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SUBMERSIBLE PUMP SEALING MEANS

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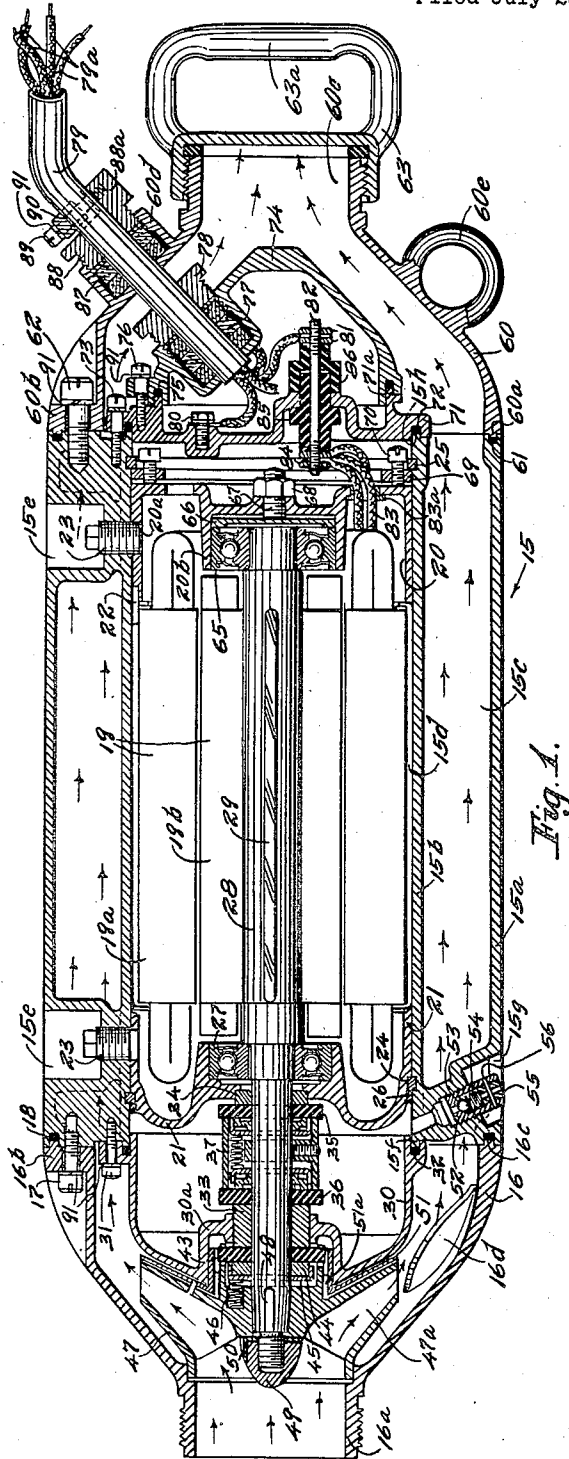


Fig. 1.

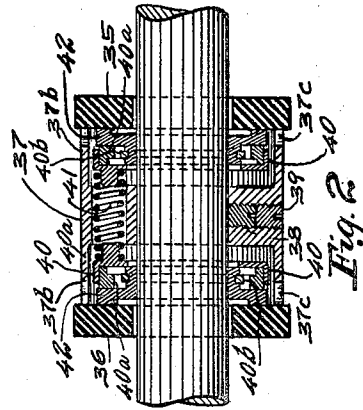


Fig. 2.

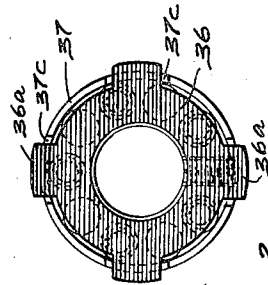


Fig. 3.

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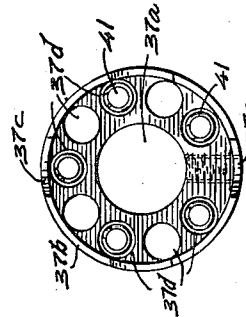


Fig. 4.

