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2,661,698

CENTRIFUGAL PUMP

Filed March 21, 1951

2 Sheets-Sheet 1

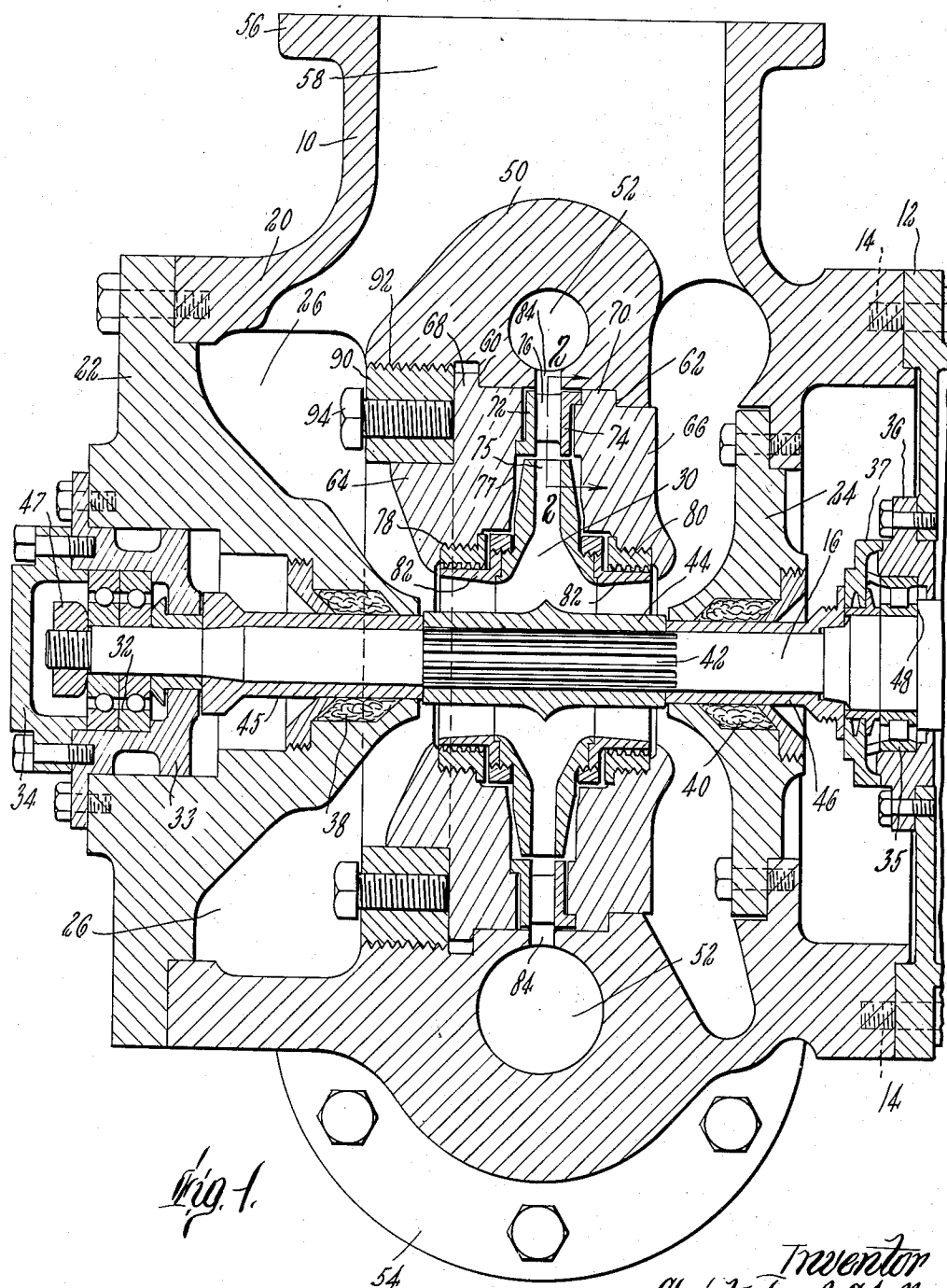


Fig. 1.

