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E. A. WILHELM

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MULTISTAGE CENTRIFUGAL PUMP

Filed Nov. 6, 1943

4 Sheets-Sheet 2

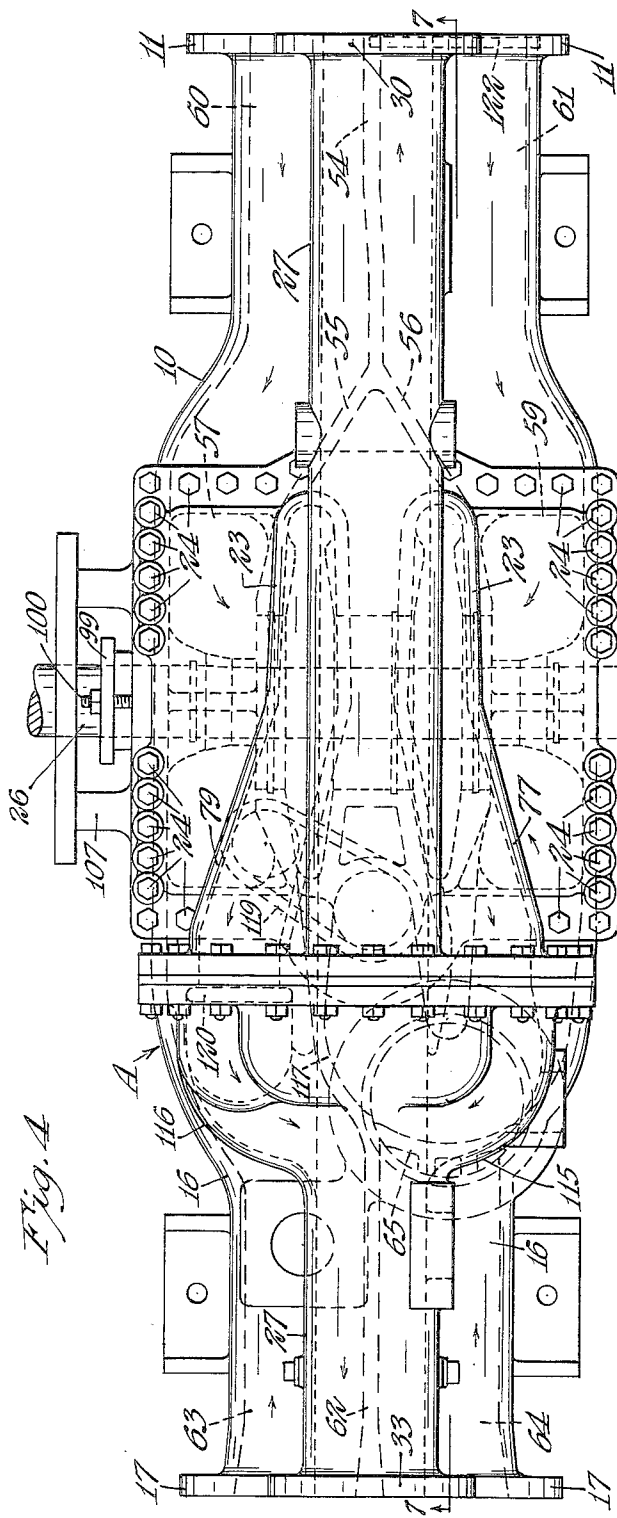


