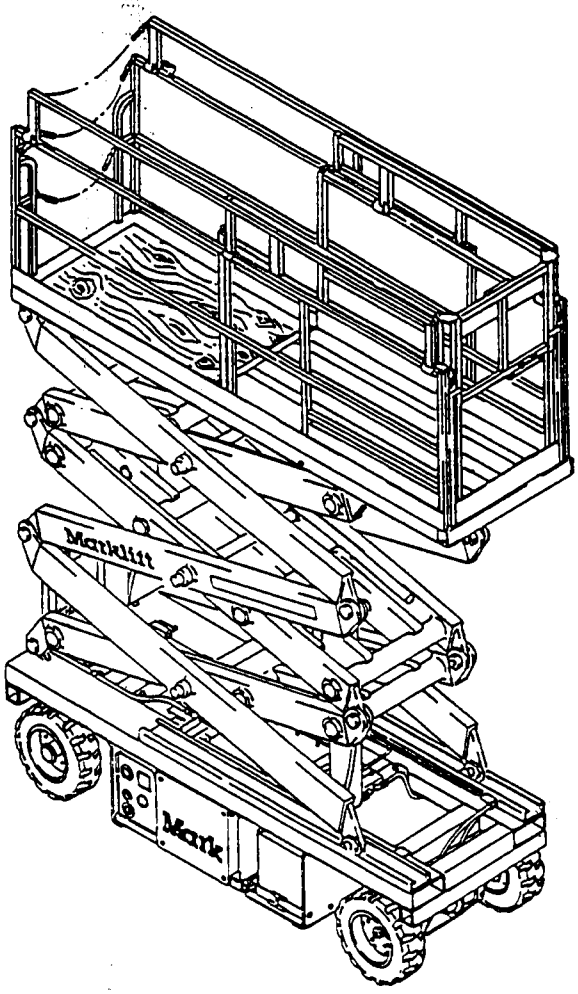
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED SCISSOR OPERATION MAINTENANCE AND PARTS MANUAL



MODELS:
M20EST
M20ESEP

FINAL EDITION
JUNE 1990

Mark Industries

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

17227

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The purpose of this manual is to provide the customer with operation,safety, maintenance and parts information that will enhance the reliable performance of the **MARKLIFT**. Schematic and vendor information is also furnished. If additional information is needed, we urge the customer to contact the local authorized MARKLIFT dealer. If this is not possible, please contact the Mark Industries Customer Service Engineering Department at (714) 879-MARK.

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

The model capacity, pressure settings and serial number can be found on the ID plate mounted the frame assembly.The serial number should be used whenever ordering parts. This will help our parts department provide 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(s)	
	M20ESEP	M20EST
Height –		
Working (maximum)	26' (7.92m)	26' (7.92m)
Platform (maximum)	20' (6.09m)	20' (6.09m)
Platform (minimum)	42.25" (1.07m)	45.75" (1.16m)
Length (overall)	96" (2.43m)	96" (2.43m)
Width (overall)	30" (.76m)	30" (.76m)
Platform –		
Dimensions (inside)	28.5" x 93.5" (.72m x 2.37m)	28.5" x 93.5" (.72m x 2.37m)
Extendable/traveling	36" forward (.91m) (manually)	48" forward (1.22m) 24" rear (.61m) (powered)
Safety rails	42" up (1.07m)	42" up (1.07m)
(Foldable)	34.75" down (.77m)	30.5" down (.77m)
Toeplate	4" (.10m)	6" (.15m)
Load capacity (evenly distributed)	750 lbs. (340kg)	750 lbs. (340kg)
Wheelbase	67.75" (1.72m)	67.75" (1.72m)
Wheel track	25"(.64m)	25"(.64m)
Turning Radius (inside)	7'7" (2.31m)	7'7" (2.31m)
Drive speed		
Low	1.3 mph (2.09 km/hr)	1.3 mph (2.09 km/hr)
High	2.5 mph (4.02 km/hr)	2.5 mph (4.02 km/hr)
High Speed cut-out	7' (2.13m)	7' (2.13m)
Lift/lower speed (maximum load)	53/23 seconds	53/23 seconds
Power System	24 VDC	24 VDC
Battery Voltage	6 VDC	6 VDC
Capacities		
Battery	250 amp/hr (4)	250 amp/hr (4)
Hydraulic tank	13 gal. (49.2 l)	13 gal. (49.2 l)
Battery charger	40 amp	40 amp
Tire size	4x8 solid	4x8 solid
Shipping Weight	3550lbs (1610kg)	3590lbs (1628kg)
Shipping cube	135 cu. ft. (3.82 m^3)	141.67 cu. ft. (4.01 m^3)

Specifications are nominal and are subject to change due to continual design improvements.

MANUFACTURERS' LIMITED WARRANTY

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

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

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

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

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

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

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

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

Warranty effective as of 2/90

Mark Industries

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

714-879-6275 800-448-MARK

TELEX 194402 FAX 1-714-879-8884

WARRANTY REGISTRATION

Purchaser/Dealer:

Company Name:

Address:

Telephone:

Date shipped (from invoice):

Date shipment received:

Date unit put into service:

Unit will be placed in rental fleet:

Unit will be sold:

Unit will be used for:

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

Comments: _____

Inspection completed by: Title:

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

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.

		YES	NO	NA
1.	Platform capacity decal _____. lbs.	☐	☐	☐
2.	All warning, caution and emergency decals installed	☐	☐	☐
3.	Operation instructions properly installed	☐	☐	☐
4.	Operation and safety handbook received	☐	☐	☐
5.	All controls (aerial & ground) are identified and operate correctly	☐	☐	☐
6.	Stop switches operate properly (aerial & ground)	☐	☐	☐
7.	Platform guard rails and other hardware, secure and undamaged	☐	☐	☐
8.	Platform access gate works properly	☐	☐	☐
9.	Horn and beacon operate properly	☐	☐	☐
10.	110V generator operates properly	☐	☐	☐
11.	Brakes adjusted and operate correctly	☐	☐	☐
12.	Circuit breakers operate properly	☐	☐	☐
13.	All hydraulic cylinders free of leaks	☐	☐	☐
14.	All hydraulic cylinder rods free of paint or scratches	☐	☐	☐
15.	Hydraulic pump free of leaks	☐	☐	☐
16.	Hydraulic hoses and fittings tight	☐	☐	☐
17.	Hydraulic oil to proper level	☐	☐	☐
18.	Hydraulic tank and fittings free of leaks	☐	☐	☐
19.	Drive motors free of leaks	☐	☐	☐
20.	Wheel lug nuts torqued to _____. Ft. lbs	☐	☐	☐
21.	Battery water level _____.	☐	☐	☐
22.	Manual overrides operate properly	☐	☐	☐
23.	All electrical connections tight	☐	☐	☐
24.	Valve manifold and fittings free of leaks	☐	☐	☐
25.	Emergency descent valve functions properly	☐	☐	☐
26.	System pressure (PSI) P1 _____ P2 _____.	☐	☐	☐
27.	Stand-by pressure _____. PSI	☐	☐	☐
28.	Tire pressure _____. PSI	☐	☐	☐
29.	Drive wheel, torque hub oil level _____.	☐	☐	☐
30.	Engine R.P.M at idle _____ at high throttle _____.	☐	☐	☐
31.	Turret rotation gear box oil level _____.	☐	☐	☐
32	Turret ring gear bolts torqued to _____ Ft. lbs	☐	☐	☐
33.	Base ring gear bolts torqued to _____ Ft. lbs	☐	☐	☐
34.	Engine coolant (radiator) to proper level	☐	☐	☐
35.	Coolant hoses and fittings free of leaks	☐	☐	☐
36.	Electric radiator fan operates properly	☐	☐	☐
37.	Fuel tank and fitting free of leaks	☐	☐	☐
38.	Muffler is tight and free of leaks	☐	☐	☐
39.	Engine oil to proper level	☐	☐	☐
40.	Engine oil filter free of leaks	☐	☐	☐
41.	Engine alternator functions properly	☐	☐	☐
42.	Retraction cable tension _____ Ft. lbs	☐	☐	☐

MODELS
SERIAL NUMBER
INSPECTOR

OPTIONS

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

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

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

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

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

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

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

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

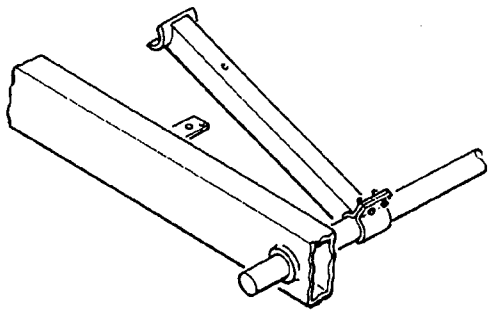
17. **Do Not** raise or lower scissor into objects.

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

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

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

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



TITLE 8 DIVISION OF INDUSTRIAL SAFETY 358.38.113
(Register 73, No. 30—7-28-73)

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

2946. Provisions for Preventing Accidents Due to Proximity to Overhead Lines.

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

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

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

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

TABLE X
Required Clearances from Overhead High-Voltage Lines

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

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

Article 86. Provisions for Preventing Accidents

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

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

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

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

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

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

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

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

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

P/N	DESCRIPTION	LOCATION	QTY
67639	Decal Set	All Standard Decals	1
2002	Forklift Boot	Final Assy	2
2003	Battery Water Level	Final Assy	1
2014	Caution High Voltage Line	Aerial Control Panel	1
2016	Do Not Work Under...	Final Assy	2
2017	Hydraulic System Fluid	Final Assy	2
2041	Do Not Lift This End...	Final Assy	1
20661	ANSI A92 Plate	Final Assy	1
31259	**MARKLIFT**	Final Assy	2
182737	Operation Instructions	Final Assy	1
11064	Attach Safety Chains Before...	Final Assy	1
130606	Freewheeling Valve	Final Assy	1
130820	Operation & Safety Handbook	Final Assy	1
32368	M-Series	Final Assy	1
130596	A Product of Mark Industries	Final Assy	2
130505	Ground Control Box	Ground Control Box	1
2023	Load Capacity 750 lbs.	Final Assy	2
20660	Identification Nameplate	Final Assy	1
181720	M20ESEP	Final Assy	1
182718	Aerial Control Box	Aerial Control Panel	1
130796	Horn & Fuel Upper Control	Aerial Control Panel	1
185707	Power to Platform 110 VAC	Final Assy	1
130782	Upper Control Box Drive	Upper Control Box	1

P/N	DESCRIPTION	LOCATION	QTY
600301	Decal Set	All Standard Decals	1
20660	Identification Nameplate	Final Assy	1
2002	Forklift Boot	Final Assy	2
2017	Hydraulic System Fluid	Final Assy	1
2003	Battery Water Level	Final Assy	1
31259	MARKLIFT	Final Assy	2
2023	Load Capacity 750 lbs.	Final Assy	4
20661	ANSI A92 Plate	Final Assy	1
182737	Operation Instructions	Final Assy	1
2016	Do Not Work Under...	Final Assy	2
31109	Caution Scissor Guard Rail...	Final Assy	2
181721	M20EST	Final Assy	2
130606	Freewheeling Valve	Final Assy	1
2041	Do Not Lift This End...	Final Assy	1
11064	Attach Safety Chains Before...	Final Assy	1
130802	Emergency Down Instructions	Final Assy	1
130596	A Product of Mark Industries	Final Assy	2
2014	Caution High Voltage Line	Aerial Control Panel	1
130820	Operation & Safety Handbook	Final Assy	1
32368	M-Series	Final Assy	1
130505	Ground Control Box	Ground Control Box	1
130782	Upper Control Box Drive	Upper Control Box	1
182718	Aerial Control Box	Aerial Control Panel	1
130796	Horn & Fuel Upper Control	Aerial Control Panel	1

UNLOADING

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

When a loading dock is unavailable and a forklift must be used, make sure that the forklift has forks sufficiently long for the forklift boots at the front of the unit. **Do Not** attempt to lift the machine from the side.

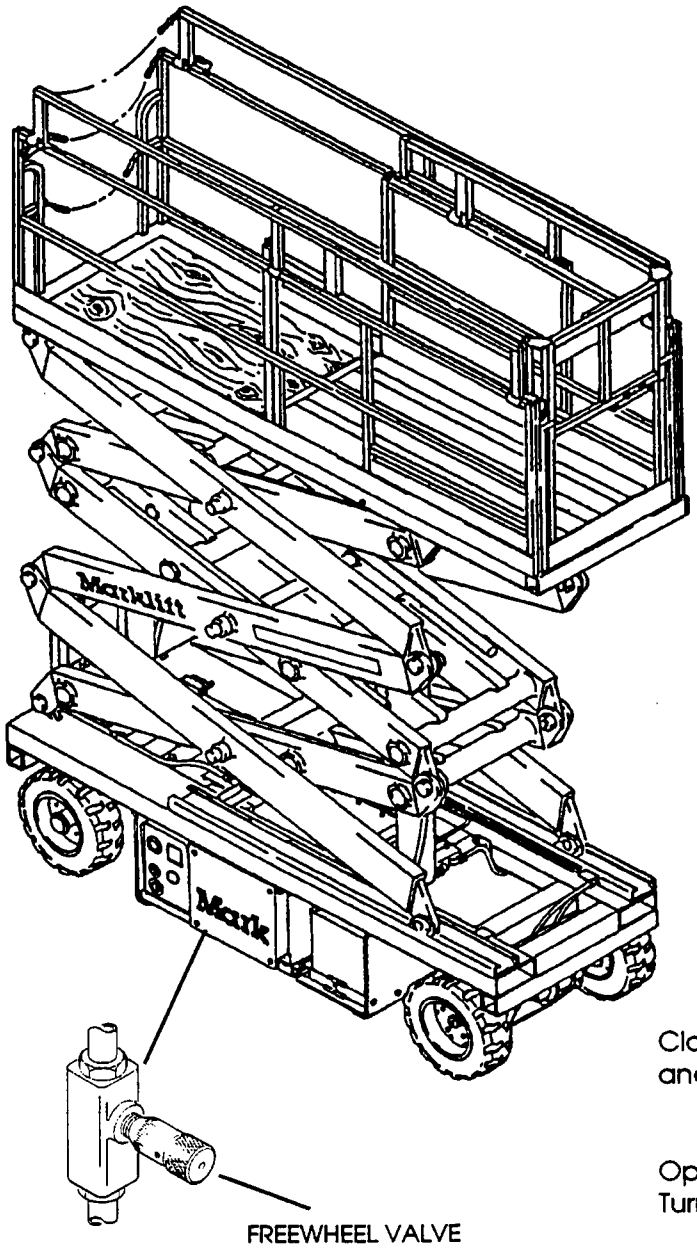
TRANSPORTING

The MARKLIFT may be freewheeled for loading, unloading and towing for a very short distance (maximum of one (1) mile), at a speed no greater than five (5) mph. To freewheel the MARKLIFT, close the brake control valve and operate drive (forward/reverse) momentarily. (See illustration on the following page.) To transport the MARKLIFT over long distances, a truck or trailer must be used.

If a rollback truck with a winch is used, attach the winch cable to the tiedown brackets and pull the MARKLIFT onto the truck. Keep the winch cable taut at all times. Be sure to open the freewheeling valve to set the brakes back into the normal mode.

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

CAUTION: MAKE SURE THE UNIT IS ON A LEVEL SURFACE BEFORE ATTEMPTING TO FREEWHEEL THE MARKLIFT. USE CAUTION WHEN BRAKES ARE DISENGAGED. ALWAYS REMEMBER TO OPEN FREEWHEELING VALVE TO RESTORE BRAKING!



FREEWHEEL VALVE

Close valve to disengage brakes and freewheel. Turn clockwise.

Open valve to restore brakes. Turn counter clockwise.

Shown: M20ESEP

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

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

2. Check hydraulic oil level - sight gauge should show full with unit in stowed position.

3. Check battery for a specific gravity reading of 1.200 ± 50 on the hydrometer. Charge the battery if the reading is below 1.125. If batteries require water, fill to proper level **AFTER** charging. See Battery Maintenance.

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

5. Check hoses for leaks.

All operators of the **MARKLIFT** should be instructed by trained operators. The new operators should spend at least 30 minutes practicing and becoming familiar with operating the MARKLIFT. The operator should begin by raising the scissor platform approximately 5 feet above the ground. The operator will soon find that gradual starts and stops are easy to perform.

For drive with a proportional controller, gradually raise the scissor higher, and drive the **MARKLIFT** until maximum height is reached. Remember that the proportional signal from the controller to the valve is controlled by the operator. There is approximately 3 degrees of "dead" motion on each side of the controller handle whenever it is moved off the center position.

1. STARTING

Turn power (key) switch at ground control station to "ON". Position grould/aerial selector switch to "AERIAL". Enter the platform, **make sure the platform entry bar, gate, or chain is attached securely after entering the platform.** Pull open the red emergency stop switch cover located on the top right of the aerial control box. Turn on power (toggle) switch to activate aerial controls and warning devices.

2. DRIVE

A. Standard Rotary Switch

Forward and reverse drive is performed from the aerial control box only. The MARKLIFT is equipped with a high and low speed for both forward and reverse drive. Rotate the drive knob forward for forward travel, low or high speed. Rotate the knob reverse for reverse travel, low or high speed. High travel speed is not operable whenever the platform is elevated over seven (7) feet or the platform is extended or traversed.

B. Optional Proportional Control

For best operation, place thumb over the controller knob and wrap fingers loosely around the locking stem. Apply a slight downward pressure with the thumb, while the index finger lifts the locking stem. Rotate the control handle forward for forward travel and backwards for reverse travel. Speed is regulated by controlling the amount of handle movement (forward/reverse) with the handle full "on" and the platform below seven (7) feet and centered, maximum travel speed can be achieved.Once the stem is disengaged and

moved forward or reverse, the pressure on the thumb may be relaxed because the locking stem has engaged the cam and cannot drop back into the locking position until the controller or handle is returned to the center position.

3. STEERING

A. Standard Toggle Switch

The unit may be steered from the aerial control console only. Push the toggle switch to the left to turn the steering (front) wheels to the left. Pushing the switch to the right will cause the wheels to turn to the right. The toggle switch is a momentary switch which will automatically return to the off position when released. The wheels will remain at the selected angle until the toggle switch is moved in another direction.

B. Optional Proportional Controller

Use the thumb rocker switch on top of the drive controller. Depressing the switch to the left causes the front wheels to turn left. Depressing the switch to the right causes the front wheels to turn to the right.

4. RAISE PLATFORM

To raise or lower the scissor platform from the ground control station, set the ground/aerial selector switch to the "Ground Control" position, then push the toggle switch up or down.

To operate from the aerial control station, position the selector switch to the "Aerial" position. Raise or lower the platform by operating the "Lift/Lower" toggle switch. The toggle switch is self-centering. When it is released it will automatically return to center (the neutral position). The scissor platform will remain stationary unless the toggle switch is operated.

To lower the platform while extended, operate the platform lowering override switch while simultaneously depressing the platform lowering switch. The platform will not lower "normally" while the platform is extended.

5. INSTABILITY ALARM, WARNING LIGHT AND BUZZER

As a special safety feature, the MARKLIFT is equipped with an "out-of- level" sensor that will automatically lower the platform whenever the MARKLIFT is used in an unsafe out-of-level position.

An unsafe out-of-level situation is sensed by the slope sensor or mercury switches whenever the machine is tilted 3° or more on either side or 6° front or rear. The unsafe condition is indicated by a red warning light and buzzer, located on the top center of the aerial control box. When the warning light and buzzer are on, the platform will automatically lower unless the platform is extended. The platform will lower automatically if not extended. Should the warning signal come on after parking the unit, it will be necessary to reposition the MARKLIFT so that it is on a safe operating surface and the system will automatically reset itself.

6. FREEWHEELING

In order to allow for easy loading and unloading of the machine, the MARKLIFT may be freewheeled. **WHEN PREPARING FOR FREEWHEELING, MAKE SURE THE MACHINE IS ON A LEVEL SURFACE!**

The parking brakes are disengaged by closing the parking brake control (freewheeling) valve and operating drive (forward/reverse) momentarily. Use caution whenever the parking brakes are disengaged. **ALWAYS REMEMBER TO OPEN FREEWHEELING VALVE TO RESTORE BRAKING.**

7. WARNING HORN (OPTION)

For some industrial applications, and to meet particular safety requirements, a warning horn may be needed. The warning horn option on the MARKLIFT can be used as an automatic movement indicator, or manually activated, as required. The horn is activated by a three-position switch on the aerial control panel. The middle position is "Off". When the switch is positioned to the right, the horn will sound when either the drive or lift function is activated (forward and reverse, up and down). When the switch is depressed to the left, the horn will sound while the switch is held in this position.

8. EXTENDING PLATFORM

The MARKLIFT M20ESEP may be manually extended from the aerial platform. Pull out the safety lock pins then push the platform outward until it is **fully** extended. Make sure that the safety lock pins drop back into the holes to secure the platform. When the platform is extended, the unit is automatically placed into low speed drive. If the slope sensor device is activated, the manually extended platform will not descend but the warning system (instability alarm, warning light and buzzer) will indicate that an unsafe condition has occurred.

9. TRAVERSING PLATFORM

The MARKLIFT M20EST may be traversed from either the ground control station or the aerial platform. The platform may be traversed forward or reverse by depressing the toggle switch up (or to the left) for forward, or down (or to the right) for reverse.

The yellow light indicates that the platform is traversed (extended or retracted) from the neutral (centered) position. Whenever the platform is traversed off the center position, high speed drive is disabled and platform lowering is operational only while simultaneously depressing the platform lowering override switch.

10 EMERGENCY DESCENT

If the operator has the platform extended and needs to descend, push down and hold the "Emergency Down" (platform lowering override) switch, then depress the "Lift" switch downward ("Down" direction).

Platform lowering while extended (traversed) can be accomplished from the ground control station by placing the ground/aerial selector switch to "ground" position and operating the platform "Lift/Lower" toggle switch to "Lower" position.

Use caution when lowering the extended platform. Remember to **check below the platform before using the emergency down switch,** to avoid damage to anything underneath.

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 periodically as stated below. Any machine not in safe operating condition must be removed from service until it is repaired by a qualified service person.

DAILY

1. Make sure that operation and safety decals are in place and easy to read.
2. Check hydraulic tank fluid level, add oil as required.
3. Check the water level in the batteries
4. Check for loose or worn hardware, wire connections, etc., repair or replace as required.
5. Inspect the controls for proper operation.
6. Check for and correct any hydraulic leaks.
7. Check for and correct any cracked welds or other structural damage.

WEEKLY

1. Perform all daily preventive maintenance items.
2. Check the condition of the tires. Make sure they are free of serious cuts or defects.
3. Test instability alarm system (slope sensor/mercury switches).
4. Record hour meter reading.
5. Clean unit by removing all dirt, oil, and grease. The machine may be washed with soap and water. (Keep clear of the electrical panels and charging units.)
6. Check for good overall performance.
7. Check for wear on electrical cables and hoses.

MONTHLY

1. Perform all daily and weekly preventive maintenance items.

2. Check and lubricate, if necessary. (See lubrication chart.)

3. Check condition of the battery. (See Battery Maintenance.)

4. Change the hydraulic oil return filter.

Yearly

1. Perform all daily, weekly and monthly preventive maintenance items.

2. Re-pack all wheel bearings.

3. Change the hydraulic oil.

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

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

Avoid Battery Hazards!

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

Battery acid will damage eyes or skin on contact. Always wear a face shield during battery maintenance to avoid acid in eyes. Also wear rubber gloves and protective clothing to keep acid off skin.

Never check the battery by placing a metal object across the posts. Serious burns or an explosion can result.

Charge batteries only in a well ventilated area.

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°

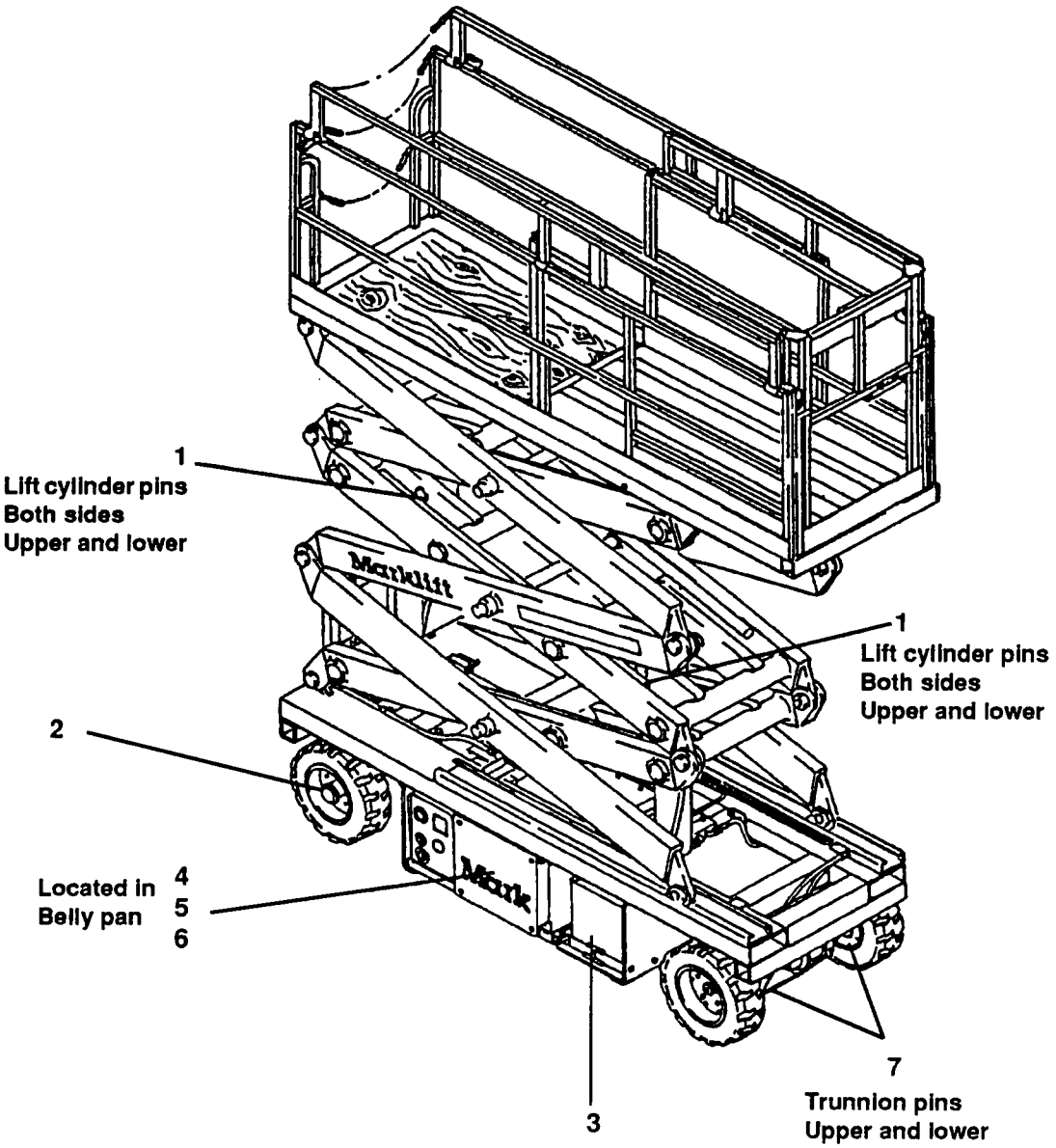
80°F (27°C)	0°F (-18°C)	-10°F (-23°C)	-20°F (-29°C)	-30°F (-34°C)	-45°F (-43°C)	-65°F (-54°C)	Approx. State of Charge In%
1.280	1.312	1.316	1.320	1.324	1.330	1.338	100
1.250	1.282	1.286	1.290	1.294	1.300	1.308	75
1.220	1.252	1.256	1.260	1.264	1.270	1.278	50
1.190	1.222	1.226	1.230	1.234	1.240	1.248	25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

LUBRICATION AND SERVICE CHART



Shown: M20ESEP

LUBRICATION AND SERVICE CHART

Item	Description	Service	Frequency
1.	Lift Cylinder Pins	Grease - Mobil VA6L36AG	Monthly
2.	Wheel Bearing Both Sides	Grease - Mobil VA6L36AG	Yearly
3.	Batteries	See Chart	Check Daily
4.	Hydrailic Oil	Fill - AFT Dextron II	Check Daily / Change Yearly
5.	Return Filter	Change - P/N 81016	100 Hourly
6.	Suction Strainer	Clean & Inspect	Yearly
7.	Trunnion Pins Upper/Lower	Grease - Mobil VA6L36AG	Quarterly

1. ELECTRICAL

Whenever trouble shooting any problem, begin by checking the basics. This means checking to make sure that the batteries are in good shape and have at least a three quarter charge, which is determined by using a hydrometer and battery maintenance instructions.

A large percentage of electrical problems are often due to poorly charged or defective batteries.

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

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

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

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

2. HYDRAULIC

Hydraulic fluid must be clean and well filtered to provide trouble free operation of a hydraulic control valve. Contaminated fluid accounts for a substantial number of hydraulic malfunctions.

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

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

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

This troubleshooting checklist is not intended to indicate all the possible fault conditions which may be encountered on the MARKLIFT, but simply provide a possible cause.

MARKLIFT will not run.

A. Check the battery for proper charge.

B. Check battery connections.

C. Check ground control box circuit braker.

D. Refer to local authorized MARKLIFT dealer.

Hydraulic Pump

Pump producing excessive noise.

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

B. Check hydraulic oil level.

C. Check suction line fittings for tightness.

D. Refer to local authorized MARKLIFT dealer.

Lift

Will not lift, all other functions work.

A. Check for loose electrical connections.

B. Defective lift solenoid valve coil.

C. Low system pressure (loss of flow to lift circuit).

D. Malfunctuioning level sensor.

E. Refer to local authorized MARKLIFT dealer.

Will not lift rated load.

A. Low system pressure (loss of flow).

B. Mechanical binding (friction).

C. Refer to local authorized MARKLIFT dealer.

Steering

Steers in one direction only.

A. Loose electrical connection.

B. Loss of ground to coil on affected directions.

C. Spool sticking in one direction.

D. Faulty steering switch on top of the drive controller.

E. Flow control valve to steering cylinder stuck.

F. Refer to local authorized MARKLIFT dealer.

Drive

Drives in one direction only.

A. Loose electrical connection in forward or reverse circuit.

B. Faulty drive controller.

C. Valve spool sticking in one direction.

D. Refer to local authorized MARKLIFT dealer.

No forward or reverse drive.

A. Low drive system pressure (loss of flow).

B. Faulty drive controller.

C. Valve spool stuck.

D. Pressure differential sensing valve malfunctioning.

E. Refer to local authorized MARKLIFT dealer.

HYDRAULIC FLUID TABLE

Milestone			Hydraulic fluid			
Oil company			Chevron	Gulf	Shell	Union
Brand Name			AW22	ATF Dextron II	Donaz-T6	ATF Dextron
Viscosity	SUS AT 100°F (37.8°C)		110.0	195	200	200
	SUS AT 210°F (98.9°C)		40.0	50.4	50	52.3
	Index	°F	99°	155°	160°	172°
		°C	37.2°	68.3°	71.1°	77.8°
Flash point		°F	350°	405°	390°	395°
		°C	176.5°	207.2°	198.9°	201.7°
Pour point		°F	-25°	-50°	-50°	-45°
		°C	-37.2°	-45.6°	-45.6°	-42.8°
Color			Clear	—	—	—

NEW EQUIPMENT MAINTENANCE RECORD

MODEL	SERIAL NUMBER
DATE	EQUIPMENT NUMBER
LOCATION	MECHANIC

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

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

MODEL: M20ESEP

PART NO.	QTY.	DESCRIPTION
67639	2	Decal set
130927	2	Plastic container
130422	10	Operations & safety handbook
65842	4	Anti-roll cap
4106	1	5 position drive switch
65753	2	Fluted knob
20481	2	Toggle switch
20884	2	Switch guard
4020	2	Push button switch
70235	1	Limit switch lever
66345	1	Alarm buzzer
771	4	White plug
4017	2	Toggle switch
70303	2	Switch guard
70391	1	Receptacle
70392	1	Cover
65241	2	White plug
65658	4	Thrust washer
70173	2	Limit switch
70032	1	Operating lever
66792	4	Bushing
4014	2	Mercury switch
70362	1	Power relay
130644	1	Hydraulic tank cover gasket
81084	1	Strainer
66739	14	Return filter element (UCC)
67024	1	Differential pressure sensing valve
16260	2	Toggle switch
66924	1	Brake shuttle valve
20562	2	Circuit breaker
2717	2	Ignition switch
67025	1	3.0 flow regulator
66865	2	20V coil
70337	2	Time delay relay
4027	10	Terminal block

MODEL: M20ESEP

PART NO.	QTY.	DESCRIPTION
117-A	2	Terminal block ends
70442	10	Diode
2793	2	Brushes for (3015-2 motor)
130326	8	Wear pad
12007	2	Ball lock pin
66822	2	Lift cylinder seal kit (before Jan. 1989)
81028	1	Solenoid valve
67676	2	Lift cylinder seal kit (after Jan. 1989)
66818	2	Lift cylinder seal kit (telescoping)
916	2	Bushing
20571	1	Hourmeter (option)
66896	2	Drive motor seal kit (81017)
66640	2	Steering cylinder seal kit (130165)
600004	2	Valve seal kit (81328)
67676	2	Lift cylinder seal kit (131411)
66965	2	Motor seal kit (81025)

MODEL: M20EST

PART NO.	QTY.	DESCRIPTION
130927	2	Plastic container
17411	2	Operations & safety handbook
65842	4	Anti-roll cap
67098	2	5 position drive switch
65753	2	Fluted knob
20481	2	Toggle switch
20884	2	Switch guard
4011	2	Push button switch
70293	2	Warning light
66345	2	Alarm buzzer
771	4	White plug
4017	2	Toggle switch
70303	2	Switch guard
70391	2	Receptacle
70392	2	Cover
70442	10	3 amp, 600V diode
65658	4	Thrust washer
70173	2	Limit switch
70032	2	Operating lever
65686	2	Race bearing
65059	2	Bearing
66113	2	Grease seal
137	2	Dust cap
117-A	2	Terminal block end
4027	10	Terminal block
70337	2	Time delay relay
16260	2	Toggle switch
65244	4	White plug
20562	2	Circuit breaker
2717	2	Ignition switch
70479	10	6 amp, 1000V diode
66806	2	Brake seal kit
67648	1	Brake lining kit
66896	2	Drive motor seal kit (81017)
66640	2	Steering cylinder seal kit (130165)

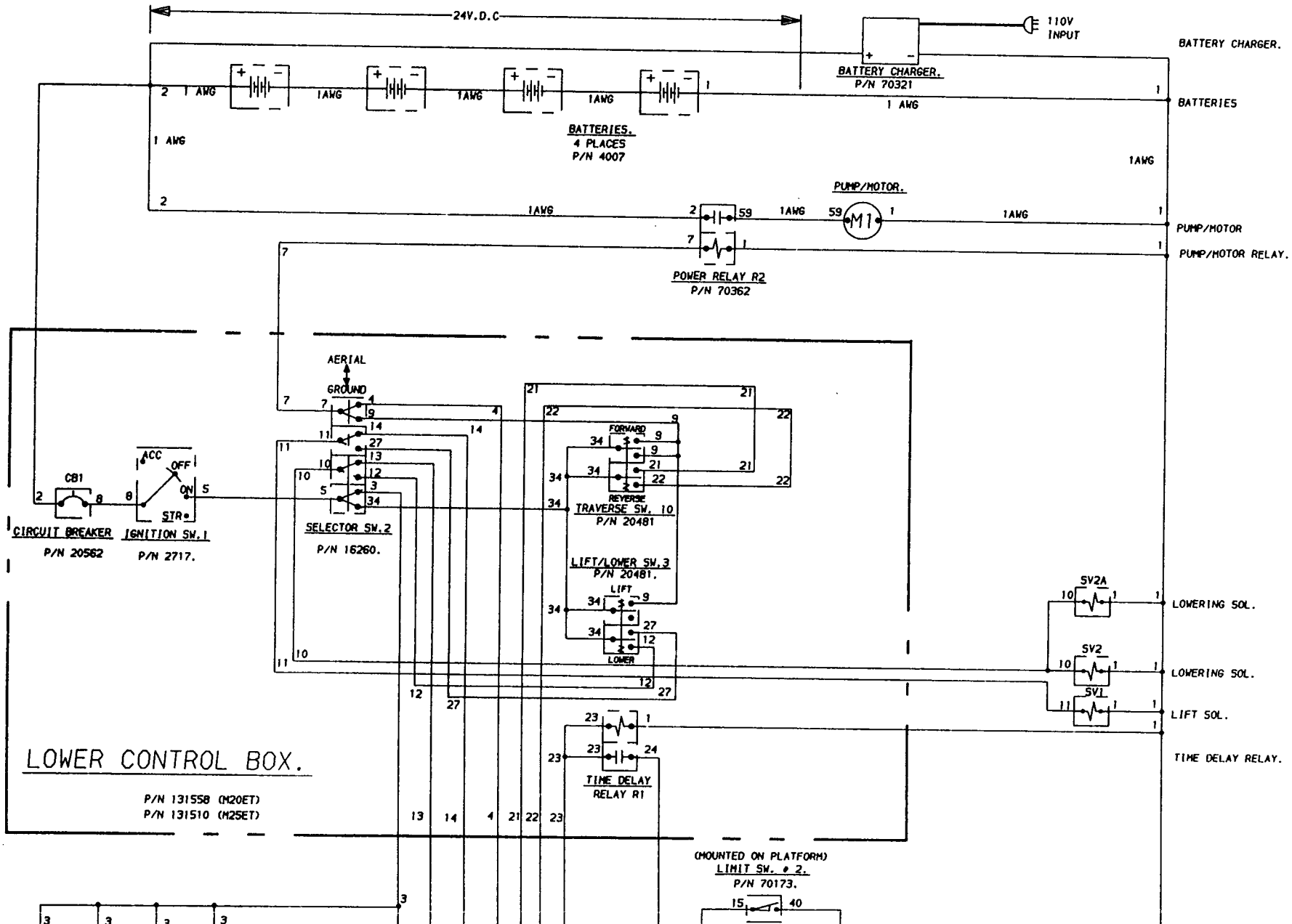
MODEL: M20EST

PART NO.	QTY.	DESCRIPTION
70362	2	Power relay
600004	2	Seal kit (valve 81328)
66924	1	Shuttle valve
66865	1	2 D V coil
66864	1	D01 coil
600003	1	Check valve
30884	1	Flow control valve
4014	2	Mercury switch
81287	1	Pump & motor
67969	1	Ammeter
66727	2	Dual fuse
66732	2	Timer
67964	2	Indicator lamp
67963	2	Switch
67969	2	Capacitor
67961	1	Transformer
66747	2	Ammeter
66726	2	Fuse
66732	2	Timer knob
66734	2	Receptacle
66736	2	Receptacle
66984	1	Transformer
66730	2	Diode
66750	2	Capacitor
66728	1	Capacitor
66728	1	Relay
67971	1	Timer
66733	2	Timer knob
67973	1	Transformer
66731	2	Diode
130696	8	Ear pivot bolt
61249	8	Hex nut
131534	8	Wear pad
65103	20	Grease fittings
916	20	Bushing

RECOMMENDED SPARE PARTS LIST

MODEL: M20EST

PART NO.	QTY.	DESCRIPTION
64922	20	Bushing
67676	2	Seal kit (lift cylinder 131411)
81028	2	Electronic check solenoid
71069	2	Operating lever
66965	2	Seal kit (motor 81025)
600301	1	Decal set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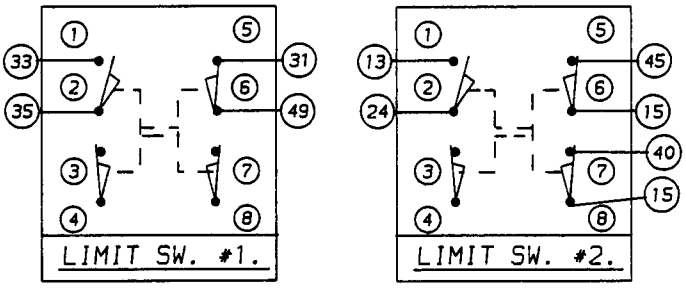
110V INPUT
BATTERY CHARGER.
BATTERY CHARGER. P/N 70321
BATTERIES
BATTERIES. 4 PLACES P/N 4007
1 AWG
PUMP/MOTOR.
PUMP/MOTOR
PUMP/MOTOR RELAY.
POWER RELAY R2 P/N 70362
AERIAL
GROUND
CIRCUIT BREAKER P/N 20562
IGNITION SW.1 P/N 2717.
ACC
OFF
ON
STR
SELECTOR SW.2 P/N 16260.
FORWARD
REVERSE
TRAVERSE SW. 10 P/N 20481
LIFT/LOWER SW.3 P/N 20481.
LIFT
LOWER
SV2A
SV2
SV1
LOWERING SOL.
LOWERING SOL.
LIFT SOL.
TIME DELAY RELAY.
TIME DELAY RELAY R1
LOWER CONTROL BOX.
P/N 131558 (M20ET)
P/N 131510 (M2SET)
(MOUNTED ON PLATFORM)
LIMIT SW. # 2.
P/N 70173.

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	M20EST
NOTES	P/N 131555-A

SCHEMATIC
PAGE
2



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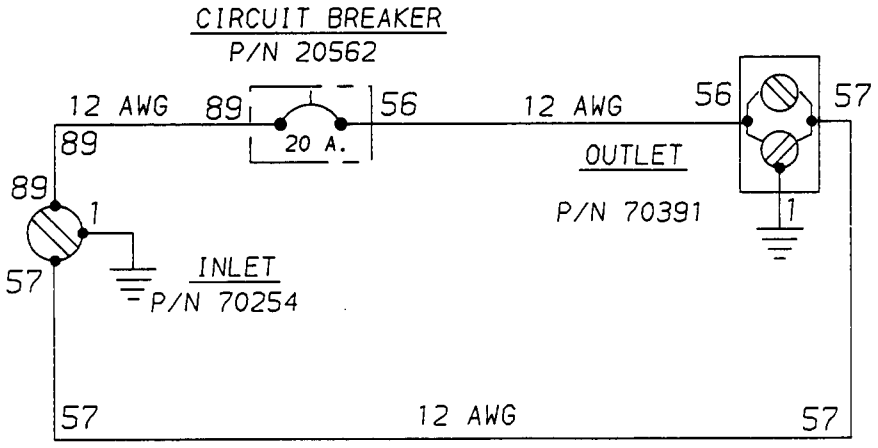
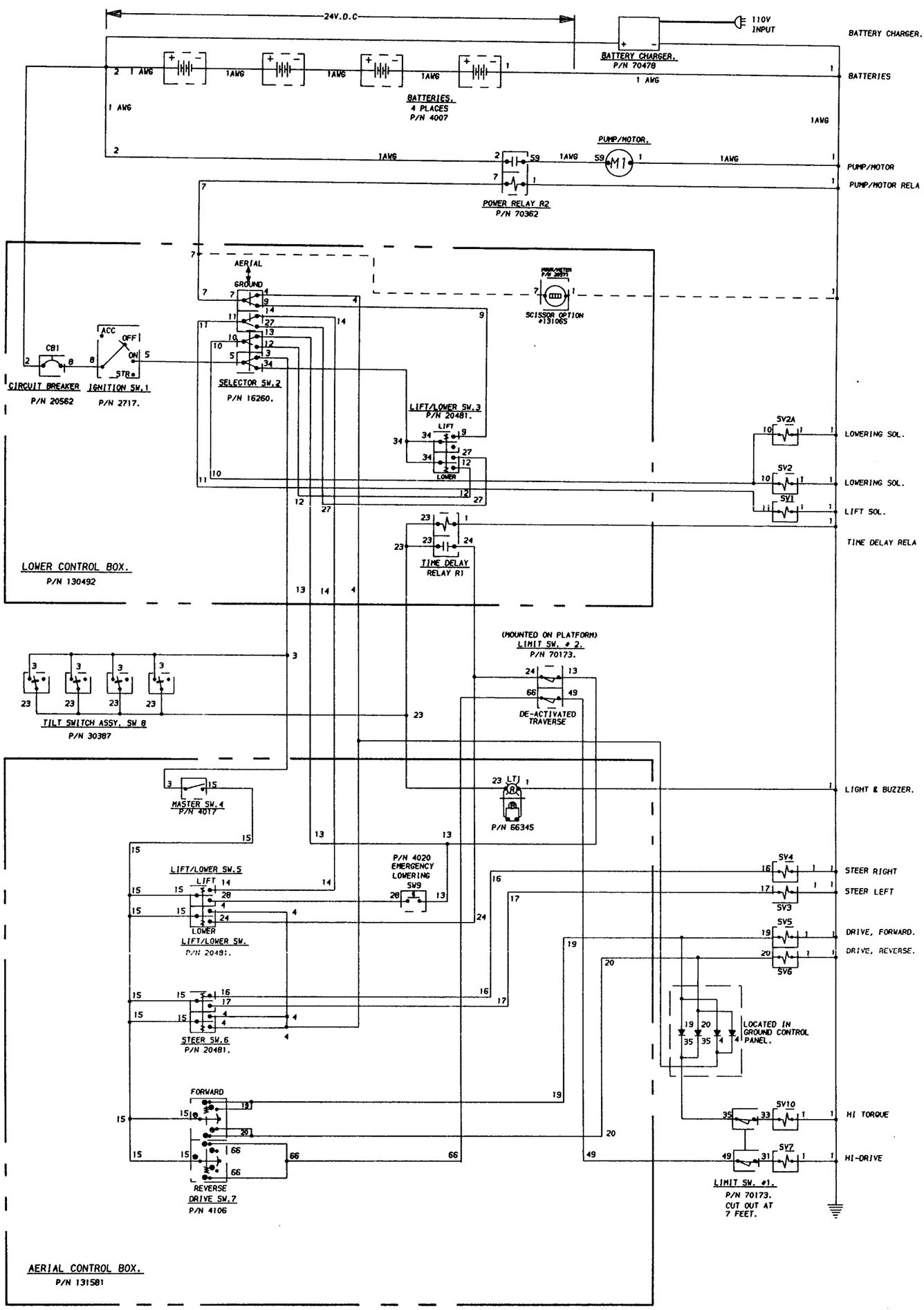


110 A.C. WIRING.

REV.



Mark Industries

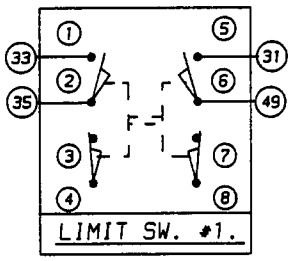
TITLE	ELECTRICAL SCHEMATIC
MODEL	M20ESEP
NOTES	P/N 131584-A

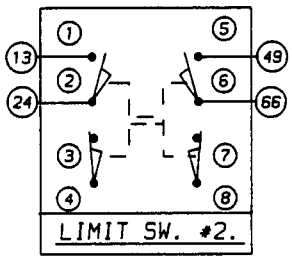
SCHEMATIC PAGE 3

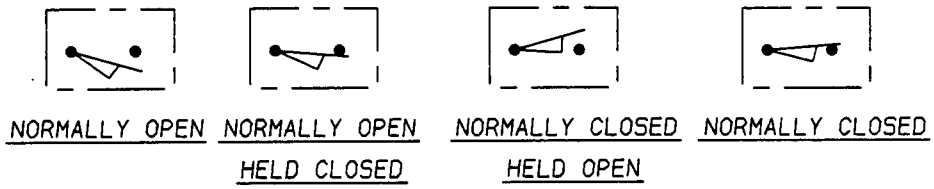
Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	M20ESEP
NOTES	P/N 131584-A

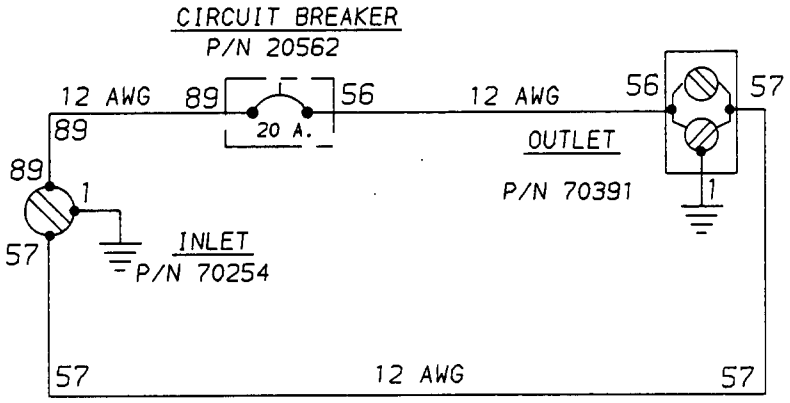
SCHEMATIC PAGE 4







LEGEND FOR LIMIT SWITCHES.



110 A.C. WIRING.

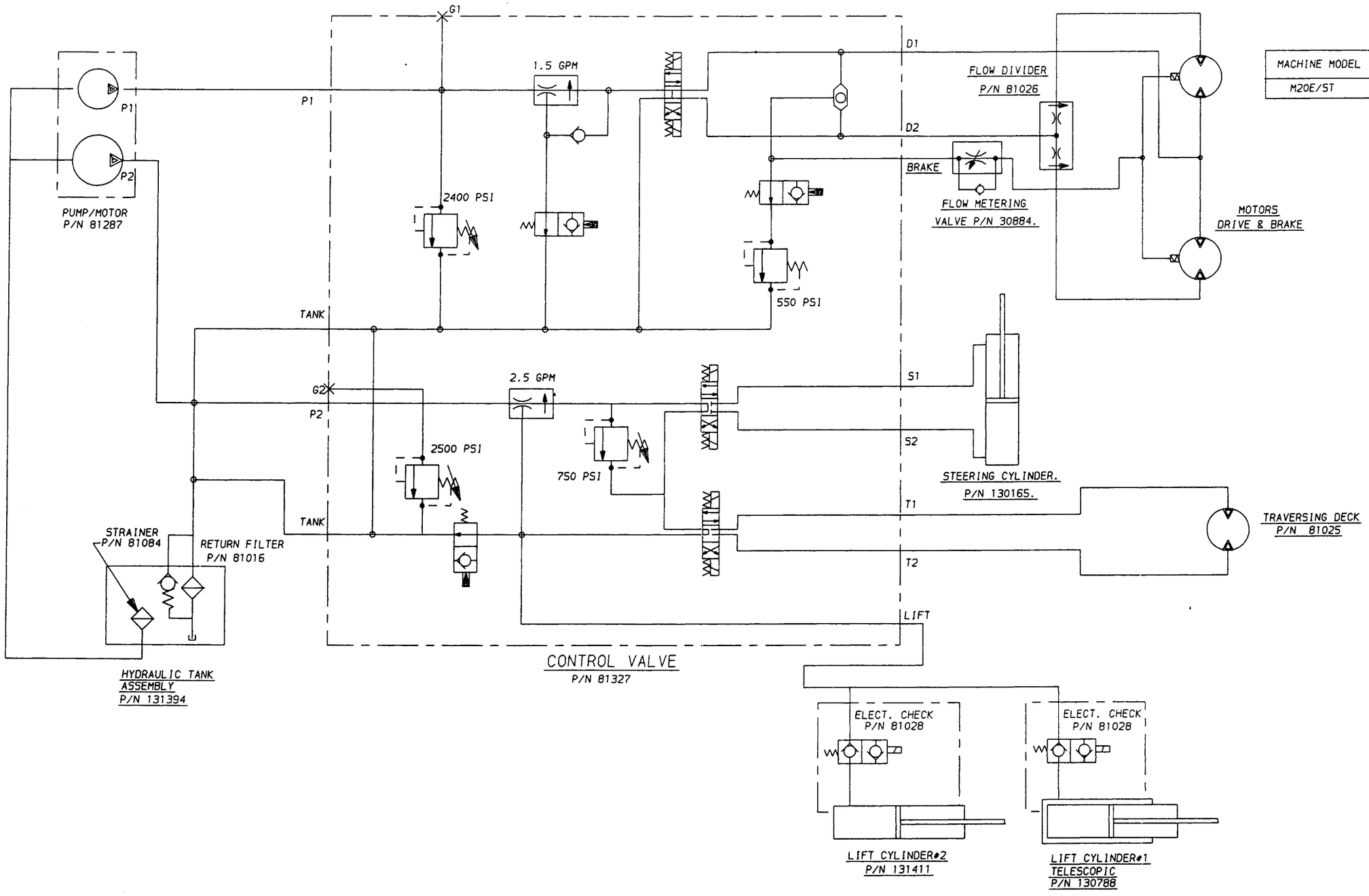
REV.

Mark Industries

TITLE	HYDRAULIC SCHEMATIC
MODEL	M20EST
NOTES	P/N 131388-A

SCHEMATIC PAGE 5

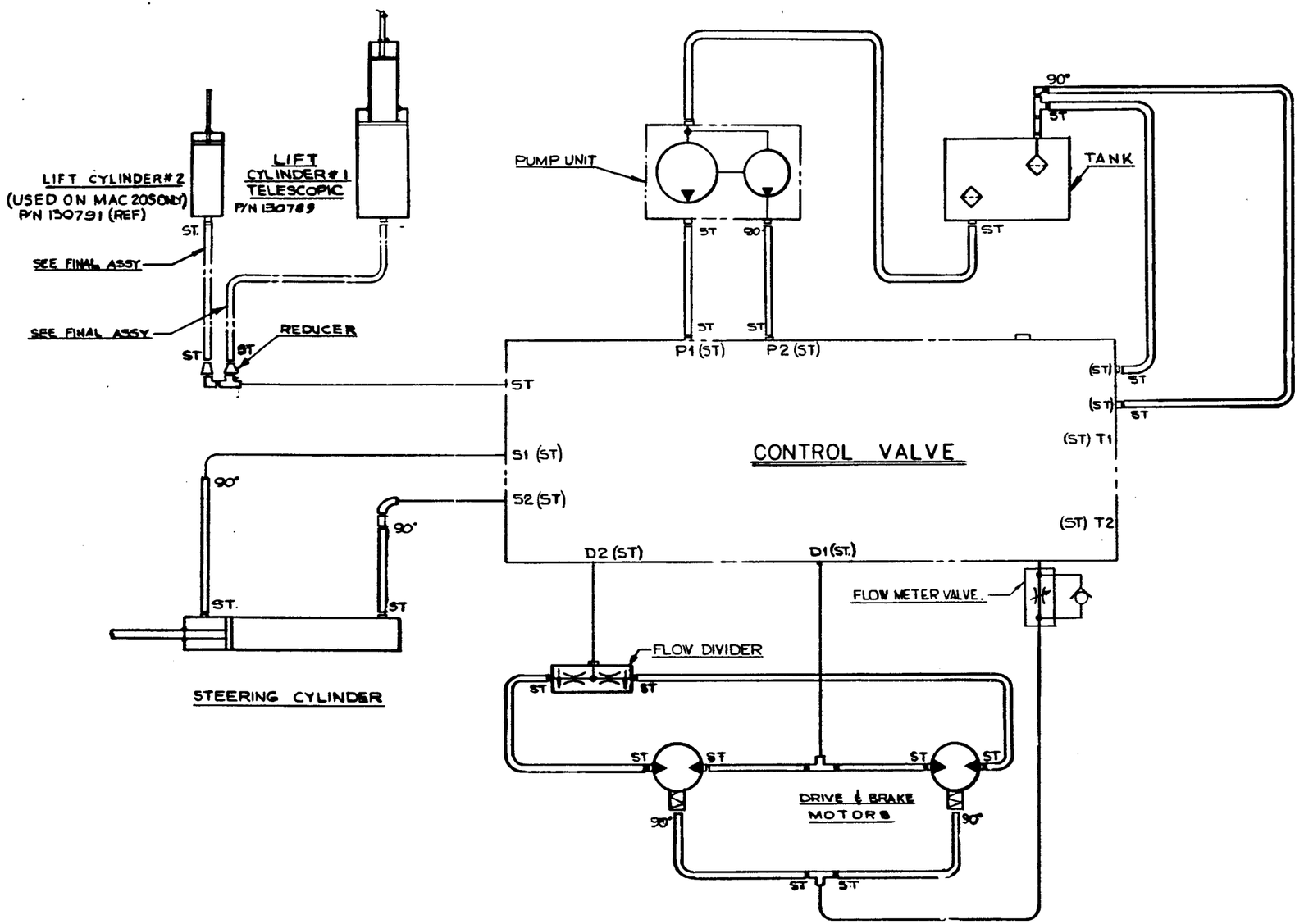
MACHINE MODEL	P/N MOTOR	P/N BRAKE
M20E/ST	81017	81019



Mark Industries

TITLE	HYDRAULIC SCHEMATIC
MODEL	M20ESEP
NOTES	P/N 130769-B

SCHEMATIC PAGE 6



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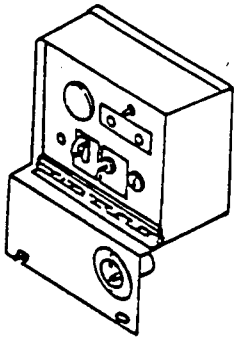
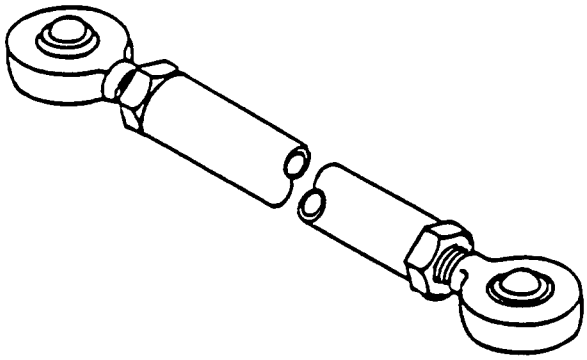
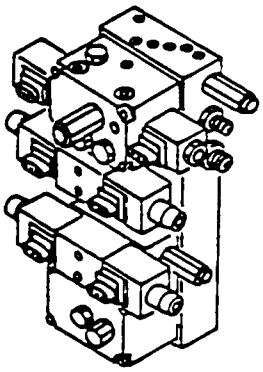
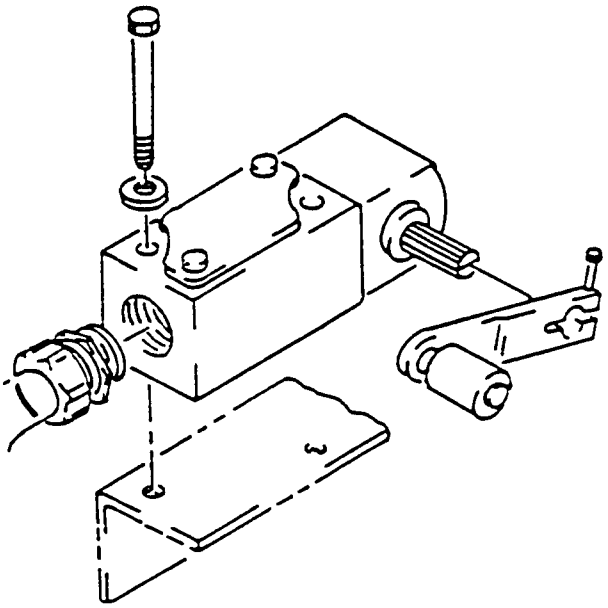
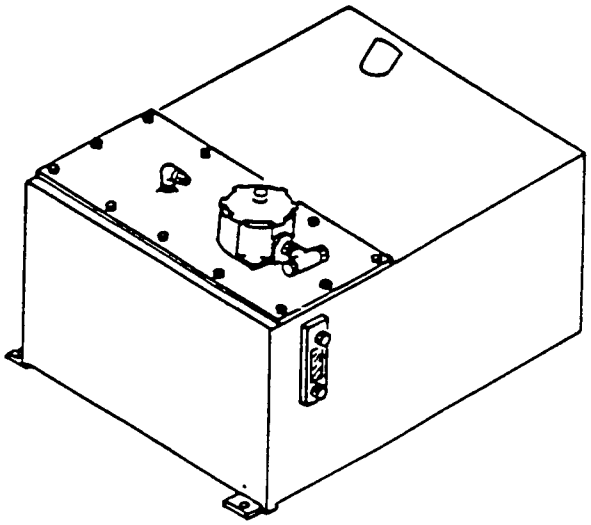










DISCLAIMER

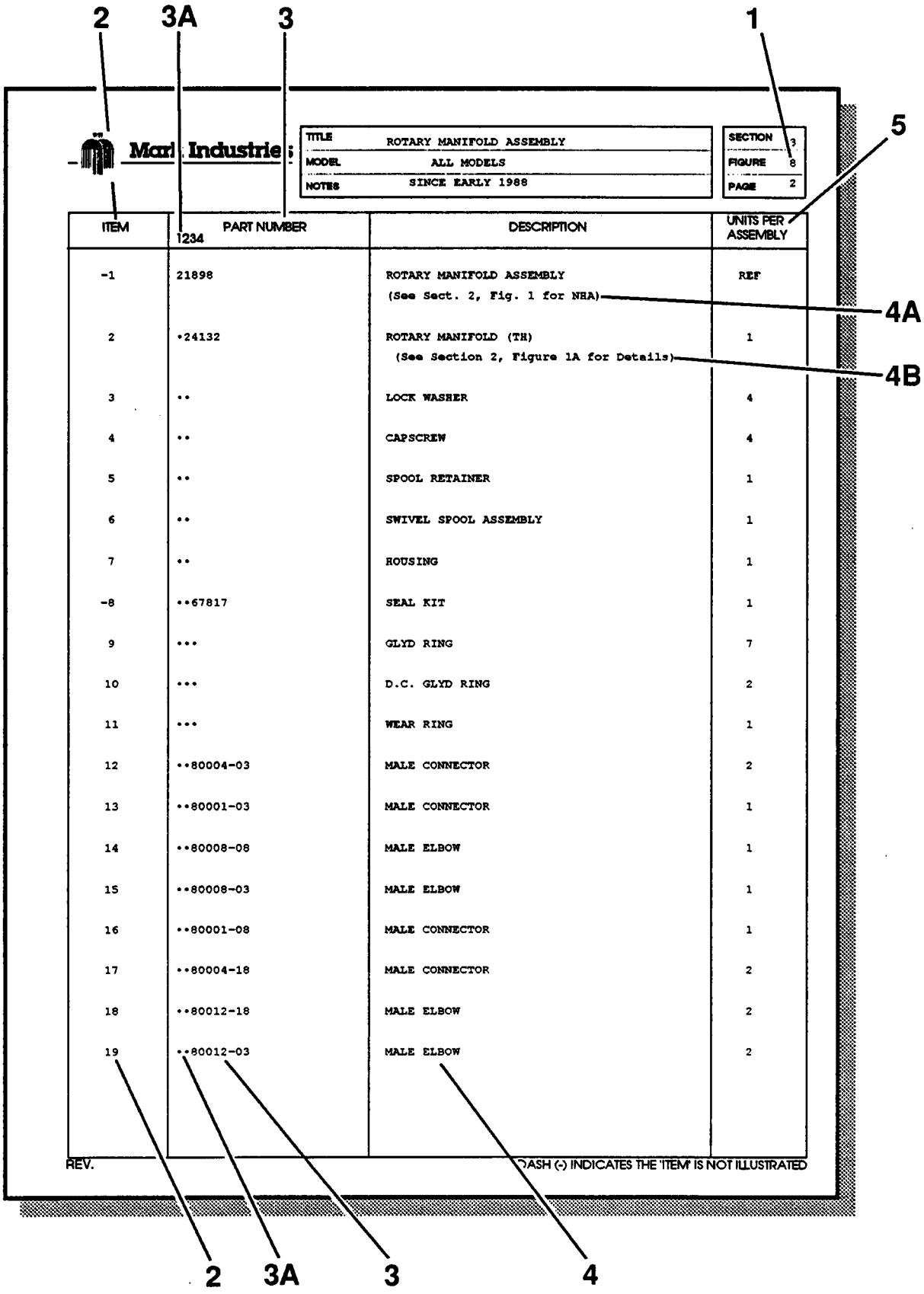
MARK INDUSTRIES strives to include in the Parts Chapter, information and illustrations that are accurate, complete, and current. Due to on-going changes and revisions by our many suppliers, it is often impossible to show all variations of a given assembly. Therefore, this information is subject to change 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 6 OPTIONS (CONT'D)



Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY
MODEL	ALL MODELS
NOTES	SINCE EARLY 1988

SECTION	3
FIGURE	8
PAGE	2

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

REV.

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

1. The Parts Chapter Pagination.

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

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

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

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

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

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

   Part Number

   1 2 3 4

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

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

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

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

4. Elements of the **Description**.

   A. **NHA** (**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.

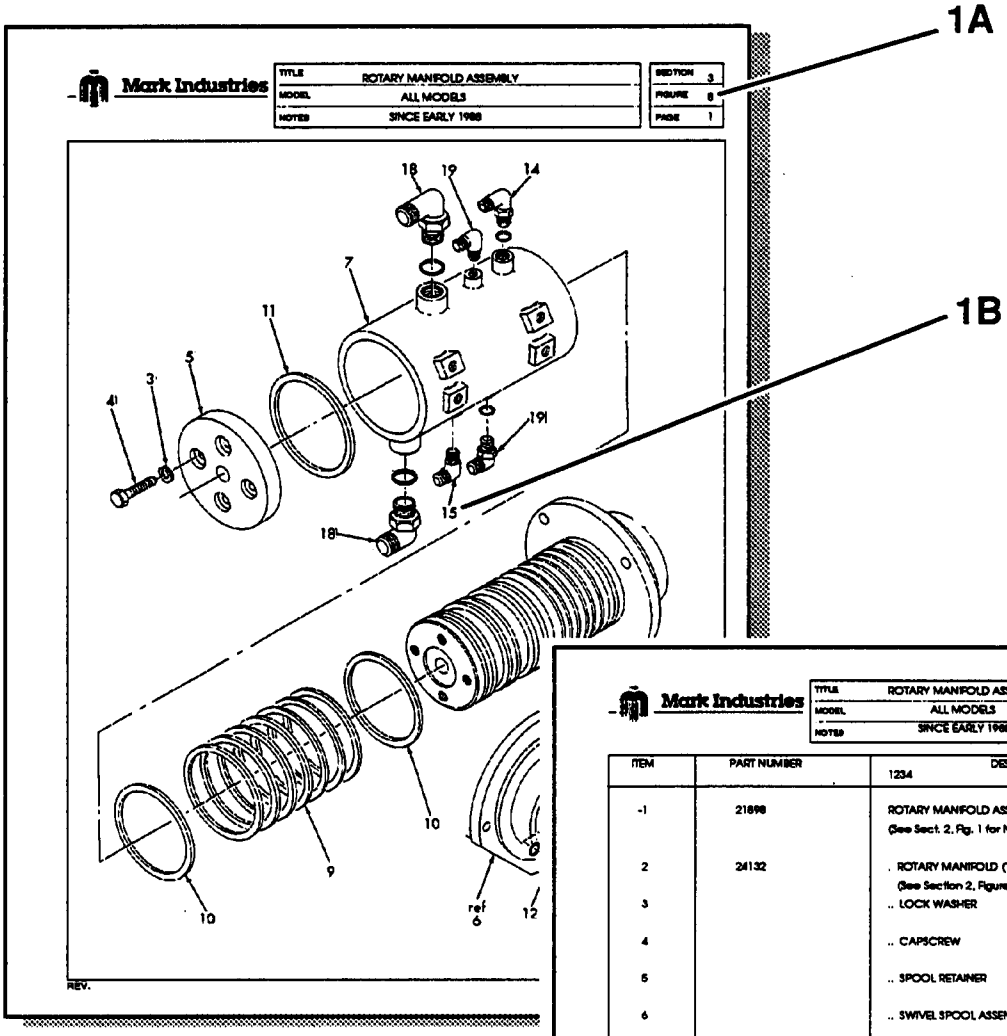
   B. **DETAILS** corresponds to the Section and Figure to be referred to for a more detailed breakdown of this item.

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

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

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

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



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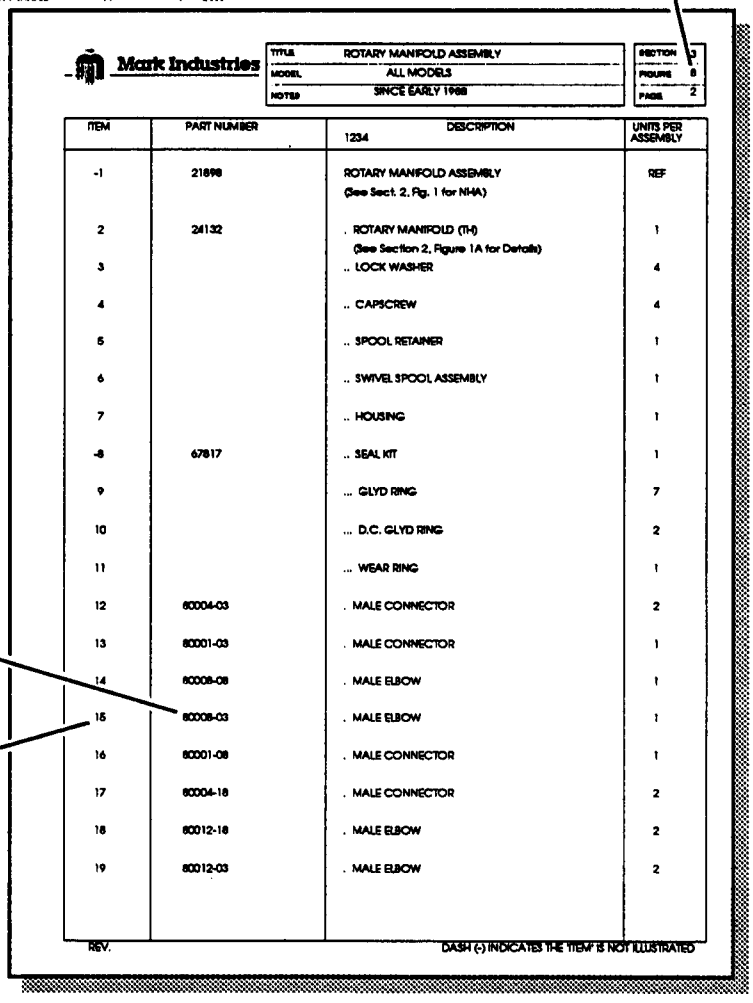
1A



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

REV.

DASH (-) INDICATES THE ITEM IS NOT ILLUSTRATED

1D

1C

1. Finding the Mark Industries Part Number.

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

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

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

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

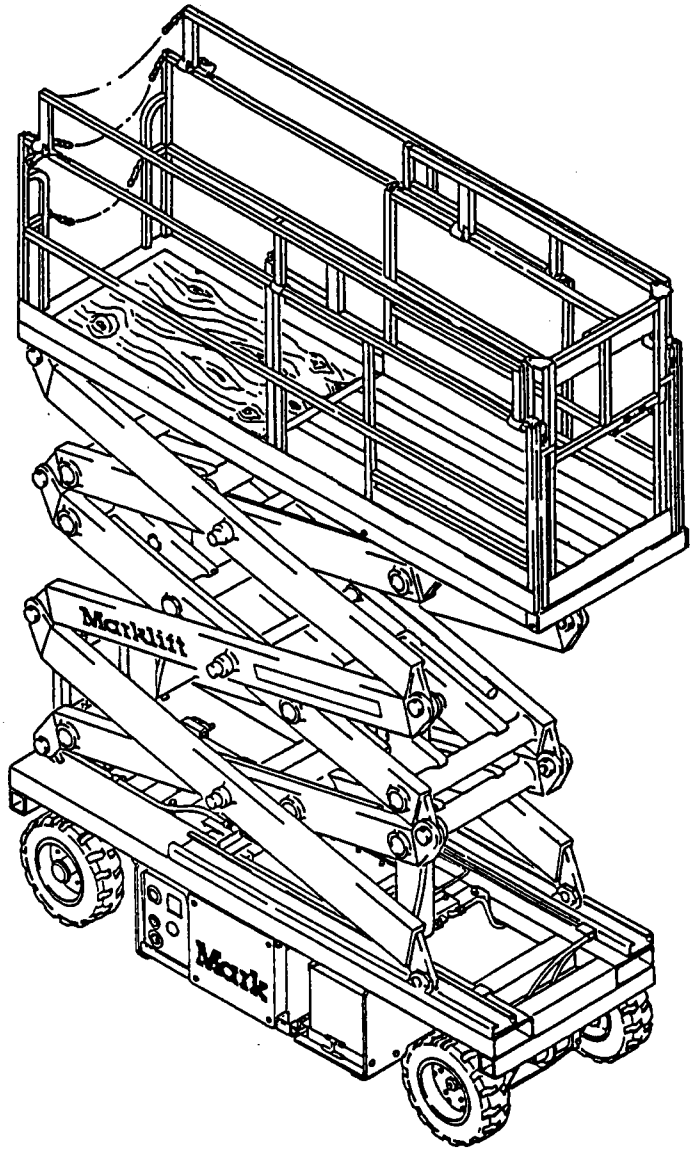
2. Ordering: Listed below are the methods of ordering parts. The **preferred** method of ordering parts is by **FAX**.

