

TM 9-2320-312-24-2

TECHNICAL MANUAL

UNIT, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

FOR

**TRUCK, TRACTOR, YARD TYPE:
46,662 GVWR, DED, 4 X 2, M878A2
(NSN 2320-01-452-5579)**



Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY

December 2003

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TM 9-2320-312-24-2

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Washington, D.C., 17 December 2003

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Caterpillar Schematic: 3126E Truck Engine Electrical System

HOW TO USE THIS MANUAL

NOTE

If at any time you are unsure how to use this manual or you cannot locate the information you need, notify your supervisor.

INTRODUCTION

1. This manual is designed to help you perform Unit, Direct Support, and General Support Maintenance on the M878A2 Yard Tractor.
2. The *Repair Parts and Special Tools List (RPSTL)*, TM 9-2320-312-24P, is to be used in conjunction with this manual, to locate and obtain the repair parts and special tools needed to maintain this equipment.
3. This manual consists of three volumes: Volume 1 contains maintenance and troubleshooting for yard tractor components NOT covered in the Commercial Service Manuals. Volumes 2 and 3 are a compilation of Commercial off-the-Shelf (COTS) Service Manuals.
4. A *Table of Contents* at the front of Volume 1 lists the contents of all volumes of this publication. Each volume also contains a *Table of Contents* for that particular volume.
5. Volume 1 is written in work package format, in accordance with MIL-STD-40051A:
 - a. Chapters divide the manual into major categories of information (e.g. *Introductory Information with Theory of Operation, Troubleshooting Procedures, Unit Maintenance, Direct Support Maintenance, General Support Maintenance, and Supporting Information*).
 - b. Each Chapter is divided into work packages, which are identified by a 6-digit number (e.g. 0001 00, 0002 00, etc.) located on the upper right-hand corner of each page. The work package page number (e.g. 0001 00-1, 0001 00-2, etc.) is located centered at the bottom of each page.
 - c. If a Change Package is issued to this manual, added work packages use the 5th and 6th digits of their number to indicate new material. For instance, work packages inserted between WP 0001 00 and WP 0002 00 are numbered WP 0001 01, WP 0001 02, etc.
6. Volumes 2 and 3 are provided in commercial format.
7. Scan through all volumes of this manual to become familiar with their organization and contents before attempting to maintain the equipment.

ORGANIZATION OF MATERIAL

1. Maintenance procedures in each volume are sequenced in accordance with the following major assembly groups, as outlined in the Maintenance Allocation Chart (MAC) in Volume 1:
 - a. Group 020—engine
 - b. Group 040—fuel
 - c. Group 050—exhaust
 - d. Group 060—cooling
 - e. Group 070—transmission
 - f. Group 080—front axle (includes front axle steering components and front service brakes)
 - g. Group 090—rear axle (includes rear service brakes)
 - h. Group 110—steering
 - i. Group 115—frame
 - j. Group 120—propshaft
 - k. Group 140—cab and sheet metal
 - l. Group 150—air piping and brake

ORGANIZATION OF MATERIAL - CONTINUED

- m. Group 160—miscellaneous
 - n. Group 170—electrical
 - o. Group 180—power take-off (PTO)
 - p. Group 190—oil piping (all fluid lines except air)
2. In the Commercial Service Manuals, troubleshooting is located in the same section as the maintenance procedures for that assembly group. For instance, engine troubleshooting is located within Group 020; transmission troubleshooting is located within Group 070.
 3. In the work package-formatted material, troubleshooting for ALL assembly group components is located in work package 0006 00. However, the Troubleshooting Symptom Index in WP 0005 00 contains a listing of ALL troubleshooting procedures, to include those contained in the Commercial Service Manuals.

CONTENTS OF VOLUME I (WORK PACKAGE-FORMATTED MANUAL)

1. A *Warning Summary* is located at the beginning of this volume. Become familiar with these warnings before performing troubleshooting or maintenance on the vehicle.
2. A *Table of Contents*, located in the front of this volume, lists all chapters and work packages in the publication, as well as the contents of Volumes 2 and 3.
 - a. The *Table of Contents* also provides *Reporting Errors and Recommending Improvements* information and DA Form 2028 addresses, for the submittal of corrections to this manual.
 - b. If you cannot find what you are looking for in the *Table of Contents*, refer to the alphabetical *Index* at the back of the manual.
3. Chapter 1, *Introductory Information with Theory of Information*, provides general information on the manual and the equipment.
4. Chapter 2, *Troubleshooting Procedures*, contains troubleshooting.
5. Chapter 3 covers all *Unit Maintenance*.
6. Chapter 4 covers all *Direct Support Maintenance*.
7. Chapter 5 covers all *General Support Maintenance*.
8. Chapter 6 covers *Supporting Information: References, Maintenance Allocation Chart (MAC) Introduction, Maintenance Allocation Chart (MAC), Expendable and Durable Items List, and Tool Identification List*.
9. There are electrical system *Foldouts* at the back of Volume 1.

