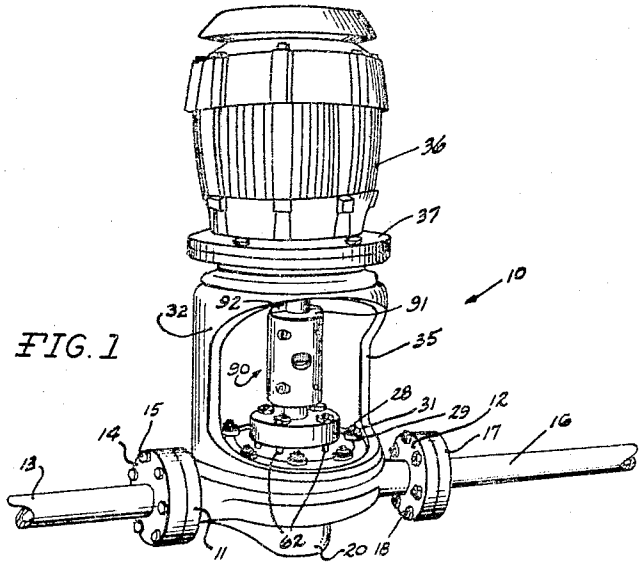
June 13, 1967 J. B. FREED ET AL 3,324,798

