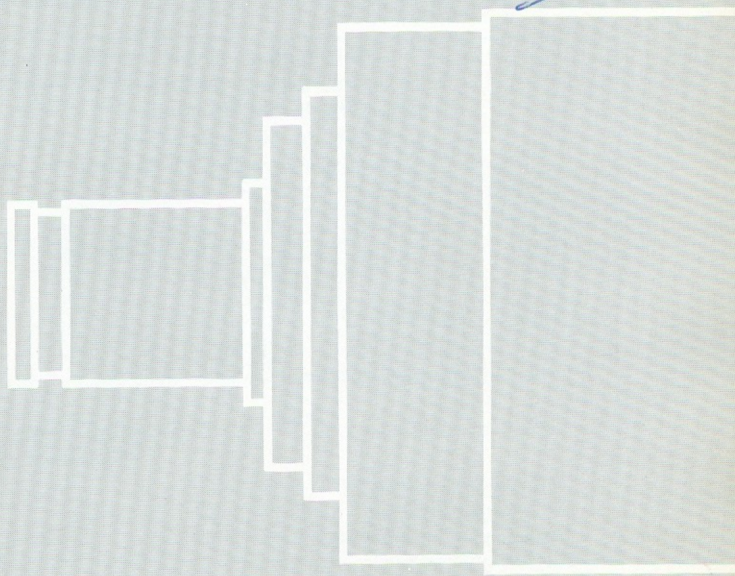
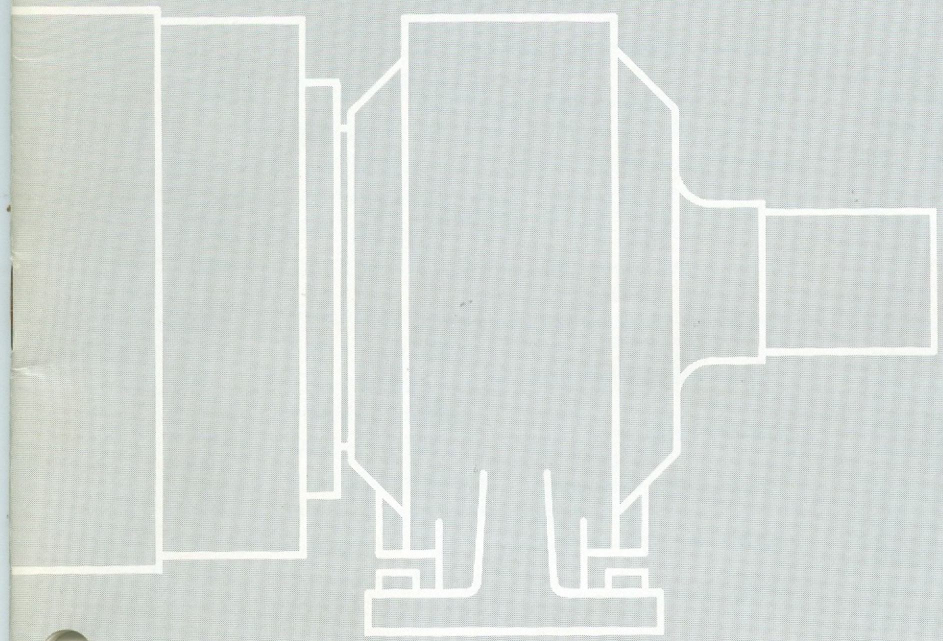
Teli: Swimming Rolls. #1 P.M Calender STACK.

