July 1, 1958 R. J. MacMEEKIN ET AL 2,841,087

VERTICAL CENTRIFUGAL PUMPING APPARATUS

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Fig. 1

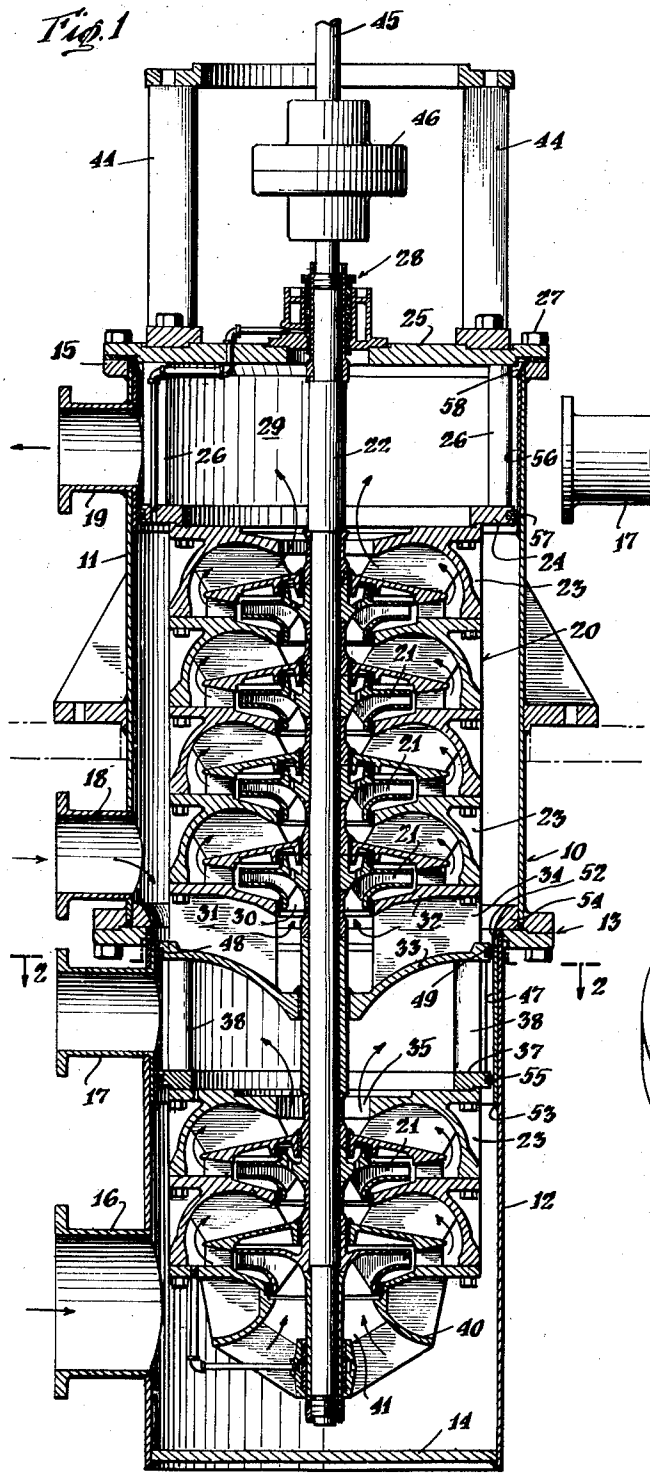


Fig. 2

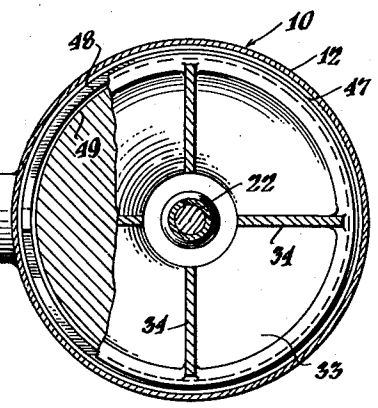
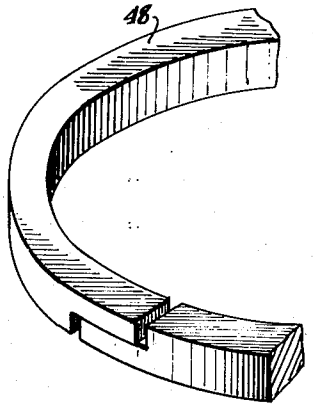


Fig. 3



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VERTICAL CENTRIFUGAL PUMPING APPARATUS

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2 Claims. (Cl. 103—107)

This invention relates to pumps and more particularly to multi-stage centrifugal pumps of the pit type. A pump of this type includes a vertically disposed barrel or outer casing having suction and discharge connections and an inner section or inside pump assembly consisting of rotating parts, stage pieces and supporting pieces. The inside pump assembly is inserted into the outer casing through an opening at the top of the outer casing and is suspended from a closure for the opening. The closure is supported by the casing and effects a seal with the casing.