VERTICAL IN-LINE CENTRIFUGAL PUMP

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FIG. 1



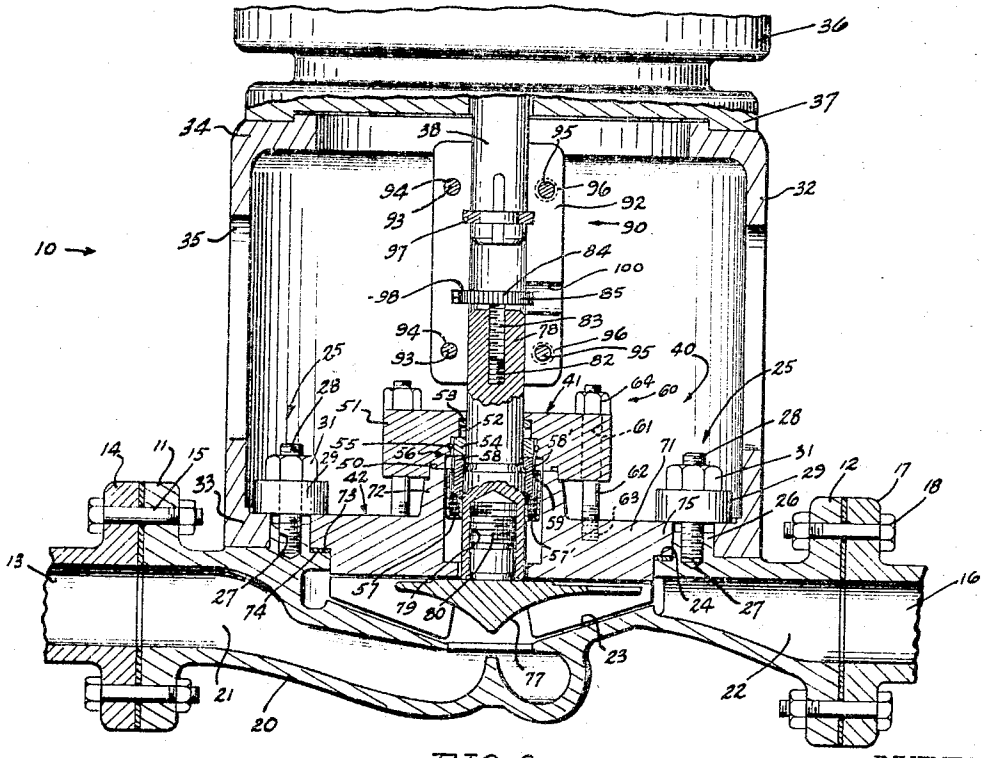


FIG. 2

INVENTORS
JACOB B. FREED
DONALD R. DISBROW
MANFRED H. BLUMENTRATH

BY Roy A. Plant
ATTORNEY

June 13, 1967 J. B. FREED ET AL 3,324,798

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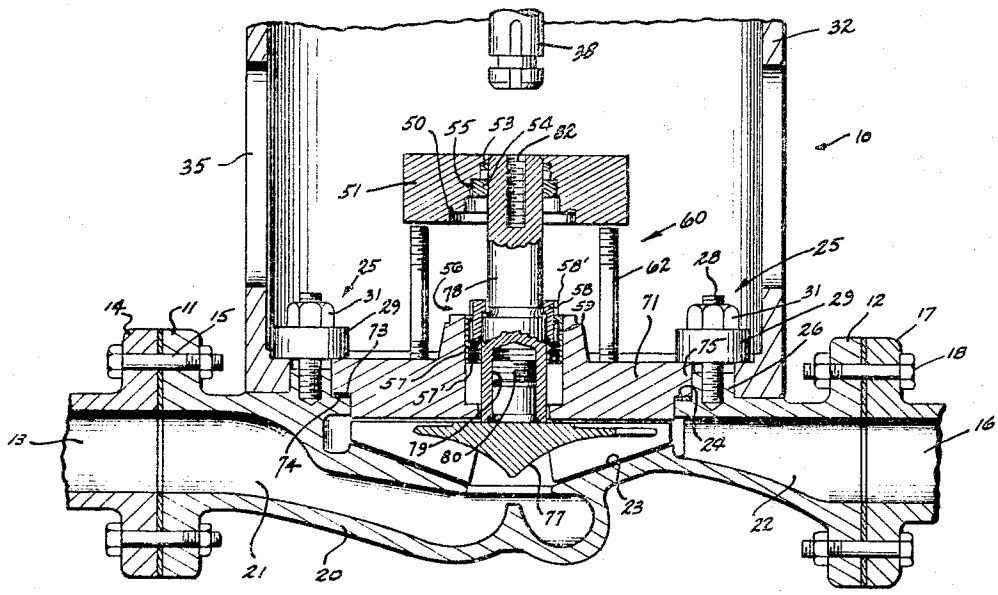


FIG. 3

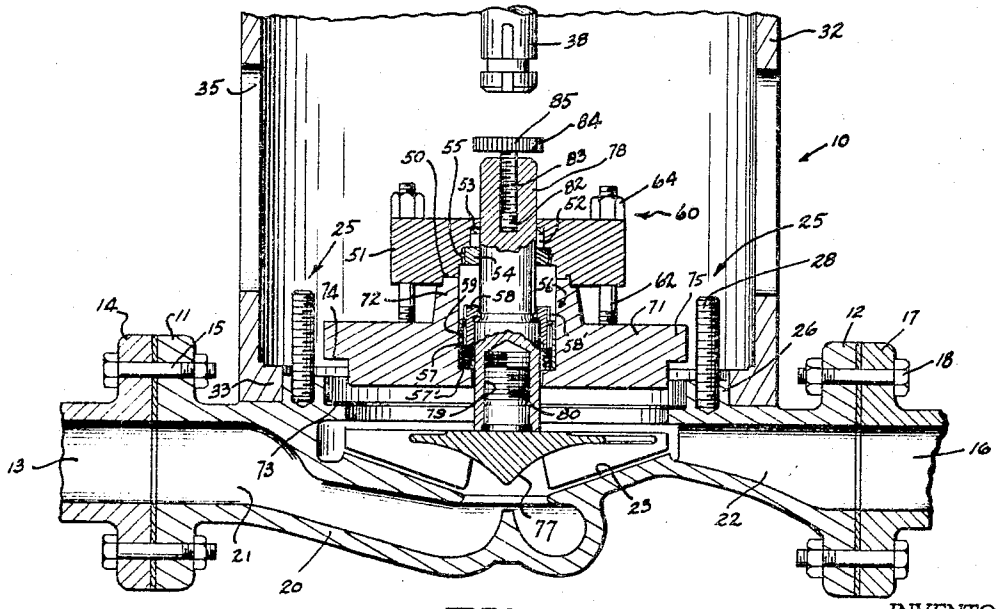


FIG. 4

INVENTORS
JACOB B. FREED
DONALD R. DISBROW
MANFRED H. BLUMENTRATH

BY Roy A. Plant
ATTORNEY

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3,324,798

VERTICAL IN-LINE CENTRIFUGAL PUMP

Jacob B. Freed, Battle Creek, Donald R. Disbrow, Richland, and Manfred H. Blumentrath, Battle Creek, Mich., assignors to Union Pump Company, Battle Creek, Mich., a corporation of Michigan

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3 Claims. (Cl. 103—87)

The present invention relates broadly to pump assembly structure and in its specific phases to vertical in-line centrifugal pumps.

