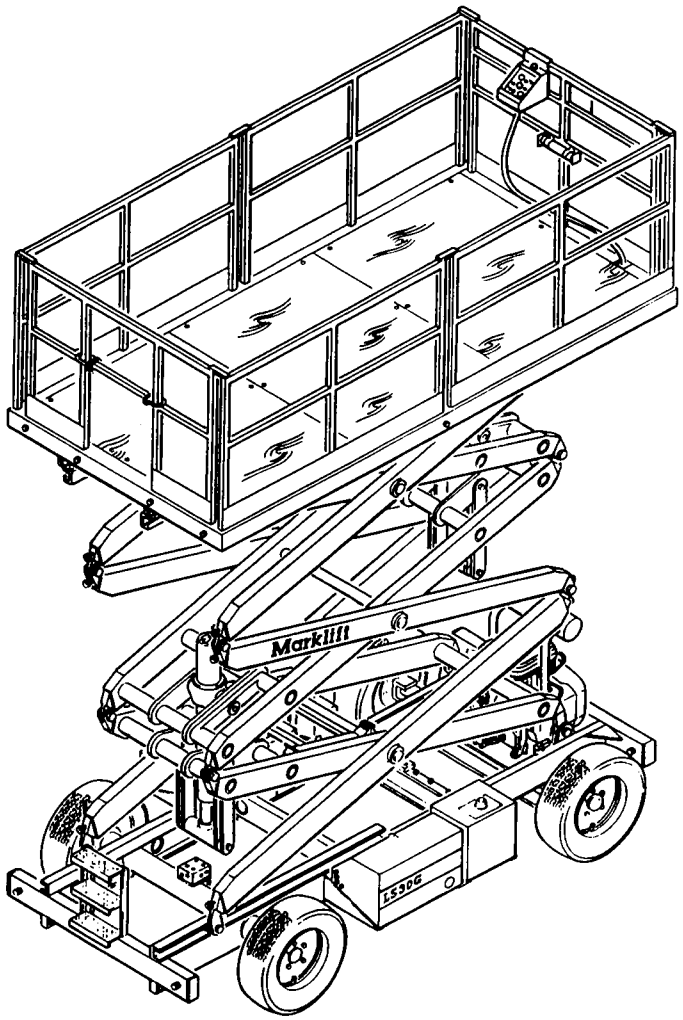
The Marklifts.®

A Product of Mark Industries

SELF-PROPELLED SCISSOR OPERATION, MAINTENANCE AND PARTS MANUAL



THIS TECHNICAL MANUAL APPLIES TO THE LS30G & LS36G MODELS

FIRST EDITION: APRIL 1990

Mark Industries

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Mark Industries

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INTRODUCTION

The purpose of this manual is to provide the customer with operation,safety, maintenance and parts information that will maintain 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 Service Engineering Department at (714) 879-MARK.

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

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

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

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

Description	Model	
	LS30G	LS36G
Height –		
Working (maximum)	36' (10.97m)	42' (12.80m)
Platform (maximum)	30' (9.14m)	36' (10.97m)
Platform (minimum)	50" (1.27m)	56.5" (1.44m)
Length (overall)	146" (3.71m)	146" (3.71m)
Width (overall)	72" (1.83m)	72" (1.83m)
Platform –		
Dimensions (inside)	64.25"x140" (1.63m x 3.56m)	64.25"x140" (1.68m x 3.56m)
Safety Rail Height	42" (1.06m)	42" (1.06m)
Toeplate Height	6" (.15m)	6" (.15m)
Load Capacity (evenly distributed)	1500 lbs. (680 kg)	1000 lbs. (454 kg)
Wheel Base	93" (2.36m)	93" (2.36m)
Wheel Track	63.5" (1.61m)	63.5" (1.61m)
Turning Radius (inside)	13' (3.96m)	13' (3.96m)
Drive speed		
Low	1.5 mph (2.4 km/hr)	1.5 mph (2.4 km/hr)
High	3.5 mph (5.6 km/hr)	3.5 mph (5.6 km/hr)
High Speed cut-out	12' (3.66m)	12' (3.66m)
Lift/Lower Speed (maximum load)	35/35 sec.	35/35 sec.
Power System	24 HP Onan	24 HP Onan
Battery Voltage	12 VDC	12 VDC
Capacities		
Battery	95 amp/hr	95 amp/hr
Hydraulic Tank	10 gal (37.85 l)	10 gal (37.85 l)
Fuel Tank	15 gal (56.78 l)	15 gal (56.78 l)
Alternator	20 amp	20 amp
Tire Size (Monofilled)	P235/60R14	P235/60R14
Ground Clearance	4.5" (.11m)	4.5" (.11m)
Shipping Weight	5500 lbs. (2495 kg)	6620 lbs. (3002 kg)
Shipping cube	378 cu. ft. ($10.70\ m^3$)	409 cu. ft. ($11.58\ m^3$)

MANUFACTURERS' LIMITED WARRANTY

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

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

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

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

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

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

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

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

Mark Industries

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Mark Industries

WARRANTY REGISTRATION

Purchaser/Dealer:

Company Name:

Address:

Telephone:

Date shipment received:

Date of invoice:

Date unit put into service:

Unit will be placed into 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.

SCISSOR LIFT NEW EQUIPMENT CONDITION REPORT

Filling in the Warranty: Please refer to the applicable decals on your machine for the figures and quantities needed to fill in the blanks below (Items 1,18, 24, 30, 31).

		YES	NO
1.	Platform capacity decal _____ . lbs.	☐	☐
2.	All warning, caution and emergency decals installed	☐	☐
3.	Emergency descent valve functions properly	☐	☐
4.	Operation instructions properly installed	☐	☐
5.	Operation and safety handbook received	☐	☐
6	All controls (aerial & ground) are identified and operate correctly	☐	☐
7	Stop switches operate properly (aerial & ground)	☐	☐
8	Platform guard rails, secure and undamaged	☐	☐
9.	Platform access gate works properly	☐	☐
10.	Horn and beacon operate properly (optional)	☐	☐
11.	Brakes adjusted and operate correctly	☐	☐
12.	Circuit breakers operate properly	☐	☐
13.	All Hydraulic cylinders free of air	☐	☐
14.	All hydraulic cylinder rods free of paint or scratches	☐	☐
15.	Hydraulic pump free of leaks	☐	☐
16.	Hydraulic hoses and fittings free of leaks	☐	☐
17.	Hydraulic oil level _____ .	☐	☐
18.	Hydraulic tank and fittings free of leaks	☐	☐
19.	Drive motors free of leaks	☐	☐
20.	Battery water level	☐	☐
21.	Manual overrides operate properly	☐	☐
22.	Muffler is tight and free of leaks	☐	☐
23.	All electrical connections tight	☐	☐
24.	Manifold valve and fittings free of leaks	☐	☐
25.	110V generator operates properly (optional)	☐	☐
29.	Wheel lug nuts torqued to _____ lbs	☐	☐

—Internal Combustion Units—

31.	Engine _____ .R.P.M	☐	☐
33.	Fuel tank and fitting free of leaks	☐	☐
34.	Engine oil level	☐	☐
35.	Engine oil filter free of leaks	☐	☐
36.	Engine alternator functions properly	☐	☐

MODEL	SERIAL NUMBER
INSPECTOR	OPTIONS

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

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

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

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

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

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

5. Always distribute the load evenly over the platform floor area.

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

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

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

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

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

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

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

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

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

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

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

17. **Do Not** raise or lower platform 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 of 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."**

DANGER, EMERGENCY, WARNING AND CAUTION DECALS

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

> It is the primary responsibility of the user and operator to be thoroughly knowledgeable of all decal information, definition and location.

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

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

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

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

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

LOAD CAPACITY 1500 LBS.
(EVENLY DISTRIBUTED LOAD) 2026

LS30G

LOAD CAPACITY 1000 LBS.
(EVENLY DISTRIBUTED LOAD) 2024

LS36G

2020
GASOLINE
OR PETROL

DO NOT LIFT
FROM THIS END

WARNING

DO NOT WORK UNDERNEATH THIS LIFT

UNLESS IT IS MECHANICALLY LOCKED.

GUARD RAILS ARE FOR YOUR SAFETY
DO NOT REMOVE
CAUTION
OPERATING THIS MACHINE WITHOUT GUARD RAILS COULD RESULT IN DEATH OR SERIOUS INJURY
CAUTION

WARNING: LIGHT
INDICATES UNSTABLE CONDITION

PLATFORM WILL LOWER
AUTOMATICALLY
2015

CAUTION
UNLAWFUL TO OPERATE THIS EQUIPMENT
WITHIN 10 FEET OF HIGH VOLTAGE LINES
CAUTION

DECAL P/N	DECAL DESCRIPTION LS30G	LOCATION	QTY
67642	Decal Set	All Standard Decals	1
32526	Power On/Off	Final Assembly	1
2008	Control Box	Final Assembly	1
2015	Warning - Unstable Condition	Final Assembly	1
2014	Caution - High Voltage Lines	Final Assembly	1
31260	Marklift (Scissor Machine)	Final Assembly	2
2003	Battery Water Level	Final Assembly	1
182743	Operation Instructions	Final Assembly	1
20661	Plate ANSI A92	Final Assembly	1
2026	Load Capacity 1500 lbs.	Final Assembly	4
2041	Do Not Lift This End	Final Assembly	2
20660	Nameplate, I.D.	Final Assembly	1
2017	Hydraulic System Fluid	Final Assembly	2
2016	Do Not Work Under...	Final Assembly	2
2019	Emergency Lowering Valve	Final Assembly	1
130596	'A Product of Mark Industries'	Final Assembly	2
130606	Freewheeling Valve	Final Assembly	1
130820	Operation & Safety Handbook	Final Assembly	1
31109	Caution Scissor Guard Rails	Final Assembly	1
30520	Nameplate - Patent Numbers (Scissors)	Final Assembly	1
32588	Circuit Breaker	Final Assembly	1
32589	110 VAC	Final Assembly	2
2004	Vapor Tank Only	Final Assembly	1
2020	Gasoline or Petrol	Final Assembly	2
30310	Switch	Final Assembly	1
181736	LS30G	Final Assembly	2
181728	Panel Strip	Final Assembly	2
181902	LS-Series	Final Assembly	1

GENERAL DECALS
LS36G

DECAL P/N	DECAL DESCRIPTION LS36G	LOCATION	QTY
67824	Decal Set	All Standard Decals	1
2008	Control Box	Final Assembly	1
2015	Warning—Unstable Condition	Final Assembly	1
182743	Operation Instructions	Final Assembly	1
2014	Caution High Voltage Lines	Final Assembly	1
20661	Plate, ANSI A92	Final Assembly	1
130606	Freewheeling Valve	Final Assembly	1
2017	Hydraulic System Fluid	Final Assembly	2
2019	Emergency Lowering Valve	Final Assembly	1
2016	Do Not Work Under	Final Assembly	2
31260	Marklift (Scissor machine)	Final Assembly	2
2024	Load Capacity 1000 lbs.	Final Assembly	4
20660	Nameplate, I.D.	Final Assembly	1
2041	Do Not Lift This End	Final Assembly	2
2004	Vapor Tank Only	Final Assembly	1
2020	Gasoline or Petrol	Final Assembly	2
2003	Battery Water Level	Final Assembly	1
31109	Caution Scissor Guard Rails	Final Assembly	1
182743	Operation Instructions	Final Assembly	1
130596	A Product of Mark Industries	Final Assembly	2
130820	Operation & Safety Handbook	Final Assembly	1
30520	Nameplate - Patent Numbers (Scissors)	Final Assembly	1
30310	Switch	Final Assembly	1
32526	Power On/Off/Start	Final Assembly	1
181738	LS36G	Final Assembly	2
181728	Panel Strip	Final Assembly	2
181902	LS - Series	Final Assembly	1
32588	Circuit Breaker	Final Assembly	1
32589	110 VAC	Final Assembly	2

UNLOADING

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

FREEWHEELING

The **MARKLIFT** may be freewheeled for loading and unloading or towing for a very short distance (maximum of one (1) mile), at a speed no greater than five (5) mph.

Make sure the unit is on a level surface before attempting to freewheel the MARKLIFT.

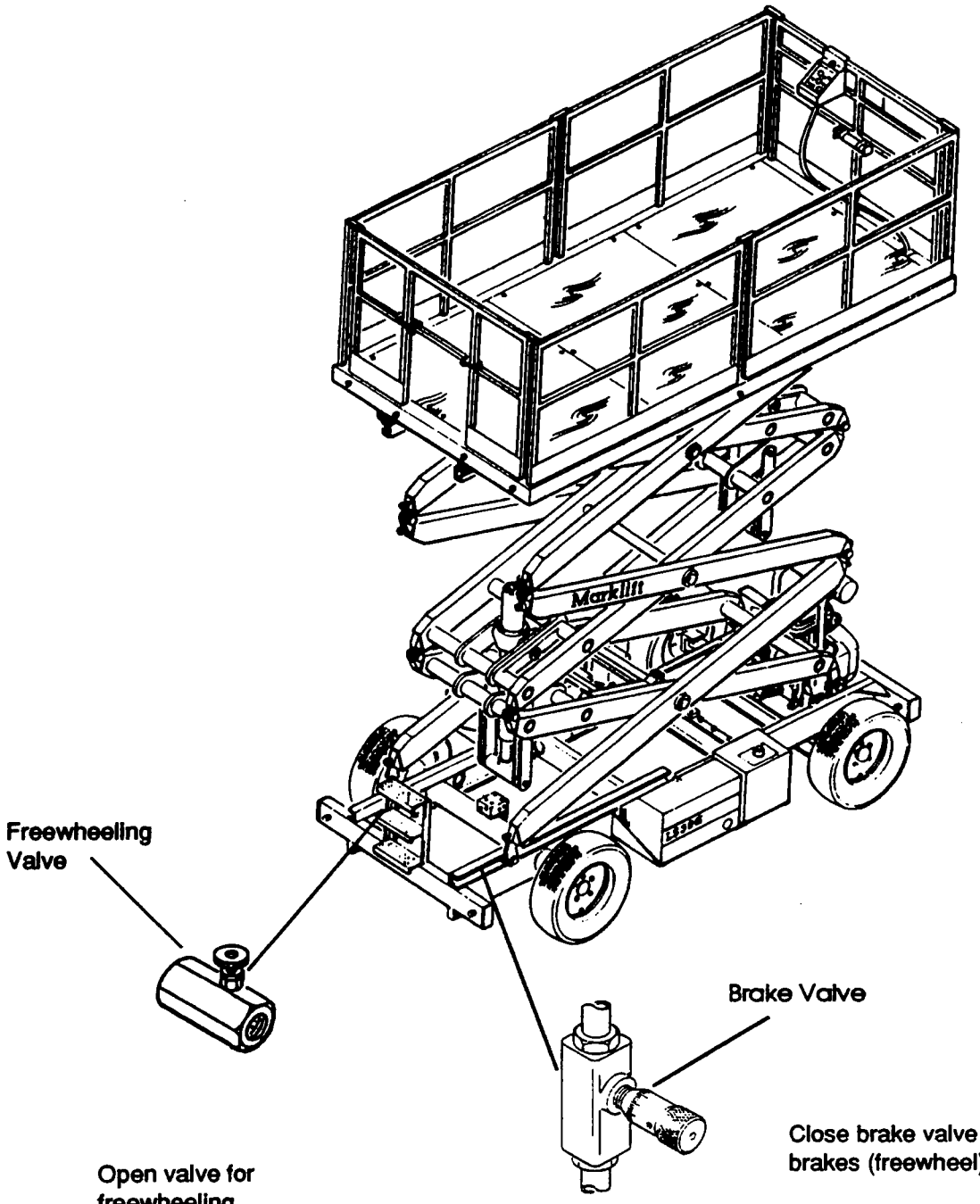
The parking brakes must be disengaged before the MARKLIFT can be freewheeled. Disengage the brakes by closing the brake valve and activating the drive switch.(See illustration on the following page.) Then open the freewheeling valve. The machine may now be pushed by hand.

Use caution when the brakes are disengaged. Always remember to close the freewheel valve and re-adjust the brake valve to restore the brakes.

Truck Transport

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 brake adjusting valve to engage the parking brakes back into the their operational mode and close the freewheeling valve to permit drive operations to resume.

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



Open valve for freewheeling

Close brake valve to disengage brakes (freewheel). Turn clockwise.

Open valve to restore brakes. Turn counter-clockwise.

Shown: LS30G

After the unit 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 the hydraulic oil level - sight gauge shows full when the scissor stack is fully lowered.

3. Check the battery for a reading of 1.200 ± 50 on the hydrometer. Charge the battery if the reading is below 1.100. If the battery requires water, fill to the proper level **AFTER** charging. **Do Not** overfill. See battery filling instructions.

4. Check the hydraulic valve manifold for leaks, loose fittings or loose electrical connections.

5. Check hoses for leaks.

6. Make sure that the brakes are adjusted to stall the drive motors. See transporting.

7. Test function switches: Position the selector switch to "Ground", then raise the platform up and down. Position the selector switch to "Aerial" and test the "Drive", "Steering", and "Raise Platform" switches.

1. STARTING

A. Aerial Control Panel

Turn master switch at ground control panel to "ON". Position selector switch to "AERIAL". Enter the platform, ATTACH SAFETY CHAIN, GATE, OR BAR AFTER ENTERING PLATFORM. Pull out the red emergency on/off button. Depress the switch to start the engine. Once the engine is started, the aerial controls are operational.

B. Ground Control Panel

Position the selector switch to 'Ground'. Turn the ignition switch to the 'On' position . The unit is operational once the engine is started.

2. DUAL FUEL SYSTEM

A. Switching From Propane to Gasoline

With the engine running, switch the fuel selector to gasoline. The engine will begin to stall as the carburetor bowl starts filling with gasoline. Switch back to propane until the engine resumes speed. Switch back and forth from propane to gasoline until the engine is running smoothly on gasoline.

B. Switching From Gasoline to Propane

With the engine running, switch the fuel selector to 'OFF'. The engine will continue to run until it uses all the fuel from the carburetor bowl. When the engine begines to run roughly, allow it to run several seconds and then switch to propane. Let the engine idle for 20-30 seconds to completely burn off any remaining gasoline.

3. DRIVE

Forward and reverse drive of the machine can only be done from the aerial control panel . Turning the five position knob to the right for forward travel; the first position is low speed, the second is high speed. Turning the knob to the left for reverse travel; the first position is low speed, the second position is high.

4. STEERING

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

5. RAISE PLATFORM

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

To operate from the aerial control, position the ground/aerial 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 the center (the neutral position). The platform will remain stationary.

6. WARNING LIGHT AND BUZZER

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

An unsafe out-of-level situation is sensed by a series of mercury switches when the machine is tilted 3° or more on either side or 6° front or rear. The unsafe condition is indicated by a red warning light and buzzer, located on the top center of the aerial control box. When the warning light and buzzer are on, the platform will lower automatically. Should the warning signal sound after parking the **MARKLIFT,** reposition the unit until it is on a safe level operating surface.

7. TRAVEL 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). To manually operate the horn, push the switch to the left.

8. STABILIZERS (Optional)

The **MARKLIFT** has been designed to meet all safety standards without the use of stabilizers. However, stabilizers are available as an option.

Hydraulic Stabilizers

1. Hydraulic stabilizers can only be operated from the aerial control panel. The switch is located on the bottom center of the face of the control panel and is labeled "Stabilizers".

2. Position the switch to "Down" to lower the stabilizers and "Up" to retract.When the stabilizers are in the down position, the drive function is cutout.

9. EMERGENCY LOWERING FROM GROUND CONTROL

To lower the platform from the ground, turn the Emergency Lowering Valve, located at the ground control station, counter-clockwise. Gradually open the valve until fully open. Remember to close the Emergency Lowering Valve once the emergency situation is under control.

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 (BEFORE USE ON EACH WORK SHIFT)

1. Make sure that operation and safety decals are in place and easy to read.
2. Check hydraulic tank level, add oil as required.
3. Check the water level in the batteries, add water as required.
4. Check for loose or worn hardware, wire connections, etc., repair or replace as needed.
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 defects.
8. Check for good overall performance.
9. Check engine oil level, add oil if required.

WEEKLY

1. Check the condition of the tires. Make sure they are free of serious cuts or defects.
2. Check for proper brake operation.
3. Record hour meter reading.
4. Clean unit by removing all dirt, oil, and grease. The machine may be washed with soap and water. (Stay away from electrical panels and charging units.)
5. Check for signs of wear on electrical cables and hoses, repair or replace if necessary.

MONTHLY (or first 50 hours)

1. Check and lubricate, if necessary.
2. Check battery condition.
3. Change the hydraulic oil return filter. (First 150 hours of operation.)
4. Check engine oil and filter. Change per engine manufacturer's recommendations.

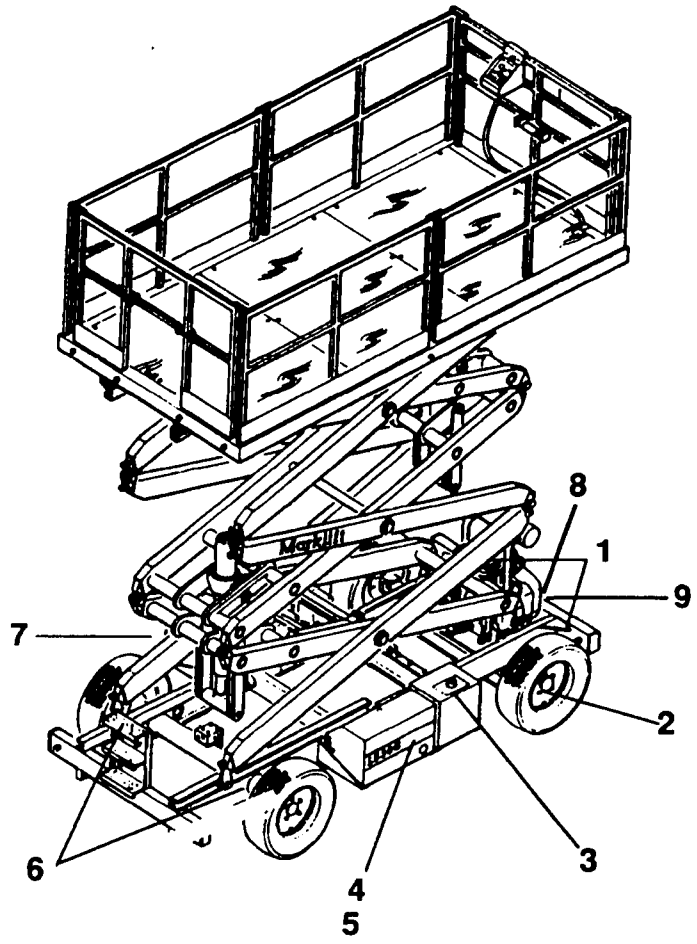
EVERY SIX MONTHS (or 100 hours)

1. Check and lubricate, if necessary.
2. Change the hydraulic oil return filter.
3. Check engine oil and filter. Change per engine manufacturer's recommendations.

EVERY YEAR

1. Re-pack all wheel bearings.
2. Change the hydraulic oil.
3. Change the hydraulic oil return filter.
4. Check engine oil and filter. Change per engine manufacturer's recommendations.

RECOMMENDED LUBRICATION AND SERVICE CHART



ITEM	DESCRIPTION	LUBRICANT	FREQUENCY
1.	Steering Tie Tod Ends and King Pins	Mobil (VA6L36AG)	Grease Monthly
2.	Wheel Bearings	Mobil (VA6L36AG)	Grease Yearly
3.	Hydraulic Return Line Filter Element	Mark Industries Part No. 21245	Replace after 100 Hours
4.	Inlet Strainer		Clean Yearly
5.	Hydraulic Oil	ATF Dexron II	Yearly
6.	Wheel Brake	Grease - Mobil (VA6L36AG)	Twice Yearly
7.	Batteries		Check Daily
8.	Engine		Refer to manufacturer's operations manual.
9.	Fuel Filter	M. I. P//N 160	100 Hours

Battery Fill Instructions

Water or Acid Loss to Batteries

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

Checking the Water Level

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

Materials and Equipment Required

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

Filling the Battery

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

AVOID BATTERY HAZARD!

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

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

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

- Charge batteries only in a well ventilated area.

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

TEMPERATURE/SPECIFIC GRAVITY CORRECTION TABLE FOR BATTERIES

ACTUAL HYDROMETER READING AT ACTUAL TEMPERATURE°

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

Specific Gravity

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

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

Protecting Engines for Winter Storage

To protect the cylinders, pistons, rings and valves from rusting and sticking, a half and half mixture of kerosene and good gasoline engine oil should be injected into the intake manifold while the engine is warm and running at moderate speed. Use approximately one ounce per cylinder or enough so that a heavy bluish smoke will appear at the exhaust. The ignition switch should then be shut off and the engine stopped. This should provide a light coating of oil on the above mentioned parts protecting them from the atmosphere.

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

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, determined by using a hydrometer and following the battery maintenance instructions. A large percentage of electrical problems are often due to poorly charged or defective batteries.

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

B. Keep in mind, if you **DO NOT** have a good ground to a valve coil, relay, etc., (even if you have enough electrical power to operate the coil or relay), these items will not function properly.

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

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

2. HYDRAULIC

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

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

C. One way valves which are either normally open or closed to prevent or permit passage of fluid when electrically energized.

Engine

1. Engine will not start or run.

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

2. Engine dies under load.

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

Hydraulic Drive Motor

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

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

Hydraulic Pump

Pump producing excessive noise.

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

Lift

Functions will not operate from aerial control console.

A. Check Aerial/Ground selector switch.
B. Check for loose wire in aerial junction box.
C. Check lift system pressure.
D. Check lift solenoid dump valve.
E. Refer to your local service facility.

Drive

Low torque drive.

A. Make sure hydraulic system is up to recommended pressure.

Mark Industries

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 (MT40 only)		
Fuel filter (gas units)			Wear pad		
Tune-up (gas units)			Front end assembly		
Choke(gas units)			Tire pressure		
Engine RPM (gas units)			Tire condition		
Charging system (gas units)			Wheel nuts		
Fuel system (LPG/gas)			Wheel bearing		
Batteries			Nuts and bolts		
Battery terminals			Guard rails		
Motor brushes (elec. units)			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		

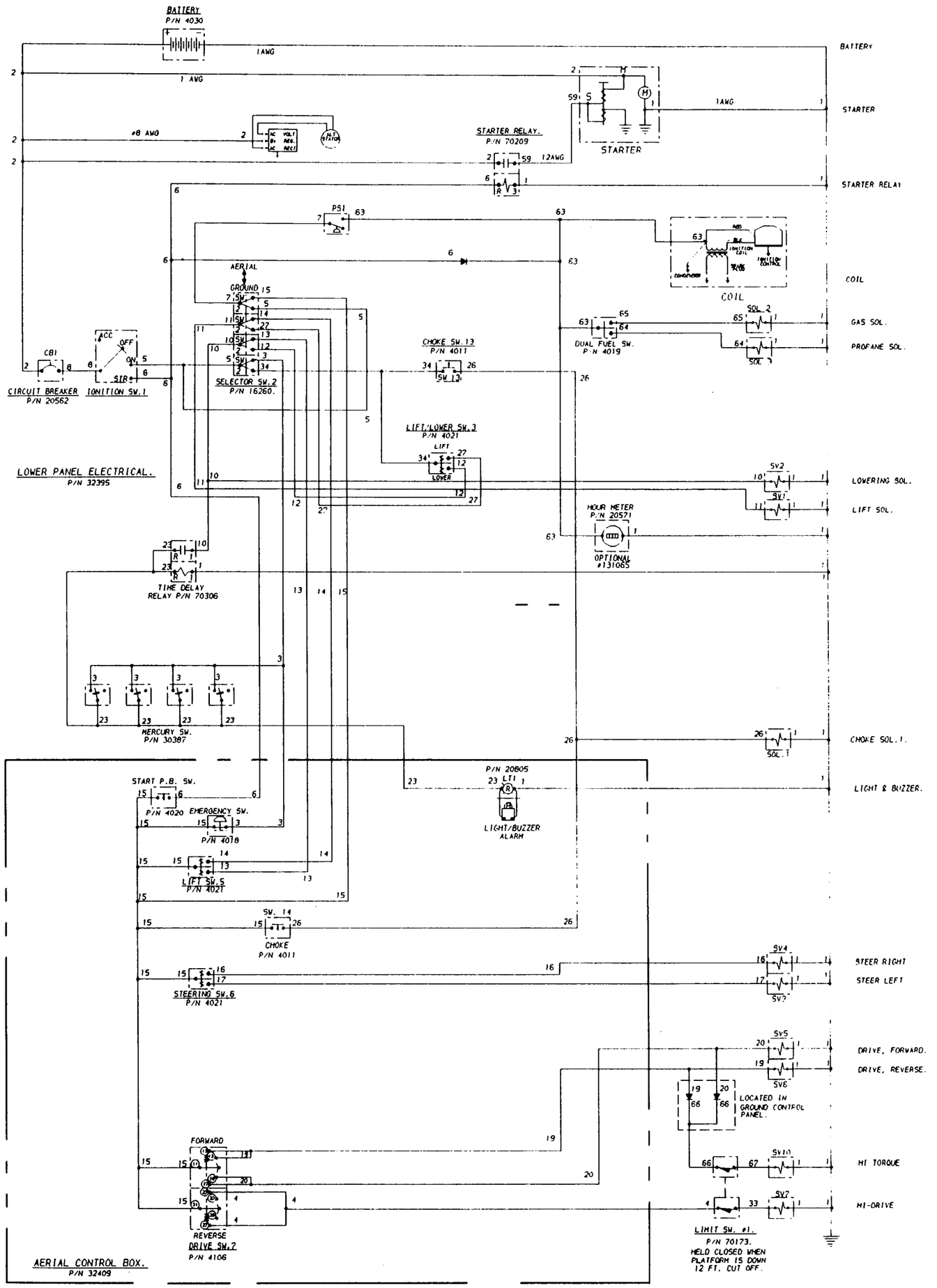
Code

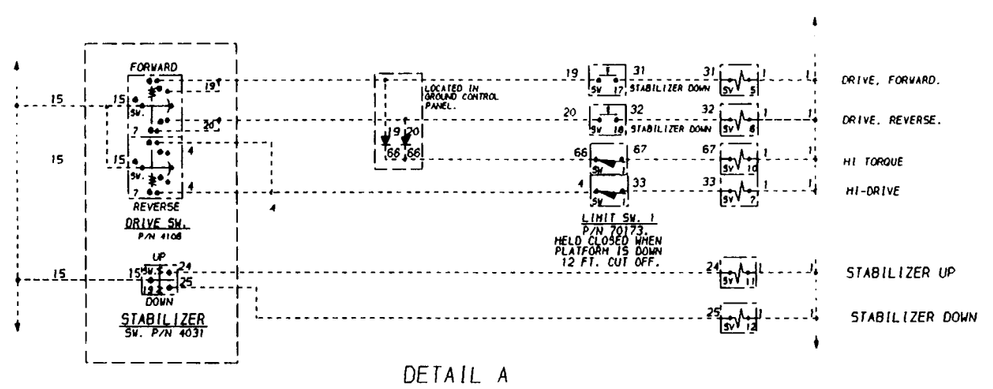
F = Filled
R = Repaired
C = Checked
A = Adjusted
X = Needs repair
NA = Not Applicable

Comments

HYDRAULIC FLUID TABLE

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



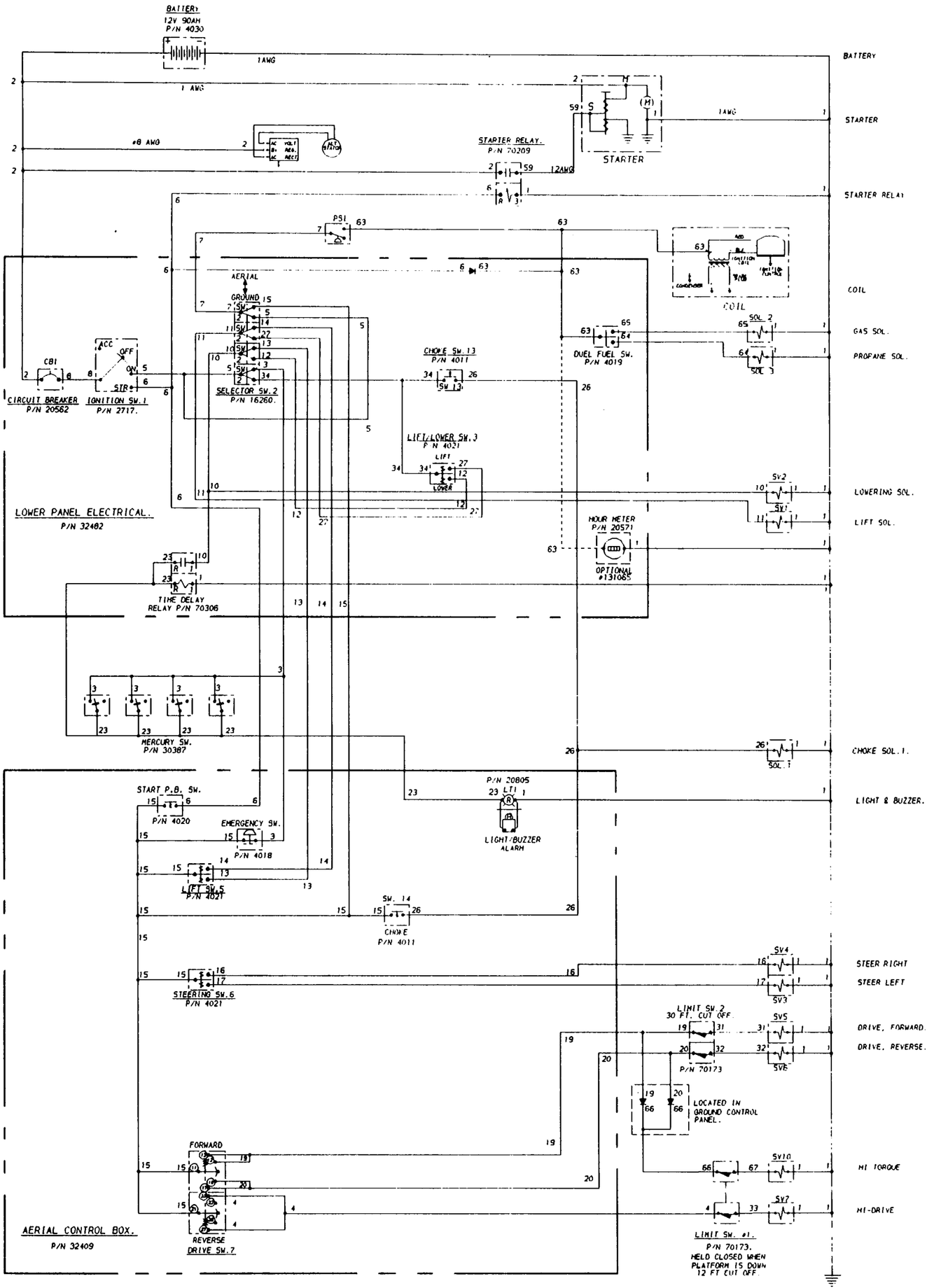


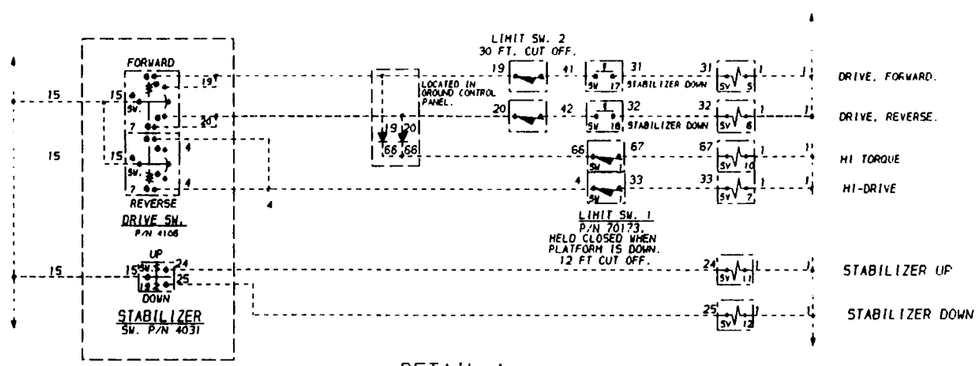
DETAIL A

WITH HYDRAULIC STABILIZER

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	LS30G
NOTES	P/N 32400
SCHEMATIC PAGE	1





DETAIL A

WITH HYDRAULIC STABILIZER

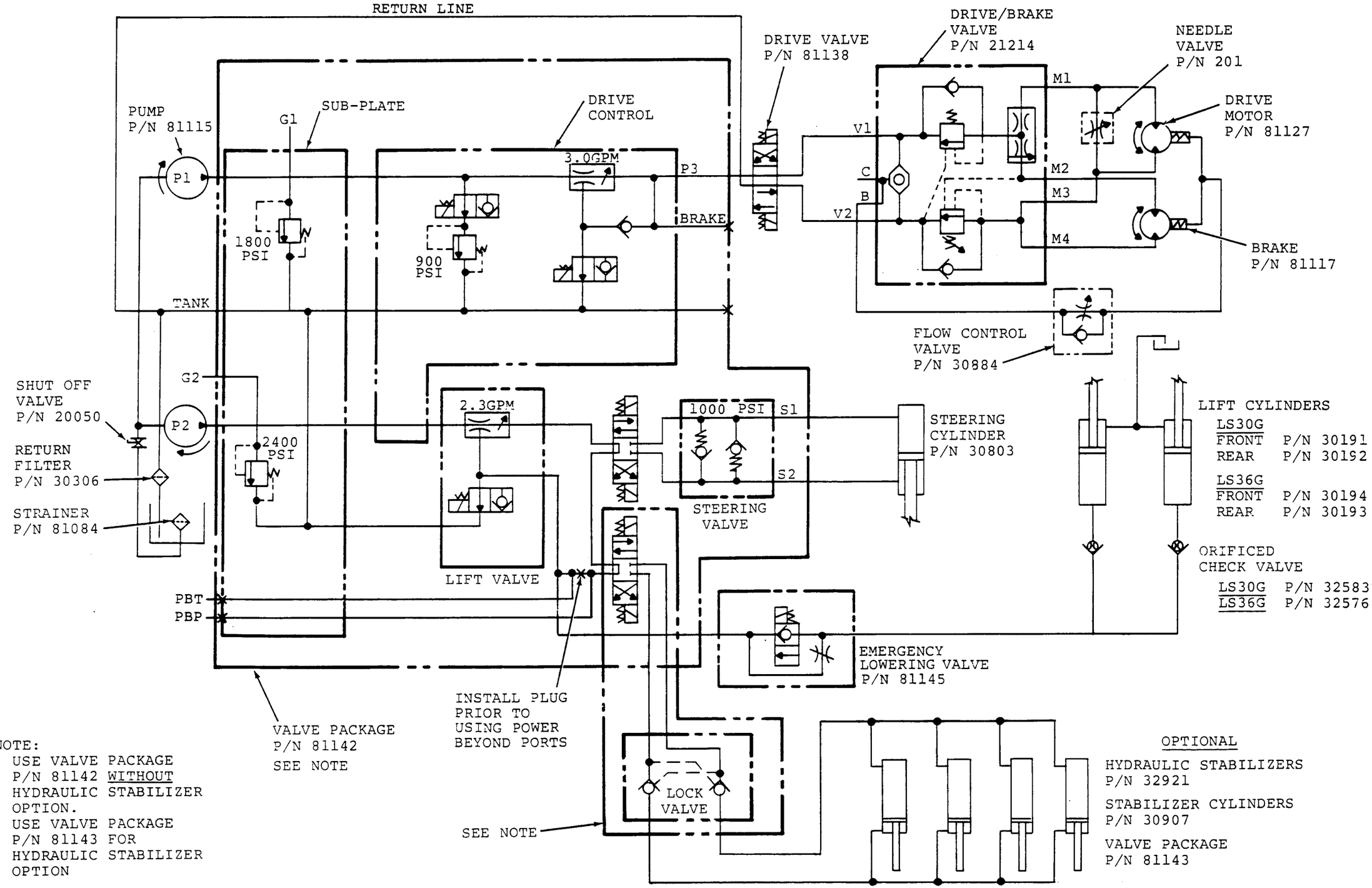
Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	LS36G
NOTES	P/N 32427
SCHEMATIC PAGE	2

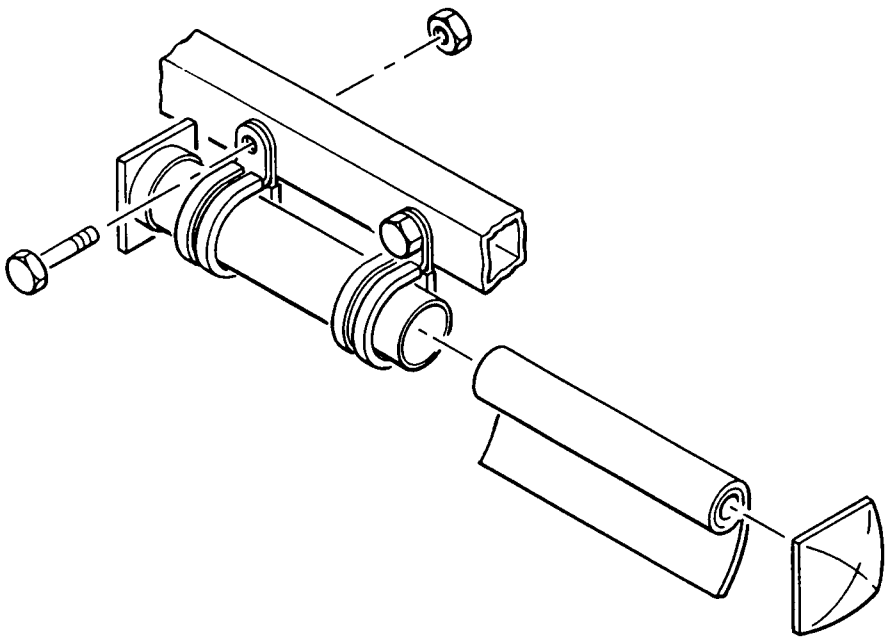
Mark Industries

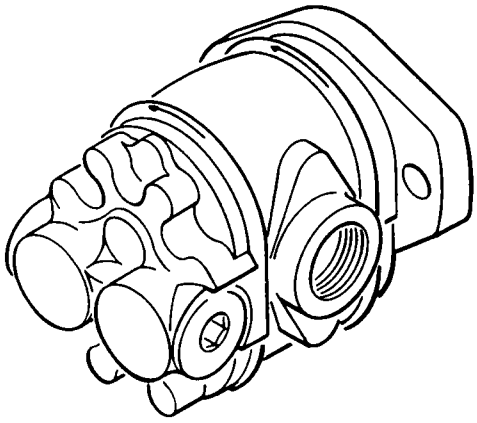
TITLE	HYDRAULIC SCHEMATIC
MODEL	LS30G & LS36G
NOTES	P/N 32360

SCHEMATIC PAGE 3



NOTE:
USE VALVE PACKAGE P/N 81142 WITHOUT HYDRAULIC STABILIZER OPTION.
USE VALVE PACKAGE P/N 81143 FOR HYDRAULIC STABILIZER OPTION





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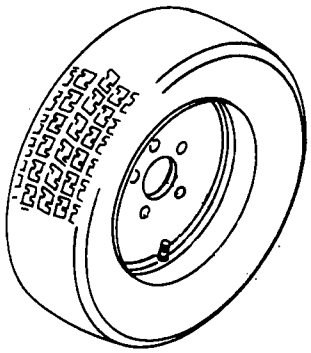
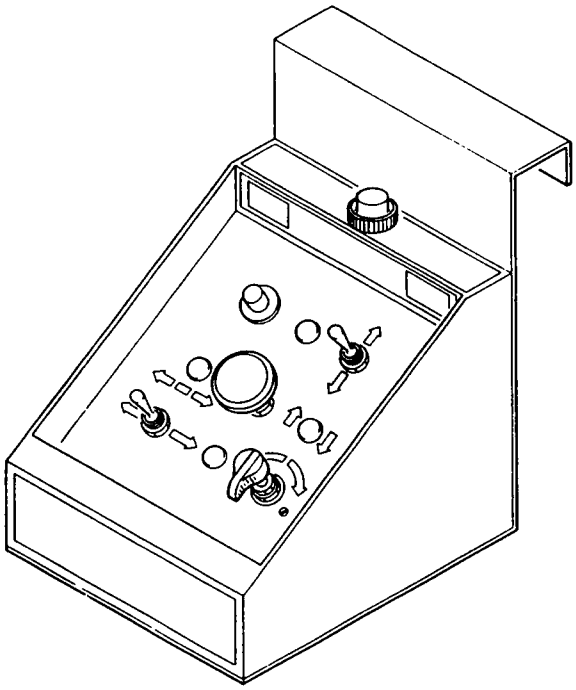
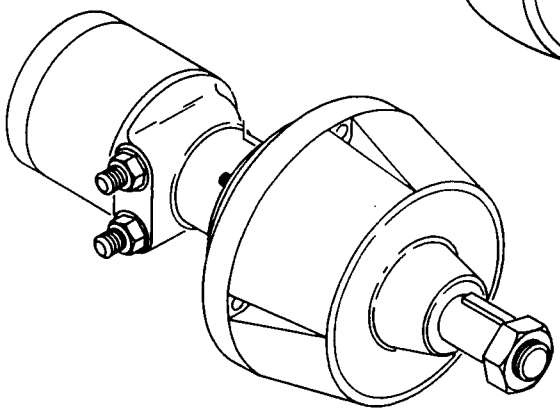






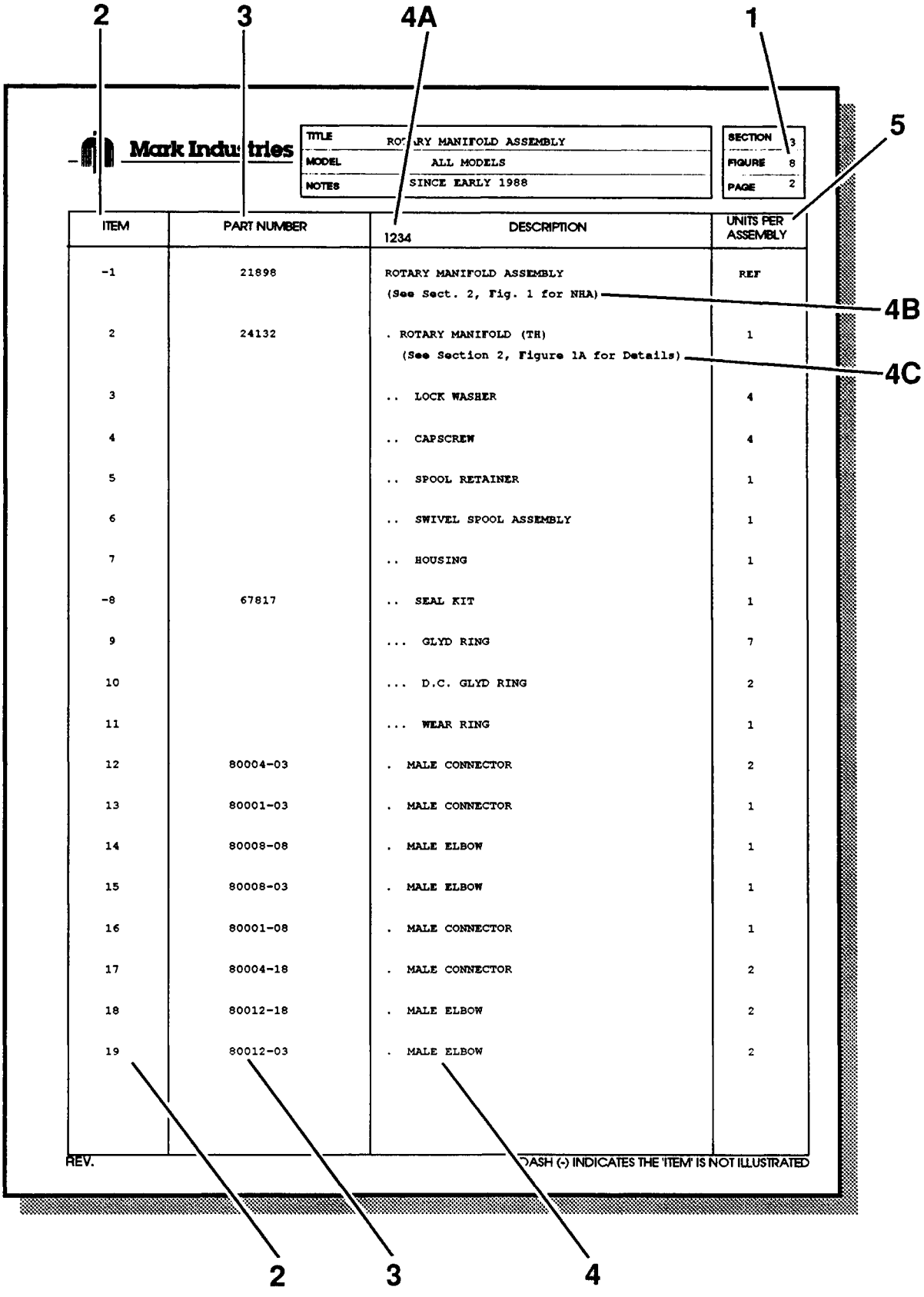
DISCLAIMER

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.



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**.

4. Elements of the **Description**.

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

   Figure Description

   1 2 3 4

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

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

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

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

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

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

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

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

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

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

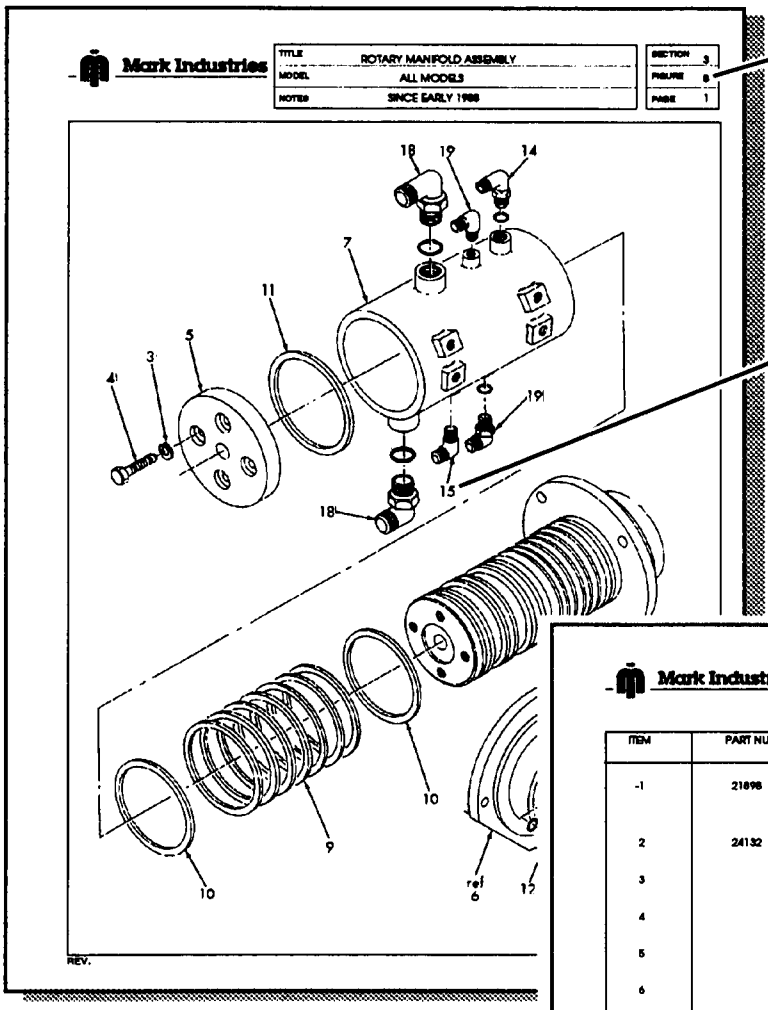
1A

1B

1A

1D

1C



Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY
MODEL	ALL MODELS
NOTES	SINCE EARLY 1988

SECTION 3
FIGURE 6
PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSEMBLY
-1	21898	ROTARY MANIFOLD ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	24132	. ROTARY MANIFOLD (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	80008-06	. MALE ELBOW	1
15	80008-03	. MALE ELBOW	1
16	80001-06	. 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. 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.

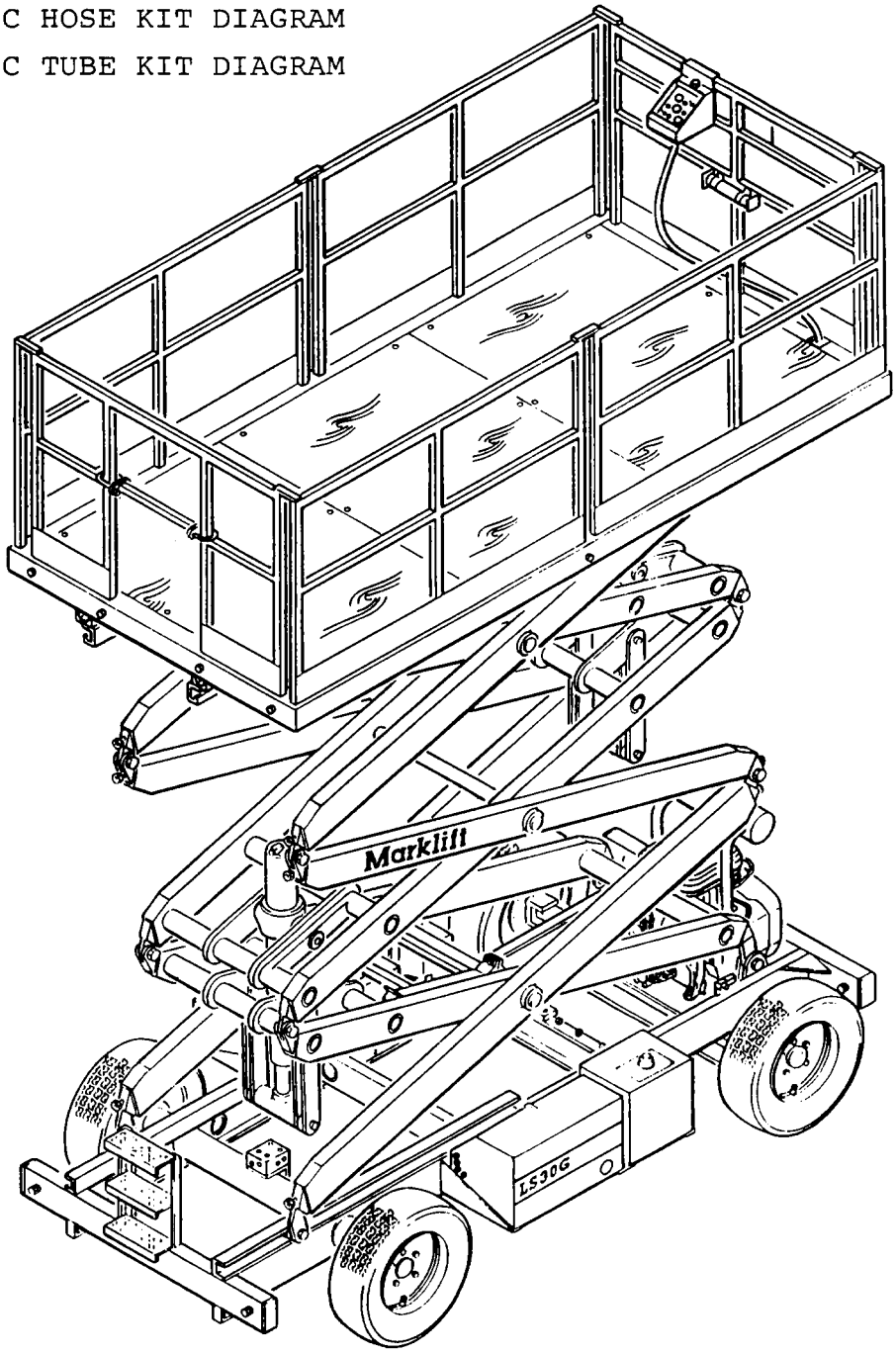
2. Ordering: Listed below are the methods of ordering parts. The **preferred** method of ordering parts is by **FAX**.

   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

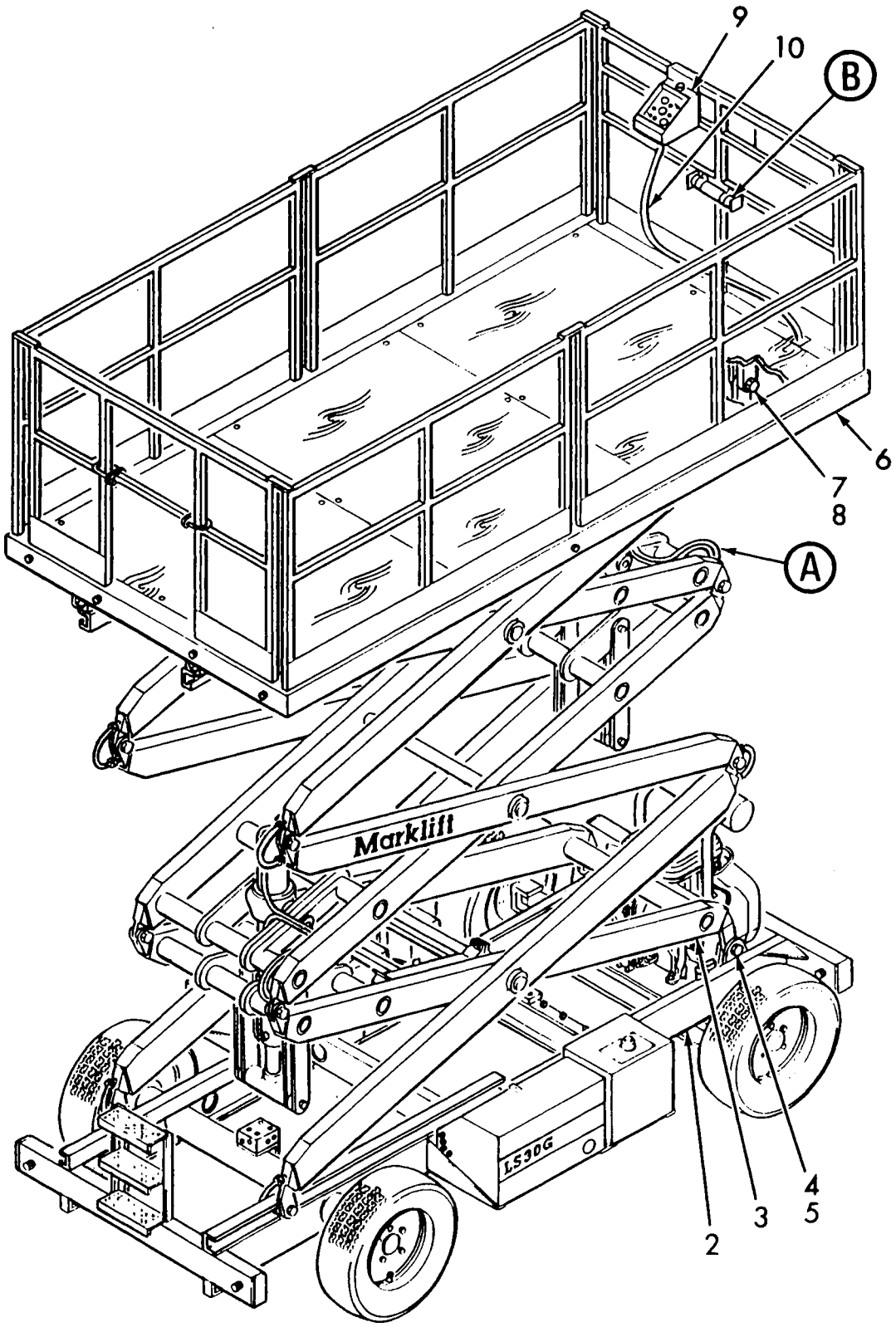
SECTION 2 CONTAINS:



Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	LS30G
NOTES	

SECT.	2
FIG.	1
PAGE	1

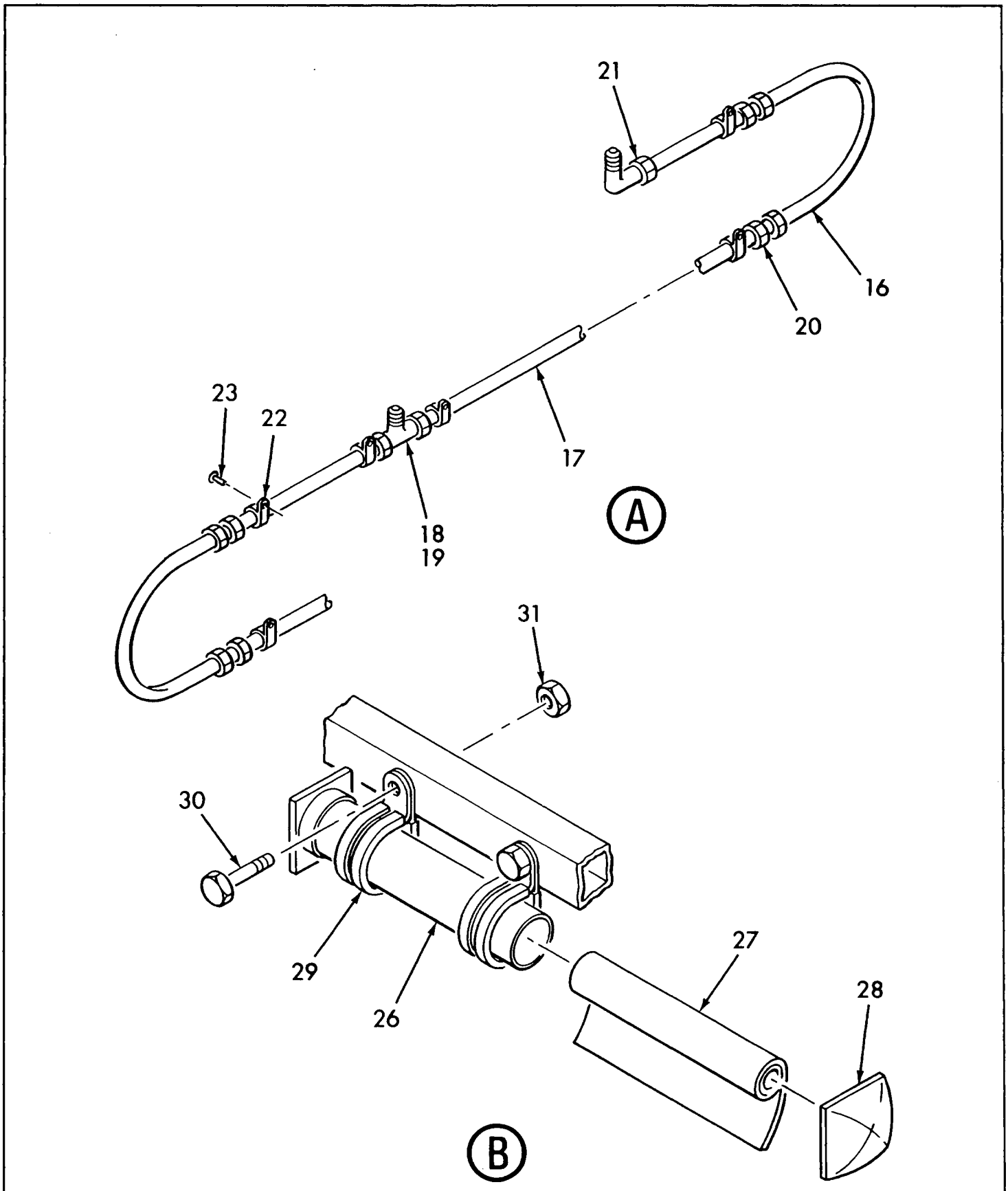


REV.

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	LS30G
NOTES	

SECT.	2
FIG.	1
PAGE	2



REV.

Mark Industries

TITLE	FINAL ASSEMBLY	SECT. 2
MODEL	LS30G	FIG. 1
NOTES		PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30007	FINAL ASSEMBLY	REF
2	32380	. FRAME ASSEMBLY (See Sect. 3, Fig. 1 for Details)	1
3	30231	. SCISSOR ASSEMBLY (See Sect. 4, Fig. 1 for Details)	1
4	30775	. EAR PIVOT BOLT	2
5	61304	. LOCK NUT	2
6	32184	. PLATFORM ASSEMBLY (See Sect. 5, Fig. 1 for Details)	1
7	30775	. EAR PIVOT BOLT	2
8	61304	. LOCK NUT	2
9	32409	. UPPER CONTROL BOX ASSEMBLY (See Sect. 2, Fig. 2 for Details)	1
10	130337-75	. CONDUCTOR CABLE	1
-11	255	. CABLE TIE (LARGE)	50
-12	256	. CABLE TIE (SMALL)	50
-13	16680	. ELECTRICAL TAPE	1 ROLL
-14	32400	. ELECTRICAL SCHEMATIC (See Schematic Section)	1
-15	67642	. DECAL SET (See Sect. 2, Fig. 3 for Details)	1
16	32403	. HYDRAULIC HOSE KIT DIAGRAM (See Sect. 2, Fig. 4 for Details)	1
17	32405	. HYDRAULIC TUBE KIT DIAGRAM (See Sect. 2, Fig. 5 for Details)	1
18	80031-05	. UNION TEE	1
19	80031-04	. UNION TEE	1
20	80042-05	. UNION	4
21	80014-05	. ELBOW UNION	2

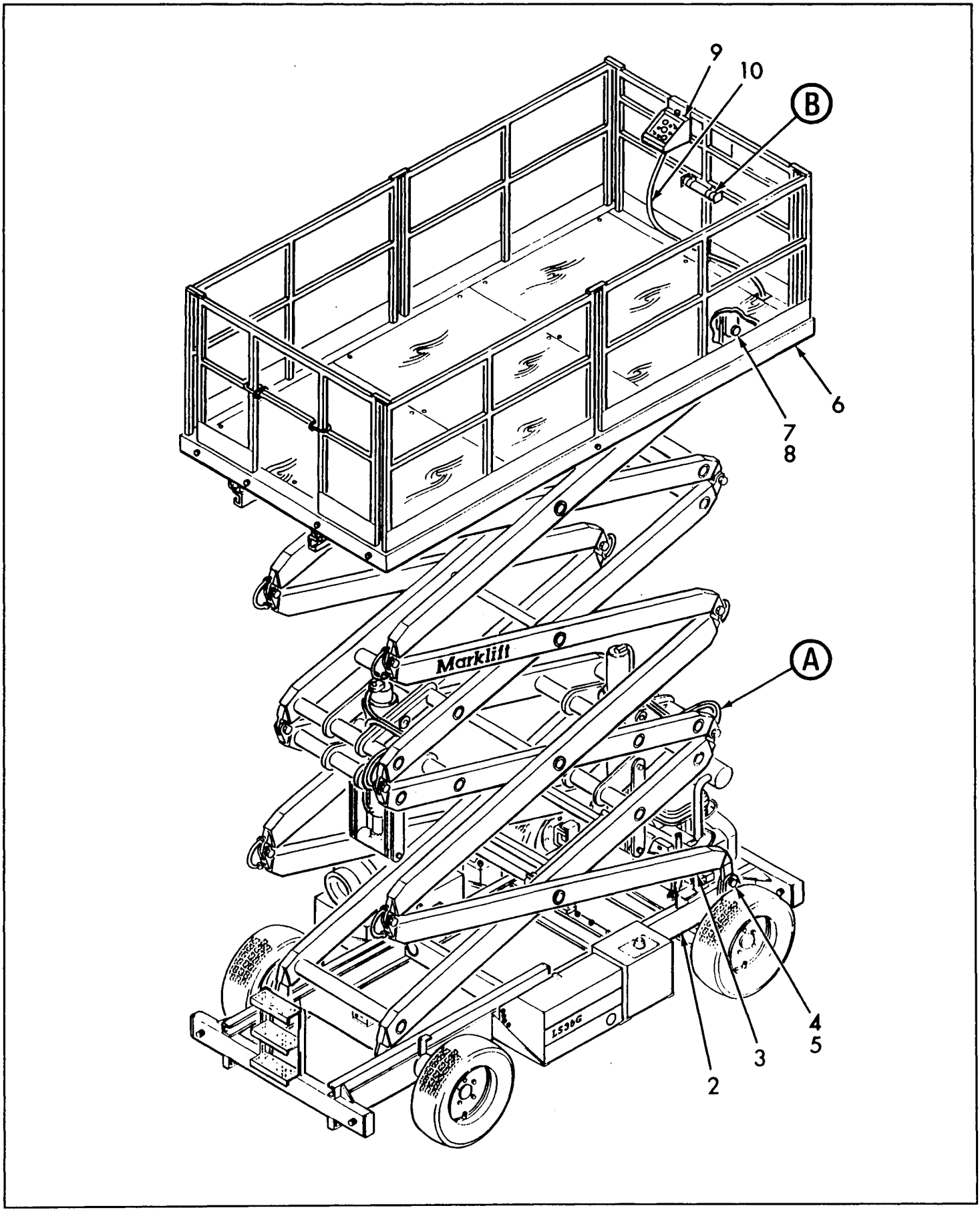
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
22	765	. CLAMP	24
23	63651	. POP RIVET	24
-24	65116	. HYDRAULIC OIL	10 GAL
-25	32360	. HYDRAULIC SCHEMATIC (See Schematic Section)	1
26	130927	. PLASTIC CONTAINER	1
27	17413	. OPERATION & SAFETY HANDBOOK	1
28	65842	. ANTI-ROLL CAP	2
29	65867	. CLAMP	2
30	60315	. CAP SCREW	2
31	60711	. LOCK NUT	2
-32	16608	. WHITE PAINT (SPRAYLAT)	5 GAL
-33	65368	. BLUE PAINT (KRYLON)	1 CAN
-34	2673	. WHITE PAINT (KITKOTE)	1 CAN
-35	16609	. BLUE PAINT (SPRAYLAT)	2 GAL
-36	65114	. GASOLINE	5 GAL
-37	17222	. MARKLIFT PARTS CATALOG	1

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	2
FIGURE	1A
PAGE	1

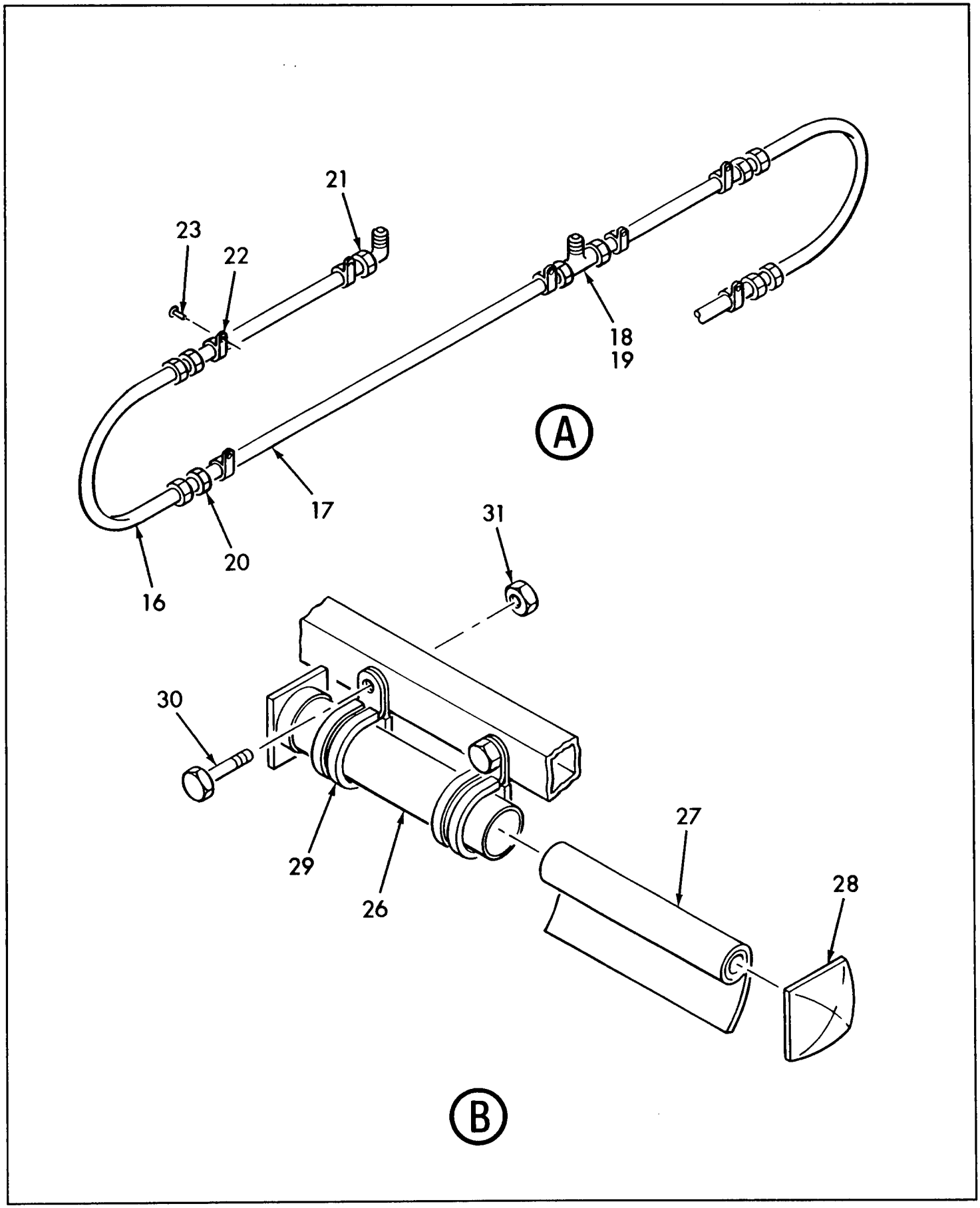


REV.

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	2
FIGURE	1A
PAGE	2



REV.

