
REV.

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	40 4X4(WISC.)
NOTES	

SECTION	2
FIGURE	1
PAGE	3





HOSE DIAGRAM

REV.

Mark Industries

TITLE	FINAL ASSEMBLY	SECT. 2
MODEL	40 4X4 (WISC.)	FIG. 1
NOTES		PAGE 4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	200024	FINAL ASSEMBLY	REF
2	211029	. CARRIAGE ASSEMBLY (See Sect. 3, Fig. 1 for Details)	1
3	24852	. TURRET ASSEMBLY (See Sect. 4, Fig. 1 for Details)	1
4	24721	. FINAL BOOM ASSEMBLY (See Sect. 5, Fig. 1 for Details)	1
5	24992	. SHEET METAL KIT (See Sect. 2, Fig. 3 for Details)	1
6	60702	. HEX NUT	12
7	60322	. CAP SCREW	12
8	63303	. LOCK WASHER	2
9	60539	. CAP SCREW	2
10	64766	. PIN	1
11	60647	. CAP SCREW	18
12	24803	. PLATFORM WELDMENT	1
13	141080	. SLIDE BAR WELDMENT	1
14	160212	. CLEVIS PIN	2
15	160213	. COTTER PIN	2
16	60309	. CAP SCREW	4
17	61239	. LOCK NUT	4
18	882	. MOUNTING SHOCKS	2
19	24918	. AERIAL CONTROL BOX ASSEMBLY (See Sect. 2, Fig. 5 for Details)	1
20	67960	. DECAL SET (See Sect. 2, Fig. 7 for Details)	1
21	63302	. LOCK WASHER	4
22	24679	. FRAME COVER	1

Mark Industries

TITLE	FINAL ASSEMBLY	SECT. 2
MODEL	40 4X4 (WISC.)	FIG. 1
NOTES		PAGE 5

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
23	60338	. CAP SCREW	4
24	60322	. CAP SCREW	63
25	63302	. LOCK WASHER	63
26	63402	. FLAT WASHER	63
27	63401	. FLAT WASHER	7
28	61921	. CAP SOCKET BUTTON HEAD SCREW	7
29	24762	. PIN (MASTER CYLINDER ROD END)	1
30	70107	. LIMIT SWITCH	1
31	70148	. ARM LEVER SWITCH	1
32	2806	. STRAIN RELIEF	1
33	63313	. LOCK WASHER	2
34	62615	. MACHINE SCREW	2
35	63303	. LOCK WASHER	2
36	62009	. ROUND HEX SOCKET HEAD CAP SCREW	2
37	65103	. STRAIGHT GREASE FITTING	2
38	24764	. PIN (BOOM PIVOT)	1
39	26454	. ROUND TUBE	1
40	61305	. LOCK NUT	4
41	63415	. FLAT WASHER	4
42	16159	. WASHER	4
43	60549	. CAP SCREW	4
44	63303	. LOCK WASHER	1
45	60539	. CAP SCREW	1
46	140436	. ROTATOR PIN	1
47	140437	. PIN	1

REV.

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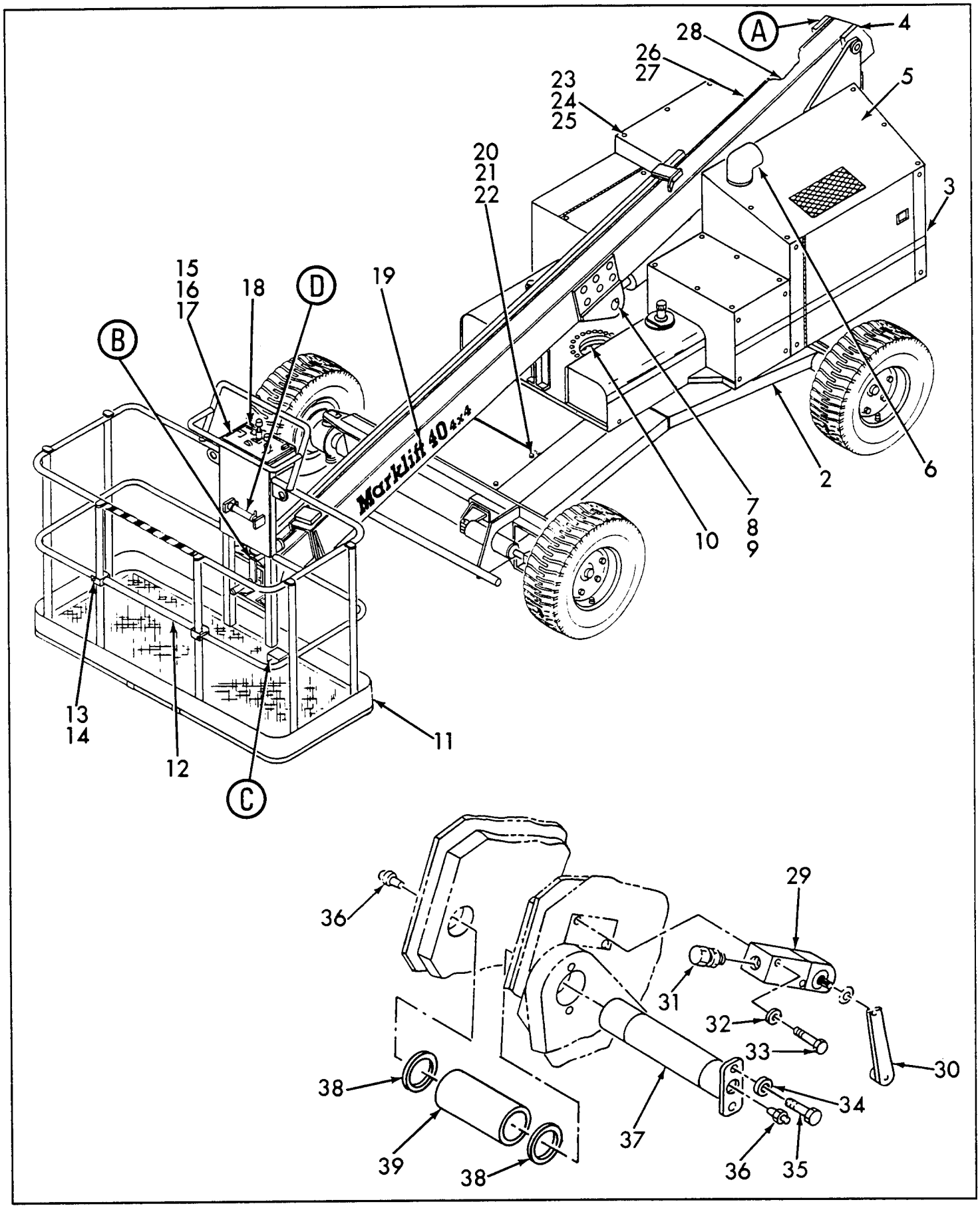
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-48	64209	. ROLL PIN	1
49	81373	. MANUAL ROTATOR (See Sect. 2, Fig. 8,8A or 8B for Details)	1
50	61834	. ROUND HEX SOCKET HEAD CAP SCREW	2
51	210168	. WEAR PAD	2
52	92202	. FOOTSWITCH	1
-53	66336	.. MICROSWITCH	1
54	23846	. FOOTSWITCH COVER	1
55	62726	. MACHINE SCREW	2
56	63413	. FLAT WASHER	2
57	23753	. BACKING PLATE DEADMAN SWITCH	1
58	63313	. LOCK WASHER	2
59	60802	. HEX NUT	2
60	60309	. CAP SCREW	2
61	65842	. ANTI-ROLL CAP	2
62	63401	. FLAT WASHER	2
63	61239	. LOCK NUT	2
64	16629	. BOOM OPERATION HANDBOOK	1
65	65867	. CLAMP	2
66	130927	. PLASTIC CONTAINER	1
67	2562	. STRAIGHT SWIVEL FITTING	12
68	2568	. HOSE (19.5 FT.)	1
-69	255	. CABLE TIE	10
-70	24927	. ELECTRICAL SCHEMATIC (See Schematic Section for Details)	1
-71	210219	. HYDRAULIC SCHEMATIC (See Schematic Section for Details)	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-72	16022	. LOC-TITE 242 (1 BOTTLE)	1
-73	65114	. GAS (2 GAL.)(REGULAR)	
-74	65116	. HYDRAULIC OIL (20 GAL.)	1
-75	16609	. PAINT (.50 GAL.) (BLUE WATER-BASE SPRAYLAT #9245)	1
-76	16608	. PAINT (5 GAL.) (WHITE WATER-BASE SPRAYLAT #9042-2)	1
-77	65112	. PAINT (1 GAL.) (190 HB CARBOLINE TANK WHITE)	1
78	23823	. BOOM PIVOT SPACER	2

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TITLE	FINAL ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

SECTION	2
FIGURE	2
PAGE	1

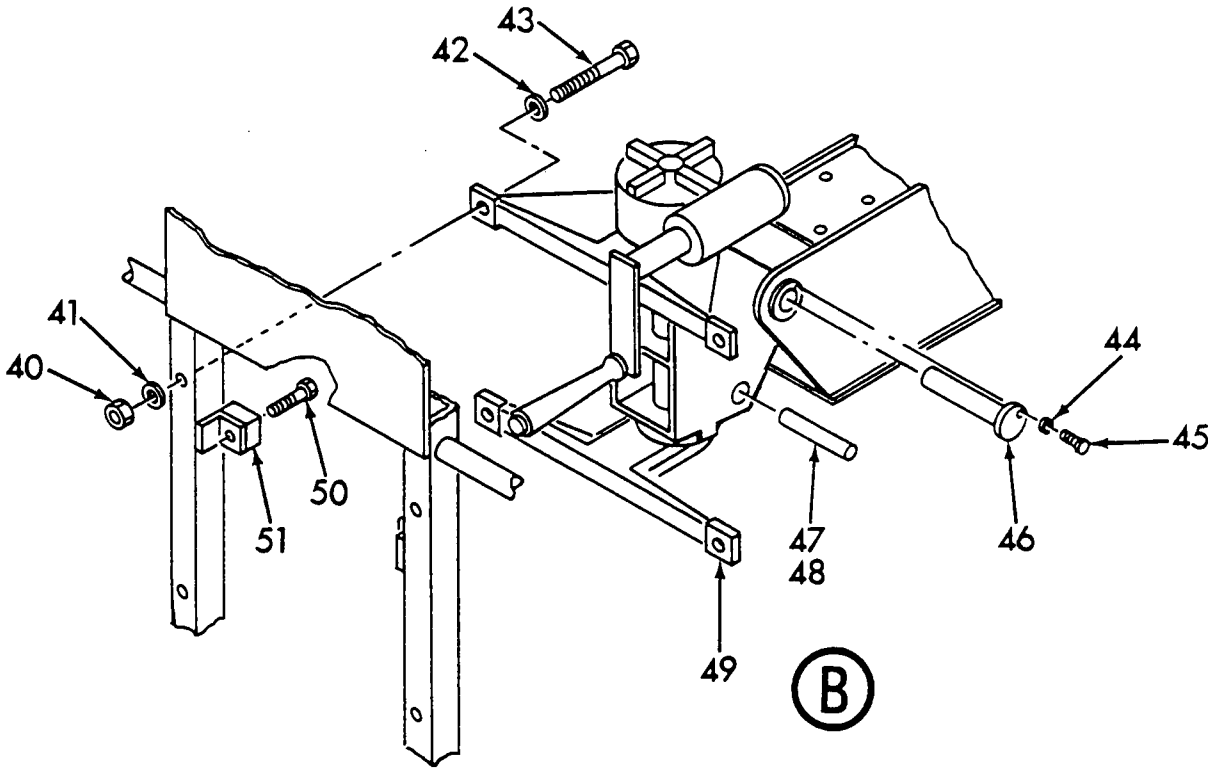


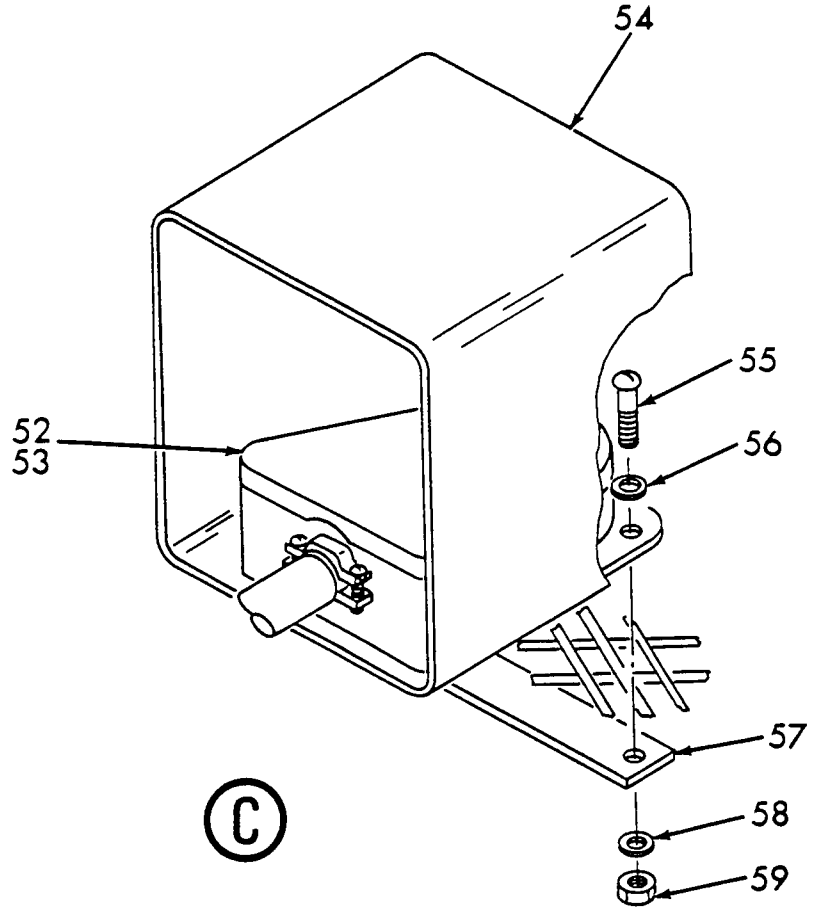
REV.

Mark Industries

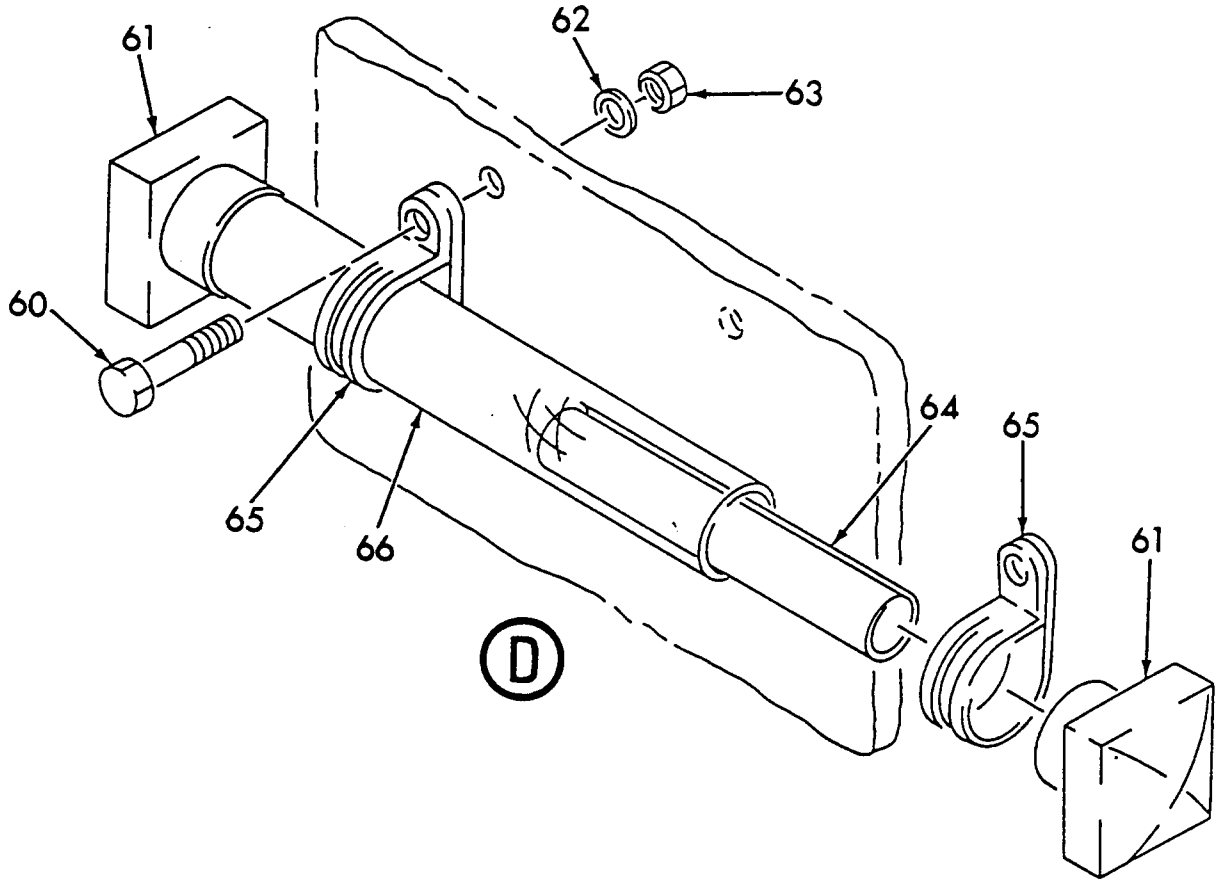
TITLE	FINAL ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

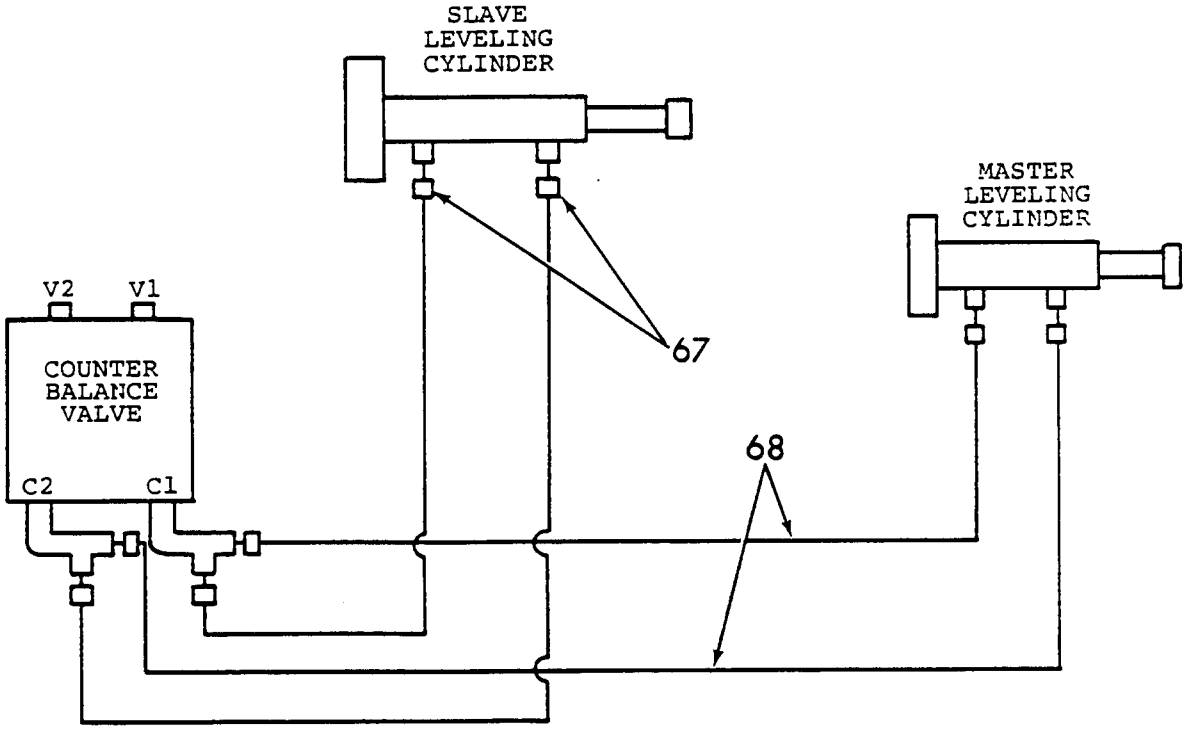
SECTION	2
FIGURE	2
PAGE	2





REV.





HOSE DIAGRAM

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	200010	FINAL ASSEMBLY	REF
2	211029	. CARRIAGE ASSEMBLY (See Sect. 3, Fig. 1 for Details)	1
3	24851	. TURRET ASSEMBLY (See Sect. 4, Fig. 1 for Details)	1
4	24721	. FINAL BOOM ASSEMBLY (See Sect. 5, Fig. 1 for Details)	1
5	24953	. SHEET METAL KIT (See Sect. 2, Fig. 4 for Details)	1
6	160204	. ELBOW	1
7	63303	. LOCK WASHER	2
8	60539	. CAP SCREW	2
9	64766	. PIN	1
10	60647	. CAP SCREW	18
11	24803	. PLATFORM WELDMENT	1
12	141080	. SLIDE BAR WELDMENT	1
13	160212	. CLEVIS PIN	2
14	160213	. COTTER PIN	2
15	60309	. CAP SCREW	4
16	61239	. LOCK NUT	4
17	882	. MOUNTING SHOCKS	2
18	24996	. AERIAL CONTROL BOX ASSEMBLY (See Sect. 2, Fig. 6 for Details)	1
19	67960	. DECAL SET (See Sect. 2, Fig. 7 for Details)	1
20	63302	. LOCK WASHER	4
21	24679	. FRAME COVER	1
22	60338	. CAP SCREW	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
23	60322	. CAP SCREW	63
24	63302	. LOCK WASHER	63
25	63402	. FLAT WASHER	63
26	63401	. FLAT WASHER	2
27	61921	. CAP SOCKET BUTTON HEAD SCREW	7
28	24762	. PIN (MASTER CYLINDER ROD END)	1
29	70107	. LIMIT SWITCH	1
30	70148	. ARM LEVER SWITCH	1
31	2806	. STRAIN RELIEF	1
32	63313	. LOCK WASHER	2
33	62615	. MACHINE SCREW	2
34	63303	. LOCK WASHER	2
35	62009	. ROUND HEX SOCKET HEAD CAP SCREW	2
36	65103	. STRAIGHT GREASE FITTING	2
37	24764	. PIN (BOOM PIVOT)	1
38	23823	. PIVOT BOOM SPACER	2
39	26454	. ROUND TUBE	1
40	61305	. LOCK NUT	4
41	62415	. FLAT WASHER	4
42	16159	. WASHER	4
43	60549	. CAP SCREW	4
44	63303	. LOCK WASHER	2
45	60539	. CAP SCREW	2
46	140436	. ROTATOR PIN	1
47	140437	. PIN	1

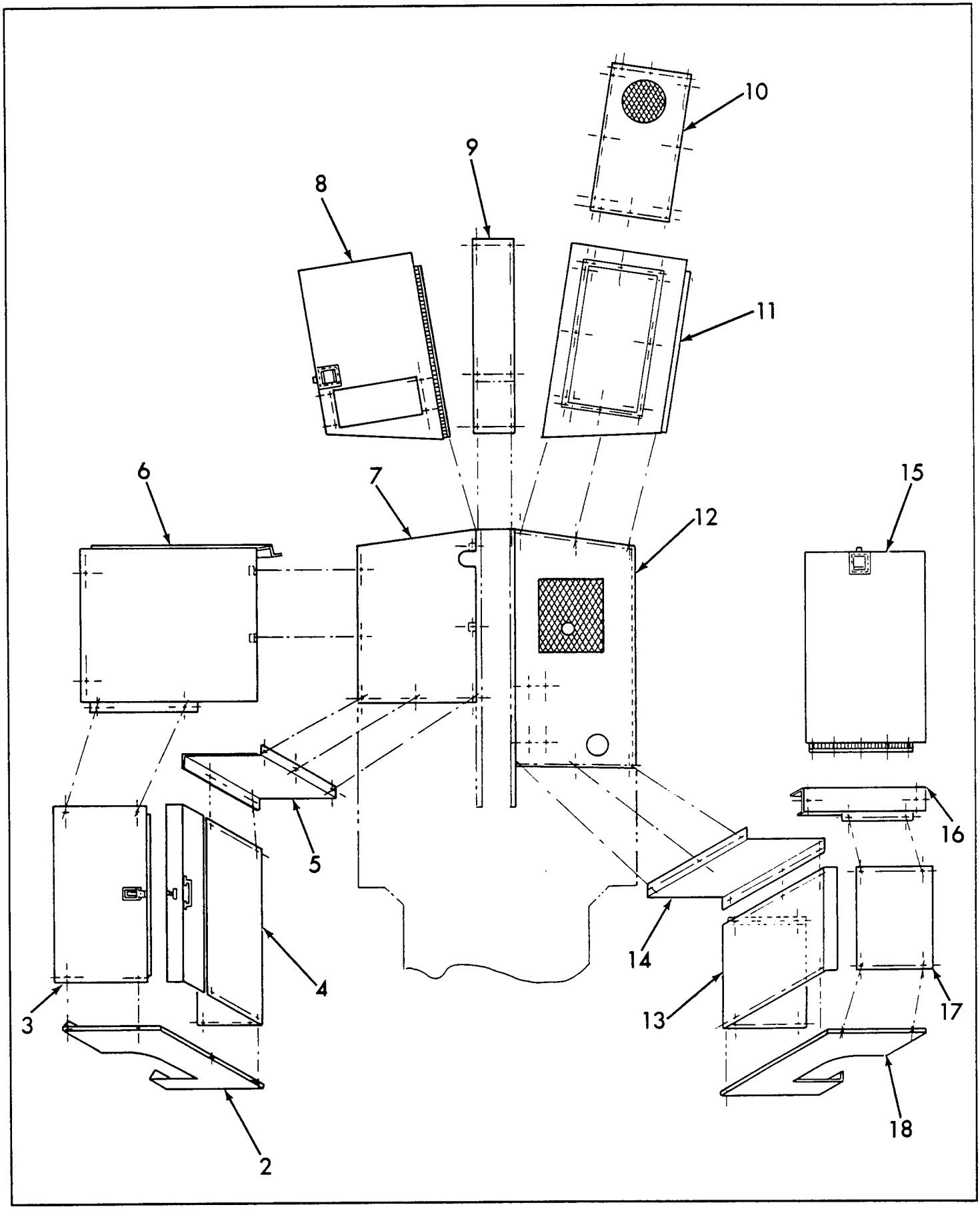
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-48	64209	. ROLL PIN	1
49	81373	. MANUAL ROTATOR (See Sect. 2, Fig. 8,8A or 8B for Details)	1
50	61834	. ROUND HEX SOCKET HEAD CAP SCREW	2
51	210168	. WEAR PAD	2
52	92202	. FOOTSWITCH	1
-53	66336	.. MICROSWITCH	1
54	23846	. FOOTSWITCH COVER	1
55	62726	. MACHINE SCREW	2
56	63413	. FLAT WASHER	2
57	23753	. BACKING PLATE DEADMAN SWITCH	1
58	63313	. LOCK WASHER	2
59	60802	. HEX NUT	2
60	60309	. CAP SCREW	2
61	65842	. ANTI-ROLL CAP	2
62	63401	. FLAT WASHER	2
63	61239	. LOCK NUT	2
64	16629	. BOOM OPERATION HANDBOOK	1
65	65867	. CLAMP	2
66	130927	. PLASTIC CONTAINER	1
-67	2562	. STRAIGHT SWIVEL FITTING	12
-68	2568	. HOSE (19.5 FT.)	1
-69	255	. CABLE TIE	10
-70	24985	. ELECTRICAL SCHEMATIC (See Schematic Section for Details)	1
-71	210219	. HYDRAULIC SCHEMATIC (See Schematic Section for Details)	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-72	160222	. LOC-TITE 242 (1 BOTTLE)	1
-73	65114	. GAS (2 GAL.)(REGULAR)	1
-74	65116	. HYDRAULIC OIL (20 GAL.)	1
-75	16609	. PAINT (.50 GAL.) (BLUE WATER-BASE SPRAYLAT #9245)	1
-76	16608	. PAINT (5 GAL.) (WHITE WATER-BASE SPRAYLAT #9042-2)	1
-77	65112	. PAINT (1 GAL.) (190 HB CARBOLINE TANK WHITE)	1

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TITLE	SHEET METAL KIT
MODEL	40 4X4 (WISC.)
NOTES	

SECTION	2
FIGURE	3
PAGE	1



REV.

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TITLE	SHEET METAL KIT
MODEL	40 4X4 (WISC.)
NOTES	

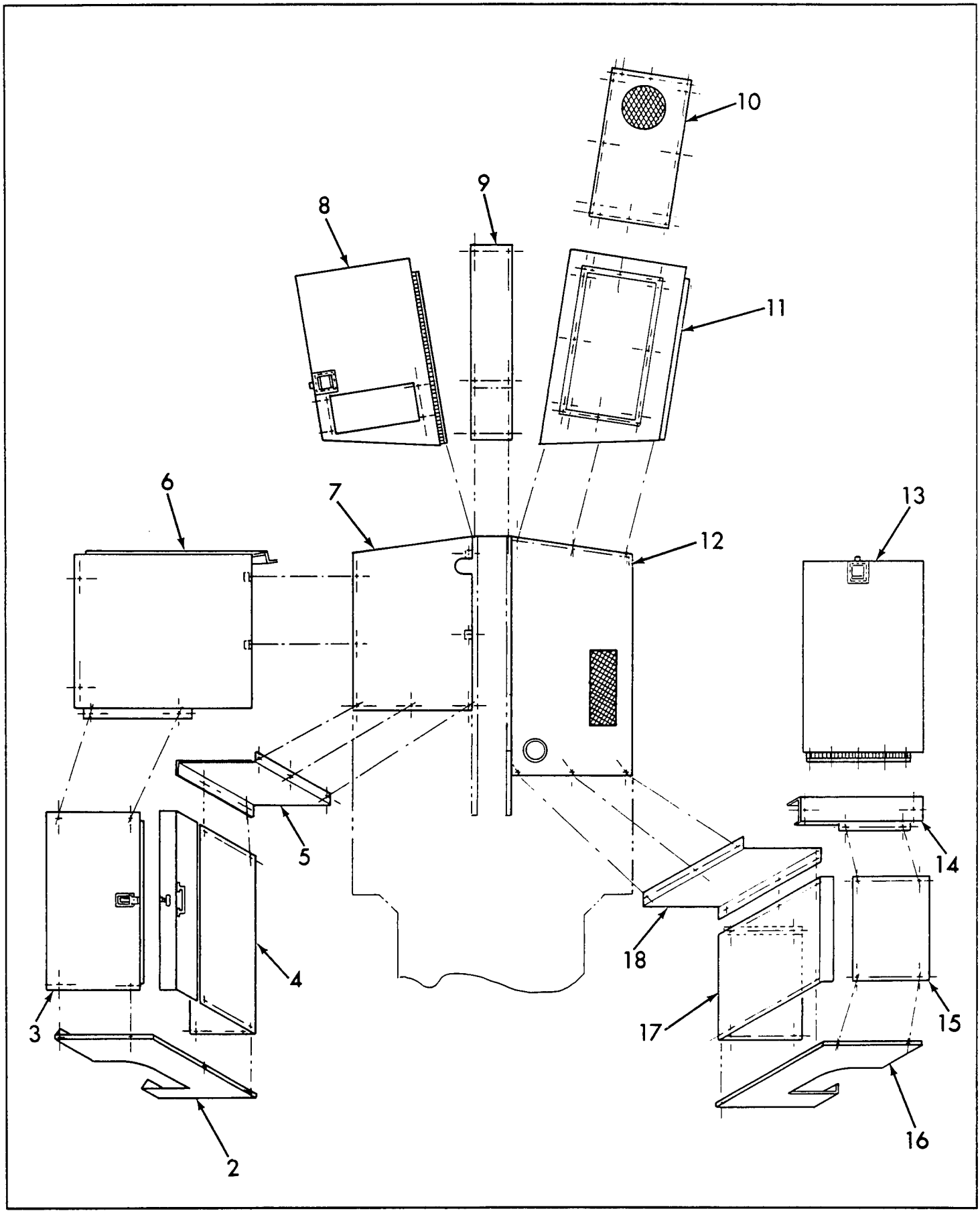
SECT.	2
FIG.	3
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24922	SHEET METAL KIT (WISC.) (See Sect. 2, Fig. 1 for NHA)	REF
2	24880	. END SUPPORT WELDMENT	1
3	24875	. LOWER FRONT PANEL MACHINING	1
4	24878	. HINGED COVER WELDMENT	1
5	24892	. PANEL MACHINING	1
6	24889	. PANEL MACHINING	1
7	24882	. COVER MACHINING	1
8	24895	. DOOR WELDMENT	1
9	24940	. BOOM END COVER	1
10	24990	. INSERT PANEL WELDMENT	1
11	24944	. INLET PANEL WELDMENT	1
12	210102	. TOP COVER WELDMENT	1
13	24966	. COVER WELDMENT	1
14	24969	. PANEL	1
15	211026	. DOOR WELDMENT	1
16	24965	. SUPPORT WELDMENT	1
17	24964	. SIDE PANEL	1
18	24917	. END SUPPORT WELDMENT	1

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TITLE	SHEET METAL KIT
MODEL	40 4X4 (DEUTZ)
NOTES	

SECTION	2
FIGURE	4
PAGE	1



REV.

Mark Industries

TITLE	SHEET METAL KIT
MODEL	40 4X4 (DEUTZ)
NOTES	

SECT.	2
FIG.	4
PAGE	2

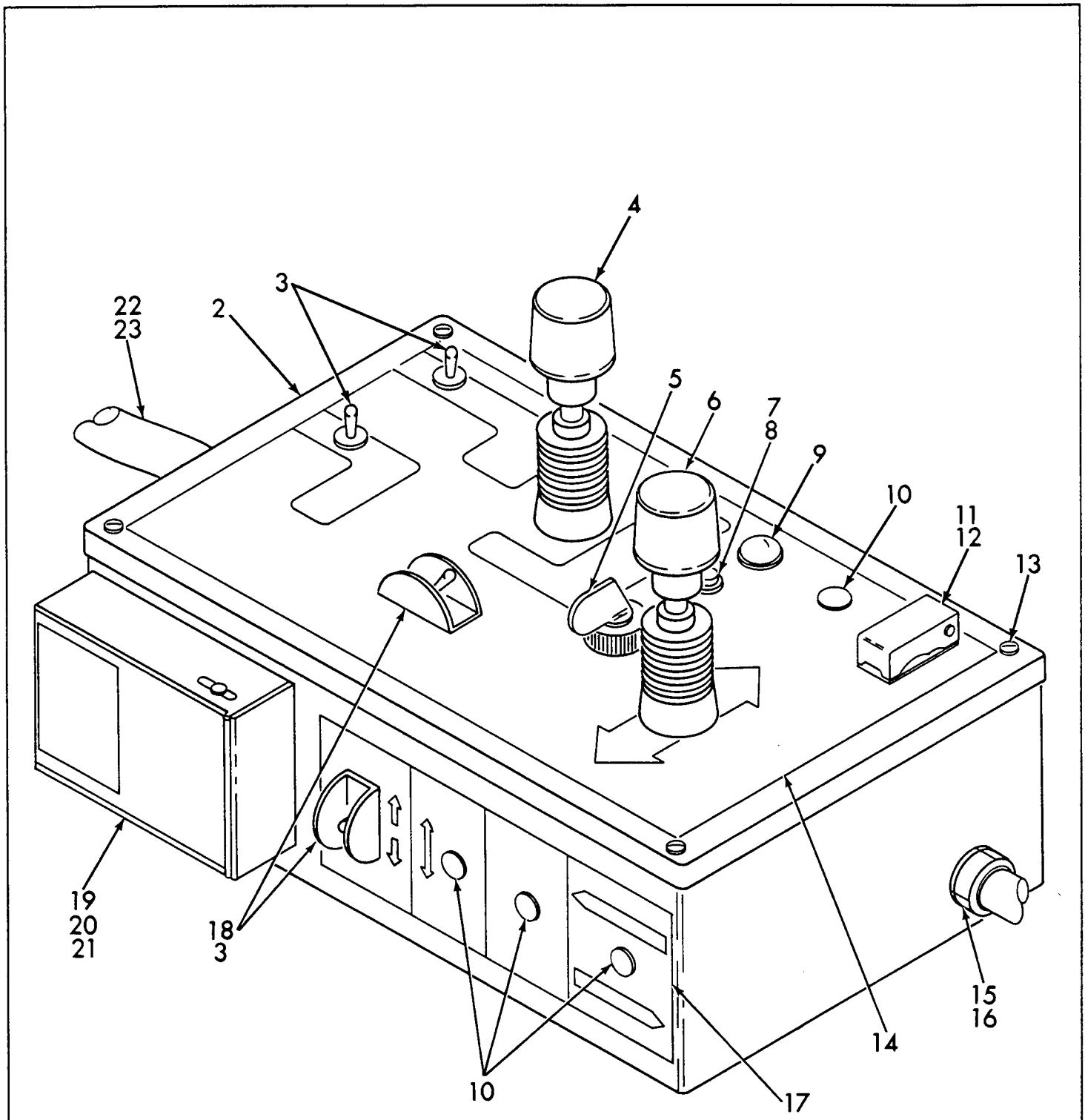
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24953	SHEET METAL KIT (See Sect. 2, Fig. 1 for NHA)	REF
2	24880	. END SUPPORT WELDMENT	1
3	24875	. LOWER FRONT PANEL MACHINING	1
4	24878	. HINGED COVER WELDMENT	1
5	24892	. PANEL MACHINING	1
6	24889	. PANEL MACHINING	1
7	24882	. COVER MACHINING	1
8	24895	. DOOR WELDMENT	1
9	24940	. BOOM END COVER	1
10	24967	. INSERT PANEL WELDMENT	1
11	24944	. INLET PANEL WELDMENT	1
12	211040	. COVER WELDMENT	1
13	211026	. DOOR WELDMENT	1
14	24965	. SUPPORT WELDMENT	1
15	24964	. SIDE PANEL	1
16	24917	. END SUPPORT WELDMENT	1
17	24966	. COVER WELDMENT	1
18	24969	. PANEL	1

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

Mark Industries

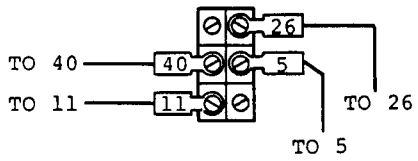
TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	40 4X4(WISC.)
NOTES	

SECTION	2
FIGURE	5
PAGE	1

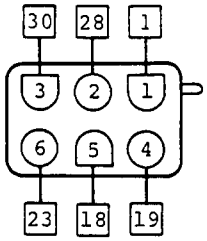


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(EMERGENCY PUMP)

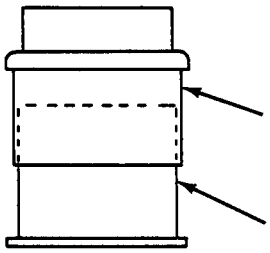


DETAIL A-A

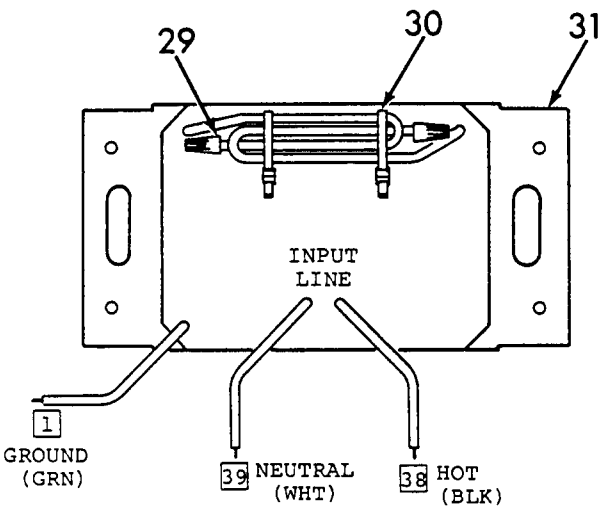


WIRE COLOR

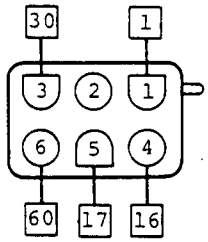
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18	ORN/BLK
19	ORN/RED
28	ORN
30	RED
31	YEL/RED



DETAIL -C-

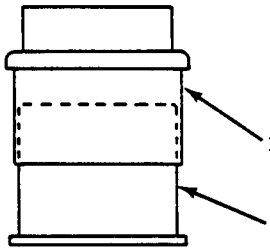


DETAIL -B-



WIRE COLOR

1	BLK
16	YEL/RED
17	YEL/BLK
30	RED
60	GRAY



DETAIL -D-

NOTES:

1. ALL WIRES ARE TO BE STRANDED 18AWG, UNLESS OTHERWISE SPECIFIED.
2. IDENTIFY EACH BY NUMBERING FLAG AT THE END WRAPPING COMPLETELY AROUND.
3. THE NUMBER OF SECTIONS USED ON THIS DECAL DEPENDS ON THE NUMBER OF FEATURES USED PER EACH MODEL.
4. REFER TO ELECTRICAL SCHEMATIC DRAWING NO.: 141205.
5 SEE DETAIL -B- FOR WIRING CONNECTIONS.

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

SECT.	2
FIG.	5
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24918	AERIAL CONTROL BOX ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	24855	. AERIAL CONTROL BOX MACHINING	1
3	20481	. TOGGLE SWITCH	4
4	70488	. CONTROLLER (ROTATE) (See Sect. 2, Fig. 9 for Details)	1
5	70405	. IGNITION SWITCH	1
6	70494	. CONTROLLER (DRIVE) (See Sect. 2, Fig. 10 for Details)	1
7	4011	. PUSH BUTTON SWITCH	1
8	117-E	. PUSH-ON TERMINAL	2
9	20805	. ALARM BUZZER	1
10	771	. WHITE PLUG	4
11	70304	. TOGGLE SWITCH -	1
12	70303	. SWITCH GUARD -	1
13	63703	. MACHINE SCREW	8
14	182748	. AERIAL CONTROL BOX DECAL	1
15	2808	. LOCK NUT	2
16	2806	. STRAIN RELIEF	1
17	182749	. REAR SIDE AERIAL CONTROL BOX DECAL	1
18	20884	. GUARD SWITCH	2
19	2991	. WHITE 12 AWG STRANDED WIRE (4 FT.)	1
20	70098	. YELLOW WITH GREEN STRIPE WIRE (1 FT.)	1
21	70392	. RECEPTACLE COVER	1
22	16105	. LOCK NUT	2
23	16215	. STRAIN RELIEF	1
-24	61532	. HEX NUT #8-32 UNC	4

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

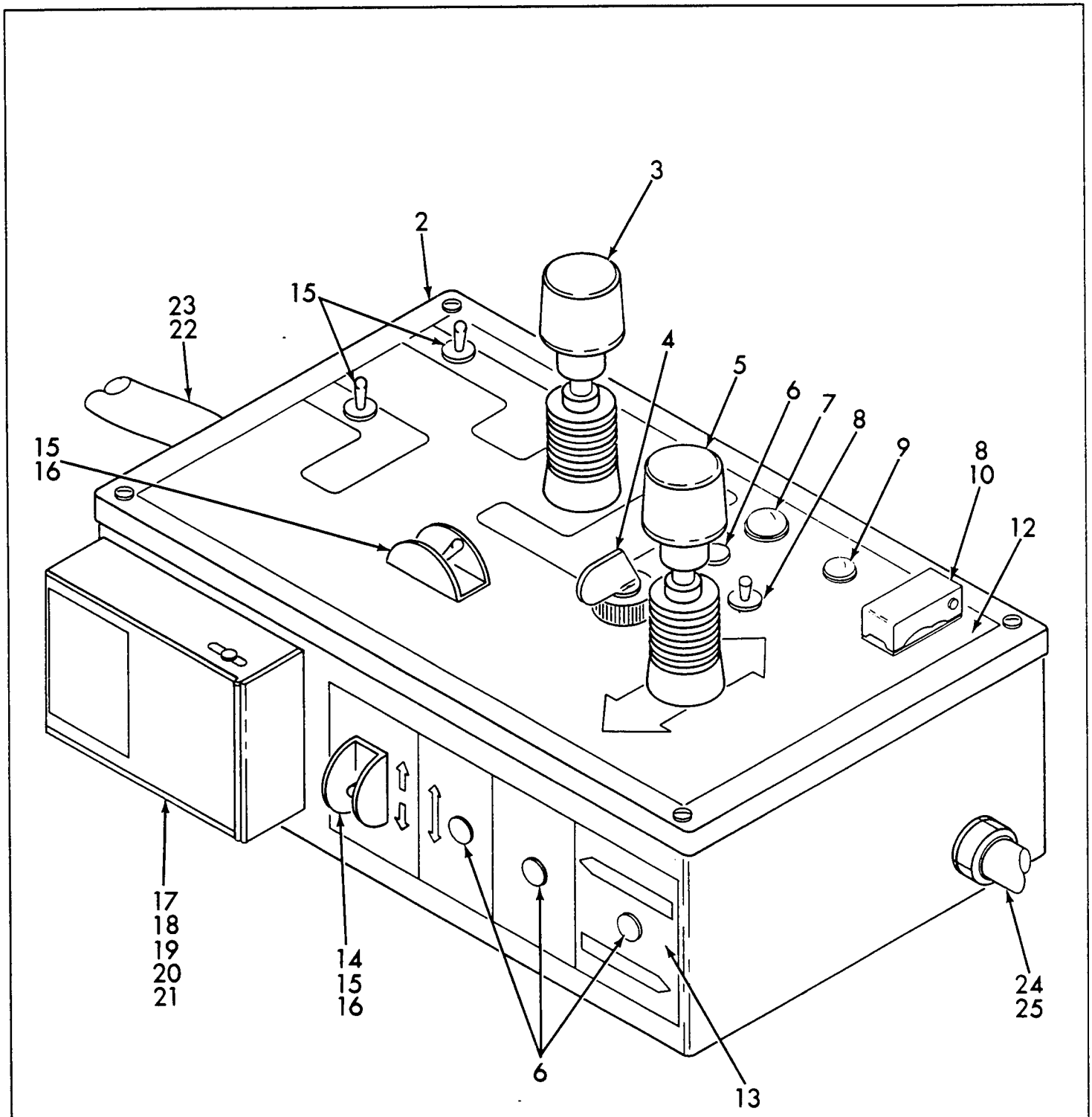
SECT.	2
FIG.	5
PAGE	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-25	63312	. LOCK WASHER SPLIT #8	4
-26	4027	. TERMINAL BLOCK	27
-27	117-A	. TERMINAL BLOCK END	4
-28	62636	. MACHINE SCREW	4
29	70394	. TWIST ON WIRE CONNECTOR	2
30	256	. CABLE TIE	2
31	70391	. RECEPTACLE	1
-32	2990	. WHITE 18 AWG STRANDED WIRE (1 FT.)	1
-33	70008	. YELLOW WITH GREEN 16 AWG WIRE (1 FT.)	1
-34	141144	. BOOM FUNCTION WIRE HARNESS ASSEMBLY	2

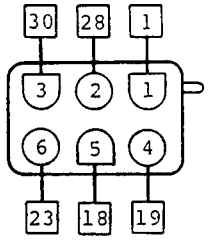
Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

SECTION	2
FIGURE	6
PAGE	1

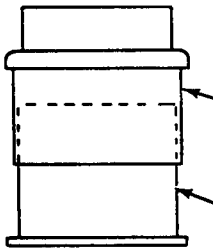


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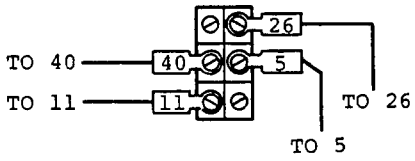


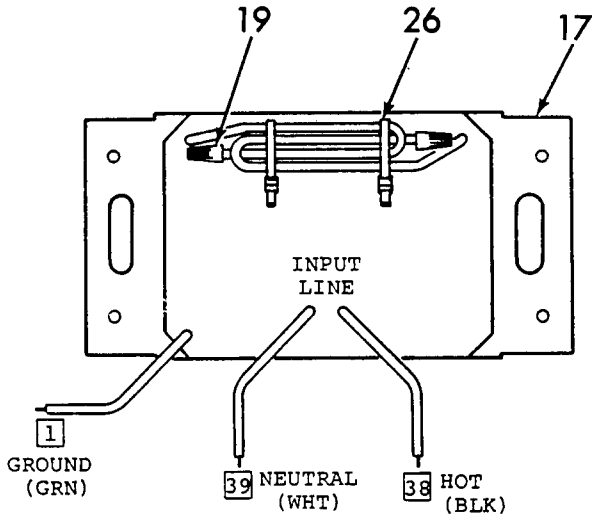
WIRE COLOR

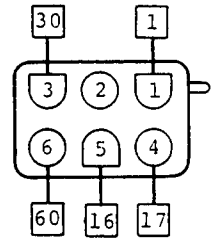
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19	ORN/RED
28	ORN
30	RED
31	YEL/RED



(EMERGENCY PUMP)

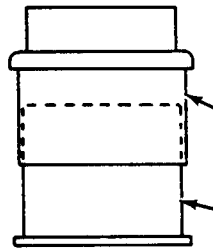






WIRE COLOR

1	BLK
17	YEL/RED
16	YEL/BLK
30	RED
60	GRAY



NOTES:

1. ALL WIRES ARE TO BE STRANDED 18AWG, UNLESS OTHERWISE SPECIFIED.
2. IDENTIFY EACH BY NUMBERING FLAG AT THE END WRAPPING COMPLETELY AROUND.
3. THE NUMBER OF SECTIONS USED ON THIS DECAL DEPENDS ON THE NUMBER OF FEATURES USED PER EACH MODEL.
4. REFER TO ELECTRICAL SCHEMATIC DRAWING NO.: 24985 .
5. SEE DETAIL -B- FOR WIRING CONNECTIONS.

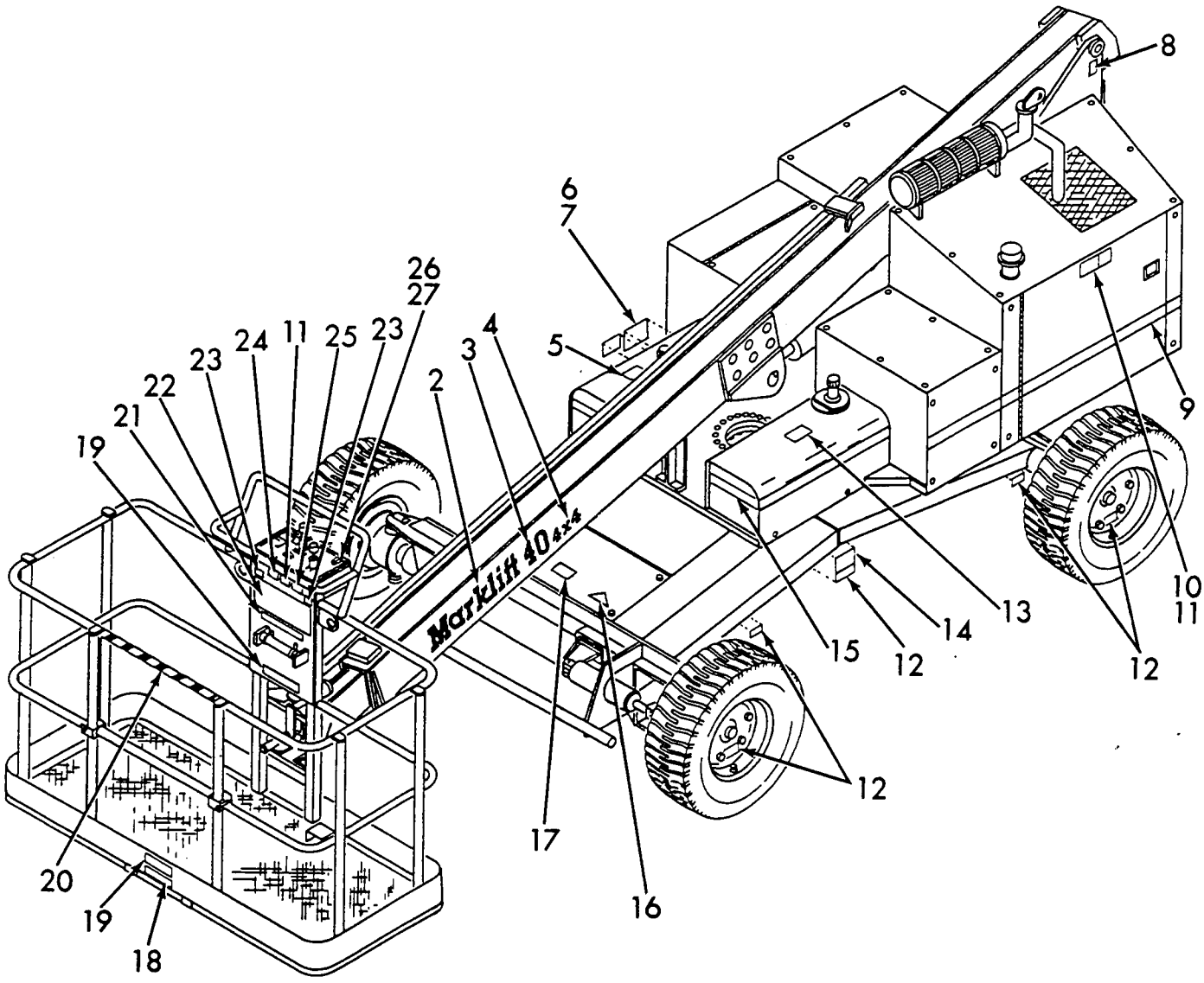
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24996	AERIAL CONTROL BOX ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	24855	. AERIAL CONTROL BOX MACHINING	1
3	70488	. CONTROLLER (ROTATE) (See Sect. 2, Fig. 9 for Details)	1
4	70405	. IGNITION SWITCH	1
5	70494	. CONTROLLER (DRIVE) (See Sect. 2, Fig. 10 for Details)	1
6	771	. WHITE PLUG	4
7	20805	. ALARM BUZZER	1
8	4017	. TOGGLE SWITCH	2
9	70195	. INDICATOR LIGHT	1
10	70303	. SWITCH GUARD	1
11	62703	. MACHINE SCREW	8
12	182748	. AERIAL CONTROL BOX DECAL	1
13	182749	. REAR SIDE AERIAL CONTROL BOX DECAL	1
14	70037	. TOGGLE SWITCH	1
15	20481	. TOGGLE SWITCH	4
16	20884	. SWITCH GUARD	2
17	70391	. RECEPTACLE	1
18	70392	. RECEPTACLE COVER	1
19	70394	. TWIST-ON WIRE CONNECTOR	2
-20	70098	. YELLOW WITH GREEN STRIPE WIRE (1 FT.)	1
-21	2991	. WHITE 12 AWG STRANDED WIRE (1 FT.)	1
22	16215	. STRAIN RELIEF	1
23	16105	. LOCK NUT	2
24	2806	. STRAIN RELIEF	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
25	2808	. LOCK NUT	2
26	256	. CABLE TIE	2
-27	4027	. TERMINAL BLOCK	28
-28	117-A	. TERMINAL BLOCK END	4
-29	62636	. MACHINE SCREW	4
-30	61532	. HEX NUT #8-32 UNC	4
-31	63312	. LOCK WASHER SPLIT #8	4
-32	2990	. WHITE 18 AWG STRANDED WIRE (1 FT.)	1
-33	70008	. YELLOW WITH GREEN 16 AWG WIRE (1 FT.)	1
-34	70479	. DIODE	1
-35	70564	. SLEEVE (1 IN.)	2
-36	117-B	. RING CONNECTOR	14
-37	70149	. RING CONNECTOR	22
-38	141144	. BOOM FUNCTION WIRE HARNESS ASSEMBLY	2
-39	70502	.. PLUG CONNECTOR	1
-40	70503	.. PIN	6
-41	2990	.. WHITE 18 AWG STRANDED WIRE (12 FT.)	1

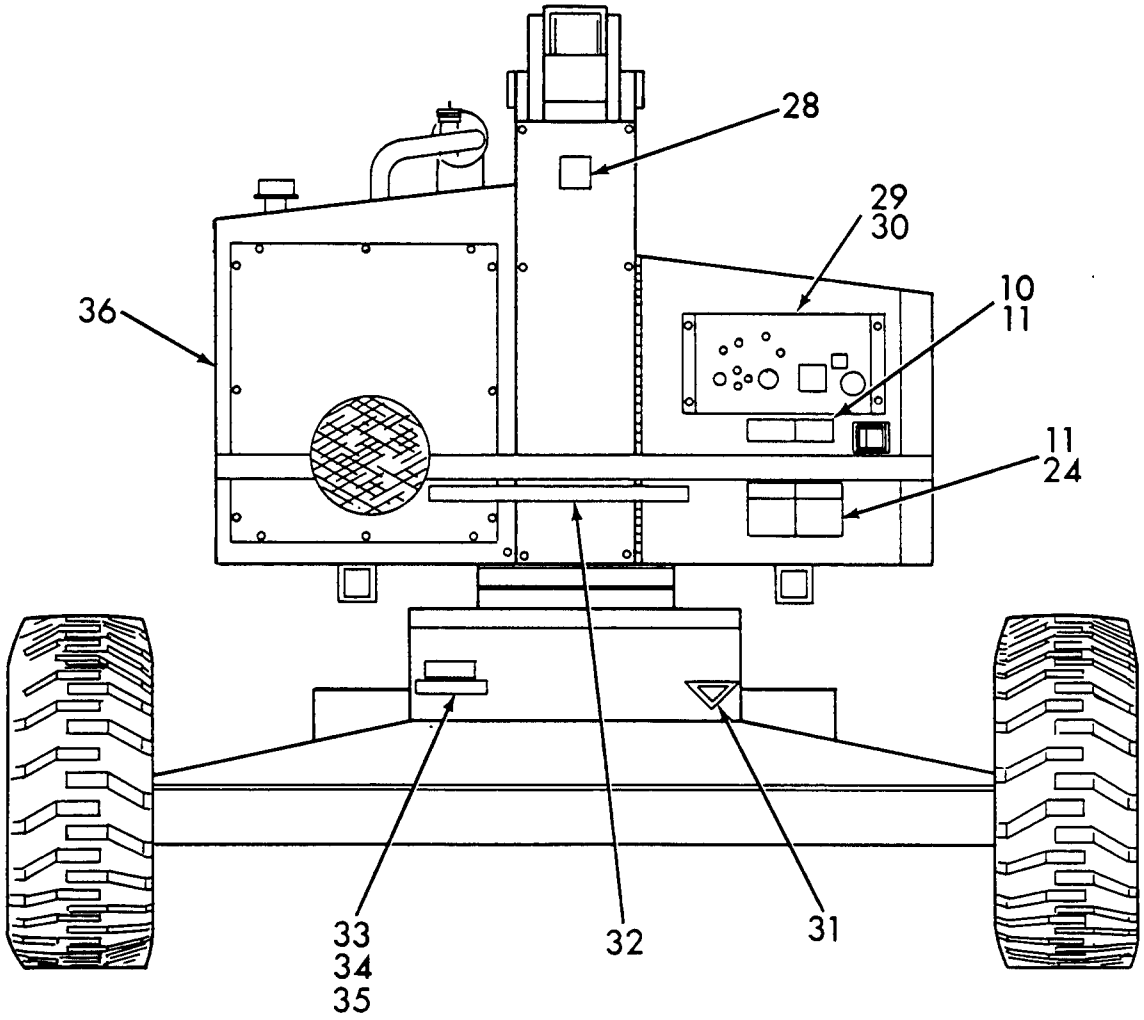
Mark Industries

TITLE	DECAL SET
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	2
FIGURE	7
PAGE	1



REV.


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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	67960	DECAL SET (See Sect. 2, Fig. 1 for NHA)	REF
2	20408	. MARKLIFT DECAL	2
3	20872	. 40 DECAL	2
4	22740	. 4X4 DECAL	2
5	2020	. GASOLINE OR PETROL DECAL (WISC.)	2
	2033	. DIESEL FUEL ONLY (DEUTZ)	2
6	2003	. BATTERY WATER LEVEL DECAL	1
7	20860	. GENERAL CHECKOUT & OPERATING INSTRUCTIONS DECAL	1
8	21237	. GREASE FITTING DECAL	2
9	20411	. BLUE STRIPE SQUARE END DECAL	1
10	20419	. DANGER KEEP CLEAR DECAL	2
11	181103	. DANGER OBEY THE FOLLOWING DECAL	4
12	22959	. TIRE PRESSURE 50 PSI DECAL (DEUTZ)	14
	181778	. TIRE PRESSURE 70 PSI DECAL (WISC.)	14
13	2017	. HYDRAULIC SYSTEM FLUID DECAL	2
14	20508	. TRANSPORTATION DECAL	2
15	20412	. BLUE STRIPES ROUND ENDS DECAL	1
16	20461	. FORWARD ARROW DECAL	1
17	20896	. BRAKE DECAL	1
18	22385	. CAUTION ATTACH YOUR SAFETY BELT FIRST DECAL	1
19	2022	. LOAD CAPACITY DECAL	2
20	160137	. WARNING TAPE (2.17 FT.)	1
21	130820	. OPERATION & SAFETY HANDBOOK DECAL	1
22	20859	. CAUTION AERIAL OPERATING INSTRUCTIONS DECAL	1
23	22386	. "O" RING ATTACH SAFETY BELT DECAL	2

Mark Industries

TITLE	DECAL SET
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECT.	2
FIG.	7
PAGE	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
24	181102	. DANGER DO NOT OPERATE UNLESS DECAL	2
25	182302	. WARNING-LIGHT & BUZZER... DECAL	1
26	182749	. REAR SIDE AERIAL CONTROL BOX	1
27	182748	. COVER AERIAL CONTROL BOX	1
28	20410	. LOGO MARK INDUSTRIES	1
29	185707	. POWER TO PLATFORM	1
30	23721	. GROUND CONTROL CONSOLE	1
31	20462	. FORWARD ARROW AFT DECAL	1
32	23195	. A PRODUCT OF MARK INDUSTRIES DECAL	1
33	63653	. POP RIVET	8
34	20660	. I.D. NAMEPLATE	1
35	20661	. ANSI A92 PLATE	1
36	20879	. DIPSTICK (INSIDE WITH ENGINE)	1

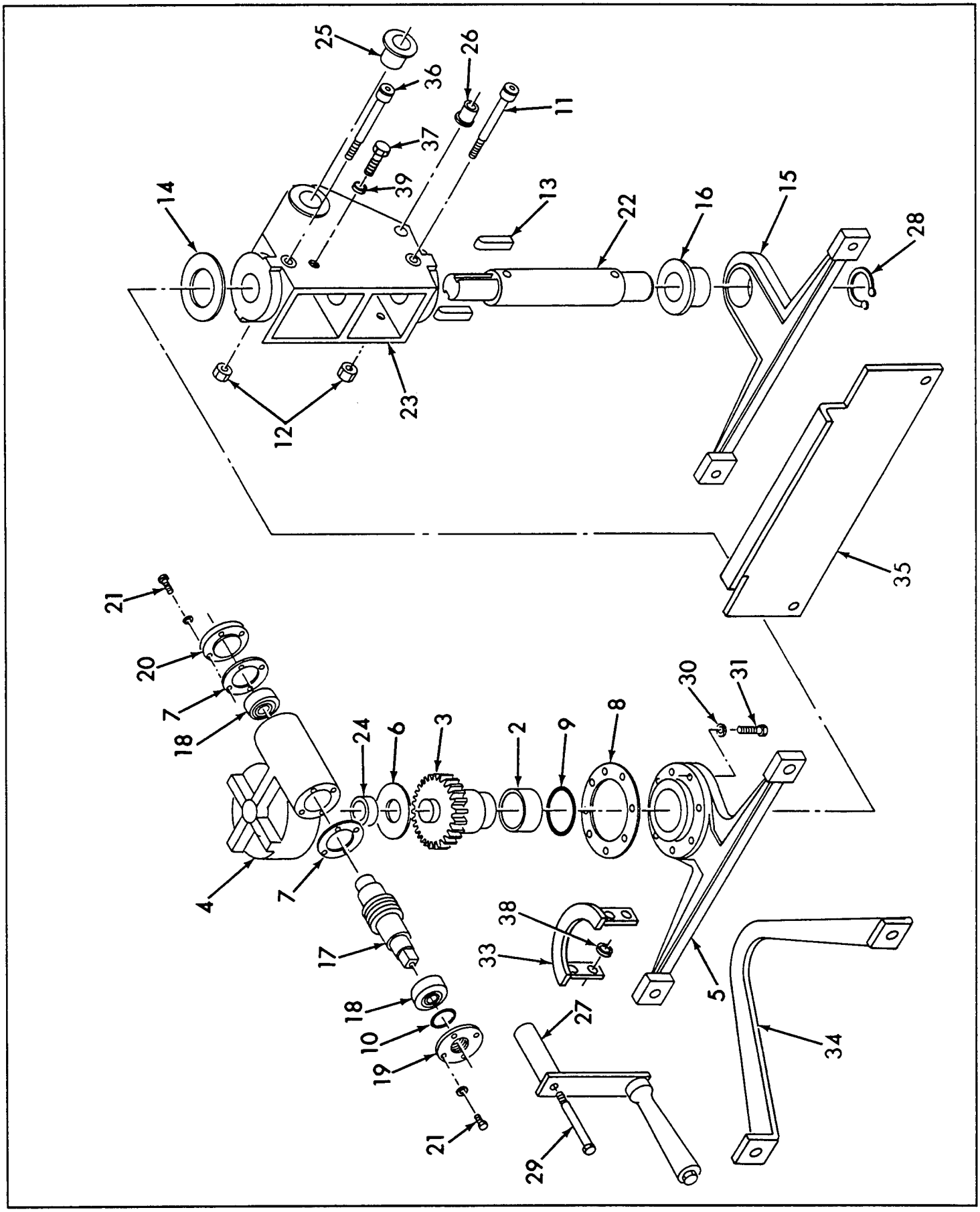
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DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	USED UNTIL MID JULY 1989

SECTION	2
FIGURE	8
PAGE	1



REV.

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	USED UNTIL MID JULY 1989

SECT.	2
FIG.	8
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	140684	MANUAL ROTATOR (See Sect. 2, Fig. 1 for NHA)	REF
2	68030	. BUSHING	1
3		. BULL GEAR	1
4	68032	. GEAR HOUSING	1
5	68035	. TOP ARM	1
6	68037	. THRUST WASHER	1
7	68038	. END CAP GASKET	2
8	68039	. GEARBOX GASKET	1
9	68040	. O-RING	1
10	68041	. O-RING	1
11		. BOLT	1
12		. NUT	2
13		. KEY	2
14	68043	. THRUST WASHER	1
15		. BOTTOM ARM	1
16	68045	. FLANGED BUSHING	1
17		. WORM GEAR	1
18	68046	. ROLLER BEARING	2
19		. THRU SHAFT END CAP	1
20	68047	. END CAP	1
21		. BOLT	8
22		. MAIN PIN	1
23		. YOKE	1
24	68049	. BUSHING	1
25	68050	. FLANGED BUSHING	2

REV.