Fig. 4

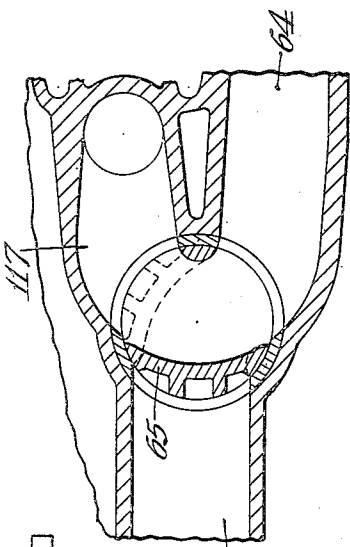


Fig. 5

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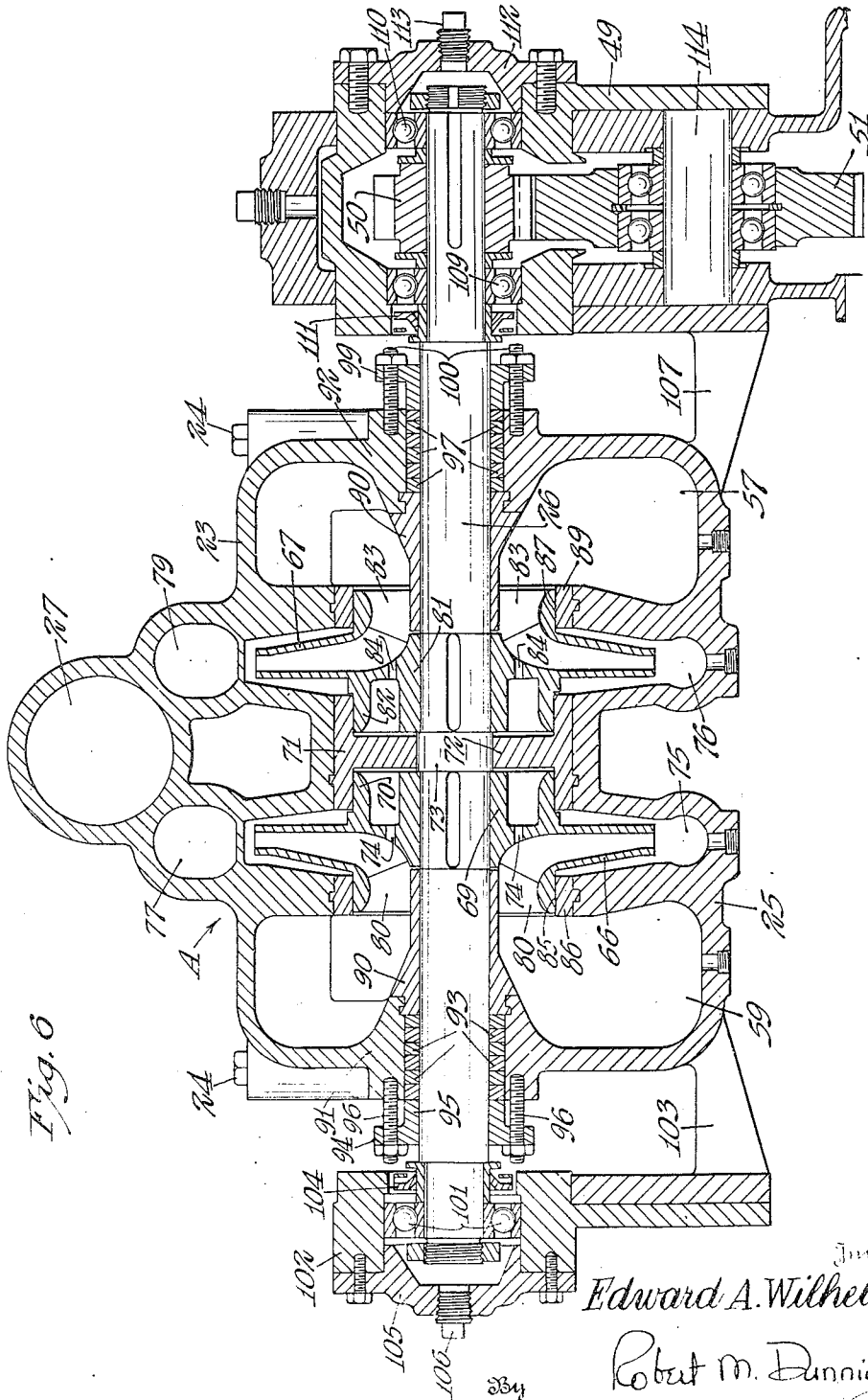
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