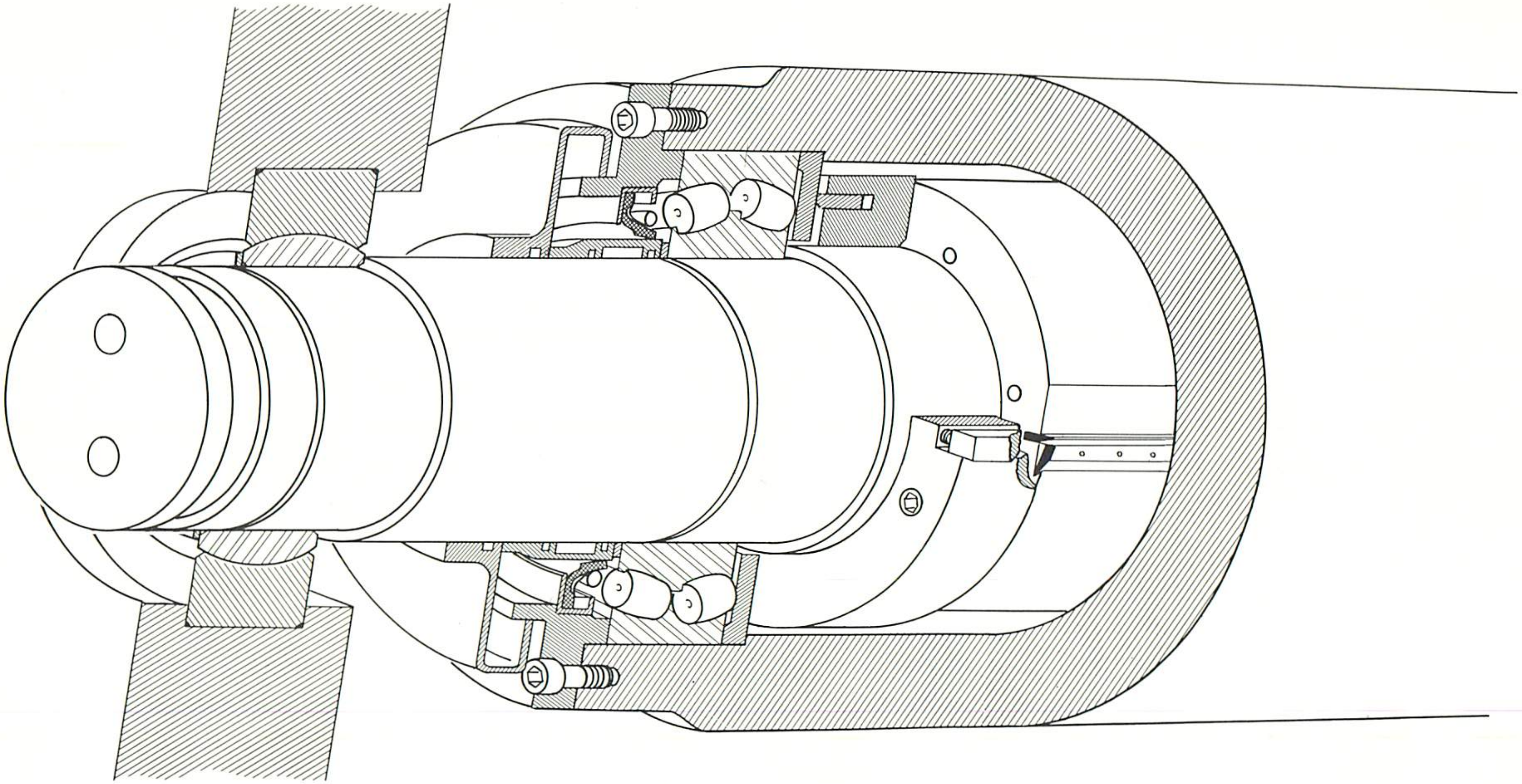


FARREL

FARREL SWIMMING ROLL

Kusters Type

Farrel Corporation
Ansonia, Connecticut

FARREL-KÜSTERS "SWIMMING ROLL" TM

The "Swimming Roll" consists of a stationary shaft supported by self-aligning bearings on which are mounted two self-aligning spherical roller bearings to support a shell which is the rotating element. The shell can be made of various materials; however, normally it is made of either chilled iron or steel. Steels, of course, can be both carbon steel or stainless steel, if required. In addition, there is no reason why we could not use some of the more exotic combinations of materials, such as STD-250 outer material with ductile iron inner material.