UNITED STATES PATENT OFFICE

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SUBMERSIBLE PUMP SEALING MEANS

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4 Claims. (Cl. 286—11)

This invention relates to a portable pump and particularly to such a pump which may be operated either submerged in the liquid to be pumped or outside of said liquid. The pump is further of the electric motor driven centrifugal or rotary type. Such pumps are generally used for pumping liquid from the holds of vessels, from mines and other places where it is convenient to lower a pump into the liquid to be pumped.

It is an object of this invention to provide a pump of the submersible type having a novel and efficient form of sealing means to prevent entry of water into certain parts thereof.

It is another object of the invention to provide a submersible pump having a propeller and a driving shaft therefor with a novel and efficient sealing means inwardly of said propeller.

It is a further object of the invention to provide a submersible pump having an inner chamber through which the driving shaft passes, an impeller secured to said shaft, said pump having an outer chamber through which water is forced by said impeller and a novel and efficient sealing means for said inner chamber operating with said shaft.

It is still another object of the invention to provide a pump of the submersible type having a motor chamber, a motor shaft projecting from said chamber and a novel and efficient sealing means for said motor chamber.

It is still further an object of the invention to provide a pump of the submersible type having a motor chamber, a propeller chamber and a sealing chamber between said motor and propeller chambers with a novel sealing means in said sealing chamber.

These and other objects and advantages of the invention will be fully set forth in the following description made in connection with the accompanying drawing, in which like reference characters refer to similar parts throughout the several views and in which:

Fig. 1 is a central vertical section through the main portion of the pump;

Fig. 2 is a partial view similar to Fig. 1 shown on an enlarged scale;

Fig. 3 is a view in end elevation as seen from the left of Fig. 1;

Fig. 4 is a view in end elevation of some of the parts shown in Fig. 2;

Referring to the drawing a pump is shown having a main or central casing portion 15. While this portion might be of various forms, in the embodiment of the invention illustrated it is

shown as substantially cylindrical, the same having an outer wall 15a and an inner wall 15b, said walls forming an annular chamber 15c therebetween and said inner wall forming a central chamber 15d therein. An end member or suction nozzle 16 is secured to the inlet end of casing 15, said member being of tapering form toward its outer end and having a cylindrical exteriorly threaded inlet portion 16a at its outer end of much less diameter than casing 15. Member 16 has a plurality of recesses about the sides thereof forming short flange portions 16b apertured to receive headed screws 17 threaded into the end of casing 15 and which secure member 16 to casing 15. Member 16 has on its inner side helical distributing plates 16d cooperating with an impeller to be later described. Casing 15 is provided in its end and adjacent its outer side with an annular groove and member 16 has a projecting annular rib 16c fitting into said annular groove and engaging a gasket 18 seated in said groove. Gasket 18 is compressed in said groove by the rib 16c so that a fluid-tight joint is formed. A motor 19 is disposed in chamber 15d, the same comprising a stator 19a and a rotor 19b. Said stator fits against the wall 15d and is engaged at one end by a cup-shaped member 20 and at its other end by a cup-shaped member 21. One or more keys 22 are fitted in the inner end of member 20 and also in the stator 19a so that said members are keyed together. Casing 15 is provided with a plurality of recesses 15e at its outer side, there being only a thickened portion of wall between the bottom of these recesses and chamber 15d. Said portion of wall has an inwardly tapered threaded opening into chamber 15d and headed drain plugs 23 are threaded into said openings, one of said drain plugs having its end extending into an opening 20a in member 20. Said latter drain plug therefore functions to prevent rotation of member 20. It will be noted that the heads of drain plugs 23 are disposed in recesses 15e and are thus protected from being struck by any object when the pump is being suspended. Wall 15b is provided in its inner side with annular slots in which are disposed snap rings 24 and 25. Said rings are substantially cylindrical but open at one point so that they can be compressed and inserted into said slots and will remain therein by their expansive elasticity or resiliency. It will be noted that member 21 has a reduced portion extending along the inner side of snap ring 24 and thus has a shoulder formed thereon engaging the inner side of snap ring 24.