Mark Industries

TITLE	FINAL ASSEMBLY	SECT. 2
MODEL	LS36G	FIG. 1A
NOTES		PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30002	FINAL ASSEMBLY	REF
2	32384	. FRAME ASSEMBLY (See Sect. 3, Fig. 1A for Details)	1
3	30232	. SCISSOR ASSEMBLY (See Sect. 4, Fig. 1A for Details)	1
4	30775	. EAR PIVOT BOLT	2
5	61304	. LOCK NUT	2
6	32184	. PLATFORM ASSEMBLY (See Sect. 5, Fig. 1 for Details)	1
7	30775	. EAR PIVOT BOLT	2
8	61304	. LOCK NUT	2
9	32409	. UPPER CONTROL BOX ASSEMBLY (See Sect. 2, Fig. 2 for Details)	1
10	130337-75	. CONDUCTOR CABLE	1
-11	255	. CABLE TIE (LARGE)	50
-12	256	. CABLE TIE (SMALL)	50
-13	16680	. ELECTRICAL TAPE	1 ROLL
-14	32427	. ELECTRICAL SCHEMATIC (See Schematic Section)	1
-15	67824	. DECAL SET (See Sect. 2, Fig. 3A for Details)	1
16	32403	. HYDRAULIC HOSE KIT DIAGRAM (See Sect. 2, Fig. 4 for Details)	1
17	32405	. HYDRAULIC TUBE KIT DIAGRAM (See Sect. 2, Fig. 5 for Details)	1
18	80031-05	. UNION TEE	1
19	80031-04	. UNION TEE	1
20	80042-05	. UNION	5
21	80014-05	. ELBOW UNION	1

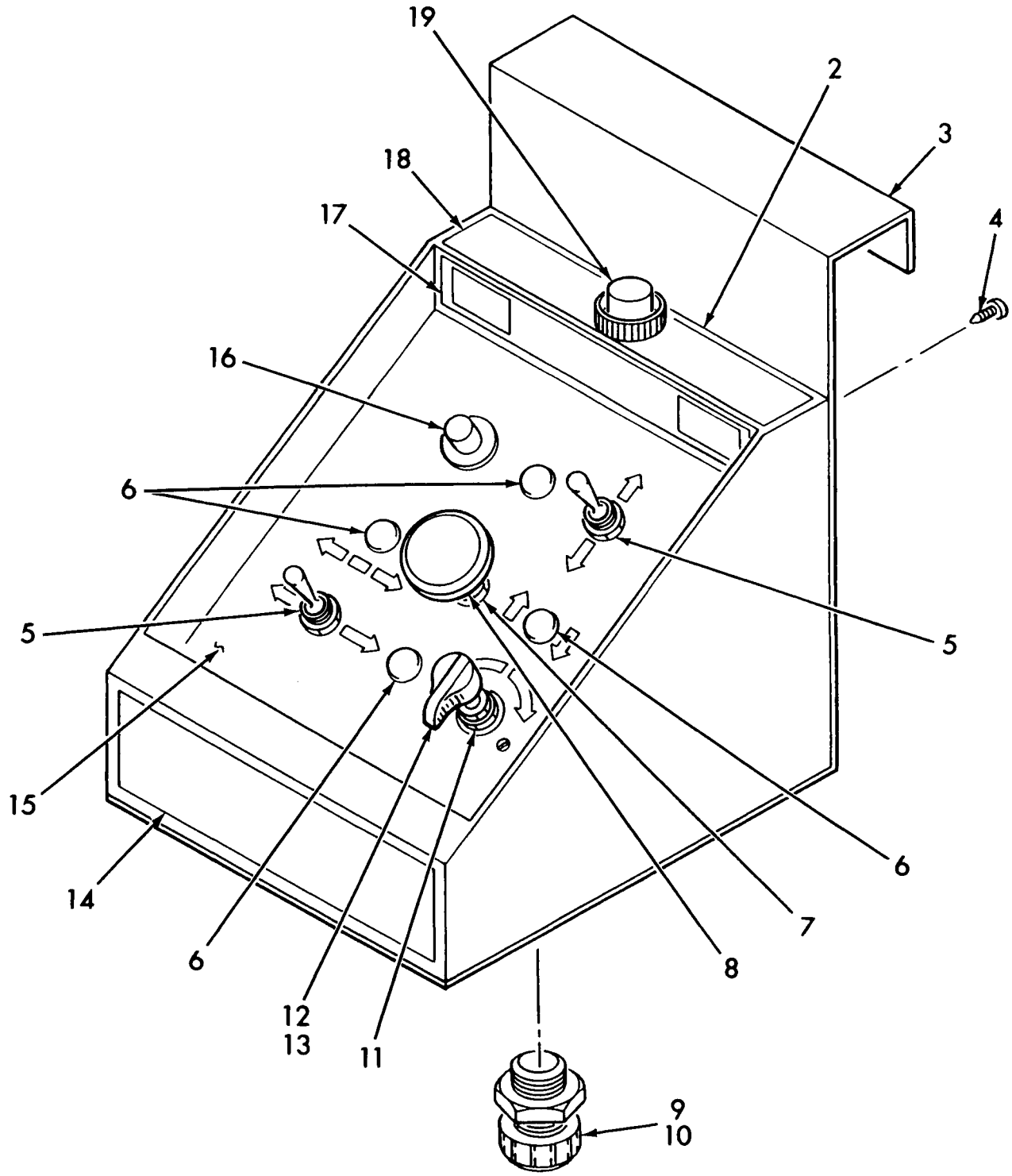
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
22	765	. CLAMP	24
23	63651	. POP RIVET	24
-24	65116	. HYDRAULIC OIL	10 GAL
-25	32360	. HYDRAULIC SCHEMATIC (See Schematic Section)	1
26	130927	. PLASTIC CONTAINER	1
27	17413	. OPERATION & SAFETY HANDBOOK	1
28	65842	. ANTI-ROLL CAP	2
29	65867	. CLAMP	2
30	60315	. CAP SCREW	2
31	60711	. LOCK NUT	2
-32	16608	. WHITE PAINT (SPRAYLAT)	5 GAL
-33	65368	. BLUE PAINT (KRYLON)	1 CAN
-34	2673	. WHITE PAINT (KITKOTE)	1 CAN
-35	16609	. BLUE PAINT (SPRAYLAT)	2 GAL
-36	65114	. GASOLINE	5 GAL
-37	17222	. AMRKLIFT PARTS CATALOG	1

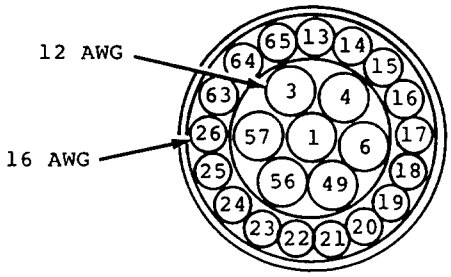
Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	2
FIGURE	2
PAGE	1

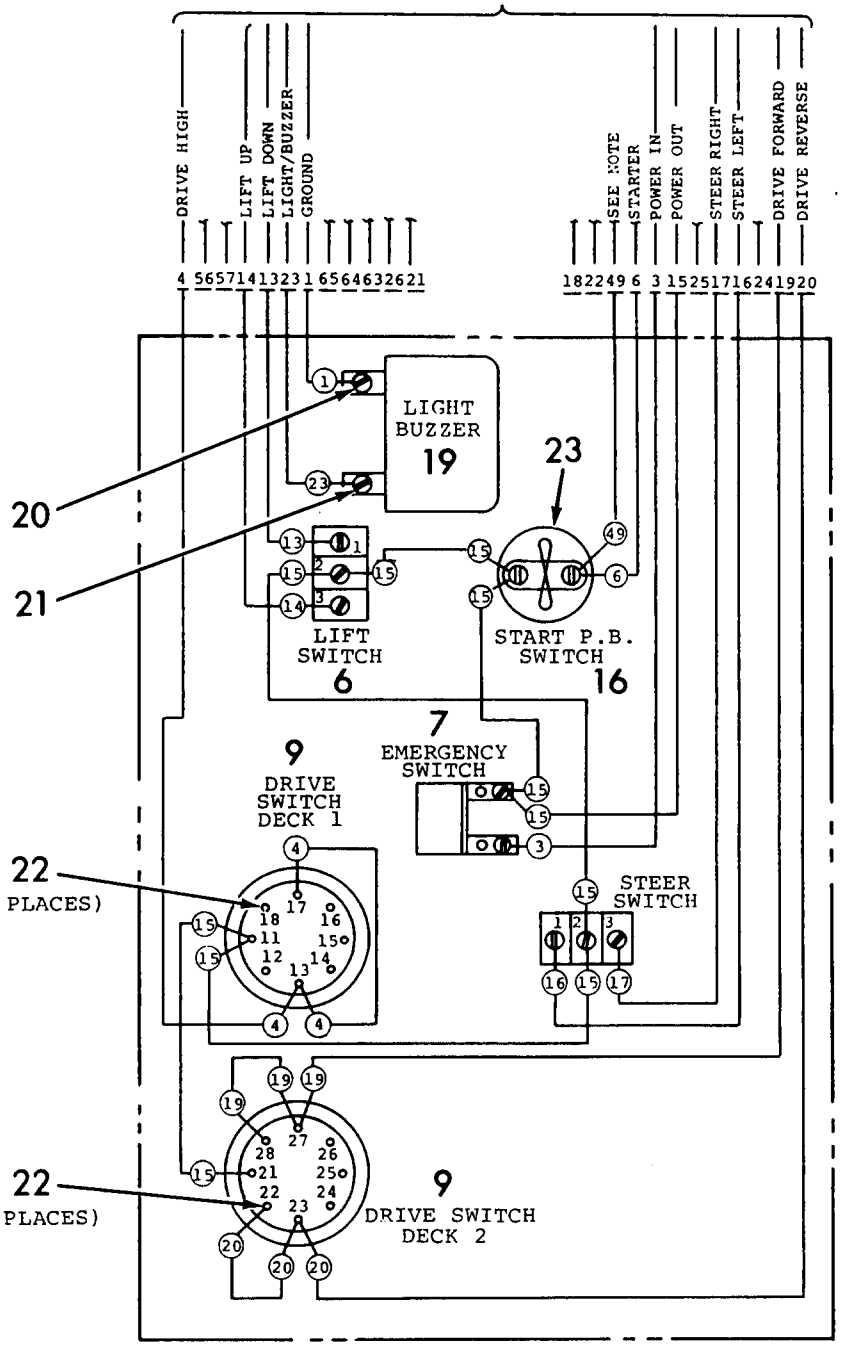


REV.



CONDUCTOR CABLE
P/N 130337 REF

TO ELECTRICAL PANNEL/COMPONENT BOX



NOTE:
CONNECT WIRE
NO. 49 & NO. 6
TOGETHER
(PARALLEL)

REV.

Mark Industries

TITLE	UPPER CONTROL BOX ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECT.	2
FIG.	2
PAGE	3

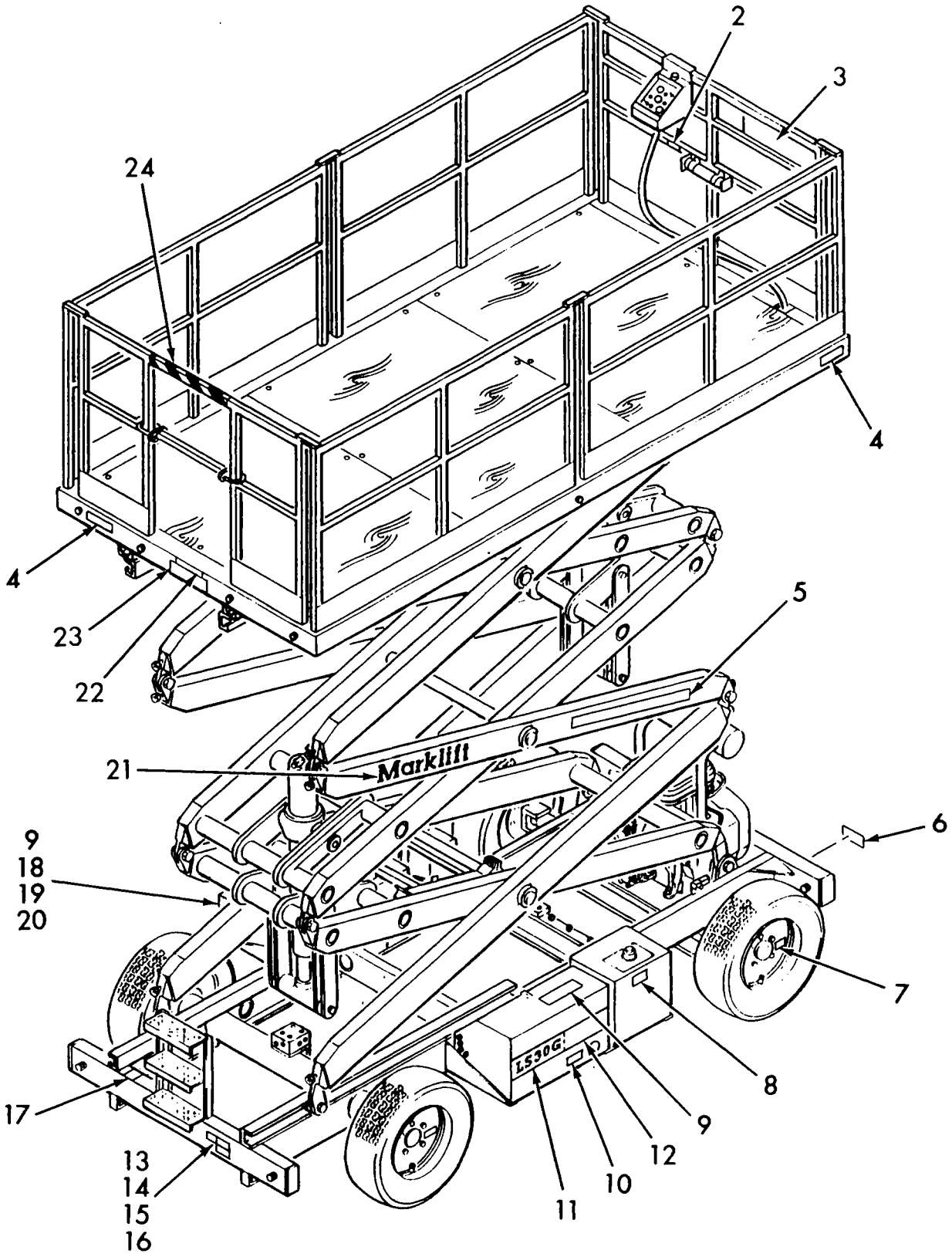
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32409	UPPER CONTROL BOX (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	31106	. CONTROL BOX MACHINING	1
3	32534	. COVER	1
4	61724	. SELF-TAPPING SCREW	6
5	4021	. TOGGLE SWITCH (STEER)(LIFT)	2
6	771	. PLUG	4
7	4018	. PUSH PULL SWITCH	1
8	31080	. KNOB (EMERGENCY ON/OFF)	1
9	2807	. STRAIN RELIEF	1
10	2809	. LOCK NUT	1
11	67098	. 5 POSITION SWITCH ASSEMBLY	1
12	65151	. KNOB (DRIVE SWITCH)	1
13	62209	. SET SCREW	1
14	2026	. DECAL: LOAD CAPACITY (LS30G)	1
14	2024	. DECAL: LOAD CAPACITY (LS36G)	1
15	2008	. DECAL: CONTROL BOX	1
16	4020	. PUSH BUTTON SWITCH (START)	1
17	2014	. DECAL: "CAUTION" HIGH VOLTAGE	1
18	2015	. DECAL: "WARNING" UNSTABLE CONDITION	1
19	20805	. BUZZER ALARM	1
20	70198	. RING CONNECTOR	4
21	117-C	. RING CONNECTOR	12
22	16228	. RING CONNECTOR	12
23	2271	. THRUST WASHER	1
-24	70009	. WIRE (16 AWG)	2 FT

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

Mark Industries

TITLE	DECAL SET
MODEL	LS30G
NOTES	

SECTION	2
FIGURE	3
PAGE	1



REV.

Mark Industries

TITLE	DECAL SET	SECT.	2
MODEL	LS30G	FIG.	3
NOTES		PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	67642	DECAL SET (See Sect. 2, Fig. 1 for NHA)	REF
2	130820	. DECAL: OPERATION & SAFETY HANDBOOK	1
3	182102	. DECAL: OPERATION INSTRUCTIONS	1
4	2026	. DECAL: LOAD CAPACITY 1500 LBS.	4
5	130596	. DECAL: A PRODUCT OF MARK INDUSTRIES	2
6	2041	. DECAL: DO NOT LIFT	2
7	22175	. DECAL: MONOFILLED TIRES	4
8	2017	. DECAL: HYDRAULIC FLUID	2
9	2016	. DECAL: WARNING DO NOT WORK UNDER	2
10	2019	. DECAL: EMERGENCY LOWERING VALVE	1
11	181736	. DECAL: LS30G	2
12	181728	. DECAL: PANEL STRIP	2
13	20660	. IDENTIFICATION NAMEPLATE	1
14	20661	. ANSI A92 NAMEPLATE	1
15	30520	. PATENT NUMBER NAMEPLATE	1
16	63653	. POP RIVET	12
17	130606	. DECAL: FREEWHEELING VALVE	1
18	2003	. DECAL: BATTERY WATER LEVEL	1
19	2020	. DECAL: GASOLINE OR PETROL	1
20	2004	. DECAL: USE VAPOR TANK ONLY	1
21	31260	. DECAL: MARKLIFT	2
22	31109	. DECAL: CAUTION DO NOT REMOVE SCISSOR GUARD RAILS	1
23	11064	. DECAL: ATTACH SAFETY CHAINS BEFORE RAISING PLATFORM (ON OLDER MACHINES)	1
24	160137	. WARNING TAPE	1

Mark Industries

TITLE	DECAL SET
MODEL	LS30G
NOTES	

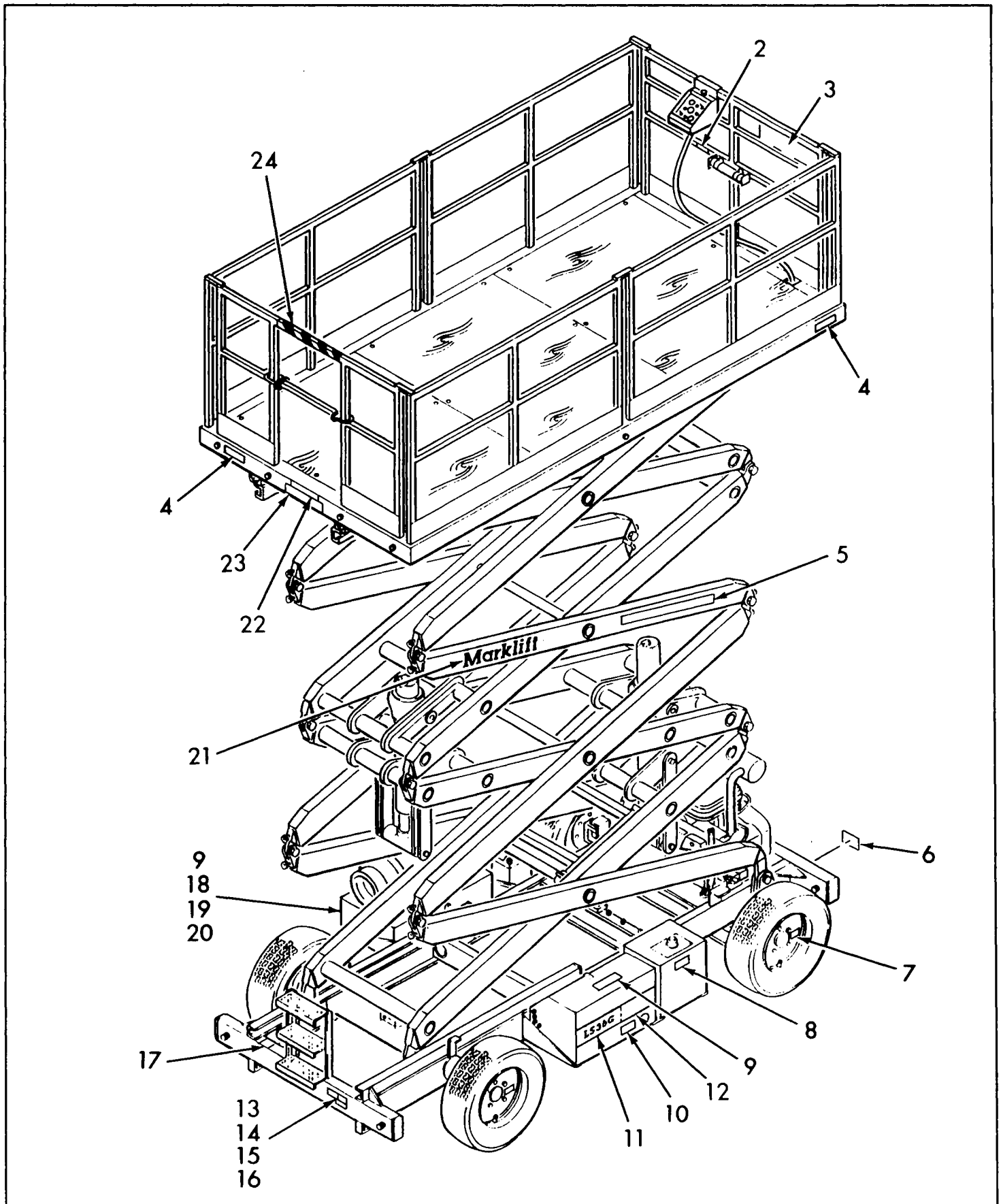
SECT.	2
FIG.	3
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	67642	DECAL SET (See Sect. 2, Fig. 1 for NHA)	REF
2	130820	. DECAL: OPERATION & SAFETY HANDBOOK	1
3	182102	. DECAL: OPERATION INSTRUCTIONS	1
4	2026	. DECAL: LOAD CAPACITY 1500 LBS.	4
5	130596	. DECAL: A PRODUCT OF MARK INDUSTRIES	2
6	2041	. DECAL: DO NOT LIFT	2
7	22175	. DECAL: MONOFILLED TIRES	4
8	2017	. DECAL: HYDRAULIC FLUID	2
9	2016	. DECAL: WARNING DO NOT WORK UNDER	2
10	2019	. DECAL: EMERGENCY LOWERING VALVE	1
11	181736	. DECAL: LS30G	2
12	181728	. DECAL: PANEL STRIP	2
13	20660	. IDENTIFICATION NAMEPLATE	1
14	20661	. ANSI A92 NAMEPLATE	1
15	30520	. PATENT NUMBER NAMEPLATE	1
16	63653	. POP RIVET	12
17	130606	. DECAL: FREEWHEELING VALVE	1
18	2003	. DECAL: BATTERY WATER LEVEL	1
19	2020	. DECAL: GASOLINE OR PETROL	1
20	2004	. DECAL: USE VAPOR TANK ONLY	1
21	31260	. DECAL: MARKLIFT	2
22	31109	. DECAL: CAUTION DO NOT REMOVE SCISSOR GUARD RAILS	1
23	11064	. DECAL: ATTACH SAFETY CHAINS BEFORE RAISING PLATFORM (ON OLDER MACHINES)	1
24	160137	. WARNING TAPE	1

Mark Industries

TITLE	DECAL SET
MODEL	LS36G
NOTES	

SECTION	2
FIGURE	3A
PAGE	1



REV.

Mark Industries

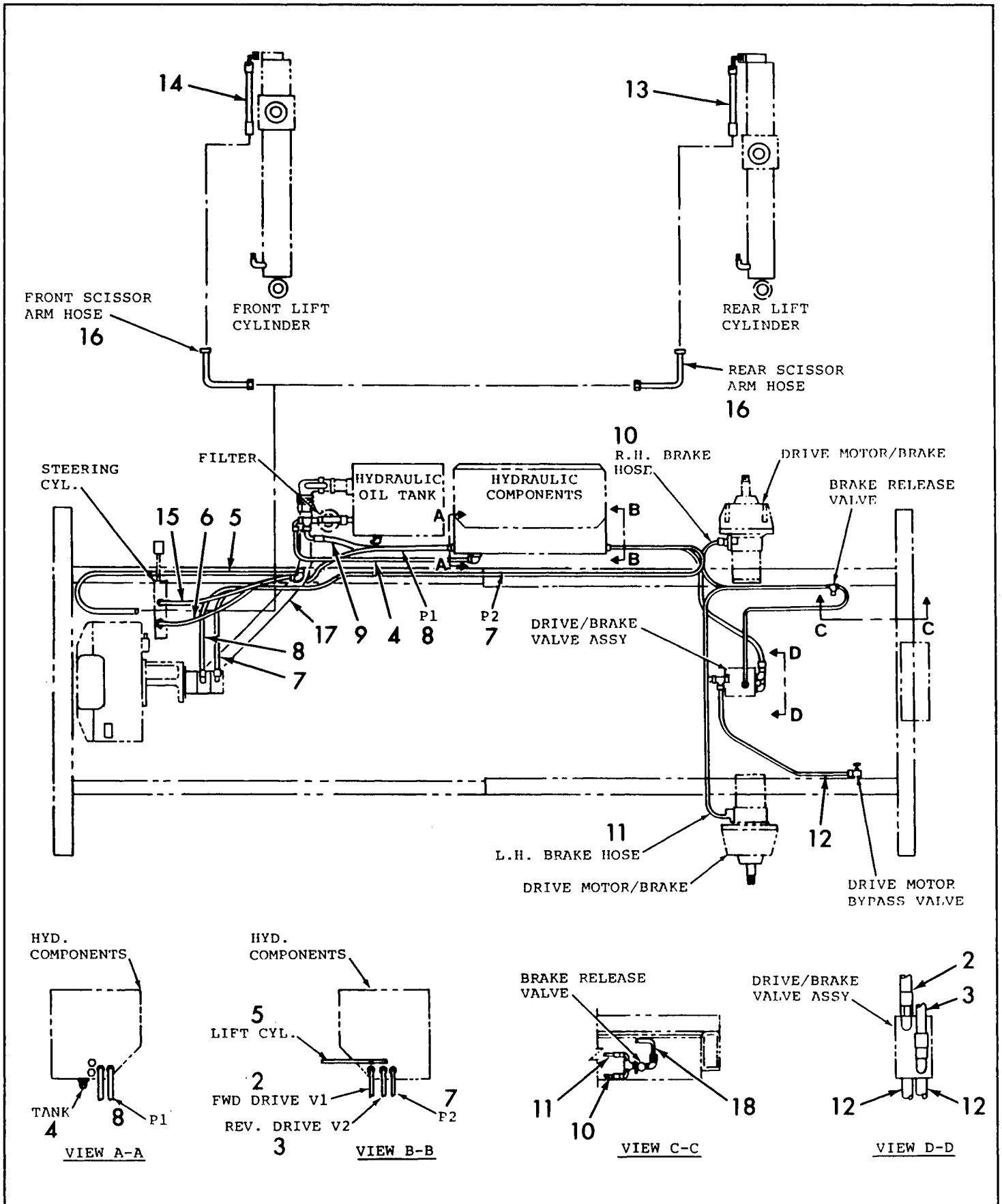
TITLE	DECAL SET	SECT. 2
MODEL	LS36G	FIG. 3A
NOTES		PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	67824	DECAL SET (See Sect. 2, Fig. 1A for NHA)	REF
2	130820	. DECAL: OPERATION & SAFETY HANDBOOK	1
3	182102	. DECAL: OPERATION INSTRUCTIONS	1
4	2024	. DECAL: LOAD CAPACITY 1000 LBS.	4
5	130596	. DECAL: A PRODUCT OF MARK INDUSTRIES	2
6	2041	. DECAL: DO NOT LIFT	2
7	22175	. DECAL: MONOFILLED TIRES	4
8	2017	. DECAL: HYDRAULIC FLUID	2
9	2016	. DECAL: WARNING DO NOT WORK UNDER	2
10	2019	. DECAL: EMERGENCY LOWERING VALVE	1
11	18173	. DECAL: LS36G	2
12	181728	. DECAL: PANEL STRIP	2
13	20660	. IDENTIFICATION NAMEPLATE	1
14	20661	. ANSI A92 NAMEPLATE	1
15	30520	. PATENT NUMBER NAMEPLATE	1
16	63653	. POP RIVET	12
17	130606	. DECAL: FREEWHEELING VALVE	1
18	2003	. DECAL: BATTERY WATER LEVEL	1
19	2020	. DECAL: GASOLINE OR PETROL	1
20	2004	. DECAL: USE VAPOR TANK ONLY	1
21	31260	. DECAL: MARKLIFT	2
22	31109	. DECAL: CAUTION DO NOT REMOVE SCISSOR GUARD RAILS	1
23	11064	. DECAL: ATTACH SAFETY CHAINS BEFORE RAISING PLATFORM (ON OLDER MACHINES)	1
24	160137	. WARNING TAPE	1

Mark Industries

TITLE	HYDRAULIC HOSE KIT DIAGRAM
MODEL	LS30G & LS36G
NOTES	

SECTION	2
FIGURE	4
PAGE	1



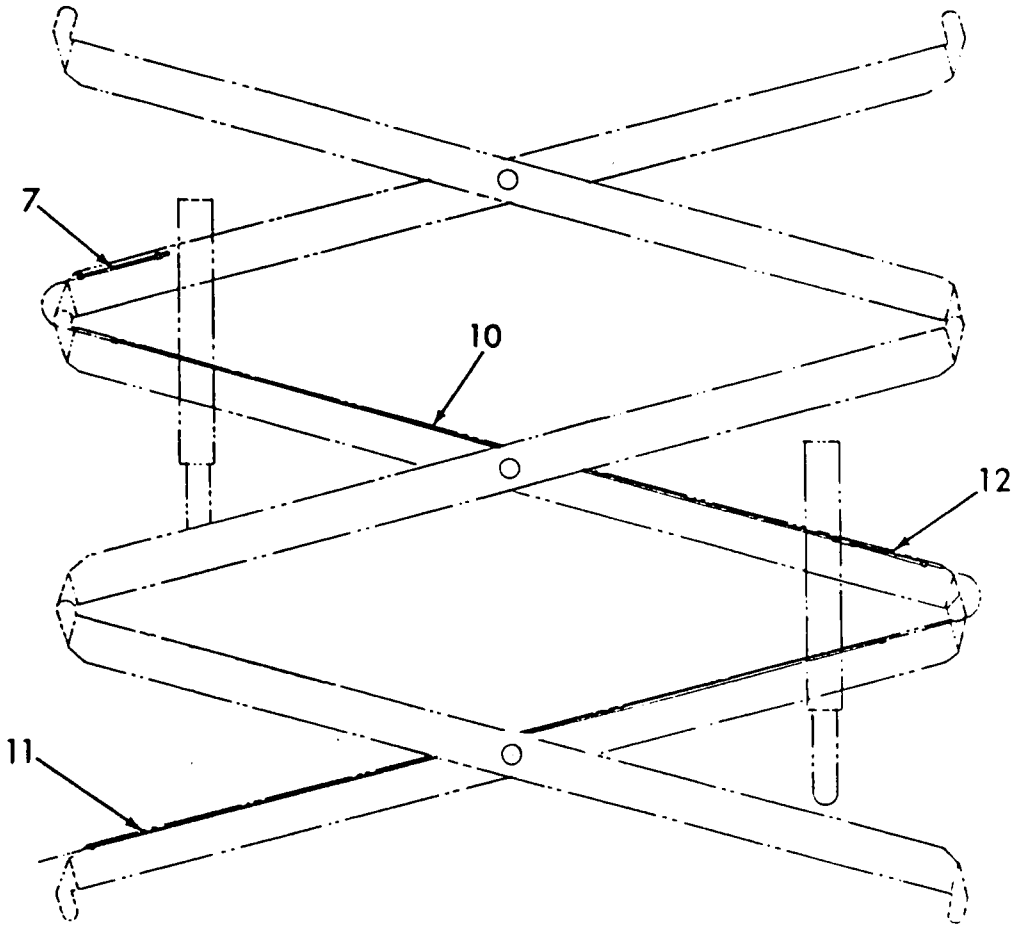
REV.

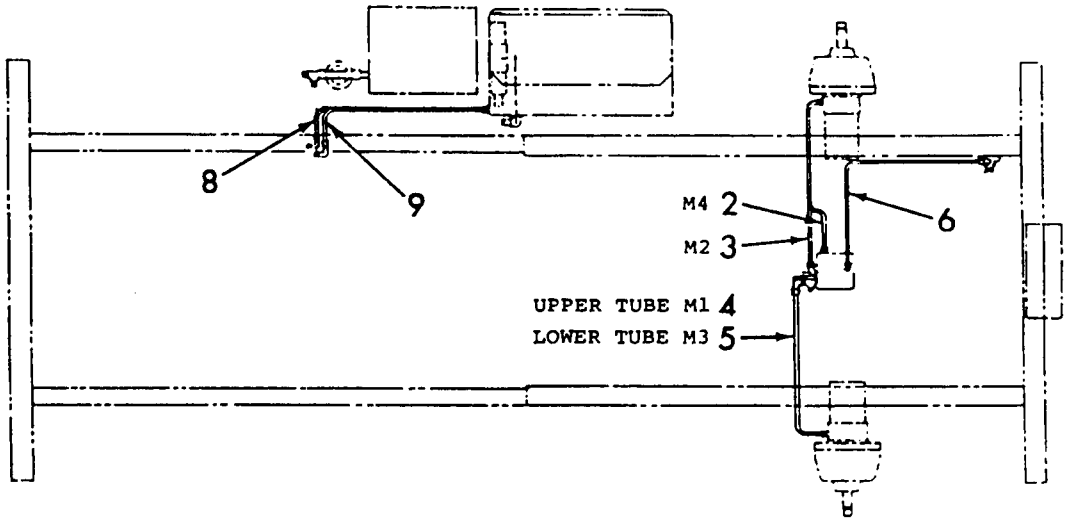
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32403	HYDRAULIC HOSE KIT DIAGRAM (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	13210-10-0430	. HOSE ASSEMBLY	1
3	13210-10-0390	. HOSE ASSEMBLY	1
4	13213-10-0340	. HOSE ASSEMBLY	1
5	13210-06-1470	. HOSE ASSEMBLY	1
6	13213-06-0290	. HOSE ASSEMBLY	1
7	13213-08-1360	. HOSE ASSEMBLY	1
8	13213-10-0750	. HOSE ASSEMBLY	1
9	13213-10-0220	. HOSE ASSEMBLY	1
10	13214-04-0350 -270	. HOSE ASSEMBLY	1
11	13214-04-0650 -270	. HOSE ASSEMBLY	1
12	13210-08-0300	. HOSE ASSEMBLY	2
13	13213-06-0250	. HOSE ASSEMBLY	1
14	13213-06-0180	. HOSE ASSEMBLY	1
15	13213-06-0260	. HOSE ASSEMBLY	1
16	13210-06-0240	. HOSE ASSEMBLY	2
17	13205-12-0570	. HOSE ASSEMBLY	1
18	13213-04-0310	. HOSE ASSEMBLY	1

Mark Industries

TITLE	HYDRAULIC TUBE KIT DIAGRAM
MODEL	LS30G & LS36G
NOTES	

SECTION	2
FIGURE	5
PAGE	1





NOTES:
1. TUBE KIT DIAGRAM IS THE SAME ON 30E, 30G & 36E, 36G THOUGH THE 36E & 36G HAS (1) SET OF ADDITIONAL ARMS.
2. SPECIFICATION FOR HYDRAULIC TUBES: D.O.M. SAE J-525

REV.

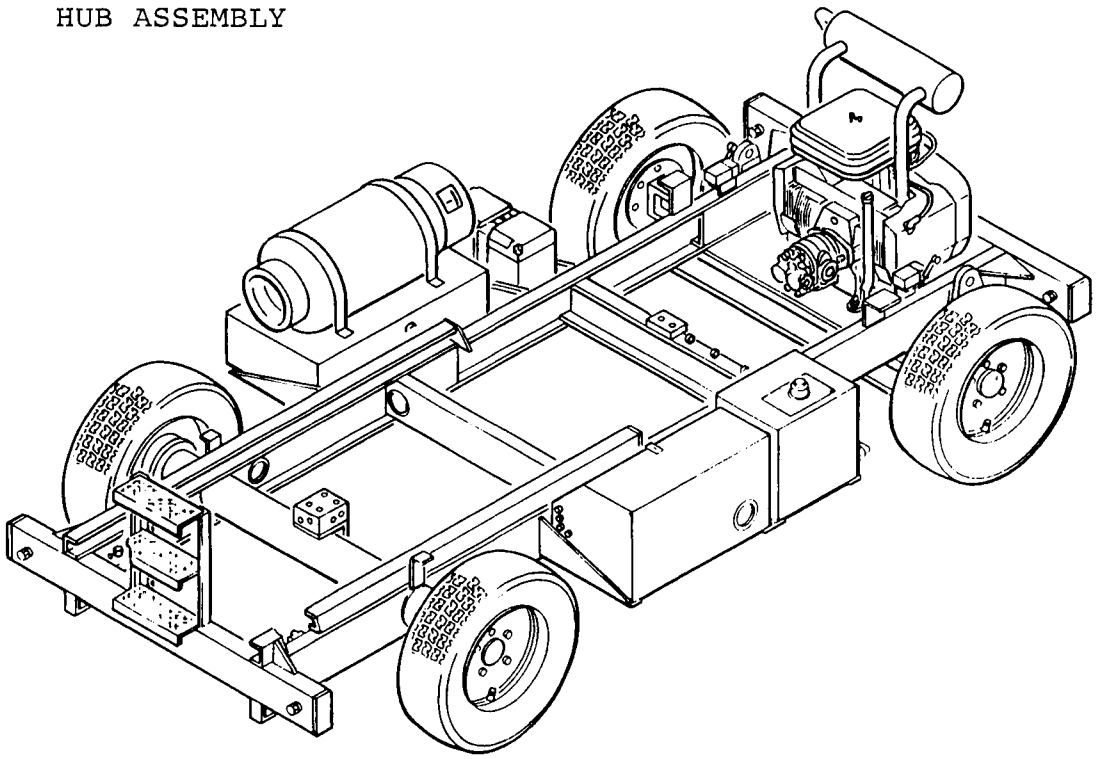
Mark Industries

TITLE	HYDRAULIC TUBE KIT DIAGRAM
MODEL	LS30G & LS36G
NOTES	

SECT.	2
FIG.	5
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32405	HYDRAULIC TUBE KIT DIAGRAM (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	32405-1	. TUBE ASSEMBLY	1
3	32405-2	. TUBE ASSEMBLY	1
4	32405-3	. TUBE ASSEMBLY	1
5	32405-4	. TUBE ASSEMBLY	1
6	32405-5	. TUBE ASSEMBLY	1
7	32405-6	. TUBE ASSEMBLY	1
8	32405-7	. TUBE ASSEMBLY	1
9	32405-8	. TUBE ASSEMBLY	1
10	32405-9	. TUBE ASSEMBLY	1
11	32405-10	. TUBE ASSEMBLY	1
12	32405-11	. TUBE ASSEMBLY	1

SECTION 3 CONTAINS:

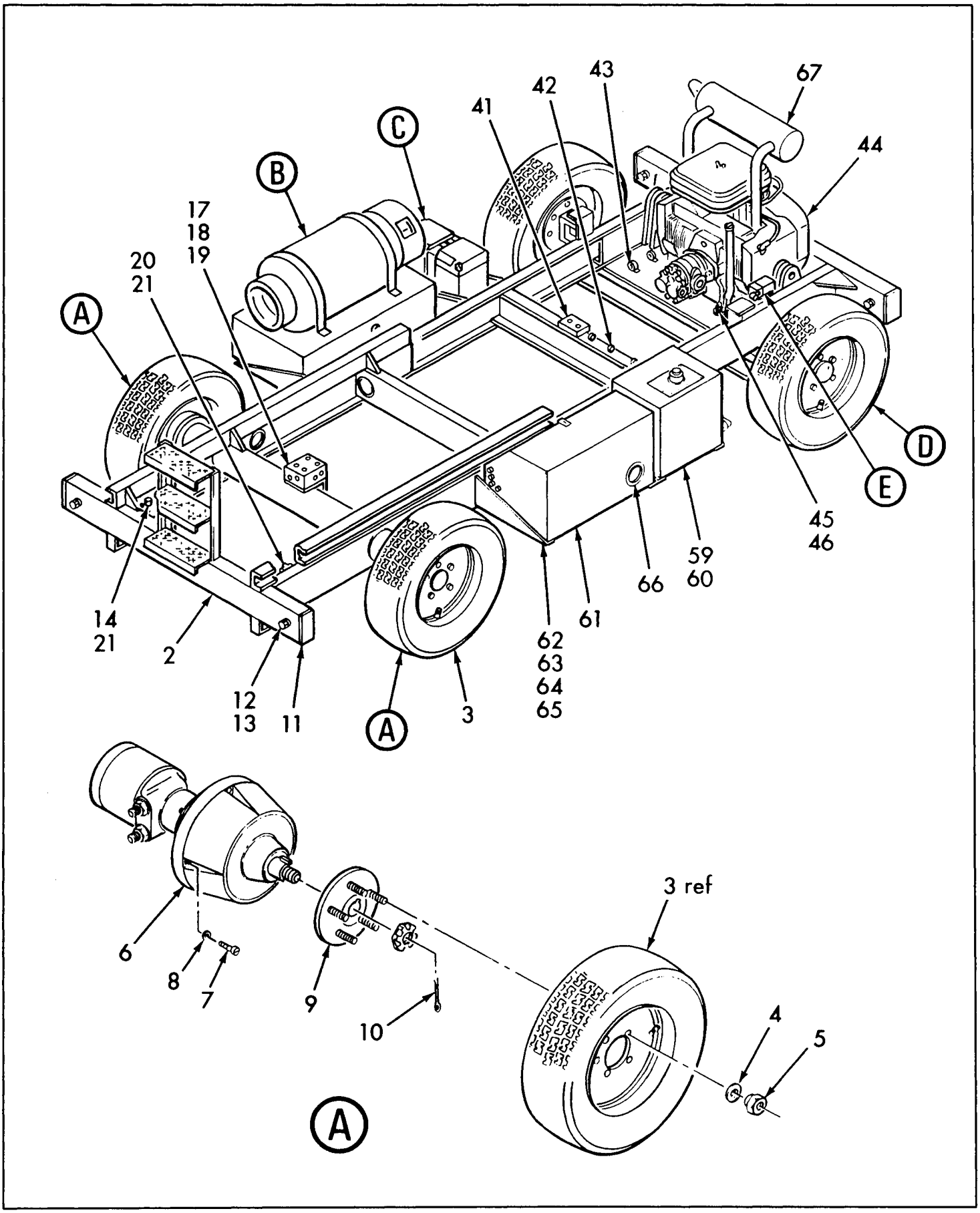


SECTION 3 (CONT'D)

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	3
FIGURE	1
PAGE	1

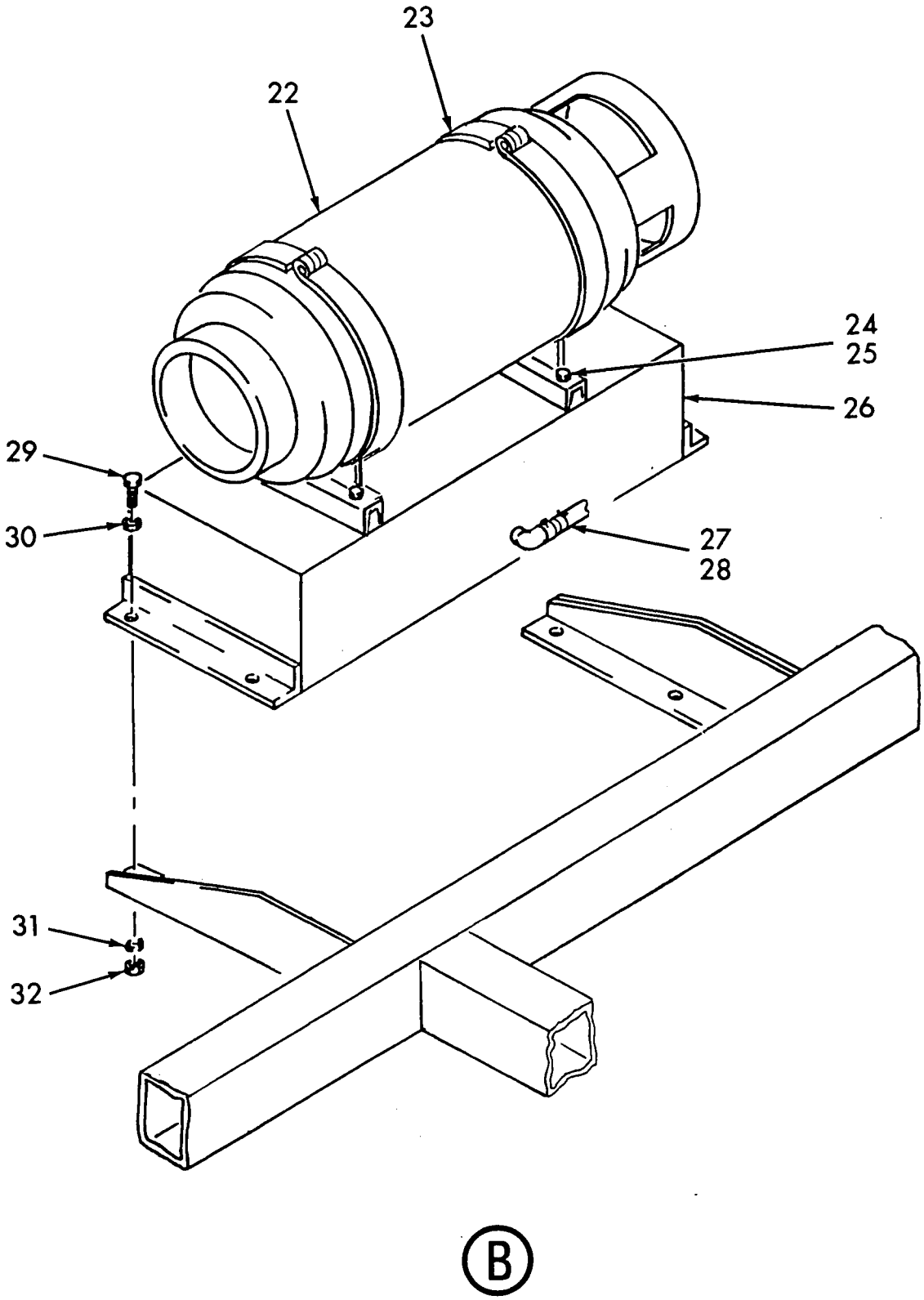


REV.

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS30G
NOTES	

SECT.	3
FIG.	1
PAGE	2

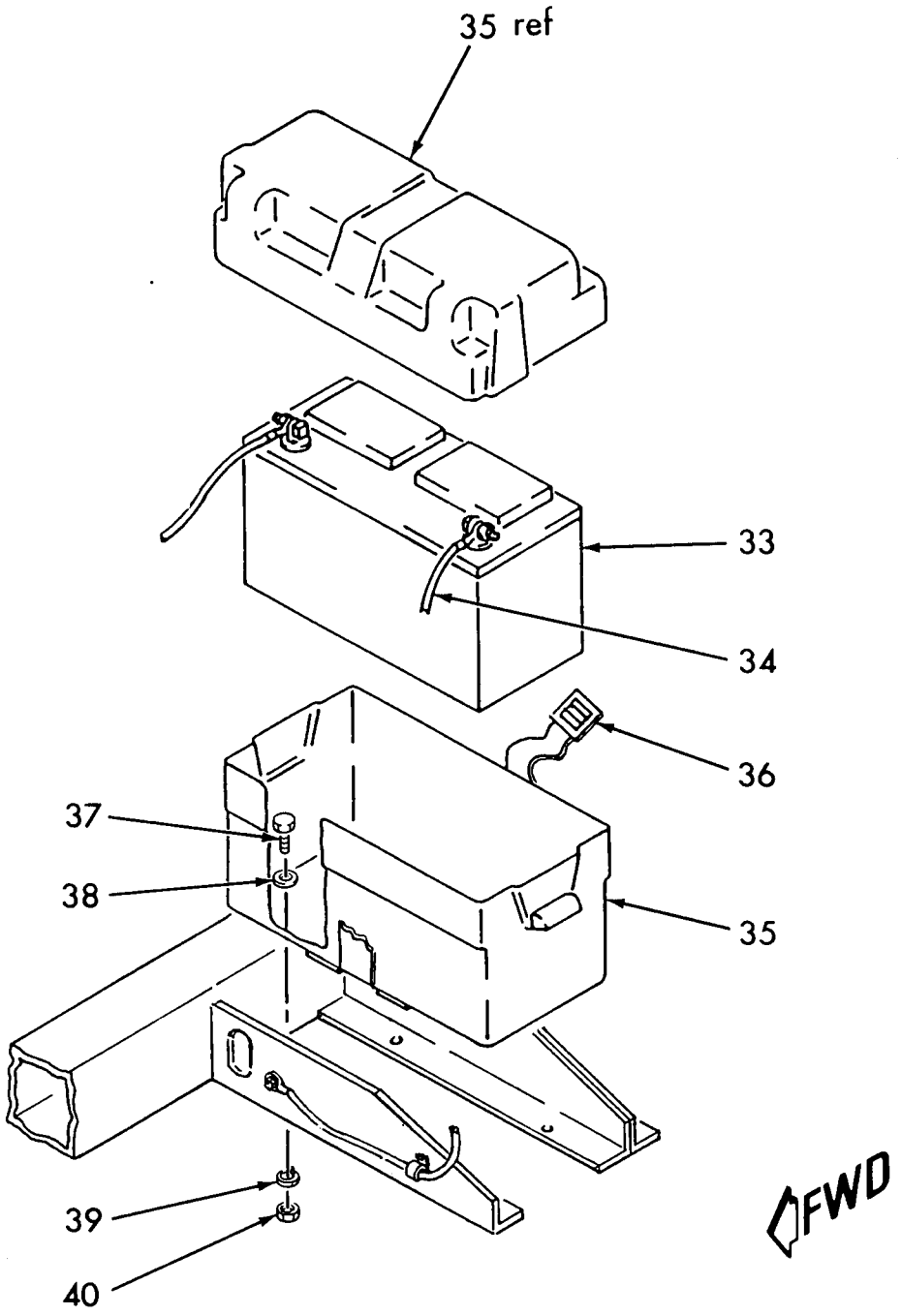


REV.

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	3
FIGURE	1
PAGE	3

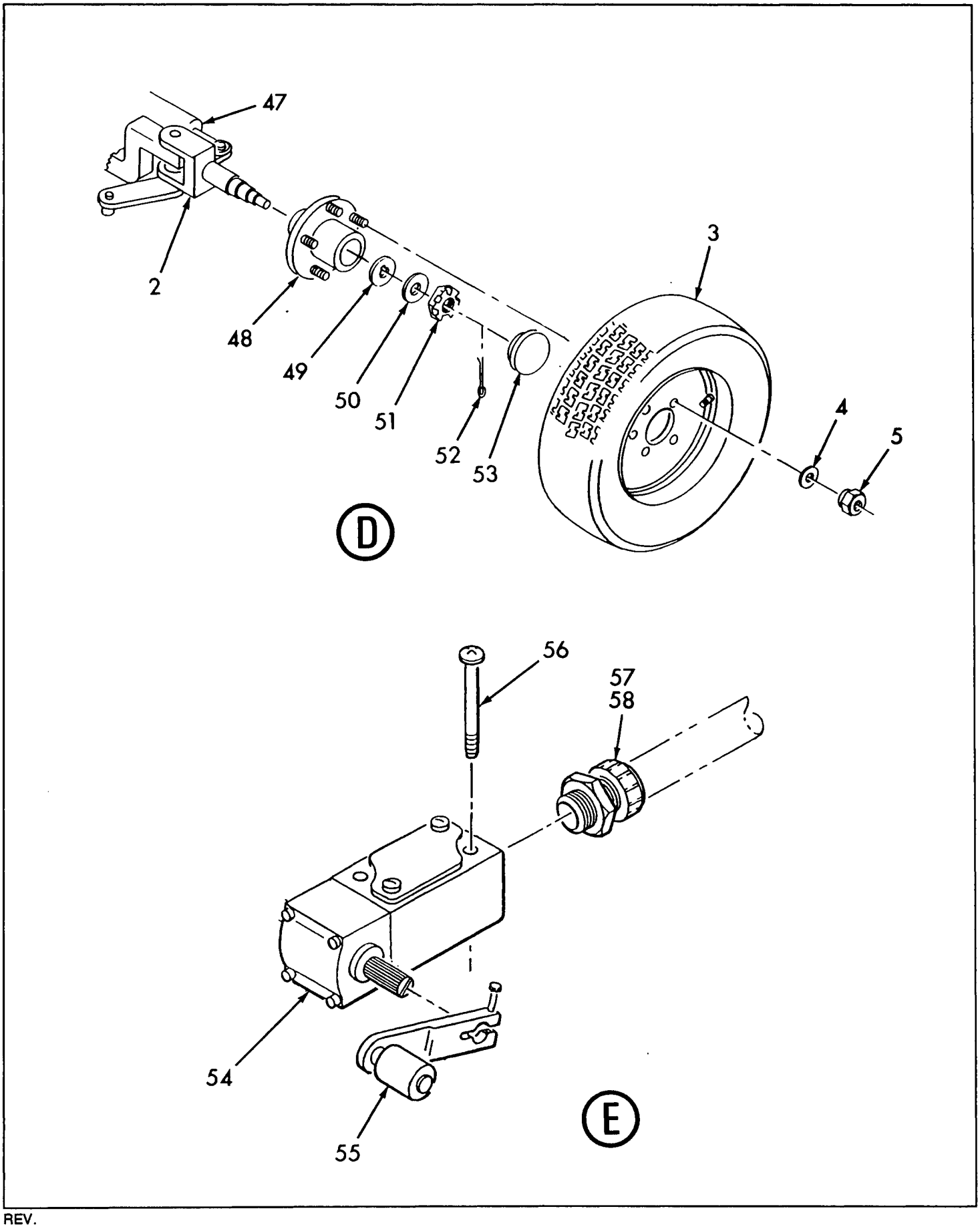


REV.

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	3
FIGURE	1
PAGE	4



REV.

Mark Industries

TITLE	FRAME ASSEMBLY	SECT. 3
MODEL	LS30G	FIG. 1
NOTES		PAGE 5

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32380	FRAME ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	1
2	32444	. FRAME WELDMENT	1
3	30358	. TIRE & WHEEL ASSEMBLY (See Sect. 3, Fig. 2 for Details)	4
4	63501	. FLAT WASHER	20
5	61314	. WHEEL NUT	20
6	32461	. DRIVE MOTOR AND BRAKE ASSEMBLY (See Sect. 3, Fig. 3 for Details)	2
7	61948	. CAP SCREW	8
8	63305	. LOCK WASHER	8
9	30294	. DRIVE HUB	2
10	64310	. COTTER PIN	2
11	30448	. BUMPER CAP	4
12	60324	. CAP SCREW	8
13	63434	. FLAT WASHER	8
14	32578	. NEEDLE VALVE ASSEMBLY (FREEWHEELING)	1
-15	201	.. NEEDLE VALVE	1
-16	80008-13	.. ELBOW	1
17	32475	. DRIVE & BRAKE VALVE ASSEMBLY (See Sect. 3, Fig. 6 for Details)	1
18	60428	. CAP SCREW	2
19	63303	. LOCK WASHER	2
20	32579	. FLOW CONTROL VALVE ASSEMBLY (See Sect. 3, Fig. 7 for Details)	1
21	65218	. U-BOLT	2
22	486-C	. LPG TANK	1
23	486-A	. TANK BRACKET	2

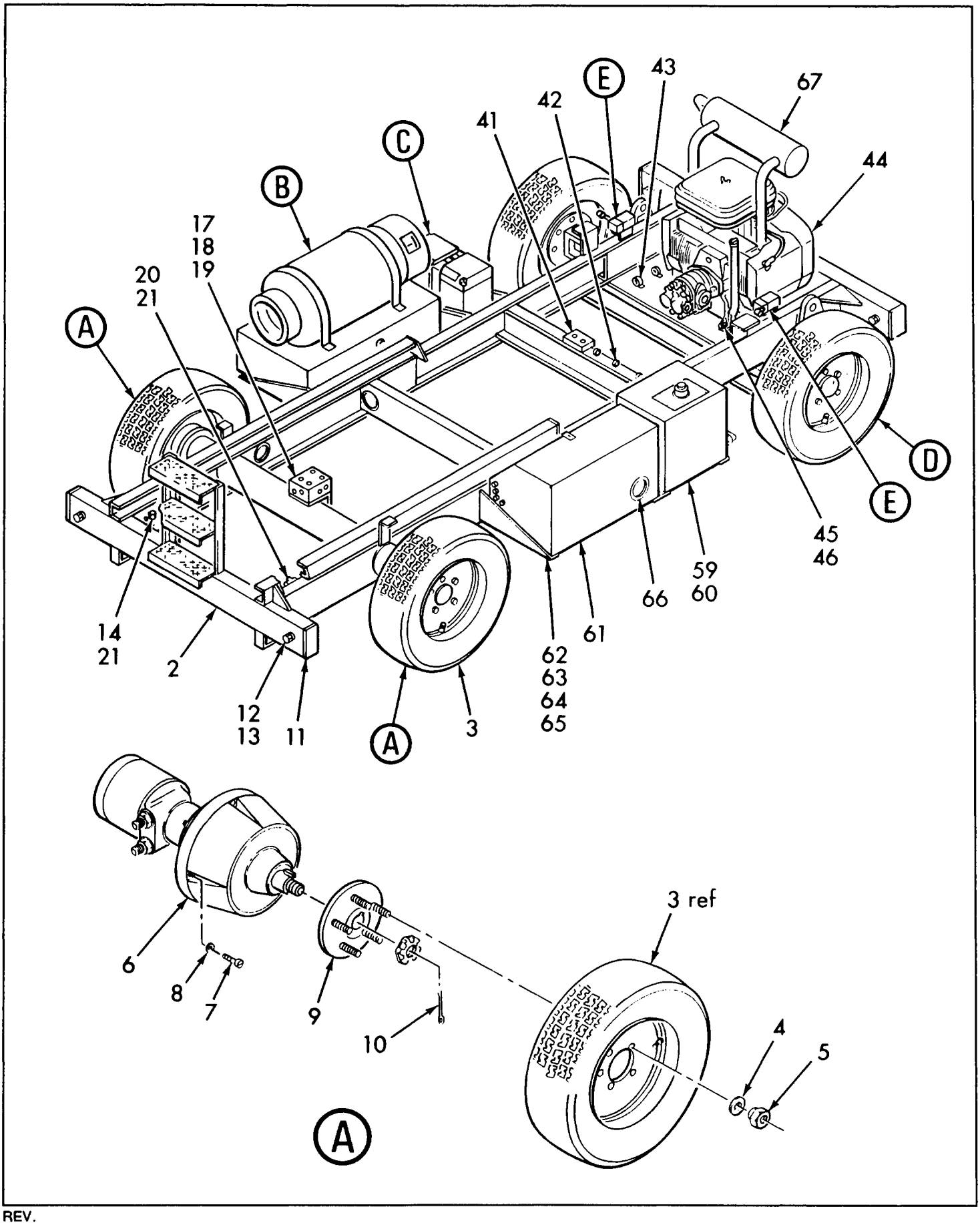
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
24	60324	. CAP SCREW	4
25	63402	. FLAT WASHER	4
26	30285	. FUEL TANK ASSEMBLY (See Sect. 3, Fig. 8 for Details)	1
27	160-B	. FUEL HOSE	7 FT
28	161-A	. HOSE CLAMP	2
29	60309	. CAP SCREW	4
30	63401	. FLAT WASHER	4
31	63301	. LOCK WASHER	4
32	60701	. HEX NUT	4
33	4030	. 12V BATTERY	1
34	31238-L	. BATTERY CABLE KIT	1
35	782	. BATTERY BOX	1
36	16935	.. BELT	1
37	60309	. CAP SCREW	4
38	63401	. FLAT WASHER	4
39	63301	. LOCK WASHER	4
40	60701	. HEX NUT	4
41	30387-2	. TILT SWITCH ASSEMBLY (See Sect. 3, Fig. 9 for Details)	1
42	764	. CLAMP	6
43	22	. LARGE JIFFY CLIP	2
44	32810	. ENGINE & PUMP ASSEMBLY (See Sect. 3, Fig. 10 for Details)	1
45	60308	. CAP SCREW	4
46	60705	. HEX NUT	4
47	32584	. STEERING CYLINDER ASSEMBLY (See Sect. 3, Fig. 13 for Details)	1

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
48	31285	. FRONT HUB ASSEMBLY (See Sect. 3, Fig. 14 for Details)	2
49	63453	. KEY WASHER	2
50	63408	. FLAT WASHER	2
51	16115	. HEX NUT (SLOTTED JAM)	2
52	64310	. COTTER PIN	2
53	16274	. DUST CAP	2
54	70173	. LIMIT SWITCH	1
55	70032	. OPERATING LEVER ARM	1
56	62708	. MACHINE SCREW	2
57	2806	. STRAIN RELIEF	1
58	2808	. LOCK NUT	1
59	32430	. HYDRAULIC TANK ASSEMBLY (See Sect. 3, Fig. 15 for Details)	1
60	80014-05	. UNION ELBOW	2
61	32374	. HYDRAULIC COMPONENT BOX ASSEMBLY (See Sect. 3, Fig. 16 for Details)	1
62	60309	. CAP SCREW	8
63	63401	. FLAT WASHER	8
64	63301	. LOCK WASHER	8
65	60701	. HEX NUT	8
66	411	. EXTRUSION	3 FT
67	32818	.. MUFFLER	1

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	3
FIGURE	1A
PAGE	1



REV.

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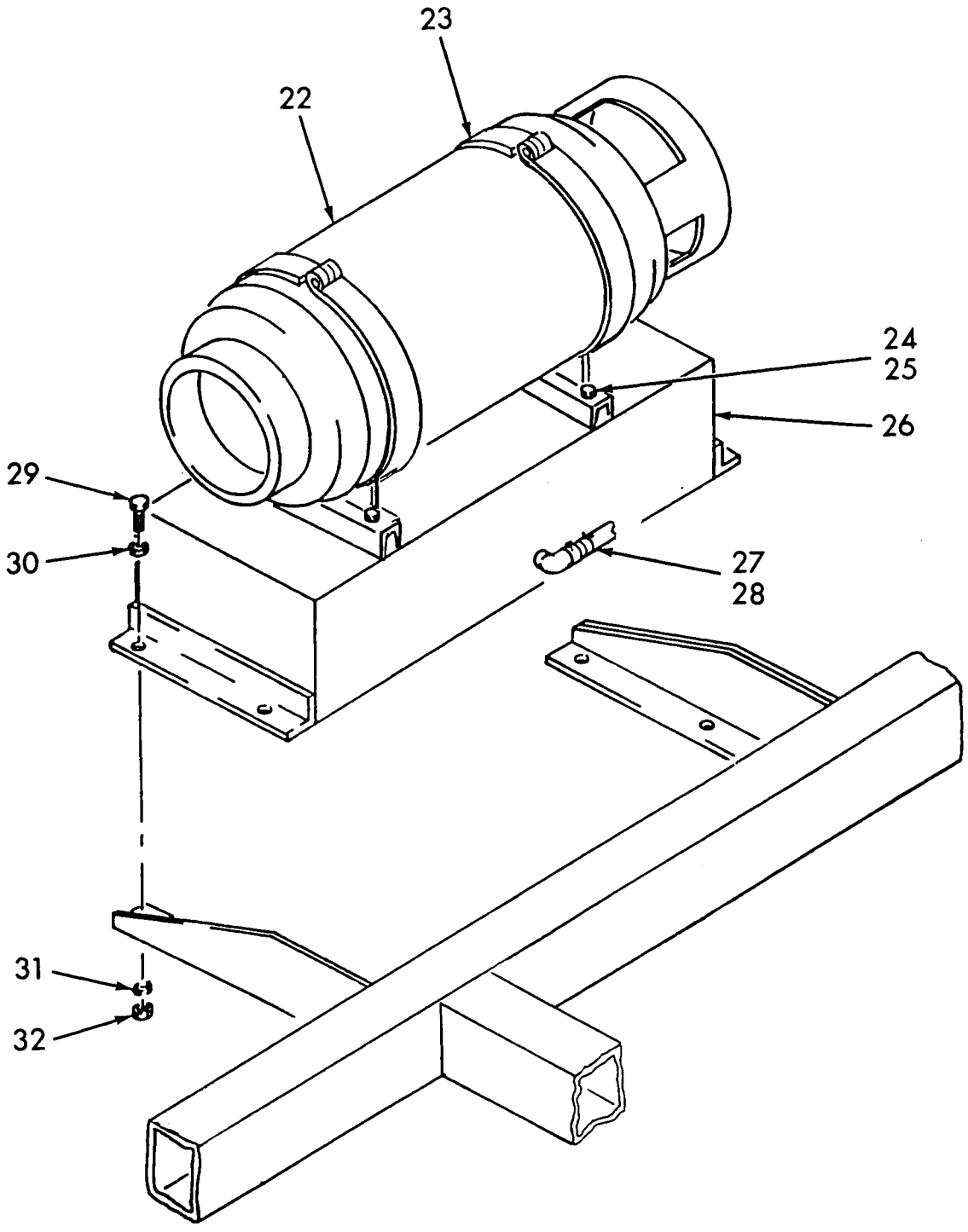
TITLE	FRAME ASSEMBLY	SECT.	3
MODEL	LS36G	FIG.	1A
NOTES		PAGE	2

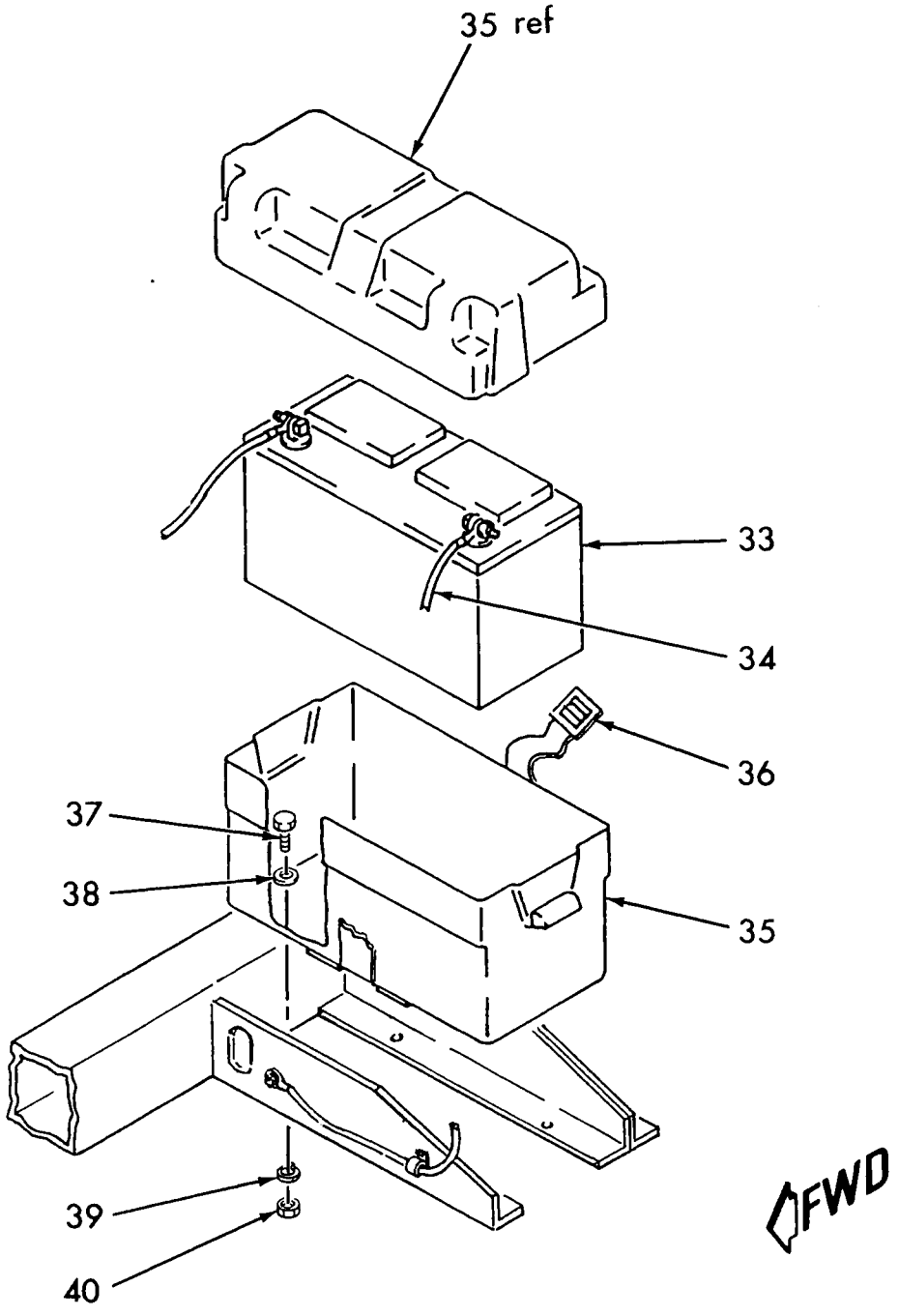


REV.

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	3
FIGURE	1A
PAGE	3

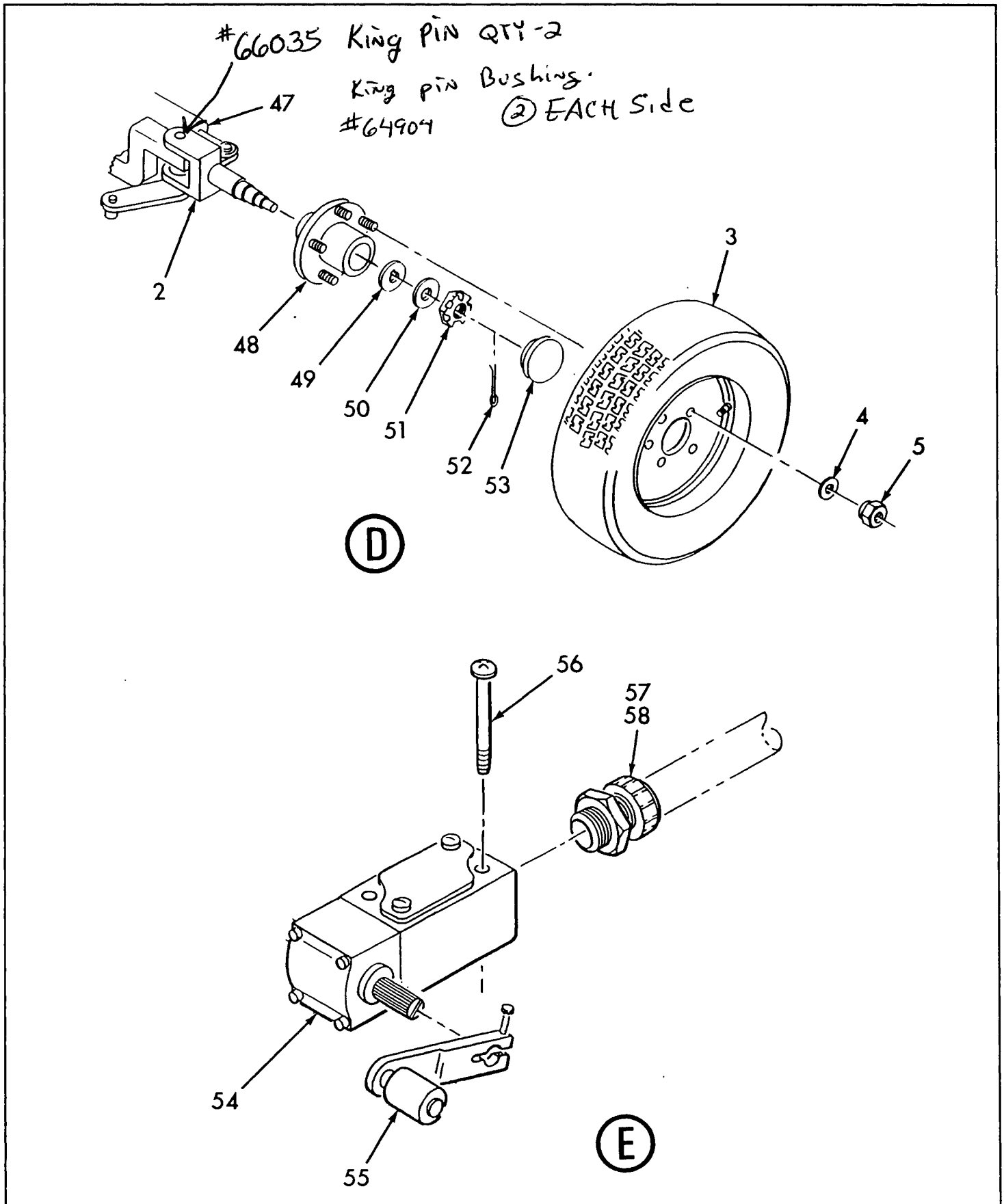


REV.

Mark Industries

TITLE	FRAME ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	3
FIGURE	1A
PAGE	4



REV.

Mark Industries

TITLE	FRAME ASSEMBLY	SECT. 3
MODEL	LS36G	FIG. 1A
NOTES		PAGE 5

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32384	FRAME ASSEMBLY (See Sect. 2, Fig. 1A for NHA)	REF
2	32448	. FRAME WELDMENT	1
3	30358	. TIRE & WHEEL ASSEMBLY (See Sect. 3, Fig. 2 for Details)	4
4	63501	. FLAT WASHER	20
5	61314	. WHEEL NUT	20
6	32461	. DRIVE MOTOR & BRAKE ASSEMBLY (See Sect. 3, Fig. 3 for Details)	2
7	61948	. CAP SCREW	8
8	63305	. LOCK WASHER	8
9	30294	. DRIVE HUB	2
10	64310	. COTTER PIN	2
11	30448	. BUMPER CAP	4
12	60324	. CAP SCREW	8
13	63434	. FLAT WASHER	8
14	32578	. NEEDLE VALVE ASSEMBLY (FREEWHEELING)	1
-15	201	.. NEEDLE VALVE	1
-16	80008-13	.. ELBOW	1
17	32475	. DRIVE & BRAKE VALVE ASSEMBLY (See Sect. 3, Fig. 6 for Details)	1
18	60428	. CAP SCREW	2
19	63303	. LOCK WASHER	2
20	32579	. FLOW CONTROL VALVE ASSEMBLY (See Sect. 3, Fig. 7 for Details)	1
21	65218	. U-BOLT	2
22	486-C	. LPG TANK	1
23	486-A	. TANK BRACKET	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
24	60324	. CAP SCREW	4
25	63402	. FLAT WASHER	4
26	30285	. FUEL TANK ASSEMBLY (See Sect. 3, Fig. 8 for Details)	1
27	160-B	. FUEL HOSE	7 FT
28	161-A	. HOSE CLAMP	2
29	60309	. CAP SCREW	4
30	63401	. FLAT WASHER	4
31	63301	. LOCK WASHER	4
32	60701	. HEX NUT	4
33	4030	. 12V BATTERY	1
34	31238-L	. BATTERY CABLE KIT	1
35	782	. BATTERY BOX	1
36	16935	.. BELT	1
37	60309	. CAP SCREW	4
38	63401	. FLAT WASHER	4
39	63301	. LOCK WASHER	4
40	60701	. HEX NUT	4
41	30387-2	. TILT SWITCH ASSEMBLY (See Sect. 3, Fig. 9 for Details)	1
42	764	. CLAMP	6
43	22	. LARGE JIFFY CLIP	2
44	32810	. ENGINE & PUMP ASSEMBLY (See Sect. 3, Fig. 10 for Details)	1
45	60308	. CAP SCREW	4
46	60705	. HEX NUT	4
47	32584	. STEERING CYLINDER ASSEMBLY (See Sect. 3, Fig. 13 for Details)	1

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

Mark Industries

TITLE	FRAME ASSEMBLY	SECT. 3
MODEL	LS36G	FIG. 1A
NOTES		PAGE 7

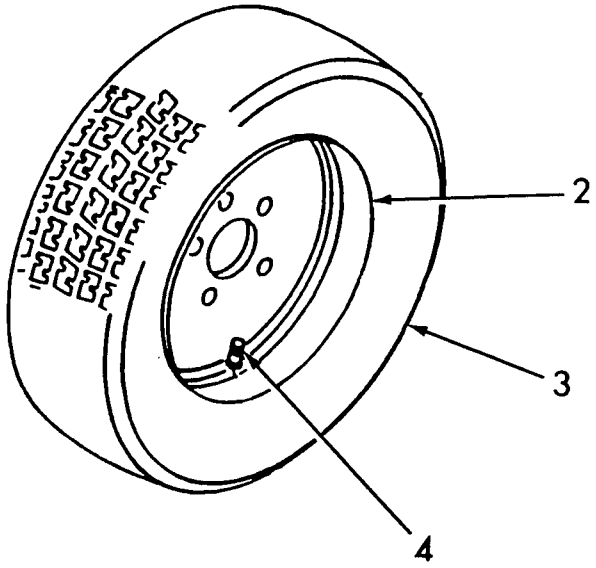
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
48	31285	. FRONT HUB ASSEMBLY (See Sect. 3, Fig. 14 for Details)	2
49	63453	. KEY WASHER	2
50	63408	. FLAT WASHER	2
51	16115	. HEX NUT (SLOTTED JAM)	2
52	64310	. COTTER PIN	2
53	16274	. DUST CAP	2
54	70173	. LIMIT SWITCH	2
55	70032	. OPERATING LEVER ARM	2
56	62708	. MACHINE SCREW	4
57	2806	. STRAIN RELIEF	2
58	2808	. LOCK NUT	2
59	32430	. HYDRAULIC TANK ASSEMBLY (See Sect. 3, Fig. 15 for Details)	1
60	80014-05	. UNION ELBOW	2
61	32485	. HYDRAULIC COMPONENT BOX ASSEMBLY (See Sect. 3, Fig. 16A for Details)	1
62	60309	. CAP SCREW	8
63	63401	. FLAT WASHER	8
64	63301	. LOCK WASHER	8
65	60701	. HEX NUT	8
66	411	. EXTRUSION	3 FT
67	32818	.. MUFFLER	1

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

Mark Industries

TITLE	TIRE & WHEEL ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	2
PAGE	1



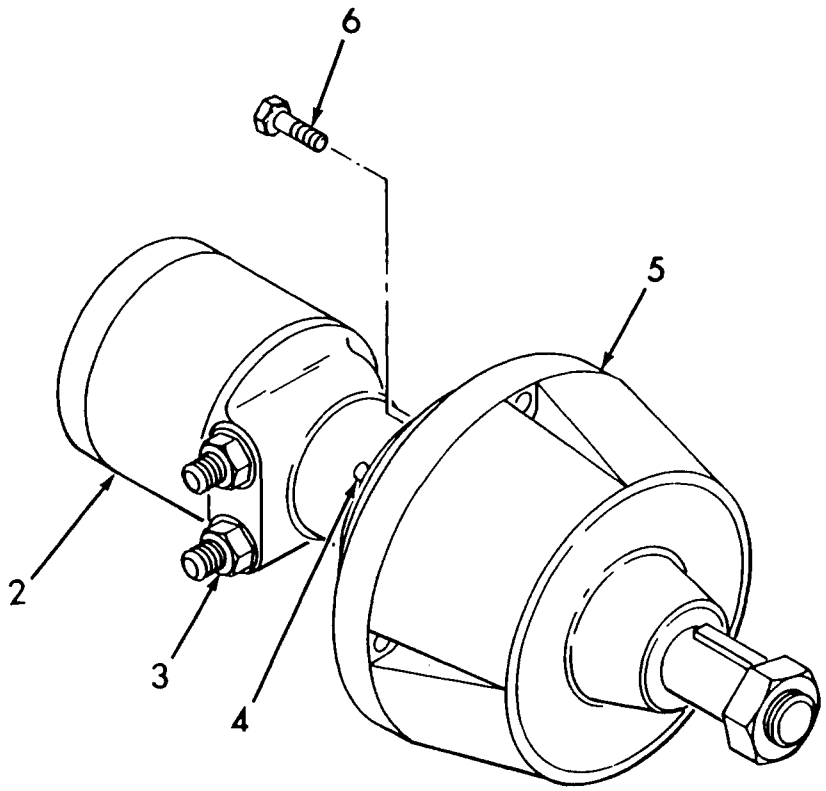
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30358	TIRE & WHEEL ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	30356	. WHEEL	1
3	30357	. TIRE	1
4	2252	. VALVE SYSTEM	1

REV.

