

HV2 Series Hydraulic Cylinders

Parts Identification, Maintenance Instructions & Seal Kits

Service Assemblies and Seal Kits

Service Assemblies and Seal Kits for Miller hydraulic cylinders simplify the ordering and maintenance processes. They contain sub-assemblies which are ready for installation, and are supplied with full instructions. When ordering Service Assemblies and Seal Kits, please refer to the identification plate on the cylinder tube, and supply the following information:

Serial Number - Bore - Stroke - Model Number³ - Fluid Type

Key to Part Numbers

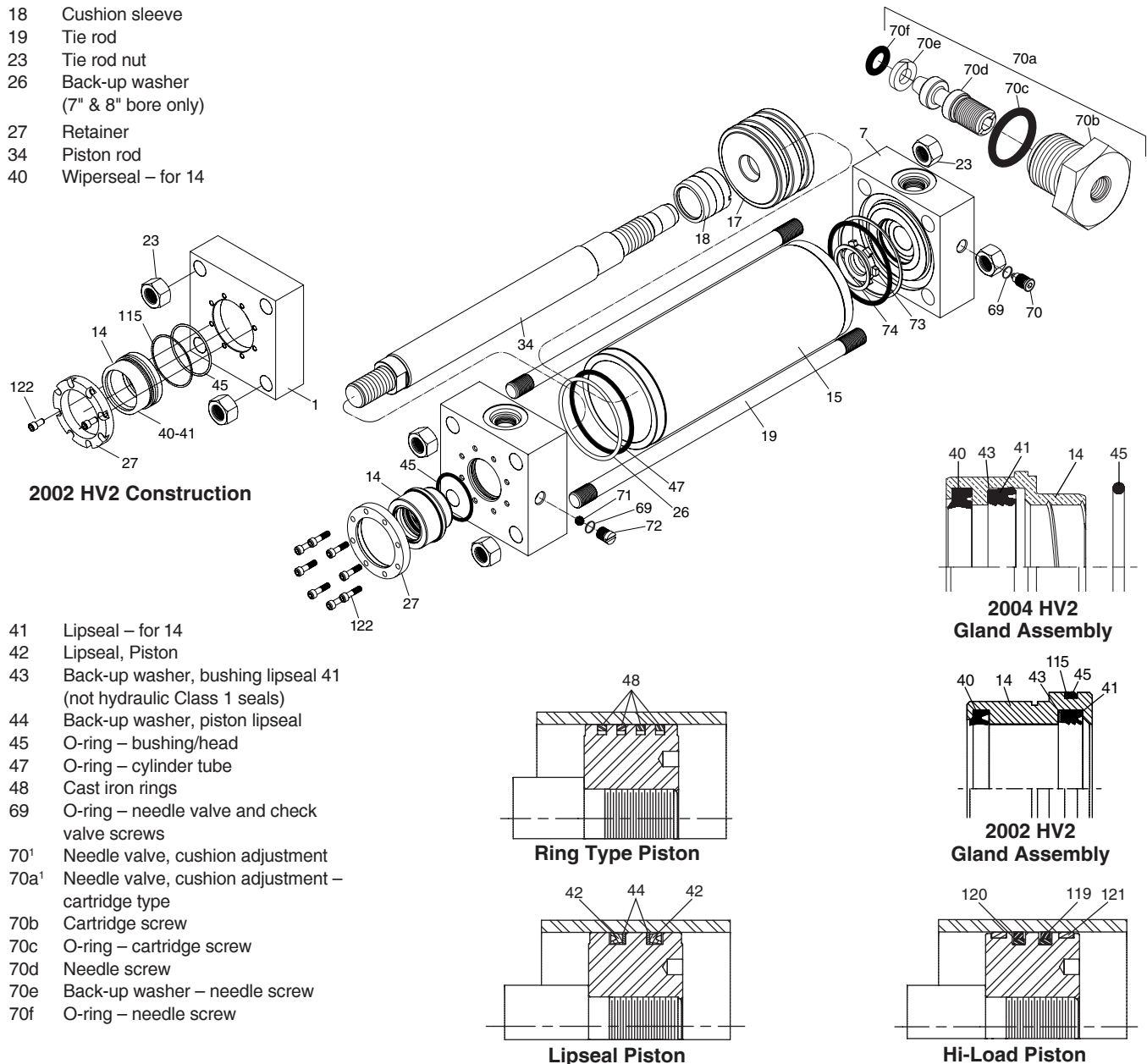
- 1 Head
- 7 Cap
- 14 Rod bushing
- 15 Cylinder tube
- 17 Piston
- 18 Cushion sleeve
- 19 Tie rod
- 23 Tie rod nut
- 26 Back-up washer
- (7" & 8" bore only)
- 27 Retainer
- 34 Piston rod
- 40 Wiperseal – for 14

