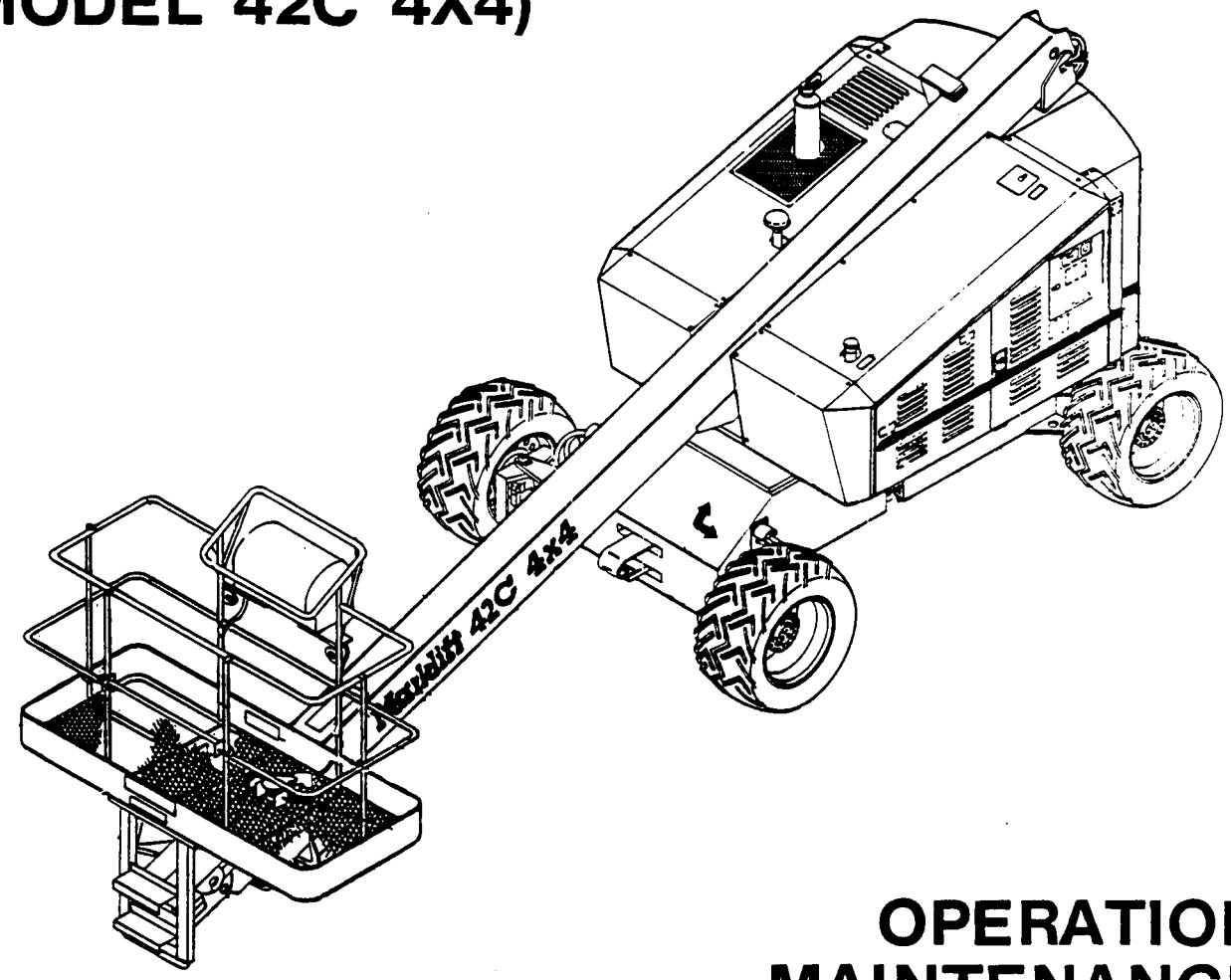
The Marklifts.®
A Product of Mark Industries

SELF-PROPELLED BOOM FOUR WHEEL DRIVE (MODEL 42C 4X4)



OPERATION, MAINTENANCE, AND PARTS MANUAL

Mark of Quality

MARK INDUSTRIES
P.O. Box 2255
Brea, California 92622
205 South Puente Street, Brea, California 92621
(714) 879-6275, FAX (714) 879-8885

REVISION 1: NOV. 1990
FIRST PRINTING SEPT. 1988

17122-988

This manual contains important information pertaining to the use and maintenance of the Marklift. A copy of the manual is provided by Mark Industries to the original purchaser * of the machine and must be made readily available to persons performing maintenance and inspection. **THIS MANUAL MUST ACCOMPANY THE MACHINE AT THE TIME OF ANY SUBSEQUENT SALE.**

Apart from the material contained in this manual, Mark Industries may send out service bulletins that pertain to this machine. These bulletins are sent to the original purchaser * of the Marklift. If you have purchased the Marklift from an authorized Marklift Dealer, you will be contacted by the dealer to perform any service that may be required per the bulletin. Since the bulletins may pertain to important safety matters, you are requested to notify your local Marklift dealer of any subsequent sale and keep him updated as to the ownership. Please provide the name of a responsible contact to whom they can direct correspondence.

If you feel you have not been provided all applicable service bulletins by the seller of the machine, copies of a volume of service bulletins for a series of years may be purchased through your local Marklift dealer. If you have trouble locating a Marklift dealer you may call Mark Industries at the phone number given below. You will be directed to the dealer closest to you.

1-800-736-MARK (Outside California)
1-714-879-6275 (California)
Ask for the Customer Service Engineering Department when calling.

It is recommended that the owner of the Marklift maintain copies of all service bulletins and maintenance records.

For your future reference write down the name, address and phone number of the Marklift dealer closest to you:

Name: _____
Address: _____
Phone: _____

* Dealer or distributor who originally purchased the machine from Mark Industries or other parties who purchased the machine from Mark Industries.

REGULATIONS PERTAINING TO YOUR MARKLIFT

There are certain OSHA, ANSI and other governmental regulations that apply to the design, manufacture, maintenance and use of this equipment. You must keep a copy of the regulations and follow their requirements. You can obtain a copy of the OSHA regulations from your local OSHA office and a copy of the ANSI regulations from the following address:

American National Standards Institute
Attention: Sales Department
1430 Broadway
New York, NY 10018

Copies of other regulations can be obtained by contacting the local office of the agency publishing the regulation.

NOTICE TO USERS REGARDING REPORTING OF INCIDENTS INVOLVING THE MARKLIFT

Should this Marklift be involved in an incident, please inform the nearest Marklift dealer immediately.

If you are not able to locate the dealer, you may call Mark Industries at the phone numbers given below:

(714) 879-MARK

(800) 736-MARK (Outside California only.)

OPERATOR TRAINING TIPS

Following are some suggestions on how to provide proper training to all operators of the Marklift. The operators must be adequately trained in accordance with the requirements of the manufacturer, OSHA, ANSI and other agencies regulating such equipment.

1. Have the operator read the Operation & Safety Handbook.

2. Show the operator important parts and features of the machine and how to use/operate them. Some important components/features that must be pointed out and explained are:

   (1) Controls
   (2) Warnings
   (3) Decals
   (4) Maximum capacity
   (5) Safety features of the machine
   (6) Emergency Lowering
   (7) Use of stabilizers (If included)
   (8) What to do in emergencies
   (9) Hazards that must be avoided

3. Safety videos for the type of machine that will be used, if available, may be shown.
4. Give the operator a demonstration i.e. operate the machine while he watches.

5. Have the operator operate the machine while you supervise and instruct him in proper operation.

6. Have the operator acknowledge the fact that he has received training by signing a copy of the operators statement in the Operation and Safety Handbook.

NOTE:
See ANSI, OSHA and other applicable standards for operator training requirements.

TABLE OF CONTENTS

GENERAL

Introduction 1

Specifications 2

New Equipment Condition Report 3

Warranty 4

Warranty Registration 5

Loading/Unloading Procedures 6
Figure 1: Park Brake Control Valve 6
Figure 2: Loading onto The Truck 6
Figure 3: Securing the Marklift 7

Inspection and Checkout 9

Marklift Safety 10

Division of Industrial Safety 12

Decals 15
General Decal Listing 16
Warning, Caution, Danger, and Emergency Decals 17

OPERATIONS

Towing Instructions 1

General Operating Instructions 2

MAINTENANCE

Preventive Maintenance 1

Recommended Service Instructions 3

Battery Maintenance 5
Battery Fill Instructions 5
Avoid Battery Hazards 5
Battery Hydrometer Reading 6

Torque Hub Lubrication 7

Troubleshooting 8
Troubleshooting Checklist 12

Hydraulic Fluid Table 14

Recommended Spare Parts List 15

SCHEMATICS

Electrical Schematic (Wisconsin Gas) 1

Electrical Schematic (42C) 3

Electrical Schematic (Nissan Diesel) 5

Electrical Schematic (Deutz) 7

Electrical Schematic (Deutz TUV) 9

Hydraulic Schematic (42C) 11

Hydraulic Schematic (Diesel TUV) 12

PARTS

Marklift Parts Catalog ..... Section 1

Final Assembly ..... Section 2

Carriage Assembly ..... Section 3

Turret Assembly ..... Section 4

Boom Assembly ..... Section 5

Options ..... Section 6

TUV ..... Section 7

VENDOR

Wisconsin Engine ..... Section 1

Mico Disk Brake ..... Section 2

Deutz Engine ..... Section 3

Nissan Engine ..... Section 4

Nissan Engine ..... Section 5

TRW Torqmotor ..... Section 6

TRW Torqmotor ..... Section 7

Torque Hub ..... Section 8

TABLE OF CONTENTS

Fairfield Torque Hub ..... Section 9

Eaton Pump ..... Section 10

Helac Rotary ..... Section 11

Minipak ..... Section 12

INTRODUCTION

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

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

The model capacity, pressure settings and serial number can be found on the ID plate mounted on the carriage 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 42C
Height	
Working (maximum)	48' (14.63m)
Platform (maximum)	42' (12.80m)
Load capacity (unrestricted)	800 lbs (363.64 kg)
Platform dimensions	72" x 36" x 42" (1.80m x .91m x 1.07m)
Horizontal reach (center of turret)	32'3" (9.83m)
Length (stowed)	21'8" (6.60m)
Width (maximum)	7'4" (2.24m)
Height (stowed)	7' (2.13m)
Wheel base	8' (2.44m)
Wheel track	6'3" (1.91m)
Turret tailswing	16" (.41m) beyond tires
Turret rotation	360° continuous
Travel speed (proportional)	0-3.5 m.p.h. (0-5.63 km/h)
Controls	Proportional and solenoid
Turning radius (inside)	12' (3.66m)
Tires (pneumatic)	12 x 16.5 10 ply rating NHS Loader lug
Ground clearance	7.5" (.19m)
Power source	Wisconsin 37 hp , gasoline (air cooled)
Drive motors	Piston type with variable displacement and internal shifters
Fuel tank capacity	22 gal. (83.71 l)
Hydraulic system	Load sensing and pressure compensating
Hydraulic operating pressure (Max.)	2500 psi (172 bar)
Hydraulic reservoir capacity	40 gal. (151.4 l)
Boom elevation	+75° above horizontal -25° below horizontal
Weight	15,780 lbs. (7.158 kg)
Shipping cube	1190 cu. ft. (33.68 m^3)

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

Filling in the Warranty: Please refer to the applicable decals on your machine for the figures and quantities needed to fill in the blanks below.

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

MODEL
SERIAL NUMBER
INSPECTOR

OPTIONS

MANUFACTURERS' LIMITED WARRANTY

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

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

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

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

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

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

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

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

Warranty effective as of 2/90

Mark Industries

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

714-879-6275 800-736-MARK

TELEX 194402 FAX 1-714-879-8884

WARRANTY REGISTRATION

Purchaser/Dealer:

Company Name:

Address:

Telephone:

Date shipped (from invoice):

Date shipment received:

Date unit put into service:

Unit will be placed in rental fleet:

Unit will be sold:

Unit will be used for:

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

Comments: _____

Inspection completed by: Title:

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

IMPORTANT:	Due to the width of the Marklifts and the overall width of the flatbed trailer, **extreme caution must be taken when loading and unloading.**

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

1. Make sure that the parking brake is set to start braking immediately by fully opening the parking brake control severity valve.

2. If the unit has a High/Low drive speed option, it must be in **LOW DRIVE** at all times when loading and unloading.

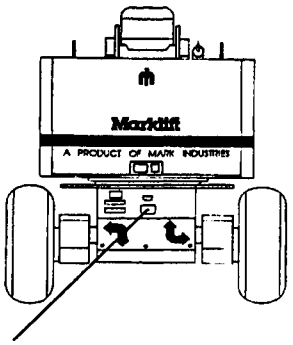


Figure 1: Parking Brake Control Valve

LOADING

1. With the trailer on level ground, align the tires of the Marklift with the back end of the trailer.

2. Attach the winch cable to the boom at the drive wheel end of the base through the tow or lift eyes if provided. (See Figure 2.)

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

4. When the unit is on the truck and its weight has been properly distributed, tie the boom down as shown in Figure 3 of this instruction.

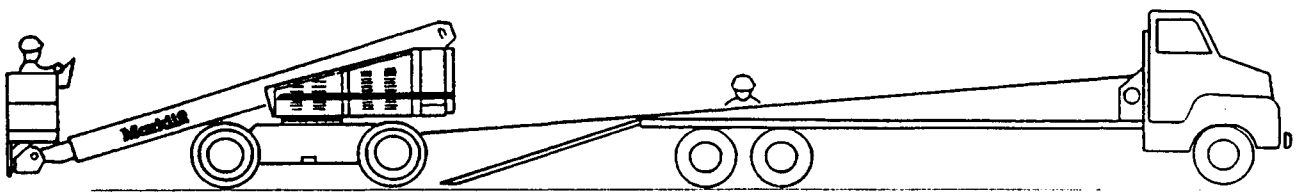


Figure 2: Loading the Marklift onto the truck

Note: Bottom of the basket weldment fork must not rest on the truck bed. Place a wooden block under the basket end of the boom arm.

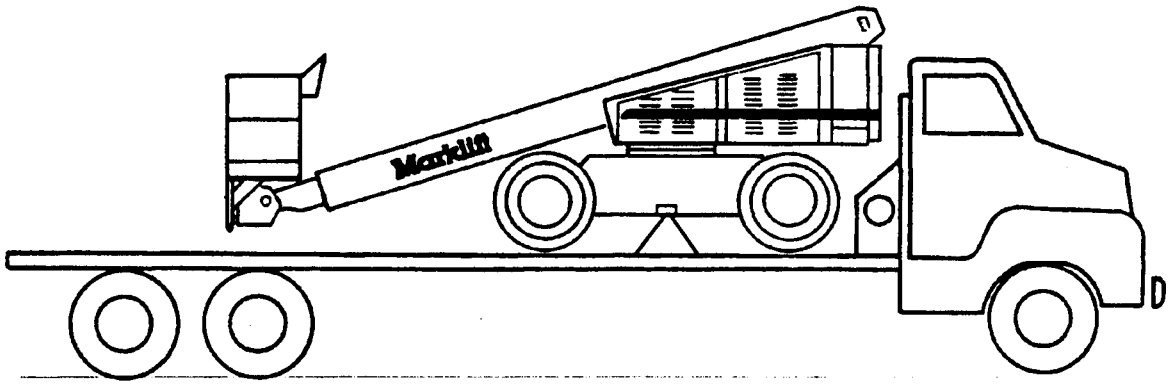


Figure 3: Securing the Marklift to the Platform

UNLOADING

1. With the trailer on level ground, disconnect the tie-downs from the Marklift and make sure that the winch cable is still properly attached to the boom.

2. Select the low drive speed.

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

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

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

5. Readjust the boom parking brakes so that they apply immediately **after** the dynamic brakes stop the unit. The procedure for re-adjusting the parking brakes is as follows: First close the needle valve completely. Open the valve 1/8 turn then place the unit on a flat, level surface, about 10' wide x 30' long. Position the boom slightly below horizontal and completely retract. Select "High" throttle at the platform console.

Drive the **MARKLIFT** with the controller handle in the "full on" (maximum) position, approximately 15 feet, letting go of the controller when the wheel is next to a visual marker on the ground. A good deceleration and braking distance would be slightly less than 3 feet measured from the marker to the center line of the same wheel after the unit has completely stopped. Adjust the valve on the parking brakes to reach this position. Repeat this procedure, driving in both directions until the **MARKLIFT** comes to a complete stop within 18" to 24".

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

9. Always distribute load evenly over platform floor area.

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

11. The **MARKLIFT** platform is equipped with safety belt rings. **Each operator of the MARKLIFT must wear a body belt. The belt must be attached with lanyard to the safety belt rings.**

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

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

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

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

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

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

18. **Do Not** operate boom functions on more than a 5 degree front to rear or 5 degree side to side out-of-level condition.

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

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

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

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

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

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

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

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.

BEFORE OPERATING THE MARKLIFT, REVIEW THE FOLLOWING PROCEDURES:

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

2. Check hydraulic oil level.

3. Check engine oil level.

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

5. Check battery for 1.200 ± 50 reading on the hydrometer. Charge battery if reading is below 1.100 (see Battery Maintenance).

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

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

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

9. Your **MARKLIFT** is equipped with proportional controls, including drive. When using any proportional function, depress the footswitch, raise the controller locking device, if provided, then gradually move the controller in the desired direction . The controller handle is spring-centered and will return to the "off" position when released.

10. The normal travel or drive configuration is with the boom located over the steering wheels. This provides the best weight distribution for maximum traction. If the boom is rotated 180° the drive and steer decals read in reverse therefore the operator must reverse the drive and steer functions in order to continue in the direction. The arrow type decals on each end of the base will show the direction correctly, regardless of the turret's position.

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

The **MARKLIFT** conforms to specified **ANSI & OSHA** requirements, it is the responsibility of the owner to instruct the operators about safety requirements made not only by **MARK INDUSTRIES,** but by the various safety boards in your area, as well as requirements set forth by **ANSI & OSHA.**

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

1. Inspect the machine periodically as specified in the Inspection and Checkout, and the 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. All safety devices on the Marklift must be inspected and tested periodically to assure their proper operation, e.g., limit switches, slope, etc...

5. Always be aware of the Marklift during its use. The weight can be obtained from the specification sheet in the front portion of the manual. Make sure the ground that the Marklift is being used on can support the weight.

6. Proper air pressure in the tires must be maintained. Inspect daily to assure that all tires are properly inflated.

7. Do not use the Marklift in severe weather conditions, e.g., high winds. Conditions that may contribute to the severity of the weather must be considered.

8. 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.

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.

(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.

Table Y

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

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

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

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

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

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

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

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.

P/N	DESCRIPTION 42C 4x4	LOCATION	QTY
67513	Decal Set	All Standard Decal	1
20460	Ground Control Console	Ground Control Box	1
20413	Engine Choke	Ground Control Box	1
185702	Circuit Breaker 110 VAC	Ground Control Box	1
20860	General Checkout & Operating Instr	Final Assembly	1
182103	Operation Instructions & Danger	Aerial Control Box	1
182707	Aerial Control Box	Aerial Control Box	1
20408	Marklift Boom	Final Assembly	2
20409	Standard Pedestal (Marklift)	Final Assembly	1
20410	Logo Mark Industries	Final Assembly	1
20411	Blue Stripe (Square End)	Final Assembly	5
20412	Blue Stripe (Round End)	Final Assembly	1
20556	Load Capacity 800 lbs.	Final Assembly	2
2020	Gasoline or Petrol	Final Assembly	2
2017	Hydraulic System Fluid	Final Assembly	2
22740	4X4 4WD Booms	Final Assembly	2
181102	Danger do not operate unless...	Final Assembly	2
181103	Danger obey the following...	Final Assembly	2
20419	Danger Keep Clear	Final Assembly	2
2003	Battery Water Level	Final Assembly	1
20495	Emergency Ground Controls	Final Assembly	1
20896	Brake	Final Assembly	1
22386	"D" Ring Attach Safety Belt	Final Assembly	2
20414	Emergency Descent	Final Assembly	1
20508	Transportation	Final Assembly	2
20660	Identification Nameplate	Final Assembly	1
20661	ANSI A92 Plate	Final Assembly	1
181904	"C" (19" x 19")	Final Assembly	2
2004	Vapor Tank Only	Final Assembly	2
20420	Tire Pressure 75 PSI	Final Assembly	2
20873	42	Final Assembly	2
21237	Grease Fitting	Final Assembly	2
182710	Directional Arrow	Final Assembly	2
22385	Caution Attach Your Safety Belt	Final Assembly	1
182709	Directional Arrow	Final Assembly	2
130820	Operation & Safety Handbook	Final Assembly	1

ATTACH SAFETY BELT 22386

LOAD CAPACITY 800 LBS. (EVENLY DISTRIBUTED LOAD) 20556

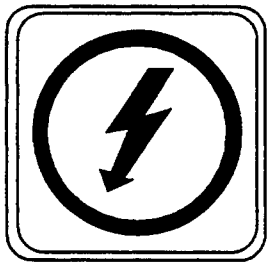
2020 GASOLINE OR PETROL

DANGER

ELECTROCUTION HAZARD
KEEP CLEAR

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

20419



DANGER

AN UNTRAINED OPERATOR
SUBJECTS HIMSELF AND
OTHERS TO

DEATH AND SERIOUS INJURY

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

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

YOU INSPECT UNIT AND ALL FUNCTIONS.

191108

DANGER

FAILURE TO OBEY THE FOLLOWING

CAN RESULT IN
DEATH OR SERIOUS INJURY
TO YOU OR OTHERS

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

VOLTAGE (PHASE TO PHASE)	MINIMUM SAFE APPROACH DISTANCE	
	(FEET)	(METERS)
OVER 50,000 TO 200,000 VOLTS	15	4.60
OVER 200,000 TO 350,000 VOLTS	20	6.10
OVER 350,000 TO 500,000 VOLTS	25	7.62
OVER 500,000 TO 750,000 VOLTS	35	10.67
OVER 750,000 TO 1,000,000 VOLTS	45	13.72

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

191108

TOWING INSTRUCTIONS

The Marklift may be towed for a distance no greater than one (1) mile at a speed not to exceed 8 M.P.H. These instructions are for units equipped with a towing package.

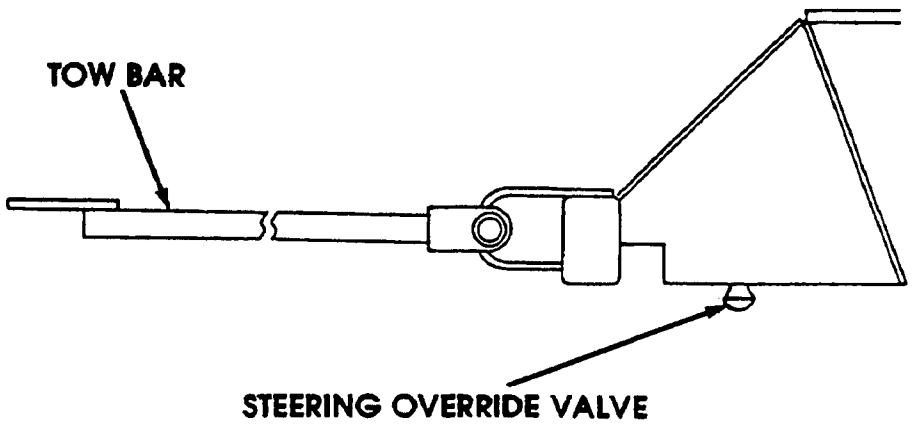
To tow the Marklift:

1. Attach the tow bar from the Marklift to the towing vehicle.

2. The torque hub **must** be disengaged.

   To disengage the torque hub, reverse the disconnect cap. The knob on the cap disengages the drive hub input shaft. **The brakes are also disengaged.**

3. **Pull down the manual steering override valve handle.**



Caution: Brakes are disengaged.

Caution: Do not tow faster than 8 miles per hour.

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

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

"EXTENSIBLE AND ARTICULATING BOOM PLATFORMS"

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

2. Only authorized persons shall operate an aerial lift.

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

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

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

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

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

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

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

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

DUAL FUEL SYSTEM

The 42C4x4 **MARKLIFTS** are equipped with a dual fuel system which allows the operator to select gasoline or propane operation. The 3-position selector switch, located on the aerial control console, energizes solenoid valves which close one fuel line and open the other.

1. **STARTING**

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

Turn the master switch at the ground control station to "ON". Position the selector switch to "Aerial". Enter the platform and **attach safety belt**. Turn the lever to the start position, **do not** depress the footswitch, when the engine starts, release the toggle switch. **Note:** if the engine fails to start and the switch has been released, it will be necessary to turn the switch to the "Off" position before attempting to turn to the "Start" position again.

Switching From Propane to Gasoline

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

Switching From Gasoline to Propane

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

and release the footswitch. Let the engine idle for 20-30 seconds to completely burn up any remaining gasoline in the fuel bowl.

2. **DRIVE**

Forward and reverse drive is operable from the aerial control box only. For the drive to function, push the drive controller in the desired direction while simultaneously depressing the foot switch. **If the boom is rotated 180°, the drive and steer decals read in reverse. The operator must reverse the drive and steer functions in order to continue in the same direction. The arrow type decals on each end of the base will show the correct direction regardless of the turret's position.**

3. **STEERING**

The steering function is incorporated in the drive controller. Depress the footswitch and push the steering controller to the left or right to turn the wheels.

4. **LIFT/LOWER**

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

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

5. **EXTENDING/RETRACTING**

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

To extend or retract the boom from the aerial control station, lift up on the lock in the handle, then push the Retract/Extend controller forward to retract or pull it back to extend.

6. **TURRET ROTATION**

The turret may be rotated from either the ground control or aerial control stations. Use the toggle switch at the ground control station or the controllers at the aerial control station to rotate the turret in the desired direction. The turret may be rotated 360° continuously.

7. **PLATFORM TILT**

The platform may be tilted forward or backward. Use the toggle switch at the aerial control station to tilt the platform.

8. **PLATFORM ROTATION**

The platform may be rotated to the right or left from the aerial control station. Use the toggle switch to rotate the platform in the desired direction.

9. **WARNING LIGHT AND BUZZER**

As a special safety feature, the **MARKLIFT** is equipped with an "out-of- level" sensor that will disable the boom functions whenever the **MARKLIFT** is in an unsafe out-of-level position. An unsafe out-of-level condition is sensed by the level sensor when the machine is tilted at an angle greater than 5° front to rear or side to side.

The unsafe condition is indicated by a red warning light and buzzer, located on the top center of the aerial control box. When the warning light and buzzer are on, Lift/Lower, Extend/Retract, and Turret Rotation will not operate but the drive and steer functions will. Should the warning signals come on, maneuver the **MARKLIFT** until it is on a safe, level operating surface and all functions will be restored.

10. **ENGINE STOPPING**

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

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

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

The following preventive maintenance information is intended as a general guide. In addition to the maintenance information provided below, the machine must be inspected and maintained as required by ANSI, OSHA, local safety boards and owners. Please refer to the vendor section of this manual for detailed information on the engine, battery, etc.

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

DAILY (Before use on Each Work Shift)

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

WEEKLY

1. Include all items indicated in daily check
2. Check the condition of the tires. Make sure they are free of serious cuts or defects.
3. Check for proper brake operation.
4. Make sure the battery is fully charged.
5. Clean unit by removing all dirt, oil, and grease. The machine may be washed with soap and water. Stay clear of all electrical panels and enclosures.

6. Check overall performance.

7. Check the air cleaner.

8. Check for proper hydraulic and engine oil level.

MONTHLY (and first 50 hours)

1. Include all items in weekly check.

2. Check and lubricate, if necessary. (See Recommended Service Instructions.)

3. Change the hydraulic oil return filter.

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

5. Grease steering linkage.

6. Change engine oil filter.

EVERY SIX MONTHS (100 hours)

1. Include all items in monthly check.

2. Check and lubricate, if necessary. (See Recommended Service Instructions)

3. Change pilot filter element. (See Recommended Service Instructions.)

EVERY YEAR

1. Include all items in bi-annual check.

2. Re-pack all wheel bearings.

3. Change the hydraulic oil.

4. Check the torque hub oil level.

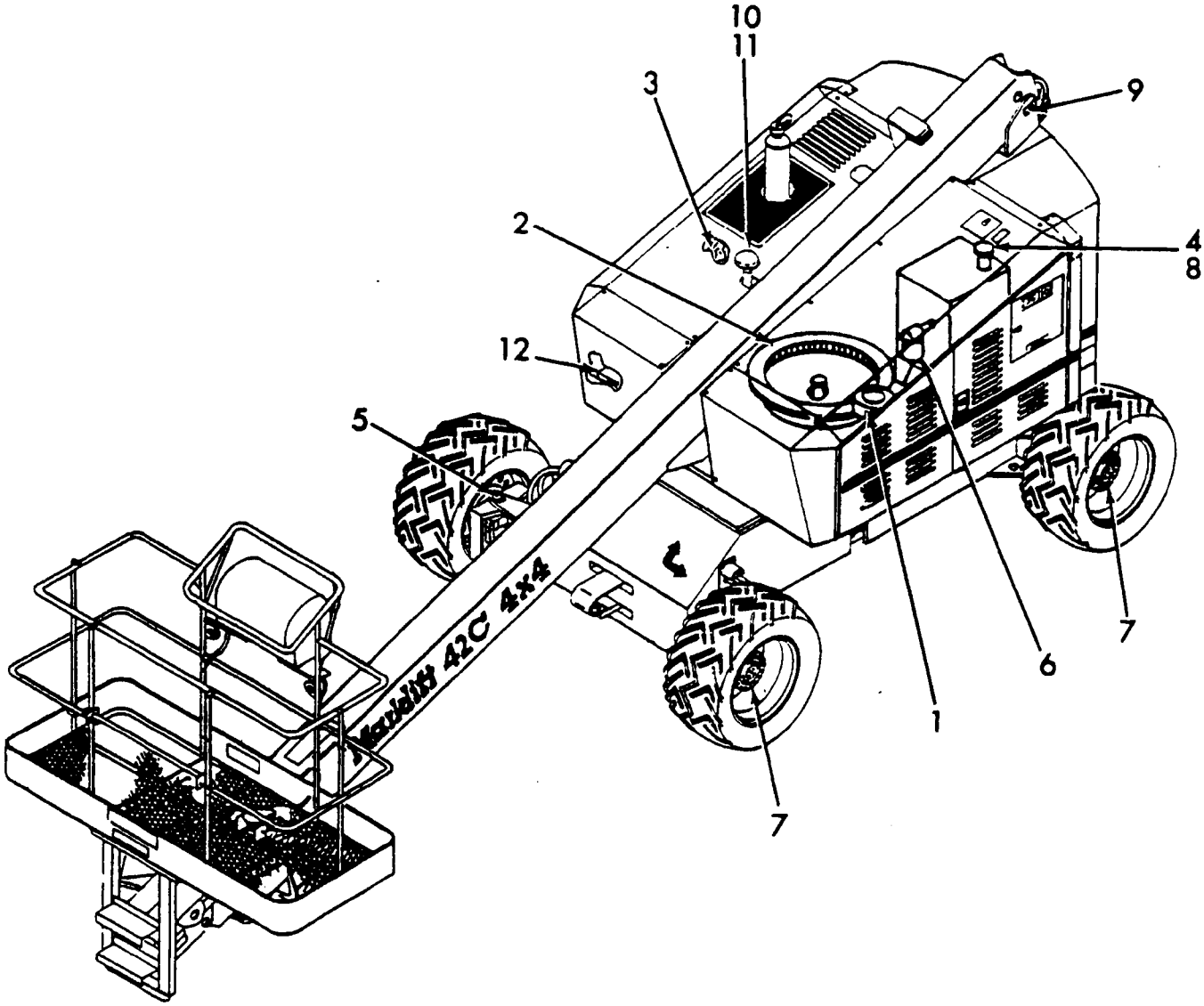
Recommended Service Instructions
42C 4x4

Item	Description*	Lubricant	Service/Frquency
1.	Rotation gear box	Gear oil SAE EP 90	Check/Monthly
2.	Ring Gear	(4) Zerks — rotate gear while greasing	Lubricate/Monthly
3.	Engine	See manufacturer's instructions	See manf. instructions
4.	Hydraulic Fluid	See Hydraulic Fluid Table	Check/Daily Replace/Yearly
5.	Steering Yoke King Pins	Mobilcote Type-S	Lubricate/Monthly
6.	Return Line Filter		Replace/100 hrs.
7.	Torque Hubs		Yearly
8.	Pilot Strainer		Inspect/100 hours
9.	Main Boom Pivot Pin	Mobilcote Type-S	Lubricate/Monthly
10.	Air Filter	Change according to filter manf. recommendations	Inspect/weekly or as conditions dictate
11.	Fuel Filter		Replace/100 hrs.
12.	Battery		Check/Daily

* See Following Page for Locations

Recommended Service Instructions

42C 4X4



Battery Fill Instructions

Water or Acid Loss to Batteries

Water loss from the battery is mainly due to evaporation brought on by temperature rises during heavy charging cycles. A very small amount of water is lost due to hydrogen and oxygen 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.

Avoid Battery Hazards!

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

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

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

Charge batteries only in a well ventilated area.

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

TEMPERATURE/SPECIFIC GRAVITY CORRECTION TABLE FOR BATTERIES

ACTUAL HYDROMETER READING AT ACTUAL TEMPERATURE

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

Specific Gravity

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

Note:

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

Marklift Self-Propelled Boom
42C 4x4

1. Type — EP 90

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

2. Oil Temperature

   Continuous — 160°F
   Intermittent — 200°F

3. Oil Change

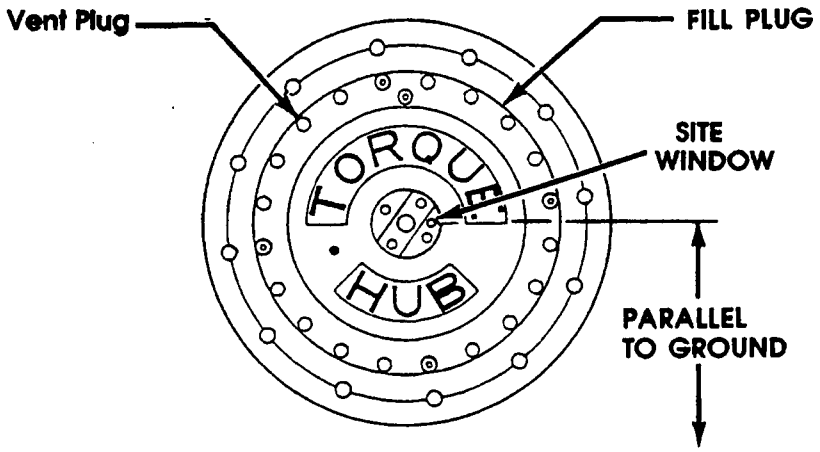
   Initial — After 50 hours or 50,000 revolutions of operation. Preferable in a loaded condition.

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

4. Oil Fill Level

   Remove fill plug
   Remove vent plug
   Pour oil into fill plug
   Fill to half -full.

Fill at slow pace, to allow air to escape.



Proportional Control Valve Operation

The following information will help the mechanic troubleshoot and make adjustments to the hydraulic system. It is the mechanic's responsibility to read and understand the given information. Please see the Vendor Chapter for additional information about the proportional control valve and its operation.

The proportional control valve is comprised of four valve "segments" which provide individual control for each proportional function; drive (forward and reverse), boom (lift/lower and extend/retract), and turret rotation (right/left).

Flow from the hydraulic pump enters the valve at the inlet port of the inlet manifold and is introduced at the directional control spool of each valve segment across a "flow compensator valve". However, since no flow occurs across the valve spool until a function is operated, an internal passage inside the valve segment generates a pressure signal to the flow compensator causing it to be seated. Simultaneously, flow enters a parallel passage where it is directed across a 40 micron wire mesh screen or strainer, and encounters the "pilot relief valve". A proportionate amount of this flow is returned to the tank across the valve, thus generating a pilot pressure signal which is then supplied to the pilot valves.

The "pilot valves" are electromechanical valves which respond to a command signal generated by the electrical controller at the control station. Inside the pilot valve there is a plunger (which responds to the magnetic field generated by the valve coil whenever the controller is operated), a concave seat and a metering rod or needle. Operating the controller causes the plunger inside the pilot valve to lift off the concave seat which permits the seat to "snap" up off the metering rod or needle. This permits pilot flow to pass across an orifice in the valve seat (which is blocked by the metering rod when it is in contact with the seat), and through the pilot valve. This metered flow is directed through the valve segment into a "control" passage for the directional control spool. Connected to the control passage is a tank return passage, pilot flow passing through the pilot valve is returned back to tank across a flow disc installed in the passage. This disc has a small orifice which meters the flow that is returned back to tank.

The rate at which the pilot valve opens and closes (the plunger releases the concave

valve seat to permit it to lift up off the metering rod) determines the rate of flow through the pilot valve and into the control passage. As long as the valve is opened and closed at a minimum specific rate, the rate of flow into the control circuit is equal to the rate of flow which can be returned to tank across the flow disc in the tank return passage. Consequently there is no increase in pressure in the control passage. However as the controller is moved farther "on", the rate that the plunger releases the concave inlet disc increases. This permits a greater volume of oil to pass across the valve and into the pilot valve body. This increased flow generates a pressure signal in the control passage (since only a finite amount of flow can be returned to tank across the flow disc at the base of the pilot valve in the tank return passage). This pressure signal is applied against the directional control spool and causes the spool to be "shifted" opposing a spring which normally maintains the spool in its centered state.

As the directional control spool is shifted off center, inlet flow from the pump is metered across tapered "lands" on the control spool and directed out the V1 or V2 ports, to the selected function. As the directional control spool shifts, a pressure drop occurs at the supply passage of the spool and results in a pressure "differential" across the flow compensator valve, this pressure difference causes the valve to open and regulates oil passed to the directional control spool based upon the difference in pressure created by the rate of flow out to the function being operated and the rate of flow being supplied by the pump. As flow out to the desired function encounters resistance, an internal passage parallel to the supply ports (V1 and V2) directs the corresponding pressure signal against a shuttle ball (located in the valve segment), which is connected in parallel to the other valve segments. This pressure signal is diverted by the shuttle ball out to the load sense port of the proportional control valve, where it is transmitted to the pump and instructs the pump to meet the flow requirements of the function being operated.

The speed at which the function operates is controlled by the metering effect across the valve spool (amount of shift determines the rate of flow), which is controlled by the operating rate (opening and closing) of the pilot valve. The load sense circuit is configured so that the pump receives the signal from whichever function has the highest flow requirement, even when multiple functions are selected.

Electrical System

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

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

A. If a problem seems to be electrical, check the schematic, (see the SCHEMATIC chapter for more information) and use a volt/OHM meter to trace the 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 proper electrical current to the coil or relay, the item will not function properly.

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

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

The ground control console houses the necessary switches for starting and stopping the engine; a selector switch for isolating either the ground or aerial control console, and the required toggle switches for moving the boom. The ground control console also contains a keyed ignition/start switch, as well as an engine stop switch, ammeter, and fuel gauge. When the selector switch is placed in the aerial position, the electrical source is routed to the aerial control box. The intent of the footswitch is to provide an additional safety interlock in the control circuit to require foot as well as hand move-

ment by the operator, thereby requiring maximum operator attention. The function of the footswitch only completes the electrical circuit to the aerial control console and engine throttle. The footswitch is not directly connected to the drive braking system.

The aerial control console is equipped with controllers and switches to operate all of the boom functions. It also contains a start/stop and an emergency pump switch. Your **MARKLIFT** is equipped with a proportional control valve. The aerial control console contains electrical controllers for these drive functions. The controller is spring-centered and is designed to produce a variable output signal to the control valve. The output signal is directly proportional to the handle movement of the controller. The valve is electrically coupled to the controller and responds only to the signal level transmitted to it by the operator.

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

The **MARKLIFT** boom unit has additional safety systems for driving. When the unit is driven with the boom extended or raised above horizontal, the unit is automatically shifted into low speed. This is accomplished through two limit switches sensing the altitude and extension positions of the boom, wired in series to a valve which supplies a hydraulic signal to the variable displacement drive motors.

ENGINE

1. Unit will not start or run.

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

2. Unit dies under load.

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

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

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

4. Unit will not idle.

   A. Check the carburetor.
   B. Check the throttle solenoid valve.
   C. Refer to your local service facility.

HYDRAULIC DRIVE MOTOR

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

A. Check hydraulic pressure.
B. Refer to your local service facility.

Hydraulic Pump

Pump producing excessive noise.

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

Lift

1. Functions will not operate from aerial control console.

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

2. Functions will not operate from ground control box.

A. Check position of Aerial/Ground box selector switch.
B. Check the Aerial/Ground selector relay.
C. Refer to your local service facility.

Drive

Low torque drive.

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

Brakes

No brakes.

A. Check the drive hub disengagement caps.
B. Check brake delay valve.
C. Refer to your local service facility.

HYDRAULIC FLUID TABLE

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

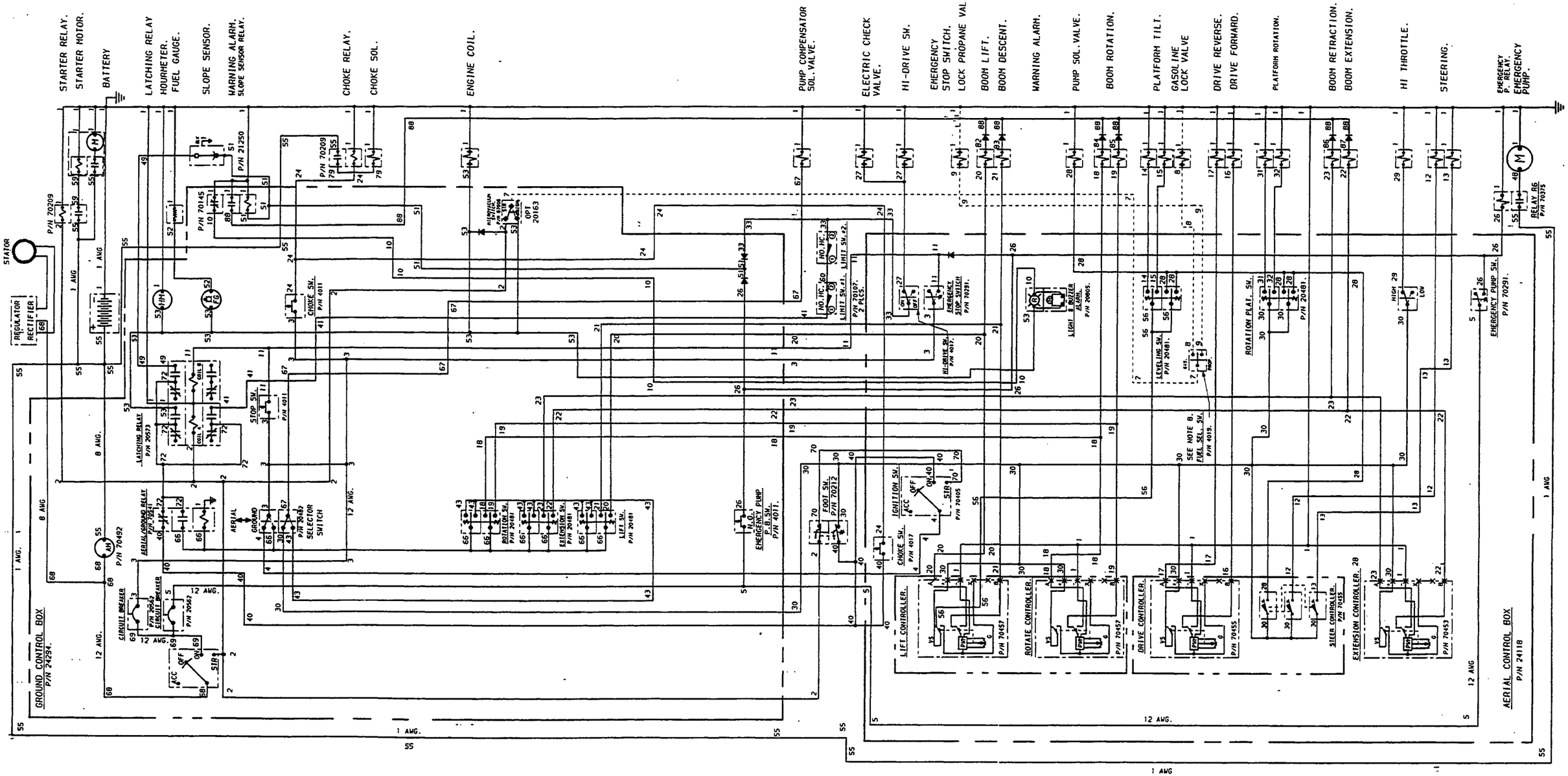
MODEL: 42C 4X4

PART NO.	QTY.	DESCRIPTION
81007	4	Element Pilot Filter
21245	4	Element Return Filter
20030	2	Seal Kit (Steering Cylinder)
20031	2	Seal Kit (Slave Cylinder)
20032	2	Seal Kit (Master Cylinder)
20033	2	Seal Kit (Lift Cylinder)
20034	2	Seal Kit (Extension Cylinder)
20035	2	Seal Kit (Shift Cylinder)
20036	2	Seal Kit (Rotation Cylinder)
20562	2	Circuit Breaker
20481	2	Toggle Switch
20482	2	Toggle Switch
20580	2	Potentiometer Assembly
20581	2	Controller Lever Lock
20466	2	Pilot Valve
66603	2	Decal Set

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C WISCONSIN (GAS)
NOTES	P/N 24405 REV. C

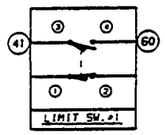
SCHEMATIC
PAGE 1

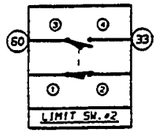


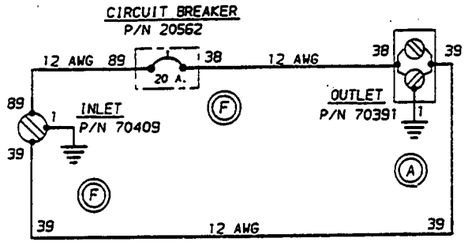
Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C WISCONSIN (GAS)
NOTES	P/N 24405 REV. C

SCHEMATIC PAGE 2



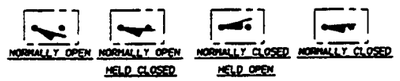




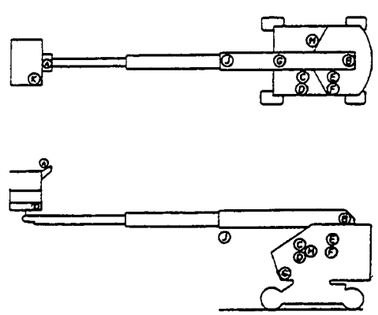
115 VAC WIRING.

NOTES:

1. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 70528.
2. ALL WIRES ARE 18 AWG.UNLESS OTHERWISE SPECIFIED.
3. USE 6A. 1000V. DIODE P/N 70479.
4. WIRING AND SWITCHES ARE FOR A BOOM IN STOWED POSITION.
5. ALL WIRES FOR 115 V.A.C. ARE 12 AWG.
6. IDENTIFY EACH WIRE BY NUMBER FLAG AT BOTH ENDS WRAPPING COMPLETELY AROUND.
7. WIRE NO.34 AT CONTROL CABLE TO BE RE-NUMBERED 53.
8. FOR 115V AC GENERATOR OPTION, SEE DWG 24452.



LEGEND FOR LIMIT SWITCHES.



ID	DESCRIPTION.	LOCATION
A	UPPER CONTROL BOX.	PLATFORM
B	LIMIT SWITCH # 1.	TURRET
C	NON-PROPORTIONAL VALVE.	TURRET
D	PROPORTIONAL VALVE.	TURRET
E	EMERGENCY PUMP/MOTOR.	TURRET
F	GROUND CONTROL PANEL.	TURRET
G	BATTERIES.	TURRET
H	ENGINE. COMPARTMENT	TURRET
J	LIMIT SWITCH #2.	BOOM
K	FOOT SWITCH #9.	PLATFORM

WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
1	1					●		●	●		
1	12	●		●	●		●		●		
2	12	●					●		●		●
3	12	●					●				
4	12	●					●				●
5	12	●					●				
6	12	●					●	SPARE			
7	18	●					●		●		
8	18	●					●		●		
9	18	●					●		●		
10	18	●					●				
11	18	●					●				
12	18	●		●			●				
13	18	●		●			●				
14	18	●		●			●				
15	18	●		●			●				
16	18	●			●		●				
17	18	●			●		●				
18	18	●			●		●				
19	18	●			●		●				
20	18	●			●		●				
21	18	●			●		●				
22	18	●			●		●				
23	18	●			●		●				
24	18	●					●		●		
25	18	●					●	SPARE			
26	18	●				R6	●				
27	18	●		●			●				
28	18	●		●			●				
29	18	●		●			●				
30	18	●					●				●
31	18	●		●			●				
32	18	●		●			●				
33	18	●					●			●	
34	18	●					●	SPARE			
35	18	●					●	SPARE			
36	18	●					●	SPARE			
37	18	●					●		●		
38	12	●					●				
39	12	●					●				
40	12	●					●				

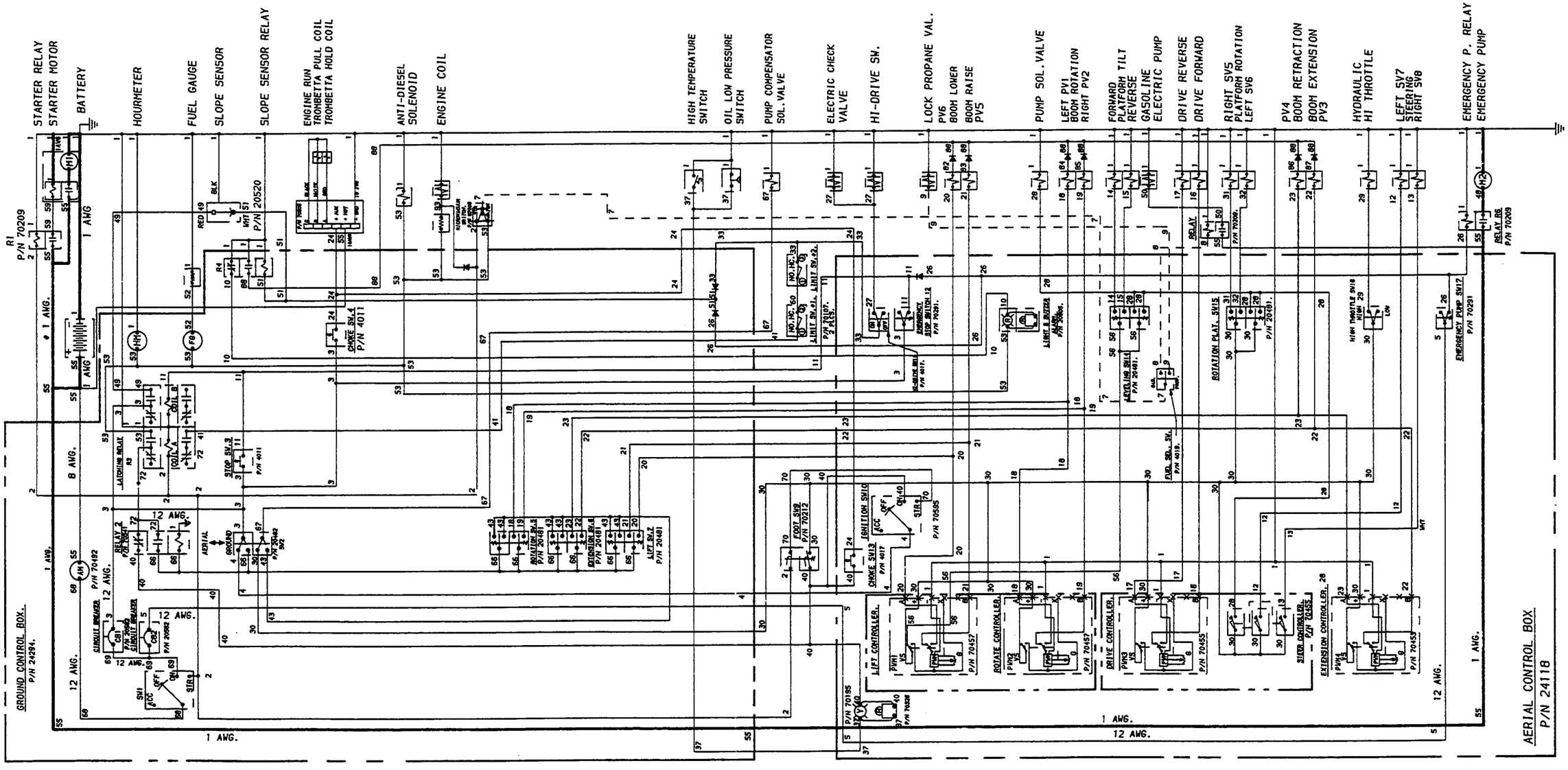
WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
43	18				●						
48	1					●					
49	18		●				●				
51	18						●				
52	18						●				
53	12						●		●		
55	8						●		●		
55	1					R6		●	●		
56	18	●									
59	12						●		●		
60	18		●				●			●	
66	18						●				
67	18			●			●				
68	8						●		●		
69	12						●				
70	12	●									●
72	12						●				
79	12						●		●		
80	12			●			●				
82	18				●		●				
83	18				●		●				
84	18				●		●				
85	18				●		●				
86	18				●		●				
87	18				●		●				
88	18				●		●				
89	12						●				
93	12						●		●		

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C
NOTES	24243 REV.B

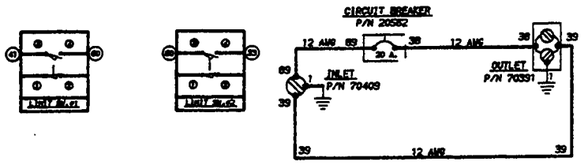
SCHEMATIC
PAGE
3



Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C
NOTES	24243 REV.B

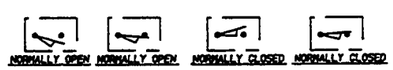
SCHEMATIC PAGE 4



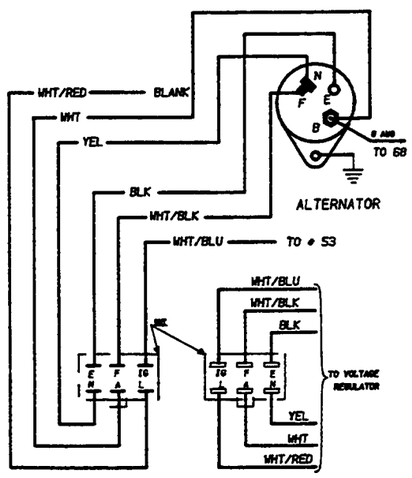
115 A.C. WIRING.

NOTES:

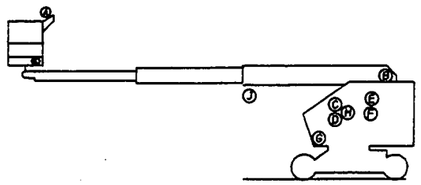
1. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 70528.
2. ALL WIRES ARE 18 AWG.UNLESS OTHERWISE SPECIFIED.
3. USE 6A. 1000V. DIODE P/N 70479.
4. WIRING AND SWITCHES ARE FOR A BOOM IN STOWED POSITION.
5. ALL WIRES FOR 115 A.C. ARE 12 AWG.
6. IDENTIFY EACH WIRE BY NUMBER FLAG AT BOTH ENDS WRAPPING COMPLETELY AROUND.
7. WIRE NO.34 AT CONTROL CABLE TO BE RE-NUMBERED 53.
8. FOR 115V AC GENERATOR OPTION, SEE DWG 24452.



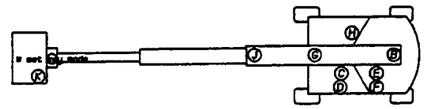
LEGEND FOR LIMIT SWITCHES.



DETAIL "A"



WIRING SCHEDULE											
NO.	AWG	A	B	C	D	E	F	G	H	J	K
1	1					⌖		⌖	⌖		
1	12	⌖		⌖	⌖		⌖		⌖		
2	12	⌖					⌖		⌖		⌖
3	12	⌖					⌖				
4	12	⌖					⌖				⌖
5	12	⌖					⌖				
6	12	⌖					⌖	SPARE			
7	18	⌖					⌖		⌖		
8	18	⌖					⌖		⌖		
9	18	⌖					⌖		⌖		
10	18	⌖					⌖				
11	18	⌖					⌖				
12	18	⌖		⌖			⌖				
13	18	⌖		⌖			⌖				
14	18	⌖		⌖			⌖				
15	18	⌖		⌖			⌖				
16	18	⌖			⌖		⌖				
17	18	⌖			⌖		⌖				
18	18	⌖			⌖		⌖				
19	18	⌖			⌖		⌖				
20	18	⌖			⌖		⌖				
21	18	⌖			⌖		⌖				
22	18	⌖			⌖		⌖				
23	18	⌖			⌖		⌖				
24	18	⌖					⌖		⌖		
25	18	⌖					⌖	SPARE			
26	18	⌖					⌖	R6			
27	18	⌖		⌖			⌖				
28	18	⌖		⌖			⌖				
29	18	⌖		⌖			⌖				
30	18	⌖					⌖				⌖
31	18	⌖		⌖			⌖				
32	18	⌖		⌖			⌖				
33	18	⌖					⌖			⌖	
34	18	⌖					⌖	SPARE			
35	18	⌖					⌖	SPARE			
36	18	⌖					⌖	SPARE			
37	18	⌖					⌖		⌖		
38	12	⌖					⌖				
39	12	⌖					⌖				
40	12	⌖					⌖				

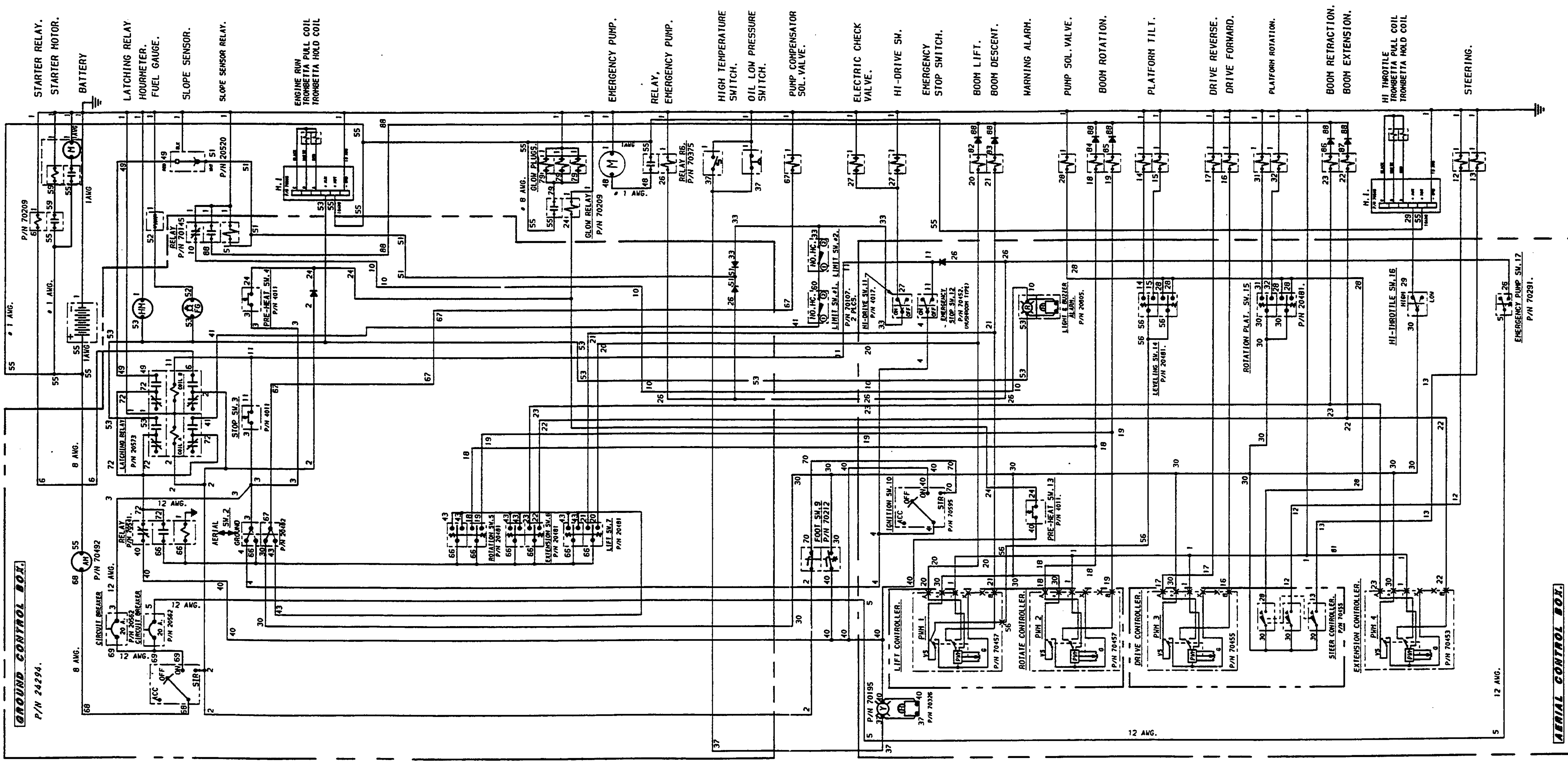


WIRING SCHEDULE											
NO.	AWG	A	B	C	D	E	F	G	H	J	K
43	18				⌖						
48	1					⌖					
49	18		⌖				⌖				
51	18						⌖				
52	18						⌖				
53	12						⌖		⌖		
55	8						⌖		⌖		
55	1					R6		⌖	⌖		
56	18	⌖									
59	12						⌖		⌖		
60	18		⌖				⌖			⌖	
66	18						⌖				
67	18			⌖			⌖				
68	8						⌖		⌖		
69	12						⌖				
70	12	⌖									⌖
72	12						⌖				
79	12						⌖		⌖		
80	12			⌖			⌖				
82	18				⌖		⌖				
83	18				⌖		⌖				
84	18				⌖		⌖				
85	18				⌖		⌖				
86	18				⌖		⌖				
87	18				⌖		⌖				
88	18				⌖		⌖				
89	12						⌖				
93	12						⌖		⌖		

ID	DESCRIPTION.	LOCATION
A	UPPER CONTROL BOX.	PLATFORM
B	LIMIT SWITCH # 1.	TURRET
C	NON-PROPORTIONAL VALVE.	TURRET
D	PROPORTIONAL VALVE.	TURRET
E	EMERGENCY PUMP/MOTOR.	TURRET
F	GROUND CONTROL PANEL.	TURRET
G	BATTERIES.	TURRET
H	ENGINE. COMPARTMENT	TURRET
J	LIMIT SWITCH #2.	BOOM
K	FOOT SWITCH #9.	PLATFORM

Mark Industries

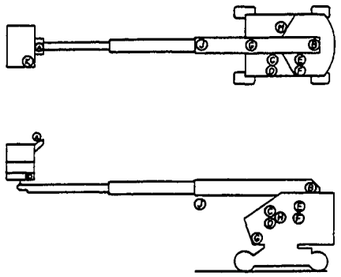
TITLE	ELECTRICAL SCHEMATIC
MODEL	42C NISSAN DIESEL
NOTES	P/N 24450 REV. B



Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C NISSAN DIESEL
NOTES	P/N 24450 REV. B

SCHEMATIC PAGE 6



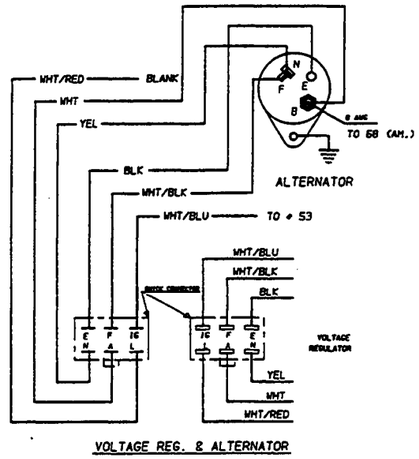
ID	DESCRIPTION.	LOCATION
A	UPPER CONTROL BOX.	PLATFORM
B	LIMIT SWITCH # 1.	TURRET
C	NON-PROPORTIONAL VALVE.	TURRET
D	PROPORTIONAL VALVE.	TURRET
E	EMERGENCY PUMP/MOTOR.	TURRET
F	GROUND CONTROL PANEL.	TURRET
G	BATTERIES.	TURRET
H	ENGINE. COMPARTMENT	TURRET
J	LIMIT SWITCH #2.	BOOM
K	FOOT SWITCH #9.	PLATFORM

WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
1	1					●		●	●		
1	12	●		●	●		●		●		
2	12	●					●		●		●
3	12	●					●				
4	12	●					●				●
5	12	●					●				
6	12	●					●	SPARE			
7	18	●					●		●		
8	18	●					●		●		
9	18	●					●		●		
10	18	●					●				
11	18	●					●				
12	18	●		●			●				
13	18	●		●			●				
14	18	●		●			●				
15	18	●		●			●				
16	18	●			●		●				
17	18	●			●		●				
18	18	●			●		●				
19	18	●			●		●				
20	18	●			●		●				
21	18	●			●		●				
22	18	●			●		●				
23	18	●			●		●				
24	18	●					●		●		
25	18	●					●	SPARE			
26	18	●				R6	●				
27	18	●		●			●				
28	18	●		●			●				
29	18	●		●			●				
30	18	●					●				●
31	18	●		●			●				
32	18	●		●			●				
33	18	●					●			●	
34	18	●					●	SPARE			
35	18	●					●	SPARE			
36	18	●					●	SPARE			
37	18	●					●		●		
38	12	●					●				
39	12	●					●				
40	12	●					●				

WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
43	18				●						
48	1					●					
49	18		●				●				
51	18						●				
52	18						●				
53	12						●		●		
55	8						●		●		
55	1					R6		●	●		
56	18	●									
59	12						●		●		
60	18		●				●			●	
66	18						●				
67	18			●			●				
68	8						●		●		
69	12						●				
70	12	●									●
72	12						●				
79	12						●		●		
80	12			●			●				
82	18				●		●				
83	18				●		●				
84	18				●		●				
85	18				●		●				
86	18				●		●				
87	18				●		●				
88	18				●		●				
89	12						●				
93	12						●		●		



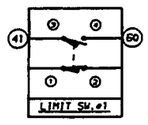
VOLTAGE REG. & ALTERNATOR WIRING DETAIL.

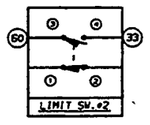
NOTES:

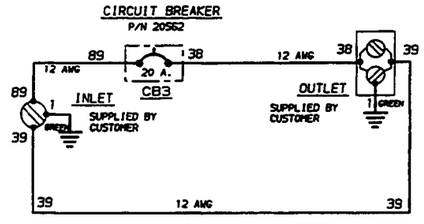
1. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 70528.
2. ALL WIRES ARE 18 AWG. UNLESS OTHERWISE SPECIFIED.
3. USE 6A. 1000V. DIODE P/N 70479.
4. WIRING AND SWITCHES ARE FOR A BOOM IN STOWED POSITION.
5. RUN SEPARATE CABLE FOR 220 V. A.C. ARE 12 AWG. (12-3 SJTO CEE, SPEC-1.) 5FT EXTRA COILED AT BOTH ENDS.
6. IDENTIFY EACH WIRE BY NUMBER FLAG AT BOTH ENDS. WRAPPING COMPLETELY AROUND.
7. WIRE # 34 AT CONTROL CABLE TO BE RE-NUMBERED 53.
8. FOR 220V GENERTOR OPTION, SEE DWG# 24484.
9. FOR AERIAL CONTROL BOX 24118, REMOVED WIRE #3 FROM EMERGENCY STOP SWITCH TO TERMINAL #3. CONNECT WIRE #4 FROM EMERGENCY STOP SWITCH TO TERMINAL #4.
10. FOR GROUND CONTROL BOX 24294, CONNECT WIRE #2 TO LATCHING RELAY. CONNECT WIRE #6 FROM LATCHING RELAY TO STARTER RELAY.



LEGEND FOR LIMIT SWITCHES.







50Hz 220V. A.C. WIRING.

Mark Industries

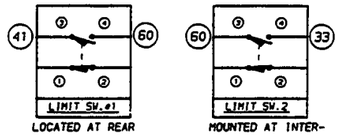
TITLE	ELECTRICAL SCHEMATIC
MODEL	42C DEUTZ
NOTES	P/N 210069 REV. B

SCHEMATIC
PAGE
7

Mark Industries

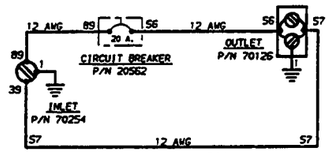
TITLE	ELECTRICAL SCHEMATIC
MODEL	42C DEUTZ
NOTES	P/N 210069 REV. B

SCHEMATIC PAGE 8



LOCATED AT REAR BOOM MOUNTING BRACKET. (BOTTOM) OPENS 15° AND ABOVE

MOUNTED AT INTERMEDIATE INNER BOOM. (BOTTOM) OPEN WHEN EXTENDED MORE THAN 1 FOOT



115 V.A.C. OPTION.



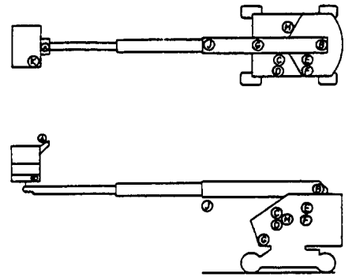
STARTER RELAY 1
P/N 70209.



EMERGENCY P. RELAY 6
P/N 70209.

NOTES:

1. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 70528.
2. ALL WIRES ARE 18 AWG. UNLESS OTHERWISE SPECIFIED.
3. USE 6A. 1000V. DIODE P/N 70479.
4. WIRING AND SWITCHES ARE FOR A BOOM IN STOWED POSITION.
5. ALL WIRES FOR 115 V.A.C. ARE 12 AWG.
6. IDENTIFY EACH WIRE BY NUMBER FLAG AT BOTH ENDS WRAPPING COMPLETELY AROUND.
7. WIRE NO.34 AT CONTROL CABLE TO BE RE-NUMBERED 53.
8. FOR 115 V.A.C. GENERATOR OPTION, SEE DWG 24452.
9. INSTALL A 12AWG YEL/GRN WIRE FROM BATTERY NEGATIVE POST TO TERMINAL #1 ON THE GROUND CONTROL PANEL.



ID	DESCRIPTION.	LOCATION
A	UPPER CONTROL BOX.	PLATFORM
B	LIMIT SWITCH # 1.	TURRET
C	NON-PROPORTIONAL VALVE.	TURRET
D	PROPORTIONAL VALVE.	TURRET
E	EMERGENCY PUMP/MOTOR.	TURRET
F	GROUND CONTROL PANEL.	TURRET
G	BATTERIES.	TURRET
H	ENGINE. COMPARTMENT	TURRET
J	LIMIT SWITCH #2.	BOOM
K	FOOT SWITCH #9.	PLATFORM

WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
1	1					●		●	●		
1	12	●		●	●		●		●		
2	12	●					●		●		●
3	12	●					●				
4	12	●					●				●
5	12	●					●				
6	12	●					●	SPARE			
7	18	●					●		●		
8	18	●					●		●		
9	18	●					●		●		
10	18	●					●				
11	18	●					●				
12	18	●		●			●				
13	18	●		●			●				
14	18	●		●			●				
15	18	●		●			●				
16	18	●			●		●				
17	18	●			●		●				
18	18	●			●		●				
19	18	●			●		●				
20	18	●			●		●				
21	18	●			●		●				
22	18	●			●		●				
23	18	●			●		●				
24	18	●					●		●		
25	18	●					●	SPARE			
26	18	●				R6	●				
27	18	●		●			●				
28	18	●		●			●				
29	18	●		●			●				
30	18	●					●				●
31	18	●		●			●				
32	18	●		●			●				
33	18	●					●			●	
34	18	●					●	SPARE			
35	18	●					●	SPARE			
36	18	●					●	SPARE			
37	18	●					●		●		
38	12	●					●				
39	12	●					●				
40	12	●					●				

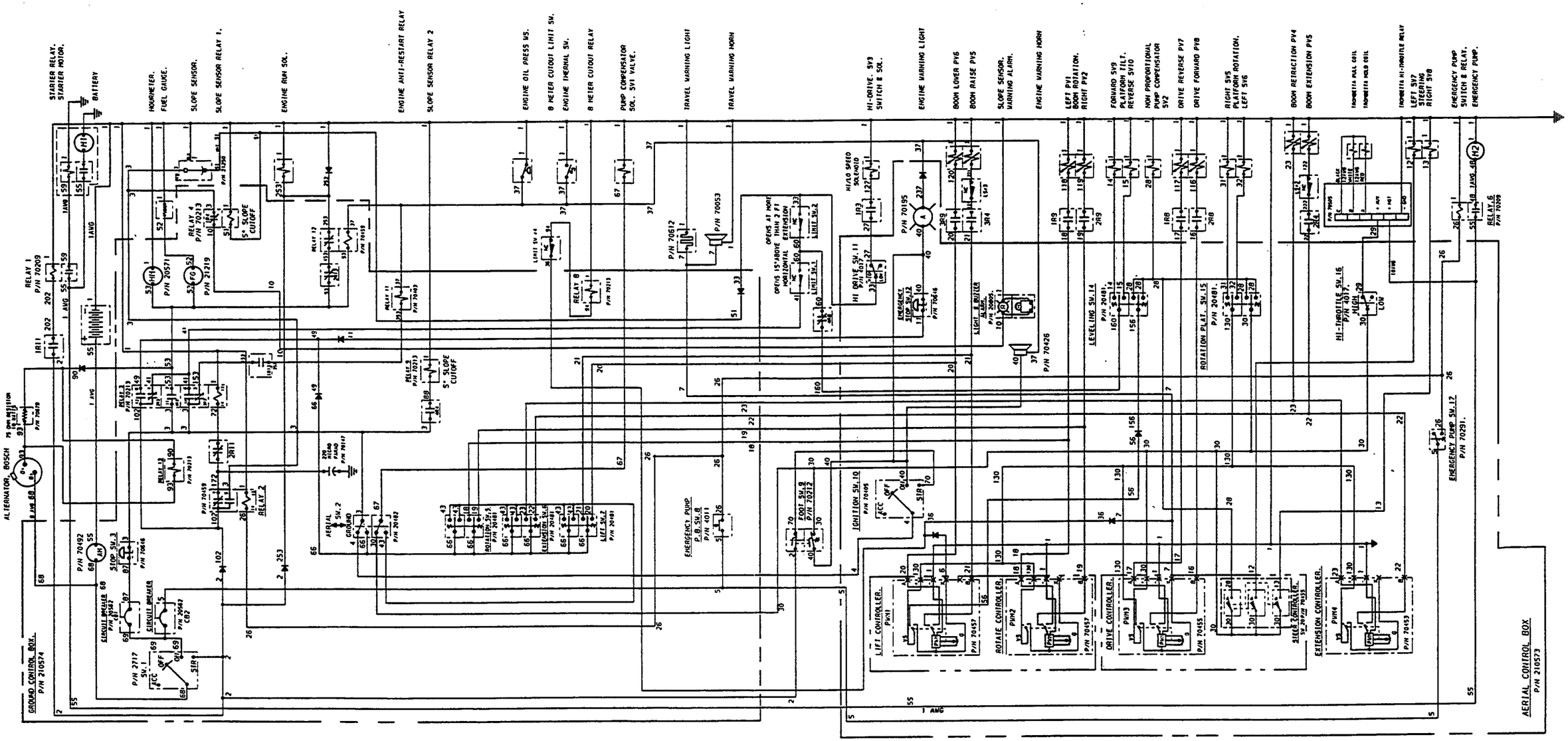
WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
43	18				●						
46	18				●		●				
48	1					●					
49	18		●				●				
51	18						●				
52	18						●				
53	12						●		●		
55	8						●		●		
55	1					R6		●	●		
56	18	●									
59	12						●		●		
60	18		●				●			●	
66	18						●				
67	18				●		●				
68	8						●		●		
69	12						●				
70	12	●									●
72	12						●				
79	12						●		●		
80	12			●			●				
82	18				●		●				
83	18				●		●				
84	18				●		●				
85	18				●		●				
86	18				●		●				
87	18				●		●				
88	18				●		●				
89	12						●				

Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C DEUTZ (TUV)
NOTES	P/N 210575 REV. A

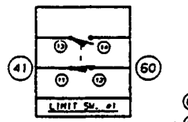
SCHEMATIC
PAGE 9



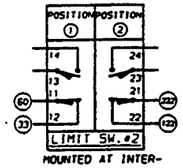
Mark Industries

TITLE	ELECTRICAL SCHEMATIC
MODEL	42C DEUTZ (TUV)
NOTES	P/N 210575 REV. A

SCHEMATIC PAGE 10

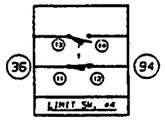


LOCATED AT REAR BOOM MOUNTING BRACKET.
OPENS AT 15° FROM HORIZONTAL

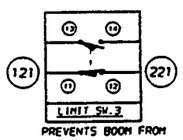


MOUNTED AT INTERMEDIATE INNER BOOM. (BOTTOM)
*POSITION #1 OPEN WHEN BOOM EXTENDED MORE THAN 1 FOOT.

*POSITION #2 OPEN WHEN BOOM IS 2" FROM FULLY EXTENDED.



LOCATED AT REAR BOOM MOUNTING BRACKET.
OPENS AT 28° FROM HORIZONTAL
8 METER CUTOUT



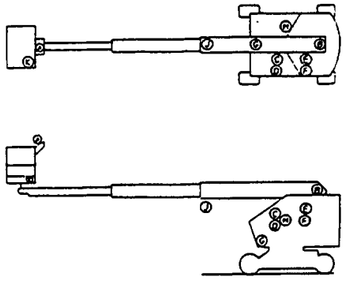
PREVENTS BOOM FROM FULLY RAISE.
OPEN WHEN BOOM AT 75° FROM HORIZONTAL.



STARTER RELAY 1
P/N 70209.



EMERGENCY P. RELAY 6
P/N 70209.



ID	DESCRIPTION.	LOCATION
A	UPPER CONTROL BOX.	PLATFORM
B	LIMIT SWITCH # 1.	TURRET
C	NON-PROPORTIONAL VALVE.	TURRET
D	PROPORTIONAL VALVE.	TURRET
E	EMERGENCY PUMP/MOTOR.	TURRET
F	GROUND CONTROL PANEL.	TURRET
G	BATTERIES.	TURRET
H	ENGINE. COMPARTMENT	TURRET
J	LIMIT SWITCH #2.	BOOM
K	FOOT SWITCH #9.	PLATFORM

WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
1	1					●		●	●		
1	12	●		●	●		●		●		
2	12	●					●		●		●
3	12	●					●				
4	12	●					●				●
5	12	●					●				
6	12	●					●	SPARE			
7	18	●					●		●		
8	18	●					●		●		
9	18	●					●		●		
10	18	●					●				
11	18	●					●				
12	18	●		●			●				
13	18	●		●			●				
14	18	●		●			●				
15	18	●		●			●				
16	18	●			●		●				
17	18	●			●		●				
18	18	●			●		●				
19	18	●			●		●				
20	18	●			●		●				
21	18	●			●		●				
22	18	●			●		●				
23	18	●			●		●				
24	18	●					●		●		
25	18	●					●	SPARE			
26	18	●				R6	●				
27	18	●		●			●				
28	18	●		●			●				
29	18	●		●			●				
30	18	●					●				●
31	18	●		●			●				
32	18	●		●			●				
33	18	●					●			●	
34	18	●					●	SPARE			
35	18	●					●	SPARE			
36	18	●					●	SPARE			
37	18	●					●		●		
38	12	●					●				
39	12	●					●				
40	12	●					●				

WIRING SCHEDULE

NO.	AWG	A	B	C	D	E	F	G	H	J	K
43	18				●						
46	18				●		●				
48	1					●					
49	18		●				●				
51	18						●				
52	18						●				
53	12						●		●		
55	8						●		●		
55	1					R6		●	●		
56	18	●									
59	12						●		●		
60	18		●				●			●	
66	18						●				
67	18			●			●				
68	8						●		●		
69	12						●				
70	12	●									●
72	12						●				
79	12						●		●		
80	12			●			●				
82	18				●		●				
83	18				●		●				
84	18				●		●				
85	18				●		●				
86	18				●		●				
87	18				●		●				
88	18				●		●				
89	12						●				

DRIVE FUNCTION CHART

	STATE	BOOM RAISE & LOWER	BOOM EXTEND & RETRACT	BOOM ROTATION	PLATFORM ROTATION	PLATFORM TILT
DRIVE	ON	OFF	OFF	OFF	OFF	OFF
	OFF	ON	ON	ON	ON	ON

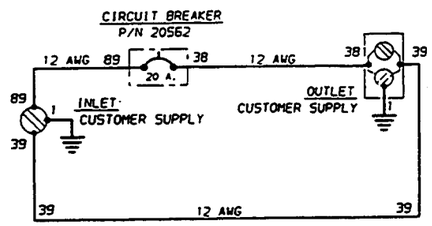
LIMIT SWITCHES & SLOPE SENSOR FUNCTION CHART

	STATE	BOOM RAISE	BOOM LOWER	TURRET ROTATE	DRIVE	BOOM EXTEND	BOOM RETRACT	MI DRIVE	PLATFORM TILT
LS#1	CLOSE	ON	ON	ON	ON	ON	ON	ON	ON
	OPEN	ON	ON	ON	ON	ON	ON	OFF	OFF
LS#2	CLOSE	ON	ON	ON	ON	ON	ON	ON	*
	OPEN	ON	ON	ON	ON	POSITION #2-OFF POSITION #1-OFF	ON	POSITION #2-ON POSITION #1-OFF	*
LS#3	CLOSE	ON	*	*	*	*	*	*	*
	OPEN	OFF	*	*	*	*	*	*	*
LS#4	CLOSE	ON	ON	ON	ON	ON	ON	*	*
	OPEN	ON	ON	ON	OFF	ON	ON	*	*
SLOPE SENSOR	BELOW 5°	ON	ON	ON	ON	ON	ON	*	*
	ABOVE 5°	OFF	OFF	OFF	ON	OFF	ON	*	*

* SWITCH SETTING DOES NOT AFFECT OPERATION.



LEGEND FOR LIMIT SWITCHES.



230 VAC WIRING.

RELAY INFORMATION:

- R1, STARTER RELAY
- R2, EMERGENCY ENGINE CUT-OFF RELAY
- R3, ENGINE HOLD RELAY
- R4, SLOPE SENSOR RELAY (1)
- R5, NOT USED
- R6, EMERGENCY PUMP RELAY
- R7, NOT USED
- R8, 8 METER CUT-OUT RELAY
- R9, SLOPE SENSOR RELAY (2)
- R10, NOT USED
- R11, ENGINE ANTI-RESTART RELAY
- R12, LOW OIL CUT-OFF RELAY
- R13, FAN BELT BREAK RELAY

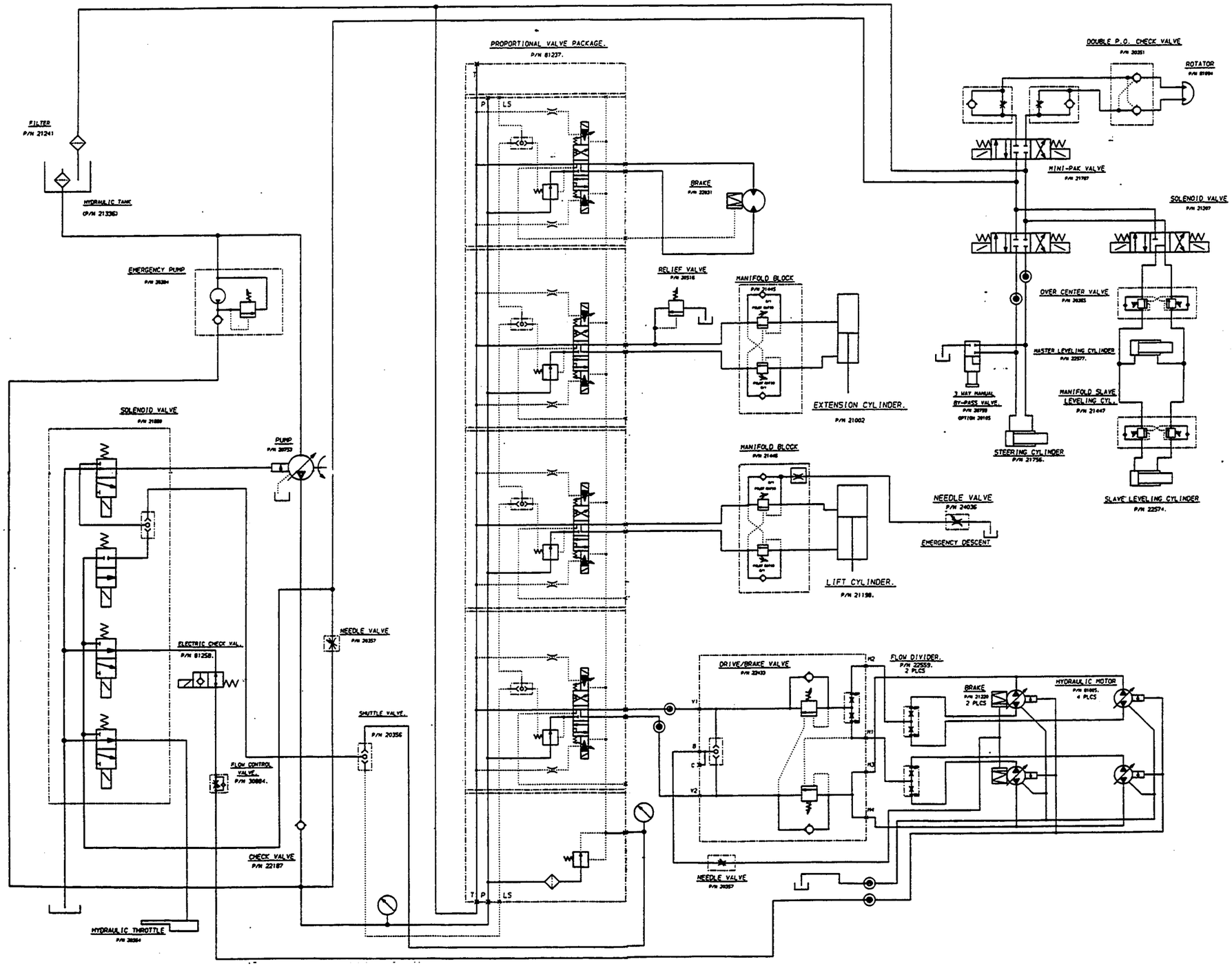
NOTES:

1. TO CONNECT GROUND CONTROL AND AERIAL CONTROL USE ARM CABLE P/N 70528.
2. ALL WIRES ARE 18 AWG. UNLESS OTHERWISE SPECIFIED.
3. USE 6A. 1000V. DIODE P/N 70479.
4. WIRING AND SWITCHES ARE FOR A BOOM IN STOWED POSITION.
5. ALL WIRES FOR 230 VAC ARE 12 AWG.
6. IDENTIFY EACH WIRE BY NUMBER FLAG AT BOTH ENDS WRAPPING COMPLETELY AROUND.
7. RUN SEPARATE CABLE P/N 70423 FOR 230 V.A.C. (12-3 SJTO CEE, SPEC-1) 5FT EXTRA COILED AT BOTH ENDS AND WRAPPED.

Mark Industries

TITLE	HYDRAULIC SCHEMATIC
MODEL	42C
NOTES	P/N 24244 REV. NC

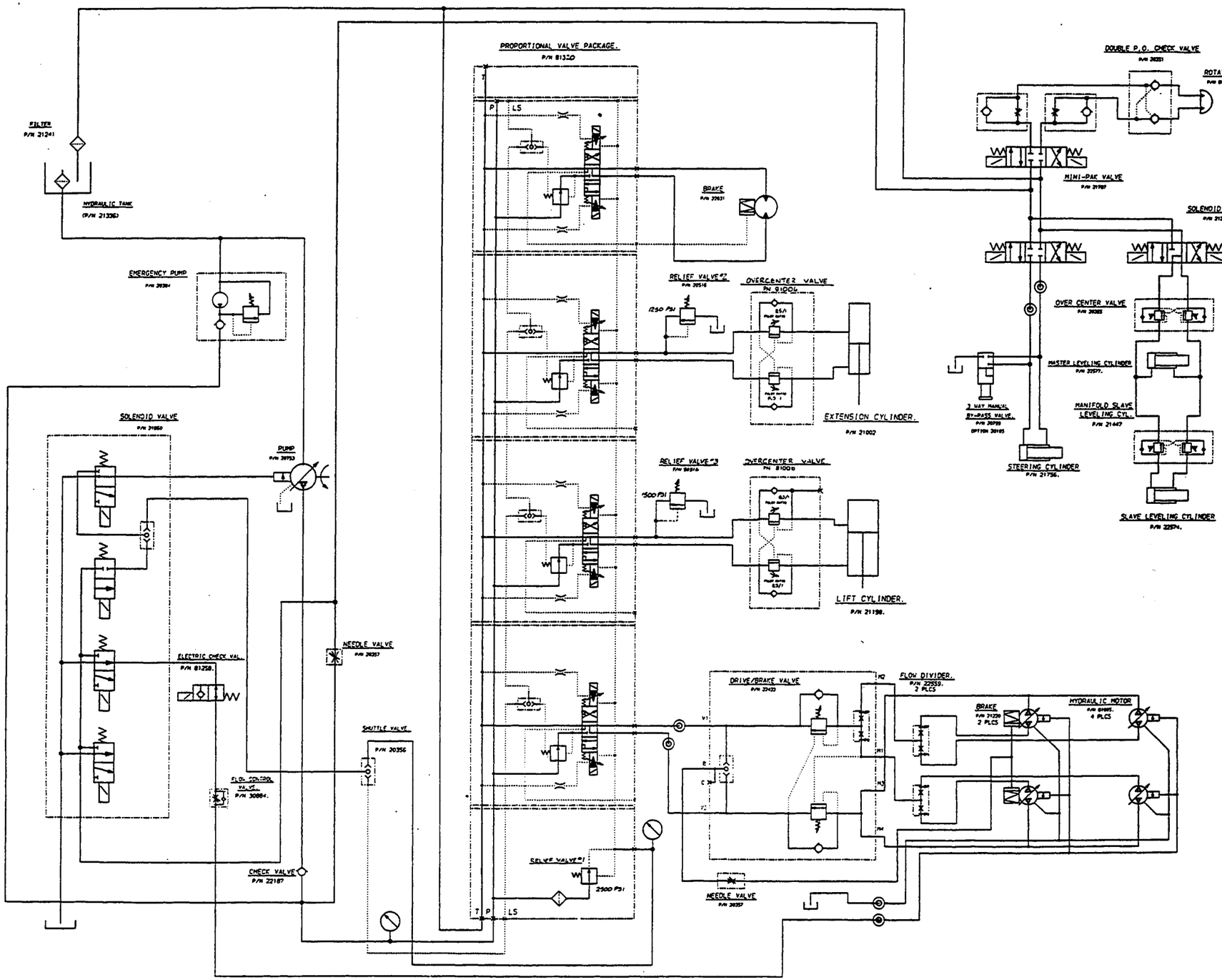
SCHEMATIC
PAGE 11



Mark Industries

TITLE	HYDRAULIC SCHEMATIC
MODEL	42C DIESEL (TUV)
NOTES	P/N 210781 REV. NC

SCHEMATIC
PAGE 12



SECTION 1 CONTAINS:

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

DISCLAIMER

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

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

NOTICE

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

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

SECTION 2	FINAL ASSEMBLY
FIG. NO.	TITLE
1	FINAL ASSEMBLY
2	SHEET METAL KIT
3	AERIAL CONTROL BOX ASSEMBLY
4	HELAC ROTATOR ASSEMBLY
5	HYDRAULIC HOSE DIAGRAM
6	DECAL SET
7	CONTROLLER (LIFT/ROTATE) (UNTIL MAY 1989)
7A	CONTROLLER (LIFT/ROTATE) (SINCE MAY 1989)
8	CONTROLLER (DRIVE/STEER) (UNTIL MAY 1989)
8A	CONTROLLER (DRIVE/STEER) (SINCE MAY 1989)
9	CONTROLLER (EXTENSION) (UNTIL MAY 1989)
9A	CONTROLLER (EXTENSION) (SINCE MAY 1989)

SECTION 3	CARRIAGE ASSEMBLY
FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY
2	TORQUE HUB (UNTIL MID 1989)
2A	TORQUE HUB (SINCE MID 1989)
3	DRIVE MOTOR ASSEMBLY
4	STEERING CYLINDER ASSEMBLY (CONCURRENT USE)
4A	STEERING CYLINDER ASSEMBLY (CONCURRENT USE, SINCE EARLY 1990)
4B	STEERING CYLINDER ASSEMBLY (CONCURRENT USE, SINCE EARLY 1990)
5	DRIVE/BRAKE VALVE ASSEMBLY

SECTION 4	TURRET ASSEMBLY
FIG. NO.	TITLE
1	TURRET ASSEMBLY
2	SOLENOID VALVE ASSEMBLY (UNTIL LATE 1989)

SECTION 4	TURRET ASSEMBLY (CONT'D)
FIG. NO.	TITLE
2A	SOLENOID VALVE ASSEMBLY (SINCE LATE 1989)
3	MASTER LEVELING CYLINDER ASSEMBLY (EARLY 1988, SOME CONCURRENT USE)
3A	MASTER LEVELING CYLINDER ASSEMBLY (CONCURRENT USE)
3B	MASTER LEVELING CYLINDER ASSEMBLY (SINCE LATE 1989, CONCURRENT USE)
4	GROUND CONTROL BOX ASSEMBLY
5	HYDRAULIC TANK ASSEMBLY
6	PROPORTIONAL VALVE ASSEMBLY
* 7	FUEL TANK ASSEMBLY
8	ROTATION GEARBOX ASSEMBLY
9	LIFT CYLINDER ASSEMBLY (CONCURRENT USE)
9A	LIFT CYLINDER ASSEMBLY (SINCE LATE 1989, CONCURRENT USE)
9B	LIFT CYLINDER ASSEMBLY (SINCE MID 1990, CONCURRENT USE)
* 10	MINIPAK ASSEMBLY (WITH PLATFORM ROTATION)
* 10A	MINIPAK ASSEMBLY (WITHOUT PLATFORM ROTATION)
11	ELECTRIC CHECK VALVE ASSEMBLY
12	EMERGENCY PUMP & MOTOR ASSEMBLY
13	ROTARY MANIFOLD ASSEMBLY (UNTIL EARLY 1988)
13A	ROTARY MANIFOLD ASSEMBLY (EARLY 1988 UNTIL LATE 1989)
* 14	ENGINE/PUMP ASSEMBLY
* 15	BATTERY CABLE KIT
16	TORQUE HUB ASSEMBLY (ROTATION GEARBOX)

SECTION 5	FINAL BOOM ASSEMBLY
FIG. NO.	TITLE
* 1	FINAL BOOM ASSEMBLY (UNTIL LATE 1988)
* 1A	FINAL BOOM ASSEMBLY (SINCE LATE 1988)
* 2	INNER BOOM ASSEMBLY (UNTIL LATE 1988)
* 2A	INNER BOOM ASSEMBLY (SINCE LATE 1988)
3	SLAVE LEVELING CYLINDER (UNTIL LATE 1989)
3A	SLAVE LEVELING CYLINDER (SINCE LATE 1989)
4	EXTENSION CYLINDER (SINCE EARLY 1986; CONCURRENT USE)

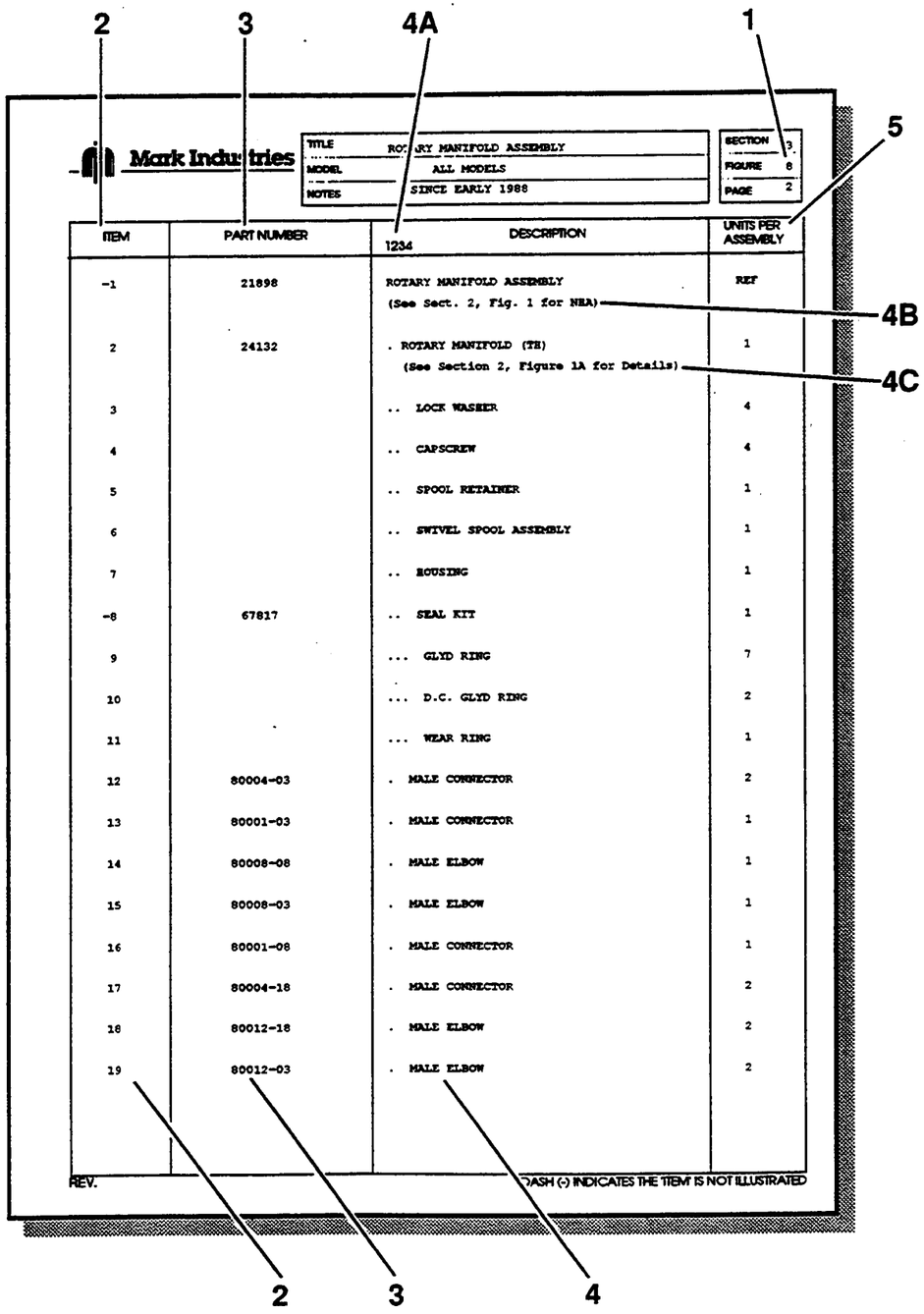
*SEE OPTION SECTION FOR OTHER VARIATION(S).

SECTION 5	FINAL BOOM ASSEMBLY (CONT'D)
FIG. NO.	TITLE
4A	EXTENSION CYLINDER (SINCE EARLY 1990; CONCURRENT USE)
4B	EXTENSION CYLINDER (SINCE EARLY 1989)

SECTION 6	OPTIONS
FIG. NO.	TITLE
1	OPTIONS
2	EXTRA TRACTION TIRES
3	SANDBLAST KIT
4	TOWING KIT
5	ROTATING AMBER BEACON
6	HEADLIGHTS
7	FRONT MOUNT PLATFORM ROTATION
8	MINIPAK SUB-ASSEMBLY
9	CATALYTIC CONVERTER
10	2.5 KW GENERATOR
11	AIRLINE (TO PLATFORM)
12	HYDRAULIC LINE (TO PLATFORM)
13	LIFTING LUGS
14	DIESEL FUEL TANK ASSEMBLY
15	ENGINE/PUMP ASSEMBLY (NISSAN A-15)
16	ENGINE/PUMP ASSEMBLY (NISSAN SD-16)
17	ENGINE/PUMP ASSEMBLY (DEUTZ F2L912)
18	BATTERY CABLE KIT (DEUTZ)
19	SHEET METAL KIT (DEUTZ)
20	SHEET METAL KIT (NISSAN)
21	FINAL BOOM ASSEMBLY (EXTERNAL POWER TRACK)
22	INNER BOOM ASSEMBLY (EXTERNAL POWER TRACK)
23	DUAL FUEL KIT (VG4D)

SECTION 7	FINAL ASSEMBLY (TUV)
FIG. NO.	TITLE
1	FINAL ASSEMBLY
2	TURRET ASSEMBLY
3	SHEET METAL KIT
4	FINAL BOOM ASSEMBLY

SECTION 7	FINAL ASSEMBLY (TUV)
FIG. NO.	TITLE
5	INNER BOOM MODIFICATION ASSEMBLY
6	BOOM MODIFICATION ASSEMBLY
7	AERIAL CONTROL BOX ASSEMBLY
8	DECAL SET
9	LIMIT SWITCH/BRACKET ASSEMBLY
10	8 METER DRIVE CUT-OUT ASSEMBLY
11	TRAVEL WARNING HORN WITH BEACON ASSEMBLY
12	CARRIAGE ASSEMBLY & TURRET WELDMENT
13	ENGINE/PUMP ASSEMBLY
14	GROUND CONTROL BOX ASSEMBLY
15	BATTERY CABLE KIT



1. The Parts Chapter Pagination.

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

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

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

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

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

4. Elements of the **Description**.

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

   Figure Description

   1 2 3 4

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

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

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

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

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

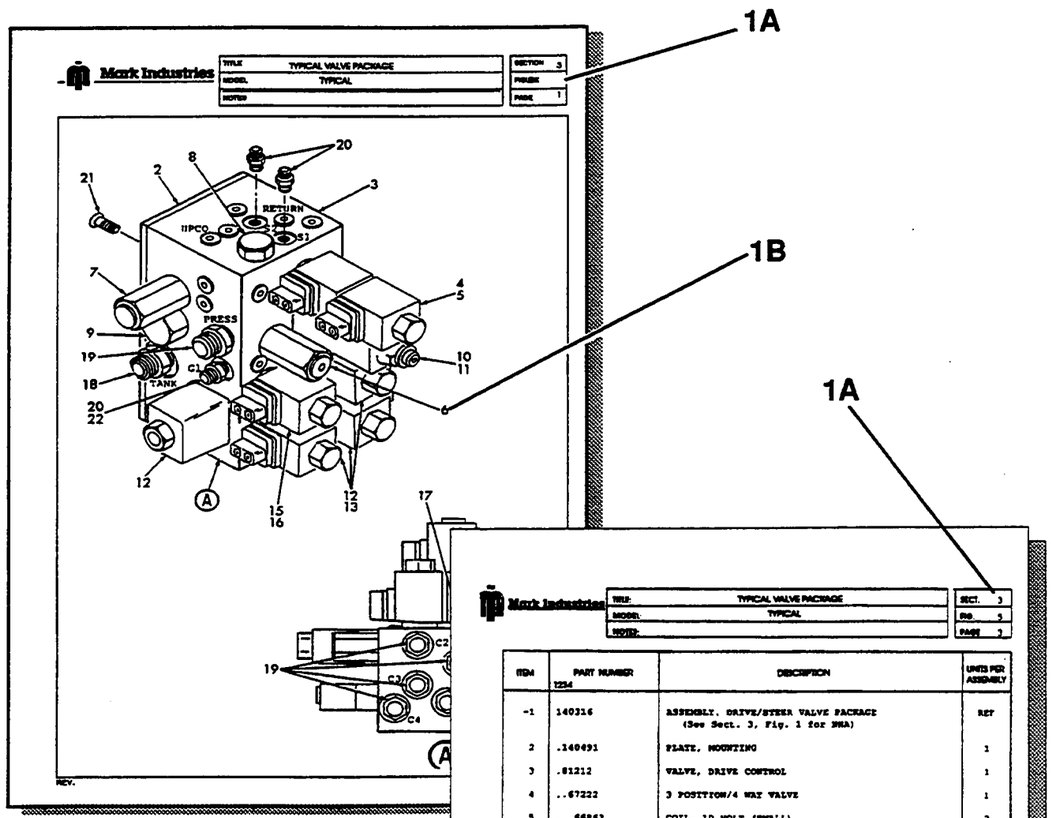
   C. **DETAILS** corresponds to the Section and Figure to be referred to for a more detailed breakdown of this item.

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

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

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

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



Mark Industries

TITLE: TYPICAL VALVE PACKAGE
MODEL: TYPICAL
NOTES:
SECT. 3
PG. 5
PAGE 3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSEMBLY
-1	140316	ASSEMBLY, DRIVE/STEER VALVE PACKAGE (See Sect. 3, Fig. 1 for BRA)	REF
2	.140491	PLATE, MOUNTING	1
3	.81212	VALVE, DRIVE CONTROL	1
4	..67222	3 POSITION/4 WAY VALVE	1
5	...66863	COIL, 10 VOLT (SMALL)	2
*6	..68060	VALVE, RELIEF	1
*7	..68057	VALVE, RELIEF	1
8	..67229	REGULATOR, FLOW	1
9	..600024	VALVE, DIFFERENTIAL SENSING	1
10	..67677	VALVE, PROPORTIONAL	1
11	...600111	COIL, 12 VOLT (LARGE)	1
12	..67220	VALVE, SOLENOID	4
13	...66863	COIL, 10 VOLT (SMALL)	4
14	..600023	VALVE, SHUTTLE	1
15	..66676	VALVE, SOLENOID	1
16	...66863	COIL, 10 VOLT (SMALL)	1
17	..67219	DIVIDER/COMBINER, FLOW	1
18	.80004-15	CONNECTOR, STRAIGHT THREAD	1
19	.80004-11	CONNECTOR, STRAIGHT THREAD	5
20	.80004-03	CONNECTOR, STRAIGHT THREAD	4
21	.61813	SCREW, CAP	3
22	.80059-03	CAP	1
		NOTE: PRIOR TO USE, RELIEF VALVES WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

REV. 1 10-89

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

MARK INDUSTRIES
205 South Puente Street
Brea, CA 92621

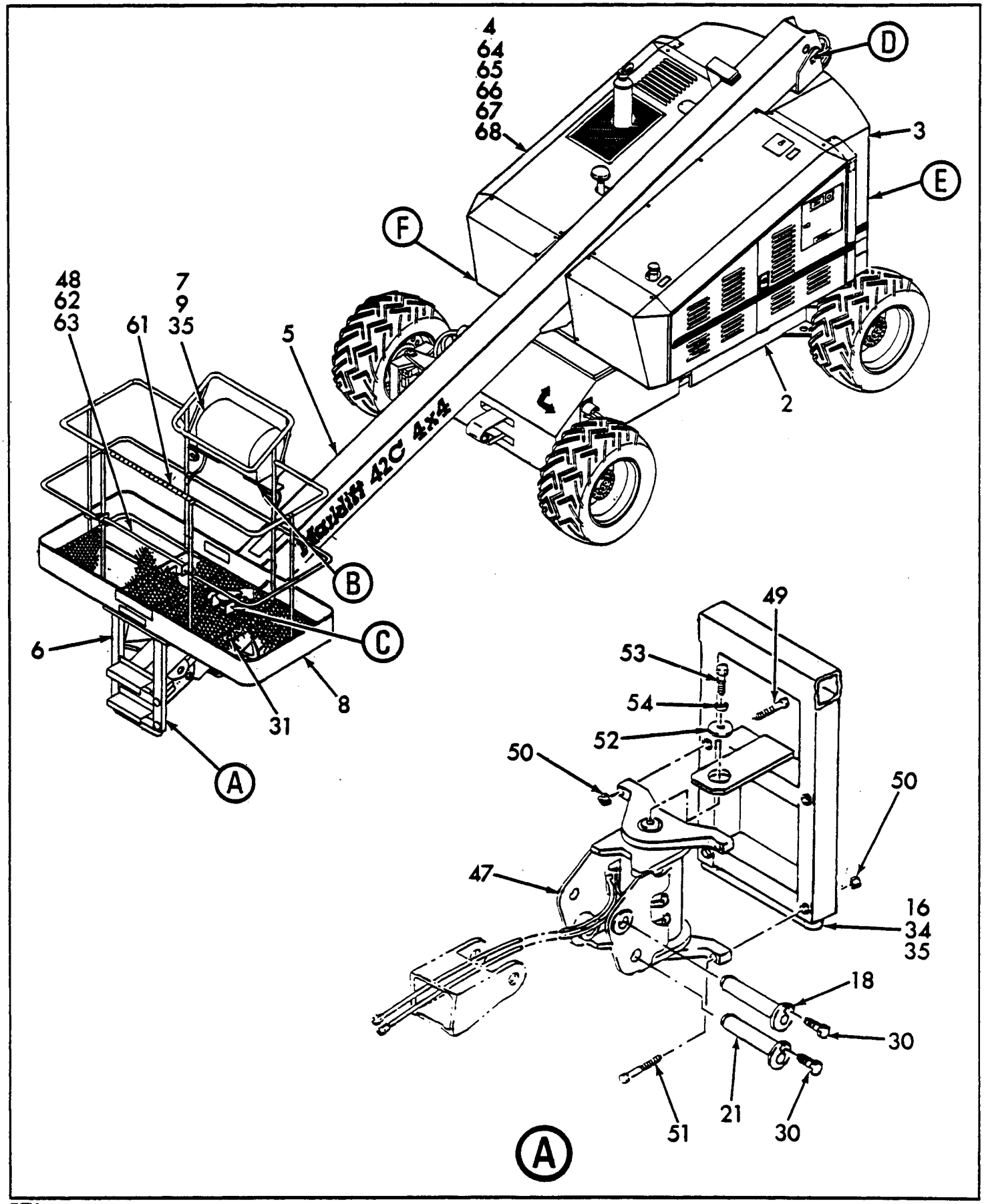
SECTION 2 CONTAINS:

FIG. NO.	TITLE
1	FINAL ASSEMBLY
2	SHEET METAL KIT
3	AERIAL CONTROL BOX ASSEMBLY
4	HELAC ROTATOR ASSEMBLY
5	HYDRAULIC HOSE DIAGRAM
6	DECAL SET
7	CONTROLLER (LIFT/ROTATE) (UNTIL MAY 1989)
7A	CONTROLLER (LIFT/ROTATE) (SINCE MAY 1989)
8	CONTROLLER (DRIVE/STEER) (UNTIL MAY 1989)
8A	CONTROLLER (DRIVE/STEER) (SINCE MAY 1989)
9	CONTROLLER (EXTENSION) (UNTIL MAY 1989)
9A	CONTROLLER (EXTENSION (SINCE MAY 1989)

Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	42C
NOTES	

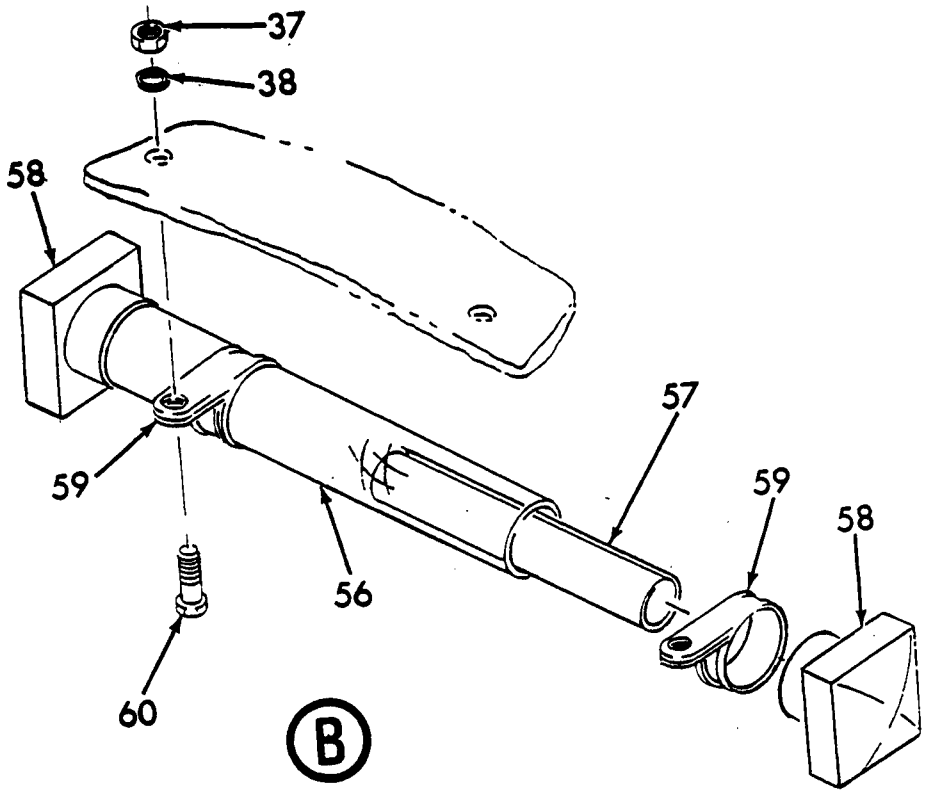
SECTION	2
FIGURE	1
PAGE	1

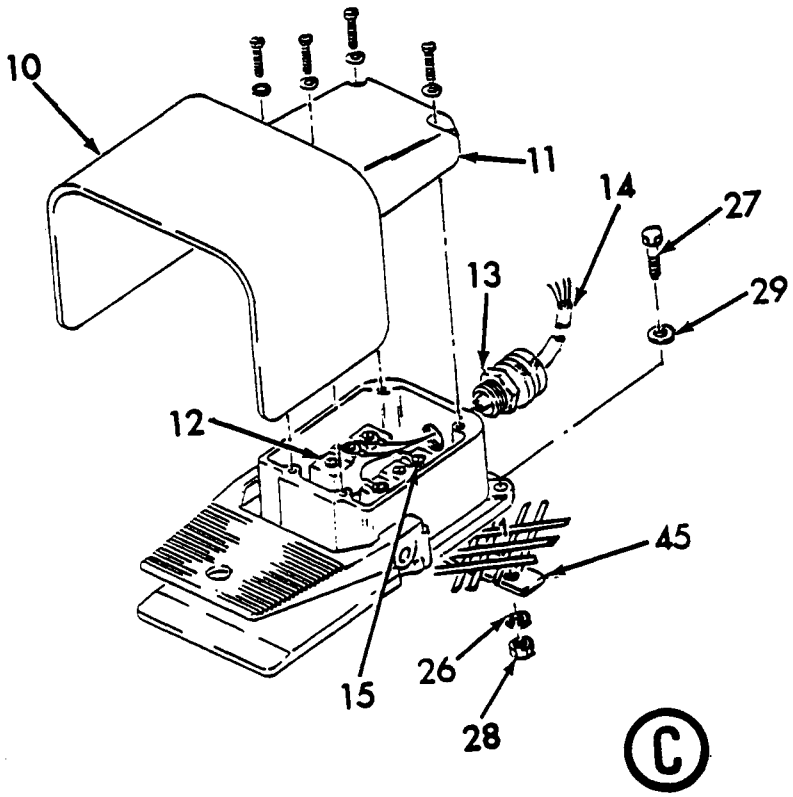


REV.

Mark Industries

TITLE	FINAL ASSEMBLY	SECTION	2
MODEL	42C	FIGURE	1
NOTES		PAGE	2



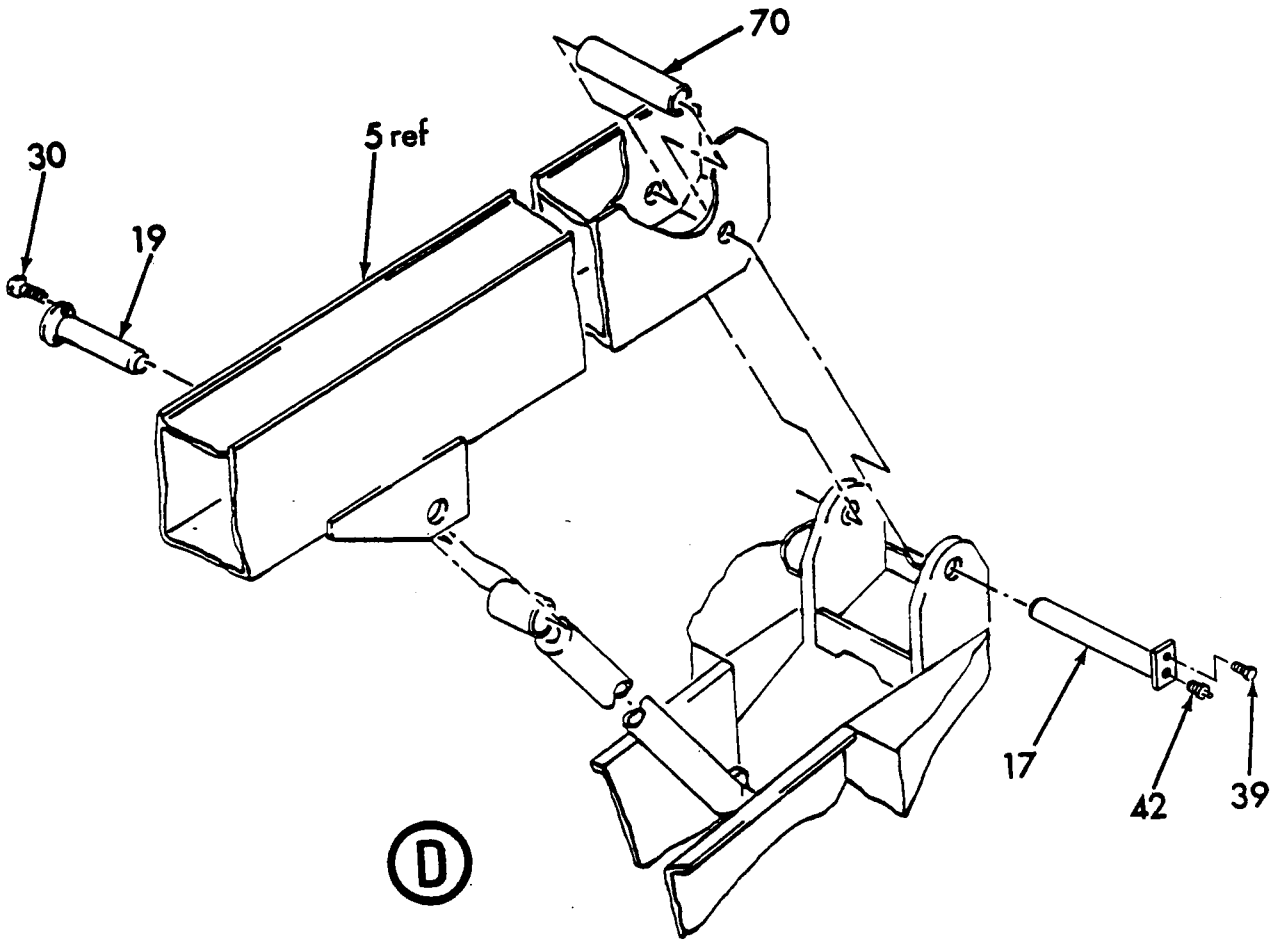


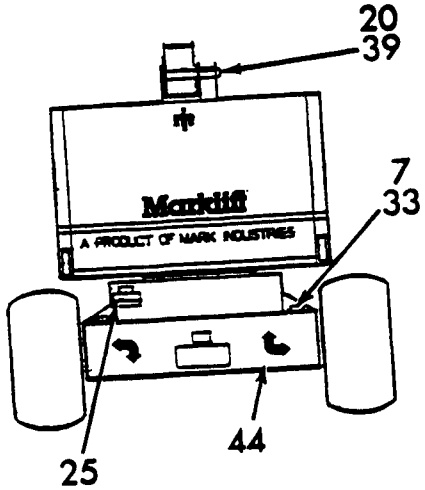
REV.

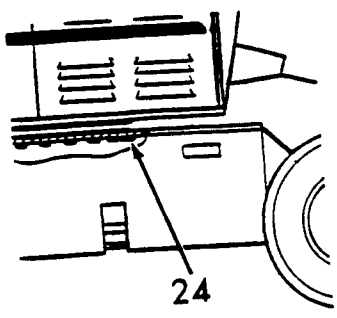
Mark Industries

TITLE	FINAL ASSEMBLY
MODEL	42C
NOTES	

SECTION	2
FIGURE	1
PAGE	3







REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20065	ASSEMBLY, FINAL	REF
2	.24089	ASSEMBLY, CARRIAGE (See Sect. 3, Fig. 1 for Details)	1
3	.24144	ASSEMBLY, TURRET (See Sect. 4, Fig. 1 for Details)	1
4	.21706	KIT, SHEET METAL (See Sect. 2, Fig. 2 for Details)	1
5	.24457	ASSEMBLY, FINAL BOOM (SINCE LATE 1988) (See Sect. 5, Fig. 1 or 1A for Details)	1
5	.23072	ASSEMBLY, FINAL BOOM (UNTIL LATE 1988) (See Sect. 5, Fig. 1 or 1A for Details)	1
6	.24171	WELDMENT, PLATFORM	1
7	.60343	SCREW, CAP	4
8	.24150	WELDMENT, PLATFORM	1
9	.24118	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 3 for Details)	1
10	.20480	ASSEMBLY, FOOTSWITCH	1
11	..70212	FOOTSWITCH	1
12	...66336	MICROSWITCH	2
13	..2531	RELIEF, STRAIN	1
14	..2912	CABLE, CONDUCTOR	5 FT
15	..876	TERMINAL, RING	4
16	.20552	BUMPER, PLATFORM	1
17	.23199	PIN, BOOM PIVOT	1
18	.20457	PIN, BOOM PIVOT (FORK)	1
19	.23509	PIN, LIFT CYLINDER	1
20	.22491	PIN, MASTER LEVELING CYLINDER	1
21	.20261	PIN, LEVELING CYLINDER	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-22	.65114	GASOLINE, REGULAR	5 GAL
-23	.16608	PAINT, WHITE WATERBASE	8 GAL
24	.60609	SCREW, CAP	18
25	.63653	RIVET, POP	8
26	.63302	WASHER, LOCK	20
27	.60346	SCREW, CAP	2
28	.60702	NUT, HEX	2
29	.63402	WASHER, FLAT	20
30	.60607	SCREW, CAP	3
31	.60515	SCREW, CAP	4
32	.61302	NUT, HEX	4
33	.63303	WASHER, LOCK	4
34	.60307	SCREW, CAP	2
35	.60703	NUT, HEX	4
-36	.65112	PAINT, TANK WHITE	.5 GAL
37	.61239	NUT, LOCK	2
38	.63401	WASHER, FLAT	31
39	.60613	SCREW, CAP	4
-40	.24405	SCHEMATIC, ELECTRICAL (WISCONSIN) (See Schematic Section for Details)	1
-41	.24244	SCHEMATIC, HYDRAULIC (See Schematic Section for Details)	1
42	.65103	FITTING, GREASE	2
-43	.65389	PAINT, BLUE WATERBASE	1 GAL
44	.21611	COVER, REAR DRIVE	1
45	.22742	PLATE, DEADMAN SWITCH BACKING	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-46	.65116	OIL, HYDRAULIC	45 GAL
47	.24444	ASSEMBLY, HELAC ROTATOR (See Sect. 2, Fig. 4 for Details)	1
48	.141080	WELDMENT, SLIDE BAR	1
49	.60540	SCREW, CAP	2
50	.160063	NUT, HEX	4
51	.60513	SCREW, CAP	2
52	.23565	WASHER	1
53	.60516	SCREW, CAP	1
54	.63305	WASHER, LOCK	1
-55	.16268	CLAMP, HOSE	5
56	.130927	CONTAINER, PLASTIC	1
57	.17409	HANDBOOK, OPERATION & SAFETY	1
58	.65842	CAP, ANTI-ROLL	2
59	.65867	CLAMP	2
60	.60309	SCREW, CAP	2
61	.160137	TAPE, WARNING (BLACK & YELLOW)	2.1 FT
62	.160212	PIN, CLEVIS	2
63	.160213	PIN, COTTER	2
64	.60322	SCREW, CAP	18
65	.61902	SCREW, CAP	44
66	.61313	NUT, SELF-LOCKING	20
67	.61816	SCREW, CAP	2
68	.63301	WASHER, LOCK	2
69	.67513	SET, DECAL (See Sect. 2, Fig. 6 for Details)	1

Mark Industries

TITLE	FINAL ASSEMBLY	SECT.	2
MODEL	42C	FIG.	1
NOTES		PAGE	7

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
70	.26454	TUBE, ROUNG	1
-71	.24185	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 5 for Details)	REF

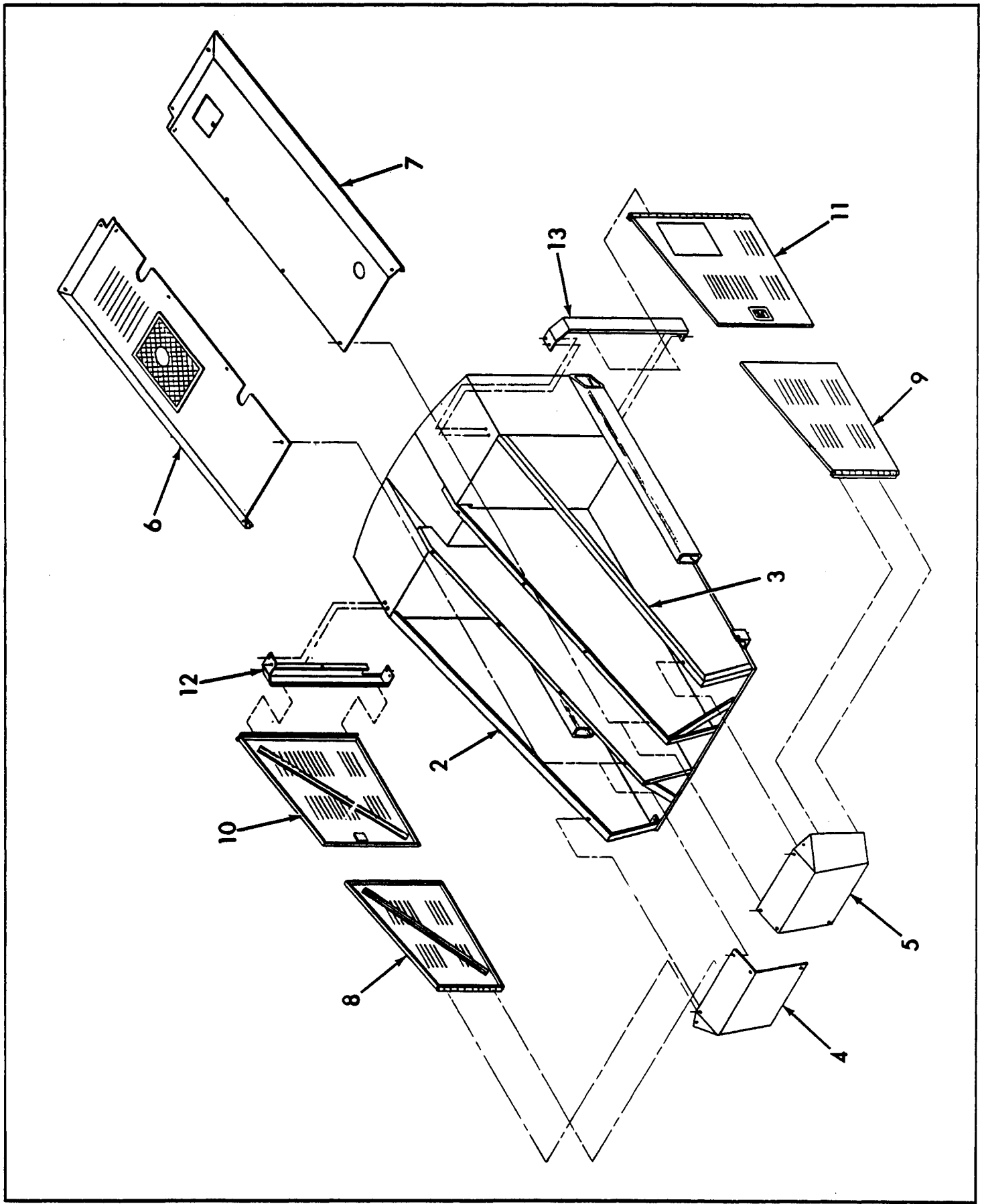
REV.

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

Mark Industries

TITLE	SHEET METAL KIT
MODEL	42C
NOTES	

SECTION	2
FIGURE	2
PAGE	1



REV.

Mark Industries

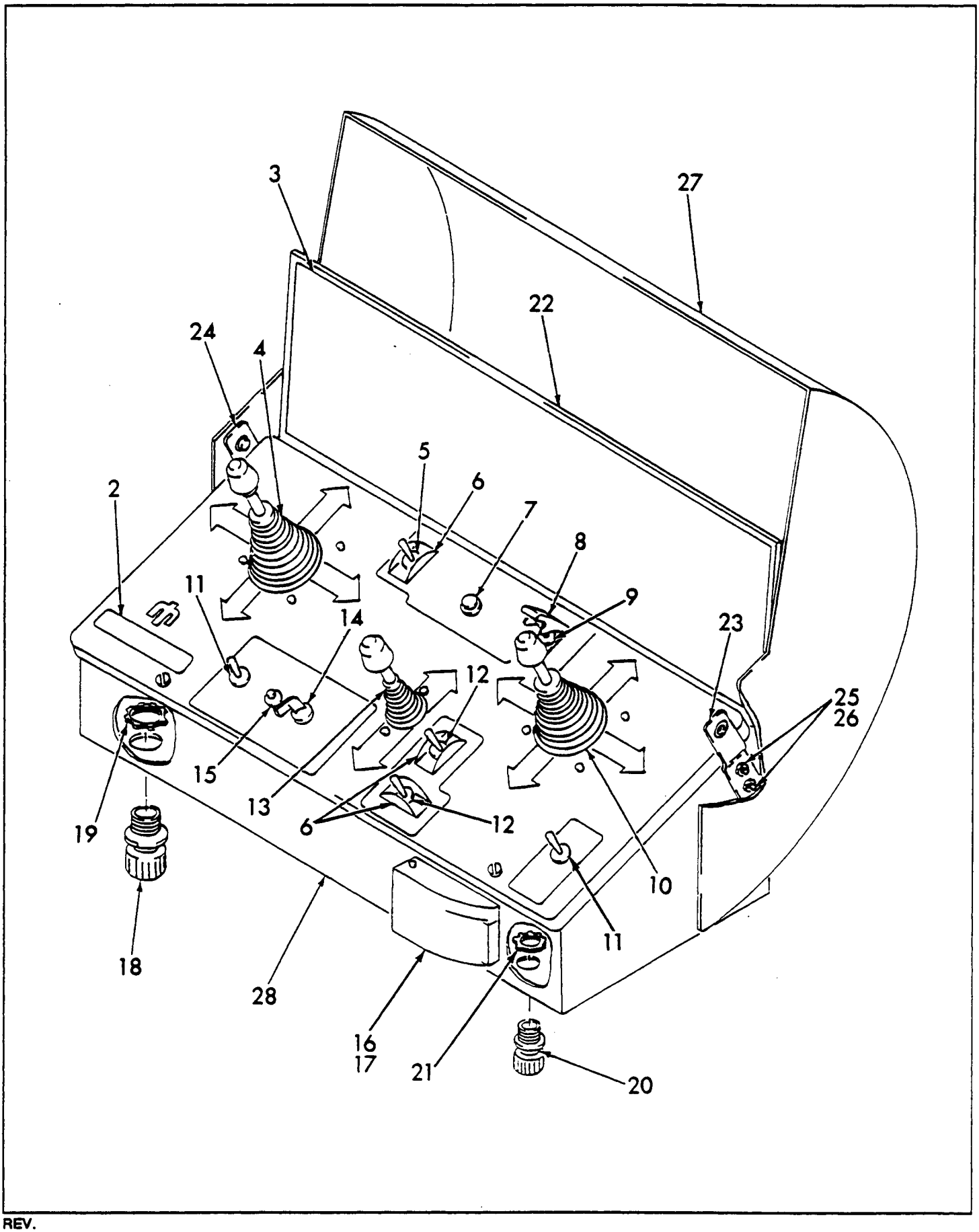
TITLE	SHEET METAL KIT	SECT.	2
MODEL	42C	FIG.	2
NOTES		PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21706	KIT, SHEET METAL (See Sect. 2, Fig. 1 for Details)	REF
2	.21742	BRACKET, LEFT ANGLE	1
3	.21741	BRACKET, RIGHT ANGLE	1
4	.21736	NOSEPIECE, LEFT	1
5	.21735	NOSEPIECE, RIGHT	1
6	.21746	COVER, LEFT TOP	1
7	.21745	COVER, RIGHT TOP	1
8	.21740	DOOR, LEFT REAR	1
9	.21739	DOOR, RIGHT REAR	1
10	.21738	DOOR, LEFT FRONT	1
11	.21737	DOOR, RIGHT FRONT	1
12	.21744	SUPPORT, LEFT FRONT	1
13	.21743	SUPPORT, RIGHT FRONT	1

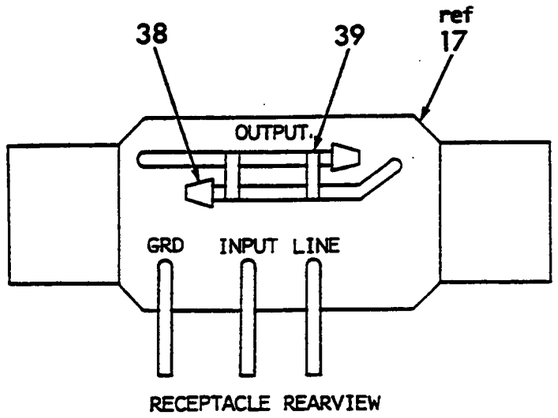
Mark Industries

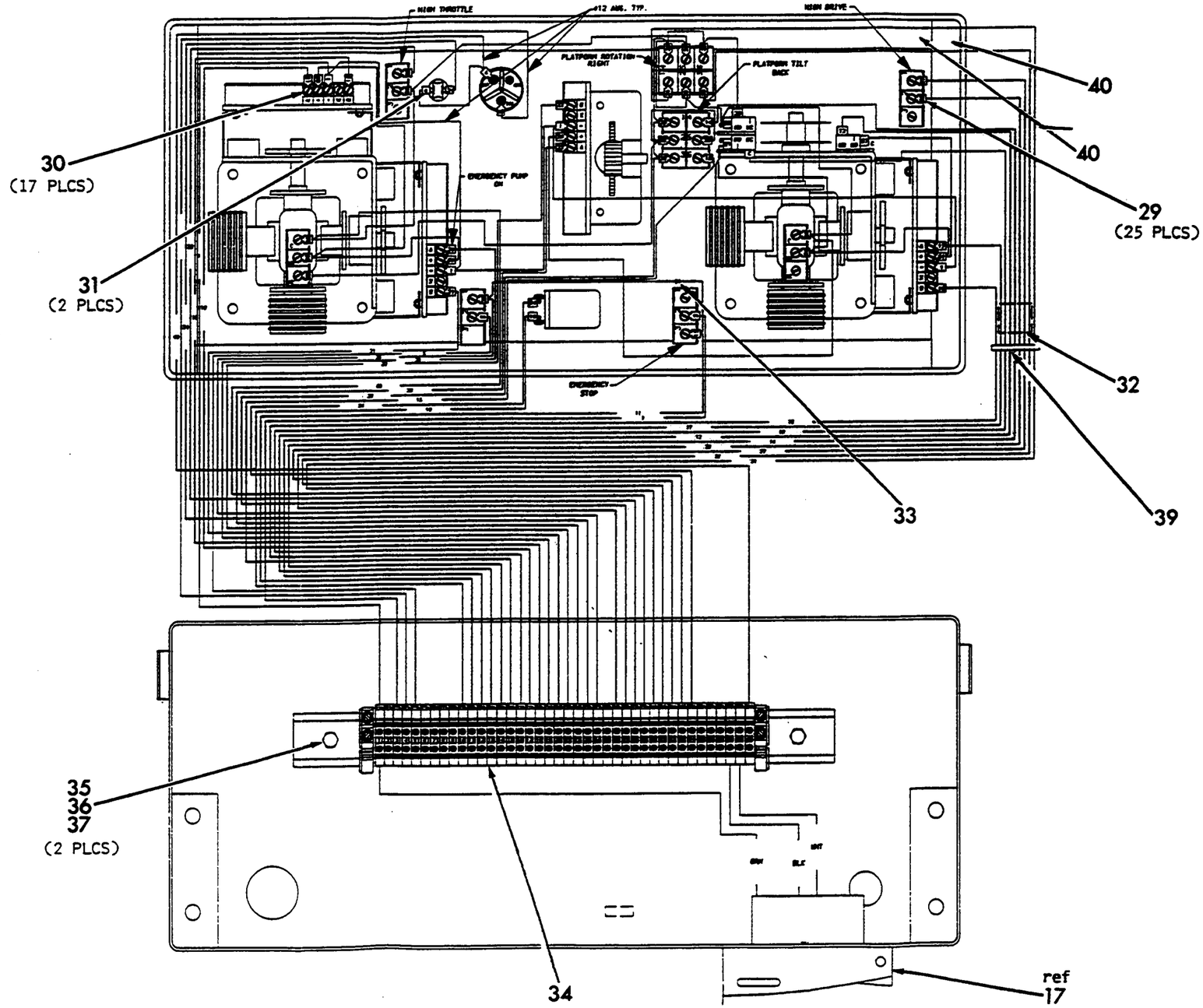
TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	42C
NOTES	UNTIL MAY 1989

SECTION	2
FIGURE	3
PAGE	1



REV.





WIRING DIAGRAM

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY	SECT. 2
MODEL	42C	FIG. 3
NOTES	UNTIL MAY 1989	PAGE 3

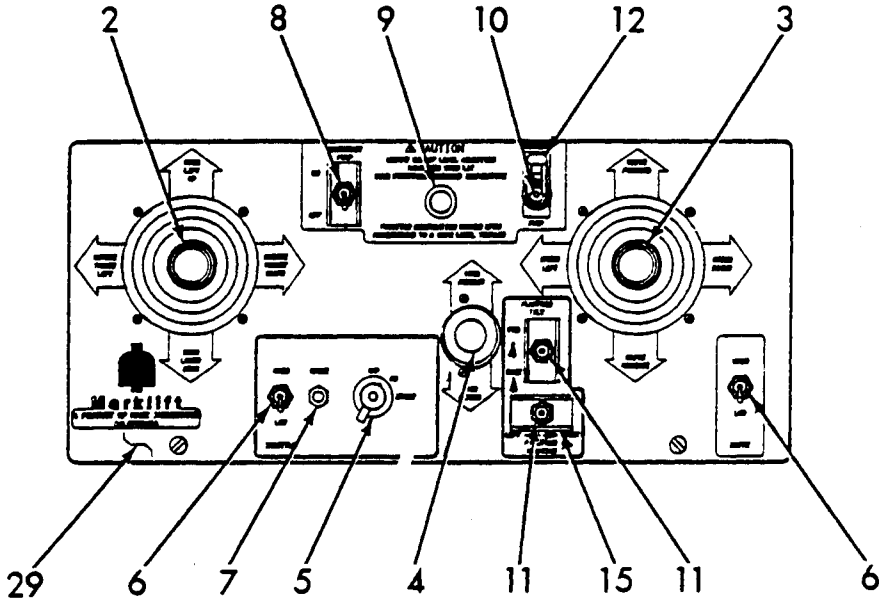
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24118	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 1 for NHA)	REF
2	.182707	DECAL, AERIAL CONTROL BOX	1
3	.182103	DECAL, OPERATING INSTRUCTIONS	1
4	.70398	CONTROLLER (LIFT/ROTATE) (See Sect. 2, Fig. 7 for Details)	1
5	.70291	SWITCH, TOGGLE	1
6	.20884	GUARD, SWITCH	3
7	.20805	BUZZER, ALARM	1
8	.70407	GUARD, SWITCH	1
9	.4021	SWITCH, TOGGLE	1
10	.70399	CONTROLLER (DRIVE/STEER) (See Sect. 2, Fig. 8 for Details)	1
11	.70313	SWITCH, TOGGLE	2
12	.20481	SWITCH, TOGGLE	2
13	.70397	CONTROLLER (EXTENSION) (See Sect. 2, Fig. 9 for Details)	1
14	.70405	SWITCH, ANTI-RESTART IGNITION	1
15	.4011	SWITCH, PUSH BUTTON	1
16	.70392	COVER, RECEPTACLE	1
17	.70391	RECEPTACLE, G.F.C.I.	1
18	.16215	RELIEF, STRAIN	1
19	.16005	NUT, LOCK	1
20	.2806	RELIEF, STRAIN	1
21	.2808	NUT, LOCK	1
22	.24122	PLATE, BACK	1
23	.24121	BRACKET, RIGHT SIDE MOUNTING	1

Mark Industries

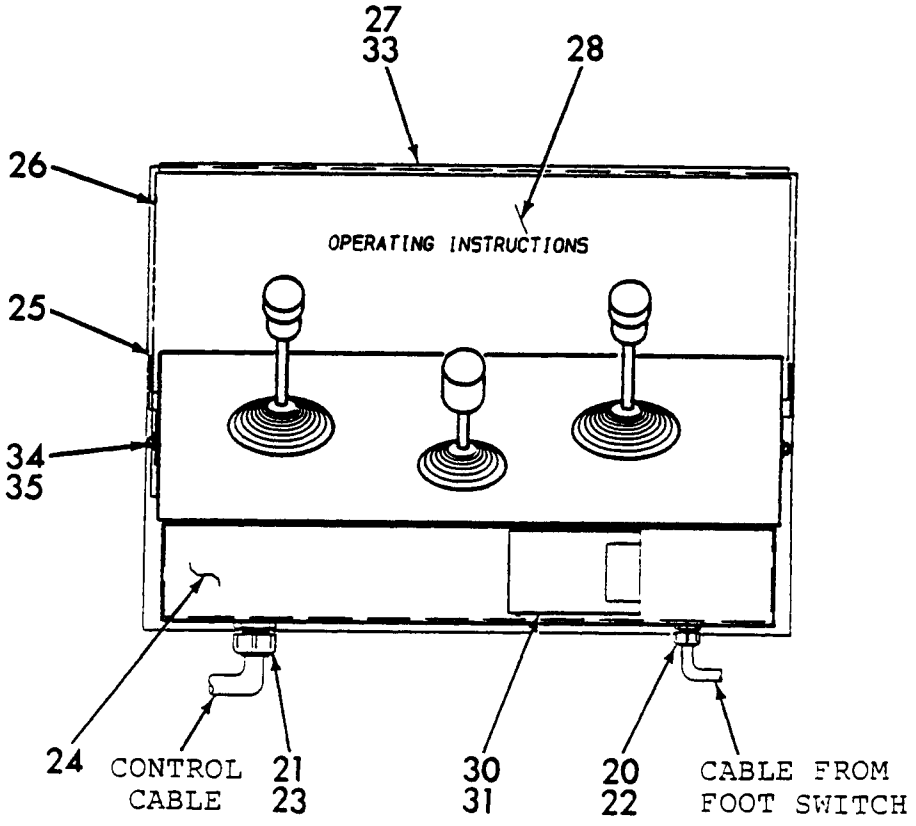
TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	42C
NOTES	UNTIL MAY 1989

SECT.	2
FIG.	3
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.24120	BRACKET, LEFT SIDE MOUNTING	1
25	.60701	NUT, HEX	7
26	.63301	WASHER, LOCK	7
27	.24123	WELDMENT, COVER	1
28	.24119	BOX, AERIAL CONTROL	1
29	.2859	TONGUE, RING	25
30	.70406	SPRING, SPADE	17
31	.117-E	TERMINAL, PUSH IN	2
32	.16214	MOUNTS	5
33	.4045	DIODE	1
34	.24127	ASSEMBLY, TERMINAL BLOCK	1
35	.63401	WASHER, FLAT	2
36	.63301	WASHER, LOCK	2
37	.60701	NUT, HEX	2
38	.70394	CONNECTOR, TWIST-ON WIRE	2
39	.256	TIE, CABLE	50
40	.160015	EXTRUSION, NEOPRENE BLACK	4



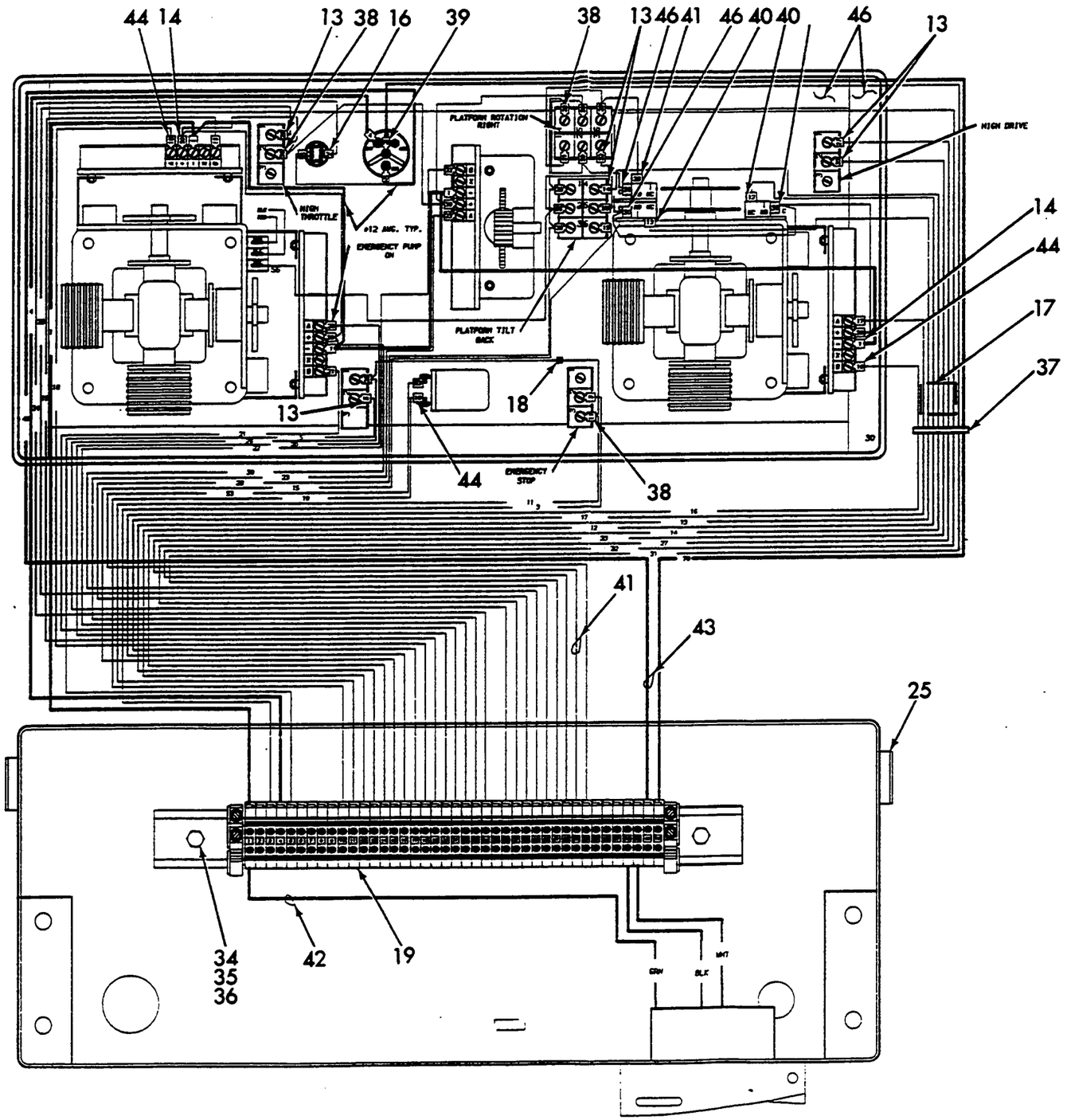
TOP VIEW

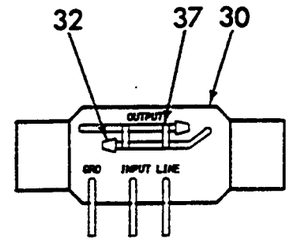


FRONT VIEW

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY	SECT.	2
MODEL	42C	FIG.	3A
NOTES	SINCE MAY 1989	PAGE	2





RECEPTACLE REAR VIEW

Mark Industries

TITLE	AERIAL CONTROL BOX ASSEMBLY
MODEL	42C
NOTES	SINCE MAY 1989

SECT.	2
FIG.	3A
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24118	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 2, Fig. 1 for NHA)	REF
2	.70457	CONTROLLER (LIFT/ROTATE) (See Sect. 2, Fig. 7A for Details)	1
3	.70455	CONTROLLER (DRIVE/STEER) (See Sect. 2, Fig. 8A for Details)	1
4	.70453	CONTROLLER (EXTENSION) (See Sect. 2, Fig. 9A for Details)	1
5	.70595	SWITCH, ANTI-RESTART IGNITION	1
6	.70313	SWITCH, TOGGLE	2
7	.4011	SWITCH, PUSH BUTTON	1
8	.70291	SWITCH, TOGGLE	1
9	.20805	BUZZER, ALARM	1
10	.4021	SWITCH, TOGGLE	1
11	.20481	SWITCH, TOGGLE	2
12	.70407	GUARD, SWITCH	1
13	.70149	CONNECTOR, RING	14
14	.70406	SPRING, SPADE	6
15	.20884	GUARD, SWITCH	3
16	.70500	DISCONNECT, FEMALE	2
17	.16214	MOUNTS	8
18	.70479	DIODE	1
19	.24127	ASSEMBLY, TERMINAL BLOCK	1
20	.2808	NUT, LOCK	1
21	.16005	NUT, LOCK	1
22	.2806	RELIEF, STRAIN	1
23	.16215	RELIEF, STRAIN	1

Mark Industries

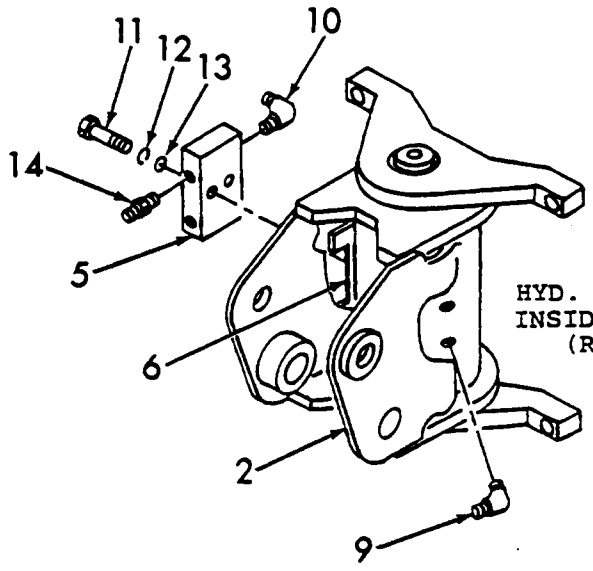
TITLE	AERIAL CONTROL BOX ASSEMBLY	SECT.	2
MODEL	42C	FIG.	3A
NOTES	SINCE MAY 1989	PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.210442	WELDMENT, AERIAL CONTROL BOX	1
25	.24120	BRACKET, MOUNTING	2
26	.24122	PLATE, BACK	1
27	.24123	WELDMENT, COVER	1
28	.182103	DECAL, OPERATING INSTRUCTIONS	1
29	.182707	DECAL, AERIAL CONTROL BOX	1
30	.70391	RECEPTACLE, G.F.C.I.	1
31	.70392	COVER, RECEPTACLE	1
32	.70394	CONNECTOR, TWIST-ON WIRE	2
33	.160015	EXTRUSION, NEOPRENE BLACK	4 FT
34	.60701	NUT, HEX	9
35	.63301	WASHER, LOCK	9
36	.63401	WASHER, FLAT	2
37	.256	TIE, CABLE	50
38	.117-B	CONNECTOR, TERMINAL	10
39	.117-C	CONNECTOR, RING	2
40	.16325	CONNECTOR, TERMINAL	3
41	.2990	WIRE, WHITE	105 FT
42	.70098	WIRE, YELLOW WITH GREEN STRIPES	1 FT
43	.2991	WIRE, WHITE	9 FT
44	.70566	CONNECTOR, SPRING SPADE	10
45	.70567	CONNECTOR, RING	3
46	.117-E	TERMINAL, PUSH-ON	3

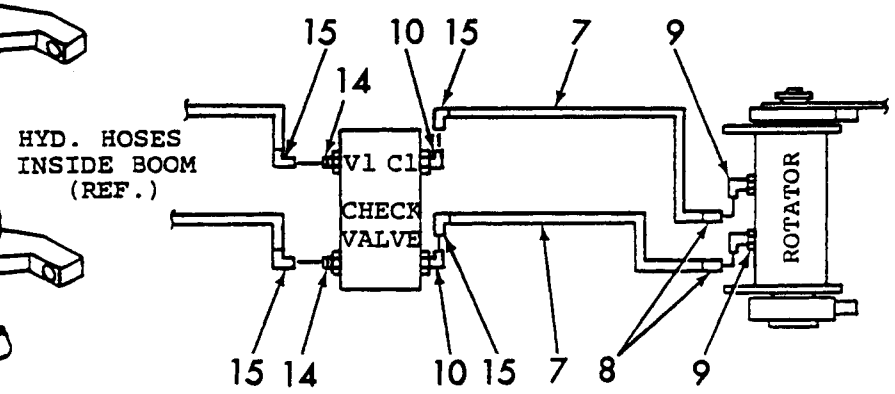
Mark Industries

TITLE	HELAC ROTATOR ASSEMBLY
MODEL	42C
NOTES	

SECTION	2
FIGURE	4
PAGE	1



HOSE DIAGRAM



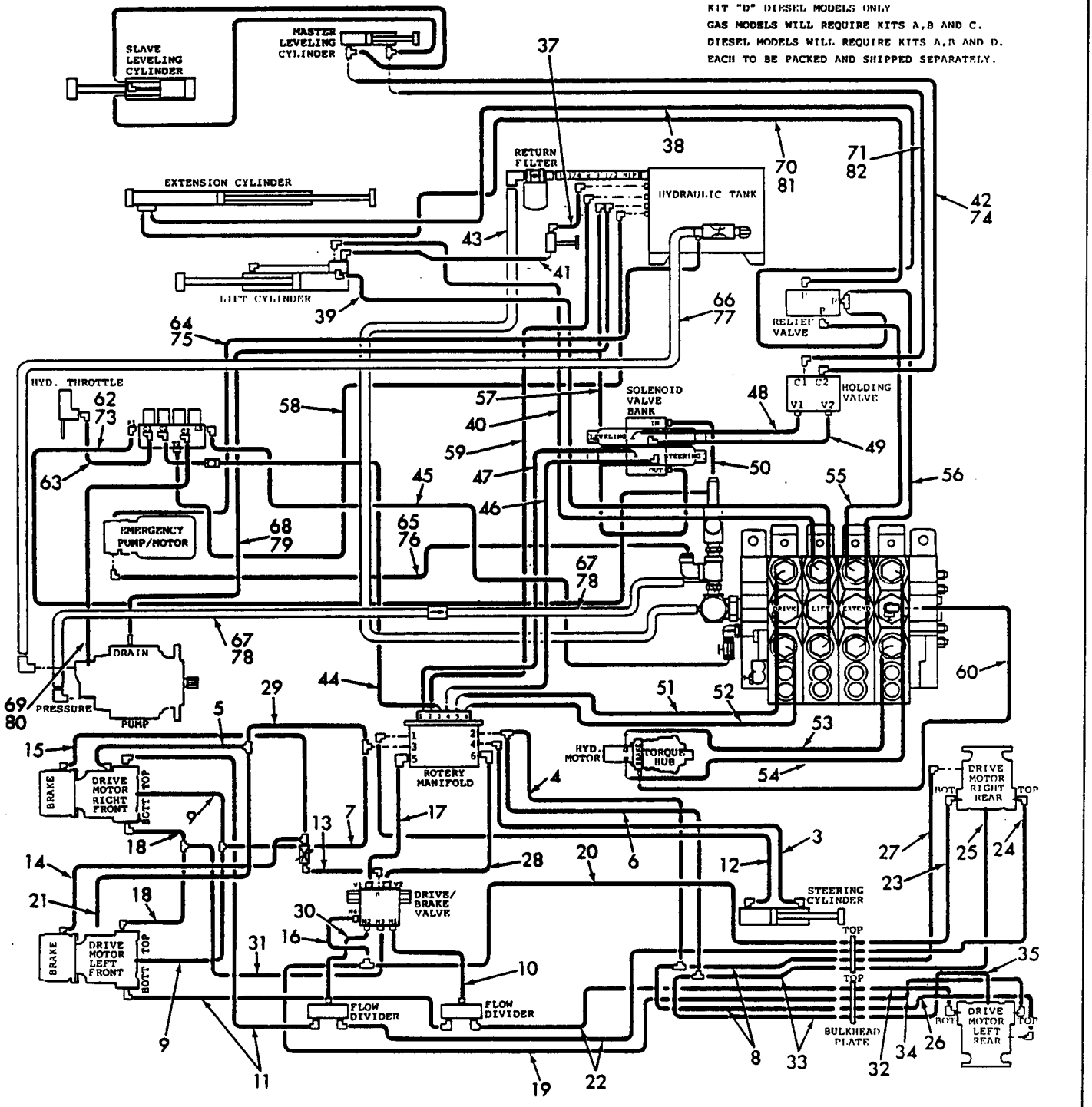
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24444	ASSEMBLY, HELAC ROTATOR (See Sect. 2, Fig. 1 for NHA)	REF
2	.81372	SUB-ASSEMBLY, HELAC ROTATOR	1
-3	..67770	KIT, SEAL	1
-4	..67771	KIT, BEARING	1
5	..23051	VALVE, CHECK	1
6	..23197	BRACKET, CHECK VALVE	1
7	..2568-0144	HOSE, HYDRAULIC	1
8	..2562	FITTING, SWIVEL	2
9	..80012-03	ELBOW, STRAIGHT THREAD	2
10	..80012-05	ELBOW, SWIVEL	4
11	..60360	SCREW, CAP	2
12	..63302	WASHER, LOCK	2
13	..63402	WASHER, FLAT	2
14	.80004-05	CONNECTOR, STRAIGHT THREAD (PARKER 4-6 F)	2
15	.2594	ELBOW, SWIVEL (AEROQUIP #23951-4-3)	2

REV.