Mark Industries

TITLE	DRIVE MOTOR & BRAKE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	3
PAGE	1



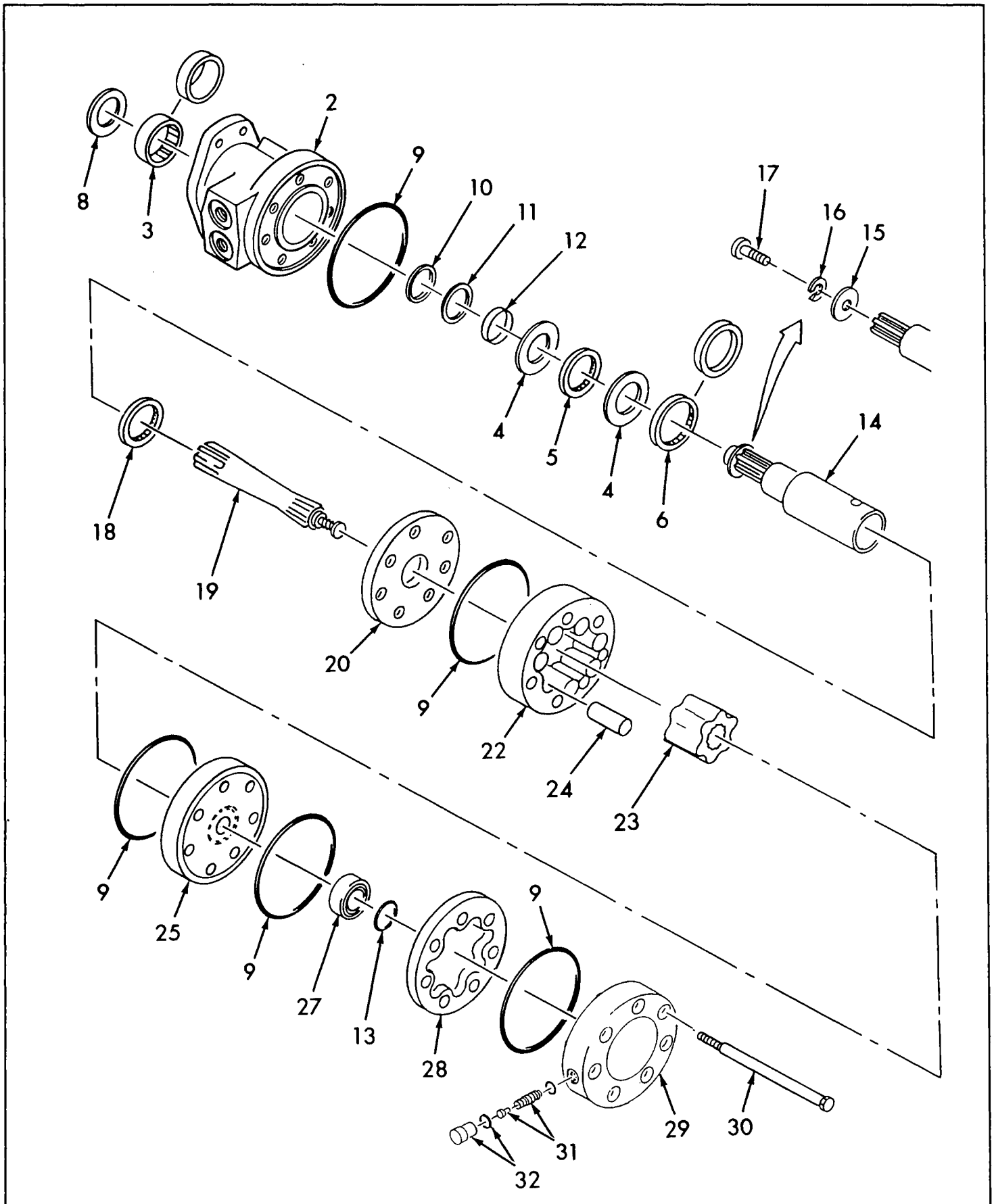
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32461	DRIVE MOTOR & BRAKE ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	81127	. DRIVE MOTOR (See Sect. 3, Fig. 4 for Details)	1
3	80004-13	. STRAIGHT THREAD CONNECTOR	2
4	80004-03	. STRAIGHT THREAD CONNECTOR	1
5	81117	. WHEEL MOUNTING BRAKE (See Sect. 3, Fig. 5 for Details)	1
6	60622	. HEX HEAD CAP SCREW	4

REV.

Mark Industries

TITLE	DRIVE MOTOR
MODEL	LS30G & LS36G
NOTES	AFTER OCT. 1988

SECTION	3
FIGURE	4
PAGE	1



REV.

Mark Industries

TITLE	DRIVE MOTOR
MODEL	LS30G & LS36G
NOTES	AFTER OCT. 1988

SECT.	3
FIG.	4
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	81273	DRIVE MOTOR (See Sect. 3, Fig. 3 for NHA)	REF
2		. HOUSING	1
3		. OUTER BEARING/BUSHING	1
4		. THRUST WASHER	2
5		. THRUST BEARING	1
6		. INNER BEARING/BUSHING	1
-7	67689	. SEAL KIT	1
8		.. DIRT & WATER SEAL	1
9		.. SEAL RING	5
10		.. BACK-UP WASHER	1
11		.. BACK-UP WASHER	1
12		.. SEAL	1
13		.. COMMUTATOR SEAL RING	1
14	67701	. COUPLING SHAFT	1
15		. WASHER	1
16		. LOCK WASHER	1
17		. BOLT	1
18		. THRUST BEARING	1
19	67696	. DRIVE LINK	1
20		. WEAR PLATE	1
-21		. ROTOR SET (MATCHED SET)	1
22		.. STATOR	1
23		.. ROTOR	1
24		.. VANE	7
25		. MANIFOLD	1

Mark Industries

TITLE	DRIVE MOTOR
MODEL	LS30G & LS36G
NOTES	AFTER OCT. 1988

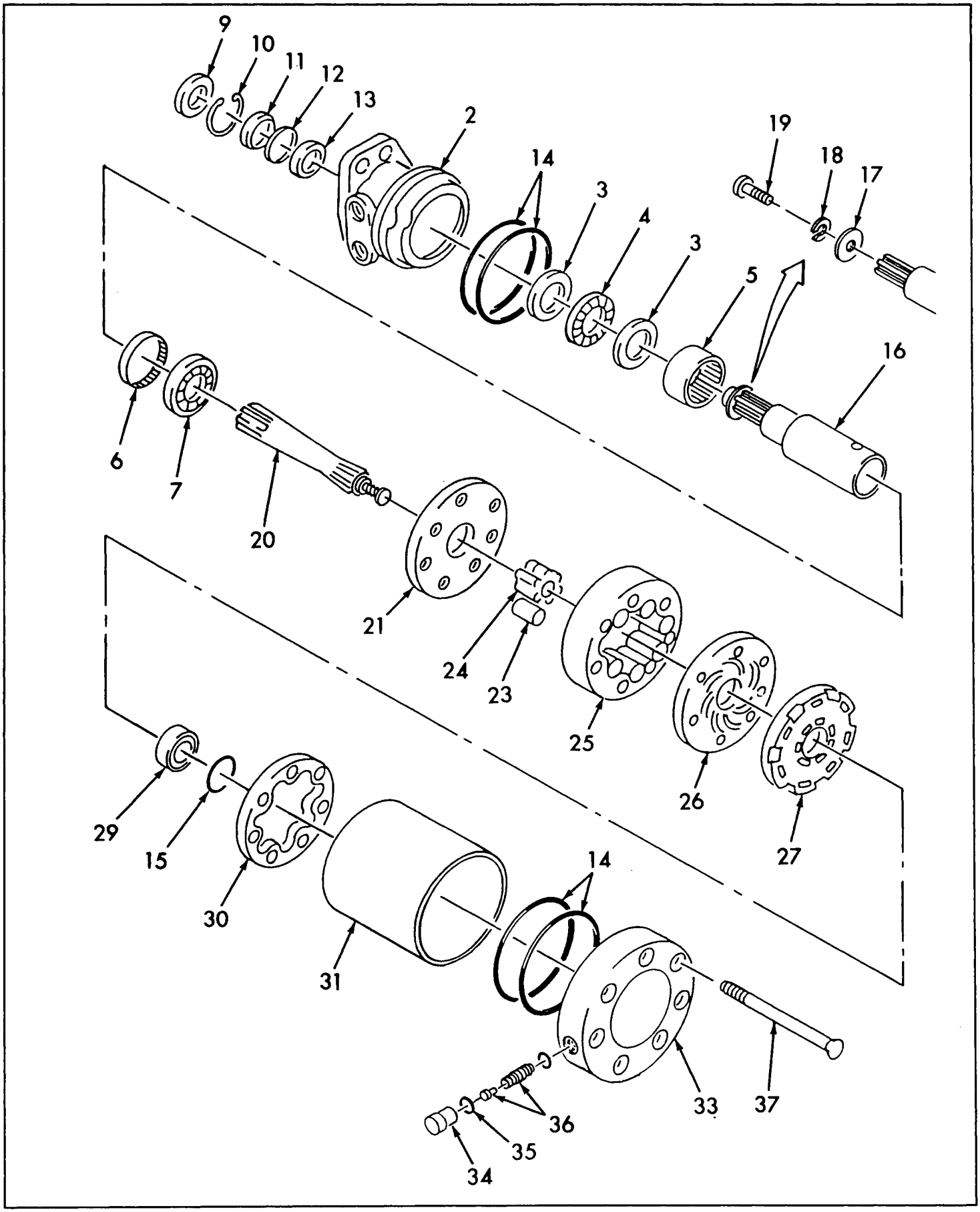
SECT.	3
FIG.	4
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-26		. COMMUTATOR SET (MATCHED SET)	1
27		.. COMMUTATOR	1
28		.. COMMUTATOR RING	1
29		. END COVER WITH RELIEF VALVE	1
30		. SPECIAL BOLTS	7
31		. PLUG & O-RING	2
32		. RELIEF VALVE	2

Mark Industries

TITLE	DRIVE MOTOR
MODEL	LS30G & LS36G
NOTES	BEFORE OCT. 1988

SECTION	3
FIGURE	4A
PAGE	1



REV.

Mark Industries

TITLE	DRIVE MOTOR	SECT. 3
MODEL	LS30G & LS36G	FIG. 4A
NOTES	BEFORE OCT. 1988	PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	81127	DRIVE MOTOR (See Sect. 3, Fig. 3 for NHA)	REF
2		. HOUSING	1
3		. THRUST WASHER	2
4		. THRUST BEARING	1
5		. BEARING	1
6		. BEARING	1
7		. THRUST BEARING	1
-8	66162	. SEAL KIT	1
9		.. SEAL	1
10		.. RETAINING RING	1
11		.. BACK-UP WASHER	1
12		.. WASHER	1
13		.. SEAL	1
14		.. SEAL RING	4
15		.. SEAL RING	1
16	67992	. COUPLING SHAFT	1
17		. WASHER	1
18		. LOCK WASHER	1
19		. BOLT	1
20	67979	. DRIVE LINK	1
21		. WEAR PLATE	1
-22		. ROTOR SET (MATCHED SET)	1
23		.. VANE	7
24		.. ROTOR	1
25		.. STATOR	1

Mark Industries

TITLE	DRIVE MOTOR
MODEL	LS30G & LS36G
NOTES	BEFORE OCT. 1988

SECT.	3
FIG.	4A
PAGE	3

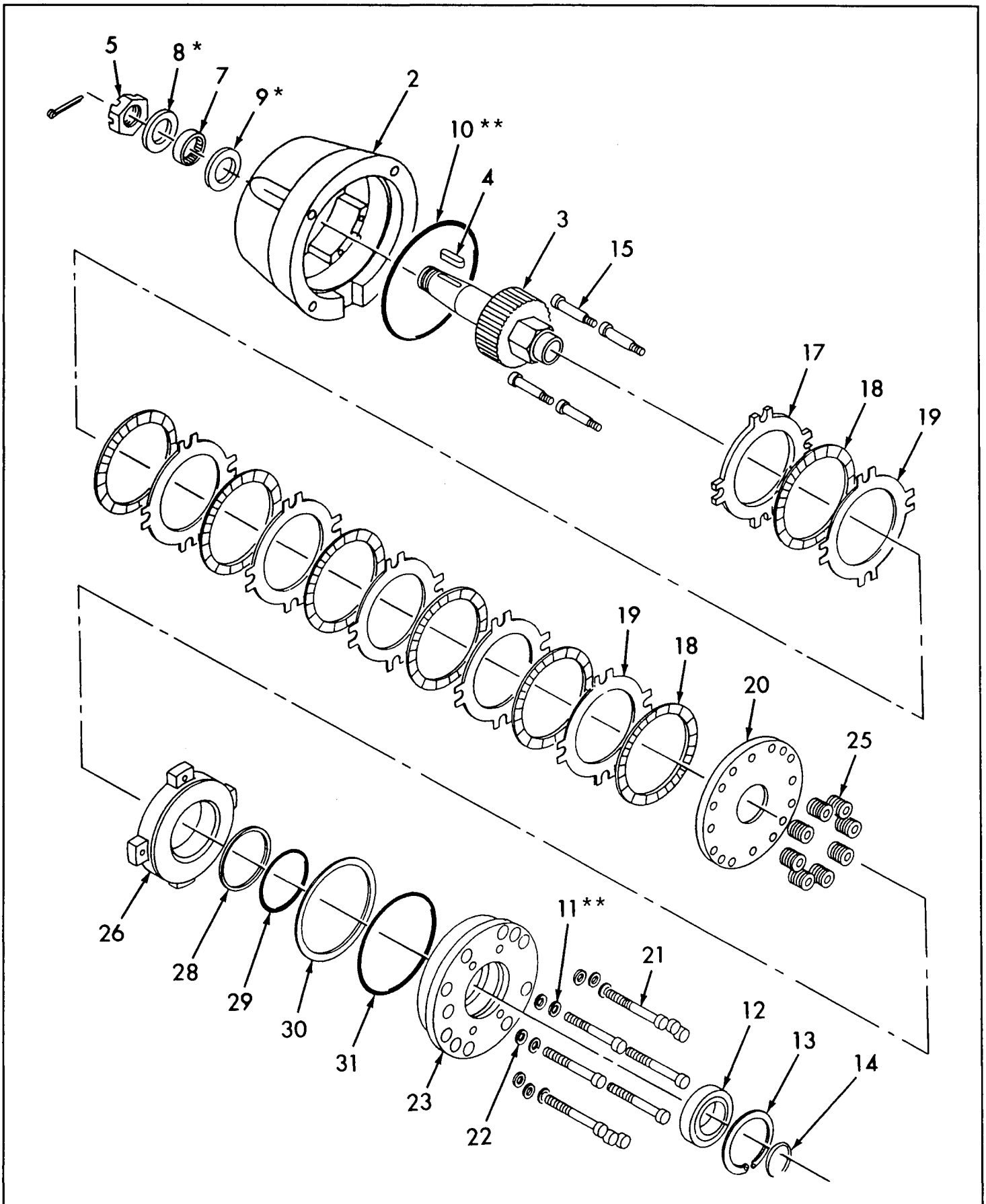
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26		. MANIFOLD PLATE	1
27		. MANIFOLD	1
-28		. COMMUTATOR ASSEMBLY (MATCHED SET)	1
29		.. COMMUTATOR	1
30		.. COMMUTATOR RING	1
31		. SLEEVE	1
-32		. END COVER ASSEMBLY	1
33		.. END COVER	1
34		.. PLUG	2
35		.. O-RING	2
36		.. RELIEF VALVE CARTRIDGE	2
37		. SPECIAL BOLT	7

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

Mark Industries

TITLE	WHEEL MOUNTING BRAKE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	5
PAGE	1



REV.

Mark Industries

TITLE	WHEEL MOUNTING BRAKE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

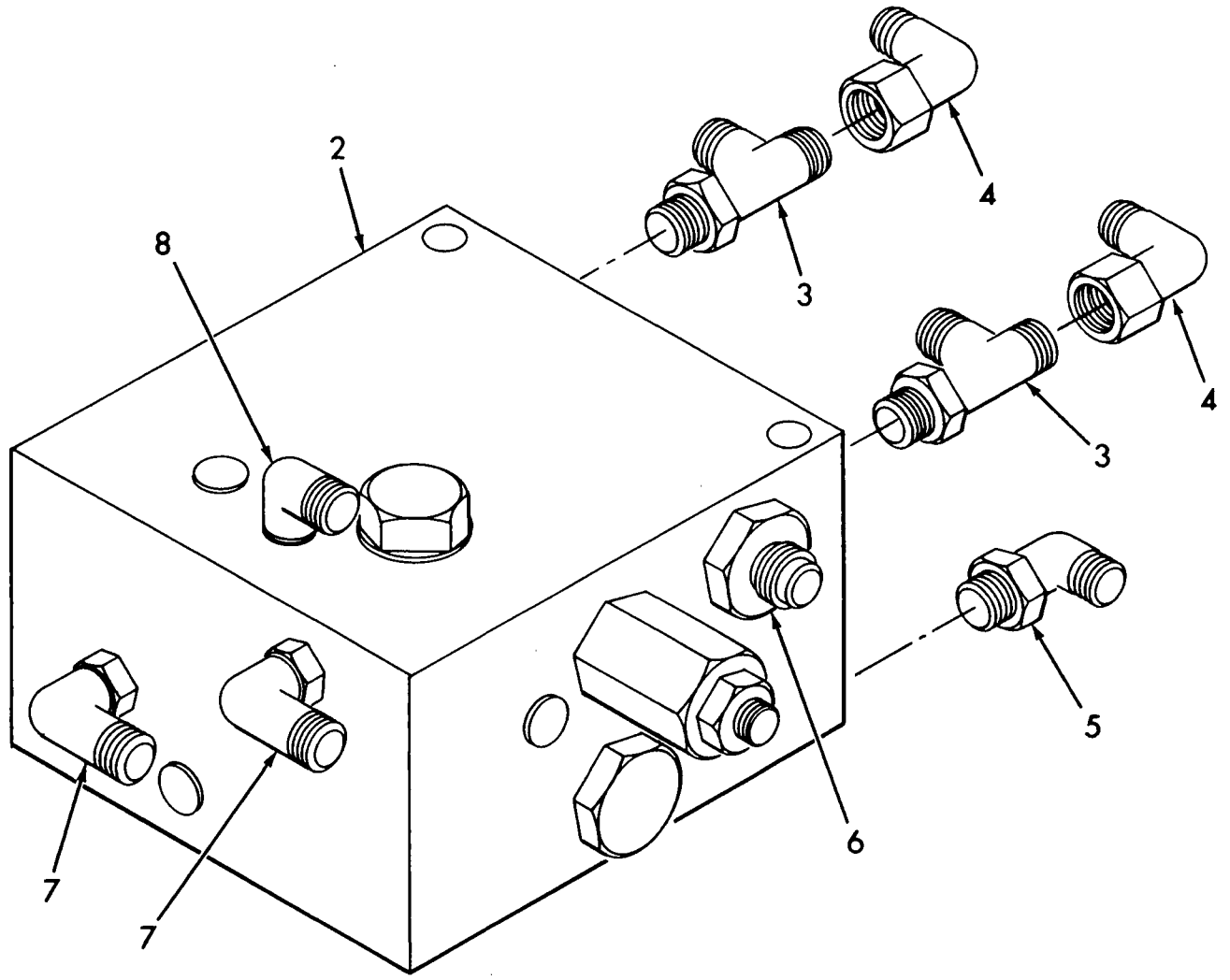
SECT.	3
FIG.	5
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	81117	MULTIPLE DISC BRAKE (See Sect. 3, Fig. 8 for NHA)	REF
2		. TRUNNION HOUSING	1
3		. SPLINE SHAFT ASSEMBLY	1
4		. KEY	1
5		. CASTLE NUT	1
-6	67659	. BEARING KIT	1
7		.. NEEDLE BEARING	1
8		.. SEAL*	1
9		.. SEAL*	1
10		.. O-RING**	1
11		.. SEALING WASHER**	10
12		.. BEARING	1
13		. RETAINING RING	1
14		. RETAINING RING	1
15		. SHOULDER BOLT (TENSION PIN)	4
-16	67646	. LINING KIT	1
17		.. PRIMARY DISC	1
18		.. ROTOR DISC	7
19		.. STATOR DISC	6
10		.. O-RING**	1
11		.. SEALING WASHER**	1
20		. SPRING PLATE	1
		NOTE: *COMES IN BEARING KIT & SEAL KIT **COMES WITH ALL KITS	

Mark Industries

TITLE	DRIVE & BRAKE VALVE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	6
PAGE	1



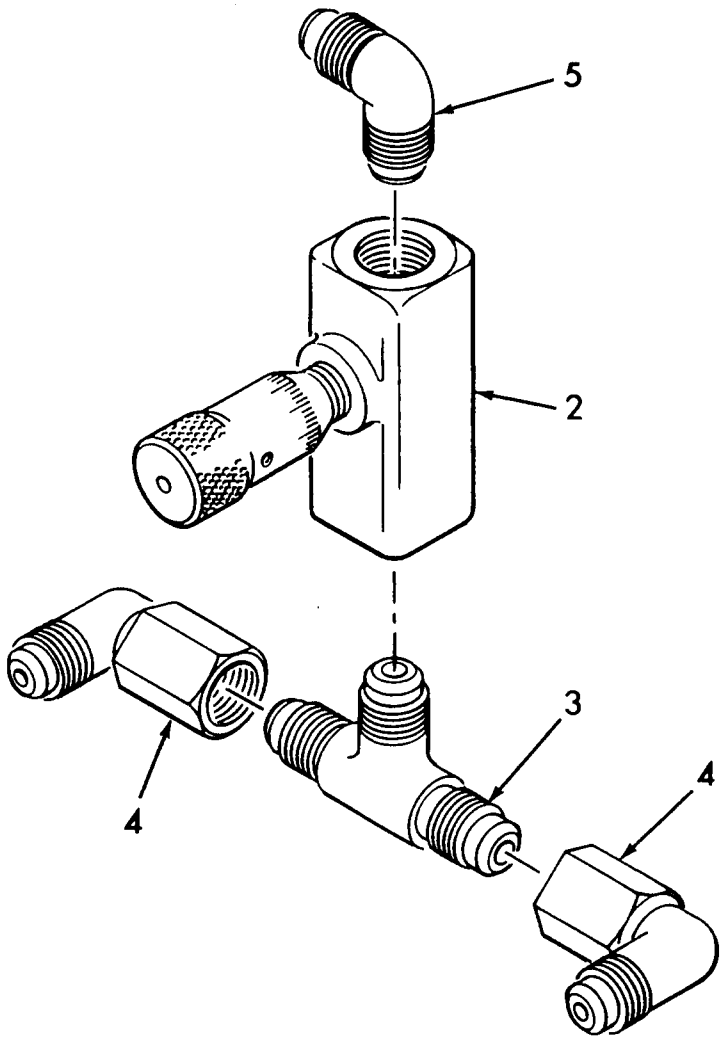
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32475	DRIVE & BRAKE VALVE ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	21214	. DRIVE BRAKE VALVE	1
3	80033-11	. STRAIGHT THREAD TEE	2
4	80015-06	. SWIVEL NUT ELBOW	2
5	80012-11	. STRAIGHT THREAD ELBOW	1
6	80004-11	. STRAIGHT THREAD CONNECTOR	1
7	80012-16	. STRAIGHT THREAD ELBOW	2
8	80008-04	. MALE ELBOW	1

REV.

Mark Industries

TITLE	FLOW CONTROL VALVE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	7
PAGE	1



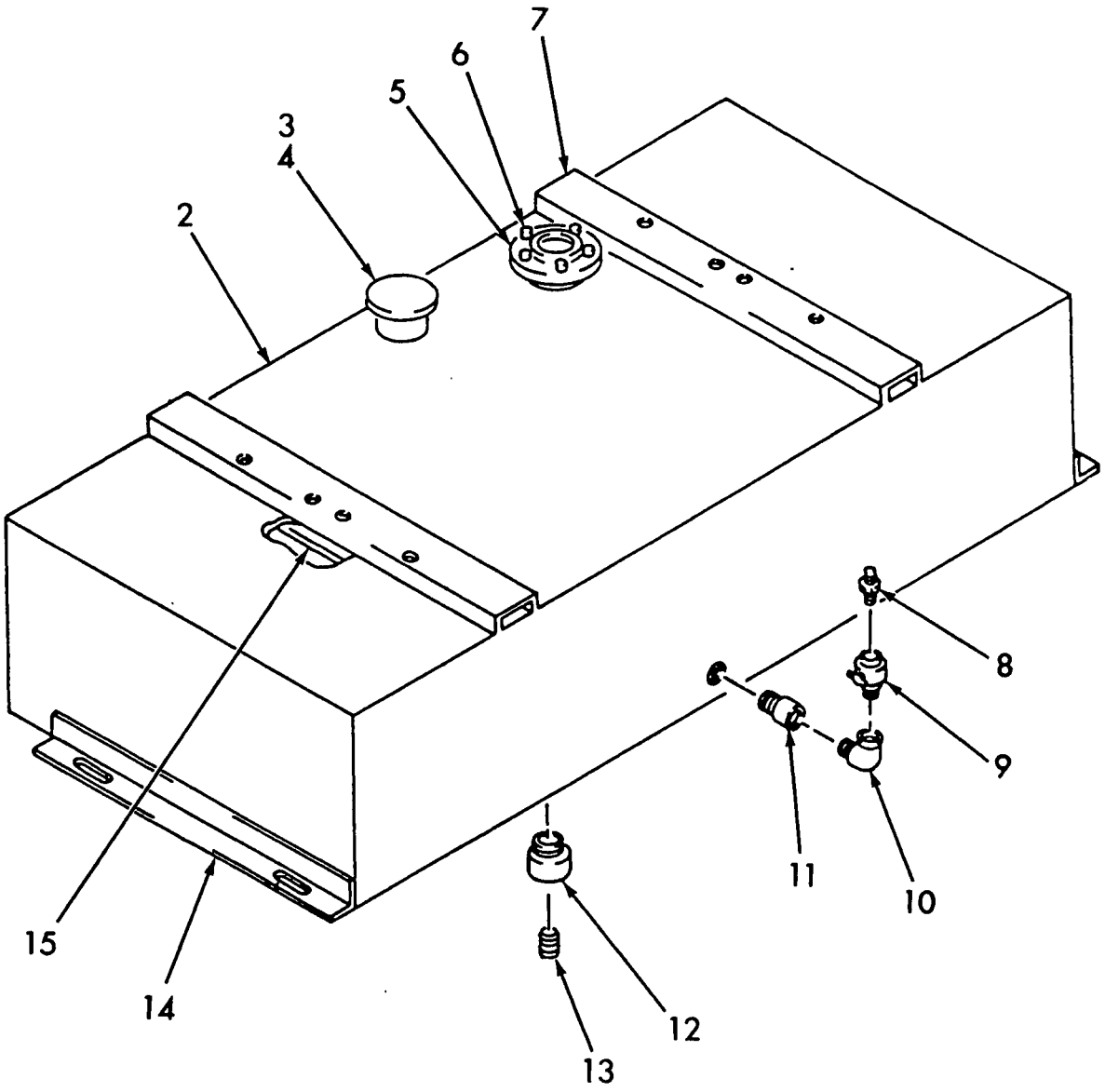
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32579	FLOW CONTROL VALVE ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	30884	. FLOW CONTROL VALVE	1
3	80034-03	. MALE BRANCH TEE	1
4	80015-03	. SWIVEL ELBOW	2
5	80008-03	. MALE ELBOW	1

REV.

Mark Industries

TITLE	FUEL TANK ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	8
PAGE	1



REV.

Mark Industries

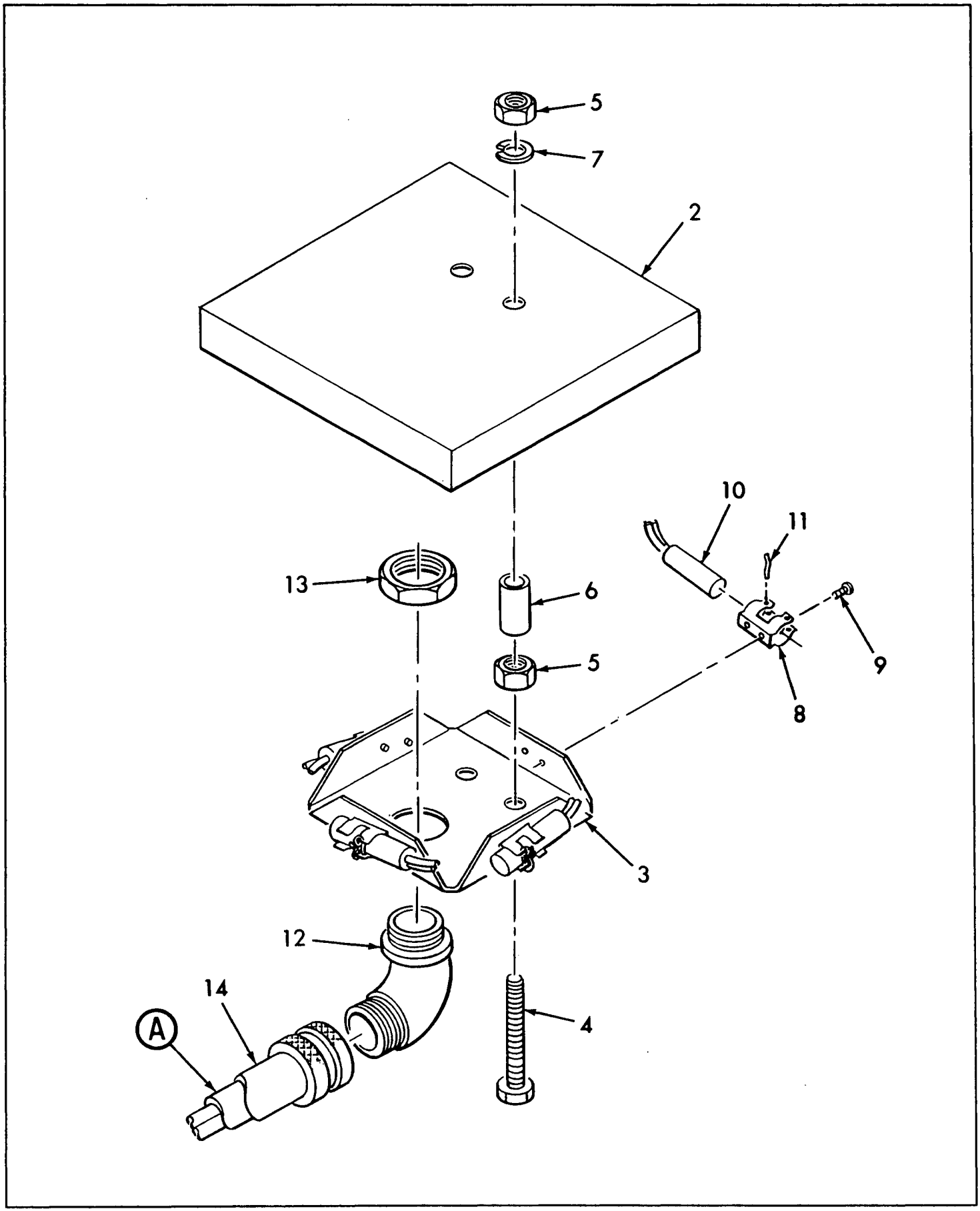
TITLE	FUEL TANK ASSEMBLY	SECT. 3
MODEL	LS30G & LS36G	FIG. 8
NOTES		PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30285	FUEL TANK ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32538	. TANK WELDMENT	1
3	3005	. BREATHER CAP ASSEMBLY	1
-4		.. ELEMENT FILTER	1
5	3017	. LIQUID LEVEL GAUGE	1
6	61729	. SCREW	5
7	37112	. CHANNEL BAR	2
8	80001-04	. MALE CONNECTOR	1
9	12000	. NEEDLE VALVE	1
10	80021-03	. STREET ELBOW	1
11	54807	. HALF COUPLING	1
12	54806	. HALF COUPLING	1
13	3027	. MAGNETIC DRAIN PLUG	1
14	37110	. ANGLE BAR	2
15	37111	. ANGLE BAR	2

Mark Industries

TITLE	TILT SWITCH ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	9
PAGE	1



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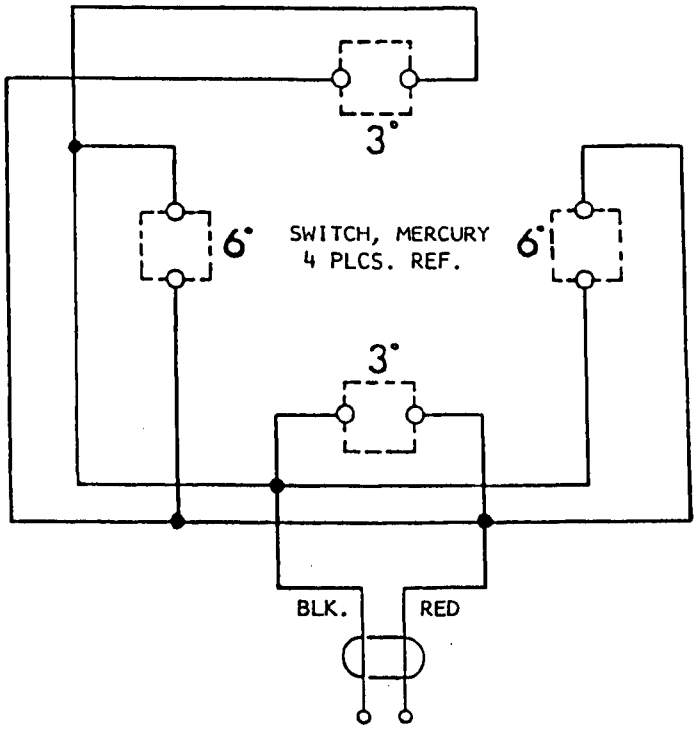
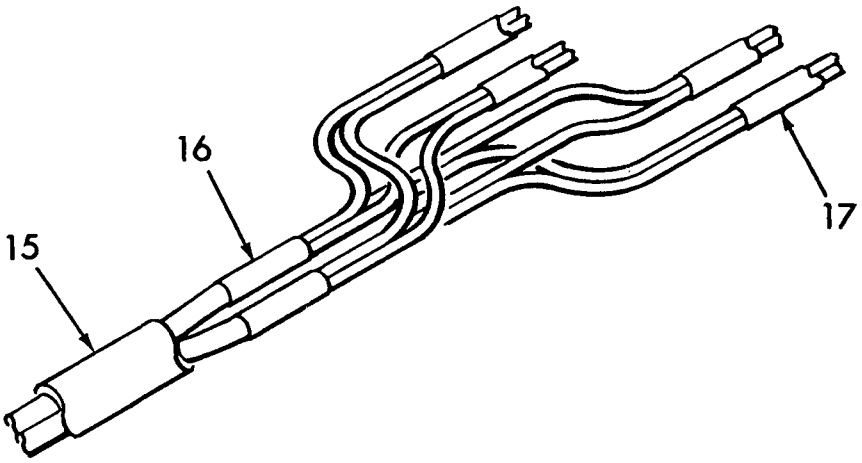

3°
6°
SWITCH, MERCURY
4 PLCS. REF.
6°
3°
BLK.
RED


16
15
17

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Mark Industries

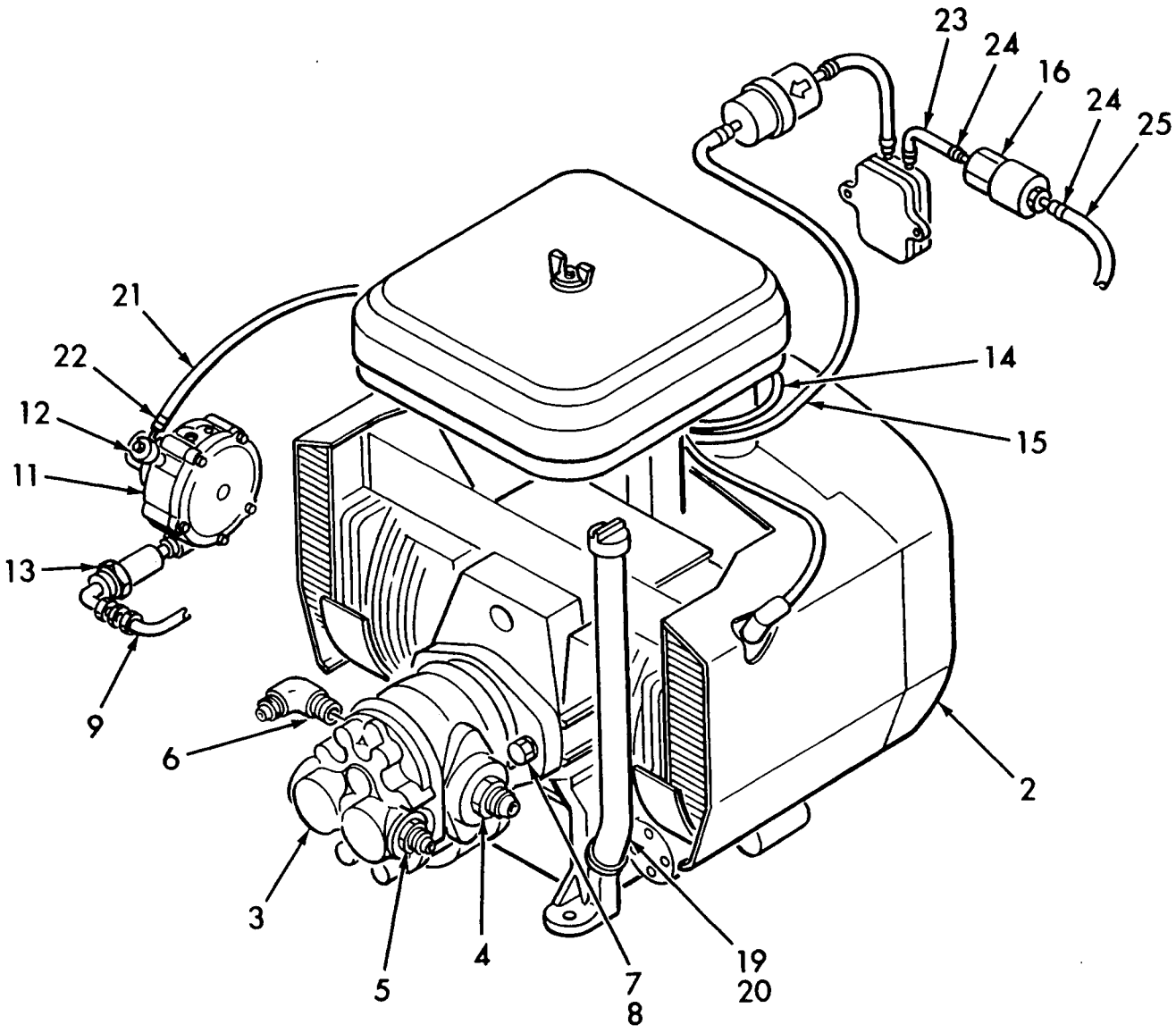
TITLE	TILT SWITCH ASSEMBLY	SECT. 3
MODEL	LS30G & LS36G	FIG. 9
NOTES		PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30387-2	TILT SWITCH ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	30386	. TILT SWITCH COVER	1
3	30385	. TILT SWITCH BRACKET	1
4	60319	. CAP SCREW	2
5	60701	. HEX NUT	4
6	35715	. ROUND TUBE	2
7	63301	. LOCK WASHER	2
8	199-A	. SWITCH BRACKET	4
9	62605	. ROUND HEAD SCREW	8
10	4014	. MERCURY SWITCH	4
11	70225	. SAFETY WIRE	8
12	70226	. 90° CONNECTOR	1
13	61317	. HEX NUT	1
14	65899	. HEAT SHRINK TUBE	1
15	70036	. WIRE (9 FT.)	AR
16	117-D	. BUTT CONNECTOR	2
17	65898	. HEAT SHRINK TUBE	4

Mark Industries

TITLE	ENGINE & PUMP ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	10
PAGE	1



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32810	ENGINE & PUMP ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32759	. ONAN P224 ENGINE	1
3	81257	. DOUBLE GEAR PUMP ASSEMBLY (See Sect. 3, Fig. 11 for Details)	1
4	80004-15	. STRAIGHT THREAD CONNECTOR	1
5	80004-13	. STRAIGHT THREAD CONNECTOR	1
6	80008-25	. STRAIGHT THREAD ELBOW	1

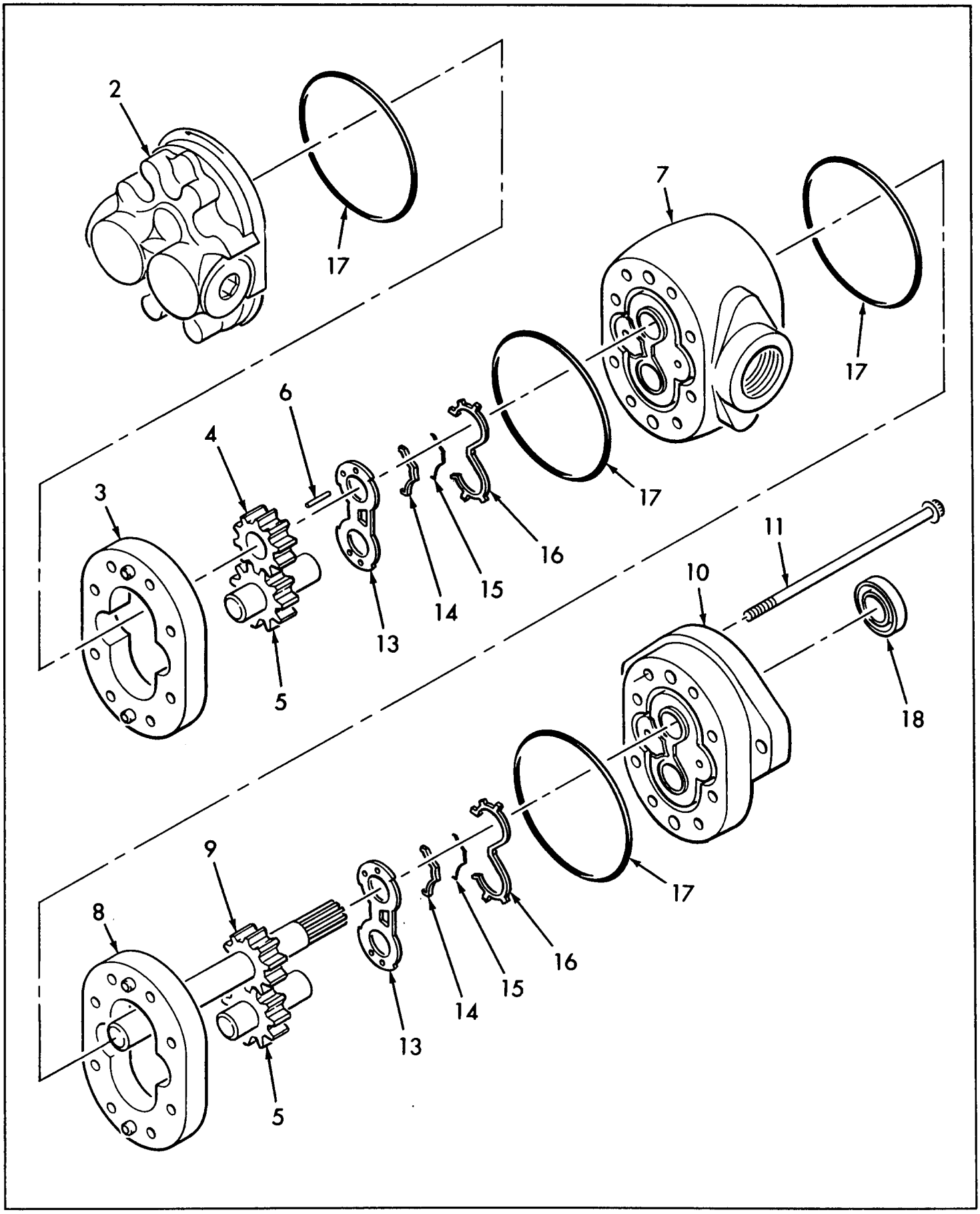
REV.

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
7	60331	. CAP SCREW	2
8	63303	. LOCK WASHER	2
9	131575	. PROPANE HOSE ASSEMBLY (See Sect. 3, Fig. 12 for Details)	1
-10	82812	. DUAL FUEL KIT	1
11	67778	.. DRY-GAS REGULATOR	1
12	67782	.. POWER ADJUSTMENT ELBOW	1
13	67780	.. GASOLINE VALVE	1
14	68029	.. CARBURETOR ADAPTER	1
15	67783	.. HOSE FITTING	1
16	67779	.. FILTER LOCK	1
17	67837	.. HOSE CLAMP (DRY-GAS)	2
18	67840	.. COOL AIR HOSE	8
19	67838	.. CRANK-CASE VENT SPACER	1
20	67839	.. CRANK-CASE VENT CLAMP	2
21	66146	. HOSE	1.5 FT
22	2713	. HOSE CLAMP	2
23	160-B-0050	. FUEL HOSE	1
24	161-A	. HOSE CLAMP	4
25	160-B-0880	. FUEL HOSE	1
-26	32818	. MUFFLER (See Sect. 3, Fig. 1 or 1A for Details)	1

Mark Industries

TITLE	DOUBLE GEAR PUMP ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECT.	3
FIG.	11
PAGE	1



REV.

Mark Industries

TITLE	DOUBLE GEAR PUMP ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

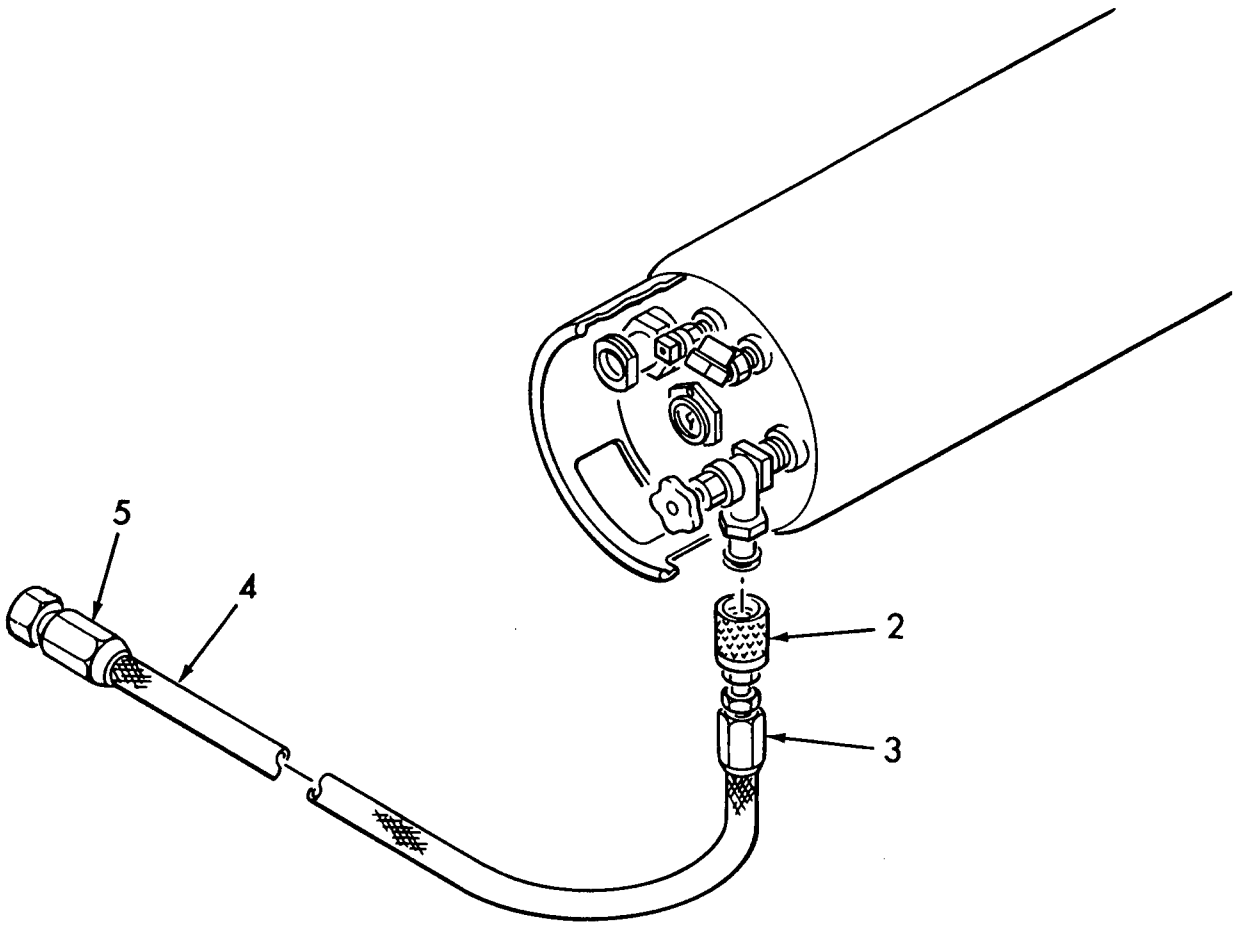
SECT.	3
FIG.	11
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	81257	DOUBLE GEAR PUMP ASSEMBLY (See Sect. 3, Fig. 10 for NHA)	REF
2	67501	. BACK PLATE ASSEMBLY	1
3		. REAR BODY	1
4		. SLIP FIT GEAR	1
5		. IDLER GEAR ASSEMBLY	2
6		. ROUND KEY	1
7	67504	. ADAPTER PLATE	1
8		. FRONT BODY	1
9		. SPLINE DRIVE GEAR ASSEMBLY	1
10	67502	. FRONT PLATE ASSEMBLY	1
11		. CAP SCREW	8
-12	66869	. SEAL KIT	1
13		.. WEAR PLATE	2
14		.. BEARING SEAL	2
15		.. MOLDED O-RING	2
16		.. BACK-UP GASKET	2
17		.. O-RING	4
18		. SHAFT SEAL	1

Mark Industries

TITLE	PROPANE HOSE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECT.	3
FIG.	12
PAGE	1



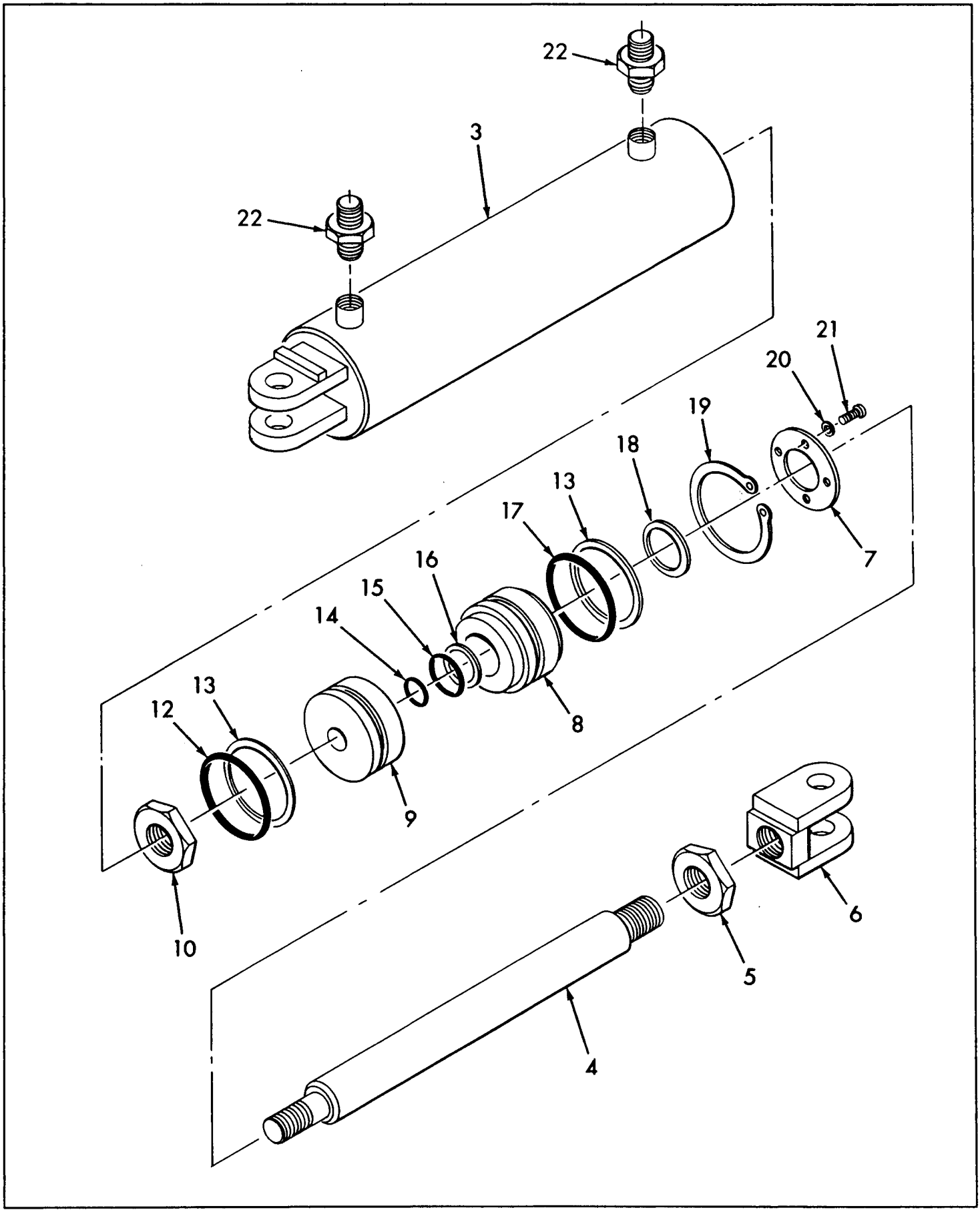
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	131575	PROPANE HOSE ASSEMBLY (See Sect. 3, Fig. 10 for NHA)	REF
2	65142	. QUICK DISCONNECT SOCKET	1
3	16452	. HOSE FITTING (MALE)	1
4	2616	. HOSE	12 FT
5	16451	. HOSE FITTING	1

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	13
PAGE	1



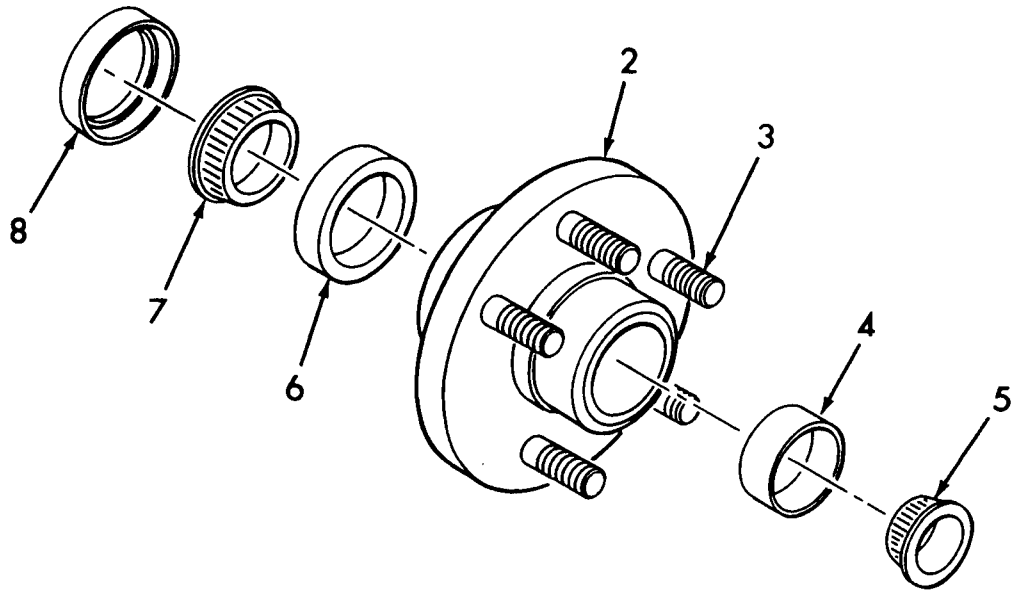
REV.

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32584	STEERING CYLINDER ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
-2	30803	. STEERING CYLINDER (SE)	1
3		.. BARREL ASSEMBLY	1
4		.. ROD	1
5		.. JAM NUT	1
6		.. ROD CLEVIS	1
7		.. RETAINING PLATE	1
8		.. HEAD	1
9		.. PISTON	1
10		.. NUT	1
-11	66548	.. SEAL KIT (RA)	1
-11	67401	.. SEAL KIT (SE)(SHOWN)	1
12		... O-RING	1
13		... BACK-UP RING	2
14		... O-RING	1
15		... O-RING	1
16		... BACK-UP RING	1
17		... O-RING	1
18		... ROD WIPER	1
19		... SNAP RING	1
20		... LOCK WASHER	4
21		... ALLEN HEAD SCREW	4
22	80001-10	. MALE CONNECTOR	2

Mark Industries

TITLE	HUB ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	14
PAGE	1



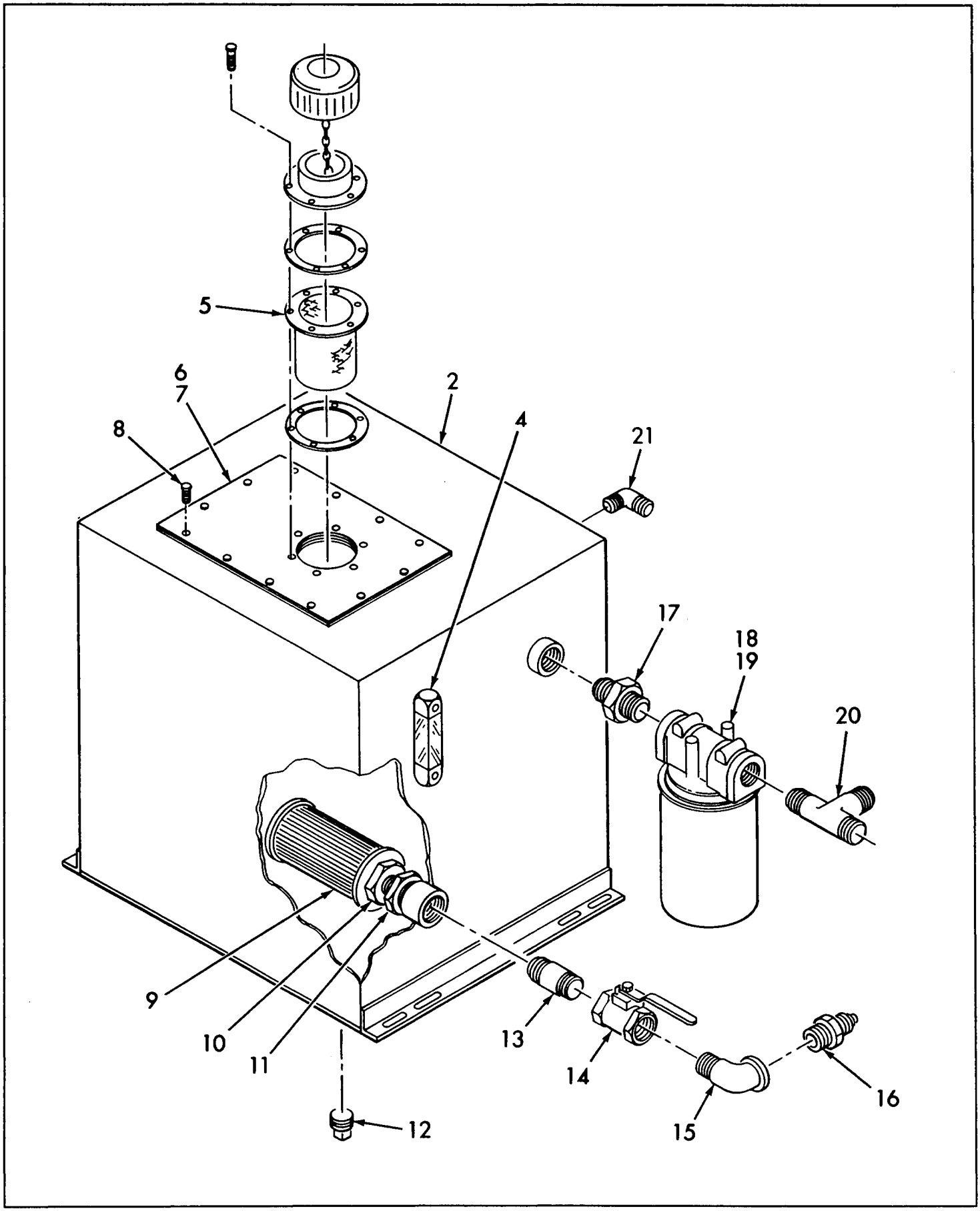
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	31285	HUB ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	31144	. HUB MACHINING	1
3	65530	. WHEEL BOLT	5
4	66138	. OUTER BEARING CUP	1
5	66139	. OUTER BEARING CONE	1
6	66136	. INNER BEARING CUP	1
7	66135	. INNER BEARING CONE	1
8	66134	. GREASE SEAL	1

REV.

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	15
PAGE	1



REV.

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

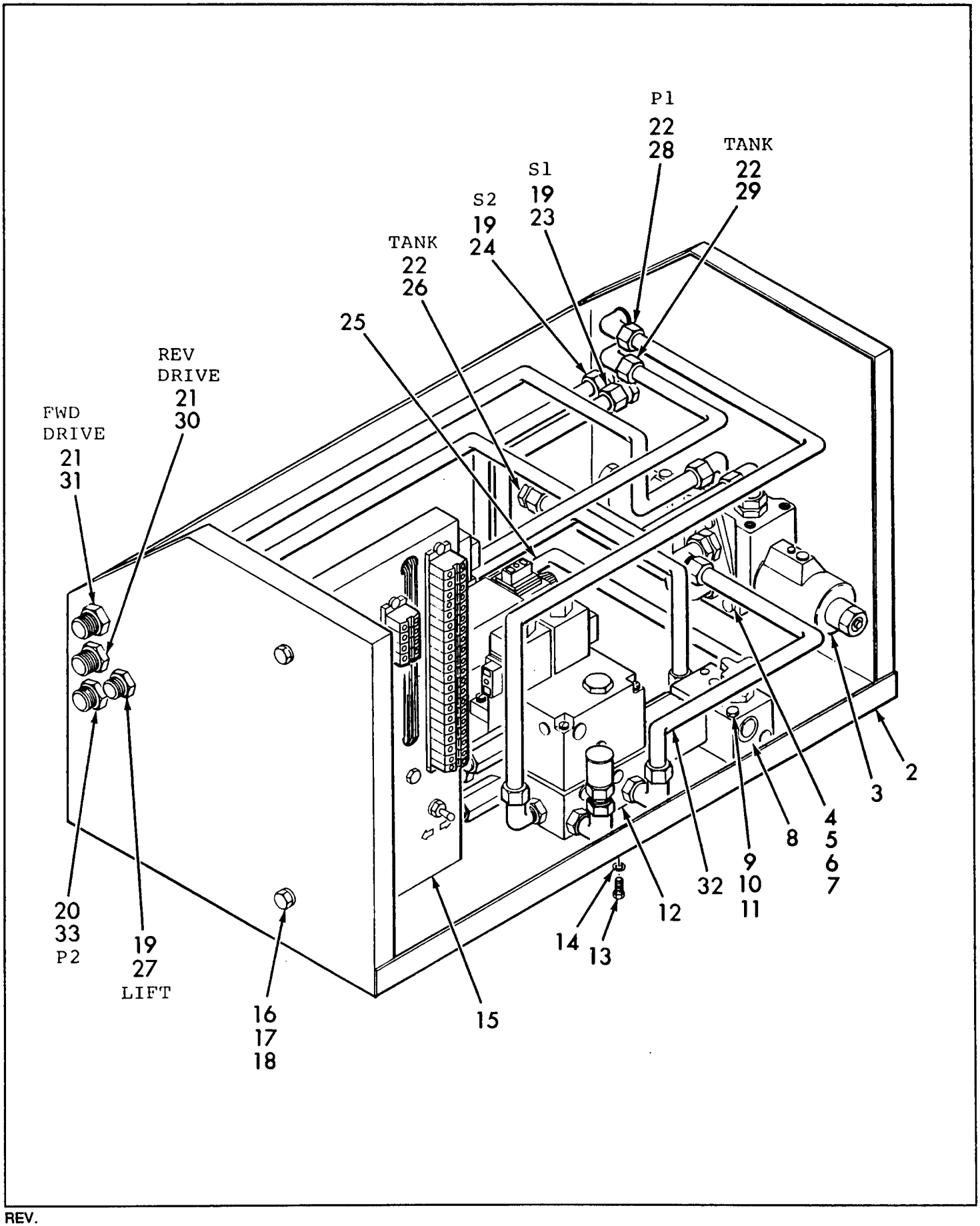
SECT.	3
FIG.	15
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32430	HYDRAULIC TANK ASSEMBLY (See Sect. 3, Fig. 1 or 1A for NHA)	REF
2	32366	. HYDRAULIC TANK SUB-ASSEMBLY	1
-3	32428	.. HYDRAULIC TANK WELDMENT	1
4	3018	.. SIGHT GAUGE	1
5	3005	.. BREATHER ASSEMBLY	1
6	8319	.. HYDRAULIC TANK COVER	1
7	8320	.. HYDRAULIC TANK GASKET	1
8	61718	.. CAP SCREW	12
9	81084	.. STRAINER	1
10	80052-12	.. PIPE NIPPLE	1
11	80057-22	.. PIPE REDUCER	1
12	3027	.. MAGNETIC DRAIN PLUG	1
13	54712	. PIPE NIPPLE	1
14	20050	. BUTTERFLY VALVE	1
15	52307	. STREET ELBOW	1
16	2968	. MALE CONNECTOR	1
17	2493	. CLOSE NIPPLE	1
18	30306	. FILTER	1
-19	16947	.. FILTER CARTRIDGE ONLY	1
20	80037-18	. MALE RUN TEE	1
21	80008-03	. MALE ELBOW	1

Mark Industries

TITLE	HYDRAULIC COMPONENT BOX ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	3
FIGURE	16
PAGE	1



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Mark Industries

TITLE	HYDRAULIC COMPONENT BOX ASSEMBLY	SECT. 3
MODEL	LS30G	FIG. 16
NOTES		PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32374	HYDRAULIC COMPONENT BOX ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	32530	. COMPONENT BOX	1
3	32533	. DRIVE SOLENOID VALVE ASSEMBLY (See Sect. 3, Fig. 17 for Details)	1
4	60339	. CAP SCREW	3
5	63402	. FLAT WASHER	3
6	63302	. LOCK WASHER	3
7	60702	. HEX NUT	3
8	32557	. LOWERING CONTROL VALVE ASSEMBLY (See Sect. 3, Fig. 18 for Details)	1
9	60352	. CAP SCREW	2
10	63301	. LOCK WASHER	2
11	60701	. HEX NUT	2
12	32358	. VALVE PACKAGE ASSEMBLY (See Sect. 3, Fig. 19 for Details)	1
13	60320	. CAP SCREW	2
14	63303	. LOCK WASHER	2
15	32395	. ELECTRICAL PANEL ASSEMBLY (See Sect. 3, Fig. 20 for Details)	1
16	60353	. CAP SCREW	3
17	63301	. LOCK WASHER	3
18	60701	. HEX NUT	3
19	80045-05	. BULKHEAD UNION	3
20	80045-06	. BULKHEAD UNION	1
21	80045-07	. BULKHEAD UNION	2
22	80011-07	. BULKHEAD ELBOW UNION	3
23	32474-1	. TUBE ASSEMBLY	1

Mark Industries

TITLE	HYDRAULIC COMPONENT BOX ASSEMBLY
MODEL	LS30G
NOTES	

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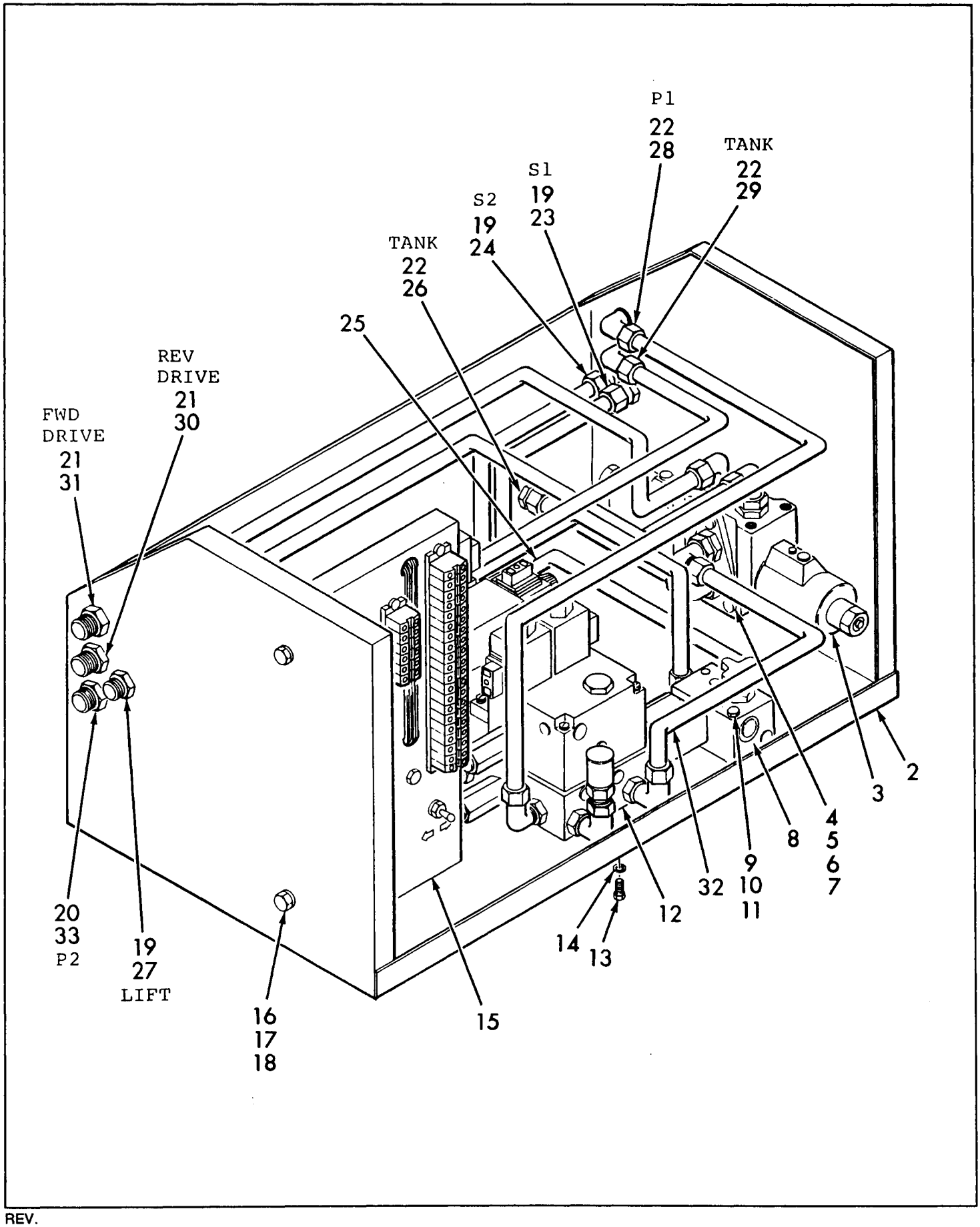
FIG.	16
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
24	32474-2	. TUBE ASSEMBLY	1
25	32474-3	. TUBE ASSEMBLY	1
26	32474-4	. TUBE ASSEMBLY	1
27	32474-5	. TUBE ASSEMBLY	1
28	32474-6	. TUBE ASSEMBLY	1
29	32474-7	. TUBE ASSEMBLY	1
30	32474-8	. TUBE ASSEMBLY	1
31	32474-9	. TUBE ASSEMBLY	1
32	32474-10	. TUBE ASSEMBLY	1
33	32474-11	. TUBE ASSEMBLY	1

Mark Industries

TITLE	HYDRAULIC COMPONENT BOX ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	3
FIGURE	16A
PAGE	1



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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32485	HYDRAULIC COMPONENT BOX ASSEMBLY (See Sect. 3, Fig. 1 for NHA)	REF
2	32530	. COMPONENT BOX	1
3	32533	. DRIVE SOLENOID VALVE ASSEMBLY (See Sect. 3, Fig. 17 for Details)	1
4	60339	. CAP SCREW	3
5	63402	. FLAT WASHER	3
6	63302	. LOCK WASHER	3
7	60702	. HEX NUT	3
8	32557	. LOWERING CONTROL VALVE ASSEMBLY (See Sect. 3, Fig. 18 for Details)	1
9	60352	. CAP SCREW	2
10	63301	. LOCK WASHER	2
11	60701	. HEX NUT	2
12	32358	. VALVE PACKAGE ASSEMBLY (See Sect. 3, Fig. 19 for Details)	1
13	60320	. CAP SCREW	2
14	63303	. LOCK WASHER	2
15	32482	. ELECTRICAL PANEL ASSEMBLY (See Sect. 3, Fig. 20A for Details)	1
16	60353	. CAP SCREW	3
17	63301	. LOCK WASHER	3
18	60701	. HEX NUT	3
19	80045-05	. BULKHEAD UNION	3
20	80045-06	. BULKHEAD UNION	1
21	80045-07	. BULKHEAD UNION	2
22	80011-07	. BULKHEAD ELBOW UNION	3
23	32485-1	. TUBE ASSEMBLY	1

Mark Industries

TITLE	HYDRAULIC COMPONENT BOX ASSEMBLY
MODEL	LS36G
NOTES	

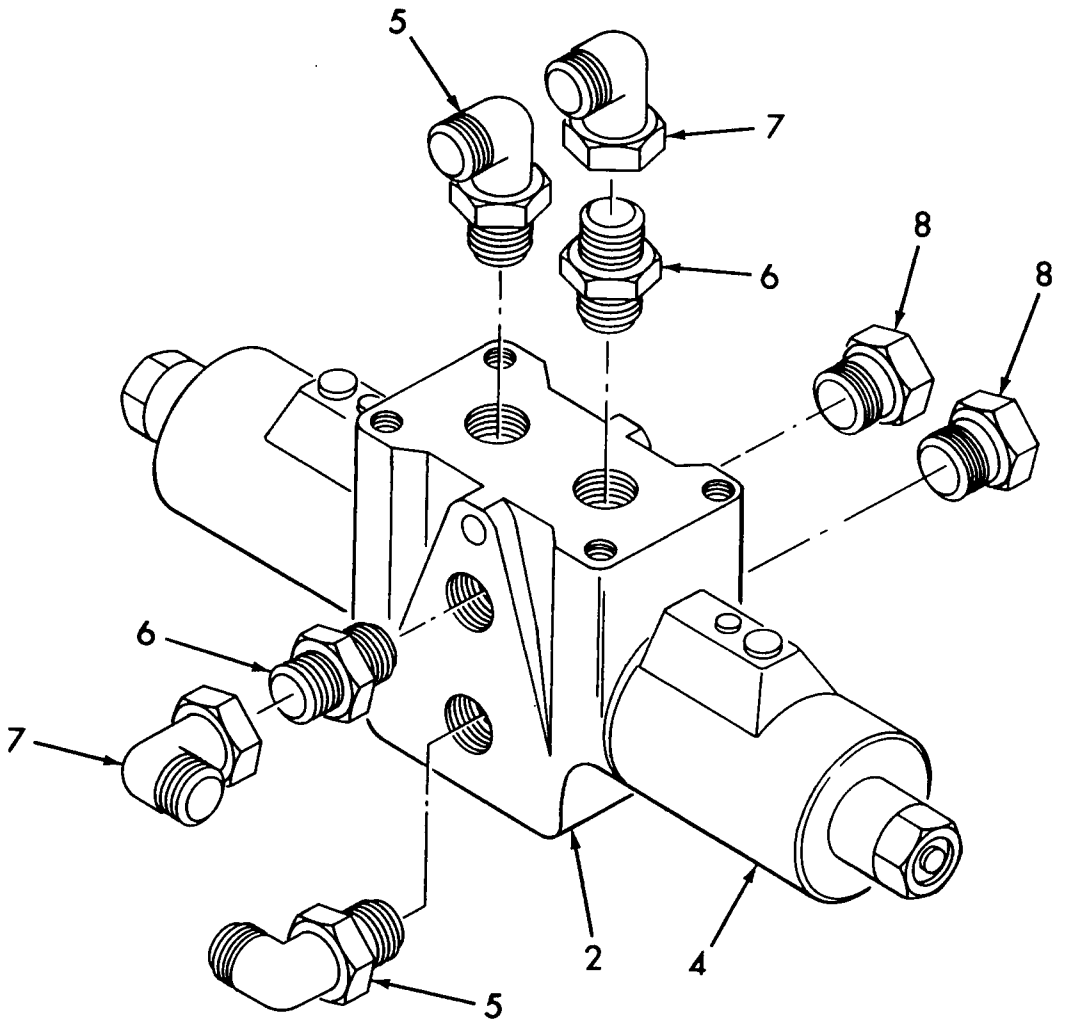
SECT.	3
FIG.	16A
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
24	32485-2	. TUBE ASSEMBLY	1
25	32485-3	. TUBE ASSEMBLY	1
26	32485-4	. TUBE ASSEMBLY	1
27	32485-5	. TUBE ASSEMBLY	1
28	32485-6	. TUBE ASSEMBLY	1
29	32485-7	. TUBE ASSEMBLY	1
30	32485-8	. TUBE ASSEMBLY	1
31	32485-9	. TUBE ASSEMBLY	1
32	32485-10	. TUBE ASSEMBLY	1
33	32485-11	. TUBE ASSEMBLY	1

Mark Industries

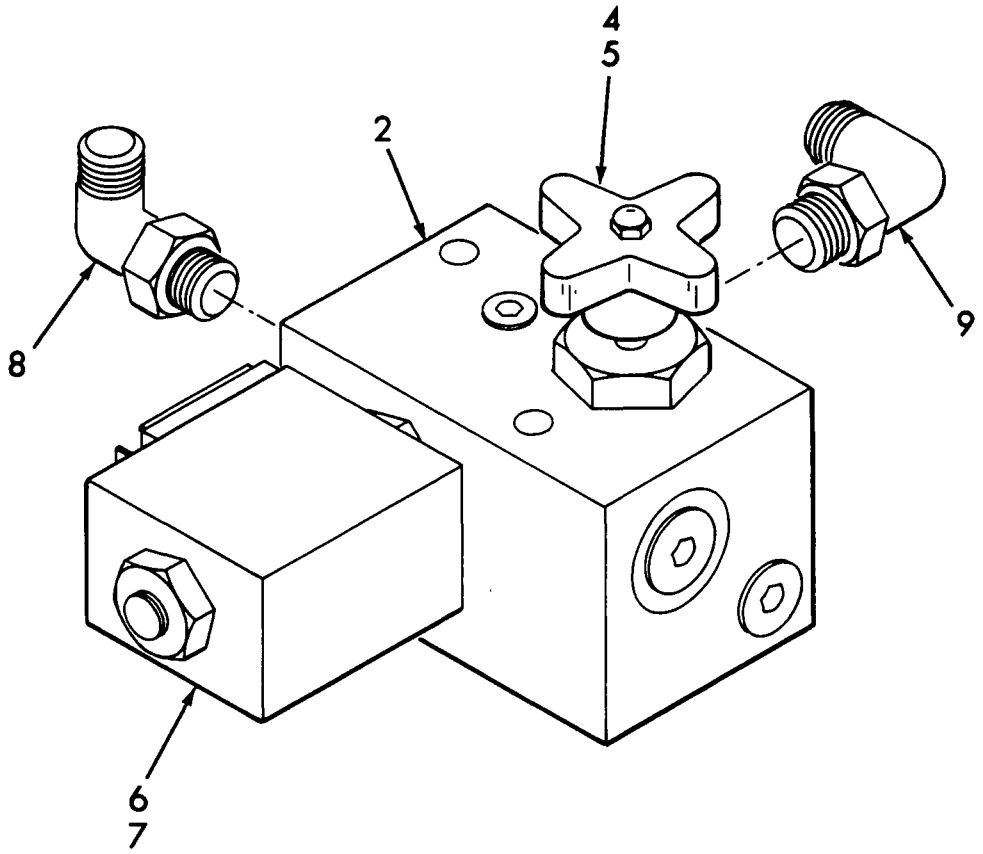
TITLE	DRIVE SOLENOID VALVE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

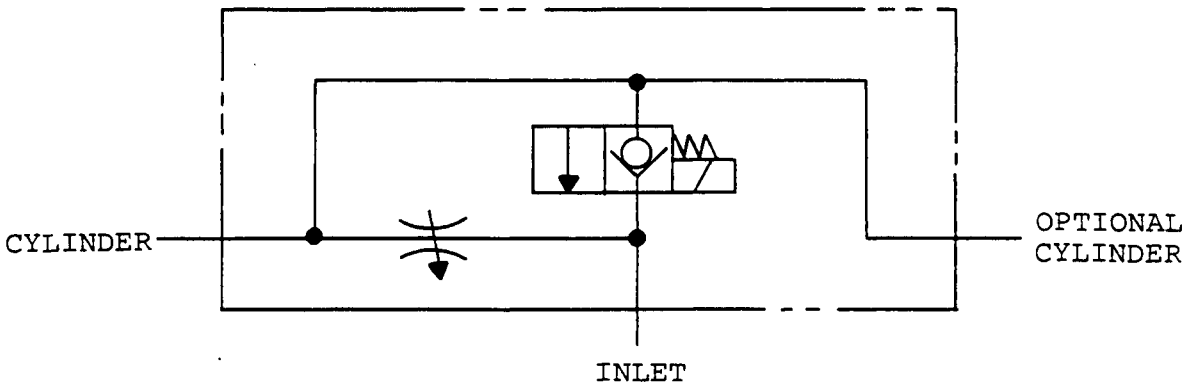
SECTION	3
FIGURE	17
PAGE	1



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32533	DRIVE SOLENOID VALVE ASSEMBLY (See Sect. 3, Fig. 16 or 16A for NHA)	REF
2	81138	. DRIVE SOLENOID VALVE	1
-3	68027	.. SEAL KIT	2
4	67012	.. COIL (12 VOLT)	2
5	80012-16	. STRAIGHT THREAD ELBOW	2
6	80004-16	. STRAIGHT THREAD CONNECTOR	2
7	80015-07	. SWIVEL NUT ELBOW	2
8	80051-06	. STRAIGHT THREAD PLUG	2

REV.