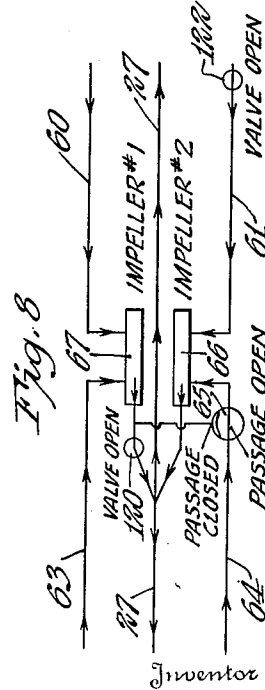
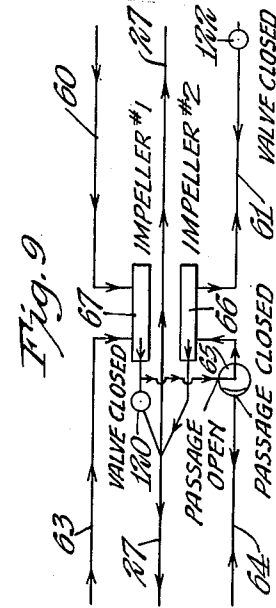
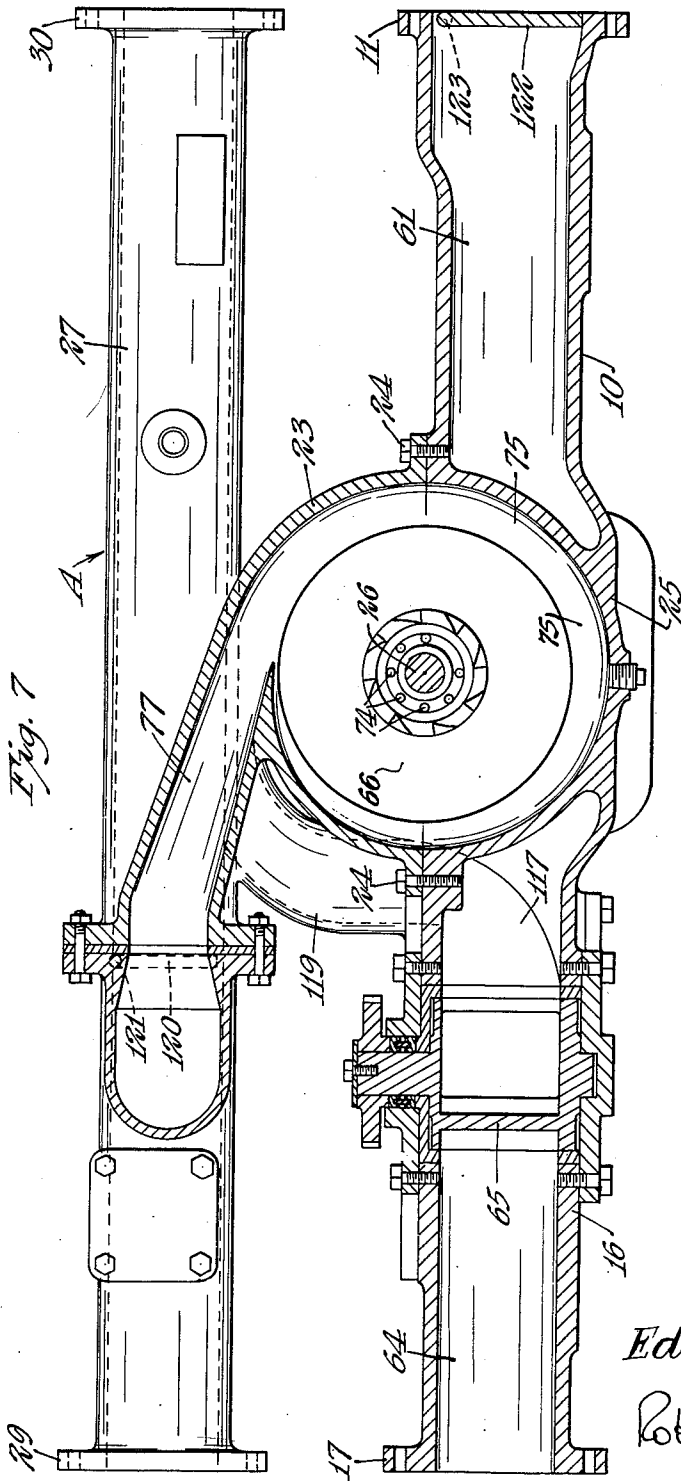
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4 Sheets-Sheet 4



