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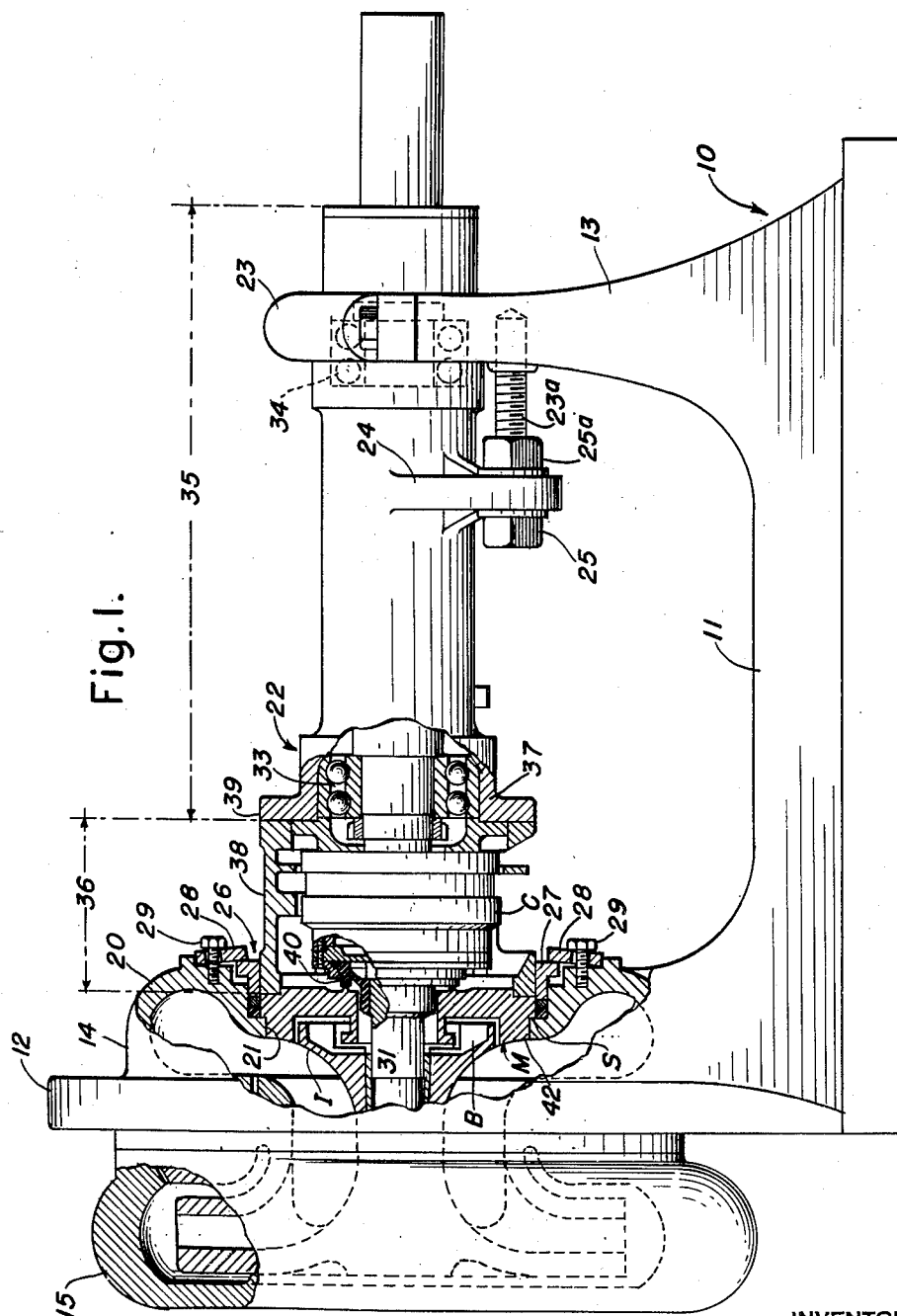
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2,620,207