There are two axial seals which run longitudinally along the axis of the shaft between the bearings and also seals at each end which seal off the pressurized chamber in the roll. This is the area in which hydraulic pressure is introduced between the shell and the shaft to oppose any nip load. Nylon plugs are inserted in the shaft to prevent any damage to the bore of the shell when assembling the roll.

The bottom chamber, or nonpressurized chamber, is not sealed. Oil under pressure is introduced into the pressurized chamber to oppose nip load. Some of this oil passes by the pressurized chamber seals into the nonpressurized chamber, which in turn fills up to a point where the oil can pass out through the center of the shaft and back to the supply tank. At the same time oil builds up in the bearing area and provides lubrication for the self-aligning spherical roller bearings. Outside of the bearings there is a full contact seal to prevent oil leakage.

The axial seals are made of bronze. The oil, which passes the seals, provides lubrication, thereby preventing wear.

In view of the construction of this roll, the usual preference is that a mating roll be driven, and that the shell be driven by surface contact. However, if necessary, the shell can be direct driven by one of several methods which will be reviewed later.

The majority of installations have been on either machine calenders or super calenders. The simplest application, of course, is a bottom roll in a machine calender. Generally, in all applications it is possible to grind all rolls straight. This eliminates any question with regard to slippage in the nip, or with regard to questions of correct crowns for a particular set of operating conditions. Normally the roll is designed to suit whatever operating condition the customer specifies.

An analysis of what happens when a user wishes to run from one nip to seven nips on a machine calender will serve to illustrate the adjustment possibilities. For a one-nip condition, the oil pressure inside of the chamber would be manually regulated so that it equals the nip pressure created by one roll above the bottom including the roll weight, bearing weights, and doctor weights, if doctors are mounted on the bearings, etc. If two additional rolls are now added to the system we then have a four-roll calender, bottom roll plus three intermediates. The internal pressure is then manually regulated in the bottom roll to counteract the nip load created by the weight of all three rolls, plus bearings, doctors, etc. This regulation would, of course, have to change with each addition of a roll, or more than one roll, or rolls plus external load.

If for some reason the operation requires that the stack have a slight overcrown or undercrown for a given nip condition, it is possible to adjust the internal pressure of the "Swimming Roll", so that the shell has a slight deflection upward or downward. Normally this would be specified at plus 10% from a maximum load condition. In effect, what is being produced under these conditions, is, with overpressure, a crowning of the shell in an upward direction, or an undercrown by having less pressure under the shell than is required to support the load being applied at the nip.

If the deflection required, either in an upward direction or a downward direction, exceeds acceptable stress conditions in the roll shell to make this deflection match a mating roll deflection, then special arrangements must be made in the design of the roll by changing its size to accommodate the conditions, or the mating roll dimensions must be changed to reduce its deflection.

The controls for a "Swimming Roll" in a top roll position and in a bottom roll position on a super calender, plus the cylinder loading of the top roll, can all be balanced through the control system so that one adjustment of the external pressure being applied at the top roll will automatically adjust the pressure in the top roll pressure chamber and the bottom roll pressure chamber, so that the system remains in balance and uniform nip pressure exists across the sheet.

Applications

As mentioned previously, the bulk of the rolls which have been installed in North America have been on machine calenders. This roll can be applied in many paper manufacturing process operations or in pulp production. It has been applied in:

- Machine Calender Stacks
- Super Calenders
- Size Presses
- Breaker Stacks
- Embossers
- Wet Presses
- Smoothing Presses
- Yankee Machine Pressure Rolls
- Coaters

Basically the roll has an application anywhere that a variable nip pressure may be required in the paper making process.

