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DOUBLE CASING PUMP

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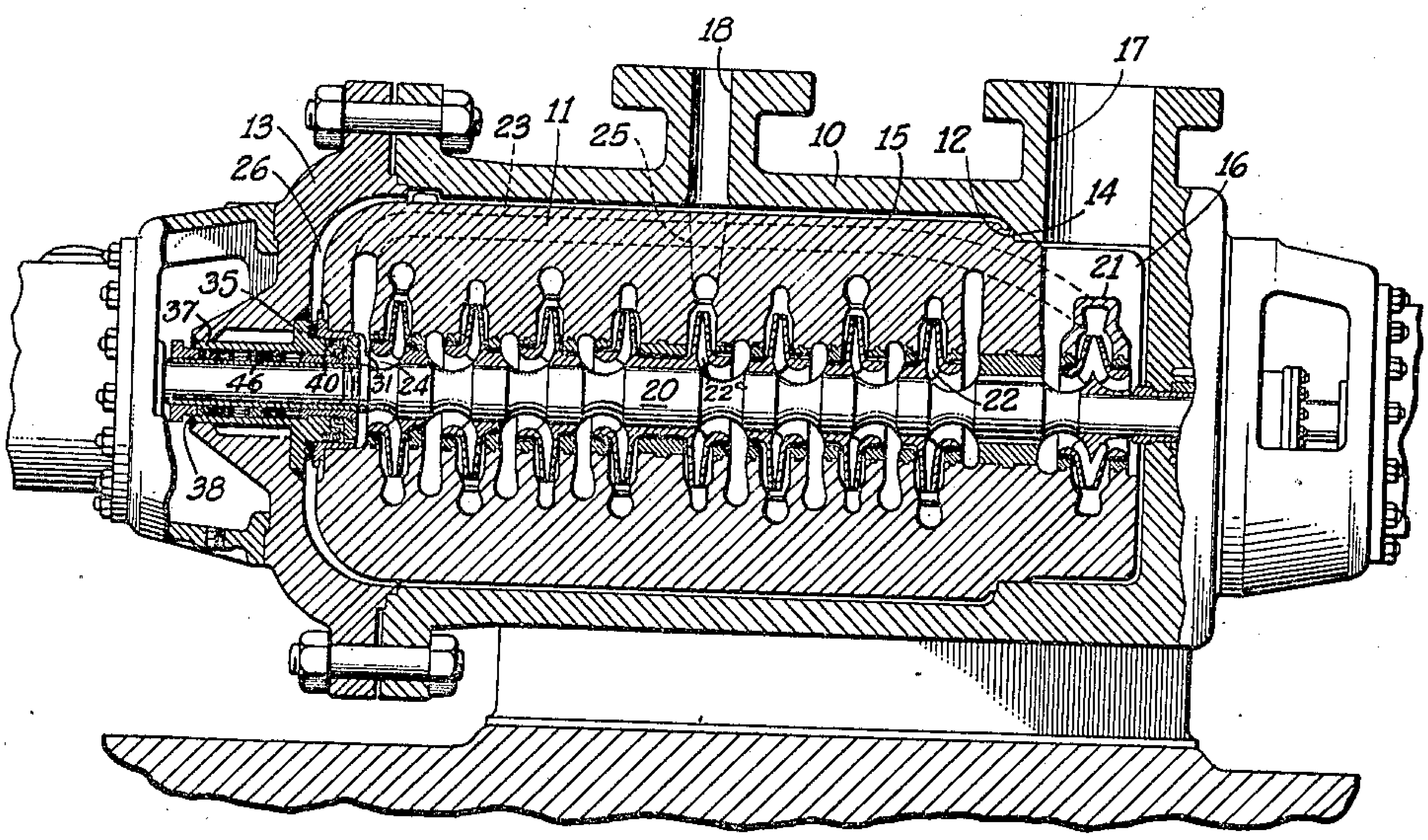

Fig. 1.

