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CENTRIFUGAL PUMPS

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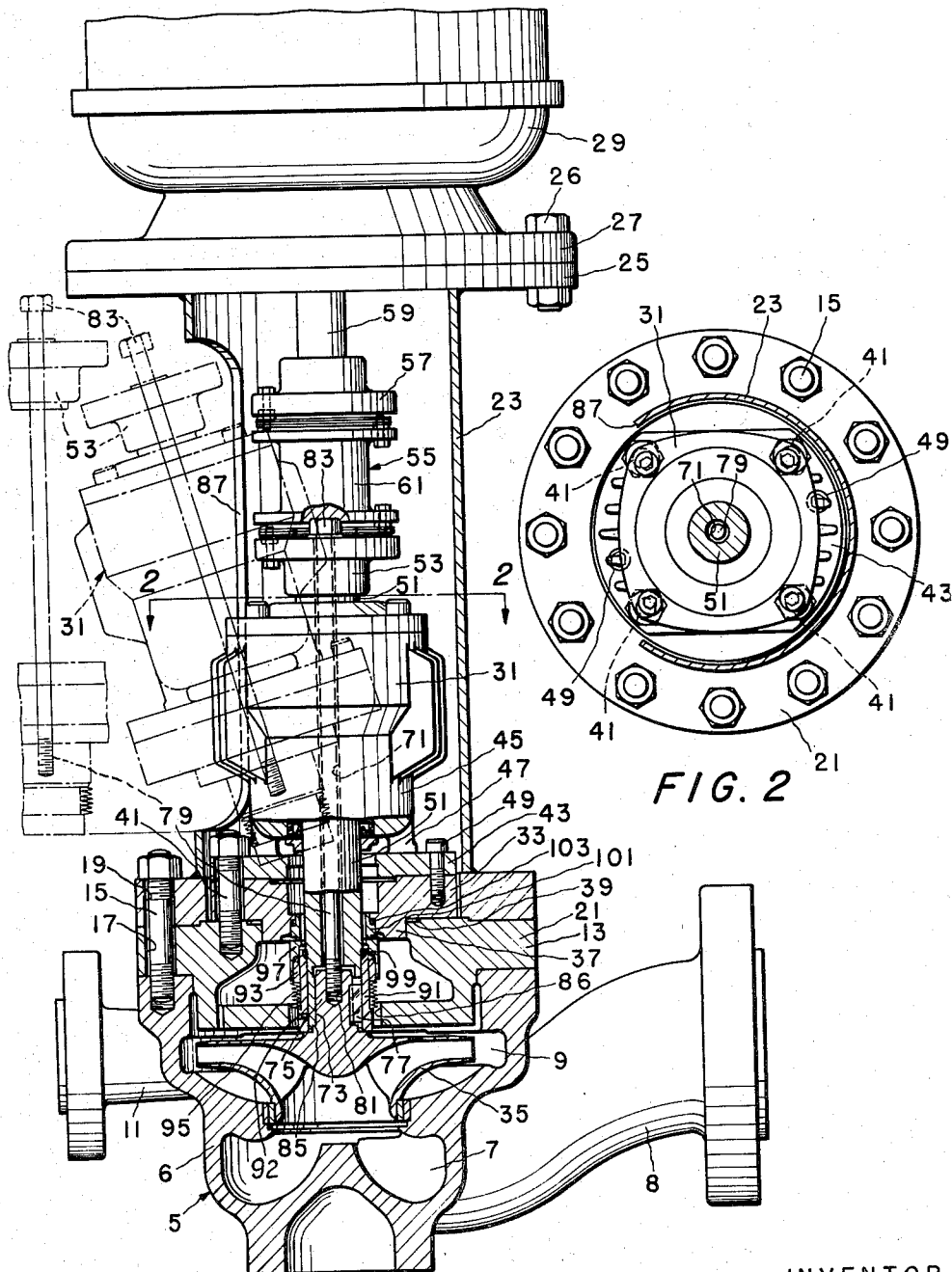


FIG. 2

FIG. 1

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1

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CENTRIFUGAL PUMPS

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This invention relates to centrifugal pumps and more specially to centrifugal pumps utilizing a bearing cradle disposed between the casing of the pump and the driving motor. The invention particularly relates to pumps of this type in which the shaft extends in cantilever relation to the bearing cradle into the pump casing and at its end carries the impeller in overhanging relation to the bearing cradle for rotation of the impeller upon rotation of the shaft driven by the motor.

In pumps of this type heretofore the impeller has been secured upon the end of the shaft by means accessible internally of the casing. It ordinarily has been necessary, therefore, to dismount parts of the casing to reach the impeller securing means, as well as to remove the supports for the bearing cradle, so as to be able to withdraw the impeller mounted on the shaft together with the bearing cradle and other parts, including the packing or sealing means. In some cases also it has been necessary to remove the driving motor at the same time. The operations of maintenance and repair, therefore, have been difficult and expensive because of the weight of these several members of the pump unit and the time required for disassembly of a large number of parts.