GLANDLESS SEAL FOR CENTRIFUGAL PUMPS

Filed July 19, 1949

4 Sheets-Sheet 1



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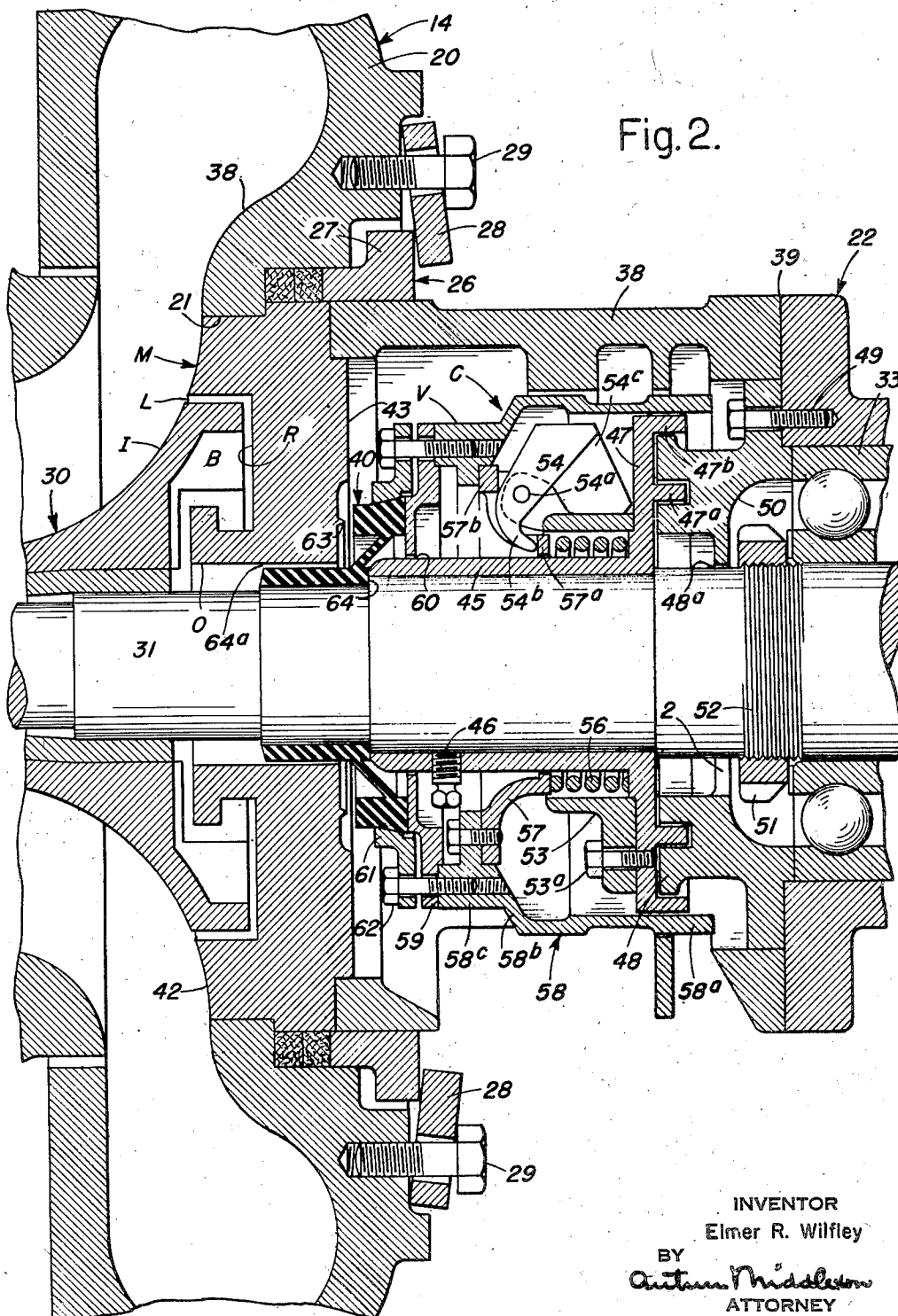
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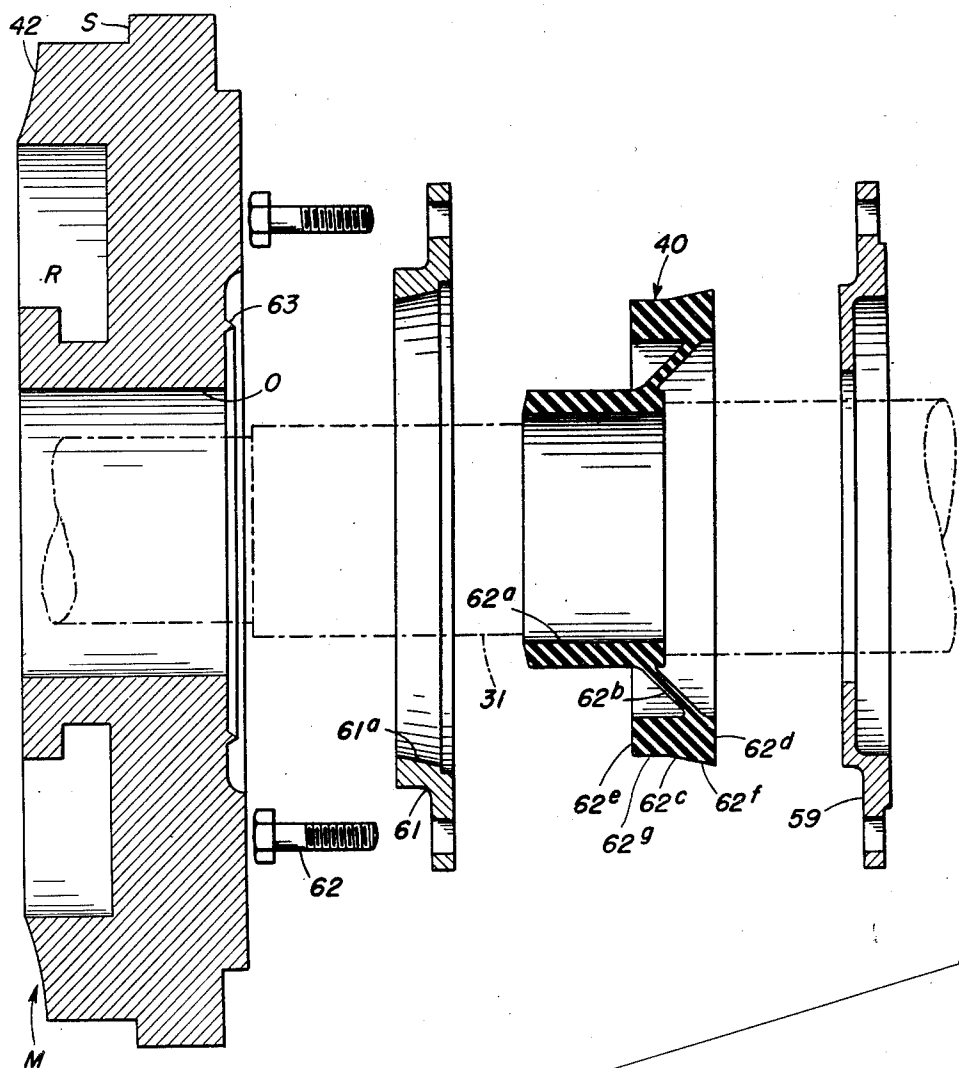


