

March 25, 1947.

J. F. JOY

2,417,828

FLUID SEAL

Filed April 21, 1943

Fig. 1.

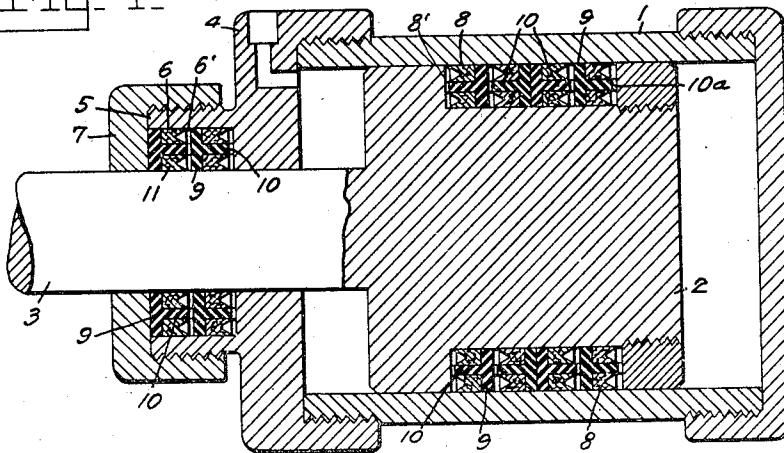


Fig. 2.

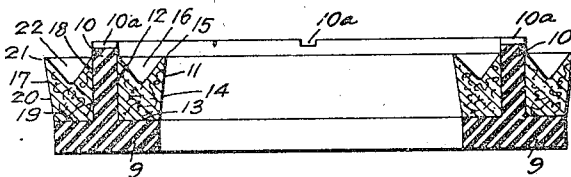


Fig. 6.

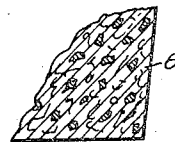


Fig. 3.

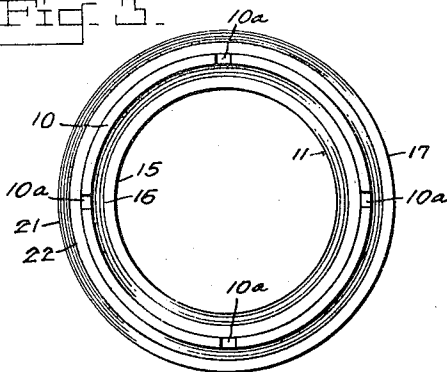


Fig. 4.

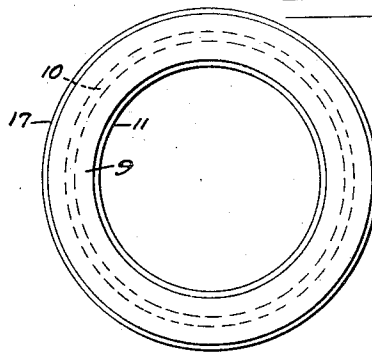
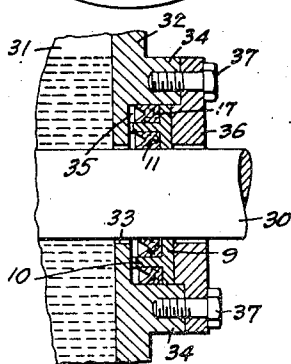


Fig. 5.



Inventor

Joseph F. Joy

By C. E. Herstrom & C. Hibodeau

Attorneys

UNITED STATES PATENT OFFICE

2,417,828

FLUID SEAL

Joseph F. Joy, Washington, D. C.

Application April 21, 1943, Serial No. 483,841

5 Claims. (Cl. 288—5)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

2

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention relates generally to the art of packing or sealing of reciprocal or rotating members of fluid mechanisms as a means of preventing loss or transfer of fluids under pressure from the confinements thereof.

More particularly the invention relates to an improved type of rod and cylinder packing adapted to be employed for the purpose of sealing hydro-pneumatic gun recoil mechanisms and hydro-pneumatic and plain pneumatic gun balancing or equilibrator mechanisms. The invention also contemplates an improved method and apparatus for sealing the operating shafts which protrude from the interior of hydraulic gun control mechanisms.