FARREL KÜSTERS

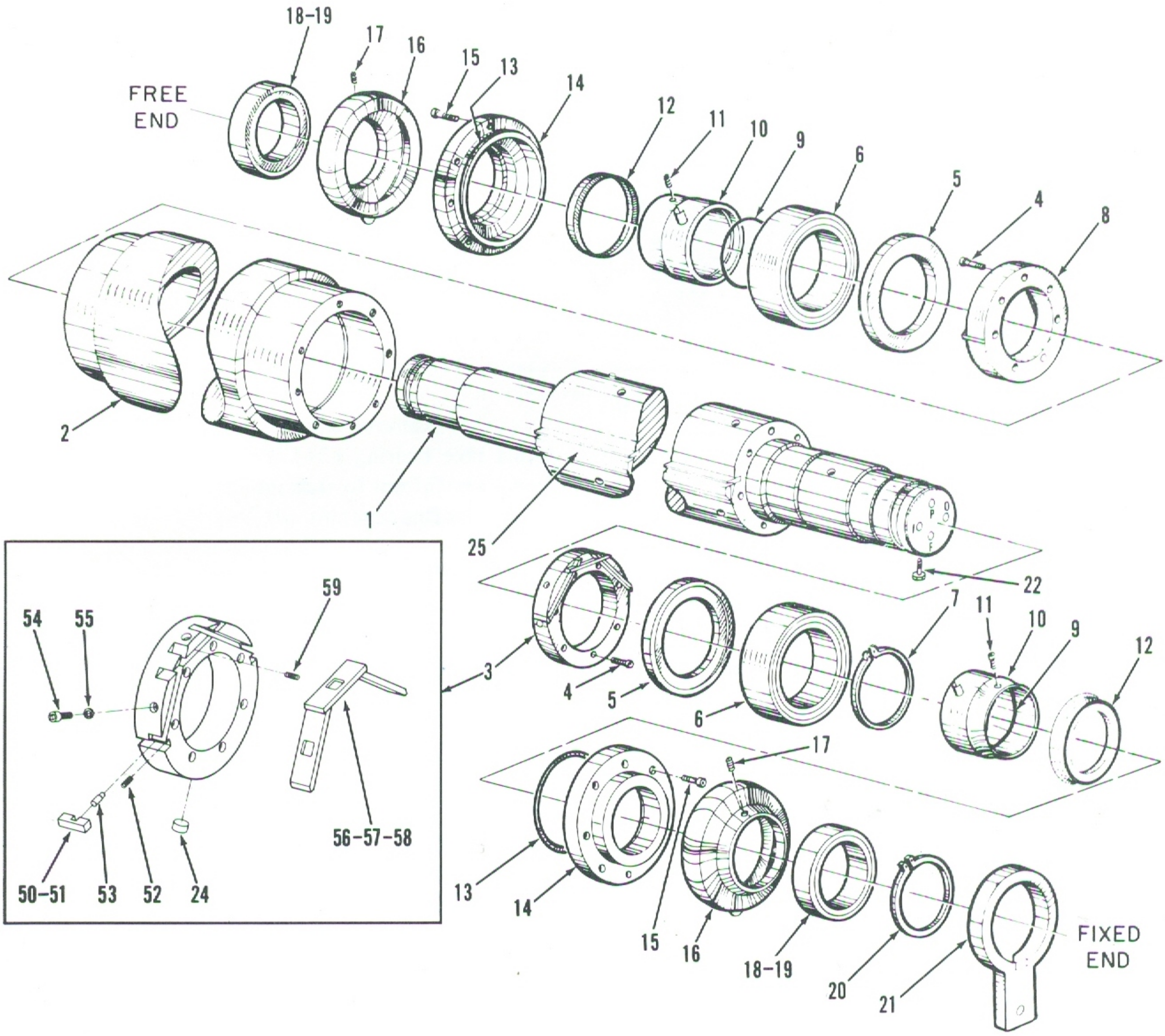


"Swimming-Roll"™ System



general instructions

FARREL CORPORATION, ANSONIA, CONN., U.S.A.



1. Shaft
2. Shell
3. End Seal Support Ring
4. Cap Screws
5. End Seal Ring
6. Self-Aligning Bearing
7. Retaining Ring
8. End Seal Support Ring
9. O Ring
10. Seal Sleeve
11. Screw
12. Oil Seal
13. O Ring
14. Seal Support Cover
15. Cap Screws
16. End Cover
17. Screw
18. Spherical Support Bushing
19. Spherical Bearing
20. Retaining Ring
21. Shaft Locating Ring
22. Hex Head Bolt
24. Nylon Plug
25. Axial Seals
50. Short axial seal (used on item 3)
51. Short axial seal (used on item 8)
52. Spring
53. Dowel
54. Socket Head Cap Screw
55. Lockwasher
56. End Seal
57. End Seal
58. End Seal
59. Spring

