Sept. 6, 1966 F. E. HAMMOND 3,271,037

PRESSURE-BALANCED SEGMENTAL PACKING RINGS

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Fig. 1.

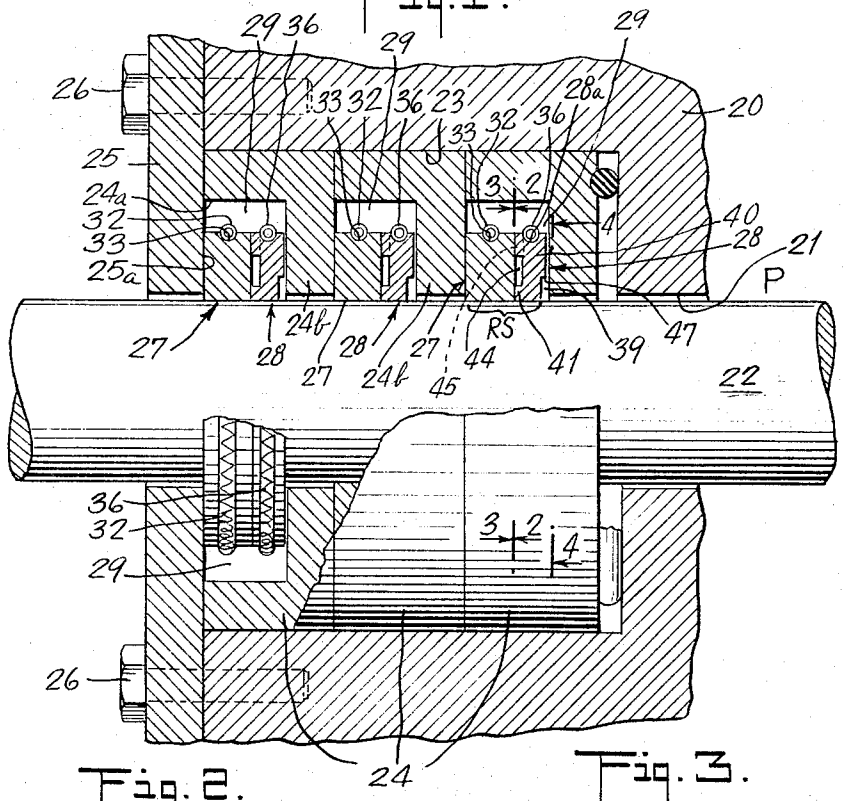


Fig. 2.

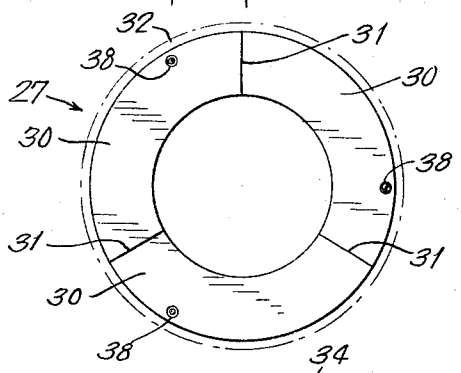
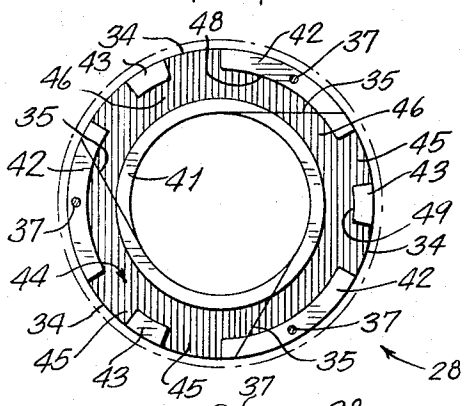


Fig. 3.



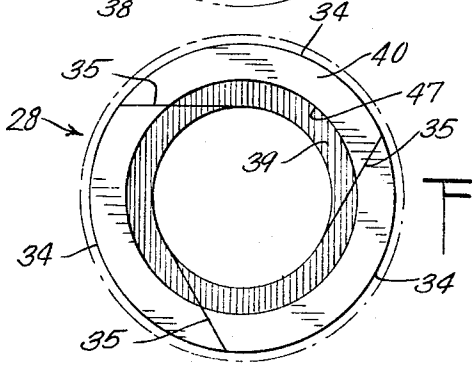


Fig. 4.

