

Feb. 5, 1952

S. DOBROSAVLJEVIĆ

2,584,679

REVERSIBLE PACKING

Filed Aug. 8, 1946

4 Sheets-Sheet 1

FIG. 2

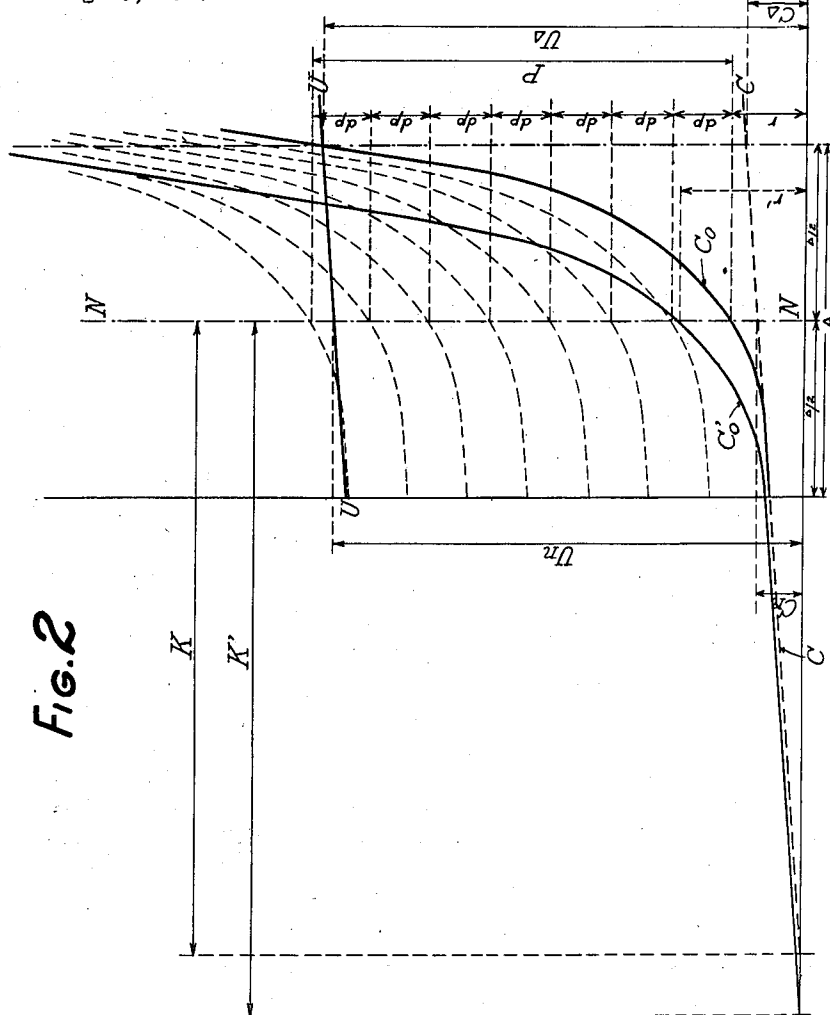
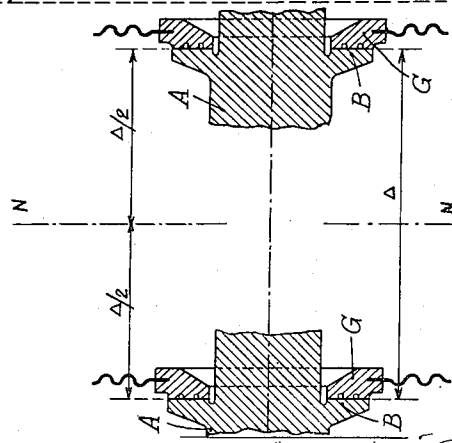


FIG. 1



Inventor:
Stojimir Dobrosavljević
By Hinkle, Norton, Adlberg, Hausmann & Knipper
Attorneys