It has been found, in general, that approximately 30% less pressure is required to obtain equivalent quality. This is a general statement probably resulting from the fact that a smaller diameter roll can be used. The smaller diameter roll results in higher specific nip pressures due to the fact that the nip is narrower than with a roll of larger diameter. A number of these rolls have been supplied with rubber covering. The straight grinding of the "Swimming Roll" offers better draw control from the press and longer life between regrinds. The cooling, due to the oil circulation, helps the rubber cover life.

It has been reported that felt life, where this roll has been used in a press location, has been increased from two weeks to six or eight weeks on a Yankee machine, apparently due to the absence of crown.

Pulp Production Applications

In general, we have used the roll in two places in pulp production: in the wet press, which is similar to paper operation, and as a densification press for dissolving cellulose production.

It has been found through experience that in connection with dissolving pulp production, high densification improves the quality. This is brought about by the fact that dissolving by the caustic solution, which is applied to the cellulose, does not occur rapidly or does not get a shock due to the fact that the high densification allows the sheet of pulp to become completely submerged in the solution before dissolving starts to occur. Fluid penetration is delayed for a short interval which results in more uniform penetration resulting in less shock to the fibers. Consider as a comparison, for example, a drop of water dropping on a blotter versus a drop of water dropping on a very dense high-finish sheet. The application of the roll to the wet press is very similar to a paper machine application.

The use of two of these rolls in the densification press provides a very sharp nip and therefore high densification. It is important to keep the diameter of the roll as small as possible. The higher the nip pressure the more important a slight difference in diameter becomes.

In sulphite pulp production we have found that the nip pressure required is as high as 2000 pli. With the smaller diameter rolls the resulting densification press machine is smaller requiring less space and in turn the mill is able to retain more drying capacity. We build a complete press, not just the rolls.

There are a multitude of potential applications for this roll. As previously mentioned, variable nip pressure requirements or variable deflection requirements represent potential applications. This roll also presents the possibility of increasing the width of existing machines, where, due to high loads, widths are limited and/or loads are so high that bearings and housings become larger than the roll to obtain sufficient journal strength. Less space is required due to reduction in roll diameter.

Points to be considered in connection with the benefits of this roll are:

1. Smaller diameter resulting in less space required, less weight to handle, and higher specific nip pressure.

2. No crown required eliminating any question with regard to speed differentials or slippage.

3. Uniform nip pressure control regardless of load conditions.

4. Since the roll is smaller it therefore weighs less and therefore represents less weight in handling.

5. Due to the fact that the roll has circulating oil inside, a resulting condition of more uniform temperature control occurs, tending to eliminate hot spots in operation.

6. Roll Materials - Any material which can be made in the form of a shell and which will withstand the load conditions which are imposed is a potential material for use in this roll construction.

7. Travel of the sheet is unlimited.

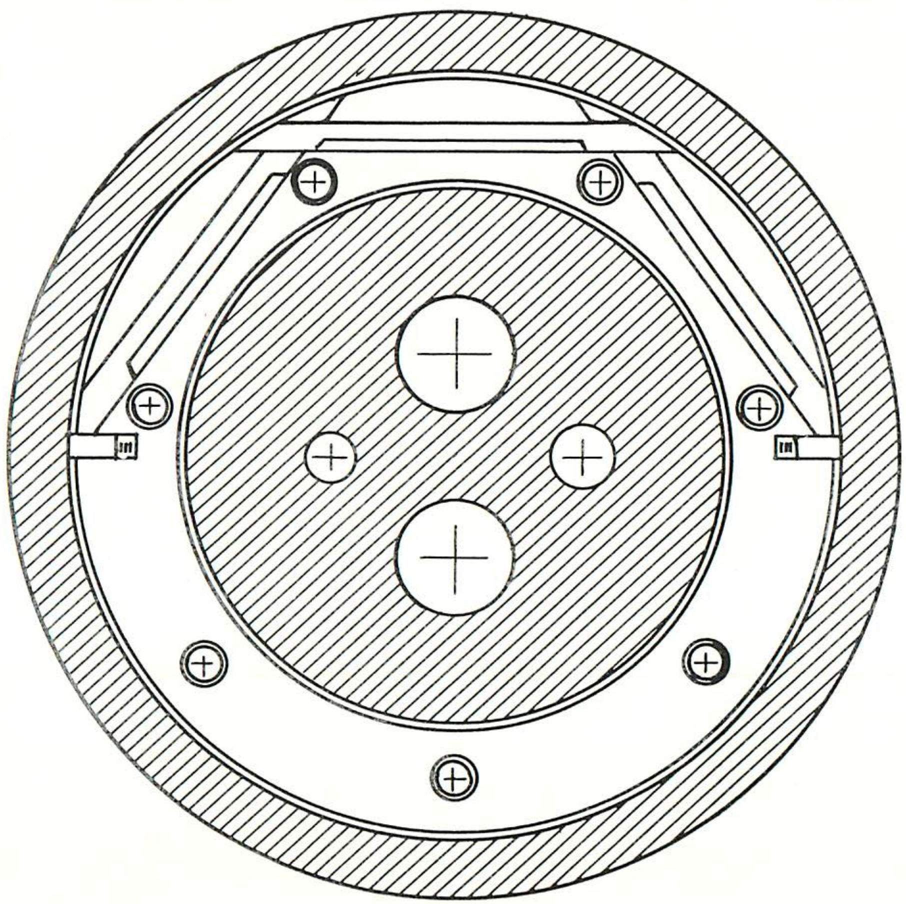
8. The roll is simple to install.