It has been proposed to separate the suction and discharge connections from communicating with one another by seals provided by flanges extending radially outwardly from the inner pump assembly and resting against shoulders on the inside of the outer casing. Such flanges and shoulders provide plano-joints with coacting sealing surfaces parallel to one another and to the sealing surfaces at the underside of the closure at the upper end of the outer casing. Owing to the fact that the outer casing and the inside pump assembly are each constituted in a rigid form, it is difficult and expensive to obtain secure seals in separated planes with up-wardly facing sealing surfaces on the outer casing and downwardly facing sealing surfaces on the inside pump assembly. Maximum manufacturing precision is required in order to provide substantially equal sealing efficiency at all levels for two or more joints constructed in this manner because the surfaces on one of the units must correspond in location and spacing with the surfaces on the other unit. Packed joints require critical control of measurements. Moreover, every time the inside pump assembly is withdrawn from the outer casing for inspection, care must be exercised and time taken to make certain that the cooperating sealing members at each of several joints are properly conditioned to assure complete sealing at all levels when the inside pump assembly is restored to its proper operating position. It is among the objects of the present invention to effect savings in the manufacture of pumps of the pit type and to effect a shortening of the period of shutdown for inspection and cleaning which has heretofore been required for the maintenance of such pumps.

In accordance with the present invention, all of the transverse sealing surfaces have been eliminated with the exception of a downwardly facing surface on the closure at the upper end of the casing and a cooperating upwardly facing surface at the upper end of the casing. This is accomplished by providing self-adjustable sliding seals between the inside of the outer casing and the outside of the pump assembly. A sliding seal is constituted of an annular member on the inside pump assembly and a ring contained in a groove in the annular member and pressing in sealing relationship with the interior surface of the outer casing or with a sleeve fastened to the outer casing and providing a cylindrical bearing surface for the ring. The seal is automatically effected when

the pump assembly is lowered to its proper position in the outer casing.

In a multiple pump having an inside pump assembly comprising two or more pumps operated by a common shaft, several sliding seals are employed and all of these seals become effective as soon as the pump is in operating position. No one of several seals is dependent upon another for accomplishing a secure seal. Owing to the manner in which the seal is accomplished, the inside pump assembly can be readied for replacement and replaced in the outer casing and the entire pumping equipment made ready for operation with more despatch than was formerly possible with previously known constructions. Savings in manufacturing costs can be effected because allowable variation in the axial dimensions of pump parts may be increased.

With these and incidental objects in view the invention consists of certain novel features of construction and combination of parts, the essential elements of which are set forth in the appended claims and a preferred form of embodiment of which is described hereinafter with reference to the drawing which accompanies and forms part of the specification.

In the drawing,

Fig. 1 is a vertical section of a pump embodying the present invention.

Fig. 2 is a horizontal section on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary perspective view of a piston ring.

The drawing illustrates the application of the invention to a double pump which includes an outer casing 10 in cylindrical form with its axis disposed vertically. The casing is formed of two hollow cylinders 11 and 12 which are connected end to end by a flanged joint 13. The lower cylinder is closed at its bottom by a plate 14 and the upper cylinder has an opening at its upper end which is bounded by a laterally extending flange 15. The casing is provided with a suction connection 16, a discharge connection 17, a suction connection 18 and a discharge connection 19, all of which are welded to the casing.

The inside pump assembly 20 includes several stages, each comprising an impeller 21 fastened to a common shaft 22 and a bowl or channel ring 23, and the usual mounting pieces comprising sleeves, bushings and wear rings. In the assembly illustrated, the lower pump has two stages and the upper pump has four stages.

The various channel rings of the upper pump are fastened together by studs and nuts in the usual manner, and the upper channel ring is secured to the underside of an annular member 24 which is spaced from and secured to a closure 25 by a plurality of vertically extending stays 26. The closure 25 rests upon the outer casing and is fastened to the flange 15 by a plurality of bolts 27. In the construction illustrated, the closure is completed by a stuffing box 28 surrounding a sleeve on the shaft 22 and containing the usual packing. The upper pump discharges into the space 29 above the annular member 24.