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

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	USED UNTIL MID JULY 1989

SECT.	2
FIG.	8
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	68051	. FLANGED BUSHING	2
27	68052	. HAND CRANK	1
28	68054	. SNAP RING	1
29	600191	. BOLT	1
30		. LOCK WASHER	8
31	600186	. BOLT	8
-32	600193	. PRODUCT IMPROVEMENT KIT	1
33	141342	.. COLLAR RETAINER	1
34	141341	.. ROTATOR COLLAR	1
35	141344	.. ANGLE BRACKET	1
36	60558	.. HEX HEAD CAP SCREW (ATTACHES ITEM 34 TO YOKE)	1
37	60338	.. HEX HEAD CAP SCREW (ATTACHES ITEM 34 TO YOKE)	2
38	63402	.. FLAT WASHER	4
39	63302	.. LOCK WASHER	2

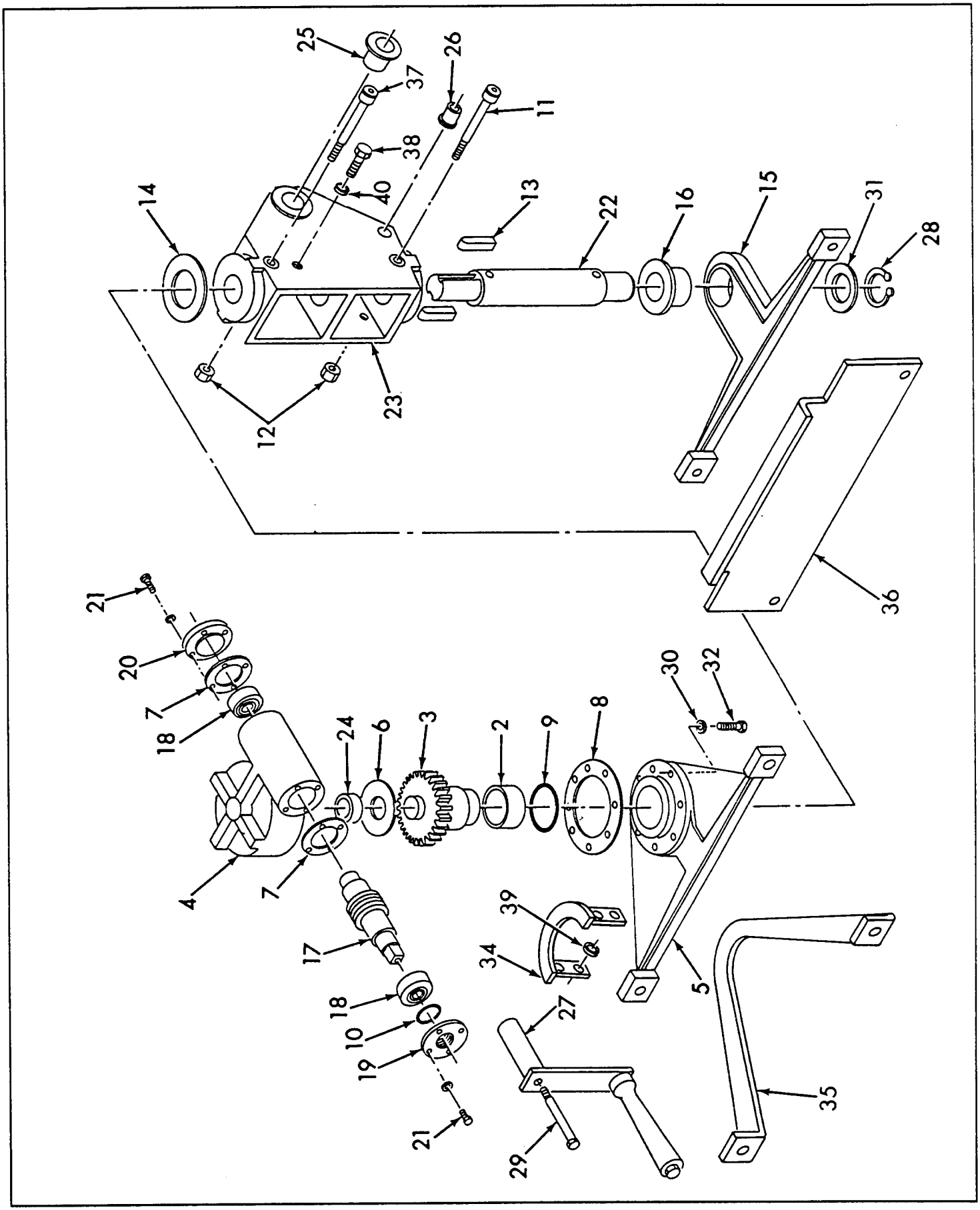
REV.

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

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	MID JULY 1989-DEC. 1989

SECTION	2
FIGURE	8A
PAGE	1



REV.

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	MID JULY 1989-DEC. 1989

SECT.	2
FIG.	8A
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24919	MANUAL ROTATOR (See Sect. 2, Fig. 1 for NHA)	REF
2	68030	. BUSHING	1
3		. BULL GEAR	1
4	68032	. GEAR HOUSING	1
5	68034	. TOP ARM	1
6	68037	. THRUST WASHER	1
7	68038	. END CAP GASKET	1
8	68039	. GEARBOX GASKET	1
9	68040	. O-RING	1
10	68041	. O-RING	1
11		. BOLT	1
12		. NUT	2
13		. KEY	2
14	68042	. THRUST WASHER	1
15		. BOTTOM ARM	1
16	68045	. FLANGED BUSHING	1
17		. WORM GEAR	1
18	68046	. ROLLER BEARING	2
19		. THRU SHAFT END CAP	1
20	68047	. END CAP	1
21		. BOLT	8
22		. MAIN PIN	1
23		. YOKE	1
24	68049	. BUSHING	1
25	68050	. FLANGED BUSHING	2

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	MID JULY 1989-DEC. 1989

SECT.	2
FIG.	8A
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	68051	. FLANGED BUSHING	2
27	68052	. HAND CRANK	1
28	68054	. SNAP RING	1
29	600191	. BOLT	1
30		. LOCK WASHER	8
31		. FLAT WASHER	1
32	600186	. BOLT	8
-33	600193	. PRODUCT IMPROVEMENT KIT	1
34	141342	.. COLLAR RETAINER	1
35	141341	.. ROTATOR COLLAR	1
36	141344	.. ANGLE BRACKET	1
37	60558	.. HEX HEAD CAP SCREW (ATTACHES ITEM 34 TO YOKE)	1
38	60338	.. HEX HEAD CAP SCREW (ATTACHES ITEM 34 TO YOKE)	2
39	63402	.. FLAT WASHER	4
40	63303	.. LOCK WASHER	2

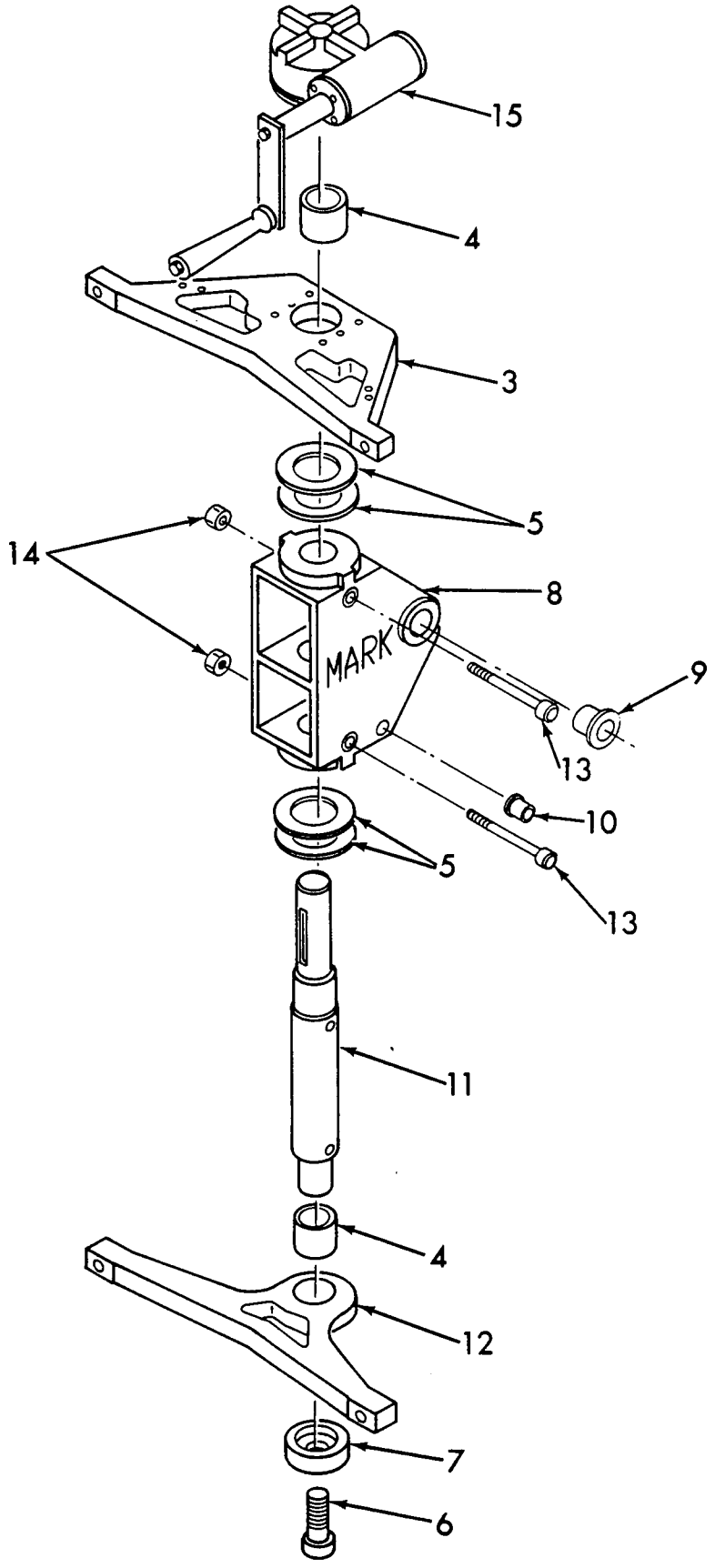
REV.

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

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	SINCE DEC. 1989

SECTION	2
FIGURE	8B
PAGE	1



REV.

Mark Industries

TITLE	MANUAL ROTATOR
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	SINCE DEC. 1989

SECT.	2
FIG.	8B
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	81373	MANUAL ROTATOR ASSEMBLY	REF
-2	81369	. ROTATOR BASE	REF
3	600221	.. STEEL TOP ARM	1
4	600222	.. BUSHING	2
5	600223	.. THRUST WASHER	4
6	600224	.. BOLT	1
7	600225	.. RETAINING WASHER	1
8		.. ROTATOR YOKE	1
9	68050	... FLANGED BUSHING	2
10	68051	... FLANGED BUSHING	2
11	600226	... MAIN PIN	1
12	600227	... STEEL BOTTOM ARM	1
13	600187	... BOLT	2
14	600188	... BOLT WITH NYLOCK	2
15	81374	. GEARHEAD	1

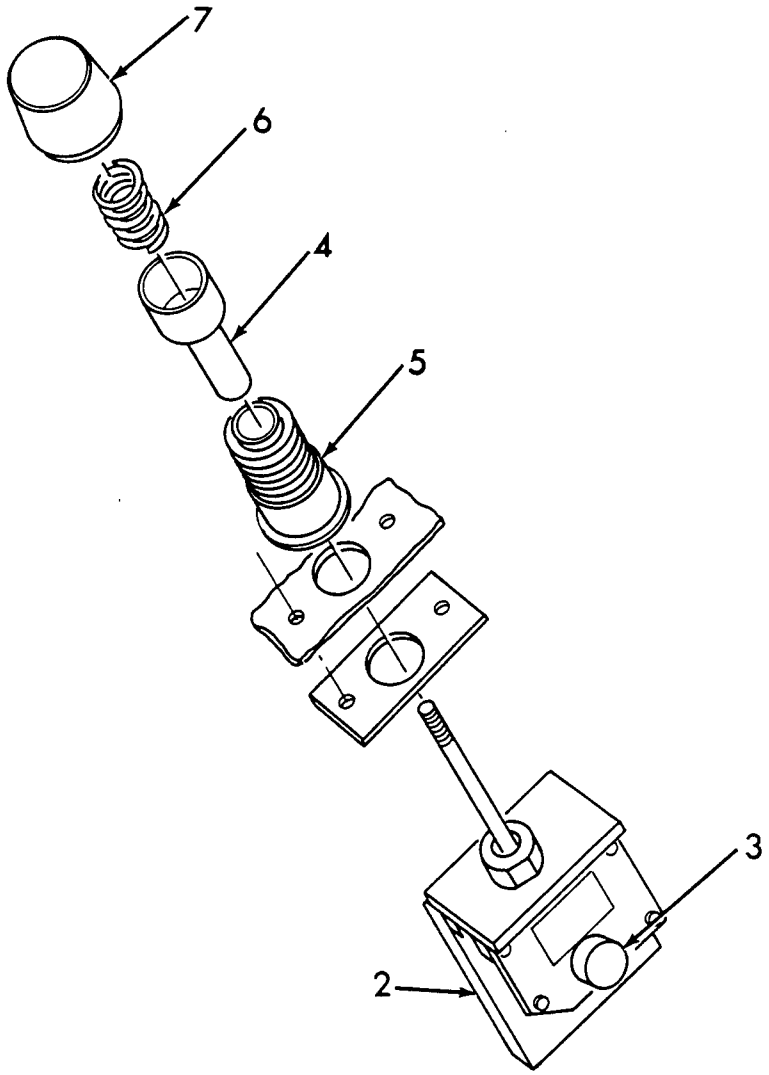
REV.

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

Mark Industries

TITLE	CONTROLLER
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	ROTATE

SECTION	2
FIGURE	9
PAGE	1



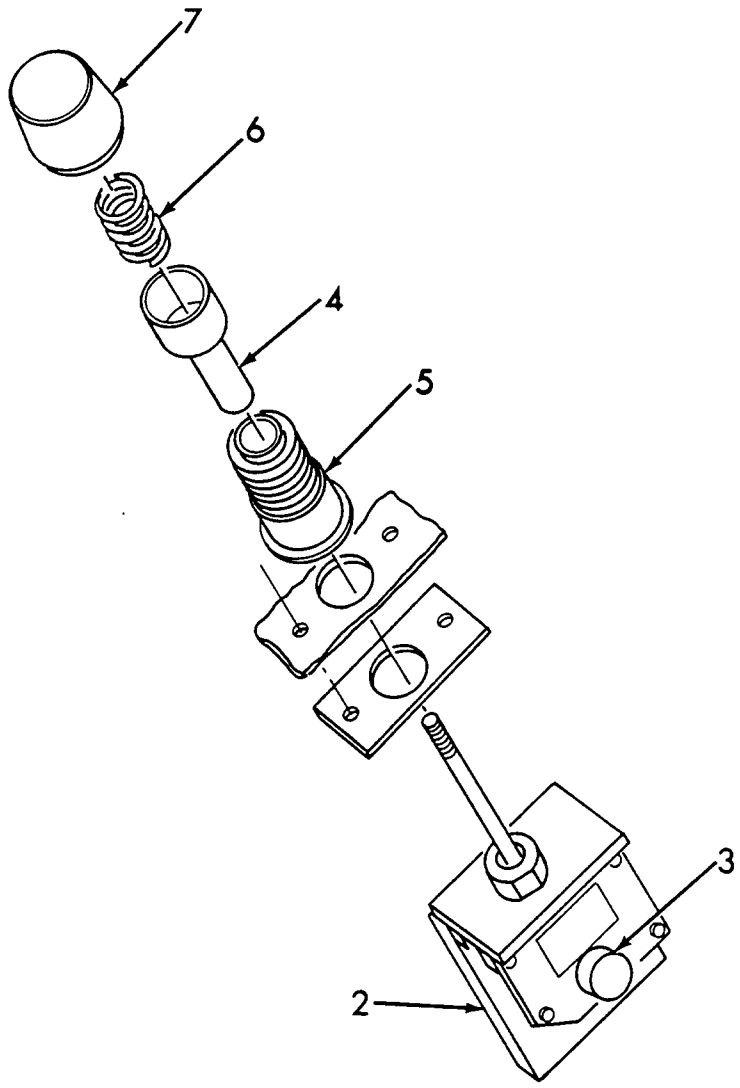
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	70488	CONTROLLER (See Sect. 2, Fig. 5 or 6 for NHA)	REF
2	67812	. ENCAPSULATED CONTROLLER BOARD	1
3	600006	. POTENTIOMETER WITH WIRES	1
4	600007	. SLIDELOCK & BOOT ASSEMBLY	1
5	600008	.. BOOT	1
6	600009	. UPPER SPRING	1
7	600010	. UPPER KNOB	1

REV.

Mark Industries

TITLE	CONTROLLER
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	DRIVE

SECTION	2
FIGURE	10
PAGE	1



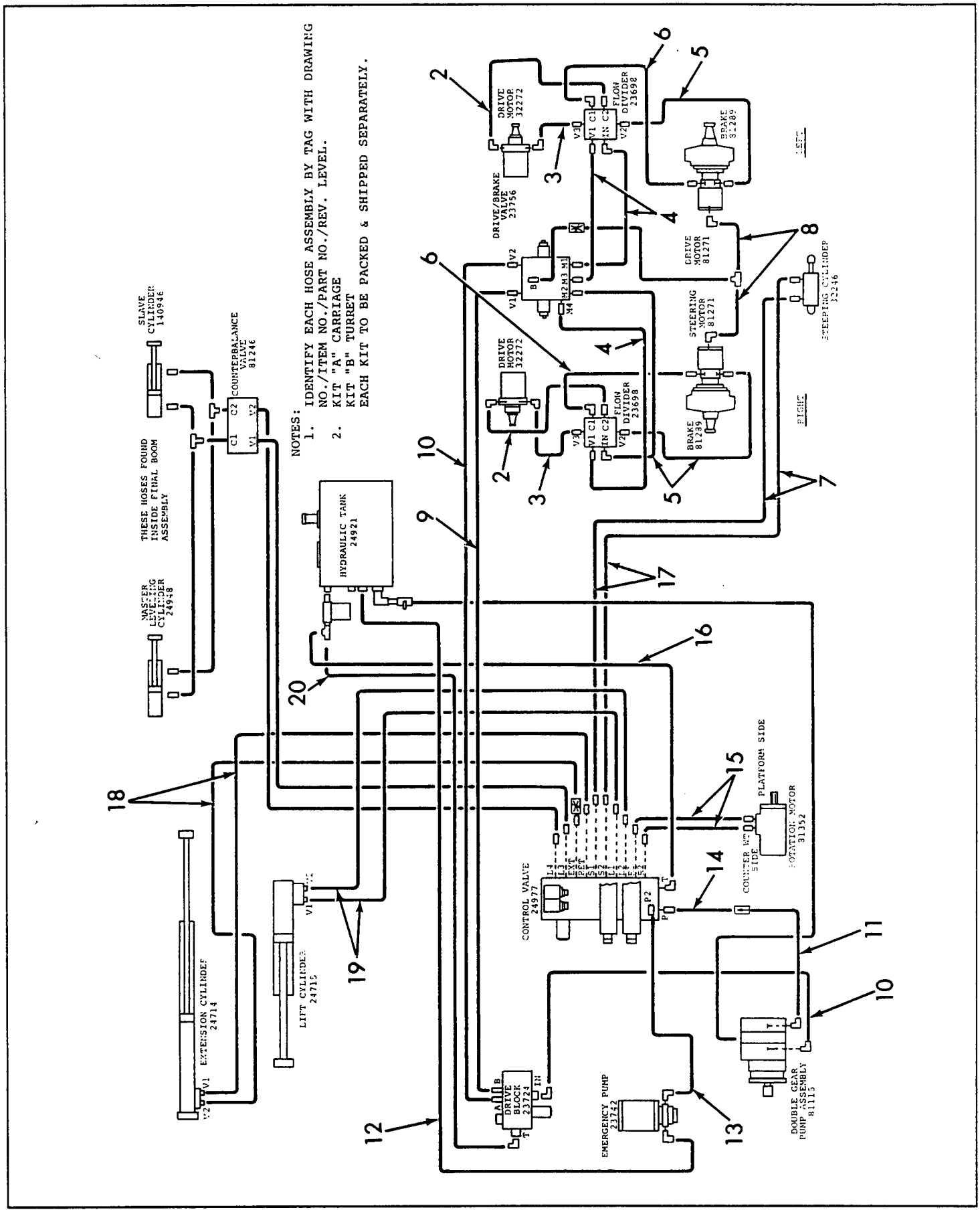
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	70494	CONTROLLER (See Sect. 2, Fig. 5 or 6 for NHA)	REF
2	67813	. ENCAPSULATED CONTROLLER BOARD	1
3	600006	. POTENTIOMETER WITH WIRES	1
4	600007	. SLIDELOCK & BOOT ASSEMBLY	1
5	600008	.. BOOT	1
6	600009	. UPPER SPRING	1
7	600010	. UPPER KNOB	1

REV.

Mark Industries

TITLE	HYDRAULIC HOSE DIAGRAM
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	NONCONTINUOUS TURRET ROTATION

SECTION	2
FIGURE	11
PAGE	1



REV.

Mark Industries

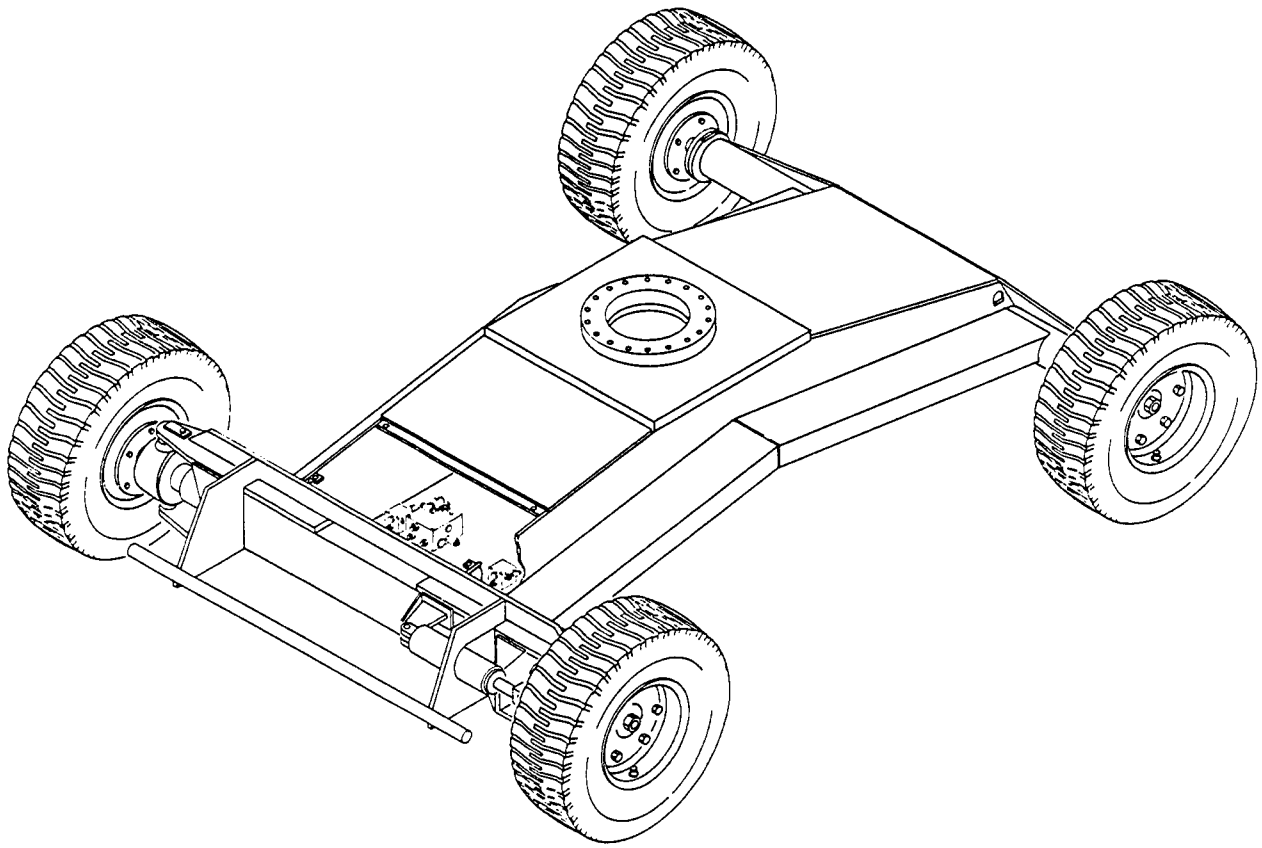
TITLE	HYDRAULIC HOSE DIAGRAM
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	NONCONTINUOUS TURRET ROTATION

SECT.	2
FIG.	11
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	210231	HYDRAULIC HOSE DIAGRAM (NONCONTINUOUS TURRET ROTATION)	REF
		KIT "A" (CARRIAGE)	
2	13210-08-1070	. HOSE ASSEMBLY	2
3	13210-08-1130	. HOSE ASSEMBLY	2
4	13213-10-0144	. HOSE ASSEMBLY	2
5	13210-08-0410	. HOSE ASSEMBLY	2
6	13213-08-0380	. HOSE ASSEMBLY	2
7	13213-04-0870	. HOSE ASSEMBLY	2
8	13213-04-0490	. HOSE ASSEMBLY	2
		KIT "B" (TURRET)	
9	13213-10-1290	. HOSE ASSEMBLY	1
10	13213-10-1260	. HOSE ASSEMBLY	2
11	13213-08-0154	. HOSE ASSEMBLY	1
12	13213-06-0560	. HOSE ASSEMBLY	1
13	13213-06-0440	. HOSE ASSEMBLY	1
14	13213-08-0580	. HOSE ASSEMBLY	1
15	13213-06-0920	. HOSE ASSEMBLY	2
16	13213-12-0920	. HOSE ASSEMBLY	1
17	13213-04-0750	. HOSE ASSEMBLY	2
18	13210-06-1400	. HOSE ASSEMBLY	2
19	13210-06-1000	. HOSE ASSEMBLY	2
20	13213-12-0780	. HOSE ASSEMBLY	1

SECTION 3 CONTAINS:

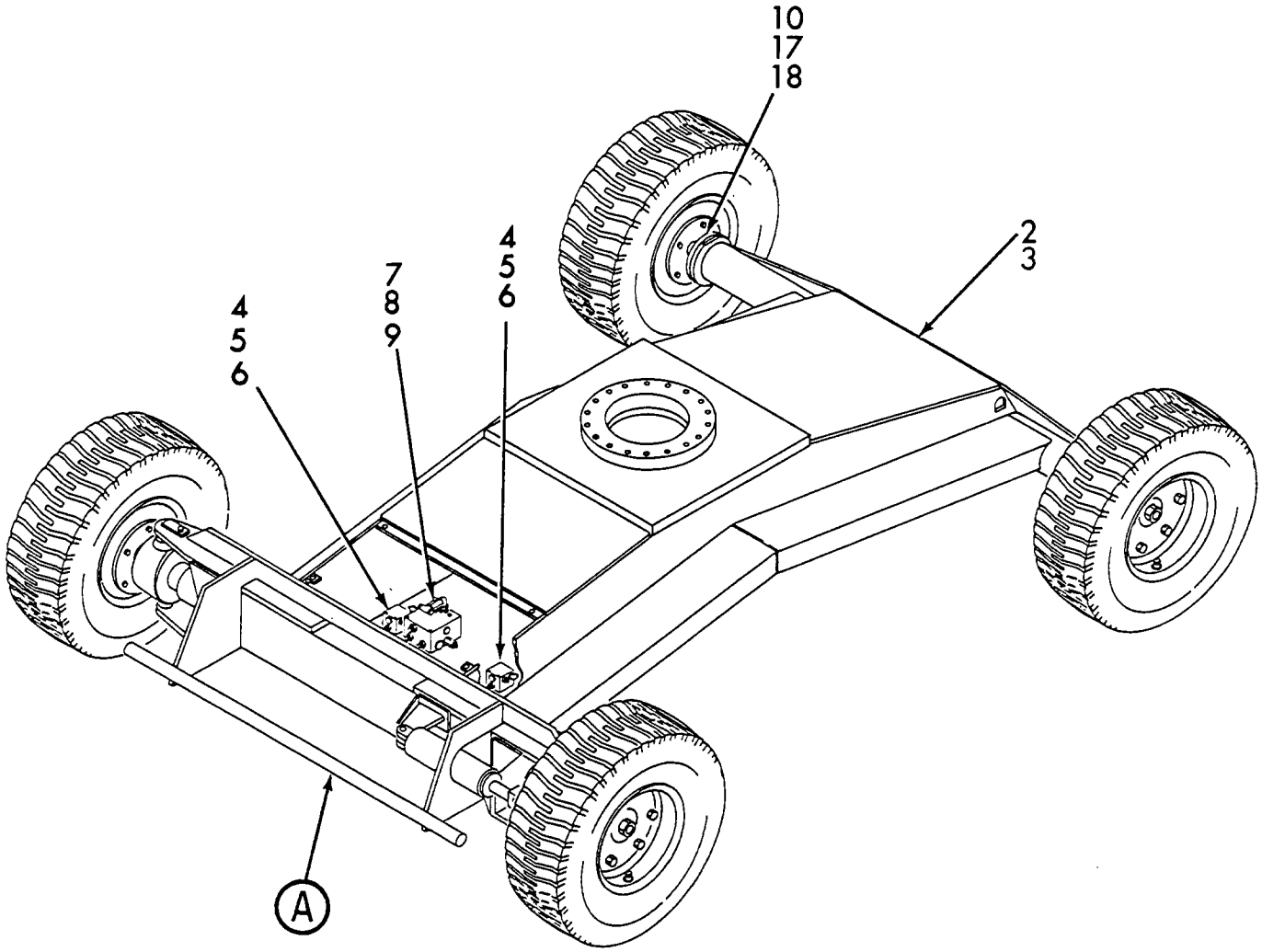
FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY (DEUTZ & WISC.)
2	FLOW DIVIDER ASSEMBLY (DEUTZ & WISC.)
3	DRIVE/BRAKE VALVE ASSEMBLY (DEUTZ & WISC.)
4	TIRE & WHEEL ASSEMBLY (L.H.)(DEUTZ & WISC.)
5	TIE ROD ASSEMBLY (DEUTZ & WISC.)
6	TIRE & WHEEL ASSEMBLY (R.H.)(DEUTZ & WISC.)
7	STEERING CYLINDER ASSEMBLY (TH)(DEUTZ & WISC.)
7A	STEERING CYLINDER ASSEMBLY (SE)(DEUTZ & WISC.)



Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	

SECTION	3
FIGURE	1
PAGE	1

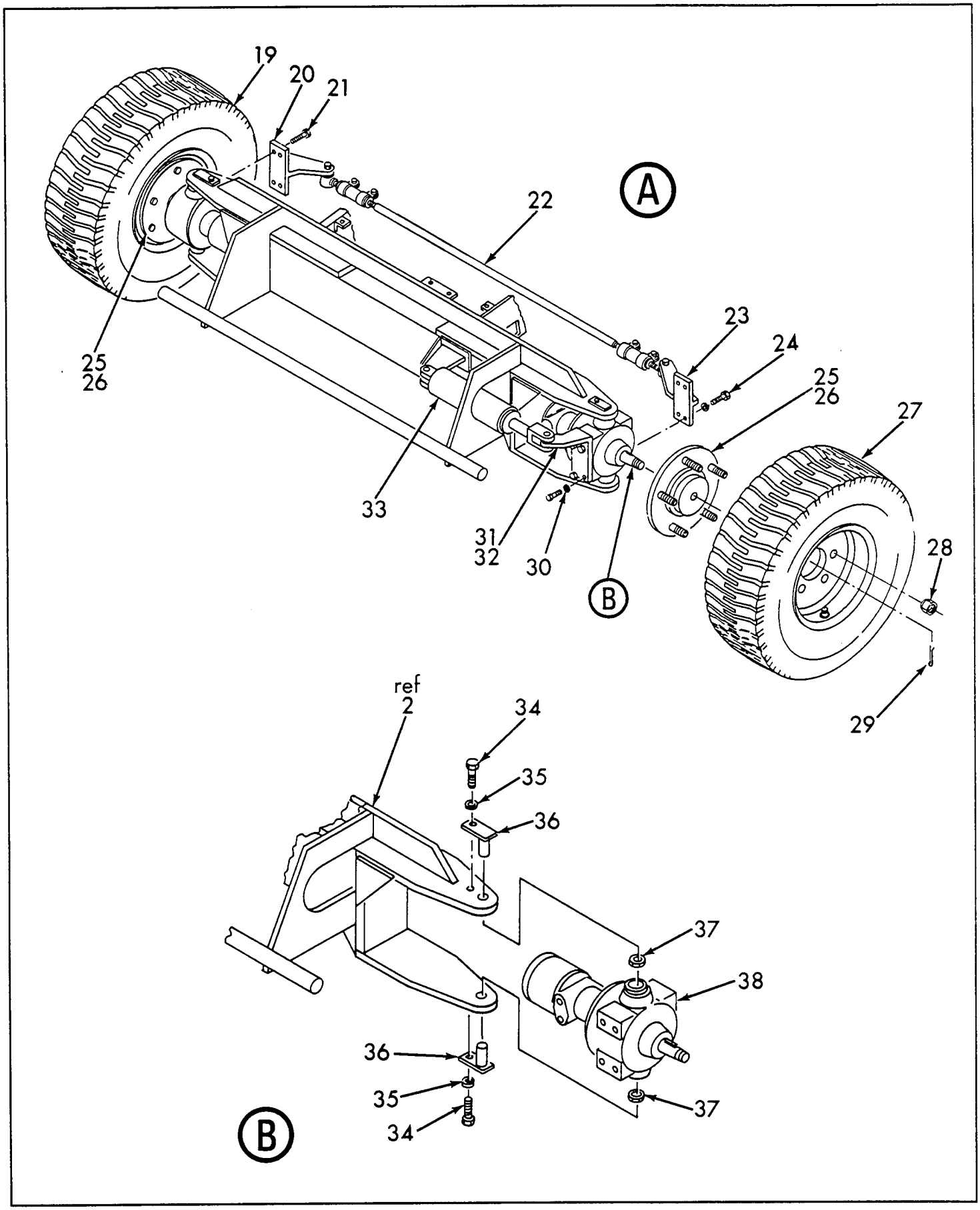


REV.

Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	3
FIGURE	1
PAGE	2



REV.

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	211029	CARRIAGE ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	24950	. CARRIAGE WELDMENT	1
3	65960	.. BUSHING	1
4	23698	. FLOW DIVIDER ASSEMBLY (See Sect. 3, Fig. 2 for Details)	1
5	60377	. CAP SCREW	4
6	63301	. LOCK WASHER	4
7	210064	. DRIVE BRAKE VALVE ASSEMBLY (See Sect. 3, Fig. 3 for Details)	1
8	60362	. CAP SCREW	2
9	63302	. LOCK WASHER	2
10	211028	. DRIVE MOTOR ASSEMBLY (REAR) (See Vendor Chapter for Details)	2
-11	30243	.. DRIVE MOTOR	1
-12	66162	... SEAL KIT	1
-13	67980	... COUPLING SHAFT	1
-14	66915	... KEY	1
-15	66514	... COMMUTATOR ASSEMBLY	1
-16	80012-13	.. STRAIGHT THREAD ELBOW	2
17	60512	. CAP SCREW	8
18	63305	. LOCK WASHER	8
19	24684	. TIRE & WHEEL ASSEMBLY (L.H.) (See Sect. 3, Fig. 4 for Details)	2
20	24687	. STEERING TIE ROD BRACKET (L.H.)	1
21	60609	. CAP SCREW	4
22	24686	. TIE ROD ASSEMBLY (See Sect. 3, Fig. 5 for Details)	1

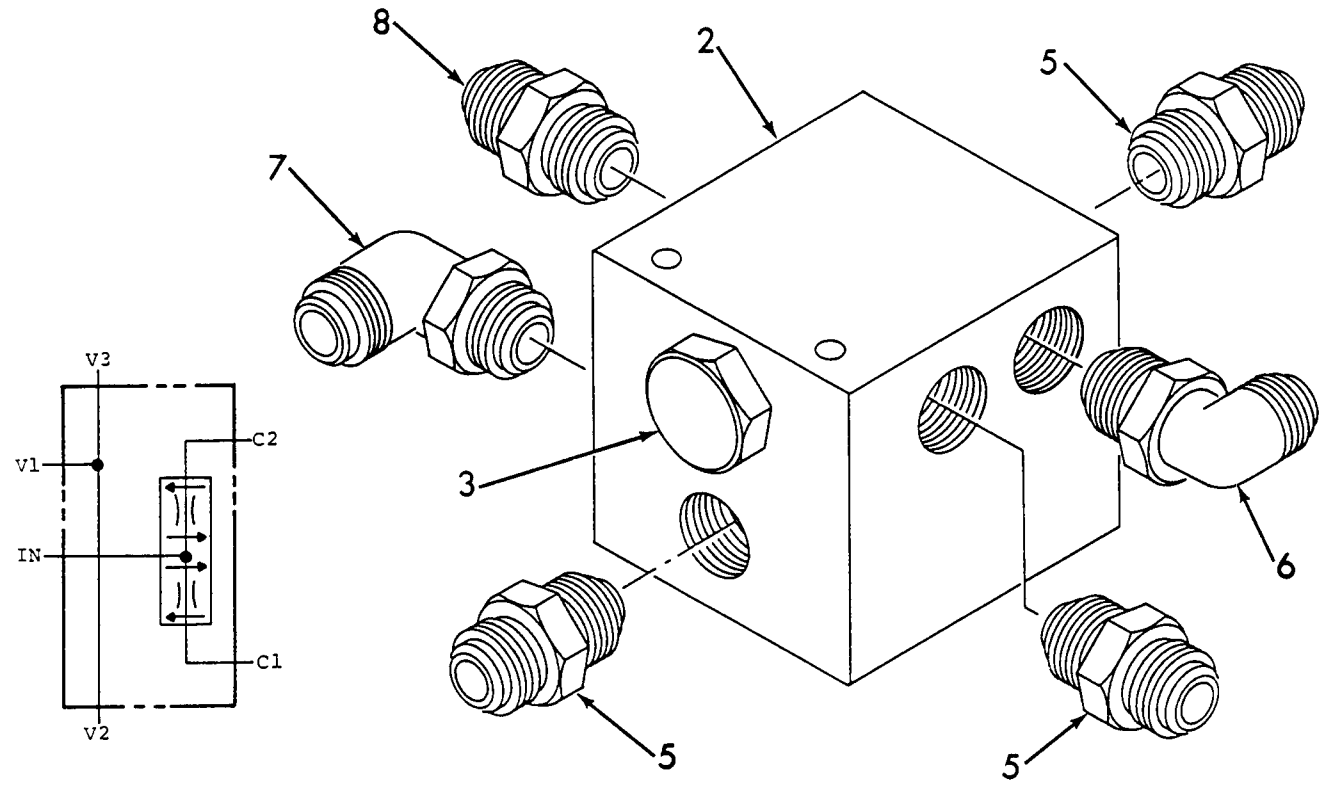
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
23	24688	. STEERING TIE ROD BRACKET (R.H.)	1
24	60609	. CAP SCREW	8
25	24681	. DRIVE HUB	4
26	65943	. WHEEL BOLT	20
27	24683	. TIRE & WHEEL ASSEMBLY (R.H.) (See Sect. 3, Fig. 6 for Details)	2
28	65117	. WHEEL NUT	20
29	64310	. COTTER PIN	4
30	63419	. FLAT WASHER	12
31	32222	. STEERING CYLINDER BRACKET	1
32	65960	.. BUSHING	1
33	210188	. STEERING CYLINDER ASSEMBLY (See Sect. 3, Fig. 7 or 7A for Details)	1
34	60322	. CAP SCREW	4
35	63302	. LOCK WASHER	4
36	32748	. KING PIN WELDMENT	4
37	64937	. THRUST BEARING	4
38	211027	. MOTOR/BRAKE ASSEMBLY	2
39	81348	.. MULTIPLE DISC BRAKE (See Vendor Chapter for Details)	1
-40	66971	... SEAL KIT	1
-41	67646	... LINING KIT	1
-42	67659	... BEARING KIT	1
-43	67653	... SPRING KIT	1
-44	600116	... TRUNNION BEARING	1
-45	81345	.. HYDRAULIC MOTOR (See Vendor Chapter for Details)	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-46	67689	... SEAL KIT	1
-47	67702	... COUPLING SHAFT	1
-48	67697	... DRIVE LINK	1
-49	SKP-1003	. HYDRAULIC HOSE KIT "A"	1
-50	13210-08-1070	.. HOSE ASSEMBLY	2
-51	13213-08-1130	.. HOSE ASSEMBLY	2
-52	13213-10-0144	.. HOSE ASSEMBLY	4
-53	13210-08-0410	.. HOSE ASSEMBLY	2
-54	13213-08-0380	.. HOSE ASSEMBLY	2
-55	13210-10-0480	.. HOSE ASSEMBLY	2
-56	13213-04-0490	.. HOSE ASSEMBLY	2
-57	13213-04-0870	.. HOSE ASSEMBLY	2

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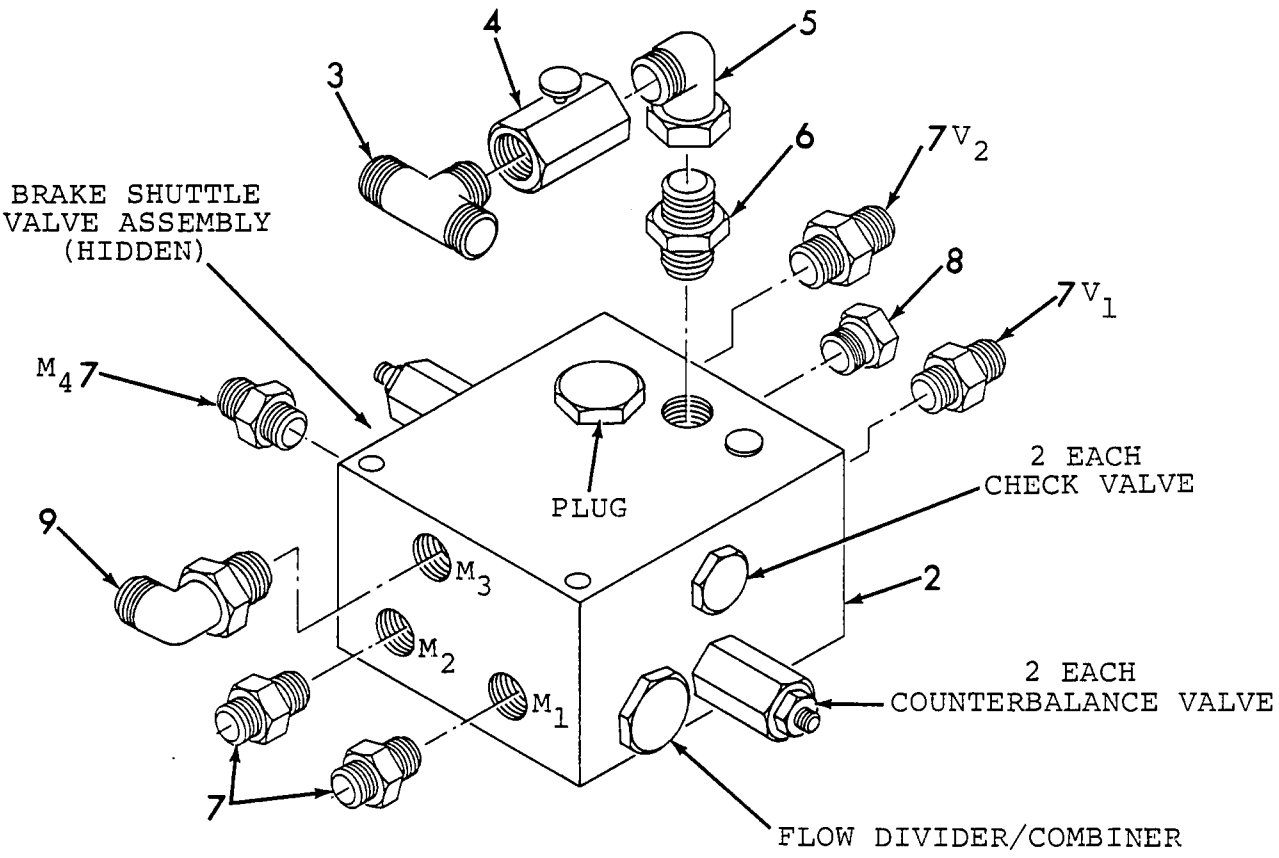
TITLE	FLOW DIVIDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	3
FIGURE	2
PAGE	1



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	23698	FLOW DIVIDER ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	81174	. FLOW DIVIDER	1
3	66967	.. COMBINATION FLOW DIVIDER	1
-4	68061	.. SEAL KIT	1
5	80004-11	. STRAIGHT THREAD CONNECTOR	3
6	80012-11	. STRAIGHT THREAD ELBOW	1
7	80012-15	. STRAIGHT THREAD ELBOW	1
8	80004-15	. STRAIGHT THREAD CONNECTOR	1

REV.

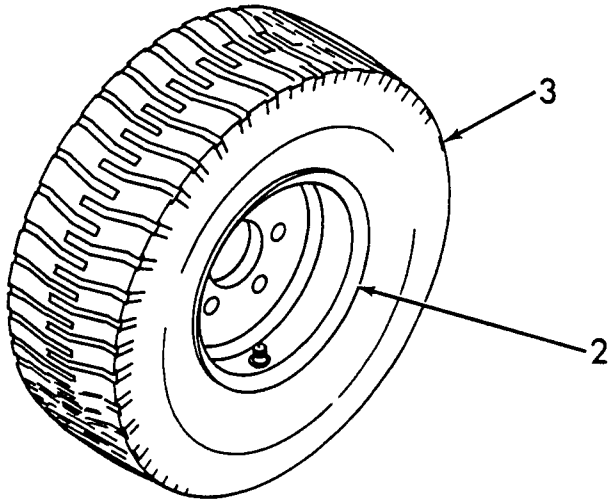


ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	210064	DRIVE/BRAKE VALVE ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	21214	. DRIVE BRAKE VALVE	1
3	80034-04	. MALE BRANCH TEE	1
4	20357	. NEEDLE VALVE	1
5	80021-03	. STREET ELBOW	1
6	80052-04	. PIPE NIPPLE	1
7	80004-16	. STRAIGHT THREAD CONNECTOR	5
8	80050-05	. HEX HEAD STRAIGHT THREAD PLUG	1
9	80012-16	. STRAIGHT THREAD ELBOW	1

Mark Industries

TITLE	TIRE & WHEEL ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	LEFT HAND

SECTION	3
FIGURE	4
PAGE	1



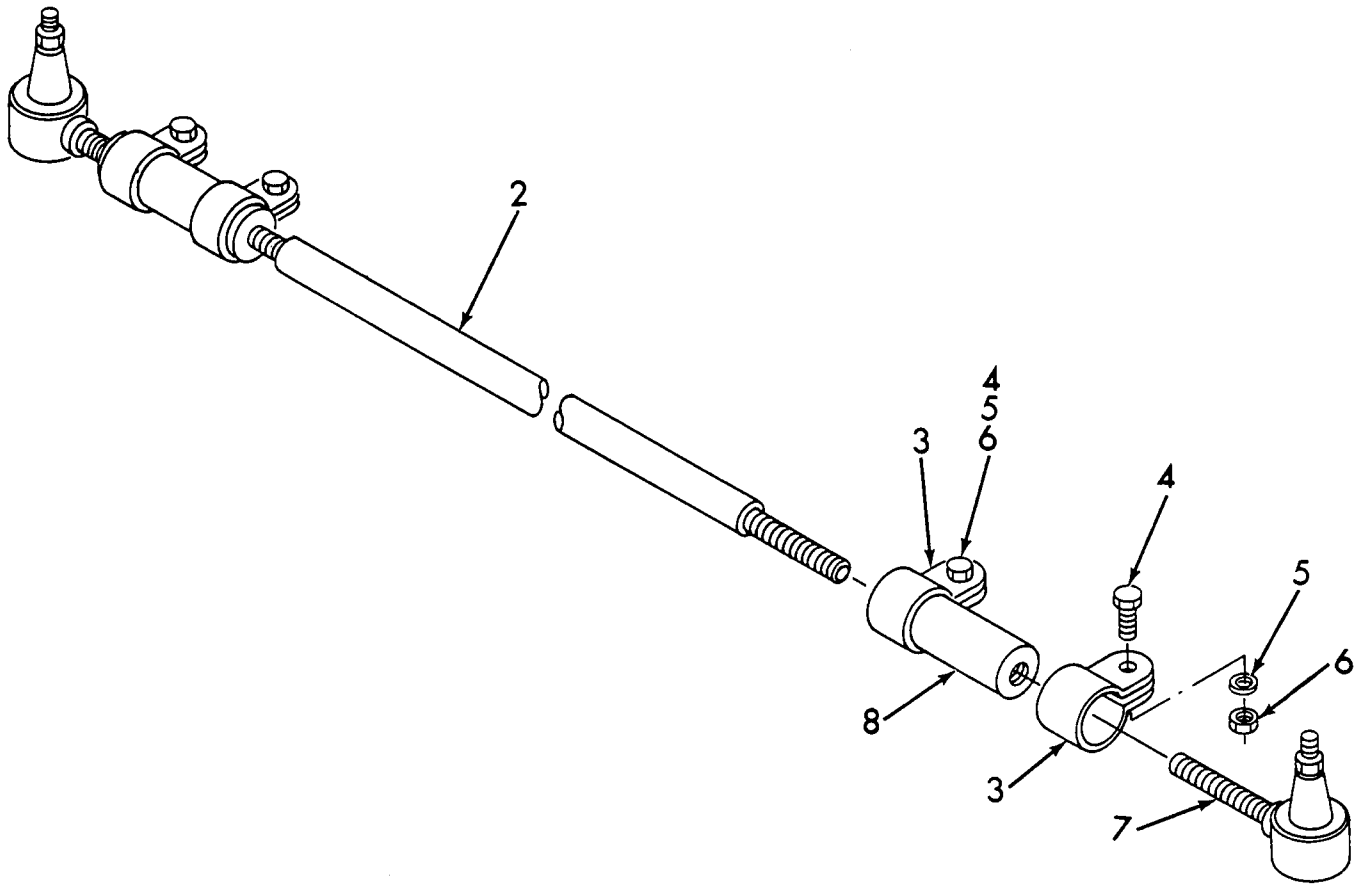
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24684	TIRE & WHEEL ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	24682	. WHEEL	1
3	24777	. TIRE	1

REV.

Mark Industries

TITLE	TIE ROD ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	

SECTION	3
FIGURE	5
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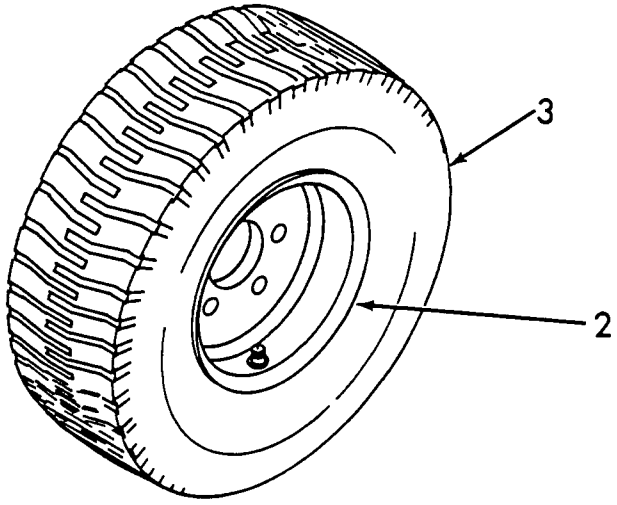
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24686	TIE ROD ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	24685	. TIE ROD	1
3	66239	. CLAMP	4
4	60415	. CAP SCREW	4
5	63303	. LOCK WASHER	4
6	60803	. HEX NUT	4
7	66037	. TIE ROD END	2
8	32212	. TURN BUCKLE	2

REV.

Mark Industries

TITLE	TIRE & WHEEL ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	RIGHT HAND

SECTION	3
FIGURE	6
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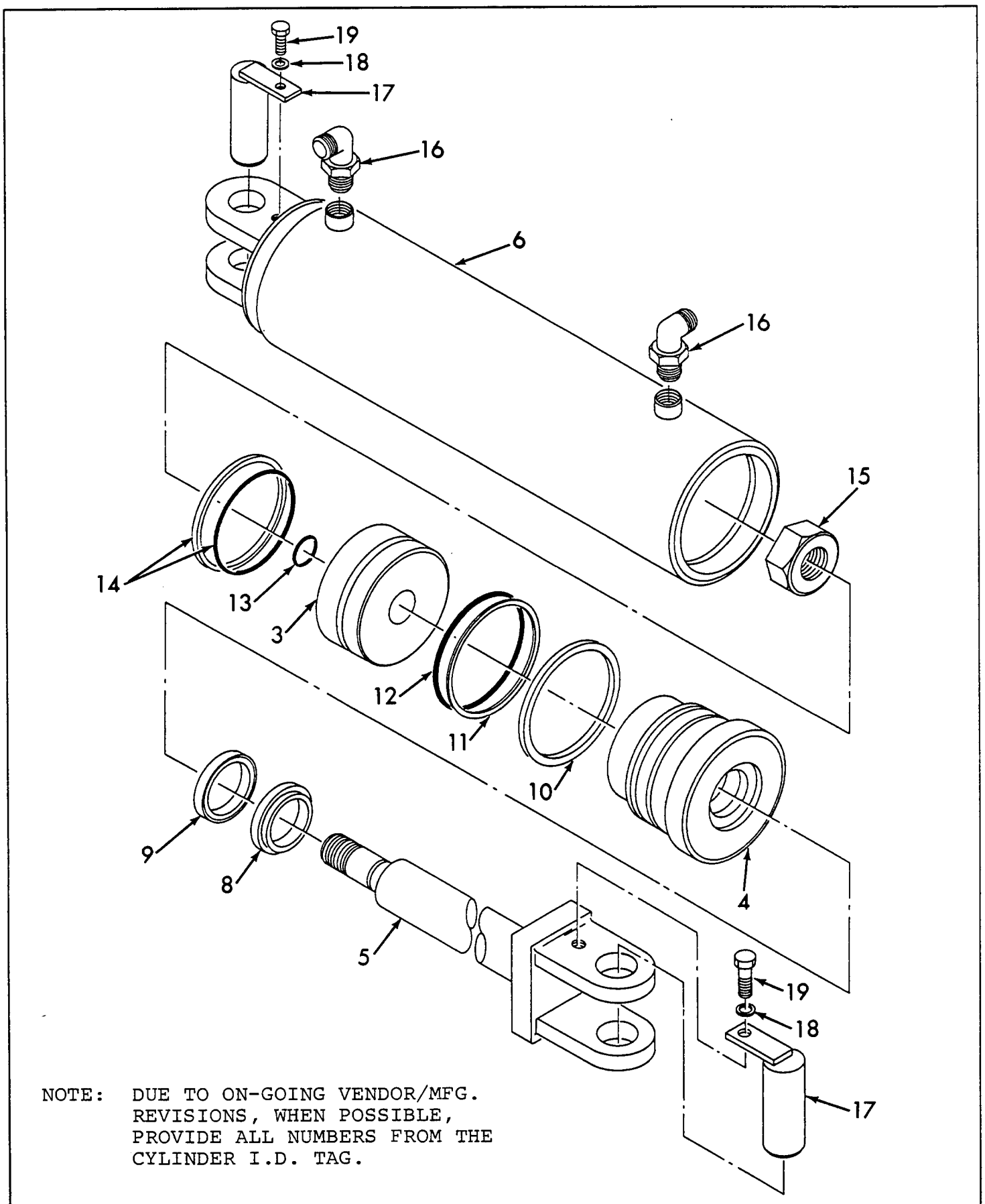
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24683	TIRE & WHEEL ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	24682	. WHEEL	1
3	24777	. TIRE	1

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	TH

SECTION	3
FIGURE	7
PAGE	1



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

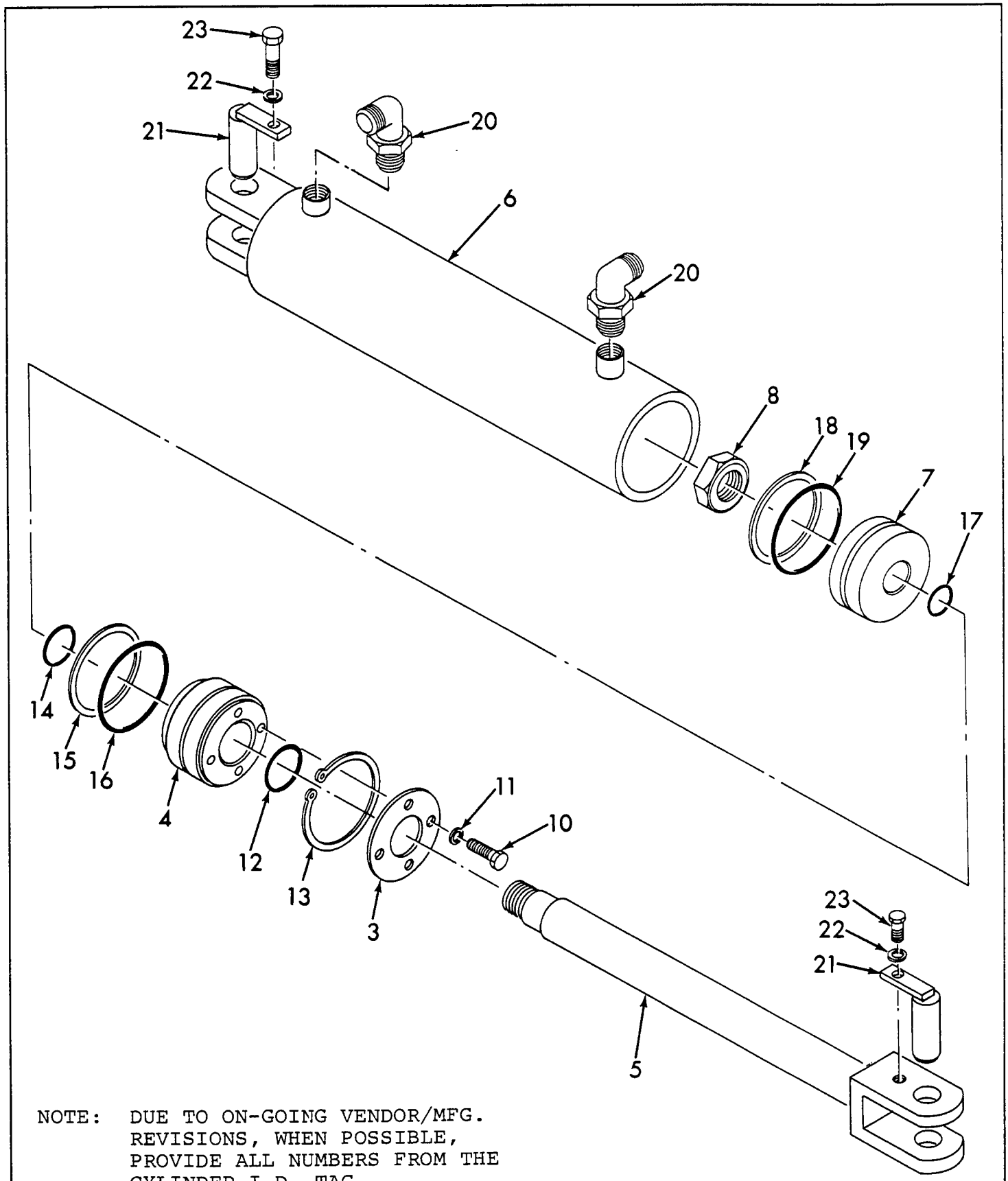
REV.

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	210188	STEERING CYLINDER ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
-2	32223	. STEERING CYLINDER (TH)	1
3		.. PISTON	1
4		.. HEAD (GLAND NUT)	1
5		.. ROD	1
6		.. TUBE (BARREL)	1
-7	68004	.. SEAL KIT	1
8		... ROD WIPER	1
9		... POLYPAK U-CUP	1
10		... RETAINING RING	1
11		... HEAD BACK-UP RING	1
12		... HEAD O-RING	1
13		... O-RING	1
14		... GLYD RING SET	1
15		... LOCK NUT	1
16	80018-03	. ELBOW	2
17	20252	PIN	REF
18	63301	LOCK WASHER	REF
19	60353	CAP SCREW	REF
		NOTE: OTHER SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	SE

SECTION	3
FIGURE	7A
PAGE	1



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

REV.

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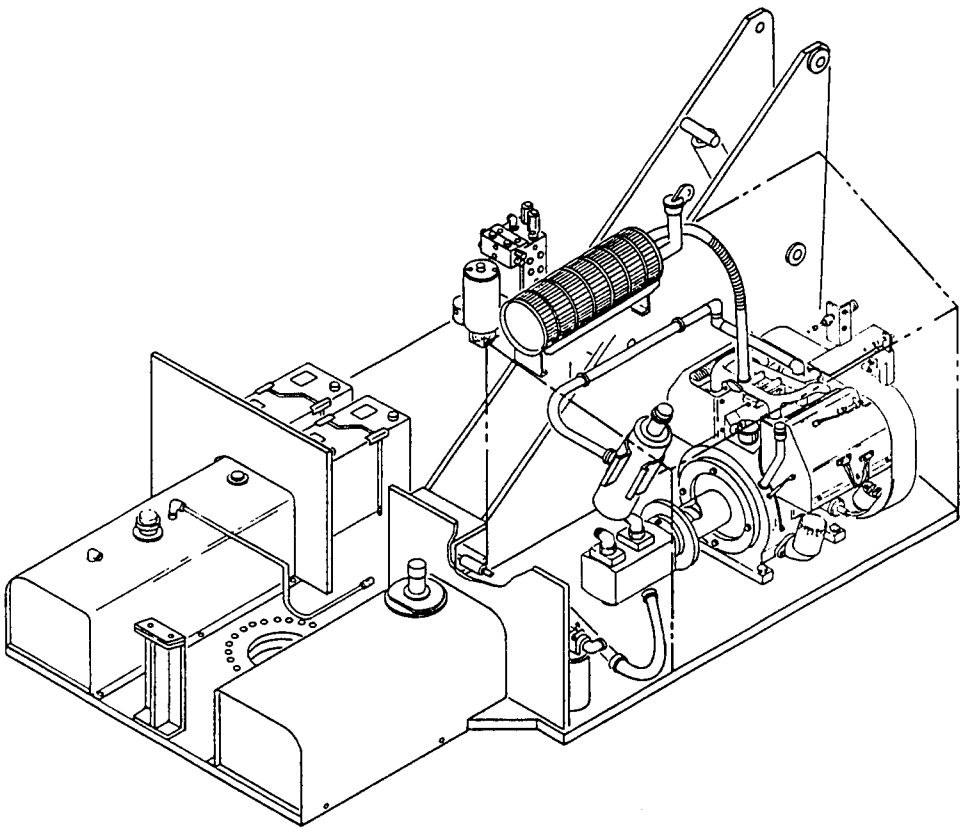
TITLE	STEERING CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	SE

SECT.	3
FIG.	7A
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	210188	STEERING CYLINDER ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
-2	32223	. STEERING CYLINDER (SE)	1
3		.. RETAINER PLATE	1
4		.. HEAD	1
5		.. ROD	1
6		.. BARREL	1
7		.. PISTON	1
8		.. NUT	1
-9	66861	.. SEAL KIT	1
10		... CAP SCREW	4
11		... LOCK WASHER	4
12		... ROD WIPER	1
13		... SNAP RING	1
14		... ROD O-RING	1
15		... HEAD BACK-UP RING	1
16		... HEAD O-RING	1
17		... O-RING	1
18		... PISTON BACK-UP RING	2
19		... PISTON O-RING	1
20	80018-03	. ELBOW	2
21	20252	PIN	REF
22	63301	LOCK WASHER	REF
23	60353	CAP SCREW	REF
		NOTE: OTHER SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	

SECTION 4 CONTAINS:

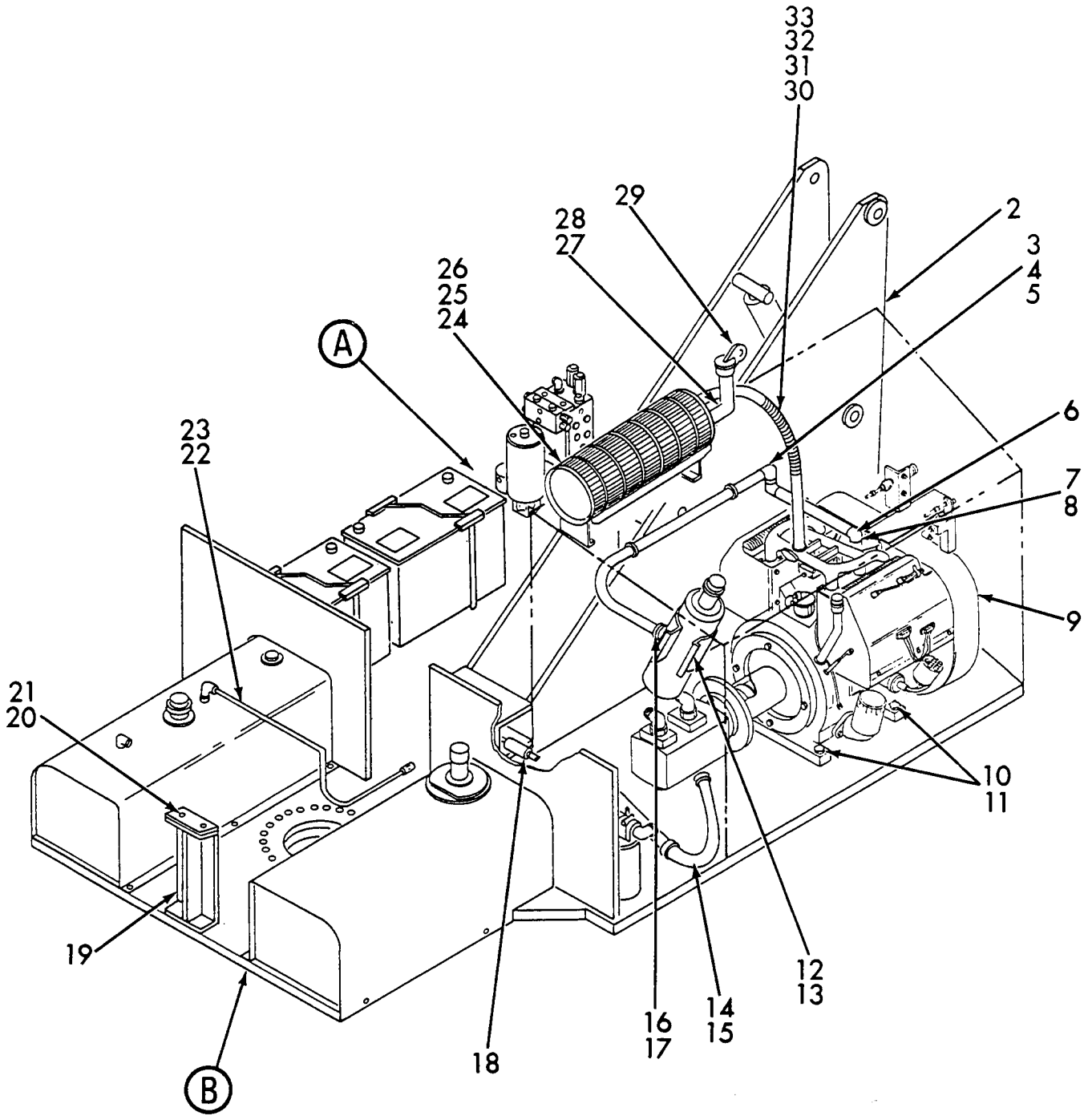
FIG. NO.	TITLE
1	TURRET ASSEMBLY (WISC.)
2	TURRET ASSEMBLY (DEUTZ)
3	ENGINE & PUMP ASSEMBLY (WISC.)
4	ENGINE & PUMP ASSEMBLY (DEUTZ)
5	MASTER LEVELING CYLINDER ASSEMBLY (DEUTZ & WISC.)
6	LIFT CYLINDER ASSEMBLY (DEUTZ & WISC.)
7	COUNTERBALANCE ASSEMBLY (DEUTZ & WISC.)
8	EMERGENCY PUMP ASSEMBLY (DEUTZ & WISC.)
9	CONTROL VALVE ASSEMBLY (DEUTZ & WISC.)
10	LOWER CONTROL PANEL ASSEMBLY (WISC.)
11	LOWER CONTROL PANEL ASSEMBLY (DEUTZ)
12	DRIVE BLOCK VALVE ASSEMBLY (DEUTZ & WISC.)
13	HYDRAULIC TANK ASSEMBLY (DEUTZ & WISC.)
14	ROTATION GEARBOX ASSEMBLY (DEUTZ & WISC.)
15	FUEL TANK ASSEMBLY (DEUTZ & WISC.)



