Miller Fluid Power
Cylinder Installation & Maintenance Instructions
STORAGE:

1. Store cylinder in a clean, dry, protected area that has as little temperature variance as possible.
2. Store cylinder in a vertical position with piston rod in up position.
3. Coat entire inside of cylinder with oil. Fill cylinders partially with oil if practical.
4. Install protective plugs in all cylinder ports.
5. Apply protective coating on any machined or critical mounting surfaces, including all treads and trunnions.

GENERAL PRECAUTIONS: Cylinders which have been in storage over 30 days should be lubricated and cycled several times before they are installed on machines and subjected to actual loads. Should excessive breakloose and cycling pressure be noted, it may indicate the cylinder(s) had been damaged during shipment or storage.

INSTALLATION:

For long, trouble-free, safe operation of your cylinders, extra care should be taken in the following areas:

1. **Fasteners:**
   
   Be sure to select fasteners and bearings suitable for the forces involved. The use of Grade 8 or better nuts & bolts is recommended. Due to the wide variety available, contact your bearing supplier for bearing recommendations.

2. **Piston Rod Attachment & Rod Accessories:**
   
   In attaching machinery components or rod clevises, rod eyes, etc., to Miller Style 2 (Threaded on Turndown Section) or Style 4 (Internally Threaded Piston Rods), the attachments should be tightened to the torques given in chart 1. This torque, or prestress, triples the fatigue strength of the rod's threaded section and makes a stronger assembly than attaching the machinery component to a full-diameter threaded rod (Style 1) and torquing it against a lock nut. Miller recommends the Style 2 (Threaded on Turndown Section) rod for most applications. Its square shoulder design helps assure proper alignment of cylinder to mechanism, eliminates need for a jam nut, provides fixed point for more accurate cylinder positioning, simplifies piloting to full rod diameter into mating part, and permits easier assembly of seals over rod without damage.
Chart 1

RECOMMENDED PRE-STRESS TORQUES
For Style 2 & 4 Piston Rods with MoS2 lubricant or equivalent
For “Dry” Assembly Increase Torques by 50%

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Torque Ft./Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/16-20</td>
<td>36</td>
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<tr>
<td>3/4-16</td>
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<tr>
<td>1-14</td>
<td>250</td>
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<td>1-1/4-12</td>
<td>460</td>
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<td>1-7/8-12</td>
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<td>30850</td>
</tr>
<tr>
<td>8-6</td>
<td>37700</td>
</tr>
</tbody>
</table>

3. **Cylinder Mounting:**

The ideal method of mounting a cylinder to the machine is to have the point of mounting on the equipment machined to the exact dimensions with proper alignment, so that bolting the cylinder in place ensures perfect alignment. In many cases this is not practical from a cost and design standpoint. Therefore, alignment must be secured at the time of installation. Whenever the piston rod is fastened to the machine, which confines the cylinder in one position, it is best to bolt the cylinder down as a last operation of assembly. Alignment can be secured in other ways, but the following sequence of installation steps is quite effective:

A. Assemble the piston rod to the machinery. The piston rod must be fastened and held squarely so its centerline is parallel to the guides of the attached machinery (or parallel to the line of movement of the attached machinery in cases of fixed mounted cylinders). Torque piston rod to attachment per chart 1.

B. Insert mounting bolts but do not tighten them.

C. In the case of horizontally mounted cylinders, it is necessary to support the weight of the cylinder body so as to eliminate strain on the piston rod.

D. Use feeler gauges under the mounting and shim at these points equal to the space indicated by the feeler gauges.

E. Finally, tighten the mounting bolts.

F. If possible, the machine operation should be tested with low pressure air to ensure that cylinder and attached parts are operating freely. This should be done with the machine operating under a no-load condition.

G. Make sure that all pipes and fittings are clean before connecting them to the cylinder.

H. Hydraulic filtration should be in accordance with the hydraulic power unit manufacturer recommendation.
I. Pneumatic systems should have a water separator, 50 micron (minimum) filter and a lubricator installed as close as possible to the cylinder. Use a 5W petroleum-based oil as a lubricant.

**Note:** As of 1/2/87, all series A air cylinders manufactured by Miller Fluid Power are lubricated at the factory and do not require an air line lubricator. When repair is necessary, we recommend using Magnalube R-G grease to pre-lubricate the piston seal and rod seal. Magnalube R-G is a registered trademark of Carlton-Stuart Corp.

**REPAIR:**

When cylinder repairs are necessary, a complete set of seals should be ordered. This set should consist of piston seals, tube-end seals, rod seal kit and a rod bushing.

To ensure proper parts selection, please provide the serial number(s) for the unit(s) being repaired.

**SERIAL NUMBER IDENTIFICATION**

All Miller cylinders have a serial number on the name tag and impression stamped in the head and cap next to the port. The serial number is helpful in determining the year of manufacture in order to supply correct repair parts (seals). The serial number is necessary to supply machined parts such as piston rods, tie rods, tubes, heads, caps and cushions.

