

HYD-RO-AC Rotary Actuator

OVERHAUL INSTRUCTIONS & PARTS LIST FOR STANDARD MODELS

HS-1.5

HS-2.5

HS-004

HS-006

HS-010

HS-015

Read the entire contents of these instructions before installing the actuator and before making any connections to the actuator. These instructions must be followed in all respects to avoid damage to the actuator and associated components and/or injury to personnel.

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INTRODUCTION.

This technical manual provides overhaul instructions for standard HS (Hollow Shaft) Hyd-ro-ac Rotary Actuators. Do not attempt to overhaul an actuator without having a seal kit on hand. Refer to applicable Parts List (Table 5, page 6) for information regarding seal kits. The Parts List should also be used as a specific guide in determining the various parts names for ordering replacement parts.

SPECIAL TOOLS.

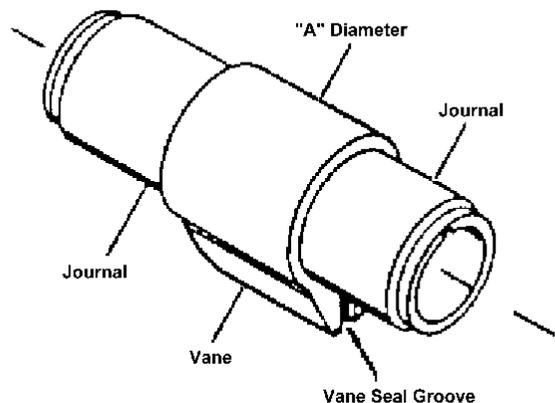
Special tools are recommended for use during reassembly of an HS Series Actuator. Alternate procedures, for use when tools are not available are provided herein but are not recommended. See figure 2 for where tools are used see Table IV on page 6 for parts listing.

Note: The procedures herein apply to all HS Series Actuators. The differences in construction between the various units do not affect the overhaul instructions unless a notation restricts the instruction to a particular HS Series Actuator.

DISASSEMBLY.

Disassembly is in the same order as the key index numbers assigned to the exploded view illustration, see figure 5 or 5a. Complete instructions are listed in the following steps.

- a. Use a holding fixture that simulates normal actuator mounting to hold the actuator during disassembly. Do not hold the actuator in a vise unless special precautions are taken to avoid marring or distorting the end or body.
- b. Pull V-rings (1) from each end of the wing shaft. Unscrew and remove cap screws (2). Tap around the periphery of end & bushing assembly (3) until the end is loose, then remove it from body & bushing assembly (19).
- c. Remove hub seal (5), hub seal ring (6), and hub seal spring (7) from end (3). Take shaft seal (8) and shaft seal O-ring (9) out of the groove in end (3). If necessary, remove dowels (4) from end (3) or body (19).
- d. Bushing (10) in end (3) is a Journal type and replacement should be governed by the following criteria.
 1. Bushing should not be replaced unless worn or damaged.
 2. If replacement is required, bushings must be machined out of the end. Care must be taken to avoid damaging the end.
 3. Journal bushings are normally installed at the factory as they are a press fit in the ends and must be machined after installation to match the wing shaft diameter with a diametrical clearance of 0.0005 to 0.0020 inches. Figure 1.
 4. End (3) supplied as a spare part contains a Journal bushing and is machined to match the wing shaft diameter.
- e. Remove end seal O-ring (11) from body(9).



IMPORTANT: Do not allow the wing shaft to cock as it may nick the sharp edges on the body, abutment or wing shaft.

- f. Use a straight, even pull and remove the wing shaft (12) from body (19).
- g. Figure 5. Take "C" type vane seal (13) and vane seal gasket (14) out of the groove in the wing shaft vane.
- g-1 Figure 5a. Some older styles have a vane seal spacer. Take the square type vane seal (13) and the vane seal gasket (14) and the vane seal spacer (14a) out of the groove in the wing shaft.

h. Pull abutment (15) out of body (19). It is not necessary to remove abutment dowels (16). The dowel pins are usually a light press fit in the abutments and a clearance fit in the ends

IMPORTANT: Do not nick the sharp edges on the body cavity and hub seal bores as this may cause internal leakage after reassembly.

i. Remove abutment seal (17) and abutment seal O-ring (18).

j. Take hub seal (5), hub seal ring (6), and hub seal spring (7) out of the body (19). Remove shaft seal (8) and shaft seal O-ring (9) from body (19).

k. Removal of bushing (10) from body (19) should be governed by the replacement criteria listed under step "d".

l. It is not necessary to remove nameplate (21) unless it is damaged and requires replacement. To remove the nameplate, pull out drive screws (20).

m. On all standard HS Series Actuators, ports are contained in body (19). Ports should always contain shipping plugs to prevent the entry of foreign material.