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## UNITED STATES PATENT OFFICE

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## MULTISTAGE CENTRIFUGAL PUMP

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Application November 6, 1943, Serial No. 509,244

11 Claims. (Cl. 103—106)

My invention relates to an improvement in centrifugal pumps, wherein it is desired to provide a novel two stage pump, the stages of which may be arranged either in series or in parallel.

In pumps of the centrifugal type designed for use on fire engines and the like, it is desirable to construct the pump as flexible as possible so that it may adopt itself for use under varying conditions. For example in some instances it is desired to pump a relatively large volume of water at a relatively low pressure. In other instances it is desirable to pump a relatively smaller quantity of water at a high pressure. The present pump is designed to accommodate itself to these varying conditions.

A feature of the present invention lies in the provision of a centrifugal pump having a pair of impellers which may be arranged either in series or in parallel. When a relatively large volume of fluid is to be pumped the impellers are arranged to operate in parallel, each impeller pumping a substantially equal amount of water. When the impellers are arranged in series only approximately one-half of the volume of water is pumped and the output of one impeller is fed to the intake of the other impeller. The pressure, however, is substantially double that developed when the impellers are arranged in parallel.

A feature of the present invention lies in the provision of a two impeller centrifugal pump controlled by a single valve. Due to the fact that each impeller is normally provided with an intake and an outlet, it is ordinarily necessary to manually operate a series of valves so as to permit the output of one impeller to enter the intake of the other, to close the normal outlet of the first impeller and to close the normal inlet of the second impeller. In my construction but a single valve is provided for manual operation, thereby greatly simplifying the operation of my pump.

A feature of the present invention lies in the provision of automatically operable valves, and in so connecting the impellers that these valves operate automatically to close the outlet of the first impeller and to close the intake of the second impeller when the impellers are arranged in series. This operation is accomplished by means of pressure normally developed within the pump casing and permits semi-automatic operation of the system.

A feature of the present invention lies in the construction of the pump casing. The pump casing is normally constructed so that substantially one-half of the casing may be disconnected from the other half thereof, thereby exposing all of the

construction details on the interior of the pump. As a result any portion of the pump is rendered readily accessible for repair or replacement.

These and other objects and novel features of my invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of my specification:

Figure 1 is a top plan view of my pump in its entirety showing the arrangement of parts thereupon.

Figure 2 is a side elevational view of the pump illustrated in Figure 1 of the drawings, showing further details of construction thereof.

Figure 3 is an end elevational view of the pump showing the drive mechanism for the pump.

Figure 4 is an enlarged top plan view of the pump casing showing the arrangement of parts within the casing in dotted outline.

Figure 5 is a transverse sectional view through the manually operable valve for changing the operation from parallel connecting impellers to series connected impellers.

Figure 6 is a cross-sectional view taken on a substantially vertical plane, the position of which is indicated by the line 6—6 of Figure 1.

Figure 7 is a sectional view taken on substantially the line 7—7 of Figure 4.

Figure 8 is a diagrammatic view showing the valve arrangement when the pump impellers are arranged in parallel.

Figure 9 is a diagrammatic view similar to Figure 8 showing the valve arrangement when the impellers are arranged to operate in series.

The pump A is constructed externally, as best illustrated in Figures 1, 2, and 3 of the drawings. A relatively wide intake manifold 10 is terminally flanged at 11 for attachment with the transition joint 12 connected to any suitable tubular connection leading to a source of fluid supply. A cap 13 may close the end of the transition joint 12 when the pump is not in use. The joint 12 is flanged at 14 and the flanges 11 and 14 are connected together in any suitable manner such as by the bolts 15.

A similar intake manifold 16 projects from the opposite end of the pump A. The manifold 16 is terminally flanged at 17 to abut the flanged end 19 of the transition joint 20 which connects the relatively wide and shallow manifold 16 with a circular connecting end 21. A closure cap 22 may be secured over the end of the transition joint 20 to close the same when the pump is not in use.

Obviously either or both of the intake manifolds may be connected by suitable tubular conduit

means to a source of fluid supply. If but one manifold is in use at any time, the remaining manifold is sealed by means of the corresponding transition joint cap 13 or 22.

The lower portion of the pump body is integrally cast with the manifolds 10 and 16. The upper section 23 of the pump body is bolted to the lower portion thereof by means of connecting bolts 24. The upper portion 23 of the pump is separated from the lower portion 25 thereof along the axis of the transversely extending impeller shaft 26 so that this shaft 26 and the impellers supported thereon may be readily removed once the upper half of the pump casing has been separated from the lower portion 25 of the pump.