Serial numbers for 1946 to 1967 consist of a letter followed by four to five numbers, possibly followed by another letter. The first letter is a year code:

- **A** - 1946
- **B** - 1947
- **C** - 1948
- **D** - 1949
- **E** - 1950
- **F** - 1951
- **G** - 1952
- **H** - 1953
- **I** - 1954
- **J** - 1955
- **K** - 1956
- **L** - 1957
- **M** - 1958
- **N** - 1959
- **O** - 1960
- **P** - 1961
- **Q** - 1962
- **R** - 1963
- **S** - 1964
- **T** - 1965
- **U** - 1966
- **V** - 1967

Serial numbers’ suffix letters were used in the phase-in periods to indicate changes as follows:

- **A** - SHEF Seal
- **B** - SHEF Seal plus bushing seal
- **C** - Above, plus new cushion assembly
- **D** - Thick Cap
- **E** - Sta-Dyn Rod Seal - 5/8 thru 1-3/8 (air cylinders only)
- **F** - Threaded piston ring pistons and one-piece cup-type pistons
- **H** - BASELOK
- **M** - Bolted Bushing
- **N** - Nodular Iron Bushing (Retainer Held)

Example: W 52175 H

- **W** = 1964
- **H** = BASELOK bushing

Serial numbers for 1967 to current consist of eight numbers with the first two being the year (68137211)

- **68** = 1968
- **137211** = 6-digit sequential number unique to a particular order (also is invoice number)
DISASSEMBLY & ASSEMBLY

The following step-by-step outline will be a valuable aid to personnel qualified to service precision equipment. By exercising only normal care, which any good workman would accord fine machinery, no undue difficulty will be encountered.

1. Wipe all external surfaces clean. Drain excess oil from hydraulic cylinders. Paint or draw a line on one side of the cylinder running from the cylinder cap to the mounting end of the piston rod. This will serve as a reference line when inspecting components and reassembling the cylinder.

2. VISUAL INSPECTION: Visually inspect all exterior surfaces for evidence of damage, and, in particular, damage to the piston rod. Evidence of rod-seal leakage can usually be traced to nicks in the piston rod or misalignment. If a slight nick is noticed in the piston rod, it can often be removed by using No. 400 grit emery cloth. The rod should then be wiped carefully for removal of any matter. UNDER NO CIRCUMSTANCES SHOULD COMPRESSED AIR BE USED TO REMOVE FOREIGN MATTER, as this practice may tend to drive such particles into close clearances. Misalignment can often be detected by observing the condition of the piston rod for evidence of excessive wear, polishing, burnishing or scoring on the side of the piston rod. Check carefully the end of the piston rod and the area around the flats on the end of the rod for burrs and nicks. If burrs and nicks are present, remove with a file or emery cloth to avoid damage to the piston rod seal, rod wiper and bushing during removal and assembly.

3. REMOVAL OF BOLTED BUSHING:
   a. Loosen and remove the cap screws that hold the bushing in the cylinder head.
   b. Remove the bushing, rod seal and any dirt, chips, etc., from the bushing cavity and head.

4. LOOSENING THE CYLINDER TIE RODS:
   a. CAUTION—SPRING-RETURN CYLINDERS: An installed spring can injure a person if special precautions are not exercised in removing the tie rods. In some cases, clamps may be used to contain the cylinder assembly while the tie rods are being removed. If such is the case, the clamps should, of course, be designed to permit gradual release of spring compression to its free length. In other instances, it is desirable to prepare two special tie rods that are longer than the original tie rods, and which are threaded for the full additional length over and above the original tie rod length. The special tie rods required to disassemble a standard Miller spring should be 1-1/2 times the length of the cylinder with the extra half-length threaded. Remove two of the original tie rods. Install the special tie rods and bring the tie rod nuts up snug. The other two original tie rods may then be removed, after which the special tie rods can be used for final safe disassembly by gradually threading the tie rod nuts off, working alternately from one tie rod to another. The special tie rods may be used to reassemble the cylinder as compressing the spring will be easy, positive and safe.
   b. NON-SPRING-RETURN CYLINDERS: Proceed to loosen the four cylinder tie rods, noting if the tie rods were tightened evenly. It may be necessary in some cases to grip the tie rods with vise grips—on the diameter located between the head and cap—to prevent the tie rod from turning.

5. REMOVAL OF ROD SEAL:
   Normally the rod seal will come out when the bushing is removed. If rod seal remains in cylinder head, pull the cylinder head away from the cylinder approximately one inch, and then place it back into original position. This will expose the rod seal for easy removal (BY NO MEANS USE A TOOL TO PRY OR LIFT OUT THE ROD SEAL FROM THE CYLINDER HEAD).
6. REMOVAL OF RETAINER-HELD PISTON ROD BUSHING:
   a. Loosen the cylinder tie rods—NOTE: Refer to step 4 on previous page.
   b. Remove the retainer plate (in some cases, this may be a flange mounting plate).
   c. Lift out the piston rod bushing.
   d. Remove rod seal; refer to step 5 on previous page.

7. REMOVAL OF CYLINDER HEAD: Remove cylinder head from cylinder. Lift out pressure ring, wave spring and cage on the hydraulic cylinders. On air cylinders, remove only rod seal—no cage assembly is used.

8. REMOVAL OF PISTON ROD AND ASSEMBLY: Remove piston rod and piston assembly from cylinder tubing. (If tubing comes off the cap pilot, merely slide piston assembly from cylinder tubing.)

9. REMOVE TIE RODS FROM CYLINDER CAP.

10. INSPECTION OF INTERNAL PARTS: Inspect internal surfaces of all cylinder parts, noting particularly any evidence of foreign matter. (Retain all foreign matter for future study if necessary.) Examine parts for misalignment as evidenced by excessive or uneven wear.

11. CONDITION OF TUBING, PISTON ROD, ETC.: If tubing, piston rod or piston rod bushing is damaged, the part, if available, should be replaced. If a replacement part is unavailable, repair the damaged part by removing nicks, burrs and other forms of damage. However, do not remove enough material to change the diameters, affecting the clearance and fit.

