United States Patent [19]

Martin

[11] **3,917,292**

[45] **Nov. 4, 1975**

[54] **SEAL ASSEMBLIES FOR WATER WELL CASINGS**

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[22] Filed: **Aug. 1, 1974**

[21] Appl. No.: **493,526**

[52] **U.S. Cl.** **277/110;** 277/188

[51] **Int. Cl.²** **F16J 15/10**

[58] **Field of Search** 217/58, 107, 110, 111, 217/113, 166, 188

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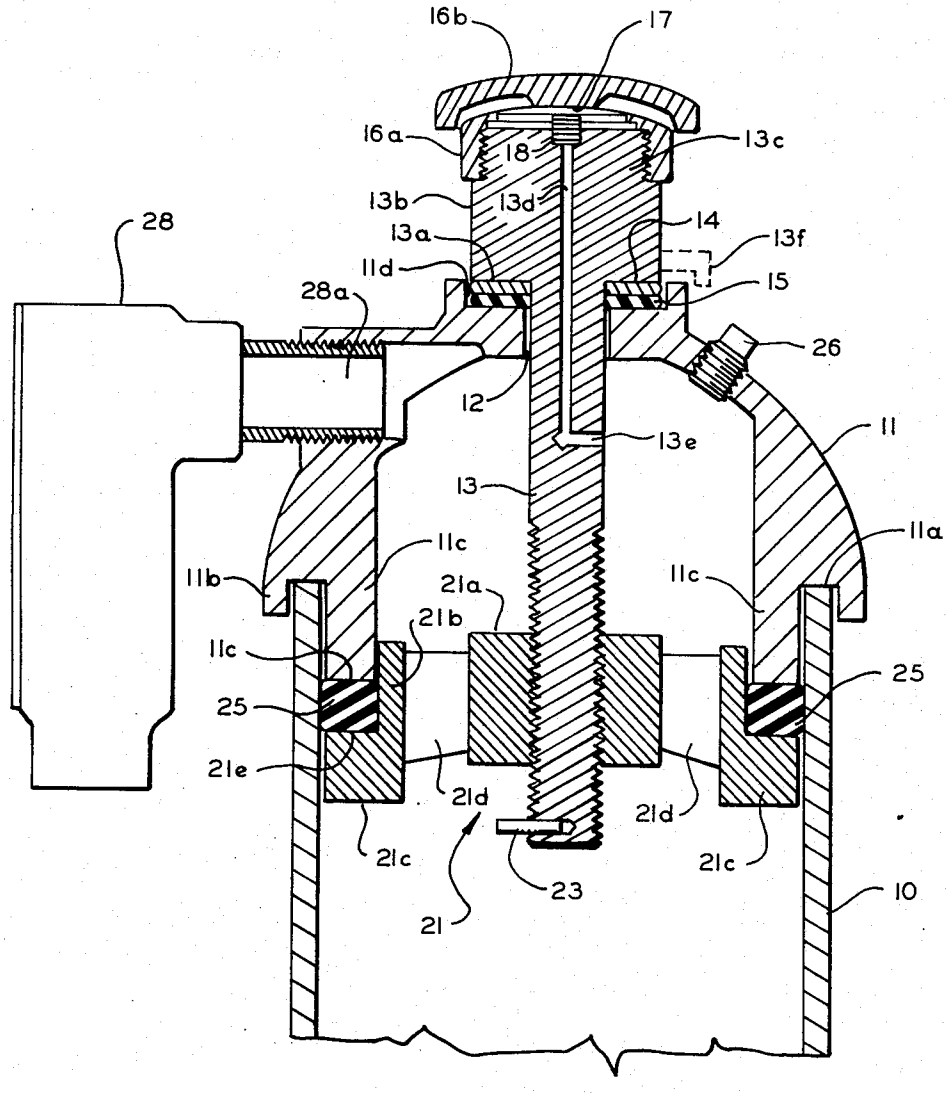
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[57] **ABSTRACT**

An economical easily installable and easily removable seal assembly for use on water well casings comprises a dome having a central shaft threaded through a lower flange means so that rotation of the shaft compresses a rubber ring between the flange means and a lower rim of the dome, radially expanding the ring to grip the inside of a well casing with uniform pressure around the periphery of the ring, and also compresses an upper ring between the dome and the shaft.