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

   B. By Phone: (714) 879-MARK

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

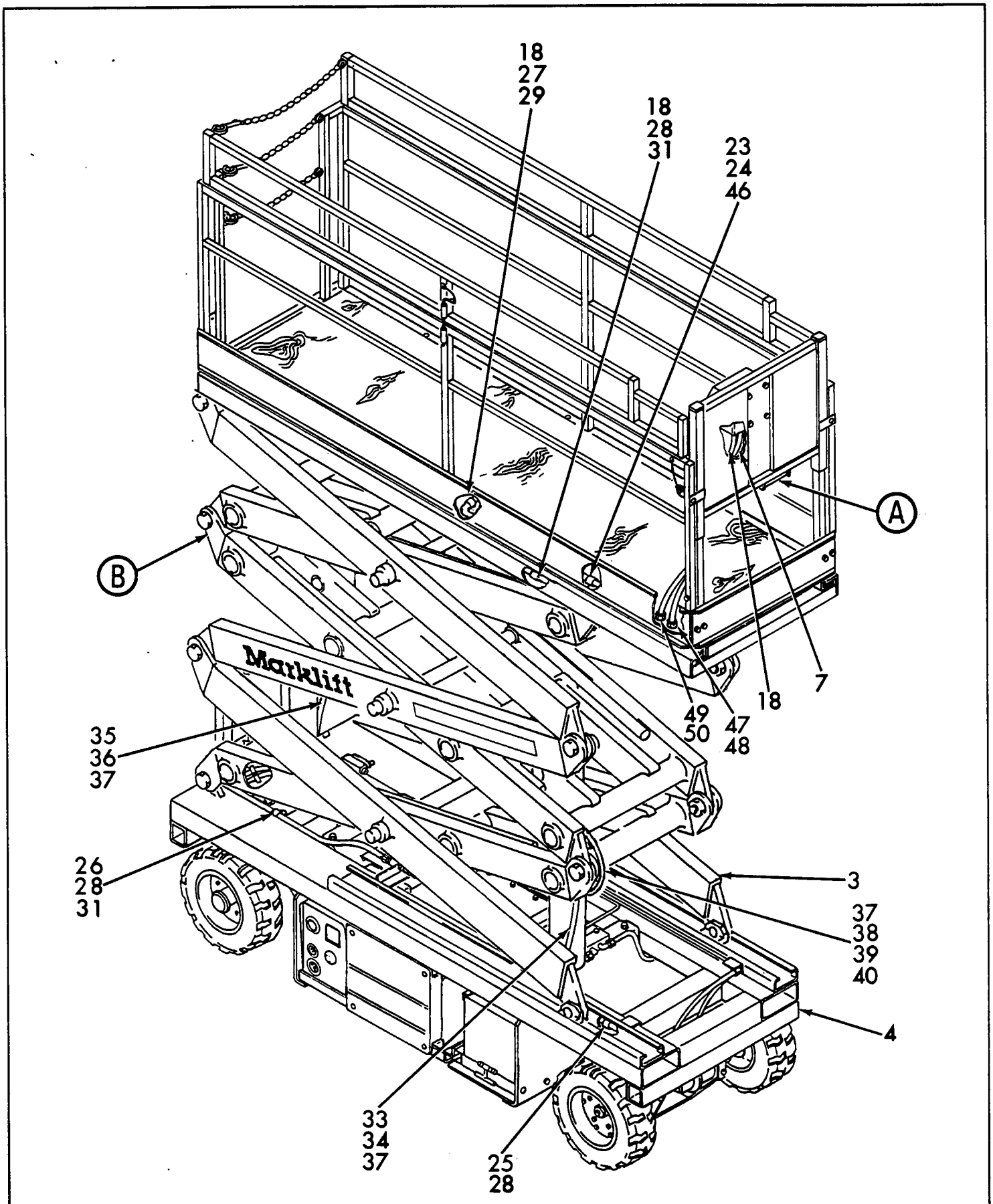
SECTION 2 CONTAINS:



Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	2
FIGURE	1
PAGE	1



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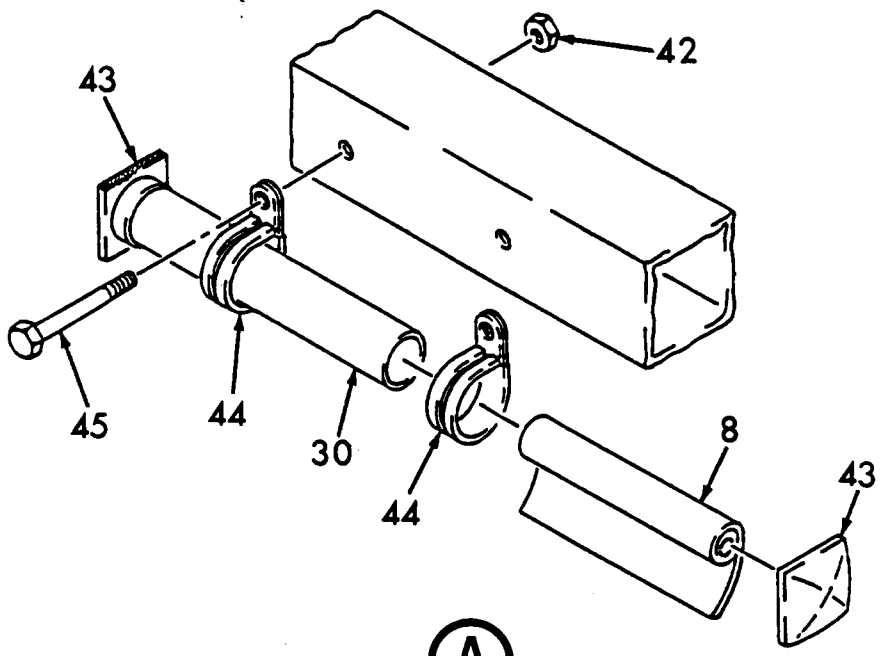

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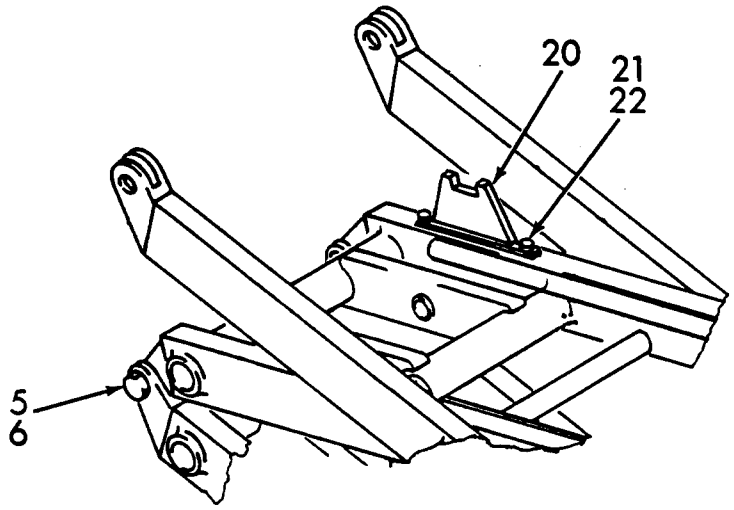


B

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130022	ASSEMBLY, FINAL	REF
2	.130358	ASSEMBLY, EXTENDABLE DECK (See Sect. 5, Fig. 1 for Details)	1
3	.130250	ASSEMBLY, SCISSOR (See Sect. 4, Fig. 1 for Details)	1
4	.130746	ASSEMBLY, FRAME (See Sect. 3, Fig. 1 for Details)	1
5	.130696	BOLT, EAR PIVOT	4
6	.61249	NUT, LOCK	4
7	.90547-144	CABLE	12 FT
8	.130422	HANDBOOK, OPERATORS	1
-9	.256	TIE, CABLE	50
-10	.255	TIE, CABLE	50
-11	.130769	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5 for Details)	1
12	.131888	SCHEMATIC, HYDRAULIC (See Schematic Chapter for Details)	1
-13	.131555	SCHEMATIC, ELECTRICAL (See Schematic Chapter for Details)	1
-14	.65389	PAINT, BLUE	2 GAL
-15	.16608	PAINT, WHITE	5 GAL
-16	.65368	PAINT, BLUE (TOUCH-UP)	1 CAN
-17	.2673	PAINT, WHITE (TOUCH-UP)	1 CAN
18	.130337	CABLE, CONDUCTOR	55 FT
-19	.375	RIVET, POP	12
20	.130478	WELDMENT, LOCK BRACKET	1
21	.60322	SCREW, CAP	2
22	.63302	WASHER, LOCK	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.131446	ASSEMBLY, UPPER CONTROL BOX (See Sect. 2, Fig. 6 for Details)	1
24	.61711	SCREW, SELF-TAP	6
25	.65787	CLAMP, CUSHIONED	2
26	.16268	CLAMP, HOSE	4
27	.65451	CLAMP, HOSE	2
28	.63654	RIVET, POP	18
29	.31034	HOSE, HYDRAULIC	1
30	.130927	CONTAINER, PLASTIC	1
31	.65655	CLAMP, CUSHIONED	8
-32	.765	CLAMP, RUBBER	11
33	.2568-15	HOSE, HYDRAULIC	1
34	..2568	HOSE, HYDRAULIC	15 FT
35	.2568-25	HOSE, HYDRAULIC	1
36	..2568	HOSE, HYDRAULIC	25 FT
37	.2562	FITTING, SWIVEL	7
38	.2568-40	HOSE, HYDRAULIC (40 FOOT EACH)	2
39	..2568	HOSE, HYDRAULIC	40 FT
40	.2594	ELBOW, SWIVEL	1
-41	.131884	DIAGRAM, HYDRAULIC TUBE (See Sect. 2, Fig. 8 for Details)	1
42	.60711	NUT, HEX	6
43	.65842	CAP, ANTI-ROLL	2
44	.65867	CLAMP	2
45	.60315	SCREW, CAP	2
46	.131576	COVER, UPPER CONTROL BOX	1

Mark Industries

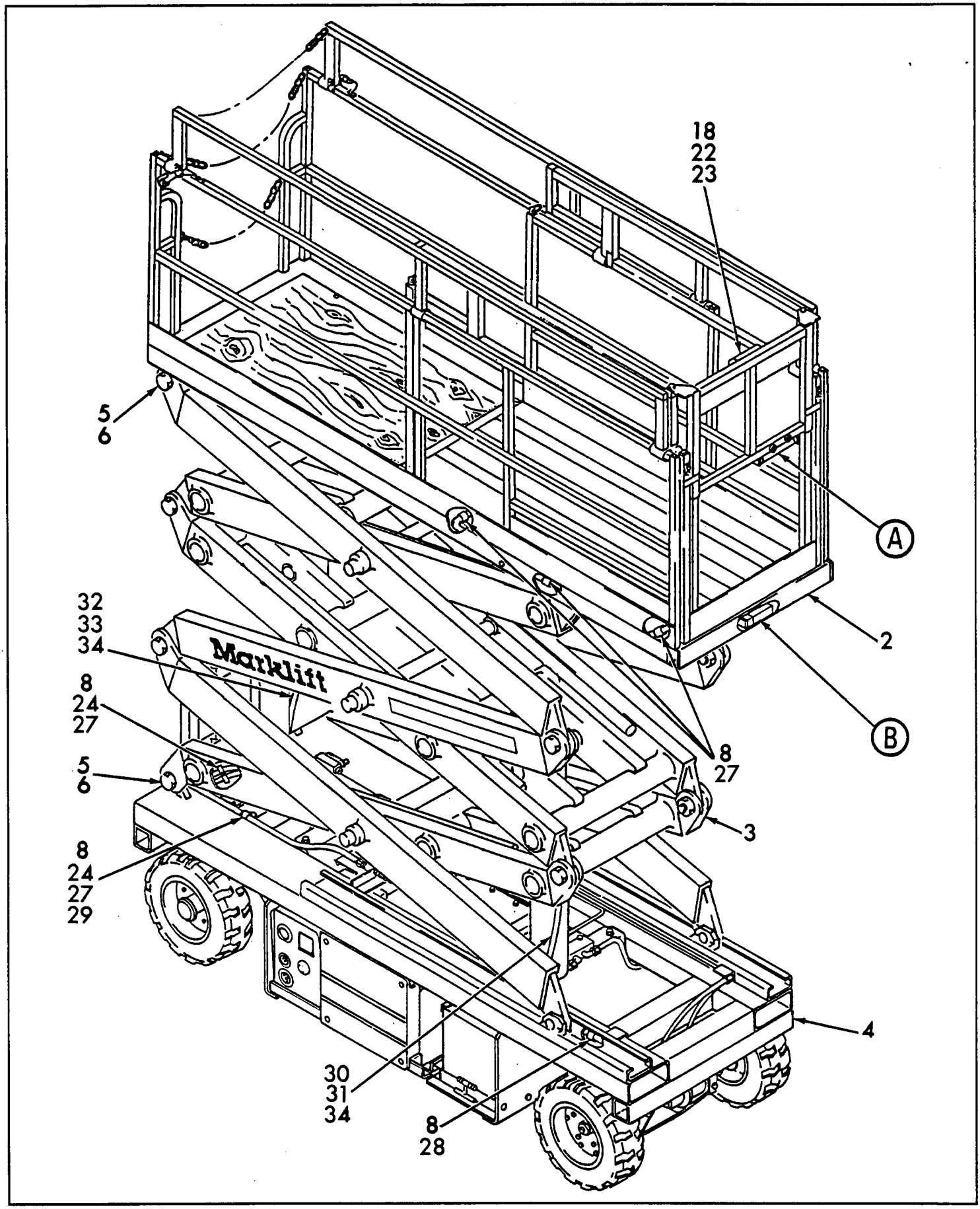
TITLE	FINAL ASSEMBLY	SECT. 2
MODEL	M20EST	FIG. 1
NOTES		PAGE 5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
47	.2807	RELIEF, STRAIN	1
48	.2809	NUT, LOCK	1
49	.2806	RELIEF, STRAIN	1
50	.2808	NUT, LOCK	1
-51	.65116	OIL, HYDRAULIC	13 GAL

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	2
FIGURE	2
PAGE	1



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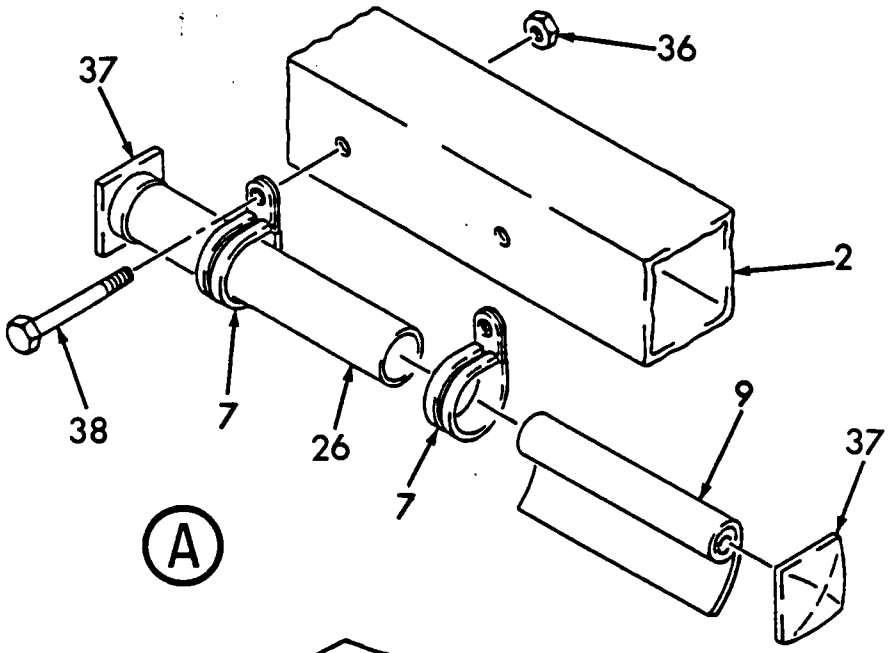
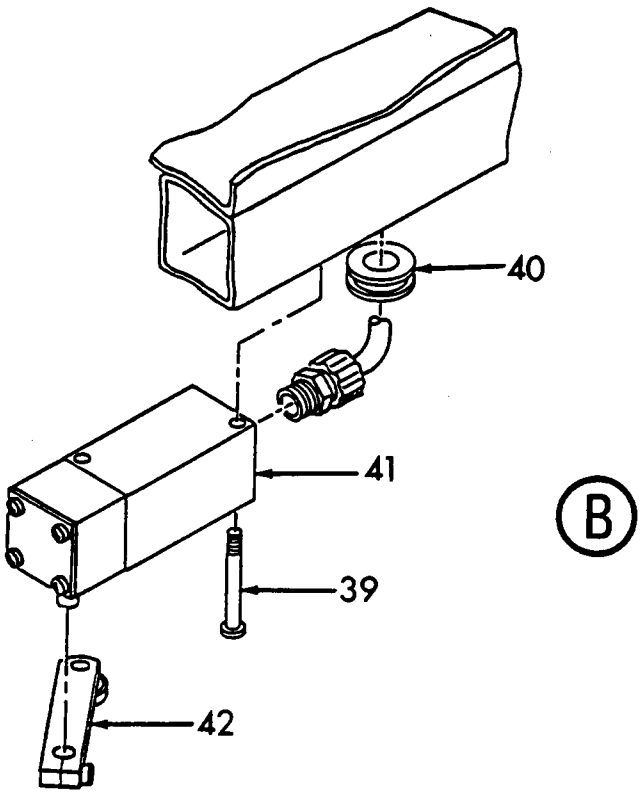
Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	2
FIGURE	2
PAGE	2





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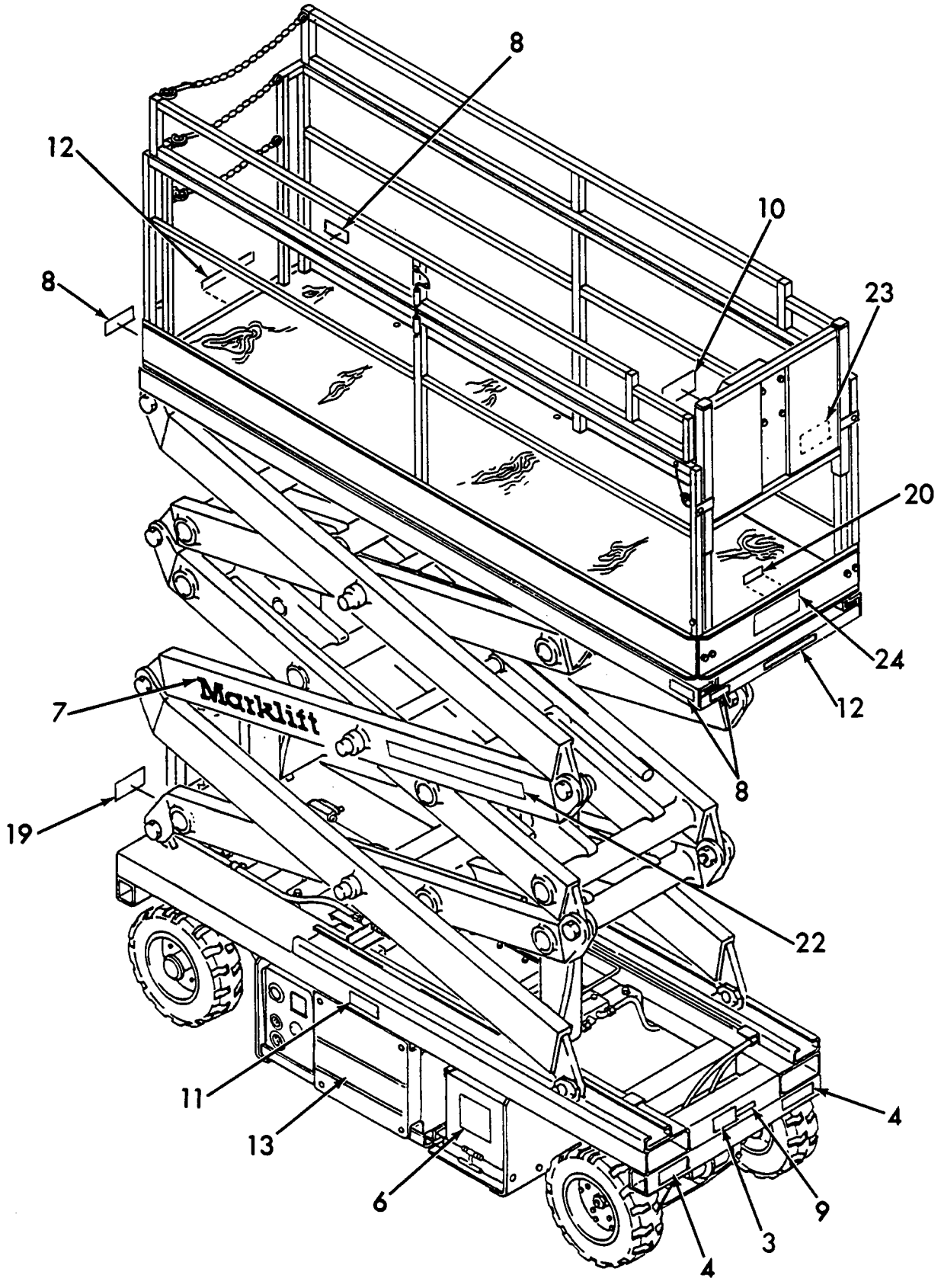
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130033	ASSEMBLY, FINAL	REF
2	.131172	ASSEMBLY, PLATFORM (SLIDE OUT/FOLD DOWN) (See Sect. 5, Fig. 1 for Details)	1
3	.130615	ASSEMBLY, SCISSOR (See Sect. 4, Fig. 1 for Details)	1
4	.131302	ASSEMBLY, FRAME (See Sect. 3, Fig. 1 for Details)	1
5	.130696	BOLT, EAR PIVOT	4
6	.61249	NUT, LOCK	4
7	.65867	CLAMP	2
8	.63654	RIVET, POP	11
9	.130422	HANDBOOK, OPERATORS	1
-10	.256	TIE, CABLE	50
-11	.255	TIE, CABLE	50
-12	.130769	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5 for Details)	1
-13	.131553	SCHEMATIC, HYDRAULIC/NON-TRAVERSING (See Schematic Chapter for Details)	1
-14	.65389	PAINT, BLUE	2
-15	.16608	PAINT, WHITE	5
-16	.65368	PAINT, BLUE (TOUCH-UP)	1
-17	.2673	PAINT, WHITE (TOUCH-UP)	1
18	.131576	COVER, UPPER CONTROL BOX	1
-19	.130337-55	CABLE, CONDUCTOR	1
-20	..130337	CABLE, CONDUCTOR	55 FT
-21	.375	RIVET, POP	12
22	.131581	ASSEMBLY, UPPER CONTROL BOX (See Sect. 2, Fig. 7 for Details)	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.61711	SCREW, SELF-TAPPING	6
24	.16268	CLAMP, HOSE	4
-25	.131584	SCHEMATIC, ELECTRICAL (See Schematic Chapter for Details)	1
26	.130927	CONTAINER, PLASTIC	1
27	.65655	CLAMP, CUSHIONED	8
28	.65787	CLAMP, CUSHIONED	2
29	.765	CLAMP, RUBBER	1
30	.2568-15	HOSE, HYDRAULIC	1
31	..2568	HOSE, HYDRAULIC	15 FT
32	.2568-25	HOSE, HYDRAULIC	1
33	..2568	HOSE, HYDRAULIC	25 FT
34	.2562	FITTING, SWIVEL	4
-35	.131883	DIAGRAM, HYDRAULIC TUBE (See Sect. 2, Fig. 9 for Details)	1
36	.60711	NUT, HEX	2
37	.65842	CAP, ANTI-ROLL	2
38	.60315	SCREW, CAP	2
39	.62620	SCREW, MACHINE	2
40	.70016	GROMMET	1
41	.70173	SWITCH, LIMIT	1
42	.70235	LEVER, LIMIT SWITCH	1
-43	.65116	OIL, HYDRAULIC	13 GAL

Mark Industries

TITLE	DECAL SET
MODEL	M20EST
NOTES	

SECTION	2
FIGURE	3
PAGE	1



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Mark Industries

TITLE	DECAL SET	SECT. 2
MODEL	M20EST	FIG. 3
NOTES		PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	600301	SET, DECAL	REF
-2	.130505	DECAL, GROUND CONTROL BOX (See Ground Control Box for Location)	1
3	.20660	NAMEPLATE, IDENTIFICATION	1
4	.2002	DECAL, FORKLIFT BOOT	2
5	.2017	DECAL, HYDRAULIC SYSTEM FLUID	1
6	.2003	DECAL, BATTERY WATER LEVEL	1
7	.31259	DECAL, MARKLIFT (SMALL SCISSOR)	2
8	.2023	DECAL, LOAD CAPACITY 750 LBS.	4
9	.20661	PLATE, ANSI A92	1
10	.182737	DECAL, OPERATION INSTRUCTIONS	1
11	.2016	DECAL, 'DO NOT WORK UNDER...'	2
12	.31109	DECAL, CAUTION SCISSOR GUARD RAILS	2
13	.181721	DECAL, M20EST	2
-14	.130782	DECAL, DRIVE UPPER CONTROL BOX (See Upper Control Box for Location)	1
-15	.182718	DECAL, AERIAL CONTROL BOX (See Upper Control Box for Location)	1
-16	.2014	DECAL, CAUTION HIGH VOLTAGE LINES (See Upper Control Box for Location)	1
-17	.130796	DECAL, HORN & FUEL UPPER CONTROL (See Upper Control Box for Location)	1
18	.130606	DECAL, FREEWHEELING VALVE	1
19	.2041	DECAL, 'DO NOT LIFT THIS END...'	1
20	.11064	DECAL, ATTACH SAFETY CHAIN BEFORE...	1
21	.130802	DECAL, EMERGENCY DOWN INSTRUCTIONS	1
22	.130596	DECAL, 'A PRODUCT OF MARK INDUSTRIES'	2

Mark Industries

TITLE	DECAL SET
MODEL	M20EST
NOTES	

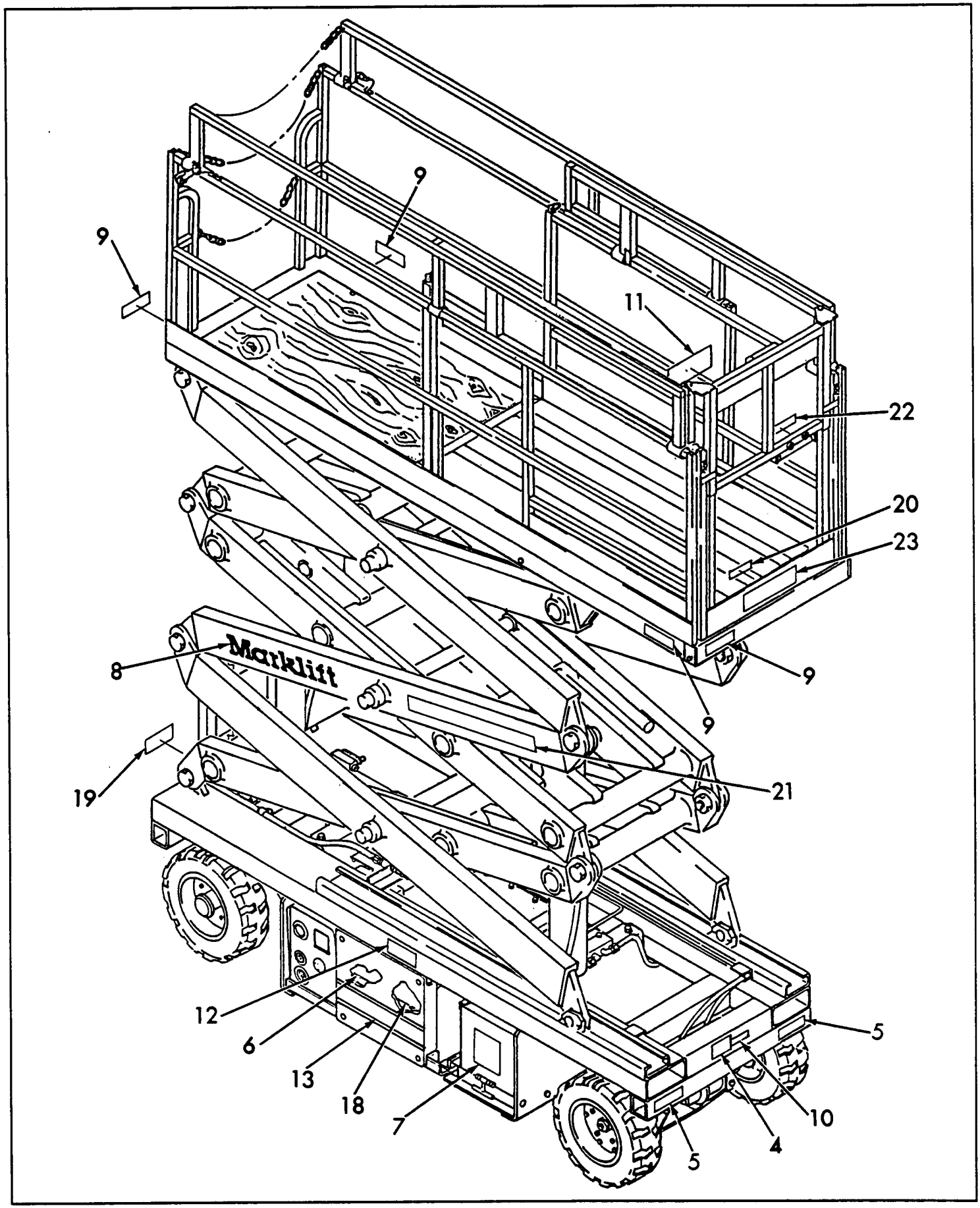
SECT.	2
FIG.	3
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.130820	DECAL, 'OPERATION & SAFETY HANDBOOK'	1
24	.32368	DECAL, M-SERIES	1

Mark Industries

TITLE	DECAL SET
MODEL	M20ESEP
NOTES	

SECTION	2
FIGURE	4
PAGE	1



REV.

Mark Industries

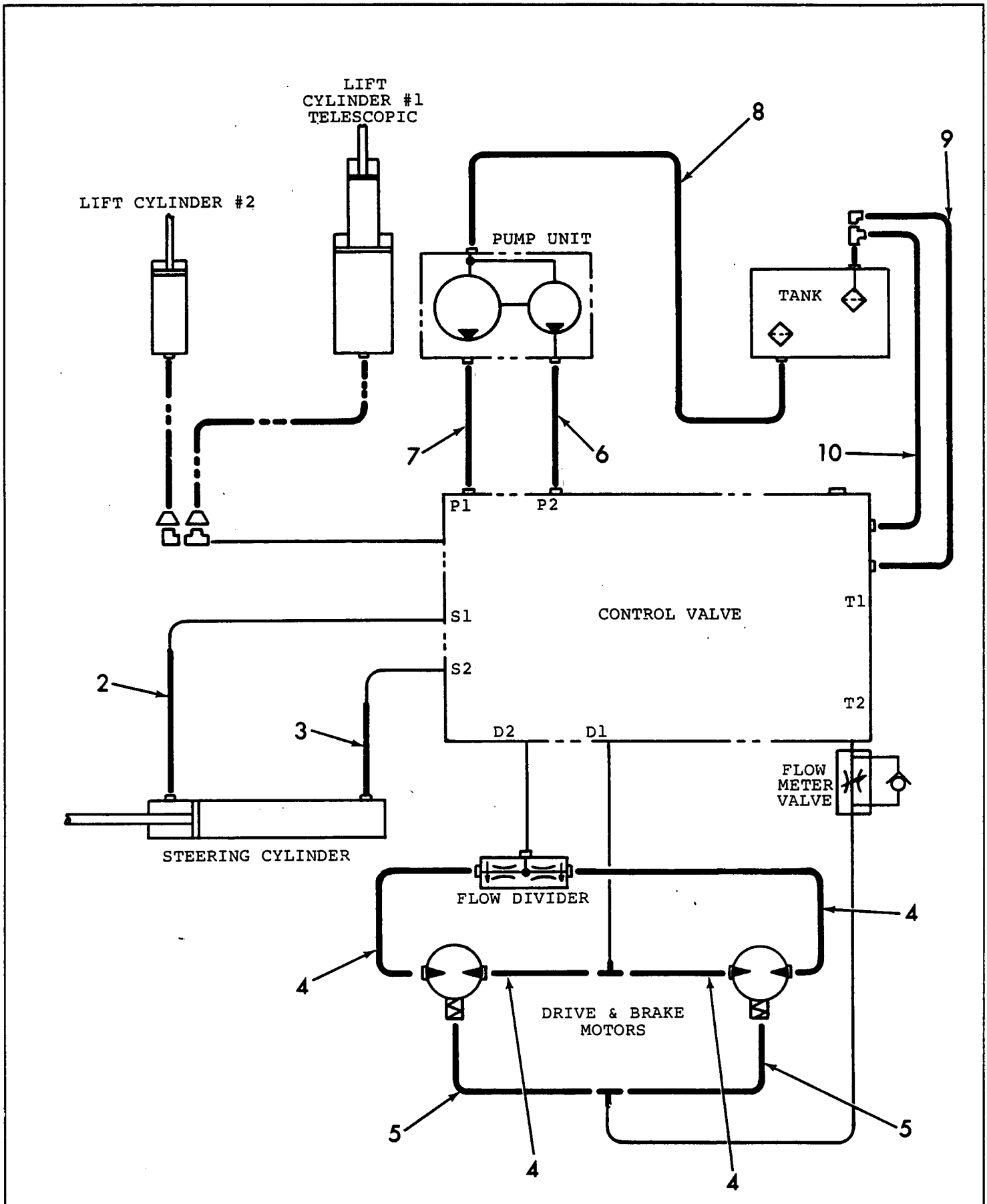
TITLE	DECAL SET	SECT. 2
MODEL	M20ESEP	FIG. 4
NOTES		PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	67639	SET, DECAL	REF
-2	.130505	DECAL, GROUND CONTROL BOX (See Ground Control Box for Location)	1
-3	.185707	DECAL, POWER TO PLATFORM 110 VAC (See Ground Control Box for Location)	1
4	.20660	NAMEPLATE, IDENTIFICATION	1
5	.2002	DECAL, FORKLIFT BOOT	2
6	.2017	DECAL, HYDRAULIC SYSTEM FLUID	1
7	.2003	DECAL, BATTERY WATER LEVEL	2
8	.31259	DECAL, MARKLIFT (SMALL SCISSOR)	2
9	.2023	DECAL, LOAD CAPACITY 750 LBS.	4
10	.20661	PLATE, ANSI A92	1
11	.182737	DECAL, OPERATION INSTRUCTIONS	1
12	.2016	DECAL, 'DO NOT WORK UNDER...'	2
13	.181720	DECAL, M20ESEP	2
-14	.130782	DECAL, DRIVE UPPER CONTROL BOX (See Upper Control Box for Location)	1
-15	.182718	DECAL, AERIAL CONTROL BOX (See Upper Control Box for Location)	1
-16	.2014	DECAL, CAUTION HIGH VOLTAGE LINES (See Upper Control Box for Location)	1
-17	.130796	DECAL, HORN & FUEL UPPER CONTROL (See Upper Control Box for Location)	1
18	.130606	DECAL, FREEWHEELING VALVE	1
19	.2041	DECAL, 'DO NOT LIFT THIS END...'	1
20	.11064	DECAL, ATTACH SAFETY CHAIN BEFORE...	1
21	.130596	DECAL, 'A PRODUCT OF MARK INDUSTRIES'	2
22	.130820	DECAL, 'OPERATION & SAFETY HANDBOOK'	1
23	.32368	DECAL, M-SERIES	1

Mark Industries

TITLE	HYDRAULIC HOSE DIAGRAM
MODEL	M20ESEP & M20EST
NOTES	

SECTION	2
FIGURE	5
PAGE	1



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Mark Industries

TITLE	HYDRAULIC HOSE DIAGRAM
MODEL	M20ESEP & M20EST
NOTES	

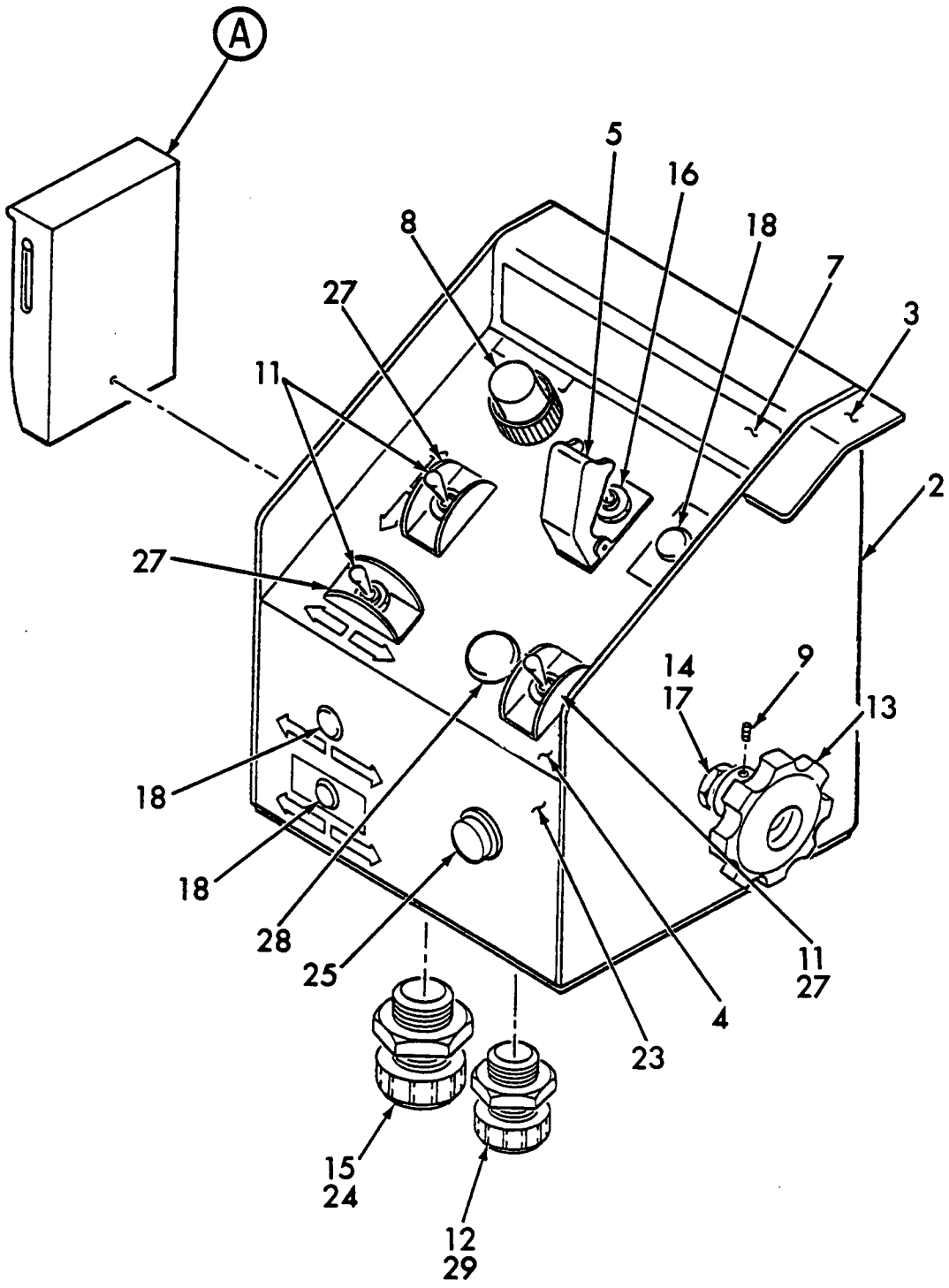
SECT.	2
FIG.	5
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130769	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 1 for NHA)	REF
2	.13213-04-0130	ASSEMBLY, HOSE	1
3	.13213-04-0180	ASSEMBLY, HOSE	1
4	.13210-08-0264	ASSEMBLY, HOSE	4
5	.13213-04-0310	ASSEMBLY, HOSE	2
6	.13213-08-0210	ASSEMBLY, HOSE	1
7	.13210-08-0204	ASSEMBLY, HOSE	1
8	.13205-12-0260	ASSEMBLY, HOSE	1
9	.13203-08-0130	ASSEMBLY, HOSE	1
10	.13205-08-0110	ASSEMBLY, HOSE	1

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	2
FIGURE	6
PAGE	1



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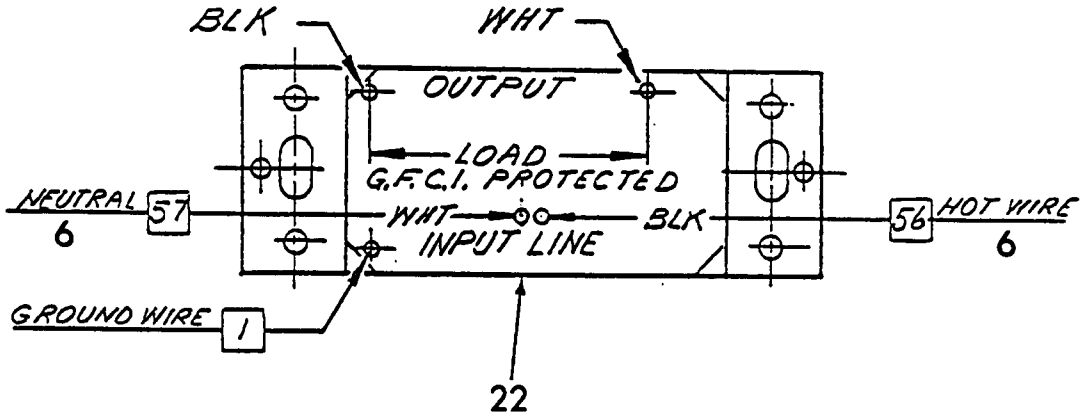
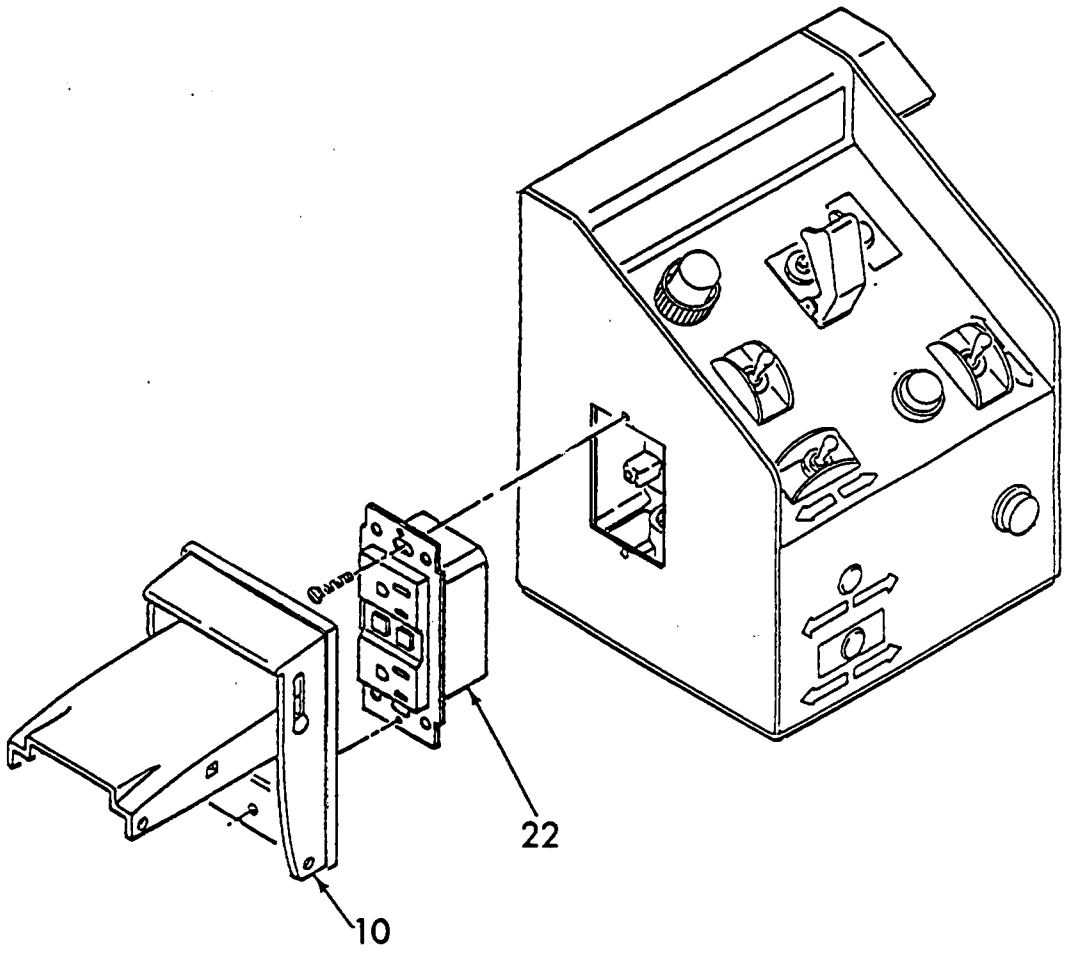

BLK
WHT
OUTPUT
LOAD
G.F.C.I. PROTECTED
NEUTRAL
6
57
WHT
BLK
56
HOT WIRE
6
INPUT LINE
GROUND WIRE
1
22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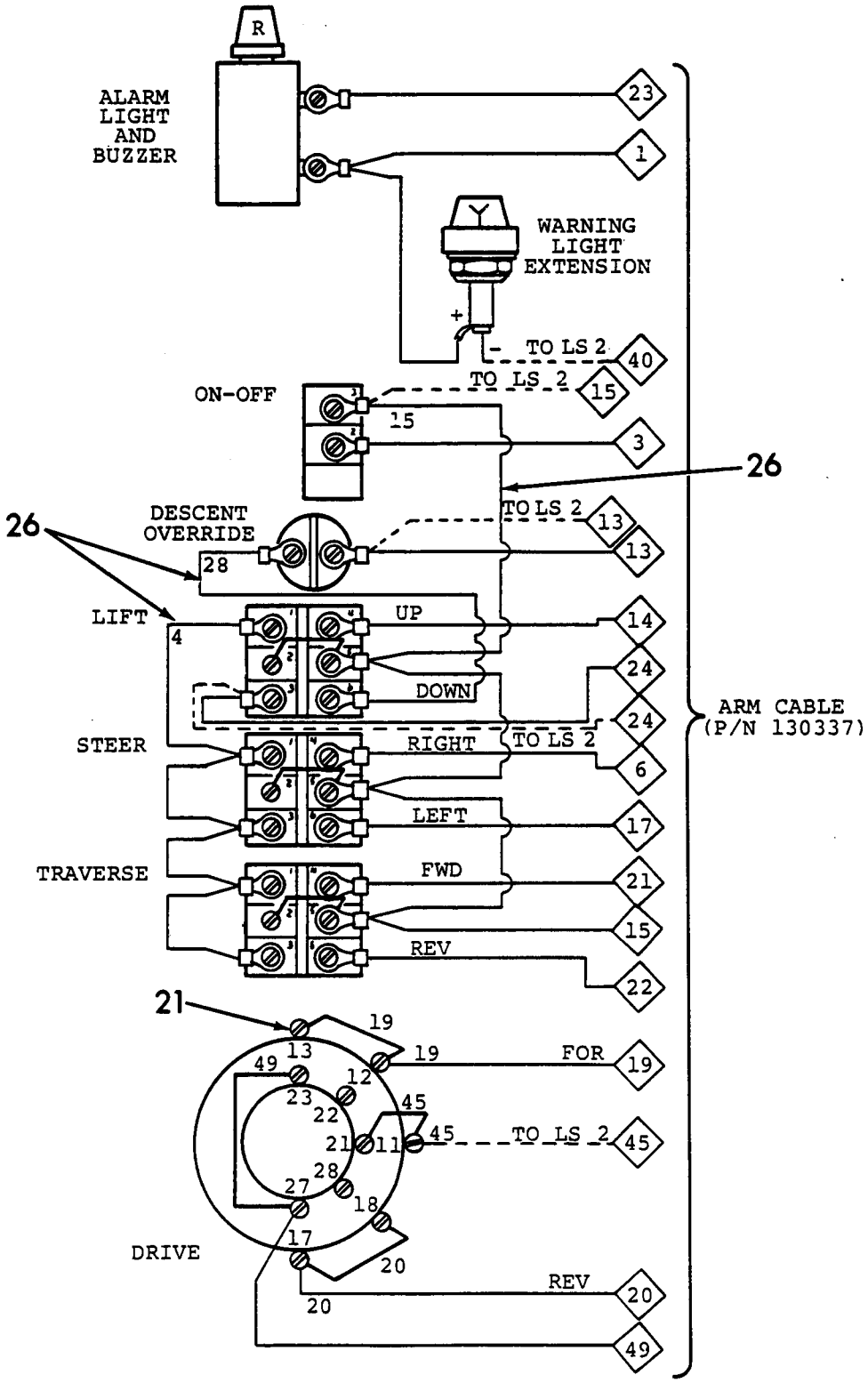


ELECTRICAL DIAGRAM
(REFER TO ELECTRICAL SCHEMATIC DWG. NO. 131555)

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20EST
NOTES	

SECT.	2
FIG.	6
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131446	ASSEMBLY, UPPER CONTROL BOX (See Sect. 2, Fig. 1 for NHA)	REF
2	.130781	WELDMENT, UPPER CONTROL BOX	1
3	.130782	DECAL, DRIVE UPPER CONTROL BOX	1
4	.182718	DECAL, AERIAL CONTROL BOX	1
5	.70303	SWITCH, GUARD	1
6	.70394	CONNECTOR, TWIST-ON WIRE	4
7	.2014	DECAL, CAUTION HIGH VOLTAGE LINE	1
8	.66345	ALARM, BUZZER	1
9	.62209	SCREW, SET	1
10	.70392	COVER, RECEPTACLE	1
11	.20481	SWITCH, TOGGLE	3
12	.2806	RELIEF, STRAIN	1
13	.65753	KNOB, FLUTED TORQUE	1
14	.4106	SWITCH, 5 POSITION	1
15	.2807	RELIEF, STRAIN	1
16	.4017	SWITCH, TOGGLE	1
17	.160369	NUT, RUBBER COATED	1
18	.771	PLUG, WHITE	3
-19	.16228	CONNECTOR, RING	4
-20	.117-C	RING, CONNECTOR	10
21	.16213	CONNECTOR	15
22	.70391	RECEPTACLE, G.F.C.I.	1
23	.130796	DECAL, HORN & FUEL UPPER CONTROL	1
24	.2809	NUT, LOCK	1
25	.4011	SWITCH, PUSH BUTTON	1

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20EST
NOTES	

SECT.	2
FIG.	6
PAGE	5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.70232	WIRE, WHITE (16 AWG)	4
27	.20884	GUARD, SWITCH	3
28	.70293	LIGHT, PILOT INDICATOR	1
29	.2808	NUT, LOCK	1

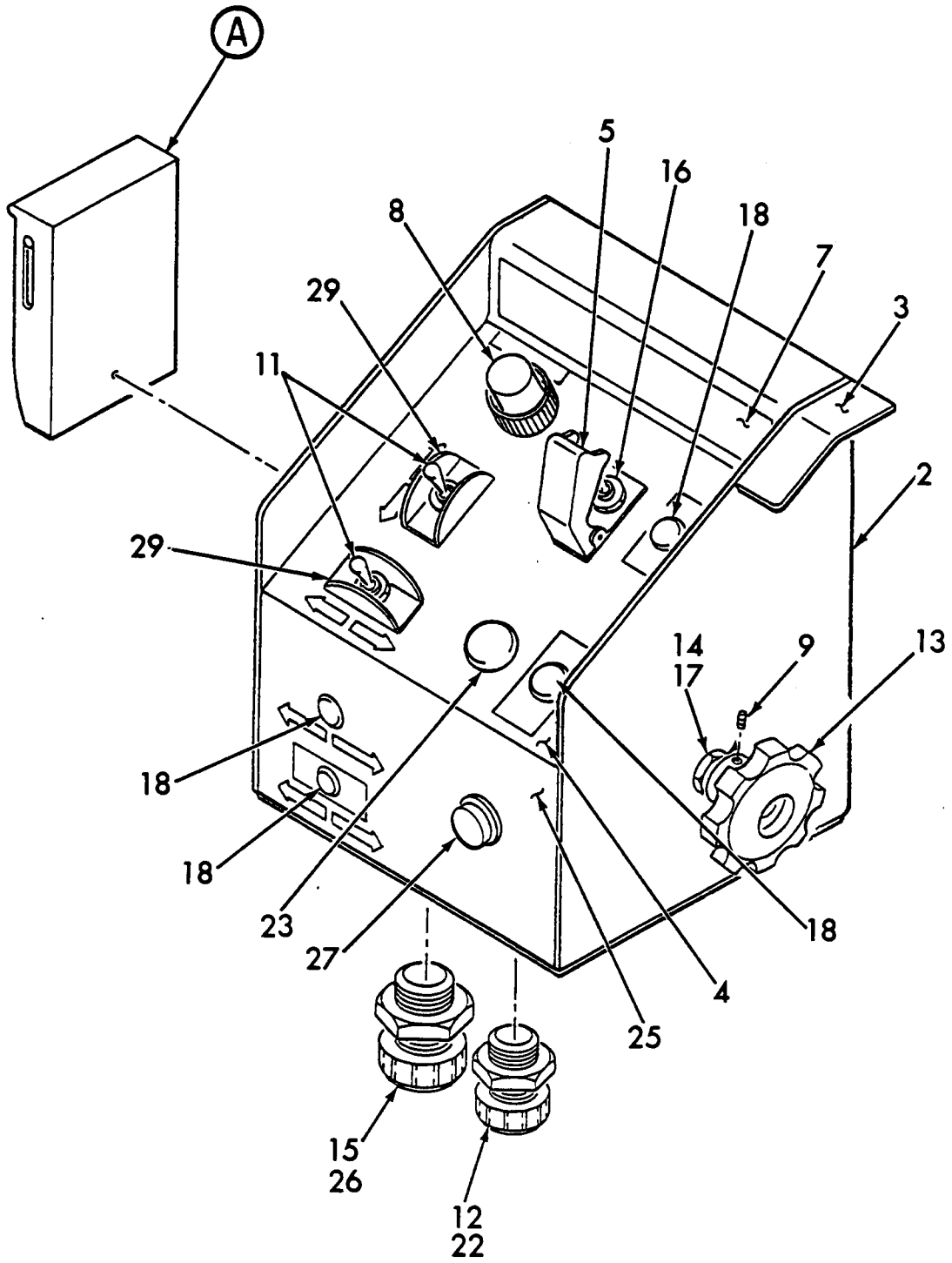
REV.

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

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	2
FIGURE	7
PAGE	1



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Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

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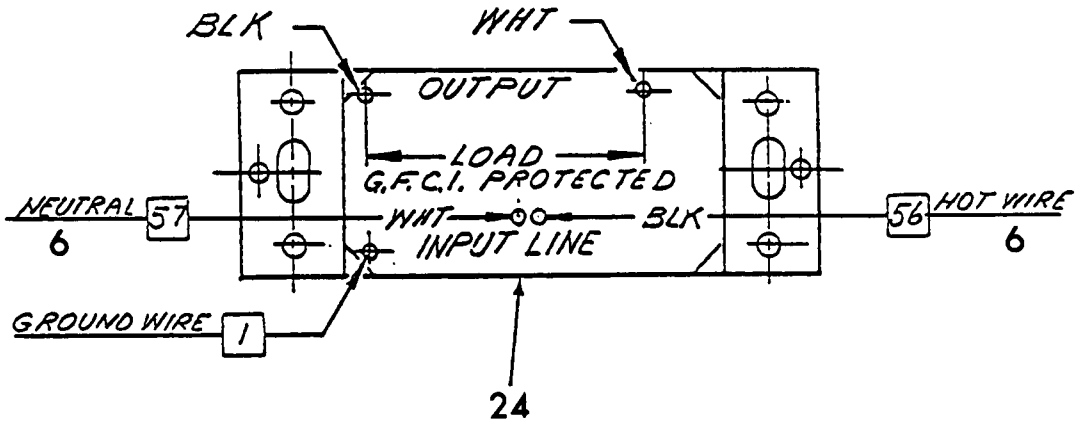

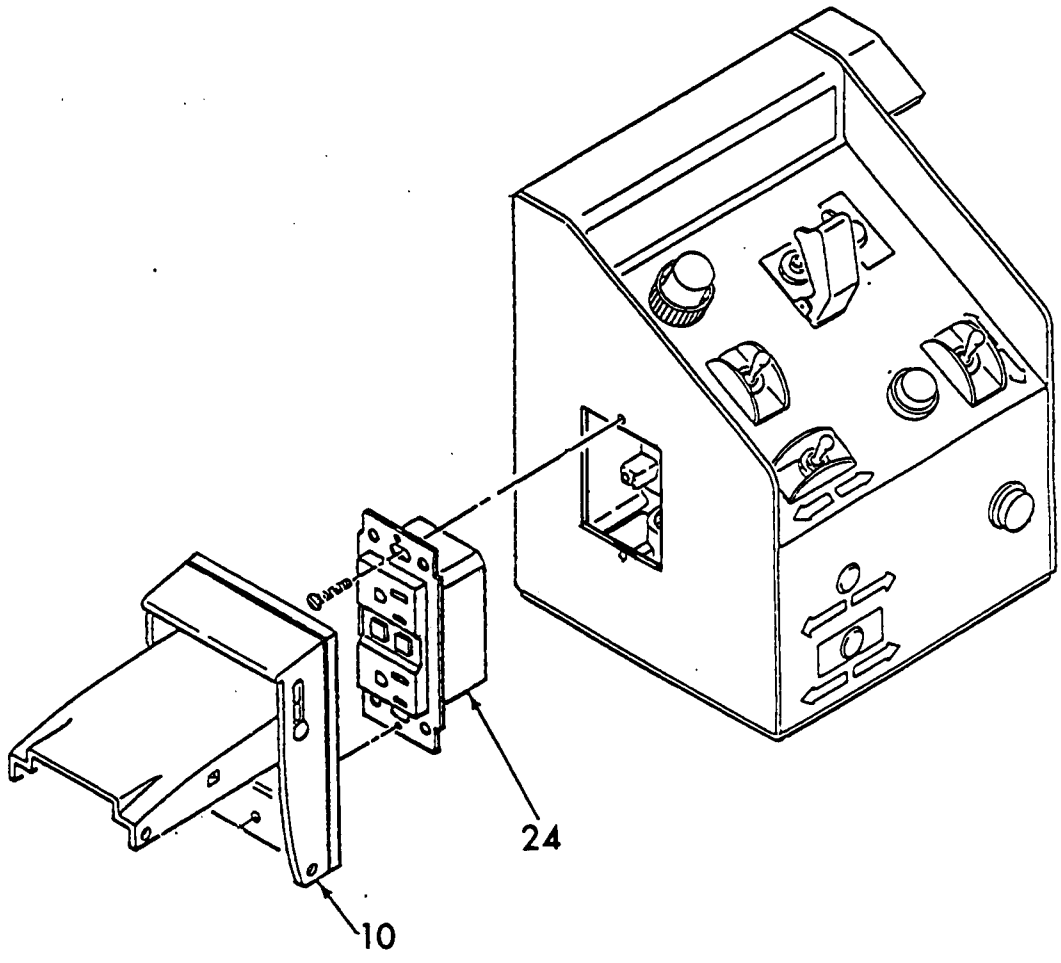

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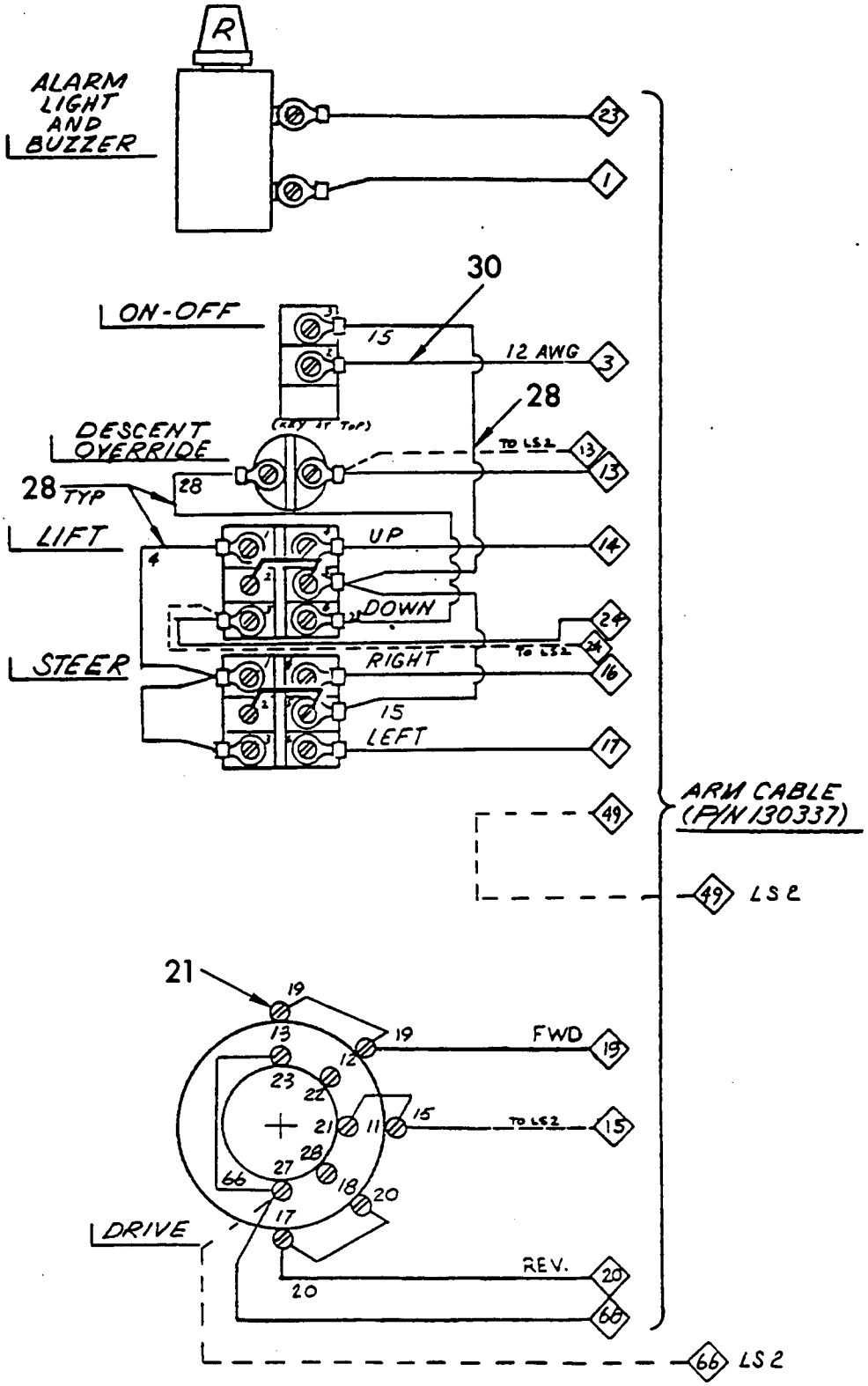

ELECTRICAL DIAGRAM
(REFER TO ELECTRICAL SCHEMATIC DWG NO 131584)

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

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FIG.	7
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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131581	ASSEMBLY, UPPER CONTROL BOX (See Sect. 2, Fig. 1 for NHA)	REF
2	.130781	WELDMENT, UPPER CONTROL BOX	1
3	.130782	DECAL, DRIVE UPPER CONTROL BOX	1
4	.182718	DECAL, AERIAL CONTROL BOX	1
5	.70303	GUARD, SWITCH	1
6	.70394	CONNECTOR, TWIST-ON WIRE	4
7	.2014	DECAL, CAUTION HIGH VOLTAGE LINES	1
8	.66345	ALARM, BUZZER	1
9	.62209	SCREW, SET	1
10	.70392	COVER, RECEPTACLE	1
11	.20481	SWITCH, TOGGLE	2
12	.2806	RELIEF, STRAIN	1
13	.65753	KNOB, FLUTED TORQUE	1
14	.4106	SWITCH, 5 POSITION	1
15	.2807	RELIEF, STRAIN	1
16	.4017	SWITCH, TOGGLE	1
17	.160369	NUT, RUBBER COATED	1
18	.771	PLUG, WHITE	4
19	.16228	CONNECTOR, RING	4
-20	.117-C	RING, CONNECTOR	10
21	.16213	CONNECTOR	15
22	.2808	NUT, LOCK	1
23	.65241	PLUG, WHITE	1
24	.70391	RECEPTACLE, G.F.C.I.	1
25	.130796	DECAL, HORN & FUEL UPPER CONTROL	1

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	M20ESEP
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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.2809	NUT, LOCK	1
27	.4020	SWITCH, PUSH BUTTON	1
28	.70232	WIRE, WHITE (16 AWG)	4
29	.20884	GUARD, SWITCH	2
30	.2991	WIRE, WHITE (12 AWG)	1

REV.

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

Mark Industries

TITLE	HYDRAULIC TUBE DIAGRAM
MODEL	M20EST
NOTES	

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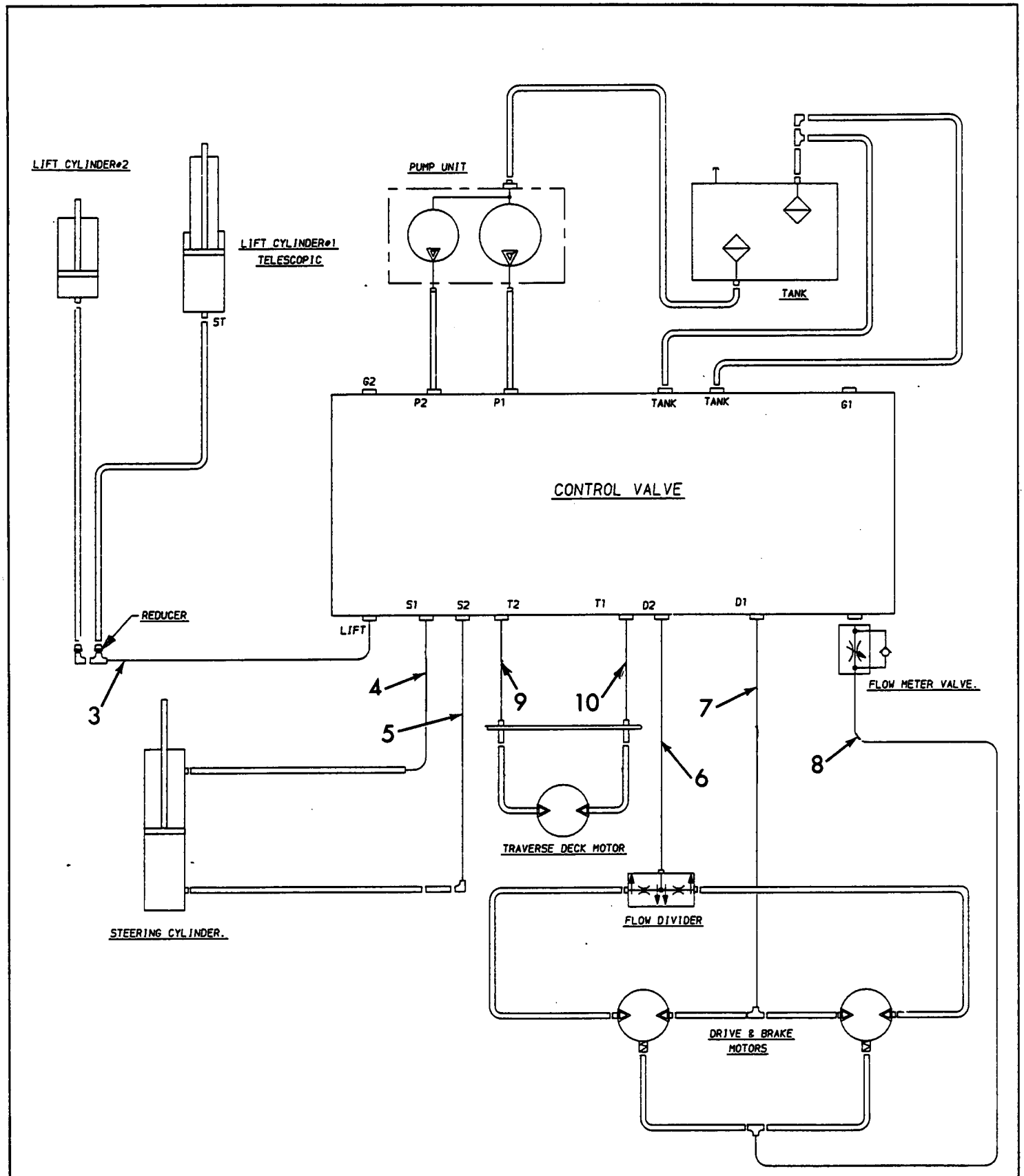

REV.

Mark Industries

TITLE	HYDRAULIC TUBE DIAGRAM
MODEL	M20EST
NOTES	

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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131884	DIAGRAM, HYDRAULIC TUBE (See Sect. 2, Fig. 1 for NHA)	REF
-2	.131883	DIAGRAM, HYDRAULIC TUBE	1
3	..131883-1	ASSEMBLY, TUBE	1
4	..131883-2	ASSEMBLY, TUBE	1
5	..131883-3	ASSEMBLY, TUBE	1
6	..131883-4	ASSEMBLY, TUBE	1
7	..131883-5	ASSEMBLY, TUBE	1
8	..131883-6	ASSEMBLY, TUBE	1
9	.131884-2	ASSEMBLY, TUBE	1
10	.131884-3	ASSEMBLY, TUBE	1

Mark Industries

TITLE	HYDRAULIC TUBE DIAGRAM
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NOTES	

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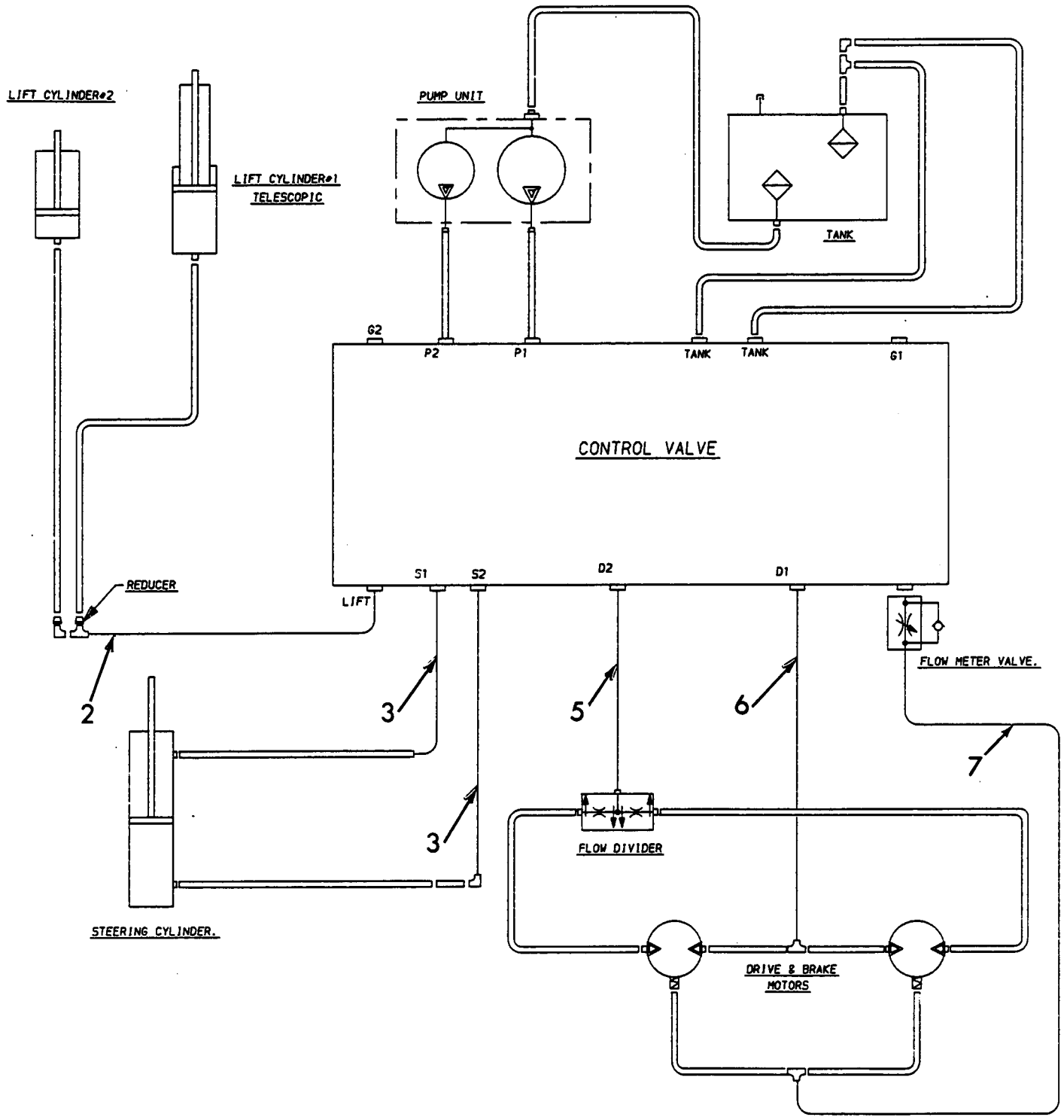

REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131883	DIAGRAM, HYDRAULIC TUBE (See Sect. 2, Fig. 1 for NHA)	REF
2	.131883-1	ASSEMBLY, TUBE	1
3	.131883-2	ASSEMBLY, TUBE	1
4	.131883-3	ASSEMBLY, TUBE	1
5	.131883-4	ASSEMBLY, TUBE	1
6	.131883-5	ASSEMBLY, TUBE	1
7	.131883-6	ASSEMBLY, TUBE	1

SECTION 3 CONTAINS:

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	M20EST
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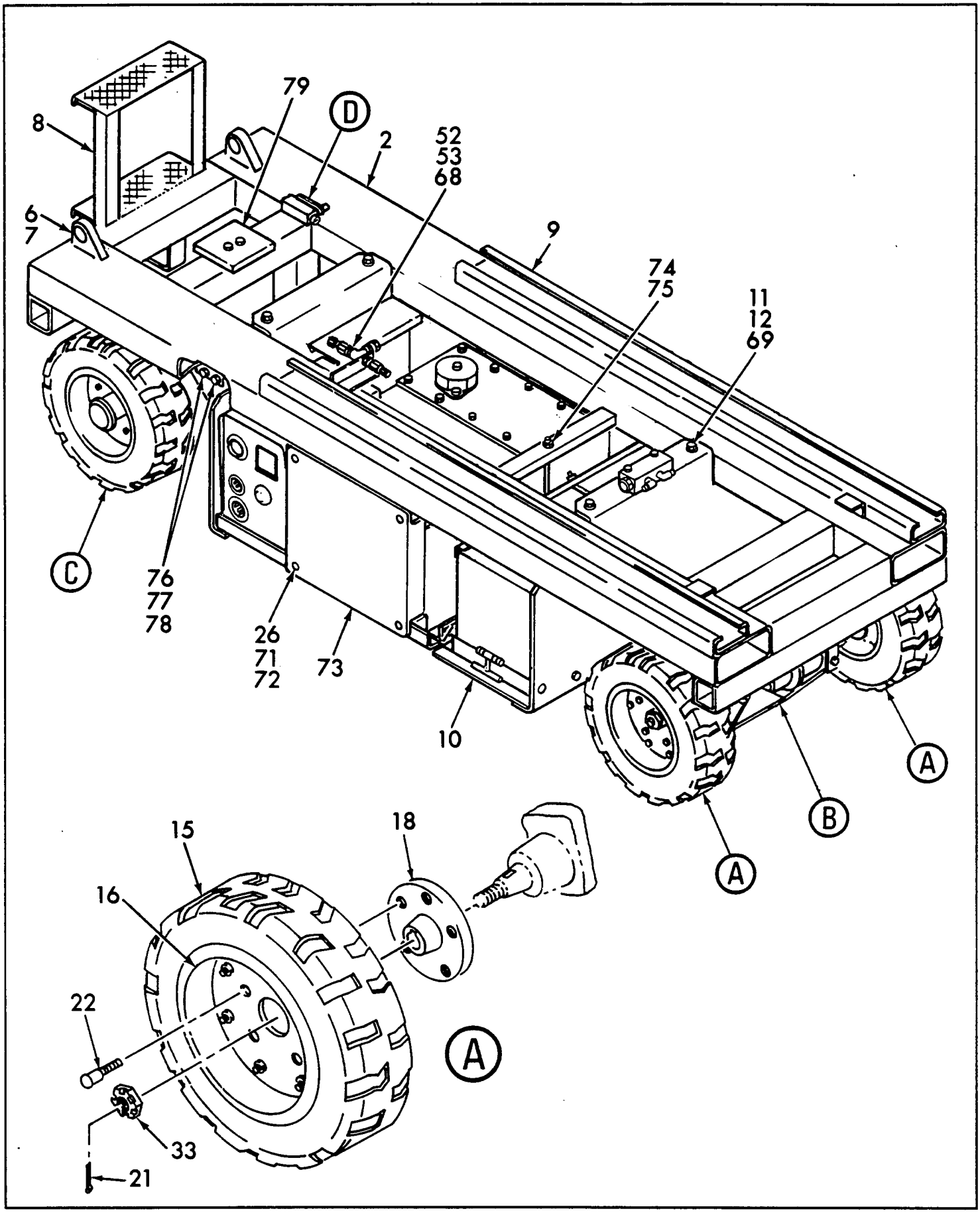

REV.