DESIGN NOTE: Miller Fluid Power has been manufacturing cylinders since 1946. In 50 years of manufacturing, there have been many design improvements as well as three distinct piston-assembly design concepts. The preceding instructions are generic to all three designs. Inspect the piston assembly that has been removed from the cylinder tube and match it to either design 1, 2 or 3 described below. Subsequent instructions for replacing piston seals and cushions will be keyed to a specific Miller design starting with the current design.

3-PIECE DESIGN SEAL
SOLID PLUNGER TYPE CUSHIONS

Three-Piece Piston, 1957 Design, A, J & H Series

Years of Manufacture: 1946-1977 Inclusive

Phase Out: Early 1978 to the Endurance-Rated Design

The piston assembly consisted of a steel or iron disk piston and two steel “followers” to sandwich and hold in place the lip-type piston seals.

The cushion was a solid plunger type which was adjustable.
12. PISTON SEAL REMOVAL

a. 1981 & ER Design Piston Seal & Wear Ring Removal

1) CYLINDERS EQUIPPED WITH STANDARD ‘U’ CUP SEALS: The replacement of the piston seals does not require the removal of the piston from the piston rod. Remove the retaining ring from the groove machined in the piston. (A small screwdriver may be used to remove this ring.) Care must be taken so that the retaining ring is not damaged. Remove the piston cup anti-roll ring and remove the piston cup seal. Repeat the procedure to remove the opposite seal. Removal of the wearband can be accomplished by locating the split in the wear ring and pulling the ends apart, and removing wear ring from machined groove in piston.

NOTE: Normally the piston will not require removal. However, if the piston is physically damaged and requires replacing, refer to paragraph 14 of these instructions (page 9) regarding disassembly of the piston and the piston rod.

ER DESIGN CUP SEAL
SELF-REGULATING CUSHIONS
(NON-ADJUSTABLE)

ER Design, ER500, ER3000 & ER6000 Series

Years of Manufacture: 1976-1981

Change Over: Jan. 1982 to the 1981 Design

All endurance-rated cylinders used a full-diameter thread on the piston rod, a wire insert and two-piece ‘split’ piston. The design also incorporated piston wear rings, ‘U’ cups and self-regulating (non-adjustable) cushions. The same ‘U’ cups, similar wear rings and cushions are used today.

1981 DESIGN CUP SEAL
SELF-REGULATING CUSHIONS

1981 Design, A, J, M & H Series

Years of Manufacture: Jan. 1982-Current

The piston is one piece with a counter-bore to pilot on the full-rod diameter for superior concentricity. Thread if UNF but increases one size in diameter for strength considerations on oversized piston rods. Air cushions are adjustable; solid plunger with soft seal and hydraulic cushions are the latest highly effective self-regulating design. Pistons use ‘U’ cups and wear rings. All four (A, J, M and H) cylinder lines share these features.
2) **CYLINDERS EQUIPPED WITH SPRING-LOADED PTFE PISTON SEALS:** With spring-loaded PTFE piston seals, the anti-roll ring is not used. After removing the retaining ring, the piston wave spring, pressure ring and piston seal can be removed. (Remove wear ring as described in 12a1.)

3) **CYLINDERS EQUIPPED WITH PISTON RING SEAL:** Piston ring type seals, can be removed by locating the split in the ring and expanding the ring with a ring expander. (Remove wear ring as described in 12a1.)

**NOTE:** During cylinder operation, the piston ring may develop sharp edges. Do not attempt to remove the ring with your fingers.

**b. Three-Piece Design Piston Seal Removal**

1) Cylinders equipped with lip-type piston seals (Non-Loaded & Spring-Loaded Types). Lip-type seals can only be removed after disassembly of the piston from the rod. See paragraph 14 of these instructions (page 9) for disassembly instructions.

2) Cylinders equipped with piston ring seals. Piston ring seals can be removed without disassembling the piston and rod. Use the same procedure as described in paragraph 12a3 above.

3) 6" bore and larger 'H' cylinders. These cylinders have a one-piece piston that does not need to be disassembled from the rod to remove the piston seals.
   a) From 1966 to 1976, lip-type seals were supplied and are removed by unthreading the cap screws holding the circular cup retainer on both sides of the piston.
   b) From 1976 to 1978, 'U' cup seals were supplied and are removed as described in paragraph 12a1 or 12a2 of this section.

13. **REMOVAL OF CUSHION PLUNGERS:** The cushion plungers are located on either side of the piston assembly. They do not require service unless they have been damaged.

**• 5/8" thru 1-3/8" Diameter Rods.**

a. **TO REMOVE CUSHION PLUNGERS FROM SERIES 1981 “A” AIR CYLINDERS, USE THE FOLLOWING PROCEDURES:**

1) **Rod-End Plunger**—Locate split in single turn wire insert under plunger. Gently pry the edge of the wire insert out of the machined groove in the rod while slowly rotating the cushion. Once the wire insert is removed, the cushion assembly can be removed.

2) **Cap-End Plunger**—Locate split in single turn wire insert under plunger. Gently pry the edge of the wire insert out of the machined groove in the rod while slowly rotating the plunger. Remove the cushion plunger assembly. Unscrew cushion adapter from rod taking care not to damage wrench flats.