11 Claims, 6 Drawing Figures



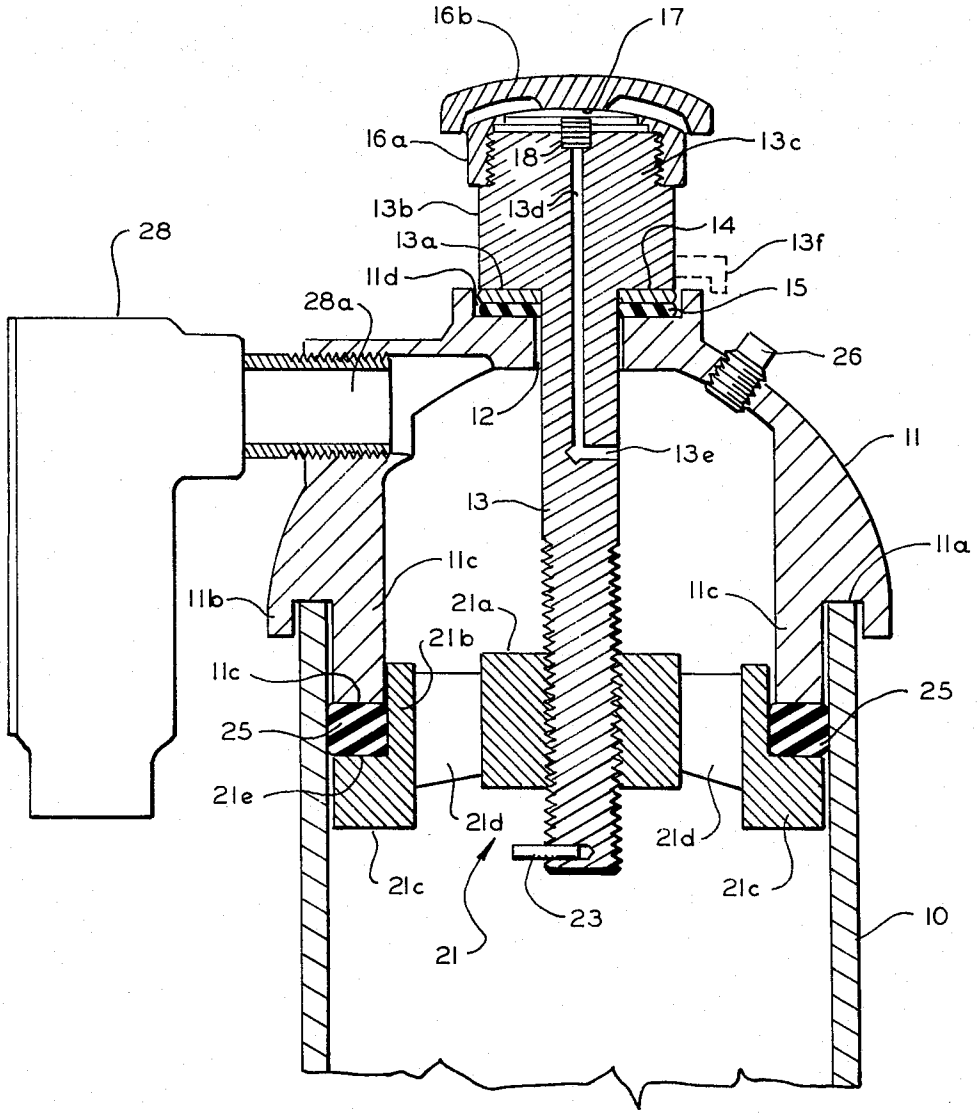

16b
17
16a
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11c
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FIG. 1