CONTENTS OF VOLUMES 2 AND 3 (COMMERCIAL SERVICE MANUALS)

1. Volume 2 contains Group 020—engine.
2. Volume 3 contains:
 - a. Group 070—transmission.
 - b. Group 080—front axle
 - c. Group 090—rear axle
 - d. Group 110—steering
 - e. Group 120—propshaft
 - f. Group 140—cab and sheet metal
 - g. Group 150—air piping and brake
 - h. Group 160—miscellaneous

FEATURES OF VOLUME I (WORK PACKAGE-FORMATTED MANUAL)

1. Because the major assembly groupings used in this manual do not correspond to military function group codes (FGC) and are unfamiliar to the soldier, maintenance tasks in Volume I include in their initial setups the following information:

- a. MAC Reference (e.g., MAC Group 160)
- b. RPSTL Reference (e.g., RPSTL Group 160, Figure 003)

This information will assist the user to locate appropriate MAC guidance and repair parts for the component being maintained.

2. WARNINGS, CAUTIONS, NOTES, subject headings, and other important information are highlighted in **BOLD** print as a visual aid.

WARNING

A WARNING indicates a hazard that may result in death or serious injury.

CAUTION

A CAUTION is a reminder of safety practices or directs attention to usage practices that may cause damage to equipment.

NOTE

A NOTE is a statement containing information that will make the procedures easier to perform.

3. Statements and words of particular interest may be printed in CAPITAL LETTERS to create emphasis.
4. Within a procedural step, reference may be made to another work package in this volume of the manual or to another volume of this manual or another manual. These references indicate where you should look for more complete information.
 - a. If you are told: "Fill hydraulic reservoir (WP 0129 00)", go to work package 0129 00 in Volume 1 of this manual for instructions on filling the hydraulic reservoir.
 - b. If you are told: "Raise fifth wheel (TM 9-2320-312-10)", go to TM 9-2320-312-10 for complete instructions on raising the fifth wheel. Use the *Table of Contents* or alphabetical *Index* in TM 9-2320-312-10 to find the procedure.
 - c. If you are told "Repair transmission torque converter (Group 070 Commercial Service Manuals)", go to Group 070 in the Commercial Service Manuals (Volume 3) to find the procedure.
5. Illustrations are placed after, and as close to, the procedural steps to which they apply. Callouts placed on the art may be text or numbers, or both.
6. Numbers located at the lower right corner of the art (e.g. 376-001, 376-002, etc.) are art control numbers and are used for tracking purposes. Disregard these numbers.
7. Dasher leader lines used in illustrations indicate that called-out items are not visible in the view depicted (i.e. they are located within or behind the structure). In Lubrication Charts (WP 0008 00, *Unit PMCS Introduction*) and in *Unit PMCS* (WP 0009 00), dashed leader lines indicate a lubrication that is required on both sides of the equipment.
8. Technical instructions include metric units as well as standard units. For your reference, a *Metric Conversion Chart* is located on the inside back cover of the manual.

**SERVICE, TROUBLESHOOTING, AND REPAIR OF
1090-0800-01 FAN CLUTCH**

INSTALLATION AND SERVICE GUIDE Front Air Fan Drives



BorgWarner
Cooling Systems

On behalf of the entire BorgWarner Cooling Systems organization, we wish to thank you for purchasing a BorgWarner Fan Clutch. We sincerely believe this product to be the highest quality, most dependable Fan Clutch on the market and we are confident that it will provide you with the high performance and

reliable service that you desire. This installation and service guide contains the information you will need to properly install and maintain your fan clutch for maximum life and dependable service. We urge you to thoroughly familiarize yourself with the contents of this guide and preserve it for future reference.