Any outward stress on member 21 is thus taken by snap ring 24 and transmitted to the casing wall 15b. Just at the outer side of snap ring 24 member 21 is soldered to the inner side of wall 15b by solder 26, which is preferably silver solder. Member 21 has an inwardly projecting central portion bored to receive and have secured therein a bearing 27 illustrated as of the ball bearing type. A shaft 28 is secured to the rotor 19b by a long key 29, said shaft having a slightly enlarged portion between the end of rotor 19b and bearing 27 and having a reduced portion journaled in said bearing so that a shoulder on said shaft engages the inner side of bearing 27 which thus takes the outward or downward thrust of said shaft. A cup-shaped member or housing 30 has an open inner end with a groove formed therein fitting over an annular outwardly projecting rib 15f on the outer end of casing 15 substantially aligned with inner wall 15d. Member 30 forms an annular passage 16d with member 16 constituting in effect a continuation of annular passage 15c. Member 30 has a multiplicity of radially projecting lugs apertured to receive headed screws 31 threaded into the end of chamber 15 for securing member 30 to said casing. A gasket 32 is disposed in the groove in the end of member 30 and engaged by the rib 15f so that a fluid-tight joint is formed. Member 30 has a central inwardly extending portion 30a having a cylindrical bore in its outer side to form a cup-shaped recess and portion 30a at its inner side has a central hub bored to receive a member 33 tightly fitting therein and having parallel end faces perpendicular to the axis of shaft 28. Member 21 also has a shallow bore at its outer side in which is tightly fitted a disk-like member 34 having an outer face perpendicular to the axis of shaft 28. A sealing disk 35 preferably made of carbon tightly surrounds shaft 28 and engages the outer face of disk 34. Another similar disk 36 also preferably made of carbon engages the inner face of member 33. Disk 36 has projections 36a extending radially at right angles to each other as shown in Fig. 3 and disk 35 has similar projections. A cage member 37 is provided having a central portion with an inner bore 37a fitting on shaft 28. At either side of said central portion member 37 has an outwardly projecting cylindrical shell portion 37b and each of said shell portions has formed in its end slots 37c in which are partially disposed the projections 36a. Between bore 37a and its outer side the central portion of member 37 has a plurality of cylindrical bores or holes 37d extending therethrough. Said central portion also has a threaded bore extending radially from the outer side of member 37 to bore 37a and said member is secured to shaft 28 by a set screw 38, a second set screw 39 also being disposed in said threaded bore and closing the outer end thereof. Cup washers 40 of thin sheet metal surround shaft 28 between disks 35 and 36, the same facing said disks respectively and having lugs 40a thereon extending into compression coiled springs 41 disposed in the holes 37d. Holes 37d are shown as nine in number and five of the springs 41 are preferably secured at their ends to one washer 40 while the remaining springs are secured at their ends to the other washer 40. This facilitates handling of the springs. Each washer 40 has in its cupped side a flanged ring 40a which extends beyond the edge of washer 40 and engages the outer portion of a resilient ring 42. Ring 42 has a central portion fitting