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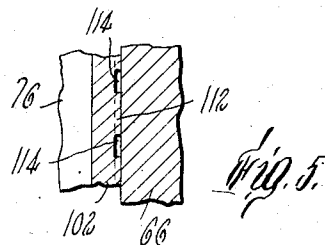
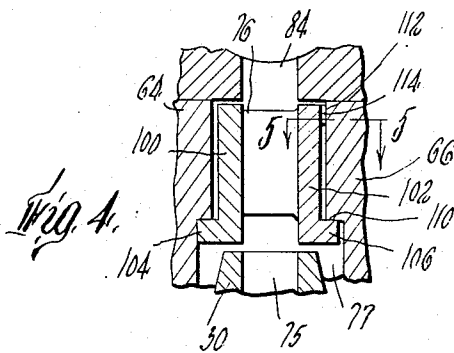
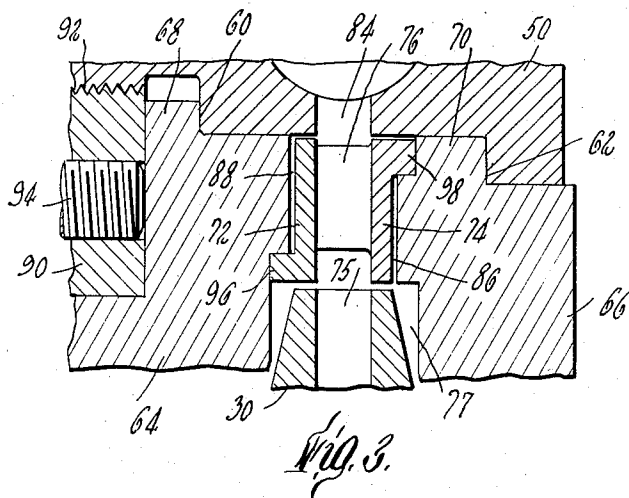
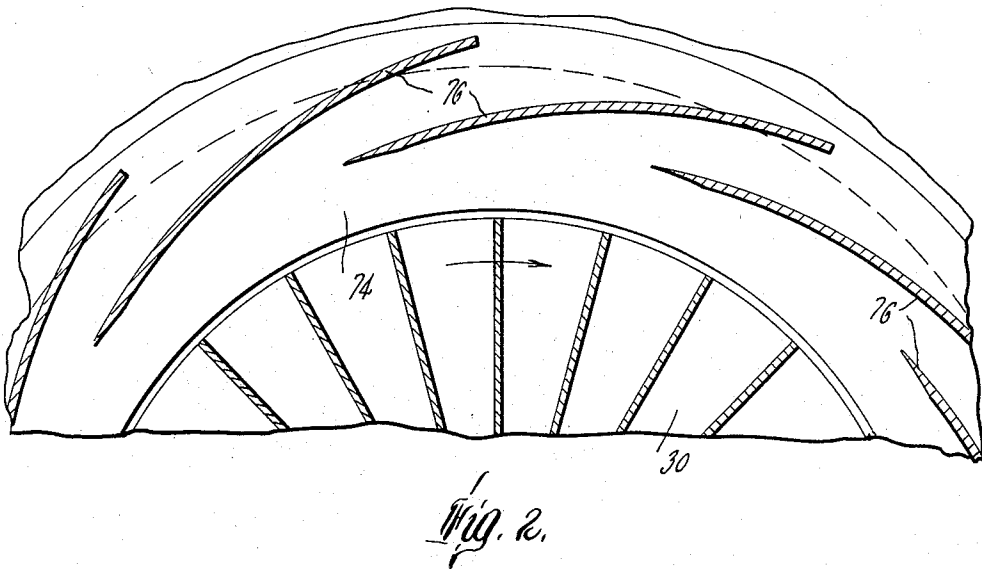
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL PUMP

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12 Claims. (Cl. 103—104)

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This invention relates to centrifugal pumps and more particularly to single stage centrifugal pumps employing one double inlet runner, such a pump being shown in my Patent No. 2,101,653, granted December 7, 1937. In order to provide for assembling such apparatus it is customary to divide the pump housing into two parts on a horizontal plane which contains the axis of the driving shaft of the runner, the two parts being secured together by bolts. It has been found difficult to make the joint between the parts tight against leakage, particularly when high pressures are developed and when diffuser vanes are employed.