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	M20EST
NOTES	

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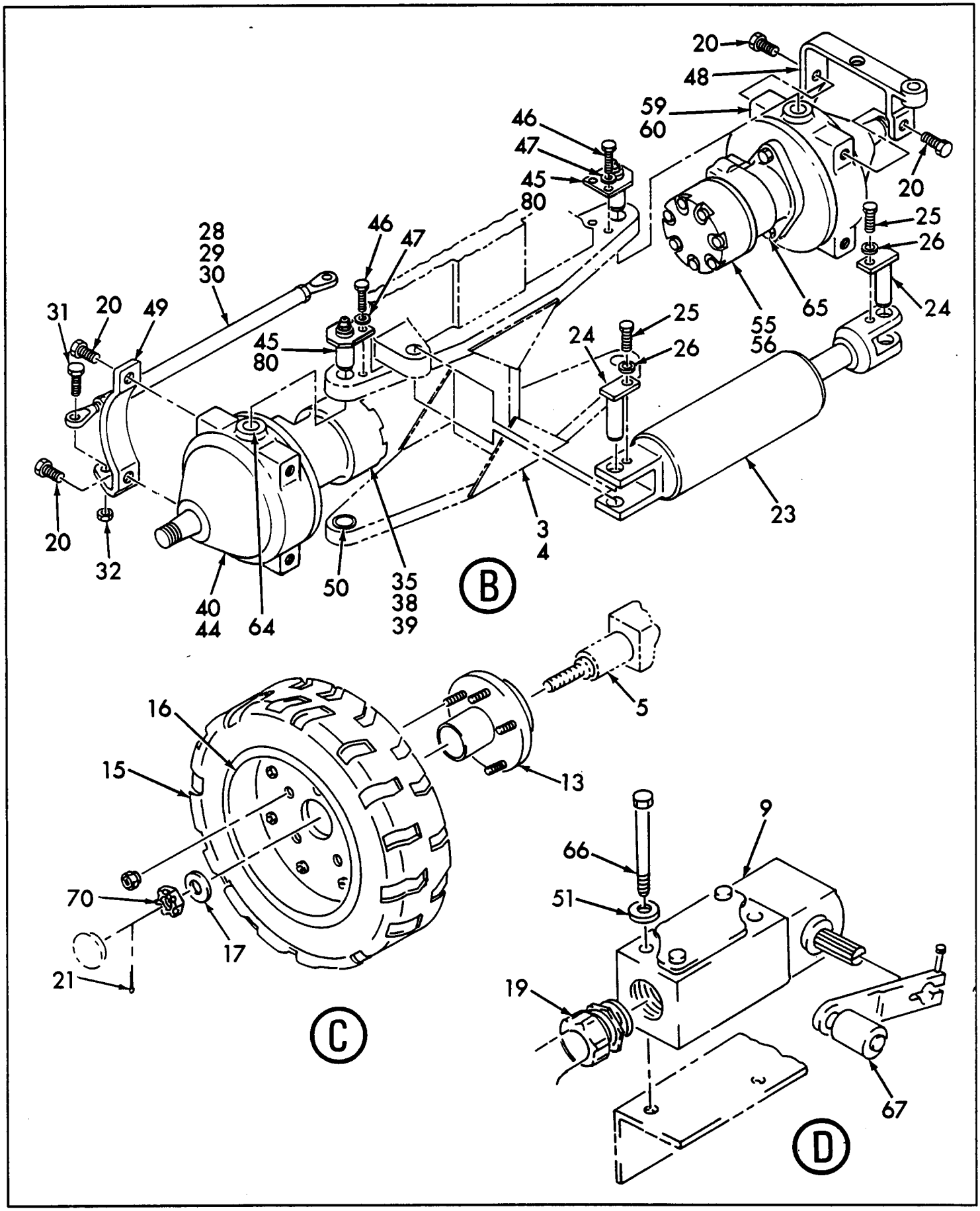

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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130746	ASSEMBLY, FRAME (See Sect. 2, Fig. 1 for NHA)	REF
2	.130738	WELDMENT, FRAME	1
3	..130277	MACHINING, FRONT AXLE	1
4	...64903	BUSHING	1
5	..130280	WELDMENT, REAR AXLE	1
6	..130283	STANDOFF, FRAME - SLAB MACHINES	2
7	...916	BUSHING	2
8	..130291	WELDMENT, STEP	1
9	.70173	SWITCH, LIMIT	1
10	.130714	ASSEMBLY, BELLY PAN - EXTENDABLE (See Sect. 3, Fig. 3 for Details)	1
11	.60311	SCREW, CAP	4
12	.63415	WASHER, FLAT	8
13	.134	ASSEMBLY, HUB (See Sect. 3, Fig. 5 for Details)	2
-14	.130945	ASSEMBLY, TIRE & WHEEL	4
15	..130946	TIRE	4
16	..30927	WHEEL	4
17	.63409	WASHER, FLAT	2
18	.31158	MACHINING, DRIVE HUB	2
19	.70288	RELIEF, STRAIN	1
20	.60622	SCREW, CAP	5
21	.64306	PIN, COTTER	4
22	.34044	BOLT, CONE	10
23	.130237	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 6 for Details)	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.20252	PIN, STEERING CYLINDER ANCHOR	2
25	.60353	SCREW, CAP	2
26	.63301	WASHER, LOCK	12
-27	.130302	ASSEMBLY, TIE ROD	1
28	..130303	ROD, TIE	1
29	..2274	END, TIE ROD	2
30	..60901	NUT, JAM	2
31	.60393	SCREW, CAP	2
32	.61242	NUT, LOCK	2
33	.65174	NUT, JAM	2
-34	.130442	ASSEMBLY, DRIVE MOTOR/BRAKE (R.H.)	1
35	..81017	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	1
-36	...66896	KIT, SEAL	1
-37	...68065	KIT, BEARING	1
38	..80004-13	CONNECTOR, STRAIGHT THREAD	2
39	..80004-03	CONNECTOR, STRAIGHT THREAD	1
40	..81290	BRAKE, MULTIPLE DISC (See Vendor Chapter for Details)	1
-41	...66806	KIT, SEAL	1
-42	...67648	KIT, LINING	1
-43	...68066	KIT, SPRING	1
44	..60610	SCREW, CAP	2
45	.131467	PIN, STEERING	4
46	.60338	SCREW, CAP	8
47	.63302	WASHER, LOCK	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
48	.130393	LEVER, STEERING (L.H.)	1
49	.130394	LEVER, STEERING (R.H.)	1
50	.65658	BEARING, THRUST	2
51	.63313	WASHER, LOCK	2
52	.80045-03	UNION	2
53	.80032-05	TEE	1
-54	.130490	ASSEMBLY, DRIVE MOTOR/BRAKE (L.H.)	1
55	..80004-13	CONNECTOR, STRAIGHT THREAD	2
56	..81017	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	1
-57	...66896	KIT, SEAL	1
-58	...68065	KIT, BEARING	1
59	..80004-03	CONNECTOR, STRAIGHT THREAD	1
60	..81290	BRAKE, MULTIPLE DISC (See Vendor Chapter for Details)	1
-61	...66806	KIT, SEAL	1
-62	...67648	KIT, LINING	1
-63	...68066	KIT, SPRING	1
64	...66792	BUSHING, TRUNNION	2
65	..60610	SCREW, CAP	2
66	.62615	SCREW, MACHINE	2
67	.70032	LEVER, OPERATING	1
68	.80056-01	REDUCER, TUBE END	2
69	.61305	NUT, LOCK	4
70	.60811	NUT, HEX	2
71	.60342	SCREW, CAP	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
72	.63401	WASHER, FLAT	8
73	.130727	COVER	2
74	.63669	ROD, THREADED	1
75	.61245	NUT, LOCK	3
76	.60343	SCREW, CAP	4
77	.63319	WASHER, LOCK	4
78	.60703	NUT, HEX	4
79	.131077	ASSEMBLY, TILT SWITCH (See Sect. 3, Fig. 7 for Details)	1
80	.65103	FITTING, GREASE	4

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	M20ESEP
NOTES	

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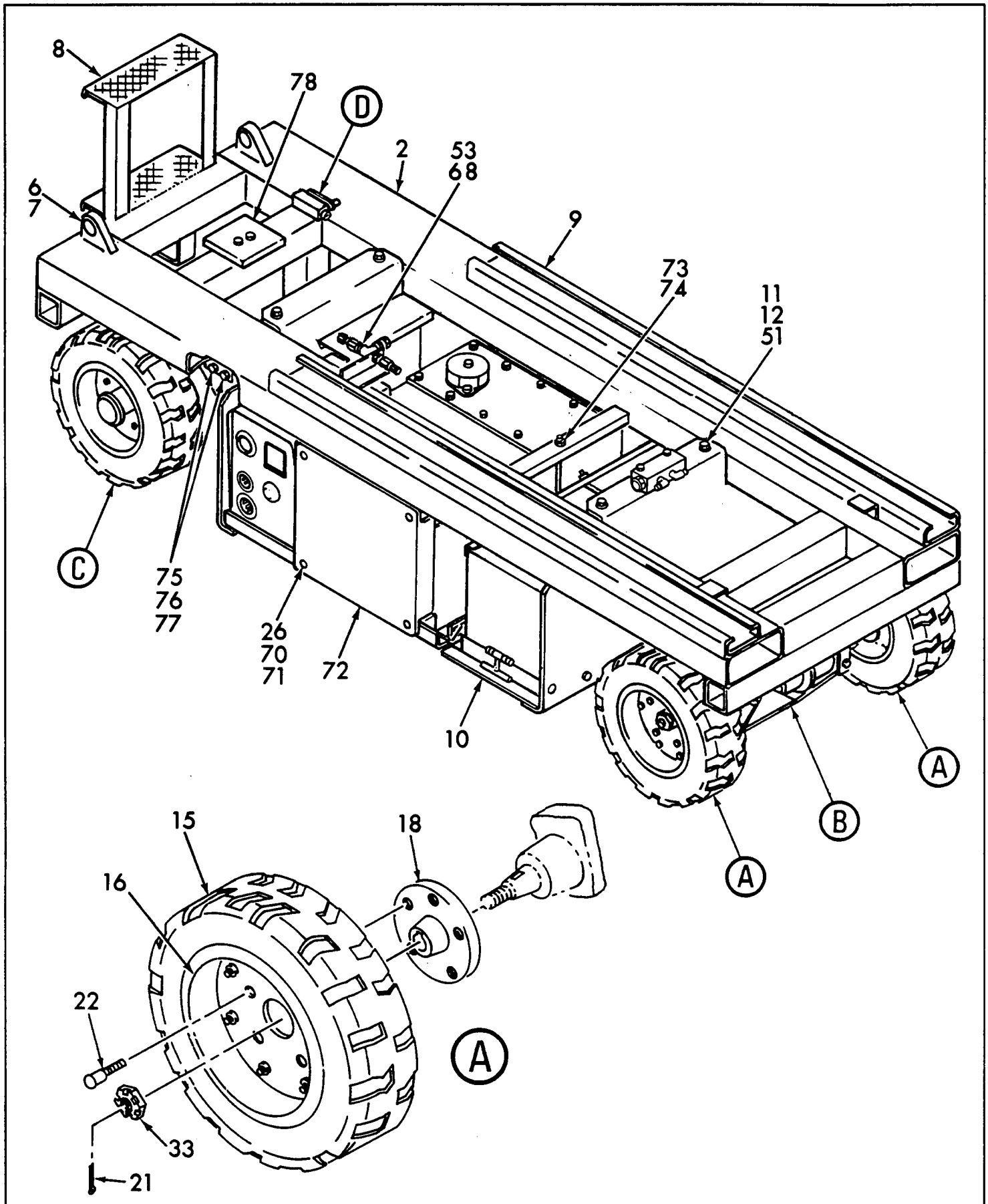

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Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	M20ESEP
NOTES	

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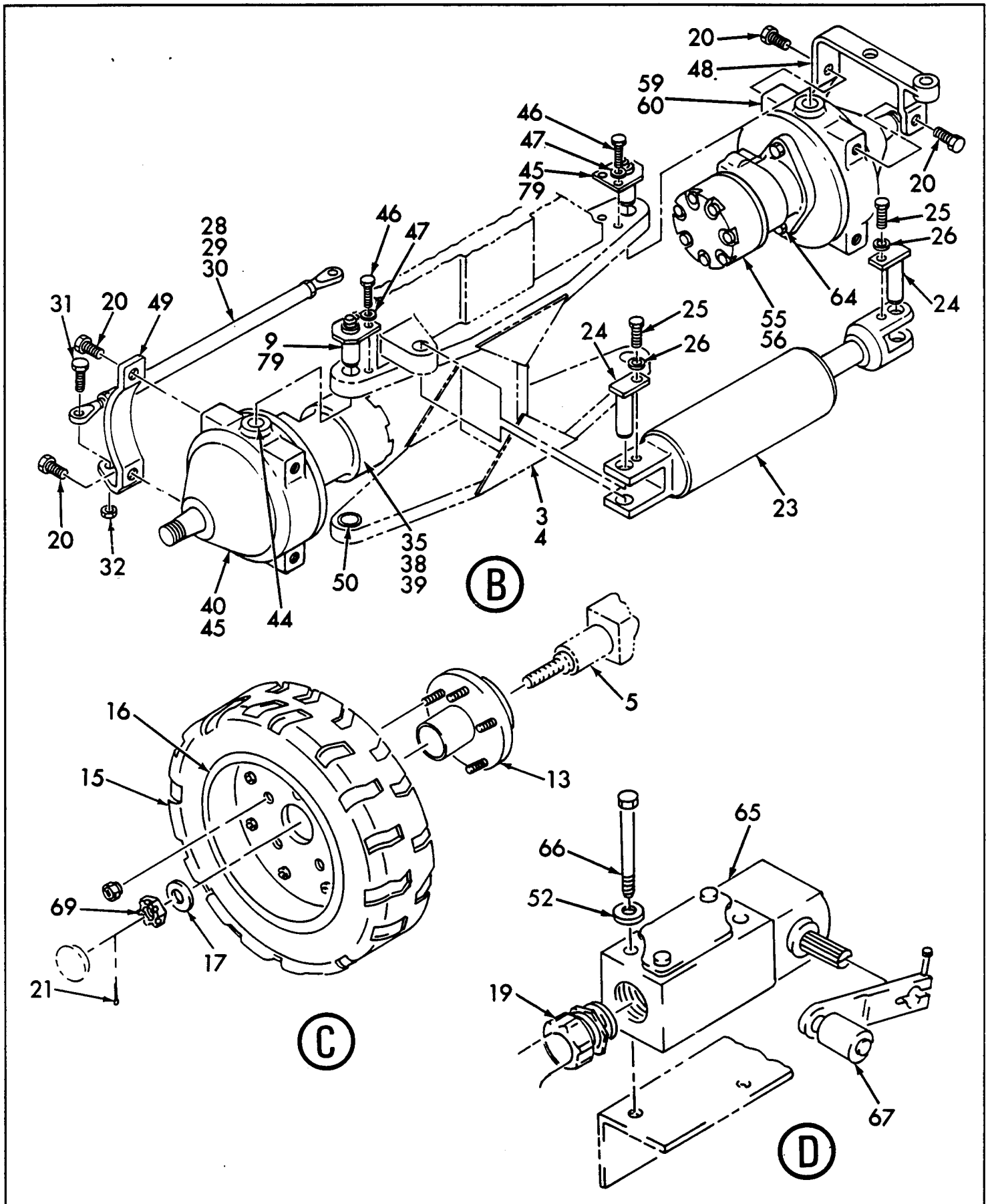

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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131302	ASSEMBLY, FRAME (See Sect. 2, Fig. 1 for NHA)	REF
2	.130738	WELDMENT, FRAME	1
3	..130277	MACHINING, FRONT AXLE	1
4	...64903	BUSHING	1
5	..130280	WELDMENT, REAR AXLE	1
6	..130283	STANDOFF, FRAME - SLAB MACHINES	2
7	...916	BUSHING	2
8	..130291	WELDMENT, STEP	1
9	.131467	PIN, STEERING	4
10	.131301	ASSEMBLY, BELLY PAN (See Sect. 3, Fig. 4 for Details)	1
11	.60311	SCREW, CAP	4
12	.63415	WASHER, FLAT	8
13	.134	ASSEMBLY, HUB (See Sect. 3, Fig. 5 for Details)	2
-14	.130945	ASSEMBLY, TIRE & WHEEL	4
15	..130946	TIRE	4
16	..30927	WHEEL	4
17	.63409	WASHER, FLAT	2
18	.31158	MACHINING, DRIVE HUB	2
19	.70288	RELIEF, STRAIN	1
20	.60622	SCREW, CAP	5
21	.64306	PIN, COTTER	4
22	.34044	BOLT, CONE	10
23	.130237	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 6 for Details)	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.20252	PIN, STEERING CYLINDER ANCHOR	2
25	.60353	SCREW, CAP	2
26	.63301	WASHER, LOCK	12
-27	.130302	ASSEMBLY, TIE ROD	1
28	..130303	ROD, TIE	1
29	..2274	END, TIE ROD	2
30	..60901	NUT, JAM	2
31	.60393	SCREW, CAP	2
32	.61242	NUT, LOCK	2
33	.65174	NUT, JAM	2
-34	.130442	ASSEMBLY, DRIVE MOTOR/BRAKE (R.H.)	1
35	..81017	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	1
-36	...66896	KIT, SEAL	1
-37	...68065	KIT, BEARING	1
38	..80004-13	CONNECTOR, STRAIGHT THREAD	2
39	..80004-03	CONNECTOR, STRAIGHT THREAD	1
40	..81290	BRAKE, MULTIPLE DISC (See Vendor Chapter for Details)	1
-41	...66806	KIT, SEAL	1
-42	...67648	KIT, LINING	1
-43	...68066	KIT, SPRING	1
44	...66792	BUSHING, TRUNNION	2
45	..60610	SCREW, CAP	2
46	.60338	SCREW, CAP	8
47	.63302	WASHER, LOCK	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
48	.130393	LEVER, STEERING (L.H.)	1
49	.130394	LEVER, STEERING (R.H.)	1
50	.65658	BEARING, THRUST	2
51	.61305	NUT, LOCK	4
52	.63313	WASHER, LOCK	2
53	.80032-05	TEE, BULKHEAD	1
-54	.130490	ASSEMBLY, DRIVE MOTOR/BRAKE (L.H.)	1
55	..80004-13	CONNECTOR, STRAIGHT THREAD	2
56	..81017	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	1
-57	...66896	KIT, SEAL	1
-58	...68065	KIT, BEARING	1
59	..80004-03	CONNECTOR, STRAIGHT THREAD	1
60	..81290	BRAKE, MULTIPLE DISC (See Vendor Chapter for Details)	1
-61	...66806	KIT, SEAL	1
-62	...67648	KIT, LINING	1
-63	...68066	KIT, SPRING	1
64	..60610	SCREW, CAP	2
65	.70173	SWITCH, LIMIT	1
66	.62615	SCREW, MACHINE	2
67	.70032	LEVER, OPERATING	1
68	.80056-01	REDUCER, TUBE END	2
69	.60811	NUT, HEX	2
70	.60342	SCREW, CAP	8
71	.63401	WASHER, FLAT	8

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	M20ESEP
NOTES	

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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
72	.130727	COVER	2
73	.63669	ROD, THREADED	1
74	.61245	NUT, LOCK	3
75	.60343	SCREW, CAP	4
76	.63319	WASHER, LOCK	4
77	.60703	NUT, HEX	4
78	.131077	ASSEMBLY, TILT SWITCH (See Sect. 3, Fig. 7 for Details)	1
79	.65103	FITTING, GREASE	4

REV.

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

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20EST
NOTES	

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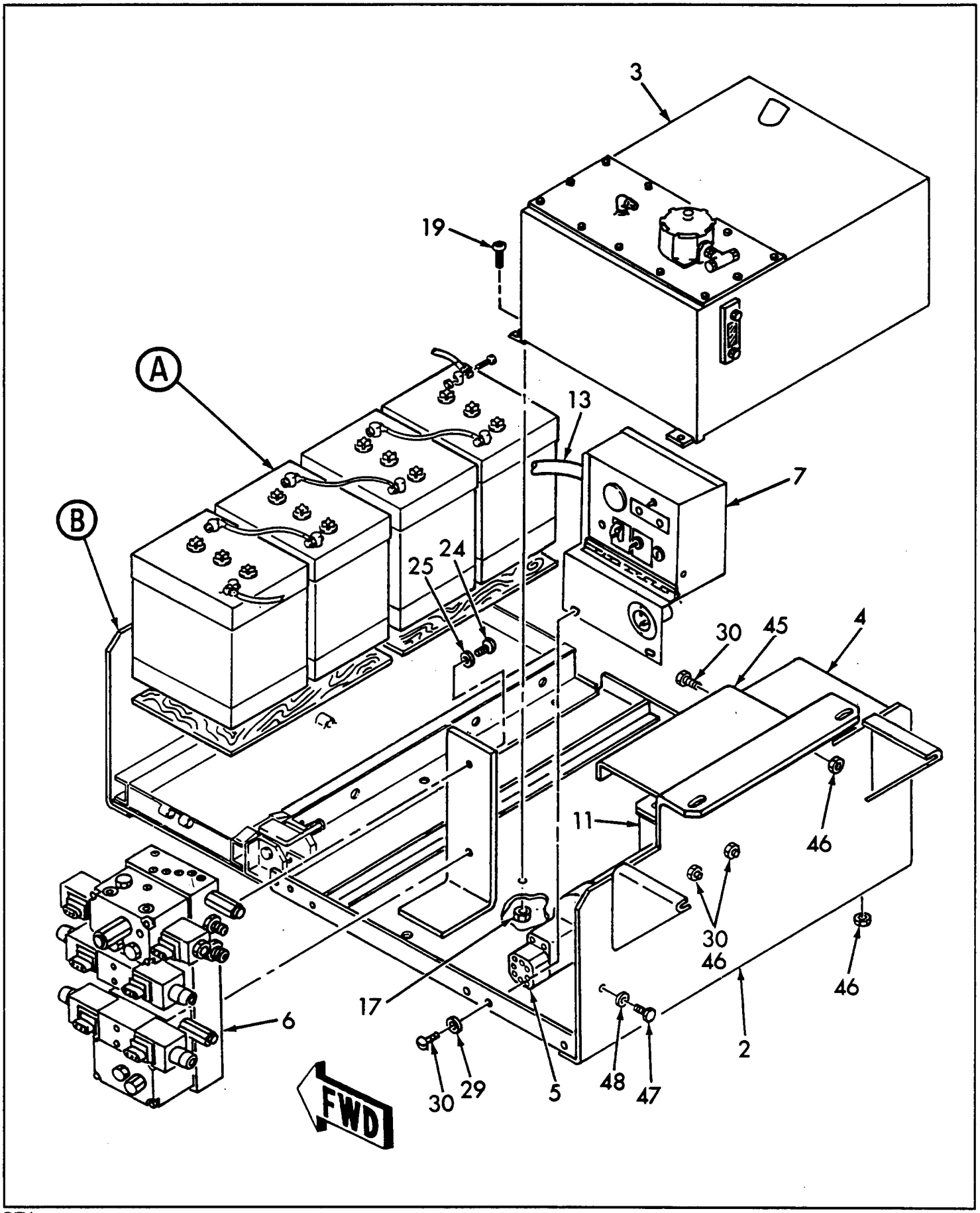

REV.

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20EST
NOTES	

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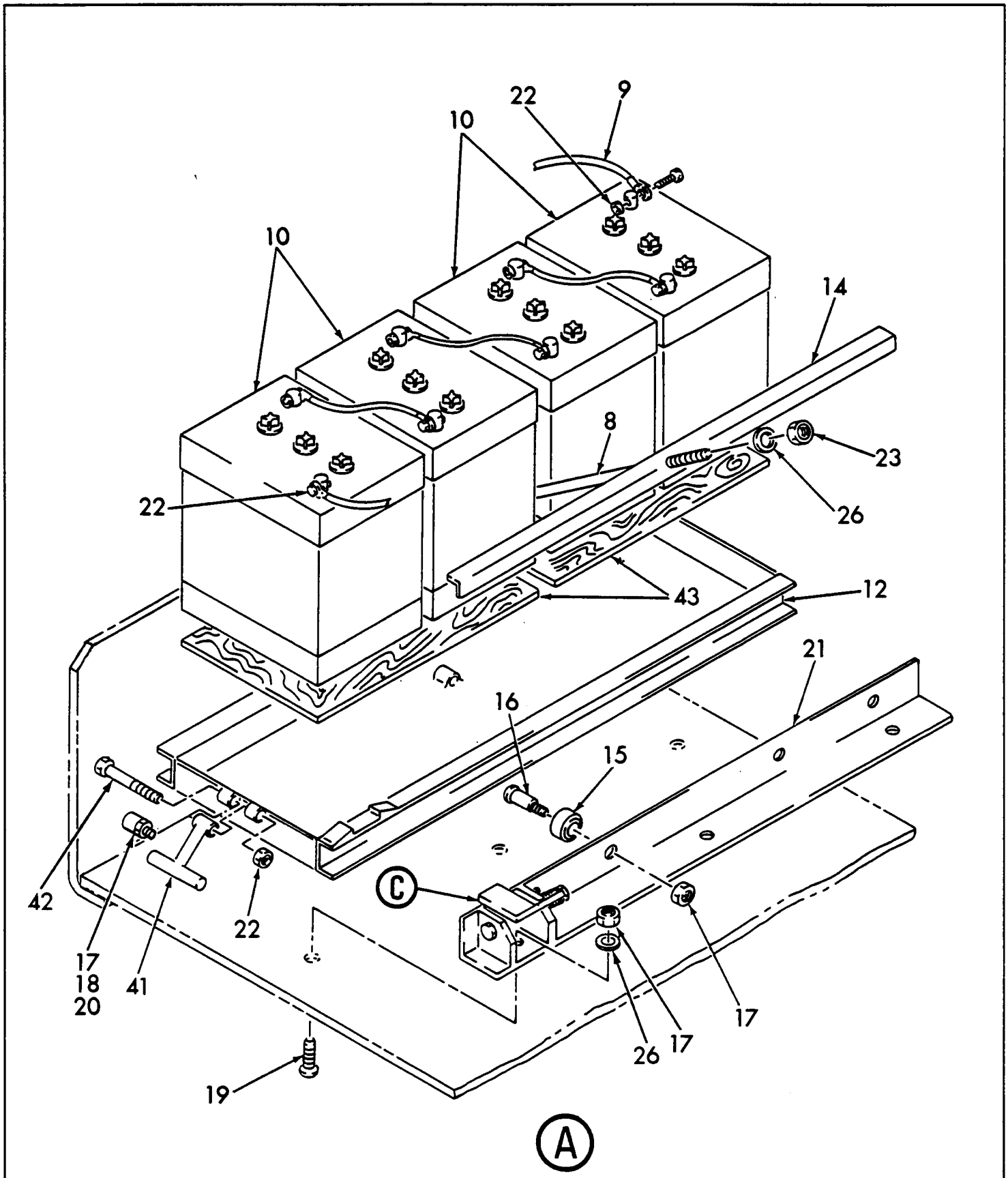

REV.

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20EST
NOTES	

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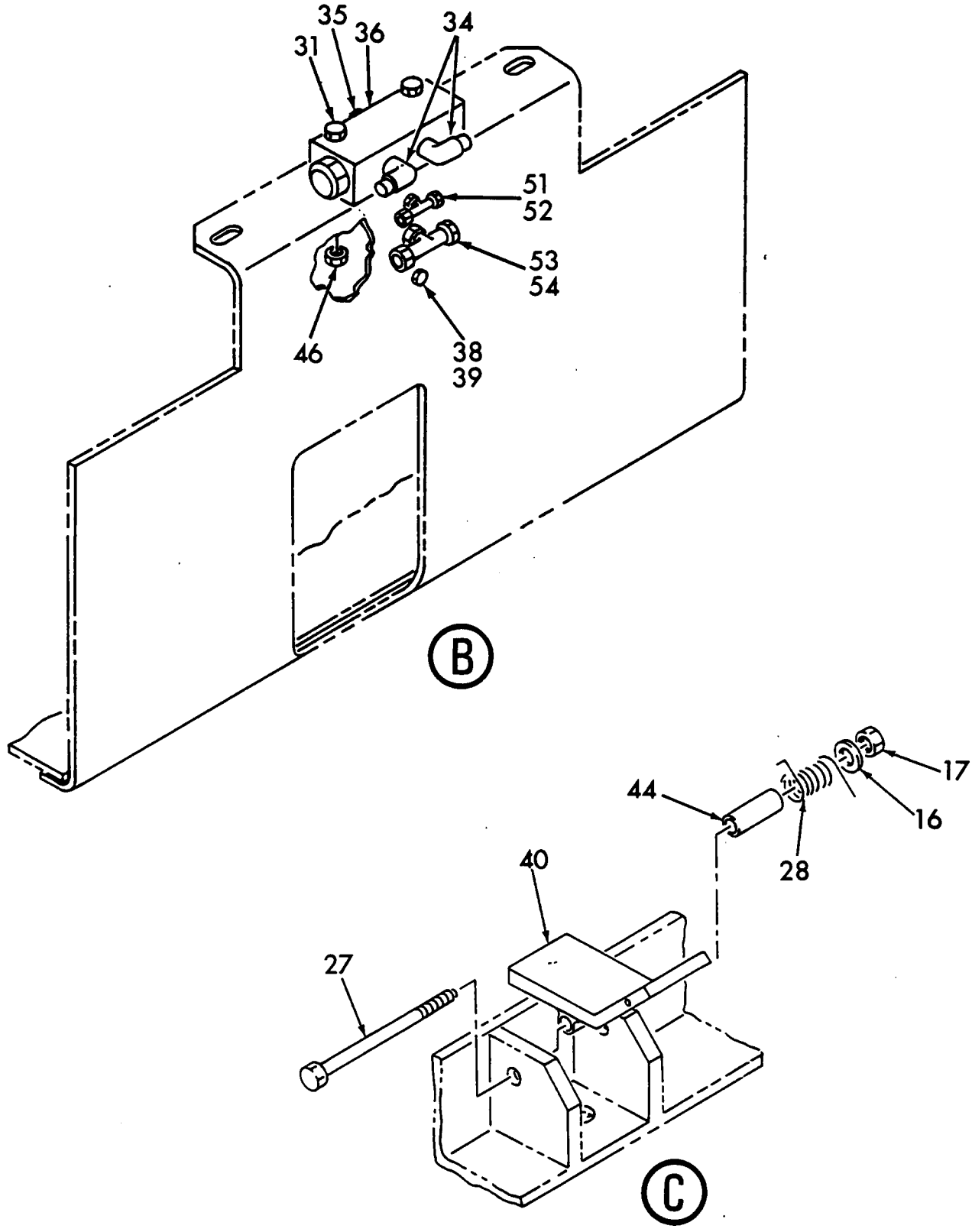

REV.

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20EST
NOTES	

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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130714	ASSEMBLY, BELLY PAN - EXTENDABLE (See Sect. 3, Fig. 1 for Details)	REF
2	.130762	WELDMENT, BELLY PAN	1
3	.130654	ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 8 for Details)	1
4	.70520	CHARGER, BATTERY (DOMESTIC) (See Sect. 3, Fig. 9,9A or 9B for Details)	1
4	.70525	CHARGER, BATTERY (INTERNATIONAL) (See Sect.3,Fig.10,10A or 10B for Details)	1
5	.130300	ASSEMBLY, PUMP & MOTOR (See Sect. 3, Fig. 11 or 11A for Details)	1
6	.131881	ASSEMBLY, CONTROL VALVE (See Sect. 3, Fig. 12 or 12A for Details)	1
7	.130389	ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 14 for Details)	1
8	.130733	BOLT, HOLD DOWN	1
9	.130768	KIT, BATTERY CABLE (See Sect. 3, Fig. 16 for Details)	1
10	.4007	BATTERY (6 VOLT 250 AMP) (See Vendor Chapter for Details)	4
11	.70362	RELAY, POWER	1
12	.130725	WELDMENT, BATTERY TRAY	1
13	.130600	CABLE, CONDUCTOR	7 FT
14	.130392	HOLD-DOWN, BATTERY	1
15	.7073	ROLLER, BATTERY TRAY	8
16	.62101	BOLT, SHOULDER	8
17	.61318	NUT, LOCK	20
18	.61946	SCREW, CAP	2
19	.61944	SCREW, CAP	9
20	.36666	TUBE	2

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20EST
NOTES	

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FIG.	3
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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
21	.130798	WELDMENT, BATTERY TRAY BRACKET	1
22	.61246	NUT, LOCK	10
23	.61302	NUT, HEX	1
24	.60343	SCREW, CAP	2
25	.63319	WASHER, LOCK	2
26	.63403	WASHER, FLAT	4
27	.60344	SCREW, CAP	1
28	.130482	SPRING, TORSION (R.H.)	1
29	.63301	WASHER, LOCK	2
30	.63359	SCREW, CAP	7
31	.60340	SCREW, CAP	2
-32	.70270	RING, TERMINAL	2
-33	.130305	ASSEMBLY, FLOW DIVIDER	1
34	..80008-12	ELBOW, MALE	2
35	..80008-14	ELBOW, MALE	1
36	..81026	DIVIDER, FLOW	1
-37	.70269	WIRE, BLACK (10 AWG)	10 FT
38	.65681	WASHER, LOCK	1
39	.60324	SCREW, CAP	1
40	.130785	WELDMENT, BELLY PAN LOCK	1
41	.130787	WELDMENT, HANDLE	2
42	.60339	SCREW, CAP	2
43	.65768	PLYWOOD	2
44	.36437	TUBE	1
45	.130797	GUARD, TILT SENSOR	1

REV.

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

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20EST
NOTES	

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FIG.	3
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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
46	.61312	NUT	11
47	.60322	SCREW, CAP	1
48	.63302	WASHER, LOCK	1
-49	.66356	TERMINAL, FEMALE	2
-50	.66357	TERMINAL, MALE	2
51	.80035-03	TEE, BRANCH	1
52	.80015-03	ELBOW, SWIVEL NUT	1
53	.80035-06	TEE, BRANCH	1
54	.80015-06	ELBOW, SWIVEL NUT	1

REV.

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

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20ESEP
NOTES	

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FIGURE	4
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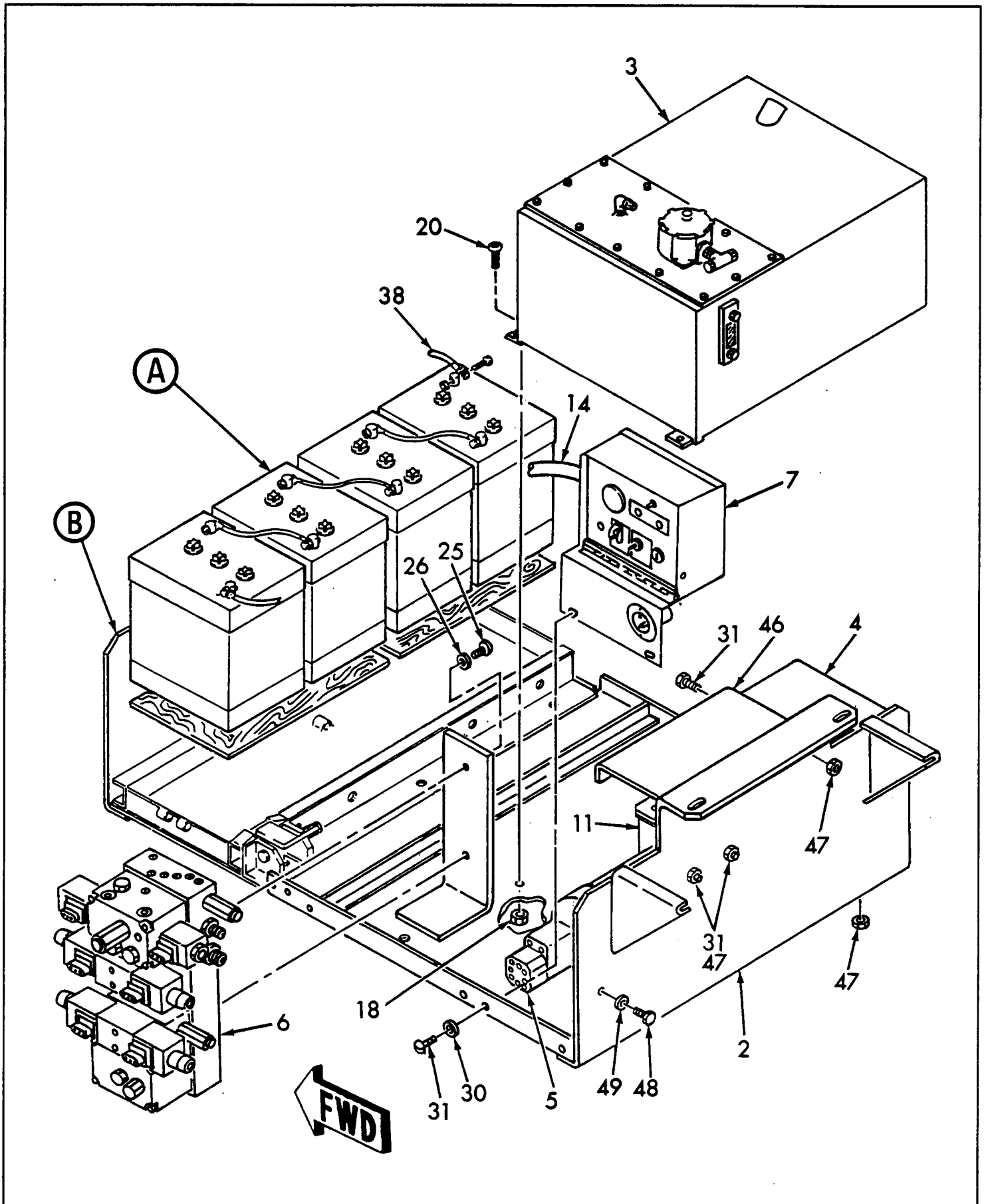

REV.

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20ESEP
NOTES	

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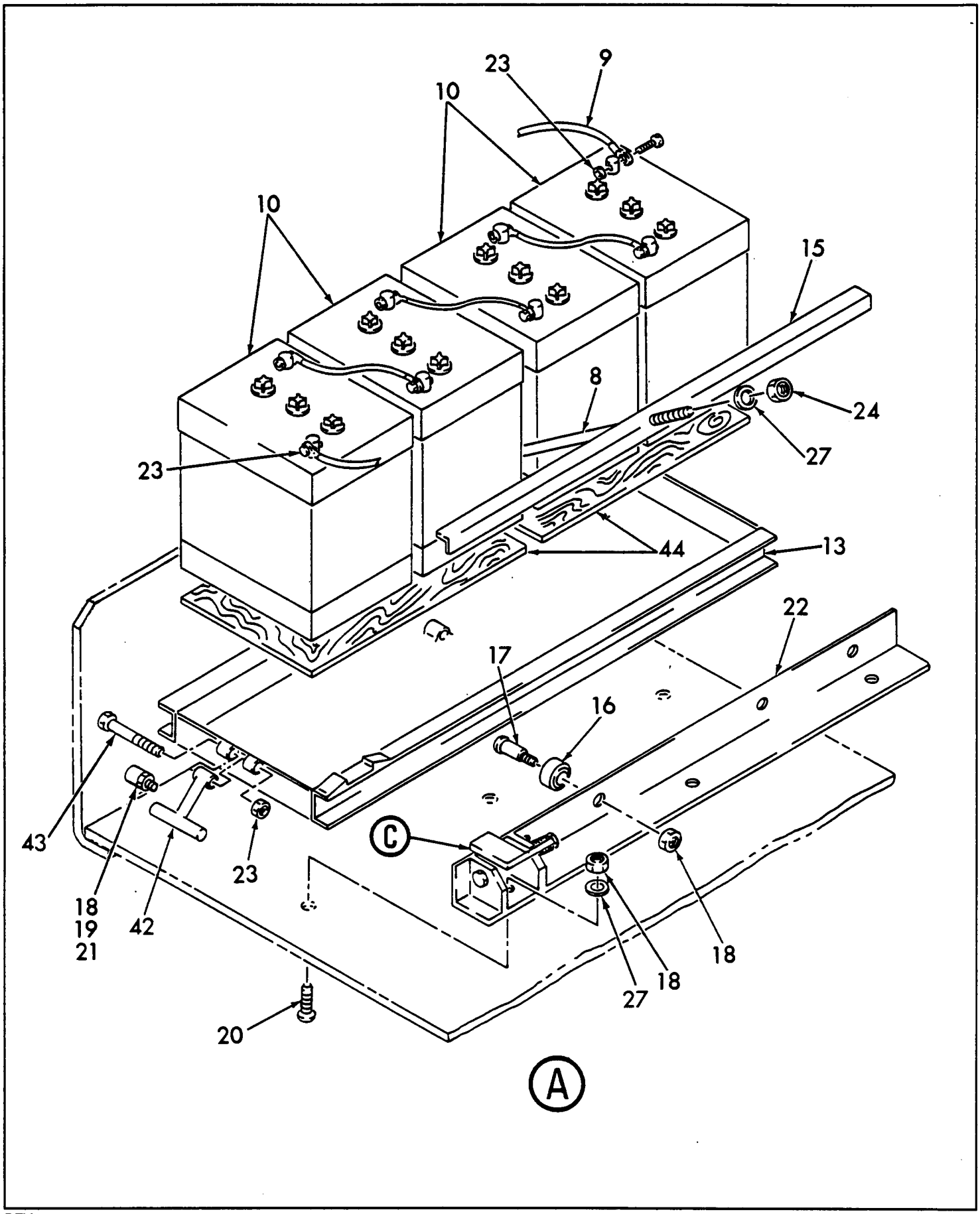
FIGURE	4
PAGE	2

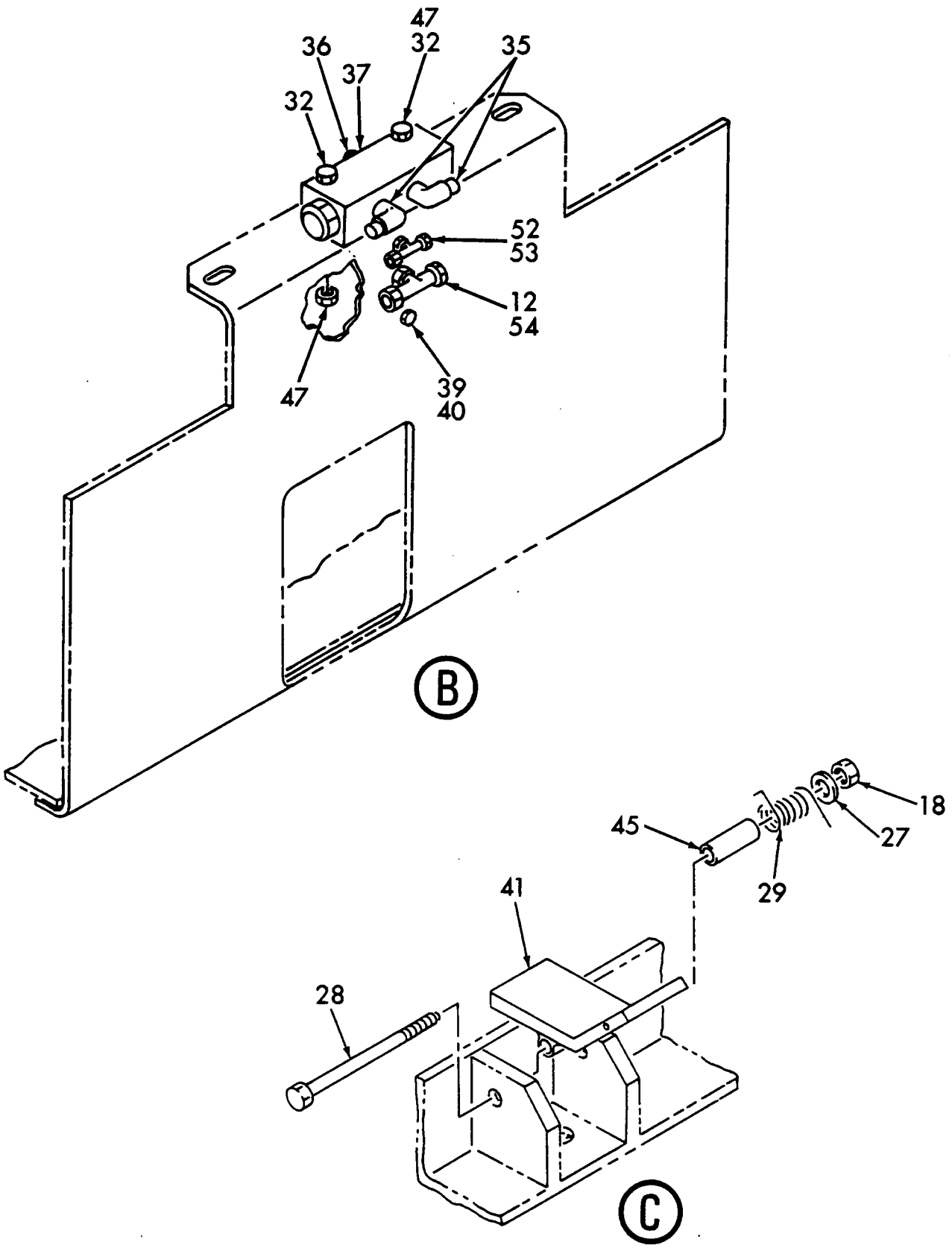


REV.

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	3
FIGURE	4
PAGE	3



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131301	ASSEMBLY, BELLY PAN (See Sect. 3, Fig. 2 for NHA)	REF
2	.130762	WELDMENT, BELLY PAN	1
3	.130654	ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 8 for Details)	1
4	.70520	CHARGER, BATTERY (DOMESTIC) (See Sect. 3, Fig. 9,9A or 9B for Details)	1
4	.70525	CHARGER, BATTERY (INTERNATIONAL) (See Sect.3,Fig.10,10A or 10B for Details)	1
5	.130300	ASSEMBLY, PUMP & MOTOR (See Sect. 3, Fig. 11 or 11A for Details)	1
6	.131880	ASSEMBLY, VALVE CONTROL (See Sect. 3, Fig. 13 or 13A for Details)	1
7	.131199	ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 15 for Details)	1
8	.130733	BOLT, HOLD-DOWN	1
9	.130768	KIT, BATTERY CABLE (See Sect. 3, Fig. 16 for Details)	1
10	.4007	BATTERY (6 VOLT 250 AMP) (See Vendor Chapter for Details)	4
11	.70362	RELAY, 24VDC	1
12	.80015-06	ELBOW, SWIVEL NUT	1
13	.130725	WELDMENT, BATTERY TRAY	1
14	.130600	CABLE, CONDUCTOR	7 FT
15	.130392	HOLD-DOWN, BATTERY	1
16	.7073	ROLLER, BATTERY TRAY	8
17	.62101	SCREW, CAP	8
18	.61318	NUT, LOCK	20
19	.61946	SCREW, CAP	2
20	.61944	SCREW, CAP	9

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20ESEP
NOTES	

SECT.	3
FIG.	4
PAGE	5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
21	.36666	TUBE	2
22	.130798	WELDMENT, BATTERY TRAY BRACKET	1
23	.61246	NUT, LOCK	10
24	.61302	NUT, HEX	1
25	.60343	SCREW, CAP	2
26	.63319	WASHER, LOCK	2
27	.63403	WASHER, FLAT	4
28	.60344	SCREW, CAP	1
29	.130482	SPRING, TORSION (R.H.)	1
30	.63301	WASHER, LOCK	2
31	.63359	SCREW, CAP	7
32	.60340	SCREW, CAP	2
-33	.70270	RING, TERMINAL	2
-34	.130305	ASSEMBLY, FLOW DIVIDER	1
35	..80008-12	ELBOW, MALE	2
36	..80008-14	ELBOW, MALE	1
37	..81026	DIVIDER, FLOW	1
38	.70269	WIRE, BLACK (10 AWG)	10 FT
39	.65681	WASHER, LOCK	1
40	.60324	SCREW, CAP	1
41	.130785	WELDMENT, BELLY PAN LOCK	1
42	.130787	WELDMENT, HANDLE	2
43	.60339	SCREW, CAP	2
44	.65768	PLYWOOD	2
45	.36437	TUBE	1

REV.

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

Mark Industries

TITLE	BELLY PAN ASSEMBLY
MODEL	M20ESEP
NOTES	

SECT.	3
FIG.	4
PAGE	6

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
46	.130797	GUARD, TILT SENSOR	1
47	.61312	NUT	11
48	.60322	SCREW, CAP	1
49	.63302	WASHER, LOCK	1
-50	.66356	TERMINAL, FEMALE	2
-51	.66357	TERMINAL, MALE	2
52	.80035-03	TEE, BULKHEAD	1
53	.80015-03	ELBOW, SWIVEL NUT	1
54	.80035-06	TEE, BULKHEAD	1

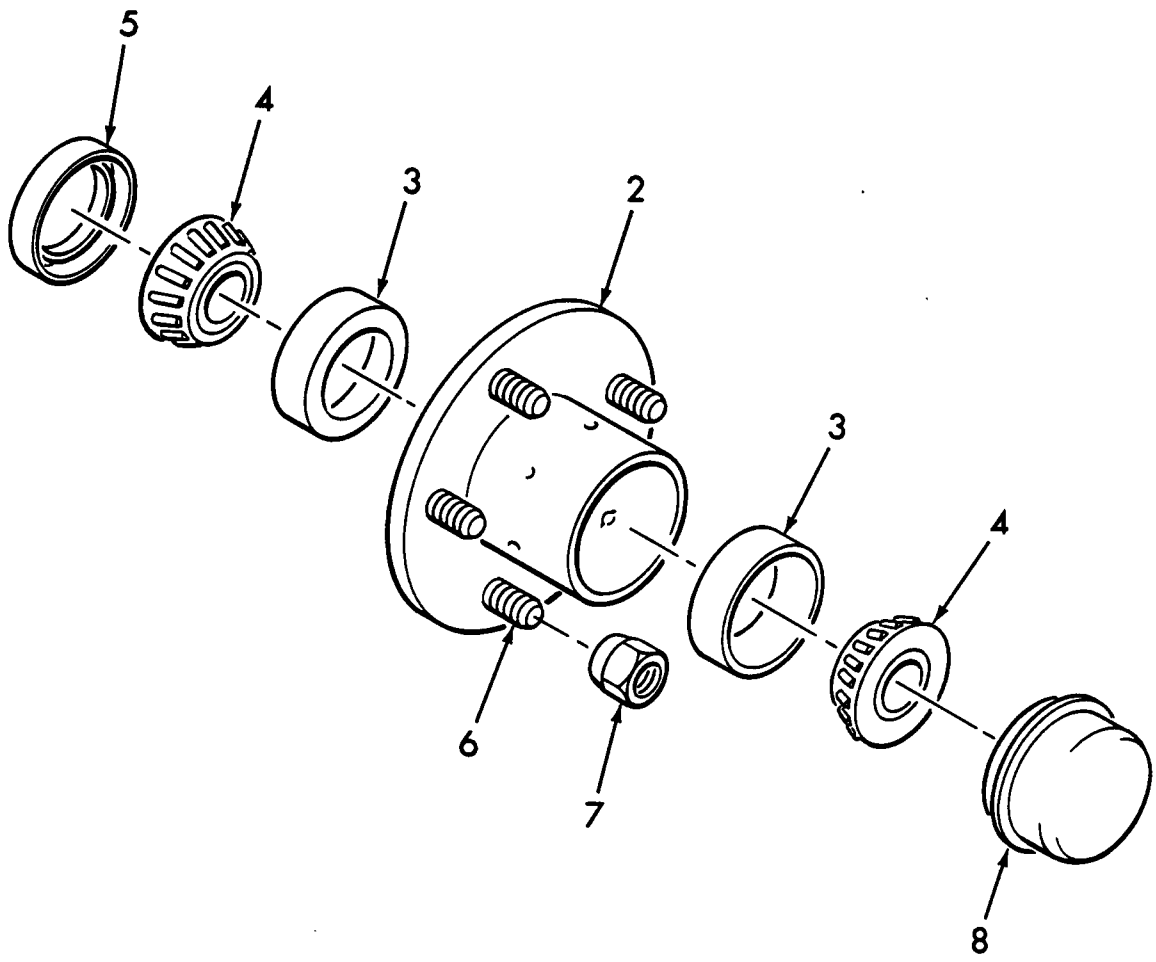
REV.

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

Mark Industries

TITLE	HUB ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	

SECTION	3
FIGURE	5
PAGE	1



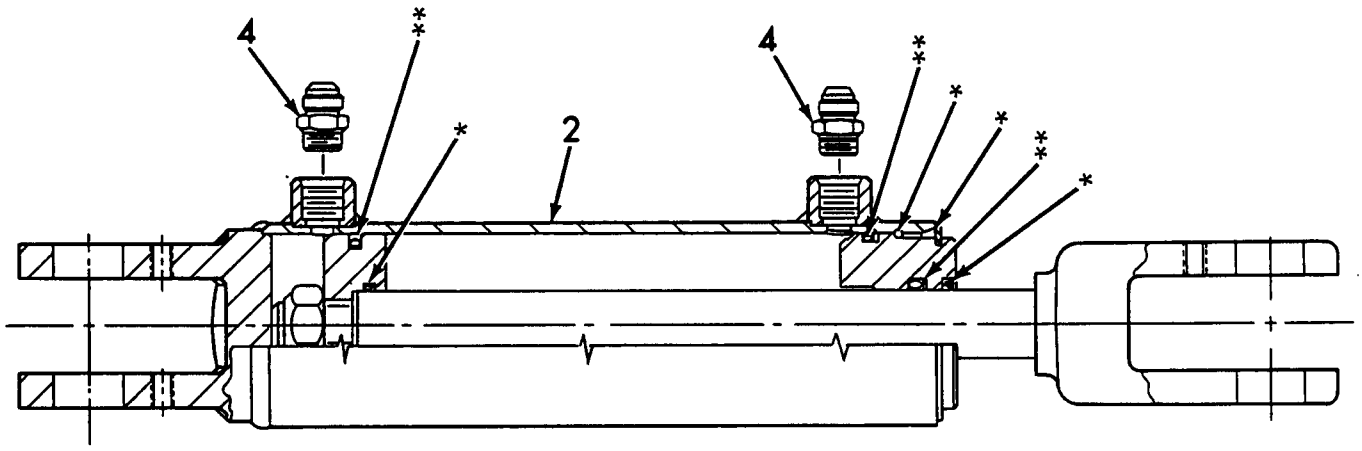
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	134-1	ASSEMBLY, HUB (See Sect. 3, Fig. 1 or 2 for NHA)	REF
2	.65684	HUB	1
3	.65686	RACE, BEARING	2
4	.65059	BEARING	2
5	.66113	SEAL, GREASE	1
6	.65685	BOLT, LUG	5
7	.61316	NUT, LUG	5
8	.137	CAP, DUST	1

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	

SECTION	3
FIGURE	6
PAGE	1



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

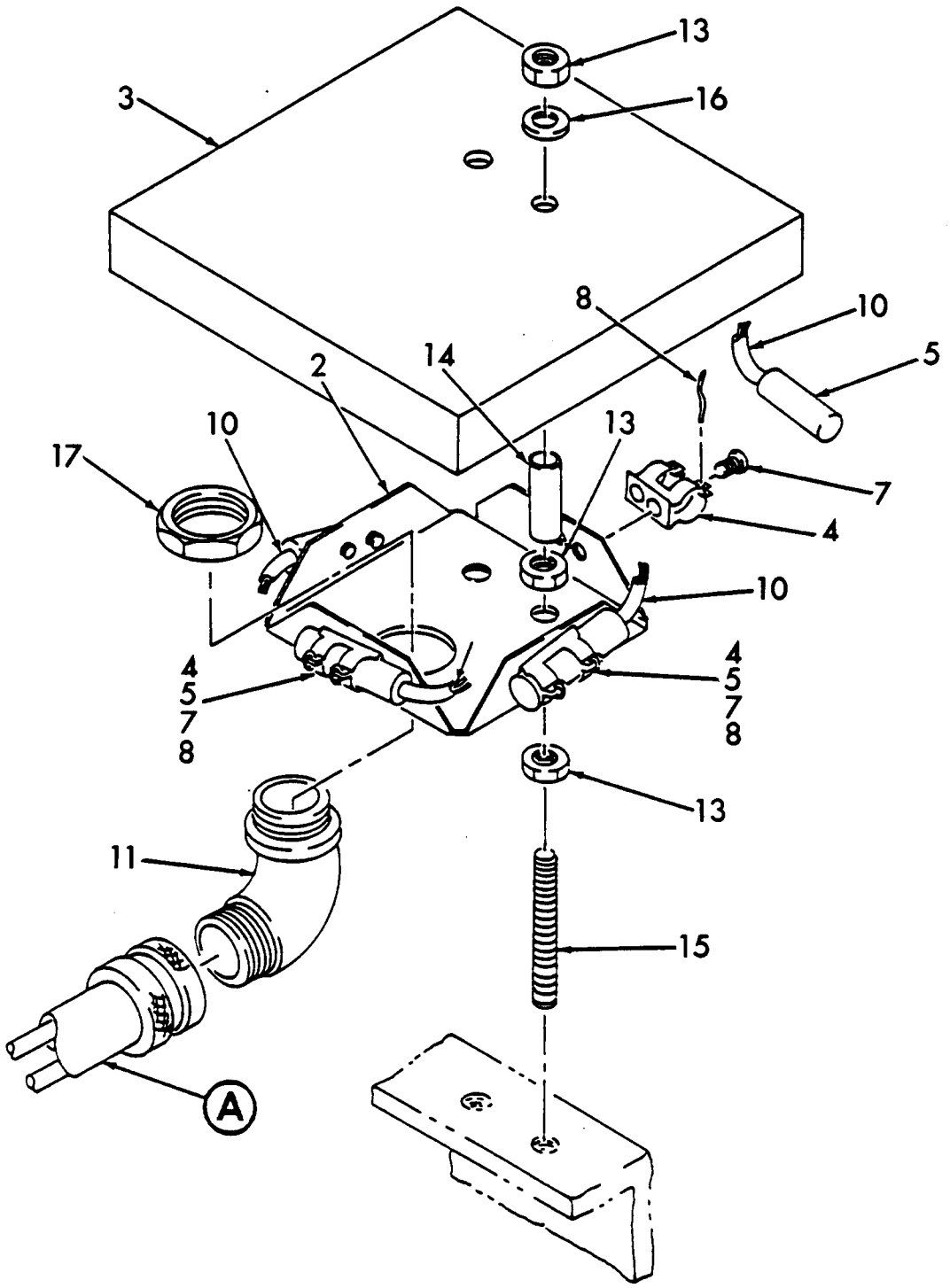
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130237	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 or 2 for NHA)	REF
2	.130165	CYLINDER, STEERING	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..66640	KIT, SEAL	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	.80004-03	CONNECTOR, STRAIGHT THREAD	2

REV.

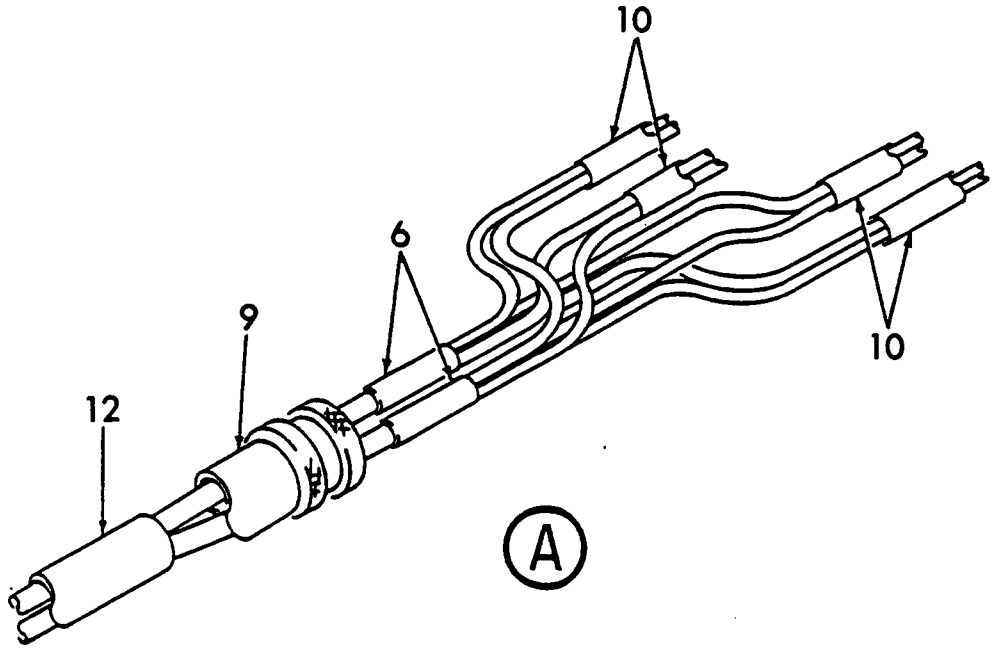
Mark Industries

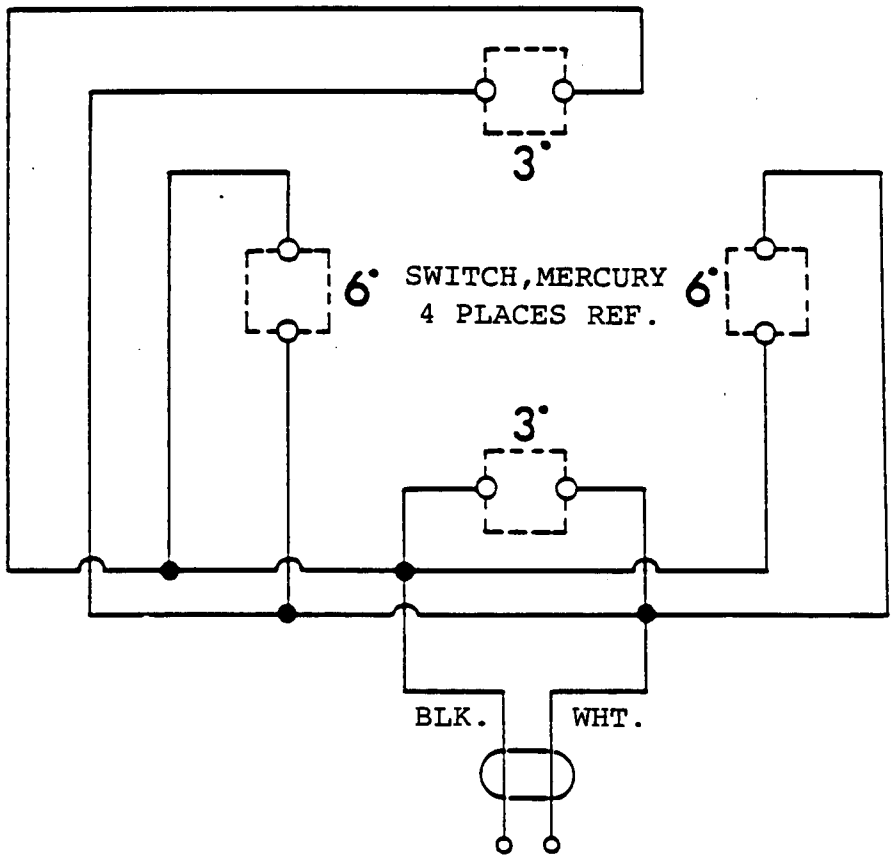
TITLE	TILT SWITCH ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	

SECTION	3
FIGURE	7
PAGE	1



REV.





WIRING DIAGRAM

Mark Industries

TITLE	TILT SWITCH ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	

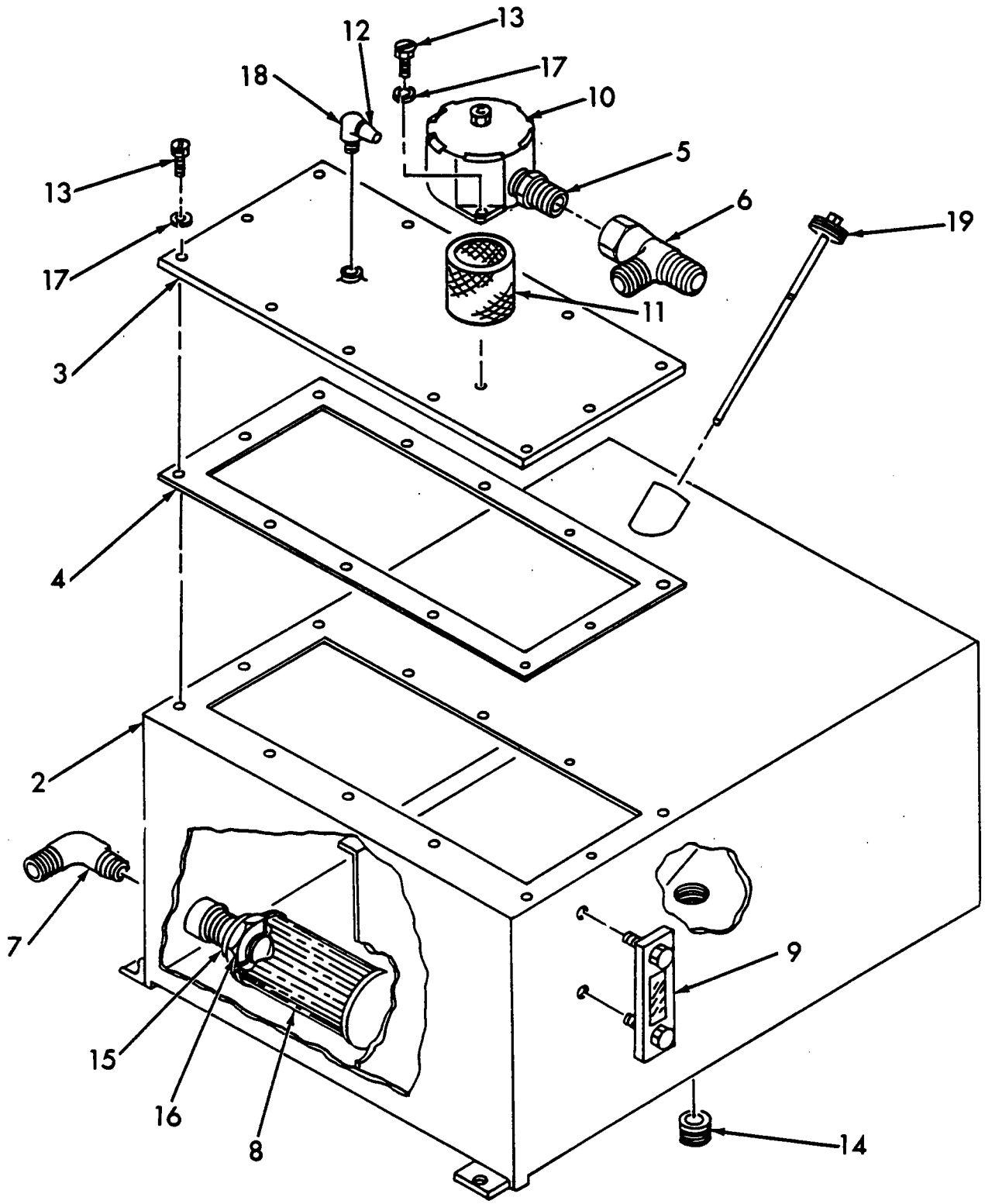
SECT.	3
FIG.	7
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131077	ASSEMBLY, TILT SWITCH (See Sect. 3, Fig. 1 or 2 for NHA)	REF
2	.30385	BRACKET, TILT SWITCH	1
3	.30386	COVER, TILT SWITCH	1
4	.199-A	BRACKET, MICRO SWITCH	4
5	.4014	SWITCH, MERCURY	4
6	.117-D	CONNECTOR, BUTT	2
7	.62605	SCREW, MACHINE	8
8	.70225	WIRE, SAFETY (3/4" LONG)	8
9	.65899	TUBE, HEAT SHRINK (4" LONG)	4
10	.65898	TUBE, HEAT SHRINK (8" LONG)	1
11	.70226	CONNECTOR, ANGLE BOX	1
12	.70036	WIRE (18/2 SJO)	9 FT
13	.60701	NUT, HEX	6
14	.35715	TUBE, ROUNG (3/4" LONG)	2
15	.63606	ROD, THREADED (2" LONG)	2
16	.63301	WASHER, LOCK	2
17	.61317	NUT, LOCK	1

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	

SECTION	3
FIGURE	8
PAGE	1

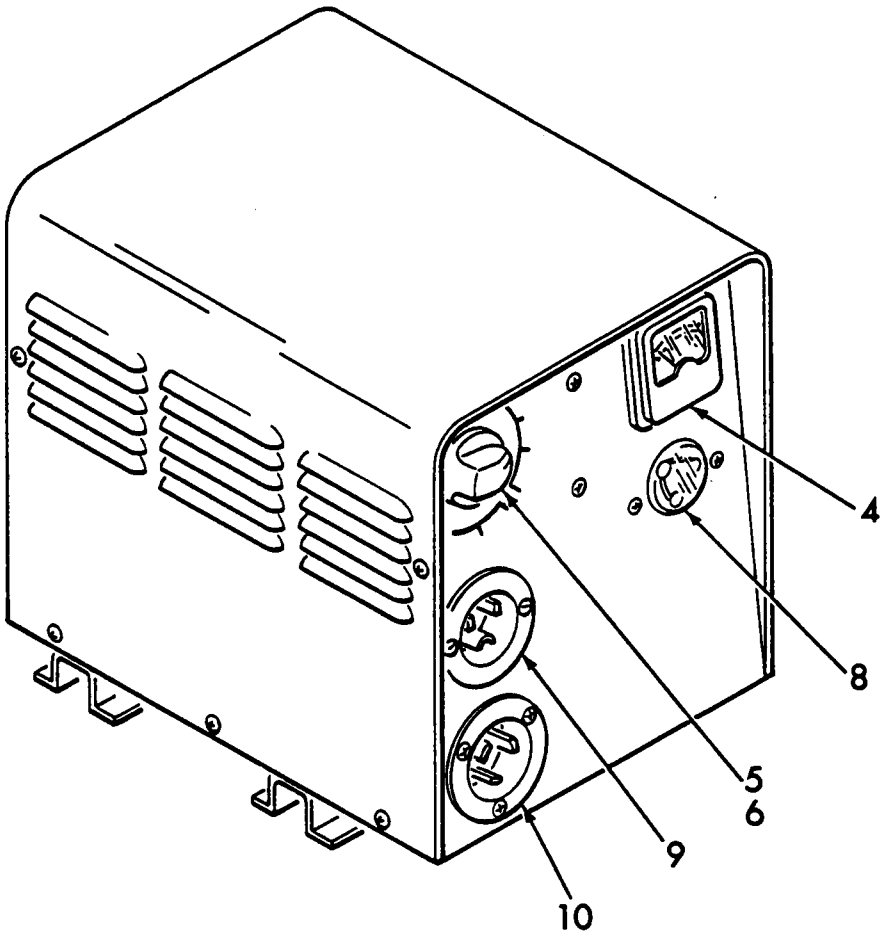


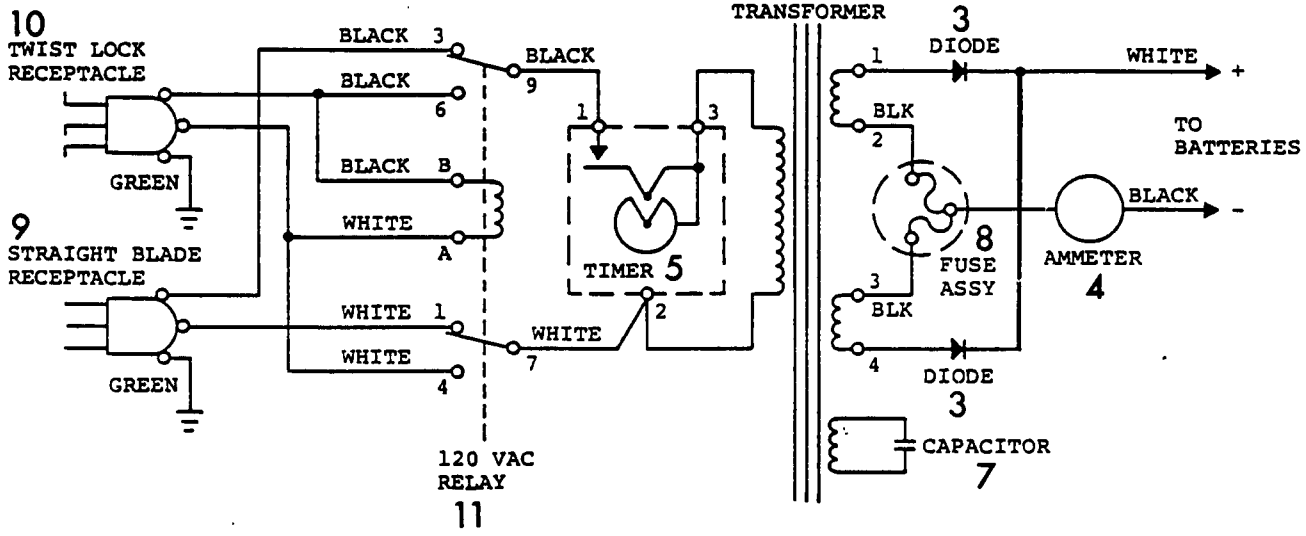
REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130654	ASSEMBLY, HYDRAULIC TANK (See Sect. 3, Fig. 3 or 4 for NHA)	REF
2	.130639	WELDMENT, HYDRAULIC TANK	1
3	.130641	COVER, TANK	1
4	.130644	GASKET	1
5	.80001-14	CONNECTOR, MALE	1
6	.80028-06	TEE, SWIVEL NUT	1
7	.80008-20	ELBOW, MALE	1
8	.81084	STRAINER	1
9	.3018	GAUGE, SIGHT - TUBE TYPE	1
10	.81016	FILTER	1
11	..66739	ELEMENT, FILTER	1
12	.65213	CAP, BREATHER	1
13	.60342	SCREW, CAP	14
14	.54200	PLUG, MAGNETIC PIPE	1
15	.65749	NIPPLE	1
16	.80057-16	REDUCER, PIPE THREAD	1
17	.63301	WASHER, LOCK	14
18	.80021-03	ELBOW, STREET	1
19	.130230	WELDMENT, DIPSTICK	1

Mark Industries

TITLE BATTERY CHARGER (DOMESTIC) 115V/60HZ,24V/36A	SECT.	3
MODEL M20EST & M20ESEP	FIG.	9
NOTES UNTIL LATE 1989, CONCURRENT USE WITH 70478	PAGE	1





REV.

Mark Industries

TITLE	BATTERY CHARGER (DOMESTIC) 115V/60HZ,24V/36A
MODEL	M20EST & M20ESEP
NOTES	UNTIL LATE 1989, CONCURRENT USE WITH 70478

SECT.	3
FIG.	9
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70321	CHARGER, BATTERY (DOMESTIC) (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.66984	ASSEMBLY, TRANSFORMER	1
-3	.66730	ASSEMBLY, DIODE	2
4	.66747	AMMETER	1
5	.66732	TIMER - 12 HOUR	1
6	.66733	KNOB, TIMER	1
-7	.66750	CAPACITOR (6 MFD, 660 VAC)	1
8	.66726	ASSEMBLY, FUSE	1
9	.66734	RECEPTACLE, STRAIGHT BLADE	1
10	.66736	RECEPTACLE, TWIST LOCK	1
-11	.66728	RELAY (120V, DPDT, 15 AMP)	1

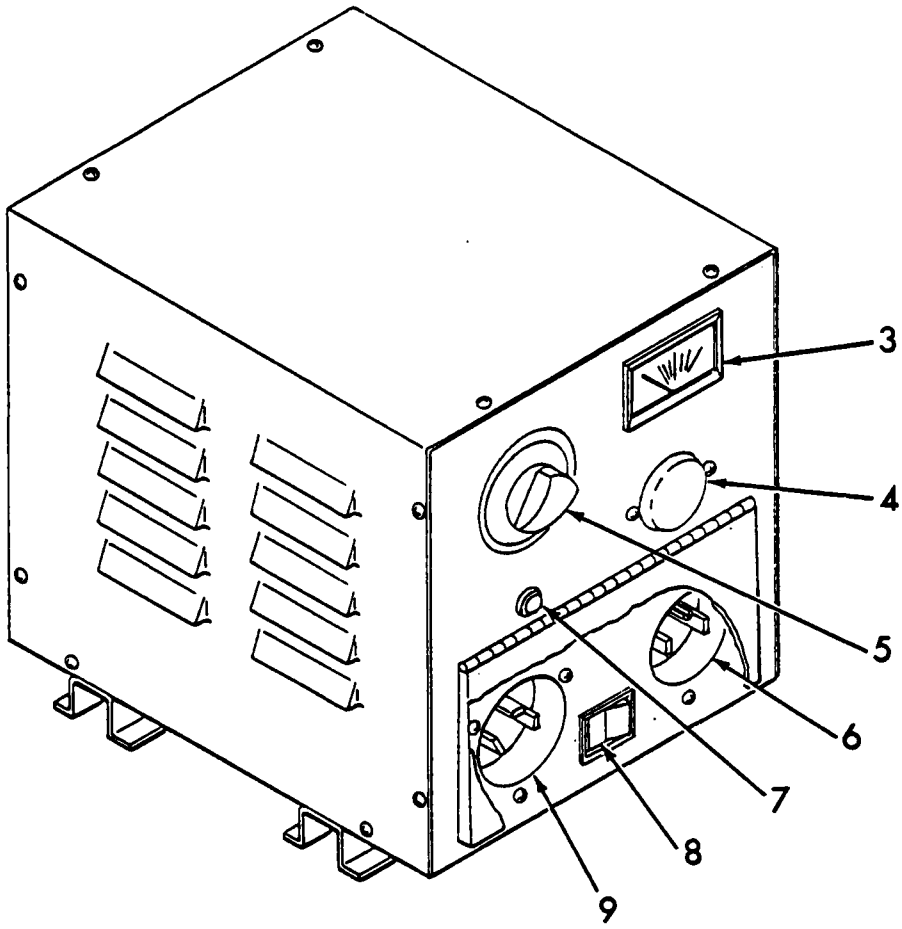
REV.

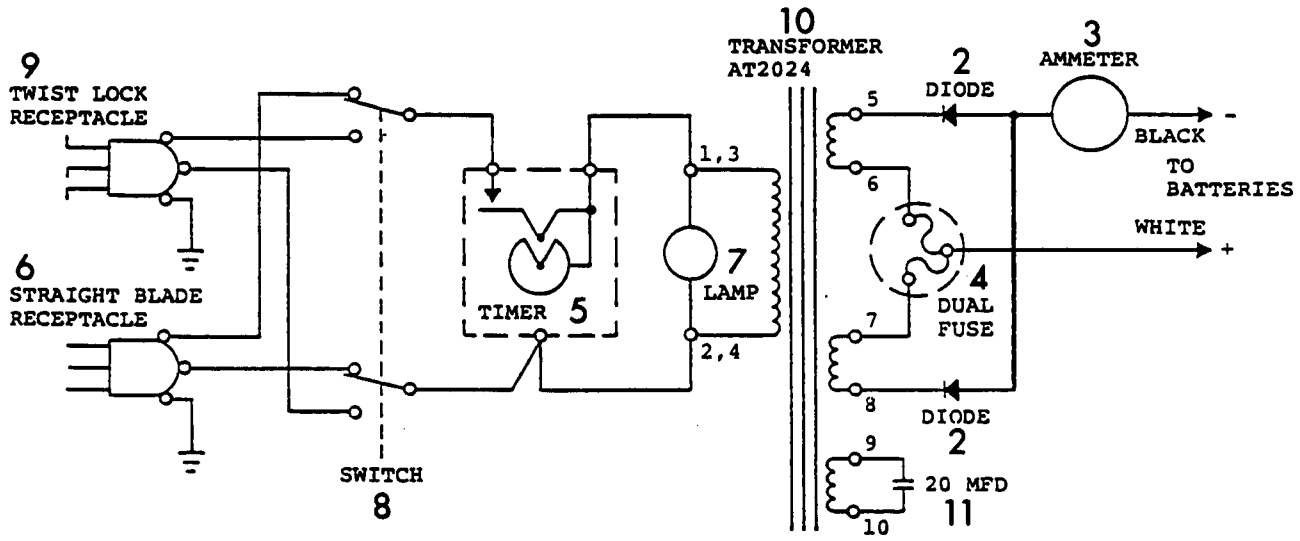
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	BATTERY CHARGER (DOMESTIC) 115V/60HZ,24V/40A
MODEL	M20EST & M20ESEP
NOTES	UNTIL LATE 1989, CONCURRENT USE WITH 70321

SECT.	3
FIG.	9A
PAGE	1





REV.