Fig. 20 – Non-Driven *Swimming Roll*, Exploded View

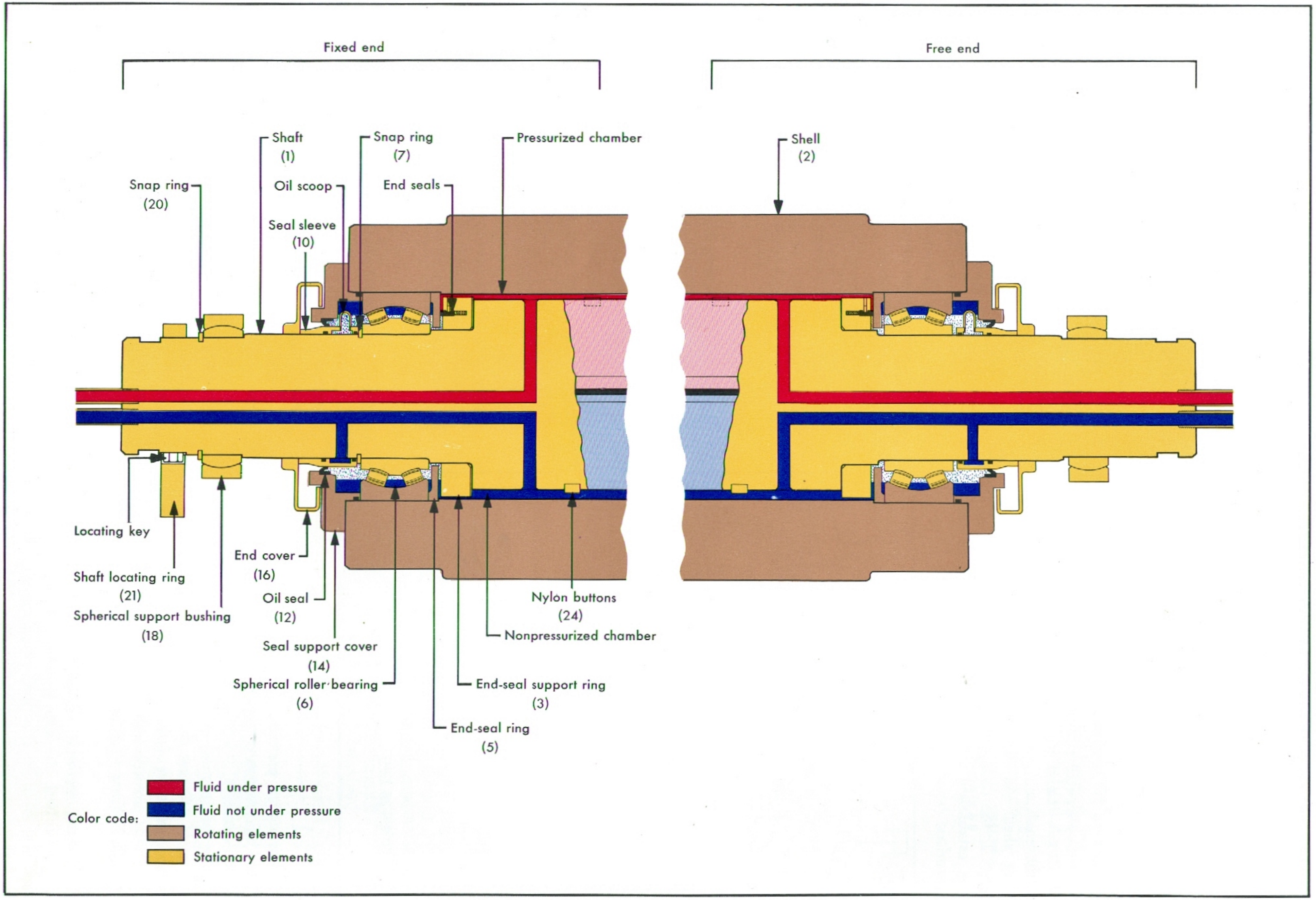


Fig. 7 — Non-Driven *Swimming-Roll* Basic Construction

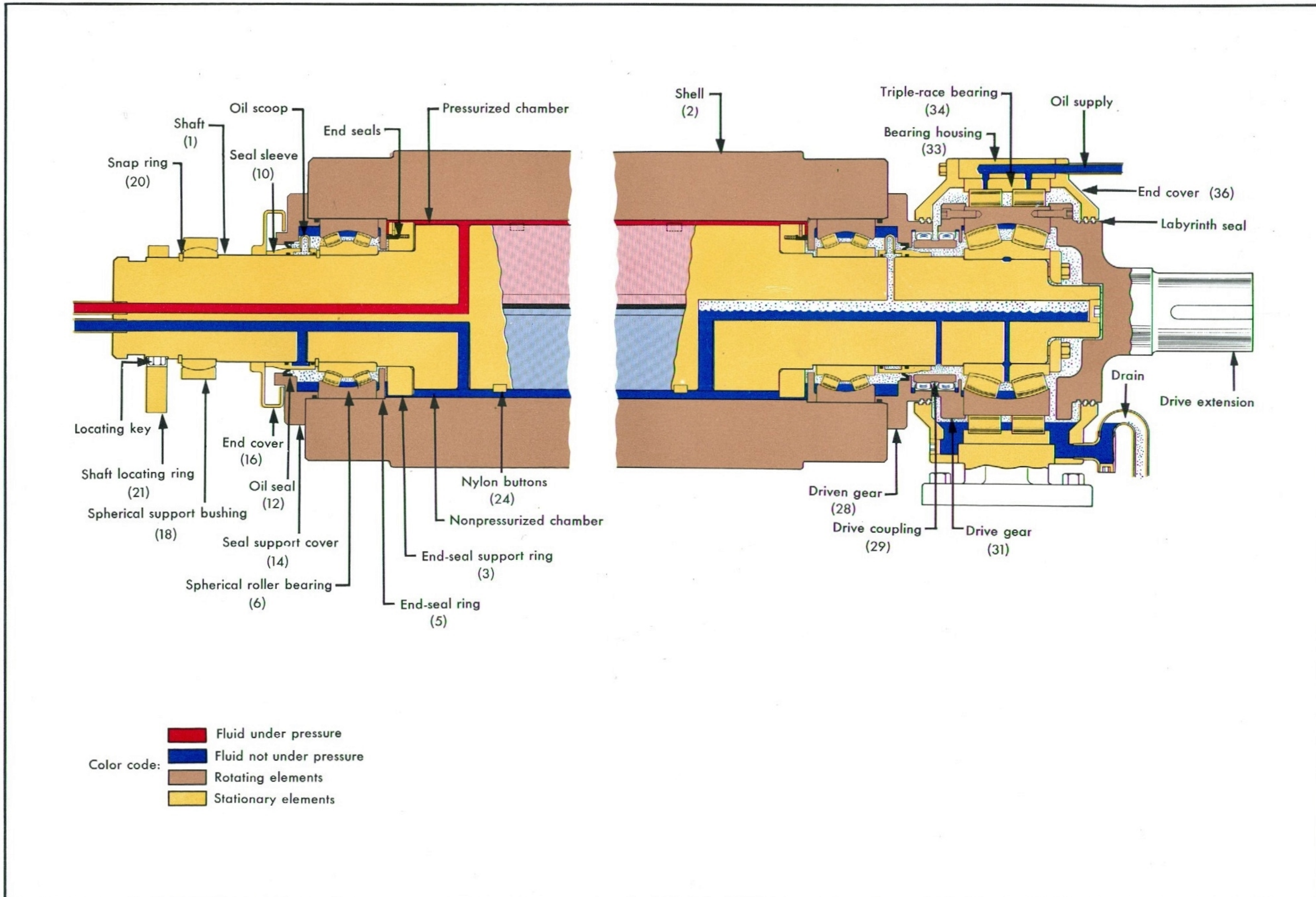


Fig. 8 – Driven *Swimming-Roll* Basic Construction

INTRODUCTION

This manual covers principles, applications, installation, operation, and maintenance of Farrel-Küsters *Swimming-Roll* Systems. Although systems in service vary somewhat according to the circumstances of their application, the information in this manual applies generally to all systems. When appropriate, special data and drawings for a particular system are furnished to supplement these general instructions.

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Section 1
DESCRIPTION

THE *SWIMMING-ROLL* SYSTEM

The Farrel-Küsters *Swimming-Roll* System* provides roll deflection control for applications where uniform pressure across the roll nip is required. The two basic components of the system are the *Swimming Roll* (or rolls) and the control unit. The *Swimming Roll,* which is the active or working element of the system, is a variable deflection roll. This roll, shown in figure 1, consists of a shell, ground straight without a crown, rotating on bearings that are mounted on a

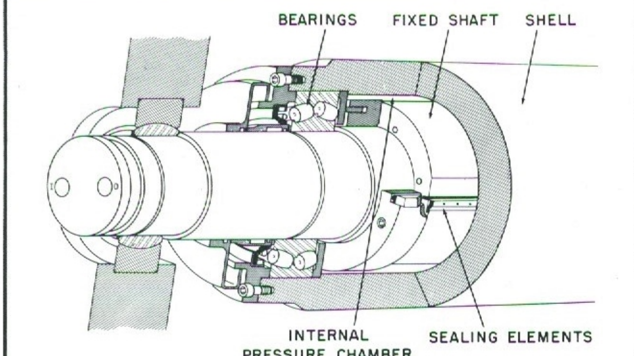


Fig. 1 – Basic *Swimming-Roll* Construction

fixed shaft. Set in this shaft are sealing elements that form an internal pressure chamber. By introduction of fluid pressure into this chamber, the shell can be made to deflect to match the curvature of the mating roll and thus produce the desired nip pressure. Control over the amount of shell deflection of the *Swimming Roll* is provided by the control unit.