In high pressure pumps it is necessary that the clearance between runner inlets and the stationary wearing rings be made as small as possible to minimize leakage of pressurized liquid from the chamber containing the discharge portion of the runner to the suction chamber at the inlets of the runner. To this end, the bearings of the shaft on which the runner is mounted must be accurately centered with respect to the wearing rings, and it is extremely difficult to secure this centering with the split casing construction. An object of this invention is to provide structure for assembling and disassembling the separable parts of the pump without disturbing the pipe joints which are secured to the casing to supply liquid to the pump suction and to conduct away the liquid discharged by the pump. For this purpose, the pump casing is made with a circular opening at one side which is concentric with the drive shaft and is of sufficient size to admit the removable parts which must be assembled within the casing to complete the pump. In assembling the pump, these parts are moved into the casing along the axis of the drive shaft, as hereinafter described, and a plate or head is secured to the casing to close the opening.

Another object of the invention is to provide a novel means for securing in place two diaphragms which are mounted with a diffuser within the casing to enclose the discharge portion of the runner or impeller in such a manner as to avoid or minimize leakage of pressurized liquid from the discharge end of the diffuser through the joints between the diaphragms and the casing.

For a more complete understanding of the invention, reference may be had to the following description thereof and to the drawing, of which—

Figure 1 is a sectional view of a single stage centrifugal pump embodying the invention;

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Figure 2 is a section on the line 2—2 of Figure 1, on a larger scale;

Figure 3 is an enlarged sectional view of a part of the structure shown in Figure 1;

Figure 4 is a sectional view of a modified form of the invention shown in Figure 3; and

Figure 5 is a section on the line 5—5 of Figure 4.

The pump illustrated in Figure 1 comprises a casing 10 which is detachably secured to a main casing 12 by suitable means such as bolts 14. The main casing 12 may contain a prime mover (not shown) for the driving shaft 16 which projects through the casing 10. The pump casing shown on the drawing consists of three parts, namely, an outer casing member 20, an outboard head 22 and an inboard head 24. These three parts enclose a suction chamber 26 which communicates with the inlets of the runner or impeller 30 hereinafter described. The heads 22 and 24 close the circular openings in the casing member 20 which are concentric with the axis of the shaft 16, the opening which is closed by the outboard head 22 being of larger size than the diameter of the inboard head 24 and also of all of the other parts, hereinafter described, which must be inserted to assemble the complete pump. The head 22 contains a suitable ball bearing assembly 32 for the end of the shaft 16, this bearing being mounted in a suitable retainer or holder 33 having a cover 34 which protects the end of the shaft. The bearing 32 may serve as a steady bearing and as a thrust bearing for axially positioning the shaft and the rotating members relatively to the casing. A roller bearing 35 is provided for the portion of the shaft between the head 24 and the main casing 12. This bearing is mounted in a retainer or holder 36 which is secured to the casing 12 and is supplied with a cover 37 which clamps the outer race of the roller bearing 35. The heads 22 and 24 are provided with suitable soft packing 38 and 40 to prevent leakage from the suction chamber 26 along the shaft. The shaft has a splined portion 42 on which is slidably fitted the hub 44 of the impeller 30, the impeller being held in proper axial position on the shaft 16 by spacing elements on the shaft, including sleeves 45 and 46, which are gripped longitudinally between a nut 47 on the outboard end of the shaft and a shoulder 48 on the shaft abutted by the inner race of the roller bearing 35.

Integral with the casing member 20 is a shell 50 which encircles the shaft and impeller and contains a volute discharge duct 52 to receive pressurized liquid from the impeller. This duct communicates with a discharge pipe (not shown)

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which may be secured to a flange 54 on the casing member 20. Similarly a supply pipe (not shown) may be secured to a flange 56 on the casing member 20 so as to communicate with the suction inlet 58 of the pump casing. The shell 50 of the casing member 20 has a stepped bore therethrough which is coaxial with the shaft 16, the steps forming shoulders 60 and 62 which face toward the outboard side of the casing. Mounted within this bore are two diaphragms 64 and 66, the outboard diaphragm 64 having a marginal area on its outer face or on a radial flange 68 which bears on the shoulder 60, the inboard diaphragm 66 having a marginal area on a radial flange 70 which bears on the shoulder 62. Gripped between the peripheral portions of the diaphragms is a diffuser which encircles the discharge ports 74 of the impeller and is preferably composed of two separable annular parts 72 and 74, the latter having a series of vanes 76 extending therefrom to about the part 72. The diaphragms and the diffuser form a chamber 77 which encloses the discharge portion of the impeller 30. Suitable wearing rings 78 and 80 are carried by the respective diaphragms, such wearing rings having a plurality of circular edges which touch or nearly touch the cylindrical inlet portions 82 of the impeller so as to minimize leakage of pressurized liquid from the chamber 76 into the suction chamber 26.