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TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

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FIGURE	1
PAGE	1

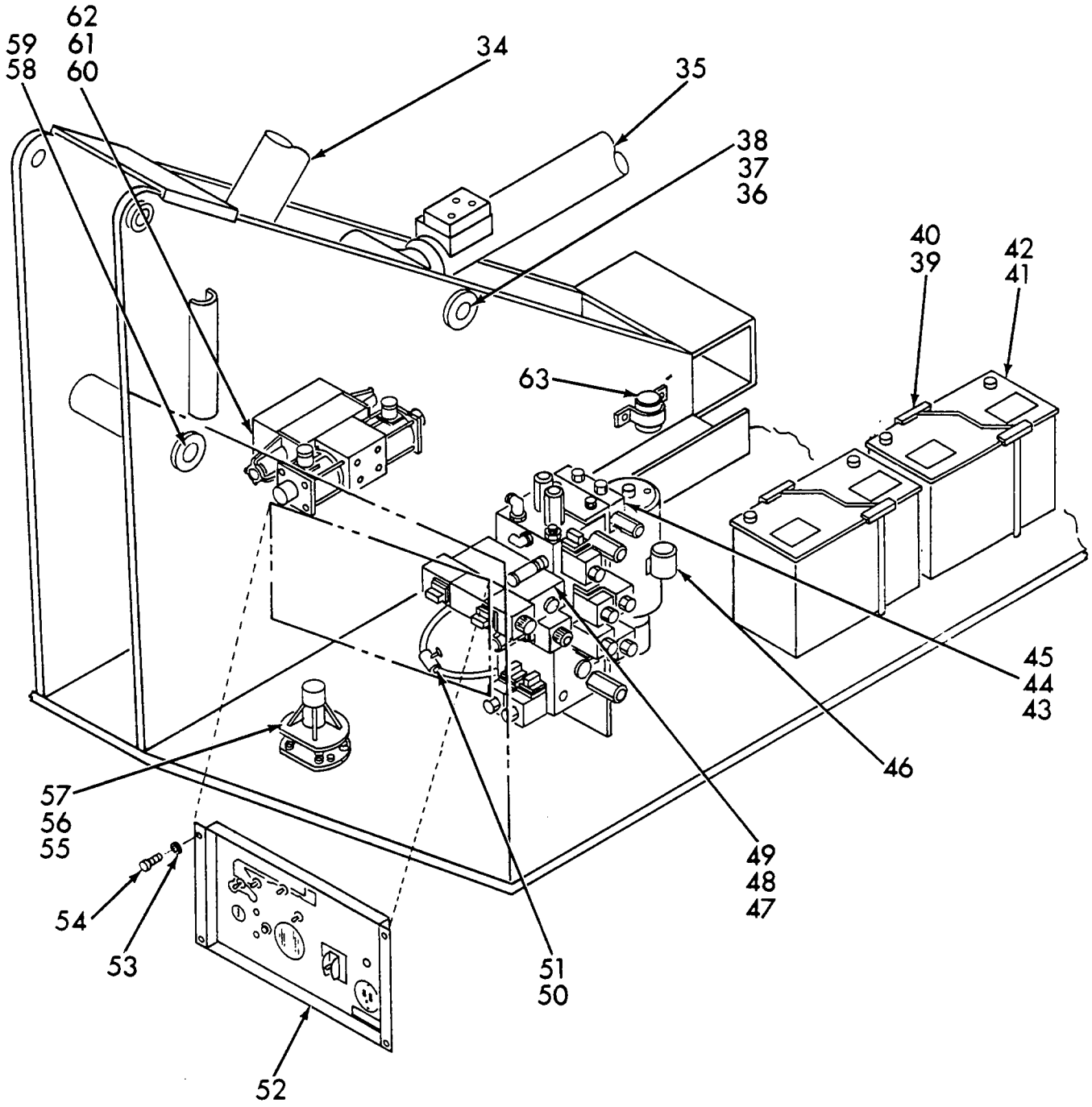


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

SECTION	4
FIGURE	1
PAGE	2

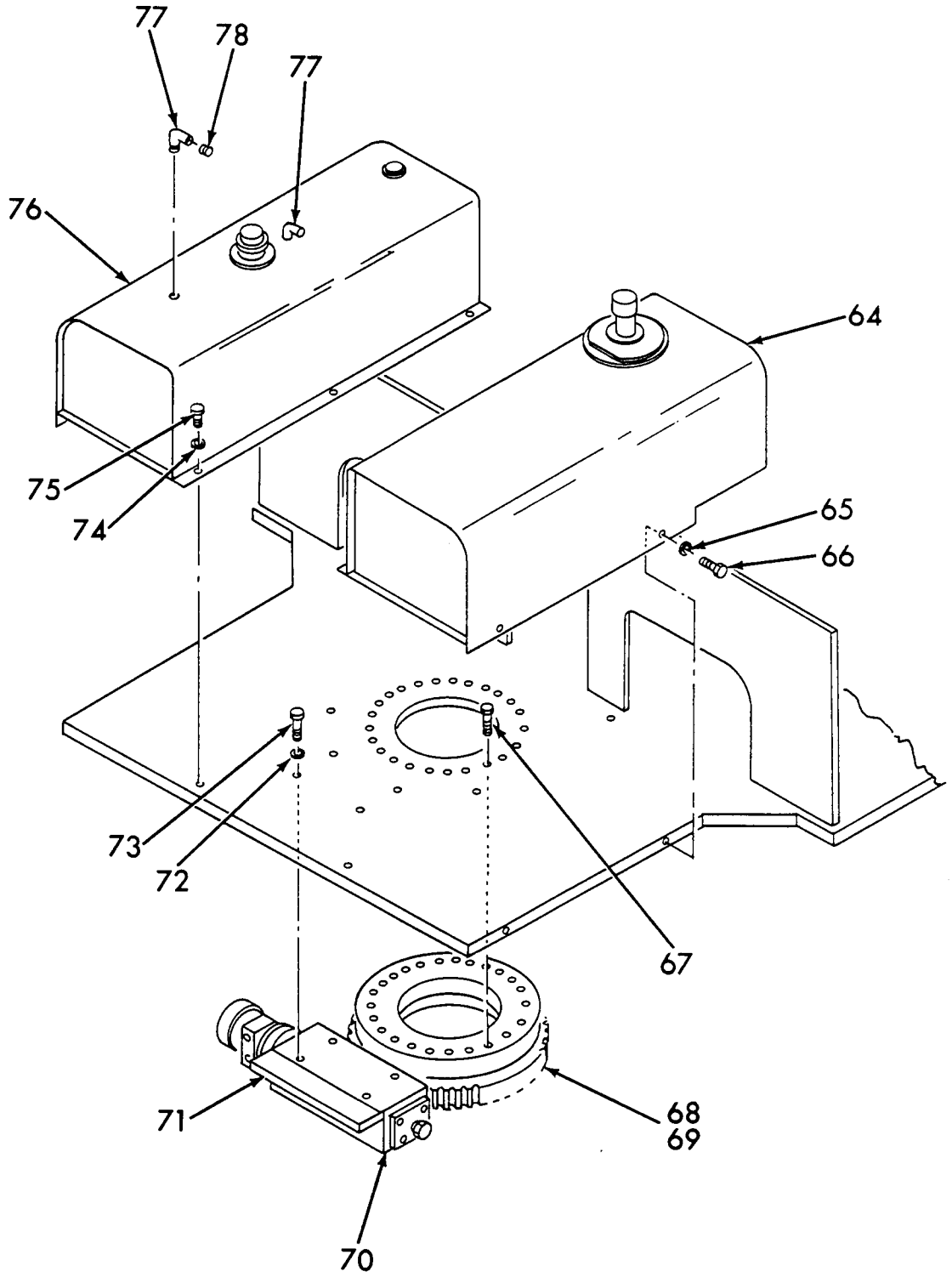


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

SECTION	4
FIGURE	1
PAGE	3



B

REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

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FIG.	1
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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24852	TURRET ASSEMBLY (WISC.) (See Sect. 3, Fig. 1 for NHA)	REF
2	24956	. TURRET WELDMENT	1
3	210144	. AIR CLEANER ELBOW	1
4		. RUBBER ELBOW	2
5	65365	. U-BOLTS WITH NUTS	2
6	210145	. AIR CLEANER ELBOW	1
7		. RUBBER (1 3/4" I.D.)	1
8	16288	. HOSE CLAMP	4
9	24864	. ENGINE/PUMP ASSEMBLY (See Sect. 4, Fig. 3 for Details)	1
10	60513	. CAP SCREW	4
11	63327	. LOCK WASHER	4
12	60353	. CAP SCREW	4
13	63301	. LOCK WASHER	4
14	161-A	. HOSE CLAMP	2
15	32242	. SUCTION HOSE (2½ FT)	1
16		. RUBBER (1 3/4" I.D.)	1
17	16288	. HOSE CLAMP	4
18	23743	. CHECK VALVE ASSEMBLY	1
19	24831	. BOOM REST WELDMENT	1
20	24822	. BOOM REST WEAR PAD	1
21	61804	. CAP SCREW	2
22	160	. FUEL FILTER	1
23	65311	. ¼" FUEL HOSE (10 FT)	1
24	63313	. LOCK WASHER	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
25	60324	. CAP SCREW	4
26	65751	. MUFFLER WITH SHIELD	1
27	23546	. ELBOW MODIFIED MUFFLER	1
28	16230	. MUFFLER CLAMP	1
29	21288	. RAIN MUFFLER CAP	1
30		. NIPPLE (1¼ NPT)	1
31		. NIPPLE (1¼ NPT)	1
32	16230	. MUFFLER CLAMP	1
33	210053	. EXHAUST FLEX	1
34	24948	. MASTER LEVELING CYLINDER ASSEMBLY (See Sect. 4, Fig. 5 for Details)	1
35	24715	. LIFT CYLINDER ASSEMBLY (See Sect. 4, Fig. 6 for Details)	1
36	24767	. LIFT CYLINDER PIN	1
37	60542	. CAP SCREW	2
38	60333	. LOCK WASHER	2
39	25108	. BATTERY HOLD DOWN	4
40	20375	. BATTERY CLAMP	2
41	210171	. BATTERY CABLE KIT	1
42	4030	. BATTERY (12 VOLT, 95 AMP) (See Vendor Chapter for Details)	2
43	210156	. COUNTERBALANCE VALVE ASSEMBLY (See Sect. 4, Fig. 7 for Details)	1
44	60360	. CAP SCREW	2
45	63302	. LOCK WASHER	2
46	23742	. EMERGENCY PUMP & MOTOR ASSEMBLY (See Sect. 4, Fig. 8 for Details)	1
47	24977	. CONTROL VALVE ASSEMBLY (See Sect. 4, Fig. 9 for Details)	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
48	63302	. LOCK WASHER	4
49	60367	. CAP SCREW	4
50	80001-08	. MALE CONNECTOR	2
51	20370	. NEEDLE VALVE	1
52	24949	. LOWER CONTROL PANEL ASSEMBLY (WISC.) (See Sect. 4, Fig. 10 for Details)	1
53	63301	. LOCK WASHER	4
54	60353	. CAP SCREW	4
55	21250	. SLOPE SENSOR	1
56	60353	. CAP SCREW	4
57	63301	. LOCK WASHER	4
58	24763	. MASTER CYLINDER PIN	1
59	60338	. CAP SCREW	2
60	210185	. DRIVE BLOCK ASSEMBLY (See Sect. 4, Fig. 12 for Details)	1
61	60352	. CAP SCREW	2
62	63301	. LOCK WASHER	2
63	24059	. 12 VDC RELAY	1
64	24921	. HYDRAULIC TANK ASSEMBLY (See Sect. 4, Fig. 13 for Details)	1
65	63302	. LOCK WASHER	5
66	60338	. CAP SCREW	5
67	60640	. CAP SCREW	24
68	65103	. GREASE FITTING	1
69	23722	. RING GEAR	1
70	24909	. ROTATION GEARBOX ASSEMBLY (See Sect. 4, Fig. 14 for Details)	1

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

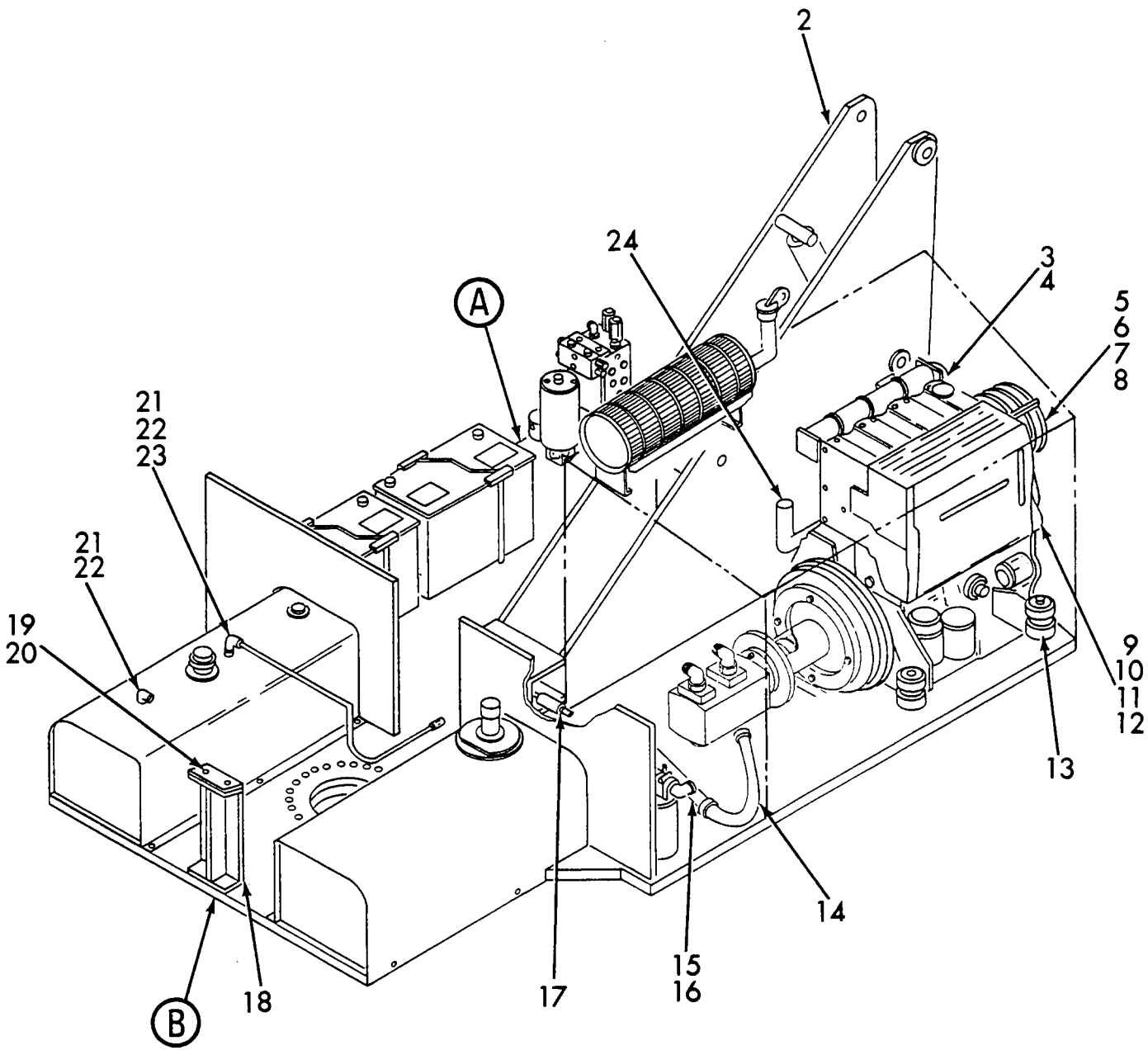
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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
71	23693	. ROTATION MOUNTING BRACKET WELDMENT	1
72	63407	. FLAT WASHER	4
73	60548	. CAP SCREW	4
74	63302	. LOCK WASHER	5
75	60338	. CAP SCREW	5
76	24810	. FUEL TANK SUB-ASSEMBLY (See Sect. 4, Fig. 15 for Details)	1
77	80021-03	. STREET ELBOW	2
78	80048-03	. HOLLOW HEX PLUG	1

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

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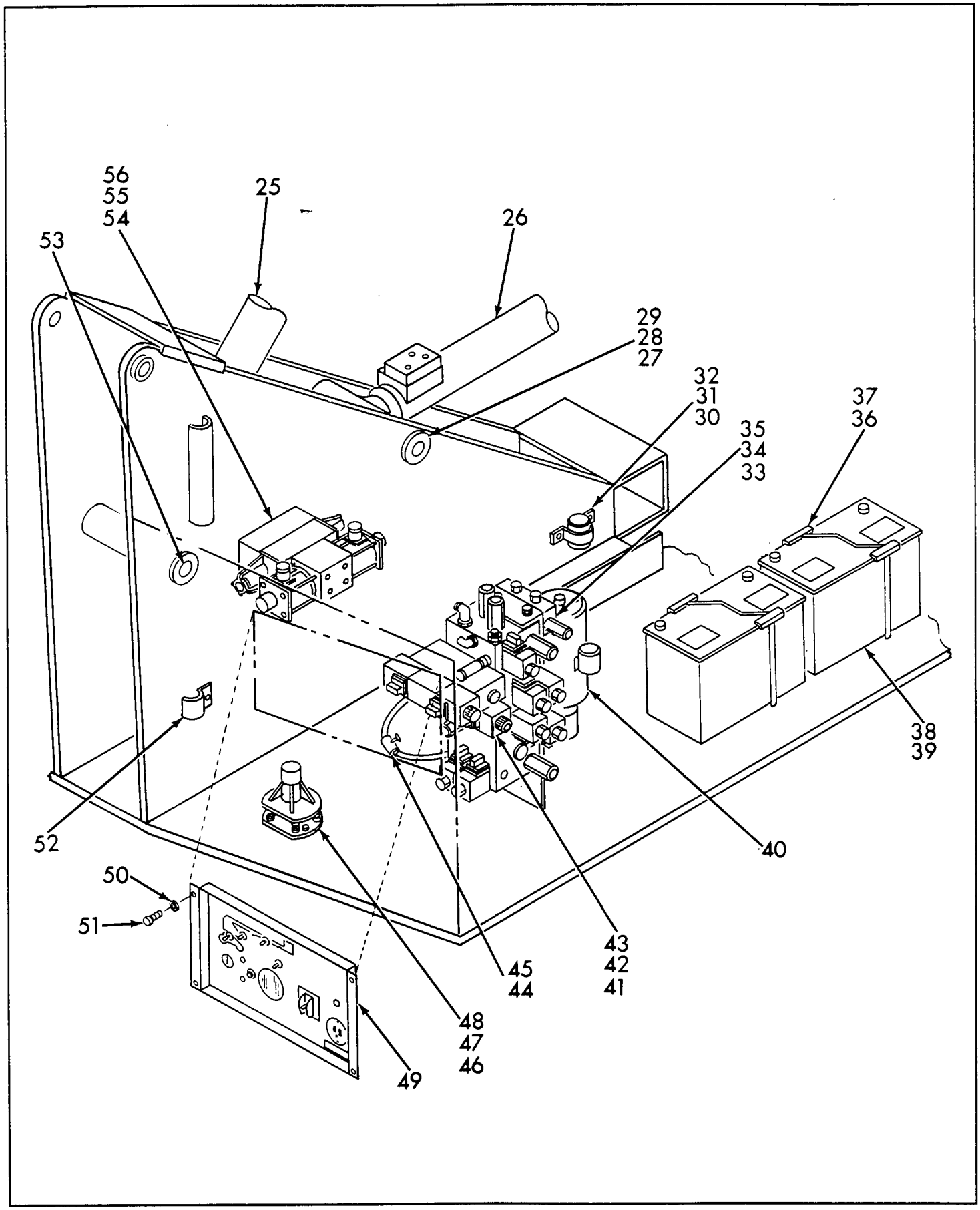


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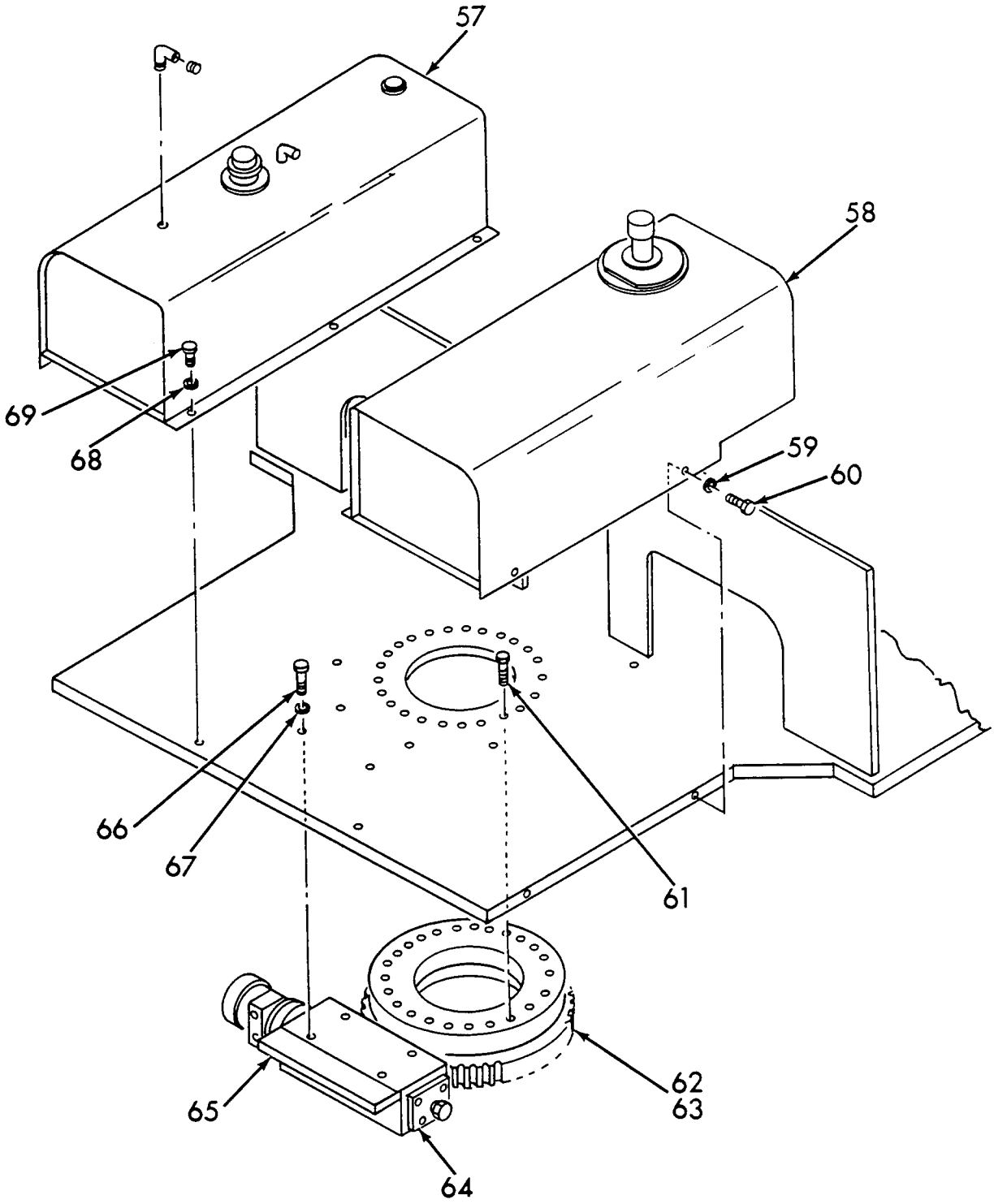
Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24851	TURRET ASSEMBLY (DEUTZ) (See Sect. 3, Fig. 1 for NHA)	REF
2	24956	. TURRET WELDMENT	1
3	160255	. AIR VENT HOSE (1.33 FT)	1
4	65416	. HOSE CLAMP	1
5	61502	. HEX NUT	8
6	62621	. ROUND HEAD SLOT MACHINE SCREW	8
7	65111	. STRAP	4
8	24972	. ENGINE INLET DUCTING	1
9	24867	. ENGINE & PUMP ASSEMBLY (See Sect. 4, Fig. 4 for Details)	1
10	60513	. CAP SCREW	4
11	63327	. LOCK WASHER	4
12	62702	. ROUND HEAD SLOT MACHINE SCREW	2
13	24871	. DEUTZ SPACER	4
14	210169	. TUBE SECTION WELDMENT	1
15	161-A	. HOSE CLAMP	4
16	32242	. SUCTION HOSE (1 FT)	1
17	23743	. CHECK VALVE ASSEMBLY	1
18	24831	. BOOM REST WELDMENT	1
19	61804	. CAP SCREW	2
20	24822	. BOOM REST WEAR PAD	1
21	65311	. ¼" FUEL HOSE (19 FT)	1
22	80021-03	. STREET ELBOW	2
23	160	. FUEL FILTER	1
24	24870	. EXHAUST TUBE	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
25	24948	. MASTER LEVELING CYLINDER ASSEMBLY (See Sect. 4, Fig. 5 for Details)	1
26	24715	. LIFT CYLINDER ASSEMBLY (See Sect. 4, Fig. 6 for Details)	1
27	24767	. LIFT CYLINDER PIN	1
28	60542	. CAP SCREW	2
29	60333	. LOCK WASHER	2
30	60353	. CAP SCREW	2
31	70209	. 12 VDC SOLENOID	1
32	63401	. FLAT WASHER	2
33	210156	. COUNTERBALANCE VALVE ASSEMBLY (See Sect. 4, Fig. 7 for Details)	1
34	63302	. LOCK WASHER	2
35	60360	. CAP SCREW	2
36	65108	. BATTERY HOLD DOWN	4
37	20375	. BATTERY CLAMP	2
38	4030	. BATTERY	2
39	210038	. BATTERY CABLE KIT	1
40	23742	. EMERGENCY PUMP & MOTOR ASSEMBLY (See Sect. 4, Fig. 8 for Details)	1
41	24977	. CONTROL VALVE ASSEMBLY (See Sect. 4, Fig. 9 for Details)	1
42	63302	. LOCK WASHER	4
43	60367	. CAP SCREW	4
44	80001-08	. MALE CONNECTOR	2
45	20370	. NEEDLE VALVE	1
46	21250	. SLOPE SENSOR	1
47	60353	. CAP SCREW	2

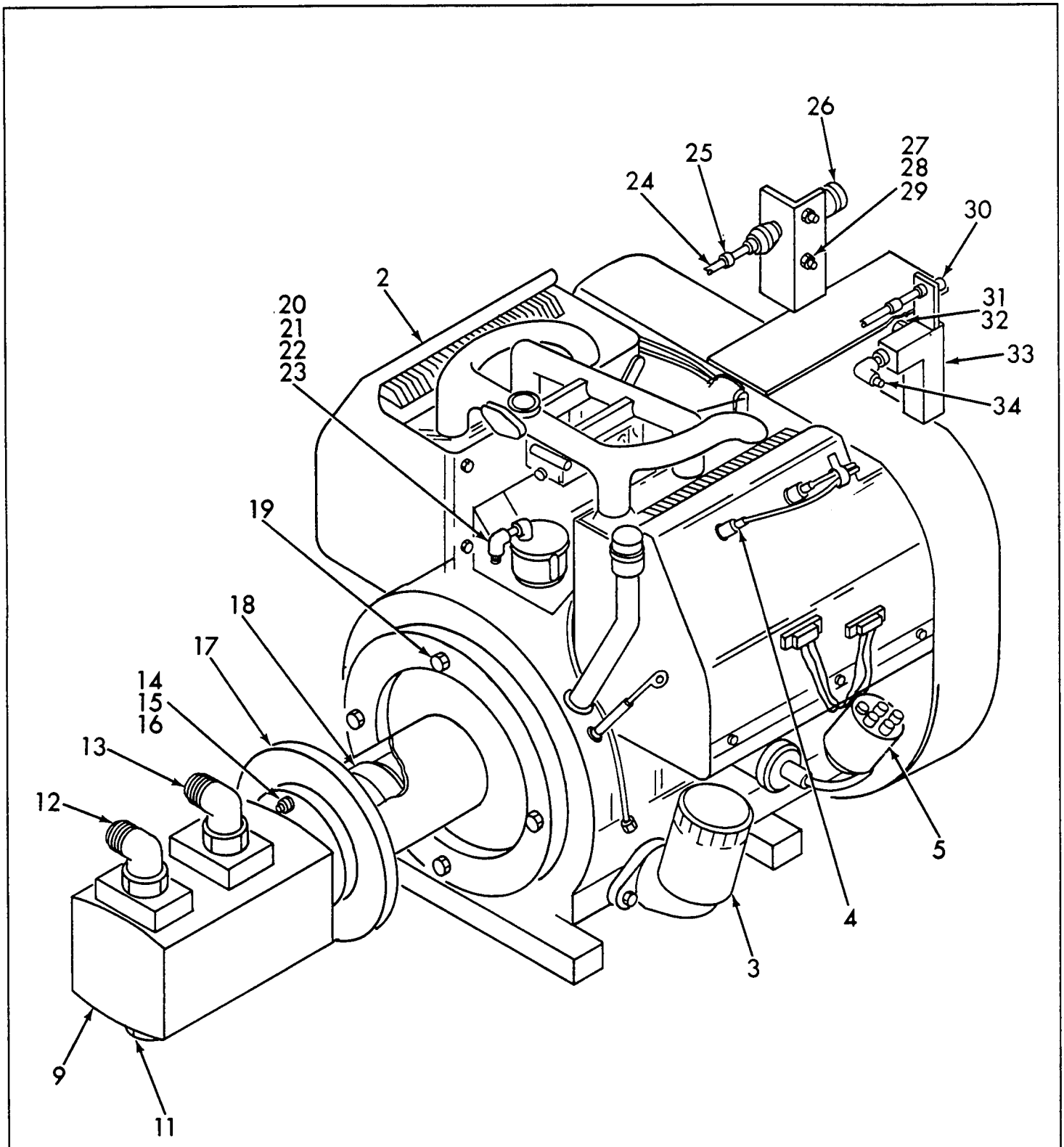
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
48	63301	. LOCK WASHER	2
49	24987	. LOWER CONTROL BOX ASSEMBLY (See Sect. 4, Fig. 11 for Details)	1
50	63301	. LOCK WASHER	4
51	60353	. CAP SCREW	4
52	140602	. CLAMP ARM CABLE ASSEMBLY	1
53	24763	. MASTER CYLINDER PIN	1
54	210185	. DRIVE BLOCK ASSEMBLY (See Sect. 4, Fig. 12 for Details)	1
55	63301	. LOCK WASHER	2
56	60352	. CAP SCREW	2
57	24810	. FUEL TANK SUB-ASSEMBLY (See Sect. 4, Fig. 15 for Details)	1
58	24921	. HYDRAULIC TANK ASSEMBLY (See Sect. 4, Fig. 13 for Details)	1
59	63302	. LOCK WASHER	5
60	60338	. CAP SCREW	5
61	60640	. CAP SCREW	24
62	23722	. RING GEAR	1
63	65103	. GREASE FITTING	1
64	24909	. ROTATION GEARBOX ASSEMBLY (See Sect. 4, Fig. 14 for Details)	1
65	23693	. ROTATION MOUNTING BRACKET WELDMENT	1
66	60548	. CAP SCREW	4
67	63407	. FLAT WASHER	4
68	63302	. LOCK WASHER	5
69	60338	. CAP SCREW	5
-70	SKP-1003	. HYDRAULIC HOSE KIT "B"	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-71	13213-10-1810	.. HOSE ASSEMBLY	2
-72	13213-10-0780	.. HOSE ASSEMBLY	1
-73	13213-08-0154	.. HOSE ASSEMBLY	1
-74	13210-06-0560	.. HOSE ASSEMBLY	1
-75	13213-06-0440	.. HOSE ASSEMBLY	1
-76	13213-08-0580	.. HOSE ASSEMBLY	1
-77	13210-06-0920	.. HOSE ASSEMBLY	2
-78	13213-12-0920	.. HOSE ASSEMBLY	1
-79	13213-04-0750	.. HOSE ASSEMBLY	4
-80	13210-06-1400	.. HOSE ASSEMBLY	2
-81	13210-06-1000	.. HOSE ASSEMBLY	2
-82	13213-12-0780	.. HOSE ASSEMBLY	1

Mark Industries

TITLE	ENGINE & PUMP ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

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Mark Industries

TITLE	ENGINE & PUMP ASSEMBLY	SECT. 4
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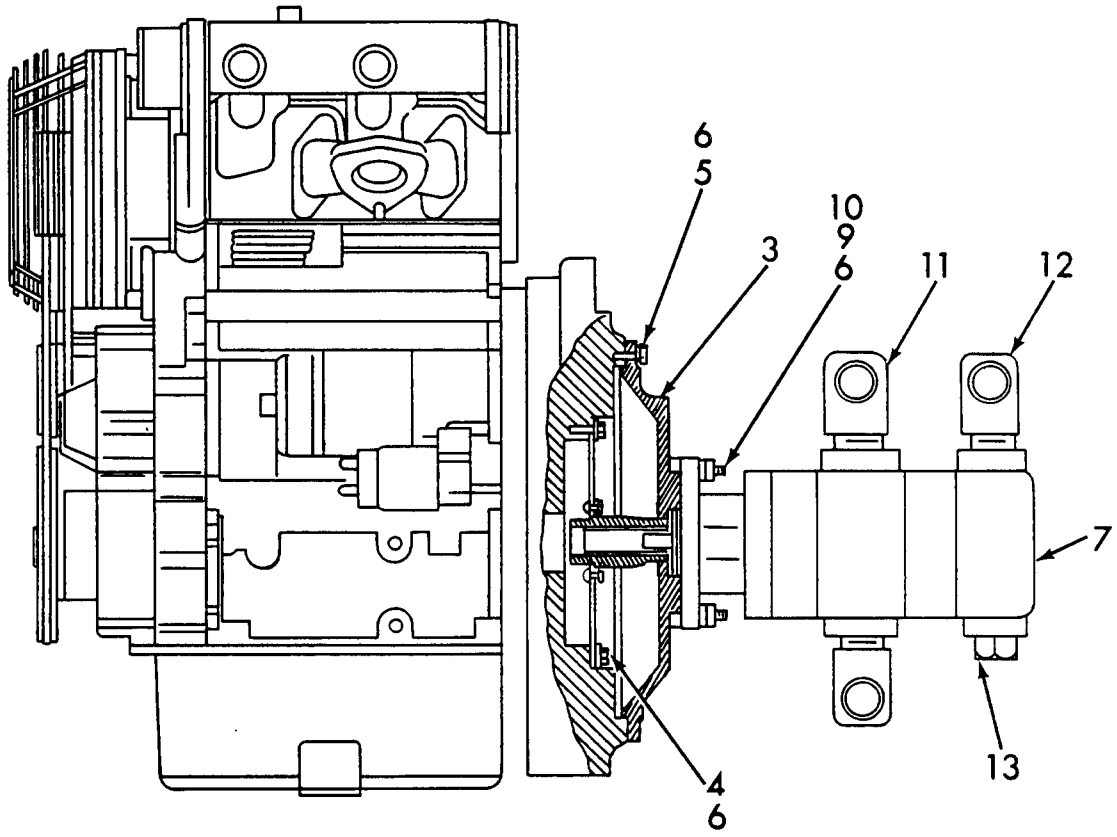
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24864	ENGINE & PUMP ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	24812	. WISCONSIN ENGINE (See Vendor Chapter for Details)	1
3	65299	.. OIL FILTER	1
4	67262	.. SPARK PLUG	4
5	600131	.. DISTRIBUTOR CAP & GASKET	1
-6	600132	.. CARBURETOR REPAIR KIT	1
-7	600129	.. FUEL PUMP REPAIR KIT	1
-8	600130	.. SOLID STATE IGNITION MODULE	1
9	81339	. HYDRAULIC PUMP	1
-10	600005	.. SEAL KIT	1
11	80050-10	. HEX HEAD STRAIGHT THREAD O-RING PLUG	1
12	80012-18	. STRAIGHT THREAD ELBOW	1
13	80012-21	. STRAIGHT THREAD ELBOW	1
14	63363	. THREADED ROD	2
15	60703	. HEX NUT	2
16	63303	. LOCK WASHER	2
17	24850	. PUMP ADAPTER MACHINING	1
18	20724	. ENGINE PUMP DRIVE COUPLING	1
19	60616	. CAP SCREW	4
20	16550	. NIPPLE PIPE	1
21	20832	. FUEL SHUT OFF VALVE	1
22	16500	. STREET ELBOW	2
23	240	. BARB HOSE	1
24	65199	. UNIVERSAL SPRING THROTTLE	1

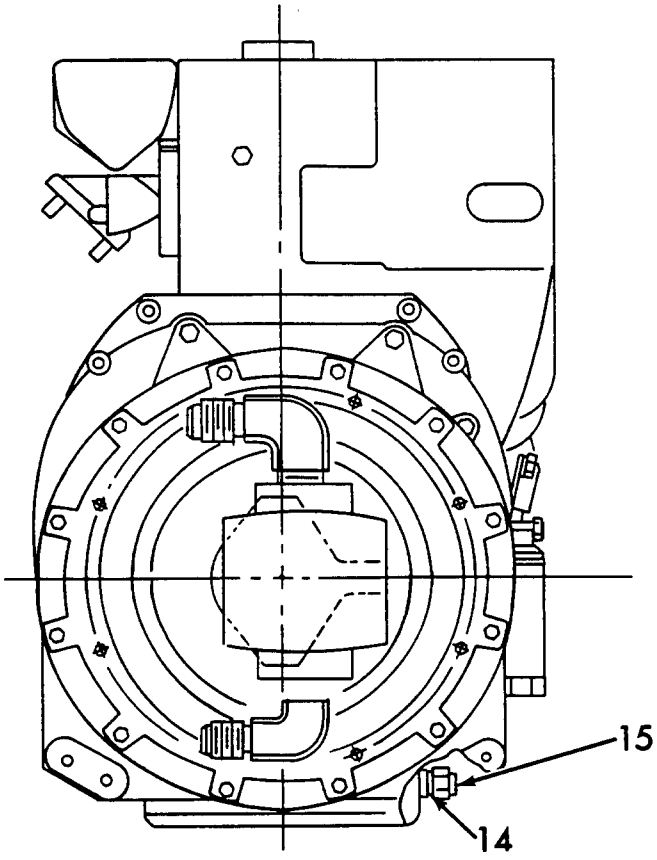
Mark Industries

TITLE	ENGINE & PUMP ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

SECT.	4
FIG.	3
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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
25	60805	. HEX NUT	2
26	21777	. SOLENOID	1
27	60533	. CAP SCREW	2
28	63302	. LOCK WASHER	2
29	60702	. HEX NUT	2
30	21775	. THROTTLE & CHOKE MOUNTING BRACKET	1
31	60404	. CAP SCREW	2
32	63302	. LOCK WASHER	2
33	20364	. HYDRAULIC THROTTLE	1
34	80008-03	. MALE ELBOW	1


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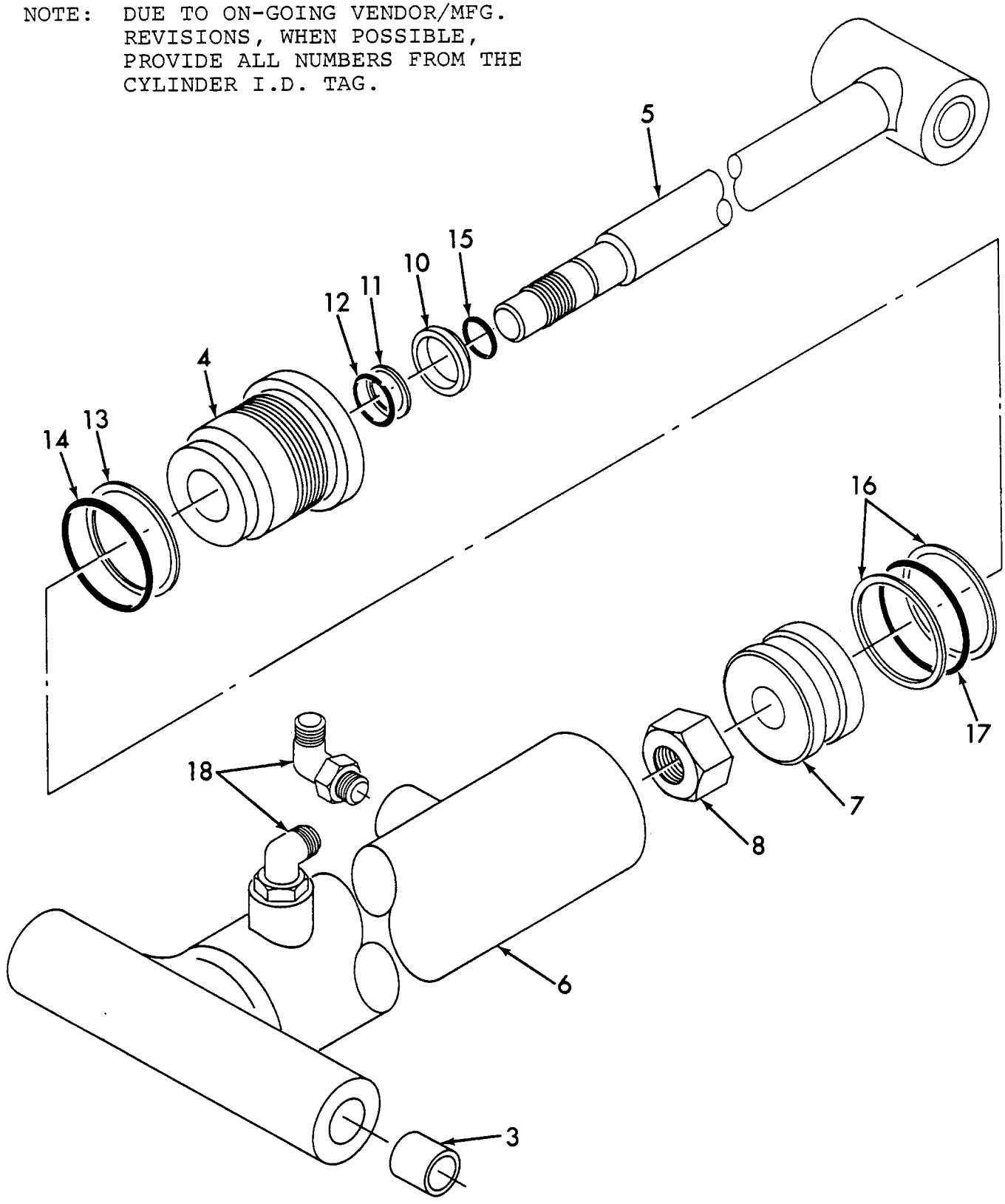
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24867	ENGINE & PUMP ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	24704	. DEUTZ ENGINE (See Vendor Chapter for Details)	1
3	160196	. DRIVE PLATE	1
4	60372	. CAP SCREW	6
5	60307	. CAP SCREW	8
6	63303	. LOCK WASHER	16
7	81339	. HYDRAULIC PUMP	1
-8	600005	.. SEAL KIT	1
9	63663	. THREADED ROD	2
10	60703	. HEX NUT	2
11	80012-21	. STRAIGHT THREAD ELBOW	1
12	80012-18	. STRAIGHT THREAD ELBOW	1
13	80050-10	. HEX HEAD STRAIGHT THREAD O-RING PLUG	1
14	81367	. METRIC THREAD CONNECTOR	1
15	80059-06	. CAP	1

Mark Industries

TITLE	MASTER LEVELING CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

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



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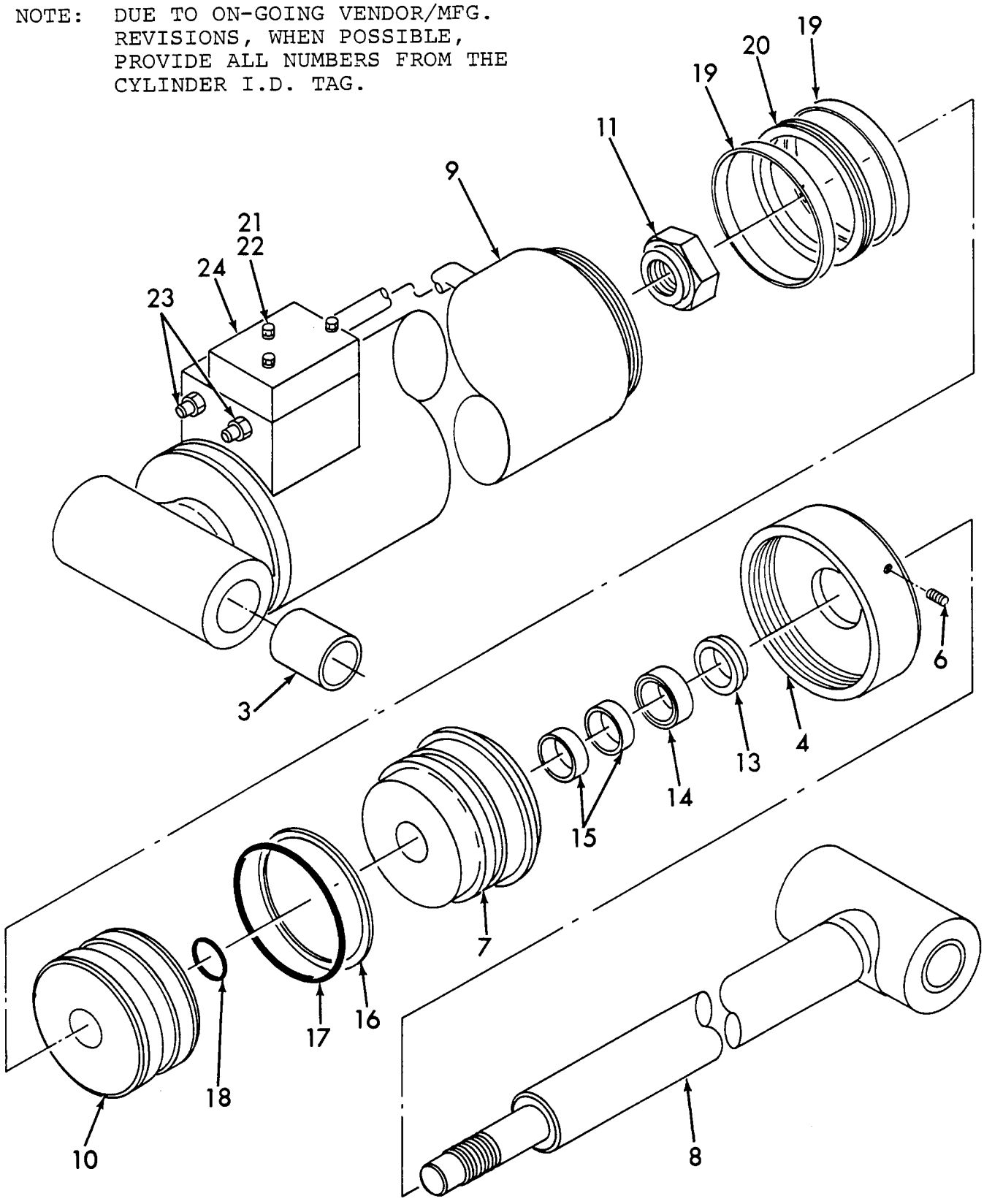
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24948	MASTER LEVELING CYLINDER ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
-2	140896	. MASTER LEVELING CYLINDER (TH)	1
3	67999	.. BUSHING	4
4		.. HEAD	1
5		.. ROD	1
6		.. TUBE	1
7		.. PISTON	1
8		.. LOCK NUT	1
-9	67997	.. SEAL KIT	1
10		.. ROD WIPER	1
11		... ROD BACK-UP RING	1
12		... ROD O-RING	1
13		... HEAD BACK-UP RING	1
14		... HEAD O-RING	1
15		... O-RING	1
16		... PISTON BACK-UP RING	2
17		... PISTON O-RING	1
18	80012-03	. STRAIGHT THREAD ELBOW	2
		NOTE: OTHER SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	

Mark Industries

TITLE	LIFT CYLINDER ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	

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



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Mark Industries

TITLE	LIFT CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

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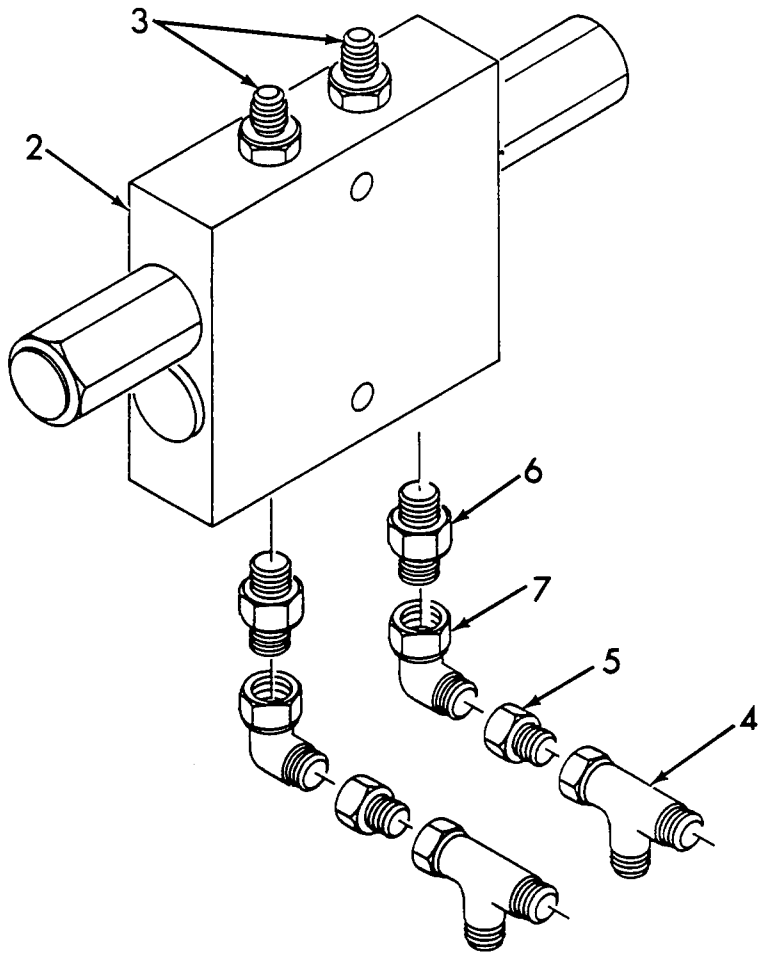
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24715	LIFT CYLINDER ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	24677	. LIFT CYLINDER (TH)	1
3	68020	.. BUSHING	4
4		.. HEAD CAP	1
-5		.. NYLON PLUG	1
6		.. SET SCREW	1
7		.. HEAD	1
8		.. ROD	1
9		.. TUBE (BARREL)	1
10		.. PISTON	1
11		.. LOCK NUT	1
-12	68017	.. SEAL KIT	1
13		... ROD WIPER	1
14		... LOADED U-CUP	1
15		... ROD WEAR RING	2
16		... HEAD BACK-UP RING	1
17		... HEAD O-RING	1
18		... O-RING	1
19		... PISTON WEAR RING	2
20		... AQ SEAL ASSEMBLY	1
21	60319	. CAP SCREW	3
22	63301	. LOCK WASHER	3
23	80004-08	. CONNECTOR	2
24	81205	. HOLDING VALVE	1
		NOTE: OTHER SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	

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

Mark Industries

TITLE	COUNTERBALANCE VALVE ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
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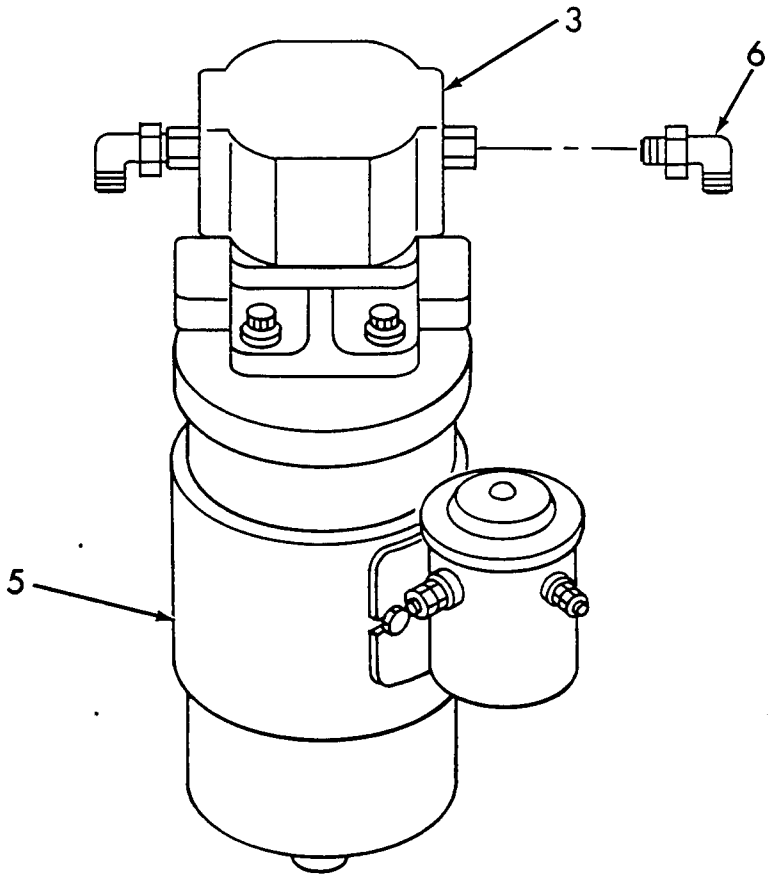
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	210156	COUNTERBALANCE VALVE ASSEMBLY	REF
2	81246	. COUNTERBALANCE VALVE	1
3	80004-05	. STRAIGHT THREAD CONNECTOR	2
4	80028-03	. SWIVEL NUT RUN TEE	2
5	80056-01	. TUBE END REDUCER	2
6	140765	. MODIFIED STRAIGHT THREAD CONNECTOR	2
7	80015-05	. SWIVEL NUT ELBOW	2

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Mark Industries

TITLE	EMERGENCY PUMP & MOTOR ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

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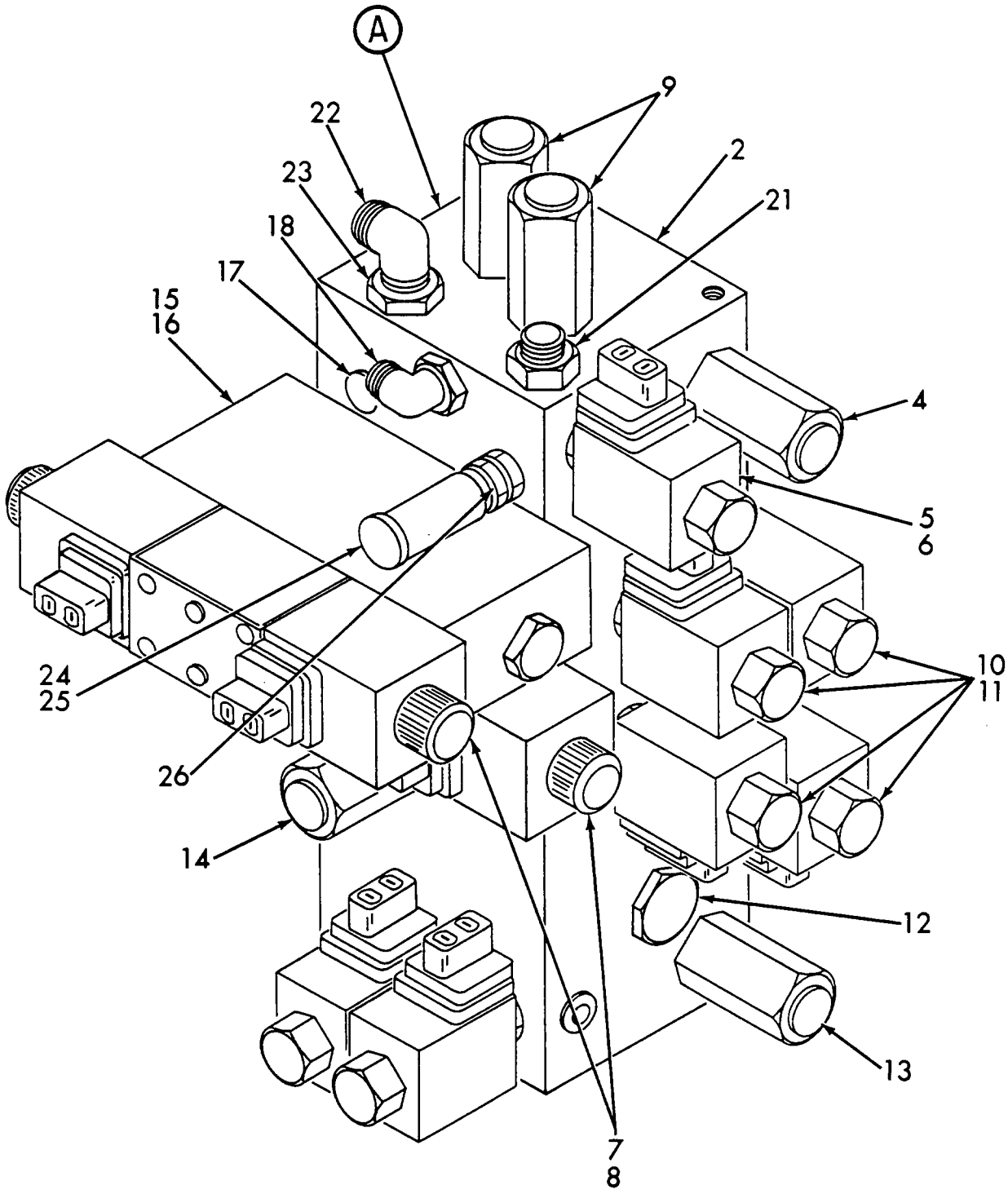
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	23742	EMERGENCY PUMP & MOTOR ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
-2	20384	. EMERGENCY PUMP & MOTOR (JSB)	1
3	66402	.. PUMP	1
-4	67935	... SEAL KIT	1
5	66780	.. MOTOR	1
6	80008-13	. MALE ELBOW	2

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Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

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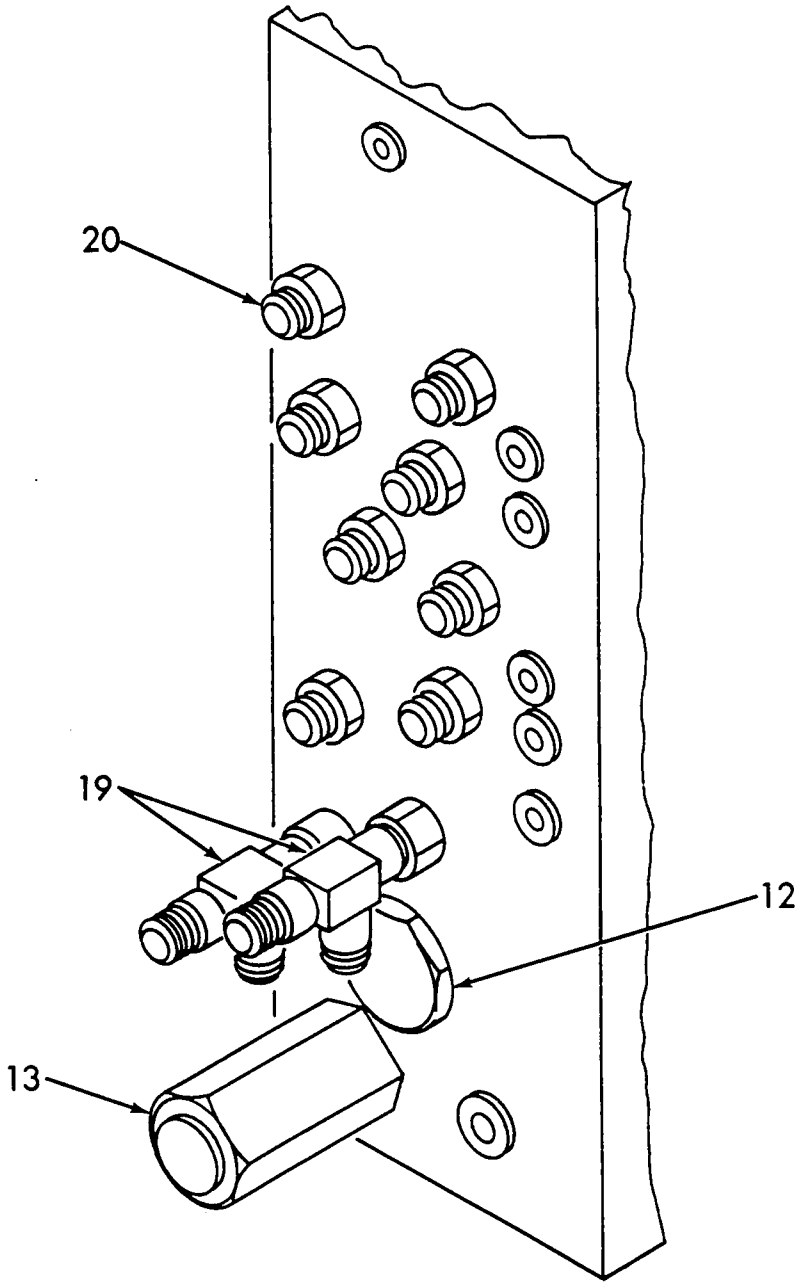


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Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

