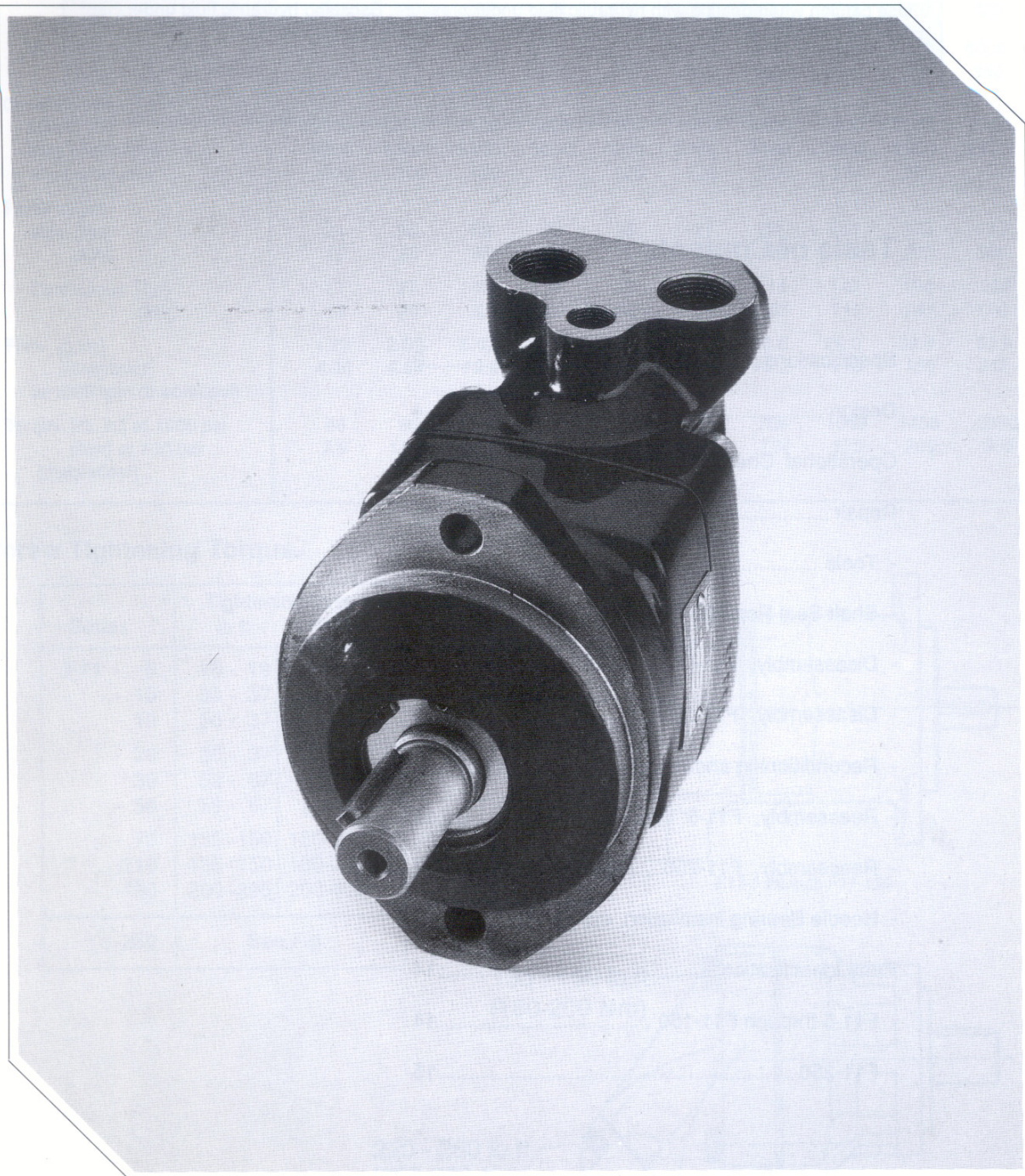


# Service Manual

ASM 3.1 - F11  
F11-05 through -250

Publ. No. 0395-9446 GB



**VOAC**  
Hydraulics



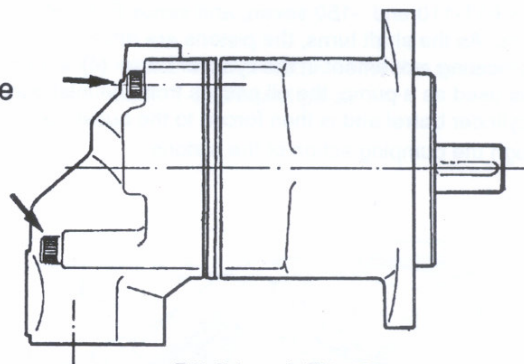
## Specifications

Designation	F11-5	F11-10	F11-19	F11-28	F11-39	F11-58	F11-78	F11-110	F11-150	F11-250
Displacement [cu. in./ rev] (cm <sup>3</sup> /rev)	0.30 4.88	0.60 9.84	1.16 19.0	1.72 28.1	2.36 38.7	3.55 58.2	4.77 78.2	6.72 110	9.15 150	14.8 242
Operating pressure										
Peak [psi] (bar)	6000 420	6000 420	6000 420	6000 420	6000 420	6000 420	6000 420	6000 420	6000 420	6000 420
Max continuous [psi] (bar)	5000 350	5000 350	5000 350	5000 350	5000 350	5000 350	5000 350	5000 350	5000 350	5000 350
Operating speed [rpm]										
Max	12000	10000	7500	6500	5200	4500	3500	3300	3000	2700
Max continuous	8500	6800	5400	5000	4200	3600	3100	2800	2600	2400
Min continuous	200	200	150	150	125	125	100	100	100	100
Power output										
Max [hp] (kW)	24 18	38 28	60 45	78 58	96 72	127 95	161 120	201 150	263 200	400 300
Continuous [hp] (kW)	17 13	27 20	43 32	54 40	70 52	91 68	114 85	147 110	194 145	255 190
Flow [gpm] (litres/min) at 1000 rpm (theoretical)	1.29 4.88	2.60 9.84	5.02 19.0	7.42 28.1	10.2 38.7	15.4 58.2	20.6 78.2	29.0 110	39.6 150	63.9 242
Torque [lb. in.] at 1000 psi (Nm) at 100 bar (theoretical)	48 7.8	96 15.7	184 30.2	273 44.7	376 61.6	564 92.5	756 124	1068 175	1458 239	2380 385