It is an object of the invention to provide a construction of a centrifugal pump unit which will facilitate removal of the bearing cradle and of the shaft together with the packing assembly.

It is another object of the invention to provide a construction of a centrifugal pump unit in which the bearing cradle and the shaft and the packing assembly may be removed without disturbing the casing or the motor.

It is a further object of the invention to provide a centrifugal pump unit in which the bearing cradle, the shaft and the packing assembly may be removed without removing the impeller from within the casing and without requiring access to the impeller through an opening in the casing.

It is an additional object of the invention to provide in such a pump unit for the easy removal of the elements referred to while maintaining a rigid structural connection between the pump casing and the motor frame.

It is a significant feature of the invention that means are provided for effecting connection and disconnection of the shaft to and from the impeller by means which extends generally coaxially with the shaft, this means being operable at the opposite end of the shaft from the impeller.

An additional important feature of the invention concerns the provision for concomitant removal of the packing or seal assembly with the shaft and with the bearing cradle when the disconnection from the impeller is effected in the manner according to the invention. Such removal of the cradle, shaft and packing assembly may be effected without dismounting these parts relative to each other.

Another feature of the invention relates to compactness of the construction in which the bearing cradle is closely adjacent the casing and the length of the overhang of the

2

shaft beyond the cradle to reach the impeller is reduced as compared with conventional constructions.

With these and other objects and features in view, the nature of which will be more apparent, the invention will be more clearly understood by reference to the drawings, the accompanying detailed description and the appended claims.

Fig. 1 shows a vertical section upon the axis of the impeller of a centrifugal pump, the bearing cradle, the coupling and the motor therefor being shown in elevation, constructed in accordance with this invention.

Fig. 2 shows a horizontal section on line 2—2 of Fig. 1. Referring to the drawings in detail, this invention as illustrated is embodied in a vertical centrifugal pump in which the motor is disposed above the pump, the frame of the motor being rigidly connected to the pump casing by a structural member of such form that the motor may be supported by the pump structure, if the pump is mounted on a supporting base, or the pump structure may be suspended from the motor, if the motor is supported on a suitable support. The invention is not limited, however, to the vertical form of a centrifugal pump unit and the structural member referred to may be designed for dispositions of the unit in which the shaft, for example, is horizontal.

In Fig. 1 the centrifugal pump 5 comprises a casing body 6 providing the conventional inlet chamber 7 to which the suction inlet 8 is connected and a scroll pressure chamber 9 to which the discharge outlet 11 is connected. In the embodiment being described the casing also provides a flanged member 13 which is secured to the body 6 by means of stud bolts 15 passing through holes 17 in the flanged member 13. These stud bolts also pass through holes 19 in a flange 21 to which is welded the wall 23 which in the embodiment being described is of cylindrical form concentric with the axis of the impeller. This wall 23 constitutes the structural member referred to above.

The wall 23 extends upwardly in Fig. 1 to and is welded to a flange 25 which is bolted by bolts 26 to a flange 27 provided on the frame 29 of the motor. The structural support of either type above mentioned as provided between the motor and the pump casing, one by the other, thus is secured. The diameter of the cylindrical wall 23 and the thickness thereof are such as to provide the requisite structural strength as well as to provide space within and defined by the wall 23 for mounting the bearing cradle 31 and the supports therefor and to provide for removal of these and other parts as hereinafter described.

In the embodiment being described the flange 21 has an internal diameter such that a closing member 33 in the form of a flange may be disposed upon the axis of the impeller 35, this closing member having a shouldered portion 37 which enters an opening in the flanged member 13 of the casing, a suitable gasket 39 being provided between the closing member 33 and the flanged member 13. The closing member 33 is held in place by stud bolts 41 tapped in the flanged member 13, these stud bolts passing through the flange of the closing member 33.

The stud bolts 41 also pass through a base flange 43 which is rigidly connected to the housing 45 of the bearing cradle 31 by supporting legs 47 spaced about the axis. The base flange 43 is secured to the closing member 33 by cap screws 49. The bearing cradle 31 otherwise is of conventional form, the housing 45 thereof containing the usual ball bearings or other suitable bearings for support of the shaft 51 coaxially with the axis of the impeller 35.

In a conventional manner also the shaft 51 at its upper end carries one of the flange coupling elements, the element 53, of a spacer coupling 55, the upper flange coupling 57 of the spacer coupling being secured upon the

3

shaft 59 of the motor 29. The removable element 61 of the spacer coupling is connected in a conventional manner to the respective flange couplings 53, 57 for transmitting the drive from the motor to the shaft.