against shaft 28 and this portion is cylindrical at its inner end and is clamped against shaft 28 by a ferrule 40b. Ring 42 has a flange or projecting portion at its outer side which bears against disk 35 or 36. From the described construction it will be seen that springs 41 urge washers 40 away from each other and through the rings 40a press on the outer portions of rings 42 which are in turn pressed against the disks 35 and 36 respectively. There is very little outward motion of members 42 against the disks 35 and 36 and what motion there is is permitted through the flexing of rings 42. The ferrules 40b have been found to be very important. Without these it was found that relative motion would occur between shaft 28 and rings 42 which would interfere with the proper functioning of the seal. With the present construction the central portion of ring 42 is held in fixed position relative to shaft 28 and any outward motion of the outer portion of the ring is accomplished by flexing of the ring. Members 33 and 34 in practice have been made of nickel and their faces which are engaged by the disks 35 and 36 are made of some extremely hard and non-corrosive metal. In practice these disks have been coated with stellite, a composition of cobalt, chromium and tungsten. Tungsten carbide has also been used. The disks 35 and 36 may be made of metal but in practice it has been found very suitable to have these made of carbon. A tight seal is thus effected designed to prevent the passage of any liquid through member 21 or through member 30. Another disk 43 similar to disks 35 and 36 engages the outer face of member 33 at the outer side of member 30. Disk 43 is engaged by ring 44 similar in all respects to ring 42 which is engaged at its outer side by a ring 44a similar to rings 40a. A cupped washer 45 receives ring 44a and is engaged at its outer side by a plurality of compression coiled springs 46 disposed in cylindrical sockets formed in the inner or upper side of an impeller member 47 having a hub secured to a slightly tapered portion of shaft 28 by a key 48. Said hub of impeller 47 has a cylindrical flange 47b extending inwardly about members 44 and 45, said flange having slots therein at right angles to each other and receiving projections on member 43 similar to the projections 36a on member 36. Member 43 is thus driven by member 47 just as member 36 is driven by member 37. Shaft 28 has a reduced threaded end beyond impeller 47 on which is threaded a closed nut 49 having an outer rounded end. A spring washer 50 is disposed between nut 49 and impeller 47. Impeller 47 has inner and outer walls between which extend a plurality of spaced vanes 47a. The inner or upper wall of impeller 47 is concave and of conical form. An auxiliary impeller 51 is disposed between member 30 and impeller 47, the same having a cylindrical hub of a size to be journaled in the bore of portion 30a. Said auxiliary impeller has a conical wall parallel to the inner surface of impeller 47 and has a plurality of radial blades 51a engaging impeller 47 by which it is driven. A pin 51b connects impellers 47 and 51 so that the latter is driven by impeller 47. It will be seen that a chamber is formed within member 30 between the impeller or pump chamber and the motor chamber 15d. Casing 15 has a recess 15g in the side thereof from the bottom of which an opening extends into the chamber in member 30, the outer end of said opening being threaded and receiving a threaded plug 52. Said plug has a passage therethrough at its

inner end having an enlargement outward thereof forming a valve seat with which a ball valve 53 cooperates. Ball 53 is pressed toward its seal by a coiled compression spring 54. Spring 54 is engaged at its outer end by plug 55 having a central passage therethrough and held in place by a transverse pin 56.