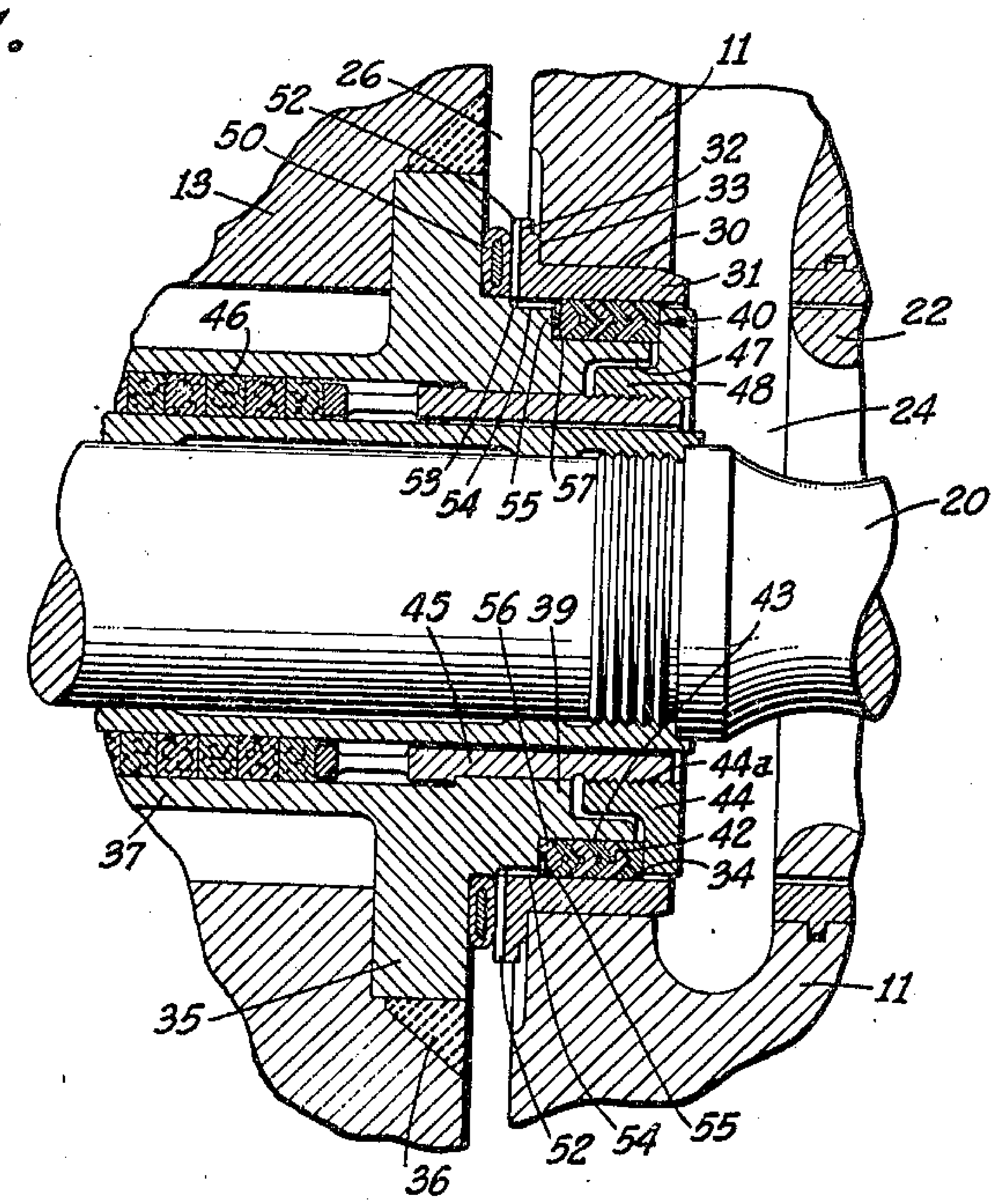

Fig. 2.