CLEANING.

Clean all parts by degreasing in a suitable solvent and dry thoroughly.

INSPECTION.

a. Visually inspect wing shaft (12), end (3), body (19), and abutment (15) for cracks, nicks or scratches.

b. Visually inspect bushings (10) in end (3) and body (19) for scoring or wear.

c. Inspect the inner diameter of abutment (15), the inner faces and diameters of end (3) and body (19), and the outer diameters of wing shaft (12) for evidence of scratches, scoring, or galling.

d. Inspect all threads for condition and cleanliness.

REPAIR OR REPLACEMENT.

a. Minor scratches may be removed by hand stoning the affected areas. Stone just enough to remove rough edges or burrs. If the scratches are deep enough to form leakage paths, the affected parts should be replaced.

b. Replace all parts in the seal kit: V-rings (1), O-rings (9), (11), (18), hub seals (5), shaft seals (8), "C" type vane seal (13), vane seal gasket (14), and abutment seal (17).

c. Replace all broken or damaged parts.

LUBRICATION

Lubricate all O-rings sparingly with petroleum jelly or other suitable lubricant compatible with the O-ring material, and with hydraulic fluid being used.

REASSEMBLY.

NOTE: Special tools should be used to prevent damage to seals during reassembly. Alternate methods for use when the tools are not available are listed herein. The alternate methods are not recommended and are listed only for convenience in the event of an emergency.

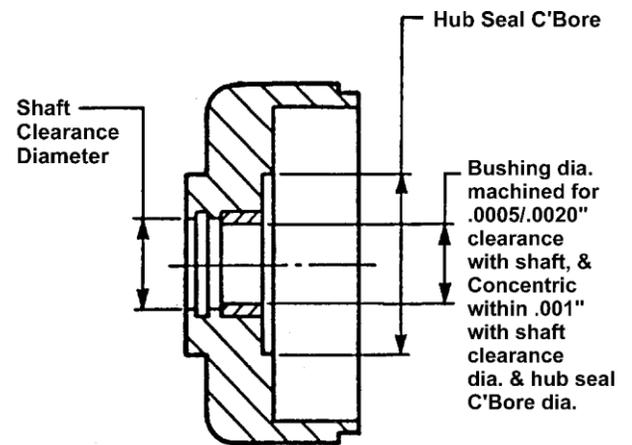


Figure 1. Bushing Machining Requirements

a. If bushings (10) were removed, press new Journal bushings into the end and/or body and then machine to match the wing shaft diameter with a diametrical clearance of 0.0005 to 0.0020 inches and concentric with the shaft bore within 0.001. If facilities are not available for machining, procure an end (3) and body (19) with installed bushings (see Parts List).

NOTE: Bushings must be fully seated and must not protrude into the hub seal area.

b. Install body (19) on a holding fixture. Lubricate shaft seal O-ring (9) sparingly with lubricant and install it and shaft seal (8) in body (19). Avoid ripples or wrinkles in the installed shaft seal. Place hub seal spring (7) and hub seal ring (6) in body (19). Install hub seal (5). The hub seal should fit snugly. Note that the hub seal is free to move in an axial direction under pressure of hub seal spring (7).

CAUTION: Abutment (15), abutment seal (17), wing shaft (12), and wing shaft vane seal (13) must be installed so that the edge radius on the parts matches the radius on the bottom of the body bore.

c. Figure 5. Install vane seal gasket (14) and "C" type vane seal (13) in the groove in wing shaft (12) noting that the edge radius on seal (13) and wing shaft (12) are on the same side. Coat seal (13) liberally with lubricant.

c1. Figure 5a. Some older styles have a vane seal spacer. Install the vane seal spacer (14a), vane seal gasket (14), and square type vane seal (13) in the groove in wing shaft (12) noting that the edge radius on seal (13) and wing shaft (12) are on the same side. Coat seal (13) liberally with lubricant.

d. Place shaft seal protector (see figure 2) in body (19) and wing shaft vane seal protector (see figure 2) on the outside of body (19). Slide the wing shaft fully into the body being sure the edge radius on the wing shaft matches the radius on the bottom of the bore in the body. Remove the shaft seal protector.

d-1. ALTERNATE METHOD. An alternate procedure for use when the tools are not available follows: Place a piece of 0.0015 inch shim stock over the body lip in the area where the vane seal will enter the body. Slide wing shaft fully into the body. Remove the shim stock. The shim stock protects the "C" type vane seal from being cut or abraded by the sharp edge on the body. If the vane seal is cut or abraded it could allow internal leakage after assembly. The wing shaft must not be allowed to distort or tear shaft seal (8) or shaft seal O-ring (9).