Mark Industries

TITLE	BATTERY CHARGER (DOMESTIC) 115V/60HZ,24V/40A
MODEL	M20EST & M20ESEP
NOTES	UNTIL LATE 1989, CONCURRENT USE WITH 70321

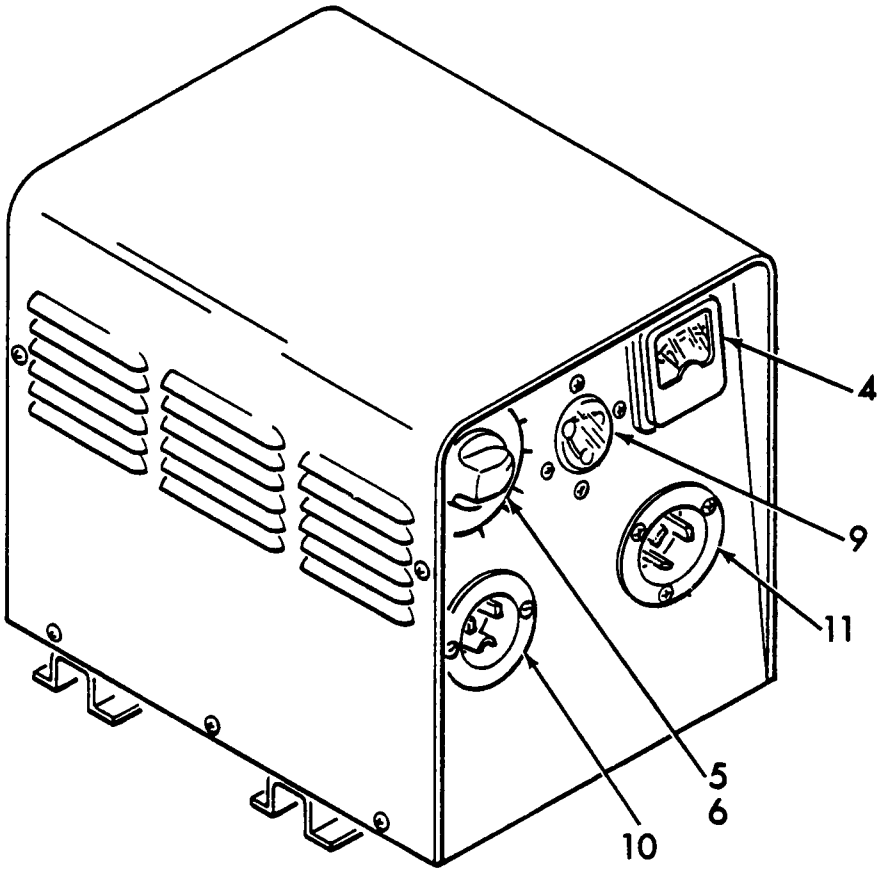
SECT.	3
FIG.	9A
PAGE	2

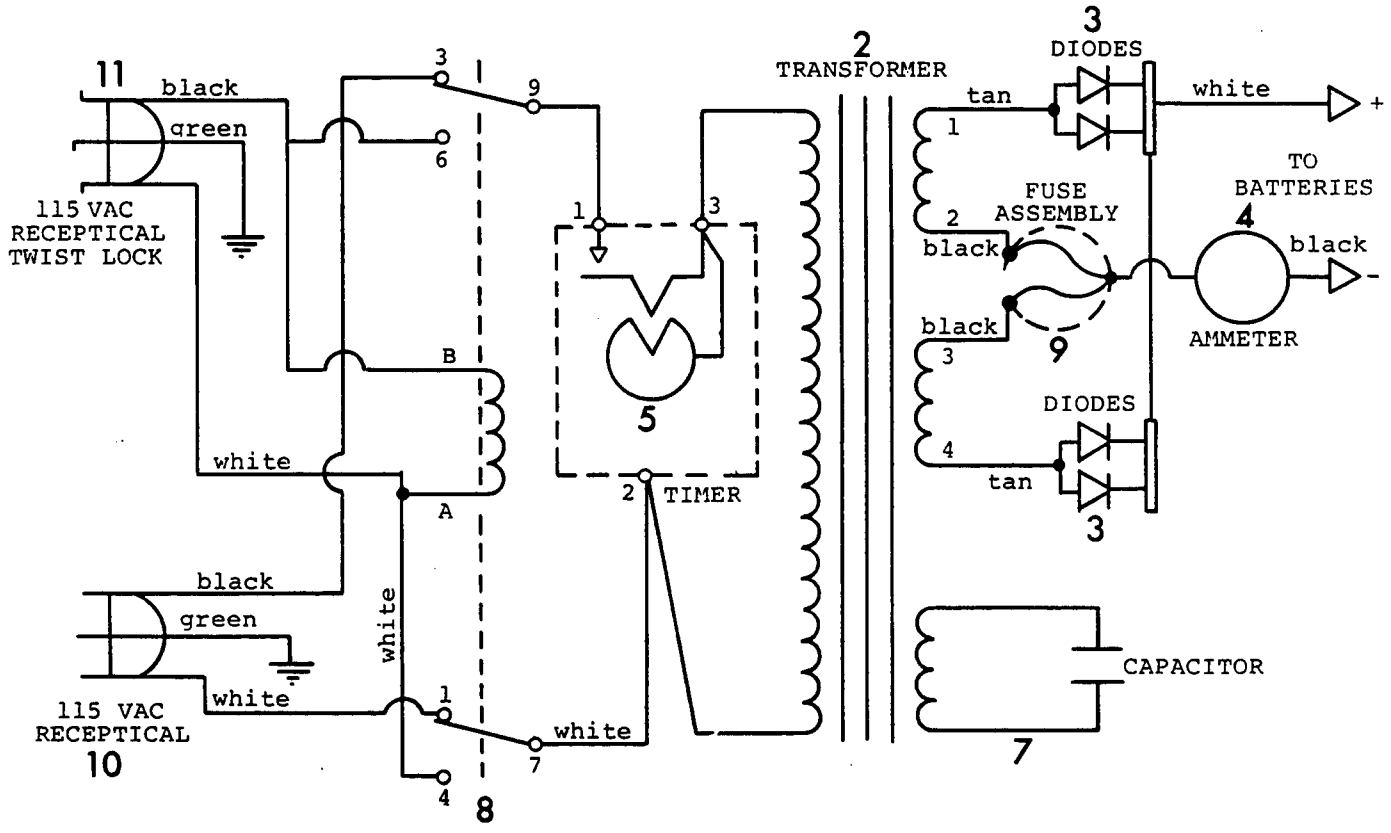
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70478	CHARGER, BATTERY (DOMESTIC) (See Sect. 3, Fig. 3 or 4 for NHA)	REF
2	.67966	DIODE	2
3	.67969	AMMETER	1
4	.66727	FUSE, DUAL	1
5	.66732	TIMER, 12 HOUR	1
6	.70050	RECEPTACLE, STRAIGHT BLADE	1
7	.67964	LAMP, INDICATOR	1
8	.67963	SWITCH, DPDT	1
9	.66183	RECEPTACLE, TWIST LOCK	1
10	.67961	TRANSFORMER	1
11	.67967	CAPACITOR (20 MFD)	1

Mark Industries

TITLE	BATTERY CHARGER (DOMESTIC) 120V/60HZ,24V/40A
MODEL	M20EST & M20ESEP
NOTES	SINCE LATE 1989

SECT.	3
FIG.	9B
PAGE	1





REV.

Mark Industries

TITLE	BATTERY CHARGER (DOMESTIC) 120V/60HZ,24V/40A
MODEL	M20EST & M20ESEP
NOTES	SINCE LATE 1989

SECT.	3
FIG.	9B
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70520	CHARGER, BATTERY (DOMESTIC) (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.600262	ASSEMBLY, TRANSFORMER	1
-3	.600259	ASSEMBLY, HEATSINK (WITH DIODES)	2
4	.66747	AMMETER	1
5	.66732	ASSEMBLY, TIMER - 12 HOUR	1
6	.66733	KNOB, TIMER	1
-7	.66750	CAPACITOR (6 MFD, 660 VAC)	1
-8	.66728	RELAY (120V, DPDT, 15 AMP)	1
9	.600258	ASSEMBLY, FUSE (WITH PANEL)	1
10	.66734	RECEPTACLE, STRAIGHT BLADE	1
11	.66736	RECEPTACLE, TWIST LOCK	1

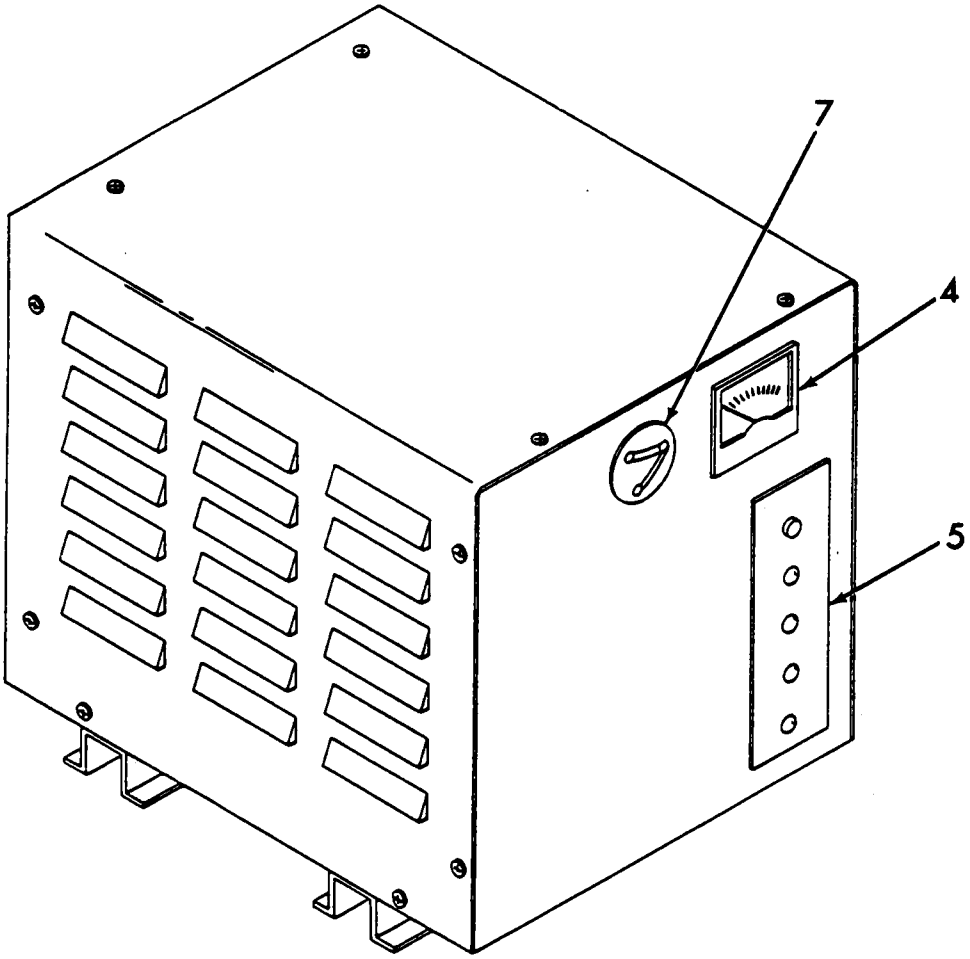
REV.

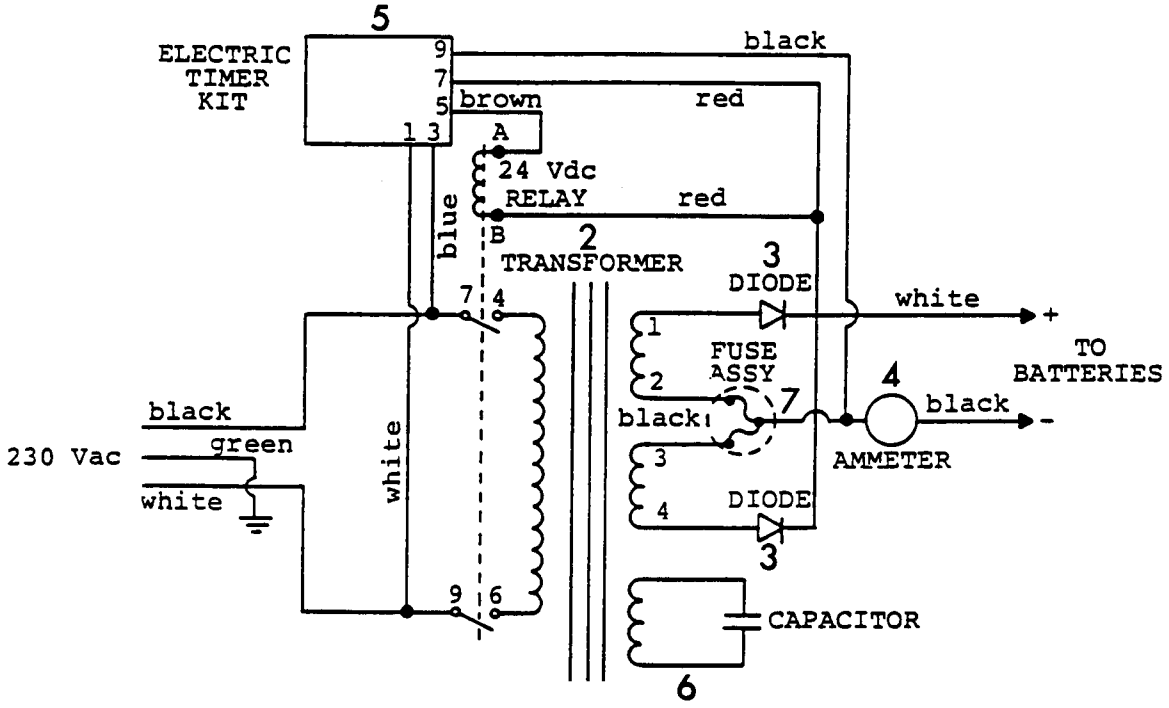
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	BATTERY CHARGER (INT'L) 230V/50HZ, 24V/30A
MODEL	M20EST & M20ESEP
NOTES	UNTIL LATE 1989, CONCURRENT USE

SECT.	3
FIG.	10
PAGE	1





REV.

Mark Industries

TITLE	BATTERY CHARGER (INT'L) 230V/50HZ, 24V/30A
MODEL	M20EST & M20ESEP
NOTES	UNTIL LATE 1989, CONCURRENT USE

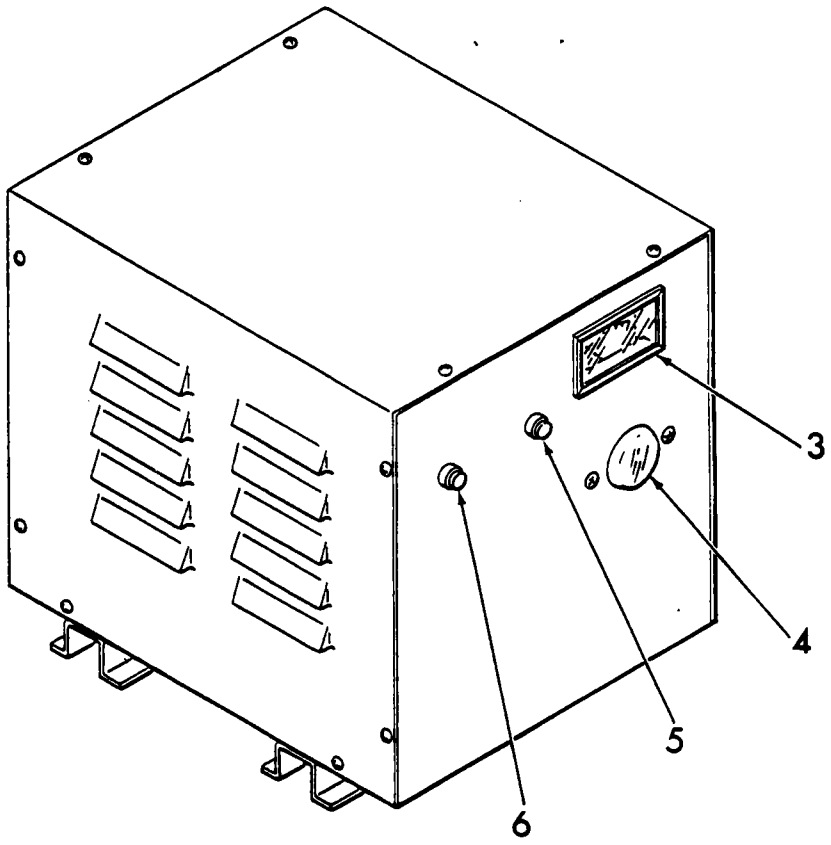
SECT.	3
FIG.	10
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70435	CHARGER, BATTERY (INTERNATIONAL) (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.67973	ASSEMBLY, TRANSFORMER	1
-3	.66731	ASSEMBLY, DIODE	2
4	.66747	AMMETER	1
5	.67975	KIT, ELECTRONIC TIMER	1
-6	.66750	CAPACITOR (6 MFD, 660 VAC)	1
7	.66727	ASSEMBLY, FUSE	1

Mark Industries

TITLE	BATTERY CHARGER (INT'L) 230V/50HZ, 24V/30A
MODEL	M20EST & M20ESEP
NOTES	UNTIL LATE 1989., CONCURRENT USE

SECT.	3
FIG.	10A
PAGE	1



NO SCHEMATIC AVAILABLE

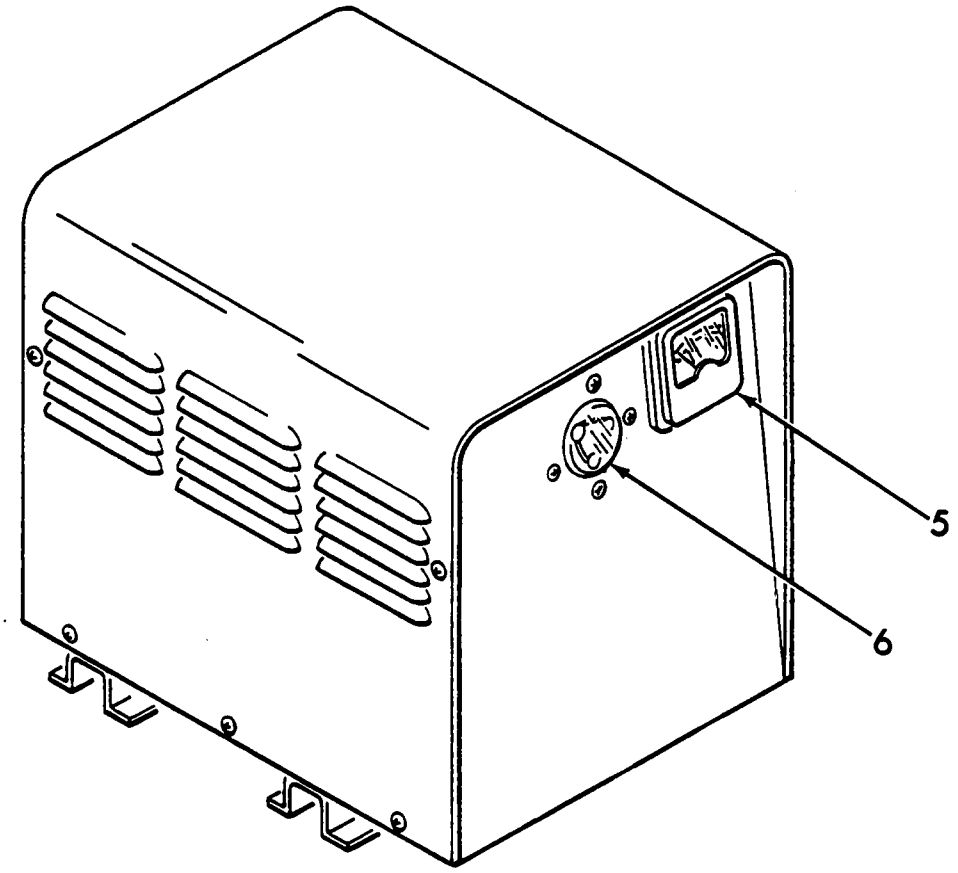
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70310	CHARGER, BATTERY (INTERNATIONAL) (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.600017	CAPACITOR	1
3	.67968	AMMETER (50 AMP)	1
4	.66726	FUSE, DUAL (30 AMP)	1
5	.600014	LED (GREEN)	1
6	.600015	LED (RED)	1
-7	.600012	TRANSFORMER	1
-8	.600013	BOARD, CONTROLLER (TIMER)	1
-9	.600017	RECTIFIER	1

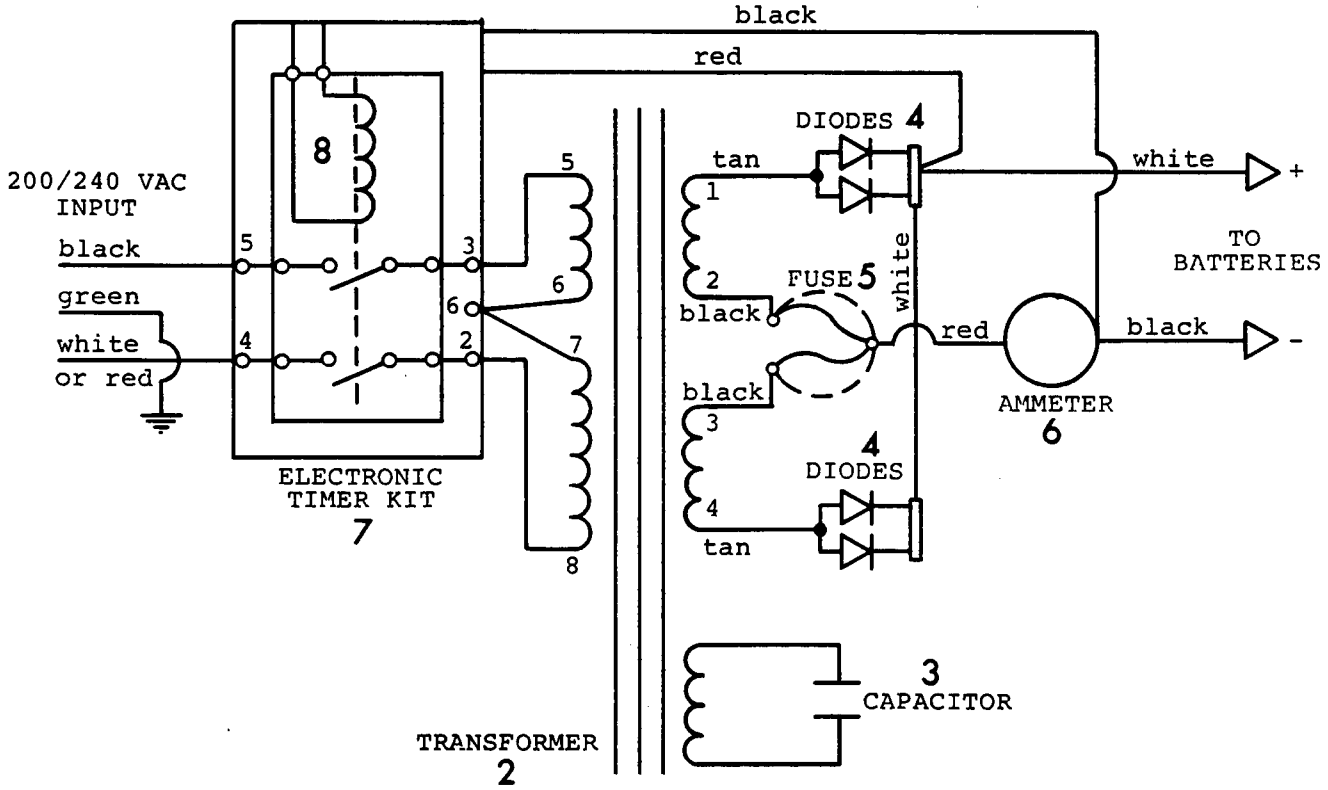
REV.

Mark Industries

TITLE	BATTERY CHARGER (INT'L) 230V/50HZ, 24V/40A
MODEL	M20EST & M20ESEP
NOTES	SINCE LATE 1989

SECT.	3
FIG.	10B
PAGE	1





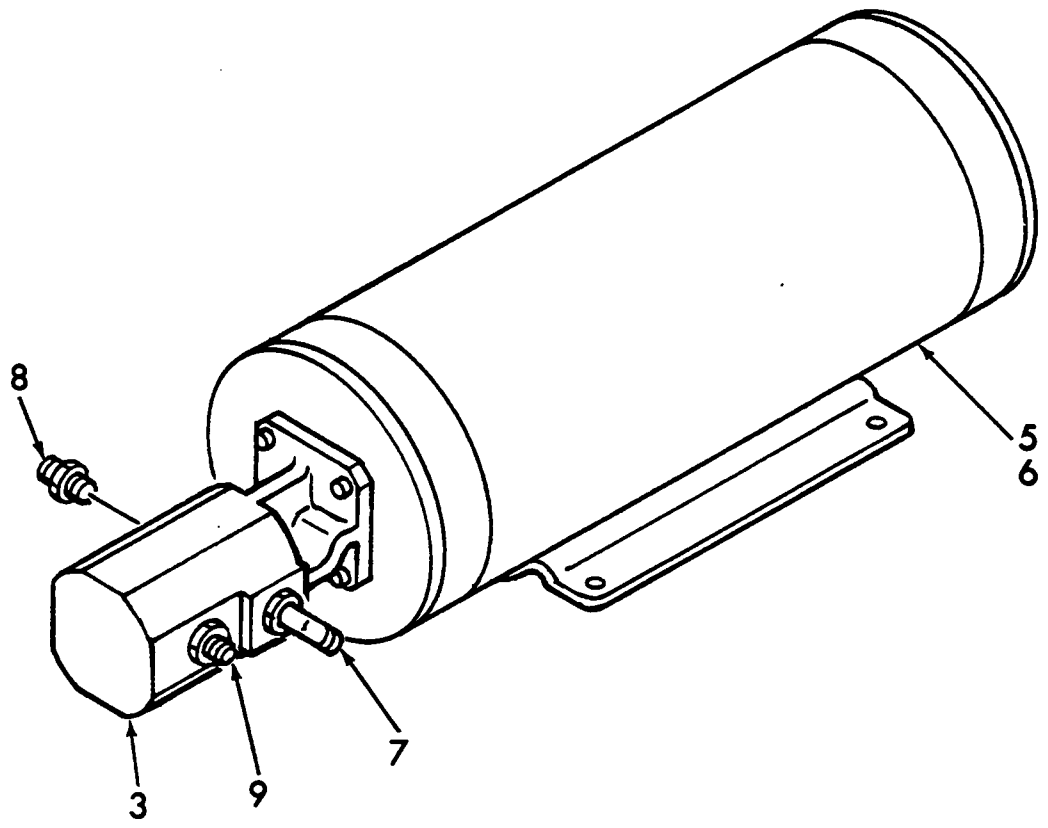
REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70525	CHARGER, BATTERY (INTERNATIONAL) (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.600260	ASSEMBLY, TRANSFORMER	1
-3	.66750	CAPACITOR (6 MFD, 660 VAC)	1
-4	.600259	ASSEMBLY, HEATSINK (WITH DIODES)	2
5	.600258	ASSEMBLY, FUSE (WITH PANEL)	1
6	.66747	AMMETER	1
-7	.600263	KIT, ELECTRONIC TIMER	1
-8	.67976	RELAY, TIMER (24 VDC)	1

Mark Industries

TITLE	PUMP & MOTOR ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	UNTIL MID 1989

SECTION	3
FIGURE	11
PAGE	1



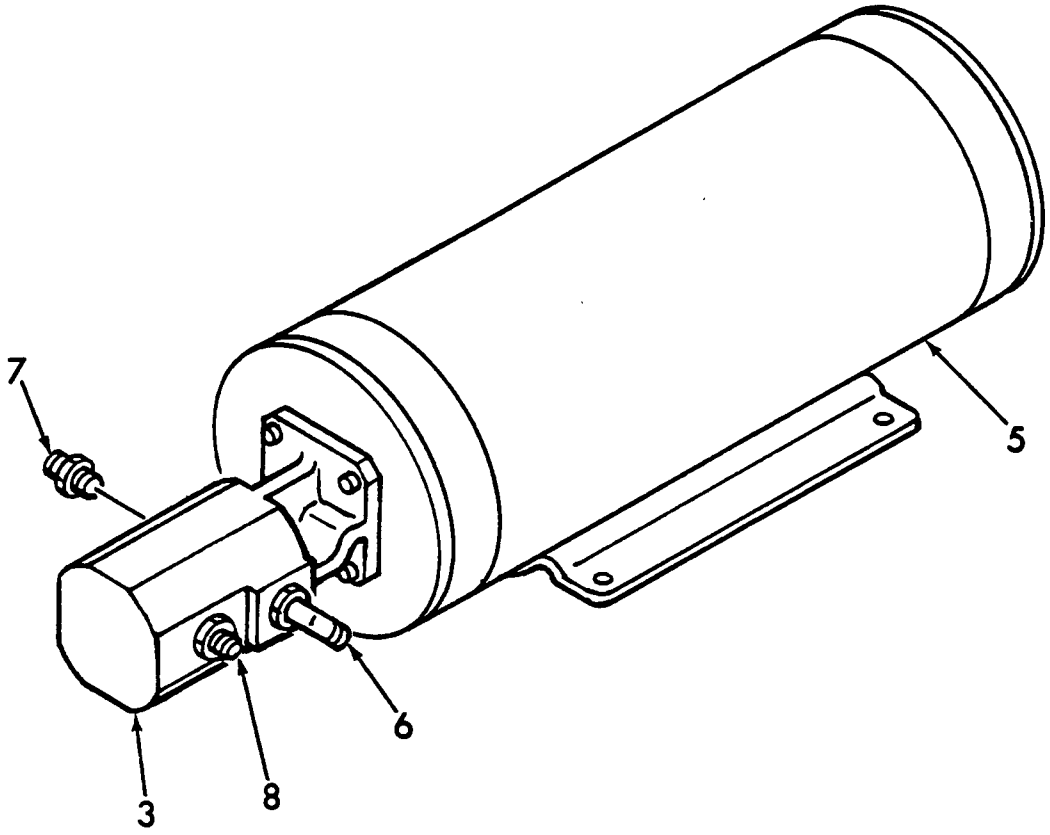
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130300	ASSEMBLY, PUMP & MOTOR (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.81021	ASSEMBLY, PUMP/MOTOR	1
3	..81021-1	PUMP (JSB)	1
-4	...67937	KIT, SEAL (JSB)	1
5	..3015-2	MOTOR	1
6	...2793	BRUSHES	1
7	.80008-15	ELBOW, MALE	1
8	.80001-20	CONNECTOR, MALE	1
9	.80001-15	CONNECTOR, MALE	1

REV.

Mark Industries

TITLE	PUMP & MOTOR ASSEMBLY
MODEL	M20EST & M20ESEP
NOTES	SINCE MID 1989

SECTION	3
FIGURE	11A
PAGE	1



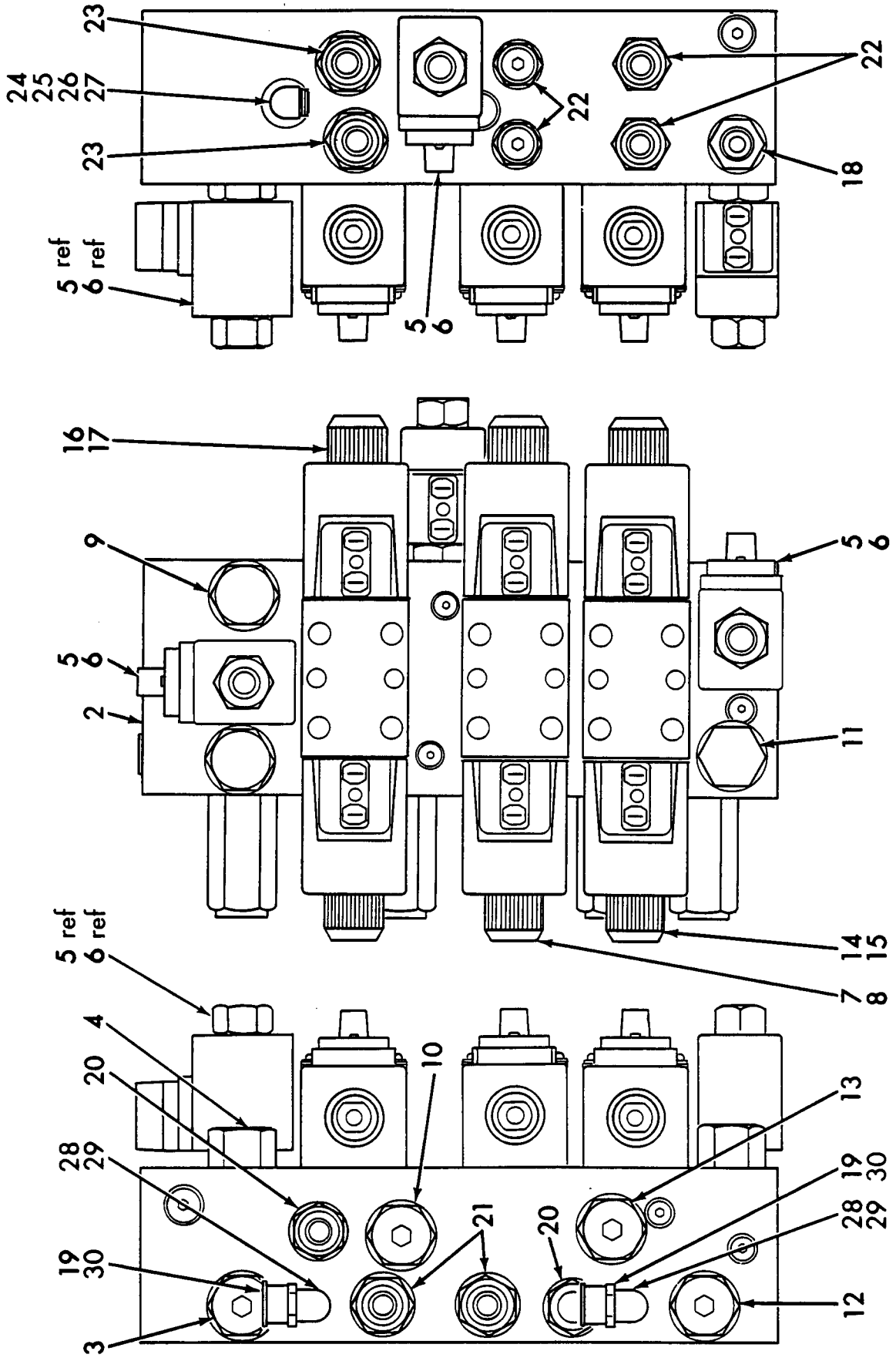
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130300	ASSEMBLY, PUMP & MOTOR (See Sect. 3, Fig. 3 or 4 for NHA)	REF
-2	.81287	ASSEMBLY, PUMP/MOTOR	1
3	..81021-1	PUMP (JSB)	1
-4	...67937	KIT, SEAL (JSB)	1
5	..67939	MOTOR	1
6	.80008-15	ELBOW, MALE	1
7	.80001-20	CONNECTOR, MALE	1
8	.80001-15	CONNECTOR, MALE	1

REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	UNTIL LATE 1989

SECTION	3
FIGURE	12
PAGE	1

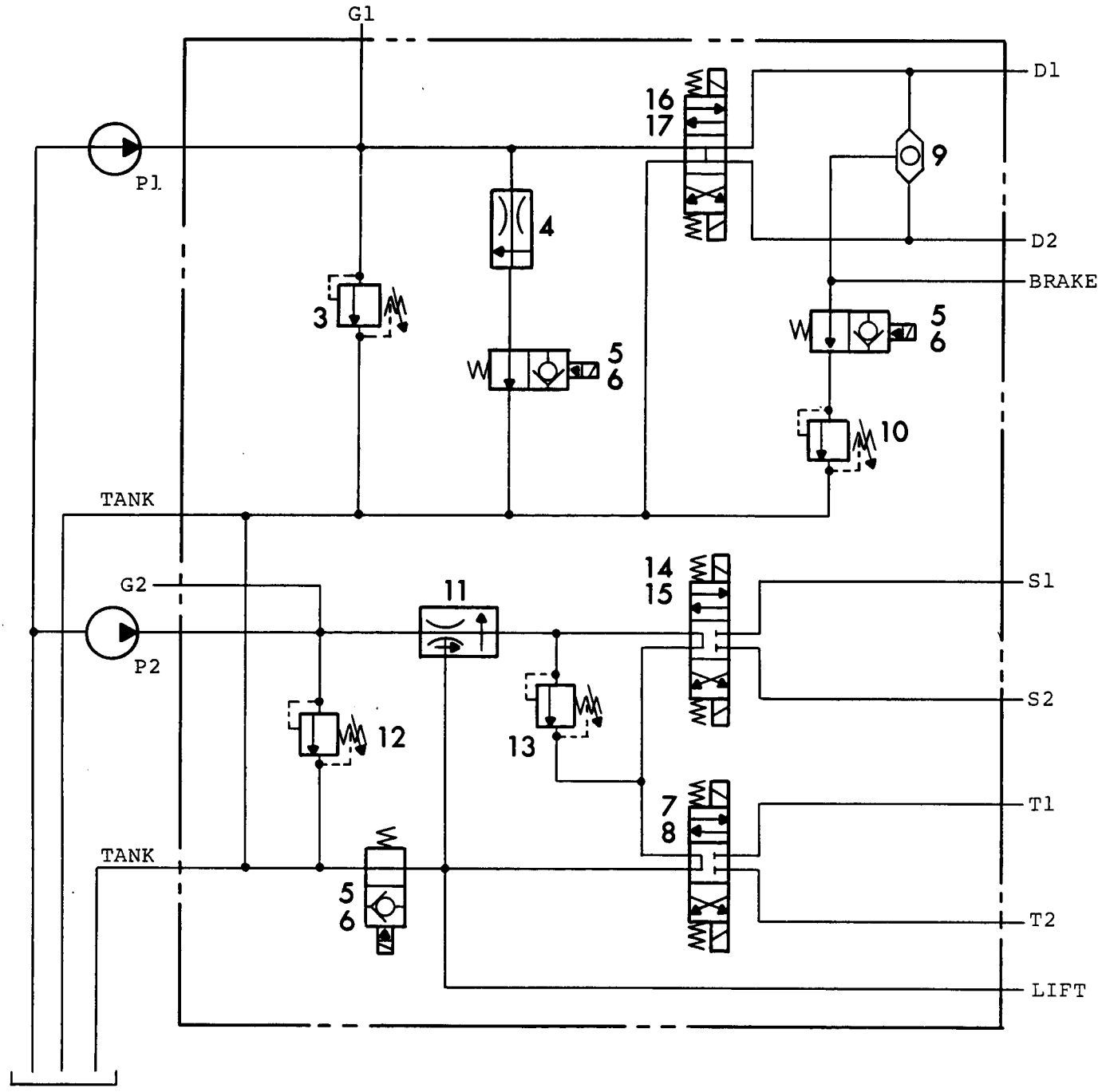


REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	UNTIL LATE 1989

SECTION	3
FIGURE	12
PAGE	2



REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	UNTIL LATE 1989

SECT.	3
FIG.	12
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131881	ASSEMBLY, CONTROL VALVE (See Sect. 3, Fig. 3 for NHA)	REF
2	.81263	VALVE, CONTROL	1
3	..68060	VALVE, RELIEF	1
4	..600000	REGULATOR, FLOW	1
5	..67000	SOLENOID, N.O. POPPET	3
6	...66865	COIL, 20 VDC (SMALL)	1
7	..67159	VALVE, D01	1
8	...66864	COIL, 20 VDC (LARGE)	1
9	..66924	VALVE, SHUTTLE	1
10	..68057	VALVE, RELIEF	1
11	..67004	REGULATOR, FLOW	1
12	..68060	VALVE, RELIEF	1
13	..68057	VALVE, RELIEF	1
14	..67159	VALVE, D01	1
15	...66864	COIL, 20 VDC (LARGE)	2
16	..600001	VALVE, D01	1
17	...66864	COIL, 20 VDC	2
18	.80004-08	CONNECTOR, STRAIGHT THREAD	1
19	.845	CAP, QUICK DISCONNECT	2
20	.80004-12	CONNECTOR, STRAIGHT THREAD	2
21	.80004-16	CONNECTOR, STRAIGHT THREAD	2
22	.80004-03	CONNECTOR, STRAIGHT THREAD	4
23	.80004-11	CONNECTOR, STRAIGHT THREAD	2
24	.51903	ADAPTER, PIPE	1
25	.80052-02	NIPPLE, PIPE	1

REV.

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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	UNTIL LATE 1989

SECT.	3
FIG.	12
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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.30884	VALVE, FLOW CONTROL	1
27	.80008-03	ELBOW, MALE	1
28	.160153	NIPPLE	2
29	.80021-03	ELBOW, STREET	2
30	.2527	COUPLING, QUICK DISCONNECT	2

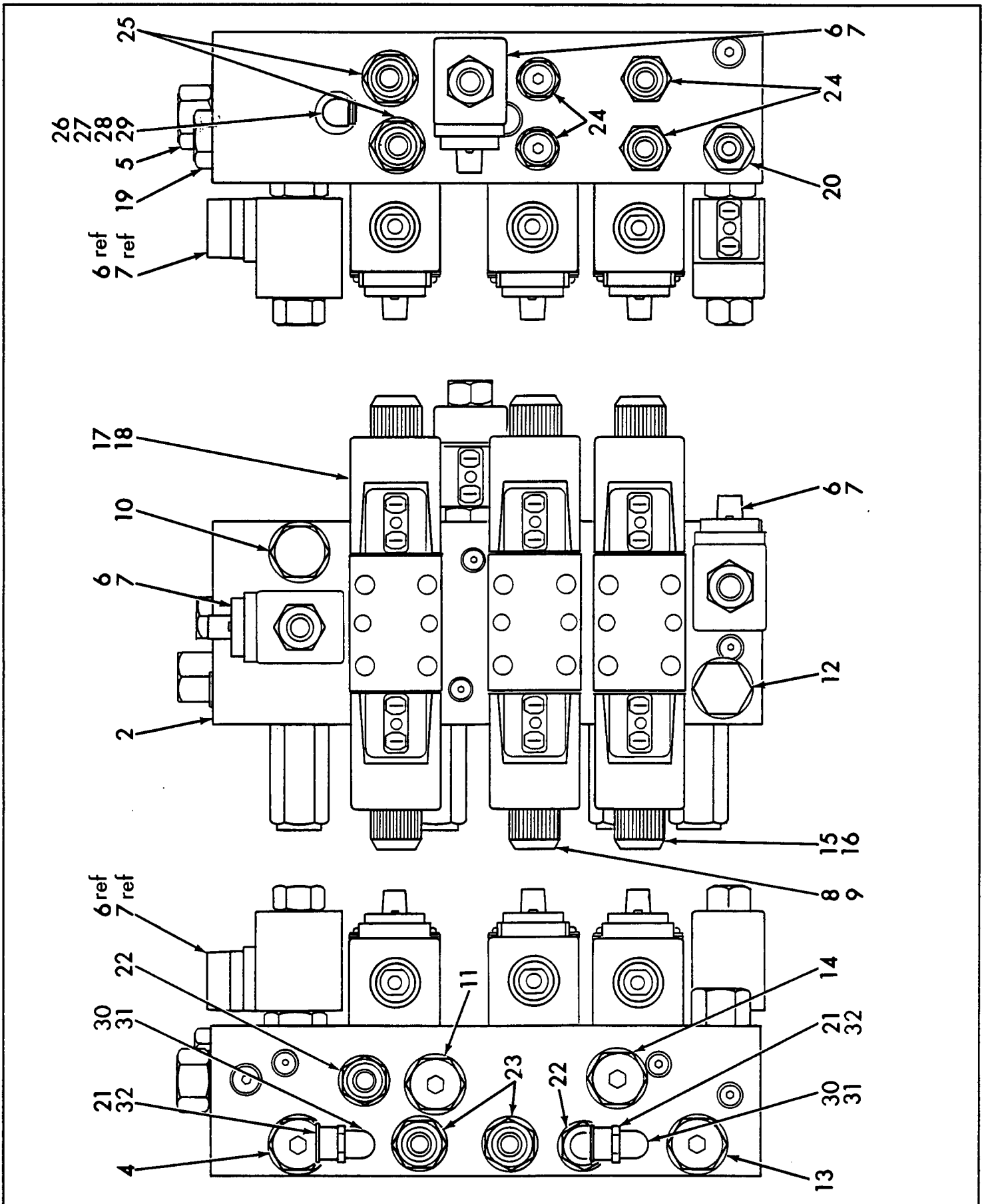
REV.

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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	SINCE LATE 1989

SECTION	3
FIGURE	12A
PAGE	1

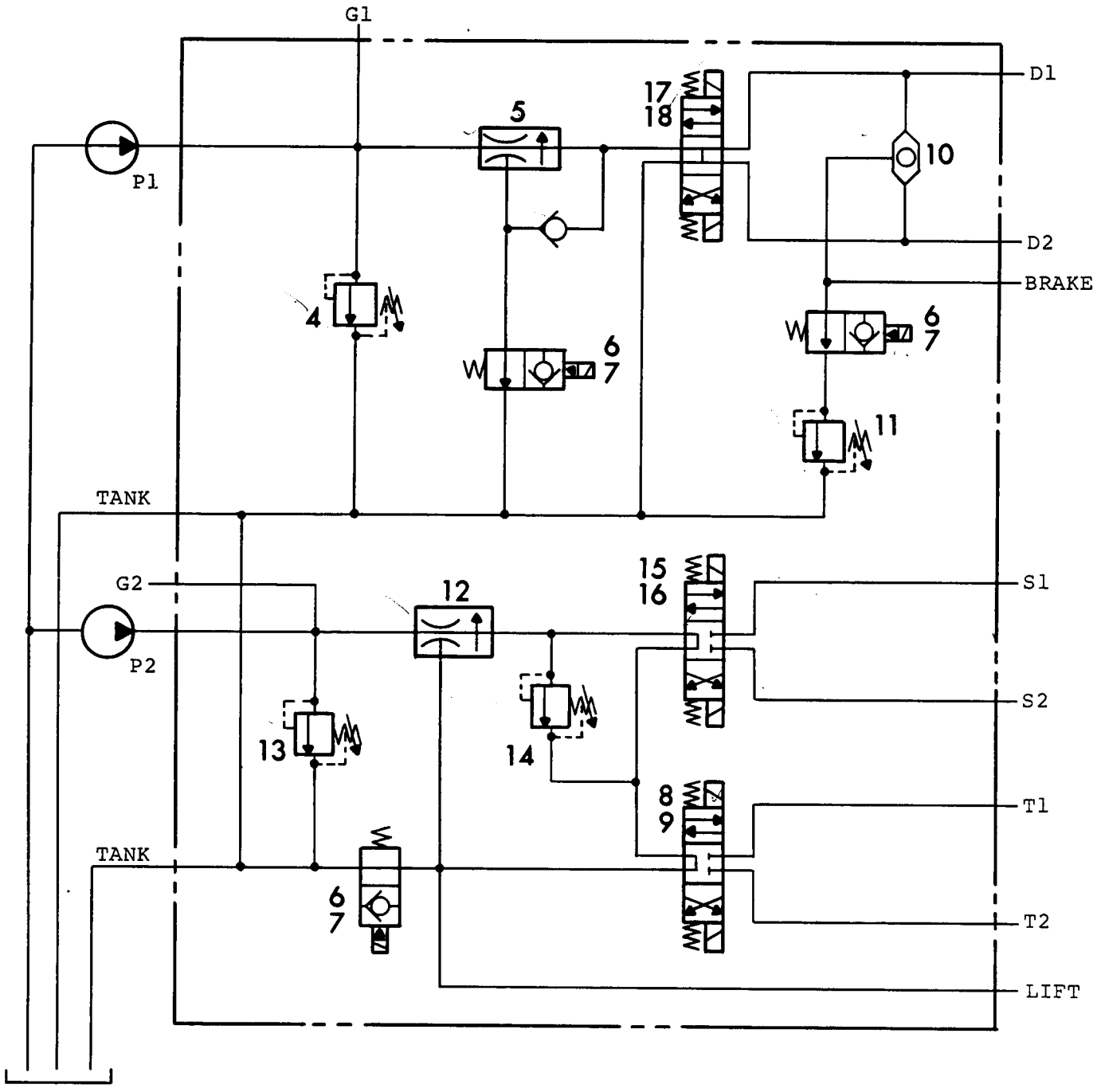


REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	SINCE LATE 1989

SECTION	3
FIGURE	12A
PAGE	2



REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	SINCE LATE 1989

SECT.	3
FIG.	12A
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131881	ASSEMBLY, CONTROL VALVE (See Sect. 3, Fig. 3 for NHA)	REF
2	.81327	VALVE, CONTROL	1
3	..600004	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
*4	..68060	VALVE, RELIEF	1
5	..600300	REGULATOR, FLOW (1.5 GPM)	1
6	..67000	SOLENOID, N.O. POPPET	3
7	...66865	COIL, 20 VOLT (SMALL)	1
8	..67159	VALVE, D01	1
9	...66864	COIL, 20 VOLT (LARGE)	2
10	..66924	VALVE, SHUTTLE	1
*11	..68057	VALVE, RELIEF	1
12	..67004	REGULATOR, FLOW (2.5 GPM)	1
*13	..68060	VALVE, RELIEF	1
*14	..68057	VALVE, RELIEF	1
15	..67159	VALVE, D01	1
16	...66864	COIL, 20 VOLT (LARGE)	2
17	..600001	VALVE, D01	1
18	...66864	COIL, 20 VOLT (LARGE)	2
19	..600003	VALVE, CHECK	1
20	.80004-08	CONNECTOR, STRAIGHT THREAD	1
21	.845	CAP, QUICK DISCONNECT	2
22	.80004-12	CONNECTOR, STRAIGHT THREAD	2
		NOTE: PRIOR TO USE, RELIEF VALVES WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

REV.

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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20EST
NOTES	SINCE LATE 1989

SECT.	3
FIG.	12A
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.80004-16	CONNECTOR, STRAIGHT THREAD	2
24	.80004-03	CONNECTOR, STRAIGHT THREAD	4
25	.80004-11	CONNECTOR, STRAIGHT THREAD	2
26	.51903	ADAPTER, PIPE	1
27	.80052-02	NIPPLE, PIPE	1
28	.30884	VALVE, FLOW CONTROL	1
29	.80008-03	ELBOW, MALE	1
30	.160153	NIPPLE	2
31	.80021-03	ELBOW, STREET	2
32	.2527	COUPLING, QUICK DISCONNECT	2

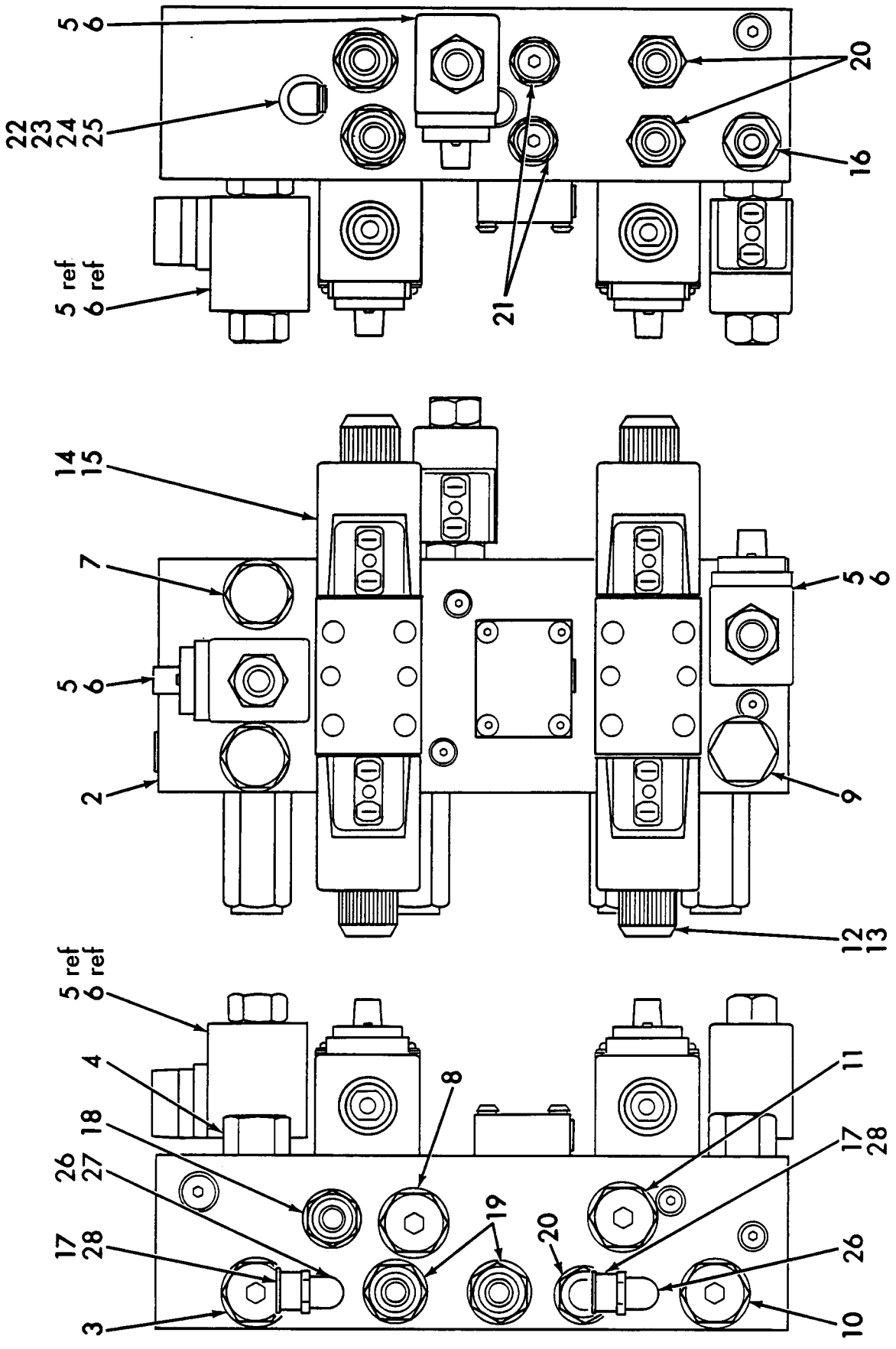
REV.

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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	UNTIL LATE 1989

SECTION	3
FIGURE	13
PAGE	1

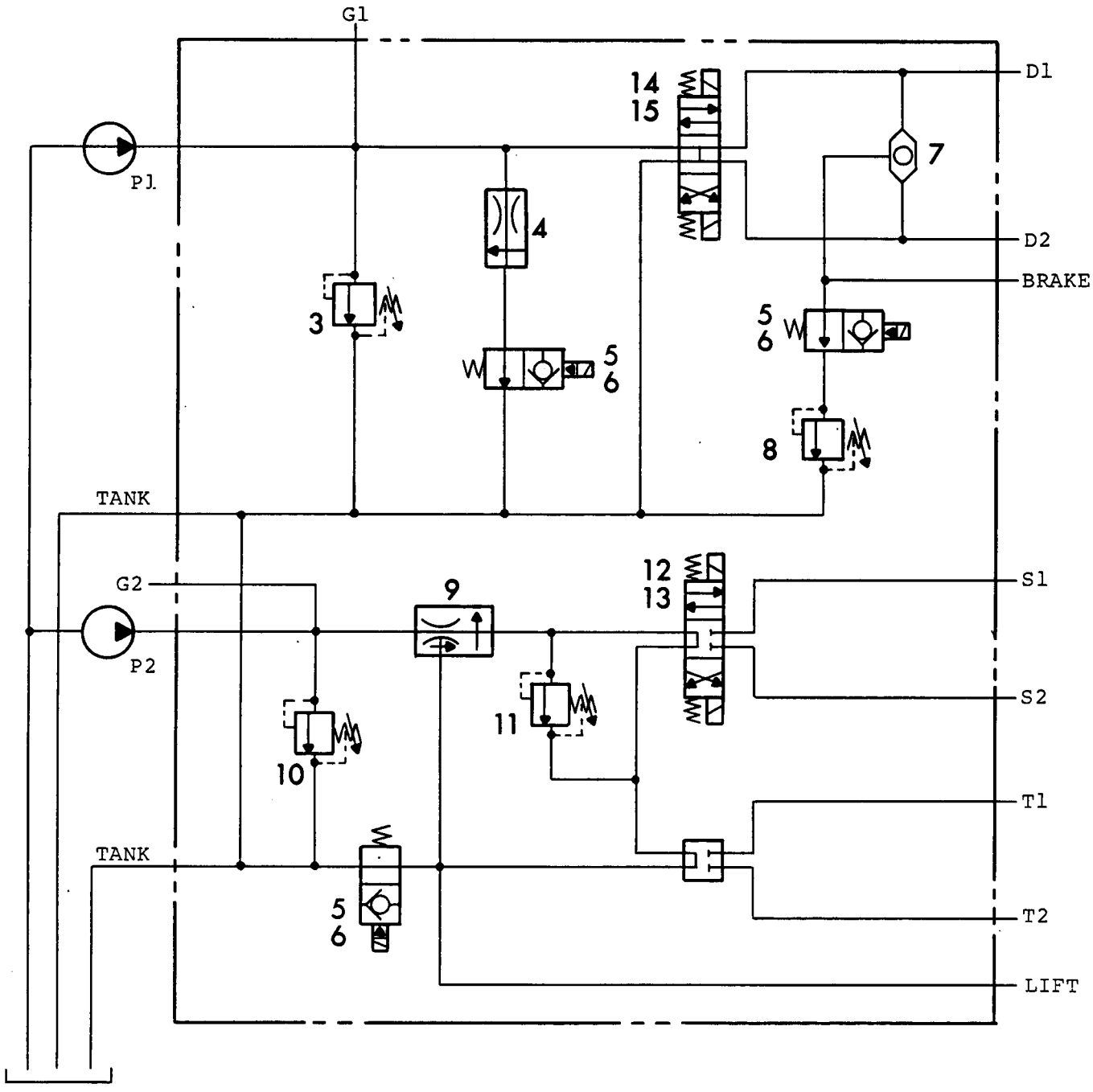


REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	UNTIL LATE 1989

SECTION	3
FIGURE	13
PAGE	2



REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	UNTIL LATE 1989

SECT.	3
FIG.	13
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131880	ASSEMBLY, CONTROL VALVE (See Sect. 3, Fig. 4 for NHA)	REF
2	.81267	VALVE, CONTROL	1
*3	..68060	VALVE, RELIEF	1
4	..600000	REGULATOR, FLOW	1
5	..67000	SOLENOID, N.O. POPPET	3
6	...66865	COIL, 20 VOLT (SMALL)	1
7	..66924	VALVE, SHUTTLE	1
*8	..68057	VALVE, RELIEF	1
9	..67004	REGULATOR, FLOW	1
*10	..68060	VALVE, RELIEF	1
*11	..68057	VALVE, RELIEF	1
12	..67159	VALVE, D01	1
13	...66864	COIL, 20 VOLT (LARGE)	2
14	..600001	VALVE, D01	1
15	...66864	COIL, 20 VOLT (LARGE)	2
16	.80004-08	CONNECTOR, STRAIGHT THREAD	1
17	.845	CAP, QUICK DISCONNECT	2
18	.80004-12	CONNECTOR, STRAIGHT THREAD	2
19	.80004-16	CONNECTOR, STRAIGHT THREAD	2
20	.80004-03	CONNECTOR, STRAIGHT THREAD	4
21	.80004-11	CONNECTOR, STRAIGHT THREAD	2
22	.51903	ADAPTER, PIPE	1
		NOTE: PRIOR TO USE, RELIEF VALVE WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

REV.

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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	UNTIL LATE 1989

SECT.	3
FIG.	13
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.80052-02	NIPPLE, PIPE	1
24	.30884	VALVE, FLOW CONTROL	1
25	.80008-03	ELBOW, MALE	1
26	.160153	NIPPLE	2
27	.80021-03	ELBOW, STREET	2
28	.2527	COUPLING, QUICK DISCONNECT	2

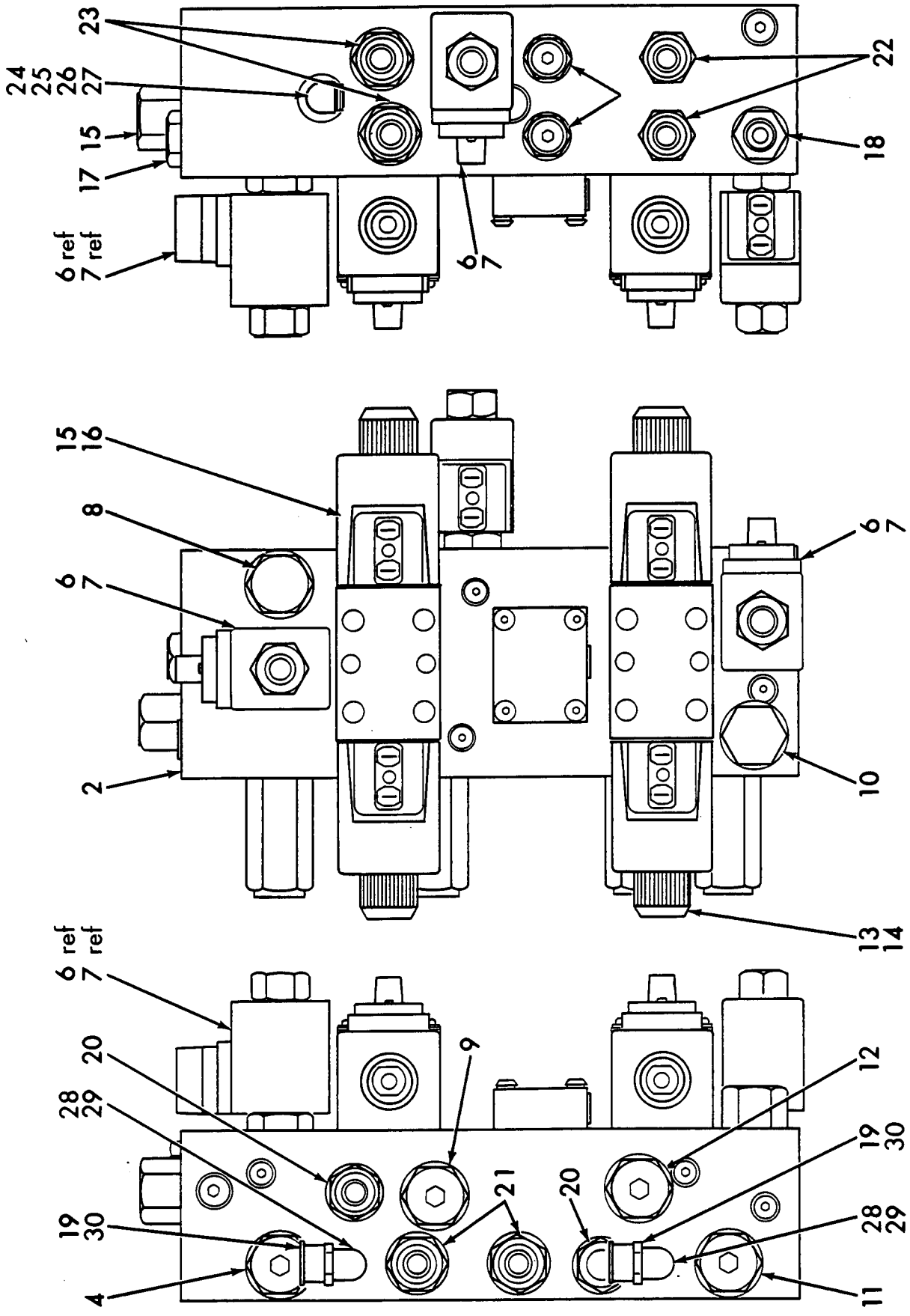
REV.

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

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	SINCE LATE 1989

SECTION	3
FIGURE	13A
PAGE	1

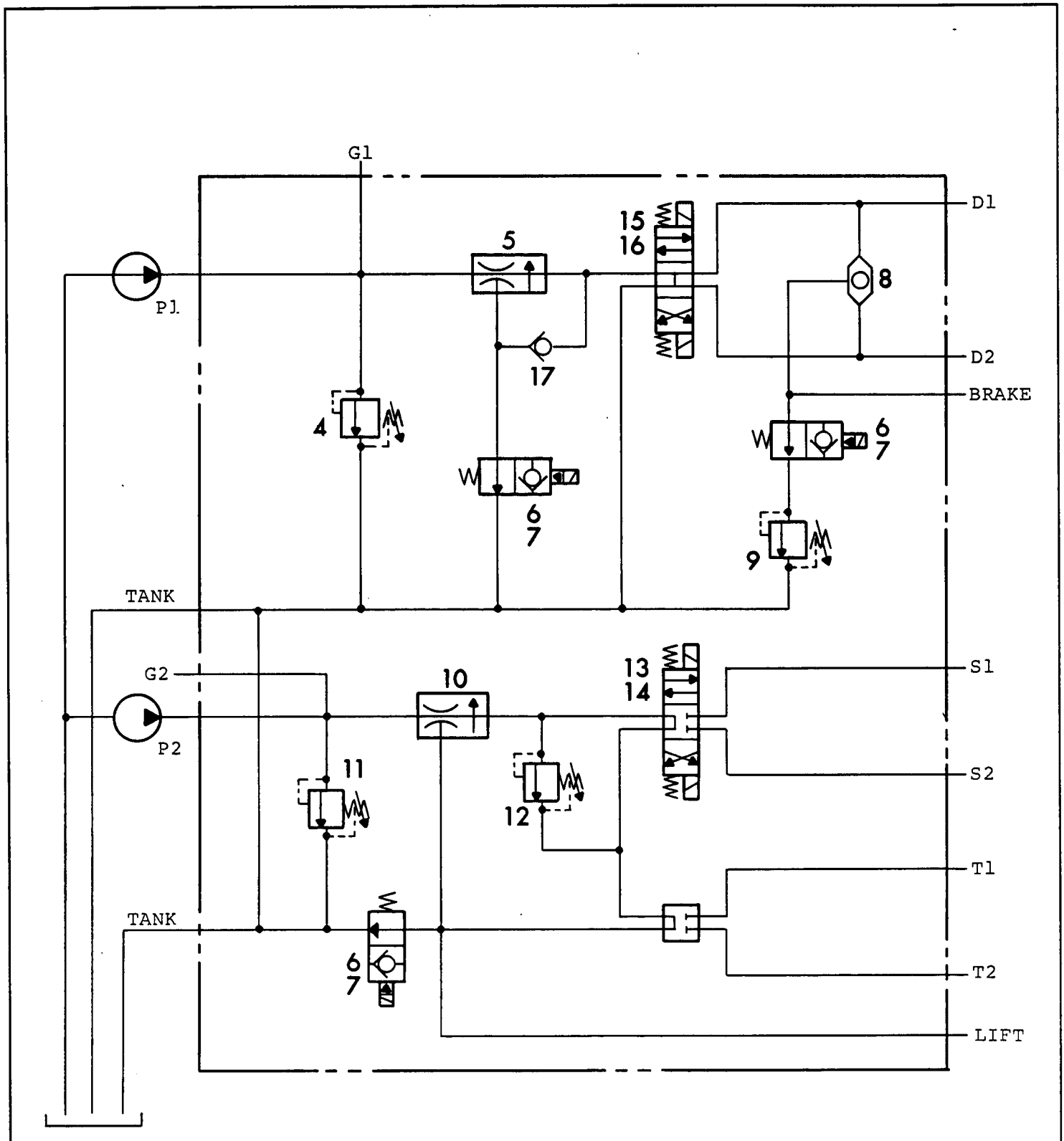


REV.

Mark Industries

TITLE	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	SINCE LATE 1989

SECTION	3
FIGURE	13A
PAGE	2



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131880	ASSEMBLY, CONTROL VALVE (See Sect. 3, Fig. 4 for NHA)	REF
2	.81328	VALVE, CONTROL	1
-3	..600004	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
*4	..68060	VALVE, RELIEF	1
5	..600300	REGULATOR, FLOW (1.5 GPM)	1
6	..67000	SOLENOID, N.O. POPPET	3
7	...66865	COIL, 20 VOLT (SMALL)	1
8	..66924	VALVE, SHUTTLE	1
*9	..68057	VALVE, RELIEF	1
10	..67004	REGULATOR, FLOW	1
*11	..68060	VALVE, RELIEF	1
*12	..68057	VALVE, RELIEF	1
13	..67159	VALVE, D01	1
14	...66864	COIL, 20 VOLT (LARGE)	2
15	..600001	VALVE, D01	1
16	...66864	COIL, 20 VOLT (LARGE)	2
17	..600003	VALVE, CHECK	1
18	.80004-08	CONNECTOR, STRAIGHT THREAD	1
19	.845	CAP, QUICK DISCONNECT	2
20	.80004-12	CONNECTOR, STRAIGHT THREAD	2
21	.80004-16	CONNECTOR, STRAIGHT THREAD	2
22	.80004-03	CONNECTOR, STRAIGHT THREAD	4
		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	CONTROL VALVE ASSEMBLY
MODEL	M20ESEP
NOTES	SINCE LATE 1989

SECT.	3
FIG.	13A
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.80004-11	CONNECTOR, STRAIGHT THREAD	2
24	.51903	ADAPTER, PIPE	1
25	.80052-02	NIPPLE, PIPE	1
26	.30884	VALVE, FLOW CONTROL	1
27	.80008-03	ELBOW, MALE	1
28	.160153	NIPPLE	2
29	.80021-03	ELBOW, STREET	2
30	.2527	COUPLING, QUICK DISCONNECT	2

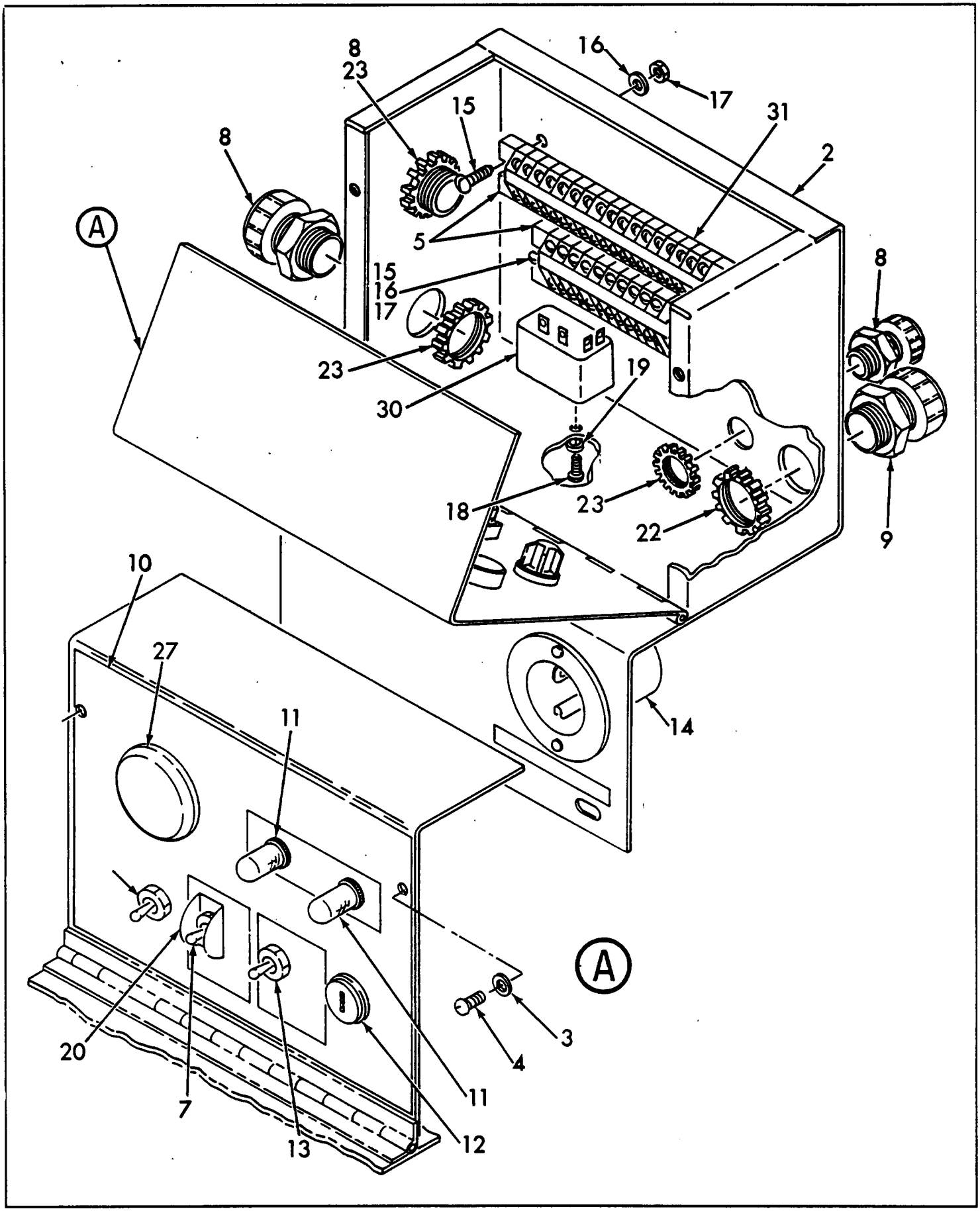
REV.

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

Mark Industries

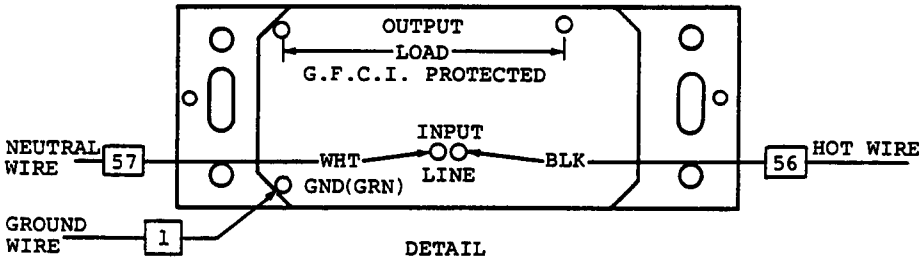
TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	3
FIGURE	14
PAGE	1

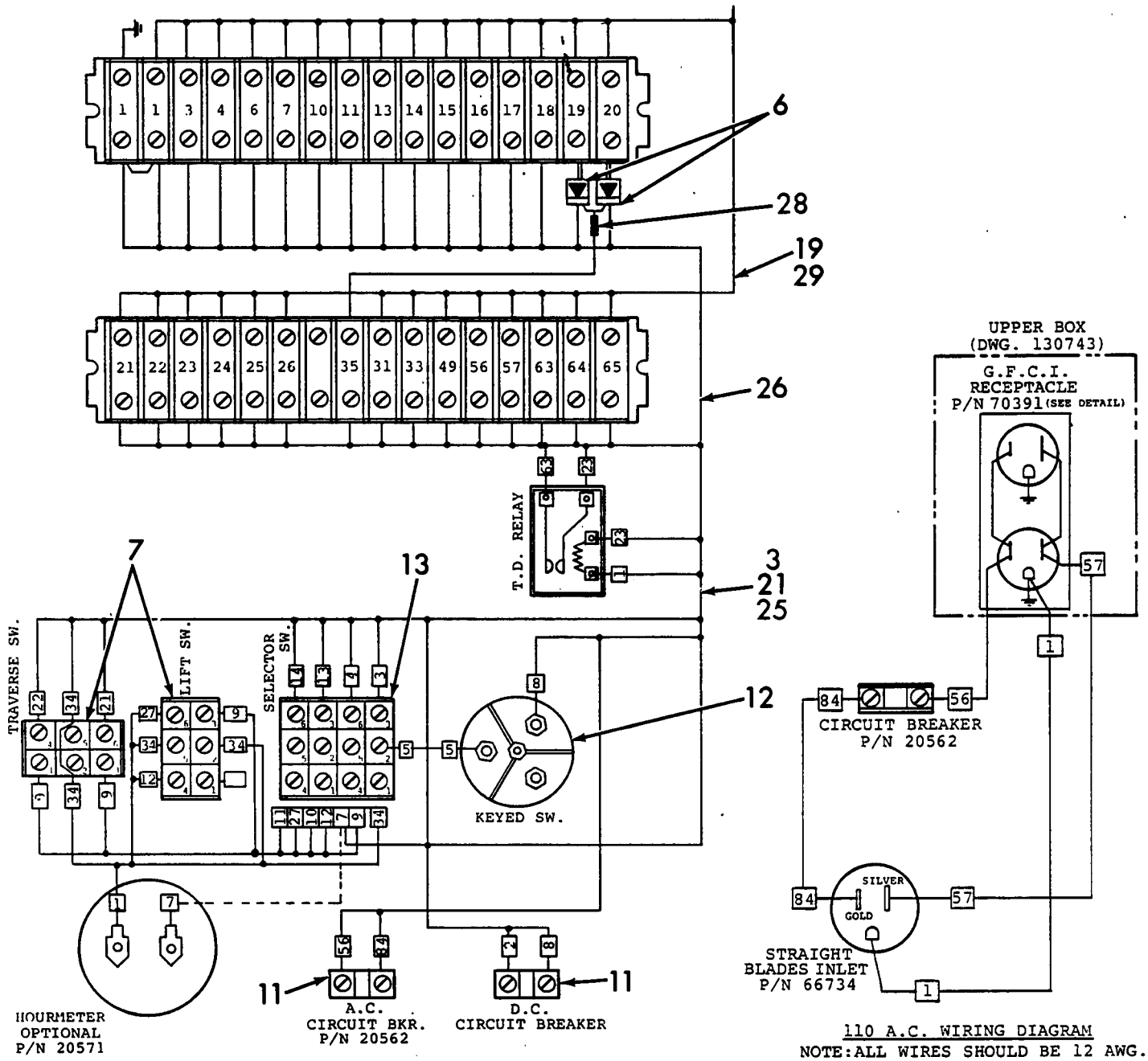


REV.

USE ON THESE WIRES (BLK & WHT) WIRE NUTS P/N 70394 TO BE INSULATED



DETAIL
G.F.C.I. RECEPTACLE
P/N 70391



110 A.C. WIRING DIAGRAM
NOTE: ALL WIRES SHOULD BE 12 AWG.

REV.

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20EST
NOTES	

SECT.	3
FIG.	14
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130389	ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 3 for NHA)	REF
2	.130390	BOX, GROUND CONTROL	1
3	..63312	WASHER, LOCK	2
4	..62612	SCREW, MACHINE	2
5	.117-A	BLOCK, TERMINAL	4
6	.70479	DIODE	2
7	.20481	SWITCH, TOGGLE	2
8	.2807	RELIEF, STRAIN	3
9	.2806	RELIEF, STRAIN	1
10	.130505	DECAL, GROUND CONTROL BOX	1
11	.20562	BREAKER, CIRCUIT	1
12	.2717	SWITCH, IGNITION	1
13	.16260	SWITCH, TOGGLE	1
14	.66734	RECEPTACLE	1
15	.62612	SCREW, MACHINE	6
16	.63312	WASHER, LOCK	6
17	.61502	NUT, HEX	6
18	.61728	SCREW, SELF-TAPPING	1
19	.63322	WASHER, LOCK	1
20	.20884	GUARD, SWITCH	1
21	.70008	WIRE, YELLOW WITH GREEN (16 AWG)	3 FT
22	.2808	NUT, LOCK	1
23	.2809	NUT, LOCK	3
24	.117-C	RING, CONNECTOR	40
25	.4034	CABLE (12 GAUGE/3 CONDUCTOR)	5 FT

REV.