In gun recoil and counterrecoil mechanisms of the hydro-pneumatic type, liquid and gas pressures are arranged in such association as to absorb the shock of firing and return the gun to battery. The hydraulic liquid is usually a low pour point oil, and nitrogen gas is most frequently used as the pneumatic element. The proper functioning of such mechanisms depends upon an extremely exact separation between the hydraulic and pneumatic mediums.

In operation the gun upon being fired moves into recoil position. It is resisted in such movement by a recoil piston attached by means of a piston rod to the gun, usually at the breech ring. The recoil movement forces the oil or other hydraulic medium from the recoil cylinder, usually through throttling ports or orifices into a recuperator or accumulator cylinder filled with gas forming the pneumatic medium of the system. The recoil forces are finally in this way overcome as a result of the throttling orifices and the increasing pressure of the gas element, after which the gun is returned to battery or firing position through the expansion of the pressure built up in the pneumatic element within the recuperator cylinder during the period of recoil.

Aeration of the hydraulic medium as a result of its absorption of gas from the pneumatic medium seriously impairs or may even destroy the proper functioning of the mechanism chiefly because of the difference in the rate of throttling between aerated and non-aerated liquids. In order to avoid aeration of the oil or hydraulic medium as would result from its direct contact with the gas or pneumatic medium, the gas and liquid are definitely separated from contact with

each other, usually by means of a floating piston arranged in the recuperator cylinder.

With respect to artillery pieces, they are usually constructed with a preponderance of weight at the muzzle end of the piece. Balancing devices commonly called equilibrators are employed to counteract this preponderance of weight for the purpose of reducing the force required for elevating the gun. In both recoil mechanisms and equilibrators, the matter of frictional resistance of the packing mediums is of paramount importance. In the case of recoil mechanisms, such frictional resistance to movement increases the forces acting upon the gun's trunnions and supporting carriage. In the case of equilibrators, any such frictional resistance increases the force required for movement of the gun, and this, being usually done by hand, makes it imperative especially in the case of large guns that equilibrator packing frictions be held to an absolute minimum. Therefore, the many common types of hydraulic and pneumatic packings ordinarily used for other purposes are in general not satisfactory for the packing of the pistons and rods of recoil and equilibrator mechanisms. This is due chiefly to the high friction of such packings and their being susceptible to gas diffusion through their various compositions.

To overcome this, it has been the practice of artillery engineers to pack such mechanisms with combination packings, a typical form of which, the well-known French type, comprises separate rings of rubber and leather backed up by pressure loaded flanged silver rings. Sealing is attained by means of the leather and rubber rings and the silver rings are provided for the purpose of obturation. Obviously such refined construction requires close and accurate machining of cylinders and rods and their ultimate honing to accurate fits, one with the other. These fits in practice are so close as to preclude the possibility of interchangeability of parts, thus making it necessary when repairs or adjustments are required that the mechanism be returned to the manufacturer or arsenal for such operations.

It should also be noted that the use of hydraulic mechanisms is at present under consideration by ordnance engineers for the purpose of gun pointing. Such mechanisms usually consist of a hydraulic pressure generator combined with a suitable fluid motor for the actuation of traversing and elevating gears employed in positioning the gun with relation to the target. These mechanisms are sometimes referred to as oil gears and include enclosures containing fluid

3

at relatively high working pressures from which input and output shafts protrude. It is common knowledge that it is extremely difficult to avoid loss of fluid from such enclosures through the shaft openings particularly when such shafts operate at high speed. However, high speed operation may be highly desirable in certain cases as power can be obtained very efficiently from a hydraulic mechanism capable of operating at high speed.

It is therefore an object of this invention to provide a standard form of piston and rod packing of low frictional characteristics, particularly adaptable for use in gun recoil and equilibrator mechanisms and capable of interchangeability and replacement in the field.

Another object of the invention is to provide a packing or sealing device of the character herein described wherein a rigid supporting ring is provided and to which one or more flexible sealing rings are secured.

A further object of the invention is to provide a sealing device wherein a rigid supporting ring has an axially extending integral flange thereon, whereby flexible sealing rings can be secured thereto, one on each side of said flange.

A still further object of the invention is to provide, in a sealing device, flexible sealing lips which are formed of a compound which has not only wear resisting qualities but also qualities which will not permit oil and other fluids to pass there-through.