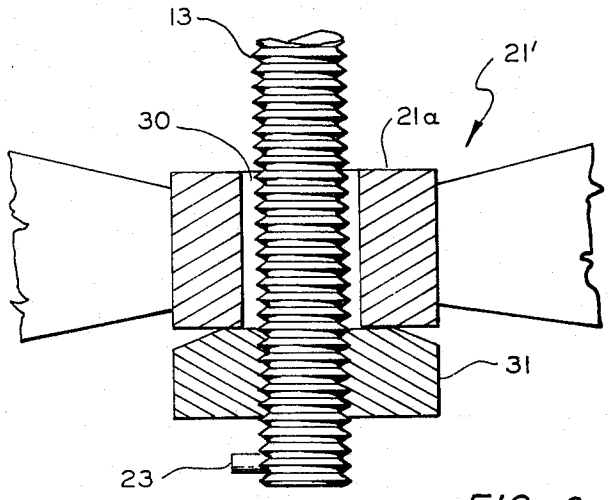


FIG. 2

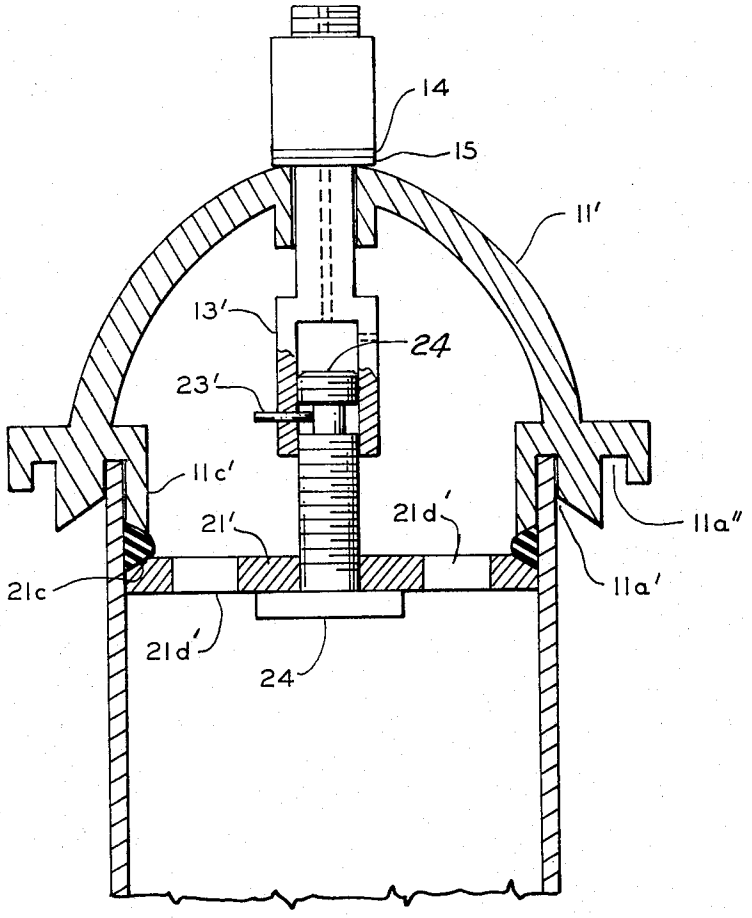


FIG. 3

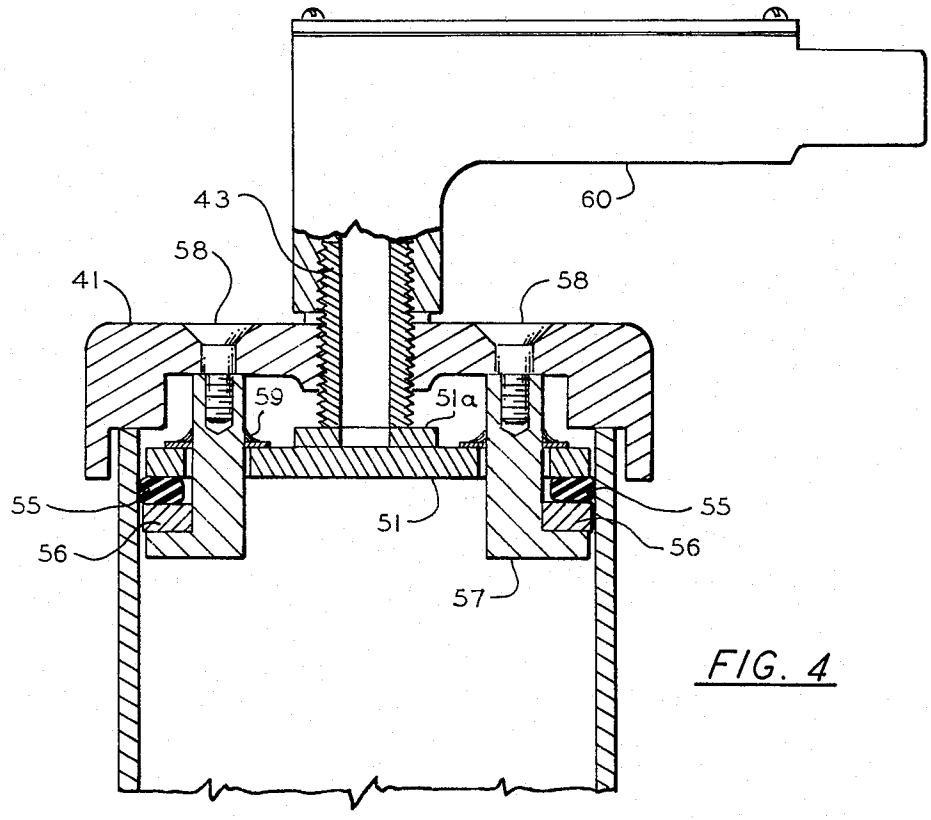


FIG. 4

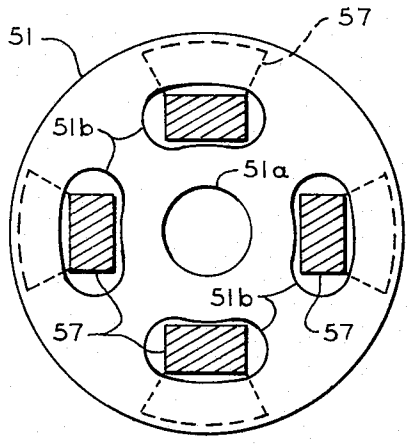


FIG. 4a

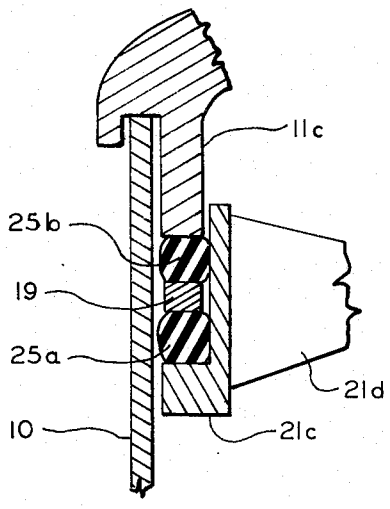


FIG. 5

SEAL ASSEMBLIES FOR WATER WELL CASINGS

My invention relates to improved seals for the upper ends of the casings of water wells, and more particularly, to improved seals which are easier to install and remove, and which are economical to fabricate.

Water wells utilized at suburban and rural residences in a large part of the United States ordinarily use a well casing, typically comprising plural sections of pipe 5 to 7 inches in diameter, which are welded (or threaded) together to extend 50 to 500 feet down into the earth to a water layer. A submersible electric motor-driven pump is immersed in the water layer near the bottom of the casing, being suspended from near the top of the casing by a water pipe, typically 1 inch in diameter, up which water is pumped. In geographical locations which are not frost free, the water pipe ordinarily extends outwardly through the side of the well casing two or three feet below ground level and then is routed underground to the residence. The upper end of the well casing extends typically 6 to 18 inches above ground level, so that ground surface water may not run into the casing and contaminate the well. It is necessary that an air passage or vent be provided near the top of the well casing, so that pumping of water from the well not create a partial vacuum inside the well casing to prevent or impede water delivery. It is also necessary that an opening be provided near the top of the casing for an electrical cable needed to supply power to the motor of the submersible pump. It is important that such openings not allow rain water, vermin or insects to enter the well casing. While simple devices such as a plate with the required openings conceivably could be permanently welded or otherwise affixed to the top end of a well casing, the fact that the motor-pumps fail and sometimes must be replaced dictates that some form of removable seal or cap be provided, and various forms of removable well seals or caps are presently widely used.