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

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20EST
NOTES	

SECT.	3
FIG.	14
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.70232	WIRE, WHITE (16 AWG)	20 FT
27	.65244	PLUG, WHITE	2
28	.70162	TERMINAL	1
29	.2991	WIRE, WHITE	2 FT
30	.70337	RELAY; TIME DELAY	1
31	.4027	BLOCK, TERMINAL	32

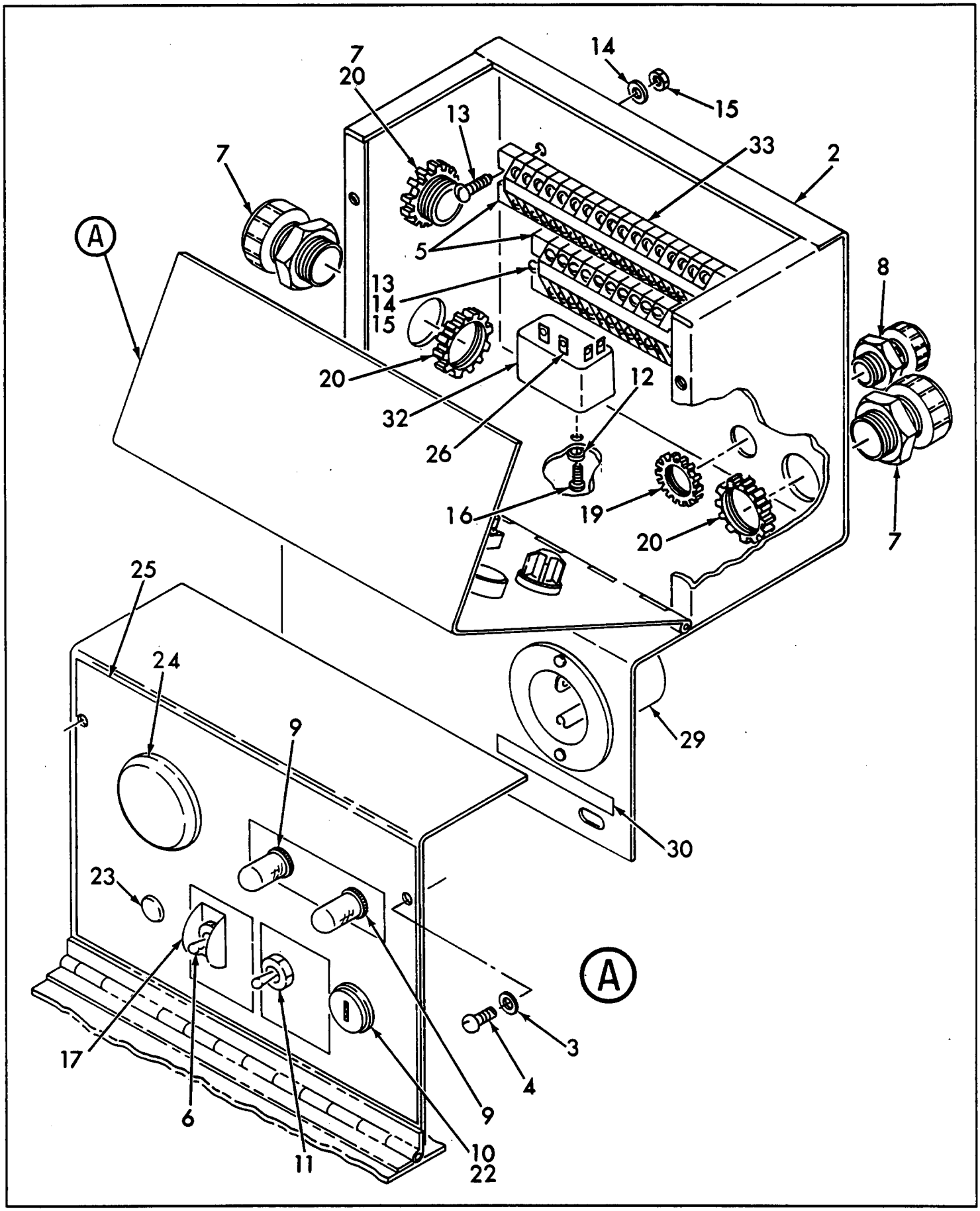
REV.

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

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	3
FIGURE	15
PAGE	1

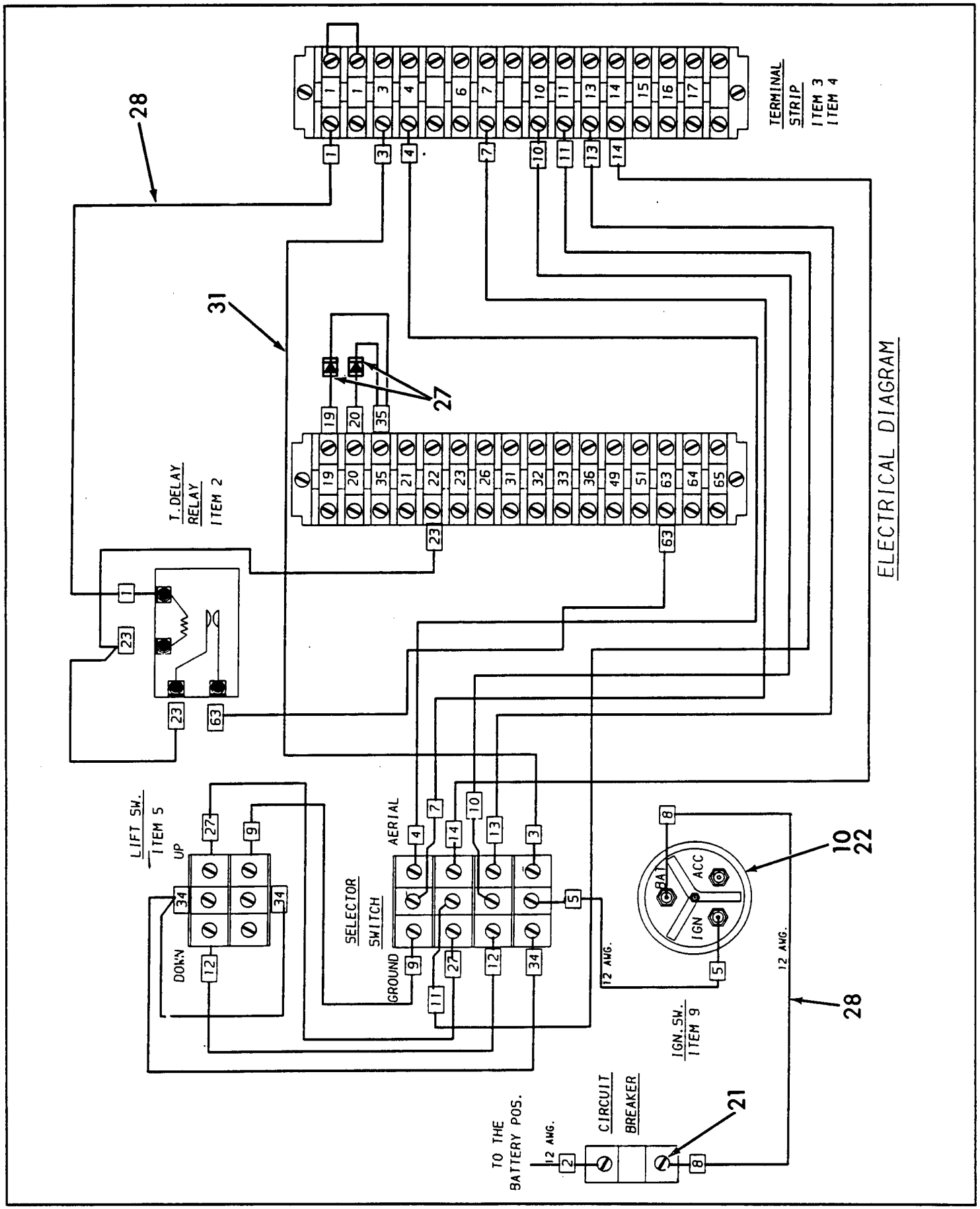


REV.

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	3
FIGURE	15
PAGE	2



REV.

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

SECT.	3
FIG.	15
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131199	ASSEMBLY, GROUND CONTROL BOX (See Sect. 3, Fig. 4 for NHA)	REF
2	.130390	BOX, GROUND CONTROL	1
3	..63312	WASHER, LOCK	2
4	..62612	SCREW, MACHINE	2
5	.117-A	END, TERMINAL BLOCK	2
6	.20481	SWITCH, TOGGLE	1
7	.2807	RELIEF, STRAIN	3
8	.2806	RELIEF, STRAIN	1
9	.20562	BREAKER, CIRCUIT	2
10	.2717	SWITCH, IGNITION	1
11	.16260	SWITCH, TOGGLE	1
12	.63322	WASHER, LOCK	1
13	.62612	SCREW, MACHINE	8
14	.63312	WASHER, LOCK	8
15	.61502	NUT, HEX	6
16	.61728	SCREW, SELF-TAPPING	1
17	.20884	GUARD, SWITCH	1
18	.70008	WIRE, YELLOW WITH GREEN	3 FT
19	.2808	NUT, LOCK	1
20	.61115	NUT, CONDUIT	3
21	.117-C	RING, CONNECTOR	33
22	.16213	CONNECTOR	2
23	.771	PLUG	1
24	.65244	PLUG	1
25	.130505	DECAL, GROUND CONTROL BOX	1

REV.

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

Mark Industries

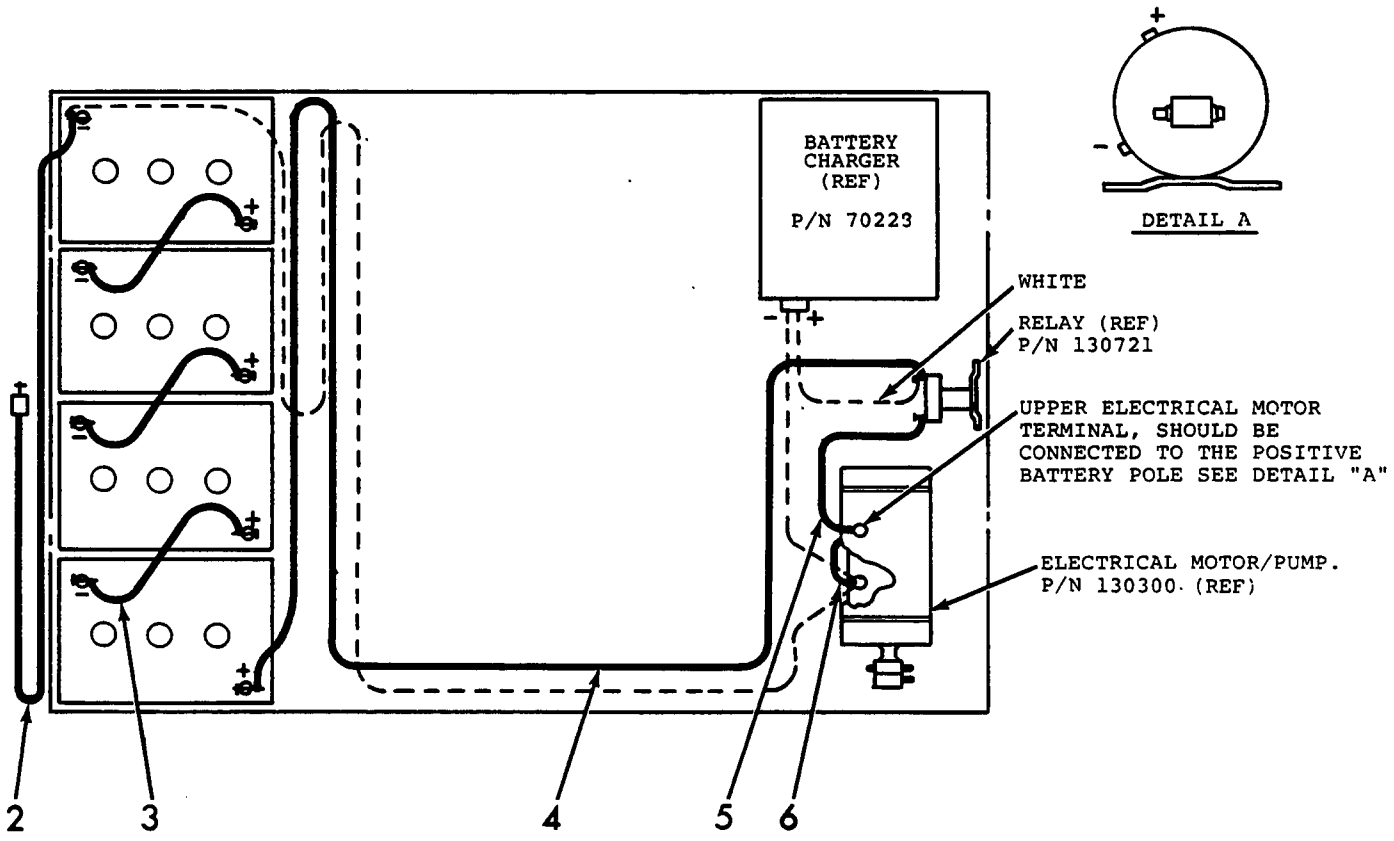
TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	M20ESEP
NOTES	

SECT.	3
FIG.	15
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.496-A	TERMINAL	4
27	.70442	DIODE (3 AMP 600V)	2
28	.2991	WIRE, WHITE	1 FT
29	.70409	INLET, FLANGED	1
30	.185707	DECAL, POWER TO PLATFORM 110 VAC	1
31	.70009	WIRE, RED (16 AWG)	15 FT
32	.70337	RELAY, TIME DELAY	1
33	.4027	BLOCK, TERMINAL	32

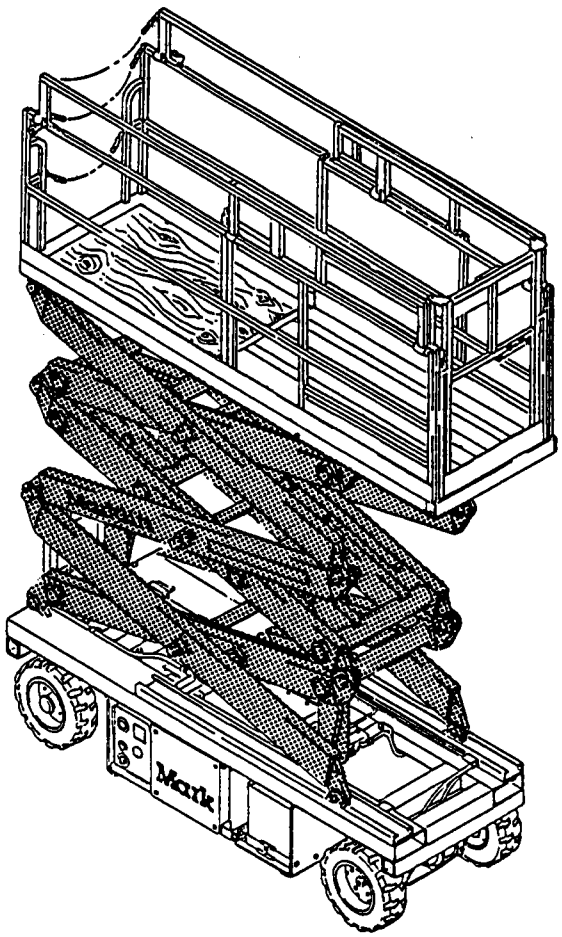
REV.

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



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130768	KIT, BATTERY CABLE (See Sect. 3, Fig. 4 for NHA)	REF
2	.13226-0303	ASSEMBLY, ELECTRICAL CABLE	1
3	.13226-0143	ASSEMBLY, ELECTRICAL CABLE	3
4	.13226-0493	ASSEMBLY, ELECTRICAL CABLE	1
5	.13226-0123	ASSEMBLY, ELECTRICAL CABLE	1
6	.13226-0053	ASSEMBLY, ELECTRICAL CABLE	1

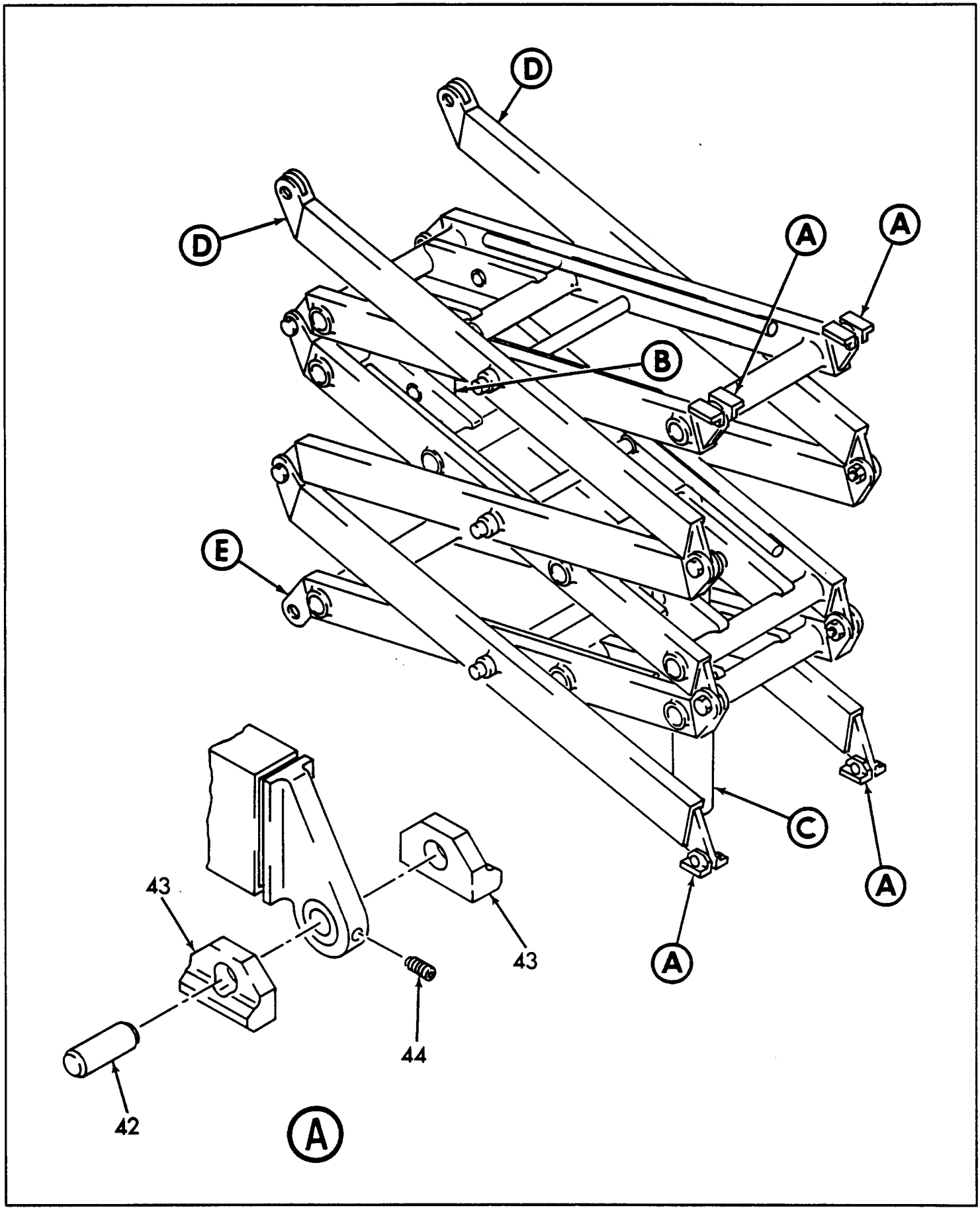
SECTION 4 CONTAINS:



Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	4
FIGURE	1
PAGE	1

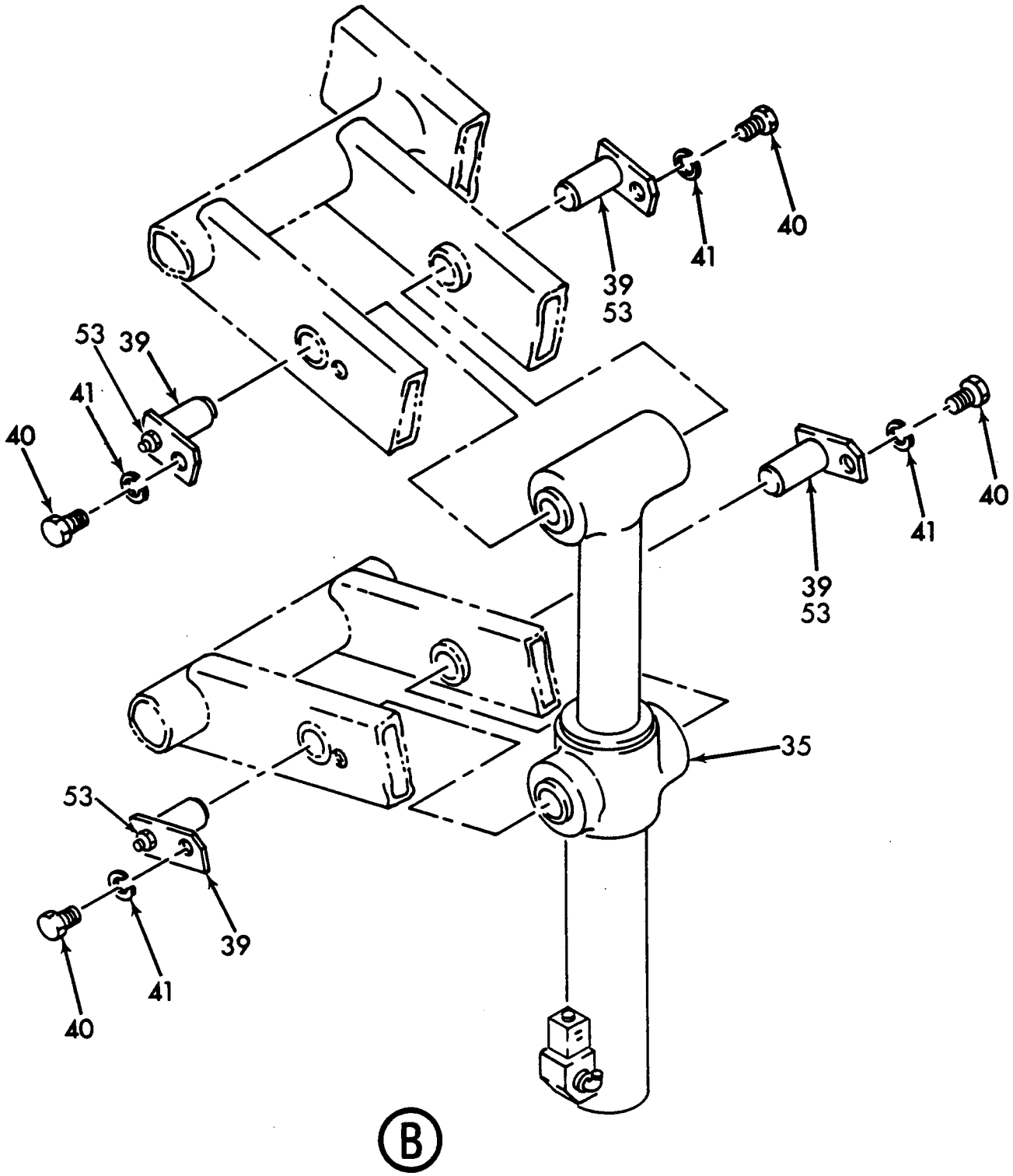


REV.

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	4
FIGURE	1
PAGE	2

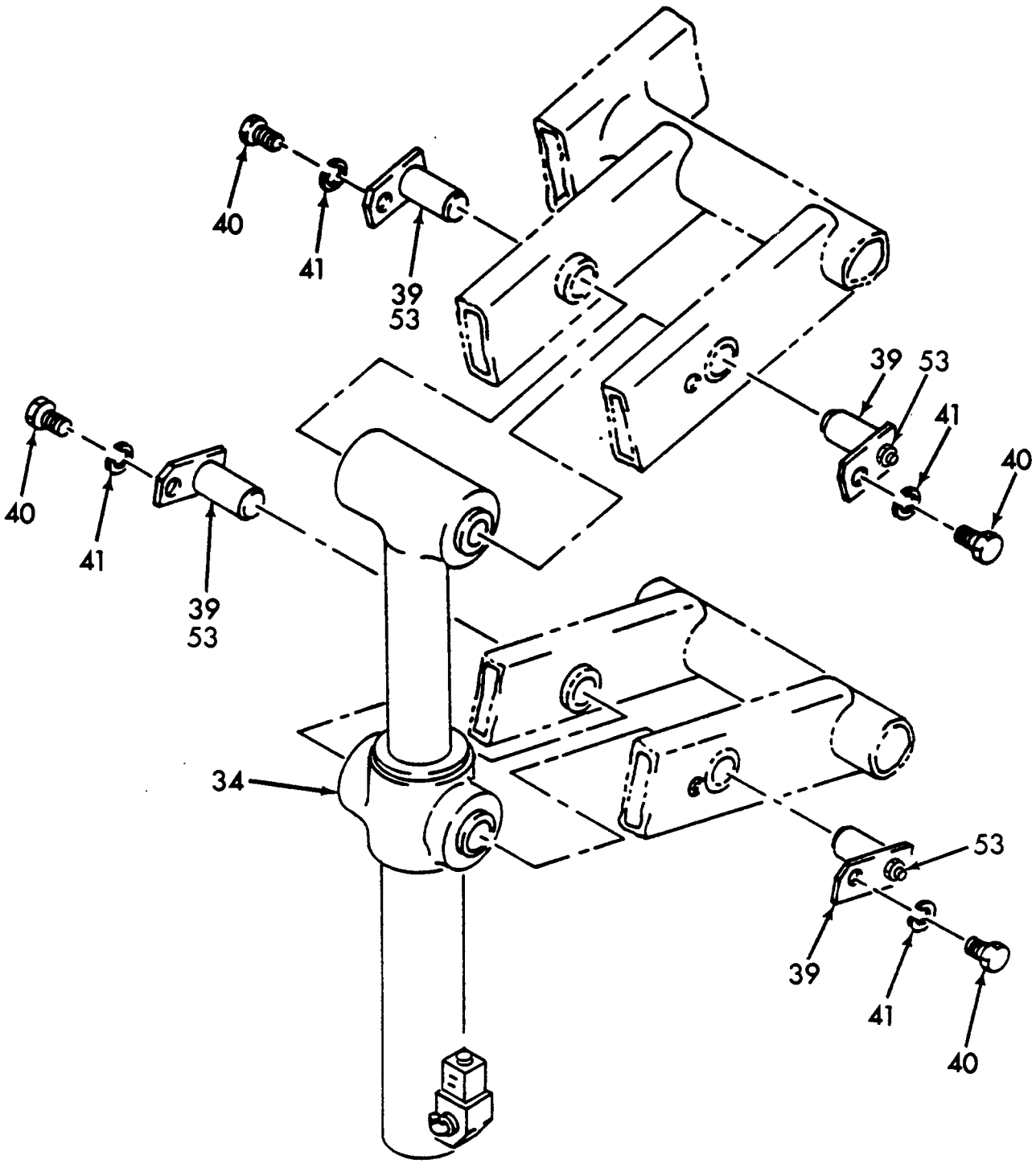


REV.

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	4
FIGURE	1
PAGE	3

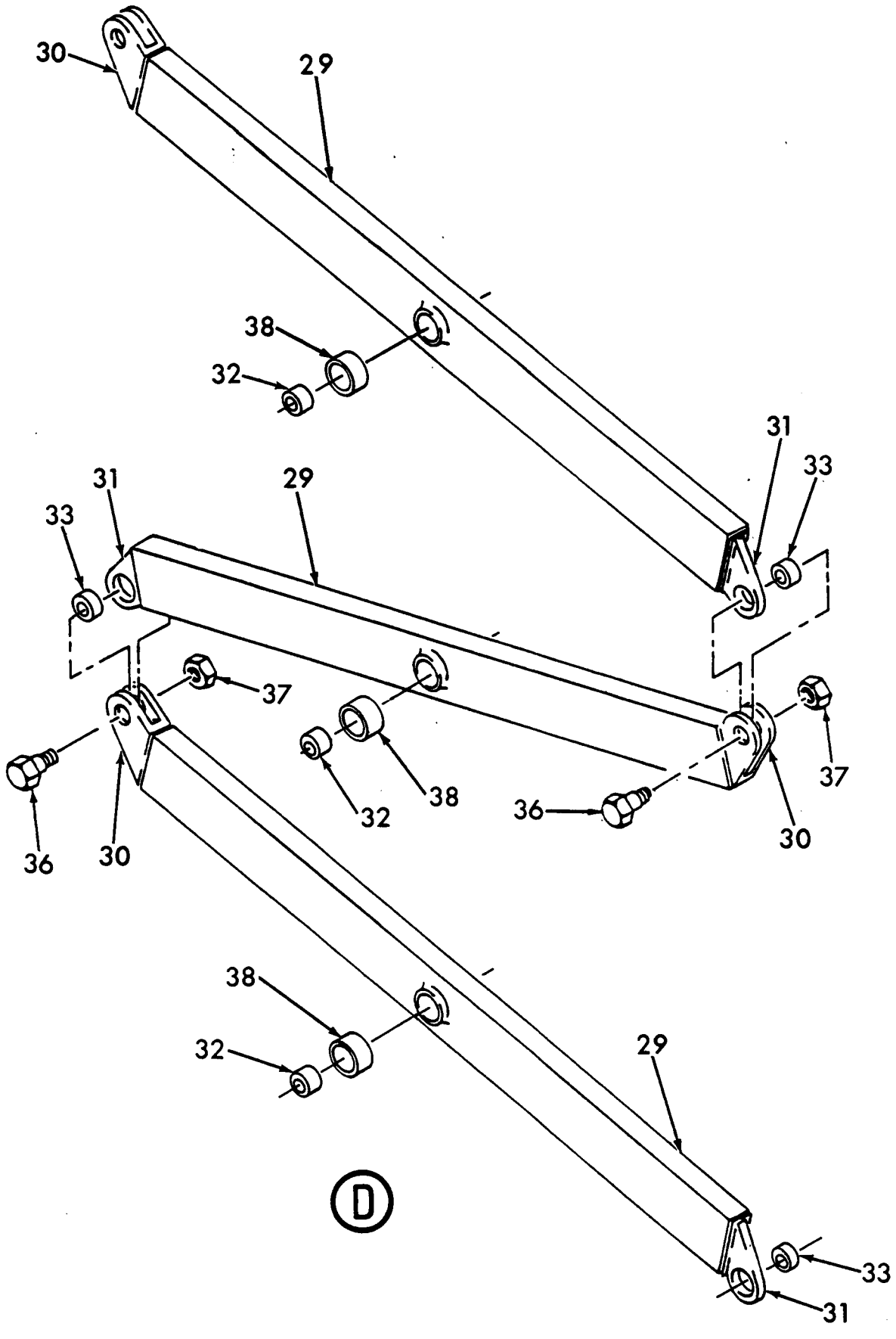


REV.

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	4
FIGURE	1
PAGE	4

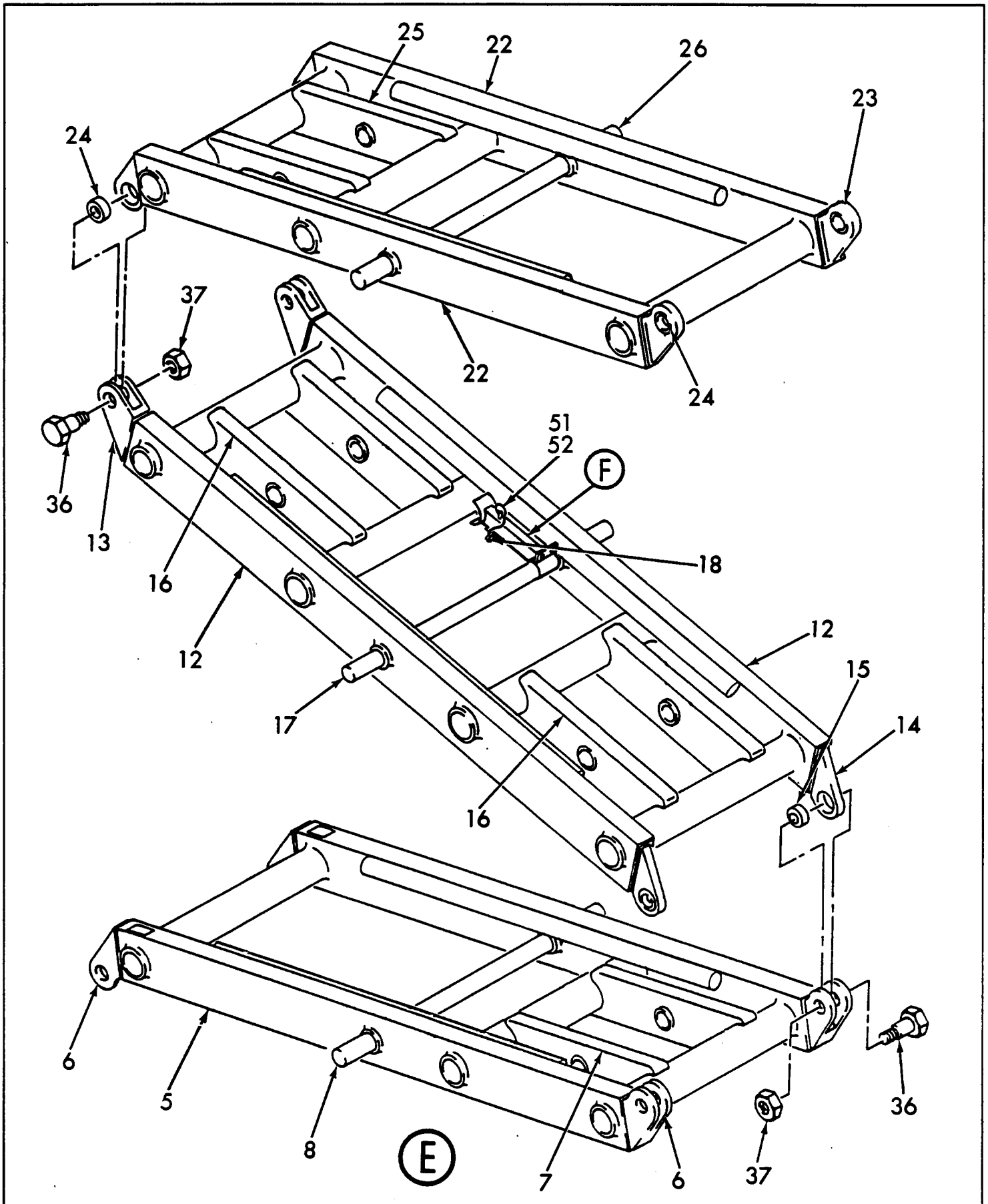


REV.

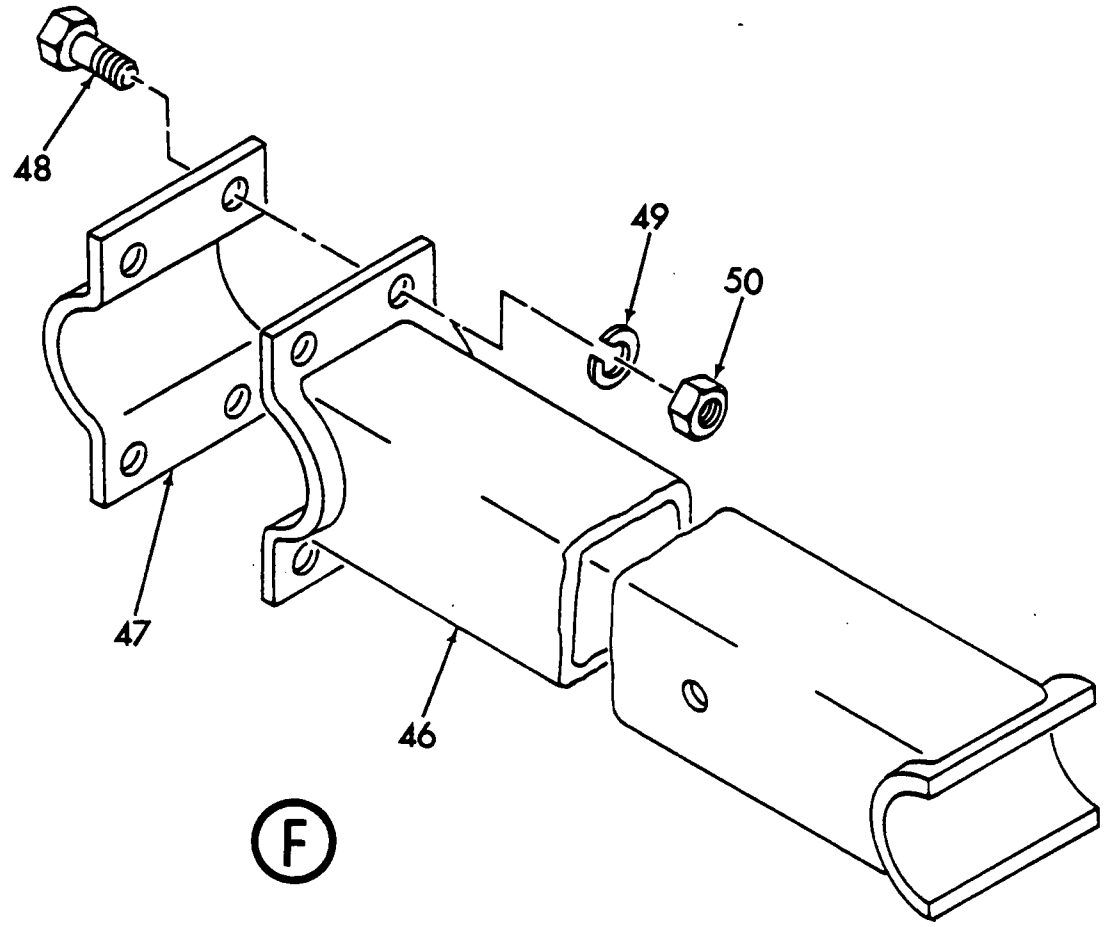
Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20ESEP
NOTES	

SECTION	4
FIGURE	1
PAGE	5



REV.



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130615	ASSEMBLY, SCISSOR (See Sect. 3, Fig. 1 for Details)	REF
-2	.130262	ASSEMBLY, INNER ARM	1
-3	..130261	SUB-ASSEMBLY, INNER ARM	2
-4	...130260	MACHINING, INNER ARM	2
5	130259	WELDMENT, ARM TUBE	2
6	130251	MACHINING, FEMALE EAR	4
7	..130273	ASSEMBLY, TRUNNION CYLINDER BRACKET	1
8	..130274	SHAFT, CENTER	1
-9	.130268	ASSEMBLY, INNER ARM	1
-10	..130267	SUB-ASSEMBLY, INNER ARM	2
-11	...130266	MACHINING, INNER ARM	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
12	130252	WELDMENT, ARM	2
13	130251	MACHINING, GEMALE EAR	2
14	130208	FORGING, MALE EAR	2
15	...916	BUSHING	2
16	..130273	ASSEMBLY, TRUNNION CYLINDER BRACKET	2
17	..130274	SHAFT, CENTER	1
18	..130515	BRACKET, ARM SUPPORT	1
-19	.130272	ASSEMBLY, INNER ARM	1
-20	..130271	SUB-ASSEMBLY, INNER ARM	2
-21	...130270	MACHINING, INNER ARM	2
22	130255	WELDMENT, ARM TUBE	2
23	130208	FORGING, MALE EAR	4
24	...916	BUSHING	4
25	..130273	ASSEMBLY, TRUNNION CYLINDER BRACKET	1
26	..130274	SHAFT, CENTER	1
-27	.130254	ASSEMBLY, OUTER ARM	6
-28	..130253	MACHINING, ARM	6
29	...130252	WELDMENT, ARM	6
30	130251	MACHINING, FEMALE EAR	6
31	130208	FORGING, MALE EAR	6
32	..160319	BEARING	6
33	..916	BUSHING	6
34	.130789	ASSEMBLY, LIFT CYLINDER (TELESCOPIC) (See Sect. 4, Fig. 3 for Details)	1
35	.131421	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 4 for Details)	1

Mark Industries

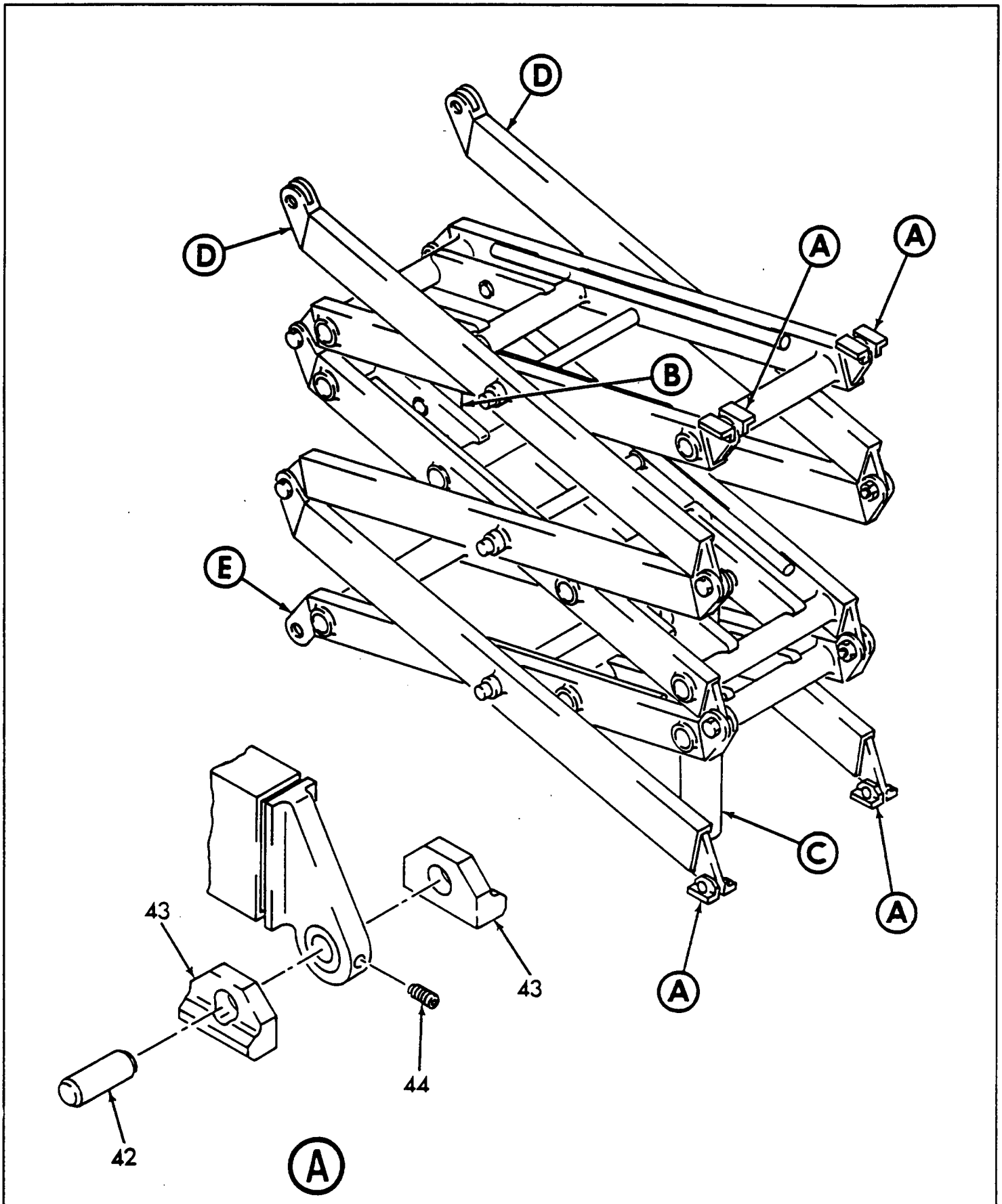
TITLE	SCISSOR ASSEMBLY	SECT.	4
MODEL	M20ESEP	FIG.	1
NOTES		PAGE	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
36	.130696	BOLT, EAR PIVOT	8
37	.61249	NUT, LOCK	8
38	.65577	COLLAR, SHAFT	6
39	.131453	PIN, TRUNNION	8
40	.60533	SCREW, CAP	8
41	.63302	WASHER, LOCK	8
42	.130327	PIN, WEAR PAD	4
43	.130326	PAD, SLAB WEAR	8
44	.62201	SCREW, SET	4
-45	.130511	ASSEMBLY, INNER ARM SUPPORT	1
46	..130512	WELDMENT, INNER ARM SUPPORT	1
47	..30693	CLAMP, INNER ARM SUPPORT	1
48	..60343	SCREW, CAP	4
49	..63303	WASHER, LOCK	4
50	..60703	NUT, HEX	4
51	.12007	PIN, BALL-LOK DETENT	1
52	.375	RIVET, POP	1
53	.65103	FITTING,GREASE	8

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	4
FIGURE	2
PAGE	1



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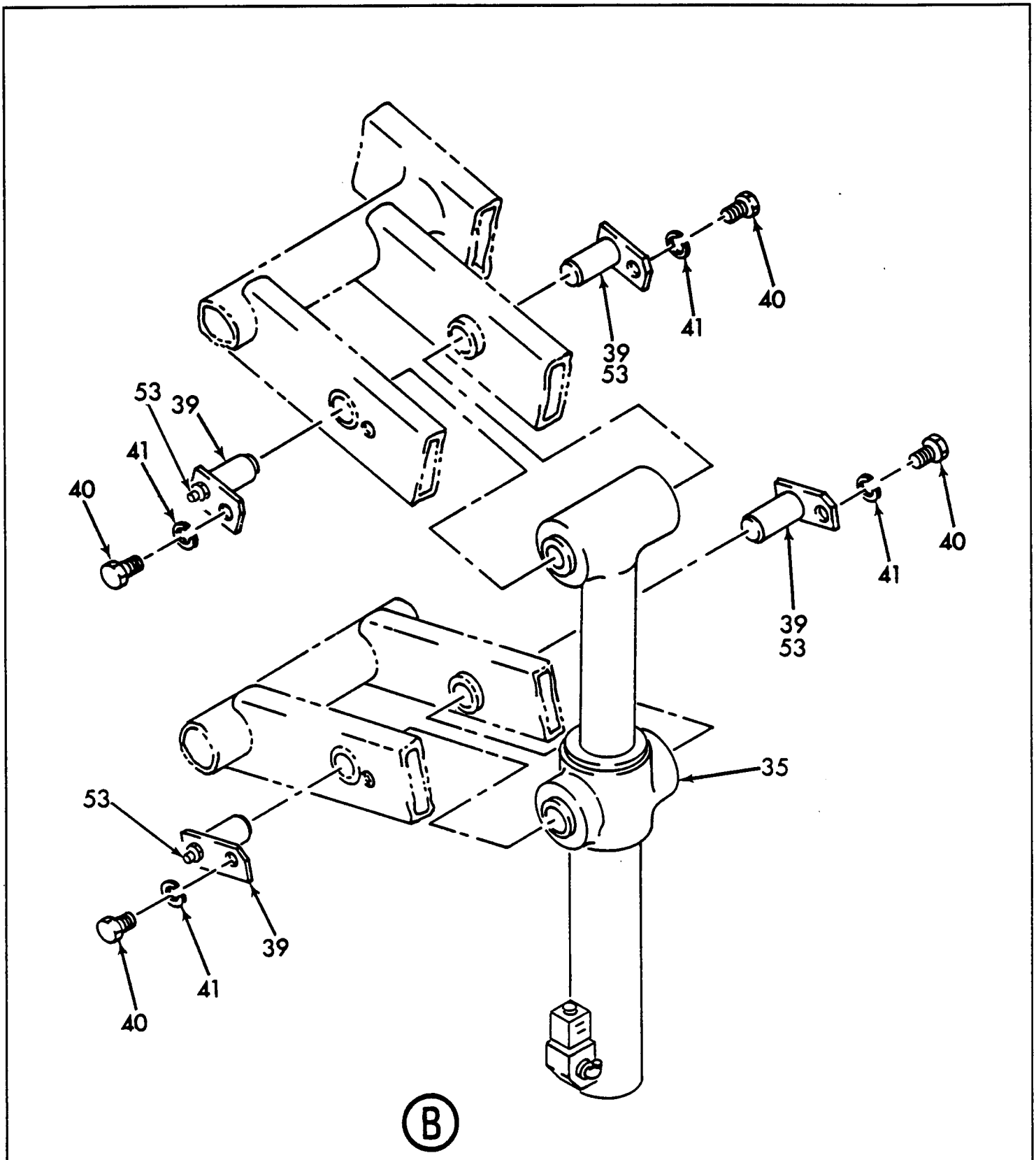
Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	4
FIGURE	2
PAGE	2

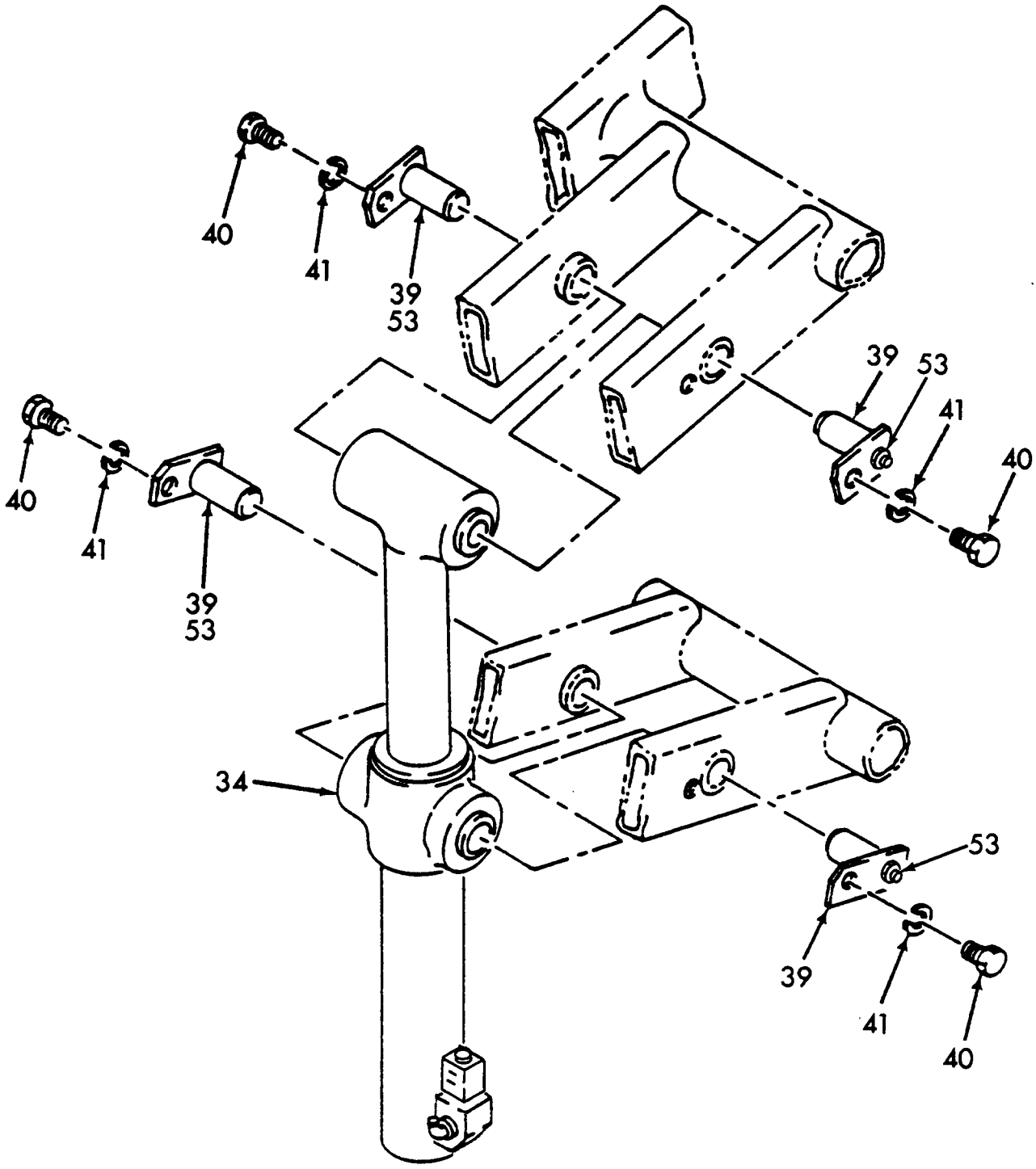


REV.

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	4
FIGURE	2
PAGE	3



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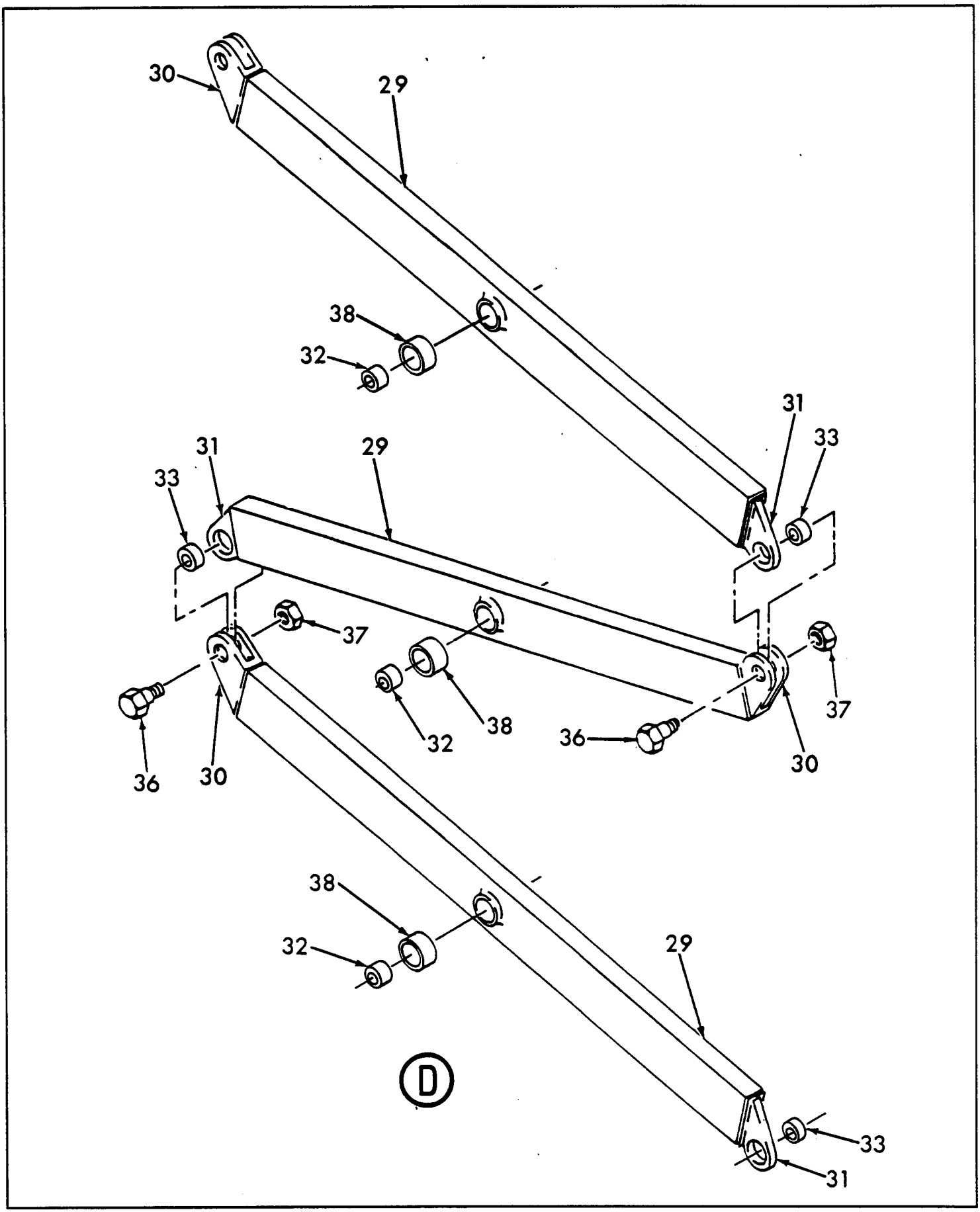
Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	4
FIGURE	2
PAGE	4

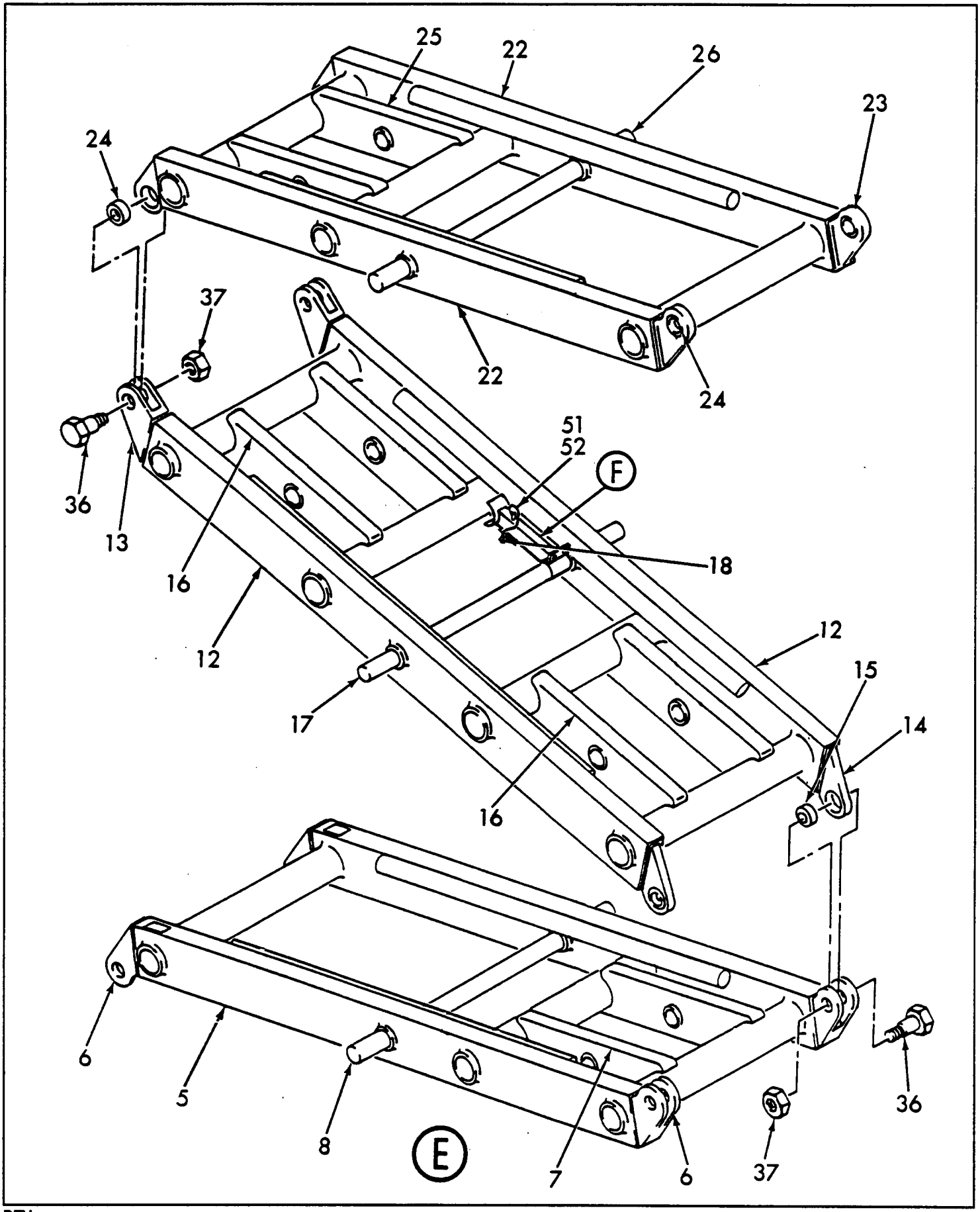


REV.

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	4
FIGURE	2
PAGE	5



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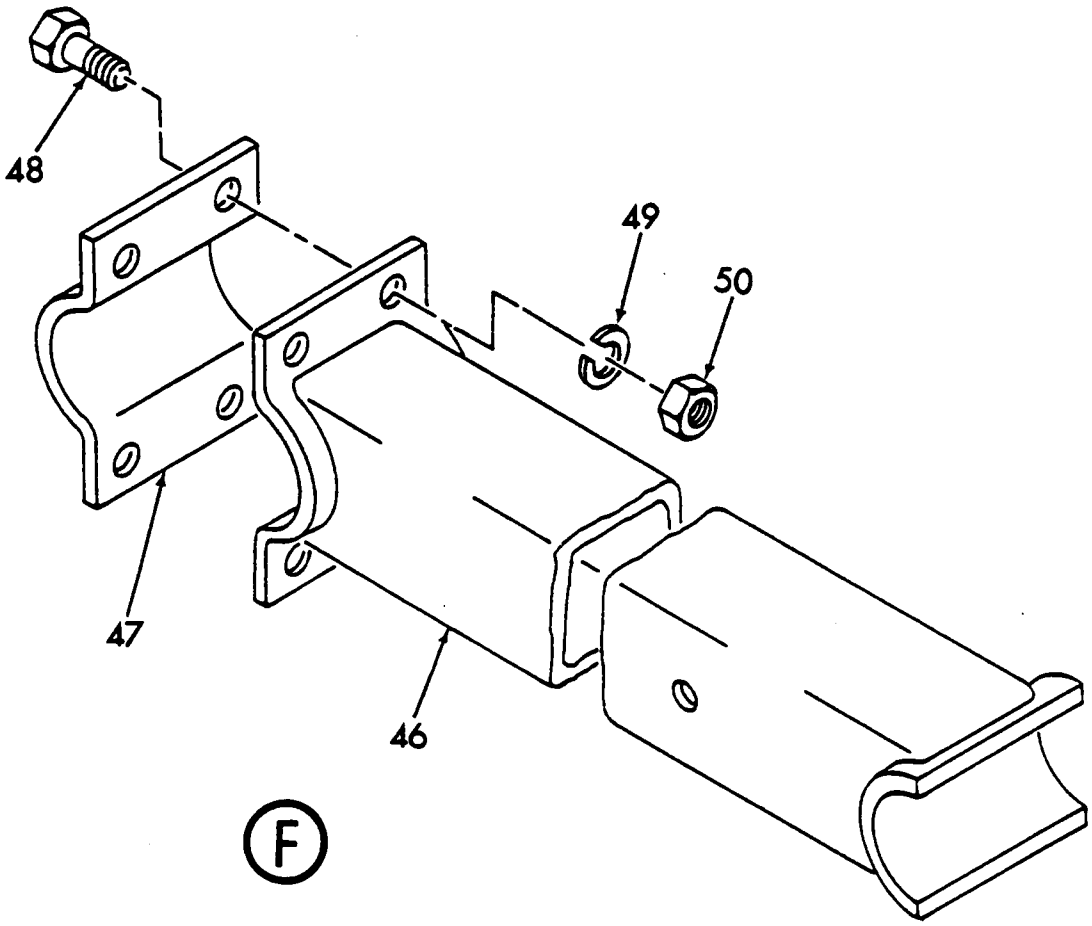


ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130250	ASSEMBLY, SCISSOR (See Sect. 3, Fig. 1 for NHA)	REF
2	.130262	ASSEMBLY, INNER ARM	1
3	..130261	SUB-ASSEMBLY, INNER ARM	2
4	...130260	MACHINING, INNER ARM	2
5	130259	WELDMENT, ARM TUBE	2
6	130251	MACHINING, FEMALE EAR	4
7	..130273	ASSEMBLY, TRUNNION CYLINDER BRACKET	1
8	..130274	SHAFT, CENTER	1
9	.130268	ASSEMBLY, INNER ARM	1
10	..130267	SUB-ASSEMBLY, INNER ARM	2
11	...130266	MACHINING, INNER ARM	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
12	130252	WELDMENT, ARM	2
13	130251	MACHINING, FEMALE EAR	2
14	130208	FORGING, MALE EAR	2
15	...916	BUSHING	2
16	..130273	ASSEMBLY, TRUNNION CYLINDER BRACKET	2
17	..130274	SHAFT, CENTER	1
18	..130515	BRACKET, ARM SUPPORT	1
19	.130272	ASSEMBLY, INNER ARM	1
20	..130271	SUB-ASSEMBLY, INNER ARM	2
21	...130270	MACHINING, INNER ARM	2
22	130255	WELDMENT, ARM TUBE	2
23	130208	FORGING, MALE EAR	4
24	...916	BUSHING	4
25	..130273	ASSEMBLY, TRUNNION CYLINDER BRACKET	1
26	..130274	SHAFT, CENTER	1
27	.130254	ASSEMBLY, OUTER ARM	6
28	..130253	MACHINING, ARM	6
29	...130252	WELDMENT, ARM	6
30	130251	MACHINING, FEMALE EAR	6
31	130208	FORGING, MALE EAR	6
32	..160319	BEARING	6
33	..916	BUSHING	6
34	.130789	ASSEMBLY, LIFT CYLINDER (TELESCOPIC) (See Sect. 4, Fig. 3 for Details)	1
35	.131421	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 4 for Details)	1

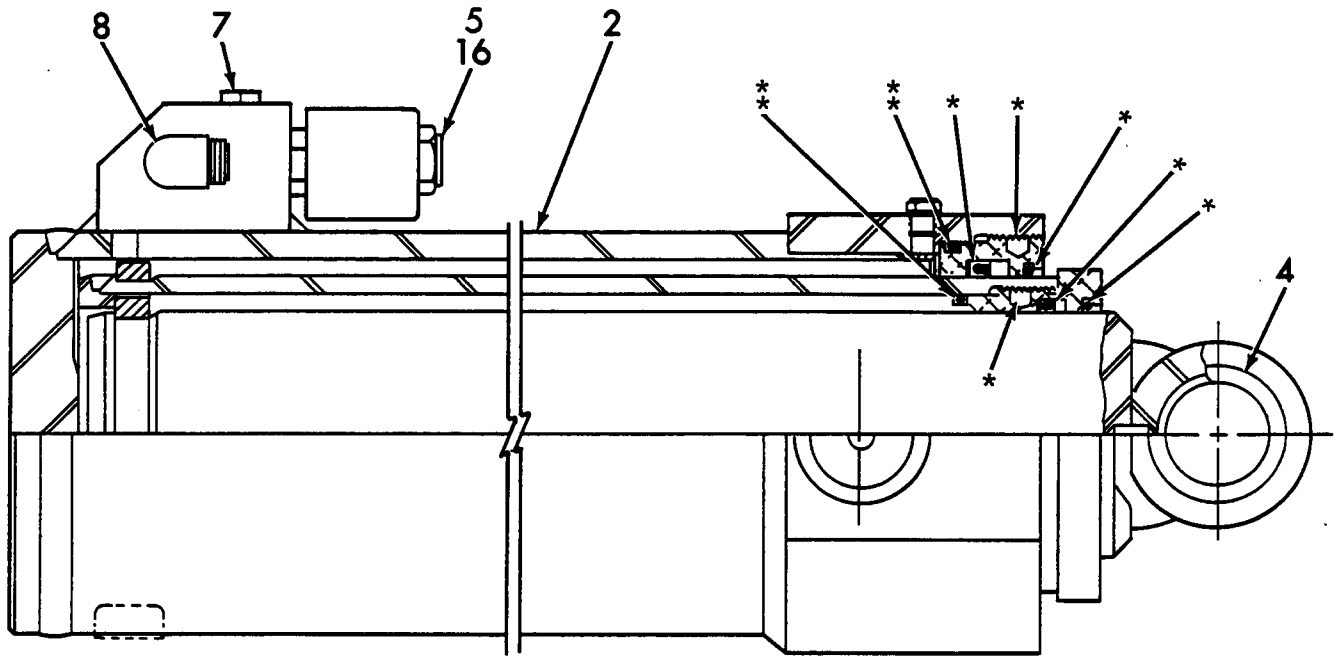
Mark Industries

TITLE	SCISSOR ASSEMBLY	SECT.	4
MODEL	M20EST	FIG.	2
NOTES		PAGE	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
36	.130696	BOLT, EAR PIVOT	8
37	.61249	NUT, LOCK	8
38	.65577	COLLAR, SHAFT	6
39	.131453	PIN, TRUNNION	8
40	.60533	SCREW, CAP	8
41	.63302	WASHER, LOCK	8
42	.130327	PIN, WEAR PAD	4
43	.130326	PAD, SLAB WEAR	8
44	.62201	SCREW, SET	4
45	.130511	ASSEMBLY, INNER ARM SUPPORT	1
46	..130512	WELDMENT, INNER ARM SUPPORT	1
47	..30693	CLAMP, INNER ARM SUPPORT	1
48	..60343	SCREW, CAP	4
49	..63303	WASHER, LOCK	4
50	..60703	NUT, HEX	4
51	.12007	PIN, BALL-LOK DETENT	1
52	.375	RIVET, POP	1
53	.65103	FITTING,GREASE	8

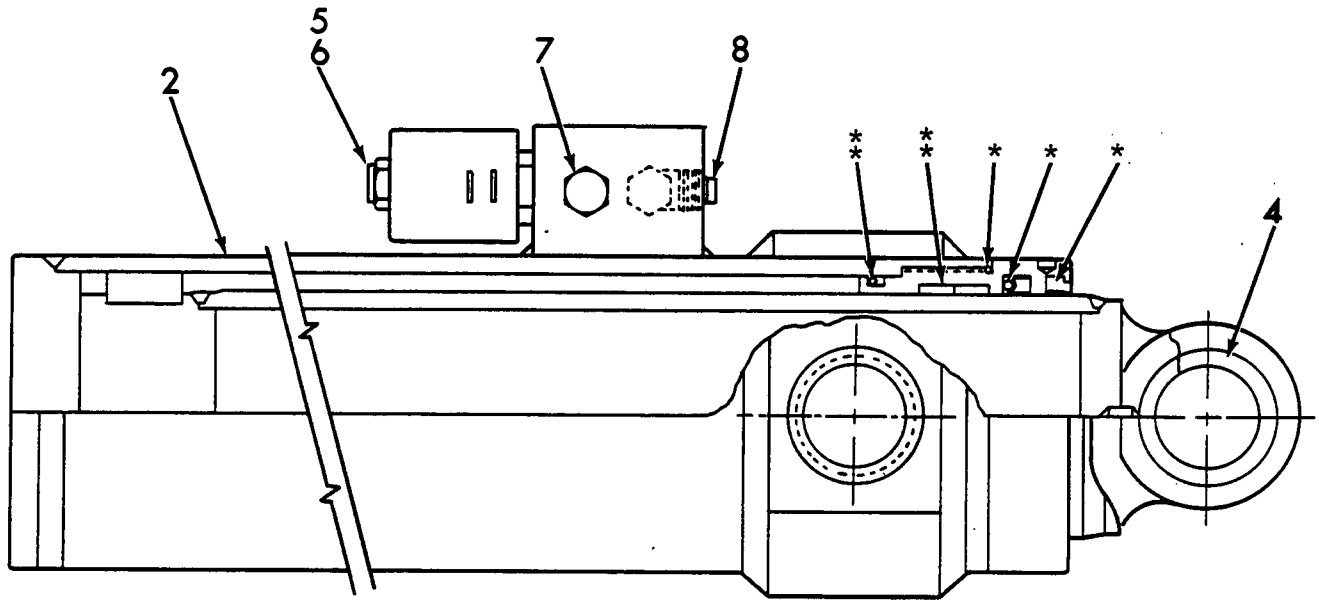
REV.

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



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

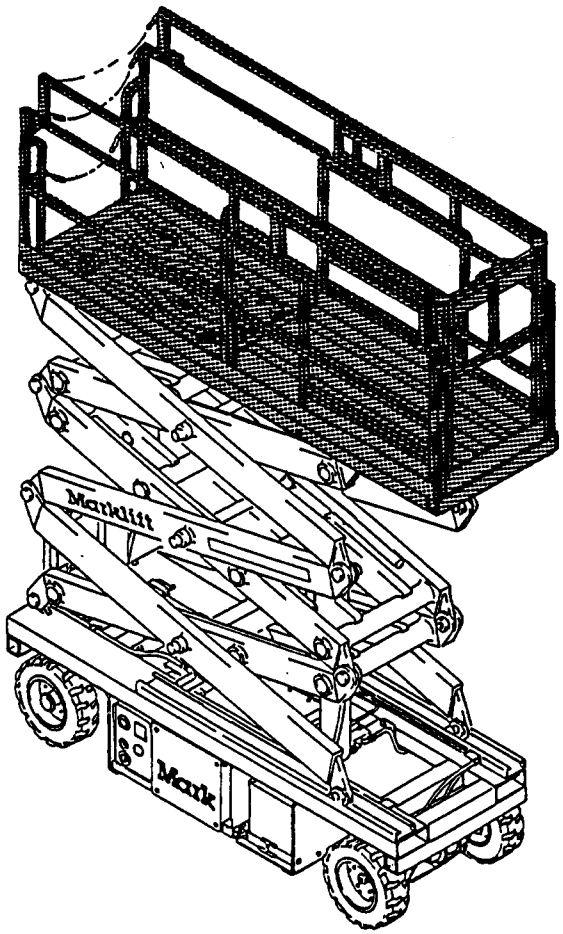
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130789	ASSEMBLY, LIFT CYLINDER (TELESCOPIC) (See Sect. 4, Fig. 1 for NHA)	REF
2	.130788	CYLINDER, LIFT (GB)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..66818	KIT, SEAL	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..66767	BUSHING, ROD	2
5	.81028	SOLENOID, ELECTRIC CHECK	1
6	..66865	COIL, 20 VOLT	1
7	.80050-03	PLUG, HEX HEAD	1
8	.80012-05	ELBOW, STRAIGHT THREAD	1



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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131421	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.131411	CYLINDER, LIFT (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..67676	KIT, SEAL	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..67830	BUSHING	4
5	.81028	SOLENOID, ELECTRIC CHECK	1
6	..66865	COIL, 20 VOLT	1
7	.80050-03	PLUG, HEX HEAD	1
8	.80012-08	ELBOW, STRAIGHT THREAD	1

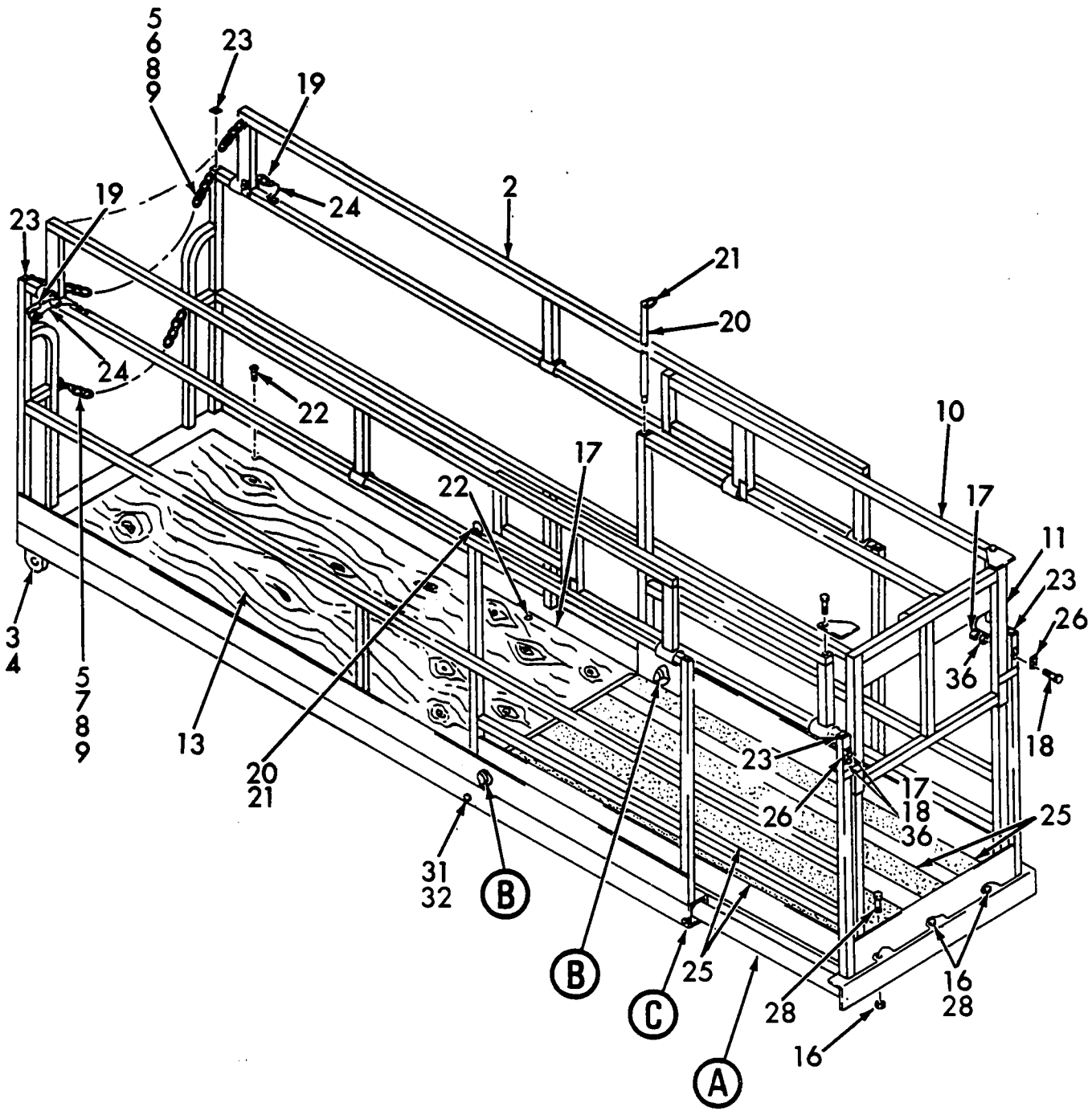
SECTION 5 CONTAINS:



Mark Industries

TITLE	PLATFORM ASSEMBLY - SLIDE-OUT/FOLD DOWN
MODEL	M20ESEP
NOTES	

SECTION	5
FIGURE	1
PAGE	1

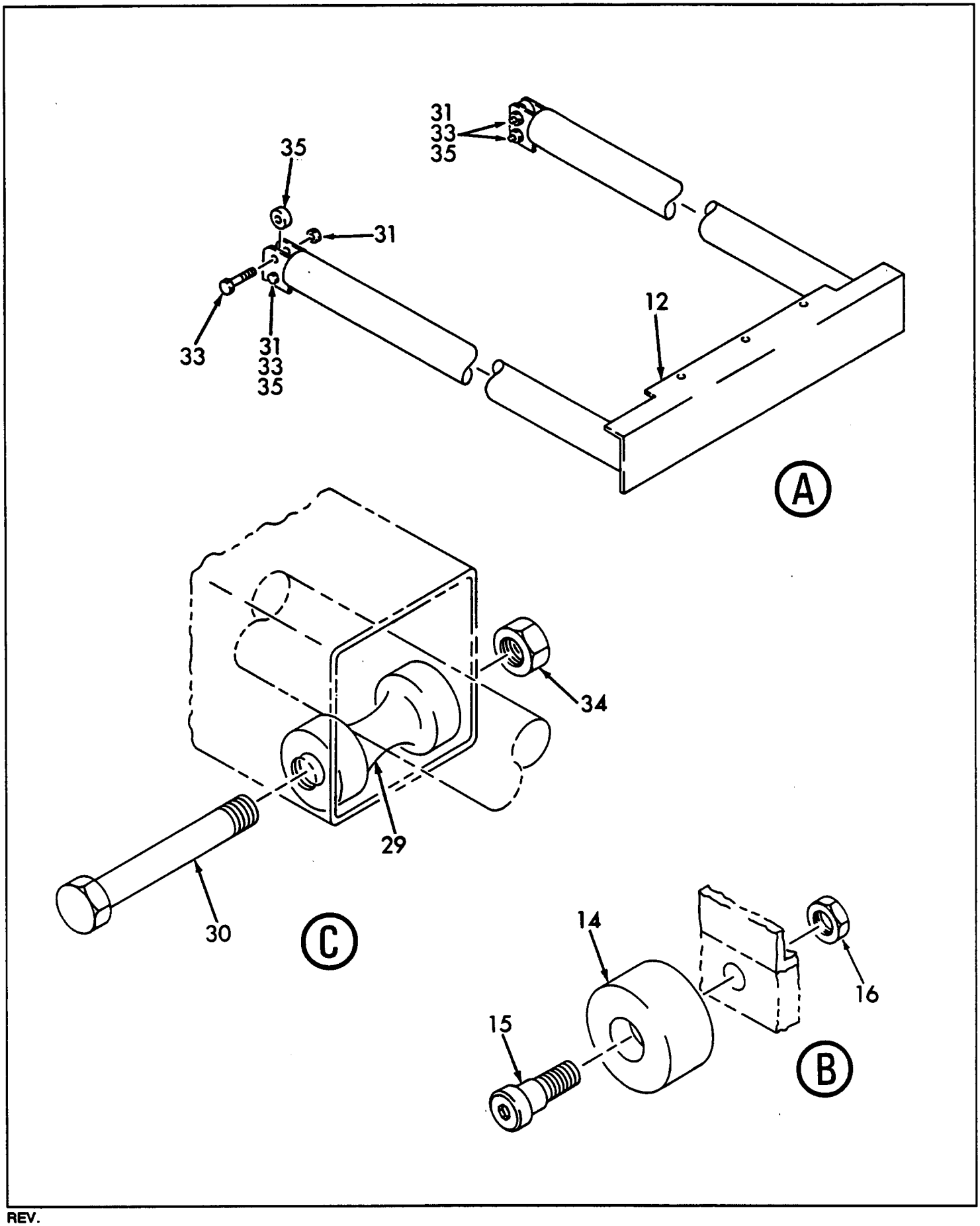


REV.