At the present time there has been limited use of vertical in-line centrifugal pumps in some industries, such as the chemical industry, because of various inherent design disadvantages. As a result of these design features, its structural make-up required maintenance programs, and procedures not desired by these industries. This type of pumping equipment used in these industries often required the construction of a base plate or a foundation member to support the pump structure. Much of the commonly used centrifugal pump equipment requires close tolerances to provide proper radial running clearances. During the re-assembly operation of this equipment feeler gauges or special measuring devices are required to assure proper operation positioning of the impeller in the pump unit. Many of the presently used pump units have a large variation of the radial thrust within the pump during diverse operating conditions and many require a "bearing assembly" between the pump and its motor.

Because of the structural construction of many of the pumps now in operation there is a need for persons of diversified skills to be used in installing, maintaining, and re-assembling the pump units. This has made this equipment costly to the user both in reference to installation procedure and maintenance programs. There is a continual demand on the pump industry to provide new and useful improvements in pump equipment to help reduce the user's initial cost and operational expense so that the user may compete on even or favorable terms with foreign and domestic competition.

Because of the limited use of vertical in-line centrifugal pumps in these various industries, including the chemical industries, the inventors of this disclosure invented, designed and developed the present pump. The disclosed pump is the first vertical in-line centrifugal pump to provide the advantageous features as are explained below.

Accordingly, among the objects of the present invention is to provide a new and improved centrifugal pump assembly structure for use in vertical in-line pump applications.

Another object of the present invention is to provide a vertical centrifugal pump assembly using the motor bearings to replace the function of the "bearing assembly."

A further object of the present invention is to provide a centrifugal pump structure where the shaft sealing mechanism can be removed from the pump assembly without disassembling the impeller of a centrifugal pump or disturbing the casing gasket operating between a cover member and a casing member.

A further object of the present invention is to provide for removal of the shaft, cover member and impeller unit without having to remove or disassemble the casing member.

A further object of the present invention is to provide a centrifugal pump structure wherein the shaft sealing mechanism or the shaft sealing mechanism and the shaft, cover member and impeller unit can be removed from the pump assembly without disturbing the motor or the casing member.

A further object is to provide a pump structure which

does not require any permanent base plate or foundation member and only temporary leg supports may be required in applications where pipeline construction is not adequate to carry the weight of the pump structure.

Another object of the present invention is to provide an adjusting impeller means outside the pump body for easy adjustment of the impeller member in respect to its axial position with the casing member.

Another object of the present invention is to provide secondary and primary securing means where the primary securing means secures the pump shaft, cover member, impeller and their associated parts as a unit to the pump casing member and the secondary securing means secures the seal gland member and its associated parts as a unit to the assembly held by the primary securing means.

Also, an object of the present invention includes the provision of a structure capable of accomplishing the above objectives with a minimum of material cost and fabricating expense, and at the same time being composed of simple and ruggedly constructed elements which are very reliable in operation.

Still further objects and advantages of the present invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends the invention, then, consists of the special pump construction hereinafter fully described and particularly pointed out in the claims; the annexed drawings and the following description setting forth in detail a certain means and structure for carrying out the invention.

In the annexed drawings:

FIGURE 1 is a perspective view of the centrifugal pump assembly having the provisions of the present invention with a mounted motor unit and being applied in a typical vertical in-line application.

FIGURE 2 is a partial sectional side elevational view of the centrifugal pump assembly showing the shaft sealing mechanism and the shaft, cover member and impeller unit in their assembled relationship to the overall pump assembly as a representation of the present invention.

FIGURE 3 is a side elevational view of the centrifugal pump assembly showing the shaft sealing mechanism as it is being disassembled from the shaft for removal from the centrifugal pump assembly.

FIGURE 4 is a side elevational view of the centrifugal pump assembly showing the shaft sealing mechanism and shaft, cover member and impeller unit as it is being disassembled as a complete assembly from the casing member for removal from the centrifugal pump casing member.