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Fan Drive Assemblies

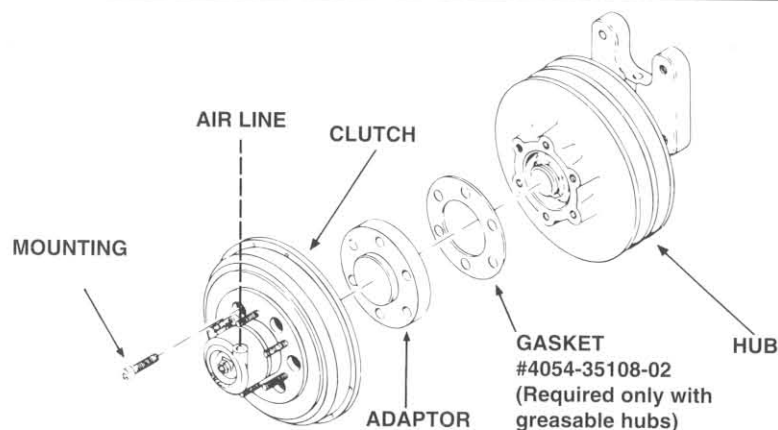
A Clutch And A Hub Combined Under A 1093 Part Number

The front air fan drive assembly shown here consists of a clutch (1090 part number), a hub (1077 part number) and in most cases, an adaptor kit (1096 part number).

REPLACEMENT CLUTCHES: The 1090-05000 and -6000 series clutches are obsolete and service parts are no longer supplied. To replace one of them, look up your 1093 drive assembly in the chart on pages 2-4, determine which clutch was used and select a new one from the table on page 5.

REPLACEMENT HUBS: None of the hubs used in front air 1093 fan drive assemblies are in production. The tapered roller bearing type hub was the most common, and the bearing kits for it are still available.

"1093" SERIES - FAN DRIVE ASSEMBLY (FRONT AIR)



Preventive Maintenance

FAN HUBS: Grease at every PM using a high quality, high temperature bearing grease with EP additives such as AeroShell 5 or Chevron SRI-2. DO NOT USE ORDINARY CHASSIS GREASE - IT WILL MELT UNDER THE TEMPERATURES GENERATED BY FAN DRIVES.

FAN CLUTCHES: (Every PM)

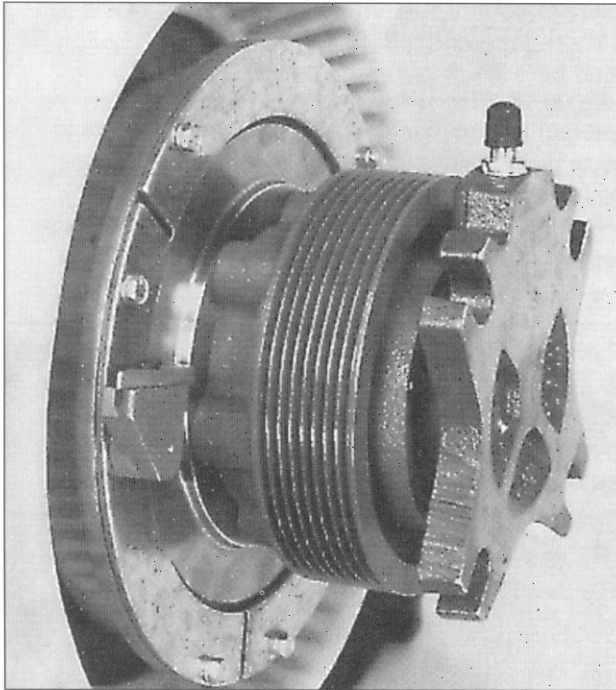
What to do	How to do it
Check operation	Turn on key or jumper control system so that 120 psi air gets to clutch. It should disengage and turn freely. Turn off key. Clutch should lock up and be difficult to turn by hand.
Check for air leaks and cylinder problems.	Turn on key or jumper control system so that 120 psi air gets to clutch. Feel front of clutch (cylinder) for air leaks. Turn cylinder back and forth to limit of air line. It should not bind or catch. (Remove clutch to repair if either problem is found.) Check that air line has some tension and cannot get into fan. (See installation instructions.)
Lining wear check	1090-07050. When clutch has no air pressure, fan should be very difficult to turn. If it seems easy, remove clutch and replace lining or rebuild as described in repair section. 1090-08000. See use of lining wear gauge, on page 12.