Mark Industries

TITLE	PLATFORM ASSEMBLY - SLIDE-OUT/FOLD DOWN
MODEL	M20ESEP
NOTES	

SECTION	5
FIGURE	1
PAGE	2



REV.

Mark Industries

TITLE	PLATFORM ASSEMBLY - SLIDE-OUT/FOLD DOWN
MODEL	M20ESEP
NOTES	

SECT.	5
FIG.	1
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131172	ASSEMBLY, PLATFORM - SLIDE-OUT/FOLD DOWN (See Sect. 4, Fig. 1 for NHA)	REF
2	.131170	WELDMENT, PLATFORM	1
3	..130999	EAR, DECK	2
4	...916	BUSHING	2
5	..65636	CHAIN	3
6	..65901	CHAIN	2
7	..160084	CHAIN	1
8	..65990	SNAP, SWIVEL	3
9	..65991	CONNECTOR, CHAIN	3
10	.131173	WELDMENT, PLATFORM - SLIDE-OUT	1
11	.131176	RAIL, GUARD (FRONT)	1
12	.130891	WELDMENT, SLIDE	1
13	.131175	FLOOR, PLYWOOD	1
14	.31161	TRAY, ROLLER BATTERY	2
15	.62101	SCREW, SHOULDER	2
16	.61318	NUT, LOCK	5
17	.60702	NUT, HEX	4
18	.60360	SCREW, CAP	4
19	.65124	PIN, BALL-LOK	2
20	.130825	WELDMENT, LOCK PIN	2
21	.65687	RING, SPLIT	2
22	.61713	SCREW, SELF-TAP	6
23	.91541	CAP, PLUG (1" SQUARE TUBE BLACK)	4
24	.65669	ASSEMBLY, LANYARD	2
25	.131035	SURFACING, ANTI-SLIP	4

REV.

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

Mark Industries

TITLE	PLATFORM ASSEMBLY - SLIDE-OUT/FOLD DOWN
MODEL	M20ESEP
NOTES	

SECT.	5
FIG.	1
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ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.130926	PLATE, LOCK	2
-27	.63651	RIVET, POP	2
28	.60325	SCREW, CAP	3
29	.131023	ROLLER, GUIDE	2
30	.90564	SCREW, CAP	2
31	.61305	NUT, LOCK	8
32	.60388	SCREW, CAP	8
33	.60370	SCREW, CAP	4
34	.60705	NUT, HEX	2
35	.131028	ROLLER, REAR	4
36	.63302	WASHER, LOCK	4

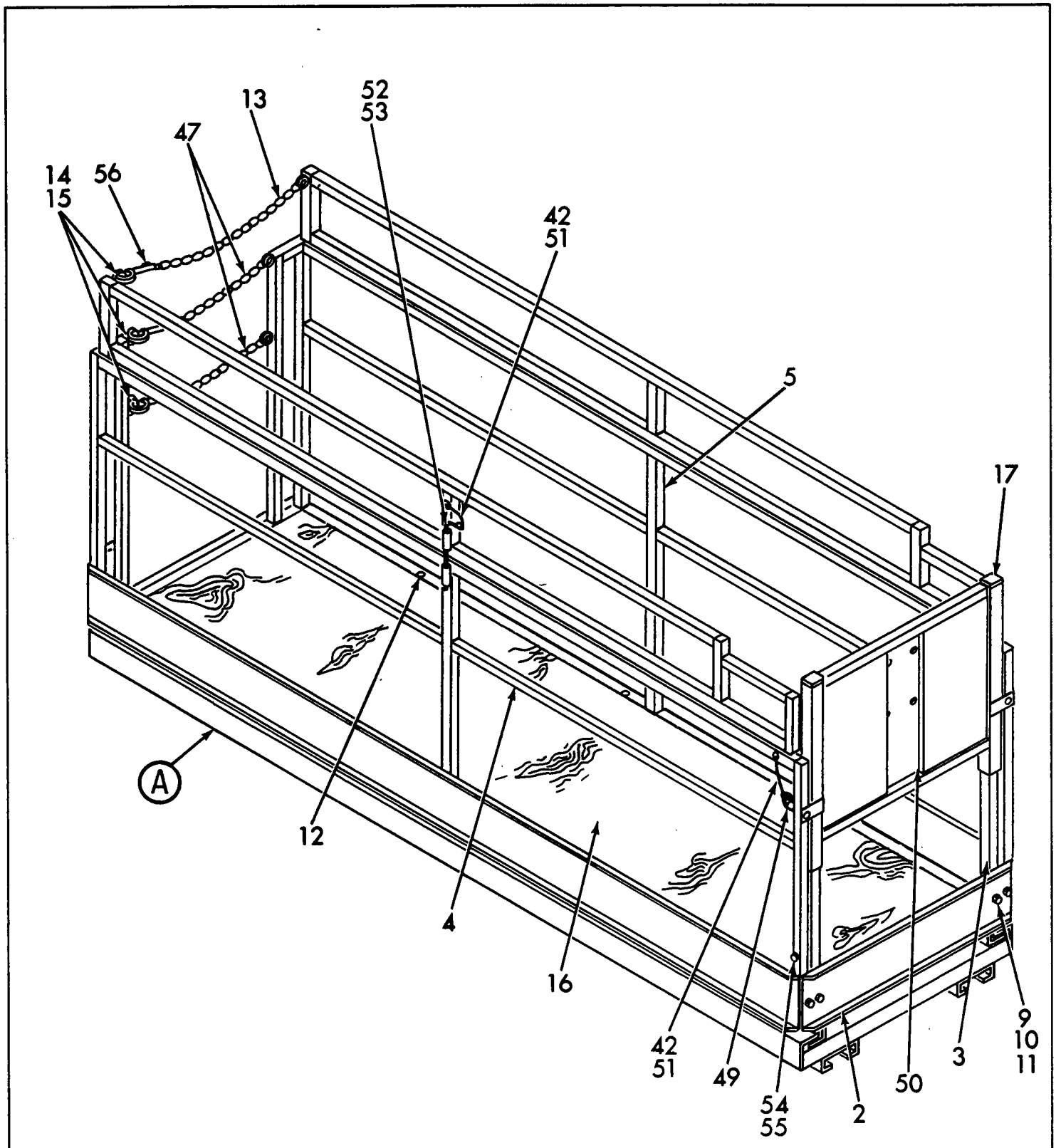
REV.

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

Mark Industries

TITLE	EXTENDABLE DECK ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	5
FIGURE	2
PAGE	1

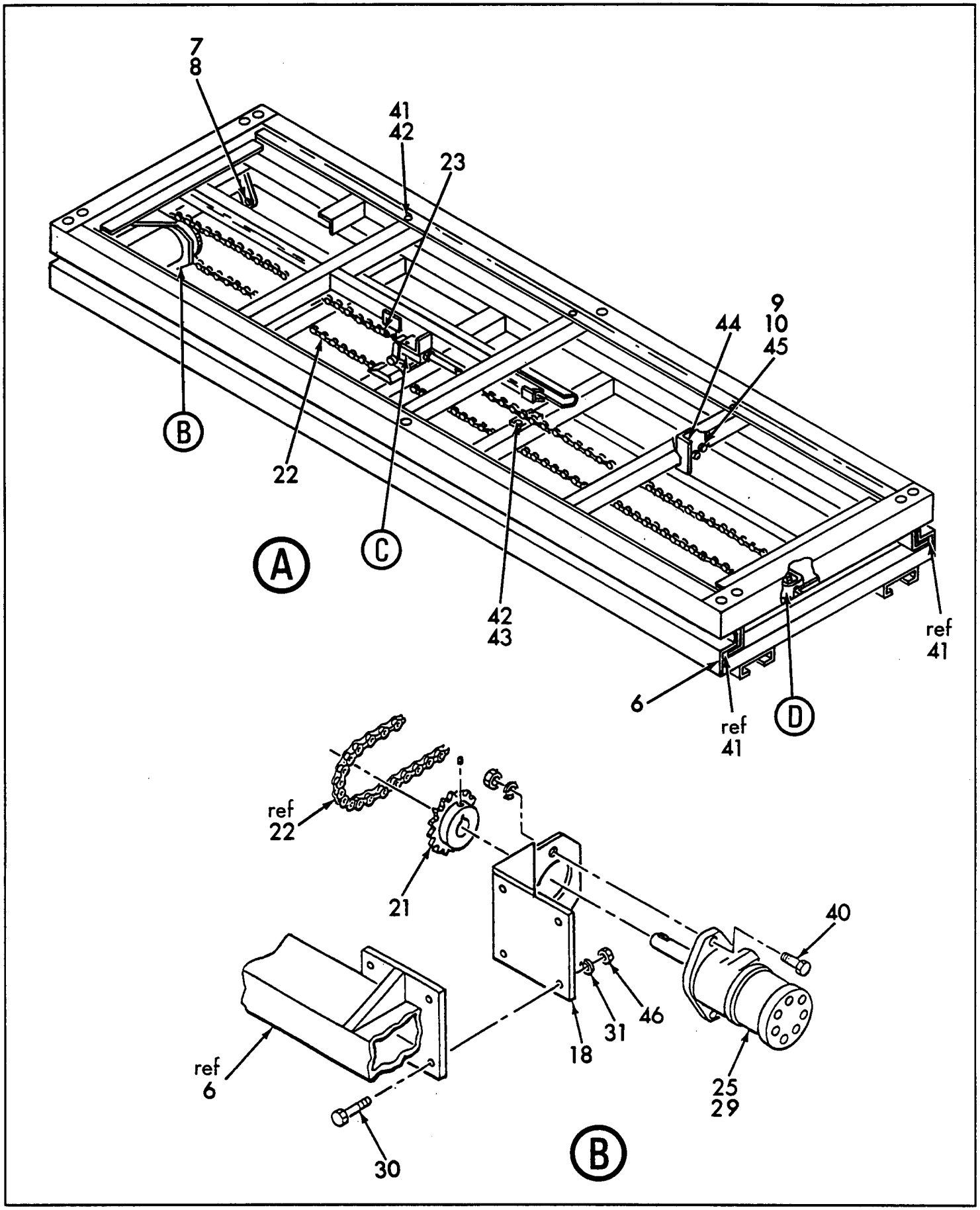


REV.

Mark Industries

TITLE	EXTENDABLE DECK ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	5
FIGURE	2
PAGE	2



REV.

Mark Industries

TITLE	EXTENDABLE DECK ASSEMBLY
MODEL	M20EST
NOTES	

SECTION	5
FIGURE	2
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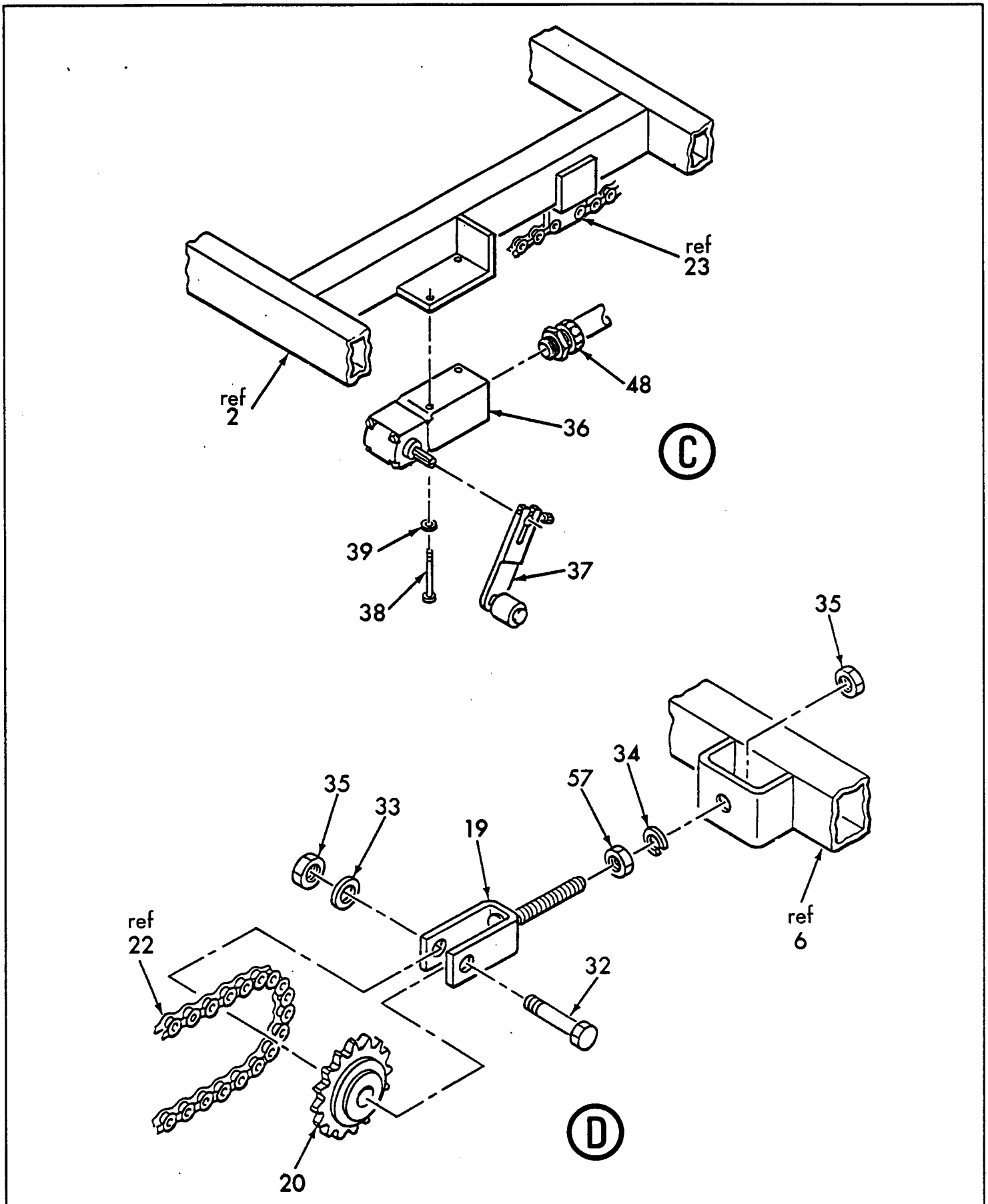

REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	130358	ASSEMBLY, EXTENDABLE DECK (See Sect. 4, Fig. 1 for NHA)	REF
2	.130306	WELDMENT, EXTENDABLE PLATFORM	1
3	.130814	WELDMENT, PLATFORM TOP END RAIL	1
4	.130813	WELDMENT, GUARD RAIL (R.H.)	1
5	.130812	WELDMENT, GUARD RAIL (L.H.)	1
6	.130363	WELDMENT, TOP FRAME	1
7	..130377	EAR, DECK STANDOFF	2
8	...916	BUSHING	2
9	.60337	SCREW, CAP	8
10	.63301	WASHER, LOCK	10
11	.60701	NUT, HEX	8
12	.61713	SCREW, SELF-TAP	10
13	.160001	CHAIN	1
14	.65636	CHAIN	3
15	.65990	SNAP, SWIVEL	3
16	.130397	FLOOR, PLYWOOD	1
17	.91541	CAP, PLUG (1" SQUARE TUBE BLACK)	8
18	.130319	WELDMENT, HYDRAULIC MOTOR BRACKET	1
19	.130320	WELDMENT, CLEVIS	1
20	.65585	SPROCKET, IDLER	1
21	.65578	SPROCKET, STEEL	1
22	.65579	CHAIN, SELF-LUBRICATED	1
23	.65580	MASTER, LINK #50	2
-24	.130341	ASSEMBLY, HYDRAULIC MOTOR	1
25	..81274	MOTOR, HYDRAULIC (See Vendor Chapter for Details)	!

Mark Industries

TITLE	EXTENDABLE DECK ASSEMBLY
MODEL	M20EST
NOTES	

SECT.	5
FIG.	2
PAGE	5

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-26	...67688	KIT, SEAL	1
-27	...67690	LINK, DRIVE	1
-28	...67698	SHAFT, COUPLING	1
29	..80001-05	CONNECTOR, MALE	2
30	.60343	SCREW, CAP	4
31	.63319	WASHER, LOCK	4
32	.60370	SCREW, CAP	1
33	.63415	WASHER, FLAT	2
34	.63305	WASHER, LOCK	1
35	.61242	NUT, LOCK	2
36	.70173	SWITCH, LIMIT	1
37	.70169	LEVER, LIMIT SWITCH	1
38	.62615	SCREW, MACHINE	2
39	.63313	WASHER, LOCK	2
40	.60326	SCREW, CAP	2
41	.31058	PAD, WEAR	2
42	.16217	RIVET, POP	24
43	.130399	PAD, WEAR	4
44	.130371	STOP, EXTENDABLE PLATFORM	2
45	.60318	SCREW, CAP	2
46	.60703	NUT, HEX	4
47	.160000	CHAIN	2
48	.2806	RELIEF, STRAIN	1
49	.65795	PIN, BALL-LOCK	2
50	.130703	WELDMENT, PLATFORM BOTTOM END RAIL	1

Mark Industries

TITLE	EXTENDABLE DECK ASSEMBLY
MODEL	M20EST
NOTES	

SECT.	5
FIG.	2
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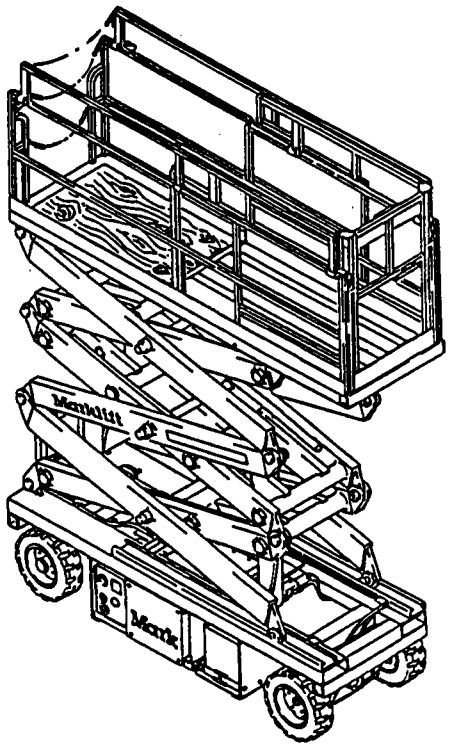
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
51	.65669	ASSEMBLY, LANYARD	4
52	.65687	RING, SPLIT	2
53	.130815	PIN, LOCK	2
54	.60360	SCREW, CAP	2
55	.63302	WASHER, LOCK	2
56	.65991	CONNECTOR, CHAIN	3
57	.60705	NUT, HEX	1

REV.

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

SECTION 6 CONTAINS:

FIG. NO.	TITLE
1	SOLID STATE SLOPE SENSOR (M20ESEP & M20EST)
2	SWING GATE (M20ESEP & M20EST)
3	HOURMETER (M20ESEP & M20EST)
4	DELUXE AUTOMATIC BATTERY CHARGER (M20ESEP & M20EST) (UNTIL EARLY 1990)(115 VAC/60 HZ, 24 VDC/36A)
4A	DELUXE AUTOMATIC BATTERY CHARGER (M20ESEP & M20EST) (SINCE EARLY 1990)(120 VAC/60 HZ, 24 VDC/40A)



Mark Industries

TITLE	SOLID STATE SLOPE SENSOR
MODEL	M20ESEP & M20EST
NOTES	

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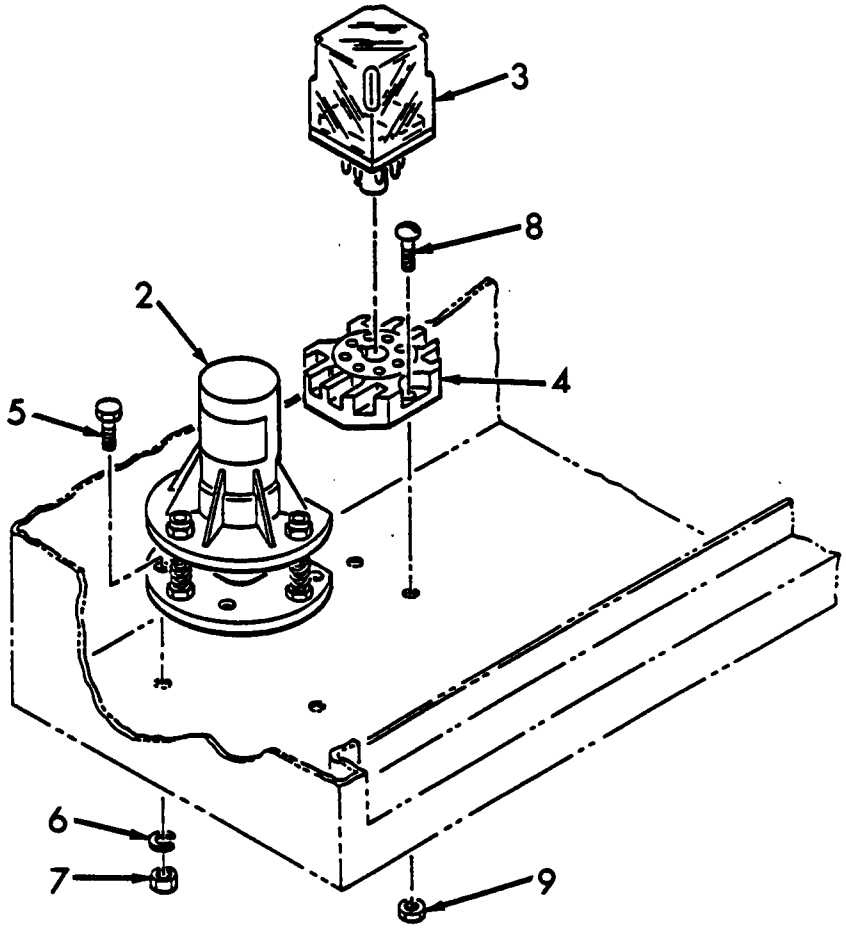
FIGURE	1
PAGE	1



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	132036	SENSOR, SOLID STATE SLOPE	REF
2	.31074	SENSOR, SLOPE	1
3	.70238	RELAY	1
4	.70239	SOCKET, 8 PIN	1
5	.60309	SCREW, CAP	2
6	.63301	WASHER, LOCK	2
7	.60701	NUT, HEX	2
8	.62623	SCREW, CAP	2
9	.61532	NUT, HEX	2

REV.

Mark Industries

TITLE	SWING GATE
MODEL	M20ESEP & M20EST
NOTES	

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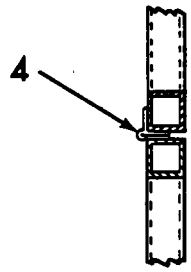
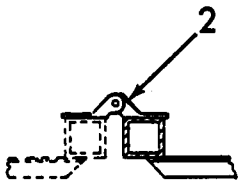
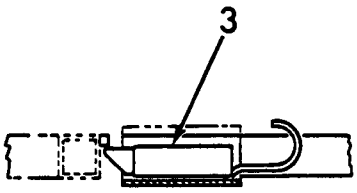
FIGURE	2
PAGE	1



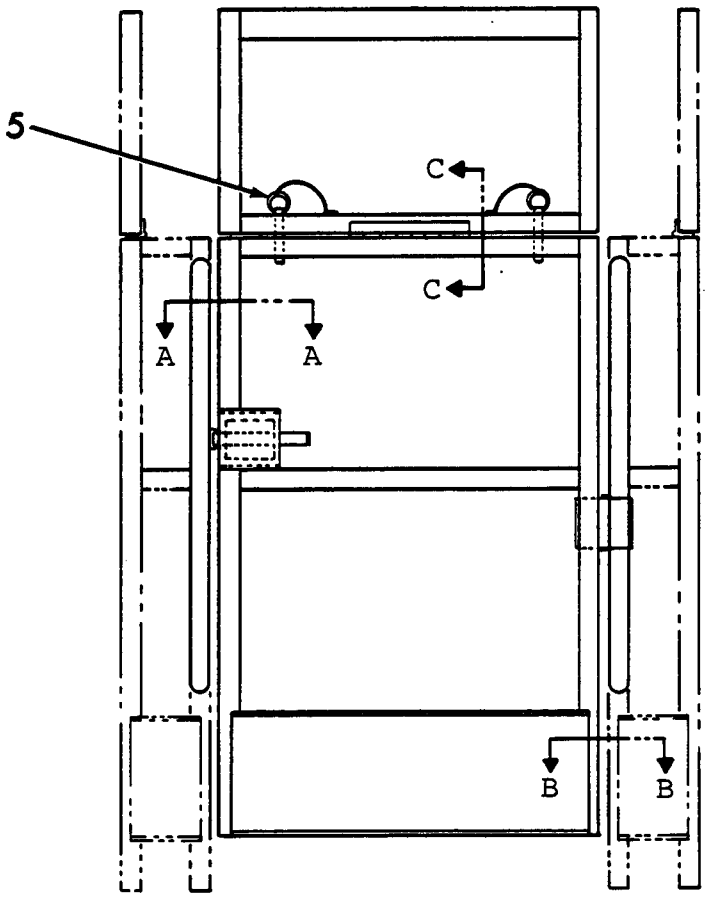
SECTION C

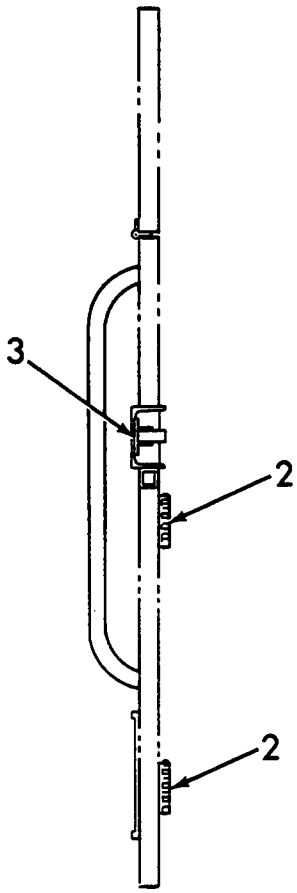


SECTION B



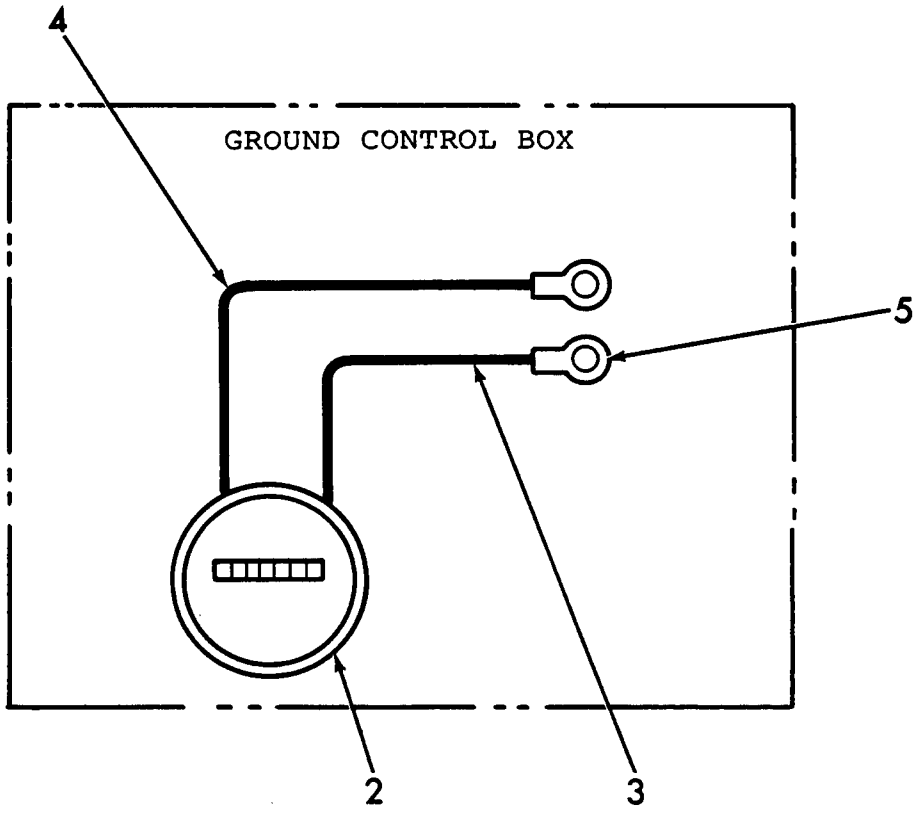
SECTION A





ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131929	GATE, SWING (FOLD DOWN)	REF
2	.12005	HINGE, SPRING	2
3	.16231	BOLT, LATCH	1
4	.12008	HINGE, CONTINUOUS	1
5	.30701	PIN, BALL-LOK (QUICK RELEASE)	2

REV.



NOTE:

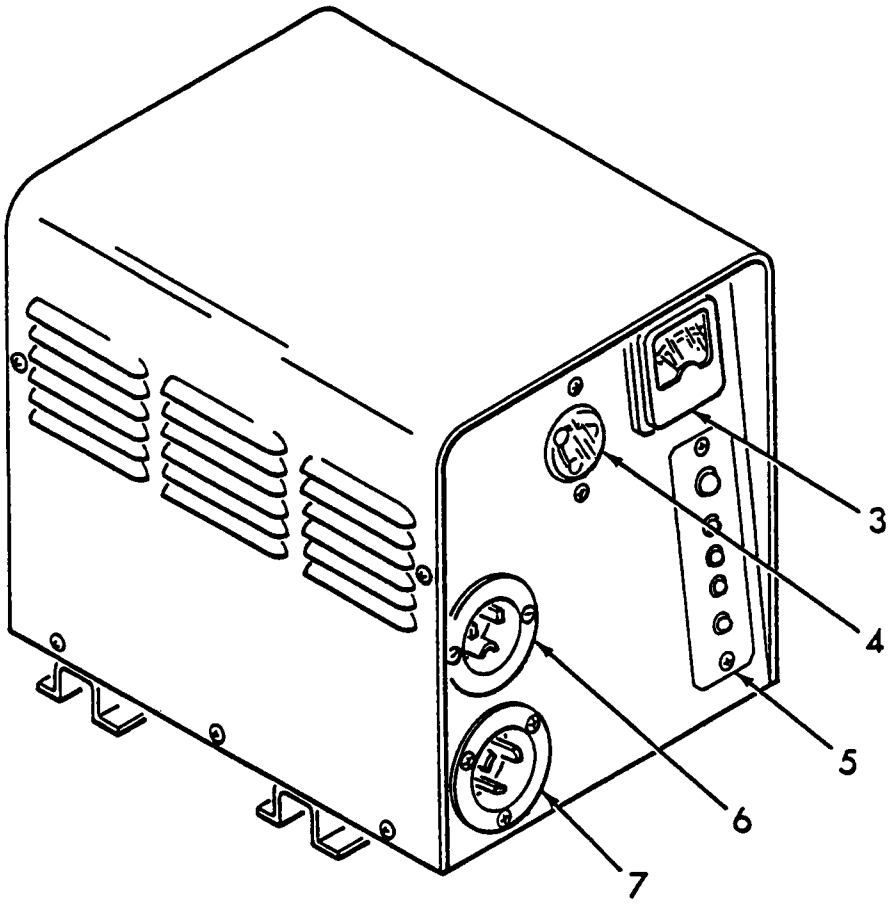
REFER TO RESPECTIVE ELECTRICAL SCHEMATIC FOR WIRING INSTALLATION

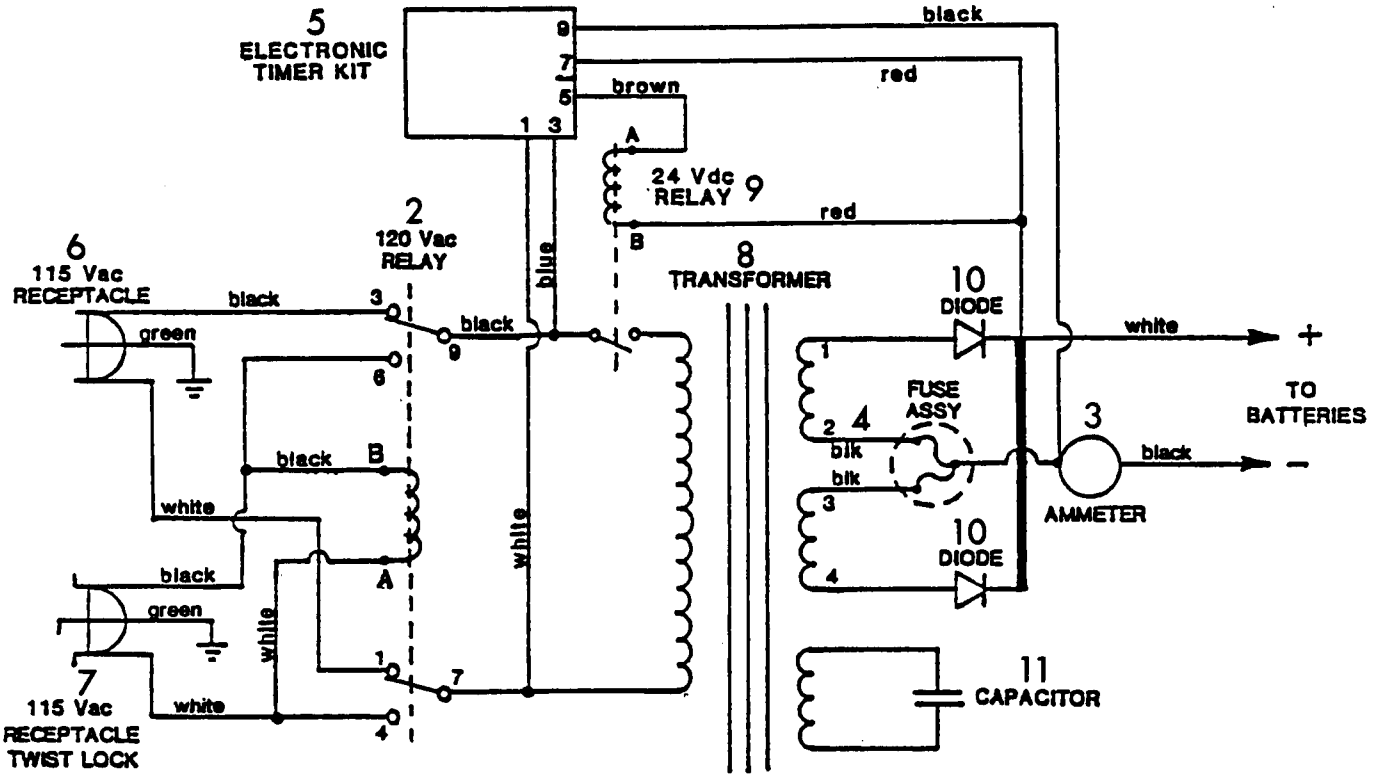
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	131065	ASSEMBLY, HOURMETER	REF
2	.20571	HOURMETER	1
3	.70232	WIRE, WHITE (16 AWG)	1.5 FT
4	.70008	WIRE, YELLOW WITH GREEN (16 AWG)	1.5 FT
5	.117-C	RING, CONNECTOR	2

Mark Industries

TITLE	DELUXE AUTOMATIC BATTERY CHARGER
MODEL	M20ESEP & M20EST
NOTES	UNTIL EARLY 1990, 115 VAC/60 HZ, 24 VDC/36A

SECT.	6
FIG.	4
PAGE	1





REV.

Mark Industries

TITLE	DELUXE AUTOMATIC BATTERY CHARGER
MODEL	M20ESEP & M20EST
NOTES	UNTIL EARLY 1990, 115 VAC/60 HZ, 24 VDC/36A

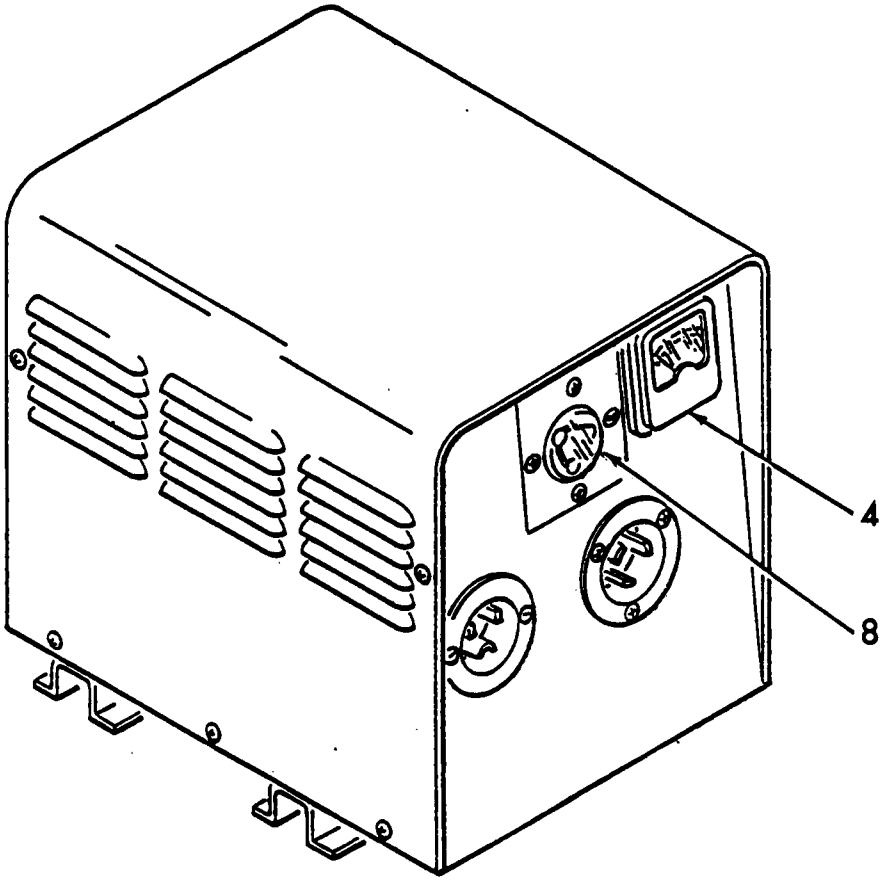
SECT.	6
FIG.	4
PAGE	2

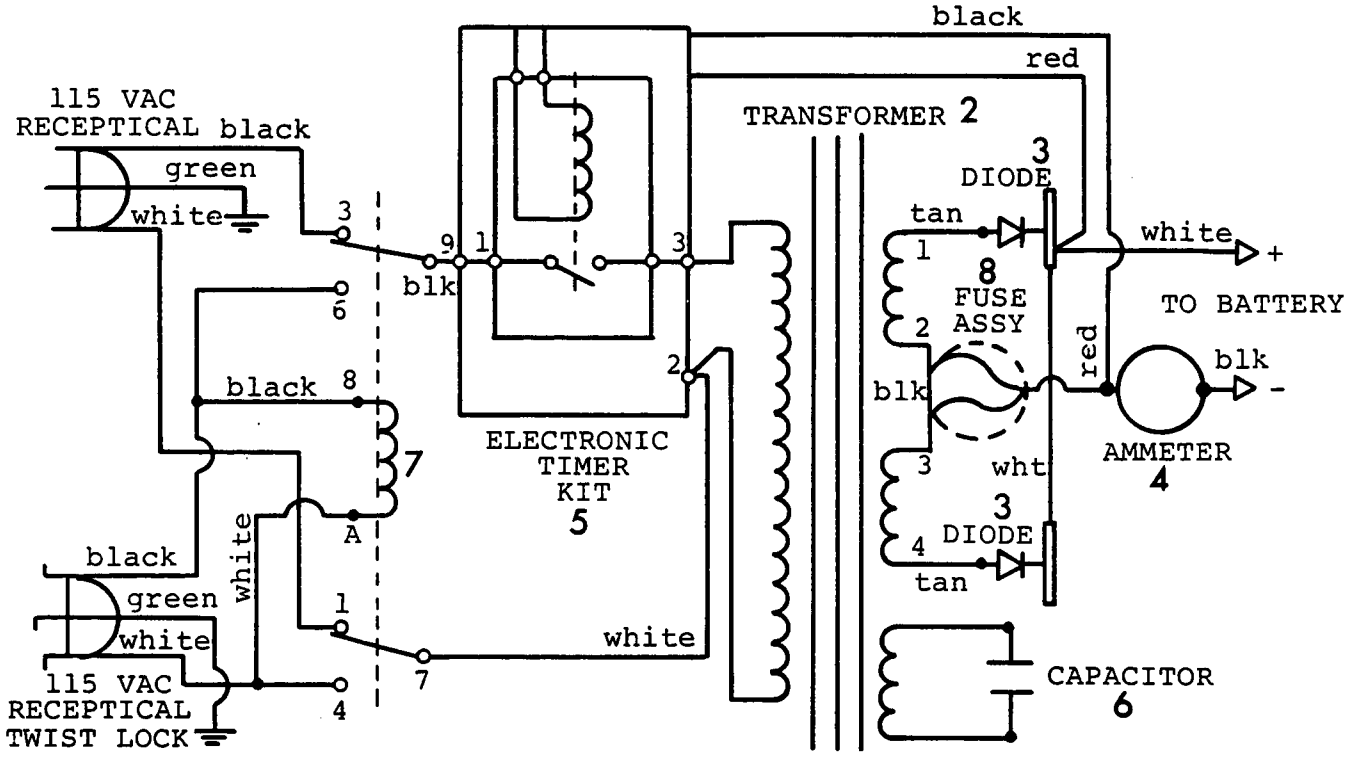
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70228	CHARGER, BATTERY (DOMESTIC)	REF
2	.66728	RELAY (120 VAC)	1
3	.66747	AMMETER	1
4	.66727	ASSEMBLY, FUSE	1
5	.66725	KIT, ELECTRONIC TIMER	1
6	.66734	RECEPTACLE, STRAIGHT BLADE	1
7	.66736	RECEPTACLE, TWIST LOCK	1
8	.67978	ASSEMBLY, TRANSFORMER	1
9	.66729	RELAY (24 VDC)	1
10	.66731	ASSEMBLY, DIODE	2
11	.66750	CAPACITOR (6 MFD, 660 VAC)	1

Mark Industries

TITLE	DELUXE AUTOMATIC BATTERY CHARGER
MODEL	M20ESEP & M20EST
NOTES	SINCE EARLY 1990, 120 VAC/60 HZ, 24 VDC/40A

SECT.	6
FIG.	4A
PAGE	1





REV.

Mark Industries

TITLE	DELUXE AUTOMATIC BATTERY CHARGER
MODEL	M20ESEP & M20EST
NOTES	SINCE EARLY 1990, 120 VAC/60 HZ, 24 VDC/40A

SECT.	6
FIG.	4A
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70522	CHARGER, BATTERY (DOMESTIC) (See Vendor Chapter for Details)	REF
-2	.600261	ASSEMBLY, TRANSFORMER	1
-3	.600259	ASSEMBLY, HEAT SINK (WITH DIODES)	1
4	.66747	AMMETER	1
5	.600264	ASSEMBLY, ELECTRONIC TIMER	1
-6	.66750	CAPACITOR (6.0 MFD, 660 VAC)	1
-7	.66728	RELAY (120 VAC, DPDT, 15 AMP)	1
8	.600258	ASSEMBLY, FUSE (WITH PANEL)	1

REV.

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

Mark Industries

TITLE	VENDOR CHAPTER
MODEL	M20ESEP & M20EST

VENDOR CHAPTER CONTAINS:

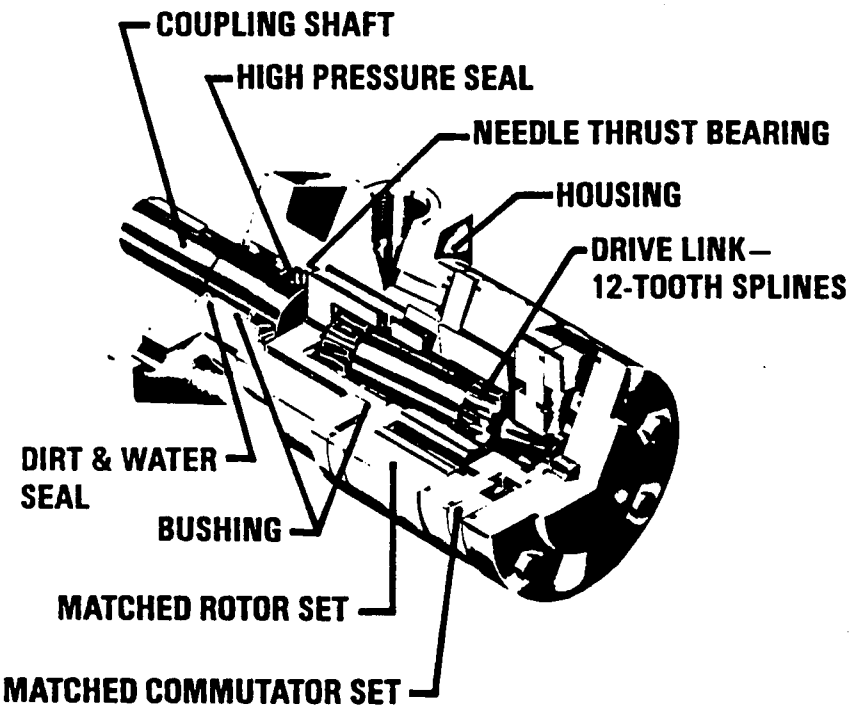
SECTION	TITLE	PART NO.
1	HYDRAULIC MOTOR (M20EST)	81274
2	HYDRAULIC MOTOR (M20ESEP & M20EST)	81017
3	MULTIPLE DISC BRAKE (M20ESEP & M20EST)	81290
4	BATTERY (M20ESEP & M20EST)	4007
5	BATTERY CHARGER (M20ESEP & M20EST)	70478 70520
6	BATTERY CHARGER (M20ESEP & M20EST)	70525 70522
7	BATTERY CHARGER (M20ESEP & M20EST)	70435
8	BATTERY CHARGER (M20ESEP & M20EST)	70228

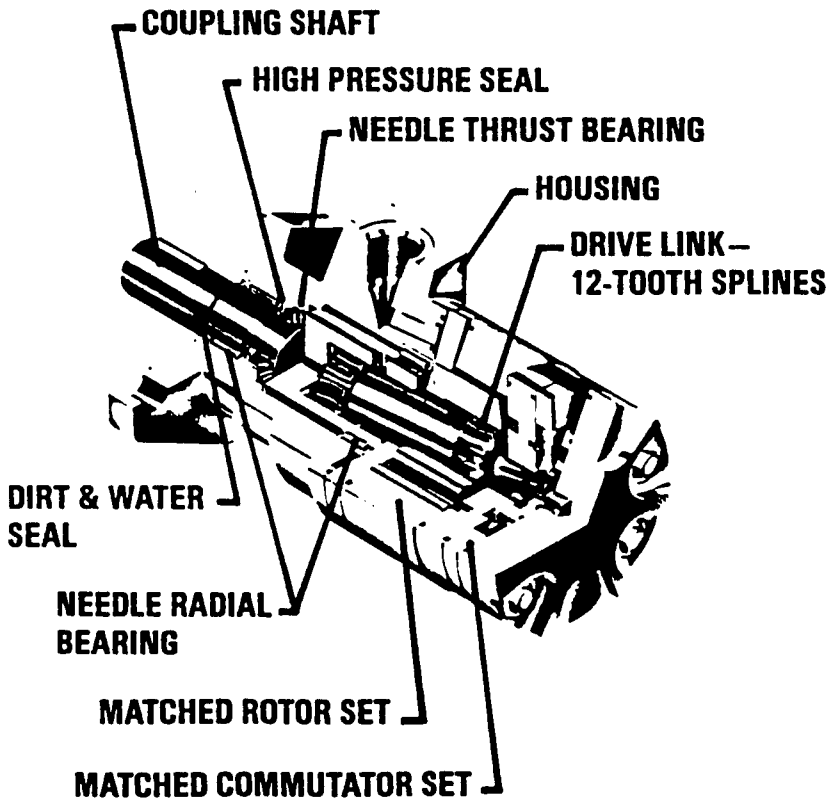
Torqmotor™

Service Procedure

MG, MF, MB, ME Series

Torqmotor™ Design Features





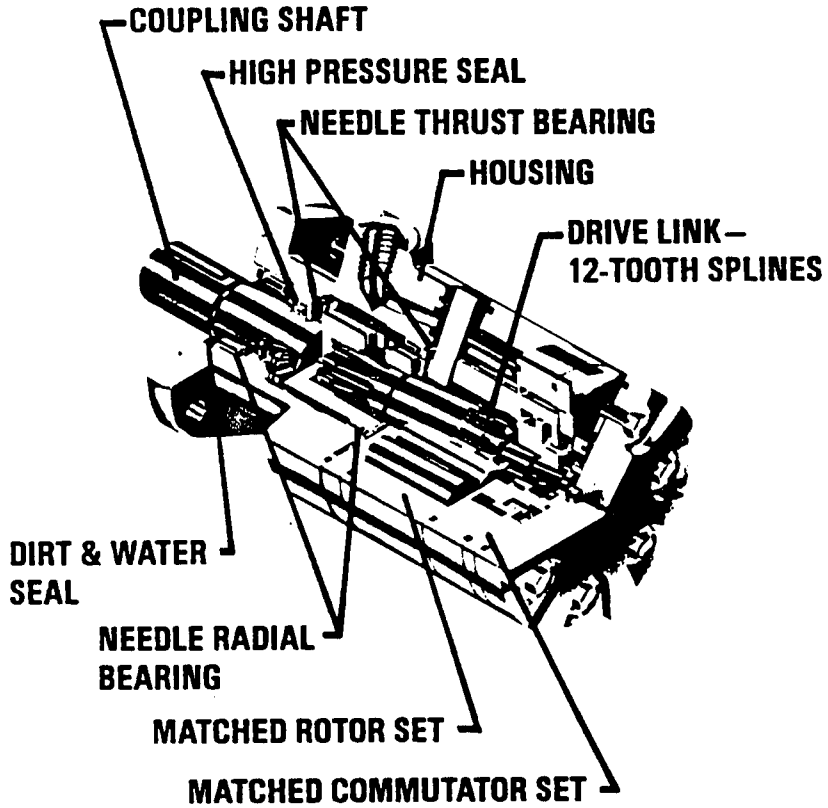
Torqmotor™ MG Series features include:

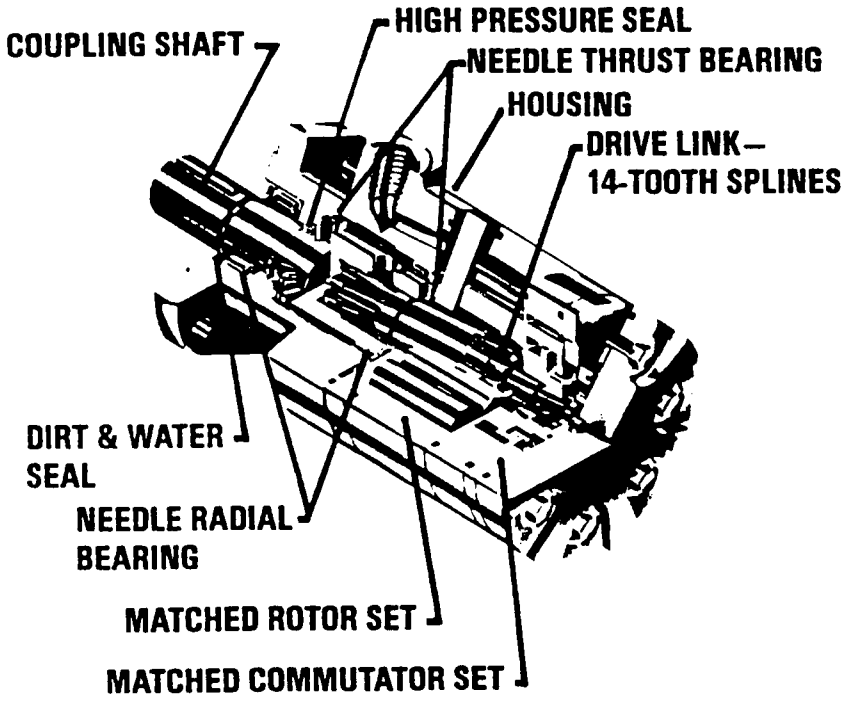
- The roller vane rotor set design offers a low-friction, wear compensation which maximizes the useful performance life of the motor.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.
- Design flexibility - MG offers the widest selection of shaft options, displacements and mounting flanges in the industry.
- Patented 60-40 spline member arrangement transmits more torque with less weight.
- Full flow lubrication maximizes cooling and may provide up to 50% longer life than motors not having this feature.
- Higher pressure ratings provide greater torque than competitive brands.
- Full interchangeability with other motors which are designed according to industry standards.
- Compatible with most hydraulic systems with regard to pressure, torque and speed.
- A unique high-pressure shaft seal that eliminates the need for case drains.
- Up to 13 horse power output.

Torqmotor™ MF Series features include:

- Roller vanes to reduce friction and internal leakage and to maintain efficiency.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.
- Wheel mount version available.
- More starting torque than competitive motors in applications where the shaft is side loaded. (Competitive brands require more pressure to start the motor.)
- A needle roller mounted coupling shaft and steel caged thrust bearing which can withstand 1000 pound thrust loads.
- Side load capacity is 1600 lbs (727.3 kg) maximum at center of output shaft.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- Up to 17 horsepower output.
- Greater durability due to superior lubrication and minimum drive spline wear.
- Patented 60-40 spline member arrangement transmits more torque with less weight.

Torqmotor™ Design Features





Torqmotor™ MB Series features include:

- Heavy-duty thrust and roller bearings for up to twice side-load capacity to the previous motor.
- Roller vanes to reduce friction and internal leakage, and to maintain efficiency.
- A patented orbiting commutation system for less wear and longer life.
- A patented 60:40 arrangement of internal and external spline members to transmit more torque with less weight.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- A unique manifold designed to improve operating efficiency.
- Up to 1000 lbs (453.6 kg) end-thrust capacity in either direction.
- A design that is less sensitive to contamination than competitive motors.
- Up to 36 horsepower output.
- Greater durability because of superior lubrication and minimum drive spline wear.
- Superior low speed performance.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.

Torqmotor™ ME Series features include:

- Roller vanes to reduce friction and internal leakage and to maintain efficiency.
- A patented orbiting commutation system for less wear and longer life.
- A patented 60:40 arrangement of internal and external spline members to transmit more torque with less weight.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- A manifold designed to improve operating efficiency.
- Heavy-duty thrust and roller bearings for up to twice the side-load capacity to the previous motor.
- Up to 1000 lbs (453.6 kg) end-thrust capacity in either direction.
- A design that is less sensitive to contamination than competitive motors.
- Up to 49 horsepower output.
- Greater durability because of superior lubrication and minimum drive spline wear.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.

Definitions

NOTE: **A NOTE provides key information to make a procedure easier or quicker to complete.**

CAUTION: **A CAUTION refers to procedure that must be followed to avoid damaging the Torqmotor™ or other system components.**

WARNING: **A WARNING REFERS TO PROCEDURES THAT MUST BE FOLLOWED FOR THE SAFETY OF THE EQUIPMENT OPERATOR AND THE PERSON INSPECTING OR REPAIRING THE TORQMOTOR™**

Disclaimer

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

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

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

Patents

Ross Gear Division products and systems described in this manual are protected by one or more of the following United States patents: 3,606,601. In addition, foreign patents have been issued in Canada, the United Kingdom, and West Germany.

Table of Contents

Introduction

Service Manual for Series MG, MF, MB, ME

This service manual has one purpose: to guide you in maintaining, troubleshooting, and servicing the MG, MF, MB & ME Torqmotor (low-speed, high-torque hydraulic motor).

Material in this manual is organized so you can work on the Torqmotor and get results without wasting time or being confused. To get these results, you should read this entire manual before you begin any work on the Torqmotor.

This manual also contains troubleshooting information and checklist. If you must service the Torqmotor, the checklist will help you to determine where the problem may be.

The three-column format of the Disassembly and Inspection, and Assembly sections will make it easier for you to conduct major work on the Torqmotor. Column 1 gives a brief key for each procedure. Column 2 explains in detail the procedure you should follow. Column 3 illustrates this procedure with photographs. Read all material carefully and pay special attention to the notes, cautions, and warnings.

A foldout page with the same Torqmotor exploded assembly view on both sides is provided in this manual. The component part names and item numbers assigned on this exploded assembly view correspond with names and item numbers (in parentheses) used in the disassembly and assembly procedures set forth in this manual. When this exploded assembly view page is folded out, you can easily identify components and locate their relative position on the exploded assembly view as you follow the disassembly and assembly procedures.

Service part list charts are also provided in this manual with the part names and exploded view item numbers cross referenced to Ross Gear service part numbers.

Service parts are available through the Original Equipment Manufacturer or Ross approved MG, MF, MB & ME Distributors.

As you gain experience in servicing the Torqmotor, you may find that some information in this manual could be clearer or more complete. If so, let us know about it. Do not try to second guess the manual. If you are stuck, contact us. Servicing the Torqmotor should be a safe and productive procedure, in order for the unit to deliver the reliable, long-life operation engineered into it.

Troubleshooting Guide

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

Preparation

Make your troubleshooting easier by preparing as follows:

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

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

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

Preliminary Checks

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

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

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

Hydraulic Components

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

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

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

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

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

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

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

Troubleshooting Checklist

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

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

Tools and Materials Required for Servicing

MG, MF, MB, ME Series Service Manual

Clean, petroleum-based solvent

Emery paper

Vise with soft jaws

Air pressure source

Arbor press

Screw driver

Masking tape

Breaker bar

Torque wrench—ft. lbs. (N m)

Sockets: 1/2 or 9/16 inch thin wall, 1 inch

Allen Sockets: 3/16, 3/8 inch

Adjustable crescent wrench or hose fitting wrenches

SAE 10W40 SE or SF oil

Special bearing mandrel for MG & MF Torqmotors (SEE FIGURE 1)

Special bearing mandrel for MB & ME Torqmotors (SEE FIGURE 2)

Feeler gage .005 inch (.13 mm)

MG & MF Torqmotors require blind hole bearing puller for 1.06 inch (26.9 mm) and 1.62 inch (41.1 mm) diameter bearing/bushing.

MB & ME Torqmotors require blind hole bearing puller for 1.40 inch dia. (35.6 mm) and 2.130 inch dia. (54.1 mm) bearing.

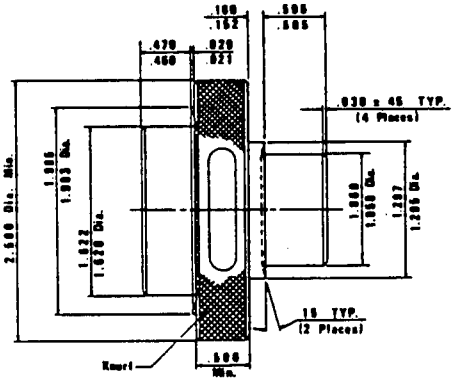
Clean corrosion resistant grease. Recommended grease is E/M Lubricant #K-70M, Ross Gear Specification #045236

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

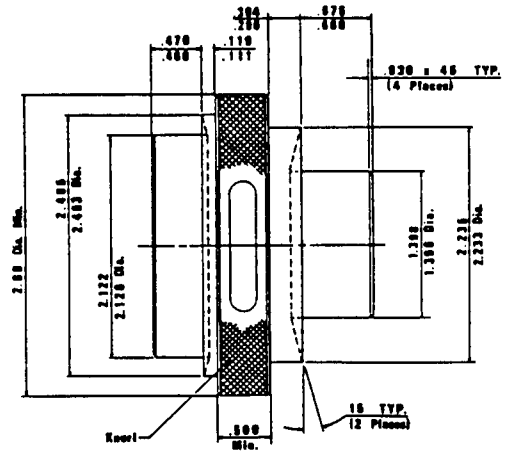
CAUTION: Mixing greases that have different bases can be detrimental to bearing life.

CONVERSIONS

INCHES	mm	INCHES	mm
.020	.51	1.060	26.92
.021	.53	1.295	32.89
.029	.74	1.297	32.94
.030	.76	1.396	35.46
.111	2.81	1.398	35.51
.119	3.02	1.620	41.15
.152	3.86	1.622	41.20
.160	4.06	1.983	50.37
.296	7.52	1.985	50.42
.304	7.72	2.120	53.85
.460	11.68	2.122	53.90
.470	11.94	2.233	56.72
.500	12.70	2.235	56.77
.585	14.86	2.483	63.07
.595	15.11	2.485	63.12
.660	16.76	2.500	63.5
.675	17.15	2.88	73.2
1.058	26.87		



(Fabricate if considered necessary)
FIGURE 1—MG & MF

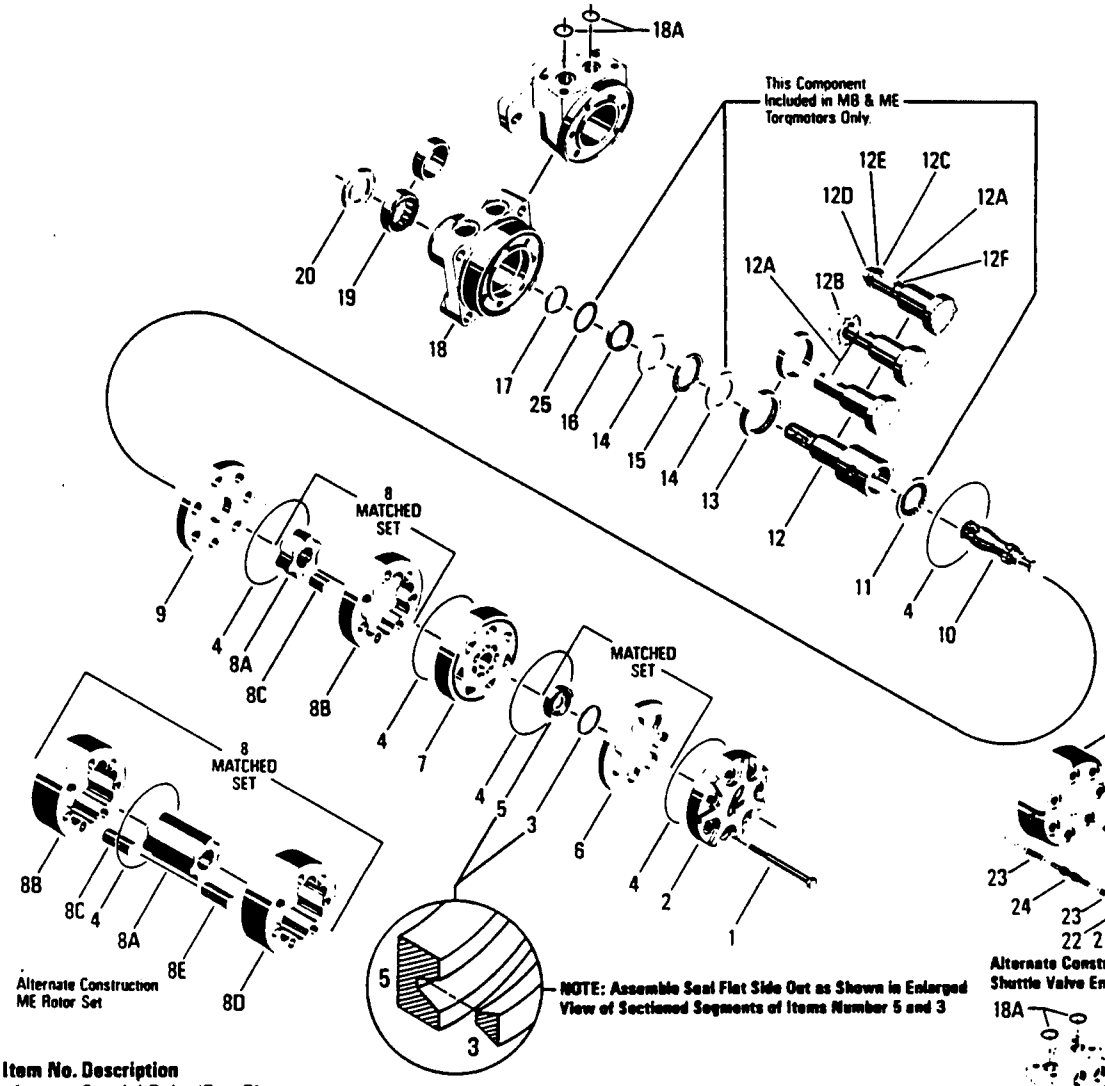


(Fabricate if considered necessary)
FIGURE 2—MB & ME

Torque Chart

Part Name	Item Number	Torque
bolt 5/16 24 UNF 2A	1, 1A, 1B or 1C	22-26 ft. lbs. (30-35 N m)
bolt 3/8 24 UNF 2A	1, 1A, 1B or 1C	45-55 ft. lbs. (60-76 N m)
bolt 5/8 18 UNF 2A	12D	140-180 ft. lbs. (190-244 N m)
nut 3/4 16 UNF 2B	12B (MG, MF)	175-255 ft. lbs. (237-305 N m)
nut 1 20 UNEF 2B	12B (MB, ME)	300-400 ft. lbs. (407-542 N m)
nut 1-1/8 18 UNEF 2B	12B (ME)	300-400 ft. lbs. (407-542 N m)

Torqmotor™ Exploded Assembly View—Typical



Item No.	Description				
1.	Special Bolts (5 or 7)	11.	Thrust Bearing	20.	Dirt & Water Seal
1A.	Special Bolts (7)	12.	Coupling Shaft	21.	Plug (2)
1B.	Special Bolts (7)	12A.	Key	22.	O-Ring (2)
1C.	Special Bolts (7)	12B.	Nut	23.	Spring
2.	End Cover	12C.	Washer	24.	Valve (Shuttle or Relief)
3.	Seal Ring-Commutator	12D.	Bolt	25.	Backup Washer
4.	Seal Ring (5)	12E.	Lockwasher		
5.	Commutator	12F.	Retaining Ring		
6.	Commutator Ring	13.	Bearing/Bushing, Inner		
7.	Manifold	14.	Thrust Washer		
8.	Rotor Set	15	Thrust Bearing		
8A.	Rotor	16.	Seal		
8B.	Stator or Stator Half	17.	Backup Washer		
8C.	Vane (7)	18	Housing		
8D.	Stator Half	18A.	O-Ring (2)		
8E.	Vane (7)	19.	Bearing/Bushing, Outer		
9.	Wear Plate				
10.	Drive Link				

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.

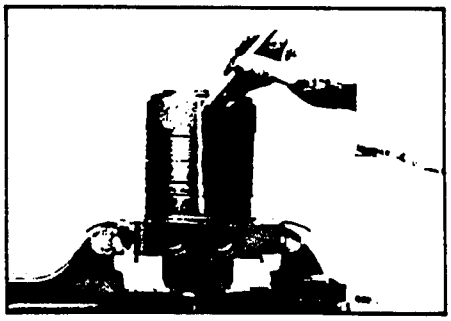


Figure 3

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.

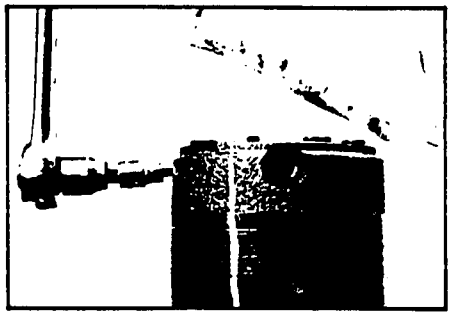


Figure 4

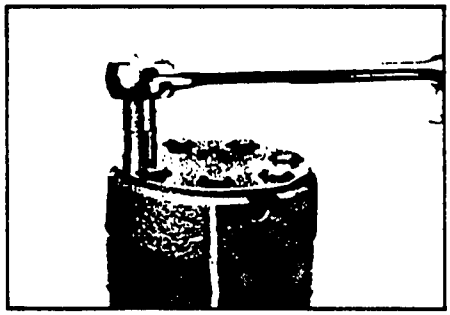


Figure 5

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.

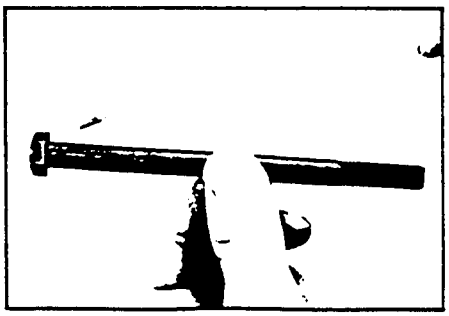


Figure 6

remove end cover & inspect bolts

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

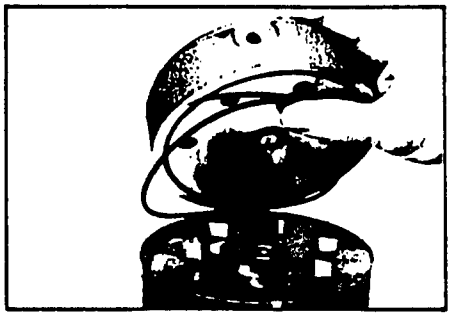


Figure 7

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.

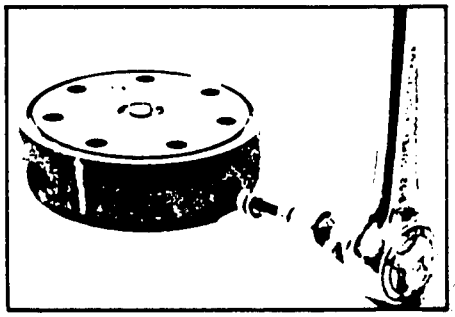


Figure 8

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.

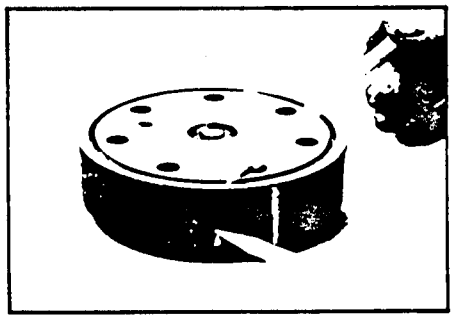


Figure 9

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.

remove & inspect commutator ring

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

Figure 10

remove & inspect commutator

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

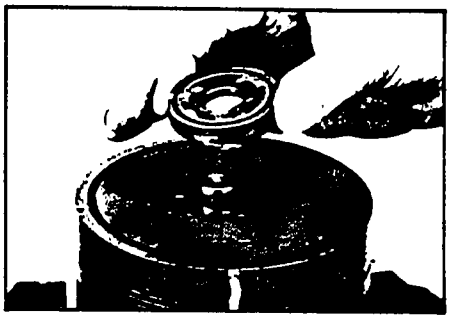


Figure 11

remove manifold

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

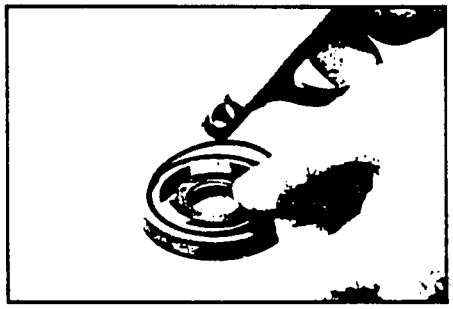


Figure 12

NOTE

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

remove & inspect rotor set & wearplate

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

Figure 13

NOTE

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

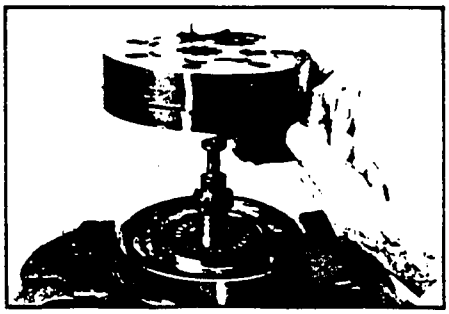


Figure 14

NOTE

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

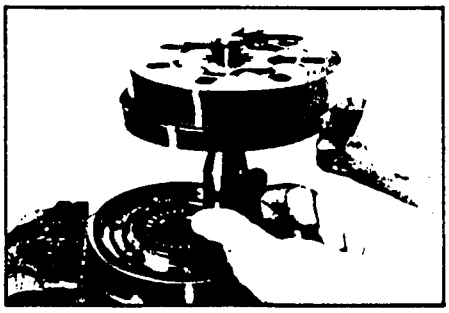


Figure 15

NOTE

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

check rotor, vane clearance

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

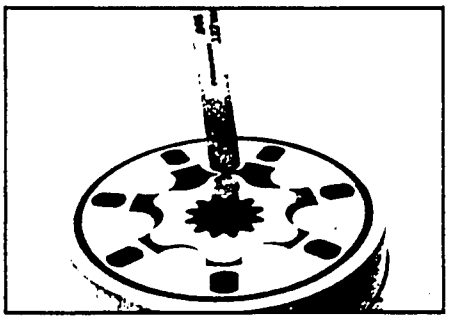


Figure 16

NOTE

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

remove & inspect drive link

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

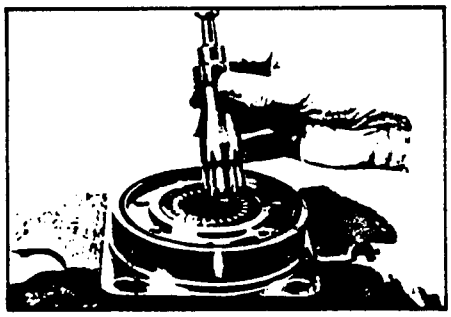


Figure 17

remove thrust bearing

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

Figure 18

check coupling shaft for rust or corrosion

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

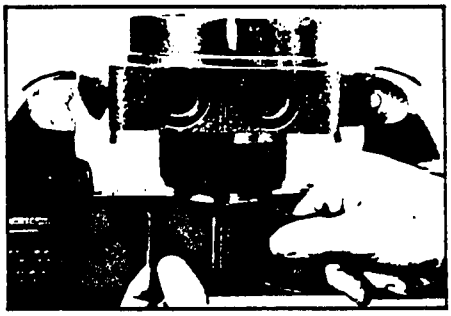


Figure 19

remove & inspect coupling shaft

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

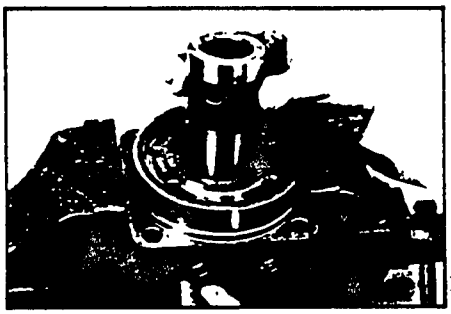


Figure 20

NOTE

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

NOTE

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

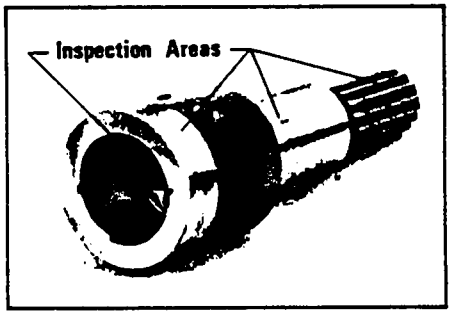


Figure 21

remove seal ring from housing

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

remove & inspect thrust washer & thrust bearing

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

NOTE

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

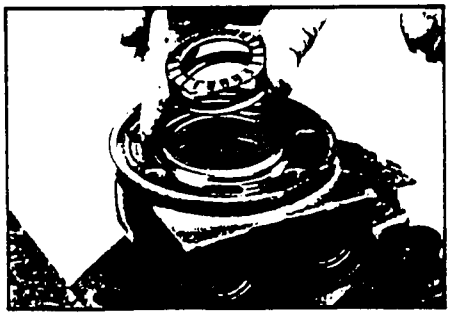


Figure 22

remove seal & washer or washers

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

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

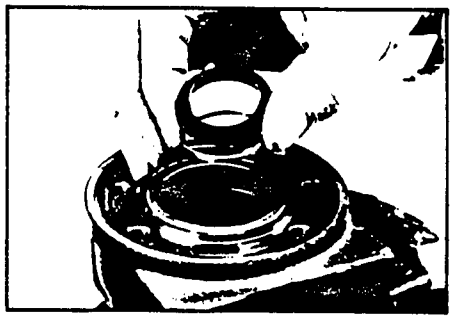


Figure 23

NOTE

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

Figure 24

remove seal

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

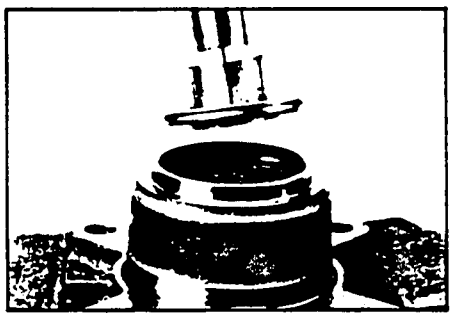


Figure 25

inspect housing assembly

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

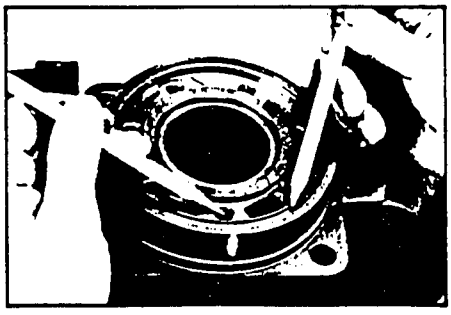


Figure 26

inspect housing bearing/bushing

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

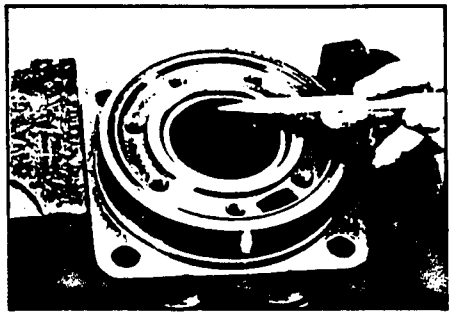


Figure 27

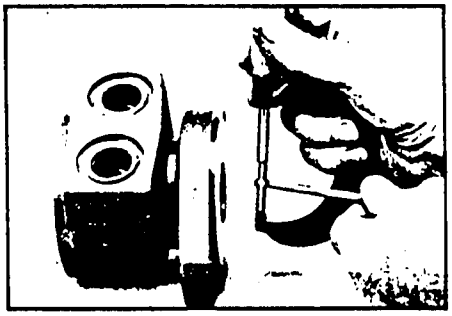


Figure 28

NOTE

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

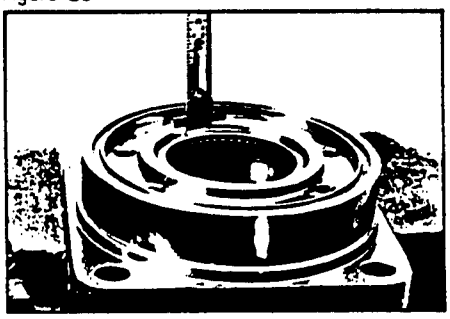


Figure 29

remove bearings or bushings & thrust washers

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

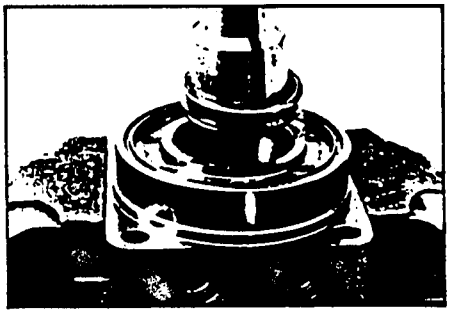


Figure 30

THE DISASSEMBLY OF TORQMOTOR IS COMPLETED.