4
5
2
8
9
6
7


CYLINDER
OPTIONAL
CYLINDER
INLET

Mark Industries

TITLE	LOWERING CONTROL VALVE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

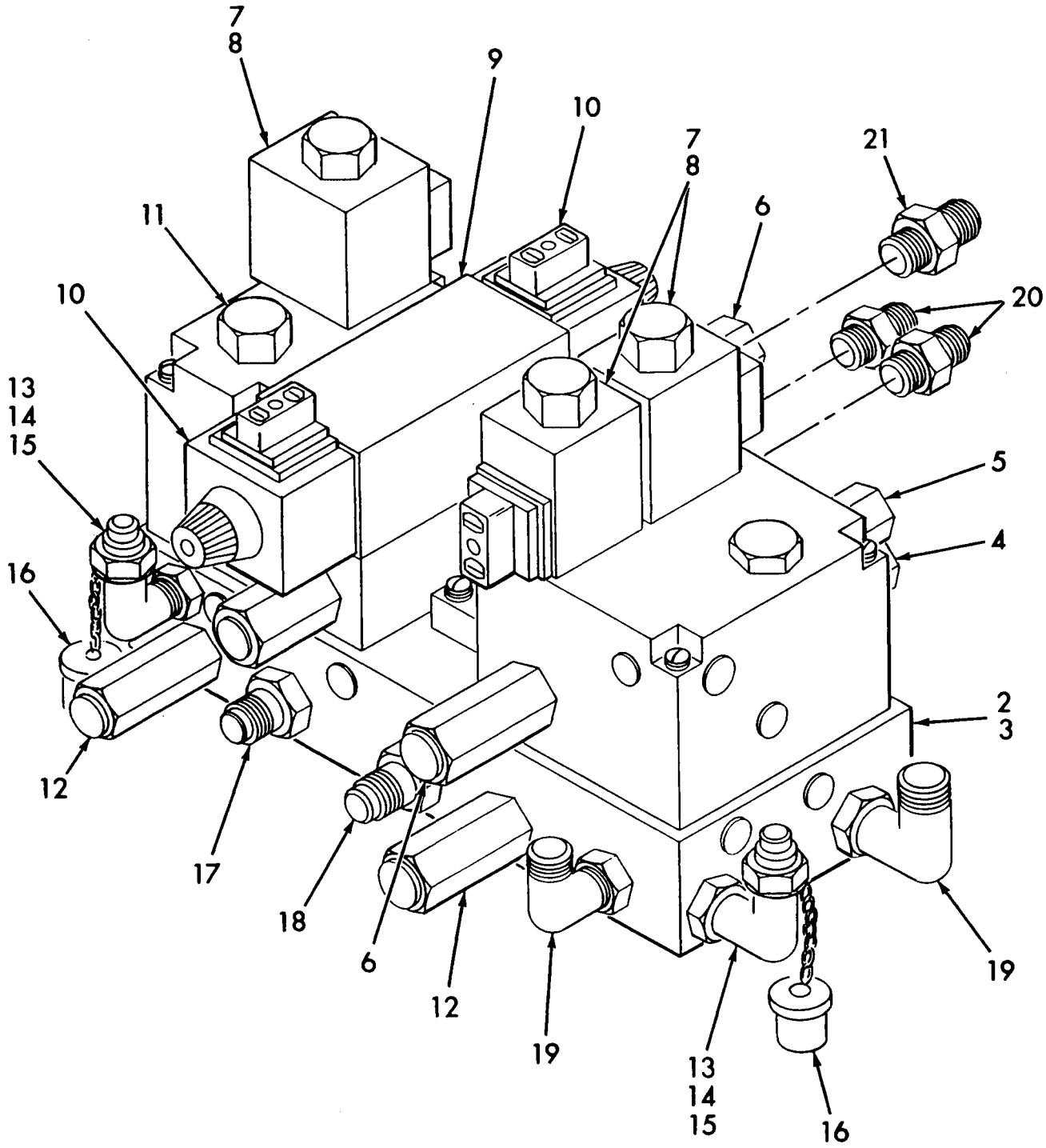
SECT.	3
FIG.	18
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32557	LOWERING CONTROL VALVE ASSEMBLY (See Sect. 3, Fig. 16 or 16A for NHA)	REF
2	81145	. LOWERING CONTROL VAVLE	1
-3	67013	.. SEAL KIT	1
4	67010	.. NEEDLE VALVE	1
5	67009	... HANDLE	1
6	67011	.. CHECK SOLENOID	1
7	66914	... COIL (12 VOLT)	1
8	80012-09	. STRAIGHT THREAD ELBOW	1
9	80012-11	. STRAIGHT THREAD ELBOW	1

Mark Industries

TITLE	VALVE PACKAGE ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	3
FIGURE	19
PAGE	1



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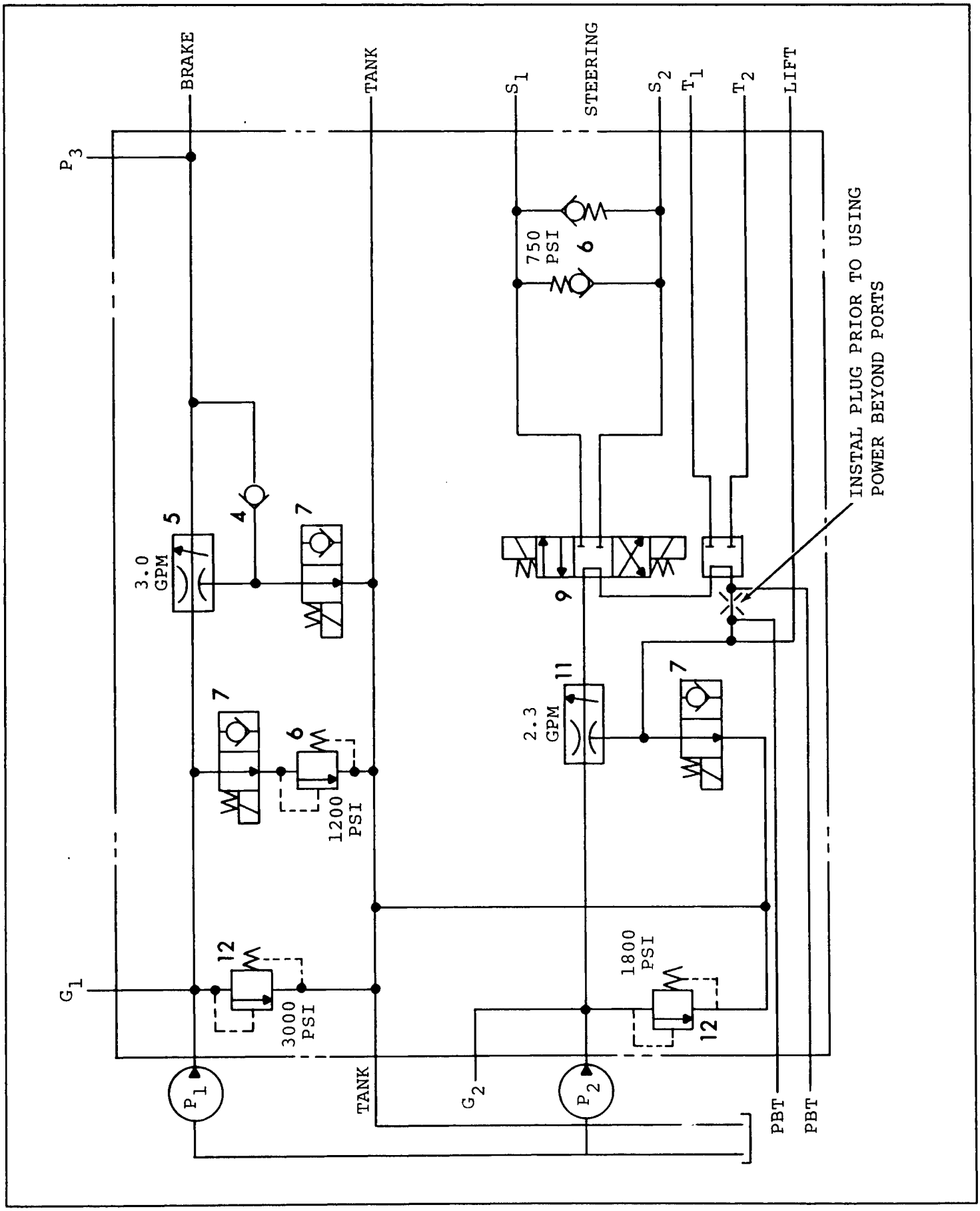

BRAKE
TANK
S1
STEERING
S2
T1
T2
LIFT
P3
750 PSI
6
INSTAL PLUG PRIOR TO USING POWER BEYOND PORTS
3.0 GPM
5
4
7
9
2.3 GPM
11
7
7
6
1200 PSI
1800 PSI
12
3000 PSI
12
G1
G2
P1
P2
TANK
PBT
PBT

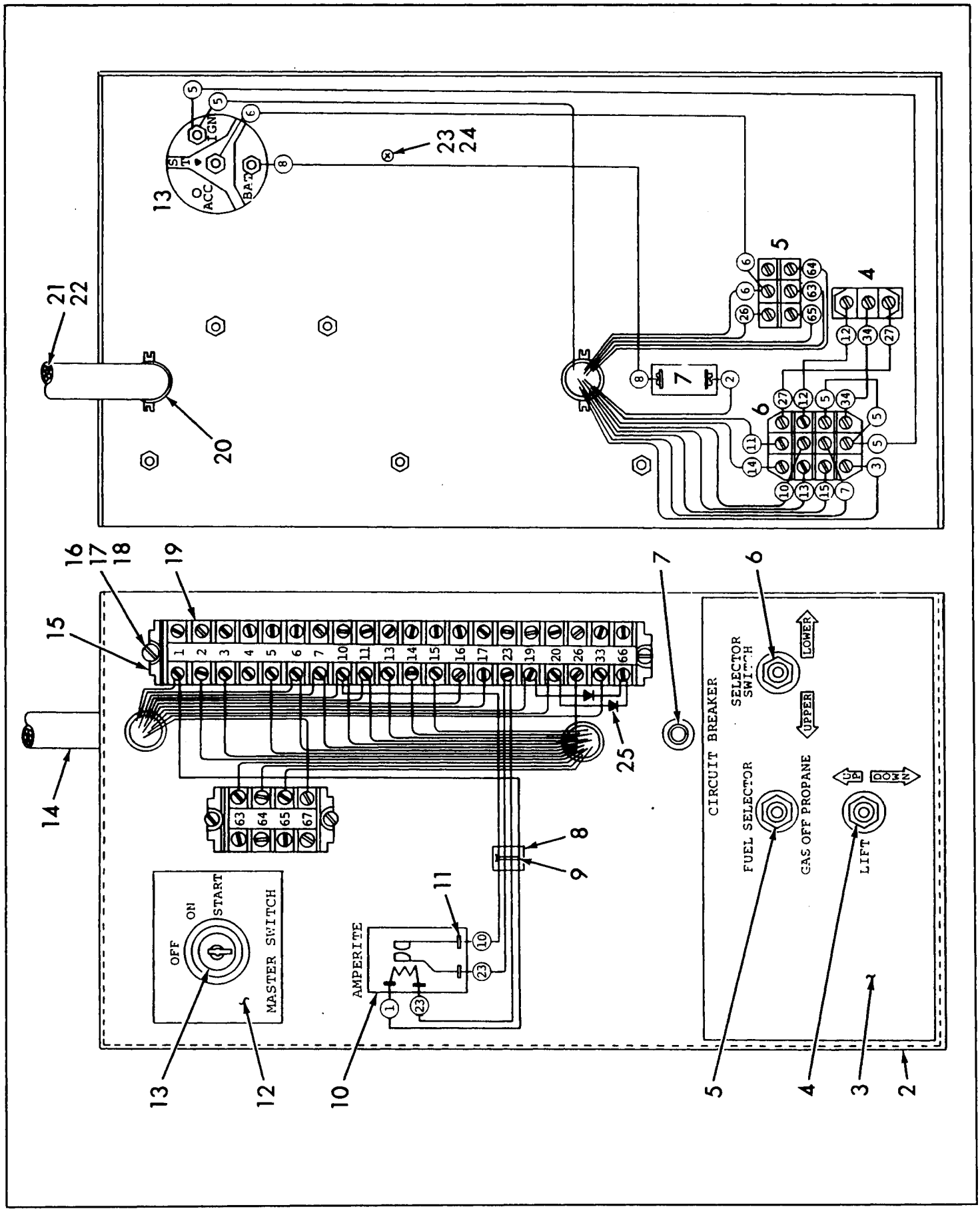
Mark Industries

TITLE	VALVE PACKAGE ASSEMBLY	SECT. 3
MODEL	LS30G & LS36G	FIG. 19
NOTES		PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32358	VALVE PACKAGE ASSEMBLY (See Sect. 3, Fig. 16 or 16A for NHA)	REF
2	81142	. VALVE PACKAGE	1
-3	67943	.. SEAL KIT (COMPLETE VALVE PACKAGE)	1
4	66674	.. CHECK VALVE	1
5	66867	.. FLOW DIVIDER	1
6	68057	.. RELIEF VALVE*	2
7	66920	.. 2 WAY N.O. SOLENOID	3
8	66914	... COIL (12 VOLT)	3
9	67153	.. D01 VALVE (STEERING)	1
10	66913	... COIL (12 VOLT)	2
11	67004	.. FLOW REGULATOR	1
12	68060	.. RELIEF VALVE*	2
13	51903	. FEMALE PIPE ADAPTER	2
14	80022-03	. MALE PIPE ELBOW	2
15	2527	. QUICK DISCONNECT COUPLING	2
16	845	. QUICK DISCONNECT CAP	2
17	80004-11	. STRAIGHT THREAD CONNECTOR	1
18	80004-16	. STRAIGHT THREAD CONNECTOR	1
19	80012-16	. STRAIGHT THREAD ELBOW	2
20	81149	. ADAPTER	2
21	80004-09	. STRAIGHT THREAD CONNECTOR	1
		NOTE: PRIOR TO USE, RELIEF VALVES WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

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

Mark Industries			
TITLE	ELECTRICAL PANEL ASSEMBLY	SECTION	3
MODEL	LS30G	FIGURE	20
NOTES		PAGE	1



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TITLE	ELECTRICAL PANEL ASSEMBLY	SECT. 3
MODEL	LS30G	FIG. 20
NOTES		PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32395	ELECTRICAL PANEL ASSEMBLY (See Sect. 3, Fig. 16 for NHA)	REF
2	30312	. PANEL	1
3	30310	. DECAL: SWITCHES	1
4	4021	. TOGGLE SWITCH	1
5	70015	. FUEL SELECTOR SWITCH	1
6	16260	. TOGGLE SWITCH	1
7	20562	. CIRCUIT BREAKER	1
8	16214	. MOUNT	5
9	256	. CABLE TIE	45
10	70306	. TIME DELAY RELAY	1
11	496-A	. PUSH-ON TERMINAL	4
12	32526	. DECAL: POWER ON/OFF/START	1
13	2717	. IGNITION SWITCH	1
14	130600	. CABLE CONDUCTOR	7 FT
15	117-A	. TERMINAL BLOCK END	2
16	62623	. CAP SCREW	5
17	63312	. LOCK WASHER	5
18	61502	. HEX NUT	5
19	4027	. TERMINAL BLOCK	24
20	70016	. GROMMET	2
21	70029	. CONNECTOR (BLUE) (8 PLACES)	8
22	70271	. CONNECTOR (YELLOW) (5 PLACES)	8
23	61728	. SELF-TAPPING SCREW	1
24	63322	. LOCK WASHER	1
25	70479	. DIODE	2

Mark Industries

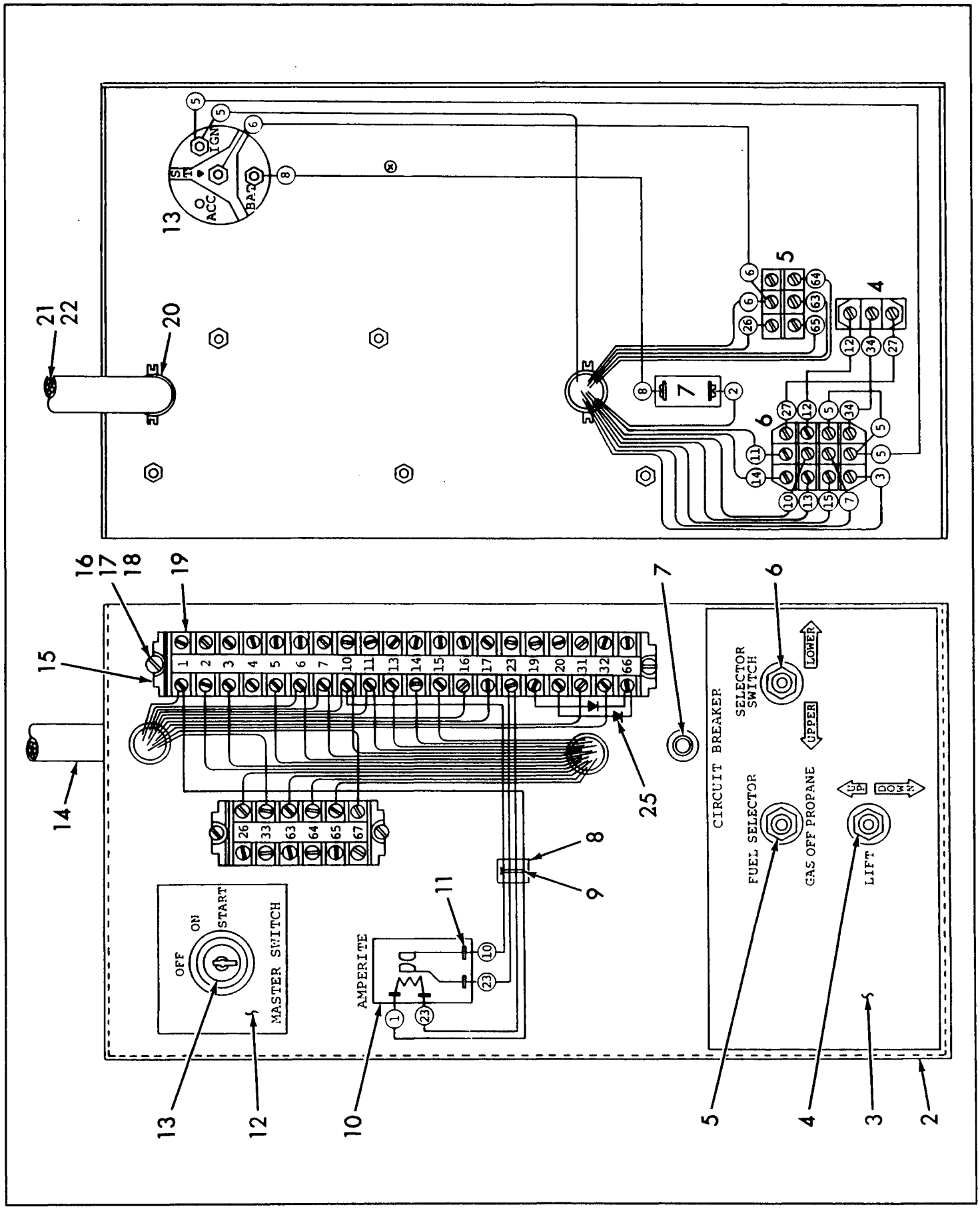
TITLE	ELECTRICAL PANEL ASSEMBLY	SECT. 3
MODEL	LS30G	FIG. 20
NOTES		PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-26	117-C	. CONNECTOR RING	28
-27	70008	. WIRE - 16 GAUGE (YELLOW/GREEN)	2 FT
-28	2991	. WIRE - 12 GAUGE (WHITE)	4 FT
-29	70232	. WIRE - 16 GAUGE (WHITE)	7 FT
-30	70233	. WIRE - 14 GAUGE (WHITE)	10 FT

Mark Industries

TITLE	ELECTRICAL PANEL ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	3
FIGURE	20A
PAGE	1



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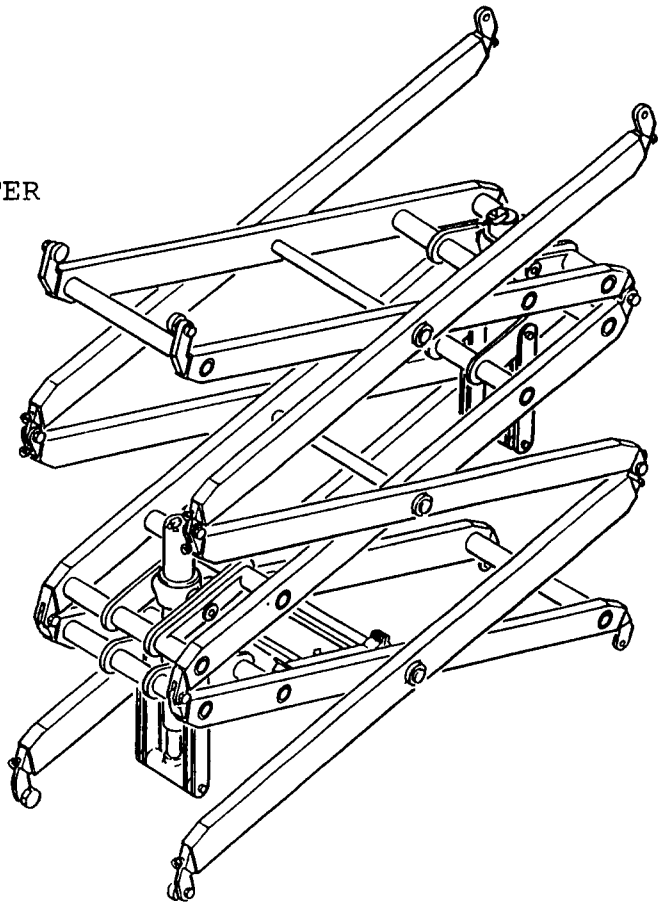
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32482	ELECTRICAL PANEL ASSEMBLY (See Sect. 3, Fig. 16 for NHA)	REF
2	30312	. PANEL	1
3	30310	. DECAL: SWITCHES	1
4	4021	. TOGGLE SWITCH	1
5	70015	. FUEL SELECTOR SWITCH	1
6	16260	. TOGGLE SWITCH	1
7	20562	. CIRCUIT BREAKER	1
8	16214	. MOUNT	5
9	256	. CABLE TIE	45
10	70306	. TIME DELAY RELAY	1
11	496-A	. PUSH-ON TERMINAL	4
12	32526	. DECAL: POWER ON/OFF/START	1
13	2717	. IGNITION SWITCH	1
14	130600	. CABLE CONDUCTOR	7 FT
15	117-A	. TERMINAL BLOCK END	2
16	62623	. CAP SCREW	5
17	63312	. LOCK WASHER	5
18	61502	. HEX NUT	5
19	4027	. TERMINAL BLOCK	26
20	70016	. GROMMET	2
21	70029	. CONNECTOR (BLUE)(8 PLACES)	8
22	70271	. CONNECTOR (YELLOW)(5 PLACES)	8
23	61728	. SELF-TAPPING SCREW	1
24	63322	. LOCK WASHER	1
25	70479	. DIODE	2

Mark Industries

TITLE	ELECTRICAL PANEL ASSEMBLY	SECT. 3
MODEL	LS36G	FIG. 20A
NOTES		PAGE 3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-26	117-C	. CONNECTOR RING	28
-27	70008	. WIRE - 16 GAUGE (YELLOW/GREEN)	2 FT
-28	2991	. WIRE - 12 GAUGE (WHITE)	4 FT
-29	70232	. WIRE - 16 GAUGE (WHITE)	7 FT
-30	70233	. WIRE - 14 GAUGE (WHITE)	10 FT

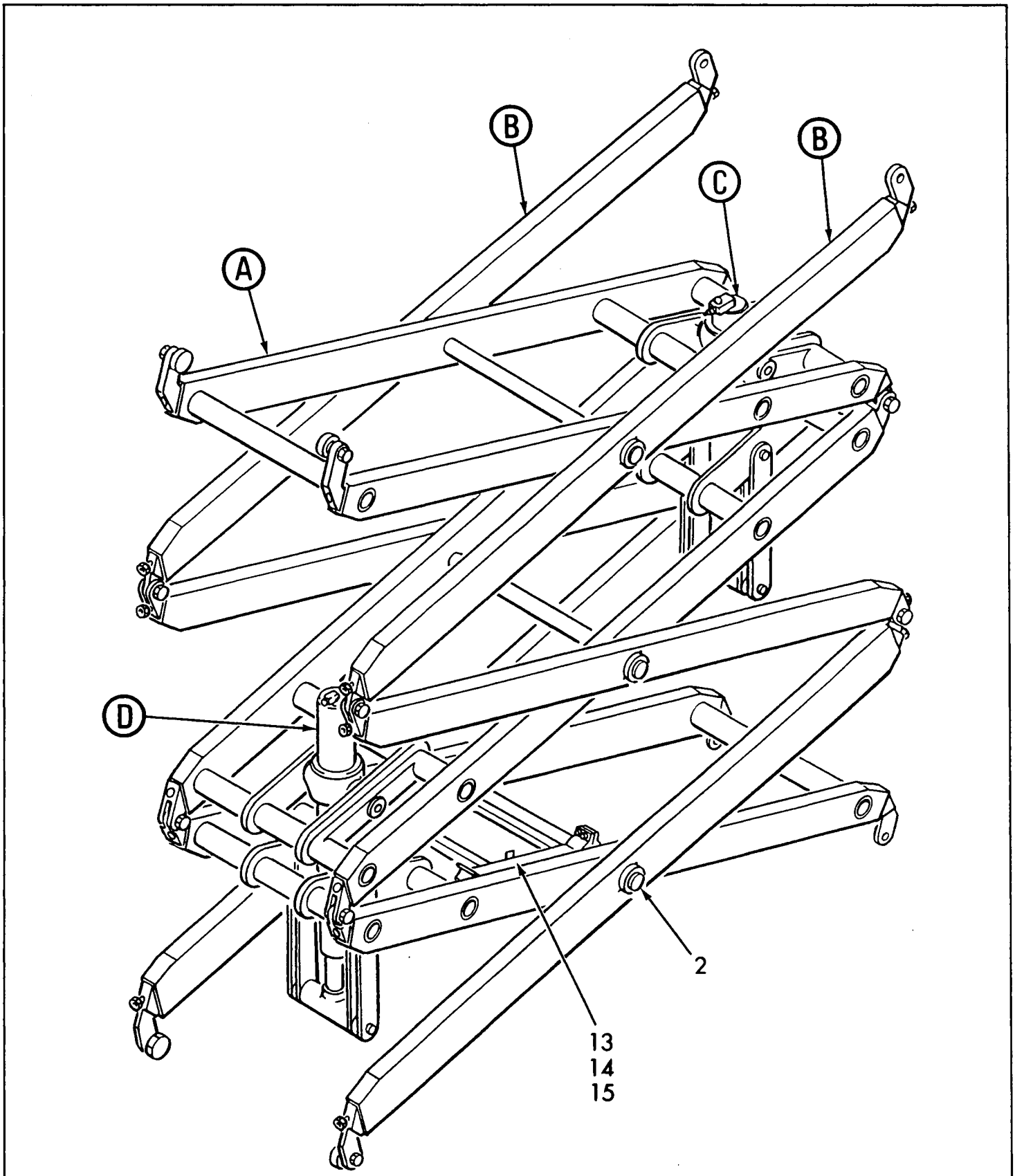
SECTION 4 CONTAINS:



Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	4
FIGURE	1
PAGE	1



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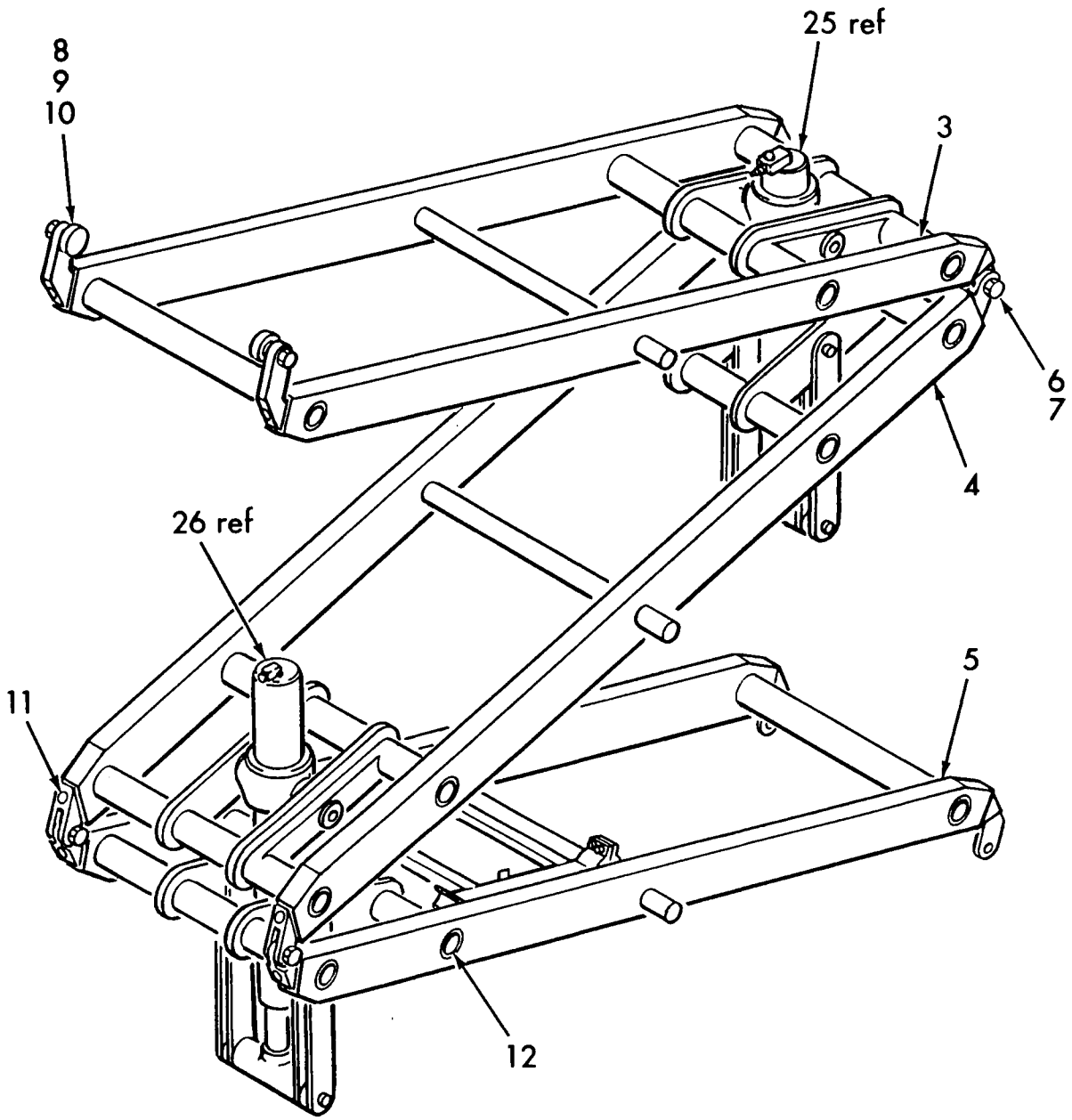
TITLE	SCISSOR ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	4
FIGURE	1
PAGE	2



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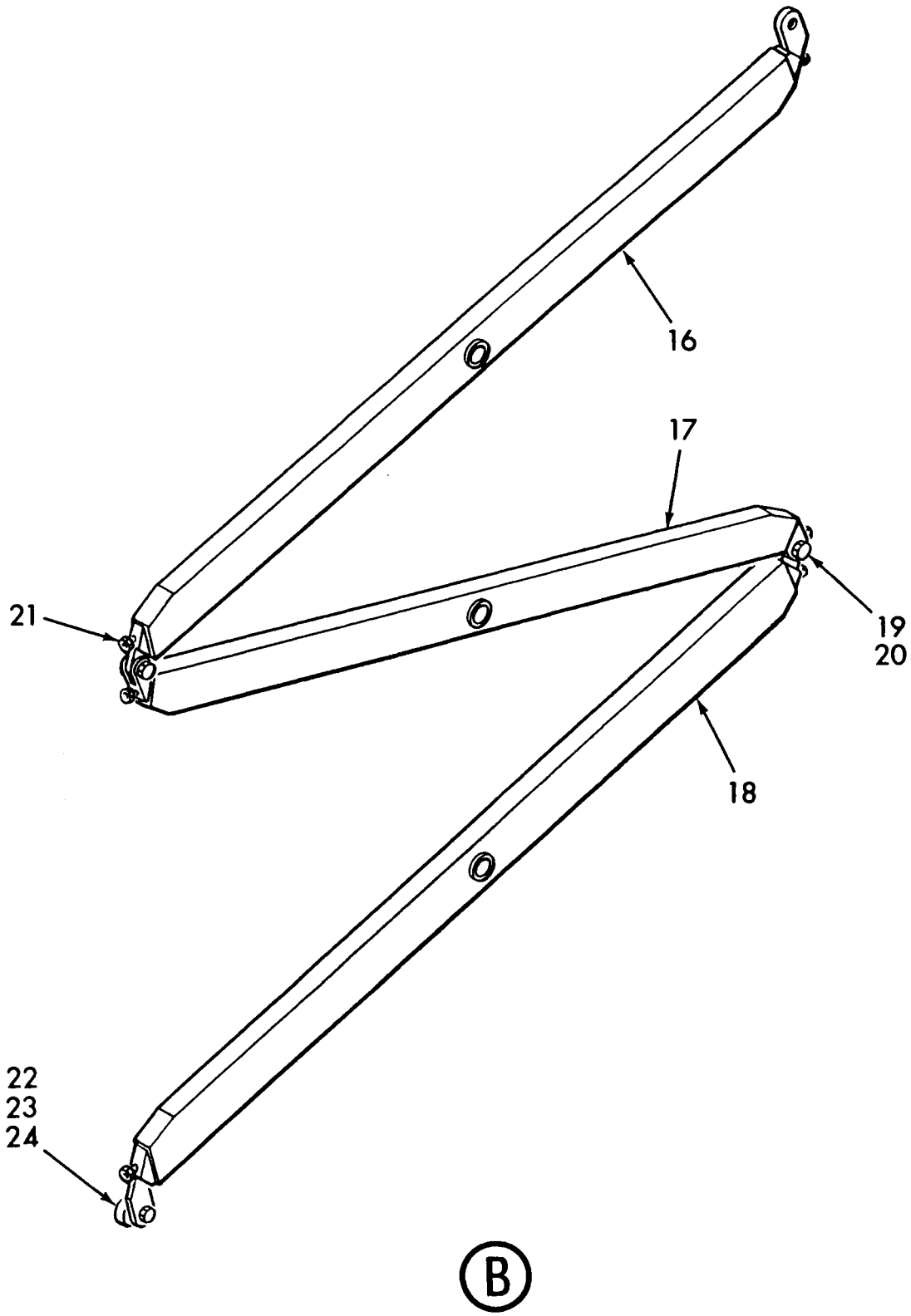
Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	4
FIGURE	1
PAGE	3



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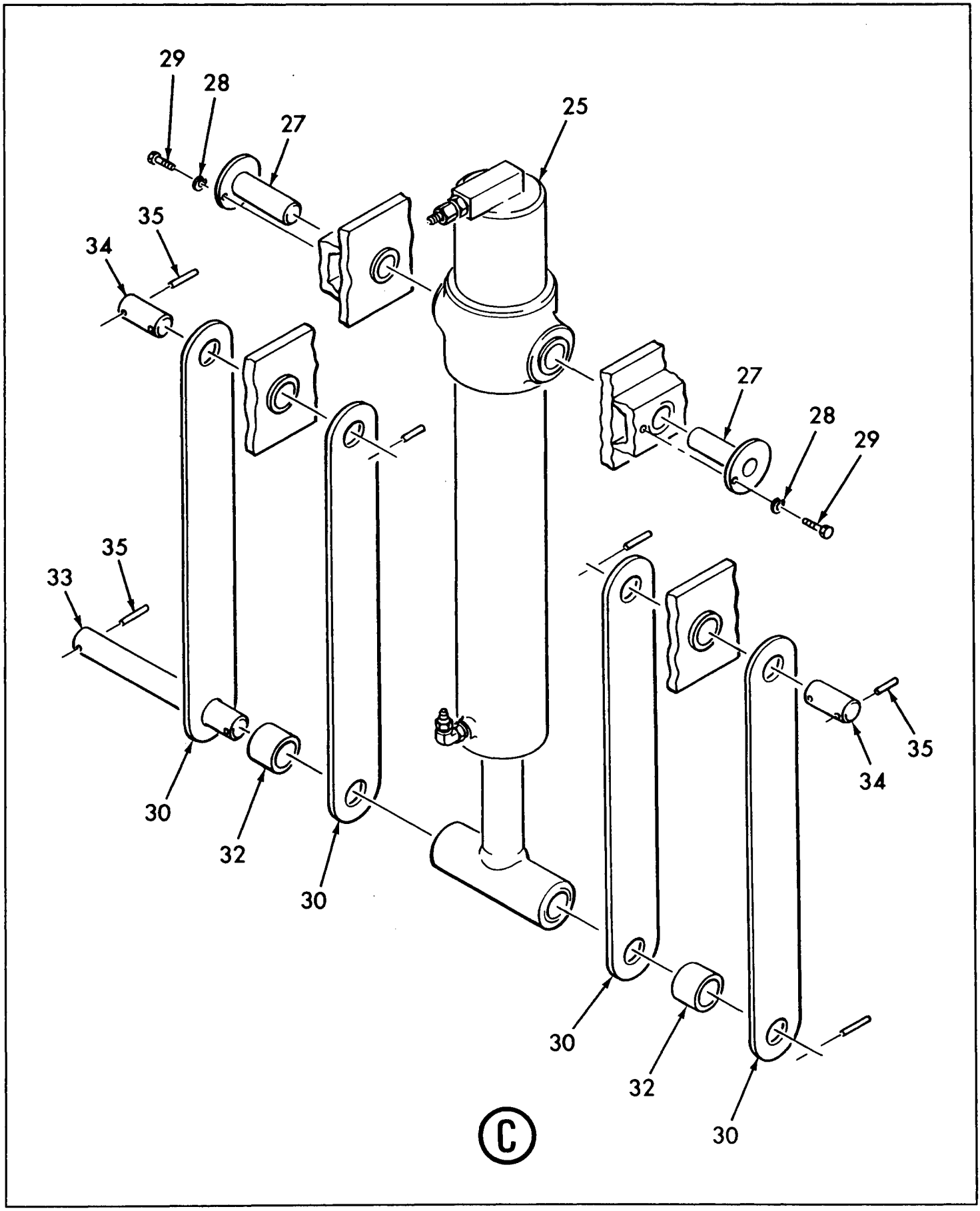
Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	4
FIGURE	1
PAGE	4



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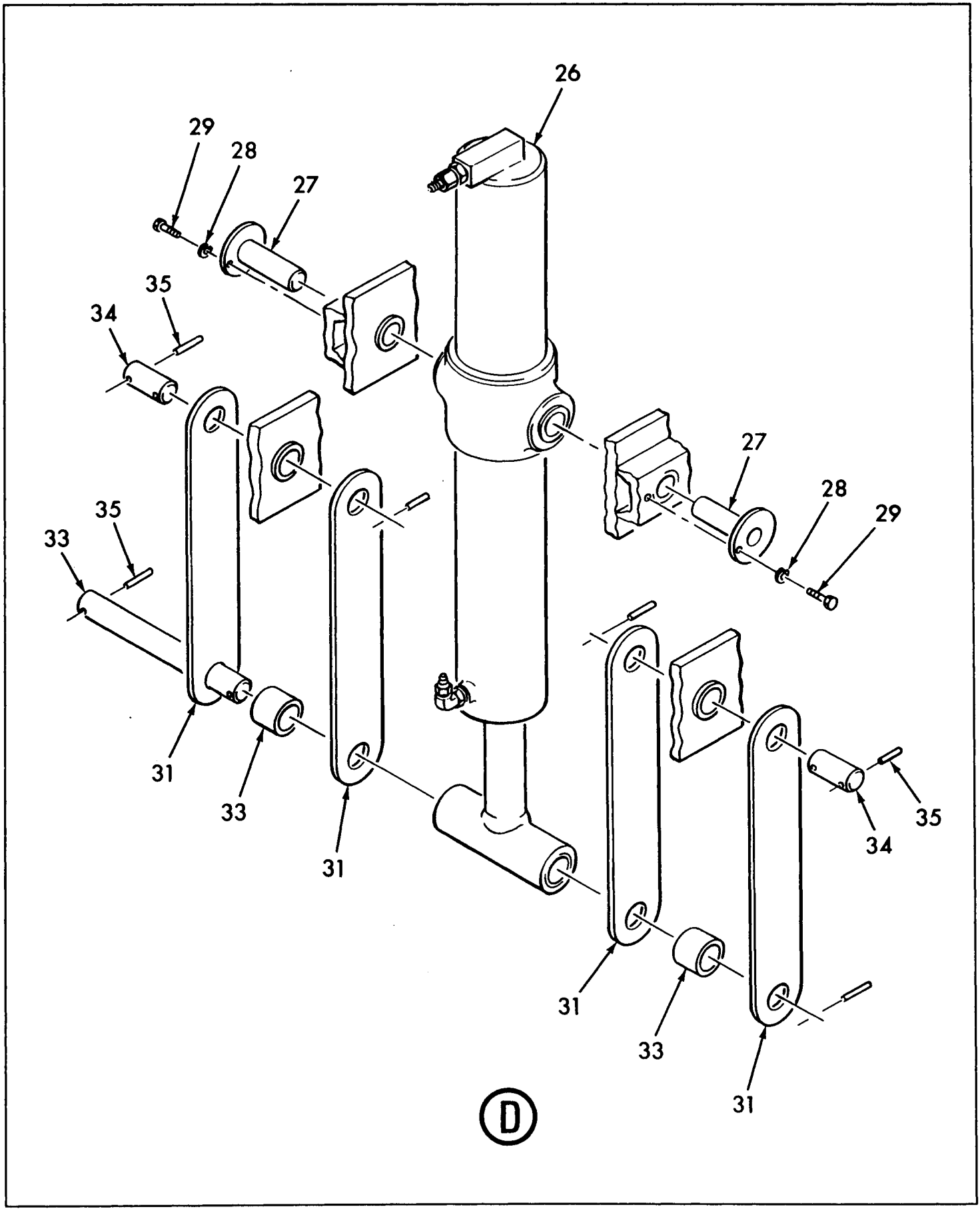
Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS30G
NOTES	

SECTION	4
FIGURE	1
PAGE	5



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TITLE	SCISSOR ASSEMBLY	SECT. 4
MODEL	LS30G	FIG. 1
NOTES		PAGE 6

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30231	SCISSOR ASSEMBLY (See Sect. 2, Fig. 1 for NHA)	REF
2	2214	. SHAFT COLLAR	6
3	30183	. INNER ARM-TOP (See Sect. 4, Fig. 2 for Details)	1
4	30182	. INNER ARM-CENTER (See Sect. 4, Fig. 3 for Details)	1
5	30181	. INNER ARM-BOTTOM (See Sect. 4, Fig. 4 for Details)	1
6	30296	. EAR PIVOT BOLT	4
7	61304	. LOCK NUT	4
8	2380	. CAM ROLLER	2
9	30475	. ROLLER SPACER	2
10	61216	. LOCK NUT	2
11	16335	. EAR PLUG	12
12	16334	. ARM CROSS MEMBER CAP	20
13	30338	. INNER ARM SUPPORT ASSEMBLY (See Sect. 4, Fig. 5 for Details)	1
14	30701	. BALL LOCK PIN	2
15	63654	. POP RIVET	2
16	30159	. OUTER ARM-TOP (See Sect. 4, Fig. 6 for Details)	2
17	30158	. OUTER ARM-CENTER (See Sect. 4, Fig. 7 for Details)	2
18	30156	. OUTER ARM-BOTTOM (See Sect. 4, Fig. 8 for Details)	2
19	30296	. EAR PIVOT BOLT	4
20	61304	. LOCK NUT	4
21	2807	. STRAIN RELIEF CONNECTOR	12

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

Mark Industries

TITLE	SCISSOR ASSEMBLY	SECT.	4
MODEL	LS30G	FIG.	1
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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
22	2380	. CAM ROLLER	2
23	30475	. ROLLER SPACER	2
24	61216	. LOCK NUT	2
25	30326	. MAIN LIFT CYLINDER ASSEMBLY (FRONT) (See Sect. 4, Fig. 9 for Details)	1
26	30325	. MAIN LIFT CYLINDER ASSEMBLY (REAR) (See Sect. 4, Fig. 10 for Details)	1
27	30151	. TRUNNION PIN	4
28	63302	. LOCK WASHER	4
29	60160	. CAP SCREW	4
30	30198	. ACTUATOR STRAP (FRONT)	4
31	30199	. ACTUATOR STRAP (REAR)	4
32	30474	. SPACER	4
33	30196	. CYLINDER PIVOT PIN	2
34	30195	. CYLINDER STRAP PIVOT PIN	4
35	64206	. ROLL PIN	12

Mark Industries

TITLE	INNER ARM-TOP ASSEMBLY
MODEL	LS30G
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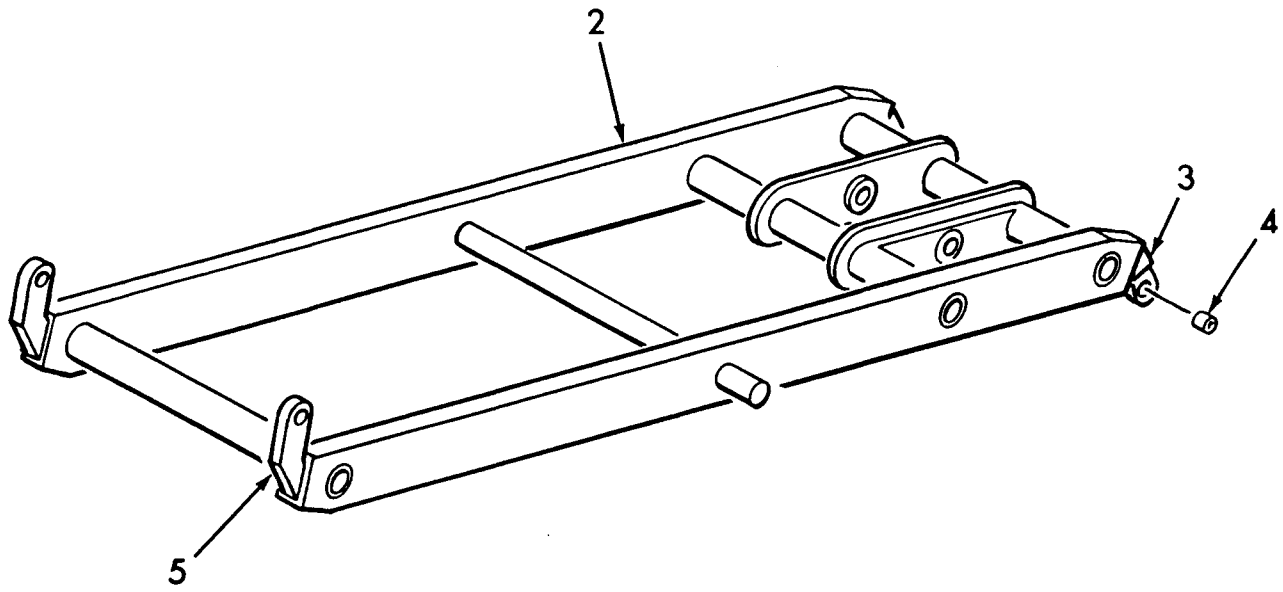

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30183	INNER ARM-TOP ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30176	. ARM FABRICATION	2
3	30154	. SHORT MALE EAR	2
4	30635	. BUSHING	2
5	30153	. LONG MALE ROLLER EAR	2

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Mark Industries

TITLE	INNER ARM-CENTER ASSEMBLY
MODEL	LS30G
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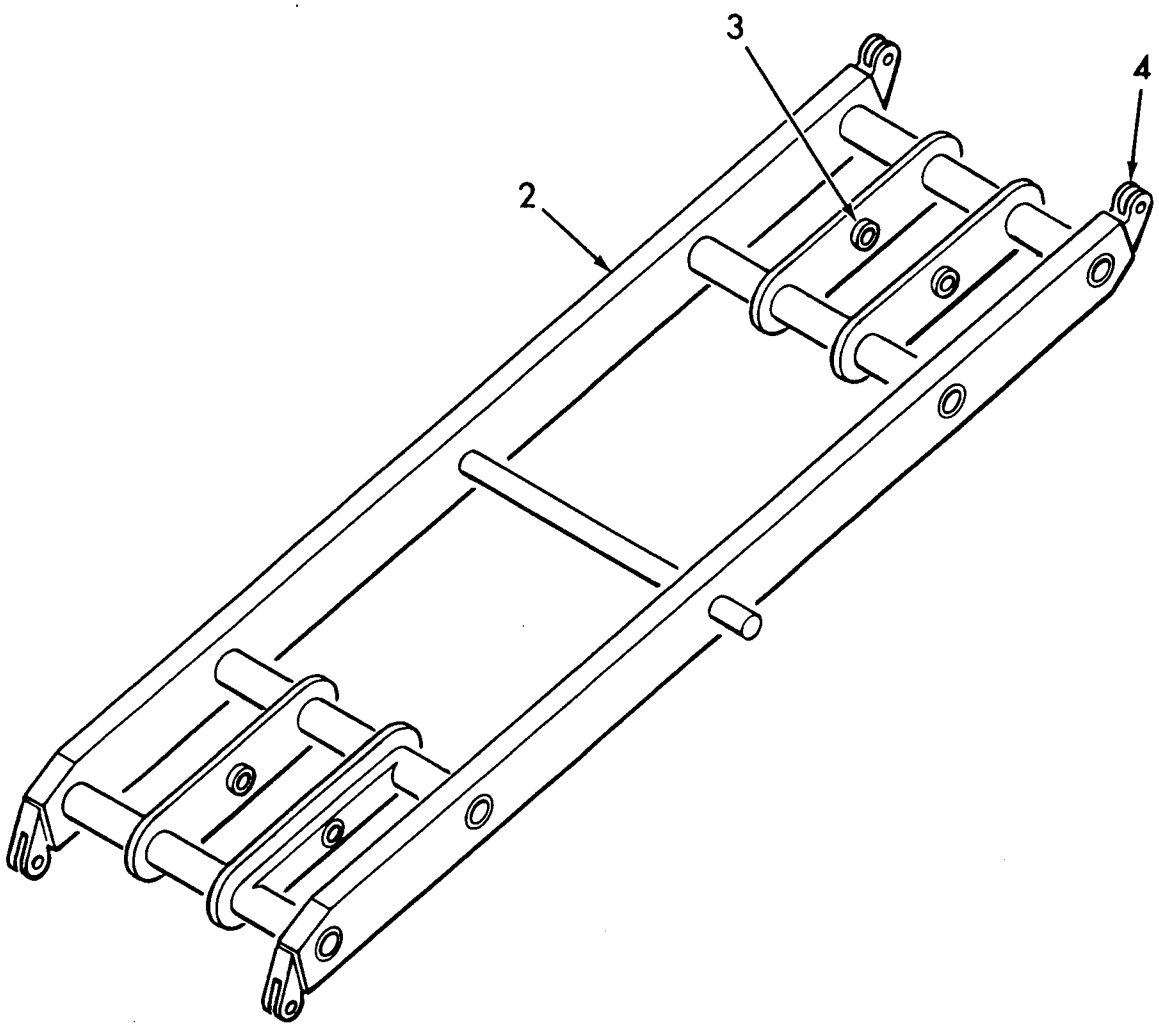

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30182	INNER ARM-CENTER ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30177	. ARM FABRICATION	2
3	30200	. BUSHING	2
4	30155	. FEMALE EAR	4

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Mark Industries

TITLE	INNER ARM-BOTTOM ASSEMBLY
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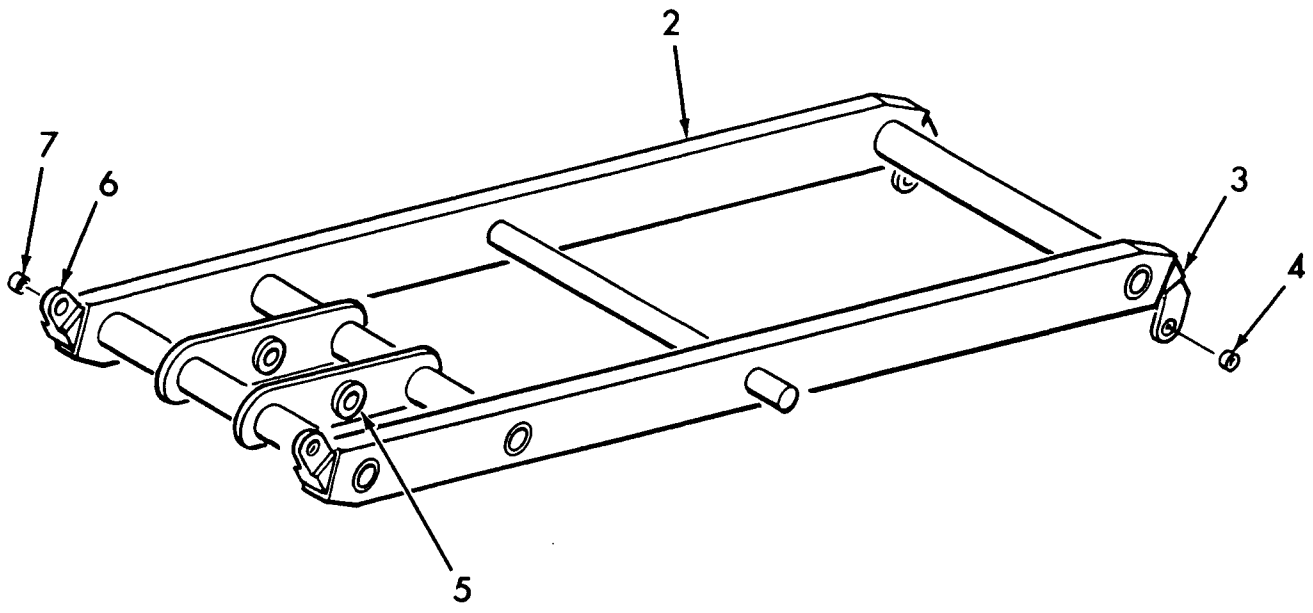

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30181	INNER ARM-BOTTOM ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30461	. ARM FABRICATION	2
3	30152	. LONG MALE PIVOT EAR	2
4	30186	. BUSHING	2
5	30200	. BUSHING	2
6	30154	. SHORT MALE EAR	2
7	30635	. BUSHING	2

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Mark Industries

TITLE	INNER ARM SUPPORT ASSEMBLY
MODEL	LS30G
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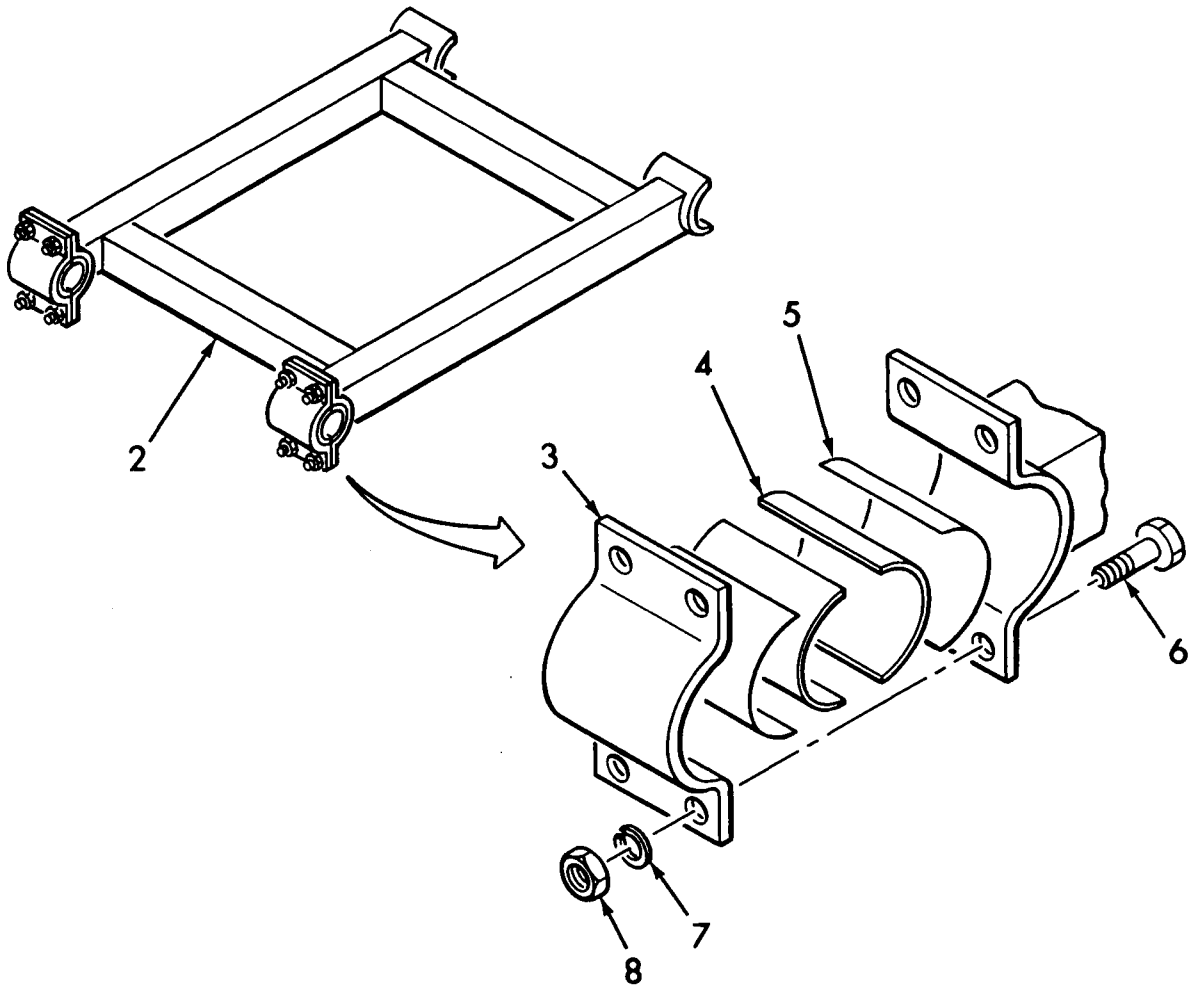

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30338	INNER ARM SUPPORT ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30808	. INNER ARM SUPPORT WELDMENT	1
3	30335	. INNER ARM SUPPORT CLAMP	2
4	65792	. SPRING RUBBER CLAMP	4
5	65192	. ADHESIVE	AR
6	60343	. CAP SCREW	8
7	63303	. LOCK WASHER	8
8	60703	. NUT	8

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TITLE	OUTER ARM-TOP ASSEMBLY
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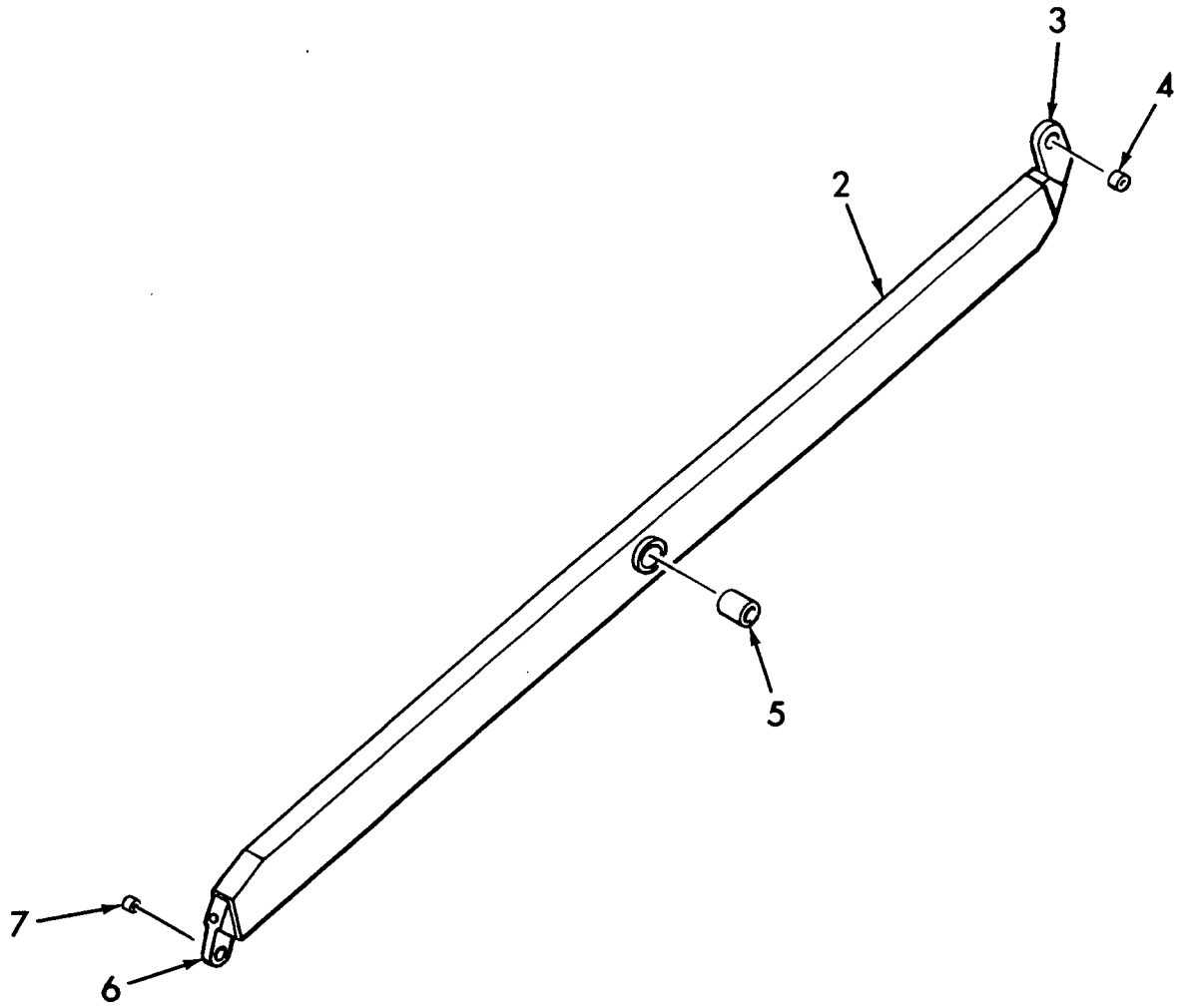

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30159	OUTER ARM-TOP ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30152	. LONG MALE PIVOT EAR	1
4	30186	. BUSHING	1
5	30207	. BUSHING	1
6	30154	. SHORT MALE EAR	1
7	30635	. BUSHING	1

REV.

Mark Industries

TITLE	OUTER ARM-CENTER ASSEMBLY
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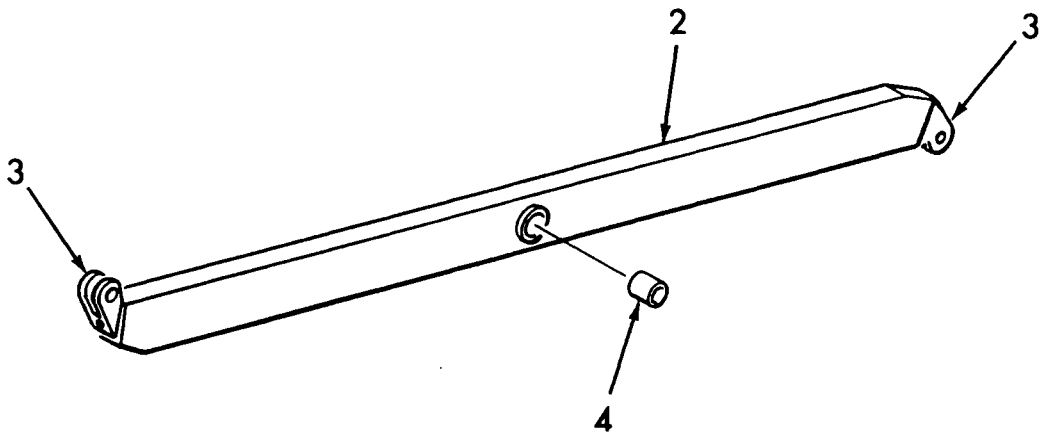

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30158	OUTER ARM-CENTER ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30155	. FEMALE EAR	2
4	30207	. BUSHING	1

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Mark Industries

TITLE	OUTER ARM-BOTTOM ASSEMBLY
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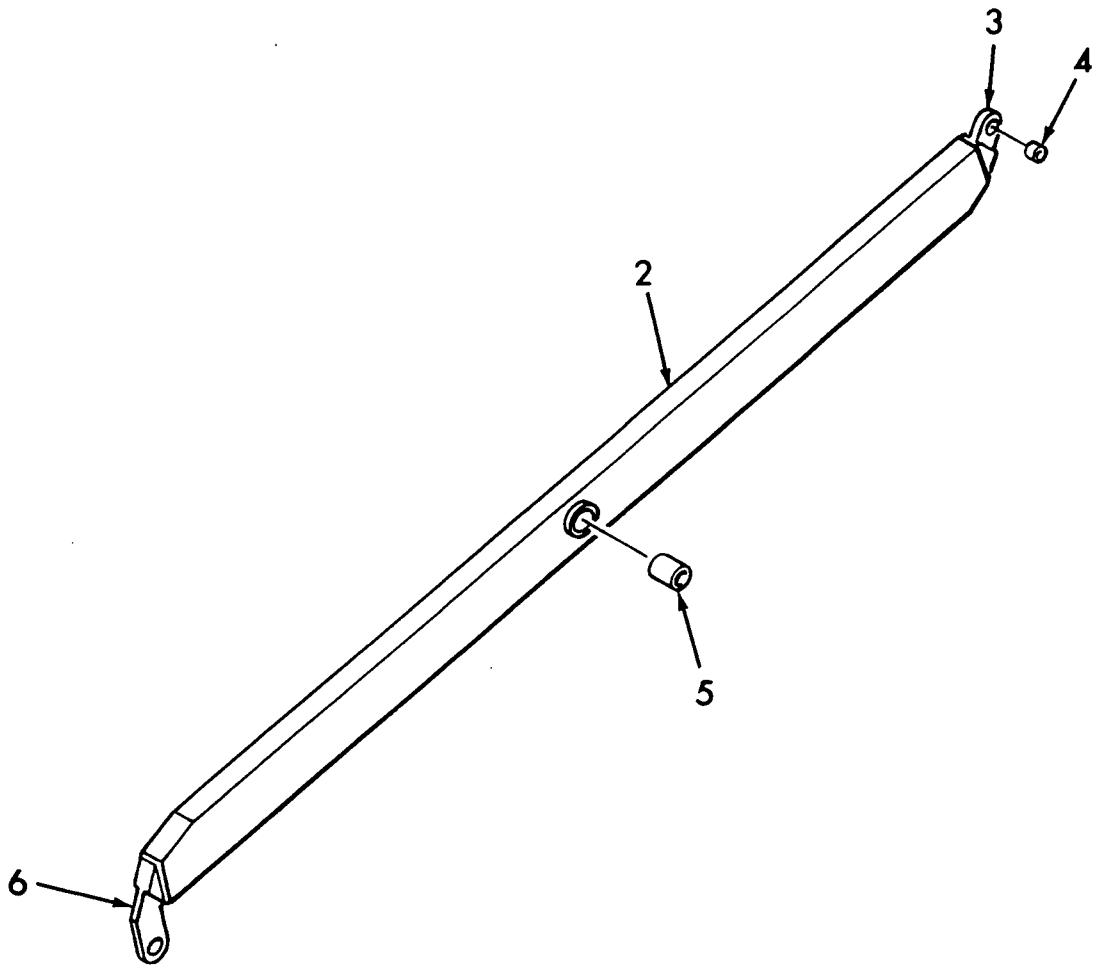

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30156	OUTER ARM-BOTTOM ASSEMBLY (See Sect. 4, Fig. 1 for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30154	. SHORT MALE EAR	1
4	30635	. BUSHING	1
5	30207	. BUSHING	1
6	30253	. LONG MALE ROLLER EAR	1

REV.