While the invention is susceptible of various modifications and alternate constructions, certain illustrative embodiments have been shown in the drawings and will be fully described below. It should be understood, however, that there is no intention to limit the invention to the specific forms disclosed, but on the contrary, the invention is to cover all modifications, alternate constructions and equivalents falling within the spirit and scope of the invention as expressed in the appended claims.

Generally referring to FIGURES 1 and 2, there is shown a centrifugal pump assembly 10 which is connected in an in-line manner in a pipeline system. The centrifugal pump assembly 10 has inlet end flange 11 and discharge end flange 12. Discharge flange 11 is connected to pipeline 13 by pipeline flange 14. This can be accomplished in various manners; however, for the present illustration tightening bolts 15 are illustrated. Discharge end flange 12 is connected to pipeline 16 by pipeline flange 17 and secured together by tightening bolts 18. Flange members 11 and 12 are part of casing member 20. Casing member 20 has inlet port 21 and discharge port 22. The material or product being pumped is drawn

into the pump assembly 10 through inlet port 21 and is passed out of pump assembly 10 through discharge port 22. Casing member 20 has centrifugal pump surface 23 and gasket surface 24. A primary securing means 25 has a securing flange 26 which is part of the top area of casing member 20 and takes on the shape of an annular ring. The securing flange 26 is provided with threaded holes 27 to receive a set of securing studs 28. The securing studs 28 are threaded into threaded holes 27 and receive a set of cover clamps 29. The cover clamps 29 are positioned by the securing studs 28 and held in position by bolts 31, as viewed in FIGURE 2. The complete function of primary securing means 25 will be explained in detail below.

Securing flange 26 is used to axially position motor support member 32. Motor support 32 is provided with a base ring section 33 and a top ring section 34. Base ring section 33 contacts securing flange 26 to axially position motor support 32. Motor support 32 has motor support opening 35 which permits the removal of various parts of the centrifugal pump assembly 10, as will be fully explained below, and because of the action between securing flange 26 and base ring section 33 it may be turned to the most convenient radial position for servicing.

Motor 36 has a mounting plate 37 as part of its end structure. The mounting plate 37 contacts top ring section 34 positioning a motor shaft 38 in axial alignment with centrifugal pump surface 23 as will be more fully explained below.

Pump unit 40 is made up of shaft sealing mechanism 41 and shaft, cover member and impeller unit 42. The shaft sealing mechanism 41 has an annular seal gland member 51 which has a groove 52 to receive a throttle bush member 53. The annular seal gland member 51 has a ring member 54 and an O-ring 55 positioned below and adjacent to groove 52. A mechanical seal assembly 56 is mounted in contact with the ring member 54 and makes sealing contact between shaft sealing mechanism 41 and the shaft portion of the shaft, cover member and impeller unit 42. A spring housing 57 of mechanical sealing assembly 56 houses a series of spring members 57'. The spring housing 57 is secured to the shaft member of the shaft, cover member and impeller unit 42 by various methods well known to persons in the art, and an example would be by setscrews, not shown in the drawings. The setscrews can be placed in and removed from a securing position by passing them through holes in the extended flange member of shaft, cover member and impeller unit 42, not shown in the drawings. A seal member 58 is positioned in spring housing 57 and held in a fixed radial position by one or more teeth 59 positioned at the top of spring housing 57. The teeth 59 are received by slots 58' of seal member 58 which hold seal member 58 in the fixed radial position to make the sealing contact mentioned above. A gland O-ring 50 provides sealing contact between seal gland member 51 and another portion of the shaft, cover member and impeller unit 42.

The shaft sealing mechanism 41 is secured to the shaft, cover member and impeller unit 42 by a secondary securing means 60. Annular seal gland member 51 is provided with a series of holes 61 through which securing bolts 62 pass. The securing bolts 62 are threaded on both ends and one end is screwed into threaded hole 63 of the shaft, cover member and impeller unit 42. The other end of securing bolts 62 pass through holes 61 and receive a set of securing nuts 64. Securing nuts 64 are screwed on that end to secure shaft sealing mechanism 41 to shaft, cover member and impeller unit 42 in a fixed relationship.