CAUTION: Sharp edges on shim stock can be dangerous. Use extreme care when handling.

e. If removed, install dowels (16) in abutment (15). Stretch O-ring (18) around the abutment and seat in the seal groove. Make a centrally located diagonal cut through the side of abutment seal (17) that contacts the body (see figure 3). Use a razor blade or utility knife, to make the cut. Place the abutment seal (17) in position on abutment (15). The diagonal cut must be on the side of the abutment next to the body, and the edge radius on the abutment seal and abutment must coincide. Apply a liberal coating of lubricant to the abutment seal. Place abutment vane seal protector (see figure 2) on the wing shaft and wing shaft vane seal protector on the outside of the body. Slide the abutment into place being sure the edge radius on the abutment matches the radius on the bottom of the body bore. Dowels (16) must seat fully in the holes in body (19).

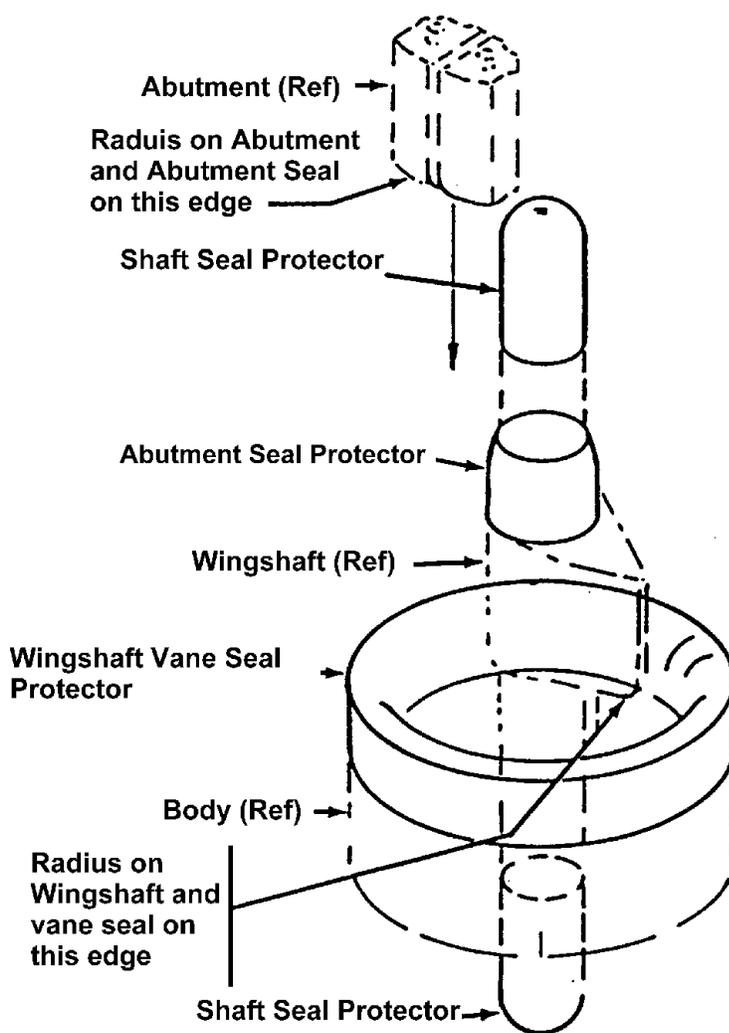


Figure 2. Special Assembly Tools Used to Protect Seals. See Table IV on Page 6 for Part Numbers.

e-1. ALTERNATE METHOD. An alternate procedure for use when the tools are not available follows: Place 0.0015 inch shim stock over the sharp edges of the body and wing shaft hub area where the abutment seal will enter. Slide the abutment into position and remove the shim stock. The shim stock protects the abutment seal from cuts or scratches that would allow internal leakage.

f. Install the end seal O-ring (11) on the outer lip of body (19) and lubricate sparingly.

g. Install shaft seal O-ring (9) and shaft seal (8) in end (3).