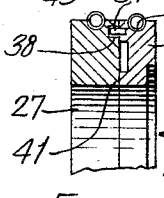


Fig. 5.

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Fig. 6.

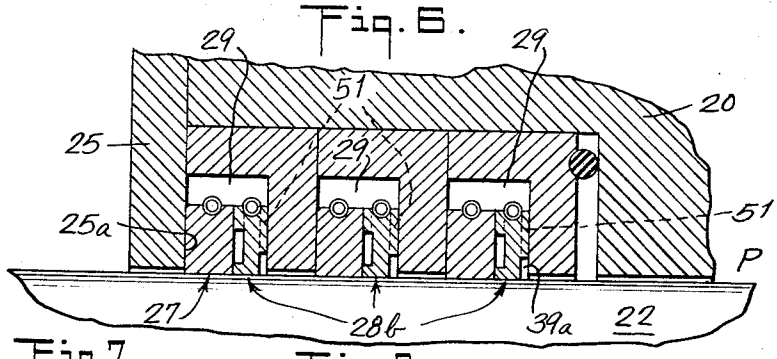


Fig. 7.

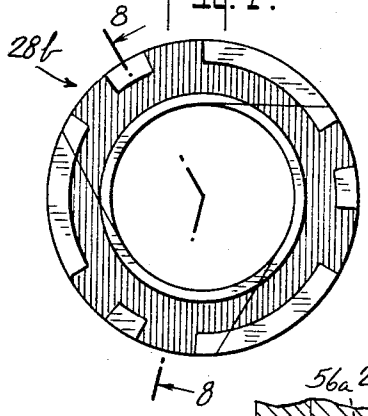


Fig. 8.

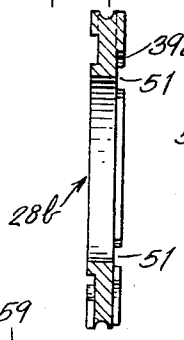
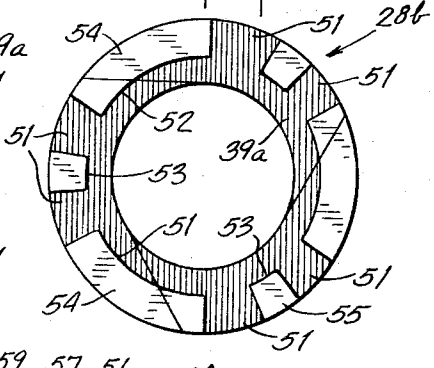


Fig. 9.



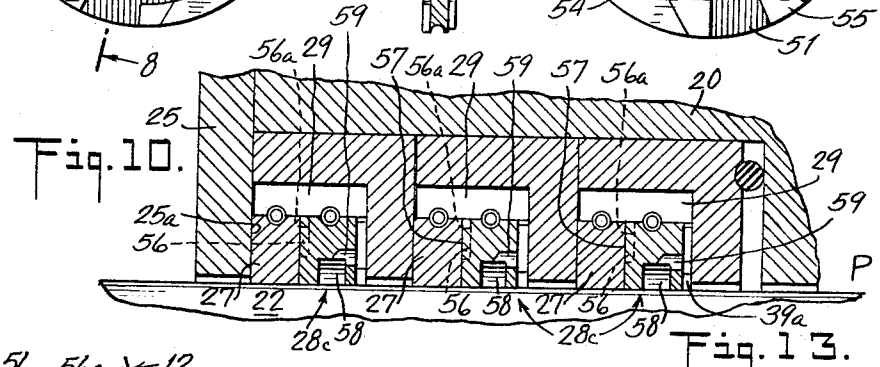


Fig. 10.

Fig. 13.

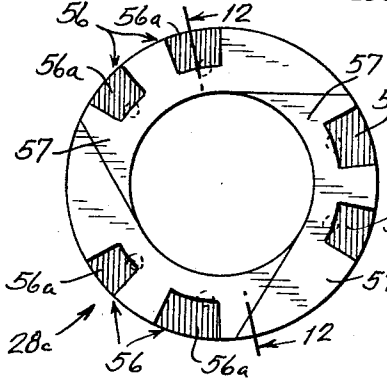


Fig. 11.