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FIG. 3

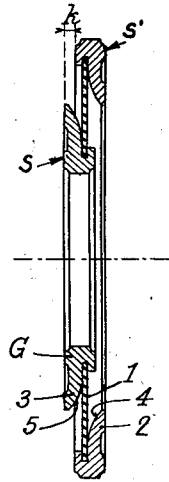


FIG. 4

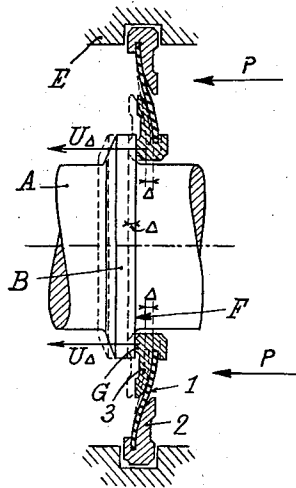
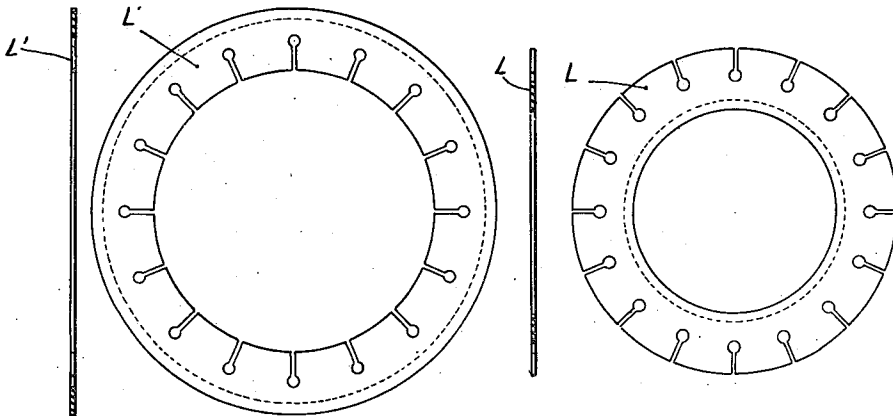


FIG. 6

FIG. 5

FIG. 8

FIG. 7



Inventor:
Stojimir Dobrosavljević
By *Hinkle, Horton, Allberg, Hansen & Kupper*
attorneys

Feb. 5, 1952

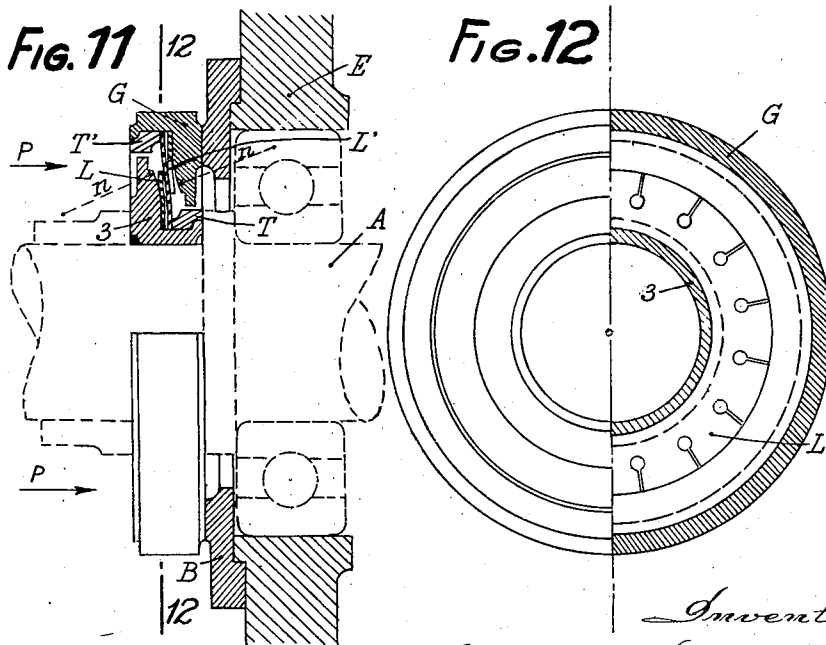
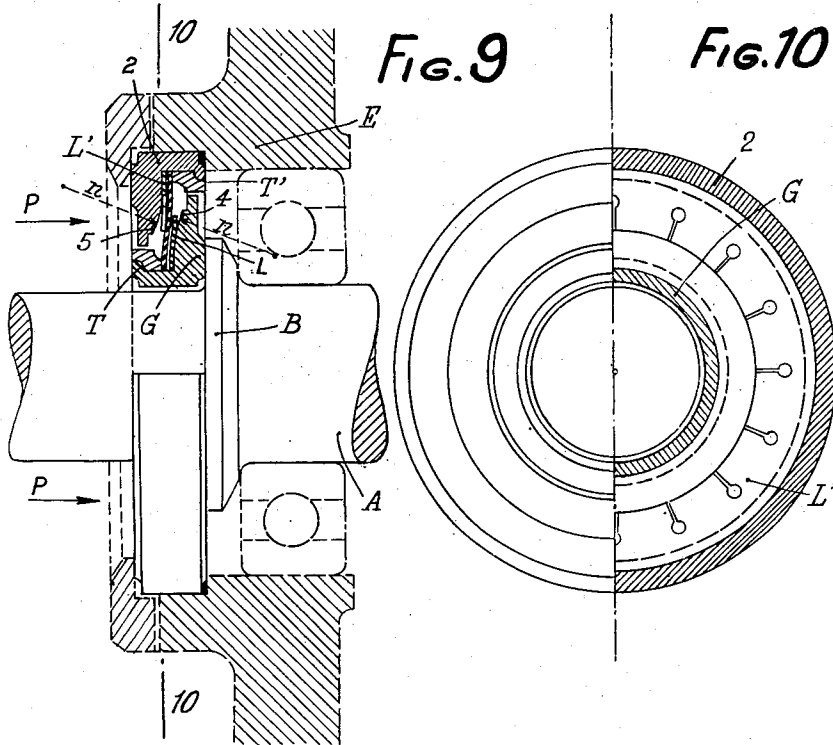
S. DOBROSAVLJEVIĆ