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DOUBLE CASING PUMP

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3 Claims. (Cl. 103—111)

This invention relates generally to double casing pumps, and particularly to double casing multi-stage centrifugal pumps especially designed for use in pumping hot liquid, particularly boiler feed water, at relatively high pressure.

The invention has particular utility as applied to double casing centrifugal pumps of the type embodying generally an inner volute casing containing the impellers and volute passages, and an outer pressure casing spaced circumferentially from the inner casing and forming therewith an annular passage adapted to contain pump liquid at discharge pressure. Axial movement of the innermost end of the inner casing in one direction with respect to the outer casing is usually limited by seating of the inner casing against a radial shoulder formed on the inner wall of the outer casing, the inner casing being held tightly against its seat by the pressure of the fluid in the annular space between the casings, exerted against the remote end of the inner casing. The end of the inner casing remote from the seat is free to move axially with respect to the outer casing. An example of this type of pump is shown in the patent to Aladar Hollander, No. 2,058,017, issued October 20, 1936.

When a pump of the aforementioned type is employed for pumping hot liquid at relatively high pressure, the axial movement of the unseated end of the inner casing with respect to the outer casing may be very substantial, and of the order of $\frac{1}{64}$ to $\frac{1}{16}$ of an inch. This movement is the combined result of pressure and temperature fluctuations. In certain types of pumping service such, for example, as pumping boiler feed water, temperature fluctuations may occur quite frequently, resulting in frequent axial movement between the two casings.

A general object of this invention is to provide a double casing pump which is particularly adapted to pumping a hot liquid at relatively high pressure under frequently recurring conditions of changing pressure and temperature.

A more specific object is to provide, in a pump of the aforementioned type, a fluid-tight seal between the inner and outer casings at the ends thereof where maximum relative axial movement between the casings occurs, the effectiveness of which seal is wholly independent of the movement between the casings.

A further object is to provide, in a pump of the aforementioned type, a fluid-tight seal between the inner and outer casings, which seal may be manually adjusted to obtain the desired sealing effect, and which will thereafter be effective over a long period of time, irrespective of the extent or frequency of axial movement between the sealing surfaces.

Other objects and advantages will be apparent from the following detailed description of a preferred embodiment of the invention, reference being had to the accompanying drawing wherein:

Fig. 1 is a central longitudinal sectional view of a pump embodying the invention; and

Fig. 2 is an enlarged fragmentary view of a portion of the pump of Fig. 1, illustrating in better detail the novel sealing means between the inner and outer casings.

For purpose of illustration, the invention is shown in Fig. 1 as applied to a double casing, multi-stage centrifugal pump of a type corresponding in all essential respects with that shown in the aforementioned Patent No. 2,058,017 to Aladar Hollander. The pump may include an outer casing **10** and an inner or impeller casing **11** mounted therein. A radial shoulder seat **12** is formed on the inner wall of the outer casing adjacent the end thereof remote from the detachable cover **13**, and is engaged by an opposed radial shoulder **14** formed on the inner casing. The annular pressure space **15** formed between the casings to the left of the shoulder **12** is thus sealed off from the suction chamber **16**. A suction passage **17** is formed in the outer casing in alignment with the suction chamber **16**, and a discharge passage **18** is formed in the outer casing in communication with the annular pressure space **15**.

An impeller shaft **20** extends axially through both casings and is provided with a double suction first stage impeller **21** and a plurality of single suction higher stage impellers **22** rotatable in the usual impeller cavities in the inner casing. It will be noted that a cross-over passage **23** extends from the first-stage impeller **21** to the suction eye **24** of the impeller at the opposite end of the pump, in order to dispose the two lowest-stage impellers at opposite ends of the pump and thus subject the stuffing boxes to the minimum pressure. The final stage impeller 22^a discharges into the annular pressure space **15** through a discharge passage **25** aligned with the discharge passage **18** in the outer casing, thus subjecting the space **15**, and also the radial clearance space **26** between the end cover **13** and the adjacent end of the inner casing, to the discharge pressure of the pump.