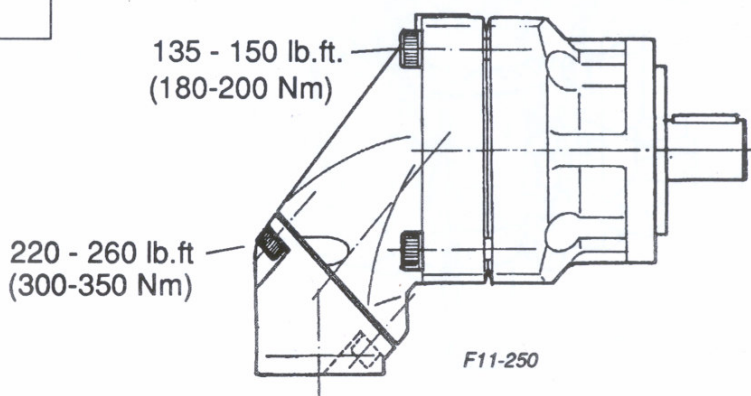
## Screw Tightening Torque.

Series	Tightening torque lb.ft. (Nm)	
F11 - 5	15 - 19	20-25
- 10	30 - 37	40-50
- 19	30 - 37	40-50
- 28	30 - 37	40-50
- 39	59 - 67	80-90
- 58	59 - 67	80-90
- 78	135 -150	180-200
-110	135 -150	180-200
-150	260 -295	200-400
-250	See Fig.	

See table



F11-5 through F11-150



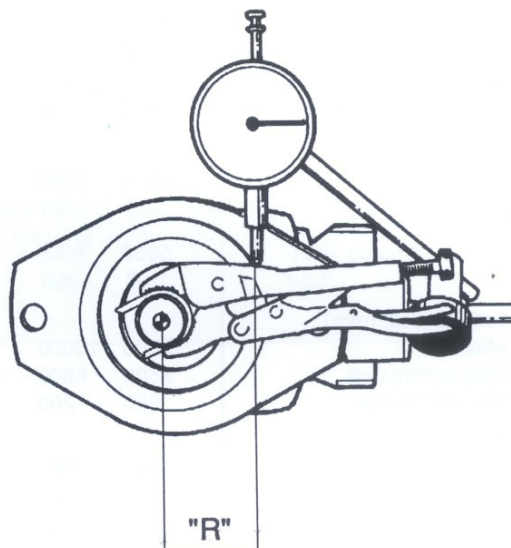
F11-250

## Gear Backlash

F11-005 through F11-110  
0.05 - 0.20 mm

F11-150 through F11-250  
0.10 - 0.30 mm

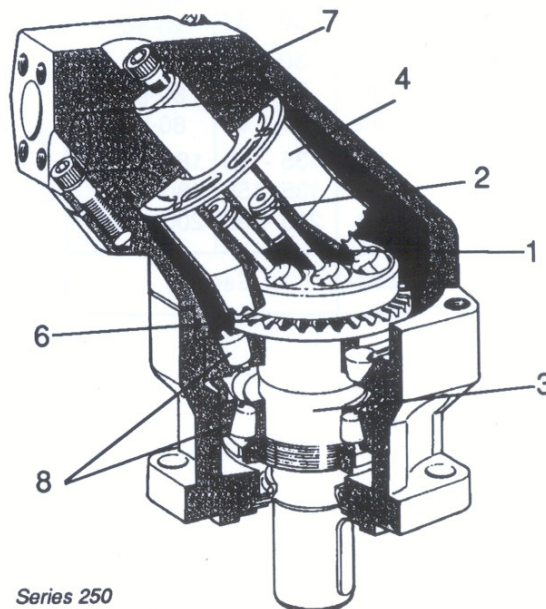
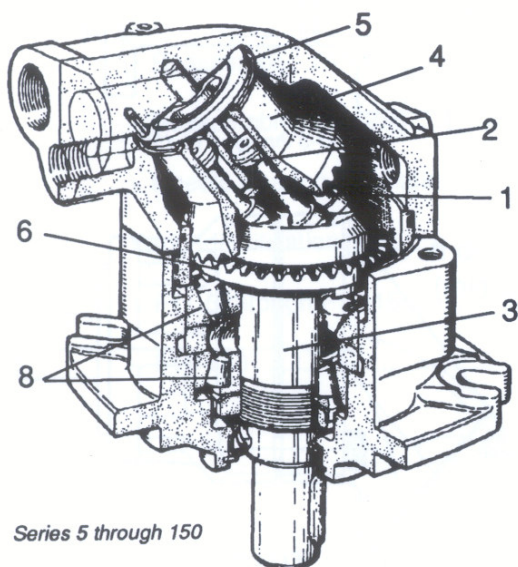
Frame size	mm
F11-005	25.0
F11-010	31.3
F11-019	37.5
F11-028	42.0
F11-039	47.5
F11-058	55.0
F11-078	62.5
F11-110	65.6
F11-150	75.0
F11-250	75.0



## Design

Series F11 pumps/motors consist of a rotating group contained in a split housing. Spherical pistons (1) with laminated piston rings (2) operate at a 40° angle relative to the shaft (3). Series F11-5 through -78 employ five pistons, series F11-110 and -150 seven, and series F11-250 nine pistons. As the shaft turns, the pistons are driven in a reciprocating movement in the cylinder barrel (4). When the unit is used as a pump, the oil passes from the inlet port to the cylinder barrel and is then forced to the outlet port through the pumping action of the pistons.