9. Since the roll is smaller in diameter and does not have a crown, grinding is simplified.

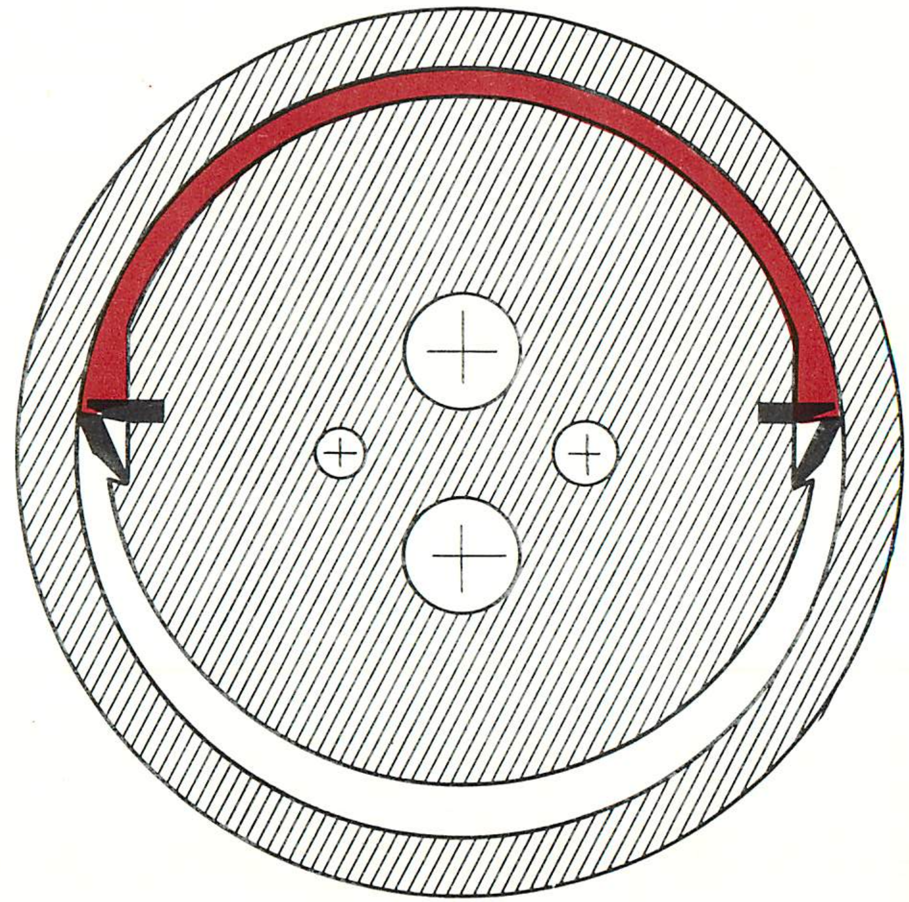
Driven Rolls

There are several methods of driving the roll as previously mentioned. The selection of non-driven or driven type is dependent on a number of factors. The preferred method of driving the roll for the paper industry is our on-center drive design which consists of providing an antifriction bearing to support the stationary shaft on the drive end rather than the normal spherical stationary type bearing support. We then provide a coupling between the shell and a stub shaft which is mounted around the O.D. of this support bearing. The stub shaft is supported by bearings mounted on its O.D. These are then mounted in a stationary housing. This provides a shaft extension on which a conventional drive coupling can be mounted. Because our design incorporates a flexible coupling between the drive extension and the shell, the driven roll functions and operates identically to the non-driven type roll.

A sprocket or a gear can be mounted on the end of the shell, and by the use of a chain or mating gear the shell can be driven. A belt drive over the end of the shell can be used as a drive. The use of a chain or gear results in certain problems of mis-alignment and therefore is not too desirable; however, a number of rolls with various external drives of the type mentioned above are satisfactorily operating on lower speed applications.