- 71 Ball – cushion check valve
- 72 Cushion check valve screw
- 73 Floating cushion bushing
- 74 Retaining ring for cushion bushing
- 115 Back-up washer, rod bushing to head o-ring
- 119² Hi-Load Piston seal
- 120² Energizing ring for Hi-Load seal
- 121 Wear ring for Hi-Load piston
- 122 Retainer Bolt

¹ In some cases, the adjusting screw is installed in a cartridge.

² 7" & 8" Bore cylinders have only one Hi-Load piston seal and energizing ring.

³ See page 2 for model number changes to 2004 HV2.



- 41 Lipseal – for 14
- 42 Lipseal, Piston
- 43 Back-up washer, bushing lipseal 41 (not hydraulic Class 1 seals)
- 44 Back-up washer, piston lipseal
- 45 O-ring – bushing/head
- 47 O-ring – cylinder tube
- 48 Cast iron rings
- 69 O-ring – needle valve and check valve screws
- 70¹ Needle valve, cushion adjustment
- 70a¹ Needle valve, cushion adjustment – cartridge type
- 70b Cartridge screw
- 70c O-ring – cartridge screw
- 70d Needle screw
- 70e Back-up washer – needle screw
- 70f O-ring – needle screw

Ring Type Piston

Lipseal Piston

2004 HV2 Gland Assembly

2002 HV2 Gland Assembly

Hi-Load Piston

Operating Fluids and Temperature Ranges

The table shows the main types of fluid used with hydraulic cylinders. If the operating conditions of the particular application cannot be met

by the seal classes described, please consult the factory and supply complete application details.

| Class No | Typical Fluids | Temperature Range |
|--------------------------|---|--|
| 1 Nitrile & Polyurethane | Air, Nitrogen, Hydraulic Oil, Mil-H-5606 Oil | -10°F (-23°C) to +165°F (+74°C) |
| 2 Nitrile | Water, Water Glycol, H.W.C.F. Water-in-Oil Emulsion - Houghto-Safe 271, 620, 5040 Mobil Pyrogard D, Shell IruS 905, Ucon Hydrolube J-4 | -10°F (-23°C) to +165°F (+74°C) |
| 5 Fluorocarbon | High Temperature Houghto-Safe 1010, 10551 1120, Fyrquel 150, 220, 300, 550 Mobil Pyrogard 42, 43, 53, 55 Note: Fluorocarbon seals are not suitable for use with Skydrol fluid, but can be used with hydraulic oil if desired. | -10°F (-23°C) to +250°F (+121°C) (Class 5 seals may be operated up to +400°F [+204°C] with reduced service life) |

Service Kit Numbers

Miller HV2 Series was originally introduced in July 2002. In January 2005 the HV2 Series rod bushing and bolted retainer design were revised to allow more universal interchange with Miller H and HV Series cylinders. This change resulted in two different style rod bushing and rod seal kits; one for the July 2002 version and another for the January 2005 version. Additionally, the July 2002 HV2 had a standard nodular iron bushing without a cataloged material option: the January 2005 HV2 has a standard bronze bushing and an optional nodular iron bushing. The January 2005 HV2 model code was revised with an additional seal field that will identify the new design.