**• 1-3/4" thru 5" Diameter Rods.**

3) **Rod-End Plunger**—Locate split in single turn wire insert under plunger. Gently pry the edge of the wire insert out of the machined groove in the rod while slowly rotating the plunger. Once the wire is removed, the cushion plunger can be slid off of the piston rod.
4) **Cap-End Plunger—8" bore is removed as described in item b of this section.**

5) **Cap-End Plunger—10" thru 20" bores are removed as described in item c of this section.**

* **5-1/2" Diameter Rods.**

6) **Rod-End Plunger—**To remove this plunger, the piston must be removed first as outlined in section 14a (page 9).

7) **Cap-End Plunger—8" bore is removed as outlined. Described in item b of this section.**

8) **Cap-End Plunger—10" thru 20" bores are removed as described in item c of this section.**

b. **TO REMOVE CUSHION PLUNGERS FROM SERIES 1981 “J”, “M” AND “H” HYDRAULIC CYLINDERS, USE THE FOLLOWING PROCEDURES:**

* **5/8"-5" Diameter Rods.**

1) **Rod-End Plunger—**Locate split in single turn wire insert under cushion support. Gently pry the edge of the wire insert out of the machined groove in the rod while slowly rotating the cushion support. After removal of the wire insert, the remainder of the cushion assembly can be removed from the rod.

2) **Cap-End Plunger—**J Series thru 8" bore, all M & H bores—Unscrew the cushion adapter from the cap end and remove the cushion assembly from the rod. Take care not to damage wrench flats on adapter.

3) **Cap-End Plunger—**J Series, 10"-20" bores are removed the same as in item a of this section.

* **5-1/2"-10" Diameter Rods.**

4) **Rod-End Plunger—**In order to remove this plunger, the piston must be removed as outlined in section 14a (page 9). Once the piston has been removed, the cushion plunger assembly will slide off of the turndown. Remove cushion ‘O’ ring located under the plunger.

5) **Cap-End Plunger—**J Series 8" bore & M & H bores are removed the same way as outlined in item b of this section.

6) **Cap-End Plunger—**J Series 10"-20" bores are removed the same way as outlined in item a of this section.

c. **CUSHION REMOVAL FROM ER DESIGN CYLINDERS**

1) **TO REMOVE THE CUSHION PLUNGERS FROM AIR CYLINDERS (aluminum plungers).** The heavy-duty thrust ring must first be removed. (A small screwdriver can be used to remove this ring.) After the thrust ring has been removed from the groove machined in the rod, the cushion plunger is to be removed next. With the removal of the second ring, the cushion check valve, wave spring and wave-spring support washer can be removed. Repeat the procedure to remove the cap-end cushion plunger.
2) TO REMOVE THE CUSHION PLUNGERS FROM HYDRAULIC CYLINDERS (steel plungers). Locate the split in the single turn wire insert located under the cushion support. Gently pry the edge of the wire insert out of the machined groove in the piston rod while slowly rotating the cushion support. Once the wire insert is removed, the remaining parts of the cushion assembly can be removed from the rod.

d. CUSHION REMOVAL FROM THREE-PIECE PISTON DESIGN CYLINDERS

1) Rod-End Plunger—in order to remove this plunger, the piston must be removed as outlined in 14a (page 9). Once the piston has been removed, the cushion plunger will slide off of the turndown.

2) Cap-End Plunger—all A & J and thru 5” bore H cylinders’ cap-end plungers are machined as part of the piston assembly turndown and cannot be removed. H cylinders 6” bore and larger have a nut-held cap-end plunger. Unthread the nut and slide the plunger off of the turndown.

14. REMOVAL OF PISTON FROM ROD

a. 1981 & THREE-PIECE DESIGN PISTON REMOVAL

Piston assemblies are staked to prevent the parts from coming loose in operation. If the piston assembly must be taken apart, first drill out the stake marks to facilitate disassembly. When removing the upset material caused by the stake mark, lightly touch the tool being used to the stake area and remove only the upset material. To disassemble single-end cylinders, you may insert two dowel pins in the spanner pin holes and use a bar to remove the piston. An alternate method is to clamp the piston assembly by the faces of the followers in a vise and screw out the piston rod using the flat on the end of the piston rod for turning. (BY NO MEANS CLAMP THE PISTON ON ITS OUTSIDE DIAMETER.) The vise should be equipped with bronze or brass jaw protectors if clamping piston rod on chrome-plated area.

On double rod-end cylinders, the female piston rod must be heated to approximately 500°F to loosen Loctite used to hold the rods together. Unscrew the rods by holding one rod by the flats in a rod clamp or soft-jawed vice while unscrewing the other rod with a wrench on the piston rod flats on the other end.

b. ER DESIGN PISTON REMOVAL

NOTE: Removal of the piston from the rod is not a recommended procedure. The piston is secured to the piston rod with Hi-Strength #680 or #620 Loctite (#620 is used for Hi-temperature operation with synthetic fluids). It is recommended that Miller be contacted for direction should piston removal be contemplated.

The procedure for piston removal is as follows should it become necessary: Before attempting to remove the piston from the rod, the cushion plungers and piston seals must first be removed as outlined in Sections 12 and 13, pages 6-9. Be sure to note the location of the piston before attempting to remove it. Either mark the piston rod, or measure the distance from the end of the rod to the face of the piston. This is done so that the piston is properly located when reassembled. The piston used in this design cylinder is made up of two identical pieces, torqued and held in position by high-tensile, non-shrink Loctite. To remove the piston from the rod, heat must be applied to the piston, raising the temperature of the piston to 500°F. With a spanner wrench, unscrew the back half of the piston. Remove the second half of the piston, and remove the wire insert.
15. REASSEMBLY OF PISTON TO ROD

a. 1981 Design Piston and Rod Assembly—Clean the piston and piston rod thoroughly. Assemble the piston and rod, then torque them to the value shown in Chart 2 below. Stake the thread joint in three positions 120° apart, using a sharp center punch, being careful not to damage threads if they extend beyond the piston.