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (FRONT)
MODEL	LS30G
NOTES	

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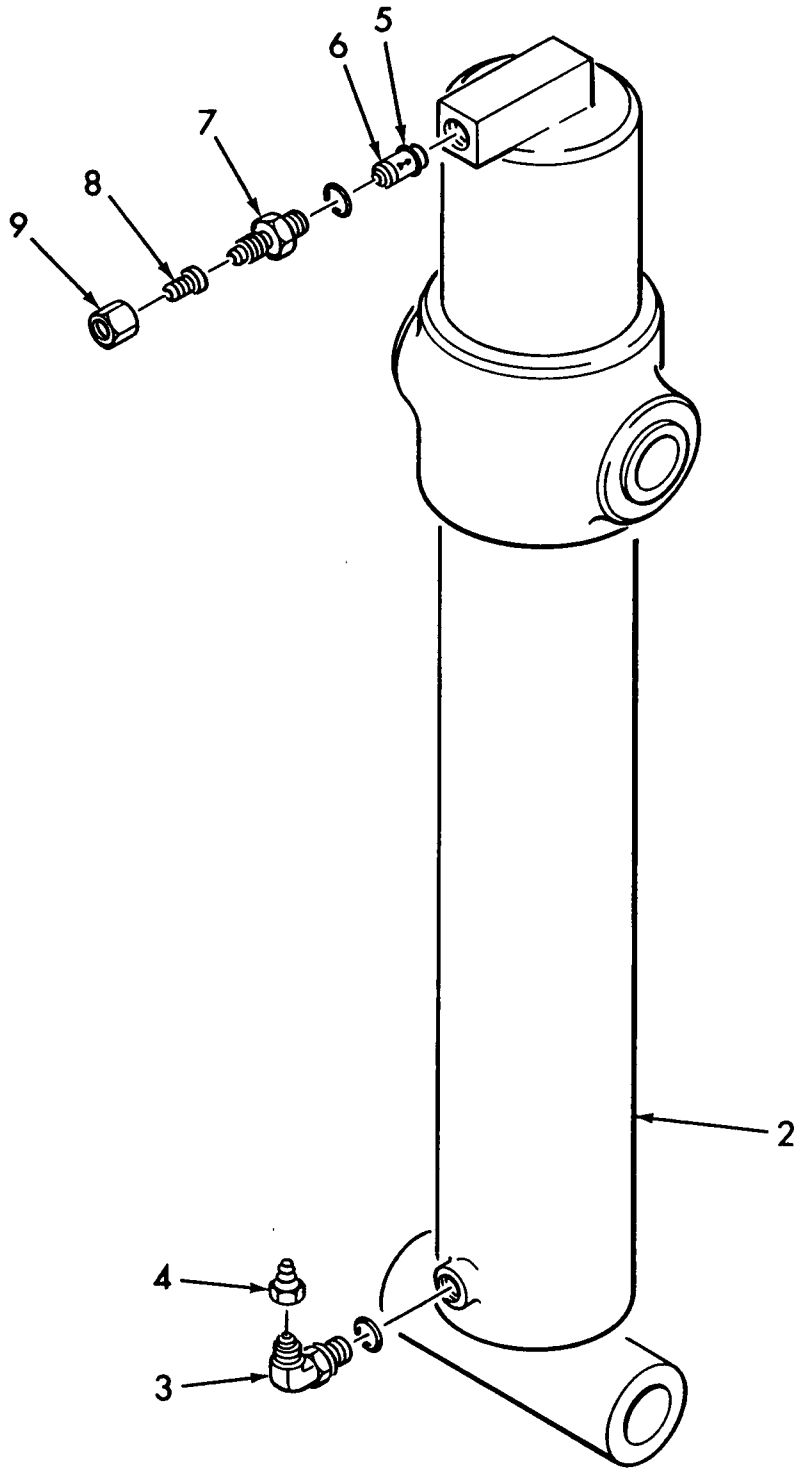

REV.

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (FRONT)
MODEL	LS30G
NOTES	

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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30326	MAIN LIFT CYLINDER ASSEMBLY (FRONT) (See Sect. 4, Fig. 1 for NHA)	REF
2	30191	. CYLINDER ASSEMBLY (See Sect. 4, Fig. 11 for Details)	1
3	80012-09	. STRAIGHT THREAD ELBOW	1
4	2468	. HOSE FITTING	1
5	880	. O-RING	1
6	32583	. CHECK VALVE MODIFICATION	1
7	80004-14	. STRAIGHT THREAD CONNECTOR	1
8	80056-03	. TUBE END REDUCER	1
9	80060-06	. NUT	1

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (REAR)
MODEL	LS30G
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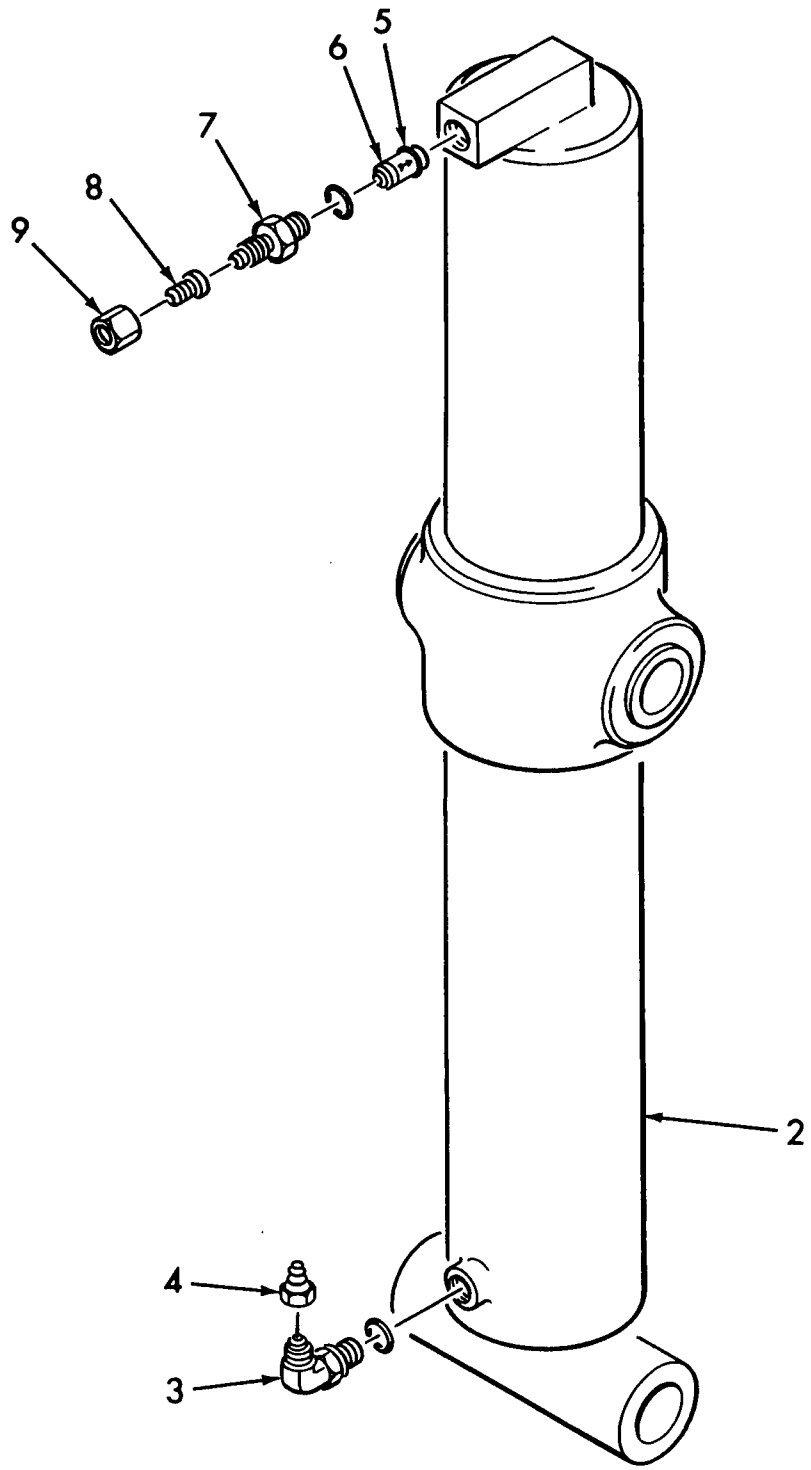

REV.

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (REAR)	SECT.	4
MODEL	LS30G	FIG.	10
NOTES		PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30325	MAIN LIFT CYLINDER ASSEMBLY (REAR) (See Sect. 4, Fig. 1 for NHA)	REF
2	30192	. CYLINDER ASSEMBLY (See Sect. 4, Fig. 11 for Details)	1
3	80012-09	. STRAIGHT THREAD ELBOW	1
4	2468	. HOSE FITTING	1
5	880	. O-RING	1
6	32583	. CHECK VALVE MODIFICATION	1
7	80004-14	. STRAIGHT THREAD CONNECTOR	1
8	80056-03	. TUBE END REDUCER	1
9	80060-06	. NUT	1

Mark Industries

TITLE	CYLINDER ASSEMBLY (FRONT & REAR)
MODEL	LS30G
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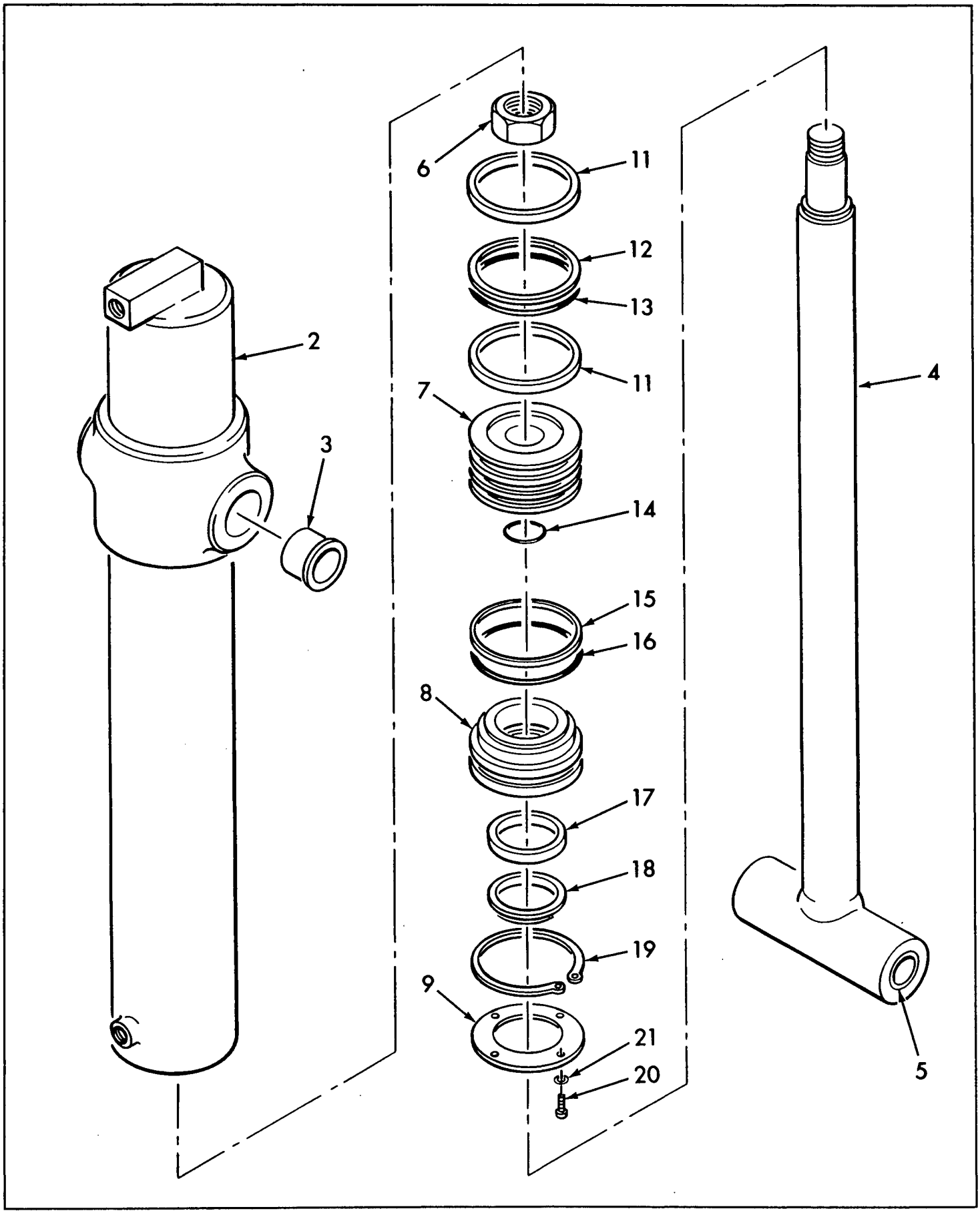

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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30191	CYLINDER ASSEMBLY (FRONT)(SHOWN) (See Sect. 4, Fig. 9 for NHA)	REF
-1	30192	CYLINDER ASSEMBLY (REAR) (See Sect. 4, Fig. 10 for NHA)	REF
2		. BARREL ASSEMBLY	1
3	64910	. TRUNNION BUSHING	2
4		. ROD ASSEMBLY	1
5		. ROD BUSHING	2
6		. NUT	1
7		. PISTON	1
8		. HEAD	1
9		. RETAINING PLATE	1
-10	66962	. SEAL KIT (STEEL PISTON RINGS)(SHOWN) SE.	1
-10	66017	. SEAL KIT (POLYPAK) SE.	1
-10	66018	. SEAL KIT (HCI)(JULY 1981 THRU MARCH 1987 USED INTERMITTENTLY)	1
11		.. WEAR RING	2
12		.. SHAMBAN SEAL	1
13		.. O-RING	1
14		.. O-RING	1
15		.. BACK-UP RING	1
16		.. O-RING	1
17		.. ROD SEAL	1
18		.. ROD WIPER	1
19		.. SNAP RING	1
20		.. CAP SCREW	4
21		.. LOCK WASHER	4

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TITLE	SCISSOR ASSEMBLY
MODEL	LS36G
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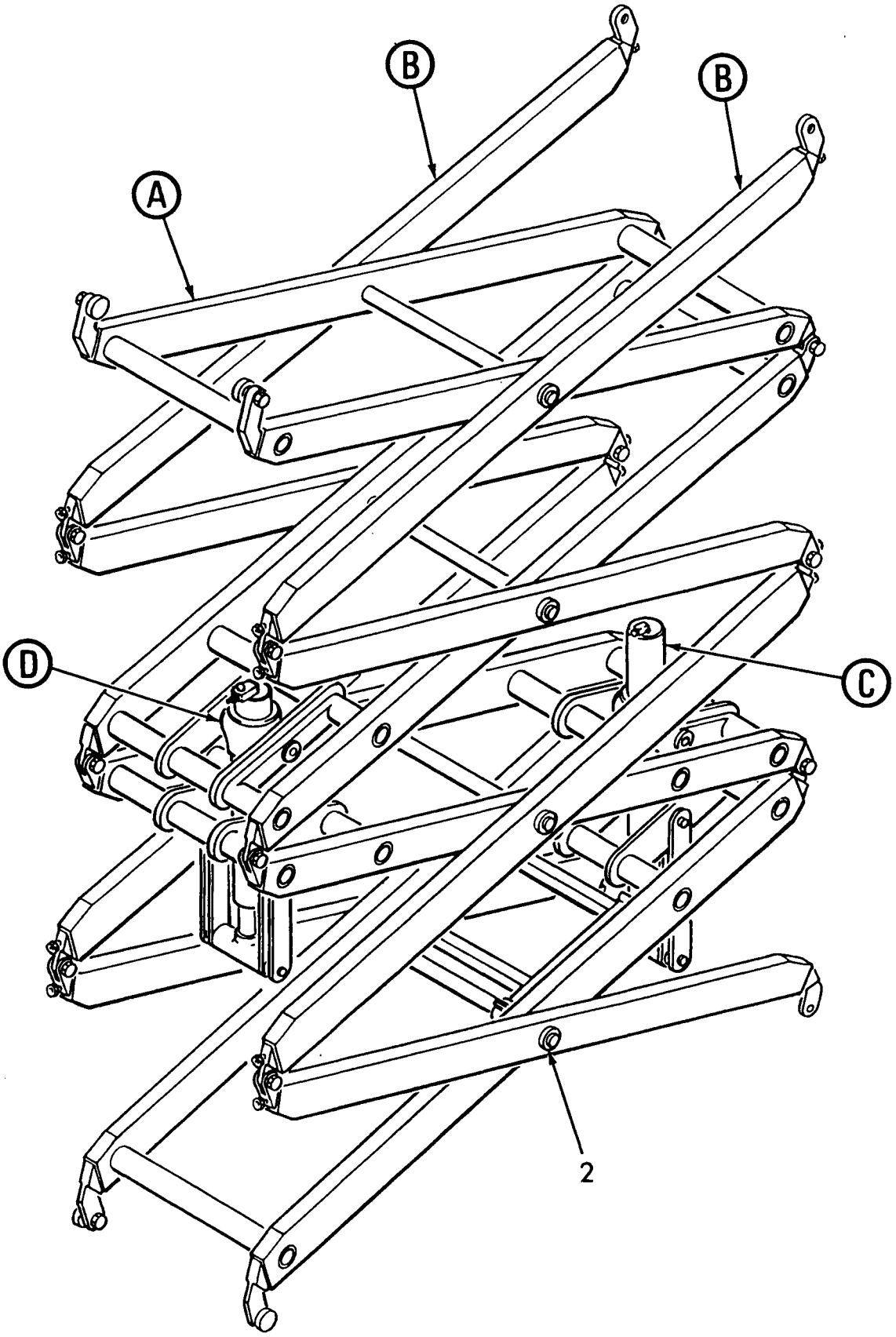

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Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	4
FIGURE	1A
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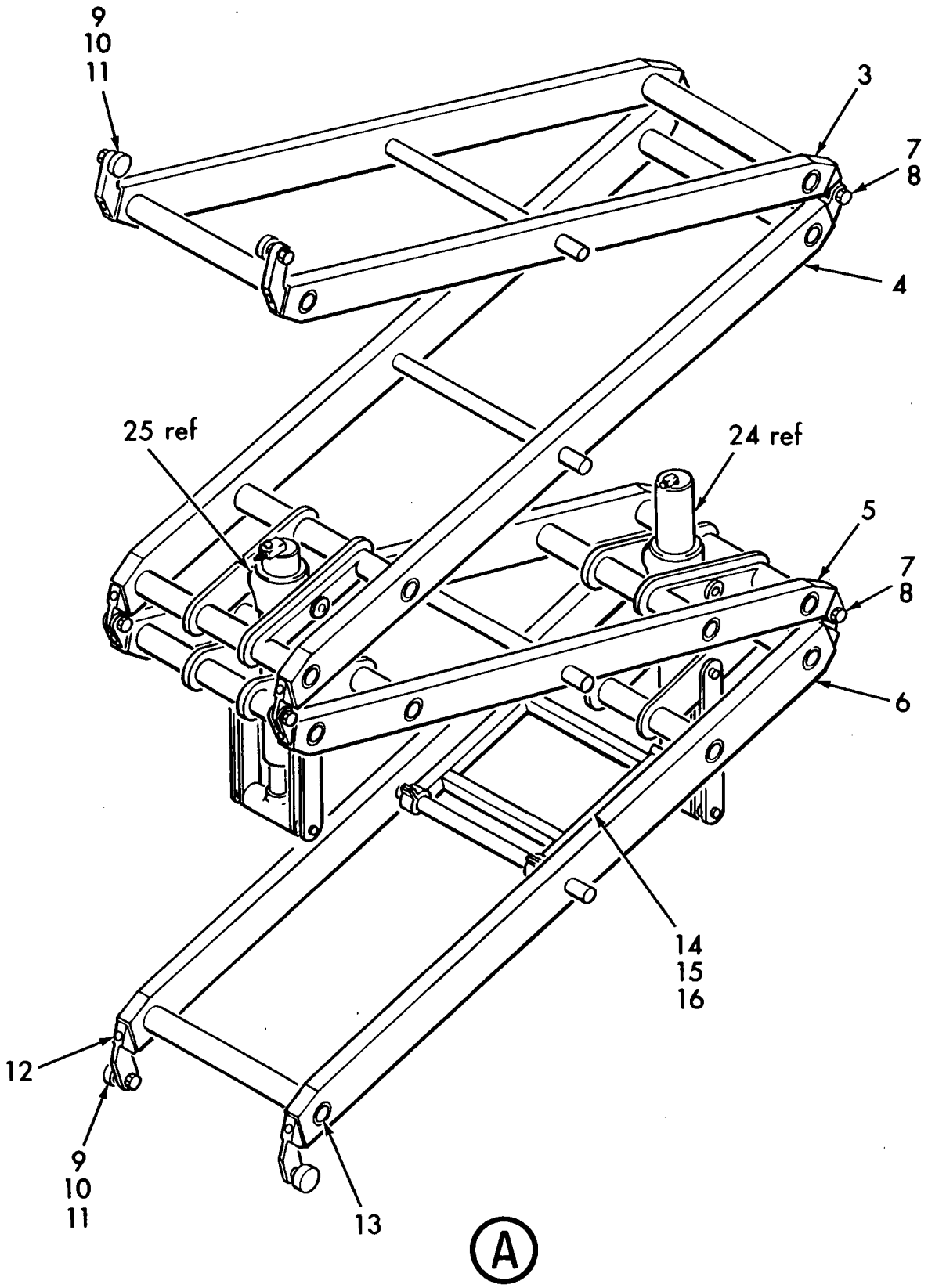

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Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS36G
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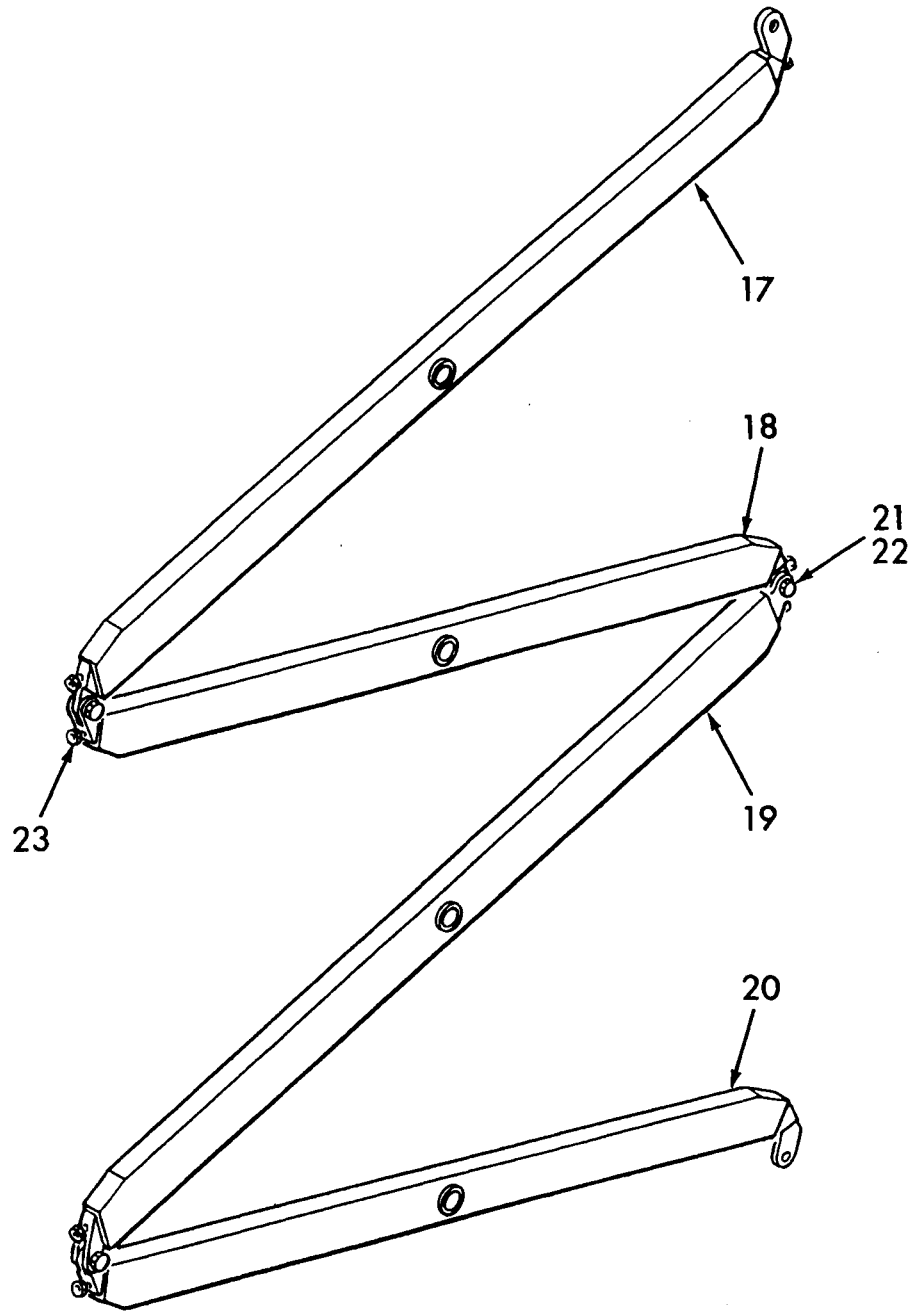

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REV.

Mark Industries

TITLE	SCISSOR ASSEMBLY
MODEL	LS36G
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FIGURE	1A
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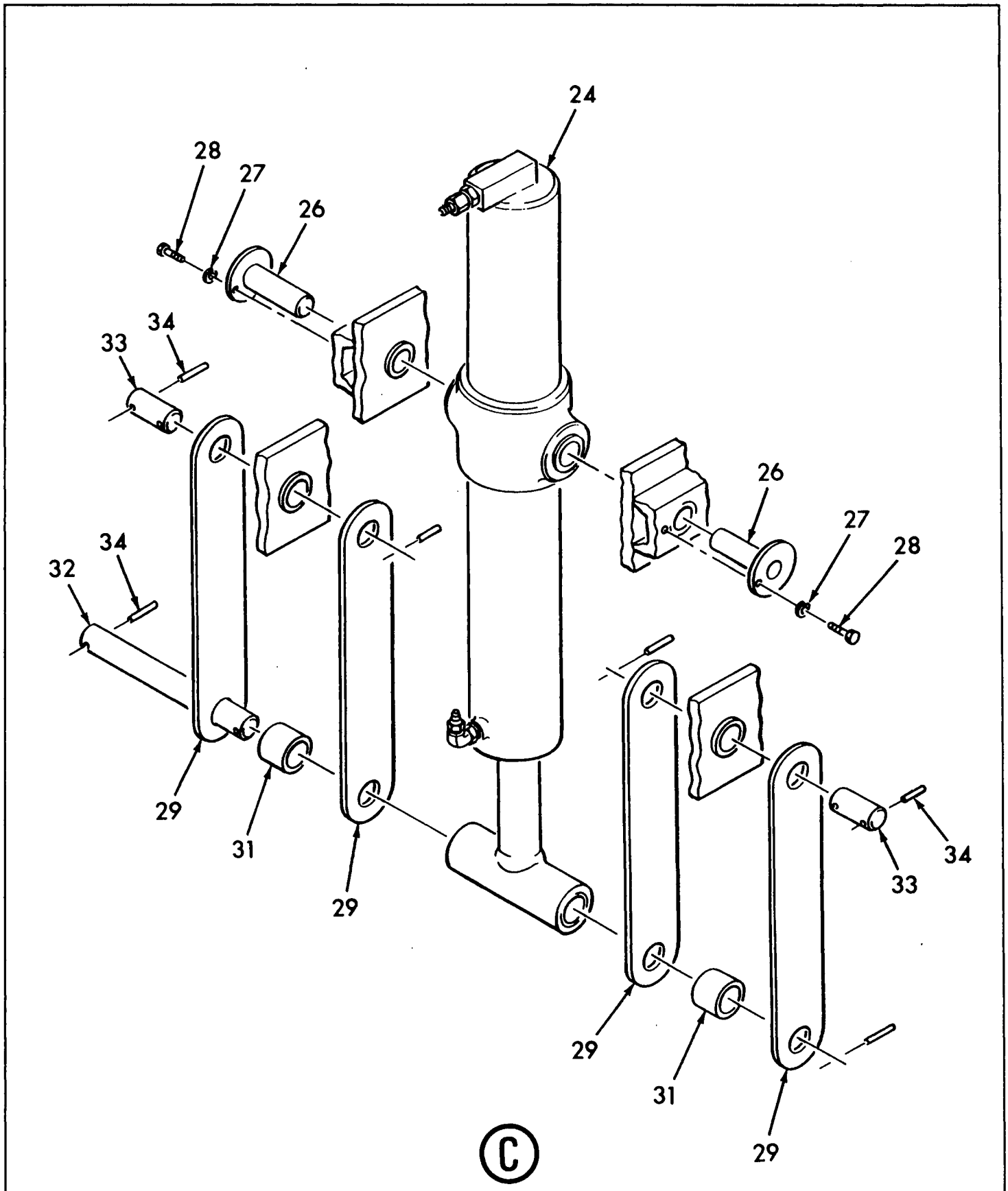

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Mark Industries

TITLE	SCISSOR ASSEMBLY
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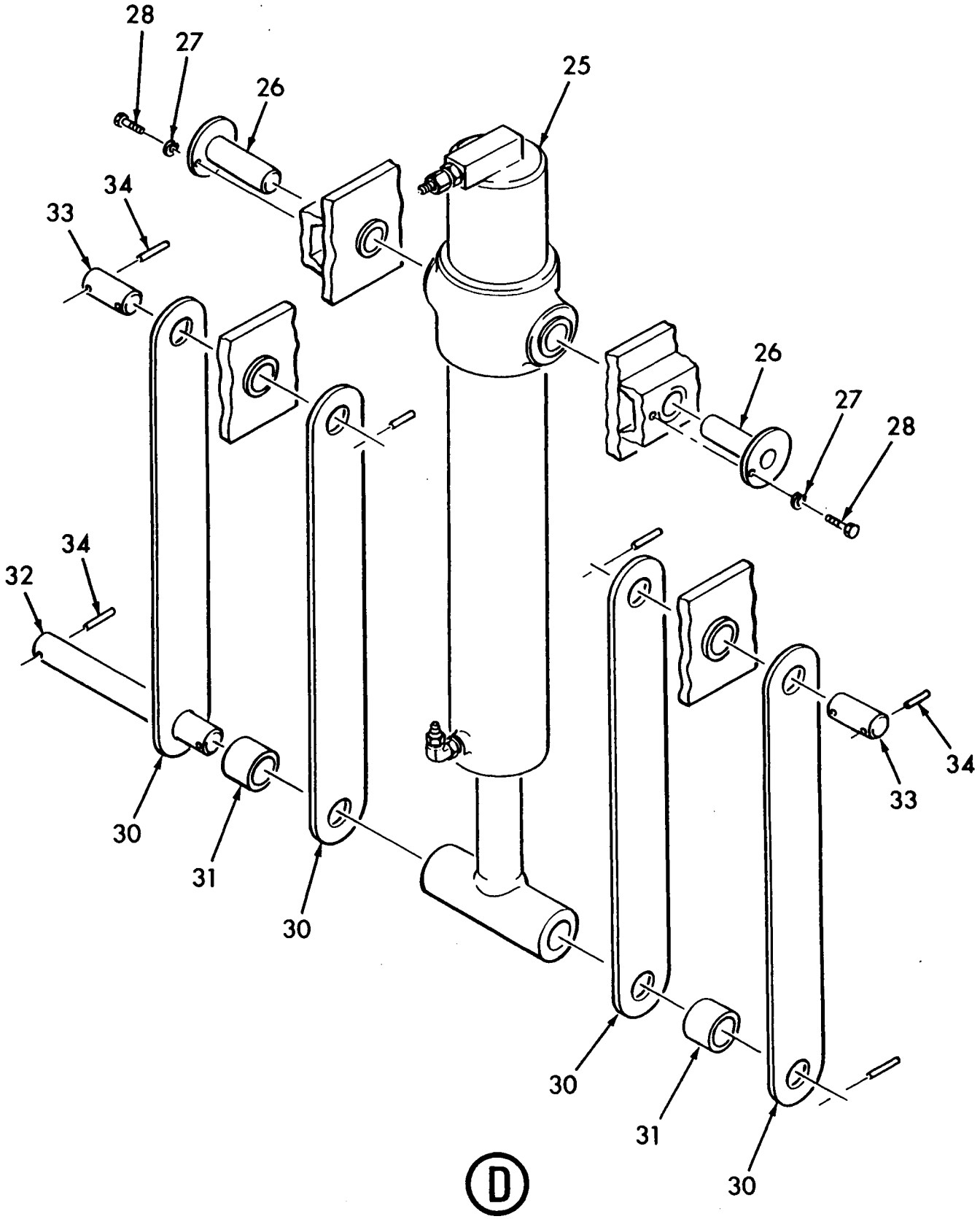

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Mark Industries

TITLE	SCISSOR ASSEMBLY	SECT. 4
MODEL	LS36G	FIG. 1A
NOTES		PAGE 6

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30232	SCISSOR ASSEMBLY (See Sect. 3, Fig. 1A for NHA)	REF
2	2214	. SHAFT COLLAR	8
3	30185	. INNER ARM-TOP ASSEMBLY (See Sect. 4, Fig. 2A for Details)	1
4	30184	. INNER ARM-TOP CENTER ASSEMBLY (See Sect. 4, Fig. 3A for Details)	1
5	30182	. INNER ARM-BOTTOM CENTER ASSEMBLY (See Sect. 4, Fig. 4A for Details)	1
6	32747	. INNER ARM-BOTTOM ASSEMBLY (See Sect. 4, Fig. 5A for Details)	1
7	30296	. EAR PIVOT BOLT	6
8	61304	. LOCK NUT	6
9	2380	. CAM ROLLER	4
10	30475	. ROLLER SPACER	4
11	61216	. LOCK NUT	4
12	16335	. EAR PLUG	16
13	16334	. ARM CROSS MEMBER CAP	24
14	30338	. INNER ARM SUPPORT ASSEMBLY (See Sect. 4, Fig. 6A for Details)	1
15	30701	. BALL LOCK PIN	2
16	63654	. POP RIVET	2
17	30225	. OUTER ARM-TOP ASSEMBLY (See Sect. 4, Fig. 7A for Details)	2
18	30157	. OUTER ARM-TOP CENTER ASSEMBLY (See Sect. 4, Fig. 8A for Details)	2
19	30346	. OUTER ARM-BOTTOM CENTER ASSEMBLY (See Sect. 4, Fig. 9A for Details)	2
20	30345	. OUTER ARM-BOTTOM ASSEMBLY (See Sect. 4, Fig. 10A for Details)	2

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TITLE	SCISSOR ASSEMBLY	SECT. 4
MODEL	LS36G	FIG. 1A
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ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
21	30296	. EAR PIVOT BOLT	6
22	61216	. LOCK NUT	6
23	2807	. STRAIN RELIEF CONNECTOR	16
24	30327	. MAIN LIFT CYLINDER (FRONT) (See Sect. 4, Fig. 11A for Details)	1
25	30328	. MAIN LIFT CYLINDER (REAR) (See Sect. 4, Fig. 12A for Details)	1
26	30151	. TRUNNION PIN	4
27	63302	. LOCK WASHER	4
28	60367	. CAP SCREW	4
29	30198	. ACTUATOR STRAP (FRONT)	4
30	30199	. ACTUATOR STRAP (REAR)	4
31	30474	. SPACER	4
32	30196	. CYLINDER PIVOT PIN	2
33	30195	. CYLINDER STRAP PIVOT PIN	4
34	64206	. ROLL PIN	12

Mark Industries

TITLE	INNER ARM-TOP ASSEMBLY
MODEL	LS36G
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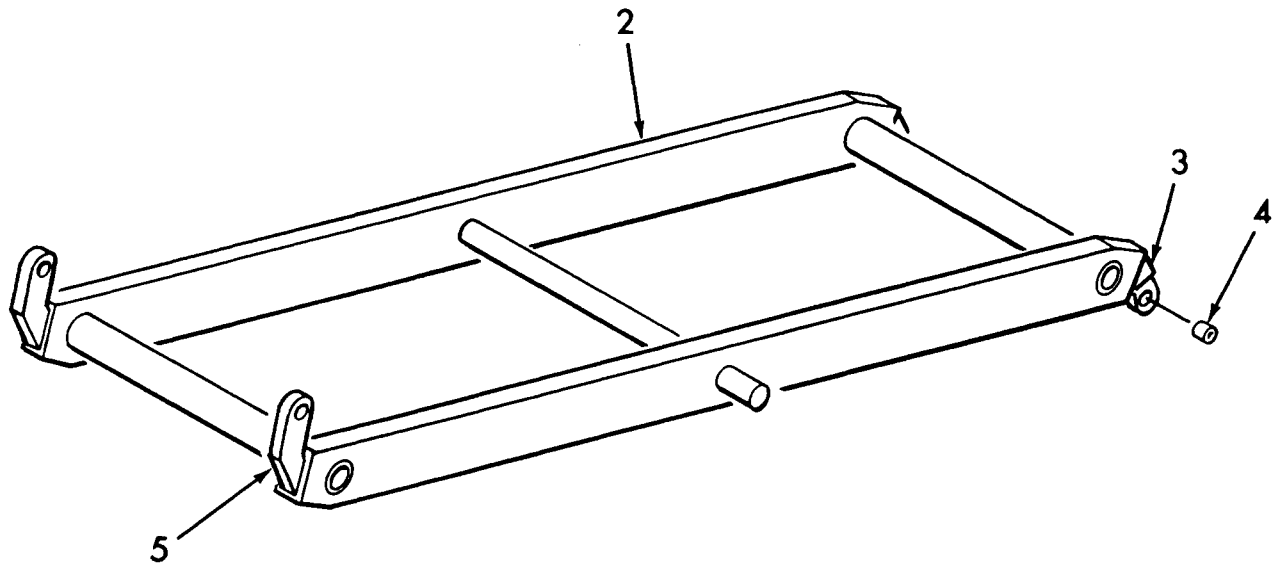

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30185	INNER ARM-TOP ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30178	. ARM FABRICATION	2
3	30154	. SHORT MALE EAR	2
4	30635	. BUSHING	2
5	30153	. LONG MALE ROLLER EAR	2

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Mark Industries

TITLE	INNER ARM-TOP CENTER ASSEMBLY
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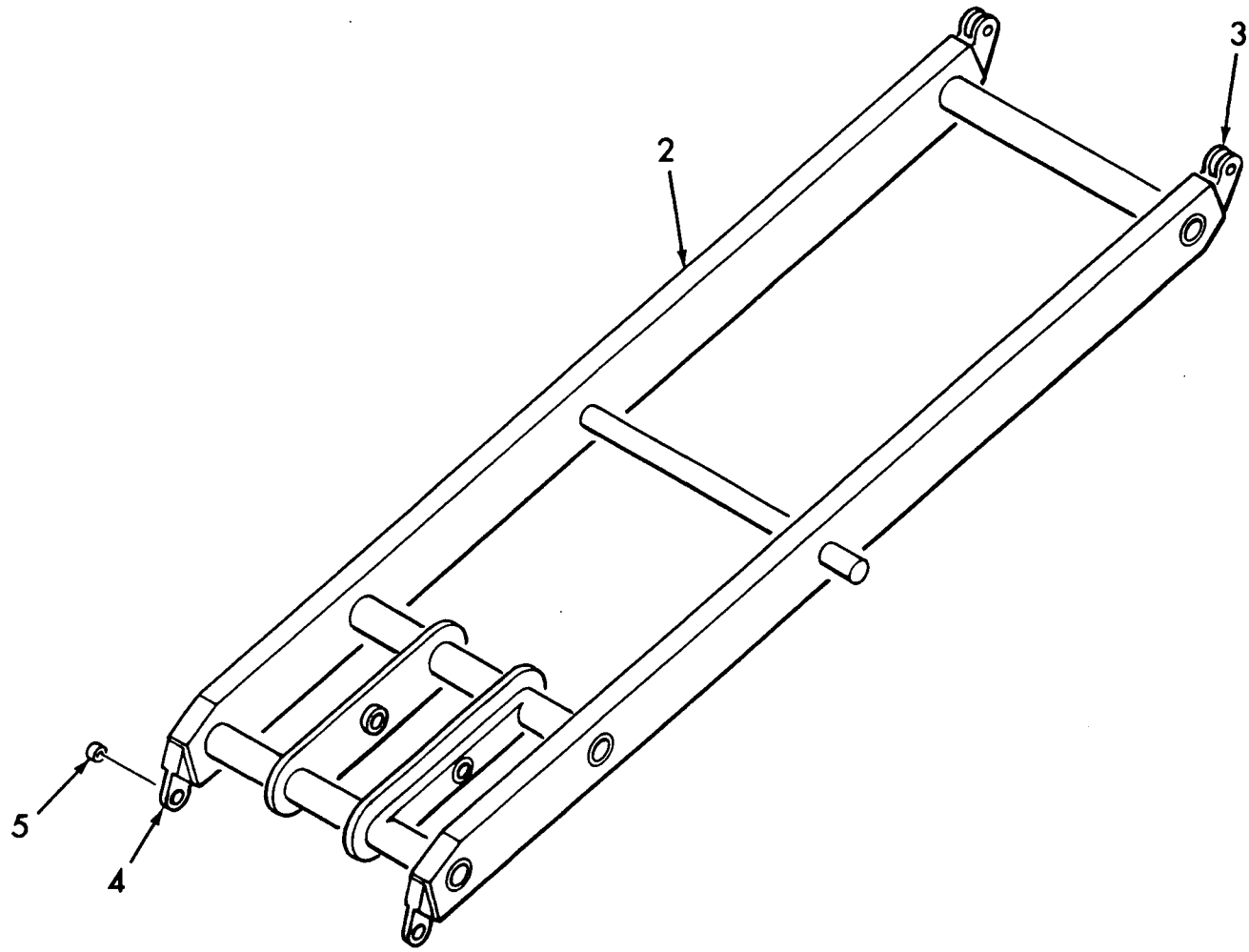

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30184	INNER ARM-TOP CENTER ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30176	. ARM FABRICATION	2
3	30155	. FEMALE EAR	2
4	30154	. SHORT MALE EAR	2
5	30635	. BUSHING	2

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TITLE	INNER ARM-BOTTOM CENTER ASSEMBLY
MODEL	LS36G
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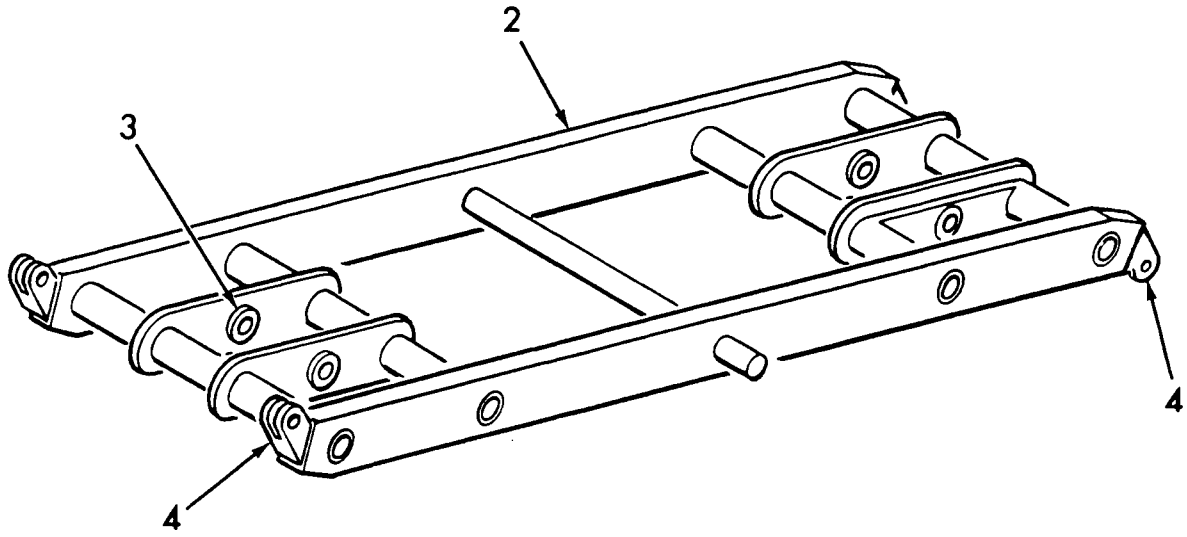

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30182	INNER ARM-BOTTOM CENTER ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30177	. ARM FABRICATION	2
3	30200	. BUSHING	2
4	30155	. FEMALE EAR	4

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TITLE	INNER ARM-BOTTOM ASSEMBLY
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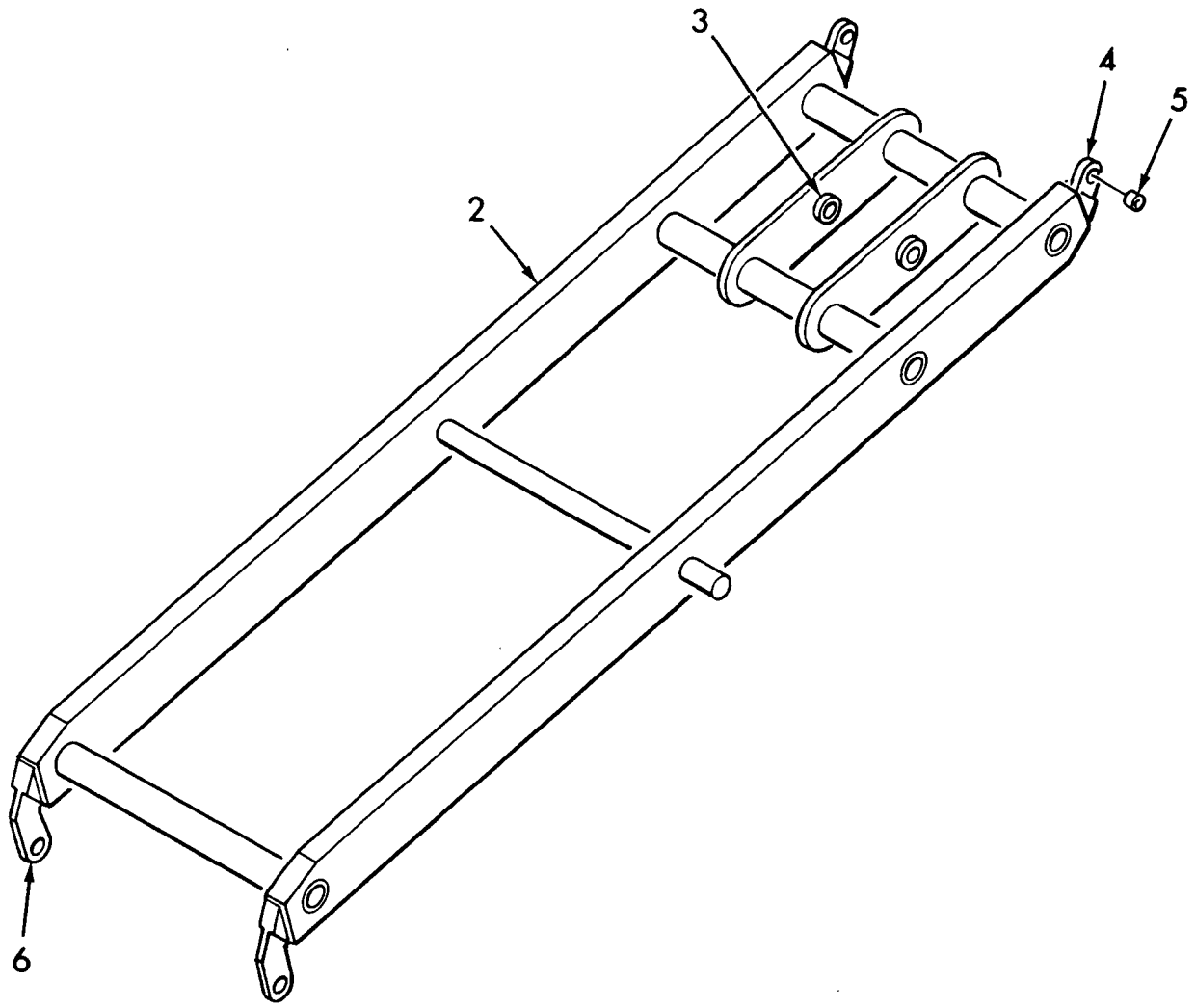

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32747	INNER ARM-BOTTOM ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30461	. ARM FABRICATION	2
3	30200	. BUSHING	2
4	30154	. SHORT MALE EAR	2
5	30635	. BUSHING	2
6	30153	. LONG MALE PIVOT EAR	2

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TITLE	INNER ARM SUPPORT ASSEMBLY
MODEL	LS36G
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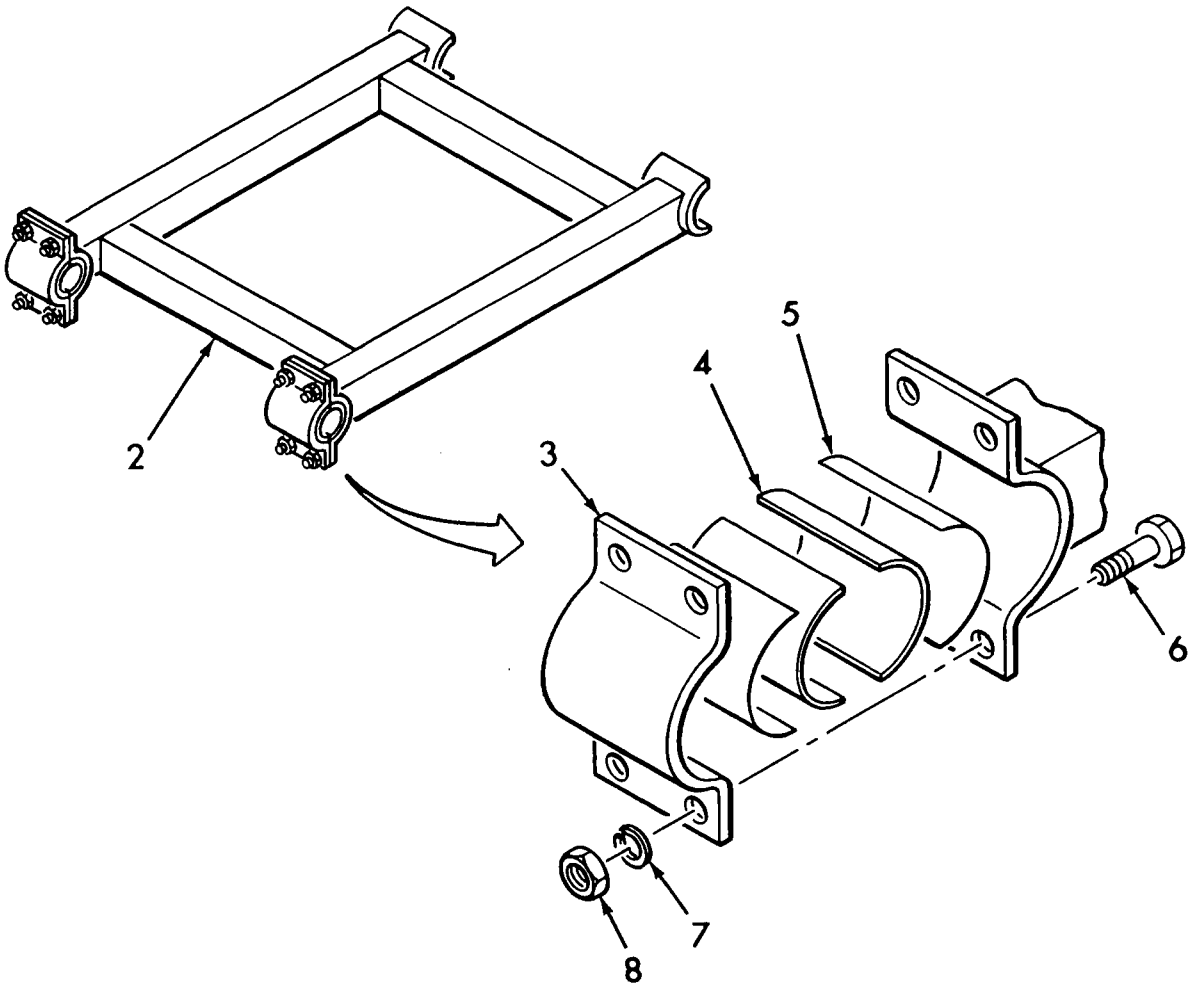

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30338	INNER ARM SUPPORT ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30808	. INNER ARM SUPPORT WELDMENT	1
3	30335	. INNER ARM SUPPORT CLAMP	2
4	65792	. SPRING RUBBER CLAMP	4
5	65192	. ADHESIVE	AR
6	60343	. CAP SCREW	8
7	63303	. LOCK WASHER	8
8	60703	. NUT	8

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TITLE	OUTER ARM-TOP ASSEMBLY
MODEL	LS36G
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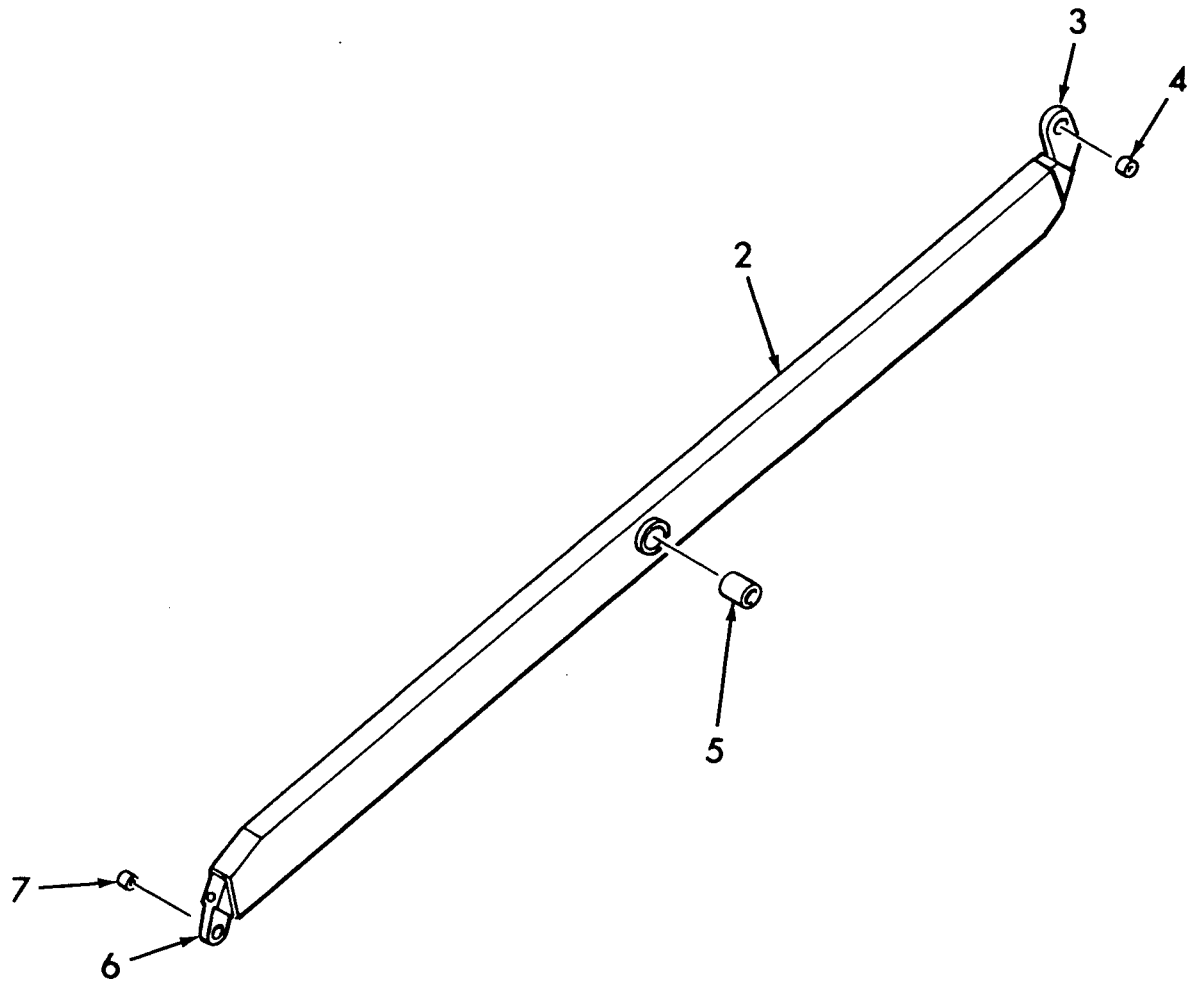

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30225	OUTER ARM-TOP ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30152	. LONG MALE PIVOT EAR	1
4	30186	. BUSHING	1
5	30207	. BUSHING	1
6	30154	. SHORT MALE EAR	1
7	30635	. BUSHING	1

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Mark Industries

TITLE	OUTER ARM-TOP CENTER ASSEMBLY
MODEL	LS36G
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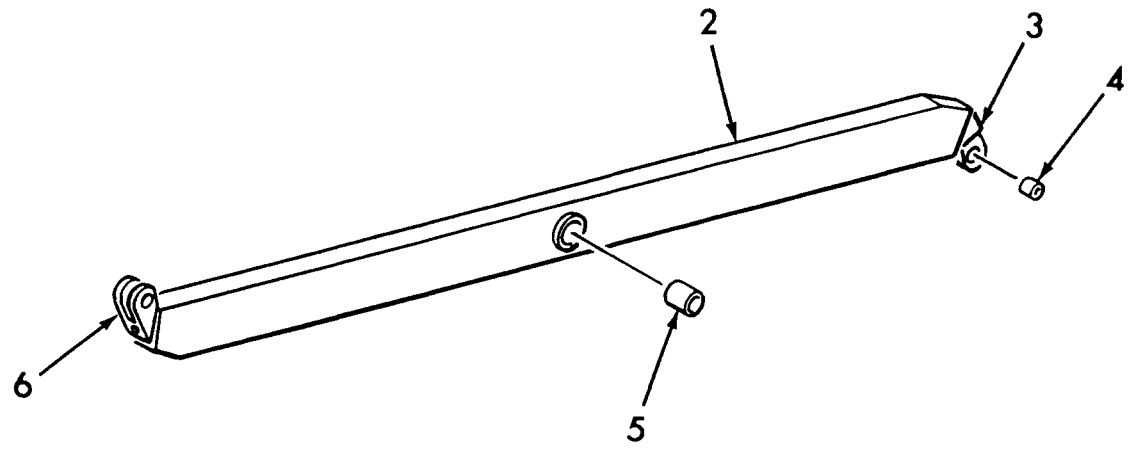
FIGURE	8A
PAGE	1



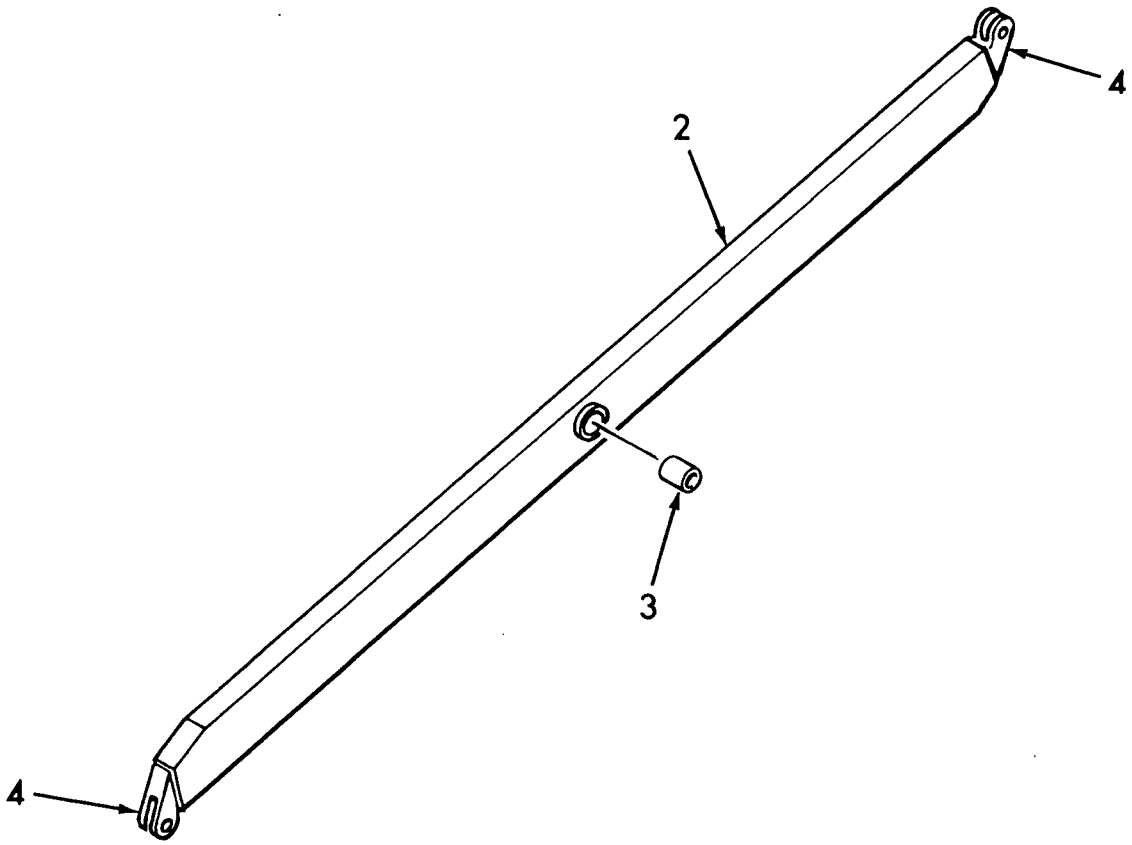
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30157	OUTER ARM-TOP CENTER ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30154	. SHORT MALE EAR	1
4	30635	. BUSHING	1
5	30207	. BUSHING	1
6	30155	. FEMALE EAR	1

REV.

Mark Industries

TITLE	OUTER ARM-BOTTOM CENTER ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	4
FIGURE	9A
PAGE	1



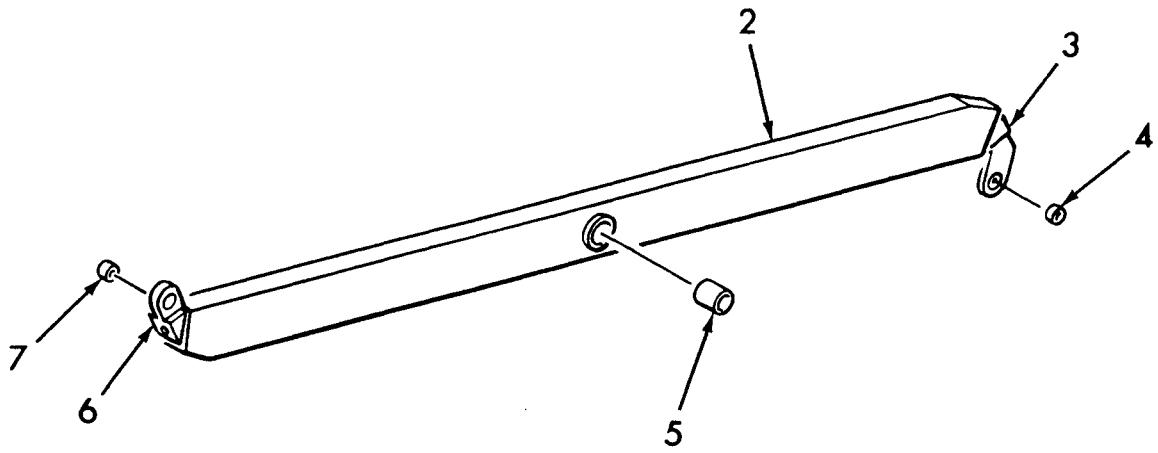
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30346	OUTER ARM-BOTTOM CENTER ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30207	. BUSHING	1
4	30155	. FEMALE EAR	2

REV.

Mark Industries

TITLE	OUTER ARM-BOTTOM ASSEMBLY
MODEL	LS36G
NOTES	

SECTION	4
FIGURE	10A
PAGE	1



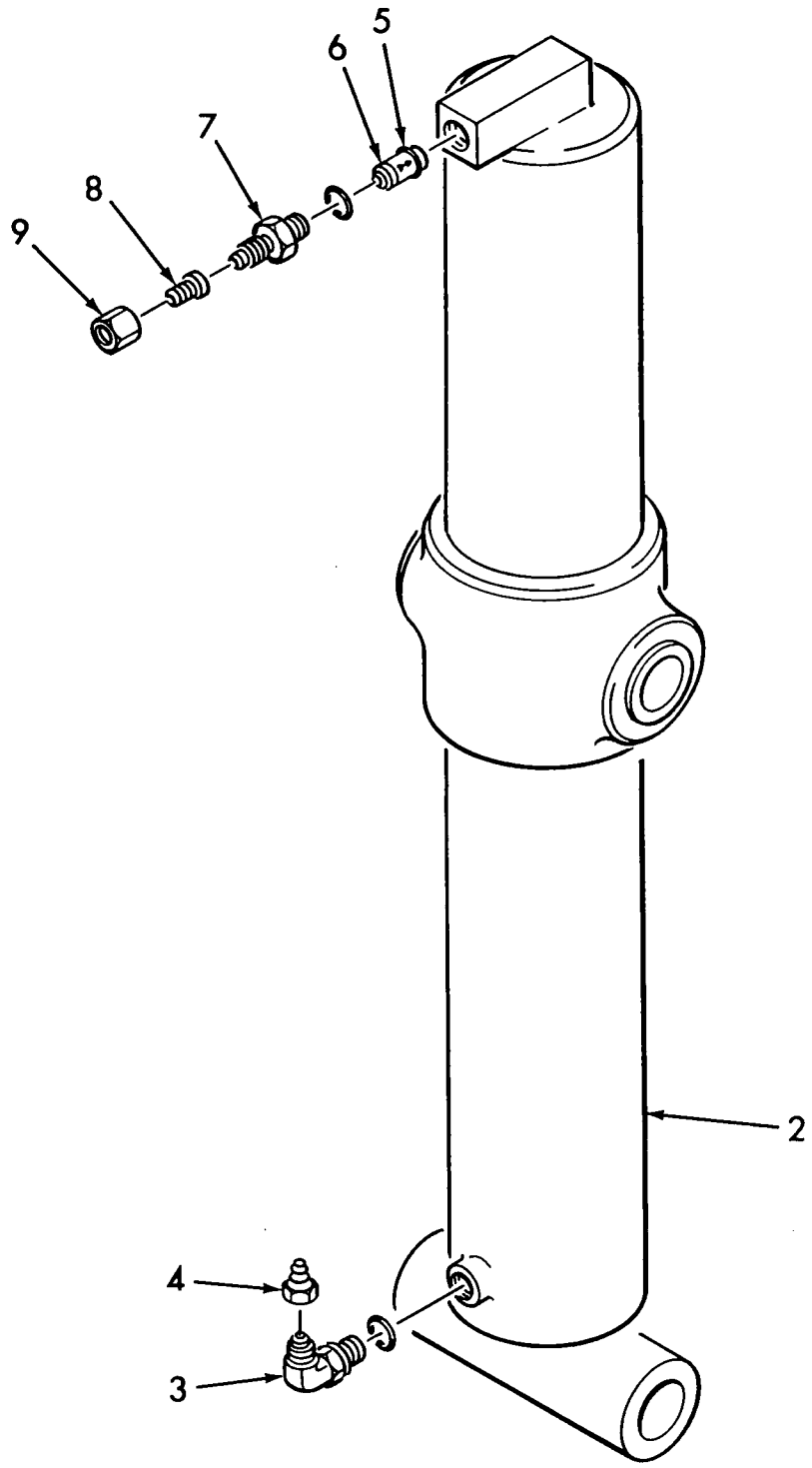
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30345	OUTER ARM-BOTTOM ASSEMBLY (See Sect. 4, Fig. 1A for NHA)	REF
2	30175	. ARM FABRICATION	1
3	30152	. LONG MALE PIVOT EAR	1
4	30186	. BUSHING	1
5	30207	. BUSHING	1
6	30154	. SHORT MALE EAR	1
7	30635	. BUSHING	1

REV.

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (FRONT)
MODEL	LS36G
NOTES	

SECTION	4
FIGURE	11A
PAGE	1



REV.

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (FRONT)
MODEL	LS36G
NOTES	

SECT.	4
FIG.	11A
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30327	MAIN LIFT CYLINDER ASSEMBLY (FRONT) (See Sect. 4, Fig. 1A for NHA)	REF
2	30194	. CYLINDER ASSEMBLY (See Sect. 4, Fig. 13A for Details)	1
3	80012-09	. STRAIGHT THREAD ELBOW	1
4	2468	. HOSE FITTING	1
5	880	. O-RING	1
6	32583	. CHECK VALVE MODIFICATION	1
7	80004-14	. STRAIGHT THREAD CONNECTOR	1
8	80056-03	. TUBE END REDUCER	1
9	80060-06	. NUT	1

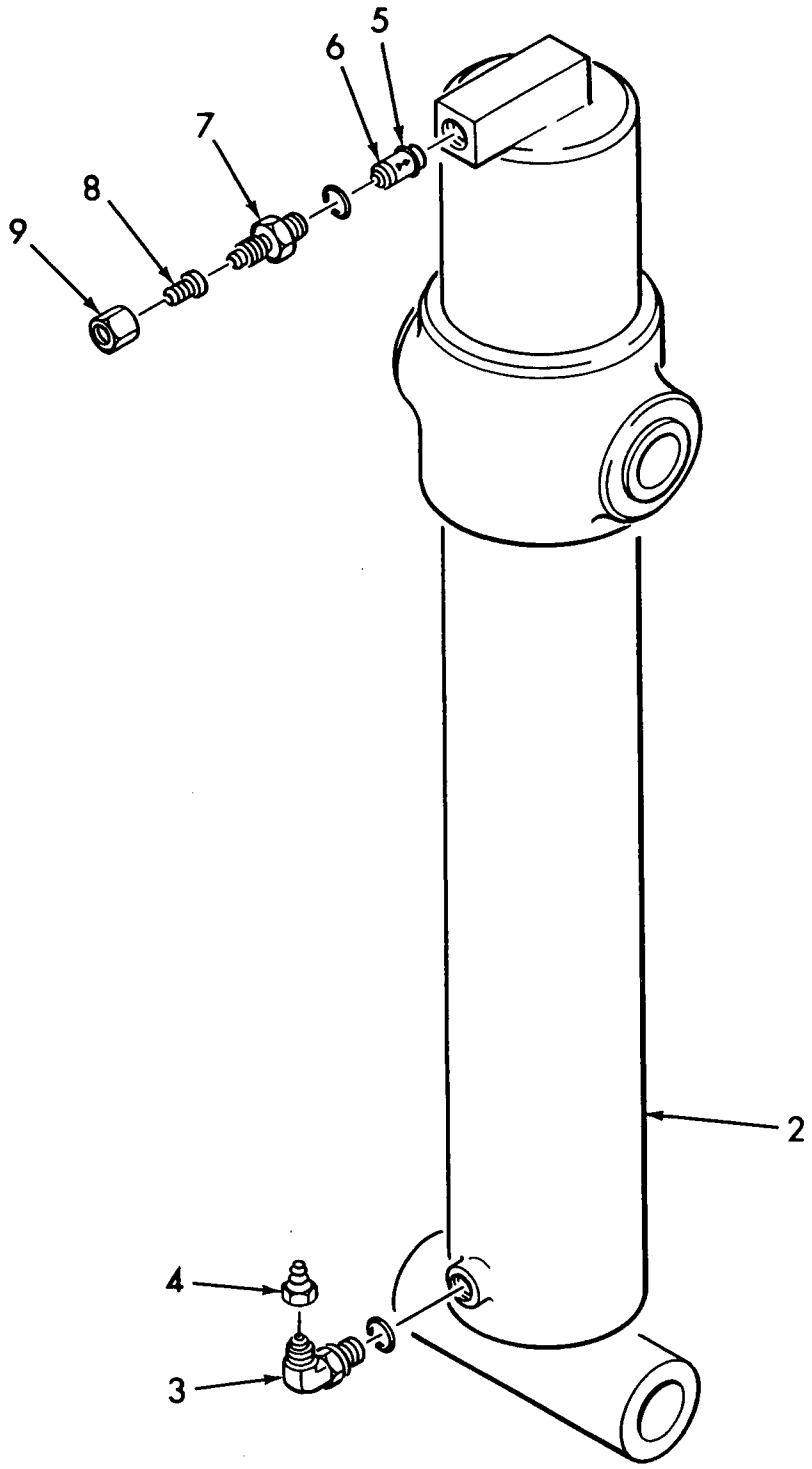
REV.

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

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (REAR)
MODEL	LS36G
NOTES	

SECTION	4
FIGURE	12A
PAGE	1



REV.

Mark Industries

TITLE	MAIN LIFT CYLINDER ASSEMBLY (REAR)
MODEL	LS36G
NOTES	

SECT.	4
FIG.	12A
PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30328	MAIN LIFT CYLINDER ASSEMBLY (REAR) (See Sect. 4, Fig. 1A for NHA)	REF
2	30193	. CYLINDER ASSEMBLY (See Sect. 4, Fig. 13A for Details)	1
3	80012-09	. STRAIGHT THREAD ELBOW	1
4	2468	. HOSE FITTING	1
5	880	. O-RING	1
6	32583	. CHECK VALVE MODIFICATION	1
7	80004-14	. STRAIGHT THREAD CONNECTOR	1
8	80056-03	. TUBE END REDUCER	1
9	80060-06	. NUT	1

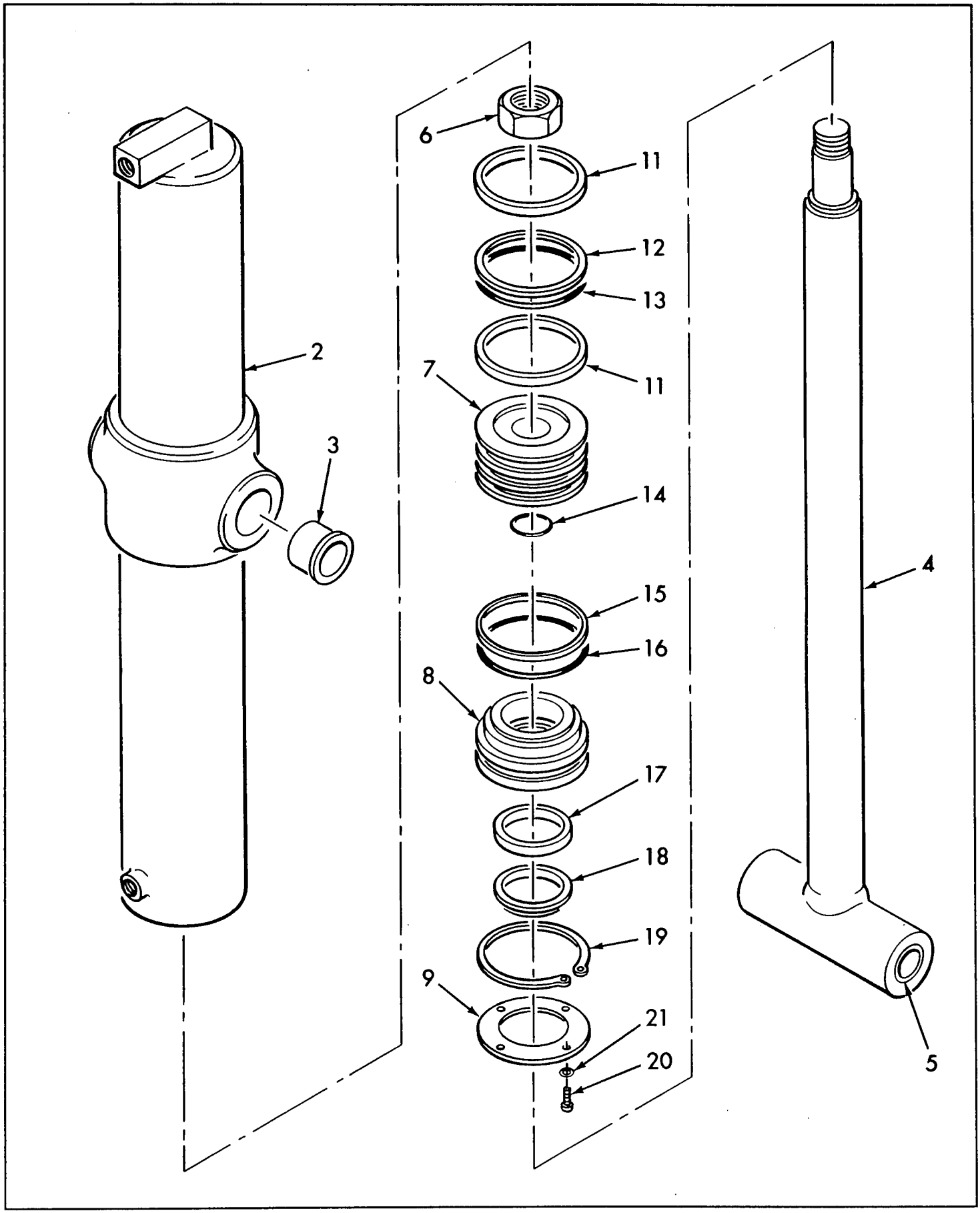
REV.