An aligned outlet conduit 27 extends longitudinally of the pump A above the level of the intake manifolds 10 and 16. This outlet manifold 27 is provided with flanged ends 29 and 30 which are designed for attachment with transition joints 31 and 32, respectively, which in turn are connected to control valves. The transition joint 31 is provided with an end flange 33 which abuts against the flange 29 and is secured thereto by bolts 34 or other suitable means. The transition joint 31 is shown of bifurcated form having flanged ends 35 arranged to abut the flanged ends 36 of the shut-off valves 37. These valves 37 are provided with outlet ends 39 which are normally closed by caps 40 when the pump is not in use.

The transition joint 32 is provided with a flanged end 41 arranged to abut the flange 30 of the outlet manifold 27 and to be secured thereto by any suitable means such as bolts 42. The transition joint 32 is likewise provided with a flanged end 43 which may be bolt connected in abutting relation to the flanged end 44 of the shut-off valve 45. The valve 45 is provided with an outlet 46 which is normally closed by a cap 47 when the pump is not in use. While I have illustrated a bifurcated double transition joint on one end of the pump A, and a single transition joint 32 at the other end thereof, obviously these transition joints could be reversed, or both joints could be similar and either of the single or double type to provide the required number of pump outlets at the most convenient points.

The pump A is operated through any desired drive mechanism and is shown provided with a gear casing 49 designed to enclose the necessary drive gears. For example, a pinion 50 on the end of the impeller shaft 26 may be gear connected by the idle gear 51 to a suitable drive gear, not illustrated, mounted upon the drive shaft 52. The drive shaft 52 is connected to any suitable source of power supply.

As best illustrated in Figure 1 of the drawings, a relief valve 53 may be connected at any point to the outlet manifold 27 so as to by-pass fluid when a predetermined maximum pressure is attained within the pump. This relief valve assists in preventing a sudden surge in the various outlet lines of the pump when one of the outlets is closed. The relief valve 53 also acts to by-pass fluid when the maximum desired pressure within the pump is exceeded due to the closure of most or all of the outlet lines.

With reference to Figures 4, 6, and 7 of the drawings, it will be noted that each of the intake manifolds is centrally divided so that the intake to each pump impeller is separated for some distance from the intake of the other impeller. In Figure 4 of the drawings, attention is

called to the fact that the hidden portions of the construction forming a part of the upper section of the pump are shown in relatively short dotted lines. The hidden portions of the lower section of the pump illustrated in Figure 4 are illustrated with longitudinal dashes so that the hidden upper portions may be distinguished from the hidden lower portions of the pump.

With reference now to Figure 4 of the drawings, the intake manifold 10 is provided with a central dividing partition wall 54 which extends from a point adjacent the flanged end 11 to the impeller casing portion of the pump casing. As illustrated the partition 54 branches to provide two separate manifold walls 55 and 56 which conduct the fluid flow therethrough into the intake chambers 57 and 59 respectively. In other words, the intake manifold 10 is divided into two separate conduits 60 and 61, the first of which leads into the impeller intake chamber 57, while the other of which leads into the impeller intake chamber 59.

The intake manifold 16 is likewise connected to the intake chambers 57 and 59. The manifold 16 is provided with a central partition wall 62 which divides the manifold into spaced conduits 63 and 64. The conduit 63 leads directly into the intake chamber 57 at a point opposite to the connection of the conduit 60 with this chamber. The conduit 64 is similarly connected with the inlet chamber 59 at a point opposite the connection of this chamber with the intake conduit 61. A valve 65 is provided in the conduit 64, however, this valve is best illustrated in Figure 5 of the drawings.

As best illustrated in Figure 6 of the drawings the impeller shaft 26 supports a pair of axially spaced impellers 66 and 67. These impellers are of any desired or preferred shape, being provided with impeller vanes not specifically illustrated in the drawings. The impeller 66 includes a hub 68 and is likewise provided with a substantially cylindrical flange 70 in spaced relation to the hub. The flange 70 is designed to engage against the inner surface of a wear ring 71 which is provided with a central ring-shaped wall 72 which extends into communication with the enlarged portion 73 of the impeller shaft 26. The ring portion 72 thus provides a central bearing for the shaft 26 between the impellers, while the wear ring 71 provides a bearing end seal for the rear side of the impeller 66. Spaced apertures 74 are provided through the impeller between the hub 68 and the flange 70 so as to release any fluid which might leak through the seal between the impeller and the wear ring 71.