Some well casings use successive threaded sections of pipe, while others have successive sections welded together. While it is theoretically possible in threaded casing installations to provide a removable well cap which threadedly engages threads provided at the upper end of the well casing, caps which thread into the well casing are deemed impractical for a number of reasons. Turning a threaded cap to install it would undesirably twist the electrical cable which must pass through it, unless the cable passed through an opening in the cap so large that insects or rainwater could also pass through the opening. Also, prohibitively great forces often would be required to unscrew a threaded cap which had been exposed to weather for some years. For such reasons, practical removable well caps cannot be threaded onto the upper ends of well casings, and the well caps in common use instead use seals including rubber rings which may be tightly clamped to the upper end of a well casing.

Various known well seals comprise plural metal plates or rings between which a rubber seal ring is disposed, with means for clamping the plates very tightly together to radially expand the rubber ring, whereby the rubber ring is pressed tightly against the inside or the outside of the well casing. To insure that the rubber seal is adequately compressed around its entire periphery so as to form a watertight seal, the prior seals use a number of bolts spaced around the seal, each of which must be tightened with substantial force. Several important disadvantages of prior seals stem from their use

of a plurality of bolts, or plurality of bolts and nuts. The bolts and nuts frequently must be installed under adverse climatic conditions. If bolts or nuts are accidentally dropped they are frequently lost in mud, snow or the like at a well site. Also, the drive shoe of a well-drilling rig often provides a hole in the earth exceeding the outer diameter of the well casing, leaving a space surrounding the casing in which bolts and nuts may be irretrievably lost should they be accidentally dropped therein. One object of the present invention is to provide an improved seal assembly of a "single-piece" nature, i.e., which does not require the tightening and loosening of a plurality of bolts and or nuts to install or remove the assembly. By provision of a single bolt means, the present invention allows a seal assembly to be installed or removed much more rapidly than prior assemblies, thereby providing a significant savings in labor costs.