Centrifugal pumps of the type herein described are designed to operate at high speeds at which high pressures are developed at the discharge end of the impeller where the liquid enters the diffuser and passes through to a passage 84 which extends around the diffuser and communicates with the volute duct 52. The liquid pressure in the passage 84 is much higher than in the suction chamber 26. Hence it is necessary that the joints between the casing member 50 and the diaphragms 64 and 66 be tight. When the pump is operating, the pressure of the liquid in the chamber 77 and the clearance 86 between the diffuser and the inboard diaphragm 66 operates to press the flange 70 against the shoulder 62 with sufficient force to maintain a tight seal at this point, but the liquid pressure in the discharge passage 84 which communicates with a clearance 88 between the diffuser and the outboard diaphragm 64 tends to push the flange 68 away from the shoulder 60 and thus to promote leakage at that point. In order to overcome the effects of such liquid pressure, I mount a ring 90 by means of a screw thread or equivalent in the outboard end portion of the bore of the casing member 50 as indicated at 92. The clearance diameter of this portion of the bore is sufficiently large to admit the diaphragms and the diffuser so that they can be inserted and assembled in the bore when introduced through the side opening normally closed by the head 22. The ring 90 is drilled at a series of points uniformly spaced around its circumference, these holes being adapted to receive a series of bolts 94 which extend through the ring in the direction parallel to the shaft 16. After the diaphragms and diffuser and impeller have been assembled as indicated in Figure 1, the ring is screwed into place until it abuts the outboard diaphragm 64. It may then be slightly backed off, whereupon the individual bolts 94 are set up to press strongly against the outboard diaphragm so as to force the flange 68 thereof tightly against the shoulder 60, thus insuring a tight joint if the parts have been properly fitted.

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In operating high speed pumps it is necessary to make frequent inspections of the bearings and to renew them when necessary. Such inspections are facilitated by the fact that the diameters of the removable parts shown in Figure 1 are less than those of the openings through which they must pass to be assembled or disassembled. Thus the roller bearing 48 and its retainer 36 and cover 37 can pass through the opening normally closed by the inboard head 24. The inboard head likewise can pass through the bore in the shell 50 when the diaphragms and diffuser have been removed, and all these parts, as well as the ring 90, can pass through the outboard opening in the casing 10. Furthermore, since the roller bearing 48 is mounted in a retainer, any scoring of the mounting due to accidental seizure will be confined to the retainer which can easily be replaced, the main casing remaining intact.

It is desirable that the flange 70 of the inboard diaphragm be firmly held against the shoulder 62 so as to avoid leakage whether or not the pump is developing its full pressure. To this end the diffuser parts are made with flanges which project in opposite directions. The part 72 has a flange 96 at its inner perimeter, this flange bearing against the adjacent side of the outboard diaphragm 64. The diffuser part 74 has a flange 98 at its outer perimeter bearing against the inboard diaphragm 66. Since these flanges are radially offset, the thrust of the outboard diaphragm against the flange 96, which is transmitted through the vanes 76 and the flange 98 to the diaphragm 66, tends to distort the diffuser by springing the parts slightly. This distortion provides a spring effect which presses the diaphragm flange 70 against the shoulder 62, the dimensions of the diffuser parts and their flanges being such as to result in such distortion of the diffuser when the outboard diaphragm is clamped strongly against the shoulder 60.

In the case of very high delivery pressures, a diffuser structure such as is shown in Figures 4 and 5 may be preferred. In this case the diffuser parts 100 and 102 are provided with flanges 104 and 106 respectively at their inner perimeter. The flange 106 is accurately shaped to have a radial force fit against the shoulder 110 on the diaphragm 66 for preventing leakage while the leakage between the flange 104 and the diaphragm 64 is prevented by the tight axial abutment between them. The part 102 of the diffuser also has a flange 112 at its outer perimeter bearing against the face of the diaphragm 66. This flange is provided with a series of radial slots 114 to equalize the liquid pressure in the clearance between the part 102 and the diaphragm 66 with the pressure in the passage 84. Since the pressure within the diffuser is at all points less than in the passage 84 and therefore in the external side clearances of the diffuser parts with which the passage 84 communicates, the two parts of the diffuser are tightly clamped together by the excess liquid pressure and the deformation of the diffuser parts due to axial pressure on flanges 104 and 112 effects the necessary tight contact at 62.