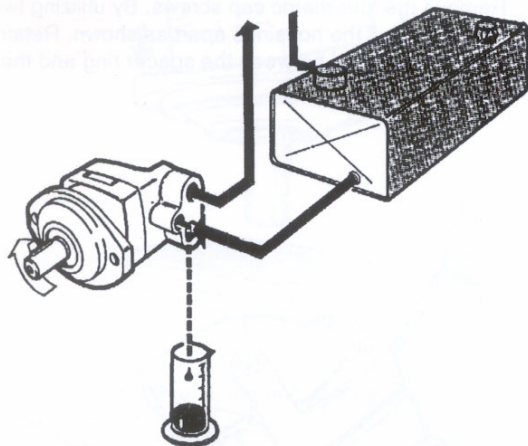
A spring device (a retaining ring, a leaf spring, or Belleville washers) maintains the barrel against the valve plate (item 5, F11-5 through -150) or the end cap (item 7, F11-250). A ring gear (6) on the shaft meshes with the corresponding teeth of the barrel (4) so that the cylinder barrel always rotates at the same speed as the shaft (3). The shaft is supported by two heavy duty tapered roller bearings (8).





## Operational Check

The general condition of the unit can be established by checking the drain flow. Remove the drain line and keep the drain port above a suitable container. Run the unit at normal speed and pressurize the system to 2000-3000 psi. (150 - 200 bar ).



### Drain Flow

Series	Normal cu.in./min (l/m)		Max. gpm. (l/m)	
F11-5	12	0.2	.25	1.0
F11-10	18	0.3	.40	1.5
F11-19	24	0.4	.55	2.0
F11-28	24	0.4	.55	2.0
F11-39	30	0.5	.65	2.5
F11-58	43	0.7	.70	2.7
F11-78	61	1.0	.80	3.0
F11-110	61	1.0	.80	3.0
F11-150	73	1.2	.80	3.0
F11-250	92	1.5	.80	3.0

## Repair

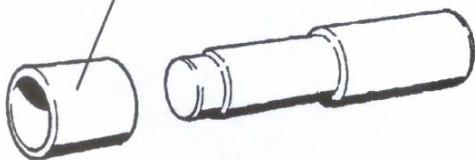
### Tools and Supplies

Metric Allen keys, retaining ring spanners, and a torque wrench with suitable metric sockets are required for the disassembly and assembly of the F11 series, plus common hand tools.

In addition, the following tools are recommended for installing cylinder barrel needle bearings:

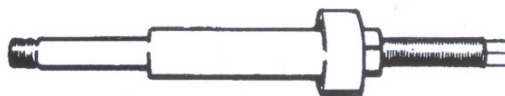
P/N 370 6526 (F11-110)  
 370 6527 (F11-150)  
 370 6528 (F11-250)

*F11-110, -150 only*



*Needle bearing installation tool*

A special tool, P/N 370 6250, is required for the removal and re-assembly of the F11-250 barrel post.



*Barrel post installation tool*

The following lapping compound can be used for reconditioning valve plates:

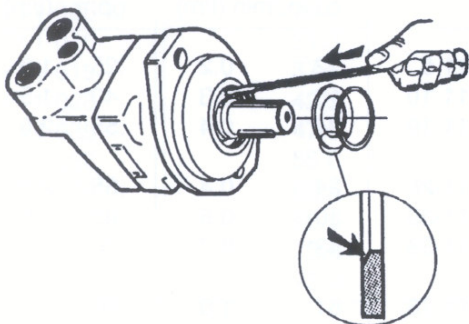
Time Saver 60      P/N 546 390 - 2400  
 Time Saver 80      P/N 546 390 - 3200

## Shaft Seal Replacement

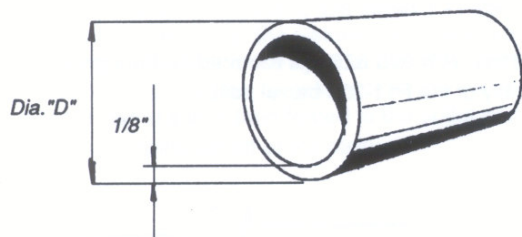
### Note

The unit does not have to be taken apart.

Remove the retaining ring and the back-up washer (units designated F11C and F11D might not have a back-up washer). Without damaging the shaft, punch through the casing of the seal with a screwdriver and remove the seal. Check the shaft sealing surface for corrosion and other damage.



The tool shown in the figure can be used to facilitate the installation of the new seal. Be careful not to cut the seal on the shaft key or spline. The chamfer of the back-up washer should face the seal when installed.

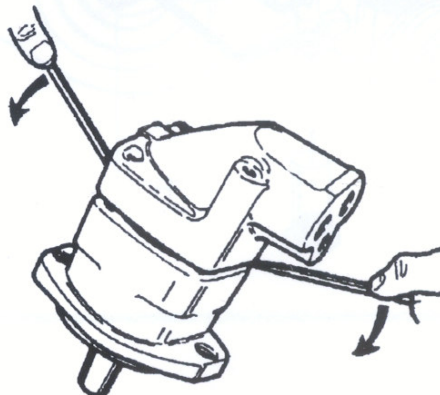


Series	Dia. "D" in. (mm)
F11- 5 10	1.375 35
19	2.045 52
28	2.440 62
39 58	2.560 65
78 110	2.835 72
150 250	3.150 80

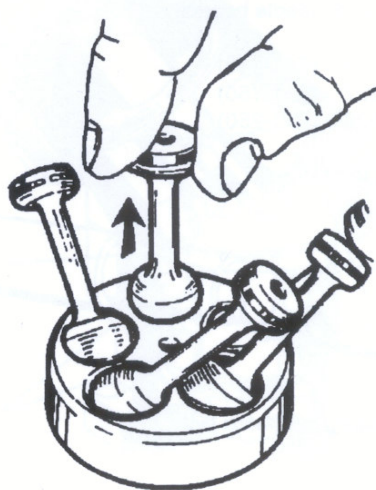
## Disassembly, Series F11-5 through -150

Before taking the unit apart, remove the shaft coupling (if applicable) and thoroughly clean the outside of the unit; seal the ports with suitable plugs or covers.

1. Remove the four metric cap screws. By utilizing two screwdrivers, pull the housings apart as shown. Retain the split shim located between the spacer ring and the barrel housing.

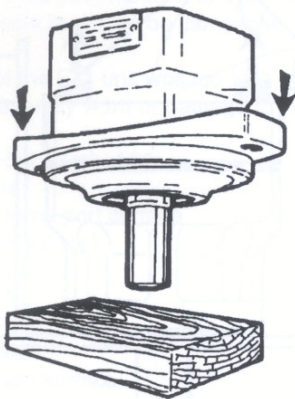


2. Mark the pistons and the corresponding ball sockets with a felt-tipped pen.
3. Remove the pistons by pulling them out when in line with the shaft as shown.