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FIGURE	9
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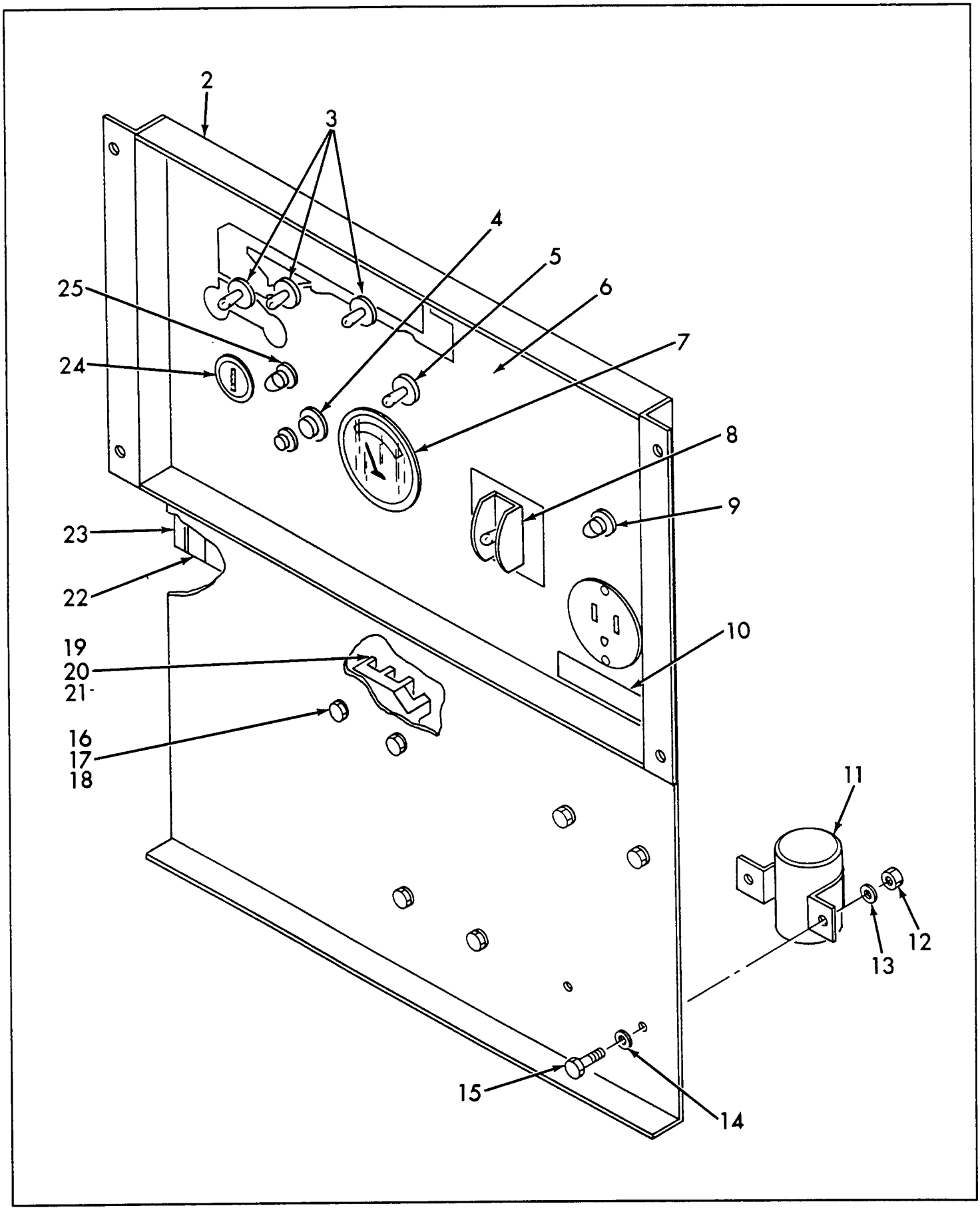
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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24977	CONTROL VALVE ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	81331	. CONTROL VALVE (See Schematic Chapter for Schematic)	1
-3	68056	.. SEAL KIT (COMPLETE VALVE PACKAGE)	1
*4	68060	.. RELIEF VALVE	1
5	66920	.. N.O. POPPET SOLENOID	1
6	66914	... COIL (12 VOLT)	1
7	68059	.. D01 VALVE	2
8	66913	... D01 COIL (12 VOLT)	4
*9	68057	.. RELIEF VALVE	2
10	66923	.. 2 POSITION 3 WAY SOLENOID	6
11	66914	... COIL (12 VOLT)	6
12	66674	.. CHECK VALVE	2
*13	68060	.. RELIEF VALVE	2
*14	68064	.. RELIEF VALVE	1
15	81341	.. PROPORTIONAL MANIFOLD	1
16	600111	... COIL (12 VOLT)	1
17	80050-03	. HEX HEAD PLUG	5
18	80012-08	. STRAIGHT THREAD ELBOW	1
19	80033-03	. STRAIGHT THREAD TEE RUN	2
20	80004-05	. STRAIGHT THREAD CONNECTOR	9
21	80004-11	. STRAIGHT THREAD CONNECTOR	1
22	80012-18	. STRAIGHT THREAD ELBOW	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	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (WISC.)
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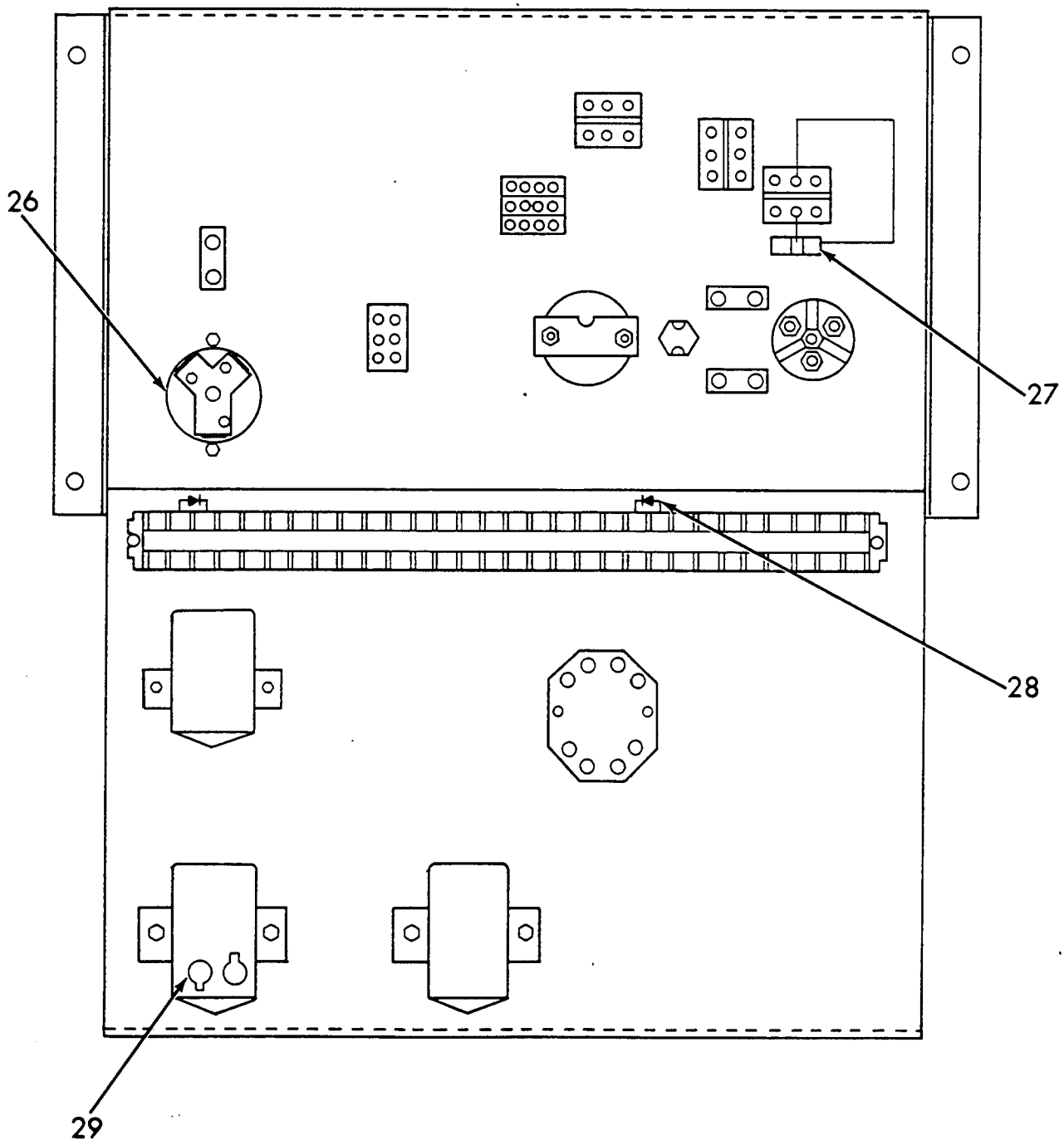


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Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (WISC.)
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FIGURE	10
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Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4(WISC.)
NOTES	

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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24949	LOWER CONTROL PANEL ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	23701	. LOWER CONTROL PANEL	1
3	20481	. TOGGLE SWITCH	3
4	4011	. PUSH BUTTON SWITCH	1
5	16260	. TOGGLE SWITCH	1
6	23721	. GROUND CONTROL CONSOLE DECAL	1
7	20492	. AMMETER	1
8	70037	. TOGGLE SWITCH	1
9	20562	. CIRCUIT BREAKER	1
10	185707	. DECAL	1
11	70209	. 12 VDC SOLENOID	3
12	63701	. HEX NUT	12
13	63301	. LOCK WASHER	8
14	63401	. FLAT WASHER	4
15	60342	. CAP SCREW	8
16	62636	. MACHINE SCREW	7
17	61532	. HEX NUT	7
18	63312	. LOCK WASHER	7
19	30215	. RELAY HOLD DOWN CLIP	1
20	70170	. 12 VDC RELAY	1
21	784-A	. 8 PIN OCTAL SOCKET	1
22	4027	. TERMINAL BLOCK	30
23	117-A	. TERMINAL END BLOCK	1
24	2717	. IGNITION SWITCH	1
25	70361	. CIRCUIT BREAKER	2

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Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (WISC.)
NOTES	

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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	70409	. FLANGED INLET	1
27	70540	. ADJUSTABLE RESISTOR	1
28	70479	. DIODE	3
29	117-C	. CONNECTOR RING	60
-30	256	. TIE CABLE	30
-31	117-F	. STRAIN RELIEF	2
-32	2991	. WIRE (2 FT.)	1
-33	70098	. WIRE (1 FT.)	1
-34	117-D	. BUTT CONNECTOR	2

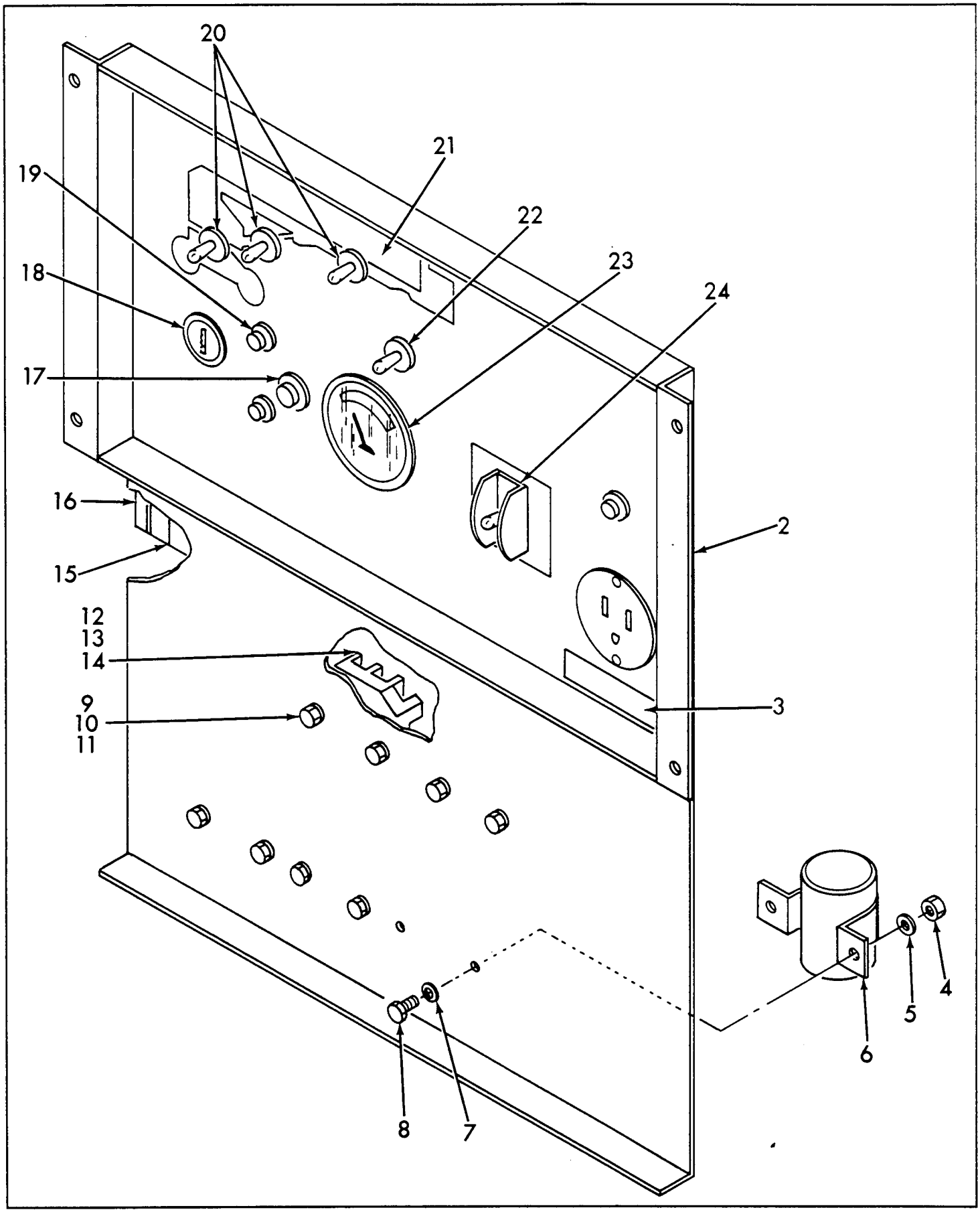
REV.

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

Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

SECTION	4
FIGURE	11
PAGE	1

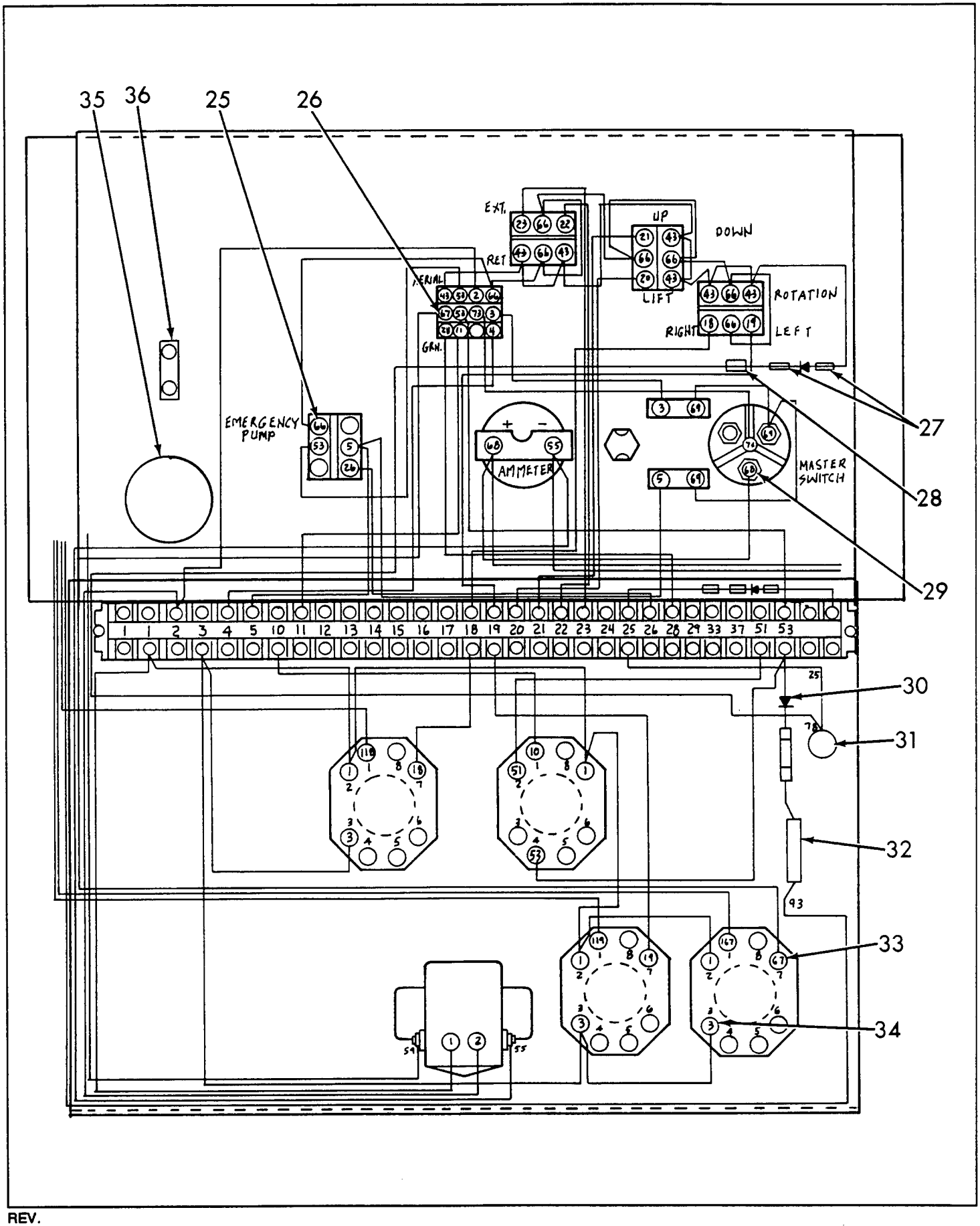


REV.

Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

SECTION	4
FIGURE	11
PAGE	2



REV.

Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

SECT.	4
FIG.	11
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24987	LOWER CONTROL PANEL ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	23701	. LOWER CONTROL PANEL	1
3	815707	. DECAL	1
4	63701	. HEX NUT	12
5	63401	. FLAT WASHER	4
6	70209	. 12 VDC SOLENOID	1
7	63301	. LOCK WASHER	8
8	60342	. CAP SCREW	8
9	62636	. MACHINE SCREW	13
10	61532	. HEX NUT	13
11	63312	. LOCK WASHER	13
12	30215	. RELAY HOLD DOWN CLIP	4
13	70170	. 12 VDC RELAY	4
14	784-A	. 8 PIN OCTAL SOCKET	4
15	4027	. TERMINAL BLOCK	31
16	117-A	. TERMINAL BLOCK END	1
17	65243	. WHITE PLUG	1
18	2717	. IGNITION SWITCH	4
19	70361	. CIRCUIT BREAKER	2
20	20481	. TOGGLE SWITCH	3
21	23721	. GROUND CONTROL CONSOLE DECAL	1
22	16260	. TOGGLE SWITCH	1
23	70492	. AMMETER	1
24	70037	. TOGGLE SWITCH	1
25	117-B	. CONNECTOR RING	19

Mark Industries

TITLE	LOWER CONTROL PANEL ASSEMBLY
MODEL	40 4X4 (DEUTZ)
NOTES	

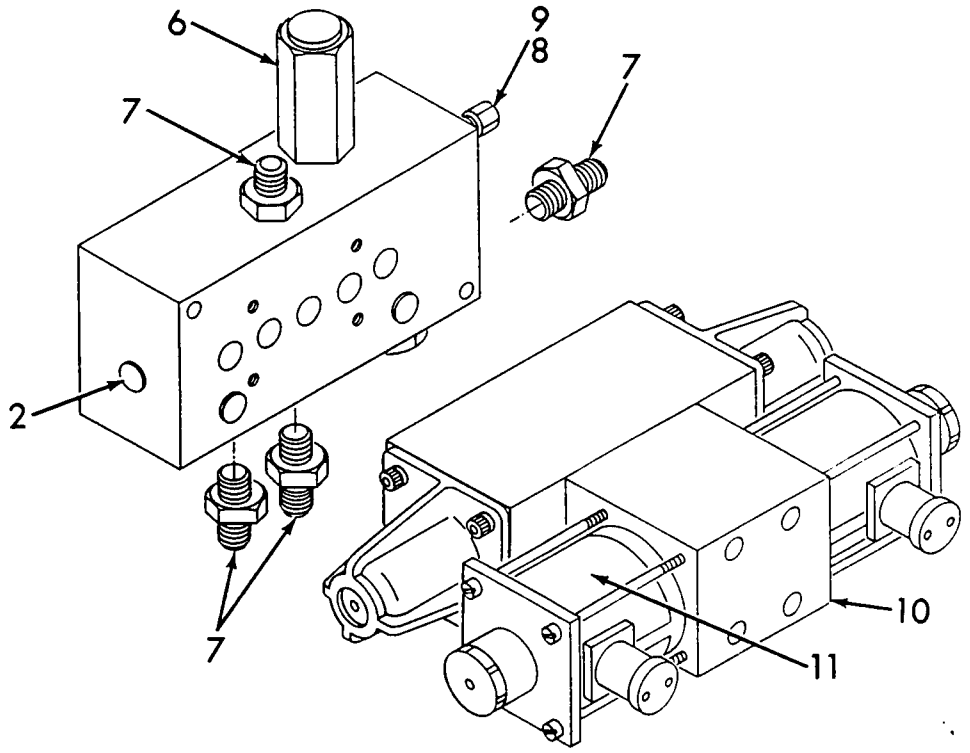
SECT.	4
FIG.	11
PAGE	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	70149	. CONNECTOR RING	16
27	70564	. SLEEVE (4 IN)	1
28	117-D	. BUTT CONNECTOR	2
29	117-C	. CONNECTOR RING	60
30	70479	. DIODE	3
31	70540	. ADJUSTABLE RESISTOR	1
32	70499	. RESISTOR	1
33	70566	. CONNECTOR FORK	8
34	70406	. CONNECTOR FORK	17
35	70409	. FLANGED INLET	1
36	20562	. CIRCUIT BREAKER	1
-37	256	. TIE CABLE	30
-38	117-F	. STRAIN RELIEF	2
-39	2991	. WIRE (WHITE, 12 AWG, STRANDED)	20 FT
-40	70098	. WIRE (YELLOW W/GREEN STRIPE, 12 GAUGE)	1 FT
-41	70205	. WIRE (BLACK, 8 AWG, 19 STRANDED)	3 FT
-42	70008	. WIRE (YELLOW W/GREEN STRIPE, 16 AWG)	3 FT

Mark Industries

TITLE	DRIVE BLOCK VALVE
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	4
FIGURE	12
PAGE	1



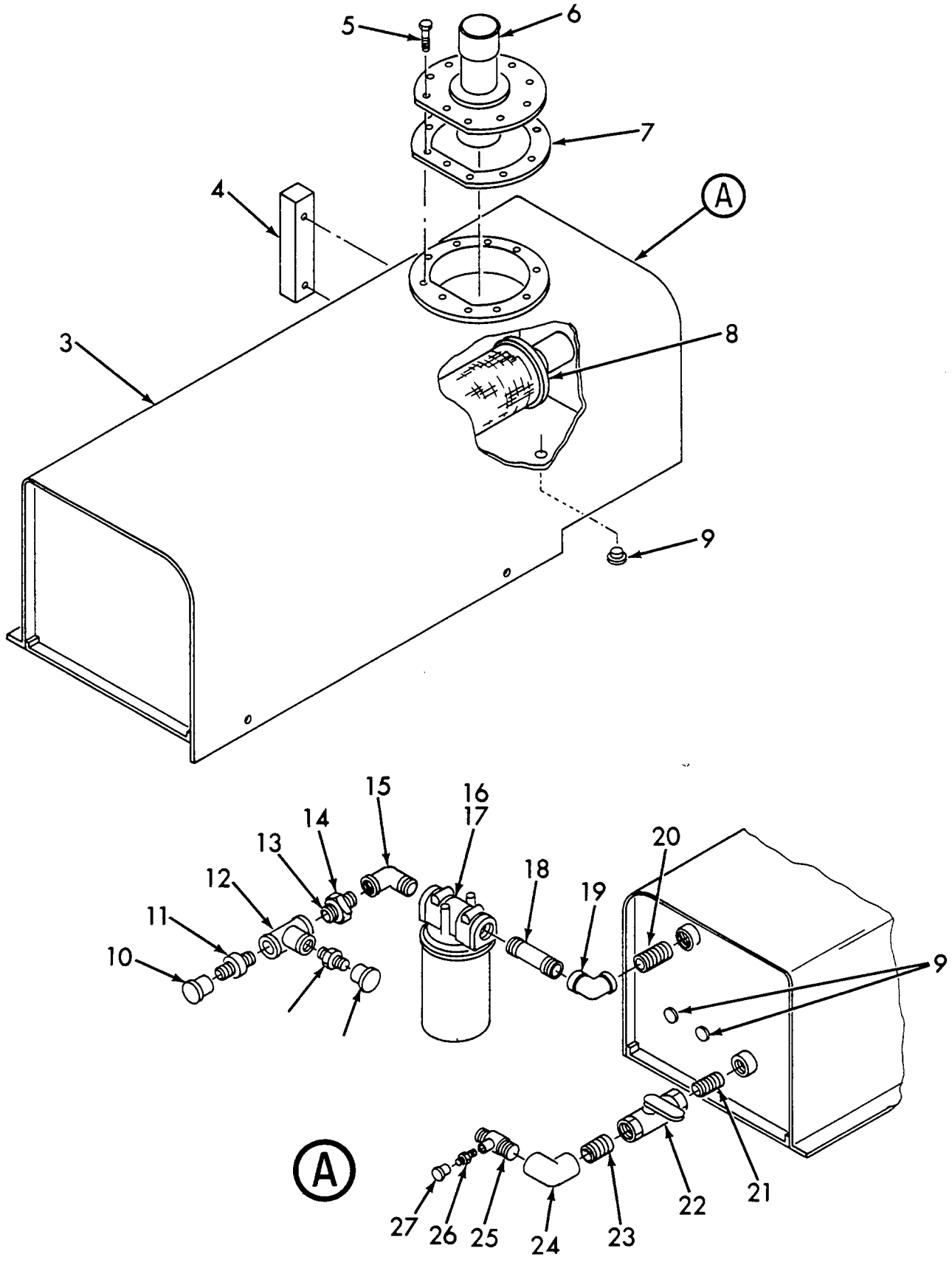
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	210185	DRIVE BLOCK ASSEMBLY	REF
2	81255	. CONTROL VALVE	1
-3	68058	.. SEAL KIT (CONTROL VALVE)	1
4	67229	.. FLOW REGULATOR	1
5	600023	.. MINI SHUTTLE VALVE	1
*6	68060	.. RELIEF VALVE	1
7	80004-16	. STRAIGHT THREAD CONNECTOR	4
8	80004-05	. STRAIGHT THREAD CONNECTOR	1
9	80059-03	. CAP	1
10	81350	. DIRECTIONAL CONTROL VALVE	1
11	66749	.. COIL (12 VOLT)	2
		NOTE: PRIOR TO USE, RELIEF VALVES WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

REV.

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	

SECTION	4
FIGURE	13
PAGE	1



REV.

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	

SECT.	4
FIG.	13
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24921	HYDRAULIC TANK ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
-2	24811	. HYDRAULIC TANK SUB-ASSEMBLY	1
3	24833	. HYDRAULIC TANK WELDMENT	1
4	81184	. FLUID LEVEL GUAGE	1
5	160193	. SCREW	10
6	81123	. FILLER BREATHER	1
7	160194	. GASKET	1
8	81183	. HYDRAULIC FILTER	1
9	53902	. DRAIN PLUG	3
10	160219	. PLUG CAP	2
11	80001-21	. MALE CONNECTOR	2
12	80039-13	. FEMALE PIPE TEE	1
13	65802	. NIPPLE	1
14	53801	. REDUCER PIPE	1
15	16503	. 90° STREET ELBOW	1
16	21241	. RETURN LINE FILTER	1
17	21245	.. FILTER ELEMENT	1
18	160250	. NIPPLE	1
19	16403	. ELBOW	1
20	16552	. NIPPLE	1
21	65803	. NIPPLE	1
22	20050	. BUTTERFLY VALVE	1
23	16553	. NIPPLE	1
24	16502	. FEMALE ELBOW	1
25	24951	. HYDRAULIC TANK SUCTION ADAPTER	1

Mark Industries

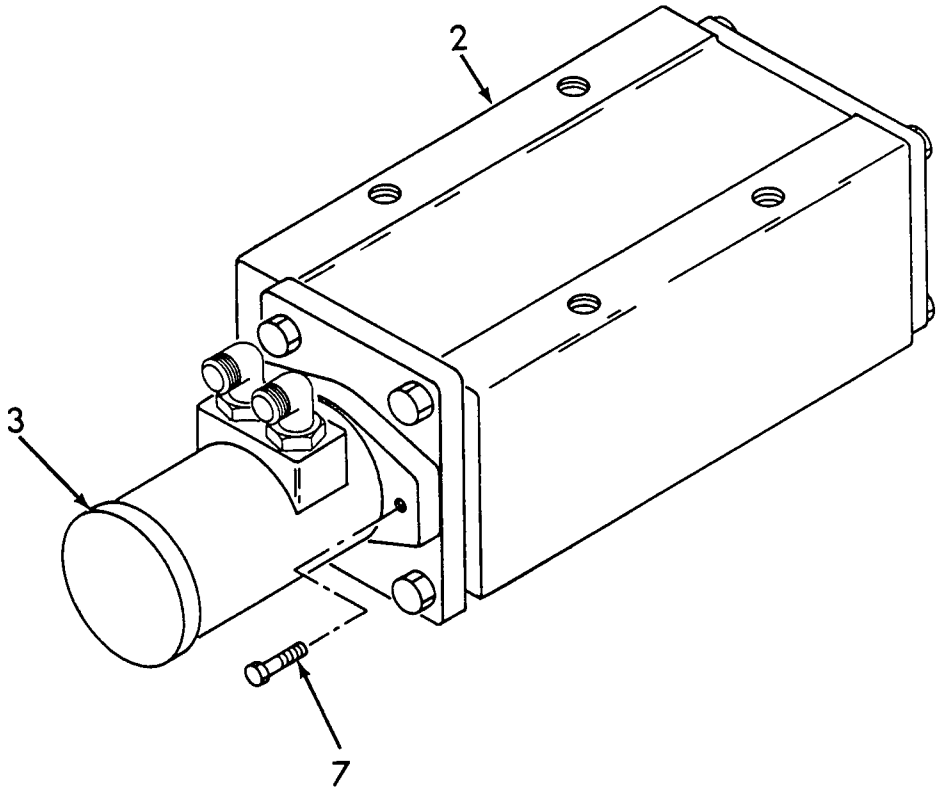
TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	40 4X4(DEUTZ & WISC.)
NOTES	

SECT.	4
FIG.	13
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	80001-10	. MALE CONNECTOR	1
27	160224	. PLUG CAP	1

REV.

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

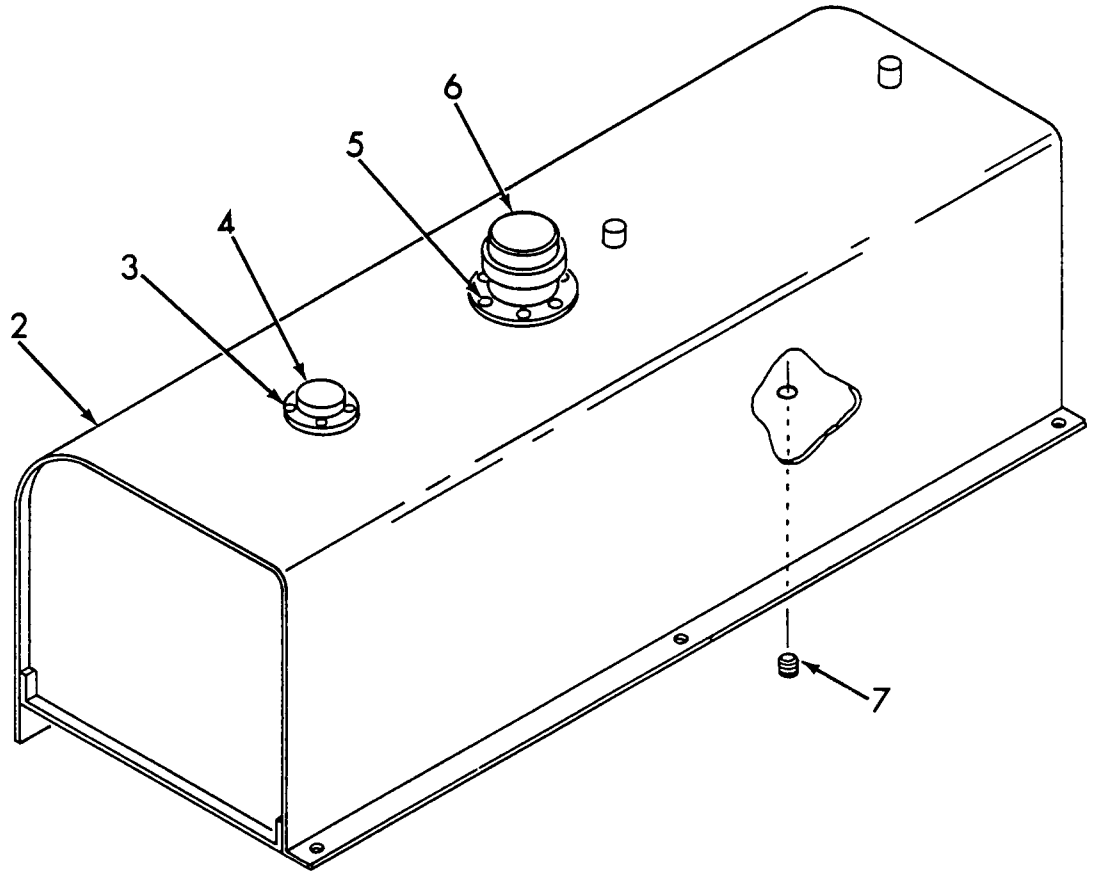


ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24909	ROTATION GEARBOX ASSEMBLY	REF
2	24930	. WORM GEAR (REWORK) ASSEMBLY	1
3	81278	. HYDRAULIC MOTOR (See Vendor Section for Details)	1
-4	67691	.. DRIVE LINK	1
-5	67698	.. COUPLING SHAFT	1
-6	67688	.. SEAL KIT	1
7	62011	. ROUND HEX SOCKET HEAD CAP SCREW	2

Mark Industries

TITLE	FUEL TANK ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	4
FIGURE	15
PAGE	1

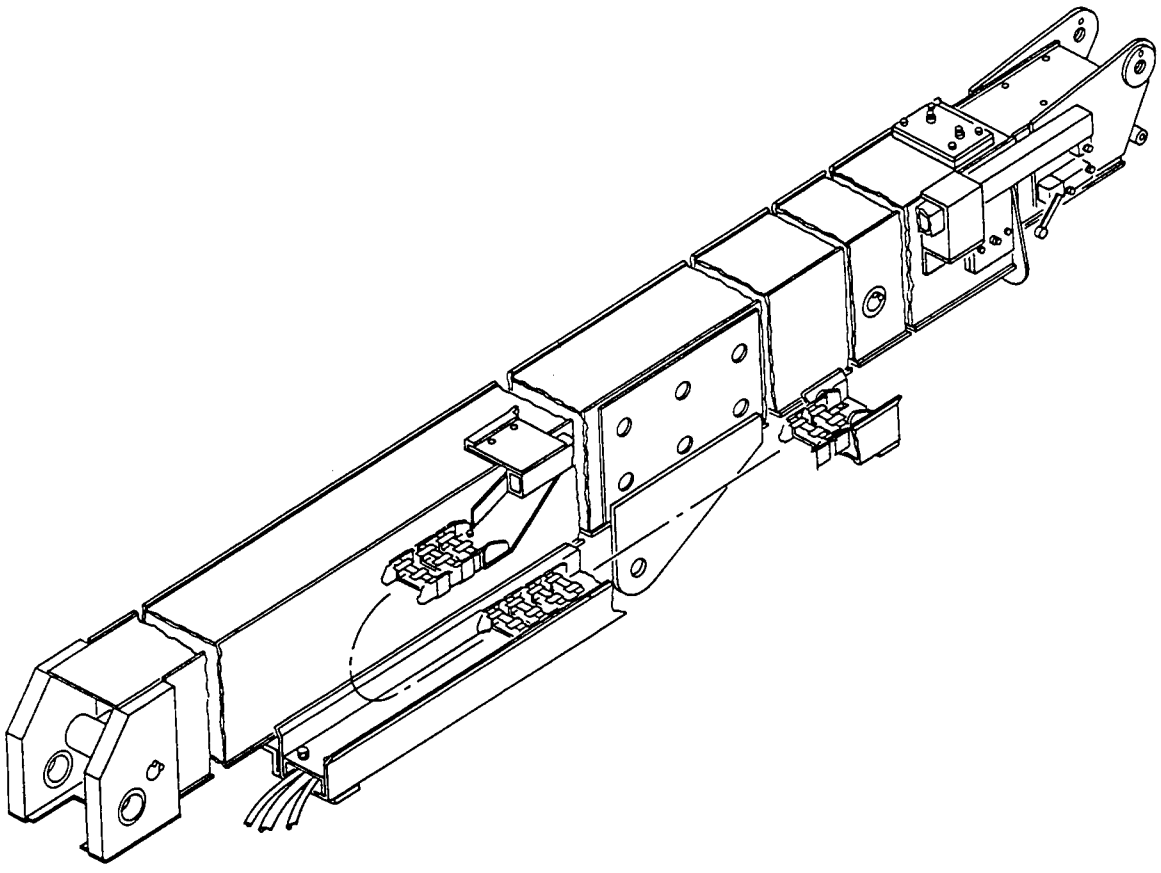


ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24810	FUEL TANK ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	24809	. FUEL TANK WELDMENT	1
3	65908	. THREAD CUTTING SCREW	5
4	81186	. MAGNETIC LIQUID LEVEL GUAGE	1
5	160242	. FILLER NECK * Dial Orient P/N 30174	1
6	160214	. ANTI-SURGE FUEL FILLER CAP	1
7	53902	. DRAIN PLUG	1

REV.

SECTION 5 CONTAINS:

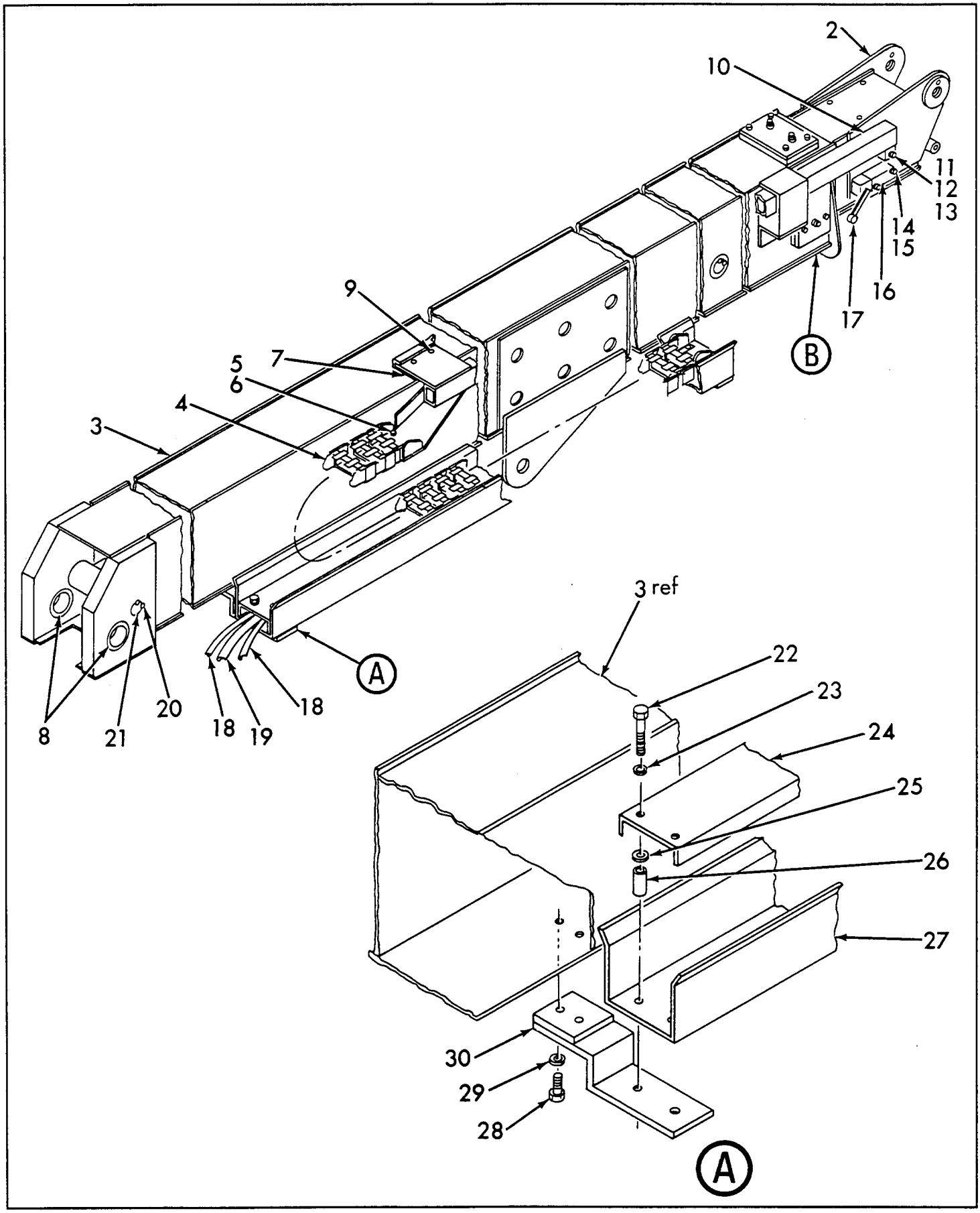
FIG. NO.	TITLE
1	BOOM ASSEMBLY (DEUTZ & WISC.)
2	INNER BOOM ASSEMBLY (DEUTZ & WISC.)
3	EXTENSION CYLINDER ASSEMBLY (DEUTZ & WISC.)
4	SLAVE CYLINDER ASSEMBLY (DEUTZ & WISC.)



Mark Industries

TITLE	BOOM ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	5
FIGURE	1
PAGE	1



REV.

Mark Industries

TITLE	BOOM ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECT.	5
FIG.	1
PAGE	3

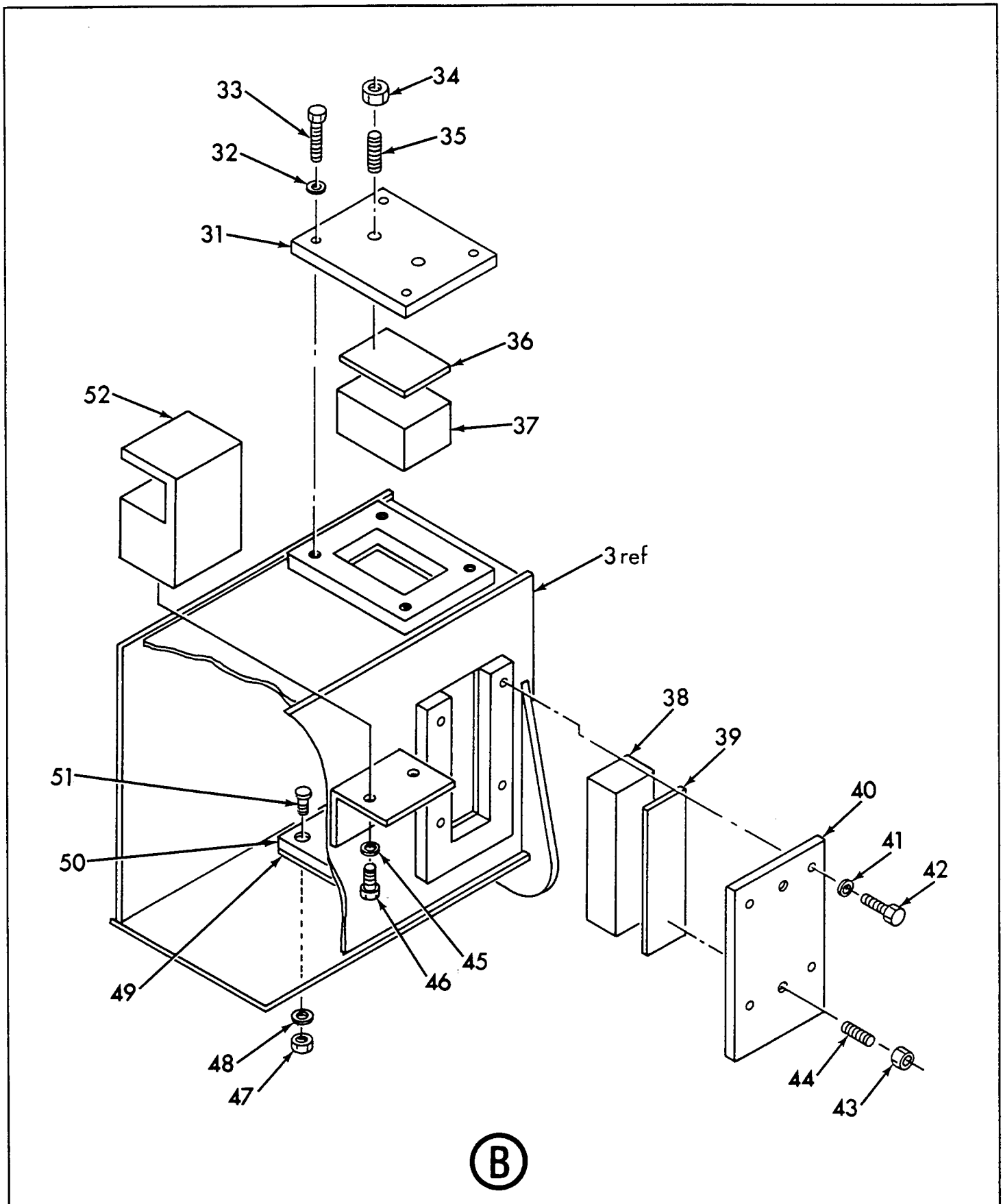
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24721	FINAL BOOM ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	24722	. INNER BOOM ASSEMBLY (See Sect. 5, Fig. 2 for Details)	1
3	24080	. OUTER BOOM MACHINING	1
4	210027	. POWER TRACK WITH BRACKETS	1
5	60633	. CAP SCREW	4
6	63301	. LOCK WASHER	4
7	24942	. WEAR PAD TUBE	1
8	24750	. BUSHING	2
9	61822	. CAP SCREW	2
10	24856	. TUBE WELDMENT	1
11	60393	. CAP SCREW	1
12	63305	. LOCK WASHER	1
13		. SPACER	1
14	62704	. MACHINE SCREW	2
15	63313	. LOCK WASHER	2
16	70107	. LIMIT SWITCH	1
17	70031	. SWITCH LEVER	1
18	20802	. ELECTRICAL CABLE (60 FEET)	1
19	2568	. HOSE (110 FEET)	1
20	62229	. SET SCREW	2
21	24759	. EXTENSION CYLINDER PIN	1
22	60319	. CAP SCREW	6
23	63301	. LOCK WASHER	6
24	24825	. POWER TRACK COVER CHANNEL	1

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

Mark Industries

TITLE	BOOM ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	5
FIGURE	1
PAGE	2



REV.

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
25	63401	. FLAT WASHER	6
26	28515	. ROUND TUBE	6
27	24829	. POWER TRACK SUPPORT CHANNEL	1
28	60322	. CAP SCREW	4
29	63302	. LOCK WASHER	4
30	24828	. SUPPORT CHANNEL BRACKET	2
31		. TOP COVER PLATE	1
32	63302	. LOCK WASHER	4
33	60338	. CAP SCREW	4
34	61101	. JAM NUT	2
35	62221	. SET SCREW	2
36	24821	. TOP-WEAR PAD PRESSURE PLATE	1
37	24820	. OUTER BOOM TOP WEAR PAD	1
38	140403	. OUTER BOOM SIDE WEAR PAD	2
39	27258	. SIDE-WEAR PAD PRESSURE PLATE	2
40	140402	. SIDE COVER PLATE	2
41	63302	. LOCK WASHER	8
42	60338	. CAP SCREW	8
43	61101	. JAM NUT	4
44	62221	. SET SCREW	4
45	63302	. LOCK WASHER	2
46	60323	. CAP SCREW	2
47	60703	. HEX NUT	4
48	63303	. LOCK WASHER	4
49	24819	. OUTER BOOM BOTTOM SHIM	1

Mark Industries

TITLE	BOOM ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

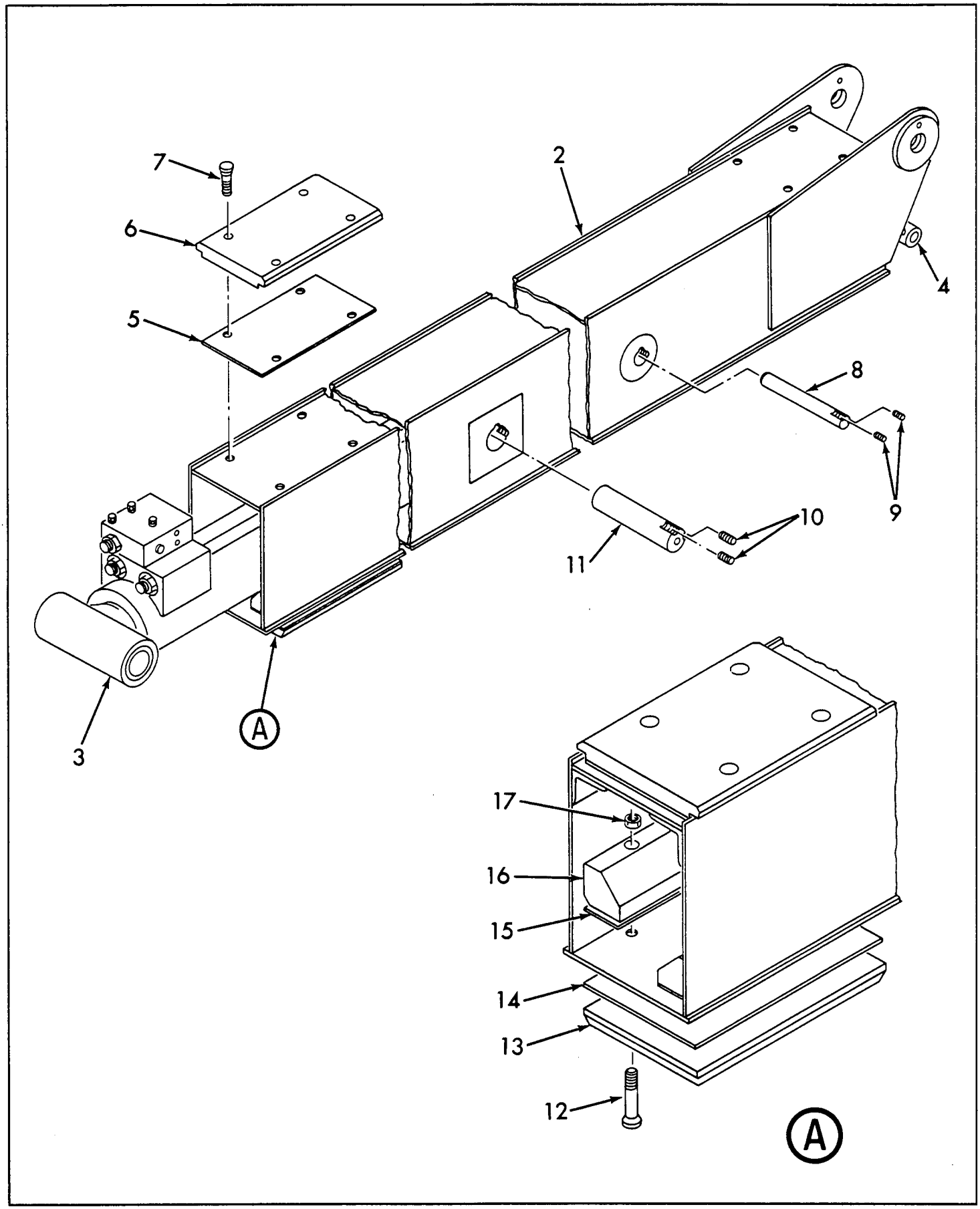
SECT.	5
FIG.	1
PAGE	5

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
50	24818	. OUTER BOOM BOTTOM WEAR PAD	1
51	61804	. FLAT SOCKET HEAD SCREW	4
52	24857	. POWER TRACK TUBE WEAR PAD	1

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	5
FIGURE	2
PAGE	1



REV.

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECT.	5
FIG.	2
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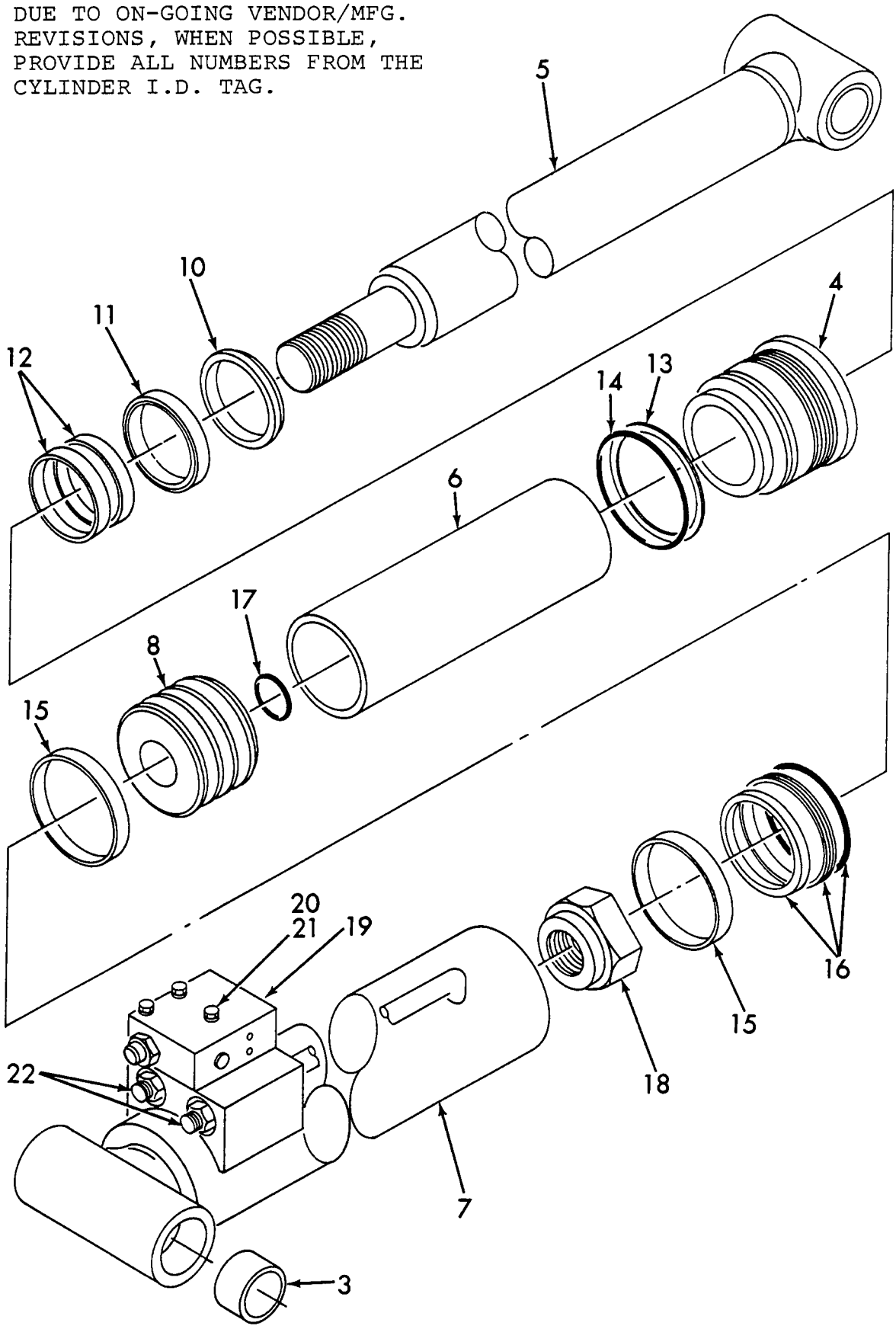
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24722	INNER BOOM ASSEMBLY (See Sect. 5, Fig. 1 for NHA)	REF
2	24082	. INNER BOOM MACHINING	1
3	24714	. EXTENSION CYLINDER ASSEMBLY (See Sect. 5, Fig. 3 for Details)	1
4	140946	. SLAVE CYLINDER ASSEMBLY (See Sect. 5, Fig. 4 for Details)	1
5	24814	. INNER BOOM TOP SHIM	1
6	24813	. INNER BOOM TOP WEAR PAD	1
7	61837	. FLAT SOCKET HEAD SCREW	4
8	140415	. SLAVE CYLINDER PIN CAP END	1
9	62235	. SET SCREW	2
10	62229	. SET SCREW	2
11	140424	. EXTENSION CYLINDER PIN ROD END	1
12	61835	. CAP SCREW	4
13	24815	. INNER BOOM BOTTOM WEAR PAD	1
14	24816	. INNER BOOM BOTTOM SHIM	1
15	24817	. INNER BOOM EXTENSION CYLINDER SUPPORT SHIM	2
16	24778	. INNER EXTENSION CYLINDER SUPPORT WEAR PAD	2
17	61318	.. LOCK NUT	4

Mark Industries

TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	5
FIGURE	3
PAGE	1

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



REV.

Mark Industries

TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECT.	5
FIG.	3
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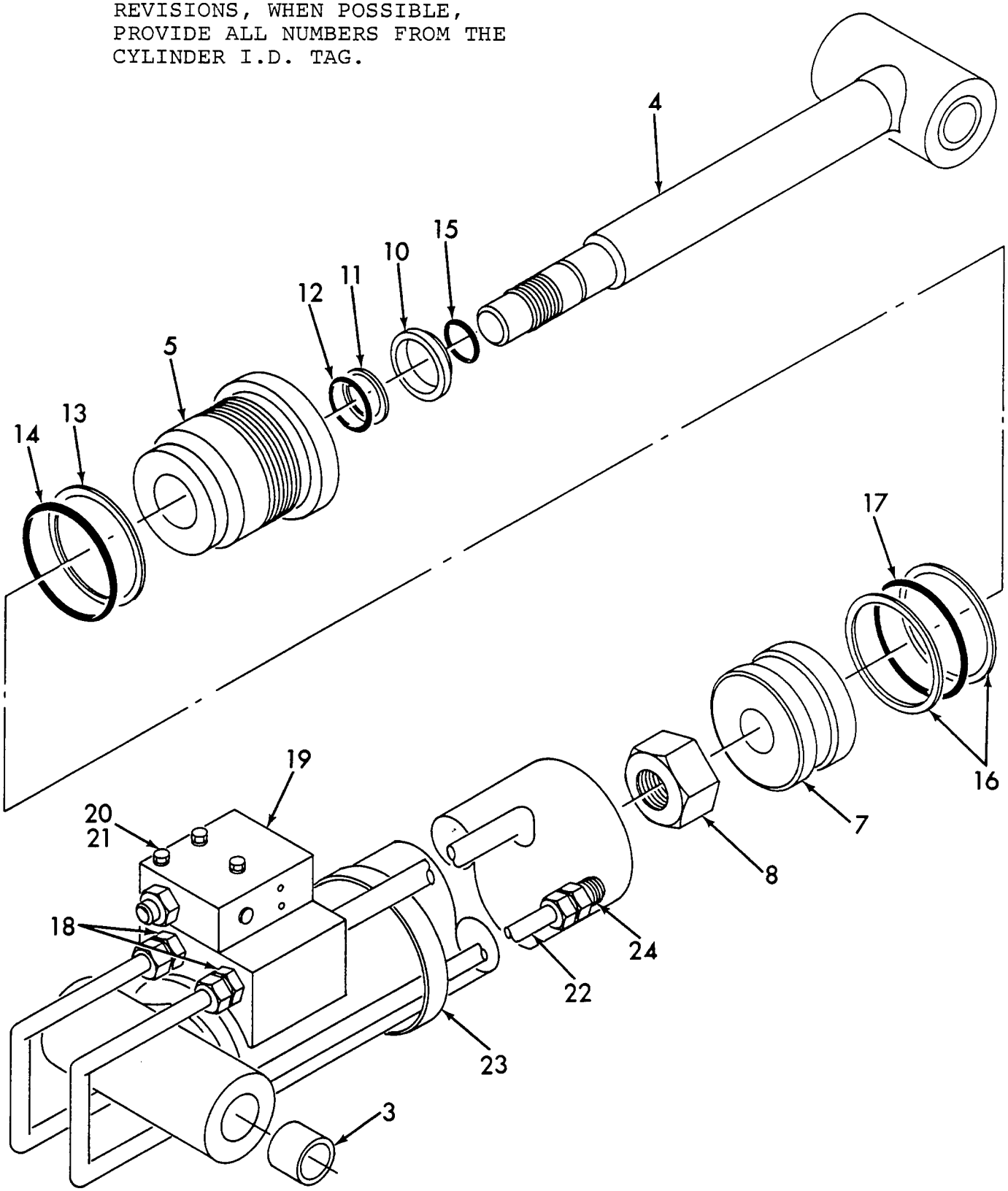
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	24714	EXTENSION CYLINDER ASSEMBLY	REF
-2	24678	. EXTENSION CYLINDER (TH)	1
3	66882	.. BUSHING	4
4		.. HEAD	1
5		.. ROD	1
6		.. SPACER	1
7		.. TUBE (BARREL)	1
8		.. PISTON	1
-9	68011	.. SEAL KIT	1
10		... ROD WIPER	1
11		... POLYPAK U-CUP	1
12		... ROD WEAR RING	2
13		... HEAD BACK-UP RING	1
14		... HEAD O-RING	1
15		... PISTON WEAR RING	2
16		... PISTON SEAL ASSEMBLY	1
17		... O-RING	1
18		... LOCK NUT	1
19	81205	. HOLDING VALVE WITH O-RINGS	1
20	60319	. CAP SCREW	3
21	63301	. LOCK WASHER	3
22	80004-08	. STRAIGHT THREAD CONNECTOR	2
		NOTE: OTHER SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	

Mark Industries

TITLE	SLAVE CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECTION	5
FIGURE	4
PAGE	1

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



REV.

Mark Industries

TITLE	SLAVE CYLINDER ASSEMBLY
MODEL	40 4X4 (DEUTZ & WISC.)
NOTES	

SECT.	5
FIG.	4
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	140946	SLAVE CYLINDER ASSEMBLY	REF
-2	140890	. SLAVE CYLINDER (TH)	1
3	67999	.. BUSHING	4
4		.. ROD	1
5		.. HEAD (GLAND NUT)	1
6		.. TUBE	1
7		.. PISTON	1
8		.. LOCK NUT	1
-9	67997	.. SEAL KIT	1
10		... ROD WIPER	1
11		... ROD BACK-UP RING	1
12		... ROD O-RING	1
13		... HEAD BACK-UP RING	1
14		... HEAD O-RING	1
15		... O-RING	1
16		... PISTON BACK-UP RING	2
17		... PISTON O-RING	1
18	80004-03	. STRAIGHT THREAD CONNECTOR	2
19	81205	. HOLDING VALVE WITH O-RINGS	1
20	60319	. CAP SCREW	3
21	63301	. LOCK WASHER	3
22	140058-6	. TUBE ASSEMBLY	2
23	65111	. STRAP	1
24	80042-03	. UNION	2
		NOTE: OTHER SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	

REV.

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

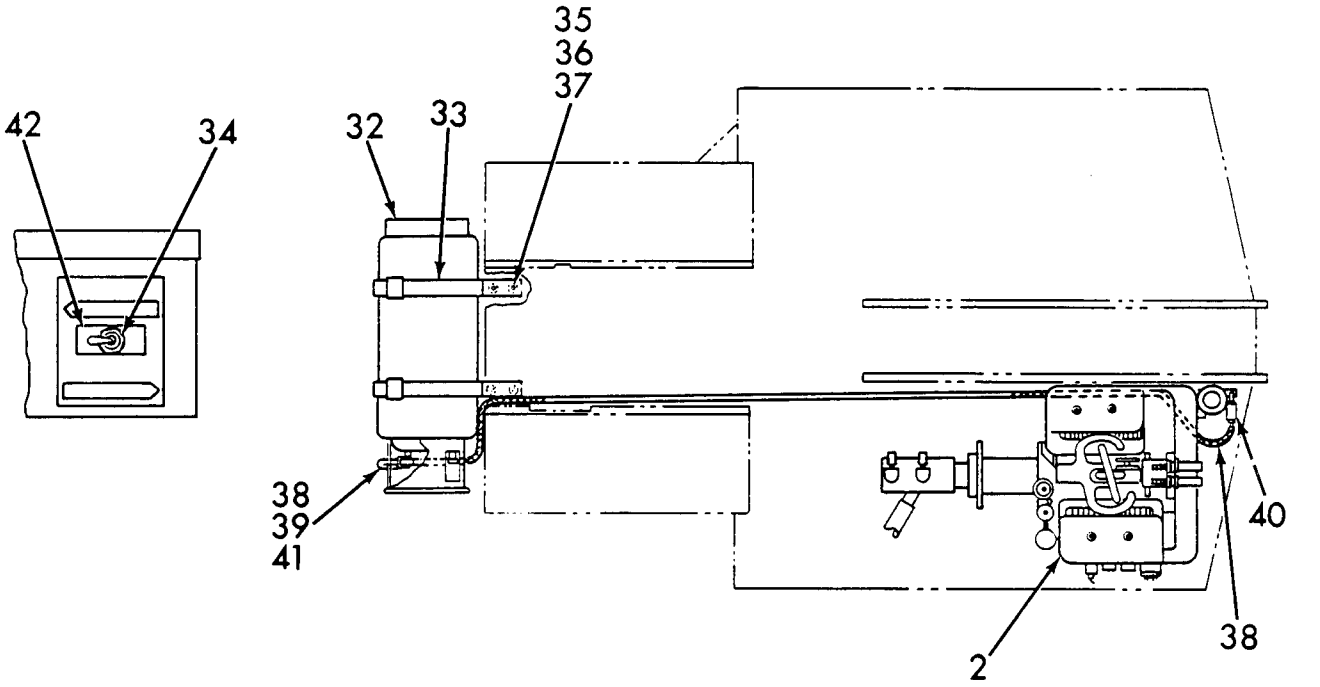
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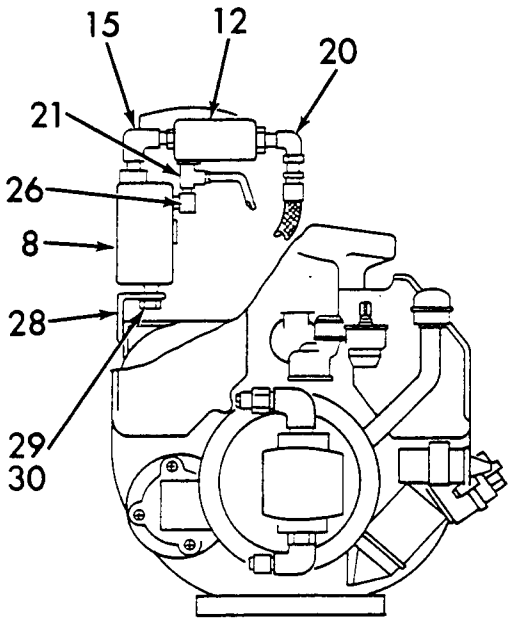
FIG. NO.	TITLE
1	DUAL FUEL KIT
2	LIFTING LUGS
3	HYDRAULIC PLATFORM ROTATION
4	SAND TIRES
5	2K WATT GENERATOR
6	CONTINUOUS TURRET ROTATION

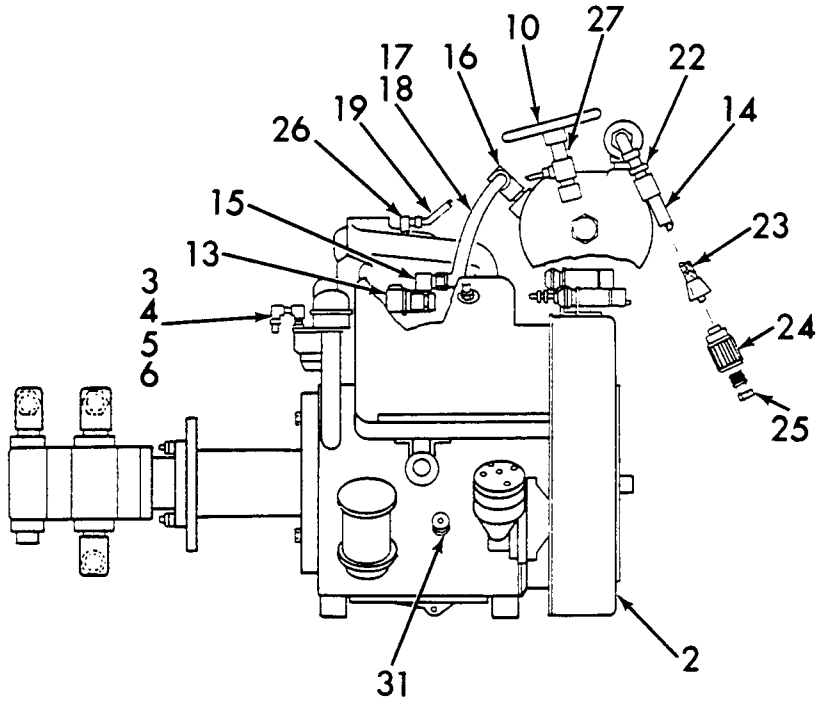
Mark Industries

TITLE	DUAL FUEL KIT
MODEL	40 4X4
NOTES	

SECTION	6
FIGURE	1
PAGE	1







REV.