Fan Clutch Lining Maintenance

FAN CLUTCH LINING MAINTENANCE

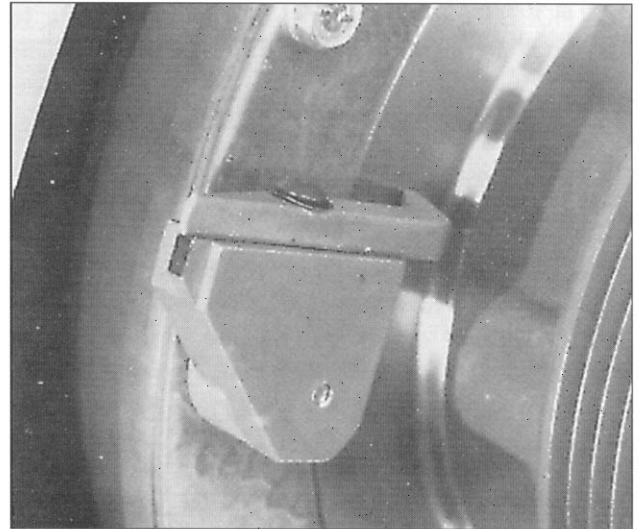
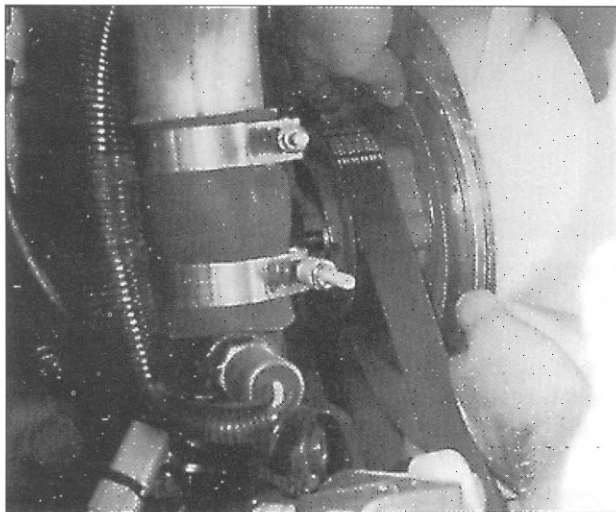
It is very important to check fan clutch lining condition on a regular basis:

CLUTCH LINING MAINTENANCE	
FIRST CHECK:	100,000 miles (160,930 km)
SUBSEQUENT CHECKS:	Every 50,000 miles (80,465 km)



Use the lining wear tool for estimating the amount of clutch lining wear.

1. Apply 90 - 120 psi (6.2 - 8.2 bar) air pressure to the fan clutch (disengage).
2. Place the lining wear tool on a retaining plate on the back of the fan clutch. Press the lever against the rear face of the fan clutch shaft assembly.



Note the position of the lever in relation to the step on the lining wear tool.

3. Remove the air pressure from the fan clutch (engage).

If the lever travels the full width of the step, the lining needs to be replaced. When the lining is new the lever will travel approximately half the width of the step. The lever may or may not line up with the rear of the step at the start of the check. If not, estimate the amount of travel.

NOTE: RAPID LINING WEAR INDICATES A PROBLEM IN THE FAN DRIVE CONTROL SYSTEM OR AN AIR LEAK. SEE PAGES 21 & 22 FOR CONTROL SYSTEM SPECIFICATIONS AND TYPES. CALL BORGWARNER COOLING SYSTEMS TECH SERVICE FOR TROUBLESHOOTING ASSISTANCE, 800-927-7811.

REPLACING THE LINING (1090-08000 ONLY)

THE BORGWARNER FAN DRIVE IS EASY TO RELINE WITHOUT REMOVING IT FROM THE VEHICLE.

TOOLS & PARTS REQUIRED

Inch pound or Newton Meter torque wrench
1/4" drive ratchet
1/4" drive 5/16" socket
Clutch lining kit, 1033-08250-01

CAUTION: THE FAN CLUTCH MUST HAVE AIR PRESSURE DURING THIS PROCEDURE (90-120 psi; 6.2-8.2 bar)