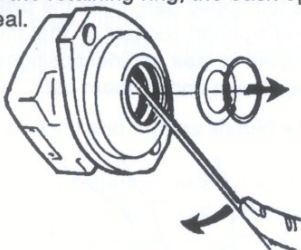




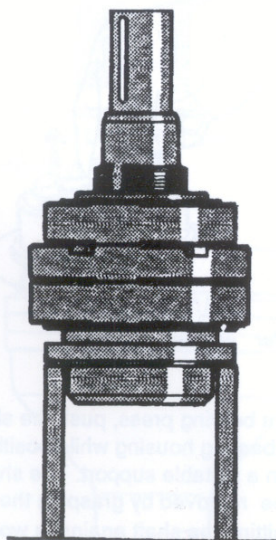
4. Using a bearing press, push the shaft assembly out of the bearing housing on a suitable support. The shaft assembly can also be removed by grasping the housing and carefully hitting the shaft against a wooden block as shown.



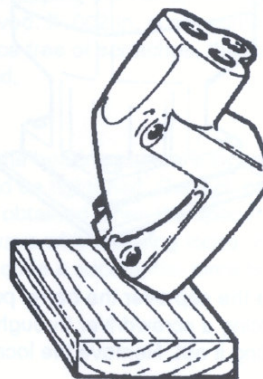
5. Remove the retaining ring, the back-up washer, and the shaft seal.



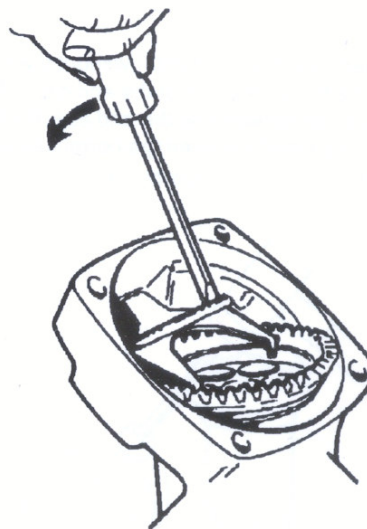
6. Do not disassemble the shaft assembly unless the bearings are worn or damaged. If the bearings or the shaft have to be replaced, remove the locknut and the tab washer, and position the shaft assembly on a piece of pipe or other suitable support that fits snugly around the shaft and supports the ring gear. The shaft can now be pressed out.



7. To remove the cylinder barrel from the housing (does not apply to Series F11-28 and -58), carefully hit the housing/barrel assembly against a piece of wood as shown; the barrel as well as the valve plate will be forced out. Be careful to protect the barrel and valve plate from damage.

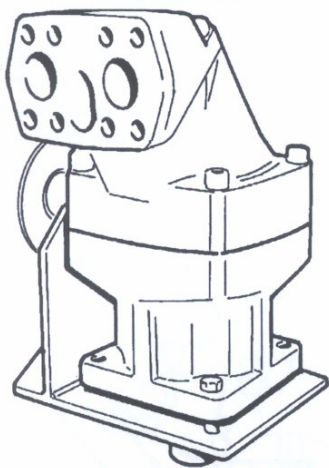


Series F11-28 and -58 cylinder barrel can be removed from the barrel post after removal of the leaf spring locating pin (utilizing a screwdriver as shown), the leaf spring, and the hold-down bearing ring.

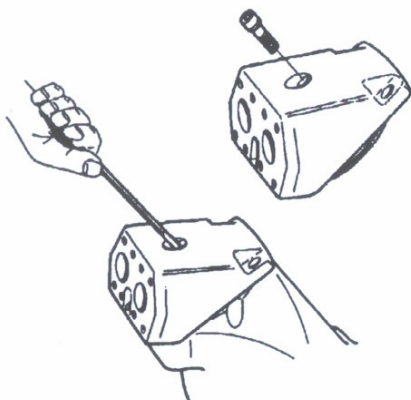


## Disassembly, Series F11-250

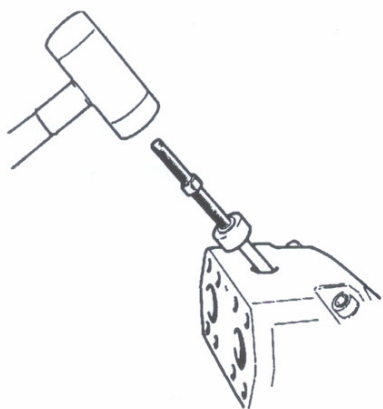
Position the unit on a table provided with a hole for the shaft or on a suitable fixture.



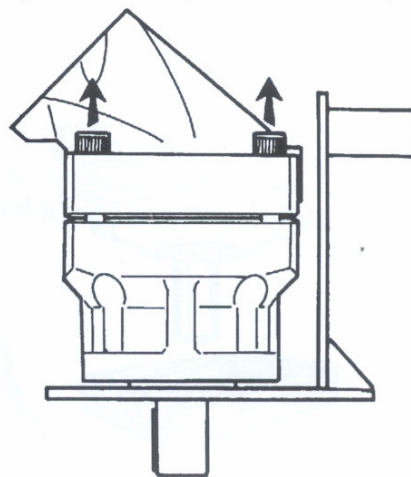
1. Remove the cap over the barrel post locating screw by forcing a screwdriver through the top of the cap and pulling it out. Remove the locating screw.



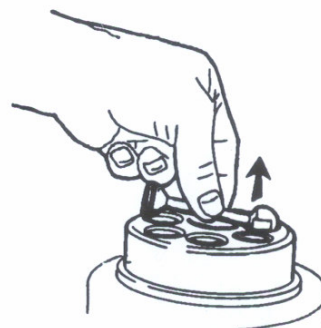
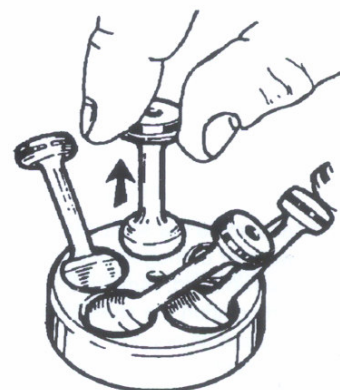
2. Insert tool P/N 370 6250 (without the sleeve) and knock the barrel post out of the end cap. Remove the three cap screws and the end cap. Retain the split shim located between the barrel housing and the end cap.