Mark Industries

TITLE	HYDRAULIC HOSE DIAGRAM
MODEL	42C
NOTES	

SECTION	2
FIGURE	5
PAGE	1



REV.

Mark Industries

TITLE	HYDRAULIC HOSE DIAGRAM
MODEL	42C
NOTES	

SECT.	2
FIG.	5
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24185	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig. 1 for NHA)	REF
-2	.24185 KIT-A	DIAGRAM, HYDRAULIC HOSE (BASE)	1
3	..13210-04-0640	ASSEMBLY, HOSE	1
4	..13213-04-0250	ASSEMBLY, HOSE	1
5	..13213-06-0234	ASSEMBLY, HOSE	1
6	..13213-04-0600	ASSEMBLY, HOSE	1
7	..13213-06-0200	ASSEMBLY, HOSE	1
8	..13213-06-0370	ASSEMBLY, HOSE	2
9	..13213-04-0184	ASSEMBLY, HOSE	2
10	..13213-12-0390	ASSEMBLY, HOSE	1
11	..13210-08-0820	ASSEMBLY, HOSE	2
12	..13210-04-0600	ASSEMBLY, HOSE	1
13	..13210-04-0500	ASSEMBLY, HOSE	1
14	..13213-04-0314	ASSEMBLY, HOSE	1
15	..13210-04-0234	ASSEMBLY, HOSE	1
16	..13213-12-0620	ASSEMBLY, HOSE	1
17	..13213-12-0220	ASSEMBLY, HOSE	1
18	..13210-08-0166	ASSEMBLY, HOSE	2
19	..13210-08-0220	ASSEMBLY, HOSE	1
20	..13210-08-0100	ASSEMBLY, HOSE	1
21	..13213-06-0214	ASSEMBLY, HOSE	1
22	..13213-08-0360	ASSEMBLY, HOSE	2
23	..13212-08-0210	ASSEMBLY, HOSE	1
24	..13212-08-0180	ASSEMBLY, HOSE	1
25	..13213-04-0200	ASSEMBLY, HOSE	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	..13213-06-0170	ASSEMBLY, HOSE	1
27	..13213-06-0160	ASSEMBLY, HOSE	1
28	..13213-12-0240	ASSEMBLY, HOSE	1
29	..13210-06-0560	ASSEMBLY, HOSE	1
30	..13213-12-0260	ASSEMBLY, HOSE	1
31	..13213-12-0430	ASSEMBLY, HOSE	1
32	..13213-08-0220	ASSEMBLY, HOSE	1
33	..13213-04-0450	ASSEMBLY, HOSE	2
34	..13213-08-0180	ASSEMBLY, HOSE	1
35	..13210-04-0230	ASSEMBLY, HOSE	1
-36	.24185 KIT-B	DIAGRAM, HYDRAULIC HOSE (TURRET)	1
37	..13213-04-0560	ASSEMBLY, HOSE	1
38	..13211-08-0430	ASSEMBLY, HOSE	1
39	..13212-06-0900	ASSEMBLY, HOSE	1
40	..13213-06-0800	ASSEMBLY, HOSE	1
41	..13213-04-1300	ASSEMBLY, HOSE	1
42	..13213-04-0530	ASSEMBLY, HOSE	1
43	..13203-16-0280	ASSEMBLY, HOSE	1
44	..13210-04-0890	ASSEMBLY, HOSE	1
45	..13213-04-0850	ASSEMBLY, HOSE	1
46	..13210-04-0260	ASSEMBLY, HOSE	1
47	..13213-04-0290	ASSEMBLY, HOSE	1
48	..13210-04-0840	ASSEMBLY, HOSE	1
49	..13213-04-0840	ASSEMBLY, HOSE	1
50	..13210-06-0380	ASSEMBLY, HOSE	1

Mark Industries

TITLE	HYDRAULIC HOSE DIAGRAM	SECT.	2
MODEL	42C	FIG.	5
NOTES		PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
51	..13215-12-0370	ASSEMBLY, HOSE	1
52	..13214-12-0370	ASSEMBLY, HOSE	1
53	..13212-08-0200	ASSEMBLY, HOSE	1
54	..13213-08-0190	ASSEMBLY, HOSE	1
55	..13213-08-0760	ASSEMBLY, HOSE	1
56	..13215-08-0820	ASSEMBLY, HOSE	1
57	..13210-06-0460	ASSEMBLY, HOSE	1
58	..13210-06-0900	ASSEMBLY, HOSE	1
59	..13210-06-0500	ASSEMBLY, HOSE	1
60	..13213-04-0220	ASSEMBLY, HOSE	1
-61	.24185 KIT-C	DIAGRAM, HYDRAULIC HOSE (GAS ONLY)	1
62	..13213-06-1000	ASSEMBLY, HOSE	1
63	..13210-04-1150	ASSEMBLY, HOSE	1
64	..13213-06-0450	ASSEMBLY, HOSE	1
65	..13213-06-0650	ASSEMBLY, HOSE	1
66	..13205-20-0650	ASSEMBLY, HOSE	1
67	..13210-12-0350	ASSEMBLY, HOSE	2
68	..13213-06-0700	ASSEMBLY, HOSE	1
69	..13210-04-0180	ASSEMBLY, HOSE	1
70	..13211-08-0500	ASSEMBLY, HOSE	1
71	..13213-04-0630	ASSEMBLY, HOSE	1
-72	.24185 KIT-D	DIAGRAM, HYDRAULIC HOSE (DIESEL ONLY)	1
73	..13213-06-0800	ASSEMBLY, HOSE	1
74	..13213-04-0720	ASSEMBLY, HOSE	1
75	..13213-06-0680	ASSEMBLY, HOSE	1

Mark Industries

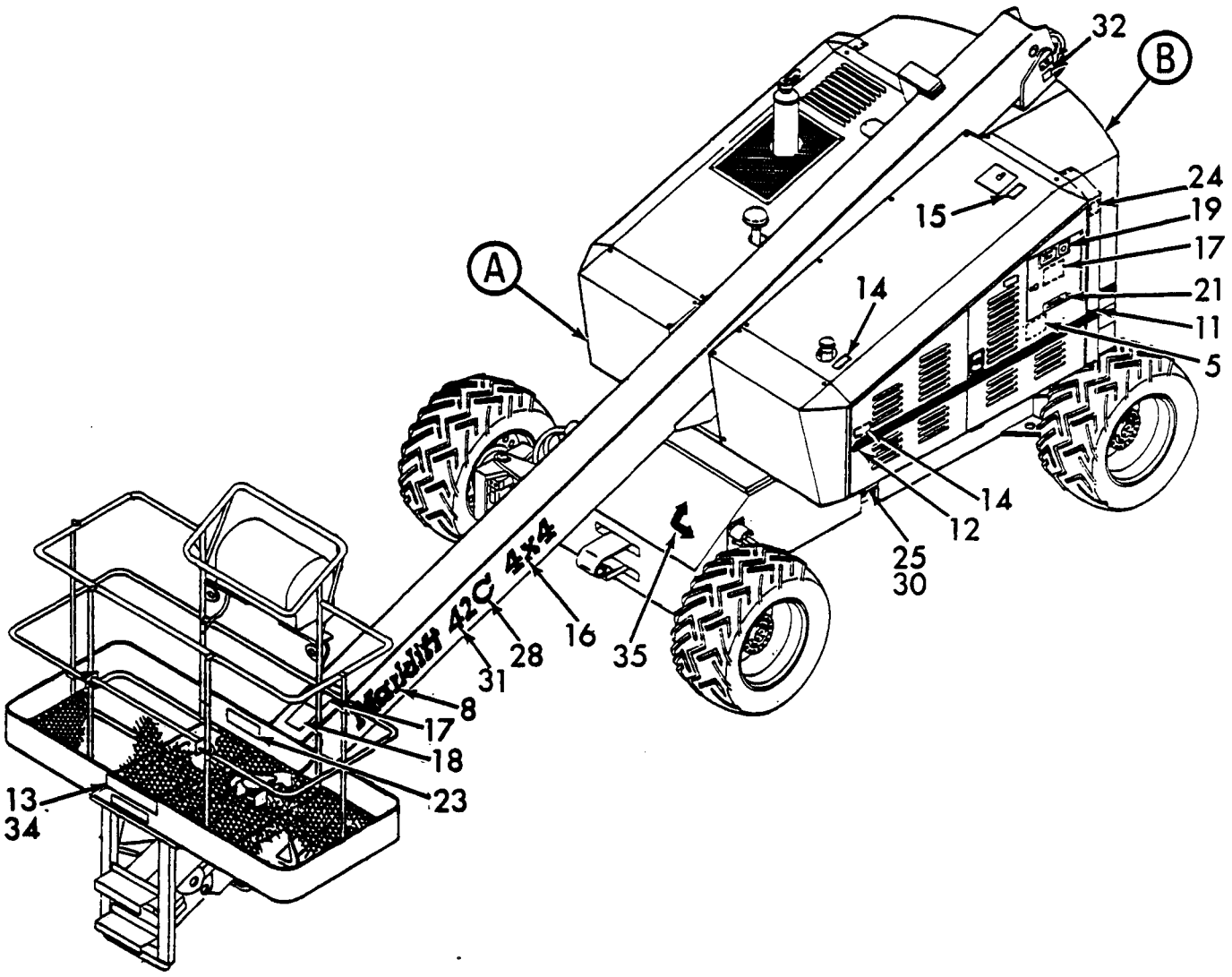
TITLE	HYDRAULIC HOSE DIAGRAM	SECT. 2
MODEL	42C	FIG. 5
NOTES		PAGE 5

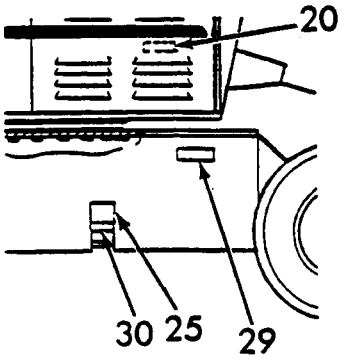
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
76	..13213-06-0650	ASSEMBLY, HOSE	1
77	..13203-20-0900	ASSEMBLY, HOSE	1
78	..13210-12-0350	ASSEMBLY, HOSE	2
79	..13210-06-0960	ASSEMBLY, HOSE	1
80	..13213-04-0290	ASSEMBLY, HOSE	1
81	..13211-08-0530	ASSEMBLY, HOSE	1
82	..13213-04-0820	ASSEMBLY, HOSE	1

Mark Industries

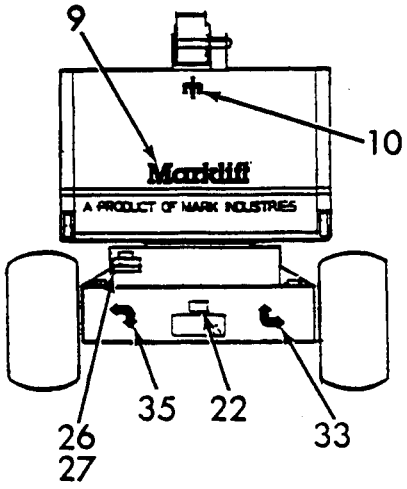
TITLE	DECAL SET
MODEL	42C
NOTES	

SECTION	2
FIGURE	6
PAGE	1





A



B

REV.

Mark Industries

TITLE	DECAL SET	SECT.	2
MODEL	42C	FIG.	6
NOTES		PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	67513	SET, DECAL (See Sect. 2, Fig. 1 for NHA)	REF
-2	.20460	DECAL, GROUND CONTROL CONSOLE (See Ground Control Box for Details)	REF
-3	.20413	DECAL, ENGINE CHOKE (See Ground Control Box for Details)	REF
-4	.185702	DECAL, CIRCUIT BREAKER 110 VAC (See Ground Control Box for Details)	REF
5	.20860	DECAL, GENERAL CHECKOUT & OPERATING INSTR.	1
-6	.182103	DECAL, OPERATION INSTRUCTIONS & DANGER (See Aerial Control Box for Details)	REF
-7	.182707	DECAL, AERIAL CONTROL BOX (See Aerial Control Box for Details)	REF
8	.20408	DECAL, MARKLIFT BOOM	2
9	.20409	DECAL, STANDARD PEDESTAL	1
10	.20410	DECAL, LOGO MARK INDUSTRIES	1
11	.20411	DECAL, BLUE STRIPE (SQUARE END)	5
12	.20412	DECAL, BLUE STRIPE (ROUND END)	1
13	.20556	DECAL, LOAD CAPACITY 800 LBS.	2
14	.2020	DECAL, GASOLINE OR PETROL	2
15	.2017	DECAL, HYDRAULIC SYSTEM FLUID	2
16	.22740	DECAL, 4X4 4WD BOOMS	2
17	.181102	DECAL, DANGER DO NOT OPERATE UNLESS...	2
18	.181103	DECAL, DANGER OBEY THE FOLLOWING...	2
19	.20419	DECAL, DANGER KEEP CLEAR	2
20	.2003	DECAL, BATTERY WATER LEVEL	1
21	.20495	DECAL, EMERGENCY GROUND CONTROLS	1
22	.20896	DECAL, BRAKE	1

Mark Industries

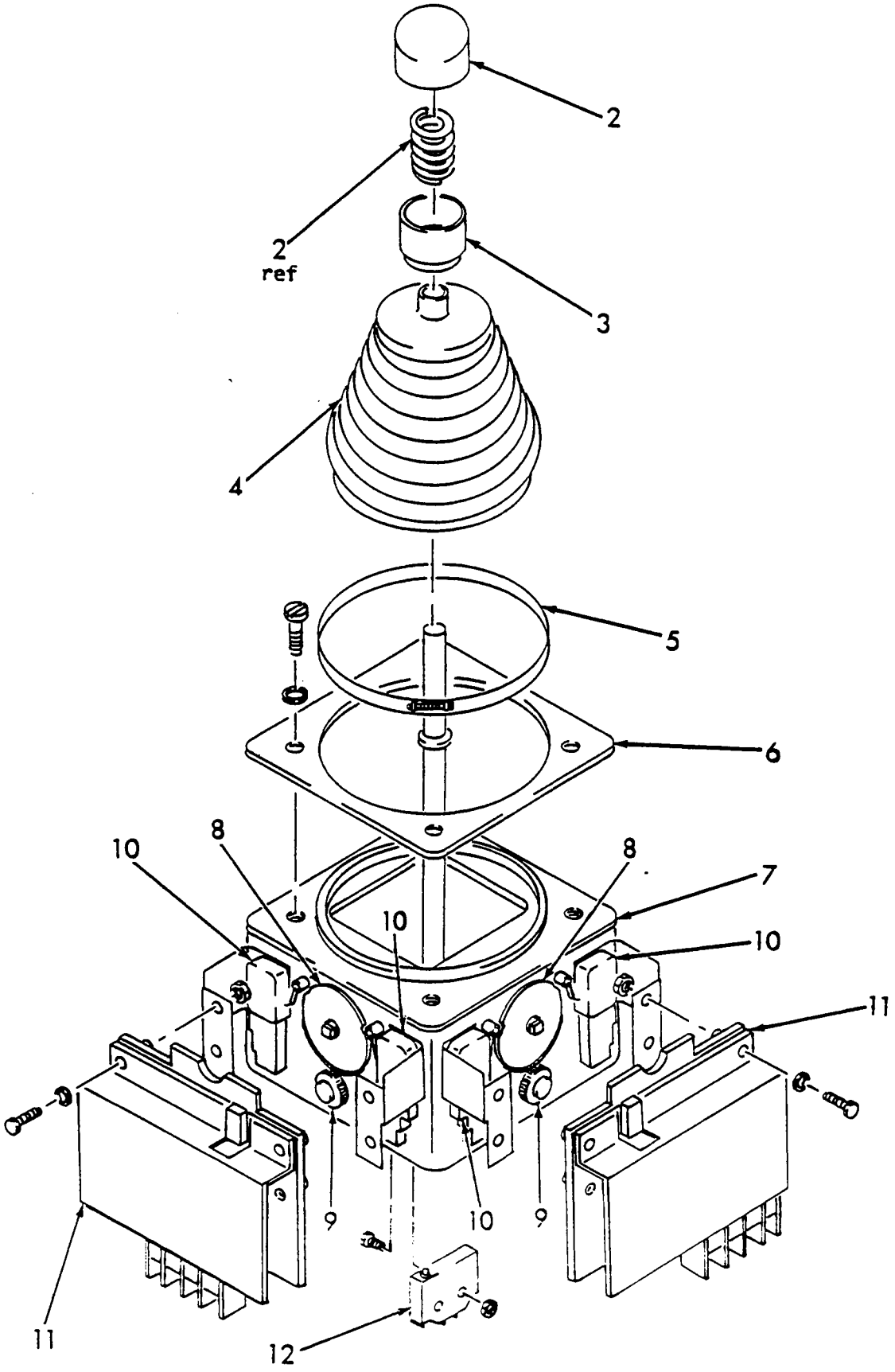
TITLE	DECAL SET	SECT.	2
MODEL	42C	FIG.	6
NOTES		PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
23	.22386	DECAL, "D" RING ATTACH SAFETY BELT	2
24	.20414	DECAL, EMERGENCY DESCENT	1
25	.20508	DECAL, TRANSPORTATION	2
26	.20660	NAMEPLATE, IDENTIFICATION	1
27	.20661	PLATE, ANSI A92	1
28	.181904	DECAL, "C" (19" X 19")	2
29	.2004	DECAL, VAPOR TANK ONLY	2
30	.20420	DECAL, TIRE PRESSURE 75 PSI	2
31	.20873	DECAL, 42	2
32	.21237	DECAL, GREASE FITTING	2
33	.182710	DECAL, DIRECTIONAL ARROW	2
34	.22385	DECAL, CAUTION ATTACH YOUR SAFETY BELT	1
35	.182709	DECAL, DIRECTIONAL ARROW	2
36	.130820	DECAL, OPERATION & SAFETY HANDBOOK	1

Mark Industries

TITLE	CONTROLLER (LIFT/ROTATE)
MODEL	42C
NOTES	UNTIL MAY 1989

SECTION	2
FIGURE	7
PAGE	1



REV.

Mark Industries

TITLE	CONTROLLER (LIFT/ROTATE)
MODEL	42C
NOTES	UNTIL MAY 1989

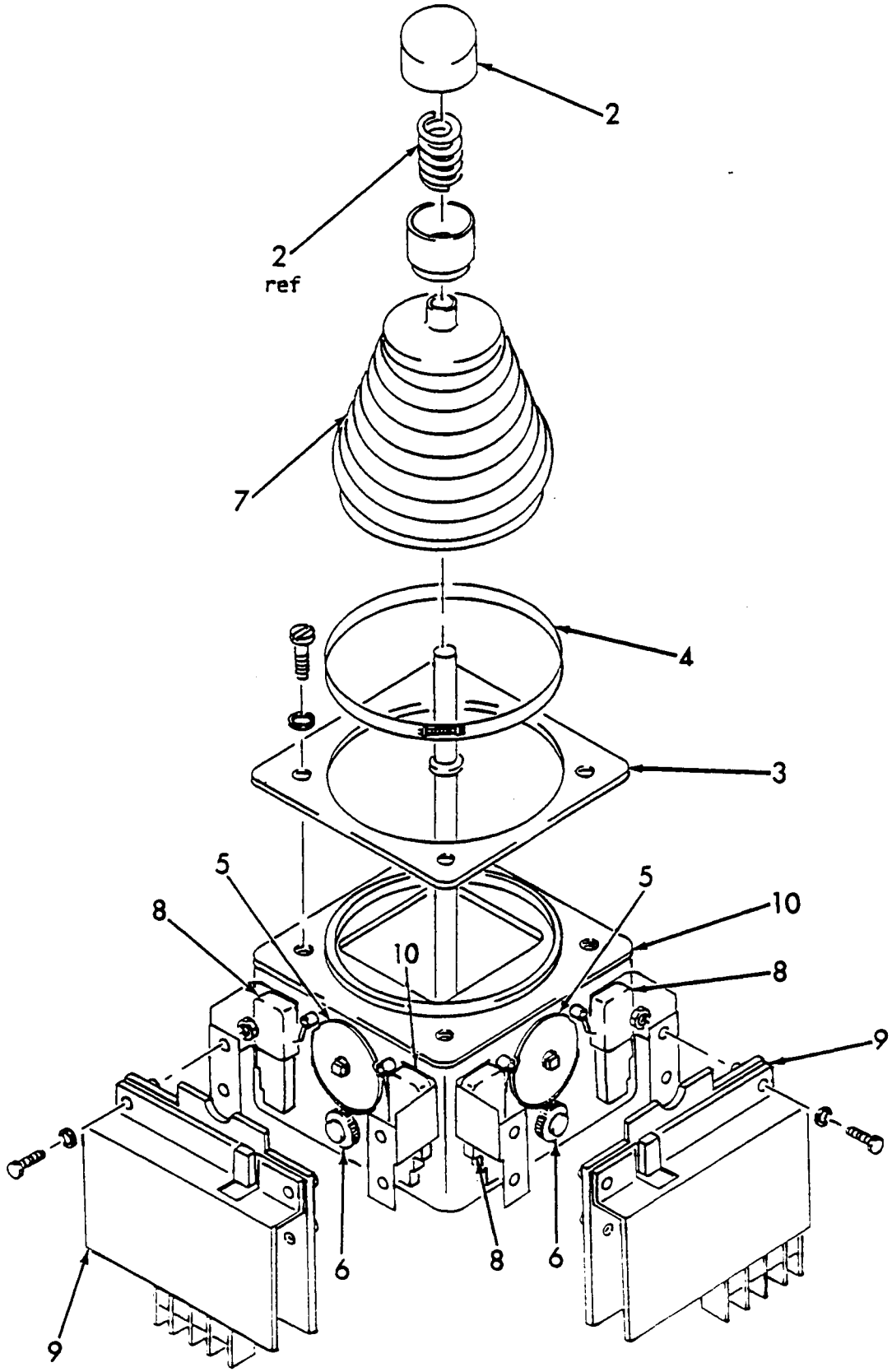
SECT.	2
FIG.	7
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70398	CONTROLLER (LIFT/ROTATE) (See Sect. 2, Fig. 3 for NHA)	REF
2	.67489	ASSEMBLY, UPPER HANDLE	1
3	.67488	HANDLE, LOWER	1
4	.67482	BOOT	1
5	.67483	CLAMP, BOOT	1
6	.67481	GASKET, MOUNTING	1
7	.67491	ASSEMBLY, POTENTIOMETER	1
8	.67484	GEAR, DRIVE	2
9	.67485	GEAR, SLAVE	2
10	.67486	MICROSWITCH	4
11	.67490	BOARD, CIRCUIT	2
12	.67487	BRACKET, AUXILIARY CONTACT	2

Mark Industries

TITLE	CONTROLLER (LIFT/ROTATE)
MODEL	42C
NOTES	SINCE MAY 1989

SECTION	2
FIGURE	7A
PAGE	1



REV.

Mark Industries

TITLE	CONTROLLER (LIFT/ROTATE)
MODEL	42C
NOTES	SINCE MAY 1989

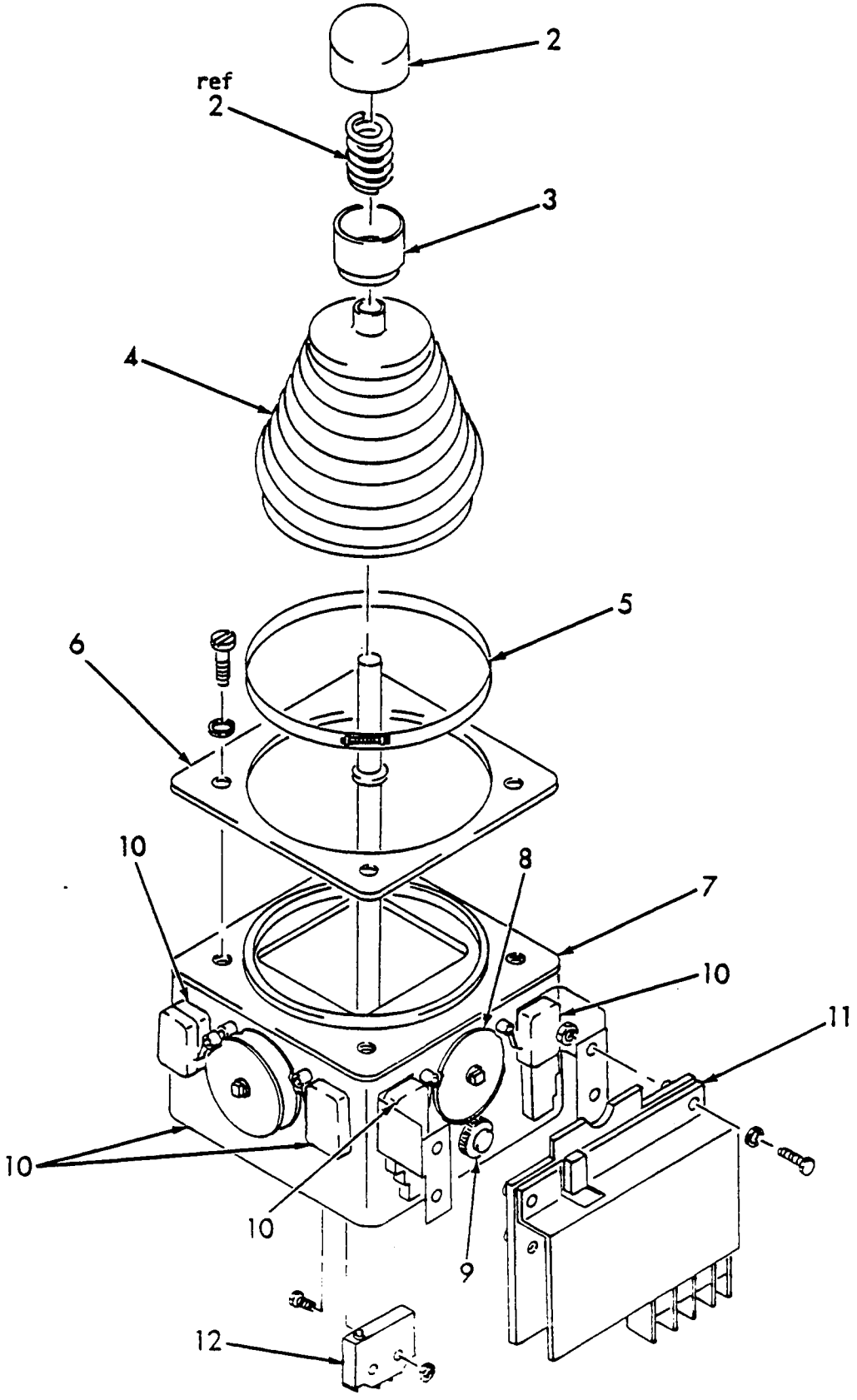
SECT.	2
FIG.	7A
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70457	CONTROLLER (LIFT/ROTATE) (See Sect. 2, Fig. 3A for NHA)	REF
2	.600114	HANDLE, SOLID CAP	1
3	.67481	GASKET, MOUNTING	1
4	.67483	CLAMP, BOOT	1
5	.67484	GEAR, DRIVE	2
6	.67485	GEAR, SLAVE	2
7	.67482	BOOT	1
8	.67486	MICROSWITCH	4
9	.600377	BOARD, CIRCUIT (CURRENT LIMITED)	2
10	.67491	ASSEMBLY, POTENTIOMETER	2

Mark Industries

TITLE	CONTROLLER (DRIVE/STEER)
MODEL	42C
NOTES	UNTIL MAY 1989

SECTION	2
FIGURE	8
PAGE	1



REV.

Mark Industries

TITLE	CONTROLLER (DRIVE/STEER)	SECT.	2
MODEL	42C	FIG.	8
NOTES	UNTIL MAY 1989	PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70399	CONTROLLER (DRIVE/STEER) (See Sect. 2, Fig. 3 for Details)	REF
2	.67489	ASSEMBLY, UPPER HANDLE	1
3	.67488	HANDLE, LOWER	1
4	.67482	BOOT	1
5	.67483	CLAMP, BOOT	1
6	.67481	GASKET, MOUNTING	1
7	.67491	ASSEMBLY, POTENTIOMETER	1
8	.67484	GEAR, DRIVE	1
9	.67485	GEAR, SLAVE	1
10	.67486	MICROSWITCH	5
11	.67490	BOARD, CIRCUIT	1
12	.67487	BRACKET, AUXILIARY CONTACT	1

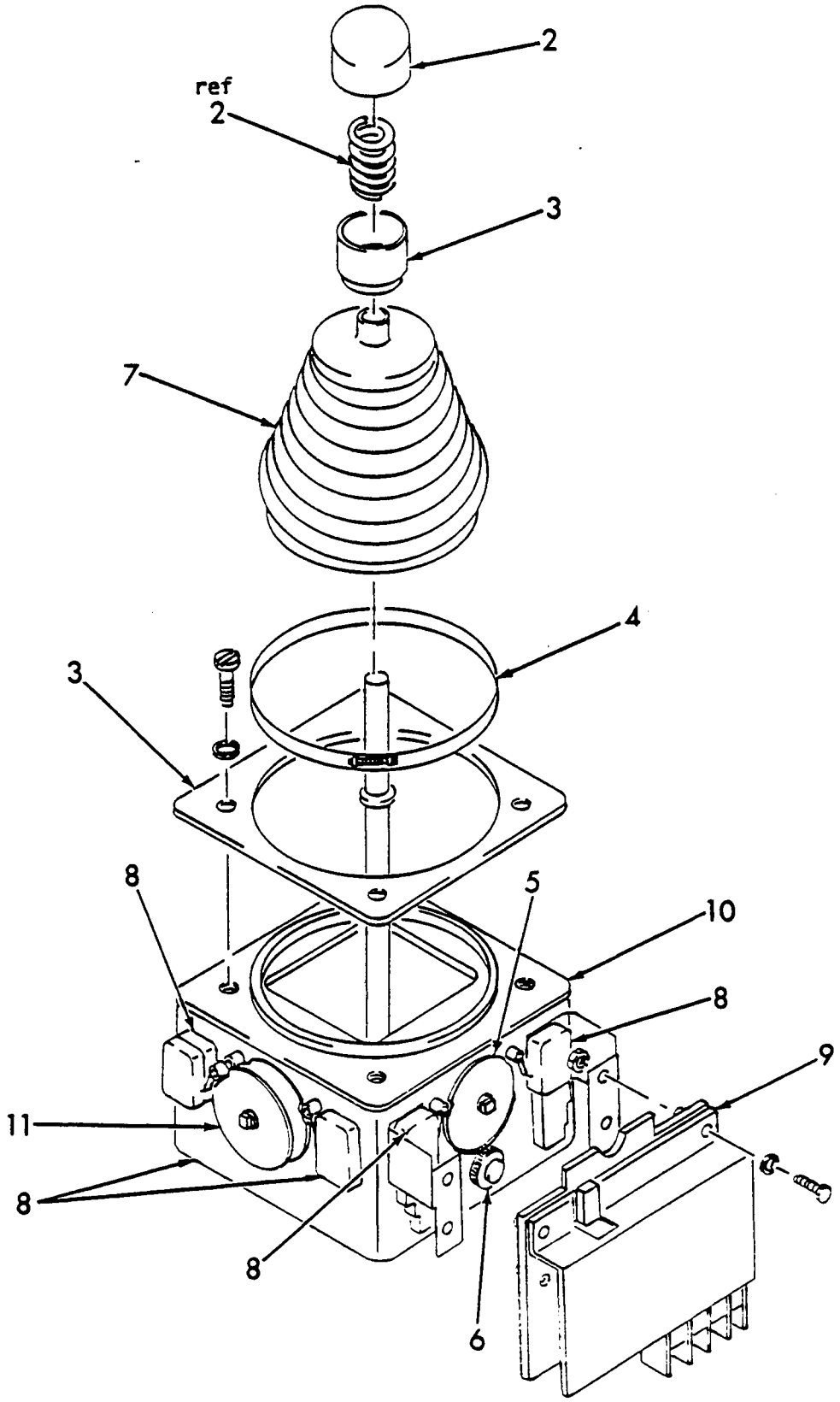
REV.

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

Mark Industries

TITLE	CONTROLLER (DRIVE/STEER)
MODEL	42C
NOTES	SINCE MAY 1989

SECTION	2
FIGURE	8A
PAGE	1



REV.

Mark Industries

TITLE	CONTROLLER (DRIVE/STEER)
MODEL	42C
NOTES	SINCE MAY 1989

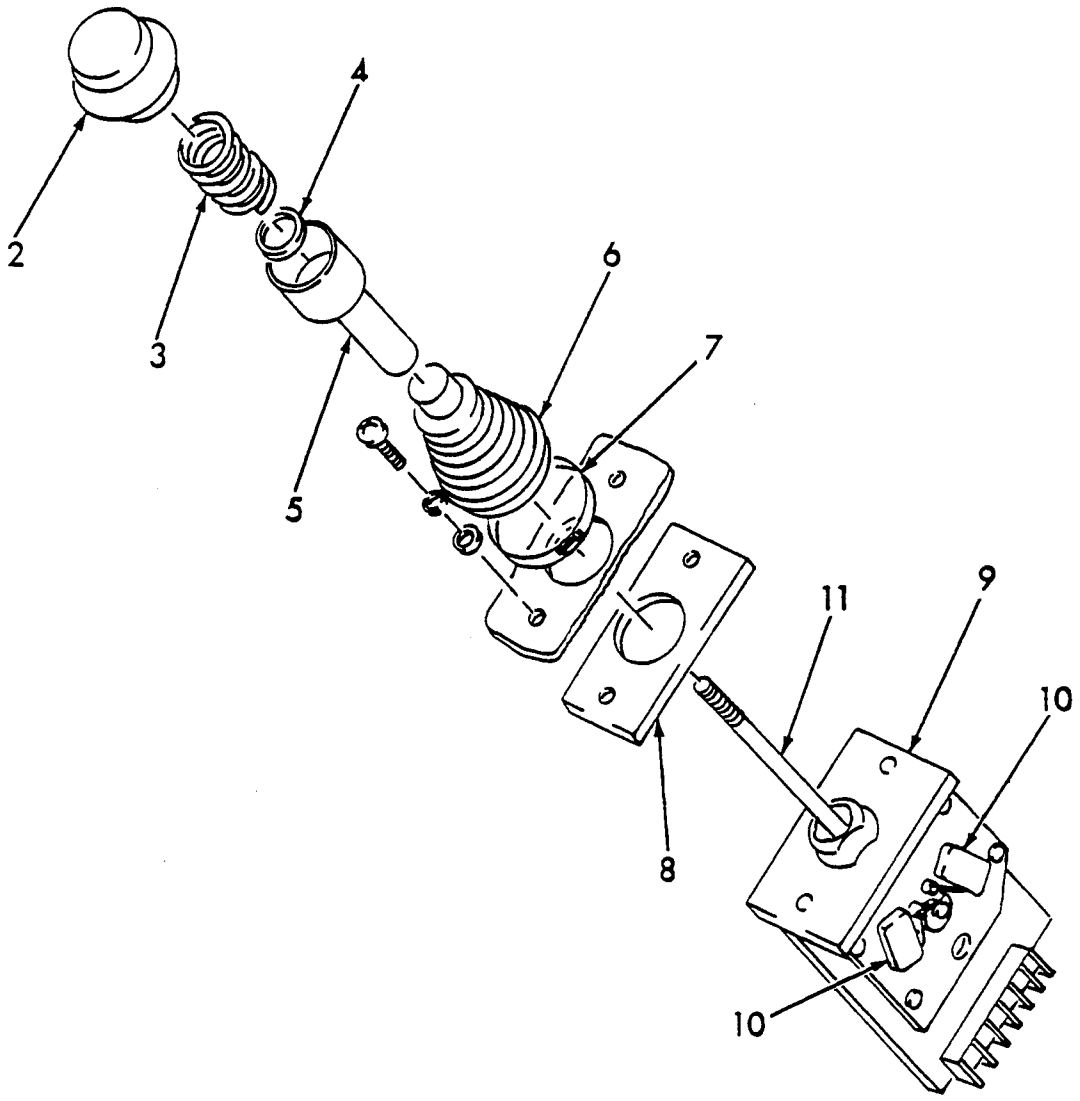
SECT.	2
FIG.	8A
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70455	CONTROLLER (DRIVE/STEER) (See Sect. 2, Fig. 3A for Details)	REF
2	.600114	HANDLE, SOLID CAP	1
3	.67481	GASKET, MOUNTING	1
4	.67483	CLAMP, BOOT	1
5	.67484	GEAR, DRIVE	1
6	.67485	GEAR, SLAVE	1
7	.67482	BOOT	1
8	.67486	MICROSWITCH	5
9	.600377	BOARD, CIRCUIT (CURRENT LIMITED)	1
10	.67491	ASSEMBLY, POTENTIOMETER	1
11	.600115	CAM, FIXED	1

Mark Industries

TITLE	CONTROLLER (EXTENSION)
MODEL	42C
NOTES	UNTIL MAY 1989

SECTION	2
FIGURE	9
PAGE	1



REV.

Mark Industries

TITLE	CONTROLLER (EXTENSION)	SECT.	2
MODEL	42C	FIG.	9
NOTES	UNTIL MAY 1989	PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70397	CONTROLLER (EXTENSION) (See Sect. 2, Fig. 3 for Details)	REF
2	.67499	CAP, UPPER (HALF)	1
3	.67498	SPRING, CAP	1
4	.67497	RING, RETAINING	1
5	.67488	HANDLE, LOWER	1
6	.67496	BOOT	1
7	.67495	CLAMP, BOOT	1
8	.67493	GASKET	1
9	.67492	BOARD, CIRCUIT (WITH POTENTIOMETER)	1
10	.67486	MICROSWITCH	2
11	.67494	TUBE, MECHANICAL INTERLOCK	1

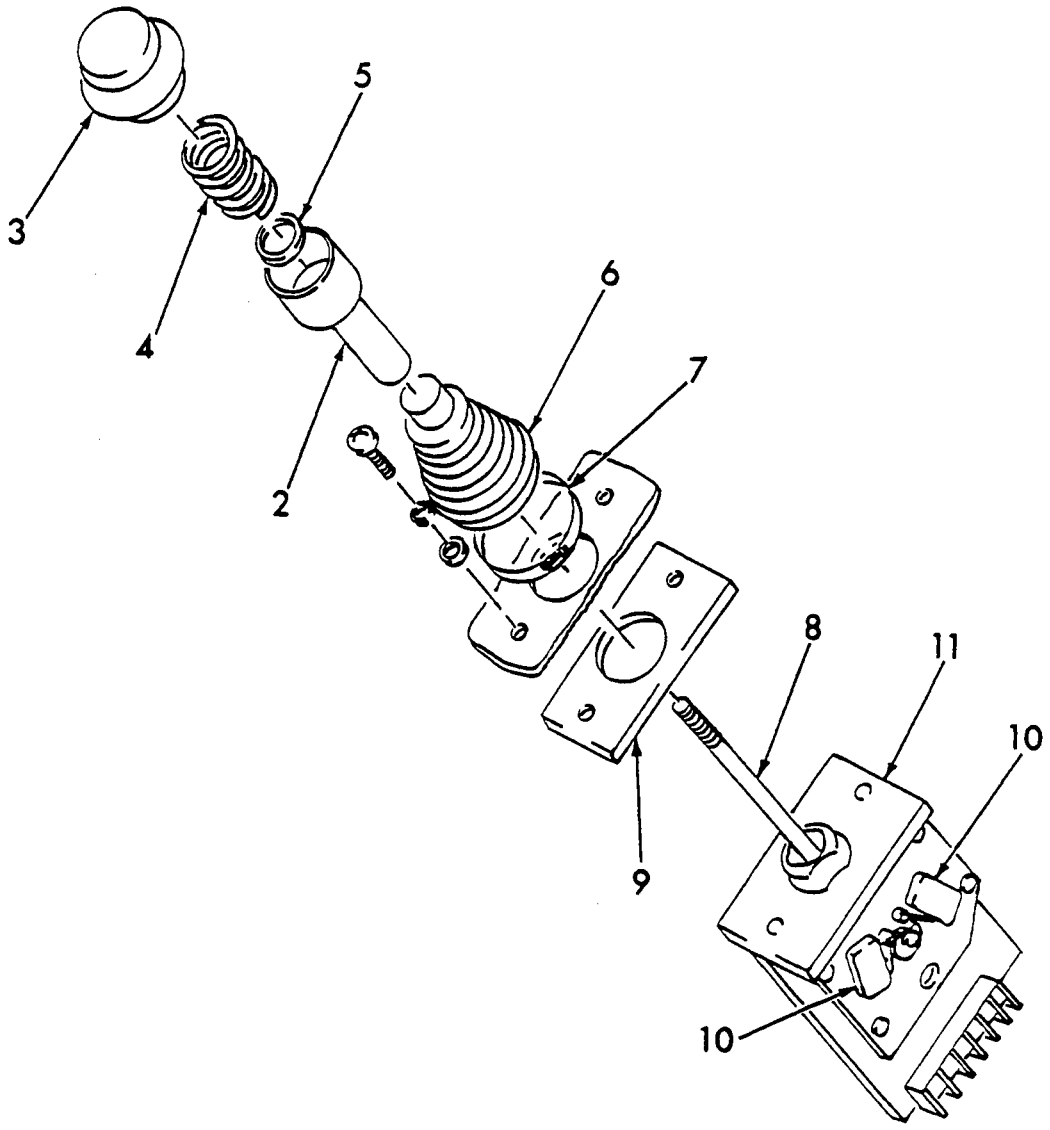
REV.

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

Mark Industries

TITLE	CONTROLLER (EXTENSION)
MODEL	42C
NOTES	SINCE MAY 1989

SECTION	2
FIGURE	9A
PAGE	1



REV.

Mark Industries

TITLE	CONTROLLER (EXTENSION)	SECT.	2
MODEL	42C	FIG.	9A
NOTES	SINCE MAY 1989	PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	70453	CONTROLLER (EXTENSION) (See Sect. 2, Fig. 3A for Details)	REF
2	.67488	HANDLE, LOWER	1
3	.67499	CAP, UPPER (HALF)	1
4	.67498	SPRING, CAP	1
5	.67497	RING, RETAINING	1
6	.67496	BOOT	1
7	.67495	CLAMP, BOOT	1
8	.67494	TUBE, MECHANICAL INTERLOCK	1
9	.67493	GASKET	1
10	.67486	MICROSWITCH	2
11	.600378	BOARD, CIRCUIT (WITH POTENTIOMETER)	

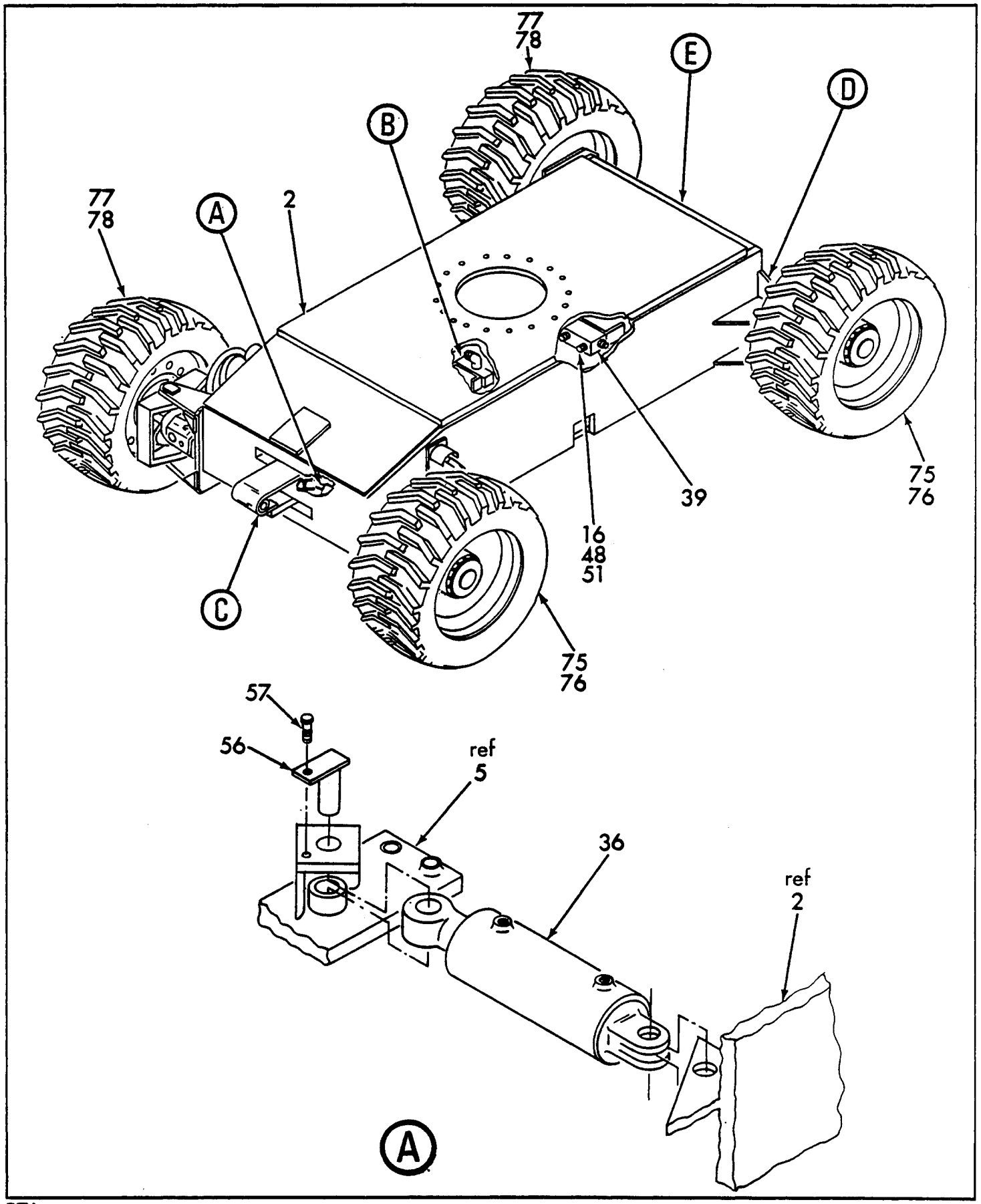
SECTION 3 CONTAINS:

FIG. NO.	TITLE
1	CARRIAGE ASSEMBLY
2	TORQUE HUB (UNTIL MID 1989)
2A	TORQUE HUB (SINCE MID 1989)
3	DRIVE MOTOR ASSEMBLY
4	STEERING CYLINDER ASSEMBLY (CONCURRENT USE)
4A	STEERING CYLINDER ASSEMBLY (CONCURRENT USE, SINCE EARLY 1990)
4B	STEERING CYLINDER ASSEMBLY (CONCURRENT USE, SINCE EARLY 1990)
5	DRIVE/BRAKE VALVE ASSEMBLY

Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	42C
NOTES	

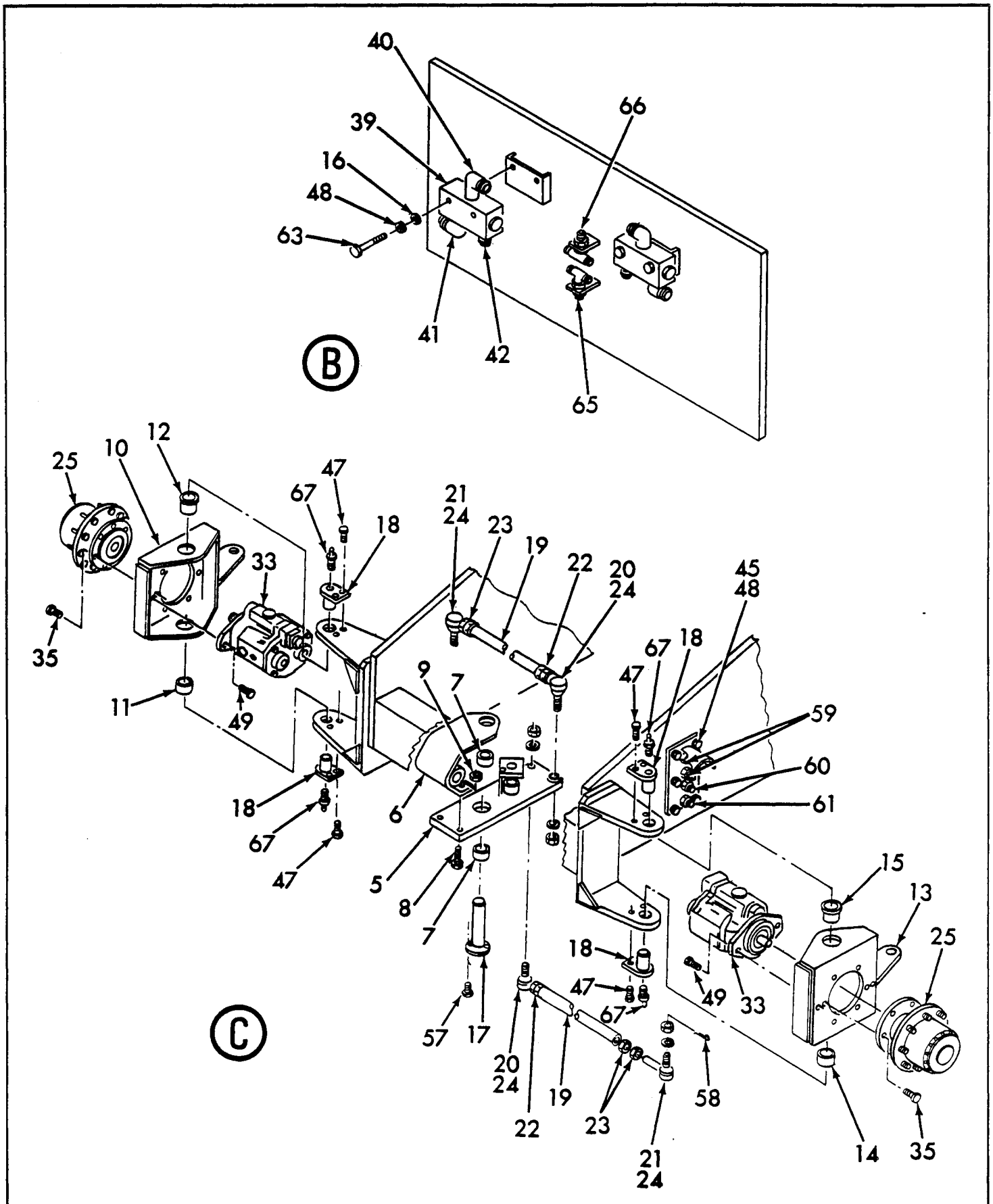
SECTION	3
FIGURE	1
PAGE	1



REV.

Mark Industries

TITLE	CARRIAGE ASSEMBLY	SECTION	3
MODEL	42C	FIGURE	1
NOTES		PAGE	2

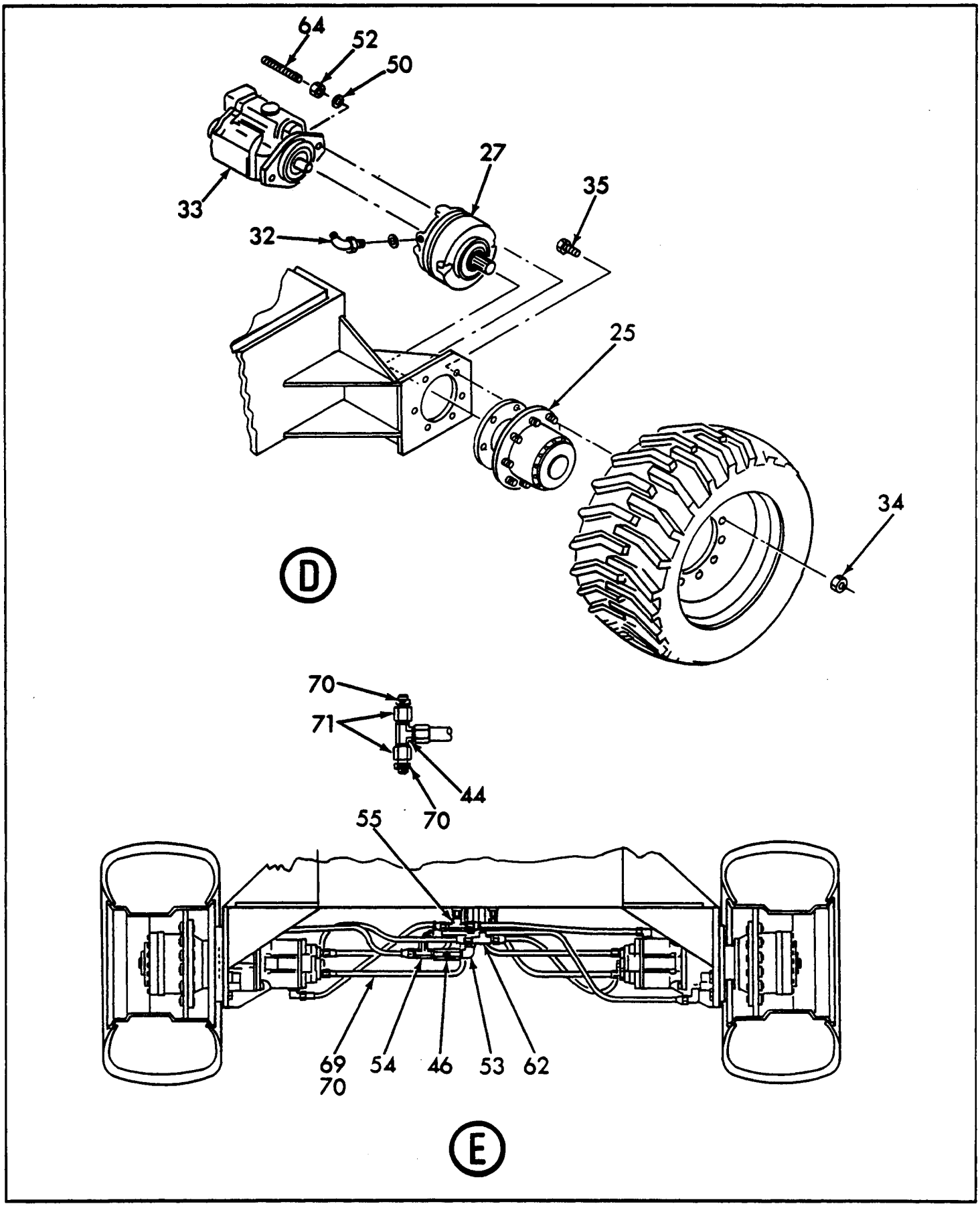


REV.

Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	42C
NOTES	

SECTION	3
FIGURE	1
PAGE	3



REV.

Mark Industries

TITLE	CARRIAGE ASSEMBLY	SECT. 3
MODEL	42C	FIG. 1
NOTES		PAGE 4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24089	ASSEMBLY, CARRIAGE (See Sect. 2, Fig. 1 for NHA)	REF
2	.21601	WELDMENT, CARRIAGE	1
3	..21602	WELDMENT, REAR AXLE	1
-4	.20776	ASSEMBLY, STEERING ARM	1
5	..20717	ARM, STEERING	1
6	..20777	BRACKET, SUPPORT	1
7	..23152	BEARING, SLEEVE	2
8	..60506	SCREW, CAP	2
9	..61304	NUT, LOCK	2
10	.21604	YOKE, STEERING (L.H.)	1
11	..21675	BUSHING, STEERING YOKE	1
12	..21676	BUSHING, FLANGED STEERING YOKE	1
13	.21603	YOKE, STEERING (R.H.)	1
14	..21675	BUSHING, STEERING YOKE	1
15	..21676	BUSHING, FLANGED STEERING YOKE	1
16	.63403	WASHER, FLAT	10
17	.21328	PIN, MAIN STEERING	1
18	.21605	PIN, KING STEERING YOKE	4
19	.20718	ROD, STEERING TIE	2
20	..20569	END, TIE ROD (L.H.)	2
21	..20568	END, TIE ROD (R.H.)	2
22	..20567	NUT, JAM (L.H.)	4
23	..20566	NUT, JAM (R.H.)	4
24	..65103	FITTING, GREASE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.24707	HUB, TORQUE (See Sect. 3, Fig. 2 or 2A for Details)	4
-26	.21668	ASSEMBLY, BRAKE	2
27	..20354	BRAKE (See Vendor Chapter for Details)	1
-28	...67150	KIT, SEAL	1
-29	...67645	KIT, LINING	1
-30	...67657	KIT, BEARING	1
-31	...67650	KIT, SPRING	1
32	..80012-03	ELBOW, STRAIGHT THREAD	2
33	.24148	ASSEMBLY, DRIVE MOTOR (See Sect. 3, Fig. 3 for Details)	4
34	.61403	NUT, HEX	36
35	.60604	SCREW, CAP	24
36	.22502	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 4,4A or 4B for Details)	1
37	.21620	WELDMENT, BULKHEAD PLATE	2
-38	.22580	ASSEMLBY, FLOW DIVIDER	2
39	..81296	VALVE, FLOW DIVIDER	1
40	..80008-21	ELBOW, MALE	1
41	..80008-15	ELBOW, MALE	1
42	..80001-15	CONNECTOR, MALE	1
43	.22500	ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 5 for Details)	1
44	.80031-08	TEE, UNION	2
45	.60325	SCREW, CAP	12
46	.20357	VALVE, NEEDLE	1
47	.62013	SCREW, CAP	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
48	.63319	WASHER, LOCK	26
49	.60622	SCREW, CAP	4
50	.63305	WASHER, LOCK	4
51	.60356	SCREW, CAP	2
52	.60705	NUT, HEX	4
53	.80031-03	TEE, UNION	1
54	.80037-04	TEE, MALE	1
55	.80031-05	TEE, UNION	1
56	.20796	PIN, STEERING CYLINDER	1
57	.60603	SCREW, CAP	3
58	.64306	PIN, COTTER	4
59	.80045-06	UNION, BULKHEAD	4
60	.80045-05	UNION, BULKHEAD	2
61	.80045-03	UNION, BULKHEAD	2
62	.80008-04	ELBOW, MALE	1
63	.60317	SCREW, CAP	4
64	.63601	STUD	4
65	.80035-03	TEE, BRANCH	1
66	.80035-05	TEE, BRANCH	1
67	.65103	FITTING, GREASE	4
68	.65106	GEAR, OIL (90 WT.)	3 QT
69	.63418	WASHER, FLAT	36
70	.80056-09	REDUCER, TUBE END	4
71	.80060-08	NUT	4
72	.65320	COIL, PROTECTIVE PLASTIC	5 FT

Mark Industries

TITLE	CARRIAGE ASSEMBLY
MODEL	42C
NOTES	

SECT.	3
FIG.	1
PAGE	7

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
73	.65322	COIL, PROTECTIVE PLASTIC	6.2 FT
74	.66846	GASKET, 2 BOLT	2
75	.210197	ASSEMBLY, TIRE & WHEEL (R.H.)	2
76	..2252	STEM, VALVE	1
77	.210196	ASSEMBLY, TIRE & WHEEL (L.H.)	2
78	..2252	STEM, VALVE	1
	23415	TIRE & WHEEL ASSY, HIGH FLOATATION (OPTION)	



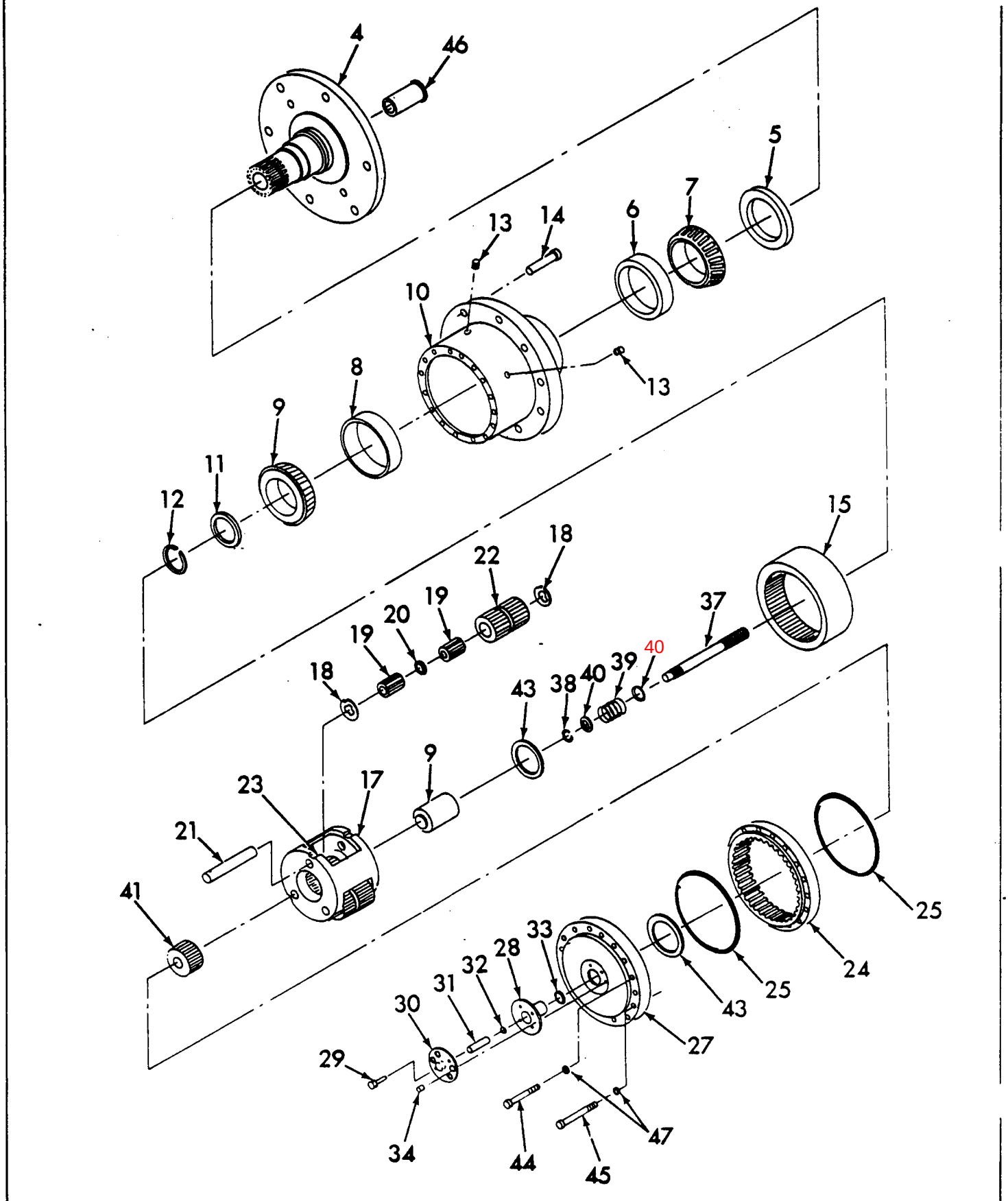
REV.

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

Mark Industries

TITLE	TORQUE HUB
MODEL	42C
NOTES	UNTIL MID 1989

SECTION	3
FIGURE	2
PAGE	1



REV.

Mark Industries

TITLE	TORQUE HUB	SECT.	3
MODEL	42C	FIG.	2
NOTES	UNTIL MID 1989	PAGE	2

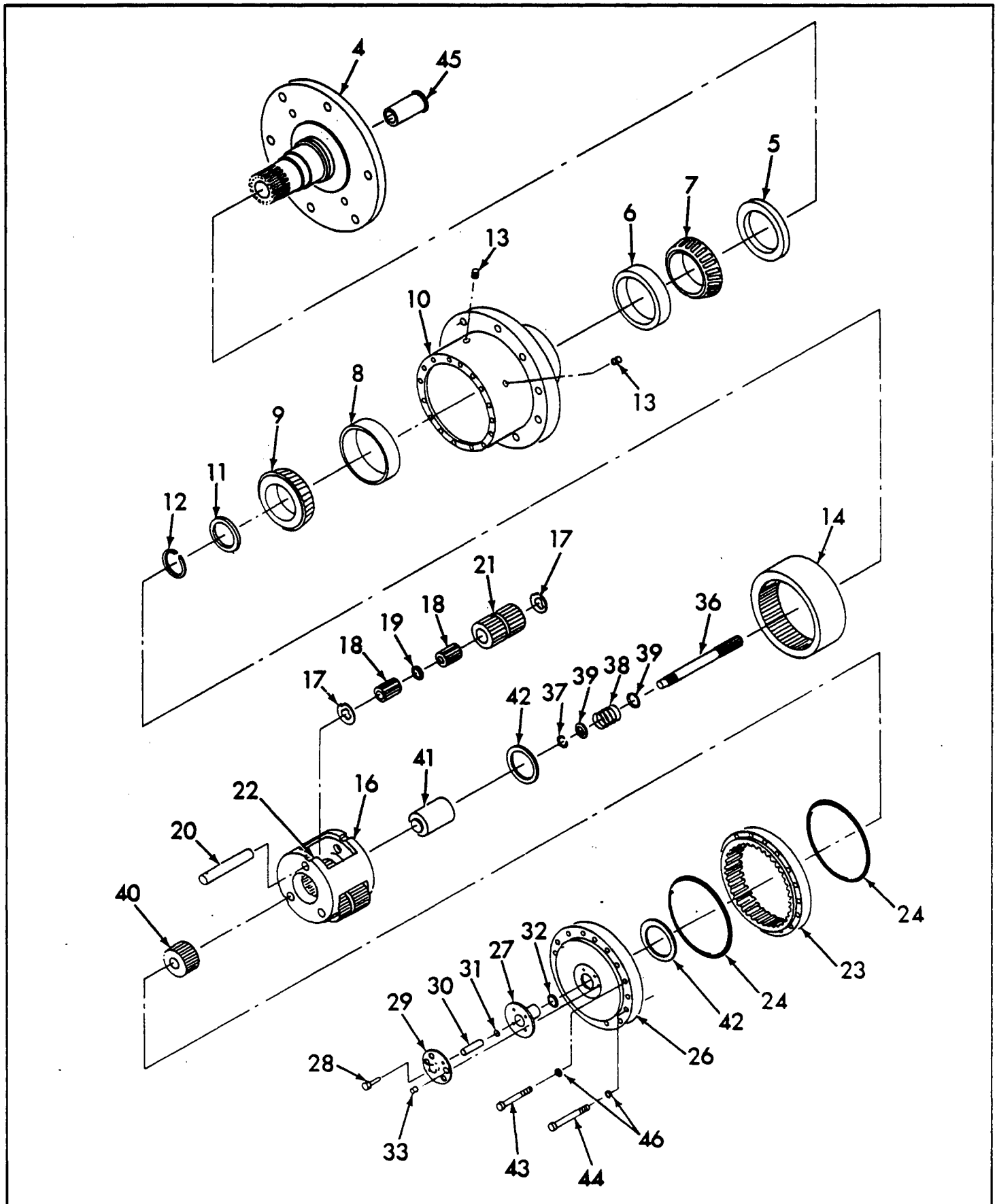
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23600	HUB, TORQUE (Fairfield W1BFF0335) (See Sect. 3, Fig. 1 for NHA) (See Vendor Chapter for Details)	REF
-2	.600219	KIT, SEAL	1
-3	.	SUB-ASSEMBLY, HUB/SPINDLE	1
4	..67872	SPINDLE	1
5	..	SEAL	1
6	..67914	CUP, BEARING	1
7	..67922	CONE, BEARING	1
8	..67915	CUP, BEARING	1
9	..67923	CONE, BEARING	1
10	..	HUB	1
11	..67906	SPACER	1
*12	..	RING, RETAINING	1
13	..	PLUG, PIPE	2
14	..67885	STUD	9
15	.66521	GEAR, INTERNAL	1
-16	.	ASSEMBLY, CARRIER	1
17	..66520	CARRIER	1
18	..67895	WASHER, THRUST	6
19	..67916	ROLLER, NEEDLE	96
20	..67907	SPACER	3
21	..	SHAFT, PLANET	3
22	..	GEAR, CLUSTER	3
23	..	PIN, ROLL	3
		NOTE: ASTERISK (*) INDICATES THE ITEM IS INCLUDED IN THE SEAL KIT.	

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.	GEAR, RING	1
*25	.	O-RING	2
-26	.66425	ASSEMBLY, COVER	1
27	..	COVER	1
28	..	CAP, COVER	1
29	..67928	BOLT	4
30	..16265	CAP, DISCONNECT	1
31	..66186	ROD, DISCONNECT	1
*32	..	O-RING	1
*33	..	O-RING	1
34	..	PLUG, PIPE	1
35	..	PLATE, IDENTIFICATION	1
-36	.	ASSEMBLY, INPUT SHAFT	1
37	..66525	SHAFT, INPUT	1
38	..66509	RING, RETAINING	1
39	..	SPRING	1
40	..67907	SPACER	2
41	.66522	GEAR, INPUT	1
42	.67908	SPACER, THRUST	1
*43	.	WASHER, THRUST	2
44	.66427	BOLT	12
45	.66426	BOLT, SHOULDER	4
46	.67879	COUPLING	1
47	.66424	WASHER, FLAT	16
		NOTE: ASTERISK (*) INDICATES THE ITEM IS INCLUDED IN THE SEAL KIT.	

Mark Industries

TITLE	TORQUE HUB
MODEL	42C
NOTES	SINCE MID 1989

SECTION	3
FIGURE	2A
PAGE	1



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24707	HUB, TORQUE (See Sect. 3, Fig. 1 for NHA) (See Vendor Chapter for Details)	REF
-2	.600219	KIT, SEAL	1
-3	.	SUB-ASSEMBLY, HUB/SPINDLE	1
4	..67872	SPINDLE	1
*5	..	SEAL	1
6	..67914	CUP, BEARING	1
7	..67922	CONE, BEARING	1
8	..67915	CUP, BEARING	1
9	..67923	CONE, BEARING	1
10	..	HUB	1
11	..67906	SPACER	1
*12	..	RING, RETAINING	1
13	..	PLUG, PIPE	2
14	.	GEAR, INTERNAL	1
-15	.	SUB-ASSEMBLY, CARRIER	1
16	..66520	CARRIER	1
17	..67895	WASHER, THRUST	6
18	..67916	ROLLER, NEEDLE	96
19	..67907	SPACER	3
20	..	SHAFT, PLANET	3
21	..	GEAR, CLUSTER	3
22	..	PIN, ROLL	3
23	.	GEAR, RING	1
		NOTE: ASTERISK (*) INDICATES THE ITEM IS INCLUDED IN THE SEAL KIT.	

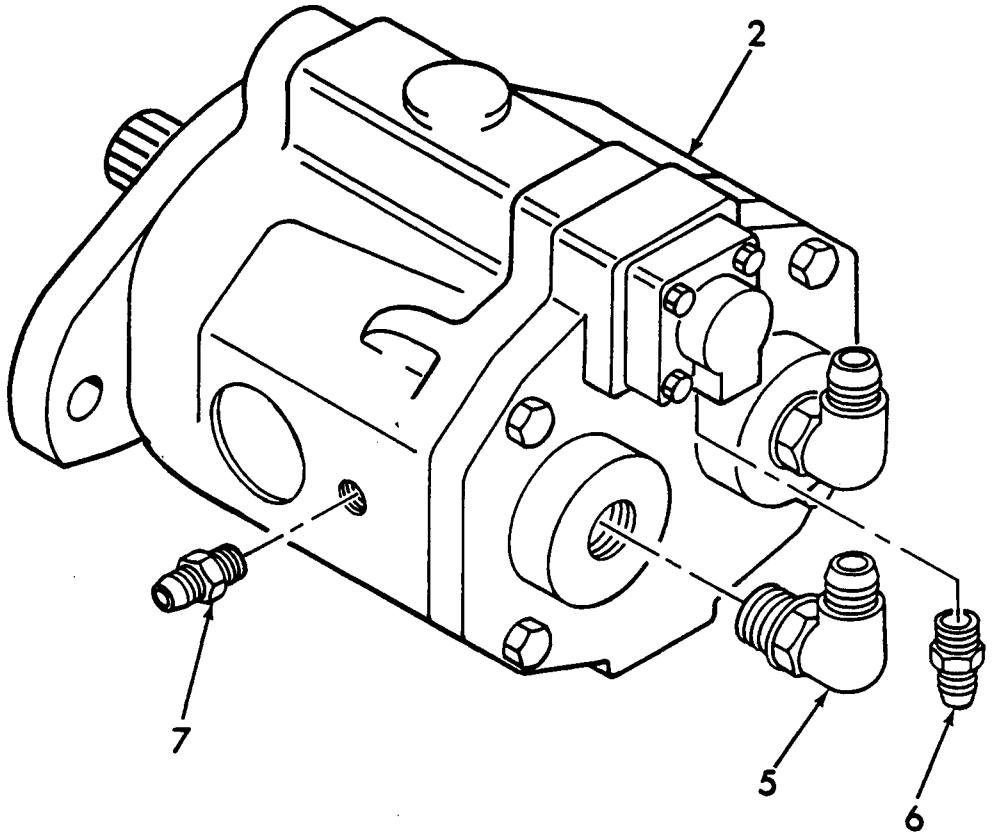
Mark Industries

TITLE	TORQUE HUB	SECT.	3
MODEL	42C	FIG.	2A
NOTES	SINCE MID 1989	PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
*24	.	O-RING	2
-25	.66425	ASSEMBLY, COVER	1
26	..	COVER	1
27	..	CAP, COVER	1
28	..	BOLT	4
29	..16265	CAP, DISCONNECT	1
30	..66186	ROD, DISCONNECT	1
*31	..	O-RING	1
*32	..	O-RING	1
33	..	PLUG, PIPE	1
-34	..	PLATE, IDENTIFICATION	1
-35	.	ASSEMBLY, INPUT SHAFT	1
36	..66525	SHAFT, INPUT	1
37	..	RING, RETAINING	1
38	..	SPRING	1
39	..67907	SPACER	2
40	.	GEAR, INPUT	1
41	.67908	SPACER, THRUST	1
*42	.	WASHER, THRUST	2
43	.66427	BOLT	12
44	.66426	BOLT, SHOULDER	4
45	.67879	COUPLING	1
46	.66424	WASHER, FLAT	16
		NOTE: ASTERISK (*) INDICATES THE ITEM IS INCLUDED IN THE SEAL KIT.	

Mark Industries

TITLE	DRIVE MOTOR ASSEMBLY	SECTION	3
MODEL	42C	FIGURE	3
NOTES		PAGE	1



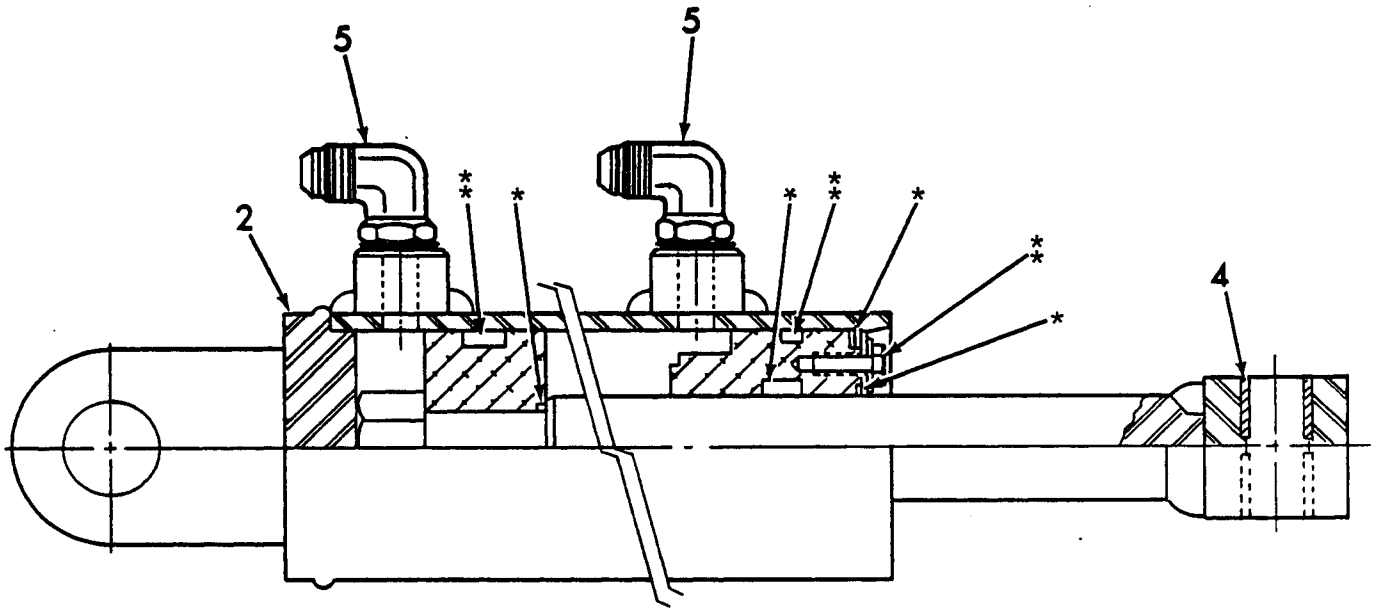
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24148	ASSEMBLY, DRIVE MOTOR (See Sect. 3, Fig. 1 for NHA)	REF
2	.81005	MOTOR	4
-3	..67869	KIT, SEAL	1
-4	...66741	SEAL, SHAFT	1
5	.80012-14	ELBOW, STRAIGHT THREAD	8
6	.80004-03	CONNECTOR, STRAIGHT THREAD	4
7	.80004-08	CONNECTOR, STRAIGHT THREAD	4

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	42C
NOTES	CONCURRENT USE

SECTION	3
FIGURE	4
PAGE	1



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

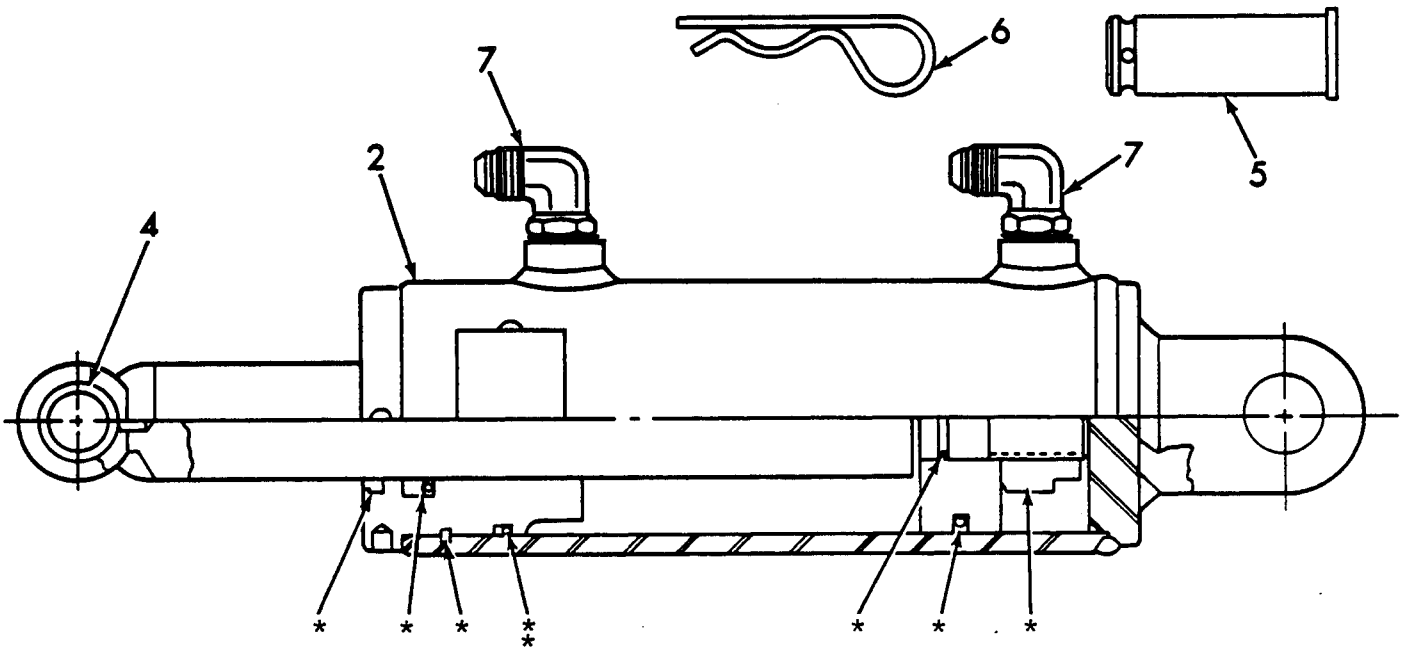
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22502	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 for NHA)	REF
2	.21756	CYLINDER, STEERING (SE)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..66226	KIT, SEAL (SE)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..67191	BUSHING	2
5	.80012-03	ELBOW, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	42C
NOTES	CONCURRENT USE, SINCE EARLY 1990

SECTION	3
FIGURE	4A
PAGE	1



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

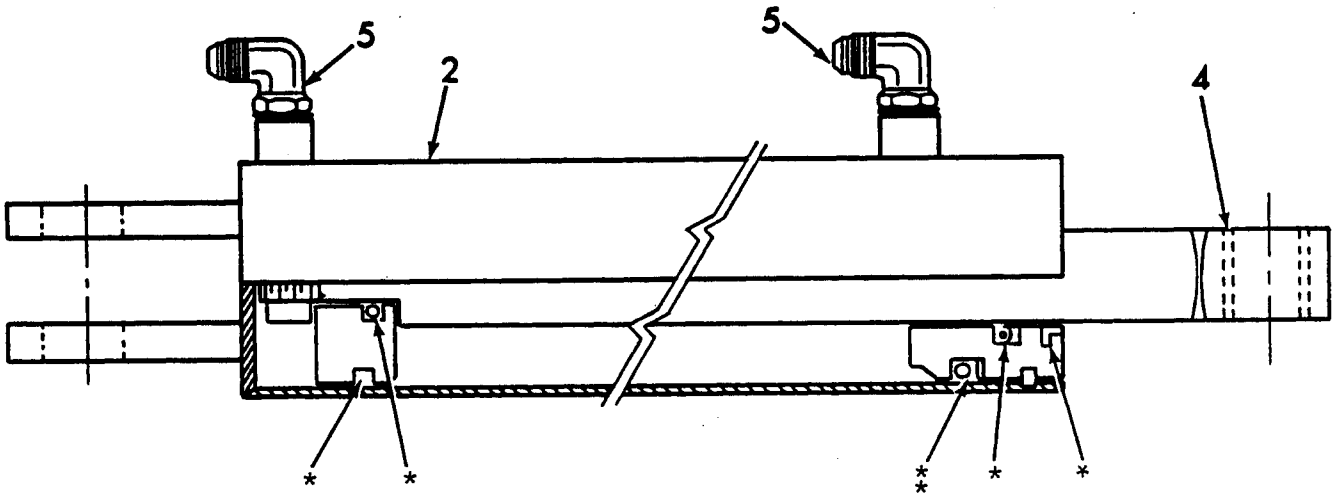
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22502	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 for NHA)	REF
2	.21756	CYLINDER, STEERING (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
3	..600409	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..600257	BUSHING	1
5	..600328	PIN, CLEVIS	1
6	..600329	PIN, CLIP	1
7	.80012-03	ELBOW, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	STEERING CYLINDER ASSEMBLY
MODEL	42C
NOTES	CONCURRENT USE, SINCE EARLY 1990

SECTION	3
FIGURE	4B
PAGE	1



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

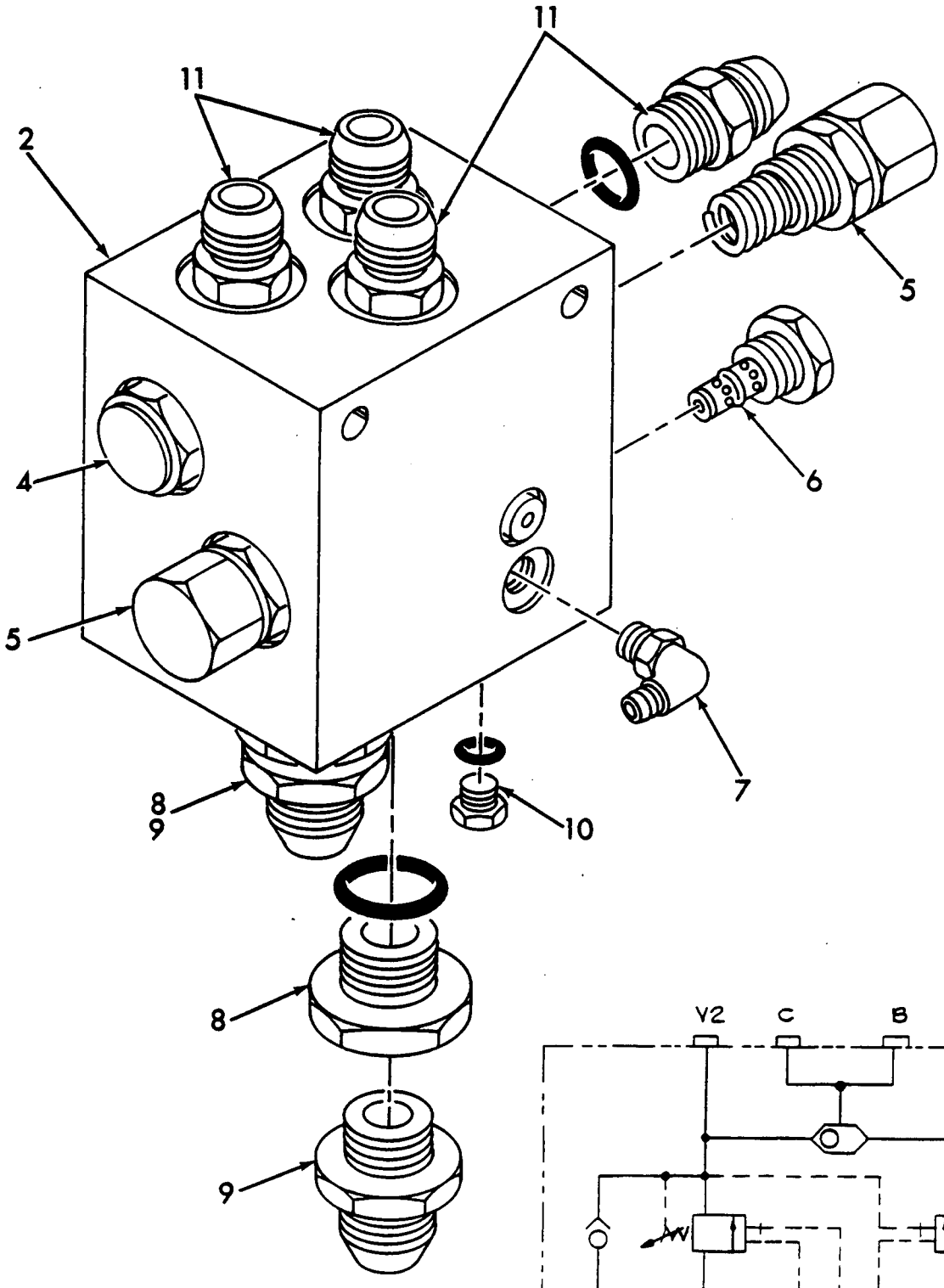
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22502	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 1 for NHA)	REF
2	.21756	CYLINDER STEERING (COL)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..600350	KIT, SEAL (COL)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..600405	BUSHING	1
5	.80012-03	ELBOW, STRAIGHT THREAD	2

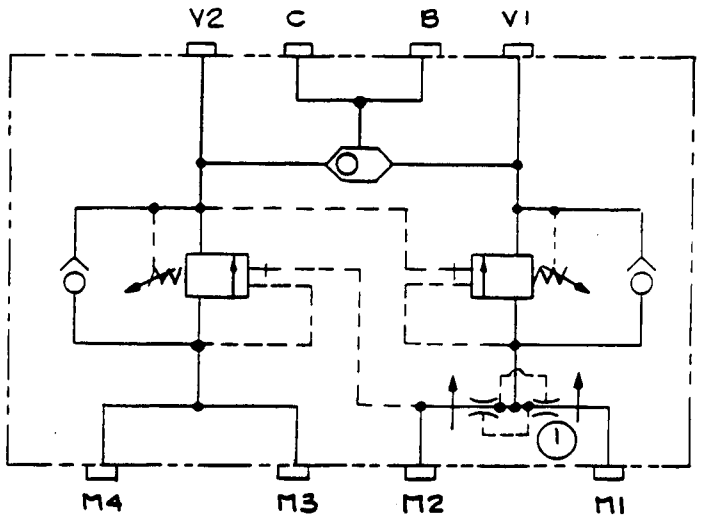
REV.

Mark Industries

TITLE	DRIVE/BRAKE VALVE ASSEMBLY
MODEL	42C
NOTES	

SECTION	3
FIGURE	5
PAGE	1





REV.

Mark Industries

TITLE	DRIVE/BRAKE VALVE ASSEMBLY
MODEL	42C
NOTES	

SECT.	3
FIG.	5
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	.22500	ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 1 for Details)	REF
2	..22433	VALVE, DRIVE/BRAKE	1
-3	...67953	KIT, SEAL	1
4	...67711	VALVE, POSITIVE TRACTION	1
5	...600302	VALVE, COUNTERBALANCE	2
6	...67713	VALVE, SHUTTLE	1
7	..80012-05	ELBOW, STRAIGHT THREAD	1
8	..80063-16	ADAPTER, FEMALE PIPE	2
9	..80001-21	CONNECTOR, MALE	2
10	..80050-05	PLUG, HEX	1
11	..80004-18	CONNECTOR, STRAIGHT THREAD	4

SECTION 4 CONTAINS:

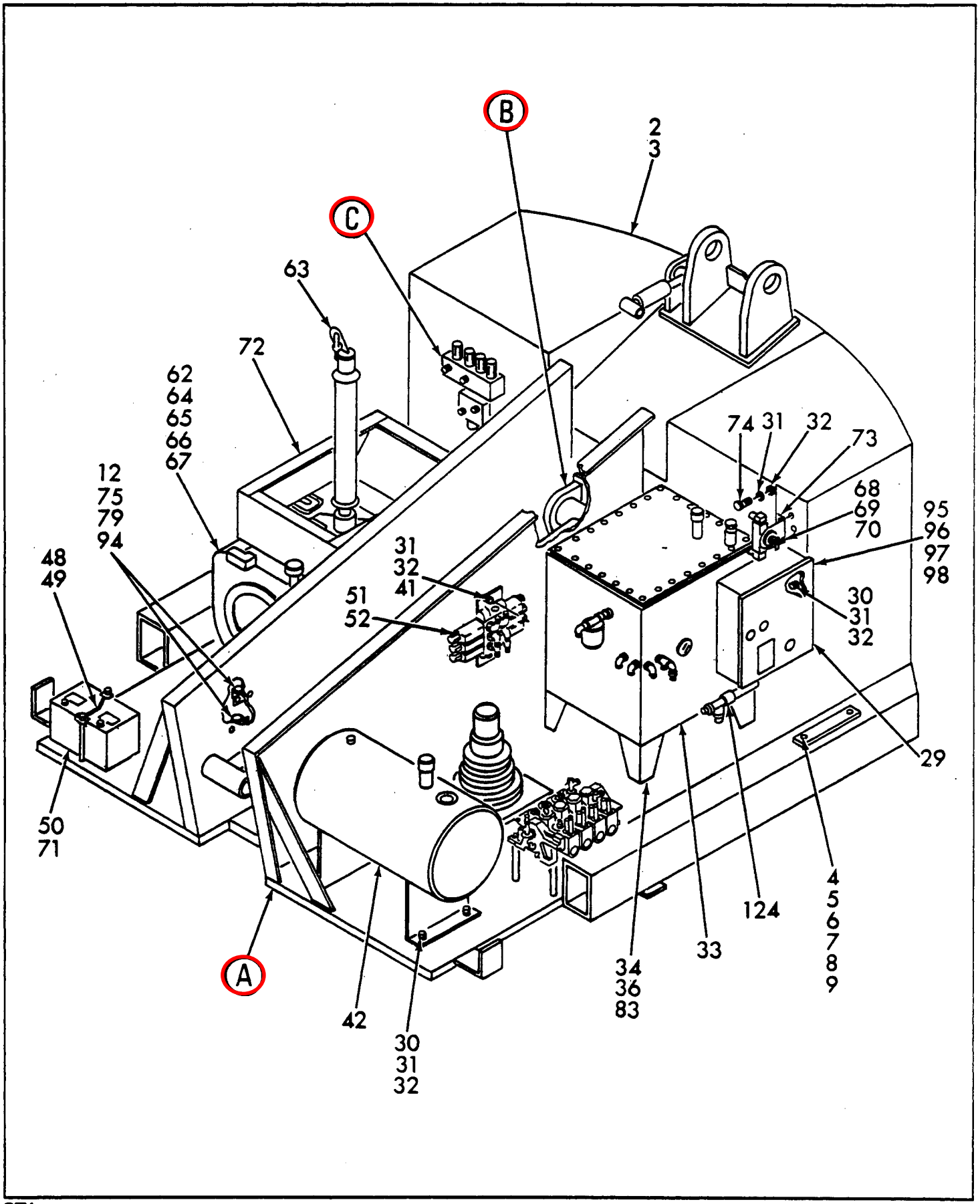
FIG. NO.	TITLE
1	TURRET ASSEMBLY
2	SOLENOID VALVE ASSEMBLY (UNTIL LATE 1989)
2A	SOLENOID VALVE ASSEMBLY (SINCE LATE 1989)
3	MASTER LEVELING CYLINDER ASSEMBLY (EARLY 1988, SOME CONCURRENT USE)
3A	MASTER LEVELING CYLINDER ASSEMBLY (CONCURRENT USE)
3B	MASTER LEVELING CYLINDER ASSEMBLY (SINCE LATE 1989, CONCURRENT USE)
4	GROUND CONTROL BOX ASSEMBLY
5	HYDRAULIC TANK ASSEMBLY
6	PROPORTIONAL VALVE ASSEMBLY
* 7	FUEL TANK ASSEMBLY
8	ROTATION GEARBOX ASSEMBLY
9	LIFT CYLINDER ASSEMBLY (CONCURRENT USE)
9A	LIFT CYLINDER ASSEMBLY (SINCE LATE 1989, CONCURRENT USE)
9B	LIFT CYLINDER ASSEMBLY (SINCE MID 1990, CONCURRENT USE)
* 10	MINIPAK ASSEMBLY (WITH PLATFORM ROTATION)
* 10A	MINIPAK ASSEMBLY (WITHOUT PLATFORM ROTATION)
11	ELECTRIC CHECK VALVE ASSEMBLY
12	EMERGENCY PUMP & MOTOR ASSEMBLY
13	ROTARY MANIFOLD ASSEMBLY (UNTIL EARLY 1988)
13A	ROTARY MANIFOLD ASSEMBLY (EARLY 1988 UNTIL LATE 1989)
* 14	ENGINE/PUMP ASSEMBLY
* 15	BATTERY CABLE KIT
16	TORQUE HUB ASSEMBLY (ROTATION GEARBOX)

*SEE OPTION SECTION FOR OTHER VARIATION(S).

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	1
PAGE	1

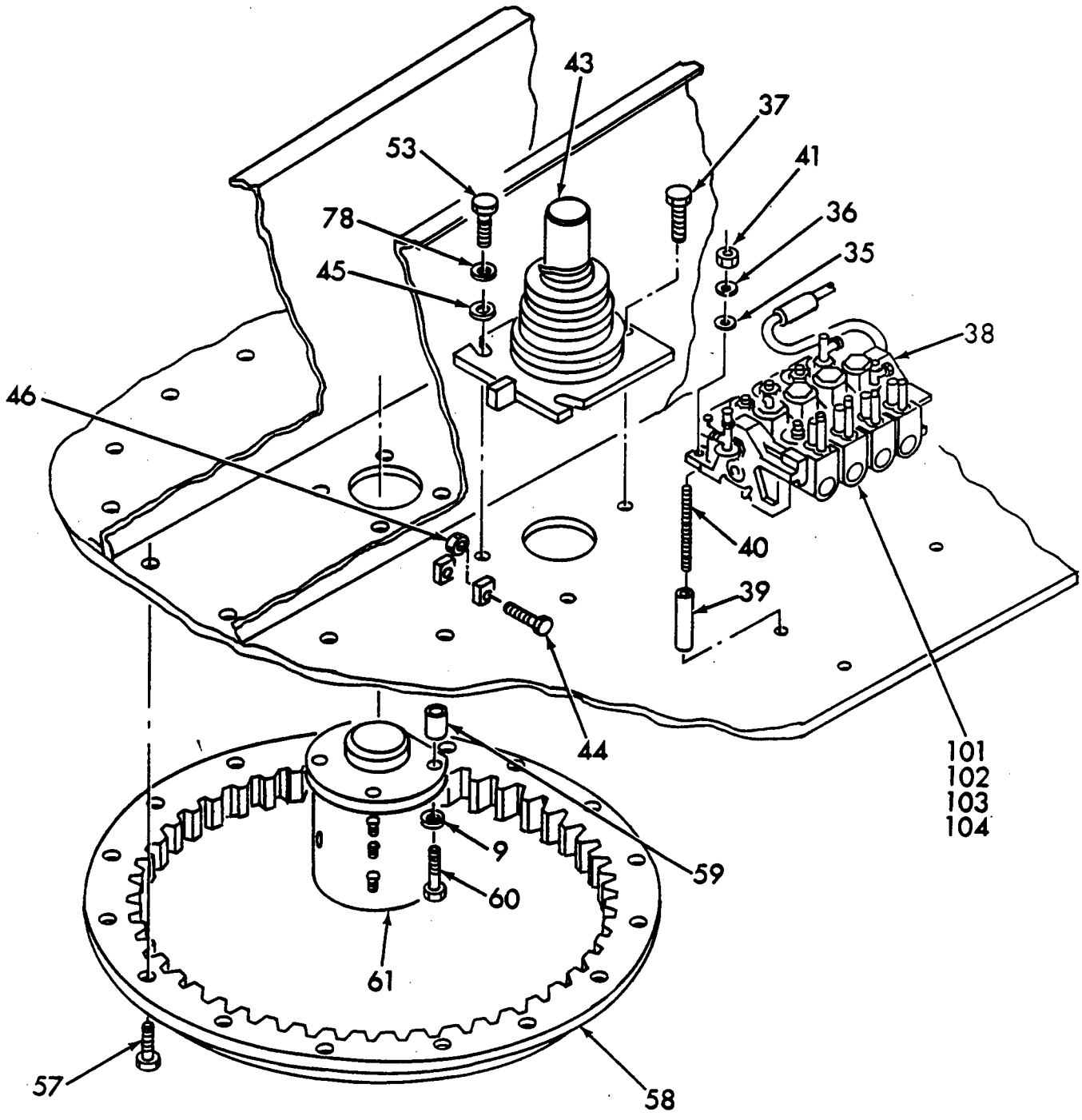


REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	1
PAGE	2

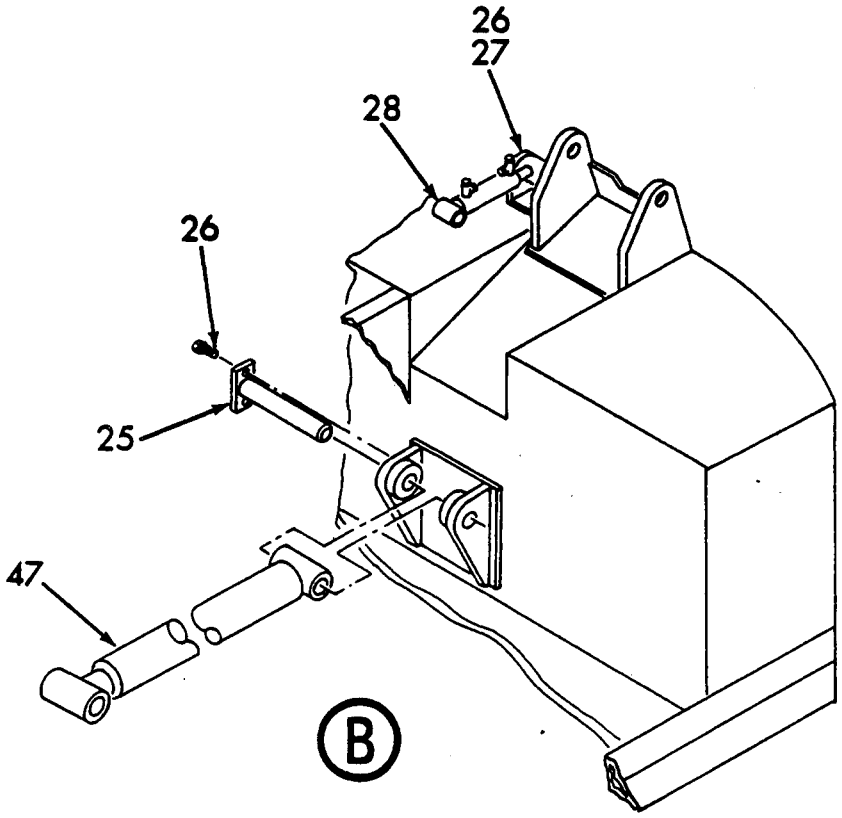


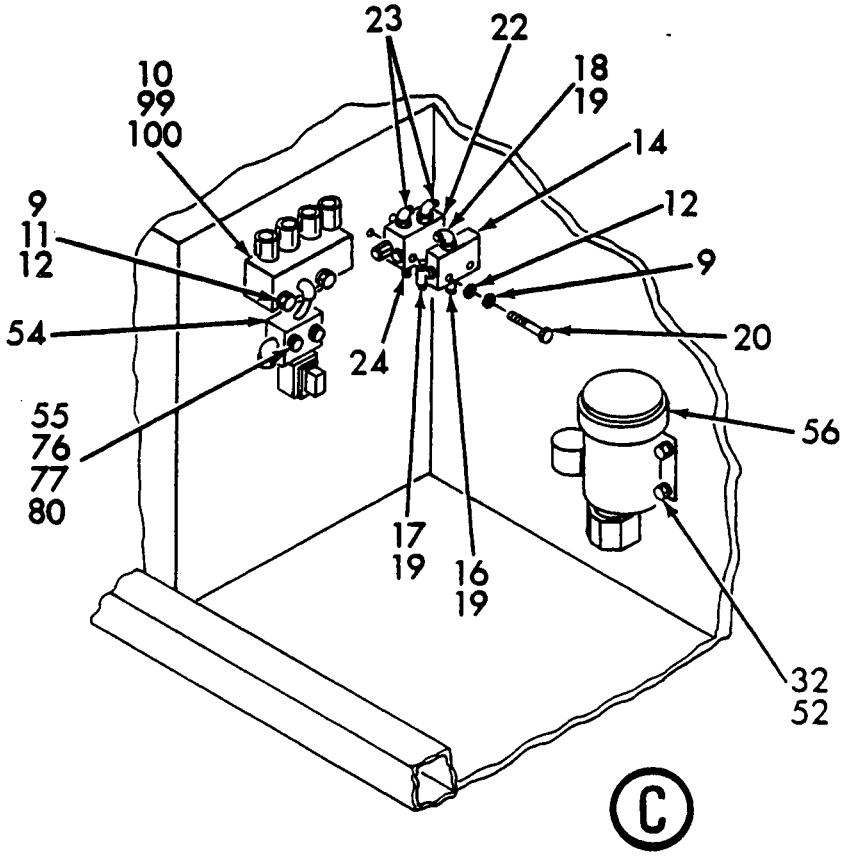
REV.

Mark Industries

TITLE	TURRET ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	1
PAGE	3





REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24144	ASSEMBLY, TURRET (See Sect. 3, Fig. 1 for NHA)	REF
2	.21751	WELDMENT, TURRET	1
3	..21752	WELDMENT, PEDESTAL	1
4	.21217	STRIP, TERMINAL	2
5	.62620	SCREW, MACHINE	4
6	.63313	WASHER, LOCK	4
7	.21386	COVER, TERMINAL STRIP	2
8	.60323	SCREW, CAP	4
9	.63302	WASHER, LOCK	12
10	.22609	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 2 for Details)	1
11	.60339	SCREW, CAP	2
12	.63402	WASHER, FLAT	11
-13	.21598	ASSEMBLY, RELIEF VALVE	1
14	..20564	REWORK, RELIEF VALVE	1
15	...20516	VALVE, RELIEF	1
16	..80004-11	CONNECTOR, STRAIGHT THREAD	1
17	..80036-11	TEE, STRAIGHT THREAD	1
18	..80012-11	ELBOW, STRAIGHT THREAD	1
19	..160225	CAP, PLUG	4
20	.60316	SCREW, CAP	4
-21	.21584	ASSEMBLY, DUAL OVERCENTER VALVE	1
22	..20365	VALVE, DUAL OVERCENTER	1
23	..80012-05	ELBOW, STRAIGHT THREAD	2
24	..80004-05	CONNECTOR, STRAIGHT THREAD	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.21780	PIN, CYLINDER LIFT	1
26	.60613	SCREW, CAP	4
27	.22492	PIN, MASTER LEVELING CYLINDER	1
28	.22583	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 3 for Details)	1
29	.24294	ASSEMBLY, GROUND CONTROL BOX (See Sect. 4, Fig. 4 for Details)	1
30	.60325	SCREW, CAP	3
31	.63403	WASHER, FLAT	6
32	.63303	WASHER, LOCK	10
33	.21704	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 5 for Details)	1
34	.60326	SCREW, CAP	4
35	.63405	WASHER, FLAT	3
36	.63305	WASHER, LOCK	7
37	.60637	SCREW, CAP	1
38	.24145	ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 6 for Details)	1
39	.27819	TUBE, ROUND	3
40	.63683	ROD, THREADED	3
41	.60705	NUT, HEX	3
42	.21702	ASSEMBLY, FUEL TANK (See Sect. 4, Fig. 7 for Details)	1
43	.22842	ASSEMBLY, ROTATION GEARBOX (See Sect. 4, Fig. 8 for Details)	1
44	.62222	SCREW, SET	2
45	.22169	WASHER	2
46	.60910	NUT, JAM	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
47	.21705	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 9 for Details)	1
48	.21286	BRACKET, BATTERY HOLD DOWN	2
49	.65108	BOLT, HOLD DOWN	2
50	.4030	BATTERY (12 VOLT)	1
51	.22607	ASSEMBLY, MINIPAK (W/PLATFORM ROTATION) (See Sect. 4, Fig. 10 for Details)	1
51	.21088	ASSEMBLY, MINIPAK (W/O PLATFORM ROTATION) (See Sect. 4, Fig. 10A for Details)	1
52	.60343	SCREW, CAP	6
53	.60628	SCREW, CAP	2
54	.24396	ASSEMBLY, ELECTRIC CHECK VALVE (See Sect. 4, Fig. 11 for Details)	1
55	.60340	SCREW, CAP	2
56	.22390	ASSEMBLY, EMERGENCY PUMP & MOTOR (See Sect. 4, Fig. 12 for Details)	1
57	.60604	SCREW, CAP	12
58	.20740	GEAR, RING	1
59	.20445	SPACER, MANIFOLD	4
60	.60511	SCREW, CAP	4
61	.21898	ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 13 for Details)	1
62	.22960	ASSEMBLY, ENGINE/PUMP (See Sect. 4, Fig. 14 for Details)	1
63	.21288	CAP, MUFFLER RAIN	1
64	.60715	NUT, LOCK	3
65	.60642	SCREW, CAP	3
66	.63423	WASHER, FLAT	3
67	.60640	SCREW, CAP	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
68	.22189	ASSEMBLY, EMERGENCY DESCENT VALVE	1
69	..20436	VALVE, NEEDLE	1
70	..51103	ELBOW, MALE	2
71	.20648	KIT, BATTERY CABLE (See Sect. 4, Fig. 15 for Details)	1
72	.21684	CHIMNEY, EXHAUST	1
73	.21279	BRACKET, MOUNTING	1
74	.60322	SCREW, CAP	2
75	.70209	SOLENOID, INSULATED	2
76	.63401	WASHER, FLAT	6
77	.63301	WASHER, LOCK	6
78	.63420	WASHER, FLAT	2
79	.60353	SCREW, CAP	4
80	.27833	TUBE, ROUND	2
81	.24185 KIT-B	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig.5 for Details)	1
82	.24185 KIT-C	DIAGRAM, HYDRAULIC HOSE (See Sect. 2, Fig.5 for Details)	1
83	.63501	WASHER, FLAT	4
-84	.4034	CABLE	15
-85	.2912	CABLE, CONDUCTOR	15 FT
-86	.70036	WIRE	45 FT
-87	.70205	WIRE, BLACK	30 FT
-88	.2990	WIRE, WHITE	2 FT
-89	.6K	WIRE, BLACK	8 FT
-90	.70008	WIRE, YELLOW WITH GREEN	3 FT
-91	.2991	WIRE, WHITE	18 FT

Mark Industries

TITLE	TURRET ASSEMBLY	SECT.	4
MODEL	42C	FIG.	1
NOTES		PAGE	8

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-92	.21351	CABLE, CONDUCTOR	12 FT
-93	.16214	MOUNTS, PANDUIT	14
94	.23808	BAR, BUSS	1
95	.16215	RELIEF, STRAIN	2
96	.16105	NUT, LOCK	3
97	.2806	RELIEF, STRAIN	6
98	.2808	NUT, LOCK	4
99	.70566	SPRING, SPADE (RED)	47
100	.70406	SPRING, SPADE	2
101	.66357	TERMINAL, MALE	1
102	.66356	TERMINAL, FEMALE	4
103	.70500	DISCONNECT, FEMALE	25
104	.70501	DISCONNECT, MALE	18
-105	.117-C	RING, CONNECTOR	5
-106	.70270	TERMINAL, RING	3
-107	.70567	CONNECTOR, RING (RED)	4
-108	.16213	CONNECTOR	3
-109	.117-N	CONNECTOR	1
-110	.117-M	CONNECTOR	3
-111	.70069	CONNECTOR, BUTT	7
-112	.70162	TERMINAL, BUTT	2
-113	.70479	DIODE, GENERAL PURPOSE	6
-114	.256	TIE, CABLE	50
-115	.255	TIE, CABLE	75
-116	.765	CLAMP, RUBBER	2

Mark Industries

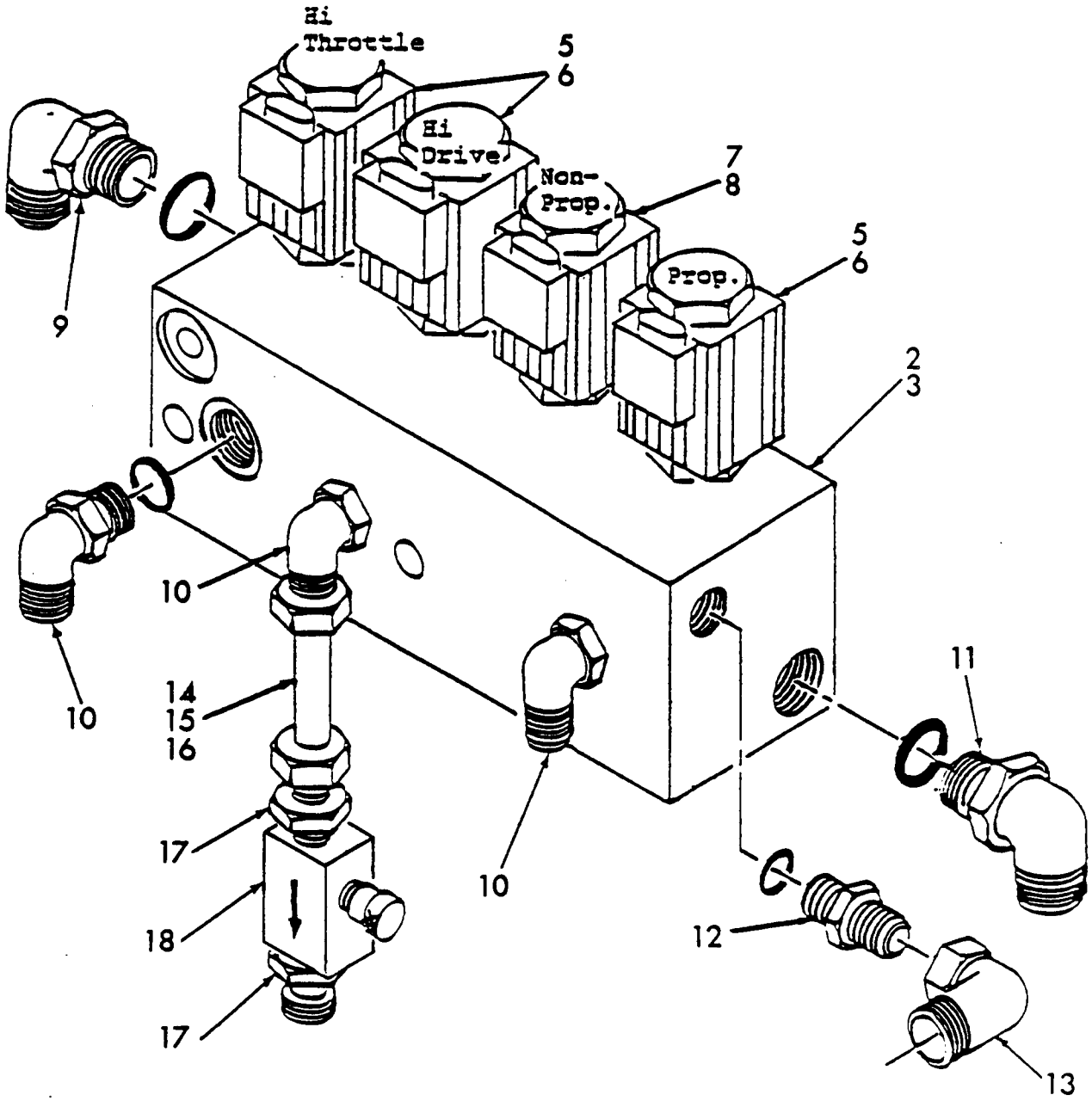
TITLE	TURRET ASSEMBLY	SECT.	4
MODEL	42C	FIG.	1
NOTES		PAGE	9

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-117	.764	CLAMP, RUBBER	1
-118	.16268	CLAMP, HOSE	4
-119	.70584	WASHER, LOCK	2
-120	.160346	WASHER, LOCK	2
-121	.70581	WASHER, LOCK	1
-122	.65681	WASHER, LOCK	1
-123	.65655	CLAMP, CUSHIONED	1
124	.21243	VALVE, CHECK	1

Mark Industries

TITLE	SOLENOID VALVE ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1989

SECTION	4
FIGURE	2
PAGE	1

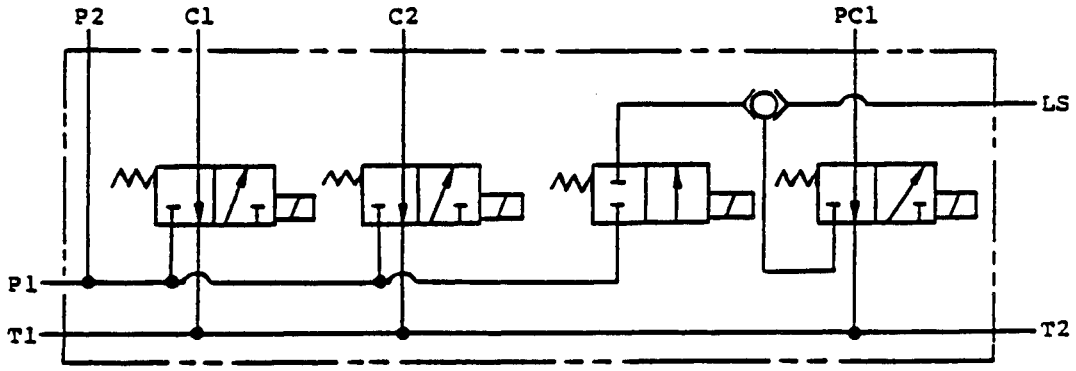


REV.

Mark Industries

TITLE	SOLENOID VALVE ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1989

SECTION	4
FIGURE	2
PAGE	2

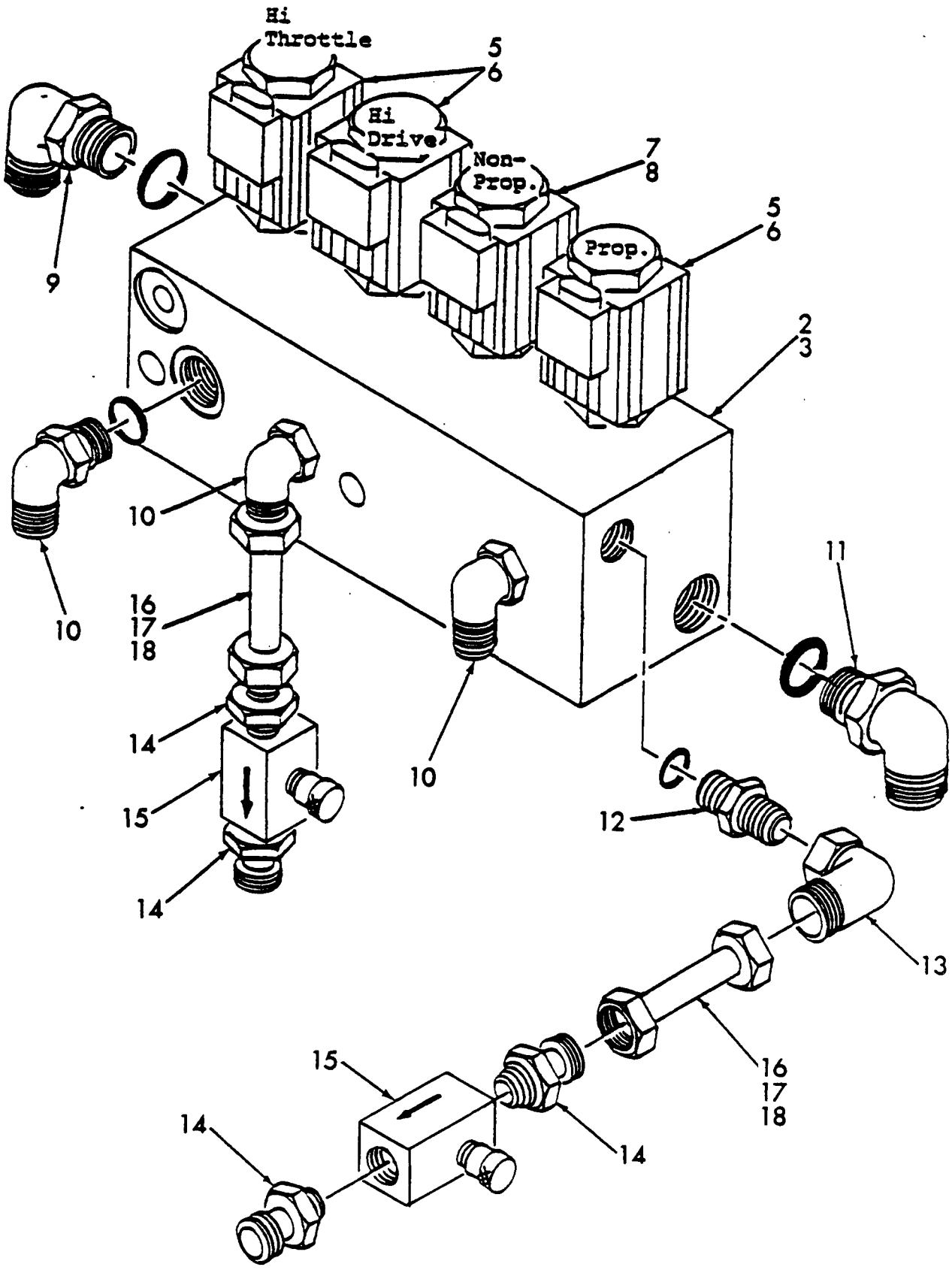


ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21692	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	.21860	VALVE, SOLENOID	1
3	..66885	BLOCK, MANIFOLD	1
-4	..67248	KIT, SEAL	1
5	..66884	CARTRIDGE & COIL	3
6	...67249	COIL (ONLY)	3
7	..66883	CARTRIDGE & COIL	1
8	...67249	COIL (ONLY)	1
9	.50900	ELBOW, STRAIGHT THREAD	1
10	.80012-03	ELBOW, STRAIGHT THREAD	3
11	.80012-08	ELBOW, STRAIGHT THREAD	1
12	.80004-03	CONNECTOR, STRAIGHT THREAD	1
13	.80015-03	ELBOW, SWIVEL NUT	1
-14	.22609-9	ASSEMBLY, TUBE	1
15	..80062-03	SLEEVE	2
16	..80060-03	NUT	2
17	.80001-03	CONNECTOR, MALE	2
18	.30884	VALVE, FLOW CONTROL	1

REV.

Mark Industries

TITLE	SOLENOID VALVE ASSEMBLY	SECTION	4
MODEL	42C	FIGURE	2A
NOTES	SINCE LATE 1989	PAGE	1

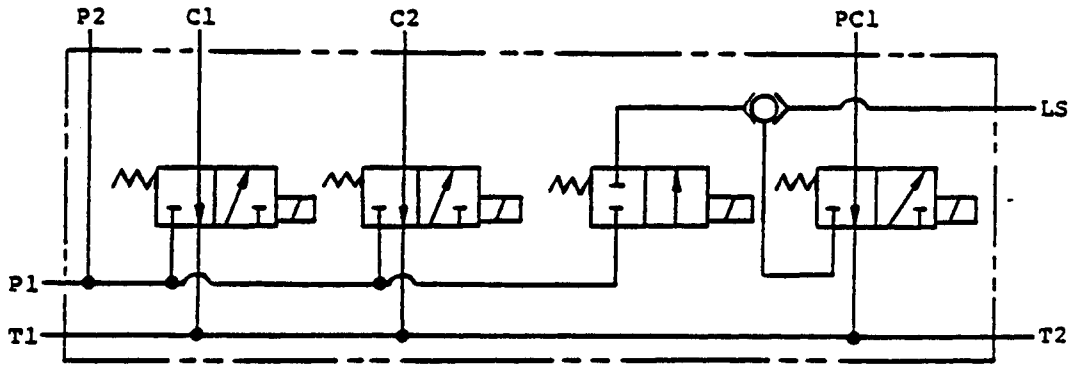


REV.

Mark Industries

TITLE	SOLENOID VALVE ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1989

SECTION	4
FIGURE	2A
PAGE	2



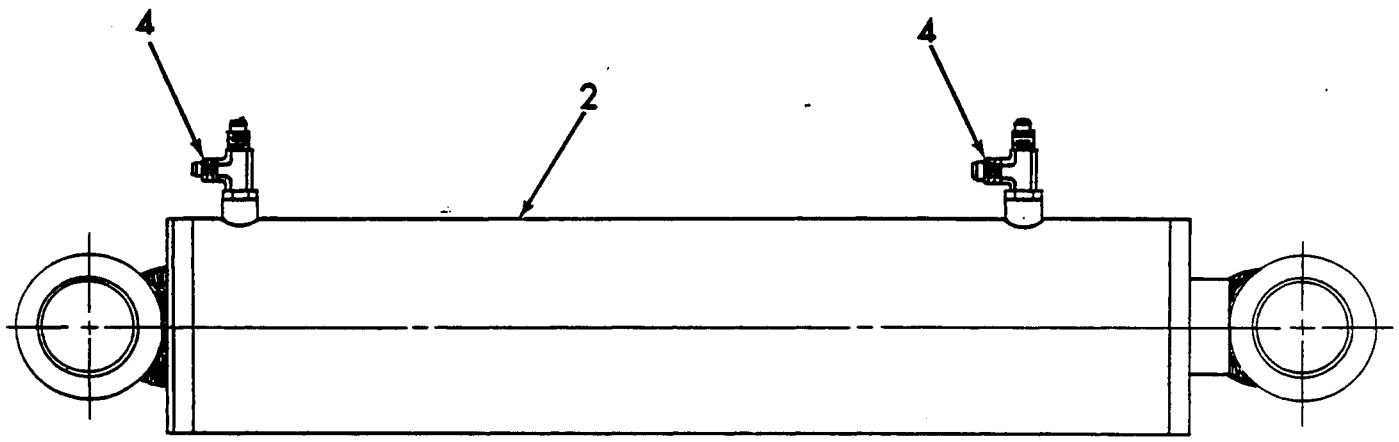
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22609	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	.21860	VALVE, SOLENOID	1
3	..66885	BLOCK, MANIFOLD	1
-4	..67248	KIT, SEAL	1
5	..66884	CARTRIDGE & COIL	3
6	...67249	COIL (ONLY)	3
7	..66883	CARTRIDGE & COIL	1
8	...67249	COIL (ONLY)	1
9	.50900	ELBOW, STRAIGHT THREAD	1
10	.80012-03	ELBOW, STRAIGHT THREAD	3
11	.80012-08	ELBOW, STRAIGHT THREAD	1
12	.80004-03	CONNECTOR, STRAIGHT THREAD	1
13	.80015-03	ELBOW, SWIVEL NUT	1
14	.80001-03	CONNECTOR, MALE	3
15	.30884	VALVE, FLOW CONTROL	2
-16	.22609-9	ASSEMBLY, TUBE	2
17	..80062-03	SLEEVE	4
18	..80060-03	NUT	4

REV.

Mark Industries

TITLE	MASTER LEVELING CYLINDER ASSEMBLY
MODEL	42C
NOTES	EARLY 1988, SOME CONCURRENT USE

SECTION	4
FIGURE	3
PAGE	1



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

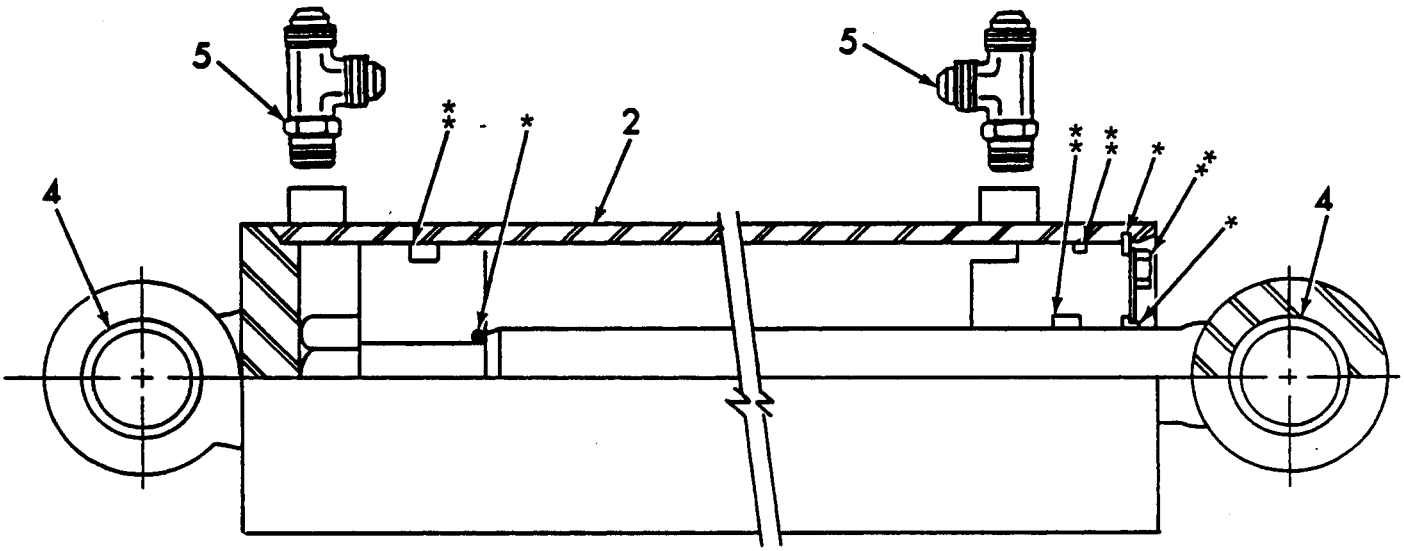
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22583	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.22577	CYLINDER, MASTER LEVELING (RA)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..66553	KIT, SEAL (RA)	1
4	.80033-05	TEE, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	MASTER LEVELING CYLINDER ASSEMBLY
MODEL	42C
NOTES	CONCURRENT USE

SECTION	4
FIGURE	3A
PAGE	1



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

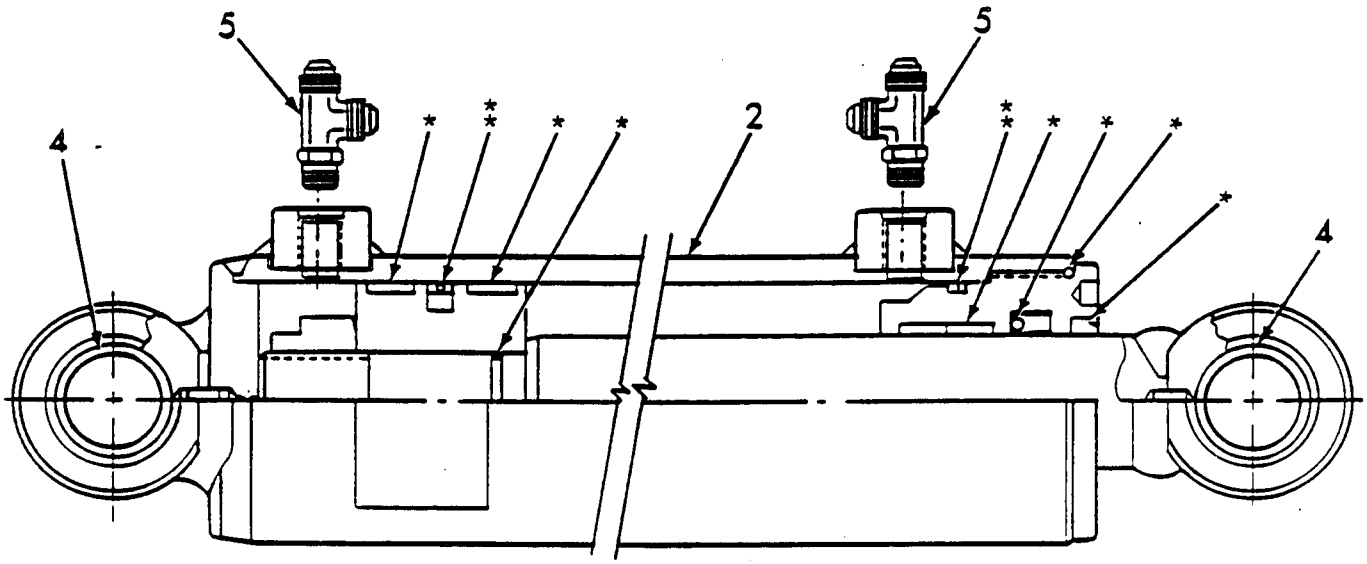
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22583	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.22577	CYLINDER, MASTER LEVELING (SE)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..67821	KIT, SEAL (SE)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..67949	BUSHING	4
5	.80033-05	TEE, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	MASTER LEVELING CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1989, CONSURRENT USE

SECTION	4
FIGURE	3B
PAGE	1



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

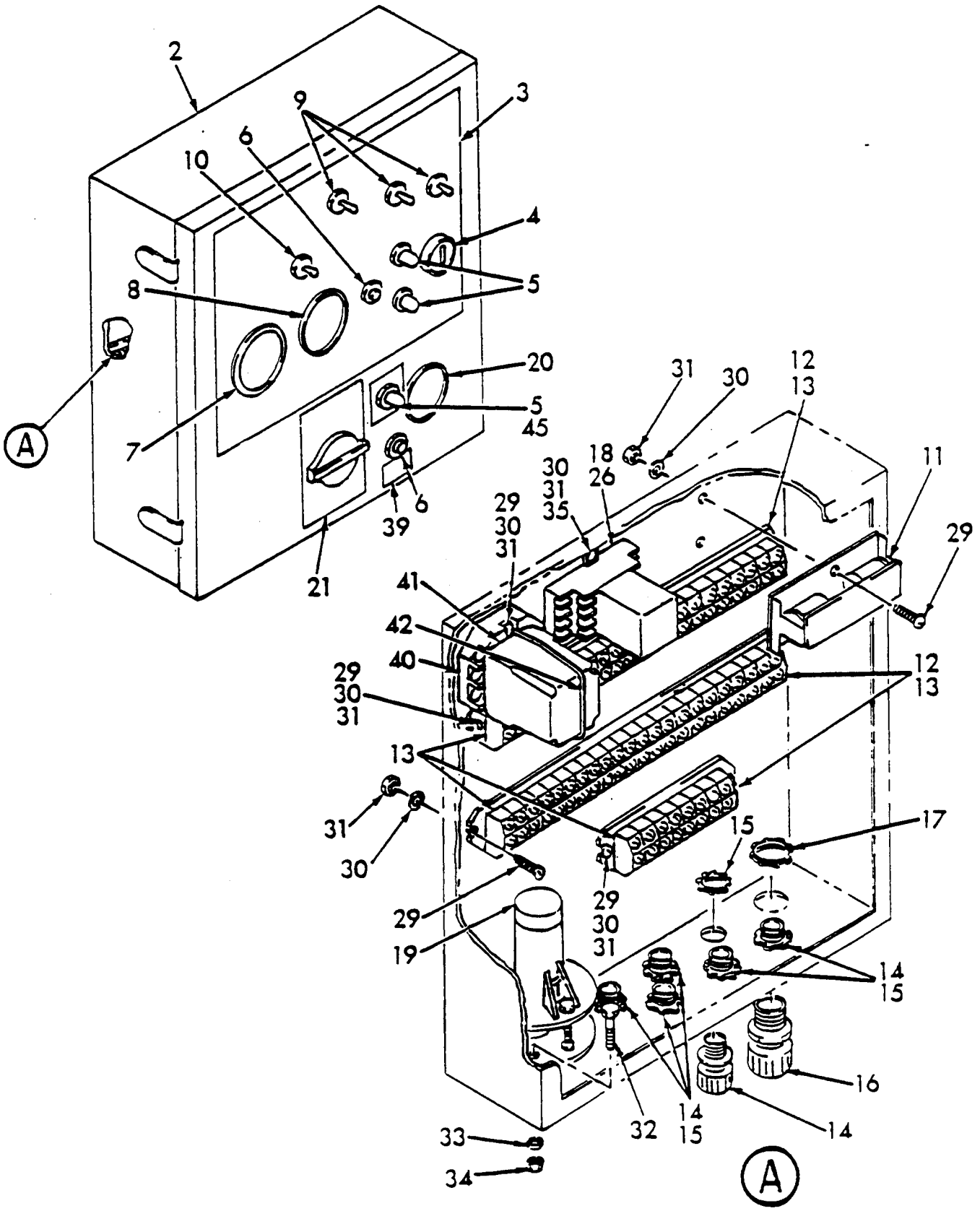
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22583	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.22577	CYLINDER, MASTER LEVELING (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-3	..600326	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
4	..600421	BUSHING	4
5	.80033-05	TEE, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	4
PAGE	1



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24294	ASSEMBLY, GROUND CONTROL BOX (See Sect. 4, Fig. 1 for NHA)	REF
2	.20977	MACHINING, ELECTRICAL ENCLOSURE	1
3	.20460	DECAL, GROUND CONTROL CONSOLE	1
4	.2717	SWITCH, IGNITION	1
5	.20562	BREAKER, CIRCUIT	3
6	.4011	SWITCH, PUSH BUTTON	2
7	.20571	HOURMETER	1
8	.70492	AMMETER	1
9	.20481	SWITCH, TOGGLE	3
10	.20482	SWITCH, TOGGLE	1
11	.20573	RELAY, LATCHING	1
12	.4027	BLOCK, TERMINAL	52
13	.117-A	BLOCK, TERMINAL	3
14	.2806	RELIEF, STRAIN	6
15	.2808	NUT, LOCK	6
16	.2807	RELIEF, STRAIN	1
17	.2809	NUT, LOCK	1
18	.70541	RELAY, DPDT	1
19	.21250	SENSOR, SLOPE	1
20	.21219	GAUGE, FUEL	1
21	.70119	COVER, PLATE (MALE RECEPTACLE)	1
22	.70479	DIODE, GENERAL PURPOSE	3
23	.70500	DISCONNECT, FEMALE	2
24	.117-D	CONNECTOR, BUTT	5
25	.117-E	TERMINAL, PUSH-ON	6

Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	42C
NOTES	

SECT.	4
FIG.	4
PAGE	3

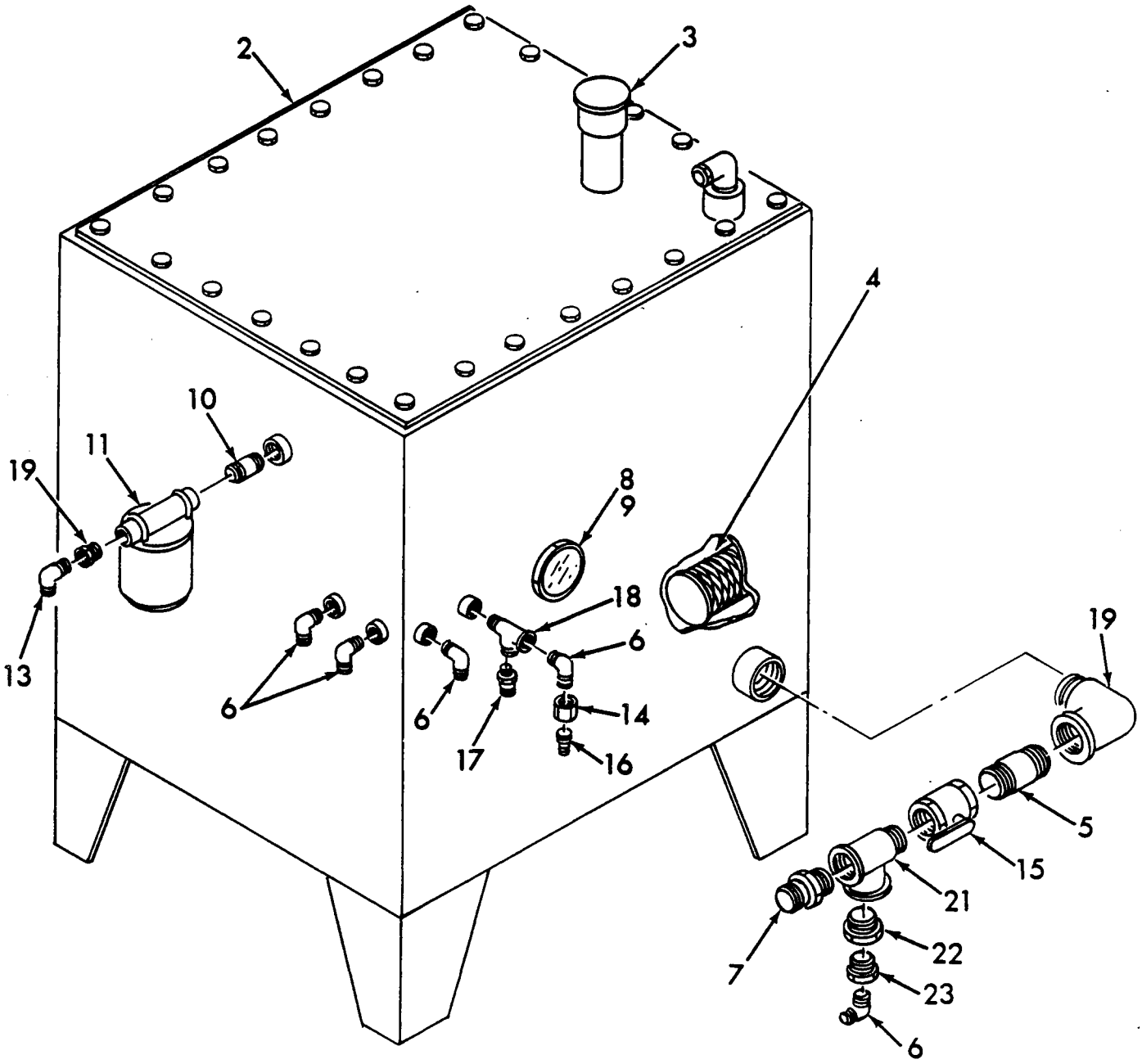
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.70214	RELAY, BASE	1
27	.2859	RING, TONGUE	26
28	.876	TERMINAL, RING	10
29	.62609	SCREW, MACHINE	14
30	.63311	WASHER, LOCK	16
31	.61501	NUT, HEX	14
32	.60325	SCREW, CAP	4
33	.63303	WASHER, LOCK	4
34	.60703	NUT, HEX	4
35	.62630	SCREW, MACHINE	2
36	.70147	CAPACITOR	1
37	.70029	CONNECTOR	2
38	.117-CC	CONNECTOR, FEMALE	2
39	.20413	DECAL, ENGINE CHOKE	1
40	.70145	RELAY	1
41	.784-A	SOCKET, 8 PIN OCTAL	1
42	.30215	CLIP, RELAY	1
-43	.2990	WIRE, WHITE 18 AWG	20 FT
-44	.2991	WIRE, WHITE 12 AWG	5 FT
45	.185702	DECAL, CIRCUIT BREAKER 110 VAC	1

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

Mark Industries

TITLE	HYDRAULIC TANK ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	5
PAGE	1



REV.

Mark Industries

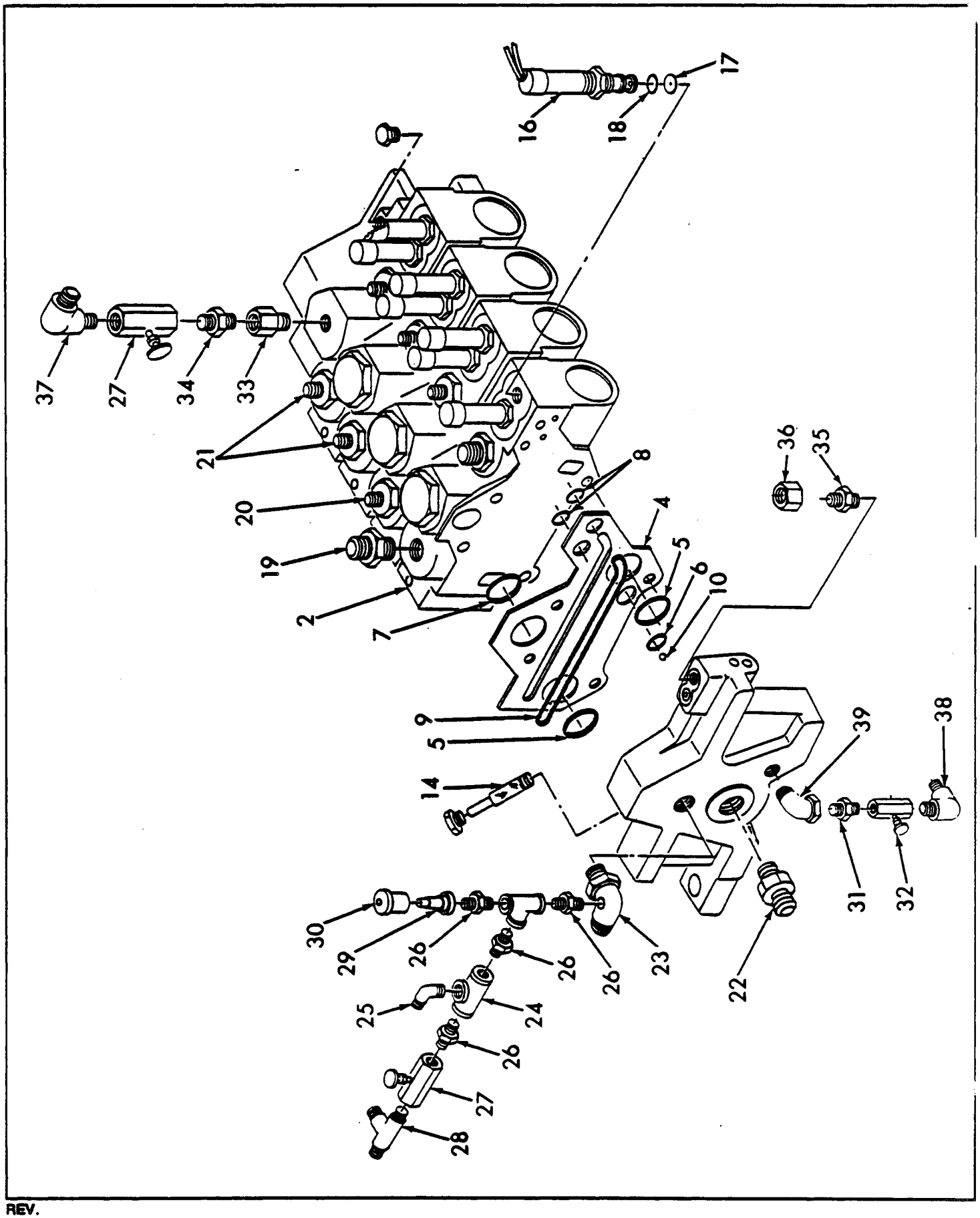
TITLE	HYDRAULIC TANK ASSEMBLY	SECT.	4
MODEL	42C	FIG.	5
NOTES		PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21704	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 1 for NHA)	REF
2	.21761	TANK, HYDRAULIC	1
3	..65843	CAP, VENTED ANTI-SURGE GAS	1
4	..81121	FILTER, SUMP	1
5	.54700	NIPPLE, BLACK PIPE	1
6	.80008-10	ELBOW, MALE	5
7	.2968	CONNECTOR, MALE	1
8	.65130	GAUGE, MECHANICAL	1
9	..65130-A	DIAL (FACE)	1
10	.16558	NIPPLE, BLACK PIPE	1
11	.21241	ASSEMBLY, FILTER	1
12	..21245	ELEMENT, FILTER	1
13	.80008-23	ELBOW, MALE	1
14	.80060-05	NUT	1
15	.20050	VALVE, BUTTERFLY	1
16	.80056-01	REDUCER, TUBE	1
17	.80001-10	CONNECTOR, MALE	1
18	.80041-06	TEE, STREET	1
19	.53801	REDUCER, PIPE	1
20	.52307	ELBOW	1
21	.55100	TEE, STREET	1
22	.53800	REDUCER, BUSHING	1
23	.80057-12	REDUCER, PIPE THREAD	1

Mark Industries

TITLE	PROPORTIONAL VALVE ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	6
PAGE	1



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24145	ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	.81237	VALVE, PROPORTIONAL (UNTIL EARLY 1989)	1
2	.81315	VALVE, PROPORTIONAL (FROM EARLY 1989 UNTIL MID 1989)	1
2	.81320	VALVE, PROPORTIONAL (SINCE EARLY 1989)	1
-3	..600180	KIT, SEAL REPAIR (4 BANKS)	1
4	...	PLATE, SEAL	5
5	...	O-RING	10
6	...	O-RING	5
7	...	O-RING	5
8	...	O-RING	10
9	...	O-RING	5
10	...	BALL	5
11	...	ROD, TIE	4
12	...	NUT, HEX	4
13	...	NUT, LOCK	4
14	..67382	FILTER, INLET	1
-15	..67380	KIT, SOLENOID CARTRIDGE (MATCHED)	8
*16	...	CARTRIDGE, SOLENOID	1
*17	...	DISK	1
18	...	O-RING	1
19	.80004-18	CONNECTOR, STRAIGHT THREAD	2
		NOTE: PRIOR TO USE, RELIEF VALVE WITH ASTERISK (*) MUST BE ADJUSTED TO THE PRESSURE INDICATED ON THE SPECIFIC MACHINE'S HYDRAULIC SCHEMATIC.	

Mark Industries

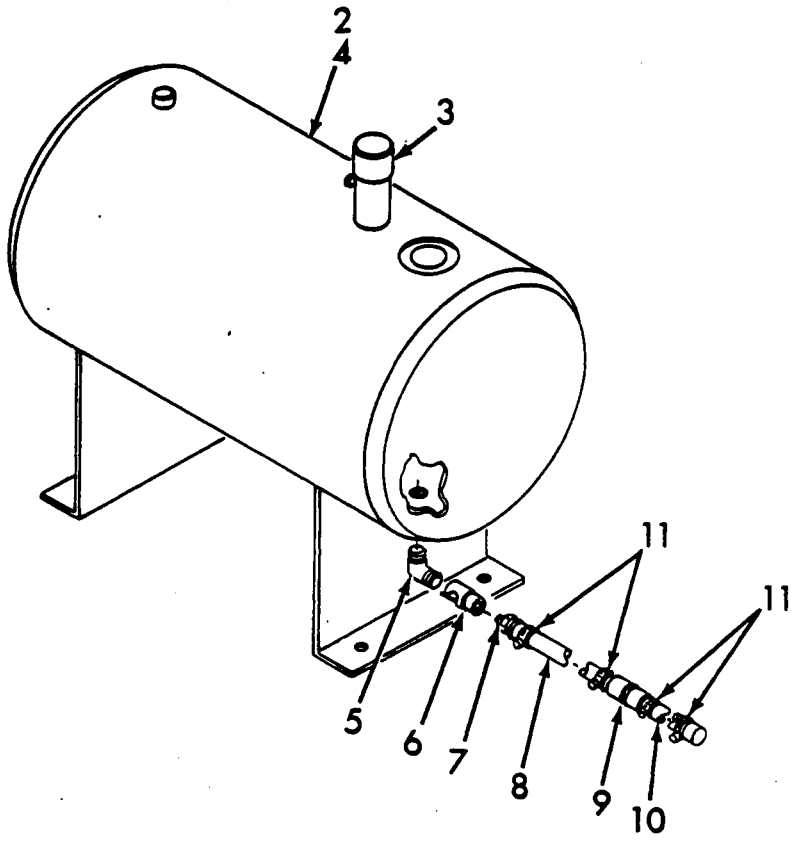
TITLE	PROPORTIONAL VALVE ASSEMBLY	SECT.	4
MODEL	42C	FIG.	6
NOTES		PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
20	.50844	CONNECTOR, STRAIGHT THREAD	2
21	.80004-14	CONNECTOR, STRAIGHT THREAD	4
22	.80004-24	CONNECTOR, STRAIGHT THREAD	1
23	.24181	ELBOW, MODIFIED STRAIGHT THREAD	1
24	.80039-04	TEE, FEMALE PIPE	2
25	.80008-08	ELBOW, MALE	1
26	.80052-04	NIPPLE, PIPE	4
27	.20357	VALVE, NEEDLE	2
28	.80037-08	TEE, MALE	1
29	.2527	COUPLING, QUICK DISCONNECT	1
30	.845	CAP, QUICK DISCONNECT	1
31	.80052-02	NIPPLE, PIPE	1
32	.20884	VALVE, FLOW CONTROL	1
33	.51903	ADAPTER, FEMALE PIPE	2
34	.80052-03	NIPPLE, PIPE	1
35	.80004-03	CONNECTOR, STRAIGHT THREAD	1
36	.80059-03	CAP	1
37	.80008-04	ELBOW, MALE	1
38	.80008-03	ELBOW, MALE	1
39	.80021-01	ELBOW, STREET	1

Mark Industries

TITLE	FUEL TANK ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	7
PAGE	1



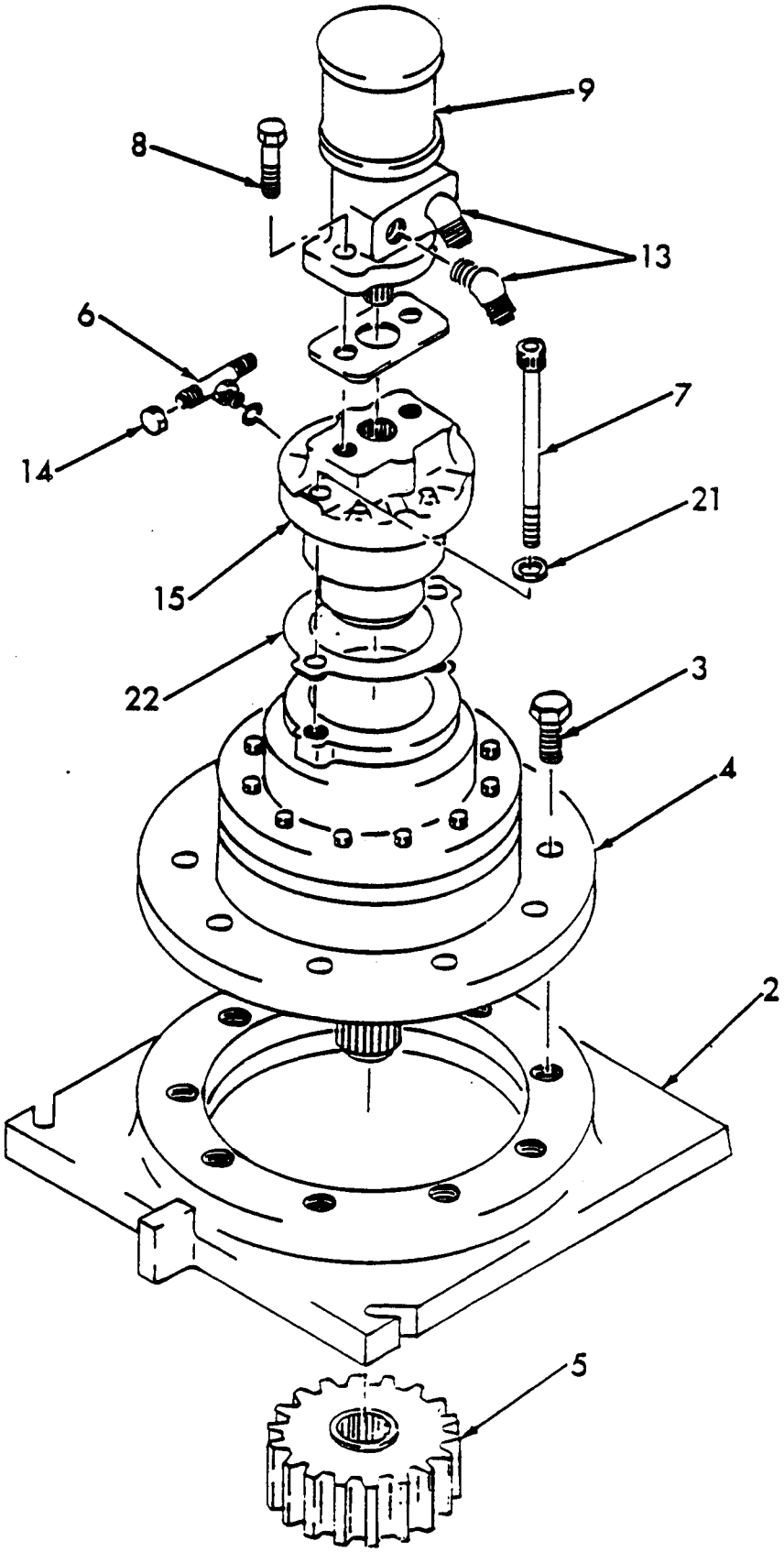
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21702	ASSEMBLY, FUEL TANK (See Sect. 4, Fig. 1 for NHA)	REF
2	.21762	TNAK, FUEL (22 GALLON)	1
3	.67959	CAP, GAS	1
4	..20041	UNIT, SENDING	1
5	.16501	ELBOW, STREET	1
6	.12000	VALVE, NEEDLE	1
7	.2589	HOSE, FITTING	1
8	.160B-0160	HOSE, GATES	1
9	.160	FILTER, FUEL	1
10	.160B-0100	HOSE, GATES	1
11	.161-A	CLAMP, HOSE	4

REV.