The portion of the pump housing sections 23 and 25 encircling the impellers 66 and 67 form volutes 75 and 76, respectively, for these impellers. In the construction illustrated, best shown in Figure 7, the volute begins at a point substantially vertically above the shaft 26 and terminates in upwardly and longitudinally extending discharge passages 77 and 79. Thus as the volute 66 rotates, fluid enters through the coaxial intake 80 of the impeller and is forced by the impeller longitudinally and upwardly through the discharge passage 77.

The impeller 67 is virtually identical with the impeller 66. This impeller 67 is provided with a hub 81 to hold the impeller upon the shaft and is provided with a spaced substantially cylindrical flange 82 designed to engage the inner surface of the wear ring 71. Vanes, not specifically illustrated in the drawings, force fluid entering the

intake 33 outwardly into the volute 76 which gradually merges into the discharge passage 79. Openings 84 through the impeller prevent fluid from becoming trapped between the impeller and the wear ring 71.

The impeller 66 is provided with a cylindrical bearing surface 85 outwardly of the intake passage 80, which is supported by a wear ring 86. Similarly, the impeller 67 is provided with an external bearing surface 87 which is supported by a wear ring 89 mounted in the impeller casing. The impellers are thus securely mounted and rotate at a high rate of speed.

Divided sleeves 90 encircle the shaft 26 between the hubs 91 and 92, respectively, of the casing sections 23 and 25, and the impeller hubs 69 and 81. These sleeves 90 are designed to protect the shaft 26 from the corrosive and sealing action of fluid flowing from intake chambers 57 and 59 into the impellers 67 and 66.

A stuffing joint is provided within each of the hubs 91 and 92. Packing 93 is provided about the shaft 26 within the hub 91 and this packing is held in sealing relation between the shaft and the hub by means of a split collar 94 provided with a split cylindrical sleeve 95 arranged to bear against the packing 93. The split collar 94 is held in place by studs or cap screws 96.

Packing 97 is provided between the shaft 26 and the hub 92 and this packing is urged in sealing relation between the hub and shaft by a split collar 99, which is held in place by studs or cap screws 100. Very little leakage may take place through the walls of the pump casing about the shaft 26.

One end of the shaft 26 is supported by bearings 101 mounted in a bearing housing 102, supported in spaced relation to the pump housing sections by brackets 103. A finger ring 104 encircles the shaft 26 to close the inner end of the bearing housing 102, while the outer end thereof is closed by means of a closure plate 105, securely bolted to the housing 102. A plug 106 or grease connection is provided in the plate 105 and may act to provide a means of lubricating the bearing and also of gaining access to the shaft, and for applying a tachometer to the end of the shaft. The other end of the shaft 26 is supported by the gear housing 49 which is secured by brackets 107 to the pump housing. Bearings 109 and 110 are provided between the gear housing 49 and the shaft, and a finger ring 111 acts to close the inner end of this gear housing. The outer end of the gear housing is provided with a closure plate 112 which is provided with a removable plug or grease fitting 113 to permit lubrication of the bearings and to provide access to the end of the shaft.

As was previously described the pinion 50 is mounted on the shaft 26 and is positioned between the bearings 109 and 110. The idle gear 51 is mounted upon a stub shaft 114 in the gear housing in the manner best illustrated in the drawings.

With reference now to Figure 4 of the drawings, it will be noted that the impeller discharge passages 77 and 79 extend upwardly and outwardly, being guided by the curved casing walls 115 and 116 into the opposite sides of the discharge manifold 27. The manner in which the passages 77 and 79 merge or blend into the discharge manifold 27 is perhaps best illustrated in Figure 1 of the drawings. As a result the fluid flowing into the discharge manifold flows into the same oil travelling at substantially right angles thereto, 75

and thus may be removed from either end of the discharge conduit with equal facility. As a result the fluid entering either or both intake manifolds 10 and 16 may flow through the associated intake chambers 57 and 59, through the impellers 66 and 67, through the volute discharge passages 77 and 79, and into the discharge manifold 27 in such a way that the fluid may flow from either end of the discharge manifold with equal ease. Parallel operation of the pump takes place in this action just described.