From the description thus far, it will be apparent that the pump liquid in the end space 26 exerts the full discharge pressure of the pump against the left-hand end of the inner casing is an axial direction, forcing the shoulder 14 tightly against its seat 12 on the outer casing. Consequently, any differential elongation of the two casings caused by pressure and/or temperature changes will result in maximum relative axial movement between the casings at the end remote from the seats 12 and 14. In order to permit this movement and at the same time maintain a fluid-tight seal between the high pressure space 26 and the low pressure space 24, a fluid-tight sliding joint is provided between the two casings. This joint is illustrated on an enlarged scale in Fig. 2.

Referring to Fig. 2, it will be observed that the end wall of the inner casing 11 is provided with an enlarged bore 30 concentric with the shaft 20. Fitting snugly within the bore is an annular bushing member 31 provided with an outwardly extending radial flange 32 at its outer end. A gasket 33 is interposed between the flange 32 and a complementary radial surface on the outer wall of the inner casing to prevent leakage of pump liquid from the space 26 along the bore 30 and into the low pressure space 24. It will be evident that the relatively high pressure in the space 26, acting against the relatively large end surface of the flange 32, will exert sufficient force in comparison with the opposing force exerted by the low pressure in the space 24 acting against the inner end of the bushing 31, to hold the flange 32 in fluid-tight sealing engagement with the inner casing.

In order to effect a fluid-tight seal between the end cover 13 and the inner wall of the bushing 31, an annular sleeve is formed on the cover and extends into the bushing in telescopic relation with the inner wall 34 thereof. In the present instance the sleeve is in the form of a separate insert comprising a central flange portion 35 rigidly secured within a recess in the inner wall of the cover as by welding at 36, an outwardly extending sleeve portion 37 extending through the shaft opening in the cover and welded to the cover at its outer end as shown at 38 in Fig. 1, and an inwardly projecting sleeve portion 39 telescoped within the bushing 31. The sleeve portion 39 has a sliding fit in the bushing in order to permit relative axial movement between the end cover and the inner casing, and the joint between the sleeve 39 and the bushing 31 is sealed by suitable packing means generally indicated at 40. It will be understood that the sleeve member may either be formed as a separate casting and welded or otherwise secured to the end cover as shown, or it may be formed as an integral part of the end cover.

It has been ascertained, from extensive tests conducted under conditions simulating actual operating conditions, that the usual types of packing means commonly employed are not effective to prevent leakage under the particular conditions encountered in the service for which these pumps are especially designed. Accordingly, special provision has been made in the instant case for effecting a tighter seal than can be obtained by methods heretofore employed. A series of packing rings 42 of the well-known "Chevron" type are mounted within a packing recess 43 in the sleeve 39, and are positively expanded into engagement with the inner wall 34 of the bushing by a follower 44. In the present instance, the follower is threadedly connected at 44[a] to the inner end of the gland 45 of the usual shaft packing 46, but it will be apparent that the follower could instead be adjustably connected to the sleeve 39 if desired. It will also be observed that the sleeve is recessed at 47 to permit the threaded hub portion 48 of the follower to telescope within the sleeve in overlapping relation to the packing rings 42. This is desirable in order to reduce the overall length of the packing assembly to a minimum, but is not essential.

It has been determined that even though the packing rings 42 are positively expanded into tight engagement with the inner wall 34 of the bushing 31, a pressure difference of the order of 2000 lbs. per sq. in., such as is frequently encountered, will cause leakage past the packing upon relative axial movement between the end cover and the inner casing, if the surface of the wall 34 is finished to the usual smoothness obtained by the customary machining operations. I have discovered, however, that by polishing the surface 34 to a very smooth finish, leakage is avoided completely. Comparative tests using polished and unpolished surfaces definitely prove that under identical pressures and degrees of tightness of the packing rings, leakage occurs past the unpolished surface whereas a perfect seal is obtained with the polished surface even after repeated axial movement between the sealing surfaces.