As well as being lost during installation, well seal assemblies which utilize numerous bolts and nuts are disadvantageous because such parts are sometimes lost or mis-placed between the factory and the well site. One object of the invention is to provide a well seal assembly which may be completely assembled at the factory, and which then need not later be disassembled to allow its installation atop a well casing.

Prior art seal assemblies which use a plurality of bolts and/or nuts spaced around the seal are also disadvantageous in that their threads sometimes become jammed or may be inadvertently stripped, sometimes ruining a seal assembly unless it is re-bored and re-tapped with a larger threaded hole, or sometimes requiring that spare bolts or nuts be obtained. Another object of the invention is to provide an improved seal assembly which obviates such problems.

A further disadvantage of seals using plural bolts and nuts spaced around the seal is that they must be tightened evenly, i.e., by tightening a given bolt only partially and then proceeding to similarly tighten each of the other bolts before further tightening the given bolt, or else the seal assemblies, which frequently are made of cast iron, may fracture. Another disadvantage is that provision of plural independent bolts may cause the seal to grip tightly at some places around its periphery, but to grip much less tightly at other places, so that leaks may occur. An additional object of the invention is to provide an improved well seal assembly which does not require sequential tightening of a plurality of bolts and/or nuts, and a further object of the invention is to provide an improved well seal assembly which automatically expands a seal ring evenly around its entire periphery as a single bolt means is tightened.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation view in cross-section of a preferred form of the present invention.

FIG. 2 is a side elevation view in cross section illustrating one possible modification of the device of FIG. 1.

FIG. 3 is a side elevation view in cross-section of one alternative embodiment of the invention.

FIG. 4 is a side elevation view in cross-section of a further form of the invention.

FIG. 4*a* is a plan view showing several portions of the assembly of FIG. 4; and

FIG. 5 is a side elevation view in cross-section illustrating one possible modification of the device of FIG. 1.

In FIG. 1 the upper end of a section of well casing pipe is shown at **10.** The improved seal assembly comprises a dome **11** of generally hemispherical shape having an annular groove, the upper surface **11***a* of which sits atop the upper end of casing **10.** An annular outer flange **11***b* extends below surface **11***a*, forming a drip edge, so that water running down the outside of dome **11** cannot enter the well casing. An inner annular flange **11***c* extends downwardly into the casing a short distance, as shown. The width of the groove between flanges **11***b* and **11***c* is not critical, and is made to exceed the wall width of standard casing pipe, so that the dome may be laid atop the casing without the need for a "press-fit." The outer surface of inner flange **11***c* is preferably made slightly less (e.g., one-sixteenth inch) than the inside diameter of casing **10** so that placing dome **11** atop the casing accurately aligns the dome with the casing. Inasmuch as the seal assembly grips the inside of the well casing, it is immaterial whether the exterior of the well casing is threaded or not.

The water pipe extends from the pump (not shown) near the bottom of the well casing to a point about 3 feet below the top of the casing, where a known form of device known as a "pitless adapter" (not shown) supports the weight of the water pipe and pump and allows the water pipe to extend laterally through the wall of the casing, from where it may run underground to the residence. Dome **11** is provided with a tapped hub at **28***a* which accommodates a threaded nipple for a standard conduit or cable fitting **28,** through which wires or electrical cable (not shown) may pass, with the cable extending down the inside of the well casing to the motor-pump. A removable plug **26** is also preferably threaded into a tapped hole through dome **11.**