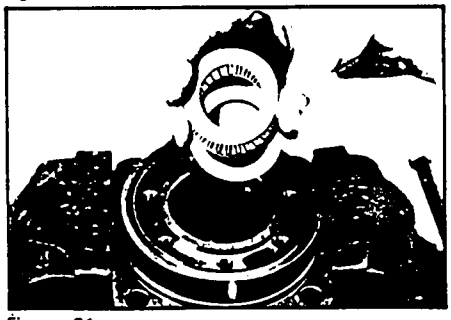


Figure 31

Torqmotor™ Assembly

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

WARNING

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

WARNING

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

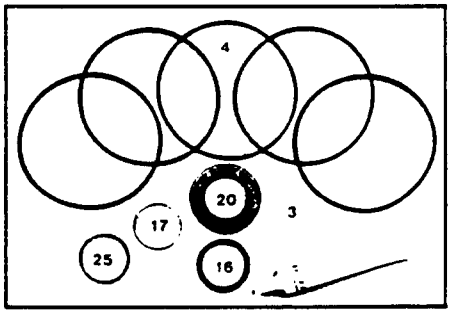


Figure 32 MB, ME seal kit

press in outer bearing/bushing

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

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

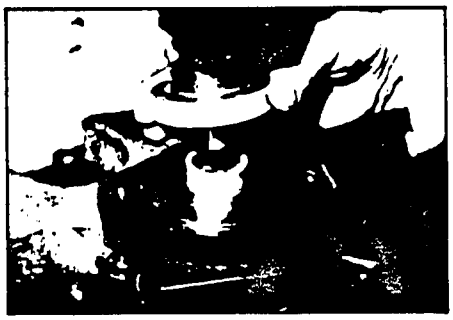


Figure 33

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

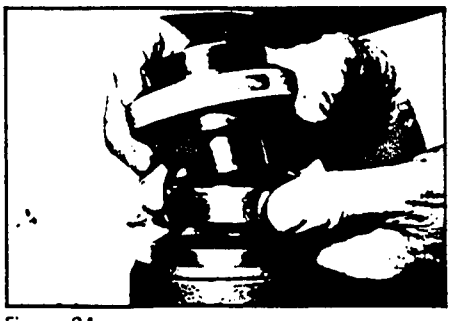


Figure 34

NOTE

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

CAUTION

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

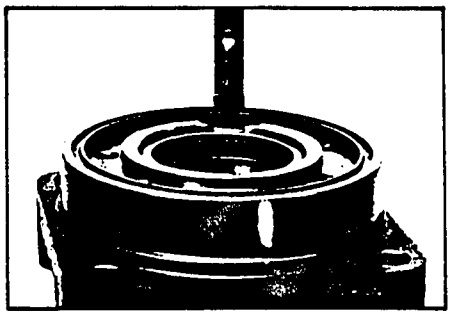


Figure 35

CAUTION

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

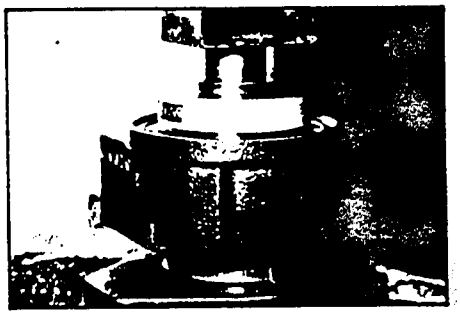


Figure 36

press in inner bearing/bushing

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

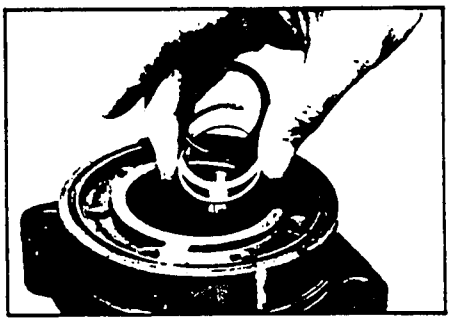


Figure 37

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

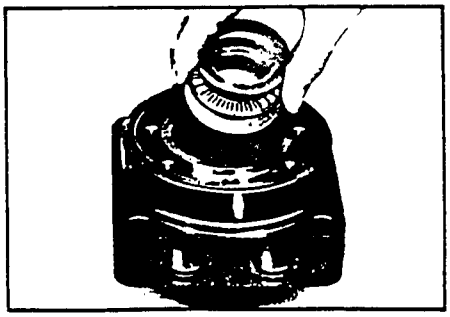


Figure 38

press in dirt & water seal

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

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

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

Figure 39

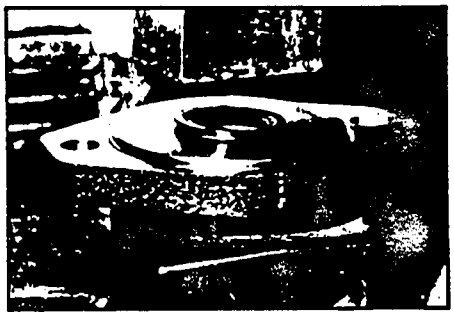


Figure 40

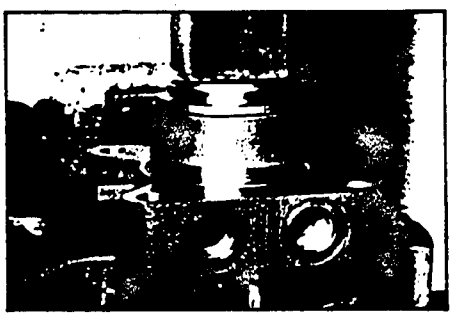


Figure 41

place housing assembly into vise

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

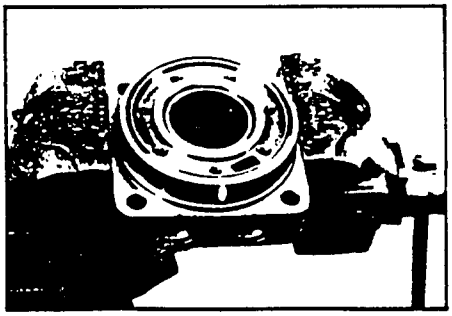


Figure 42

assemble backup washer & seal

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

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

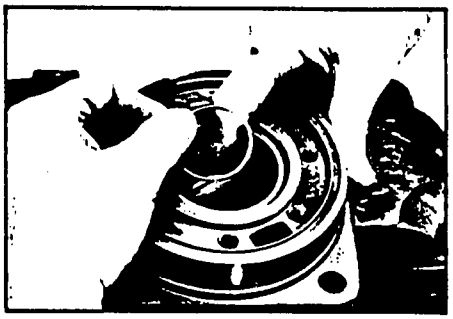


Figure 43

CAUTION

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

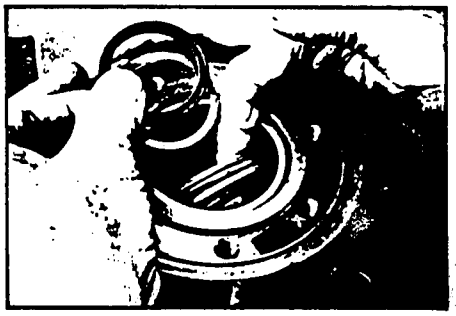


Figure 44

assemble thrust washer & bearing

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

NOTE

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

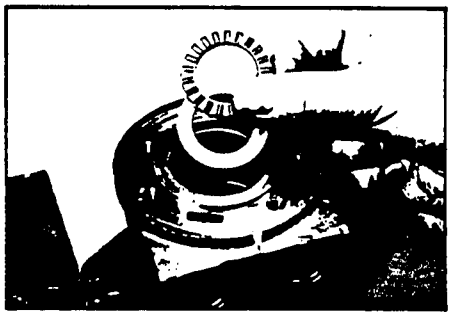


Figure 45

apply masking tape to shaft

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

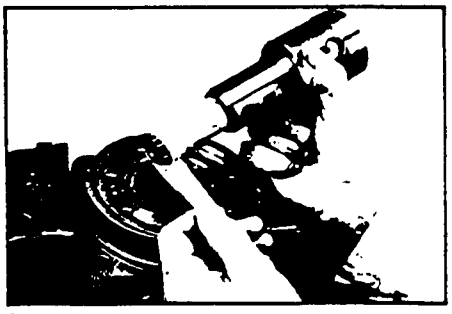


Figure 46

install coupling shaft

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

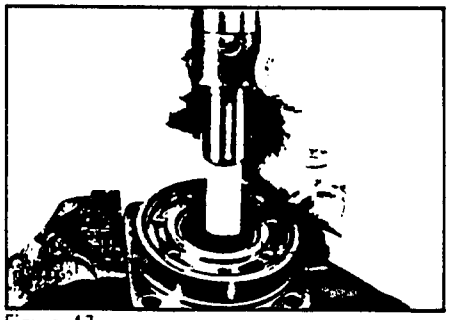


Figure 47

CAUTION

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

NOTE

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

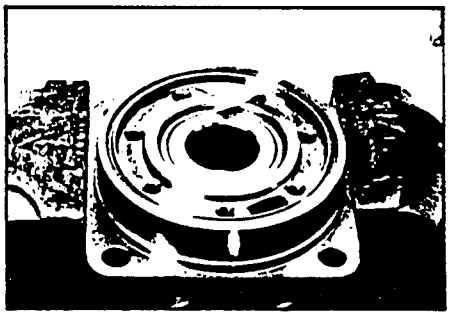


Figure 48

install thrust bearing

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

Figure 49

insert seal ring

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

NOTE

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

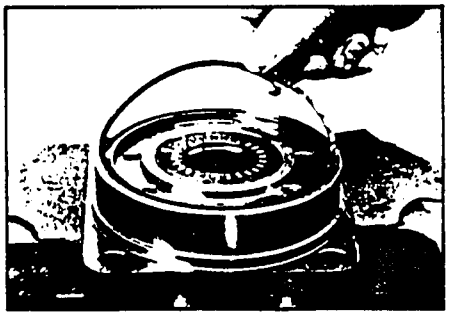


Figure 50

install drive link

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

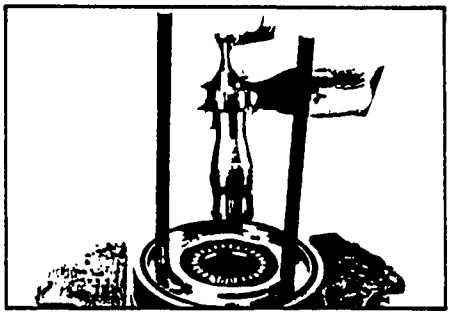


Figure 51

NOTE

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

assemble wear plate

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

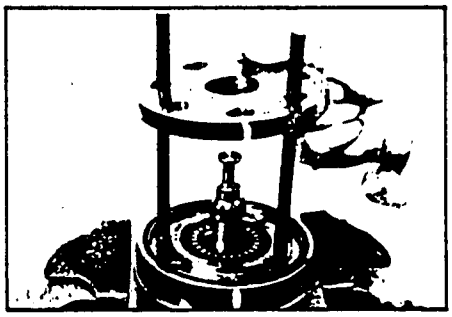


Figure 52

assemble seal ring

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

install the assembled rotor set

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

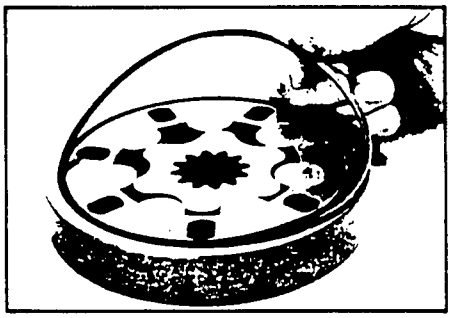


Figure 53

NOTE

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

NOTE

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

NOTE

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

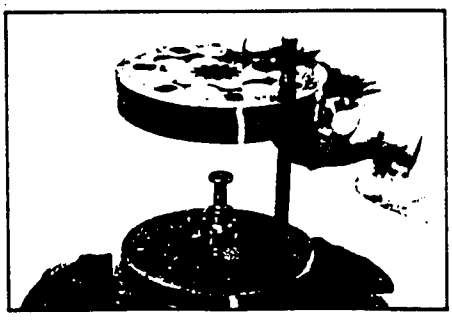


Figure 54

assemble seal ring in manifold

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

Figure 55

NOTE

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

assemble manifold

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

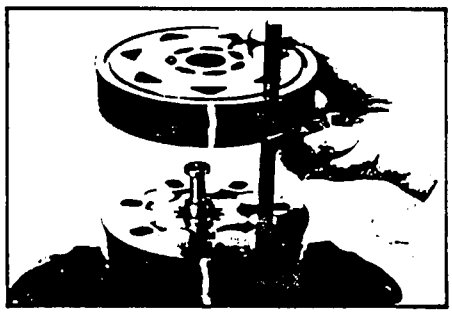


Figure 56

insert a seal in manifold

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

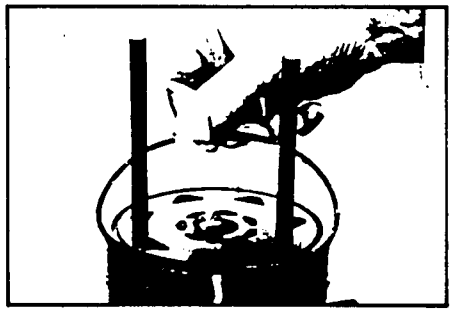


Figure 57

assemble commutator ring

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

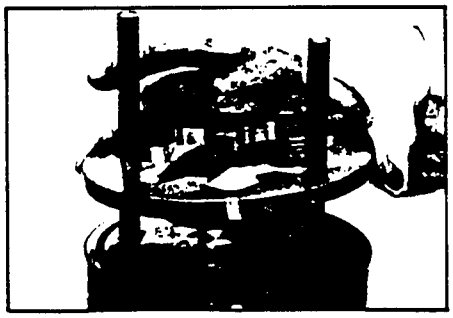


Figure 58

assemble seal & commutator

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

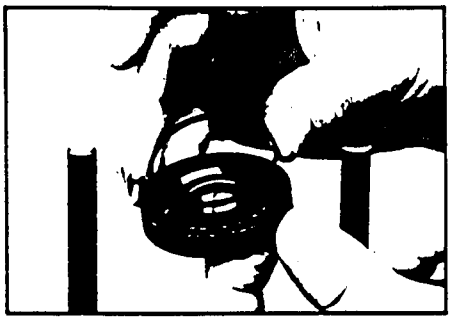


Figure 59

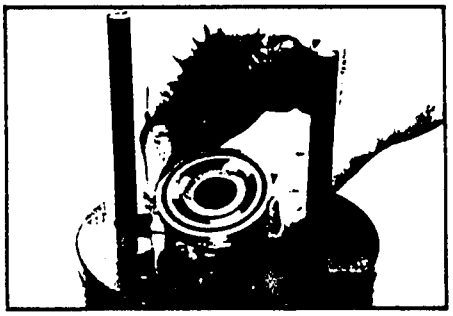


Figure 60

assemble shuttle valve parts into end cover

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

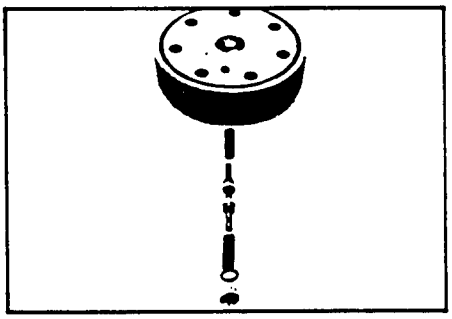


Figure 61

assemble relief valve parts in end cover

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

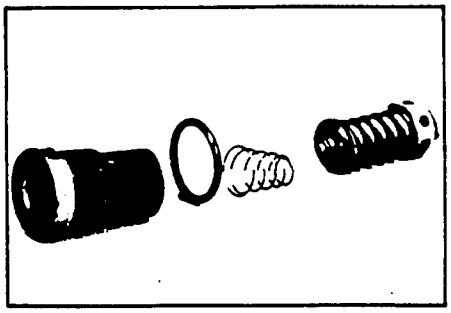


Figure 62

assemble seal ring & end cover

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

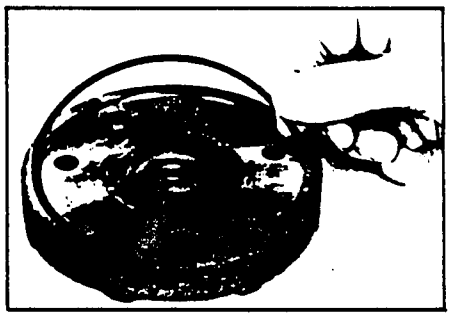


Figure 63

NOTE

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

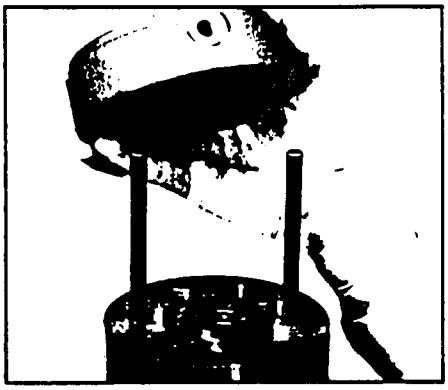


Figure 64

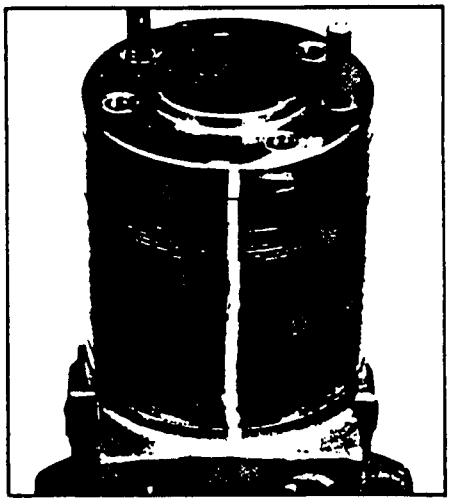


Figure 65

assemble cover bolts

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

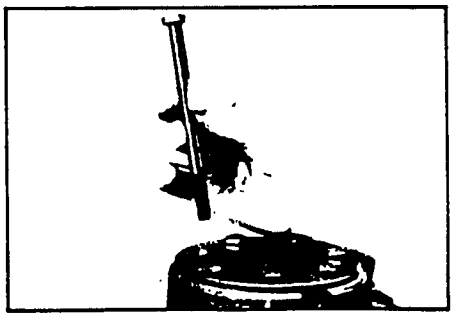


Figure 66

NOTE

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

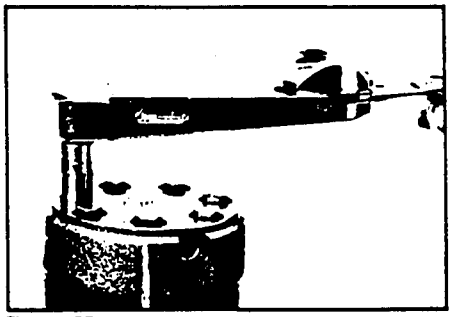


Figure 67

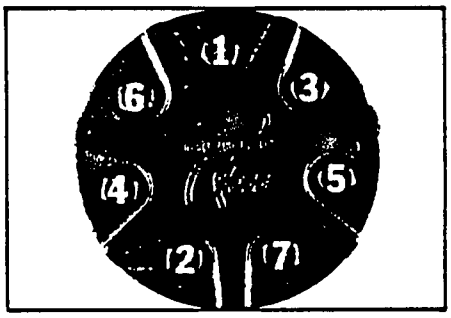


Figure 68

torque the valve plugs

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

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

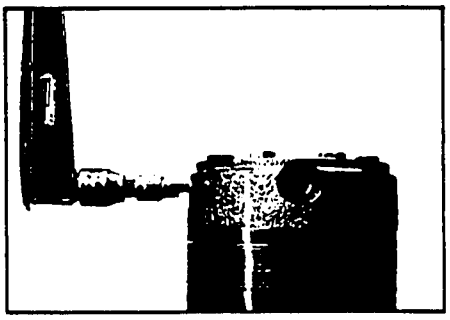


Figure 69

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

Rotor Set Component Assembly Procedure

One Piece Stator Construction

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

assemble stator

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

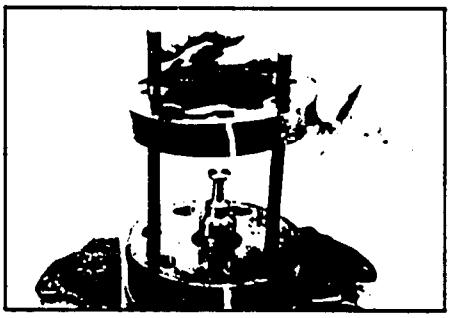


Figure 70

insert two bolts

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

assemble rotor

3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines. SEE FIGURE 71.

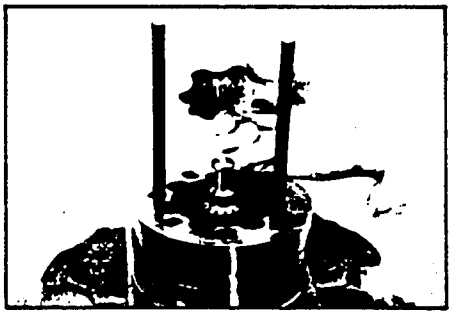


Figure 71

NOTE

NOTE: If the manifold side of the rotor was etched during Torqmotor disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.

assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets. SEE FIGURE 72.

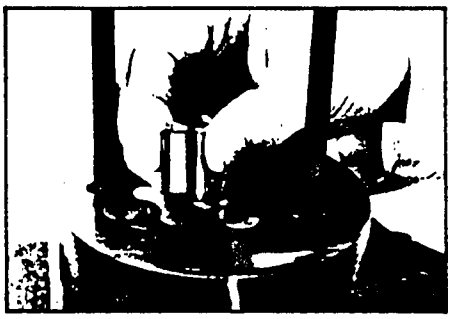


Figure 72

CAUTION

CAUTION: Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

assemble full complement of vanes

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force. SEE FIGURE 73.

remove two assembled bolts

6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

   Go to Torqmotor assembly procedure #15, page 25 to continue Torqmotor assembly.

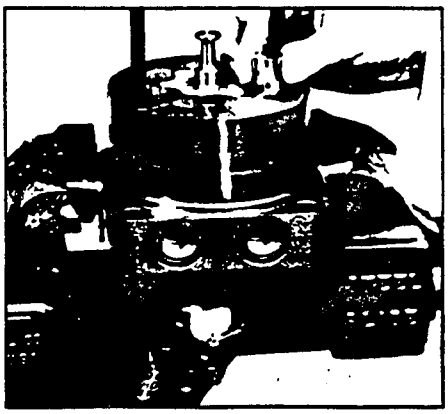


Figure 73

Rotor Set Component Assembly Procedure

Two Piece Stator Construction

A disassembled rotor set (8) that cannot be readily assembled by hand and has a two piece stator can be assembled by the following procedures.

assemble stator halfs

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

insert two alignment studs

2. Align stator bolt holes with wear plate and housing bolt holes and turn two alignment studs finger tight into bolt holes approximately 180 degrees apart to retain stator half and wear plate stationary.

assemble rotor

3. Assemble rotor (8A), counterbore down if applicable, into stator half (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.

NOTE

NOTE: Use any marking you applied to rotor set components to reassemble the components in their original relationship to ensure ultimate wear life and performance.

assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.

CAUTION

CAUTION: Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

assemble full complement of vanes

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator half (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

assemble seal ring in stator half

6. Place second stator half (8D) on a flat surface with seal ring groove up. Apply a small amount of grease to a **new** seal ring (4) and assemble it into stator half ring groove.

assemble second stator half

7. Assemble the second stator half (8D) over the two alignment studs and rotor (8A) with seal ring side down onto the first stator half (8B) aligning any timing marks applied for this purpose.

CAUTION

CAUTION: If the stator half (8B) is a different height (thickness) than stator half (8D) the stator vanes (8C) or (8E) of the same length (height) as the stator half must be reassembled in their respective stator half for the rotor set to function properly.

assemble vanes

8. Assemble six vanes (8E), or as many vanes that will readily assemble into the stator vane pockets.

assemble full complement of vanes

9. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8E) into stator (8D), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

Go to Torqmotor assembly procedure #15, page 25 to continue Torqmotor assembly.

Final Checks

Final Checks

- Pressurize the Torqmotor™ with 100 p.s.i. dry air or nitrogen and submerge in solvent to check for external leaks.
- Check Torqmotor™ for rotation. Torque required to rotate coupling shaft should not be more than 50 ft. lbs. (68 N m)
- On MG & MF Series Torqmotors, pressure port with "A" cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "B" cast under it is for counter clockwise coupling shaft rotation.
- On MB & ME Series Torqmotors, pressure port with "B" cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "A" case under it is for counter clockwise coupling shaft rotation.
- Use test stand if available, to check operation of the Torqmotor™.

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

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

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

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

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

Tips for Maintaining the Torqmotor™ Hydraulic System

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

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

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

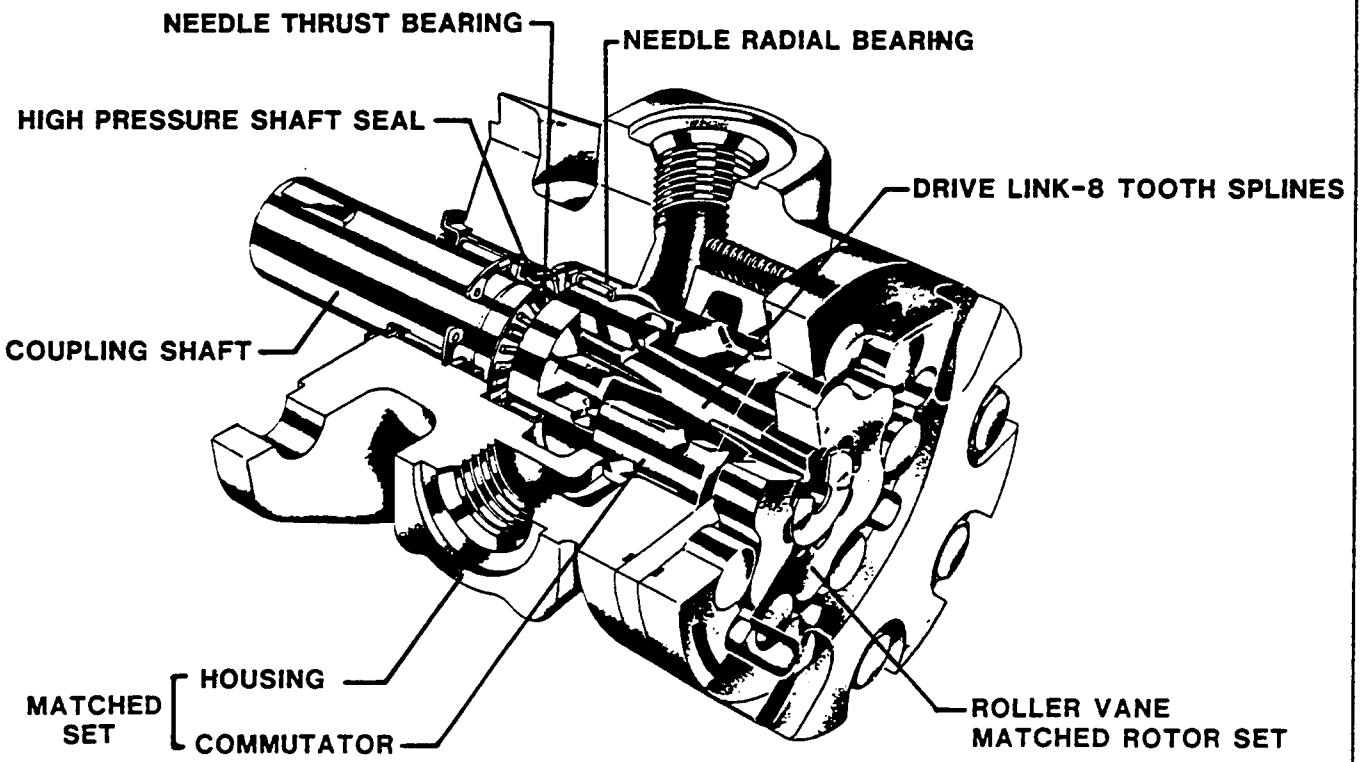
CAUTION: Always carefully inspect any system component that may have been struck or damaged during operation or in an accident. Replace any component that is damaged or that is questionable.

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

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

Torqmotor™

MAF Series Service Procedure



MAF Design Features

Torqmotor™

MAF Design Features

- New standard for compactness and light weight relative to power output, increases installation design latitude.
- Displacements range from 20 cubic inches (328 CM^3) down to 3 cubic inches (49 CM^3) per revolution.
- Continuous rated pressure up to 1750 psi (120.7 BAR), depending on displacement with fully competitive volumetric efficiency.
- Patented roller vanes for high performance and durability.
- Commutation radially independent of load induced shaft movement, minimizing wear induced commutation leakage.
- Coupling shaft mounted in steel caged needle radial and thrust bearings to withstand higher side and thrust loads.
- Optimized drive link contact with 8 tooth spline drive to reduce wear.
- Unique high pressure shaft seal allows MAF Torqmotors to be run in series without need for case drains. Only simple direct-line circuitry required.
- Standard SAE porting and mounting configurations.
- Fewer parts reduced maintenance, while maintaining quality performance.

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 MAF 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 MAF

Patents

Ross Gear Division products and systems described in this manual are protected by one or more of the following United States patents: 3,289,602:3,460,481. In addition, patent applications have been filed in Brazil, Canada, Denmark, France, Italy, Japan, Sweden, the United Kingdom, and West Germany.

Table of Contents

Introduction

Service Manual for Model MAF

This service manual has one purpose: to guide you in maintaining, troubleshooting, and servicing the MAF Torqmotor™ (low-speed, high-torque hydraulic motor, MAF).

Material in this manual is organized so you can work on the MAF 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 MAF.

This manual also contains troubleshooting information and checklist. If you must service the MAF, 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 MAF. 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. Pay special attention to the notes, cautions, and warnings.

A foldout page with an MAF exploded assembly view 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 parts are available through the Original Equipment Manufacturer (OEM) or Ross approved MAF Distributors.

As you gain experience in servicing the MAF, 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 MAF 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 but the MAF 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 not properly repaired, or that should have been replaced; and
- improperly spec'd replacement parts.
- 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. 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 MAF 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.

It may be necessary that you run hydraulic tests on the performance of the hydraulic components. To do so, consult the manuals published by the equipment or component manufacturers.

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 (5) deteriorated by excess heat	Replace oil seal rings by disassembling MAF unit.
	3. Special bolt (2) loose or its sealing area deteriorated by corrosion	(a) Loosen then tighten single bolt to 22-26 ft.-lbs. (30-35 N m) (b) Replace bolt.
	4. Internal shaft seal (16) worn or damaged	Replace seal by disassembling MAF unit.
	5. Worn coupling shaft (11) and internal seal (16)	Replace coupling shaft and seal by disassembling MAF 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 MAF unit.
	3. Severely worn or damaged internal splines	Replace rotor set, drive link and coupling shaft by disassembling MAF unit.
	4. Excessive heat	Locate excessive heat source in the system and correct the condition.
Low mechanical efficiency or undue high pressure required to operate MAF unit	1. Line blockage	Locate blockage source and repair or replace.
	2. Internal interference	Disassemble MAF 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	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

MAF service manual

Clean, petroleum-based solvent

Emery paper

Vise with soft jaws

Air pressure source

Arbor press

Screw driver

Retaining ring pliers (internal)

Breaker bar

1/2 inch thin wall socket

Torque wrench - foot pounds

Adjustable crescent wrench or hose fitting wrenches

Marking pencil or chalk

SAE 10W40 oil

Clean grease

Feeler gage .005 inch (.127 mm)

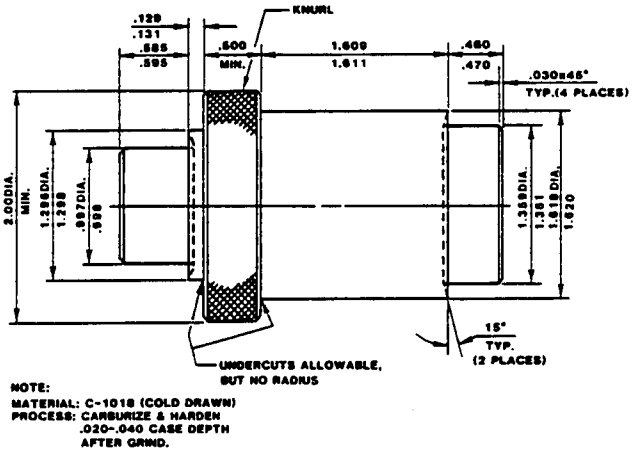
Blind hole bearing puller for 1 inch (25.4 mm) and 1.38 inch (35.1 mm) diameter bearing,

Special bearing mandrel (SEE FIGURE 1)

Special rotor set assembly tool (See FIGURE 2) or large locking pliers and two 16 penny nails or equivalent #8 US gage (.162 Dia. [4.1 mm]) metal rods (See FIGURE 62)

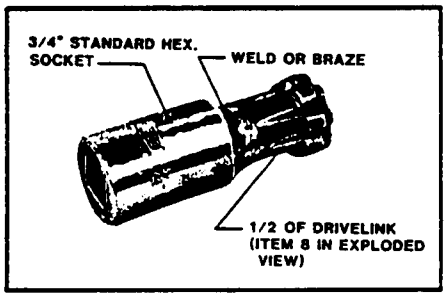
CONVERSIONS

INCHES	mm	INCHES	mm
.020	.51	.998	25.35
.030	.76	1.296	32.92
.040	1.02	1.298	32.97
.129	3.28	1.359	34.52
.131	3.33	1.361	34.57
.460	11.68	1.609	40.87
.470	11.94	1.611	40.92
.500	12.70	1.618	41.10
.585	14.86	1.620	41.15
.595	15.11	2.00	50.8
.997	25.32		



Bearing Mandrel
(Fabricate if considered necessary)

FIGURE 1



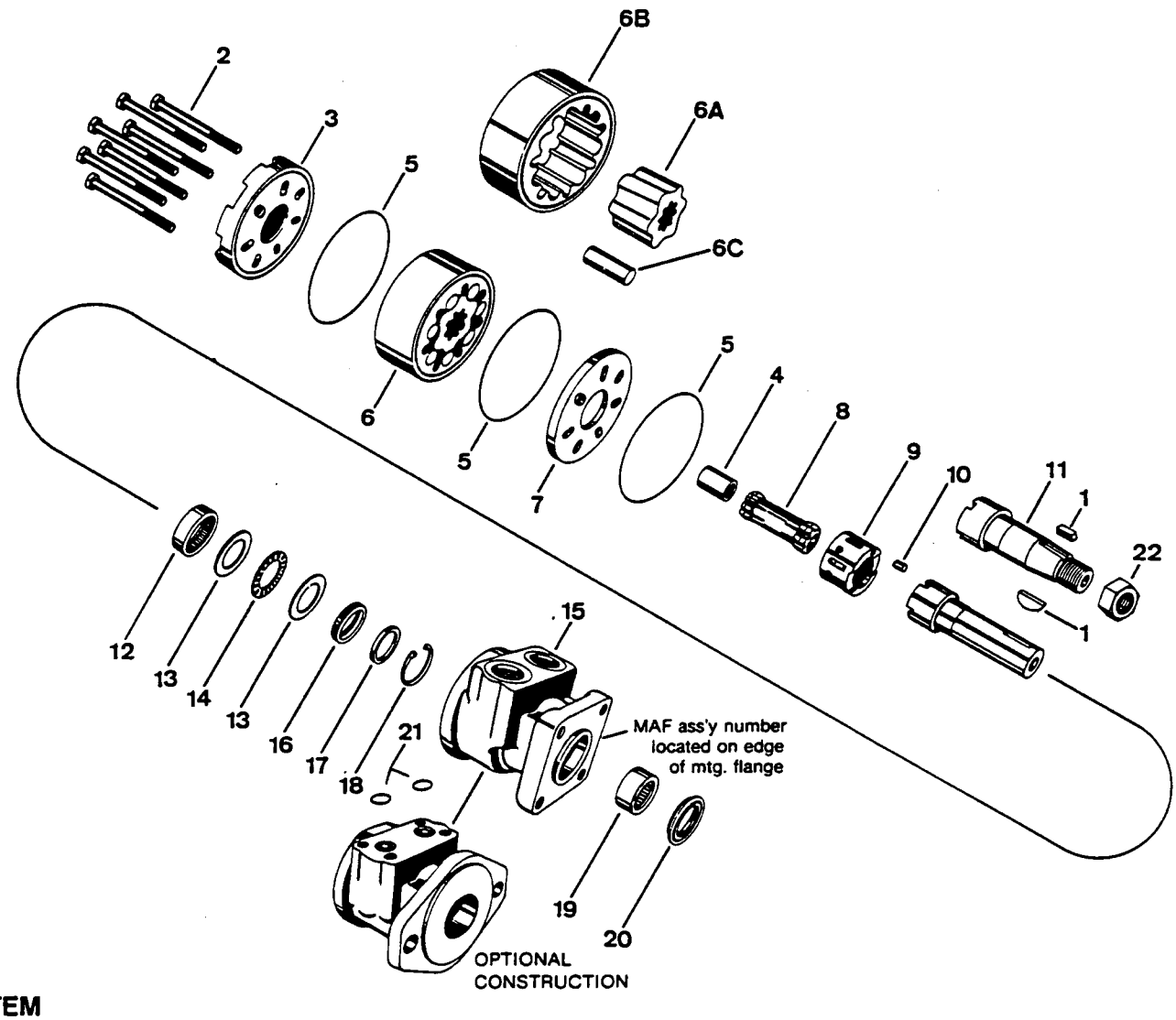
Rotor Set Assembly Tool
(Fabricate if considered necessary)

FIGURE 2

Torque Chart

Part Name	Item Number	Torque
bolt 5/16 24	2	22-26 ft. lbs. (30-35 Nm)

MAF Torqmotor™ Exploded Assembly View - Typical



ITEM NO.	DESCRIPTION
1	WOODRUFF KEY
2	BOLT 5/16 24 (7)
3	END COVER
4	SPACER/WASHER
5	SEAL RING (3)
6	ROTOR ASSY. SET (Matched set, not serviced separately)
6A	ROTOR
6B	STATOR
6C	VANE (7)
7	WEAR PLATE
8	DRIVE LINK
9	COMMUTATOR-(Matched with housing as a set. Not serviced separately)
10	DRIVE PIN
11	COUPLING SHAFT
12	BEARING - INNER
13	THRUST WASHER (2)
14	THRUST BEARING
15	HOUSING-(Matched with commutator as a set. Not serviced separately)
16	SEAL - INNER
17	BACKUP WASHER
18	RETAINING RING
19	BEARING
20	SEAL - DIRT & WATER
21	O-RING (2)
22	NUT

MAF: Disassembly and Inspection

(Preparation Before Disassembly)

- Before you disassemble the MAF 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 MAF.
- Refer to page 7A for tools and other items required to service the MAF, and have them available.
- Thoroughly clean off all outside dirt, especially from around fittings and hose connections, before disconnecting and removing the MAF. Remove rust or corrosion from coupling shaft.
- Remove coupling shaft connections and hose fittings, and immediately plug port holes and fluid lines.
- Remove the MAF 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 MAF before you start to disassemble the unit.
- As you disassemble the MAF, clean all parts, except seals, in clean petroleum-based solvent, and blow them dry.

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.

CAUTION 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 MAF. Replace all seals, seal rings and any damaged or worn parts with genuine Ross or OEM approved service parts.

Disassembly and Inspection

position Torqmotor™ in a vise

1. Position the MAF assembly in a soft jawed vise, with coupling shaft (11) pointed down, the vise jaws clamping firmly on the sides of the housing (15) mounting flange. SEE FIGURE 3.

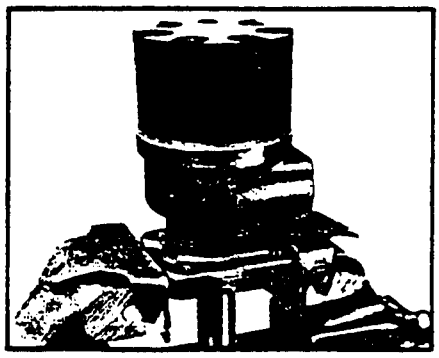


Figure 3

CAUTION

CAUTION: Do not clamp the housing port area between the vise jaws as it might distort the housing around the commutator (9), preventing the disassembly of the commutator.

WARNING

WARNING: IF THE MAF ASSEMBLY IS NOT FIRMLY HELD IN THE VISE, IT COULD FALL AND INJURE SOMEONE.

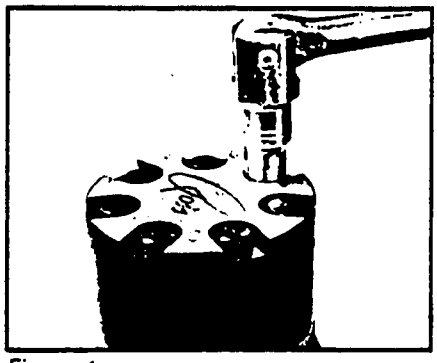


Figure 4

remove special bolts & inspect bolts

2. Remove the seven special ring head bolts (2) using a ½ inch thin wall socket to enter the end cover bolt head recess. SEE FIGURE 4. Inspect bolts (2) for damaged threads, or sealing ring, under the bolt head. Replace damaged bolts. SEE FIGURE 5.

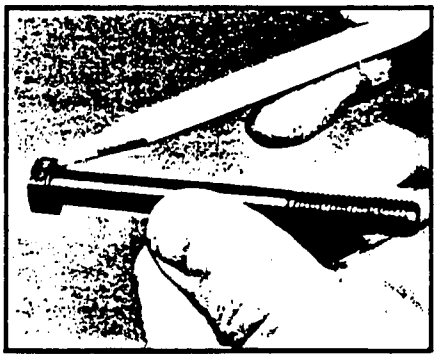


Figure 5

remove end cover & seal ring

3. Remove end cover (3) and seal ring (5). Discard seal ring (5). SEE FIGURE 6.

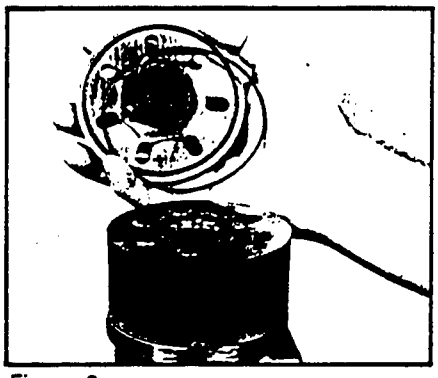


Figure 6

inspect end cover

4. Inspect the end cover (3) for severe wear, nicks, burrs and spalling on the ground surface that has the seal ring groove. Inspect the bolt head recesses where the bolt head sealing ring makes contact for damage that would prohibit good sealing contact. Replace cover if any of these conditions exist.

Figure 7

NOTE

NOTE: A polished pattern on the cover surface from rotation of the rotor (6A) is normal. Discoloration would indicate excess fluid temperature, thermal shock or excess speed and require system investigation for cause, and very close inspection of end cover, rotor set, and wearplate.

remove & inspect drive link spacer/washer

5. Remove drive link spacer/washer (4). Inspect it for badly burred or nicked ends that would interfere with rotor and drive link rotation. Replace if necessary. SEE FIGURE 7.

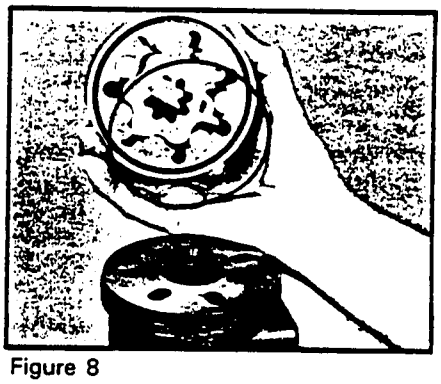


Figure 8

remove & inspect rotor set and seal ring

6. Remove rotor set (6), retaining it in its assembled form, if possible, to avoid an involved reassembly procedure. Inspect the rotor set in its assembled form, for nicks, scoring, or spalling, on any surface, and broken or worn rotor splines. If any of the rotor set components require replacement, the complete rotor set must be replaced as it is a matched set. SEE FIGURE 8. Discard seal ring (5).

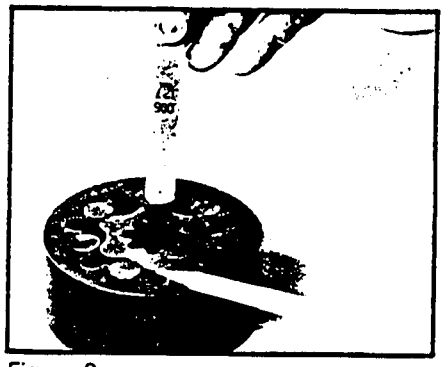


Figure 9

check clearance

7. Using a feeler gage, check the rotor (6A) to vane (6C) clearance. The rotor should be centered at the pencil point. SEE FIGURE 9. If there is more than .005 inches (.13 mm) of clearance, replace rotor set.

remove & inspect wearplate

8. Lift off wearplate (7) and inspect it for scoring or brinelling (dinging) on the rotor and commutator contact and sealing surfaces. Replace wearplate if any of these conditions exist. SEE FIGURE 10.

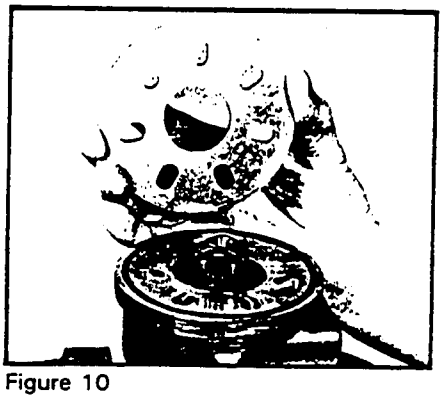


Figure 10

NOTE

NOTE: A polished pattern from rotor or commutator rotation is normal.

remove drive link

9. Remove drive link (8) and inspect it for cracks and for chipped or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Replace, if necessary SEE FIGURE 11.

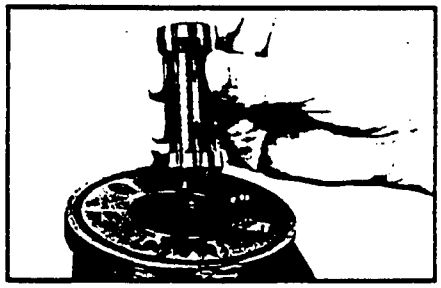


Figure 11

remove & discard seal ring

10. Remove seal ring (5) from housing (15) seal ring groove and discard seal ring. SEE FIGURE 12.

Figure 12

remove & inspect commutator

11. Remove commutator (9) which is a close slip fit into housing (15), by inserting two fingers into its center cavity and lifting. SEE FIGURE 13. The commutator drive pin (10) will probably be in the commutator when the commutator is removed. Inspect the commutator for nicks, burrs, or brinelling on the outside diameter surface. Inspect for broken edges on the commutation slots. Inspect the exposed area of the drive pin slot for extreme wear or damage. Only the commutator drive pin can be serviced separately. A worn or damaged commutator will require a new matched housing and commutator service assembly set.

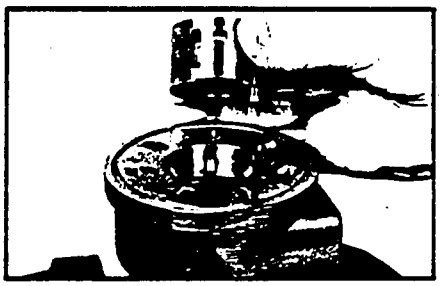


Figure 13

remove commutator drive pin

12. Remove commutator drive pin (10) only if it must be replaced. If the pin does not readily pull out of the commutator, clamp the exposed portion of the drive pin in a vise and twist the commutator from the drive pin by hand only. SEE FIGURES 14 and 15.

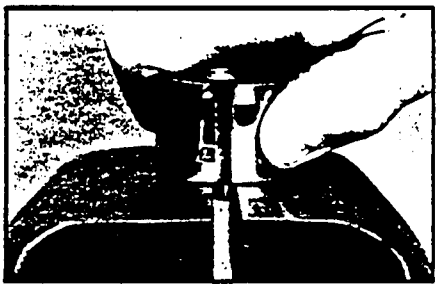


Figure 14

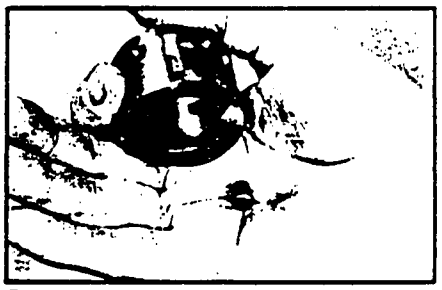


Figure 15

check thrust bearing operation

13. Replace drive link (8) into mesh with coupling shaft (11) and exert a downward force on it with the palm of one hand while pulling down and rotating the coupling shaft with the other hand. SEE FIGURE 16. A damaged thrust bearing (14) package would be indicated by roughness "felt" or heard during this procedure and would require thrust bearing and thrust washer (13) removal for further inspection in subsequent procedures. Remove drive link.

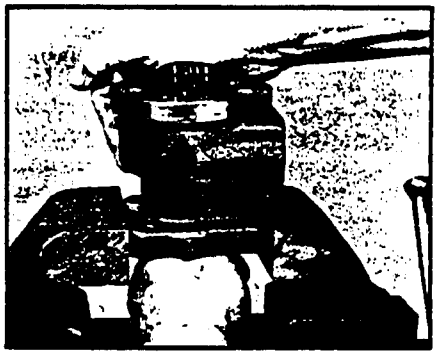


Figure 16

check coupling shaft for rust or corrosion

14. Check exposed portion of coupling shaft (11) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal. Crocus cloth or fine emery paper may be used. SEE FIGURE 17.

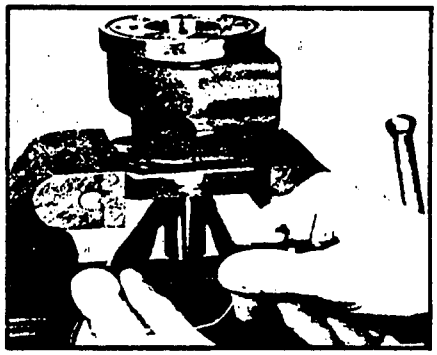


Figure 17

remove & inspect coupling shaft

15. 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. SEE FIGURE 18. Inspect for damaged or worn internal and external splines, drive pin slot, and keyway. SEE FIGURE 19. Replace coupling shaft if any of these conditions exist.

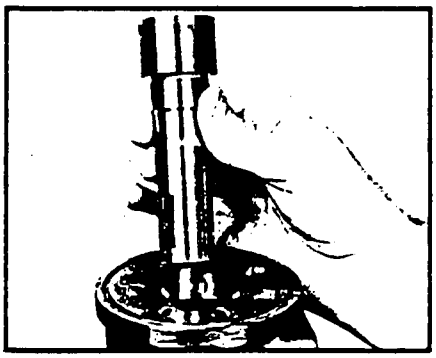


Figure 18

NOTE

NOTE: Minor shaft wear in seal (17) area is permissible. If wear exceeds .020 inches (.51mm) diametrically, replace coupling shaft.

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

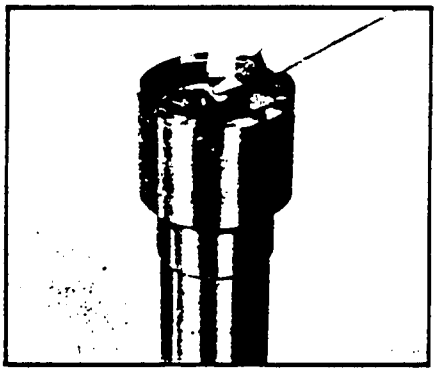


Figure 19

NOTE

NOTE: If commutator (9) was discarded as worn or damaged in Step 10, discard housing (15) assembly as well. If this is the case, the disassembly of the MAF Torqmotor™ is now complete. If, however, the commutator passed inspection, continue the disassembly procedures.

remove seals

16. Remove housing (15) from vise and place it on a clean flat work surface with wearplate end down. Pry out and discard the dirt and water seal (20) and inner seal (16) using a dull-edged screw driver. Be careful not to gouge or nick other components during the process. SEE FIGURE 20 and 21.

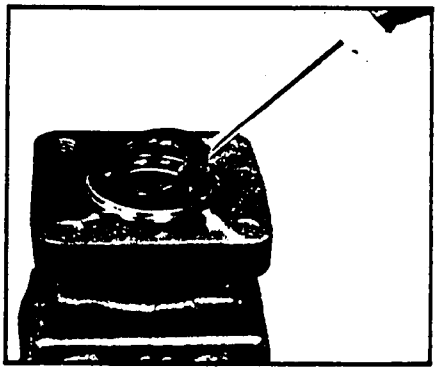


Figure 20

inspect housing assembly

17. Inspect the housing (15) assembly for cracks, the housing machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect the tapped holes for thread damage. SEE FIGURE 22. If the housing is defective in these areas, discard the housing (15) assembly and commutator (9) assembly and the disassembly of the MAF Torqmotor™ is completed. If the housing assembly passed inspection to this point, continue the inspections per Step 18.

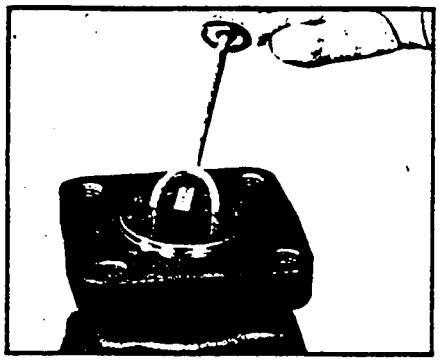


Figure 21

inspect housing bearings, thrust washers & backup washer

18. Inspect the outer bearing (19), the inner bearing (12), the thrust bearing (14), thrust washers (13), and back-up washer (17), while assembled in the housing (15). The bearing rollers should be firmly retained in the bearing cages, but must turn and revolve freely. The full complement of bearing rollers and the thrust washers must be free of brinelling and corrosion. Seal back-up washer must be free of cracks, chipped edges or burrs. SEE FIGURE 23. If the housing assembly passed this inspection, and the inspections in Step 13 and 17, the disassembly of the MAF Torqmotor™ is completed.

    If only the bearings, thrust washers, or back-up washer show deterioration, they can be replaced. Go to the next step.

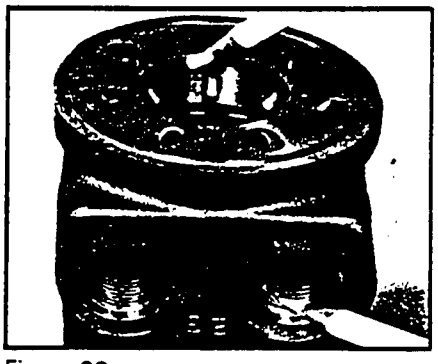


Figure 22

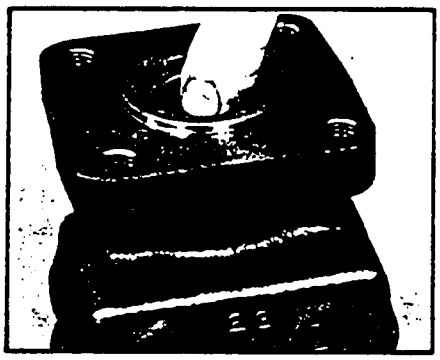


Figure 23

remove inner bearing

19. If the inner bearing (12), thrust washers (13), thrust bearing (14), or back-up washer (17), need replacement, place housing back into the vise as in disassembly Step 1. Insert a puller for a 1.38 inch (35.1mm) diameter bearing, through the wearplate end of the housing, through bearing (12). SEE FIGURE 24. Expand bearing puller and remove bearing (12) and discard. SEE FIGURE 25.

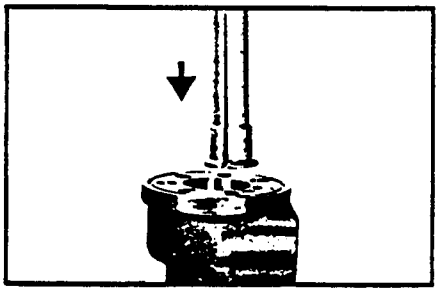


Figure 24

CAUTION

CAUTION: Use care when pulling the bearing, that the commutator bore in the housing is not scored or damaged during the process.

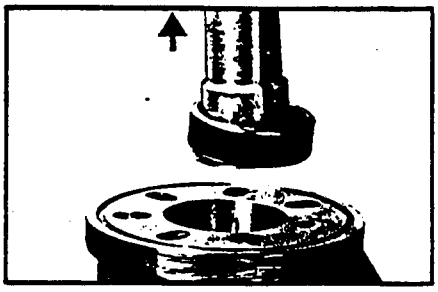


Figure 25

remove & inspect thrust washers, thrust bearings, & back-up washer

20. Remove and inspect thrust washers (13), thrust bearing (14), and back-up washer (17), again per Step 18. These parts can be retained for reassembly if they pass this inspection, but it is recommended that they be replaced if removed. These are included in the bearing service kit. SEE FIGURE 26.

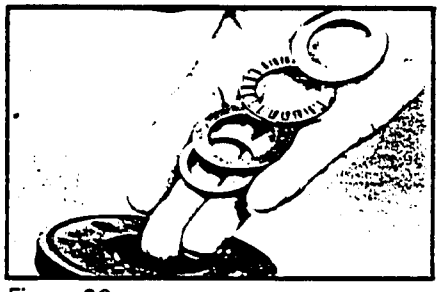


Figure 26

remove retaining ring

21. If the outer bearing is to be removed, remove retaining ring (18) using the appropriate retaining ring pliers. SEE FIGURE 27. A damaged or deformed retaining ring should be replaced.

remove outer bearing

22. Invert housing (15) in the vise, clamping on the mounting flange. Insert a puller for a 1.00 inch (25.4mm) diameter bearing, through outer bearing (19) from the flange end of the housing, expand puller and remove and discard bearing. SEE FIGURE 28.

The MAF Torqmotor™ disassembly is now complete.

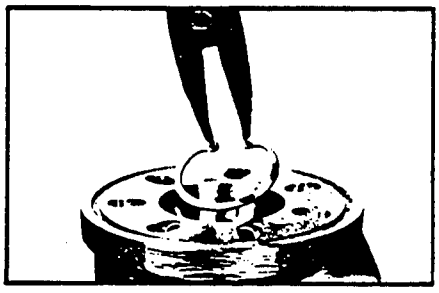


Figure 27

NOTE

NOTE: A service bearing package kit is available which includes inner bearing (12), thrust washers (13), thrust bearings (14), inner seal (16), back-up washer (17), retaining ring (18), outer bearing (19), and dirt and water seal (20). If a housing bearing or thrust bearing requires replacement, it is recommended that all the housing bearings and relative components be replaced that are available in this service kit.

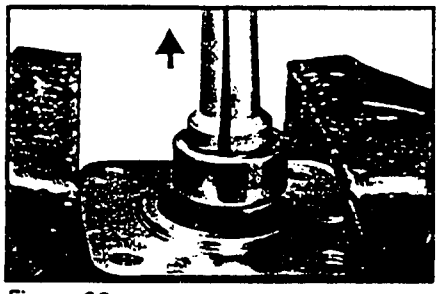


Figure 28

MAF Assembly

- Replace all seals and seal rings with new ones each time you reassemble the MAF 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 29. The parts should be available through most OEM parts distributors or Ross approved MAF 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, stator, wearplate and housing and from port and sealing areas.

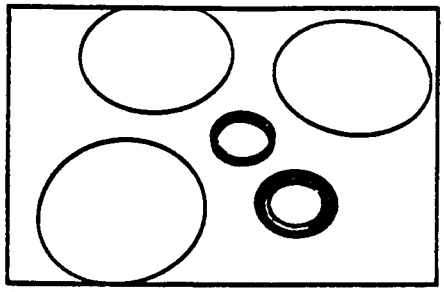


Figure 29

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.

service housing and commutator replacement

1. If a service housing and commutator assembly set has been procured for the MAF unit being serviced, the housing components are already installed. Start the assembly procedure with Step 9.

housing seal replacement only

2. If the housing assembly (15) is being reused with original bearings intact, place housing on a clean work surface with the housing wearplate surface up. Apply a small amount of clean grease to a new inner seal (16). Deform the seal between two fingers and insert the seal into the housing seal cavity between the back-up washer (17) and a thrust washer (13). SEE FIGURE 30. The seal must be properly seated and against the back-up washer (17), with the seal lip facing the thrust washer (13). The back-up washer (17) must be seated against the retaining ring (18). Go directly to assembly procedure #8.

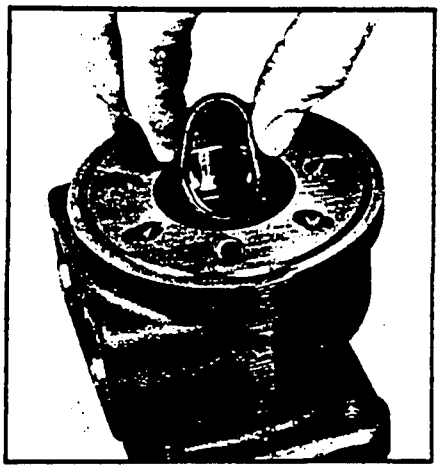


Figure 30

NOTE

NOTE: You will probably have to pick-up the housing and use fingers through each end of the housing to seat the seal into the correct position.

install retaining ring

3. If the housing (15) has been completely disassembled, place the housing, mounting flange end down, on a clean work surface. Install retaining ring (18) into the housing retaining ring groove. Be sure the rounded edge of retaining ring is facing in toward the larger housing cavity. Use appropriate retaining ring pliers. SEE FIGURE 31.

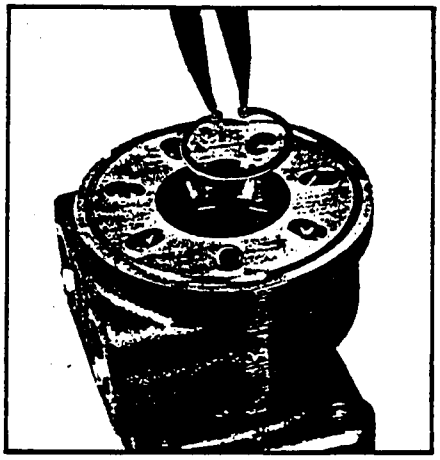


Figure 31

press in bearing

4. Thoroughly grease the rolls of a NEW bearing (19) with clean wheel bearing grease. Press the bearing into housing (15) from the mounting flange end of the housing bore, using bearing mandrel (special tool FIGURE 1, Page 7A) against the lettered end of the bearing shell. SEE FIGURES 32 and 33. Take care during this procedure that the housing is square with the press base and that the bearing is not cocked. The bearing mandrel will control the bearing (19) press depth to the required .135/.125 inches (3.43/3.18 mm) from the flange end of the housing.

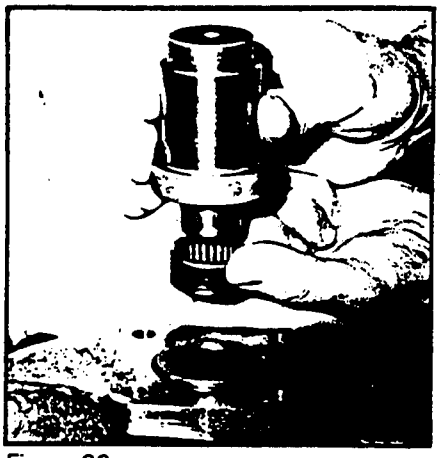


Figure 32

NOTE:

NOTE: If the bearing mandrel shown is not available, alternate methods may be used to press in the bearing but the bearing depth location must be maintained.

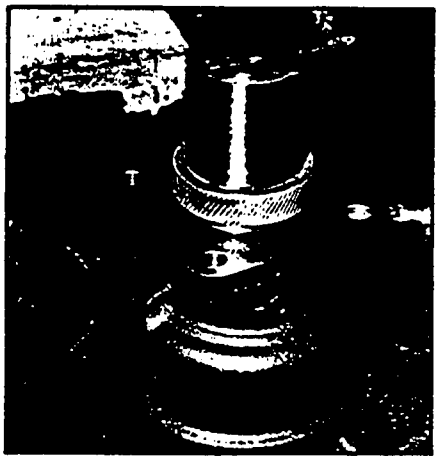


Figure 33

CAUTION

CAUTION: The controlled press depth of bearing (12) and (19) into the housing is required to ensure adequate bearing support, and correct bearing relationship to adjacent components when assembled.

CAUTION

CAUTION: Because bearings (12) and (19) have a press fit into the housing, they must be discarded if removed from the housing. They must not be reused.

install backup washer & seal

5. Place housing (15), wearplate surface up, on a clean work surface. Apply a small amount of clean grease to inner seal (16). Install back-up washer (17) then seal (16) into housing coupling shaft bore from the wearplate end of the housing (15). Seat the back-up washer against the retaining ring (18) and the seal against the back-up washer, with the seal lip facing away from the back-up washer. SEE FIGURE 34.

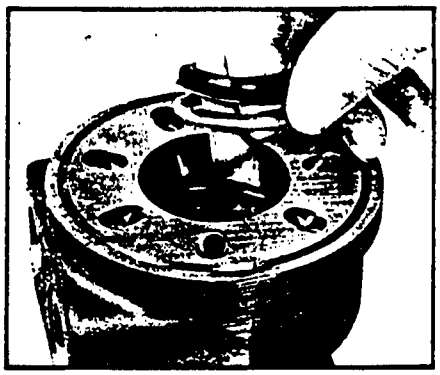


Figure 34

install thrust washers & thrust bearing

6. Install a thrust washer (13), the thrust bearing (14) and then another thrust washer (13) into the housing (15) inner bearing bore until they are seated at the bottom of the bore. SEE FIGURE 35.

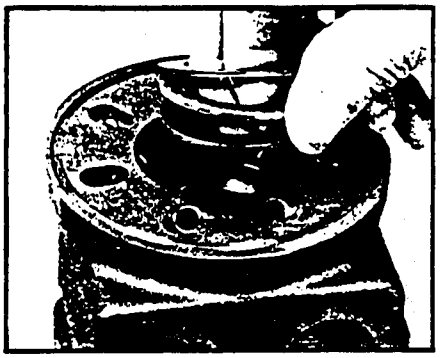


Figure 35

press in bearing

7. Press a ***new*** bearing (12) into the housing (15) inner bearing bore, from the wearplate face end, using bearing mandrel (special tool SEE FIGURE 1, Page 7A) against the lettered end of the bearing shell. Take care during this procedure that the housing is square with the press base and that the bearing is not cocked. The bearing mandrel will control the bearing press depth to the required 1.618/1.598 inches (41.10/40.59mm) from the wearplate face of the housing. SEE FIGURES 36 and 37.

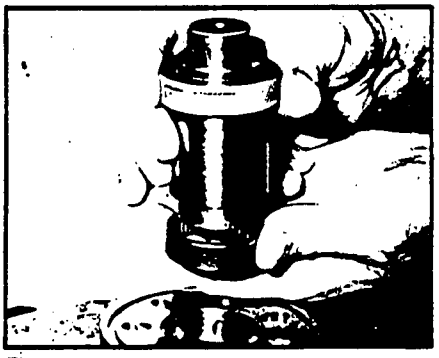


Figure 36

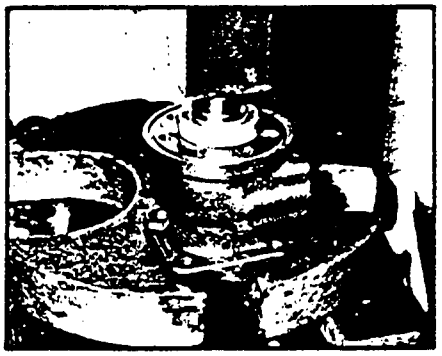


Figure 37

NOTE

NOTE: If the bearing mandrel shown is not available, alternate methods may be used to press in the bearing but the bearing depth location must be maintained.

insert dirt & water seal

8. Place housing (15), wearplate surface down, on a clean work surface. Apply a small amount of clean grease to a new dirt and water seal (20) and press the seal into the housing seal cavity. The end of a hammer handle would be an appropriate tool. Be sure the seal is not cocked or deformed as it enters housing seal bore. SEE FIGURE 38.

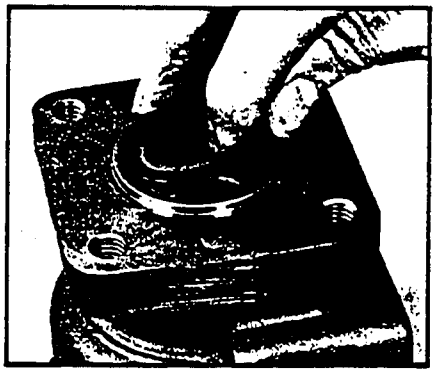


Figure 38

place housing assembly into vise

9. Place housing (15) assembly into a soft-jawed vise with coupling shaft bore down, and clamp the vise jaws against the edges of the mounting flange. SEE FIGURE 39.

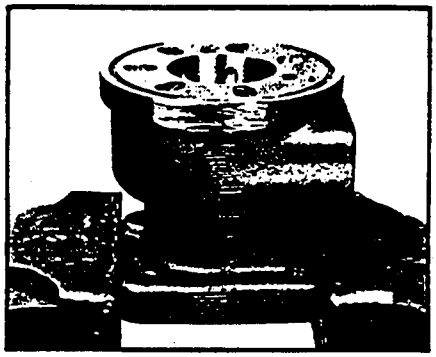


Figure 39

CAUTION

CAUTION: Clamping on the body of the housing in the area of commutator bore could distort the housing and prevent the assembly of the commutator (9).

NOTE

NOTE: The assembly of the rotor set (6) components, if required, should be done at this time in order to utilize the housing in the vise, as a rotor set assembly "Fixture". SEE "Rotor Set Component Assembly Procedure" on page 23.

NOTE

NOTE: The coupling shaft (11) has a timing mark on the small (output) end that is radially in line with two internal spline teeth and a "commutator drive pin slot" that transverses the opposite end of the coupling shaft, SEE FIGURE 40. The "commutator drive pin slot" indicated by the timing mark is the only slot of two oil passage slots across the large end of the coupling shaft, wide enough to engage the commutator drive pin (10) at assembly. This orientation of the coupling shaft splines and drive pin slot is important to subsequent assembly procedures that will produce the required rotor (6A) lobe and commutator (9) "fixed" radial relationship at assembly.

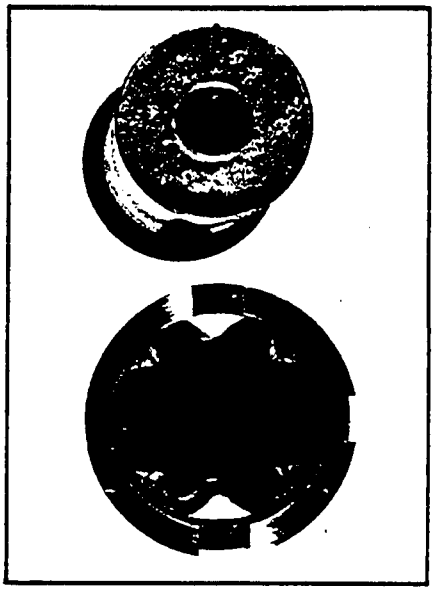


Figure 40

NOTE

NOTE: FIGURE 40, shows two coupling shafts to better illustrate the relative positioning of the timing mark, drive pin slot and internal spline tooth.

extend timing mark

10. Using chalk or marking pencil, extend the timing mark that is on the end of coupling shaft (11) up the side of the coupling shaft so that the timing mark location will be visible for alignment purposes when the coupling shaft is assembled into the housing held in the vise. SEE FIGURE 41.

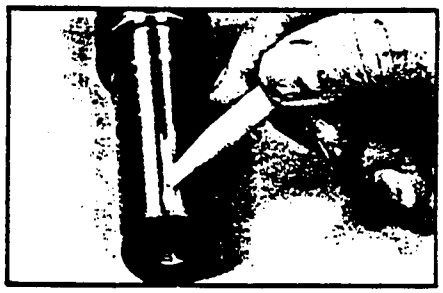


Figure 41

install coupling shaft

11. Be sure that a generous amount of clean wheel bearing grease is applied to housing bearing (19) then install coupling shaft (11) into housing (15) seating it against thrust washer (13). SEE FIGURE 42. The coupling shaft must rotate smoothly on the thrust bearing package.

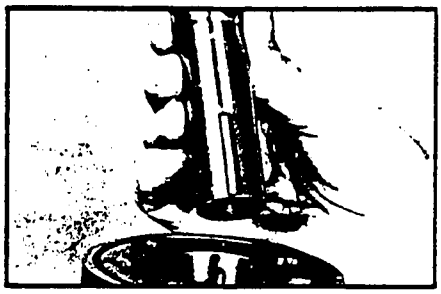


Figure 42

insert new drive pin

12. Insert new drive pin (10) if it was removed, into the commutator (9) drive pin hole until it bottoms out. SEE FIGURE 43.

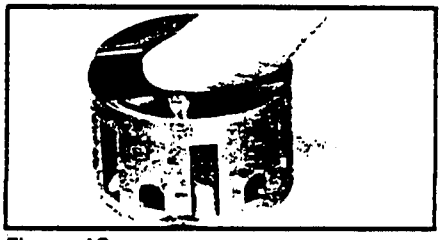


Figure 43

install commutator assembly

13. Install commutator (9) assembly into housing (15) commutator bore. SEE FIGURE 44. The commutator must not be cocked as it enters the bore and the drive pin (10) must be in line with the coupling shaft (11) commutator drive pin slot indicated by the timing mark. Engage the drive pin (10) protruding from the commutator into the coupling shaft drive pin slot, rotating the coupling shaft if necessary. The commutator must be below the housing wearplate surface when correctly seated. SEE FIGURE 45.