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4 Sheets-Sheet 3



Inventor:
Stojimir Dobrosavljević
By Hinkle, Horton, Ahlberg, Hanson & Kupper
attorneys

Feb. 5, 1952

S. DOBROSAVLJEVIĆ

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Fig. 17

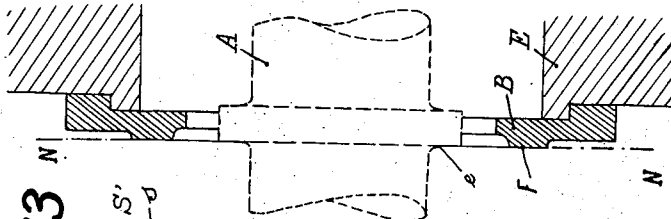


Fig. 13

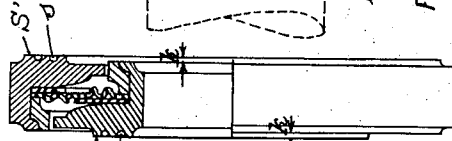


Fig. 16

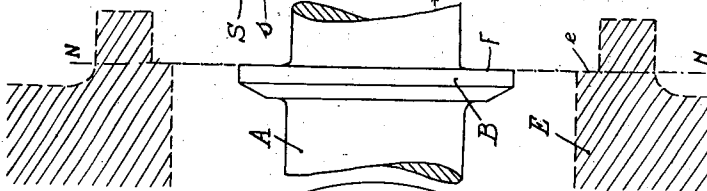


Fig. 15

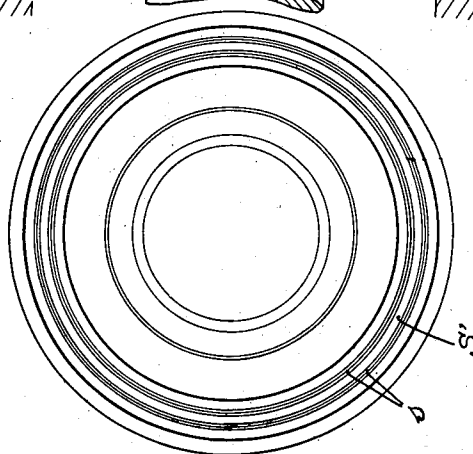
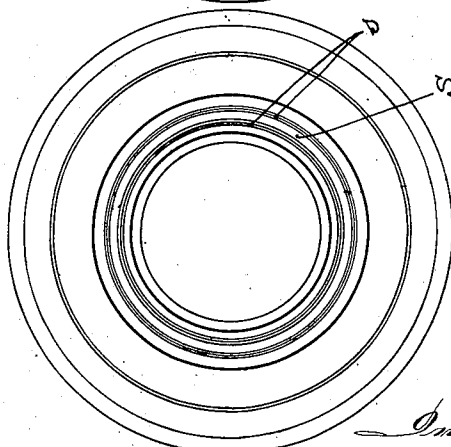


Fig. 14



Inventor:

Stojimir Dobrosavljević
By Hinkle, Horton, Alberg, Hausmann & Kupper
attorneys

UNITED STATES PATENT OFFICE

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REVERSIBLE PACKING

Stojimir Dobrosavljević, Paris, France, assignor,
by mesne assignments, to International Engi-
neering General Research & Licensing Com-
pany, Wilmington, Del.