In accordance with the significant feature of the invention above referred to, the shaft 51 is provided with an axial bore 71 which in the embodiment disclosed extends throughout the length of the shaft between the end thereof on which the flange coupling 53 is mounted and the lower end thereof to which the impeller 35 is connected. This lower end or impeller end of the shaft 51 is machined to an internal bore 73 and the impeller 35 is provided with a hub 75 which is machined to fit the bore 73 of the shaft 51. A keyway and key 77 are provided respectively in the hub and in the bore of the shaft to provide the driving relation between the shaft and the impeller.

Extending through the bore 71 from the upper end of the shaft 51 is a bolt 79 which is threaded at its lower end and engages the threads in a hole 81 provided internally of the hub 75. The bolt is provided at its upper end with a head 83 which may be of hexagon form for turning the bolt within the bore 71 to screw the bolt into the threaded hole 81, thereby to draw a shoulder on the impeller 35 and a shoulder 85 at the end of the shaft 51 into engagement with each other and to hold the impeller securely at the end of the shaft for rotation within the scroll 9 upon rotation of the shaft driven by the motor 29.

It will be understood, when the lower end of the shaft is inserted into the opening 86 in the wall of the flanged member 13 adjacent the impeller, that by screwing the bolt 79 into the impeller hub, the shaft supported by the bearing cradle may be brought to its proper operating position with respect to the impeller and the impeller to its proper position within the casing. It further will be understood, when it is desired to remove the shaft, that this may be accomplished by unscrewing the bolt 79 so that the shaft 51 then may be drawn axially upwardly. This insertion and removal of the shaft are effected concomitantly with mounting and removal of the bearing cradle. Access to the bolt head 83 is obtained by removal of the spacer coupling 61 and this may be accomplished in the embodiment disclosed by providing an opening 87 in the cylindrical wall 23.

In accordance with an important feature of the invention, the packing or sealing assembly which prevents leakage of the fluid at the discharge pressure outwardly along the shaft may be removed together with the shaft upon loosening the bolt 79 in the manner described. In the drawing, Fig. 1, is shown a sleeve 91 carrying a ring 93 slidable thereon and biased upwardly by the spring 95 to press into the recess of a stuffing box 97 and a packing ring 99. The sleeve 91 is carried by the impeller end of the shaft 51 and connected to be rotated thereby by a set screw 92. The set screw 92 also serves for the withdrawal of the sleeve 91 and its associated components together with the shaft 51. A further gland 101 is carried by the closing member 33 and bears on the packing ring 103 disposed in a recess formed in the closing member 33. The gland 101, being stationary relative to the shaft 51, cooperates with the face of the rotary stuffing box 97 to form a seal therewith in a commonly known manner to prevent leakage along the shaft outwardly of the casing. Since this closing member 33 is removable from the casing flange member 13 over the studs 41 together with the base flange 43 supporting the bearing cradle 31, as above described, it will be understood that the entire packing or sealing assembly carried on the impeller end of the shaft 51 and by the closing member 33 also will be withdrawn upwardly with the shaft so that this packing assembly may become accessible for replacement or repair.

It will be recognized that the shaft 51 and the pack-

4

ing assembly cooperating therewith, together with the closing member 33 and the bearing cradle 31 supporting the shaft 51, as well as the coupling member 53, constitute a sub-unit which is removable through the opening 87. As will be seen in Fig. 2, this opening is of such size that the closing member 33 and the base flange 43 may be withdrawn through the opening 87, sector portions of the closing member flange being removed, as shown in Fig. 2. The opening 87 is of such width also that the bearing cradle 31 may pass through the opening 87.

The drawing shows in dotted outline the position of the sub-unit as it is being passed through the opening 87. The upper end of the shaft 51 and coupling 53 have been moved outwardly through the opening to the inclined position shown after the sub-unit has been lifted vertically utilizing the space of the spacer coupling 55 upon removal thereof. The lower end of the sub-unit then may be moved outwardly through the opening 87 by moving this sub-unit upwardly in the inclined direction until the packing assembly clears the wall 23 and so as to reach a position such as that in dotted outline in which the shaft axis may be vertical or in such position as will facilitate further handling of the sub-unit.

It will be realized further that when the sub-unit is thus removed it may be disassembled to the desired extent without difficulty to obtain access to the bearings and to the full extent of the shaft for replacement and repair. Access, moreover, is obtained to the upper part of the impeller and its hub 75. If necessary or desired also the casing flanged member 13 may be removed over the studs 15 so as to provide for removing the impeller from within the casing 6 without disturbing the casing or its connections to the inlet and outlet pipes.