Mark Industries

TITLE	DUAL FUEL KIT
MODEL	40 4X4
NOTES	

SECT.	6
FIG.	1
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1		DUAL FUEL KIT (WISC.)	REF
2	24812	WISCONSIN VH4D ENGINE	REF
3	16550	PIPE NIPPLE	1
4	20832	FUEL SHUT-OFF VALVE	1
5	16500	STREET ELBOW	2
6	240	HOSE	1
-7	20816	DUAL FUEL KIT	1
8	16921	. REGULATOR	1
-9	16965	.. REGULATOR REPAIR KIT	1
10	16975	. VACUUM SAFETY SWITCH KIT	1
-11	16919	.. SWITCH REPAIR KIT	1
12	16925	. PROPANE FILTER LOCK	1
13	16924	. CARBURETOR ADAPTER	1
14	2616	. HOSE	11
15	16519	. STREET ELBOW	2
16	66143	. ELBOW	1
17	65485	. HOSE	1.25 FT
18	66147	. HOSE CLAMP	2
19	2568	. HOSE	1.25 FT
20	80008-08	. MALE ELBOW	1
21	80041-01-B	. STREET TEE	1
22	16451	. FITTING	1
23	16452	. FITTING	1
24	65142	. QUICK DISCONNECT SOCKET	1
25	65141	. QUICK DISCONNECT NIPPLE	1

REV.

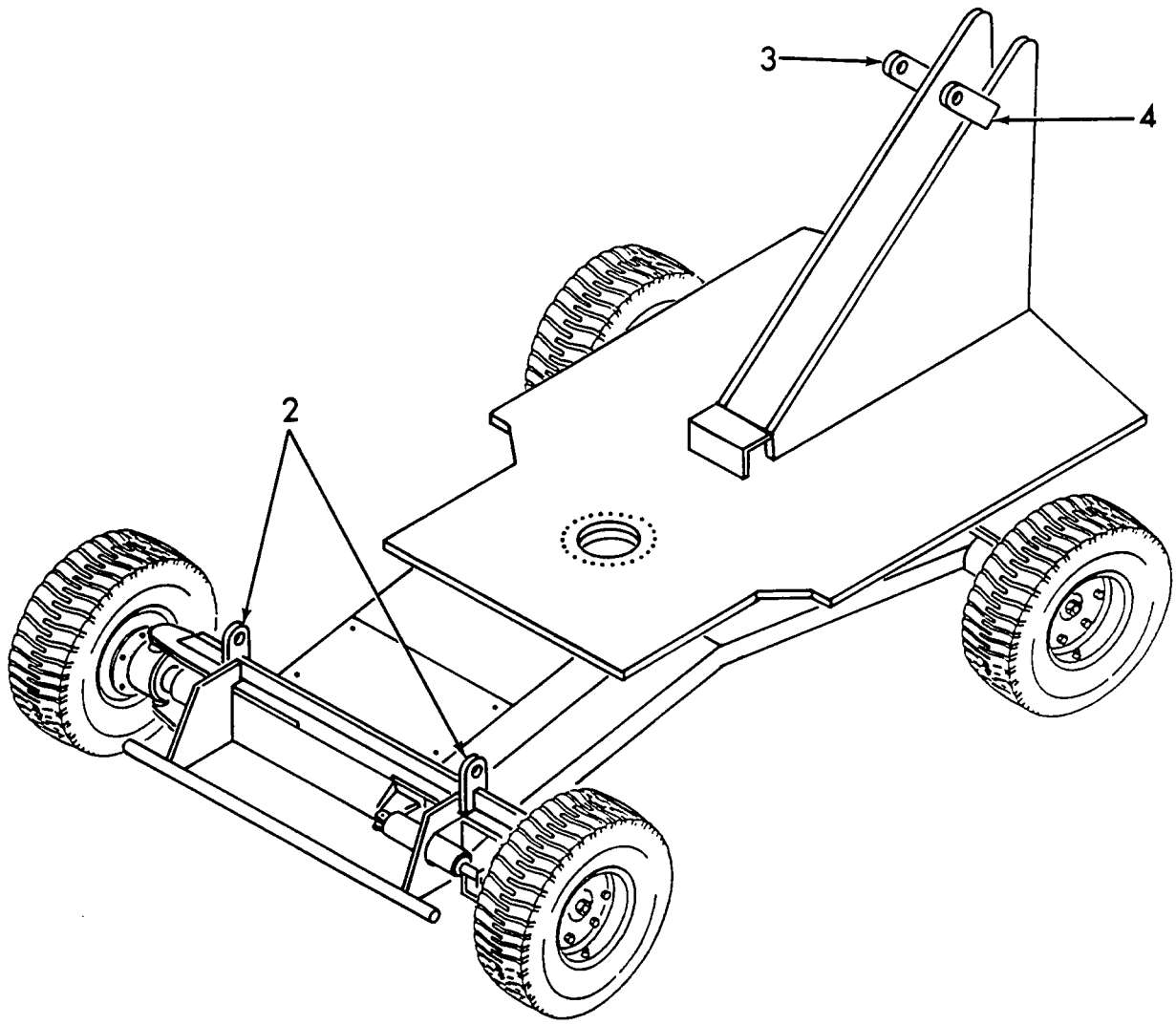
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	80021-01-B	. STREET ELBOW	2
27	80052-02-B	. PIPE NIPPLE	1
28	210143	REGULATOR BRACKET	1
29	60353	CAP SCREW	2
30	63301	LOCK WASHER	2
31	70563	PRESSURE SWITCH	1
32	486-C	LPG TANK	1
33	24830	PROPANE TANK BRACKET	2
34	4019	MICROSWITCH	1
35	60401	CAP SCREW	4
36	63305	LOCK WASHER	4
37	60705	HEX NUT	2
38	2616	HOSE	11
39	16452	FITTING	1
40	16451	FITTING	1
41	65141	QUICK DISCONNECT NIPPLE	1
42	20884	SWITCH GUARD	1

Mark Industries

TITLE	LIFTING LUGS
MODEL	40 4X4
NOTES	

SECTION	6
FIGURE	2
PAGE	1



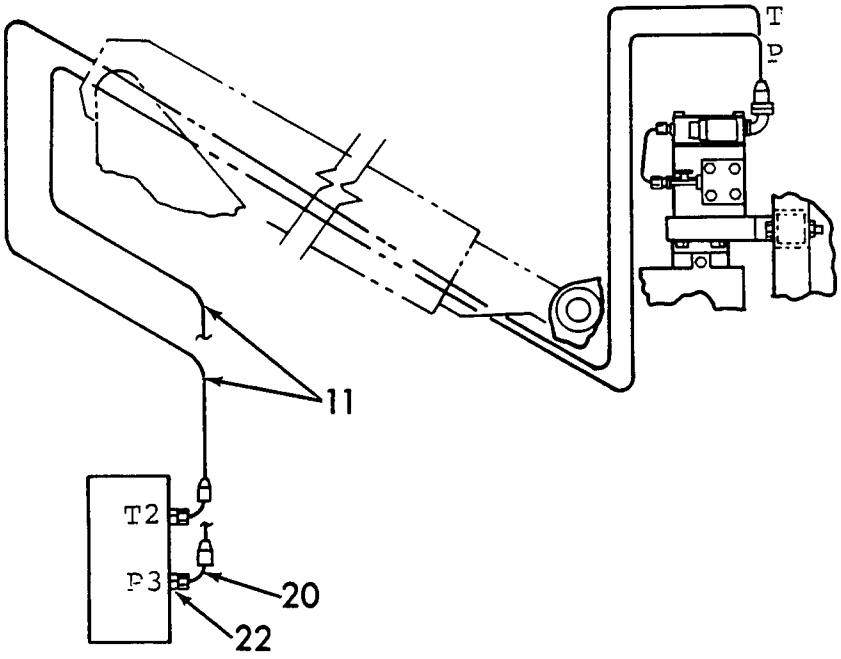
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	23426	LIFTING LUGS	REF
2	210230	. LIFTING LUGS CARRIAGE	2
3	23793	. LIFTING LUGS L.H. (TURRET)	1
4	23794	. LIFTING LUGS R.H. (TURRET)	1

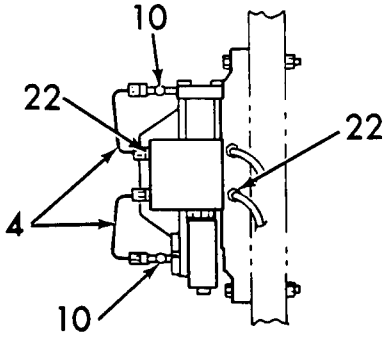
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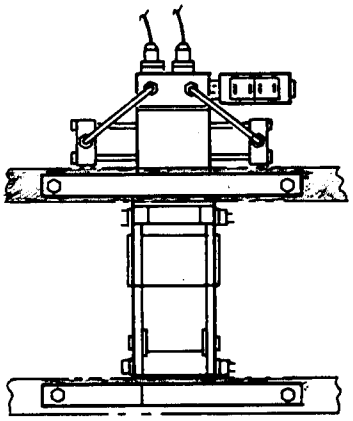
Mark Industries

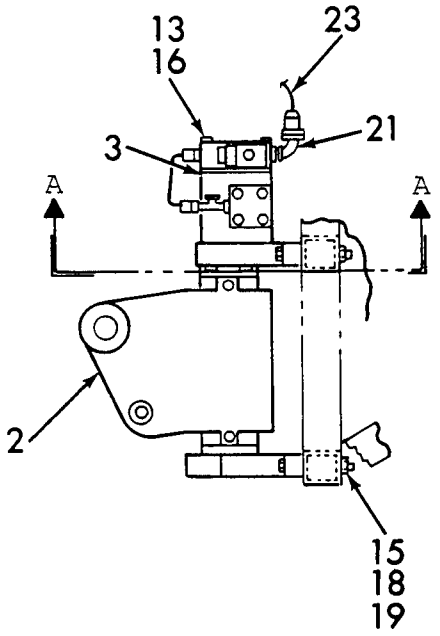
TITLE	HYDRAULIC PLATFORM ROTATION
MODEL	40 4X4
NOTES	SINCE DEC. 1989

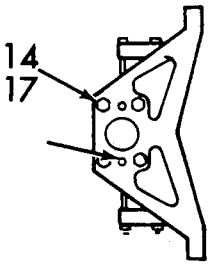
SECTION	6
FIGURE	3
PAGE	1

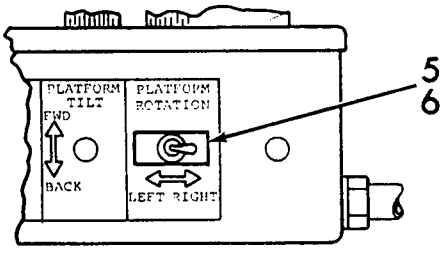












PARTIAL SECTION "A"

NOTES:
1. TORQUE ITEM 13 TO 87 FT-LBS.
2. EACH HOSE, ITEM 9, TO BE 50 FT LONG.

REV.

Mark Industries

TITLE	HYDRAULIC PLATFORM ROTATION
MODEL	40 4X4
NOTES	SINCE DEC. 1989

SECT.	6
FIG.	3
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	200023	HYDRAULIC PLATFORM ROTATION	REF
2	81369	. BASE-PLATFORM ROTATOR	1
3	210210	. GASKET-ACTIVATOR	1
4	210211	. TUBE ASSEMBLY	2
5	4021	. TOGGLE SWITCH	1
6	20884	. SWITCH GUARD	1
7	81351	. PLATFORM ROTATION MANIFOLD	1
8	81352	. HYDRAULIC ROTARY ACTUATOR	1
-9	600230	. SEAL KIT (see)	1
10	30884	. FLOW CONTROL VALVE	2
11	2568	. PARAFLEX HOSE	100
12	160309	. ROLL PIN	2
13	60329	. CAP SCREW	4
14	60307	. CAP SCREW	4
15	60549	. CAP SCREW	4
16	63302	. LOCK WASHER	4
17	63319	. LOCK WASHER	4
18	63415	. FLAT WASHER	4
19	61305	. LOCK NUT	4
20	2594	. SWIVEL ELBOW	2
21	80012-03	. STRAIGHT THREAD ELBOW	2
22	81078	. STRAIGHT THREAD CONNECTOR	6
23	2562	. SWIVEL FITTING	2

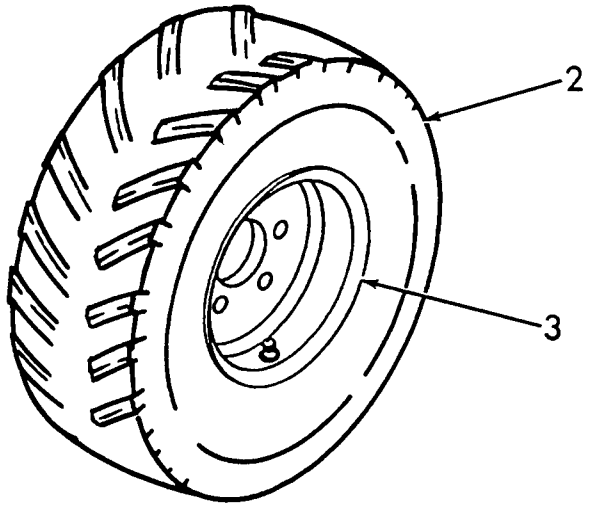
REV.

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

Mark Industries

TITLE	SAND TIRES
MODEL	40 4X4
NOTES	

SECTION	6
FIGURE	4
PAGE	1



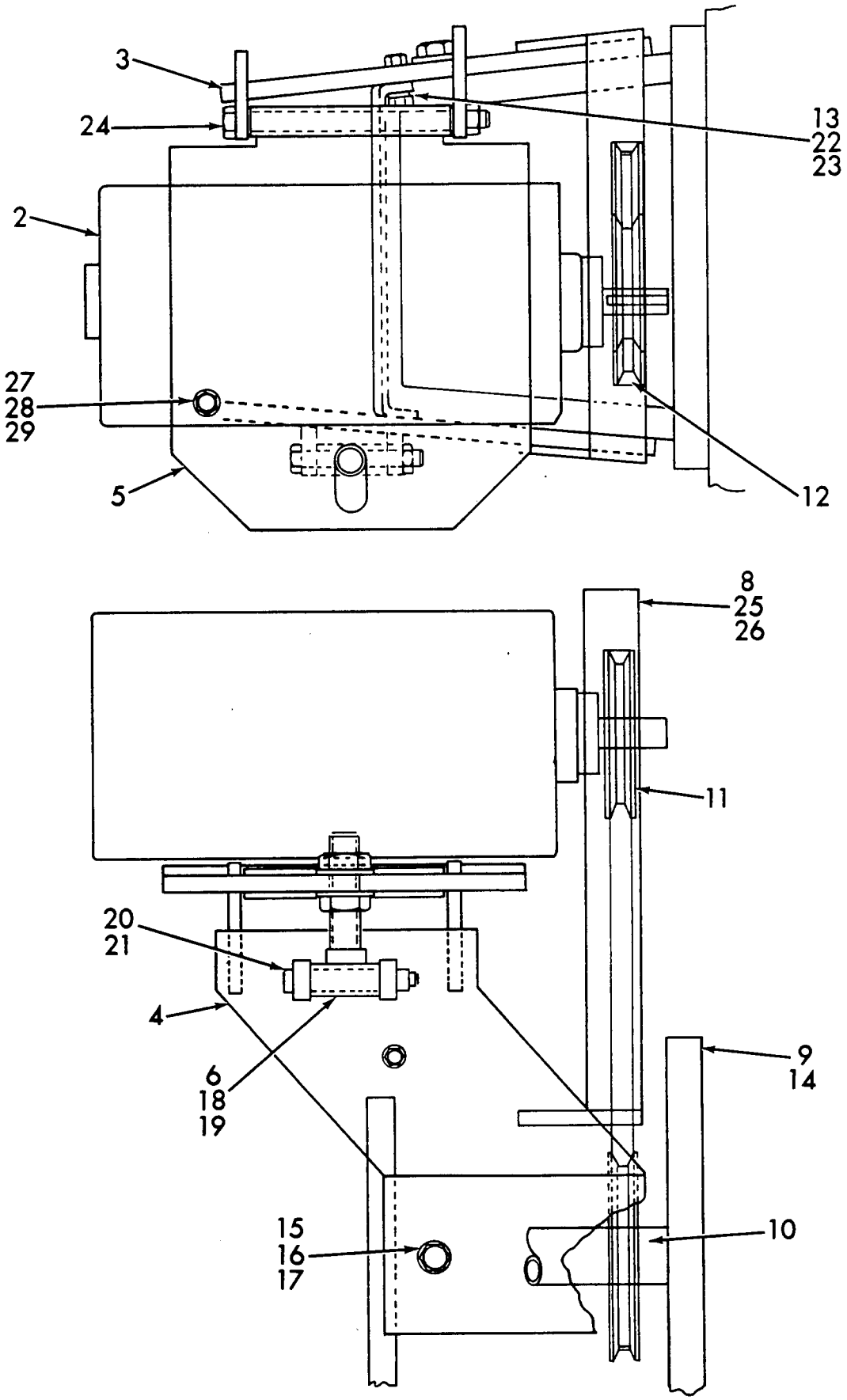
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	200026	SAND TIRES	REF
2	210172	. TIRE	1
3	24682	. WHEEL	1

REV.

Mark Industries

TITLE	2K WATT GENERATOR
MODEL	40 4X4
NOTES	

SECTION	6
FIGURE	5
PAGE	1



REV.

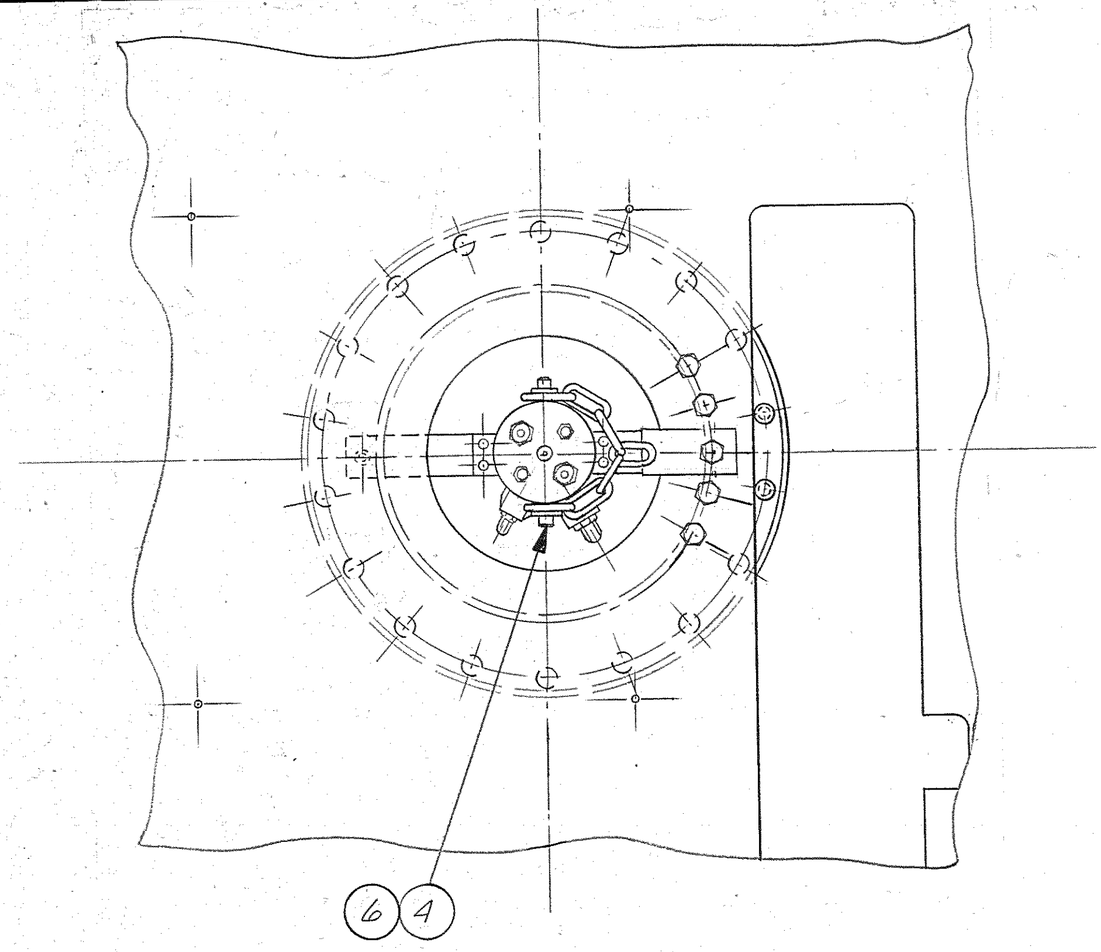
Mark Industries

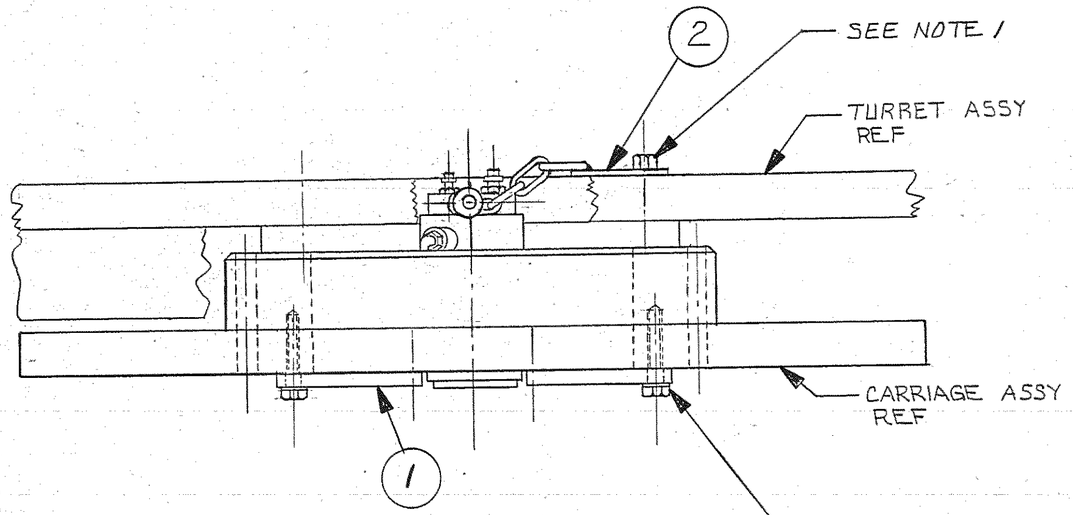
TITLE	2KW GENERATOR	SECT.	6
MODEL	40 4X4	FIG.	5
NOTES		PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	23499	2KW GENERATOR	REF
2	4071	. 2000 WATT GENERATOR	1
3	210115	. HINGE SIDE WELDMENT	1
4	210116	. ADJUSTMENT SIDE WELDMENT	1
5	210117	. GENERATOR MOUNT PLATE	1
6	210118	. GENERATOR MOUNT WELDMENT	1
-7	62222	.. SET SCREW	1
8	210119	. BELT GUARD	1
9	210124	. MACHINING REWORK	1
10	160280	. PULLEY WITH TAPER LOCK BUSHING	1
11	160281	. PULLEY WITH TAPER LOCK BUSHING	1
12	160284	. V-BELT	1
13	210125	. GENERATOR MOUNT STRAP	1
14	60616	. CAP SCREW	4
15	60357	. CAP SCREW	4
16	63415	. FLAT WASHER	5
17	60705	. HEX NUT	5
18	60707	. HEX NUT	1
19	60910	. JAM NUT	1
20	60344	. CAP SCREW	1
21	60703	. HEX NUT	1
22	60541	. CAP SCREW	4
23	63428	. FLAT WASHER	4
24	160287	. CAP SCREW	1
25	60312	. CAP SCREW	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	63401	. FLAT WASHER	4
27	60702	. HEX NUT	4
28	60338	. CAP SCREW	4
29	63402	. FLAT WASHER	4

REVISIONS–SEE E.O.		
REV	BY	DATE
A	RICHARD D	2-28-90





NOTES:

1. REMOVE ONE BOLT AND REASSEMBLE WITH MANIFOLD BRACKET AS SHOWN. TORQUE TO 175 FT/LBS.

ITEM NO.	QTY. REQ'D	UNIT OF MEASURE	PART OR IDENTIFYING NO.	DESCRIPTION	DATA: SPECIFICATIONS SIZES, NOTES, SUPPLIERS.
6	2	EA	63403	WASHER,	3/8 FLAT
5	2	EA	63327	WASHER, LOCK	1/2 SPLIT GR.8
4	2	EA	60325	SCREW, CAP	3/8-16 UNC X 3/4 LG
3	2	EA	60529	SCREW, CAP	1/2-13 UNC X 1.50 LG GR.8
2	1	EA	23791	WELDMENT, MANIFOLD CHAIN	
1	1	EA	23797	ASSY, ROTARY MAN.	

BILL OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES ON:
ANGLES ± ½° FRACTIONS ± 1/16 DECIMAL
BREAK ALL SHARP EDGES .010 MAX X 45° .XX=± .03 .XXX=± .005

DR. BY T. J. Bigelow 11-20 89
CHK BY G. REYES 11-27 89
APP'D

THIS DRAWING EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN ORIGINATED BY MARK INDUSTRIES, AND ALL DESIGN, MANUFACTURING, REPRODUCTION, USE, AND SCALE RIGHTS REGARDING THE SAME ARE EXPRESSLY RESERVED. IT IS SUBMITTED UNDER A CONFIDENTIAL RELATIONSHIP FOR A SPECIFIED PURPOSE, AND THE RECIPIENT AGREES BY ACCEPTING THIS DRAWING NOT TO SUPPLY OR DISCLOSE ANY INFORMATION REGARDING IT TO ANY UNAUTHORIZED PERSON, OR TO INCORPORATE IN OTHER PROJECTS ANY SPECIAL FEATURES PECULIAR TO THIS DESIGN. ALL PATENT RIGHTS HERETO ARE EXPRESSLY RESERVED BY MARK INDUSTRIES.

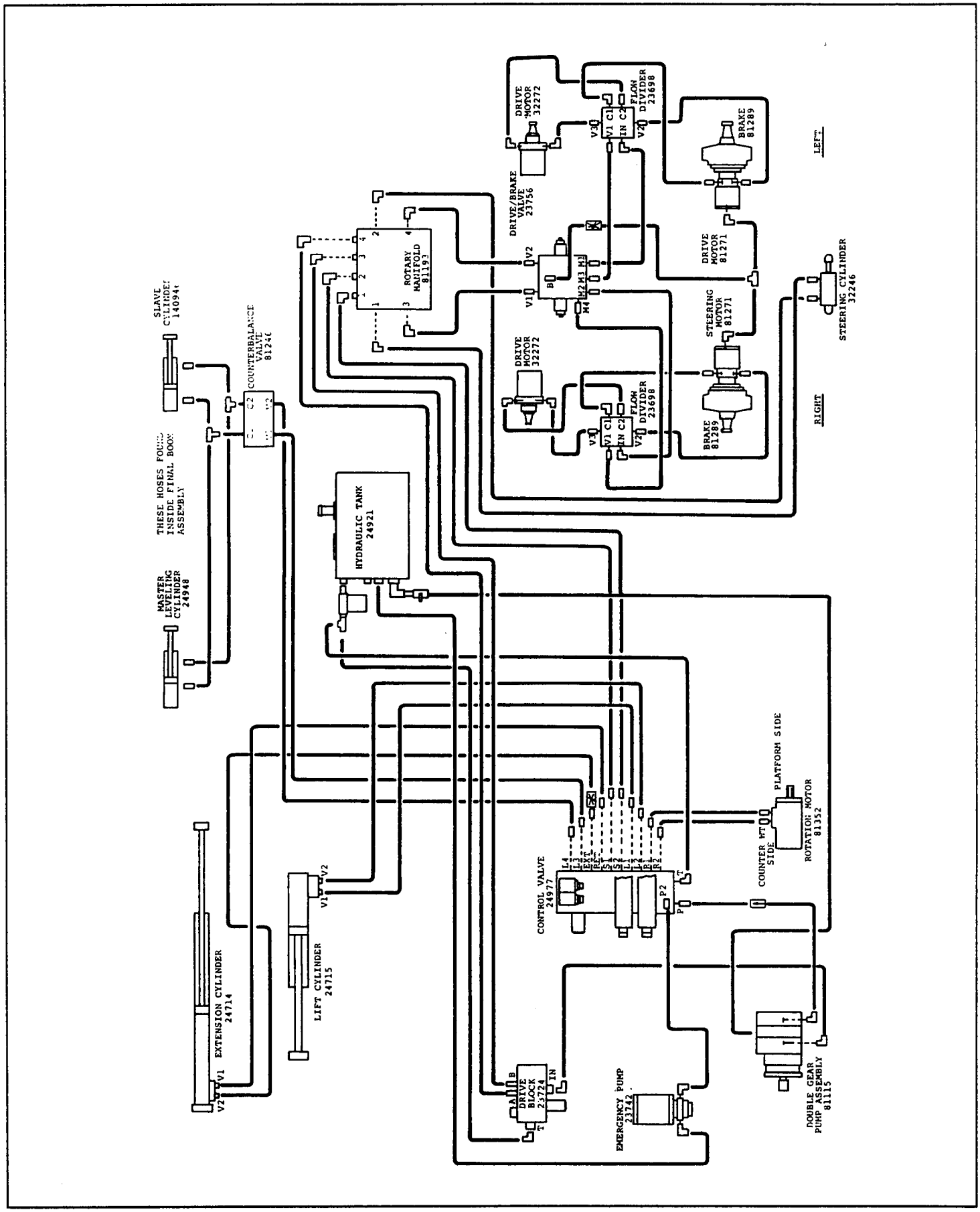
MARK INDUSTRIES
205 S. PUENTE ST., BREA, CALIFORNIA 92621

OPTION- CONTINUOUS TURRET ROTATION
MARKLIFT 40 4X4

CODE IDENT NO.	SIZE	DWG. NO.	REV.
131-011	C	MK23487	A

SCALE 1/4 WEIGHT SHEET 1 OF 1

CONSOLIDATED REPROGRAPHIC 132134


DRIVE MOTOR 32272
FLOW DIVIDER 23698
BRAKE 81289
LEFT
DRIVE/BRAKE VALVE 23756
ROTARY MANIFOLD 81193
DRIVE MOTOR 81271
STEERING MOTOR 81271
STEERING CYLINDER 32246
SLAVE CYLINDER 140944
COUNTERBALANCE VALVE 81244
THESE HOSES FOUND INSIDE FINAL BOOM ASSEMBLY
MASTER LEVELING CYLINDER 24948
HYDRAULIC TANK 24921
RIGHT
PLATFORM SIDE
COUNTER WT SIDE
ROTATION MOTOR 81352
CONTROL VALVE 24977
EXTENSION CYLINDER 24714
LIFT CYLINDER 24715
DRIVE BLOCK 23724
EMERGENCY PUMP 23742
DOUBLE GEAR PUMP ASSEMBLY 81115

REV.

Mark Industries

TITLE	CONTINUOUS TURRET ROTATION
MODEL	40 4X4
NOTES	

SECT.	6
FIG.	6
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	23487	CONTINUOUS TURRET ROTATION	REF
-2	23797	. ROTARY MANIFOLD ASSEMBLY	1
-3	81193	.. ROTARY 4 PORT MANIFOLD	1
-4	600228	... SEAL KIT	1
-5	80012-15	.. STRAIGHT THREAD ELBOW	2
-6	80012-05	.. STRAIGHT THREAD ELBOW	2
-7	80004-15	.. STRAIGHT THREAD CONNECTOR	2
-8	80004-05	.. STRAIGHT THREAD CONNECTOR	2
-9	23791	. MANIFOLD CHAIN WELDMENT	1
-10	60417	. CAP SCREW	2
-11	60325	. CAP SCREW	2
-12	63305	. LOCK WASHER	2
-13	63403	. FLAT WASHER	2
-14	210078	HYDRAULIC HOSE DIAGRAM	REF

Mark Industries

TITLE	VENDOR CHAPTER
MODEL	40 4x4
NOTES	

VENDOR CHAPTER CONTAINS:

SECTION	TITLE
1	DRIVE MOTOR P/N 30243
2	ROTATION GEARBOX MOTOR P/N 81278 & P/N 81345
3	BATTERY P/N 4030
4	WISCONSIN ENGINE P/N 24812
5	DEUTZ ENGINE P/N 24704
6	BRAKE P/N 81348

KHD DEUTZ SERVICE

Torqmotor™



MICO INCORPORATED
MICO WEST / SY-TEC

REV.

Torqmotor™

Service Procedure

MAB and MAE Series

REV.

Table of Contents

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Trouble Shooting Guide	3
Exploded Assembly View	4
Trouble Shooting Checklist	5
Seal Installation Tools	6
Disassembly & Inspection	7
Assembly	9
Final Checks	11
Hydraulic Fluids	11
Filtration, Operating Temperature	11
Tips for Maintaining the System	12

Troubleshooting Guide

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

Preparation

Make your troubleshooting easier by preparing as follows:

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

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

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

Preliminary Checks

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

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

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

Hydraulic Components

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

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

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

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

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

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

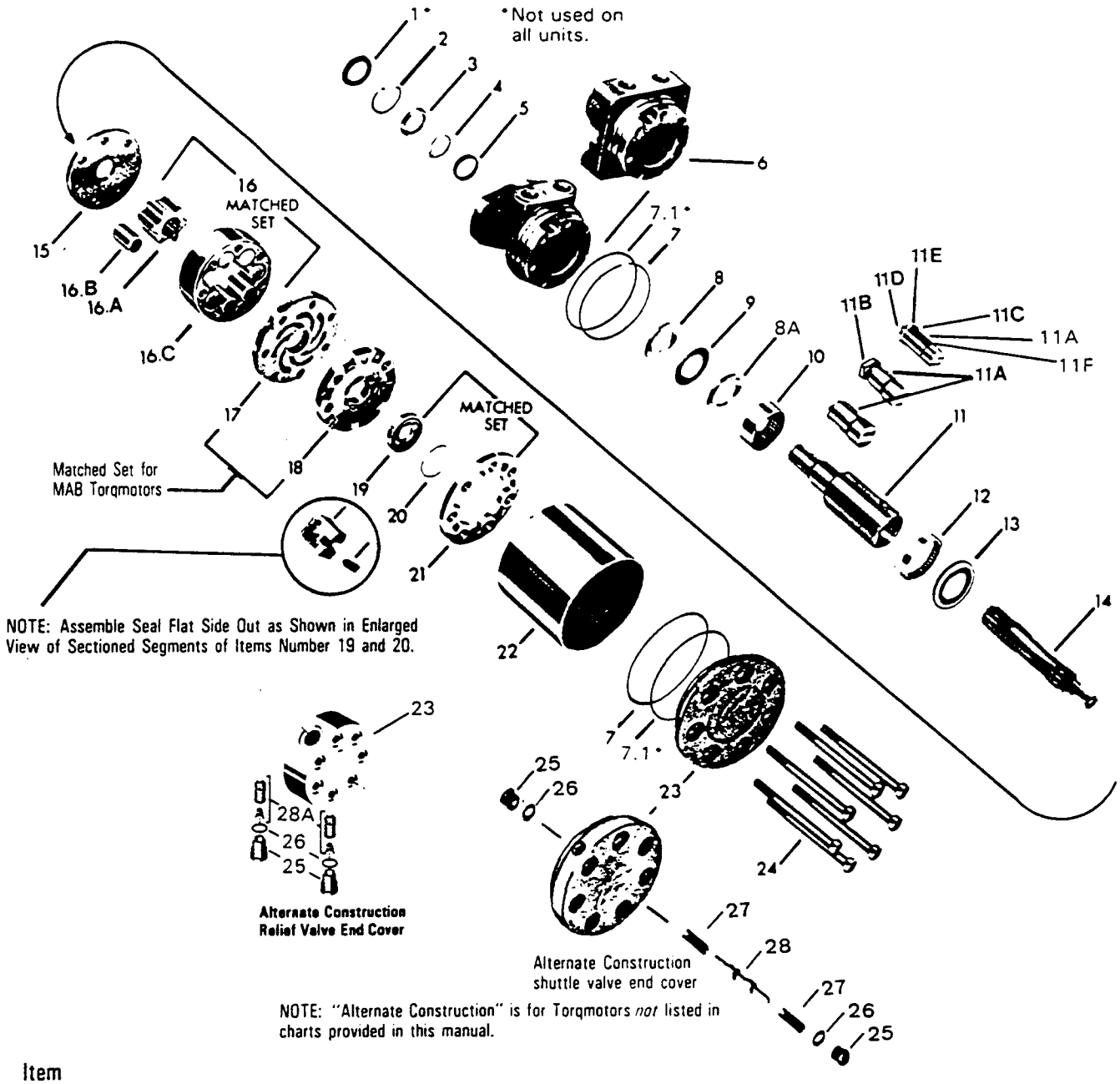
A normal temperature range means an efficient hydraulic system. Consult the manuals published by equipment and/or component manufacturers for maximum allowable temperatures and hydraulic tests that may be necessary to run on the performance of the hydraulic components. The MAB and MAE are not recommended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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY	SECT.	4
MODEL	40 4X4 (DEUTZ & WISC.)	FIG.	9
NOTES		PAGE	4

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
23	80063-10	. FEMALE PIPE ADAPTER	3
24	2527	. QUICK DISCONNECT COUPLING	1
25	845	. QUICK DISCONNECT CAP	1
26	80052-04	. PIPE NIPPLE	1

MAB/MAE Torqmotor™ Exploded Assembly View—Typical



Item No.

*1.	Seal	9.	Thrust Bearing	13.	Thrust Bearing	20.	Seal Ring
2.	Retaining Ring	10.	Bearing	14.	Drive Link	21.	Commutator Ring
3.	Back-Up Washer	11.	Coupling Shaft	15.	Wear Plate	22.	Sleeve
4.	Washer	11A.	Key	16.	Rotor Set	23.	End Cover Assembly
5.	Seal	11B.	Nut	16A.	Rotor	24.	Special Bolt (7)
6.	Housing	11C.	Washer	16B.	Vane (7)	25.	Plug
7.	Seal Ring (2)	11D.	Bolt	16C.	Stator	26.	O-Ring
*7.1	Back Up Ring (2)	11E.	Lock Washer	17.	Manifold Plate	27.	Spring (2)
8.	Thrust Washer	11F.	Retaining Ring	18.	Manifold	28.	Valve (Shuttle)
8A.	Thrust Washer	12.	Bearing	19.	Commutator	28A.	Relief Valve (2) (Two piece)

Troubleshooting Checklist

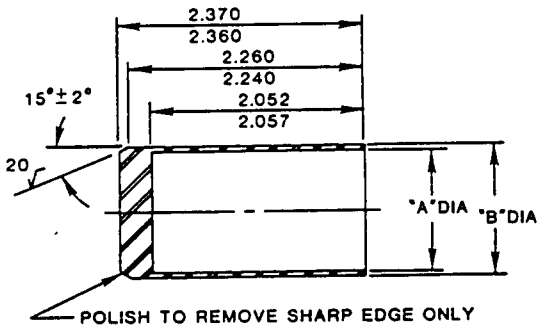
Trouble	Cause	Remedy
Oil Leakage	1. Hose fittings loose, worn or damaged	Check & replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings (7) deteriorated by excess heat	Replace oil seal rings by disassembling Torqmotor™ unit.
	3. Special bolt (24) loose or its sealing area deteriorated by corrosion	(a) Loosen then tighten single bolt to 45-55 ft.lbs. (60-76 N m)
		(b) Replace bolt.
	4. Internal shaft seal (5) worn or damaged	Replace seal. Disassembly of Torqmotor™ unit not necessary.
	5. Worn coupling shaft (11) and internal seal (5)	Replace coupling shaft and seal by disassembling Torqmotor™ unit.
Significant loss of speed under load	1. Lack of sufficient oil supply	(a) Check for faulty relief valve and adjust or replace as required.
		(b) Check for and repair worn pump.
		(c) Check for and use correct oil for temperature of operation.
	2. High internal motor leakage	(a) Replace worn rotor set by disassembling Torqmotor™ unit.
	3. Severely worn or damaged internal splines	Replace rotor set, drive link and coupling shaft by disassembling Torqmotor™ unit.
	4. Excessive heat	Locate excessive heat source (usually a restriction) in the system and correct the condition.
Low mechanical efficiency or undue high pressure required to operate Torqmotor™ unit	1. Line blockage	Locate blockage source and repair or replace.
	2. Internal interference	Disassemble Torqmotor™ unit, identify and remedy cause and repair, replacing parts as necessary.
	3. Lack of pumping pressure	Check for and repair worn pump.
	4. Excessive binding or loading in system external to MAB/MAE unit.	Locate source and eliminate cause.

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

Patents

Ross Gear Division products and systems described in this manual are protected by one or more of the following United States patents: 3,289,602; 3,288,034; 3,452,680 and 3,606,601. In addition, patent applications have been filed in Brazil, Canada, Denmark, France, Italy, Japan, Sweden, the United Kingdom, and West Germany.

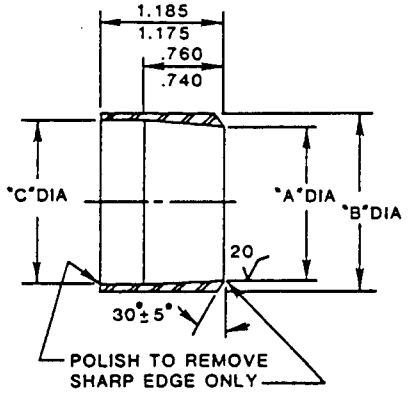
Seal Installation Tools



Dimensions Shown in Inches

Tool No.	Shaft Seal Dia.	Dim. "A"	Dim. "B"
J26751	1¼	1.252/1.258	1.290/1.280
J33074-1	1½	1.502/1.508	1.540/1.530

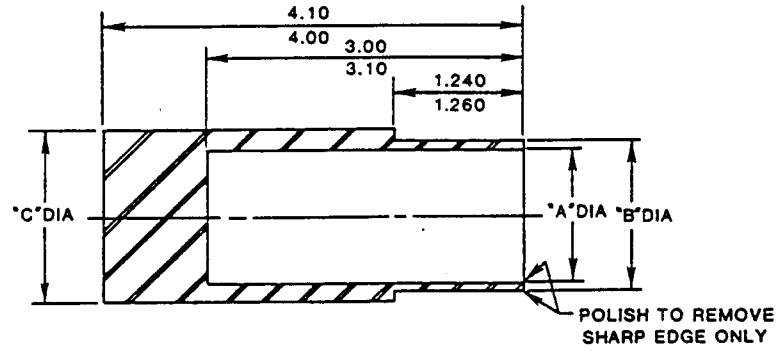
Seal Thimble
Figure 1.



Dimensions Shown in Inches

Tool No.	Shaft Seal Dia.	Dim. "A"	Dim. "B"	Dim. "C"
J26753	1¼	1.502/1.504	1.735/1.715	1.590/1.610
J33074-3	1½	1.751/1.753	1.985/1.965	1.840/1.860

Seal Compression Ring
Figure 3.



Dimensions Shown in Inches

Tool No.	Shaft Seal Dia.	Dim. "A"	Dim. "B"	Dim. "C"
J26752	1¼	1.300/1.350	1.500/1.498	1.800/1.600
J33074-2	1½	1.550/1.600	1.747/1.745	2.400/2.200

Seal Driver
Figure 2.

CONVERSIONS

Inches	mm	Inches	mm
.740	18.80	1.610	40.89
.760	19.30	1.715	43.55
1.175	29.85	1.735	44.07
1.185	30.10	1.745	44.32
1.240	31.50	1.747	44.37
1.252	31.80	1.751	44.48
1.258	31.95	1.753	44.53
1.260	32.00	1.800	45.72
1.280	32.51	1.840	46.74
1.290	32.77	1.860	47.24
1.300	33.02	2.052	52.12
1.350	34.29	2.057	52.25
1.498	38.05	2.200	55.88
1.500	38.10	2.240	56.90
1.502	38.15	2.260	57.40
1.504	38.20	2.360	59.94
1.508	38.30	2.370	60.20
1.530	38.87	2.400	60.96
1.540	39.12	3.00	76.2
1.550	39.37	3.10	78.7
1.590	40.39	4.00	101.6
1.600	40.46	4.10	104.1

NOTE: Tool Kit J26905 for 1¼ inch (32 mm) seal diameter coupling shaft includes tools J26751, J26752 and J26753.

Tool Kit J33074 for 1½ inch (38 mm) seal diameter coupling shaft includes tools J33074-1, J33074-2 and J33074-3.

Tool Kits available from: Kent-Moore, 29784 Little Mack, Roseville, Michigan 46066, Phone (313) 774-9500.

Disassembly and Inspection Procedures

PREPARATION BEFORE DISASSEMBLY

Before disconnecting hoses, thoroughly clean off all outside dirt around fittings. (After disconnecting hoses and before removing from vehicle, IMMEDIATELY plug portholes.) Drain fluid and finish cleaning and drying assembly before placing on a clean work surface. (A piece of clean paper makes an excellent disposable top.) All disassembled parts should be cleaned separately in clean petroleum-based solvent and blown dry with air to avoid nicks and burrs. Discard all seal and seal rings as they are removed from Torqmotor. Use Ross Gear Division or OEM approved service parts.

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

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

CAUTION: Never steam or high pressure wash hydraulic components. Do not force or abuse closely fitted parts.

REPLACEMENT OF HIGH PRESSURE SEAL (5) WITHOUT COMPLETE TORQMOTOR™ DISASSEMBLY

(Reference Exploded Assembly View)

1. Remove and discard dirt seal (1) and retaining ring (2) from Torqmotor. (Some applications may not require dirt seal (1).)
2. Completely fill Torqmotor with oil. Plug "A" and "B" ports and set Torqmotor in a clean pan. Place a clean rag around the coupling shaft seal area of the housing to prevent oil spray. Carefully grip coupling shaft with appropriate wrench and rotate coupling shaft rapidly in a counter-clockwise direction. Oil pressure generated by Torqmotor will eject backup washer (3), washer (4) and seal (5).
3. Select the proper seal assembly tools for the 1¼ inch (31.8 mm) or 1½ inch (38.1 mm) seal diameter coupling shaft involved. See Figures 1, 2 and 3, page 2.

   Insert the selected seal compression ring tool (Figure 3), with chamfered end inward, into housing (6) until it bottoms out. Assemble the selected seal thimble tool (Figure 1) over coupling shaft (11). Coat new seal (5) with clean grease and assemble over seal thimble with lip side inward. Push new seal (5) into housing (6) with the appropriate seal driver tool (Figure 2). Remove seal driver, thimble and compression tools.
4. Hold washer (4) between thumb and index finger and slightly collapse washer and assemble into housing (6). Assemble back-up washer (3) tab side out, and retaining ring (2). Be sure rounded edge of retaining ring is faced inward, and that back-up washer tab is between ends of retaining ring. Be sure the new retaining ring (2) is the same thickness as the one removed. (Seal kit contains two retaining rings to select from.) Apply a small amount of clean grease to the back side of new seal (1) and assemble into housing (6) if required.

TORQMOTOR DISASSEMBLY

(Reference Exploded Assembly View)

1. Place Torqmotor in a vise, clamping down on the housing (6) port bosses with the coupling shaft (11) pointed down.

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

2. If the end cover assembly (23) has a shuttle valve (28), scribe a line on housing (6) in some manner in line with the port in the end cover for reassembly orientation. Loosen the two plugs (25) with a 3/16 or 3/8 inch Allen wrench, for later disassembly. Remove the seven special bolts (24) using a 9/16 inch thin wall socket. Inspect bolts for damaged threads, or the sealing ring under the bolt head. Replace damaged bolts.
3. Remove end cover assembly (23) and seal ring (7) and back up ring (7.1) if included by inserting screwdriver between end cover assembly and sleeve (22). Pry up end cover assembly and lift from unit with rings attached. Discard seal ring and back up ring. It may be necessary to use a chisel and hammer to break the end cover loose.
4. If the end cover (23) has shuttle valve (28) or relief valve (28A) and the previously loosened plugs (25), remove the two plugs and o-rings (26).

   CAUTION: Be ready to catch two springs (27) and shuttle valve (28) or relief valve (28A) that will fall out of the end cover valve cavity when the plug assemblies are removed.

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

   NOTE: O-ring (26) is not included in seal kits but is serviced separately if required.
5. Remove commutator ring (21), commutator (19), seal ring (20), and manifold (18) by using two of the special bolts (24) as a lifting tool—insert the two special bolts into two holes and lift out the previously mentioned parts.
6. Remove seal ring (20) from commutator (19), using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator and commutator ring (21) for cracks or burrs. Inspect commutator for wear, scoring, spalling or brinelling. If

any of these conditions exist, replace commutator and commutator ring as a matched set.

7. Remove manifold plate (17) by again using two special bolts (24) as a lifting tool. Inspect manifold (18) and manifold plate (17) for cracks, surface scoring, brinelling or spalling. Replace manifold or manifold plate that exhibits any of these conditions. A polished pattern on the ground surfaces from commutator or rotor rotation is normal.

8. Remove rotor set (16) and wear plate (15), by again using the two bolts as a lifting tool. Retain rotor set in its assembled form, if possible, to maintain the same rotor vane to stator contact surfaces. Inspect the rotor set in its assembled form for nicks, scoring, or spalling, on any surface and broken or worn rotor splines. If any rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the wear plate for cracks, brinelling, or scoring.

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

10. Remove drive link (14) from coupling shaft (11) if it was not removed with rotor set and wear plate. Inspect drivelink for cracks and for worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts.

11. Remove thrust bearing (13) and inspect for wear, brinelling, corrosion, and a full complement of retained rollers.

12. Remove coupling shaft (11) by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Replace coupling shaft if any of these conditions exist.

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

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

13. Remove sleeve (22) by inserting screwdriver between sleeve and housing (6) and pry up. Inspect sleeve for deformation from the original cylindrical shape to a "barrel" or "hour glass" shape. Inspect sleeve ends for severe nicks, burrs or corrosion. Replace sleeve if any of these conditions exist.

    NOTE: Minor burrs and corrision that would damage new seal rings during assembly can be removed from sleeve ends.

14. Remove seal ring (7) and back up ring (7.1) if included from housing (6) and discard seal and back up ring.

15. Remove housing (6) from vise, turn over and reclamp in vise with dirt seal (1) end pointed up.

16. Remove dirt seal (1), retaining ring (2), back-up washer (3), washer (4), and seal (5) from housing (6). Discard seals and washers but keep retaining ring (2) for comparison when selecting new retaining ring from seal kit. If burr exists on retaining ring groove, remove with a scraping tool.

17. Inspect housing (6) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly and the disassembly of the Torqmotor is complete.

18. If the housing assembly (6) has passed inspection to this point, inspect the bearings (9), (10), (12) and thrust washers (8) and (8A). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and the thrust washers must be free of brinelling and corrosion. If the housing has passed this inspection the disassembly of the Torqmotor is completed.

19. If only the outer bearing (12) requires replacement, carefully use a suitable bearing puller to remove bearing so the housing is not damaged.

20. If bearing (10) requires replacement, use a 1.488 inch (37.80mm) maximum diameter shaft or a 1.745 inch (44.32 mm) maximum diameter shaft based on the internal seal (5) bore diameter and press out thrust washers (8), (8A), thrust bearing (9), and bearings (10) and (12). The housing wearplate face should be placed on a block of wood during the pressing operation to protect it. Discard thrust washers (8) and (8A), thrust bearings (9), and bearings (10) and (12) and replace with new parts, as parts will have been damaged when being pressed out.

    NOTE: The depth or location of bearings (10) and (12) in relation to the housing wearplate face should be measured and noted before pressing the bearings out. This will facilitate the correct reassembly of new bearings.

The disassembly of Torqmotor is completed.

TORQMOTOR ASSEMBLY PROCEDURES

(Reference Exploded Assembly View)

Replace all seals and seal rings with new ones each time you reassemble the Torqmotor unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.

NOTE: Individual seals and seal rings as well as a complete seal kit are available. The parts should be available through most OEM parts distributors or Ross approved Torqmotor distributors. (Contact your local dealer for availability.)

NOTE: Unless otherwise indicated, do not oil or grease parts before assembly.

Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, sleeve, and housing and from port and sealing areas.

HOUSING BEARING REPLACEMENT PROCEDURES

1. If bearing components were removed for replacement, assemble new thrust washer (8), new thrust bearing (9) and new thrust washer (8A) in that order into housing (6) bearing cavity. If thrust washer (8A) has a chamfer on the inside diameter, the chamfered side must face away from thrust bearing (9).

   NOTE: Thrust washer (8A) will be identical to thrust washer (8) unless a chamfered inside diameter is required because of coupling shaft design.

   NOTE: An appropriate size piloted bearing mandrel is required to press in housing bearings.

2. If bearings (10) and (12) required are for a 2.25 inch (57.2 mm) diameter (nominal) housing bearing bore, press in new bearing (10) which is 1.0 inch (25.4 mm) long, into housing (6) bearing bore to a depth of 2.410 ± .010 inch (61.2 ± 0.254 mm), measured from the housing wear plate contact surface. Then, press in new bearing (12) which is .5 inch (12.7 mm) long into housing bearing bore to a depth of .115 ± .010 inch (2.92 ± 0.254 mm) measured from the housing wear plate contact surface.

   NOTE: Press against the lettered end of bearing cage when pressing in a roller bearing assembly.

3. If the bearings (10) and (12) required are for a 2.50 inch (63.5 mm) diameter (nominal) bearing bore, press in new bearing (10) which is 1.0 inch (25.4 mm) long into housing (6) bearing bore to a depth of 2.379 ± .010 inch (60.43 ± 0.254 mm) measured from housing wear plate contact surface. Press new bearing (12) which is identical to bearing (10) into housing bearing bore to a depth of .115 ± .010 inch (2.92 ± 0.254 mm) measured from the housing wear plate contact surface.

   NOTE: The bearings (10) and (12) must be assembled to the correct depths to assure the necessary clearance for thrust washer (8A) and thrust bearing (13) and to assure required bearing support.

TORQMOTOR ASSEMBLY

If the sealing diameter of the coupling shaft (11) is larger than any other diameter on the output end of the coupling shaft, begin the Torqmotor assembly procedures with Step 1 below. If there is a diameter on the output end of the coupling shaft equal to the sealing diameter of the coupling shaft begin the procedures with Step 6 below.

1. Place housing (6) in a vise and clamp down on housing port bosses with small bore end pointed up. Apply clean grease to new seal (5) and assemble into housing with seal lip pointed inward.
2. Hold washer (4) between thumb and index finger and slightly collapse to facilitate assembly into housing (6).
3. Assemble back-up washer (3) into housing (6) with the anti-rotation tab facing out.
4. Select a new retaining ring (2) from the seal kit, that is the same thickness as the retaining ring removed. Assemble the new retaining ring into housing (6). Be sure rounded edge of retaining ring is faced inward and that back-up washer tab is between ends of retaining ring.
5. Apply a small amount of clean grease to back side of new seal (1) and assemble into housing (6), if a seal (1) is required.
6. Invert housing (6) in vise so that the large bore end is up.
7. Apply cellophane tape around splines or keyway on coupling shaft (11) to prevent damaging seals.
8. Lubricate and assemble coupling shaft (11), firmly seating it against thrust washer (8A).
9. Assemble thrust bearing (13) onto end of coupling shaft (11).
10. Assemble drive link (14) into coupling shaft (11) with their splines in mesh. (Align hole in drive link with hole in coupling shaft (11), if applicable.)

NOTE: Two alignment studs screwed finger tight into housing (6) bolt holes, approximately 180° apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of 3/8-24 UNF 2A bolts that are over .5 inch (12.7 mm) longer than the bolts (24) used in the Torqmotor.

11. Assemble wear plate (15) over drive link (14) and studs onto housing (6).
12. Install assembled rotor set (16) with counterbore in rotor (16A) down, if applicable, and splines in mesh with drive link splines.

    NOTE: If necessary, go to "Rotor, Stator, Vane Assembly" procedures on page 9.

13. Assemble manifold plate (17), manifold (18) and then the commutator ring (21) over the drive link (14) onto rotor set (16) per the exploded assembly view. Be sure swirls in manifold and manifold plate are faced together.

14. Assemble a new seal ring (20), flat side up, into commutator (19) and assemble commutator over end of drive link (14) onto manifold (18) with seal side up.

15. Assembly new back up ring (7.1) if required and new seal ring (7) on housing (6), apply a generous amount of SAE 10W40 to both ends of sleeve (22) and assemble onto housing. Make sure sleeve is sitting in a non-cocked position.

16. Turn a plug (25) with a new O-ring (26) loosely onto each end of cover (23) valve cavity if shuttle valve (28) is required.

17. Then insert a spring (27), the valve (28) and another spring (27) into the other end of the valve cavity. Turn another plug (25) with new O-ring (26) loosely into cover valve cavity.

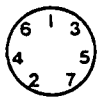
    If relief valve (28A) components were removed from the end cover, assemble new O-ring (26) onto the relief valve plugs (25). Assemble the two piece relief valve (28A) with large end of conical spring into the plug first and the small nut of the other valve piece in the small end of the conical spring. Turn these plug and relief valve assemblies into the end cover loosely to be torqued later.

18. Assemble a new back up ring (7.1) if required and a new seal ring (7) onto end cover and assemble end cover onto sleeve (22) in a non-cocked position.

    NOTE: If the end cover has a valve (28) or (28A) use the line you previously scribed on the housing (6) to radially align the end cover port into its original position.

19. Assemble seven special bolts (24) and screw in finger tight. Removal of the two alignment studs should be made after at least two bolts have been assembled. Alternately and progressively tighten the bolts to pull end cover assembly (23) and sleeve (22) into place with a final torque of 50 ± 5 ft.lbs. (68 ± 8 N m).

    Tightening sequence:



    NOTE: The special bolt (24) required for use with the shuttle valve (28) end cover assembly (23) is longer than the bolt required with the standard end cover assembly. Refer to the individual service parts list for correct service part number.

20. Torque the two shuttle plug valve assemblies (25) into a end cover assemble to 12-19 ft.lbs. (16-26 N m). Torque the relief valve plug assemblies (25) into an end cover assembly to 45-55 ft.lbs. (61-75 N m).

21. If seal (5), washer (4), back-up washer (3), snap ring (2) and seal (1) have not yet been assembled, invert housing in vise so the coupling shaft (11) is pointing up and follow procedures #3 and #4 under "Replacement of High Pressure Seal" on page 6 to assemble these components.

The assembly of Torqmotor is now complete except for woodruff key (11A), nut (11B), washer (11C), bolt (11D), lock washer (11E) or retaining ring (11F) if applicable at Torqmotor installation. See final checks. All ports should be plugged until Torqmotor is installed in system.

ROTOR, STATOR, VANE ASSEMBLY PROCEDURE

A disassembled rotor (16A), stator (16C) and vanes (16B) that cannot be readily assembled by hand can be assembled by the following procedures.

1. Place stator (16C) onto wear plate (15) after following Torqmotor assembly procedures 1 through 11.
2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate bolt holes and turn two bolts (24) finger tight into bolt holes 180° apart to retain stator and wear plate stationary.
3. Assemble six vanes (16B) into the stator vane pockets.
4. Assemble rotor (16A), counterbore down, if applicable, into stator (16C) and onto wear plate (15) with rotor splines in mesh with drive link splines.
5. Grasp the output end of coupling shaft (11) with locking pliers or other appropriate turning devices and rotate coupling shaft, drive link and rotor to seat the rotor and assembled vanes into stator, creating necessary clearance to assemble seventh vane. Assemble the seven vanes using minimum force.
6. Remove the two assembled bolts if used to retain stator and wear plate.

Final Checks

Final Checks

- Pressurize the Torqmotor™ with 100 p.s.i. (6.9 BAR) dry nitrogen and submerge in solvent to check for external leaks.
- Check Torqmotor™ for rotation. Torque required to rotate coupling shaft should not be more than 50 ft.lbs. (68 N m)
- Pressure port with "A" cast under it on housing (6) is for counter-clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "B" cast under it is for clockwise coupling shaft rotation.
- Use test stand if available, to check operation of the Torqmotor™.

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

- 10W40 SE or SF manufacturers suggested oil.
- Hydraulic fluid as recommended by equipment manufacturer, but the viscosity should not drop below 50 SSU or contain less than .125% zinc anti-wear additives.

CAUTION: Do not mix oil types. Any mixture, or an unapproved oil, could deteriorate the seals. Maintain the proper fluid level in the reservoir. When changing fluid, completely drain old oil from the system. It is suggested also that you flush the system with clean oil.

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

Maximum operating temperature 200°F (93.3°C).

Tips for Maintaining the Torqmotor™ Hydraulic System

- Adjust fluid level in reservoir as necessary.
- Encourage all operators to report any malfunction or accident that may have damaged the hydraulic system or component.
- Do not attempt to weld any broken Torqmotor™ component. Replace the component with original equipment only.
- Do not cold straighten, hot straighten, or bend any Torqmotor™ part.
- Prevent dirt or other foreign matter from entering the hydraulic system. Clean the area around and the filler caps before checking oil level.
- Investigate and correct any external leak in the hydraulic system, no matter how minor the leak.
- Comply with manufacturer's specifications for cleaning or replacing the filter.

CAUTION: Do not weld, braze, solder or any way alter any Torqmotor™ component.

CAUTION: Maximum operating pressure must not exceed recommended Torqmotor™ pressure capacity.

CAUTION: Always carefully inspect any system component that may have been struck or damaged during operation or in an accident. Replace any component that is damaged or that is questionable.

CAUTION: Do not force any coupling onto the Torqmotor™ coupling shaft as this could damage the unit internally.

Ross Gear extends close technical cooperation and assistance. If problems occur which you cannot solve, please contact our Ross Service Department or local Ross approved Distributor. Our phone number and telex number and address are on the back cover of this manual.

Disclaimer

This Service Manual has been prepared by TRW Ross Gear Division for reference and use by mechanics who have been trained to repair and service hydraulic motors and systems on commercial and non-commercial equipment applications. TRW Ross Gear Division has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the techniques and tools required for maintaining, repairing and servicing the complete line of TRW Ross Gear MAB & MAE Torqmotor Units. However, despite the care and effort taken in preparing this general Service Manual, TRW **makes no warranties** that (a) the Service Manual or any explanations, illustrations, information, techniques or tools described herein are either accurate, complete or correct as applied to a specific Torqmotor unit, or (b) any repairs or service of a particular Torqmotor unit will result in a properly functioning Torqmotor unit.

If inspection or testing reveals evidence of abnormal wear or damage to the Torqmotor unit or if you encounter circumstances not covered in the Manual, STOP – CONSULT THE EQUIPMENT MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE A TORQMOTOR UNIT WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL TRW REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO TRW'S SPECIFICATIONS FOR THE TORQMOTOR UNIT.

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular Torqmotor unit to (a) inspect the unit for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the equipment, or the safe operation of the Torqmotor, and (c) fully inspect and test the Torqmotor unit and the hydraulic system to insure that the repair or service of the Torqmotor unit has been properly performed and that the Torqmotor and hydraulic system will function properly.

Mark Industries

TITLE	ROTATION GEARBOX MOTOR
MODEL	40 4X4
NOTES	P/N 81278 AND P/N 81345

VENDOR	
SECTION	2
PAGE	1

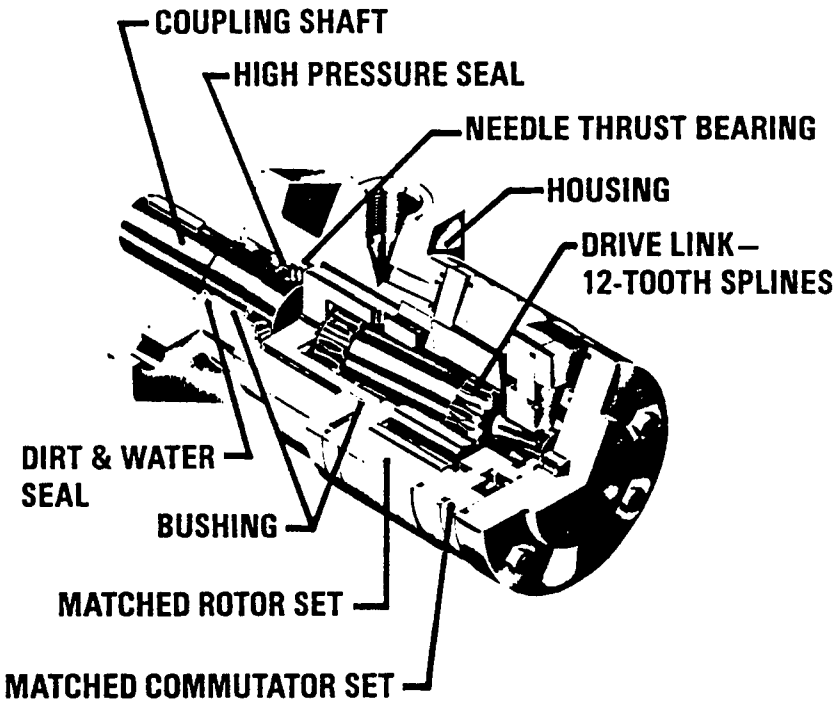
Torqmotor™

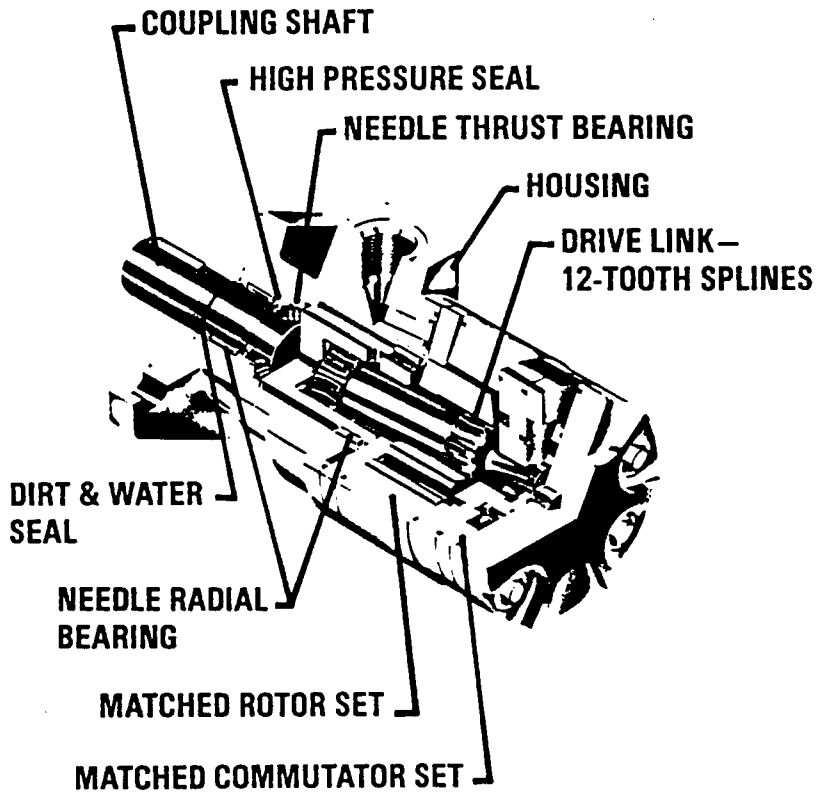
Service Procedure

MG, MF, MB, ME Series

REV.