Application August 8, 1946, Serial No. 689,076

3 Claims. (Cl. 286—11)

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The present invention relates to a reversible packing, the purpose of which is to provide impermeability between two mechanical parts which are in relative rotating movement.

The different packings known at the present time utilize either a supple diaphragm of variable profile, more or less flat, or a cylindrical membrane similar to a bellows. These elements are utilized for their own quality of impermeability and for their suppleness which permits a relative play in the axial direction, of the turning parts between which impermeability is to be effected. In addition to the aforesaid diaphragms, these packings include an elastic body, in general a coil spring, assuring the necessary average pressure between the rubbing tight surfaces which usually are, on the one hand, a thrust-block surface, and on the other hand, the surface of an element (tight face) of the packing. The average pressure is that which the spring exerts in the average position of the thrust-block between the two extreme positions of its possible axial oscillation having an amplitude Δ .

In order to give greater suppleness to this packing, the spring has a relatively large number of turns, and consequently a relatively great length.

These prior art packings present numerous inconveniences: In the first place, in view of the fact that the average pressure of the spring is practically constant, that is to say, not proportional to the pressure of the fluid, it is necessary to employ a spring sufficiently strong to resist the maximum pressure of the fluid, hence exaggerated wear and damage is caused on the rubbing surfaces, even when that is not necessary, that is to say, when the fluid is at much lower pressure. This wear and damage give rise to leaks.

Besides these inconveniences, of a hydrostatic nature, there are others of a kinetic nature. When there is a possibility of axial displacements in the course of the relative rotation of the parts, these displacements are produced at a relatively great speed, in the form of oscillations. As a result of the inertia of the different parts of the packing, the tight face in particular has a tendency to lose close contact with its thrust-block surface at the frequency of the oscillations. Leaks result therefrom at each oscillation. These oscillations can also be produced or aided by geometrical irregularities existing between the rubbing surfaces of the face and of one of the parts. Moreover, irregularities which may exist on the rubbing surfaces other than these tight faces are also susceptible of producing the same detrimental effect.

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In addition to the aforesaid inconveniences which are sources of leaks, these packings are cumbersome, they impose special conditions to be considered in the plans for machines or installations, they must be specially studied and designed for each installation and for their installation and their maintenance, qualified personnel is required. In any case, they cannot be standardized, nor can they in any case be utilized in a tight bearing.

The tight packing according to the invention remedies all of the aforesaid inconveniences.

Consequently, an object of this invention is to produce a tight packing universally utilizable in all cases where it is necessary to assure impermeability against the passage of gas, of liquids or of steam, between mechanical parts in relative rotation (complete rotation or rotary oscillation of an interior part opposite an exterior part) whether these movements are continuous or intermittent.

Another object is also to produce a tight packing utilizable for different pressures from zero to the highest pressures, and capable of being used under different temperature conditions, including those considered as maximum permissible for the preservation of good physical and chemical qualities of the materials employed.

The invention has also for another object to produce a packing maintaining perfect impermeability, while permitting the maximum radial and axial play usually tolerated in turning joints, as in the case of a shaft in a smooth bearing and in the case of speeds of rotation ranging from zero to the maximum permitted by the other machine parts, while permitting the reversing of direction of rotation of the parts between which impermeability must be accomplished. The packing according to the invention is also utilizable for all diameters of interior or exterior parts.

A further object is to provide tight packing which can be utilized also as a protection shutter against the ingress of impurities and of different fluids harmful by reason of their high temperature or their chemical action and against losses of oil etc.