3. Remove the four cap screws and the barrel housing. Remove the cylinder barrel off the pistons.



4. With a felt-tipped pen, mark the pistons and the corresponding shaft sockets so that the pistons can be re-installed in their original positions. Hold the pistons as shown and lift them out.



*Older version F11-250*

5. Using a bearing press, push the shaft assembly out of the bearing housing while positioning the housing on a suitable support. The shaft assembly can also be removed by grasping the housing and carefully hitting the shaft against a wooden block.



## Reconditioning and Replacement of Parts

After disassembly, all parts should be thoroughly cleaned in a suitable solvent.

Caution: Follow directions for use of solvent carefully. Protect your hands and eyes from the solvent. Solvent may also be flameable.

If leakage of the F11 unit was too high, the following parts are generally worn or damaged:

Series F11-5 through -150:

- Valve plate
- Cylinder barrel port surface (facing valve plate)
- Piston rings

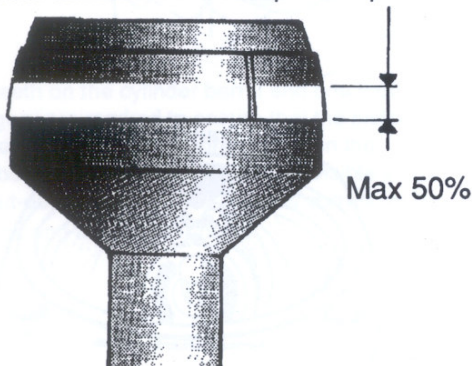
Series F11-250:

- Bearing plate
- End cap port surface (facing bearing plate)
- Piston rings

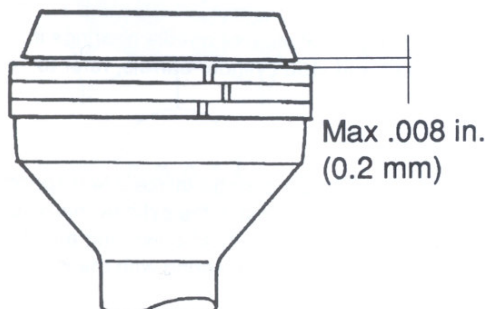
Scratches and wear marks on these parts always affect the performance of the unit; they should be replaced if scratched or worn.

1. Shaft seal and o-rings should always be replaced.

2. Replace spherical piston rings that are worn more than 50 % of the spherical surface as shown. A small retaining ring pliers will facilitate the removal. When installing a new piston ring, make sure the spherical surface coincides with the shape of the piston head.



Laminated piston rings should always be replaced at major repairs. The piston assembly if play indicated in the figure is exceeded.



Production of the spherical piston ring is discontinued. The old ring and piston has to be replaced by the laminated version.

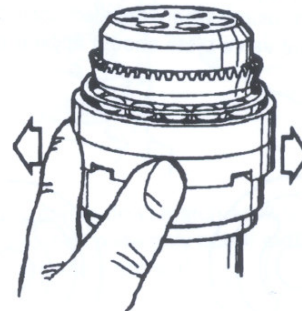
3. On series F11-5 through -150, the valve plate surface can be reconditioned by careful lapping. Use 'Time Saver' (refer to page 5).

Series F11-250 end cap port surface can be lapped but the bearing plate must be replaced if worn.

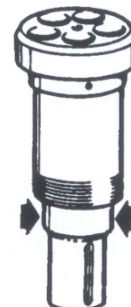
### Note

When lapping the valveplate, up to .002 in. can be removed. If .002 in. is not sufficient to obtain a flat surface free of scratches, the part should be replaced.

4. If the bearing cups are loose, the shaft lock nut should be tightened. Correct bearing preload has been obtained when the spacer ring can be moved sideways without being loose. Note, for the bigger units quite a substantial force is required.



5. Check that the shaft surface in contact with the shaft seal is in good condition; if grooved, corroded, or otherwise damaged, the shaft should be replaced.



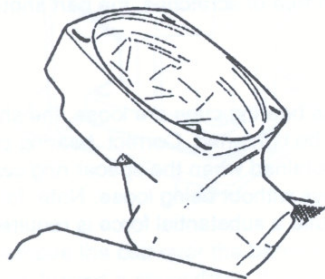


## Reassembly, Series F11-5 through -150

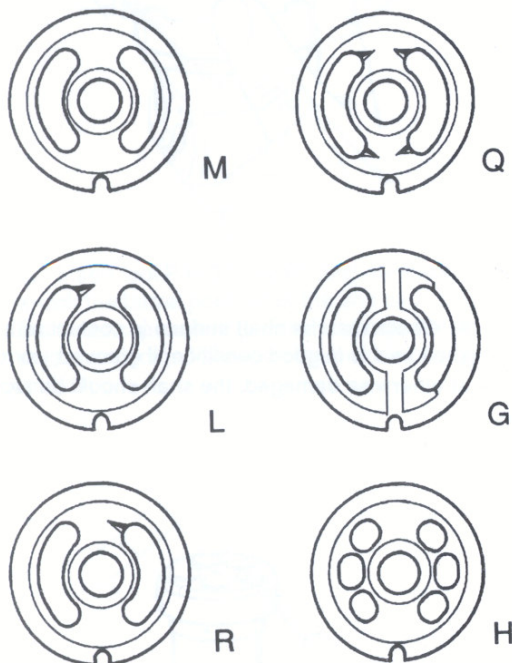
All parts should be thoroughly cleaned and lightly lubricated with hydraulic fluid. Reassembly is carried out in reverse order of disassembly.

**Caution:** Follow directions for use of hydraulic fluid carefully. Protect your hands and eyes from fluid. Fluid may also be flammable.

1. Place the cylinder barrel housing in a vise as shown.



2. Install the valve plate making sure it is seated properly in the housing; when installed correctly, the visible face of the valve plate should appear as shown.