Torqmotor™ Design Features





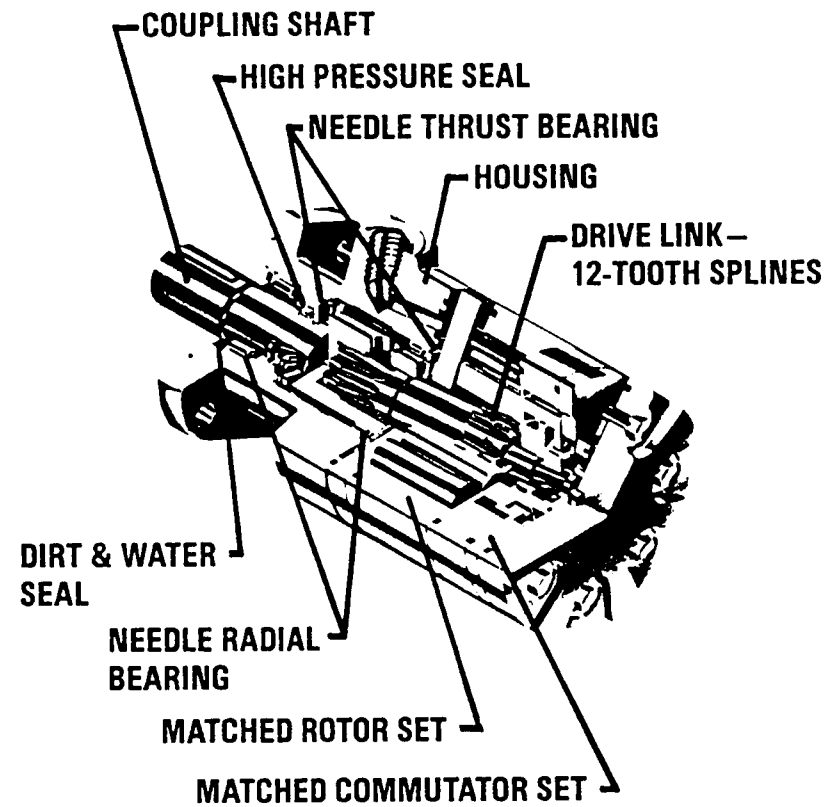
Torqmotor™ MG Series features include:

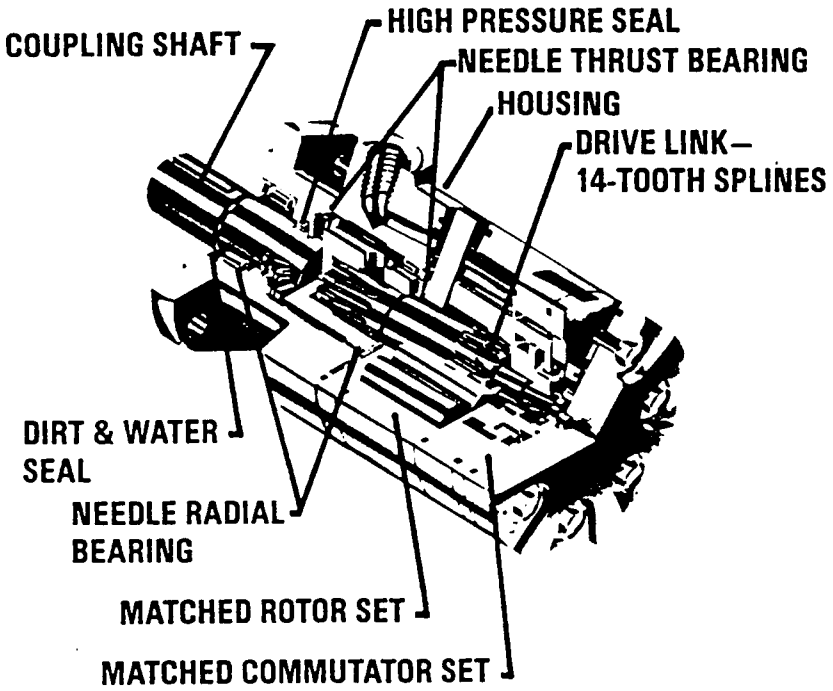
- The roller vane rotor set design offers a low-friction, wear compensation which maximizes the useful performance life of the motor.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.
- Design flexibility - MG offers the widest selection of shaft options, displacements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

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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.

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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.

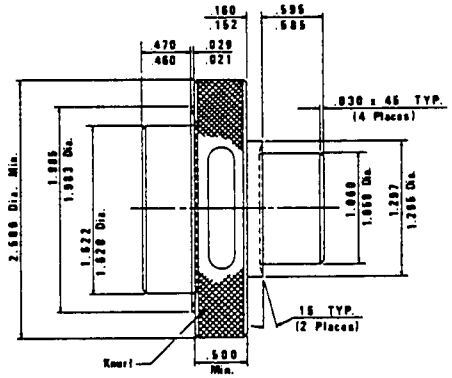
Clean corrosion resistant grease. Recommended grease is E/M Lubricant #K-70M, Ross Gear Specification #045236

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

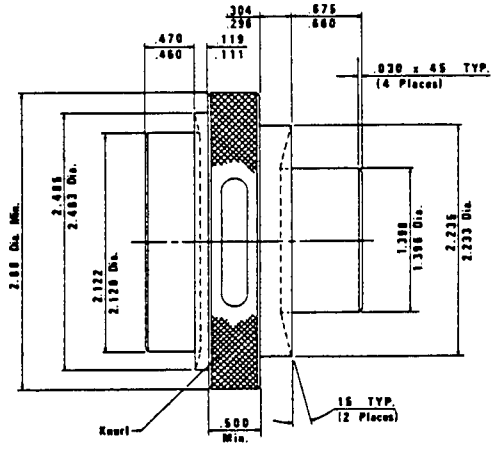
CAUTION: Mixing greases that have different bases can be detrimental to bearing life.

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

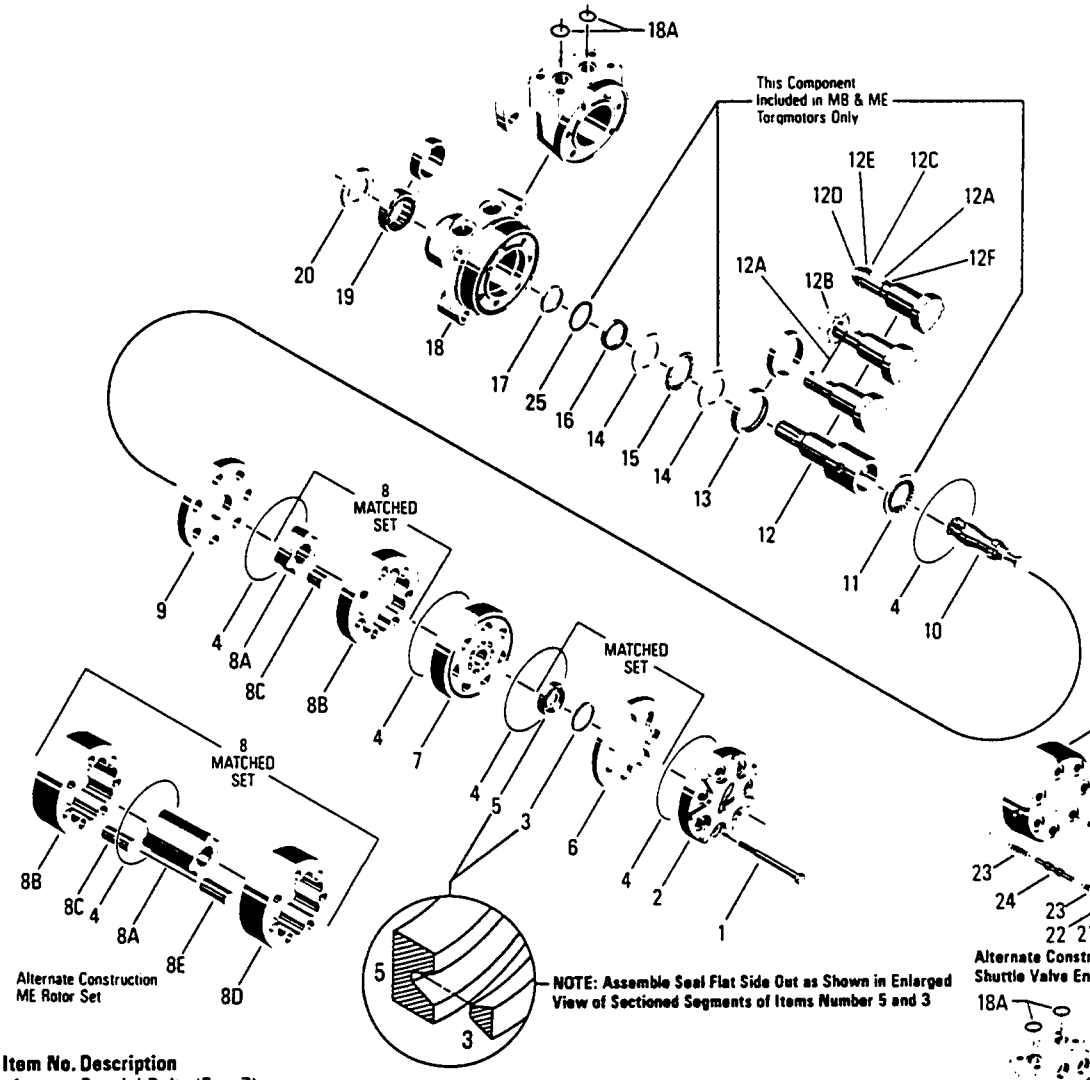


(Fabricate if considered necessary)
FIGURE 2—MB & ME

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.

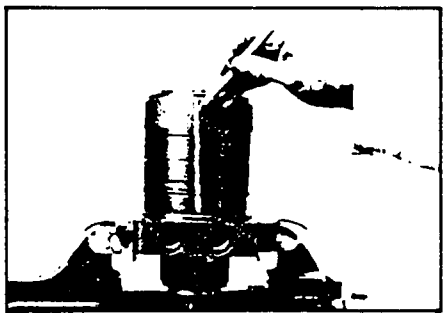


Figure 3

WARNING

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

scribe alignment mark & loosen valve plugs

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

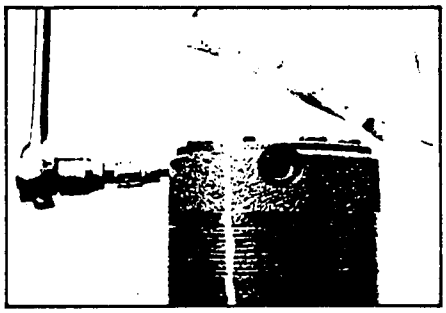


Figure 4

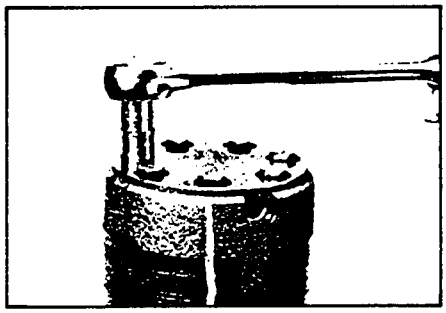


Figure 5

remove special bolts & inspect bolts

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

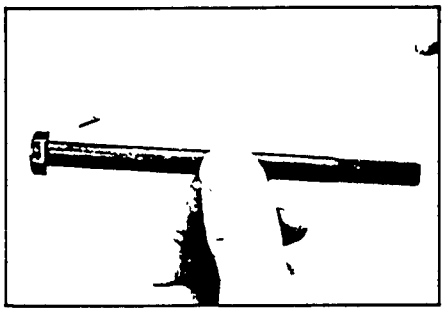


Figure 6

remove end cover & inspect bolts

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

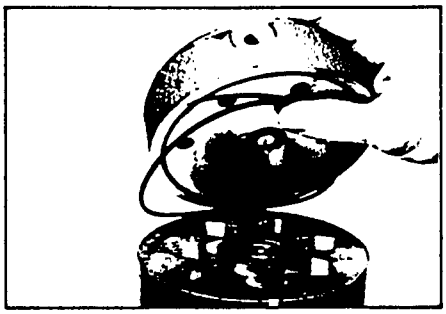


Figure 7

NOTE

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

remove plugs and valves

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



Figure 8

CAUTION

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

NOTE

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

NOTE

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

wash & inspect end cover

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

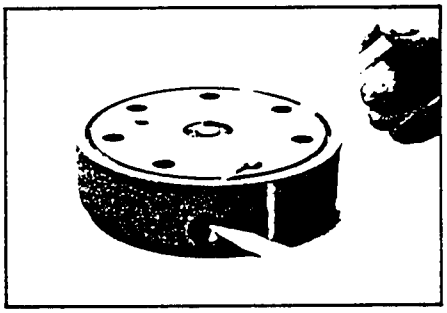


Figure 9

NOTE

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



Figure 10

remove & inspect commutator ring

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

remove & inspect commutator

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

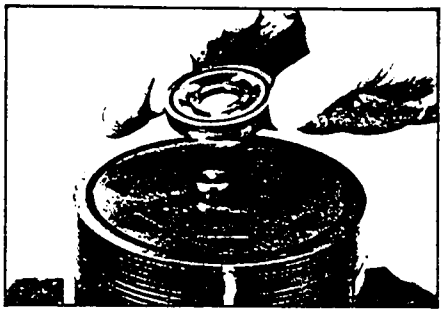


Figure 11

remove manifold

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

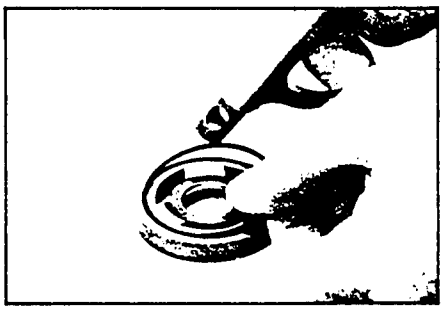


Figure 12

NOTE

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

remove & inspect rotor set & wearplate

10. Remove rotor set (8) and wearplate (9) together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. SEE FIGURE 14. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wearplate. You may have to shift the rotor set on the wearplate to work the drive link out of the rotor (8A) and wearplate. SEE FIGURE 15, Page 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.

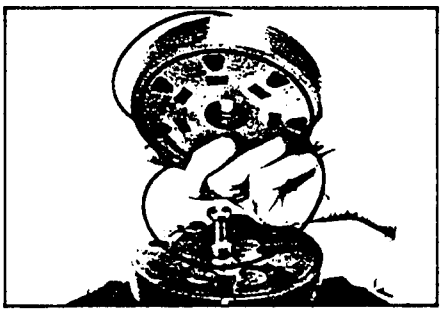


Figure 13

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.

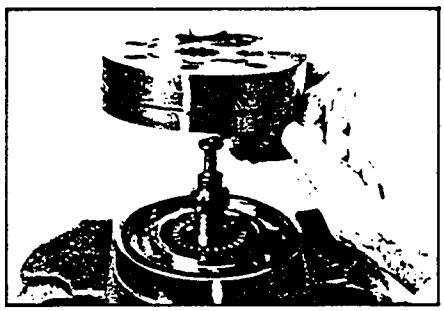


Figure 14

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.

NOTE

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

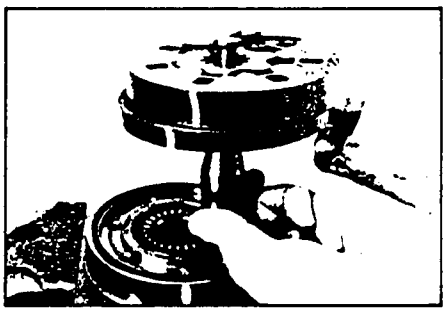


Figure 15

check rotor, vane clearance

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

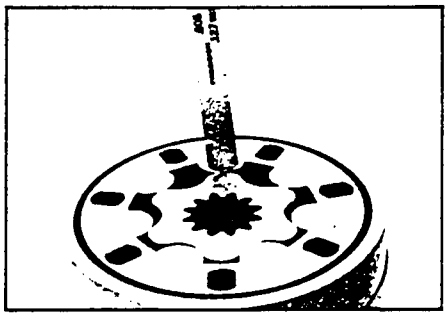


Figure 16

NOTE

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

remove & inspect drive link

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

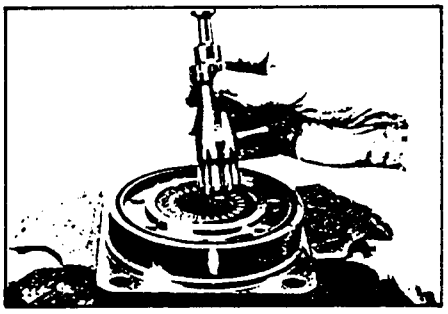


Figure 17

remove thrust bearing

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

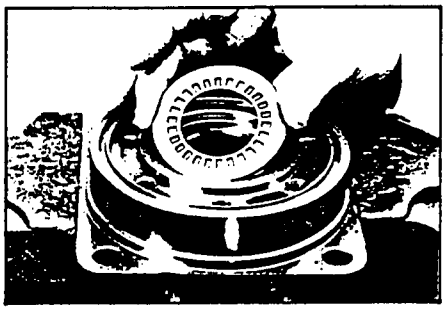


Figure 18

check coupling shaft for rust or corrosion

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

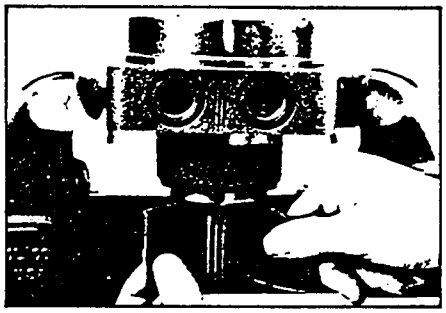


Figure 19

remove & inspect coupling shaft

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

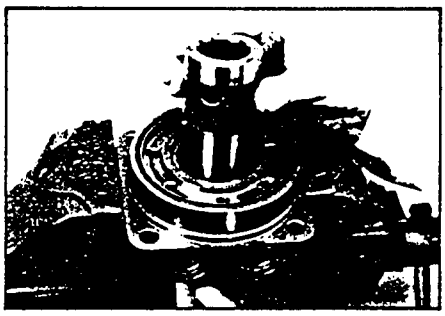


Figure 20

NOTE

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

NOTE

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

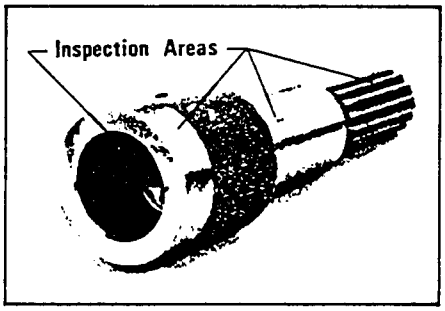


Figure 21

remove seal ring from housing

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

remove & inspect thrust washer & thrust bearing

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

NOTE

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

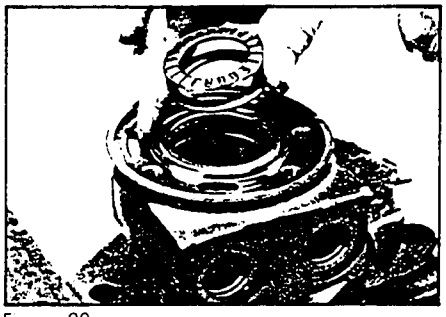


Figure 22

remove seal & washer or washers

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

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

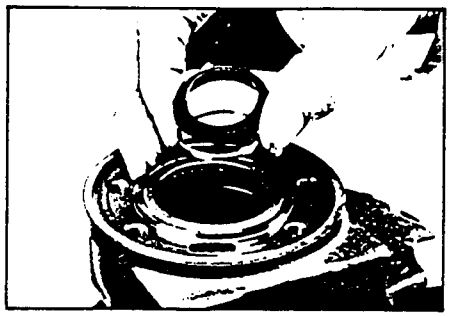


Figure 23

NOTE

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



Figure 24

remove seal

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

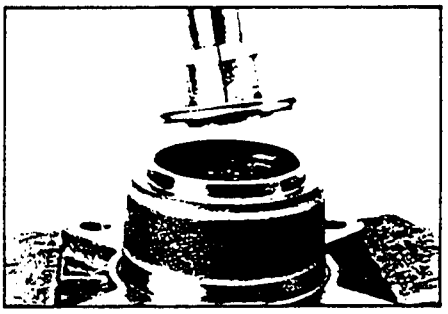


Figure 25

inspect housing assembly

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

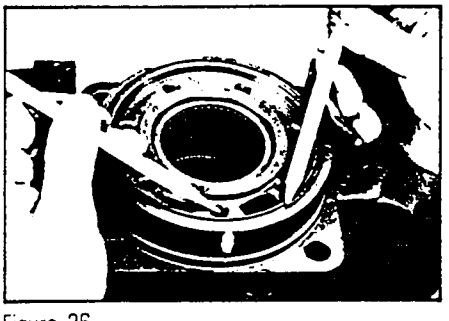


Figure 26

inspect housing bearing/bushing

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

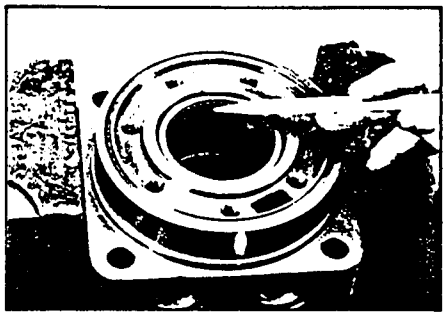


Figure 27

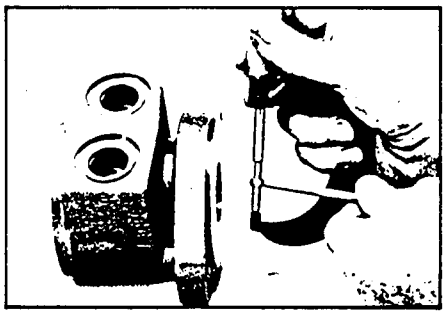


Figure 28

NOTE

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

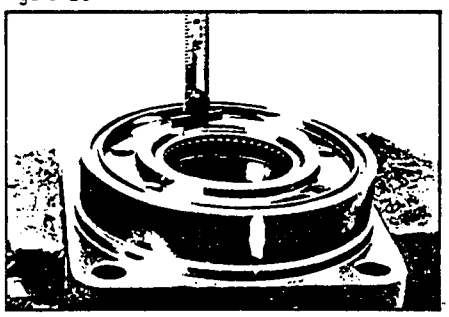


Figure 29

remove bearings or bushings & thrust washers

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

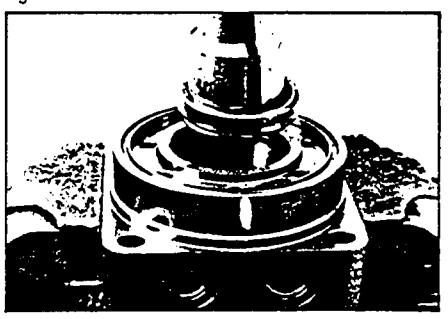


Figure 30

THE DISASSEMBLY OF TORQMOTOR IS COMPLETED.

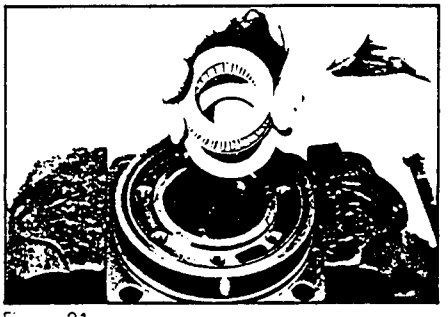


Figure 31

Torqmotor™ Assembly

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

WARNING

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

WARNING

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

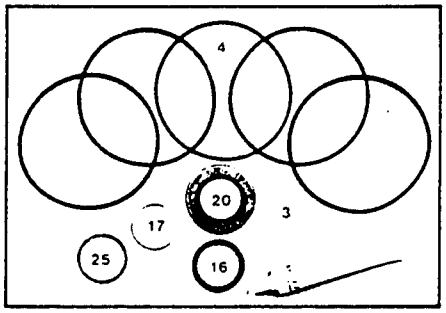
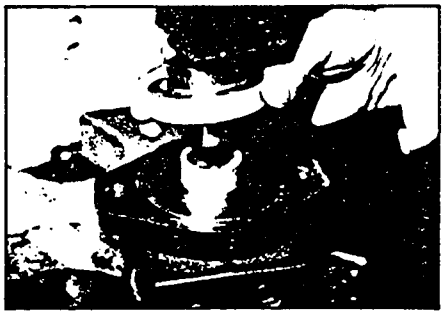


Figure 32 MB, ME seal kit

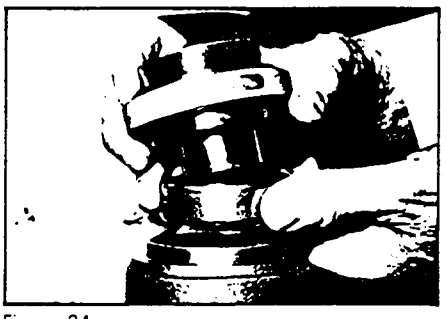
press in outer bearing/bushing

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

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


Figure 33

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


Figure 34

NOTE

NOTE: Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.

CAUTION

CAUTION: If the bearing mandrel specified on page 7 is not available and alternate methods are used to press in bearing/bushing (13) and (19) the bearing/bushing depths specified must be achieved to insure adequate bearing support and correct relationship to adjacent components when assembled. SEE FIGURE 35.

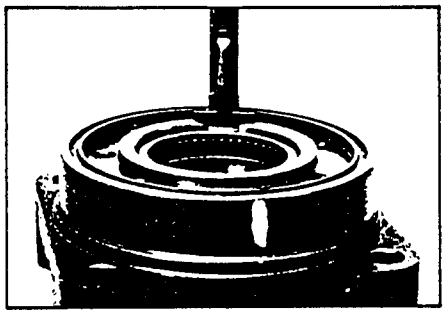


Figure 35

CAUTION

CAUTION: Because the bearing/bushings (13) and (19) have a press fit into the housing they must be discarded when removed. They must not be reused.

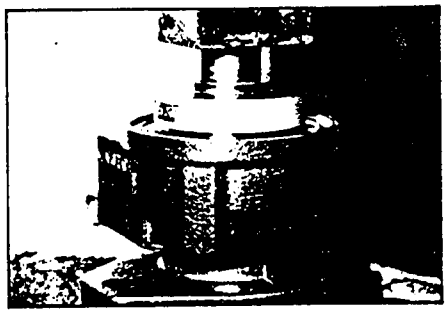


Figure 36

press in inner bearing/bushing

2. The Small Frame Series MG and MF Torqmotor inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to .03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19). Reference figure 1, page 7. SEE FIGURE 36.



Figure 37

The Large Frame Series MB and ME Torqmotor housing (18) requires that you assemble a **new** backup washer (17), **new** backup washer (25), **new** seal (16), with the lip facing out, **new** thrust washer (14), **new** thrust bearing (15) and a **new** second thrust washer (14) in that order before pressing in the inner housing bearing (13). SEE FIGURE 37 & 38. When these components are in place, press **new** bearing (13) into the housing (18) to a depth of .105/.125 inches (2.67/3.18) below the housing wear plate contact face. Use the opposite end of the bearing mandrel used to press in outer bearing (19). Reference figure 2, page 7. SEE FIGURE 39.

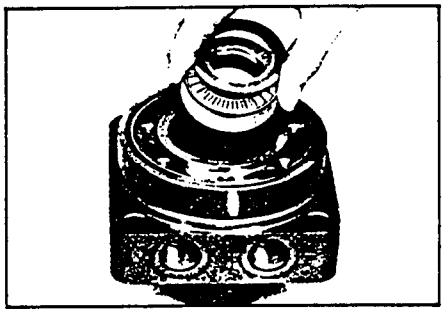


Figure 38

press in dirt & water seal

3. Apply a small amount of clean grease to a new dirt and water seal (20) and press it into the housing (18) outer bearing counterbore.

   The Small Frame Series MG and MF Torqmotor dirt and water seal (20) must be pressed in until its' flange is flush against the housing. SEE FIGURE 40.

   The Large Frame Series MB and ME Torqmotor dirt and water seal (20) must be pressed in with the lip facing out and until the seal is flush to .020 inches (.51 mm) below the end of housing. SEE FIGURE 41.



Figure 39



Figure 40

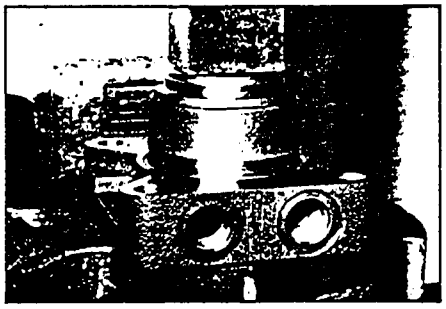


Figure 41

place housing assembly into vise

4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange. SEE FIGURE 42.

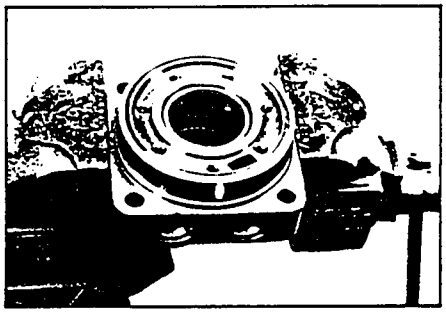


Figure 42

assemble backup washer & seal

5. On Small Frame, Series MG & MF Torqmotors assemble a **new** backup washer (17) and **new** seal (16) with the seal lip facing out, into their respective counterbores in housing (18) if they were not assembled in procedure 2.

   Large Frame, Series MB and ME Torqmotor housing (18) that did not require replacement of the bearing package will require that the two "captured" thrust washers (14) and thrust bearing (15) be unseated and vertical to the counterbore and the **new** backup washer (17), **new** backup washer (25), and **new** seal (16) be worked around the thrust bearing package and placed into their respective counterbores. The seal lip must face out of the seal counterbore. Be sure the thrust bearing package is reseated correctly after assembly of the seal and backup washer. SEE FIGURE 43 & 44.

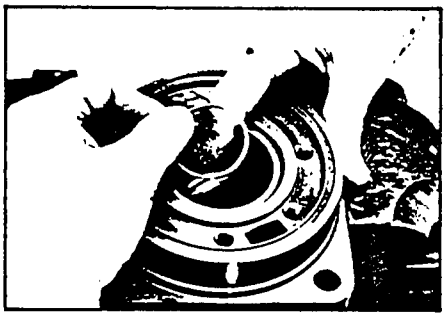


Figure 43

CAUTION

CAUTION: Original design Large Frame, MB & ME Torqmotors that do not have backup washer (25) when disassembled must be assembled with a new backup washer (17), new backup washer (25), and new seal (16).

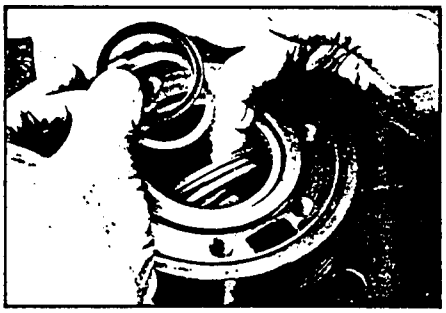


Figure 44

assemble thrust washer & bearing

6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Series MG or MF Torqmotor. SEE FIGURE 45.

NOTE

NOTE: Small Frame Series MG and MF Torqmotors require one thrust washer (14) with thrust bearing (15). The coupling shaft will be seated directly against the thrust bearing.

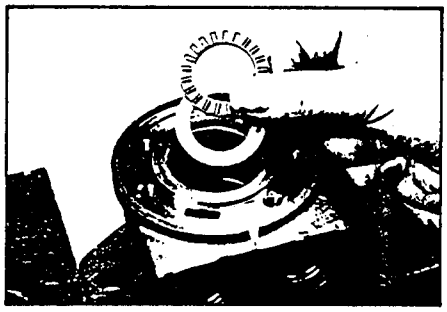


Figure 45

apply masking tape to shaft

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

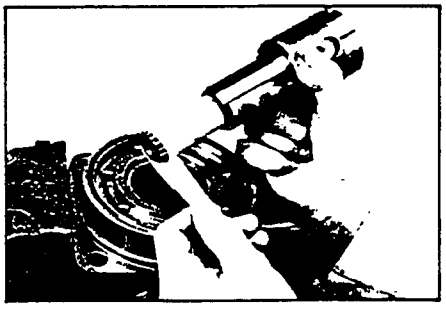


Figure 46

install coupling shaft

8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in MG and MF Series housings and against the second thrust washer (14) in MB and ME Series housings. SEE FIGURE 47.

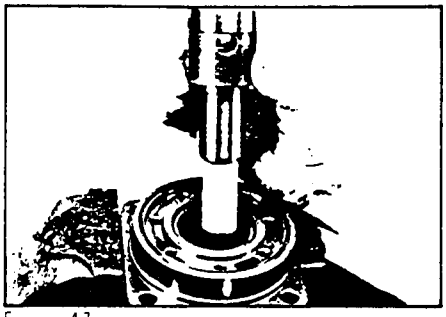


Figure 47

CAUTION

CAUTION: The outer bearing (19) is not lubricated by the system's hydraulic fluid. Be sure it is thoroughly packed with the recommended grease, Ross Gear grease specification #045236, E/M Lubricant #K-70M.

NOTE

NOTE: The coupling shaft (12) will be flush or just below the housing wear plate surface on Small Frame, Series MG and MF Torqmotors when properly seated while the coupling shaft (12) on Large Frame, Series MB and ME Torqmotors will be approximately .10 inch (2.54 mm) below the housing wear plate surface to allow the assembly of thrust bearing (11). The coupling shaft must rotate smoothly on the thrust bearing package. SEE FIGURE 48.

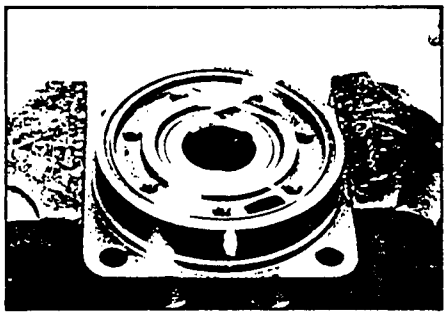


Figure 48

install thrust bearing

9. Install thrust bearing (11) onto the end of coupling shaft (12) only if you are servicing an MB or ME Series Torqmotor. SEE FIGURE 49.



Figure 49

insert seal ring

10. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove. SEE FIGURE 50.

NOTE

NOTE: One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over .5 inch (12.7 mm) longer than the bolts (1, 1A, 1B or 1C) used in the Torqmotor.

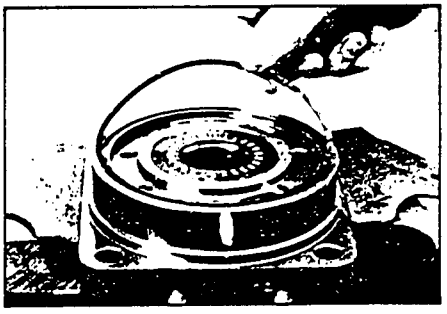


Figure 50

install drive link

11. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines. SEE FIGURE 51.

NOTE

NOTE: Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.

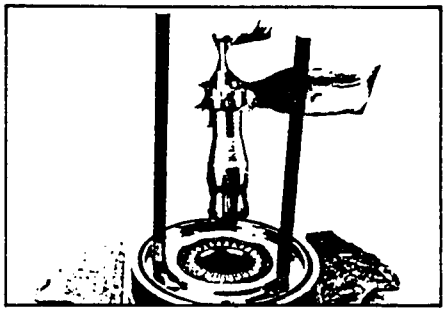


Figure 51

assemble wear plate

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

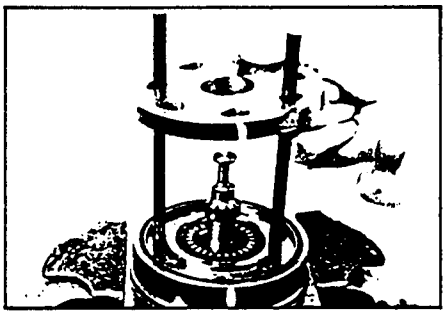


Figure 52

assemble seal ring

13. Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B). SEE FIGURE 53.

install the assembled rotor set

14. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines. SEE FIGURE 54.

NOTE

NOTE: It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.

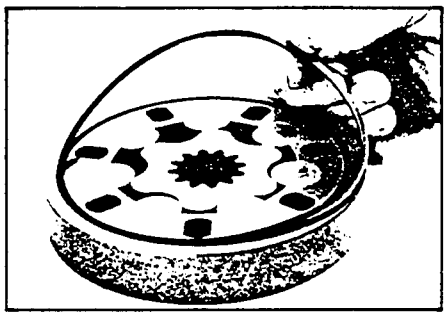


Figure 53

NOTE

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

NOTE

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

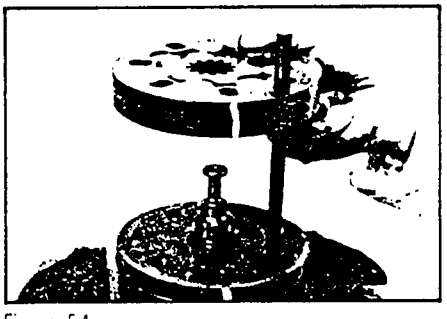


Figure 54

assemble seal ring in manifold

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

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.

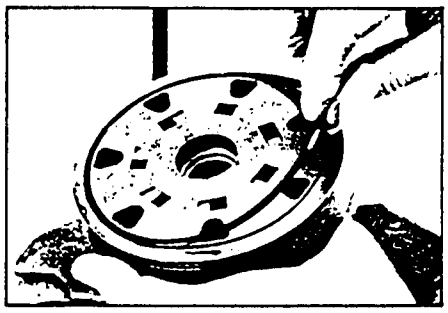


Figure 55

assemble manifold

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

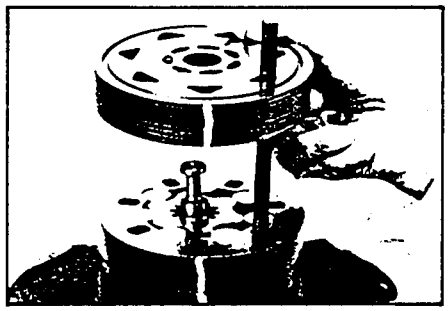


Figure 56

insert a seal in manifold

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

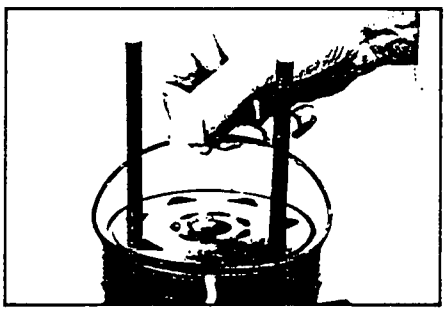


Figure 57

assemble commutator ring

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

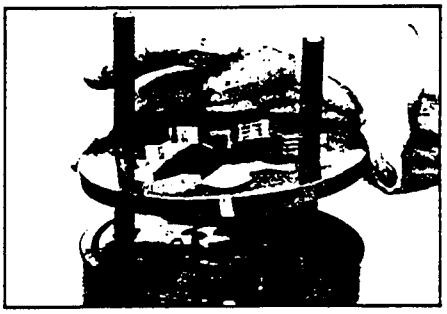


Figure 58

assemble seal & commutator

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

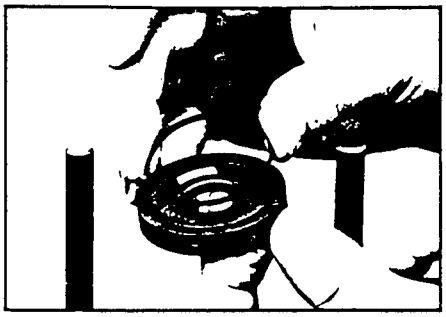


Figure 59

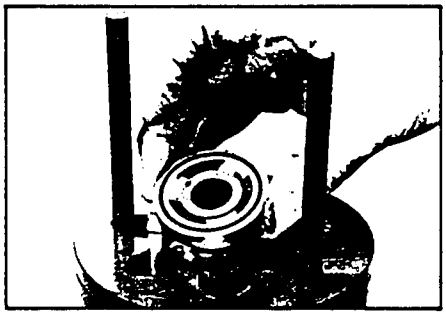


Figure 60

assemble shuttle valve parts into end cover

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

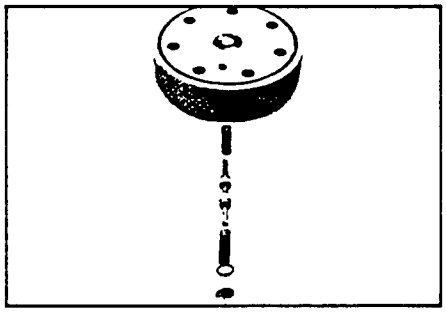


Figure 61

assemble relief valve parts in end cover

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

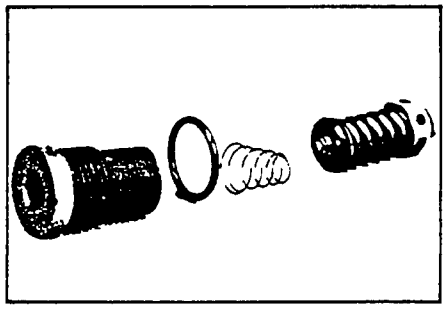


Figure 62

assemble seal ring & end cover

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

NOTE

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

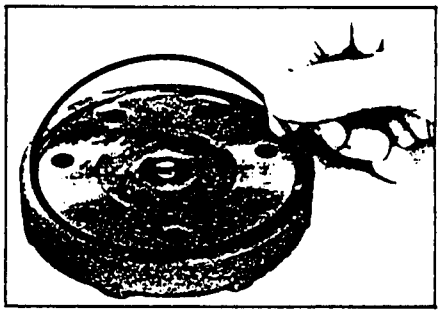


Figure 63

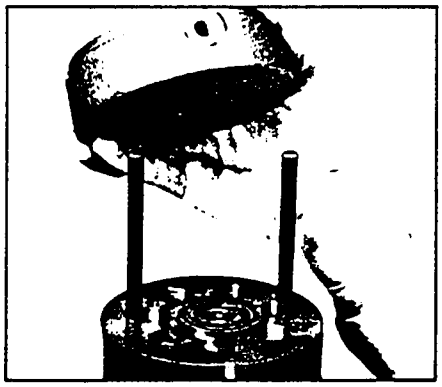


Figure 64

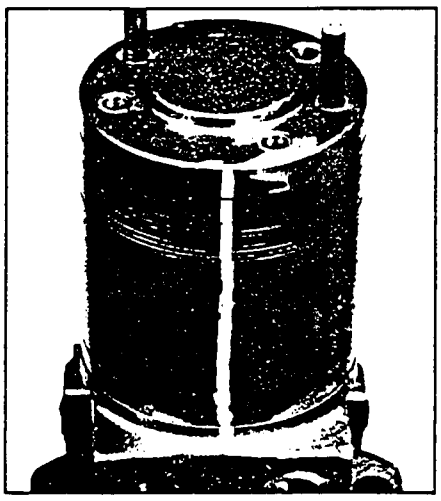


Figure 65

assemble cover bolts

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

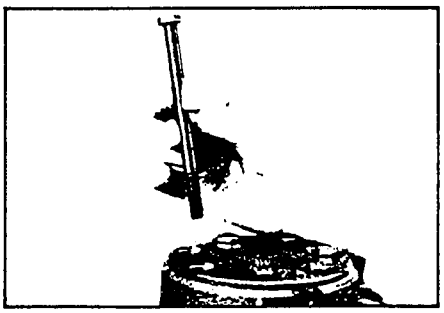


Figure 66

NOTE

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

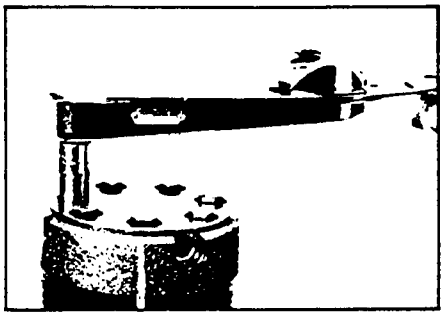


Figure 67

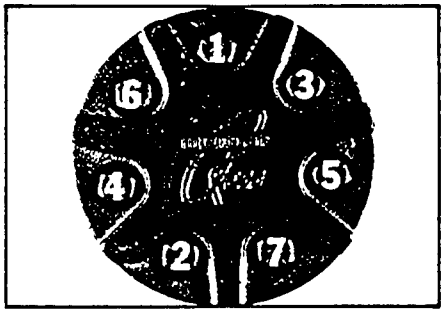


Figure 68

torque the valve plugs

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

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

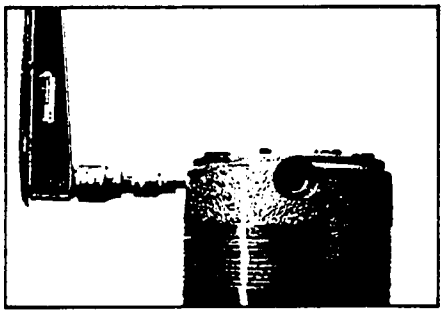


Figure 69

THE ASSEMBLY OF THE TORQMOTOR IS NOW COMPLETE EXCEPT FOR WOODRUFF KEY (12A), NUT (12B), WASHER (12C), BOLT (12D), LOCKWASHER (12E), RETAINER RING (12F) or PORT O-RINGS (18A) AT INSTALLATION IF APPLICABLE. SEE PAGE 32 FOR FINAL CHECKS.

Rotor Set Component Assembly Procedure

One Piece Stator Construction

A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

assemble stator

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqmotor assembly procedures 1 through 13. Be sure the seal ring is in place. SEE FIGURE 70.

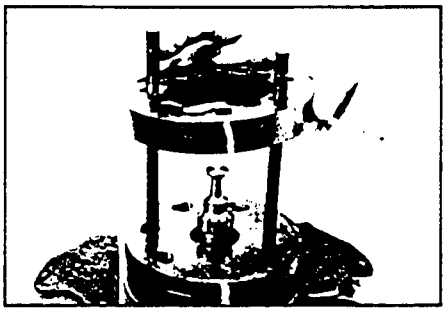


Figure 70

insert two bolts

2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

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.

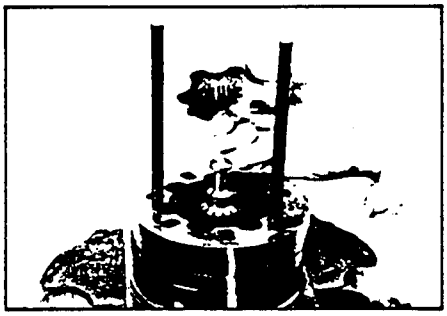


Figure 71

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.

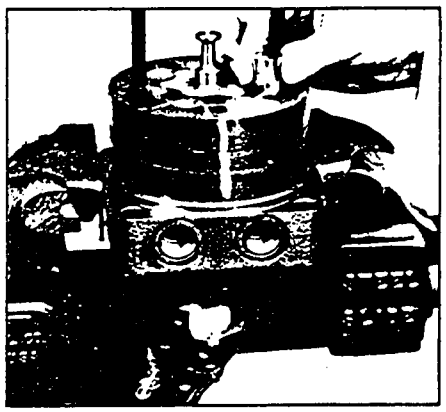


Figure 73

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.

THE 10 COMMANDMENTS OF GOOD BATTERY CARE

1. Add approved water only--never acid.
2. Keep electrolyte level above separator protectors.
3. Keep battery top clean and dry.
4. Keep flame and metal away from battery top.
5. Keep vent caps tightly in place.
6. Do not use battery with specific gravity below 1.120.
7. Cool before charging or operating if battery is above 115°F.
8. Charge only at proper voltage and ampere-hours.
9. Keep truck compartment and battery cover open during charging.
10. When in doubt, call your Trojan Battery service representative for long, reliable battery life.

Watering Instructions

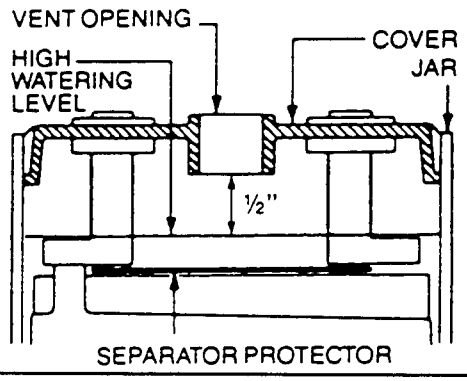
Approved Water

In most areas of the United States, tap water is satisfactory for use in lead acid batteries. The local Trojan Battery office will advise, upon request, if the public water is approved. Use distilled water when in doubt or if the public water source is not approved.

CAUTION—DO NOT OVERFILL. MOISTURE ON THE TOPS OF THE BATTERIES INDICATES OVERFILLING HAS OCCURRED.

Proper Electrolyte Level

The electrolyte level must be kept between the "High Warning Level" and the separator protectors as shown in the sketch. The batteries should be filled only at the end of the charging cycle.



1. NEW BATTERY RECEIVAL AND INSTALLATION

1. **Always** inspect incoming shipments of batteries for damage.

   Look for and pay particular attention for damage to or wet spots on the shipping cartons, examine those batteries for signs of breakage.

2. If damaged batteries are found secure acknowledgment of the damage from the carrier's representative and file a claim against the transportation company. Contact your supplier for battery replacement.

3. If batteries are received wet and **not** immediately placed in service, they must be charged at regular intervals as follows:

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

4. Never stack one battery directly on top of another. Post damage and/or container damage can occur from improper stacking. If batteries are stored individually, place supporting boards between layers. **Do not** stack layers more than three (3) high and rotate stock so that the oldest batteries can be used first.

5. Dry charge batteries should be activated in accordance with instructions of the battery manufacturer.

6. Batteries should be installed in accordance with the vehicle manufacturer's instructions. Connections should be made tight enabling good contact between connector lugs and battery terminals. Always charge sets of batteries immediately after installation into the car.

2. MAINTENANCE- INSPECTION PROCEDURES

1. **Water batteries at least once a week.**

   a. Add only approved water to the cells. Distilled water is recommended, high mineral content water must not be used. Maximum allowable impurities in percent-iron (.003), chloride (.004), fixed residue (.075).

   b. Remove vent caps and water batteries preferable after charging to prevent over flow of acid due to expansion.

   c. Fill all cells to the proper level. **Do not overfill cells.** Fill to level indicator or 1/2 inch over the top of the separators if there is no level indicator. Do not use a hose to water batteries.

   d. Spot check cells between weekly waterings to assure electrolyte is above separators. Excess water usage indicates the presence of any one or all of the following conditions which should be checked.

      1. Overcharging
      2. High temperature operation
      3. Nearing end of service life

   e. **Do not allow the electrolyte level** to drop below the top of the separators since this will lead to shortened battery life.

2. **Clean batteries after weekly watering or when washing cars.**

   a. Wash the tops of the batteries making sure the vent caps are in place. Do not allow water or other foreign matter to enter the cells.

   b. Use a solution of bicarbonate of soda and water to wash batteries if there is an accumulation of acid.

3. **Inspection** to insure good conditions which will give better battery service.

   a. When watering batteries inspect battery and other terminal connections for:

      1. **Corrosion** -- If any exists, clean connection and apply a non-metallic grease or protective spray to retard further corrosion.

      2. **Loose Connections** -- Be sure all connections are tight and that good contact is made between terminals.

3. **Broken or Frayed Cables** -- Be sure all cable connections are good and that no loose or broken wires are exposed. Replace any which look suspicious.

b. Once a week after the batteries have been charged, spot check two (2) or more cells for specific gravity reading. Gravity should be 1.250-1.280. If low readings are noted:

1. Check charger to insure that proper charge is being returned to the batteries.

2. Check connections as specified under **inspection 3a.**

3. Check all cells to determine if batteries are near the end of life. This should be done to the same procedure as called for under **Section IV covering "Troubleshooting" of batteries.**

c. On a regular interval, check car as outlined in the instruction manual for:

1. Brake drag
2. Proper tire pressure
3. Proper alignment
4. Proper lubrication
5. Proper operation of electrical system
6. Proper operation of drive and transmission system
7. Condition of charger plug and receptacle in car

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

3. CHARGING PROCEDURE

1. Become familiar with instructions issued with the charger car manual.

2. Batteries are to be charged after each day's use as soon as play has been completed. Charging between rounds is permissible if it is determined feasible to do so.

3. **Do not charge batteries** if car was not used that day.

4. **Do not allow batteries to sit in discharged condition** for prolonged periods of time.

5. **Always be sure batteries are fully charged** each day prior to starting play.

4. TROUBLE SHOOTING FOR WEAK OR BAD BATTERIES

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

1. Check terminal connections for corrosion, loose connections and broken or frayed cables.

2. If terminal connections appear to be in good condition, check all cells with a hydrometer for variation in specific gravity among cells. A variation of .030 points or more between cells of a battery is cause for suspect. Mark the low cells.

3. Recharge the batteries as recommended by the manufacturer.

4. Read all gravities again after recharge. Be sure that batteries are fully charged at gravities of 1.250 to 1.280. If cells vary by .030 points or more it is an indication of possible trouble within that battery.

5. Connect a load tester to the set of batteries and discharge the batteries at 75 Amps and record the time to a terminal voltage of 31.5 volts. Testers are now available having an automatic Shut-Off at this voltage. New batteries should run a minimum of 75 minutes on this test.

   a. If the batteries run less than 40 minutes they have either reached the end of life or a defective battery is in the circuit. Battery replacement is then necessary.

   b. If batteries run 40-50 minutes they have lost capacity and may be nearing the end of their useful life. In golf car service one round of golf may be expected on an average golf course.

   c. If batteries run more than 50 minutes, they are in good condition and satisfactory for continued service. Prior to putting the car back in serviced it should be checked for the existence of other trouble as outlined in the instruction manual.

5. BATTERY REPLACEMENT

Defective Batteries (Premature Failures)

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

Worn Out Batteries

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

6. WINTER STORAGE OF WET BATTERIES

1. Prior to storing car, batteries should be cleaned, fully charged and properly leveled.

2. While in storage the batteries should be recharged to full charge at time intervals shown below:

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

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

9. **Q.** WHAT IS MEANT BY "SPECIFIC GRAVITY" OF BATTERY ELECTROLYTE?

   A. It is the weight of the sulfuric acid-water mixture compared to an equal volume of water. Pure water has a specific gravity of 1.000.

10. **Q.** WHAT EFFECT DOES MAXIMUM SPECIFIC GRAVITY HAVE ON A BATTERY?

    A. Experience has proved that the optimum specific gravity of a new lead-acid industrial truck battery is 1.265-1.285. If the maximum gravity of a new battery is higher than that, slightly more ampere hour capacity will result but battery life will be shortened.

11. **Q.** WHAT IS MEANT BY BATTERY LIFE?

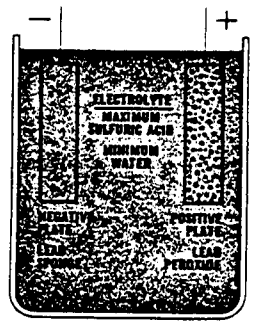
    A. Battery life normally refers to the number of times that a battery can be charged and discharged before it is no longer able to do a required day's work. One complete charge and one complete discharge is called a cycle. The number of complete cycles a battery will give depends on: 1) construction of the battery, 2) charging procedure, 3) maintenance, 4) operation.

12. **Q.** HOW DOES SPECIFIC GRAVITY VARY WITH DISCHARGE?

    A. This normal range of a lead-acid battery from full charge to full discharge is from 1.275 to 1.130. By the time the specific gravity gets down to 1.130 the rated capacity is usually out of the battery and a maximum amount of acid has combined with the active material on the plates. If discharge is frequently continued below the 1.130 point, battery life will be shortened.

13. **Q.** DOES VOLTAGE (FORCE OR PRESSURE) VARY AS THE BATTERY IS DISCHARGED?

    A. Yes, voltage drops as specific gravity of the electrolyte drops. A full charged lead-acid battery with a specific gravity of 1.275 has an average initial discharge cell voltage of 2.03 volts. It is considered to be fully discharged when the average cell voltage is 1.75. Since truck speed is dependent on battery voltage, the truck will go approximately 14% slower at the end of discharge than it did at beginning of discharge. This difference cannot be detected in the average operation.



Discharge Reaction in a Lead Acid Cell

14. **Q.** HOW DOES THE ELECTRICAL SIZE (K.W.H.) OF THE BATTERY AFFECT INDUSTRIAL TRUCK OPERATION?

    A. The work that can be done by an industrial truck is proportional to the total kilowatt hour capacity of the battery. A 16-cell, 19-plate lead-acid battery has a 23.57 kilowatt hour capacity. It will do approximately the same total amount of work as an 18-cell, 17-plate battery which is rated at 23.56 kilowatt hours, *if it is used in the same truck.*

Lead Industries Association
292 Madison Ave.
New York, New York 10017

A PRIMER ON THE LEAD-ACID BATTERY

1. **Q.** WHAT IS A STORAGE BATTERY?

   A. A reservoir which may be used repeatedly for storing energy. Energy is put into it and removed from it in the form of electricity, but it is stored as chemical energy.

2. **Q.** WHAT ARE AMPERES?

   A. Units of quantity of electric current. The current forced through a resistance of one ohm by a pressure of one volt is one ampere.

3. **Q.** WHAT ARE VOLTS?

   A. Units of force or pressure of electric current. In an industrial truck, running speed, lifting speed and controller operations are dependent upon battery voltage. The voltage of a battery depends on the number of cells. Each lead-acid cell has 2 volts; a 6-cell battery has 12 volts and an 18-cell battery has 36 volts.

4. **Q.** WHAT ARE WATTS?

   A. The product of volts times amps. (Volume of electric current times pressure of electric current.) The total power is measured in watts.

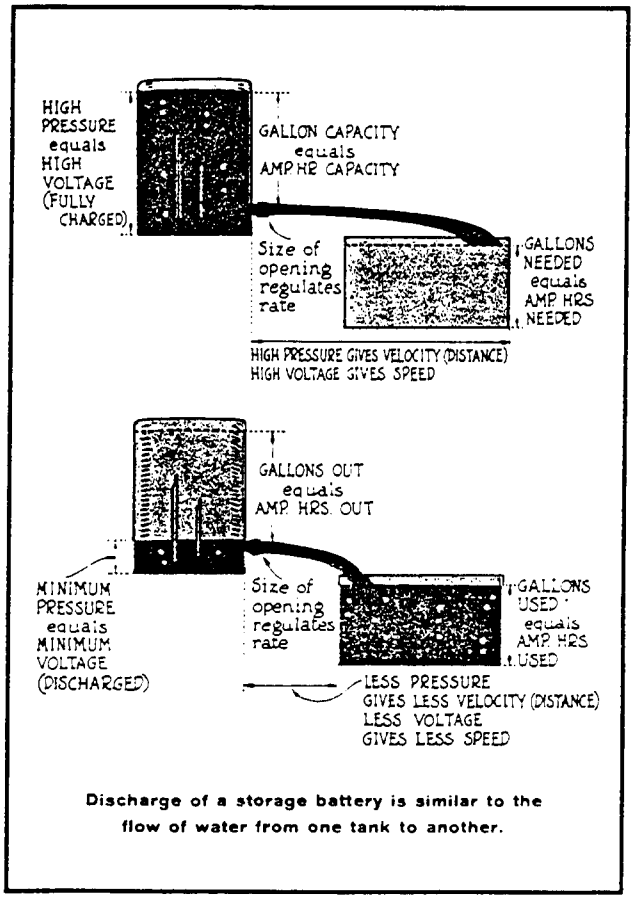
5. **Q.** WHAT IS AMPERE HOUR (A.H.) CAPACITY?

   A. Product of amps multiplied by time. It refers to the volume of electricity that can be drawn from a battery. Other things being equal*, higher ampere hour capacity batteries will run a truck longer than those with lower ampere hour capacities. A.H. capacity of a battery depends on the number and design of plates per cell.

   *"Other things" refers to number of cells in battery, truck resistance, truck motor, rate of discharge, etc.

6. **Q.** WHAT IS KILOWATT HOUR (K.W.H.) CAPACITY?

   A. A kilowatt is 1,000 watts. The kilowatt hour capacity is the total amount of power (volts x amps x hours divided by 1,000) that can be drawn from a battery. It is the watt or kilowatt which does the work—not amps alone.



Discharge of a storage battery is similar to the flow of water from one tank to another.

7. **Q.** HOW ARE BATTERIES RATED?

   A. Lead-acid batteries are rated at the six hour rate. For example: a 16 cell, 19 plate lead-acid battery will deliver a total of 765 ampere hours if it is discharged at a continuous rate of 127.5 amperes per hour for six hours.

8. **Q.** WHAT IS ELECTROLYTE?

   A. In lead-acid batteries, it is a mixture of sulfuric acid and water. The operation of the batteries is affected by the specific gravity, quantity, purity, etc. of the electrolyte within the cell.

STARTING and OPERATING INSTRUCTIONS

ISSUE MM-357

WISCONSIN

Air-Cooled Engines

Four Cylinder Engine Models

VH4D • VG4D • V-465D

TELEDYNE TOTAL POWER

WORLD'S FOREMOST SOURCE FOR HEAVY DUTY AIR COOLED ENGINES

INTRODUCTION

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

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

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

SPECIFICATIONS

MODEL VH4D

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

MODEL VG4D

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

MODEL V-465D

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

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

SAFETY PRECAUTIONS

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

NEW ENGINE Instructions

• LUBRICATION

Operating without oil will ruin engine.

IMPORTANT

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

Refer to *GRADE OF OIL* chart (page 2) and fill with proper oil *before* starting engine.

• AIR CLEANER

Oil bath type — Add same grade oil as used in crankcase to the level line indicated on cleaner bowl. Maintain oil level or dirt will be drawn in and damage engine.

Dry element type, optional equipment – DO NOT OIL – Follow instructions on cleaner body.

• FUEL

Use 'REGULAR' grade gasoline. Engines built to operate on FUEL OIL, KEROSENE, L.P.G. or NATURAL GAS are so identified in the model designation. Refer to *'FUEL'* paragraphs of instructions. Buy fresh fuel. Do not use *out-of-season* gasoline.

• NEGATIVE GROUND CIRCUIT

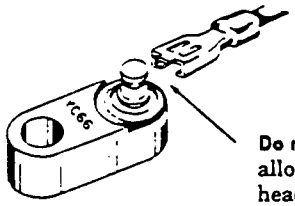
, if engine is equipped with STARTING MOTOR, DISTRIBUTOR IGNITION and FLYWHEEL ALTERNATOR, or GENERATOR.



GROUND ENGINE TO NEGATIVE TERMINAL ON BATTERY.

CAUTION: Be absolutely sure of proper connection or damage to the Alternator or Generator circuits will result.

• PREVENT OVERHEATING



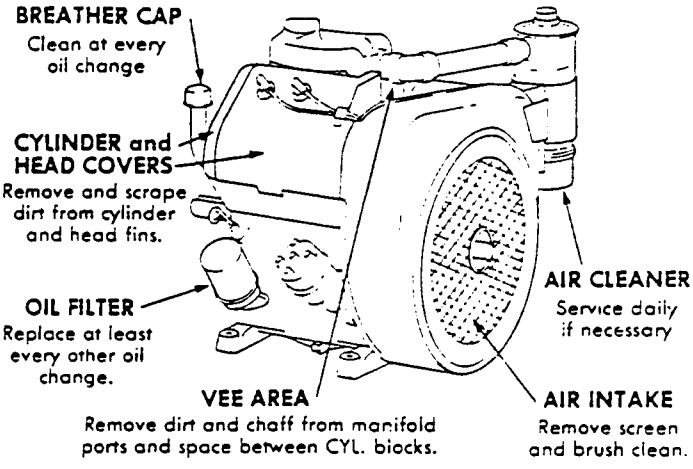
Temperature Safety Switch

Do not disconnect wire or allow terminal to touch head fins or shrouding.

Optional accessory mounted to cylinder head bolt near spark plug — *TO PROTECT ENGINE AGAINST OVERHEATING.* If engine stops, check first to see if engine is overheated. Other conditions may have caused the engine to stop. Clean air cleaner, air intake screen, fins, and check oil level, spark plugs and wiring. Let engine cool at least 10 minutes before restarting.

Keep Engine Clean

External dirt restricts cooling and internal dirt causes wear.



• NEW ENGINE BREAK-IN

Proper *break-in* will lead to trouble-free operation and increased engine life. The factory test given to a new engine is not sufficient to establish the polished bearing surfaces which are so necessary for good performance and long engine life. There is no quick way to force the establishment of good bearing surfaces, and these can only be obtained by running a new engine carefully and under reduced speeds and loads for a short period of time. Run the engine for a half hour without load at low idle speed (1000 to 1200 R.P.M.). The speed should then be increased gradually, to engine operating r.p.m. still without load, for an additional two hours. If at all possible, operate the engine at light loads for a period totaling about eight hours, before maximum load is applied.