The shaft, cover member and impeller unit 42 has a casing cover 71 as its main body. The casing cover 71 has a central annular flange member 72 which extends from the casing cover 71 and receives a portion of the shaft sealing mechanism 41. The casing cover 71 is sealed to the casing member 20 by a gasket 73. The gasket 73 contacts the gasket surface 24 of casing member 20 and a casing gasket surface 74 of casing cover 71. The casing cover 71 has an annular securing flange 75 which provides the casing gasket surface 74 and a surface to act with the primary securing means 25. The cover clamp 29 of the primary securing means 25 acts on the annular securing flange 75 when the nuts 31 are tightened down on securing studs 28 compressing the gasket 73 into sealing position. The shaft, cover member and impeller unit 42 will be firmly secured in a fixed relationship to casing member 20. An impeller member 77 is connected to a shaft member 78 which is positioned by the casing cover 71. In the present illustration the impeller member 77 and the shaft member 78 are two separate pieces. They could be one unit or two units as illustrated. The shaft member 78 has a threaded hole 79 which receives a threaded end 80 of impeller member 77 to secure these two pieces together.

The shaft member 78 has a threaded hole 82 at its opposite end to receive the threaded end 83 of an adjusting stud 84. The threaded end 83 of the adjusting stud 84 is a very fine thread and acts as a micrometer screw. Adjusting stud 84 has a series of uniformly placed notches 85 surrounding its circumference. The threaded end 83 will move the shaft member 78 a graduated distance in its axial direction for every turn or partial turn of adjusting stud 84. Notches 85 provide a means to finely adjust the axial distance between the impeller member 77 and the centrifugal pump surface 23.

The motor shaft 38 is in axial alignment with the shaft member 78. They are connected together by a coupling assembly 90 which is made up of two half body members 91 and 92. Half body members 91 and 92 are shown in FIGURE 1, and half body member 92 alone is shown in FIGURE 2. Securing bolts 93 pass through holes 94 of half body member 92 and are threaded into threaded holes of half body member 91. Securing bolts 95 pass through holes in half body member 92 and are screwed into threaded holes 96 of half body member 92.

A shaft collar member 97 is positioned on motor shaft 38 to position the coupling assembly 90 with respect to motor shaft 38 and shaft member 78. A groove 98 is provided in the half body members 91 and 92 to receive the adjusting stud 84. The shafts 38 and 78 are keyed to the coupling assembly 90 so that they will rotate with each other, which is a normal type construction well known to persons in the art. Coupling assembly 90 provides an adjusting hole 100 through which an adjusting tool, such as a screwdriver, for example, can be placed to contact notches 85 of the adjusting stud 84 so that the adjusting stud 84 can be rotated. This causes shaft member 78 to move axially along the threaded end 83 of adjusting stud 84, as explained above, either towards or away from the centrifugal pump surface 23. The adjusting stud 84 is held in a fixed axial position by groove 98 with respect to centrifugal pump surface 23. Therefore, when the adjusting stud 84 is turned the impeller member 77 will be moved toward centrifugal pump surface 23 or away from centrifugal pump surface 23 permitting proper adjusting of the impeller without disassembling of the centrifugal pump assembly 10 or any special tooling. The proper adjustment of the impeller member 77 with the centrifugal pump surface 23 is quite critical. A proper setting range would be .012 to .015 of an inch, for example. If the impeller member 77 is placed a greater distance than the proper range from the centrifugal pump surface 23 for a given pump set-up the efficiency of the pump is greatly reduced.

Generally referring to FIGURES 2 and 3, we will discuss the disassembling requirements necessary to service the shaft sealing mechanism 41. Securing bolts 93 and 95 are removed from the coupling assembly 90. This permits the coupling half body members 91 and 92 to be removed. The adjusting stud 84 is then removed from the shaft member 78 to permit the seal gland member 51 to pass the end of shaft member 78 when it is removed.

Secondary securing means **60** are then removed. This is accomplished by removing securing nuts **64** from securing bolts **62**. This permits the shaft sealing mechanism **41** to be removed from the shaft member **78**. The mechanical sealing assembly **56** will remain on shaft member **78**. The seal member **58** can be separated from the spring housing **57**. The seal gland member **51** and its associated parts can be moved through the space provided between motor shaft **38** and shaft member **78**. The needed repair, such as replacing O-rings, et cetera, can then be accomplished, or the unit can be replaced if replacement units are available holding the maintenance time and cost to a minimum. If necessary, the setscrews holding spring housing **57** in place can be released so that spring housing **57** can be removed for servicing, et cetera. It should specifically be noted as viewed in FIGURE 3 that the primary securing means **25** and the gasket **73** sealing between the casing cover **71** and the casing member have not been disturbed nor has the impeller member **77** been removed.