Cylinders ordered after January 5, 2005 can be identified by a model code that includes a seal material specification. See the example below (or refer to Catalog M1140-2 or later) and compare to the cylinder label model number. **Cylinders ordered prior to January 5, 2005 do not have a seal material specification in the model code**

HV272B2N-04.00-8.000-0175-S11I-0 - where T=Class 1 seals, V=Class 5 seals

Rod Bushing Kits and Rod Seal Kits – 2004 HV2 Series Bushing Seal Kits

| Rod Dia. | Seal Type | | | | | |
|----------|---------------------------------------|----------------------------|----------------|------------------------------|----------------------------|----------------|
| | Class 1 Service Polyurethane & Buna-N | | | Class 5 Service Fluorocarbon | | |
| | Bronze Bushing Kits† | Nodular Iron Bushing Kits† | Rod Seal Kits† | Bronze Bushing Kits† | Nodular Iron Bushing Kits† | Rod Seal Kits† |
| 5/8 | HV2-KR110-63 | HV2-KR120-63 | HV2-KR310-63 | HV2-KR210-63 | HV2-KR220-63 | HV2-KR410-63 |
| 1 | HV2-KR110-100 | HV2-KR120-100 | HV2-KR310-100 | HV2-KR210-100 | HV2-KR220-100 | HV2-KR410-100 |
| 1 3/8 | HV2-KR110-138 | HV2-KR120-138 | HV2-KR310-138 | HV2-KR210-138 | HV2-KR220-138 | HV2-KR410-138 |
| 1 3/4 | HV2-KR110-175 | HV2-KR120-175 | HV2-KR310-175 | HV2-KR210-175 | HV2-KR220-175 | HV2-KR410-175 |
| 2 | HV2-KR110-200 | HV2-KR120-200 | HV2-KR310-200 | HV2-KR210-200 | HV2-KR220-200 | HV2-KR410-200 |
| 2 1/2 | HV2-KR110-250 | HV2-KR120-250 | HV2-KR310-250 | HV2-KR210-250 | HV2-KR220-250 | HV2-KR410-250 |
| 3 | HV2-KR110-300 | HV2-KR120-300 | HV2-KR310-300 | HV2-KR210-300 | HV2-KR220-300 | HV2-KR410-300 |
| 3 1/2 | HV2-KR110-350 | HV2-KR120-350 | HV2-KR310-350 | HV2-KR210-350 | HV2-KR220-350 | HV2-KR410-350 |
| 4 | HV2-KR110-400 | HV2-KR120-400 | HV2-KR310-400 | HV2-KR210-400 | HV2-KR220-400 | HV2-KR410-400 |
| 5 | HV2-KR110-500 | HV2-KR120-500 | HV2-KR310-500 | HV2-KR210-500 | HV2-KR220-500 | HV2-KR410-500 |
| 5 1/2 | HV2-KR110-550 | HV2-KR120-550 | HV2-KR310-550 | HV2-KR210-550 | HV2-KR220-550 | HV2-KR410-550 |

Cushion Hardware Kits (Fluorocarbon seals for Class 1, 2, 5, 6, & 8 service)

| Bore Size | Rod Dia. | For Head Assemblies† | For Cap Assemblies† |
|-----------|----------|----------------------|---------------------|
| 1 1/2 | All | HV2-CUKH1-394 | HV2-CUKH1-398 |
| 2 | All | HV2-CUKH1-395 | HV2-CUKH1-399 |
| 2 1/2 | All | HV2-CUKH1-395 | HV2-CUKH1-400 |
| 3 1/4 | All | HV2-CUKH1-396 | HV2-CUKH1-401 |
| 4 | All | HV2-CUKH1-396 | HV2-CUKH1-403 |
| 5 | All | HV2-CUKH1-396 | HV2-CUKH1-404 |
| 6 | All | HV2-CUKH1-397 | HV2-CUKH1-405 |
| 7 | All | HV2-CUKH1-397 | HV2-CUKH1-406 |
| 8 | All | HV2-CUKH1-397 | HV2-CUKH1-407 |

† Contents and Part Numbers of Seal Kits For Rod Bushings (See key to part numbers on page 1)

Rod Bushing Kits – Contain items 14, 40, 41, 45, 115 (2002 HV2 only), (43 class 2 & 5 only except 5/8" & 1" rod in 2004 HV2.)

Rod Seal Kits – Contain items 40, 41, 45, 115 (2002 HV2 only), (43 class 2 & 5 only except 5/8" & 1" rod in 2004 HV2.)