h. Place hub seal spring (7), hub seal ring (6), and hub seal (5) in end (3) being sure the hub seal (5) fits snugly and that it is free to move axially under the pressure of hub seal spring (7). Apply a heavy coating of lubricant around hub seal (5). The lubricant must keep the hub seal correctly positioned when end (3) is turned over to install it on body (19). Place shaft seal protector (see figure 2) on the end of wing shaft (12). Position end (3) over body (19) and wing shaft (12) and press it onto the body being sure the cap screw and dowel pin holes are aligned. Remove the shaft seal protector from the wing shaft. If the shaft seal protector is not available, use caution to avoid tearing or distorting shaft seal (8) by the wing shaft.

i. Install cap screw (2) in end, and tighten all cap screws lightly. Install dowels (4) into the body and head assembly. Using a "star pattern" tighten caps crews evenly. Newer Style Actuators have waxed cap screws; older units have hex head screws. See table III for torque specs

j. If removed, replace nameplate (21) and secure to body (19) with drive screws (20).

k. Install V-rings (1) on each end of the wing shaft. Work the V-rings onto the wing shaft being careful to avoid cutting the inner diameter with the sharp edges on the wing shaft.

l. Install the shipping plugs (22) to prevent dirt from entering the actuator ports.

NOTE: Radius on this Corner ONLY Mates with the Radius at the bottom of the Body Bore

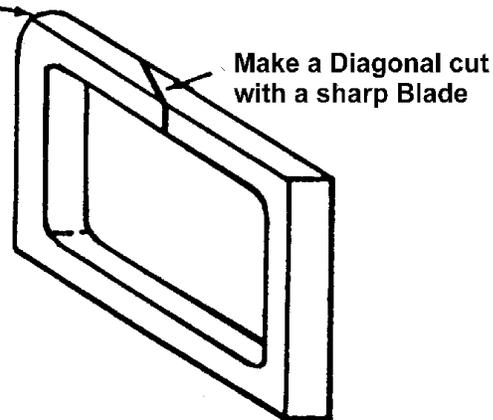


Figure 3. Cut abutment seal to permit installation on abutment

Table I. Trouble Shooting Chart

TROUBLE	PROBABLE CAUSE	REMEDY
External Leakage at Shaft	Defective shaft seal(s) (8) or O-ring(s) (9).	Replace defective parts.
	Wing shaft (12) scored or worn. Bushings (10) defective.	Repair the wing shaft or replace defective parts.
External Leakage at Joint Between End (3) and Body (19)	Defective O-ring (11), or damaged sealing surface on end (3) or body (19).	Replace defective O-ring. Repair or replace damaged parts.
Wing shaft Binds	Foreign material in actuator working chambers.	Disassemble and clean thoroughly.
	Improperly seated abutment seal (17), vane seal (13) and/or hug seal(s) (5).	Disassemble and replace improperly seated seal making sure it seals properly at assembly.
Excessive Internal Leakage	Defective abutment seal (17), "C" type vane seal (13), O-ring (18) and/or vane seal gasket (14)	Replace defective parts.
	Defective hub seal (5), hub seal ring (6), or hub seal spring (7).	Replace defective parts.
	Worn or scratched end faces in end (3) or body (19).	Repair or replace.
	Deep scratches in body (19).	Repair or replace.
	Worn bushings (10).	Replace bushings.
	Cap screws (2) not tightened sufficiently.	Tighten to recommended torque.
	"C" type vane seal not seated properly (applicable to units immediately after overhaul only).	Operate through full cycles for a few minutes to attempt to seat seals.

TEST PROCEDURE.

- a. Apply 50 psi air or hydraulic pressure (normal operating fluid) to one of the inlet ports. The applied pressure should move the wing shaft until it is stopped by the abutment. If the actuator fails to move under the applied pressure it indicates that the wing shaft is binding.
- b. At the minimum pressure required to rotate the actuator, pressurize one of the ports with hydraulic fluid and rotate the shaft until the vane of the shaft comes in contact with the shoe of the actuator. Then increase the pressure (see Table II) to operating pressure. Check for internal by-pass leakage by measuring the flow out of the opposite (exhaust) port. Internal by-pass leakage should not exceed the value shown in Table II for the particular HS Series Actuator and operating pressure, and no external leakage is allowed. Remove the pressure, reverse the hydraulic connections and check the internal by-pass leakage out the opposite port.