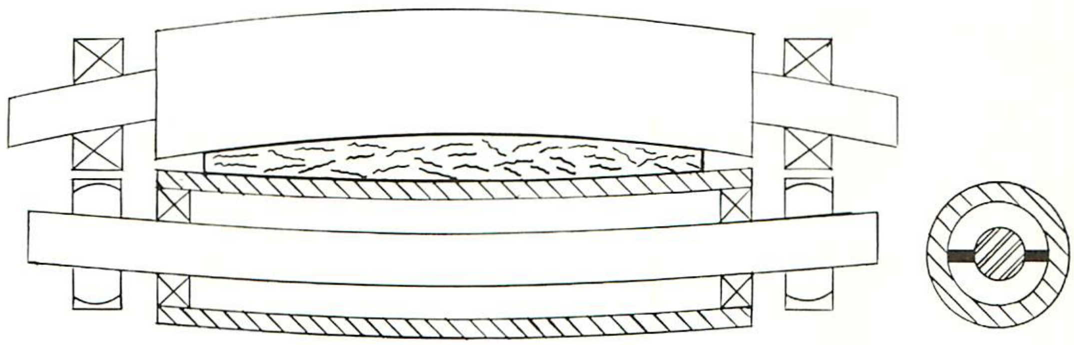


END SEALS



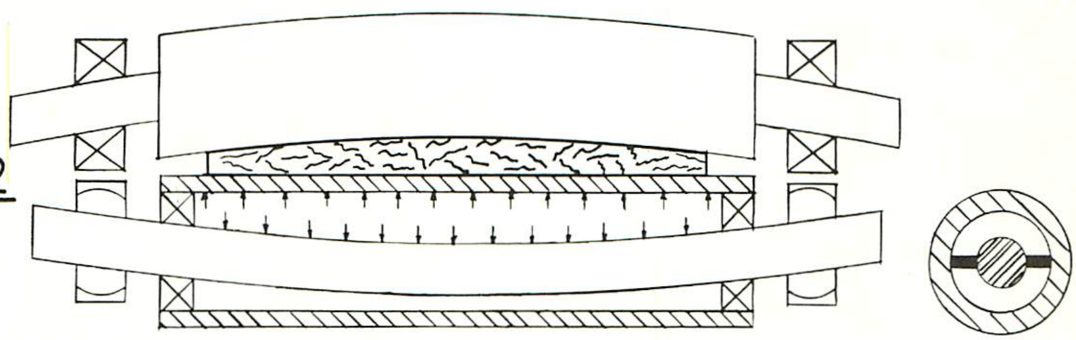
AXIAL SEALS

CASE #1



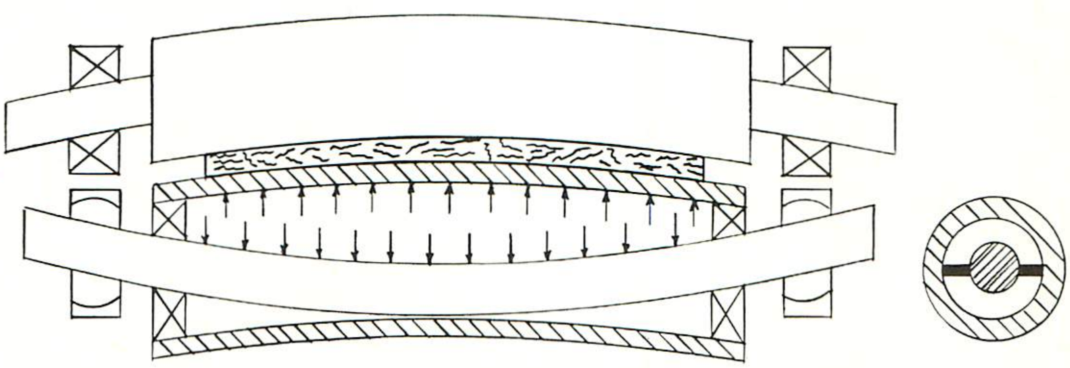
NO INTERNAL PRESSURE

CASE #2



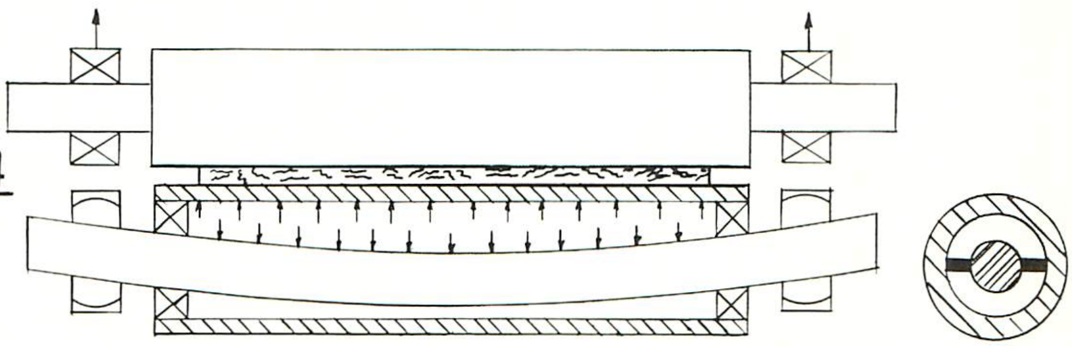