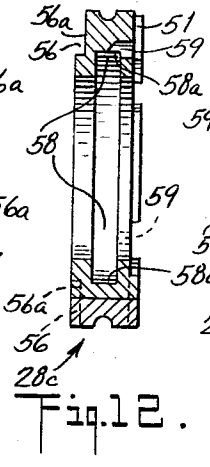
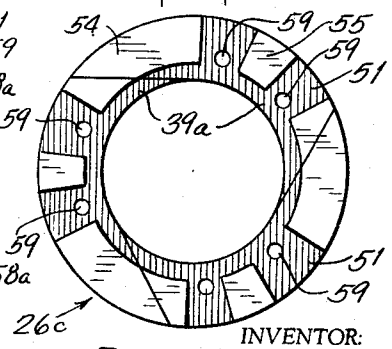


Fig. 12.



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Fig. 14.

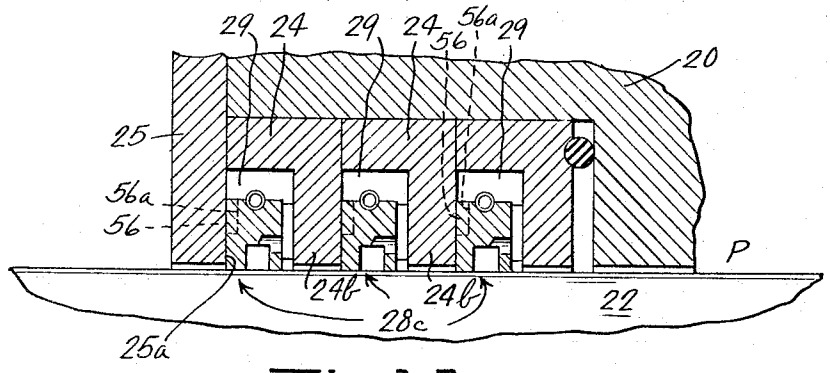


Fig. 15.

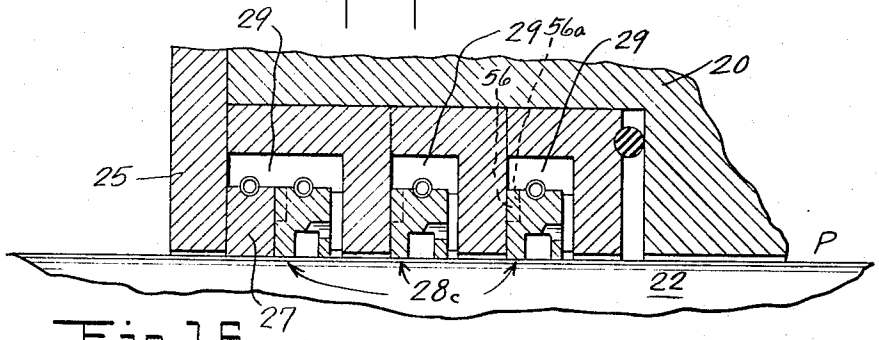


Fig. 16.

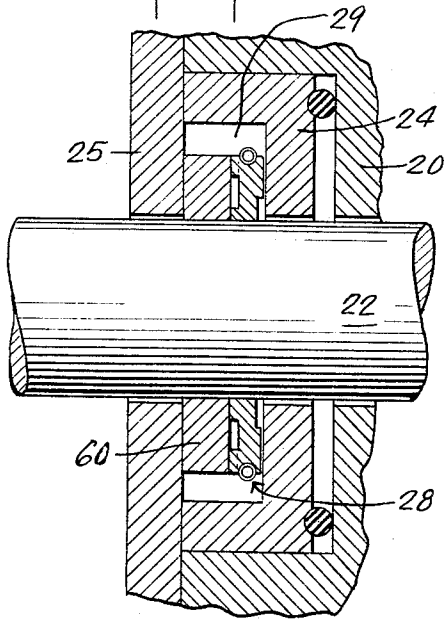
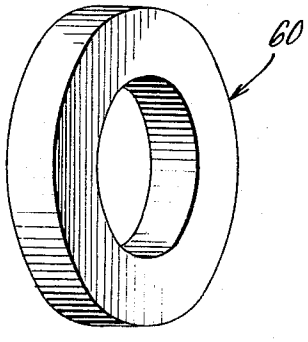


Fig. 17.