Fig. 3.

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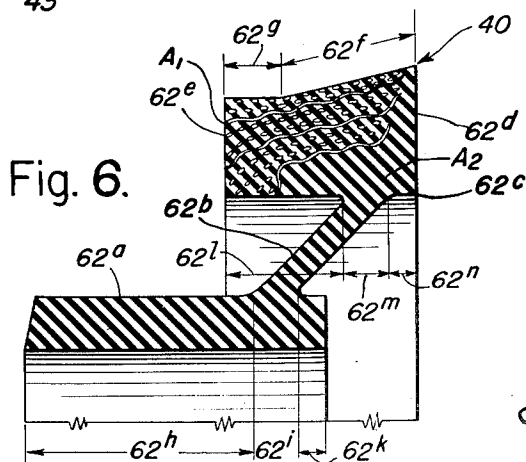
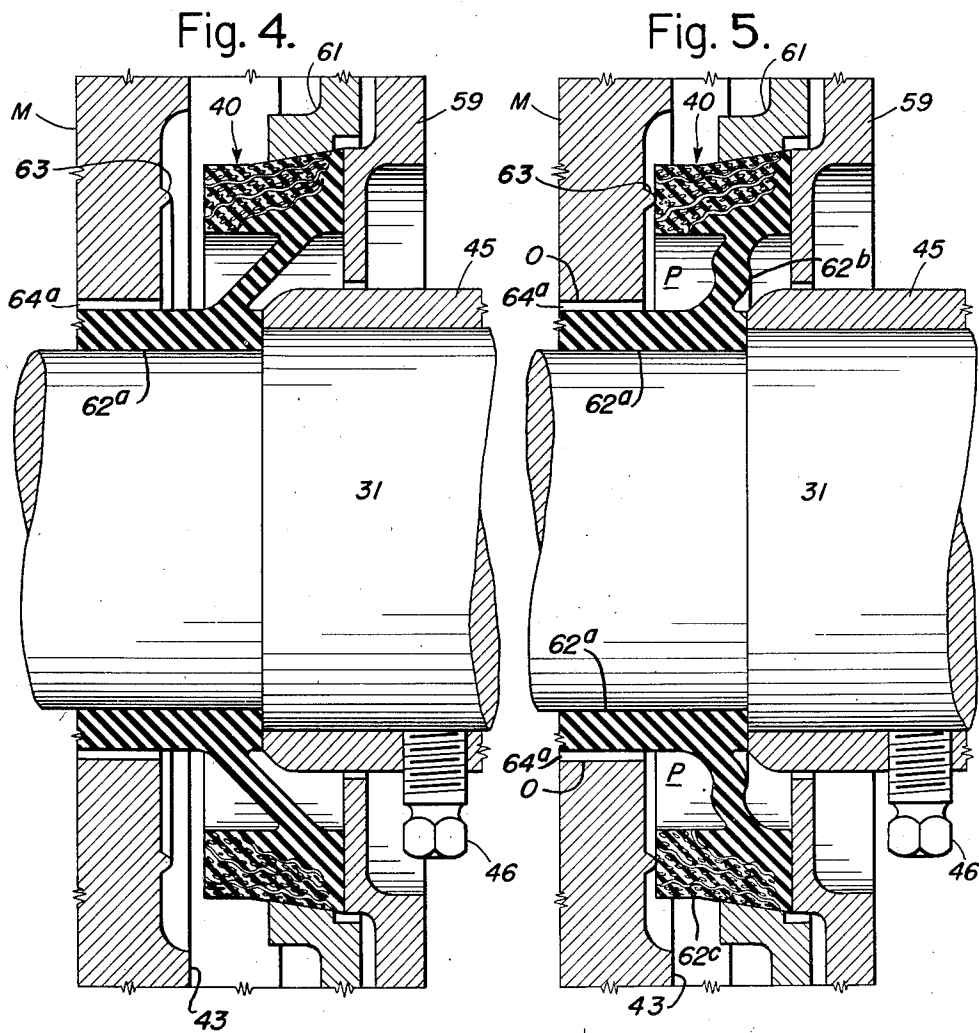
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GLANDLESS SEAL FOR CENTRIFUGAL PUMPS

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4 Sheets-Sheet 4



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2,620,207

GLANDLESS SEAL FOR CENTRIFUGAL PUMPS

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2 Claims. (Cl. 286—11.11)

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This invention relates to centrifugal pumps and in particular to that class of centrifugal pumps which avoid the use of a stuffing box or gland between the impeller shaft and the pump housing, to render such pumps serviceable for pumping corrosive liquids or liquids carrying grit or sand or other sand constituents. Such pumps are herein simply termed sand or slurry pumps.

Such pumps are provided with an annular valve member which normally closes an annular non-frictional clearance or gap between the impeller shaft and the housing, which clearance is automatically opened when the pump starts running, is kept open while the pump is running, and is again closed when the rotation of the impeller shaft stops. Leakage of liquid through the annular clearance is counteracted by suitable hydraulic sealing pressure created by the pump itself while running.