Generally referring to FIGURES 2 and 4, it is shown how both the shaft sealing member **41** and the shaft, cover member and impeller unit **42** can be disassembled together as a unit. In this application the coupling assembly **90** is disassembled as explained above and then the primary securing means **25** is released as will be explained. The nuts **31** will be removed from the securing studs **28** and the cover clamps **29** are taken off, freeing the casing cover **71** of the shaft, cover member and impeller unit **42**. The sealing action between the casing gasket surface **74** and the gasket surface **24** is then made so that the pump unit **40** can be completely separated. The shaft sealing mechanism **41** and the shaft, cover member and impeller unit **42** are then raised as the pump unit **40**. As soon as raising is started, the pump unit **40** is then tilted so that the shaft member **78** and the adjusting stud **84** will miss the motor shaft **38**. The pump unit **40** is then removed through motor support opening **35** so that complete inspection of the impeller member **77** is possible without removing the casing member **20** from the pipelines **13** and **16**. Neither is it necessary to remove or disassemble the motor support **32** or the motor **36**. In most applications the weight of the motor **36** will hold the motor support **32** in its position with securing flange **26**. However, in some embodiments it may be necessary to provide for every other cover clamp **29** or some other number to make contact with only the base ring section **33** and not make contact or extend over annular securing flange **77**.

In this way the pump unit **40** can be disassembled as just explained and the motor support **32** will remain positively secured during repair, removal or while maintenance is being performed on the centrifugal pump assembly **10**. This procedure provides for a vertical in-line centrifugal pump unit which does not require complete disassembly of the pump unit to repair, inspect, perform maintenance, or perform various other actions on the impeller member or other parts. It also provides a means of easily repairing the shaft sealing unit without disturbing the gasket **73** or the primary securing means **25**. It permits these features to be accomplished while also providing external adjustment of the unit through adjusting stud **84**. Other shaft sealing mechanisms which are well known in the art could be used in the place of the mechanical seal **56**. For example, a packing seal set-up could be used between the shaft member **78** and the annular flange member **72** and still utilize all the advantages of the present disclosed structural features.

While but one form of the invention has been shown and described in detail, other forms, such as just discussed, and other forms will be within the spirit and scope of the invention and apparent to those skilled in the art. Therefore, the embodiments shown in the drawings are to be considered as merely setting forth the invention for illustrative purposes and are not intended to limit the scope of the invention herein described and shown.

Other modes of applying the principles of our invention may be employed instead of those explained, change being made as regards the mechanism herein disclosed, provided the means and features stated by any of the following claims or the equivalent of such stated means or features be employed.

We therefore particularly point out and distinctively claim as our invention:

1. A vertical centrifugal pump comprising, in combination

(a) a casing member having a centrifugal pump surface with inlet and discharge ports,

(b) a motor support member having a large open side portion with said support member being supported at its lower end by said casing member,

(c) a motor and motor shaft supported by the upper end of said motor support member,

(d) said motor shaft axially aligned with said centrifugal pump surface,

(e) a casing cover positioned within said motor support and accessible through the large open side portion of same, said casing cover being supported by making sealing contact with said casing member,

(f) a shaft and impeller member axially aligned by said casing cover with said centrifugal pump surface of said casing member and said motor shaft,

(g) a longitudinally split coupling assembly for connecting opposite sides of the adjacent ends of said motor shaft and said shaft with the impeller member mounted on same,

(h) a primary securing means separately securing said casing cover and motor support member to said casing member,

(i) a shaft sealing mechanism mounted on said casing cover and making sealing contact with said shaft and said casing cover,

(j) a secondary securing means mounted on said casing cover for securing said shaft sealing mechanism to said casing cover,

(k) an adjusting means within said longitudinally split coupling assembly and axially aligned with said motor shaft and said shaft carrying said impeller member, said adjusting means being held in a fixed axial position by said coupling assembly when the latter is tightened,

(l) said longitudinally split coupling assembly having a side opening providing access for operating said adjusting means when said coupling assembly is loosened,

(m) means anchoring said coupling assembly on one of said shafts and preventing endwise movement of said shaft relative to same,

(n) said adjusting means in said coupling assembly being connected to the other of said shafts for moving same axially of said coupling assembly and in line with the axis of said first shaft, said adjusting means being substantially fixed against endwise movement relative to said coupling assembly,

(o) the portion of said adjusting means for axially moving the other of said shafts being rotatable and threadedly connected to the other of said shafts so that rotation of same in one direction will move said impeller toward said casing cover of said casing member and away from same when moved in the other direction, and

(p) means for locking said split coupling assembly, adjusting means, and both shafts in fixed but releasable position for positive rotation in unison with said impeller.