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United States Patent Office

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PRESSURE-BALANCED SEGMENTAL PACKING RINGS

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Filed Apr. 1, 1963, Ser. No. 269,617

1 Claim. (Cl. 277—27)

This invention relates to segmental packing rings such as are employed for effecting a seal at high pressure between a machine casing and a rod or shaft which extends through and reciprocates or rotates in an opening in said casing. Without limitation thereto, reference is hereinafter made only to a reciprocating rod as comprehending also a shaft. Although the subject segmental rings are disclosed herein, for illustrative purposes, as being of metal, it should be understood that they may be of other suitable relatively non-deformable, hard, or rigid material.

Such rings are commonly formed of three or more similar segments which fit closely together and are so shaped, with tangential, inter-abutting edges, that the pressure of sealed fluid, directed radially inwardly upon the outer periphery of the ring, urges the segments radially inwardly into substantially fluid-tight association with a reciprocating rod extending through the ring. Such rings commonly have a smooth side sealing face at a rear side thereof which face, under pressure of sealed fluid, applied axially to the opposite or pressure side of the ring, forms a substantially fluid-tight seal with a related back-up ring or with a wall of a container assembly within which it is mounted. Such segments, independently of such pressure, are commonly held together in co-planar relationship by a garter spring.

The mentioned radially directed fluid pressure and the axially directed fluid pressure give rise, in rings hitherto employed, to a very forceful sealing engagement of the rings' segments with the rod and with the side wall of a related container, thereby causing relatively rapid wear of the rings' segments and/or of the rod and the container wall. Additionally, such forceful sealing engagement of the composite ring with the rod gives rise to excessive power losses.

An important object of this invention is to provide a segmental packing ring which substantially eliminates all excessively forceful engagement of the ring's segments, both with a rod extending through the ring and with a side wall of a related container to minimize wear and power losses.

The foregoing and other more or less obvious objects are accomplished, according to the broader aspects of this invention, by forming the segments of the packing ring with balancing surfaces which are exposed to the high pressure of the sealed fluid. The conformation of the segments is such that the force of radially inwardly directed fluid pressure imposed upon the segments of the ring is largely offset by the force of fluid pressure applied to balancing surfaces of the ring exerting a radially outwardly directed opposing force. The rings, according to this invention, also may be formed with balancing surfaces upon which the pressure of the sealed fluid is effective axially in opposition to the fluid pressure urging the ring against a side wall of a related container.

Several embodiments of this invention are shown in the accompanying drawings for illustrative purposes, it being understood, however, that this invention is not limited to such illustrated embodiments.

In the drawings:

FIGURE 1 is a central vertical sectional view through

a portion of a machine casing showing, associated therewith, a preferred embodiment of segmental packing rings and packing ring sets according to this invention, employed for effecting a seal between the machine casing and a rod extending through an opening in said casing.

FIG. 2 is a side elevational view, as from the plane of the arrows 2—2 of FIG. 1, of a radially split, segmental back-up ring such as is usually employed in practicing this invention, in side-by-side relationship with a tangentially split, segmental, packing ring, in the arrangement illustrated in the latter figure; the opposite side surfaces of this back-up ring being uninterruptedly planar, except for dowel provisions hereinafter detailed.

FIG. 3 is a side elevational view, as from the plane of the arrows 3—3 of FIG. 1, of the rear side of a tangential, segmental, packing ring, as illustrated in the latter figure.

FIG. 4 is a side elevational view, as from the plane of the arrows 4—4 of FIG. 1, of the opposite or pressure side of the tangential ring shown in FIGS. 1 and 3.

FIG. 5 is a fragmentary sectional view of a set of the packing and back-up rings illustrated in FIG. 1, showing a dowel pin arrangement for preventing relative rotation of the two rings to keep their splits in non-alignment with each other.

FIG. 6 is a vertical sectional view somewhat similar to the upper portion of FIG. 1 but illustrating the use of modified tangential rings according to a second embodiment of this invention.

FIG. 7 is an elevational view of the rear side of the tangentially split packing ring illustrated in FIG. 6.

FIG. 8 is a radial sectional view of the tangential ring shown in FIGS. 6 and 7, substantially on the irregular line 8—8 of the latter figure.

FIG. 9 is an elevational view of the pressure side of the tangential ring shown in FIGS. 6, 7, and 8.

FIG. 10 is a vertical sectional view somewhat similar to FIG. 6 but illustrating the use of further modified tangential rings according to a third embodiment of this invention.

FIGS. 11, 12, and 13 are views generally similar in character, respectively, to FIGS. 7, 8, and 9, illustrating, however, the tangential ring shown in FIG. 10; the section shown in FIG. 12 being substantially on the line 12—12 of FIG. 11.