Cushion Screw Assembly – Screw type: 69, 70. Cartridge type: 70, b, 70c, 70d, 70e, 70f

Cushion Assembly – Screw type: 69, 71, 72

Rod Bushing Kits and Rod Seal Kits

2002 HV2 Series Bushing Seal Kits For 1 1/2 - 6 inch Bore Sizes

| Rod Dia. (1 1/2 - 6 Inch Bore Sizes) | Seal Type | | | | | |
|---|--|----------------|---------------------------|----------------|---------------------------------|----------------|
| | Class 1 Service Polyurethane & Buna-N | | Class 2 Service Buna-N | | Class 5 Service Fluorocarbon | |
| | Bushing Kits† | Rod Seal Kits† | Bushing Kits† | Rod Seal Kits† | Bushing Kits† | Rod Seal Kits† |
| 5/8 | HV2-KR100-63 | HV2-KR300-63 | HV2-KR500-63 | HV2-KR600-63 | HV2-KR200-63 | HV2-KR400-63 |
| 1 | HV2-KR100-100 | HV2-KR300-100 | HV2-KR500-100 | HV2-KR600-100 | HV2-KR200-100 | HV2-KR400-100 |
| 1 3/8 | HV2-KR100-138 | HV2-KR300-138 | HV2-KR500-138 | HV2-KR600-138 | HV2-KR200-138 | HV2-KR400-138 |
| 1 3/4 | HV2-KR100-175 | HV2-KR300-175 | HV2-KR500-175 | HV2-KR600-175 | HV2-KR200-175 | HV2-KR400-175 |
| 2 | HV2-KR100-200 | HV2-KR300-200 | HV2-KR500-200 | HV2-KR600-200 | HV2-KR200-200 | HV2-KR400-200 |
| 2 1/2 | HV2-KR100-250 | HV2-KR300-250 | HV2-KR500-250 | HV2-KR600-250 | HV2-KR200-250 | HV2-KR400-250 |
| 3 | HV2-KR100-300 | HV2-KR300-300 | HV2-KR500-300 | HV2-KR600-300 | HV2-KR200-300 | HV2-KR400-300 |
| 3 1/2 | HV2-KR100-350 | HV2-KR300-350 | HV2-KR500-350 | HV2-KR600-350 | HV2-KR200-350 | HV2-KR400-350 |
| 4 | HV2-KR100-400 | HV2-KR300-400 | HV2-KR500-400 | HV2-KR600-400 | HV2-KR200-400 | HV2-KR400-400 |

Rod Bushing Kits and Rod Seal Kits

2002 HV2 Series Bushing Seal Kits For 7 & 8 inch Bore Sizes

| Rod Dia. (7 & 8 Inch Bore Sizes) | Seal Type | | | | | |
|-------------------------------------|--|----------------|---------------------------|----------------|---------------------------------|----------------|
| | Class 1 Service Buna-N & Polyurethane | | Class 2 Service Buna-N | | Class 5 Service Fluorocarbon | |
| | Bushing Kits† | Rod Seal Kits† | Bushing Kits† | Rod Seal Kits† | Bushing Kits† | Rod Seal Kits† |
| 3 | HV2-KR108-300 | HV2-KR308-300 | HV2-KR508-300 | HV2-KR608-300 | HV2-KR208-300 | HV2-KR408-300 |
| 3 1/2 | HV2-KR108-350 | HV2-KR308-350 | HV2-KR508-350 | HV2-KR608-350 | HV2-KR208-350 | HV2-KR408-350 |
| 4 | HV2-KR108-400 | HV2-KR308-400 | HV2-KR508-400 | HV2-KR608-400 | HV2-KR208-400 | HV2-KR408-400 |
| 5 | HV2-KR108-500 | HV2-KR308-500 | HV2-KR508-500 | HV2-KR608-500 | HV2-KR208-500 | HV2-KR408-500 |
| 5 1/2 | HV2-KR108-550 | HV2-KR308-550 | HV2-KR508-550 | HV2-KR608-550 | HV2-KR208-550 | HV2-KR408-550 |

† Contents and Part Numbers of Seal Kits For Rod Bushings (See key to part numbers on page 1)

Rod Seal Kits – Contain items 40, 41, 45, 115 (2002 HV2 only), (43 class 2 & 5 only except 5/8" & 1" rod in 2004 HV2.)

Rod Bushing Kits – Contain items 14, 40, 41, 45, 115 (2002 HV2 only), (43 class 2 & 5 only except 5/8" & 1" rod in 2004 HV2.)