Further particularized this invention relates to the type of sand pump exemplified in the patent to Wilfley No. 1,976,532, that is, a sand pump in which the impeller shaft is axially non-shiftable with respect to the pump housing, but has an axially shiftable annular valve member surrounding it. In other words, shiftable upon the shaft is a sleeve or ring member representing an annular valve body adapted to close or open the annular clearance between the impeller shaft and the surrounding portion of the housing. In that patent the sleeve valve member is normally held weighted upon and in sealing relationship with the housing by spring pressure, when the pump is not operating. As soon as the impeller shaft starts rotating, a set of centrifugal weights operate to retract the valve member from its seat against the pressure of the spring, the valve to remain open while the pump is running. Leakage through the annular clearance is counteracted by an auxiliary or sealing impeller which is co-axial and rotating with the impeller shaft and which is effective to create hydraulic pressure that opposes the tendency of leakage of liquid or slurry through the annular clearance. When the pump is stopped the valve-carrying sleeve shifts due to the spring pressure closing the annular clearance as the hydraulic sealing pressure from the auxiliary impeller dies down.

In that patent the valve-actuating mechanism is protected against contact with liquid or particles that may leak from the pump-housing, for example during the periods of starting up or shutting down the pump. Such protection in the patented construction is afforded by a shell, housing or cup surrounding the mechanism and

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bodily shiftable with the valve-carrying sleeve. A diaphragm of a flexible material such as rubber or the like interconnects the shaft and the protective shell and acts as a septum that prevents liquid from penetrating to and into the mechanism surrounded by the shell, yet without interfering with the shifting movement of the valve-carrying sleeve upon the shaft.

It is among the objects of this invention to improve and to simplify the construction of the sealing valve means and of the protective diaphragm means interconnecting the valve-carrying sleeve with the shaft, as well as to render the valve means reliable and durable and substantially independent of the machining of associated parts of the pump.

According to the invention this object is attained by providing a protective rubber diaphragm member in which a protective septum and a valve member are combined as a unit in a special manner.

According to one feature the dual-purpose diaphragm has an inner cylindrical portion snugly fitting over the shaft, an intermediate annular diaphragm portion of outwardly widening cone shape and joining the cylindrical portion intermediate the ends thereof, an outer rim portion constituting an annular valve or sealing member which is joined by the diaphragm portion intermediate its ends so that this rim portion in turn can be and is circumferentially clamped to the inner end of the protective shell. The intermediate diaphragm portion by its deformation absorbs the shifting movement of the valve-carrying sleeve.

According to a more specific feature of this invention, the valve member never closes off the annular clearance but when shifted to sealing position, seals against fluid-flow therethrough by contacts made outside of the clearance between the outer face of the impeller housing and the rim portion of the valve pressed thereagainst in fluid-sealing contact through the medium of the flexed diaphragm portion.

The best embodiment of this invention now known to me is described herein by way of example but it is not to be taken as limiting because obviously changes can be made therein so long as they do not depart from the scope of the appended claims, remembering, however, the principle of patent law of equivalents.

The preferred embodiment is illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a longitudinal elevational view of the

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pump with portions broken away to show the environment of the improved diaphragm.

Fig. 2 is an enlarged view of the sectional portion of the pump shown in Fig. 1, showing more clearly the disposition of the diaphragm.

Fig. 3 is a further enlarged detail view of the diaphragm shown in Fig. 2 along with associated structural elements, although showing the parts in exploded fashion.

Fig. 4 shows the diaphragm further enlarged together with directly associated parts, and with the valve portion of the diaphragm in open position.

Fig. 5 is a view similar to Fig. 4, although with the valve portion in closing position.

Fig. 6 is a still further enlarged partial view of the diaphragm alone.

The pump unit comprises a frame member in the form of a casting 10 which in turn comprises the longitudinal body portion 11, an annular frame portion 12, rising from one end of the base portion and defining a plane extending transversely of the base portion. This casting further comprises a bearing-receiving or bearing-sustaining portion herein also termed a bearing lug 13 which rises from the other end of the base portion 11.