Other objects and advantages will become apparent from the specification taken in conjunction with the accompanying drawings wherein:

Fig. 1 diagrams the extreme positions of oscillation in a packing, and is to be correlated to the diagram of Fig. 2;

Fig. 2 is a diagram showing the pressures exerted by the packing against a thrust-block in terms of the relative axial displacements of the parts between which impermeability should be assured and contrasts the pressures of the prior

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art packings with those of the packing of this invention;

Fig. 3 is a medial sectional view of a packing constructed according to the present invention (before its installation);

Fig. 4 is a medial sectional view showing the packing of Fig. 3 in installed position and in service;

Figs. 5 and 6, 7 and 8 illustrate in plan and sectional views elastic reinforcement washers of the diaphragm, the use of these washers being optional;

Fig. 9 illustrates in elevation and in partial axial section one form of a packing constructed according to this invention in a first use setting;

Fig. 10 is a corresponding plan view on the left half and a sectional view, following the line 10—10 of Fig. 9, on the right half;

Figs. 11 and 12 are similar views of the same packing, in a second use setting, and illustrating the reversible feature of the packing;

Fig. 13 is a view similar to Figs. 9 and 11, and illustrates a reversible packing with another type of diaphragm;

Figs. 14 and 15 are elevational views illustrating the tight faces or support faces seen on the two sides of the reversible packing of Fig. 13; and

Figs. 16 and 17 show two methods of installing the packing of Fig. 13 to illustrate its quality of reversibility according to this invention.

The packing according to the invention is based, like the prior art packings, on the application of a tight diaphragm, preferably metallic, having sufficient suppleness and a certain elasticity. Nevertheless, non-metallic diaphragms can be utilized by reason of their better qualities of suppleness and of flexibility, but on condition that their mechanical, chemical and thermic qualities are suitable for the conditions of use. However, to eliminate the inconveniences of the prior art devices, mentioned heretofore, the packing according to this invention includes neither a coil spring nor any elastic body subject to torsions and to resonance.

In the packing according to this invention, illustrated in medial section in Fig. 3, the annular diaphragm 1 is mounted between two concentric rings 2 and 3, fixed in a tight manner on the outer and inner peripheries respectively of the diaphragm 1, this attachment being sufficiently positive to prevent any possibility of relative rotation of the parts constituting the packing; for example, the latter is set in these rings, as seen in Fig. 1. These rings embody a system of convex and concentric bearing surfaces 4 and 5, respectively, on which the diaphragm rests at the time of a relative axial displacement in service, of the parts A and E between which impermeability is to be effected, as shown in Fig. 4.

At the back of these convex bearing surfaces and the outside of the rings, the later present surfaces S and S' intended to act, either as tight faces or support faces, according to the variants of uses which will be explained hereinafter, which give to the packing the property of being reversible. There are shown in Fig. 4, in dotted lines and in solid lines, the two extreme positions which the tight face G and the diaphragm of the packing can take, at the time of relative axial displacements of the parts A and E which carry it, these extreme positions corresponding to a maximum oscillation Δ . (This is shown in more exaggerated fashion in Fig. 1.) As seen, the packing is mounted in the exterior part E, while in its center, it bears against a surface F of a

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thrust-block B of the interior part A, with a pressure resulting from the elastic deformation of the diaphragm and pressure P from the fluid itself. If the two bearing surfaces 4 and 5 were not provided, this elastic deformation would be proportional to the force of action obviously according to Hooke's law, and it would be approximately represented in the diagram of Fig. 2 by the straight dotted line C. By reason of the presence of the convex bearing faces 4 and 5 on which the diaphragm rests when it is deformed, the elastic reactions do not follow the lineal law of proportionality but they increase more rapidly, obviously in the form of a parabola, as represented by the line C₀.

The convex profiles of the bearing surfaces are not necessarily the same for the two rings of the same packing, and it is not absolutely necessary to provide them on the two rings. By selecting these profiles in an appropriate manner and considering the initial elasticity characteristics of the diaphragm 1, one can obtain in each case the desired elastic reaction force U_Δ, for the sudden reaction of the packing, maintaining at the same time the initial pressure against the surface F of the thrust-block B as low as possible, and determining with precision the initial point of the curve C₀, that is to say, the point starting from which the elastic reactions will no longer be represented by the straight line C, but by the parabola C₀. This point should be adjoining the straight line NN, corresponding to the average position

$$\frac{\Delta}{2}$$

of the tight face in the course of the relative axial oscillation Δ . Starting with the relatively weak elastic reaction forces of the diaphragm assembly, which are represented on the diagram of Fig. 2 by the straight line C in dotted line, corresponding approximately to Hooke's law, the packing is assured an average pressure C_n (disregarding here the action of the convex bearing surfaces), very weak, against the thrust-block in comparison with the pressure U_n of a coil spring. This weak average pressure is sufficient to maintain the tight face in contact with its thrust-block, even without intervention of the pressure P of the fluid. Thus, too great support pressures of the tight face against the thrust-block are avoided when not necessary.