The upper end of casing 15 has secured thereto an upper end member 60. The upper end of casing 15 adjacent its outer side has an annular groove therein into which enters an annular rib 60a formed on the end of member 60. A gasket 61 is disposed in said groove and engaged by said rib. Member 60 has a plurality of recesses about the outer side thereof forming short flange portions 60b apertured to receive headed screws or bolts 62 threaded into the end of casing 15 for holding rib 60a tightly against the gasket 61 to form a fluid-tight closure. Member 60 is tapered toward its outer end and has a reduced exteriorly threaded cylindrical outlet portion 60c. As shown in Fig. 1 this portion is closed by a cap 63 threaded onto portion 60c and engaging a gasket 63 held between the same and the end of member 60. Cap 63 has secured to and projecting from its outer side a bail handle 63a. The member 20 previously referred to has an inwardly or downwardly extending central portion 20b bored at its inner side to receive a bearing 65 shown as of the ball bearing type in which is journaled a reduced portion of shaft 28. Bearing 65 is engaged at its upper or outer side by a disk 66 having a central portion thinner than its peripheral portion. Disk 66 is engaged centrally by a screw 67 extending through portion 20b, said screw having a slotted outer end and carrying a jamb nut 68 engaging the outer side of portion 20b. Disk 66 has considerable resiliency and shaft 28 is thus held with some resiliency lengthwise thereof. An annular plate 69 extends about an inner side of wall 15b and at its upper or outer side engages the inner side of snap ring 25. A plurality of circumferentially spaced screws 70 are threaded through plate 69 and engage the outer end of member 20. Member 20 as already stated engages the upper end of stator 19a so that the latter is thus held longitudinally in place by screws 70. It will be noted that the snap ring 25 takes the outward or upward thrust caused by the action of screws 70. The endwise thrust or stress of the motor is thus taken at both ends by the snap rings 24 and 25. An end cover plate 71 has an annular groove adjacent its outer edge fitting over a projection or rib 15h at the upper end of wall 15b and a gasket 72 is disposed in said groove and engaged by said projection or rib. End cover plate 71 has a plurality of lugs at its periphery apertured to receive headed screws or bolts 73 which are threaded into the end of casing 15 and hold said cover plate in place compressing gasket 72 and forming a fluid-tight joint. A stuffing box cover 74 of conical cup-shaped form is provided having an annular groove at its inner end into which fits an annular rib or flange 72a on cover 71, a gasket 75 being disposed in said groove and engaged by rib 71a. Member 74 has a plurality of lugs at its periphery apertured to receive headed bolts or screws 76 threaded into cover plate 71 and holding member 74 in place with gasket 75 compressed to form a fluid-tight joint. Member 74 has a recess at one side thereof with an opening at its bottom leading to the interior of member 74, said recess being adapted to receive packing 77. The walls of said recess are interiorly

threaded and a packing gland 78 is screwed therein compressing said packing about a cable cover or sleeve 79 passing through said gland and through said opening into member 74. Cable 79 covers a plurality of conductors 79a, one of which is shown as secured to the upper side of cover 71 by a screw 80 and another of which is shown clamped between nuts 81 threaded onto a rod 82 forming a binding post and extending through cover 71. Rod 82 has secured thereto at the inner side of cover plate 71 a plurality of conductors 83 held in place thereon by nuts 84 and passing through an insulating bushing 84a in member 20. An insulating bushing 85 surrounds rod 82 and is tightly fitted in cover 71 and passes therethrough, the same being enclosed at its outer side by another insulating plug or member 86. Rod or binding post 82 is thus insulated from cover 71. Member 60 has a cup-like projection 60d at its upper side adapted to receive packing 87. Member 79 passes outwardly through an opening in member 60 through the packing 87 and through a packing gland 88 threaded into portion 60d and compressing packing 87 about member 79. Gland 88 has an outer portion 88a threaded to receive a pair of headed screws 89 extending through a clamping cap 90 overlying cable sleeve 79 so that the latter is clamped in position by the clamping cap 90. Screws 89 as well as screws 17, 31, 62, 73 and 76 are shown as having split spring washers 91 beneath the heads thereof. Member 60 is shown as having a ring lug 60e at one side thereof.