Referring to Fig. 1, the pump housing is of substantially standard construction and comprises an intake portion 14 and a discharge portion 15. The intake portion has an intake neck or intake connection here not shown, and constitutes an integral portion of the casting 10 and specifically of the annular frame portion 12 thereof. The discharge portion 15 is in the form of a removable shell or cover portion surrounding an impeller 30 and suitably bolted to the annular frame portions by means of bolt connections here not shown. The intake portion may also be termed the inner or low-pressure portion, while the discharge portion may be termed the outer or high-pressure portion. The intake housing shell 14 has an outer wall portion 20 provided centrally with an opening 21 into which fits and through which extends a shaft-carrying horizontally extending stationary structure collectively designated as 22. Thus the inner end of this shaft-carrying structure 22 is supported by the intake portion 14 through an intermediate annular member M which in turn fits into the opening 21 and has a shoulder S seating upon the housing portion 14. The outer end of the structure 22 is supported by the bearing lug 13 upon which it is held down by a bearing cover 23 bolted to the lug. Longitudinally the position of the shaft-carrying structure 22 is fixed, although adjustably, relative to the frame member 10, that is relative to the stationary parts of the pump unit by means of a stud 23^a extending horizontally and parallel to the longitudinal axis of the structure 22, the stud 23^a being screwed tightly into the bearing lug 13 so as to be unitary therewith. The stud 23^a in turn extends through a lug or forked lateral extension 24 of the shaft-carrying structure 22, and a pair of nuts 25 and 25^a upon the stud engage the lug 24 thereby anchoring and fixing the shaft-carrying structure 22 in an adjusted position relative to the stud 23 and thus relative to the base or stationary parts of the pump unit.

The shaft-bearing structure 22 extending into the intake housing portion 14 has sealing relationship therewith due to the provision of a stuffing box 26 comprising a gland member 27 held in place and under suitable pressure by re-

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taining lugs 28 which in turn are held by screws 29 upon the intake housing shell 14.

An impeller 30 is surrounded by the discharge housing portion 15 and is mounted upon the outer end of an impeller shaft 31. This impeller is formed with and terminates rearwardly in an extended and widened or flaring hub portion which constitutes an auxiliary or sealing impeller I having impeller blades B. The shaft is carried by a pair of ball bearings 33 and 34 provided within the structure 22. The structure 22 comprises a shaft-bearing section 35 and a control section 36 containing the control devices for actuating the sealing means described further below. The shaft-bearing section 35 comprises a cylindrical member 37 in which are mounted the ball bearings 33 and 34 which in turn carry the impeller shaft 31. The control section 36 comprises a cage member 38 open at the bottom and having a flange connection 39 with the cylindrical member 37, and also comprises the control device proper indicated at C which in turn comprises an improved sleeve valve member 40 which integrally combines and serves the dual purpose of a sealing diaphragm and of a valve member. The inner end of the cage member 38 is closed by annular member M which is marginally sealed against the intake housing portion 14 through the stuffing box 26. The annular member M is finished off inwardly, that is towards the interior of the pump housing by a contour face 42 so-termed because it provides the contour as part of the interior contour of the intake portion of the pump housing and at its opposite side has an outer vertical face 43. The annular closure member M has an opening O and an annular recess R into which extends and in which rotates the auxiliary impeller I, there being an annular clearance L between the impeller I and the member M.

Description of the control device

Referring more particularly to Fig. 2 the control device C is similar in the general principle of its function to the one shown in the aforementioned patent to Wilfley No. 1,976,532, but includes structural modifications whereby it is adapted for combination and connection with the improved sleeve valve 40. The device C comprises a sleeve member 45 fitted over and fixed to the impeller shaft 31 as is indicated by a set screw 46. This sleeve member at its rear end terminates in a flange 47 having cylindrical rearward projections 47^a and 47^b concentric with the axis of shaft 31. The cylindrical projections constitute labyrinth portions interacting with a labyrinth plate 48 which is fixed to the stationary cylindrical member 37 as by screws 49. This plate 48 also serves as a retainer for the front ball bearing 33. The rear of the labyrinth plate 48 is gouged out to form an annular recess 50 which accommodates a nut 51 screwed onto the impeller shaft 31 as indicated by a thread 52 thereon, this nut being effective together with a similar nut associated with the rear ball bearing 34 to confine the shaft 31 in a predetermined axial position. The labyrinth plate 48 has a suitable running clearance 48^a with the shaft 31.