Mark Industries

TITLE	ROTATION GEARBOX ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	8
PAGE	1



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22842	ASSEMBLY, ROTATION GEARBOX (See Sect. 4, Fig. 1 for NHA)	REF
2	.22996	WELDMENT, MOUNTING PLATE	1
3	.60602	SCREW, CAP	9
4	.22830	HUB, TORQUE (See Sect. 4, Fig. 16 for Details)	1
5	.22859	PINION	1
6	.80036-03	TEE, STRAIGHT THREAD	1
7	.61940	SCREW, CAP	2
8	.60622	SCREW, CAP	2
9	.81080	MOTOR, HYDRAULIC (UNTIL LATE 1988) (See Vendor Chapter for Details)	1
-10	..66965	KIT, SEAL	1
9	.81276	MOTOR, HYDRAULIC (SINCE LATE 1988) (See Vendor Chapter for Details)	1
-10	..67688	KIT, SEAL	1
-11	..67692	LINK, DRIVE	1
-12	..67699	SHAFT, COUPLING	1
13	.80018-13	ELBOW, STRAIGHT THREAD	2
14	.80059-03	CAP	1
15	.22831	BRAKE (See Vendor Chapter for Details)	1
-16	..67150	KIT, SEAL	1
17	..67644	KIT, LINING	1
18	..67657	KIT, BEARING	1
19	..67650	KIT, SPRING	1
20	..67660	PISTON, BRAKE	1

Mark Industries

TITLE	ROTATION GEARBOX ASSEMBLY
MODEL	42C
NOTES	

SECT.	4
FIG.	8
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
21	.63305	WASHER, LOCK	2
22	.66846	GASKET	1

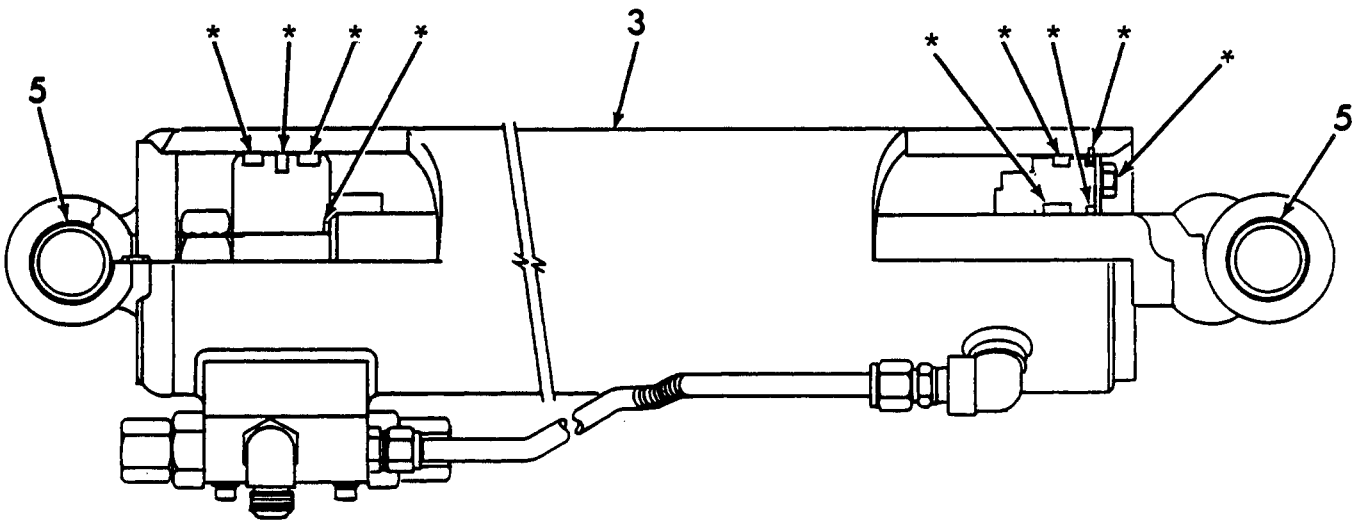
REV.

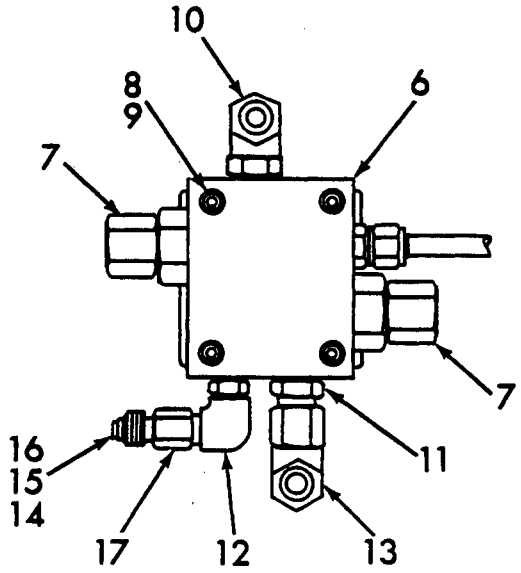
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	LIFT CYLINDER ASSEMBLY
MODEL	42C
NOTES	CONCURRENT USE

SECTION	4
FIGURE	9
PAGE	1





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

Mark Industries

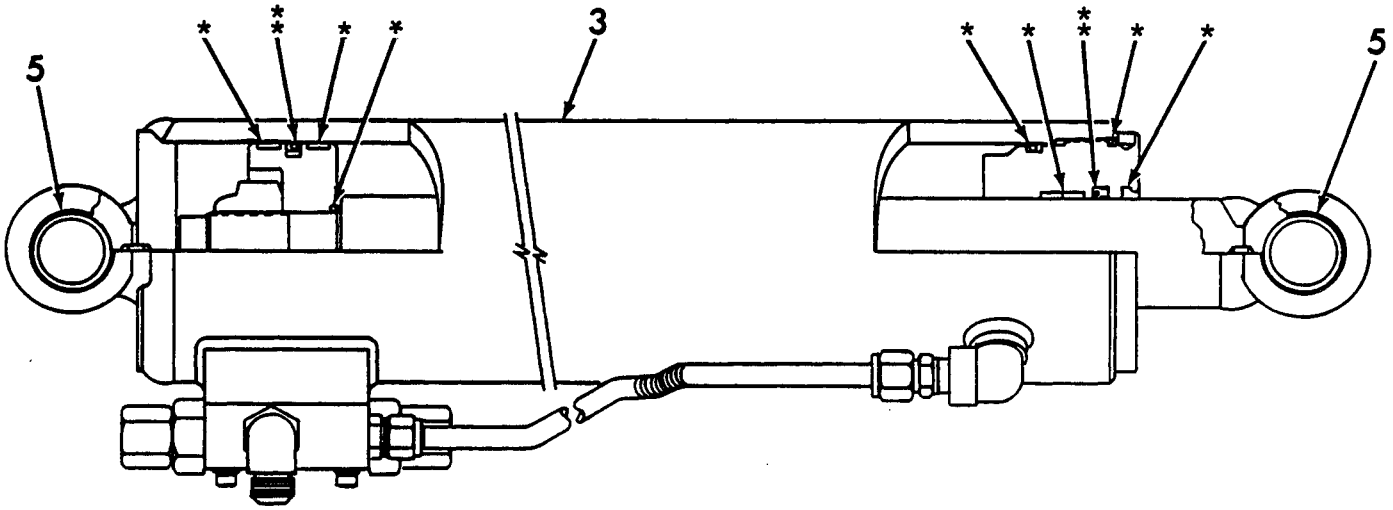
TITLE	LIFT CYLINDER ASSEMBLY	SECT.	4
MODEL	42C	FIG.	9
NOTES	CONCURRENT USE	PAGE	2

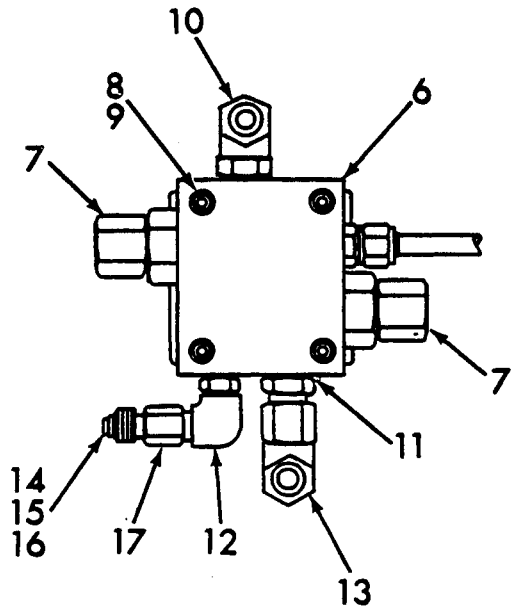
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21705	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
2	.20968	SUB-ASSEMBLY, LIFT CYLINDER (SE)	1
3	..21198	CYLINDER, LIFT	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...66502	KIT, SEAL (SHOWN: WITH 2.5" ROD)	1
-4	...66165	KIT, SEAL (NOT SHOWN: WITH 2" ROD)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...67121	BUSHING	2
6	..21445	BLOCK, VALVE	1
7	..81006	CARTRIDGE, OVERCENTER	2
8	..61918	SCREW, CAP	4
9	..63302	WASHER, SPLIT	5
10	.80012-09	ELBOW, STRAIGHT THREAD	1
11	.80004-09	CONNECTOR, STRAIGHT THREAD	1
12	.50900	ELBOW, STRAIGHT THREAD	1
13	.80015-05	ELBOW, SWIVEL NUT	1
-14	.20348	ORIFICE, BLEED DOWN	1
15	..80056-01	REDUCER, TUBE END	1
16	..62202	SCREW, SET	1
17	.80060-05	NUT	1

Mark Industries

TITLE	LIFT CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1989, CONCURRENT USE

SECTION	4
FIGURE	9A
PAGE	1





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

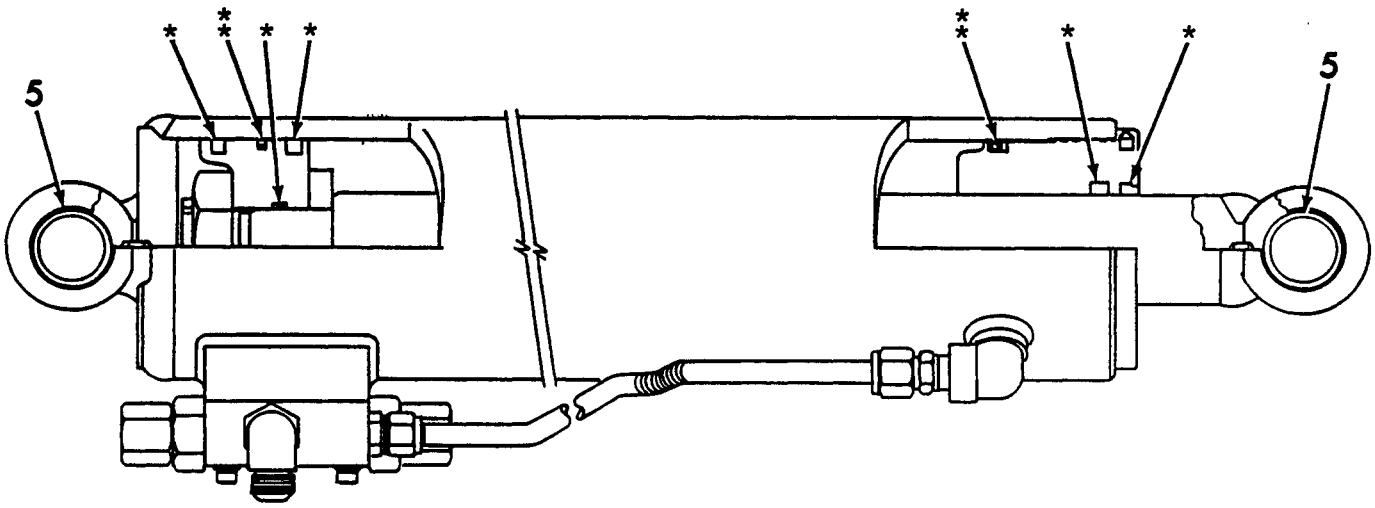
REV.

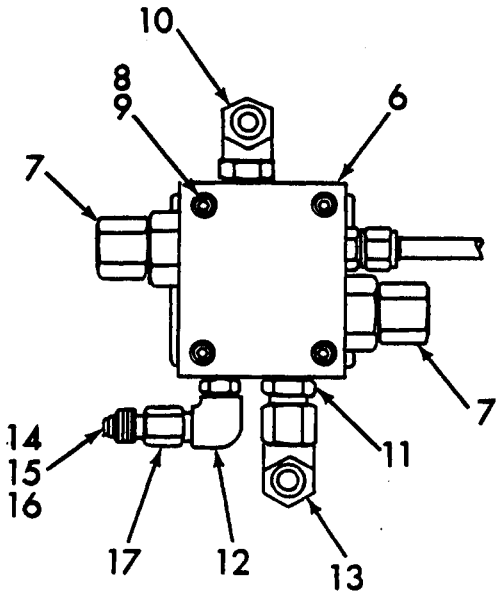
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21705	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
-2	.20968	SUB-ASSEMBLY, LIFT CYLINDER (TH)	1
3	..21198	CYLINDER, LIFT	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...600067	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...68020	BUSHING	4
6	..21445	BLOCK, VALVE	1
7	..81006	CARTRIDGE, OVERCENTER	2
8	..61918	SCREW, CAP	4
9	..63302	WASHER, LOCK	4
10	.80012-09	ELBOW, STRAIGHT THREAD	1
11	.80004-09	CONNECTOR, STRAIGHT THREAD	1
12	.50900	ELBOW, STRAIGHT THREAD	1
13	.80015-05	ELBOW, SWIVEL NUT	1
14	.20348	ORIFICE, BLEED DOWN	1
15	..80056-01	REDUCER, TUBE	1
16	..62202	SCREW, SET	1
17	.80060-05	NUT	1

Mark Industries

TITLE	LIFT CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE MID 1990, CONCURRENT USE

SECTION	4
FIGURE	9B
PAGE	1





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

REV.

Mark Industries

TITLE	LIFT CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE MID 1990, CONCURRENT USE

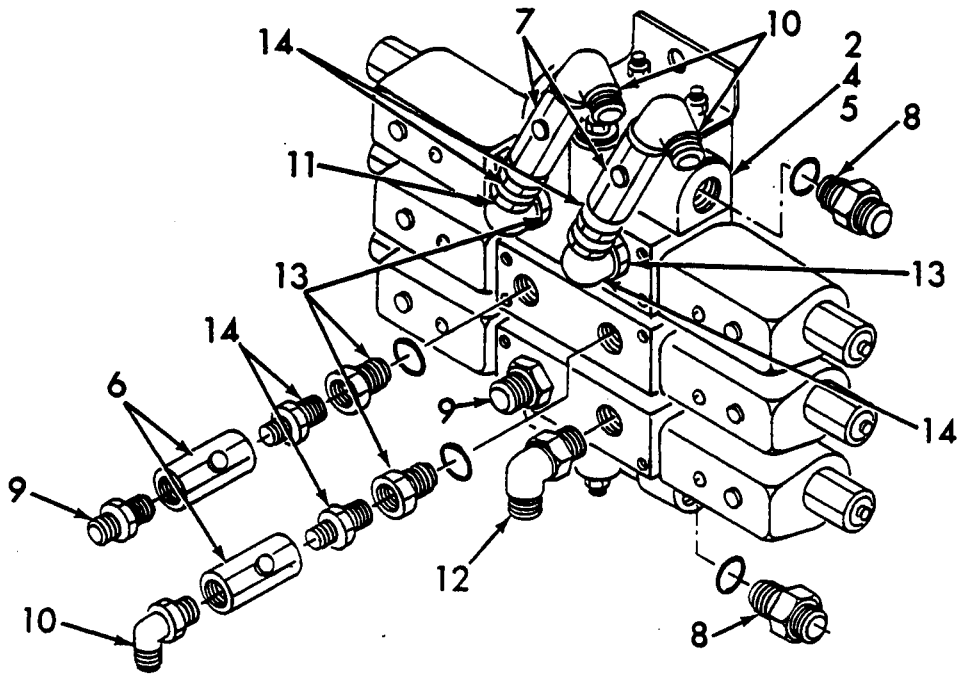
SECT.	4
FIG.	9B
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21705	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 1 for NHA)	REF
-2	.20968	SUB-ASSEMBLY, LIFT CYLINDER (SB)	1
3	..21198	CYLINDER, LIFT	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...600426	KIT, SEAL (SB)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...600366	BUSHING	4
6	..21445	BLOCK, VALVE	1
7	..81006	CARTRIDGE, OVERCENTER	2
8	..61918	SCREW, CAP	4
9	..63302	WASHER, LOCK	5
10	.80012-09	ELBOW, STRAIGHT THREAD	1
11	.80004-09	CONNECTOR, STRAIGHT THREAD	1
12	.50900	ELBOW, STRAIGHT THREAD	1
13	.80015-05	ELBOW, SWIVEL NUT	1
14	.20348	ORIFICE, BLEED DOWN	1
15	..80056-01	REDUCER, TUBE	1
16	..62202	SCREW, SET	1
17	.80060-05	NUT	1

Mark Industries

TITLE	MINIPAK ASSEMBLY
MODEL	42C
NOTES	WITH PLATFORM ROTATION

SECTION	4
FIGURE	10
PAGE	1



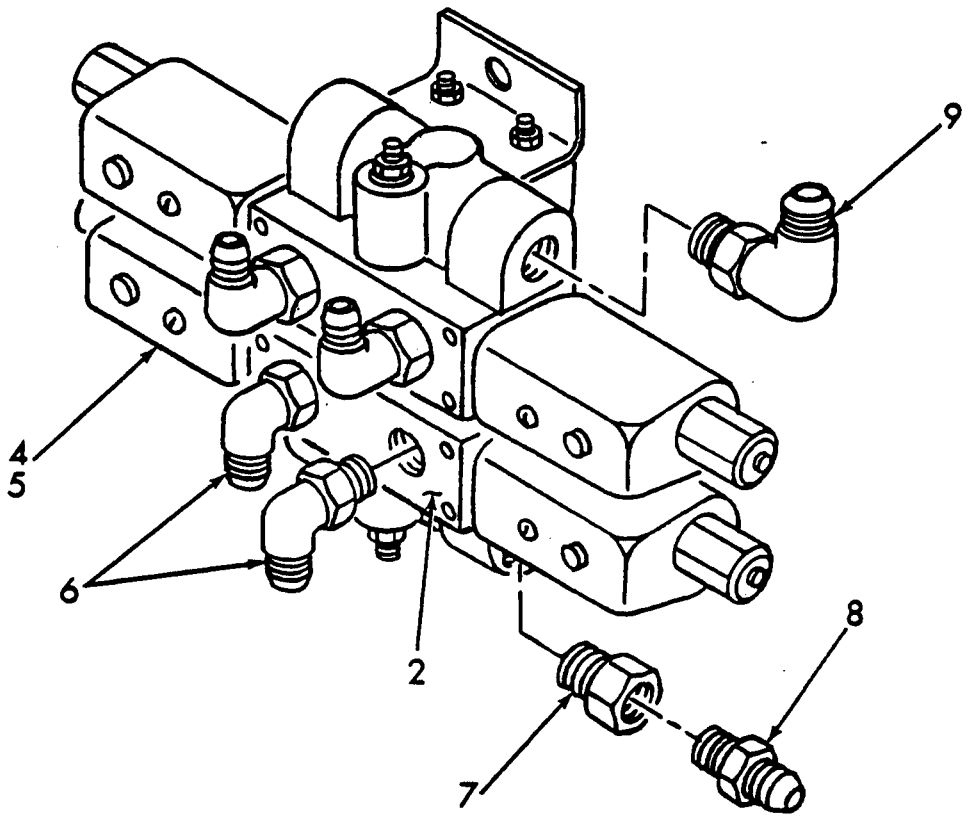
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23551	ASSEMBLY, MINIPAK (See Sect. 4, Fig. 1 for NHA)	REF
2	.21787	VALVE, MINIPAK (3 BANK)	1
3	..67825	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
4	..67958	CARTRIDGE (ONLY)	6
5	..16953	COIL (ONLY)	6
6	.20357	VALVE, NEEDLE	2
7	.20370	VALVE, NEEDLE	2
8	.80004-05	CONNECTOR, STRAIGHT THREAD	3
9	.80001-04	CONNECTOR, MALE	1
10	.80008-04	ELBOW, MALE	3
11	.80021-03	ELBOW, STREET	2
12	.80012-05	ELBOW, STRAIGHT THREAD	1
13	.80063-01	ADAPTER, FEMALE PIPE	4
14	.80052-04	NIPPLE, PIPE	4

REV.

Mark Industries

TITLE	MINIPAK ASSEMBLY
MODEL	42C
NOTES	WITHOUT PLATFORM ROTATION

SECTION	4
FIGURE	10A
PAGE	1



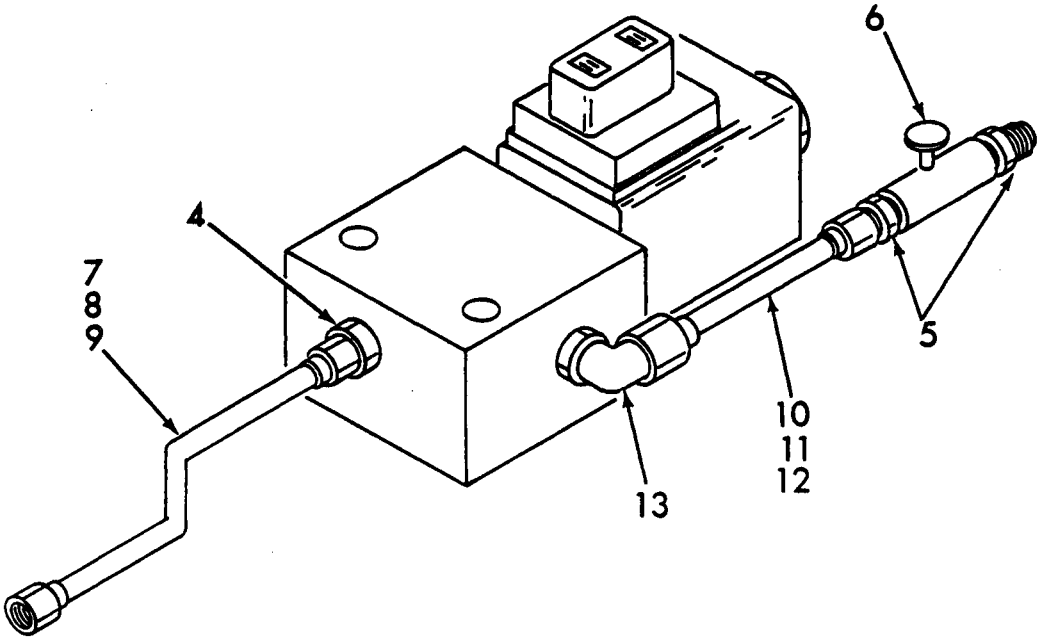
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21088	ASSEMBLY, MINIPAK (See Sect. 4, Fig. 1 for NHA)	REF
2	.21207	VALVE, SOLENOID	1
-3	.67825	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
4	..67958	CARTRIDGE (ONLY)	4
5	..16953	COIL (ONLY)	4
6	.80012-05	ELBOW, STRAIGHT THREAD	4
7	.80063-01	ADAPTER, FEMALE	1
8	.80001-08	CONNECTOR, MALE	1
9	.80012-08	ELBOW, STRAIGHT THREAD	1

REV.

Mark Industries

TITLE	ELECTRICK CHECK VALVE ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	11
PAGE	1



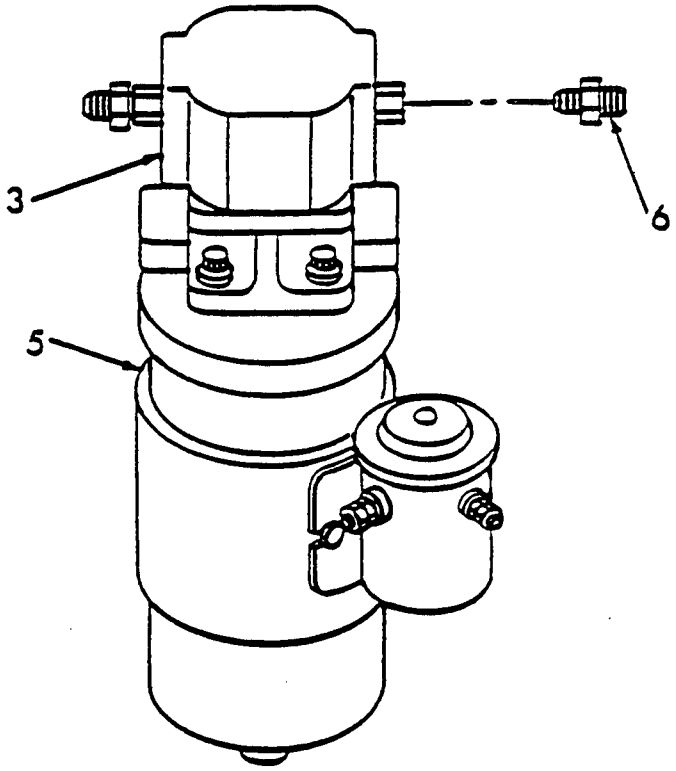
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	.24396	ASSEMBLY, ELECTRIC CHECK VALVE (See Sect. 4, Fig. 1 for NHA)	REF
2	..81258	VALVE, ELECTRIC CHECK	1
3	...66863	COIL, 10 VOLT	1
4	..80004-06	CONNECTOR, STRAIGHT THREAD	1
5	..80001-03	CONNECTOR, MALE	2
6	..30884	VALVE	1
7	..24396-5	ASSEMBLY, TUBE	1
8	...80060-03	NUT	2
9	...80062-03	SLEEVE	2
10	..24396-6	ASSEMBLY, TUBE	1
11	...80060-03	NUT	2
12	...80062-03	SLEEVE	2
13	..80012-06	ELBOW, STRAIGHT THREAD	1

REV.

Mark Industries

TITLE	EMERGENCY PUMP & MOTOR ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	12
PAGE	1



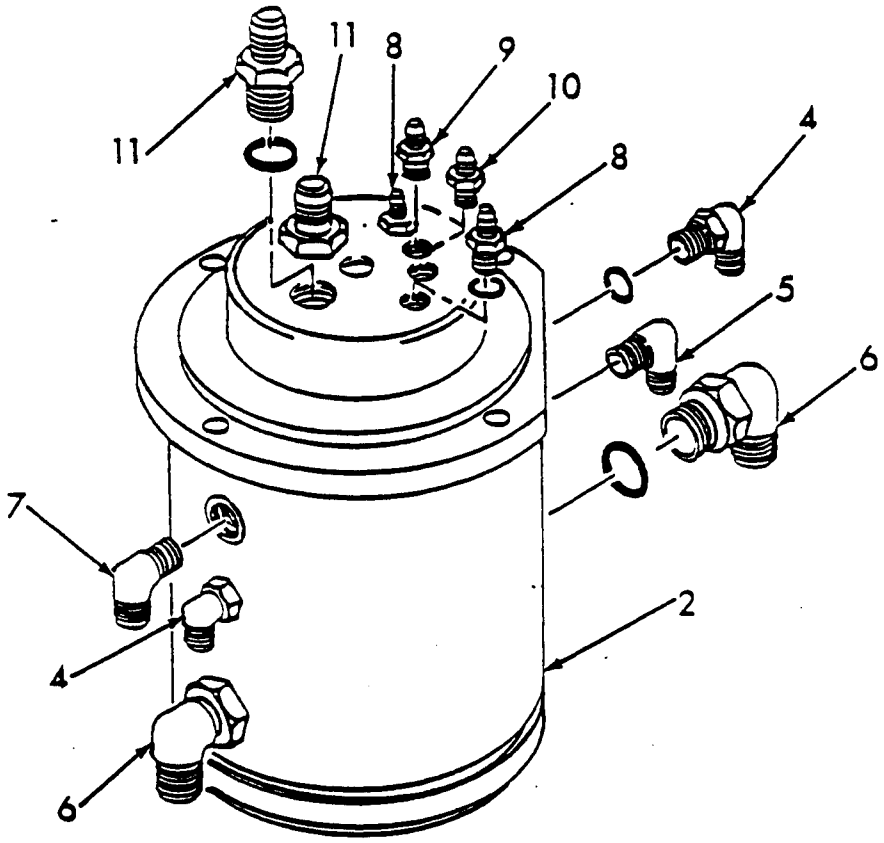
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22390	ASSEMBLY, EMERGENCY PUMP & MOTOR (See Sect. 4, Fig. 1 for NHA)	REF
-2	.20384	PUMP/MOTOR, EMERGENCY (JSB)	1
3	..66402	PUMP	1
-4	...67935	KIT, SEAL (JSB)	1
5	..66780	MOTOR	1
6	.80001-08	CONNECTOR, MALE	2

REV.

Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY
MODEL	42C
NOTES	UNTIL EARLY 1988

SECTION	4
FIGURE	13
PAGE	1



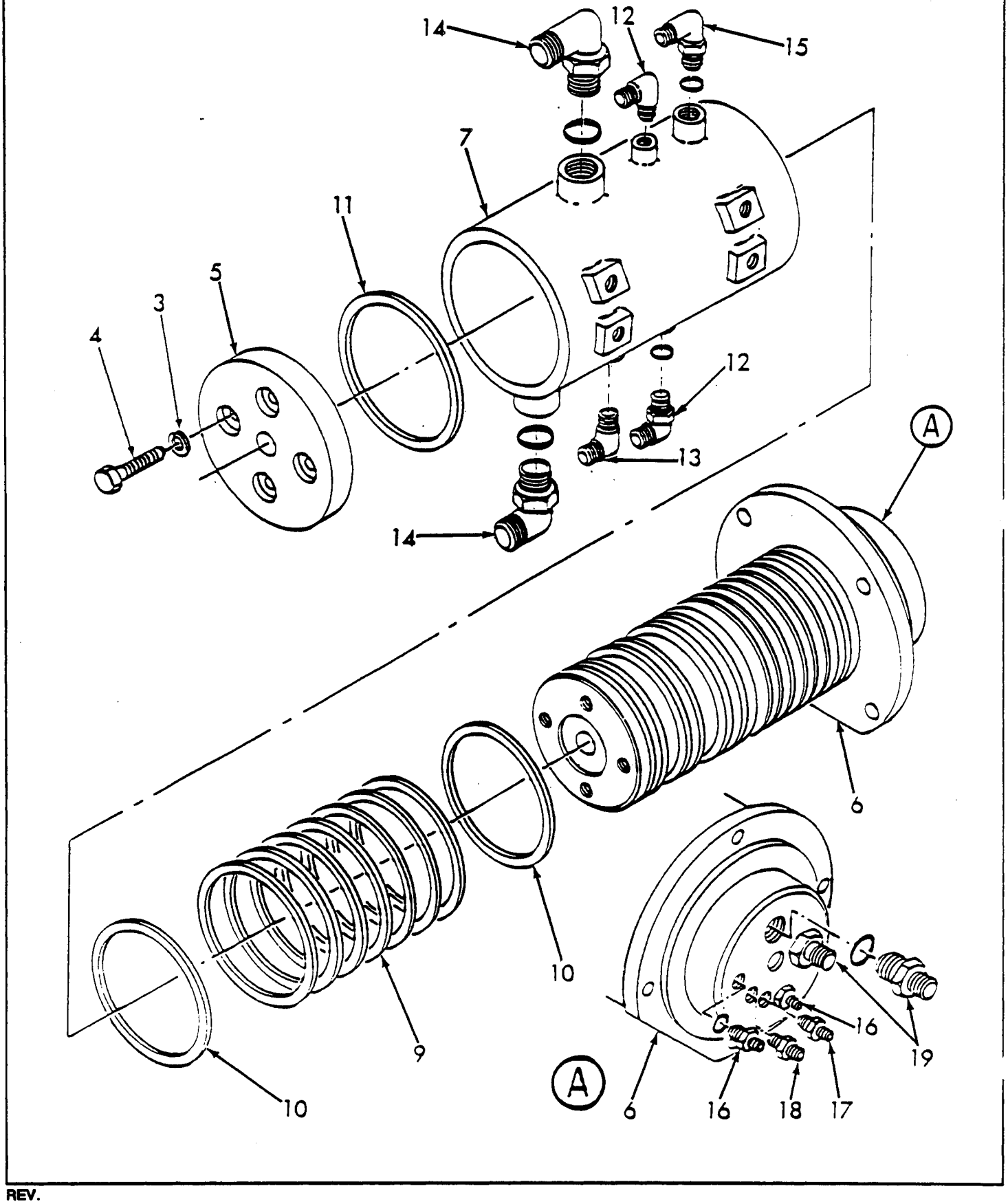
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21898	ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 1 for NHA)	REF
2	.21895	MANIFOLD, ROTARY (RA)	1
-3	..66561	KIT, SEAL (RA)	1
4	.80012-03	ELBOW, STRAIGHT THREAD	2
5	.80008-03	ELBOW, MALE	1
6	.80012-18	ELBOW, STRAIGHT THREAD	2
7	.80008-08	ELBOW, MALE	1
8	.80004-03	CONNECTOR, STRAIGHT THREAD	2
9	.80001-08	CONNECTOR, MALE	1
10	.80001-03	CONNECTOR, MALE	1
11	.80004-18	CONNECTOR, STRAIGHT THREAD	2

REV.

Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY
MODEL	42C
NOTES	EARLY 1988 UNTIL LATE 1989

SECTION	4
FIGURE	13A
PAGE	1



REV.

Mark Industries

TITLE	ROTARY MANIFOLD ASSEMBLY
MODEL	42C
NOTES	EARLY 1988 UNTILL LATE 1989

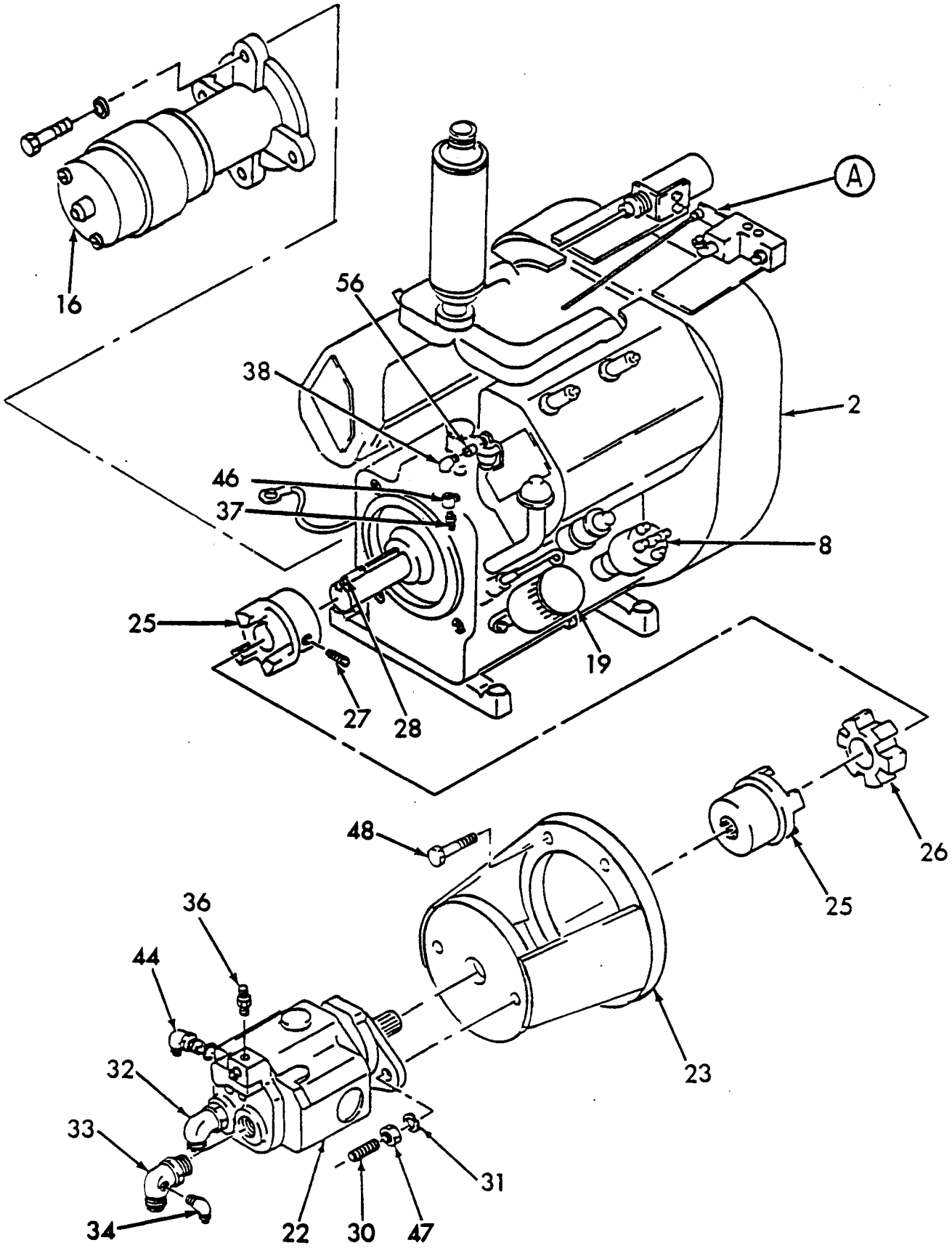
SECT.	4
FIG.	13A
PAGE	2

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

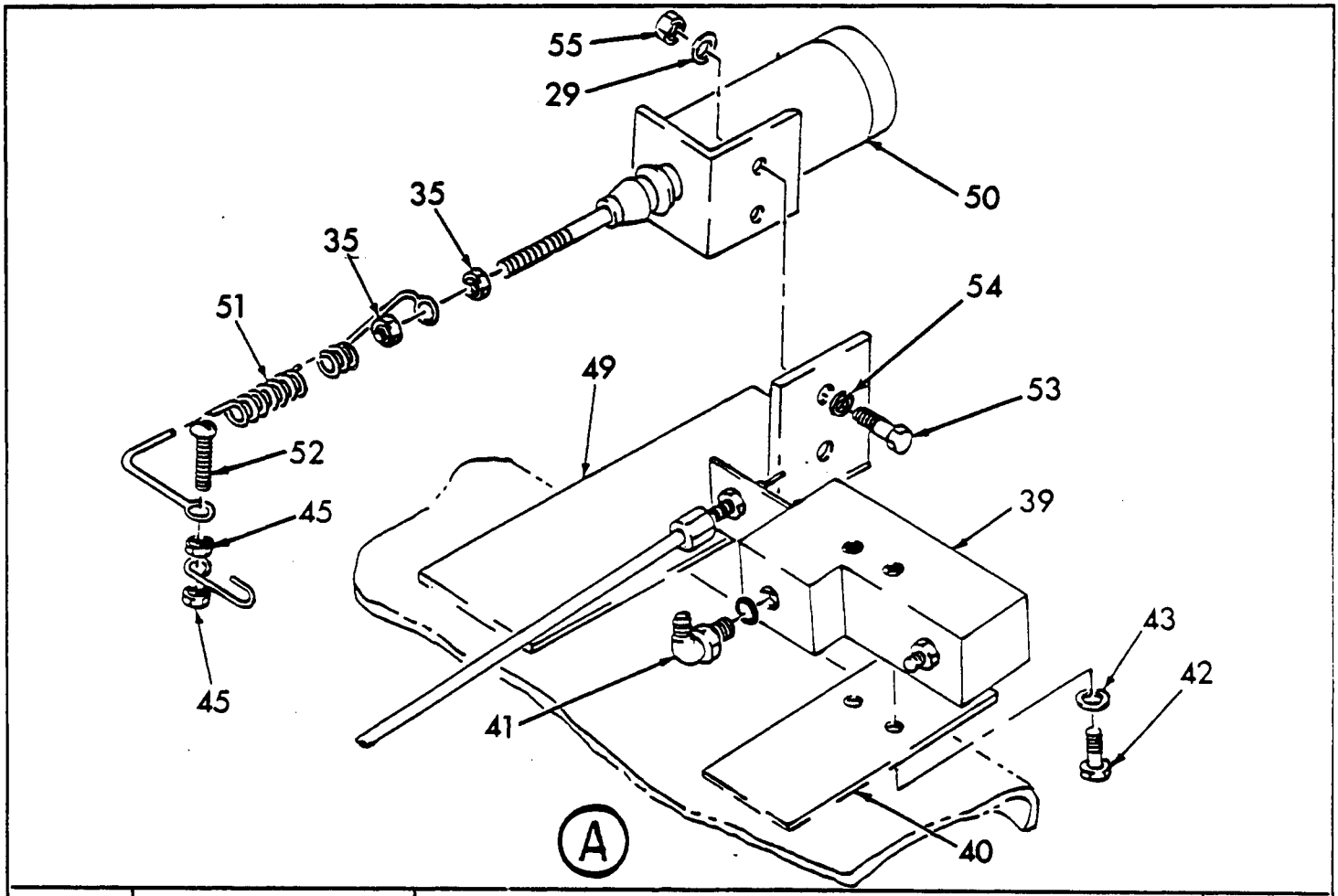
Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	

SECTION	4
FIGURE	14
PAGE	1



REV.



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22960	ASSEMBLY, ENGINE/PUMP (See Sect. 4, Fig. 1 for NHA)	REF
2	.21215	ENGINE (WISCONSIN VG4D) (See Vendor Chapter for Details)	1
-3	..67252	GASKET, OIL PAN	1
-4	..67253	SEAL, CRANK SHAFT	1
-5	..67255	COVER, VALVE INSPECTION	2
6	..67257	CARBURETOR	1
-7	...67258	KIT, CARBURETOR REPAIR	1
8	..67259	CAP, DISTRIBUTOR	1
-9	..67260	ROTOR, DISTRIBUTOR	1
-10	..67261	POINTS	1

Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY	SECT.	4
MODEL	42C	FIG.	14
NOTES		PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
11	..67262	PLUG, SPARK	4
12	..67263	DISTRIBUTOR	1
13	..67264	PUMP, FUEL	1
-14	...67298	KIT, FUEL PUMP REPAIR	1
-15	..67265	GASKET, FUEL PUMP	1
16	..67266	STARTER	1
17	..67267	SET, IGNITION WIRE	1
18	..67268	COIL	1
19	..65299	FILTER, OIL	1
20	.21389	MACHINING, PUMP ADAPTER	1
21	..21297	CASTING, PUMP ADAPTER	1
22	.20801	PUMP (See Vendor Chapter for Details)	1
-23	..66741	SEAL, SHAFT	1
-24	..21757	ASSEMBLY, PRESSURE FLOW COMPENSATOR	1
25	.21306	COUPLING, ENGINE PUMP DRIVE LINE	1
26	..20930	SPIDER, RUBBER	1
27	..62201	SCREW, SET	2
28	.25253	KEY	1
29	.63401	WASHER, FLAT	2
30	.63613	STUD	2
31	.63305	WASHER, LOCK	2
32	.80012-28	ELBOW, STRAIGHT THREAD	1
33	.20798	ELBOW, MODIFIED STRAIGHT THREAD	1
34	.80008-08	ELBOW, MALE	1
35	.60805	NUT, HEX	2

Mark Industries

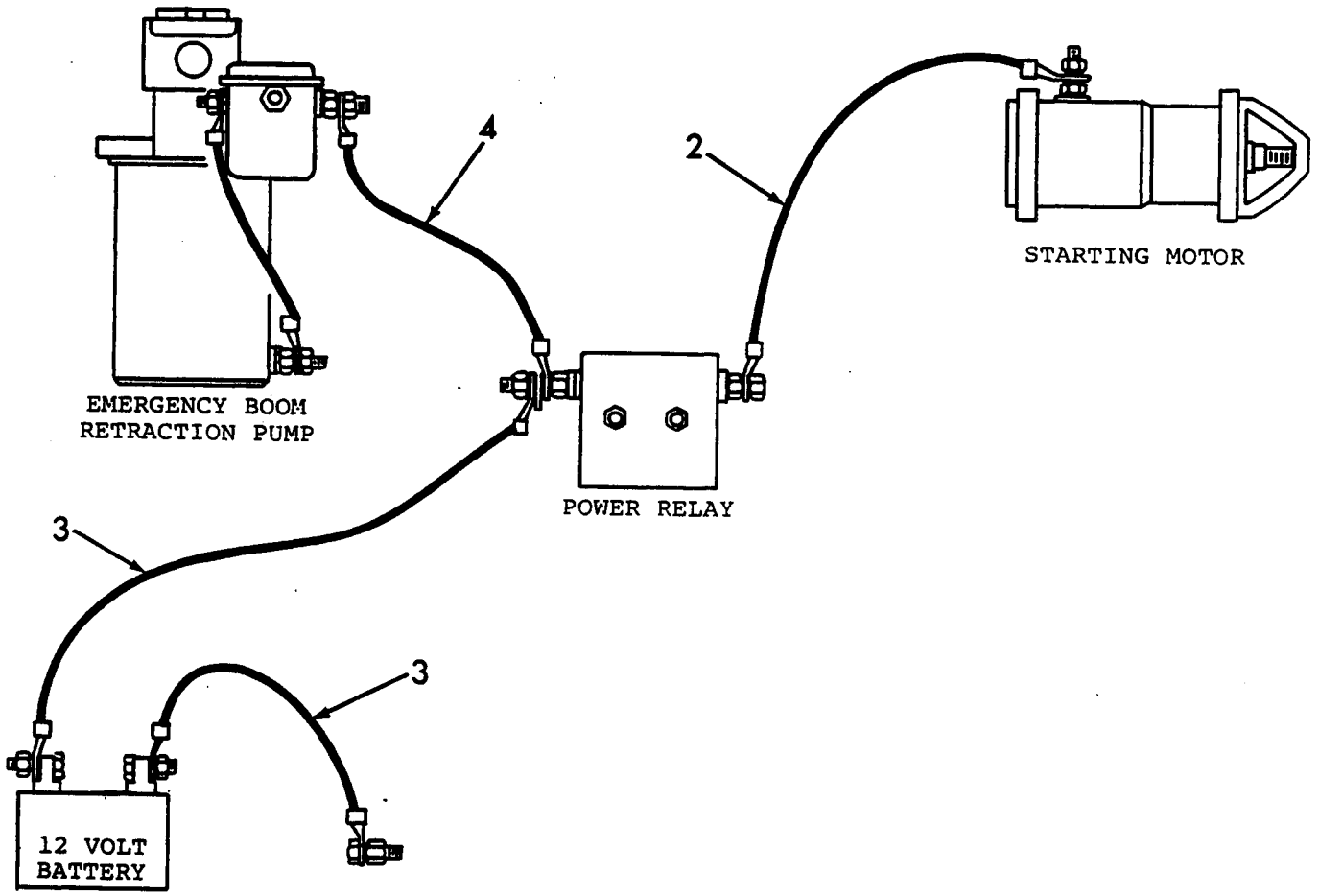
TITLE	ENGINE/PUMP ASSEMBLY	SECT. 4
MODEL	42C	FIG. 14
NOTES		PAGE 4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
36	.80004-03	CONNECTOR, STRAIGHT THREAD	1
37	.240	HOSE, BARB	1
38	.66196	ELBOW, STREET (WEATHERHEAD)	1
39	.20364	THROTTLE, HYDRAULIC	1
40	.20811	BRACKET, THROTTLE MOUNTING	1
41	.80010-04	ELBOW, MALE	1
42	.60404	SCREW, CAP	2
43	.63302	WASHER, LOCK	2
44	.80012-08	ELBOW, STRAIGHT THREAD	1
45	.61501	NUT, HEX	2
46	.20832	VALVE, FUEL SHUT OFF	1
47	.60705	NUT, HEX	2
48	.60604	SCREW, CAP	4
49	.21097	BRACKET, SYNCHRO START	1
50	.21777	SOLENOID, D.C.	1
51	.65199	SPRING, THROTTLE	1
52	.62609	SCREW, MACHINE	1
53	.60309	SCREW, CAP	2
54	.63301	WASHER, LOCK	2
55	.60701	NUT, HEX	2
56	.16550	NIPPLE, PIPE	1

Mark Industries

TITLE	BATTERY CABLE KIT
MODEL	42C
NOTES	

SECTION	4
FIGURE	15
PAGE	1



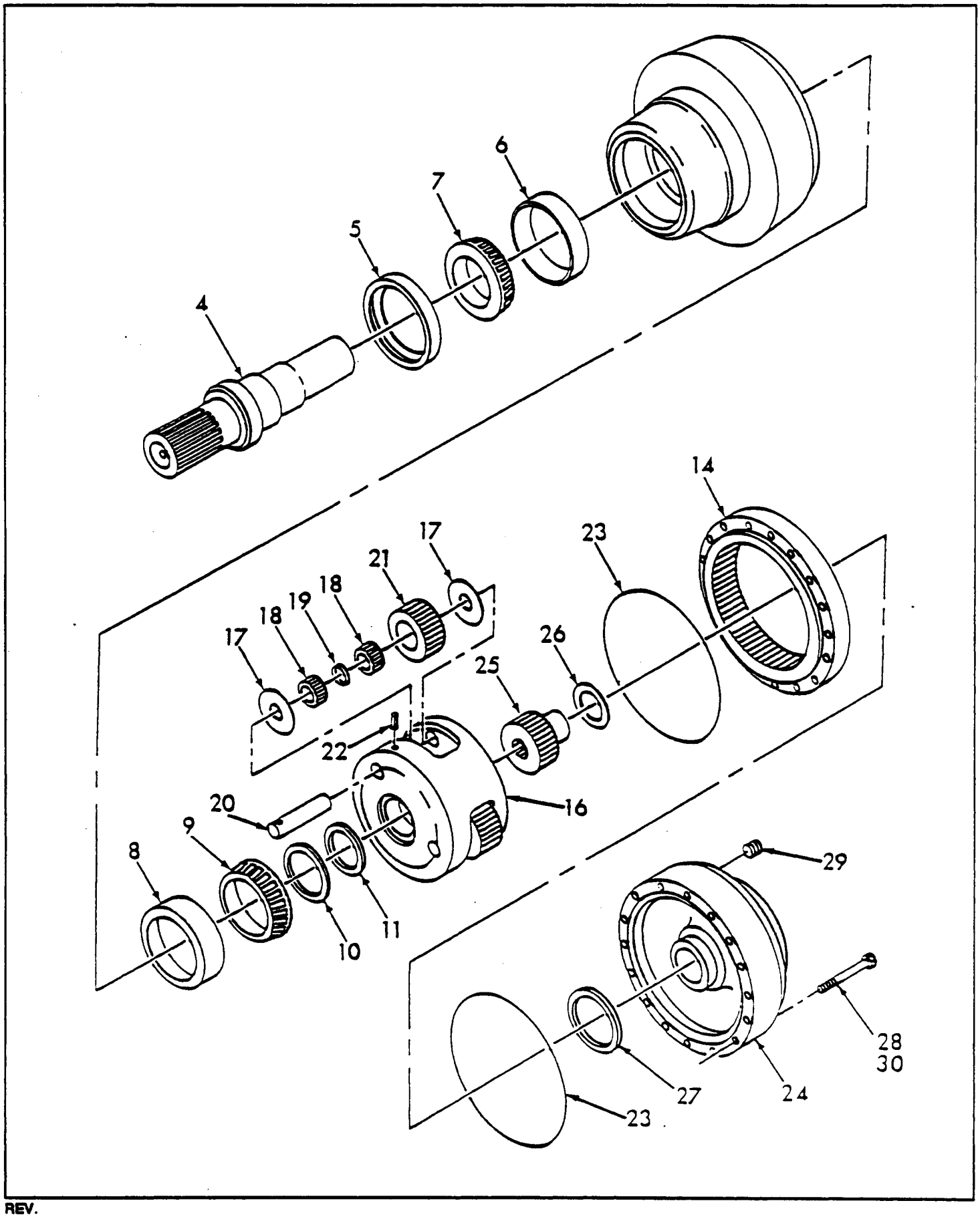
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20648	KIT, BATTERY CABLE (See Sect. 4, Fig. 1 for NHA)	REF
2	.13226-060	ASSEMBLY, ELECTRICAL CABLE (60")	1
3	.13226-018	ASSEMBLY, CABLE ELECTRICAL (18")	2
4	.13226-072	ASSEMBLY, CABLE ELECTRICAL (72")	1

REV.

Mark Industries

TITLE	TORQUE HUB ASSEMBLY
MODEL	42C
NOTES	ROTATION GEARBOX

SECTION	4
FIGURE	16
PAGE	1



REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22830	HUB, TORQUE (See Sect. 4, Fig. 8 for NHA) (See Vendor Chapter for Details)	REF
-2	.600220	KIT, SEAL	1
-3	.	SUB-ASSEMBLY, HUB/SPINDLE	1
4	..67877	SHAFT, OUTPUT	1
*5	..	SEAL	1
6	..67917	CUP, BEARING	1
7	..67924	CONE, BEARING	1
8	..67915	CUP, BEARING	1
9	..67923	CONE, BEARING	1
10	..67911	SPACER	1
*11	..	RING, RETAINING	1
-12	..	PLUG, PIPE	3
-13	..	PLUG, PIPE	1
14	.	GEAR, RING	1
-15	.	SUB-ASSEMBLY, CARRIER	1
16	..	CARRIER	1
17	..67898	WASHER, THRUST	6
18	..67918	ROLLER, NEEDLE	96
19	..67907	SPACER	3
20	..	SHAFT, PLANET	3
21	..	GEAR, PLANET	3
-22	..	PIN, ROLL	3
*23	.	O-RING	2
		NOTE: ASTERISK (*) INDICATES THE ITEM IS INCLUDED IN THE SEAL KIT.	

Mark Industries

TITLE	TORQUE HUB
MODEL	42C
NOTES	ROTATION GEARBOX

SECT.	4
FIG.	16
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.	COVER	1
25	.67882	GEAR, INPUT	1
26	.67899	WASHER, THRUST	1
*27	.	WASHER, THRUST	1
28	.66427	BOLT	8
29	.	PLUG, PIPE	1
30	.66426	BOLT, SHOULDER	4

NOTE: ASTERISK (*) INDICATES THE ITEM IS INCLUDED IN THE SEAL KIT.

SECTION 5 CONTAINS:

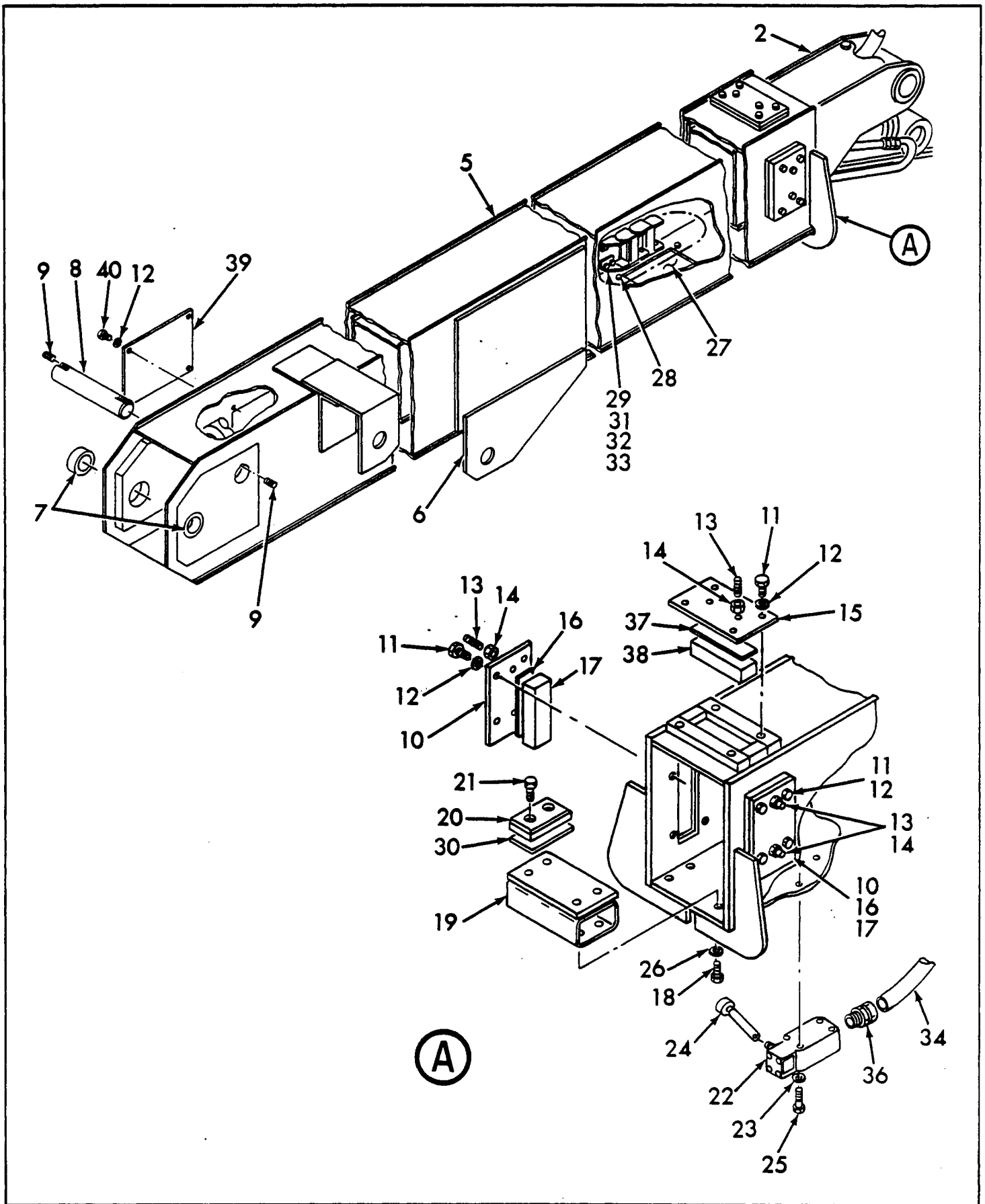
FIG. NO.	TITLE
* 1	FINAL BOOM ASSEMBLY (UNTIL LATE 1988)
* 1A	FINAL BOOM ASSEMBLY (SINCE LATE 1988)
* 2	INNER BOOM ASSEMBLY (UNTIL LATE 1988)
* 2A	INNER BOOM ASSEMBLY (SINCE LATE 1988)
3	SLAVE LEVELING CYLINDER (UNTIL LATE 1989)
3A	SLAVE LEVELING CYLINDER (SINCE LATE 1989)
4	EXTENSION CYLINDER (SINCE EARLY 1986; CONCURRENT USE)
4A	EXTENSION CYLINDER (SINCE EARLY 1990; CONCURRENT USE)
4B	EXTENSION CYLINDER (SINCE EARLY 1989)

*SEE OPTION SECTION FOR OTHER VARIATION(S).

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1988

SECTION	5
FIGURE	1
PAGE	1



REV.

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1988

SECT.	5
FIG.	1
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23072	ASSEMBLY, FINAL BOOM (See Sect. 4, Fig. 1 for NHA)	REF
2	.23073	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 2 for Details)	1
-3	.23068	MACHINING, OUTER BOOM	1
-4	..23067	WELDMENT, OUTER BOOM	1
5	...23066	BOOM, OUTER SECTION	1
6	...23074	WELDMENT, LIFT CYLINDER	1
7	..21782	BUSHING, BOOM PIVOT	2
8	.23163	PIN, EXTENSION CYLINDER	1
9	.62203	SCREW, SET	2
10	.23158	COVER, PRESSURE PAD	2
11	.60338	SCREW, CAP	12
12	.63302	WASHER, LOCK	16
13	.62204	SCREW, SET	6
14	.61101	NUT, JAM	6
15	.23159	COVER, PRESSURE PAD	1
16	.22372	PLATE, PRESSURE PAD	2
17	.23160	PAD, WEAR	2
18	.60325	SCREW, CAP	4
19	.23161	BRACKET, BOOM END	1
20	.23162	PAD, WEAR	2
21	.61805	SCREW, CAP	4
22	.70107	SWITCH, LIMIT	1
23	.63313	WASHER, LOCK	2
24	.70148	SWITCH, ARM LEVER	1

Mark Industries

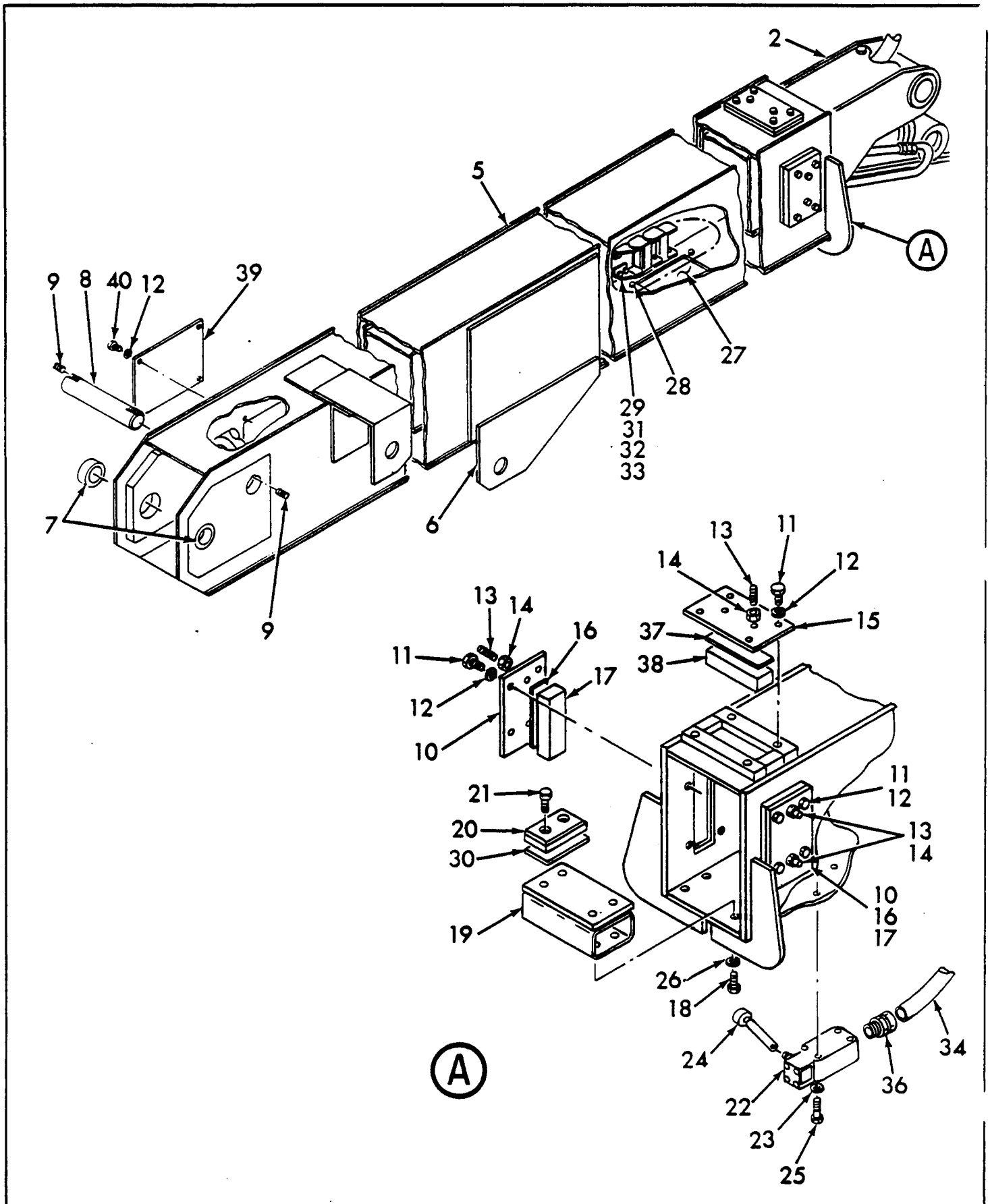
TITLE	FINAL BOOM ASSEMBLY	SECT. 5
MODEL	42C	FIG. 1
NOTES	UNTIL LATE 1988	PAGE 3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.62615	SCREW, MACHINE	2
26	.63303	WASHER, LOCK	4
27	.22373	COVER, ACCESS	1
28	.60322	SCREW, CAP	4
29	.23875	BRACKET, STATIONARY (MALE)	1
30	.21278	SHIM, WEAR PAD	2
31	.60501	SCREW, CAP	2
32	.61312	NUT, SELF LOCK	2
33	.63401	WASHER, FLAT	2
34	.2768-340	CABLE, ELECTRICAL	1
35	..2768	CABLE	28.3 FT
36	.2806	RELIEF, STRAIN	1
37	.23164	PLATE, PAD PRESSURE	1
38	.23165	PAD, WEAR	1
39	.23515	COVER, DOUBLER PLATE	1
40	.60324	SCREW, CAP	4
-41	60343	SCREW, CAP	4
-42	24150	WELDMENT	1

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1988

SECTION	5
FIGURE	1A
PAGE	1



REV.

Mark Industries

TITLE	FINAL BOOM ASSEMBLY	SECT. 5
MODEL	42C	FIG. 1A
NOTES	SINCE LATE 1988	PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24457	ASSEMBLY, FINAL BOOM (See Sect. 4, Fig. 1 for NHA)	REF
2	.24458	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 2A for Details)	1
-3	.24461	MACHINING, OUTER BOOM	1
-4	..24460	WELDMENT, OUTER BOOM	1
5	...24459	BOOM, OUTER SECTION	1
6	...23074	WELDMENT, LIFT CYLINDER	1
7	..21782	BUSHING, BOOM PIVOT	2
8	.23163	PIN, EXTENSION CYLINDER	1
9	.62209	SCREW, SET	2
10	.23158	COVER, PRESSURE PAD	2
11	.60338	SCREW, CAP	12
12	.63302	WASHER, LOCK	20
13	.62204	SCREW, SET	6
14	.61101	NUT, JAM	6
15	.23159	COVER, PRESSURE PAD	1
16	.24470	PLATE, PAD PRESSURE	1
17	.24471	PAD, WEAR	2
18	.60325	SCREW, CAP	4
19	.23161	BRACKET, BOOM END	1
20	.23162	PAD, WEAR	2
21	.61805	SCREW, CAP	4
22	.70107	SWITCH, LIMIT	1
23	.63313	WASHER, LOCK	2
24	.70148	SWITCH, ARM LEVER	1

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1988

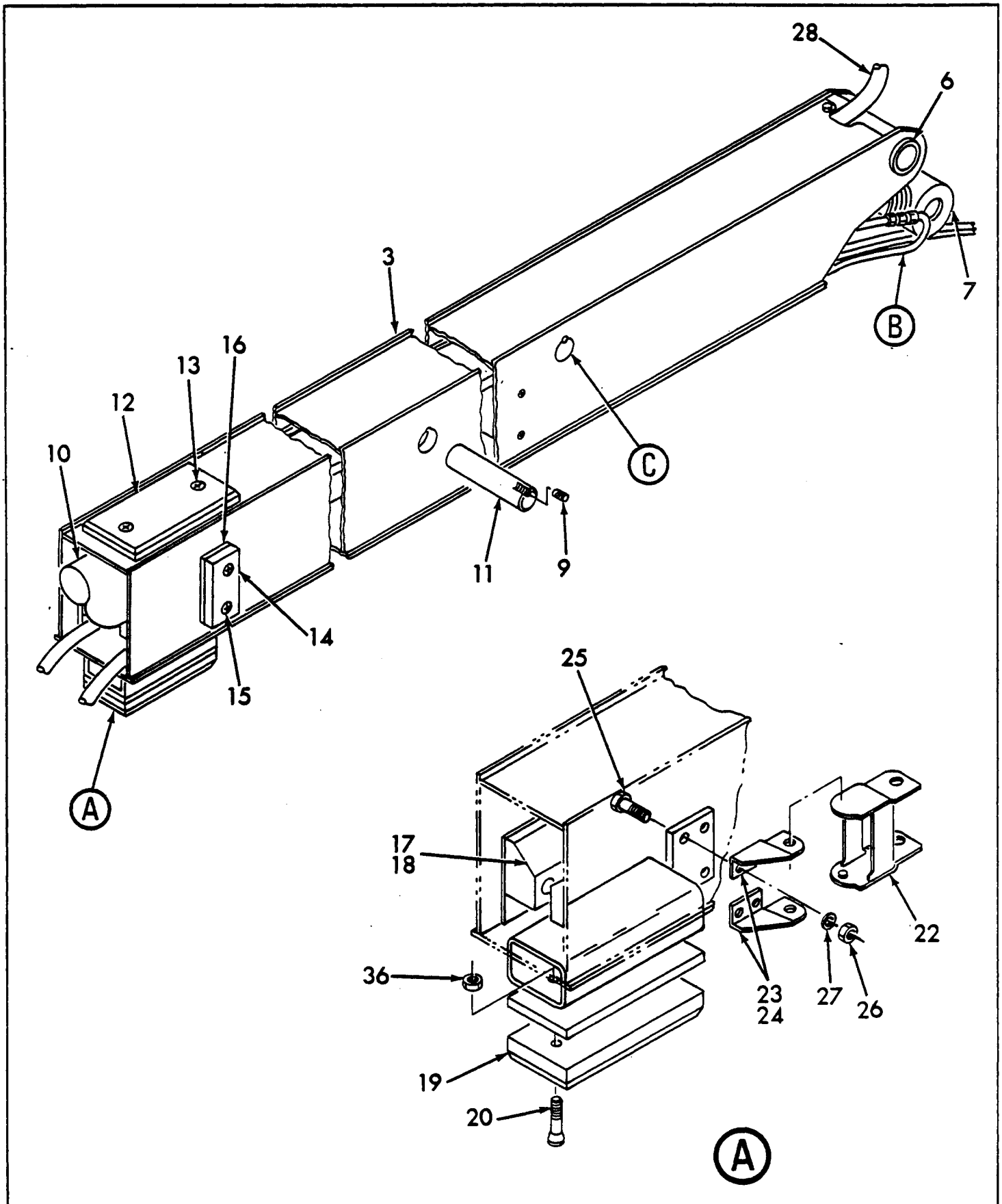
SECT.	5
FIG.	1A
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.62615	SCREW, MACHINE	2
26	.63303	WASHER, LOCK	4
27	.24472	COVER, ACCESS	1
28	.60322	SCREW, CAP	4
29	.23875	BRACKET, STATIONARY (MALE)	1
30	.21278	SHIM, WEAR PAD	2
31	.60501	SCREW, CAP	2
32	.61312	NUT, SELF LOCK	2
33	.63401	WASHER, FLAT	2
34	.2768-340	CABLE, ELECTRICAL	1
35	..2768	CABLE	28.3 FT
36	.2806	RELIEF, STRAIN	1
37	.23164	PLATE, PAD PRESSURE	1
38	.210239	PAD, WEAR	1
39	.23515	COVER, DOUBLER PLATE	1
40	.60324	SCREW, CAP	4
41	60343	SCREW, CAP	4
42	24150	WELDMENT	1

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1988

SECTION	5
FIGURE	2
PAGE	1

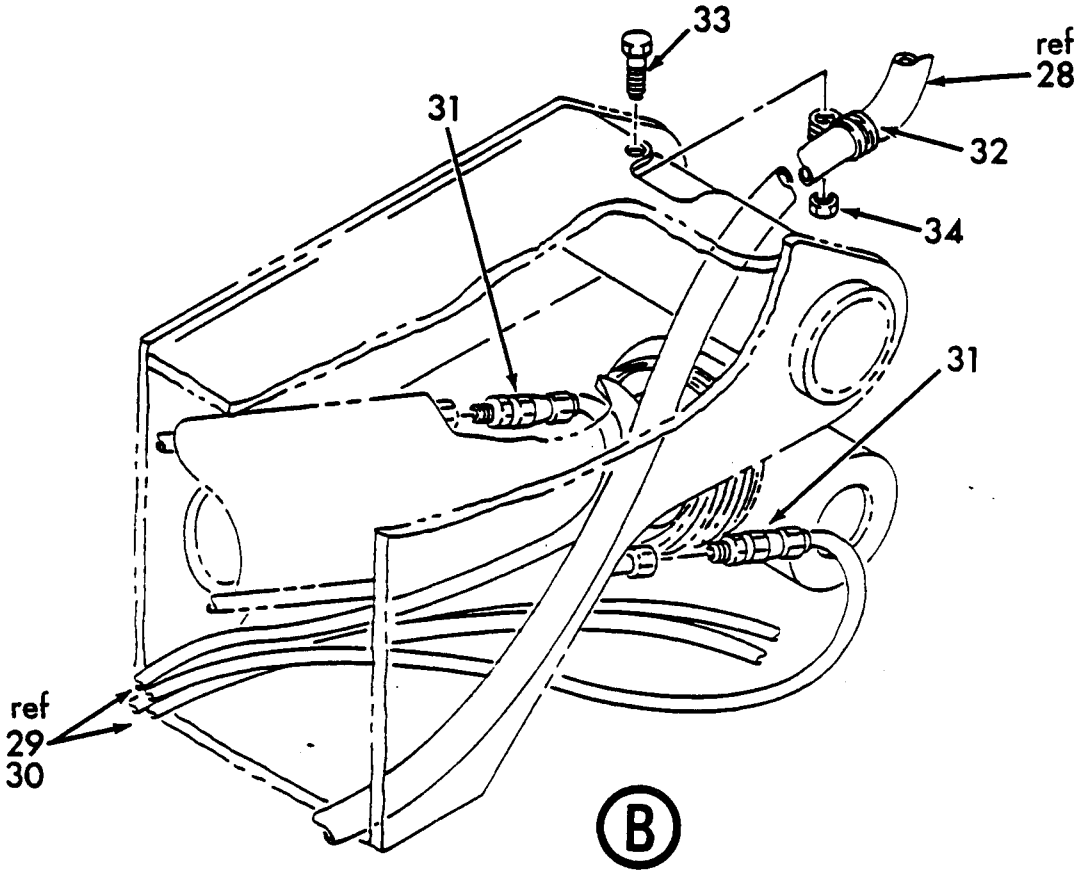


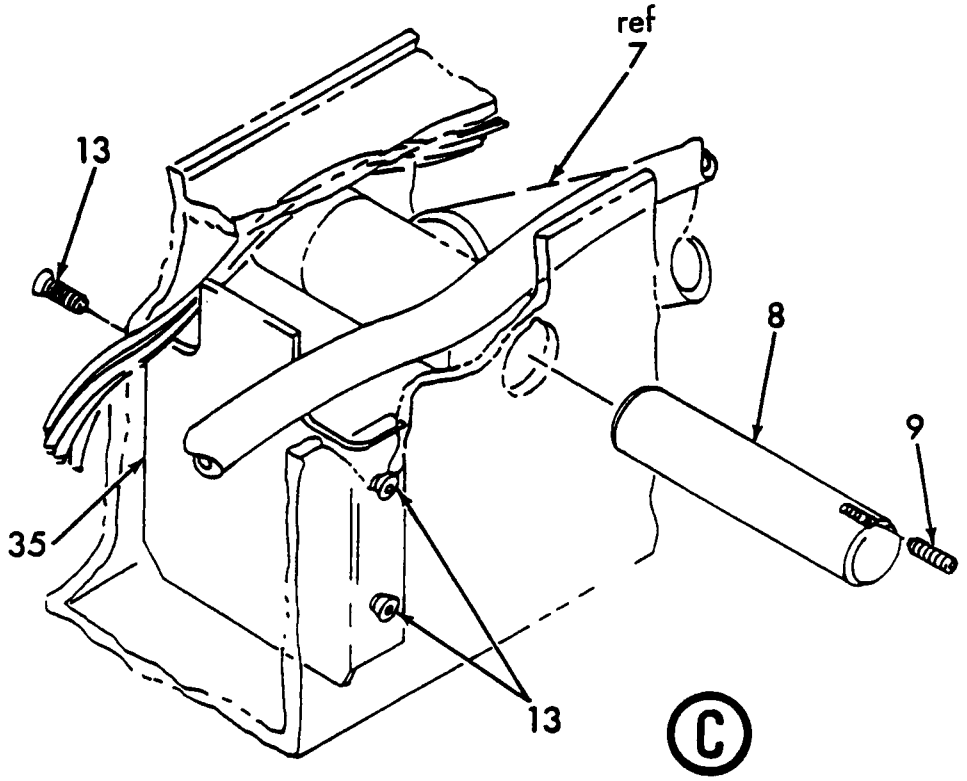
REV.

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1988

SECTION	5
FIGURE	2
PAGE	2





REV.

Mark Industries

TITLE	INNER BOOM ASSEMBLY	SECT.	5
MODEL	42C	FIG.	2
NOTES	UNTIL LATE 1988	PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23073	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 1 for NHA)	REF
-2	.23071	MACHINING, INNER BOOM	1
3	..23070	WELDMENT, INNER BOOM	1
4	...23069	BOOM, INNER SECTION	1
5	...23022	DOUBLER	2
6	..20582	BUSHING	2
7	.23550	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 3 or 3A for Details)	1
8	.23084	PIN, SLAVE LEVELING CYLINDER	1
9	.62203	SCREW, SET	2
10	.23185	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig.4,4A or 4B for Details)	1
11	.23156	PIN, EXTENSION CYLINDER	1
12	.23157	PAD, WEAR	1
13	.61822	SCREW, CAP	6
14	.22567	PAD, WEAR	2
15	.61801	SCREW, CAP	4
16	.21278	SHIM, WEAR PAD	2
17	.23151	PAD, WEAR	2
18	.61802	SCREW, CAP	4
19	.23150	PAD, WEAR	1
20	.61805	SCREW, CAP	2
-21	.22804	ASSEMBLY, MARK TRACK	1
22	..21933	MARK TRACK	59
23	.22587	BRACKET, MOVABLE (R.H.)	1
24	.22588	BRACKET, MOVABLE (L.H.)	1

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	UNTIL LATE 1988

SECT.	5
FIG.	2
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.60501	SCREW, CAP	4
26	.61312	NUT	4
27	.63401	WASHER, FLAT	4
28	.20802-792	CABLE, ELECTRICAL (40 CONDUCTOR)	1
29	.2568-840	HOSE, HYDRAULIC	4
30	..2568	HOSE, PARAFLEX	280 FT
31	.65133	FITTING, HOSE (FEMALE)	2
32	.16268	CLAMP, HOSE	2
33	.60309	SCREW, CAP	2
34	.60711	NUT, HEX	2
35	.23166	WELDMENT, BULKHEAD PLAT	1
36	.61302	NUT, HEX	2

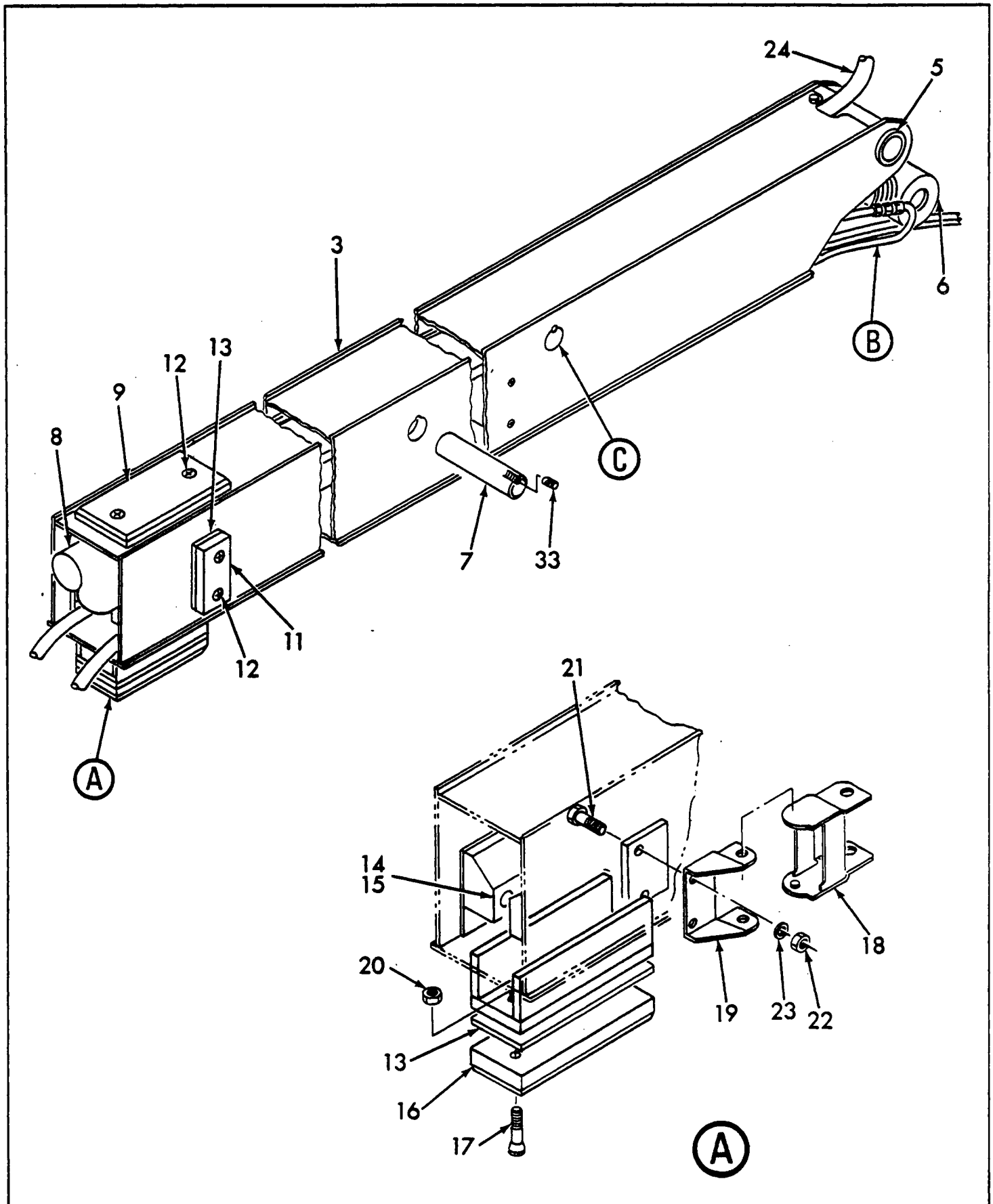
REV.

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

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1988

SECTION	5
FIGURE	2A
PAGE	1

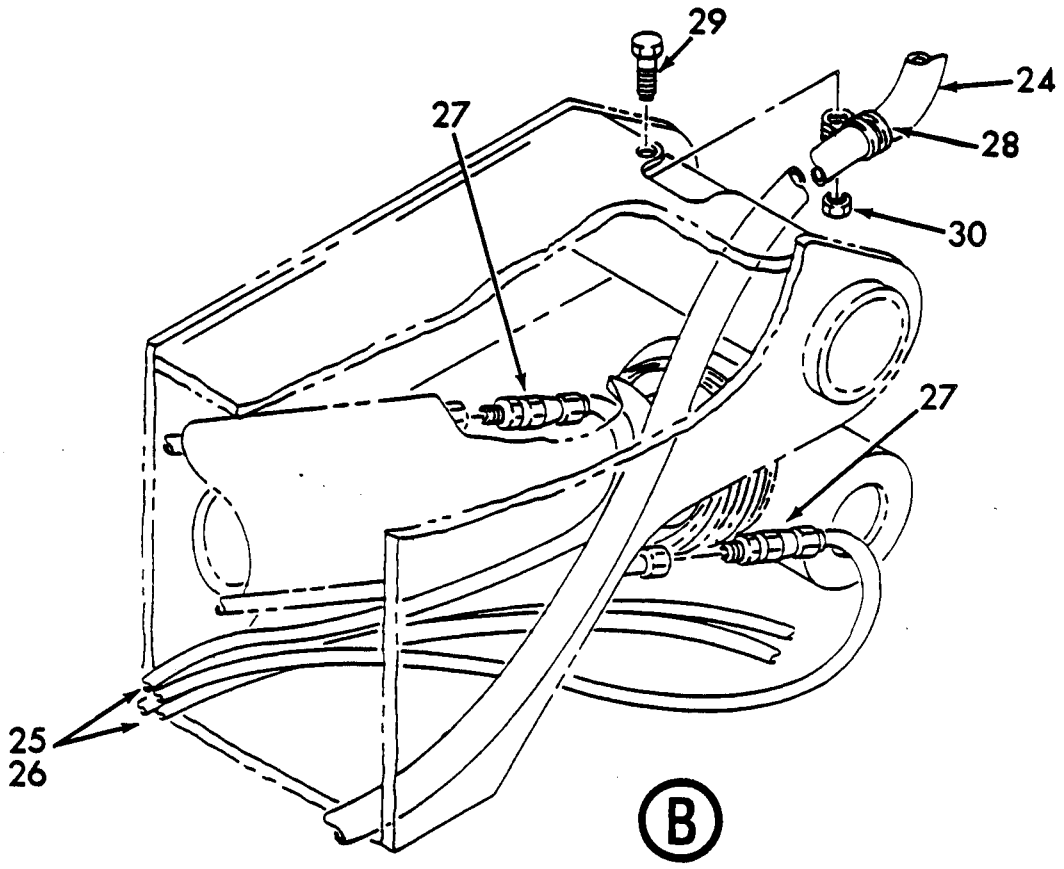


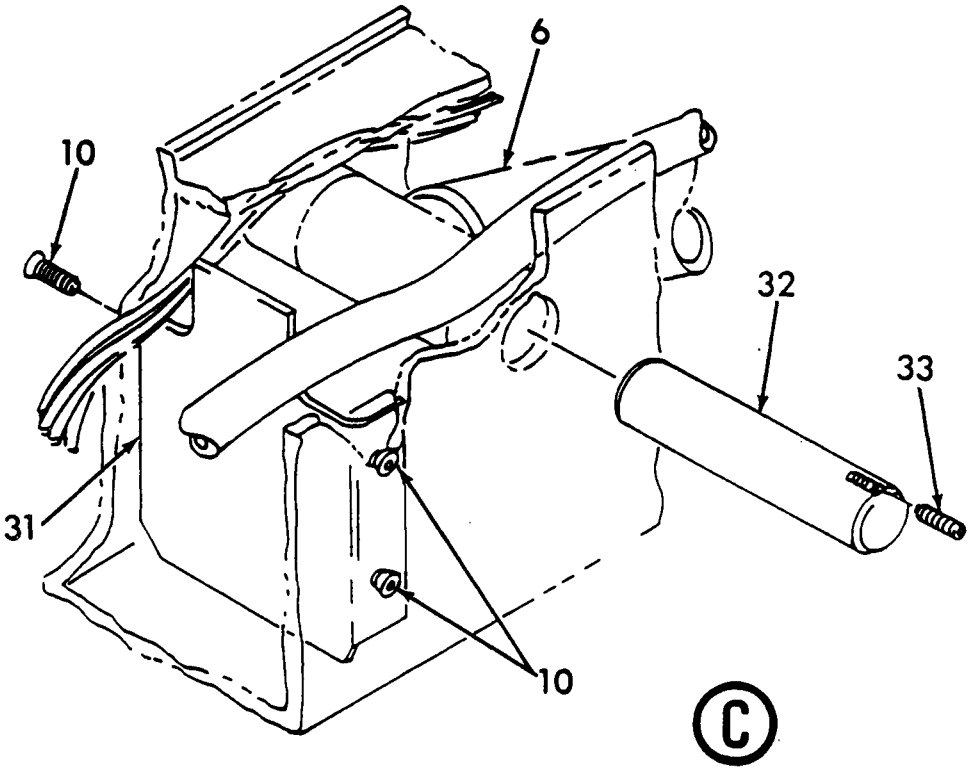
REV.

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1988

SECTION	5
FIGURE	2A
PAGE	2





REV.

Mark Industries

TITLE	INNER BOOM ASSEMBLY	SECT.	5
MODEL	42C	FIG.	2A
NOTES	SINCE LATE 1988	PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24458	ASSEMBLY, INNER BOOM (See Sect. 5, Fig. 1A for NHA)	REF
-2	.24463	MACHINING, INNER BOOM	1
3	..24462	WELDMENT, INNER BOOM	1
4	...24467	WELDMENT, PAD SUPPORT	1
5	..20582	BUSHING	2
6	.23550	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 3 or 3A for Details)	1
7	.23156	PIN, EXTENSION CYLINDER	1
8	23185	ASSEMBLY, EXTENSION CYLINDER	1
9	.24804	PAD, WEAR	1
10	.61822	SCREW, CAP	6
11	.22567	PAD, WEAR	2
12	.61801	SCREW, CAP	4
13	.24501	SHIM, WEAR PAD	1
14	.23151	PAD, WEAR	2
15	.61802	SCREW, CAP	4
16	.24469	PAD, WEAR	1
17	.61805	SCREW, CAP	3
18	.23824	TRACK, POWER	59
19	.23874	BRACKET, MOVABLE (FEMALE)	1
20	.61302	NUT, HEX	2
21	.60501	SCREW, CAP	2
22	.61312	NUT	2
23	.63401	WASHER, FLAT	2
24	.70528	CABLE, 40 CONDUCTOR (WITH BRAIDING)	66 FT

Mark Industries

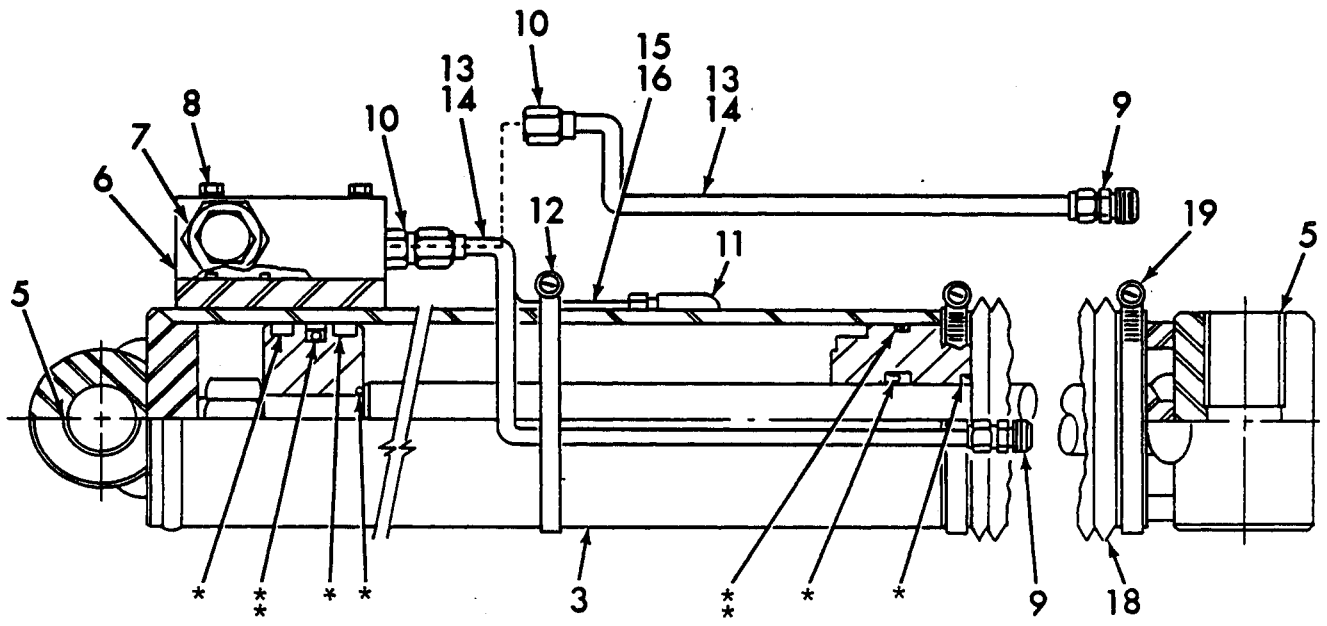
TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1988

SECT.	5
FIG.	2A
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.2568-840	HOSE, HYDRAULIC	4
26	..2568	HOSE, PARAFLEX	280 FT
27	.65133	FITTING, HSOE (FEMALE)	2
28	.16268	CLAMP, HOSE	2
29	.60309	SCREW, CAP	2
30	.60711	NUT, HEX	2
31	.23166	WELDMENT, BULKHEAD PLATE	1
32	.23084	PIN, SLAVE LEVELING CYLINDER	1
33	.62229	SCREW, SET	4

REV.

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



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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23550	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 2 or 2A for NHA)	REF
-2	.22576	SUB-ASSEMBLY, SLAVE LEVELING CYLINDER (SE)	1
3	..22574	CYLINDER, SLAVE LEVELING	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...67053	KIT, SEAL (W/POLYPAK; NOT SHOWN)(SE)	1
	...67029	KIT, SEAL (W/STEEL PISTON RINGS)(SE) (UNTIL MID 1989)	1
	...66553	KIT, SEAL (NOT SHOWN)(RA)(UNTIL EARLY 1987)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...66468	BUSHING (SE)	4
6	..21447	MANIFOLD, SLAVE LEVELING CYLINDER	1
7	..21267	CARTRIDGE, OVERCENTER	2

Mark Industries

TITLE	SLAVE LEVELING CYLINDER ASSEMBLY
MODEL	42C
NOTES	UNTIL MID 1989

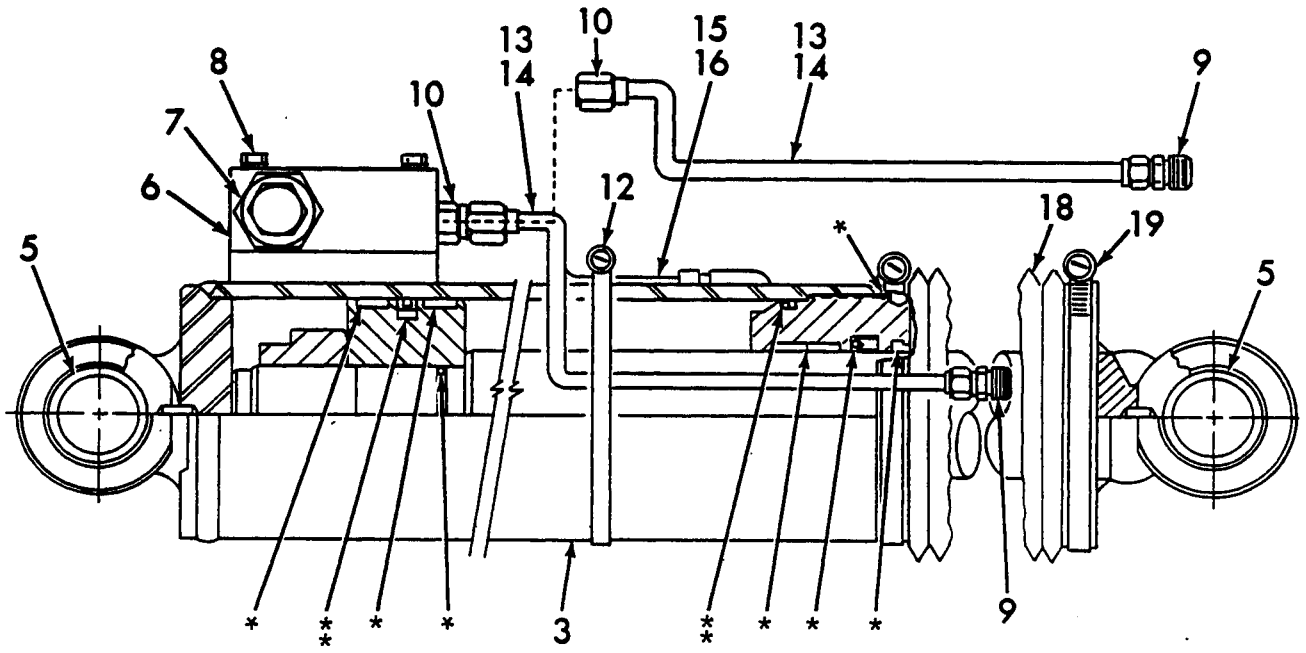
SECT.	5
FIG.	3
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
8	..61903	SCREW, CAP	3
9	.80042-03	CONNECTOR, UNION	2
10	.80004-03	CONNECTOR, STRAIGHT THREAD	3
11	.80012-03	ELBOW, STRAIGHT THREAD	1
12	.16206	STRAP	1
13	.23550-6	ASSEMBLY, TUBE	2
14	..80060-03	NUT	4
15	.23550-7	ASSEMBLY, TUBE	1
16	..80062-03	SLEEVE	2
17	..80060-03	NUT	2
18	.23513	TUBING, CONVOLUTED (WITH ZIPPER)	1
19	.65416	CLAMP, HOSE	2

Mark Industries

TITLE	SLAVE LEVELING CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE MID 1989

SECTION	5
FIGURE	3A
PAGE	1



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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23550	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 2 or 2A for NHA)	REF
-2	.22576	SUB-ASSEMBLY, SLAVE LEVELING CYLINDER (TH)	1
3	..22574	CYLINDER, SLAVE LEVELING	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...600326	KIT, SEAL (TH)(SINCE MID 1989)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...600418	BUSHING	4
6	..21447	MANIFOLD, SLAVE LEVELING CYLINDER	1
7	..21267	CARTRIDGE, OVERCENTER	2
8	..61903	SCREW, CAP	3

Mark Industries

TITLE	SLAVE LEVELING CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE MID 1989

SECT.	5
FIG.	3A
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
9	.80042-03	CONNECTOR, UNION	2
10	.80004-03	CONNECTOR, STRAIGHT	3
11	.80012-03	ELBOW, STRAIGHT	1
12	.65111	STRAP	1
13	.23550-6	ASSEMBLY, TUBE	2
14	..80060-03	NUT	4
15	.23550-7	ASSEMBLY, TUBE	1
16	..80060-03	NUT	2
17	.23513	TUBING, CONVOLUTED (WITH ZIPPER)	1
18	.65416	CLAMP, HOSE	2
19	.160223	CAP, PLUG	3

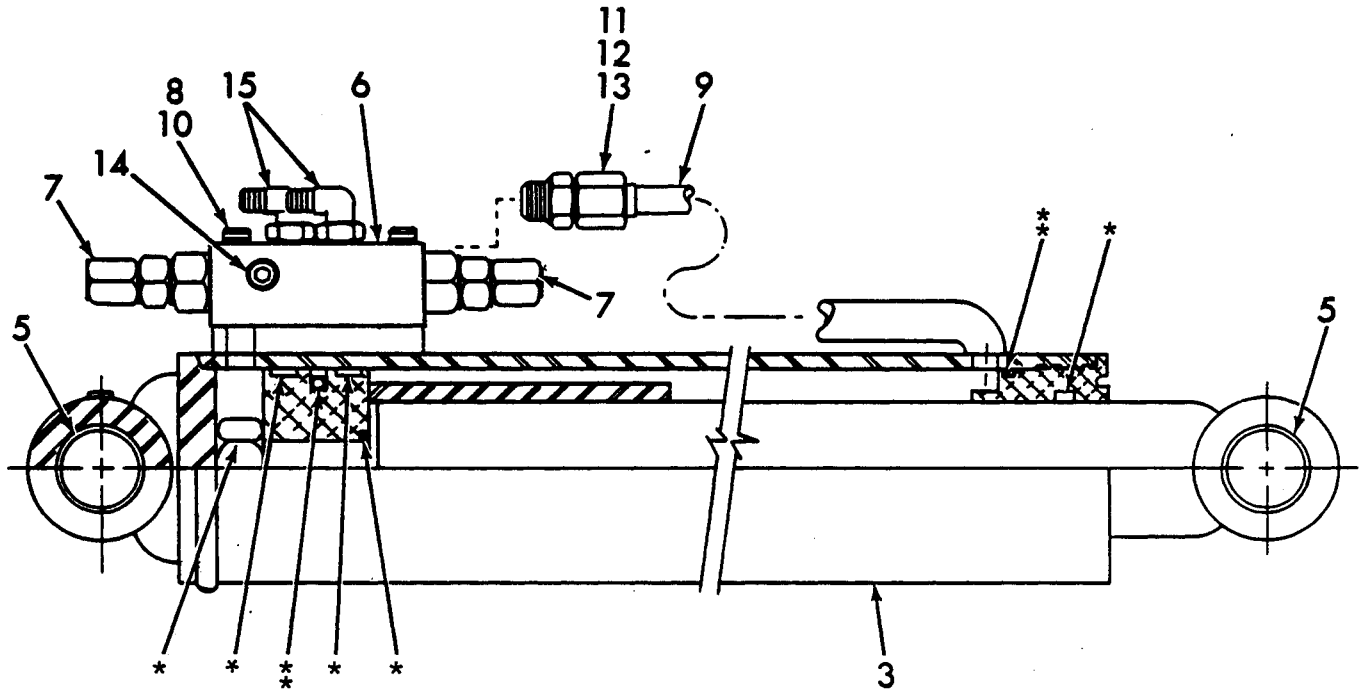
REV.

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

Mark Industries

TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE EARLY 1986; CONCURRENT USE

SECTION	5
FIGURE	4
PAGE	1



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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23185	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig. 2 or 2A for NHA)	REF
-2	.23186	SUB-ASSEMBLY, EXTENSION CYLINDER (SE)	1
3	..23187	CYLINDER, BOOM EXTENSION (SE)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...67047	KIT, SEAL (SE)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...67180	BUSHING	4
6	..22820	BLOCK, MANIFOLD	1
7	..81006	CARTRIDGE, OVERCENTER	2
8	..61947	SCREW, CAP	4

REV.

Mark Industries

TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE EARLY 1986; CONCURRENT USE

SECT.	5
FIG.	4
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
9	..25990	TUBE, HYDRAULIC	1
10	..63302	WASHER, LOCK	4
11	..80004-11	CONNECTOR, STRAIGHT THREAD	1
12	..80060-06	NUT	1
13	..80062-06	SLEEVE	1
14	..80051-03	PLUG, STRAIGHT THREAD	1
15	.80012-11	ELBOW, STRAIGHT THREAD	2

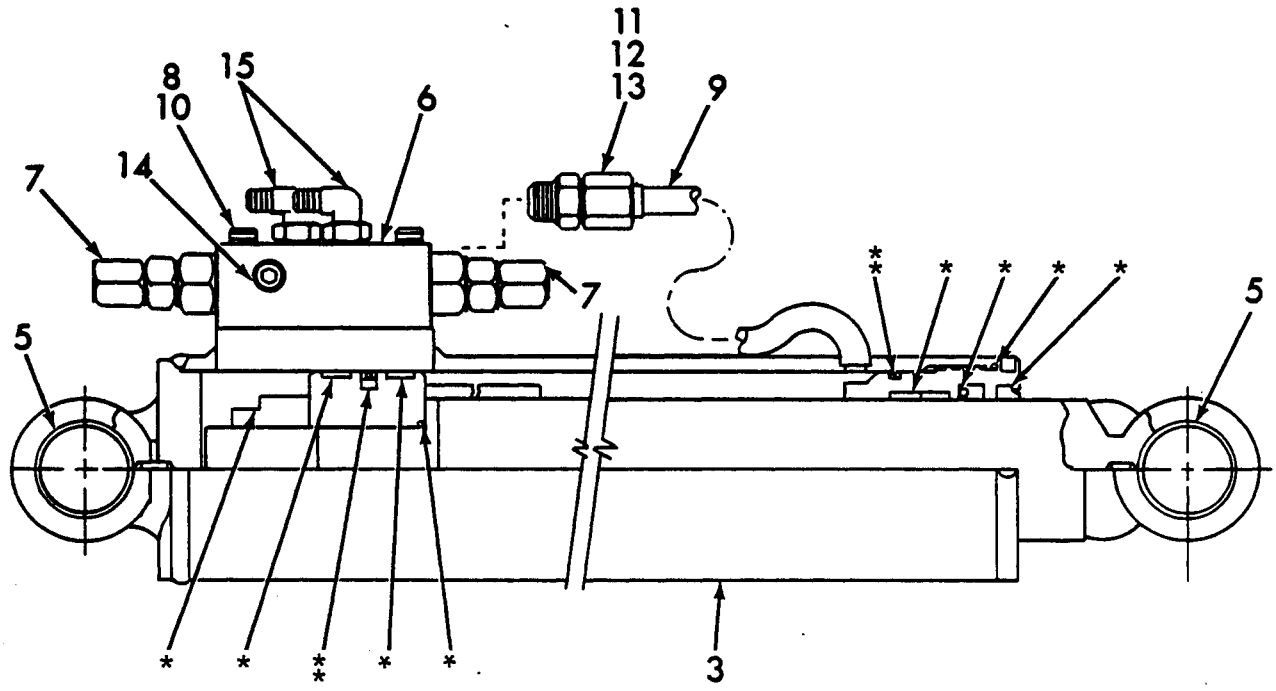
REV.

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

Mark Industries

TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE EARLY 1990; CONCURRENT USE

SECTION	5
FIGURE	4A
PAGE	1



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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23185	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig. 2 or 2A for NHA)	REF
-2	.23186	SUB-ASSEMBLY, EXTENSION CYLINDER	1
3	..23187	CYLINDER, BOOM EXTENSION (TH)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...68011	KIT, SEAL (TH)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...600419	BUSHING	4
6	..22820	BLOCK, MANIFOLD	1
7	..81006	CARTRIDGE, OVERCENTER	2
8	..61947	SCREW, CAP	4

REV.

Mark Industries

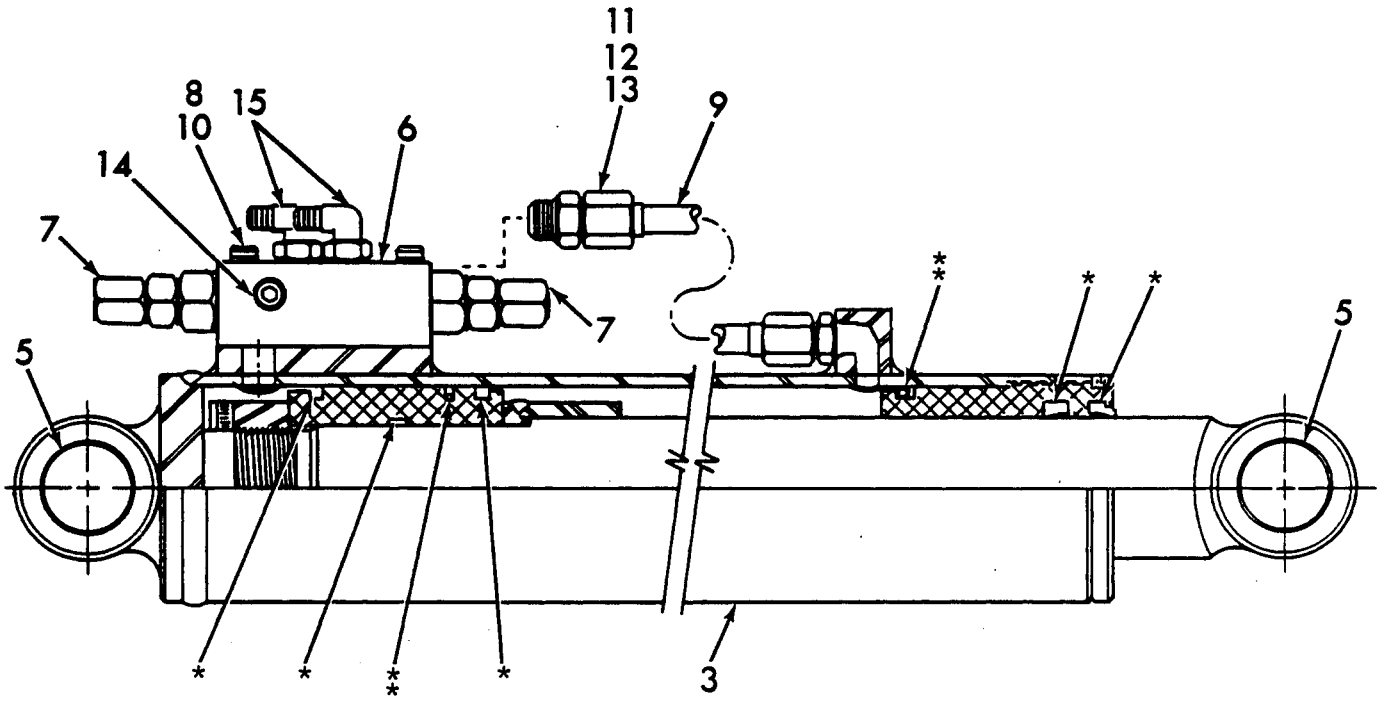
TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE EARLY 1990; CONCURRENT USE

SECT.	5
FIG.	4A
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
9	..25990	TUBE, HYDRAULIC	1
10	..63302	WASHER, LOCK	4
11	..80004-11	CONNECTOR, STRAIGHT THREAD	1
12	..80060-06	NUT	1
13	..80062-06	SLEEVE	1
14	..80051-03	PLUG, STRAIGHT THREAD	1
15	.80012-11	ELBOW, STRAIGHT THREAD	2

REV.

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



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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23185	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig. 2 or 2A for NHA)	REF
-2	.23186	SUB-ASSEMBLY, EXTENSION CYLINDER	1
3	..23187	CYLINDER, BOOM EXTENSION (SB)	1
		NOTE 2: INTERNAL SERVICE REPLACEMENT PARTS AVAILABLE ON A SPECIAL ORDER BASIS.	
-4	...600319	KIT, SEAL (SB)	1
		NOTE 3: THE SEAL KIT INCLUDES ITEMS SHOWN WITH AN ASTERISK (*).	
5	...600372	BUSHING	4
6	..22820	BLOCK, MANIFOLD	1
7	..81006	CARTRIDGE, OVERCENTER	2
8	..61947	SCREW, CAP	4

Mark Industries

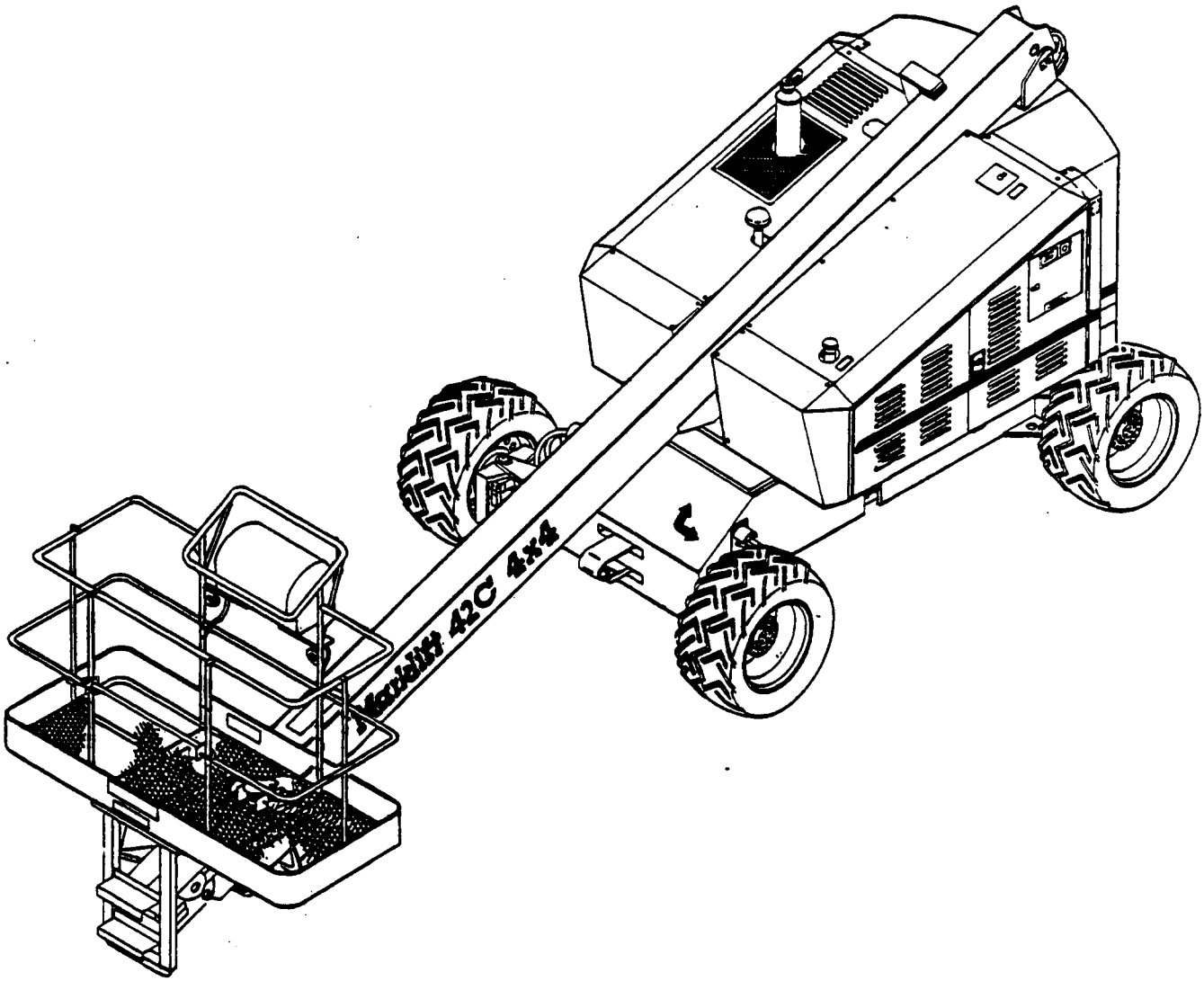
TITLE	EXTENSION CYLINDER ASSEMBLY
MODEL	42C
NOTES	SINCE LATE 1989

SECT.	5
FIG.	4B
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
9	..25990	TUBE, HYDRAULIC	1
10	..63302	WASHER, LOCK	4
11	..80004-11	CONNECTOR, STRAIGHT THREAD	1
12	..80060-06	NUT	1
13	..80062-06	SLEEVE	1
14	..80051-03	PLUG, STRAIGHT THREAD	1
15	.80012-11	ELBOW, STRAIGHT THREAD	2

SECTION 6 CONTAINS:

FIG. NO.	TITLE
1	OPTIONS
2	EXTRA TRACTION TIRES
3	SANDBLAST KIT
4	TOWING KIT
5	ROTATING AMBER BEACON
6	HEADLIGHTS
7	FRONT MOUNT PLATFORM ROTATION
8	MINIPAK SUB-ASSEMBLY
9	CATALYTIC CONVERTER
10	2.5 KW GENERATOR
11	AIRLINE (TO PLATFORM)
12	HYDRAULIC LINE (TO PLATFORM)
13	LIFTING LUGS
14	DIESEL FUEL TANK ASSEMBLY
15	ENGINE/PUMP ASSEMBLY (NISSAN A-15)
16	ENGINE/PUMP ASSEMBLY (NISSAN SD-16)
17	ENGINE/PUMP ASSEMBLY (DEUTZ F2L912)
18	BATTERY CABLE KIT (DEUTZ)
19	SHEET METAL KIT (DEUTZ)
20	SHEET METAL KIT (NISSAN)
21	FINAL BOOM ASSEMBLY (EXTERNAL POWER TRACK)
22	INNER BOOM ASSEMBLY (EXTERNAL POWER TRACK)
23	DUAL FUEL KIT (VG4D)


Mark Industries 42C 4x4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23360	TIRES, MONOFILLED	REF
-2	20108	HORN, TRAVEL WARNING	REF
-3	23392	ALARM, ALL MOTION	REF
-4	24149	PLATFORM, 5' X 36"	REF
-5	23415	TIRE, EXTRA TRACTION (See Sect. 6, Fig. 2 for Details)	REF
-6	23307	KIT, SANDBLAST (See Sect. 6, Fig. 3 for Details)	REF
-7	20105	KIT, TOWING (See Sect. 6, Fig. 4 for Details)	REF
-8	20107	BEACON, ROTATING AMBER (See Sect. 6, Fig. 5 for Details)	REF
-9	20078	HEADLIGHTS (See Sect. 6, Fig. 6 for Details)	REF
-10	23304	ROTATION, PLATFORM (FRONT MOUNT) (See Sect. 6, Fig. 7 for Details)	REF
-11	21713	SUB-ASSEMBLY, MINIPAK (See Sect. 6, Fig. 8 for Details)	REF
-12	20122	CONVERTER, CATALYTIC (See Sect. 6, Fig. 9 for Details)	REF
-13	20159	GENERATOR, 2.5 KW (VG4D) (See Sect. 6, Fig. 10 for Details)	REF
-14	20140	AIRLINE (TO PLATFORM) (See Sect. 6, Fig. 11 for Details)	REF
-15	23324	LINE, HYDRAULIC (TO PLATFORM) (See Sect. 6. Fig. 12 for Details)	REF
-16	22243	LUGS, LIFTING (See Sect. 6, Fig. 13 for Details)	REF
-17	22389	ASSEMBLY, DIESEL FUEL TANK (See Sect. 6, Fig. 14 for Details)	REF
-18	210290	ASSEMBLY, ENGINE/PUMP (NISSAN A-15) (See Sect. 6, Fgi. 15 for Details)	REF

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-19	24344	ASSEMBLY, ENGINE/PUMP (NISSAN SD-16) (See Sect. 6, Fig. 16 for Details)	REF
-20	22490	ASSEMBLY, ENGINE/PUMP (DEUTZ F2L912) (See Sect. 6, Fig. 17 for Details)	REF
-21	20645	KIT, BATTERY CABLE (DEUTZ) (See Sect. 6, Fig. 18 for Details)	REF
-22	22445	KIT, SHEET METAL (DEUTZ) (See Sect. 6, Fig. 19 for Details)	REF
-23	210286	KIT, SHEET METAL (NISSAN) (See Sect. 6, Fig. 20 for Details)	REF
-24	24962	ASSEMBLY, FINAL BOOM (EXTERNAL POWER TRACK) (See Sect. 6, Fig. 21 for Details)	REF
-25	24959	ASSEMBLY, INNER BOOM (EXTERNAL POWER TRACK) (See Sect. 6, Fig. 22 for Details)	REF
-26	20163	KIT, DUAL FUEL (VG4D) (See Sect. 6, Fig. 23 for Details)	REF

Mark Industries

TITLE	EXTRA TRACTION TIRE
MODEL	42C
NOTES	

SECTION	6
FIGURE	2
PAGE	1

ILLUSTRATION NOT AVAILABLE; PARTS LIST ONLY

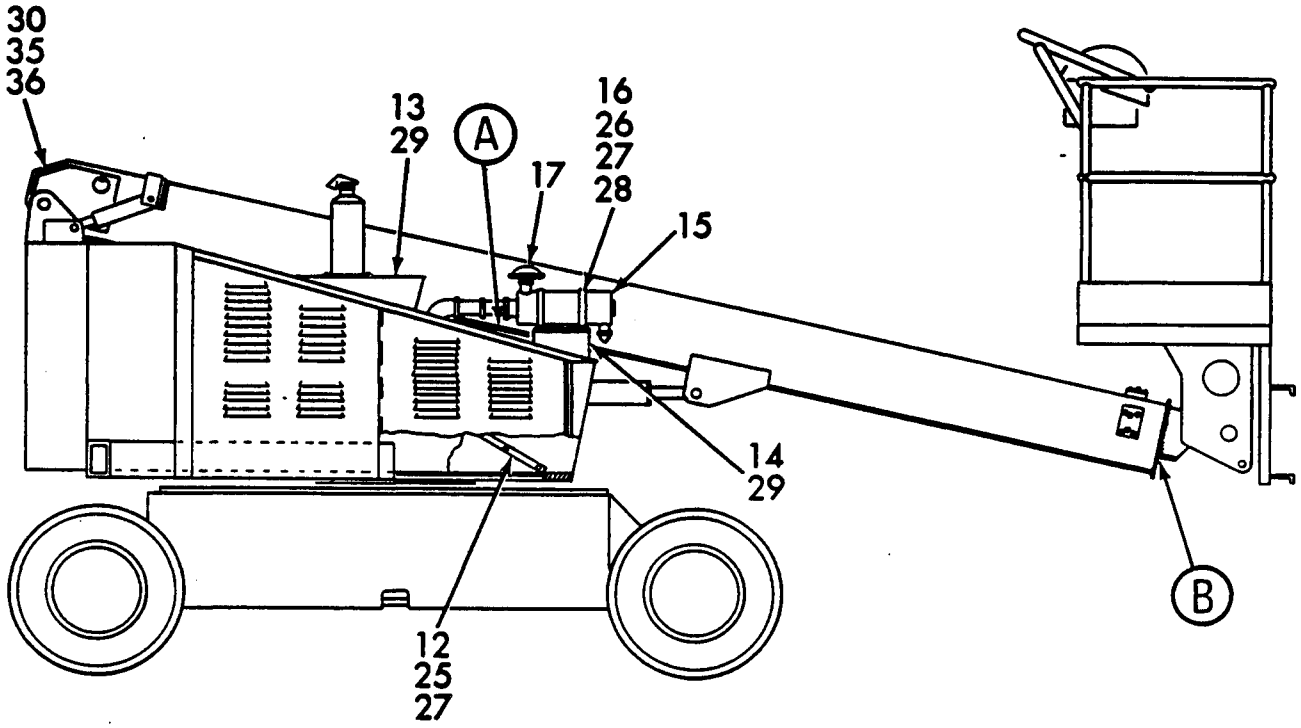
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23415	TIRE, EXTRA TRACTION	REF
-2	.23599	ASSEMBLY, TIRE & RIM (L.H.)	2
3	..23773	TIRE	2
4	..66928	RIM	2
-5	.23602	ASSEMBLY, TIRE & RIM (R.H.)	2
6	..23773	TIRE	2
7	..66928	RIM	2

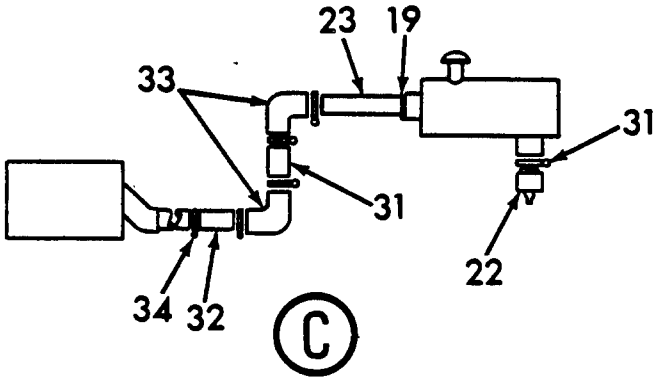
REV.

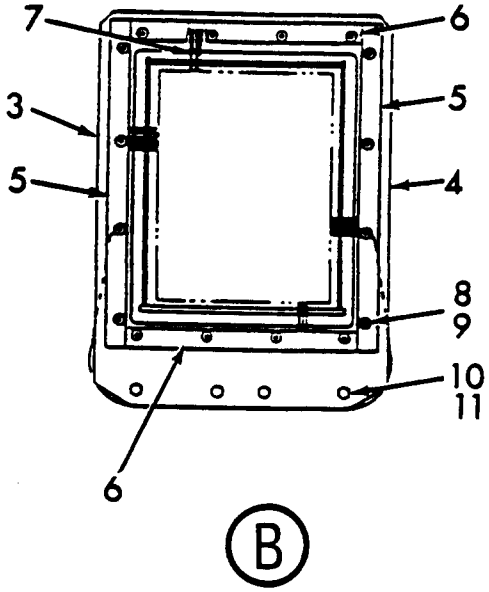
Mark Industries

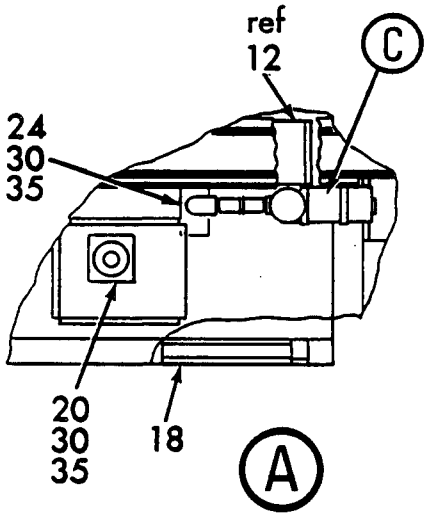
TITLE	SANDBLAST KIT
MODEL	42C
NOTES	

SECTION	6
FIGURE	3
PAGE	1









REV.

Mark Industries

TITLE	SANDBLAST KIT
MODEL	42C
NOTES	

SECT.	6
FIG.	3
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23307	KIT, SANDBLAST	REF
-2	.23626	ASSEMBLY, BOOM WIPER (OUTER/INNER)	1
3	..23624	WELDMENT, WIPER FRAME (L.H.)	1
4	..23625	WELDMENT, WIPER FRAME (R.H.)	1
5	..23622	STRIP	2
6	..23623	STRIP	2
7	..65434	BRUSH	1
8	..61914	SCREW, CAP	14
9	..63313	WASHER, LOCK	14
10	..60353	SCREW, CAP	8
11	..63301	WASHER, LOCK	8
12	.23397	COVER, ROTARY MANIFOLD	1
13	.22333	DUCT, EXHAUST	1
14	.22329	BRACKET, AIR FILTER	1
15	.65411	FILTER, AIR	1
16	.65412	BAND, MOUNTING	1
17	.65348	HOOD, AIR INLET	1
18	.22401	WELDMENT, INTAKE FRAME	1
19	.26463	METAL, SHEET (3 FT. DIAMETER)	1
20	.22966	COVER, MUFFLER	1
-21	.65335	CLAMP, HOSE	1
-22	.65690	VALVE, VACUATOR	1
23	.26114	TUBE	1
24	.22968	COVER, AIR CLEANER	1
25	.60324	SCREW, CAP	22

Mark Industries

TITLE	SANDBLAST KIT
MODEL	42C
NOTES	

SECT.	6
FIG.	3
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.60322	SCREW, CAP	4
27	.63302	WASHER, LOCK	26
28	.60702	NUT, HEX	4
29	.61813	SCREW, CAP	4
30	.62622	SCREW, MACHINE	22
31	.26446	TUBE	1
32	.26447	TUBE	1
33	.65552	ELBOW, MOLDED RUBBER	2
34	.16288	CLAMP, HOSE (2")	5
35	.63313	WASHER, LOCK	24
36	.23617	COVER, BOOM END	1

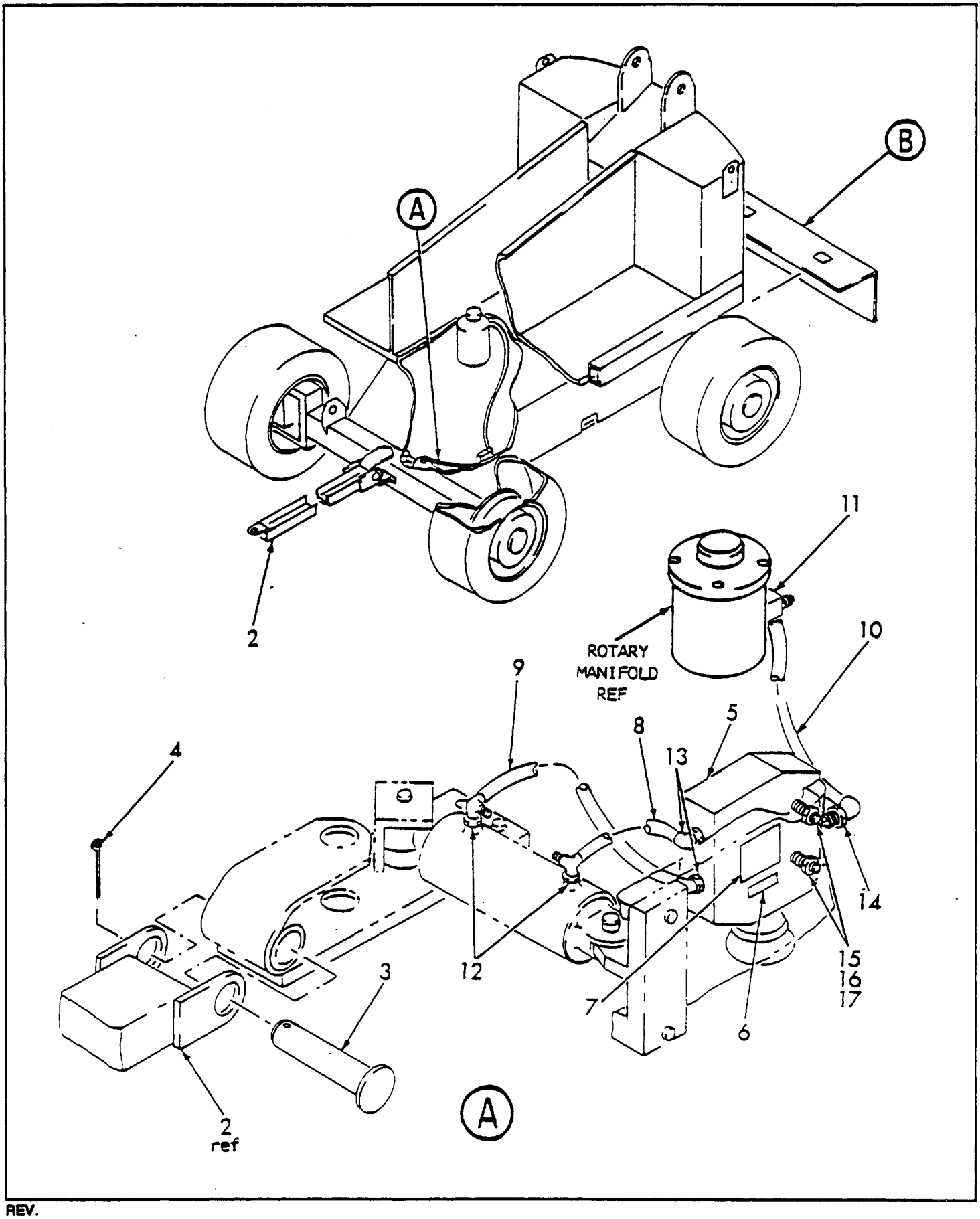
REV.

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

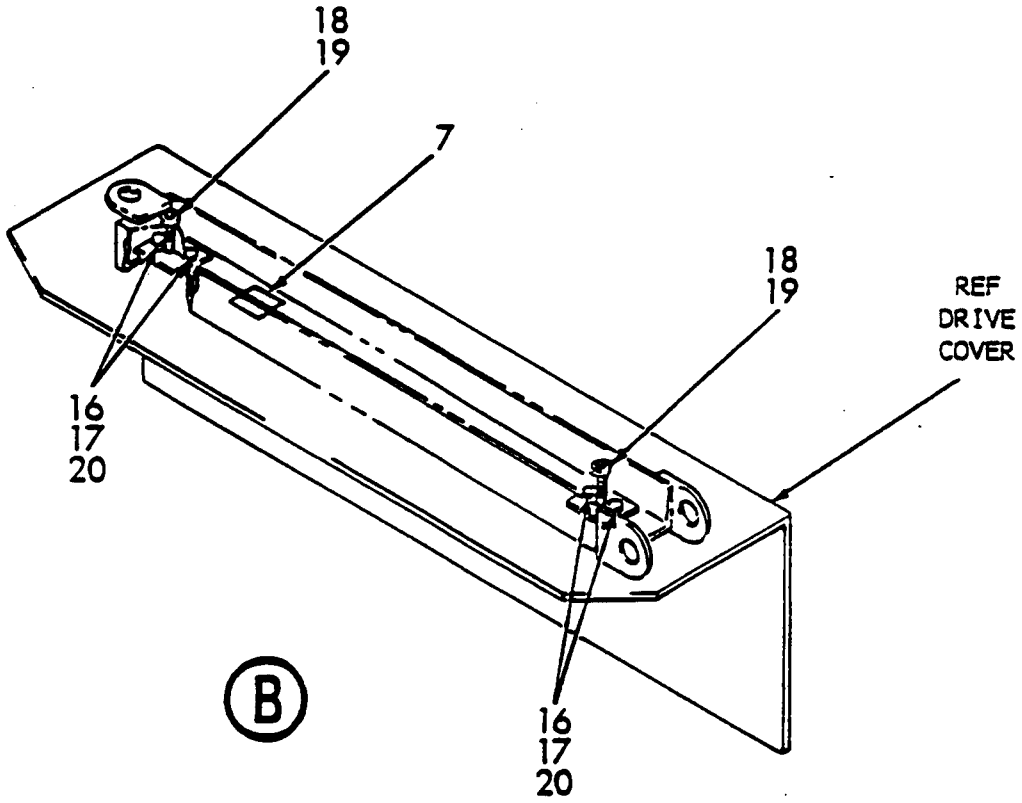
Mark Industries

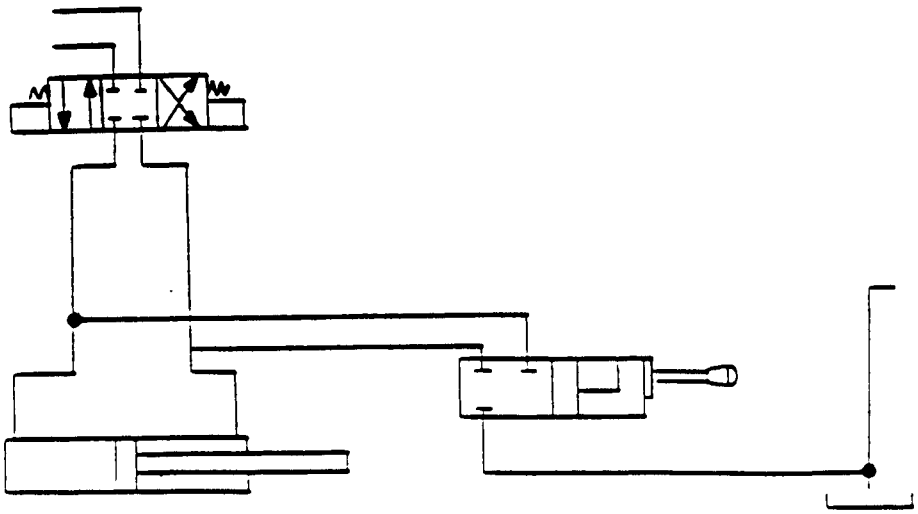
TITLE	TOWING KIT
MODEL	42C
NOTES	

SECTION	6
FIGURE	4
PAGE	1



REV.





HYDRAULIC SCHEMATIC

Mark Industries

TITLE	TOWING KIT
MODEL	42C
NOTES	

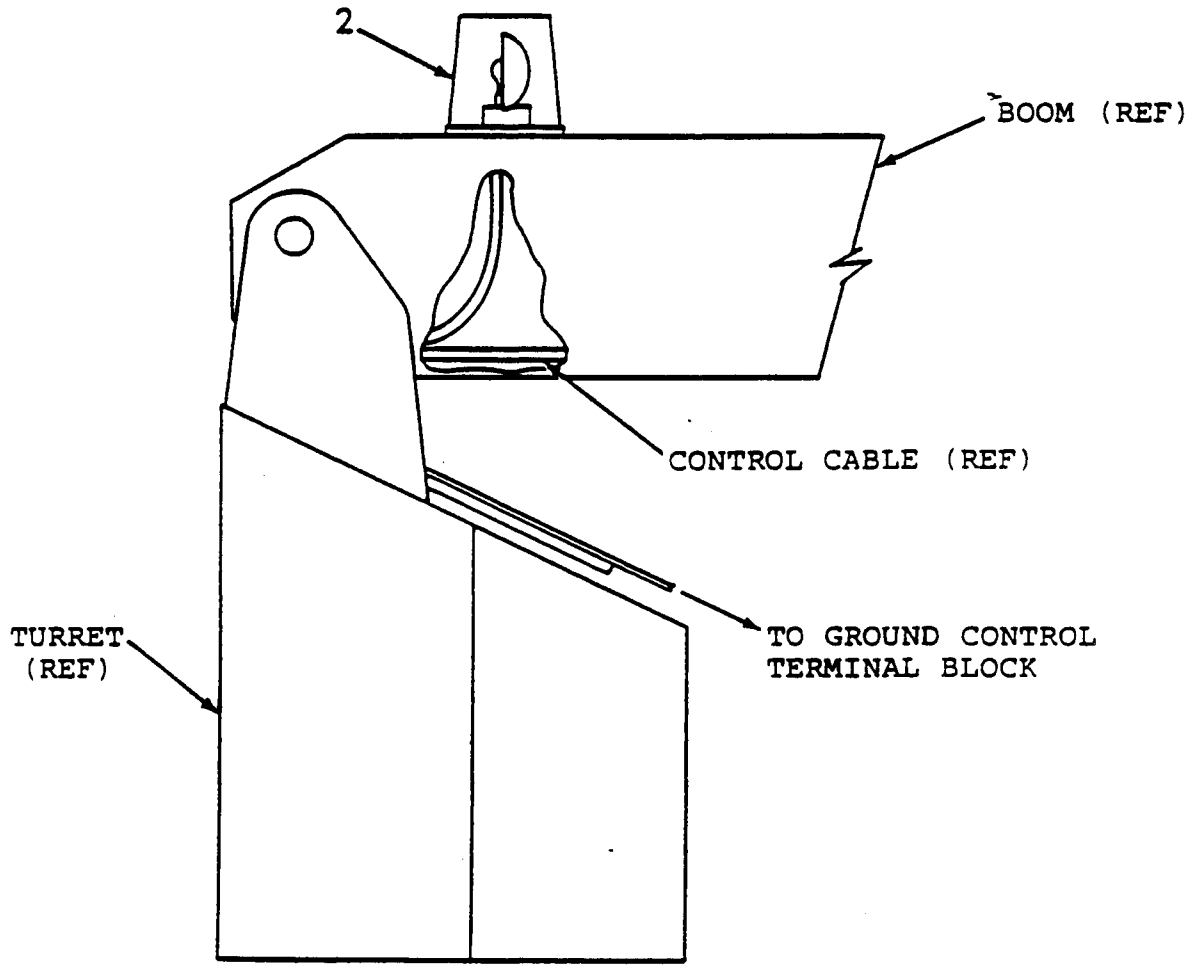
SECT.	6
FIG.	4
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20105	KIT, TOWING	REF
2	.20425	BAR, DRAW (TOW)	1
3	.20426	PIN	1
4	.64314	PIN, COTTER	1
5	.20799	VALVE, BYPASS	1
6	.20492	DECAL, STEER OVERRIDE VALVE	1
7	.20491	DECAL, TOWING INSTRUCTIONS	2
8	.13210-04-0300	ASSEMBLY, HOSE	1
9	.13210-04-0340	ASSEMBLY, HOSE	1
10	.13210-06-0700	ASSEMBLY, HOSE	1
11	.2425	TEE, MALE	1
12	.53200	TEE, STRAIGHT THREAD	2
13	.2584	ELBOW, MALE	2
14	.2443	ELBOW, MALE	1
15	.60317	SCREW, CAP	2
16	.60703	NUT, HEX	6
17	.63303	WASHER, LOCK	6
18	.20837	STUD, FLANGED	2
19	.60705	NUT, HEX	2
20	.60343	SCREW, CAP	4

Mark Industries

TITLE	ROTATING AMBER BEACON
MODEL	42C
NOTES	

SECTION	6
FIGURE	5
PAGE	1



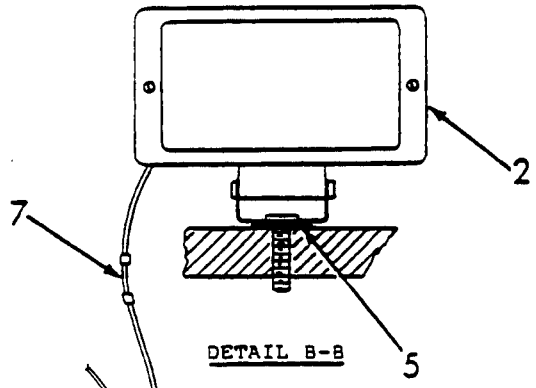
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20107	BEACON, ROTATING AMBER	REF
2	.20863	BEACON (WITH SWITCH)	1

REV.

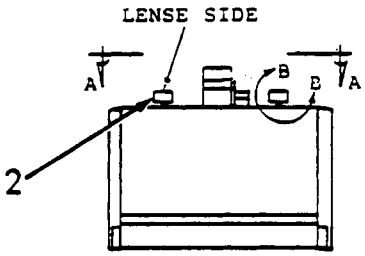
Mark Industries

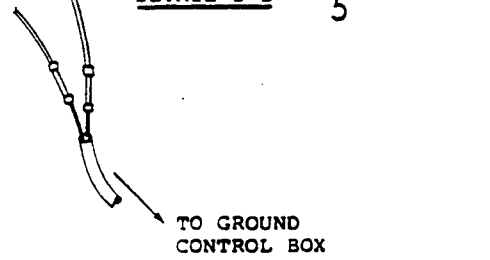
TITLE	HEADLIGHTS
MODEL	42C
NOTES	

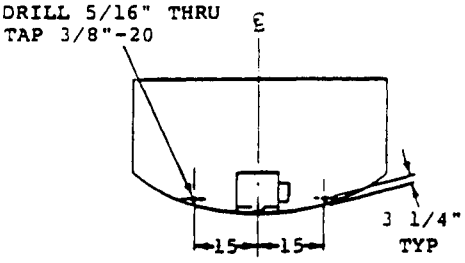
SECTION	6
FIGURE	6
PAGE	1



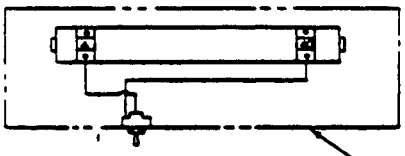
DETAIL B-B

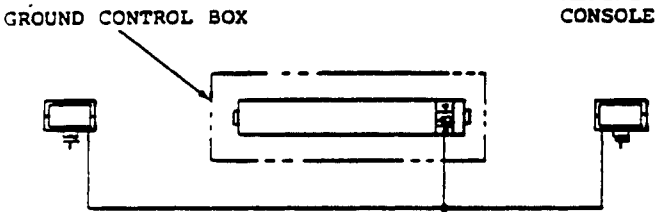






VIEW A-A





ELECTRICAL DIAGRAM

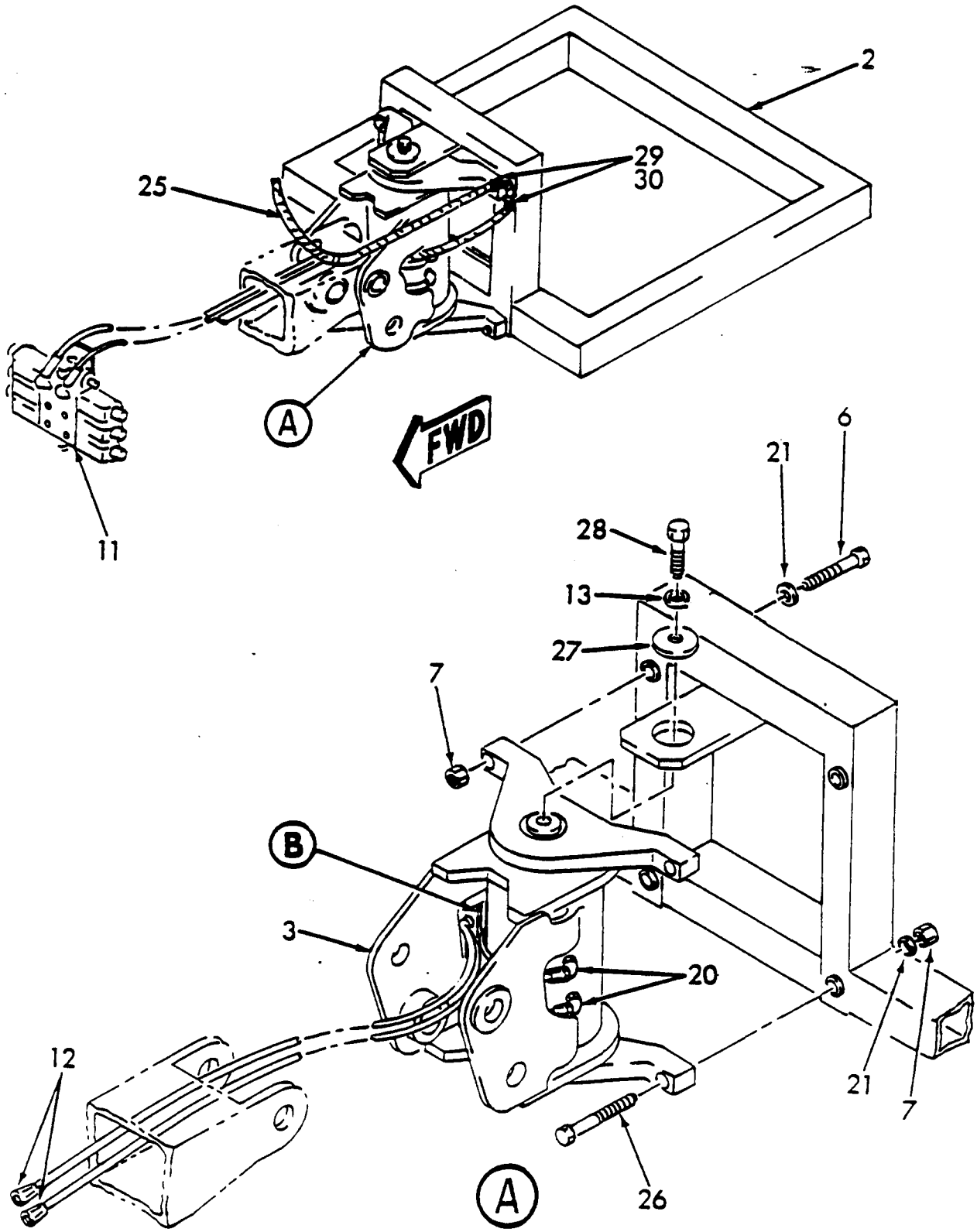
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20078	HEADLIGHTS	REF
2	.20971	HEADLIGHT	2
3	.4017	SWITCH, TOGGLE	1
4	.20509	DECAL, LIGHTS	1
5	.63403	WASHER, FLAT	1
6	.2991	WIRE, WHITE	6 FT
7	.117-D	CONNECTOR, BUTT	4

REV.

Mark Industries

TITLE	FRONT MOUNT PLATFORM ROTATION
MODEL	42C
NOTES	

SECTION	6
FIGURE	7
PAGE	1

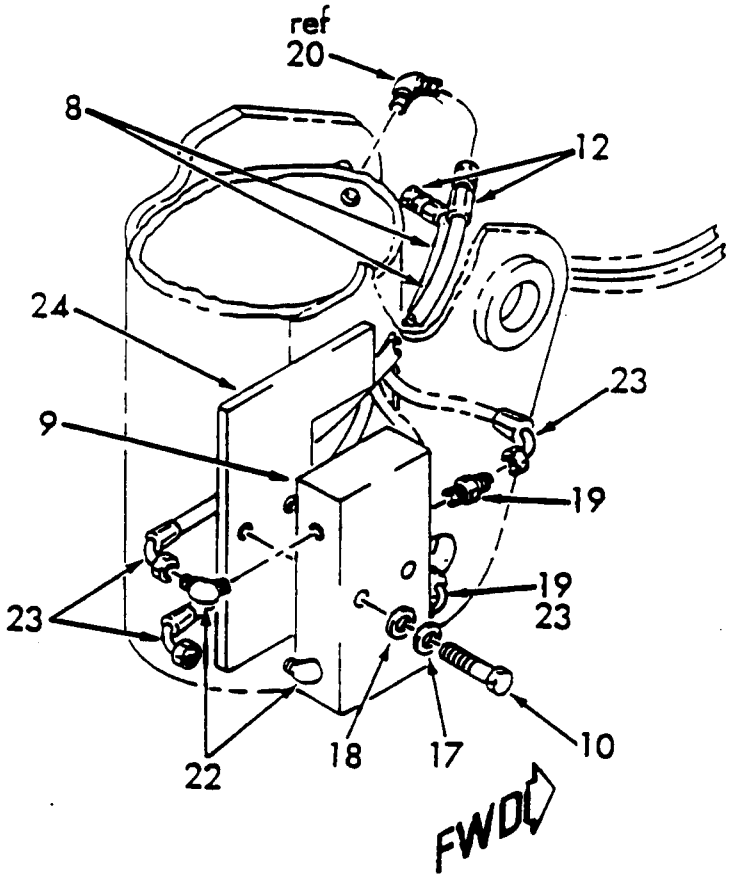


REV.

Mark Industries

TITLE	FRONT MOUNT PLATFORM ROTATION
MODEL	42C
NOTES	

SECTION	6
FIGURE	7
PAGE	2



B

REV.

Mark Industries

TITLE	FRONT MOUNT PLATFORM ROTATION
MODEL	42C
NOTES	

SECT.	6
FIG.	7
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23304	ROTATION, FRONT MOUNT PLATFORM	REF
2	.23564	WELDMENT, FORK	1
3	.81094	ROTATOR, HELAC (See Vendor Chapter for Details)	1
-4	..67770	KIT, SEAL	1
-5	..67771	KIT, BEARING	1
6	.60540	SCREW, CAP	2
7	.61305	NUT, LOCK	4
8	.2568-0144	HOSE, HYDRAULIC	2
9	.20351	VALVE, CHECK	1
10	.60360	SCREW, CAP	2
11	.21713	SUB-ASSEMBLY, MINIPAK (See Sect. 6, Fig. 8 for Details)	1
12	.2562	FITTING, SWIVEL	4
13	.63305	WASHER, LOCK	1
-14	.4021	SWITCH, TOGGLE	1
-15	.20884	GUARD, SWITCH	1
-16	.22571	DECAL, AERIAL CONTROL BOX	1
17	.63302	WASHER, LOCK	2
18	.63402	WASHER, FLAT	2
19	.80004-05	CONNECTOR, STRAIGHT THREAD	2
20	.80012-03	ELBOW, STRAIGHT THREAD	2
21	.63415	WASHER, FLAT	4
22	.80012-05	ELBOW, STRAIGHT THREAD	2
23	.2594	ELBOW, SWIVEL	4
24	.23197	BRACKET, CHECK VALVE	1

Mark Industries

TITLE	FRONT MOUNT PLATFORM ROTATION
MODEL	42C
NOTES	

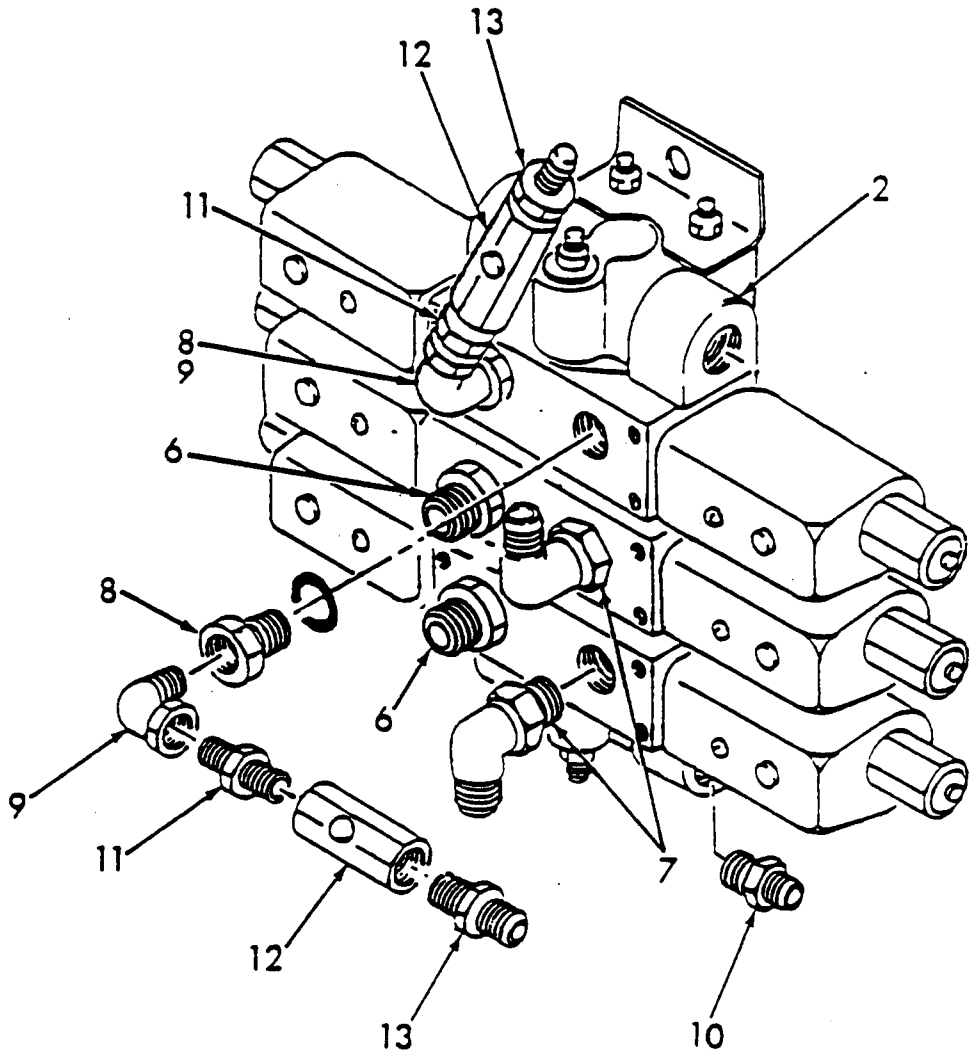
SECT.	6
FIG.	7
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	.65321	SLEEVE, PLASTIC COIL	3.5 FT
26	.60513	SCREW, CAP	2
27	.23565	WASHER	1
28	.60516	SCREW, CAP	1
29	.16268	CLAMP, HOSE	5
30	.61902	SCREW, CAP	5

Mark Industries

TITLE	MINIPAK SUB-ASSEMBLY
MODEL	62C
NOTES	WITH FRONT MOUNT PLATFORM ROTATION

SECTION	6
FIGURE	8
PAGE	1



REV.