NOTE: The rod-end cushion on 5-1/2"-10" diameter piston rods must be installed prior to assembling the piston and piston rod.

<table>
<thead>
<tr>
<th>1981 A/J 3-Piece A/J Bores</th>
<th>1981 M 3-Piece Bores</th>
<th>1981 H 3-Piece H Bores</th>
<th>Thread Size</th>
<th>Torque (Ft./Lbs.)</th>
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<td>37700</td>
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</table>
b) **ER Design Piston and Rod Assembly**—Clean piston rod, piston halves and wire insert thoroughly. (Allen Loctite Speed Primer is recommended.) Assemble wire insert onto piston rod. Apply Loctite sealant to piston rod assembly end and on wire insert. Apply sealant to I.D. of one-half of piston and screw onto piston rod. Locate piston half to exact dimension noted before disassembly. Apply sealant to I.D. on remaining half of piston and assemble second half of piston to rod and torque the two halves together to the value shown in Chart 3 below. Make sure that the first half of the piston is firmly held in place during the torqueing to obtain the proper preload and position of the piston.

**NOTE:** Use Loctite #680 for all air and hydraulic cylinders with operating temperature not exceeding 300°F. Loctite #620 is to be used with synthetic fluids with temperature from 300°F to 450°F.

<table>
<thead>
<tr>
<th>Bore Size</th>
<th>Piston Rod Sizes</th>
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<tr>
<td>2</td>
<td>5/8, 1</td>
<td>20-18</td>
<td>16</td>
<td>500: 66 3000: 103 6000: 182</td>
</tr>
<tr>
<td></td>
<td>1-3/8&quot;</td>
<td>12'-10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>2-1/2</td>
<td>5/8, 1</td>
<td>20-18</td>
<td>16</td>
<td>500: 9 3000: 178</td>
</tr>
<tr>
<td></td>
<td>1-3/8, 1-3/4</td>
<td>12'-10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>3-1/4&quot;</td>
<td>1</td>
<td>20-18</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-3/8, 1-3/4, 2</td>
<td>12'-10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1-3/8, 1-3/4, 2</td>
<td>12'-10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-1/2</td>
<td>8'-6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>20'-18</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-3/8, 1-3/4, 2</td>
<td>12'-10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-1/2, 3, 3-1/2</td>
<td>8'-6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1-3/8, 1-3/4, 2</td>
<td>12'-10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-1/2, 4</td>
<td>8'-6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>All</td>
<td>8'-6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>All</td>
<td>8'-6</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

**Chart 3**

**Piston Torque for ER Assemblies**

**c) Three-Piece Design Piston and Rod Assembly**—Clean the piston, follower and piston rod thoroughly and assemble them to the rod along with the follower seal and cup seals. Torque the threaded follower to the value shown in chart 2 on page 10. Re-stake the thread joint in three positions different from the original stake marks.

**NOTE:** The rod-end cushion must be installed prior to assembling the piston and piston rod.
16. ASSEMBLY OF CUSHION PLUNGERS

a) Cushion Assembly in 1981 design A, J, M & H Cylinders

1) To assemble cushion plungers in 1981 series “A” air cylinders use the following procedures:

• 5/8" - 1-3/8" Diameter Rods.

   a. Rod-End Plunger
   Assemble cushion seal retainer on rod with flat side against the piston. Assemble block vee rod seal onto rod and over seal retainer with flat side of seal away from the piston. Slide cushion onto the rod with the flat side against the block vee rod seal. Install single turn wire insert onto rod and insert leading edge into groove machined in piston rod O.D. and cushion I.D. Holding wire insert firmly, slowly turn the cushion plunger, drawing the wire insert under the plunger.

   b. Cap-End Plunger
   Apply grade #242 or #262 Loctite to turndown and screw on cushion adapter to the rod with shoulder of adapter against the piston. Torque adapter to recommended torque figure on enclosed chart. (Caution should be used not to damage adapter with wrench when torquing.) Install cushion seal retainer onto adapter with flat side of retainer against the shoulder of the adapter. Slide block vee rod seal onto adapter and over the retainer with flat side of seal away from the piston. Install cushion onto adapter with flat side of cushion plunger against rod seal. Insert leading edge of single turn wire insert into groove machined in adapter O.D. and cushion I.D. Slowly turn cushion plunger to draw wire insert under the cushion plunger.

• 1-3/4"-5" Diameter Rods.

   c. Rod-End Plunger
   Slide plunger over rod with flat side against piston. Install single-turn wire insert onto rod and insert leading edge into groove machined in piston rod O.D. and cushion I.D. Holding wire insert firmly, slowly turn the cushion plunger, drawing the wire insert under the plunger.

   d. Cap-End Plunger
   Assemble this plunger the same way as outlined in item b of this section for 1-1/2 thru 8" bores, and as in item c of this section for 10" thru 20" bores.

• 5-1/2" Diameter Rods.

   e. Rod-End Plunger
   Rod-end plungers must be assembled prior to assembling the piston on the rod.

   f. Cap-End Plunger
   Plungers for 8" bore are assembled as outlined in item b of this section, and plungers for 10"-20" bores are assembled as outlined in item c of this section.