The suction port 30 of the upper pump receives fluid from a chamber 31 having an upper wall 32 extending laterally from around the suction port to the perimeter of the lower channel ring, and a lower wall 33. Vertically disposed spacers 34 connect the walls 32 and 33.

The wall 33 separates the chamber 31 from the lower pump and serves to confine the flow of fluid from the discharge port 35 of the lower pump to the passage in the discharge connection 17. A ring member 37 is supported by and fastened to the wall 33 by a plurality of stays 38. The walls 32 and 33, the spacers 34, the ring member 37 and the stays 38 may be integrally cast, or otherwise constituted in one piece.

The channel rings of the lower pump and the suction

bell 40, including the lower shaft bearing, are fastened together in the usual manner by studs and nuts, and the upper channel ring is likewise fastened to the ring member 37. The casing of the upper and lower pumps are thus constituted as a single unit suspended from the closure 25 by the stays 26, and the whole assembly, including the closure 25, is supported by and is removable from the outer casing 10 as a unit. Fluid is drawn into the suction port 41 from the space around the lower pump and the lower connection 16.

A support 44 for a motor (not shown) is removably mounted on the top side of the closure 25. The motor drives the shaft 20 through a shaft 45 and a coupling 46.

The pump illustrated is well suited for below floor installation which places the first stage of the lower pump below the level of the hotwell of a condenser. Water is taken in through the connection 16 and delivered to a heater (not shown) through the connection 17 and is withdrawn from the heater through the connection 18. It is delivered from the upper pump to the compartment immediately below the closure 25 and thence to the discharge connection 19. The direction of flow in the connections 18 and 19 would be reversed for a pump which discharges downwardly. The several connections on the outer casing are located at different levels irrespective of their functions in an apparatus in which the invention is used.

The outlet passage from the lower pump is separated from the inlet passage to the upper pump by the transverse wall 33 and means for sealing between the wall 33 and the outer casing 11. The wall 33 extends radially outwardly beyond the maximum diameter of the pump and has a rim with an outer periphery which is slightly spaced from the interior of the outer casing or from an annular member 47 attached to the outer casing and which provides a bearing surface for a sealing ring 48. Suitable sliding seals are obtained with split rings having overlapping ends such as metal piston rings of the kind used in Diesel engines. The rings are resilient and press outwardly into contact with the bearing surface on the interior of the outer casing. Owing to their hardness and lateral rigidity they retain their form when functioning to seal against fluid pressure. A circumferential groove 49 in the rim of the wall 33 is so dimensioned that the ring effects a seal with the rim and is allowed to expand.

As shown in the drawing, the sealing ring 48 presses outwardly against the inner circumferential surface of the sleeve 47 which is fastened to the inside of the casing by welds 52 and 53. The sleeve is made of a corrosion-resistant material such as bronze, and the welds continue around the interior of the casing and thus prevent fluid from having access to the exterior of the sleeve. The inner surface of the sleeve is accurately machined to provide a true circular surface to assure contact with the ring throughout its circumference. Similar results may be obtained by coating the interior surface of an outer casing with a layer of corrosion-resistant material, such as nickel or zinc, or the surface can be Parkerized, but if the casing itself is made of corrosion-resistant material, such as stainless steel, its interior in the vicinity of the seal may be finished to provide a circular bearing surface.

In the pumping apparatus illustrated in Fig. 1, the outer casing is formed of two parts, an upper hollow cylinder 11 and a lower hollow cylinder 12. The upper hollow cylinder 11 is sufficiently large to avoid having the sealing rings come into contact with the interior thereof as the pump is lowered into the casing. This construction facilitates access to the upper end of the lower cylinder so that the bearing surface of the seal may be machined and accurately finished.

A bevelled ring 54 is fastened to the inside of the cylinder 11 in order to guide the inside pump assembly to a central position within the casing. Weld metal bridges the gap between the bevelled ring and the upper edge of the sleeve and this weld material is smoothed to a taper continuous with the slope of the bevel of the ring 54. The flare thereby provided serves as a ramp for contracting the sealing ring as the pump is moved axially along the casing and the ring moves onto the bearing surface of the sleeve.

The sealing ring 55 is mounted in a circumferential groove in the annular member 37 and serves to separate the space connecting the inlet port 41 and the suction connection 16 from the discharge connection 17. The sleeve is located and dimensioned to serve as a bearing surface for both of the sealing rings 48 and 55.