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

Mark Industries

TITLE	CYLINDER ASSEMBLY (FRONT & REAR)
MODEL	LS36G
NOTES	

SECT.	4
FIG.	13A
PAGE	1



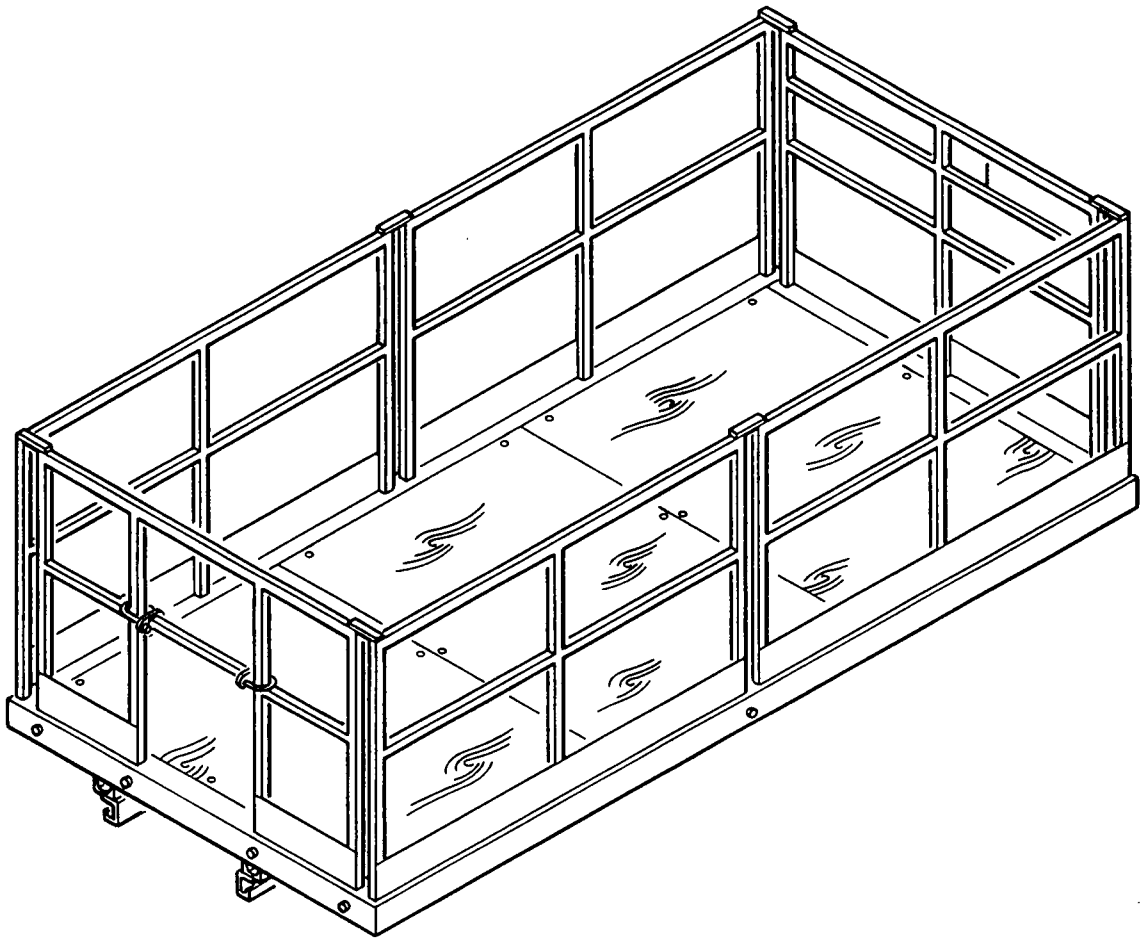
REV.

Mark Industries

TITLE	CYLINDER ASSEMBLY (FRONT & REAR)	SECT. 4
MODEL	LS36G	FIG. 13A
NOTES		PAGE 2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30194	CYLINDER ASSEMBLY (FRONT)(SHOWN) (See Sect. 4, Fig. 11A for NHA)	REF
-1	30193	CYLINDER ASSEMBLY (REAR) (See Sect. 4, Fig. 12A for NHA)	REF
2		. BARREL ASSEMBLY	1
3	64910	. TRUNNION BUSHING	2
4		. ROD ASSEMBLY	1
5		. ROD BUSHING	2
6		. NUT	1
7		. PISTON	1
8		. HEAD	1
9		. RETAINING PLATE	1
-10	66962	. SEAL KIT (STEEL PISTON RINGS)(SHOWN) SE.	1
-10	66017	. SEAL KIT (POLYPAK) SE.	1
-10	66018	. SEAL KIT (HCI)(JULY 1981 THRU MARCH 1987 USED INTERMITTENTLY)	1
11		.. WEAR RING	2
12		.. SHAMBAN SEAL	1
13		.. O-RING	1
14		.. O-RING	1
15		.. BACK-UP RING	1
16		.. O-RING	1
17		.. ROD SEAL	1
18		.. ROD WIPER	1
19		.. SNAP RING	1
20		.. CAP SCREW	4
21		.. LOCK WASHER	4

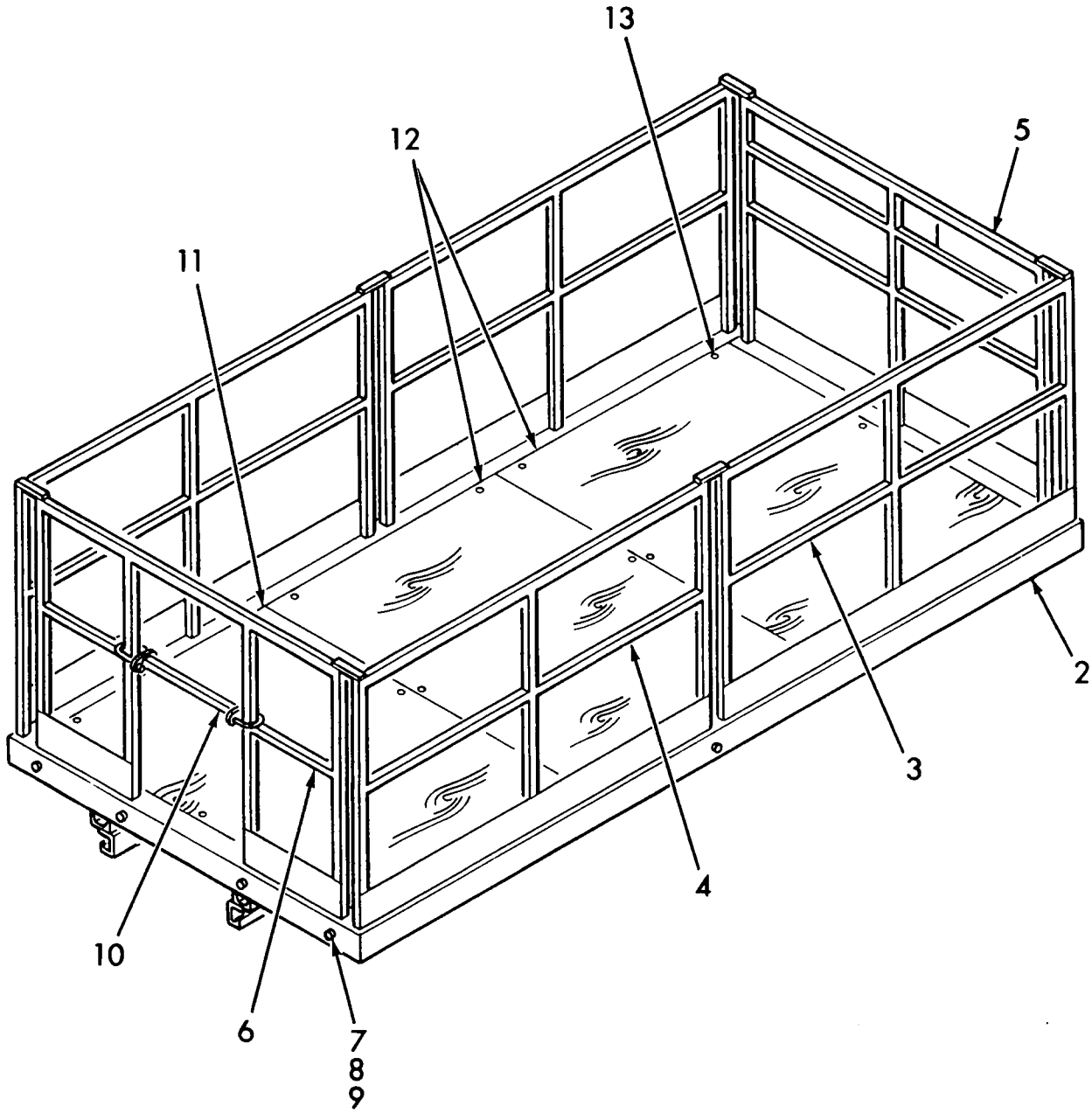
SECTION 5 CONTAINS:



Mark Industries

TITLE	PLATFORM ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	5
FIGURE	1
PAGE	1



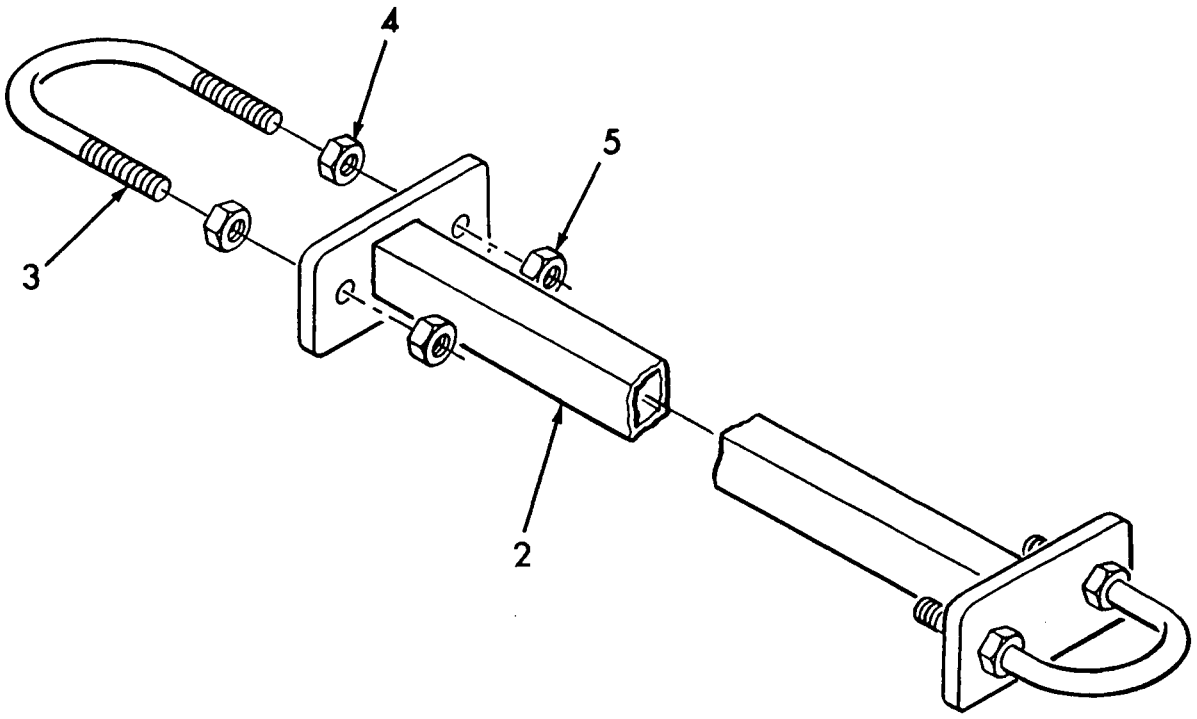
REV.

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32184	PLATFORM ASSEMBLY (See Sect. 2, Fig. 1 or 1A for NHA)	REF
2	32183	. PLATFORM WELDMENT ASSEMBLY	1
3	32176	. SIDE GUARD RAIL ASSEMBLY	2
4	32177	. SIDE GUARD RAIL ASSEMBLY	2
5	32042	. FRONT GUARD RAIL ASSEMBLY	1
6	32765	. REAR GUARD RAIL	1
7	60352	. CAP SCREW	9
8	63301	. LOCK WASHER	9
9	60701	. NUT	9
10	32741	. SLIDE BAR ASSEMBLY (See Sect. 5, Fig. 2 for Details)	1
11	31117	. PLYWOOD FLOOR	1
12	30643	. PLYWOOD FLOOR	2
13	61708	. FLAT HEAD SELF TAPPING SCREW	18

Mark Industries

TITLE	SLIDE BAR ASSEMBLY
MODEL	LS30G & LS36G
NOTES	

SECTION	5
FIGURE	2
PAGE	1



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32741	SLIDE BAR ASSEMBLY (See Sect. 5, Fig. 1 for NHA)	REF
2	32740	. SLIDE BAR WELDMENT	1
3	160017	. U-BOLT	2
4	61318	. LOCK NUT	4
5	60703	. NUT	4

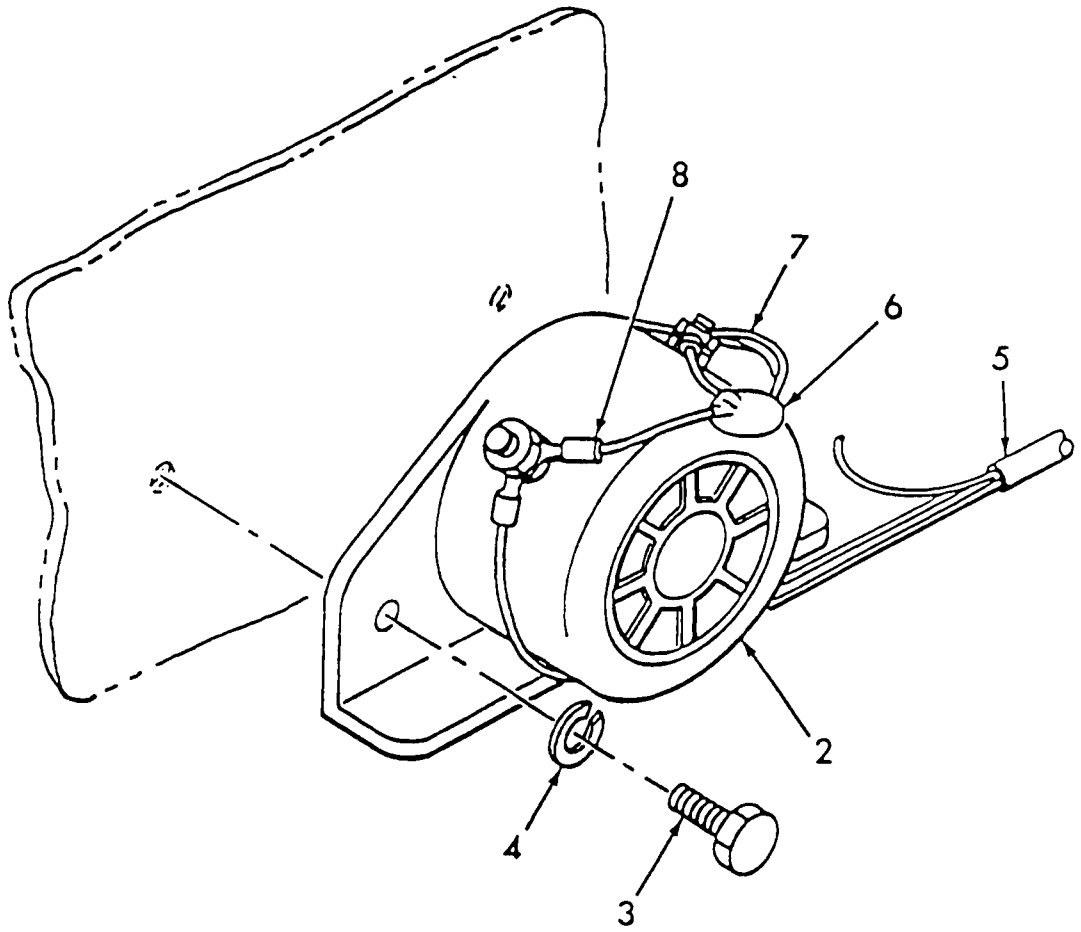
REV.

SECTION 6 CONTAINS:

Mark Industries

TITLE	TRAVEL WARNING HORN
MODEL	LS30G & LS36G
NOTES	

SECTION	6
FIGURE	1
PAGE	1



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	30408	TRAVEL WARNING HORN	REF
2	70053	. WARNING HORN	1
3	60309	. CAP SCREW	2
4	63301	. LOCK WASHER	2
5	16201	. WIRE	3 FT
6	130705	. VARISTOR	1
7	70007	. YELLOW WIRE	6 IN
8	117-C	. RING CONNECTOR	10

REV.

Drawing for **Option Assembly**

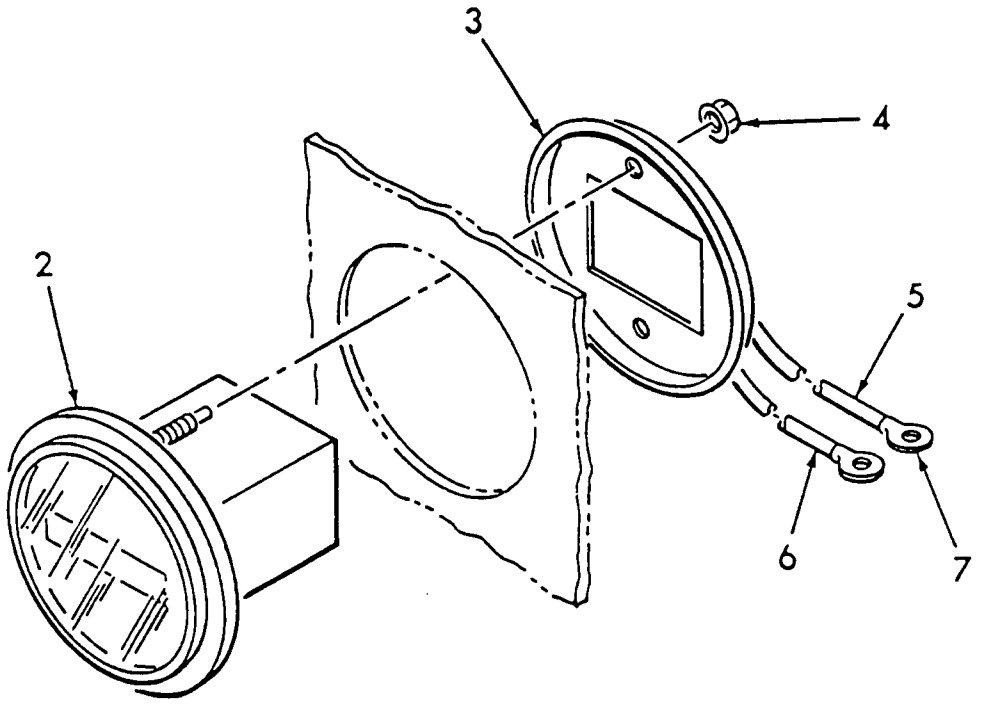
Part No. 131900 is not

available this edition.

Mark Industries

TITLE	HOURMETER
MODEL	LS30G & LS36G
NOTES	

SECTION	6
FIGURE	3
PAGE	1



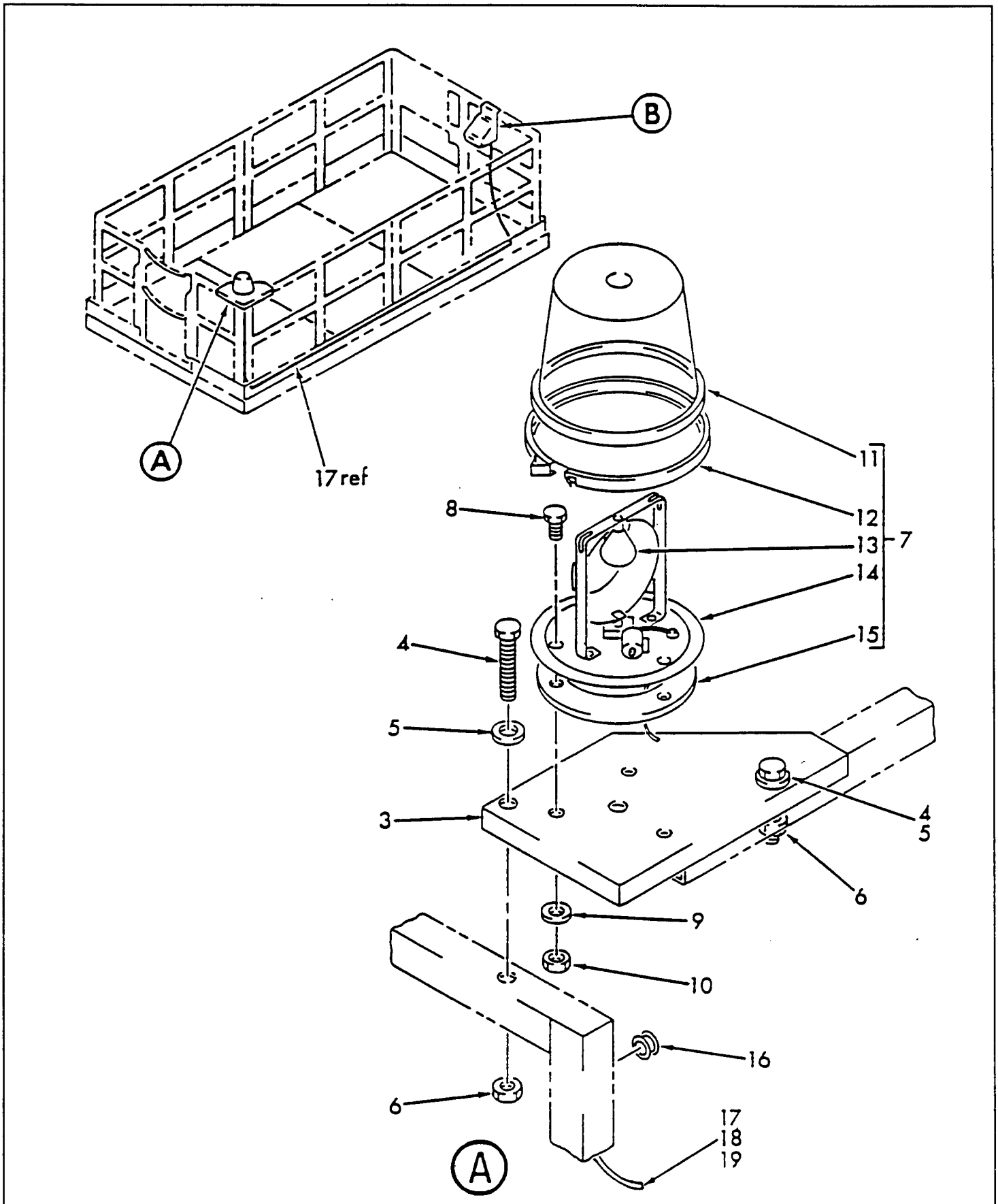
ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	131065	HOURMETER	REF
2	20571	. HOURMETER	1
3		. BACK COVER	1
4		. LOCK NUT	2
5	70232	. WHITE WIRE	1.5 FT
6	70008	. YELLOW/GREEN WIRE	1.5 FT
7	117-C	. RING CONNECTOR	2

REV.

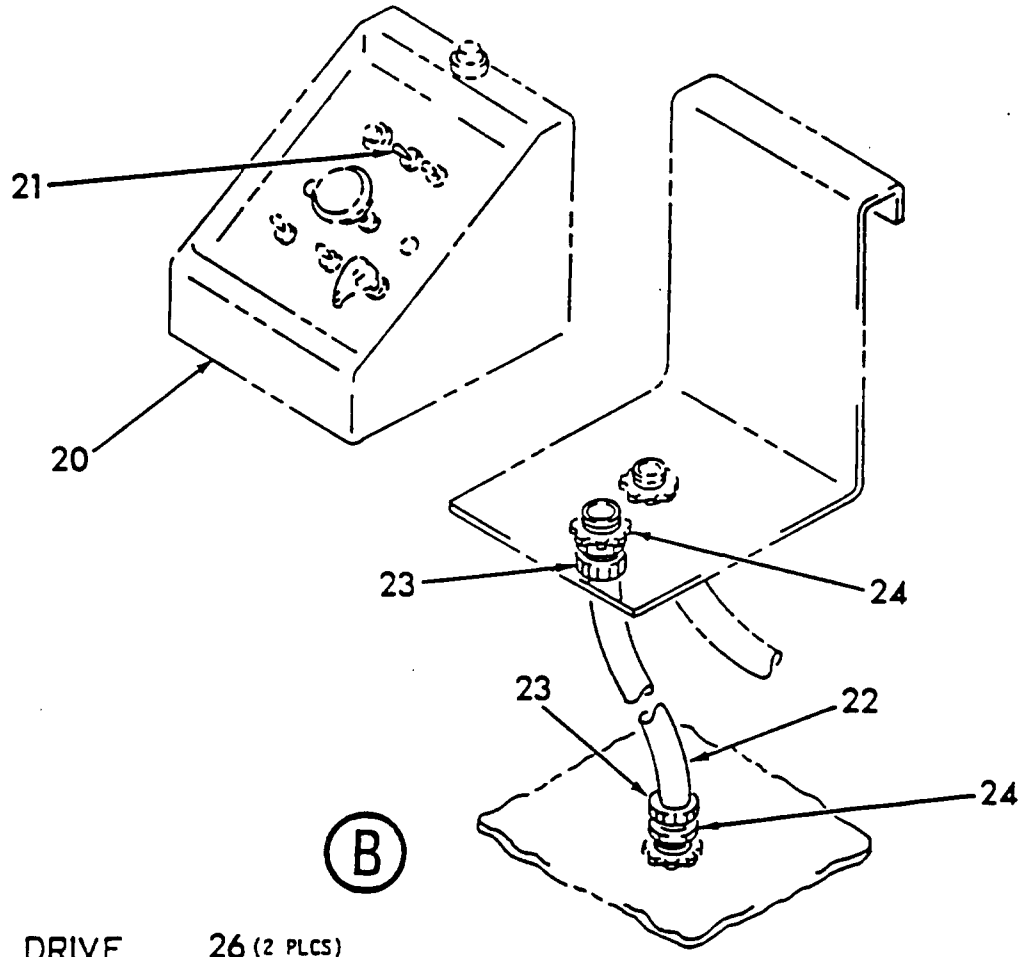
Mark Industries

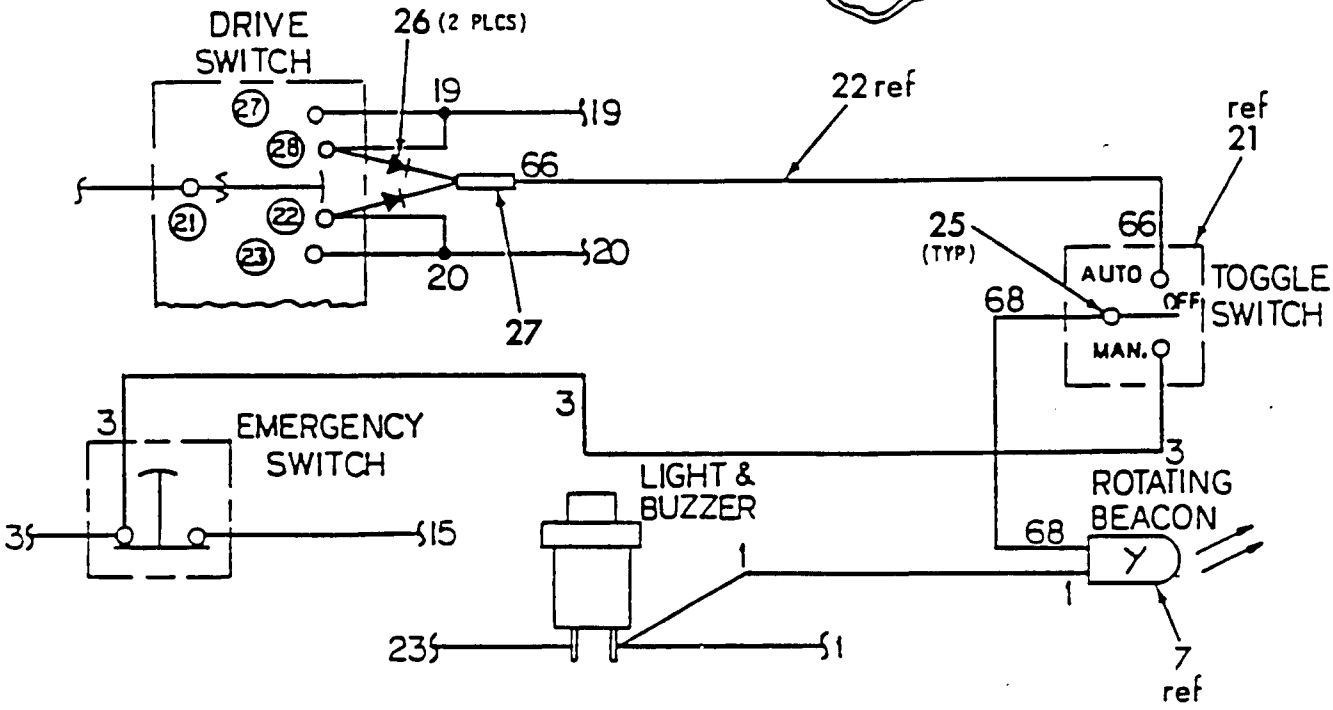
TITLE	ROTATING BEACON
MODEL	LS30G & LS36G
NOTES	

SECTION	6
FIGURE	4
PAGE	1



REV.





WIRING DIAGRAM

Mark Industries

TITLE	ROTATING BEACON	SECT.	6
MODEL	LS30G & LS36G	FIG.	4
NOTES		PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32907	ROTATING BEACON	REF
-2	32184	. DECK ASSEMBLY	1
3	11068	. BEACON MOUNTING BRACKET	1
4	60319	. CAP SCREW	2
5	63401	. FLAT WASHER	2
6	60711	. LOCK NUT	2
7	20586	. ROTATING BEACON	1
8	60396	. CAP SCREW	3
9	63413	. FLAT WASHER	3
10	61247	. LOCK NUT	3
11		.. CAP	1
12		.. CLAMP	1
13		.. BULB	1
14		.. BODY	1
15		.. GASKET	1
16	729	. BUSHING	1
17	70036	. CABLE (16 FT)	AR
18	66356	. FEMALE TERMINAL	2
19	66357	. MALE TERMINAL	2
20	32408	. UPPER CONTROL BOX	REF
21	4019	. TOGGLE SWITCH	1
22	70232	. WIRE (4 FT)	AR
23	2807	. STRAIN RELIEF	2
24	2808	. LOCK NUT	2
25	117-C	. RING CONNECTOR	5

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
26	70479	. DIODE	2
27	70069	. BUTT CONNECTOR	1

Drawing for **Option Assembly**

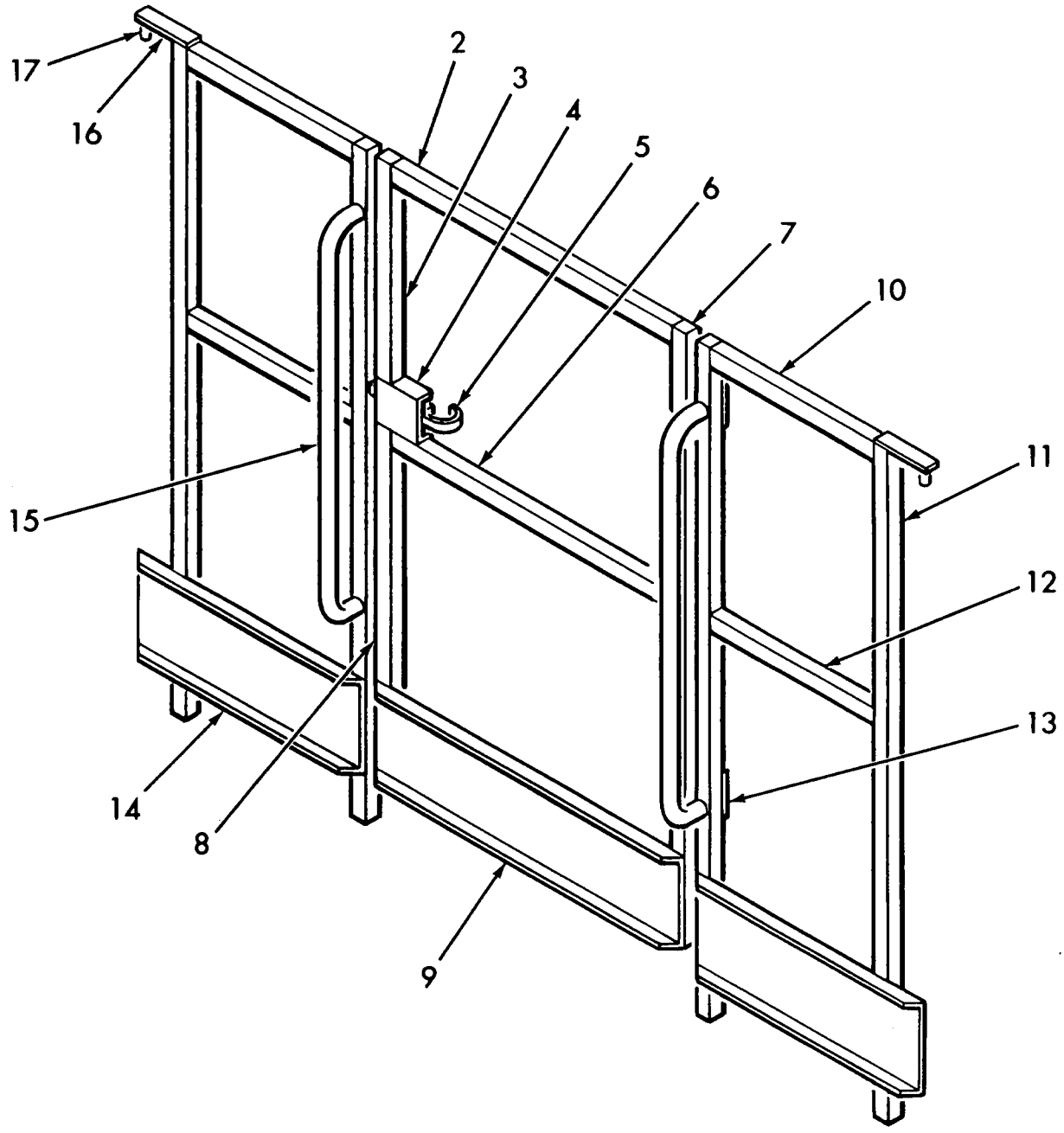
Part No. 131928 is not

available this edition.

Mark Industries

TITLE	SWING GATE
MODEL	LS30G & LS36G
NOTES	

SECTION	6
FIGURE	6
PAGE	1



REV.

Mark Industries

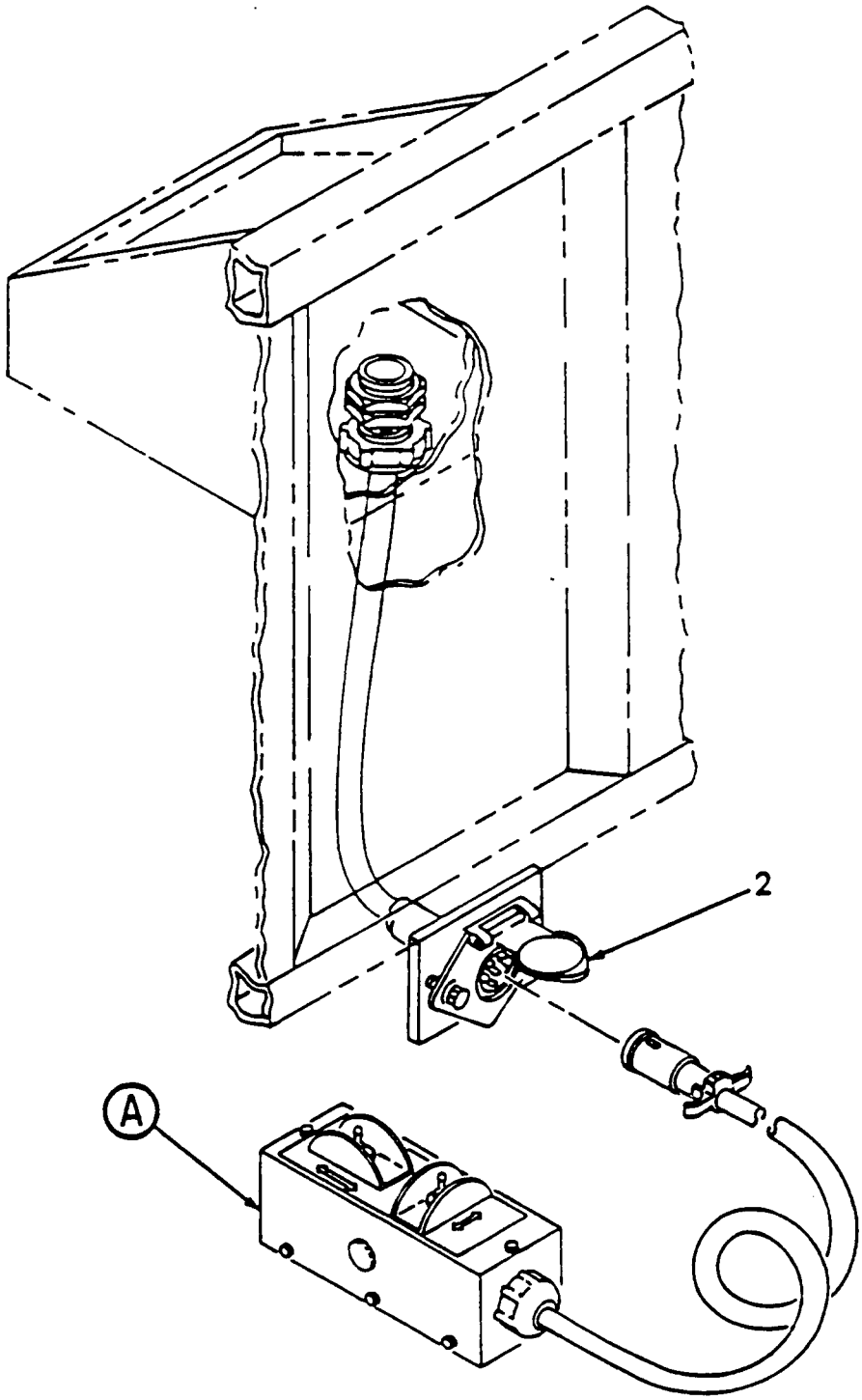
TITLE	SWING GATE	SECT.	6
MODEL	LS30G & LS36G	FIG.	6
NOTES		PAGE	2

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	32044	REAR GUARD RAIL WELDMENT	REF
2	36302	. RECTANGULAR TUBE	1
3	36245	. SQUARE TUBE	1
4	35015	. CHANNEL	1
5	16231	. LATCH BOLT	1
6	36209	. SQUARE TUBE	1
7	36247	. SQUARE TUBE	1
8	36246	. SQUARE TUBE	1
9	30149-19.0	. TOE PLATE	1
10	36303	. RECTANGULAR TUBE	2
11	36249	. SQUARE TUBE	4
12	36248	. SQUARE TUBE	2
13	130692	. HINGE ASSEMBLY	2
14	30149-21.6	. TOE PLATE	2
15	32031	. HAND RAIL	2
16	36256	. FLAT BAR	2
17	36255	. ROUND TUBE	2

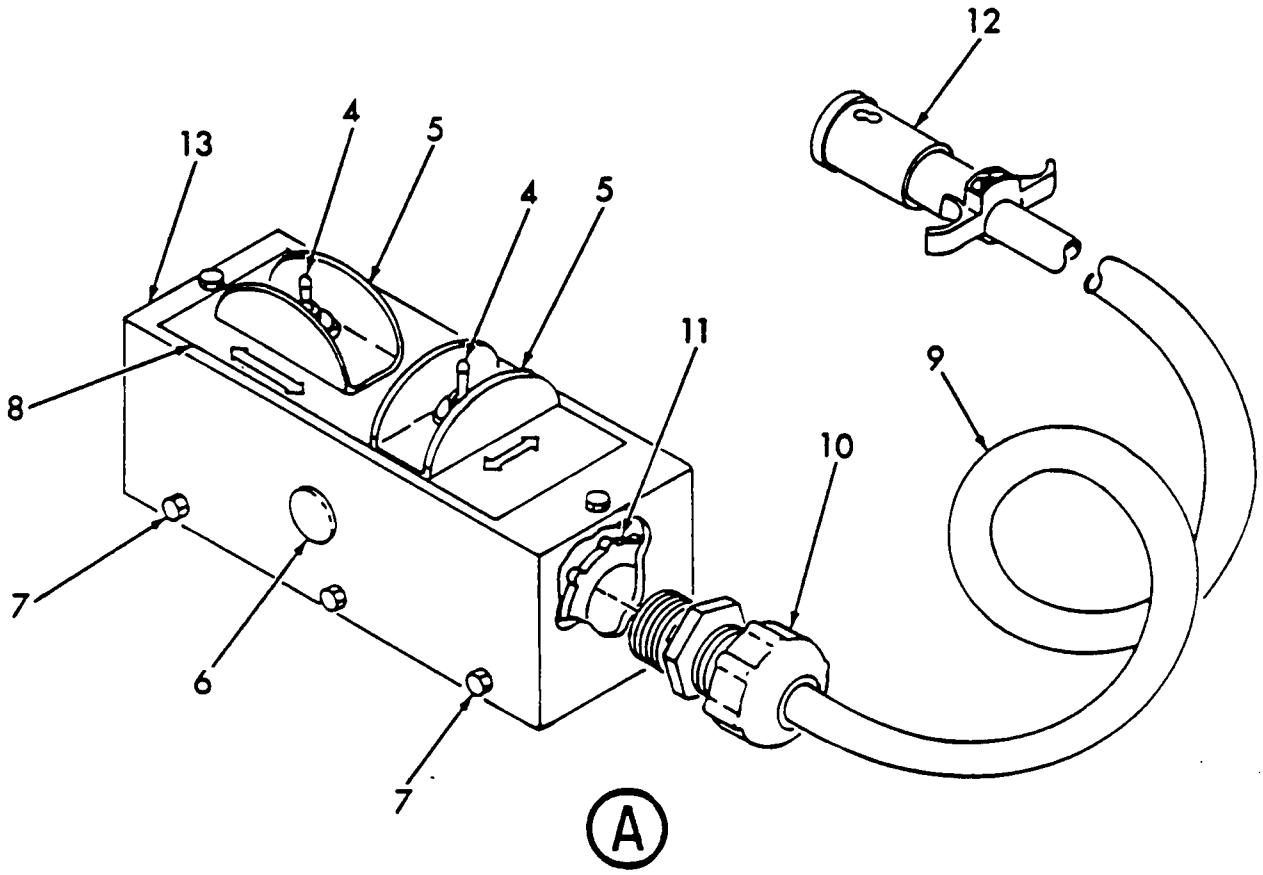
Mark Industries

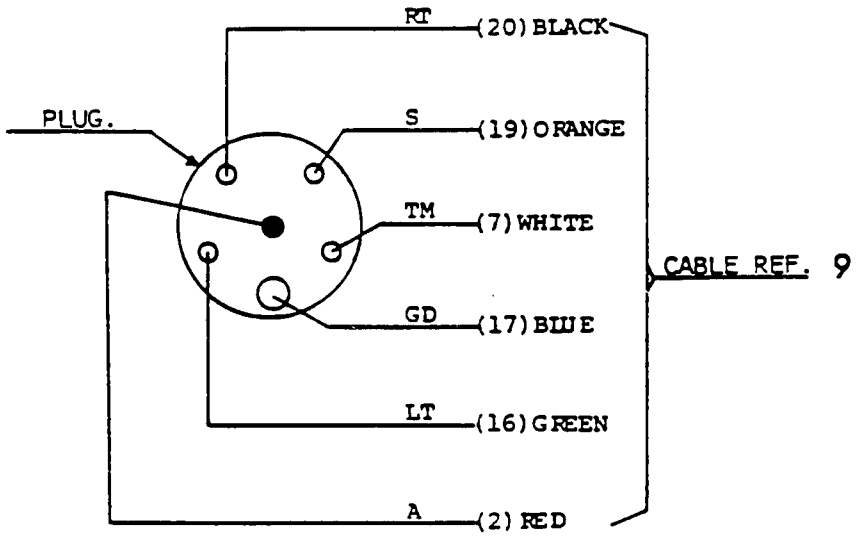
TITLE	REMOTE DRIVE KIT
MODEL	LS30G & LS36G
NOTES	

SECTION	6
FIGURE	7
PAGE	1



REV.





PLUG WIRING DIAGRAM

Mark Industries

TITLE	REMOTE DRIVE KIT
MODEL	LS30G & LS36G
NOTES	

SECT.	6
FIG.	7
PAGE	3

ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	131916	REMOTE DRIVE KIT	REF
2	131940	. FEMALE REMOTE DRIVE & STEER PLUG	1
-3	130911	. REMOTE DRIVE LANYARD/CONTROL ASSEMBLY	1
4	20481	.. TOGGLE SWITCH	2
5	20884	.. SWITCH GUARD	2
6	771	.. WHITE PLUG	1
7	61726	.. SELF-TAPPING SCREW	8
8	130906	.. REMOTE CONTROL DRIVE & STEER DECAL	1
9	130902-08	.. CONDUCTOR CABLE	1
10	70281	.. STRAIN RELIEF	1
11	2808	.. LOCK NUT	1
12	70266	.. PLUG (6-POLE)	1
13	130901	.. ELECTRICAL ASSEMBLY	1

Drawing for **Option Assembly** Part No. 70267 is not available this edition.

Drawing for **Option Assembly**

Part No. 130911 is not

available this edition.

Drawing for **Option Assembly**

Part No. 32927 is not

available this edition.

Drawing for **Option Assembly**

Part No. 131908 is not

available this edition.

Drawing for **Option Assembly**

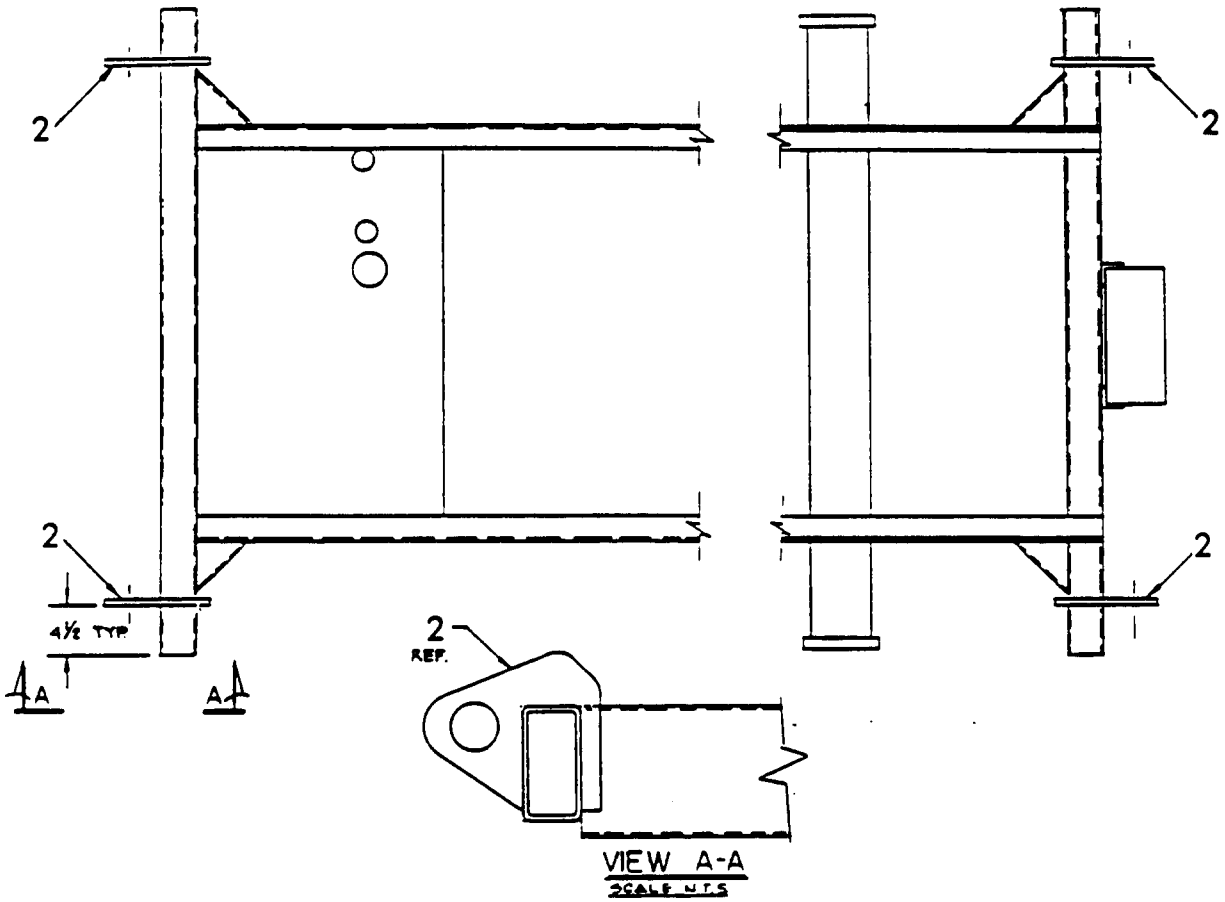
Part No. 32921 is not

available this edition.

Mark Industries

TITLE	LIFTING LUGS
MODEL	LS30G & LS36G
NOTES	

SECT.	6
FIG.	13
PAGE	1



ITEM	PART NUMBER	DESCRIPTION 1234	UNITS PER ASSY
-1	31010	LIFTING LUGS	REF
2	30920	. LIFTING LUG	4

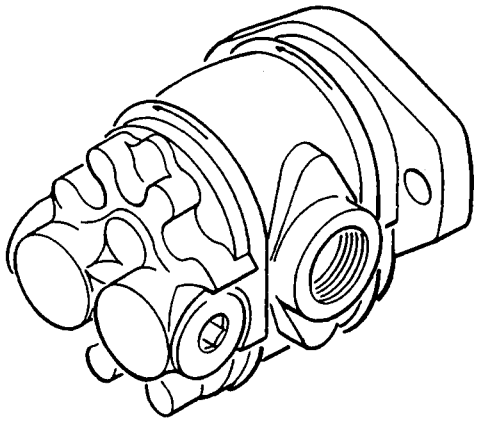
REV.

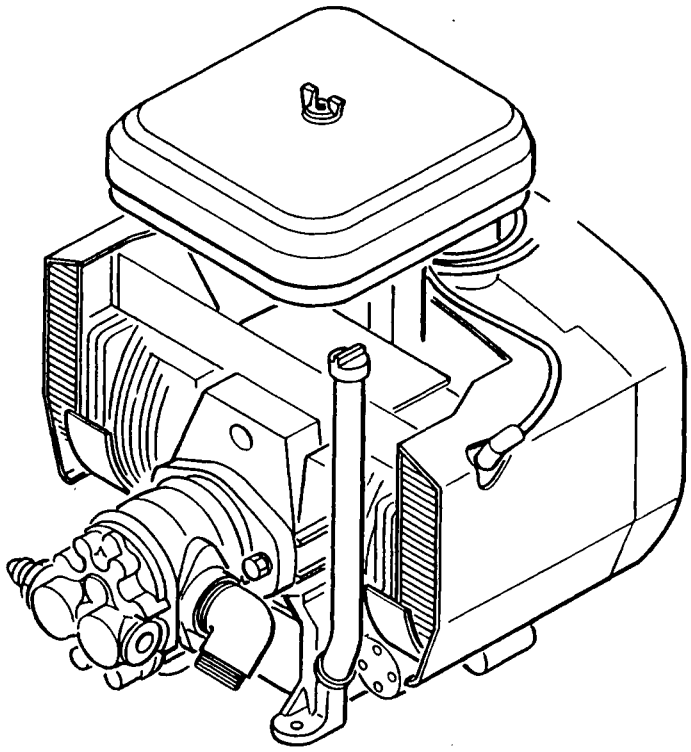
Mark Industries

TITLE	VENDOR CHAPTER
MODEL	

VENDOR CHAPTER CONTAINS:

SECTION	TITLE	PART NO.
1	CESSNA DOUBLE GEAR PUMP	81257
2	ONAN P224 ENGINE	32759



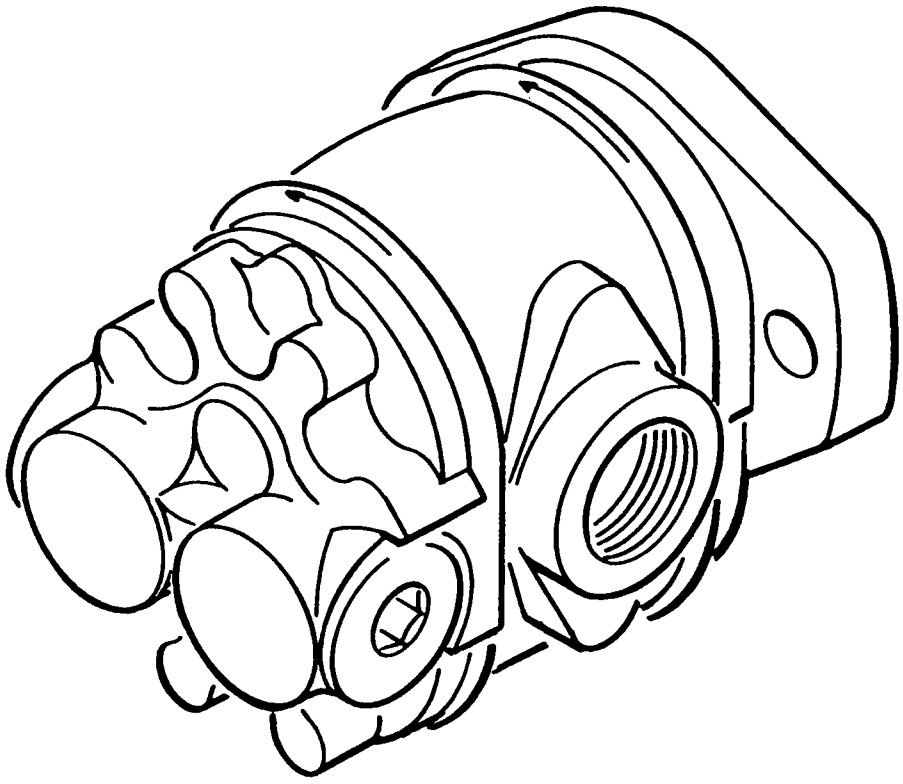


Mark Industries

TITLE	CESSNA DOUBLE GEAR PUMP
MODEL	
NOTES	P/N 81257

SECTION 1

Service Manual

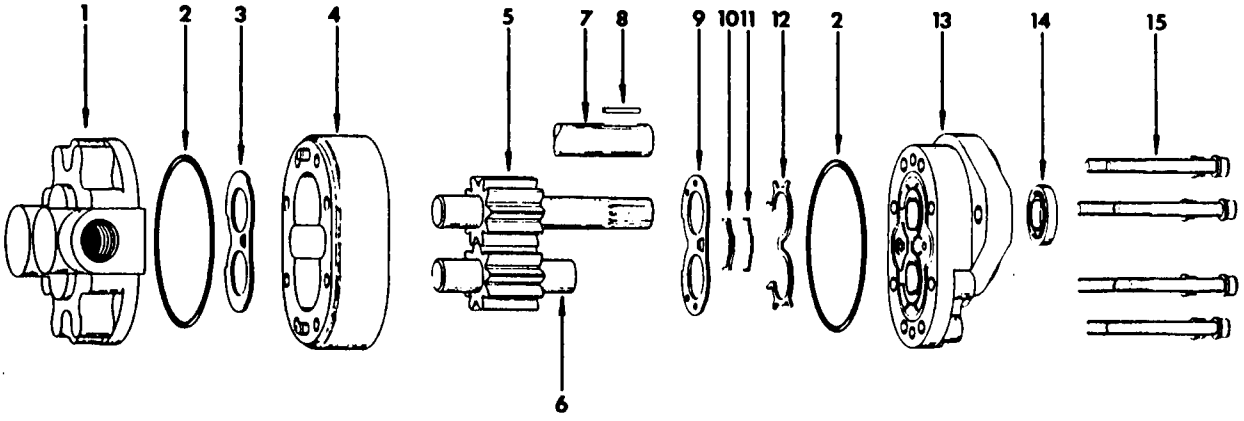


Model 25300 High Pressure Gear Pump

Inspection/Servicing

REV.

SINGLE PUMP



PARTS LIST

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

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

DISASSEMBLY

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

INSPECT PARTS FOR WEAR

GENERAL

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

GEAR ASSEMBLY

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

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

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

FRONT AND BACKPLATE

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

BODY

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

GENERAL INFORMATION

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

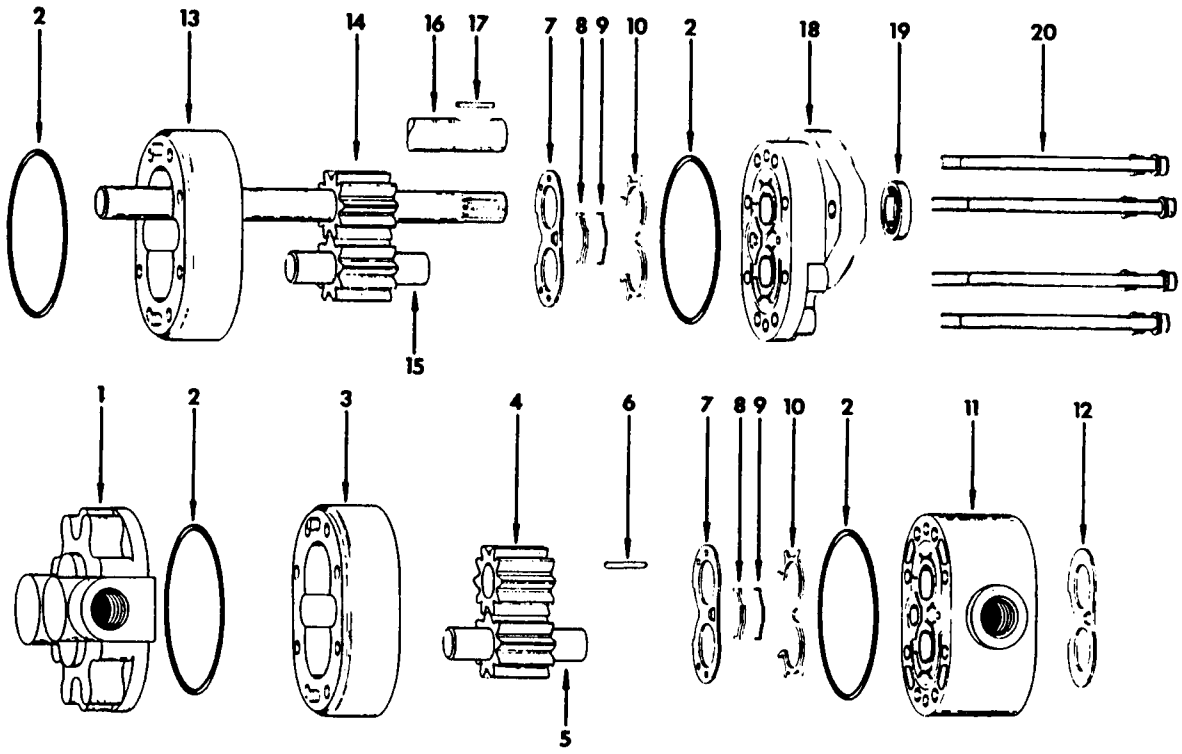
REASSEMBLY

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

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

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

DOUBLE PUMP



PARTS LIST

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

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

DISASSEMBLY

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

INSPECT PARTS FOR WEAR

GENERAL

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

GEAR ASSEMBLY

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

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

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

FRONT PLATE, BACKPLATE & ADAPTER PLATE

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

BODY

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

GENERAL INFORMATION

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

REASSEMBLY

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

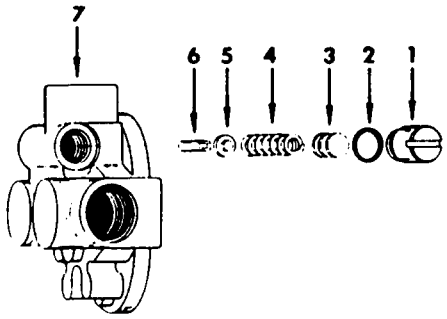
PLACING PUMP BACK INTO SERVICE

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

SINGLE OR DOUBLE PUMP TROUBLE SHOOTING

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

RELIEF VALVE BACKPLATE



PARTS LIST

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

DISASSEMBLY

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

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

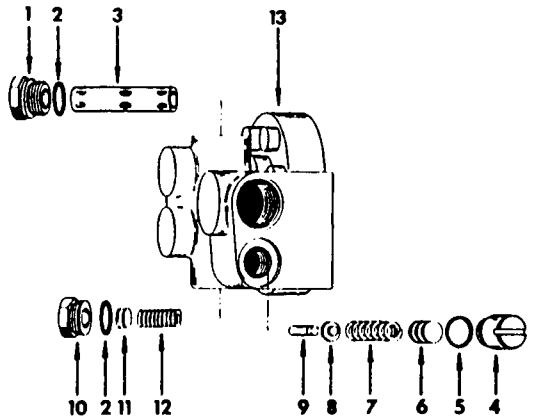
INSPECTION

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

REASSEMBLY

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

FLOW DIVIDER/FLOW CONTROL BACKPLATE



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Hex Plug	1
2	O-ring	2
3	Flow Divider Spool	1
4	Slotted Plug	1
5	O-ring	1
6	Shims	As Req'd
7	Spring, Relief Valve	1
8	Plug Seat	1
9	Seat	1
10	Hex Plug	1
11	Shims	As Req'd
12	Spring, Flow Divider	1
13	Backplate	1

DISASSEMBLY

1. Use slotted socket and remove relief valve plug (4), shims (6), spring (7), plug seat (8) and seat (9) from backplate (13).
   Note: Do not remove internal relief valve cartridge assembly. Cartridge assembly has been set to a predetermined depth with locktite applied.
2. Remove plug (1), spool (3), plug (10), shims (11) and spring (12) from backplate (13).

INSPECTION

1. Clean and dry all parts.
2. The o-rings need not be inspected as they should be replaced as new items.
3. Remove all nicks and burrs from all parts with emery cloth.
4. Oil grooves in bushings should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to the respective pin holes.
5. If I.D. of bushings in backplate exceed .755 the backplate should be replaced. (Bushings are not available as separate items).
6. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.
7. Inspect backplate spool bore for scoring or contamination.
8. Inspect spool O.D. for scratches, it should be smooth and free of nicks and burrs. Spool should slide freely inside backplate bore.
9. Check shims (6) and (11) for wear.
10. Check springs (7) and (12) for weakness or breakage.
11. Wash backplate in clean solvent, direct compressed air into relief valve cavity in backplate to dry relief valve cartridge assembly. The procedure removes any trapped contamination.

REASSEMBLY

1. Install relief valve parts in backplate (13), seat (9), plug seat (8), spring (7), same number of shims (6), new o-ring (5) on plug (4) and torque plug (4) to 21 to 24 ft. lbs.
2. Install flow divider parts in backplate (13) spool (3), spring (12), same number of shims (11), new o-rings (2) on plugs (1) and (10) and torque plugs (1) and (10) to 27 to 30 ft. lbs.

FLOW DIVIDER/FLOW CONTROL TROUBLE SHOOTING

FLOW DIVIDER TROUBLE	PROBABLE CAUSE	REMEDY
1. External leakage.	a. Spool plug o-ring. b. Relief valve plug o-ring.	a. Remove spool plug and replace o-ring. b. Remove relief valve plug and replace o-ring.
2. Low priority pressure.	a. Low relief valve setting.	a. Replace weak or broken spring. b. Shim as required. c. Replace backplate assy.
3. Low priority flow.	a. Relief valve open or leaking. b. Scratched machined sealing surface in relief valve. (Either in seat or poppet within cartridge) c. Contaminant lodged in relief valve. d. Missing spring shims. e. Weak Spool spring.	a. Replace weak or broken spring. b. Replace parts as required. c. Clean relief valve cavity. d. Add shims as required. e. Replace spool spring.
4. No priority flow.	a. Broken spool spring. b. Orifice inside spool plugged.	a. Replace spool spring. b. Check for contaminant lodged in orifice.
5. No secondary flow.	a. Spool sticking.	a. Remove and clean spool bore.
6. Low secondary flow.	a. Pump flow degradation due to wear.	a. Check pump for worn parts and replace.

Service Manual

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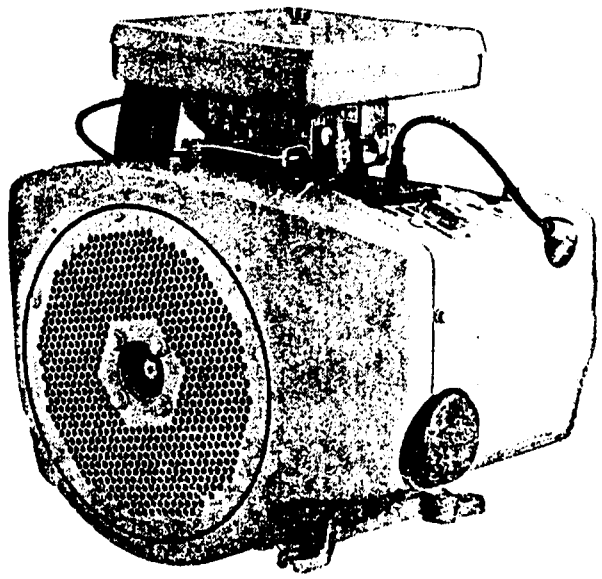
Engine



Safety Precautions

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

⚠DANGER ***This symbol if used warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that can result in serious, personal injury. Take care in following these recommended procedures. All local, state and federal codes should be consulted and complied with.

⚠WARNING ***This engine is not designed or intended for use in any type of aircraft. Use of this engine in aircraft can result in engine failure and causes serious personal injury or death.***

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure and accurately torqued. Keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- DO NOT SMOKE while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- DO NOT fill fuel tanks while engine is running.
- DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping for flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Exhaust Gas is Deadly!

Exhaust gases contain carbon monoxide, a poisonous gas that can cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- Dizziness
- Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Cooling System

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator pressure cap when coolant temperature is above 212°F (100°C) or while engine is running.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and present a potential fire hazard.

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⚠WARNING

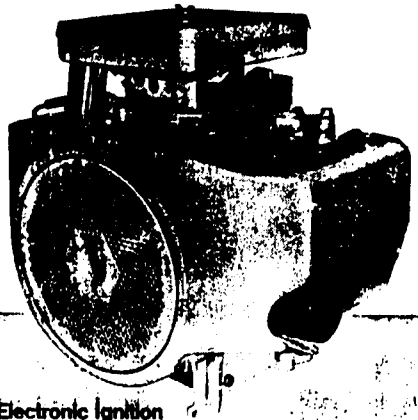
EXHAUST GAS IS DEADLY!

Exhaust gases from all fuels (including diesel, gasoline, liquid propane, natural gas) contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- *Dizziness*
- *Nausea*
- *Headache*
- *Weakness and Sleepiness*
- *Throbbing in Temples*
- *Muscular Twitching*
- *Vomiting*
- *Inability to Think Coherently*

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation, ventilation and regular, frequent visual and audible inspections of the complete exhaust system.



Performer 24

P224 Gasoline Engine
Air Cooled
24 bhp (17.9 kW) at 3600 rpm

- **Electronic Ignition**
- **Electric Starter, Solenoid Type**
- **Mechanical Flyball Governor (constant speed)**
- **Top Access Oil Fill and Level Indicator**
- **Oil Pump**
- **Full-Flow, Spin On Oil Filter**
- **Anti-Flood Choke**
- **Air Cleaner, Replaceable Dry Element**
- **Rotating Blower Screen**
- **Valve Rotators** (Exhaust)
- **Cobalt Alloy Exhaust Seats**
- **Intake Valve Stem Seals**

Optional

- ☐ **Variable Speed Governor** Front or LH Pull
- ☐ **Crossover Exhaust Manifold** RH Rear Outlet
- ☐ **Vacuum Pulse Fuel Pump**
- ☐ **Exhaust Silencers**
- ☐ **Low Oil Pressure Switch**
- ☐ **Fuel Filter**
- ☐ **Polyurethane Air Cleaner Element Wrapper**
- ☐ **Flywheel Alternator,** 20 or 30 amp with Regulator (Installed on Cylinder Air Housing)
- ☐ **Stationary Blower Wheel Guard**
- ☐ **Inner Air Cleaner Safety Cover**
- ☐ **PTO Modifications:** Internally Splined Crankshafts, Hydraulic Pump Adapters, Front PTO Shaft
- ☐ **High Capacity Oil Base**

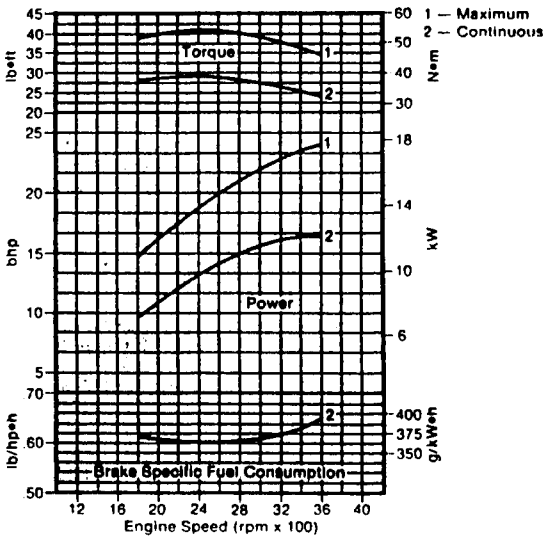
- ☐ **Extended Service Life Package** - Includes Chrome-Cobalt Faced Exhaust Valves, Polyurethane Air Cleaner Element Wrapper, and Inner Safety Cover, High Capacity Oil Base, Fuel Filter

Performance Characteristics

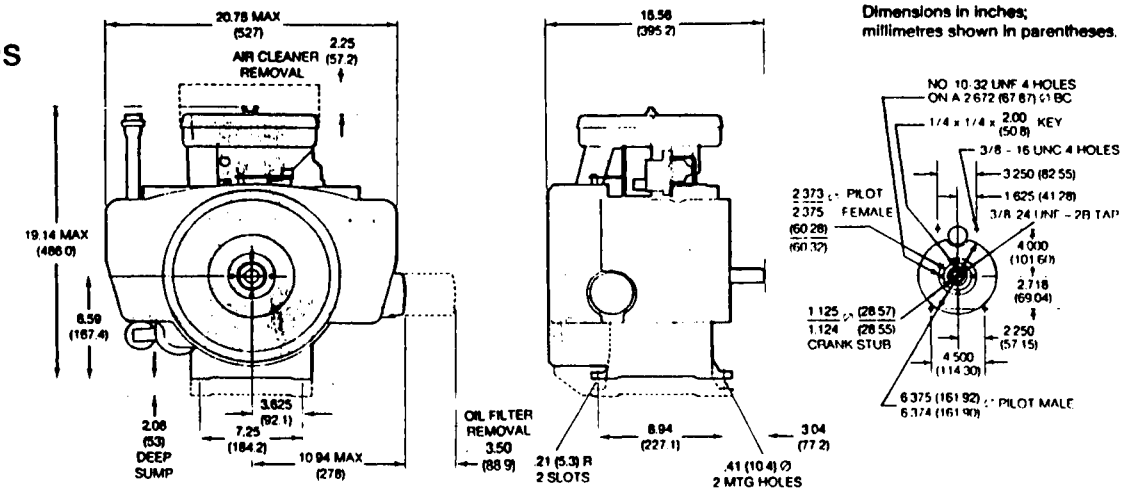
Recommended for variable speed or continuous duty to 3600 rpm.

Production engines when shipped will develop after deduction for non-standard accessories, not less than 85% of maximum corrected bhp. After run-in to reduce friction and the performance of service, engines should develop not less than 95% of maximum corrected bhp.

Engine power decreases approximately 3.5% for each 1000 ft. (305 m) above sea level and 1% for each 10°F (5.5°C) above 60°F (15.5°C). For continuous duty at constant load do not exceed 80% of available horsepower. For heavy duty applications requiring maximum output, the Extended Service Life package is recommended. Performance curves obtained and corrected in conformance with SAE J607b.



Basic Dimensions



Engine Detail

Cycle: 4

Cylinders: 2, horizontally opposed

Bore: 3.56 in (90.42 mm)

Stroke: 3 in (76.20 mm)

Displacement: 60 in³ (983.22 cm³)

Compression Ratio: 7.0 to 1

Piston Speed: 1800 fpm (9144 mm/s) at 3600 rpm

Power: 24.0 bhp (17.9 kW) max. at 3600 rpm

Net Weight: 127 lb (57.6 kg) dry, approximate.

Breather System: Closed, recirculating.

Cooling System: Pressure air-cooled, radial flow blower. Cooling air volume 1000 cfm (28.32 m³/min) at 3600 rpm.

Fuel System: Modern downdraft carburetor with fixed main jet, limited adjustment idle system. Semi-automatic choke operation with anti-flooding feature. Combustion air required at 3600 rpm, 50 cfm (1.4 m³/min).

Governor: Constant speed cam-gear driven. Adjustable mechanical flyball, 300 rpm droop to 3600 rpm.

Ignition System: Solid state breakerless ignition with fixed timing, 12 volt negative ground. RFI suppression spark plug wires meet UL and CSA interference requirements.

Starter: Positive engagement solenoid type starter. 12 volt negative ground.

Lubrication System: Positive displacement, gear-design oil pump. Full pressure lubrication to main and connecting rod bearings and governor. Fixed bypass, oil pressure control. Oil fill tube and level indicator. Removable aluminum oil base. Capacity, 1.5 qt (1.42 L); add 0.5 qt (0.47L) for filter. Optional high capacity oil base, 2.75 qt (2.60 L); add 0.5 qt (0.47 L) for oil filter.

Power-Take-Off: Rear mount PTO pilot and keyed crankshaft extension. Rotation, CCW when facing PTO shaft. Front mount PTO pilot.

Main Bearings: Steel-backed aluminum. Length 1 in (25.4 mm). ID 2 in (50.8 mm). Replaceable, precision inserts.

Camshaft: Cast iron alloy. Replaceable lead babbitt bearings (2).

Connecting Rods: Forged steel. Replaceable bearings.

Crankshaft: Ductile iron. Machined-in oil passages. Simultaneous oil feed from both ends of crankshaft.

Cylinders, Crankcase: Aluminum alloy with integrally cast pearlitic iron cylinder liners.

Cylinder Heads: Removable, aluminum alloy. High turbulence combustion chambers.

Pistons: Aluminum alloy. Three ring, two *compression*, one *oil control*. Cooled and lubricated by oil spray.

Tappets: Barrel type, adjustable.

Valves: *Exhaust*, austenitic steel alloy. *Intake*, steel alloy. Replaceable valve guides.

Valve Seats: Replaceable intake and exhaust.

Valve Rotators: Exhaust valves.

General Information

INTRODUCTION

This manual deals with specific mechanical and electrical information needed by engine mechanics for troubleshooting, servicing, repairing, or overhauling the engine.

Use the separate PARTS MANUAL for parts identification and for establishing their proper location on assemblies. The PARTS MANUAL contains detailed exploded views of each assembly and the individual piece part numbers and their proper names for ordering replacement parts.