Dome **11** is provided with a central upper bore **12** through which the lower portion of shaft **13** passes. Bore **12** need not closely correspond in diameter with the portion of shaft **13** passing through it, and indeed is preferably made somewhat oversize, so as to allow an appreciable amount of "rocking" of the axis of shaft **13** relative to the axis of bore **12.** The lower face **13***a* of a widened portion **13***b* of shaft **13** sits atop metal washer **14,** which in turn sits atop rubber (or other elastomeric) washer **15,** washers **14** and **15** being situated in a circular recess **11d** in the top of dome **11.** If desired, portion **13***b* of shaft **13** may be provided with a depending flange of the nature shown in dashed lines at **13***f*, to prevent the accumulation of water on washers **14** and **15,** although such a refinement is deemed ordinarily unnecessary. The upper reduced-diameter portion **13***c* of shaft **13** is threaded to engage internal threads in the depending hub portion **16***a* of vent cap **16.** Cap **16** comprises a generally hollow dome portion **16***b* connected to hub **16***a* by a plurality of ribs so that air may flow between the interior of hub portion **16***a* and the outside of cap **16,** through a screen **17** situated inside dome **16***b* atop hub portion **16***a* of cap **16.** Shaft **13** includes a central bore or passage **13***d* which extends downwardly from the upper end of the shaft to a point inside dome **11,** and a laterally extending passage **13***e*. The upper end of passage **13***d* is preferably threaded to receive a small plug **18.**

A length of the lower end of shaft **13** is threaded to engage the internal threads of hub **21***a* of a lower flange means **21,** which integrally includes an annular ring portion **21***b* and an annular lower flange **21***c* supported by and spaced from hub **21***a* by a plurality of arms or web members **21***d*, only two of which are visible in FIG. **1.** The electrical cable (not shown) may pass between a pair of the web members to reach the pump near the bottom of the well. The lower flange means **21** comprised of portions **21***a*–**21***d* is preferably cast as a single piece. A laterally extending pin **23** is either threaded or permanently staked in a hole near the lower end of shaft **13.** With pin **23** in place, it will be seen that the entire assembly may be carried in one piece, i.e., that no loose parts such as additional nuts and/or bolts are required and susceptible to loss or mis-placement prior to placement of the assembly atop the well casing. An annular rubber (or other elastomeric) ring **25** surrounds ring **21** *b*. It may be noted that neither hub portion **21***a* nor shaft **13** need be threaded with extremely precise threads.

Section **13***b* of shaft **13** is preferably provided with a cylindrical periphery so that it may be gripped by an ordinary pipe wrench, although it may be provided with flat surfaces to allow alternative use of another form of wrench. As shaft **13** is rotated by a wrench, lower flange means **21** will be seen to be drawn upwardly, assuming that it does not rotate with shaft **13.** If, before the assembly is seated atop the well casing, lower flange **21** is lightly screwed up shaft **13** so as to slightly engage and squeeze rubber ring **25,** sufficient friction will be provided between ring **25** and lower flange means **21** that the latter will not rotate as shaft **13** is rotated. As screw **13** is rotated, ring **25** then will be compressed tightly between the upper face **21***e* of lower flange **21***c* and the lower face **11***e* of inner flange **11***c*, and due to the compressibility of ring **25,** portions of it will be urged radially outwardly against the inside wall of the well casing **10,** and portions of it will be urged radially inwardly against the vertical outer face of ring portion **21***b*. Rotation of screw **13** causes lower flange means **21** to apply a very large upward force to dome **11** through ring **25,** but also causes shaft portion **13***b* to apply an equal downward force to dome **11** via washers **14** and **15,** with the result that no appreciable net vertical force is applied to dome **11,** and it continues to rest atop the well casing **10,** with the weight of the pipe wrench tending to hold it atop casing **10** as shaft **13** is rotated. Because of the tremendous mechanical advantage obtainable by means of the threads on screw **13,** sufficient compression to securely lock the seal assembly in the end of casing **10** is readily achieved. As screw **13** is rotated to lock the seal assembly in place, the downward pull on shaft **13** will be seen to cause face **13***a* of shaft **13** to press metal washer **14** downwardly, compressing rubber washer **14,** thereby to provide a watertight seal at the top of dome **11.**

As compression of ring **25** expands the ring radially inwardly and outwardly, the ring will tend to be compressed with equal pressures against ring **21***b* and the inside of the well casing at all locations around the periphery of the ring **25.** Due to the slight oversize of bore **12,** shaft **13** may pivot slightly in bore **12** so as to tend to equalize the compressive forces all around the ring, hub **21***a* may also tilt slightly relative to the axis of shaft

13, and the lower portion of shaft 13 may deflect slightly, so that equal forces are applied around the entire seal, even if none of the mentioned portions of the assembly are machined to close tolerances.