A still further object of the invention is to provide a sealing device having a rigid supporting ring and flexible sealing members secured thereto, wherein the flexible members are formed of a composition consisting mainly of a synthetic rubber and a finely powdered anti-friction metal.

A still further object of this invention is to provide an effective and dependable seal for the rotary members of fluid mechanisms particularly where it is desirable to prevent leakage or loss of fluid under conditions of both high pressure and high rotational operating speeds.

Still another object is to provide an easily installed rotary shaft seal capable of withstanding severe operating conditions and composed of a material which embodies a high degree of heat conductivity whereby the heat resulting from operation is effectively conducted away and dissipated into the supporting frame.

One of the difficulties attendant upon the use of various synthetic compounds such as "neoprene" for packing purposes has been the tendency of such materials to absorb or react with certain oils used in conjunction therewith. This absorption or reaction results in an expansion of the material which in certain cases may in turn cause an increase in pressure and consequently friction at the seal. For example, referring briefly to Fig. 1 it will be noted that my improved packing is shown at 8 and again at 6 as being wholly contained within chambers of relatively fixed volume in the piston and gland, respectively. It will be further noted that the synthetic material in each case occupies only a portion of the total available volume of these chambers so that ample free volume remains to accommodate any expansion of the packing material. In conventional packings on the contrary where high pressures are involved, this space would ordinarily be entirely filled with the synthetic material under an initial pressure. It is obvious that any absorption of oil and resultant expansion of the packing under such circum-

4

stances would result in increased pressure and friction at the seal. This is in fact a common occurrence in such packings and is known to result from the use of various newly-developed recoil oils. It is accordingly an important feature of my invention to eliminate this defect by providing a packing which allows ample room for expansion without any appreciable increase in pressure or friction.

Other and more specific objects of the invention will appear more fully upon a reading of the following description taken in connection with the accompanying drawing wherein:

Fig. 1 is a vertical section through a conventional cylinder, piston and rod showing the sealing device of my invention assembled in proper relation to the other parts;

Fig. 2 is an enlarged vertical section through a sealing device forming a preferred embodiment of my invention;

Fig. 3 is a plan view of the device shown in Fig. 2;

Fig. 4 is a plan view of the back or opposite face of the ring from that shown in Fig. 3;

Fig. 5 is a fragmentary section of a fluid enclosure showing a rotating shaft extending from the interior to the exterior of said enclosure and the manner in which a sealing ring forming a preferred embodiment of my invention may be used to prevent loss of fluid through the opening provided for the rotation of said shaft; and

Fig. 6 illustrates an enlarged fragmentary cross sectional view taken through one of the flexible sealing members or annular rings illustrated in Fig. 2.

Referring now more particularly to the drawing, for purposes of convenience Fig. 1 shows a plurality of the sealing devices embodying my invention as they are applied to a conventional cylinder and piston. While it has been explained hereinbefore that the invention is primarily intended for use with artillery equipment, it will be clear that it will also have many other uses common to hydraulic and pneumatic devices. In Fig. 1, a conventional cylinder is shown at 1 having a piston 2 therein to which is secured a piston rod 3. One end of the cylinder is shown as being provided with a cap 4 having an annular flange 5 thereon in spaced relation to the piston rod 3 so as to provide an annular retaining cavity 6'. A cap 7 is then shown as located around the piston rod to maintain the sealing device in place in the retaining cavity 6'.

Two of these devices are shown as surrounding the piston rod 3 and are used to prevent fluid from passing outwardly along the piston rod. The piston 2 is also provided with an annular groove 8', which forms a retaining cavity with the inner wall of the cylinder 1. A plurality of my sealing devices are shown inserted within this cavity 8'. Two are shown at the left hand side of the cavity for the purpose of preventing the flow of fluid toward the right and two other devices are placed at the right hand end of the cavity to prevent the flow of fluid toward the left. This is merely illustrative of the manner in which the sealing devices of my invention may be used. However, as explained above, they may also be used in recoil mechanisms and equilibrators wherein it is desired to prevent oil or other fluid on one side of a piston from becoming aerated by gas on the opposed side of the piston.