The illustrations and procedures presented in each section apply to the engines listed on the cover. The flywheel-blower end of the engine is the front end so right and left sides are determined by viewing the engine from the front. The No. 1 cylinder is on the left, No. 2 cylinder is on the right.

If a major repair or an overhaul is necessary, a competent mechanic should either do the job or supervise and check the work of the mechanic assigned to the job to ensure that all dimensions, clearances and torque values are within the specified tolerances.

Use the table of contents for a quick reference to the separate engine system sections.

The troubleshooting guide is provided as a quick reference for locating and correcting engine trouble.

The wiring diagram shows how the electrical components are interconnected.

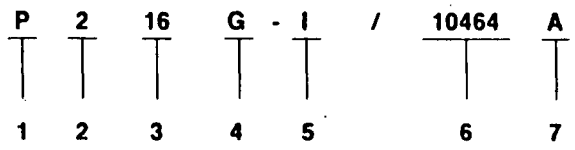
The disassembly section contains major overhaul procedures for step by step removal, disassembly, inspection, repair, and assembly of the engine components.

Use only Genuine Onan replacement parts to ensure quality and the best possible repair and overhaul results. When ordering parts, always use the complete model and spec number as well as the serial number shown on the nameplate.

ENGINE MODEL REFERENCE

Identify your model by referring to the model and specification (spec letter) as shown on the unit nameplate. Always use these numbers and the engine serial number when making reference to your engine.

How to interpret MODEL and SPEC NO.



1. Factory code for general identification of basic engine series.
2. Number of cylinders.
3. BHP rating.
4. Fuel required (G = gasoline).
5. Engine duty cycle.
6. Factory code for designated optional equipment, if any.
7. Specification (spec letter) which advances with factory production modifications.

⚠WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Specifications

This manual contains SI metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

SPECIFICATION	UNIT OF MEASURE	SERIES P216	P218	P220	P224
Number of Cylinders		2	2	2	2
Bore	in	3.250	3.250	3.250	3.560
	(mm)	(82.55)	(82.55)	(82.55)	(90.42)
Stroke	in	2.620	2.875	2.875	3.000
	(mm)	(66.55)	(73.01)	(73.01)	(76.20)
Displacement	cu in	43.3	47.7	47.7	59.7
	(cm^3)	(710)	(782)	(782)	(983)
Compression Ratio		6.5 to 1	7.0 to 1	7.0 to 1	7.0 to 1
Rated Speed (Maximum)	RPM	3600	3600	3600	3600
Power at	BHP	16	18	20	24
Rated Speed	(kW)	(11.9)	(13.4)	(14.9)	(17.9)
Oil Capacity					
Standard Base	Qts	1.5	1.5	1.5	1.5
Without Filter	(litre)	(1.4)	(1.4)	(1.4)	(1.4)
High Capacity Base	Qts	2.7	2.7	2.7	2.7
Without Filter	(litre)	(2.6)	(2.6)	(2.6)	(2.6)
Oil Filter Capacity	Qts	.3	.3	.3	.3
	(litre)	(.3)	(.3)	(.3)	(.3)
Crankshaft Rotation (viewed from flywheel)		Clockwise	Clockwise	Clockwise	Clockwise
Valve Clearance (Cold)					
Intake	in	.005	.005	.005	.005
	(mm)	(.13)	(.13)	(.13)	(.13)
Exhaust	in	.013	.013	.013	.013
	(mm)	(.33)	(.33)	(.33)	(.33)
Spark Plug Gap	in	.025	.025	.025	.025
	(mm)	(.64)	(.64)	(.64)	(.64)
Ignition Timing	BTC	20°	20°	20°	20°
Cylinder Compression	psi	75 to 115	75 to 115	75 to 115	75 to 115
	(kPa)	(517 to 793)	(517 to 793)	(517 to 793)	(517 to 793)

Dimensions and Clearances

P216, P218, P220

All clearances given at room temperature of 70°F. (21°C). All dimensions in inches (approximate millimeter dimensions in parentheses) unless otherwise specified.

DESCRIPTION	MINIMUM Inches	MINIMUM (mm)	MAXIMUM Inches	MAXIMUM (mm)
CYLINDER BLOCK				
Cylinder Bore Honed Diameter	3.2490	(82.52)	3.2500	(82.55)
Maximum Allowable				
Taper			0.005	(0.13)
Out-of-Round			0.003	(0.08)
Main Bearing Inside Diameter (Without bearing)	2.1870	(55.55)	2.1880	(55.58)
Main Bearing Inside Diameter (Installed service bearing)	2.0015	(50.84)	2.0040	(50.90)
Camshaft Bearing Bore (Installed service bearing)	1.3757	(34.94)	1.3787	(35.02)
CRANKSHAFT				
Main Bearing Journal Diameter	1.9992	(50.78)	2.0000	(50.80)
Main Bearing Clearance	0.0024	(0.061)	0.0042	(0.107)
Connecting Rod Journal Diameter	1.6252	(41.28)	1.6260	(41.30)
Crankshaft End Play	0.0060	(0.152)	0.0120	(0.305)
CONNECTING ROD				
Large Bore Diameter (Rod bolts properly torqued)	1.6280	(41.35)	1.6285	(41.36)
Connecting Rod Side Clearance	0.0020	(0.051)	0.0160	(0.406)
Piston Pin Bushing Bore (Finished bore)	0.6879	(17.47)	0.6882	(17.48)
Bearing to Crankshaft Clearance	0.0020	(0.051)	0.0033	(0.084)
CAMSHAFT				
Bearing Journal Diameter	1.3740	(34.90)	1.3745	(34.91)
Bearing Clearance	0.0015	(0.038)	0.0030	(0.076)
End Play	0.0110	(0.279)	0.0480	(1.219)
Lobe Height				
P216, P218 Intake		1.1370	(28.88)	
P216, P218 Exhaust		1.1570	(29.39)	
P220 Intake		1.1670	(29.64)	
P220 Exhaust		1.1570	(29.39)	
PISTON				
Clearance in Cylinder				
Measure 90° to pin 1.187 inch below top of piston	0.0033	(0.084)	0.0053	(0.135)
Piston Pin Bore	0.6877	(17.47)	0.6882	(17.48)
Ring Groove Width				
Top Compression Ring	0.0800	(2.032)	0.0810	(2.057)
Middle Compression Ring	0.0800	(2.032)	0.0810	(2.057)
Bottom Oil Control Ring	0.1880	(4.775)	0.1890	(4.800)

P216, P218, P220

DESCRIPTION	MINIMUM Inches	MINIMUM (mm)	MAXIMUM Inches	MAXIMUM (mm)
PISTON PIN				
Clearance in Piston	0.00004	(0.001)	0.00064	(0.016)
Clearance in Connecting Rod	0.0002	(0.005)	0.0007	(0.018)
Diameter	0.6875	(17.46)	0.6877	(17.47)
PISTON RINGS				
Clearance				
Top Groove	0.0030	(0.076)	0.0080	(0.203)
Ring End Gap in Cylinder	0.0100	(0.254)	0.0200	(0.508)
INTAKE VALVE				
Stem Diameter	0.2795	(7.099)	0.2800	(7.112)
Clearance (Stem to Guide)	0.0010	(0.025)	0.0025	(0.064)
Valve Face Angle		44°		
INTAKE VALVE SEAT				
Seat Bore Diameter in Block	1.4395	(36.56)	1.4405	(36.59)
Seat Outside Diameter	1.4700	(37.34)	1.4710	(37.36)
Valve Seat Width	0.0310	(0.787)	0.0470	(1.194)
Valve Seat Angle		45°		
EXHAUST VALVE				
Stem Diameter	0.2780	(7.061)	0.2785	(7.074)
Clearance (Stem to Guide)	0.0020	(0.051)	0.0035	(0.089)
Valve Face Angle		44°		
EXHAUST VALVE SEAT				
Seat Bore Diameter in Block	1.1890	(30.20)	1.1900	(30.23)
Seat Outside Diameter	1.1920	(30.28)	1.1930	(30.30)
Valve Seat Width	0.0310	(0.787)	0.0470	(1.194)
Valve Seat Angle		45°		
VALVE GUIDE				
Intake Inside Diameter	0.2810	(7.137)	0.2820	(7.163)
Exhaust Inside Diameter	0.2805	(7.125)	0.2815	(7.150)
TAPPET				
Body Diameter	0.7475	(18.99)	0.7480	(19.00)
Bore Diameter	0.7500	(19.05)	0.7515	(19.09)
Clearance in Bore	0.0020	(0.051)	0.0040	(0.102)
VALVE SPRINGS INTAKE AND EXHAUST				
Valve Spring Free Length (Approx.)		1.600	(40.64)	
Valve Spring Length				
Valve Open		1.055	(26.80)	
Valve Closed		1.346	(34.19)	
Spring Load (Valve Open Length)		55 lb.	(25 kg)	
Spring Load (Valve Closed Length)		25 lb.	(11 kg)	
GEAR BACKLASH				
Timing Gear	0.0010	(0.025)	0.0050	(0.127)
Oil Pump Gear	0.0010	(0.025)	0.0080	(0.203)

P224

DESCRIPTION	MINIMUM Inches	MINIMUM (mm)	MAXIMUM Inches	MAXIMUM (mm)
CYLINDER BLOCK				
Cylinder Bore Honed Diameter	3.5625	(90.49)	3.5635	(90.51)
Maximum Allowable				
Taper			0.003	(0.08)
Out-of-Round			0.003	(0.08)
Main Bearing Inside Diameter (Without bearing)	2.1870	(55.55)	2.1880	(55.58)
Main Bearing Inside Diameter (Installed)	2.0015	(50.84)	2.0040	(50.90)
Camshaft Bearing Bore (Bearing Installed)	1.3757	(34.94)	1.3787	(35.02)
CRANKSHAFT				
Main Bearing Journal Diameter	1.9992	(50.78)	2.0000	(50.80)
Main Bearing Clearance	0.0024	(0.061)	0.0042	(0.107)
Connecting Rod Journal Diameter	1.6252	(41.28)	1.6260	(41.30)
Crankshaft End Play	0.0060	(0.152)	0.0120	(0.305)
CONNECTING ROD				
Large Bore Diameter (Without bearing installed and rod bolts properly torqued)	1.7505	(44.46)	1.7510	(44.48)
Connecting Rod Side Clearance	0.0020	(0.051)	0.0160	(0.406)
Piston Pin Bushing Bore (Without bushing)	0.8115	(20.61)	0.8125	(20.64)
Piston Pin Bushing Bore (Finished bore)	0.7504	(19.06)	0.7508	(19.07)
Bearing to Crankshaft Clearance	0.0020	(0.051)	0.0033	(0.084)
CAMSHAFT				
Bearing Journal Diameter	1.3740	(34.90)	1.3745	(34.91)
Bearing Clearance	0.0015	(0.038)	0.0030	(0.076)
End Play	0.0110	(0.279)	0.0480	(1.219)
Lobe Height				
Intake		1.1670	(29.64)	
Exhaust		1.1570	(29.39)	
PISTON				
Clearance in Cylinder				
Measure 90° to pin 1.187 inch below top of piston	0.0070	(0.178)	0.0090	(0.229)
Piston Pin Bore	0.7502	(19.06)	0.7506	(19.07)
Ring Groove Width				
Top Compression Ring	0.0800	(2.032)	0.0810	(2.057)
Middle Compression Ring	0.0800	(2.032)	0.0810	(2.057)
Bottom Oil Control Ring	0.1880	(4.775)	0.1890	(4.801)
PISTON PIN				
Clearance in Piston	0.00004	(0.001)	0.00064	(0.016)
Clearance in Connecting Rod	0.0002	(0.005)	0.0008	(0.020)
Diameter	0.7500	(19.05)	0.7502	(19.06)
PISTON RINGS				
Clearance				
Top Groove	0.0020	(0.051)	0.0080	(0.203)
Ring End Gap in Cylinder	0.0100	(0.254)	0.0200	(0.508)

P224

DESCRIPTION	MINIMUM Inches	MINIMUM (mm)	MAXIMUM Inches	MAXIMUM (mm)
INTAKE VALVE				
Stem Diameter	0.3425	(8.700)	0.3430	(8.712)
Clearance (Stem to Guide)	0.0010	(0.025)	0.0025	(0.064)
Valve Face Angle		44°		
INTAKE VALVE SEAT				
Seat Cylinder Head Bore Diameter	1.5645	(39.74)	1.5655	(39.76)
Seat Outside Diameter	1.5690	(39.85)	1.5700	(39.88)
Valve Seat Width	0.0310	(0.787)	0.0470	(1.194)
Valve Seat Angle		45°		
EXHAUST VALVE				
Stem Diameter	0.3410	(8.661)	0.3420	(8.687)
Clearance (Stem to Guide)	0.0025	(0.064)	0.0040	(0.102)
Valve Face Angle		44°		
EXHAUST VALVE SEAT				
Seat Cylinder Head Bore Diameter	1.2510	(31.78)	1.2520	(31.80)
Seat Outside Diameter	1.2550	(31.88)	1.2560	(31.90)
Valve Seat Width	0.0310	(0.787)	0.0470	(1.194)
Valve Seat Angle		45°		
VALVE GUIDE				
Intake Inside Diameter	0.3440	(8.738)	0.3460	(8.788)
Exhaust Inside Diameter	0.3440	(8.738)	0.3460	(8.788)
TAPPET				
Body Diameter	0.7475	(18.99)	0.7480	(19.00)
Bore Diameter	0.7500	(19.05)	0.7515	(19.09)
Clearance in Bore	0.0020	(0.051)	0.0040	(0.102)
VALVE SPRINGS INTAKE AND EXHAUST				
Valve Spring Free Length (Approx.)		1.662	(42.21)	
Valve Spring Length				
Valve Open		1.125	(28.58)	
Valve Closed		1.375	(34.93)	
Spring Load (Valve Open Length)		71 lb.	(32 kg)	
Spring Load (Valve Closed Length)		38 lb.	(17 kg)	
GEAR BACKLASH				
Timing Gear	0.0010	(0.025)	0.0050	(0.127)
Oil Pump Gear	0.0010	(0.025)	0.0080	(0.203)

Assembly Torques

The torque values given in Table 1 have been determined for specific applications. Standard torque values must not be used where those listed in Table 1 apply. The engine assembly torques given here will assure proper tightness without danger of stripping threads. All threads must be clean and lubricated with new engine oil before torquing.

Tighten all studs, nuts, and capscrews as required to keep them from working loose. Refer to the *PARTS MANUAL* for the location of washers and capscrews.

TABLE 1.

P216, P218, P220 DESCRIPTION	TORQUE SPECIFICATION Ft.-Lb.	Nm
Gearcase Cover	8-10	11-14
Rear Bearing Plate Screws	25-27	34-37
Starter Mounting Bolts	19-21	25-28
Connecting Rod Bolts	12-14	16-19
Flywheel Capscrews	50-55	67-75
Oil Base	18-23	24-31
Oil Pump	7-9	10-12
Valve Cover	1-2	1-3
Cylinder Head Bolts (Cold)		
Asbestos Gasket	16-18	22-24
Graphoil Gasket	14-16	19-22
Intake Manifold Mounting Screws	6-10	8-14
Exhaust Manifold Mounting Screws	9-11	12-15
Other 1/4" Cylinder Block Stud and Nuts	7-9	10-12
Other 5/16" Cylinder Block Stud and Nuts	8-10	11-14
Other 3/8" Cylinder Block Stud and Nuts	18-23	24-31

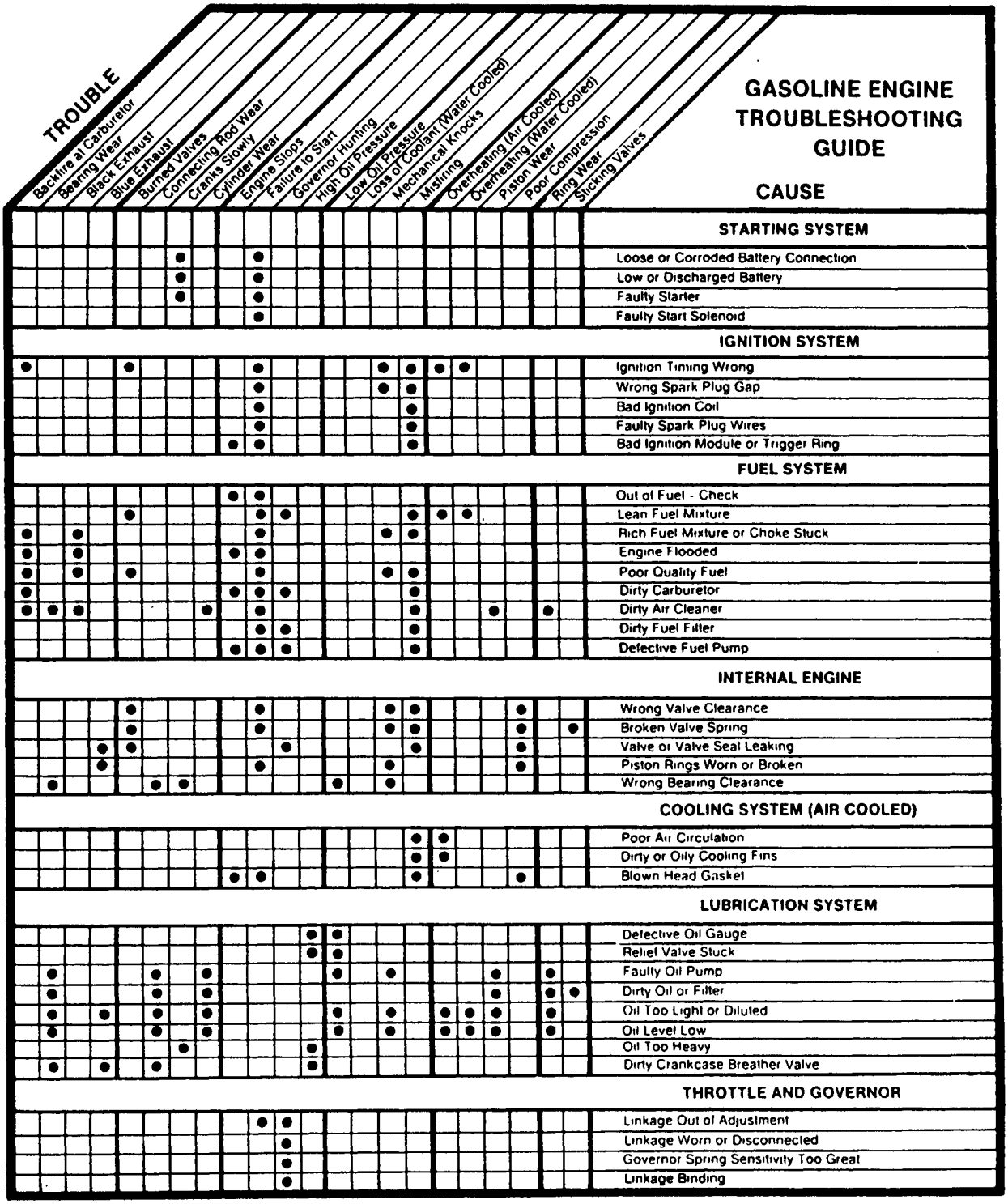
P224 DESCRIPTION	TORQUE SPECIFICATION Ft.-Lb.	Nm
Gearcase Cover	8-10	11-14
Rear Bearing Plate Screws	25-27	34-37
Starter Mounting Bolts	19-21	25-28
Connecting Rod Bolts	27-29	37-39
Flywheel Capscrews	50-55	67-75
Oil Base	18-23	24-31
Oil Pump	7-9	10-12
Valve Cover	4-8	5-11
Cylinder Head Nuts (Cold)		
(w/Compression Washers)	14	19
(w/o Compression Washers)	17	23
Intake Manifold Mounting Screws	20-23	27-31
Exhaust Manifold Mounting Screws	9-11	12-15
Other 1/4" Cylinder Block Stud and Nuts	7-9	10-12
Other 5/16" Cylinder Block Stud and Nuts	8-10	11-14
Other 3/8" Cylinder Block Stud and Nuts	18-23	24-31

Special Tools

The following special tools are available from Onan. For further information see *TOOL CATALOG 900-0019.*

Valve Seat Driver
Valve Guide Driver
Oil Seal Guide and Driver
Combination Bearing Remover (Main and Cam)
Combination Bearing Driver (Main and Cam)
Flywheel Puller

Engine Troubleshooting



Oil System

CRANKCASE OIL

Refer to *Periodic Maintenance Schedule* (located in the Operator's Manual) for oil change interval. If operating in extremely dusty, high ambient, or low ambient conditions, change oil more often.

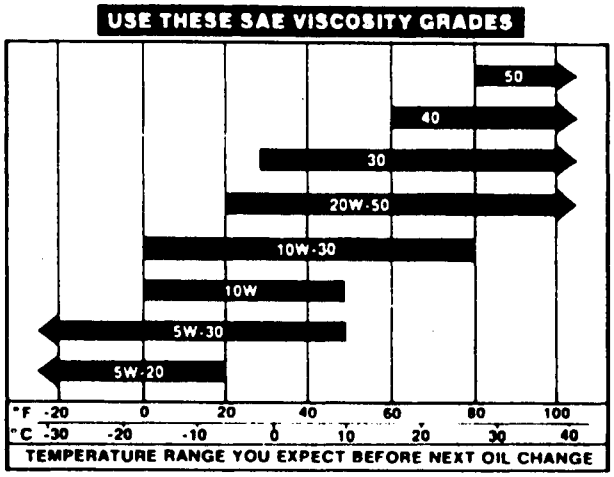
⚠WARNING ***Hot crankcase oil can cause burns if it comes in contact with skin. Wear protective clothing and keep fingers and hands clear when draining oil.***

⚠CAUTION ***Excess oil can cause high oil consumption, high operating temperatures, and oil foaming. Do not overfill crankcase.***

Run engine until thoroughly warm before draining oil. Stop the engine, place a pan under the drain outlet and remove the oil drain plug. After the oil is completely drained, clean and replace the drain plug. Fill crankcase with correct amount of oil. Refer to *SPECIFICATIONS* for crankcase capacity. Use oils meeting the API classification SF, SF/CC, or SF/CD. Refer to chart to determine the proper viscosity grade of oil to use. Straight weight oils are recommended for severe duty use and at temperatures above 32°F (0°C) for minimum oil consumption.

⚠WARNING ***Crankcase pressure can blow out hot oil, which can cause severe personal injury. Do not check oil while the engine is running.***

Oil level should be to the FULL mark of the dipstick. Start engine and run for a short time to check for oil leaks around the drain plug.



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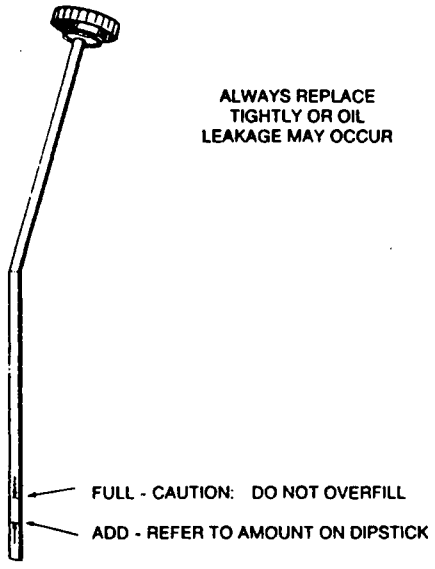

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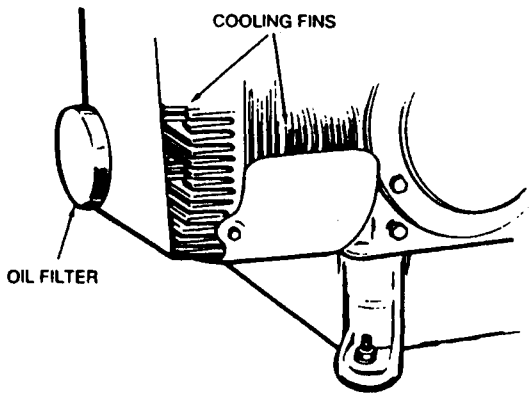
FIGURE 1. CRANKCASE OIL FILL



C-1001

FIGURE 2. OIL FILTER

OIL FILTER CHANGE

Refer to *Periodic Maintenenace Schedule* (located in the Operator's Manual) for oil filter change interval. If operating in extremely dusty, high ambient, or low ambient conditions, change oil filter more often.

Spin off oil filter element and discard it. Thoroughly clean filter mounting surface and make sure new gasket is inserted in the element. Apply a thin film of clean oil to the gasket. Spin element down by hand until gasket just touches mounting pad and then turn down an additional 1/2-3/4 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks; do not overtighten.

CRANKCASE BREATHER

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture or gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the carburetor where they are mixed with incoming air and burned in the combustion chamber. A sticky breather valve can cause oil leaks, high oil consumption, rough idle, reduced engine power, and a rapid formation of sludge and varnish within the engine.

Crankcase Breather Service

If the crankcase becomes pressurized as evidenced by oil leaks at the seals or excessive oil in the air cleaner housing, use the following procedure to service.

⚠WARNING ***Most parts cleaning solvents are flammable and can cause severe personal injury or death if used improperly. Follow the manufacturer's recommendations when cleaning parts.***

P216, P218, P220

Remove the breather tube from the valve cover (Figure 3A). Remove capscrew, flatwashers, valve cover, pack, spring, washer, reed valve, and breather baffle. Discard gasket and clean all parts in part cleaning solvent.

⚠CAUTION ***Overtightening the valve cover can cause engine damage. Do not overtighten valve cover.***

The reed valve must be flat with no sign of a crease. Assemble using a new gasket. Refer to *ASSEMBLY TORQUES* for valve cover capscrew torque specification.

P224

Remove the breather hose from cap and valve assembly. Remove cap and valve assembly and wash in a suitable solvent. Replace cap and valve if balls do not move freely. Pull pack out and wash in solvent. To allow free operation of the valve, screens must be positioned as shown in Figure 3B.

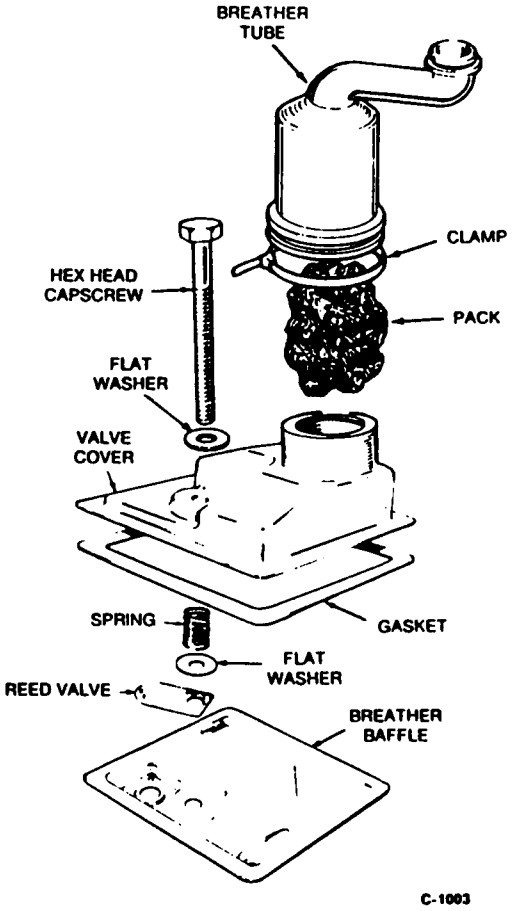


FIGURE 3A. CRANKCASE BREATHER - P216, P218, P220

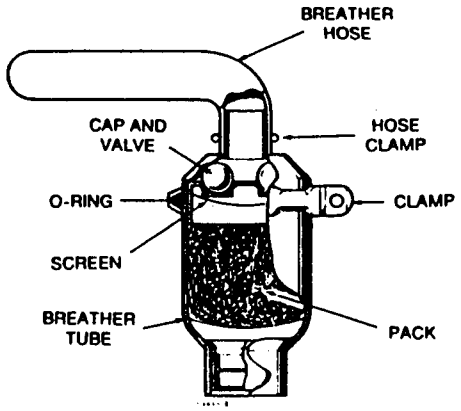


FIGURE 3B. CRANKCASE BREATHER - P224

PRESSURE LUBRICATION

All engines use an oil pump to provide a constant flow of oil to the engine parts. The oil supply collects in the oil base where it is picked up by the oil pump pick-up cup. A by-pass valve is used to control oil pressure. Drain oil before removing oil base and always use a new gasket when replacing the oil base.

Oil Pump

The oil pump (Figure 4) is mounted behind the gear cover and is driven by the crankshaft gear. Inlet pipe and screen assembly are attached directly to the pump body. A discharge passage in pump cover registers with a drilled passage in the crankcase. Parallel passages distribute oil to the front and rear main bearing and the oil bypass valve.

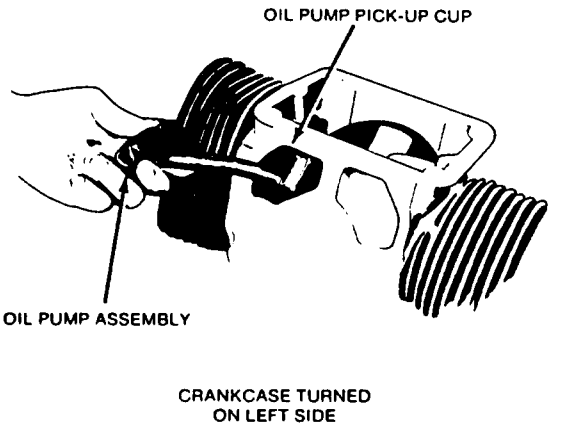


FIGURE 4. OIL PUMP ASSEMBLY

Circumferential grooves in the main bearings supply oil to connecting rod bearings through drilled passages from each main journal. A drilled passage connects the front main bearing oil supply to the front camshaft bearing; rear cam bearing is splash lubricated.

Normal oil pressure should be 8 psi (55 kPa) or higher at 1500 rpm when the engine is at normal operating temperature. If pressure at 1500 rpm drops below this value, inspect oil system for faulty components.

Check oil pump thoroughly for worn parts. Oil pump to prime it before reinstalling. Except for gaskets and pick-up cup, component parts of the pump are not available individually. Install a new pump assembly if any parts are worn.

Oil By-Pass Valve

The by-pass valve (located to the right and behind gear cover) controls oil pressure by allowing excess oil to flow directly back to the crankcase. The valve limits oil pressure to a maximum of about 20 psi (138 kPa) on the P216, P218, and P220, and about 30 psi (207 kPa) on the P224 at normal operating temperature.

The valve is non-adjustable and normally does not need maintenance. Determine if valve is operating correctly by inspecting plunger action as follows:

1. Remove the cap screw located behind gear cover and under governor arm.
2. Remove spring and plunger with a magnetic tool.
3. Determine proper valve operation by checking the spring and plunger according to the following measurements:

   Plunger Diameter ..... 0.3105 to 0.3125 in. (7.89 to 7.94 mm)

   Spring
   Free Length ..... 1.00 inch (25.4 mm)
   Load .....2.6 ± 0.2 lbs (11.6 ± 0.9 N) when compressed to 0.5 inch (12.7 mm)

4. Check the valve seat and clean away any accumulation of metal particles which could cause erratic valve action. Verify that the valve seat is not damaged.
5. Clean plunger and spring in parts cleaning solvent and install.

Fuel System

CARBURETOR

All carburetors have a fixed main jet. An optional fixed main jet is available for altitude compensation above 5,000 feet.

The carburetor idle mixture was set for maximum efficiency at the factory and should normally not be disturbed. If adjustments seem necessary, first be sure the ignition system is working properly and governor sensitivity is properly adjusted.

The carburetor has a limited adjustment range between stops of ±1/8 turn. The screw should only be adjusted within these limits; in to lean the mixture, out to richen.

⚠CAUTION ***Overtightening the mixture adjustment screw will cause carburetor damage. Turn mixture adjustment screw in only until light tension can be felt.***

If replacing idle mixture screw, turn in until lightly seated, then turn screw back out 1-1/4 turns for the P216, P218, and P220 carburetors, and 1-1/2 turns for the P224 carburetor. Replace limiter cap with the plastic stop approximately centered.

Carburetor Speed Settings

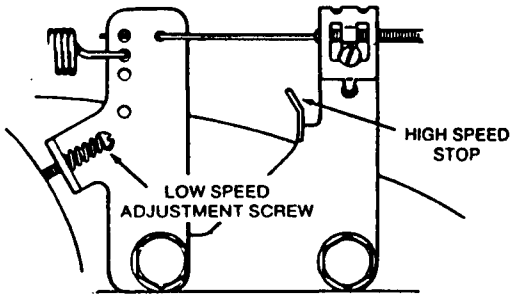
1. Start the engine and allow it to warm up thoroughly (at least 10 minutes).

   Some equipment manufacturers may require higher throttle stop speed and governor low speed rpm settings. Refer to equipment manufacturer's Operator's Manual for the correct rpm settings. When rpm settings are not specified by the equipment manufacturer, use the rpm settings listed in Steps 2 and 3.

2. Move the engine speed control to the slow position. Bend or turn the low speed stop on the governor so the throttle stop screw on the carburetor controls engine speed. Adjust the throttle stop screw for 1000 rpm idle (Figures 1 and 2).

3. Adjust the governor low speed stop for 1100 rpm idle.

4. Move the engine speed control to the fast position. Bend the high speed stop on the governor so the engine runs at the equipment manufacturer's recommended speed.



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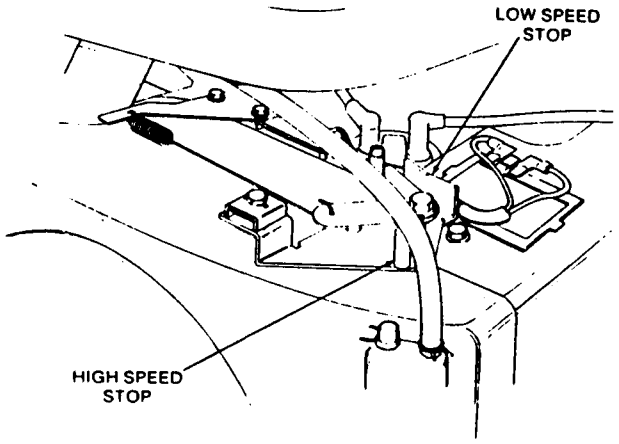
SIDE PULL GOVERNOR ASSEMBLY



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FRONT PULL GOVERNOR ASSEMBLY

FIGURE 1. GOVERNOR SPEED ADJUSTMENT

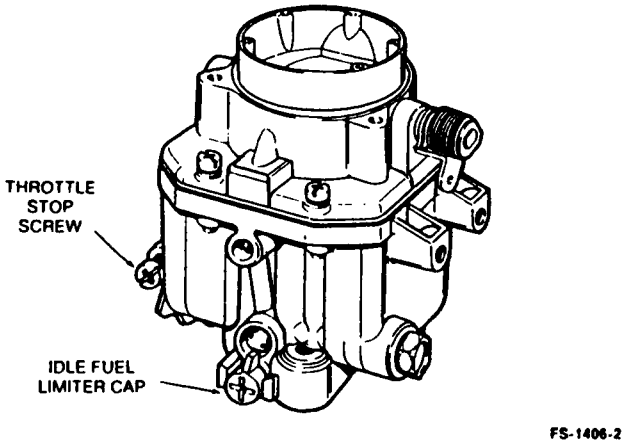


FIGURE 2. CARBURETOR ADJUSTMENTS

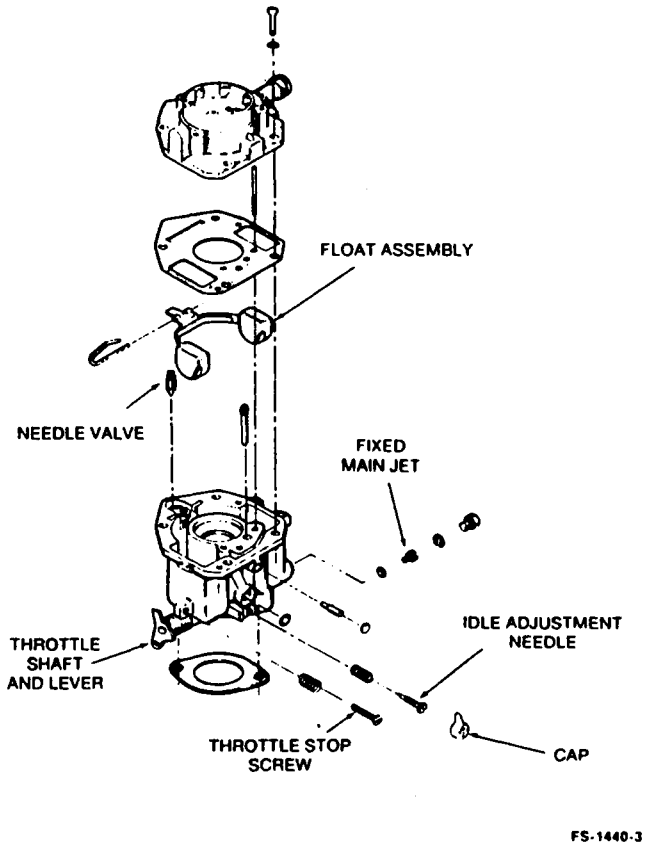


FIGURE 3. CARBURETOR ASSEMBLY

CARBURETOR OVERHAUL

Carburetion problems that are not corrected by mixture adjustments are usually a result of gummed-up fuel passages or worn internal parts. The most effective solution is a carburetor overhaul.

In general, overhauling a carburetor consists of disassembly, a thorough cleaning, and replacement of worn parts. Carburetor overhaul kits are available.

General instructions for overhauling a carburetor are given below. Carefully note the position of all parts while removing to assure correct placement when reassembling. Read through all the instructions before beginning for a better understanding of the procedures involved. Carburetor components are shown in Figure 3.

⚠WARNING ***Ignition of fuel can result in severe personal injury or death. Do not smoke or allow any spark, pilot light, or arcing equipment near the fuel system.***

Removal

1. Remove air cleaner assembly.
2. Disconnect governor and throttle linkage, choke control, and fuel line from carburetor.
3. Remove the four intake manifold cap screws and lift complete manifold assembly from engine.
4. Remove carburetor from intake manifold.

Disassembly

1. Remove main jet and idle adjustment needle.
2. Remove attaching screws and separate upper and lower carburetor sections.
3. Carefully note position of float assembly parts, then pull out retaining pin and float assembly.
4. Remove needle valve.

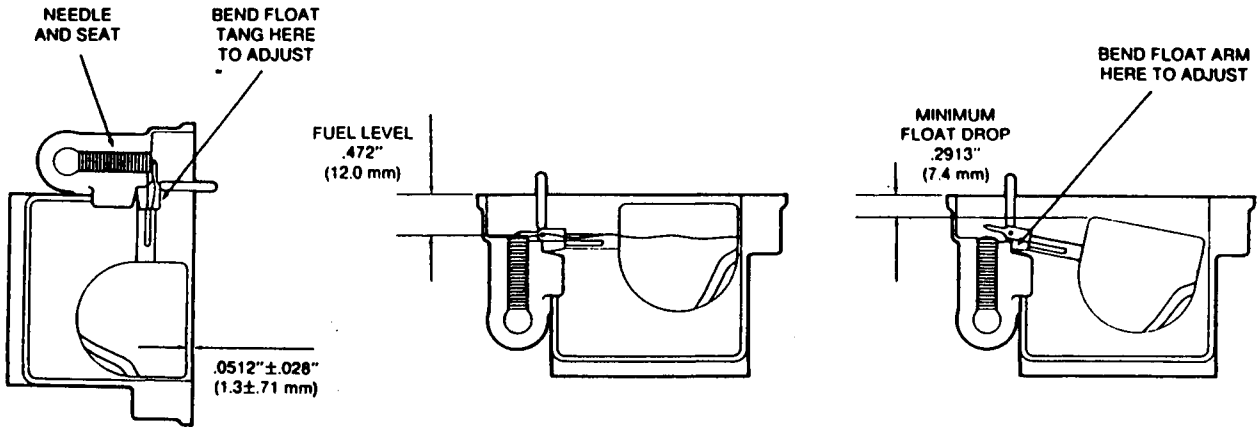


FIGURE 4. CARBURETOR FLOAT LEVEL ADJUSTMENTS

Cleaning and Repair

1. Soak all metal components not replaced in carburetor cleaner. Do not soak non-metal floats or other non-metal parts. Follow the cleaning manufacturer's recommendations.
2. Clean all carbon from the carburetor bore, especially where the throttle and choke plates seat. Be careful not to plug the idle or main fuel ports.
3. Dry out all passages with low pressure air (35 PSI). Avoid using wire or other objects for cleaning which may increase the size of critical passages.
4. Check the condition of the adjustment needle; replace if damaged. Replace float if loaded with fuel or damaged.
5. Check the choke and throttle shafts for excessive play in their bore. This condition may necessitate replacement of the carburetor.
6. Replace old components with new parts.

Reassembly and Installation

1. Install needle valve, main jet, and float assembly. Make sure float pivot pin is properly placed and float moves freely without binding.
2. Turn carburetor on its side and measure float level (Figure 4). Adjust float level only if necessary. Measure float drop (the distance from the top of carburetor body to top of float). Adjust only if necessary.
3. Position gasket on lower carburetor section and install upper carburetor section.
4. Install idle adjustment screw, throttle stop screw, and fixed main jet plug.
5. Mount carburetor on intake manifold and install assembly on engine.
6. Connect governor and throttle linkage, choke control, and fuel line. Mount air cleaner assembly.
7. Adjust carburetor and governor according to directions given in this section.

PULSATING-DIAPHRAGM FUEL PUMP

Pulsating-diaphragm fuel pumps, or pulse pumps, rely on changes in crankcase vacuum to create a pulsating movement of the pump diaphragm. As the engine's pistons move outward, a vacuum is created. This vacuum is transmitted to the pump diaphragm causing it to pull back and suck fuel into the pump. As the engine's pistons move inward, crankcase vacuum is reduced and the diaphragm return spring pushes the pump diaphragm forward, forcing fuel through the pump outlet.

Fuel Pump Test Procedure

Before testing make certain the fuel pump vacuum and fuel line connections are tight and free of leaks.

1. Operate engine at an idle for five minutes to ensure that carburetor is full of fuel.

⚠WARNING ***Ignition of fuel can result in severe personal injury or death. Thoroughly clean up any spilled fuel.***

2. Shut engine off and remove fuel inlet line from fuel pump.

3. Connect a vacuum gauge to fuel pump inlet using a piece of fuel hose with clamps.

4. Start engine and allow to idle for at least five seconds. Record vacuum gauge reading.

5. Move throttle control to high idle position. Wait at least five seconds and record vacuum gauge reading.

6. Shut engine off and remove vacuum gauge hose from fuel pump inlet. Connect fuel inlet line to fuel pump.

⚠WARNING ***Ignition of fuel can result in severe personal injury or death. Thoroughly clean up any spilled fuel.***

7. Remove fuel outlet line from fuel pump.

8. Connect a pressure gauge to fuel pump outlet using a piece of fuel hose with clamps.

9. Start engine and allow to idle for at least five seconds. While holding pressure gauge level with pump outlet record pressure gauge reading.

10. Move throttle control to high idle position and allow engine to run for at least five seconds. While holding pressure gauge level with pump outlet record pressure gauge reading.

11. Shut engine off and remove pressure gauge hose from fuel pump outlet. Connect fuel outlet line to fuel pump.

Replace the fuel pump if test readings are not within the values specified in TABLE 1.

TABLE 1
PULSE PUMP TEST SPECIFICATIONS

ENGINE SPEED	PUMP INLET VACUUM (Minimum)	PUMP OUTLET PRESSURE (Minimum)
Low Idle	2.6 inches of mercury	1.7 psi
High Idle	2.6 inches of mercury	1.7 psi

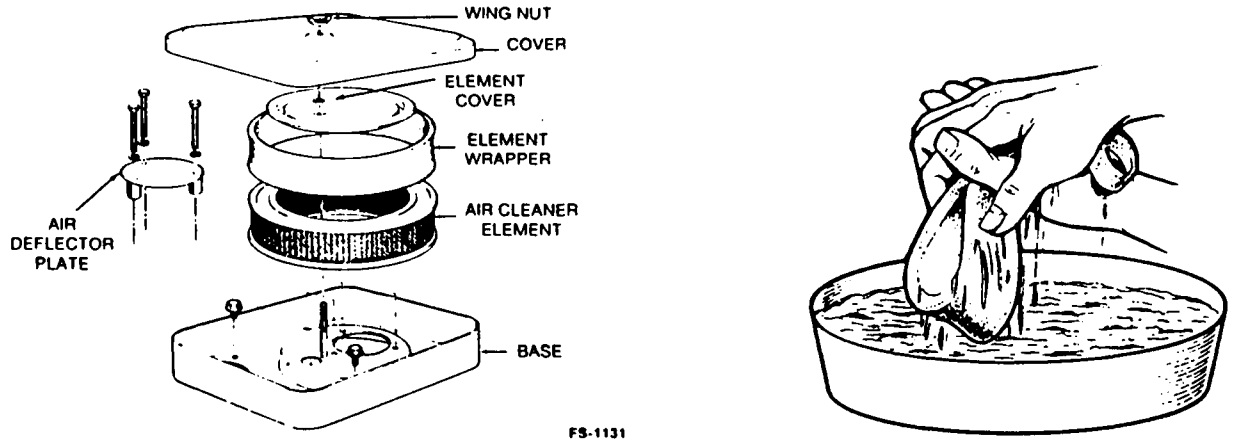


FIGURE 5. AIR CLEANER ASSEMBLY

AIR CLEANER

⚠CAUTION ***A dirty air cleaner element can cause engine damage. Ensure air cleaner element is kept clean and free of excess debris.***

Engine is equipped with a paper element. If the engine is equipped with an element wrapper, it must be removed, cleaned, and oiled every 25 hours of operation; more often under extremely dusty conditions.

1. To clean element wrapper, wash in water and detergent (Figure 5). Remove excess water by squeezing like a sponge, and allow to dry thoroughly. Distribute one tablespoon of SAE 30 engine oil evenly around the precleaner. Knead into precleaner and wring out excess oil.

2. Depending on conditions in which the engine is operating, the inner paper element should be replaced whenever it becomes excessively dirty or oily.

⚠CAUTION ***Running engine without air cleaner element will result in engine damage. Do not run engine without air cleaner element installed.***

GOVERNOR SENSITIVITY

These engines are adapted for use where a wide range of speed settings is desired. Engine speed is controlled at any given point between minimum and maximum by simply shifting the throttle lever on the control panel until the desired speed is reached.

A reliable instrument for checking engine speed is required for accurate governor adjustment. Engine speed can be checked with a tachometer.

Check the governor arm, linkage, throttle shaft, and lever for binding condition or excessive slack and wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness may cause a hunting condition and regulation could be erratic. Work the arm back and forth several times by hand while the engine is idling to check for above conditions.

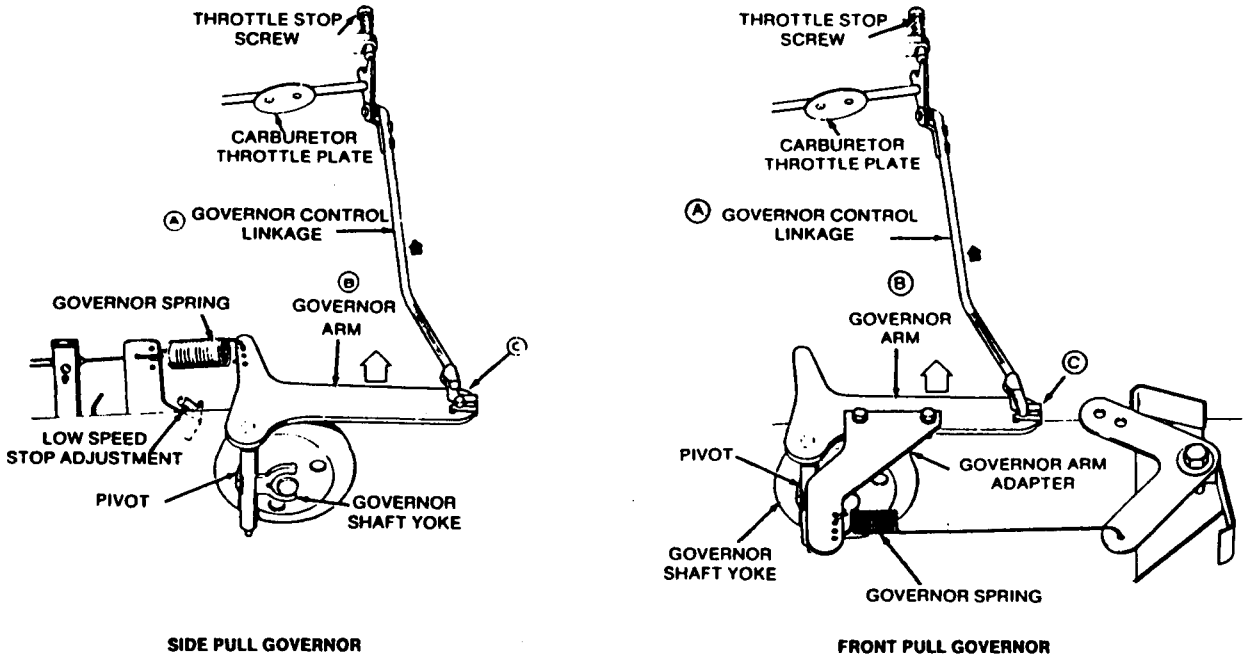


FIGURE 6. VARIABLE SPEED GOVERNOR ADJUSTMENTS

If the governor is hunting or not operating properly, adjust as follows (Figure 6):

1. Disconnect linkage (A) from one of holes (C).
2. Push linkage (A) and governor arm (B) as far back toward carburetor as they will go.
3. Holding linkage and governor arm toward direction of carburetor, insert end of linkage into whichever hole (C) in governor arm lines up the closest. If between two holes, insert in next hole out.

On side pull governors the governor spring is set by the factory in the third hole of the governor arm (third hole from pivot). On front pull governors the governor spring is set by the factory in the second hole of the governor arm adapter (second hole from pivot). To increase sensitivity, move spring loop into a hole closer to the pivot. To decrease sensitivity, move spring loop into a hole farther away from the pivot. After sensitivity has been set, recheck the low speed rpm setting. Adjust if necessary.

Ignition and Battery Charging

IGNITION SYSTEM DESCRIPTION

This engine is equipped with an electronic battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. The electronic ignition module is located on the engine gear cover behind the flywheel. The module receives a timing signal from magnets within the trigger ring which rotates with the engine crankshaft (Figure 1). If the electronic ignition is suspected of malfunctioning, proceed as follows:

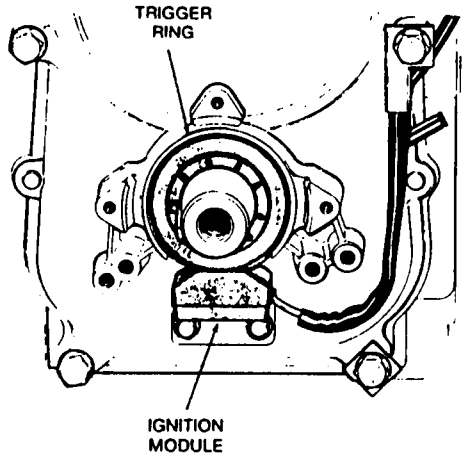


FIGURE 1. IGNITION MODULE AND TRIGGER RING

1. Check all electrical connections to be sure they are clean and tight. If all connections are good and wiring is intact, go to step 2.

2. Refer to IGNITION COIL section to test coil for proper resistance. If coil checks out good, go to step 3.

⚠WARNING ***The electronic ignition produces current which can cause electrical shock. Do not touch electrical components or wires while ignition is on.***

⚠WARNING ***Accidental starting of the engine can result in severe personal injury or death. Remove spark plugs before proceeding.***

⚠WARNING ***Ignition of cylinder gases can cause severe personal injury. Ground spark tester away from spark plug hole.***

3. Pull spark plug wires off spark plugs and remove spark plugs. Connect an approved spark tester to each of the spark plug wires and ground them away from spark plug hole. Turn key on and crank engine over for 5 seconds while watching for spark. If a spark occurs regularly, the problem is not in the ignition system. If no spark occurs, go to step 4.

⚠CAUTION ***Incorrect wiring can cause electronic ignition damage. Do not attach any lead or jumper with power (such as B+) to coil negative terminal.***

4. Connect a jumper lead directly from the positive battery terminal to the positive (+) coil terminal (smaller diameter of the two threaded posts). Crank engine over while watching for spark. If spark occurs, the problem is in the low oil pressure cut out switch (if equipped) or related wiring, the lubricating system (low oil pressure), or in the other circuitry bringing voltage to the coil. If no spark occurs, go to step 5.

5. Connect positive side of voltmeter to negative (-) coil terminal (larger diameter of the two threaded posts) and negative side of voltmeter to engine ground. Turn key on and rotate flywheel slowly by hand while observing voltmeter. Voltage should switch between battery voltage and 1-1.5 for each revolution. If voltage does not switch properly, replace ignition module.

⚠CAUTION ***Incorrect wiring can cause electronic ignition damage. Do not attach any lead or jumper with power (such as B+) to coil negative terminal.***

6. Install spark plugs and wires. If ignition module is being replaced, be sure to connect red lead from new ignition module to positive (+) terminal of coil, black lead from module to negative (-) terminal of coil.

IGNITION TIMING

The ignition timing is preset at the factory and is not adjustable. For troubleshooting purposes, it is possible to make an approximate check of the ignition timing using reference marks on the blower housing and flywheel (Figure 2). This check can be performed by a continuity test.

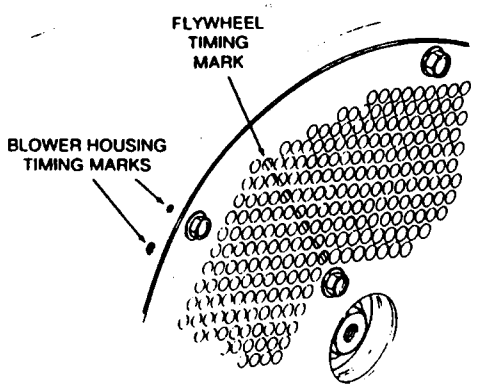


FIGURE 2. IGNITION TIMING MARKS

Continuity Test

1. Pull spark plug wires off spark plugs and remove spark plugs.

   ⚠WARNING ***Accidental starting of the engine can result in severe personal injury or death. Remove spark plugs before proceeding.***

2. Turn ignition on.

3. Connect a voltmeter between the negative (-) coil terminal (larger diameter of the two threaded posts) and a good engine ground.

   ⚠WARNING ***The electronic ignition produces current which can cause electrical shock. Do not touch electrical components or wires while ignition is on.***

4. Rotate the flywheel slowly by hand in the clockwise direction until the voltmeter reading switches from approximately 1 volt to battery voltage. At this point, one of the chaff screen screws should lie between the two timing marks on the blower housing. To recheck timing, the flywheel must be rotated another complete revolution in the clockwise direction. Moving the flywheel back and forth across the reference timing mark will not activate the electronic ignition control.

5. Install spark plugs and wires.

IGNITION COIL

To test primary and secondary windings within the ignition coil first make sure the ignition power is off and coil is at room temperature of 70°F (21°C).

1. Use a Simpson 260 VOM or equivalent.

2. Place a black lead on negative (-) coil terminal and red lead to positive (+) coil terminal. Primary resistance should read between 2.90-3.60 ohms.

3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 3). Secondary resistance should read between 14,500-19,800 ohms.

4. If either of the above resistances are not within specification, replace coil.

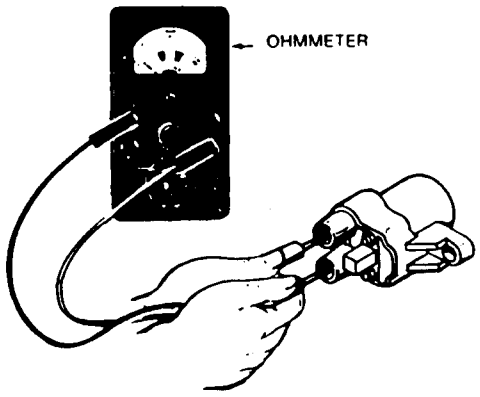


FIGURE 3. COIL TEST

SPARK PLUGS

Check or replace spark plugs as recommended in the *Periodic Maintenance Schedule* (located in Operator's Manual). Replace spark plugs that show signs of fouling or electrode erosion.

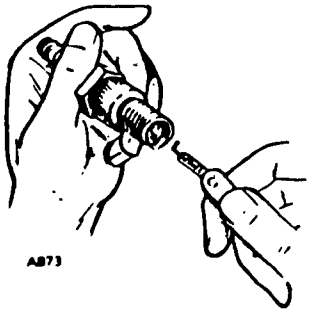


FIGURE 4. SPARK PLUG GAP

BATTERY INSPECTION

⚠WARNING ***Ignition of explosive battery gases can result in severe personal injury. Do not smoke or allow any ignition source near the battery.***

Check battery cells with a hydrometer (Figure 5). Specific gravity reading should be between 1.260 and 1.290 at 77°F (25°C).

If one or more cells are low on water, add distilled water and recharge. Keep the battery case clean and dry. An accumulation of moisture or dirt will accelerate discharge and battery failure.

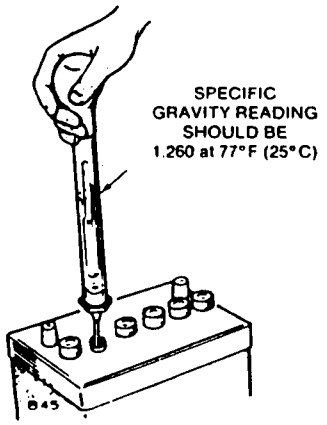


FIGURE 5. SPECIFIC GRAVITY TEST

Keep the battery terminals clean and tight. Push the cable terminal down flush with or slightly below the top of the battery post (Figure 6). After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.

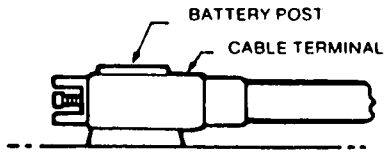


FIGURE 6. BATTERY CABLE CONNECTION

BATTERY JUMP STARTING

Occasionally, it may be necessary to jump start (charge) a weak battery using a charged booster battery. If jump starting is necessary, the following procedure is recommended to prevent starter damage, battery damage, and personal injuries.

1. Disconnect engine load.
2. Use a battery of the same voltage (12V) as is used with your engine.
3. Attach one end of the positive booster cable (red) to the positive (+) terminal of the booster battery. Attach the other end of the positive cable to the positive (+) terminal of your engine battery.

⚠WARNING ***Electrical arcing can cause severe personal injury. Do not allow positive and negative cable ends to touch.***

4. Attach one end of the negative booster cable (black) to negative (-) terminal of booster battery. Attach other end of negative cable to a solid chassis ground on your engine.

5. Jump starting in any other manner may result in damage to the battery or the electrical system.

⚠CAUTION ***Overcranking the engine can cause starter damage. Allow 5 minutes for starter to cool if engaged for longer than 30 seconds.***

⚠WARNING ***Jump starting a battery incorrectly can cause battery to explode, resulting in severe personal injury or death. Do not smoke or allow any ignition source near the battery, and do not jump start a frozen battery.***

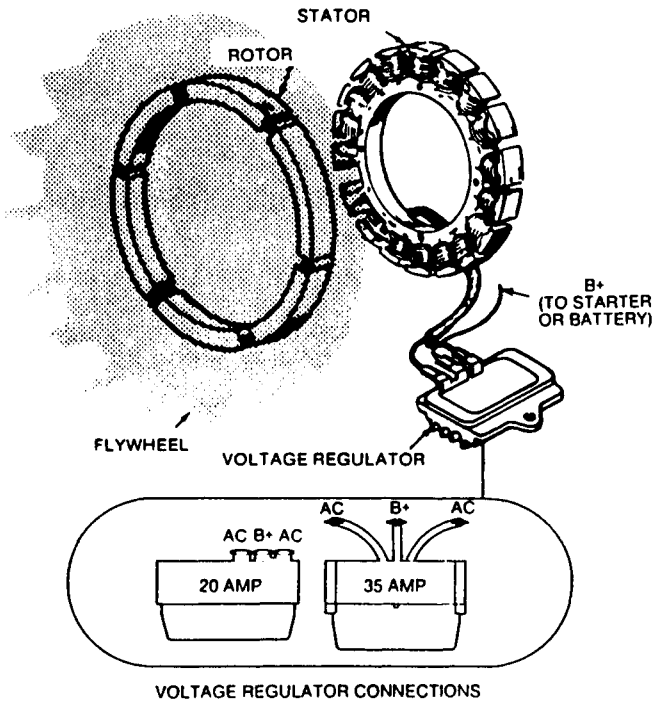
6. Turn ignition switch to ON to start engine.

FLYWHEEL ALTERNATOR

This unit is equipped with a permanent magnet flywheel alternator and solid-state voltage regulator-rectifier (Figure 7). As with all solid-state electrical units, precautions are necessary when servicing.

⚠CAUTION ***Reversing positive and negative battery connections or allowing engine to run without being connected to the alternator will result in engine electrical system damage. Do not switch battery connections or allow engine to run without being connected to the alternator.***

Weak ignition spark or a discharged battery indicates trouble in the charging system. Before testing the engine's charging system, always check the battery for serviceability.



VOLTAGE REGULATOR CONNECTIONS

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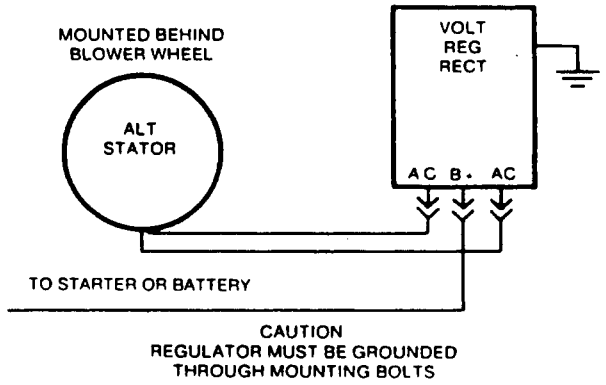

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FIGURE 7. FLYWHEEL ALTERNATOR SYSTEM

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure engine is being run long enough and fast enough to recharge battery after each start. Charging system tests require a full charged battery. Alternator output is reduced in direct proportion to engine rpm. Also, power required for accessories reduces power available to recharge battery.

2. The regulator-rectifier has built in protection against open circuits or short circuits on the alternator output (B+) terminal. Either condition will cause the regulator-rectifier to shut off and appear as if it is not functioning. Prior to checking the regulator-rectifier, check all wiring between the regulator-rectifier B+ terminal and the battery positive (+) terminal to assure it is free of open circuits, resistances or short circuits. Also, if the battery is extremely discharged it may have insufficient power to "turn on" the regulator-rectifier.

3. Be sure regulator-rectifier plug (connector) is inserted properly. Plug must bottom in receptacle; this eliminates any resistance due to a poor connection. Keep clean and tight.

4. Make sure alternator stator leads are not shorted together.

5. Be sure regulator-rectifier has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.

6. Never reverse the battery leads.

When the engine is running between 1800 to 2600 rpm, observe the panel ammeter (if not already equipped, connect a test ammeter). If no charging is evident, proceed with the *Alternator Output Test.*

ALTERNATOR OUTPUT TEST

Use a volt-ohmmeter, such as the Simpson 270, when testing the charging system.

1. Check battery voltage with unit not running. If not within specifications (Table 1) charge battery before proceeding to step 2.

2. With the engine running, check the battery terminal voltage (regulator output) using a DC voltmeter. Voltage output should be within the values specified in Table 1. If voltage is greater than specified, replace regulator-rectifier assembly. If voltage is less than specified, proceed to step 3.

3. Examine all wires for loose, corroded, broken connections, short circuits, etc. Check fuses. Repair as needed to assure complete circuits from regulator-rectifier B+ terminal to battery positive (+) terminal and from battery negative (-) terminal to regulator-rectifier case. If battery voltage remains low with engine running, proceed to step 4.

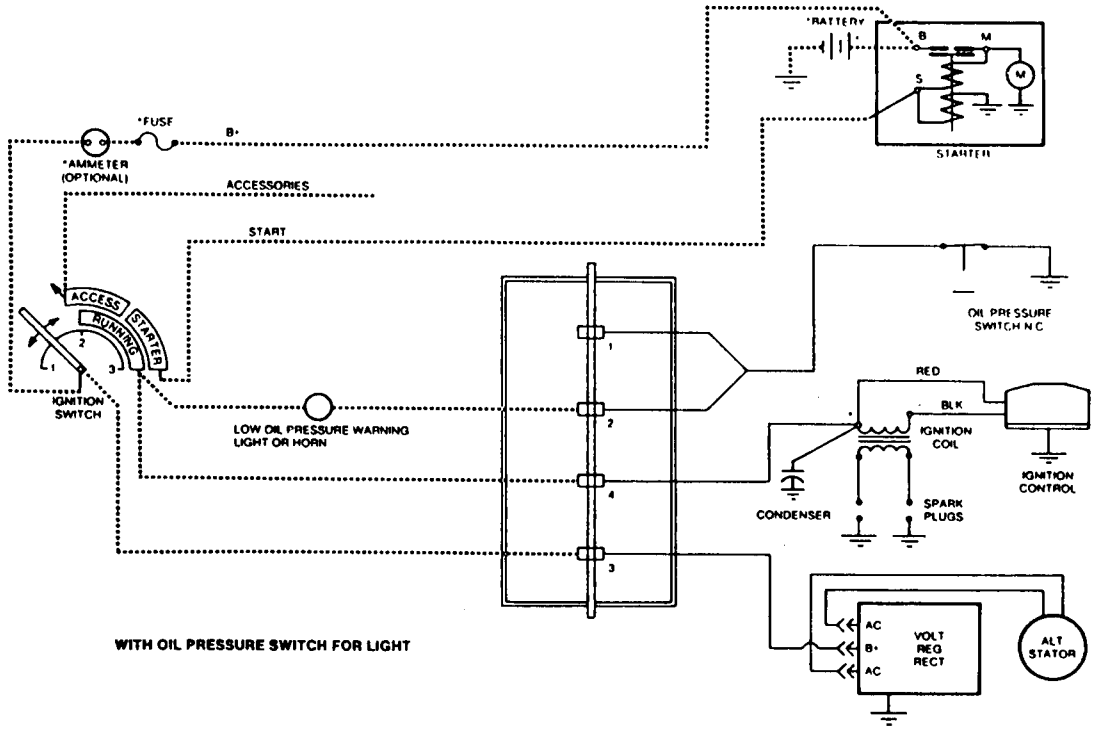
4. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running. If AC voltage reads more or less than specified in Table 1, proceed to step 5. If AC voltage is as specified but DC voltage is low, replace regulator-rectifier.

5. Use the Rx1 scale on the ohmmeter for detecting an open or ground in the stator (unit not running). Disconnect plug from the regulator-rectifier. Connect one ohmmeter test lead to a stator wire, connect the other test lead to ground. Reading should show an open (no continuity). If it doesn' t, stator must be replaced. If reading shows no continuity connect one ohmmeter lead to each wire coming from the stator. Refer to Table 1 for resistance specifications. If resistance is not as specified, replace stator. If stator resistance readings are as specified and windings are not shorted or open, low AC voltage may be due to loss of magnetism. If so, blower wheel assembly must be replaced.

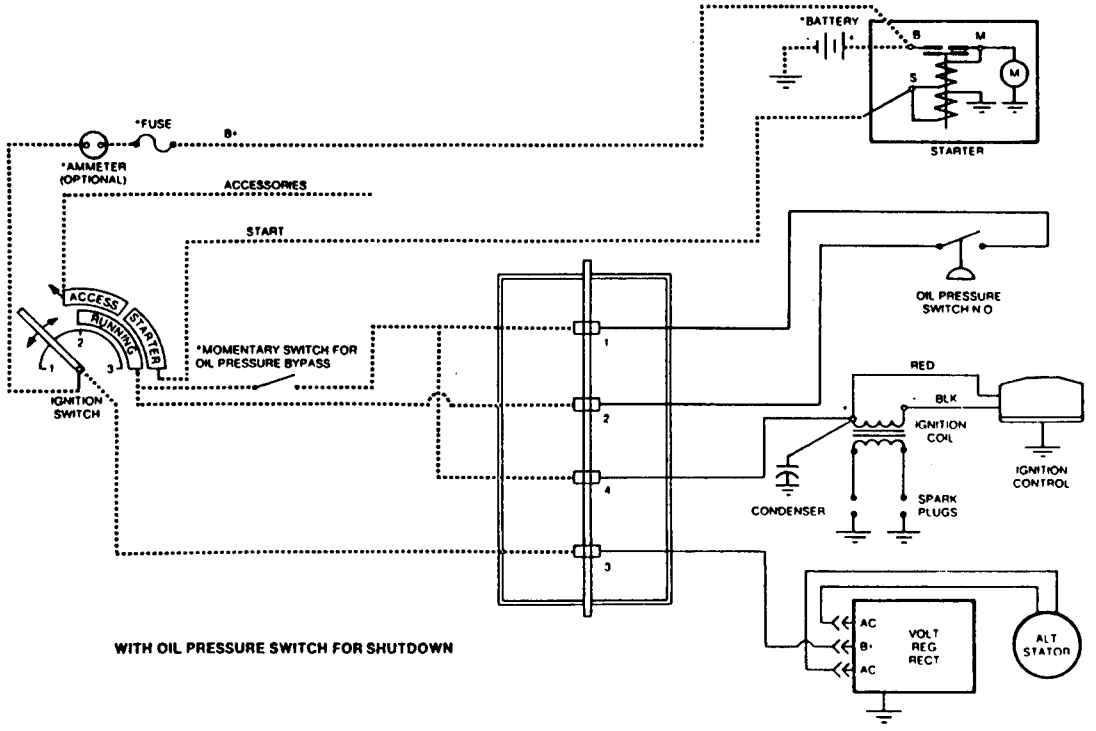
TABLE 1. TESTING 20 AND 35 AMPERE SYSTEMS

BASIC TEST	BATTERY	REGULATOR	STATOR AC VOLTAGE	STATOR RESISTANCE
PROCEDURE	Refer to *Alternator Output Test*	Refer to *Alternator Output Test*	Refer to *Alternator Output Test*	Refer to *Alternator Output Test*
SPEC A 20 AMP	12 to 13 VDC	13.6 to 14.7 VDC	Approximately 21 VAC @ 1800 rpm Approximately 41 VAC @ 3600 rpm	0.06 to 0.10 Ohms
BEGIN SPEC B 20 AMP	12 to 13 VDC	13.6 to 14.7 VDC	Approximately 29 VAC @ 1800 rpm Approximately 57 VAC @ 3600 rpm	0.10 to 0.19 Ohms
35 AMP	12 to 13 VDC	13.6 to 14.7 VDC	Approximately 24 VAC @ 1800 rpm Approximately 47 VAC @ 3600 rpm	0.06 to 0.10 Ohms

TYPICAL WIRING DIAGRAM



WITH OIL PRESSURE SWITCH FOR LIGHT



WITH OIL PRESSURE SWITCH FOR SHUTDOWN

ES-1667

These typical wiring diagrams show the basic wiring necessary for operation of the engine. Your engine may differ in circuitry and features depending on how the equipment manufacturer chose to configure the final product.

Starting System

ELECTRIC STARTER

Normally the starter will require little or no service other than possible brush replacement. However, if through accident or misuse, the starter requires service or overhaul, the following will provide the information necessary to perform this service.

Service

When starting engine, note starter motor action. The pinion gear should mesh quickly with flywheel ring gear and spin engine. Once engine starts and solenoid opens, the starter should disengage and stop. If starter cranks engine slow, or not at all, check start circuit components. Failure to crank is normally caused by low battery charge, defective battery cables, corroded or poor connections, or low temperatures. If after checking these variables, starter continues to crank slowly, starter must be removed and repaired.

Starter Removal

⚠WARNING ***Accidental starting of the engine can result in severe personal injury or death. Disconnect the negative battery cable and spark plug wires while servicing engine, controls, or associated equipment.***

1. Remove both battery cables from battery. Disconnect ground cable first.
2. Disconnect battery cable and electrical lead wires from starter.
3. Remove starter motor.

Starter Disassembly

1. Remove "M" terminal nut and wire lead from solenoid (Figure 1).
2. Remove the two solenoid mounting screws and remove solenoid.
3. Scribe a mark across frame and rear bracket to aid in assembly. Remove the two through bolts.
4. Remove rear bracket and frame assembly.
5. Carefully remove armature and lever from front bracket. Note direction of lever and retainer.
6. Remove the two brush mounting screws, and remove the rear bracket.
7. Remove brush holder assembly from the frame by pulling the brushes out.

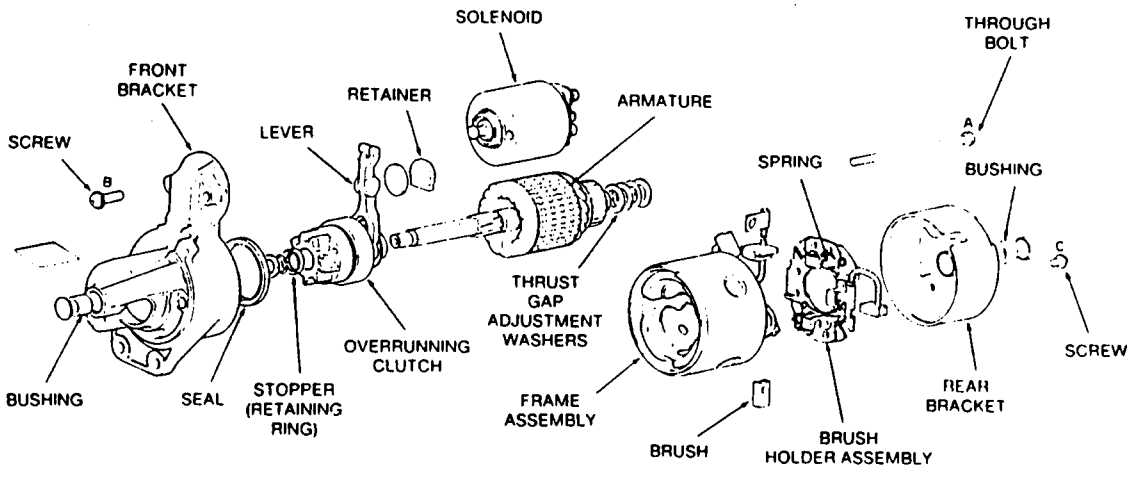


FIGURE 1. STARTER MOTOR

8. Push stopper toward pinion and remove snap ring (Figure 2).

9. Remove stopper and overrunning clutch from armature shaft.

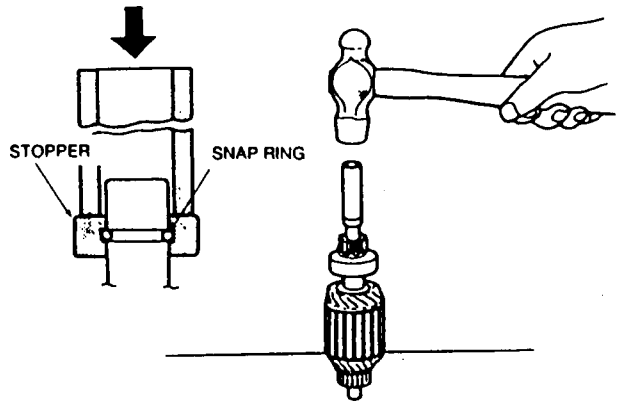


FIGURE 2. REMOVING OVERRUNING CLUTCH

10 Inspect starter for damaged or worn parts.

11. Repair or replace all damaged or worn parts as needed.

Starter Assembly

1. Install seal in nose housing. Install overrunning clutch on the armature shaft.

2. Slide stopper on the armature shaft. Position snap ring in groove in armature shaft.

3. Pull stopper all the way over snap ring (Figure 3). It may be necessary to tap snap ring into groove with a punch while maintaining tension on stopper.