The sleeve member 45 has mounted on it an annular bracket member 53 fastened by screws 53^a. The sleeve member 45 also has mounted on it a set of swingable centrifugal weight members one of which is visible at 54 having a pivotal mounting 54^a upon the bracket member 53 which is unitary with the sleeve member 45. The centrif-

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ugal weight members 54 are in the form of double-armed levers the outer ends 54^a of which are the free weighted ends while the inner ends 54^b engage a shiftable assembly which represents the valve- or seal-carrying assembly for sealing the pump housing against the impeller shaft at the intake while the pump is standing still. This shiftable valve-carrying assembly is collectively designated as V. Normally this assembly V is urged inwardly, that is towards the pump housing, by a compression coil spring 56 surrounding the sleeve member 45 while the pump is standing still. When the pump runs and the impeller shaft 31 is rotating that rotation will force the weighted ends of the centrifugal weight members 54 outwardly causing the assembly V to be shifted outwardly that is away from the pump housing against the pressure of the spring 56.

The valve-carrying assembly V further comprises a cage-like ring member 57 the outward end 57^a of which is engaged by the compression spring 56 while the inward end 57^b is weighted upon and interiorly engages a cup member 58 serving as a cylindrical shield surrounding the centrifugal control mechanism and is herein also called a shield member. This shield member 58 has an outer free end portion 58^a which is rearwardly or outwardly open, an intermediate beveled shoulder portion 58^b and a reduced inner end portion 58^c closed by an annular end plate 59 having a running clearance 60 between it and the sleeve member 45. The annular end plate 59 is associated with a clamping or retaining ring 61 whereby the annular sleeve- or valve-member 40 is retained upon and held tightly against the annular end plate 59. The valve member 40 consists of a resiliently deformable material, for example rubber or rubberized material. The clamping ring 61 is held by screws 62 threaded into the shield member 58. The resiliently deformable valve member 40 is engageable upon a corresponding annular liquid obstructing ridge or dam 63 formed upon the outer face of the annular member M. The valve member 40 an enlarged detail of which is shown in Fig. 4 consists of a sleeve or hub portion 62^a snugly fitted over the shaft 31, an intermediate conical flexible diaphragm portion 62^b extending from the hub 62^a at substantially 45° and an outer portion representing a rim 62^c, all portions 62^a, 62^b and 62^c constituting the integral valve member 40. The rim portion 62^c is defined by a flat outer face 62^d set against the annular end plate 59 and an inner flat face 62^e adapted to engage and close upon the ridge 63. The rim portion 62^c positioned so that its length overlaps that of the sleeve or hub 62^a is also formed with an outer conical face 62^f which is complementary to and engaged by a similar conical face 61^a formed upon the retaining ring 61. The assembly V as controlled by the centrifugal device within may shift axially so as to open or close a gap between the rim portion 62^c of the valve member and the ridge 63. Indeed a leak-proof closure between rim portion 62^c and ridge 63 is obtainable as the ridge may impress itself or dig into the resilient rubber material of the valve member, so that none of the close machining or highly accurate forming of the conventional members is required. Moreover no extra sealing means and extra mounting means are required to establish a diaphragm septum between the shiftable assembly V and the impeller shaft such as had to be provided in the aforementioned Wilfley patent

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No. 1,976,532. It will be noted that the inner or cylindrical portion 62^a is tightly confined upon the shaft 31 between the auxiliary impeller I and a shoulder 64 of the shaft, while the rim portion 62^c of the valve member is tightly clamped to the shiftable assembly V. In this way a simple and effective protective seal is established for the interior centrifugal control mechanism disposed within the shield member 58. Since the hub portion 62^a of the valve member 40 extends into the opening O of the annular member M, there is provided a suitable annular clearance 64^a between them.

The outline or profile of the valve member 40 is defined in further detail in Fig. 6 in so far as it subdivides the hub portion 62^a into an intermediate portion 62ⁱ, a long end portion 62^h and short end portion 62^g, and similarly subdivides the rim portion 62^c into an intermediate portion 62^m, a long end portion 62^l, and a short end portion 62ⁿ. The intermediate portions 62ⁱ and 62^m are interconnected and merge with the intermediate conical diaphragm portion 62^b. The rim portion 62^c is otherwise subdivided into a cylindrical portion 62^s and a conical portion 62^f. It is to be noted that the rim portion 62^c of the valve member 40 although consisting integrally of rubber, contains internal stiffening or reinforcement in the form of canvas threads or fabric comparable to automobile tire reinforcement. This reinforcing thread material is shown to partially pervade the rim portion 62^c. That is to say, the material pervades the cylindrical portion 62^s and partially the conical portion 62^f. Thus there may be discerned in the rim portion 62^c a reinforced area A₁ and a non-reinforced area A₂, the dividing line between both areas running roughly diagonally through the conical portion 62^f (see Fig. 6). Therefore, this valve member is tough, relatively stiff and durable in its reinforced portion which presents the sealing face, yet sufficiently yielding in its non-reinforced portion.