If and when it becomes necessary to remove the seal assembly, so as to withdraw the motor-pump, for example, the seal assembly may be easily removed by rotating shaft 13 in the reverse direction by means of a wrench, thereby lowering lower flange means 21 so that rubber ring 25 is no longer compressed by it, and then the assembly may be lifted off of the casing. After long usage, the rubber ring 25 may tend to stick to the inside of the casing even if it is no longer being squeezed. One or a few upward hammer blows on flange 11*b* of the dome readily breaks the rubber ring loose from the inside of the casing. As the assembly is lifted from the casing, flange 21*c* lifts the rubber ring out of the casing, lifting all portions of it even if it should be broken into several pieces, so that none of the pieces fall down inside the casing.

Well seal assemblies are frequently removed, after many years of use, by persons who are not familiar with the internal construction of such seals, and if bolts which tighten various prior art seals are loosened too much, nuts or other parts may drop down inside the well casing and be irretrievably lost. Provision of pin 23 on shaft 13 below lower flange means 21 prevents an unknowing person from turning shaft 13 so as to screw shaft 13 entirely out of hub 21*a*. An extreme turning of shaft 13 in the reverse direction will lower flange means 21 no more than to where it jams against pin 23, and then continued rotation of shaft 13 will merely rotate lower flange means 21 without further lowering it. Hence it will be clear that no parts of the assembly can drop down inside the well casing.

A further feature of the invention is its versatility in allowing the well to be vented in a variety of different ways. If plug 18 is removed, venting may occur through vent cap 16 and passages 13*d*, 13*e*. Alternatively, in some applications, such as where it is preferred that a vent line be attached leading from an area (such as from inside a residence) where a preferred source of air is located, plug 18 may be left in place and plug 26 removed, and replaced by a conventional tubing connector. In some applications both plugs 18 and 26 may be left in place and venting allowed to occur through conduit or cable fitting 28 and any conduit (not shown) connected thereto.

In a modified seal assembly partially shown in FIG. 2, hub 21*a'* of the lower flange means 21' is provided with an oversize central bore 30, and a nut 31 is threaded onto shaft 13 below hub 21*a'*. The upper face of nut 31 may be slightly convexly rounded (and is shown in FIG. 2 with an exaggerated roundness), and/or, if desired, the lower face of hub 21*a'* may be similarly rounded concavely. As shaft 13 is rotated to raise nut 31 and lower flange means 21', the latter may tilt slightly, so that the lower flange means applies the same upward pressure to the rubber ring (not shown in FIG. 2) at all locations around the ring. Because nut 31 does not frictionally engage the side of the well casing, it is necessary before installing the assembly of FIG. 2 that nut 31 be tightened enough that friction between hub 21*a'* and nut 31 prevent the latter from turning as screw 13 is turned.

A further modified seal assembly shown in FIG. 3 includes a dome 11' which is provided with a pair of concentric annular grooves 11*a'* and 11*a''*, so that the dome may be installed on either of two distinctly different diameters of well casing. In FIG. 3 the upper hub portion of the dome through which shaft 13' extends is situated inside the dome rather than outside as in FIG. 1. Shaft 13' is provided with an internal threaded bore into which bolt 24 extends. The wide head of bolt 24 lies against the lower surface of lower plate means 21'. A plurality of holes 21*d'*, 21*d'* are provided in plate means 21' to allow electrical wires to pass therethrough. The lower edge of flange 11*c'* and an outer edge 21*c'* of plate means 21' are shown beveled or chamfered, and as shaft 13' is rotated to pull bolt 24 and plate 21' upwardly, the beveled surfaces tend to press rubber ring 25' principally outwardly against the casing 10. A length of bolt 24 is counterbored as shown, and after bolt 24 is threaded into shaft 13' pin 23' (or a set screw) is inserted in a hole through shaft 13. The pin 23' will be seen to act as a limit stop, preventing bolt 24 from being entirely threaded out of shaft 13', so that bolt 24 and plate means 21' will not drop down the well casing no matter how much one rotates shaft 13' to loosen the seal assembly. In order to use the assembly of FIG. 3 with the larger diameter well casing for which it is also designed, one need merely provide a plate means 21' of larger outside diameter than that shown.