Mark Industries

TITLE	MINIPAK SUB-ASSEMBLY
MODEL	42C
NOTES	WITH FRONT MOUNT PLATFORM ROTATION

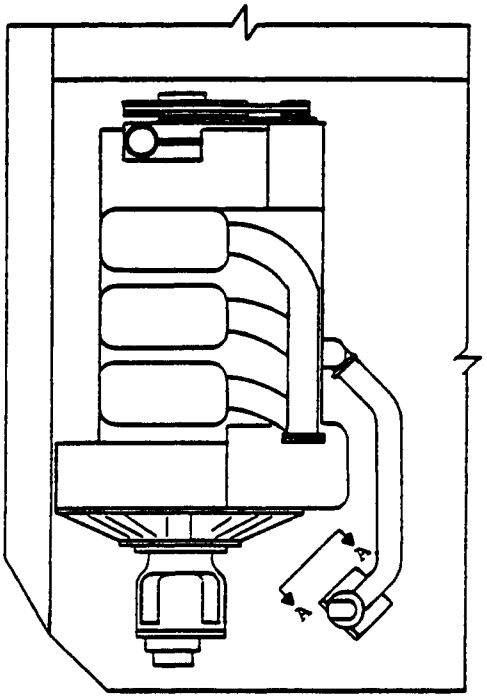
SECT.	6
FIG.	8
PAGE	2

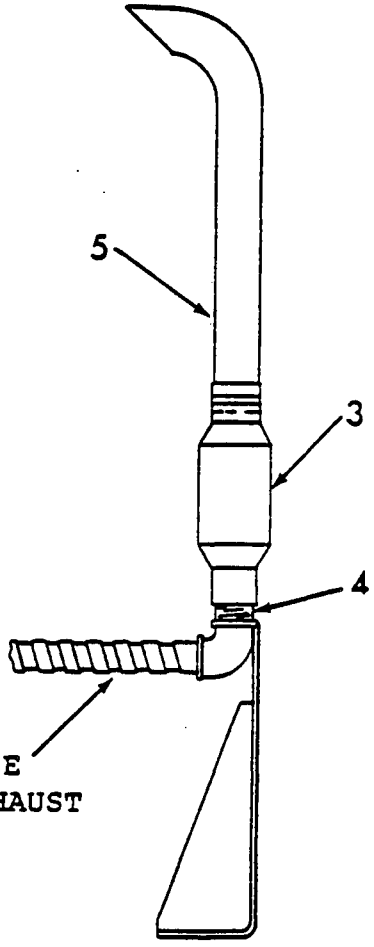
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	21713	SUB-ASSEMBLY, MINIPAK (See Sect. 6, Fig. 7 for NHA)	REF
2	.21787	VALVE, MINIPAK (See Vendor Chapter for Details)	1
-3	..67825	KIT, SEAL (COMPLETE VALVE PACKAGE)	1
4	..67958	CARTRIDGE (ONLY)	6
5	..16953	COIL (ONLY)	6
6	.2608	CONNECTOR	2
7	.2572	ELBOW	2
8	.80063-01	ADAPTER, FEMALE PIPE	2
9	.2450	ELBOW, STREET	2
10	.2474	CONNECTOR, STRAIGHT THREAD	2
11	.2475	NIPPLE, PIPE	2
12	.20370	VALVE, NEEDLE	2
13	.2415	CONNECTOR, MALE	2

Mark Industries

TITLE	CATALYTIC CONVERTER
MODEL	42C
NOTES	

SECTION	6
FIGURE	9
PAGE	1

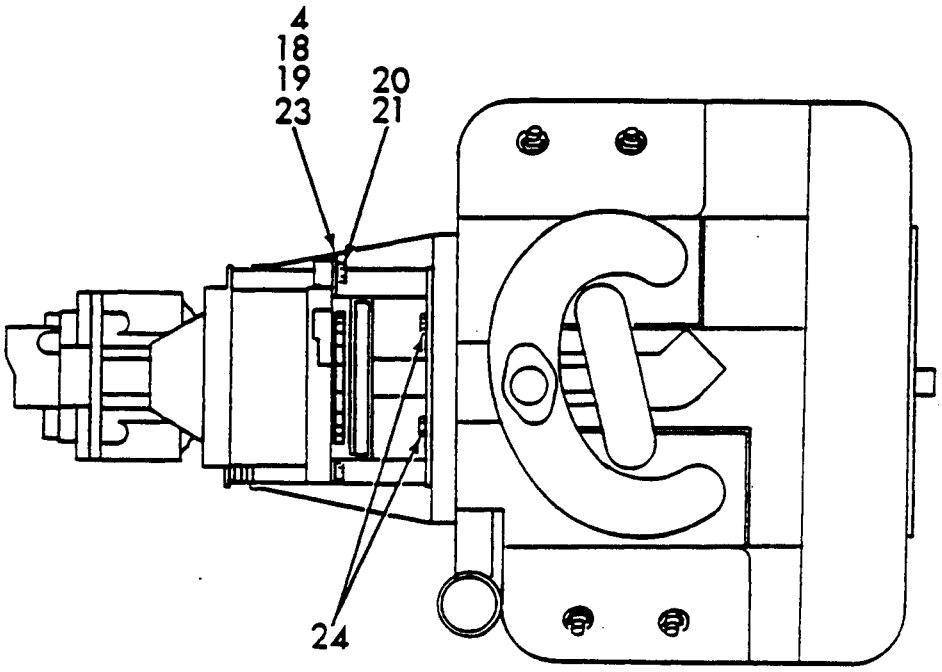


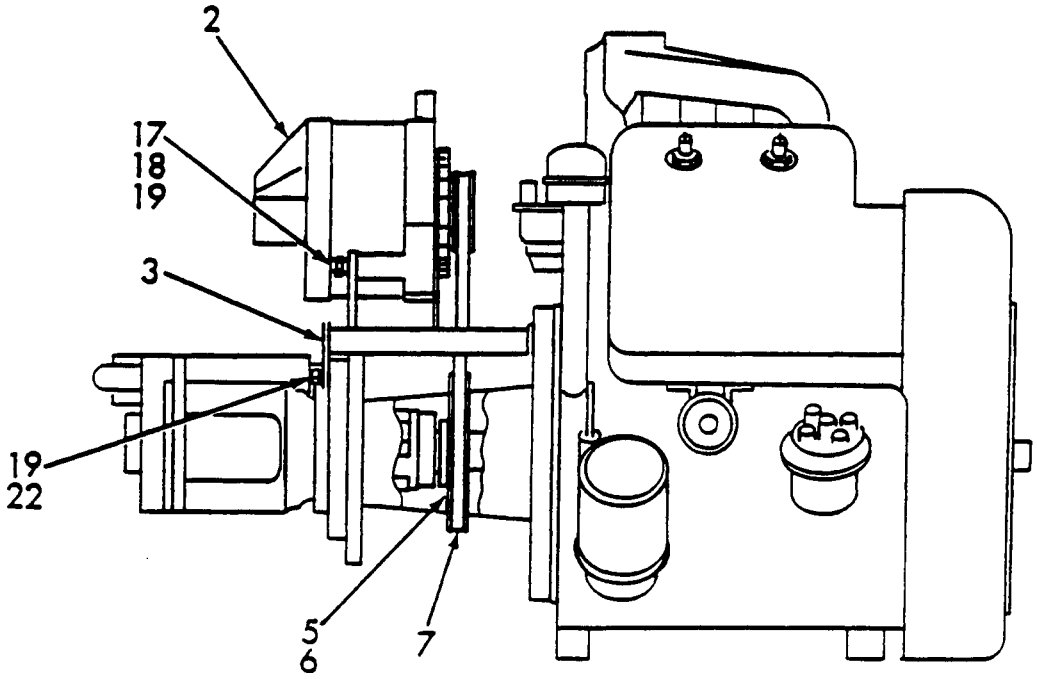


VIEW "A-A"

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20122	CONVERTER, CATALYTIC	REF
-2	.20867	CONVERTER, CATALYTIC (MODIFIED)	1
3	..20868	CONVERTER, CATALYTIC	1
4	..54700	NIPPLE, BLACK PIPE	1
5	..20854	PIPE, EXHAUST	1

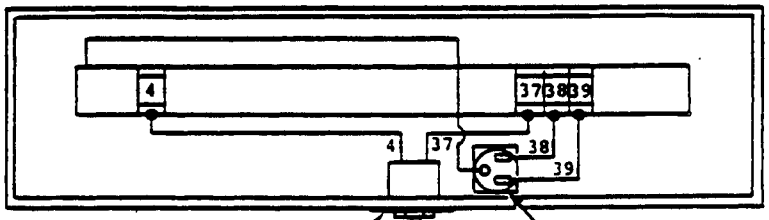
REV.



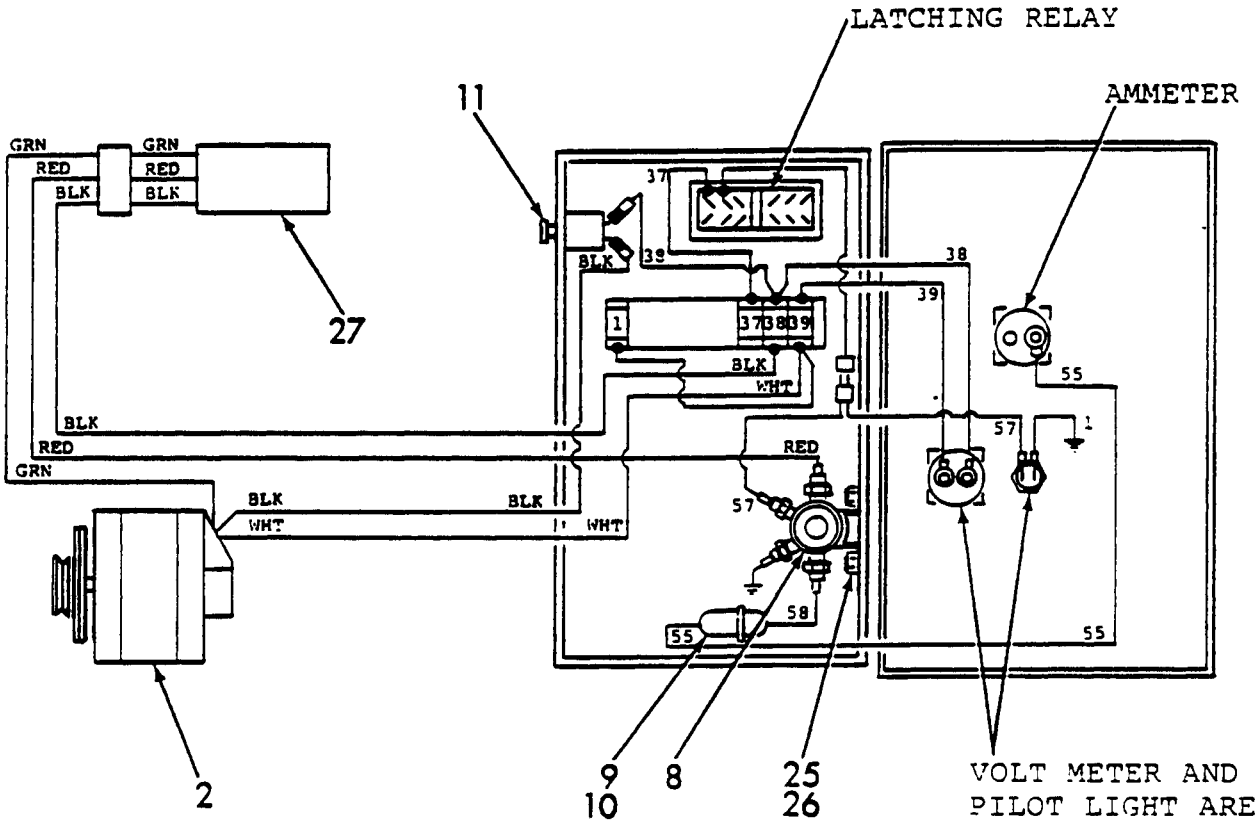


ENGINE ASSEMBLY

AERIAL CONTROL CONSOLE



SWITCH SUPPLIED WITH ITEM 2



VOLT METER AND PILOT LIGHT ARE SUPPLIED WITH ITEM 2

GROUND CONTROL CONSOLE

Mark Industries

TITLE	2.5 KW GENERATOR
MODEL	42C
NOTES	VG4D

SECT.	6
FIG.	10
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20159	GENERATOR, 2.5 KW	REF
2	.20907	GENERATOR (ALTERNATOR)	1
3	.21381	BRACKET, GENERATOR	1
4	.20900	TENSIONER, GENERATOR BELT	1
5	.65001	SHEAVE, TAPER-LOK	1
6	.65005	BUSHING	1
7	.65019	V-BELT, GENERATOR	1
8	.70209	RELAY	1
9	.16337	HOLDER, FUSE	1
10	.16310	FUSE (30 AMP SLO-BLO)	1
11	.20562	BREAKER, CIRCUIT	1
12	.70126	RECEPTACLE, DUPLEX	1
13	.288	PLATE, COVER	1
14	.185717	DECAL, 110 VAC	1
15	.2806	RELIEF, STRAIN	1
16	.2808	NUT, LOCK	1
17	.60347	SCREW, CAP	1
18	.60703	NUT, HEX	2
19	.63303	WASHER, LOCK	4
20	.60338	SCREW, CAP	1
21	.63302	WASHER, LOCK	1
22	.60325	SCREW, CAP	2
23	.60343	SCREW, CAP	1
24	.60624	SCREW, CAP	2
25	.60150	SCREW, CAP	2

Mark Industries

TITLE	2.5 KW GENERATOR
MODEL	42C
NOTES	VG4D

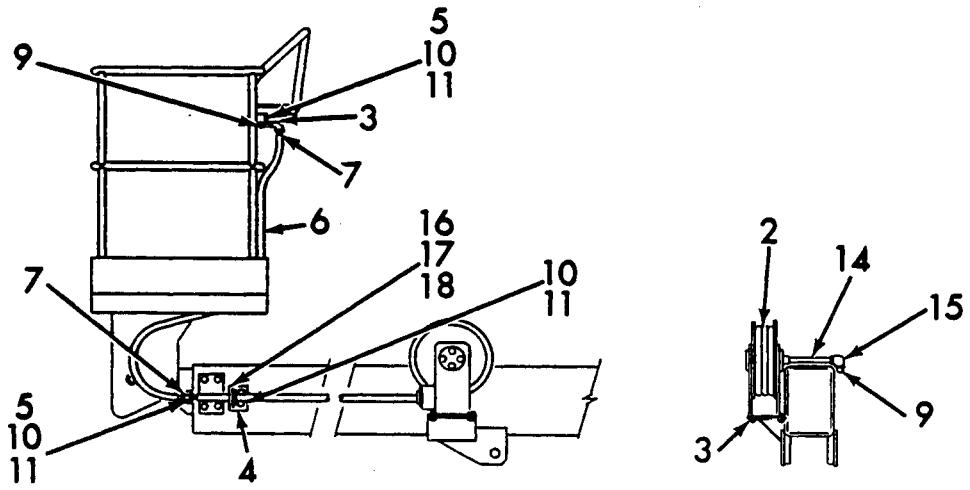
SECT.	6
FIG.	10
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.60701	NUT, HEX	2
27	.20986	REGULATOR, VOLTAGE	1

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

Mark Industries

TITLE	AIRLINE (TO PLATFORM)	SECTION	6
MODEL	42C	FIGURE	11
NOTES		PAGE	1



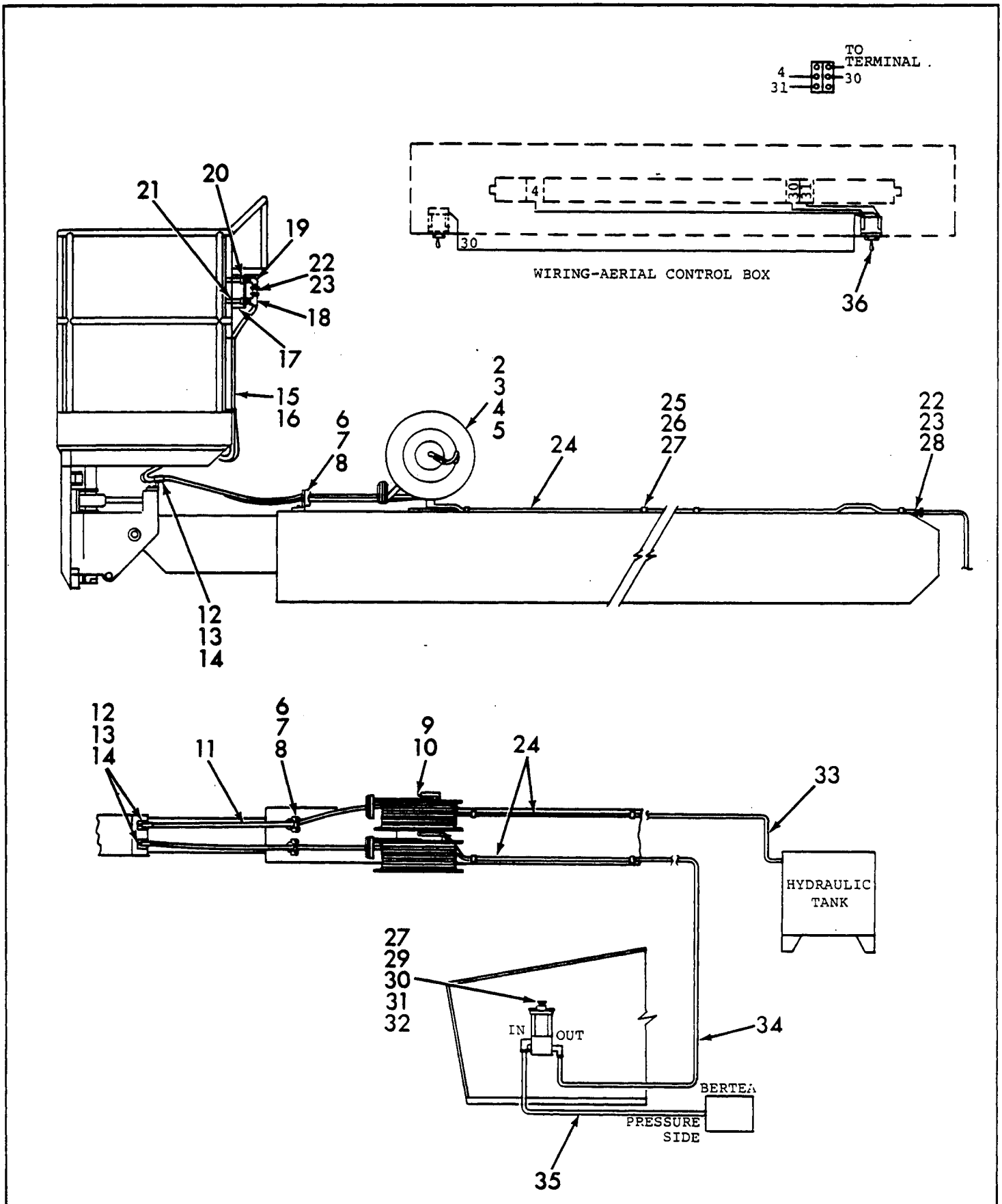
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20140	AIRLINE (TO PLATFORM)	REF
2	.20923	REEL, HOSE	1
3	.20920	PLATE, HOSE REEL MOUNTING	1
4	.20921	MOUNTING, HOSE GUIDE	1
5	.20922	BRACKET, HOSE END	2
6	.65485	HOSE	7
7	.65486	FITTING, HOSE	2
8	.52304	ELBOW, STREET	1
9	.53902	PLUG, PIPE	2
10	.60325	SCREW, CAP	6
11	.63319	WASHER, LOCK	10
12	.60343	SCREW, CAP	4
13	.60703	NUT, HEX	4
14	.65487	NIPPLE, PIPE	1
15	.65488	ELBOW, FEMALE	1
16	.60353	SCREW, CAP	4
17	.63301	WASHER, LOCK	4
18	.20924	GUIDE, HOSE	1

REV.

Mark Industries

TITLE	HYDRAULIC LINE (TO PLATFORM)
MODEL	42C
NOTES	

SECTION	6
FIGURE	12
PAGE	1



REV.

Mark Industries

TITLE	HYDRAULIC LINE (TO PLATFORM)	SECT. 6
MODEL	42C	FIG. 12
NOTES		PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	23324	LINE, HYDRAULIC (TO PLATFORM)	REF
2	.65955	REEL, LUBRICATION	2
3	.23896	PLATE, LUBRICATION REEL MOUNTING	1
4	.60383	SCREW, CAP	8
5	.63305	WASHER, LOCK	8
6	.20983	GUIDE, HOSE	2
7	.60322	SCREW, CAP	2
8	.63302	WASHER, LOCK	2
9	.65957	NIPPLE, BLACK PIPE	2
10	.80009-09	ELBOW, FEMALE	2
11	.23897	ASSEMBLY, HOSE	2
12	.21954	BRACKET, HOSE END	2
13	.60325	SCREW, CAP	4
14	.63303	WASHER, LOCK	4
15	.80001-11	CONNECTOR, MALE	2
16	.13210-06-0660	ASSEMBLY, HOSE	2
17	.21948	WELDMENT, HYDRAULIC OUTLET	1
18	.54800	COUPLING, PIPE	6
19	.80034-10	TEE, MALE	2
20	.80008-10	ELBOW, MALE	2
21	.80052-07	NIPPLE, PIPE	4
22	.80062-05	SLEEVE	12
23	.80060-05	NUT	12
24	.45	TUBE, HYDRAULIC	4
25	.764	CLAMP, RUBBER	24

REV.

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

Mark Industries

TITLE	HYDRAULIC LINE (TO PLATFORM)
MODEL	42C
NOTES	

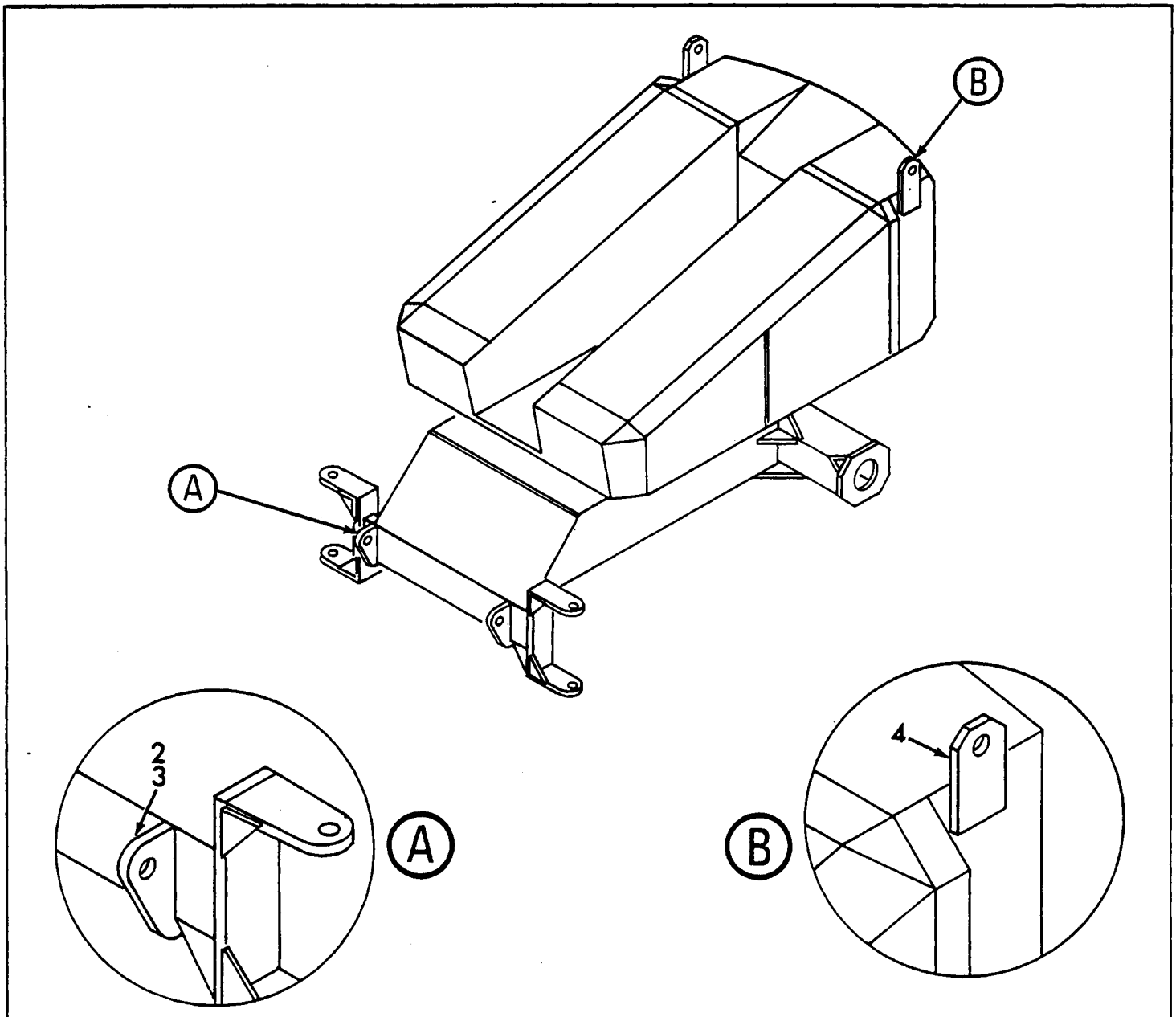
SECT.	6
FIG.	12
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.60353	SCREW, CAP	24
27	.63301	WASHER, LOCK	32
28	.80042-05	UNION	2
29	.20376	VALVE, SOLENOID	1
30	.60315	SCREW, CAP	2
31	.60701	NUT, HEX	2
32	.80008-08	ELBOW, MALE	2
33	.13210-06-1300	ASSEMBLY, HOSE	1
34	.13210-06-1460	ASSEMBLY, HOSE	1
35	.13210-06-0340	ASSEMBLY, HOSE	1
36	.20482	SWITCH, TOGGLE	1

Mark Industries

TITLE	LIFTING LUGS
MODEL	42C
NOTES	

SECTION	6
FIGURE	13
PAGE	1



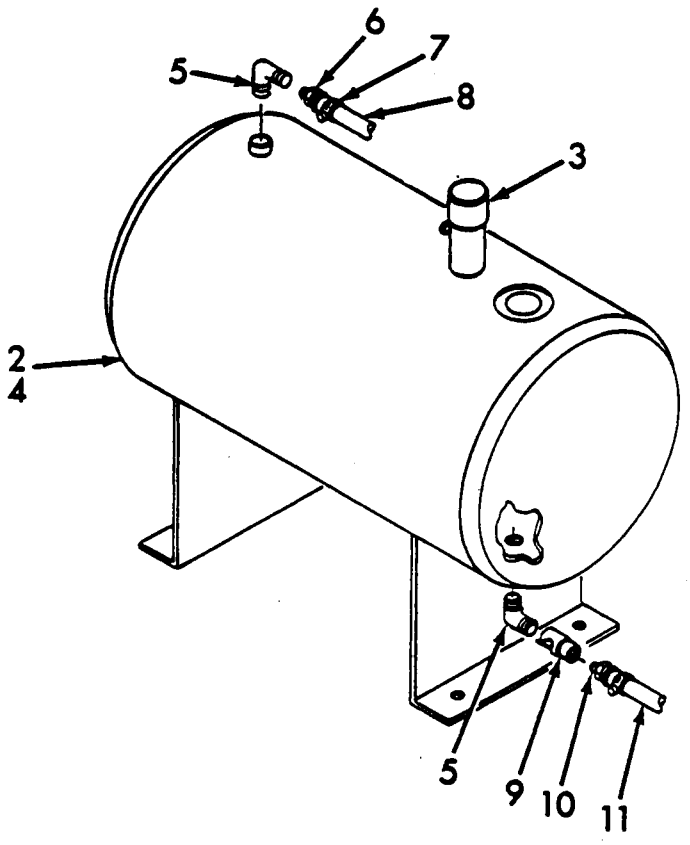
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22243	LUGS, LIFTING	REF
2	.22518	LUG, LIFTING	2
3	..25574	PLATE	2
4	.21758	TURRET, LIFTING LUG	2

REV.

Mark Industries

TITLE	DIESEL FUEL TANK ASSEMBLY
MODEL	42C
NOTES	

SECTION	6
FIGURE	14
PAGE	1



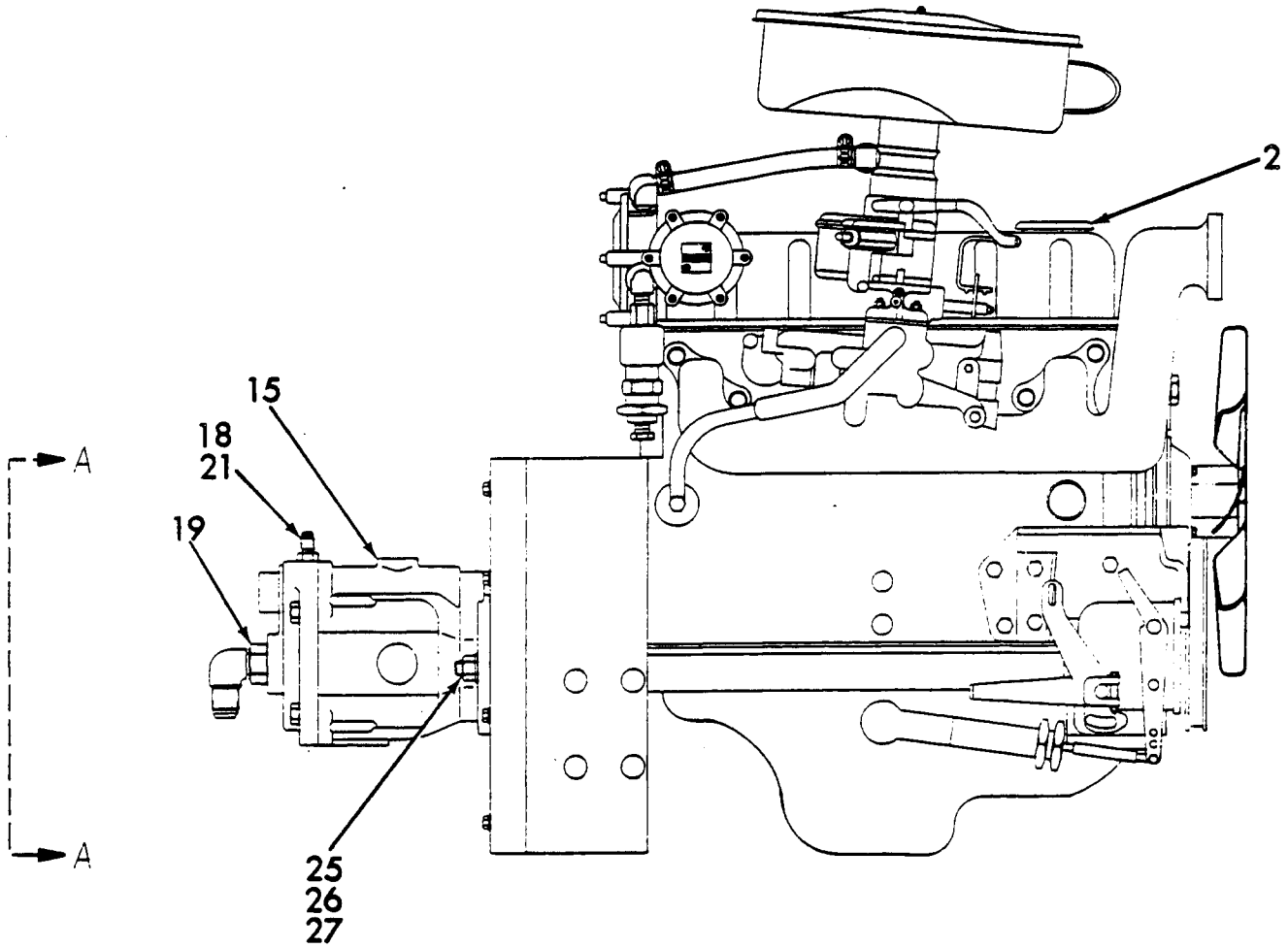
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22389	ASSEMBLY, DIESEL FUEL TANK	REF
2	.21762	TANK, FUEL (22 GALLON)	1
3	.67959	CAP, GAS	1
4	..20041	UNIT, SENDING	1
5	.80021-03	ELBOW, STREET	2
6	.864	HOSE, BARB	1
7	.161-A	CLAMP, HOSE	2
8	.65226	HOSE, FUEL (DIESEL)	1 FT
9	.12000	VALVE, NEEDLE	1
10	.2589	FITTING, HOSE	1
11	.65227	HOSE, FUEL (DIESEL)	1 FT

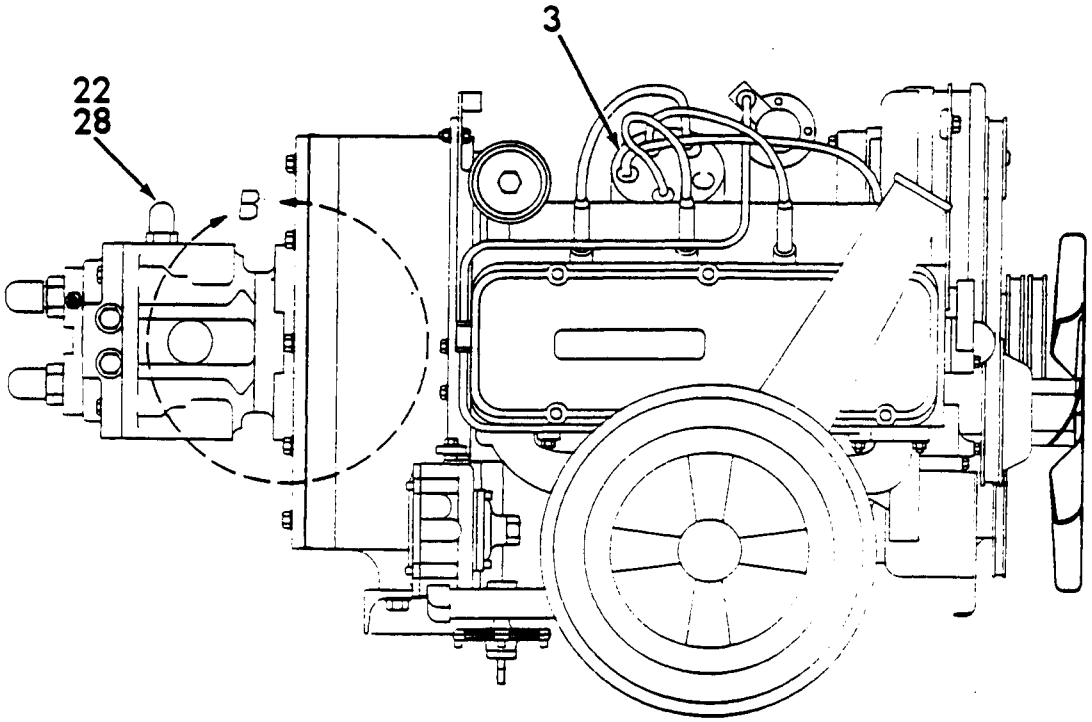
REV.

Mark Industries

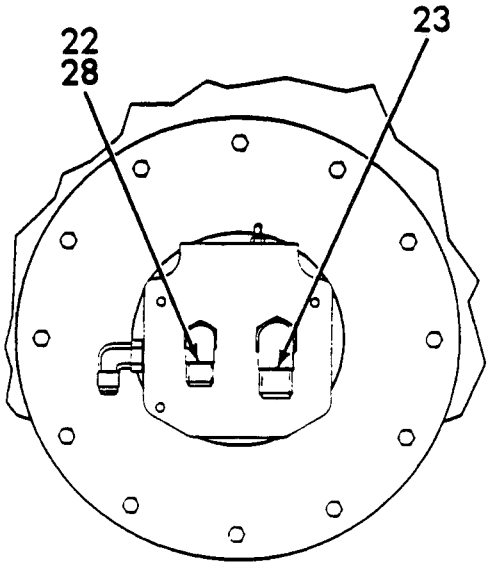
TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	NISSAN A-15

SECTION	6
FIGURE	15
PAGE	1

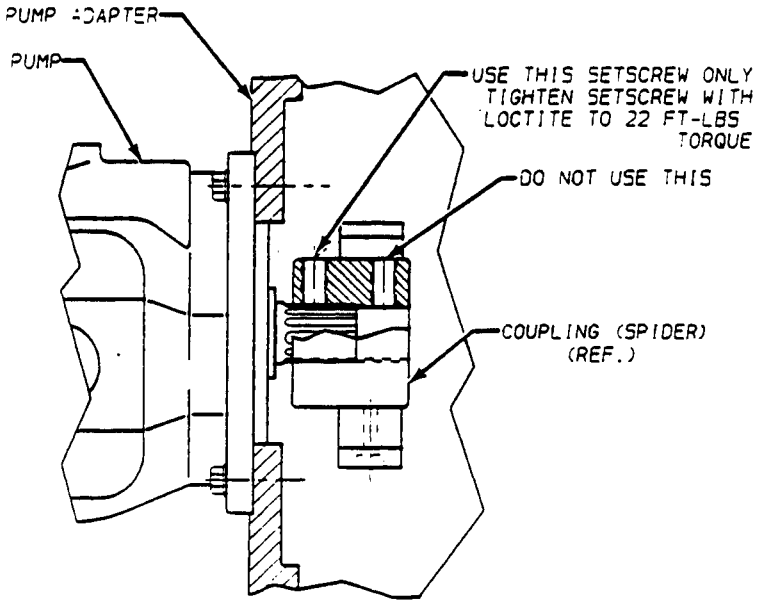




REV.



VIEW A-A



VIEW B-B

PUMP AND COUPLING INSTALLATION

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	210290	ASSEMBLY, ENGINE/PUMP (NISSAN A-15)	REF
2	.210281	ENGINE WITH FAN (NISSAN A-15) (See Vendor Chapter for Details)	1
3	..67469	DISTRIBUTOR	1
-4	...600040	KIT, TUNE-UP	1
-5	..67640	CARBURETOR	1
-6	...600049	KIT, CARBURETOR REBUILD	1
-7	..160103	HOSE, UPPER RADIATOR	1
-8	..160104	HOSE, LOWER RADIATOR	1
-9	..600047	ELEMENT, AIR FILTER	1
-10	..67114	GOVERNOR, MECHANICAL	1
-11	..67334	FILTER, OIL	1
-12	..67436	SWITCH, OIL PRESSURE	1
-13	..67453	PUMP, FUEL	1
-14	..67457	BELT, GOVERNOR	1
-15	.20801	PUMP	1
-16	..66741	SEAL, SHAFT	1
-17	..21757	COMPENSATOR, PRESSURE FLOW	1
18	.80004-03	CONNECTOR, STRAIGHT THREAD	1
19	.80063-15	ADAPTER, FEMALE	1
20	.80017-24	ELBOW, STRAIGHT THREAD	1
21	.160223	PLUG, CAP	1
22	.80012-08	ELBOW, STRAIGHT THREAD	1
23	.80012-28	ELBOW, STRAIGHT THREAD	1
24	.160217	PLUG, CAP	1
25	.63613	STUD	2

Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	NISSAN A-15

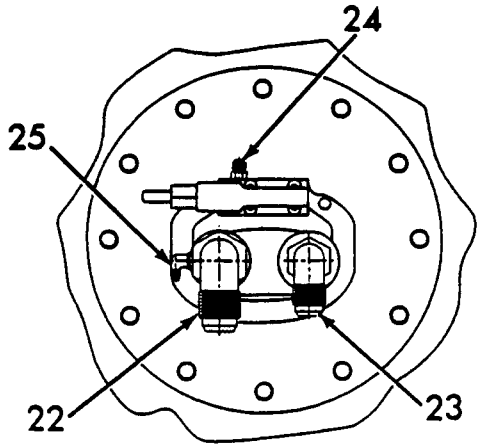
SECT.	6
FIG.	15
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.63305	WASHER, LOCK	2
27	.60705	NUT, HEX	2
28	.160224	PLUG, CAP	1

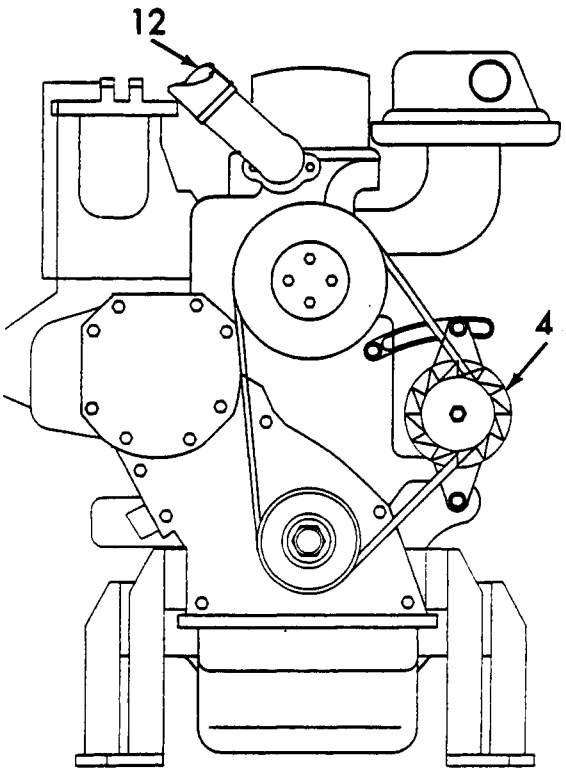
Mark Industries

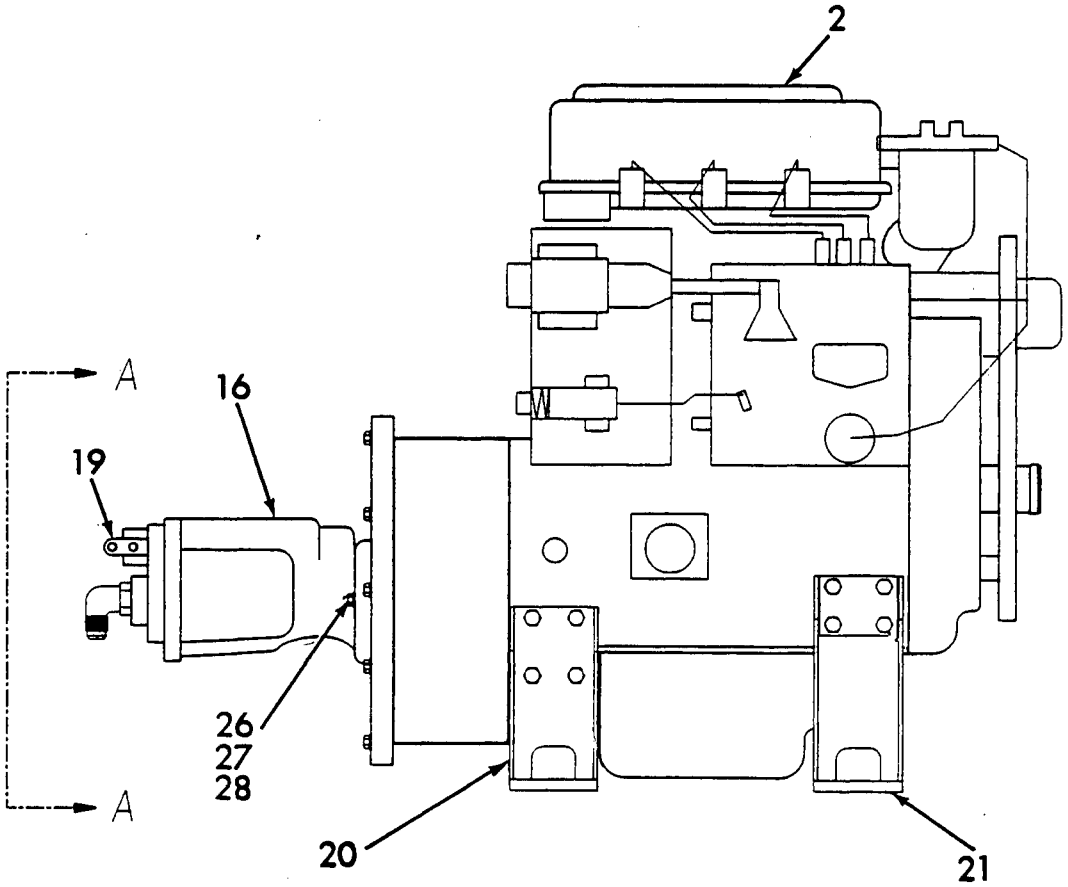
TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	NISSAN SD-16

SECTION	6
FIGURE	16
PAGE	1



VIEW A-A





REV.

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24344	ASSEMBLY, ENGINE/PUMP	REF
2	.24624	ENGINE, DIESEL (NISSAN SD-16) (See Vendor Chapter for Details)	1
-3	..67406	STARTER (12V)	1
4	..67076	ALTERNATOR	1
-5	..67079	REGULATOR, VOLTAGE	1
6	..67411	BELT, FAN	1
-7	..67416	PUMP, WATER	1
-8	..67420	PUMP, FEED	1
-9	..67421	FILTER, FUEL	1
-10	..67424	ELEMENT, AIR CLEANER	1
-11	..67791	FLYWHEEL (8" O.C.)	1
12	..67413	HOSE, UPPER	1
-13	..67795	HOSE, LOWER	1
-14	..66941	SWITCH, OIL	1
-15	..66942	SWITCH, TEMPERATURE	1
16	.20753	PUMP	1
-17	..600163	KIT, SEAL	1
-18	...66741	SEAL, SHAFT	1
19	..21757	ASSEMBLY, PRESSURE FLOW COMPENSATOR	1
20	.24315	WELDMENT, BRACKET	2
21	.24314	WELDMENT, BRACKET	2
22	.80012-28	ELBOW, STRAIGHT THREAD	1
23	.80012-21	ELBOW, STRAIGHT THREAD	1
24	.80004-03	CONNECTOR, STRAIGHT THREAD	1
25	.80012-08	ELBOW, STRAIGHT THREAD	1

Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	NISSAN SD-16

SECT.	6
FIG.	16
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.63613	STUD	2
27	.63305	WASHER, LOCK	2
28	.60705	NUT, HEX	2

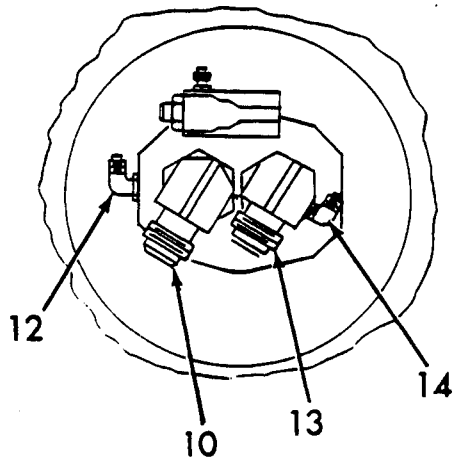
REV.

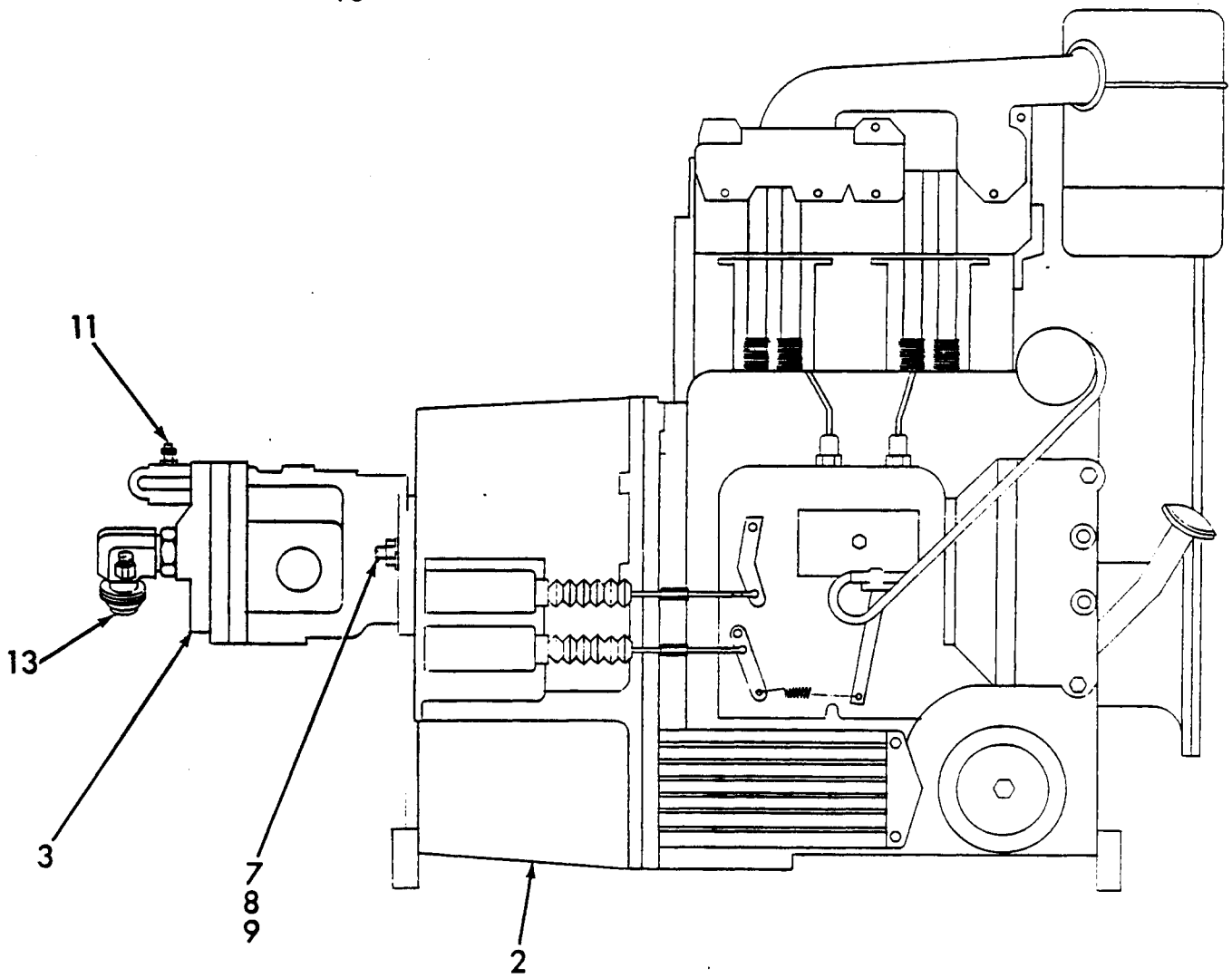
DASH (-) INDICATES THE 'ITEM' IS NOT ILLUSTRATED

Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	DEUTZ F2L912

SECTION	6
FIGURE	17
PAGE	1





REV.

Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C
NOTES	DEUTZ F2L912

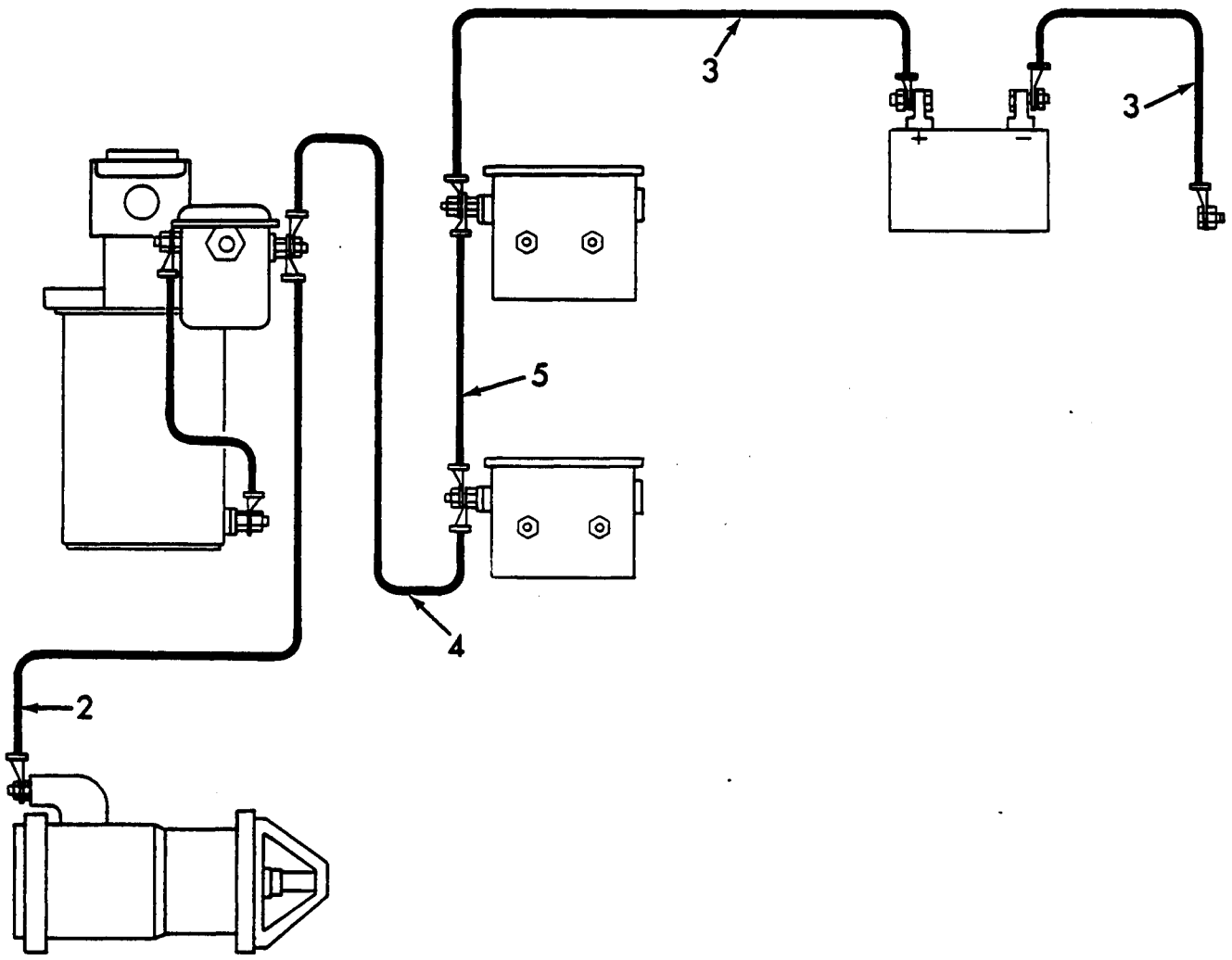
SECT.	6
FIG.	17
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22490	ASSEMBLY, ENGINE/PUMP (DEUTZ)	REF
2	.22489	ENGINE (DEUTZ F2L-912) (See Vendor Chapter for Details)	1
3	.20753	PUMP	1
-4	..600163	KIT, SEAL	1
-5	...66741	SEAL, SHAFT	1
6	..21757	ASSEMBLY, PRESSURE FLOW COMPENSATOR	1
7	.63613	STUD	2
8	.60705	NUT, HEX	2
9	.63305	WASHER, LOCK	2
10	.80012-28	ELBOW, STRAIGHT THREAD	1
11	.80004-03	CONNECTOR, STRAIGHT THREAD	1
12	.80012-08	ELBOW, STRAIGHT THREAD	1
13	.20798	ELBOW, MODIFIED STRAIGHT THREAD	1
14	.80008-08	ELBOW, MALE	1

Mark Industries

TITLE	BATTERY CABLE KIT
MODEL	42C
NOTES	DEUTZ

SECTION	6
FIGURE	18
PAGE	1



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20645	KIT, BATTERY CABLE (DEUTZ)	REF
2	.13226-0470	ASSEMBLY, ELECTRICAL CABLE	1
3	.13226-0200	ASSEMBLY, ELECTRICAL CABLE	2
4	.13226-0400	ASSEMBLY, ELECTRICAL CABLE	1
5	.13226-0070	ASSEMBLY, ELECTRICAL CABLE	1

REV.

Mark Industries

TITLE	SHEET METAL KIT
MODEL	42C
NOTES	DEUTZ

SECT.	6
FIG.	19
PAGE	2

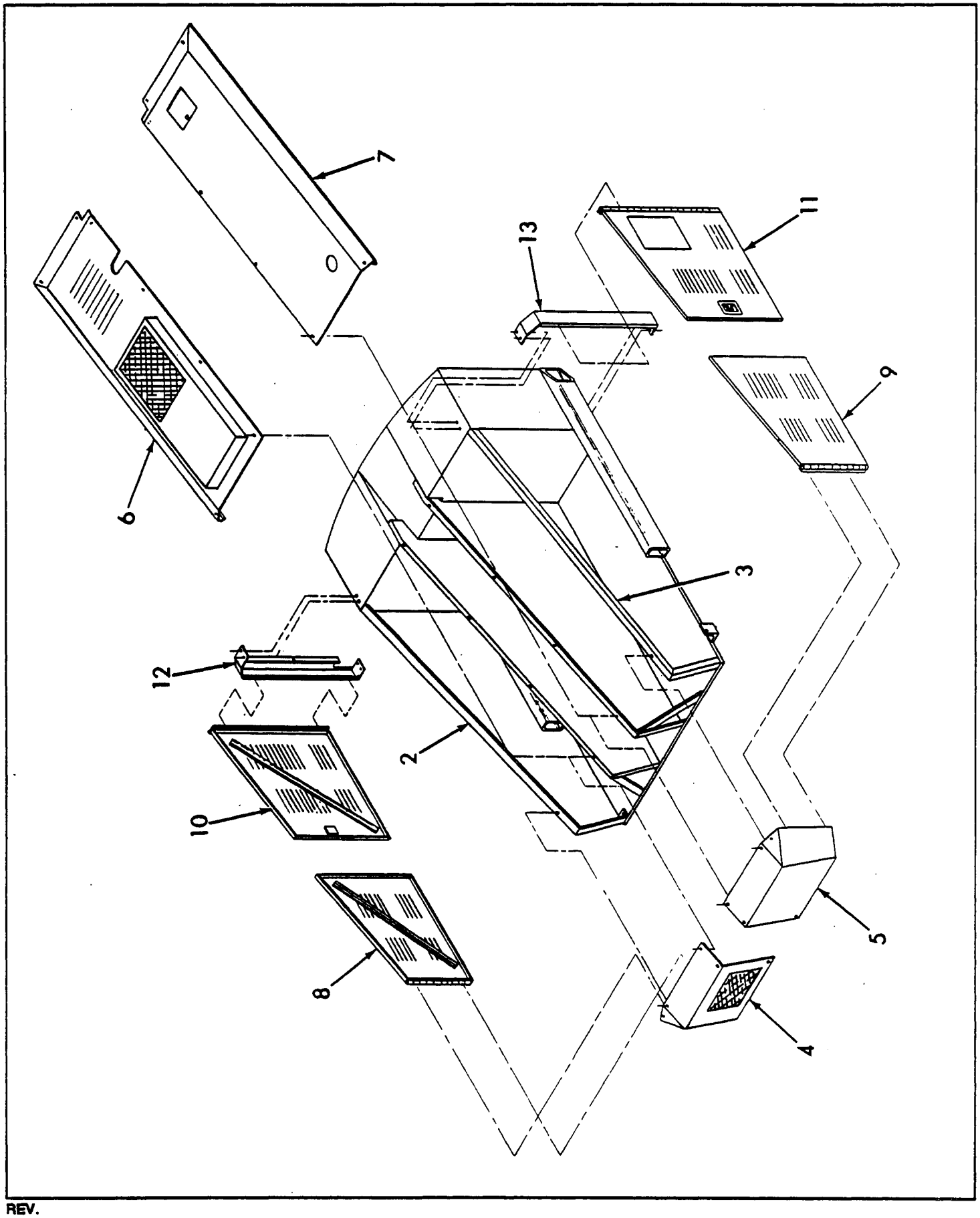
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	22445	KIT, SHEET METAL	REF
2	.21742	BRACKET, LEFT ANGLE	1
3	.21741	BRACKET, RIGHT ANGLE	1
4	.22504	NOSEPIECE, LEFT	1
5	.21735	NOSEPIECE, RIGHT	1
6	.22446	COVER, TOP LEFT	1
7	.21745	COVER, TOP RIGHT	1
8	.21740	DOOR, LEFT REAR	1
9	.21739	DOOR, RIGHT REAR	1
10	.21738	DOOR, LEFT FRONT	1
11	.21737	DOOR, RIGHT FRONT	1
12	.21744	SUPPORT, LEFT FRONT	1
13	.21743	SUPPORT, RIGHT FRONT	1

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

Mark Industries

TITLE	SHEET METAL KIT
MODEL	42C
NOTES	DEUTZ

SECTION	2
FIGURE	19
PAGE	1



REV.

Mark Industries

TITLE	SHEET METAL KIT
MODEL	42C
NOTES	NISSAN

SECTION	6
FIGURE	20
PAGE	1

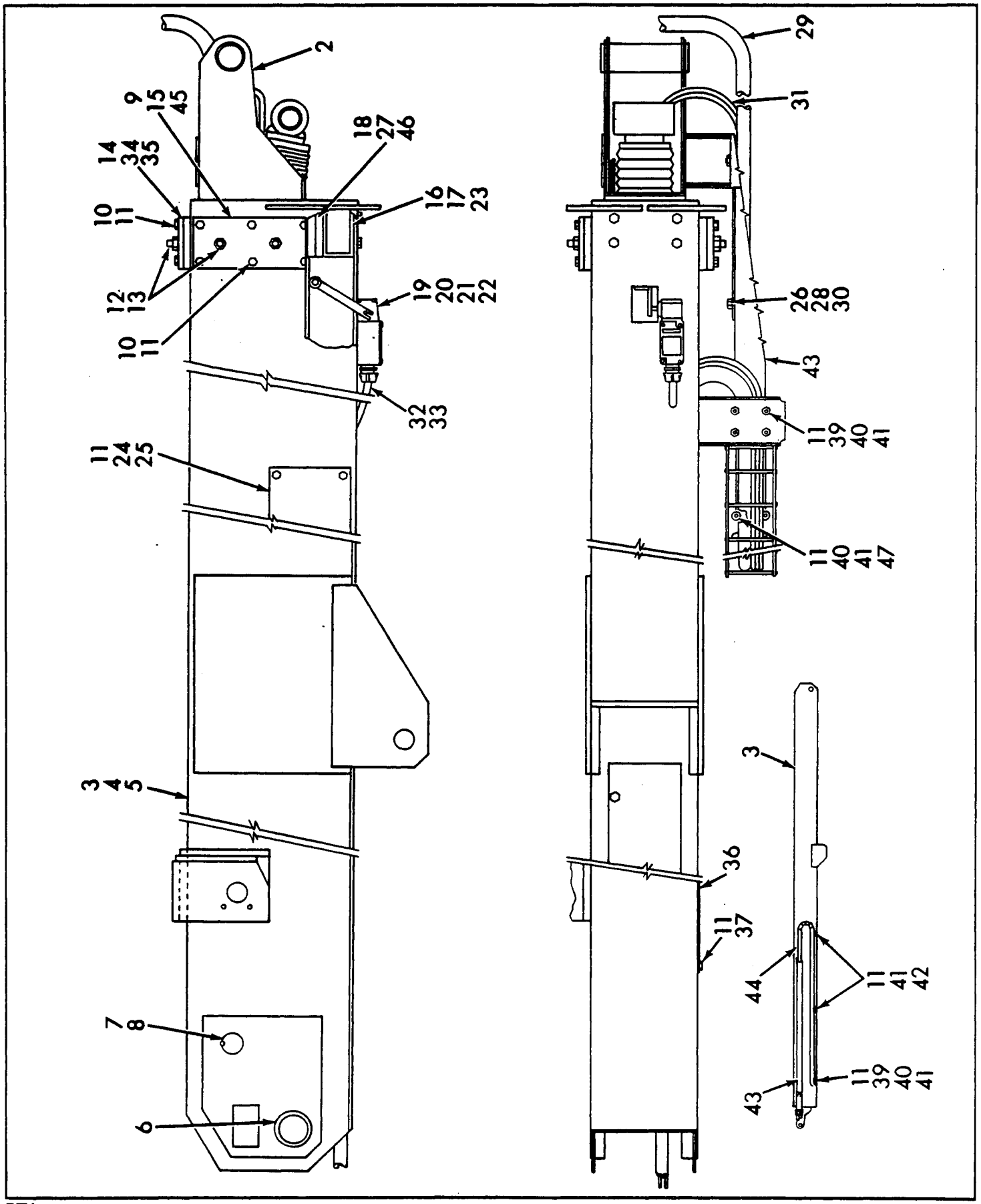
ILLUSTRATION NOT AVAILABLE; PARTS LIST ONLY

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	210286	KIT, SHEET METAL	REF
2	.21742	BRACKET, LEFT ANGLE	1
3	.21741	BRACKET, RIGHT ANGLE	1
4	.21736	NOSEPIECE, LEFT	1
5	.21735	NOSEPIECE, RIGHT	1
6	.24511	COVER, TOP LEFT	1
7	.21745	COVER, TOP RIGHT	1
8	.21740	DOOR, LEFT REAR	1
9	.21739	DOOR, RIGHT REAR	1
10	.21738	DOOR, LEFT FRONT COVER	1
11	.21737	DOOR, RIGHT FRONT	1
12	.21744	SUPPORT, LEFT FRONT	1
13	.21743	SUPPORT, RIGHT FRONT	1
14	.60102	SCREW, CAP	18
15	.63403	WASHER, FLAT	18
16	.63303	WASHER, LOCK	18
17	.61902	SCREW, CAP	40
18	.61313	NUT, HEX	18
19	.63401	WASHER, FLAT	40
20	.61816	SCREW, CAP	2
21	.63301	WASHER, LOCK	2

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C
NOTES	EXTERNAL POWER TRACK

SECTION	6
FIGURE	21
PAGE	1



REV.

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C
NOTES	EXTERNAL POWER TRACK

SECT.	6
FIG.	21
PAGE	2

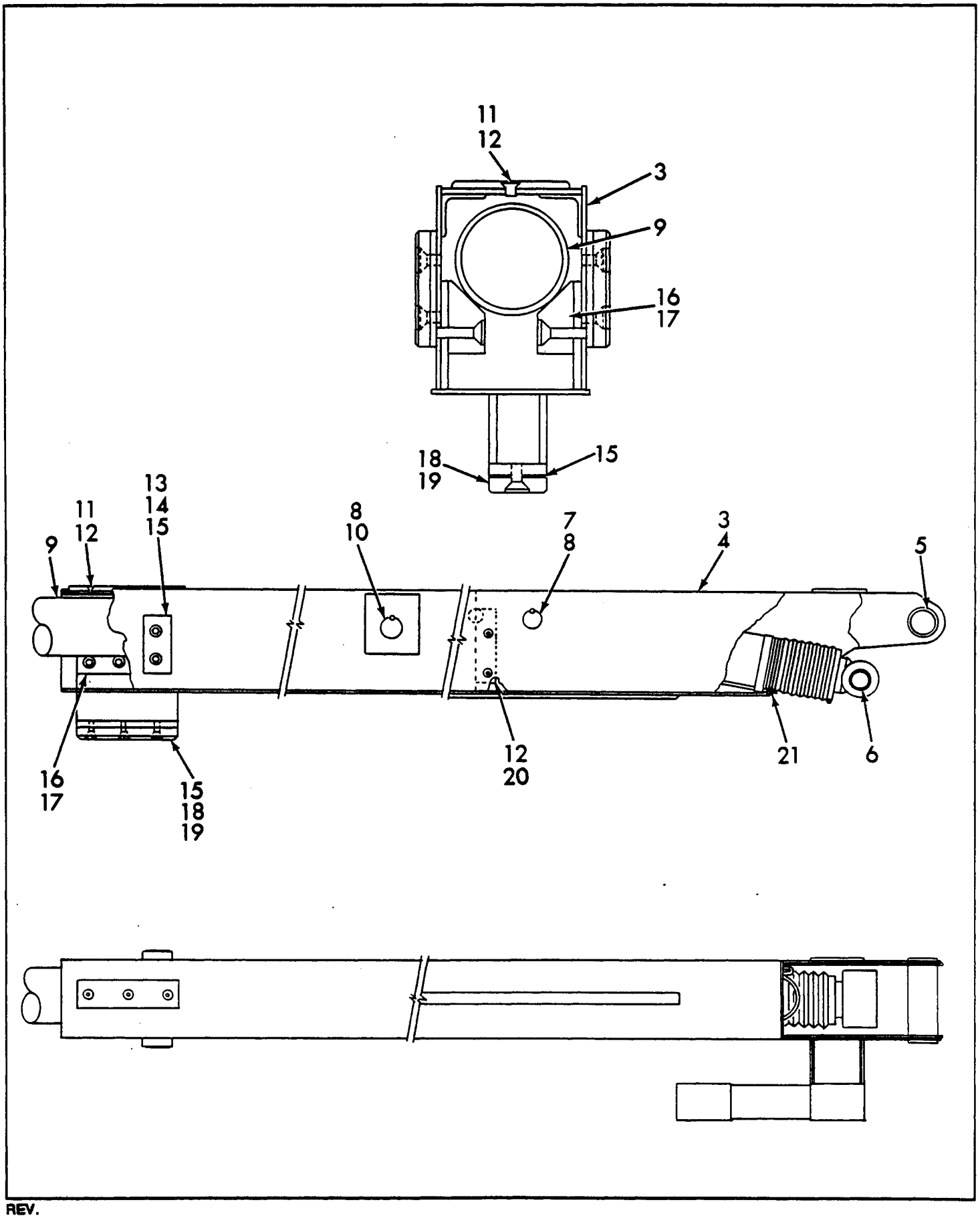
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24962	ASSEMBLY, FINAL BOOM	REF
2	.24959	ASSEMBLY, INNER BOOM (See Sect. 6, Fig. 22 for Details)	1
3	.24961	MACHINING, OUTER BOOM	1
4	..24960	WELDMENT, OUTER BOOM	1
5	...23074	WELDMENT, LIFT CYLINDER BRACKET	1
6	..21782	BUSHING, BOOM PIVOT	2
7	.23163	PIN, EXTENSION CYLINDER	1
8	.62203	SCREW, SET	2
9	.24473	COVER, PRESSURE PAD	2
10	.60338	SCREW, CAP	12
11	.63302	WASHER, LOCK	32
12	.62204	SCREW, SET	6
13	.61101	NUT, JAM	6
14	.23159	COVER, PRESSURE PAD	1
15	.24471	PAD, WEAR	2
16	.60325	SCREW, CAP	4
17	.23162	PAD, WEAR	2
18	.61805	SCREW, CAP	4
19	.70107	SWITCH, LIMIT	1
20	.63313	WASHER, LOCK	2
21	.70148	ARM, LEVER SWITCH	1
22	.62615	SCREW, MACHINE	2
23	.63303	WASHER, LOCK	4
24	.24472	COVER, ACCESS	1
25	.60322	SCREW, CAP	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.63405	WASHER, FLAT	4
27	.21278	SHIM, WEAR PAD	2
28	.61245	NUT, LOCK	2
29	.20802	CABLE, ELECTRICAL	66 FT
-30	.2568-840	HOSE, HYDRAULIC	4
31	..2568	HOSE	70 FT
32	.2768	CABLE, ELECTRICAL	28.3 FT
33	.2806	RELIEF, STRAIN	1
34	.23164	PLATE, PAD PRESSURE	1
35	.210239	PAD, WEAR	1
36	.23515	COVER, DOUBLER PLATE	1
37	.60324	SCREW, CAP	1
38	.62119	SCREW, SHOULDER	2
39	.61931	SCREW, CAP	8
40	.63402	WASHER, FLAT	8
41	.60702	NUT, HEX	12
42	.61828	SCREW, CAP	4
43	.24841	WELDMENT, TUBE	1
44	.24869	TRACK, STAINLESS STEEL POWER	49 LKS
45	.24470	PLATE, PAD PRESSURE	2
46	.23162	PAD, WEAR	2
47	.61952	SCREW, CAP	4

Mark Industries

TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	EXTERNAL POWER TRACK

SECTION	6
FIGURE	22
PAGE	1



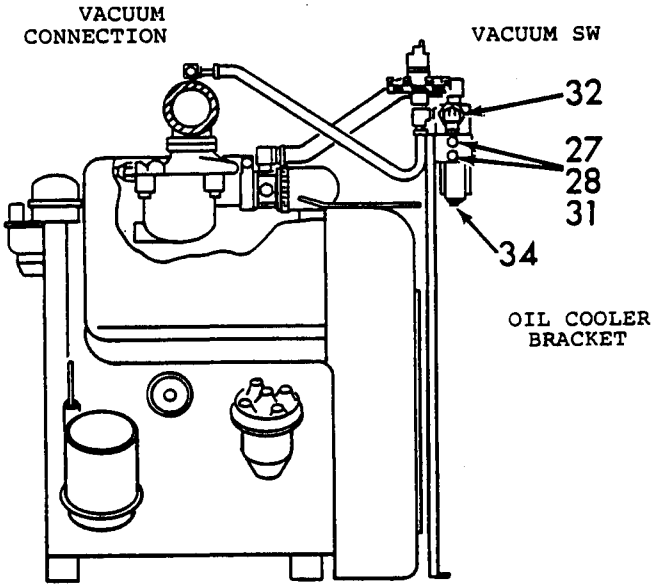
REV.

Mark Industries

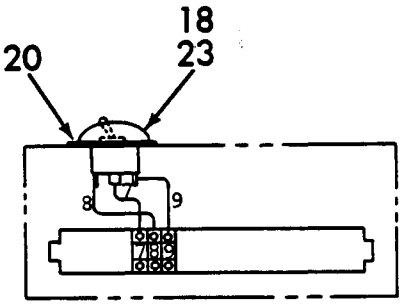
TITLE	INNER BOOM ASSEMBLY
MODEL	42C
NOTES	EXTERNAL POWER TRACK

SECT.	6
FIG.	22
PAGE	2

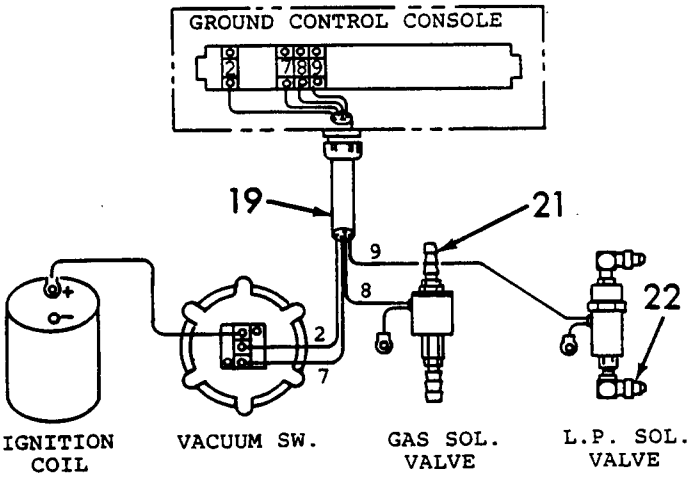
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	24959	ASSEMBLY, INNER BOOM (See Sect. 6, Fig. 21 for NHA)	REF
-2	.24958	MACHINING, INNER BOOM	1
3	..24462	WELDMENT, INNER BOOM	1
4	...24467	WELDMENT, PAD SUPPORT	1
5	..20582	BUSHING	2
6	.23550	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 4, Fig. for Details)	1
7	.23084	PIN, SLAVE LEVELING CYLINDER	1
8	.62203	SCREW, SET	2
9	.23185	ASSEMBLY, EXTENSION CYLINDER (See Sect. 4, Fig. for Details)	1
10	.23156	PIN, EXTENSION CYLINDER	1
11	.24804	PAD, WEAR	1
12	.61822	SCREW, CAP	6
13	.22567	PAD, WEAR	2
14	.61801	SCREW, CAP	4
15	.24501	SHIM, WEAR PAD	1
16	.23151	PAD, WEAR	2
17	.61802	SCREW, CAP	4
18	.24469	PAD, WEAR	1
19	.61805	SCREW, CAP	3
20	.23166	WELDMENT, BULKHEAD PLATE	1
21	.65133	FITTING, FEMALE HOSE	1



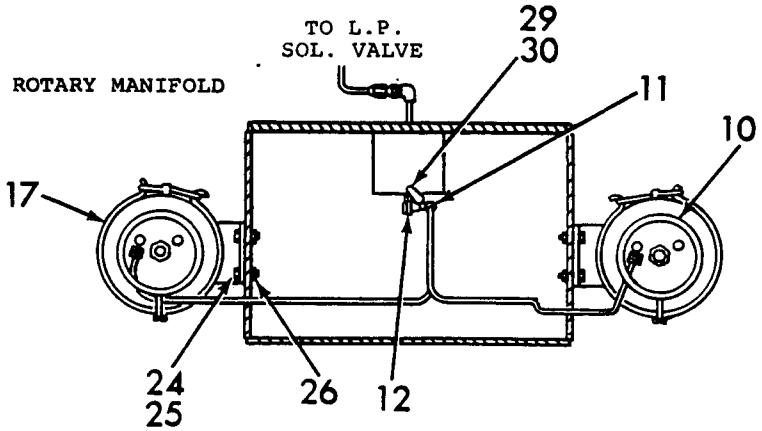
ENGINE ASSY.



AERIAL CONTROL CONSOLE



IGNITION COIL | VACUUM SW. | GAS SOL. VALVE | L.P. SOL. VALVE



Mark Industries

TITLE	DUAL FUEL KIT
MODEL	42C
NOTES	VG4D

SECT.	6
FIG.	23
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20163	KIT, DUAL FUEL (VG4D)	REF
-2	.21240	KIT, DUAL FUEL	1
-3	..16921	REGULATOR (50E)	1
-4	...16919	KIT, REGULATOR REPAIR	1
-5	..67779	LOCK, LPG FILTER	1
-6	..16975	KIT, VACUUM SAFETY SWITCH	1
-7	...16923	SWITCH, VACUUM SAFETY (MICROVAC)	1
-8	16919	KIT, SAFETY SWITCH REPAIR	1
-9	..67780	VALVE, GASOLINE	1
10	.486-C	TANK, LPG	2
11	.80029-07	TEE, FEMALE	1
12	.21897	ASSEMBLY, LPG LINE SWIVEL JOINT	1
-13	..21896	BRACKET, SWIVEL LPG LINE	1
-14	..20815	JOINT, LPG LINE SWIVEL	1
-15	..65391	NIPPLE, PIPE	1
-16	..16506	ELBOW, FEMALE	2
17	.486-A	BRACKET, TANK	4
18	.20884	GUARD, SWITCH	1
19	.2912	CABLE, CONDUCTOR	1 FT
20	.182706	DECAL, DUAL FUEL SELECTOR	1
21	.65209	BARB, HOSE	2
22	.80009-07	ELBOW, FEMALE	1
23	.4019	SWITCH, SELECTOR	1
24	.63303	WASHER, LOCK	8
25	.60307	SCREW, CAP	8

Mark Industries

TITLE	DUAL FUEL KIT	SECT. 6
MODEL	42C	FIG. 23
NOTES	VG4D	PAGE 3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.60703	NUT, HEX	8
27	.60312	SCREW, CAP	2
28	.60701	NUT, HEX	2
29	.60612	SCREW, CAP	1
30	.60613	SCREW, CAP	1
31	.63401	WASHER, FLAT	4
32	.80001-08	CONNECTOR, MALE	1
-33	.65135	PROPANE	10 GAL
34	.20886	REWORK, THROTTLE BRACKET	1

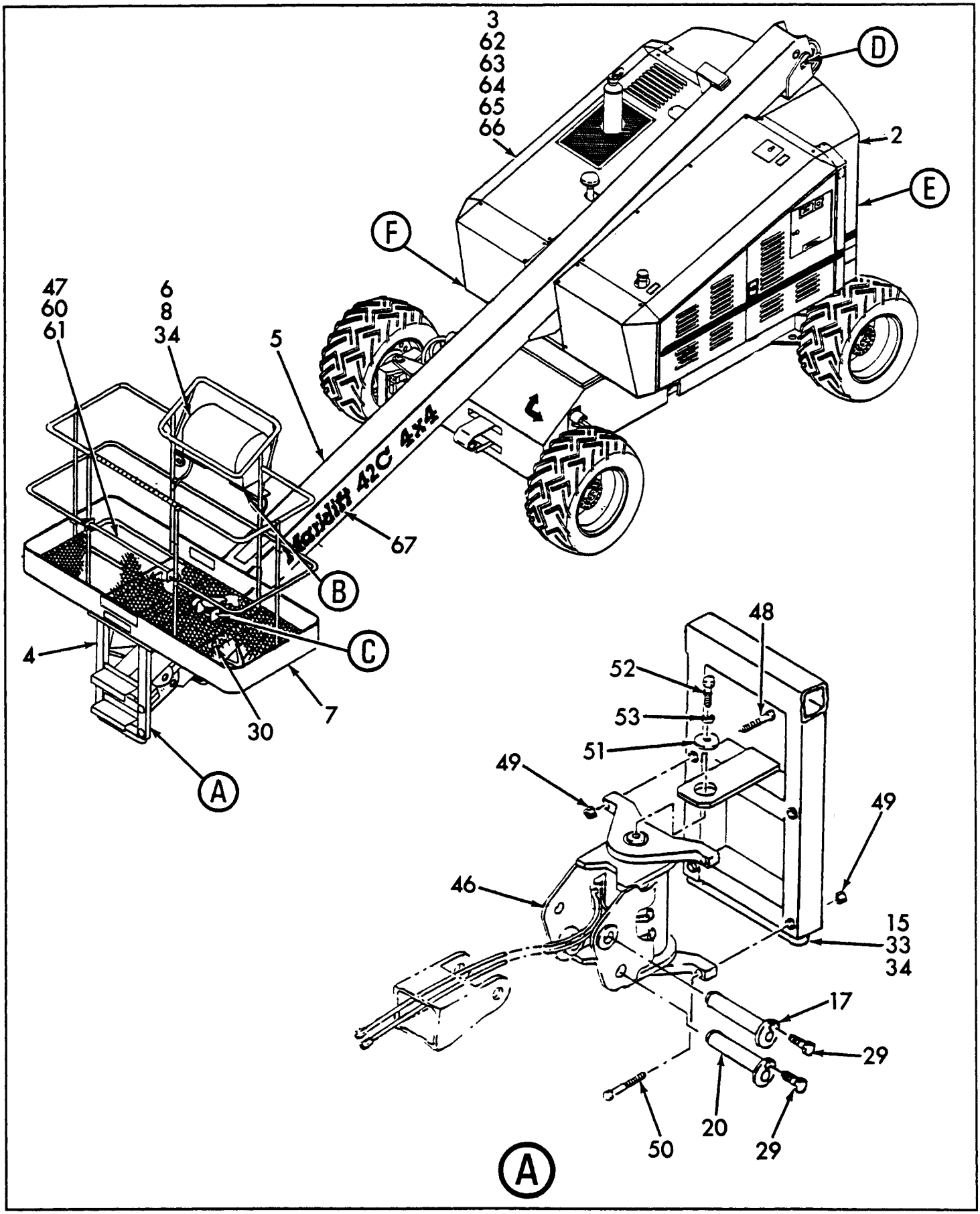
SECTION 7 CONTAINS:

FIG. NO.	TITLE
1	FINAL ASSEMBLY
2	TURRET ASSEMBLY
3	SHEET METAL KIT
4	FINAL BOOM ASSEMBLY
5	INNER BOOM MODIFICATION ASSEMBLY
6	BOOM MODIFICATION ASSEMBLY
7	AERIAL CONTROL BOX ASSEMBLY
8	DECAL SET
9	LIMIT SWITCH/BRACKET ASSEMBLY
10	8 METER DRIVE CUT-OUT ASSEMBLY
11	TRAVEL WARNING HORN WITH BEACON ASSEMBLY
12	CARRIAGE ASSEMBLY & TURRET WELDMENT
13	ENGINE/PUMP ASSEMBLY
14	GROUND CONTROL BOX ASSEMBLY
15	BATTERY CABLE KIT

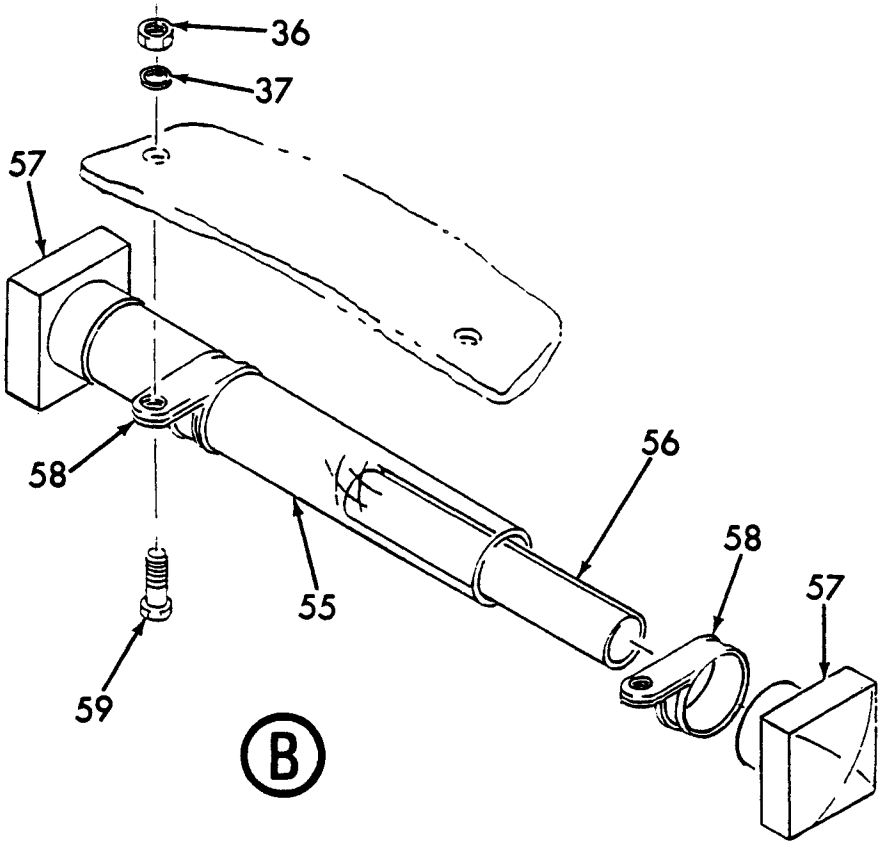
Mark Industries

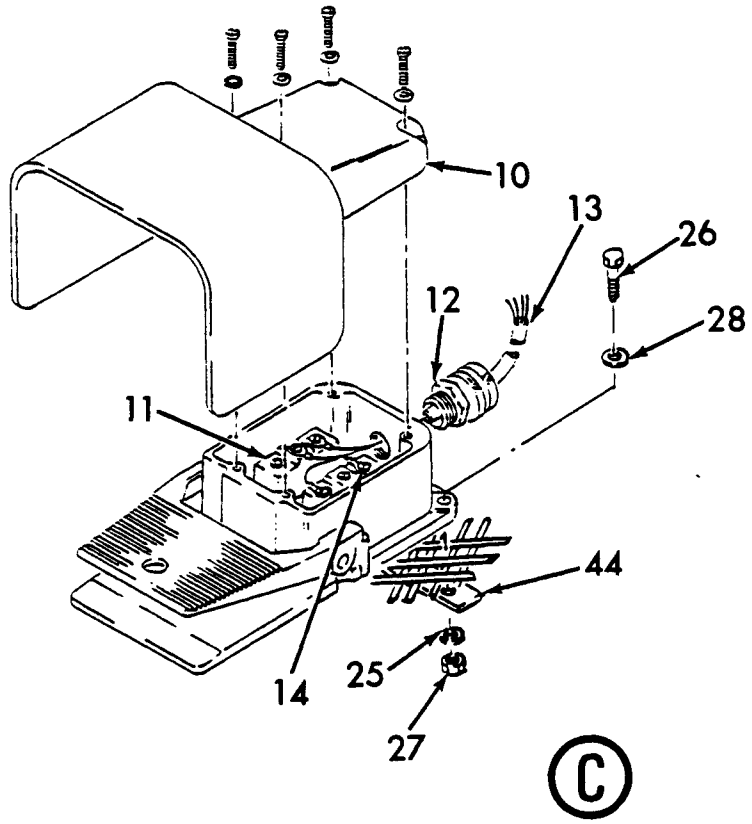
TITLE	FINAL ASSEMBLY
MODEL	42C (TUV)
NOTES	

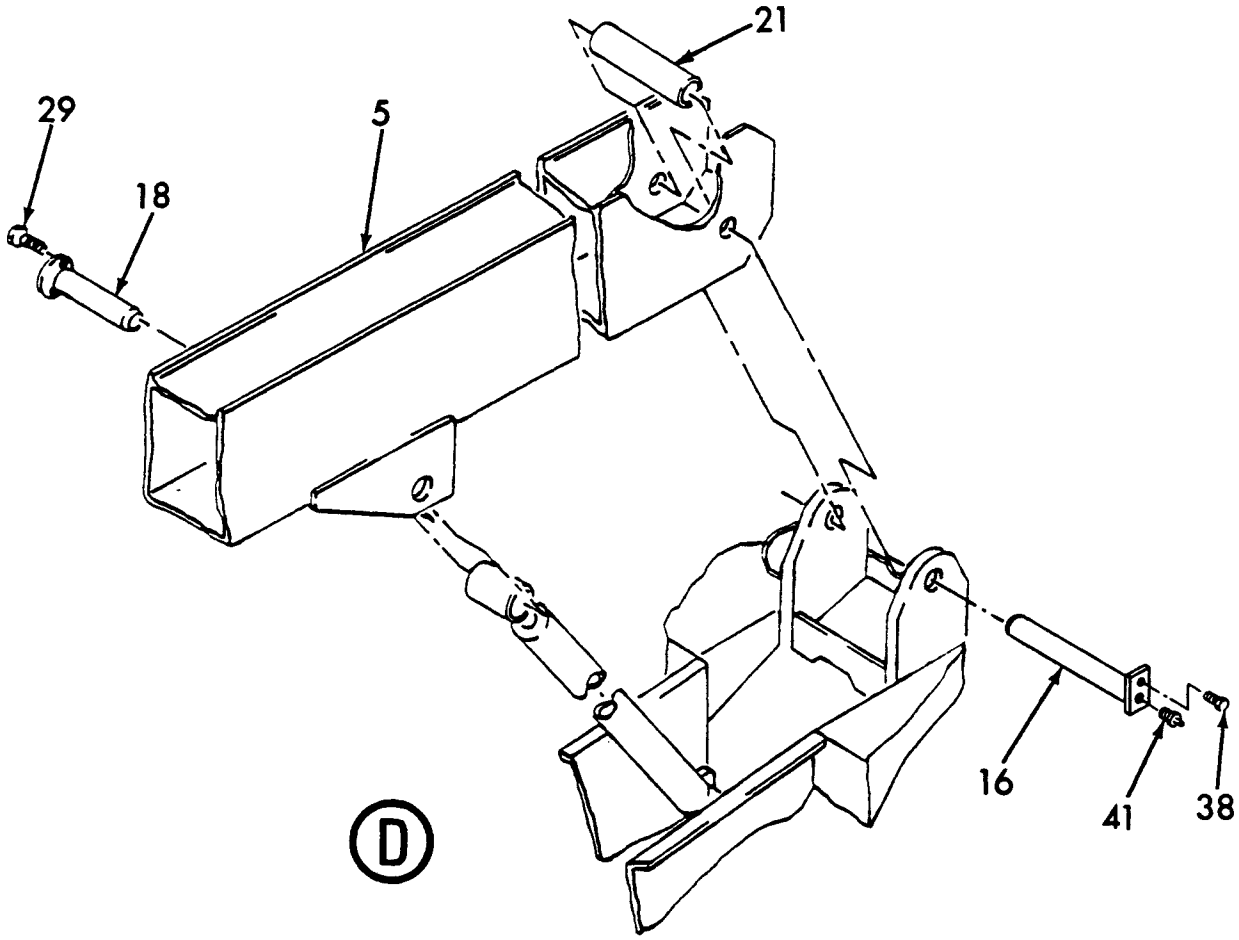
SECTION	7
FIGURE	1
PAGE	1

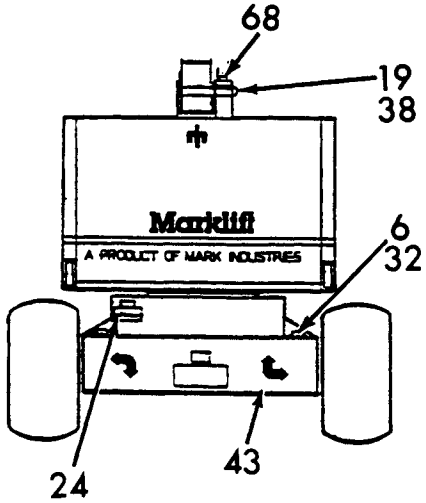


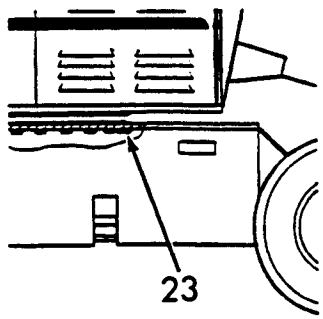
REV


36
37
57
58
56
58
57
55
59
B


10
13
26
12
28
11
44
25
14
27
C


21
29
5
18
16
41
38
D


68
19
38
Markliff
A PRODUCT OF MARK INDUSTRIES
6
32
24
43
E


23
F

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	SKP-1277	ASSEMBLY, FINAL	REF
2	.210800	ASSEMBLY, TURRET (See Sect. 7, Fig. 2 for Details)	1
3	.SKP-1285	KIT, SHEET METAL (See Sect. 7, Fig. 3 for Details)	1
4	.210682	WELDMENT, FORK	1
5	.SKP-1286	ASSEMBLY, FINAL BOOM (See Sect. 7, Fig. 4 for Details)	1
6	.60343	SCREW, CAP	4
7	.24150	WELDMENT, 6' PLATFORM (36" WIDE)	1
8	.210573	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 7, Fig. 7 for Details)	1
-9	.20480	ASSEMBLY, FOOTSWITCH	1
10	..70212	FOOTSWITCH	1
11	...66336	MICROSWITCH	2
12	..2531	RELIEF, STRAIN	1
13	..2912	CABLE, CONDUCTOR (18 AWG/4 COND.)	5 FT
14	..876	TERMINAL, RING	4
15	.20552	BUMPER, PLATFORM	1
16	.23199	PIN, BOOM PIVOT	1
17	.20457	PIN, BOOM PIVOT - FORK	1
18	.23509	PIN, LIFT CYLINDER ROD END	1
19	.22491	PIN, MASTER LEVELING CYLINDER (BLIND END)	1
20	.20261	PIN, LEVELING CYLINDER (ROD END)	1
21	.26454	TUBE, ROUND	1
22	.16608	PAINT, WHITE WATERBASE #9042-2	8 GAL
23	.60609	SCREW, CAP	18

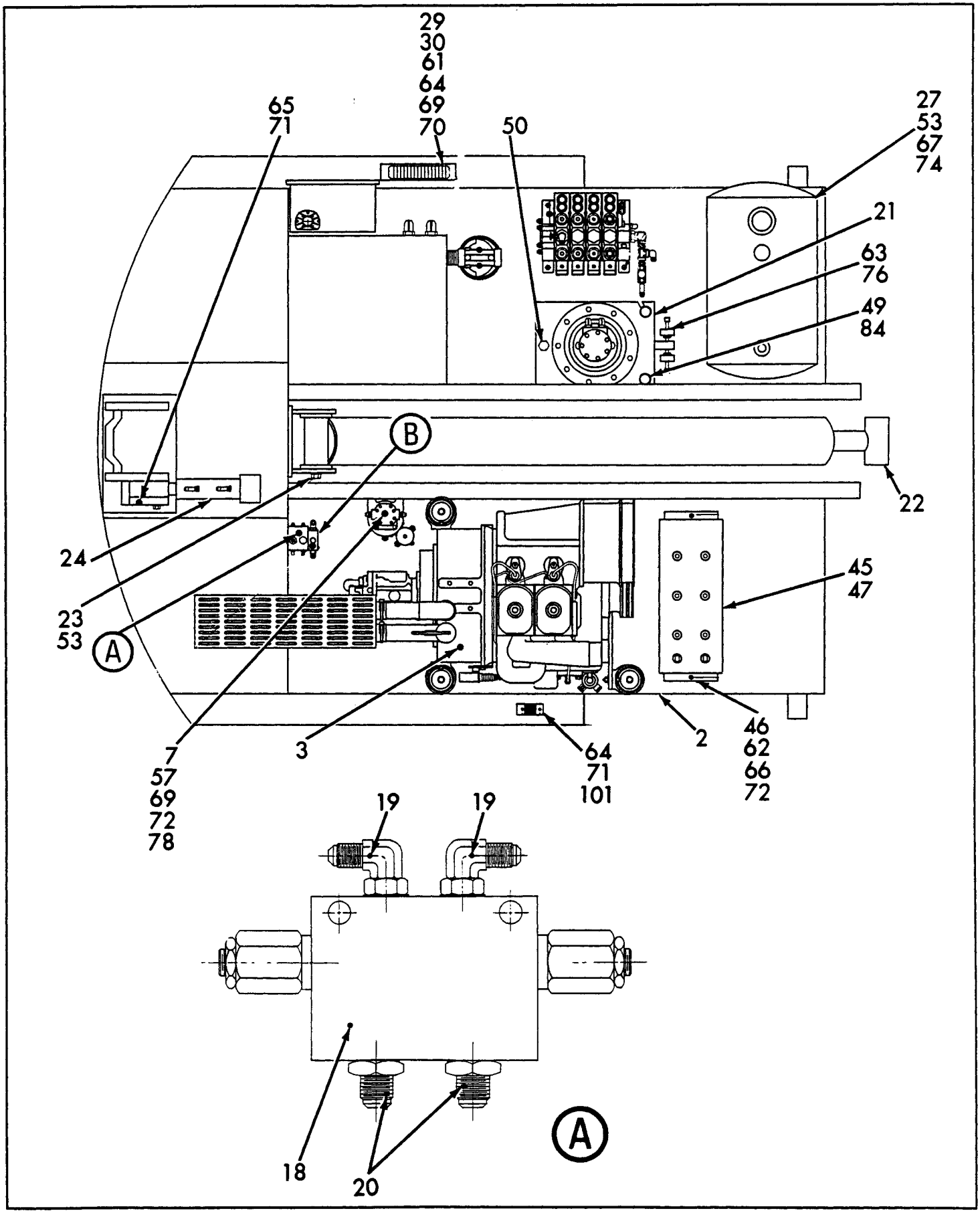
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	.63653	RIVET, POP	8
25	.63302	WASHER, SPLIT	20
26	.60346	SCREW, CAP	2
27	.60702	NUT, HEX	2
28	.63402	WASHER, FLAT	20
29	.60607	SCREW, CAP	3
30	.60515	SCREW, CAP	4
31	.61302	NUT, HEX	4
32	.63303	WASHER, SPLIT	4
33	.60307	SCREW, CAP	2
34	.60703	NUT, HEX	4
35	.65112	PAINT, TANK WHITE	½ GAL
36	.61239	NUT, LOCK	2
37	.63401	WASHER, FLAT	31
38	.60613	SCREW, CAP	4
39	.210575	SCHEMATIC, ELECTRICAL (DEUTZ)	1
40	.210781	SCHEMATIC, HYDRAULIC (DIESEL)	1
41	.65103	FITTING, GREASE	2
42	.65389	PAINT, BLUE	1 GAL
43	.21611	COVER, REAR DRIVE	1
44	.22742	PLATE, DEADMAN SWITCH BACKING	1
45	.65116	OIL, HYDRAULIC	45 GAL
46	.24444	ASSEMBLY, HELAC ROTATOR (See Sect. 2, Fig. 4 for Details)	1
47	.141080	WELDMENT, SLIDE BAR	1
48	.60540	SCREW, CAP	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
49	.160063	NUT, HEX	4
50	.60513	SCREW, CAP	2
51	.23565	WASHER	1
52	.60516	SCREW, CAP	1
53	.63305	WASHER, SPLIT	1
54	.16268	CLAMP, HOSE	5
55	.210681	HOLDER, DOCUMENT (INTERNATIONAL)	1
56	.17409	HANDBOOK, OPERATION & SAFETY	1
57	.65842	CAP, ANTI-ROLL	2
58	.65867	CLAMP	2
59	.60309	SCREW, CAP	2
60	.160212	PIN, CLEVIS	2
61	.160213	PIN, COTTER	2
62	.60322	SCREW, CAP	18
63	.61902	SCREW, CAP	44
64	.61313	NUT, SELF-LOCKING	20
65	.61816	SCREW, CAP	2
66	.63301	WASHER, SPLIT	2
67	.SKP-1207	DECAL, MODIFICATION (GERMAN) (See Sect. 7, Fig. 8 for Details)	1
68	.211046	ASSEMBLY, LIMIT SWITCH/BRACKET (See Sect. 7, Fig. 9 for Details)	1
69	.211047	ASSEMBLY, 8 METER DRIVE CUT-OUT (See Sect. 7, Fig. 10 for Details)	1
70	.211048	ASSEMBLY, TRAVEL WARNING HORN W/BEACON (See Sect. 7, Fig. 11 for Details)	1

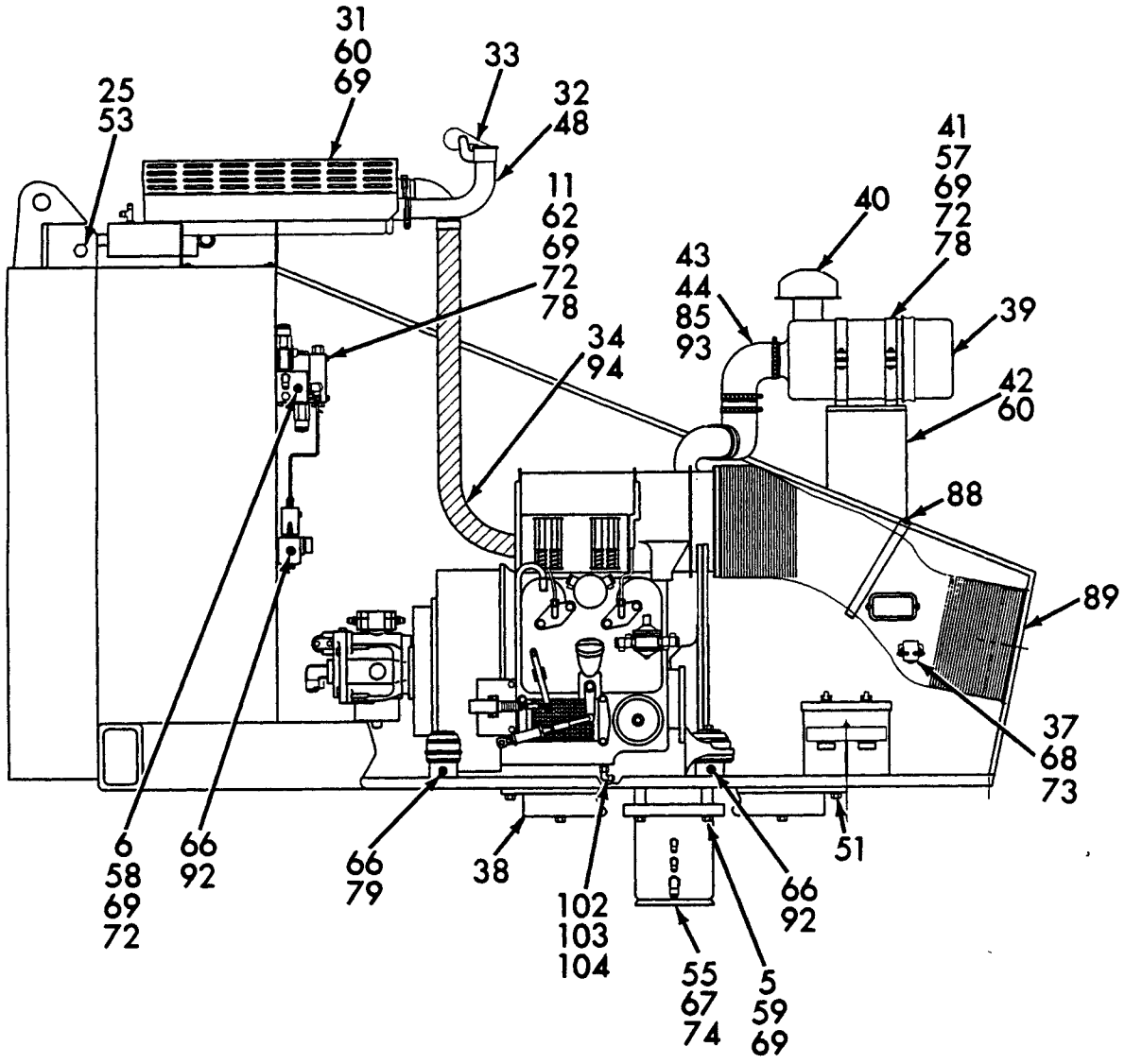
Mark Industries

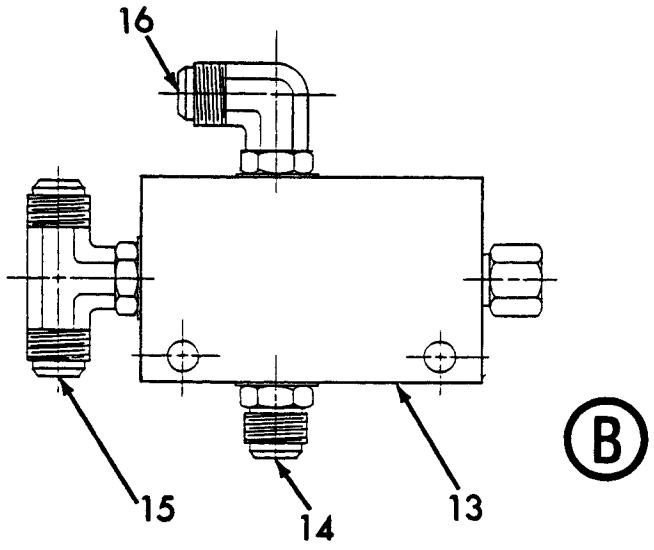
TITLE	TURRET ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECTION	7
FIGURE	2
PAGE	1

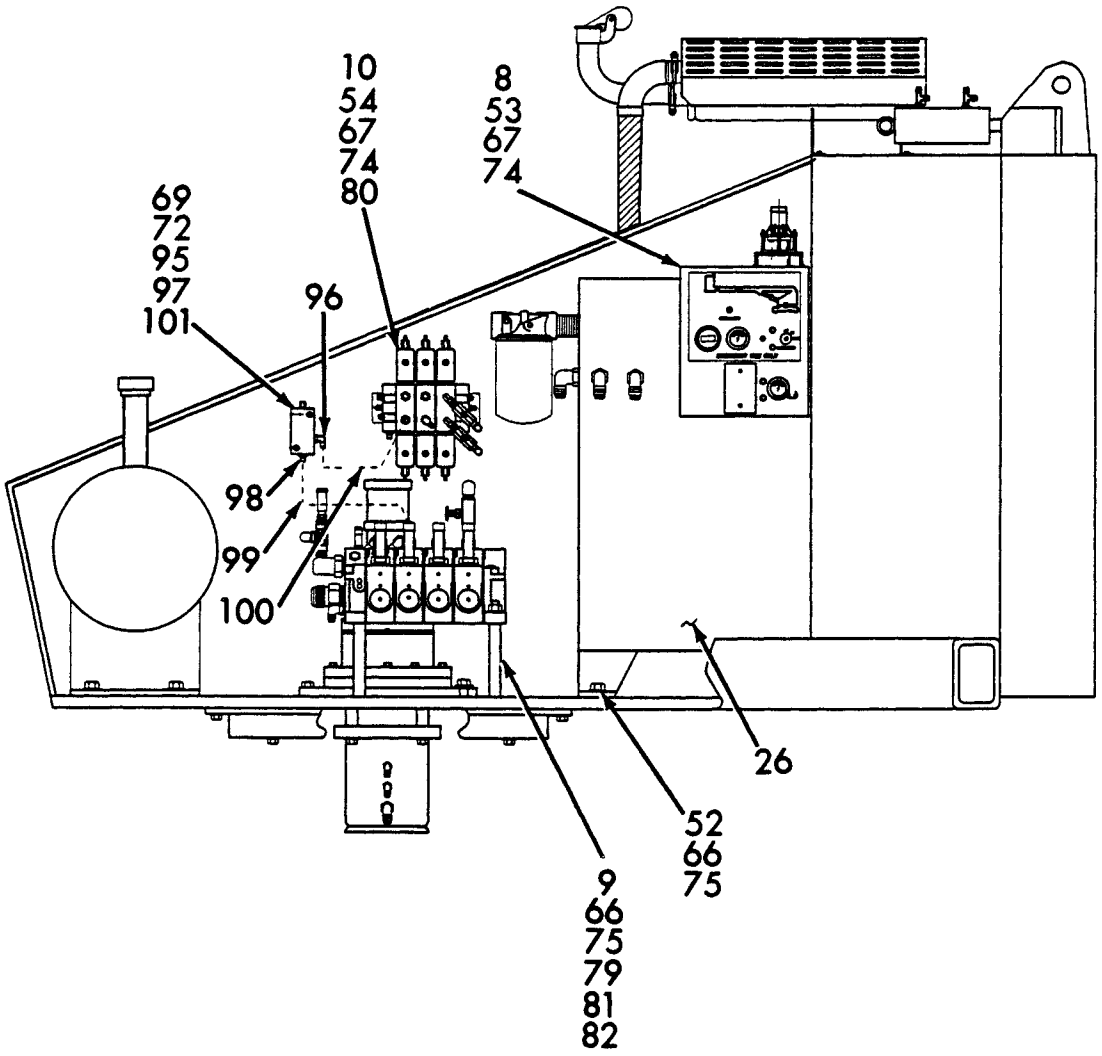


REV


31
60
69
33
25
53
32
48
41
57
69
72
78
11
62
69
72
78
40
43
44
85
93
39
34
94
42
60
88
89
37
68
73
6
58
69
72
66
92
66
79
38
102
103
104
51
66
92
55
67
74
5
59
69


16
15
14
13
B

REV


10
54
67
74
80
8
53
67
74
69
72
95
97
101
96
98
99
100
26
52
66
75
9
66
75
79
81
82

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	210800	ASSEMBLY, TURRET (See Sect. 7, Fig. 1 for NHA)	REF
2	.SKP-1308	ASSEMBLY, CARRIAGE (AND TURRET WELDMENT) (See Sect. 7, Fig. 12 for Details)	1
3	.210789	ASSEMBLY, ENGINE & PUMP (DEUTZ) (See Sect. 7, Fig. 13 for Details)	1
4	.21898	ASSEMBLY, ROTARY MANIFOLD (See Sect. 4, Fig. 13 for Details)	1
5	.20445	SPACER, MANIFOLD	4
6	.22609	ASSEMBLY, SOLENOID VALVE (See Sect. 4, Fig. 2 for Details)	1
7	.22390	ASSEMBLY, EMERGENCY PUMP/MOTOR (See Sect. 4, Fig. 12 for Details)	1
8	.210574	ASSEMBLY, GROUND CONTROL BOX (See Sect. 7, Fig. 14 for Details)	1
9	.24145	ASSEMBLY, PROPORTIONAL VALVE (See Sect. 4, Fig. 6 for Details)	1
10	.23551	ASSEMBLY, MINIPAK (See Sect. 4, Fig. 10 for Details)	1
-11	.21598	ASSEMBLY, RELIEF VALVE	1
-12	..20564	REWORK, RELIEF VALVE	1
13	...20516	VALVE, RELIEF	1
14	..80004-11	CONNECTOR, STRAIGHT THREAD	1
15	..80036-11	TEE	1
16	..80012-11	ELBOW, STRAIGHT THREAD	1
-17	.21584	ASSEMBLY, DUAL OVERCENTER VALVE	1
18	..20365	VALVE, DUAL OVERCENTER	1
19	..80012-05	ELBOW, STRAIGHT THREAD	2
20	..80004-05	CONNECTOR, STRAIGHT THREAD	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
21	.22842	ASSEMBLY, ROTATION GEARBOX (See Sect. 4, Fig. 8 for Details)	1
22	.21705	ASSEMBLY, LIFT CYLINDER (See Sect. 4, Fig. 9 for Details)	1
23	.21780	PIN, CYLINDER LIFT (BLIND END)	1
24	.22583	ASSEMBLY, MASTER LEVELING CYLINDER (See Sect. 4, Fig. 3 for Details)	1
25	.22492	PIN, MASTER LEVELING CYLINDER (ROD END)	1
26	.21704	ASSEMBLY, HYDRAULIC TANK (See Sect. 4, Fig. 5 for Details)	1
27	.22389	ASSEMBLY, DIESEL FUEL TANK (See Sect. 6, Fig. 14 for Details)	1
28	.24396	ASSEMBLY, ELECTRIC CHECK VALVE (See Sect. 4, Fig. 11 for Details)	1
29	.21217	STRIP, TERMINAL	1
30	.21386	COVER, TERMINAL STRIP	1
31	.65751	MUFFLER, MODIFIED (WITH SHIELD)	1
32	.23546	ELBOW, MODIFIED MUFFLER	1
33	.21288	CAP, MUFFLER RAIN	1
34	.16559	COUPLING	2
35	.70031	LEVER, LIMIT SWITCH	1
36	.70107	SWITCH, LIMIT	1
37	.70209	SOLENOID	1
38	.20740	GEAR, RING	1
39	.160082	CLEANER, AIR	1
40	.160083	HOOD, AIR INLET	1
41	.65412	BAND, MOUNTING	2
42	.24790	BRACKET, AIR CLEANER (DEUTZ)	1

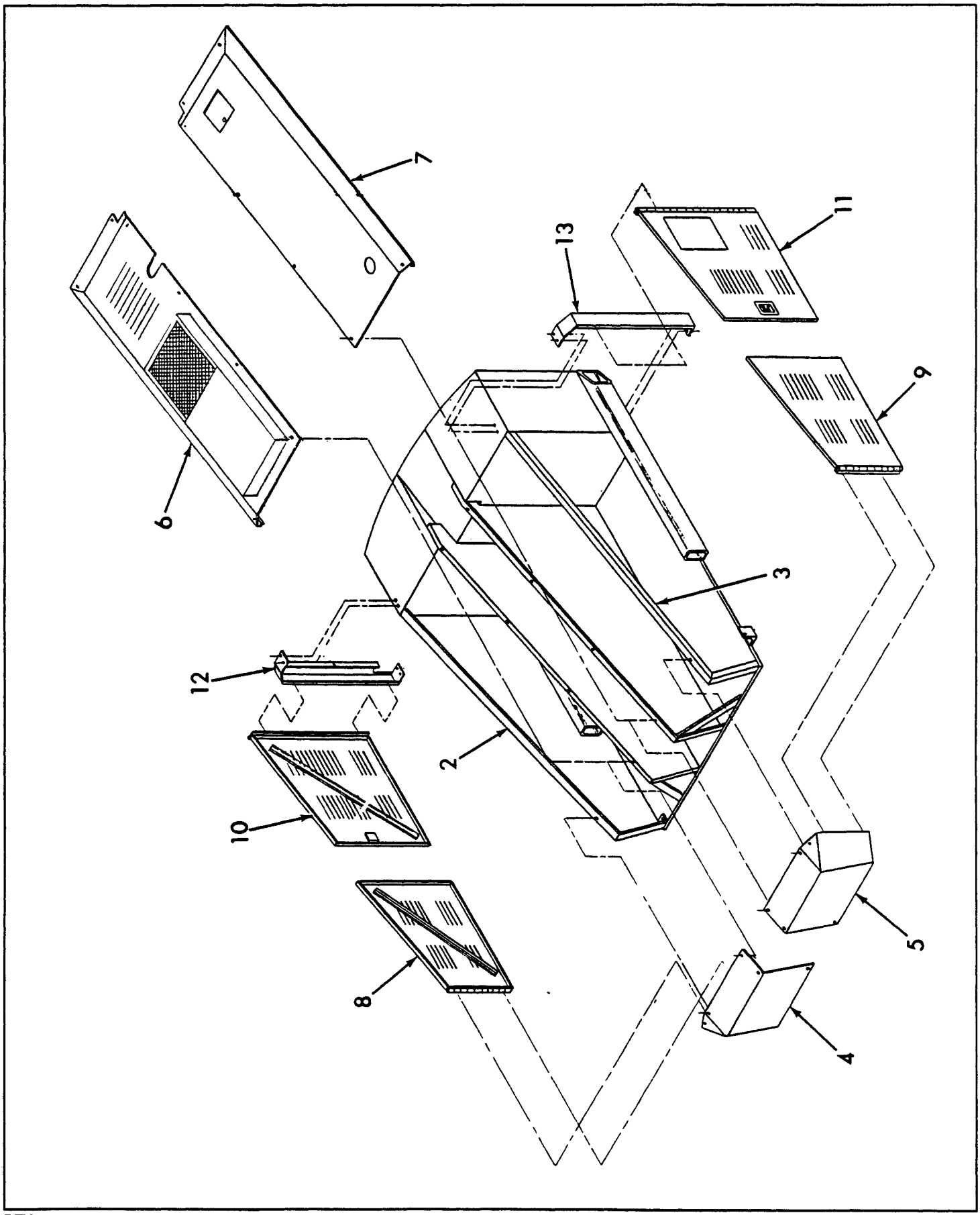
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
43	.160085	ADAPTER, MOLDED RUBBER	2
44	.28297	RUBE, ROUND	1
45	.21244	BATTERY, 12 VOLT	1
46	.21286	BRACKET, BATTERY HOLD DOWN	2
47	.20670	KIT, BATTERY CABLE (See Sect. 7, Fig. 15 for Details)	1
48	.16230	CLAMP, MUFFLER (2 INCH)	2
49	.60637	SCREW, CAP	2
50	.60601	SCREW, CAP	2
51	.60604	SCREW, CAP	16
52	.60326	SCREW, CAP	4
53	.60325	SCREW, CAP	10
54	.60613	SCREW, CAP	2
55	.60612	SCREW, CAP	2
56	.60352	SCREW, CAP	4
57	.60338	SCREW, CAP	10
58	.60329	SCREW, CAP	2
59	.60511	SCREW, CAP	4
60	.61828	SCREW, CAP	4
61	.60323	SCREW, CAP	2
62	.60316	SCREW, CAP	2
63	.62222	SCREW, SET	2
64	.62620	SCREW, MACHINE	4
65	.62704	SCREW, MACHINE	2
66	.63305	WASHER, SPLIT	37
67	.63303	WASHER, SPLIT	21

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
68	.63301	WASHER, SPLIT	2
69	.63302	WASHER, SPLIT	31
70	.63326	WASHER, SPLIT	4
71	.63313	WASHER, SPLIT	4
72	.63402	WASHER, FLAT	31
73	.63401	WASHER, FLAT	8
74	.63403	WASHER, FLAT	17
75	.63405	WASHER, FLAT	7
76	.60910	NUT, JAM	2
77	.60707	NUT, HEX	3
78	.60702	NUT, HEX	6
79	.60705	NUT, HEX	8
80	.60703	NUT, HEX	3
81	.27672	TUBE, ROUND	3
82	.63683	ROD, THREADED	3
83	.27833	TUBE, ROUND	2
84	.22169	WASHER, ROTATION GEARBOX	2
85	.65417	CLAMP, 2½" HOSE	6
-86	.211049 KIT-B	DIAGRAM, HYDRAULIC HOSE	1
-87	.211049 KIT-D	DIAGRAM, HYDRAULIC HOSE	1
88	.210794	CLAMP, ENGINE INLET DUCT	1
-89	.210791	ASSEMBLY, INLET DUCT (F3L1011)	1
90	..210792	DUCT, INLET	2
91	..160543	DUCT, FLEX (48")	1
92	.60551	SCREW, CAP	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
93	.210797	WELDMENT, BRACKET AIR CLEANER	1
94	.210799	WELDMENT, EXHAUST	1
95	.20516	VALVE, RELIEF	1
96	.80012-09	ELBOW, STRAIGHT THREAD	1
97	.80051-06	PLUG, HOLLOW	1
98	.80004-09	CONNECTOR, STRAIGHT THREAD	1
99	.13210-06-0340	ASSEMBLY, HOSE	1
100	.13213-06-0170	ASSEMBLY, HOSE	1
101	.60360	SCREW, CAP	2
102	.81367	CONNECTOR, METRIC THREAD	1
103	.80015-06	ELBOW, SWIVEL NUT	1
104	.80059-06	CAP	1

Mark Industries

TITLE	SHEET METAL KIT	SECTION	7
MODEL	42C (TUV)	FIGURE	3
NOTES		PAGE	1



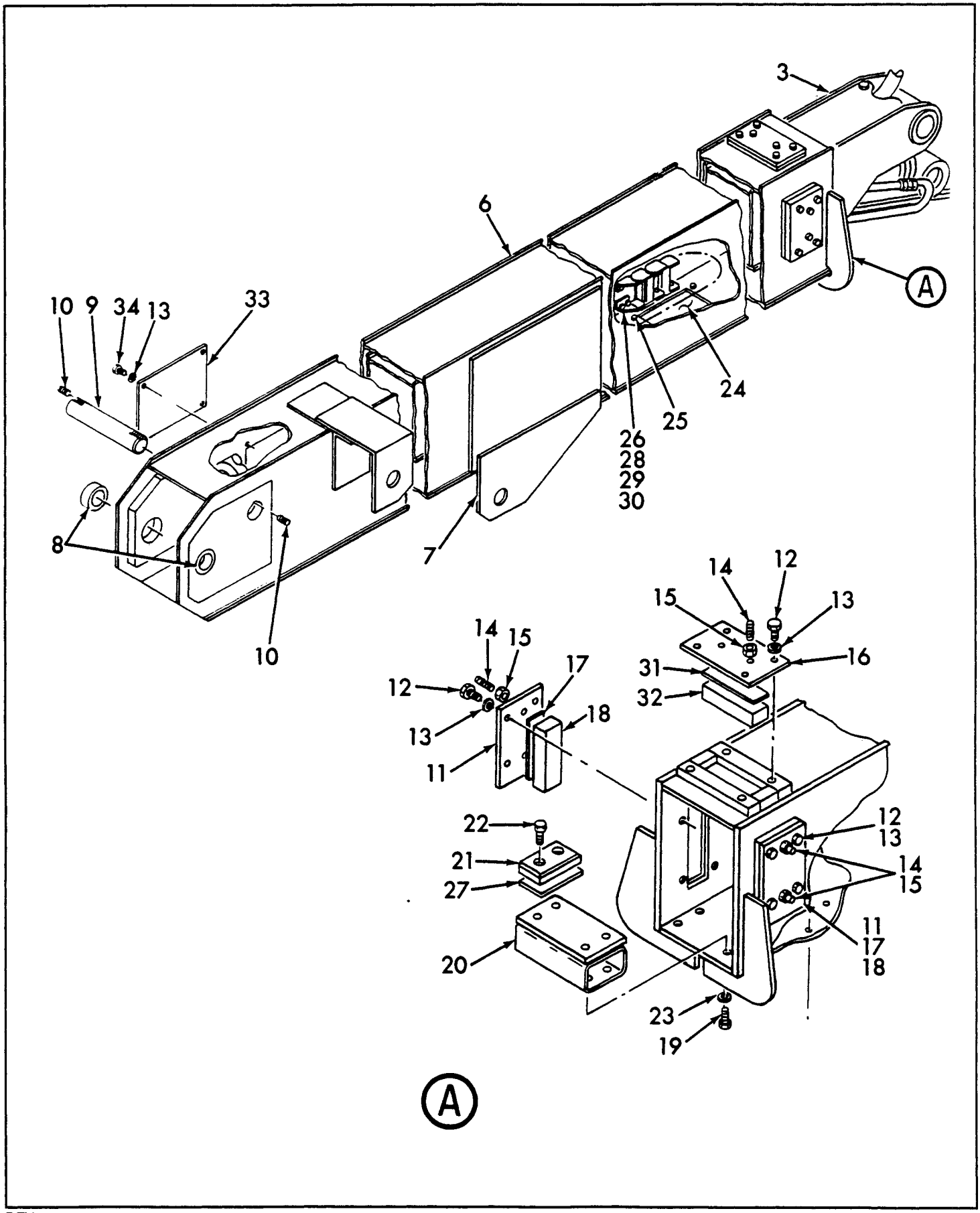
REV

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	SKP-1285	KIT, SHEET METAL (See Sect. 7, Fig. 1 for NHA)	REF
2	.21742	BRACKET, LEFT ANGLE	1
3	.21741	BRACKET, RIGHT ANGLE	1
4	.210785	NOSEPIECE, LEFT	1
5	.21735	NOSEPIECE, RIGHT	1
6	.210786	COVER, TOP LEFT	1
7	.210782	COVER, TOP RIGHT	1
8	.21740	DOOR, LEFT REAR	1
9	.21739	DOOR, RIGHT REAR	1
10	.210784	DOOR, LEFT FRONT	1
11	.210783	DOOR, RIGHT FRONT	1
12	.21744	SUPPORT, LEFT FRONT	1
13	.21743	SUPPORT, RIGHT FRONT	1

Mark Industries

TITLE	FINAL BOOM ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECTION	7
FIGURE	4
PAGE	1



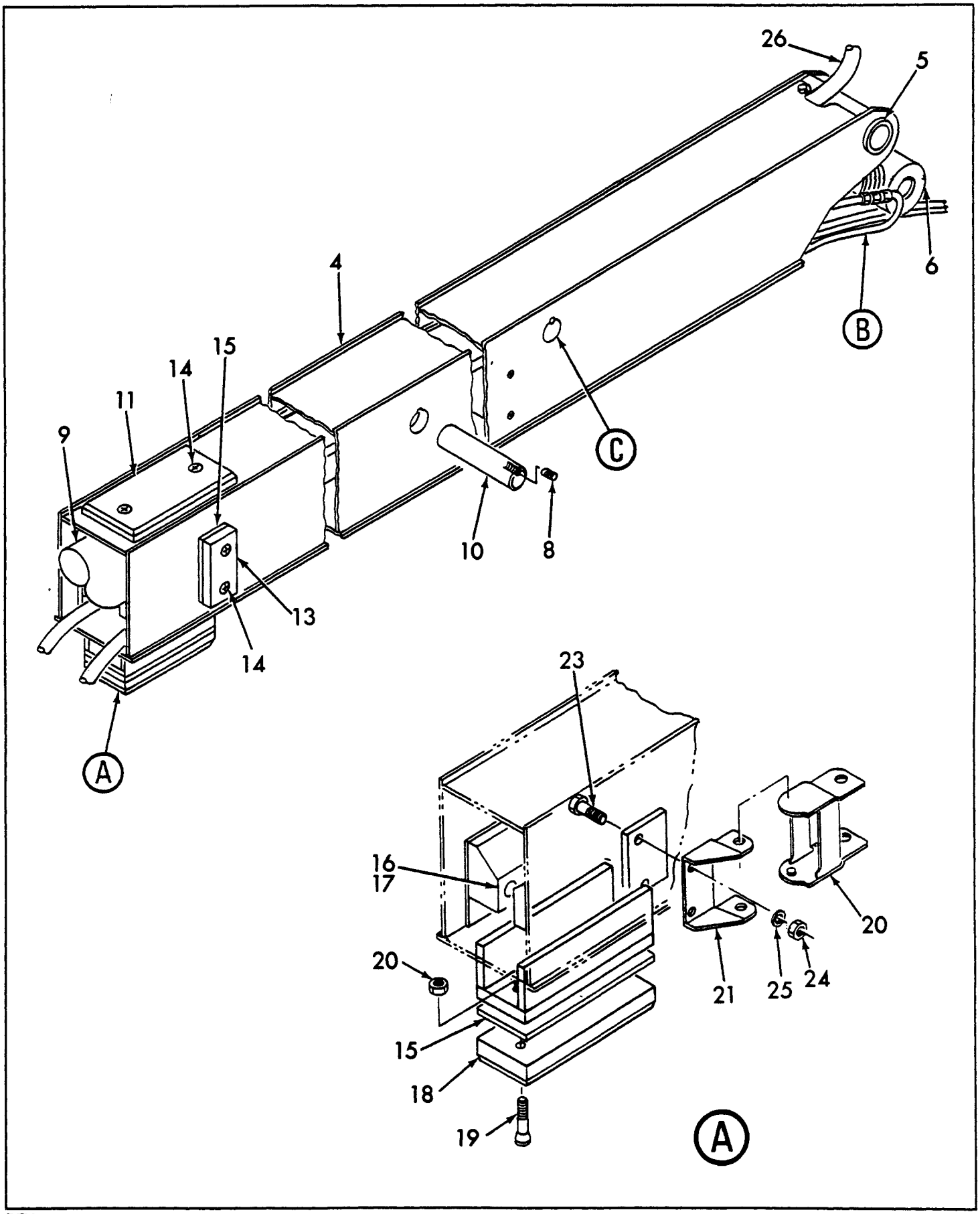
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	SKP-1286	ASSEMBLY, FINAL BOOM (See Sect. 7, Fig. 1 for NHA)	REF
-2	.SKP-1291	ASSEMBLY, FINAL BOOM	1
3	..SKP-1288	ASSEMBLY, INNER BOOM MODIFICATION (See Sect. 7, Fig. 5 for Details)	1
-4	..SKP-1289	MACHINING, OUTER BOOM MODIFICATION	1
-5	...24461	MACHINING, OUTER BOOM	1
6	24460	WELDMENT, OUTER BOOM	1
7	23074	WELDMENT, LIFT CYLINDER BRACKET	1
8	21782	BUSHING, BOOM PIVOT	2
9	..23163	PIN, EXTENSION CYLINDER	1
10	..62229	SCREW, SET	2
11	..24473	COVER, PRESSURE PAD	2
12	..60338	SCREW, CAP	12
13	..63302	WASHER, SPLIT	20
14	..62204	SCREW, SET	6
15	..61101	NUT, JAM	6
16	..23159	COVER, PRESSURE PAD	1
17	..24470	PLATE, PAD PRESSURE	2
18	..24471	PAD, WEAR	2
19	..60325	SCREW, CAP	4
20	..23161	BRACKET, BOOM END	1
21	..23162	PAD, WEAR	2
22	..61805	SCREW, CAP	4
23	..63303	WASHER, SPLIT	4
24	..24472	COVER, ACCESS	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	..60322	SCREW, CAP	4
26	..23875	BRACKET, STATIONARY PLASTITRAK (MALE)	1
27	..21278	SHIM, WEAR PAD	2
28	..60501	SCREW, CAP	2
29	..61312	NUT	2
30	..63401	WASHER, FLAT	2
31	..23164	PLATE, PAD PRESSURE	1
32	..210239	PAD, WEAR	1
33	..23515	COVER, DOUBLER PLATE	1
34	..60324	SCREW, CAP	4
-35	.SKP-1290	ASSEMBLY, BOOM MODIFICATION (See Sect. 7, Fig. 6 for Details)	1

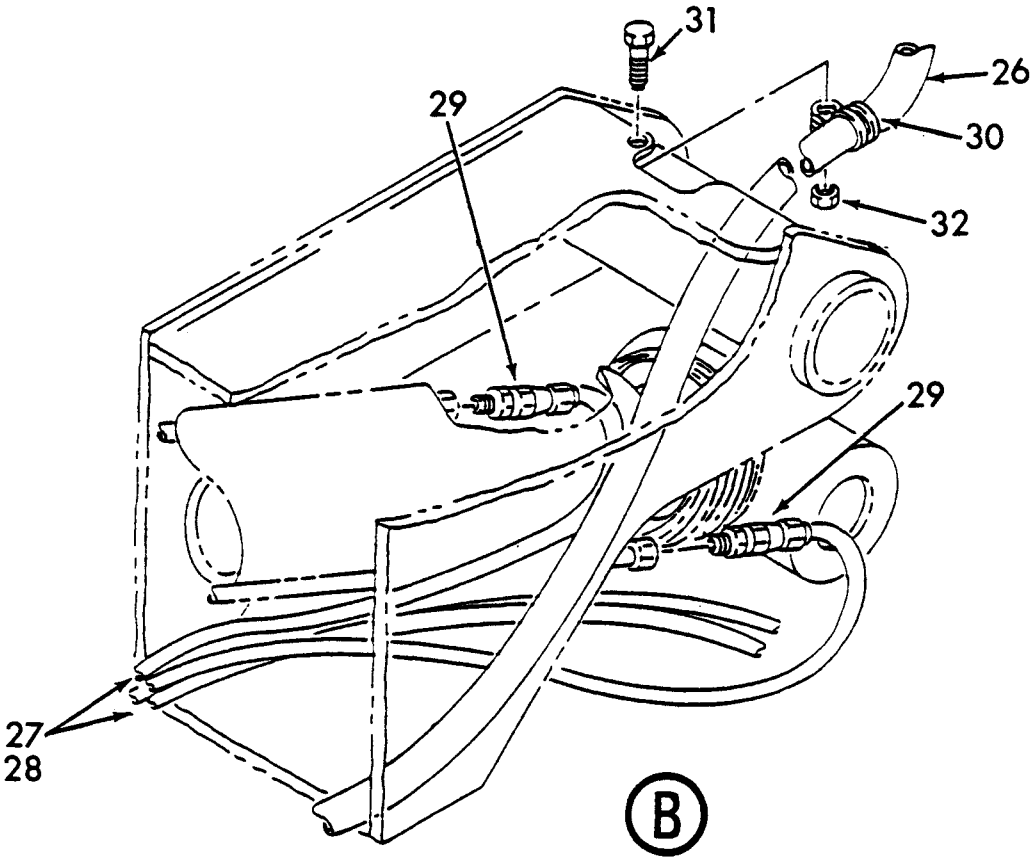
Mark Industries

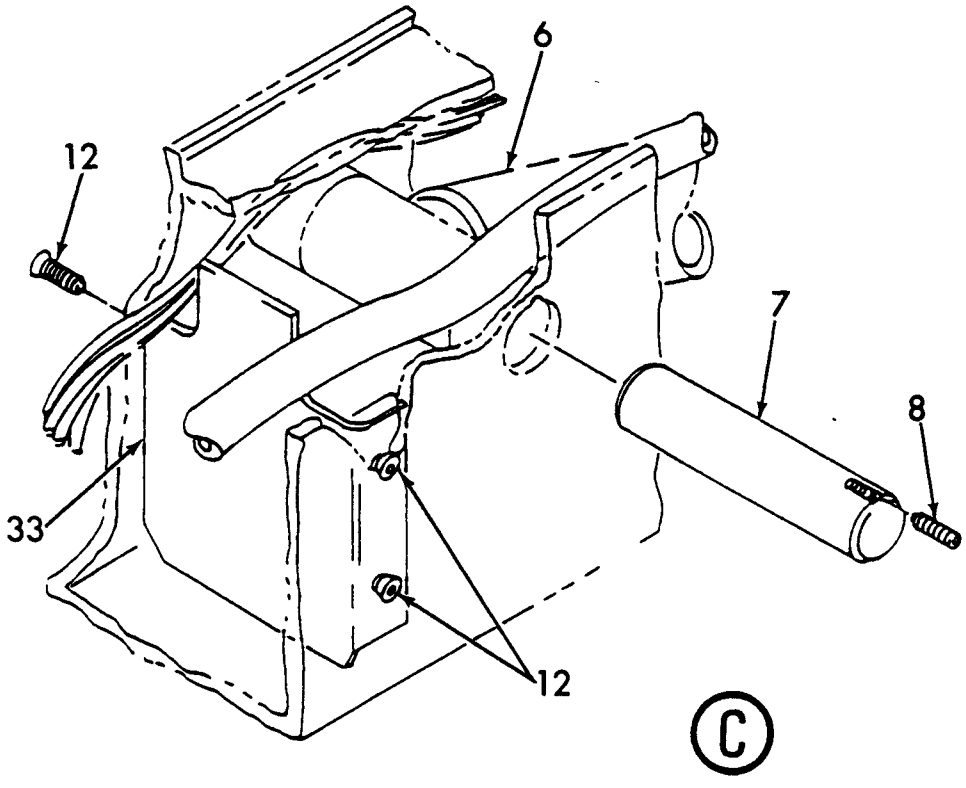
TITLE	INNER BOOM MODIFICATION ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECTION	7
FIGURE	5
PAGE	1



REV


31
26
29
30
32
29
27
28
B


6
12
7
8
33
12
C

Mark Industries

TITLE	INNER BOOM MODIFICATION ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECT	7
FIG	5
PAGE	3

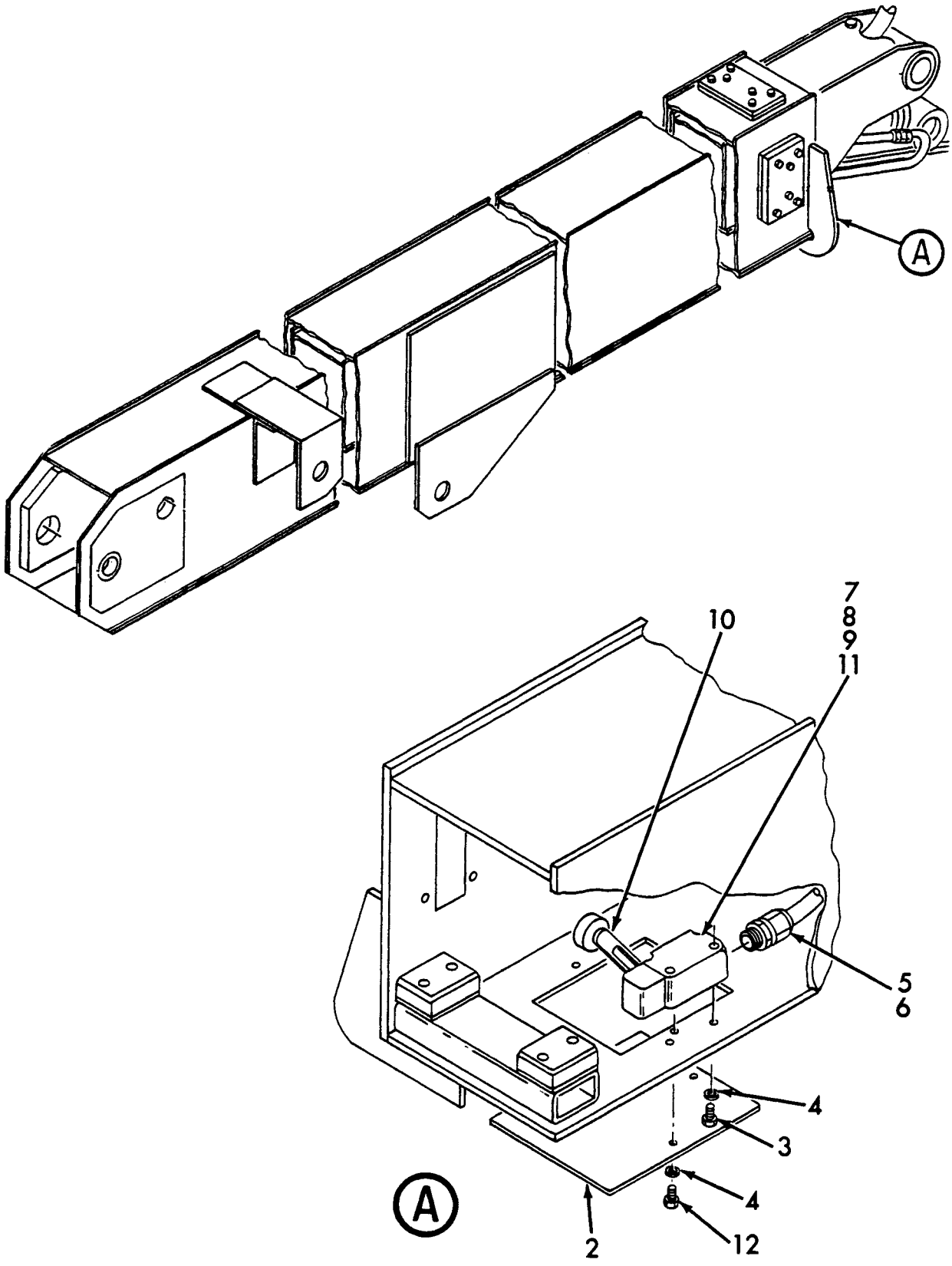
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	SKP-1288	ASSEMBLY, INNER BOOM MODIFICATION (See Sect. 7, Fig. 4 for NHA)	REF
2	.24458	ASSEMBLY, INNER BOOM	1
3	..24463	MACHINING, INNER BOOM	1
4	...24462	WELDMENT, INNER BOOM	1
5	...20582	BUSHING	2
6	..23550	ASSEMBLY, SLAVE LEVELING CYLINDER (See Sect. 5, Fig. 3 or 3A for Details)	1
7	..23084	PIN, SLAVE LEVELING CYLINDER	1
8	..62229	SCREW, SET	4
9	..23185	ASSEMBLY, EXTENSION CYLINDER (See Sect. 5, Fig.4,4A or 4B for Details)	1
10	..23156	PIN, EXTENSION CYLINDER	1
11	..24804	PAD, WEAR	1
12	..61822	SCREW, CAP	6
13	..22567	PAD, WEAR	2
14	..61801	SCREW, CAP	4
15	..24501	SHIM, WEAR PAD	1
16	..23151	PAD, WEAR	2
17	..61802	SCREW, CAP	4
18	..24469	PAD, WEAR	1
19	..61805	SCREW, CAP	3
20	..23824	TRACK, POWER	59
21	..23874	BRACKET, MOVABLE PLASTITRAK (FEMALE)	1
22	..61302	NUT, HEX	2
23	..60501	SCREW, CAP	2
24	..61312	NUT	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	..63401	WASHER, FLAT	2
26	..70528	CABLE, 40 CONDUCTOR (WITH BRAIDING)	66 FT
27	..2568-840	HOSE, HYDRAULIC	4
28	...2568	HOSE, PARAFLEX	70 FT
29	..65133	FITTING, FEMALE HOSE	2
30	..16268	CLAMP, HOSE	2
31	..60309	SCREW, CAP	2
32	..60711	NUT, HEX	2
33	..23166	WELDMENT, BULKHEAD PLATE	1
-34	.134116	PLATE, LIMIT SWITCH TRIP	1

Mark Industries

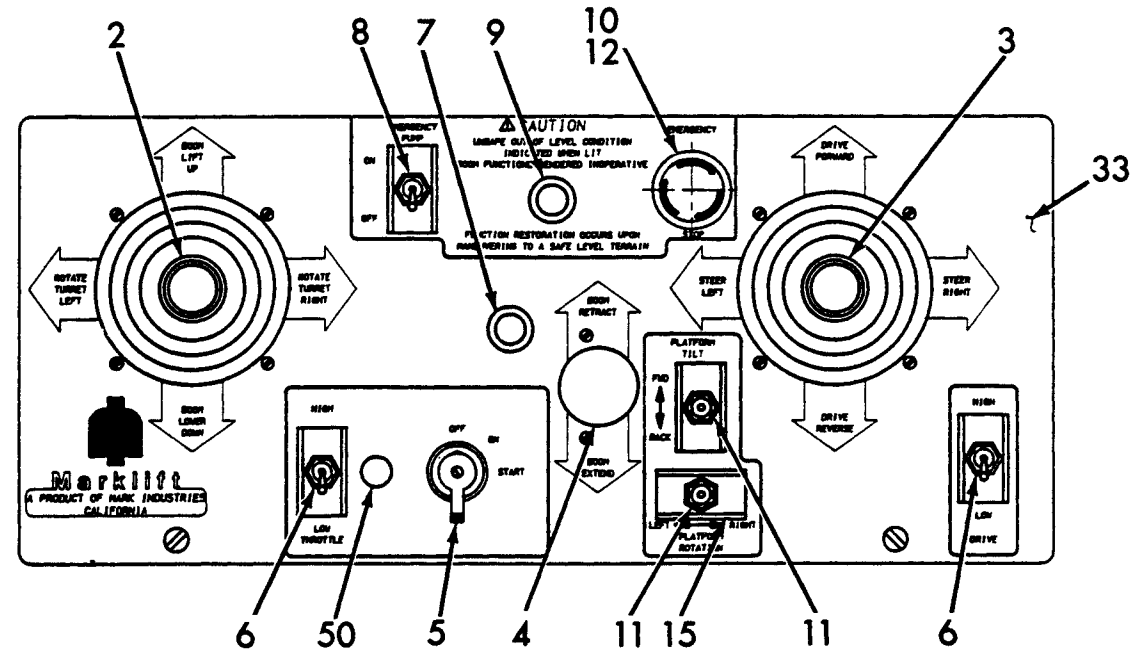
TITLE	BOOM MODIFICATION ASSEMBLY
MODEL	42C (TUV)
NOTES	

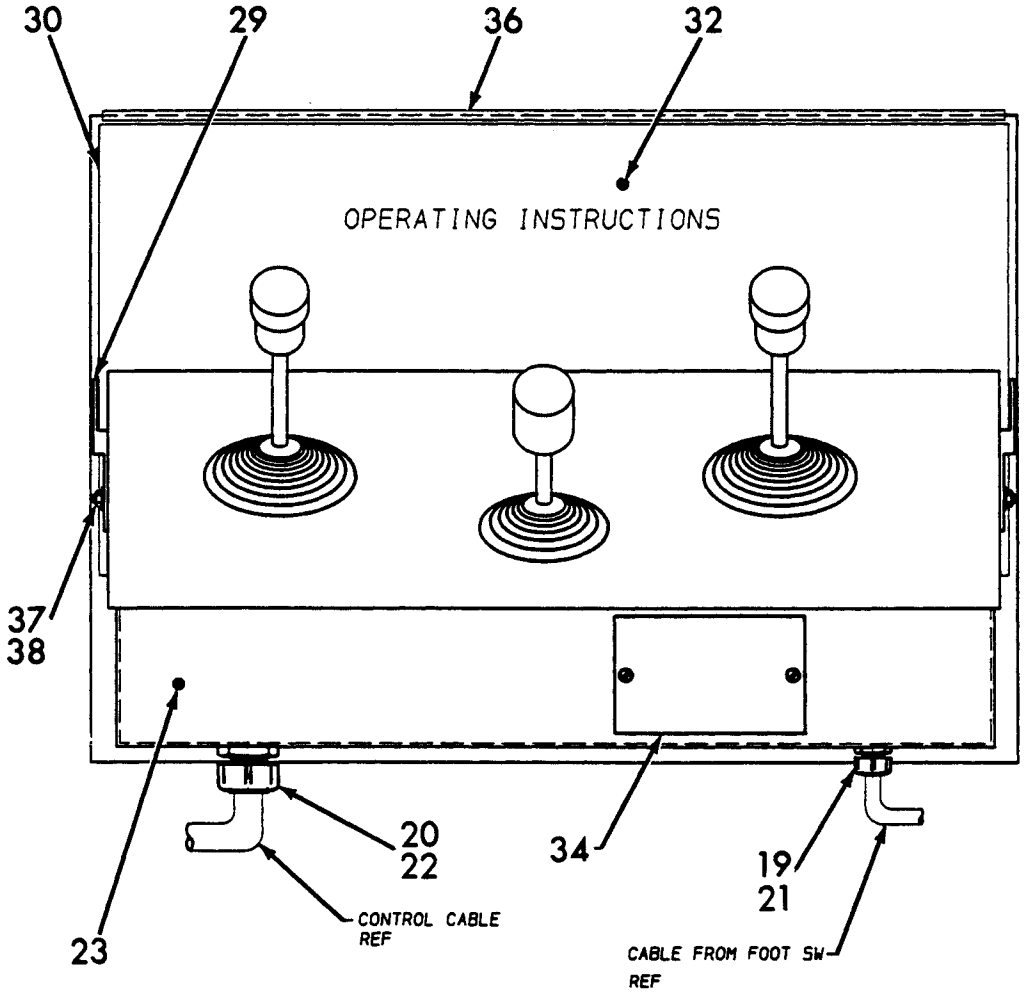
SECTION	7
FIGURE	6
PAGE	1

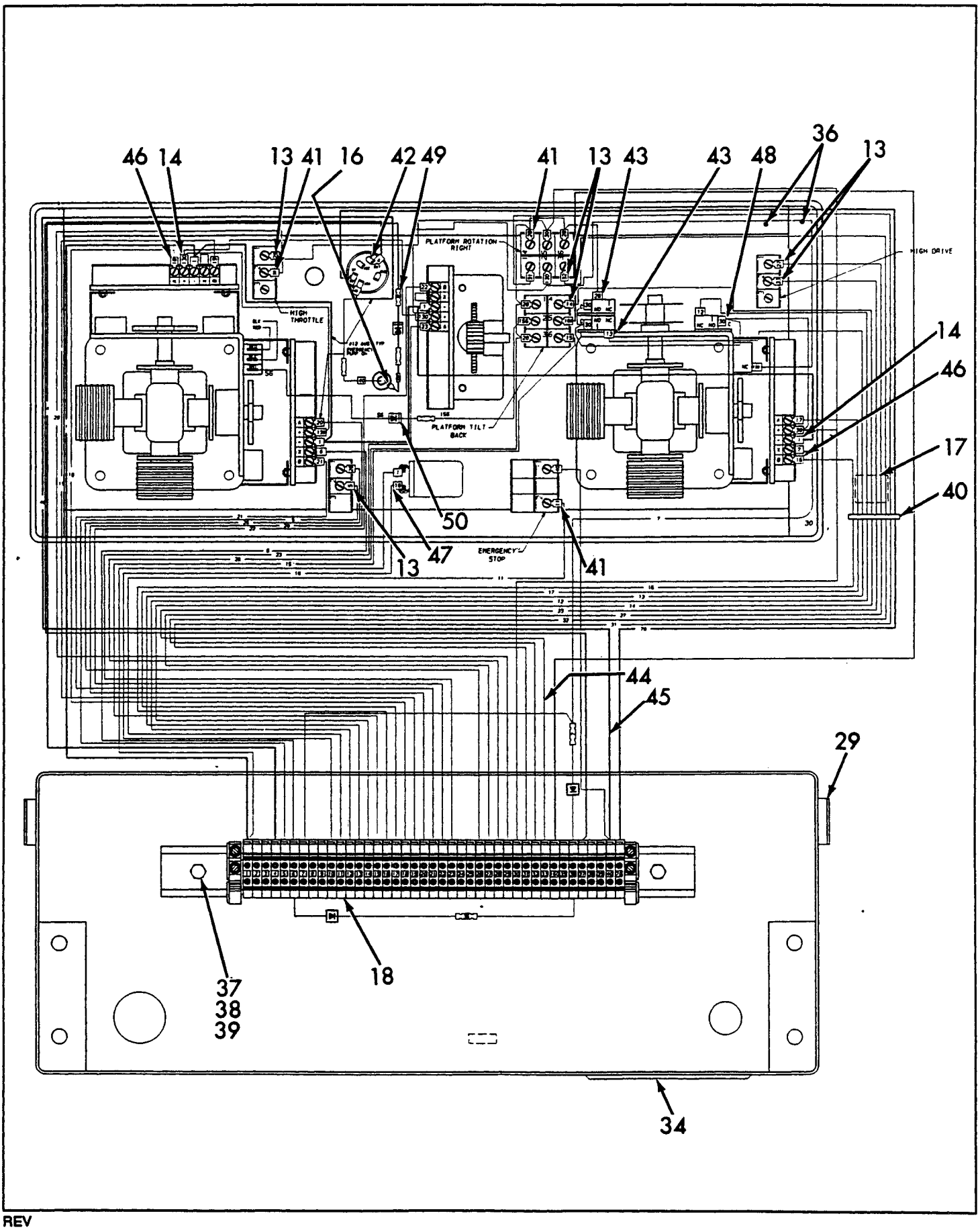


REV

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	SKP-1290	ASSEMBLY, BOOM MODIFICATION (See Sect. 7, Fig. 4 for NHA)	REF
2	.211050	COVER, ACCESS PANEL	1
3	.60396	SCREW, CAP	4
4	.63313	WASHER, SPLIT	4
5	.2806	RELIEF, STRAIN	1
6	.2912	CABLE, CONDUCTOR (18 AWG/4 COND.)	30 FT
7	.211016	SUB-PLATE, LIMIT SWITCH	1
8	.70668	BODY, LIMIT SWITCH (DP-DT 2 STEP)	1
9	.70546	HEAD, LIMIT SWITCH (SIDE ROTARY)	1
10	.70626	LEVER	1
11	.62726	SCREW, MACHINE	2
12	.60408	SCREW, CAP	4
13	.63301	WASHER, SPLIT	4


2
8
7
9
10
12
3
33
6
50
5
4
11
15
11
6
CAUTION
Markliff
A PRODUCT OF MARK INDUSTRIES
CALIFORNIA


30
29
36
32
OPERATING INSTRUCTIONS
37
38
20
22
34
19
21
23
CONTROL CABLE
REF
CABLE FROM FOOT SW
REF


46
14
13
41
16
42
49
41
13
43
43
48
36
13
14
46
17
40
50
47
13
41
44
45
29
37
38
39
18
34
HIGH THROTTLE
PLATFORM ROTATION RIGHT
PLATFORM TILT BACK
EMERGENCY STOP
HIGH DRIVE

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	210573	ASSEMBLY, AERIAL CONTROL BOX (See Sect. 7, Fig. 1 for NHA)	REF
2	.70457	CONTROLLER (LIFT/ROTATE) (See Sect. 2, Fig. 7A for Details)	1
3	.70455	CONTROLLER (DRIVE/STEER) (See Sect. 2, Fig. 8A for Details)	1
4	.70453	CONTROLLER (EXTENSION) (See Sect. 2, Fig. 9A for Details)	1
5	.70595	SWITCH, ANTI-RESTART IGNITION	1
6	.70313	SWITCH, TOGGLE	2
7	.70195	LIGHT, INDICATOR	1
8	.70291	SWITCH, TOGGLE	1
9	.20805	ALARM, BUZZER	1
10	.70646	SWITCH, CONTACT	1
11	.20481	SWITCH, TOGGLE	2
12	.70645	BUTTON, EMERGENCY (TURN TO RELEASE)	1
13	.70149	TERMINAL, RING	14
14	.70406	TERMINAL, FORK SPADE	6
15	.20884	GUARD, SWITCH	3
16	.70500	TERMINAL, FEMALE DISCONNECT (RED)	2
17	.16214	MOUNT, CABLE TIE	8
18	.24127	ASSEMBLY, TERMINAL STRIP	1
19	.2808	NUT, LOCK	1
20	.16005	NUT, LOCK	1
21	.2806	RELIEF, STRAIN	1
22	.16215	RELIEF, STRAIN	1
23	.210442	WELDMENT, AERIAL CONTROL BOX	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
24	..160471	RIVET, POP	2
25	..160397	CATCH, TENSIONER	1
26	..160473	SCREW, QUICK OPENING CAPTIVE	2
27	..160474	RECEPTACLE, CLIP-ON	2
28	..160042	GASKET	5 FT
29	.24120	BRACKET, COVER MOUNTING	2
30	.24122	PLATE, BACK	1
31	.24123	WELDMENT, COVER	1
32	.184000	DECAL, OPERATION INSTRUCTIONS & DANGER	1
33	.182783	DECAL, AERIAL CONTROL BOX	1
34	.902	PLATE, BELL COVER	1
35	.70394	CONNECTOR, TWIST-ON WIRE	2
36	.160015	EXTRUSION, NEOPRENE	4 FT
37	.60701	NUT, HEX	9
38	.63301	WASHER, SPLIT	9
39	.63401	WASHER, FLAT	2
40	.256	TE, CABLE (3½" X 1/8")	50
41	.117-B	TERMINAL, RING (BLUE)	10
42	.117-C	TERMINAL, RING (BLUE)	2
43	.16325	TERMINAL, FEMALE DISCONNECT (RED)	3
44	.2990	WIRE, WHITE (18 AWG)	105 FT
45	.2991	WIRE, WHITE (12 AWG)	9 FT
46	.70566	TERMINAL, FORK SPADE	10
47	.70567	TERMINAL, RING (RED)	3
48	.117-E	TERMINAL, FEMALE DISCONNECT (BLUE)	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
49	.70069	SPLICE, BUTT (RED)	7
50	.70479	DIODE (6 AMP/1000V)	2

TITLE	DECAL SET
MODEL	42C (TUV)
NOTES	CRITICAL DECALS PROVIDED IN GERMAN

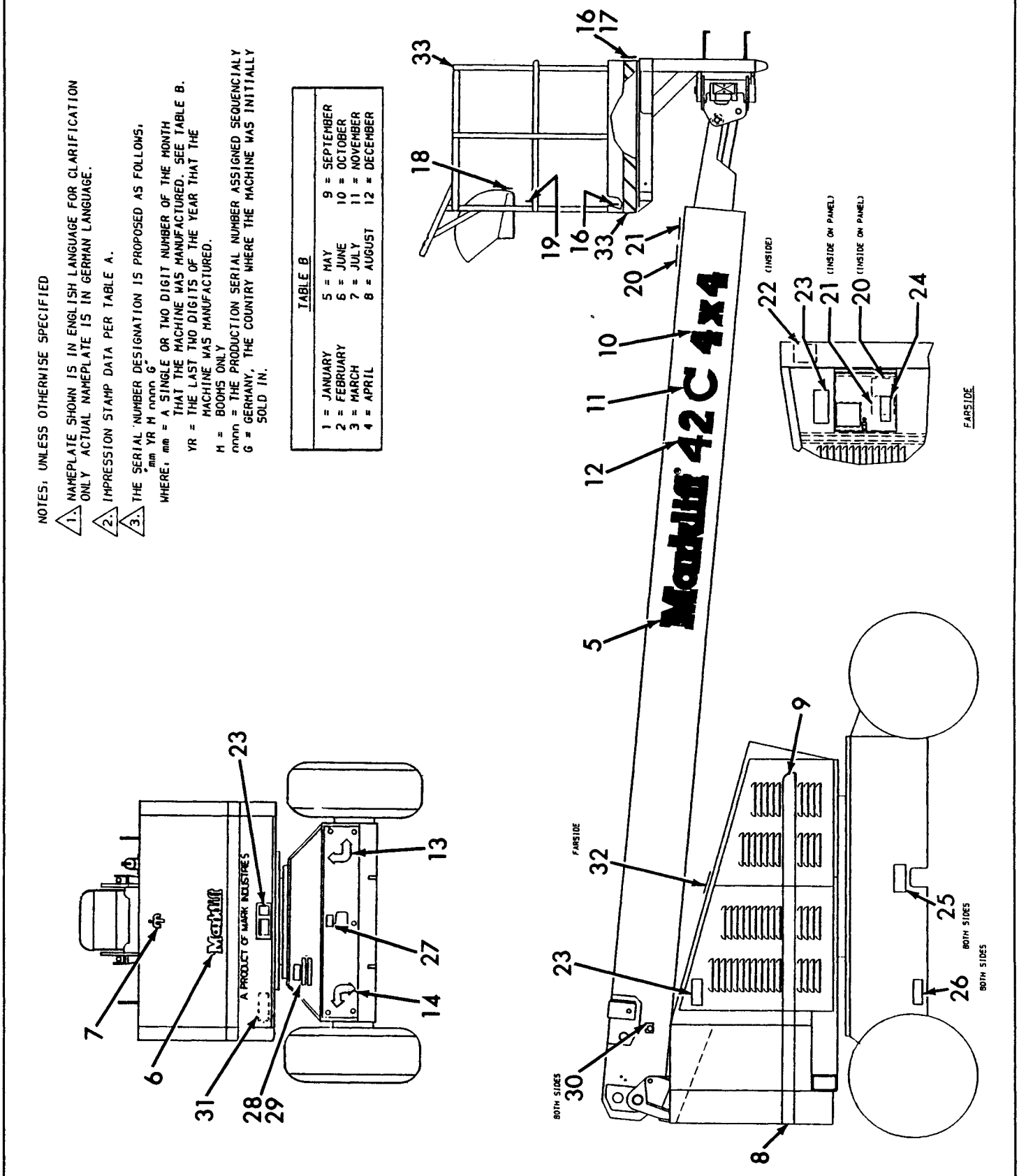
SECTION	7
FIGURE	8
PAGE	1

NOTES: UNLESS OTHERWISE SPECIFIED

1. NAMEPLATE SHOWN IS IN ENGLISH LANGUAGE FOR CLARIFICATION ONLY ACTUAL NAMEPLATE IS IN GERMAN LANGUAGE.
2. IMPRESSION STAMP DATA PER TABLE A.
3. THE SERIAL NUMBER DESIGNATION IS PROPOSED AS FOLLOWS;
   WHERE; mm YR M nnnn G
   mm = A SINGLE OR TWO DIGIT NUMBER OF THE MONTH THAT THE MACHINE WAS MANUFACTURED. SEE TABLE B.
   YR = THE LAST TWO DIGITS OF THE YEAR THAT THE MACHINE WAS MANUFACTURED.
   M = BOOMS ONLY
   nnnn = THE PRODUCTION SERIAL NUMBER ASSIGNED SEQUENCIALY
   G = GERMANY, THE COUNTRY WHERE THE MACHINE WAS INITIALLY SOLD IN.