A sleeve 56, similar to the sleeve 47, is located adjacent the open end of the outer casing and serves as a bearing surface for a sealing ring 57 which is mounted in a groove in the annular member 24 to which the upper channel ring of the upper pump is connected. In this position the ring and the sleeve seals the passage communicating with the inlet connection 18 from the passage communicating with the outlet connection 19. The weld 58 along the upper edge of the sleeve 56 is tapered to provide a flare for contracting the sealing ring as the inner pump assembly is lowered into its operative position.

The bearing surfaces on the casing should be sufficiently high to assure their engagement by the respective rings even though there may be some variation vertically of the position of the inside pump assembly relative to the outer casing, such as might occur should gaskets of different materials or thicknesses be used at different times between the closure 25 and the outer casing. Equally effective seals are produced by each of the three sealing rings, regardless of any slight variation which may occur in the axial dimension of the inner pump assembly.

This invention is capable of numerous forms and various applications without departing from the essential features herein disclosed. It is therefore intended and desired that the specific description herein be deemed illustrative and not restrictive and that the patent shall cover all patentable novelty herein set forth; reference being had to the following claims rather than to the particular showing herein to indicate the scope of this invention.

What is claimed is:

1. In a vertical centrifugal pumping apparatus, a vertical outer casing containing an inside pump assembly withdrawable through an opening at the upper end of said casing, said pump assembly including a lower pump and an upper pump driven from a vertical shaft, each of said pumps spaced from said outer casing and having a suction port and a discharge port, said outer casing having an inlet passage extending around the exterior of said lower pump and in open communication with the suction port of said lower pump, an outlet passage in said casing in open communication with the discharge port of said lower pump, an inlet passage in said casing extending around the exterior of said upper pump and in open communication with the suction port of said upper pump, and an outlet passage in said casing in open communication with the discharge port of said upper pump, means for supporting said pump assembly from the upper end of said outer casing, said supporting means comprising a closure for the opening at the upper end of said outer casing, said closure having a downwardly facing surface complementary to an upwardly facing surface on said outer casing and forming therewith a joint sealing a compartment at the upper end of said casing from the atmosphere, said compartment forming part of said outlet passage communicating with the discharge port of said upper pump, and members depending from said closure and suspending said pump assembly from said closure, said joint between said upwardly and downwardly facing surfaces reacting to sustain the full downward thrust of the weight of the pump assembly on said

closure; and a plurality of sealing means providing sliding seals between said inside pump assembly and said outer casing, vertically separated from one another and acting independently of one another to prevent communication between the suction port of said lower pump and the discharge port of said lower pump, between the discharge port of said lower pump and the inlet port of said upper pump, and between the suction port of said upper pump and the discharge port of said upper pump, each of said sealing means comprising a cylindrical bearing surface interiorly of said outer casing and a self-adjusting resilient ring mounted in a circumferentially continuous groove in an annular member of said pump assembly and pressing outwardly upon said bearing surfact.

2. In a vertical centrifugal pumping apparatus, an outer casing and an inside pump assembly removable through an opening at the upper end of said casing, said casing including a lower hollow cylinder and an upper hollow cylinder having a diameter greater than the diameter of said lower hollow cylinder, said lower hollow cylinder closed at its lower end and connected at its upper end to the lower end of said upper hollow cylinder, each of said cylinders having a discharge connection adjacent its upper end and a suction connection below its discharge connection, said inside pump assembly comprising an upper pump disposed within and spaced from said upper cylinder, a lower pump disposed within and spaced from said lower cylinder, the discharge and suction ports of said upper pump communicating, respectively, with a passage in said casing to said discharge connection of said upper cylinder and with a passage in said casing to said suction connection of said upper cylinder, the discharge and suction ports of said lower pump connecting, respectively, with a passage in said casing to said discharge connection of said lower cylinder and with a passage in said casing to said suction connection of said lower cylinder, a transverse wall intermediate said passage communicating with the suction port of said upper pump and said passage connecting with the discharge port of said lower pump, means connecting said transverse wall to said upper and lower pumps, an annular member extending laterally from said upper pump to adjacent a cylindrical bearing surface on the interior of said upper cylinder on a level intermediate said suction and discharge connections of said upper cylinder, an annular member extending laterally from said lower pump to adjacent a cylindrical bearing surface on the interior of said lower cylinder at a level intermediate said suction and discharge connections of said lower cylinder, said transverse wall and said annular members each having a piston ring groove in its outer peripheral edge, and piston rings in said grooves pressing outwardly against said cylindrical bearing surfaces, said cylindrical bearing surfaces being of sufficient expanse vertically for the piston rings to remain in sealing contact therewith irrespective of variations in the vertical position of said pump assembly and piston rings relatively to said outer casing.

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