Referring now more specifically to Fig. 2; the preferred embodiment of the invention is disclosed herein and comprises a rigid supporting

5

T shaped ring 9, which has integral therewith an axially extending cylindrical section 10. This cylindrical section is preferably located intermediate the inner and outer periphery of the ring 9.

This supporting ring is then provided with two flexible ring members. The inner ring being indicated by the numeral 11 is secured to the supporting ring at its walls 12 and 13, the wall 12 being secured to the cylindrical section and the wall 13 being secured directly to the base of the ring. The inner wall 14 of the flexible ring extends in a generally axial direction but is flared inwardly slightly and terminates in a sealing lip 15 which in turn is spaced from the cylindrical section 10 by means of an annular groove 16.

The outer sealing ring 17 is similar to that just described and is secured to the supporting ring at its walls 18 and 19, the inner wall 18 being secured to the cylindrical section 10 and the wall 19 being secured directly to the base of the supporting ring. The outer sealing wall or periphery 20 of the flexible ring 17 also extends in a generally axial direction and is flared outwardly slightly and terminates in a flexible sealing lip 21, which is also spaced from the cylindrical section 10 by means of an annular groove 22.

A plurality of communicating passages are provided in the outer edge of cylindrical section 10 by crosswise through-slots 10a connecting channels 22 and 16 and thus providing a fluid pressure balance over the entire area of the seal exposed to fluid pressure.

It will be clear from the foregoing that when this ring is inserted in a retaining cavity, the inner and outer flexible walls 14 and 20 thereof will be flexed inwardly toward each other until they become substantially parallel, thus forming a tight seal against the walls of the cavity. If fluid under pressure attempts to move past the seal a quantity of it will first become lodged within either or both of the annular grooves 16 and 22 and thus exert further pressure outwardly against the walls of the cavity. It will thus be evident that the more pressure exerted the tighter will the flexible sealing lips be pressed against the walls of the cavity and thus form a better seal. It should also be noted that the cylindrical section 10 of the supporting ring extends in an axial direction beyond the sealing lips 15 and 21 so that when two or more of these rings are placed in a cavity adjacent each other as shown in Fig. 1, the sealing lips will still remain free to be flexed and perform their objectives.

Referring now to Fig. 5 of the drawings, I have shown an operating shaft 30 extending from the interior of a fluid pressure mechanism which may be either a pump or a motor, and which has an area generally designated by the numeral 31 which is subject to relatively high operating pressures. A portion of the wall 32 is illustrated which serves to confine the fluid under pressure within the space 31. The shaft 30 extends through an aperture 33 in the wall 32 and is mounted for rotation therein. The wall 32 is also formed with an annular flange member 34 which surrounds the shaft 30 and provides an annular space 35 therearound. This annular space 35 contains one of my sealing units 9 held in place by a suitable gland or cover plate 36, which in turn is secured to the flange member 34 by means of suitable hold down bolts 37. The inner lip of the packing bears against the rotating shaft 30, while the outer lip bears against the inside of the flange 34 and it should be noted that the aperture 33 is of sufficient size to freely allow fluid under

6

pressure from the space 31 to flow around the shaft 30 and act against the operating faces and lips of the sealing member. In this case the seal operates both to prevent the escape of fluid from space 31 and to absorb and transmit the frictional heat induced by the rotation of shaft 30 away from the sealing area.

While it will be clear that my invention resides in the novel features of design, the invention itself goes further and is considered as also residing in the composition of not only the flexible ring members, but also the rigid supporting ring as well.

As far as the supporting ring is concerned a number of substances may be satisfactorily used, such as bronze, steel with a thin layer of silver on the outer walls, various plastics, or molded hard rubber. Almost any material having anti-friction characteristics can be used although experiments have disclosed that certain materials are better suited for this purpose than others. By process of elimination, it has been determined that molded hard rubber is well suited for the purpose.

With respect to the flexible rings which are secured to the rigid supporting ring, numerous materials have been compounded and have been tested. In the first place, the material used for these flexible rings should be capable of resisting diffusion of gas through the walls thereof, and of the numerous synthetic rubbers and plastics available and after a considerable amount of experimentation it was discovered that "neoprene" compounds possessed the most desirable characteristics.