SCOPE OF APPLICATION

The versatility of the *Swimming Roll* makes it suitable for application wherever a uniform nip pressure is desired under varying load conditions. To date, the most popular usage of it is in the paper industry. Typical applications include:

- Calenders
- Super calenders
- Size presses
- Breaker stacks
- Wet presses
- Smoothing presses
- Yankee machine pressure rolls
- Coaters
- Embossers

PRINCIPLES OF OPERATION

Figure 2 shows two end views of the *Swimming Roll.* Note that in (a), axial seals divide the annular space between the stationary shaft and the rotating shell into two chambers. The configuration of the seals establishes a pressurized chamber (shaded area of a). When oil under pressure is introduced into this chamber,

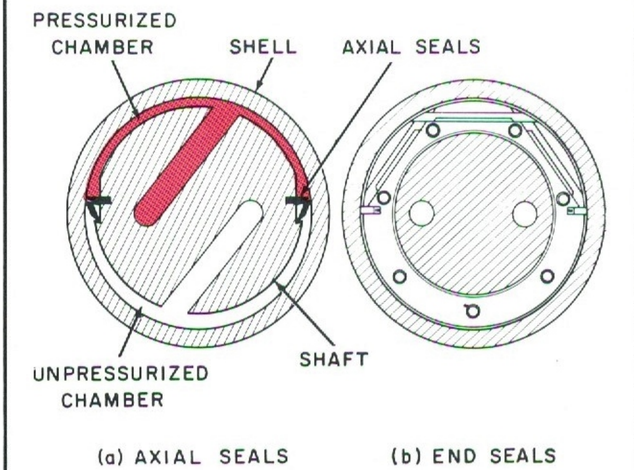


Fig. 2 – End Views of the *Swimming Roll*

a reaction between the shaft and shell is created. This reaction force which is directly related to the pressure exerted on the oil causes a deflection of the *Swimming Roll.* Control and regulation of this oil pressure is provided by the control unit.

The deflections shown in figure 3 are exaggerated to demonstrate more clearly the principles involved. For proper operation, the mating roll must be adjacent to the center line of the pressurized chamber of the *Swimming Roll.* For this discussion, the *Swimming Roll,* as shown in figure 3, is mounted in the bottom position; therefore, the pressurized chamber is on the top. Figure 3(a) shows both the *Swimming Roll* and the mating roll deflecting in opposite directions causing an unequal nip pressure across the sheet (thick center). Mating roll deflection is the result of forces on the roll outside the edges of the sheet (end effects). In this case, there is no pressure exerted on the oil in the *Swimming Roll;* therefore, the rotating shell and the stationary shaft both deflect away from the mating roll (negative deflection). In (b), some pressure is exerted on the oil in the pressurized chamber. The reaction between the shaft and shell causes the shell to straighten with the shaft deflecting a greater amount. The nip pressure, although improved over (a), is still unequal because of the deflection of the mating roll. If additional pressure is exerted (c), the shell will deflect positively. The pressure is increased until the shell deflection matches the mating roll deflection, producing

*Designed and patented by Eduard Küsters of Krefeld, West Germany and produced under license by Farrel Corporation of Ansonia, Connecticut, USA.

uniform nip pressure. In this example, the nip pressure obtained is a function of the weight of the mating roll and its bearings (also any accessories attached to the bearings, such as a doctor).

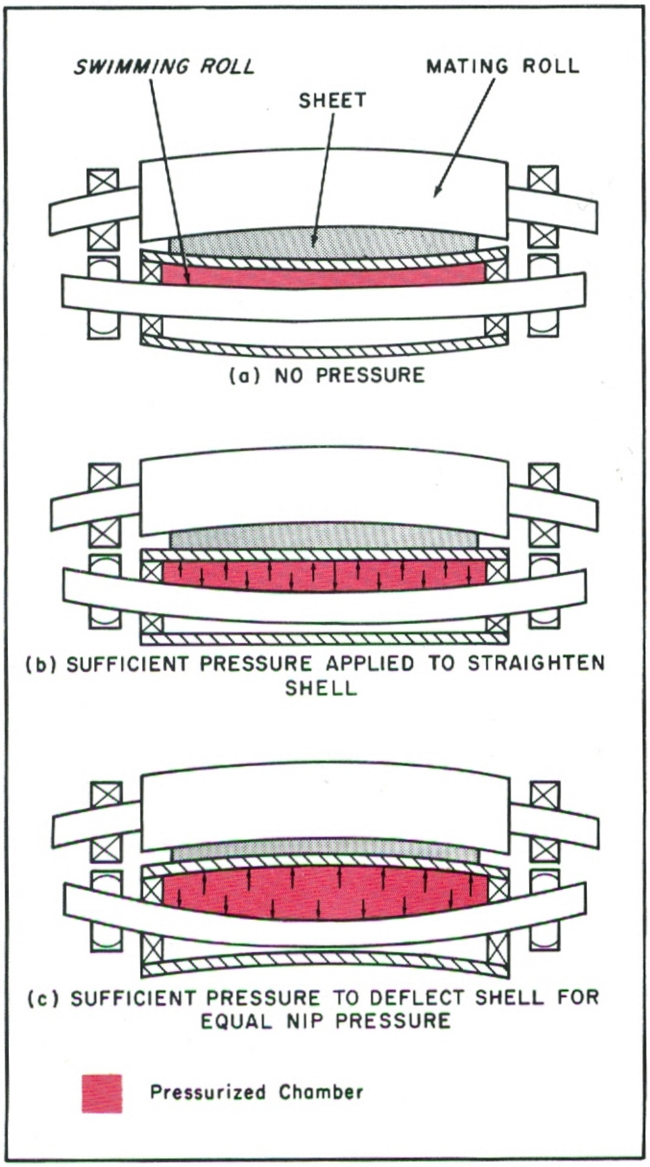


Fig. 3 – Principles of *Swimming-Roll* Operation

When standard rolls are added or removed from the calender, uniform nip pressure is maintained by increasing or decreasing the system oil pressure. Loading cylinders can also be used to vary nip pressures. This method is shown in figure 4. A change in loading cylinder pressure is balanced by a change in *Swimming-Roll* pressure to maintain a uniform nip.

The two *Swimming-Roll* System with external loading (figure 4a) provides uniform nip pressure under all operating conditions within the pressure limits of the rolls. Whereas, the arrangement shown in figure 4b is limited by the design of the mating roll.

Figure 5 illustrates another method of increasing control over nip pressure distribution . . . weight relieving. Weight relieving provides a means of reducing nip pressure. With weight relieving, the *Swimming-Roll* is operated at lower internal pressure to obtain uniform nip pressure.