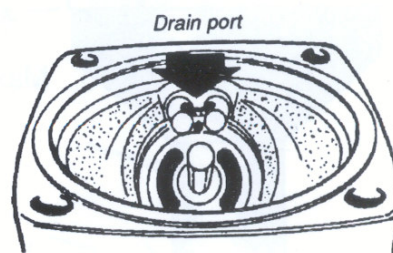
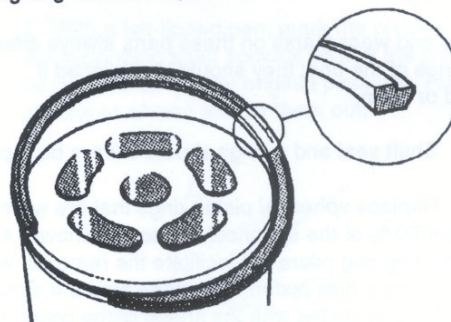
The internal drain valve plate G is shown from the back side of the plate. From the front, when installed, it looks the same as the M plate.

The following valve plates are available (designation appears on the nameplate):

- M = Bi-directional, motor or pump operation
- L = L.H. rotation, pump operation
- R = R.H. rotation, pump operation
- G = L.H. rotation, internal drain, motor operation
- J = R.H. rotation, internal drain, motor operation
- H = Bi-directional, motor operation, high pressure
- Q = Bi-directional, motor operation, low noise

3. The cylinder barrel retaining ring (does not apply to Series F11-28 and -58) should be installed as illustrated below. When installing the barrel in the housing, the opening of the retaining ring should face the housing cut-out as shown; the barrel has to be pushed down to overcome the spring force of the retaining ring.

Some resistance should be felt when trying to turn the cylinder barrel by hand; if no resistance is felt, the retaining ring must be replaced.

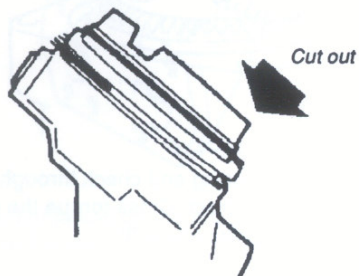


### Note

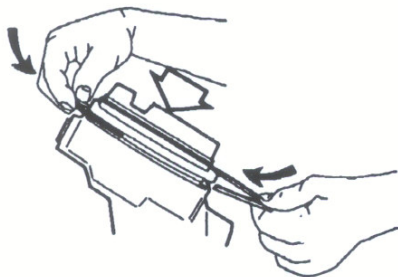
Regarding installation of needle bearings in F11-110 and -150 cylinder barrels, refer to page 16.

4. Series F11-28 and -58 utilize a leaf spring for barrel hold-down. Install the cylinder barrel on the barrel post, install the hold-down ring and the leaf spring, and secure the spring with the locating pin.

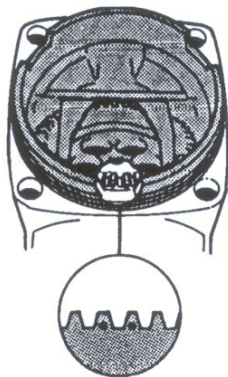
5. Install the guide spacer (with new o-rings) to the barrel housing; make sure one of the cut-outs is in the position shown, and leave room for the split shim between the spacer and the housing .



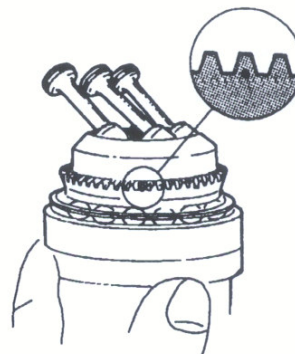
6. Install the split shim as illustrated. Make sure the shim is properly located in the barrel housing recess. Correct thickness of the shim should result in a gear backlash of .002 to .008 in. If any part of the rotating group has been replaced, it might be necessary to change to a shim of different thickness; backlash is checked according to paragraph 12 (page 12).



7. Two teeth on the cylinder barrel and one tooth on the ring gear are marked to ensure that the pistons are in line with the cylinder bores. Position the cylinder barrel so that the markings are visible in the spacer cut-out as shown, this assures correct timing of the shaft and the cylinder barrel.



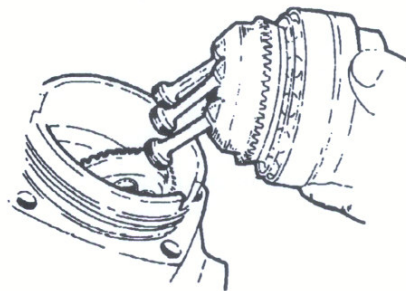
8. Locate the marked tooth of the shaft ring gear.



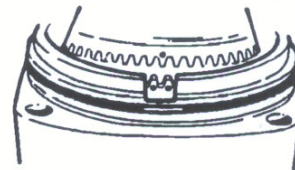
#### Note

If the shaft assembly has been taken apart, refer to "Reassembly, Series F11-250" for instructions.

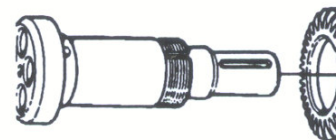
9. Position the shaft/piston assembly over the housing/barrel assembly as shown, so that the timing marks of the ring gear and cylinder barrel are lined up. Locate each piston into the corresponding, previously marked cylinder bore.



10. If the timing marks don't match as illustrated, carefully pull the shaft assembly out of mesh with the ring gear and reposition correctly.



11. Install the bearing housing with a new shaft seal on the shaft/bearing assembly, being careful not to cut or otherwise damage the seal. A spacer ring that is not concentric with the bearing cups will prevent the installation of the housing. Cross-torque the cap screws according to specifications on page 3.



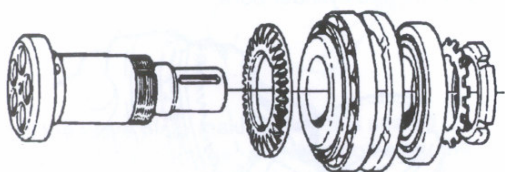


12. Turn the shaft by hand to assure correct assembly. A "clicking" noise generated when the shaft is rapidly turned back and forth reveals that there is backlash between the ring gear and the cylinder barrel. A "no noise" condition indicates no backlash, and a thicker shim has to be installed.