By the fact that such a weak average pressure is used, the fluid itself, for which impermeability should be realized, is permitted to exert by its own pressure P acting on the whole surface of the diaphragm, the necessary pressure against the thrust-block, which is added to the elastic reaction r to maintain the tight face against its thrust-block about in proportion to the pressure P.

In Fig. 2, there is indicated in dotted lines the displacement of the characteristic line C₀ as the pressure of the fluid increases by equal quantities dp .

It will be noted, with regard to the diagram of Fig. 2, that its dimensions have been greatly exaggerated to make it clearer, as shown by comparison of the value of Δ on this figure and in Fig. 4. There is also seen in the diagram on an exaggerated scale in a similar manner the length K representing the deformation (average dip) of the packing from its position before installation to its average position following the line NN, a length which appears also in Fig. 3.

but obviously in its actual size. The displacement K thus defined as elastic average dip is then to be considered as determinant length of the elastic reaction r , that is to say, of the initial pressure against the thrust-block, supposing the pressure of fluids equal to zero.

By simple comparison of the prior art packings with the packing of this invention, it is seen that the omission of the coil spring permits considerable reduction of the dimensions (and consequently all of the masses) of the packing and in particular of the tight face G, which reduces the effect of all of the detrimental kinetic phenomena.

To determine with precision the important points of the curve C_0 , that is to say, to have the desired elastic deformation, it is necessary to give certain initial characteristics to the diaphragm with regard to its elasticity and, to obtain the desired result, it may be necessary to reinforce the diaphragm by the aid of one or two or several elastic washers such as shown in Figs. 5 to 8. These washers are mounted on one side or the other, or on both sides, on the interior periphery or on the exterior periphery, as the case may be. The use of such washers is particularly desirable when using very thin or non-metallic diaphragms.

As, neither the diaphragm itself, nor its support washers are subject to elastic torsions (as in the case of a coil spring), there is no tangential chattering of the tight face on the thrust-block surface. They do not give rise either to phenomena of axial resonance, which suppresses all of the cause of leaks due to these two phenomena.

The sudden reaction of the packing due to the parabolic form of the curve C_0 , as diagrammed in Fig. 2, gives the very favorable possibility of using such a packing also as an automatic valve, whether the parts A and E are in relative rotation movement or whether they are arrested.

For the same reason, it always acts as a very energetic centering element by the fact that it energetically opposes itself to the relative axial oscillations between the parts A and E, due to the rapid movement of these parts and also to the fact that it tends clearly to reduce to the minimum the amplitude of these oscillations. In this manner, the packing acts at the same time as an elastic stop-buffer forming part of the bearing (while assuring the impermeability) and can be employed solely for this purpose. Moreover, it can be employed as an element for taking up the play between the different mechanical parts, as an elastic spacing ring, etc.

Inasmuch as such a packing can have small dimensions, as well as simple exterior geometric forms, and being reversible according to the invention, it can be standardized in the same manner as ball bearings.

In cases where the conditions of use permit, the packing can be utilized as a tight bearing with elastic thrust-block according to three typical variants of use, to wit, attachment on the outer part, attachment on the inner part, and floating mounting.

In Figs. 9, 11, 16 and 17 there is always represented in dotted lines the part on which the packing is attached, and in solid lines, the part carrying the thrust-block. The purpose of these methods of designation and of illustration is to show more clearly the reversibility of the packing.

For greater clarity, and with the purpose of giving to the designations NN and K employed on the graph of Fig. 2, a concrete significance

in the simplest possible manner, there is represented, in Figs. 16 and 17, the tight surface F of the thrust-block B and the support surface e in the same plane NN, the plane NN always representing the average position between the two extreme points of relative axial displacement of the parts A and E in the course of their possible oscillations of amplitude Δ , and representing at the same time the initial average position, starting from which the average elastic dip or displacement K of the packing is counted.