TABLE B

1 = JANUARY	5 = MAY	9 = SEPTEMBER
2 = FEBRUARY	6 = JUNE	10 = OCTOBER
3 = MARCH	7 = JULY	11 = NOVEMBER
4 = APRIL	8 = AUGUST	12 = DECEMBER



REV

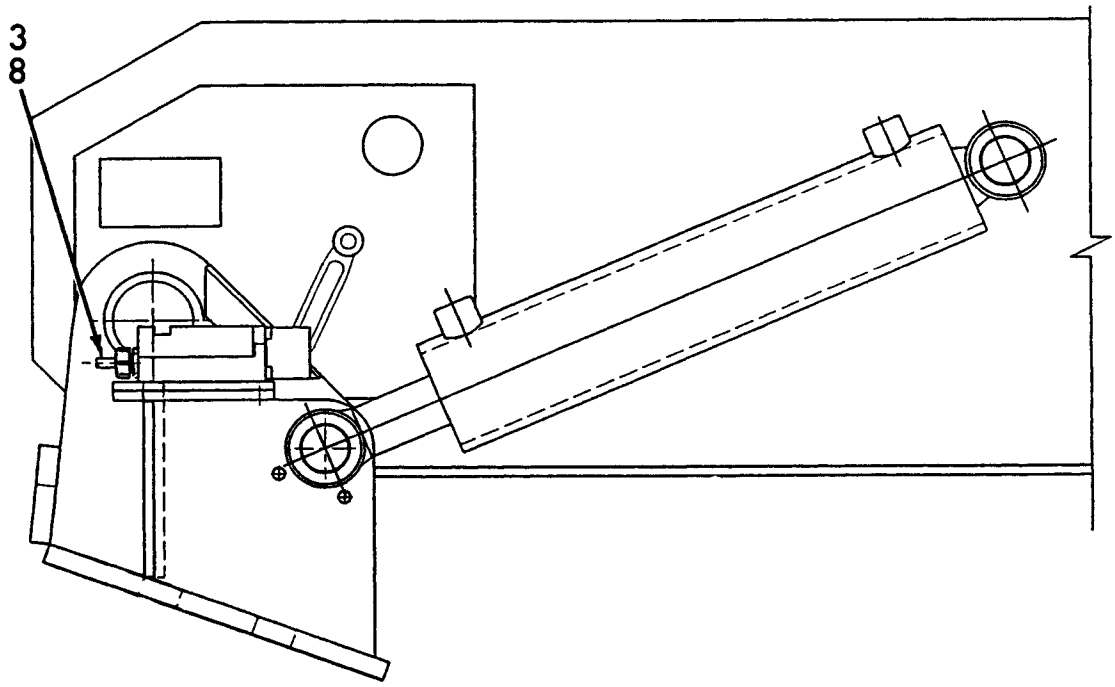
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	600433	SET, DECAL	REF
-2	.182782	DECAL, GROUND CONTROL BONSOLE (GERMAN) (See Ground Control Box for Details)	1
-3	.184000	DECAL, OPERATION INSTRUCTIONS & DANGER (See Aerial Control Box for Details)	1
-4	.182783	DECAL, AERIAL CONTROL BOX (GERMAN) (See Aerial Control Box for Details)	1
5	.20408	DECAL, BOOM MARKLIFT	2
6	.20409	DECAL, STANDARD PEDESTAL (MARKLIFT)	1
7	.20410	DECAL, LOGO MARK INDUSTRIES	1
8	.20411	DECAL, BLUE STRIPE (SQUARE END)	5
9	.20412	DECAL, BLUE STRIPE (ROUND END)	1
10	.22740	DECAL, 4X4 4WD BOOMS	2
11	.181904	DECAL, "C" (19' X 19")	2
12	.20873	DECAL, 42	2
13	.182710	DECAL, DIRECTIONAL ARROW	2
14	.182709	DECAL, DIRECTIONAL ARROW	2
-15	.SKP-1207	DECAL, MODIFICATION (GERMAN)	1
16	..184415	DECAL, RATED CAPACITY 364 KGS.	2
17	..182507	DECAL, CAUTION, ATTACH YOUR SAFETY...	1
18	..184409	DECAL, OPERATION & SAFETY HANDBOOK	1
19	..181805	DECAL, D-RING ATTACH SAFETY BELT	2
20	..182110	DECAL, DANGER, DO NOT OPERATE...	2
21	..182109	DECAL, DANGER VOLTAGE RANGE	2
22	..184410	DECAL, EMERGENCY DESCENT...	1
23	..181106	DECAL, DANGER DEEP AWAY...	3
24	..184400	DECAL, EMERGENCY GROUND CONTROLS	1

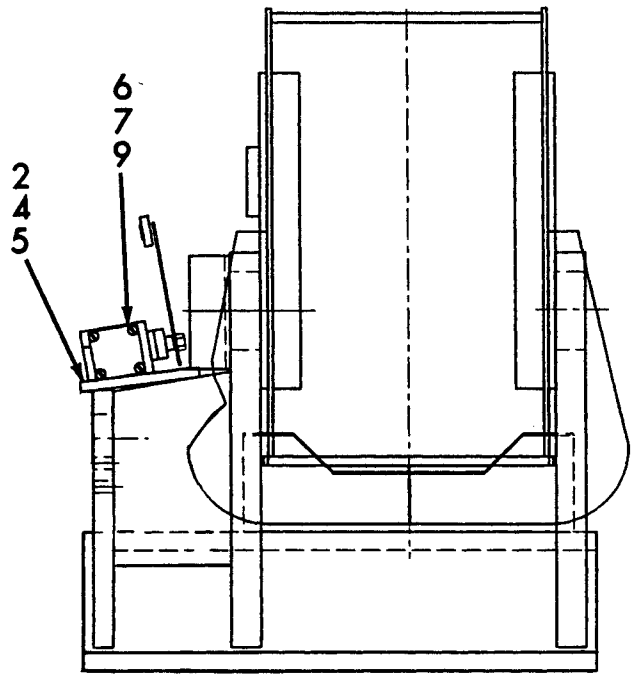
Mark Industries

TITLE	DECAL SET
MODEL	42C (TUV)
NOTES	CRITICAL DECALS PROVIDED IN GERMAN

SECT	7
FIG	8
PAGE	3

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
25	..20508	DECAL, TRANSPORTATION	2
26	..184300	DECAL, CAUTION, MONOFILLED TIRES...	2
27	..184408	DECAL, BRAKE	1
28	..210572	NAMEPLATE, IDENTIFICATION	1
29	..184600	PLATE, DIN APPROVAL	1
30	..184405	DECAL, GREASE FITTING	2
31	..2033	DECAL, DIESEL FUEL ONLY	1
32	..2017	DECAL, HYDRAULIC SYSTEM FLUID	2
33	..160483	TAPE, WARNING (RED & WHITE)	20 FT


3
8


6
7
9
2
4
5

Mark Industries

TITLE	LIMIT SWITCH/BRACKET ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECT	7
FIG	9
PAGE	2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	211046	ASSEMBLY, LIMIT SWITCH/BRACKET (See Sect. 7, Fig. 1 for NHA)	REF
2	.211019	BRACKET, LIMIT SWITCH	1
3	.70036	WIRE (18 AWG/2 COND.)	15 FT
4	.62613	SCREW, MACHINE	2
5	.63312	WASHER, SPLIT	2
6	.70536	BODY, LIMIT SWITCH	1
7	.70546	HEAD, LIMIT SWITCH (SIDE ROTARY)	1
8	.70627	CONNECTOR, STRAIN RELIEF	1
9	.70548	LEVER, LIMIT SWITCH (ADJUSTABLE)	1

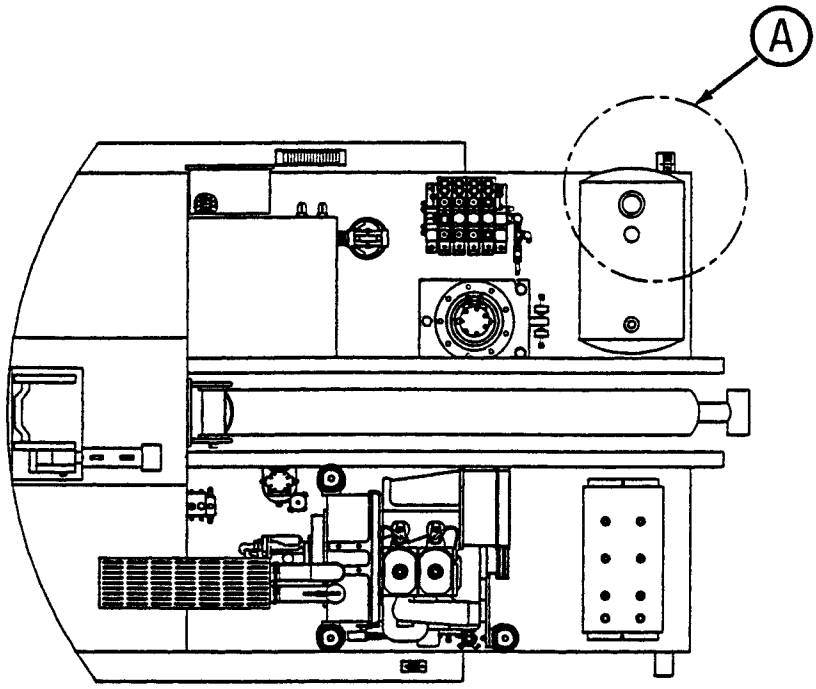
NO ILLUSTRATION AVAILABLE

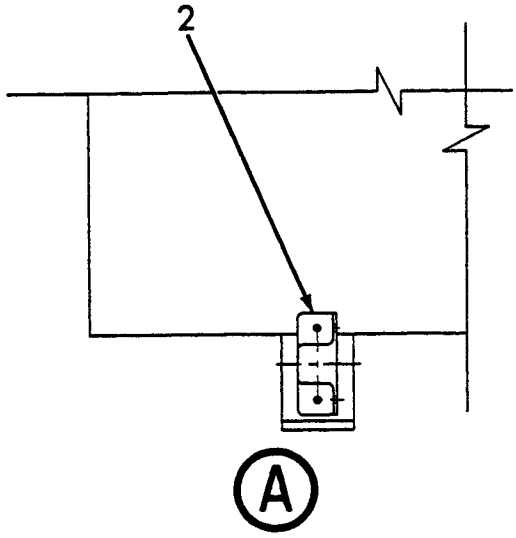
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	211047	ASSEMBLY, 8 METER DRIVE CUT-OUT (See Sect. 7, Fig. 1 for NHA)	REF
2	.211020	CAM, LIMIT SWITCH	1
3	.62726	SCREW, MACHINE	4
4	.63313	WASHER, SPLIT	4
5	.70669	LEVER, LIMIT SWITCH	2
6	.70546	HEAD, LIMIT SWITCH (SIDE ROTARY)	2
7	.70536	BODY, LIMIT SWITCH	2
8	.211018	CAM, 8 METER CUT-OUT	1
9	.2912	CABLE (18 AWG/4 COND.)	2 FT
10	.70627	CONNECTOR, STRAIN RELIEF	2

Mark Industries

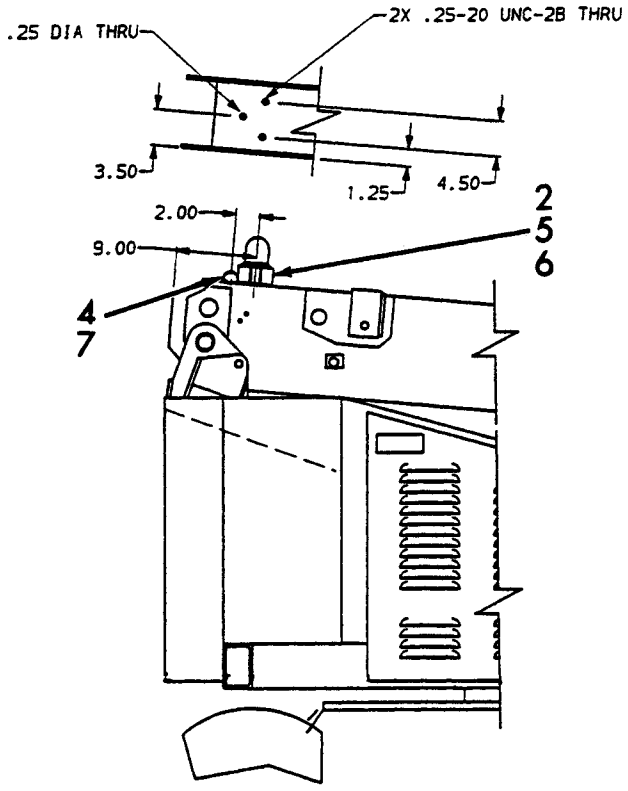
TITLE	TRAVEL WARNING HORN WITH BEACON ASSEMBLY
MODEL	42C (TUV)
NOTES	

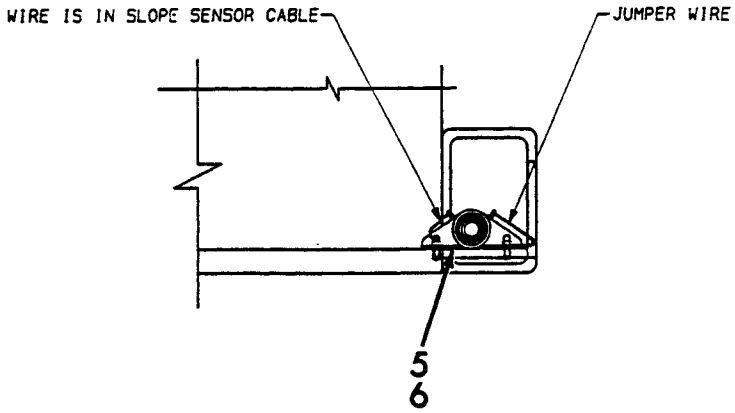
SECT	7
FIG	11
PAGE	1





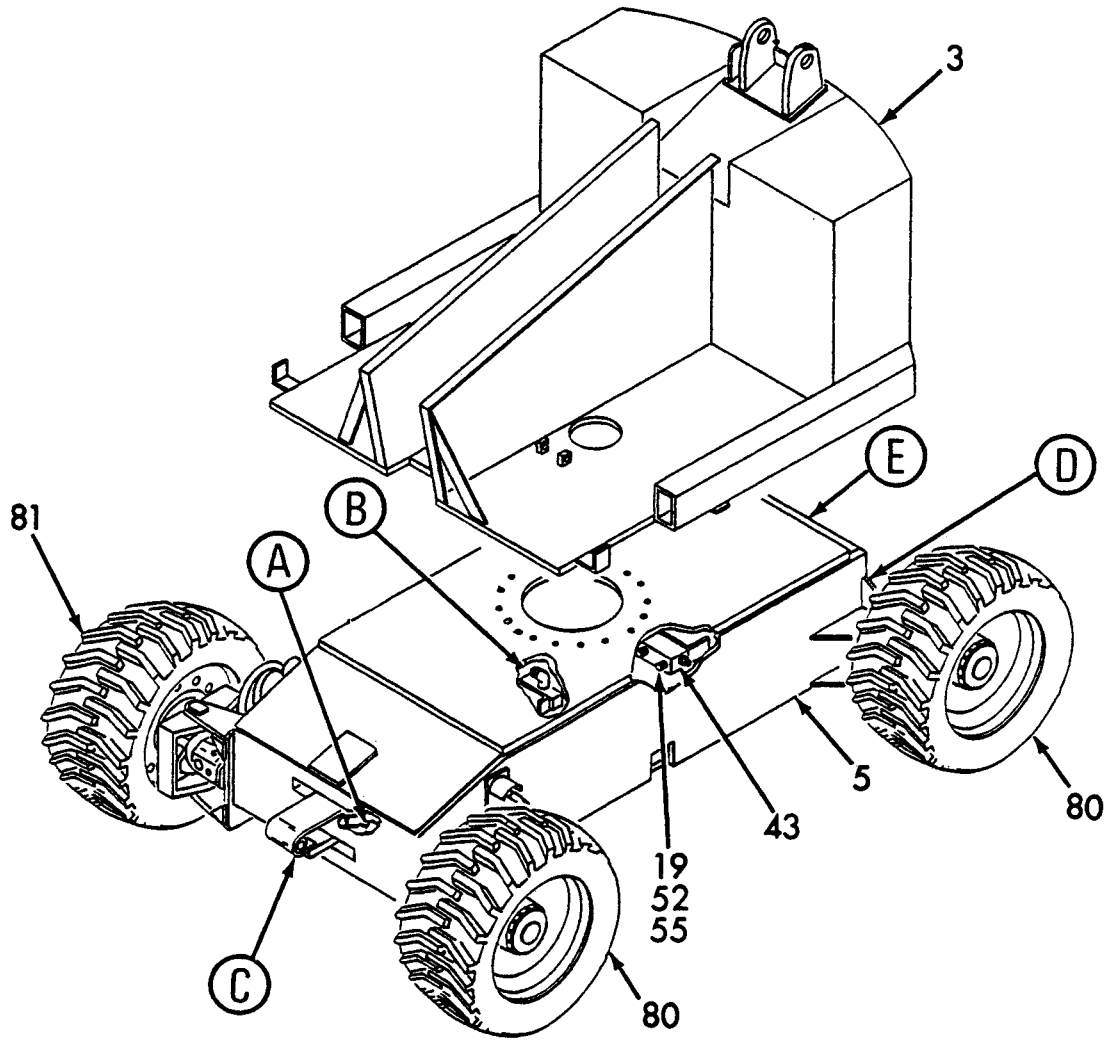
TURRET ASSEMBLY

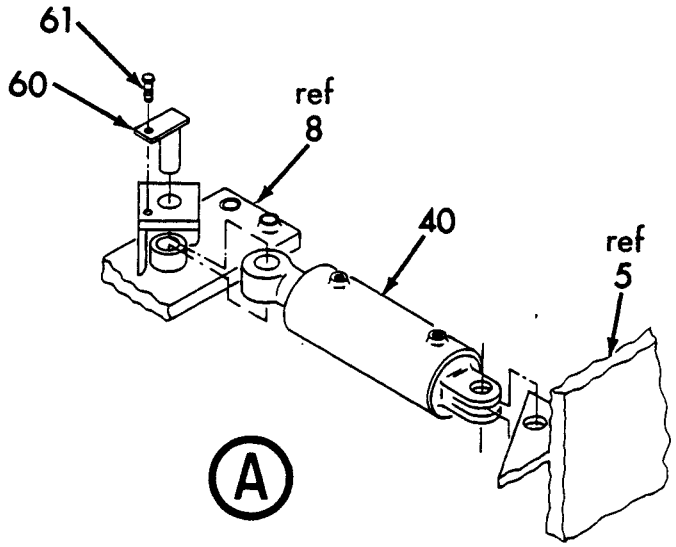


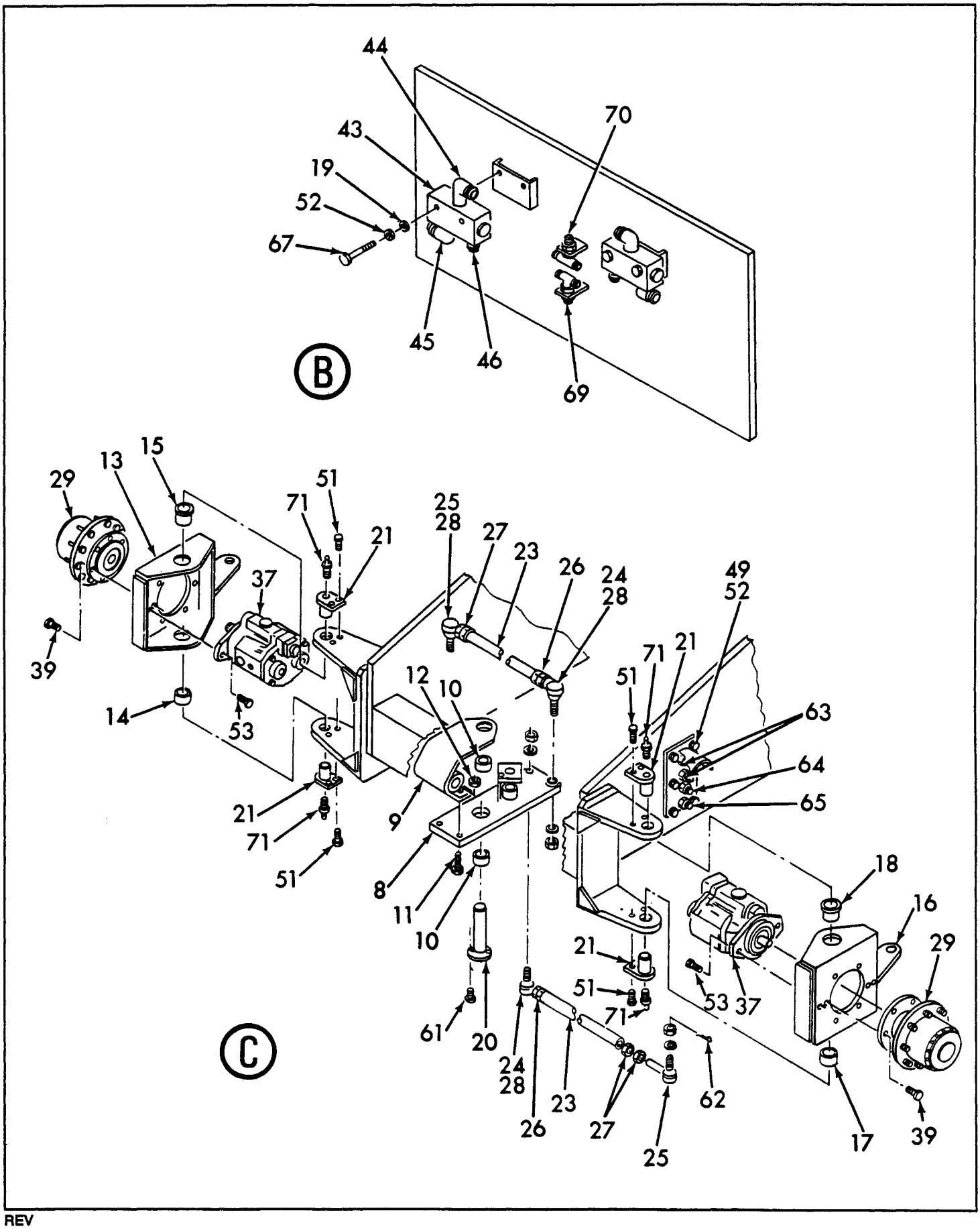


REV

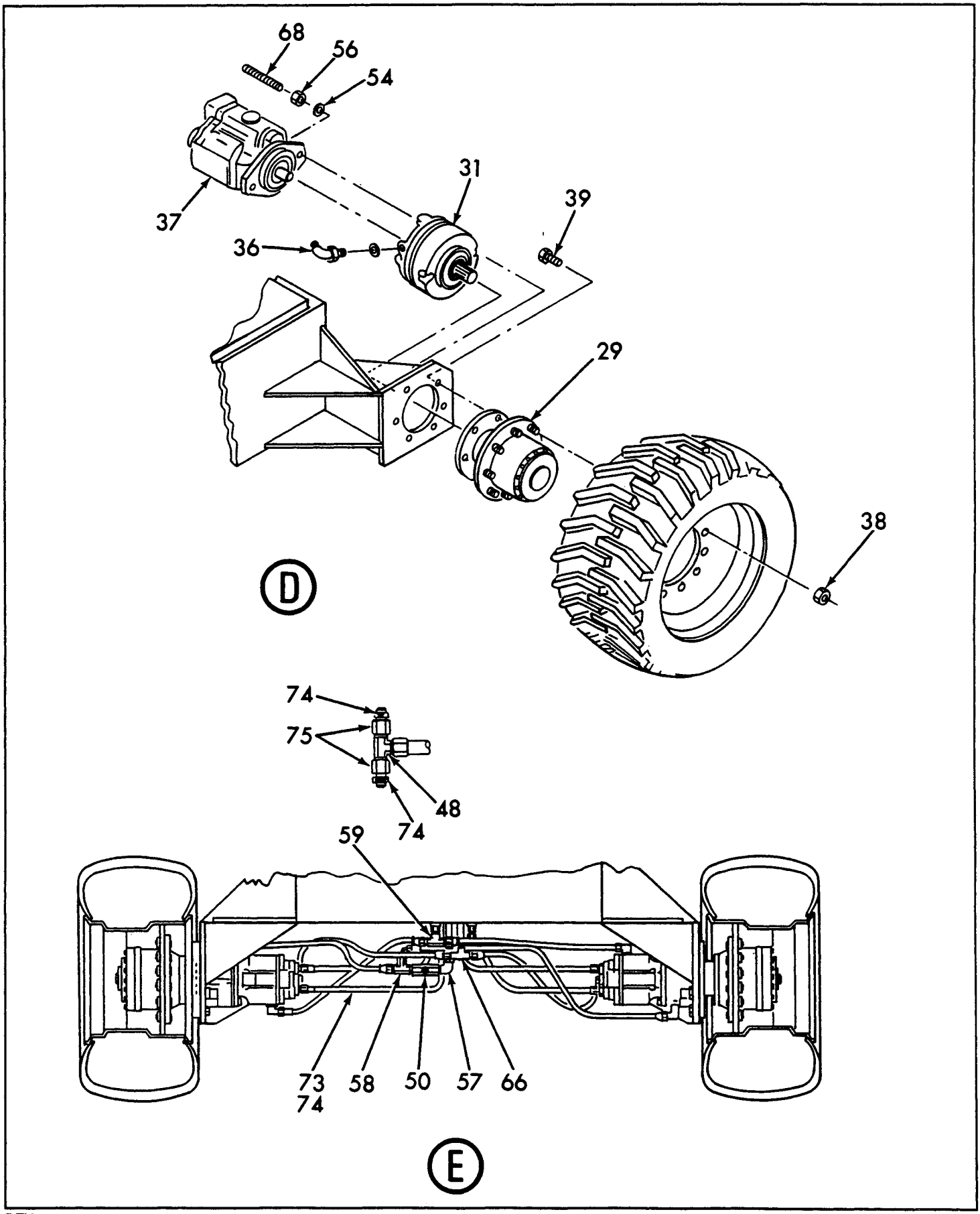
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	211048	ASSEMBLY, TRAVEL WARNING HORN WITH BEACON (See Sect. 7, Fig. 1 for NHA)	REF
2	.70053	HORN, WARNING	1
3	.70612	STROBE, MINI	1
4	.70036	WIRE (18 AWG/2 COND.)	15 FT
5	.60543	SCREW, CAP	4
6	.63301	WASHER, SPLIT	4
7	.70069	SPLICE BUTT (RED)	2


3
81
B
A
E
D
5
80
43
19
52
55
C
80


61
60
ref
8
40
ref
5
A


44
43
19
52
67
70
45
46
69
B
15
13
29
51
71
21
25
28
27
23
26
24
28
49
52
37
39
14
53
12
10
9
63
64
65
21
71
51
8
11
10
18
16
29
61
20
24
28
26
23
27
25
62
17
39
C

REV


68
56
54
31
39
37
36
29
38
D
74
75
48
74
59
73
74
58
50
57
66
E

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	SKP-1308	WELDMENT, CARRIAGE ASSEMBLY & TURRET (See Sect. 7, Fig. 1 for NHA)	REF
2	.210798	WELDMENT, TURRET	1
3	..21752	WELDMENT, PEDESTAL	1
-4	.SKP-1284	ASSEMBLY, CARRIAGE	1
5	..21601	WELDMENT, CARRIAGE	1
6	...21602	WELDMENT, REAR AXLE	1
-7	..20776	ASSEMBLY, ARM STEERING	1
8	...20717	STEERING, ARM	1
9	...20777	BRACKET, SUPPORT	1
10	...23152	BEARING, SLEEVE	2
11	...60506	SCREW, CAP	2
12	...61304	NUT, LOCK	2
13	..21604	STEERING, YOKE (L.H.)	1
14	...21675	BUSHING, STEERING YOKE	1
15	...21676	BUSHING, FLANGED STEERING YOKE	1
16	..21603	STEERING, YOKE (R.H.)	1
17	...21675	BUSHING, STEERING YOKE	1
18	...21676	BUSHING, FLANGED STEERING YOKE	1
19	..63403	WASHER, FLAT	10
20	..21328	PIN, MAIN STEERING	1
21	..21605	PIN, KING (STEERING YOKE)	4
-22	..20718	ASSEMBLY, TIE ROD	2
23	...25001	ROD, TIE	1
24	...20569	END, TIE ROD (L.H. THREAD)	1
25	...20568	END, TIE ROD (R.H. THREAD)	1

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	...20567	NUT, JAM (L.H. THREAD)	2
27	...20566	NUT, JAM (R.H. THREAD)	2
28	...65103	FITTING, GREASE	2
29	..24707	HUB, TORQUE (See Sect. 3, Fig. 2A for Details)	4
-30	..21668	ASSEMBLY, BRAKE	2
31	...20354	BRAKE, MULTIPLE DISC (See Vendor Chapter for Details)	2
32	67150	KIT, SEAL	1
33	67645	KIT, LINING	1
34	67657	KIT, BEARING	1
35	67650	KIT, SPRING	1
36	...80012-03	ELBOW, STRAIGHT THREAD	2
37	..24148	ASSEMBLY, HYDRAULIC DRIVE MOTOR (See Sect. 3, Fig. 3 for Details)	4
38	..61403	NUT, HEX	36
39	..60604	SCREW, CAP	24
40	..22502	ASSEMBLY, STEERING CYLINDER (See Sect. 3, Fig. 4 for Details)	1
41	..21620	WELDMENT, BULKHEAD PLATE	2
-42	..22580	ASSEMBLY, FLOW DIVIDER	2
43	...81296	VALVE, FLOW DIVIDER (COMBINER)	2
44	...80008-21	ELBOW, MALE	2
45	...80008-15	ELBOW, MALE	2
46	...80001-15	CONNECTOR, MALE	2
47	..22500	ASSEMBLY, DRIVE/BRAKE VALVE (See Sect. 3, Fig. 5 for Details)	1
48	..80031-08	TEE	2

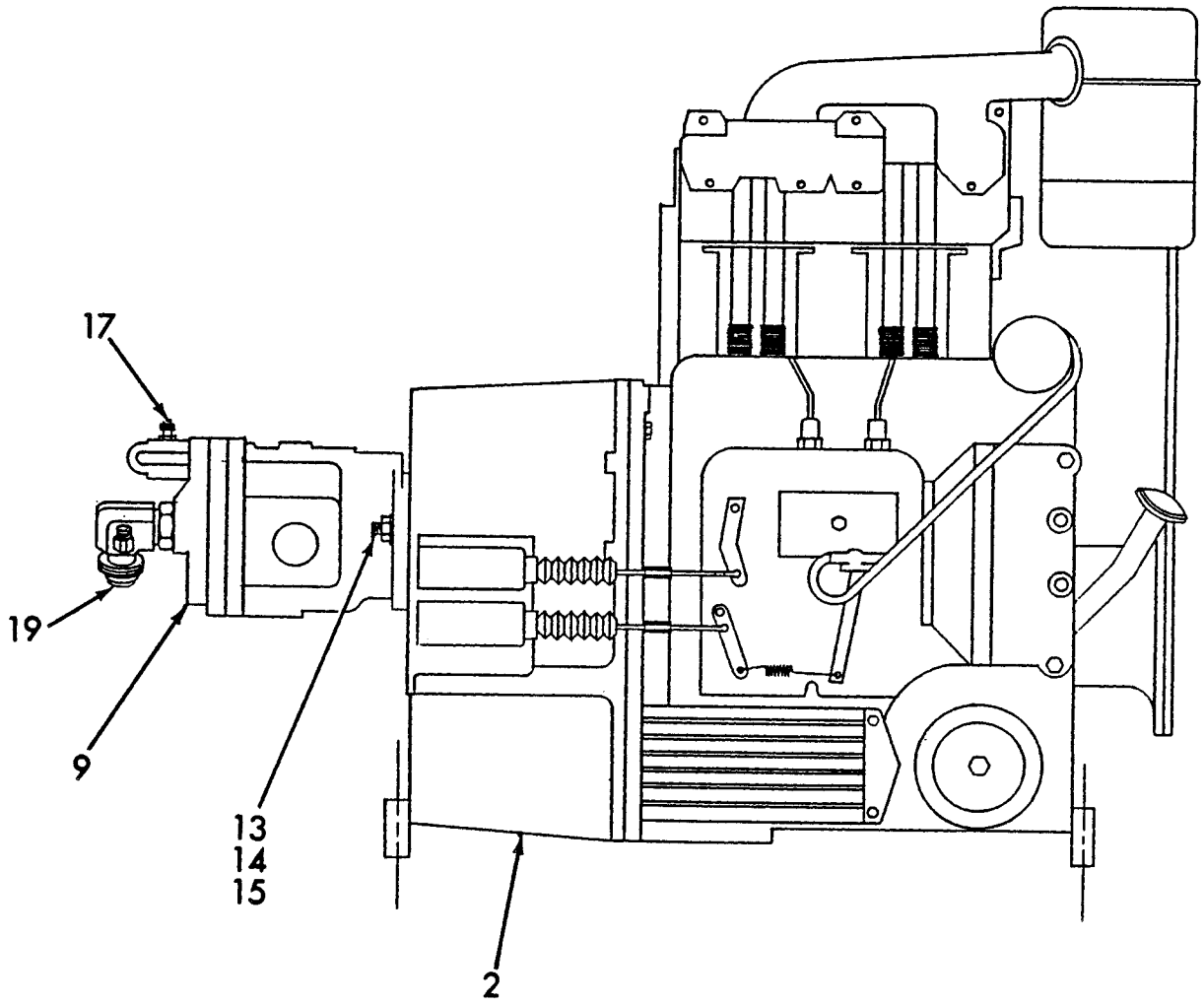
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
49	..60325	SCREW, CAP	12
50	..20357	VALVE, NEEDLE	1
51	..62013	SCREW, CAP	8
52	..63319	WASHER, SPLIT	26
53	..60622	SCREW, CAP	4
54	..63305	WASHER, SPLIT	4
55	..60356	SCREW, CAP	2
56	..60705	NUT, HEX	4
57	..80031-03	TEE	1
58	..80037-04	TEE	1
59	..80031-05	TEE	1
60	..20796	PIN, STEERING CYLINDER	1
61	..60603	SCREW, CAP	3
62	..64306	PIN, COTTER	4
63	..80045-06	UNION, BULKHEAD	4
64	..80045-05	UNION, BULKHEAD	2
65	..80045-03	UNION, BULKHEAD	2
66	..80008-04	ELBOW, MALE	1
67	..60317	SCREW, CAP	4
68	..63601	STUD	4
69	..80035-03	TEE	1
70	..80035-05	TEE	1
71	..65103	FITTING, GREASE	4
72	..65106	OIL GEAR (90 WT.)	3 GAL
73	..63418	WASHER, FLAT	36

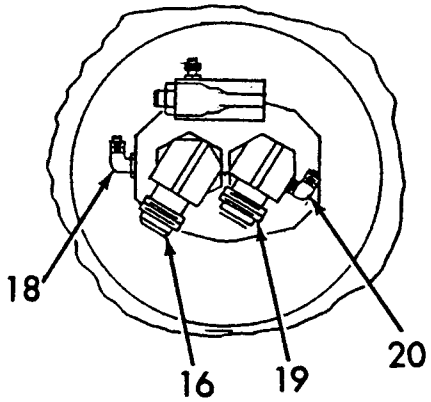
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
74	..80056-09	REDUCER, TUBE END	4
75	..80060-08	NUT	4
76	..65320	COIL, PROTECTIVE PLASTIC (¼" DIAMETER)	5 FT
77	..65322	COIL, PROTECTIVE PLASTIC	6.2 FT
78	..66846	GASKET, 2 BOLT	2
-79	..211049 KIT-A	DIAGRAM, HYDRAULIC HOSE	1
80	..210787	ASSEMBLY, WHEEL TIRE (R.H.)(MONOFILLED)	2
81	..210788	ASSEMBLY, WHEEL TIRE (L.H.)(MONOFILLED)	2
82	.60609	SCREW, CAP	18

Mark Industries

TITLE	ENGINE/PUMP ASSEMBLY
MODEL	42C (TUV)
NOTES	F3L1011

SECTION	7
FIGURE	13
PAGE	1





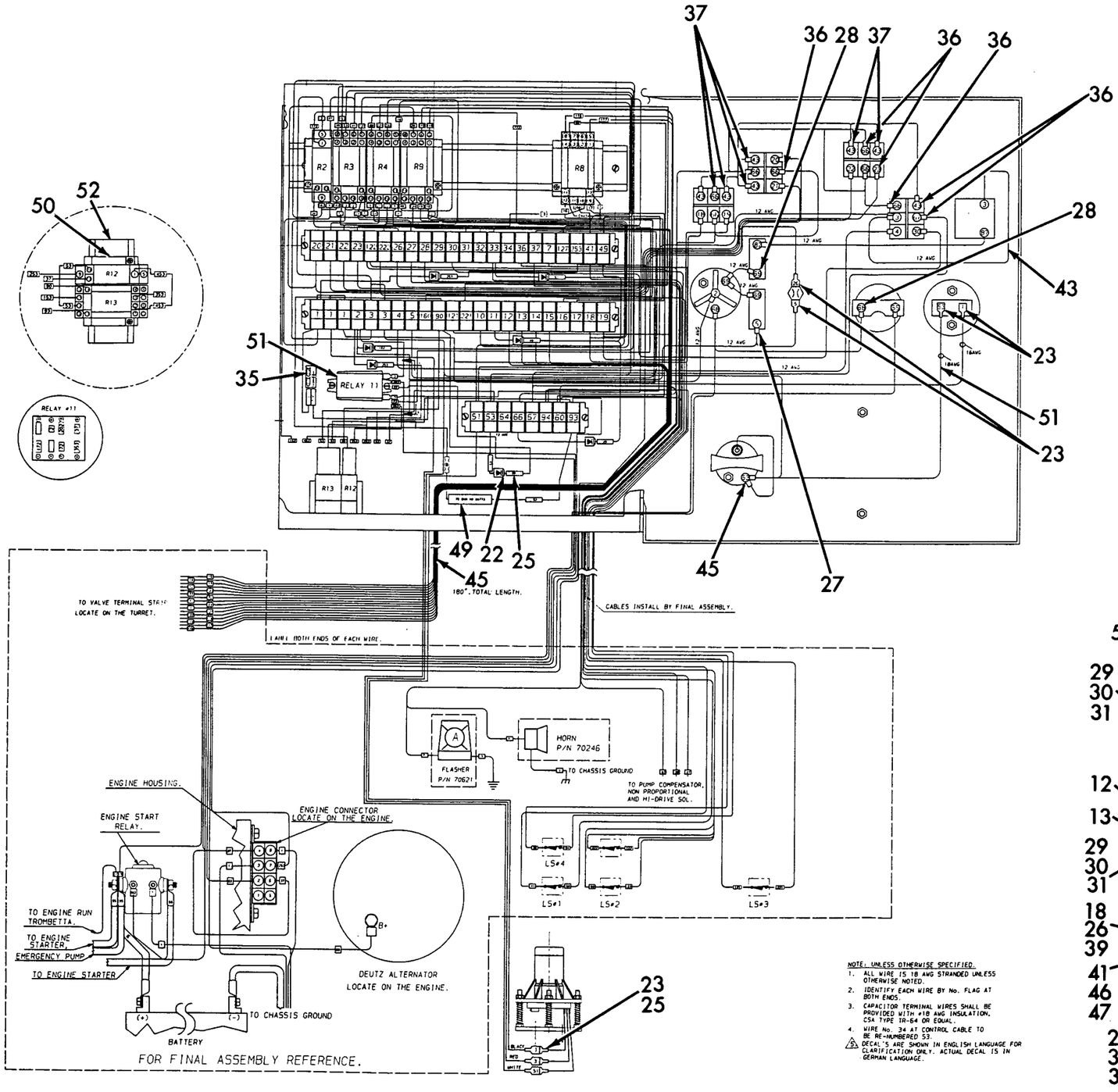
REV

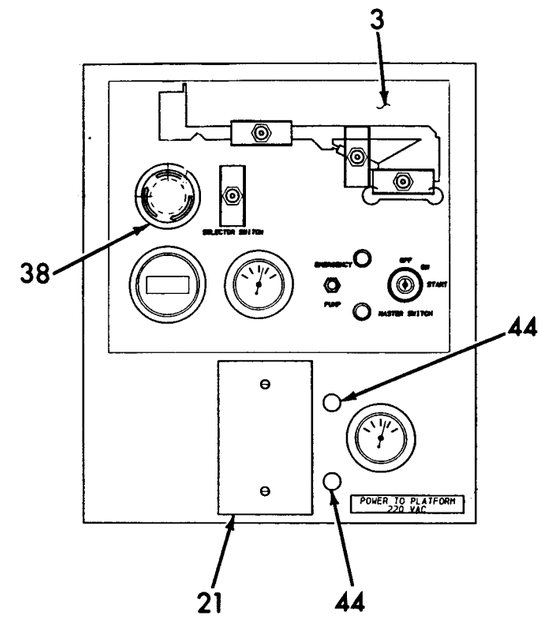
ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	210789	ASSEMBLY, ENGINE/PUMP (See Sect. 7, Fig. 2 for Details)	REF
2	.210793	ENGINE, DEUTZ (F3L1011)	1
-3	..600370	SWITCH, OIL PRESSURE	1
-4	..600437	FILTER, FUEL	1
-5	..600438	FILTER, OIL	1
-6	..600439	STARTER	1
-7	...600440	BENDIX, STARTER	1
-8	..600441	GEAR, RING	1
9	.20753	PUMP (EA)	1
-10	..600163	KIT, SEAL (EA)	1
-11	...66741	SEAL, SHAFT	1
-12	..21757	ASSEMBLY, COMPENSATOR	1
13	.63613	STUD	2
14	.60705	NUT, HEX	2
15	.63305	WASHER, SPLIT	2
16	.80012-28	ELBOW, STRAIGHT THREAD	1
17	.80004-03	CONNECTOR, STRAIGHT THREAD	1
18	.80012-08	ELBOW, STRAIGHT THREAD	1
19	.20798	ELBOW, MODIFIED STRAIGHT THREAD	1
20	.80008-08	ELBOW, MALE	1

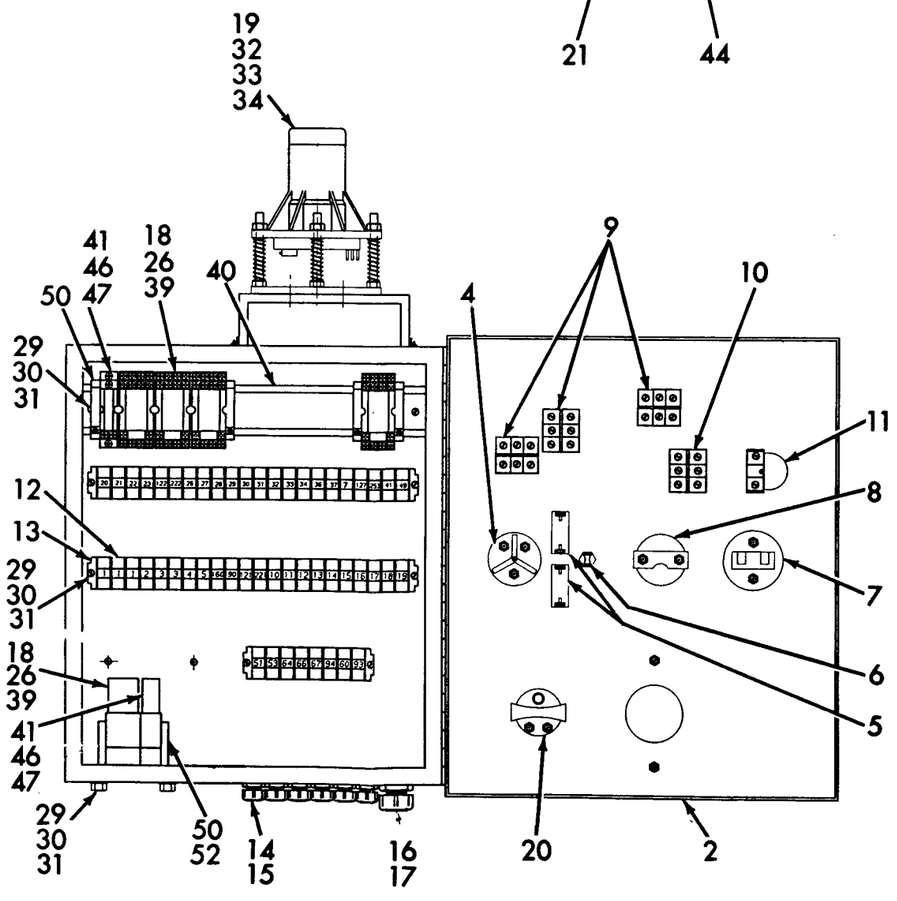
Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECT.	7
FIG.	14
PAGE	1







Mark Industries

TITLE	GROUND CONTROL BOX ASSEMBLY	SECT 7
MODEL	42C (TUV)	FIG 14
NOTES		PAGE 2

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	210574	ASSEMBLY, GROUND CONTROL BOX	REF
2	.20977	MACHINING, ELECTRICAL ENCLOSURE	1
3	.182782	DECAL, GROUND CONTROL CONSOLE	1
4	.2717	SWITCH, IGNITION	1
5	.20562	BREAKER, CIRCUIT	2
6	.4011	SWITCH, PUSH BUTTON	1
7	.20571	HOURMETER	1
8	.70492	AMMETER	1
9	.20481	SWITCH, TOGGLE	3
10	.20482	SWITCH, TOGGLE	1
11	.70646	SWITCH, CONTACT	1
12	.4027	BLOCK, TERMINAL	52
13	.117-A	END, TERMINAL BLOCK	3
14	.2806	RELIEF, STRAIN	7
15	.2808	NUT, LOCK	7
16	.2807	RELIEF, STRAIN	1
17	.2809	NUT, LOCK	1
18	.70213	RELAY	5
19	.21250	SENSOR, SLOPE	1
20	.21219	GAUGE, FUEL	1
21	.902	PLATE, COVER BELL	1
22	.70479	DIODE	7
23	.70500	TERMINAL, FEMALE DISCONNECT (FULLY INSUL.)	14
24	.70069	CONNECTOR, BUTT	7
25	.70501	TERMINAL, MALE DISCONNECT (FULLY INSUL.)	4

REV

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

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
26	.70593	BASE, RELYA	5
27	.16213	TERMINAL, RING (YELLOW)	1
28	.117-C	TERMINAL, RING (BLUE)	8
29	.62609	SCREW, MACHINE	8
30	.63311	WASHER, SPLIT	8
31	.61501	NUT, HEX	6
32	.60325	SCREW, CAP	4
33	.63303	WASHER, SPLIT	4
34	.60703	NUT, HEX	4
35	.70147	CAPACITOR	1
36	.70149	TERMINAL, RING (RED)	13
37	.2859	TERMINAL, RING (BLUE)	11
38	.70645	BUTTON, EMERGENCY/TURN TO RELEASE	1
39	.70359	SPRING, HOLD-DOWN	5
40	.70680	RAIL, RELAY MOUNTING	1
41	.70462	CLIP, RELAY	6
42	.2990	WIRE, WHITE (18 AWG)	40 FT
43	.2991	WIRE, WHITE (12 AWG)	5 FT
44	.771	PLUG	2
45	.21351	CABLE (18 AWG/16 COND.)	20 FT
46	.70460	BASE, RELAY	3
47	.70459	RELAY	3
48	.256	TIE, CABLE (3½" X 1/8")	60
49	.70679	RESISTOR (75 OHM/10 WATT)	1
50	.70568	TERMINAL, STOP	6

Mark Industries

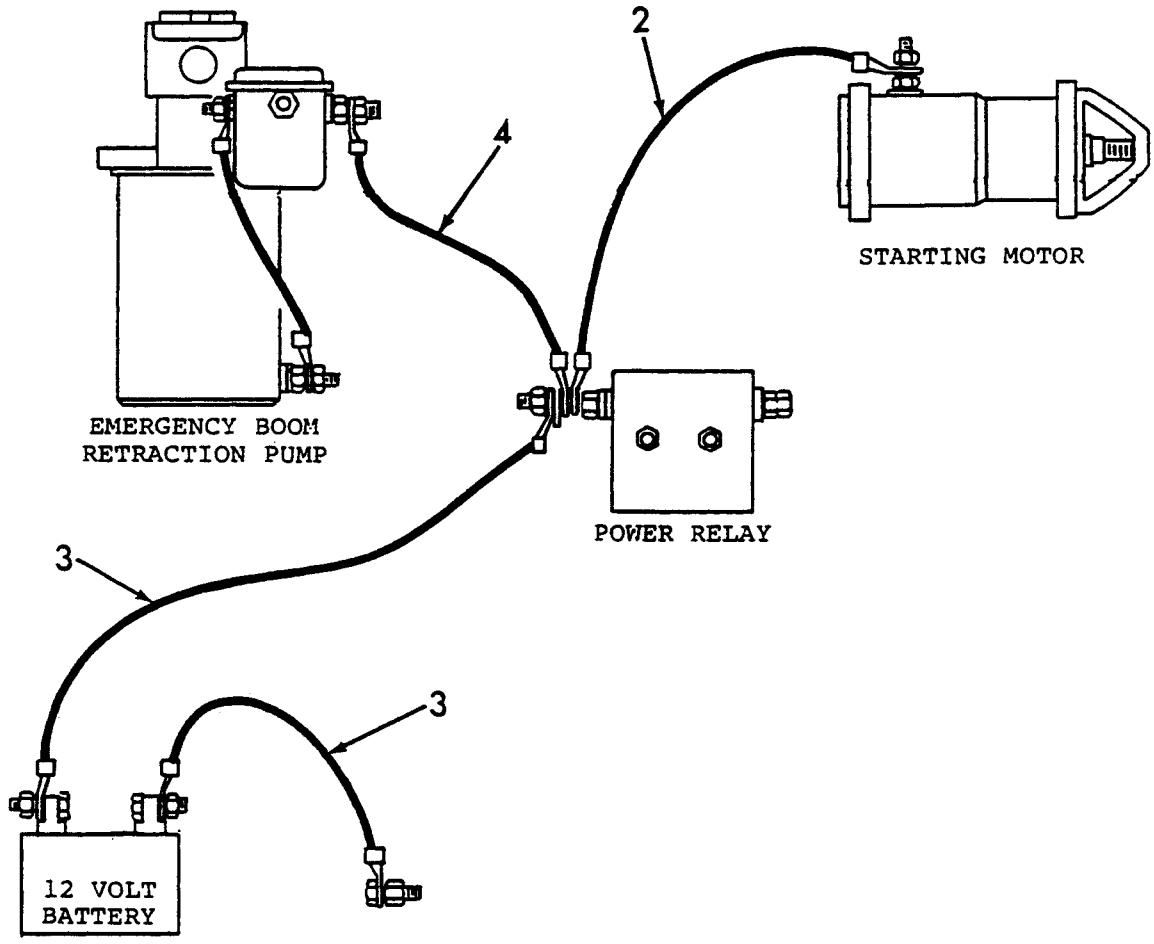
TITLE	GROUND CONTROL BOX ASSEMBLY
MODEL	42C (TUV)
NOTES	

SECT	7
FIG	14
PAGE	4

ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
51	.70403	RELAY	1
52	.70678	RAIL, RELAY MOUNTING	1

REV

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



ITEM	PART NUMBER 1234	DESCRIPTION	UNITS PER ASSY
-1	20670	KIT, BATTERY CABLE (See Sect. 7, Fig. 1 for NHA)	REF
2	.13226-060	ASSEMBLY, ELECTRICAL CABLE (60")	1
3	.13226-018	ASSEMBLY, ELECTRICAL CABLE (18")	2
4	.13226-038	ASSEMBLY, ELECTRICAL CABLE (38")	1

Mark Industries

TITLE	VENDOR CHAPTER
MODEL	42C
NOTES	

VENDOR CHAPTER CONTAINS:

SECTION	DESCRIPTION	PART NO.
1	WISCONSIN ENGINE	21215
2	MICO DISC BRAKE	20359, 22831
3	DEUTZ ENGINE	22489
4	NISSAN ENGINE	210281
5	NISSAN ENGINE	24624
6	TRW TORQMOTOR	81081
7	TRW TORQMOTOR	81276
8	TORQUE HUB	22830
9	FAIRFIELD TORQUE-HUB	23600, 24707
10	EATON PUMP	20801, 20753
11	HELAC ROTATOR	81372, 81094
12	MINIPAK	21787



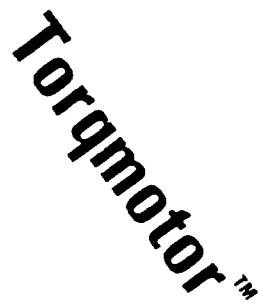














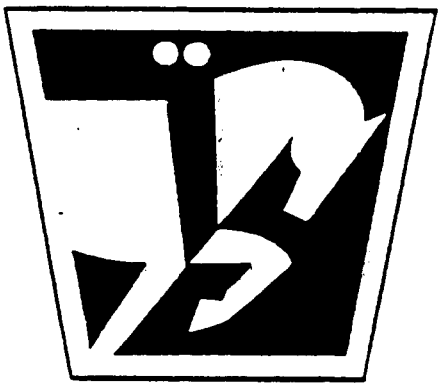
REV.

STARTING and OPERATING INSTRUCTIONS

ISSUE MM-357

WISCONSIN

Air-Cooled Engines



Four Cylinder Engine Models

VH4D • VG4D • V-465D

TELEDYNE TOTAL POWER

WORLD'S FOREMOST SOURCE FOR HEAVY DUTY AIR COOLED ENGINES

INTRODUCTION

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

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

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

SPECIFICATIONS

MODEL VH4D

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

MODEL VG4D

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

MODEL V-465D

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

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

SAFETY PRECAUTIONS

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

NEW ENGINE Instructions

• LUBRICATION Operating without oil will ruin engine.

IMPORTANT

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

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

• AIR CLEANER

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

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

• FUEL

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

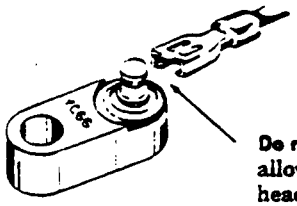
• NEGATIVE GROUND CIRCUIT , if engine is equipped with STARTING MOTOR, DISTRIBUTOR IGNITION and FLYWHEEL ALTERNATOR, or GENERATOR.



GROUND ENGINE TO NEGATIVE TERMINAL ON BATTERY.

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

• PREVENT OVERHEATING



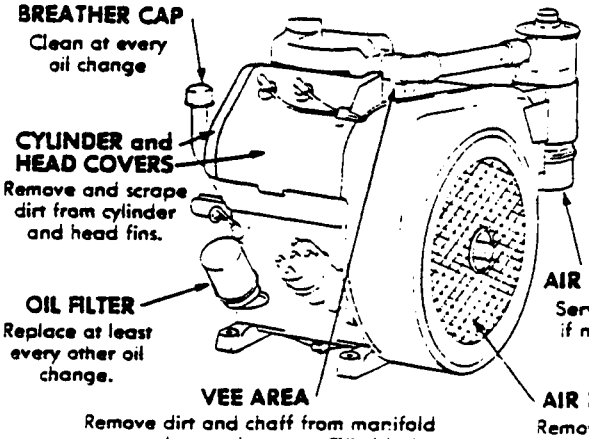
Temperature Safety Switch

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

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

Keep Engine Clean

External dirt restricts cooling and internal dirt causes wear.



• NEW ENGINE BREAK-IN

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

STARTING AND OPERATING INSTRUCTIONS

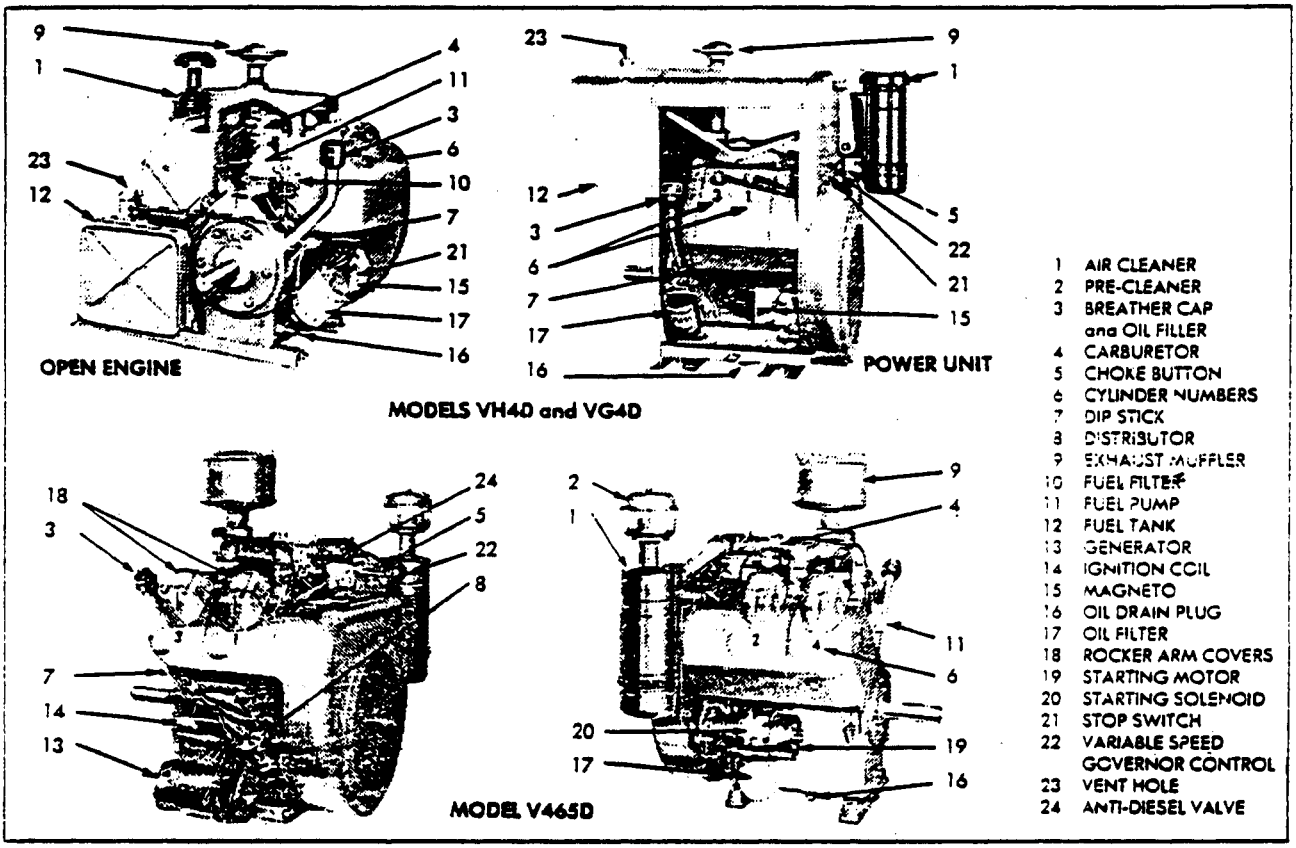


Fig. 1, REFERENCE VIEWS

GENERAL INFORMATION

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

COOLING

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

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

IGNITION

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

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

ROTATION

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

BEFORE STARTING NEW ENGINE

1. Fill tank with Regular grade gasoline.

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

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

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

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

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

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

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

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

GRADE OF OIL

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

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

Model VH4D, Fig 2 and Fig. 3:

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

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

Mark

REV.

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

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

WARM-UP

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

TO STOP ENGINE

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

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

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

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

MAINTENANCE

AIR CLEANERS

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

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

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

OIL BATH AIR CLEANER, Fig. 9

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

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

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

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

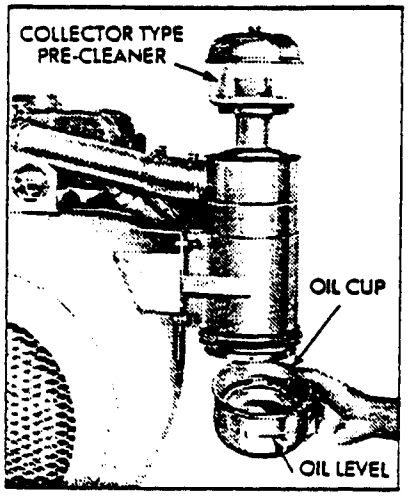


Fig. 9 OIL BATH AIR CLEANER

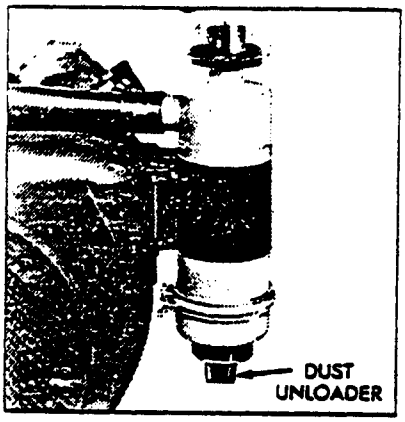


Fig. 10, DRY TYPE AIR CLEANER

DRY TYPE AIR CLEANER, Fig. 10

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

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

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

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

PRE-CLEANER

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

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

BREATHER CAP, Fig. 1, Ref.3

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

DISTRIBUTOR, Fig. 1, Ref. 8

If engine is equipped with battery ignition distributor:

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

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

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

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

GENERATOR - Belt Driver, Fig. 1, Ref 13

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

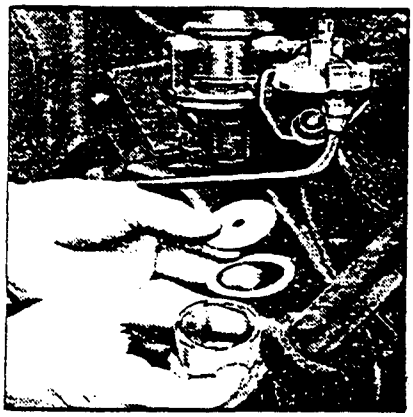
FUEL FILTER, Fig. 11

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

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

OIL FILTER, Fig. 1, Ref. 17

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


Fig. 11, FUEL FILTER

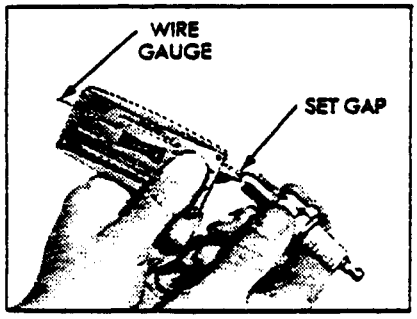


Fig. 12

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

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

SPARK PLUGS, Fig. 12

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

Spark plug gap - .030 inch.

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

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

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

STARTING MOTOR, Fig. 1, Ref. 19

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

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

ADJUSTMENTS

CARBURETOR

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

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

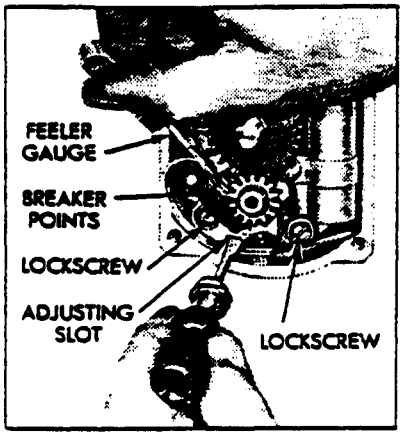


Fig. 13

MAGNETO BREAKER POINTS, Fig. 13

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

.015 inch at full separation.

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

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

DISTRIBUTOR (Battery Ignition), Fig. 14

The breaker point gap should be:

.020 inch at full separation.

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

Points that are badly pitted or worn should be replaced.

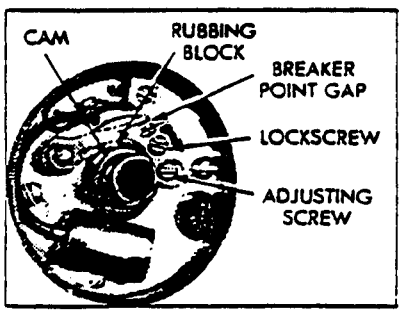


Fig. 14

VALVE TAPPET ADJUSTMENT

Models VH4D, VG4D, Fig. 15

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

Inlet - .008" Exhaust - .016"

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

Model V465D, Fig. 16

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

Inlet - .008" Exhaust - .014"

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

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

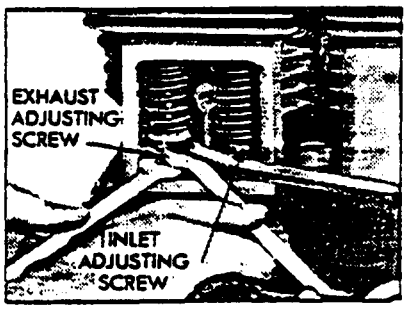


Fig. 15, VH4D, VG4D
VALVE TAPPET ADJUSTMENT

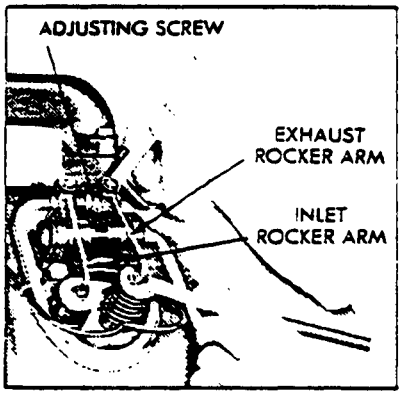


Fig. 16, V465D
VALVE TAPPET ADJUSTMENT

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

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

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

TIMING

FIRING ORDER

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

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

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

TIMING CHECK, Fig. 17

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

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

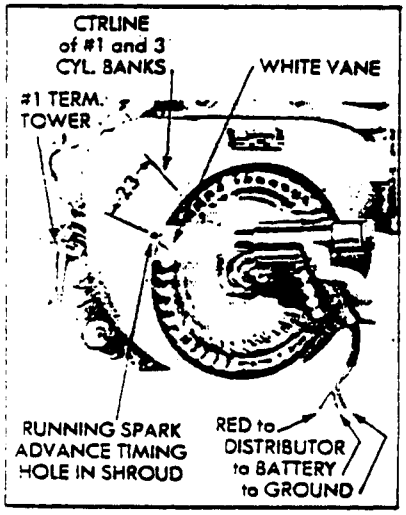


Fig. 17

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

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

CLUTCH ADJUSTMENT

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

VH4D Clutch, Fig. 18

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

VH4D CLUTCH REDUCTION, Fig. 19

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

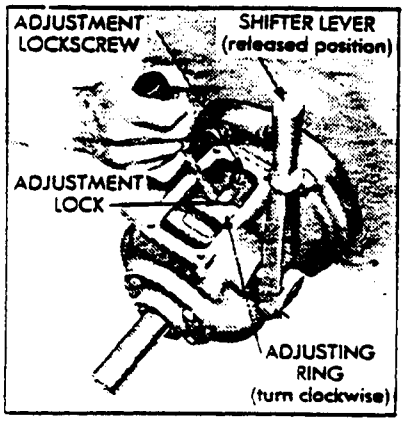


Fig. 18, VH4D
CLUTCH ADJUSTMENT

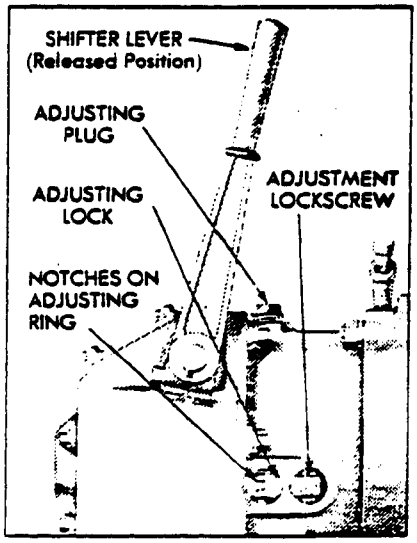


Fig. 19, VH4D
CLUTCH REDUCTION ADJUSTMENT

VG4D, V465D CLUTCH ADJUSTMENT

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

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

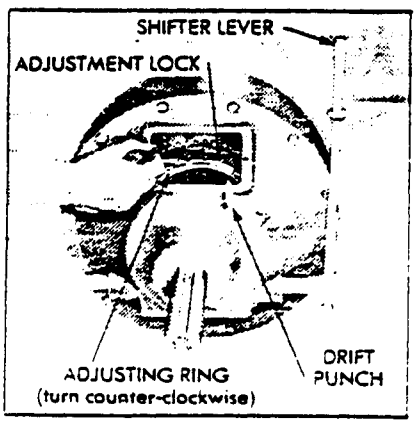


Fig. 20, VG4D, V465D
ROCKFORD CLUTCH ADJUSTMENT

TROUBLE SHOOTING

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

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

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

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

FUEL MIXTURE

No fuel in tank or fuel valve closed.

Plugged vent hole in fuel tank cap.

Fuel line clogged.

Fuel pump diaphragm worn or punctured.

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

Carburetor not choked sufficiently, especially if engine is cold.

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

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

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

Carburetor float needle valve stuck open. This condition would be indicated if fuel continues to drip from carburetor with engine standing idle.

COMPRESSION

Cylinders dry due to engine having been out of use. Pour one fluid ounce of crankcase oil through spark plug holes.

Loose or broken spark plug. A hissing noise will be heard in cranking due to escaping gas mixture on compression stroke.

Damaged cylinder head gasket or loose cylinder head. This will likewise cause hissing noise on compression stroke.

Valve stuck open. Piston rings stuck or worn.

Valves adjusted with insufficient clearance.

IGNITION

Test for spark by removing spark plugs and observe spark at plug gap while turning engine over. No spark or weak spark may be attributed to the following:

Ignition wires loose or disconnected at magneto, spark plug, distributor or coil.

Broken or frayed ignition wires.

Spark plug insulator broken.

Spark plugs wet or dirty.

Spark plug gap incorrect.

Condensation on spark plug electrodes.

Breaker point gap incorrect.

Breaker points pitted or fused.

Breaker arm sticking.

Condenser leaking or grounded.

Spark timing wrong.

Weak battery. Faulty ignition coil.

ENGINE MISSES

Spark plug gap incorrect.

Worn, leaking or loose ignition cables.

Weak spark. See 'Ignition' test for spark.

Breaker points pitted or worn.

Water in gasoline.

Poor compression. See 'Compression'.

Sticky valves.

ENGINE STOPS

Fuel tank empty.

Water, dirt or gum in gasoline.

Gasoline vaporized in fuel lines, due to excessive heat around engine (Vapor Lock). See 'Stopping Engine'.

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

Air vent hole in fuel tank cap plugged.

Ignition troubles. See 'Ignition'.

OVERHEATING

Crankcase oil supply low.

Ignition timing wrong.

Low grade of gasoline.

Engine overloaded.

Restricted cooling air circulation.

Part of air shroud removed from engine.

Dirt between cooling fins.

Intake or rotating screen clogged with dirt.

Restricted exhaust.

ENGINE MAINTENANCE SCHEDULE	Page Ref.	Daily	Weekly or 50 hrs.	100 hrs.	250 hrs.	Seasonally or 500 hrs.
CHECK OIL LEVEL. Add to full mark - Do not overfill.	2	●				
CHECK AIR CLEANER. Shake out accumulated dirt from dry element cleaner - Maintain oil level in oil bath type cleaner.	4	●				
CLEAN AIR INTAKE SCREEN. Clean cooling fins if necessary.	1	●				
GREASE CLUTCH THROWOUT BEARING (VG4D, V465D).	3	●				
CHANGE CRANKCASE OIL.	2		●			
CLEAN AIR FILTER ELEMENT. DRY Element and OIL Bath types.	4		●			
CLEAN CRANKCASE BREATHER CAP.	4		●			
GREASE CLUTCH HOUSING BEARING (VG4D, V465D).	3		●			
REPLACE OIL FILTER. In adverse conditions replace every oil change.	4			●		
LUBRICATE DISTRIBUTOR SHAFT.	4				●	
CHECK COMPRESSION. Pressure should not vary more than 10 p.s.i. between cylinders. Remove head - clean out carbon deposits. Reseat valves if necessary.	-				●	
INSPECT SPARK PLUGS and BREAKER POINTS. Replace if necessary and regap to specification.	5				●	
INSPECT FUEL FILTER. Clean filter screen and glass bowl.	4				●	
LUBRICATE DISTRIBUTOR CAM and breaker arm pivot.	4				●	
INSPECT COOLING SYSTEM. Remove shrouding and scrape off dirt from between fins, around cylinders and from shrouding.	1				●	
INSPECT STARTING MOTOR. Check for loose mounting and cable connections.	5				●	
CHANGE OIL IN CLUTCH and REDUCTION GEAR HOUSINGS.	2					●

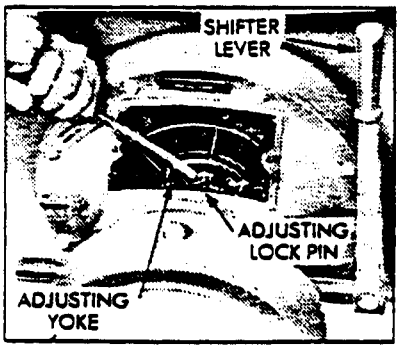


Fig. 21, VG4D, V465D
TWIN DISC CLUTCH ADJUSTMENT

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

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

FLYWHEEL ALTERNATOR

Fig. 22 and Fig. 23

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

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

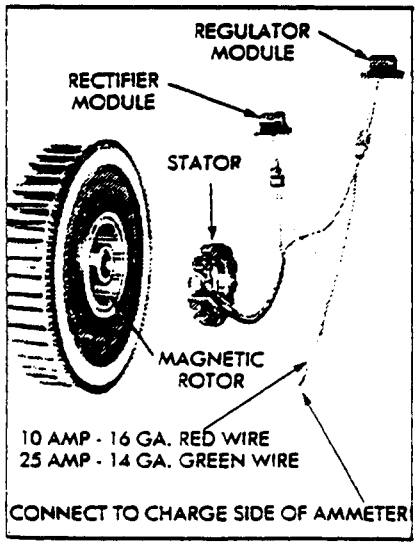


Fig. 22, FLYWHEEL ALTERNATOR

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

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

GENERATOR — WIRING CIRCUIT, Fig. 24

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

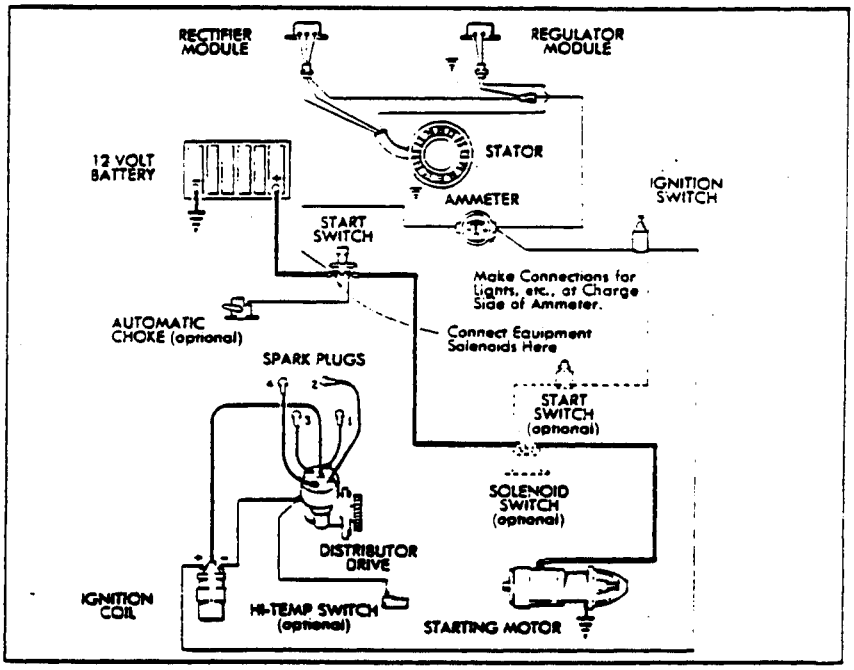


Fig. 23, WIRING DIAGRAM, Flywheel Alternator and Battery Ignition, Models VH4D, VG4D

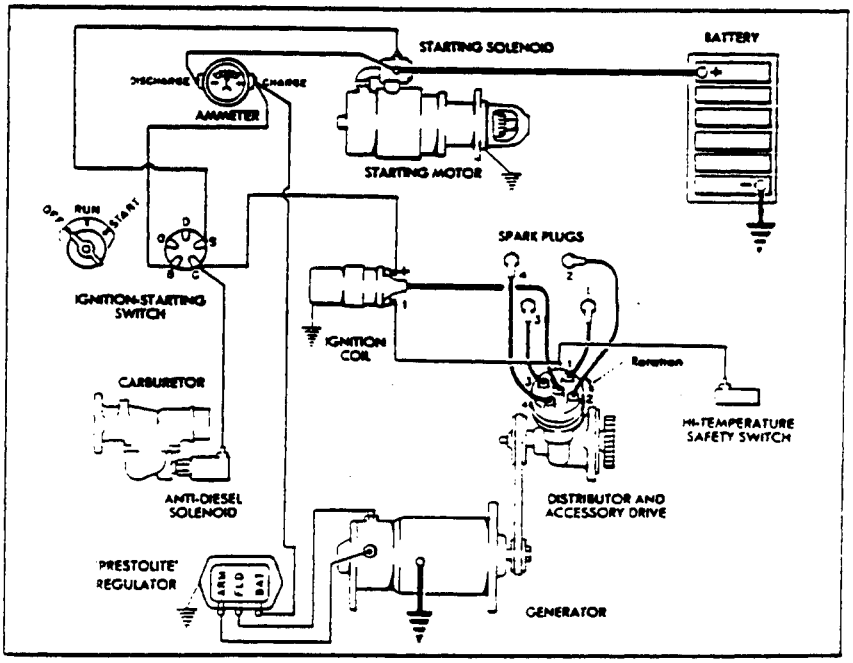


Fig. 24, WIRING DIAGRAM, Generator and Battery Ignition, Model V465D

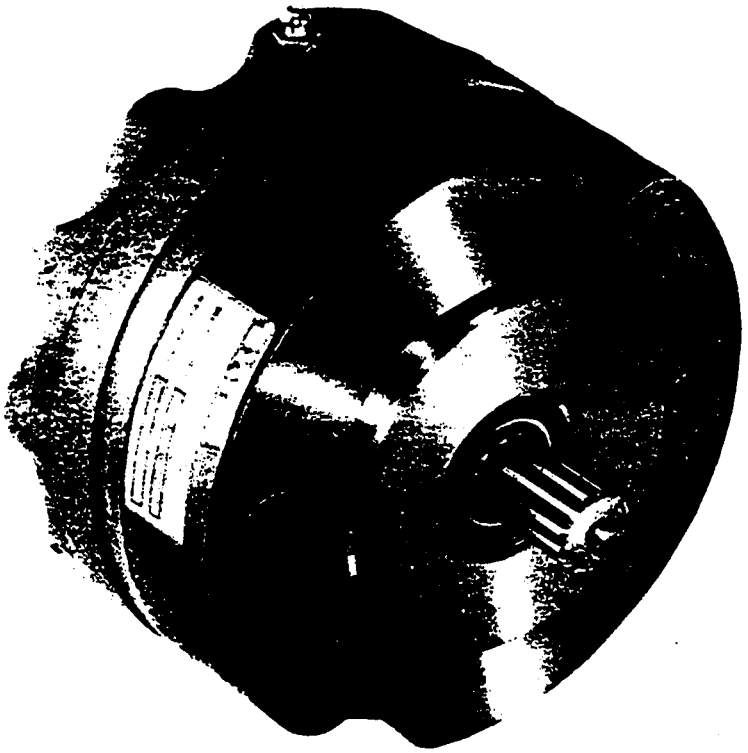
REV.

SY·TEC SERIES

MULTIPLE DISC BRAKE

(dry design - SAE B size)

SERVICE MANUAL



TYPICAL BRAKE

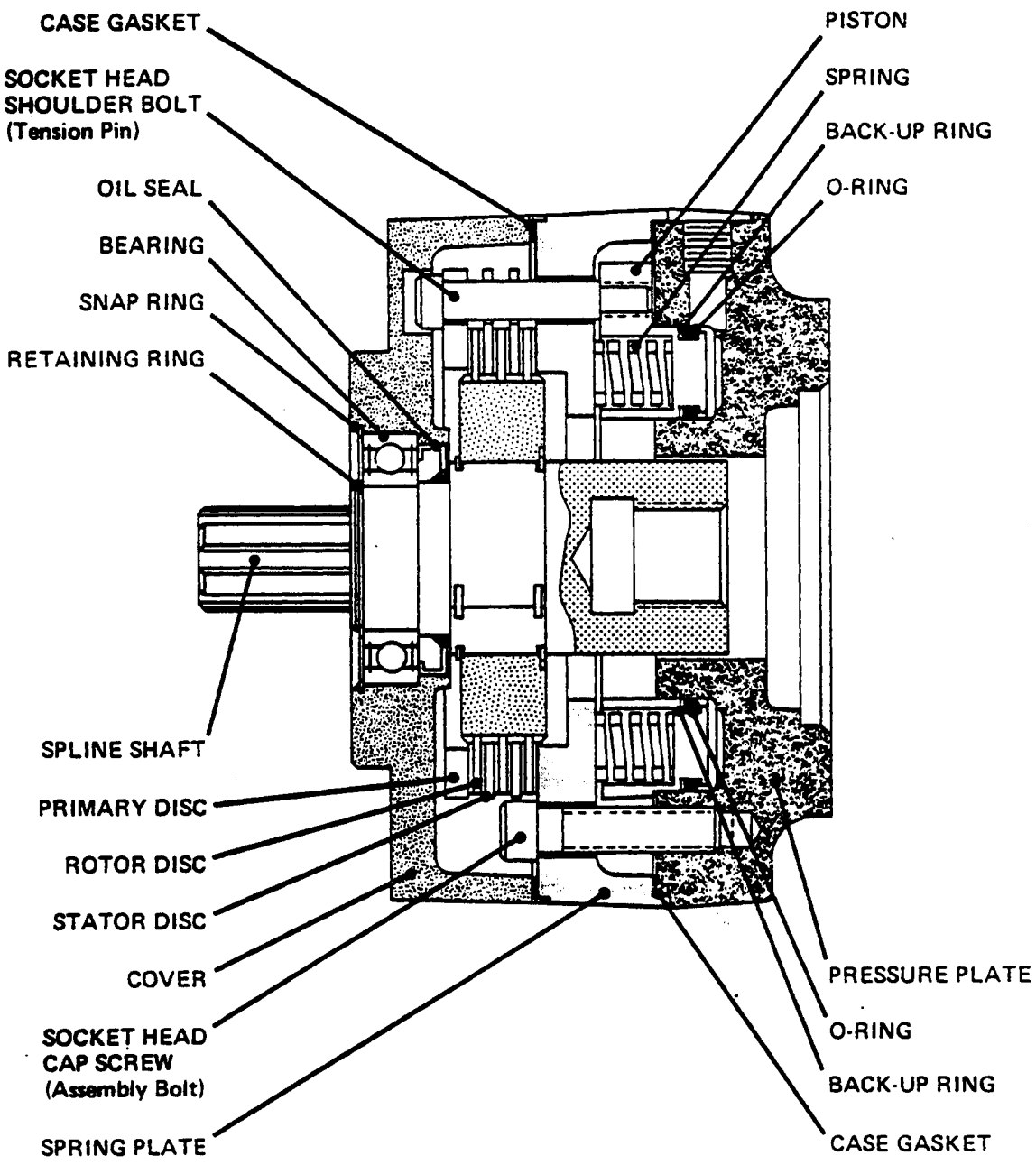


FIGURE 1

PRINCIPLES OF OPERATION

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

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

Two application examples.

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

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

DESCRIPTION OF MODEL NUMBERS



SERIES
S - Sy-Tec

OUTPUT FACE
B - SAE B-Mount 2-Bolt

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

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

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

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

TORQUE 1 psi = .06895 bar

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

For use with input spline codes 14 and 25 only.

DISASSEMBLY

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

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

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

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

ASSEMBLY

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

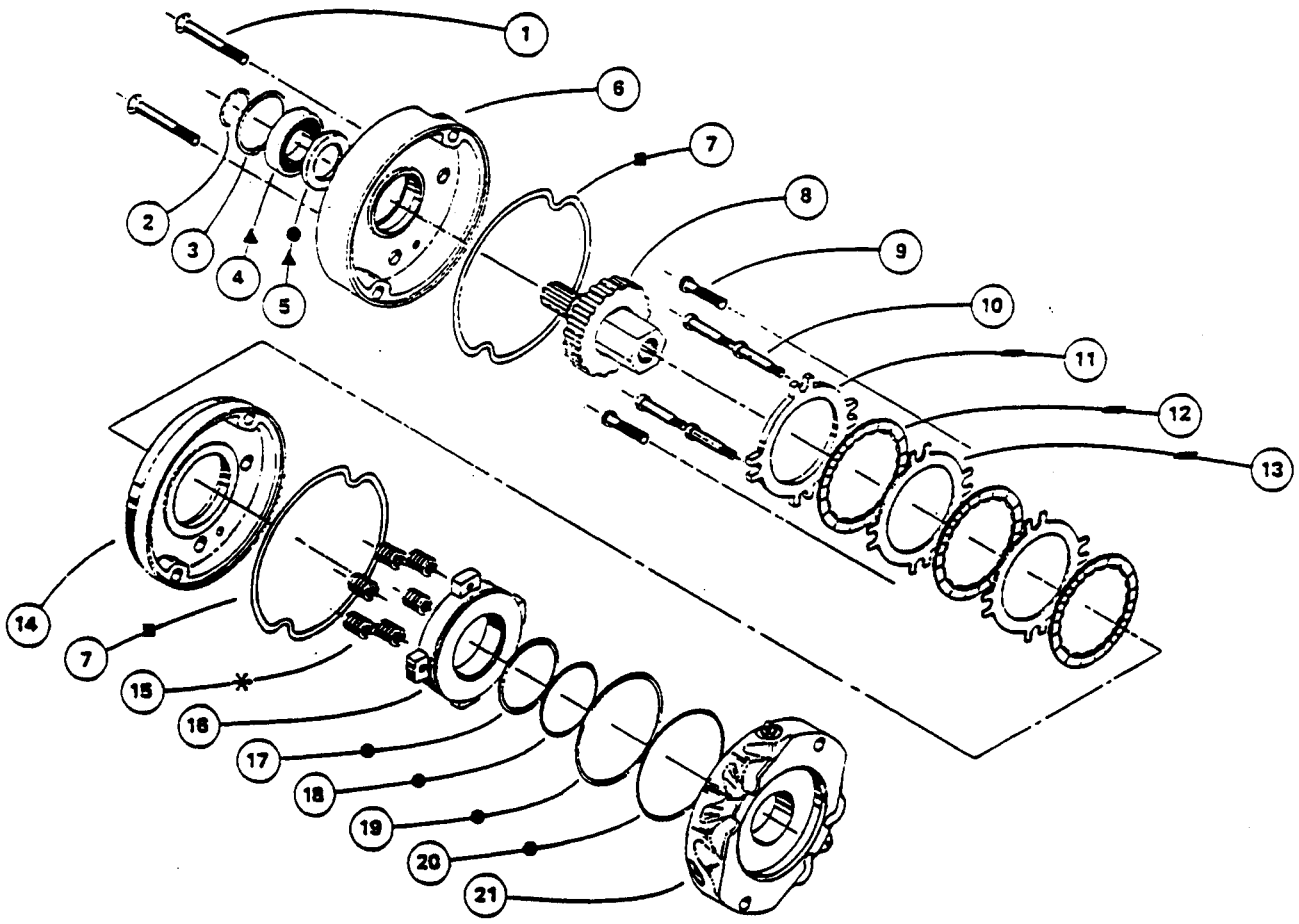
1. Clean all parts thoroughly before assembling.
2. Press oil seal (item 5) into bore until it is flush with bearing shoulder. Open side of oil seal must face toward the front side of cover (item 6).
3. Press bearing (item 4) into position until it bottoms out on oil seal borestep.
4. Install snap ring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

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

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

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

- ● Items included in O-ring and Back-up Ring Kit
- ▬ Items included in Lining Kit
- ▲ Items included in Bearing Kit
- ✱ Items included in Spring Kit
- ■ Items included in all Repair Kits listed above



PARTS LIST

ITEM	QTY.	DESCRIPTION
1	2	Flat Head Socket Cap Screws
2	1	Retaining Ring
3	1	Snap Ring
4	1	▲ Bearing
5	1	● ▲ Oil Seal
6	1	Cover Plate
7	2	■ Case Seals
8	1	Spline Shaft Assembly
	1	Shaft
	1	Outer Spline
	1	Retaining Ring
9	2	Socket Head Cap Screws (Assembly Bolt)
10	4	Socket Head Shoulder Bolts (Tension Pin)

ITEM	QTY.	DESCRIPTION
11	1	▬ Primary Disc
12	3	▬ Rotor Discs
13	2	▬ Stator Discs
14	1	Spring Plate
15	4	✱ Springs - Red
	2	✱ Springs - Blue
16	1	Piston
17	1	● Back-up Ring (I.D.)
18	1	● O-ring (I.D.)
19	1	● Back-up Ring (O.D.)
20	1	● O-ring (O.D.)
21	1	Pressure Plate

BLEEDING

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

SERVICE DIAGNOSIS

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

REPAIR KITS

(Refer to Page 5 for item numbers)

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

Foreword

Before Commissioning Your New Engine:
Surely you expect top service from your DEUTZ engine ... So please give this manual your top attention!

All necessary safety precautions and regulations have been observed in the design, choice of material and manufacture of your engine, and before the engine left our factory, it stood up satisfactorily to the severest tests and trials.

Maximum engine performance is however not possible without a minimum of upkeep. Remember that even simple household appliances need some care and attention once in a while. **So be sure to maintain your engine as scheduled herein and to use the fuels and lube oils** recommended. **You will get a lot in return: a long lifespan of your DEUTZ engine, high power output and reliability, plus low consumption rates and exhaust emissions.**

Should, on the other hand, any trouble arise on engine calling for overhaul or repair, do not tamper with it but **entrust the job to a workshop of the worldwide DEUTZ organization**, where you will find a staff of DEUTZ-trained mechanics, the latest special tools and facilities, and a full stock of

KHD DEUTZ

Genuine Spare Parts

For ordering such spares, please always refer to the relevant Parts Catalogue. Otherwise ask your local DEUTZ distributor.

By the way, you will agree with us that "Safety first" is a good slogan. **So please be sure to refit any guards and protective devices that should have been removed for carrying out work on the engine.**

To prevent pollution of the environment, please let old fuel and oil run into a special receptacle.

Note: In view of the constant improvements to our engines, the specification data as well as other information included in this manual are subject to change without notice.

Safety and dependability result from superior technology, correct operation, plus proper care and maintenance



When reading through this manual, you will find the above symbol marking all important safety instructions. Give particular heed to these instructions and proceed with special care. Pass on these safety instructions to your operating personnel.

General Safety Rules

Apart from the safety instructions given in this manual, it is also necessary to observe the official safety rules, which may vary from country to country.

The Right Work Clothing

Work clothing should be closely fitting, so that it cannot be caught by rotating or projecting parts.

Beware of Running Engine

Always stop the engine before refuelling.

Always stop the engine before carrying out maintenance or repair work.

Care and Maintenance

Reliability of the engine largely depends on close observance of the Maintenance Schedule (page 89).

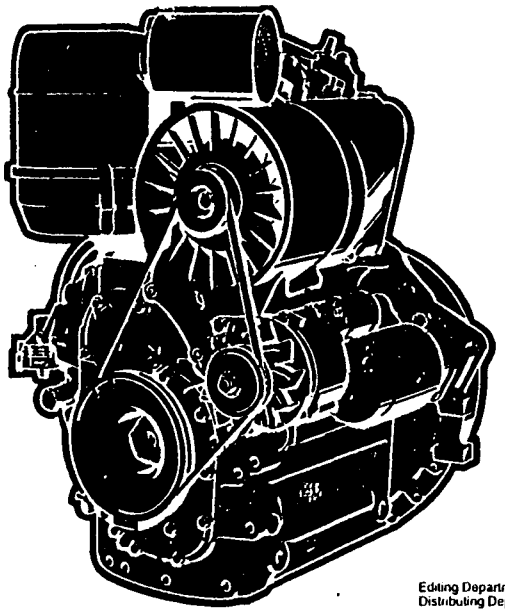
Never attempt to rectify faults or carry out repairs for which you do not have the necessary experience and special tools. Entrust the job to your DEUTZ Service Station, where DEUTZ-trained personnel will give your engine expert attention.

Operation Manual

KHD DEUTZ

297 3911 D/E

F2L 912/W



Printed in Germany (West)
19th Edition

Editing Department: AE-ZI
Distributing Department: MZA

Contents

Page

Foreword
- Before Commissioning Your New Engine 64
- Safety Precautions 65

Description of Engine
- Description of Engine 66
- Numbering of Cylinders 67
- Lube Oil Circuit 68
- Combustion Method 69
- Layout of Fuel System (Deutz Injection Pump) 70
- Layout of Fuel System (Bosch Injection Pump) 71
- Engine Model and Engine Serial No. 72
- Specification Data 73

Operation of Engine
- Fuel (Filling-up/Air-venting) 74
- Motor Oil 76
- Starting 79
- Stopping 82
- Winter Operation 83

Maintenance
- Maintenance Schedule 89
- Important: Commissioning New or Overhauled Engines 92
- Checking Oil Level in Engine 93
- Checking and Cleaning Air Cleaners 94
- Checking Water Separator on Two-stage Fuel Filter . . 97
- Changing Motor Oil 98
- Inspecting/Cleaning the Cooling System 100
- Checking Electrolyte in Battery 102
- Checking V-belt/V-belt Tension 103
- Cleaning Lube Oil Filter 105
- Checking Valve Clearance/Decompression Clearance 106
- Cleaning Strainer of Fuel Feed Pump 108
- Renewing Fuel Filter Cartridge 109
- Renewing Two-stage Fuel Filter Cartridge (1st stage) . 110
- Renewing Two-stage Fuel Filter Cartridge (2nd stage) . 111

Workshop Maintenance
- Checking Fastenings of Intake and Exhaust Manifolds . 112
- Checking Cylinder Head Temperature Monitoring System 112
- Testing Alternator/Starter Motor 113
- Testing Injectors 114

Trouble Shooting 115

Workshop Information 118

Engine Preservation 121

Description of Engine

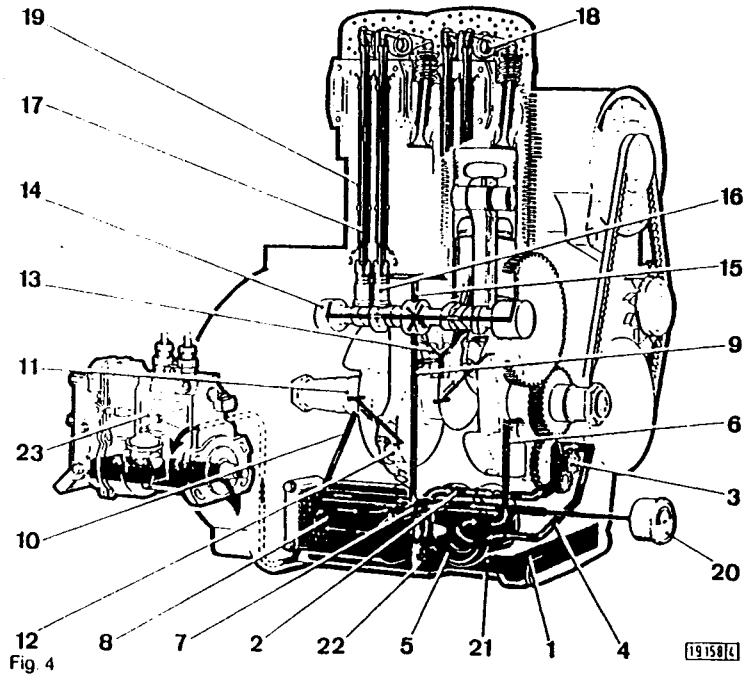


Fig. 4

Lube Oil Circuit

1 Oil sump
2 Suction pipe
3 Oil pump
4 Delivery pipe
5 Oil filter with cartridge (full-flow)
6 Oil bore to 3rd main bearing
7 Oil pipe to oil cooler
8 Oil cooler (version optional)
9 Oil bore to 2nd main bearing, valve drive and piston cooling
10 Oil bore to 1st main bearing
11 Main bearing
12 Big-end bearing
13 Spray nozzle for piston cooling
14 Camshaft bearing
15 Oil duct to tappets
16 Tappet (with groove for pulse-fed rocker arm lubrication)
17 Pushrod (hollow, supplying oil to rocker arms)
18 Rocker arm bearing
19 Pushrod cover tube (surplus oil returning from rocker arm chamber to sump)
20 Oil pressure gauge
21 Oil drain plug, for lube oil filter housing
22 Main oil drain plug
23 Injection pump (connected to engine lube oil circuit (on version with Bosch injection pump)

Combustion Method

FL 912
Direct Injection

FL 912 W
Two-stage Combustion

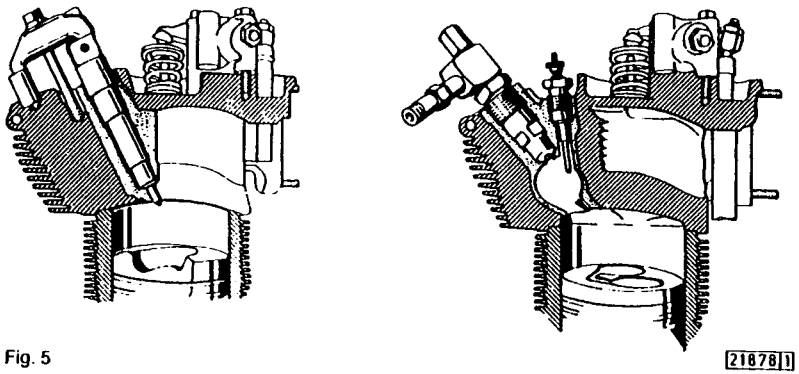


Fig. 5

Note:

This Instruction Manual applies both to FL 912 engines using direct injection and to FL 912 W engines using two-stage combustion.

The difference in the two systems is dealt with in the sections »Specification Data«, »Starting« and »Operation in Winter«.

Direct-injection engines are used where high power output and compact construction are more important than high exhaust-gas quality, while two-stage combustion engines are designed for applications where low exhaust emissions are of prime importance.

Description of Engine

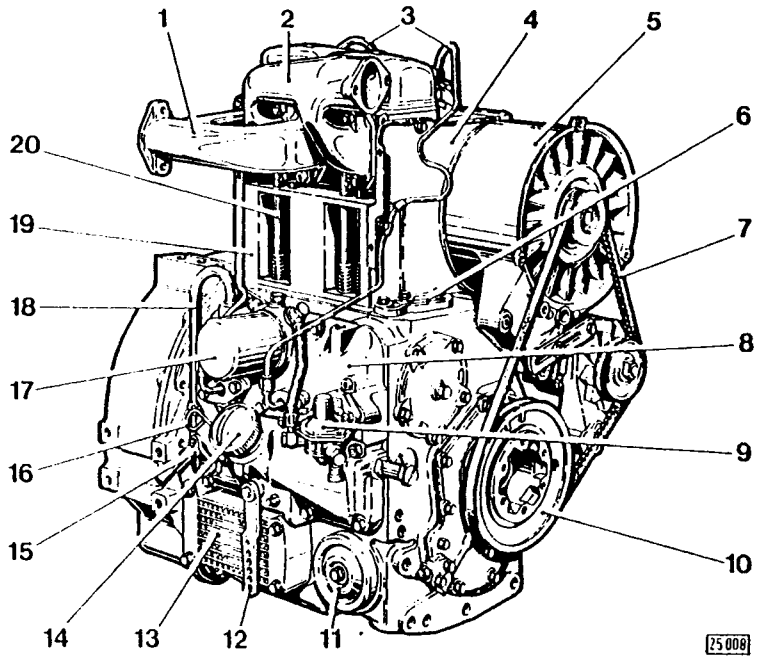


Fig. 1

Description of Engine (service side) (shown: F2L 912 – with Deutz fuel-injection pump)

1 Exhaust manifold
2 Air intake manifold
3 Injection lines
4 Vertical plate, front
5 Cooling air blower
6 Hydraulic pump connection
7 V-belt
8 Deutz fuel-injection pump
9 Fuel feed pump
10 V-belt pulley
11 Lube oil filter
12 Speed control lever
13 Lube oil cooler
14 Oil filler cap
15 Shutdown lever
16 Oil dipstick
17 Fuel filter
18 Crankcase breather
19 Waste air box
20 Pushrod with cover tube

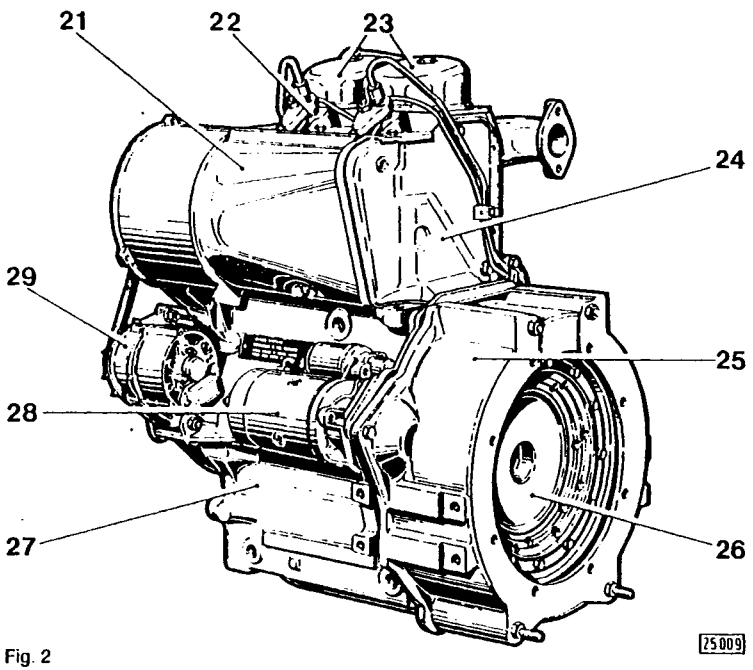


Fig. 2

Description of Engine (Air intake side)

21 Air cowling
22 Injector
23 Rocker chamber covers
24 Vertical plate, rear
25 Adapter housing
26 Flywheel
27 Crankcase
28 Starter motor
29 Alternator

Cylinder Numbers

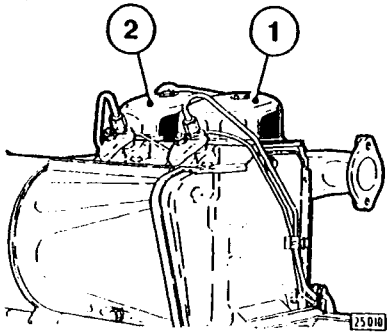


Fig. 3

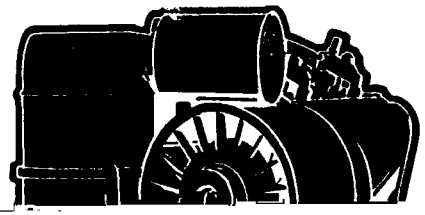
REV.

Operation Manual

KHD DEUTZ

297 3911 D/E

F2L 912/W



Contents

Page

Foreword

Before Commissioning Your New Engine 64
Safety Precautions 65

Description of Engine

Description of Engine 66
Numbering of Cylinders 67
Lube Oil Circuit 68
Combustion Method 69
Layout of Fuel System (Deutz Injection Pump) 70
Layout of Fuel System (Bosch Injection Pump) 71
Engine Model and Engine Serial No. 72
Specification Data 73

Operation of Engine

Fuel (Filling-up/Air-venting) 74
Motor Oil 76
Starting 79
Stopping 82
Winter Operation 83

Maintenance

Maintenance Schedule 89
Important: Commissioning New or Overhauled Engines 92
Checking Oil Level in Engine 93
Checking and Cleaning Air Cleaners 94
Checking Water Separator on Two-stage Fuel Filter . . 97
Changing Motor Oil 98
Inspecting/Cleaning the Cooling System 100
Checking Electrolyte in Battery 102
Checking V-belt/V-belt Tension 103
Cleaning Lube Oil Filter 105
Checking Valve Clearance/Decompression Clearance 106

Mark Industries

TITLE	VENDOR CE
MODEL	42C
NOTES	P/N 22489

Foreword

Before Commissioning Your New Engine:
Surely you expect top service from your DEUTZ engine ... So please give this manual your top attention!

All necessary safety precautions and regulations have been observed in the design, choice of material and manufacture of your engine, and before the engine left our factory, it stood up satisfactorily to the severest tests and trials.

Maximum engine performance is however not possible without a minimum of upkeep. Remember that even simple household appliances need some care and attention once in a while. **So be sure to maintain your engine as scheduled herein** and to use the fuels and lube oils recommended. **You will get a lot in return: a long lifespan of your DEUTZ engine, high power output and reliability, plus low consumption rates and exhaust emissions.**

Should, on the other hand, any trouble arise on engine calling for overhaul or repair, do not tamper with it but **entrust the job to a workshop of the worldwide DEUTZ organization**, where you will find a staff of DEUTZ-trained mechanics, the latest special tools and facilities, and a full stock of

KHD DEUTZ

Genuine Spare Parts

For ordering such spares, please always refer to the relevant Parts Catalogue. Otherwise ask your local DEUTZ distributor.

By the way, you will agree with us that "Safety first" is a good slogan. **So please be sure to refit any guards and protective devices that should have been removed for carrying out work on the engine.**

To prevent pollution of the environment, please let old fuel and oil run into a special receptacle.

Note: In view of the constant improvements to our engines, the specification data as well as other information included in this manual are subject to change without notice.

Safety and dependability result from superior technology, correct operation, plus proper care and maintenance



When reading through this manual, you will find the above symbol marking all important safety instructions. Give particular heed to these instructions and proceed with special care. Pass on these safety instructions to your operating personnel.

General Safety Rules

Apart from the safety instructions given in this manual, it is also necessary to observe the official safety rules, which may vary from country to country.

The Right Work Clothing

Work clothing should be closely fitting, so that it cannot be caught by rotating or projecting parts.

Beware of Running Engine

Always stop the engine before refuelling.

Always stop the engine before carrying out maintenance or repair work.

Care and Maintenance

Reliability of the engine largely depends on close observance of the Maintenance Schedule (page 89).

Never attempt to rectify faults or carry out repairs for which you do not have the necessary experience and special tools. Entrust the job to your DEUTZ Service Station, where DEUTZ-trained personnel will give your engine expert attention.

Description of Engine

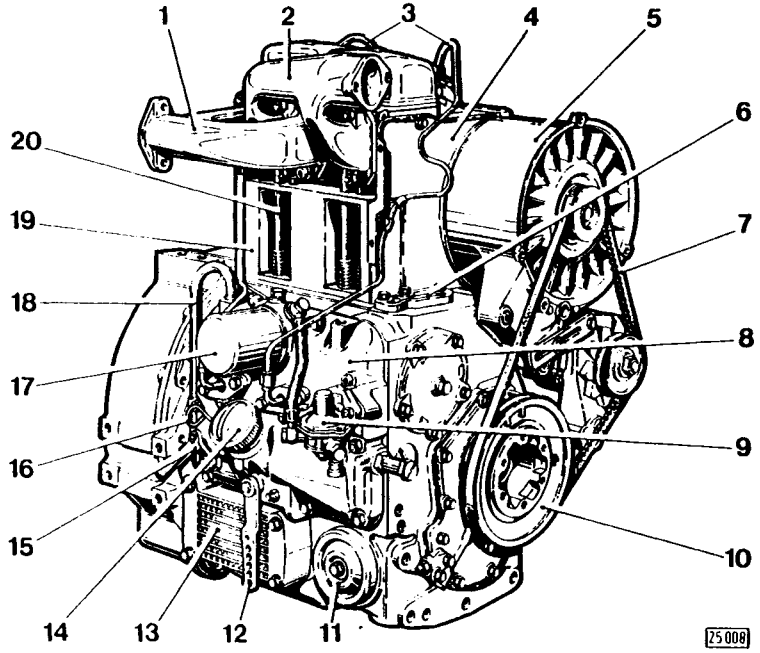


Fig. 1

Description of Engine (service side) (shown: F2L 912 – with Deutz fuel-injection pump)

1 Exhaust manifold
2 Air intake manifold
3 Injection lines
4 Vertical plate, front
5 Cooling air blower
6 Hydraulic pump connection
7 V-belt
8 Deutz fuel-injection pump
9 Fuel feed pump
10 V-belt pulley
11 Lube oil filter
12 Speed control lever
13 Lube oil cooler
14 Oil filler cap
15 Shutdown lever
16 Oil dipstick
17 Fuel filter
18 Crankcase breather
19 Waste air box
20 Pushrod with cover tube

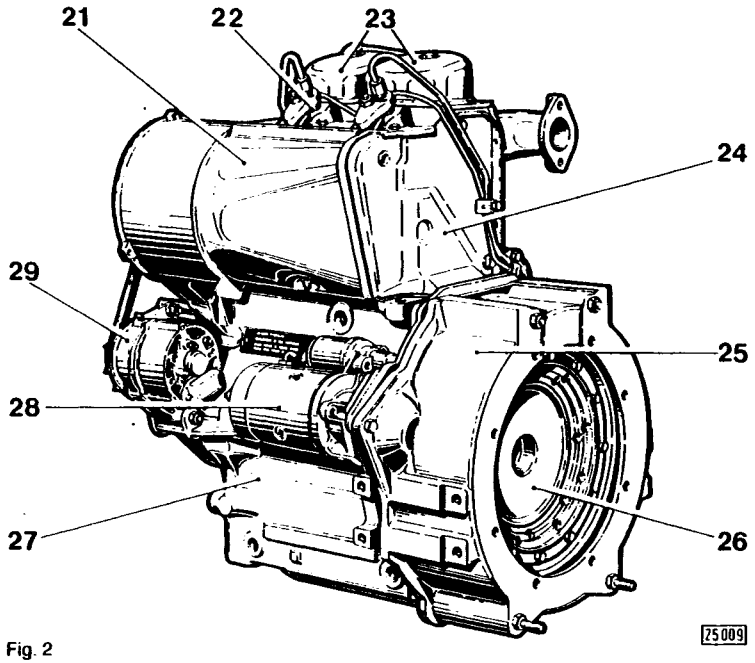


Fig. 2

Description of Engine (Air intake side)

21 Air cowling
22 Injector
23 Rocker chamber covers
24 Vertical plate, rear
25 Adapter housing
26 Flywheel
27 Crankcase
28 Starter motor
29 Alternator

Cylinder Numbers

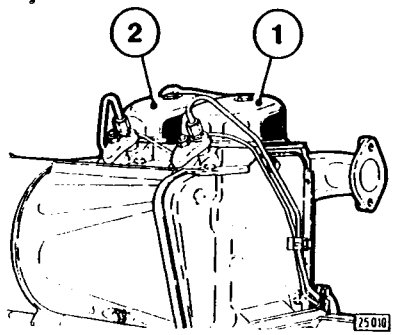


Fig. 3

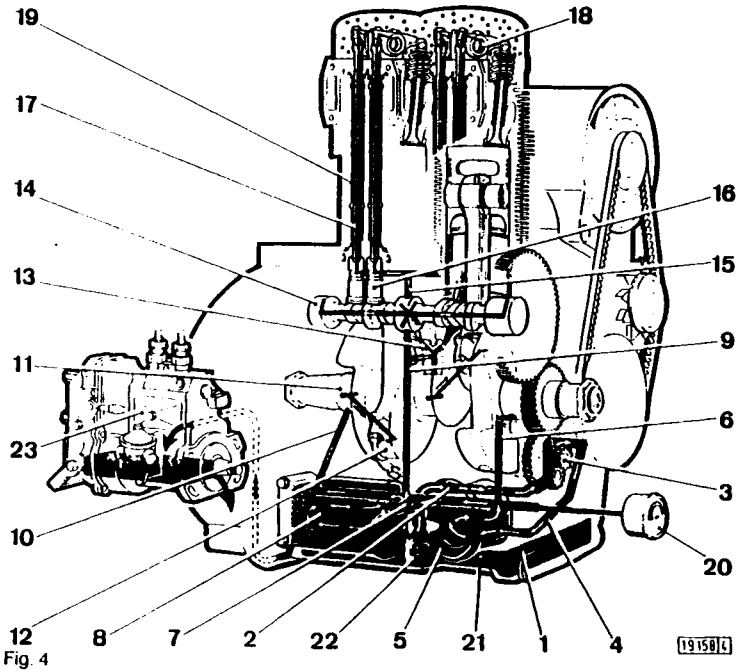


Fig. 4

Lube Oil Circuit

1 Oil sump
2 Suction pipe
3 Oil pump
4 Delivery pipe
5 Oil filter with cartridge (full-flow)
6 Oil bore to 3rd main bearing
7 Oil pipe to oil cooler
8 Oil cooler (version optional)
9 Oil bore to 2nd main bearing, valve drive and piston cooling
10 Oil bore to 1st main bearing
11 Main bearing
12 Big-end bearing
13 Spray nozzle for piston cooling
14 Camshaft bearing
15 Oil duct to tappets
16 Tappet (with groove for pulse-fed rocker arm lubrication)
17 Pushrod (hollow, supplying oil to rocker arms)
18 Rocker arm bearing
19 Pushrod cover tube (surplus oil returning from rocker arm chamber to sump)
20 Oil pressure gauge
21 Oil drain plug, for lube oil filter housing
22 Main oil drain plug
23 Injection pump (connected to engine lube oil circuit (on version with Bosch injection pump)

Combustion Method

FL 912
Direct Injection

FL 912 W
Two-stage Combustion

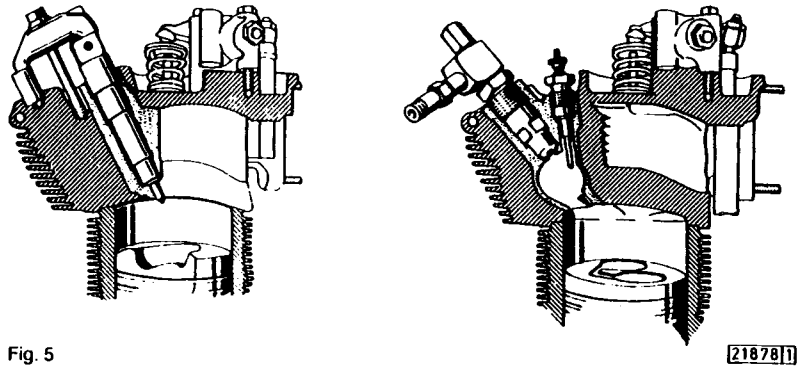


Fig. 5

Note:

This Instruction Manual applies both to FL 912 engines using direct injection and to FL 912 W engines using two-stage combustion.

The difference in the two systems is dealt with in the sections »Specification Data«, »Starting« and »Operation in Winter«.

Direct-injection engines are used where high power output and compact construction are more important than high exhaust-gas quality, while two-stage combustion engines are designed for applications where low exhaust emissions are of prime importance.

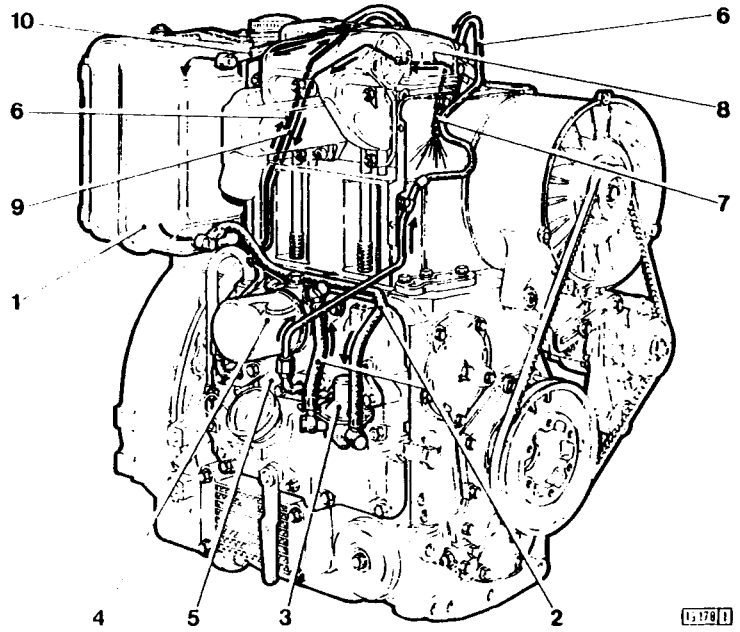


Fig. 6

Layout of Fuel System (here with Deutz injection pump)

1 Fuel tank
2 Fuel supply line
3 Fuel feed pump
4 Fuel filter
5 Injection pump (Deutz)
6 Injection lines
7 Injector
8 Backleakage line
9 Overflow line
10 Fuel return line

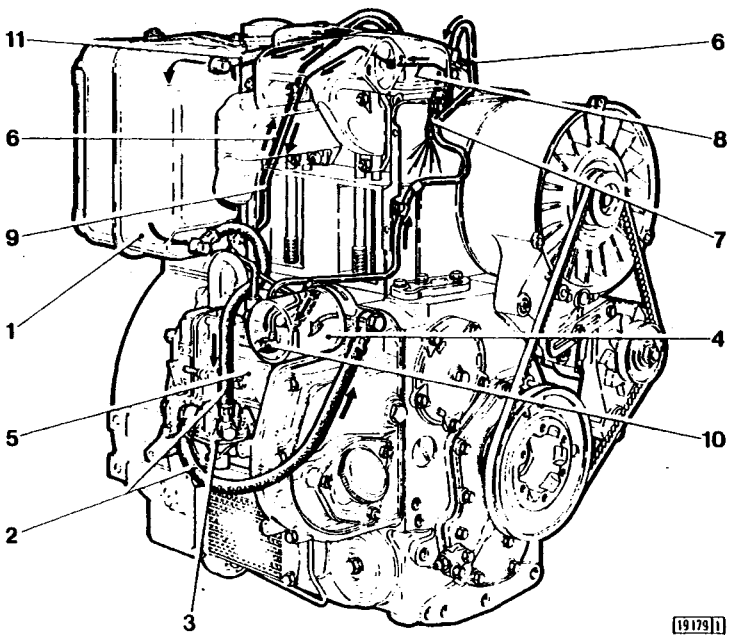


Fig. 7

Layout of Fuel System (here with Bosch injection pump)

1 Fuel tank
2 Fuel supply line
3 Fuel feed pump
4 Fuel filter
5 Injection pump
6 Injection lines
7 Injector
8 Backleakage line
9 Overflow line
10 Overflow valve
11 Fuel return line

Description of Engine

Engine Model and Engine Serial No.

The model designation A and the engine serial No. B are given on the rating plate (Fig. 8).

The rating plate is attached to the crankcase below air cowling (Fig. 9).

The serial No. is also stamped into the crankcase, see Fig. 10.

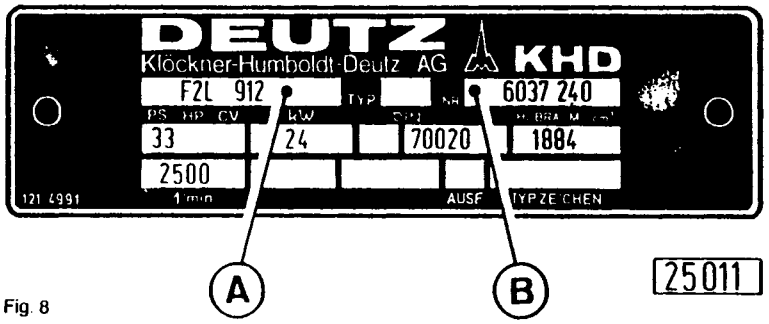


Fig. 8

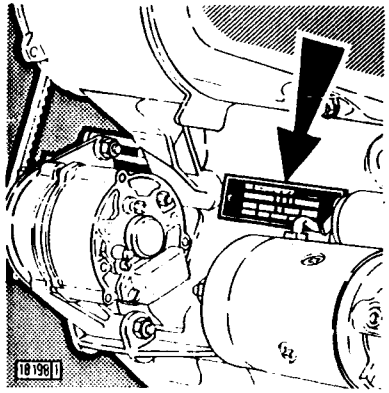


Fig. 9

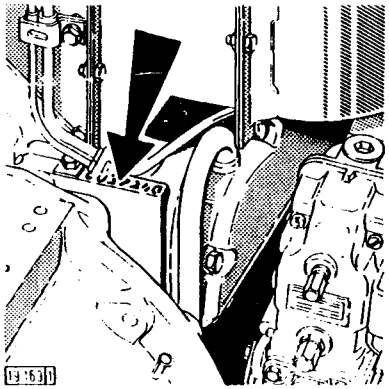


Fig. 10

Description of Engine

Specification Data

Model	F2L 912	F2L 912 W
Number of cylinders	2	
Bore mm	100	
Stroke mm	120	
Piston displacement cm^3	1884	
Direction of rotation (facing flywheel)	counter-clockwise	
Working principle	four-stroke diesel with direct injection	four-stroke diesel with two-stage combustion
Weight (depending on version) approx. kg	255	
Power output* kW (HP)	see rating plate	
Speed* rev./min	see rating plate	
Lubrication system	forced lubrication	
Oil capacity initial fill approx. ltr.	6	
refill approx. ltr.	4.5	
Valve clearance (engine cold) mm	0.15	
Valve timing:		
with Deutz injection pump		
Inlet opens bTDC	26°	
Inlet closes aBDC	67°	
Exhaust opens bBDC	73°	
Exhaus closes aTDC	30°	
with Bosch injection pump		
Inlet opens bTDC	32°	
Inlet closes aBDC	60°	
Exhaust opens bBDC	70°	
Exhaust closes aTDC	32°	
Piston crown clearance (measured with lead wire) mm	1.0 – 1.2	
Injection test pressure (during operation) bar	175 + 8	115 + 8
Commencement of Delivery		
Deutz injection pump		
up to 2300/min bTDC	32° ± 1°	25° ± 1°
above 2301/min bTDC	38° ± 1°	25° ± 1°
Bosch injection pump		
with advance unit bTDC	22° ± 1°	–
without advance unit		
up to 1800/min bTDC	26° ± 1°	–
from 1801 - 2300/min bTDC	30° ± 1°	–
above 2301/min bTDC	32° ± 1°	–
Firing order	1-2	

* The power output and speed of the engine are stamped on the nameplate.

Engine Operation

Starting up a new engine for the first time involves a number of preparatory jobs, some of which must also be carried out later on in the course of routine maintenance (see Maintenance Schedule on page 89).

1. Fuel

1.1 Grade

Always use a reputable branded grade of gas oil, the sulphur content of which should be below 0.5 %, and observe strict cleanliness when filling in. Higher sulphur contents affect the oil-change intervals (page 98). At low ambient temperatures use winter-grade fuel only (see hints on page 83). The fuel must be replenished promptly to prevent the tank from running dry, otherwise fuel filter and injection lines will need air-venting.

The following fuel specifications are approved: DIN 51601; NATO Codes F 54, F 75, F 76; BS 2869: A 1 and A 2*; ASTM D 975-78: 1-D and 2-D; VV-F-800 a: DF-A, DF-1 and DF-2.

1.2 Air-venting

Never let the tank run dry!

Any air which has found its way into the fuel system can cause irregular running of the engine and decrease its performance, even leading to stopping of the engine and preventing its restarting.

Not only when the fuel tank has been run dry, but also after changing the fuel filter or working on the fuel line system, is it therefore necessary to air-vent the system as follows:

1.2.1 Version with Deutz Injection Pump (Fig. 11)

- Loosen vent screw 1 by 2 – 3 turns.
- Actuate priming lever 2 by pressing repeatedly upwards against spring force until fuel emerges free of air bubbles at the loosened vent screw 1.
- Tighten vent screw securely, while still pumping.
- Loosen banjo bolt 3 at smaller hexagon by 2 – 3 turns.
- Actuate priming lever 2 by pressing repeatedly upwards against spring force until fuel emerges free of air bubbles at the loosened banjo bolt 3.
- Tighten banjo bolt securely, while still pumping.

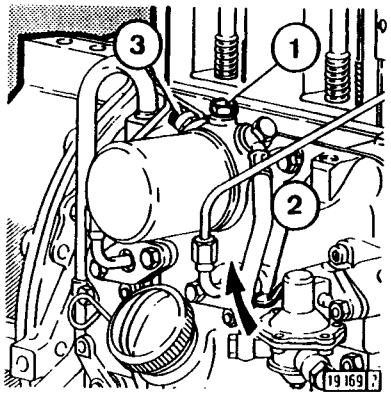


Fig. 11

* Observe sulphur content!

1.2.2 Version with Bosch Injection Pump (Fig. 12)

- Loosen banjo bolt 1 by 2 – 3 turns.
- Actuate priming lever 2 by pressing repeatedly until fuel emerges free of air bubbles at the loosened banjo bolt 1.
- Tighten banjo bolt securely, while still pumping.
- Loosen overflow valve 3 (Fig. 12) at the lower (larger) hexagon by 2 – 3 turns.
- Actuate priming lever 2 by pressing repeatedly downwards against spring force until fuel emerges free of air bubbles at the loosened overflow valve 3.
- Tighten overflow valve securely, while still pumping.

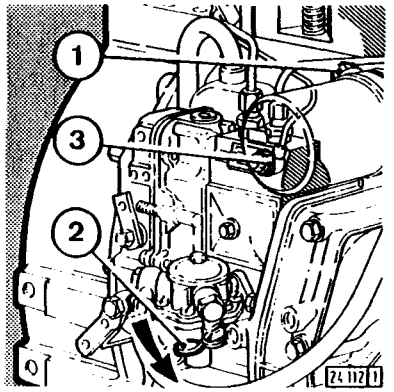


Fig. 12

Note:

When operating the priming lever, the distinctly perceivable "pressure point", i. e. the commencement of the lifting movement of the diaphragm, must occur in the first quarter of its total travel. Failing this, turn engine over a little by hand.

(When operated by hand, the feed pump will only work if the camshaft of the injection pump is in such position that the diaphragm of the feed pump is not lifted.)

Caution:

Stop engine before filling fuel tank!

Observe strict cleanliness! Do not spill any fuel!

2. Motor Oil

2.1 Filling In Oil (Fig. 13)

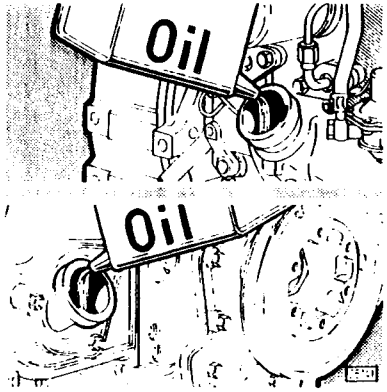


Fig. 13

2.2 Checking Oil Level (Fig. 14)

- see page 93 -

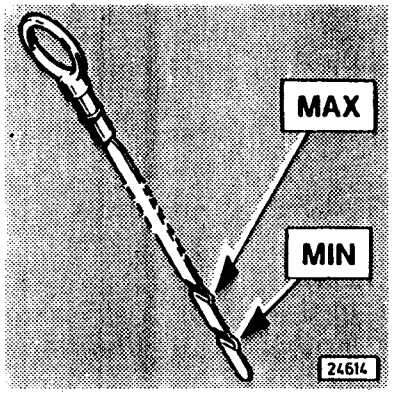


Fig. 14

2.3 Oil Quality

By preference, use oils of the API quality grade **CD/SE** or **CD/SF**. You will thus attain the longest possible oil change intervals.

Oils of the API quality grade **CC/SE** and **CD/SF** can be used when halving the length of oil intervals (see page 98).

During operation of the engine, not only part of the oil lubricating the pistons is burnt but the thermal stress and the combustion residues mixing with the oil also entail a deterioration of the oil and in particular of its chemical additives. Therefore, a complete change of the oil should be carried out at the recommended intervals.

As this deterioration is greatly influenced by the operating conditions as well as by the quality of the fuel and oil used, the oil change intervals differ accordingly. Be sure, therefore, strictly to observe the specifications given on page 98.

Do not mix different oil grades.

2.4 Oil Viscosity

The viscosity of the oil being greatly influenced by the ambient temperature, the choice of the SAE-grade should be governed by the ambient temperature at engine site (see diagram). If temperatures temporarily fall below the limit of the SAE-grade selected, this will merely affect the starting performance but cause no engine damage.

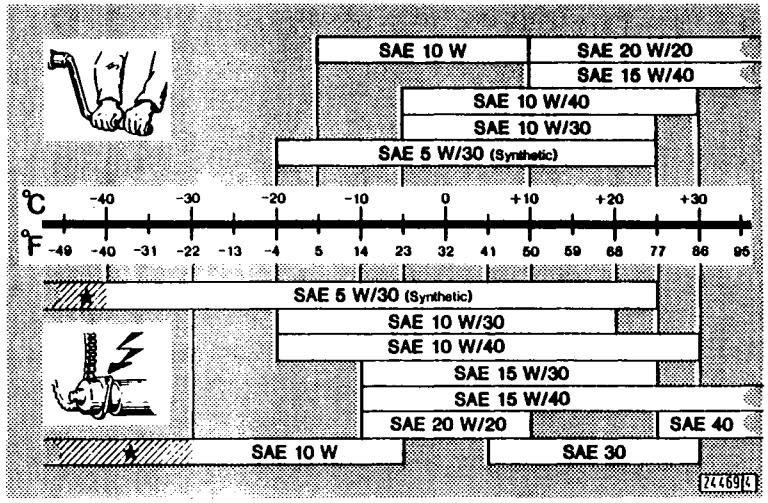


Fig. 15

★ Only with engine oil preheating.

Since a too viscous oil causes starting difficulties, the choice of the viscosity grade **during winter operation should be governed by the ambient temperature prevailing at the time of starting the engine.** Oil changes as a function of ambient temperatures can be avoided by using multigrade oils, which are again subject to the oil change intervals recommended on page 98. The required oil capacities are given under "Specification Data" on page 73.

Note:

For manually started engines, other viscosity grades are prescribed than for electrically started engines. The upper part of Fig. 15 therefore shows the viscosity grades for the manually started engine, while the lower part shows the grades for the electrically started engine.

3. Oil Bath Air Cleaner (if mounted)

The air cleaner bowl 1, Fig. 16, must be filled with oil before starting up (use the same grade of motor oil as for the engine).

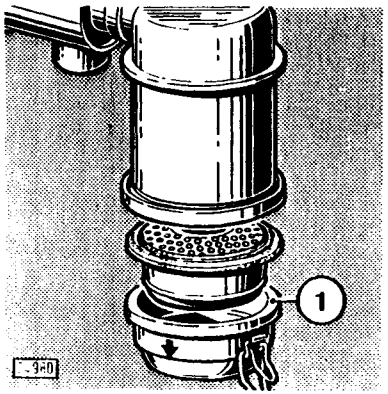


Fig. 16

4. Important for your Engine's Power Output

Power output, temperature level and exhaust gas quality of any diesel engine are governed by careful matching of combustion air and fuel injection volumes, and since the density of the combustion air taken in varies with the atmospheric pressure and the ambient temperature, full rated power is obtained only at standard reference conditions in respect of atmospheric pressure (altitude of engine site) and ambient temperature.

Standard reference conditions are as follows:

(a) 1013 mbar = 760 Torr (sea level) and 20 C for automotive engines to DIN 70020

(b) 981 mbar = 736 Torr (300 m above sea level) and 20 C for industrial and marine engines to DIN 6270

Where engines are operated at greater altitudes and/or higher ambient temperatures, they must be de-rated (reduced fuel injection and hence engine loading) in accordance with special Tables available.

Note:

Therefore, never run your DEUTZ diesel in "thin air" under heavy-duty conditions unless your engine has been de-rated accordingly, otherwise the engine's lifespan, reliability and exhaust emissions may be affected, especially at altitudes above 1000 m and/or temperatures above 30 C. Be sure to contact us or your equipment supplier in good time!

5. Starting

5.1 Starting with Electric Starter

- Disengage clutch to disconnect engine from driven equipment, where possible.
- Move speed control lever 1 or 2 (Fig. 17) to about quarter speed by hand or foot.

5.1.1 Version F2L 912 (Direct Injection) without Heating Tube

- Insert starter key 1 (Fig. 18), turn clockwise to detent.
- Check that charging pilot lamp 2 lights up.
- Push in starter key 1 deeper and turn farther clockwise against spring pressure.
- Starter motor turns engine; as soon as the engine starts firing, release starter key 1.

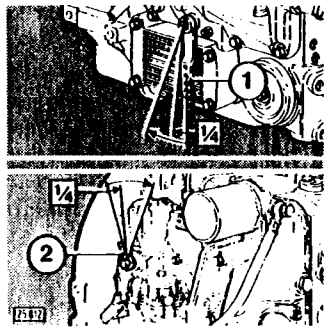


Fig. 17

5.1.2 Version F2L 912 (Direct Injection) with Heating Tube (Item 1, Fig. 19)

- Insert starter key 3 (Fig. 18), "Stage 0".
- Turn clockwise, "Stage 1".
- Check that charging pilot lamp 2 lights up.
- To start, push in starter key deeper and turn farther clockwise against spring pressure through "Stage 2" to "Stage 3".
- Starter motor turns engine; as soon as the engine starts firing, release starter key 3.

5.1.3 Version F2L 912 W (Two-stage Combustion)

- Insert starter key 3 (Fig. 18), "Stage 0".
- Turn clockwise, "Stage 1".
- Check that charging pilot lamp 2 lights up.
- To preheat, push in starter key deeper and turn farther clockwise against spring pressure to "Stage 2", and hold.
- Preheat for about 30 to 60 seconds, while observing that heater plug indicator 4 glows up.
- To start, turn key farther clockwise to "Stage 3".
- Starter motor turns engine; as soon as the engine starts firing, release starter key 3.

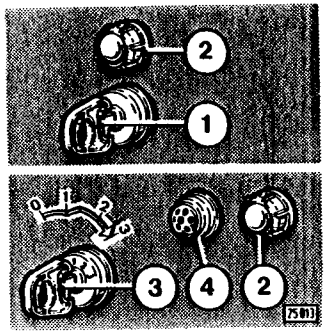


Fig. 18

Note:

Do not actuate the starter for more than 20 seconds at a time. You will protect your battery if you wait for 1 minute between each starting attempt.

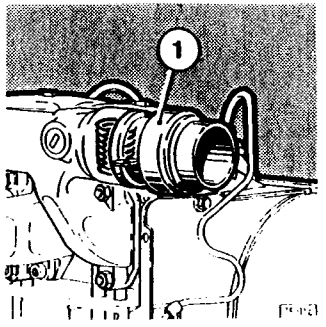


Fig. 19

Engine Operation

5.2 Starting Manually

Version F2L 912 (Direct injection)

Possible down to about – 5 °C.

- Disengage clutch to disconnect engine from driven equipment, where possible.
- Set speed control lever 1 or 2 (Fig. 20) by hand or foot about quarter speed in the direction of the arrow.
- Move decompression lever 1 (Fig. 21) from stop to stop (see arrows) **and then back into the initial position. This is important for safety reasons!**

Caution!

Do not actuate the decompression device while the engine is running.

- Grasp crank handle 1 (Fig. 22) **with both hands, all fingers and thumbs up,** and turn handle briskly until decompression shuts off automatically (after some 6 camshaft revolutions) and the engine starts firing.
- As soon as the engine runs smoothly, cut back the speed. When a moderate load is applied and the speed is varied, the engine will warm up to its working temperature in a short time.

5.3 Starting at Low Ambient Temperatures

See "Operation in Winter", pages 83 – 85

Caution!

Before starting, make sure that no one is standing in the close vicinity of the engine or driven machine. After carrying out repairs: Check that all safety guards have been refitted and all tools have been removed from engine

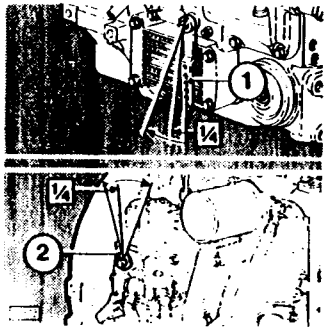


Fig. 20

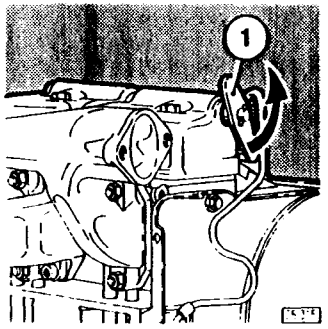


Fig. 21

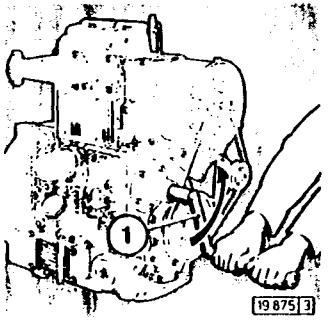


Fig. 22

6. Attendance in Service

6.1 Motor Oil Pressure

At idling speed,

- the green oil pressure pilot light should have gone out or
- the pointer of oil pressure gauge 1 (Fig. 23) – if mounted – should be in the green sector, or
- the pointer of the oil pressure gauge 2 (Fig. 23) – if mounted – should indicate about 1.0 bar.

Note:

Lighting up of the warning lamp at low idling speed (engine warm) or a drop of the gauge indicator into the red sector is still permissible if, when speed is increased, the lamp goes out again or the indicator moves back into the green sector.

The oil pressure checking system is based solely on the low idling speed of the engine. Where a continuous monitoring of the oil pressure is desired also within the engine's working speed range, this will require optional extras.

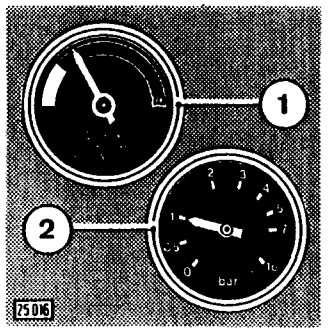


Fig. 23

6.2 Temperature* (Fig. 24)

Through the window of the temperature indicator, the pointer is to be seen in the yellowish-green sector when the engine is at normal working temperature. **If the pointer is in the orange sector, this means that the engine is overheated and must be shut down immediately.** In this case the cause of the overheating must be traced on the lines indicated in the Trouble Chart (see pages 116 and 117).

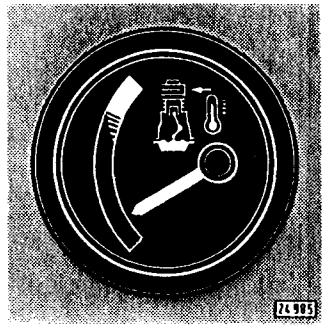


Fig. 24

Fan Drive*

If a mechanical V-belt breakage monitoring system (Fig. 25) is provided, the engine is shut down by the action of the tensioning pulley 1 in the case of V-belt breakage

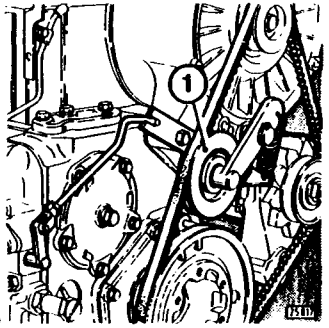


Fig. 25

* Not mounted on all engine versions.

Engine Operation

7. Stopping

- Set speed control lever 1 or 3 (Fig. 26) to idling position.
- Operate stopping lever 2 or 4 (Fig. 26) on the injection pump until the engine stops, whereupon the pilot lamp 2 (Fig. 27) should light up again.
- Turn starter key 1 or 3 (Fig. 27) fully anticlockwise and pull out: this will cause the pilot lamp to go out.

Note:

Like all internal combustion engines, the air-cooled DEUTZ diesel engine should not be shut down suddenly from full-load running. It is better to let the engine idle for 1 - 2 minutes to allow for temperature balance.

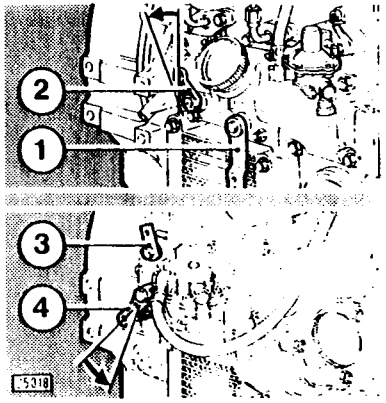


Fig. 26

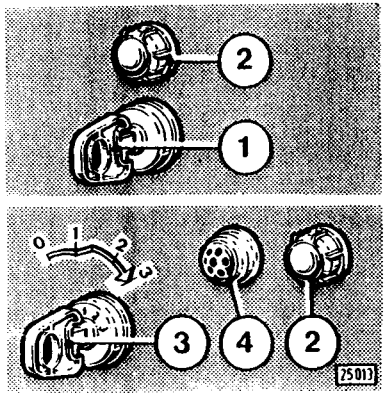


Fig. 26a

8. Operation in Winter

8.1 Use winter-grade motor oil

To ensure satisfactory cold starting, the choice of the viscosity grade (SAE-grades page 77) should be governed by the ambient temperature prevailing **at the time of starting.**

As to the oil change intervals, it should be borne in mind that operation below – 10 °C requires shorter oil change intervals (see page 98, "Changing Motor Oil").

8.2 Fuel

Use winter-grade fuel in winter because with ordinary fuel, clouding may occur at low temperatures and clog the fuel filter. At excessively low temperatures, even winter-grade fuel may tend to cloud.

Therefore, if only summer-grade fuel is available, or if winter-grade fuel is used at excessively low temperatures, we recommend the following percentages (see diagram) for mixtures of diesel fuel and kerosene or regular-grade gasoline*. Admixture of the latter is however not permissible for more than one tank filling.

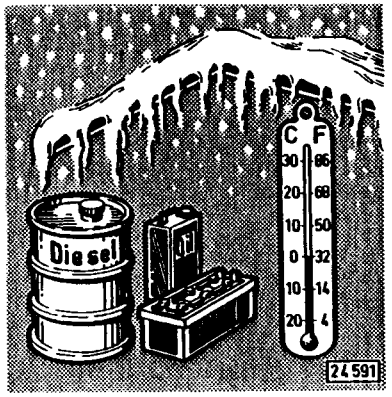
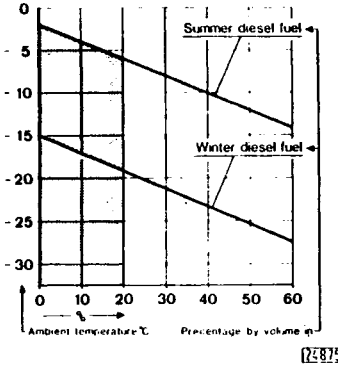


Fig. 27



Caution!

Prepare the blend in the tank itself: fill in the gasoline first, then add diesel fuel. The blend is as easily inflammable as pure gasoline.*

Maximum admixture of regular-grade gasoline* 20 %; when admixing **more than 20 %, use kerosene only**.

For using a commercial additive, please consult your DEUTZ Service Station.

* **Never** use premium fuel

8.3 Additional Maintenance Jobs

- **Drain off the thick sludge from the fuel tank once a week.** Do this by taking out the sludge drain plug.
- **The grade of oil in the oil bath air cleaner** – if fitted – should preferably suit the ambient temperature just like the engine oil.
- **The flywheel ring gear**
  should be lubricated, at temperatures below – 20 °C (– 4 °F), with a low temperature grease, e. g. Bosch FT 1 V 31, from time to time through the pinion hole (if necessary remove starter). This will ensure full engagement of the pinion.

8.4 Cold Starting Aids

Note:

Cold starting of a Diesel engine depends, among other things, on the capacity of the starter motor and that of the battery, as well as the turning resistance offered by the transmission and driven machine. Since the starting equipment of the engine may differ according to its application, no data on limit temperatures for cold starting are given in this Manual. Any DEUTZ distributor, however, will furnish you with the desired information on this subject.

The viscosity specification for lube oils should by all means be observed.

Cold starting requires satisfactory condition of the battery.
Lowering the limit temperatures by 4 – 5 °C (39 – 41 °F) is possible by raising the battery temperature to about + 20 °C (68 °F). This is done by removing the battery with the engine stopped and storing it in a warm room.

When installing the battery, ensure satisfactory terminal contact by keeping contact surfaces clean and bright. To avoid distortion of terminal cones, be sure to tighten screws only moderately.

At very low temperatures (below – 30 °C)
In the case of extremely low temperatures, the engine is to be warmed up to ensure satisfactory starting and lube oil supply. Parts for connecting preheating units, however, are provided only on engines intended for operation in very cold regions.

8.4.1 Heating Tube (Item 1, Fig. 28)

The heating tube should be used at ambient temperatures near or below freezing point. It not only lowers the starting limit temperature, but proves also useful at temperatures normally not requiring a starting aid.

Located at the inlet of the air intake pipe 3, the heating tube 1 contains an electric glow coil 2 for preheating the combustion air.

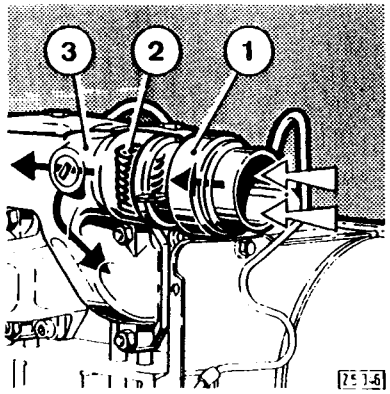


Fig. 28

8.5 Starting

8.5.1 Starting with Electric Starter: Version F2L 912 with Heating Tube or Version F2L 912 W (Two-stage combustion)

- Prior to starting, preheat for about 2 minutes, then start as per 5.1.2 or 5.1.3 respectively.
- Should the engine not fire smoothly or emit grey-white smoke, do not attempt to accelerate with the speed control lever 1 or 2 (Fig. 29), but
- Afterheat for not more than 3 minutes in the preheating stage.

Note:

Continue starting attempt for not more than 20 seconds if no firing occurs. Intervals between starting attempts should be 1 minute or so, enabling the battery to recover. The next starting attempt has to begin again in preheating position (1 minute).

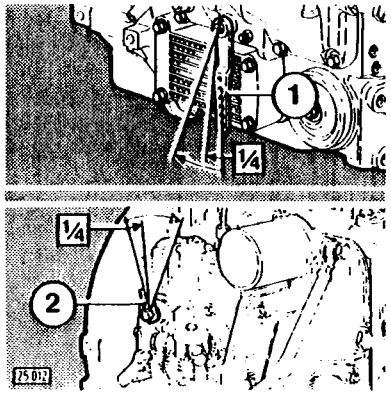


Fig. 29

8.5.2 Starting Manually

Manually Started Engines: at very low temperatures it is advisible to cut in the decompression device and then merely turn the engine before starting with speed lever in idling position.

Starting procedure as per 5.2.1.

8.5.3 With Start Pilot

During starting operation, the start pilot sprays fuel of very high ignition quality into the intake pipe.

Assist starting operation by actuating the pump until the engine fires smoothly. Closed observe special instructions for VISO F 27 pilots.

Order No. 297 3654.

Caution!

Do not inject an excessive amount of fuel.

Excessive quantities of fuel injected **before** *starting can lead to engine damage. For safety reasons, never use start pilot simultaneously with preheating systems.*



Stop engine before carrying out any maintenance work.