Piston Seal and Tube Seal Kits (All HV2 Versions)

| Bore Size | Class 1 & 2 Service Buna-N | | | | Class 5 Service Fluorocarbon | | | |
|-----------|-------------------------------|----------------------|-------------------|---------------------------|---------------------------------|----------------------|-------------------|---------------------------|
| | Tube Seal Kits† | Piston Lipseal Kits† | Piston Ring Kits† | Hi-Load Piston Seal Kits† | Tube Seal Kits† | Piston Lipseal Kits† | Piston Ring Kits† | Hi-Load Piston Seal Kits† |
| 1 1/2 | HV2-ES100-150 | HV2-KB100-150 | HV2-KB300-150 | HV2-KB500-150 | HV2-ES200-150 | HV2-KB200-150 | HV2-KB400-150 | HV2-KB600-150 |
| 2 | HV2-ES100-200 | HV2-KB100-200 | HV2-KB300-200 | HV2-KB500-200 | HV2-ES200-200 | HV2-KB200-200 | HV2-KB400-200 | HV2-KB600-200 |
| 2 1/2 | HV2-ES100-250 | HV2-KB100-250 | HV2-KB300-250 | HV2-KB500-250 | HV2-ES200-250 | HV2-KB200-250 | HV2-KB400-250 | HV2-KB600-250 |
| 3 1/4 | HV2-ES100-325 | HV2-KB100-325 | HV2-KB300-325 | HV2-KB500-325 | HV2-ES200-325 | HV2-KB200-325 | HV2-KB400-325 | HV2-KB600-325 |
| 4 | HV2-ES100-400 | HV2-KB100-400 | HV2-KB300-400 | HV2-KB500-400 | HV2-ES200-400 | HV2-KB200-400 | HV2-KB400-400 | HV2-KB600-400 |
| 5 | HV2-ES100-500 | HV2-KB100-500 | HV2-KB300-500 | HV2-KB500-500 | HV2-ES200-500 | HV2-KB200-500 | HV2-KB400-500 | HV2-KB600-500 |
| 6 | HV2-ES100-600 | HV2-KB100-600 | HV2-KB300-600 | HV2-KB500-600 | HV2-ES200-600 | HV2-KB200-600 | HV2-KB400-600 | HV2-KB600-600 |
| 7 | HV2-ES100-700 | N/A | HV2-KB300-700 | HV2-KB500-700 | HV2-ES200-700 | N/A | HV2-KB400-700 | HV2-KB200-700 |
| 8 | HV2-ES100-800 | N/A | HV2-KB300-800 | HV2-KB500-800 | HV2-ES200-800 | N/A | HV2-KB400-800 | HV2-KB200-800 |

† Contents and Part Numbers of Seal Kits For Pistons & Tubes (See key to part numbers on page 1)

Hi-Load Piston Seal Kits – (Includes Cylinder Tube End Seals): Contains two each of items 47, 119, 120 & 121 (26 7" & 8" bore only).

Piston Lipseal Kits – (Includes Cylinder Tube End Seals) Contain two each of items 47, 42, & 44 (26 7" & 8" bore only).

Cylinder Tube End Seal Kits - Contains two each of item 47 (26 7" & 8" bore only).

Piston Ring Kits – (Includes Cylinder Tube End Seals) Contain two each of item 47, (26 7" & 8" bore only) & four each of item 48.

Cylinder Modifications or Repairs

Cylinders as shipped from the factory are not to be disassembled and or modified. If cylinders require modifications, these modifications must be done at company locations or by The Company's certified facilities. The Cylinder Division Engineering Department must be notified in the event of a mechanical fracture or permanent deformation of any cylinder component (excluding seals). This includes a broken piston rod, tie rod, mounting accessory or any other cylinder component. The notification should include all operation and application details. This information will be used to provide an engineered repair that will prevent recurrence of the failure.

It is allowed to disassemble cylinders for the purpose of replacing seals or seal assemblies. However, this work must be done by strictly following all the instructions provided in this bulletin.

Although Miller Hydraulic Cylinders are designed to make on-site maintenance or repairs as easy as possible, some operations can only be carried out in our factory. It is standard policy to fit a cylinder returned to the factory for repair with those replacement parts which are necessary to return it to 'as good as new' condition. Should the condition of the returned cylinder be such that repair would be uneconomical, you will be notified.