It was necessary in order to obtain the desired low friction values to impregnate the "neoprene" compound with an anti-friction material. Such materials of course are many and varied. However, for best results it should be a material which would bond well with the "neoprene"; that is, would serve not only to lower the friction of the resulting material but also be capable of acting as a filler in place of the usual carbon black. There are numerous metals which satisfy these requirements such as bronze, brass, silver, and the like. However, experimentation has shown that finely powdered bronze is very satisfactory and not only reduces the friction value but also bonds well with and acts as a filler for the "neoprene" compound.

To begin with a compound substantially as follows was used:

Materials	Parts by Weight
Neoprene "GN".....	54
Magnesium Oxide (extra light).....	2
Carbon Black (P53).....	30
Stearic Acid.....	3
Oil (Circolight).....	2
Neozone D.....	.6
Zinc Oxide.....	1.5
Cumar R. S.....	2.6
Bronze Powder.....	45
	138.0

It appeared, however, that this compound was too soft for the purposes of this invention and in order to obtain a greater hardness, the same compound was used except that 7½ parts of channel black were added to the compound as a hardening agent. This compound then showed some improvement in hardness but it was desired to lower the friction value still further. Another

compound was then made consisting of the following materials:

Materials	Parts by Weight
Neoprene "GN".....	54
Magnesium Oxide (extra light).....	2
Carbon Black (P33).....	30
Stearic Acid.....	3
Oil (Cireo light).....	2
Neozone D.....	6
Zinc Oxide.....	1.5
Cumar.....	2.6
Bronze Powder.....	80
	173.0

It will be noted that this is substantially the same as the first compound used except that the bronze powder content was almost doubled. It was determined that this compound had the desired characteristics not only as to hardness but also as to its anti-friction qualities.

Other subsequent compounds were also made wherein shredded leather was used, and "Pliolite," which is a commercial name for a rubber stiffener. The shredded leather compound indicated the sealing lips to be noticeably brittle and hence were likely to crack as a result of handling and operating conditions.

The compound using "Pliolite" appeared to be firm yet was somewhat tacky and not too resilient.

Subsequent tests of the various compounds mentioned under conditions of high fluid pressures and high operating speeds showed conclusively that all compounds containing metallic dust particularly bronze powder operated at greatly reduced temperatures as compared to non-metallic compounds. It was further found that the reduced operating temperature of the metalized compounds was due to their possessing sufficient heat conductivity to carry the heat away from the rubbing surfaces and dissipate the same into the supporting frame, whereas, the non-metallic compounds allowed the heat to concentrate at the rubbing surfaces thus causing early destruction of the seal under conditions of high operating speeds. The latter is particularly true of high speed shaft seals and more so where the latter operate under high fluid pressure.

Numerous other tests were made involving various compounds but it was determined that the one containing the 80 parts of bronze powder by weight appeared to be the best. Extensive tests have been carried out with this compound and it has proven most satisfactory. While I have explained above in detail some of the compounds used and tested and I have indicated the one which has appeared thus far to be most desirable, I do not wish to be limited to any one particular compound as far as this invention is concerned. It is contemplated that others may be used without departing in any way from the spirit of the invention, provided, of course, that they possess the necessary characteristics as outlined hereinbefore.

Any desired means can be used for securing permanently the flexible rings to the rigid supporting base, such as by using a cement for bonding, or curing under high pressures and temperatures, and the like.

One method which has proven satisfactory is to first mold the rubber supporting base and cure it for half of its required time and then mold the resilient rings thereto and cure the entire ring

for the remaining time. This has proven satisfactory where the curing time of the resilient rings is approximately half that of the supporting ring.

Another method of securing which has proven satisfactory is to make a liquid by dissolving a portion of the flexible ring compound in benzine, coating the rigid supporting ring with this liquid, and immediately applying the flexible rings thereto and then curing in the usual manner. The specific securing means is not important, however, as long as a permanent bond is provided between the two flexible rings and the rigid supporting ring.

It is to be particularly noted that each of my improved fluid seals is a complete self-contained sealing unit within itself. They do not require adjustment for wear and in fact the very purpose of the cylindrical section 10 extending beyond the tips of the sealing lips 15 and 21 is to prevent any pressure other than that of the fluid acting upon the sealing sections. Each seal as a unit is capable of being securely held in operating position without the holding force in any way acting upon or interfering with the freedom of action of the sealing lips.