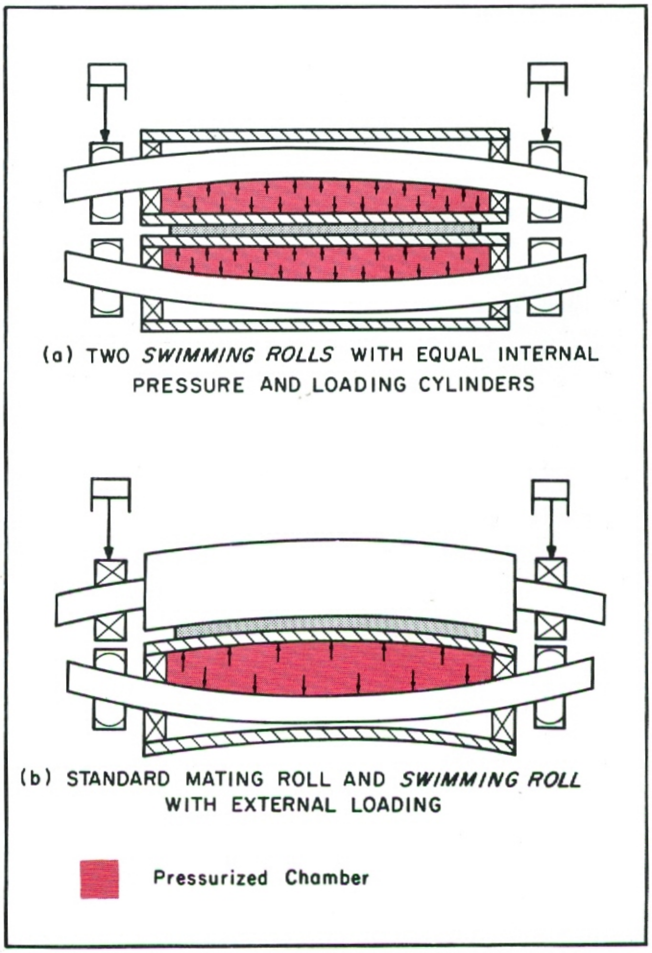


Fig. 4 – *Swimming-Roll* Operation with Loading Cylinders

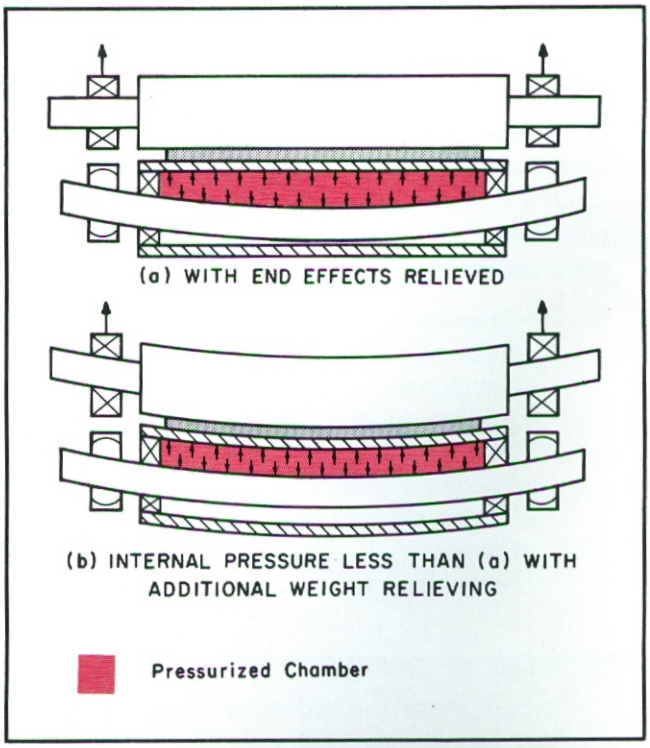
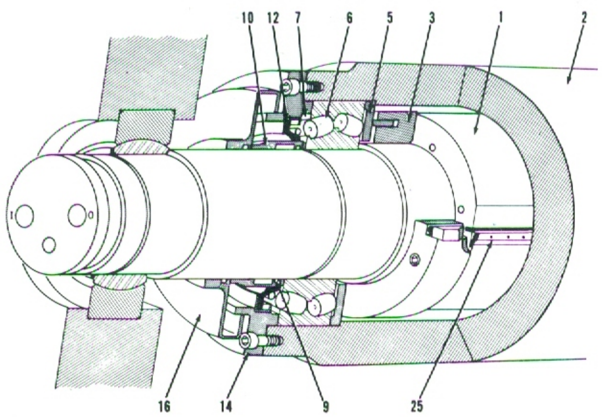


Fig. 5 – *Swimming-Roll* Operation with Weight Relieving on Standard Roll

DESCRIPTION OF *SWIMMING ROLLS*

To obtain maximum benefits of the Swimming-Roll, it is recommended that a Farrel Product Service Representative be present during initial system operation.

Figure 7 shows the basic *Swimming-Roll* internal construction and figure 6 a detailed cutaway view of the end seal area. The shell (2) rotates around the fixed shaft (1) on two spherical roller bearings (6) mounted in the shell ends. The annular space between the shaft and shell is divided into two chambers by two full length axial seals (25). These seals are mounted on the shaft and contact the inside surface of the rotating shell. As discussed previously and shown in figure 2, the configuration of the axial seals and end seals establishes two chambers of which one can be pressurized (shaded area in figure 2).



1. Shaft
2. Shell
3. End Seal Support Ring
5. End Seal Ring
6. Self-Aligning Bearing
7. Retaining Ring
9. O Ring
10. Seal Sleeve
12. Oil Seal
14. Seal Support Cover
16. End Cover
25. Axial Seals

Fig. 6 – End Seal Area of the *Swimming-Roll* (Fixed End)

Oil under pressure is introduced into the pressurized chamber through inlet port marked I (figure 7). The oil causes a deflection between the shaft and shell, keeping the rotating shell virtually floating on oil. The amount of pressure determines the degree of deflection of the *Swimming Roll.* Once the deflection is established, the control unit keeps the pressure constant ensuring uniform nip pressure distribution.