Maintenance Chart*

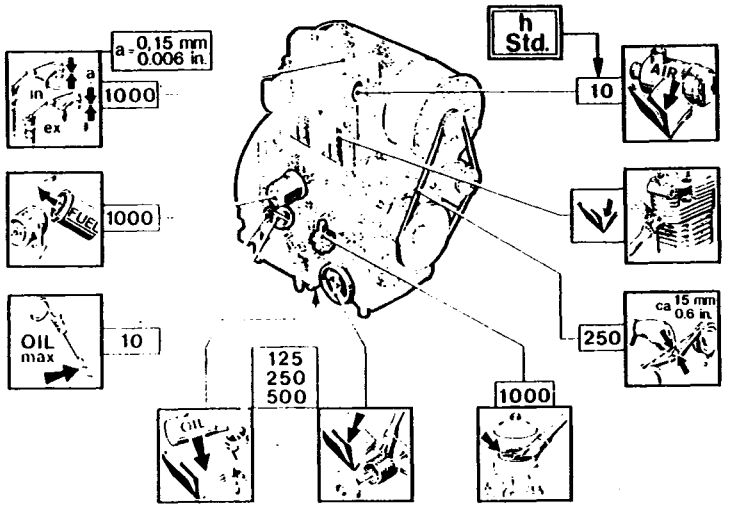
IMPORTANT!

The Maintenance Chart displayed below is supplied as a self-adhesive label along with each engine.

Check that this label is stuck at a convenient location on the engine or driven equipment.

If necessary, ask for a fresh supply of labels.

* **Note:**
Valid for routine maintenance work is the Maintenance Schedule on page 89.



F2L912/W

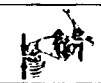
297 3629

DEUTZ

Maintenance

Engine Maintenance

The maintenance jobs described on the following pages ensure ready engine availability at all times and long life span.

Improvement of → / by servicing ↓	Engine power	Specific fuel consumption	Specific oil consumption	Bearing clearances	Exhaust emissions	Engine noise	Starting performance	Engine reliability	Long life
			O	O			O	O	O
OIL 				O				O	O
AIR 	O	O	O	O	O			O	O
FUEL 	O			O			O	O	O
				O				O	O
							O	O	
	O	O		O	O	O	O	O	O
	O	O			O	O	O	O	O

24866

● Check ■ Clean ▲ Change — See Note

Every 10 hours	●  93	● ■  94-96	●  97		Job: Maintenance point — See page
Every 125 hours	▲  98/99	● ■  100/101	●  102		Job: Maintenance point — See page
Every 250 hours	▲  98/99	●  103/104			Job: Maintenance point — See page
Every 500 hours	▲  98/99	▲  105			Job: Maintenance point — See page
Every 1000 hours	●  106/107	■  108	▲  109-111		Job: Maintenance point — See page

Workshop Maintenance

Every 1000 hours	●	Air intake and exhaust manifolds	112
	●	Cylinder-head temperature indicator	112
Every 1500 hours	●	Alternator	113
	●	Starter motor	113
Every 3000 hours	●	Injectors	114

Maintenance

The maintenance jobs duly completed can be recorded and certified in the schedule below.

Completed Maintenance Jobs

Hours	Date	Signature	Hours	Date	Signature
			–		
* 30 - 60			–		
125			250		
375			500		
625			750		
875			1000		
1125			1250		
1375			1500		
1625			1750		
1875			2000		
2125			2250		
2375			2500		
2625			2750		
2875			3000		
3125			3250		
3375			3500		
3625			3750		
3875			4000		
4125			4250		
4375			4500		
4625			4750		
4875			5000		
5125			5250		
5375			5500		
5625			5750		
5875			6000		

* See instructions on page 92

Maintenance

The maintenance jobs duly completed can be recorded and certified in the schedule below.

Completed Maintenance Jobs

Hours	Date	Signature	Hours	Date	Signature
6125			6250		
6375			6500		
6625			6750		
6875			7000		
7125			7250		
7375			7500		
7625			7750		
7875			8000		
8125			8250		
8375			8500		
8625			8750		
8875			9000		
9125			9250		
9375			9500		
9625			9750		
9875			10000		
10125			10250		
10375			10500		
10625			10750		
10875			11000		
11125			11250		
11375			11500		
11625			11750		
11875			12000		
12125			12250		
12375			12500		

Important: Commissioning New or Overhauled Engines

At the end of 15 – 20 minutes' running:

- **Retension V-belts** (Fig. 30).
  See pages 103/104.

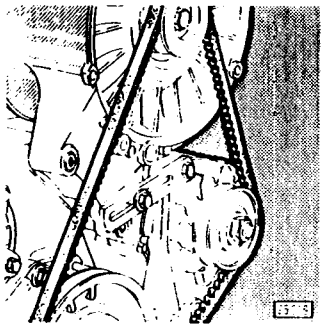


Fig. 30

At the end of 30 – 60 hours' running:

- **Change oil.**
  See pages 98/99.

  At the first oil change, the following jobs are due in addition:
- **Renew lube oil filter cartridge** (item 1, Fig. 31) See page 105

Note:

With a view to matching the intervals for subsequent oil changes and maintenance jobs to the total running time of the engine, we recommend, after the initial maintenance work at the end of 30 – 60 running hours, that the ensuing maintenance jobs be carried out after 125, 250 and 500 hours, etc.

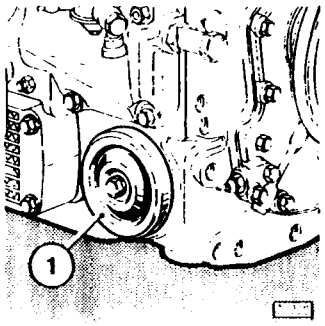


Fig. 31

- **Retighten engine mounting bolts.**
- **Retighten bolts securing air intake and exhaust manifolds** to the cylinder heads (item 3, Fig. 32) See page 112
- **Check valve clearance** readjusting if necessary See page 106/107

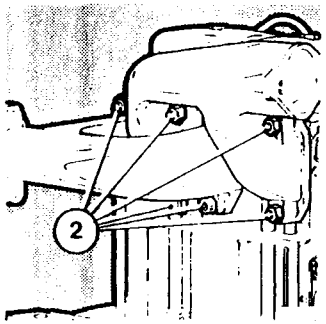


Fig. 32

Make sure that the illustrated Maintenance Chart, supplied loose, is stuck at a conspicuous point. (See page 87).

Routine Maintenance



Check Oil Level in Engine

- Engine must be in horizontal position and shut down.
- Pull out dipstick 1 (Fig. 33).
- wipe with clean, non-fraying rag,
- reinsert as far as it will go, and then
- withdraw again.

  The oil level should be between the marks 2 and 3 (Fig. 33). If the level is only up to or even below the lower mark 3, top up with oil immediately, preferably up to the upper mark 2, in order to prevent serious damage being caused to engine.

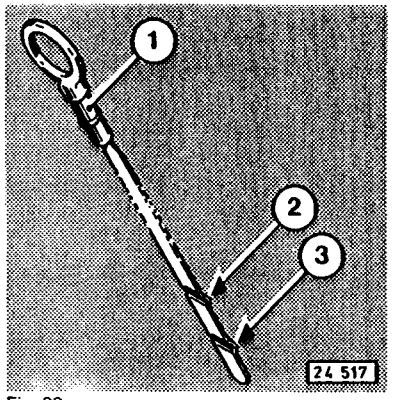


Fig. 33

Note:

Checking the oil level **prior** *to starting the engine ensures a sufficient engine oil level for the start.*

To check the oil level accurately, it is necessary to shut down the engine after about one minute of operation. The entire oil system will then be filled. The immediate oil level check will then show the oil sump filling volume actually available during operation of the engine.

We strongly recommend to carry out this double check of the oil level before any prolonged engine operation, particularly if the check prior to the engine start discloses an oil level in the vicinity of the lower or minimum mark on the dipstick.

Normally, new engines have a higher oil consumption. During the running-in period (about 200 running hours) it is therefore essential to check the oil level twice a day. After the running-in period, one check per day is sufficient.

Where engines are inclined, oil level should reach top mark of dipstick.

Checking and Cleaning Air Cleaners

Dust in the combustion air can cause premature wear of the engine. Maintenance of the air cleaners is therefore essential to ensure long life. **It is also necesary to check unions and connections of the intake manifold regularly.**

The maintenance intervals for air cleaners depend on the amount of dust fall-out. No fixed intervals can therefore be given.

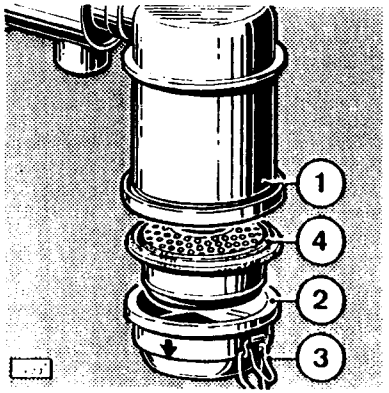


Fig. 34

1. Oil Bath Air Cleaner (if mounted, otherwise see page 95)

- Before checking, wait at least one hour after stopping the engine, so that the oil has had time to drip down from the cleaner element.
- Release the snap clips 3 (Fig. 34) and remove oil bowl 2.
- Remove element 4 by sidewise tapping with the hand or by inserting a screwdriver. Do not damage rubber gasket!
- Renew oil in bowl 2 (for motor oil viscosity, see page 76). Note oil level mark (arrow).
- Rinse filter element 4 in diesel fuel (never in gasoline!) and allow to drip-dry **thoroughly**.
- Once or twice a year (depending on amount of dust), remove also the filter upper part 1 and likewise rinse in diesel fuel. Allow to drip-dry **thoroughly**.
- Following reassembly, check all connections for leaks.

2. Dry-type Air Cleaner (if mounted)

The life of the expendable paper cartridges in dry-type air cleaners depends on dust collector 2 (Fig. 35) being emptied in good time. Failing this, the cartridge will clog up fast. Be sure, therefore, to empty the collector not later than when filled half-way. **Where the air is very dust-laden, this may require daily servicing.**

If a special dust ejector 8 is provided, it is only necessary to clear the discharge slot from time to time.

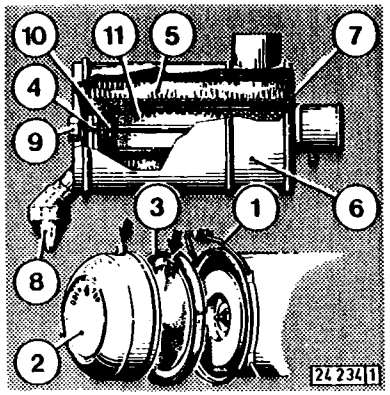


Fig. 35

2.1 Emptying the Dust Collector

- Stop engine.
- Release clip 1 (Fig. 35) and remove dust collector 2 along with cover 3.
- Take off cover 3 and empty collector.
- Refit assembly, making sure that recess on cover mates with lug on collector (see arrows, Fig. 35).
- When cleaner is installed in horizontal position, check that the "Top" mark is actually at top.

2.2 Servicing the Cartridge

Where a service gauge (Fig. 36) is fitted and keeps displaying the red warning signal 1 when the engine is stopped, or where a yellow warning light goes on with the engine running, the cartridge is due for servicing. (Also indicated by smoking exhaust and decreasing engine output.) It is not advisable to service the cartridge more frequently, as this may affect seal 7 (Fig. 35) between cartridge 5 and housing 6.

Replace cartridge not later than at the end of 12 months or when soiled by soot.

- Proceed by taking down dust collector 2 (Fig. 35) as described under 2.1.

  (Where a dust ejector 8 is provided, unscrew wing nut 9 and remove cover.)

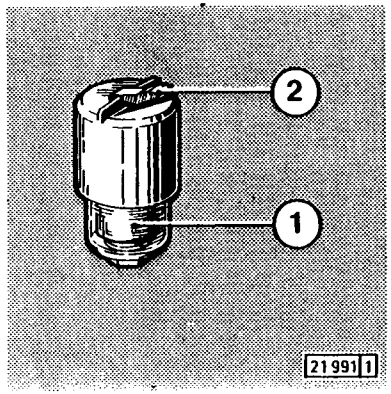


Fig. 36

- Unscrew hex. nut 4 and remove soiled cartridge 5.
- Renew or clean cartridge.
- After having serviced cartridge 5 five times, or after two years at the latest, renew together with safety cartridge 11 (secured to body 6 by nut 10). Enter the number of servicings of cartridge 5 in the spaces provided on safety cartridge 11.
- **Safety cartridge 11 may not be cleaned and reused.**
- Renewal of cartridge 11 is also required when cartridge 5 is renewed because of defects, etc., or when warning signal reappears although cartridge 5 has been serviced.
- **Make sure that only genuine cartridges are used as supplied by the air cleaner manufacturer. Cartridges of other make usually do not fit and are a hazard to the engine.**

2.2.1 Cleaning by dry means:

a) provisional: Tap cartridge 5 with its front end gently against the palm of your hand or on a soft surface, to shake off the dust. Take care not to damage the front end of the cartridge.

b) intensive: Apply air blast of max. 5 bar diagonally inside and out until no more dust is coming out. **Do not blow out housing 6.**

2.2.2 Washing the cartridge:

Wash the cartridge 5 by shuttling in lukewarm water containing a commercial-grade mild detergent. Rinse thoroughly in clean water, shake off water and let **dry well.**

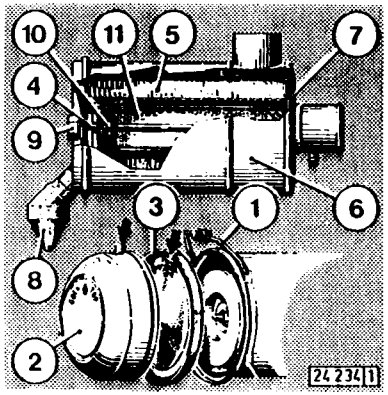


Fig. 35

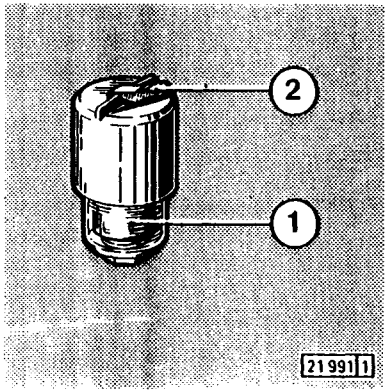


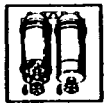
Fig. 36

Caution:

In no event use gasoline or hot liquids for washing the cartridge!

3. Checking:

Prior to reassembly, introduce a lighted bulb into filter cartridge 5 to see whether it suffered damage (damaged cartridges must definitely be renewed). Also make sure that gasket 7 is not defective. If a service gauge with visual signal is fitted (Fig. 36), press push button 2; this causes the red signal to disappear from the window.



Checking Water Separator on Two-stage Fuel Filter

(if mounted)

Some engine versions use a two-stage fuel filter with water separator for protection of the injection system. The water collects in bowls 2 and 3 (Fig. 37). In the transparent bowl 2, the water is distinguished from the fuel above by its lighter shade. Make sure that water level will not exceed the lower rim of bead 4.

The maintenance intervals for the water separator depend on the amount of water contained in the fuel and cannot be stated definitely. Initially, therefore, check daily whether there are indications of water in the transparent bowl 2.

Draining off the water:

- Loosen knurled screws 5 and bowls 2 and 3 through one or two turns.
- Observe the flow of draining liquid and the transition from water to diesel fuel.
- Gently retighten knurled screws 5.

Note:

Catch fuel in special receptacle to prevent pollution of the environment.

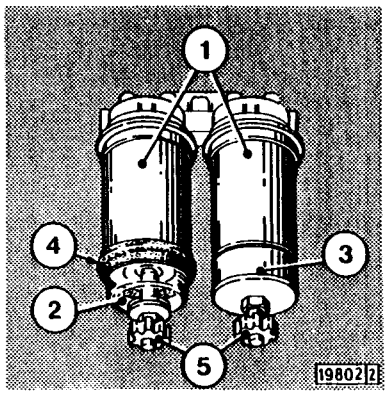


Fig. 37



Changing the Motor Oil

Important:

Should the engine run less than the hours stated in the following Table, the oil must be changed in any case **once a year.**

Oil Change Periods

Engine Application	Category of Oil Stressing	Oil Change Intervals (running hours) Oil Grade **API: CC/SE or CC/SF**	Oil Grade **API: CD/SE or CD/SF**
Tractors, Lift trucks, Cranes, Construction machinery, Rail traction units, Ships, Base-load gensets, Pumps	**A**	**250**	**500**
Farm equipment (seasonal) Underground mining, Road sweepers, Winter service, Emergency gensets, Emergency pumps Engines with two-stage combustion (FL 912 W)	**B**	**125**	**250**

Important:

The above intervals are based on the use of a diesel fuel containing max. 0.5 % b.w. of sulphur and **ambient temperatures above – 10 °C.**

Periods between oil changes should be cut by half

- when using fuels containing **more than 0.5 % up to 1 % sulphur** or
- if the ambient temperatures are permanently below – 10 °C.
  In the case of fuels containing more than 1 % up to 1.5 % sulphur, the motor oil should have a TBN* of about 12 × % S-content, with the periods between oil changes being halved.

Typical examples:

1) Tropical climate, oil stressing category A, fuel containing 0.8 % sulphur, lube oil grade CD/SE: Change oil every 250 hours.
2) Tropical climate, oil stressing category A, fuel containing 1.2 % sulphur: Change oil every 250 hours, using CD/SE or CD/SF oil having a TBN* of about 14 mg KOH/g.

Oil Grades

The responsibility for the grading of his particular oil product to API Specification is borne by the supplier

* TBN = "Total Base Number", expresses the neutralising capacity of the oil
Ask your supplier to quote TBN

Change Oil

while the engine is still hot, since the old oil will run more easily in this condition.

- Shut down engine.
- Unscrew drain plugs 1 (Fig. 38), after placing suitable receptacle underneath.
- When all old oil has run off, refit drain plugs 1 complete with new sealing rings 2.
- Fill in fresh oil through filler neck 3 (Fig. 39) up to the upper dipstick mark (Max., Fig. 40).
- Following a short trial run, check oil level again, topping up to the upper mark (Max.) if necessary.

Oil capacity at refill approx. 4.5 litres.

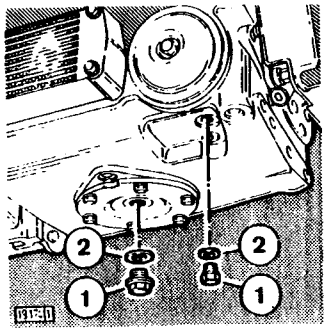


Fig. 38

Caution:

Danger of scalding when draining off the hot oil!

Catch old oil in suitable receptacle to prevent pollution of the environment!

Note:

Upon changing over to a higher grade of oil following a prolonged period of operation, change oil at the end of 20 hours and clean oil filter element.

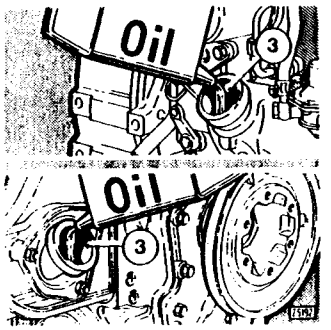


Fig. 39

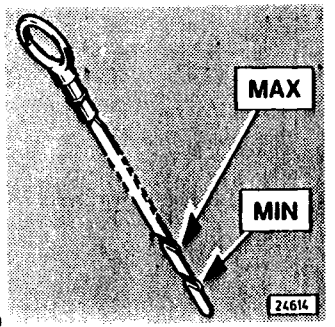


Fig. 40



Inspecting/Cleaning the Cooling System

Cleaning the cooling system is most important since accumulation of dust on the cooling air blower blading 1, on the cooling fins of the cylinder heads 2, cylinders 3 (Fig. 41) or oil cooler 4 (Fig. 42) is liable to reduce cooling efficiency substantially, especially where the dust is retained by a film of fuel or oil.

Check the cooling system regularly for contamination in accordance with the following table, and clean if necessary. Please note that the inspection intervals can only be given as guide figures based on normal operating conditions, and that in the case of abnormally contaminated cooling air – check mounted cooling air sieve boxes for correct seating and good condition – the inspection and cleaning intervals may have to be substantially shortened accordingly.

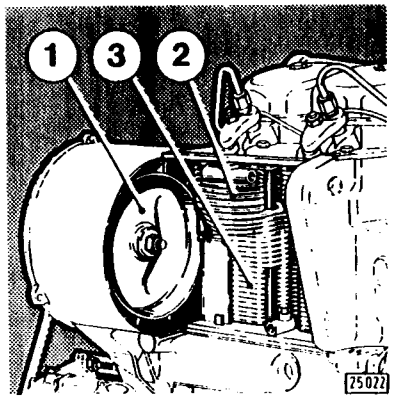


Fig. 41

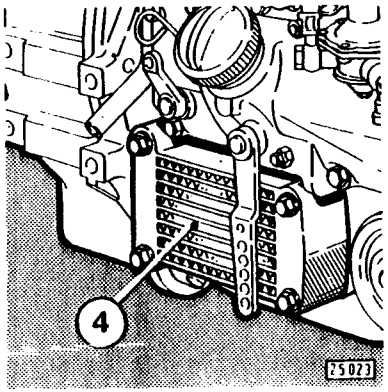


Fig. 42

Inspection Interval (guide figures only) Running hours	Engine Application
2000	Ships, Gensets in closed rooms, Pumps
1000	Vehicles on paved roads
500	Tractors, Lift trucks, Mobile gensets
250	Vehicles on building sites and unpaved roads, Construction machinery, Compressors, Underground mine units
125	Farm equipment, Tractors doing harvesting work

For inspecting and cleaning, proceed by undoing the hex. bolt 1 (Fig. 43) securing the air cowling hood 2 on the alternator side, and removing the hood.

Cleaning methods:

- **Dry cleaning** by means of compressed air. Start blowing through from the exhaust-air side (Fig. 44).

  Any dirt blown into the air cowling space (Fig. 45) must be removed afterwards, of course.
- **Use of cold cleansing agent** (e.g. P 3 or Nalfleet). After allowing an adequate soaking-in period, wash the engine with a powerful water jet.
- If a **steam-jet** is available, this method of of cleaning is preferable to any other.

Note:

When cleaning the vehicle or engine by means of cold cleansing agent or steam, cover up the injection pump, alternator, voltage regulator and starter motor as protection against direct application of the jet.

After wet-cleaning, let the engine run until warm so that any water left behind will be evaporated before rust can form.

Caution:

Always stop the engine before cleaning!

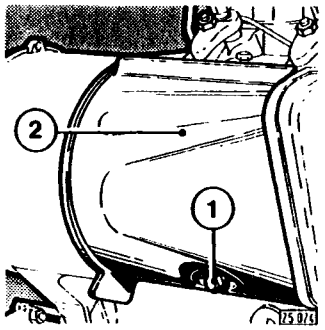


Fig. 43

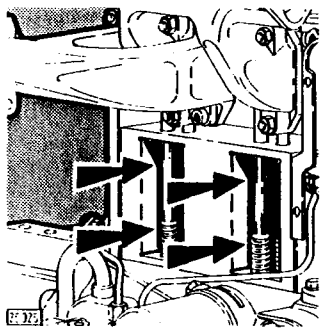


Fig. 44

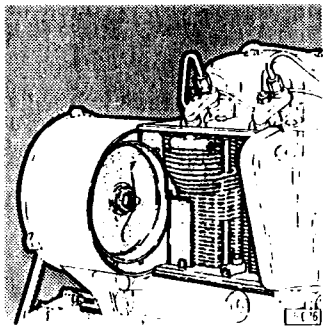
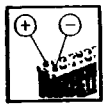


Fig. 45



Checking Electrolyte in Battery

- Remove cell caps 1 (Fig. 46).
- In some cases, electrolyte level testers 2 are provided: the level should be high enough to wet the bottom of these.
- An alternative method is to insert a clean wooden stick 3 into the cell until it touches the top of the plates. The electrolyte should wet the stick over a length of about 10 – 15 mm.
- If the electrolyte level is low, top up with **distilled water** only.
- Replace cell caps.
- For hints on battery care in winter, see page 84.

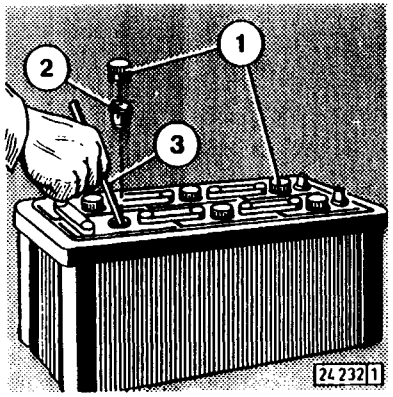


Fig. 46

Caution:

When working on the battery, keep naked lights away, do not smoke!

Do not allow acid to come into contact with the skin or clothing!

Wear protective goggles!

Do not place tools on battery!



Checking V-belt/ V-belt Tension

- Inspect V-belt over whole length for damage or cracks. Renew damaged or cracked V-belts.
- Check by pressing with the thumb (Fig. 47) midway between the pulleys to see whether the V-belt deflects inwards by max. 10 – 15 mm (0.4 – 0.6 in.).

Retensioning V-belt with Alternator:

- Slacken hex. bolts 1, 2 and 3 (Fig. 48).
- Pull alternator 4 in direction A until the correct belt tension is obtained.
- Then securely retighten hex. bolts 1, 2 and 3.

Retensioning V-belt with Idler Pulley:

- Slacken hex. bolts 1 and 2 (Fig. 49).
- Pull idler pulley 3 in direction A until the correct belt tension is obtained.
- Then securely retighten hex. bolts 1 and 2.

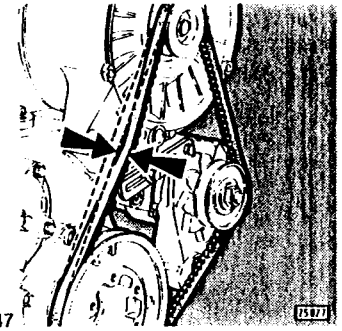
Renewing the V-belt:

- Slacken hex. bolts 1, 2 and 3 (Fig. 48) or 1 and 2 (Fig. 49).
- Push alternator 4 or idler pulley 3 in direction B against the engine. In this position, it is easy to fit the new V-belt.
- Tension V-belt as described above.

Note:

Retension new V-belts after running for 15 - 20 minutes. (Not applicable to cooling blower drive with automatic tensioning pulley 1 (Fig. 50).

When two V-belts are provided, always renew both belts when only **one** *is worn or damaged. The difference in length of the new V-belts may not exceed 0.15 %.*


Fig. 47

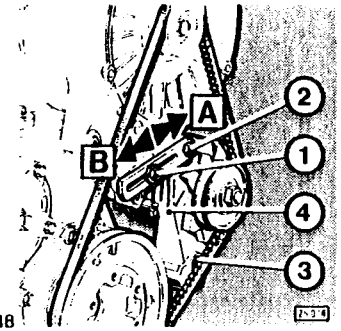


Fig. 48

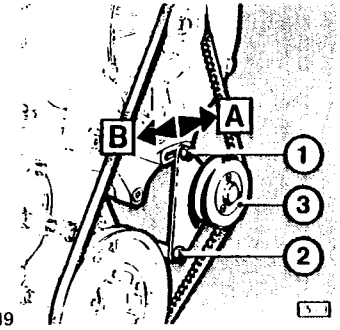


Fig. 49

Checking V-belt Tension on Version equipped with Mechanical Shut-down system upon V-belt Breakage
(Fig. 50)

On this version, it has to be ensured that the V-belt has the correct tension, since otherwise the shut-down device 2 will be actuated by the swing movement of the idler Pulley 1.

It is therefore essential to tension the V-belt by swinging out the alternator so that distance A between V-belt pulley 5 (Fig. 51) and idler pulley 1 measures 10 mm.

At every oil change, apply a drop of motor oil to pin 3.

The shut-down device 2 must be so adjusted that the shut-down lever 4 can be moved about 3° further until reaching the stop.

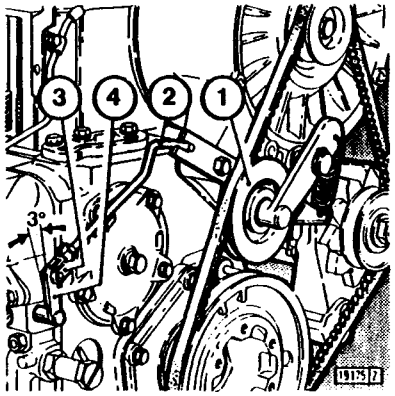


Fig. 50

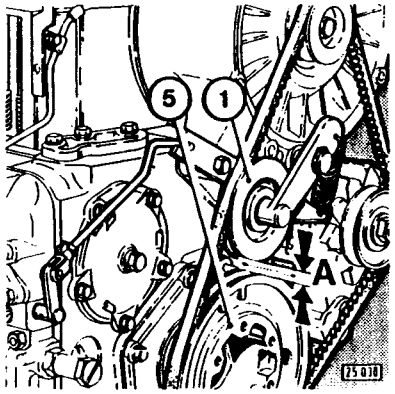


Fig. 51



Cleaning the Oil Filter

Cleaning the Oil Filter (Wash-filter*)

- Unscrew hex. bolt 1 (Fig. 52).
- Remove cover 2 with gasket 3 and filter element 4.
- Unscrew hex. nut 5 of hex. bolt 1, and take off element 4.
- Wash element 4 in clean diesel fuel and **allow to drip-dry thoroughly.**
- When reassembling, ensure correct positioning of gasket 3 for cover 2 and gasket of element 4.

Cleaning the Oil Filter (Edge Filter*)

- To clean, turn handle 2 of plate-pack 1 (Fig. 53) once or twice.
- The deposited sludge is thus carried outwards and sinks into the sludge chamber of filter body 3.
- Drain off the sludge from time to time by loosening filter body 3.

Note:

During trial run following reassembly, check oil pressure and tightness of filter mountings.

Caution!

A small amount of oil runs out when screwing off the oil filter.

Danger of scalding in case of hot oil!

Catch old oil in suitable receptacle to prevent pollution of the environment!

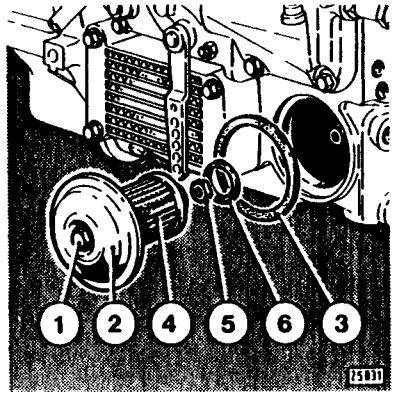


Fig. 52

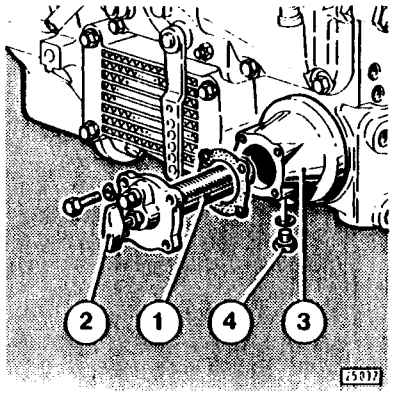
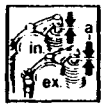


Fig. 53

* If mounted.



Checking Valve Clearance

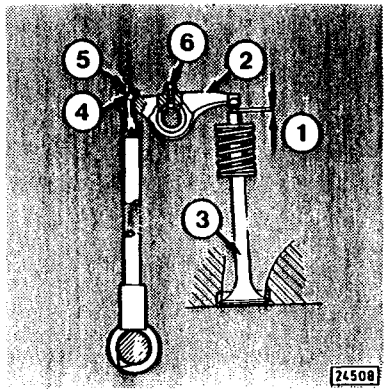


Fig. 54

- Valve clearance **to be checked with engine cold.**

Note:

The valve clearance is the requisite gap 1 between the pads of rocker arms 2 and valves 3 (Fig. 54). Good engine performance and power output depend on its correct setting which may be carried out by a skilled mechanic according to the following instructions, but preferably by a specialist.

- First remove rocker chamber covers.
- Turn crankshaft at front end until the valves of the cylinder in question are "overlapping" (exhaust valve about to close, inlet valve about to open).
- Then continue turning the crankshaft through 360 .
- Check valve clearance:
  Valve clearance 1 is correct when a **0.15 mm feeler gauge** can be inserted with a slight drag between rocker arm 2 and valve 3.
- Failing this, the valve clearance must be readjusted.
- Readjust as follows:
  Loosen locknut 4 by two to three turns.
  Adjust setscrew 5 with screwdriver so that, when locknut is retightened, the feeler gauge can be inserted and withdrawn with slight drag.
- Check the valve clearances of each of the remaining cylinders and readjust if necessary.
- Do not change the setting of oil nozzle 6 unless required. With hot engine running at idling, an oil flow to pad of rocker arm 2 must be just noticeable. An excessive oil flow can lead to higher oil consumption.

Checking Decompression Clearance (manually started engine)

Whenever checking valve clearance, be sure also to check the adjustment of thrust screw 1 (Fig. 55) located on the rocker arm and designed for determining the clearance of the decompression device, where provided. Proceed as follows:

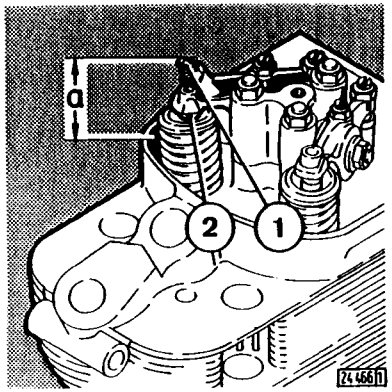


Fig. 55

- Remove rocker chamber cover.
- With valves closed, i. e. piston in compression TDC, press thrust pad 2 by hand against the valve stem end.
- In this position of the rocker arm, the setting dimension "a" should be 59.7 + 0.2 mm.
- Setting the thrust screw 1: Loosen hex. nut 3 (Fig. 55) by 2 – 3 turns with a 13 mm spanner.
- Adjust thrust screw 1 with a screwdriver so that the setting "a" stated above is obtained when hex. nut 3 is tightened.
- Refit rocker chamber cover 1 (Fig. 56).
- After tightening the cover fastening bolts, check that the decompression shafts 2 can be turned easily through some 10°.

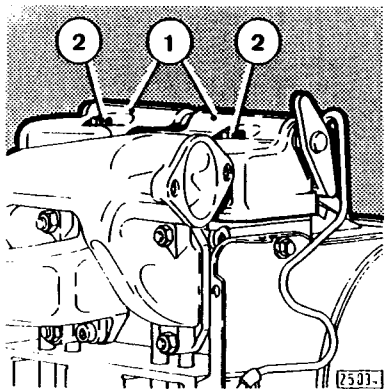


Fig. 56



Cleaning Strainer of Fuel Feed Pump

- In case of high-level tank, close fuel cock.
- Remove hex. bolt 1 (Fig. 57).
- Take off cover 2.
- Take out gasket 3 and strainer 4.
- Clean strainer in diesel fuel.
- Following reassembly, check unit for tightness.

Note:

Falling-off engine performance can be due to contamination of this strainer.



Caution:

When working on the fuel system, keep naked lights away, do not smoke!

Do not spill any fuel!

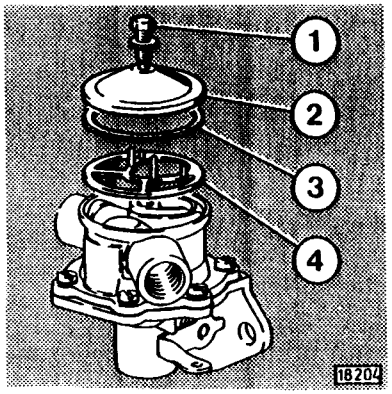


Fig. 57



Renewing the Fuel Filter Cartridge

- In case of high-level tank, close fuel cock.
- Place receptacle in position to catch escaping fuel.
- Screw off fuel filter cartridge 1 (Fig. 58), using special tool if necessary.
- Clean sealing surface.
- Apply a light film of oil to rubber gasket 2 of the new filter cartridge.
- Screw new cartridge in place by hand until gasket is evenly seated.
- Give cartridge a final half turn.
- Air-vent fuel system (see page 74).

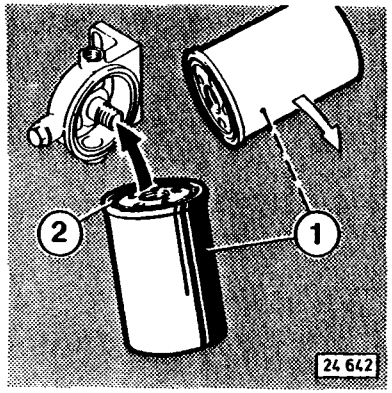


Fig. 58

Note:

Falling-off engine performance can be due to clogged filter cartridge. If the filter cartridge clogs up too quickly, check fuel for contamination, clean tank, check sealing of filler cap.



Caution:

When working on the fuel system, keep naked lights away, do not smoke!
Do not spill any fuel!



Renewing the Two-stage Fuel Filter Cartridge (1st stage)

- In case of high-level tank, close fuel cock.
- Place receptacle in position to catch draining-off fuel.
- Unscrew drain plug 2 (Fig. 59).
- Release clamping pin 3.
- Remove water bowl 5 and the two seals 4 and 6.
- Unscrew cartridge 1 from bracket and replace by new cartridge.
- Refit water bowl in reverse sequence, taking care that seals 4 and 6 are properly seated.
- Air-vent fuel system (see page 74).

Spare No. of filter cartridge:
1st stage 213 3558

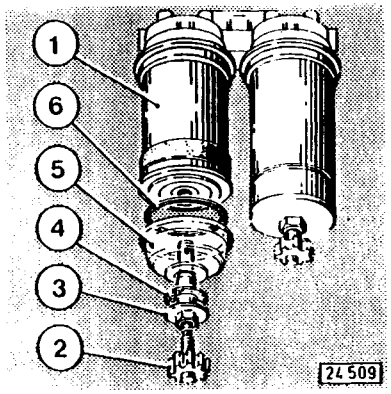


Fig. 59

Note:
Falling-off engine performance can be due to clogged filter cartridges. If the filter cartridges clog up too quickly, check fuel for contamination, clean tank, check sealing of filler cap.

Caution:
When working on the fuel system, keep naked lights away, do not smoke!
Do not spill any fuel!



Renewing the Two-stage Fuel Filter Cartridge (2nd stage)

- In case of high-level tank, close fuel cock.
- Place receptacle in position to catch escaping fuel.
- Unscrew filter cartridge 1 (Fig. 60) complete with drain plug by means of hexagon 2 at the bottom.
- Clean sealing surface.
- Apply a light film of oil to the rubber gasket of the new filter cartridge and screw new cartridge in place by hand until gasket is evenly seated, then give cartridge a final half-turn.
- Air-vent fuel system (see page 74).

Spare No. of filter cartridge:
2nd stage 213 3943

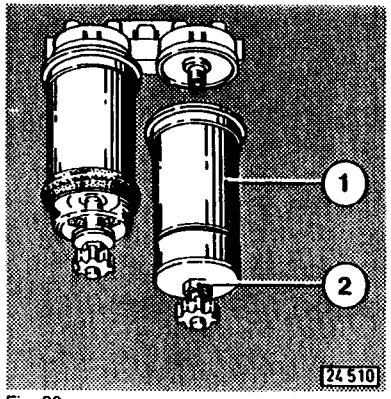


Fig. 60

Note:
Falling-off engine performance can be due to clogged filter cartridges. If the filter cartridges clog up too quickly, check fuel for contamination, clean tank, check sealing of filler cap.

Caution:
When working on the fuel system, keep naked lights away, do not smoke!
Do not spill any fuel!

Inspecting Air Intake and Exhaust Manifolds

Check the connections of air intake manifold 1 (Fig. 61) and exhaust manifold 2 to the cylinder heads for tightness and retighten if necessary.

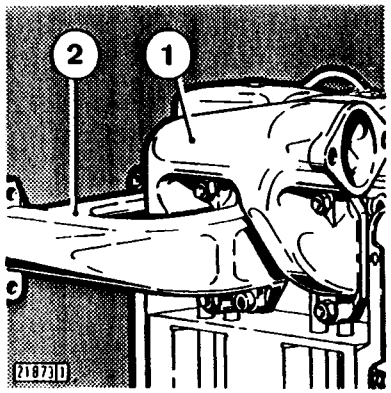


Fig. 61

Testing Temperature Indicator/Pilot Light

Unscrew sensor or switch 1, as provided (Fig. 62), from cylinder head 2 and immerse in oil heated to 150 – 155 °C (302 – 311 °F). This should cause the red sector to appear in the window of the indicator or the lamp, if provided, to light up.

Note:

The temperature elements 1 (sensor or switch) are always screwed into the head of the No. 1 cylinder.

Caution:

Heat the oil in a container on a hot-plate (not with welding torch). Do not exceed the specified temperature range. Danger of burns.

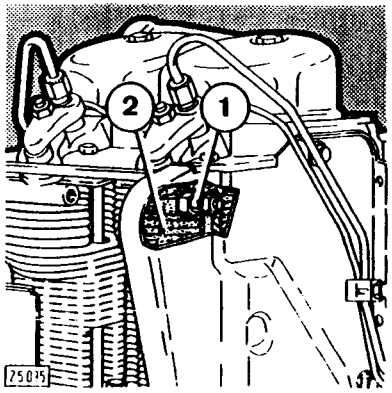


Fig. 62

Testing Alternator

It is advisable to have the alternator 1 (Fig. 63) tested in a specialized workshop.

Notes on three-phase system:

- *When the engine is* **running**, *never disconnect the leads between battery, alternator and regulator. Where it is however necessary to operate the engine without battery, disconnect, before starting, the alternator from the regulator.*
- *Never interchange the battery leads.*
- *Renew a defective charging pilot light bulb immediately.*
- *Before washing the engine, fit covers to protect the alternator and regulator.*
- *The common practice on a DC-system of touching a lead against earth for checking whether the lead is live must under no circumstances be adopted on a three-phase current system.*
- *In case of electric welding, connect the earth terminal of the welding unit direct to the piece to be welded.*

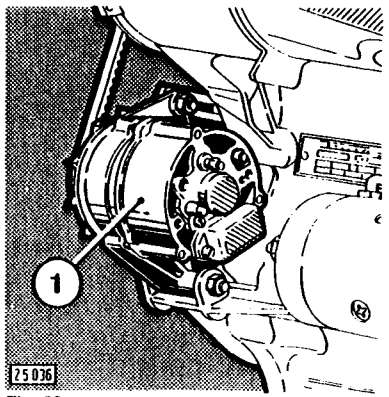


Fig. 63

Testing Starter Motor

It is advisable to have the starter motor 1 (Fig. 64) tested in a specialized workshop.

Note:

Cover up starter motor before washing engine.

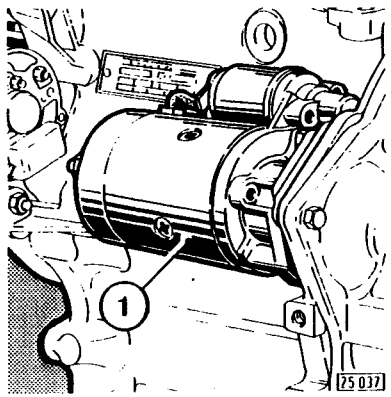


Fig. 64

Workshop Maintenance

Testing Injection Nozzles

- Remove injectors.
- Have the injectors tested in a specialized workshop. For specified injection pressure, see Specification Data, page 73.
- When refitting the injectors, observe tightening torque (see page 119)!

Note:

Inspection of the injectors between the times stated on page 89 is unnecessary unless the engine displays unusual symptoms (e.g. black exhaust smoke, harsh combustion noises).

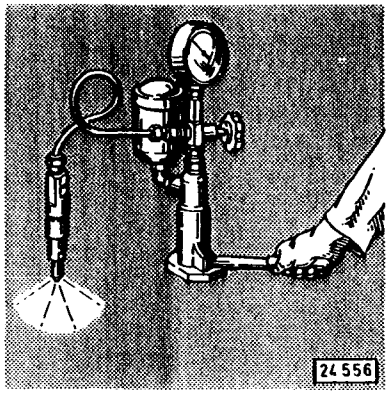


Fig. 65

Caution!

To prevent personal injury, do not allow the pressurized spray-jet to come into contact with the skin!

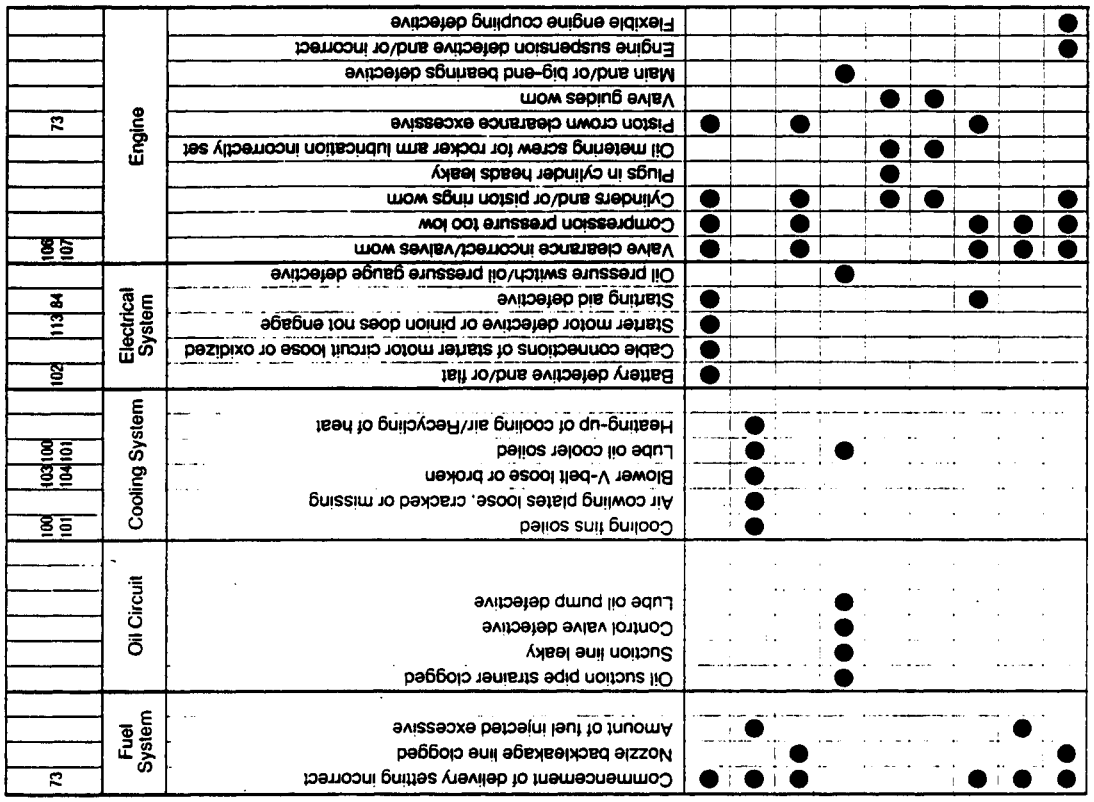
Trouble Shooting

If troubles should occur, these will be frequently due to incorrect operation, lubrication or maintenance of the engine. In such a case, therefore, make a point of thoroughly re-reading the Sections on pages 74 to 114.

If you cannot identify the cause of the trouble or are unable to put it right yourself, the best plan is to contact your local DEUTZ distributor.

See Trouble Charts on pages 116 and 117.

Trouble Chart



Trouble Chart

Workshop Information

The Workshop Manual dealing with the engines described in this Instruction Manual bears the number 291 1842 and can be ordered from our headquarters in Cologne, Department MZA.

Tightening Heavy-duty Bolts and Nuts

To prevent faulty assembly, the following information includes instructions on the tightening of heavy-duty bolts, because the procedure differs from that normally employed. The tightening angle is particularly important and, for this reason, Fig. 66 indicates how various angles can be readily obtained by comparison with a clock face.

1. **Wet threads and seatings with motor oil before fitting.**
2. **Screw the bolts in** until they are uniformly positioned ready for pre-loading.
3. **Pre-load the bolts** to the value stated in the "Tightening Table for Bolts and Nuts" on page 119.
4. **Tighten the bolts** according to the Table, if necessary in stages, in conformity with the tightening angles specified.

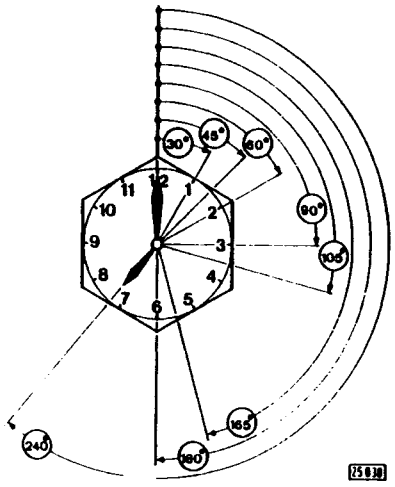


Fig. 66

Workshop Information

Tightening Table for Bolts and Nuts

Designation		Pre-loading Nm	Tightening				
			1st stage	2nd stage	3rd stage	4th stage	Total
Cylinder head	210 1681	30	45°	45°	45°	30°	165°
Connecting rod	M 12 × 1.5 × 55	30	30°	60°	–	–	90°
Bearing cap	M 14 × 110	30	45°	60°	–	–	105°
Rocker bracket	M 8 × 55	–	–	–	–	–	28 Nm
Balance weight	M 12 × 70	30	30°	30°	–	–	60°
Flywheel		50	90°	90°	–	–	180°
Injectors	M 10	–	–	–	–	–	25 Nm (FL 912)
V-belt pulley	M 35 × 1.5	50	60°	–	–	–	60°
Cooling blower	M 12 × 140	30	30°	60°	–	–	90°
Adapter housing	216 4062	30	60°	90°	90°	–	240°
Oil filter cover	337 1962	–	–	–	–	–	35 Nm

Note:

When renewing main and big-end bearings or after piston seizures, be sure to **renew** *the bearing bolts as well.*

Workshop Information

Fitting Valve Springs

Be sure the close-coil end is at the bottom (Fig. 67).

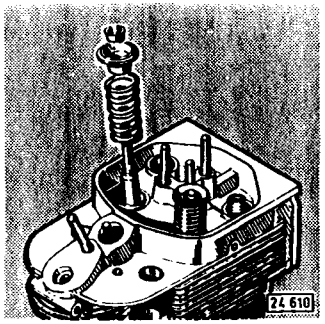


Fig. 67

FL 912 (Direct Injection)

When fitting a new piston, make sure that the stamped-in arrow points to the exhaust-air side of the engine (Fig. 68).

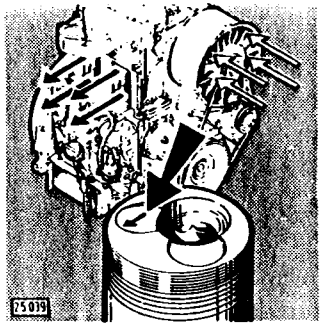


Fig. 68

FL 912 W (Two-stage Combustion)

When fitting a new piston, make sure that the stamped-in arrow points to the exhaust-air side of the engine (Fig. 69).

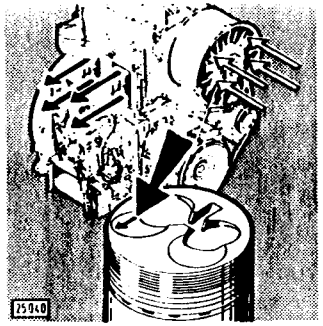
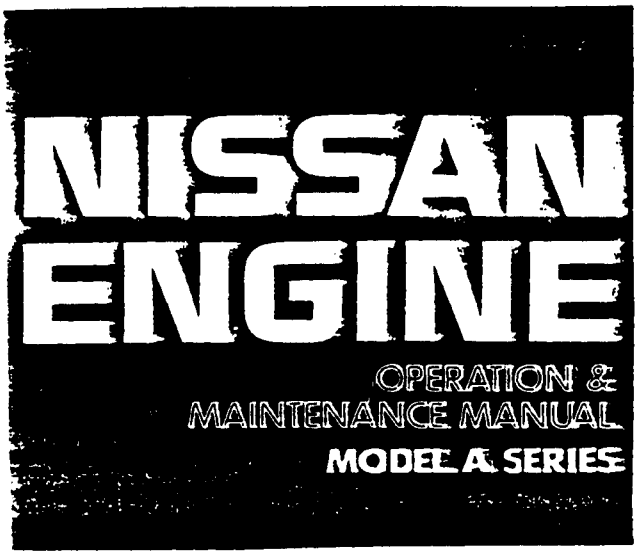


Fig. 69



NISSAN MOTOR CO., LTD.
Tokyo, Japan

A12/15-A

Foreword

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

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

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

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

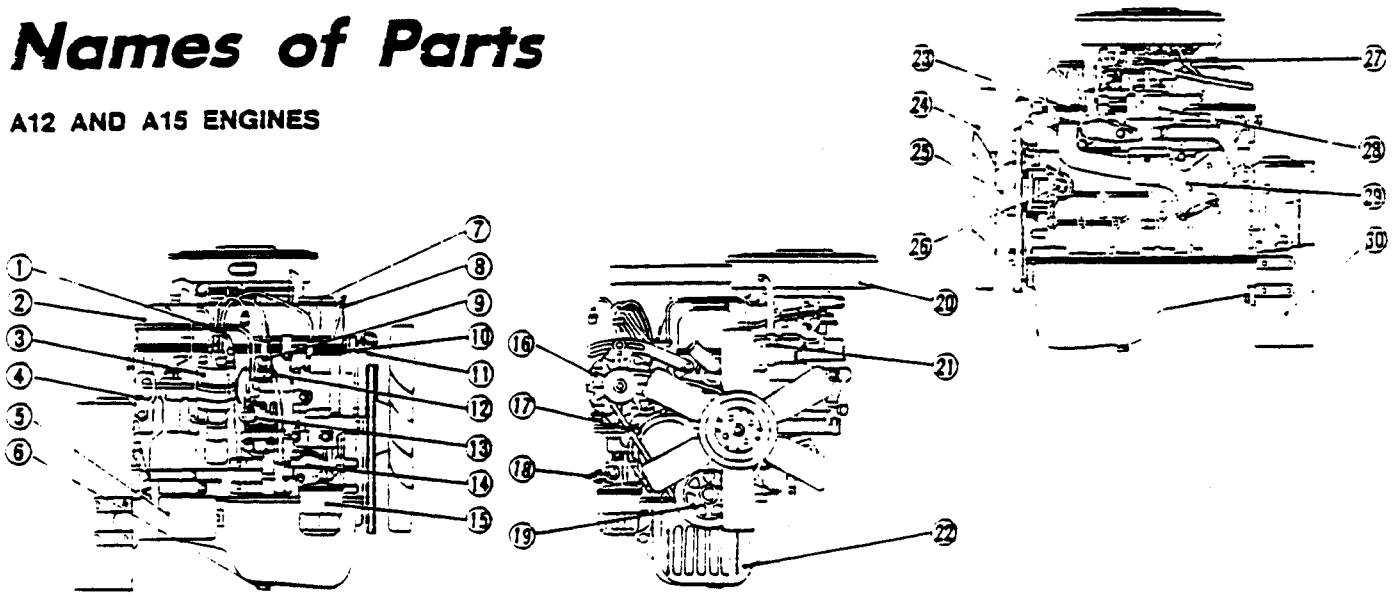
NISSAN

Contents

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

Names of Parts

A12 AND A15 ENGINES



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

Operation

HANDLING OF NEW ENGINE

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

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

Cautions in operation

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

ENGINE HANDLING PRECAUTIONS

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

When starting the engine

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

During engine operation

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

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

When stopping the engine

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

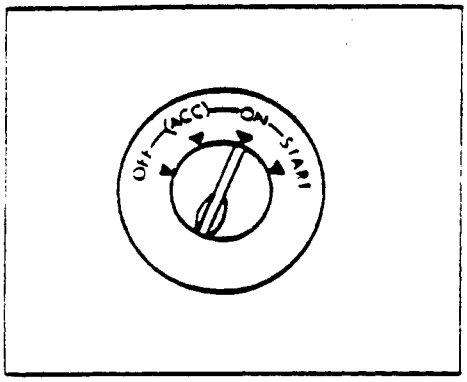
Note that stopping the engine immediately after heavily loaded operation will deteriorate the engine because it is still in a very hot state.

Others

Perform periodical inspection and replacement of the following items:

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

STARTING AND OPERATING



Starting

1. Pull out the choke control knob.
2. Turn the ignition key to the extreme right. Release the key as soon as the engine starts.

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

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

Stopping

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

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

CAUTIONS DURING OPERATION

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

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

At completion of the day's operations

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

Other Handling and Operations

AGAINST COLD AND HOT WEATHER

In cold weather

● Oil

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

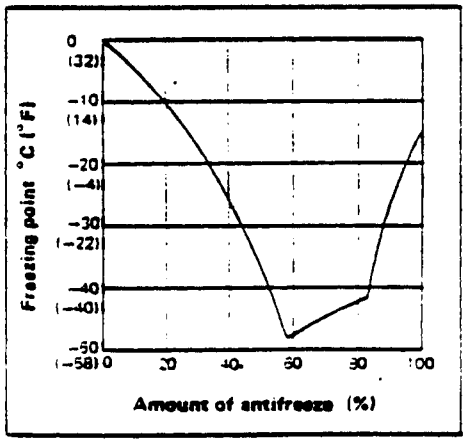
● Coolant

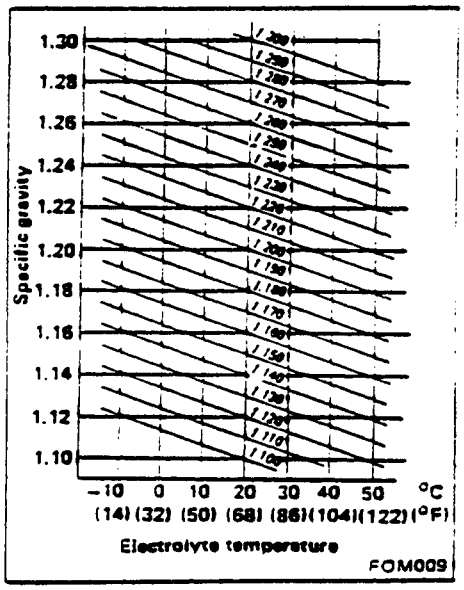
When coolant might freeze under low ambient temperature, drain out the coolant completely.

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

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

Coolant mixture ratio





● Battery

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

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

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

In hot weather

- **Oil**

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

- **Coolant**

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

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

- **Battery**

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

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

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

During in-use period

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

During out-of-use period

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

1. Perform loaded operation once a month.
   - Run the engine and perform checks set forth in item 1 above.
   - Apply a load in excess of 50% of the rated load to the engine, and operate it for more than 10 minutes. Make sure that no abnormal noise or vibration is produced.
2. Perform the following inspection and adjustment before placing the engine in use period.
   - Drain sediment from the fuel system (fuel filter and fuel tank).
   - Change engine oil and oil filter element.
   - Check and adjust valve clearance.
   - Check and adjust fan and governor belt tension.
   - Check battery electrolyte level and specific gravity.
   - Change air cleaner element.
   - Check cooling water
   - Check exhaust leakage

PROCEDURES FOR PLACING THE ENGINE IN LONG-TERM STORAGE

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

Lubricating system

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

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

Fuel system

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

Cooling system

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

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

Combustion chamber

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

Engine exterior

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

Others

1. Remove the fan and governor belt or keep it loosened.
2. Seal the air intake hole of the air cleaner and air outlet hole of the exhaust tube with adhesive tape.
3. Wrap the open type generator with a porous bag, and fasten the bag with a rubber band or similar item.
4. If the engine is equipped with a clutch, spray an evaporative anti-rust agent into the clutch housing, and seal the opening with adhesive tape.
5. When storing the engine as a complete assembly outdoors, cover it fully with a porous water-proof sheet.
   Do not use a vinyl sheet, because it lacks porosity and retains water inside.

Preparations for operation after long-term storage

1. Remove all adhesive sealing tapes from the openings of the engine.
2. Drain the rust preventing oil and anti-rust agent by using the following procedure, and replace it with the specified amount of engine oil, fuel and cooling water.

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

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

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

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

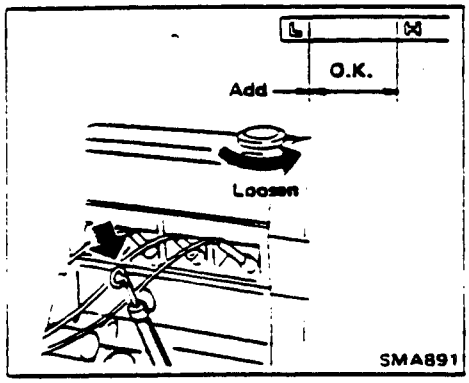
3. Replace the elements of the oil filter, the air cleaner and the fuel filter with new ones.
4. Adjust the fan and governor belt for proper tension.
5. Check and adjust valve clearance. Apply engine oil to the rocker arm and other valve mechanism.
6. Check the battery electrolyte level and specific gravity. Refill and/or recharge if it is necessary.
7. Before the engine starts, disconnect the high tension cables from the spark plugs.
8. Set the ignition switch at the "START" position, and crank the engine for about 10 seconds. Repeat this cranking operation two or three times in order to disperse engine oil to every portion of the engine, and then install the high tension cable.
9. Start the engine, and let it idle for about 5 minutes.
10. Gradually increase the engine speed to the rated rpm, and run the engine for about 10 minutes under no load. Make sure that the charge warning lamp and oil warning lamp are off and cooling water temperature are normal, and that the engine does not produced any abnormal vibration or noise.

Daily Care

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

If you note any defects, notify your authorized NISSAN dealer.

CHECK ENGINE OIL LEVEL



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

CHECK COOLING WATER LEVEL

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

If cooling water is dirty, flush the cooling system.

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

CHECKING THE ENGINE FOR LEAKAGE

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

CHECKING THE ENGINE OPERATION DURING BOTH IDLING AND ACCELERATION

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

OTHERS

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

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

PERIODIC MAINTENANCE AND LUBRICANT SCHEDULE

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

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

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

Check: Check, correct and replace if necessary.

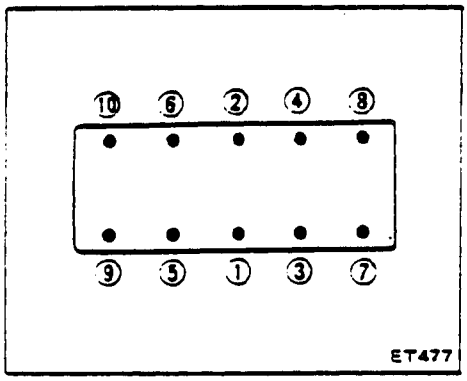
REV.

Mark Industries

TITLE VENDOR CHAPTER
MODEL 42C
NOTES P/N 210281

VENDOR
SECTION 4
PAGE 7

MAINTENANCE OPERATION



Retightening cylinder head

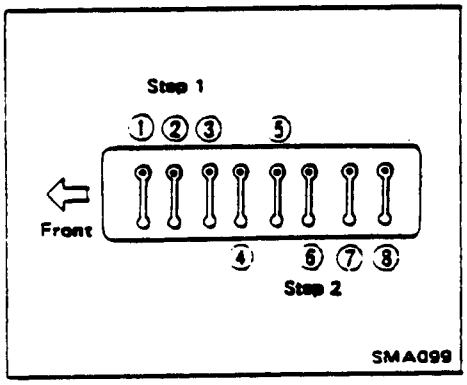
1. Warm up engine sufficiently.
2. Tightening should be made in the sequence shown.

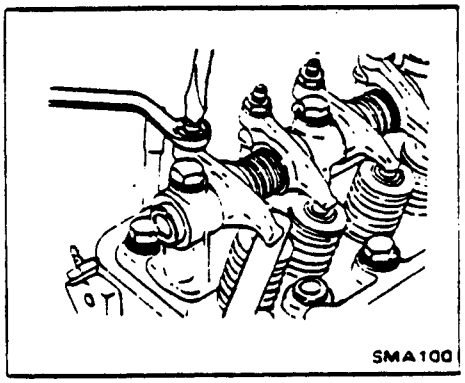
(T): **69 to 74 N·m (7.0 to 7.5 kg-m, 51 to 54 ft-lb)**

Retightening manifold, carburetor and exhaust tube

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

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





Adjusting intake and exhaust valve clearance

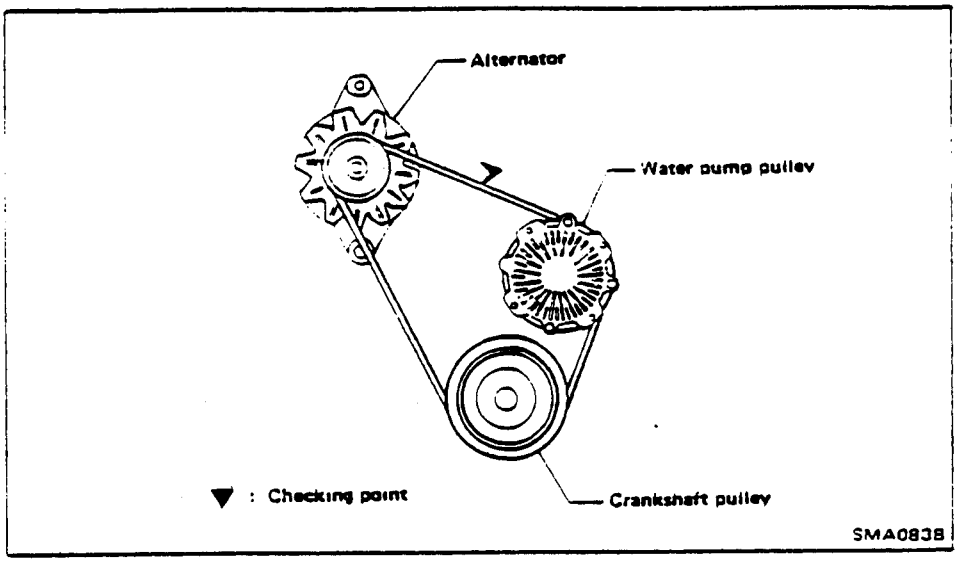
Adjustment should be made while engine is warm but not running.

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

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

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

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



Checking and adjusting drive belts

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

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

2. Check belt tension by pushing midway between pulleys.

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

Changing engine oil and oil filter

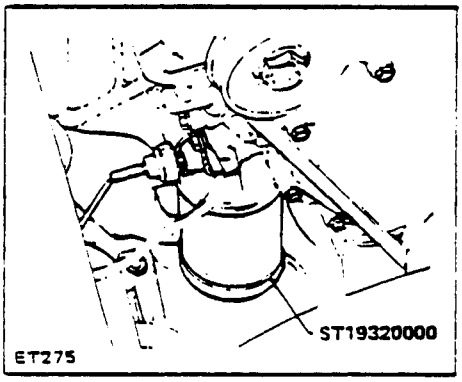
1. Start engine and warm up engine sufficiently, then stop engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

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

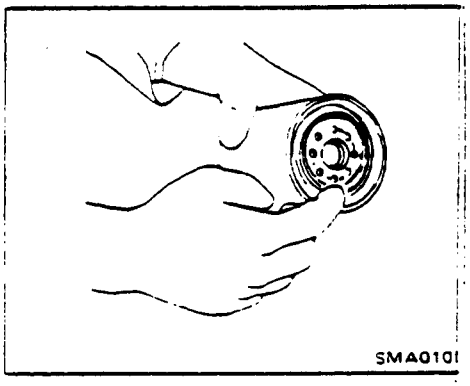
- **A milky oil indicates the presence of cooling water. Isolate the cause and take corrective measure.**
- **An oil with extremely low viscosity indicates dilution with fuel.**

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

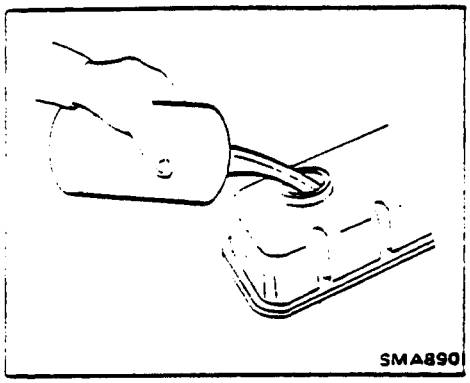
㊦ : **Oil pan drain plug**
20 to 29 N·m
(2.0 to 3.0 kg-m, 14 to 22 ft-lb)

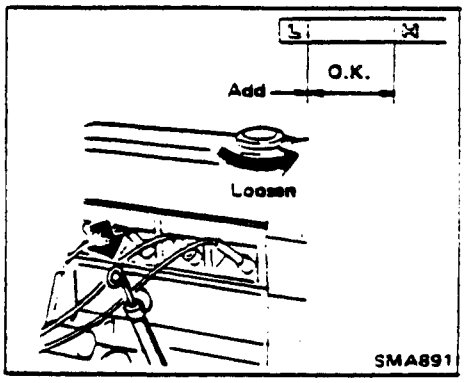


4. Using Tool, remove oil filter.
5. Wipe oil filter mounting surface with a clean rag.



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


SMA890



SMA891

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

Check oil level with dipstick.

Oil capacity:

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

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

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

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

When checking oil level, set engine at level.

Changing engine coolant

WARNING:

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

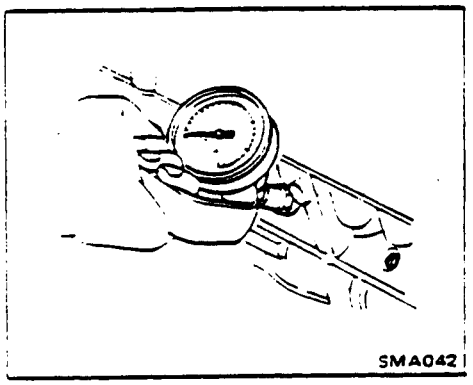
When using antifreeze coolant, mix the antifreeze coolant with water, observing instructions attached to antifreeze container.

Cleaning radiator outside

Clean outside of radiator with dry compressed air.

Checking cooling system, hoses and connections

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


SMA042

Checking engine compression pressure

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

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

Compression pressure:

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

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

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

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

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

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

Cleaning or replacing fuel strainer element

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

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

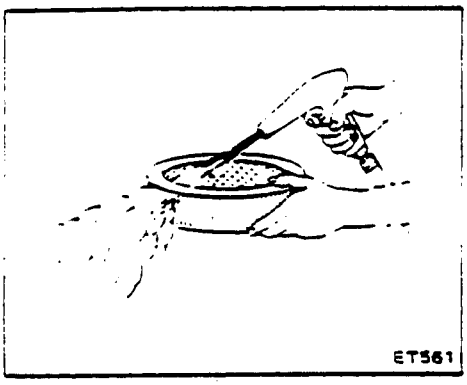
Checking fuel lines (Hoses, piping, connections, etc.)

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

Adjusting choke mechanism (Choke valve and linkage)

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

Adjust stroke if necessary.

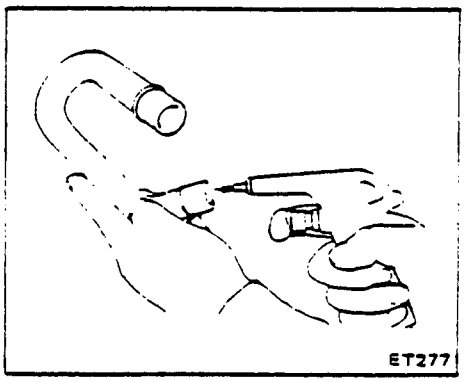


Cleaning and replacing air cleaner element (Dry paper type)

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

Be careful not to drop into carburetor.

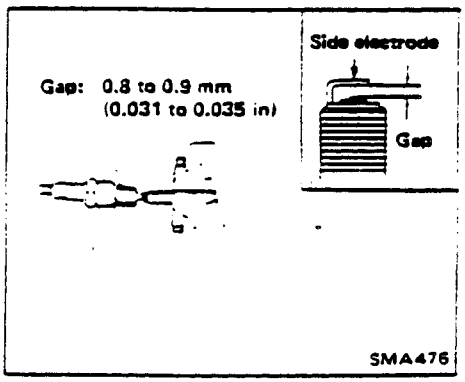
4. Install element and air cleaner cover.



Checking crankcase ventilation hose

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

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



Checking and replacing spark plugs

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

Do not pull on the cable.

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

Spark plug type:
B4ES

Gap:
0.8 to 0.9 mm
(0.031 to 0.035 in)

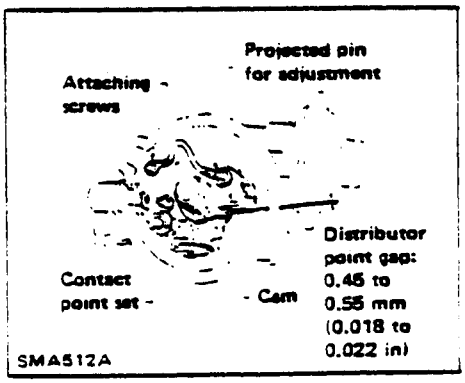
(T): **15 to 20 N·m**
(1.5 to 2.0 kg-m, 11 to 14 ft-lb)

Checking distributor point cap and rotor

Visual check

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

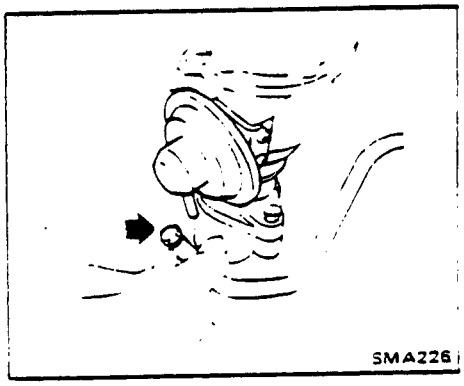
Do not attempt to remove all roughness.



Checking point gap

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

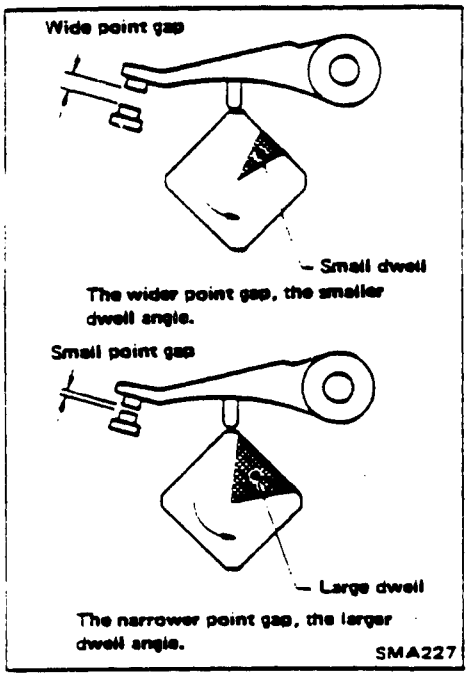
If the gap is out of specification, loosen contact point plate attaching screws and adjust point gap by pivoting projected pin.



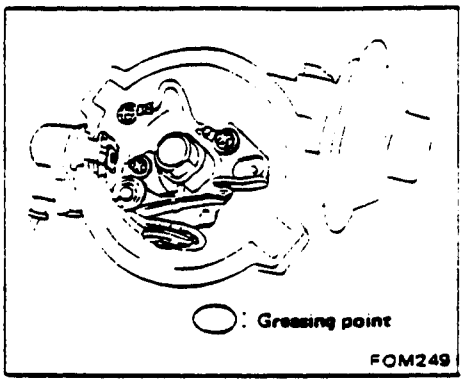
Checking dwell angle

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

Dwell angle:
49° to 55°

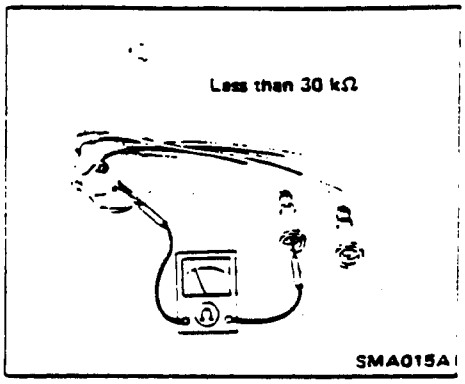


4. If dwell angle is not within the specified value turn off engine and adjust point gap.
5. If dwell angle is not within the specified value when point gap is correct, cam lobe is worn. Replace cam.



Greasing distributor cam and cam heel

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



Checking ignition high tension cable

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

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

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

CAUTION:

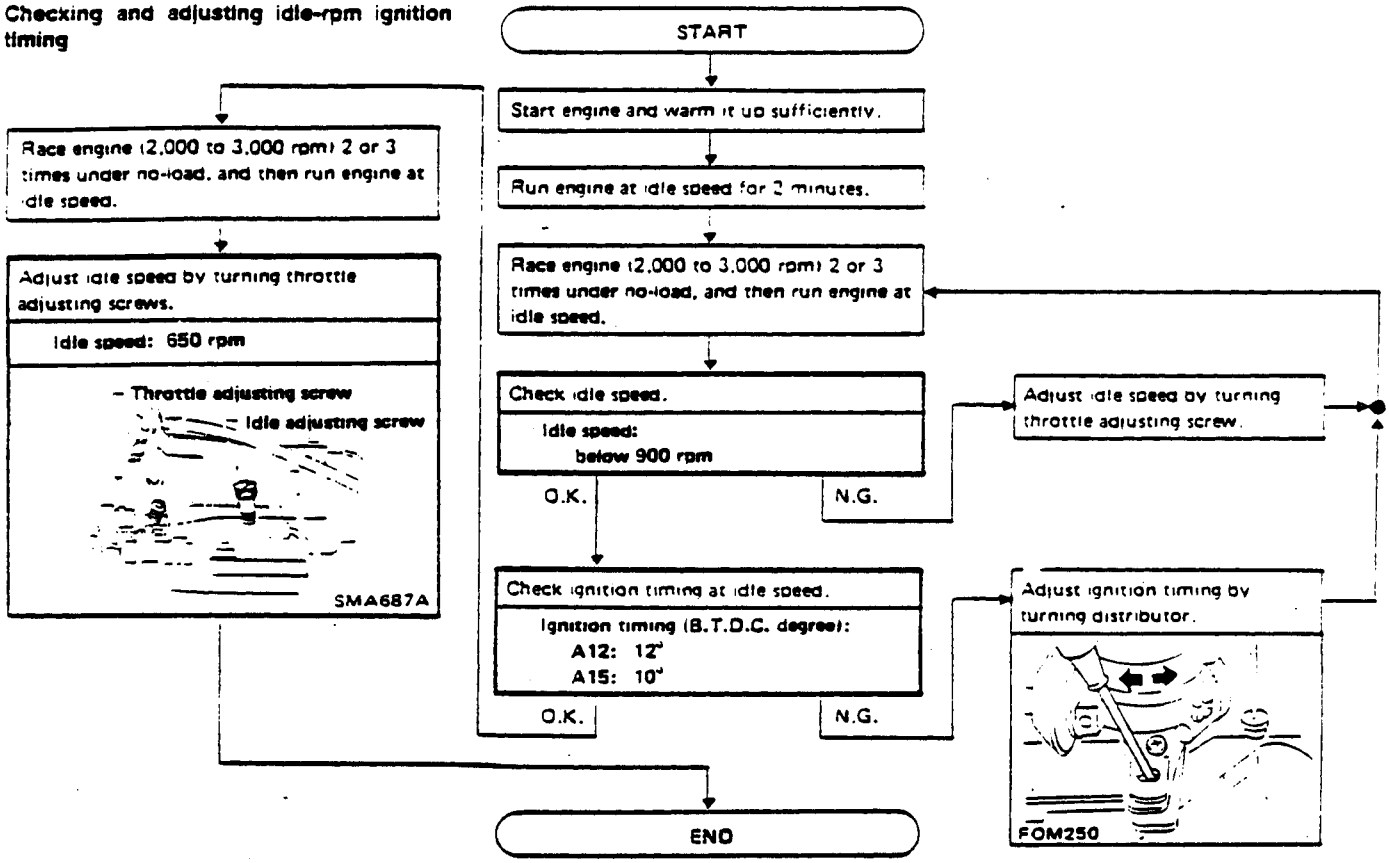
a. Idle mixture ratio is adjusted at factory and requires no further adjustment. If it becomes necessary to adjust it, proceed with the following steps.

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

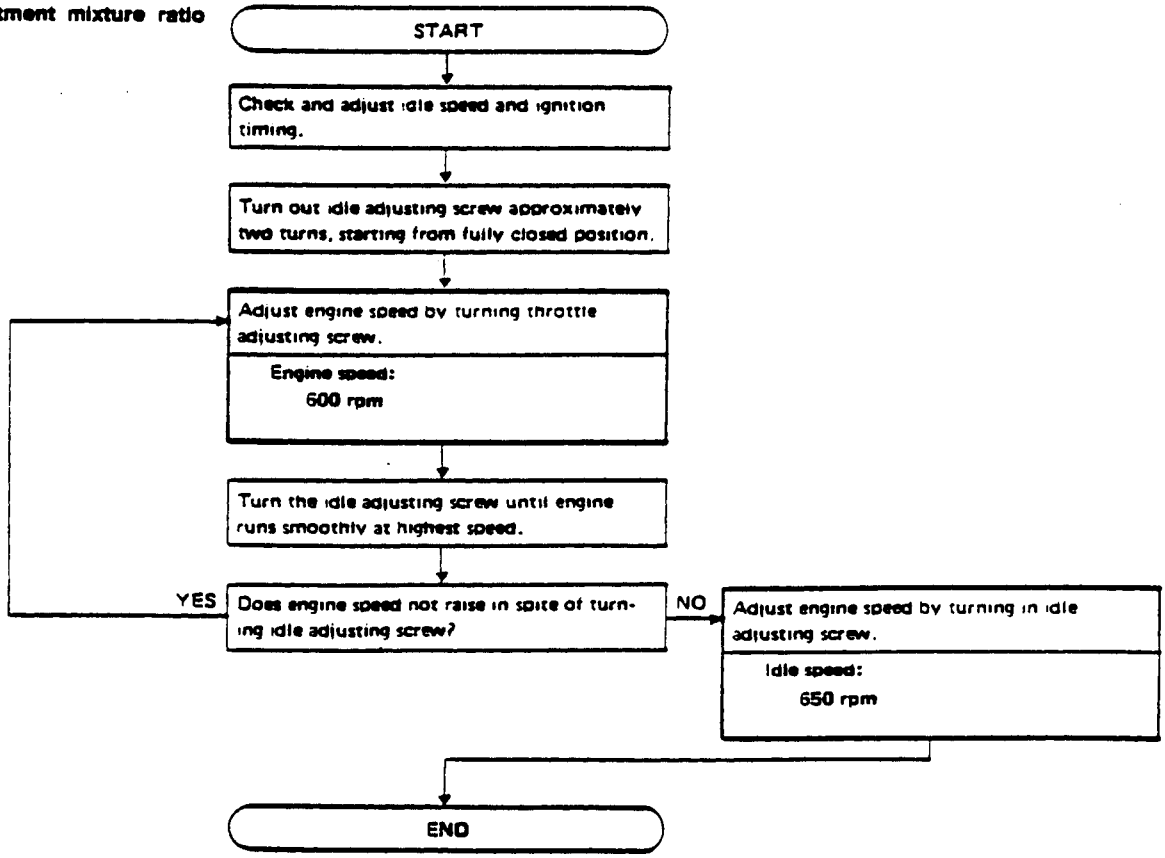
Preparation

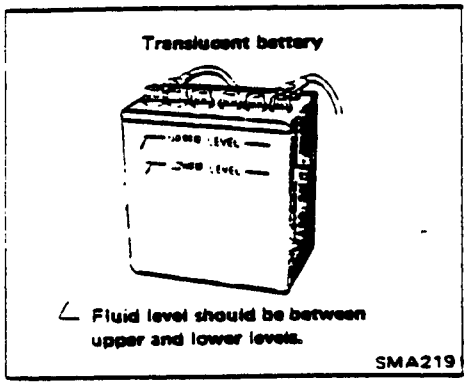
1. **Make sure that the following parts are in good order.**
   - **Ignition system**
   - **Engine oil and coolant levels**
   - **Valve clearance**
   - **Float level at idling speed**
2. **Set shift lever in "Neutral" position.**

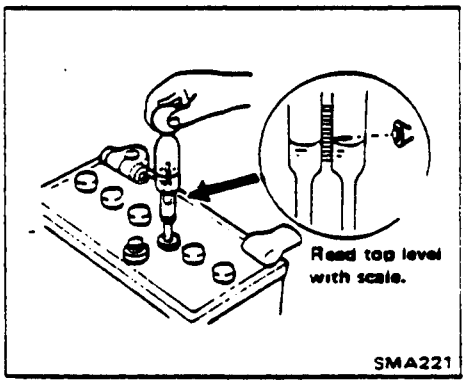
Checking and adjusting idle-rpm ignition timing



Checking and adjustment mixture ratio







Checking electrolyte level

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

Do not overfill.

Checking electrolyte gravity

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

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

Trouble Diagnosis and Corrections

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

ENGINE WILL CRANK NORMALLY BUT WILL NOT START

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

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

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

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

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

Condition	Probable cause	Corrective action
Low compression	Weak or damaged valve springs.	Replace.
	Compression leak at cylinder head gasket.	Replace gasket.
	Sticking damaged piston ring.	Replace piston rings.
	Worn piston ring or cylinder.	Overhaul engine.
	(Trouble-shooting procedure) Inject a small quantity of engine oil in spark plug hole, and then measure cylinder compression.	
	Compression increases.	Malfunctioning cylinder or piston ring.
	Compression does not change.	Compression leaks from valve, cylinder head or head gasket.
IMPROPER ENGINE IDLING (Low engine idle speed)	Clogged or damaged carburetor jets.	Clean or replace.
	Incorrect idle adjustment.	Adjust.
	Clogged air cleaner filter.	Clean or replace filter.
Fuel system out of order	Damaged manifold gaskets or carburetor insulator.	Replace gasket or insulator.
	Improper float level adjustment.	Adjust.
	Loose or cracked vacuum hoses or air hoses from carburetor and intake manifold.	Check for loose connections or cracks.
	Malfunctioning carburetor choke.	Check and adjust.
Low compression		Previously mentioned.

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

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

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

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

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

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

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

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

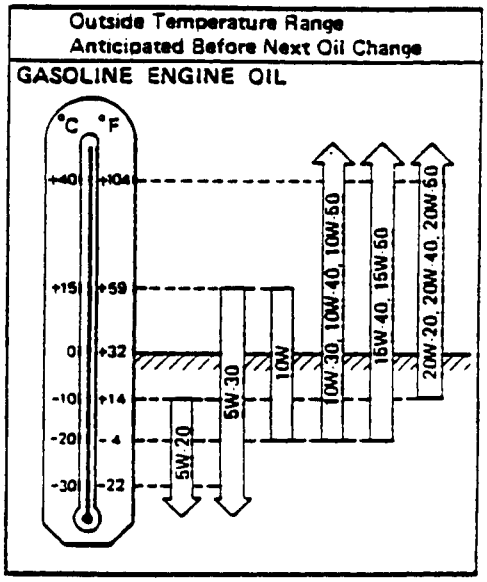
Condition	Probable cause	Corrective action
Decreased oil pressure	Functional deterioration of oil pump.	Repair or replace it with a new one.
	Blocked oil filter.	Replace with a new one.
	Increased clearance in various sliding parts.	Disassemble and replace the worn parts with new ones.
	Blocked oil strainer.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

Recommended Lubricant

LUBRICANT

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

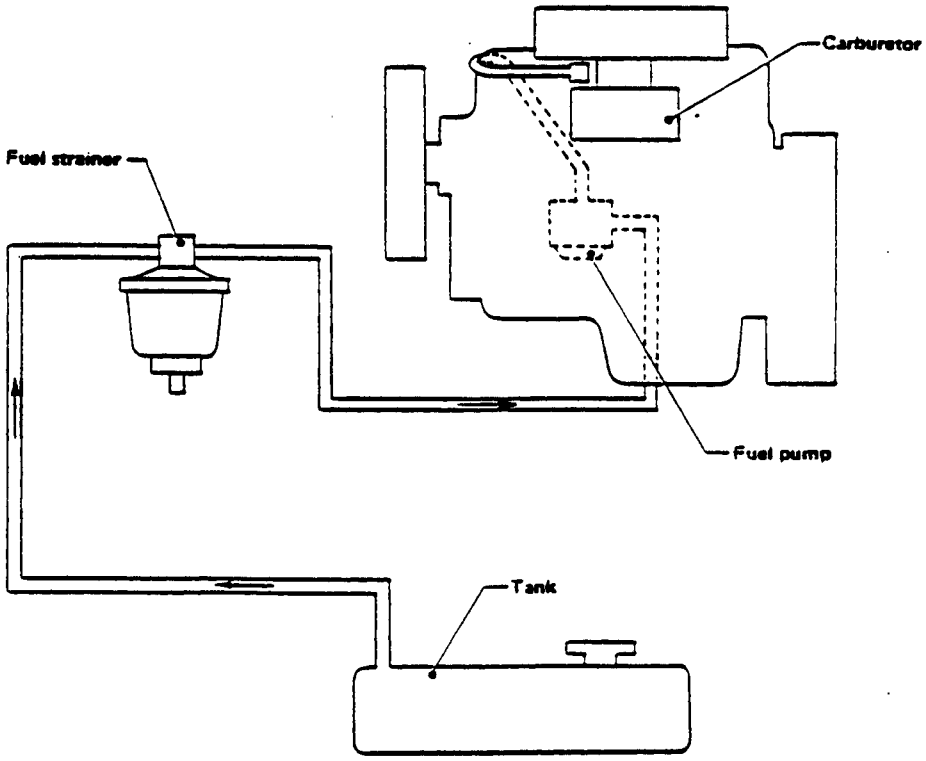
SAE VISCOSITY NUMBER



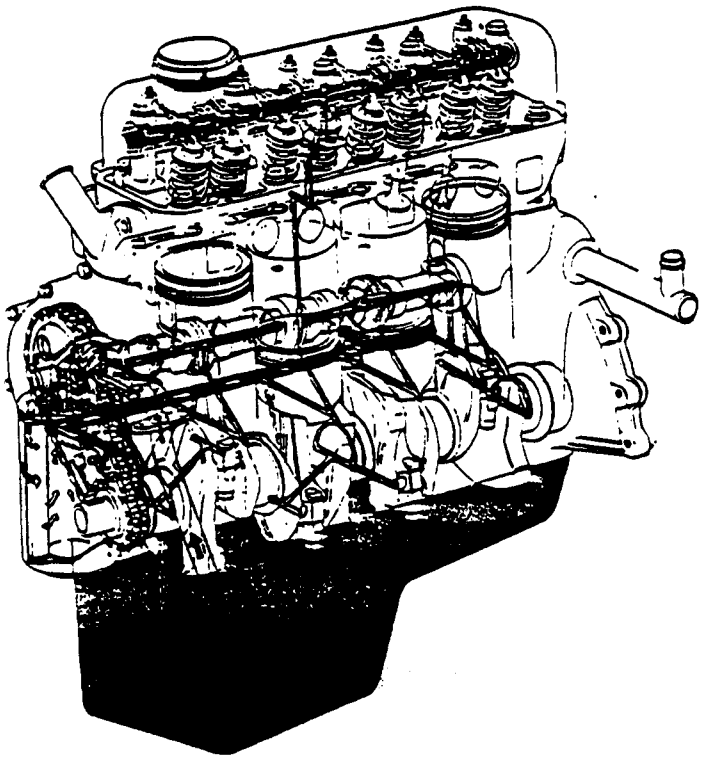
T10005

System Diagram

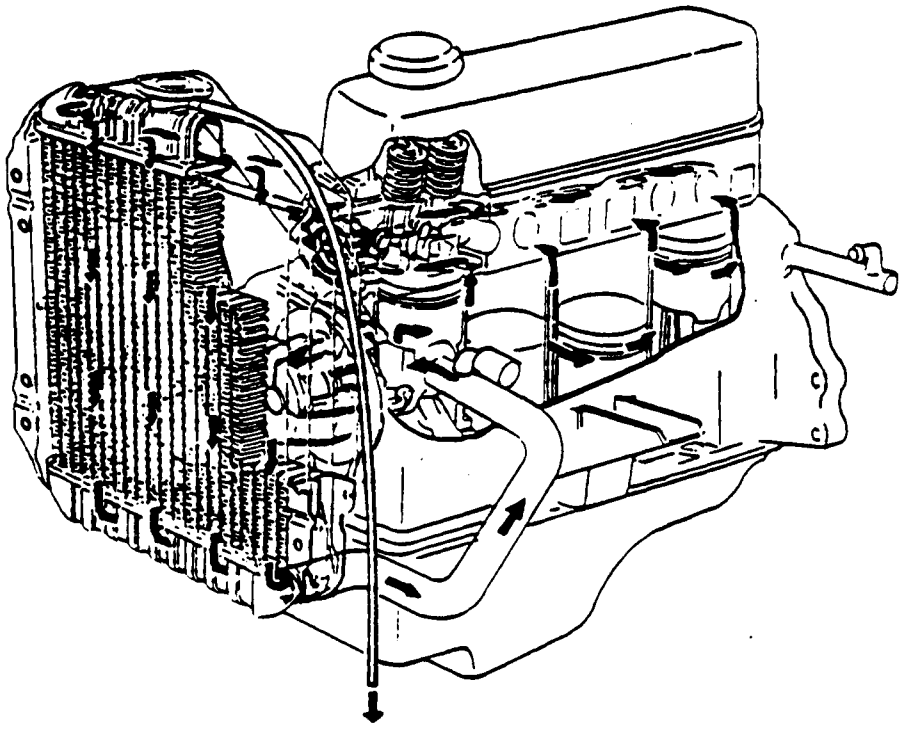
FUEL SYSTEM DIAGRAM



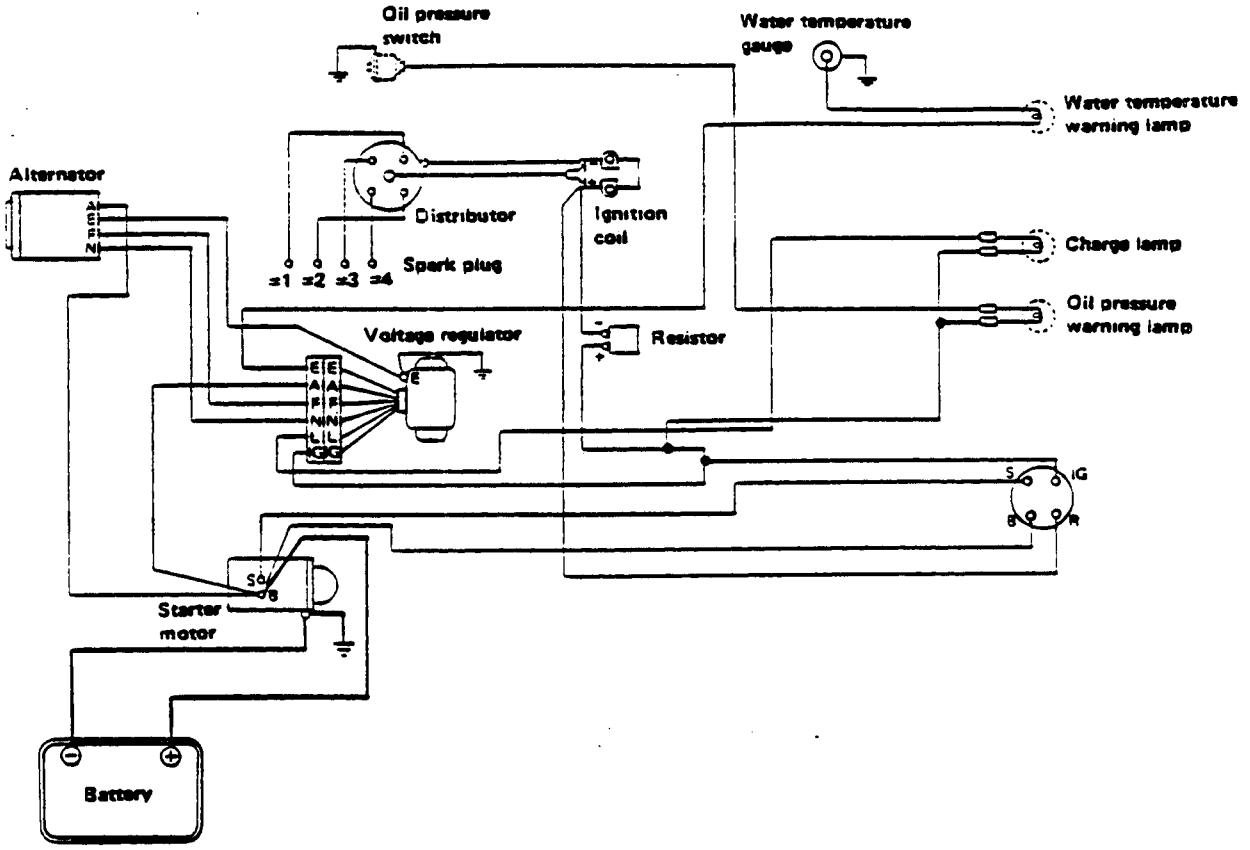
LUBRICATION SYSTEM DIAGRAM



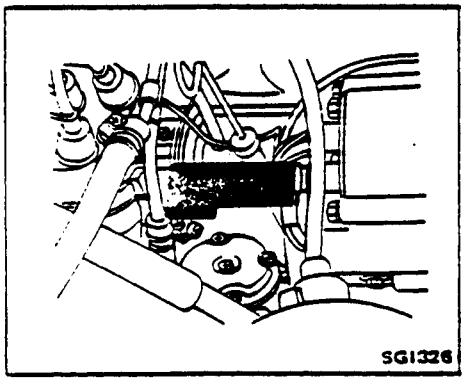
COOLING SYSTEM DIAGRAM



ELECTRICAL SYSTEM DIAGRAM



Engine Serial Number



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

A12-xxxxxx x

A15-xxxxxx x

Serial No.

Engine model

Specifications

ENGINE GENERAL

Item \ Engine model	A12	A15
Engine general specifications		
Classification	Gasoline	
Cycle	4	
No. of cylinders and arrangement	4, in-line	
Valve arrangement	O.H.V. (Overhead valve)	
Bore x stroke mm (in)	73 x 70 (2.87 x 2.76)	76 x 82 (2.99 x 3.23)
Displacement cm³ (cu in)	1,171 (71.45)	1,488 (90.80)
Compression ratio	9.0	
Number of piston rings		
Compression	2	
Oil	1	
Number of main bearings	5	
Firing order	1-3-4-2	

INSPECTION AND ADJUSTMENT

Valve clearance (Hot) mm (in)	
Intake	0.35 (0.014)
Exhaust	
Drive belt deflection mm (in)	8 to 12 (0.31 to 0.47)
Applied pushing force N (kg, lb)	98 (10, 22)
Engine oil capacity ℓ (US qt, Imp qt)	
With oil filter	3.2 (3-3/8, 2-7/8)
Without oil filter	2.7 (2-7/8, 2-3/8)
Engine compression pressure kPa (bar, kg/cm², psi)/rpm	
Standard	1,245 (12.45, 12.7, 181)/350
Minimum	981 (9.81, 10.0, 142)/350
Spark plug	
Type	B4ES
Gap mm (in)	0.8 to 0.9 (0.031 to 0.035)
Distributor	
Point gap mm (in)	0.45 to 0.55 (0.018 to 0.022)
Dwell angle (degree)	49 to 55°
High tension cable resistance (Ohm)	Less than 30,000

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

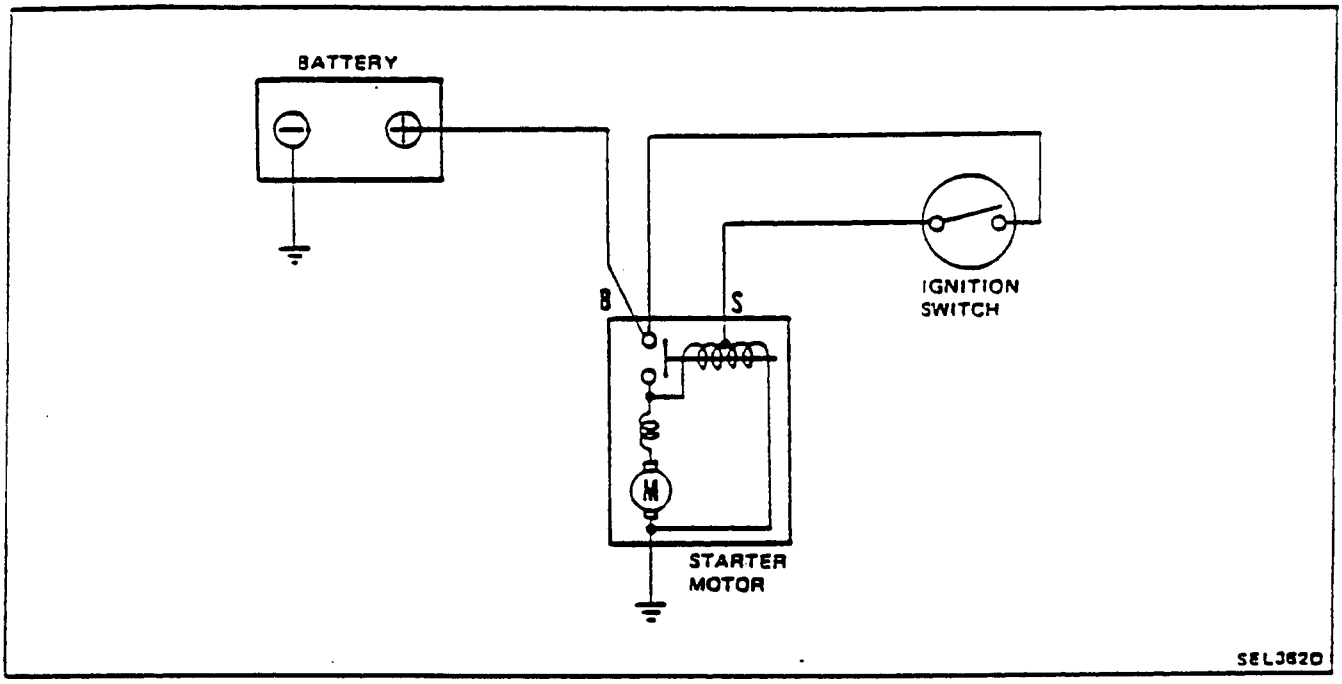
TIGHTENING TORQUE

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

STARTING SYSTEM

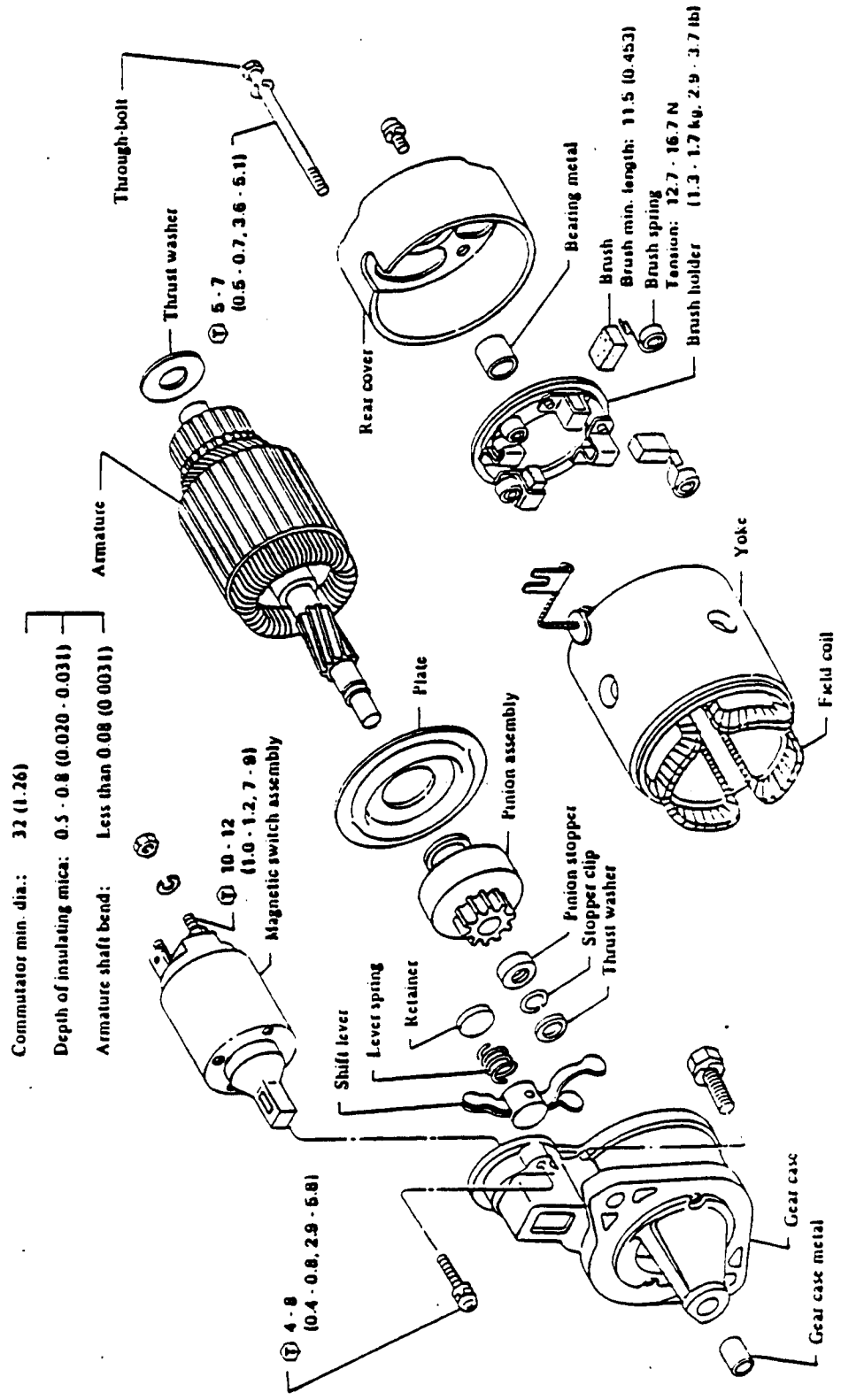
CAUTION: Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

SCHEMATIC



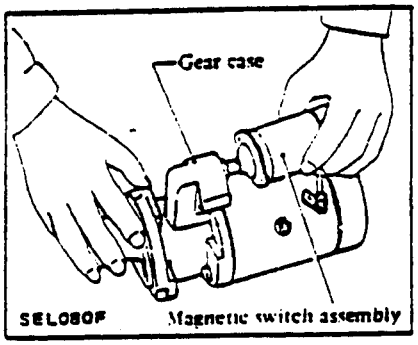
STARTER MOTOR

M2T20181

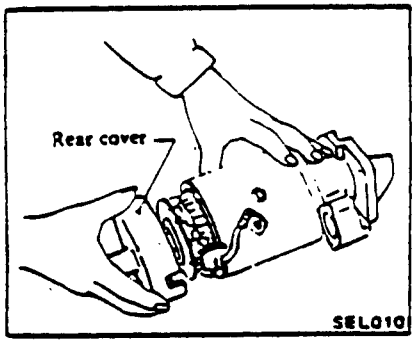


DISASSEMBLY

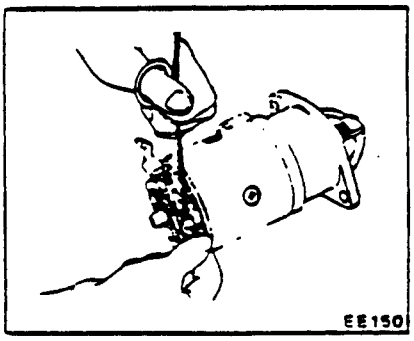
1. Remove magnetic switch.



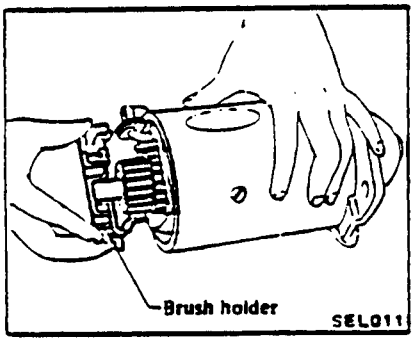
2. Remove rear cover.



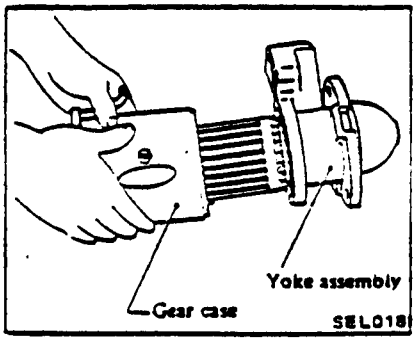
3. Lift up brush springs.



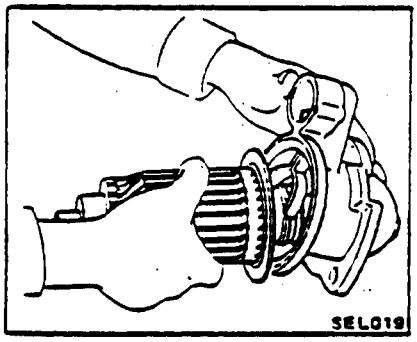
4. Remove brush holder



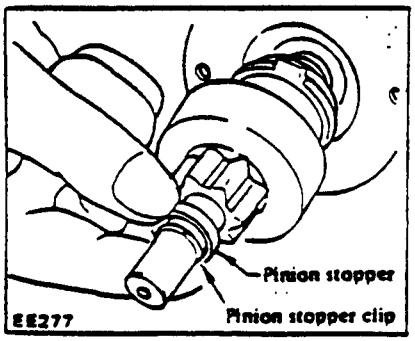
5. Remove yoke.



6. Withdraw armature and shift lever.



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

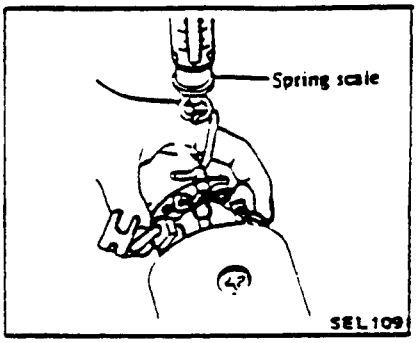


Brush spring

Check brush spring tension.

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

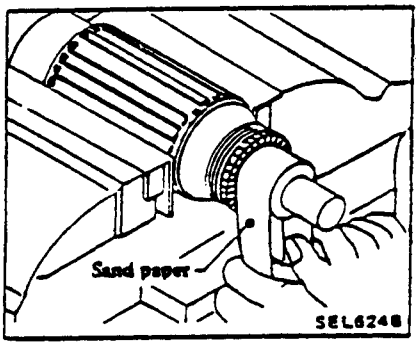
- Not in the specified value. ... Repair or replace.



INSPECTION

Armature assembly

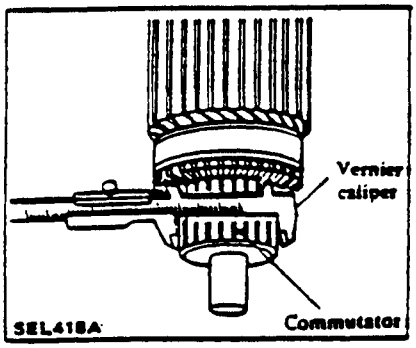
1. Check commutator surface.
- Rough ... Sand lightly with No. 500 ~600 sandpaper.



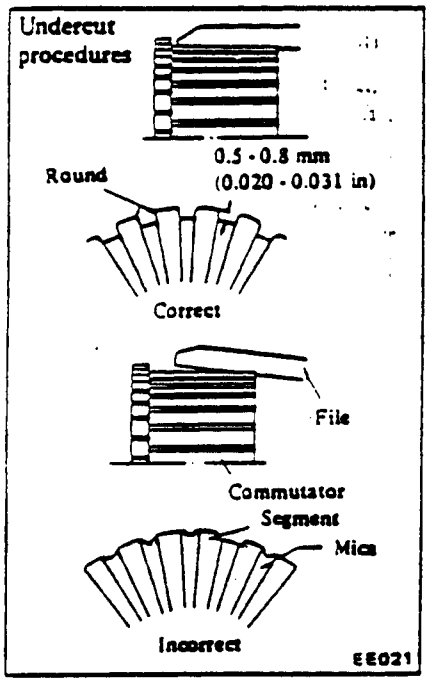
2. Check diameter of commutator.

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

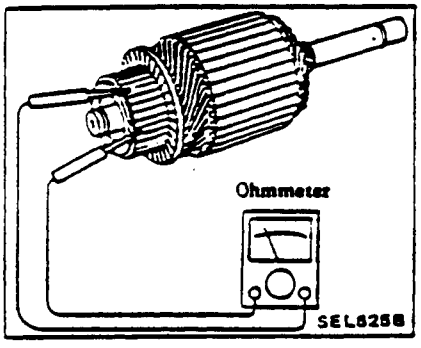
- Less than specified value ... Replace.



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

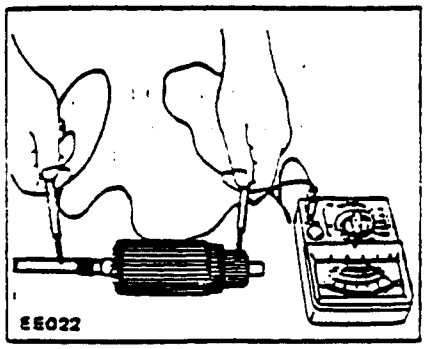


4. Continuity test (between two segments side by side).



- No continuity ... Replace.

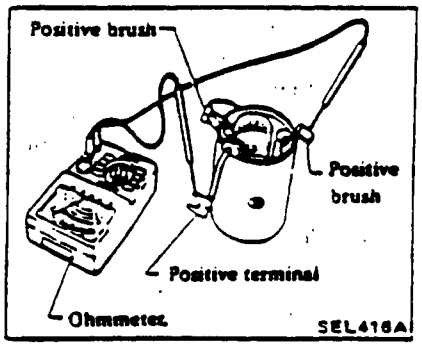
5. Insulation test (between each commutator bar and shaft).



- Continuity exists ... Replace.

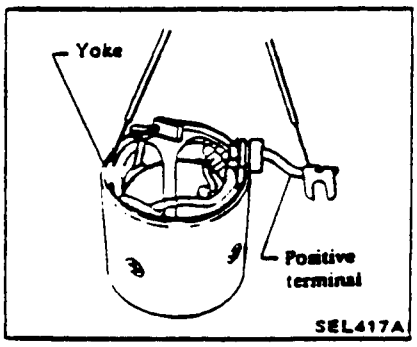
Field coil

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



- No continuity ... Replace field coil.

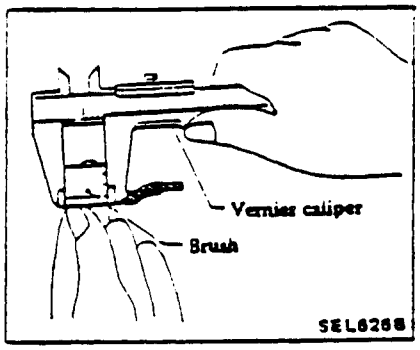
2. Insulation test (between field coil positive terminal and yoke).



- Continuity exists ... Replace field coil.

Brush

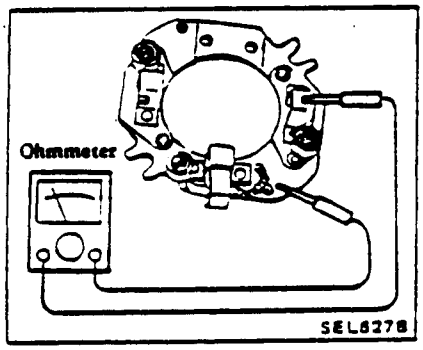
Check wear of brush.
Wear limit length: Refer to S.D.S.



- Excessive wear ... Replace.

Brush holder

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

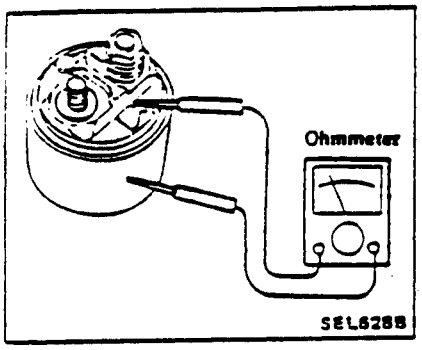


- Continuity exists ... Replace.

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

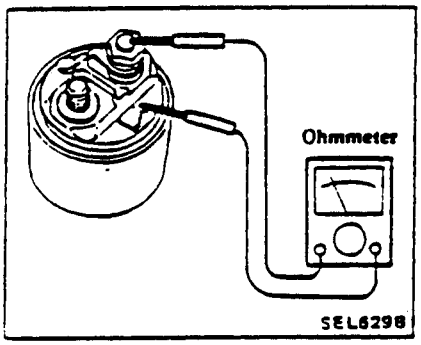
Magnetic switch

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



- No continuity ... Replace.

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

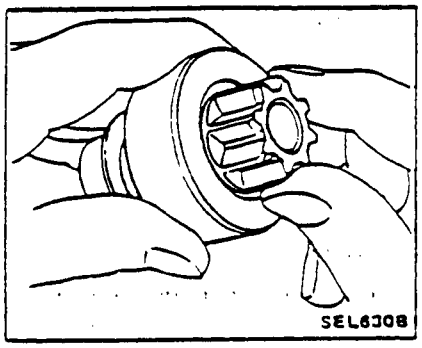


- No continuity ... Replace.

Pinion assembly

1. Check clutch.

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



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

2. Inspect pinion teeth.

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

ASSEMBLY

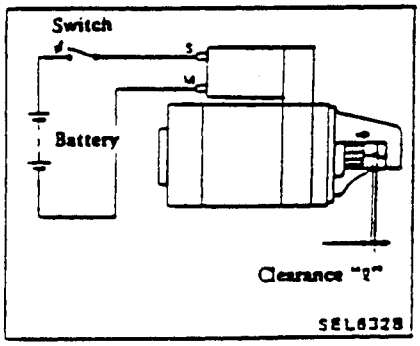
a. Apply grease to:

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

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

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

Clearance "ℓ":
Refer to S.D.S.



CHARGING SYSTEM

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

DESCRIPTION

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

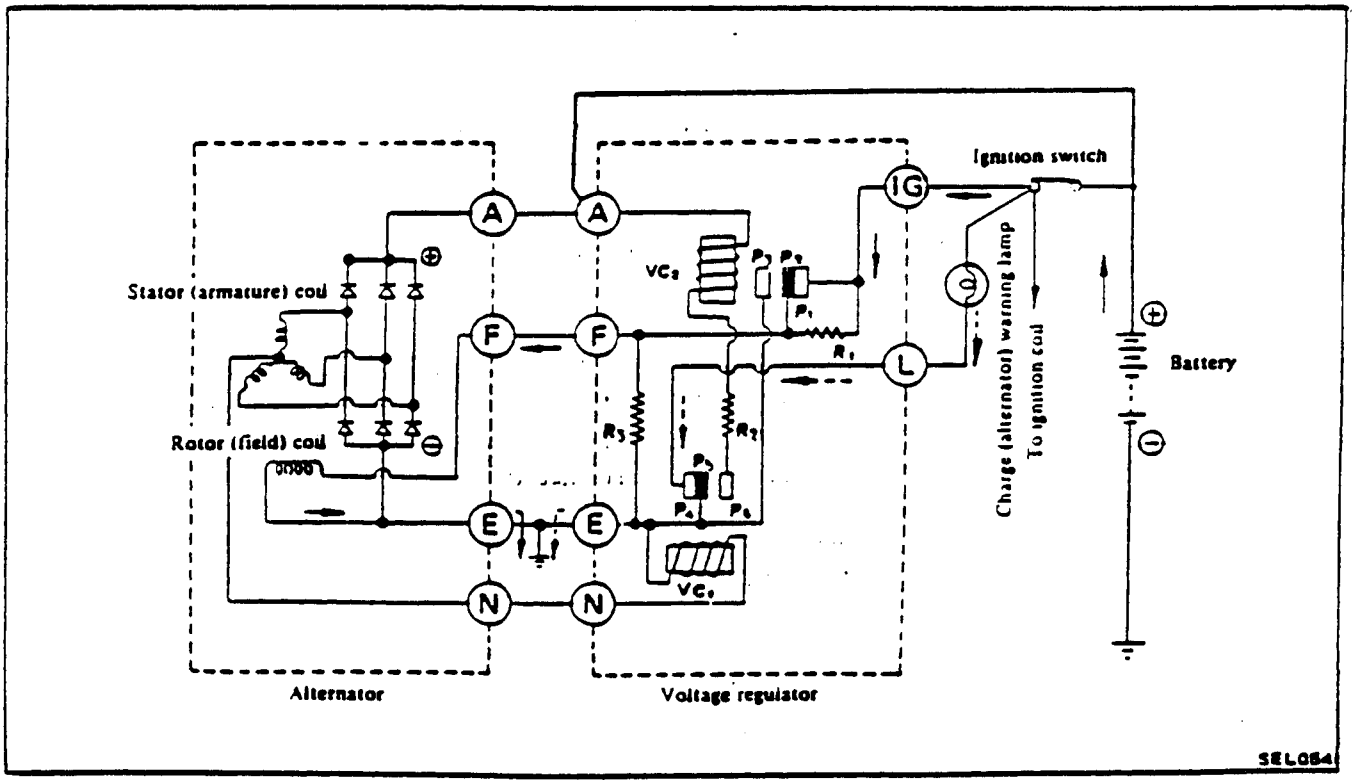
When the ignition switch is set to "ON", current flows from the battery to ground through the ignition switch, voltage regulator IG terminal, primary side contact point "P1", movable contact point "P2", voltage regulator "F" terminal, alternator "F" terminal, rotor (field) coil and alternator "E" terminal,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

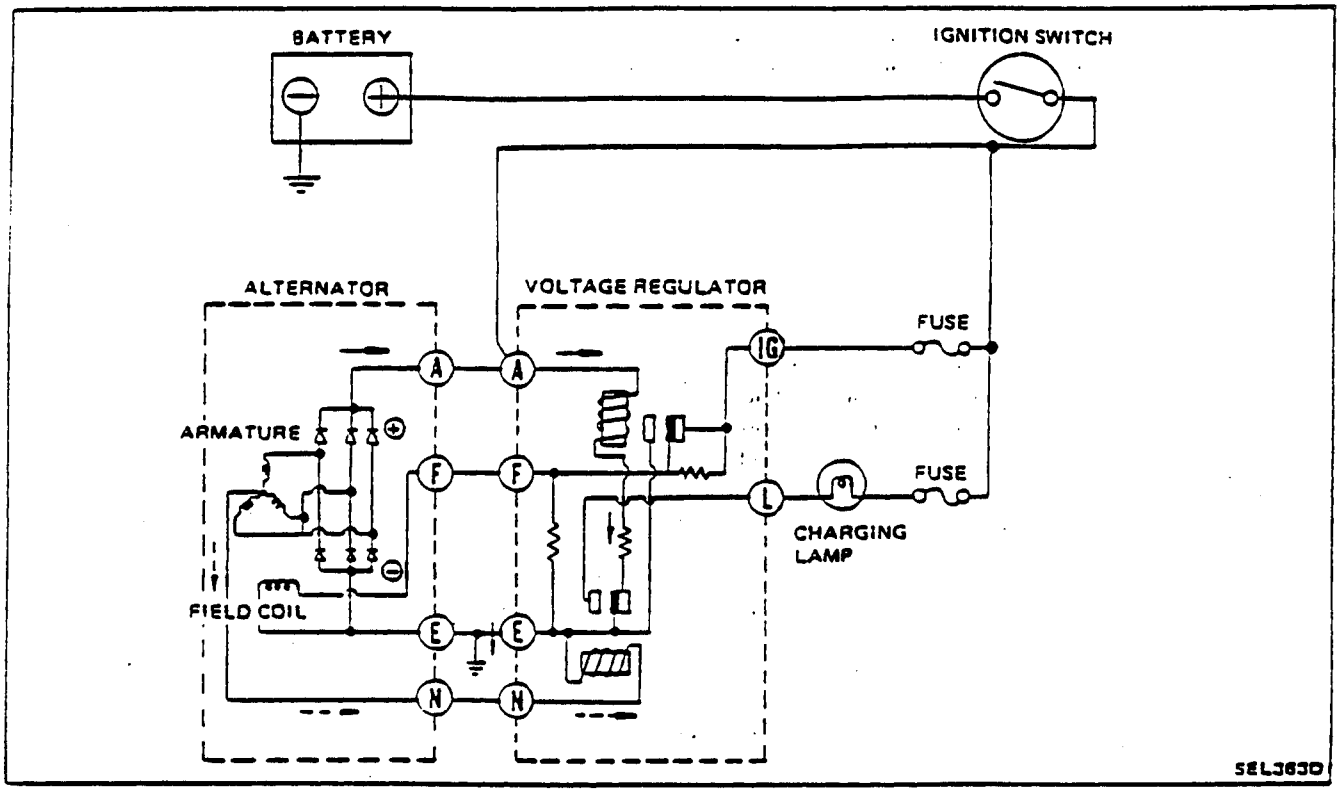
When the alternator begins to operate, three-phase alternating current is induced in the stator (armature) coil. This alternating current is rectified by the positive and negative silicon diodes. The rectified direct current output reaches the alternator "A" and "E" terminals.

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

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

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





CHARGING SYSTEM TROUBLE-SHOOTING

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

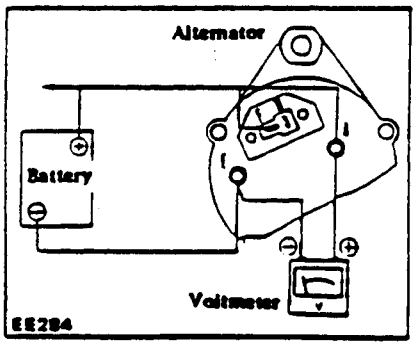
To conduct test, it is necessary to use a 30-volt voltmeter and suitable test probes.

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

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

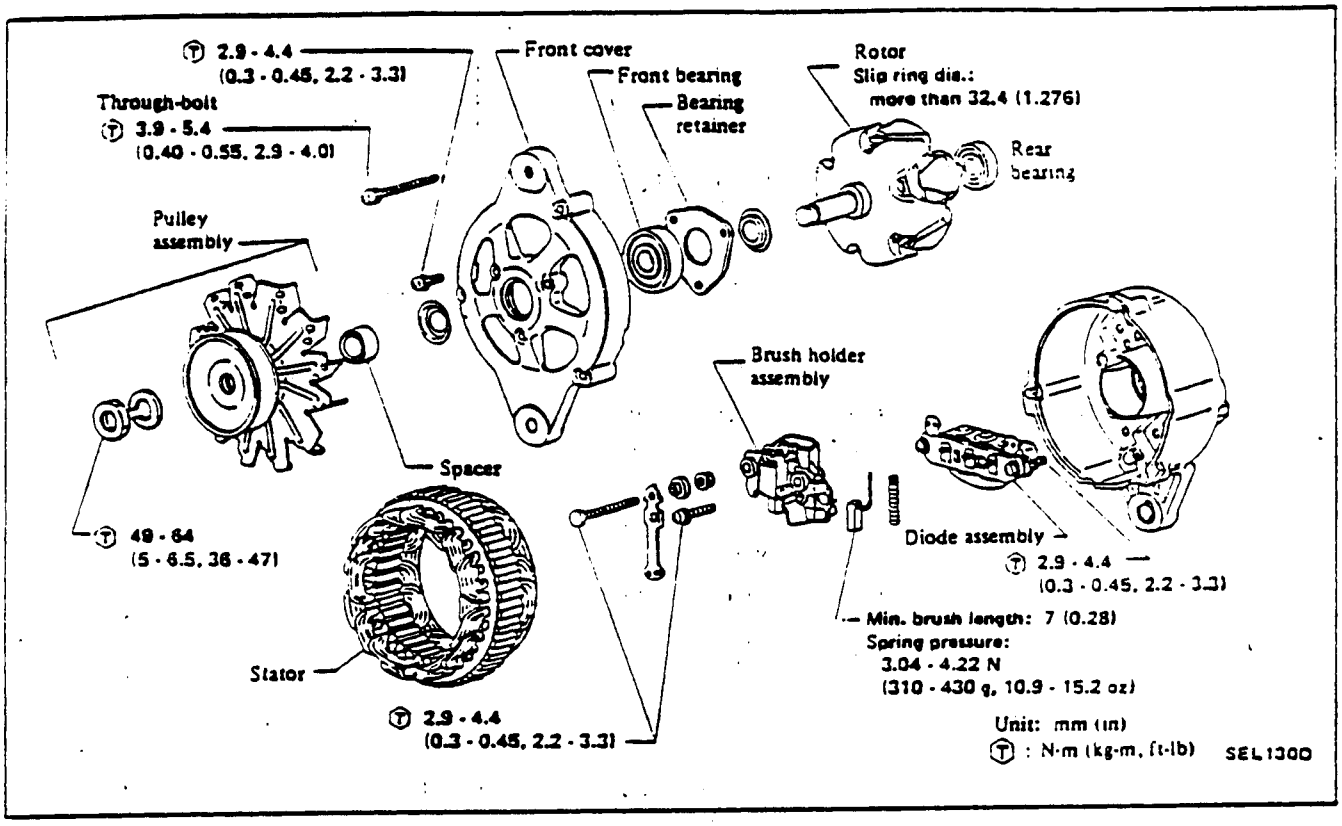
Measured value: Below 12.5 volts
Alternator is run-down. Remove and check it for condition.

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



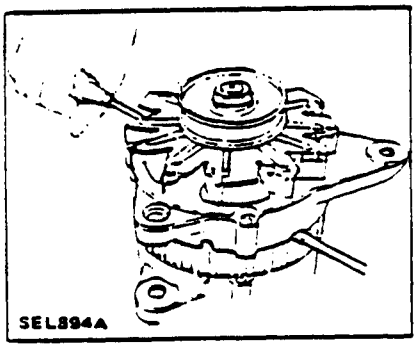
a. Do not run engine at more than 1,100 rpm while test is being conducted on alternator.
b. Do not race engine.

ALTERNATOR

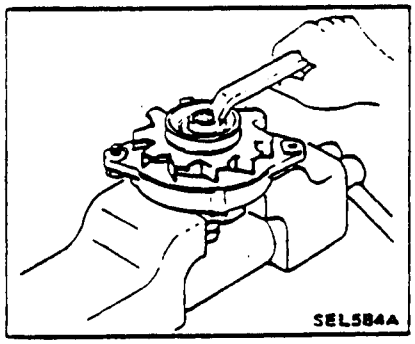


DISASSEMBLY

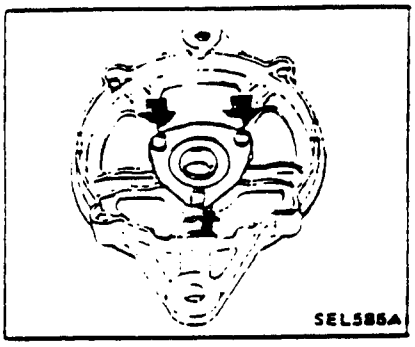
1. Remove through-bolts.
2. Separate front cover and rear cover.

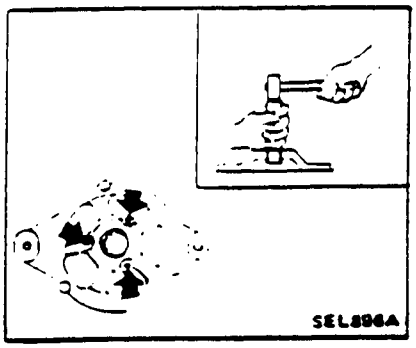


3. Separate front cover and rotor shaft.
(1) Place rear cover side of rotor in a vice.
(2) Remove pulley nut.
(3) Take out pulley, fan and front cover.



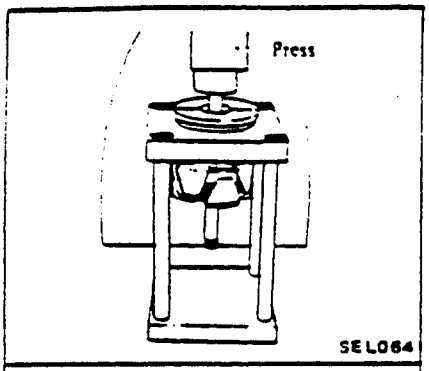
4. Remove bearing retainer and take out bearing.

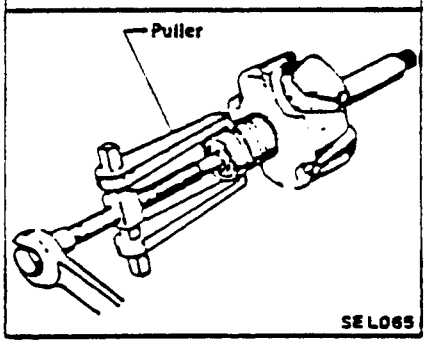




Rotor

Pull rear bearing off rotor assembly.

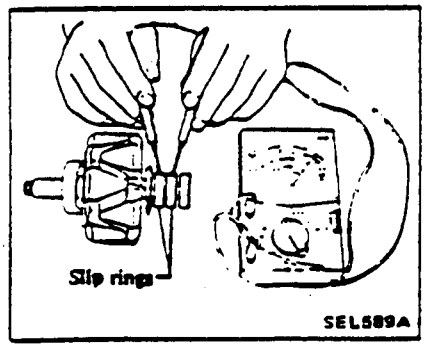




INSPECTION

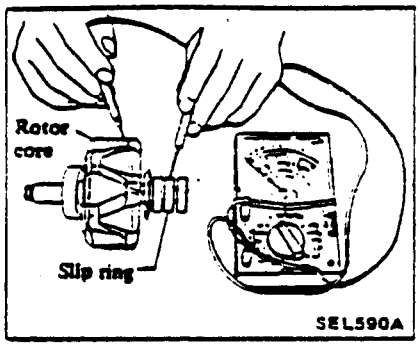
Rotor

1. Continuity test.



- No continuity ... Replace rotor.

2. Insulation test.



- Continuity exists ... Replace rotor.

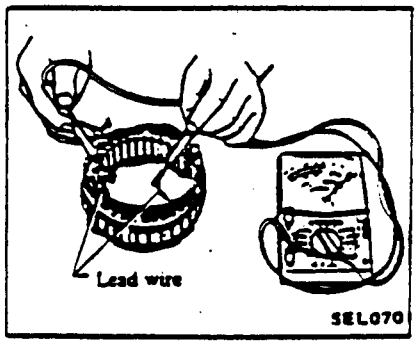
3. Check slip ring for wear.

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

If necessary, replace rotor assembly.

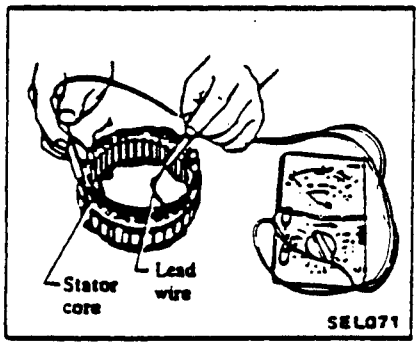
Stator

1. Continuity test



- No continuity ... Replace stator.

2. Insulation test



- **Continuity exists ... Replace stator.**

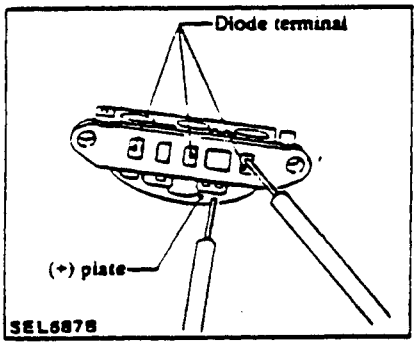
Diode

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

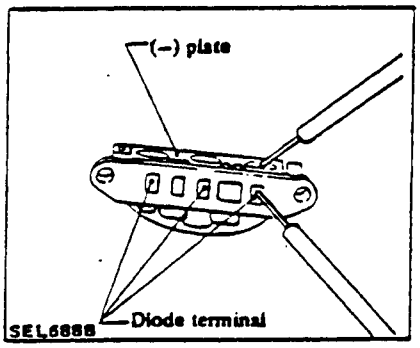
Circuit tester terminal		Conduction
Positive	Negative	
(+) plate Holder plate	Diode terminal	Yes
Diode terminal	(+) plate Holder plate	No
(−) plate	Diode terminal	No
Diode terminal	(−) plate	Yes

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

Positive diode



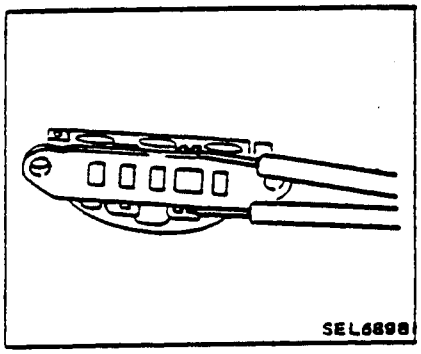
Negative diode



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

Sub-diode

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

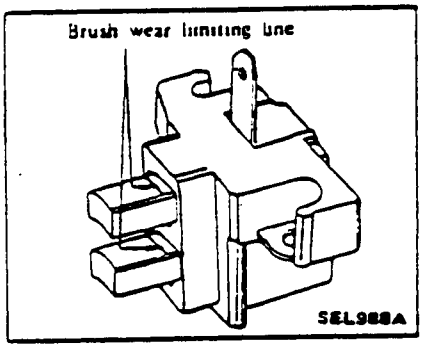


Brush

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

2. Check brush for wear.

Min. brush length:
8.0 mm (0.315 in)



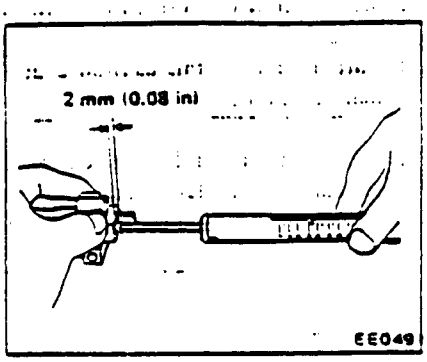
- Less than the specified value ... Replace.

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

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

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

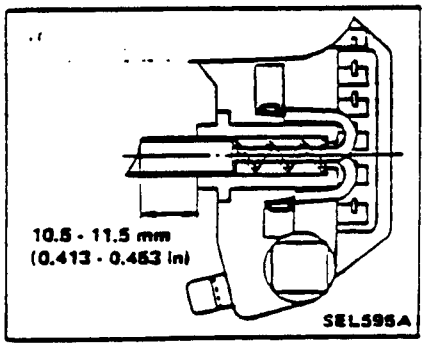
When brush is worn, pressure decreases approximately 0.196 N (20 g, 0.71 oz) per 1 mm (0.04 in) wear.



- Not in the specified value ... Replace.

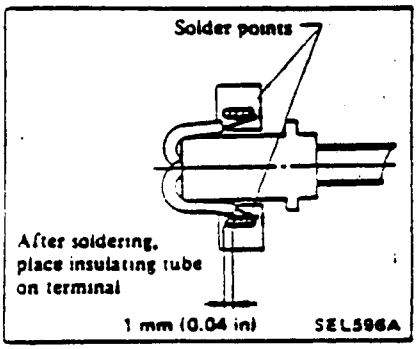
ASSEMBLY

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

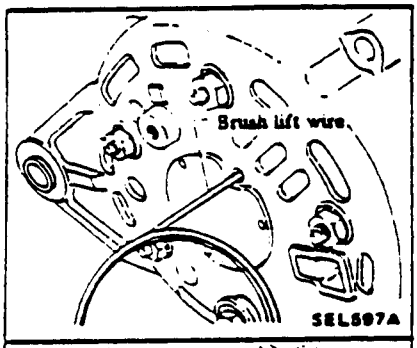


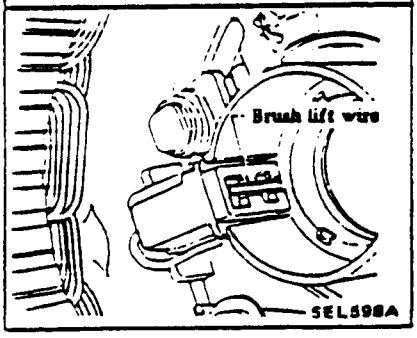
(2) Coil lead wire 1.5 times around terminal groove. Solder outside of terminal.

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



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





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

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

6. Tighten through-bolts.

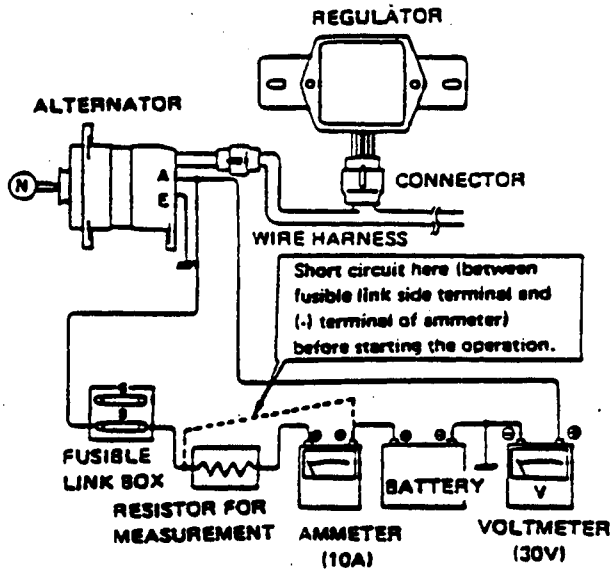
VOLTAGE REGULATOR

MEASUREMENT OF REGULATING VOLTAGE

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

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

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



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

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

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

Current falls below 5A.

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

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

Current does not fall below 5A.

Recharge battery and see if current falls below 5A.

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

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

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

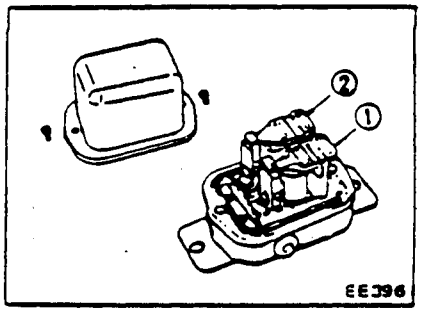
Temperature °C (°F)	Voltage V (RQB2220B)
−10 (14)	14.75 - 15.25
0 (32)	14.60 - 15.10
10 (50)	14.45 - 14.95
20 (68)	14.30 - 14.80
30 (86)	14.15 - 14.65
40 (104)	14.00 - 14.50

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

ADJUSTMENT

Voltage regulator

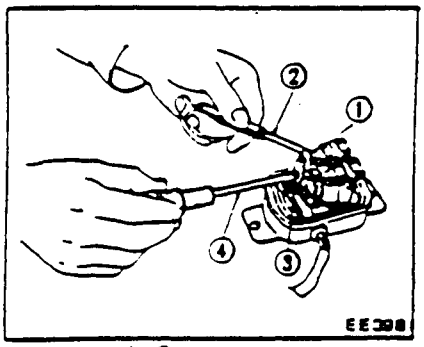
Adjusting regulating voltage



1 Charge relay
2 Voltage regulator

1. Inspect contact surface.
Rough ... Lightly polish with sand paper (#500 or 600).
2. Measure each gap. Adjust core gap and point gap in that order. No adjustment is required for yoke gap.
3. Adjusting core gap
Loosen screw which is used to secure contact set on yoke, and move contact upward or downward properly.

Core gap:
Refer to S.D.S.

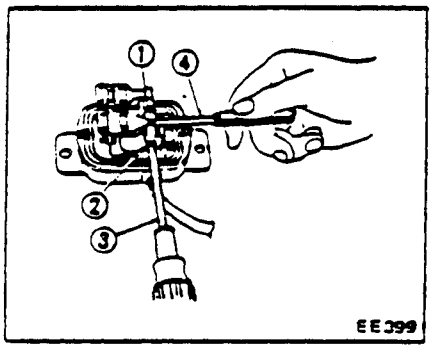


1 Contact set
2 Thickness gauge
3 4 mm (0.16 in) dia. screw
4 Crosshead screwdriver

4. Adjusting point gap

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

Point gap:
Refer to S.D.S.

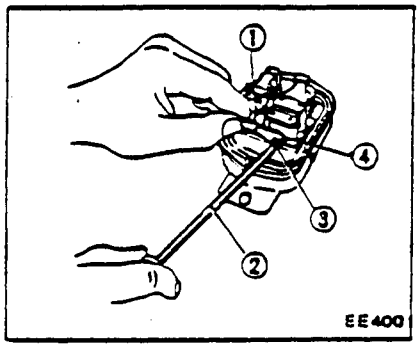


1 Thickness gauge
2 3 mm (0.12 in) dia. screw
3 Crosshead screwdriver
4 Upper contact

5. Adjusting voltage

Adjust regulating voltage as follows:

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

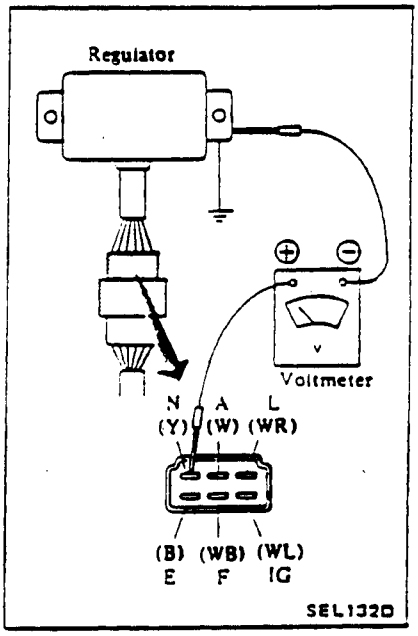


1 Wrench
2 Crosshead screwdriver
3 Adjusting screw
4 Lock nut

Charge relay

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

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



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

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

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

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

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

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

DESCRIPTION

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

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

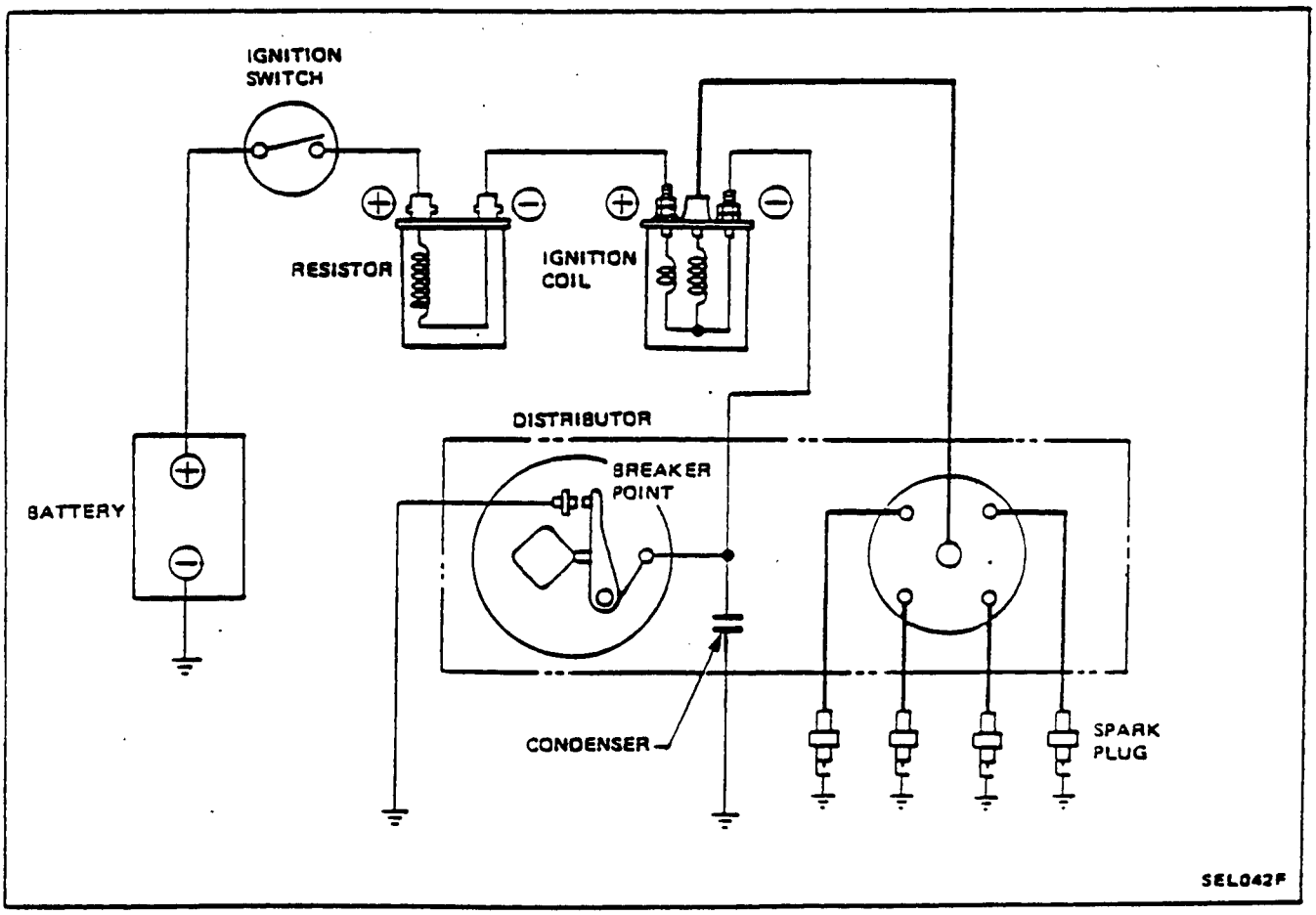
Low voltage current is supplied by the battery or alternator and flows through the primary circuit. It consists of the ignition switch, resistor, primary winding of the ignition coil, distributor contact points, condenser and all connecting low tension wiring.

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

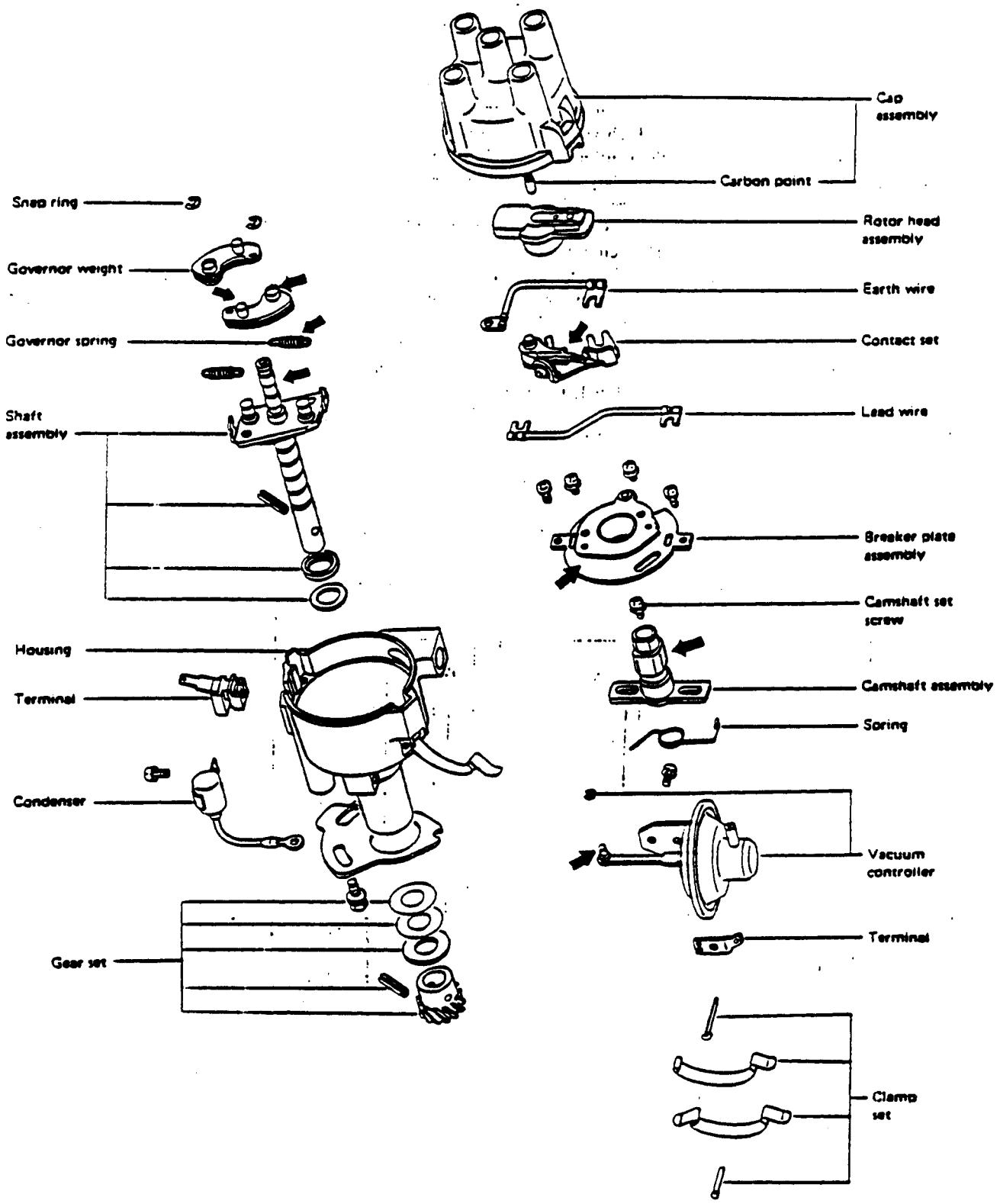
When the ignition switch is turned on and the distributor contact points are closed, the primary current flows through the primary winding of the coil and through the contact points to ground.

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

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



DISTRIBUTOR



CHECKING AND ADJUSTMENT

Cap and rotor head

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

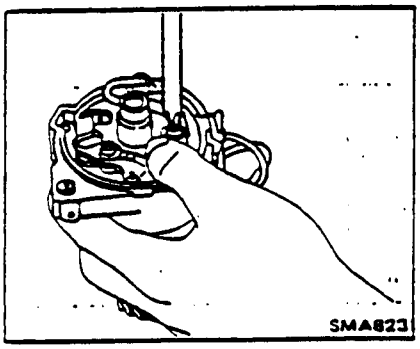
Contact point

1. Check the point surface.

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

2. Adjust point gap.

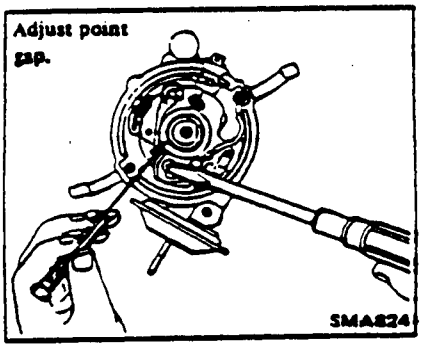
Loosen breaker plate set screws.



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

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

Point gap:
Refer to S.D.S.



Tighten breaker plate set screws.