I claim:

1. In a centrifugal pump, a casing including a member having a circular opening with a screw-threaded outboard portion and an inboard portion of smaller diameter than the outer portion forming a shoulder between said portions, a circular diaphragm closing said opening, said di-

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aphragm having a marginal area fitting against said shoulder to form a joint normally washed by liquid pressurized by said pump, and means for pressing said area strongly against said shoulder to make the joint tight, said means consisting of a ring screw threaded in the outboard portion of said opening to abut the outer side of said diaphragm, the clear diameter of the threaded portion of the opening being greater than the diameter of the diaphragm, and a series of bolts threaded through said ring parallel to the axis thereof to bear against the outer side of said diaphragm, said bolts being uniformly spaced around the circumference of said ring.

2. In a centrifugal pump, a casing including a member having a circular opening with two annular shoulders therein, the inboard shoulder being of lesser diameter than the outboard shoulder, two circular diaphragms in said opening bearing against said shoulders respectively to form joints washed by liquid pressurized by said pump, a stiffly resilient deformable member between said diaphragms engaging the opposing faces of the diaphragms near the perimeter thereof, and means for pressing said diaphragms strongly against the respective shoulders to make said joints tight, said means consisting of a ring screw-threaded in said opening against the outboard diaphragm, the clear diameter of the opening being greater than the diameter of the diaphragms and the deformable member, and a series of bolts threaded through said ring parallel to the axis thereof to bear against the outer side of the outboard diaphragm, said shoulders being axially spaced relatively to the axis dimension of the deformable member so that when the outboard diaphragm is pressed strongly against its shoulder by said bolts, the member is deformed to press the inboard diaphragm against its shoulder.

3. Apparatus of the class described comprising a main casing, a pump casing secured thereto, said pump casing having an opening in the outboard side thereof remote from said main casing, a head secured to said pump casing to close said opening, a shaft projecting from said main casing through said pump casing, an end of said shaft being journaled in said head, a double-inlet impeller keyed on said shaft, said pump casing and head enclosing a suction chamber communicating with both inlets of said impeller, said pump casing having an inner portion enclosing a volute discharge duct and having a stepped bore coaxial with said shaft, two diaphragms mounted within said bore and pressing against the steps therein, a diffuser gripped by the said diaphragms in said bore and encircling the discharge ports of the impeller, and means for pressing said diaphragms against said steps, the opening in the outboard side of the pump casing being of larger diameter than the impeller, diffuser, diaphragms, and pressing means whereby said impeller, diffuser, diaphragms and pressing means can be introduced through said opening along the shaft to assemble the pump structure.

4. Apparatus as in claim 3, said pressing means consisting of a ring removably mounted in said bore next to the outboard diaphragm, and a series of bolts threaded through said ring parallel to the axis thereof and bearing against said outboard diaphragm, the portion of said bore in which the ring is mounted having a clear diameter greater than that of the diaphragms, diffuser and impeller.

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5. Apparatus as in claim 3, said pump casing having an opening on its inboard side concentric with the shaft, an inboard head closing said opening, said inboard head being of smaller diameter than the outboard opening, whereby it can be introduced into said casing through said outboard opening.

6. A centrifugal pump comprising a casing consisting of an outer shell enclosing a suction chamber, a shaft projecting through and journaled in said outer shell and an inner shell within the outer shell enclosing a volute discharge duct and encircling said shaft, said outer shell including a member with a circular opening concentric with said shaft and large enough to admit all removable parts within the outer shell and a circular head secured to said member to close said opening, said head carrying a bearing for said shaft, an impeller keyed to said shaft within said inner shell, two spaced diaphragms fitted within said inner shell and enclosing a chamber within which said impeller is rotatable, said inner shell having a stepped bore within which said diaphragms are mounted and annular shoulders within the bore against which the diaphragms are pressed, a diffuser gripped between the peripheral portions of the diaphragms, and means holding the diffuser and diaphragms in assembled relation, said means consisting of a ring threaded into a portion of said bore to abut one of said diaphragms and a plurality of bolts threaded through said ring and parallel to the shaft axis to press the adjacent diaphragm against one of said shoulders and against said diffuser.