During operation, oil passes by the seals into the non-pressurized chamber providing lubrication of the seals. The oil in the non-pressurized chamber flows into the anti-friction bearing areas providing lubrication. An oil seal (12) in the seal support cover (14) seals the assembly. Oil from the non-pressurized chamber and the bearing area is returned to the oil reservoir through the oil-return port (marked 0) on the shaft end. There is an oil scoop on the seal sleeve (10) which connects the bearing chamber to the oil-return port. The *Swimming Roll* is always at least half full of oil providing necessary lubrication of all interior parts under all operating conditions.

The circulating oil maintains uniform *Swimming Roll* temperature. A heat exchanger is used in the oil lines to help maintain uniform temperature. An oil filter is used to keep the oil free of foreign material. To ensure that clean oil is supplied at all times, it is recommended that the oil filter be installed immediately adjacent to the *Swimming Roll.* Optional valve and piping arrangements can be used to increase control of temperature regulation.

Drive to the *Swimming Roll* can be supplied indirectly (non-driven) or directly (driven). Both types of drive are discussed here.

Non-Driven *Swimming Rolls* (Figure 7)

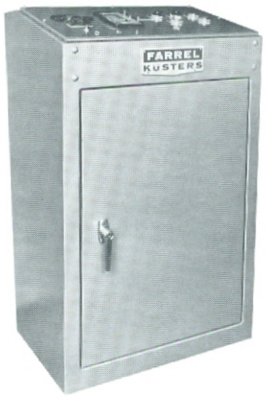
When a non-driven *Swimming Roll* is used to replace a conventional bottom roll, it is necessary to drive another roll (usually the mating roll). There are two common methods of supplying this type of drive. The first is to raise the existing drive to the mating roll. The second method is to use a Farrel gear unit which is placed between the existing drive and the roll stack. The gear unit reverses rotation and changes speed of the mating roll. A flexible coupling arrangement is required between the gear unit and the mating roll journal. The lower output shaft of the gear unit is arranged to drive the calender with a standard bottom roll.

Driven *Swimming Rolls* (Figure 8)

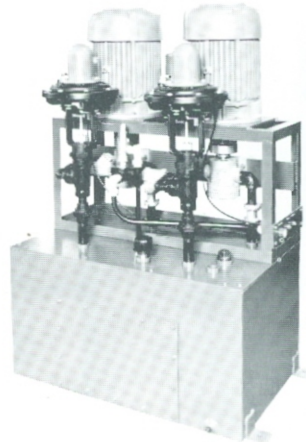
This type of *Swimming Roll* is directly driven like standard bottom rolls. The drive end bearing arrangement is designed to drive the shell of the *Swimming Roll* while keeping the inner shaft stationary. This is accomplished by the use of a triple race bearing (34). One end of the middle race is attached to the drive shaft (39). A drive gear (31) which is attached to the other end of the middle race drives a driven gear (28) attached to the shell of the *Swimming Roll* through a drive coupling (29). The outer race of the bearing is mounted in the bearing housing (33). The inner race is attached to the stationary shaft. In this way, the shaft is supported through the bearing and is held from rotation by securing it to the support housing or frame at the opposite end by the shaft locating ring (21) or a key.

DESCRIPTION OF CONTROL UNITS

The control unit supplies and regulates the oil pressure to the *Swimming Roll*. The control unit is available in either a split type or a one-piece cabinet. Both types are shown in figure 9. The split type; including a desk console, pump assembly, and electrical box (not shown in figure 9), offers more installation flexibility. All operating controls and indicators are located on the desk console, the pump assembly and electrical box may be remotely installed. The one-piece type contains all control unit components. Both units operate in the same manner.

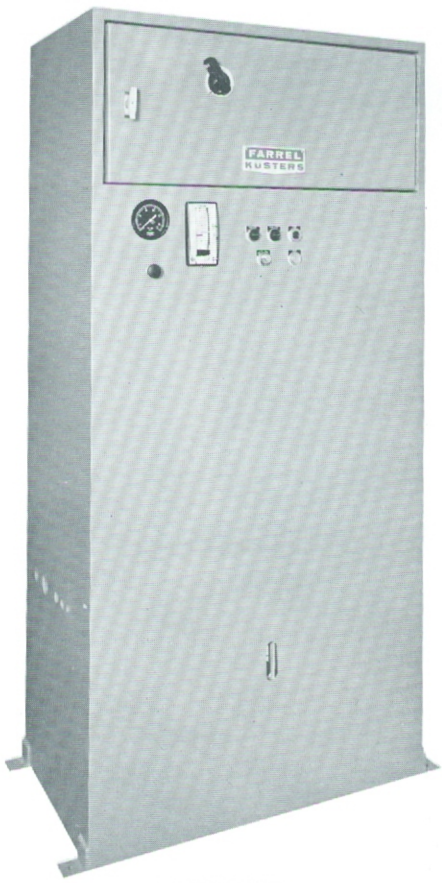


DESK CONSOLE



PUMP ASSEMBLY

SPLIT TYPE



CABINET TYPE

Fig. 9 – Control Units

Operation of Single *Swimming-Roll* Control Units

The operation of control units for either the driven or the non-driven *Swimming Roll* is the same. Two modes of operation are available . . . manual and automatic. Refer to figure 10 for the following discussions on these modes of operation.

Manual Mode (Figure 10a). The summary of manual operation is as follows:

a. Filtered shop air is supplied to the air supply set and the pressure transmitter.

b. Pressure transmitter receives a sensing signal from the *Swimming Roll.*

c. Pressure transmitter generates a pneumatic signal which is directly proportional to the internal *Swimming-Roll* pressure and is transmitted to the controller. Magnitude of this signal is given by the black pointer on the left side of the vertical scale.