Table II. Maximum Allowable Internal By-pass Leakage Values

Operating Pressure - psi	0 - 1000	1000-2000	2000-3000
By-Pass Leakage Test Pressure - psi	1000psi	2000psi	3000psi
Model HS-1.5	110 cc per min	150 cc per min	200 cc per min
Model HS-2.5	110 cc per min	150 cc per min	200 cc per min
Model HS-004	110 cc per min	150 cc per min	200 cc per min
Model HS-006	150 cc per min	200 cc per min	250 cc per min
Model HS-010	200 cc per min	250 cc per min	300 cc per min
Model HS-015	250 cc per min	300 cc per min	350 cc per min

Note: Leakage in Cubic Centimeters per Minute

Table III. Bolt Torque

Bolt Style Grade 8	Dry Hex Head	Waxed Cap Screw
Model HS-1.5/2.5/004	70 Foot Pounds	84 Foot Pounds
Model HS-006/010/015	70 Foot Pounds	84 Foot Pounds

Table IV. Assembly Tools

Assembly Tool Kit for the HS-1.5, HS-2.5 and HS-004

PART NUMBER	DESCRIPTION
220144-HS-004	Assembly Tool Kit - includes the three parts listed below.
220038-HS-004	Shaft Seal Protector
220039-HS-004	Abutment Seal Protector
220041-HS-004	Vane Seal Protector.

Assembly Tool Kit for the HS-006, HS-010 and HS-015

PART NUMBER	DESCRIPTION
220144-HS-015	Assembly Tool Kit - includes the three parts listed below.
220038-HS-015	Shaft Seal Protector
220039-HS-015	Abutment Seal Protector
220041-HS-015	Vane Seal Protector.

Table V. Seal Kit Part Numbers for Standard Actuators

Model Size	Buna, N Rubber**	Fluorocarbon Rubber	Ethylene-Propylene Rubber
Model HS-1.5-1V	510308-001S	510309-001S	510310-001S
Model HS-2.5-1V	510308-002S	510309-002S	510310-002S
Model HS-004-1V	510308-004S	510309-004S	510310-004S
Model HS-006-1V	450256-006S	450257-006S	450258-006S
Model HS-006-2V Adder	450256-006DA	450257-006DA	450258-006DA
Model HS-010-1V	450256-010S	450257-010S	450258-010S
Model HS-010-2V Adder	450256-010DA	450257-010DA	450258-010DA
Model HS-015-1V	450256-015S	450257-015S	450258-015S
Model HS-015-2V Adder	450256-015DA	450257-015DA	450258-015DA

**** Standard Seal Kit**

Note: For a 2V unit, you need the 1V seal kit and the 2V adder seal kit.