In Figs. 9 and 11, analogous arrangements have been represented with relation to the plane NN. Nevertheless, it is to be noted that, for exceptional reasons, the surface F should not necessarily always be in the same plane NN as the surface e .

The diaphragm constructed according to this invention can have the most diverse forms although only two are shown in the drawings. Moreover, the diaphragm can be made of a single washer or of several, of the same profile or of different profiles, superimposed in a bundle.

In Figs. 9 and 10, a first use setting of a packing made according to the invention, has been shown. The thrust-block B is shown there, carried by the interior part A, while the packing is attached in a tight manner on the exterior part E. It is seen that the diaphragm properly speaking (which is represented for reasons of simplicity in the form of a flat washer) is supported, on both sides, by an interior spring washer L and by an exterior spring washer L'.

To assure perfect impermeability and not only between the face G and the surface of thrust-block B, the diaphragm I should itself be mounted in a tight manner in the rings, to prevent any possibility of relative rotation between the exterior and interior rings. This mounting can be done by the setting shown, or in any other manner. To facilitate the setting, two auxiliary rings T and T', of tempered steel, can be used, the form of which can vary according to the forms of the diaphragm. The washers L and L' are mounted and set together with the diaphragm. They reinforce the diaphragm and they complete, if that is necessary, its characteristics of elasticity by modifying them at will according to their dimensions. The form of the washers L and L' can vary with the form of the diaphragm and according to other requirements.

For greater simplicity, in Fig. 9 the convex bearing surfaces 4 and 5 have been shown as being arcs of a circle of radii r , but these curves could be others and may be different for the two bearing surfaces, according to the desired packing characteristics, but it is necessary, however, that the support faces or tight faces S and S' of the rings 2 and 3 be arranged back of these convex bearing surfaces.

The second use setting, illustrated in Figs. 11 and 12, presents appreciably the same characteristics as the device of Figs. 9 and 10, except that the thrust-block B is provided on the outer part E and that the packing is attached, in a tight manner, on the inner part A, this being possible since the packing is reversible.

In Figs. 14 and 15, it is seen that the tight faces S and S' of packing of Fig. 13 can include grooves s permitting lubrication.

Fig. 13 shows a similar packing which may be mounted on the device of Fig. 16 by attachment in the seat of the outer part E while the inner ring bears by its face S on the surface F of thrust-block B of the inner part A. When the packing is mounted in the device of Fig. 17 the

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relationship is reversed. It is seen in Fig. 13 that the displacement K, dimension determining with relation to NN, the initial pressure, and which has been mentioned above, is the same in the two cases of use of the packing, but this is not absolutely necessary.

From the foregoing description of a limited number of examples of how the reversible packing of this invention might be used it is clear that the objectives claimed for the packing have been attained. Numerous additional methods of using the packing will suggest themselves to those skilled in the art as will structural variations in the packing itself. I therefore desire, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. A reversible packing of the type sealing between inner and outer machine members having relative rotational movement and which may be displaced slightly axially and angularly relative to each other, including in combination two concentric rings having on their outer sides tight faces engageable, respectively, with the machine members, at least one elastic diaphragm extending between said rings and held in a tight and relatively non-rotational manner in each of said rings, and at least one of said rings having a convex bearing surface on its inner face against which said diaphragm is adapted to come more or less into contact as said diaphragm is axially elastically deformed by axial displacement of the machine parts and pressure exerted on the face of the diaphragm, the packing being mounted under tension by axial elastic deformation of said diaphragm, and the curvature of said convex

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bearing surface being such that as said elastic diaphragm, as a result of the axial displacement of the machine members and the pressure acting on the diaphragm face, comes into contact with a greater amount of the area thereof the pressure exerted by the packing tight faces and the machine members increases parabolically.

2. A reversible packing as claimed in claim 1 wherein the inner faces of both said concentric rings are provided with convex bearing surfaces the curvature of which causes the pressure exerted by the packing tight faces on the machine members to increase parabolically as a greater amount of the area of said diaphragm comes in contact with said bearing surfaces.

3. A reversible packing as claimed in claim 1 including at least one elastic washer interposed between said diaphragm and said convex bearing surface and held within said diaphragm in that ring having said convex bearing surface.

STOJIMIR DOBROSAVLJEVIĆ.

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