STARTING AND OPERATING INSTRUCTIONS

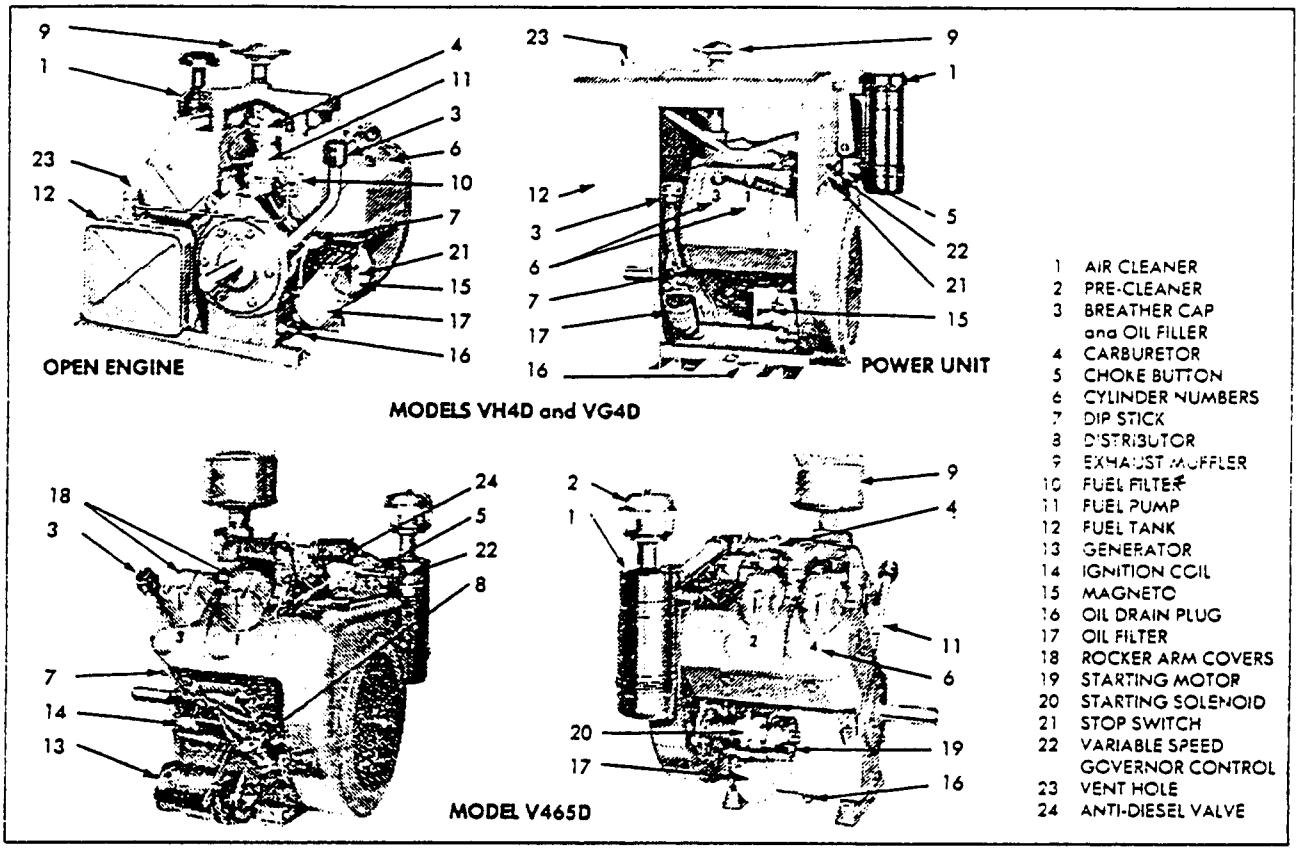


Fig. 1, REFERENCE VIEWS

GENERAL INFORMATION

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

COOLING

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

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

IGNITION

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

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

ROTATION

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

BEFORE STARTING NEW ENGINE

1. Fill tank with Regular grade gasoline.

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

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

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

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

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

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

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

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

GRADE OF OIL

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

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

Model VH4D, Fig 2 and Fig. 3:

Fill clutch and gear reduction units to the height of the oil level plug opening - Use same grade oil as used in engine crankcase. Add sufficient oil between changes to keep oil up to the level plug opening.

Change oil in clutch and reduction units at least every 500 hours of operation.

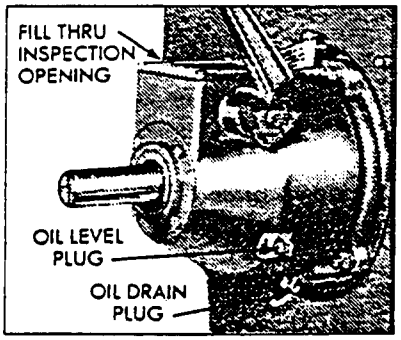


Fig. 2, VH4D
CLUTCH LUBRICATION

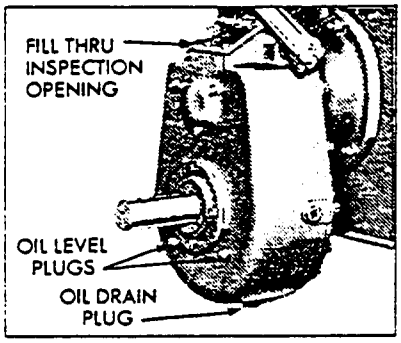


Fig. 3, VH4D
CLUTCH REDUCTION LUBRICATION

Models VG4D and V465, Fig. 4 and Fig. 5:

The clutch in both the power take-off and clutch reduction units is of the dry disc type, therefore NO OIL should be put into the clutch housing. Grease fittings are provided for periodic lubrication of the bearings. The HOUSING BEARING should be greased every 50 hours of operation, and the THROWOUT BEARING every day before starting. use Mobil Gargoyle grease BRB No 3, Sinclair AF-1 grease, or equal.

The PILOT BEARING is sealed and requires no external lubrication.

The SHIFTER SHAFT should be lubricated periodically if external oil fittings are provided.

THE REDUCTION UNIT IS OPERATED IN OIL and the gear case oil level must be maintained to the oil DIPSTICK mark or PLUG opening, which ever is applicable. In ROCKFORD units use No. 30 S.A.E. crankcase oil, for TWIN DISC units use

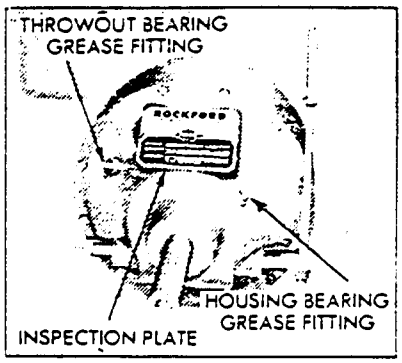


Fig. 4, VG4D, V465D
CLUTCH LUBRICATION

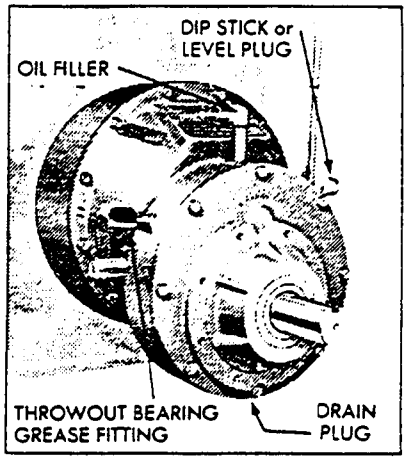


Fig. 5, VG4D, V465D
CLUTCH REDUCTION LUBRICATION

high grade transmission oil, S.A.E. No. 90 to No. 110 viscosity. Change oil every 500 hours of service, while unit is warm.

STARTING

With reference to Fig. 1: Engines enclosed in a sheet metal house are referred to as Power Units, whereas those without a house are called Open Engines.

Power Unit side doors should always be removed when operating.

STARTING PROCEDURE Fig.'s 6,7,8

1. Check crankcase oil level and gasoline supply. Open shut-off valve in fuel strainer.

   OIL BURNING engines must be started on gasoline and run for 2 or 3 minutes before switching to oil. Special instructions are available for starting L.P.G. and NATURAL GAS burning engines.

2. Disengage clutch, if furnished.

3. Prime new engine — if necessary, see Fig. 6. Hand primer lever at fuel pump (available option), should be worked back and forth until strainer bowl is full — then an additional 5 or 10 strokes to fill carburetor bowl. If primer does not function — turn crankshaft one complete revolution.

   Gravity feed (power units), and electric start engines do not require priming.

4. Set throttle about 1/2 open if variable speed governor control is furnished. With a two speed control, start in full load position — idle after engine starts.

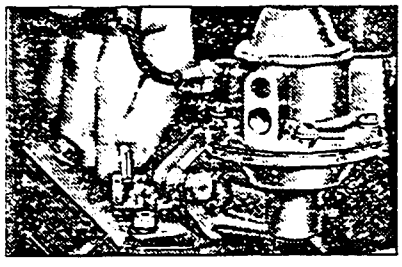


Fig. 6, FUEL PUMP PRIMER

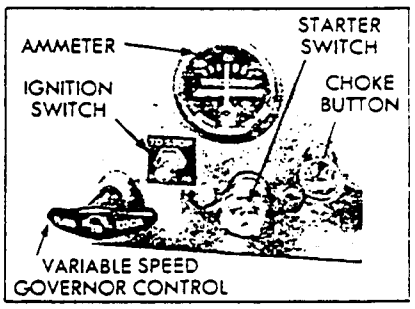


Fig. 7, VH4D, VG4D
CONTROL PANEL

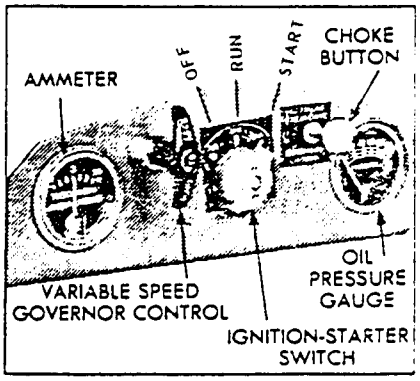


Fig. 8, V465D
CONTROL PANEL

Models VH4D and VG4D only, Fig. 7

5. Pull out ignition switch, if applicable (tag reads "TO STOP PUSH IN").

   Magneto ignition engines (less ignition switch), have a lever type ground switch on side of magneto which is always in the ON or running position, except when depressed for stopping.

5a. Close choke by pulling choke button to extreme out position.

5b. Turn engine over slowly one or two revolutions. CAUTION: Be sure that crank does not bind — apply oil to the crank jaw and crank nut extension for ease of engagement and release.

   Push choke control button in about halfway and then pull up rapidly on the starting crank. Do not attempt to spin the engine with the starting crank. If engine does not start on the first pull up of the crank, re-engage the crank and repeat the operation.

   With electric starting motor: depress starter switch button in place of hand cranking. See Fig. 7.

5c. After engine starts, push choke button in as required for smooth running. Choke should be completely open (button in), when engine is warmed up.

Less choking is necessary in warm weather or when engine is warm, than when cold. Should flooding occur, open choke fully and continue cranking.

Model V465D only, Fig. 8

6. After setting throttle as per paragraph 4.
   Turn IGNITION-STARTING SWITCH to 'Start' position and at the same time pull out choke button only sufficient to start the engine.

6a. Release choke button to open position after engine starts, but rechoke if it tends to stop. EVEN A HOT ENGINE REQUIRES MOMENTARY CHOKING WHEN STARTING. When engine starts release switch to 'RUN' position.

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

WARM-UP

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

TO STOP ENGINE

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

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

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

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

MAINTENANCE

AIR CLEANERS

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

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

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

OIL BATH AIR CLEANER, Fig. 9

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

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

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

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

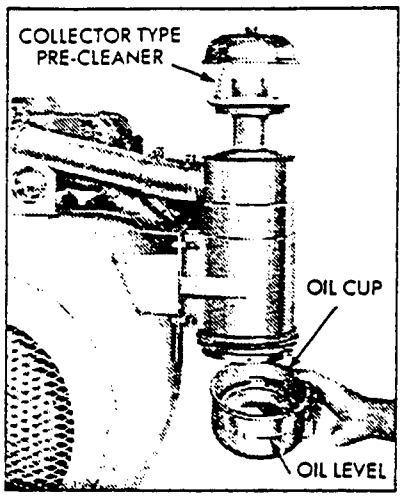


Fig. 9 OIL BATH AIR CLEANER

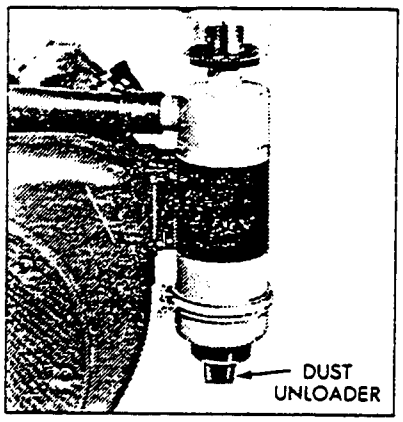


Fig. 10, DRY TYPE AIR CLEANER

DRY TYPE AIR CLEANER, Fig. 10

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

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

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

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

PRE-CLEANER

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

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

BREATHER CAP, Fig. 1, Ref.3

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

DISTRIBUTOR, Fig. 1, Ref. 8

If engine is equipped with battery ignition distributor:

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

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

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

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

GENERATOR - Belt Driver, Fig. 1, Ref 13

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

FUEL FILTER, Fig. 11

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

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

OIL FILTER, Fig. 1, Ref. 17

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

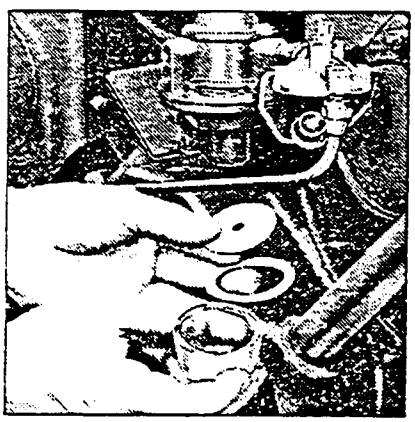


Fig. 11, FUEL FILTER

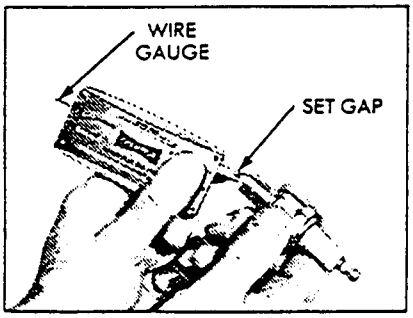


Fig. 12

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

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

SPARK PLUGS, Fig. 12

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

Spark plug gap - .030 inch.

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

Model	Thread Size	Make
VH4D VG4D	18mm	Champion D-16J (Wisconsin YD-6)
V465D	14mm	Champion N-12Y Wisconsin YD-301

Torque spark plugs 25 to 30 foot pounds for Models VH4D, VG4D, and to 22 foot pounds for Model V465D.

STARTING MOTOR, Fig. 1, Ref. 19

No maintenance is required other than keeping the outside of the starting motor clean, and periodic inspection for insecure mounting and loose or corroded cable connections.

In extreme dust and dirt conditions it may be necessary to occasionally remove the starter from the engine and clean the Bendix by brushing with Kerosene. Do not oil Bendix.

ADJUSTMENTS

CARBURETOR

The carburetor MAIN METERING JET is of the fixed type and therefore no adjustment is necessary.

The correct amount of throttle plate opening for the proper low idle speed is obtained by means of the THROTTLE STOP SCREW. However, this is set at the factory so that no immediate adjustment is necessary. The IDLE ADJUSTMENT is for smooth low speed operation and this adjustment, if necessary, must be made with the carburetor throttle lever closed. Initial setting is approximately 1½ turns open.

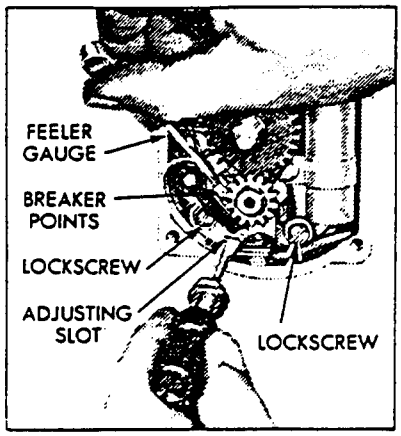


Fig. 13

MAGNETO BREAKER POINTS, Fig. 13

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

.015 inch at full separation.

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

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

DISTRIBUTOR (Battery Ignition), Fig. 14

The breaker point gap should be:

.020 inch at full separation.

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

Points that are badly pitted or worn should be replaced.

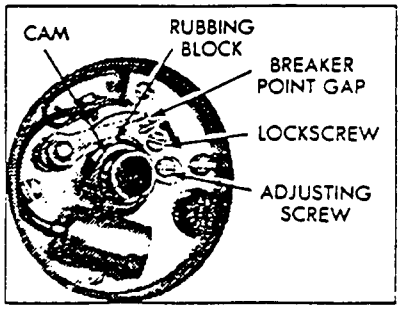


Fig. 14

VALVE TAPPET ADJUSTMENT

Models VH4D, VG4D, Fig. 15

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

Inlet - .008" Exhaust - .016"

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

Model V465D, Fig. 16

The clearance between the valve and rocher arm, with the tappet in its lowest position (valve completely closed) and the engine cold.

Inlet - .008" Exhaust - .014"

The rocker arms can be identified as follows: When facing toward the sideof the engine, the Exhaust Rocker Arm is to the right in the cylinder head and the inlet rocker arm to the left.

Measure clearance between the top of the valve and nose of rocker arm with a feeler

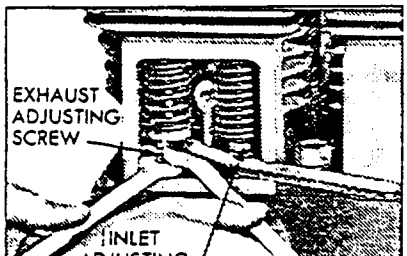


Fig. 15, VH4D, VG4D
VALVE TAPPET ADJUSTMENT

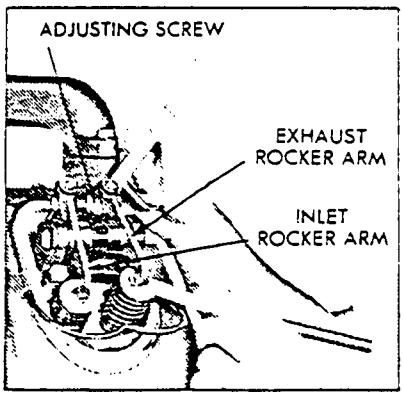


Fig. 16, V465D
VALVE TAPPET ADJUSTMENT

gauge as shown. By means of a ½ inch tappet wrench, turn the adjusting screw clockwise to decrease valve clearance and counter-clockwise to increase the clearance.

The sequence in which the tappets are adjusted is determined by the 1-3-4-2 firing order. Start by adjusting No. 1 inlet valve clearance first, then by just a short turn of the crank. No. 3 inlet can be adjusted. Return to No. 1 cylinder and adjust the exhaust clearance, then adjust the No. 3 exhaust.

The same procedure applies to the No. 2 and No. 4 bank of cylinders, starting with No. 4 inlet valve. Mark each rocker arm with chalk as adjustment is completed, to prevent repetition.

TIMING

FIRING ORDER

The firing order of the cylinders is 1-3-4-2, and the magneto or distributor rotor turns at one-half engine speed, as is the case with conventional 'In Line' engines.

The intervals between the firing of the cylinders is 180°. No. 1 cylinder is the one nearest to the flywheel in the left bank of cylinders, when viewed from the flywheel end of the engine. No. 3 cylinder is the other cylinder in this bank. No. 2 cylinder is the one nearest to the flywheel in the right bank of cylinders and No. 4 is the other cylinder in this bank. The cylinders are numbered on the head covers.

Note: When disconnecting ignition wires, mark cap, and tag wires for correct re-assembly.

TIMING CHECK, Fig. 17

The running spark advance for both magneto and battery ignition, is 23°, and timing must be checked with the engine running at 2000 R.P.M. or over.

Insert a small screw driver into the No. 1 terminal tower on the distributor cap, making contact with the ignition wire terminal. Connect the red terminal clip, from an automotive Timing Light to the metal part of the screw driver. Connect the other two wires of the timing light; one to the positive side of the battery, the other to ground. Chalk or paint the end of the 'X' marked vane of the flywheel, white. Then, with the engine operating at 2000 r.p.m. or over, allow the flash from the timing light to illuminate the white vane. At the time of the flash the leading edge of the vane should line up with the running spark advance timing hole in the front face of the flywheel shroud.

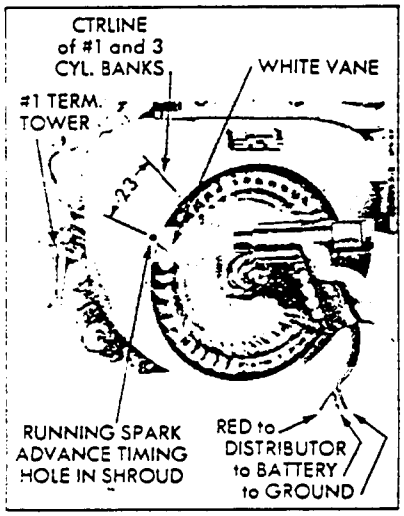


Fig. 17

Note: Timing can be checked without removing flywheel shroud screen (Fig. 17 shows screen removed), by illuminating leading edge of white vane with timing light thru the ⅜" diameter hole in rim face of flywheel screen.

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

CLUTCH ADJUSTMENT

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

VH4D Clutch, Fig. 18

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

VH4D CLUTCH REDUCTION, Fig. 19

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

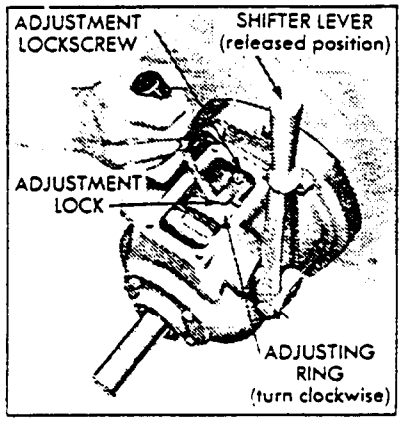


Fig. 18, VH4D
CLUTCH ADJUSTMENT

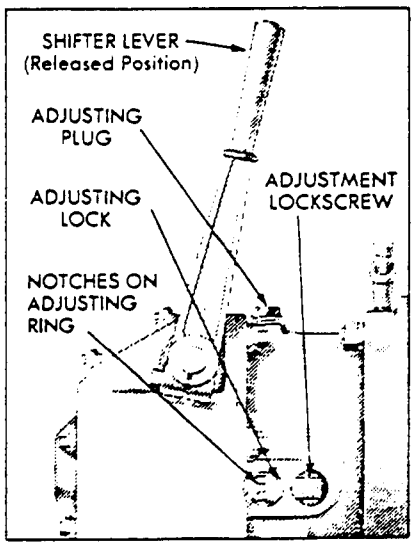


Fig. 19, VH4D
CLUTCH REDUCTION ADJUSTMENT

VG4D, V465D CLUTCH ADJUSTMENT

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

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

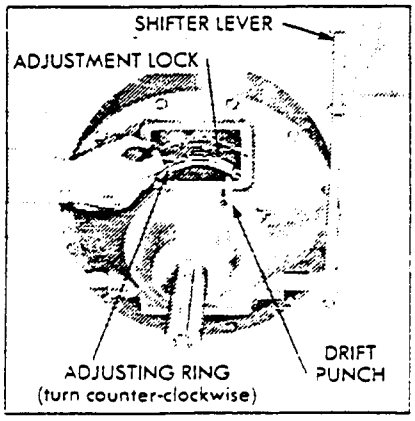


Fig. 20, VG4D, V465D
ROCKFORD CLUTCH ADJUSTMENT

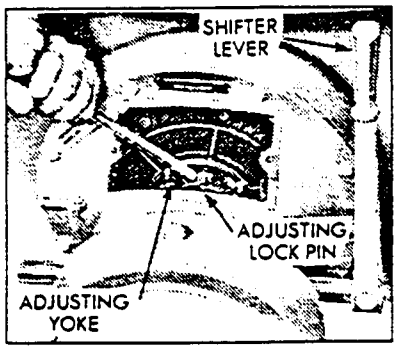


Fig. 21, VG4D, V465D
TWIN DISC CLUTCH ADJUSTMENT

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

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

FLYWHEEL ALTERNATOR

Fig. 22 and Fig. 23

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

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

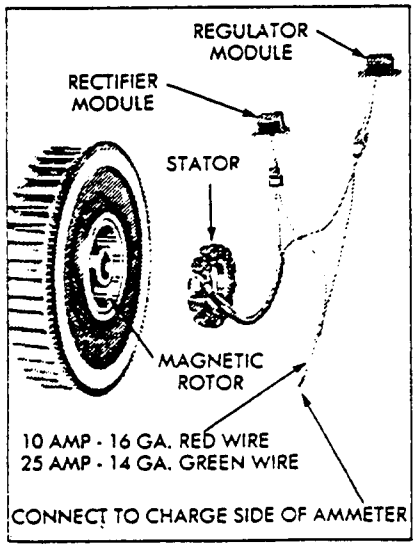


Fig. 22, FLYWHEEL ALTERNATOR

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

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

GENERATOR — WIRING CIRCUIT, Fig. 24

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

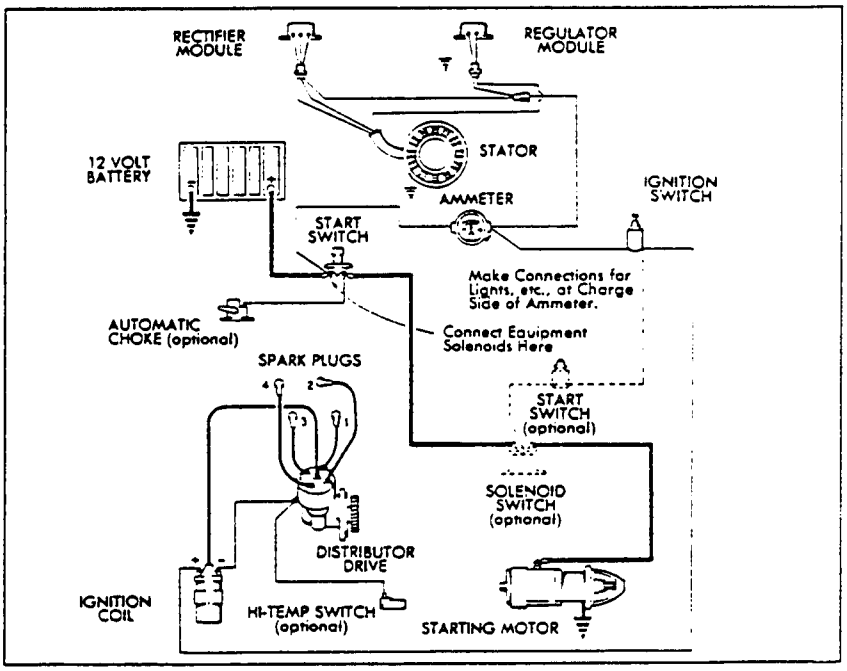


Fig. 23, WIRING DIAGRAM, Flywheel Alternator and Battery Ignition, Models VH4D, VG4D

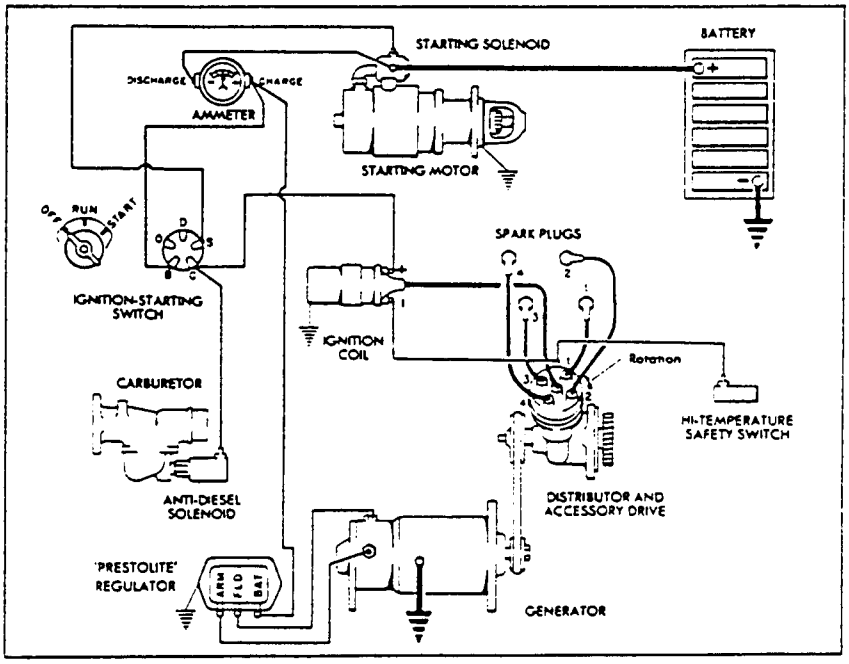


Fig. 24, WIRING DIAGRAM, Generator and Battery Ignition, Model V465D

TROUBLE SHOOTING

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

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

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

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

FUEL MIXTURE

No fuel in tank or fuel valve closed.

Plugged vent hole in fuel tank cap.

Fuel line clogged.

Fuel pump diaphragm worn or punctured.

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

Carburetor not choked sufficiently, especially if engine is cold.

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

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

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

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

COMPRESSION

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

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

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

Valve stuck open. Piston rings stuck or worn.

Valves adjusted with insufficient clearance.

IGNITION

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

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

Broken or frayed ignition wires.

Spark plug insulator broken.

Spark plugs wet or dirty.

Spark plug gap incorrect.

Condensation on spark plug electrodes.

Breaker point gap incorrect.

Breaker points pitted or fused.

Breaker arm sticking.

Condenser leaking or grounded.

Spark timing wrong.

Weak battery. Faulty ignition coil.

ENGINE MISSES

Spark plug gap incorrect.

Worn, leaking or loose ignition cables.

Weak spark. See 'Ignition' test for spark.

Breaker points pitted or worn.

Water in gasoline.

Poor compression. See 'Compression'.

Sticky valves.

ENGINE STOPS

Fuel tank empty.

Water, dirt or gum in gasoline.

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

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

Air vent hole in fuel tank cap plugged.

Ignition troubles. See 'Ignition'.

OVERHEATING

Crankcase oil supply low.

Ignition timing wrong.

Low grade of gasoline.

Engine overloaded.

Restricted cooling air circulation.

Part of air shroud removed from engine.

Dirt between cooling fins.

Intake or rotating screen clogged with dirt.

Restricted exhaust.

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

- Please read and comply with the information given in this Operation Manual. Thus, you will prevent the occurrence of accidents, preserve the warranty granted by the manufacturer and keep an efficient engine ready for operation.
- This engine is exclusively built for the application provided in the scope of supply – and defined by the manufacturer – (use in accordance with regulations). Any use exceeding that scope is considered to be contrary to regulations. The manufacturer will not assume any responsibility for any damage resulting thereform. The risks involved are to be borne solely by the operator.
- Use in accordance with regulations also implies compliance with the conditions laid down by the manufacturer for operation, maintenance and repairs. The engine may only be used, maintained and repaired by persons familiar with engines and informed about the risks involved.
- The relevant regulations for prevention of accidents as well as other general and legal rules regarding safety and industrial medicine are to be complied with.
- Unauthorized alterations on the engine will exclude any responsibility by the manufacturer for any resulting damage.

Operation Manual

FL 1011

KHD DEUTZ SERVICE

0297 4706 en

Engine Serial Number:

Please enter here the engine serial number. By quoting this number, you will help to facilitate dealing with questions concerning Customer Service, Repairs and Spare Parts (see Section 2.1).

All rights reserved. In view of the constant improvements to our engines, the specification data and other technical information included in this Operation Manual are subject to change. No part of this Manual may be reproduced in any form or by any means without our written permission.

KHD DEUTZ

Foreword

Dear Customer!

The air-cooled DEUTZ engines have been developed for a wide range of applications. Consequently, a correspondingly high number of variants are offered to meet the special requirements of each special case.

Your engine is appropriately equipped for the installation concerned, which means that not all of the components described in this Operation Manual are necessarily mounted to your engine.

We have taken pains to point out the differences, so that you can easily find the operating and maintenance instructions relevant to your engine.

Please read these instructions before commissioning your engine and give them your due consideration.

Should you have further enquiries, please do not hesitate to contact the KHD-DEUTZ SERVICE, who gladly remain at your disposal.

Yours sincerely,

KLÖCKNER-HUMBOLDT-DEUTZ AG

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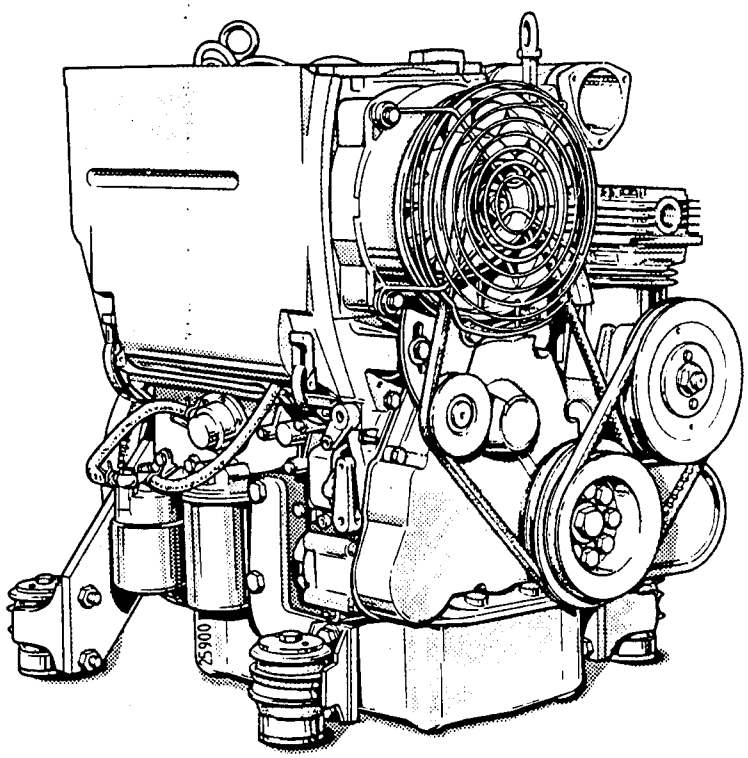
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10. DEUTZ SERVICE



General

DEUTZ Diesel Engines

are the product of research and development ranging over many years. The know-how thereby gained, coupled with high demands with regard to quality, forms the guarantee for the manufacture of engines featuring long service-life, high reliability, and low fuel consumption.
It goes without saying that the high demands regarding protection of the environment are also fulfilled.

Service and Maintenance

will also play a decisive role as to whether the engine fulfills to your satisfaction the demands you make on it. Observance of the prescribed maintenance intervals and careful carrying out of the service and maintenance jobs are therefore essential.
Particular attention must be given with regard to applications involving differing and harder operating conditions as compared with normal operation.

DEUTZ SERVICE

In case of operational troubles and queries concerning spare parts, please contact your DEUTZ agent. Where necessary, our trained specialists will ensure a quick and professional repair, using DEUTZ spare parts. Genuine DEUTZ spare parts are always manufactured to the latest technical standards. More information on DEUTZ SERVICE is to be found at the end of this Operation Manual.

Beware of Running Engine

Always stop the engine before carrying out maintenance or repair work. After completing the work, refit any guards which had to be removed.
Closely-fitting work clothing should be worn when working on the running engine.
Always stop the engine before refuelling.
Never run the engine in an enclosed space – danger due to poisonous vapours.

Safety

When reading through this Manual, you will find this symbol marking all safety instructions and proceed with special care. Pass on these safety instructions to your operating personnel.
In addition, it is also necessary to observe the official safety and accident prevention rules.

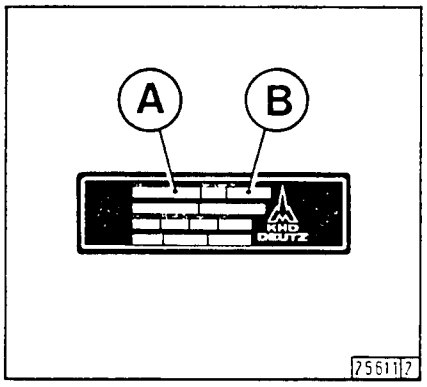
Asbestos

Gaskets used in this engine may contain asbestos.
When carrying out repair work, pay special attention to spare parts which are marked „a".

Description of Engine

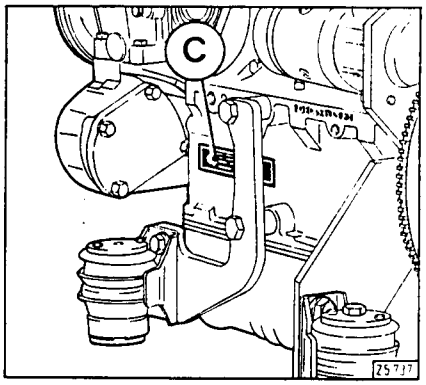
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2.1.1 Rating Plate



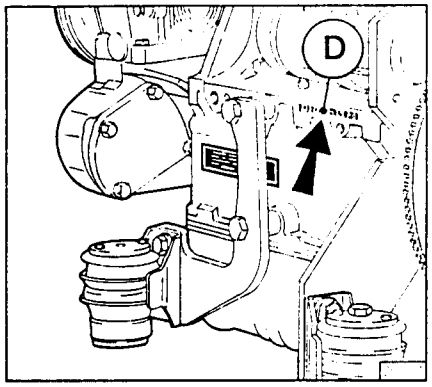
The model designation A, the engine serial number B and the performance data are stamped on the rating plate. When ordering spare parts, it is essential to quote the model designation and engine serial number.

2.1.2 Location of Rating Plate



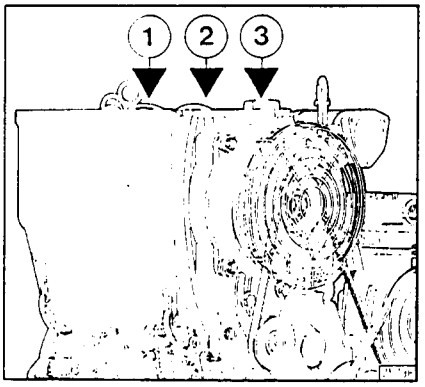
The rating plate C is attached to the crankcase; depending on the version, an additional rating plate may be attached to the air cowling.

2.1.3 Engine Serial Number



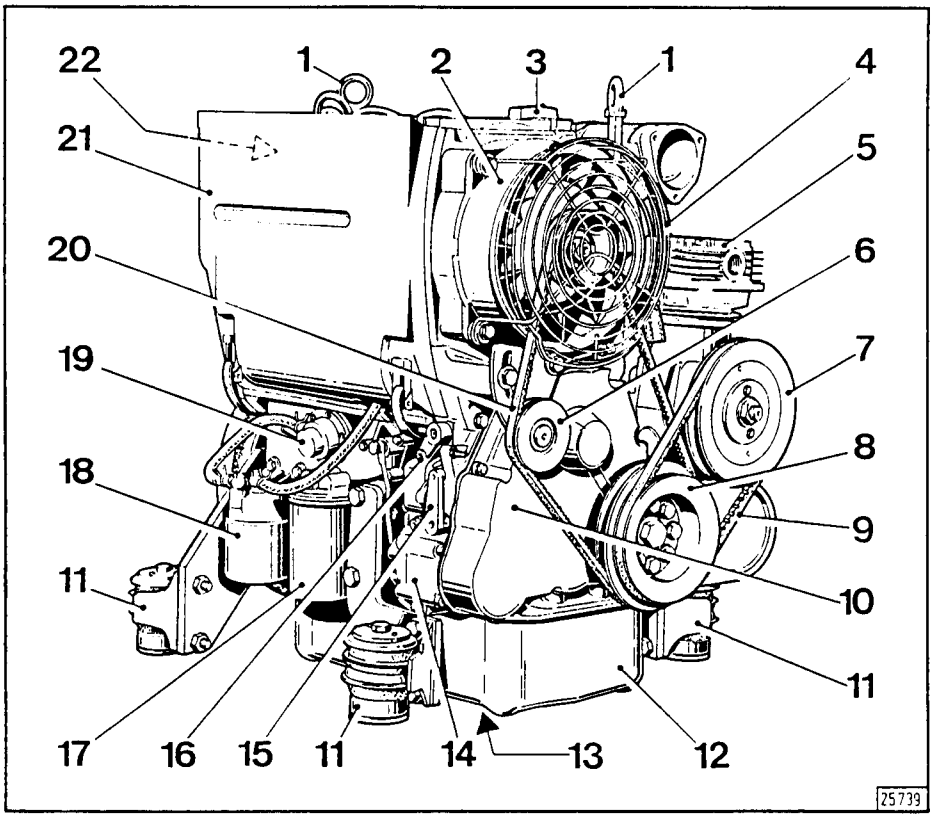
The engine serial number D is stamped into the crankcase as well as on the rating plate(s).

2.1.4 Numbering of Cylinders



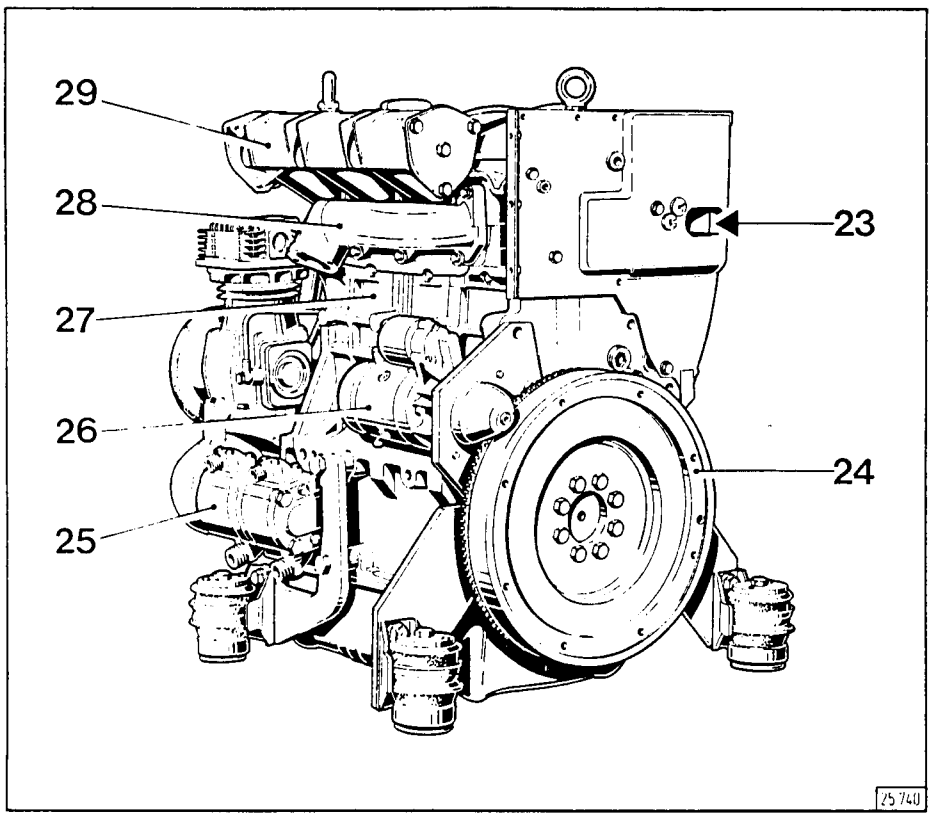
The cylinders are numbered consecutively, beginning at the flywheel end.

2.2 Engine Illustration



2.2.1 Service Side

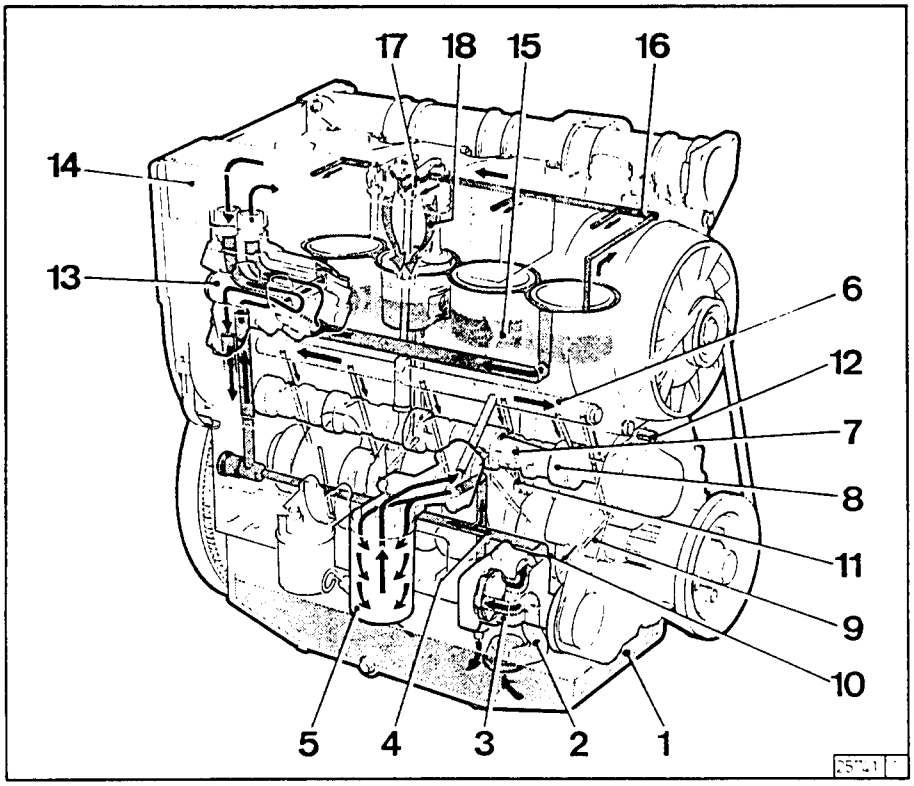
1 Lifting eyebolts
2 Cooling blower (with integrated alternator)
3 Oil filler neck
4 Guard
5 Air compressor
6 V-belt idler pulley
7 V-belt pulley (air compressor)
8 V-belt pulley (crankshaft)
9 Air compressor V-belt
10 Hood of toothed belt drive
11 Flexible engine mountings
12 Oil pan
13 Oil drain plug
14 Oil pump
15 Speed control lever
16 Shut-down lever
17 Oil filter
18 Fuel filter
19 Fuel pump
20 Cooling blower V-belt
21 Removable air cowling
22 Oil cooler



2.2.2 Exhaust-Air Side

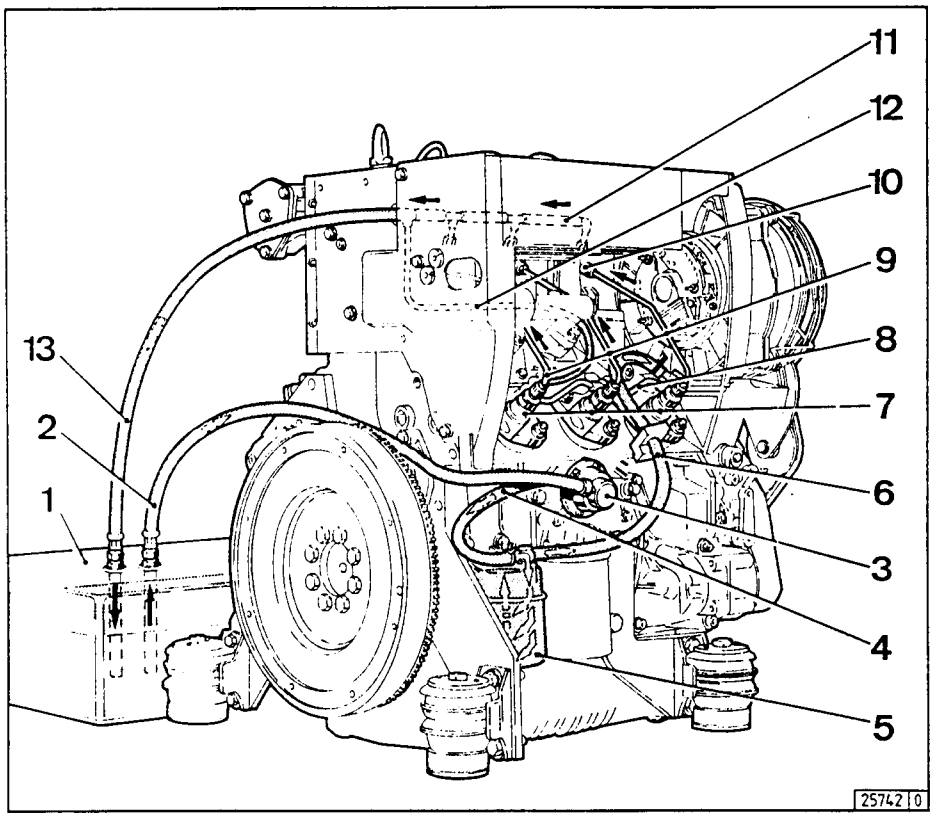
23 Cut-out for passage of lines (in case of engine-oil cab heating system)
24 Flywheel
25 Hydraulic pump
26 Starter motor
27 Cylinder crankcase
28 Exhaust manifold
29 Air intake manifold

2.3 Lube Oil Circuit



1 Oil pan
2 Suction pipe
3 Oil pump
4 Oil duct to oil filter and thermostat housing
5 Oil filter
6 Oil gallery
7 Oil bores to camshaft and main bearings
8 Camshaft bearing
9 Main bearing
10 Big-end bearing
11 Spray nozzle for piston cooling
12 Connection for air compressor lubrication
13 Thermostat housing
14 Oil cooler
15 Oil-cooled cylinder
16 Oil duct for lubrication of rocker arms
17 Rocker arm lubrication
18 Oil return via crankcase to oil pan

2.4 Layout of Fuel System



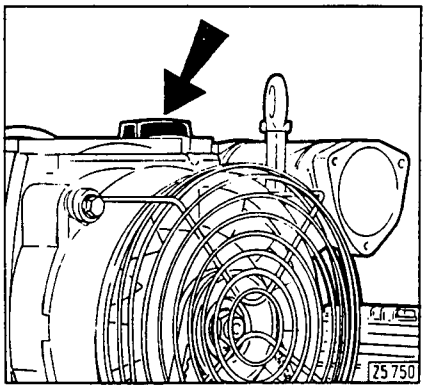
1 Fuel tank
2 Fuel line from tank to fuel feed pump
3 Fuel feed pump
4 Fuel line from feed pump to fuel filter
5 Fuel filter
6 Fuel line from filter to plug-in injection pump
7 Plug-in injection pumps
8 Fuel distribution line
9 Injection lines
10 Injectors
11 Fuel backleakage line
12 Fuel overflow line
13 Fuel return line to tank

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3.4 Stopping
3.5 Operating Conditions

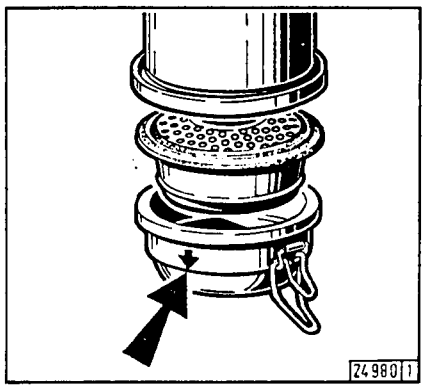
3.1 Commissioning

3.1.1 Filling in Engine Oil



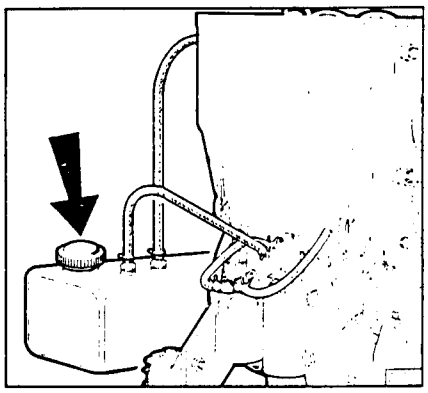
As a rule, the engines are delivered without oil filling.
Fill the engine with lube oil through the oil filler neck (arrow).
For oil filling volume, see 9.1
For oil quality grade and oil viscosity, see 4.1

3.1.2 Filling Oil Bath Air Cleaner with Engine Oil



Fill oil bath air cleaner (if mounted) with engine oil up to the arrow mark.

3.1.3 Filling the Fuel Tank



Use only commercial-grade diesel fuel. See 4.2 for fuel quality grade.
In accordance with ambient temperatures, summer or winter diesel fuel should be used.



Stop engine before filling fuel tank!
Observe strict cleanliness!
Do not spill any fuel!

3.1.4 Other Preparations

- Check battery and lead connections: see 6.7.1
- Remove lifting eyebolts, if mounted: see 6.7.2
- Trial Run
  Upon completing the preparations, run the engine for a short trial period of about 10 minutes without load.

  Steps to be taken during and after trial run:
  Check engine for leakages.
  Check oil level, top up with oil if necessary: see 3.1.1 and 6.1.2
  – Retension V-belts: see 6.5
- Running In
  Normally, new engines have a higher oil consumption. During the running-in phase, approx. 200 running hours, it is recommended to check the oil level twice daily. After the running-in phase, checking once a day will be sufficient.

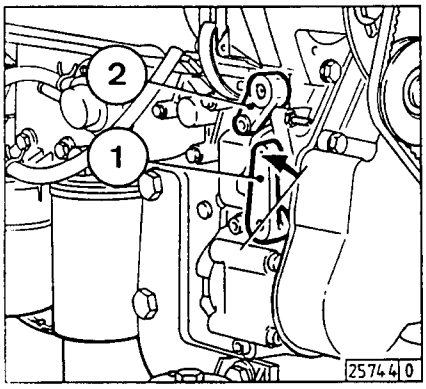
3.1.5 Additional Maintenance Jobs

After 50 running hours, the following maintenance jobs are to be carried out:

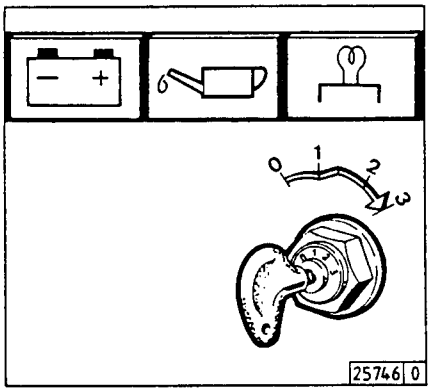
- Change lube oil: see 6.1.2
- Renew oil filter cartridge: see 6.1.3
- Renew fuel filter cartridge: see 6.2.1
- Check V-belt tension, retension if necessary: see 6.5
- Check valve clearances, readjust if necessary: see 6.6.1
- Check engine for leakages
- Check engine mountings, retighten if necessary: see 9.2

3.2 Starting

3.2.1 Electric Starting



- Disengage the clutch – where possible – to separate engine from driven equipment.
- Set speed control lever 1 to idling speed position.
- Set shut-down lever 2 to operating position.
- Insert key:
  Position 0 - No operating voltage.
- Turn key clockwise:
  – Position 1 = Operating voltage.
  Charging pilot lamp 3 lights up.
  Oil pressure pilot lamp 4 lights up.



without Cold-Starting Aid

- Push key in deeper and turn further clockwise against spring pressure as far as detent.
  – Position 2 = No function.
  – Position 3 = Start.
- Release key as soon as engine starts firing.
  – Pilot lamps go out.

Before starting , make sure that no-one is standing in the close vicinity of the engine or driven machine.
After carrying out repairs: Check that all safety guards have been refitted and all tools have been removed from the engine.
When starting with heating plug, do not use any additional starting aids (e.g. spraying of start pilot). Danger of accident!

with Cold-Starting Aid (Heating Plug)

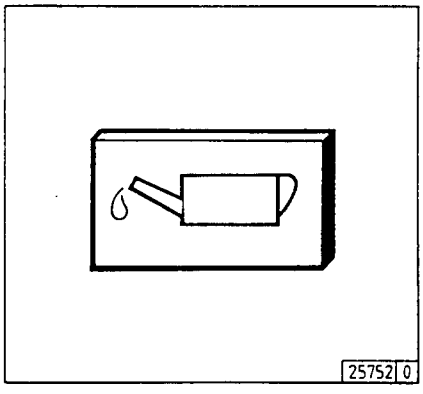
- Push key in deeper and turn further clockwise against spring pressure.
  – Position 2 = Preheating.
  Hold in position 2 for about 1 minute for preheating.
- Turn key further as far as detent.
  – Position 3 = Start.
- Release key as soon as engine starts firing.
  – Pilot lamps go out.

Do not actuate starter for more than 20 seconds at a time. If engine does not start, wait 1 minute before repeating attempt.
If engine does not start after two attempts, trace the cause with aid of Diagnosis Chart (see 7.1).

3.3 Monitoring Systems

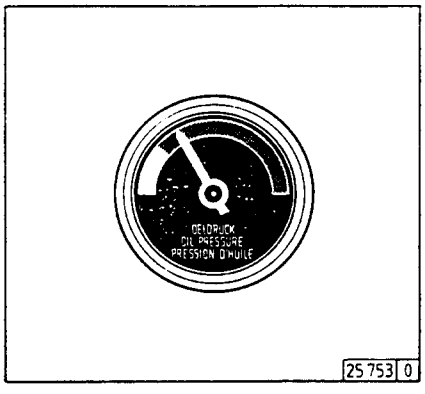
3.3.1 Engine Oil Pressure

Oil Pressure Pilot Lamp



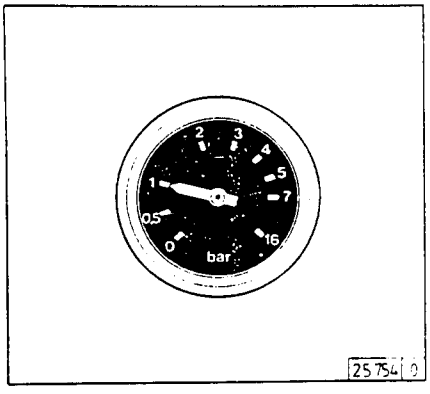
- The oil pressure pilot lamp lights up with operating voltage switched on but engine stopped.
- When the engine is running, the oil pressure pilot lamp must be out.

Oil Pressure Indicator



- The pointer of the oil pressure indicator must remain in the green sector over the entire operating range.

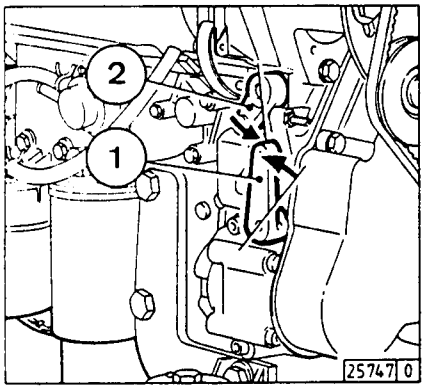
Oil Pressure Gauge



- The pointer of the oil pressure gauge must show the minimum oil pressure (see 9.1).

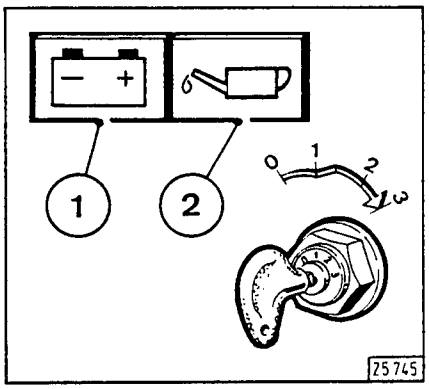
3.4 Stopping

3.4.1 Mechanical Shut-Down



- Set speed control lever 1 to low speed position.
- Actuate shut-down lever 2 until engine stops, whereupon charging pilot lamp and oil pressure pilot lamp light up.
- Turn key counter-clockwise (to postition 0) and withdraw. Pilot lamps go out.

3.4.2 Electrical Shut-Down (Ignition Key)



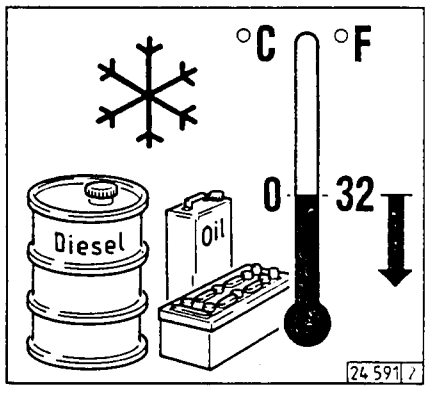
- Turn key counter-clockwise (to position 0) and withdraw. Pilot lamps 1 and 2 go out.

Do not shut engine down suddenly from full-load running.

3.5 Operating Conditions

3.5.1 Operation in Winter

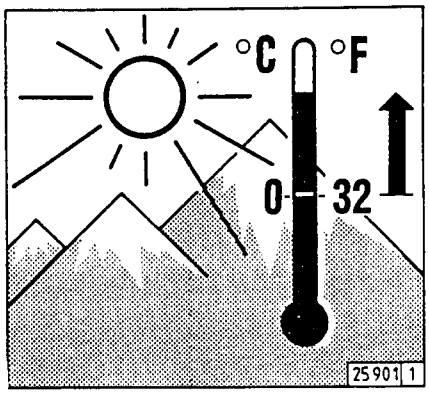
- Lube Oil Viscosity
  Select viscosity (SAE-grade) as governed by the ambient temperature prevailing at the time of starting the engine: see 4.1.2.
  Note shorter periods between oil changes when operating below – 10 °C (+ 14 °F): see 6.6.1.
- Diesel Fuel
  – Use winter-grade fuel for operation below 0 °C (+ 32 °F): see 4.4.2.
- Additional Maintenance Jobs
  – Drain the thick sludge from fuel tank once a week (by undoing the sludge drain plug).
  – Match the oil filling in oil bath air cleaner (if fitted) to ambient temperature, as in case of engine oil.
  – At temperatures below – 20 °C (– 4 °F), lubricate the flywheel ring gear with low-temperature grease, e.g. Bosch FT 1 V 31, from time to time through the pinion hole (if necessary, remove starter).
- Cold-Starting Aids
  – At temperatures near or below freezing point, start if necessary with heating plug: see 3.2.1.
  This not only lowers the starting limit temperature, but proves also useful at temperatures normally not requiring a starting aid.
- Battery
  – Cold starting requires a good state of charge of the battery: see 6.7.1.
  – Lowering the limit temperatures by 4 – 5 °C (39 – 41 °F) is possible by raising the battery temperature to about + 20 °C (+ 68 °F). This is achieved by removing the battery and storing it in a warm room.



3.5 Operating Conditions

3.5.2 High Ambient Temperature, High Altitude

- With increasing altitude and increasing ambient temperature, the density of the air tends to decrease. This has an effect on the maximum power output of the engine, the exhaust gas quality, the temperature level and, in the extreme case, the starting behaviour. For non-stationary engines, operation at altitudes up to 1000 metres is admissible (up to 30 °C [86 °F]). When operating under unfavourable conditions (higher altitude or higher temperature), a reduction in the amount of injected fuel, and therefore in the engine's power output, is necessary.
- In case of doubt concerning such engine applications, ask your engine or equipment supplier whether, in the interests of operational safety, service life and exhaust gas quality (smoke!), an engine derating had been considered necessary, or simply contact the DEUTZ SERVICE.



Operating Media

4.1 Lube Oil
4.2 Fuel

4.1 Lube Oil

4.1.1 Quality Grade

Lube oils are differentiated according to their efficiency and quality grade. Commonly used are the API-Specifications, named after the „American Petroleum Institute".

Approved Oils:

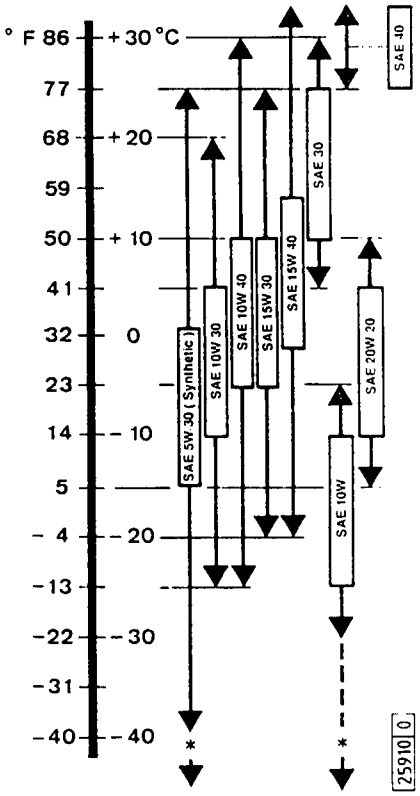
Unturbocharged Engines	API-Specific.	
	CC/SE	CC/SF
	CD/SE	CD/SF
Turbocharged Engines	API-Specific.	
	CD/SE	CD/SF
	SHPD*	

* SHPD (Super High Performance Diesel) oils are approved by KHD by name only, since a valid Specification has not yet been laid down. Should you have any doubt, ask the DEUTZ SERVICE.

Oil change intervals: see 6.1.1
Oil filling volumes: see 9.1.

4.1.2 Viscosity

As the viscosity of lube oil is greatly influenced by the temperature, the choice of SAE-grade should be governed by the ambient temperature at engine site. Optimum operating behaviour will be attained if you take as guide the oil viscosity diagram appearing alongside.
Should temperatures temporarily fall below the limits of the SAE-grade selected, this will merely affect the starting performance but cause no damage to the engine. Exceeding the application limits should not be over a prolonged period, in order to keep wear down to a minimum.
Oil changes dictated by the time of year can be avoided by using multi-grade oils. Multi-grade oils – particularly light-flowing oils – also tend to reduce fuel consumption.



4.2 Fuel

4.2.1 Quality Grade

Always use branded grades of diesel fuel having a sulphur content of below 0.5 %. In the case of a higher sulphur content, the periods between oil changes must be shortened: see 6.1.1.

The following fuel specifications are approved:

- DIN 51 601
- NATO Codes F 54, F 75 and F 76
- BS 2869: A 1 and A 2 (in case of A 2, note sulphur content)
- ASTM D 975-81: 1-D and 2-D
- VV-F-800a: DF-A, DF-1 and DF-2.

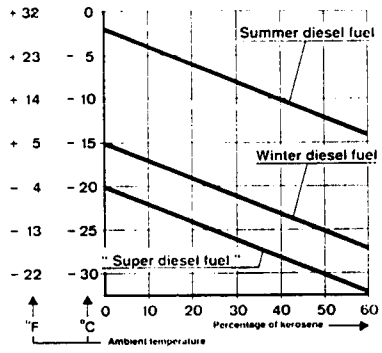
4.2.2 Winter-Grade Fuel

At low temperatures, waxing may occur and clog the fuel system, thus causing operational troubles. In the case of ambient temperatures below 0 °C (+ 32° F), use winter-grade diesel fuel (down to – 15 °C [+ 5 °F]). Normally, this is offered at filling stations in good time before the cold season starts. Diesel fuel with additives („Super diesel") is frequently also on sale for use at temperatures down to – 20 °C (– 4 °F).

- At temperatures as low as – 15 °C (+ 5 °F) to – 20 °C (– 4 °F), kerosene should be mixed with the diesel fuel. The necessary percentages for admixing are to be seen in the diagram at right.

If summer diesel fuel has to be used at temperatures below 0 °C (+ 32 °F), up to 60 % kerosene can be admixed (see diagram).