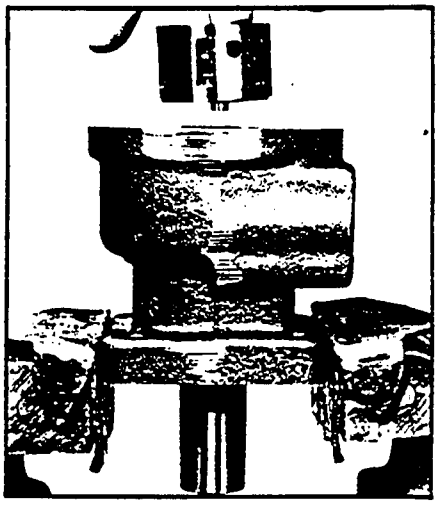


Figure 44

NOTE

NOTE: The commutator drive pin (10) and coupling shaft (11) drive pin slot, at this point in the assembly, are visible through the commutator center cavity for coupling pin engagement purposes in addition to the timing mark.

CAUTION

CAUTION: Do not force commutator into bore. It is a close slip fit and must rotate.

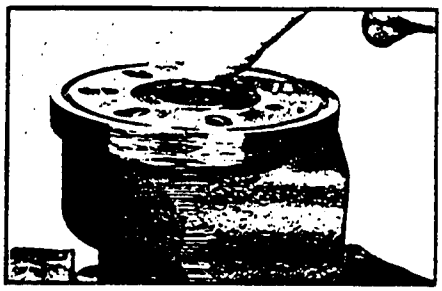


Figure 45

install drive link

14. Install either end of the drive link (8) through the commutator (9) cavity and engage the lower drive link splines into mesh with the internal splines in the coupling shaft (11). SEE FIGURE 46. A spline valley on both ends of the drive link will now be in line with the commutator drive pin (10) and coupling shaft timing mark.

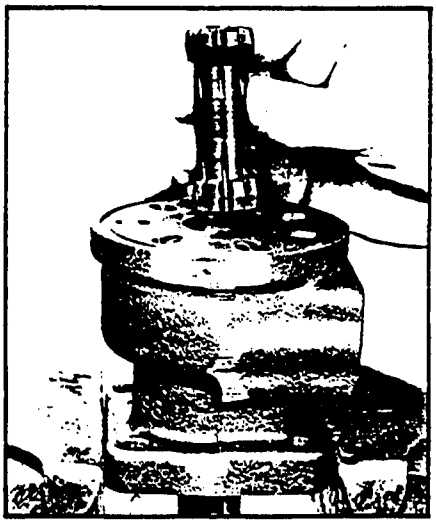


Figure 46

insert seal ring into housing

15. Apply a small amount of clean grease to a new seal ring (5) and insert the seal ring into housing (15) seal ring groove. SEE FIGURE 47.

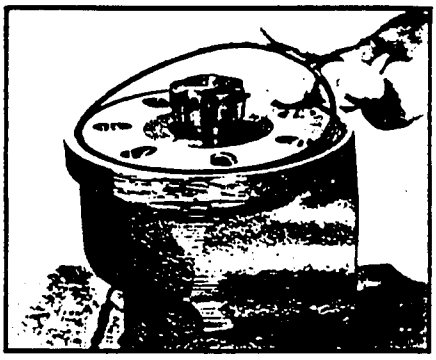


Figure 47

insert seal ring into stator

16. Place assembled rotor set (6) on a clean work surface with the stator (6B) seal ring groove up. Apply a small amount of clean grease to a new seal ring (5) and insert the seal ring into the stator (6B) seal ring groove. SEE FIGURE 48.

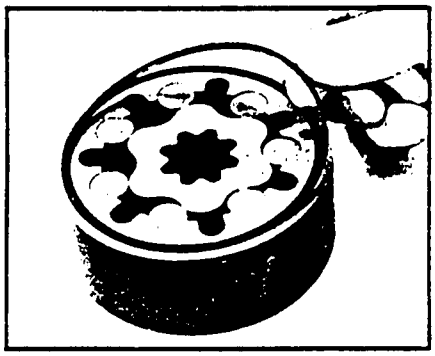


Figure 48

place wearplate on rotor set

17. Place wearplate (7) either side up, onto the rotor set (6) and align wearplate bolt holes with the stator (6B) bolt slots. SEE FIGURE 49.

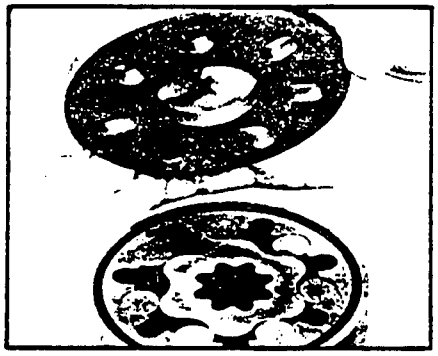


Figure 49

install rotor set & wearplate on housing

18. Locate on the rotor (6A) the only two spline teeth, 180° apart, that are diametrically aligned (on the same center line) with two rotor lobes. SEE FIGURE 50. Take the rotor set (6), seal ring (5) and wearplate (7) as a unit and align these two just located rotor spline teeth to mesh with the two drive link (8) spline valleys that are diametrically aligned with the timing mark on the coupling shaft (11) and install this unit onto the housing (15) with the wearplate against the housing. SEE FIGURE 51. With the rotor set (6) now correctly in mesh with the drive link, rotate the rotor set (6) wearplate (7) drive link (8) and coupling shaft (11) to align the stator (6B) and wearplate bolt holes with the bolt holes in the housing. SEE FIGURE 52.

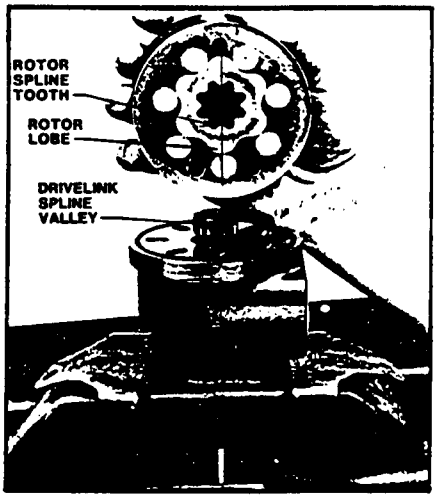


Figure 50

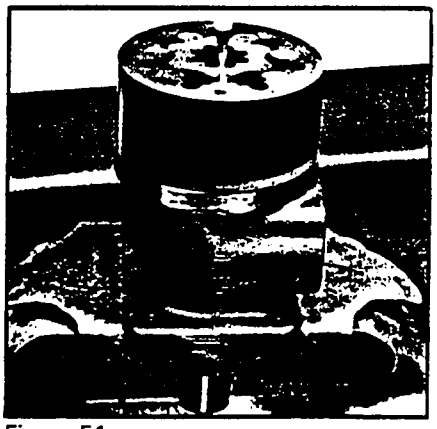


Figure 51

CAUTION

CAUTION: Be careful not to disengage the rotor, drive link or coupling shaft while aligning bolt holes as this could affect the timing you just achieved.

CAUTION

CAUTION: The meshing of the precise rotor (6A) teeth with the precise drive link (8) spline valleys as described above is absolutely crucial to a correctly timed and functional MAF Torqmotor™. Misalignment by one spline tooth will be indicated by the timing mark on the coupling shaft (11) being radially 45° from the specified rotor lobe. Refer to "Final Checks" Page 25.

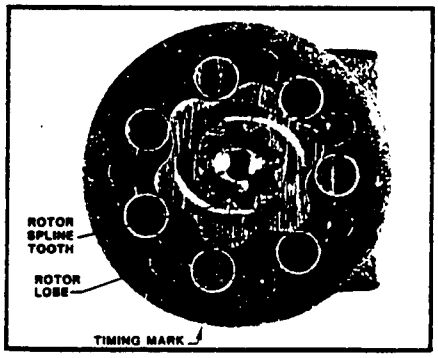


Figure 52

install drive link spacer/washer

19. Install drive link spacer/washer (4) into the rotor spline cavity onto the end of the drive link (8). SEE FIGURE 53.

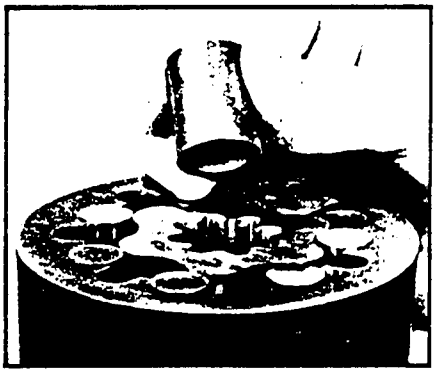


Figure 53

insert seal ring

20. Apply a small amount of clean grease to a seal ring (5) and insert the seal ring into the end cover (3) seal ring groove. SEE FIGURE 54.

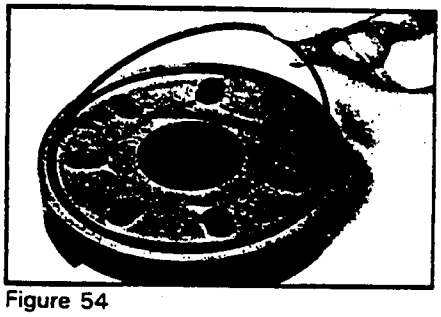


Figure 54

install end cover

21. Install end cover (3) assembly onto the rotor set (6) with seal ring (5) against the stator (6B) and align the end cover bolt holes with the stator (6B) bolt holes. SEE FIGURE 55.

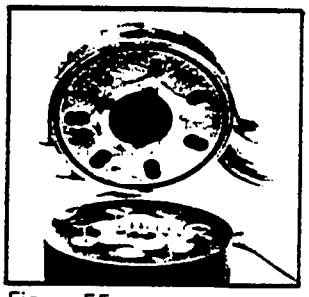


Figure 55

install & torque bolts

22. Install 7 bolts (2) into the assembly bolt holes finger tight, then torque the bolts to 22-26 foot pounds, (30-35Nm), in the sequence shown, using the appropriate torque wrench. SEE FIGURES 56, 57 and 58.

    The assembly of the MAF Torqmotor™ is now complete, except for the woodruff key (1), port manifold o-rings (21) or nut (22), if required, at Torqmotor™ installation. See Page 25 for final checks.

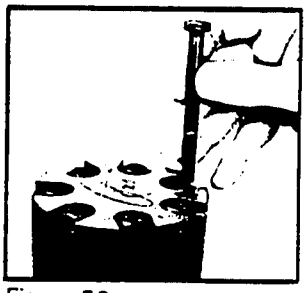


Figure 56

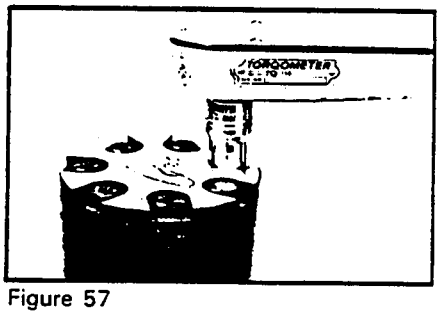


Figure 57

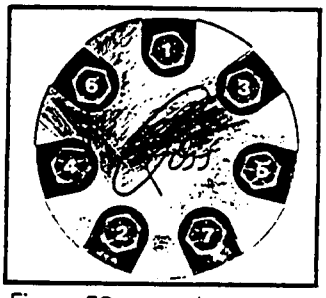


Figure 58

Rotor Set Component Assembly Procedure

place housing in vise

1. Place housing (15) in a vise per MAF motor assembly procedure #9 and FIGURE 39 (Page18).

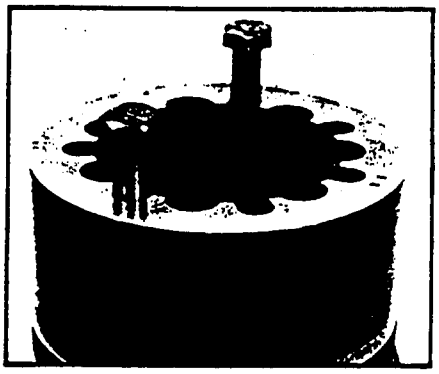


FIGURE 59

place wearplate & stator on housing

2. Place wearplate (7) and then stator (6B) on the housing (15) and align the bolt holes of the three parts.

insert two bolts

3. Insert two bolts (2) into bolt holes finger tight, approximately 180° apart to retain the stator (6B) and wearplate (7) stationary on the housing (15). SEE FIGURE 59.

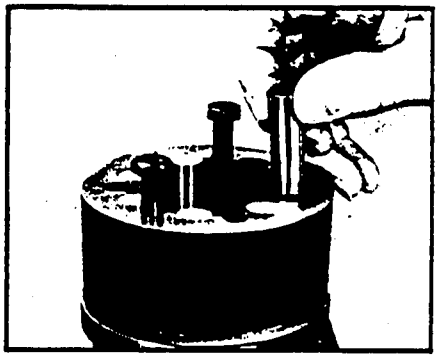


Figure 60

assemble six stator vanes & rotor

4. Assemble the rotor (6A) into the stator (6B) with six vanes (6C) or as many vanes that will readily fit into the stator vane pockets. SEE FIGURE 60 and 61.

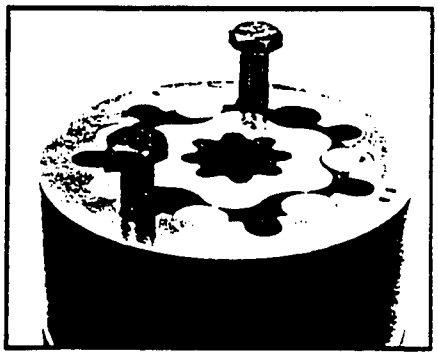


Figure 61

NOTE

NOTE: A special tool (See Page 7A) or the drive link (8) held in large locking pliers between two rods or nails to protect the drive link splines (SEE FIGURE 62) will be required to rotate the rotor in the following procedure.

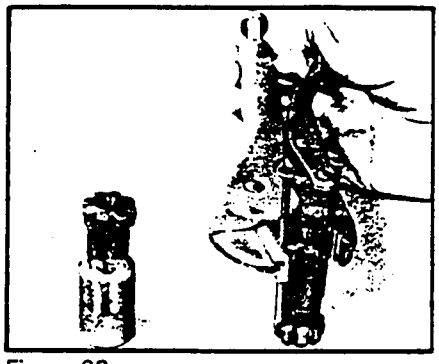


Figure 62

assemble seventh stator vane

5. Rotate the rotor (6A) using the tool described above to seat the rotor and assembled vanes (6C) into the stator (6B) and to create necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force. SEE FIGURE 63.

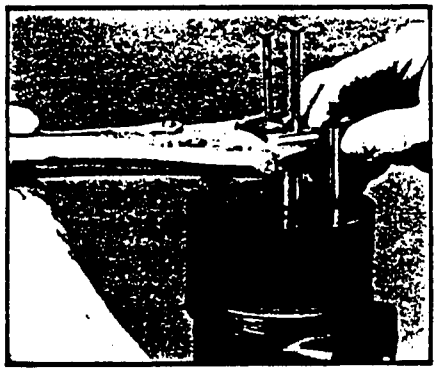


Figure 63

CAUTION

CAUTION: Too much force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets. Use care during this procedure to prevent damage to rotor set and the drive link splines, if you use your drive link as the assembly tool as shown in FIGURE 63.

remove tool, bolt, rotor set & wear plate

6. Remove drive link tool, the two bolts, then the assembled rotor set (6) and wearplate (7) as a unit from the housing and set them aside for subsequent Torqmotor™ assembly procedures. SEE FIGURE 64.

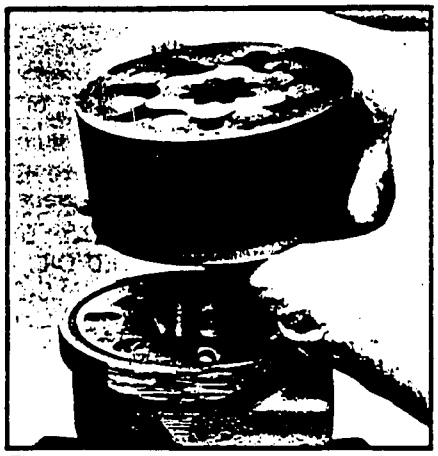


Figure 64

NOTE

NOTE: Go to the notes preceding Step 10 of the MAF Assembly Procedure if the MAF Assembly Procedure was interrupted after MAF Assembly Step 9, to assemble the rotor set.

Final Checks

Pressure port with "A" cast under it on housing (15) 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.

CAUTION: If the MAF Torqmotor™ is reassembled with rotor and coupling shaft internal splines one tooth (45°) or three teeth (135°) out of phase in either direction, the MAF will not function.

If the MAF Torqmotor™ is reassembled with rotor and coupling shaft internal splines two teeth (90°) out of phase, in either direction, it is fully functional but, the direction of rotation of coupling shaft will be reversed to what is designated for a pressurized port "A" or port "B".

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.

Cautions required for Proper Torqmotor™ Hydraulic System Operation

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.

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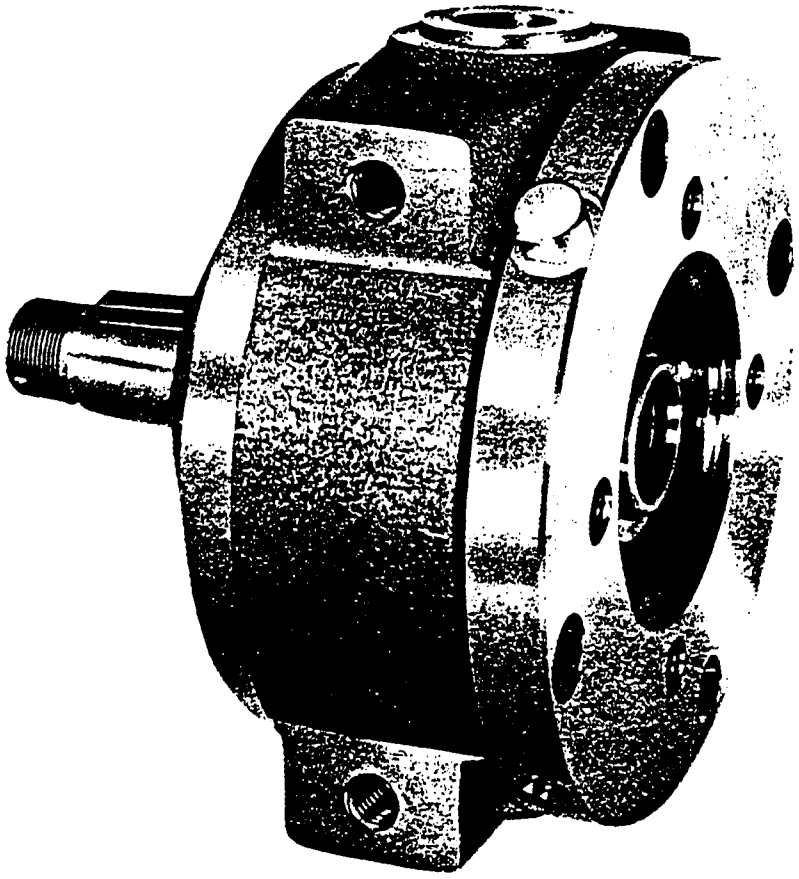
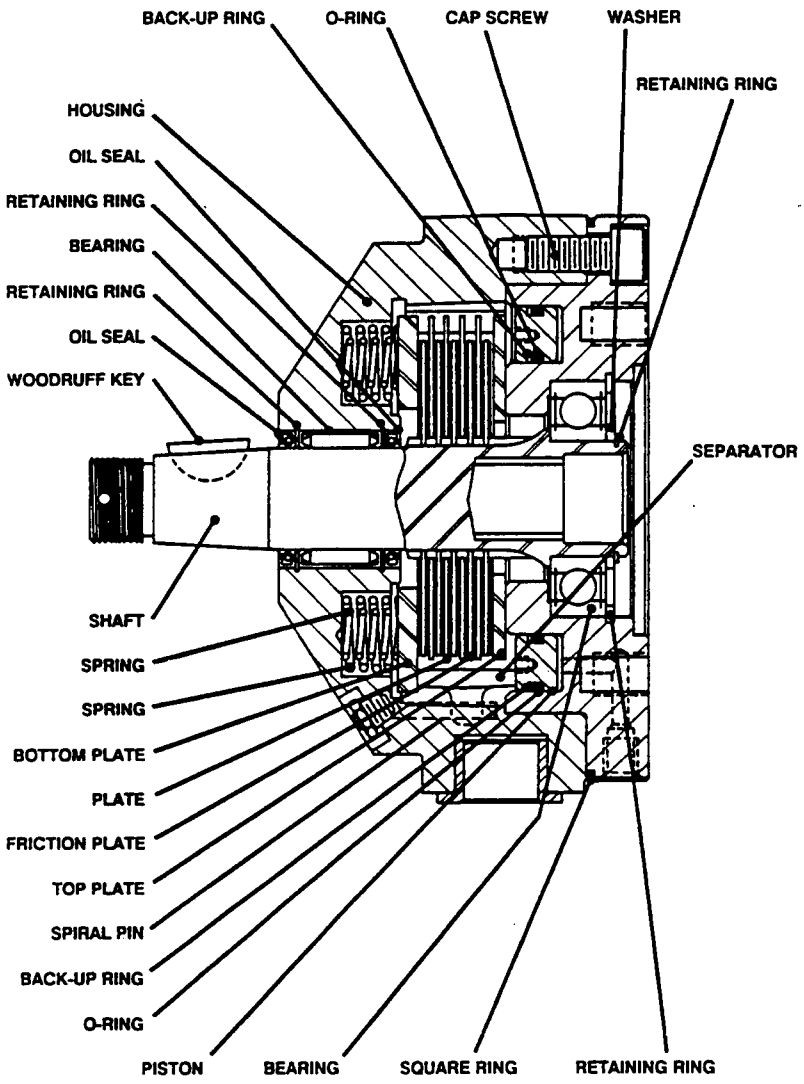
Service Manual



MULTIPLE DISC BRAKE

(trunnion)

TYPICAL TRUNNION BRAKE



DESCRIPTION AND OPERATION OF THE MICO MULTIPLE DISC BRAKE

The MICO Multiple Disc Trunnion Brake (dry design) is a wheel mount brake designed specifically for use with vehicles requiring parking or emergency brake capabilities on their steering axle.

This Multiple Disc Trunnion Brake provides consistent braking torque, positive hold, and long life in rugged environments.

The Brake will reduce maintenance and downtime because contaminants which cause brake lining wear are prevented from entering the brake.

Braking is provided by a pack of rotating friction discs splined to the shaft, and stationary separator plates restrained by broached slots in the housing. Force is transmitted to the disc pack through a hydraulic piston and a series of preloaded springs. The brake is released by hydraulic pressure applied to the piston to compress the springs. The brake is self-applying since any function which reduces the hydraulic system pressure of the brake will start to initiate a brake application. Zero pressure produces maximum brake torque.

DISASSEMBLY

1. Remove woodruff key (item 27) from shaft (item 20).
2. Remove cover (item 6) from housing (item 26) by removing four cap screws (items 1).

   CAUTION: Cover is under spring tension of approximately 1500 pounds. The four cap screws should be loosened evenly to relieve this force. If a hydraulic press is available (3000 lbs. max.) the cover can be held in position while removing the cap screws.

3. Tap threaded end of shaft with a soft mallet to dislodge cover and shaft assembly from housing (item 26).
4. Remove retaining rings (items 2 & 3) and washer (item 4) from cover (item 6). Then separate shaft (item 20) and bearing (item 5) from cover.
5. Separate bearing (item 5) and shaft (item 20).
6. Remove square ring (item 7) from cover (item 6).
7. Remove piston (item 10) from cover (item 6) by inserting two 1/4 - 20 UNC bolts into threaded holes in piston. By turning and pulling, piston can be removed from bore.
8. Remove o-rings (items 9 & 12) and back-up rings (item 8 & 11) from piston (item 10).
9. Remove separators (item 13) from housing (item 26).
10. Remove top plate (item 14), friction plates (items 15), plates (items 16) and bottom plate (item 17) from housing (item 26).
11. Remove springs (items 18 & 19) from housing (item 26)
12. Remove oil seals (items 21 & 25), retaining rings (items 22 & 24) and bearing (item 23) from housing (item 26).

ASSEMBLY

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

1. Clean all parts thoroughly before assembly.
2. Press new bearing (item 23) into housing (item 26) and hold in place with new retaining rings (items 22 & 24).
3. Press new oil seals (items 21 & 25) into housing (item 26). Note direction of seals.
4. Insert springs (items 18 & 19) into housing (item 26).
5. Install new bottom plate (item 17) into housing so it is resting on springs.
6. Install new friction plates (items 15) and new plates (items 16) in an alternating pattern starting with a friction plate (item 15).
7. Install new top plate (item 14) over stack of friction plates (items 15) and plates (items 16).

   NOTE: Chamfered side of tabs must face downward towards housing (item 26).

8. Insert separators (items 13) over spiral pins in housing (item 26).
9. Insert shaft (item 20) into housing (item 26) engaging splines of shaft with splines of friction plates (items 15) until shaft bottoms out against oil seal (item 21).
10. Install new o-rings (items 9 & 12) and new back-up rings (items 8 & 11) on piston (item 10). Insert piston assembly into cover (item 6) being careful not to shear o-rings or back-up rings. Inserting 1/4 - 20 UNC bolts in piston may simplify installation.
11. Install new square ring (item 7) on cover (item 6).
12. Position cover (item 6) on housing (item 26). Install four cap screws (items 1) and tighten evenly to draw cover (item 6) to housing (item 26). Torque cap screws to 55 ft. lbs.

    NOTES:

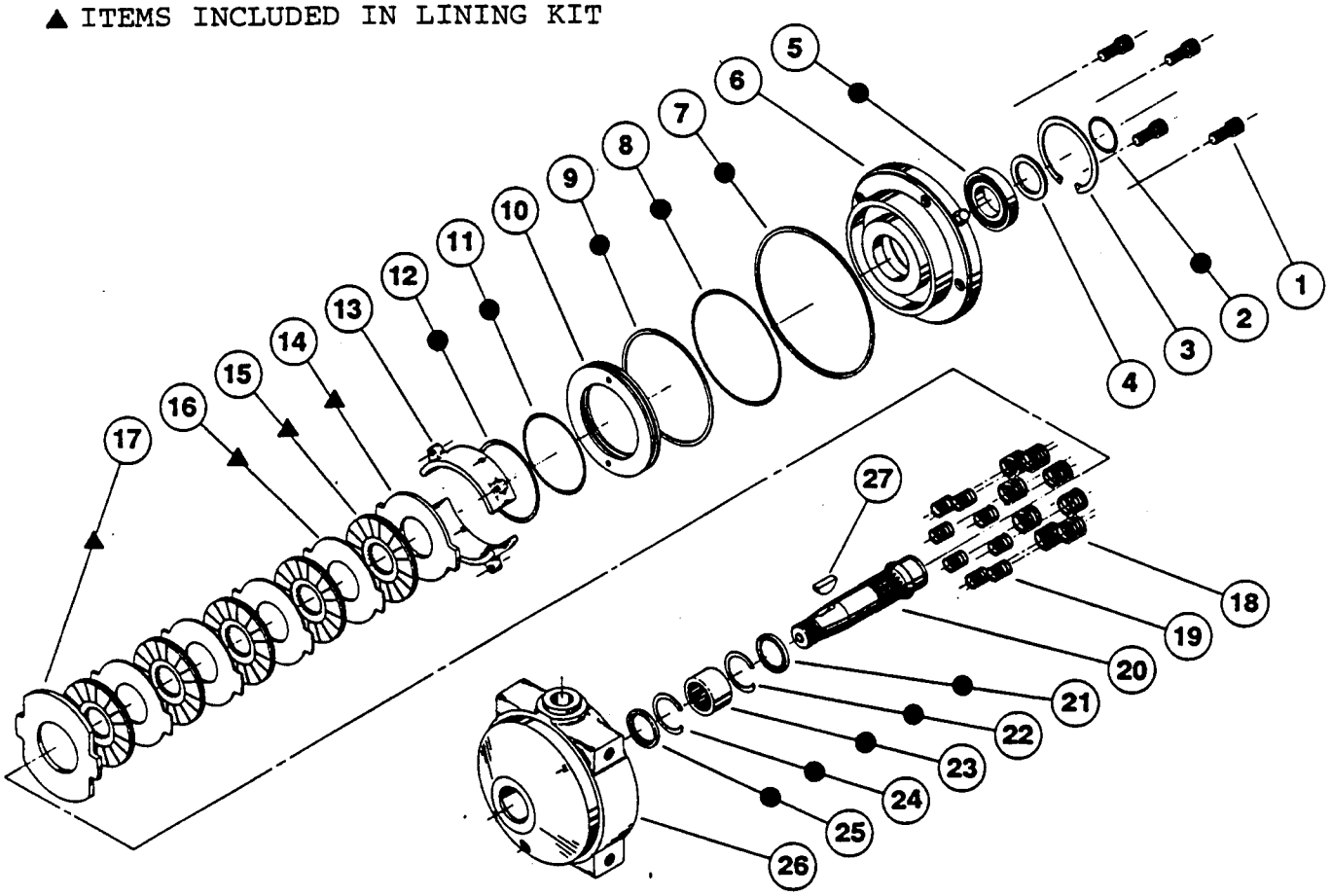
    1) If available, a hydraulic press will simplify installation of cover on housing. Clamp cover in position while tightening the cap screws.

    2) Top plate (item 14) is not engaged with broached slots in housing (item 26) during assembly. Therefore, alignment of tabs with broached slot is critical.

13. Move shaft (item 20) upward so that bearing shoulder on shaft is slightly above bearing shoulder in cover (item 6). With shaft held in this position press new bearing (item 5) until it shoulders on shaft (item 20).
14. Install washer (item 4) and new retaining ring (item 2) on shaft to hold bearing (item 5) in place.
15. Press outer race of bearing (item 5) until it shoulders out in cover (item 6).
16. Install retaining ring (item 3) in cover (item 6) to retain bearing (item 5) in position.
17. Install woodruff key (item 27) in shaft (item 20).

● ITEMS INCLUDED IN SEAL KIT

▲ ITEMS INCLUDED IN LINING KIT



ITEM	DESCRIPTION
1	CAP SCREW (4)
● 2	RETAINING RING
3	RETAINING RING
4	WASHER
● 5	BEARING
6	COVER
● 7	SQUARE RING
● 8	BACK-UP RING
● 9	O-RING
10	PISTON
● 11	BACK-UP RING
● 12	O-RING
13	SEPARATOR
▲ 14	TOE PLATE

ITEM	DESCRIPTION
▲ 15	FRICTION PLATE (5)
▲ 16	PLATE (4)
▲ 17	BOTTOM PLATE
18	SPRING (8)
19	SPRING (8)
20	SHAFT
● 21	OIL SEAL
● 22	RETAINING RING
● 23	BEARING
● 24	RETAINING RING
● 25	OIL SEAL
26	HOUSING
27	WOODRUFF KEY
▲●	MOUNTING GASKET (NOT SHOWN)

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

BRAKE WON'T RELEASE

1. Insufficient release oil pressure.
2. Damaged o-rings (items 9 or 12).
3. Damaged piston (item 10).
4. Damaged bearings (items 5 or 23).
5. Discs (items 15 & 16) warped or welded together due to excessive heat.

BRAKE WON'T APPLY

1. Residual oil pressure in release section of brake.
2. Damaged spring (items 18 & 19).
3. Damaged piston (item 10).
4. Broken cap screws (items 1) allowing cover (item 6) to move away from housing (item 26).

BRAKE APPLIES BUT
TORQUE LOW

1. Residual oil pressure in release section of brake.
2. Springs (items 18 & 19) have taken permanent set due to excessive heat.
3. Friction discs (items 15) worn out.
4. Oil leakage into plate area of brake.

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

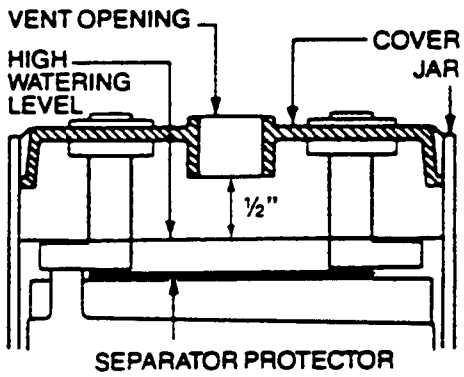
Approved Water

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.

MANUAL BATTERY CHARGER OPERATION

INTRODUCTION

The Lester-Matic battery charger is a highly reliable, line compensating unit. When used according to instructions, the Lester-Matic will tend to lengthen battery life with less frequent additions of water.

INITIAL INSTALLATION

Provide adequate circuit breaker or fuse protection in the AC line to which the charger is to be plugged. Refer to electrical specifications on charger nameplate for input power requirements. When it is necessary to use an AC extension cord to the charger, use a three conductor No. 12 AWG cord with ground, and keep as short as possible. Instructions printed on the charger case are for daily reference.

NORMAL OPERATION

1. Provide adequate ventilation for both batteries and charger. The convection-cooled design requires an unobstructed flow of cooling air for proper operation.

2. Connect charger DC output cord to batteries.

3. Turn timer to "ON" for well discharged batteries or to "7" for lightly discharged batteries. Charger shuts off automatically at end of set period.

The state of discharge of the batteries will be slightly different each time they are put on charge, but the Lester-Matic varies automatically the initial charge rate, and taper of charge rate over the charge period. For well discharged batteries the charge rate at the start of the charge period should correspond to the "DC AMPS" rating on the charger nameplate. The rate should then taper gradually down to a lower finish rate. Normal charging at the low finish rate during the last 1-3 hours is necessary to achieve equalization of all battery cells. This equalization period allows the specific gravity of the battery electrolyte solution to rise to its full charge value. Since the taper of the charging rate (in amps, as indicated by the ammeter needle) is controlled by the rising voltage of the batteries being charged, proper performance of the charger and resulting good battery life is dependent upon the following factors:

a. An adequate AC line to handle the power required.

b. All cells of the batteries must be good, rising to approximately 2.5 DC volts per cell while still on charge or near the end of a charging period. When in doubt, check each cell with a single cell volt-meter while still on charge. If a low reading is obtained, check the low cells with a temperature corrected hydrometer. NOTE: Hydrometer float must be thoroughly clean to obtain accurate specific gravity readings.

c. Connections on the battery terminals and connector wiring must be clean and tight.

The necessity of adding water more frequently than two or three weeks, and/or hot battery cases at the end of the charging cycle, indicates the finish rate is

NORMAL OPERATION (CONTINUED)

too high, due to one or both of the following:

a. One or more bad cells in the batteries.

b. Batteries are starting to age to the point where hours of charge should be reduced gradually to obtain prolonged battery life.

4. To determine approximate full charge at start of day's use, turn timer knob to "1". Drop of ammeter needle to the low finish rate within 15 minutes indicates full charge.

5. Always turn timer to "OFF" before disconnection charger from batteries.

STORAGE

Charger may be left connected to the batteries and should be turned on for a full charge period once a month. In extremely cold conditions it may be necessary to charge more frequently. Check with your battery manufacturer. After each charge cycle the charger should be checked to insure that it has turned off. Severe overcharging and possible damage to the batteries could result if the charger remains on for prolonged periods of time.

CAUTION

THIS CHARGER IS FOR USE ONLY ON BATTERY SYSTEMS AS SPECIFIED ON THE CHARGER NAMEPLATE. USE OTHERWISE WILL DAMAGE CHARGER AND/OR BATTERIES.

Due to the electrical characteristics of this charger, it is possible to improperly hook up batteries and not blow the fuses when charging. When installing batteries, be sure polarity is correct. With a DC voltmeter, check terminal voltage and polarity at the battery connector.

When working near capacitor terminals be sure charger is turned off. With charger "on" transformer capacitor terminals provide a very high voltage. Care is to be shown.

MALFUNCTION SYMPTOMS AND THEIR REMEDIES

The Lester-Matic charger is designed with as few parts as possible making it a very reliable unit. Since each component can be tested individually, trouble shooting is a simple task. The following is a list of symptoms with their associated test procedures and remedies.

NO TRANSFORMER HUM AND AMMETER DOES NOT REGISTER

In the event no hum is detected from the transformer, check the AC cord to be sure it is securely plugged into a live AC outlet. When three-prong or two-prong adapters are used, they tend to work loose giving a poor connection. If the cord connection is secure and still no hum is noticed, a continuity test of the AC circuit is necessary. Turn the timer to "ON" and with a suitable continuity tester, check circuit across the AC plug prongs. CIRCUIT SHOULD BE COMPLETE. If not complete, individually check the AC cord, timer, primary transformer coil, and all connections.

TRANSFORMER HUMS BUT NO AMMETER INDICATION

Inspect the charger DC output connection to the batteries and also check to insure that the batteries are connected properly. If there is still no ammeter indication, a continuity test of the charger DC circuit must be performed. Turn the timer to "OFF" and disconnect the A.C. and D.C. plugs. Perform the following tests, using a low voltage test light, to check the continuity of the DC circuit.

(a) Connect tester clip to negative (-) blade and probe to positive (+) blade. CIRCUIT SHOULD BE COMPLETE. If not complete, first check the DC fuse link. If one or both fuses have blown, the link will be broken and usually the clear plastic fuse cover will be discolored. Refer to "Fuse Link Blowing" for test procedures. If fuses are good, individually check the fuse connections, DC cord, and diode connections (each may be checked with the continuity test light).

(b) If the circuit in (a) is complete, reverse test light leads. CIRCUIT SHOULD NOT BE COMPLETE. If circuit is complete, check DC cord for a "short" between the two wires. More probably, one or both diodes have "shorted". Refer to "Fuse Link Blowing" part (b) for continuity test of diodes.

(c) If (a) and (b) check good, assume the capacitor is shorted. Remove one wire from a capacitor terminal and place continuity tester clip to one terminal and probe to other. If circuit is complete, capacitor is "shorted" and must be replaced.

CHARGER DC FUSE LINK(S) BLOWS

This condition may be caused by:

(a) Reverse polarity between charger and batteries, such as incorrect installation of batteries, wiring of DC connector or charger plug.

(b) A short circuit failure of one or both diodes. First disconnect one diode. Using a low voltage continuity tester check each diode. Then reverse the tester leads and check each diode again. If the diode conducts current in both directions the diode is shorted and must be replaced. Replace either the entire heat-sink assembly or the defective diode. When replacing a single diode be sure the new diode is pressed squarely into the hole and that it does not extend beyond the rear surface of the heat sink plate.

(c) If (a) and (b) fail to reveal the malfunction, check wiring of both charger and battery connections against their respective wiring diagrams. The charger wiring diagram is shown on the enclosed sheet along with the parts list.

CHARGER OUTPUT IS LOW

The most probable cause is one diode shorting and blowing one fuse. Refer to "Fuse Link Blowing" part (b) to check the diodes. If a diode is shorted, both the defective diode/heat sink and the defective fuse assembly must be replaced.

CHARGER DOES NOT TURN OFF

In models equipped with timers, this is due to an inoperative timer. In this case replace timer assembly.

AC LINE FUSE OR CIRCUIT BREAKER BLOWS

If this occurs when charger is turned on without being plugged into the vehicle, the AC cord, timer motor coil, or the transformer may be shorted. To check the AC cord, insure that the timer is "OFF" and connect the continuity tester across the AC plug prongs. If circuit is complete the LAC cord is shorted and must be replaced. To check the timer motor coil, disconnect one of the timer motor wires and connect continuity tester to the motor coil leads. If the lamp glows, the coil is shorted. To test the transformer, first disconnect all the secondary leads to the diodes. Then reconnect the AC cord and turn timer "ON". If the AC fuse or circuit breaker still blows, the transformer is probably shorted internally and must be replaced.

PROPER CARE OF MOTIVE POWER BATTERIES

1. New batteries should be given a full charge before their first use because it is difficult to know how long the batteries have been in storage without a charge.

2. Limit use of new batteries between charges for the first 5 cycles. New batteries and older batteries which have been in storage are not capable of their rated output until they have been discharged and charged a number of times.

3. During the first month of use, particularly when temperatures are below 60°F, new batteries should be given an extra full charge once a week. The ampere-hours of energy that batteries can deliver and their charge acceptance varies directly with battery temperature.

4. As long as the charger tapers down to the specified finish charge rate near the end of the charge cycle, the batteries should be given a full charge. All cells in a set of batteries do not react identically to the same discharge and charge current. In a normal charge, the last 1 to 3 hours at the low finish charge rate equalize the cells for better battery life.

5. When batteries age to the point where the charge rate will no longer taper into the low finish rate area, reduce the hours of charge progressively. Reducing the charge period will prevent excessive battery heating and the resultant high water use rate.

6. Prior to each day's use, turn the charger on and check to see if charger ammeter needle jumps smartly upward and then tapers down to the finish rate area within 15 minutes. This will provide a very simple means of verifying that the batteries were charged.

7. Add water carefully to the proper level in cells as required after they have beenfully charged. Do not fill them so high that they bubble over while charging. New batteries require very little addition of water, whereas very old batteries may need additional water two or three times a week. Water (electrolyte) level in the cells settles when batteries are discharged and rises during charge. The probability of overfilling can be reduced by adding water when batteries are fully charged.

8. When the temperature falls below 65°F, batteries should be placed on charge as soon after use as possible. In these low temperatures a 4 hour equalizing charge once a week will improve state of charge and battery life.

9. Keep tops of batteries and battery hold-downs clean and dry at all times. This will reduce the amount of current leakage between batteries and the frame.

LESTRONIC II BATTERY CHARGER(S)

OPERATING INSTRUCTIONS

1. CONNECT POWER SUPPLY CORD TO PROPERLY GROUNDED OUTLET OF THE PROPER VOLTAGE AND FREQUENCY AS SPECIFIED ON THE CHARGER NAMEPLATE. CIRCUIT BREAKER OR FUSE PROTECTION IN THE AC LINE MUST BE ADEQUATE TO HANDLE THE INPUT POWER REQUIREMENTS. WHEN IT IS NECESSARY TO USE AN AC EXTENSION CORD TO THE CHARGER USE A THREE CONDUCTOR, 12 GAUGE CORD WITH GROUND AND KEEP AS SHORT AS POSSIBLE.

   IF DC OUTPUT CORD IS CONNECTED TO BATTERIES, CHARGER WILL AUTOMATICALLY TURN "ON" AFTER A SHORT DELAY.

2. CONNECT DC OUTPUT CORD TO BATTERIES (IF NOT ALREADY CONNECTED).

3. MONITOR AMMETER FOR CORRECT CHARGE RATE. NORMAL CHARGING AT THE FINISH CHARGE RATE FOR THE LAST 3 TO 5 HOURS IS IMPORTANT TO ACHIEVE EQUALIZATION OF ALL BATTERY CELLS EVERY TIME THE BATTERIES ARE CHARGED. NEW BATTERIES OR BATTERIES CHARGED IN COLD TEMPERATURES (BELOW 50 DEGREES F) WILL REQUIRE MORE TIME TO ACHIEVE FULL CHARGE.

4. CHARGER TURNS "OFF" AUTOMATICALLY WHEN BATTERIES ARE FULLY CHARGED.

CAUTION

DO NOT LEAVE CHARGER "ON" WHILE UNATTENDED FOR MORE THAN TWO CONSECUTIVE DAYS. SEVERE OVERCHARGING AND POSSIBLE DAMAGE TO BATTERIES WILL RESULT IF CHARGER SHOULD FAIL TO TURN "OFF".

OWNERS MANUAL

AUTOMATIC BATTERY CHARGER

P/N 70435

INPUT: 230 VAC, 50 HZ.
OUTPUT: 24 VDC, 30 AMP.

CAUTION

THIS CHARGER IS INTENDED FOR THE CHARGING OF A 12 CELL (24V) LEAD ACID STORAGE BATTERY ONLY. USE OF THIS CHARGER ON ANY OTHER BATTERY COULD CAUSE DAMAGE TO THE BATTERY AND/OR TO THE CHARGER.

THIS MANUAL CONTAINS VITAL INFORMATION FOR THE SAFE USE AND EFFICIENT OPERATION OF THE BATTERY CHARGER. CAREFULLY READ THIS MANUAL BEFORE USING CHARGER, AND RETAIN FOR FUTURE REFERENCE. FAILURE TO ADHERE TO INSTRUCTIONS COULD RESULT IN SERIOUS BODILY INJURY OR PROPERTY DAMAGE. ALL REPAIRS SHOULD BE MADE BY QUALIFIED PERSONNEL ONLY.

CAUTION

DO NOT EXPOSE CHARGER TO WATER, MOISTURE, CLEANING AGENTS OR POWER WASH.

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CHARGER OPERATION

1. CHARGER INSTALLATION: MOUNT THE CHARGER IN THE VEHICLE AND CONNECT THE CHARGER POSITIVE (WHITE) DC CORD LEAD TO THE POSITIVE BATTERY TERMINAL AND CONNECT THE CHARGER NEGATIVE (BLACK) DC CORD LEAD TO THE NEGATIVE BATTERY TERMINAL.

2. ELECTRICAL SUPPLY: THIS CHARGER MUST BE OPERATED FROM A PROPERLY GROUNDED 230 VOLT, 50 HZ AC OUTLET ONLY.

3. CHARGER OPERATION:

   A. STARTING THE CHARGER, INSERT THE AC PLUG INTO THE APPROPRIATE CHARGER AC RECEPTACLE. THE CHARGER WILL START WHEN THE AC PLUG IS INSERTED.

   B. MONITOR METERS: THE AMMETER SHOULD INDICATE AN INITIAL CHARGE RATE OF APPROXIMATELY 30 AMPS. THE CHARGE RATE WILL GRADUALLY TAPER TO A FINISH RATE OF FROM 2 TO 10 AMPS.

   C. MONITOR LIGHTS (LIGHT EMITTING DIODES - L.E.D.):

      (1) THE GREEN "AC POWER ON" LIGHT SHOULD GLOW AT ALL TIMES WHEN THE AC CORD IS PLUGGED INTO A "LIVE"

230 VAC 50 HZ OUTLET AND THE DC CORD IS CONNECTED TO THE BATTERY.

NOTE: THE GREEN LIGHT, DUE TO THE CHARACTERISTICS OF THE L.E.D., MAY NOT BE HIGHLY VISIBLE WHEN THE CHARGER IS LOCATED IN A BRIGHTLY LIGHTED AREA.

(2) THE RED LIGHT "CHARGE ON/COMPLETE" SHOULD BLINK WHEN THE CHARGE STARTS AND REMAIN BLINKING UNTIL THE CHARGE IS COMPLETED. WHEN THE CHARGE IS COMPLETE THE LIGHT WILL STOP BLINKING AND GLOW CONTINUOUSLY. IF THE RED LIGHT IS "OFF", NOT GLOWING OR BLINKING, THEN A POSSIBLE PROBLEM EXISTS.

(3) THE YELLOW LIGHT "AC INTERRUPT" WHEN GLOWING INDICATES THAT THE 230 VAC POWER SOURCE HAS BEEN INTERRUPTED WHILE THE CHARGE WAS IN PROGRESS. ALL LIGHTS WILL BE OFF DURING THE ABSENCE OF THE AC POWER.

NOTE: IF THE CHARGE IS TERMINATED BY UNPLUGGING THE AC CORD OR IF THE "AC INTERRUPT" LIGHT IS GLOWING WHEN THE AC CORD IS UNPLUGGED, THE STOP/RESTART SWITCH MUST BE MOMENTARILY ENGAGED PRIOR TO THE NEXT CHARGE TO PREVENT THE "AC INTERRUPT" LIGHT FROM GLOWING WHEN THE NEXT CHARGE IS STARTED.

(4) THE ORANGE LIGHT "CHECK BATTERY" INDICATES ONE OF THE FOLLOWING TWO CONDITIONS: THAT THE BATTTERIES ARE NOT BEING CHARGED BEFORE THE PRESET MAXIMUM TIME HAS ELAPSED, OR THE BATTERY POTENTIAL OF 2.35 VOLTS/CELL HAS NOT BEEN REACHED IN THE COURSE OF THE CHARGE. THIS LIGHT SHOULD NOT GLOW UNDER NORMAL CIRCUMSTANCES. IF THE ORANGE LIGHT GLOWS AFTER THE CHARGE IS TERMINATED, CHECK THE BATTERY FOR WEAK CELLS.

D. CHARGE TERMINATION: THE CHARGER AUTOMATICALLY TERMINATES THE CHARGE WHEN THE BATTERIES ARE FULLY CHARGED OR WHEN THE PRESET MAXIMUM TIME HAS ELAPSED OR IF THE BATTERY POTENTIAL AFTER REACHING 2.16 VOLT/CELL STOPS INCREASING FOR A TIME PERIOD OF 80 MINUTES BEFORE REACHING 2.35 VOLTS/CELL. THE CHARGE MAY ALSO BE TERMINATED MANUALLY BY MOMENTARILY ENGAGING THE STOP/RESTART SWITCH. IF THE SWITCH IS DEPRESSED BEFORE (SIX) 6 MINUTES OF CHARGE TIME HAS ELAPSED OR IF THE BATTERY VOLTAGE IS BELOW 2.35 VOLT/CELL THE FAULT LIGHT WILL GLOW. IF VOLTAGE IS HIGHER THAN 2.35, THE COMPLETE LIGHT WILL GLOW. THE PRESET MAXIMUM CHARGE TIME IS TWENTY (20) HOURS.

CAUTION

DO NOT DISCONNECT THE DC CORD FROM THE VEHICLE DURING CHARGE. IF THE BATTERY MUST BE DISCONNECTED, STOP CHARGER WITH THE STOP/RESTART SWITCH, THEN UNPLUG AC CORD.

E. CHARGE TIME: THE TIME REQUIRED TO FULLY CHARGE THE BATTERIES WILL NORMALLY BE 8 TO 12 HOURS.

F. FULL CHARGE TEST: TO TEST FOR A FULL CHARGE ON A 24V BATTERY, RESTART THE CHARGER WITH THE STOP/RESTART SWITCH. IF THE BATTERY IS FULLY CHARGED, THE CHARGE RATE SHOULD DROP TO APPROXIMATELY 8 TO 15 AMPS WITHIN 10 TO 20 MINUTES. THE CHARGER WILL AUTOMATICALLY SHUT OFF WITHIN 45 TO 90 MINUTES OR IT MAY BE SHUT OFF WITH THE STOP/RESTART SWITCH.

G. AC POWER FAILURE: IF AN AC POWER FAILURE OCCURS DURING THE CHARGE, THE CHARGER WILL AUTOMATICALLY RESUME THE CHARGE WHEN THE AC POWER RETURNS. ALL CHARGER TIMING IS RESET TO ZERO TIME. THE "AC INTERRUPT" LIGHT WILL GLOW TO INDICATE THAT THE AC POWER HAS FAILED.

H. CHARGER RESTART: THE CHARGER MAY BE RESTARTED AFTER IT HAS SHUT OFF BY UNPLUGGING THE AC POWER CORD FOR A FEW SECONDS (3 TO 5 SECONDS) AND THEN PLUGGING THE CORD BACK IN. ALSO, THE CHARGER MAY BE RESTARTED BY MOMENTARILY ENGAGING (3 TO 5 SECONDS) THE STOP/RESTART SWITCH.

IF THE CHARGER AC CORD REMAINS CONNECTED TO THE 230 VAC 50 HZ AND THE DC CORD REMAINS CONNECTED TO THE BATTERIES AFTER THE CHARGER HAS FINISHED THE FIRST CHARGE, THE CHARGER WILL AUTOMATICALLY RESTART AFTER A PRESET NUMBER OF DAYS (24 HOUR PERIODS). THE CHARGE TIME (PROVIDED THE BATTERIES ARE UNLOADED) WILL NORMALLY BE 15 TO 90 MINUTES. THE CHARGER WILL AUTOMATICALLY SHUT OFF AND AGAIN TURN ON AFTER THE PRESET NUMBER OF DAYS. THIS CYCLE (CALLED A STORAGE MODE) WILL CONTINUE AS LONG AS THE CHARGER REMAINS CONNECTED TO THE AC POWER AND BATTERIES. THE PRESET NUMBER OF DAYS FOR TURN "ON" IS FOUR (4).

NOTE: THE ALLOWABLE MAXIMUM CHARGE TIME BEFORE SHUT OFF IS AUTOMATICALLY REDUCED IN THE STORAGE MODE TO PREVENT POSSIBLE OVERCHARGING OF THE BATTERIES. THE MAXIMUM CHARGE TIME IN THE STORAGE MODE IS THREE (3) HOURS.

IF AN AC POWER FAILURE OCCURS WHEN THE CHARGER IS IN THE STORAGE MODE THE CHARGER WILL START WHEN THE AC POWER RETURNS AND CONTINUE OPERATING IN THE STORAGE MODE.

IF THE BATTERY VOLTAGE DROPS TO APPROXIMATELY 21 VOLTS WHEN THE CHARGER IS "OFF" IN THE STORAGE MODE, THE CHARGER WILL AUTOMATICALLY RESTART WITHOUT WAITING FOR THE PRESET NUMBER OF DAYS TO ELAPSE. THE STORAGE MODE WILL CONTINUE AFTER THE BATTERIES ARE FULLY CHARGED.

TROUBLESHOOTING INSTRUCTIONS FOR CHARGER

THE FOLLOWING IS A LIST OF POSSIBLE PROBLEMS AND REMEDIES WHICH MIGHT OCCUR TO THE CHARGER.

THE VOM USED FOR MEASUREMENTS SHOULD HAVE A RESISTANCE OF 20,000 OHMS/VOLT DC, 5000 OHMS/VOLT AC OR GREATER.

IF A PROBLEM OCCURS IN THE CHARGER, DISCONNECT THE CHARGER

FROM THE 230 VAC OUTLET AND BATTERIES AND EXAMINE THE AC AND DC CORDS FOR DAMAGE OR LOOSE CONNECTIONS. AFTER THE COVER HAS BEEN REMOVED, EXAMINE THE INTERNAL PARTS AND CONNECTIONS FOR SIGNS OF DAMAGE OR LOOSE ELECTRICAL CONNECTIONS.

1. GREEN LIGHT (L.E.D.) DOES NOT GLOW AND CHARGER DOES NOT WORK WHEN CHARGER IS CONNECTED TO 230 VAC 50 HZ AND BATTERIES:

NOTE: IF THE CHARGER WORKS WHEN USING ONE OF THE AC RECEPTACLES ONLY, THEN THE AC RELAY SHOULD BE REPLACED.

CAUTION

USE EXTREME CARE WHEN WORKING INSIDE THE CHARGER WHEN IT IS CONNECTED TO THE 230 VAC LINE AND/OR THE BATTERIES IN ORDER TO PREVENT ELECTRICAL SHOCK OR TO PREVENT POSSIBLE DAMAGE TO THE PRINTED CIRCUIT BOARD COMPONENTS.

READ THE AC VOLTAGE BETWEEN PINS 1 AND 3 OF THE COMPU-TIME 4 PRINTED CIRCUIT BOARD EDGE CONNECTOR. THE VOLTAGE SHOULD BE THE SAME POTENTIAL AS THE 230 VAC POWER. IF THE VOLTAGE IS NOT PRESENT, CHECK FOR LOOSE ELECTRICAL CONNECTIONS. IF THE VOLTAGE IS CORRECT, THE P.C. BOARD IS FAULTY AND MUST BE REPLACED. READ THE PRECAUTIONS BELOW ON HANDLING P.C. BOARD BEFORE REMOVING THE BOARD FROM THE CHARGER.

2. GREEN "AC POWER ON" LIGHT GLOWS BUT CHARGER WILL NOT START OR STARTS BUT WILL NOT SHUT OFF WHEN CONNECTED TO THE 230 VAC AND THE BATTERY: THESE PROBLEMS COULD BE CAUSED BY THE P.C. BOARD AND THE FOLLOWING VOLTAGE MEASUREMENTS SHOULD DETERMINE IF THAT IS THE CASE.

   A. P1 VOLTAGE READINGS (P1 IS THE EDGE CONNECTOR OF THE P.C. BOARD), ALL VOLTAGE READINGS ARE REFERENCED TO PIN 9.

PIN	APPROXIMATE PIN VOLTAGE
7	SAME AS BATTERY VOLTAGE
5	CHARGER ON = LESS THAN 1 VDC CHARGER OFF = BATTERY VOLTAGE

IF ALL VOLTAGES ARE CORRECT, CHECK THE CONNECTOR TERMINALS TO BE SURE THEY ARE MAKING PROPER CONTACT WITH PINS. IF VOLTAGES ARE NOT CORRECT, REPLACE THE P.C. BOARD AND RETURN THE DEFECTIVE BOARD TO THE FACTORY FOR REPAIR.

CAUTION

BEFORE REMOVING THE P.C. BOARD, FIRST DISCONNECT THE CHARGER FROM THE 230 VAC AND BATTERIES. THEN REMOVE THE TWO MOUNTING SCREWS FROM THE FRONT PANEL AND REMOVE THE BOARD BY PULLING IT OUT THRU THE FRONT OF THE CHARGER. UNPLUG THE EDGE CONNECTOR.

DO NOT ATTEMPT TO REPLACE INDIVIDUAL COMPONENTS ON THE BOARD. DO NOT HANDLE THE BOARD ANY MORE THAN NECESSARY. SOME OF THE

COMPONENTS ON THE BOARD COULD BE DAMAGED BY STATIC ELECTRICITY. PLACE THE BOARD IN AN ANTI-STATIC BAG OR CARDBOARD BOX AND SHIP TO FACTORY.

TO INSTALL A NEW PRINTED CIRCUIT BOARD, REVERSE THE REMOVAL PROCEDURES DESCRIBED ABOVE.

IF THE PRINTED CIRCUIT BOARD IS NOT THE PROBLEM, CHECK THE RELAY TO SEE IF THE CONTACTS ARE CLOSING OR STICKING.

3. CHARGER OPERATES AT A REDUCED RATE OF CHARGE CURRENT AND/OR TRIPS AN AC POWER CIRCUIT BREAKER OR BLOWS DC FUSES: (A BLOWN DC FUSE WILL DISCOLOR THE BUBBLE WINDOW ON THE FUSE HOLDER. BEFORE CHANGING DC FUSE, CHECK BOTH DIODES FOR SHORTING CONDITION.)

   THE PROBLEM COULD BE A FAILED DIODE: DISCONNECT THE CHARGER FROM THE 230 VAC OUTLET AND BATTERIES AND CHECK CONTINUITY ACROSS THE DIODES WITH THE VOM. REMOVE THE TRANSFORMER LEADS FROM THE DIODES BEFORE READING CONTINUITY. IF A DIODE SHOWS APPROXIMATELY ZERO OHMS IN BOTH DIRECTIONS, IT IS SHORTED AND SHOULD BE REPLACED. IF A DIODE SHOWS AN OPEN CIRCUIT IN BOTH DIRECTIONS, IT IS OPEN AND SHOULD BE REPLACED.

   IF THE DIODES ARE OK, CONNECT THE TRANSFORMER LEADS BACK TO THE DIODES. RECONNECT THE CHARGER TO THE BATTERIES AND PLUG IN THE AC CORD TO THE 230 VAC OUTLET AND MAKE THE FOLLOWING VOLTAGE MEASUREMENTS.

DANGER: USE EXTREME CAUTION WHEN WORKING NEAR THE CAPACITOR.

PLACE METER LEADS ACROSS	*APPROXIMATE VOLTAGE READINGS	
	WITH CAPACITOR CONNECTED	WITH CAPACITOR DISCONNECTED
(1) AMMETER POST TO EACH DIODE ANODE (TRANSFORMER LEAD)	25-30 VAC	15-16 VAC
(2) AMMETER POST TO DIODE CATHODES (HEAT SINK)	27-31 VDC	26-31 VDC
(3) TRANSFORMER LEADS CONNECTED TO THE CAPACITOR	560-665 VAC	350 VAC

*NOTE: THESE READINGS WILL VARY AS SHOWN DEPENDING ON THE VOLTAGE OF THE BATTERIES AT THE TIME OF THE READING.

IF THE READINGS ARE THE SAME WITH THE CAPACITOR CONNECTED AS THEY ARE WITH THE CAPACITOR DISCONNECTED, THE CAPACITOR SHOULD BE REPLACED.

IF READING # (2) ONLY IS ABOUT ONE HALF OF THE VALUES SHOWN, A DIODE IS OPEN. RECHECK DIODE CONTINUITY AS WAS DONE ABOVE JUST PREVIOUS TO READING VOLTAGES.

IF THE VOLTAGES ARE STILL NOT CORRECT AND THE CAPACITOR AND DIODES ARE GOOD, THE TRANSFORMER MAY HAVE FAILED AND SHOULD BE REPLACED.

OWNERS MANUAL

AUTOMATIC BATTERY CHARGER

P/N 70228

INPUT: 115 VAC, 60 HZ.
OUTPUT: 24 VDC, 30 AMP.

CAUTION

THIS CHARGER IS INTENDED FOR THE CHARGING OF A 12 CELL (24V) LEAD ACID STORAGE BATTERY ONLY. USE OF THIS CHARGER ON ANY OTHER BATTERY COULD CAUSE DAMAGE TO THE BATTERY AND/OR TO THE CHARGER.

THIS MANUAL CONTAINS VITAL INFORMATION FOR THE SAFE USE AND EFFICIENT OPERATION OF THE BATTERY CHARGER. CAREFULLY READ THIS MANUAL BEFORE USING CHARGER, AND RETAIN FOR FUTURE REFERENCE. FAILURE TO ADHERE TO INSTRUCTIONS COULD RESULT IN SERIOUS BODILY INJURY OR PROPERTY DAMAGE. ALL REPAIRS SHOULD BE MADE BY QUALIFIED PERSONNEL ONLY.

CAUTION

DO NOT EXPOSE CHARGER TO WATER, MOISTURE, CLEANING AGENTS OR POWER WASH.

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CHARGER OPERATION

1. CHARGER INSTALLATION: MOUNT THE CHARGER IN THE VEHICLE AND CONNECT THE CHARGER POSITIVE (WHITE) DC CORD LEAD TO THE POSITIVE BATTERY TERMINAL AND CONNECT THE CHARGER NEGATIVE (BLACK) DC CORD LEAD TO THE NEGATIVE BATTERY TERMINAL.

2. ELECTRICAL SUPPLY: THIS CHARGER MUST BE OPERATED FROM A PROPERLY GROUNDED 115 VOLT, 60 HZ AC OUTLET ONLY.

3. CHARGER OPERATION:

   A. STARTING THE CHARGER, INSERT THE AC PLUG INTO THE APPROPRIATE CHARGER AC RECEPTACLE. THE CHARGER WILL START WHEN THE AC PLUG IS INSERTED.

   B. MONITOR METERS: THE AMMETER SHOULD INDICATE AN INITIAL CHARGE RATE OF APPROXIMATELY 30 AMPS. THE CHARGE RATE WILL GRADUALLY TAPER TO A FINISH RATE OF FROM 2 TO 10 AMPS.

   C. MONITOR LIGHTS (LIGHT EMITTING DIODES - L.E.D.):

      (1) THE GREEN "AC POWER ON" LIGHT SHOULD GLOW AT ALL TIMES WHEN THE AC CORD IS PLUGGED INTO A "LIVE"

115 VAC 60 HZ OUTLET AND THE DC CORD IS CONNECTED TO THE BATTERY.

NOTE: THE GREEN LIGHT, DUE TO THE CHARACTERISTICS OF THE L.E.D., MAY NOT BE HIGHLY VISIBLE WHEN THE CHARGER IS LOCATED IN A BRIGHTLY LIGHTED AREA.

(2) THE RED LIGHT "CHARGE ON/COMPLETE" SHOULD BLINK WHEN THE CHARGE STARTS AND REMAIN BLINKING UNTIL THE CHARGE IS COMPLETED. WHEN THE CHARGE IS COMPLETE THE LIGHT WILL STOP BLINKING AND GLOW CONTINUOUSLY. IF THE RED LIGHT IS "OFF", NOT GLOWING OR BLINKING, THEN A POSSIBLE PROBLEM EXISTS.

(3) THE YELLOW LIGHT "AC INTERRUPT" WHEN GLOWING INDICATES THAT THE 115 VAC POWER SOURCE HAS BEEN INTERRUPTED WHILE THE CHARGE WAS IN PROGRESS. ALL LIGHTS WILL BE OFF DURING THE ABSENCE OF THE AC POWER.

NOTE: IF THE CHARGE IS TERMINATED BY UNPLUGGING THE AC CORD OR IF THE "AC INTERRUPT" LIGHT IS GLOWING WHEN THE AC CORD IS UNPLUGGED, THE STOP/RESTART SWITCH MUST BE MOMENTARILY ENGAGED PRIOR TO THE NEXT CHARGE TO PREVENT THE "AC INTERRUPT" LIGHT FROM GLOWING WHEN THE NEXT CHARGE IS STARTED.

(4) THE ORANGE LIGHT "CHECK BATTERY" INDICATES ONE OF THE FOLLOWING TWO CONDITIONS: THAT THE BATTTERIES ARE NOT BEING CHARGED BEFORE THE PRESET MAXIMUM TIME HAS ELAPSED, OR THE BATTERY POTENTIAL OF 2.35 VOLTS/CELL HAS NOT BEEN REACHED IN THE COURSE OF THE CHARGE. THIS LIGHT SHOULD NOT GLOW UNDER NORMAL CIRCUMSTANCES. IF THE ORANGE LIGHT GLOWS AFTER THE CHARGE IS TERMINATED, CHECK THE BATTERY FOR WEAK CELLS.

D. CHARGE TERMINATION: THE CHARGER AUTOMATICALLY TERMINATES THE CHARGE WHEN THE BATTERIES ARE FULLY CHARGED OR WHEN THE PRESET MAXIMUM TIME HAS ELAPSED OR IF THE BATTERY POTENTIAL AFTER REACHING 2.16 VOLT/CELL STOPS INCREASING FOR A TIME PERIOD OF 80 MINUTES BEFORE REACHING 2.35 VOLTS/CELL. THE CHARGE MAY ALSO BE TERMINATED MANUALLY BY MOMENTARILY ENGAGING THE STOP/RESTART SWITCH. IF THE SWITCH IS DEPRESSED BEFORE (SIX) 6 MINUTES OF CHARGE TIME HAS ELAPSED OR IF THE BATTERY VOLTAGE IS BELOW 2.35 VOLT/CELL THE FAULT LIGHT WILL GLOW. IF VOLTAGE IS HIGHER THAN 2.35, THE COMPLETE LIGHT WILL GLOW. THE PRESET MAXIMUM CHARGE TIME IS TWENTY (20) HOURS.

CAUTION

DO NOT DISCONNECT THE DC CORD FROM THE VEHICLE DURING CHARGE. IF THE BATTERY MUST BE DISCONNECTED, STOP CHARGER WITH THE STOP/RESTART SWITCH, THEN UNPLUG AC CORD.

E. CHARGE TIME: THE TIME REQUIRED TO FULLY CHARGE THE BATTERIES WILL NORMALLY BE 8 TO 12 HOURS.

F. FULL CHARGE TEST: TO TEST FOR A FULL CHARGE ON A 24V BATTERY, RESTART THE CHARGER WITH THE STOP/RESTART SWITCH. IF THE BATTERY IS FULLY CHARGED, THE CHARGE RATE SHOULD DROP TO APPROXIMATELY 8 TO 15 AMPS WITHIN 10 TO 20 MINUTES. THE CHARGER WILL AUTOMATICALLY SHUT OFF WITHIN 45 TO 90 MINUTES OR IT MAY BE SHUT OFF WITH THE STOP/RESTART SWITCH.

G. AC POWER FAILURE: IF AN AC POWER FAILURE OCCURS DURING THE CHARGE, THE CHARGER WILL AUTOMATICALLY RESUME THE CHARGE WHEN THE AC POWER RETURNS. ALL CHARGER TIMING IS RESET TO ZERO TIME. THE "AC INTERRUPT" LIGHT WILL GLOW TO INDICATE THAT THE AC POWER HAS FAILED.

H. CHARGER RESTART: THE CHARGER MAY BE RESTARTED AFTER IT HAS SHUT OFF BY UNPLUGGING THE AC POWER CORD FOR A FEW SECONDS (3 TO 5 SECONDS) AND THEN PLUGGING THE CORD BACK IN. ALSO, THE CHARGER MAY BE RESTARTED BY MOMENTARILY ENGAGING (3 TO 5 SECONDS) THE STOP/RESTART SWITCH.

IF THE CHARGER AC CORD REMAINS CONNECTED TO THE 115 VAC 60 HZ AND THE DC CORD REMAINS CONNECTED TO THE BATTERIES AFTER THE CHARGER HAS FINISHED THE FIRST CHARGE, THE CHARGER WILL AUTOMATICALLY RESTART AFTER A PRESET NUMBER OF DAYS (24 HOUR PERIODS). THE CHARGE TIME (PROVIDED THE BATTERIES ARE UNLOADED) WILL NORMALLY BE 15 TO 90 MINUTES. THE CHARGER WILL AUTOMATICALLY SHUT OFF AND AGAIN TURN ON AFTER THE PRESET NUMBER OF DAYS. THIS CYCLE (CALLED A STORAGE MODE) WILL CONTINUE AS LONG AS THE CHARGER REMAINS CONNECTED TO THE AC POWER AND BATTERIES. THE PRESET NUMBER OF DAYS FOR TURN "ON" IS FOUR (4).

NOTE: THE ALLOWABLE MAXIMUM CHARGE TIME BEFORE SHUT OFF IS AUTOMATICALLY REDUCED IN THE STORAGE MODE TO PREVENT POSSIBLE OVERCHARGING OF THE BATTERIES. THE MAXIMUM CHARGE TIME IN THE STORAGE MODE IS THREE (3) HOURS.

IF AN AC POWER FAILURE OCCURS WHEN THE CHARGER IS IN THE STORAGE MODE THE CHARGER WILL START WHEN THE AC POWER RETURNS AND CONTINUE OPERATING IN THE STORAGE MODE.

IF THE BATTERY VOLTAGE DROPS TO APPROXIMATELY 21 VOLTS WHEN THE CHARGER IS "OFF" IN THE STORAGE MODE, THE CHARGER WILL AUTOMATICALLY RESTART WITHOUT WAITING FOR THE PRESET NUMBER OF DAYS TO ELAPSE. THE STORAGE MODE WILL CONTINUE AFTER THE BATTERIES ARE FULLY CHARGED.

TROUBLESHOOTING INSTRUCTIONS FOR CHARGER

THE FOLLOWING IS A LIST OF POSSIBLE PROBLEMS AND REMEDIES WHICH MIGHT OCCUR TO THE CHARGER.

THE VOM USED FOR MEASUREMENTS SHOULD HAVE A RESISTANCE OF 20,000 OHMS/VOLT DC, 5000 OHMS/VOLT AC OR GREATER.

IF A PROBLEM OCCURS IN THE CHARGER, DISCONNECT THE CHARGER

FROM THE 115 VAC OUTLET AND BATTERIES AND EXAMINE THE AC AND DC CORDS FOR DAMAGE OR LOOSE CONNECTIONS. AFTER THE COVER HAS BEEN REMOVED, EXAMINE THE INTERNAL PARTS AND CONNECTIONS FOR SIGNS OF DAMAGE OR LOOSE ELECTRICAL CONNECTIONS.

1. GREEN LIGHT (L.E.D.) DOES NOT GLOW AND CHARGER DOES NOT WORK WHEN CHARGER IS CONNECTED TO 115 VAC 60 HZ AND BATTERIES:

NOTE: IF THE CHARGER WORKS WHEN USING ONE OF THE AC RECEPTACLES ONLY, THEN THE AC RELAY SHOULD BE REPLACED.

CAUTION

USE EXTREME CARE WHEN WORKING INSIDE THE CHARGER WHEN IT IS CONNECTED TO THE 115 VAC LINE AND/OR THE BATTERIES IN ORDER TO PREVENT ELECTRICAL SHOCK OR TO PREVENT POSSIBLE DAMAGE TO THE PRINTED CIRCUIT BOARD COMPONENTS.

READ THE AC VOLTAGE BETWEEN PINS 1 AND 3 OF THE COMPU-TIME 4 PRINTED CIRCUIT BOARD EDGE CONNECTOR. THE VOLTAGE SHOULD BE THE SAME POTENTIAL AS THE 115 VAC POWER. IF THE VOLTAGE IS NOT PRESENT, CHECK FOR LOOSE ELECTRICAL CONNECTIONS. IF THE VOLTAGE IS CORRECT, THE P.C. BOARD IS FAULTY AND MUST BE REPLACED. READ THE PRECAUTIONS BELOW ON HANDLING P.C. BOARD BEFORE REMOVING THE BOARD FROM THE CHARGER.

2. GREEN "AC POWER ON" LIGHT GLOWS BUT CHARGER WILL NOT START OR STARTS BUT WILL NOT SHUT OFF WHEN CONNECTED TO THE 115 VAC AND THE BATTERY: THESE PROBLEMS COULD BE CAUSED BY THE P.C. BOARD AND THE FOLLOWING VOLTAGE MEASUREMENTS SHOULD DETERMINE IF THAT IS THE CASE.

   A. P1 VOLTAGE READINGS (P1 IS THE EDGE CONNECTOR OF THE P.C. BOARD), ALL VOLTAGE READINGS ARE REFERENCED TO PIN 9.

PIN	APPROXIMATE PIN VOLTAGE
7	SAME AS BATTERY VOLTAGE
5	CHARGER ON = LESS THAN 1 VDC CHARGER OFF = BATTERY VOLTAGE

IF ALL VOLTAGES ARE CORRECT, CHECK THE CONNECTOR TERMINALS TO BE SURE THEY ARE MAKING PROPER CONTACT WITH PINS. IF VOLTAGES ARE NOT CORRECT, REPLACE THE P.C. BOARD AND RETURN THE DEFECTIVE BOARD TO THE FACTORY FOR REPAIR.

CAUTION

BEFORE REMOVING THE P.C. BOARD, FIRST DISCONNECT THE CHARGER FROM THE 115 VAC AND BATTERIES. THEN REMOVE THE TWO MOUNTING SCREWS FROM THE FRONT PANEL AND REMOVE THE BOARD BY PULLING IT OUT THRU THE FRONT OF THE CHARGER. UNPLUG THE EDGE CONNECTOR.

DO NOT ATTEMPT TO REPLACE INDIVIDUAL COMPONENTS ON THE BOARD. DO NOT HANDLE THE BOARD ANY MORE THAN NECESSARY. SOME OF THE

COMPONENTS ON THE BOARD COULD BE DAMAGED BY STATIC ELECTRICITY. PLACE THE BOARD IN AN ANTI-STATIC BAG OR CARDBOARD BOX AND SHIP TO FACTORY.

TO INSTALL A NEW PRINTED CIRCUIT BOARD, REVERSE THE REMOVAL PROCEDURES DESCRIBED ABOVE.

IF THE PRINTED CIRCUIT BOARD IS NOT THE PROBLEM, CHECK THE RELAY TO SEE IF THE CONTACTS ARE CLOSING OR STICKING.

3. CHARGER OPERATES AT A REDUCED RATE OF CHARGE CURRENT AND/OR TRIPS AN AC POWER CIRCUIT BREAKER OR BLOWS DC FUSES: (A BLOWN DC FUSE WILL DISCOLOR THE BUBBLE WINDOW ON THE FUSE HOLDER. BEFORE CHANGING DC FUSE, CHECK BOTH DIODES FOR SHORTING CONDITION.)

   THE PROBLEM COULD BE A FAILED DIODE: DISCONNECT THE CHARGER FROM THE 115 VAC OUTLET AND BATTERIES AND CHECK CONTINUITY ACROSS THE DIODES WITH THE VOM. REMOVE THE TRANSFORMER LEADS FROM THE DIODES BEFORE READING CONTINUITY. IF A DIODE SHOWS APPROXIMATELY ZERO OHMS IN BOTH DIRECTIONS, IT IS SHORTED AND SHOULD BE REPLACED. IF A DIODE SHOWS AN OPEN CIRCUIT IN BOTH DIRECTIONS, IT IS OPEN AND SHOULD BE REPLACED.

   IF THE DIODES ARE OK, CONNECT THE TRANSFORMER LEADS BACK TO THE DIODES. RECONNECT THE CHARGER TO THE BATTERIES AND PLUG IN THE AC CORD TO THE 115 VAC OUTLET AND MAKE THE FOLLOWING VOLTAGE MEASUREMENTS.

DANGER: USE EXTREME CAUTION WHEN WORKING NEAR THE CAPACITOR.

PLACE METER LEADS ACROSS	*APPROXIMATE VOLTAGE READINGS	
	WITH CAPACITOR CONNECTED	WITH CAPACITOR DISCONNECTED
(1) AMMETER POST TO EACH DIODE ANODE (TRANSFORMER LEAD)	25-30 VAC	15-16 VAC
(2) AMMETER POST TO DIODE CATHODES (HEAT SINK)	27-31 VDC	26-31 VDC
(3) TRANSFORMER LEADS CONNECTED TO THE CAPACITOR	560-665 VAC	350 VAC

*NOTE: THESE READINGS WILL VARY AS SHOWN DEPENDING ON THE VOLTAGE OF THE BATTERIES AT THE TIME OF THE READING.

IF THE READINGS ARE THE SAME WITH THE CAPACITOR CONNECTED AS THEY ARE WITH THE CAPACITOR DISCONNECTED, THE CAPACITOR SHOULD BE REPLACED.

IF READING # (2) ONLY IS ABOUT ONE HALF OF THE VALUES SHOWN, A DIODE IS OPEN. RECHECK DIODE CONTINUITY AS WAS DONE ABOVE JUST PREVIOUS TO READING VOLTAGES.

IF THE VOLTAGES ARE STILL NOT CORRECT AND THE CAPACITOR AND DIODES ARE GOOD, THE TRANSFORMER MAY HAVE FAILED AND SHOULD BE REPLACED.

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