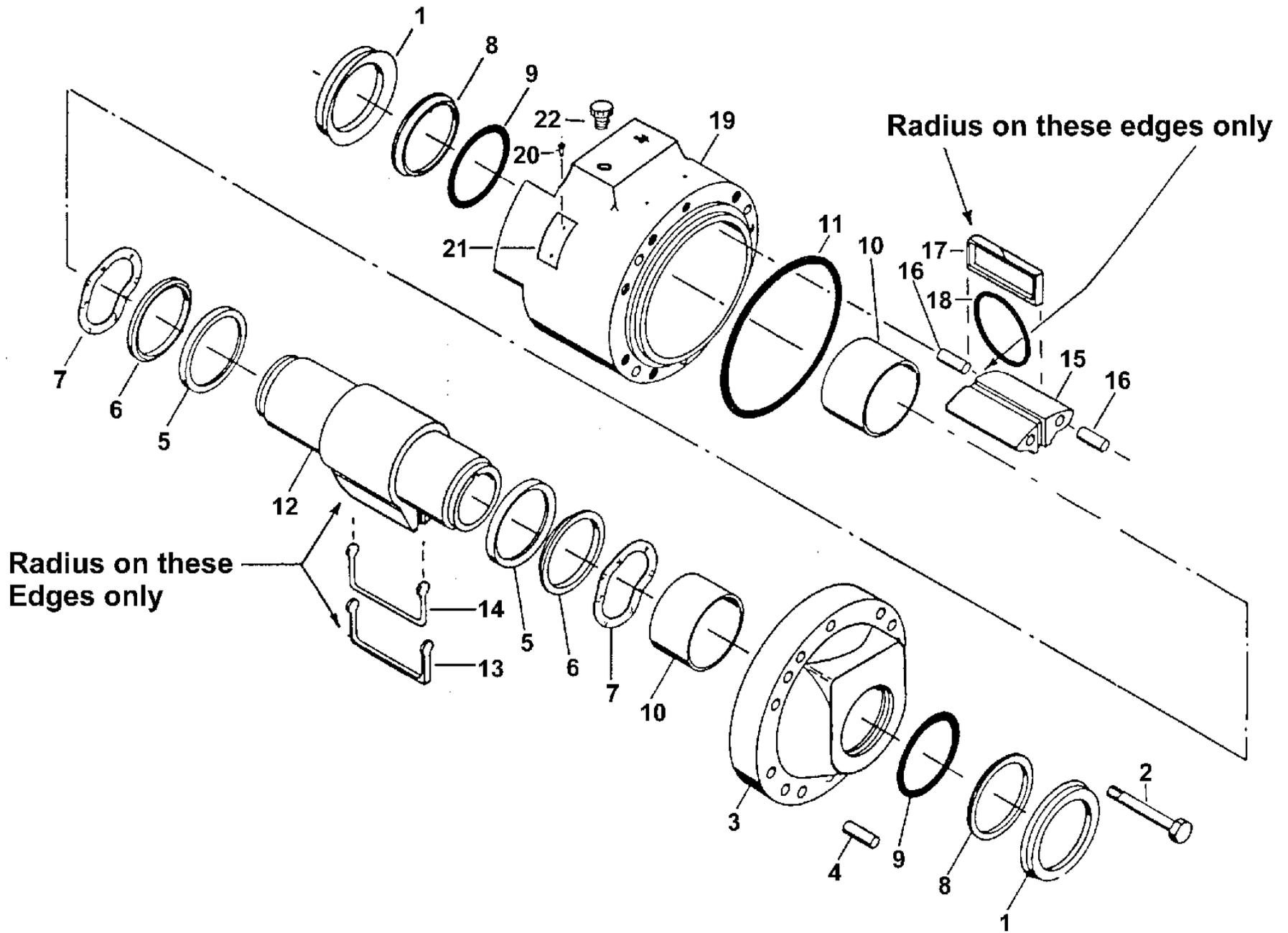


Figure 5 -- HS Series Rotary Actuator Assembly exploded view. See page 8 for reference.