FIG. 14 is a view somewhat similar to FIG. 10 illustrating, however, a fourth embodiment wherein tangential packing rings, according to this invention, are employed without any related back-up ring.

FIG. 15 is a view similar to FIG. 14 showing, however, a fifth embodiment of this invention wherein a single back-up ring is employed in association with one (usually the outermost) of plural tangential rings; the latter being illustrated as of the same character as the tangential rings of FIGS. 10–14.

FIG. 16 is a view generally similar to FIG. 1, illustrating, however, the use of only a single set of segmental packing rings according to this invention; the tangential ring being shown as like those illustrated in FIGS. 1, 3, and 4 (although, optionally, it could be of any other suitable form within this invention), while the back-up ring is solid rather than segmental.

FIG. 17 is a perspective view of the back-up ring of FIG. 16.

High pressure, as referred to herein, contemplates all fluid pressures which, in the use of prior segmental packing rings not embodying this invention, would give rise to the mentioned excessive wear and power losses. Segmental seals, according to this invention, are particularly useful in sealing gases which are contained at rela-

tively high pressure and in most applications use would be made of plural segmental packing rings or sets of such rings.

Referring to FIGS. 1–5, a machine casing wall **20** is shown as formed with a bore **21** through which extends a rod **22**. A counterbore **23**, formed in the casing wall, constitutes a packing recess accommodating tightly therewithin a series of three angular ring containers **24**, held in place by a closure plate **25** which is suitably secured to the casing wall by plural machine screws **26**.

The containers **24** are similarly of angular shape in cross-section, and each has, in an internal rabbet **24***a* thereof, a packing ring set consisting of a back-up ring **27** and a tangentially split-packing ring **28**. The inside diameter of the rabbet **24***a* is substantially greater than the outside diameters of the rings **27** and **28**, thereby providing a fluid-pressure chamber **29** extending about the outer peripheries of said rings; and the axial dimension of said rabbet is at least slightly greater than the combined axial thicknesses of said rings.

Back-up ring **27** is a segmental ring comprising, as shown in FIG. 2, three segments **30** abutting each other at radial splits **31**; and the three segments are held together by means of a garter spring **32** which is tensioned about the periphery of the thus constituted ring and seats within a circumferential groove **33** extending about all three segments. Because of the fact that the splits **31** extend radially, as illustrated, the constituted ring is limited as to its inside diameter, which is only slightly larger than the diameter of the rod **22** to provide a free sliding fit therewith.

The packing rings **28**, illustrated in FIGS. 1–5, are all alike. Each is constituted of three similar segments numbered **34** which, however, abut each other at splits **35** which are tangential to the inside cylindrical surface of the composite ring. The segments **34** are held together by a tensioned garter spring **36** seated in a peripheral groove **28***a*. Thus, the packing ring **28**, because of its tangential split arrangement, is capable of closing-in radially to compensate for wear which may occur at the inside of the ring during operation. As it is desirable, for sealing purposes, to keep the splits **31** of ring **27** out of alignment with the splits **35** of ring **28**, the two mentioned rings are held in such non-aligned condition and against relative rotation by any suitable means as, for example, by dowel pins **37** which may be provided in the segments **34** of ring **28** and which extend axially into recesses **38** of the segments **30** of ring **27**, these recesses preferably being oversize at least radially of the ring to allow for the mentioned wear-compensating closing-in of the segments of ring **28**.

The inventive aspects of the ring **28** reside chiefly in certain conformations thereof providing oppositely facing pressure-receptive surfaces which cause the segments **34** of ring **28** to be subjected to counteracting forces from the pressure of sealed fluid directed radially, both inwardly and outwardly, and/or axially in opposite directions to minimize wear as hereinbefore mentioned.

The pressure side of the composite ring **28** is formed with a continuous inner circumferential recess or rabbet **39** defined radially by an annular land **40**, at the outer periphery of the ring.

The rear side of the composite ring **28** is formed with an annular land **41** at its inner periphery and, at its outer periphery, a circular series of relatively long, equidistantly spaced, arcuate lands **42** and smaller lands **43** equally spaced, in said series, between the lands **42**.