In a further modified embodiment of the invention shown in FIG. 4 the "dome" of the assembly in actuality comprises a substantially flat cap 41 having a threaded central bore through which hollow screw shaft 43 is threaded. The lower end of shaft 43 engages a ring-shaped boss 51*a* on plate means 51. As shaft 43 is turned into cap 41, by rotating the conduit fitting 60, for example, into which the upper end of shaft 43 is threaded, plate 51 is urged downwardly relative to the cap, compressing rubber ring 55 against lower ring 56, and hence radially expanding ring 55 so that it will engage the well casing. The outer edge of plate 51 and the upper surface of ring 56 are preferably beveled in the manner shown in FIG. 3, to prevent much of the rubber from being pushed inwardly. Metal lower ring 56 is suspended or prevented from lowering relative to cap 41 by a plurality of arms 57, 57 which are fastened at their upper ends to cap 41, and which extend downwardly through holes or arcuate slots in plate 51 and then radially outwardly to engage the underside of ring 56. Only two arms 57 are shown in FIG. 4, but a larger number may be used, all preferably spaced equidistantly apart around the assembly. In FIG. 4 four arms 57 are shown extending through respective arcuate slots 51b in plate 51. Neither ring 56 nor ring 55 are shown in FIG. 4a. Arms 57 are shown fastened to cap 41 by means of screws 58, 58, which are preferably countersunk, provided with no drive slot, and painted over, and indeed screws 58 and/or arms 57 may be welded to cap 40 once they have been inserted through slots 51*b* in plate 51. Alternatively, sheet metal retaining clips 59 may be inserted on arms 57 above plate 51 so that no arm may fall into casing 10 even if screws 58 are allowed to be loosened.

FIG. 5 illustrates a portion of modified embodiment which otherwise is constructed in accordance with FIG. 1, but wherein two separate rubber rings 25*a*, 25*b* are compressed between the lower flange means and flange 11*c* of hub 11, with a metal ring 19 interposed between the two rubber rings.

It should be noted that the invention may be used to seal well casings used with jet pumps, and various other

pumps, as well as submersible electric motor driven pumps, and also may be used to seal pumpout pipes of septic tanks.

It is important to note that various of the features shown may be used in combinations other than those shown in the drawings. For example, chamfered surfaces engaging the rubber ring **25** may be used in FIG. **1**, the double ring arrangement of FIG. **5** may be used with the other embodiments in addition to that of FIG. **1**, the cap or dome of FIG. **1** may incorporate a pair of concentric annular grooves of the type shown in FIG. **3**, etc.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained, and since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A well seal assembly for sealing the upper end of a hollow cylindrical well casing, comprising, in combination: a cap having a first annular surface adapted to seat on said end of said casing, an annular first flange adapted to extend into said casing adjacent the inner wall of said casing, and a bore extending through said cap substantially along the cylindrical axis of said casing; shaft means extending through said bore of said cap means; a lower flange means adapted to be situated within said casing and be supported by said shaft means, said lower flange means having an annular surface extending below said annular first flange; a compressible seal ring situated between said first flange and said surface of said lower flange means; and a threaded connection between said shaft means and said lower flange means, whereby rotation of said shaft means may raise said lower flange means to compress said compressible seal ring between said first flange and said lower flange means, causing radial expansion of said seal ring against said inner wall of said casing.

2. An assembly according to claim **1** wherein said threaded connection comprises mating screw threads on a lower end portion of said shaft means and on a hub portion of said lower flange means.

3. An assembly according to claim **1** wherein said shaft means extends slidingly through an opening in said lower flange means, nut means are situated on said shaft means below said lower flange means, and said threaded connection comprises mating screw threads on a lower end portion of said shaft means and said nut means.

4. An assembly according to claim **1** having bolt means extending upwardly from said lower flange means, and said threaded connection comprises mating screw threads on said bolt means and said shaft means.

5. An assembly according to claim **1** having stop means to limit operation of said threaded connection to limit lowering of said lower flange means.

6. An assembly according to claim **1** having a second compressible seal ring between said first flange and said lower flange means, and a substantially incompressible ring situated between compressible seal ring and said second compressible seal ring.

7. An assembly according to claim **1** wherein said cap includes a hub portion carrying said bore, said hub portion having a flat upper surface portion, said shaft means includes a widened shaft portion having a diameter exceeding that of said bore, said widened shaft portion having an annular lower surface; and washer means situated between said flat upper surface portion and said annular lower surface.

8. An assembly according to claim **1** wherein said shaft means includes an internal passageway extending from a portion of said shaft means below said bore to a portion of said shaft means above said bore.

9. An assembly according to claim **1** wherein said cap includes an annular second flange adapted to extend below said upper end of said casing adjacent the outer wall of said casing.

10. An assembly according to claim **1** wherein said cap means comprises a generally hemispherical hollow cap having at least one threaded opening through the wall thereof.

11. An assembly according to claim **2** wherein lower flange means comprises a ring-shaped portion carrying said annular surface, a hub portion threaded on said shaft means, and rigid means interconnecting said ring-shaped portion and said hub portion, said rigid means containing at least one opening allowing passage of electrical wiring through said opening.

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