The piston is sealed and securely locked to the piston rod with anaerobic adhesive. This threaded connection is ONLY to be disassembled or reassembled by factory trained personnel.

⚠ WARNING: Some cylinders contain heavily loaded springs. Improper disassembly of these cylinders can cause severe bodily injury or death. Always disassemble a cylinder containing a spring by following the instructions in Bulletin 0805-G-TSD-1.

After the cylinder has been disassembled, carefully remove the seals that will be replaced to avoid damaging groove surfaces. Carefully clean all parts.

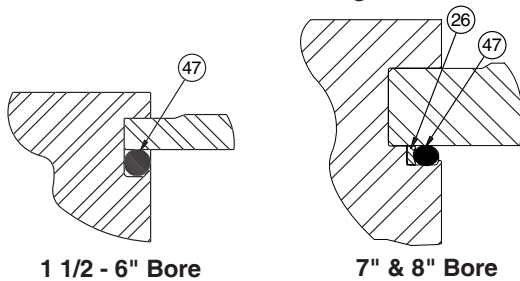
Seals will be easier to install if they are lubricated. Always lubricate seals and other components of a hydraulic cylinder with the operating fluid. Cylinders fitted with Class 3 seals (EPR) cannot be lubricated or operated with petroleum based products.

Servicing Piston Seals

The cylinder bore and piston must be closely examined for signs of scoring. If either the cylinder tube or piston is damaged they must be replaced.

When a cylinder is overhauled, a new set of piston seals is required. It is also recommended that the cylinder be reassembled with new cylinder tube O-rings. All piston seal kits contain piston seals as well as two cylinder tube O-rings (47) and for 7 and 8 inch bore hydraulic cylinders, their mating back-up washers (26).

Tube End O-Rings

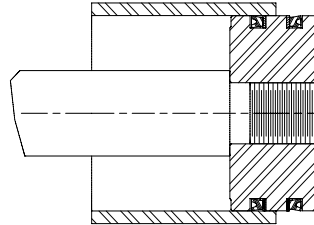


Lipseal Piston

Kits for Lipseal pistons contain two lipseals (42) and two back-up washers (44).

Apply lubricant to the piston OD and all grooves. Install one piston seal in the groove nearest the rod. The two 'lips' of this Lipseal should face toward the rod end of the piston. Install the back-up washer in the same groove opposite the 'lips' of the seal. Lubricate the cylinder body ID and insert the piston – cap end first – into the cylinder body as shown.

Next, turn the cylinder body on its side and push the piston through the tube just far enough to expose the groove for the second seal. Now, install the second Lipseal and back-up washer in the exposed groove with the two 'lips' facing away from the rod. Then pull the piston into the cylinder tube



Hi-Load Piston

Kits for Hi-Load pistons contain two sets of seals for 1½" - 6" bore cylinders and one set of seals for 7" - 8" bore cylinders. Each seal set includes one filled PTFE sealing ring (119) and an elastomeric energizing ring (120). The kit also contains two wear rings (121). Install the inner energizing ring(s) in the seal groove(s).

Install the wear rings in the two grooves on each end of the piston. Stretch the PTFE seal ring(s) by hand until it fits over the wear ring. Push the outer ring(s) over the wear ring and into the seal groove(s). With the outer ring(s) in the groove(s), compress them with a ring compressor. Alternatively, the PTFE rings can be compressed using a large hose clamp over thin shim stock. In all cases, take care not to damage the sealing ring(s). Keep the sealing ring(s) compressed for some time before inserting the piston into the tube. A starting sleeve having an ID the same size as the cylinder bore, and tapered at one end, will aid the installation process.

Cast Iron Piston Rings

Kits for cast iron piston rings contain four rings (48). Iron piston rings seldom need replacement. If the rings show no signs of damage or abnormal wear, they may be reused. To install piston rings, collapse the rings one at a time while inserting the piston into the cylinder body, using a light oil to aid this process.