In considering the manner in which the pressure of sealed fluid is caused to impose counteracting forces on the segments of the tangential ring **28** to achieve the stated objects of this invention, it should be noted that fluid pressure at P (FIG. 1) is communicated along the rod **22** into rabbet **39**, thereby urging the ring set RS axially outwardly against radial flange **24***b* of the center ring container **24** and enabling the fluid pressure to be communicated radially outwardly past the pressure side of the innermost ring **28** into pressure chamber **29** surrounding the latter ring and thence, into a pressure chamber **44** constituted of channels **45** between the several lands and a circular channel **46** between the annular land **41** and the series of lands **42**, **43**.

It will be understood that, with uniform unit pressure of the sealed fluid present in areas as just indicated, the force of fluid pressure imposed axially outwardly upon the exposed entire, axially facing surfaces of the pressure side of the innermost ring **28** is substantially but not completely counteracted by the force of the fluid pressure imposed axially inwardly upon said ring in the pressure chamber **44**, the exposed, axially facing surfaces of which are of lesser total area than the oppositely, axially facing surfaces of the pressure side of said ring **28**. Thus, the described land and channel configuration of the rear side of ring **28** causes the latter to bear relatively lightly against its related back-up ring **27**, thereby minimizing side-surface wear and subsequent distortion incident to the use of prior metal packing rings.

It will also be understood that the force of fluid pressure in pressure chambers **29** and **44**, effective radially inwardly upon radially outwardly facing cylindrical surfaces defining said chambers, is very substantially but not completely counteracted by the force of fluid pressure, effective radially outwardly upon radially inwardly facing cylindrical surface **47** defining rabbet **39** and upon radially inwardly facing arcuate surfaces **48** and **49**, respectively, of the several lands **42** and **43**. Thus, the described rabbet, land, and channel configurations of the two sides of ring **28** cause the segments of the latter to bear relatively lightly upon the rod **22**, thereby minimizing wear of the interengaging surfaces of said segments and said rod and also minimizing power losses.

The foregoing description of the effect of counteracting pressure forces upon the innermost ring **28** also applies to the rings **28** of the two other illustrated ring sets, it being understood that each of said two other ring sets is operative only with respect to the pressure of fluid which may have escaped past a preceding, more inwardly located one of said ring sets.

It will also be understood that the degree of balancing of the rings **28** (i.e., the relationship of counteracting fluid pressure forces), may be considerably varied to adapt such rings for use under various operating conditions. Such variation may be effected by suitably varying the dimensions of the different pressure-responsive surfaces of the rings as, e.g., by changing the width of the channels **45**, by changing the depth of the pressure chamber **44** and by changing the dimensions of the rabbet **39**.

The second embodiment, illustrated in FIGS. 6–9, differs from the already detailed first embodiment chiefly in that, at the pressure side (FIG. 9) of each of the three similar tangential rings **28***b*, radial channels **51** are provided, freely interconnecting a continuous rabbet **39***a* with pressure chamber **29**; and said channels **51** may serve two purposes. First, they may serve to change the radial balance of the ring, as compared to such balance in a ring according to the first embodiment, because the radially inwardly facing cylindrical surfaces **52** and **53** of lands **54** and **55**, formed by the provision of said channels, present less pressure response area than is presented by the surface **47** of FIGS. 1 and 4. Second, the channels **51** afford free fluid communication between rabbet **39***a* and pressure chamber **29**, thereby permitting the set of rings **27**, **28***b* to fit quite closely, but nevertheless freely slidable radially, between radial flanges of successive ring containers **24**. Such fit in the first embodiment would be less close to assure fluid communication to chamber **29**.

It may be observed that the segmental rings **28** and **28***b* of the first two detailed embodiments are quite thin or narrow, this being desirable in order to minimize the axial dimension of the entire packing assembly provided

for the rod **22**. This narrowness is accentuated by the cutting out of the rabbet **39***a* and the pressure chamber **44**. But for an important feature of this invention, the thin segments of the rings **28** and **28***b* tend to wobble, in operation, as a result of the varying fluid pressure forces imposed upon their side faces. The mentioned feature is the disclosed arrangement wherein the lands **42** of the first embodiment (FIG. 3) and the corresponding lands of the second embodiment (FIG. 7) as well as the latter embodiment's lands **54** (FIG. 9) extend across tangential splits at which the segments abut. Thus, the ends of the segments, at the outer periphery of the segmental ring, are given substantial width and resultant full support against wobbling. The intermediate, smaller lands **43** (FIGS. 3 and 7) provide support between the lands **42** both to oppose wobbling and to oppose distortion of the segments by fluid pressure imposed upon the pressure sides of the segments.