The pump can be conveniently transported by using the handle 63a when cap 63 is in place and the pump is not in pumping operation. When the pump is to be used cap 63 will be removed and the discharge hose or conduit will be connected to portion 60c. The pump can be lowered into the hold of a vessel or other desired place by a cable secured in the lug 60e. When it is desired to operate the pump the motor 19 will be started by current supplied through the conductors 79a which will be controlled by a suitable switch. Rotor 19b rotates and shaft 28 is driven. Impeller 47 is rotated and water is drawn through member 16 which water passes from impeller 47 into the annular chamber between members 16 and 30. The water is directed against the distributing vanes 16d on member 16 which assist the flow and distribution of the water and the water passes upwardly through annular chamber 15c, through the annular chamber between members 74 and 60 which aligns with passage or chamber 15c and the water then passes out through the end of member 60 and is discharged in the desired place by the attached conduits. The auxiliary impeller 51 is driven by impeller 47 and discharges any liquid which may have passed into the cylindrical chamber in portion 30a. Since the average effective diameter of the auxiliary impeller 51 is greater than the average diameter of the main impeller 47, the fluid pressure on the seal member 43 is either zero or less than zero or in other words there is a partial vacuum in the chamber in portion 30a. This vacuum reaches about five pounds when the pump is operating at zero pressure and is at zero when the pump discharge is shut off. It will be seen from this that the auxiliary impeller 51 thus acts to draw out any liquid from portion 30a and will draw out and discharge any fine particles of dirt or foreign matter which might work through the running fit between the cylindrical portion of impeller 51 and the bore

in portion 30a. When the pump is running, therefore, there is no tendency for the liquid to pass into the chamber in portion 30a and thus to work past the seal members 43 or 36. It will be seen that by having the auxiliary impeller 51 that the pressure on the sealing members 33 and 34 is substantially zero and that there is a negative pressure on these members at all times when the pump is operating or when the motor is running. The seals are subjected to a maximum pressure equal to the submergence pressure when the pump is not running. The auxiliary impeller thus constitutes means for limiting the pressure on the sealing members to a small percentage of the discharge pressure of the pump.

It will be noted that by having the springs 46 housed in the impeller 47 the structure is made quite compact lengthwise of shaft 28. This eliminates extra parts and saves space lengthwise of the pump. This is highly important since the shaft overhang from the lower bearing 27 must be kept as short as possible. It is also pointed out that members 30 and 16 each has one single annular sealing gasket. This results in a structure where both gaskets can be kept tight. It is quite difficult to have two parallel gaskets on one part and keep both tight. The inner gasket 32 is quite inaccessible and it is all the more important to have this gasket kept tight. Members 60, 71 and 74 also have only a single gasket and the above remarks apply to these members. Gaskets 16c, 32, 60, 71 and 72 are of resilient material, preferably containing cork. Members 16, 30, 60, 71 and 74 are drawn down to a metal to metal contact at the sides of the gasket grooves thus assuring concentric assembly, the engaging edges being disposed in planes perpendicular to the central axis of the parts. The member 74 forms a terminal chamber independent of the chamber within member 71. This forms a convenient chamber for the distribution of the conductors and a convenient connection for a ground conductor for grounding the casing is made by the screw 80. A tight and insulating seal is made by the telescoping members 85 and 86 which are clamped on member 71 by the nuts 84 and 81. The cable member 79 is flexible so that no strain is put on member 74 by any exterior stresses on the cable. Should any water leak into the chamber in member 74 about the cable, this water can be removed by removing member 74 without removing member 71 and thus breaking the seal into the motor chamber. By having the recesses 15e and 15g the plugs therein are protected from striking exterior objects in the handling of the pump. Should the pressure in the chamber between members 21 and 30 exceed the outside pressure and any water be in said chamber it will lift ball valve 53 and pass out through plug 52. The pressure within member 30 therefore cannot exceed the exterior or submergence pressure plus the pressure of spring 54.

The motor unit is held by members 20 and 21. These members react against the snap rings 24 and 25 so that the end thrust is taken by the casing wall. No end thrust of the motor due to holding it in place or due to expansion and contraction of the parts due to temperature can place any pressure on member 71 and thus cannot affect the seal between member 71 and wall 15b of the casing. It should also be noted that no endwise pressure is exerted on the solder 26 since the end thrust of member 21 is taken by snap ring 24. The action of screw 67 on resilient

disk 66 places a slight tension on shaft 28. This prevents any axial displacement of the shaft which might disturb the accurate positioning of the sealing disks 35, 36 and 43 or which might disturb the proper positioning and clearances of the impellers. The yielding tension on shaft 28 also acts to prevent any hammer effect due to a shock to the pump due to dropping or other cause.