Condenser

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

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

Condenser capacity:
0.2 - 0.24 μF

Condenser insulation resistance:
More than 5MΩ

Advance mechanism

Specifications

Refer to S.D.S.

Vacuum advance mechanism mechanical parts

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

If leak is found, replace vacuum controller assembly.

3. Inspect breaker plate for smooth moving.

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

Centrifugal advance mechanical parts

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

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

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

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

DISASSEMBLY

Disassemble distributor, noting the following especially.

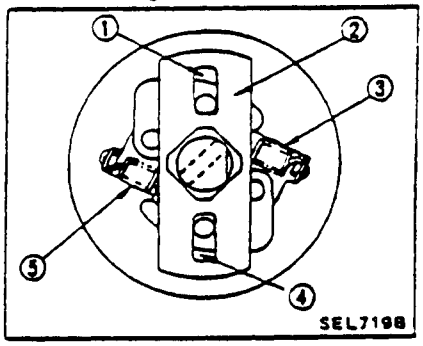
CAUTION:
Put match mark across cam and shaft so that original combination can be restored at assembly.

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

ASSEMBLY

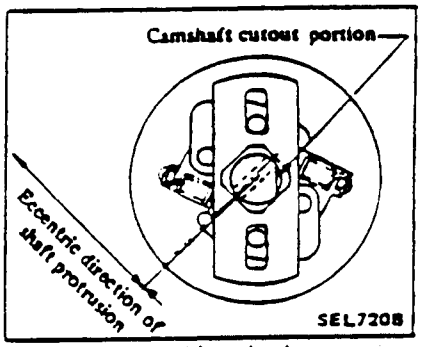
Carefully observe the following instructions.

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



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

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



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

SERVICE DATA AND SPECIFICATIONS

STARTER MOTOR

Model		MITSUBISHI M2T20181
Nominal output	kW	0.8
System voltage	V	12
Weight	kg (lb)	4.2 (9.3)
No load		
Terminal voltage	V	11.5
Current	A	Less than 50
Revolution	rpm	More than 7,400

Minimum length of brush	mm (in)	11.5 (0.45)
Brush spring tension	N (kg, lb)	12.7 - 16.7 (1.3 - 1.7, 2.9 - 3.7)
Outer diameter of commutator	mm (in)	32 (1.26)
Depth of mica		
Wear limit	mm (in)	0.2 (0.008)
Repair accuracy	mm (in)	0.5 - 0.8 (0.020 - 0.031)
Clearance between armature shaft and bearing		
Wear limit	mm (in)	0.2 (0.008)
Repair accuracy	mm (in)	0.03 - 0.10 (0.0012 - 0.0039)
Gap "t" between pinion front edge and pinion stopper	mm (in)	0.5 - 2.0 (0.020 - 0.079)

ALTERNATOR

Model		MITSUBISHI A1T24371
Nominal rating	V-A	12 - 35
Ground polarity		Negative
Minimum revolution under no load (When 14 volts is applied)	rpm	Less than 1,000
Hot output current	A/rpm	More than 27.5/2,500 More than 35/5,000
Pulley ratio		2.25
Minimum length of brush	mm (in)	More than 7 (0.28)
Brush spring pressure	N (g, oz)	3.040 - 4.217 (310 - 430, 10.93 - 15.17)
Slip ring outer diameter	mm (in)	More than 32.4 (1.276)

VOLTAGE REGULATOR

Model		MITSUBISHI RQ8222085
Regulator voltage [at 20°C (68°F)] (With fully charged battery)	V	14.3 - 15.3
Voltage coil resistance [at 20°C (68°F)]	Ω	23.6
Rotor coil inserting resistance [at 20°C (68°F)]	Ω	10
Voltage coil series resistance [at 20°C (68°F)]	Ω	38

Core gap	mm (in)	0.7 - 1.3 (0.028 - 0.051)
Point gap	mm (in)	0.3 - 0.45 (0.012 - 0.018)
Charge relay		
Release voltage at "N" terminal	V	4.2 - 5.2
Voltage coil resistance	Ω	23.6
Core gap	mm (in)	0.9 - 1.4 (0.035 - 0.055)
Point gap	mm (in)	0.7 - 1.1 (0.028 - 0.043)

DISTRIBUTOR

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

IGNITION COIL

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

SPARK PLUG

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

MODEL SD SERIES

FOREWORD

This manual has been prepared to provide the necessary information for the operation, inspection and maintenance of the Nissan Diesel engine.

We strongly recommend that you read this manual throughly and familiarize yourself with the information and procedures contained herein. Only in this way is it possible to ensure proper operation and maintenance, with a minimum of difficulty and with the utmost safety.

This manual is based upon information which is applicable to the standard engine. Should you have any problem understanding the information, please contact the nearest Nissan Diesel Service Station for assistance.

ENGINE SERIAL NUMBER 1

NAMES OF PARTS 1

HANDLING OF VARIOUS DEVICES 2

OPERATION 4

HANDLING UNDER SPECIAL CONDITIONS 7

PRELIMINARY INSPECTION 11

INSPECTION AND MAINTENANCE 13

TROUBLE-SHOOTING 23

TABLE OF PERIODIC INSPECTION ITEMS 27

RECOMMENDED LUBRICANTS, FUEL AND ANTI-FREEZE 30

SYSTEM DIAGRAMS 34

Metric units are used as the unit of measure throughout this manual. When conversion to the corresponding U.S. system is necessary, use the following table:

1 mm	0.0394 in.
1 m	3.2808 ft.
1 km	0.6214 mile

$$t\,(°F) = 32 + \frac{9}{5}\,T\,(°C)$$

1 kg	2.205 lb
1 liter	0.22 Imp. gal.
1 liter	0.264 U.S. gal.
1 kgm	7.23 lb. ft.
1 kg/cm^2	14.223 psi
1 km/h	0.6214 mph.

Nissan Diesel reserves the right to make changes for improvement at any time without notice.
Accordingly, some of the descriptions contained in this manual may not be applicable to your particular vehicle.

Automotive Use	Automotive engine. SD22, SD25, SD33, SD33T
Industrial Use	Engines for construction machinery, and engines as general power units. SD16, SD22, SD25, SD33

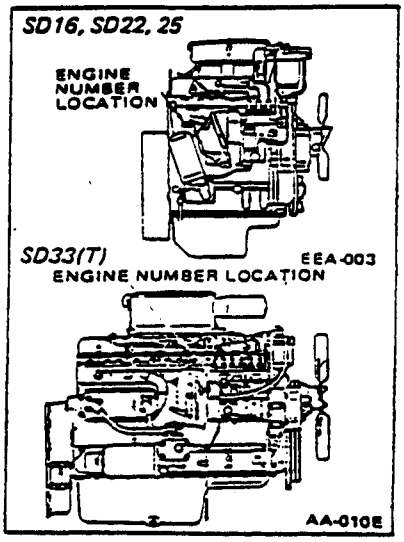
© 1983 NISSAN DIESEL MOTOR CO., LTD.

Issued: June 1983 8306161-56-1,000-S(M)

ENGINE SERIAL NUMBER

The engine serial number given to each engine indicates the type of engine and its manufactured sequence. When ordering parts at the Service Station or asking for repair, this engine serial number should also be given to ensure smooth and quick service.

LOCATION OF ENGINE SERIAL NUMBER



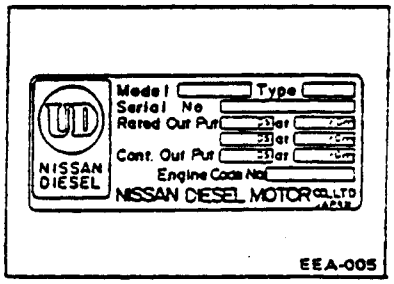
FORMAT OF ENGINE SERIAL NUMBER

SD16 – XXXXXX
SD22 – XXXXXX
SD25 – XXXXXX
SD33 – XXXXXX
SD33 – XXXXXXT

Engine serial number

Engine model designation

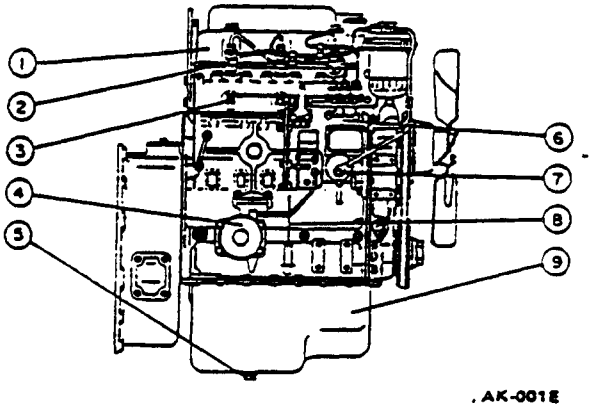
ENGINE NAME PLATE



The engine name plate is attached to the rocker cover, and the engine serial number, engine model and engine performance data are stamped on the plate.

NAMES OF PARTS

MODEL SD16 ENGINE



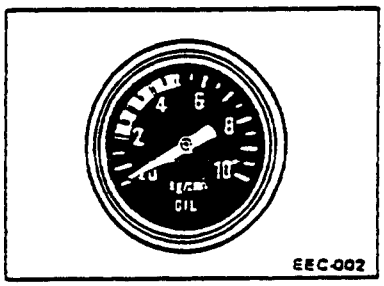
Right-hand side view

1	Rocker cover	6	Fuel injection pump
2	Injection nozzle	7	Feed pump
3	Glow plug	8	Oil level gauge
4	Oil filter	9	Oil pan
5	Drain plug		

HANDLING OF VARIOUS DEVICES

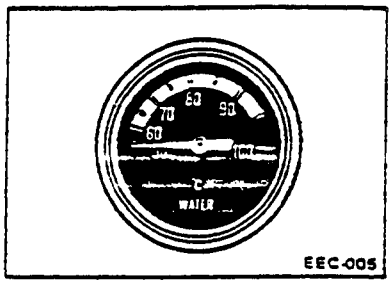
Meters and Gauges (Reference)

OIL PRESSURE GAUGE



The needle pointer indicates the pressure of engine lubricating oil. Normal pressure during engine operation is 2.0 to 5.0 kg/cm^2.

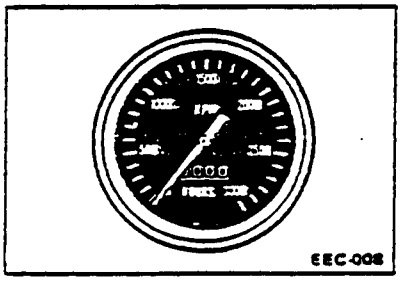
WATER TEMPERATURE GAUGE



The needle pointer indicates the temperature of engine cooling water. Normal temperature during normal engine operation is around 80°C.

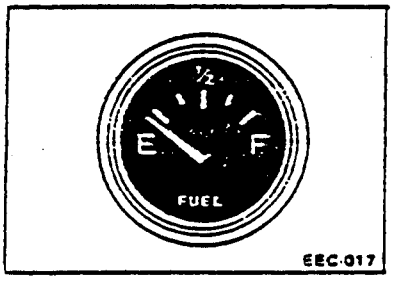
Meters and gauges (Reference) 2
Switches and controls (Reference) 3
Alarm devices (Reference) 3

HOUR METER AND ENGINE TACHOMETER



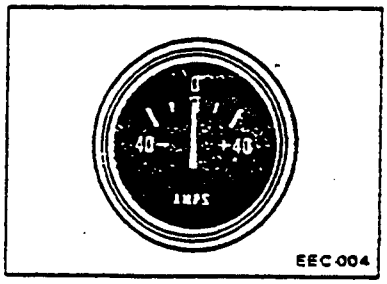
The needle pointer indicates the engine rpm. The engine speed should never exceed the rated rpm.
The hour meter registers the total operating hours of the engine (equivalent to operation at 1,600 rpm).

FUEL GAUGE



The needle pointer indicates the amount of fuel in the fuel tank. Fuel should be added to the tank when the needle approaches the "E" position.

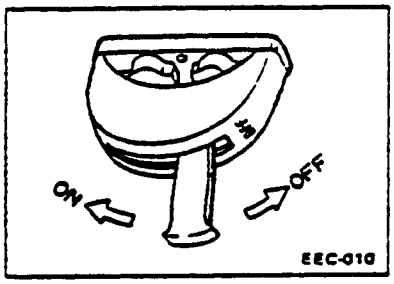
AMMETER



The needle pointer indicates the charge level of the battery. During engine operation, the needle should be on the "0" or to the "+" side of the meter scale.

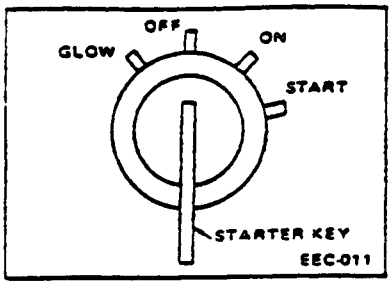
Switches and Controls (Reference)

MAIN SWITCH



The main switch is used to connect and disconnect the circuit between the engine and the battery. Before starting the engine, set this switch at the "ON" position.
During engine operation, never move the switch from the "ON" position; otherwise, electrical units may be damaged.

KEY SWITCH



OFF: Engine stop position
After the engine has stopped, return the key to this "OFF" position. The key can be either inserted or taken out at this position.

ON: Engine operation position
During engine operation, never move the key switch from this "ON" position; otherwise, electrical units may be damaged.

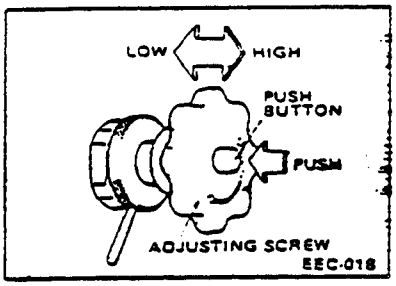
START: Engine starting position
Do not leave the key switch at the "START" position for more than 15 seconds at a time. Wait about 20 seconds before trying to start the engine again.

GLOW: Preheating position
Use this position for starting the engine easily. However, do not use this position for more than 40 seconds at a time, and be sure to wait about 20 seconds, before using it again.

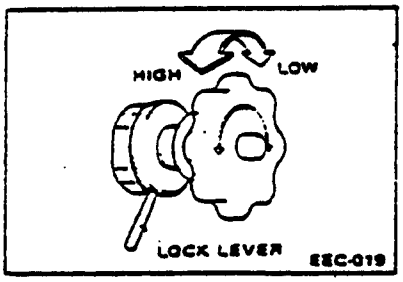
ENGINE CONTROL BUTTON

The engine control button is used to adjust engine rpm and to stop the engine.

Engine rpm adjustment



Approximate adjustment



Precise adjustment

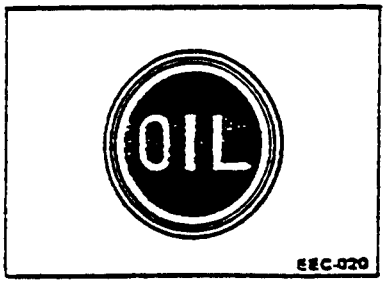
To adjust engine rpm approximately, depress the push button, and then operate the adjusting screw. The adjusting screw will be fixed upon release of the push button.
To adjust engine rpm precisely, simply turn the adjusting screw, without depressing the push button.
The engine control button is fixed when the lock lever is tightened by turning it fully clockwise.

Stopping engine

Release the lock lever by turning it fully counterclockwise, and fully depress the adjusting screw while pushing the push button. This will stop the engine operation.

Alarm Devices (Reference)

OIL PRESSURE WARNING LIGHT



If the lubricating oil pressure drops below the specified level during engine operation, this light lights up to warn the driver of low oil pressure. Do not operate the engine when the lubricating oil pressure is low; otherwise, engine trouble may result.

CHARGE WARNING LIGHT



If any failure occurs in the charging circuit during engine operation, this light lights up as a warning to the driver. If this warning light lights up occasionally or steadily during engine operation, check the charging circuit and make the necessary correction.

OPERATION

Check prior to engine operation (Preliminary inspection) 4
Handling of new engine 4
Engine handling precautions 4
Starting and operating the engine 5
Cautions during operation 5
Stopping the engine and completion of the day's operation 6

ENGINE OIL

Change the engine oil after the first 25 hours of operation or 1,000 km of driving.

Check Prior to Engine Operation (Preliminary Inspection)

In order to prevent engine trouble, the driver must always be aware of the condition of the engine. To this end the driver is required to inspect the engine himself before starting the day's operation. This is called the "Daily inspection".

Engine Handling Precautions

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

WHEN STARTING THE ENGINE

1. After starting up, make sure that the lubricating oil pressure is higher than 0.5 kg/cm^2, or that the "OIL" warning light is OFF.
2. Warm up the engine until it runs smoothly, emitting normal exhaust gases (colorless or light bluish).
3. During this warming up operation, or when the cooling water temperature is still low, never attempt to race the engine.

DURING ENGINE OPERATION

1. During operation, always make sure that the cooling water temperature and lubricating oil pressure are both normal. Normal cooling water temperature is 75 to 80°C.
   Normal oil pressure is over 0.5 kg/cm^2 during idling, and is 2.0 to 5.0 kg/cm^2 during normal operation. Oil pressure is normal if the "OIL" warning light remains OFF during engine operation.

Handling of New Engine

The life and performance of an engine are greatly influenced by how it is handled and serviced during the initial period.
Operate the engine by observing the following the precautions during the initial 100 hours of operation, or initial 4,000 km of driving.

CAUTIONS IN OPERATION

1. After starting, warm the engine throughly by means of warming-up operation until the cooling water temperature rises above 50°C.
2. Never attempt to race the engine under non-loaded conditions.
3. Avoid sudden starts and sudden stops. (Automotive engine only)
4. Never overload the engine. (Automotive engine only)
   Note that overloading will shorten the service life of an engine.
5. Always maintain the operating speed of the engine below 70% of the maximum engine rpm.
6. Avoid overloading. (Engines for construction machinery, and engines as general power units)

2. Always be aware of the condition of the engine, paying attention to any abnormal vibration, noise or other unusual circumstances. If any abnormality is found, immediately stop the operation, examine the cause, and make the necessary correction.

WHEN STOPPING THE ENGINE

Upon completion of operation, idle the engine for some time to lower its temperature before stopping. This procedure will help to extend the engine life.
Note that stopping the engine immediately after high speed driving or heavily loaded operation will deteriorate the engine because it is still in an overheated state.

OTHERS

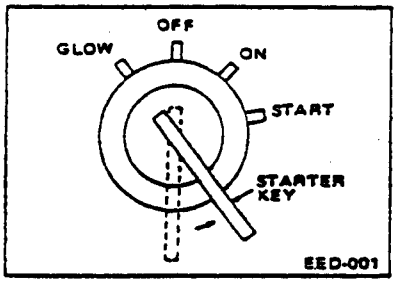
Perform periodical inspection and replacement of the following items:
Engine oil, oil filter element, air cleaner element, fuel filter element.
Use the recommended API service class CD engine oil. Use genuine Nissan Diesel parts for the cleaner and filter element.

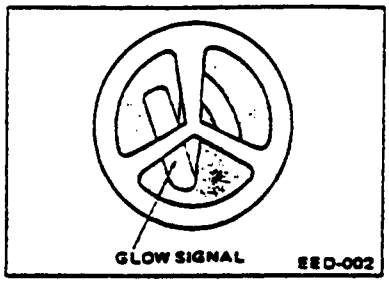
Starting and Operating the Engine

STARTING PROCEDURE

1. Insert the engine key into the key switch.
2. Set the main switch at the "ON" position.
3. Turn the key switch to the "GLOW" position to preheat the glow plug.

The glow plug indicator will turn red in 10 to 15 seconds indicating that the glow plug is already heated.
Note that prolonged use of the glow plug for more than 40 seconds may burn out the heater wire in the plug.





4. During this preheating operation, pull the adjusting screw of the engine control button all the way out while pushing the button.
5. When the glow plug indicator has turned red, set the engine key at the "START" position.

1. **Do not hold the engine key in the "START" position for more than 15 seconds at a time. Holding this position too long may shorten the life of the battery, or damage the starting motor.**
2. **Be sure to wait about 20 seconds before trying again.**

6. When starting, release the engine key, and return the adjusting screw to its original position.
7. Turn the adjusting screw to adjust engine idling speed, and to perform warming-up operation.
   In this case set the engine speed slightly higher, and readjust the speed after the warming-up operation is over. Never race the engine during this warming-up period.

Cautions During Operation

During engine operation, the warning light should remain OFF. If it comes ON, immediately stop operation, and take the actions that are described below.
If any other abnormalities such as unusual noise, vibration, or shocks are observed, again, stop the operation, and make the necessary inspection and repair.

LOW ENGINE OIL PRESSURE

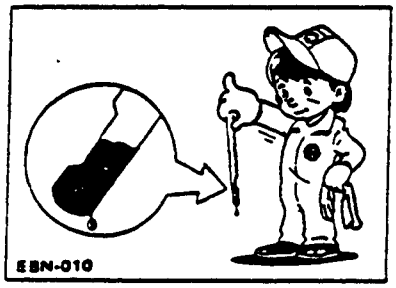
Oil pressure warning light is ON, or oil pressure gauge indication is below 0.5 kg/cm^2.

Trouble

The oil pressure is low due to failure in the engine lubricating system. If operation is continued, the engine's moving parts may be seized, resulting in a disabled engine.

Corrective action

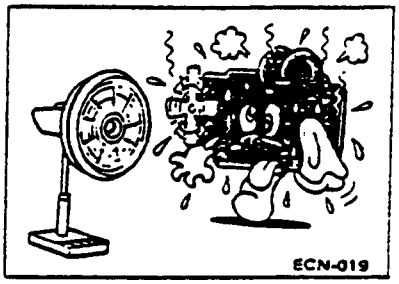
1. Immediately stop the engine operation.
2. Check each portion of the engine for any sign of an oil leak. If any oil leak is found, examine the cause and make the necessary correction.
3. Check the engine oil level after the engine has been stopped for at least 30 minutes.
   If the oil level is below the "L" mark on the oil level gauge, add engine oil up to the "H" mark.



4. If no oil leak is detected and the oil level is normal, something else is causing the trouble. Have the engine checked and repaired by the Service Station.

ENGINE OVERHEATING

Water temperature gauge is pointing to around 100°C, and the temperature not lower quickly.



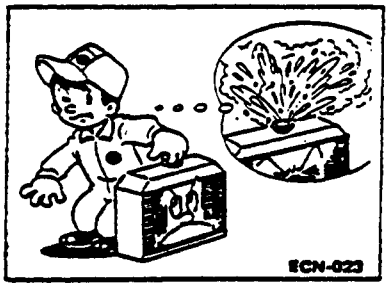
Trouble

The engine is overheated due to failure of the cooling system. Continued engine operation will lead to seizure in each portion of the engine, finally disabling the engine.

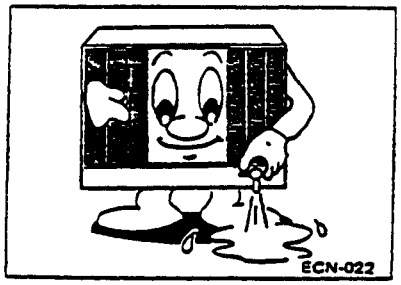
Corrective action

1. Immediately stop whatever operation is being performed. In this case do not stop the engine; run the engine at high idle until the water temperature comes down.

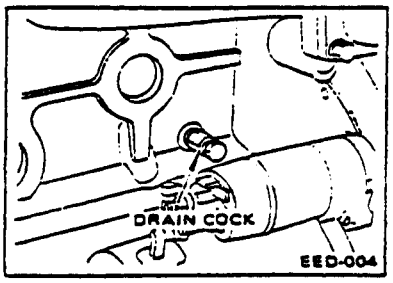
2. Check each portion of the engine and the radiator for any sign of a water leak.
3. Using a cloth to avoid the danger of being burned by hot steam, slightly loosen the radiator cap to release pressure in the radiator. After the pressure has been released and a hissing sound can no longer be heard, remove the cap.
1. **Do not remove the radiator cap without first releasing the pressure inside the radiator, because scalding water and steam will spout out, possibly causing serious injury.**
2. **If the cap is provided with a pressure releasing push button, be sure to depress it and release the pressure before removing the cap.**



4. If the cooling water level is up to the filler neck of the radiator and no water leak is detected, have the engine checked and repaired by the Service Station.
   If the cooling water level is too low, slightly open the drain valve of the radiator or engine while carefully adding new cooling water so that the change in cooling water will be gradual. By using this method, gradually lower the engine temperature.



Radiator



Left side view of cylinder block

Be sure to continue the idling operation of the engine when adding new cooling water, because sudden addition of cold water into an overheated engine when it is stopped will cause great stress in the engine, leading to a cracked cylinder block.

5. After the temperature has lowered, checked for faulty parts. If the cause is not found or if repair is impossible, have the engine checked and repaired by the Service Station.

Stopping the Engine and Completion of the Day's Operation

STOPPING THE ENGINE

When operation of the engine is over, run the engine at idling speed to lower the engine temperature before stopping.

1. Using the engine control button, stop the engine.
2. Return the key switch to the "OFF" position.
3. Return the main switch to the "OFF" position.

AT COMPLETION OF THE DAY'S OPERATIONS

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

HANDLING UNDER SPECIAL CONDITIONS

Care in hot weather 7
Care in cold weather 7
Flushing of cooling system 8
Operating under adverse conditions 9
Precedures for preparing the engine when it will be out of operation for an extended time 9

Care in Hot Weather

In hot weather engine overheating may occur easily due to fast evaporation of water. Take the following precaution's to prevent engine overheating:

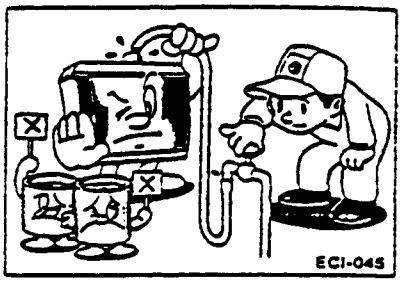
COOLING WATER

Make sure that the cooling system is filled with clean water. Insufficient water and formation of scale can cause overheating.

Scale and rust may be easily formed in the cooling water passage of the radiator and engine when the atmospheric temperature is high. To prevent clogging, change the cooling water from time to time so that clean water flows through the passage. Accumulation of dirt, dust, or mud on the front portion of the radiator and core obstructs the normal flow of air, causing a reduction in cooling efficiency. Always keep the radiator and core clean.

Be sure to use clean, soft water such as processed city water when adding cooling water to the radiator. Do not use hard water such as well water or river water because such water can easily form scale.

If cooling water is contaminated due to formation of scale or rust, flush out the cooling water passage.



LUBRICATING OIL

The viscosity of engine oil lowers when atmospheric temperature increases and this decreases the lubricating effect. Use engine oil which has higher viscosity and suits the atmospheric temperature condition.

BATTERY

Insufficiency battery electrolyte will result in damaged plates. Keep the electrolyte at the specified level (10 to 15 mm above the plate), and maintain the specific gravity of electrolyte within the specified range (1.250 to 1.270 at electrolyte temperature 20°C).

V-BELT

Always maintain the proper tension on the V-belt.

OTHERS

Check each portion of the engine, and take the necessary precautions to protect it against high temperatures.

Care in Cold Weather

Low temperatures may cause a loss of engine power when starting and difficulty in starting the engine due to decreased battery capacity, as well as other problems. When the temperature falls below 0°C, the engine and radiator may suffer damage resulting from frozen cooling water, and the battery case may be damaged by frozen electrolyte. To avoid such troubles, be sure to take the following precautions:

COOLING WATER

When antifreeze is not used

After completion of the day's operations, open the drain valve and throughly drain the cooling water. This will prevent frozen water in the cooling system from obstructing normal feeding of water, which in extreme situations can cause damage to the engine and radiator. Before beginning the next day's operations, fill the water and run the engine until the cooling water level stabilizes at the specified level. After the level is stablized, bleed air from the cooling system.

When using antifreeze

The above described procedure will be unnecessary if antifreeze is used in the cooling system.

Flush the cooling system, and pour in the amount of antifreeze recommended by Nissan Diesel.

Precautions for handling antifreeze solution

General precautions on the use of antifreeze are set forth below: When using a recommended brand of antifreeze, always follow the manufacturer's instructions.

1. Limit the use of antifreeze to the winter only. After winter is over, drain the coolant from the cooling system, and flush it thoroughly before adding fresh water and an anti-rust agent.
2. If the coolant level is lowered naturally while antifreeze is being used, add undiluted antifreeze or 50% diluted solution of antifreeze.
3. The antifreeze mixture ratio must be 45 to 60%. Excessively thin or thick mixture will reduce the antifreeze's effect and also reduce its rust and

corrosion prevention powers.

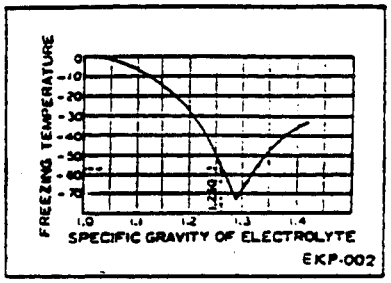
4. Always use city water or other soft water to mix the antifreeze solution.
5. Do not mix different brands of antifreeze because they each contain special additives. Careless mixing often diminishes the effect of these additives.
6. Be sure to flush the interior of the cooling system thoroughly before and after antifreeze is used.
7. Before using any antifreeze, carefully check the engine, radiator and hoses for any sign of water leakage.
8. Do not use antifreeze that has already been used once.

LUBRICATING OIL

The viscosity of engine oil increases as the atmospheric temperature lowers, causing low engine speed when the engine is started. To prevent such trouble, use engine oil which has lower viscosity relative to atmospheric temperature.

BATTERY

Main tain the specific gravity of battery electrolyte within the specified range (1.250 to 1.270 at electrolyte temperature of 20°C). Since a low electrolyte temperature may cause difficut starting due to reducted charge or damage the battery as a result of frozen electrolyte, keep the battery warm in very cold weather.



Relation between specific gravity of electrolyte and freezing temperature

FUEL TANK

To minimize water in the air inside the tank, when adding fuel, it is recommended that the fuel tank be completely filled. This practice will prevent freezing and formation of rust in the fuel system which is caused by the condensation of water. Securely tighten the fuel tank cap to prevent a rainwater and snow from entering the tank.

OTHERS

When the engine is extremely cold, it takes a considerable time to raise the cooling water to the proper temperature (75 to 85°C). In such event, to more effectively raise the temperature of the cooling water, place a cover on the front face of the radiator. While operating the engine with the radiator cover attached, observe the water temperature gauge, and remove the cover when the proper temperature is attained.

If it is necessary to leave the engine exposed to the open air, place it in a sheltered location out of the rain and snow, and cover it with a suitable sheet or similar covering.

Flushing of Cooling System

Flush the interior of the cooling system before and after antifreeze is used or whenever any heavy contamination in the coolant is noticed. In addition, flush the system every six months. Flushing removes water scale and fat from the cooling system, and restores its original cooling efficiency, which greatly reduces the possibility of the engine overheating.

FLUSHING PROCEDURE

The cooling system must be flushed when the coolant temperature is higher than 80°C and the engine is run at high idle. If the water temperature is too low, the thermostat will remain closed, and the flushing agent will not circulate in the radiator, so no flushing effect will occur. It is also necessary to keep the heater inlet valves (both on the engine and the heater proper) open.

1. Drain the cooling water from each water drain cock completely.
2. Close the drain cock, and pour city water and flushing agent into the radiator.
3. Run the engine at high idling speed (refer to the flushing agent manufacturer's instructions). Cover the front end of the radiator to prevent the temperature of the fluid in the cooling system from dropping. Observe the fluid level carefully for five minutes after starting the engine. If it lowers, add city water.
4. After flushing, stop the engine, and thoroughly drain the fluid from each drain cock.
5. Close the drain cocks, and add fresh city water. Start the engine and run it at high idle until the water temperature goes above 80°C. Then stop the engine, and drain the water from the drain cocks once again.
   Repeat this operation two or more times, until only clean water is discharged from the drain cocks. Dirty or colored water from the drain cocks means that fat or scale is still in the cooling system.
6. After completing the flushing operation, close each drain cock securely, and add fresh city water up to the

specified level. Then start the engine, and purge the air from the system until the coolant level is stabilized at the specified position. If the coolant level lowers during this operation, add fresh city water.

Operating Under Adverse Conditions

WHEN USING THE ENGINE EITHER IN MUDDY AREAS, RAIN OR SNOW

Upon completion of preliminary inspection, insure that all the drain plugs and drain valves are tightened securely. After completing the day's operation, check the engine oil and fuel for water; if they contain any amount of water, change the oil or fuel.

WHEN USING IN DUSTY AREAS

Use special care to prevent dust from entering either the lubricating oil or any portion of the engine. (Dust is particularly harmful to electrical units such as the generator and starting motor).
To extend the service life of the engine, observe the following procedures:

1. Check the air cleaner every 100 hours or every 4,000 km. Since contamination is heavier, reduce the replacement interval.
2. Also reduce the checking and replacing interval for the fuel filter and oil filter elements.
3. Cover or plug all the oil filter holes and grease fittings. Also clean the breather pipe on a regular basis.
4. Securely attach the covers of the starting motor and generator.
   Please note that the accumulation of dust on the brush may lead to low engine output, or other troubles.
5. To prevent a reduction in cooling efficiency, occasionally clean the radiator core and remove dirt and dust.

Procedures for Preparing the Engine When It Will Be Out of Operation for an Extended Time

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

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

During in-use period

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

During out-of-use period

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

1. Perform non-loaded engine operation once a week.
   - Conduct checks prescribed in the "daily inspection" before starting the engine.
   - Start the engine, and idle it for about 30 seconds. Make sure that the lubricating oil pressure is over 0.5 kg/cm^2.
   - Slowly raise the engine rpm to the rated rpm, and run the engine at this speed for about 10 minutes. Make sure that no abnormal noise or vibration is produced, and that the lubricating oil pressure remains at the specified level (2.0 to 5.0 kg/cm^2).
   - Operate the engine at idling speed for some time before stopping it.
2. Perform loaded operation once a month.
   - Run the engine and perform checks set forth in item 1 above.
   - Apply a load in excess of 50% of the rated load to the engine, and operate it for more than 10 minutes. Make sure that no abnormal noise or vibration is produced, and that the lubricating oil pressure and cooling water temperature are all normal.

   Oil pressure gauge:
   2.0 to 5.0 kg/cm^2
   Water temperature gauge:
   50 to 80°C
   Ammeter:
   Pointer on charge (+) side
3. Perform the following inspection and adjustment before placing the engine into operation.
   - Drain sediment from the fuel system (fuel filter and fuel tank).
   - Change engine oil and oil filter element.
   - Check and adjust valve clearance.
   - Check and adjust fan belt tension.
   - Check battery electrolyte level and specific gravity.
   - Change air cleaner element.

PROCEDURES FOR PLACING THE ENGINE IN LONG-TERM STORAGE

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

Lubricating system

Drain the engine oil, pour the specified amount of rust preventive oil equivalent to P-10 into the oil pan, and then run the engine under no load at approximately 1,500 rpm for about 10 minutes. Stop the engine, and seal all the openings of the lubricating system (such as oil filler, level gauge, breather, etc.) with sealing tape.

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

Fuel system

Drain fuel from the fuel system, and pour the mixed fuel (the ratio of fuel to rust preventing oil equivalent to P-9 should be 1 : 1) into the fuel tank. Operate the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, drain the mixed fuel, and then seal all of the openings in the fuel system (such as the breather of the fuel tank) with sealing tape.

Cooling system

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

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

Combustion chamber

After completing the rust preventive procedure, allow the engine temperature to drop to room temperature. Then disconnect the air cleaner from the intake manifold, and spray or pour rust preventing oil P-10 or its equivalent into the combustion chamber. Next, turn the engine control button to the "STOP" position, and crank the engine five to ten times.

Engine exterior

Using a petroleum solvent, remove dirt and oil from the uncoated metal surfaces of the engine (injection pump, fuel tube, oil cooler, intake manifold, exhaust manifold, rocker cover, V-belt groove of pulleys, etc.). Spray or apply anti-rust agent P-1, P-19 or their equivalent to the cleaned surfaced. Do not apply any type mineral or vegetable oil to the V-belt groove of the pulley.

Others

1. Remove the V-belt or keep it loosened.
2. Seal the air intake hole of the air cleaner and air outlet hole of the exhaust tube with adhesive tape.
3. Wrap the open type generator with a porous bag, and fasten the bag with a rubber band or similar item.
4. If the engine is equipped with a clutch, spray an evaporative anti-rust agent into the clutch housing, and seal the opening with adhesive tape.
5. When storing the engine as a completement outdoors, cover it fully with a porous water-proof sheet.
   Do not use a vinyl sheet, because it lacks porosity and retains water inside.

Preparations for operation after long-term storage

1. Remove all adhesive sealing tapes from the openings of the engine.
2. Drain the rust preventing oil and anti-rust agent by using the following procedure, and replace it with the specified amont of engine oil, fuel and cooling water.

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

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

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

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

3. Replace the elements of the oil filter, the air cleaner and the fuel filter with new ones.
4. Adjust the V-belt for proper tension.
5. Check and adjust valve clearance. Apply engine oil to the rocker arm and other valve mechanism.
6. Set the engine control button at the "STOP" position, and crank the engine for about 10 seconds. Repeat this cranking operation two or three times in order to disperse engine oil to every portion of the engine.
7. Start the engine, and let it idle for about 5 minutes. Make sure that the lubricating oil pressure is above 0.5 kg/cm^2.
8. Gradually increase the engine speed to the rated rpm, and run the engine for about 10 minutes under no load. Make sure that the lubricating oil pressure and cooling water temperature are normal, and that the engine does not produced any abnormal vibration or noise.

PRELIMINARY INSPECTION

In order to prevent trouble in daily operation, it is necessary that the operator be constantly aware of the condition of the engine. To achieve this awareness, the operator must personally inspect the engine before starting the day's activities. This inspection is called "Daily inspection".
Take the following precautions before commencing the daily inspection. (These precautions should also be confirmed before starting operation.)

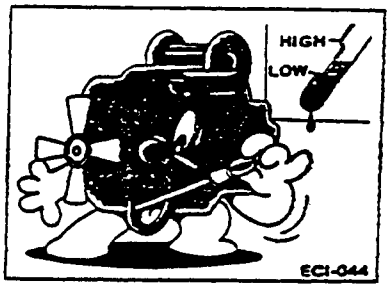
1. Insure that the vehicle or engine is placed on a level surface.
2. Be sure that the key switch is at the "OFF" position.
3. Make sure that the main switch is also set at "OFF".
4. Insure that the parking brake lever is applied.
5. Make sure that the transmission gear selector lever is set at "NEUTRAL".

Inspection items prior to engine start..... 11
Inspection items after engine start..... 12

Inspection Items Prior to Engine Start

CHECK ENGINE OIL LEVEL

1. Pull out the oil level gauge, wipe oil from the gauge surface, and insert the gauge into its original position. After several seconds, carefully pull it out, and read the oil level on the gauge.
   The oil level is correct if it is found to be between the "H" mark and the "L" mark on the gauge. If the oil level is lower than the "L" mark position, add the specified quality of engine oil in an amount sufficient to raise the level to the "H" level.

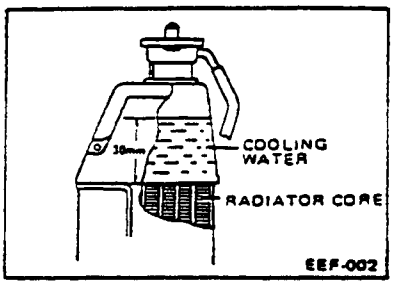


2. Inspect the oil adhering to the level gauge and examine it to see whether the oil is contaminated or if it contains foreign matter such as fuel or water. If it is determined to be faulty, replace the engine oil.

1. Always check the oil level before starting the engine.
2. Use the engine oil recommended by Nissan Diesel.
3. Do not add engine oil to exceed the "H" mark position.

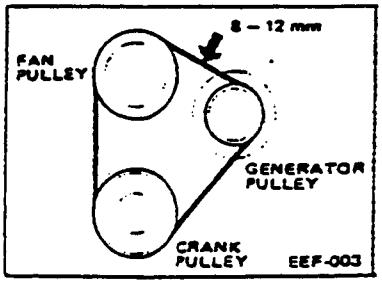
CHECK COOLING WATER LEVEL

Remove the radiator cap, and check the cooling water level. Also check the cap and determine if it functions correctly.
The cooling water level is correct if it is near to the filler neck of radiator. Insufficient water level may be caused by leakage from the engine or radiator. Check carefully for any sign of leakage; if no leaks are discovered, add water to the filler neck portion.
If cooling water is dirty, flush the cooling system.
When replacing the radiator cap, be sure to fit it securely. If replaced loosely or improperly, the cooling water will quickly evaporate, causing the engine to overheat.



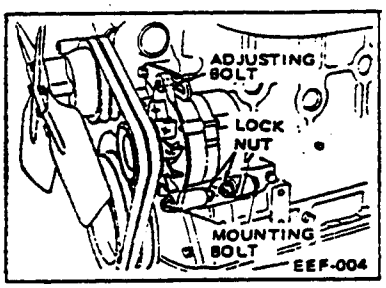
CHECK V-BELT TENSION

1. To check the V-belt tension, push the V-belt at a point located midway between the fan pulley and generator pulley, applying a force of approximately 10 kg.



If the belt tension is insufficient, the cooling fan, water pump and generator cannot be driven with enough power. Engine overheating and insufficient charging of the battery will result. On the other hand, too much belt tension can cause damage to the pulleys as well as the belt.

2. If the belt tension is incorrect, adjust it using the following procedure. Remember to recheck the tension after completing the adjustment.
   Loosen the generator upper adjusting bolt and the lock nut on the lower mounting bolt. Then move the generator either toward or away from the engine, until the belt can be depressed about 8 to 12 mm when it is pushed at the midway point using a force of 10 kg. Then, tighten the adjusting bolt.
   Finally, tighten the lock nut.



CHECKING METERS, GAUGES AND THE WARNING DEVICE

With the main switch and key switch set at "ON", perform the following checks:

1. The fuel gauge reads normal if the pointer indicates somewhere between "E" and "F" on the scale.
2. The oil pressure warning device indicates normal if the warning light is ON.

CHECKING AMOUNT OF FUEL

By looking at the fuel gauge, determine whether or not the fuel tank is filled.

Inspection Items after Engine Start

After the engine has been started, perform the folloing checks:

CHECKING METERS, GAUGES AND WARNING DEVICE

1. The lubrication system and alarm device are functioning normally if the needle pointer of the oil pressure gauge indicates over 0.5 kg/cm^2, and the oil pressure warning light is "OFF".
2. The charging circuit is functioning normally if the needle pointer of the ammeter points either at "0" or to the (+) side, and deflects toward the (+) side when the engine rpm is gradually increased.
   The charge light (charge warning light), if the engine is so equipped, sould remain OFF when the charging circuit is functioning normally.
3. The water temperature gauge reads normal if the pointer indicates around 50°C.

CHECKING THE ENGINE FOR LEAKAGE

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

CHECKING ENGINE EXHAUST SMOKE

After completing the warming up procedures for the engine, observe the color of exhaust smoke, and check its state of combustion.

- Colorless or light bluish smoke:
  Normal:
  Complete combustion
- Black smoke:
  Abnormal:
  Incomplete combustion
- Whitish smoke
  Abnormal:
  Engine is also burning.

Also check the engine for abnormal noise or vibration.

CHECKING THE ENGINE OPERATION DURING BOTH IDLING AND ACCELERATION

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

OTHERS

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

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

INSPECTION AND MAINTENANCE

Periodic inspection and service will extend the life of an engine, and assure the maximum efficiency of its opeation.
After completing inspection and adjustment work, make sure that waste cloth, tools or any other foreign materials are not left on or near the engine. Remember that any flammable matter left on the engine (particularly near the exhaust manifold) can cause a fire.

Engine proper 13
Fuel system 14
Air cleaner 16
Lubricating system 18
Cooling system 19
Electrical system 20
Others 22

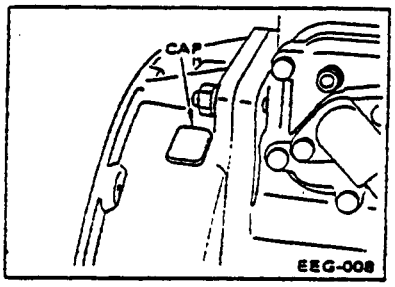
Engine Proper

VALVE CLEARANCE

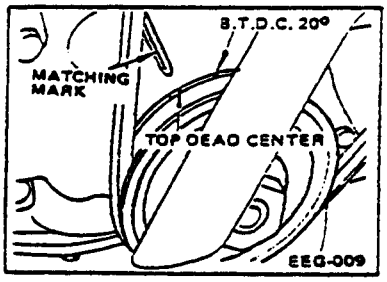
Inspection Interval
Initial inspection:
25 hours or 1,000 km
Subsequent inspections:
Every 300 hours or 12,000 km

Standard clearance
0.3 mm or over; GO
0.4 mm; NO GO

Inspection procedure
1. Remove the air cleaner and rocker cover.
2. Remove the cover from the top of the flywheel housing.

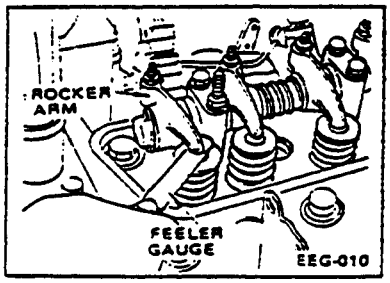


3. Using a bar, turn the flywheel in the normal direction (counterclockwise as viewed from the flywheel side), and align the TDC mark of the torsional damper (crank pulley for SD16 type) with the mark line provided on the gear case. If the TDC mark is mistakenly moved beyond the mark line, return the flywheel, and try again to obtain the correct alignment. This position indicates that the piston in the No. 1 cylinder is at the TDC position.
Note that the TDC position occurs twise in one cycle of piston operation, once during the compression stroke and once during the exhaust stroke. Inspection and adjustment of valve clearance should be performed when both the intake and exhaust valves are closed, that is, when play can be felt on both push rods.



4. Check the clearance between the valve stem and rocker arm using a feeler gauge. The valve clearance is correct if the 0.3 mm gauge fits and the 0.4 mm gauge does not fit. When the No. 1 cylinder is in the TDC position in compression stroke, the valves with the "○" mark as indicated in the following table, can be checked for clearance.
When the No. 1 cylinder is in the TDC position during exhaust stroke, the valves with the "●" mark, as indicated in the table, can be checked.

The cylinders and valves are numbered 1, 2, 3, . . starting from the one on the end nearest the cooling fan.



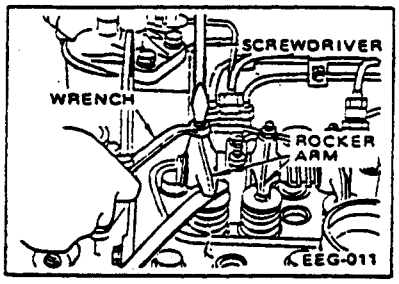
5. If the valve clearance is incorrect, adjust it to the standard clearance by referring to the "Adjustment procedure", below.

Engine Type	Cylinder No.	1		2		3		4		5		6	
	Valve No.	1	2	3	4	5	6	7	8	9	10	11	12
		Ex	In	In	Ex	Ex	In	In	Ex	Ex	In	In	Ex
SD33, SD33T	No. 1 compression TDC	o	o		o		o		o		o		
	No. 1 exhaust TDC			•		•		•		•		•	•
SD22, SD25	No. 1 compression TDC	o	o	o		o							
	No. 1 exhaust TDC				•		•	•	•				

Engine Type	Cylinder No.	1		2		3	
	Valve No.	1	2	3	4	5	6
		In	Ex	Ex	In	In	Ex
SD16	No. 1 compression TDC	o	o		o		o
	No. 1 exhaust TDC			•		•	

Adjustment procedure

1. Loosen the lock nut on the adjusting screw.
2. Insert the 0.3 mm gauge into the clearance between the valve stem and rocker arm.
3. Rotate the adjusting screw until some resistance is felt when you slide the feeler gauge; then tighten the lock nut. In this procedure, hold the adjusting screw at the adjusted position with a screwdriver so that it will not rotate along with the lock nut.



4. Upon completing the adjustment, turn the flywheel two or three turns in the normal direction of the engine, and check the valve clearance again to insure that the standard clearance has been attained.

CRANKSHAFT DAMPER (Model SD33 and 33T)

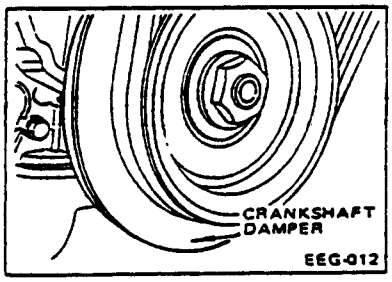
Inspection interval

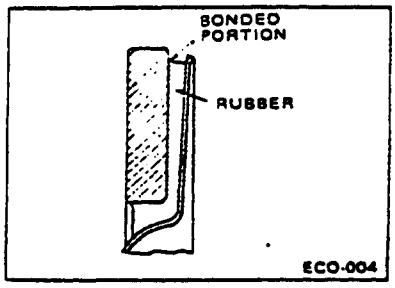
Periodic inspection:

Every 1,200 hours or 48,000 km

Inspection procedure

Inspect the rubber adhering to the crankshaft damper for cracking or separation from the damper. If either adhesion is poor or there is any crack in the circumferential direction, replace the damper. Be careful not to mistake peeling paint for a crack. If the V-belt frequently comes off during operation, suspect a problem with the damper.

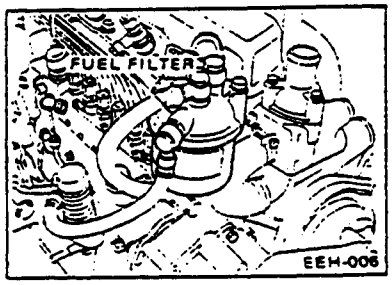




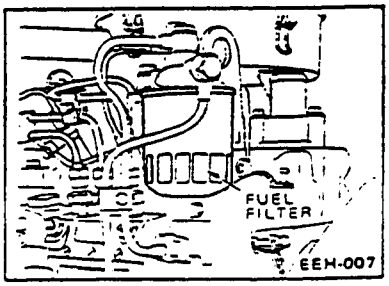
Fuel System

FUEL FILTER

The fuel filter, located on the right side of engine, uses a paper type filteer element. Periodically clean and replace the element.



Center bolt type filter



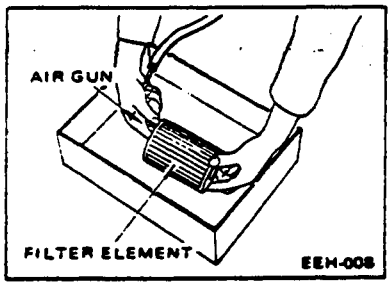
Cartridge type filter

Inspection and replacement intervals
Inspection:
Every 300 hours or 12,000 km
Replacement:
Every 600 hours or 24,000 km

Inspection is not required on the models SD16, 22 and 25.

Inspection and replacement procedure: Models SD33 and SD33T

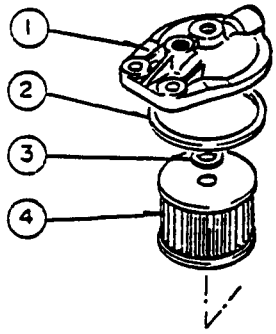
1. Place a receptacle to receive fuel under the filter, remove the drain plug, and drain fuel and sediment. If water or dirt are frequently found in the filter, clean the tank and take action to discover the cause.
2. Loosen the center bolt located at the bottom of filter case. Remove the elements, packings, springs, and case from the body.
3. Check the element for clogging and contamination. If the element is clogged or heavily contaminated, replace the element immediately, even if it is before the normal replacement period.
4. Clean each part of the filter using a clean light oil.
5. Clean the element by closing one hole of the element with a finger, and applying compressed air of 1.5 to 2.0 kg/cm^2 to the other hole, blowing off dirt which has become attached to the outside of the element. Change holes and repeat the cleaning process.
   Next, close both holes with fingers so as to prevent entrance of dirt into the inside of element, and wash the element in light oil by shaking it.

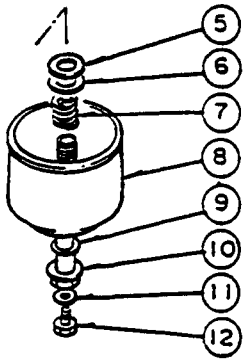


6. Reassemble the parts, being careful not to incorrectly install the packings.

Replace the gasket each time it is removed.

7. After completing assembly, be sure to bleed the air from the fuel system.





1	Filter cover	7	Set spring
2	Packing	8	Filter case
3	Packing	9	Packing
4	Element	10	Center bolt
5	Packing	11	Packing
6	Spring seat	12	Drain plug

Replacement procedure: Models SD16, 22 and 25

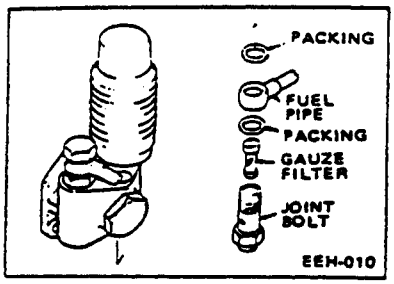
1. Remove the filter case and cartridge element together, and replace the element with a new one.
2. When installing the filter, apply a thin coat of light oil to the "O" ring fitting portion of the filter.
3. Tighten the filter by hand only. After the "O" ring contacts the filter bracket, tighten it another 2/3 turn.
4. Upon completing the installation, bleed air from the fuel system.

FUEL FEED PUMP

The gauze filter is attached to the fuel suction side of the feed pump. Clean the filter periodically.

Cleaning interval
Cleaning of filter:
Every 600 hours or 24,000 km

Cleaning procedure

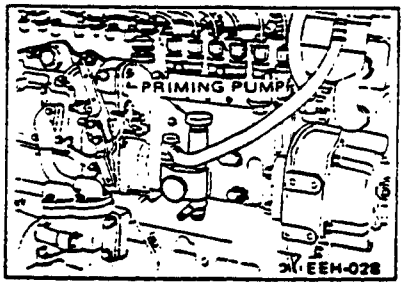


1. Place a receptacle under the feed pump, and drain the fuel by loosening the joint bolt. Remove the bolt being careful not to lose the gasket.
2. Remove the gauze filter from the joint bolt, and wash it with clean light oil.
3. To reassemble, reverse the disassembly procedure.
   Be sure to fit a packing on both the upper and the lower side of the fuel pipe.
4. After reassembling, bleed air from the fuel system.

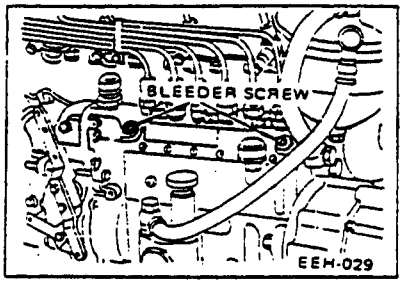
AIR BLEEDING PROCEDURE

Air in the fuel line will result in poor fuel injection, and difficult starting, insufficient engine output or the engine stopping entirely. To prevent such difficulties, be sure to bleed air from the fuel line after the filter element has been checked or replaced, or when the fuel pipe has been reconnected.

1. Remove the priming pump cover of the injection pump, and turn the knob counterclockwise. This will automatically cause the knob to lift up.



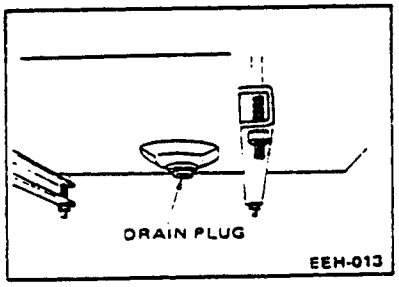
2. Move the knob up and down. Fuel will be sucked up from the tank and retained in the filter.
   Slightly loosen the injection pump bleeder screw, and continue operation of the priming pump until no bubbles are contained in the fuel coming out of the bleeder.
   There are two bleeders, and bleeding operation must be conducted using each of them, separately.



3. After conducting air bleeding operation, sequre the priming pump knob to its original position and put the cover on.

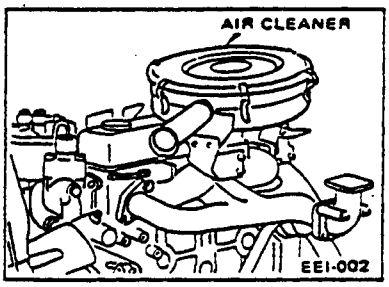
FUEL TANK

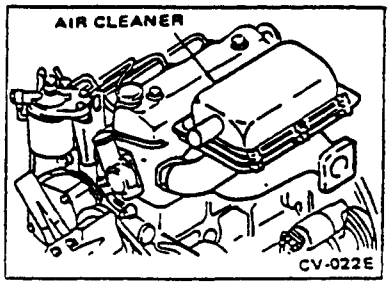
Drain sediment in the fuel tank every 600 hours or 24,000 km. However if water, dirt or other foreign matter is found in the fuel filter, perform this draining operation. To drain sediment, remove the drain plug which is located at the bottom of the fuel tank.



Air Cleaner

The air cleaner uses a paper type filter element.





Inspection and replacement intervals

Inspection and cleaning:

- Every 200 hours or 8,000 km (In dusty area, every 100 hours or 4,000 km)
  Every 2,500 hours or 10,000 km (Model SD16)

Replacement interval:

Every 1,200 hours or 48,000 km
Every 10,000 hours or 40,000 km (Model SD16)

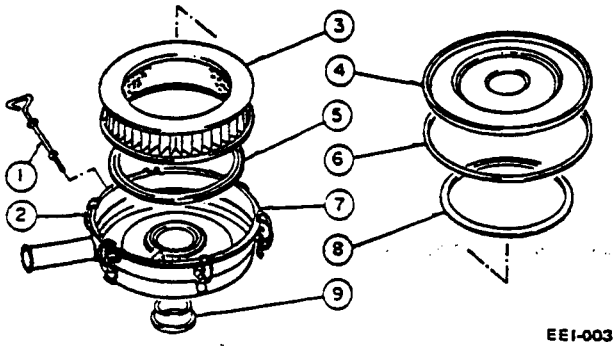
Cleaning is not required on the model SD16.

AIR CLEANER HANDLING PRECAUTIONS

1. Install the cleaner cover and element securely. Loose or improper installation may cause dust to be sucked into the air cleaner, preventing its normal functioning.
2. Do not touch the filter paper portion of the element with hands or other objects. Particularly, use care to prevent oils from adhering to it.

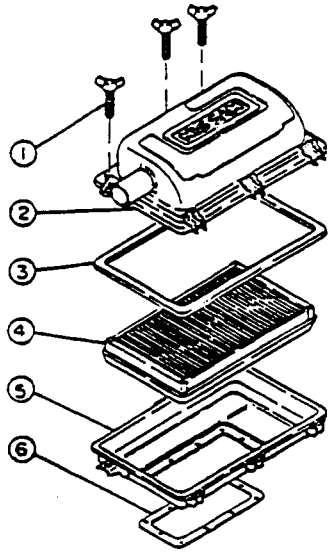
ELEMENT REMOVAL

1. Remove the clip which secures the cleaner cover (or wing bolt), and take off the cleaner cover.
2. Remove the element.



EEI-003

1	Band bolt	6	Packing
2	Clip	7	Cleaner case
3	Element	8	Packing
4	Cleaner cover	9	Insulator
5	Packing		



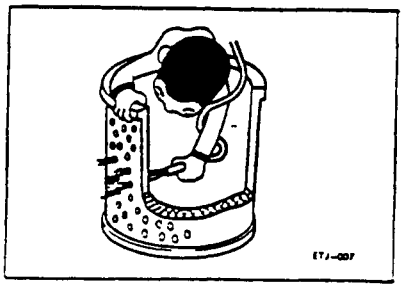
CV-023E

1	Wing bolt
2	Cleaner cover
3	Packing
4	Element
5	Cleaner case
6	Gasket

ELEMENT CLEANING

Clean the element by using one of the following two methods depending upon the nature of its contamination.

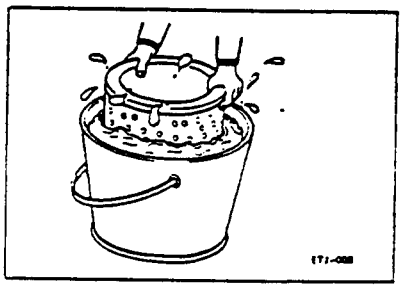
Element contaminated with dry dust:
Apply compressed air of 2 to 3 kg/cm^2 for cleaning. First, direct the air in the circumferential direction towards the inside of element, then direct air towards the outside in a lengthwise, direction to blow off the dirt.



ETJ-007

Element contaminated with carbon and oils:
Wash the element in a cleaning fluid prepared using the cleaning agent ND-1500 or D-1400 (manufactured by Donaldson C.).

1. Dissolve the cleaning agent (300g) in 5 liters of water, and dilute it with 20 liters of water to prepare the cleaning fluid.
2. Place the dirty element in the fluid for about 20 to 30 minutes, and then wash it by shaking it 4 to 5 times.
   For a more thorough cleaning, warm the cleaning fluid to 40 to 50°C.



ETJ-008

3. Remove the element and rinse it thoroughly with clean water.

The pressure of water should be less than 2.8 kg/cm^2.

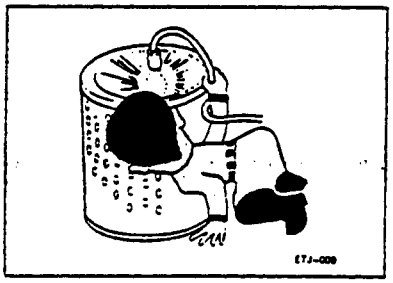
4. Thoroughly shake water from the element, and place it in a well ventilated location for drying but avoid direct sunlight. Use an electric fan or a drying furnace for quick drying.
   Since natural drying of the element will take two or three days, it is recommended that a spare element be available.

1. When using a drying furnace, keep the temperature below 80°C.
2. Do not dry the element by direct sunlight, by placing it near a fire, or by applying compressed air.
3. Never use an incompletely dried element.

Lubricating System

ELEMENT INSPECTION

After thoroughly drying the element, check the element for any damage, pin hole, or thinned portion by shining light through it from the inside. If any faults are found, or if the packing is damaged or deformed, replace the element with a new one.



ENGINE OIL

Replacement interval

Initial replacement:
- Automotive use: Initial 1,000 km
- Industrial use: Initial 25 hours

Subsequent replacement:
- Automotive use: Every 3,000 km
- Industrial use: Every 100 hours

Quantity of oil

Engine model	SD16	SD22	SD33	SD33T
Oil pan capacity	5.5 ℓ	5.5 ℓ	7.5 ℓ	9.5 ℓ
Total capacity	7.0 ℓ	7.0 ℓ	10.5 ℓ	11.5 ℓ

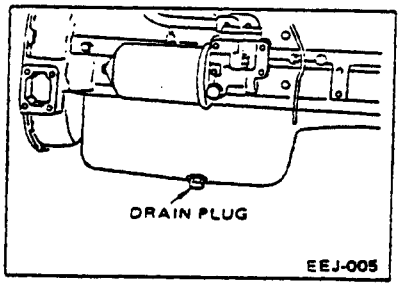
The oil quantity may vary according to specifications.

Do not add amounts of oil which will exceed the "H" level.

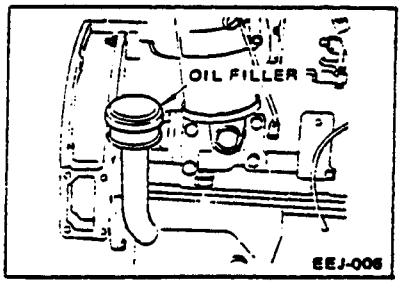
Replacement method

Change engine oil while it is still warm, following the below described procedure.

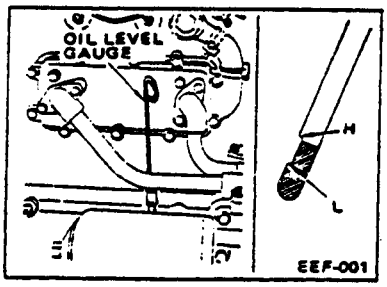
1. Remove the drain plug located at the bottom of the oil pan, and drain the oil.
2. Pour new engine oil through the oil filler. Check the oil level after the oil has stabilized in the pan, and make sure that the level approaches, the "H" mark position of the level gauge.



Drain plug



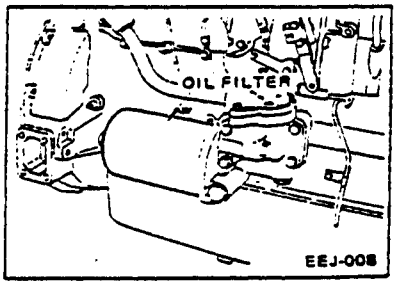
Oil filler (oil pan)



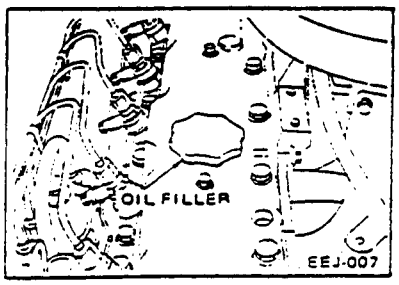
Level gauge

OIL FILTER

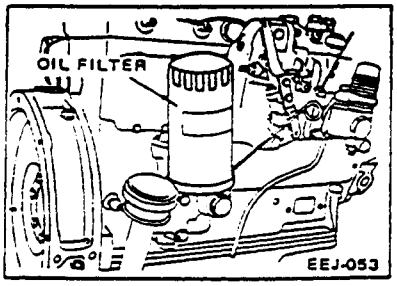
The oil filter is a full-flow type, and is mounted on the right side of the engine. The models SD16, 22 and 25 engine adopts the cartridge type oil filter.



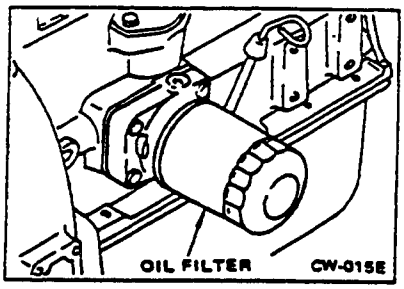
SD33 and SD33T



Oil filler (rocker cover)



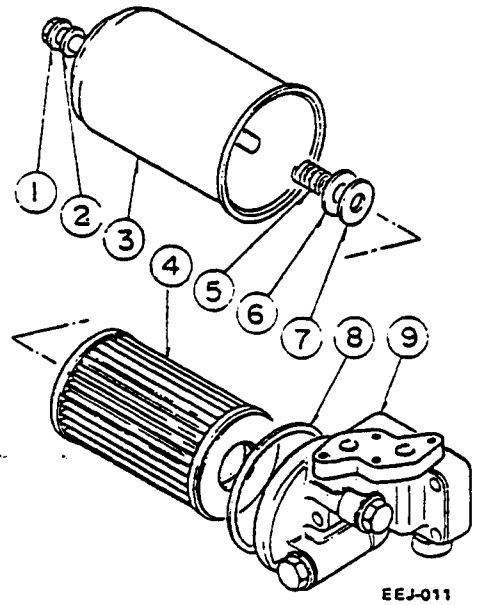
SD22 and SD25



SD16

Replacement intervals:
Element replacement:
Automotive use
Every 3,000 km
Industrial use
Every 200 hours

SD33 and SD33T



1	Center bolt	6	Spring retainer
2	Packing	7	Packing
3	Filter case	8	Packing
4	Element	9	Filter bracket
5	Set spring		

Cooling System

Element replacement procedure:
Models SD33 and SD33T

1. Place a receptacle under the filter.
2. Drain the oil by loosening the center bolt, and remove the element, gasket, case, spring and other parts from the body.
3. Replace the element with a new one.
4. Clean all the parts except the element with light oil.
5. Assemble each part correctly, being careful not to incorrectly install the gasket.

Replace the packing with a new one whenever disassembling.

6. After reassembling, start the engine, and make sure that oil does not leak from the oil filter.

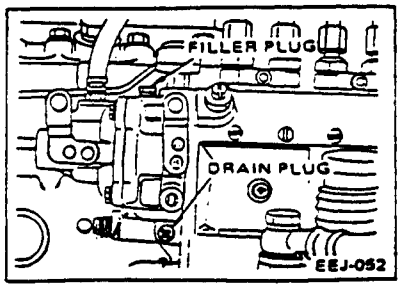
Replacement procedure:
Models SD16, 22 and 25

1. Remove the filter case togetehr with the element, and replace the whole unit with a new one.
2. Apply a thin coat of the engine oil to the "O" ring of the filter before installing.
3. Tighten the filter by hand until the "O" ring touches the filter bracket. From this position, tighten the filter another 2/3 turn.
4. After installing the filter, start the engine and make sure that no oil leaks from the mounting portion.

When pneumatic governor is used

Check the oil level and change the oil in the camshaft camber in the same manner as described above. Remove the filler plug of the governor chamber, and add the specified quantity (4 to 5cc) of diaphragm oil.

Use diaphragm oil recommended by Nissan Diesel.



FLUSHING OF COOLING SYSTEM

Flush the interior of the cooling system before and after antifreeze is used or whenever any heavy contamination in the coolant is noticed. In addition, flush the system every six months. Flushing removes water scale and fat from the cooling system, and restores its original cooling efficiency, which greatly reduces the possibility of the engine overheating.

FLUSHING PROCEDURE

The cooling system must be flushed when the coolant temperature is higher than 80°C and the engine is run at high idle. If the water temperature is too low, the thermostat will remain closed, and the flushing agent will not circulate in the radiator, so no flushing effect will occur. It is also necessary to keep the heater inlet valves (both on the engine and the heater proper) open.

1. Drain the cooling water from each water drain cock completely.
2. Close the drain cock, and pour city water and flushing agent into the radiator.

3. Run the engine at high idling speed (refer to the flushing agent manufacturer's instructions). Cover the front end of the radiator to prevent the temperature of the fluid in the cooling system from dropping. Observe the fluid level carefully for five minutes after starting the engine. If it lowers, add city water.
4. After flushing, stop the engine, and thoroughly drain the fluid from each drain cock.
5. Close the drain cocks, and add fresh city water. Start the engine and run it at high idle until the water temperature goes above 80°C. Then stop the engine, and drain the water from the drain cocks once again.
   Repeat this operation two or more times, until only clean water is discharged from the drain cocks. Dirty or colored water from the drain cocks means that fat or scale is still in the cooling system.
6. After completing the flushing operation, close each drain cock securely, and add fresh city water up to the specified level. Then start the engine, and purge the air from the system until the coolant level is stabilized at the specified position. If the coolant level lowers during this operation, add fresh city water.

ANTIFREEZE

Precautions for handling antifreeze solution

General precautions on the use of antifreeze are set forth below: When using a recommended brand of antifreeze, always follow the manufacturer's instructions.

1. Limit the use of antifreeze to the winter only. After winter is over, drain the coolant from the cooling system, and flush it thoroughly before adding fresh water and an antirust agent.
2. If the coolant level is lowered naturally while antifreeze is being used, add undiluted antifreeze or 50% diluted solution of antifreeze.
3. The antifreeze mixture ratio must be 45 to 60%. Excessively thin or thick mixture will reduce the antifreeze's effect and also reduce its rust and corrosion prevention powers.
4. Always use city water or other soft water to mix the antifreeze solution.
5. Do not mix different brands of antifreeze because they each contain special additives. Careless mixing often diminishes the effect of these additives.
6. Be sure to flush the interior of the cooling system thoroughly before and after antifreeze is used.
7. Before using any antifreeze, carefully check the engine, radiator and hoses for any sign of water leakage.
8. Do not use antifreeze that has already been used once.

Electrical System

Before performing any service for the electrical system, be sure to disconnect the battery minus side cable from the battery to assure safety in operation.

BATTERY

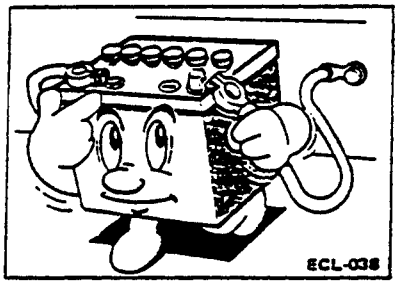
Always keep the battery in good condition.

Inspection interval

Electrolyte level:
Every 100 hours or 4,000 km
Specific gravity:
Initial check:
After 100 hours or 4,000 km
Subsequent check:
Every 300 hours or 12,000 km

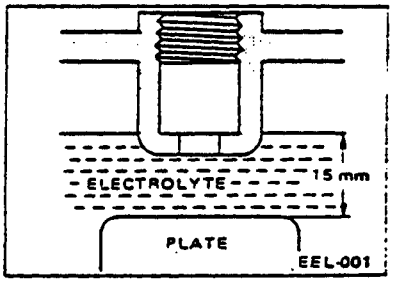
Checking electrolyte level

1. When the electrolyte level can be seen from the side of the battery case:



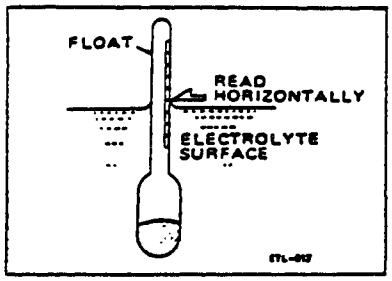
Check the level using the level mark provided on the side of the case. The electrolyte level should be anywhere between the "UPPER LEVEL" and "LOWER LEVEL" marks. If the level is below the "LOWER LEVEL" mark, add distilled water up to the "UPPER LEVEL" mark, and charge the battery for more than 30 minutes so that the fluid will be thoroughly mixed.

2. When the electrolyte level cannot be seen from the side of the battery case:

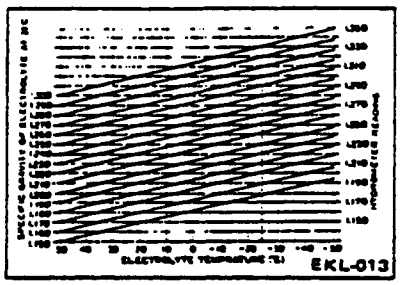


Remove the cap on the top of the battery, and check the electrolyte level. The leve is correct if it is 10 to 15 mm above the plates. If the level is lower than this, add distilled water until the correct level is attained, and charge the battery for more than 30 minutes to thoroughly mix the fluid.

Checking specific gravity



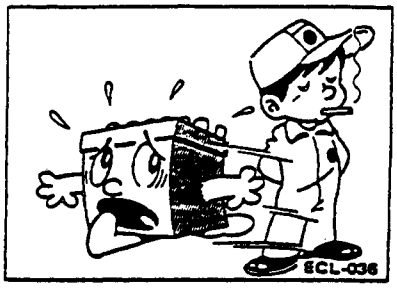
The specific gravity of the electrolyte lowers as the battery is discharged, and rises as it is recharged. Therefore, the charge condition of a battery can be determined by measuring the specific gravity of the electrolyte.
The specific gravity of the electrolyte of a fully charged battery is 1.250 to 1.270 when the electrolyte temperature is 20°C. If the specific gravity is lower than 1.200, the battery must be recharged.



Relation between atmospheric temperature and specific gravity of the electrolyte

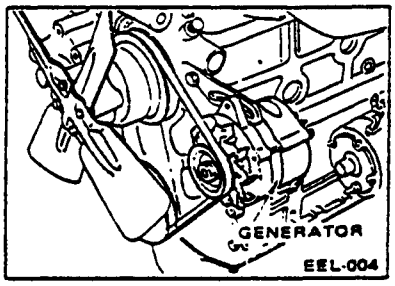
Handling precautions

1. Do not permit a fire to occur in the vicinity of the battery. Note that explosive gas (hydrogen and oxygen) is produced in the battery due to charging and discharging actions, and this can cause an explosion if it comes in contact with fire.



2. Improper or loose mounting of the battery may cause damage to the battery case or plates due to vibration during operation, resulting in a reduced battery life. To avoid this, be sure to install the battery securely. After connecting the battery cable, apply a thin coat of vaseline or grease to the portion which joints with the terminal to prevent corrosion.
3. Always keep the battery clean.
   Note that accumulation of dirt on the battery may cause damage to the plate due to the entrance of impurities into electrolyte, or cause an electrical leak over the cover.
   To clean, wash the battery, with the caps attached, with lukewarm water, and dry it by wiping with a dry cloth; or, remove the battery, and with the caps attached, wash it with water using a brush, and then reinstall the battery.
4. Be sure to add distilled water before recharging.
   After adding the distilled water, run the engine for more than 30 minutes, or take out the battery and charge it with a battery charge so that the eletrolyte and distilled water will be thoroughly mixed.
   Note that a thorough agitation of trolyte by charging should especially be performed in cold season; otherwise, the distilled water may freeze in the battery, resulting in a damaged battery.
5. During the recharging operation, pay attention to the temperature of the battery.
   If the electrolyte temperature rises above 45°C during the charging operation, suspend the charging, or reduce the charge current by one-half, or pour water on the battery from the outside to prevent a temperature rise in the electrolyte.

GENERATOR



This generator is of the AC type, and special attention should be paid to the following points:

1. When installing the battery, be careful not to make a mistake in connecting it.
2. Do not try to disconnect wires in the charging circuit and take care not to cause a shortcircuit while the engine is running.
3. Do not change the main switch and key switch from the "ON" position or "OPERATE" position during engine operation.
4. Do not splash any water or oils onto the generator.
5. Whenever servicing the generator, also change the bearing grease. It is recommended to have this grease changing operation done by the Service Shop.

STARTING MOTOR

When the starting motor has been removed from the engine and inspection and maintenance completed, apply grease to the sliding portion of the pinion.

Others

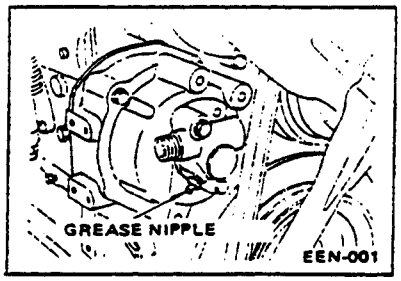
GREASING

Periodically apply grease to the hour meter driver. Also apply grease the hour meter cable.

Greasing interval

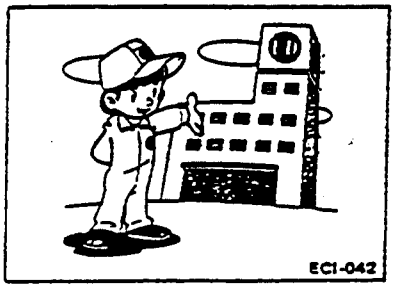
Hour meter driver:
Every 300 hours or 12,000 km
Hour meter cabel:
Every 600 hours or 24,000 km

Greasing points



TROUBLE-SHOOTING

It is necessary to detect any faults or abnormalities early and to correct them before they become greater and cause dry damage. If any of the difficulties listed herein occur, take proper corrective action without delay.
Troubles and their possible causes are listed in this capter. In order to prevent the expansion of trouble into other areas or the creation of new trouble due to the wrong diagnosis, be sure to disclose the nature of the trouble to the Service Station before repair work is begun.



When starting engine 24
When warming-up engine 24
During operation of engine 25
Others 26

When Starting Engine

Difficulty				Possible Cause
Engine will not start	Engine will not rotate		Starting system	Insufficient battery charge
				Loose battery terminal
				Faulty starting motor
				Faulty ring gear
				Faulty wiring or switch
				Blown fuse
			Engine proper	Improper viscosity of engine oil
				Seizure in rotating parts
				Frozen cooling water
	Engine rotates	Large amount of exhaust smoke	Incorrect injection timing	
			Faulty injection nozzle	
			Insufficient compression pressure in combustion chamber	Incorrect valve clearance
				Worn cylinder liner and piston rings
				Seized piston rings
			Poor fuel	Improper quality of fuel
				Dirt, water, or air in fuel
			Low compression air temperature in combustion chamber	Faulty glow plug
				Slow starting motor speed
		Small amount of exhaust smoke	Poor returning of stop wire	
			Air in fuel system	
			Clogged fuel system (element, etc.)	
			Faulty injection pump	
			Insufficient injection quantity (faulty injection nozzle)	

Difficulty			Possible Cause
Engine will not start	Engine rotates	No exhaust smoke	Lack of fuel
			Faulty feed pump
			Faulty injection pump
			Clogged fuel system (element)
			Clogged injection nozzle

When Warming-up Engine

Difficulty		Possible Cause	
Abnormal noise		Engine	Incorrect injection timing
			Poor spraying of injection nozzle
			Faulty fan pulley bearing
			Deformed or damaged fan or fan shroud
			Loose V-belt
			Faulty gear train
			Faulty pumps
			Faulty valve mechanism
			Faulty generator
			Wear on main bearing shell
			Poor fuel
			Cold engine (lack of warming-up)
			Loose tightening
		Damaged muffler or improper mounting	
Unstable idling	Hunting occurs	Low injection pressure of nozzle	
		Fuel leak from nozzle pipe	
		Faulty engine control linkage	
		Faulty governor	
		Faulty injection pump	
		Wear or deterioration in quality of engine mounting rubber	
		Water or air in fuel	

Difficulty		Possible Cause
Unstable idling	Engine stops immediately after starting	Faulty injection pump
		Clogged fuel system (element)
		Cold engine (lack of warming-up)
		Lack of fuel
Low oil pressure	Oil pressure warning lamp will not go out	Improper viscosity of engine oil
		Lack of engine oil
		Faulty oil pump or pump drive
		Faulty oil pressure switch

During Operation of Engine

Difficulty		Possible Cause		
Abnormal noise	Engine knocks	Faulty injection nozzle		
		Faulty injection pump		
		Insufficient or uneven compression pressure		
		Abnormal wear in cylinder		
		Incorrect injection timing		
		Incorrect valve clearance		
		Poor fuel (Low cetane number)		
		Cold engine (lack of warming-up)		
	Others	Loose tightening		
Poor acceleration	Engine rpm will not go up to the specified max. rpm	Incorrect adjustment of governor		
		Faulty injection pump (worn plunger)		
		Faulty injection nozzle		
		Faulty engine control linkage		
		Lack of fuel		Water or air in fuel
				Clogged fuel system (element)
				Faulty feed pump
				Insufficient injection quantity in injection pump
		Insufficient compression pressure in combustion chamber		
Unusual engine exhaust	Engine emits too much whitish smoke	Delay in injection timing		
		Faulty injection nozzle		
		Oil is burning	Oil comes down	Worn piston rings
			Oil comes up	Worn valve guide

Difficulty		Possible Cause	
Unusual engine exhaust	Engine emits too much whitish smoke	Cold engine	Lack of warming-up
			Faulty cooling system
	Engine emits too much black smoke	Clogged air cleaner element	
		Insufficient compression pressure in combustion chamber	Incorrect valve clearance
			Worn cylinder liner and piston rings
			Seized piston rings
		Advanced injection timing	
		Incorrect valve timing	
		Incorrect timer advance	
		Faulty injection nozzle	
		Faulty injection pump	Excessively large injection quantity (faulty governor)
			Uneven injection quantity
		Faulty turbo-charger	
	Small amount of exhaust smoke	Clogged fuel filter element	
		Clogged fuel pipe	
		Faulty injection pump	Excessively small injection quantity
			Faulty feed pump
			Faulty overflow valve
Oil pressure drops	Oil pressure warning lamp is ON	Insufficient engine oil	
		Oil leak from engine	
		Worn main bearing	
		Faulty oil pump or pump drive	
		Faulty oil pressure switch	

Difficulty		Possible Cause	
Excessive oil consumption		Oil leak from engine	
		Oil comes up into combustion chamber	Worn piston rings
		Oil comes down into combustion chamber	Worn valve guide
Engine overheats		Cooling system	Faulty water pump or pump drive
			Lack of cooling water due to water leak
			Faulty thermostat
			Dirty cooling water
			Clogged radiator core
		Fuel system	Faulty injection nozzle
			Delay in injection timing
			Excessive injection quantity
		Engine proper	Seized piston
			Seized piston rings
		Rough handling	Forced operation on uphill
			Operation carrying too much load
			Operation under over-loaded condition
		Clogged muffler (carbon accumulation)	
Unstable engine speed	Irregular engine rpm	Dirt, water, or air in fuel	
		Faulty governor	
		Faulty injection pump (Non-uniform injection quantity, irregular injection interval, etc.)	

Difficulty		Possible Cause
Unstable engine speed	Irregular engine rpm	Faulty fed pump
		Clogged fuel system (element)
		Fuel leak from fuel system
		Faulty engine control linkage
	Engine stops suddenly	Lack of fuel in tank
		Dirt, water, or air in fuel
		Clogged fuel system (filter, pipe, etc.)
		Seizure in injection pump drive
		Faulty governor
		Seized parts in engine proper
Failure in charging system	Needle of ammeter will not deflect	Faulty ammeter
		Faulty charging circuit or poor connection
	Needle of ammeter remains on minus (−) side	Faulty generator
		Faulty regulator
		Faulty charging circuit or poor connection
		Too much electric current is being used
		Blown fuse
	Needle of ammeter remains on plus (+) side	Faulty regulator
		Faulty battery
	Needle of ammeter remains in deflected position	Faulty ammeter
		Faulty generator
		Faulty regulator
		Faulty charging circuit or poor connection

Others

Difficulty		Possible Cause	
Oil leak from engine		Loose tightening	
		Clogged breather	
		Faulty gasket, packing, oil seal, etc.	
		Oil level too high	
Engine oil in cooling water		Faulty oil cooler	Cracks in oil cooler core
			Faulty rubber ring (cracks, etc.)
		Engine proper	Cracks in cylinder block
			Cracks in cylinder head
			Faulty cylinder head gasket rubber ring
Cloudy engine oil due to mixing of cooling water		Faulty cylinder head rubber ring	
		Faulty cylinder liner rubber ring	
High oil level due to mixing of fuel		Faulty injection pump (plunger portion)	
Cooling water runs short too quickly	Water leak	Faulty water hose or loose connection	
		Loose drain valve	
		Faulty radiator	Crack or damage in core
			Crack or damage in upper or lower tank
		Faulty water pump	
		Faulty radiator cap	
		Blow-back due to entrance of burnt gases	

Difficulty		Possible Cause	
Too much fuel consumption	Engine emits large quantity of black smoke	Refer to "Unusual Engine Exhaust".	
	Engine exhaust is normal	Fuel leak from fuel system	
		Operating conditions	Condition of road (type of surface, uphill, etc.)
			Carried load
			Operating method (sudden start-up, sudden braking, etc.)
			Route (geography, distance, etc.)
			Others (running resistance)
			Load condition (overload)

TABLE OF PERIODIC INSPECTION ITEMS

In order to keep the engine in top condition as well as to prevent unexpected trouble, it is necessary to periodically perform inspection and maintenance.
This chapter provides the table of daily inspection items and periodic inspection items that must be done at the specified intervals according to the operating hours or running distance.
The periodic inspection should be performed by the Service Shop.

Inspection interval

1. The "●" mark in the table indicates the interval of periodic inspection or adjustment.
2. The "●" mark in column "D" indicates that the item should be checked before beginning the day's operation by referring to "PRELIMINARY INSPECTION".
3. The "*" mark in the table indicates the time of initial inspection, adjustment and replacement on a new engine.
4. The "☆" mark in the table indicates the replacement interval of the parts that must be replaced periodically.
5. "D, 1, 2, 3, 6, 12" in the "Inspection interval" column indicate:
   - D: Daily inspection
   - 1: Every 100 operating hours or every 4,000 km
   - 2: Every 200 operating hours or every 8,000 km
   - 3: Every 300 operating hours or every 12,000 km
   - 6: Every 600 operating hours or every 24,000 km
   - 12: Every 1,200 operating hours or every 48,000 km

Oils and fluids

Oils and fluids should be replaced periodically according to the operating hours of the engine or the driving distance of the vehicle. However, the quality of the oils and fluids will deteriorate in time even if the engine is not operated. If the operating hours are small, replacement should be made according to the number of months. In this case "1, 2, 3, 6, 12" in the inspection interval column may be regarded as "Every month, Every 2 months, Every 3 months, Every 6 months, and Every 12 months".
When adding or replacing oils and fluids, be sure to use the brands recommended by Nissan Diesel.

Periodic replacement parts

Some component parts of the engine may experience change or deterioration in material, or may wear in time, and it is difficult to determine the degree of such deterioration by periodic inspection. Such parts are classified as periodic replacement parts, and must be periodically replaced with new ones even if no particular abnormality is observed. For the Nissan Diesel engine, be sure to use the Nissan Diesel genuine replacement parts.

	Inspection item	Inspection interval D	1	2	3	6	12	Remarks
Engine proper	Check for normal starting, or for noise	●	●					
	Check low speed operation, and acceleration	●	●					
	Check the condition of exhaust	●	●					
	Check condition of air cleaner element			●				In dusty area, every 100 hours or 4,000 km
	Check cylinder head and manifold for looseness						●	*25 hours or 1,000 km Tightening torque: Cylinder head Main bolt 13 kgm Sub bolt 5 kgm Manifold Intake 1.5 to 1.8 kgm Exhaust 1.5 to 1.8 kgm
	Check compression pressure						●	Limit of compression pressure: 19 kg/cm² — 180 to 220 rpm Difference among cylinders: Within 4 kg/cm²
	Check valve clearance				●			*25 hours or 1,000 km Intake and exhaust valves: 0.3 to 0.4mm (both for cold and hot engines)
	Check condition of crankshaft damper						●	
	Replace air cleaner element							* Every 1,200 hours or 48,000 km * Every 10,000 hours or 40,000 km (Model SD16)
Lubricating system	Check for oil leak	●	●					
	Check for contamination	●	●					

	Inspection item	Inspection interval D	1	2	3	6	12	Remarks
Lubricating system	Check oil level	●	●					
	Replace engine oil		●					*25 hours or 1,000 km Automotive use: Every 3,000 km
	Replace oil filter element			●				Automotive use: Every 3,000 km
Fuel system	Check for fuel leak	●	●					
	Check fuel filter for clogging						●	
	Check injection pressure and spray condition of injection nozzle						●	Injection pressure ..... 100 kg/cm²
	Check injection timing						●	Injection timing (B.T.D.C.) ..... 20.0°
	Check injection quantity of injection pump				●			
	Clean gauze filter of feed pump					●		
	Drain sediment in fuel tank					●		
	Add diaphragm oil				●			Pneumatic governor equipped models only
	Replace fuel filter element					●		
	Check fuel level	●						
	Check function of feed pump						●	
	Replace fuel hose							* Every two years

	Inspection item	Inspection interval						Remarks
		D	1	2	3	6	12	
Cooling system	Check for water leak	●	●					
	Check water level	●	●					
	Check installation of radiator cap	●						
	Check function of radiator cap						●	
	Check V-belt for looseness, or damge	●	●					
	Change cooling water and flush the inside of system					●		
	Check function of thermostat						●	
Electrical system	Check battery electrolyte level		●					Between "H" and "L", or 10 to 15 mm above plates
	Check specific gravity of electrolyte		●		●			1.250 to 1.270 at fluid temperature of 20°C If less than 1.200 recharge
	Check function of generator and regulator		●					
	Check connections of electrical wires for looseness or damage		●					
	Check switch operation	●	●			●		
	Apply grease to pinion sliding surface of starting motor						●	In Service Station upon disassembly and check
	Replace grease of generator bearing						●	In Service Station upon disassembly and check

	Inspection item	Inspection interval						Remarks
		D	1	2	3	6	12	
Meter	Check operation of each meter	●	●					
	Add grease to hour meter driver				●			
	Apply grease to hour meter cable					●		
Other	Check engine mounting bolts for looseness						●	
	Check for play of turbocharger turbine rotor and rotation						●	Turbocharger equipped models only

RECOMMENDED LUBRICANTS, FUEL AND ANTI-FREEZE

Engine oil 30
Bearing grease 31
Antifreeze 32
Fuel 32
Diaphragm oil 33
Cooling water 33
Anti-rust agent 33

In order to maintain the original high performance of the Nissan Diesel engine and to extend its service life as much as possible, it is strongly recommended to use those oils and fluids recommended by Nissan Diesel Co., Ltd, and to replace them periodically.

Engine Oil

The Nissan Diesel engine requires high performance, high quality engine oil capable of withstanding high speed and heavily loaded operations. Be sure to use API service class CD or CC engine oil.

The engine oil will not exhibit its original performance if used under improper temperature conditions. It is therefore important to use engine oil having proper viscosity corresponding to the atmospheric temperature conditions under which the engine is to be operated.

Specifications and Viscosity

Recommended A.P.I. Service Classification
CD class (MIL-L-2104C) or CC class (MIL-L21048 or MIL-L-46152)

In SD33T engines, be sure to use CD class (MIL-L-2104C) engine oil.

Atmospheric temperature	Recommended SAE viscosity	
−18 to +10°C	10W	10W/30
−7 to +25°C	20W/20	
−12 to +40°C	15W/40, 20W/40	
+5 to +40°C	30	
Over +30°C	40	

A.P.I.: American Petroleum Institute
S.A.E.: Society of Automotive Engineers

Recommended class-CD engine oils (MIL-L-2104C)

Petroleum Maker	Brand	SAE Viscosity
CALTEX	CALTEX RPM DELO 300 OIL	10W, 20W/20, 30, 40
	CALTEX RPM DELO 400 OIL	15W/40, 20W/20, 10W, 30, 40
TEXACO	URSA OIL LA-3	10W, 20W/20, 30, 40
	TEXACO URSA SUPER PLUS	10W, 15W/40, 20W/20, 30, 40
	TEXACO URSA OIL SUPER 3	10W, 20W/20, 30, 40
ESSO	ESSOLUBE D-3 SERIES	10W, 20W, 30, 40
	ESSOLUBE XD-3	10W, 10W/30, 15W/40, 20W/20, 30, 40
	ESSOLUBE XD-3 EXTRA	10W, 10W/30, 15W/40, 20W/20, 30, 40
MOBIL	MOBIL DELVAC 1300 SERIES	30, 40
GULF	GULF SUPER DUTY MOTOR OIL	10W, 15W/40, 20W/20, 30, 40
SHELL	SHELL RIMULA CT OIL or SHELL RIMULA X OIL	10W, 20W/20, 30, 40
	SHELL MYRINA OIL	15W/40, 20W/20, 30, 40
BP	BP VANELLUS C3	10W, 20W, 30, 40

Petroleum Maker	Brand
CASTROL	CASTROL LM GREASE
AGIP	AGIP F.1 GREASE 1530
VALVO-LINE	VAL-LITH NO. 2 EP GREASE
	GLO GREASE
CHEV-RON	CHEVRON MULTI-MOTIVE GREASE NO. 2
	CHEVRON POLYUREA EP GREASE NO. 2
VEEDOL	VEEDOL MULTIPURPOSE or ALL PURPOSE GREASE NO. 2

Antifreeze

Use high quality, ethylene glycol base antifreeze which prevents, both corrosion in the cooling system and attachment of scale. Note that low quality antifreeze can reduce the cooling effect and cause engine trouble due to corrosion.

Recommended antifreeze

Petroleum Maker	Brand	Remarks
CALTEX	CALTEX AF ENGINE COOLANT	Ethylene glycol base
TEXACO	TEXACO ANTIFREEZE COOLANT AND SUMMER COOLANT	
	TEXACO STARTEX ANTI-FREEZE AND SUMMER COOLANT	
ESSO	ESSO ANTIFREEZE	
MOBIL	MOBIL PERMAZONE	
GULF	GULF ANTIFREEZE AND SUMMER COOLANT	
SHELL	SHELL ANTIFREEZE	
BP	BP ANTIFROST	
CASTROL	CASTROL ANTIFREEZE	
AGIP	AGIP F.1 ANTIFREEZE	

Petroleum Maker	Brand	Remarks
VALVO-LINE	VALVOLINE ANTIFREEZE & COOLANT	Ethylene glycol base
CHEV-RON	CHEVRON ATLAS PERMA GUARD ANTIFREEZE AND COOLANT	
VEEDOL	VEEDOL ANTIFREEZE	

Fuel

The Nissan Diesel engine is designed to produce power by using light oil as fuel. Do not use any fuel except light oil; otherwise, engine trouble will result.

The light oil should have a cetane number greater than 45, specific gravity of 0.81 to 0.85, boiling point ranging from 180 to 350°C, sulfer content of less than 0.5%, and should prove neutral in a chemical reaction test. It should be clean, posses the proper viscosity, and contain no water or sediment.

Diaphragm Oil

How the diaphragm of the pneumatic governor is lubricated can influence the engine performance. To obtain top engine performance, be sure to use the recommended diaphragm oil.

Recommended oil: Diesel Kiki Diaphragm Oil (Part No. 55413-132)

Cooling Water

Be sure to use clean, soft water such as city water in the cooling system. Do not use hard water such as well water or river water, because such water can easily form scale in the system. Note that scale attached to the water passage in the cooling system (particularly in the radiator) can cause engine overheating.

Anti-rust Agent

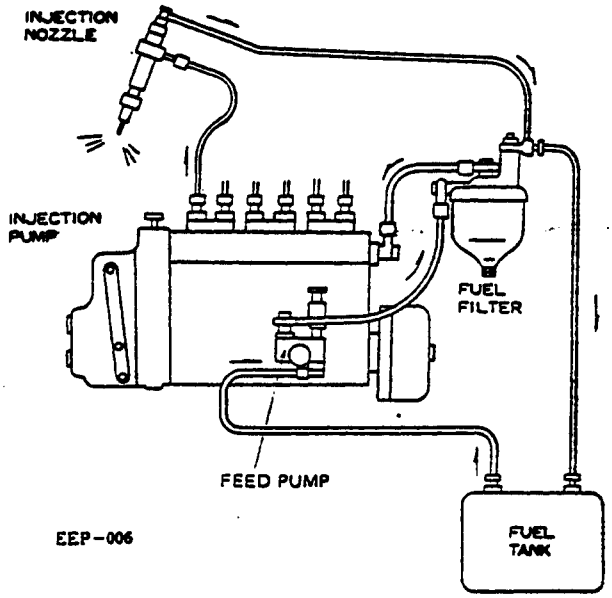
Recommended anti-rust agents for long term storage

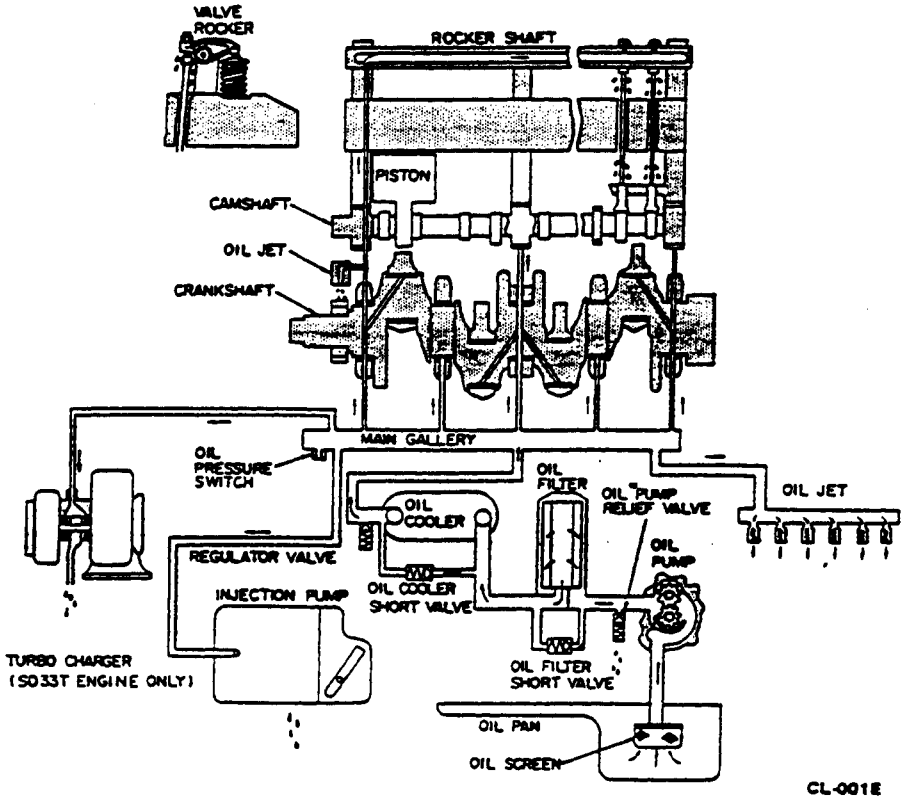
Maker	Brand Name	Specifications
CALTEX	CALTEX PRESERVATIVE OIL 30	P-10 MIL-L-21260 Grade II, MIL-L-21260B Type II Grade 30 Use for lubricating system
ESSO	RUST-BAN 339	
MOBIL	MOBIL KOTE 503	
	MOBIL ARMA 524	
GULF	GULF NO RUST ENGINE OIL Grade II	
SHELL	SHELL ENSSIS ENGINE OIL 30	
CALTEX	CALTEX 564 RUST PROOF OIL	P-9 MIL-L-6448 Use for fuel system
ESSO	RUST-BAN 334	
MOBIL	MOBIL ARMA 777	
GULF	GULF OIL COAT R	
SHELL	SHELL ENSSIS OIL 152	
CALTEX	CALTEX TEXACOAT	P-1 MIL-L-16173B Grade I Apply to metal surface
MOBIL	MOBIL KOTE 601	
GULF	GULF NO-RUST A	
SHELL	SHELL ENSSIS FLUID 264	

Maker	Brand Name	Specifications
ESSO	ELOMA AK50F	P-19 MIL-C-16173C Grade 4 Apply to metal surface
	ELOMA PH32S	
CALTEX	SOLUBLE OIL C	EMULSION TYPE MIL-C-40084A, MIL-C-22572 Type I Use for cooling system
ESSO	KUTWELL 40	
	RUST-BAN 310	
MOBIL	SOLVAC 1535G	
	PROSOL 35	
GULF	GULF CUT SOLUBLE OIL	
SHELL	SHELL DROMUS OIL B	

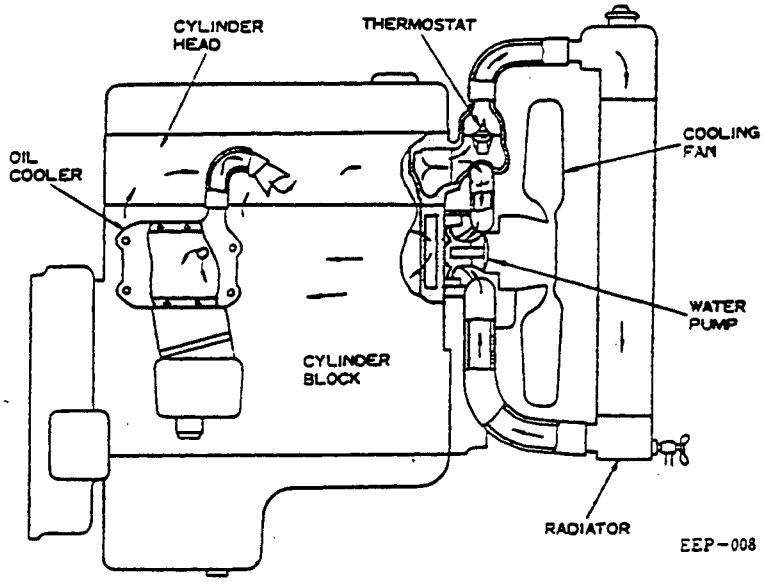
SYSTEM DIAGRAMS

FUEL SYSTEM DIAGRAM

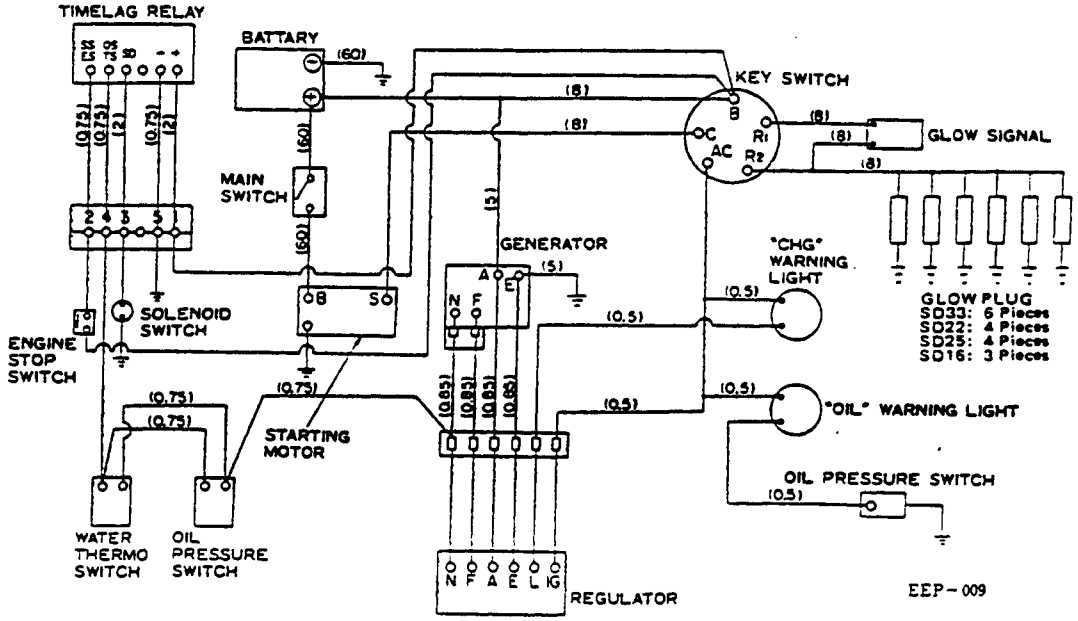




COOLING SYSTEM DIAGRAM



ELECTRICAL SYSTEM DIAGRAM



Torqmotor™ MAG Design Features

- Displacements range from 23.6 cubic inches (387 CM^3) down to 3 cubic inches (49 CM^3) per revolution.
- Continuous rated pressure up to 1500 psi (103.4 BAR), depending on displacement with fully competitive volumetric efficiency.
- Coupling shaft mounted in steel caged needle radial and thrust bearings to withstand higher side and thrust loads.
- Optimized drive link contact with 12 tooth spline drive to reduce wear.
- Unique high pressure shaft seal allows MAG Torqmotors to be run in series without need for case drains. Only simple direct-line circuitry required.
- Standard SAE porting and mounting configurations.
- Fewer parts reduced maintenance, while maintaining quality performance.
- Full flow spline lubrication minimizes spline wear.
- Disc valve commutation maintains timing to promote efficiency and increase durability.
- Dirt and water shaft seal and corrosion resistant grease give added protection from environment.

Definitions

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

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

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

Patents

Ross Gear Division products and systems described in this manual are protected by the following United States patents: 3,606,601. In addition, patents have been issued or patent applications have been filed in Canada, Japan, The United Kingdom, and West Germany.

Table of Contents

	Page
Design Features Illustrated	1
Design Features	2
Definitions	2
Introduction	4
Trouble Shooting Guide	5
Trouble Shooting Check List	6
Tools & Material Required for Servicing	7
Bolt Torque	7
Exploded Assembly View Fold Out	8
Disassembly & Inspection	9
Assembly	16
Final Checks	22
Hydraulic Fluids	22
Filtration, Operating Temperature	22
Tips for Maintaining the System	23

Introduction

Service Manual for Model MAG

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

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

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

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

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

Service parts are available through the Original Equipment Manufacturer (OEM) or Ross approved MAG Distributors.

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

Troubleshooting Guide

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

Preparation

Make your troubleshooting easier by preparing as follows:

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

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

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

Preliminary Checks

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

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

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

Hydraulic Components

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

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

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

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

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

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

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

Troubleshooting Checklist

Trouble	Cause	Remedy
Oil Leakage	1. Hose fittings loose, worn or damaged	Check & replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings (4) deteriorated by excess heat	Replace oil seal rings by disassembling MAG unit.
	3. Special bolt (1) loose or its sealing area deteriorated by corrosion	(a) Loosen then tighten single bolt to 22-26 ft.-lbs. (30-35 N m) (b) Replace bolt.
	4. Internal shaft seal (16) worn or damaged	Replace seal by disassembling MAG unit.
	5. Worn coupling shaft (12) and internal seal (16)	Replace coupling shaft and seal by disassembling MAG unit.
Significant loss of speed under load	1. Lack of sufficient oil supply	(a) Check for faulty relief valve and adjust or replace as required. (b) Check for and repair worn pump. (c) Check for and use correct oil for temperature of operation.
	2. High internal motor leakage	(a) Replace worn rotor set by disassembling MAG unit.
	3. Severely worn or damaged internal splines	Replace rotor set, drive link and coupling shaft by disassembling MAG unit.
	4. Excessive heat	Locate excessive heat source (usually a restriction) in the system and correct the condition.
Low mechanical efficiency or undue high pressure required to operate MAG unit	1. Line blockage	Locate blockage source and repair or replace.
	2. Internal interference	Disassemble MAG unit, identify and remedy cause and repair, replacing parts as necessary.
	3. lack of pumping pressure	Check for and repair worn pump.
	4. Excessive binding or loading in system external to MAG unit	Locate source and eliminate cause.

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

Tools and Materials Required for Servicing

MAG service manual

Clean, petroleum-based solvent

Emery paper

Vise with soft jaws

Air pressure source

Arbor press

Screw driver

Retaining ring pliers (internal)

Breaker bar

1/2 inch thin wall socket

Torque wrench - foot pounds or Newton meter

Adjustable crescent wrench or hose fitting wrenches

SAE 10W40 SE or SF oil

Special bearing mandrel (SEE FIGURE 1)

Feeler gage .005 inch (.13 mm)

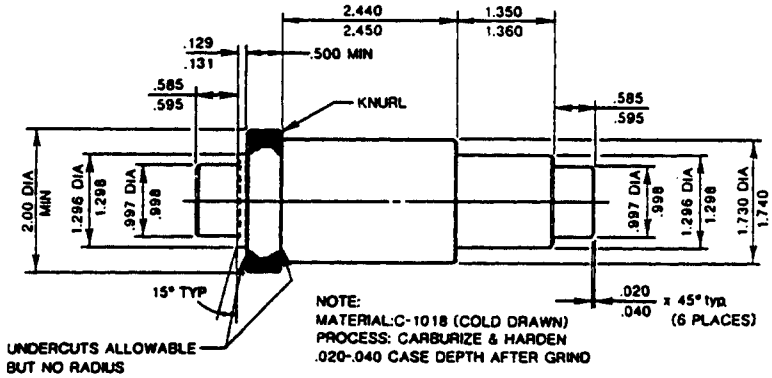
Clean corrosion resistant grease. Recommended grease is E/M Lubricant #K-70 Alternate compatible greases are:

- Shell Darina #2
- Lubriplate #930AA
- Union High Temp 2
- Sunoco High Temp 2

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

CONVERSIONS

INCHES	mm	INCHES	mm
.020	.51	1.296	32.92
.040	1.02	1.298	32.97
.129	3.28	1.350	34.29
.131	3.33	1.360	34.54
.500	12.70	1.730	43.94
.585	14.86	1.740	44.20
.595	15.11	2.00	50.8
.997	25.32	2.440	61.98
.998	25.35	2.450	62.23

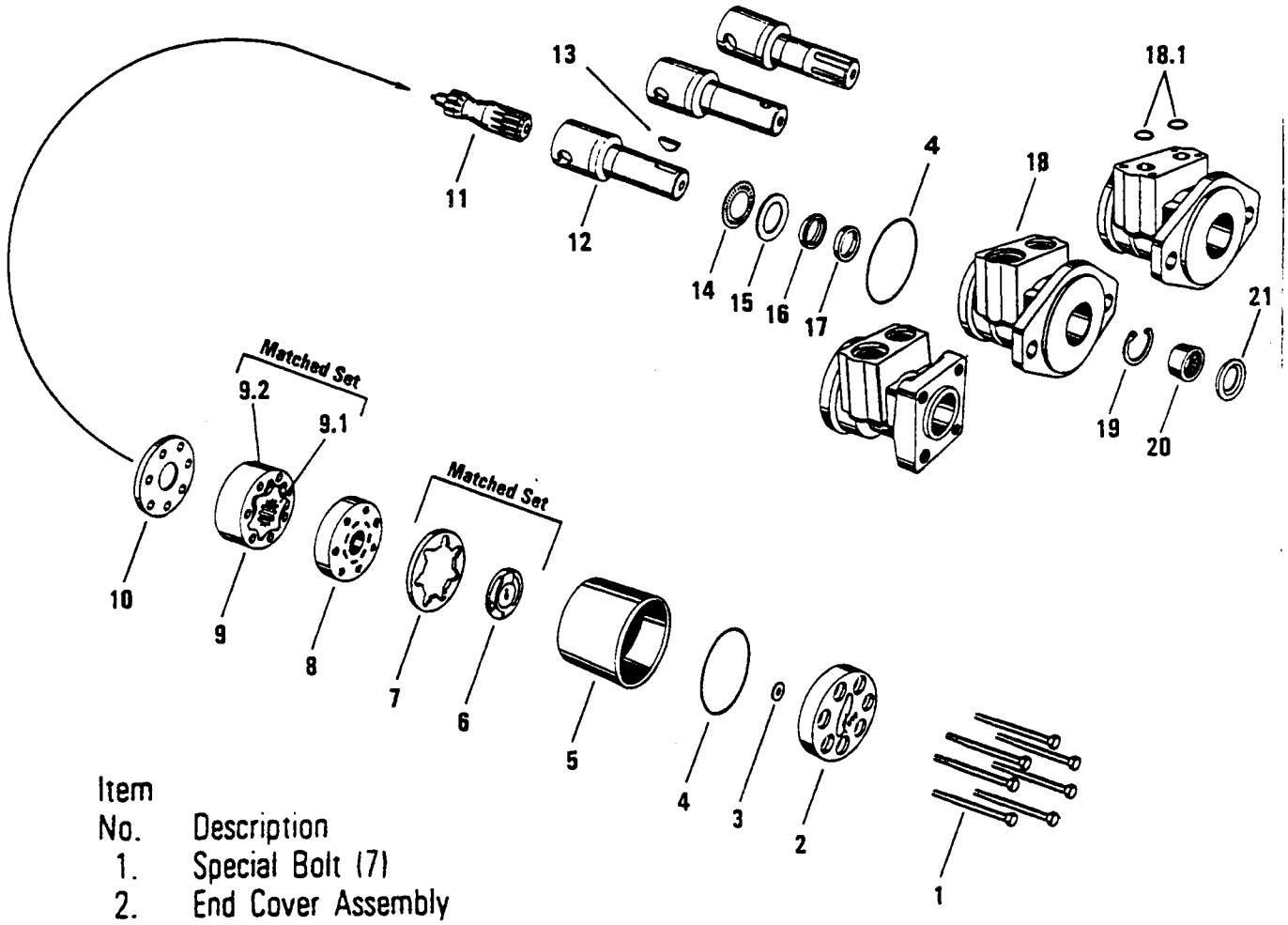


Bearing Mandrel (Fabricate if considered necessary)
Figure 1

Torque Chart

Part Name	Item Number	Torque
bolt 5/16 24 thread	1	22-26 ft. lbs. (30-35 N m)

MAG Torqmotor™ Exploded Assembly View-Typical



Item No.	Description	Item No.	Description
1.	Special Bolt (7)	13.	Woodruff Key
2.	End Cover Assembly	14.	Thrust Bearing
3.	Washer	15.	Thrust Washer
4.	Seal Ring(2)	16.	Seal
5.	Sleeve	17.	Spacer
6.	Commutator	18.	Housing
7.	Commutator Ring	18.1	"O" Ring
8.	Manifold	19.	Retaining Ring
9.	Rotor Set	20.	Needle Bearing
9.1	Rotor	21.	Seal
9.2	Stator		
10.	Wearplate (Spacer)		
11.	Drive Link		
12.	Coupling Shaft		

MAG Torqmotor Exploded View

MAG: Disassembly and Inspection

(Preparation Before Disassembly)

- Before you disassemble the MAG Torqmotor™ unit or any of its components, read this entire manual. It provides important information on parts and procedures you will need to know to service the MAG.
- Refer to page 7A for tools and other items required to service the MAG, and have them available.
- Thoroughly clean off all outside dirt, especially from around fittings and hose connections, before disconnecting and removing the MAG. Remove rust or corrosion from coupling shaft.
- Remove coupling shaft connections and hose fittings, and immediately plug port holes and fluid lines.
- Remove the MAG from system, drain it of fluid and take it to a clean work surface. (A piece of wrapping paper makes an excellent disposable top.)
- Clean and dry the MAG before you start to disassemble the unit..
- As you disassemble the MAG, clean all parts, except seals, in clean petroleum-based solvent, and blow them dry.

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

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

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

- Keep parts separate to avoid nicks and burrs.
- Discard all seals and seal rings as they are removed from the MAG. Replace all seals, seal rings and any damaged or worn parts with genuine Ross or OEM approved service parts.

Disassembly and Inspection

position Torqmotor™ in a vise

1. Position the MAG assembly in a soft jawed vise, with coupling shaft (12) pointed down, the vise jaws clamping firmly on the sides of the housing (18) mounting flange. SEE FIGURE 2. Remove manifold port O-Rings (18.1) if applicable.

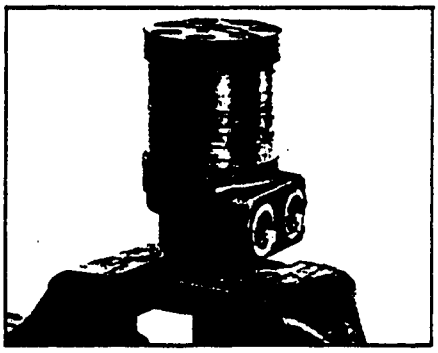


Figure 2

WARNING

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

remove special bolts & inspect bolts

2. Remove the seven special ring head bolts (1) using a 1/2 inch thin wall socket to enter the end cover bolt head recess. SEE FIGURE 3. Inspect bolts for damaged threads, or sealing ring, under the bolt head. Replace damaged bolts. SEE FIGURE 4.

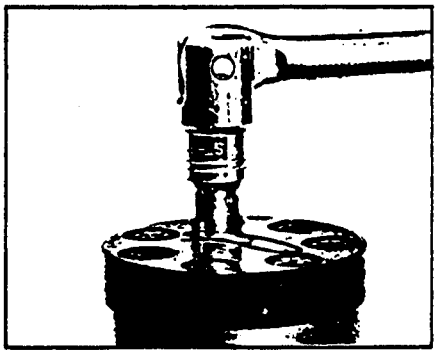


Figure 3

remove end cover & seal ring

3. Remove end cover assembly (2) and seal ring (4). Discard seal ring. SEE FIGURE 5.

NOTE

NOTE: The pin in the end cover must not be removed as it is serviced only as an integral part of the end cover.

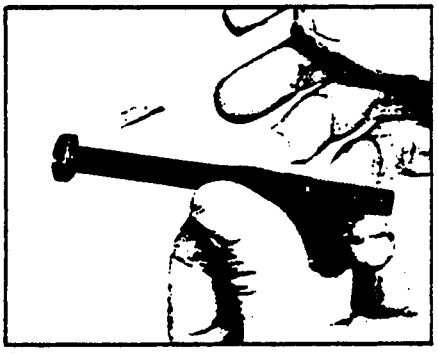


Figure 4

inspect end cover

4. Inspect the end cover (2) for severe wear, nicks, burrs and spalling on the ground surface that has the seal ring groove. Inspect the integral pin for out of round condition (flats). Inspect the bolt head recesses where the bolt head sealing ring makes contact for damage that would prohibit good sealing contact. Replace cover if any of these conditions exist.

NOTE

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



Figure 5

remove & inspect drive link washer

5. Remove drive link washer (3) from the commutator (6) or from the end cover if it was removed with the end cover. Replace washer if it shows signs of wear, spalling, nicks or is bent or has other deformation that could interfere with commutator or drive link rotation. SEE FIGURE 6.

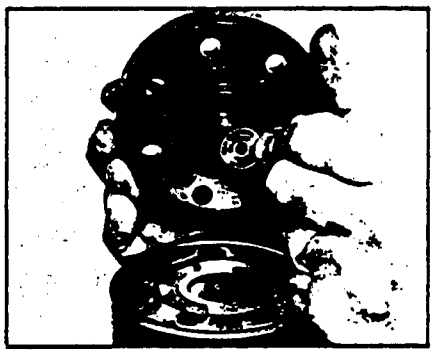


Figure 6

remove & inspect sleeve

6. Remove sleeve (5) and inspect if for deformation from the original cylindrical shape to a "barrel" or "hour glass" shape. Inspect the ends for severe nicks or burrs. Replace sleeve if any of these conditions exist. SEE FIGURE 7.

NOTE

NOTE: Minor burrs can be removed.



Figure 7

remove & inspect commutator ring

7. Remove commutator ring (7). SEE FIGURE 8. Inspect commutator ring for cracks, or burrs.

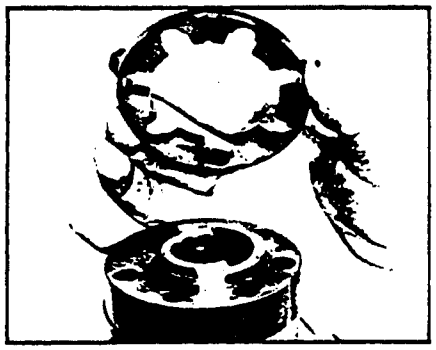


Figure 8

remove & inspect commutator

8. Remove commutator (6) and inspect its ground surfaces for scoring, spalling, brinelling (denting) or wear. SEE FIGURE 9. Inspect the drive link pin slot and cover pin hole for wear. Inspect for cracks. If any of these conditions exist replace the commutator and commutator ring as a matched set.



Figure 9

remove manifold

9. Remove manifold (8) and inspect for cracks, surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. SEE FIGURE 10. A polished pattern on the ground surfaces from commutator or rotor rotation is normal.



Figure 10

remove & inspect rotor set

10. Remove rotor set (9) retaining it in its assembled form if possible, to maintain the same rotor to stator contact surfaces. Inspect the rotor set for nicks, scoring or spalling on any surface, and broken or worn rotor splines. Replace as a matched rotor set if either component exhibits any of these conditions. SEE FIGURE 11.



Figure 11

NOTE

NOTE: The rotor (9.1) may become disassembled from stator (9.2) during service procedures. Marking the surface of the rotor and stator that is facing UP with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set into Torqmotor™. Be sure to remove all foreign material from rotor set before reassembly into Torqmotor™.

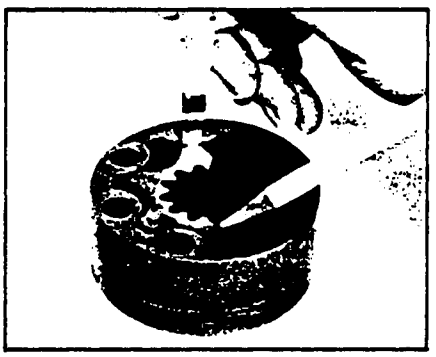


Figure 12

check rotor, stator clearance

11. Using a feeler gage, check the rotor (9.1) to stator (9.2) tip clearance with the rotor centered in the stator. SEE FIGURE 12. If there is more than .005 inches (13 mm) of clearance, replace rotor set.

remove & inpect spacer

12. Lift off wearplate (10) and inspect it for scoring or brinelling on the rotor contact surface. Inspect for cracks. Replace wearplate if any of these conditions exist. SEE FIGURE 13.



Figure 13

NOTE

NOTE: A polished pattern from rotor rotation is normal.

remove & inspect drive link

13. Remove drive link (11) and inspect it for cracks and for chipped, worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. SEE FIGURE 14. Inspect the pin in the end of the drive link for flats or wear. Replace drive link if these conditions exist.

NOTE

NOTE: The pin in the end of drive link is serviced as an integral part of the drive link and is not subject to disassembly.

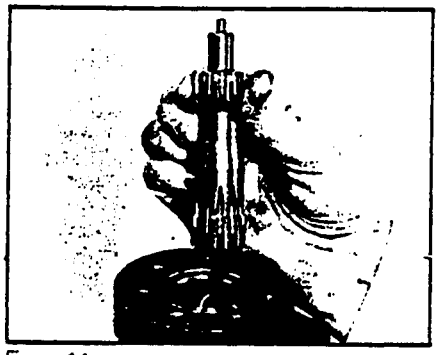


Figure 14

check coupling shaft for rust or corrosion

14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used. SEE FIGURE 15.

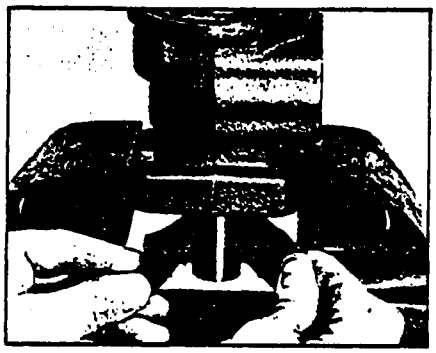


Figure 15

remove & inspect coupling shaft

15. Remove coupling shaft (12), by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. SEE FIGURE 16. Inspect for damaged or worn internal and external splines or keyway (FIG. 17). Replace coupling shaft if any of these conditions exist.

NOTE

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

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

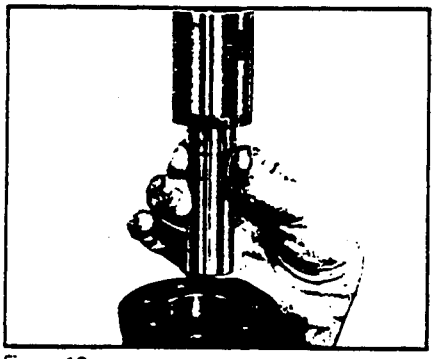


Figure 16

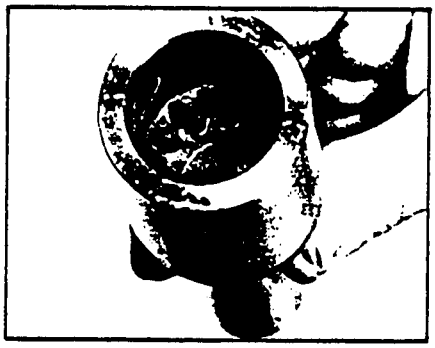


Figure 17

remove seal ring from housing

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

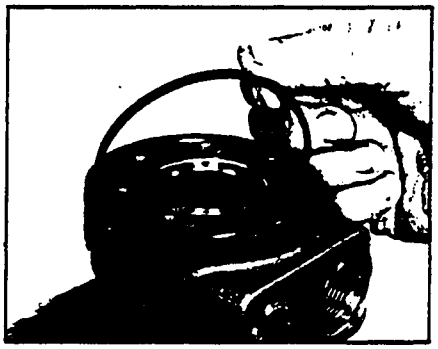


Figure 18

remove & inspect thrust bearing, washer

17. Remove thrust bearing (14) and thrust washer (15). Inspect for wear, brinelling and corrosion. The full complement of bearing rollers must be firmly retained in the bearing cage but revolve freely. Replace as required. SEE FIGURE 19.



Figure 19

remove seal & spacer

18. Remove seal (16) and spacer (17). Discard both. SEE FIGURE 20.



Figure 20

remove seal

19. Remove housing (18) from vise, invert it and remove and discard seal (21). SEE FIGURE 21.

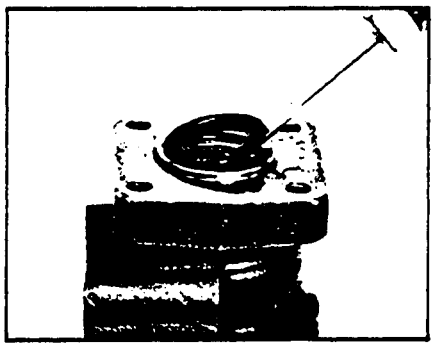


Figure 21

inspect housing assembly

20. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. SEE FIGURE 22. If the housing is defective in these areas, discard the housing assembly.

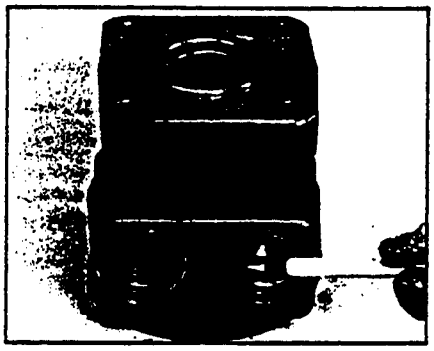


Figure 22

inspect housing bearing

21. If the housing assembly has passed inspection to this point, inspect the housing bearing (20) and retaining ring (19). The bearing rollers must be firmly retained in the bearing cage but must rotate and orbit freely. The full complement of rollers must be free of brinelling and corrosion. A bearing that does not pass this inspection must be replaced. SEE FIGURE 23.

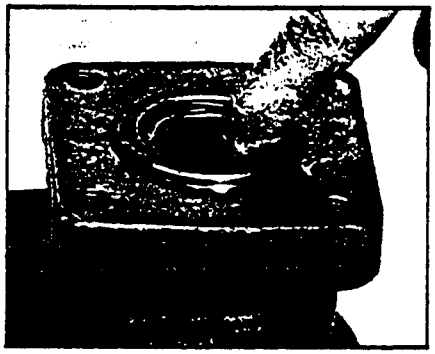


Figure 23

remove retaining ring & bearing

22. Only if the bearing (20) must be replaced, remove retaining ring (19) and press the bearing out of the mounting face end of the housing using a 1.300 inch (33.02 mm) maximum diameter shaft or appropriate bearing mandrel (reference FIG. 1). SEE FIGURE 24 & 25.

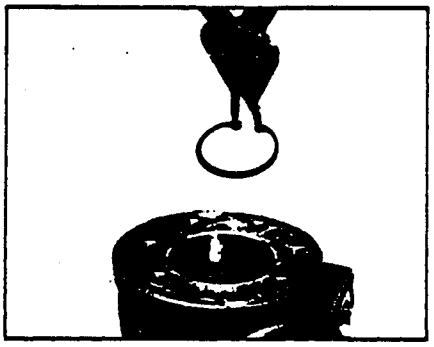


Figure 24

The MAG Torqmotor™ disassembly is now complete.

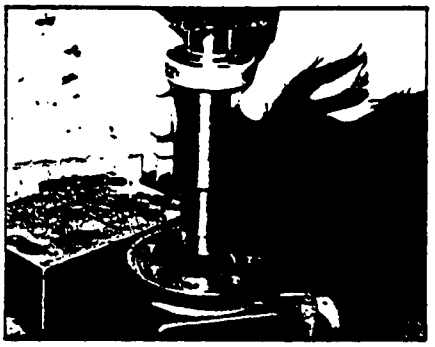


Figure 25

MAG Assembly

- Replace all seals and seal rings with new ones each time you reassemble the MAG unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.
- **NOTE: Individual seals and seal rings as well as a complete seal kit are available. SEE FIGURE 26. The parts should be available through most OEM parts distributors or Ross approved MAG distributors. (Contact your local dealer for availability).**
- **NOTE: Unless otherwise indicated, do not oil or grease parts before assembly.**
- Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, sleeve, and housing and from port and sealing areas.

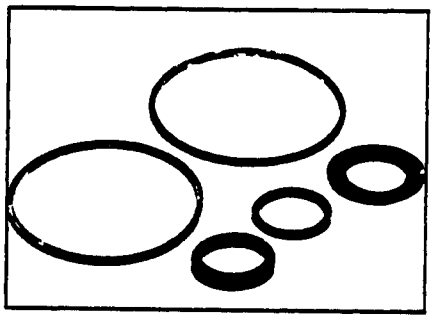


Figure 26

WARNING

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

WARNING

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

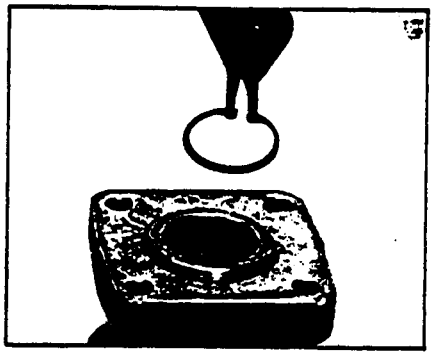


Figure 27

install retaining ring

1. If the housing (18) has been completely disassembled, place the housing, mounting flange end up, on a clean work surface. Install retaining ring (19) into the housing retaining ring groove. Be sure the rounded edge of retaining ring is facing in toward the larger housing cavity. Use appropriate retaining ring pliers. SEE FIGURE 27.

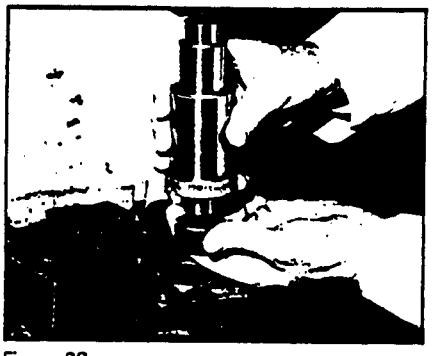


Figure 28

press in bearing

2. Thoroughly grease the rolls of a NEW bearing (20) with clean corrosion resistant grease recommended in the material section, Page 7A. Press the bearing into housing (18) from the mounting flange end of the housing bore, using bearing mandrel (special tool FIG. 1, Page 7A) against the lettered end of the bearing shell. SEE FIGURE 28 & 29. Take care during this procedure that the housing is square with the press base and that the bearing is not cocked. The bearing mandrel will control the bearing press depth to the required .135/.125 inches (3.43/3.18 mm) from the flange end of the housing.

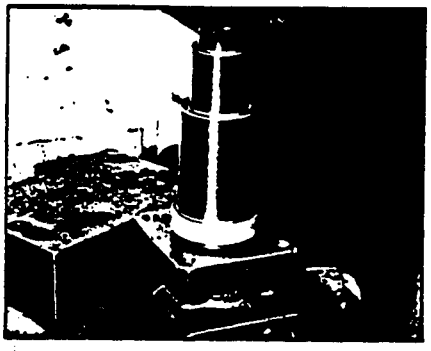


Figure 29

NOTE

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

CAUTION

CAUTION: The controlled press depth of bearing (20) into the housing is required to ensure adequate bearing support, and correct bearing relationship to adjacent components when assembled.

CAUTION

CAUTION: Because the bearing (20) has a press fit into the housing, it must be discarded if removed from the housing. It must not be reused.

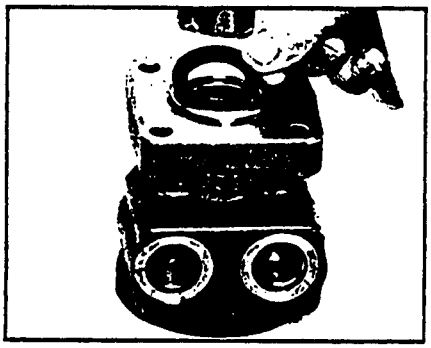


Figure 30

insert dirt & water seal

3. Place housing (18), wearplate surface down, on a clean work surface. Apply a small amount of clean grease to a NEW dirt and water seal (21) and press the seal into the housing seal cavity. The end of a hammer handle would be an appropriate tool. Be sure the seal is not cocked or deformed as it enters housing seal bore. SEE FIGURE 30.

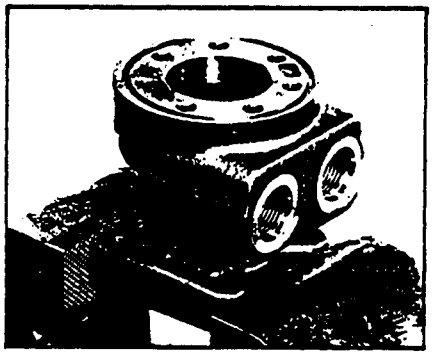


Figure 31

place housing assembly into vise

4. Place housing (18) assembly into a soft-jawed vise with coupling shaft bore down, and clamp the vise jaws against the edges of the mounting flange. SEE FIGURE 31.

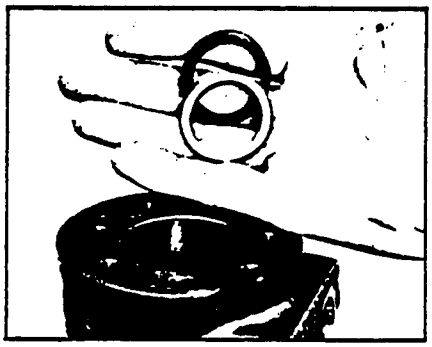


Figure 32

install backup washer & seal

5. Apply a small amount of clean grease to a NEW seal (16). Install a NEW spacer (17) then seal (16) into housing coupling shaft bore from the sleeve end of the housing (18). Seat the spacer against the retaining ring (19) and the seal against the spacer, with the seal lip facing away from the spacer. SEE FIGURE 32.

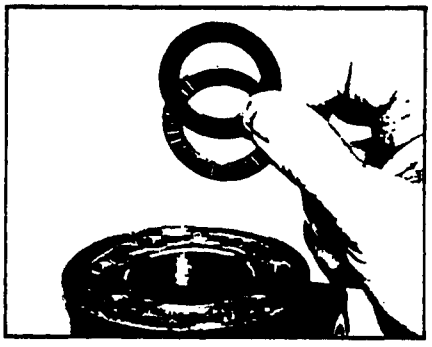


Figure 33

install thrust washer & thrust bearing

6. Install the thrust washer (15) and then the thrust bearing (14) into housing (18), until they are seated at the bottom of the counterbore. SEE FIGURE 33.

install coupling shaft

7. Be sure that a generous amount of a clean corrosion resistant grease, recommended in the materials section, Page 7A, is applied to housing bearing (20). Then install coupling shaft (12) into housing (18), seating it against thrust bearing (14). SEE FIGURE 34.

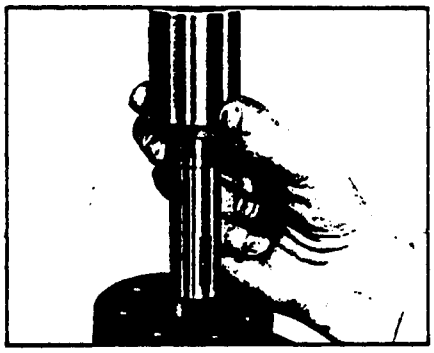


Figure 34

NOTE

NOTE: The coupling shaft must be flush with or below the housing surface when properly seated and rotate smoothly on the thrust bearing package.

insert seal ring

8. Apply a small amount of clean grease to a NEW seal ring (4) and insert it into the housing (18) seal ring groove. SEE FIGURE 35.

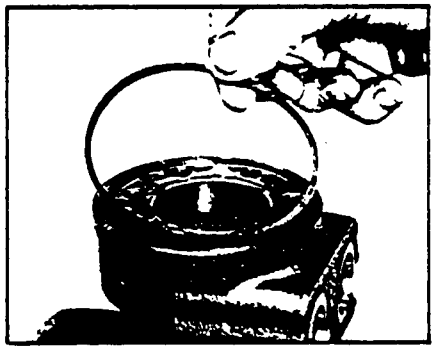


Figure 35

install drive link

9. Install drive link (11), pin end up, into coupling shaft (12) and engage drive link splines into mesh with coupling shaft splines. SEE FIGURE 36.

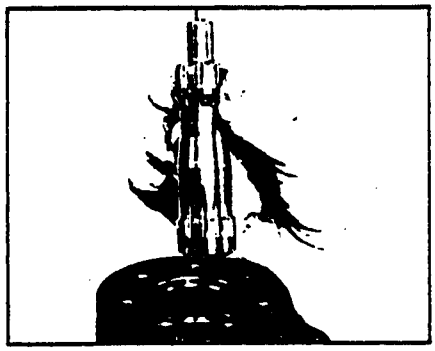


Figure 36

assemble spacer

10. Assemble wearplate (10) onto the housing (18) with recessed (cavity) side down and bolt holes aligned. SEE FIGURE 37.

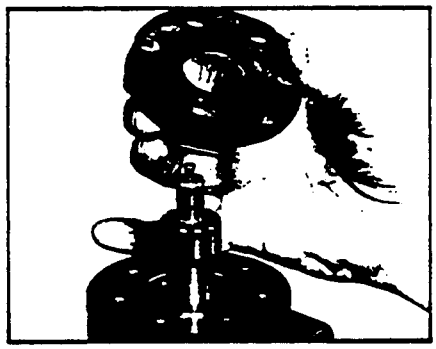


Figure 37

assemble rotor set

11. Assemble rotor set (9) onto wearplate (10) with rotor (9.1) counter bore side down and splines into mesh with drive link (11) splines. SEE FIGURE 38. Align stator bolt holes.

NOTE

NOTE: The rotor set counterbore side must be down against wearplate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore can be reinstalled using the drive link spline contact pattern on the rotor splines to determine which side was down.

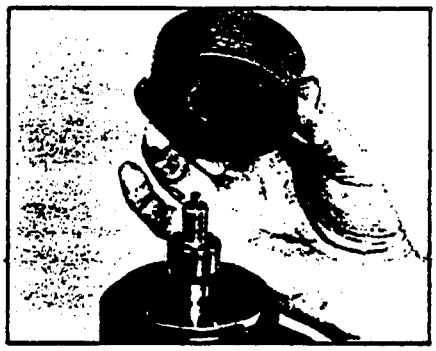


Figure 38

assemble manifold

12. Assemble manifold (8) onto the rotor set (9) so that the side with slots closest to the inside diameter is up. SEE FIGURE 39. Align bolt holes.



Figure 39

assemble commutator ring

13. Assemble commutator ring (7) either side up onto manifold (8) and align bolt holes. SEE FIGURE 40.



Figure 40

assemble commutator

14. Assemble commutator (6) onto manifold (8) with counterbore (washer recess) side up. The elongated hole must be engaged over the drive link (11) pin. SEE FIGURE 41.



Figure 41

assemble sleeve

15. Assemble sleeve (5) over the stacked components onto the housing (18). SEE FIGURE 42.

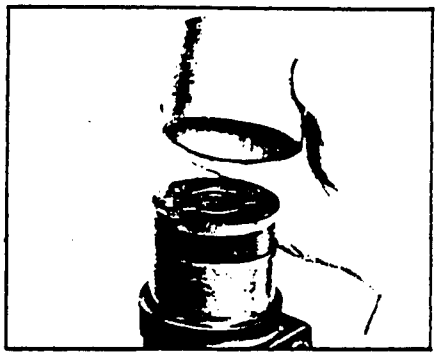


Figure 42

assemble washer

16. Assemble a generous amount of clean grease to washer (3) and assemble washer over pin in end cover assembly (2). SEE FIGURE 43.

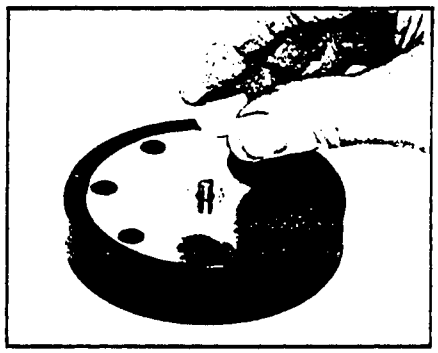


Figure 43

assemble seal ring

17. Apply a small amount of clean grease to a NEW seal ring (4) and insert it into the cover assembly (2) seal ring groove. SEE FIGURE 44.

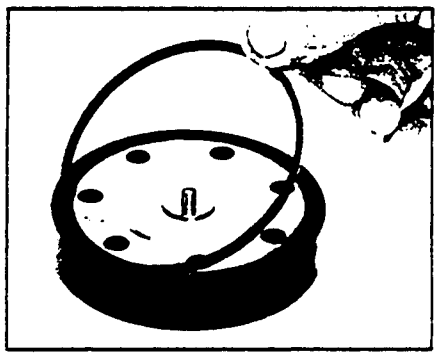


Figure 44

assemble end cover assembly

18. Assemble end cover assembly (2) with washer (3) and seal ring (4) attached onto the sleeve (5) and commutator set. The cover pin must be inserted into the center hole in the commutator (6) and the bolt holes aligned. SEE FIGURE 45.



Figure 45

NOTE

NOTE: It may be necessary to use one or two bolts (1) as probes to align the bolt holes of the components for bolt installation.

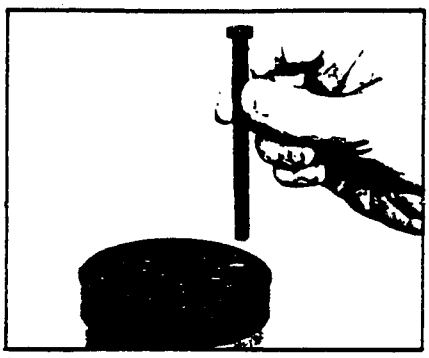


Figure 46

install and torque bolts

19. Install 7 bolts (1) into the assembly bolt holes finger tight, then torque the bolts to 22-26 foot pounds, (30-35 N m), in the sequence shown, using a 1/2 inch, thin wall socket and appropriate torque wrench. SEE FIGURES 46, 47, 48.

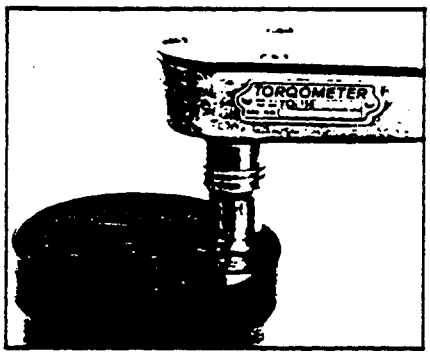


Figure 47

The assembly of the MAG Tormotor™ is now complete, except for woodruff key (13) and/or two port manifold O-Rings (18.1) if applicable at Torqmotor installation. See Page 21 for final checks.

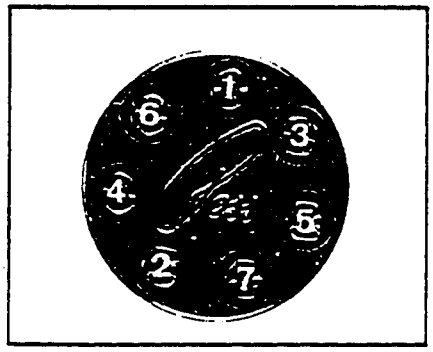


Figure 48

Final Checks

Final Checks

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

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

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

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

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

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

Tips for Maintaining the Torqmotor™ Hydraulic System

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

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

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

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

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

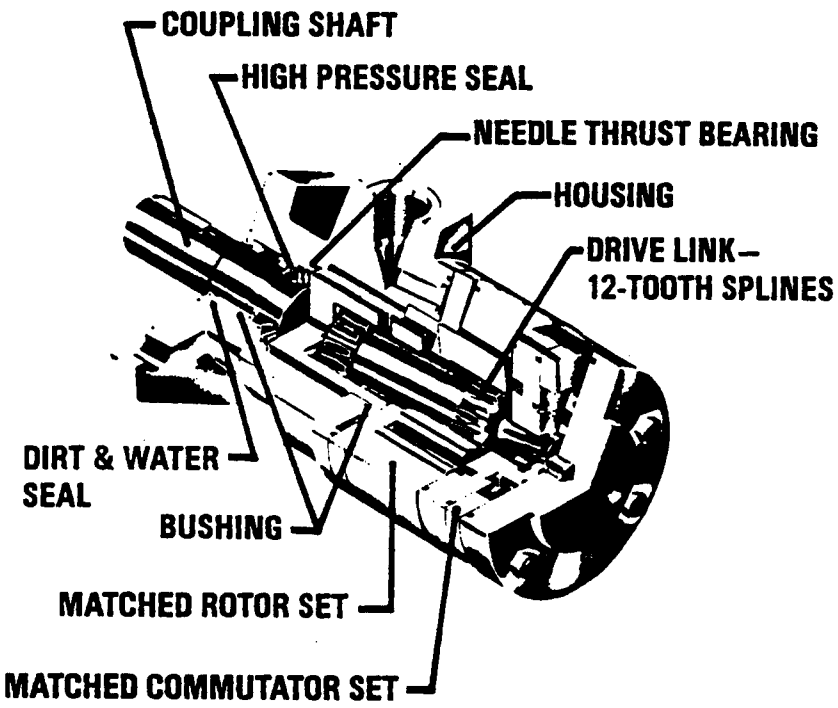
Ross Gear extends close technical cooperation and assistance. If problems occur which you cannot solve, please contact our Ross Service Department or local Ross approved Distributor. Our phone number and telex number and address are on the back cover of this manual.

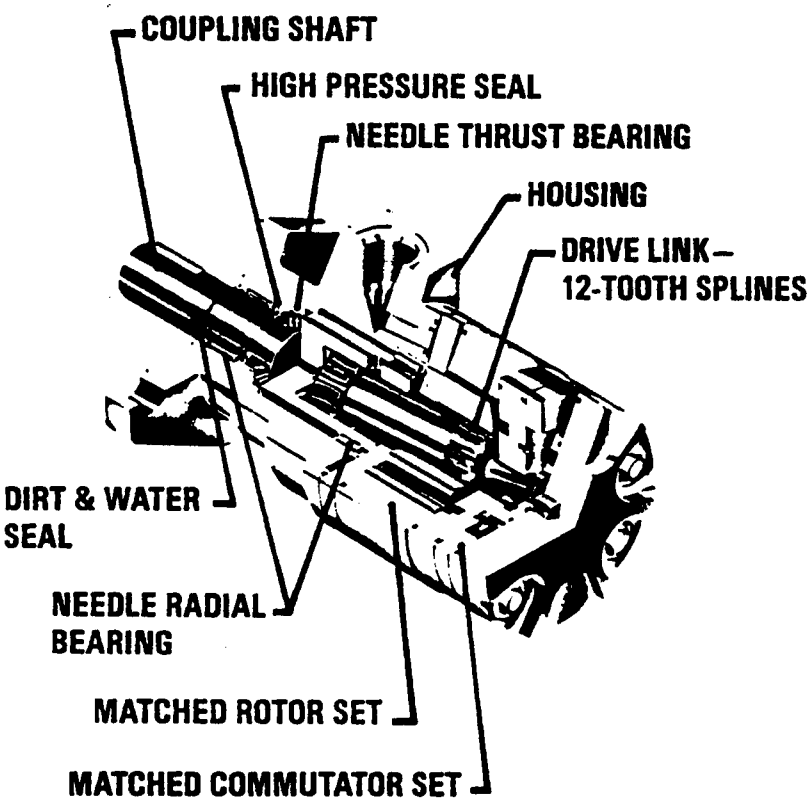
Torqmotor™

Service Procedure

MG, MF, MB, ME Series

Torqmotor™ Design Features





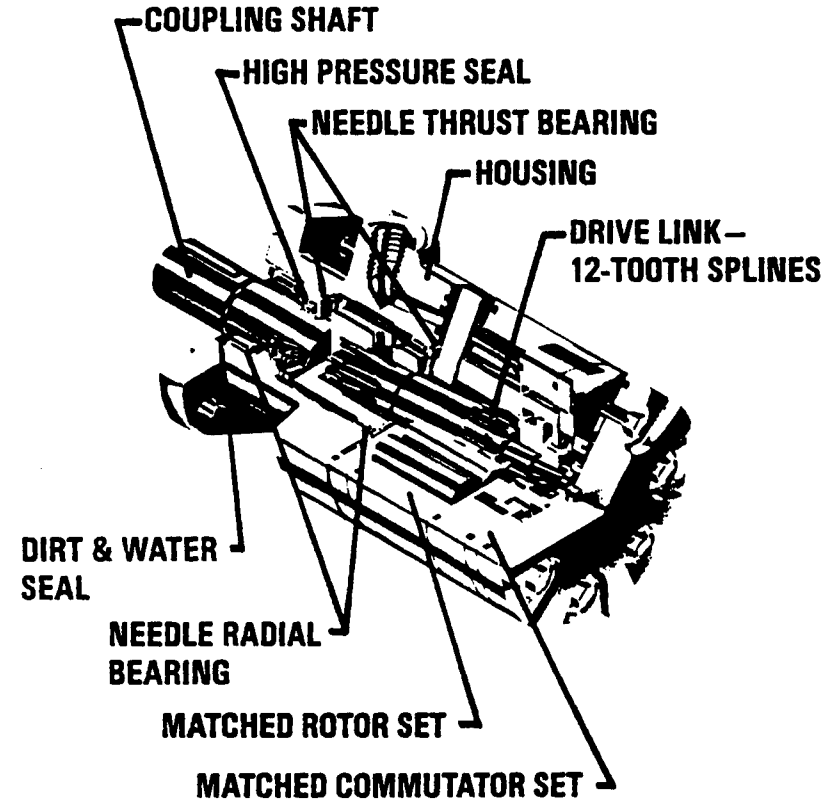
Torqmotor™ MG Series features include:

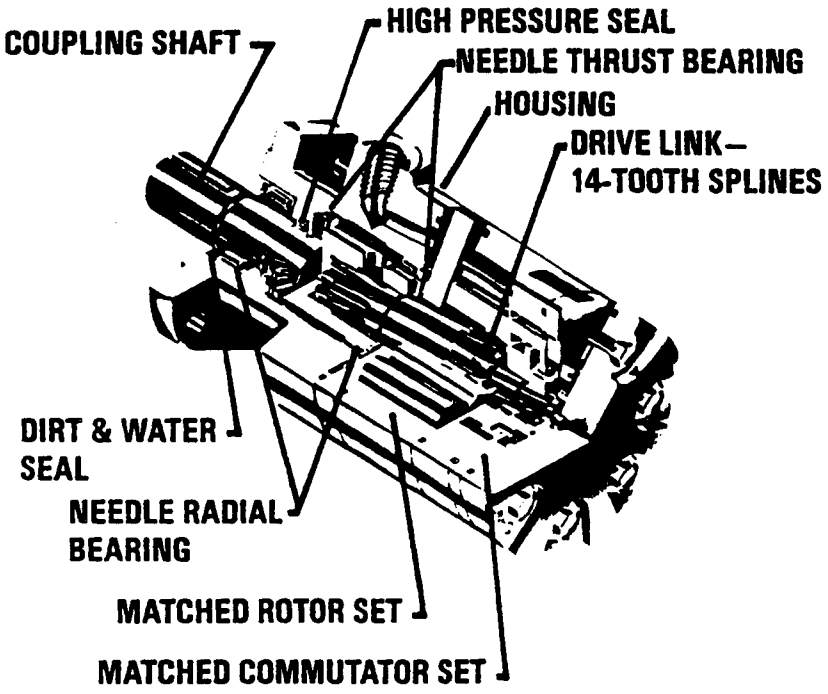
- The roller vane rotor set design offers a low-friction, wear compensation which maximizes the useful performance life of the motor.
- **Zero leak** commutation valve provides greater, more consistent volumetric efficiency.
- Design flexibility - MG offers the widest selection of shaft options, displacements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

Torqmotor™ MF Series features include:

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

Torqmotor™ Design Features





Torqmotor™ MB Series features include:

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

Torqmotor™ ME Series features include:

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

Definitions

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

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

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

Disclaimer

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

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

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

Patents

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

Table of Contents

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

Introduction

Service Manual for Series MG, MF, MB, ME

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

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

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

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

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

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

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

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

Troubleshooting Guide

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

Preparation

Make your troubleshooting easier by preparing as follows:

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

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

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

Preliminary Checks

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

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

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

Hydraulic Components

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

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

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

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

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

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

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

Troubleshooting Checklist

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

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

Tools and Materials Required for Servicing

MG, MF, MB, ME Series Service Manual

Clean, petroleum-based solvent

Emery paper

Vise with soft jaws

Air pressure source

Arbor press

Screw driver

Masking tape

Breaker bar

Torque wrench—ft. lbs. (N m)

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

Allen Sockets: 3/16, 3/8 inch

Adjustable crescent wrench or hose fitting wrenches

SAE 10W40 SE or SF oil

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

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

Feeler gage .005 inch (.13 mm)

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

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

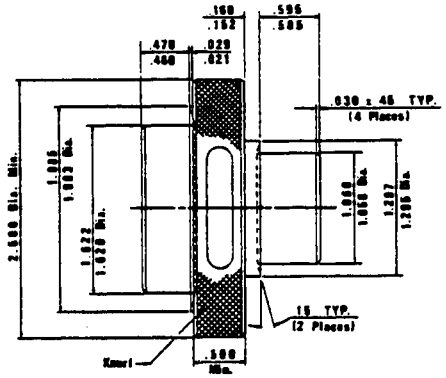
Clean corrosion resistant grease. Recommended grease is E/M Lubricant #K-70M, Ross Gear Specification #045236

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

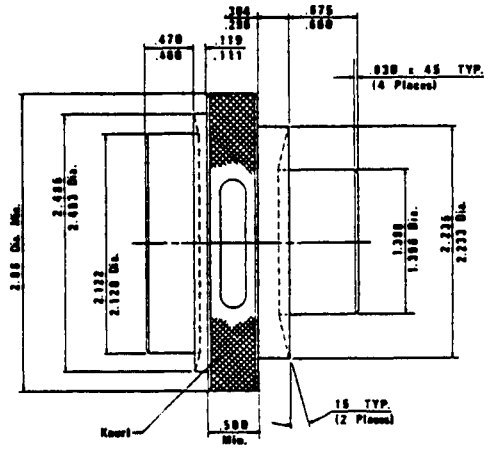
CAUTION: Mixing greases that have different bases can be detrimental to bearing life.