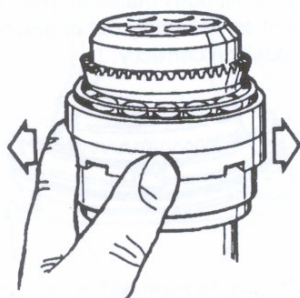
The correct backlash should be .002 to .008 in.

## Reassembly, Series F11-250

1. If the shaft/bearing assembly has been taken apart, start the reassembly by installing the ring gear over the locating dowel pin. Press the cone of the large roller bearing against the ring gear. Install the large bearing cup, the spacer ring (note the position of the cut-outs), and the small bearing cup. Press the small bearing cone onto the shaft, but only so far that the spacer ring can still be moved sideways easily.



2. Install a new tab washer and tighten the lock nut gradually until the spacer ring between the bearing cups is held firmly but not tight; you should be able to push the spacer sideways with your thumbs as shown. Secure the nut with one of the tabs of the washer.

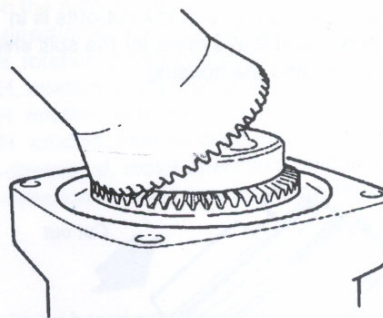


### Note

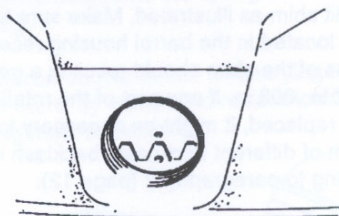
If the lock nut has been tightened too much as to allow the spacer to be moved sideways, the bearings have to be removed from the shaft and the assembly procedure started over again.

3. Install a new shaft seal and push the shaft assembly into the bearing housing. Install the pistons in the ball sockets.

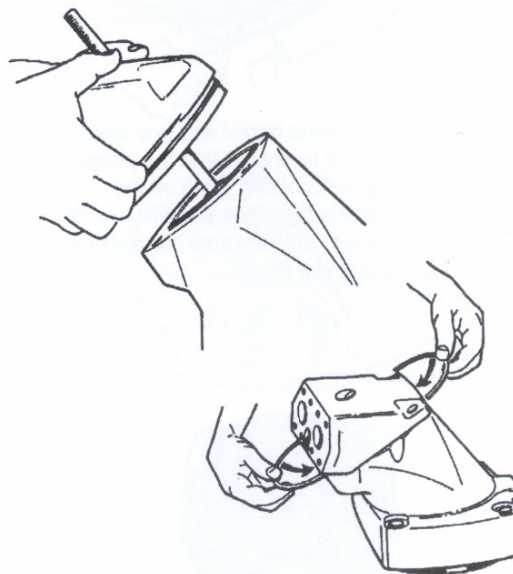
4. If a new cylinder barrel is used, install the groove pins that locate the bearing plate, the internal retaining ring, and the needle bearings (refer to page 14). Install the barrel post/bearing assembly in the cylinder barrel. Locate each piston into the corresponding, previously marked cylinder bore, and position the cylinder barrel assembly on the ring gear as shown so that the timing marks are lined up.



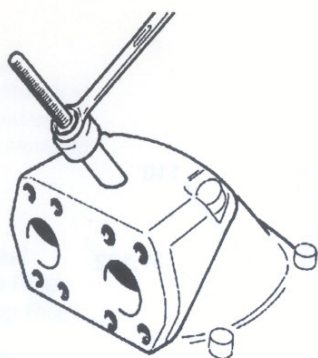
5. Install the barrel housing and check through the drain port that the timing is correct. Cross-torque the cap screws according to specifications (page 3).



6. Install new o-rings on the end cap; one o-ring is located in the barrel post bore. Screw tool P/N 370 6250 (without nut and bearing) into the barrel post, and install the end cap over the tool spindle against the block housing. Install the split shim as shown, making sure it is located correctly in the barrel housing recess.



7. Install the nut/bearing of the tool on the spindle, and pull, by tightening on the nut, the barrel post partly into the end cap. Install the three cap screws and tighten according to specification (page 3).



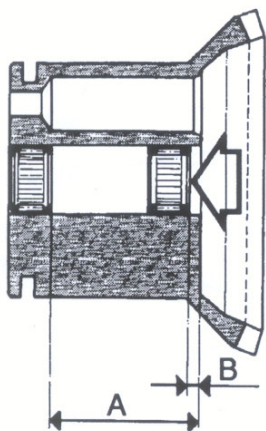
8. By further tightening on the nut, pull the block post completely into the end cap; do not overtighten.

9. Remove the assembly tool. Install the cap screw that secures the barrel post, and torque it to .40-.45 Nm; back off 1/3 turn to obtain correct axial play. Push the seal cap over the screw head.

10. Check the backlash through the drain port; correct backlash is .10-.30 mm.

## Needle Bearing Installation

F11-110, -150

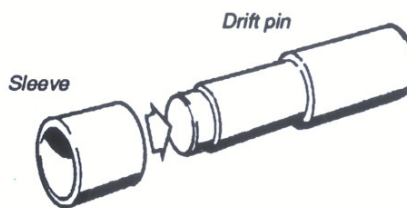


Series	Dim. A mm	Dim. B mm
F11-110	56.0	4.5
F11-150	61.5	10.0

Refer to page 5 for information on recommended tools.

### Note

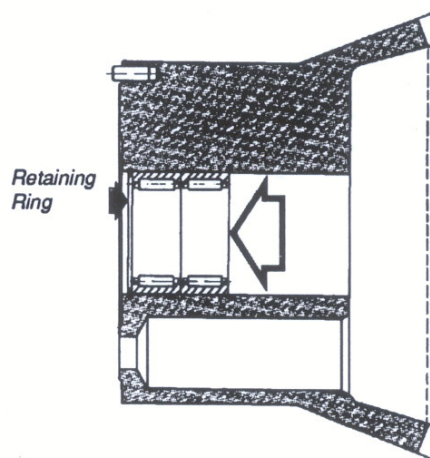
When installing the needle bearings, the marked end of the cage should face the drift pin or sleeve.



1. Install the sleeve and a needle bearing on the drift pin; press the bearing to the bottom of the cylinder barrel (dimension A).