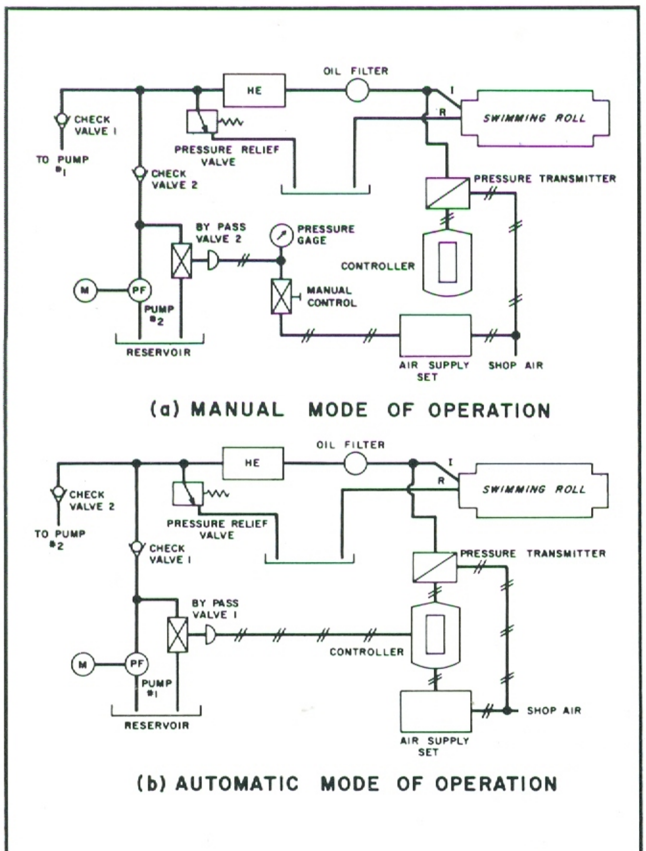


Fig. 10 – Single *Swimming-Roll* Control Systems

d. Air supply set supplies filtered 20-psi air to the manual control (front panel control labeled MANUAL).

e. Position of the manual control determines the amount of air sent to by-pass valve 2. The amount of air sent is shown by the gage on the control unit located directly over the manual control.

f. Position of the by-pass valve determines the internal *Swimming-Roll* pressure. An increase of the air signal to the by-pass valve raises the *Swimming-Roll* pressure (increases deflection), a decrease in signal lowers the pressure (decreases deflection).

g. In the event of an air signal failure, all oil from the pump is by-passed to the reservoir and the internal *Swimming-Roll* pressure drops to zero.

Automatic Mode (Figure 10b). The summary of automatic operation is as follows:

a. Filtered shop air is supplied to the air supply set and the pressure transmitter.

b. Pressure transmitter receives a sensing signal from the *Swimming Roll.*

c. Pressure transmitter generates a pneumatic signal which is directly proportional to the internal *Swimming-Roll* pressure and is transmitted to the controller. Magnitude of this signal is given by the black pointer on the left side of the vertical scale.

d. Desired *Swimming-Roll* pressure is set by the SET point control on the controller and is shown by the red pointer on the right side of the vertical scale.

e. Controller compares the pressure setting against the proportional *Swimming-Roll* pressure signal from the pressure transmitter and automatically develops a control signal. The magnitude of the control signal is directly related to the amount of deviation between the two input signals. This control signal is applied to by-pass valve 1. The action of this valve determines the actual internal *Swimming-Roll* pressure.

f. Controller continuously compares signals until they balance. At this time, the red and black pointers on the vertical scale will indicate equal pressures.

Operation of *Swimming-Roll* Control Units with External Loading

Single *Swimming-Roll* Systems with External Loading (Figure 11a). The summary of operation is as follows:

a. Pressure transmitters receive sensing signals from the loading cylinders and generate proportional pneumatic signals which are transmitted to the analog station.

b. Analog station averages the two signals and transmits the resultant to the bias relay.

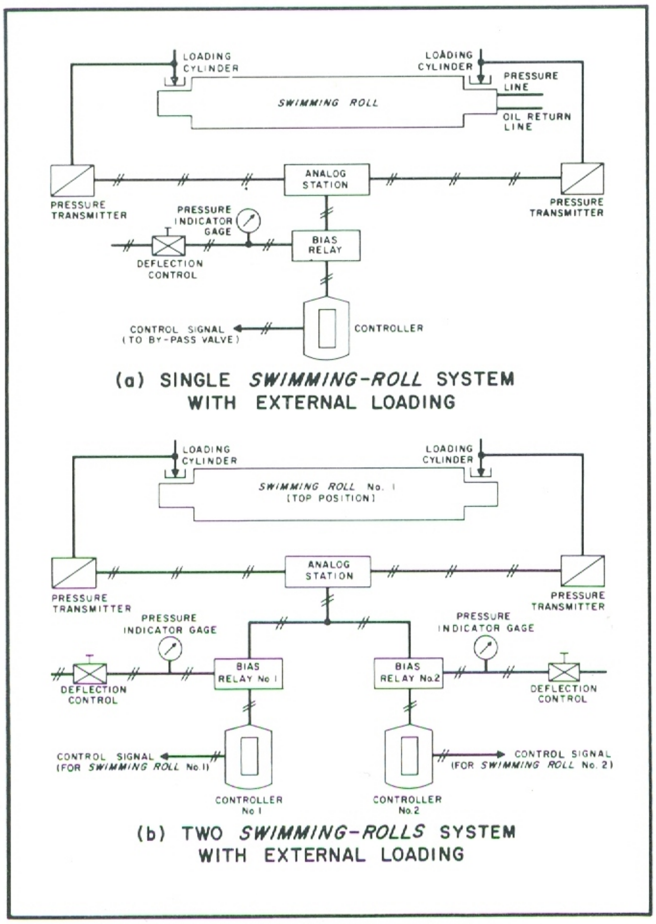


Fig. 11 – Control Systems for *Swimming Rolls* with External Loading

c. Bias relay provides a means of manually adjusting *Swimming-Roll* pressure. The DEFLECTION control (located on the front panel) regulates a second air signal to the bias relay which in turn varies the amount of air pressure transmitted to the controller. A gage, located directly above the manual regulator knob, provides an indication of the *Swimming-Roll* deflection adjustment.

d. Output of the bias relay is transmitted to the controller where it automatically determines the set point. The remaining operation is the same as discussed under automatic operation.

Two *Swimming-Roll* Systems with External Loading (Figure 11b). The summary of operation is as follows:

a. Pressure transmitters receive sensing signals from the loading cylinders and generate proportional pneumatic signals which are transmitted to the analog station.

b. Analog station averages the two sensing signals and transmits the resultant to the bias relays.

c. Bias relays provide a means of manually adjusting *Swimming-Roll* pressures. DEFLECTION controls (located on the front panel) regulate a second air signal to the bias relays which in turn vary the air pressures transmitted to the controllers. Gages, located directly above the controls, provide indications of *Swimming-Roll* deflection corrections.

d. The outputs of the bias relays are transmitted to the controllers where they automatically determine set point. The remaining operation is the same as discussed under automatic operation.