Another advantageous feature provided by the structure of the invention relates to the compactness of the pump unit. The mounting of the closing member 33, which together with the shaft 51 carries the packing assembly internally of the casing with respect to the member 33, directly on the pump casing flanged member 13 makes it possible to mount the base flange 43 supporting the housing 45 of the bearing cradle directly on the closing member 33. Not only are these elements of the structure thereby removable as a self-supporting sub-unit, but this arrangement and structure reduce the axial space required between the cradle and the impeller. The reduced overhang of the shaft and of the impeller thereon thus obtained increases the rigidity of the revolving parts against spring as well as the rigidity of the supporting connection between the pump and the cradle.

It will be understood, in using the term "motor" in the above description, that a motor element of any suitable type is intended to be indicated whether this element be an electric motor, a turbine or other prime mover or any suitable mechanical rotating driving element.

Within the scope of the invention modifications of particular elements of the structure disclosed may be made while providing the significant and important features of the disclosed invention which utilizes a fastening element extending through the shaft generally coaxially therewith and engaging the impeller to hold this impeller in the proper driving relation to the shaft.

I claim:

1. In a centrifugal pump unit having a pump casing, an impeller disposed within said casing for rotation on its axis, a motor coaxial with said impeller, a bearing cradle disposed between said casing and said motor and supported on said casing and extending about said axis, a shaft extending through said cradle coaxially with said impeller and said motor and in bearing relation in said cradle, the combination with said unit of coupling means connected to said motor and to said shaft for effecting rotation of said shaft by said motor, said coupling means being disposed in a space between said motor and the ad-

5

5 adjacent end of said shaft, said shaft at its opposite end extending into said casing and engaging said impeller for effecting rotation of said impeller upon rotation of said shaft, and a fastening element extending through said shaft generally coaxially therewith and at one end thereof engaging said shaft adjacent said coupling end of said shaft and at its other end engaging said impeller to hold said impeller in said engagement with said shaft, said coupling space upon removal of said coupling being sufficient to provide for axial movement of said shaft out of engagement with said impeller upon releasing said fastening element from engaging said impeller.

2. In a centrifugal pump unit the combination as defined in claim 1 which comprises a closing member having a flange coaxial with said impeller, stud bolts carried by said casing and passing through said closing member flange parallel to said axis, said bearing cradle being supported on said closing member, the axial length of said coupling space providing for movement of said closing member flange over said stud bolts concomitantly with said movement of said shaft out of engagement with said impeller for removal of said closing member and said bearing cradle together with said shaft.

3. In a centrifugal pump unit the combination as defined in claim 2 in which said bearing cradle is provided with a flange base engaging said closing member, and removable fasteners securing said flange base to said closing member.

4. In a centrifugal pump unit the combination as defined in claim 1 which comprises a closing member removably supported on said casing and supporting said bearing cradle, and sealing means carried by the impeller end of said shaft and said closing member to prevent leakage along said shaft outwardly of said casing, said closing member and said bearing cradle and said sealing means and said shaft as a sub-unit movable axially upon removal of said coupling and release of said fastening element to remove said sub-unit from said pump unit without removal of said impeller and without disturbing said casing.

5. In a centrifugal pump unit the combination as defined in claim 4 in which said shaft at the impeller end thereof is provided with a bore coaxial therewith, said impeller being provided with a hug coaxial therewith and extending into said bore in engagement with said shaft for rotating said impeller upon rotation of said shaft.

6. In a centrifugal pump unit having a pump casing,

6

an impeller disposed within said casing for rotation on its axis, a motor coaxial with said impeller, and a structural member extending about said axis and providing a space therewithin, said structural member being disposed between and connecting said casing and said motor for support of one by the other, a sub-unit comprising a bearing cradle, a shaft supported in said cradle for rotation on its axis and extending axially outwardly from said cradle, means extending about said axially extending portion of said shaft and connected to said bearing cradle for supporting thereon said cradle and said shaft, said means being adapted to be mounted on and secured to said casing for supporting in the mounted portion of said means said cradle and said shaft coaxially with said impeller and with said shaft in driving engagement with said impeller, and fastening means carried by and extending axially through said shaft and engaging said shaft and engageable with said impeller in said mounted position of said cradle and shaft supporting means to hold said shaft and said impeller in said driving engagement, said bearing cradle in said mounted position of said cradle and shaft supporting means being disposed within said space of said structural member.

7. A sub-unit for a centrifugal pump unit having a pump casing and an impeller disposed within said casing for rotation on its axis, said sub-unit comprising a bearing cradle, a shaft supported in said cradle for rotation on its axis and extending axially outwardly from said cradle, means extending about said axially extending portion of said shaft and removably connected to said bearing cradle for supporting thereon said cradle and said shaft, said means being adapted to be mounted on and secured to said casing for supporting in the mounted position of said means said cradle and said shaft coaxially with said impeller and with said shaft in driving engagement with said impeller, and fastening means carried by and extending axially through said shaft and engaging said shaft and engageable with said impeller in said mounted position of said cradle and shaft supporting means to hold said shaft and said impeller in said driving engagement.

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