The importance of using finely pulverized metallic dust as a constituent of the compound used for forming the flexible sealing sections of the seals cannot be overemphasized. I have found that fine metal dust, particularly bronze powder, compounds well with most synthetics such as "neoprene" without materially affecting the resiliency and elasticity of the product. I have also found that the finely powdered metal dust greatly contributes to the heat conductivity of the compound which is an element of great importance where seals are for use under conditions of high operating speeds and pressures as is particularly true in the case of rotary seals. Where it is desirable to dissipate the heat from rubbing surfaces of rotary type seals into the supporting frame this can be best achieved through the use of metal T ring sections and sealing lip facings formed of a high percentage of bronze powder or other heat conducting anti-friction metallic powder.

From the foregoing it will be obvious that I have provided a packing or sealing ring which not only possesses a novel design but is also compounded in a novel manner. The invention herein resides as pointed out above not only in the form of the ring itself, but also in the compounds which make up the various components of the ring. In actual tests it has been proven that the frictional value is extremely low and yet the sealing qualities are very high. Little or no so-called "trading" as between oil and gas positioned at opposite sides of the piston within the cylinder of gun recoil mechanisms is obtained.

It is contemplated that the invention may assume other forms than that disclosed herein, change being made as regards the particular device described, provided, however, that such changes come within the scope of the appended claims.

I claim:

1. A sealing device for spaced-apart generally parallel co-extensive walls, comprising: rigid means, having a first leg portion adapted for position transversely with respect to said co-extensive walls, and at least one second leg portion extending laterally from said first leg portion intermediate its transverse margins, said first and second leg portions being adapted to form at

least two grooves co-extensive with said walls; resilient sealing means, disposed in each of said grooves, each having a recess formed therein, providing a base portion abutting the adjoining surface of said first leg and a pair of sealing lips each of tapered construction and extending from said base portion, each sealing means, when the sealing device is assembled with said co-extensive walls, having spaced surfaces, one of which is adapted to engage and lie along the adjoining one of said co-extensive walls, and the other of which abuts and lies along the adjoining surface of said second leg portion, and each sealing means also having facing surfaces extending from said base portion in diverging relation to intersection with said spaced surfaces, thereby forming the tapered sealing lips; the foregoing construction being such that fluid pressure on said sealing device urges said base portion against the adjacent surface of said first leg and each of said sealing lips against its respective wall and the adjoining surface of said second leg portion.

2. A sealing device for concentric spaced-apart surfaces, comprising: an annular rigid supporting means of substantially T cross-section, the base of the T being adapted for position in transverse relation with respect to said spaced-apart surfaces, forming concentric inner and outer annular grooves directed toward respective ones of said spaced-apart surfaces; and resilient sealing means disposed in each of said grooves, each having an annular recess generally co-axial with said grooves, forming a base portion bearing against the adjoining surface of the base of the T, and a pair of sealing lips, each tapered in cross-section and extending from said base portion, each sealing means, when the sealing device is assembled with said concentric spaced-apart surfaces, having generally concentric inner and outer walls respectively bearing against the adjoining surface of the stem of the T and against an adjoining one of said concentric spaced-apart walls, and each sealing means also having facing walls extending from said base portion in diverging relation to intersection with said inner and outer walls, thereby forming the tapered sealing lips; the foregoing construction being such that fluid pressure exerts force on each of said sealing means, holding said sealing means in position in its groove, and also urging said sealing lips against the adjoining wall surface and against the adjoining surface of the stem of the T.

3. A sealing device for concentric spaced-apart surfaces, comprising: an annular rigid supporting means of substantially T cross-section, the base of the T being adapted for position in transverse relation with respect to said spaced-apart surfaces, forming concentric inner and outer annular grooves directed toward respective ones of said spaced-apart surfaces; and resilient sealing means disposed in each of said grooves, each having an annular recess generally co-axial with said grooves, forming a base portion bearing against the adjoining surface of the base of the T, and a pair of identical sealing lips, each tapered in cross-section and extending from said base portion, each sealing means, when the sealing device is assembled with said concentric spaced-apart surfaces, having generally concentric inner and outer walls respectively bearing against the adjoining surface of the stem of the T and against an adjoining one of said concentric spaced-apart walls, and each sealing means also having facing walls extending from said base portion in diverg-

ing relation to intersection with said inner and outer walls, thereby forming the tapered sealing lips; the foregoing construction being such that fluid pressure exerts force on each of said sealing means, holding said sealing means in position in its groove, and also urging said sealing lips against the adjoining wall surface and against the adjoining surface of the stem of the T with equal force.