TYPICAL SYSTEM CONFIGURATIONS

Several typical system configurations are shown in figures 12 through 15.

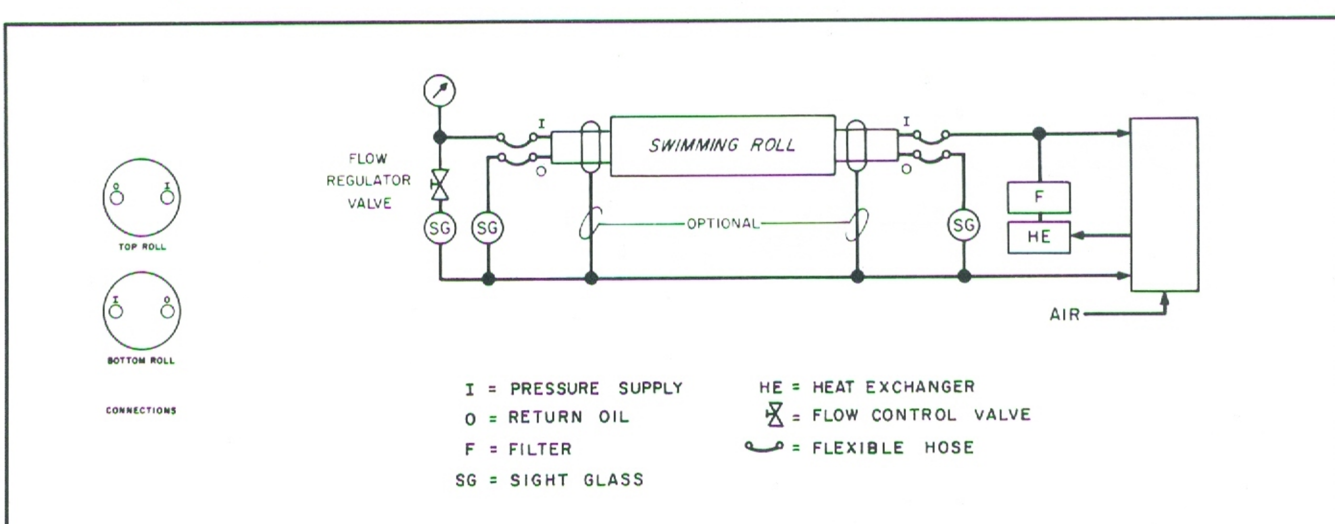


Fig. 12 – Single *Swimming-Roll* System (Cabinet-Type Control Unit)

Section 4
MAINTENANCE AND SERVICE

Always observe normal safety precautions when workingin the Swimming-Roll area.

GENERAL MAINTENANCE INFORMATION

This section contains information on lubrication, roll disassembly and assembly, regrinding, recovering, control-unit maintenance, system troubleshooting, and ordering replacement parts. The *Swimming-Roll* System requires minimum maintenance. In general, periodic checks are limited to cleaning and inspecting components and changing oil- and air-filter elements. Cleaning and inspecting are the best form of preventive maintenance and can avoid costly downtime. Grease, grime, moisture, and dust should be removed regularly from all components in the system.

LUBRICATION

After the first 300 working hours, the system oil should be drained and replaced. Thereafter, the oil should be changed every 3000 operating hours. The oil filter should always be cleaned or replaced with every oil change. When replacing the oil, fill the reservoir to the gage full mark. When the system is started, the oil level will drop. This new level should be noted and maintained.

The *Swimming Roll* is lubricated completely by the control-unit oil system. Oil passes by the seals lubricating the bearings at the roll ends. An indication of the amount of oil can be seen in the sight glasses located in the oil-return lines. In operation, the roll is always at least half full of oil, therefore, always lubricated.

The driven *Swimming Roll* has an oil line piped to the drive bearing housing. A valve in the line is used to adjust the oil flow to the drive bearing. This valve should be adjusted so a continuous oil flow is seen in the sight glass in the bearing housing drain line.

The importance of an adequate lubrication maintenance program cannot be over emphasized. The extent of such a program will vary with the size of plant and machinery installation. However, the program should include these items as a minimum:

a. Select a capable employee to be responsible for this program, in many plants this is the maintenance supervisor.

b. Be thoroughly familiar with the lubrication device or system before the machine is started.

c. Follow the Farrel Corporation lubricant recommendations carefully and use only approved lubricants.

d. Make sure that all lubricants supplied to the machine are kept clean.

e. Make sure that the recommended amounts, flow rates, or lubricator settings and relubrication periods are maintained.

f. Establish a definite supervisory inspection procedure. Inspection forms should be prepared and weekly checks made of lubricating equipment.

Nearly all causes of bearing or gear failure can be prevented by strict attention to this maintenance program. Its cost is far outweighed by the total cost of rigging, lost time, and damage resulting from improper lubrication.

NON-DRIVEN *SWIMMING-ROLL* DISASSEMBLY

To disassemble a non-driven *Swimming Roll,* perform the following:

a. Disconnect the oil lines and drain oil with the roll in the horizontal position. Some oil will be retained in the roll at this time. Oil seepage from the roll during the disassembly procedure will occur.

b. Remove shaft locating ring and pedestals.

c. Place the roll on horses or blocking with the pressure chamber upward. To assure proper positioning, keep the tap for hex head bolt (22, figure 20) or the keyway in the six o'clock position.

d. Remove hex head bolt (22) and retaining ring (20).

e. Remove spherical support bushing (18) and bearings (19) from both ends.

f. Loosen set screws (17) and remove end covers (16) from both ends.

g. Remove cap screws (15) and insert two guide rods in cap screw taps 180° apart. These rods protect the lip of the oil seal and therefore should be long enough to allow the oil seal to clear the seal sleeve. Remove the seal support covers (14) from both ends (O rings (13) and oil seals (12) on the seal support covers can be inspected and replaced if necessary).

h. Loosen screws (11) and seal sleeves (10) from both ends (O rings (9) can be inspected and replaced if necessary).