INTERNAL PRESSURE TO STRAIGHTEN ROLL

CASE #3



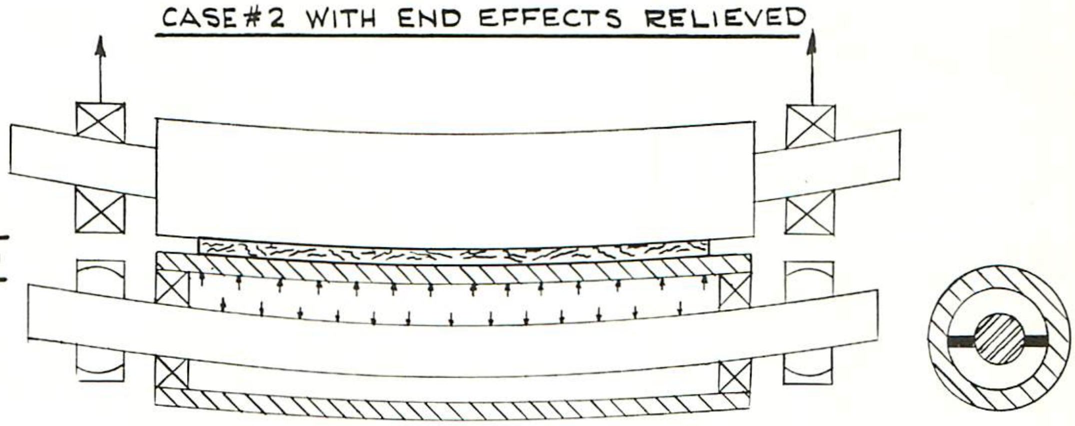
INTERNAL PRESSURE EQUAL TO NIP PRESSURE

CASE #4



CASE#2 WITH END EFFECTS RELIEVED

CASE #5



INTERNAL PRESSURE LESS THAN CASE #2
WITH ADDITIONAL WEIGHT RELIEVING