The Fig. 4 condition of the valve member 40 shows that member in its non-deformed condition when the valve is open with the pump running, while Fig. 5 shows the member in its deformed condition when the valve is closed and the pump has stopped running. It will be seen that the intermediate diaphragm portion 62^b merges with non-reinforced rubber portions of the hub portion 62^a and of the rim portion 62^c, while the sealing portion proper is relatively stiff although tough and durable, yet of a kind that will adapt itself to effective sealing upon the annular ridge 63.

Operation

The operation of the pump with respect to sealing the intake side of the pump housing against leakage is as follows:

When the pump stands still and the centrifugal weight members 54 are inactive the spring 56 forces the assembly V inwardly towards the pump housing thereby forcing the rim portion of the valve member 40 upon the ridge 63 (see Fig. 5) so that liquid from the pump housing cannot leak from between the impeller shaft and the surrounding housing portion. When the pump has started and the shaft is rotating sufficiently fast to actuate the centrifugal weight members 54, these weight members will shift the assembly V outwardly away from the housing against the pressure of spring 56 thereby lifting the rim portion 62^c of the valve member

from the ridge 63 (see also Fig. 4) thereby removing all friction between the rotary parts and the housing. No substantial leakage will occur through the annular gap created by the outward movement of the rim portion 62^c since the hydraulic pressure set up by the rotation of the auxiliary impeller 44 will contain or balance the outward pressure of the liquid within the intake portion of the housing. As soon as rotation of the impeller shaft stops the rim portion 62^c will again return to its closing or sealing position upon the ridge 63 while the hydraulic balancing pressure from the auxiliary impeller I dies down.

In connection with the position of the parts shown in Fig. 5, which is the position they take when the pump is not running, it is to be noted that the diaphragm 62^b is flexed and the inner face 62^a of the rim 62^c has been moved into sealing contact with the annular dam 63 on the outer vertical face 43 of the housing 14. The hub 62^a of the valve member 40 enters the opening O, but to a diametrical extent such that the opening is never closed thereby since there is at all times an annular clearance 64^a between the hub 62^a and the peripheral wall of that opening. Thus the hub 62^a is submerged constantly in fluid in that clearance. But significantly when the parts are in the position shown in Fig. 5, fluid of the clearance extends into and forms a pool thereof P in the space defined by the rim 62^a, the flexed diaphragm 62^b, the inner periphery of the rim 62^c, the annular dam 63, the face 43 from which it projects, and the opening O. In this manner flow of fluid from that clearance is sealed, but the sealing means are all external of that clearance and its opening. No flow-stopping means are inserted into that clearance since the hub of the valve remains there at all times in non-closing relationship thereto. So the actual sealing is done between the flexed diaphragm plus the rim of the sleeve valve and the vertical face of the housing.

What I claim is:

1. A glandless seal for a pump that has a generally vertical impeller housing with a face exteriorly thereof with an axially located open-

ing therein, a horizontal driven impeller-bearing shaft entering the opening with an annular clearance between shaft and opening through which clearance fluid from the pump flows when not sealed, an annular assembly rotatable with the shaft but shiftable thereon toward and away from the face of the housing, and a valve member for controllably sealing flow of fluid from the clearance having a rim portion carried by the assembly with a hub portion extending sufficiently from the rim toward the opening to lie non-closingly in the clearance within the opening while snugly fitted on the shaft and a flexurable conical diaphragm connecting the hub and rim which, when flexed by shifting of the assembly, allows the rim to reciprocate with respect to the hub, said rim extending sufficiently from the assembly so that it sealingly engages the face of the housing when the assembly is in its maximum shifted position adjacent the housing thus sealing fluid of the clearance against flow past the diaphragm and its rim.

2. A glandless seal according to claim 1, with the addition of a fluid-flow-obstructing annular dam located concentric with the opening between the face of the housing and the rim when the latter is in sealing position.

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