2) To assemble cushion plungers in 1981 Series J, M & H Hydraulic Cylinders, use the following procedures:
Miller Fluid Power
Installation & Maintenance Instructions

• 5/8”-5” Diameter Rods.

  a. **Rod-End Plunger**
  After the piston has been assembled and torqued as outlined in section 15a (page 10), the rod-end cushion can be assembled. Install the cushion spring over the rod and slide down until contacting piston. Install the cushion plunger with the counterbore over the spring. Install the cushion support with flat side of support against the plunger. Install single turn wire insert over the rod and insert on end under cushion support into the groove machined into the rod and I.D. of cushion support. Holding the wire insert steady, slowly turn the cushion support to draw in the wire under the support.

  b. **Cap-End Plunger**
  J Series thru 8” bore and all Series M & H bores. Assemble cushion plunger onto adapter with taper of plunger against adapter shoulder. Assemble cushion spring into plunger counterbore, apply grade #242 or #262 Loctite on threads of piston rod. Screw on adapter with cushion assembled onto rod and torque to figure in chart 4 below.

  c. **Cap-End Plunger**
  J Series 10”-20” bores are assembled as outlined in item a of this section.

  Chart 4

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Loctite*</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-16-20</td>
<td>25</td>
</tr>
<tr>
<td>3-4-16</td>
<td>40</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>60</td>
</tr>
<tr>
<td>1-1/4-12</td>
<td>80</td>
</tr>
<tr>
<td>1-1/2-12</td>
<td>100</td>
</tr>
<tr>
<td>2-12”</td>
<td>145</td>
</tr>
<tr>
<td>3-12”</td>
<td>720</td>
</tr>
<tr>
<td>4-1/2-12</td>
<td>1490</td>
</tr>
</tbody>
</table>

  *Grade #242 or #262

• 5-1/2 - 10” Diameter Rods.

  d. **Rod-End Plunger**
  Must be assembled prior to assembling the piston on the rod. Replace the ‘O’ Ring located under the plunger.

  e. **Cap-End Plunger**
  J Series 8” bore and all Series M & H bores are assembled as outlined in item b of this section.

  f. **Cap-End Plunger**
  J Series 10”-20” bores are assembled as outlined in item a of this section.
b) **CUSHION ASSEMBLY IN ER DESIGN CYLINDERS**

1) To assemble the cushion plunger on an air cylinder (aluminum plunger), the following procedure is to be followed. Assembly of the cushion plunger is accomplished by first installing the spring-support washer and wave spring.

**NOTE:** The wave spring should be installed so that the edges of the split in the spring are against the piston.

Next, the cushion check valve is to be installed with the counterbore against the wave spring. The light-duty thrust ring (thinner of the two thrust rings) is to be installed in the innermost groove machined in the rod. The cushion plunger is positioned on the rod with the castellated edge away from the piston. The heavy-duty thrust washer is then installed in the groove machined in the rod to complete the assembly.

2) To assemble the cushion plunger on a hydraulic cylinder (steel plunger), the following procedure is to be followed. First install the cushion spring (coil a wave spring). The cushion plunger is positioned on the rod next, with the tapered edge away from the piston. Make sure that the cushion spring is properly seated in the counterbore of the cushion plunger. Position the cushion support ring on the rod next, with the concave machined slot away from the piston. Slide the single turn wire insert onto the rod and insert leading edge of insert into groove machined in rod, visible under the concave machined slot in the cushion support. Hold the wire insert in place and carefully rotate the cushion support, which will draw the wire insert into place.

c) **CUSHION ASSEMBLY IN THREE-PIECE PISTON DESIGN CYLINDERS**

1) Rod-end plungers must be assembled to the piston rod prior to installing the piston assembly.

2) Cap-end plungers in all A & J series and through 5" bore. H series are an integral part of the piston rod and no assembly is required. 6" thru 20" bore series H plungers are assembled after the piston is torqued and are held on the rod by a threaded nut.

17. **REASSEMBLY OF PISTON SEALS**

a) **PISTON CUP SEAL ASSEMBLY IN ER AND 1981 DESIGN CYLINDERS**

The following instructions give a detailed breakdown of the proper methods to be used when assembling ‘U’ cup piston seals. These instructions should be followed closely to prevent damage to the cups during assembly.

1) Make certain that all parts are free from any contamination or foreign material and that the assembly area is clean.

2) Install the wear ring into the center groove of the piston.

3) Insert the piston rod, piston and wear ring into the tube until the tailing edge of the wear ring is just inside the tube.

4) Install the piston seal on the piston with the flat side against the piston.

5) Push the piston assembly and seal into the tube until the edge of the piston seal is inside the tube. Skip to step 7 if you are assembling spring-loaded PTFE cups.

6) Install the anti-roll ring with its edge under the ‘U’ cup lip. Skip to step 9.

7) Install the piston pressure ring with the angular side against the piston seal.
8) Install the piston wave spring on the stepped edge of the pressure ring.
9) Install the retainer ring on the piston and snap it into the groove machined into the piston.
10) Push the piston rod and 1/2 the piston assembly thru the tube until the rear end of the assembly is approximately 1/4" from the end of the tube. Care must be taken to keep the rod as parallel to the tube as possible and that the piston assembly is not pushed out of the tube.
11) Repeat steps 4 thru 9, as appropriate, to assemble the other cup seal.

b) PISTON CUP SEAL ASSEMBLY IN THREE-PIECE DESIGN CYLINDERS

The following instructions give a detailed breakdown on the proper methods to be used when assembling lip-type cup seals. These instructions should be followed closely to prevent damage to the cups during assembly.