Cylinder Assembly

The cylinder should be re-assembled as follows:

- 1) The back-up washers, where fitted, and then the tube O-rings should be lightly lubricated and pressed into the grooves in the head and cap, without twisting. The cylinder tube, with the piston and rod already fitted, can then be assembled to the cap by 'rocking' it down over the O-ring until the cylinder tube is in contact with the cap. The head is then fitted over the piston rod and assembled to the cylinder tube. Rock gently until the tube and head are in metal-to-metal contact.
- 2) Lightly lubricate the bushing seals.
- 3) Slide the bushing over the piston rod end, taking care not to damage the seal lips. Slide the small circular or full square retainer over the bushing. Orient holes in full square retainers over the tie rod holes in the head or line up holes in smaller retainers with threaded mounting holes. Assemble bolts that secure bolt-on retainers finger tight.
- 4) Ensuring that the head and cap are kept in alignment, refit the cylinder tie rods.

Note: Some cylinder configurations have tie rods threaded into a component other than tie rod nuts (e.g. head, cap, flange plate, etc). Before torquing the tie rods, use paint on the tie rods as an indicator that adequate thread engagement is achieved. Ensure that no unpainted thread is exposed at the connection to the mating component.

For both style retainers, torque tie rod nuts to values listed on page 6. **Torque tie rods gradually starting at one corner and work in a diagonal pattern to ensure evenness of tightening. DO NOT TORQUE ONE TIE ROD COMPLETELY AND THEN THE OTHERS.** Then, on cylinders with bolt-on retainers, torque bolts to the values listed on page 6.

Trunnion Mounts

Trunnion mount with trunnion in groove on cylinder body – Torque cap end tie rods to value listed in table, then torque head tie rods to the same value.

Trunnion mounts with trunnion located against a single shoulder on the cylinder body – Torque tie rods on the larger diameter side of the shoulder to approx. 10% of torque table value. Then torque the tie rods on the opposite end to the full table value.

Trunnion mounts located on a cylinder body without a shoulder – Assemble short set of tie rods first, using paint marks on the cylinder body as a location guide. Ensure the trunnion pins are square to the body. Install the longer tie rods and torque to values in the table.

Servicing Cushion Needle and Check Valves

Leakage from cushion adjusters or check valve screws indicates that the screw or cartridge-type assembly must be replaced. The replacement assembly includes a new O-ring.

Removal

The screw/cartridge assembly should be unscrewed and its mounting hole cleaned, paying close attention to the surface on which the O-ring sits.

Installation – Cushion Needle Valves

Where a cartridge-type adjuster is fitted, lightly lubricate the screw threads and torque to the figures shown in the table on page 6. With both types, the hex-headed screw may be adjusted to provide the required cushioning performance.

Installation – Check Valve

Ensure that the ball is correctly positioned. Screw-type adjusters should be screwed fully home, and then backed off by a full turn.

Servicing Cylinder Bushing Seals

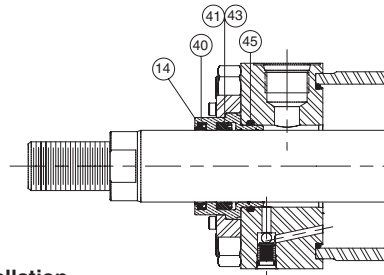
Fluid leakage from the piston rod at the bushing normally indicates worn rod seals. The cylinder should, if possible, be removed for overhaul, or the piston rod disconnected.

Removal

- 1) Inspect the piston rod to make sure it is free from burrs or damage which would prevent the bushing sliding off the rod.

The Miller bushing is a cartridge design consisting of a bronze or iron bushing (14), primary rod seal (41), back-up washer (43) for all hydraulic cylinder seal classes, and a double lip wiperseal (40). The HV2 bushing is usually held in place with a bolt-on retainer. However, some HV2 Series mounting styles with oversize piston rod diameters will utilize a retainer plate held in place by tie rods.

- 2) Where the bushing is secured by a circular retainer, undo the socket head cap screws and slide the bushing and retainer off the piston rod.
- 3) Remove the seals using a sharp pointed instrument, taking care not to damage the bushing. Clean and inspect the bushing bore and seal grooves. If any wear is present replace with a Rod Bushing Kit containing seals of the correct type for the conditions.



Installation

Inspect the surface of the piston rod for damage which could cause early seal failure. When fitting the bushing over the rod thread, a slight rotary motion will help prevent damage to the seals. In addition, shim stock or other thin, tough material can be wrapped around the threads to protect the seal lips.