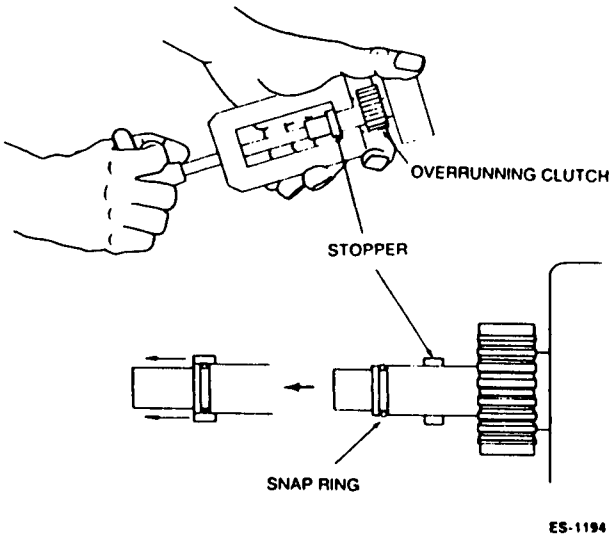


FIGURE 3. INSTALLING STOPPER

4. Lubrication: When starter motor is assembled apply grease to each of the following points (Recommended grade: Multemp PS No. 2):

   - Armature shaft spline
   - Both bushings (Both ends of armature)
   - Stopper on armature shaft
   - Pinion gear
   - Sliding portion of lever

5. Fit overrunning clutch into lever, and install with armature in the front bracket.

6. Install lever retainer and spacer. Position frame assembly over armature on the front bracket.

7. Install brush holder assembly. Position brushes in brush holder. Make certain positive lead wires are not grounded.

8. Install washers, as required, on the rear end of armature shaft to obtain an armature shaft thrust gap of 0.002 to 0.02 inch (0.05 to 0.5 mm). New washers are required if rear bracket is replaced.

Table 1. Starter Assembly Torques

Solenoid Screws	54 in.-lb.	(6.1 Nm)
Brush Retaining Screws	33 in.-lb.	(3.7 Nm)
Through Bolts	51 in.-lb.	(5.8 Nm)

9. Install rear bracket. Secure brush holder to rear bracket with two machine screws.

10. Install and tighten the two through capscrews.

11. Install solenoid plunger in lever. Secure solenoid to front bracket with two machine screws.

12. Install wire lead to the terminal "M" on solenoid.

13. After assembly, adjust pinion clearance. Pinion clearance should be 0.02 to 0.08 inch (0.5 to 2.0 mm); if not, check as follows (Figure 4):

    A. Connect starter to a battery. Close switch. This will shift pinion into cranking position.

    B. Push pinion back by hand and measure pinion clearance. If clearance does not fall within the specified limits, adjust by adding or removing shims located between solenoid and front bracket. Adding shims decreases clearance; removing shims increases clearance. Shims are included with replacement solenoid.

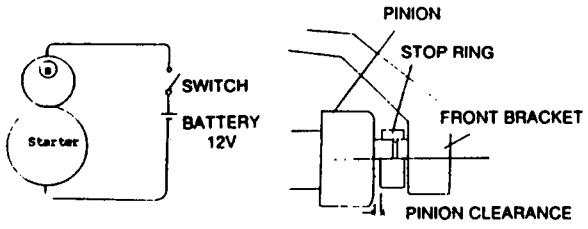


FIGURE 4. PINION CLEARANCE ADJUSTMENT

Inspection and Testing

Inspect the starter components for mechanical defects before testing for grounds or shorts.

Testing Armature for Grounds: Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads (Figure 5). A low ohmmeter reading indicates a grounded armature. Replace grounded armature.

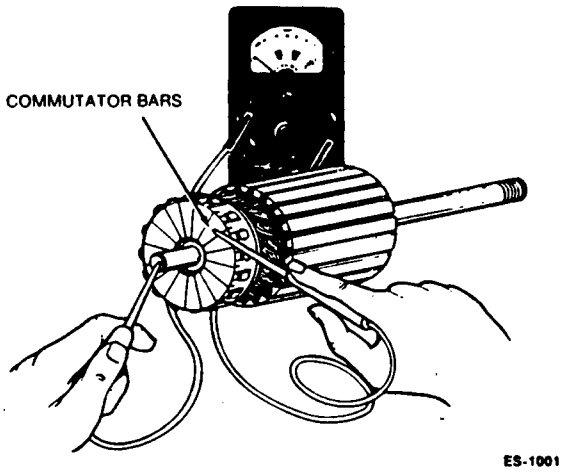


FIGURE 5. TESTING ARMATURE FOR GROUNDS

Testing Armature for an Open Circuit: Using an ohmmeter, check for continuity between the commutator segments. If there is no continuity (high resistance), the segments are open and armature must be replaced.

Testing Armature for a Short Circuit: Use a growler for locating shorts in the armature (Figure 6). Place armature in growler and hold a thin steel blade (e.g. hacksaw blade) parallel to the core and just above it while slowly rotating armature in growler. A shorted armature will cause the blade to vibrate and be attracted to the core. If armature is shorted, replace with a new one.

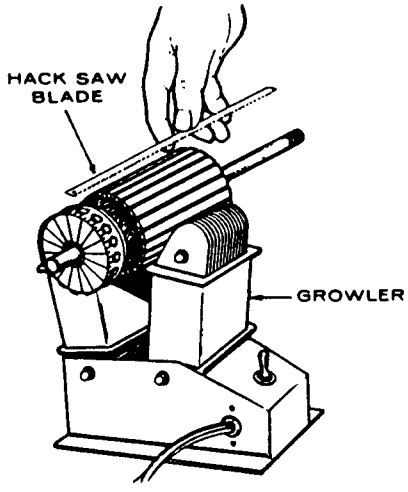


FIGURE 6. TESTING ARMATURE FOR SHORT CIRCUITS

Commutator Inspection: If commutator is dirty or discolored, clean with number 00 to 000 commutator paper. Blow grit out of armature after cleaning.

If commutator is scored, rough, or worn, turn it down in a lathe.

Field Coil: Use an ohmmeter to check for continuity between brushes. If there is no continuity, the field coil is open and must be replaced. With field coil mounted in the frame, check for continuity between the field coil and frame. Replace frame assembly if there is continuity.

Brushes: Clean around brushes and holders, wiping off all brush dust and dirt. If brushes are worn shorter than .4528 inch (11.5 mm) replace them (Figure 7).

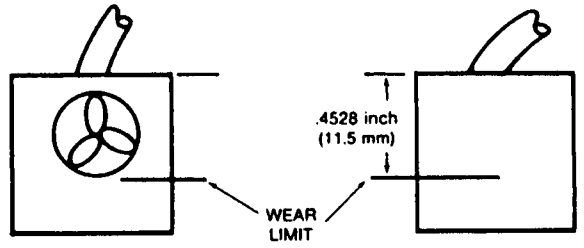


FIGURE 7. BRUSH WEAR LIMIT

Check for shorts between positive side of brush holder and brush holder base. If there is continuity, replace holder assembly. Check for free movement of brushes. All brushes should move freely in the brush holders.

Overrunning Clutch: Inspect pinion and spline teeth for wear or damage.

If pinion gear is worn or damaged, inspect flywheel ring gear also. Rotate pinion. It should turn free when turned in one direction, and lock when turned in the opposite direction.

⚠CAUTION ***Cleaning overrunning clutch in liquid cleaning solution will result in starter damage. Do not clean overrunning clutch in liquid cleaning solutions.***

Solenoid: Push solenoid plunger in and release it. The plunger should return to its original position. While holding plunger all the way in, check for continuity between terminals "M" and "B". If there is no continuity, replace the solenoid (Figure 8). After replacing solenoid check pinion clearance.

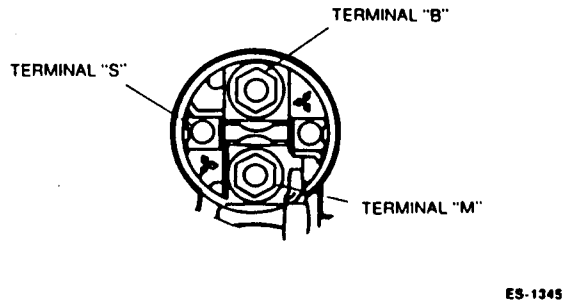


FIGURE 8. SOLENOID TERMINALS

Bushings: If either the front or rear bushing show signs of wear or damage, replace them. Bushing and rear bracket are replaced as an assembly. Check armature shaft thrust gap if rear bracket is replaced.

Remove front bushing by tapping bushing from inside with a 7/16 inch tap. Do not remove cap from front bracket. Thread capscrew, same size as tap, into bushing. Using a slide hammer remove bushing from front bracket. Press new bushing into front bracket. Use care not to distort inside diameter of bushing.

Brush Replacement: Cut old positive brush from pigtail at the brush. Be careful not to damage field coil. Clean 1/4 to 3/8 inch (6.5 to 9.5 mm) of brush end of pigtail with sandpaper or emery cloth. (Figure 9).

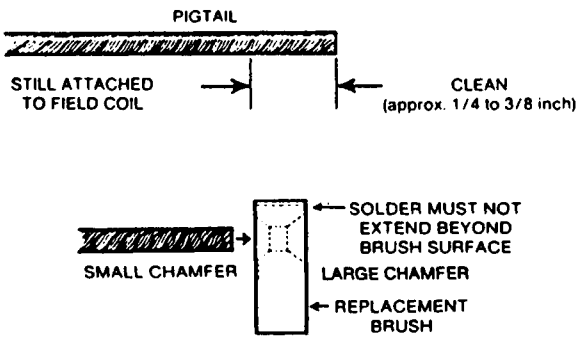


FIGURE 9. BRUSH REPLACEMENT

Push prepared end of pigtail lead into hole in replacement brush from the small chamfered side. Solder pigtail lead to replacement brush on the large chamfered side, using 50/50 tin/lead, rosin core solder and a standard 240/325 Watt soldering iron. Use a file to remove any excess solder that may extend beyond brush surface.

⚠CAUTION ***Material protruding from soldered side surface of brush can cause equipment damage. Do not use excessive solder or heat and file any excess material from brush surface.***

Starter Mounting

Before installing starter motor, make sure the starter mounting surface on the engine base is clean and free of oil.

To install starter use the following procedure. The starter pinion gear lash does not require adjustment.

1. Install starter motor and torque mounting capscrews to that specified in *ASSEMBLY TORQUES.*

2. Connect battery cable and wires to starter. Connect battery cables to battery. Connect ground cable last.

Engine Disassembly

DISASSEMBLY/ASSEMBLY

When complete engine disassembly is necessary, first remove all complete assemblies. Individual assemblies such as fuel pump and carburetor can be disassembled and repaired at another time.

Suggested Disassembly Order

1. Drain crankcase.
2. Disconnect all exhaust and electrical lines.
3. Remove engine from its mountings and place on a suitable bench or work stand.
4. Remove all housings, shrouds, blower housings, etc.
5. Remove flywheel, using a puller.
6. Remove ignition trigger and gear cover, being careful to protect oil seal from keyway damage.
7. Remove crank gear, using a gear puller and ring.
8. Remove all accessories such as oil filter, starter, intake manifold, fuel lines, spark plugs, etc.
9. Remove oil base, oil pump and cylinder heads.
10. Remove valves, springs, lifters, etc.
11. Remove camshaft and gear assembly.
12. Remove connecting rods and pistons.
13. Remove rear bearing plate, crankshaft, and front bearing.

Keep all parts in their respective orders. Keep valve assemblies together. Return rod caps to their respective pistons. Analyze the reasons for parts failure.

Suggested Assembly Procedure

Engine assembly is normally the reverse of the disassembly procedure, observing proper clearances and torques. Use a torque wrench to assure proper tightness. Coat the internal engine parts with oil as they are assembled. After the internal engine parts are assembled, the engine should turn over by hand freely. Use only genuine Onan parts and special tools when reassembling your engine.

1. Use proper bearing driver to install front main bearing after coating it with a light film of oil.
2. Insert rear main bearing in rear bearing plate.
3. Insert crankshaft, rear bearing plate, and crankshaft gear.
4. Install pistons and connecting rods.
5. Install camshaft and gear assembly; align crank gear mark with cam gear mark.
6. Install valve assemblies, oil pump, oil base, and cylinder heads.
7. Install all accessories such as oil filter, starter, fuel lines and spark plugs.
8. Install gear cover with oil seal, trigger ring, and flywheel.
9. Check valve clearance.
10. Install all housings and air cleaner.
11. Fill crankcase with oil.

Operation

Start engine and check oil pressure. Run for approximately 15 minutes to bring engine to operating temperatures. Check for oil leaks, fuel leaks, and exhaust leaks. Adjust carburetor and governor for speed and sensitivity.

Testing Compression

The compression tester is used to determine the condition of valves, pistons, piston rings and cylinders.

To check compression:

1. Run the engine until thoroughly warm.
2. Stop engine and remove spark plugs.
3. Remove air cleaner and place throttle and choke in the wide open position.
4. Insert the compression gauge in one spark plug hole.
5. Crank the engine and note the reading.

Refer to *SPECIFICATIONS* for compression pressures. There may be variations due to equipment, temperature, atmospheric conditions and altitude. These pressures are for a warm engine at cranking speed (about 300 rpm).

Tappet Adjustment

The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted as specified in the *Periodic Maintenance Schedule* (located in the Operator's Manual). Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove ignition key to prevent accidental starting.
2. Remove all parts necessary to gain access to valve tappets.
3. Remove spark plugs to ease the task of turning the engine over by hand.
4. Place a socket wrench on the flywheel capscrew and rotate the crankshaft in a clockwise direction until the left intake valve (viewed from flywheel end) opens and closes. Continue turning the crankshaft until the TC mark on the flywheel is lined up with the TC mark on the gear cover. This should place the left piston (#1) at the top of its compression stroke. Verify that the left intake and exhaust valves are closed and there is no pressure on the valve lifters.
5. The correct feeler gauge for the valve adjustment (see *SPECIFICATIONS)* should pass freely between valve cap (P216, P218, P220) or valve stem (P224) and tappet; a 0.002 inch (0.05 mm) thicker gauge should not (Figure 1).
6. To correct valve clearance, use a 7/16 inch open end wrench to turn the adjusting screw to obtain the correct clearance. The screw is self-locking and will stay where it is set. A 9/16 inch (14 mm) open end wrench is required to hold the tappet while turning the adjusting screw.
7. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
8. Replace all parts removed in Step 2. Tighten all screws securely. Torque manifold bolts to specified torque.

VALVE SYSTEM

A properly functioning valve system is essential for good engine performance. All engines utilize an L-head type valve design as shown in Figure 1. Access to the valve system can be obtained by removing the cylinder heads and the valve covers on top of the engine. A valve spring compressor must be used to remove valves from the cylinder block.

A valve stem seal is used on the intake valve guides. This seal must be replaced each time the valve is removed.

Place valves, springs, retainers, and tappets in a rack as they are removed from cylinder block so they can be identified and reinstalled in their original locations. Discard old valve stem seals and replace with new ones during assembly.

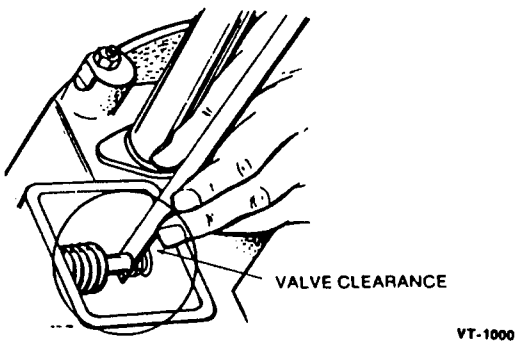
Use the following procedures to inspect and service the valve system.

Inspection

Clean carbon from the valves, valve seats, valve guides, and cylinder block.

Valves: Check the valve face for evidence of burning, warpage, out-of-round, and carbon deposits.

Burning and pitting are caused by the valve failing to seat tightly. This condition is often caused by hard carbon particles on the seat. It may also be due to weak valve springs, insufficent tappet clearance, warpage, and misalignment.



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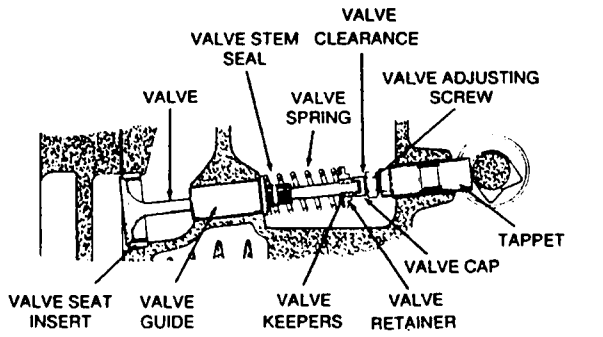
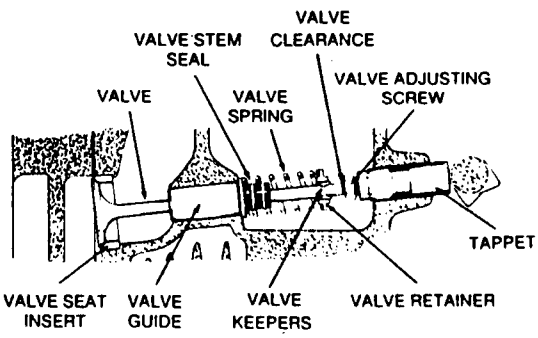


VT-1034

FIGURE 1A. INTAKE VALVE ASSEMBLY - P216, P218, P220



VT-1035

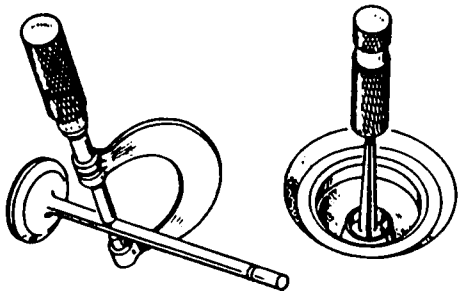
FIGURE 1B. INTAKE VALVE ASSEMBLY - P224

Warpage occurs chiefly in the upper stem due to its exposure to intense heat. Out-of-round wear follows when the seat is pounded by a valve whose head is not in line with the stem and guide. If a valve face is burned or warped, or if the stem is worn, install a new valve.

Too much clearance in the intake guide admits air and oil into the combustion chamber, upsetting carburetion, increasing oil consumption, and making heavy carbon deposits. Carbon reduces heat dissipation. Clean metal is a good heat conductor but carbon insulates and retains heat. This increases combustion chamber temperatures which causes warping and burning.

Unburned carbon residue gums valve stems and causes them to stick in the guide. Deposits of hard carbon with sharp points projecting become white hot and cause pre-ignition and pinging.

Refinish valves that are slightly pitted or burned on an accurate valve grinder. If valves are badly pitted or have a thin margin when refacing, replace them.



VT-1020

FIGURE 2. VALVE STEM AND VALVE GUIDE INSPECTION

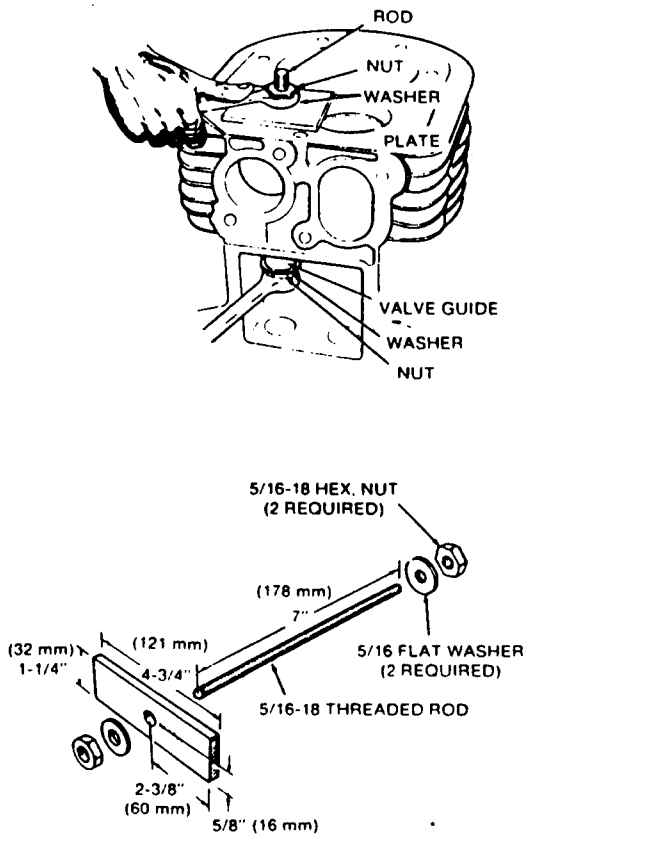
Stems and Guides: Always check valve stems and guides for wear (Figure 2). Use a hole gauge to measure the valve guide. When clearance with stem exceeds that specified in *DIMENSIONS AND CLEARANCES* replace either valve or guide or both, as may be necessary. Always regrind seat to make concentric with the newly installed guide.

Worn valve stem guides can be replaced from inside the valve chamber (a seal is provided behind the intake valve guides only). The smaller diameter of the tapered valve guides must face toward the valve head. Tappets are also replaceable from the valve chamber after first removing the valve assemblies.

Valve Guide Removal: Before removing valve guides, use an electric drill with a wire brush to remove carbon and other foreign material from top surface of guides. Failure to perform this operation may result in damage to the guide bores. Drive the guides out with a hammer and valve guide drive.

⚠CAUTION ***Driving out old valve guides can cause guide and tappet bore damage. Do not strike guide or tappet bores with driver during removal.***

Valve Guide Installation: Run a small polishing rod covered with crocus cloth through valve guide holes to clean out carbon and other foreign materials. Place a new gasket on the intake valve guide, and coat the outer edge of each new guide with oil. Place guide in cylinder block and press in until guide protrudes 11/32 inch (8.7 mm) from valve box side of block. A suggested method of installation is shown in Figure 3.



VT-1023

FIGURE 3. VALVE GUIDE INSTALLATION

Valve Stem Seals (intake only): Do not reuse valve stem seals. Each time the valves are removed from cylinder block, a new seal must be used when valve is reinstalled.

⚠CAUTION ***Removing a valve after installing valve stem seal can cause seal damage. Do not allow valve stem groove to come in contact with valve stem seal after installation.***

Valve Spring: Check valve springs for cracks, worn ends, distortion, and tension. If spring ends are worn, check valve spring retainer for wear. Check for spring distortion by placing spring on a flat surface next to a square. Measure height of spring and rotate it against square edge to measure distortion. If distortion exceeds 0.06 inch (1.5 mm) replace spring. Check spring tension at the installed height for both the valve open and closed position using an accurate valve spring tester. Replace any valve spring that is weak, cracked, worn, or distorted.

Valve Rotators: The P216, P218, and P220 engines use free-rotating intake and exhaust valves. While in the open position, the valves must rotate freely.

The P224 engine uses positive type valve rotators on the exhaust valves. When functioning properly, the valves are rotated a fraction of a turn each time they open. While in the open position, the valves must rotate freely. There is no easy way to determine if a valve rotator is good or bad. Onan recommends that valve rotators be replaced at each major overhaul or if a build up of carbon is noted on valve face and valve seat.

Valve Seats: Inspect valve seat inserts. If seats are loose, cracked or severely pitted, new ones must be installed. Remove valve seat inserts using a valve seat removal tool. If valve seat insert bores in cylinder block are damaged or worn so that a press fit cannot be obtained when installing new standard size valve seat inserts, the bores must be machined for an oversize seat.

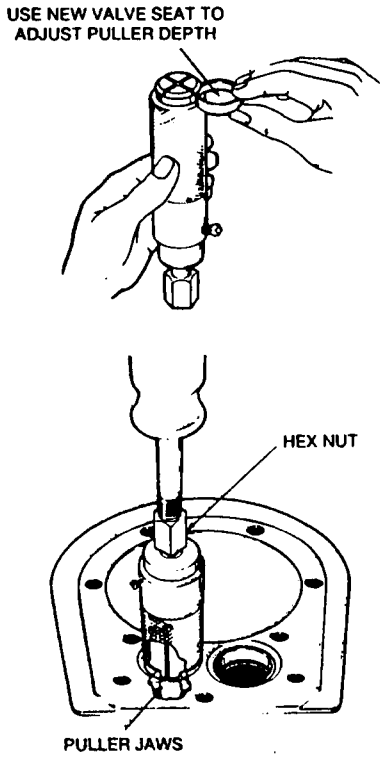


FIGURE 4. VALVE SEAT REMOVAL

Valve Seat Removal: Remove carbon and combustion deposits from valve seat. Select proper puller size determined by inside diameter of valve seat. On some pullers use a new seat as a guide to adjust puller depth (Figure 4). Puller jaws must expand into cylinder block at the point where bottom of valve seat insert rests on cylinder block. Position puller on valve seat and tighten hex nut. Clamp cylinder block to a solid bench. Attach slide hammer to puller. Tighten hex nut between each blow with the slide hammer.

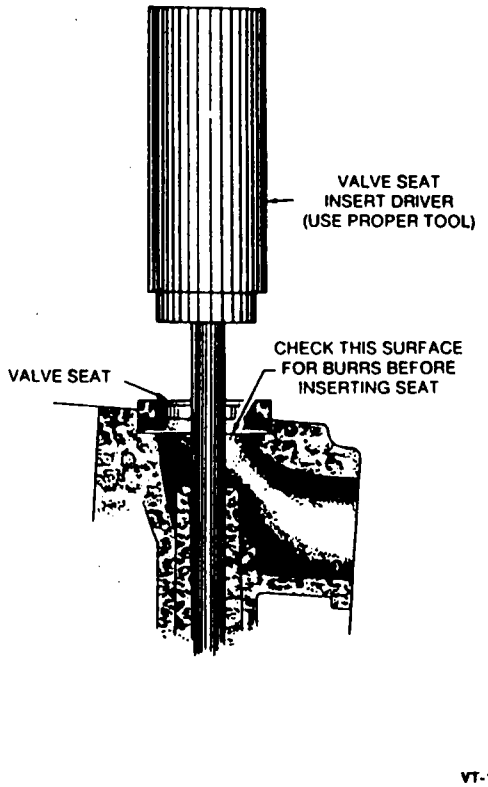


FIGURE 5. INSERTING NEW VALVE SEAT

Valve Seat Installation: After the old seat has been removed, clean out any carbon or metal burrs from the seat insert recess. Use a valve seat insert driver and hammer to install the insert (Figure 5). Drive the valve seat insert in so the insert enters the recess evenly. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference.

To assure a tight valve seat fit and eliminate the danger of seat loosening in the bore, valve seat must be staked.

Insert valve seat staker into valve seat or guide in cylinder block. Using a lead hammer, strike the staking tool a sharp blow to wedge new valve seat securely in place. It will be necessary to refinish valve seat inserts before installing valves.

TAPPETS

Very little wear takes place on tappet diameters or in tappet bores. If the clearance between tappet and bore in cylinder block exceeds specifications, replace the tappet.

Inspect the tappet faces which contact camshaft lobes for roughness, scuffing, or concave wear. Replace any worn tappets. If tappets are worn, inspect camshaft for wear.

VALVE FACE AND SEAT GRINDING

Before installing new valves or previously used valves, inspect valve seats for proper valve seating. If used valves are reinstalled, the valve stems should be cleaned and valve faces ground to their specified angles of 44°. Refinish valve seats to a 45° angle. When refacing valves and seats, remove all evidence of pitting and grooving. If end of valve stem is pitted or worn, true it and clean it up on the refacer wheel. A very light grind is usually enough to square stem and remove any pits or burrs. The valve guide should be thoroughly cleaned. If valve guide is worn, or valve is warped, the necessary parts must be replaced.

By grinding the valve face and seat at slightly different angles, a fine line of contact on face and seat is obtained, eliminating the need to lap the seating surfaces. The one degree difference in angles is defined as the interference angle (Figure 6). The seat angle is greater than that of the valve face. This assures contact at the maximum diameter on valve seat seating surface.

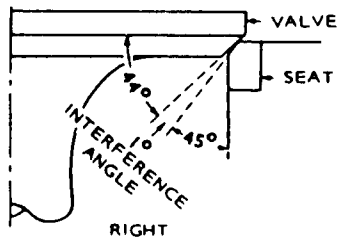


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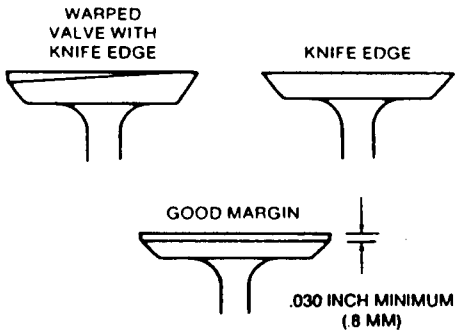
FIGURE 6. VALVE INTERFERENCE ANGLE

Refinish valve faces to a 44° angle on a valve refacing machine. The first cut from valve face must be a light grinding. Check if there is an unevenness of metal being removed. If only part of valve's face has been touched, check to see if valve is properly seated in machine or if valve is warped, worn, or distorted. When cut is even around the whole valve face, keep grinding until complete face is ground clean. Be sure the correct valve face angle is maintained. When valve head is warped, a knife edge will be ground (Figure 7) on part or all of the head due to the large amount of metal that must be removed to completely reface valve. Heavy valve heads are required for strength and good heat dissipation. Knife edges lead to breakage, burning, and pre-ignition due to heat localizing on the edge.

Replace any valve that cannot be entirely refaced while keeping a good valve margin (Figure 7) or is warped, worn, or damaged in any way. The amount of grinding necesary to true a valve indicate whether valve head is worn or warped.



M-1184

FIGURE 7. VALVE HEAD MARGIN

When new valve seats are installed, or previously used seats reground, refinishing must be done with a valve seat grinder used according to the manufacturer's directions.

Valve seats should be ground with a 45 degree stone and the width of the seat band should be 1/32 inch to 3/64 inch (0.8 to 1.2 mm) wide. Grind only enough to assure proper seating.

Place each valve in its proper location. Check each valve for a tight seat. Make several marks at regular intervals across the valve face using machinist's bluing. Observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat. The valve seat should contact the valve face evenly at all points. The line of contact should be at the center of the valve face.

FLYWHEEL

Removing the flywheel is a relatively simple process, but the following procedure must be followed to avoid damage to the gear case and possible injury to the operator.

1. Turn the flywheel mounting screw outward about two turns.

   ⚠WARNING ***Incorrect flywheel removal can result in severe personal injury. Do not remove flywheel screw completely when using flywheel puller.***

2. Install a puller bar on the flywheel (Figure 8).

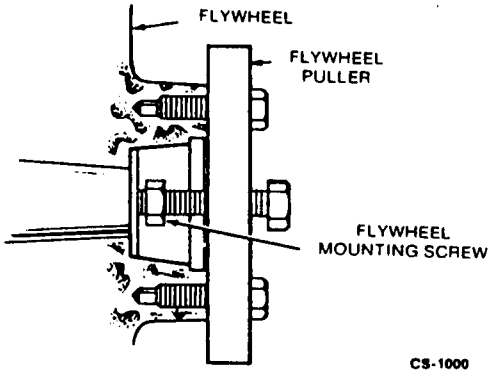


FIGURE 8. BLOWER WHEEL PULLEY

3. Turn the puller bar bolts in, alternately, until the wheel snaps loose on the shaft.

   ⚠CAUTION ***Improper flywheel removal can cause gear case damage. Do not use any tools to pry against gear cover when removing flywheel.***

4. Unscrew the puller from the flywheel, remove the flywheel mounting screw and washer and pull the flywheel off the shaft. Take care not to drop the wheel. A bent or broken fin will destroy the balance.

GEAR COVER

After removing the mounting screws, tap the gear cover gently with a soft faced hammer to loosen it.

When installing the gear cover, make sure the pin in the gear cover engages the nylon lined (smooth) hole in the governor cup. Turn the governor cup so the nylon lined hole is at the three o'clock position. Use a small amount of grease to assist in holding governor cup in position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal (Figure 9).

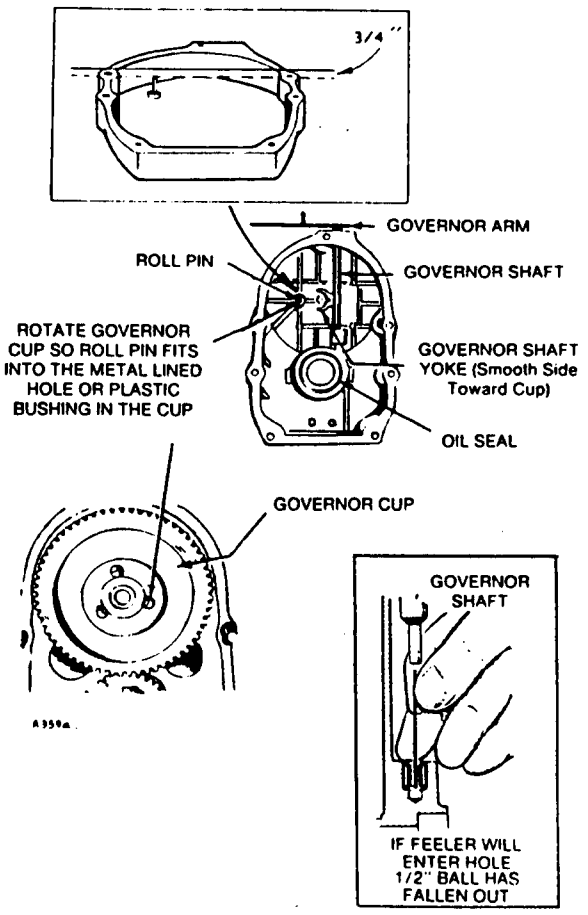


FIGURE 9. GEAR COVER ASSEMBLY

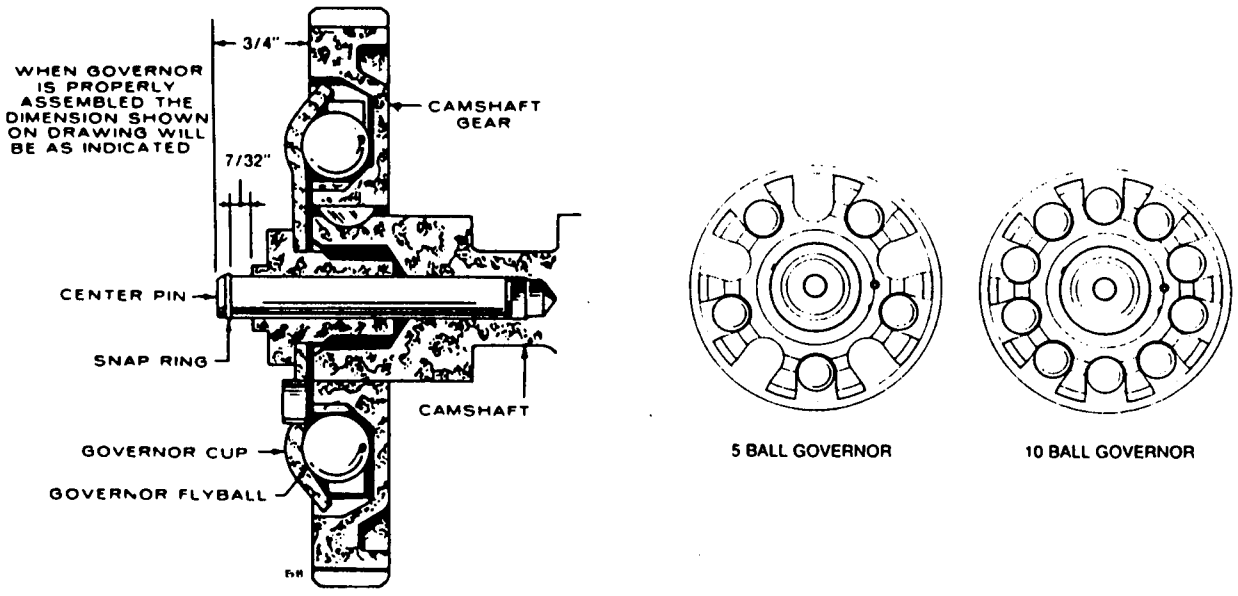


FIGURE 10. GOVERNOR CUP DETAILS

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off (Figure 10).

Replace with a new part any flyball which is grooved or has a flat spot; the ball spacer if its arms are worn or otherwise damaged; the gear/spacer assembly if loose on gear hub, and the governor cup if the race surface is grooved or rough. The governor cup must be a free-spinning fit on the camshaft center pin, but without any excessive play.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place (Figure 10), and install the cup and snap ring on the center pin.

The camshaft center pin extends out 3/4 inch (19 mm) from the end of the camshaft. This distance provides an in-and-out travel distance of 7/32 inch (5.6 mm) for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly. If the distance is less than 7/32" (5.6 mm), the engine will race, especially at no load. Remove the center pin and press in a new pin.

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, always install both gears new.

The camshaft and gear must be replaced as an assembly. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies.

To remove the crankshaft gear, first remove the snap ring and retainer washer, then attach the gear pulling ring using two No. 10-32 screws (Figure 11). Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and proceed to remove the gear.

Each timing gear is stamped with "O" near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. When installing the camshaft gear and shaft assembly, be sure the thrust washer is properly in place behind the camshaft gear. Then install the crankshaft retaining washer and lock ring.

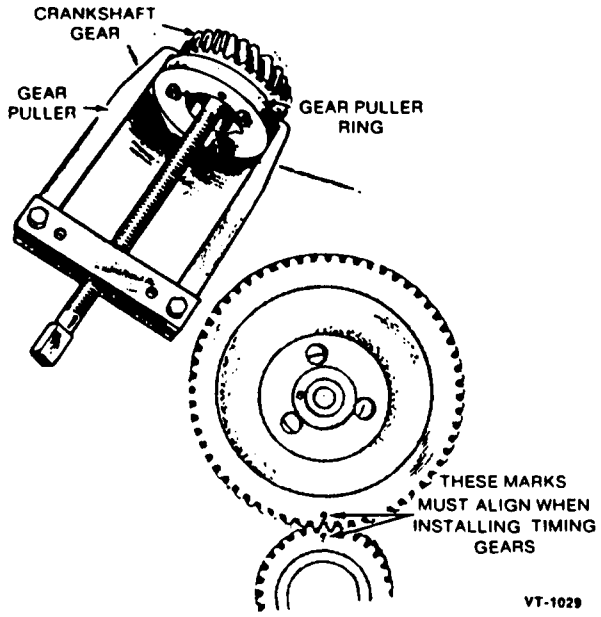


FIGURE 11. TIMING GEAR REMOVAL AND INSTALLATION

PISTONS AND CONNECTING RODS

Observe the following procedure when removing pistons and connecting rods from the engine.

1. Drain oil.
2. Remove the cylinder head and oil base pan from the engine.
3. Remove the ridge from the top of each cylinder with a ridge reamer before attempting piston removal (Figure 12).

⚠CAUTION ***Improper piston removal can cause piston damage. Use ridge reamer to remove cylinder ridge before removing piston.***

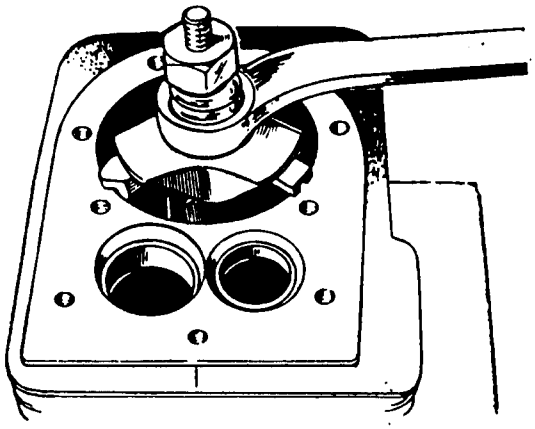


FIGURE 12. REMOVING RIDGE FROM CYLINDER

4. Turn the crankshaft until the piston is at the bottom of its stroke and remove the connecting rod nuts. Lift the rod bearing cap from the rod and push the rod and piston assembly out through the top of the cylinder using a hammer handle. Do not scratch the crankpin and cylinder wall when removing the piston and rod.
5. Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps with their respective rods.
6. Remove the piston rings from the piston with a piston ring spreader (Figure 13). Remove the piston pin retainer and push the piston pin out.

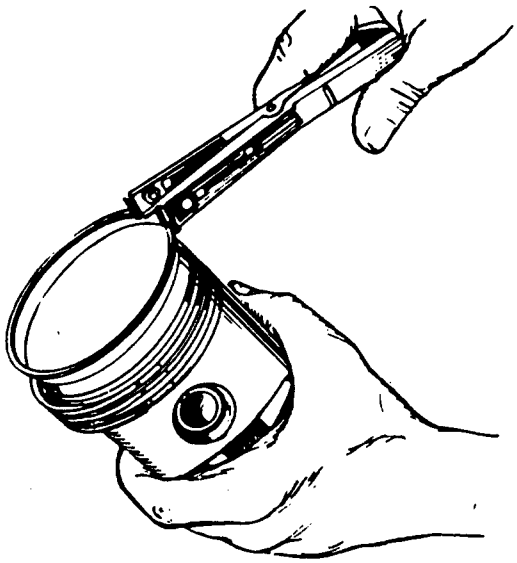


FIGURE 13. REMOVING PISTON RINGS

7. Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (Figure 14). Care must be taken not to remove metal from the groove sides.

⚠CAUTION ***Improper piston cleaning can cause piston damage. Do not use a caustic cleaning solvent or wire brush for cleaning pistons.***

8. Clean the connecting rods in solvent. Blow out all passages with compressed air.

P224

Engines that have been filled with 0.005 inch (0.13 mm) oversize pistons at the factory are identified by the letter E after the serial number. Number is stamped on the cylinder block and on the unit nameplate.

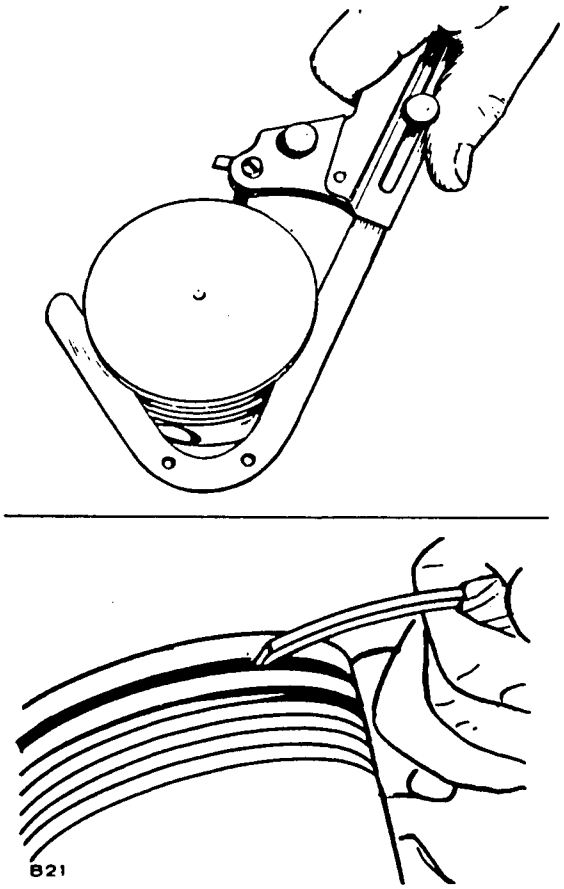


FIGURE 14. PISTON GROOVE CLEANING

Inspection

Follow the procedures given below when inspecting pistons and connecting rods.

Piston Inspection:

1. Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge (Figure 15). Replace the piston when the side clearance of the top compression ring reaches that specified in *DIMENSIONS AND CLEARANCES.*

2. Replace pistons showing signs of scuffing, scoring, worn ring lands, fractures or damage from preignition. Excessive piston wear near the edge of the top ring land indicates preignition.

Connecting Rod Inspection:

Replace connecting rod bolts and nuts that have damaged threads. Replace connecting rods that

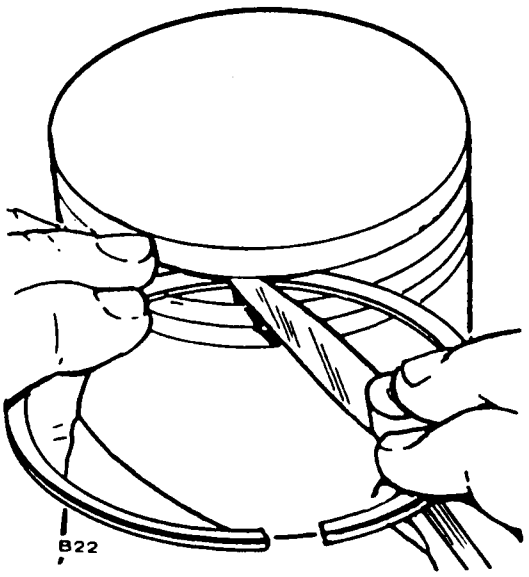


FIGURE 15. CHECKING RING SIDE CLEARANCE

have deep nicks, signs of fractures, scored bores, or bores with dimensions which exceed that specified in *DIMENSIONS AND CLEARANCES.*

Measuring Pistons:

1. Proper piston tolerances must be maintained for satisfactory operation.

2. Refer to *DIMENSIONS AND CLEARANCES* to determine where to measure piston to be sure the total clearance follows specifications.

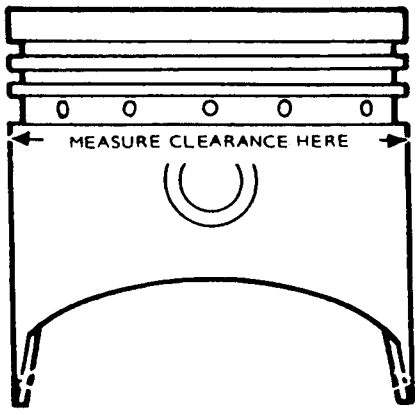


FIGURE 16. MEASURING PISTON CLEARANCE

Measuring Piston Rings:

1. Install the piston ring in the cylinder bore. Invert the piston and push the ring to the end of ring travel, about halfway into the bore, which trues the ring end gap. Check the gap with a feeler gauge (Figure 17).

2. The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correct set of rings and the correct bore size. A cylinder bore that is 0.001 inch (0.03 mm) under size will reduce the end gap 0.003 inch (0.08 mm).

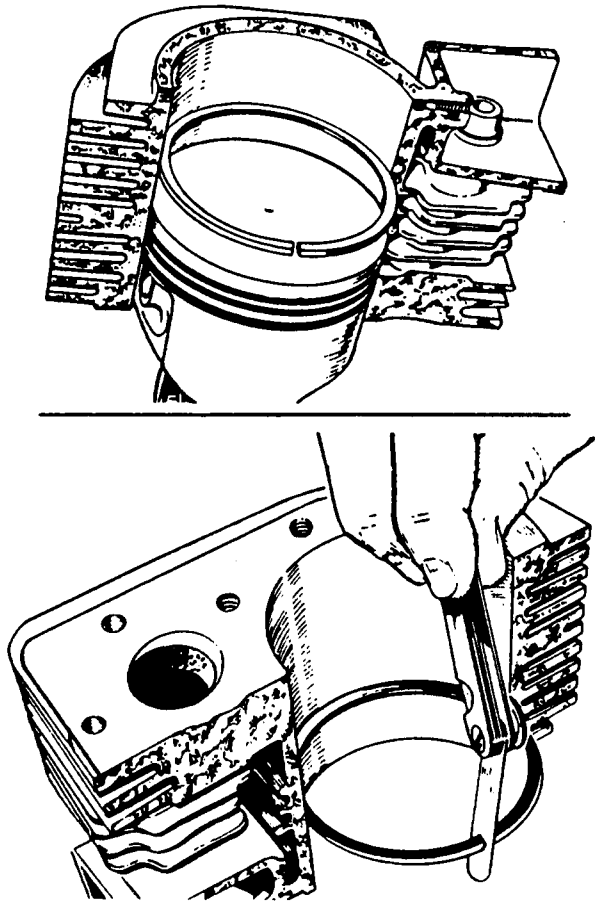


FIGURE 17. POSITIONING OF PISTON RING AND MEASURING OF END GAP

CYLINDER BLOCK

The cylinder block is the main support for all other basic engine parts. Crankshaft and camshaft are supported by the block, assuring alignment of the crankshaft and cylinder bores.

Cleaning

After removing pistons, crankshaft, cylinder heads, etc., inspect block for cracks and wear. If block is still serviceable, prepare it for cleaning as follows:

1. Scrape all old gasket material from block. Remove oil by-pass to allow cleaning solution to contact inside of oil passages.

2. Remove grease and scale from cylinder block by agitating in a bath of commercial cleaning solution or hot soapy washing solution.

3. Rinse block in clean hot water to remove cleaning solution.

Inspection

When rebuilding the engine, thoroughly inspect block for any condition that would make it unfit for further use. This inspection must be made after all parts have been removed and block has been thoroughly cleaned and dried.

1. Make a thorough check for cracks. Minute cracks may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area. Always replace a cracked cylinder block.

2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.

3. Check top of block for flatness with a straight edge and a feeler gauge.

Cylinder Bore Inspection: Inspect cylinder bores for scuffing, scratches, wear, and scoring. If cylinder bores are scuffed, scratched, worn, or scored, they must be rebored and honed for the next oversize piston.

When the appearance of cylinder bores is good and there are no scuff marks, check cylinder bore for wear or out of roundness as follows:

1. Check cylinder bore for taper, out of round, and wear with a cylinder bore gauge, telescopic gauge, or inside micrometer. These measurements should be taken at four places: top and bottom of piston ring travel, parallel and perpendicular to axis of crankshaft (Figure 18).

2. Record measurements taken at top and bottom of piston travel as follows:

   A. Measure and record as "A" the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore.

   B. Measure and record as "B" cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.

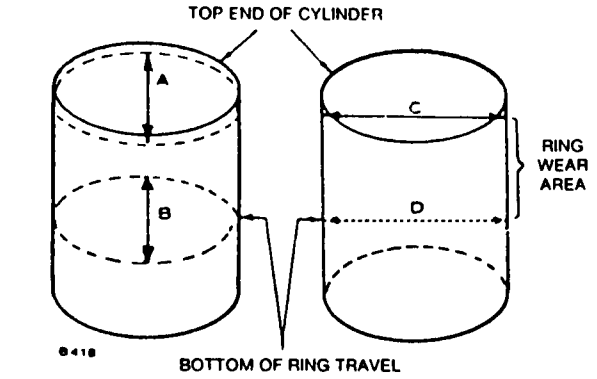
   C. Measure and record as "C" cylinder bore diameter (perpendicular to crankshaft) near the top of cylinder bore.

   D. Measure and record as "D" cylinder bore diameter (perpendicular to crankshaft) at the bottom of piston travel.

   E. Reading "A" subtracted from reading "B" and reading "C" subtracted from reading "D" indicates cylinder taper.

      If cylinder taper exceeds that specified in *DIMENSIONS AND CLEARANCES* rebore and hone cylinder to the next oversize.

   F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicate whether or not cylinder is out of round. If out of round exceeds that specified in *DIMENSIONS AND CLEARANCES* the cylinders must be rebored and honed to the next oversize.



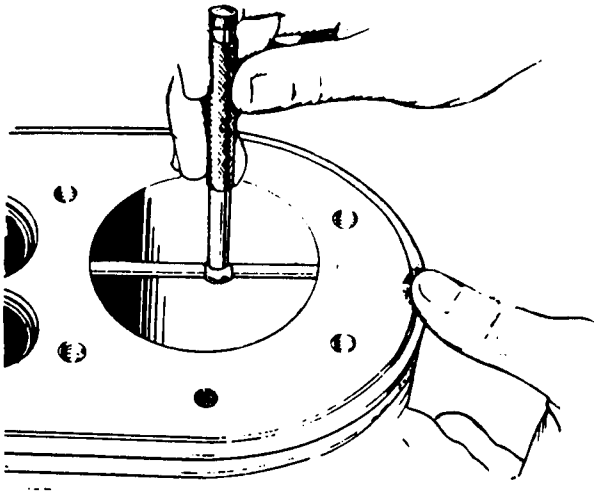


FIGURE 18. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

Reboring the Cylinder

Rebore and hone engine whenever cylinder bore is worn, damaged, out of round, or if cylinder taper exceeds specifications. A worn cylinder bore should be resized to the smallest standard oversize diameter at which it will clean up. The final finish and bore diameters should then be obtained by honing. Final bore diameter should equal the standard diameter added to the oversize.

⚠CAUTION ***Improper boring will result in engine damage. Boring must be done by qualified mechanics.***

After boring to the correct oversize cylinder bore dimension piston and ring clearance should be appropriate. There is no need to adjust or "fit" pistons and rings.

When reboring cylinders, take the following precautions:

1. Make sure cutting tool is properly ground before using it.

2. Be sure top of engine block is smooth and deposit free.

3. Clean base of boring bar before bar is set up. Deposits under boring bar will cause it to tilt and the cylinder will be distorted after boring.

4. Make an initial rough cut, followed by a finish cut. Then hone cylinder bore to the specified oversize.

Honing Cylinders (Using Precision Hones)

Refer to hone manufacturer's recommended grit size to produce specified surface finish of 20 to 40 RMS. Too rough of a finish will wear out the rings and too smooth of a finish can retard piston ring seating.

1. Position block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.

2. Follow hone manufacturer's instructions for the use of oil or lubricant on stones. Do not use lubricants with a dry hone.

3. Insert hone in bore and adjust stones to fit snugly to the narrowest section. When adjusted correctly, the hone should not shake or chatter in cylinder bore, but will drag freely up and down when hone is not running.

4. Connect drill to hone and start drill. Feel out bore for high spots, which cause an increased drag on stones. Move hone up and down in bore with short overlapping strokes about 40 times per minute. Usually bottom of cylinder must be worked out first because it is smaller. As cylinder takes a uniform diameter, move hone up and down all the way through cylinder bore.

5. Check diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check size at six places in bore: measure twice at top, middle and bottom at 90-degree angles.

6. Crosshatch formed by the stones should form an included angle of 23 degrees. This can be achieved by moving the rotating hone (250 to 450 rpm) up and down in cylinder bore about 40 times per minute.

7. Clean cylinder bores thoroughly with soap, water and clean rags. A clean white rag should not become soiled on wall after cleaning is complete. Do not use a solvent or gasoline since they wash oil from the walls but leave the metal particles.

8. Dry crankcase and coat it with oil.

Deglazing Cylinder Bores

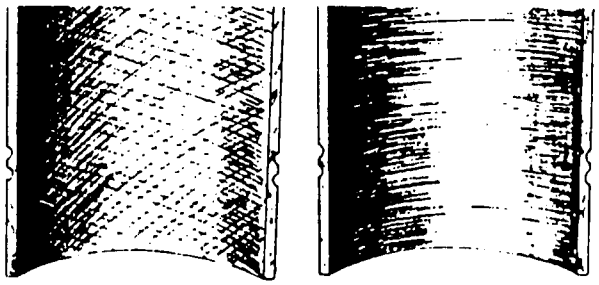
Deglaze the cylinder bores if there are no scuff marks and no wear or out of round beyond specifications before installing new rings. Deglazing gives a fine finish, but does not enlarge cylinder diameter, so the original pistons with new rings may still be used.

The reason for deglazing a cylinder is to provide cavities to hold oil during piston ring break-in.

1. Wipe cylinder bores with a clean cloth which has been dipped in clean, light engine oil.

2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.

3. Use a slow speed drill to drive the deglazing tool. Move deglazing tool up and down in cylinder (10 to 12 complete strokes) rapidly enough to obtain a crosshatch pattern (Figure 19).



PRODUCE CROSSHATCH SCRATCHES FOR FAST RING SEATING

AVOID THIS FINISH

FIGURE 19. CROSSHATCHING

⚠CAUTION ***Improper cylinder cleaning will result in engine damage. Do not use gasoline, solvents, or commercial cleaners to clean cylinder bores.***

4. Clean cylinder bore thoroughly with soap, water and clean rags. Continue cleaning until a clean white rag shows no discoloring when wiped through cylinder bore.

CRANKSHAFT

Clean crankshaft thoroughly and inspect journals for scoring, chipping, cracking, or signs of overheating. If crankshaft has overheated, is scored, or excessively worn, reconditioning or replacement will be required. Examine bearing journals for cracks if overheating has occurred.

Measure crankshaft main bearing and connecting rod journals at several places on their diameter to check for roundness and taper.

The only recommended method of reconditioning the crankshaft is regrinding, as required to accommodate undersize bearings. Metalizing of bearing journals is not recommended.

If regrinding of crankshaft journals is necessary, the work should be done by a reputable machine shop that has suitable equipment to handle precision work of this type. Undersize main bearings and connecting rods are available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

BEARINGS

With camshaft and crankshaft removed, use a micrometer to measure diameter of bearing journals. Use a dial bore gauge or a telescopic gauge and micrometer to measure inside diameter of bearings. Refer to *DIMENSIONS AND CLEARANCES* to determine if clearances are within specifications.

Any bearing that is scored, chipped, pitted or worn beyond the specified limits must be replaced.

Removal of the camshaft bearings requires complete disassembly of the engine. Use a press or a suitable driver to remove bearings. Support casting to avoid distortion and to avoid damaging the bearing bore during removal and installation.

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Clean outside of the bearing and bearing bore in the block. Before installing cam bearings use Locktite Bearing Mount on outside diameter of bearing. Use a combination bearing driver to install bearings.

Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in the proper position. Be sure to start the bearing straight. Press in the front bearing flush with the outside end of the bearing bore. Front cam bearing oil hole must line up with oiling hole in cylinder block (Figure 20). Press in the rear camshaft bearing to the dimension shown (Figure 20). Lubricate bearing surfaces with oil after installing.

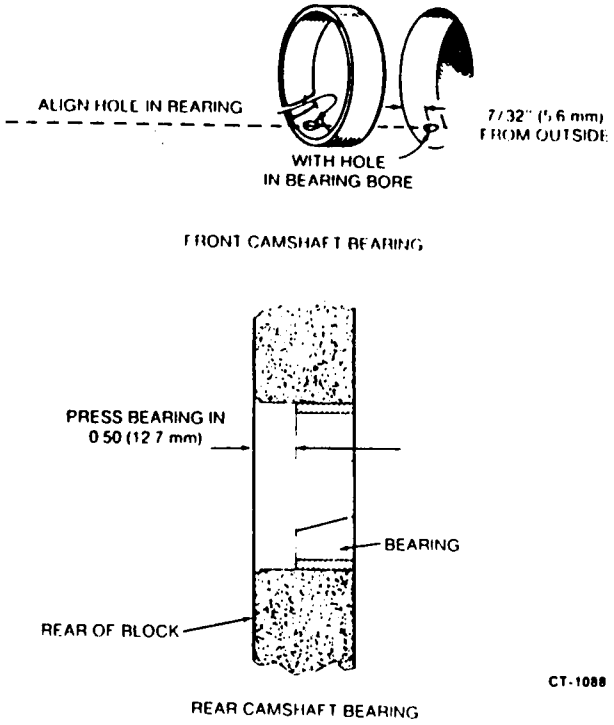


FIGURE 20. CAMSHAFT BEARINGS

New crankshaft main bearings are precision type which do not require line reaming or line boring after installation. Use a press or a suitable driver to remove bearings. Support casting to avoid distortion and to avoid damaging the bearing bore during removal and installation.

Before installing main bearings, expand bearing bore by placing the casting in an oven heated to 200°F (94°C). If practical, cool the precision bearing to shrink it.

Before installing the front main bearing, use the towelette included with the bearing kit to clean the outside of the bearing and bearing bore in the block.

⚠WARNING ***Breathing vapor from towelette and prolonged contact with skin can be harmful. Use only in well ventilated area and avoid prolonged contact with skin.***

After allowing three to four minutes for drying, apply the Locktite from the small tube to the mating surfaces of the bearing and the bearing bore. Align the oil holes in the bearing with the oil holes in the bearing bore (Figure 22). The oil passage should be at least half open. Install the bearing flush with the block, using the combination driver. Wipe off excess Locktite around the bearing. Allow at least one hour for hardening at room temperature.

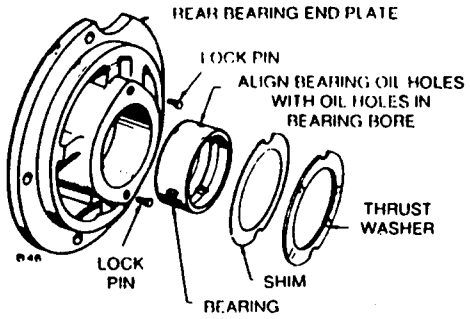


FIGURE 21. BEARINGS FOR REAR BEARING PLATE

Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 22. Do not add an additional thrust washer to this front bearing.

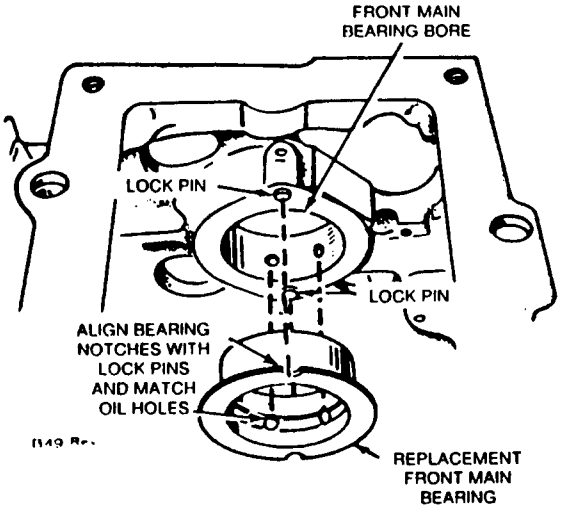


FIGURE 22. FRONT BEARING INSTALLATION

In the rear bearing plate, install the bearing flush to 1/64 inch (0.40 mm) below the end of the bore. Be sure to align the oil holes in the bearing with the oil holes in the bearing bore (Figure 21). The oil passage must be at least half open. Lubricate bearing after installation.

If head of lock pin is damaged, use side cutters or Easy Out tool to remove and install new pin. Oil grooves in thrust washers must face the crankshaft, and washers must be flat (not bent). The two notches on each washer must fit over the two lock pins to prevent riding on the crankshaft (Figure 21).

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. A light film of oil on the thrust washer may hold it in place while installing bearing plate over crankshaft. Line up notches of thrust washer with lock pins before tightening end plate or lock pins will be damaged.

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened, using the torque recommended in *ASSEMBLY TORQUES AND SPECIAL TOOLS*, check the crankshaft endplay (Figure 23). If there is too much endplay (see *DIMENSIONS AND CLEARANCES* for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 21) between the thrust washer and plate. Reinstall the end plate, making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

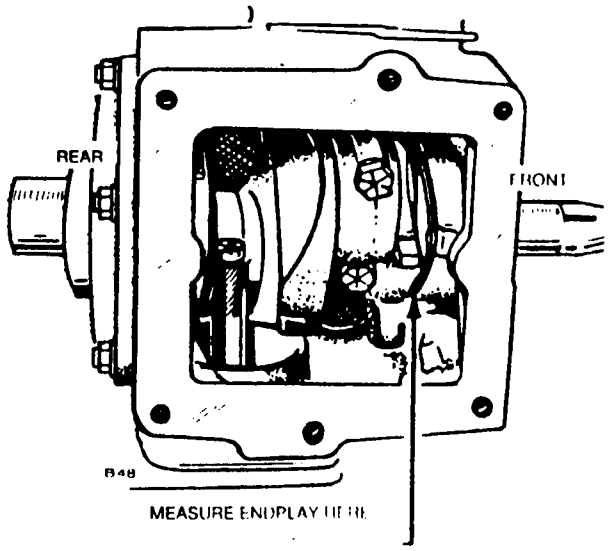


FIGURE 23. CRANKSHAFT ENDPLAY

CHECKING CONNECTING ROD BEARING CLEARANCE WITH PLASTIGAUGE

1. Make certain that all parts are marked or identified so they are installed in their original positions. Using a clean dry cloth, thoroughly clean all oil from crankshaft journal and connecting rod. If connecting rod bearing inserts are being replaced (P224 only), install them in rod and cap.

2. Place a piece of correct size Plastigauge in the bearing cap the full width of the journal surface and about 1/4 inch (6.35 mm) off center (Figure 24).

3. Rotate the crankshaft about 30 degrees from bottom dead center and reinstall the bearing cap; tighten rod bolts to the torque specified in *ASSEMBLY TORQUES AND SPECIAL TOOLS*. Do not turn the crankshaft.

4. Remove bearing cap. The flattened Plastigauge will be found adhering to either the bearing cap or crankshaft.

5. Compare flattened Plastigauge with the graduations on Plastigauge envelope to determine clearance.

   The number within the matching graduation on the envelope indicates total clearance in millimeters or thousandths of an inch.

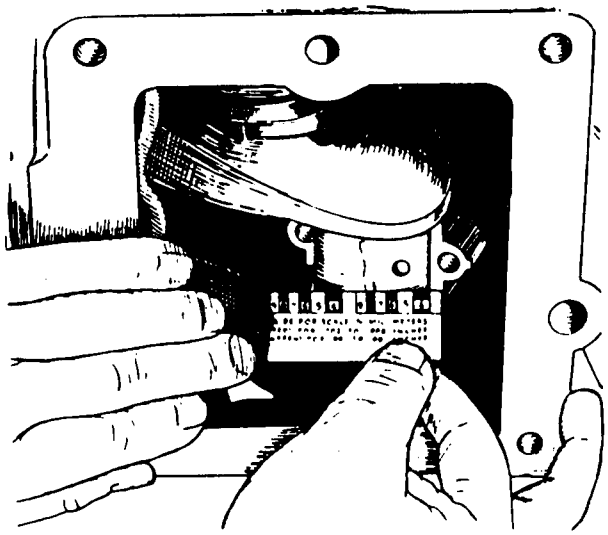


FIGURE 24. MEASURING BEARING CLEARANCE

OIL SEALS

The bearing plate must be removed to replace the oil seal (Figure 25). Drive the oil seal out from the inside.

Before installing seals, fill the space between lips with a multi-purpose grease. This will improve sealing.

When installing the gear cover oil seal, tap the seal inward until it is .645 inch (16.4 mm) from the front of the gear cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander or place a piece of heavy paper around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the paper as soon as the plate is in place.

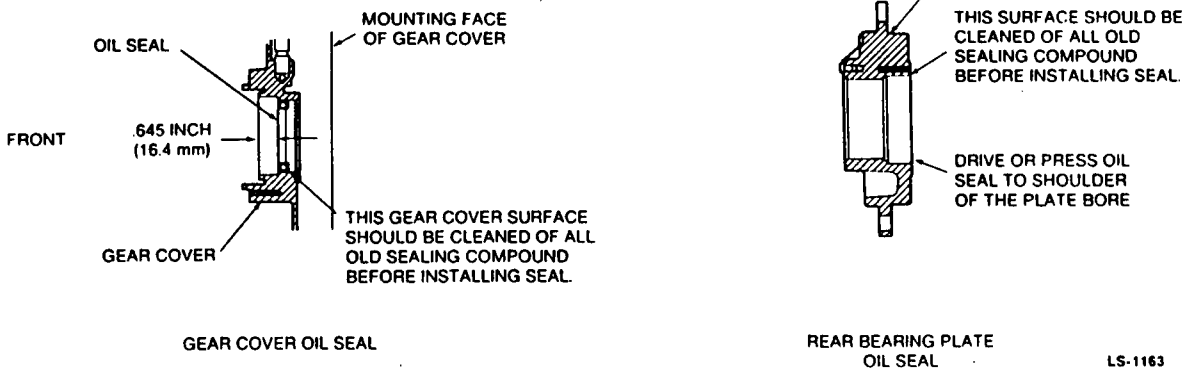


FIGURE 25. GEAR COVER AND REAR BEARING PLATE OIL SEALS

PISTON ASSEMBLY

1. Lubricate all parts with engine oil.
2. Position piston on its respective rod and install the pin.
3. Install the rings on the pistons starting with the oil control ring (Figure 26). Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings have a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. The oil control ring has an expander; install the expander first and then close until the expander ends butt. The joint should be 180 degrees from the gap of that ring.

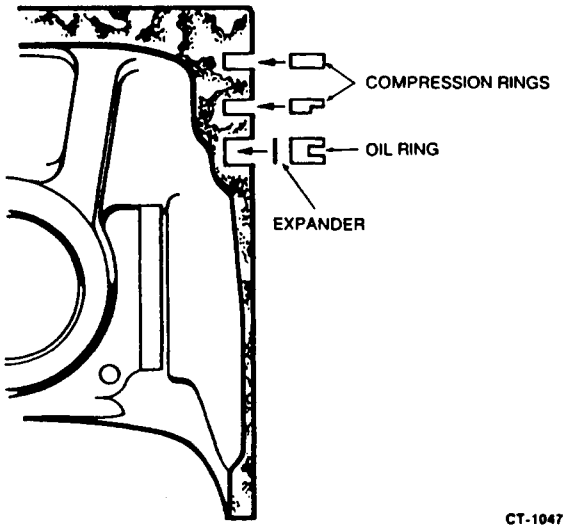


FIGURE 26. PISTON RINGS

INSTALLATION OF PISTON IN CYLINDER

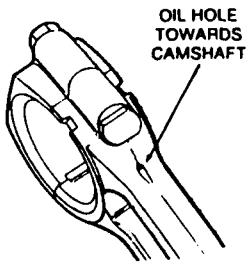
1. Turn the crankshaft to position the number one rod bearing journal at the bottom of its stroke.
2. Lubricate the number one piston assembly and inside of the cylinder. Compress the rings with a ring compressor (Figure 27).
3. Position the piston and rod assembly in the cylinder block. Oil squirt hole of connecting rod must face camshaft.
4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal (Figure 27). Install the bearing cap on the rod.

P216, P218, P220

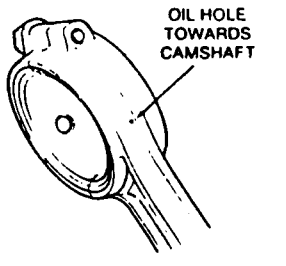
Install one fastener and tighten to 5 ft-lbs (7 Nm). Repeat this for the other fastener. Tighten both fasteners down to the torque specified in *ASSEMBLY TORQUES.*

P224

Install and tighten the nuts evenly in steps, to the torque specified in *ASSEMBLY TORQUES.*



P216, P218, P220 CONNECTING ROD



P224 CONNECTING ROD

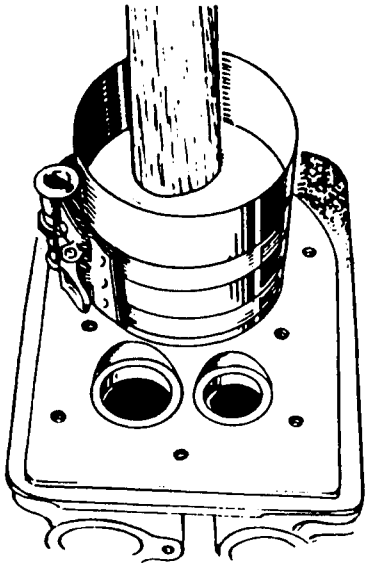


FIGURE 27. INSTALLING PISTON AND CONNECTING ROD

5. Install the remaining piston and rod in the same manner. Crank the engine over by hand to see that all bearings are free.
6. Install the oil base with a new gasket.
7. Install the cylinder heads. See *Cylinder Head* section for torques and torquing procedure.
8. Replace oil and break in engine.

CYLINDER HEADS

Remove the cylinder heads for carbon cleaning and gasket change at intervals specified in the *Periodic Maintenance Schedule* (located in the Operator's Manual).

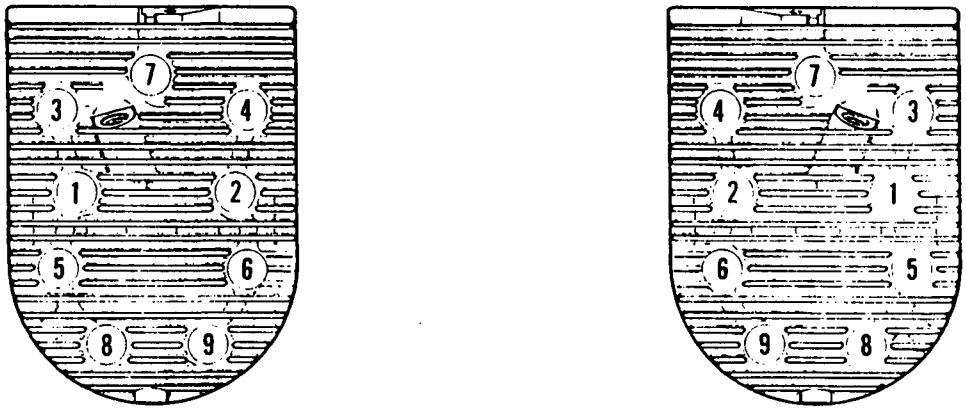
1. Use a 1/2 inch (13 mm) socket wrench to remove cylinder head bolts or nuts. Lift heads off.

⚠CAUTION ***Torquing or removing cylinder heads when hot (above 100° F [37° C]) will result in head damage. Allow heads to cool to below 100° F (37° C) before torquing or removing.***

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.

P216, P218, P220 Installation

1. Place a head gasket on the cylinder block and align the holes in the gasket with the holes in the cylinder block. While holding the gasket against the cylinder head, carefully install the cylinder head on the engine. Do not attempt to slide the head bolts through the gasket without the cylinder block behind it or the gasket may tear.
2. Follow the head torque sequence shown in Figure 28. Tighten all bolts to 5 ft-lbs (7 Nm), then 10 ft-lbs (14 Nm), then to the torque specified in *ASSEMBLY TORQUES*. Recheck all head bolts for correct torque.



NO. 1 CYLINDER (LH)

NO. 2 CYLINDER (RH)

C-1002

FIGURE 28. CYLINDER HEAD TORQUE SEQUENCE

P224 Installation

1. Place a head gasket on the cylinder head and align the stud holes in the gasket with the stud holes in the cylinder head. While holding the gasket against the cylinder head, carefully install the cylinder head on the engine. Do not attempt to slide the gasket over the studs without the cylinder head behind it or the gasket may tear.

2. Install a flat washer, two compression washers, and nut on each of the top six studs (Figure 29 for correct sequence). When properly installed, only the outside edges of the compression washers will be in contact with each other. Install a flat washer and nut on each of the four bottom studs.

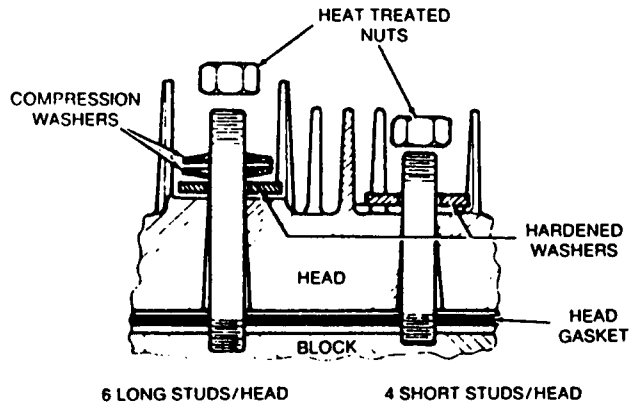


FIGURE 29. CYLINDER HEAD WITH COMPRESSION WASHERS

⚠CAUTION ***Over torquing nuts can cause engine damage. Do not over torque nuts.***

3. Follow the head torque sequence shown in Figure 30. Tighten all nuts to 5 ft-lbs (7 Nm), then 10 ft-lbs (14 Nm), then to the torque specified in *ASSEMBLY TORQUES*. Recheck all nuts for correct torque.

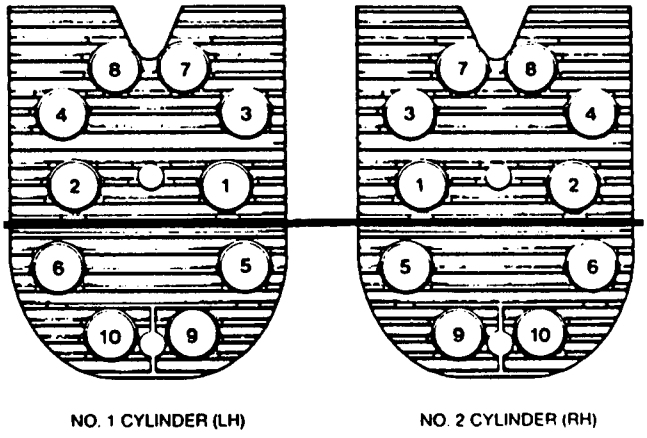


FIGURE 30. CYLINDER HEAD TORQUE SEQUENCE

4. Recheck torque when the engine has run a total of 50 hours.

SERVICE BULLETINS

As we make improvements to the **MARKLIFTS**, we like to supply you, the customer, with updated information which applies to your machine.

This section is provided as a place to store Service Bulletins as you receive them from MARK INDUSTRIES.