In most cases, adequate resistance to cold is also attained by adding a flow improver (fuel additive). Ask your DEUTZ SERVICE about this.



Prepare the blend in the tank itself!
Fill in the necessary amount of kerosene first, then add diesel fuel.

Routine Maintenance

5.1 Maintenance Schedule
5.2 Maintenance Chart
5.3 Completed Maintenance Jobs

5.1 Maintenance Schedule

In running hours (h) [1]									Check				See Section
Every 10 h resp. daily	Every									Clean			
											Renew		
	50[2]	125	250	500	750	1000	2000	3000				Job	
•									•			Oil level in engine/separate tank	6.1.2
	•								•			Engine for leakages	
•									•			Oil bath- and dry-type air cleaners [3][6]	6.4
		•							•			Battery and lead connections	6.7.1
		•	•	•		•	•		•			Cooling system (dep. on engine use)[3]	6.3
	•			•[4]	•[5]						•	Engine oil (dep. on engine use)	6.1.2
	•			•	•						•	Oil filter (dep. on oil change interval)	6.1.3
	•					•					•	Fuel filter	6.2.1
	•					•			•			Valve clearances (readjust if necessary)	6.6.1
	•								•			Engine mountings (retighten if necessary)	9.2
	•			•					•			V-belts (retension if necessary)	6.5
						•			•			Toothed belt	6.5.5
								•	•			Injectors	

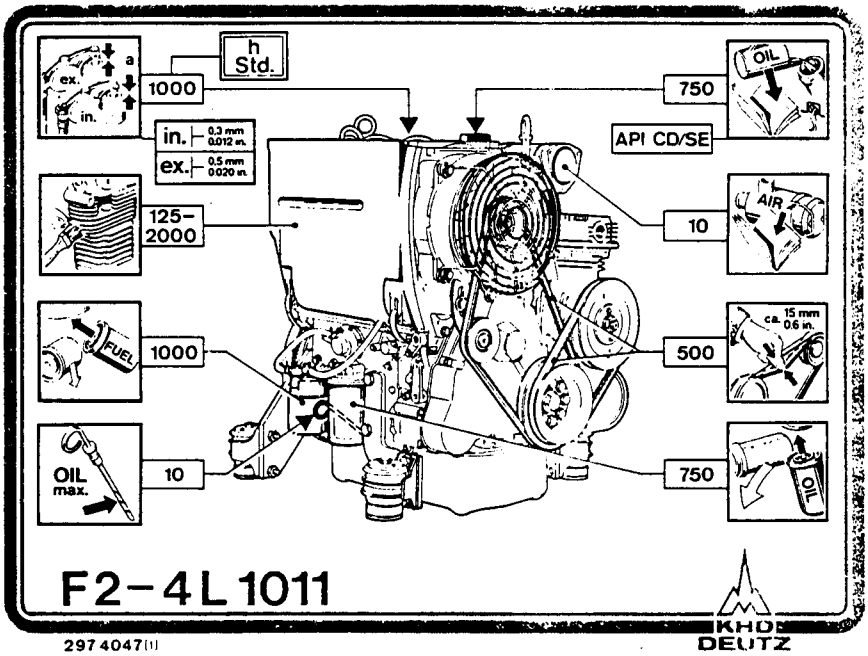
[1] Max. permissible guide-times
[2] Commissioning new and overhauled engines
[3] Clean if necessary
[4] Oil quality grade API: CC/SE
[5] Oil quality grade API: CD/SE
[6] Renew if necessary

5.2 Maintenance Chart

The Maintenance Chart displayed here is supplied as self-adhesive label along with each engine. Check that this label is stuck at a convenient location on the engine or driven equipment.

If necessary, ask for a fresh supply of labels.

Valid for routine maintenance work is the Maintenance Schedule: see 5.1



297 4047(1)

Stop engine before carrying out any maintenance work

5.3 Completed Maintenance Jobs

Hours	Date	Signature/Stamp	Hours	Date	Signature Stamp
*50			–		
125			250		
375			500		
625			750		
875			1000		
1125			1250		
1375			1500		
1625			1750		
1875			2000		
2125			2250		
2375			2500		
2625			2750		

The maintenance jobs duly completed can be recorded in the above table.
* Commissioning new and overhauled engines.

5.3 Completed Maintenance Jobs

Hours	Date	Signature/Stamp	Hours	Date	Signature/Stamp
2875			3000		
3125			3250		
3375			3500		
3625			3750		
3875			4000		
4125			4250		
4375			4500		
4625			4750		
4875			5000		
5125			5250		
5375			5500		
5625			5750		
5875			6000		
6125			6250		
6375			6500		
6625			6750		
6875			7000		
7125			7250		
7375			7500		
7625			7750		
7875			8000		
8125			8250		
8375			8500		
8625			8750		

The maintenance jobs duly completed can be recorded in the above table.

Service and Maintenance

6.1 Lubrication System
6.2 Fuel System
6.3 Cooling System
6.4 Combustion Air Cleaner
6.5 Belt Drives
6.6 Adjustments
6.7 Accessories

6.1 Lubrication System

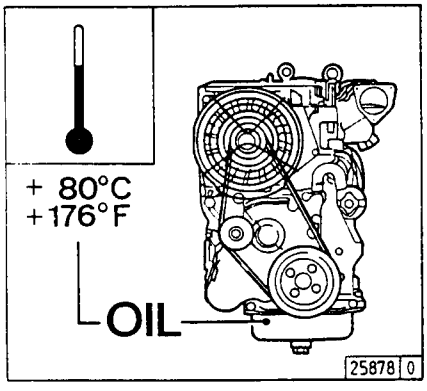
6.1.1 Oil Change Interval

- The oil change intervals are dependent on the engine application and on the quality of the lubrication oil.
- Should, within one year, the engine run less than the hours stated in the table, the oil must be changed at least once a year.
- The table is subject to the following conditions:
  - For diesel fuel, sulphur content max. 0.5 % b. w.
  - Prevailing ambient temperature above – 10 °C (+ 14 °F).
- In the case of sulphur content > 0.5 up to 1 %, or prevailing ambient temperatures being below – 10 °C (+ 14 °F), the intervals between oil changes are to be halved.
- In the case of fuels containing more than 1 up to 1.5 % sulphur, a lube oil with a TBN of 12 x % sulphur content must be used.

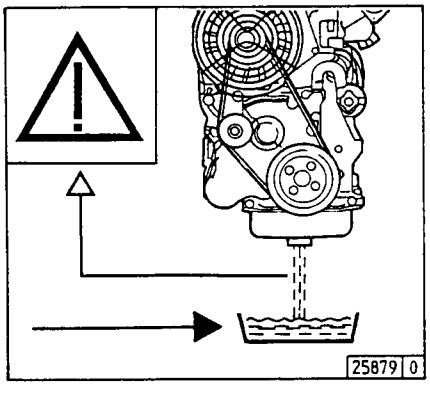
	Naturally Aspirated Engines	
Oil Grade	CC SE CC SF	CD SE CD SF
Equipment engines	Oil Change (running hours)	
Light duties, e.g.: Road vehicles, Tractors, Lift trucks, Cranes, Construction machinery, Rail traction units, Ships, Generating sets, Pumps	500	750
Heavy duties, e.g.: Combine harvesters, Underground mining, Road sweepers, Winter service, Emergency gensets, Emergency pumps	250	375

TBN = „Total Base Number": expresses the neutralising capacity of the oil. Ask your supplier to quote TBN.

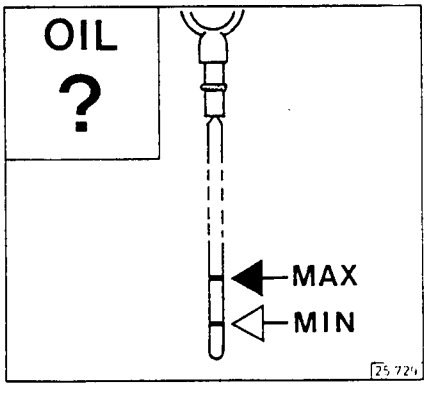
6.1.2 Changing Engine Oil
Checking Oil Level



- Position engine or vehicle on level surface.
- Set cab heater actuating lever to maximum heating capacity (only in the case of vehicles with engine oil-operated cab heater system).
- Warm up engine
  - lube oil temperature approx. 80 °C (+ 176 °F).
- Stop engine.



- Place oil tray under engine.
- Screw out oil drain plug.
- Drain oil.
- Refit oil drain plug complete with new sealing ring and tighten firmly. (For tightening torque, see 9.2)
- Fill in fresh lube oil.
  - Oil grade/viscosity: see 4.1
  - Filling volumes: see 9.1
- Start engine and run at low idling speed (for about 2 min. in case of oil-operated heater system).

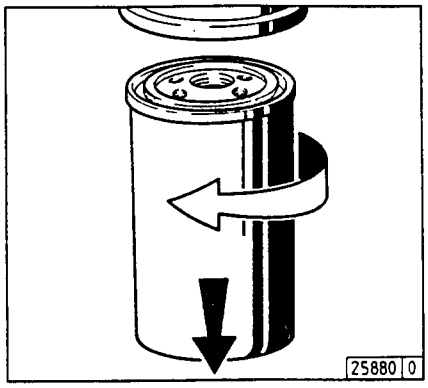


- Stop engine.
- Check oil level.
  - In case of oil dipsticks with double marking (● and –), the dash mark is applicable.
  - If necessary, top up with oil as far as the upper dash mark.

Take care when draining off hot oil: Danger of scalding!
Catch old oil in suitable receptacle ready for proper disposal to prevent environmental pollution!

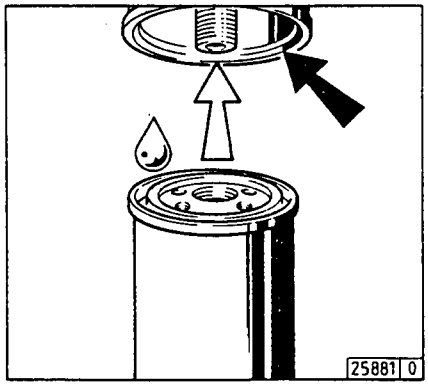
6.1 Lubrication System

6.1.3 Renewing Oil Filter

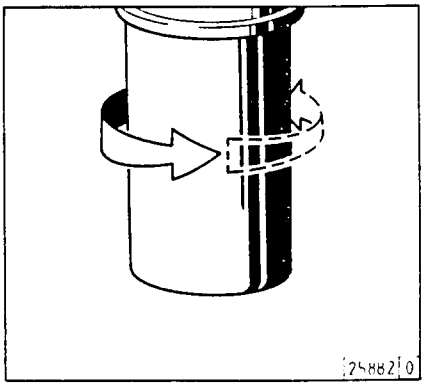


- Release lube oil filter cartridge with normal commercial tool and spin off.
- Catch any escaping oil in receptacle.

Beware of hot oil:
Danger of scalding!



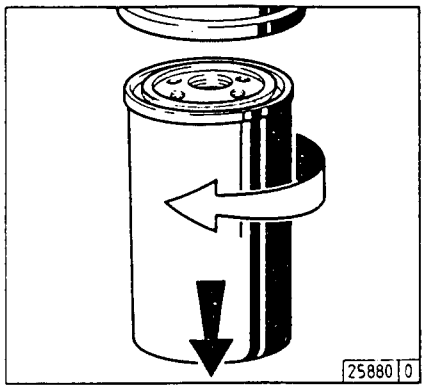
- Clean sealing surface of filter carrier.
- Apply light film of oil to rubber gasket of new lube oil filter cartridge.
- Screw cartridge into place by hand until gasket is evenly seated.



- Tighten lube oil filter cartridge firmly by giving a final half turn.
- Check oil level: see 6.1.2
- Check oil pressure: see 3.3.1
- Check sealing of lube oil filter cartridge for leaks.

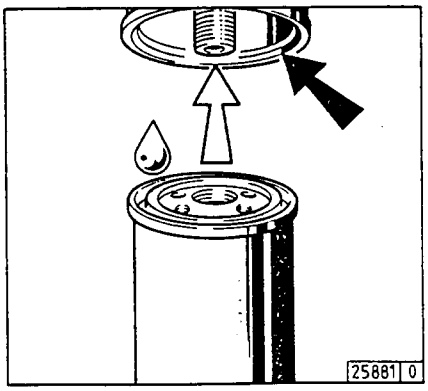
6.2 Fuel System

6.2.1 Renewing Fuel Filter

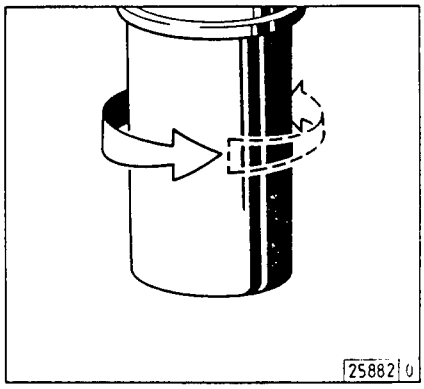


- Close fuel stopcock.
- Release fuel filter cartridge with normal commercial tool and spin off.
- Catch escaping fuel in receptacle.

When working on the fuel system, keep naked lights away! Do not smoke!



- Clean sealing surface of filter carrier.
- Apply light film of oil or diesel fuel to rubber gasket of new fuel filter cartridge.
- Screw cartridge into place by hand until gasket is evenly seated.



- Tighten fuel filter cartridge firmly by giving a final half turn.
- Open fuel stopcock.
- Check sealing for leaks.

Bleeding of the fuel system is not necessary.

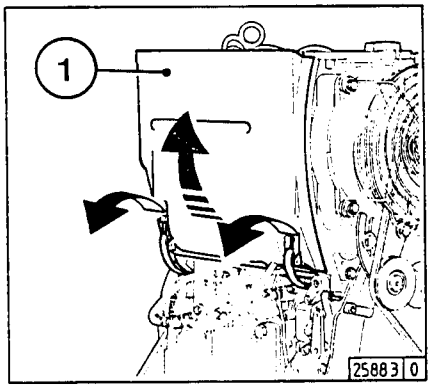
6.3 Cooling System

6.3.1 Cleaning Intervals

- The degree of soiling of the cooling system is dependent on the type of engine application.
- More severe contamination can occur, e.g. in case of:
  - Construction site application, due to heavily dust-laden air.
  - Harvesting work, due to the high proportion of chaff and chopped straw, for example, in the vicinity of the implement.
- The danger of contamination is increased due to residues of oil and fuel on the engine. Check extra carefully, therefore, for leakages when applications involve high dust fall-out.
- In view of the varying conditions of application, the cleaning intervals must be determined from case to case. The cleaning intervals stated in the table can be taken as guide values.

Checking or Cleaning Intervals Guide Values (running hours)	**Engine Application**
2000	Ships, Generating sets in closed rooms, Pumps
1000	Vehicles on paved roads
500	Tractors, Lift trucks, Mobile gensets
250	Vehicles on construction sites and unpaved roads, Construction machinery, Compressors, Underground mine units
125	Farm equipment, Tractors doing harvesting work

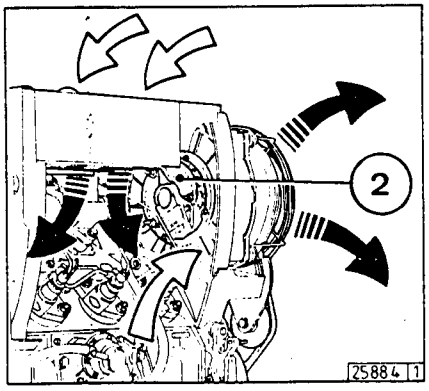
6.3.2 Cleaning the Cooling System



With Compressed Air

- Remove cooling-air cowling 1.
- Start blowing through the engine with compressed air from the exhaust-air side, paying particular attention to the cooling fins and oil cooler. Remove any dirt blown into the air cowling space.
- Remount cooling-air cowling 1.

Engine must be stopped and cooled down prior to cleaning!



With Cold Cleansing Agent

- Remove cooling-air cowling 1.
- Spray engine with a commercial cold cleansing agent and allow a soaking-in period of about 10 minutes:
- Wash engine clean with a powerful water jet (taking care to avoid direct contact of the water jet with sensitive engine components, e.g. alternator 2).
- Repeat procedure, if necessary.
- Remount cooling-air cowling 1.
- Run engine until warm, in order to prevent rust formation.

With High-Pressure Steam Jet

- Remove cooling-air cowling 1
- Clean engine with steam jet (taking care to avoid direct contact of the steam jet with sensitive engine components, e.g. alternator 2).
- Remount cooling-air cowling 1.
- Run engine until warm, in order to prevent rust formation.

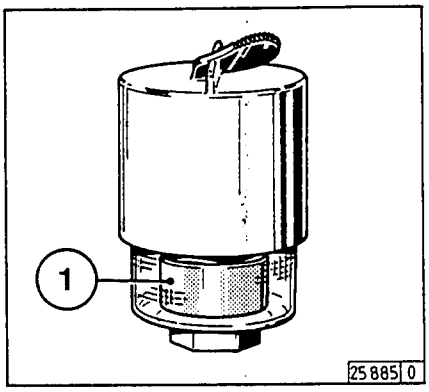
6.4 Combustion Air Cleaner

6.4.1 Cleaning Intervals

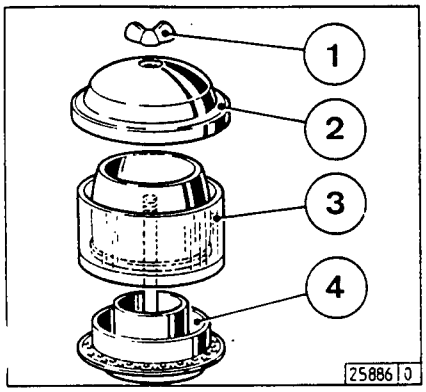
- The degree of soiling of the combustion air cleaner depends on the amount of dust in the air and the size of filter used. If very dusty air is to be expected, the combustion air cleaner can be preceded by a cyclone-type pre-cleaner.
- Consequently, the cleaning intervals cannot be laid down generally, but have to be determined from case to case.
- If dry-type air cleaners are used, cleaning should be carried out only when the service gauge indicates that servicing is due.
- Too frequent dismantling and refitting may damage the seal between filter cartridge and housing.

Servicing of the air cleaner becomes necessary if:

- with contamination indicator
  the red flag 1 is fully visible with engine stopped.
- with filter service trip
  – the yellow warning lamp lights up with engine running.



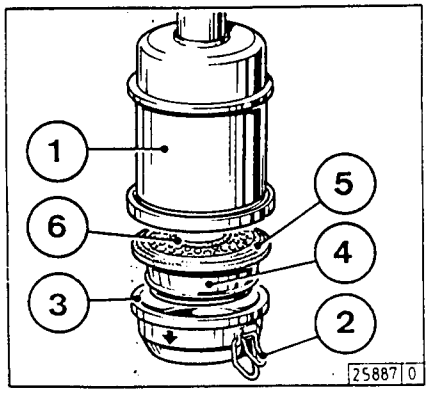
6.4.2 Emptying the Cyclone-Type Pre-Cleaner



- Undo wing nut 1 and take off housing cap. 2.
- Lift dust collector 3 off cyclone base 4 and empty. Clean cyclone base by removing leaves, straw, etc.
- Reposition dust collector 3 onto base 4 and fasten housing cap 2 in place by tightening wing nut 1.

Never fill dust collector with oil!
Renew dust collector if damaged!

6.4.3 Cleaning the Oil Bath Air Cleaner



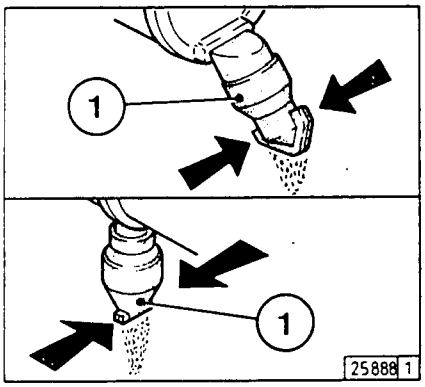
- Stop engine and wait about 10 minutes until the oil has run out of filter upper part 1.
- Release snap clips 2 and remove oil bowl 3 together with filter lower part 4, loosening filter element at joint by means of a screwdriver, if necessary. Do not damage rubber seal 5!
- After removing dirty oil and sludge, clean oil bowl.
- Rinse filter lower part 4 in diesel fuel and allow to drip-dry thoroughly.
- Clean filter upper part 1, if necessary.
- Inspect rubber seals 5 and 6, renewing if necessary.
- Fill oil bowl with engine oil up to oil level mark (arrow). For oil viscosity, see 4.1.2.
- Refit oil bowl and filter element to filter upper part and fasten snap clips.

Never rinse filter in petrol (gasoline)!
Dispose of used oil in compliance with statutory provisions.

6.4 Combustion Air Cleaner

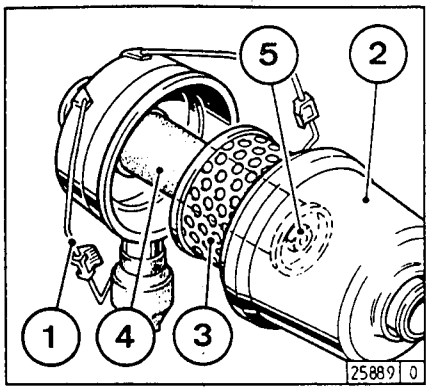
6.4.4 Dry-Type Air Cleaner

Dust Ejector Valve



- Discharge the dust ejector valve 1 by pressing apart the lips of the ejection slot, applying pressure as indicated by the arrows.
- Clean the ejection slot from time to time.
- Remove any cakes of dust by pressing together the upper part of the valve.

Filter Cartridges



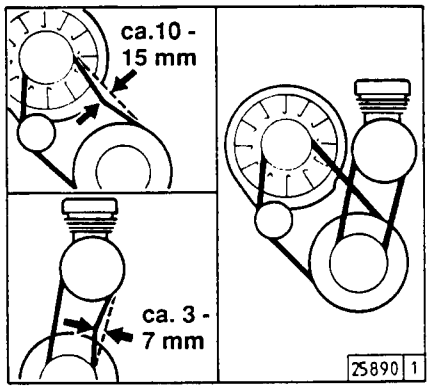
- Release fastening clamps 1.
- Take off filter hood 2 and pull out filter cartridge 3.
- Clean filter cartridge or renew after 1 year at latest.
- Clean filter cartridge 3:
  - With dry compressed air (max. 5 bar), applied from inside to outside, or
  - Tap out (emergency measure only), taking care not to damage cartridge, or
  - Wash out as per maker's instructions.
- Check cartridge for damage to filter paper (by introducing lighted lamp), and check seals. Renew, if necessary.
- After having serviced the filter cartridge five times, or after 2 years at the latest, renew safety cartridge 4 (never clean!).
  Proceed as follows:
  - Undo hex. nut 5 and pull out cartridge 4.
  - Insert new cartridge and secure with hex. nut.
- Insert filter cartridge 3, place on hood 2 and fasten with clamps 1.



In no event use petrol (gasoline) or hot liquids for washing the filter cartridge!

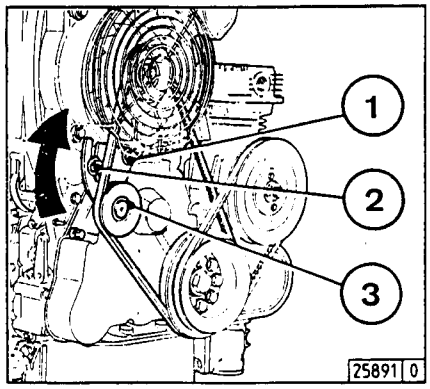
6.5 Belt Drives

6.5.1 Checking V-Belts



- Inspect V-belt over whole length for damage or cracks. Renew damaged or cracked V-belts.
- Check by pressing with the thumb midway between the pulleys to see whether the V-belt deflects inwards by not more than approx.
  10-15 mm - cooling blower or 3-7 mm-air compressor.
- If necessary, retension V-belt: see 6.5.2 and 6.5.4.

6.5.2 Retensioning Blower V-Belt

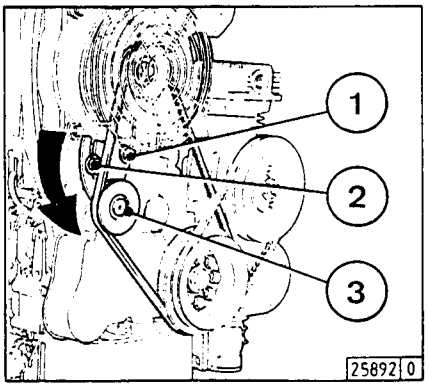


- Slacken hex. bolts 1 and 2.
- Push idler pulley 3 outwards until correct V-belt tension is attained.
- Retighten hex. bolts 1 and 2.



Stop engine before retensioning V-belts! If applicable, refit V-belt guard.

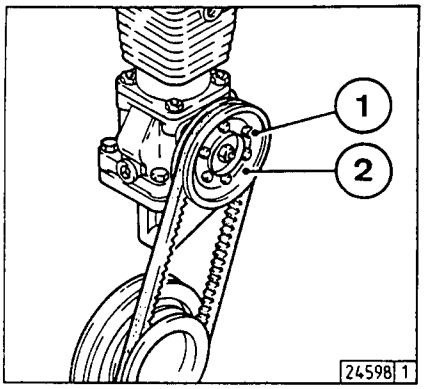
6.5.3 Renewing Blower V-Belt



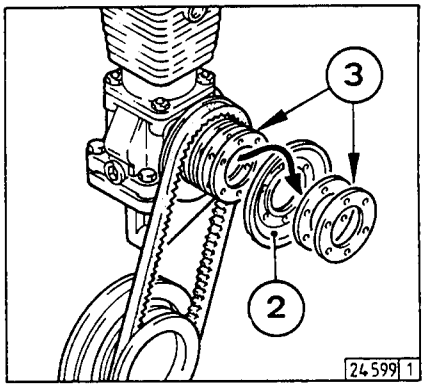
- If air compressor is mounted: First, remove compressor V-belt: see 6.5.4.
- Slacken hex. bolts 1 and 2.
- Push idler pulley 3 inwards.
- Remove V-belt and place on new belt.
- Push idler pulley 3 outwards until correct V-belt tension is attained.
- Retighten hex. bolts 1 and 2.
- If applicable, refit air compressor V-belt: see 6.5.4.

6.5 Belt drives

6.5.4 Retensioning or Renewing Air Compressor V-Belt



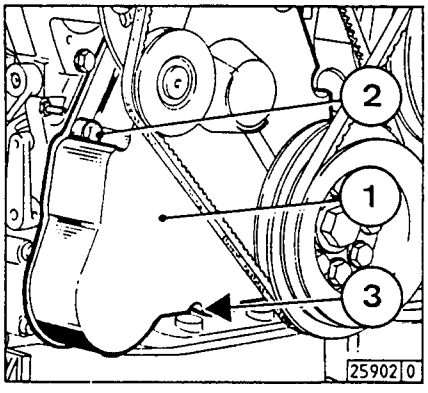
- Unscrew hex. bolts 1.
- Take off outer half-pulley 2.
- Renew V-belt if necessary
- To retension, remove one or more shims 3 – as may be required – from inside. Place removed shim(s) outside on removed half-pulley 2.



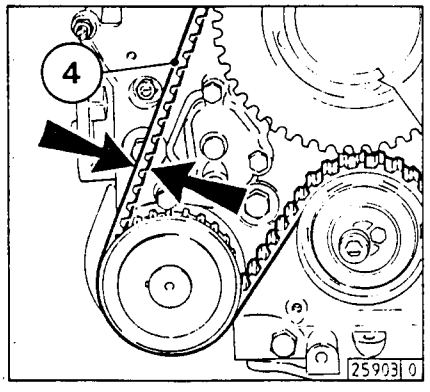
- Retighten bolts 1, while turning engine with turning tool to prevent the V-belt being squeezed.

In the case of new V-belts, recheck belt tension after running for 15 minutes.

6.5.5 Checking Toothed Belt

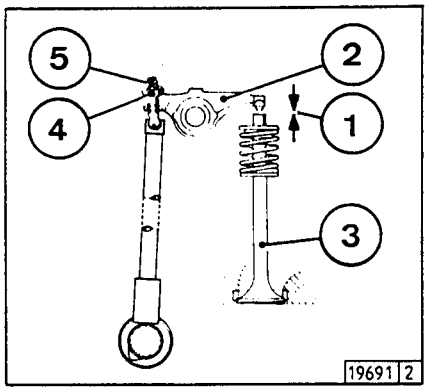


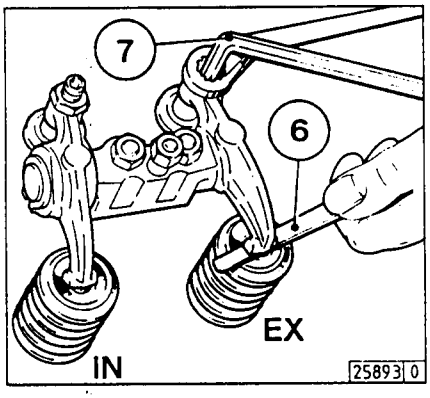
- Take off left-hand covering hood 1 of the toothed belt drive, after undoing hex. bolts 2 and 3.
- Check toothed belt 4 over whole length at tooth roots and tooth backs for cracks (see arrows).
- To do this, turn engine four revolutions with turning tool.



- If cracks are found, renew toothed belt (see Workshop Manual).
- Replace hood 1 and secure with hex. bolts 2 and 3.

6.6.1 Checking/ Adjusting Valve Clearances

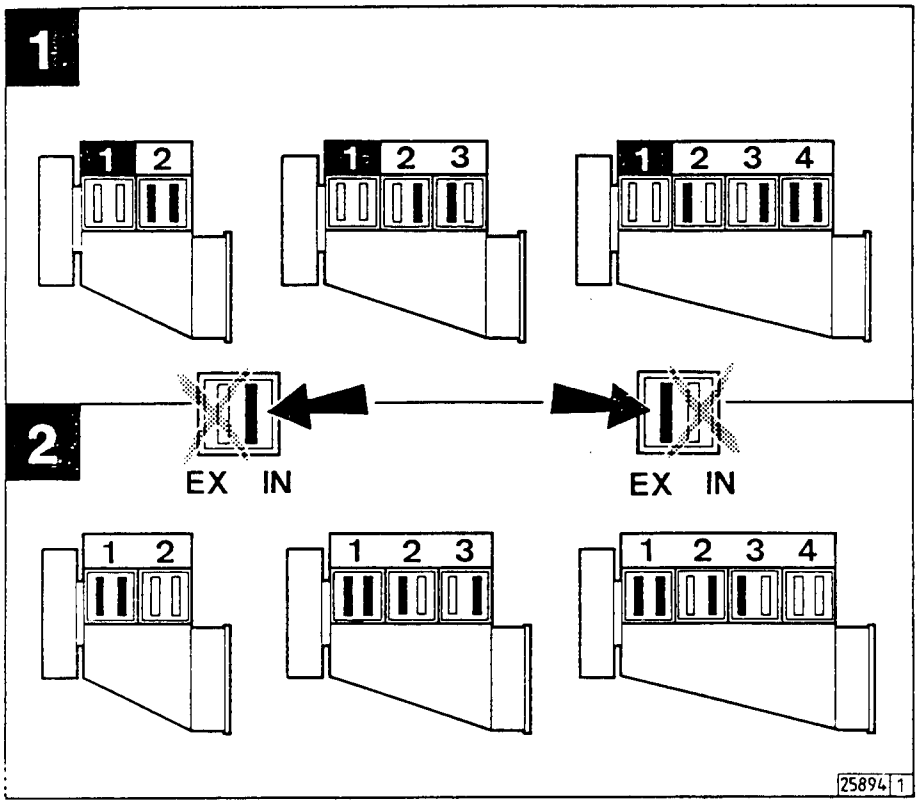




- Remove rocker cover.
- Position crankshaft as per setting schematic: see 6.6.1.1.
- Before adjusting valve clearance: Allow engine to cool down for at least 30 minutes (oil temperature below 80 °C (176 °F).
- Check valve clearance 1 between pad of rocker arm 2 and valve 3 with feeler blade 6 (clearance is correct if feeler blade can be inserted in gap with a slight drag).
  For permissible valve clearance, see 9.1.
- If necessary, adjust valve clearance as follows:
  - Loosen locknut 4 by 2 - 3 turns.
  - With Allen key 7 adjust setscrew 5 so that, when locknut 4 is retightened, the correct valve clearance is attained.
- Check the valve clearances at each of the remaining cylinders and adjust if necessary.
- Refit rocker cover with new seal.

6.6 Adjustments

6.6.1.1 Setting Schematic for Adjusting Valve Clearances



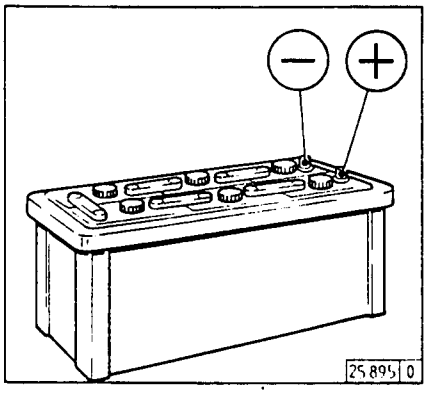
- Crankshaft Position 1:
  Turn the crankshaft until both valves at cylinder 1 are on „overlap" (i.e. exhaust valve about to close, inlet valve about to open).
  The valves marked black can now be adjusted.
  Mark each adjusted valve with chalk to show that it has been done.

- Crankshaft Position 2:
  Turn the crankshaft further by one rotation (360). The valves marked black can now be adjusted.

6.7 Accessories

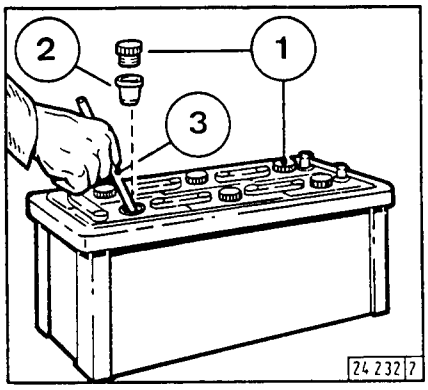
6.7.1 Battery

6.7.1.1 Checking Battery and Lead Connections



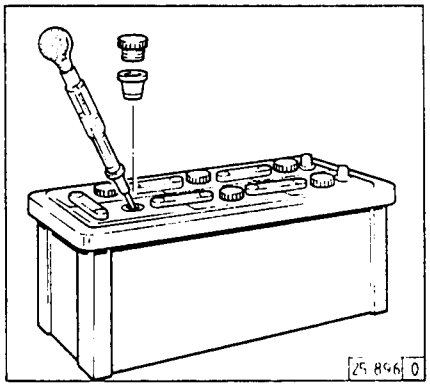
- Keep battery clean and dry.
- Undo soiled terminal clamps.
- Clean battery terminal posts (+ and −) and clamps, and treat with an acid-free and acid-resistant grease.
- When reconnecting, ensure good contact of the terminal clamps. Tighten clamping bolts firmly.

6.7.1.2 Checking Electrolyte Level



- Remove cell caps 1.
- If electrolyte level testers 2 are provided: the level should be high enough to wet the bottom of these.
- An alternative method is to insert a wooden stick 3 into the cell until it touches the top of the plates. The electrolyte should wet the stick over a length of about 10 - 15 mm.
- If the electrolyte level is low, top up with distilled water.
- Replace cell caps.

6.7.1.3 Checking Specific Gravity of Electrolyte



- Measure the specific gravity of the individual cells with a hydrometer.

  The measured values (see table alongside) indicate the state of charge of the battery.
  During the measurement, the temperature of the electrolyte should preferably read 20 °C (68 °F).

Specific Gravity				
in kg l		in °Be (°Baumé)*		State of Charge
Normal	Tropics	Normal	Tropics	
1.28	1.23	32°	27°	Fully charged
1.20	1.12	24°	16°	Half charged: Recharge
1.12	1.08	16°	11°	Discharged: Charge up immediately

* Measurement of the specific gravity in °Bé (Baumé) is obsolete and rarely used today.

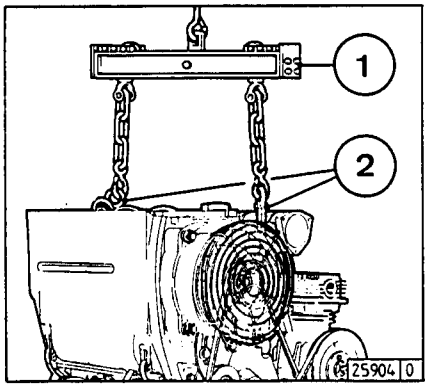
The gases emitted by the battery are explosive! Avoid formation of sparks in vicinity of battery, keep naked lights away!
Do not allow acid to come into contact with the skin or clothing! Wear protective goggles!
Do not place tools on battery!

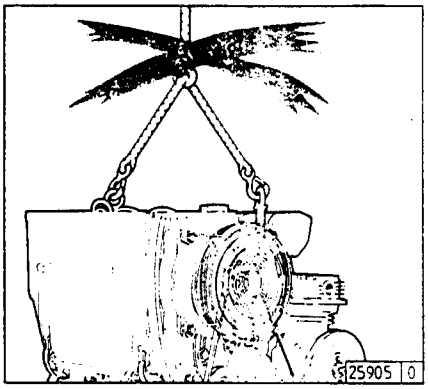
6.7 Accessories

6.7.2 Notes on three-phase system:

- When the engine is **running,** never disconnect the leads between battery, alternator and regulator. Where it is however necessary to operate the engine without battery, disconnect, before starting, the regulator from the alternator.
- Be sure not to confuse the battery terminals.
- Renew a defective charging pilot light bulb immediately.
- Before washing the engine, fit covers to protect the alternator and regulator.
- The common practice on a DC-system of touching a lead against frame for checking whether the lead is live must under no circumstances be adopted on a three-phase current system.
- In case of electric welding, connect the earth terminal of the welding unit direct to the part to be welded.

6.7.3 Lifting Tackle





- For transporting the engine, always use the correct lifting tackle 1.
- Upon completion of transporting manoeuvres, prior to recommissioning the engine: Remove lifting eyebolts 2.



Always use the correct lifting tackle!

Trouble Shooting

7.1 Diagnosis Chart

- If engine problems occur, they will frequently be caused by improper operation or maintenance of the engine.
- In case of any trouble, always check whether the operating and maintenance instructions have been observed.
- An appropriate Diagnosis Chart appears on the page opposite.
- If you cannot identify the cause of the trouble or are unable to put it right yourself, contact your DEUTZ SERVICE.

Trouble

Engine fails (or difficult) to start
Engine starts, but runs unevenly or stalls
Engine becomes too hot, temperature monitor gives warning
Engine gives poor performance
Engine not working on all cylinders
Engine has little or no oil pressure
Engine oil consumption excessive
Engine smokes - blue
- white
- black

Remedial Measure

Check	CH
Adjust	A
Renew	R
Clean	CL
Top up	TU
Lower level	LL

Cause	Section	
Not declutched (where possible)	Operation	CH
Below start limit temperature		CH
Oil level too low		TU
Oil level too high		LL
Excessive inclination of engine		CH
Wrong SAE-grade of engine oil and oil quality	Op. Media	R
Fuel quality not as quoted in Op. Manual		R
Air cleaner: Filter soiled	Combustion Air	R
Air cleaner: Contamination indicator/Filter service trip defective		R
Cooling fins soiled	Cooling System	CL
Cooling blower faulty, V-belt broken/loose		CH/R
Heating-up of cooling air/Recycling of heat		CH
Battery defective or flat	Electrics	CH
Connections of starter circuit loose/oxidized		CH
Starter faulty or pinion does not engage		CH
Valve clearances incorrect	Engine	A
Injection line leaky		CH
Injector defective		CH/R

Engine Preservation

8.1 Preservation

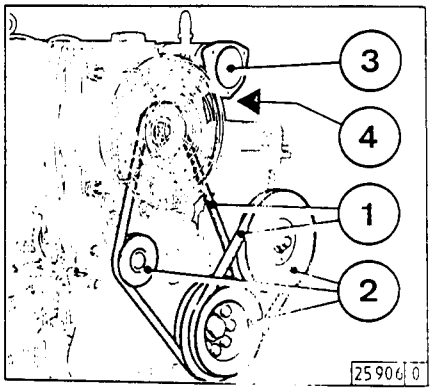
8.1 Preservation

If the engine is to be shut down for a major period, it is necessary to take preservative measures to prevent rust formation. The preservative measures described here will protect the shut-down engine for a period of up to about 6 months. Before re-using the engine, the preservatives must be removed, except from the oil and fuel.

- Anti -corrosive oils to Specification:
  - MIL-L-21260B
  - TL 9150-037/2
  - NATO Code C 640 / 642
- Anti-corrosive agent to Specification:
  - NATO Code C 632
- Recommended cleansing agent for removing preservatives:
  - Benzine
    (dangerous materials class A 3)

Preserving Engine:

- Clean engine with high-pressure steam jet (in case of need, cold cleansing agent): see 6.3.2.
- Warm up engine and stop.
- Drain engine oil: see Chapter 6, and fill in anti-corrosive oil.
- Clean oil bath air cleaner (if provided): see 6.4.3, and fill in anti-corrosive oil.
- Drain fuel out of tank.
- Prepare fuel mixture of 90 % diesel fuel and 10 % anti-corrosive oil and fill up tank.
- Run engine for about 10 minutes.
- Stop engine.
- Turn engine over several times by hand.
- Remove V-belts 1 and store in wrapped condition.
- Spray grooves of V-belt pulleys 2 with anti-corrosive agent, which must be wiped off before re-using engine.
- Close intake opening 3 and exhaust opening 4.



Removing Engine Preservatives:

- Remove anti-corrosive agent from the grooves of the V-belt pulleys 2.
- Fit V-belts 1. Retension later, if necessary, after short period of operation: see 6.5.
- Remove closures of intake opening 3 and exhaust opening 4.
- Engine now ready for operation.

Specification Data

9.1 Engine Specifications and Settings
9.2 Torque Wrench Settings

9.1 Engine Specifications and Settings

Model		F2L 1011	F3L 1011	F4L 1011
Number of cylinders		2	3	4
Cylinder arrangement		vertical, in-line		
Bore	mm	91	91	91
Stroke	mm	105	105	105
Piston displacement	cm^3	1366	2049	2732
Compression ratio		18.5	18.5	18.5
Working principle		4-stroke diesel		
Combustion system		direct injection		
Direction of rotation (facing flywheel)		counter-clockwise		
Weight incl. integrated cooling system (excl. starter, incl. alternator), approx.	kg	162	202	242
Power	kW (HP)	[1]	[1]	[1]
Speed	rpm	[1]	[1]	[1]
Lubrication system		forced-feed lubrication		
Min. oil pressure (engine warm, oil temp. ~ 100 °C [212 °F])				
at: 900 rpm (low idling speed)	bar	1.8	1.8	1.8
1800 rpm	bar	2.6	2.6	2.6
3600 rpm	bar	4.3	4.3	4.3
Oil capacity (initial filling), approx.	ltr. [2]	8.0	8.0	13.0
Oil capacity with filter renewal (standard 0.5 ltr.), approx.	ltr. [2]	6.5	6.0	10.5
Valve clearance	mm (in.)	inlet valve 0.3 (0.012)		
(engine left to cool down for at least 30 min.: oil temperature below 80 °C/176 °F)	mm (in.)	exhaust valve 0.5 (0.020)		
Injector working pressure	bar	250 [1][8]	250 [1][8]	250 [1][8]
Commencement of delivery	crank angle bTDC	[1]	[1]	[1]
Firing order		1-2	1-2-3	1-3-4-2

[1]) Engine power, speed and commencement of delivery are stamped on the rating plate (see also 2.1).
[2]) Approximate values, can vary depending on design. Decisive is always the upper oil dipstick mark. For engines with heating system, add about 1 ltr.

9.2 Torque Wrench Settings

Location	Preloading (Nm)	Tightening Nm 1st Stage	2nd Stage	3rd Stage	4th Stage	Total (Nm)	Note
Idler pulley/V-belt pulley	–	–	–	–	–	40 ± 4	
Rocker cover	–	–	–	–	–	9 ± 1	
Rocker arm setscrew	–	–	–	–	–	20 ± 2	
Mounting foot, rear (flywheel end)	–	–	–	–	–	106	
Mounting foot, front (blower end)	–	–	–	–	–	168	
Intake manifold	–	–	–	–	–	22 ± 2	TORX
Exhaust manifold	–	–	–	–	–	40 ± 4	TORX + Never Seize
Oil drain plug	–	–	–	–	–	55 ± 5	
Injector fastening	–	–	–	–	–	20 ± 2	TORX
Injector unio nut	–	–	–	–	–	45 ± 5	

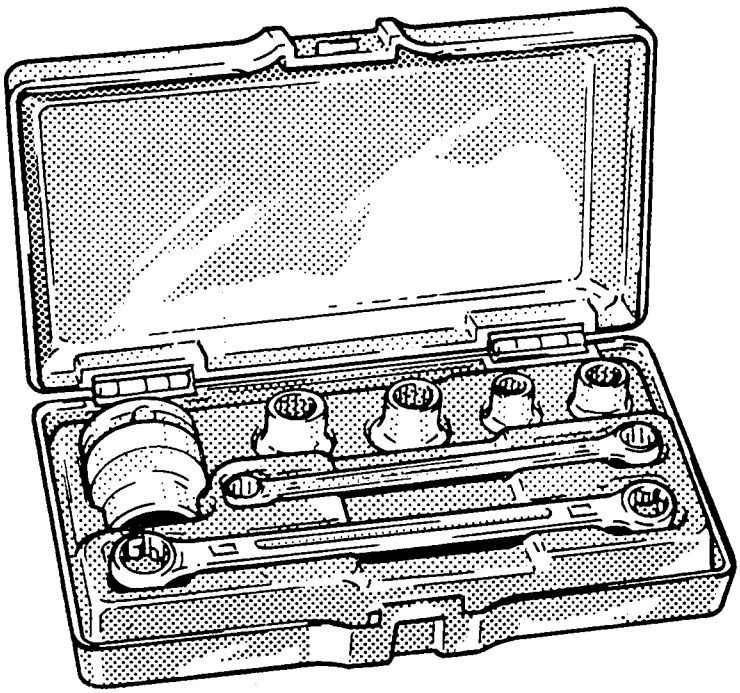
TORX Tools

The TORX bolt/screw fastening system, among others, is used on the engines FL 1011. This system was introduced in view of its many advantages:

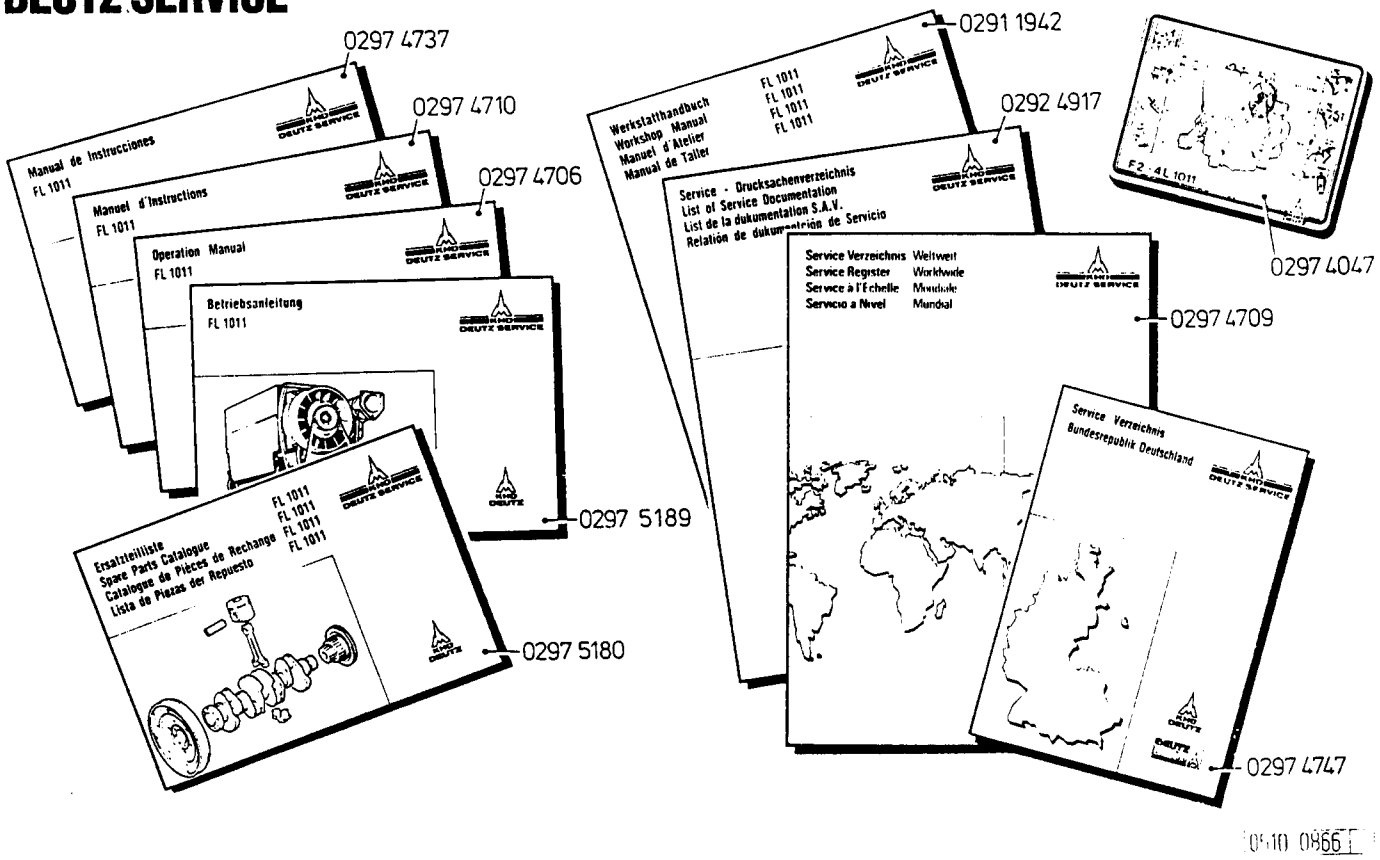
- Excellent access to the bolts/screws.
- Highly efficient torque transmission when loosening or tightening.
- Slipping or breaking of the wrench, and the danger of injury thereby involved, is practically ruled out.

TORX tools are obtainable as set under the Order No. 8189 from:

Messrs. WILBÄR
Postfach 140580
D-5630 Remscheid 1



DEUTZ SERVICE



0510 0866

Klöckner-Humboldt-Deutz AG
DEUTZ SERVICE
P. O. Box 80 05 09
D-5000 Köln 80

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	Telefax	(02 21) 822 2909			
	Telex	8812 253 KHD D			
Spare Parts	Telephone	(02 21) 822 5556	(02 21) 822 5557	(02 21) 822 5559	
	Telefax	(02 21) 822 2700			
	Telex	8812 251 KHD D			
Service	Telephone	(02 21) 822 3168			
	Telefax	(02 21) 822 5356			
	Telex	8812 241 KHD D			

Give us a ring and we shall furnish you with the address of the DEUTZ SERVICE outpost nearest to your facility.
A "Service Register – World" can be ordered under no. 0297 4709.

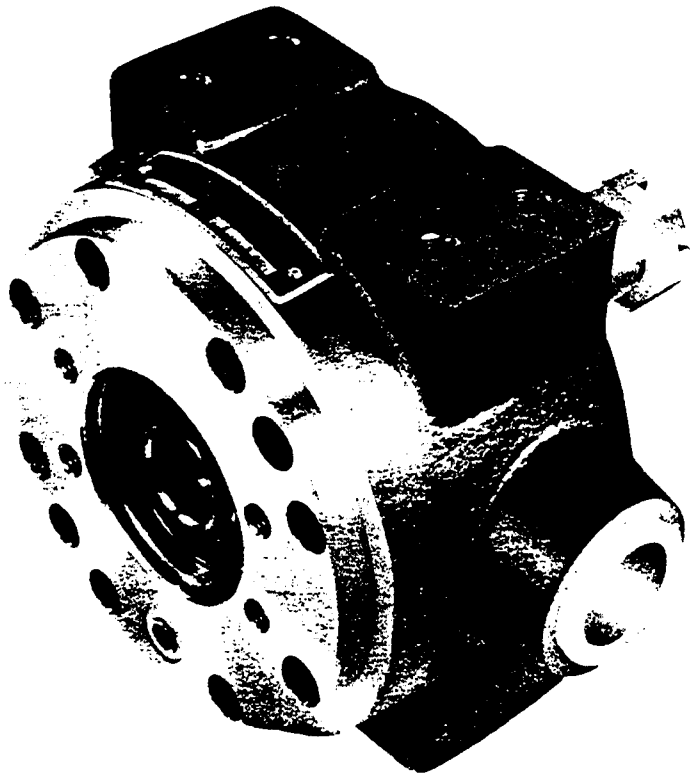
SERVICE Phone for technical questions: (02 21) 822 5454
Direct dial from 8.00 a.m. to 5.00 p.m.
At night, on weekends and holidays automatic phone answerer.
(We shall respond the next working day.)

SY·TEC SERIES

MULTIPLE DISC BRAKE

(trunnion)

SERVICE MANUAL mico

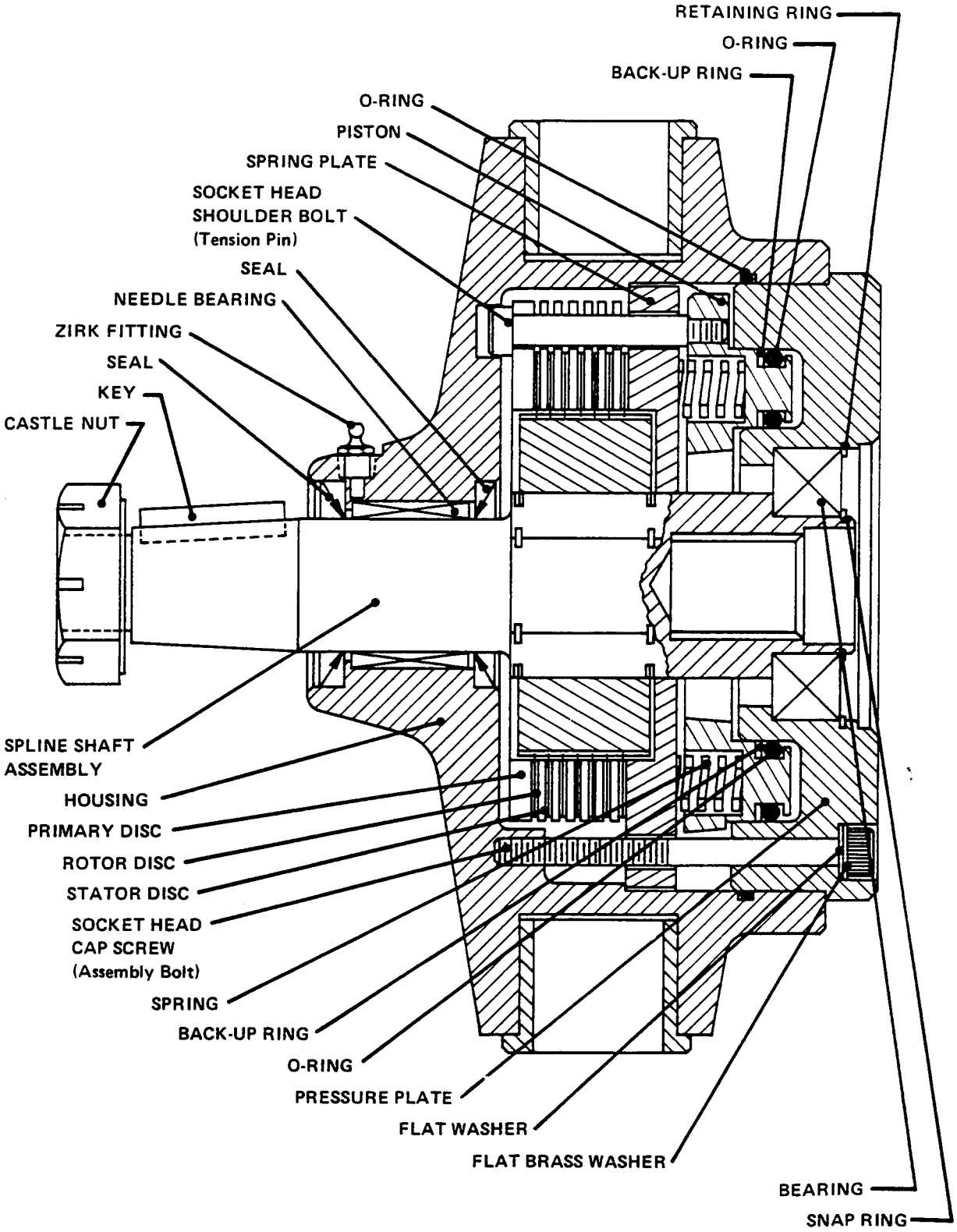


mico INCORPORATED

mico WEST / SY·TEC

REV.

TYPICAL BRAKE



REV.

PRINCIPLES OF OPERATION

These brakes are spring-set, hydraulically released, multi-disc brakes. They are used primarily for holding loads, vehicles, conveyors, etc. in place when the hydraulic drive system is shut down or fails. Although the brakes are rated at 3,000 psi, they only require 300 psi to make them function normally. The exact pressure required for operation is dependent upon the number of springs used to generate the torque necessary to hold the designed load. Thus, a brake with a full compliment of springs, will generate the highest level of torque and require approximately 300 psi to fully release the brake and provide adequate running clearance for the individual discs.

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

Two application examples:

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

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

DESCRIPTION OF MODEL NUMBERS



T - TRUNNION BRAKE

OUTPUT FACE
C - SAE C Mt. (4) Bolt

OUTPUT SPLINE
50 - 1.50 Taper Shaft

INPUT SPLINE
14 - 14T 12/24

TORQUE

Code	High	Release Pressure	Full Release Pressure
16	16,000	250	300

INPUT FACE
M - MAB & SAE A

DISASSEMBLY

1. Remove castle nut (26) and key (20) from output end of spline shaft assembly (19).
2. Remove 10 socket head assembly bolts (4) and flat washers (5 & 6). Washers (5) are brass. A suitable holding fixture is useful to keep brake in position.
3. Tap output end of spline shaft assembly (19) with a soft mallet to separate housing (22) from internal parts assembly.
4. Remove o-ring (21) from housing (22).
5. Needle bearing (24) and seals (23 & 25) will remain in housing (22). Inspect parts for wear and remove only if necessary.
6. Remove snap ring (1) from input end of spline shaft assembly (19).
7. Tap input end of spline shaft assembly (19) with a soft mallet to separate spline shaft from internal parts assembly. Bearing (3) and retaining ring (2) will remain in pressure plate (7).
8. Remove both and inspect for wear.
9. Remove four socket head shoulder bolts (18). A suitable holding fixture is useful to hold brake in position.

   CAUTION: Do not remove shoulder bolts without pressurization of brake (approx. 300 psi) or damage may result.
10. Remove primary disc (17), seven rotor discs (16) and six stator discs (15).
11. Remove spring plate (14).
12. Before removing spring (13), note pattern for reassembly purposes.
13. Separate piston (12) and pressure plate (7) by carefully exerting hydraulic pressure through brake release port on pressure plate.
14. Remove outside and inside o-rings (8 & 10) and outside and inside back-up rings (9 & 11) from piston (12).

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

ASSEMBLY

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

1. Use an alkaline wash to clean parts before assembly.
2. Install back-up rings (9 & 11) on piston (12) toward spring pockets.
3. Install o-rings (8 & 10) on piston (12). Be sure o-rings are flat and all twists removed.

   CAUTION: Care must be taken so as not to scratch or mar piston.
4. Lubricate piston (12) with type fluid found in the system. Carefully press piston into pressure plate (7). Be sure piston is aligned correctly at all times and that there are no extrusions. Press piston until it bottoms on pressure plate (7).
5. Install springs (13) according to pattern noted during disassembly.
6. Place spring plate (14) over springs (13).
7. Install stator discs (15) and rotor discs (16). Begin with a rotor disc (16) and alternate with stator discs (15).
8. Install primary disc (17).
9. Align discs and partially screw in four socket head shoulder bolts (18).

   NOTE: Socket head shoulder bolts (18) should have loctite applied. Apply one or two drops of Loctite to the threads.

   Inspect for free movement of stack. Align and center internal splined teeth such that shaft assembly (19) will engage rotors properly. Pressurize brake release port (approx. 300 psi) to release discs. Torque shoulder bolts to 20 ft. lbs. and release pressure. A suitable holding fixture is useful to hold brake in position.
10. Install spline shaft assembly (19) through stack input end first and out pressure plate (7).
11. Install bearing (3) and retaining ring (2) in pressure plate (7).
12. Install snap ring (1) on input end of spline shaft assembly (19).
13. If seals (23 & 25) and needle bearing (24) were removed from housing (22) they must be installed. Note direction of both seals.
14. Install o-ring (21) in housing (22).
15. Install housing (22) with the internal parts assembly using 10 socket head assembly bolts (4) and flat washers (5 & 6).

    NOTE: The ten socket head assembly bolts (4) should have Loctite applied. Apply one or two drops of Loctite to the threads.

    Washers (5) are brass and should be installed first on the bolts. Torque bolts to 35 ft. lbs.
16. Install castle nut (26) and key (20) on output end of spline shaft assembly (19).

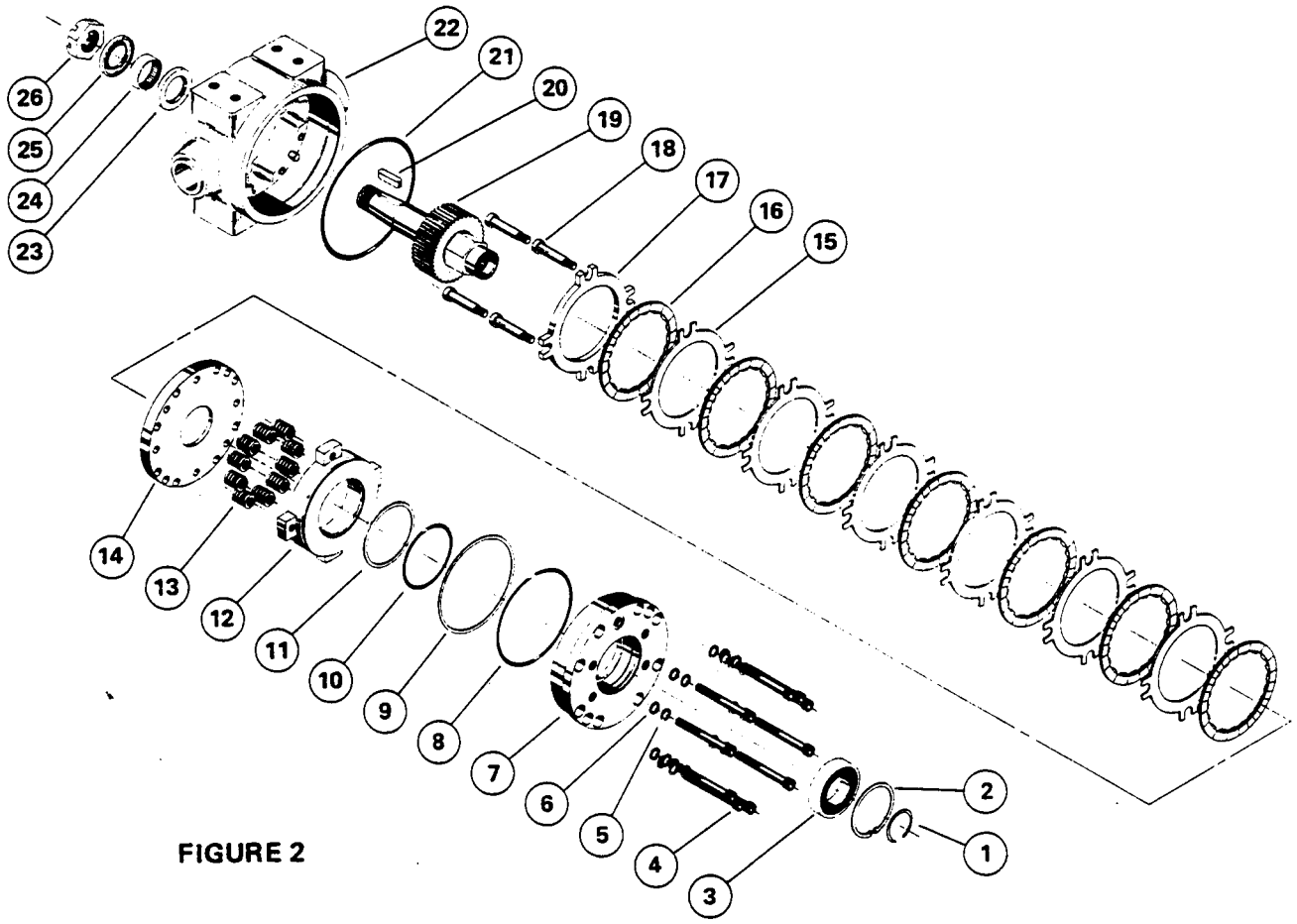


FIGURE 2

PARTS LIST

ITEM	DESCRIPTION
1	SNAP RING
2	RETAINING RING
3	BEARING
4	SOCKET HEAD CAP SCREWS (10) (Assembly Bolts)
5	FLAT BRASS WASHERS (10)
6	FLAT WASHERS (10)
7	PRESSURE PLATE
8	O-RING
9	BACK-UP RING
10	O-RING
11	BACK-UP RING
12	PISTON
13	SPRINGS (10)
14	SPRING PLATE
15	STATOR DISCS (6)
16	ROTOR DISCS (7)
17	PRIMARY DISC
18	SOCKET HEAD SHOULDER BOLTS (4) (Tension Pins)
19	SPLINE SHAFT ASSEMBLY
20	KEY
21	O-RING
22	HOUSING
23	SEAL
24	NEEDLE BEARING
25	SEAL
26	CASTLE NUT

BLEEDING

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

SERVICE DIAGNOSIS

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

REPAIR KITS

NUMBER	DESCRIPTION	INCLUDES
12-501-026 (66971)	O-ring and Back-up Ring Kit	Flat Brass Washers (items 5) Seals (items 23 & 25) O-rings (items 8, 10, & 21) Back-up Rings (items 9 & 11) Loctite
12-501-106 (67646)	Lining Kit	Flat Brass Washers (items 5) O-ring (item 21) Primary Disc (item 17) Stator Discs (items 15) Rotor Discs (items 16) Loctite
12-501-108 (67659)	Bearing Kit	Flat Brass Washers (items 5) O-ring (item 21) Seals (items 23 & 25) Bearings (items 3 & 24) Loctite
12-501-114 (67653)	Spring Kit	Flat Brass Washers (items 5) O-ring (item 21) Springs (items 13) Loctite

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.