CONVERSIONS

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



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

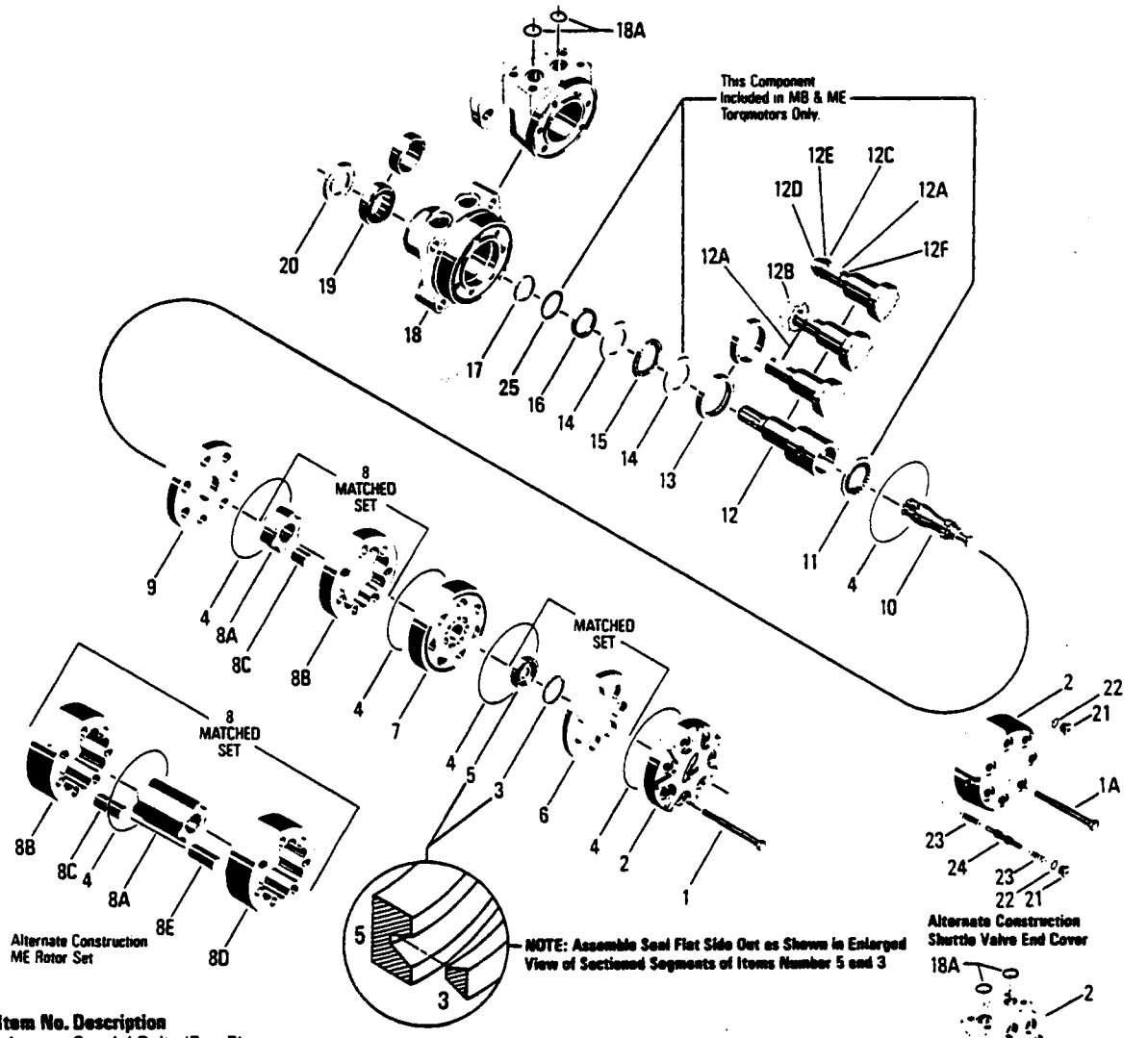


(Fabricate if considered necessary)
FIGURE 2—MB & ME

Torque Chart

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

Torqmotor™ Exploded Assembly View—Typical



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

Disassembly and Inspection

(Preparation Before Disassembly)

- Before you disassemble the Torqmotor unit or any of its components read this entire manual. It provides important information on parts and procedures you will need to know to service the Torqmotor.
- Determine whether the Torqmotor you are about to disassemble is the Small Frame Series MG or MF or the Large Frame Series MB or ME so you can follow those procedures that pertain to that Series Torqmotor. The first two letters of the "spec" number on the Torqmotor identification tag is the Series designation. Also determine the type of end cover construction from the alternate views shown on page 7A and 7B.
- The Small Frame Series MG & MF Torqmotors will have a 3.66 inch (92.9 mm) main body outside diameter and five 5/16-24 UNF 2A cover bolts. The Large Frame Series MB & ME Torqmotors will have a 5 inch (127.0 mm) main body outside diameter and seven 3/8 24 UNF 2A cover bolts.
- Refer to page 7 for tools and other items required to service the Torqmotor and have them available.
- Thoroughly clean off all outside dirt, especially from around fittings and hose connections, before disconnecting and removing the Torqmotor. Remove rust or corrosion from coupling shaft.
- Remove coupling shaft connections and hose fittings and immediately plug port holes and fluid lines.
- Remove the Torqmotor from system, drain it of fluid and take it to a clean work surface. (A piece of wrapping paper makes an excellent disposable top.)
- Clean and dry the Torqmotor before you start to disassemble the unit.
- As you disassemble the Torqmotor clean all parts, except seals, in clean petroleum-based solvent, and blow them dry.

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

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

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

- Keep parts separate to avoid nicks and burrs.
- Discard all seals and seal rings as they are removed from the Torqmotor. Replace all seals, seal rings and any damaged or worn parts with genuine Ross or OEM approved service parts.

Disassembly and Inspection

(Reference Exploded Assembly View)

place Torqmotor in a vise

1. Place the Torqmotor in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

WARNING

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

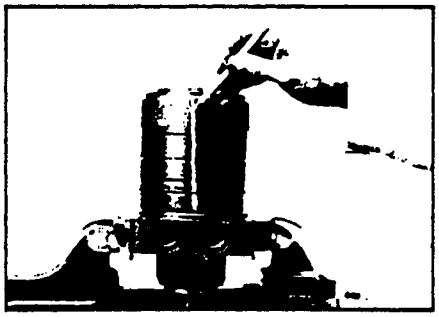


Figure 3

scribe alignment mark & loosen valve plugs

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

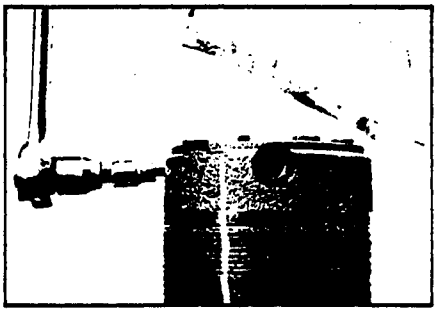


Figure 4

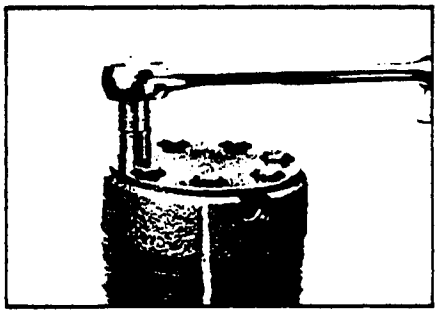


Figure 5

remove special bolts & inspect bolts

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

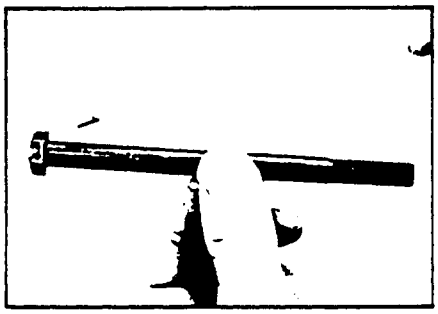


Figure 6

remove end cover & inspect bolts

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

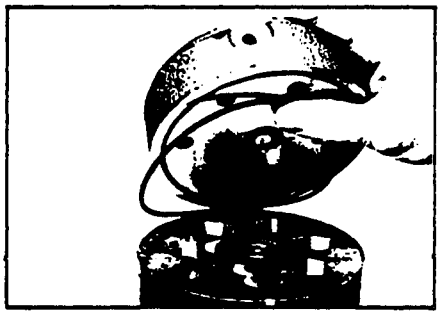


Figure 7

NOTE

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

remove plugs and valves

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

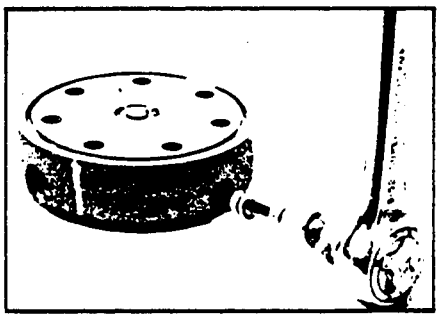


Figure 8

CAUTION

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

NOTE

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

NOTE

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

wash & inspect end cover

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

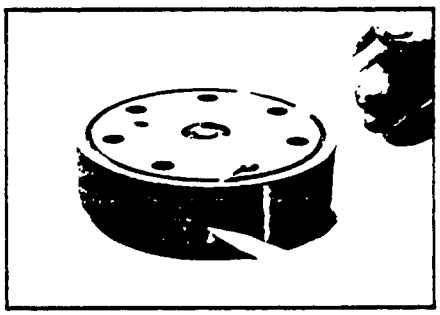


Figure 9

NOTE

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



Figure 10

remove & inspect commutator ring

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

remove & inspect commutator

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



Figure 11

remove manifold

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

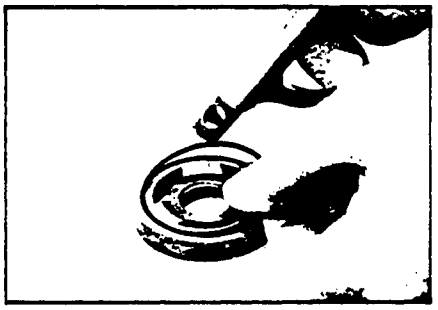


Figure 12

NOTE

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

remove & inspect rotor set & wearplate

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



Figure 13

NOTE

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

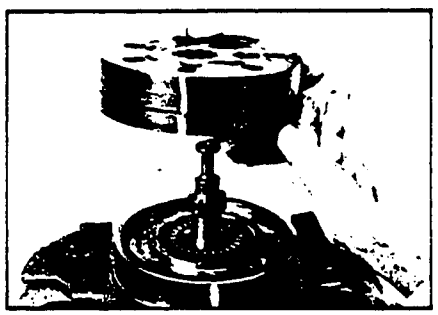


Figure 14

NOTE

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

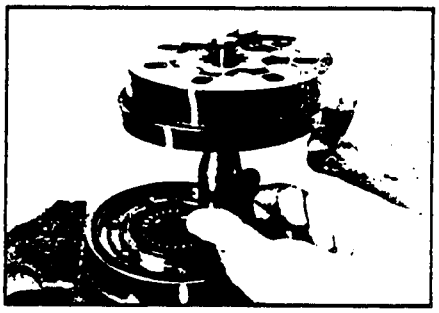


Figure 15

NOTE

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

check rotor, vane clearance

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

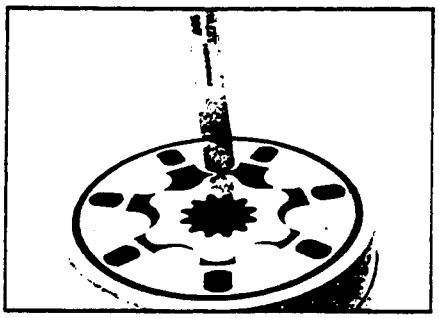


Figure 16

NOTE

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

remove & inspect drive link

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

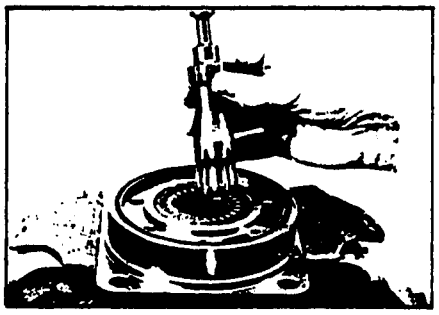


Figure 17

remove thrust bearing

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

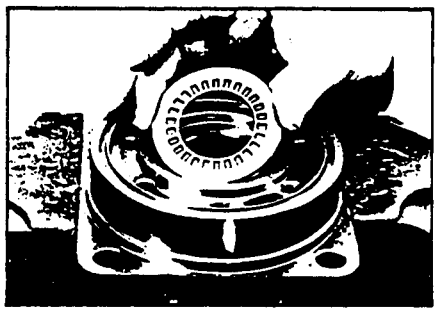


Figure 18

check coupling shaft for rust or corrosion

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

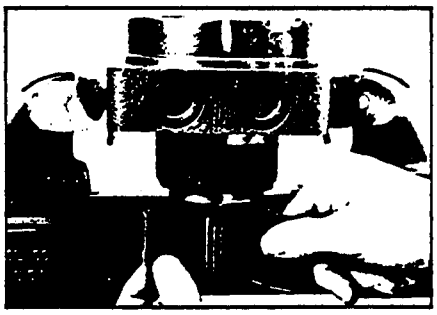


Figure 19

remove & inspect coupling shaft

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

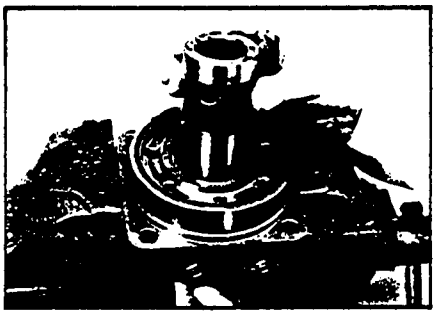


Figure 20

NOTE

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

NOTE

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

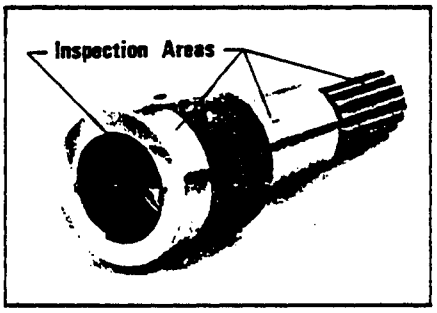


Figure 21

remove seal ring from housing

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

remove & inspect thrust washer & thrust bearing

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

NOTE

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

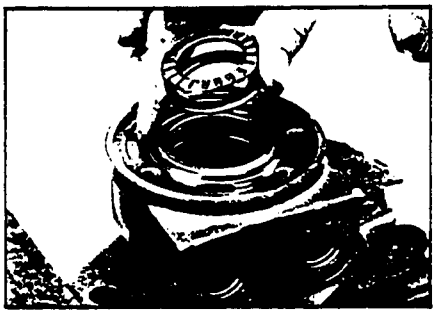


Figure 22

remove seal & washer or washers

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

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

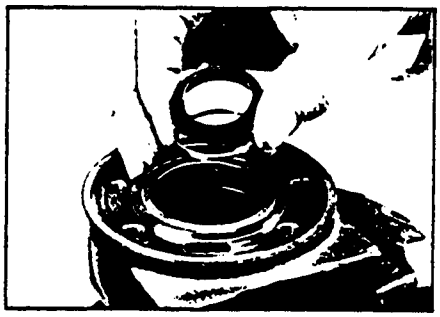


Figure 23

NOTE

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



Figure 24

remove seal

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

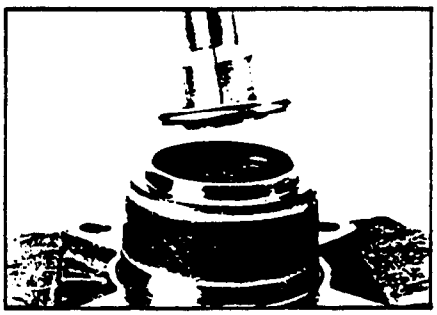


Figure 25

inspect housing assembly

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

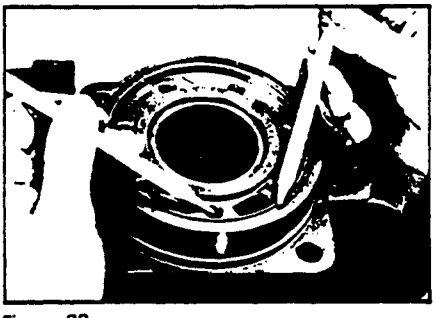


Figure 26

inspect housing bearing/bushing

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

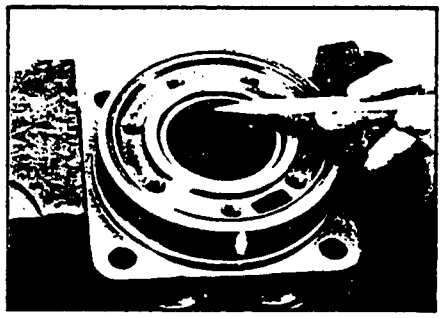


Figure 27

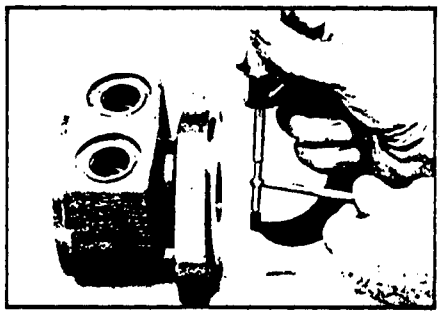


Figure 28

NOTE

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

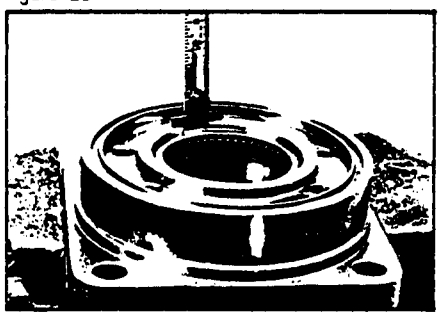


Figure 29

remove bearings or bushings & thrust washers

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

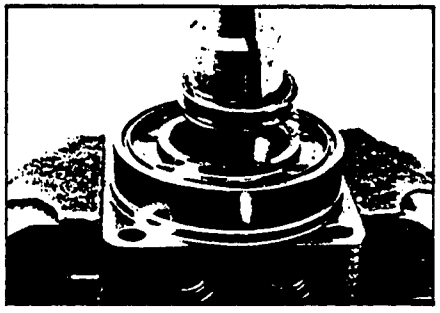


Figure 30

THE DISASSEMBLY OF TORQMOTOR IS COMPLETED.

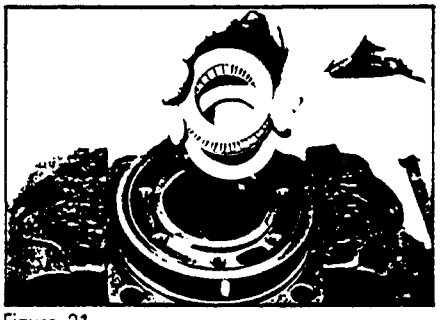


Figure 31

Torqmotor™ Assembly

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

WARNING

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

WARNING

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

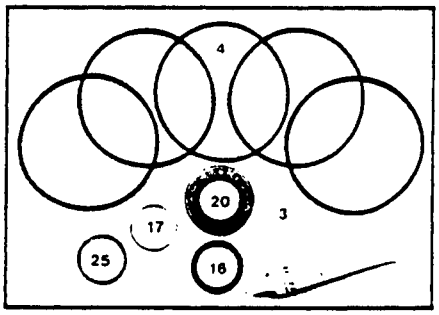


Figure 32 MB, ME seal kit

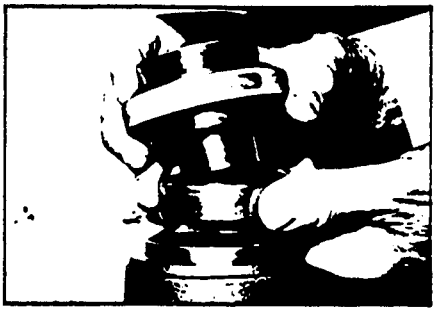
press in outer bearing/bushing

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

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


Figure 33

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


Figure 34

NOTE

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

CAUTION

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

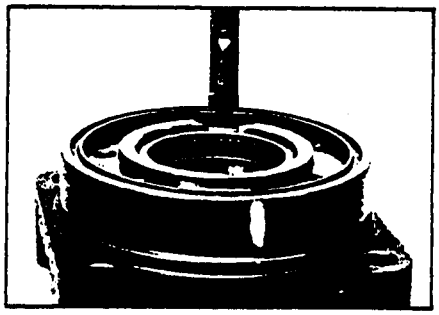


Figure 35

CAUTION

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

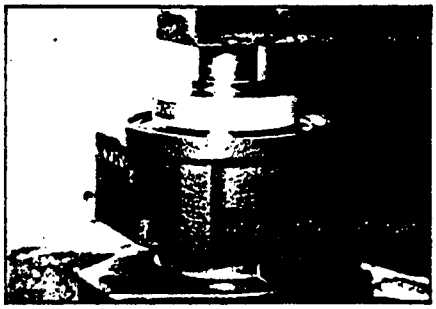


Figure 36

press in inner bearing/bushing

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



Figure 37

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

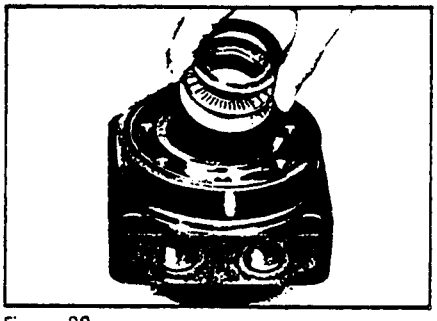


Figure 38

press in dirt & water seal

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

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

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



Figure 39

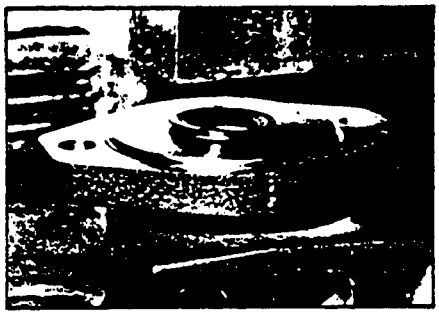


Figure 40

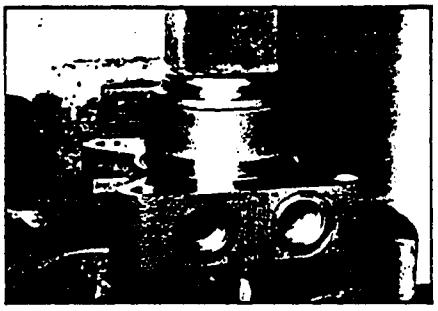


Figure 41

place housing assembly into vise

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

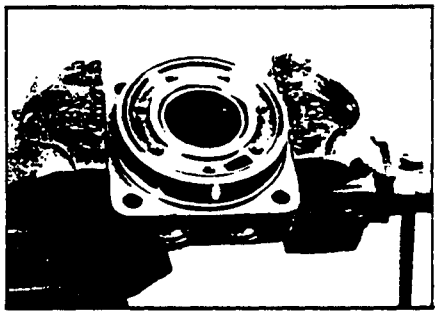


Figure 42

assemble backup washer & seal

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

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

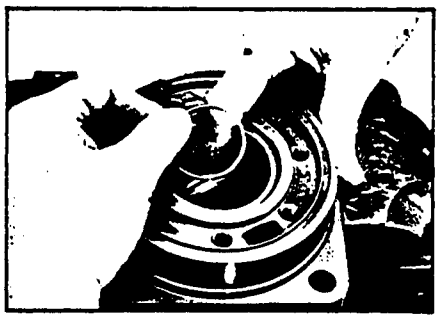


Figure 43

CAUTION

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

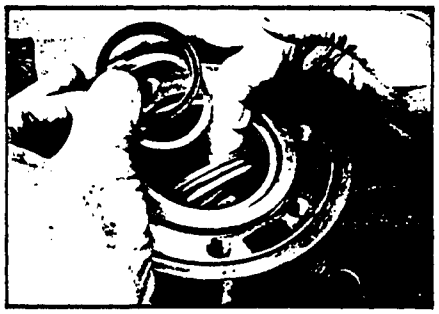


Figure 44

assemble thrust washer & bearing

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

NOTE

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

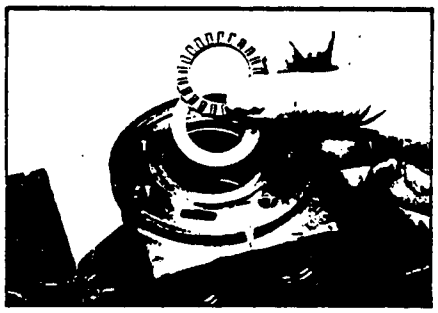


Figure 45

apply masking tape to shaft

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

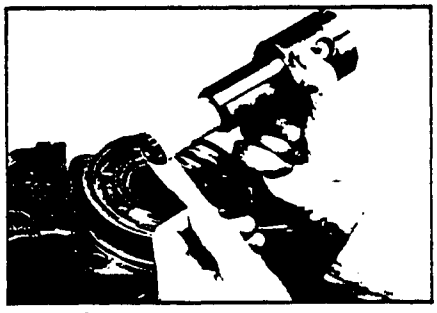


Figure 46

install coupling shaft

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

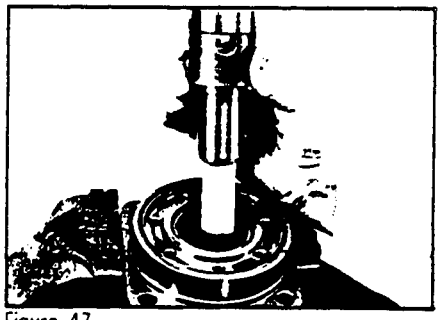


Figure 47

CAUTION

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

NOTE

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

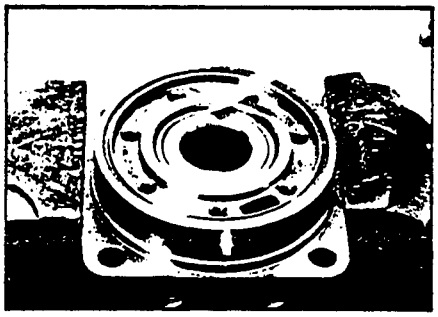


Figure 48

install thrust bearing

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



Figure 49

insert seal ring

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

NOTE

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

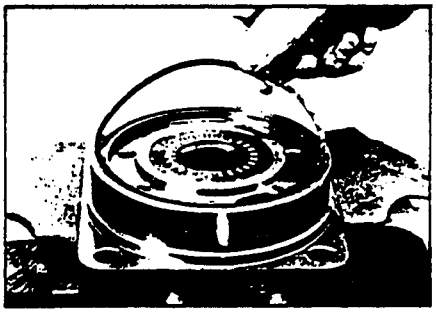


Figure 50

install drive link

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

NOTE

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

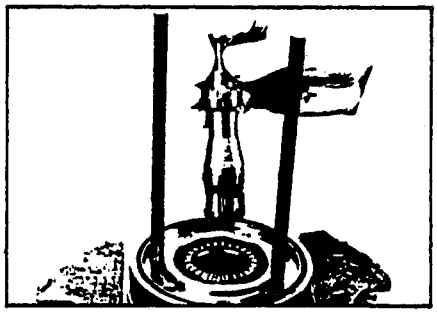


Figure 51

assemble wear plate

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

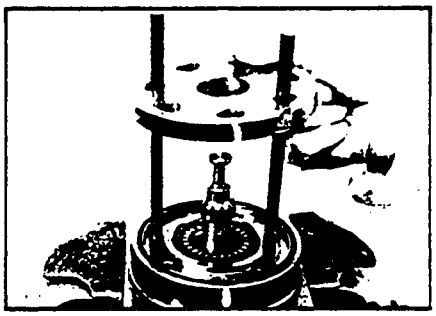


Figure 52

assemble seal ring

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

install the assembled rotor set

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

NOTE

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

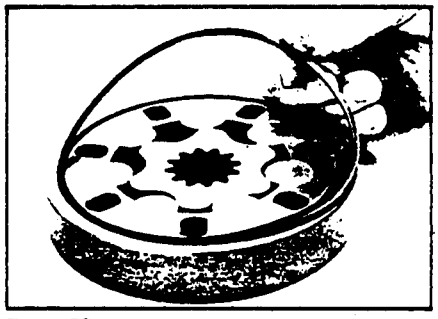


Figure 53

NOTE

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

NOTE

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

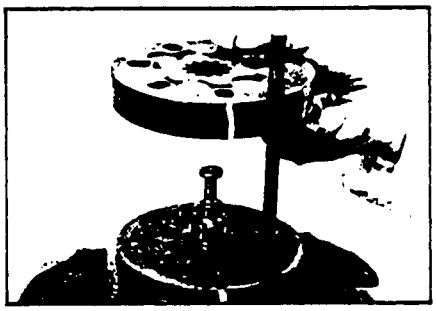


Figure 54

assemble seal ring in manifold

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

NOTE

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



Figure 55

assemble manifold

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

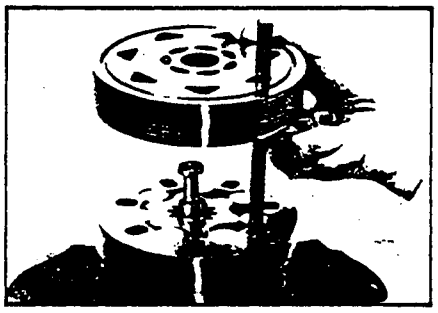


Figure 56

insert a seal in manifold

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



Figure 57

assemble commutator ring

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

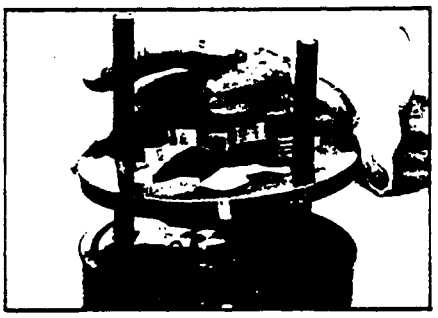


Figure 58

assemble seal & commutator

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

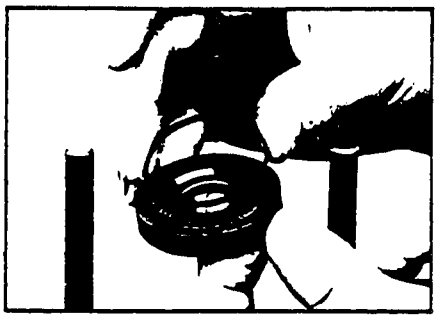


Figure 59

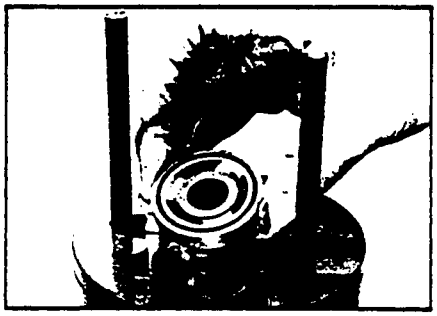


Figure 60

assemble shuttle valve parts into end cover

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

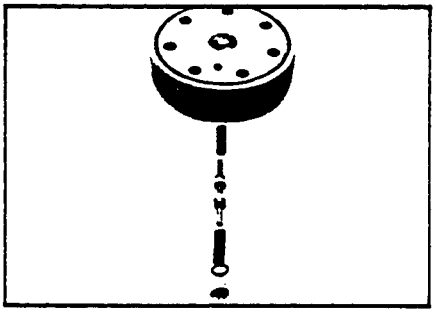


Figure 61

assemble relief valve parts in end cover

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

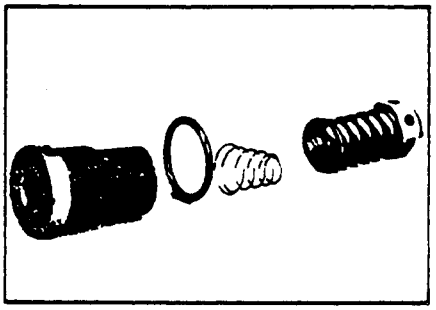


Figure 62

assemble seal ring & end cover

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

NOTE

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

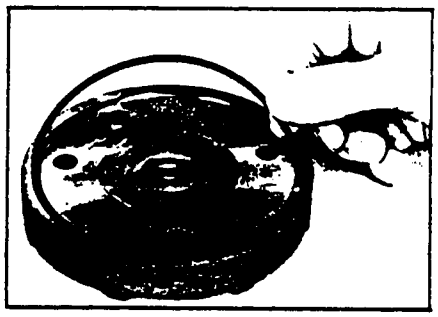


Figure 63

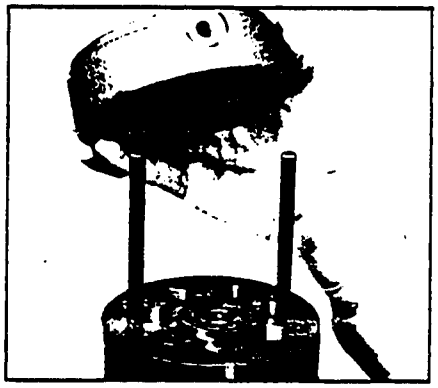


Figure 64

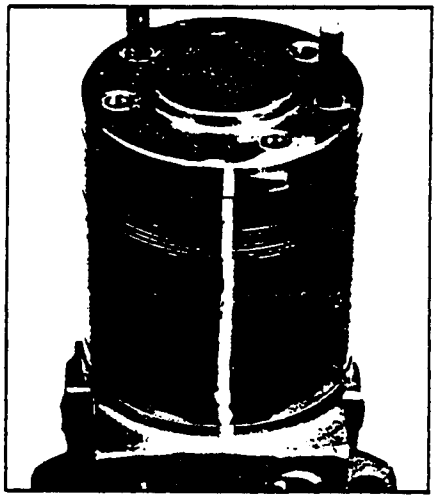


Figure 65

assemble cover bolts

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

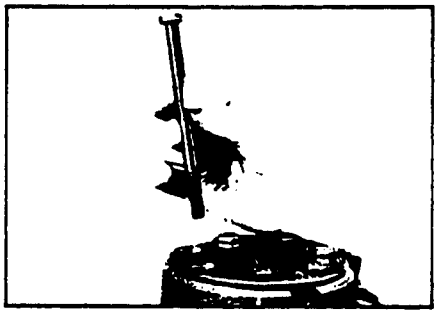


Figure 66

NOTE

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

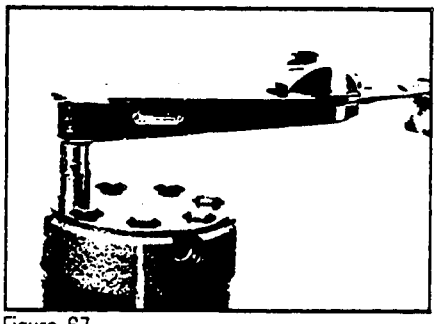


Figure 67

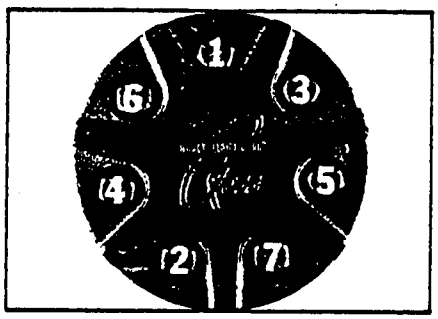


Figure 68

torque the valve plugs

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

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

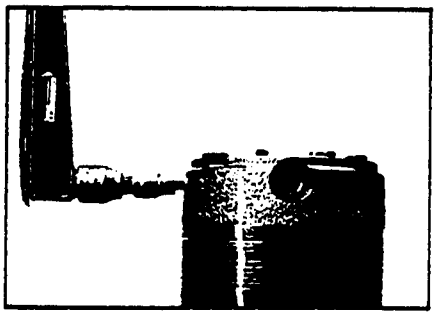


Figure 69

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

Rotor Set Component Assembly Procedure

One Piece Stator Construction

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

assemble stator

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

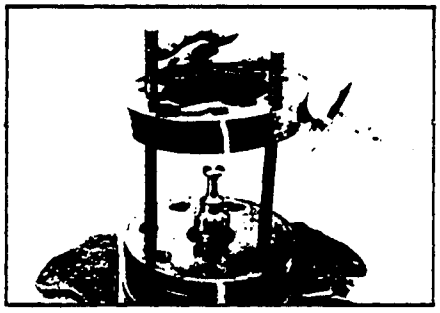


Figure 70

insert two bolts

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

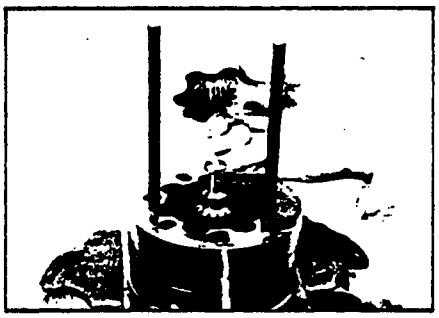


Figure 71

assemble rotor

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

NOTE

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

assemble vanes

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



Figure 72

CAUTION

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

assemble full complement of vanes

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

remove two assembled bolts

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

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

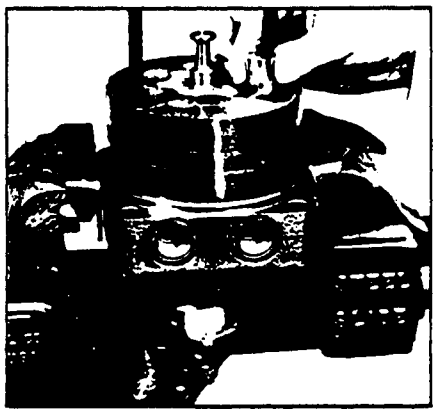


Figure 73

Rotor Set Component Assembly Procedure

Two Piece Stator Construction

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

assemble stator halfs

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

insert two alignment studs

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

assemble rotor

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

NOTE

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

assemble vanes

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

CAUTION

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

assemble full complement of vanes

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

assemble seal ring in stator half

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

assemble second stator half

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

CAUTION

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

assemble vanes

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

assemble full complement of vanes

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

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

Final Checks

Final Checks

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

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

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

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

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

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

Tips for Maintaining the Torqmotor™ Hydraulic System

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

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

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

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

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

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

TORQUE-HUB®

Final Drives

ASSEMBLY-DISASSEMBLY MANUAL

FOR THE

S1C

UNIT

INTRODUCTION

This manual is a step-by-step guide to assembly and disassembly of torque-hub units. It is designed for the customer or shop mechanic who is repairing a particular model of torque-hub final drive.

Users of this manual should note that each part mentioned is followed by an identification number enclosed in parentheses. These part numbers may be referred to in the Parts List section of this manual and on the cross-sectional view of this unit.

Any specialized tools normally used to assemble this unit are noted in the assembly procedures and diagrammed in the tooling section. However, it is not mandatory that these tools be used in this unit's assembly. Bearing cups and cones can be pressed using a punch and hammer along their top edges. Seals can be pressed by laying a board flat on top of the seal and then hammering the board down until it meets the hub. Studs can be hammered into stud holes. Should you use these methods, be very careful not to damage parts when using a punch and/or hammer.

Users should familiarize themselves with the procedures for roll and leak testing and bolt tightening and torquing found on the following pages before getting started.

SAFETY

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

ROLL and LEAK TESTING

Torque-hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

The Roll Test

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for improper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

The Leak Test

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at the main seal or wherever "O" rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where "O" rings or gaskets meet the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, "O" ring, or gasket, the part must be replaced.

TIGHTENING and TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to insure that the bolts are not tightened beyond their specified torque. Never use an impact wrench to tighten shoulder bolts. All shoulder bolts should be tightened by hand.

The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.

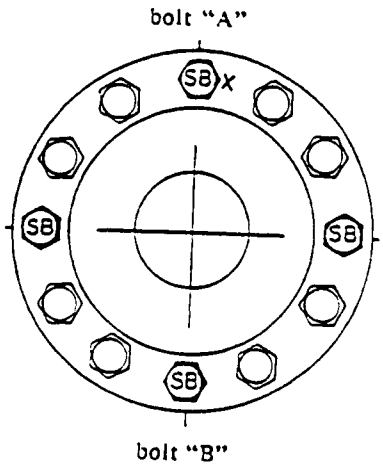
1. Tighten (but do not torque) bolt "A" until snug.

2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.

3. Continue around the bolt circle and tighten the remaining bolts.

4. Now use a torque wrench to apply the specified torque to bolt "A".

5. Continue around the bolt circle and apply an equal torque to the remaining bolts.



CONTENTS

Introduction, Safety I

Roll and Leak Testing I

Tightening and Torquing Bolts II

Main Disassembly 5

Carrier Disassembly 6

Carrier Sub-Assembly 7

Hub-Shaft Sub-Assembly 10

Main Assembly. 15

Tooling 20

Tool Prints 21

MAIN DISASSEMBLY

1. Remove the two **pipe plugs (13)** in **cover (6)** and drain the oil from the unit.

2. Loosen and remove the four **shoulder bolts (14)** and eight **grade 8 bolts (12)** from **cover (6)**.

3. Remove **cover (6)** from **hub (1G)**.

4. Remove **"O" ring (5)** from the counterbore in **cover (6)** and discard.

5. Remove **thrust washer (11)** from the counterbore in **carrier housing (3A)**.

6. Remove **input gear (9)** from mesh with **planet gears (3F)**.

CAUTION: **Safety glasses should be worn during this step:**
7. Using a punch, remove **retaining ring (20)** from the groove around the inside of **input gear (9)** and discard.

8. Lift **carrier sub-assembly (3)** out of **hub (1G)**.

9. Lift **ring gear (2)** off of **hub (1G)**.

10. Remove **"O" ring (5)** from the counterbore in **hub (1G)** and discard.

11. Remove the three **pipe plugs (1J)** from side of **hub (1G)**.

12. Apply a preload to **output shaft(1A)** in order to remove **retaining ring(1I)**. To do this, follow steps a-b:

a. Place bearing cone pressing tool (T-116407) on top of **retaining ring (1I)**.

b. Apply pressure to the fixture using a hydraulic ram or by striking the fixture with a soft face hammer. Pressure should be applied until the hub rotates with difficulty.

CAUTION: **Safety glasses should be worn during this step:**
13. Using retaining ring pliers, remove **retaining ring (1I)** and discard.

14. Remove **spacer (1H)** from **output shaft (1A)**.

15. Raise **hub (1G)** above your work surface and place a support underneath it in such a manner that **output shaft (1A)** will be able to fall through the bottom when pressed in next step.

16. Press **output shaft (1A)** out of **hub (1G)**. The output shaft may come out with **bearing cone (1D)** and **seal (1B)** attached. If so, remove **seal (1B)** from output shaft and discard. Use a soft punch and hammer to remove **bearing cone (1D)** from the shaft. Be very careful not to strike the shaft when using the punch.

17. If **seal (1B)** and **bearing cone (1D)** remain in the hub, press the seal and bearing cone out using a bearing cone pressing tool (T-116407). Discard the seal.

18. Lift **bearing cone (1F)** out of **hub (1G)**.

19. Stand **hub(1G)** on its small diameter end. Using a soft punch and hammer, remove **bearing cup (1C)** from the counterbore of **hub (1G)**. Be very careful not to strike the counterbore when using the punch.

20. Turn **hub (1G)** over so that it rests on its large end. Using a soft punch and hammer, remove **bearing cup (1E)** from the counterbore of **hub (1G)**. Be very careful not to strike the counterbore when using the punch.

21. At this point the main disassembly is complete.

CARRIER DISASSEMBLY

1. Locate **roll pin (3G)** which holds **planet shaft (3E)** in the **carrier housing (3A)**.

2. Drive the **roll pin (3G)** down into **planet shaft (3E)** until it bottoms against the carrier housing. If the roll pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

3. Remove **planet shaft (3E)** from **carrier housing (3A)**. The two **thrust washers (3B)** and **planet gear (3F)** will slide off.

4. Place **planet shaft (3E)** in a vise and drive **roll pin (3G)** out through the roll pin hole.

5. Remove the **needle rollers (3C)** and **spacer (3D)** from inside **planet gear (3F)**.

6. Repeat steps 1-5 to remove and disassemble the two remaining planet gears.

7. At this point the carrier disassembly is complete.

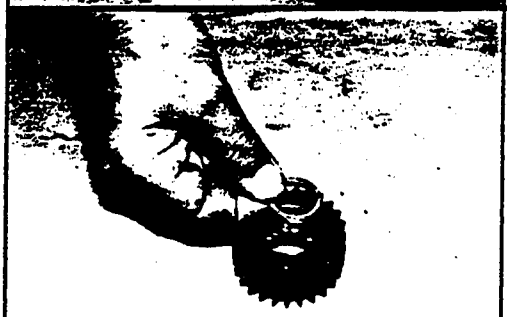
CARRIER SUB-ASSEMBLY



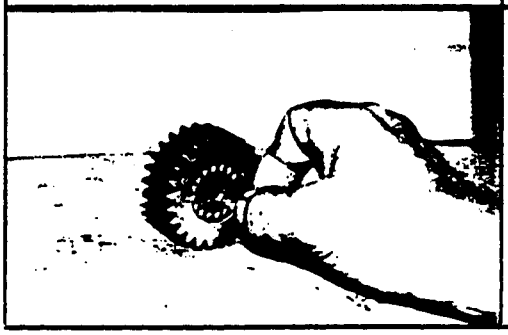
1. Apply grease to the inside of one **planet gear (3F).**



2. Line one half of **planet gear (2F)** with 16 **needle rollers (3C).**

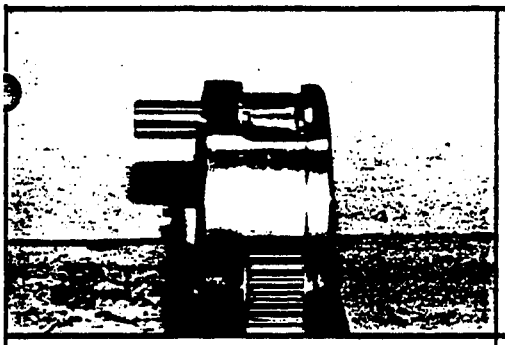


3. Place one **spacer (3D)** inside **planet gear (3F)** so that it rests on top of the **needle rollers (3C).**

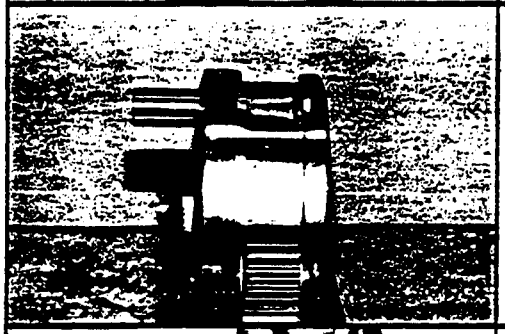


4. Line the remaining half of **planet gear (3F)** with 16 **needle rollers (3C).**

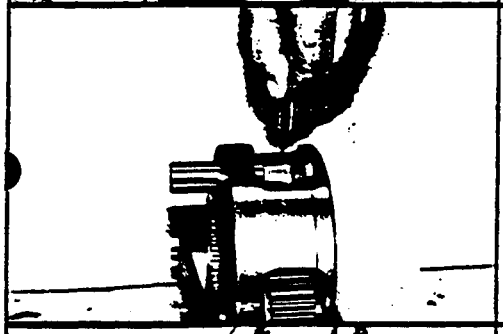
Carrier Sub-Assembly



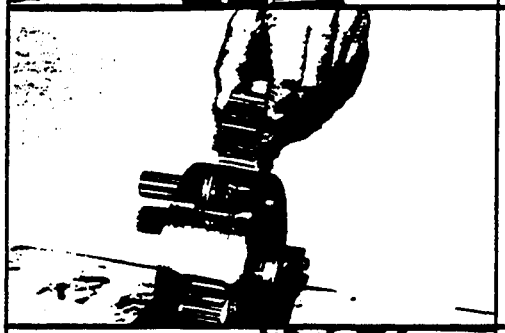
5. Stand **carrier housing** (3A) in an upright position.



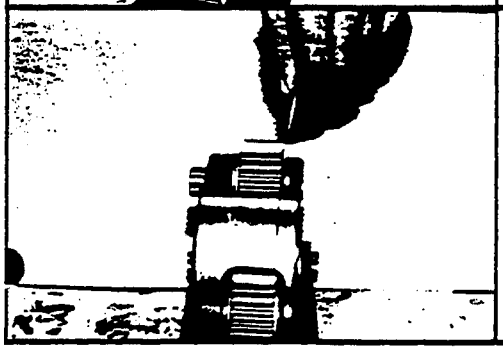
6. Insert a **planet shaft** (3E) into one of the planet shaft holes which also has a roll pin hole on **carrier housing** (3A). The end of the planet shaft that does not have the roll pin hole should be inserted into the carrier housing first.



7. Place one **thrust washer** (3B) onto the end of **planet shaft** (3E) which has been inserted through the planet shaft hole. Notice that the thrust washer has a tang on it: the tang should point straight down so as to fit within the space in the raised inside edge of the planet shaft hole.

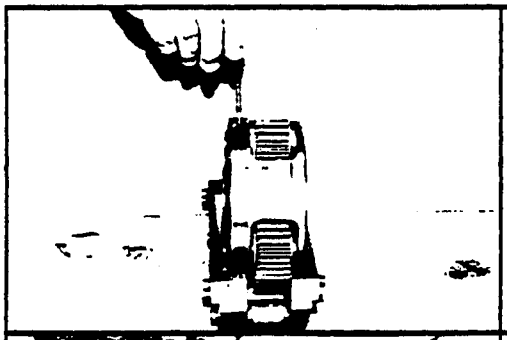


8. Following the thrust washer, place assembled **planet gear** (3F) onto **planet shaft** (3E).

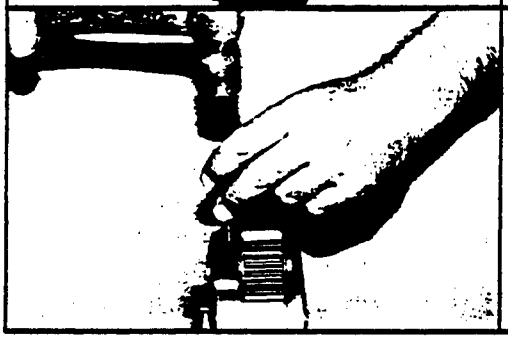


9. Following the planet gear, place one more **thrust washer** (3B) onto **planet shaft** (3E). Now insert planet shaft (3E) through the opposite planet shaft hole on **carrier housing** (3A).

Carrier Sub-Assembly



10. Use an alignment punch or similar tool to align the roll pin holes on the **carrier housing (3A)** and **planet shaft (3E)**.



11. Drive **roll pin (3G)** down into the aligned roll pin holes.

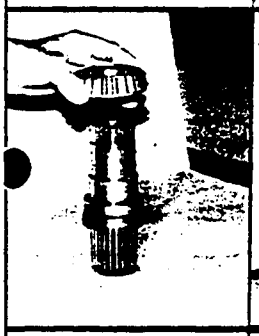
12. Repeat steps 1-11 to assemble and install the two remaining planet gears.

13. At this point the carrier sub-assembly is complete.

HUB-SHAFT SUB-ASSEMBLY



1. Oil **output shaft (1A)** and **bearing cone (1D)**.



2. Using bearing cone pressing tool (T-116407), press **bearing cone (1D)** onto the end of **output shaft (1A)** that has the retaining ring groove.



3. Stand **hub (1G)** on its small end. Using bearing cup pressing tool (T-116412), press **bearing cup (1E)** down into **hub (1G)**.

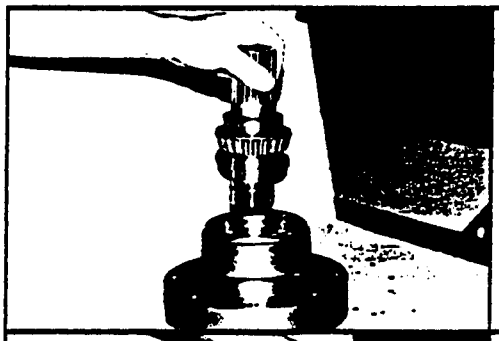
NOTE: Make sure that the cup sits square with the counterbore before pressing.



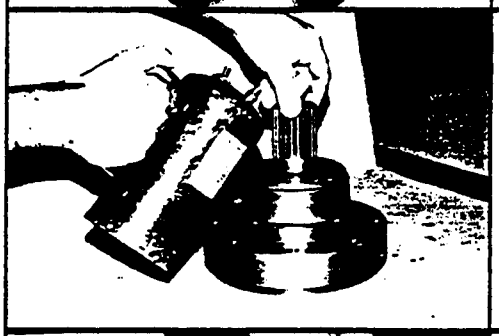
4. Turn **hub (1G)** over so that it rests on its large diameter end. Using bearing cup pressing tool (T-116412), press **bearing cup (1C)** into the small end of **hub (1G)**.

NOTE: Make sure that the cup sits square with the counterbore before pressing.

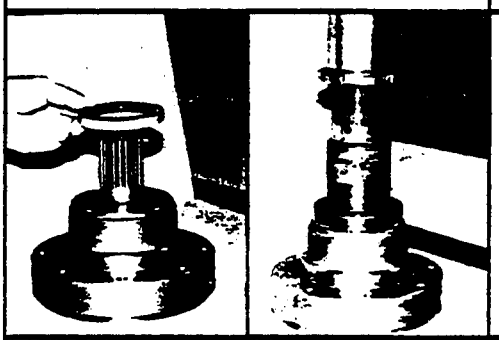
Hub-Shaft Sub-Assembly



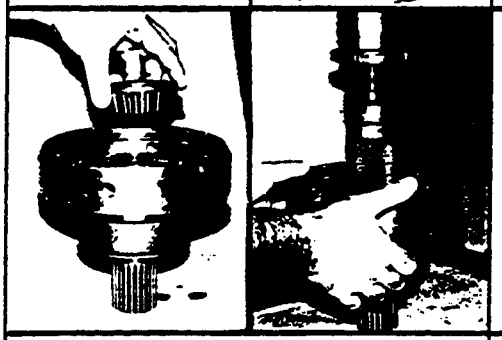
5. With **hub** (1G) still standing on its large end, place **output shaft** (1A) into **hub** (1G) so that the end of the shaft with the retaining ring groove points down.



6. Oil **output shaft** (1A).



7. Using seal pressing tool (T-116402), press **seal** (1B) into the counterbore in the small end of **hub** (1G). The closed face of the seal should be up.

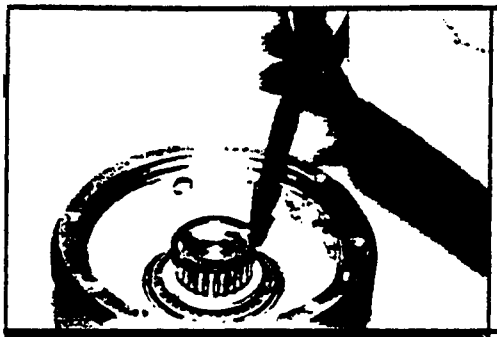


8. Turn **hub**(1G) over so that its small end points down. Using bearing cone pressing tool (T-116407), press **bearing cone** (1F) onto **output shaft** (1A). Rotate the hub while pressing the bearing. Stop pressing when the hub starts to resist rotating.

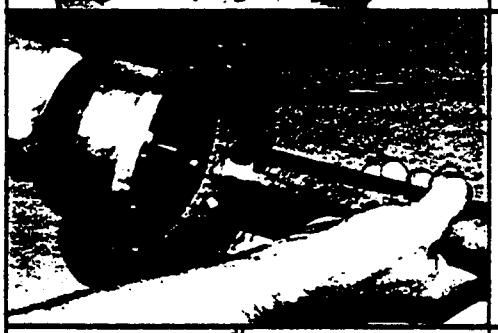


9. Place **spacer** (1H) onto **output shaft** (1A) so that it rests on top of **bearing cone** (1F).

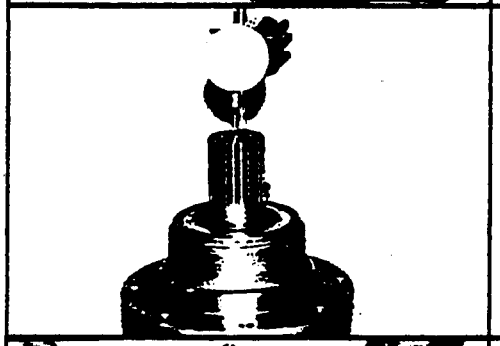
Hub-Shaft Sub-Assembly



CAUTION: Safety glasses should be worn during this step:
10. Using retaining ring pliers, place **retaining ring (1I)** into the groove on **output shaft (1A)**. Use a soft punch against the retaining ring to make sure that it is seated.

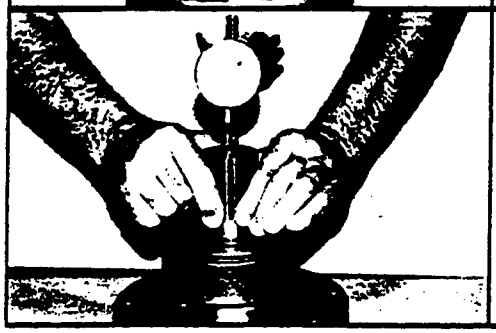


11. Hit the end of **output shaft (1A)** once or twice with a soft face hammer. Turn the shaft in both clockwise and counter clockwise directions while hitting. This will seat the bearing cone against the spacer and retaining ring, allowing necessary endplay in the hub-shaft sub-assembly.



12. Turn **hub (1G)** over so that it rests on its large end. Measure the endplay in the **hub-shaft sub-assembly**. To do this, follow steps a-c:

a. **Mount a dial indicator on hub (1G).Locate the dial rod on top of output shaft (1A).**

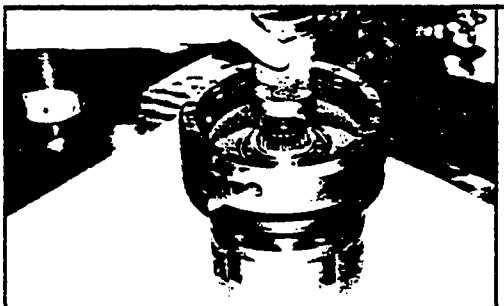


b. Lift up on the output shaft until the needle on the dial stops moving.

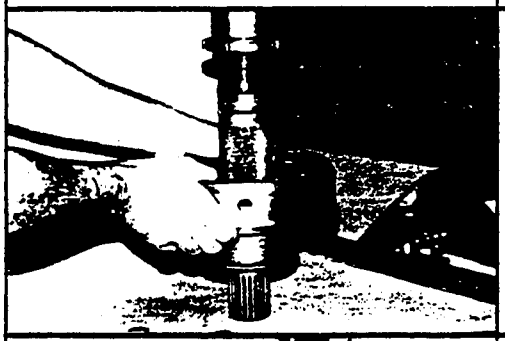
NOTE: Before doing step c, be aware that some applications of this unit may require an endplay of 0.000 in. to 0.003 in. If this is the case, installation of shims on **bearing cone (1F)** may be necessary to achieve this endplay. Contact your original equipment manufacturer (OEM) for the endplay information on your unit.

c. Read the dial. The reading on the dial should be no greater than 0.008 in.
- If the reading is less than 0.008 in., go to step 13.
- If the reading is above 0.008 in., continue to do steps d-h.

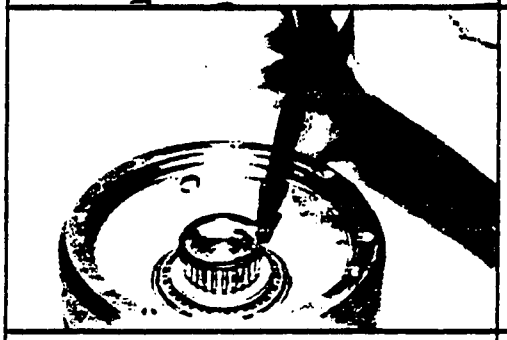
Hub-Shaft Sub-Assembly



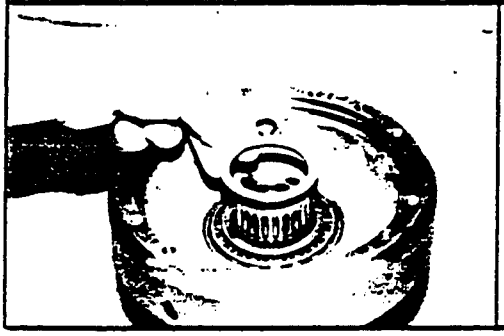
d. Place a bearing cone pressing tool (T-116407) on top of **retaining ring (1I).**



e. Press the fixture with a hydraulic ram or by striking it with a soft face hammer. Pressure should be applied until the hub rotates with difficulty. This step is necessary in order to remove the preload against the retaining ring.



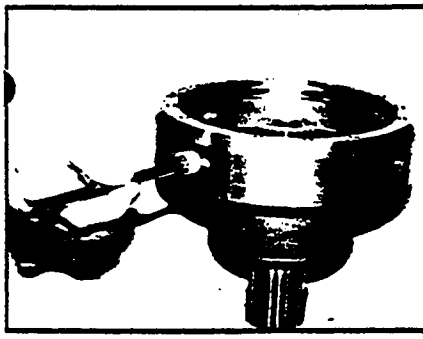
CAUTION: Safety glasses should be worn during this procedure.
f. Using retaining ring pliers, remove **retaining ring (1I)** and discard.
NOTE: Do not reuse the retaining ring.



g. Remove **spacer (1H)** and replace it on the output shaft with an **SK91** spacer. This spacer is thicker and will reduce the endplay.

h. Repeat steps 8-12 to reassemble the shaft and remeasure the endplay.

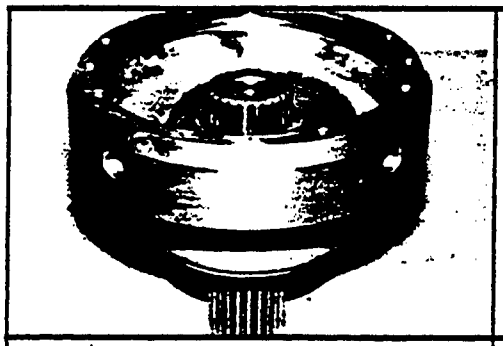
Hub-Shaft Sub-Assembly



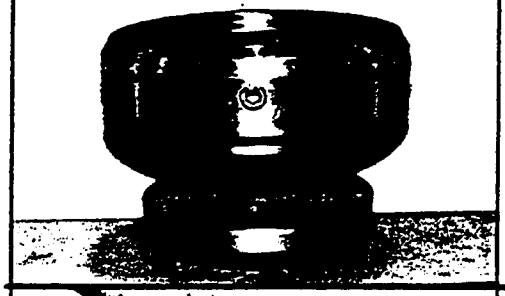
13. Apply a light coat of "Never-Seize" to the three **pipe plugs** (1J). Tighten **pipe plugs** (1J) into the three pipe plug holes on **hub** (1G).

14. At this point the hub-shaft sub-assembly is complete.

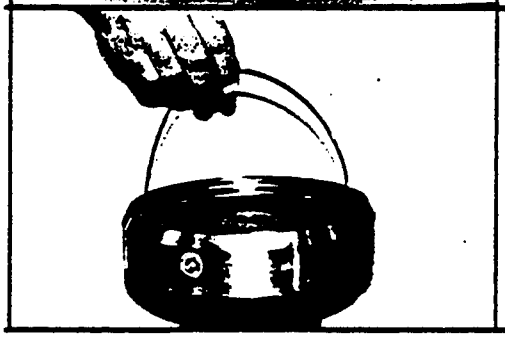
MAIN ASSEMBLY



1. Position **hub (1G)** on its **output shaft (1A)** so that the hub's small diameter end points down.



2. Mark the four shoulder bolt holes in **hub (1G)** with chalk or marker so that they can be aligned with the shoulder bolt holes in the **ring gear (2)** in a later step.

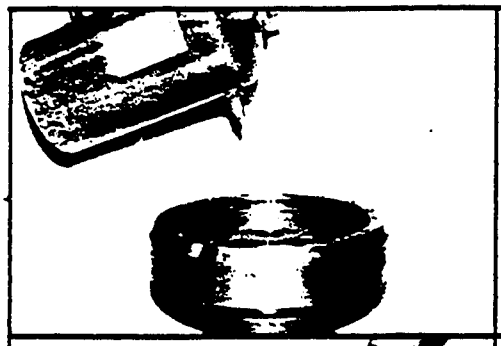


3. Grease **"O" ring (5)**. Place **"O" ring (5)** into the counterbore of **hub (1G)**.

CAUTION: Beware of sharp edges and burrs around the counterbore when installing the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.

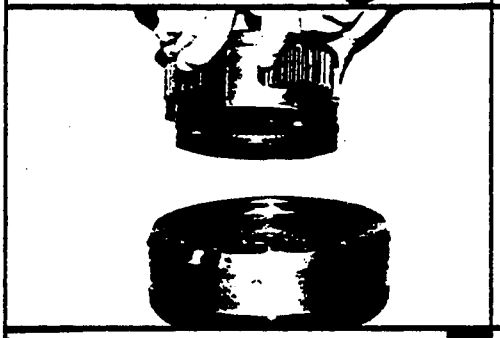
Main Assembly



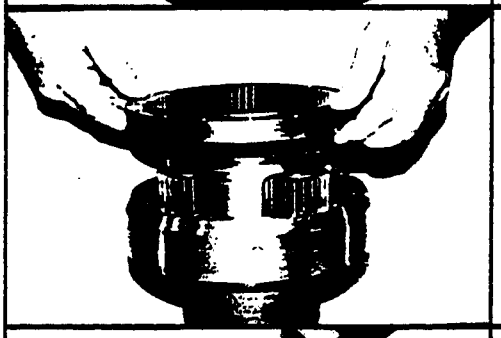
4. Oil all exposed surfaces inside **hub (1G)**.



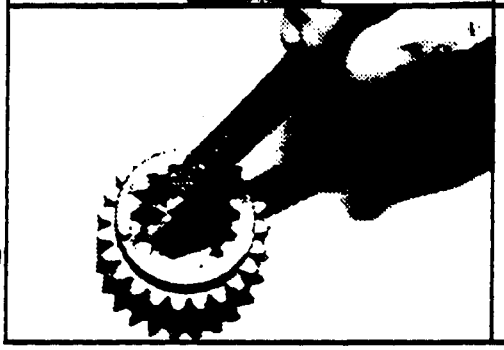
5. Oil **carrier sub-assembly** (3).



6. Place **carrier sub-assembly** (3), with spline connections down, into mesh with **output shaft** (1A).



7. Place **ring gear** (2), with squared shoulder side down, into mesh with the **planet gears** (3F) of the carrier sub-assembly. Make sure that the shoulder bolt hole that is marked with an "X" on the ring gear aligns with any one of the marked shoulder bolt holes on the hub. The "X" should be on the cover side the ring gear.

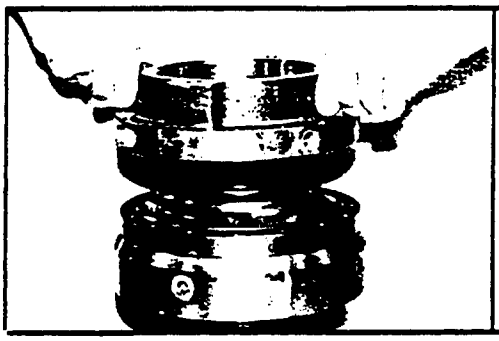


8. Start one half of **retaining ring** (20) into the groove inside **input gear** (9). Use a soft punch to press the remaining half of the retaining ring into the groove.

Main Assembly

	9. Insert **input gear (9)**, with large diameter end down, into mesh with **planet gears (3F)**.
	10. Place large **thrust washer (11)** over **input gear (9)** so that it rests on **carrier housing (3A)**.
	11. Oil all exposed surfaces inside **hub (1G)**.
	12. Grease **"O" ring (5)**. Place **"O" ring (5)** into the counterbore of **cover (6)**. CAUTION: Beware of sharp edges and burrs around the counterbore when installing "O" ring.

NOTE: "O" rings may be stretched to fit counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



14. Place cover (6) on top of ring gear (2) so that the two pipe plug holes in the cover line up between the pipe plug holes in the hub as shown in Diagram 1: pipe plug timing.

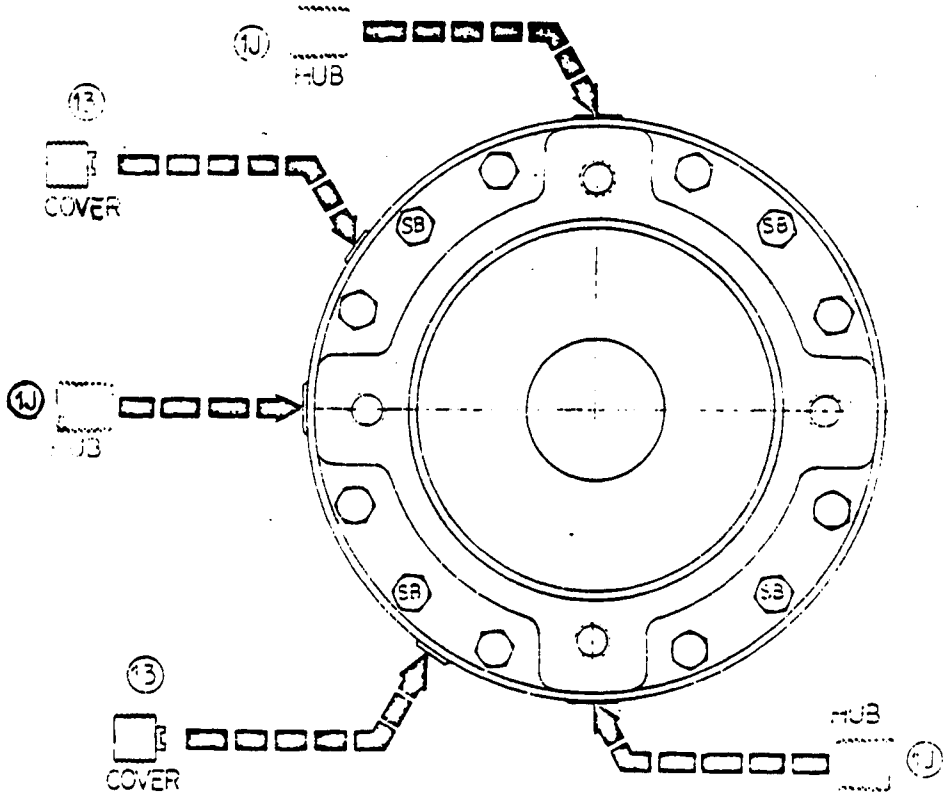
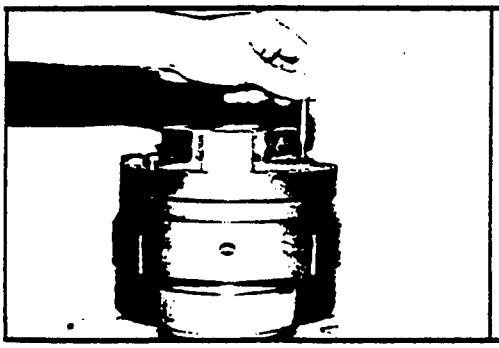
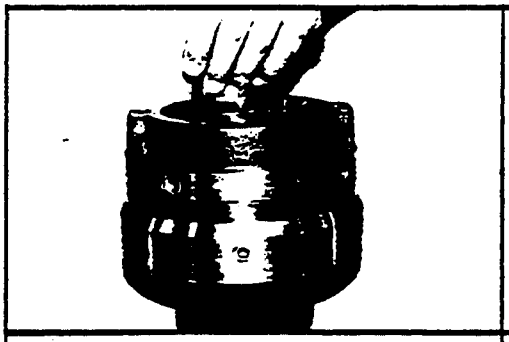


DIAGRAM 1: Pipe plug timing.



15. Place the four shoulder bolts (14) into the shoulder bolt holes marked on the hub and tighten.

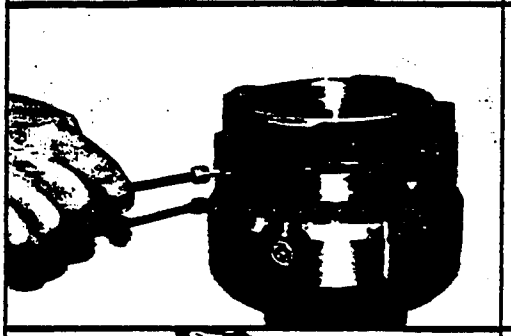
Main Assembly



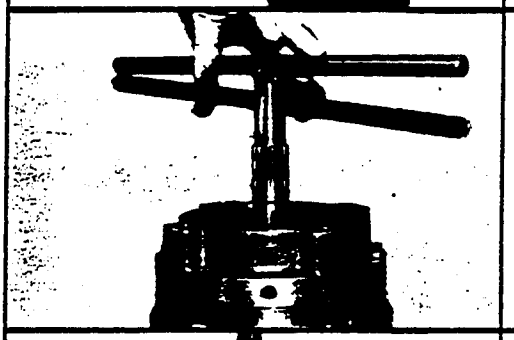
16. Place the eight grade 8 bolts (12) into the remaining bolt holes and tighten.



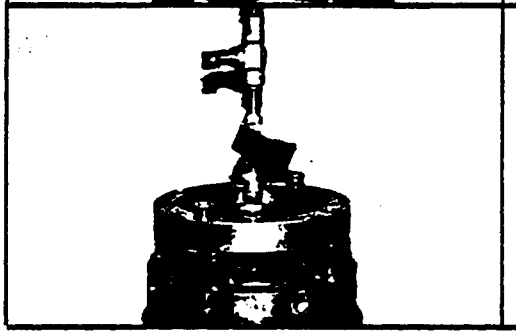
17. Apply 23-27 ft.-lbs. of torque to all bolts.



18. Apply a light coat of "Never-Seize" to both **pipe plugs (13)**. Tighten **pipe plugs (13)** into the two pipe plug holes on **cover (6)**.



19. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns as the ratio of the unit. The ratio is the last two digits of the model number found on the unit's ID tag. For example, unit S1C544S4 should be rolled 4 times in each direction.



20. Leak test the unit at a pressure of 5 psi for 2-3 minutes.

21. At this point the main assembly is complete.

TOOLING

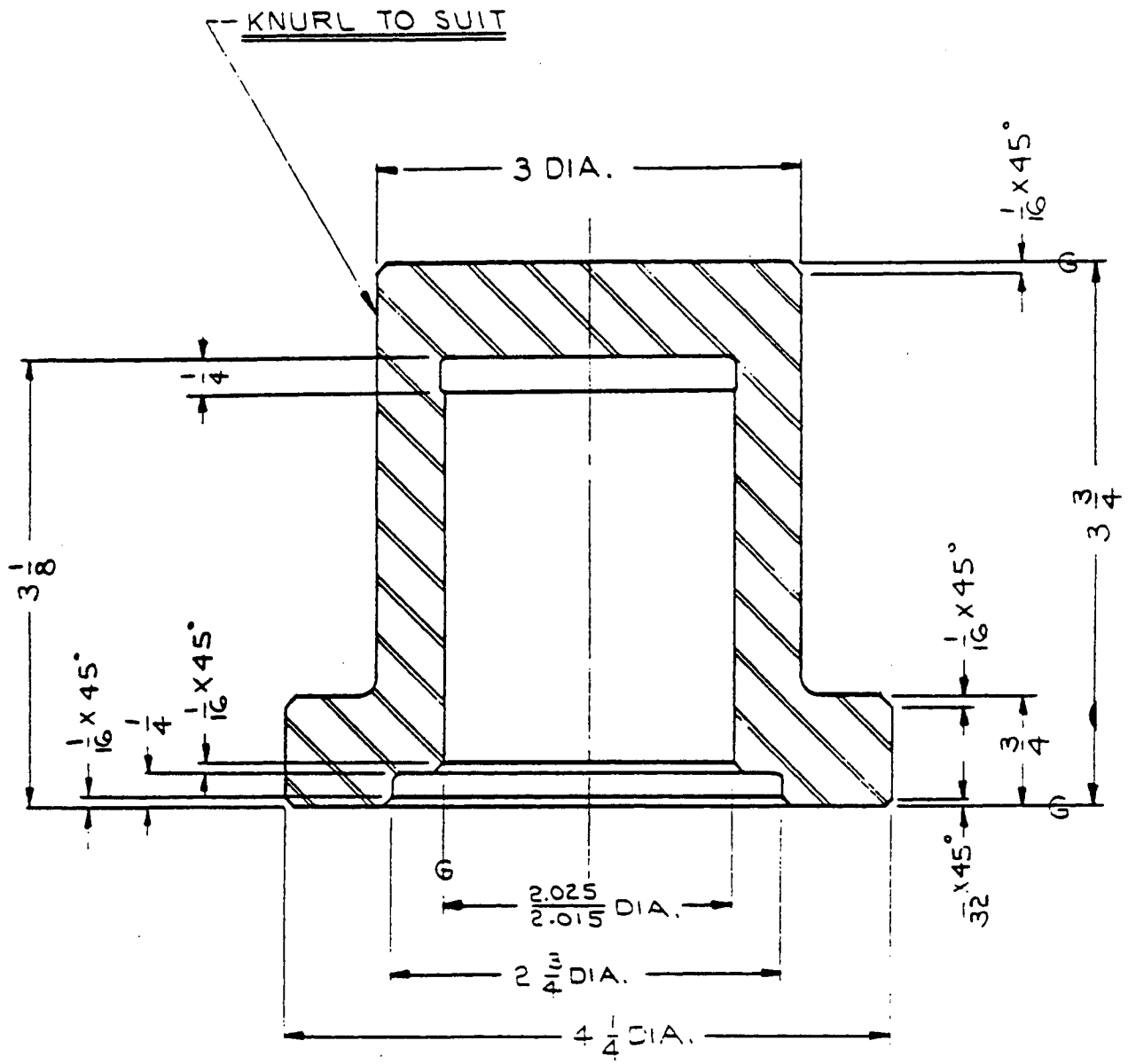
The following specialized tools are used in the assembly of this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools exist as one piece and must be made from mild steel. All dimensions are given in inches.

OPTIONAL: In order to improve tool life, tools may be carburized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a "G" on the tool diagram.

1.) T-116402
SEAL PRESSING FIXTURE for SEAL (1B)

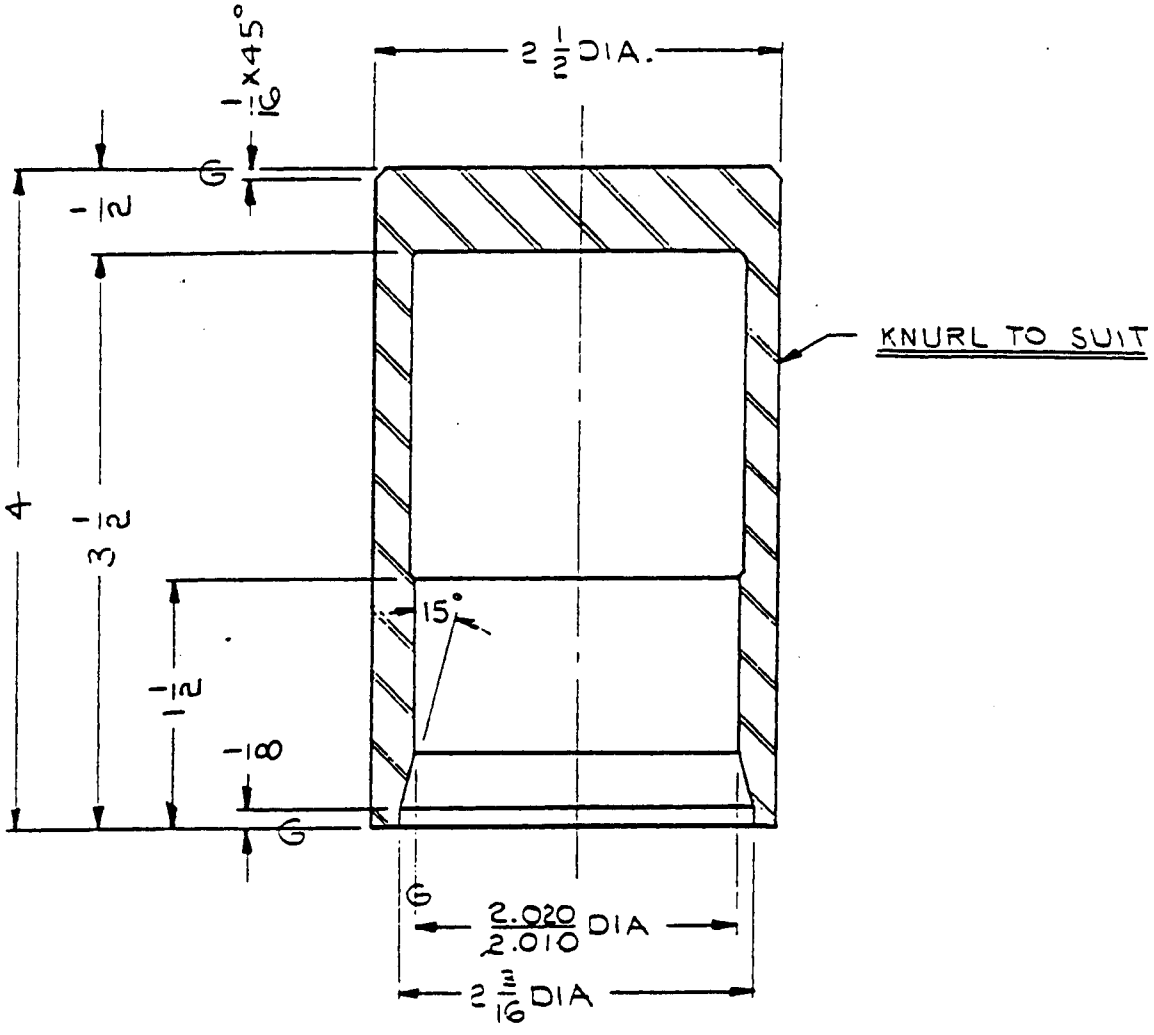
2.) T-116407
ASSEMBLY PRESSING TOOL for BEARING CONES (1D) and (1F)

3.) T-116412
ASSEMBLY PRESSING TOOL for BEARING CUPS (1C) and (1E)



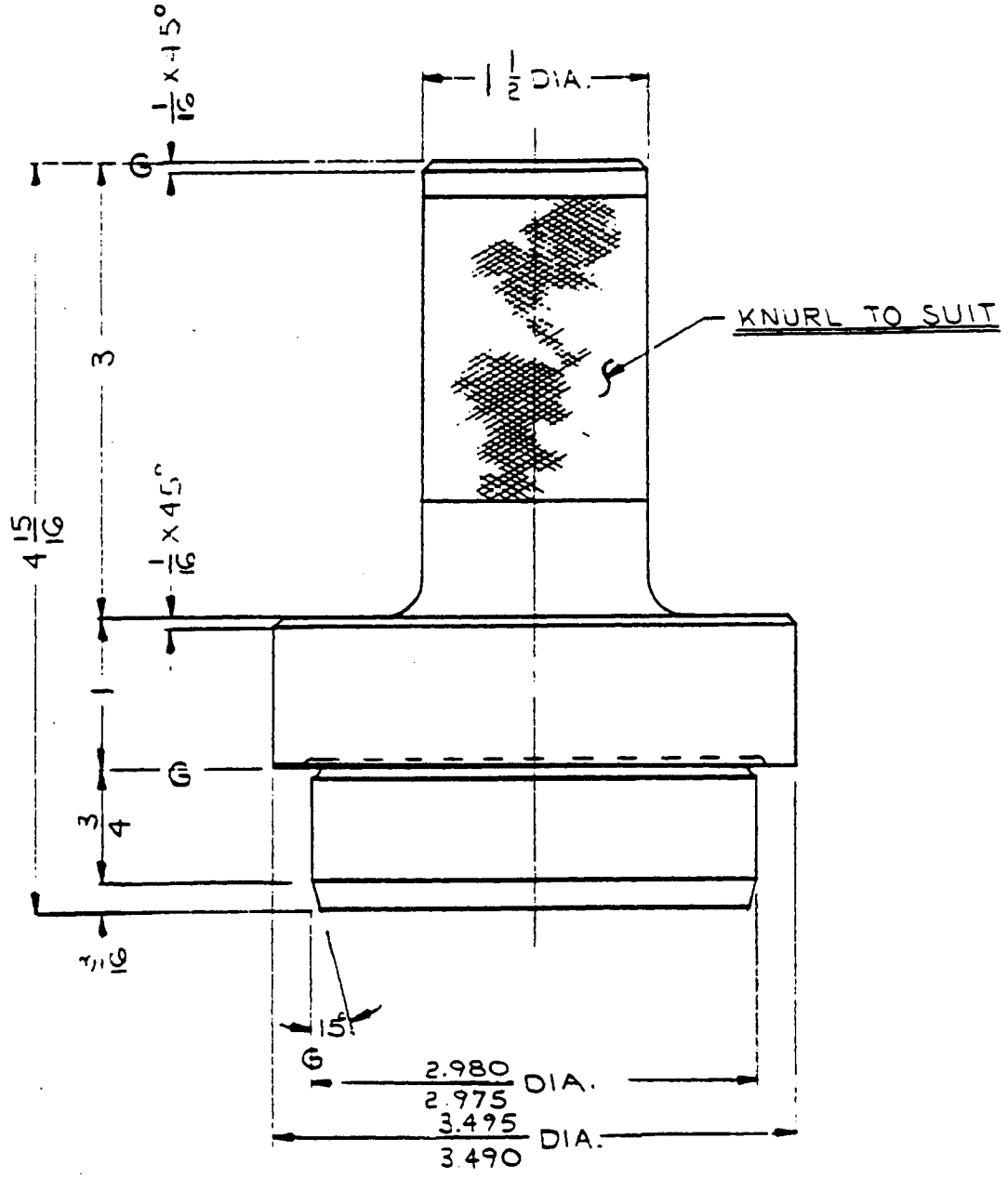
TOOL NO. T-116402

SEAL PRESSING FIXTURE
Used with seal(1B)



TOOL NO. T-116407

BEARING CONE PRESSING FIXTURE
Used with bearing cones(1D) and (1F)

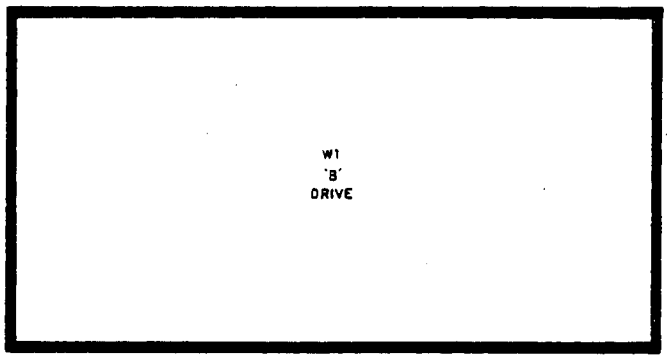


TOOL NO. T-116412

BEARING CUP PRESSING FIXTURE
Used with bearing cups(1C) and (1E)

Torque-Hub® Final Drives

Service Manual



Fairfield Manufacturing Company, Inc.
South Concord Road. Lafayette. Indiana 47902. U.S.A. 317/474-3474

Fairfield

THE DRIVE PEOPLE

Introduction

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

Included are —

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

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

Safety

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

W1A-W1B Disassembly Procedure

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

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

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

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

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

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

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

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

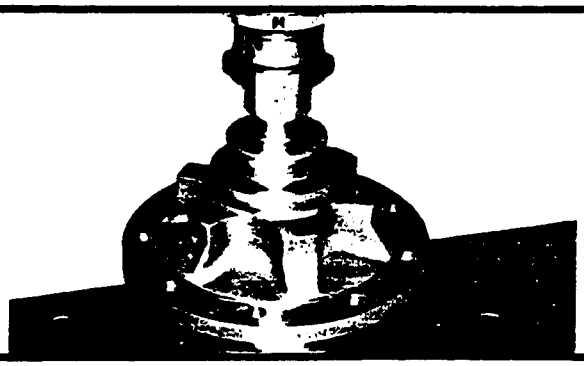
9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

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

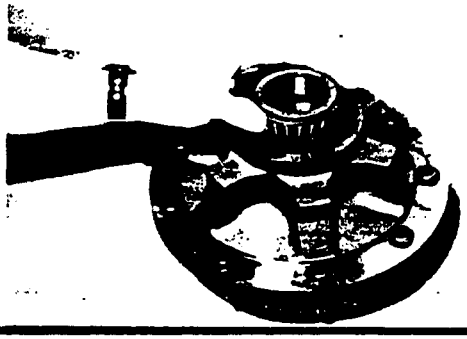
10. To remove the Cluster Gears from the Carrier, drive the anti-roll pin into the Planet Shaft of the Cluster Gear. After the Planet Shaft is removed the roll pin should be driven out of the Planet Shaft.

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

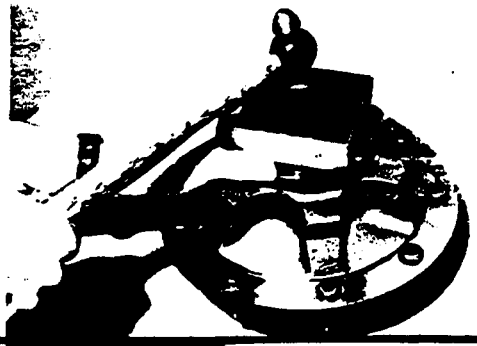
Main Assembly Procedure



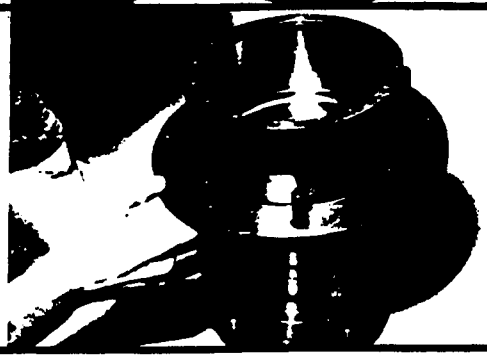
1. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JLM506810 will go into small end of Hub, and Cup #JM205110 will go into large end of Hub. If Studs are being used, they can be pressed in at this time. Solid support must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



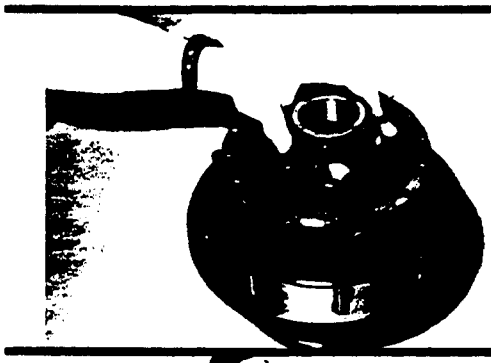
2. Place Bearing cone #JLM506849 into Bearing Cup in small end of Hub.



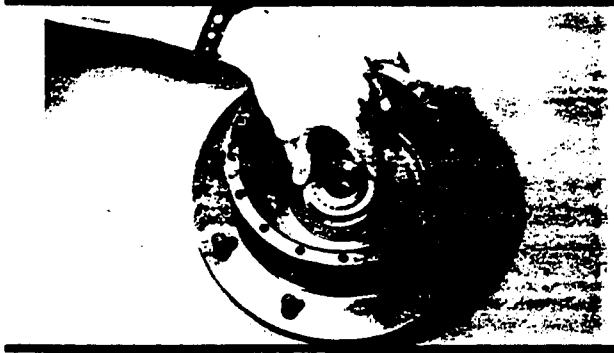
3. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.



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



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

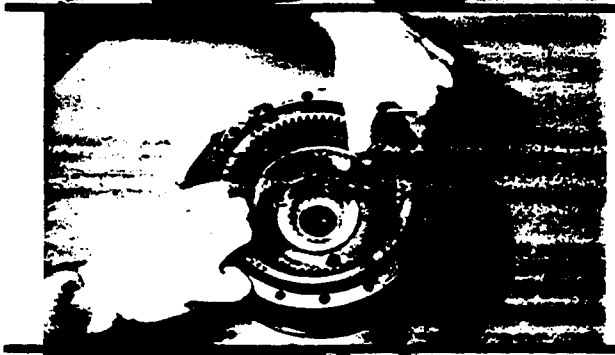


6. Place Bearing Shim over end of Spindle and against Bearing Cone.



7. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

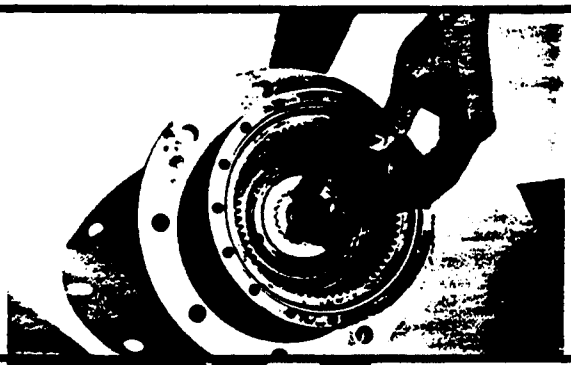
⚠ Eye protection should be worn during Retaining Ring installation.



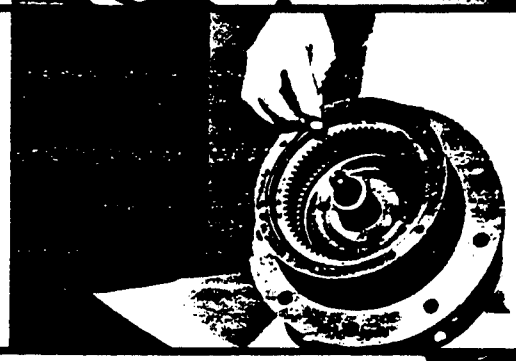
8. Place Internal Gear onto end of Spindle.



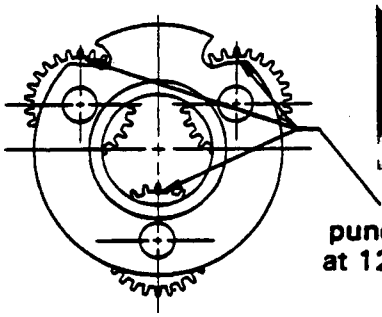
9. Place Input Shaft Assembly into Spindle bore with unsplined end facing out.



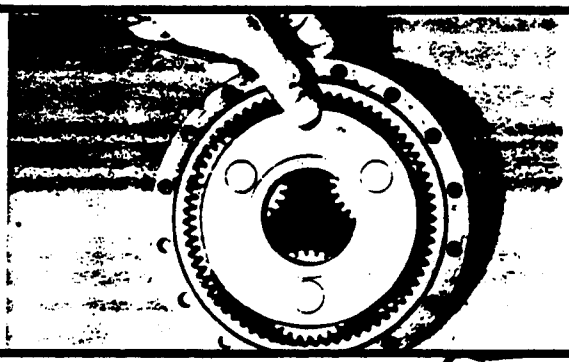
10. Place narrow Thrust Spacer over Input Shaft with counterbore side facing Spindle.



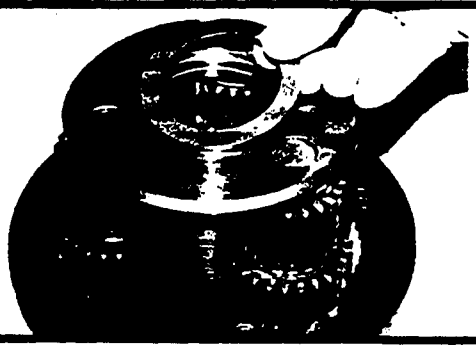
11. Place 'O' Ring into Hub counterbore. Use petroleum jelly or grease to hold 'O' Ring in place. Slight stretching of the 'O' Ring may be necessary to insure proper seating.



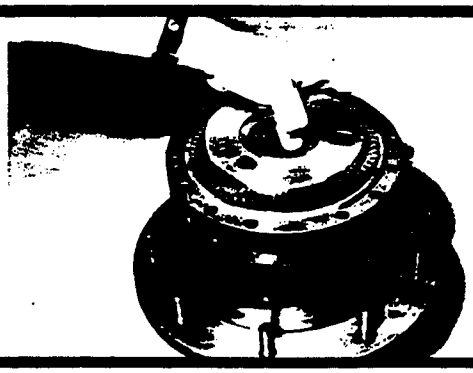
12. Place Carrier Assembly on a flat surface with the large gears up and positioned as shown. Find the punch marked tooth on each large gear and locate at 12 o'clock (straight-up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears.



13. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation.

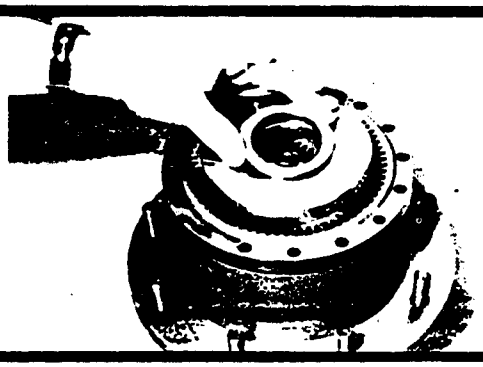


14. Turn over Carrier Assembly and Ring Gear while keeping gears in mesh. Place Thrust Washer into Carrier counterbore. Use petroleum jelly or grease to hold washer in place.



15. While holding Ring Gear, Input Gear and Cluster Gears in mesh, place small side of Cluster Gears into mesh with the Internal Gear. On the Ring Gear locate the hole marked "X" over one of the counterbored holes in Hub. Mark these holes on outside diameter for later use.

Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.

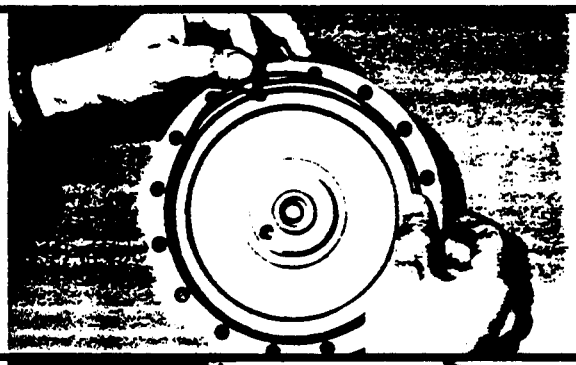


16. Place Thrust Washer into Carrier counterbore.

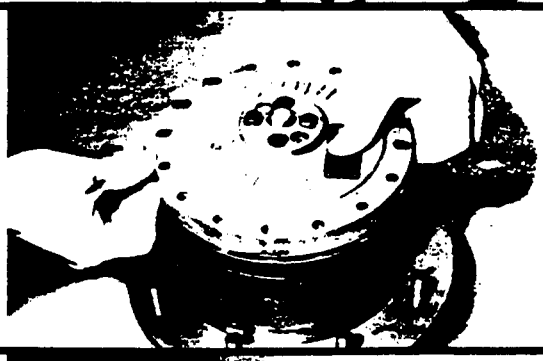


17. The Input Gear is now installed into the carrier meshing with the large diameter cluster gear. The counterbore in the bore of the Input Gear must be to the inside of this assembly.





19. Place 'O' Ring into Cover Assembly counterbore. Use petroleum jelly or grease to hold 'O' Ring in place.



20. Place Cover Assembly over Ring Gear with oil level check plug in Cover located approximately 90° from oil fill plug in Hub.



21. Locate four Shoulder Bolts with flat washers, 90° apart into counterbored holes in Hub marked in step 16. Torque Shoulder Bolts to 23-27 ft. lbs.



22. Use standard grade 8-5/16-18x2¼ bolts with flat washers in remaining holes. Torque to 23-27 ft. lbs.



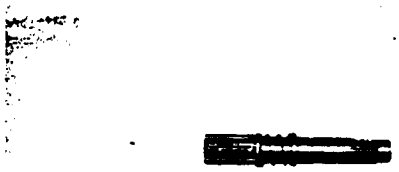
23. Place Coupling into Spindle and onto Input Shaft.

This completes the Torque-Hub Assembly. The unit must be filled one-half full of EP90 lubricant before operation.

Assembly Procedure
For Sub-Assemblies
Input Shaft Sub-Assembly



1. Place Washer, Spring and Washer, in that order, onto Input Shaft.



2. Install Retaining Ring into Input Shaft groove to secure Spacers and Spring to shaft.

   ⚠ Eye protection should be worn during Retaining Ring installation.

Carrier Sub-Assembly



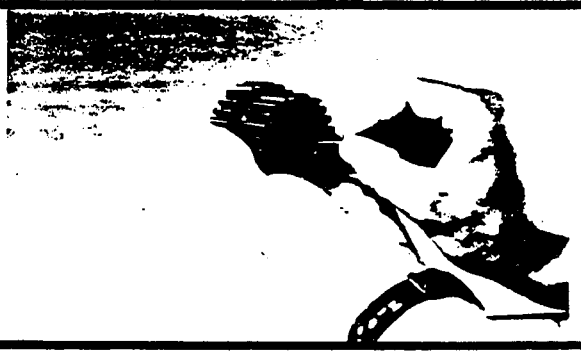
1. Apply a coat of grease or petroleum jelly to Cluster Gear bore.



2. Place sixteen Needle Rollers into Cluster Gear bore.



3. Place Spacer washer into opposite side of Cluster Gear and against Needle Rollers.

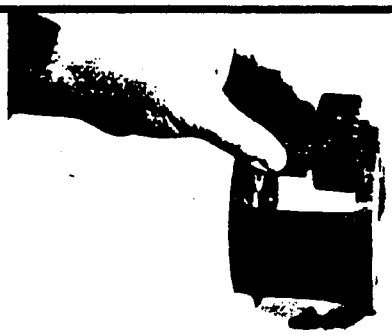


4. Place second set of sixteen Needle Rollers into Cluster Gear.

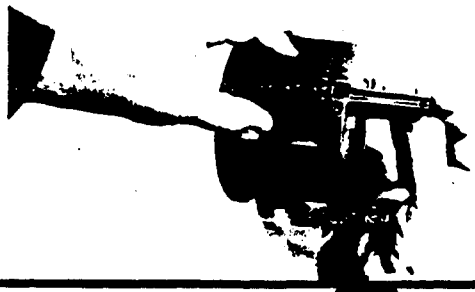


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

   Note: Some old style Carriers will not have slots and tangs should be located inside boss relief.



6. While keeping Thrust Washers in place, slide Cluster Gear into Carrier with the larger gear on the side with the small pin hole.



7. Line up Cluster Gear and thrust Washers with hole in Carrier and slide Planet Shaft through. Line up chamfered side of hole in Planet Shaft with pin hole in Carrier.

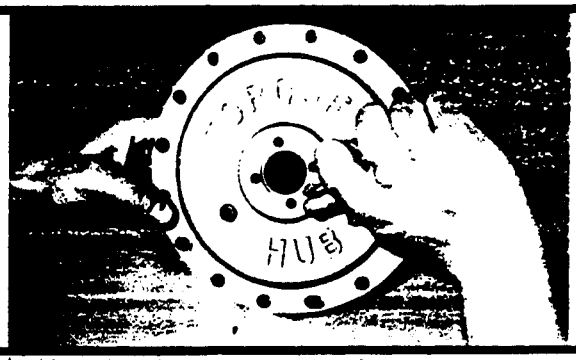


8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

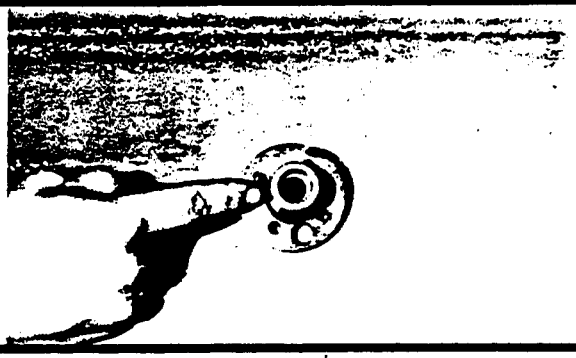
   Repeat these steps for remaining two Cluster Gears to complete Carrier Sub Assembly.

Carrier Sub-Assembly

Cover Sub-Assembly



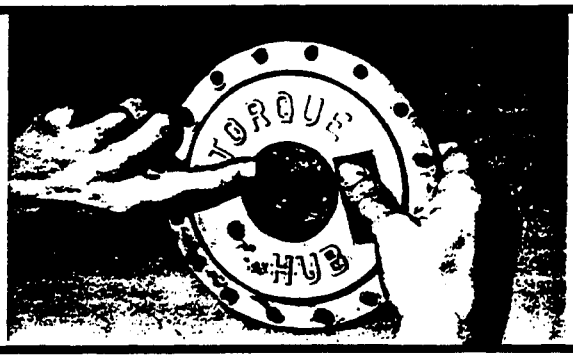
1. Screw Pipe Plug into Cover.



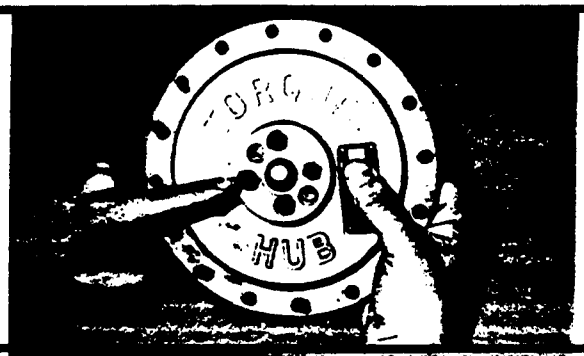
2. Slip 'O' Ring over Cover Cap and against face.



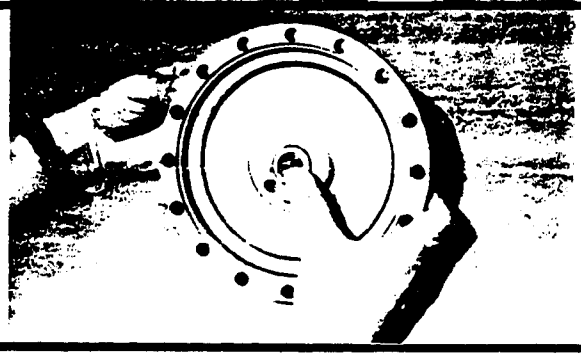
3. Place 'O' Ring into Cover Cap internal groove. The Disconnect Rod may be used to push 'O' Ring into groove.



4. Place Cover Cap into Cover with large hole located over Pipe Plug. Secure Cover Cap to Cover with two ¼-20x¾ bolts. Torque bolts to 70-80 in. lbs.

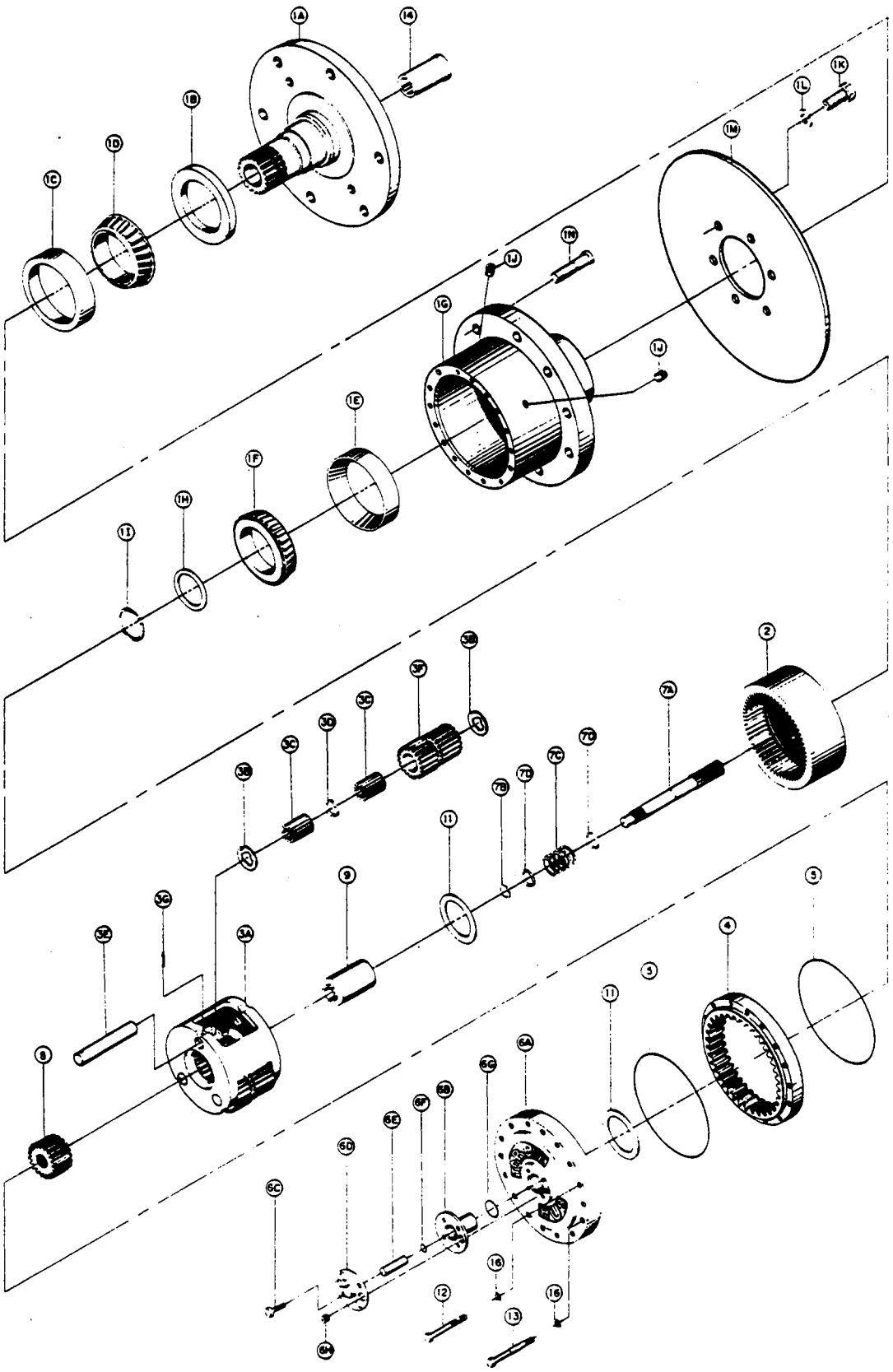


5. Place Disconnect Cap over Cover Cap with nipple facing out. Secure Disconnect Cap to Cover with two ¼-20x¾ bolts. Torque bolts 70-80 in. lbs.



6. Turn Cover over and push Disconnect Rod into Cover Cap. Rod will be held in place by friction from the 'O' Ring.

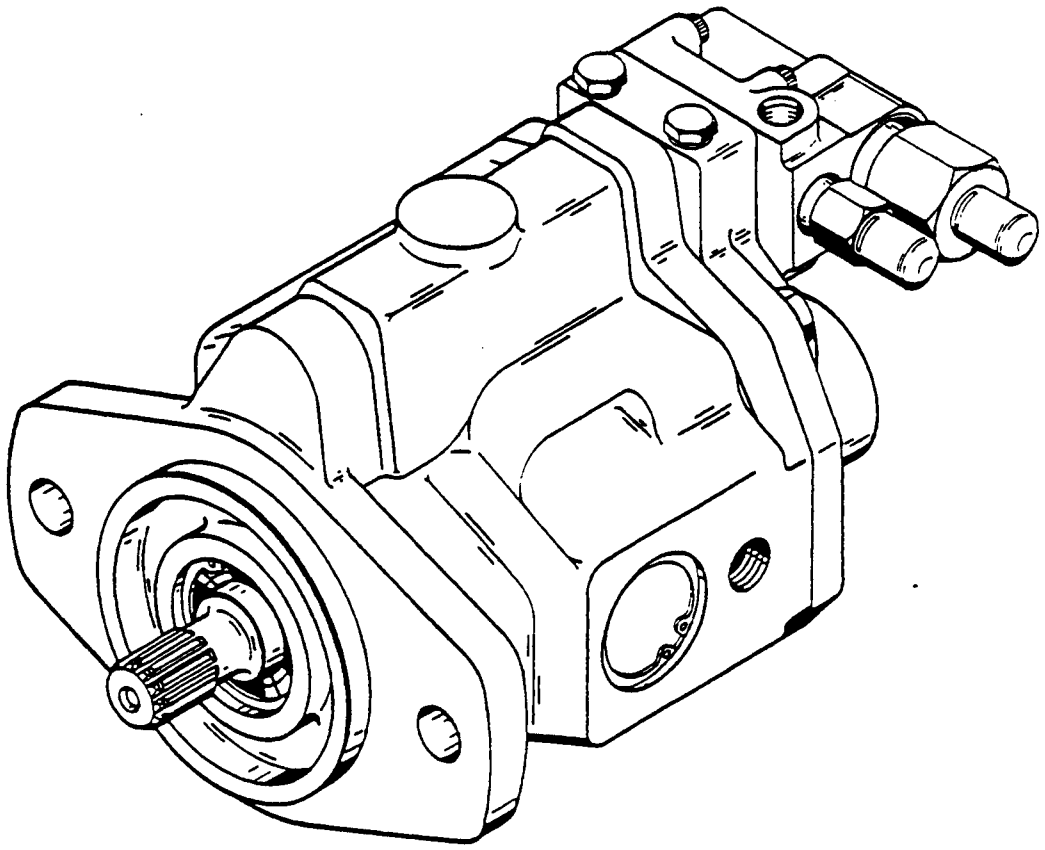
Cover Sub-Assembly


1A
1B
1C
1D
1E
1F
1G
1H
1I
1J
1K
1L
1M
1N
2
3A
3B
3C
3D
3E
3F
3G
3H
4
5
6A
6B
6C
6D
6E
6F
6G
6H
7A
7B
7C
7D
7E
8
9
11
12
13
14
16

Eaton
Hydraulics
Division

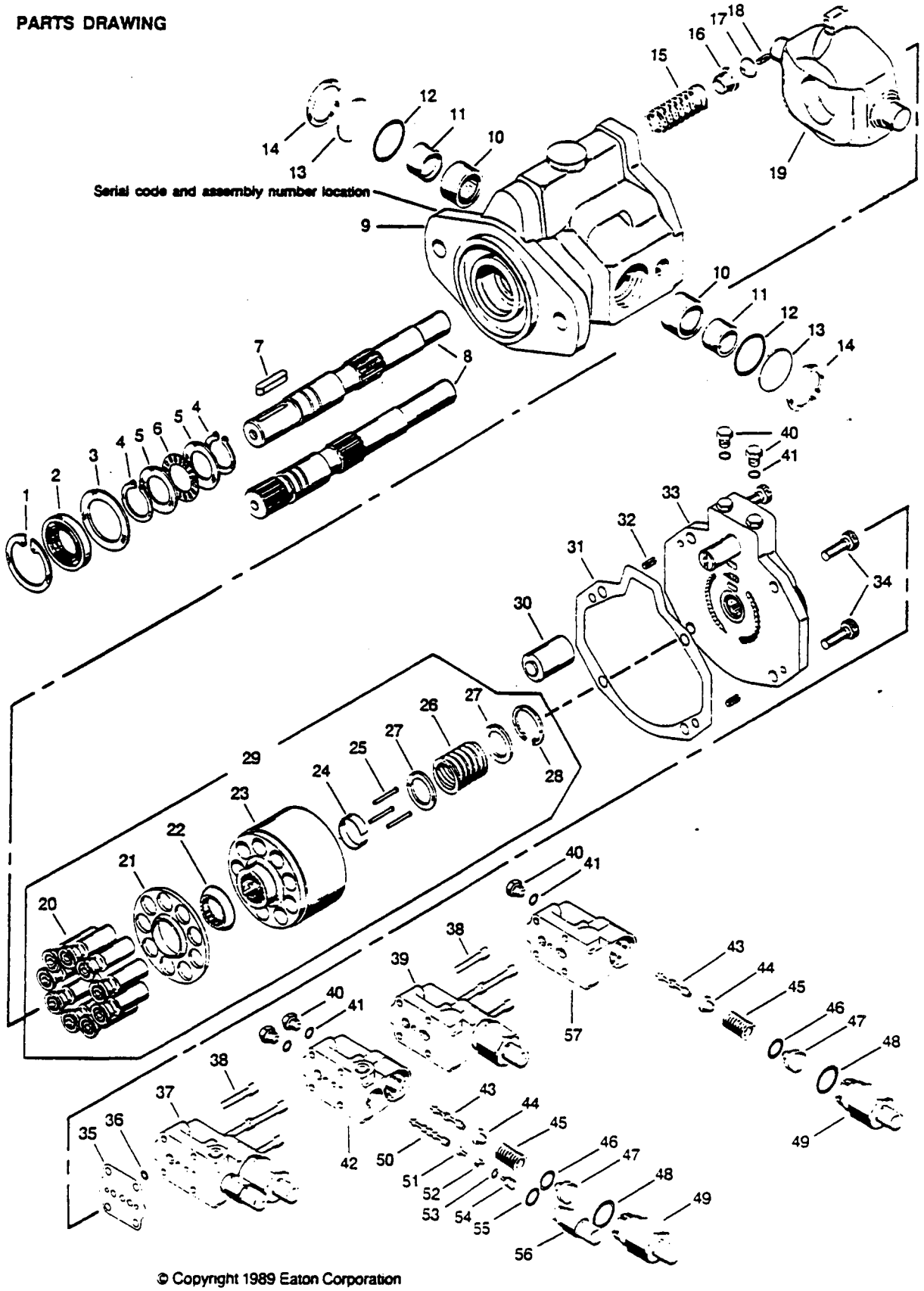
Repair Information

Model 70422 and 70423
Pressure, Pressure-Flow Compensated Piston Pump



EATON

PARTS DRAWING



© Copyright 1989 Eaton Corporation

PARTS LIST

Item No.	Description	Quantity
1	Retaining ring	1
2	Shaft seal	1
3	Washer	1
4	Retaining ring	2
5	Thrust washer	2
6	Thrust bearing	1
7	Key	1
8	Drive shaft	1
9	Housing assembly	1
10	Needle bearing	2
11	Inner race	2
12	O-ring, 3/32 x 1-7/16 I.D.	2
13	Trunnion cover	2
14	Retaining ring	2
15	Camplate control spring	1
16	Spring collar	1
17	Pivot button	1
18	Roll pin	1
19	Camplate	1
20	Piston assembly	9
21	Spider	1
22	Spider pivot	1
23	Piston block	1
24	Pin keeper	1
25	Pin	3
26	Washer	2
27	Spring	1
28	Retaining ring	1
29	Rotating kit assembly	1
30	Control piston	1
31	Gasket	1
32	Roll pin	2
33	Backplate assembly	1
34	Cap screw	4
35	Gasket, compensator	1
36	O-ring, 1/16 x 1/4 I.D.	1
37	Compensator assy., pressure-flow	1
38	Allen head cap screw	4
39	Compensator assembly, pressure	1
40	Plug	4
41	O-ring, 1/16 x 19/64 I.D.	4
42	Compensator housing, pressure-flow	1
43	Spool, pressure compensator	1
44	Spring pivot cap	1
45	Spring, pressure compensator	1
46	O-ring, 3/32 x 9/16 I.D.	1
47	Spring follower, pressure	1
48	O-ring, 3/32 x 7/8 I.D.	1
49	Adjustment cap, pressure	1
50	Spool, flow compensator	1
51	Spring pivot	1
52	Spring, flow compensator	1
53	O-ring, 1/16 x 7/32 I.D.	1
54	Spring follower, flow	1
55	O-ring, 5/64 x 15/32 I.D.	1
56	Adjustment cap, flow	1
57	Compensator housing, pressure	1

Tools Required For Disassembly And Reassembly

- 3/16 Allen wrench
- 9/16 Socket
- 1-1/8 Open end wrench
- 11/16 Open end wrench
- O-ring pick
- Plastic or wooden mallet
- Internal and External Retaining Pliers (Straight, .070" tip)
- 3/8 I.D. x 1-1/8 O.D. Flat washer (2 ea.)
- 3/8 x 3-1/4 N.C. Cap screw (1 ea.)
- 3/8 N.C. Nut
- Screw driver (1/4 in. blade)
- Torque wrench (40 lb-ft [54 N-m] capacity)

REPAIR INFORMATION - Model 70422 and 70423

Cleanliness is extremely important when repairing these pumps. Work in a clean area. Before disconnecting the lines clean port area of pump. Disconnect hydraulic lines and remove pump assembly from vehicle and plug ports. Thoroughly clean the outside of pump. After cleaning, remove port plugs and drain oil.

DISASSEMBLY

ATTENTION: Removal of the adjusting screw covers from cap may void the warranty on this assembly.

1 Clamp the end of the drive shaft in a protected jaw vise with the body of the pump up and remove the four allen head screws (38) holding compensator (37).

2 Remove the compensator assembly (37 or 39), o-ring (36), and gasket (35).

3 Remove the four cap screws (34) from the backplate of the pump.

4 Place a screw driver in slots provided between housing and loosen backplate. Remove backplate (33) and gasket (31) from housing.

5 Remove the control piston (30) remaining on the backplate or in housing. Also remove plug (40) from backplate (33).

6 To remove rotating assembly (29) from housing, remove pump from vise and slide rotating assembly off shaft. Caution: pistons may not come out with piston block.

7 Remove pistons (20), spider (21), and spider pivot (22) from piston block (23).

8 The piston block assembly (23) need not be disassembled unless the internal pins (25) or spring (27) are damaged.

CAUTION: Use the following procedure if the spring is to be removed from the piston block. The spring (27) is highly compressed and the snap ring (28) should not be removed without compressing the spring (27).

The following parts will be needed to disassemble the piston block:
2 ea. 3/8 I.D. x 1-1/8 O.D. flat washer,
1 ea. 3/8 x 3-1/4 N.C. cap screw, and
1 ea. 3/8 N.C. nut.

Place one of the flat washers over the 3/8 x 3-1/4 cap screw and place this through the center of the piston block (23). Place the other washer over the cap screw and let it rest on the three pins. Screw the nut on and compress the spring inside the piston block. Use a pair of snap ring pliers and remove the internal snap ring (28). Remove the bolt and the two washers (26), three pins (25), and the internal pin keeper (24).

9 To free shaft seal and shaft, remove retaining ring (1).

10 Remove shaft (8) from housing (9) by tapping backplate end of shaft with a wooden or plastic mallet.

11 Remove shaft seal (2), washer (3), the two retaining rings (4), the two thrust washers (5), and bearing (6) from shaft.

12 To remove the camplate (19) from the housing, remove the two internal retaining rings (14) from the sides of the housing. Remove the two covers (13), the two o-rings (12), the two inner races (11), and the bearings (10). The camplate can now be moved over to one side and removed. The two camplate pivot bearings are a loose slip fit into the housing. Do not be concerned if they are not tight.

13 Remove the spring collar (16) and spring (15). Do not remove the button (17) and roll pin (18) unless they are worn or loose.

14 The pressure-flow compensator assembly (37) may be disassembled for cleaning and inspection.

ATTENTION: Removal of the adjusting screw covers from cap may void the warranty on this assembly.

15 Remove pressure adjustment cap (49) from compensator housing (37). Pressure spring follower (47) will remain in cap (49), pull follower from cap.

16 Remove flow adjustment cap (56) from compensator housing (37). Flow spring follower (54) will remain in cap (56). Pull follower from cap.

17 Remove springs (45 and 52) and spring pivots (44 and 51) from compensator housing.

18 Remove plugs (40), pressure compensator spool (43), and flow compensator spool (50) from compensator housing (37).

19 The shaft seal, all o-rings, and all gaskets should be removed and replaced with new items upon reassembly.

INSPECT PARTS FOR WEAR

1 Inspect the flat surface of the backplate (33), the finish on the piston block side should be smooth and free of grooves. The piston guide should be tight in the backplate. The needle bearing in the backplate should be free of excessive play and remain in the bearing cage. If the backplate has any of the wear characteristics outlined above, replace complete backplate assembly.

2 Inspect the piston block (23). The surface that contacts the backplate should be smooth and free of grooves.

3 The pistons (20) should move freely in the piston block bore. If they stick in the bore, examine the bore for scoring or contamination.

4 Examine the O.D. of the piston (20) for finish condition. They should not show wear or deep scratches. The shoes should be a snug fit on the ball end of the piston. The flat surface of the shoes should be flat, and smooth. **Do not lap piston shoes.**

5 Examine the spider (21). It should be flat, no cracks, and no signs of wear in the pivot area.

6 Examine the pivot (22). It should be smooth and show no signs of wear.

7 Inspect the camplate (19) for the condition of finish of the polished shoe surface. It should show no signs of scoring.

8 Inspect shaft (8) for wear in bearing and spline areas.

9 Inspect thrust bearing (6) and thrust washers (5) for wear.

10 Inspect the needle bearing in the housing assembly (9). If the needles are free of excessive play and remain in the bearing cage, there is no need to replace the housing.

11 Inspect the compensator springs (45 and 52) for breakage or weakness.

12 Inspect the spools (43 and 50) for scoring.

13 It is not necessary to inspect the o-rings, retaining rings, gaskets, or shaft seal as they should be replaced as new items and are included in the seal repair kit available for this assembly.

REASSEMBLY

1 Clean all parts in suitable solvent; lubricate all critical moving parts before reassembly.

2 Install camplate control spring (15) and spring collar (16) in housing (9).

3 Insert camplate (19) into housing (9). Insert needle bearings (10) and bearing inner race (11) over the camplate arms and slide into housing (9). The numbered end of the bearing should face outward and the chamfered I.D. of the race should face inward.

4 Install new o-ring (12) around O.D. of camplate pivot bearing (10). Install trunnion covers (13) and secure with retaining rings (14).

5 Install retaining ring (4) on shaft (8). Install thrust washer (5), thrust bearing (6), and second thrust washer (5). Secure with second retaining ring (4).

6 Install shaft (8) in housing (9) and install washer (3), shaft seal (2), and retain with retaining ring (1). Make sure retaining ring is seated in the groove.

7 If piston block assembly was disassembled, compress the pin keeper (24), and install in the spline area of piston block. Install the three pins (25) with the head end to the inside of the block and install in the special grooves of the piston block spline.

8 Install the washer (26), spring (27), and second washer (26) in the piston block. Use the two 3/8 I.D. washers and the 3/8 x 3-1/4 cap screw to compress the spring and retain with retaining ring (28). Remove the 3/8 x 3-1/4 cap screw and the two washer.

9 Install the pivot (22), spider (21), and piston assemblies (20) in the piston block. Install this assembly in the housing assembly, the piston shoes must be in contact with the camplate. Be sure all the parts are in their proper position.

10 Clamp this assembly in a protected jaw vise with the open end of the housing (9) up.

11 Install new gasket (31).

12 Install control piston (30), and plug (40) with new o-ring onto backplate. Note roll pin (32) locations.

13 Install backplate (33) and retain with cap screws (34). Torque to 27 to 31 lb-ft [37 to 42 N-m].

14 Place new o-ring (41) on plug (40). Install plug assembly (40),flow compensator spool (50), spring pivot (51), spring (52), flow spring follower (54) with new o-ring (53), and flow adjustment cap (56) with new o-ring (55) into compensator housing (42). Torque plug (40) 6 to 8 lb-ft [8 to 11 N-m] and torque flow adjustment cap (56) 10 to 12 lb-ft [14 to 16 N-m].

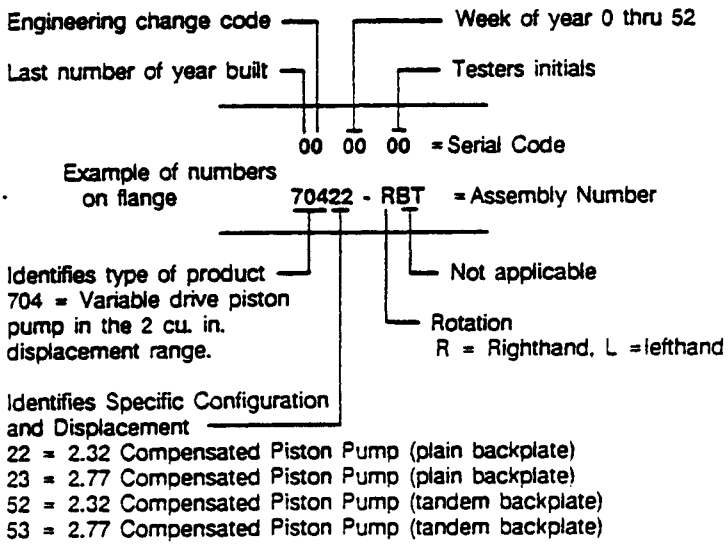
15 Place new o-ring (41) on plug (40). Install plug assembly (40), pressure compensator spool (43), spring pivot (44), spring (45), pressure spring follower (47) with new o-ring (46), and pressure adjustment cap (49) with new o-ring (48) into compensator housing (42). Torque plug (40) 6 to 8 lb-ft [8 to 10 N-m] and torque pressure adjustment cap (49) 35 to 40 lb-ft [47 to 54 N-m].

16 Install new gasket (35) and new o-ring (36), then install compensator assembly (37 or 39),and retain with four allen head cap screws (38) and torque to 10 to 12 lb-ft [14 to 16 N-m].

17 Plug ports to preserve cleanliness until installation on vehicle. (Refer to start up procedures.)

EACH ORDER MUST INCLUDE
THE FOLLOWING INFORMATION
1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts

Identification Numbers



22 = 2.32 Compensated Piston Pump (plain backplate)
23 = 2.77 Compensated Piston Pump (plain backplate)
52 = 2.32 Compensated Piston Pump (tandem backplate)
53 = 2.77 Compensated Piston Pump (tandem backplate)

Start-Up Procedure

When initially starting a rebuilt load sensing system, it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the pump which might occur if the system was not properly purged with oil before start-up.

1 After the pump has been properly installed onto the machine and all hydraulic connections have been made, check all fittings to make sure that they are tight.

2 Fill the pump housing at least 1/2 full with system oil that has been filtered through a 10 micron filter.

3 Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Leave the filler cap loose as a means of air that is trapped in the system.

4 Note on gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds. This procedure enables the pump to pick-up the oil before start-up. At this time disconnect the sensor line from the pump compensator and pull one of the valve spools while the engine is being turned over. This allows oil to flow through the sensor line, thus, removing any air in the sensor line. Reconnect the sensor line after a steady flow of oil is coming from the line.

5 Replace the coil wire or return the fuel flow to the injectors and start the engine. Run at low idle speed for one minute. The pump should immediately pick up oil and go into low pressure standby. If there is no indication of fill in 30 seconds, stop engine and determine the cause.

6 After the pump has stabilized in low pressure standby, operate the control valve and steering, if the system is equipped with one, to purge the system of air and to fill the cylinders with oil. Continue operating the system slowly with no load until it responds fully.

7 Check fluid level at the reservoir and refill if necessary to the proper level at the reservoir and refill if necessary to the proper level with an approved filtered oil.

8 Check all line connections for leaks tighten if necessary.

9 The machine is now ready to be put into operation.

10 Short hour filter changes are recommended for the first two changes after placing the machine back into operation. The first filter would be changed in 3-5 hours and the second at approximately 50 hours. Routine scheduled filter changes are recommended for maximum life of hydraulic system.

EATON
REPAIR INFORMATION
PRESSURE OR PRESSURE-FLOW
COMPENSATED PISTON PUMP
MODEL 70422 AND 70423
NO. 7-609

Trouble Shooting

Problem	Possible Cause	Correction
1 Noisy pump caused by cavitation.	A Oil too heavy. B Suction strainer or filter plugged. C Suction line plugged, too small, or too long.	A Change to proper viscosity. B Clean or replace. C Clean line and check for proper size and length.
2 Noisy pump caused by aeration.	A Oil supply low. B Air leaking into suction line. C Foaming oil.	A Fill reservoir. B Tighten fittings. C Drain reservoir and fill with non-foaming type oil.
3 Hydraulic system overheating.	A Oil supply low. B Oil in system too light. C Excessive internal leakage. D Aeration of oil.	A Fill reservoir. B Drain reservoir and refill with proper viscosity oil. C Disconnect case, drain line, measure leakage volume while pressurizing hydraulic system. Case drain flow should not exceed 3 G.P.M. if excessive, remove pump, disassemble and repair. D Tighten fittings.
4 System not developing adequate pressure.	A Excessive internal leakage. B Either compensator spool stuck open. C Either compensator spring weak or broken. D Loss of flow compensator signal.	A Refer to 3-c. B Disassemble compensator, inspect for stuck spool, clean or replace compensator assembly. C Disassemble compensator, inspect for weak or broken spring. Replace spring if necessary. D Check signal line connections, check for line obstruction, line damage and line size and length.
5 System not developing adequate flow.	A Excessive internal leakage. B Either compensator spool stuck open. C Either compensator spring weak or broken. D Pump cavitation. E Loss of flow compensation signal.	A Refer to 3-c. B Refer to 4-b. C Refer to 4-c. D Refer to 1-a,1-b,1-c. C Refer to 4-d.

HELAC

MAINTENANCE MANUAL

FOR

"HELAC" PIVOT

ROTARY ACTUATORS

HP-SERIES

TABLE OF CONTENTS

I. THEORY OF OPERATION
II. HYDRAULIC LINE ATTACHMENT
III. DISASSEMBLY AND INSPECTION
IV. ASSEMBLY AND TESTING

HP-286

I. THEORY OF OPERATION

In reference to Fig. I, fluid entering Port E2 under pressure will bear on piston (4) and force piston sleeve (3) upwards. The left-handed spline of piston sleeve (3) will combine with the right-handed spline of shaft (2) and cause rapid CW rotation of shaft and flange (2) (looking down). Fluid entering Port E1 will reverse this rotation.

Displacement and torque are identical for CW and CCW rotation.

Shaft (2A) is integral with shaft flange (2B) and bearing tube (2C). The shaft is supported radially by the large upper radial bearing (19) and the lower radial bearing (18). Axially, the shaft is separated from the housing by upper and lower thrust rings (20). End cap (5) is adjusted for axial clearance and locked in position by cap screw (7).

II. HYDRAULIC LINE ATTACHMENT

Ports E1 and E2 are provided with either NPT or SAE threads. The hydraulic lines from the control valve to the actuator should be as short as possible. If the lines are too long, the actuator cycles the fluid back and forth, not allowing sufficient fluid to reach the continuous flow circuit for filtering.

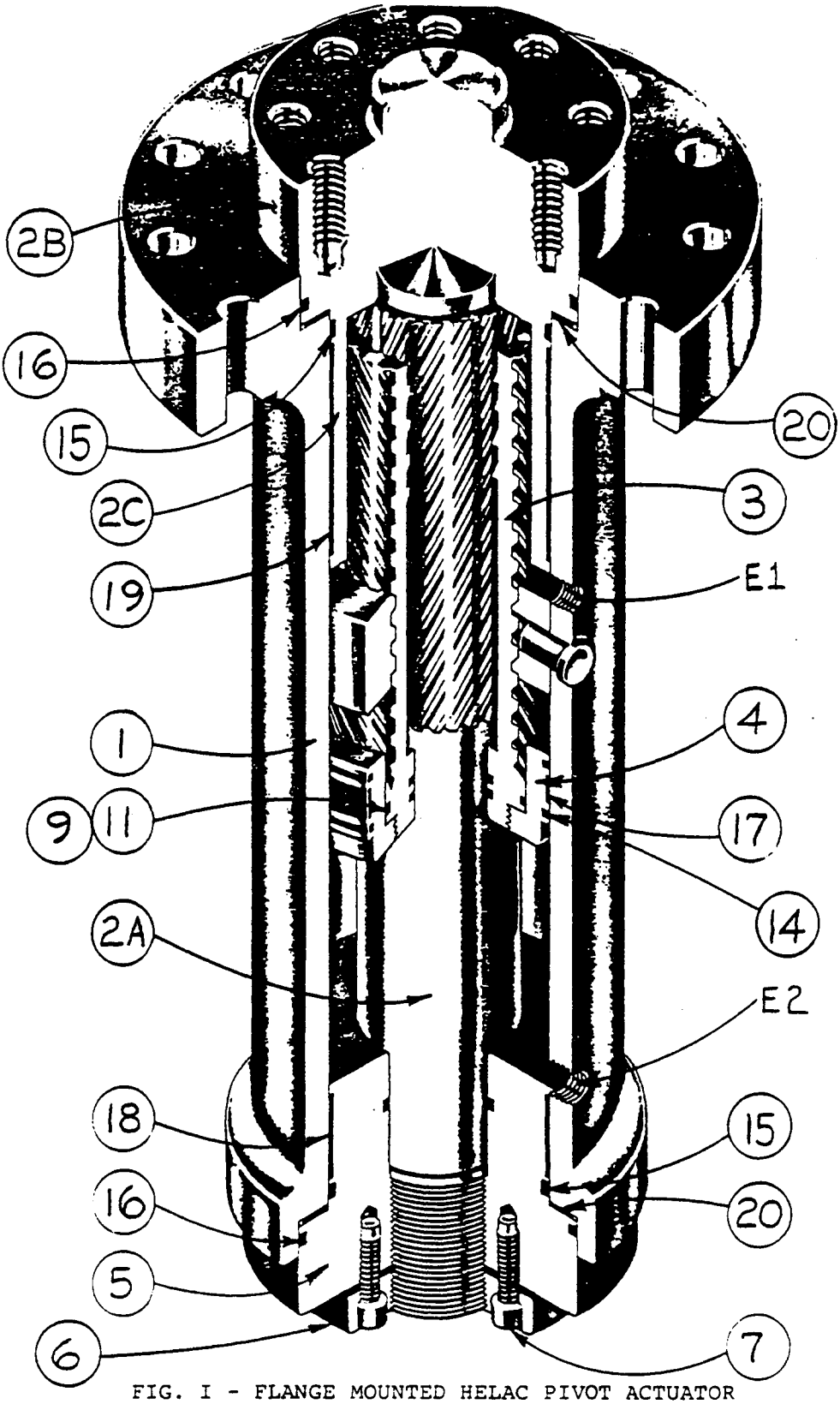


FIG. I - FLANGE MOUNTED HELAC PIVOT ACTUATOR

III. DISASSEMBLY AND INSPECTION

Place on clean work bench with room to place the internal parts as they are removed. Remove all hydraulic fittings. Loosen cap screws (7) and unscrew locknut (6) and end cap (5). The shaft is now free to slide up and out of engagement with the piston sleeve (3). Note the orientation (see Fig. II) between the spline teeth, as this will greatly simplify actuator timing upon reassembly.

After removing the shaft, the piston sleeve and the piston assembly can now be moved down and out of the housing. Remove all seals and wear strips from their grooves, except static piston seals (9) and (11). These seals generally do not require replacement. Clean all parts thoroughly and inspect for wear. A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about .005 per mating set. After long service, a backlash of about .015 per set may still be acceptable in most cases, depending on the required accuracy of the application.

Item (1) is the integral housing and ring. Check the ring gear for wear and weld damage to the pins. Inspect the cylinder bore for wear and scratches. The surface finish should be 32 RMS or better, rehone if necessary. The radial bearing (18) and (19) and the piston wear strip (17) should have maximum radial clearance of

III. DISASSEMBLY AND INSPECTION (CONT'D)

.006. A clearance in excess of .008 calls for replacement of the bearings. Rough and grooved shaft journals require shaft replacement.

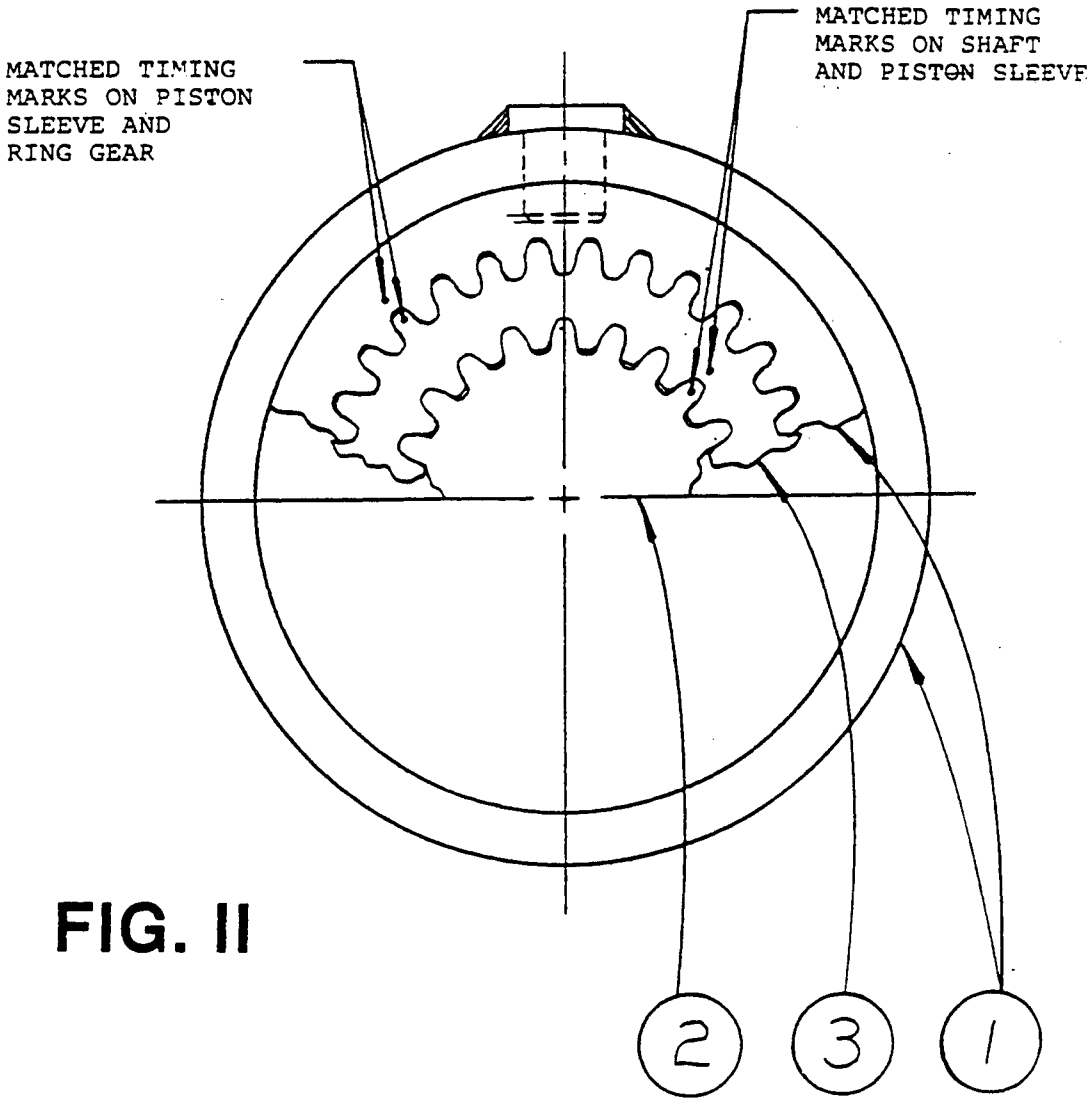


FIG. II

IV. ASSEMBLY AND TESTING

Wash all parts thoroughly in cleaning solvent and blow dry. Coat all sealing and working surfaces with a good grade hydraulic oil. Install seals in piston sleeve, piston and end caps. The lips of exclusion seals (16) face outward, and the lips of high pressure seals (15) face inwards.

Place the actuator in a vertical position, install the piston sleeve (3) in timed relation to the housing, applying firm pressure as the new seals and wear strip enter the housing and become compressed by the housing chamber. (CAUTION: Do not cock the sleeve too much any one way, for it will mar the cylinder bore). The timing marks (small punch marks on the face of each gear), must be lined up for proper shaft orientation. (Fig. II).

Thrust rings (20) are coated with good grease before sliding on the shaft and end cap. The shaft is installed by again aligning the proper punched timing marks (Fig. II). Temporary taping (masking tape works well) of threaded portion of shaft will help installation past the shaft seals. Apply antiseize to threaded and surrounding areas of end caps. Also depending on the size of the actuator (some 60K's& up), the end cap may need to be installed with the actuator in a vertical position.

IV. ASSEMBLY AND TESTING (CONT'D)

End cap (5) is torque to 40-80 ft-lb depending on the actuator size, such that the actuator begins rotation at approximately 100 PSI pressure. The torque flange cannot be rotated by hand. The combined back-drive efficiency and friction prevent manual rotation. If the end cap is torqued too high, the actuator may take as much as 300 PSI to rotate. If end cap is not torqued high enough, shaft axial motion in excess of .015 will occur and damage the ring gear, piston, sleeve and/or shaft can result. The end cap must be secured against the shaft by tightening cap screws (7). Apply hydraulic pressure and check for shaft axial motion.

To test for leakage, pressurize port E2 to 3000 PSI. No oil should seep from port E1 or from around end cap (5). Repeat test for pressurizing port E1 and check for leakage out of port E2 and around shaft flange (2B).

Note: End cap torque should be checked at least every 800 hours or once a year. If end play is observed, (the torque flange moving out of the housing), tighten end cap.

MINIPAK DISASSEMBLY/ASSEMBLY INSTRUCTIONS

DISASSEMBLY: **(See Figure)**

NOTE: Before attempting to disassemble this or any other hydraulic component, prepare a **CLEAN** work area.

1. Remove coil nut (1) and slide coil (3) off tube (4).
2. Remove nuts (18), mounting bracket (17) and washer (16) from the inlet end of the valve bank.
3. Remove inlet (15), attachments (20) as necessary, and O-Rings.
4. Remove valve sections (14), one at a time, removing O-Rings (12) or (13) between each section. Remove only those sections to be repaired or replaced.
5. Use a 1 1/4" wrench to loosen tubes (4) from body.

CAUTION: Use proper tools to avoid damaging tube sub-assembly.

6. Remove tube sub-assembly by hand. Spring (8) and spring retainer (9) may fall from valve body.
7. Slide pin, plug, and plunger out of tube.

NOTE: Pin, plug, and plunger are a matched set. Do **NOT** mix parts.

8. Use a small punch to gently push manual override pin into tube until it is free and falls out.
9. If valve has manual override option "JJ", use a screwdriver inside the tube to hold pin (5) from turning while removing the palm button.
10. Repeat steps 5 through 8 to remove tubes on the opposite side of the valve.
11. Gently slide spool (14) from valve body. Make a note of its position in the valve body. Spool cannot be turned around. It must slide into the body in the same position it came out.

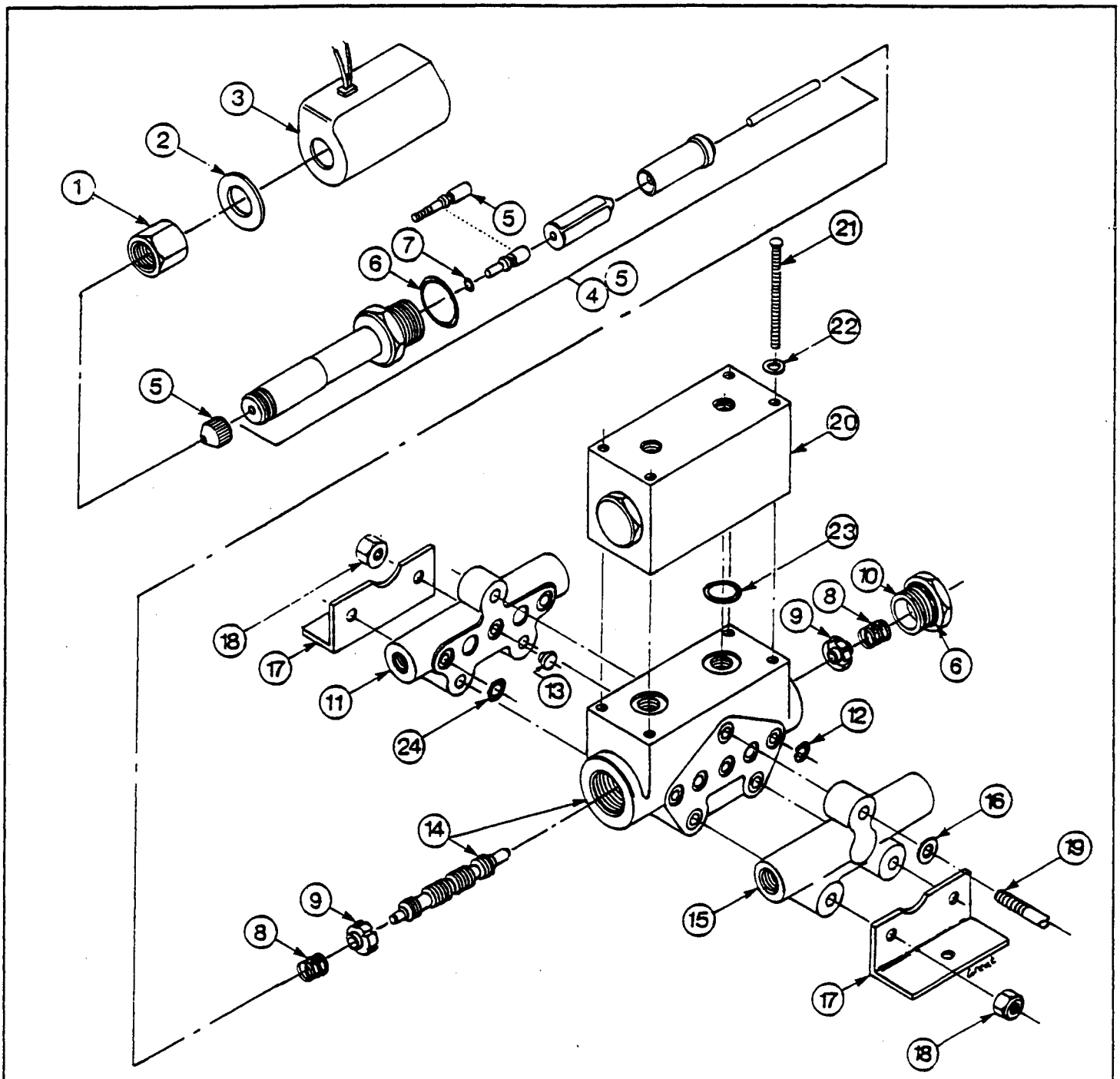
CAUTION: **BODY AND SPOOL ARE A MATCHED SET.** If either one is damaged, BOTH must be replaced.

12. Wash all parts in cleaning solvent and dry with air gun. Be sure to remove all traces of solvent.

ASSEMBLY:

NOTE: Before re-assembly, discard all used O-Rings.

1. All parts should be individually inspected to verify they are free from wear, burrs, nicks, scratches or any other defect that could cause poor performance.
2. Lubricate all system parts and O-Rings with clean system oil before assembly.
3. Lubricate spool (14) and valve body and carefully slide spool into body, making sure it is in the same position as when it was removed. Spool should slide freely in plug.
4. Install O-Ring (7) on manual override pin. Lubricate inside of tube where pin is installed. Carefully push pin into place. Install O-ring (6) on tube. Install plunger, plug and pin. Make sure that these parts are lubricated with oil. Pin should slide freely in plug.
5. Place spring retainer (9) onto spool with prongs towards spool. Place spring (8) over retainer and install tube subassembly into valve body by hand.
6. Repeat steps 4 and 5 for the opposite side of the valve.
7. For single solenoid sections, place O-ring (6) on plug (10), retainer (9) on spool with prongs towards spool and spring (8) over retainer. Tighten plug and/or tube subassembly to 100 in./lbs.
8. Install one nut (18) on each tie rod (19). Place two tie rods through the mounting bracket (17). Place one flat washer (16) on the third tie rod. Place outlet section (11) over the tie rods. An aid in banking sections is to place the mounting bracket in a vice or on the edge of a flat surface with the tie rods in a vertical positions. Place five O-rings (24). Install a valve section over the tie rods. Place the O-rings (12) on this section. Replace remaining sections as above.
9. Install inlet section (15). Place mounting bracket (17) over lower tie rods and install two nuts (18). Place a flat washer (16) over top tie rod only.
10. Torque tie rods in three steps of 50 in./lbs., 90 in/lbs. and finally 115 in./lbs.
    THIS IS VERY IMPORTANT! OVERTORQUEING WILL CAUSE BORE DISTORTION & MAY CAUSE SPOOL BINDING OR INCREASED LEAKAGE.
11. In order to set the relief, if installed, the complete valve must be placed on a test stand capable of flow from 1 to 5 GPM. Remove the cap over the adjustment screw and loosen the lock nut (see below). Set incoming pressure on test stand to desired valve setting and adjust screw in to increase relief setting or out to decrease relief setting. Setting is correct when .25 GPM flows out of valve at desired pressure.
12. If painting is required make sure all ports are plugged and electrical connections are masked.



Parts List

Item	Description	Item	Description	Item	Description
1.	Nut	9.	Spring retainer	18.	Nut
2.	Nameplate	10.	Plug	19.	Tie rod
3.	Solenoid coil	11.	Outlet section	20.	Attachment (optional)
4.	Tube S/A (standard)	12.	O-ring (5)		
5.	Tube S/A (palm button)	13.	Closed center plug	21.	Bolt
6.	O-ring	14.	Body & spool	22.	Washer
7.	O-ring	15.	Inlet section	23.	O-ring
		16.	Washer	24.	O-ring (5)

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.