4. A sealing device for concentric spaced-apart surfaces, comprising: an annular hard rubber supporting means of substantially T cross-section, the base of the T being adapted for position in transverse relation with respect to said spaced-apart surfaces, forming concentric inner and outer annular grooves directed toward respective ones of said spaced-apart surfaces; and resilient rubber sealing means disposed in each of said grooves, each having an annular recess generally co-axial with said grooves, forming a base portion bearing against the adjoining surface of the base of the T, and a pair of sealing lips, each tapered in cross-section and extending from said base portion, each sealing means, when the sealing device is assembled with said concentric spaced-apart surfaces, having generally concentric inner and outer walls respectively bearing against the adjoining surface of the stem of the T and against an adjoining one of said concentric spaced-apart walls, and each sealing means also having facing walls extending from said base portion in diverging relation to intersection with said inner and outer wall, thereby forming the tapered sealing lips; the foregoing construction being such that fluid pressure exerts force on each of said sealing means, holding said sealing means in position in its groove, and also urging said sealing lips against the adjoining wall surface and against the adjoining surface of the stem of the T; each of said resilient rubber sealing means being bonded to said hard rubber supporting means along the contacting surfaces of the base of said T and the base portion of said sealing means, and also along the contacting surfaces of the stem of the T and an adjacent one of the sealing lips.

5. A sealing device for apparatus including concentric spaced-apart surfaces, comprising: an annular rigid supporting means of substantially T cross-section, the base of the T being adapted for position in transverse relation with respect to said spaced-apart surfaces, forming concentric inner and outer annular grooves adapted to be directed toward respective ones of said spaced-apart surfaces; and resilient sealing means disposed in each of said grooves, each having an annular recess generally coaxial with said grooves, forming a base portion bearing against the adjoining surface of the base of the T, and pair of identical sealing lips, each tapered in cross-section and extending from said base portion, each sealing means, when the sealing device is assembled with said concentric spaced-apart surfaces, having generally concentric inner and outer walls respectively bearing against an adjoining one of said concentric spaced-apart walls and against the adjoining surface of the stem of the T, and each sealing means also having facing walls extending from said base portion in diverging relation to intersection with said inner and outer walls, thereby forming the tapered sealing lips; the foregoing construction being such that fluid pressure exerts force on each of said sealing means, holding said sealing means in position in

11

its grooves, and also urging said sealing lips against the adjoining wall surface and against the adjoining surface of the stem of the T with equal force; the extremity of the stem being disposed in a plane positioned beyond a plane including the free tips of said sealing lips, so as to be in position to bear against part of said apparatus or a portion of another sealing device and thereby relieve said sealing lips of all force other than that caused by fluid pressure, and the peripheral margin of said stem being formed with spaced-apart notches to provide for fluid communication between said sealing means.

JOSEPH F. JOY. 15

REFERENCES CITED

The following references are of record in the file of this patent:

12

UNITED STATES PATENTS

Number	Name	Date
2,046,724	Buffington	July 7, 1935
2,067,499	Millmine	Jan. 12, 1937
2,211,899	Kriegbaum	Aug. 20, 1940
2,214,261	Roth	Sept. 10, 1940
2,263,178	Lignian et al.	Nov. 18, 1941
2,007,501	Millmine	July 9, 1935
2,081,040	King	May 18, 1937
2,244,135	Wallace	June 3, 1941
1,555,023	Prokofieff	Sept. 29, 1925
2,238,654	Maier	Apr. 15, 1941
2,365,774	Pool	Dec. 26, 1944

OTHER REFERENCES

Report No. 42-1, Neoprene Type FR, D. F. Fraser, May 1942, E. I. du Pont de Nemours & Co., Wilmington, Delaware.