- 1) Ensure that the kit contains seals of the correct type. Lubricate the bushing and seals, and fit the wiper (40) into the groove closest to the outside face of the bushing.
- 2) If a Class 1 material rod seal is being fitted to a standard bushing, no back-up washer is necessary. A back-up washer (43) is included in seal kits for all other service classes. Install this in the rod seal groove, against the wall closest to the wiper. Install the lipseal (41) in the groove, **with the lips facing the pressure (cylinder) side of the bushing.**
- 3) Slide the bushing cartridge over the piston rod end thread and into the cylinder head. Place the retainer plate over the bushing, install the mounting bolts and torque to the values listed on page 6. Note that some mounting styles with oversize piston rod diameters will utilize a retainer plate held in place by tie rods.
- 4) Each kit contains an O-ring (45) which seals the bushing to the cylinder head. This O-ring is a static seal, and the original must be left in place unless it is faulty.

For cylinders that utilize a retainer plate held in place by tie rods, torque the rod nuts to values listed on page 6. **Torque tie rods gradually starting at one corner and work in a diagonal pattern to ensure evenness of tightening. DO NOT TORQUE ONE TIE ROD COMPLETELY AND THEN THE OTHERS.**

Rod seals are pressure activated and do not need adjustment.

Tie Rod Torque

An extreme pressure lubricant (such as molybdenum disulphide) should be used on tie rod threads and nut bearing surfaces to control friction and reduce tie rod twist.

| Bore Size | Tie Rod Torque* | |
|-----------|----------------------|------------------|
| | 1 1/2 | 18 - 19 ft.-lbs. |
| 2 | 45 - 49 ft.-lbs. | 61 - 67 N-m |
| 2 1/2 | 45 - 49 ft.-lbs. | 61 - 67 N-m |
| 3 1/4 | 120 - 124 ft.-lbs. | 163 - 169 N-m |
| 4 | 131 - 135 ft.-lbs. | 178 - 184 N-m |
| 5 | 312 - 316 ft.-lbs. | 423 - 429 N-m |
| 6 | 528 - 544 ft.-lbs. | 716 - 738 N-m |
| 7 | 800 - 816 ft.-lbs. | 1085 - 1107 N-m |
| 8 | 1168 - 1184 ft.-lbs. | 1584 - 1606 N-m |

* The tie rod torque values listed in this table are intended for HV2 Series cylinders having a pressure envelope pressure rating of 3000 psi. Consult factory for tie rod torque of cylinders having a higher pressure rating.

Cartridge Cushion Adjuster Torque

| Nominal Screw Size | Torque | |
|--------------------|------------------|-------------|
| M8 | 6 - 7 ft.-lbs. | 9 - 10 N-m |
| M10 | 18 - 22 ft.-lbs. | 25 - 30 N-m |
| M14 | 44 - 48 ft.-lbs. | 60 - 65 N-m |

Retainer Bolt Torque For Cylinders with Round Bushing Retainers

| Rod Dia. | Torque | |
|----------|------------------|-------------|
| 5/8 | 24-25 in.-lbs. | 28-29 cm-kg |
| 1 | 24-25 in.-lbs. | 28-29 cm-kg |
| 1 3/8 | 24-25 in.-lbs. | 28-29 cm-kg |
| 1 3/4 | 24-25 in.-lbs. | 28-29 cm-kg |
| 2 | 120-126 in.-lbs. | 14-15 N-m |
| 2 1/2 | 120-126 in.-lbs. | 14-15 N-m |
| 3 | 240-252 in.-lbs. | 27-28 N-m |
| 3 1/2 | 240-252 in.-lbs. | 27-28 N-m |
| 4 | 240-252 in.-lbs. | 27-28 N-m |
| 5 | 240-252 in.-lbs. | 27-28 N-m |
| 5 1/2 | 240-252 in.-lbs. | 27-28 N-m |

Warning

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

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Miller Fluid Power
500 South Wolf Road
Des Plaines, IL 60016 USA
Tel.: (847) 298-2400
Fax: (800) 892-1008

Miller Fluid Power
160 Chisholm Drive
Milton, Ontario
Canada L9T 3G9
Tel.: (905) 693-3000
Fax: (905) 876-1958