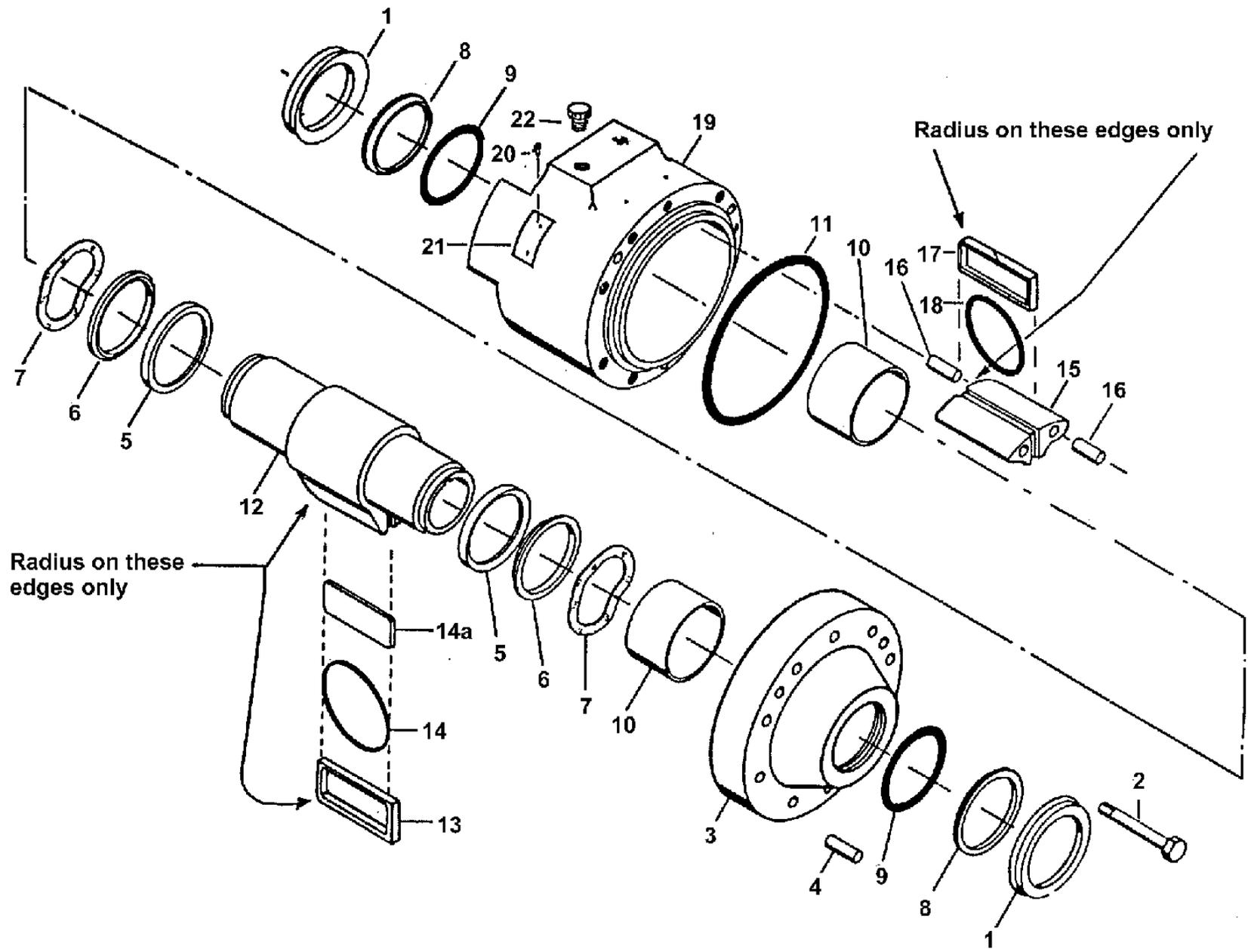


Figure 5a -- Old Style HS Series Rotary Actuator Assembly exploded view. See page 8 for reference

PARTS LIST

The Parts List provides is a complete listing of where parts are used in the HS- Model Series Rotary Actuator Assemblies. The seal kit contains all items indicated with an asterisk (*). It is essential that a seal kit be available at overhaul as all parts in the seal kit should be replaced during reassembly.

Index #	Description	Figure 5A HS 1.5/ 2.5/4 Qty	Figure 5 HS 6/10/15 Qty
**1	V-Ring	2	2
2	Cap Screw Hex, Waxed, Grade 8	10	10
-	Flat Washers	10	10
3	End & Bushing Assy	1	1
4	Dowel	2	4
**5	Hub Seal	2	2
**6	Hub Seal Ring	2	2
7	Hub Seal Spring	2	2
**8	Shaft Seal	2	2
**9	O-Ring Shaft Seal	2	2
10	Bushing Journal (Part of items 3 and 19)	2	2
**11	O-Ring, End Seal	1	2
12	Wing Shaft	1	1
**13	"C" Type Vane Seal	1	1
**14	Vane Seal Gasket	1	1
14A	Vane Seal Spacer (Old Style)	1	
15	Abutment	1	1
16	Dowel	4	4
**17	Seal, Abutment	1	1
**18	O-Ring, Abutment Seal	1	1
19	Body & Bushing Assembly ² Ported	1	1
20	Drive Screw, No.0 by 3/16 in long, Type "U"	2	2
21	Nameplate	1	1
22	Shipping Plug	2	2

**** DENOTES ITEMS THAT ARE INCLUDED IN SEAL KIT**

- Notes: 1. All seal kits contain all items indicated with a double asterisk (**)
2. After 7/1/77 the Body Bushing Assembly was changed to add a porting boss. Body Bushing Assemblies without the Boss are available on special orders. However long lead times may exist.

WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN DAMAGE TO THE ACTUATOR AND ASSOCIATED COMPONENTS AND/OR INJURY TO PERSONNEL.

INSTALLATION INSTRUCTIONS

Important Hydraulic Features

1. The standard unit is designed to operate in the temperature range of -40 to +225 degrees F when filled with any filtered petroleum or mineral base fluid that has viscosity value of 70-250 SSU at 150 degrees F.
2. Standard units are fitted with Nitrile (Buna N) seals. Fluorocarbon rubber (Viton) and ethylene propylene seals are available for special fluids and high temperature applications. Filtered and lubricated air may be used; however, the temperature should not exceed 150 degrees F.
3. THE FLUID PRESSURE APPLIED TO THE HYD-RO-AC MUST NOT EXCEED THE RATED MAXIMUM PRESSURE GIVEN ON THE NAMEPLATE ("MAX. P.S.I."). IN NO CASE IS THE RATED PRESSURE PERMITTED TO BE GREATER THAN 3000 P.S.I. A relief valve must be installed in the supply line to restrict system pressure. The hydraulic system must be designed to eliminate pressure surges that could exceed the actuator design pressure. Relief valves must be installed between the control valve and the HYD-RO-AC to eliminate the surge pressure in the actuator which may be caused by attempting to stop a high inertial load. These valves must be adequately sized and installed as close as possible to the actuator and between any control or shutoff valve and the actuator.