It is pointed out that since sealing members 36 and 43 are urged in opposite directions against member 33 that one of these members will be urged to sealing position by the pressure whether the pressure is positive or negative in the chamber within member 30. The springs of one of the sealing members will thus always act with the pressure. It is impossible to balance or adjust a spring pressure for a wide range of positive and negative pressures. With the described arrangement as above stated one seal always acts with the pressure whatever the pressure in the adjacent chamber. By having member 33 made with parallel sealing faces this part can be made with extreme accuracy. This results in a very efficient seal.

By having gland member 88 constitute the cable clamp the necessity for a separate or auxiliary cable clamp is eliminated.

From the above description it is seen that applicant has provided a very simple and highly efficient pump. The pump is designed to withstand the rigorous use to which it is put when submerged at considerable depths. The motor is protected from the liquid to be pumped and is mounted in a very efficient manner. The parts are all contained within the outer wall of the casing. The pump has been amply demonstrated in actual practice, found to be very successful and efficient and is being commercially made.

This application is a continuation in part of applicant's copending application S. N. 91,484, filed July 20, 1936, for all parts common therewith.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts, without departing from the scope of applicant's invention, which generally stated, consists in a device capable of carrying out the objects above set forth in the parts and combinations of parts disclosed and defined in the appended claims.

What is claimed is:

1. A sealing structure having in combination, a shaft, spaced members through which said shaft passes having flat adjacent faces, spaced disks of hard material surrounding said shaft and having their remote faces engaging said first mentioned faces respectively, a member having a central bore in which said shaft fits, said member being secured to said shaft between said disks and having driving engagement with said disks, resilient members secured to said shaft adjacent each disk and having portions extending radially with terminal portions extending toward and engaging said disks at points spaced from said shaft, annular members engaging said resilient members opposite said terminal portions, cup-shaped members in which said annular members are connected and a plurality of circumferentially spaced compression coiled springs held on and engaging the adjacent sides of said cup-shaped members to press said disks outwardly against said first mentioned faces respectively.

2. A sealing structure having in combination, a shaft, spaced members through which said shaft passes having flat adjacent faces, spaced disks of hard material surrounding said shaft and having their remote faces engaging said first mentioned faces respectively, a shell disposed between said disks having cylindrical end portions notched to interfit with said disks to drive the same, said shell having a central hub bored to receive said shaft, means securing said shell to said shaft, said shell having a plurality of circumferentially spaced bores therein extending parallel to said shaft, resilient members secured to said shaft adjacent said disks and having portions extending radially and then toward said disks respectively, means engaging the outer portions of said resilient members at the sides remote from said disks and a compression coiled spring disposed in each of said latter bores engaging said last mentioned members to press the same away from each other and press said disks against said first mentioned faces.

3. A sealing structure having in combination, a shaft, spaced members through which said shaft passes having flat adjacent faces, spaced disks of hard material surrounding said shaft and having their remote faces engaging said first

mentioned faces respectively, a shell disposed between said disks having cylindrical end portions notched to interfit with said disks to drive the same, said shell having a central hub bored to receive said shaft, means securing said shell to said shaft, said shell having a plurality of circumferentially spaced bores therein extending parallel to said shaft, resilient members each having a hub surrounding said shaft, means for clamping said hubs to said shaft, said resilient members extending radially outward and having outer annular portions engaging the adjacent sides of said disks respectively, washers engaging the inner sides of said resilient members, cup-shaped members carrying said washers respectively, said cup-shaped members having circumferentially spaced projections on their adjacent sides and compression coiled springs having their ends fitting over said projections and acting to press said disks against said first mentioned faces.

4. The structure set forth in claim 3, said shell having cylindrical chambers at each end in which said resilient members, washers and cup-shaped members are disposed and having circumferentially spaced bores extending there-through in which said springs are disposed.

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