7. A centrifugal pump comprising a casing, a shaft extending therethrough and an impeller keyed on the shaft, said casing consisting of an outer shell member having two opposed openings concentric with the shaft, two suction heads secured to said member to close said openings and enclose with said member a suction chamber, each said head having a bearing for said shaft, an inner shell within and integral with the outer shell member, said inner shell enclosing a volute discharge duct and having a stepped bore concentric with said shaft, two diaphragms mounted in said bore and spaced to form a chamber in which said impeller is rotatable, a diffuser gripped between said diaphragms and encircling said impeller, said diaphragms having annular shoulders bearing against steps in said bore, and means for holding the diaphragms and diffuser in assembled relation, said means consisting of a ring screw-threaded into said bore to abut one of said diaphragms, and a plurality of bolts threaded through said ring parallel to the shaft axis to bear against the adjacent diaphragm at spaced points.

8. In a centrifugal pump having a casing, a shaft extending through the casing and an impeller keyed to the shaft, said casing having a stepped bore coaxial with the shaft and of larger diameter than the impeller, two diaphragms mounted in said bore and spaced to form a chamber in which said impeller is rotatable, said diaphragms having peripheral shoulders bearing against steps in said bore, a diffuser gripped between the peripheral portions of said diaphragms, said diffuser consisting of two separable annular parts with vanes between, said vanes being attached to one part and bearing against the other, a flange on the inner periphery of one said part bearing against the adjacent diaphragm, a flange on the outer periphery of the other said part

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bearing on the other diaphragm, and means carried by the casing for pressing said diaphragms and diffuser together.

9. A pump as in claim 8, wherein said pressing means consists of a ring screw-threaded in said bore to abut one of said diaphragms and a plurality of bolts threaded through said ring parallel to said shaft to press against the adjacent diaphragm.

10. A pump as in claim 8, wherein the casing includes a member having a circular side opening concentric with the shaft and of greater diameter than said diaphragms and diffuser, whereby said diaphragms, diffuser and impeller can be inserted axially through said opening for assembling in said casing, and a circular head to close said opening, said head having a bearing for said shaft.

11. In a centrifugal pump having a casing, a shaft extending through said casing and an impeller keyed on said shaft, said casing having a stepped bore coaxial with the shaft and of larger diameter than the impeller, two diaphragms and a diffuser between them mounted within said bore forming a chamber in which said impeller is rotatable, said diffuser consisting of two annular parts, one of said parts having vanes abutting the other part to provide space between the parts for the passage of pressurized liquid discharged from the impeller, flanges on said parts extending in opposite directions from the inner peripheries thereof, said flanges having a drive fit with shoulders on the corresponding diaphragms, the flange on one of said parts bearing in the axial direction against the adjacent diaphragm, said other part having at its outer periphery a flange bearing in the axial direction against the other diaphragm and provided with radial slots.

12. Apparatus of the class described comprising a main casing, a pump casing secured thereto, said pump casing having therein and integral therewith a shell with a stepped bore there-through forming two outwardly facing should-

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ders within the bore, said pump casing also having an opening in the outboard side thereof of larger diameter than the said bore and a smaller opening in the inboard side thereof adjacent to the main casing said openings being coaxial with said bore, outboard and inboard heads secured to said casing to close said openings, a shaft projecting from said main casing through said inboard head and the interior of said pump casing, a ball bearing carried by said outboard head for the end portion of said shaft, a bearing holder mounted on said main casing coaxially with said shaft, a roller bearing in said holder in which said shaft is journaled, an impeller mounted on said shaft between the ball bearing and the roller bearing, two removable diaphragms mounted in said pump casing around said impeller to form a discharge chamber therefor each said diaphragm having a marginal portion bearing against one of said shoulders, and means including a ring screw threaded into the outboard portion of said bore for clamping said diaphragms tightly in place, said clamping means, diaphragms, impeller, inboard head, roller bearing holder, and roller bearing being removable through said outboard opening in the pump casing by movement along the axis of the shaft when the outboard head has been removed.

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