Important Installation Considerations

1. It is essential that no end loads be transmitted to the output shaft of the actuator. To insure maximum life for any installation, side loading and bending movements caused by improper alignment should be eliminated by use of shims. If side loads cannot be avoided, consideration should be given to provide outboard pillow blocks and/or flexible couplings. However, where side loads cannot be avoided, recommendations should be obtained from the factory.
2. In the installation of an END MOUNT actuator it is essential that the two untapped holes in the mounting flange be reamed and fitted with press fit dowels to take the torque. Do not try to carry the torque load on the threads of the four mounting bolts or the friction under the heads of these mounting bolts alone. In the installation of a foot mount actuator, it is essential that fasteners be used in each of the four mounting holes.
3. All mounting bolts must be tight and of sufficient strength. The actuator must be aligned properly and attached to sufficiently rigid structure to assure that there are no unrecognized side loads applied to the HYD-RO-AC shaft or bearings. Use shims where necessary to maintain alignment.
4. The adapter connecting the HYD-RO-AC output shaft to the mechanism should be machined for a slip fit with minimum backlash, and all linkages must be snug to assure proper response. No end loads should be transmitted to the actuator.
5. Hydraulic lines must be at least as large as the ports of the HYD-RO-AC and as short as possible to minimize hydraulic pressure drop problems.
6. If the actuator is mounted with ports other than at the top of the unit, or if only a small portion of the stroke is utilized, a method for bleeding air out of the system must be provided.

CAUTION: THE INTERNAL STOPS IN THE ACTUATORS ARE NOT DESIGNED TO ABSORB DYNAMIC LOADS. EXTERNAL STOPS MUST BE USED TO LIMIT OUTPUT SHAFT TRAVEL. VANES STRIKING ABUTMENTS WILL RESULT IN PREMATURE ACTUATOR FAILURE.

7. Angular travel. Total shaft travel for a standard unit is 280 degrees +/- 5 degrees for single vane and 100 degrees +/- 5 degrees for double vane. Position the output shaft correctly prior to connecting it to the mechanism to insure full angular rotation.
8. The mid-position of travel of each HYD-RO-AC equipped with a standard spline is readily obtainable by positioning the missing tooth area of the spline 180 degrees opposite the centerline of the hydraulic connecting ports for single vane units, and 90 degrees clockwise from a centerline between the two ports for double vane units. These positions are located while facing the splined end of the actuator. The mid-travel position for each HYD-RO-AC with a standard keyway is readily obtainable by positioning the keyway between the hydraulic connection ports.

HYD-RO-AC WARRANTY

The Company warrants, to the original purchaser, that this product is free from defects in materials and workmanship if properly installed, serviced and operated under normal conditions according to the Company's instructions. The Company's obligation under said warranty and its total legal obligation under this contract is expressly limited to correcting, without charge at its factory, any unit or parts thereof returned to its factory, transportation charges prepaid, for a defect which occurred during the first 6 months of operation or 12 months from date of shipment to the original purchaser, whichever occurs first; and which upon examination shall disclose to the company's satisfaction to have been originally defective. Corrections of such defects by repair to, or supplying of replacements for defective parts, shall constitute fulfillment of all obligations to the original purchaser. This warranty shall not apply to any of the Company's products which must be replaced because of normal wear, which have been subject to misuse, negligence or accident or which shall have been repaired or altered outside the Company's factory unless authorized in writing by the Company. The Company assumes no liability for injury, loss, damage, or expense directly or indirectly resulting from the use of this product or from any other cause. THIS WARRANTY SUPERSEDES, AND IS IN LIEU OF, ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, AND OF ALL OTHER LIABILITIES OR OBLIGATIONS ON THE PART OF THE COMPANY. No distributor, agent, or dealer is authorized to give any other warranties on behalf of the Company nor to assume for the Company any other liability in connection with any of its products. UNDER NO CIRCUMSTANCE WILL THE COMPANY BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL, OR ANY OTHER DAMAGE IN CONNECTION WITH THE USE OF ANY INFORMATION OR MATERIAL CONTAINED HEREIN. THE COMPANY DISCLAIMS ALL WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.