2. Remove the sleeve, install the second needle bearing on the drift pin and press in place (dimension B).

F11-250:



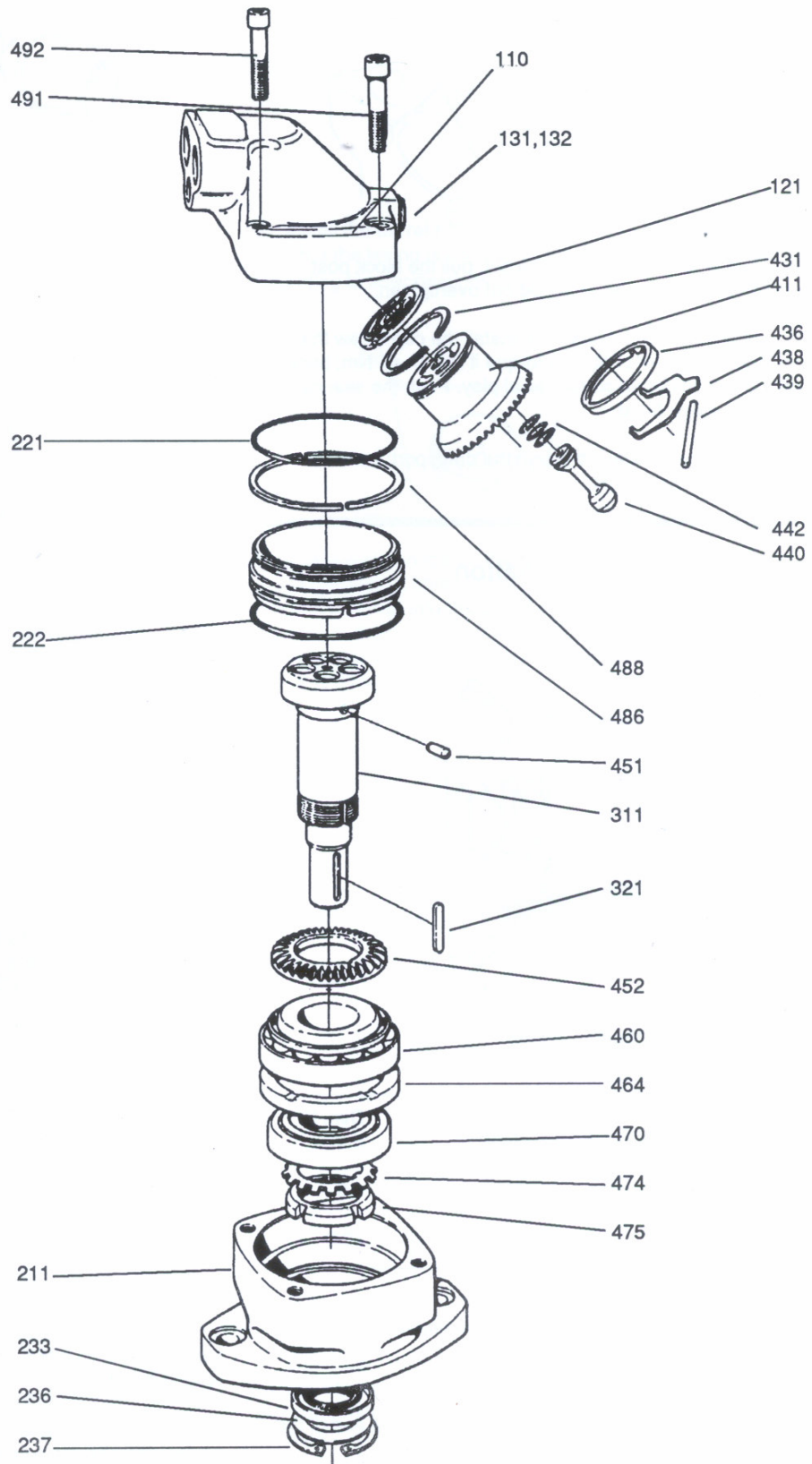
1. Install a needle bearing on the drift pin (there is no sleeve); press in place so that it just touches the retaining ring.

2. The second needle bearing should be located against the one previously installed.



**Pos Title**

- 110 Barrel Housing Assy
- 121 Valve Plate
- 131 Hex Socket Plug
- 132 Seal Washer
- 211 Bearing Housing
- 221 O-Ring
- 222 O-Ring
- 233 Shaft Seal
- 236 Back-up Ring
- 237 Retaining Ring
- 311 Shaft
- 321 Flat Key
- 411 Cylinder Barrel
- 415 Needle bearing
- 431 Barrel Retaining Ring
- 436 Bearing Ring
- 438 Leaf Spring
- 439 Pivot Pin
- 440 Piston Assy
- 442 Piston Ring
- 451 Pin
- 452 Ring Gear
- 460 Tap Rol Bearing
- 464 Spacer Ring
- 470 Tap Rol Bearing
- 474 Lock Washer
- 475 Round Nut
- 486 Guide Spacer
- 488 Shim
- 491 Hex Socket Screw



**Pos Title**

- 111 End Cap
- 131 Hex Socket Plug
- 132 Seal Washer
- 211 Bearing Housing
- 222 O-Ring
- 223 O-Ring
- 224 O-Ring
- 233 Shaft Seal
- 236 Back-up Ring
- 237 Retaining Ring
- 311 Shaft
- 321 Flat Key
- 411 Cylinder Barrel
- 413 Spring Pin
- 414 Retaining Ring
- 415 Needle Bearing
- 422 Spacer Sleeve
- 423 Barrel Spindle
- 424 Sliding Plate
- 425 Tap Rol Bearing
- 426 Spacer Washer
- 427 Retaining Ring
- 428 Hex Socket Screw
- 429 Cap Plug
- 433 Disc Spring
- 440 Piston Assy
- 442 Piston Ring
- 451 Pin
- 452 Ring Gear
- 461 Tap Rol Bearing Cone
- 462 Tap Rol Bearing Cup
- 464 Spacer Ring
- 470 Tap Rol Bearing
- 474 Lock Washer
- 475 Round Nut
- 481 Barrel Housing
- 488 Shim
- 491 Hex Socket Screw
- 493 Hex Socket Screw