2. A vertical centrifugal pump comprising, in combination

(a) a casing member having a centrifugal pump surface with inlet and discharge ports,
(b) a motor support member supported at its lower end by said casing member,
(c) a motor and motor shaft supported by the upper end of said motor support member,
(d) said motor shaft axially aligned with said centrifugal pump surface,
(e) said motor support member having a motor support opening in the side of same,
(f) means for adjustably fastening said motor support member on said casing member to position said motor support opening in any desired radial direction,
(g) a casing cover positioned at the lower portion of said motor support, said casing cover being supported by and making sealing contact with said casing member,
(h) a shaft and impeller member axially aligned by said casing covered with said centrifugal pump surface of said casing member and said motor shaft,
(i) a coupling assembly connecting said shaft and impeller member to said motor shaft,
(j) a primary securing means securing said casing cover to said casing member,
(k) a shaft sealing mechanism supported by said casing cover and making sealing contact with said shaft and said casing cover,
(l) a secondary securing means securing said shaft sealing mechanism to said casing cover,
(m) means anchoring said coupling assembly on one of said shafts and preventing endwise movement of said shaft relative to same,
(n) adjusting means in said coupling assembly connected to the other of said shafts for moving same in line with the axis of said first shaft, said adjusting means being substantially fixed against endwise movement relative to said coupling assembly,
(o) the portion of said adjusting means for axially moving the other of said shafts being rotatable and threadedly connected to the other of said shafts so that rotation of same in one direction will move said impeller toward said casing cover of said casing member and away from same when moved in the other direction, and
(p) means for locking said split coupling assembly, adjusting means, and both shafts in fixed but releasable position for positive rotation in unison with said impeller.

3. A vertical in-line centrifugal pump in a piping system comprising, in combination
(a) a casing member having a gasket surface, a centrifugal pump surface and in-line inlet and discharge ports,
(b) said inlet and discharge ports having end flanges connecting said pump into said piping system,
(c) a motor support member having a base ring, a top ring and a motor support opening,

(d) said motor support member adjustably supported by its base ring on said casing member for positioning said motor support opening in any desired direction,
(e) a motor and motor shaft supported by said top ring with said motor shaft axially aligned with said centrifugal pump surface,
(f) a casing cover positioned within said motor support,
(g) a gasket member positioned on said gasket surface of said casing member to support said casing cover on said casing member,
(h) a shaft and impeller member axially aligned with said centrifugal support surface and said motor shaft by said casing cover,
(i) a series of securing studs positioned in said casing member adjacent said casing cover,
(j) cover clamps positioned on said securing studs,
(k) nuts screwed on said securing studs acting on said cover clamps to secure said casing cover to said casing member,
(l) a shaft sealing mechanism supported by said casing cover and making sealing contact with said shaft and said casing cover,
(m) a series of securing bolts positioned on said casing cover and passing through said shaft sealing mechanism,
(n) securing nuts screwed on said securing bolts securing said shaft sealing mechanism to said casing cover,
(o) a coupling assembly connecting said shaft and impeller member to said motor shaft,
(p) a shaft collar securing to said motor shaft and positioning said coupling assembly in a fixed axial location with respect to said motor shaft,
(q) a groove in said coupling assembly,
(r) an adjusting stud rotatably secured in said groove in a fixed axial position with respect to said motor shaft and threadably connected to said shaft of said shaft and impeller member,
(s) an adjusting hole in said coupling assembly to permit an adjusting tool to rotate said adjusting stud, and
(t) said adjusting stud moving said shaft and impeller member in an axial direction towards said centrifugal pump surface when rotated in a first direction and away from said centrifugal pump surface when rotated in a second direction.

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ROBERT M. WALKER, *Primary Examiner.*