The third embodiment, illustrated in FIGS. 10–13, differs from the first and second embodiments in a substantial change of form of the three similar tangential rings **28***c* which are tangentially split similarly to rings **28** and **28***b*. Referring to the innermost or most rightward of the rings **28***c* of FIG. 10 for description, also of the other two identical rings **28***c*, the pressure side of the ring **28***c* (FIG. 13), like the pressure side of ring **28***b* (FIG. 9), is formed with a discontinuous inner marginal rabbet **39***a*, in fluid communication with pressure chamber **29** through radial channels **51**; said rabbet and channels defining lands **54** and **55**. The rear side of ring **28***c* (FIG. 11), except for separate peripheral bays **56**, has a flat land surface **57**.

Each ring **28***c* is formed with a radially inwardly facing groove **58**, and axial apertures **59** afford free communication of fluid pressure from the pressure side of the ring to said groove.

It will readily be seen that, with tangential rings **28***c*, fluid pressure effective axially inwardly upon the bottom surfaces **56***a* of the bays **56** operates to counteract, in a measure, the axially outwardly directed force of the fluid pressure applied to the pressure side of the ring; and fluid pressure effective radially outwardly upon the cylindrical bottom area **58***a* of groove **58** operates to counteract, in a measure, the radially inwardly directed force of the fluid pressure applied to the outer peripheral surfaces of the ring at pressure chamber **29**.

FIG. 14 merely illustrates that tangential rings within this invention may be employed without any back-up rings, in which arrangement the two innermost tangential rings (shown for illustrative purposes as rings **28***c*), are pressure urged against radial flanges **24***b* of the two outermost containers **24** and the outer tangential ring is urged by fluid pressure against the inner face **25***a* of closure plate **25**.

FIG. 15 shows that, under some conditions, it may be desirable to employ a single back-up ring **27** disposed between the outermost tangential ring and the closure plate **25**.

FIG. 16 shows that, under some conditions, a single set of rings may be employed in a single container **24** and directly held in place by plate **25**. In this set of rings, the tangential ring is shown, for illustrative purposes, as a ring such as is shown at **28** in FIGS. 1–5. The back-up ring, however, is shown, for illustrative purposes, as a continuous or non-split ring **60**.

It should be understood that either a split back-up ring **27** or a continuous back-up ring **60** or equivalents of either of these rings may be employed with any tangential ring within this invention. The dowel arrangement, shown at **37**, **38** in FIGS. 2–5, should preferably be employed when a split back-up ring is employed but is not necessary when a continuous back-up ring is used.

One familiar with the subject art will perceive that the various forms of tangential rings disclosed herein serve, as examples, to show various ways in which such rings may be formed to give rise to fluid pressure forces acting upon the ring in opposition to fluid pressure forces acting thereon radially inwardly and/or axially outwardly. Moreover, the extent or value of such opposing forces may, of course, be quite minutely varied or proportioned to the opposed forces by suitably varying the dimensions of the disclosed lands, channels, grooves, and the several pressure chambers generally.

It is worthy of note that, at the rear sides of the tangential rings, the land areas extend substantially along or into marginal areas bordering the outer and inner peripheries of the rings. This affords support for the ring against the axially outwardly directed force of the high fluid pressure of the sealed fluid, thereby opposing distortion of the ring.

It should also be understood that the inventive concepts disclosed herein may be practiced in various other ways without, however, departing, from this invention as set forth in the following claim.

I claim:

A segmental packing ring comprising segments, of substantially non-deformable material, which are in abutment at axially extending surfaces of tangentially extending splits; said segments having radially outwardly facing surfaces receptive to fluid pressure directed radially inwardly thereon to urge the segments forcefully against a rod extending through said ring and each of said segments being formed with spaced arcuate lands extending circumferentially of the ring and having radially inwardly facing surfaces receptive to fluid pressure directed radially outwardly thereon to oppose said radially inwardly directed pressure and thereby ease the engagement of said segments with the rod; said lands on each segment being located adjacent the segment's outer circumferential surface and at the tangentially extending splits at opposite ends of the segment in abutment with similarly located arcuate lands of adjacent segments, whereby to provide lateral support at the outer periphery of the ring against wobbling of the segments thereof; said lands, further, being provided at both the pressure side and the rear side of the ring.

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