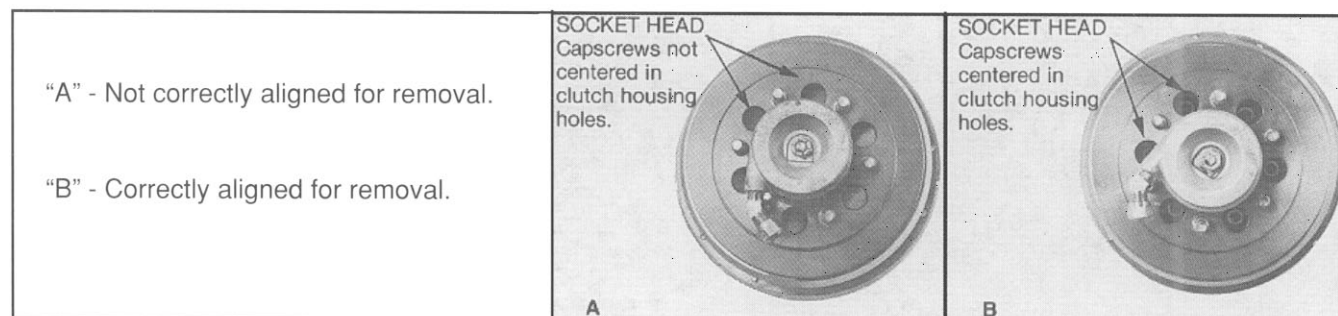
Remove the six lining plate screws and the three lining plates. Remove the old lining and install the new lining. Replace the plates and screws and torque screws to 30 pounds inch (3.4 Newton Meters).

Troubleshooting Guide

Problem	Cause	Solution	Reference
Front air leaks	Dirty or worn seals	Rebuild or replace clutch.	See Page 5, 14-20
Air leaking in the clutch	Internal "O" ring damaged	Rebuild or replace clutch.	See Page 5, 14-20
Clutch will not engage when air pressure is removed	Worn out lining or Dust seal hanging up on cylinder wall	Rebuild clutch.	See Page 14-20
Lining worn	Over cycling caused by bad temperature or A/C switch	1090-08000 ONLY: Supply air pressure to clutch and remove and replace lining. Clean out back of clutch. 1090-07050 ONLY: Remove to repair Both clutches: Replace switches if necessary.	See Page 12 See Page 14-17 See Page 20-22
	Air line leaks	Check for air leaks in line and fittings. Replace lining.	See Page 12, 14-17
	Stationary vehicle or PTO over cycling the fan clutch	Install an override device. Replace lining.	See Page 20-22 See Page 12, 14-17
	Insufficient air pressure or debris in solenoid valve restricting air flow.	Air pressure 90-150 PSI check air supply. Replace lining and solenoid valve if necessary.	See Page 12, 14-17, 20-22
Clutch will not disengage	Over cycling caused by bad temperature or A/C switch or clutch lining rusted to the shaft.	1090-08000 ONLY: Supply air pressure to clutch and remove and replace lining. Clean out back of clutch. 1090-07050 ONLY: Remove to repair Both clutches: Replace switches if necessary.	See Page 12 See Page 16-17 See Page 20-22

Fan Clutch Removal

Pressurize clutch to disengage so that holes can be lined up. If clutch will not disengage, put fan back on studs and manually rotate clutch to line up holes.



Rebuild Procedures, Continued

B. Place new tab washer into cylinder cavity. Align tab and keyway in piston rod, and push cylinder onto clutch. Start the nut.

C. SLOWLY compress clutch until it disengages and can be turned. Restrain cylinder from turning, and torque the cylinder nut to 84 lbs-inch.

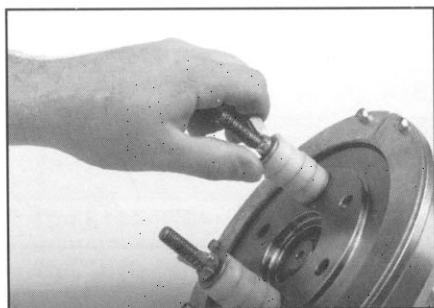
8. Pressurize clutch to 90 psi several times to test free movement and to center wear plate and lining in housing. While clutch is pressurized, torque lining plate screws and nuts to 30 lbs-inch. Make sure you have no air leaks. While clutch is pressurized, line up access holes in front with bolt holes in rear.

Fan Clutch Service Parts And Repair

1090-08000 REPAIR

I. Tools Required:

A. Two carriage bolts with wing nuts and washers. These must be about two inches longer than the distance through the holes in the fan clutch, as shown. Install them and compress the clutch slightly while loosening the cylinder nut (item 2 in the blow-up) and the lining plate screws, (item 18 in the blow-up). Then, back them off evenly to allow the clutch halves to separate. During re-assembly, tighten the carriage bolts evenly to compress the clutch before you install and tighten the cylinder nut and the lining plate screws.