1) Make certain that all parts are free from any contamination or foreign material and that the assembly area is clean.
2) Assemble plain follower on piston rod with flat side toward the rod shoulder.

NOTE: If PTFE Cups are spring-loaded (in 2-1/2 - 20" bores), the spir “o” lox retaining ring is to be assembled on the followers prior to their assembly to the piston rod.

3) Assemble the follower seal over the piston rod and against the plain follower.
4) Place the cylinder tube in a vertical position on the bench, if possible.

NOTE: Extreme caution must be exercised when performing the following operations to prevent damage to cups, piston or tube.

5) Insert a cup seal into the tube approximately 4” with its lip parallel to the top of the tube and down or away from the assembler.
6) Insert the piston into the tube allowing it to rest evenly against the cup seal.
7) Insert the second cup seal snugly against the piston with its lip up toward the assembler. Skip to step 10 if the cups are not spring-loaded.
8) Assemble one wave spring over the plain follower which was assembled to the rod in step 3.
9) Assemble one pressure ring over the wave spring on the follower with the angled side up toward the assembler and the step side squarely against the wave spring.
10) Place the tube with both cups and piston carefully over the plain follower and over the rod end. Skip to step 3 if the cups are not spring-loaded.
11) Insert the second cup pressure ring into the cup seal so that the angled side is evenly against the angled side of the cup.
12) Insert the wave spring squarely into the step side of the pressure ring.
13) Carefully assemble the threaded follower to the rod end. Torque the threaded follower as specified in Chart 2 on page 10.
14) Stake the threaded follower to the piston rod in three places 120 degrees apart.
c. **PISTON RING SEAL ASSEMBLY IN ALL CYLINDER DESIGNS**

Step Seal Piston Rings are used in Miller cylinders. A ring expander should be used to install rings onto piston; however, if this tool is unavailable, the rings can be put on by hand.

Installation of piston rings into cylinder tubing can be simplified by using a piston ring compressor. If a compressor is not available, the piston should be inserted into the tubing until it meets a ring. Pressure should then be applied to the first ring at positions 90 degrees from the split in the ring. When a ring is compressed, the piston can move forward until the entire piston is completely installed in the tube. Do not use a tool which will damage the piston ring. A non-metallic tool is suggested, such as wood, plastic, fibre, etc.

18. **INSTALLATION OF MILLER “SHEF” TUBING END SEAL IN ALL CYLINDER DESIGNS**

“Shef Seal” is a rectangular strip of PTFE sealing material, either already cut to length for the various bore sizes, or supplied in a 30-foot long length on a spool. The strip is easily cut with a knife or scissors to the required lengths shown in the table below. Squareness of cut is not critical and length of cut need only approximate the values shown in the table below.

<table>
<thead>
<tr>
<th>Bore</th>
<th>1-1/2</th>
<th>2</th>
<th>2-1/2</th>
<th>3-1/4&quot;</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model A or J</td>
<td>10-1/4&quot;</td>
<td>13-3/8&quot;</td>
<td>16-1/2</td>
<td>21-1/4&quot;</td>
<td>26</td>
<td>32-1/8&quot;</td>
<td>38-1/2&quot;</td>
<td>–</td>
<td>51</td>
<td>63-5/8&quot;</td>
<td>77</td>
<td>89-1/2&quot;</td>
</tr>
<tr>
<td>Model H</td>
<td>10-3/4&quot;</td>
<td>14</td>
<td>18</td>
<td>22-3/4&quot;</td>
<td>28</td>
<td>34-1/2&quot;</td>
<td>40-3/4&quot;</td>
<td>47-1/4&quot;</td>
<td>53-1/2&quot;</td>
<td>67</td>
<td>79-1/2&quot;</td>
<td>93</td>
</tr>
</tbody>
</table>

**SUGGESTED “SHEF-SEAL” LENGTHS IN INCHES**

A. Apply grease to the tubing groove of cylinder head or cap.

B. Coil the PTFE strip on its narrow edge into the greased tubing groove. The strip should make two complete revolutions plus about 1/2" overlap, and be snugly against the O.D. of the groove.

For convenience of demonstration, the sketch at right exaggerates the space between the “Shef Seal” coils which actually hug each other closely when fitted into tubing groove.
19. REASSEMBLY OF THE CYLINDER

After the cylinder has been assembled in the reverse order of the disassembly, tighten tie rods snugly with hand wrench and light pressure, and accomplish final tightening gradually, working from one tie rod to the diagonally opposite tie rod to ensure evenness of tie rod tightening. DO NOT TIGHTEN ONE TIE ROD COMPLETELY AND THEN THE OTHERS. THIS WILL RESULT IN IMPROPER TIGHTENING OF TIE RODS AND IMPROPER ALIGNMENT OF THE HEAD AND CAP. See Charts 5 and 6 below for proper torque values of bolted bushing screws and tie rod nuts.