It is also desirable but not so essential, that the cylindrical wall of the packing recess 43 be polished.

In order to maintain the inner casing held tightly against its seat 12 in the outer casing during assembly and shipment of the pump, a deformable ring 50 is interposed between the outer end of the bushing 31 and the adjacent wall of the end cover. The ring is preferably composed of an outer metallic sheath of corrosion-resistant material and a core of compressible plastic material, and is originally circular in cross-section. When deformed slightly during assembly of the pump, the ring assumes the shape illustrated in Fig. 2, and exerts pressure on the inner casing to hold the latter on its seat. The plasticity of the ring is such as to permit it to deform further when the axial expansion of the inner casing exceeds that of the outer casing.

The ring 50 is not, in the instant case, intended to effect a seal between the casings. In fact, provision is made for by-passing pump liquid past the ring in order to enable the pressure in the space 26 to supplement the action of the packing follower 44 in expanding the packing rings. As shown most clearly in Fig. 2, radially extending grooves 52 are formed in the outer face of the flange 32 on the bushing 31. The grooves extend past the ring 50 and communicate with an annular groove 53 formed in the outer wall of the sleeve 39. A plurality of grooves 54 extend axially along the outer surface of the sleeve 39 from the groove 53 to the inner end of the packing recess 43, and communicate with radial grooves 55 formed in the base wall of the packing header ring 56 and leading to a centrally disposed annular recess 57 in the header ring, whereby the pressure in the pressure space 26 is exerted against the header ring to expand the packing elements.

From the foregoing description of a preferred embodiment of the invention, it will be apparent that I have provided a double case pump which is particularly adapted to cope successfully with the extreme conditions of pressure and temperature fluctuation encountered when pumps of this type are employed for particular services such as boiler feed service. When equipped with a sealing arrangement such as that described herein, a fluid-tight seal may be maintained between the inner and outer casings at all times, irrespective of the extent or frequency of the axial movement between the casings resulting from changes in temperature or pressure of the pump liquid.

It will be understood that the embodiment of the invention illustrated and described herein may be modified in various respects without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a double-casing pump of the type comprising an outer pressure casing and an inner pump casing spaced therefrom and defining therewith a pressure chamber, and in which changes in temperature and/or pressure cause substantial relative axial movement between an end wall of the inner casing and the adjacent end wall of the outer casing, the combination therewith of means providing a fluid-tight seal between said end walls in all relative axial positions thereof, said means comprising: an opening extending through one of said walls, an annular bushing member fitting said opening and having a central bore, means forming a fluid-tight seal between said bushing member and said wall opening, a sleeve member projecting from the other of said walls and into said bushing bore and defining with the latter a packing receiving recess, a plurality of packing elements of the pressure-expansible type positioned in said recess in position to be expanded by the pressure of the pump liquid in said pressure chamber, a packing follower adjustably connected to said sleeve member and engaging an end one of said packing elements for mechanically applying pressure in an axial direction to said packing elements to positively expand the latter into fluid-tight engagement with the opposed walls of said packing recess and said bushing bore, the wall of said bushing bore engaged by said packing elements being polished to a high degree of smoothness.

2. A double-casing pump as set forth in claim 1, and including a deformable spacer ring interposed between the adjacent end walls of said casings for resiliently urging said end walls apart, said spacer ring being disposed between said pressure chamber and said packing, and passage means in one of said end walls extending past said spacer ring for by-passing pump liquid from said pressure chamber around said spacer ring to said packing.

3. A double-casing pump as set forth in claim 1, and including a deformable spacer ring interposed between the end wall of said outer casing and the adjacent end of said bushing member, said spacer ring being disposed between said pressure chamber and said packing elements, and passage means communicating said pressure chamber with said packing elements including a by-pass in said bushing member extending past said spacer ring.

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