B. Inch pound torque wrench with 5/16 and 1/2 inch sockets, 5/16 inch box wrench

C. Loc Tite® 640

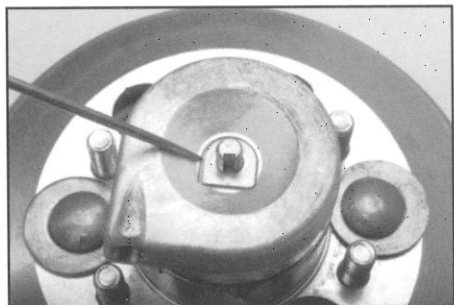
D. Internal snap ring pliers

II. Parts Required

Description	Part Number
Repair Kit	1033-05435-02
Cylinder Assembly	4043-41130-01
Piston Rod Assembly	4079-41133-01

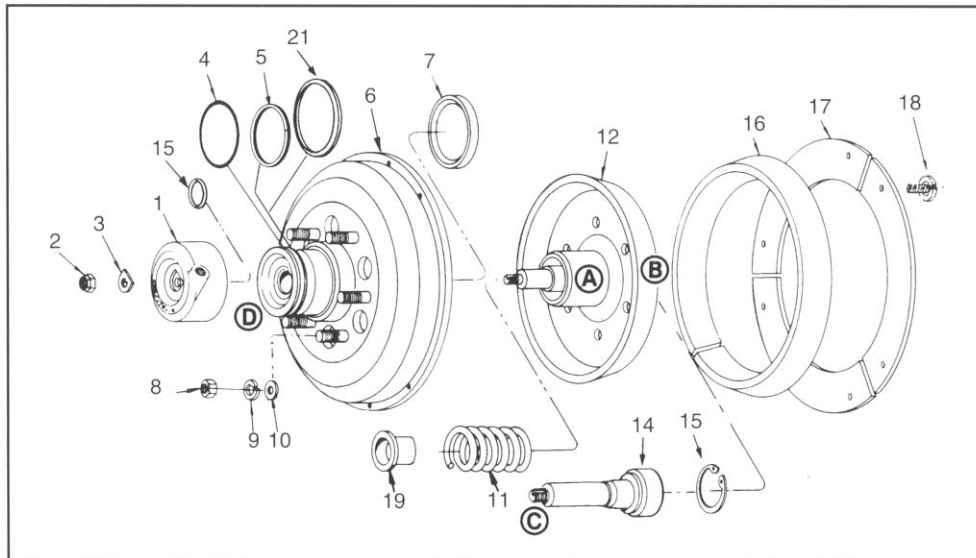
III. CYLINDER INSTALLATION

Use the picture below to help you correctly line up the tab washer (item 3 in the blow-up) with the cylinder during assembly.



Rebuild Procedures

8000 SERIES "K-22" FRONT AIR 1090-08000-XX



KEY	DESCRIPTION	PART NUMBERS
1	Cylinder Assy.	4043-41130-01
2	Cylinder Nut	3029-01371-01
3	Tab Washer	3058-01264-02
4	"O" Ring	9002-00491-68
5	Dust Seal "O" Ring	3018-01703-01
6	Housing Assy.	4040-41131-01 (-01, -02 & -05) 4040-41131-02 (-03 & -04)
7	Grease Seal	3018-01507-01
8	Fan Nut	3030-00364-01
9	Lock Washer	3059-00870-06
10	Flat Washer	3058-00843-07
11	Spring	4088-40615-01
12	Shaft Assy.	4079-41132-01 (-01 & -03) 4079-41132-02 (-02 Only) 4079-41132-04 (-04 Only) 4079-41132-05 (-05 Only)

KEY	DESCRIPTION	PART NUMBERS
13	"O" Ring	1 of 9002-00741-58
14	Piston Rod Assy.	4079-41133-01
15	Snap Ring	3038-01510-01
16	1 Pc. Lining	4026-36900-01
17	Retaining Plate(s)	3 of 4073-38444-01
18	Screw	3042-01684-01
19	Spring End Cap	4001-40690-01
20	Spring Carrier*	4001-40691-01
21	Dust Seal	3018-01702-01
	Grease Packet	2035-01353-01
	REPAIR KITS (1)	1033-05435-02

NOTE: (1) Items listed in blue screened rows are included in the repair kits.

* Included in Piston Rod Assembly Item #14.