<table>
<thead>
<tr>
<th>Piston-Rod Diameter</th>
<th>Cap-Screw Size</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8&quot;</td>
<td>10-32 x 3/8</td>
<td>76 inch/lbs.</td>
</tr>
<tr>
<td>1&quot; thru 3-1/2&quot;</td>
<td>1/4-28 x 5/8</td>
<td>180 inch/lbs.</td>
</tr>
<tr>
<td>4&quot; thru 10&quot;</td>
<td>5/16-24 x 1</td>
<td>360 inch/lbs.</td>
</tr>
</tbody>
</table>

### Chart 5

Bolted Bushing Mounting Screw Torque

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2</td>
<td>Dry 6</td>
<td>Dry 6</td>
<td>Dry 16</td>
<td>Dry 13</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>11</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>2-1/2</td>
<td>11</td>
<td>20</td>
<td>50</td>
<td>42</td>
</tr>
<tr>
<td>3-1/4</td>
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<td>28</td>
<td>90</td>
<td>75</td>
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<td>N/A</td>
</tr>
<tr>
<td>20</td>
<td>425</td>
<td>325</td>
<td>560</td>
<td>N/A</td>
</tr>
</tbody>
</table>
20. TESTING THE RE-ASSEMBLED CYLINDER

Test freedom of movement in small-bore, short-stroke cylinders by laying the cylinder horizontally and cycling the piston rod by hand. Large-bore or long-stroke cylinders that may be difficult to cycle by hand can be cycled with low pressure (10 to 24 psi) air. Double rod-end cylinders, cylinders with oversized piston-rod diameters and strokes longer than 6 feet may require more than 25 psi to move the piston. In no case, however, should more than 45 psi be required to cycle the cylinder.

Consistent cycling pressure of 45 psi can indicate improper assembly, which will result in mechanical damage and premature failure of cylinder components. The cylinder should, therefore, be disassembled, re-assembled after corrective action, and re-checked before installation into the mechanism.

Before installing the rebuilt cylinder into the machine, it is advisable to test it for seal leakage. To test 'U' cup or lip-type piston seals, connect one end of a short length of hose to the head-end port and submerge the other end in a small container of water. Pressurize the cap-end port with shop air and observe the container of water. If more than an occasional bubble appears in the water, the cap-end piston cup is not sealing properly. To test the head-end cup, repeat the procedure with the hose connected to the cap-end port and shop air applied to the head-end.

Rod seal leakage can be checked when the head-end port is pressurized. With the rod wiper removed, deposit a small quantity of oil in the wiper cavity around the rod and bushing clearance. An occasional bubble in the oil indicates that the rod seal is expected to be leakproof when operated hydraulically. If more than an occasional bubble appears, the rod seal should be tested for oil leakage (with the wiper removed) by hydraulically pressurizing the head-end port.
J, M & H Series Cylinders
Exploded Parts Assembly

Bolted Retainer (5/8" - 1 3/8" Rods only)
Flange Held Bushing

Piston Rod Wiper
Bolted Bushing (1 3/4" - 10" Rods)

Tie Rod Nut

Rod Seal Cage
Rod Seal Pressure Ring

Shef Tube End Seal
Cap

Retaining Ring
Piston Seal Anti-Roll Ring
Piston Seal

Wear Ring
Piston Seal Anti-Roll Ring Retaining Ring

Wave Spring
Piston Plunger

Cushion Adapter
Cushion Plunger

Wave Spring
Support Ring
Cushion Wire Insert

J, M & H Series Cylinders Cushion Assembly for 1 1/2" thru 8" Bores 5/8" thru 5" Rod Dia.
STAR<sup>SM</sup> Seal System for Cylinders

This kit contains Miller's new STAR seal system, which includes either a bolted-design or a retainer-held bushing. Please note: This seal system is interchangeable with all A, J & H series cylinders with skin-cut (rod diameter reduced at wrench flat area) piston rods. The STAR seal system is designed for use with air- or petroleum-based fluids having operating temperatures up to 200°F.

**Step 1** If bushing is held by a tie rod retainer, remove tie rod nuts and retainer. For bolted design, remove socket head cap screws only. Remove all rod-seal parts (air cyl. rod seal or rod seal, wave spring, pressure ring, and cage if replacing caged BASELOK PTFE design) from cylinder and discard. Remove any dirt, chips, etc., from bushing cavity in cylinder head. Inspect and polish out any nicks or scratches in the piston rod with 400 emery cloth.

**Step 2** Apply some grease to bushing I.D. and seals. Apply sufficient grease to 'O' ring to hold it in the groove. Install 'O' ring, rod seal and wiper in the new bushing as shown in the cross-sectional view of the bushing assembly. Please note: The 5/8", 1" and 1-3/8" size rod seals have been factory-installed for ease of installation.

**Step 3** For convenience, extend piston rod partially.

**Step 4**

A. Slip bushing assembly over the piston rod using care to prevent damage to the seals by the piston rod thread or wrench flats. Some resistance will be experienced and will need to be overcome.

B. Insert the bushing assembly into the counterbore of the cylinder head.

C. If bolted-design bushing is used, socket head-cap screws are to be torqued to the figures below.

<table>
<thead>
<tr>
<th>Piston-Rod Diameter</th>
<th>Cap-Screw Size</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8&quot;</td>
<td>10-32 x 3/8</td>
<td>76 in./lbs.</td>
</tr>
<tr>
<td>1&quot; thru 3-1/2&quot;</td>
<td>1/4-28 x 5/8</td>
<td>180 in./lbs.</td>
</tr>
<tr>
<td>4&quot; thru 10&quot;</td>
<td>5/16-24 x 1</td>
<td>360 in./lbs.</td>
</tr>
</tbody>
</table>

D. If retainer-held bushing is used, reinstall retainer and tie rod nuts (retorque tie rod nuts to values shown in catalog).

**Sealed To Assure Reliability**