With reference now to Figure 5 of the drawings, it will be noted that the by-pass conduit 117 extends into communication with the inlet conduit 64. This conduit 117 is illustrated in Figures 4, 5, and 7 of the drawings and communicates upwardly through a conduit 119 in the upper pump section 23 with the volute discharge passage 79. As a result a continuous passage is provided from the volute discharge passage 79 to the intake passage 64 of the second impeller. The valve 65 is so mounted as to rotate on a substantially vertical axis and selectively close either the intake passage 64 or the by-pass passage 117. When in one extreme position, illustrated in full lines in Figure 5 of the drawings, the intake chamber 59 of the impeller 66 is in communication with the discharge passage 79 of the volute 76. When the valve 65 is in the position illustrated in dotted outline in Figure 5 of the drawings, the volute discharge passage 79 is sealed from the intake passage 64 and the intake passage 64 is connected to the source of fluid supply.

As best illustrated in Figures 4 and 7 of the drawings, an automatically operable valve 120 is provided at the end of the volute discharge passage 79. When this valve 120 is closed the discharge 77 of the volute 76 is not connected to the discharge outlet manifold 27. As may be seen from Figure 4 of the drawings, the valve 120 closes off the discharge passage within the curved casing wall 116 so that the volute 76 is not connected directly with the discharge. The valve 120 is illustrated as being hinged along its upper edge at 121.

A valve 122, similar to the valve 120, is hinged mounted along its upper edge 123 within the intake passage 61. When the valve 122 is closed, it abuts against the transition joint 12 and closes off the adjacent intake passage. When open, fluid may be drawn from a suitable source of fluid supply.

The operation of the pump A is believed obvious from the foregoing description, and is diagrammatically illustrated in Figures 8 and 9 of the drawings. When the valve 65 is open, or in the position illustrated in dotted outline in Figure 5 of the drawings, fluid may enter any or all of the suction passages 60, 61, 63, and 64. Certain of these passages may be closed, as by caps 13 or 22 mounted upon the ends of the transition joints 12 and 20, respectively. However, the fluid may be drawn through any open intake passage into the suction room 59 of the impeller 66 and into the suction room 57 of the impeller 67. Fluid entering the impeller 66 is urged through the volute 75 and the volute discharge passage 77, through the curved casing portion 115 entering the outlet or discharge manifold 27 at substantially right angles thereto. This fluid under pressure may be withdrawn through any open passage connected to the discharge manifold 27, either flowing through the transition joint 31, the transition joint 32, or both of these joints, as the case may be.

Fluid entering the impeller 67 is forced through the volute 76 and through the volute discharge passage 79 from which it flows, through the curved casing portion 116 to enter the outlet or discharge manifold 27 at substantially right angles thereto. This fluid may flow from the discharge passage from either or both ends thereof.

It will therefore be seen that when the valve 65 is in the open position, or in the dotted outline position of Figure 5, the impellers 66 and 67 operate in parallel and force a relatively high volume of water from the discharge manifold 27 at a relatively low speed.

When it is desired to pump a smaller volume of water at a higher pressure from the discharge manifold, the valve 65 is rotated into the position shown in full lines in Figure 5 of the drawings, thereby closing the intake passage 64 leading to the impeller 66. Under such conditions the fluid is drawn through the inlet passage 60, 63, or both of these passages into the intake chamber 57 of the impeller 67. Fluid is then urged through the impeller 67 into the volute 76 and into the volute discharge passage 79. Due to the opening of the passages 117 and 119 in the pump casing by the valve 65, the fluid leaving the impeller 67 through the discharge passage 79 has two possible courses to travel. The first course is through the curved casing portion 116 into the discharge manifold 27. Considerable pressure is necessary to force fluid through this discharge manifold under normal operating conditions. The second possible course of travel is through the passages 119 and 117 to the inlet passage 64, leading to the intake chamber 59 of the impeller 66. There is relatively no back pressure retarding the flow of fluid in this direction, and in fact the rotation of the impeller 66 has a tendency to draw water from the intake chamber 59 as fast as this chamber is filled. Therefore the main flow of fluid leaving the volute 76 through the discharge passage 79 will pass through the passages 119 and 117 into the intake 59 of the volute 66.

Due to the flow of fluid from the discharge of the first volute to the intake of the second, pressure will be built up within the intake chamber 59 which is communicated through the intake passage 61, thereby tending to close the valve 122. For example, if each volute is capable of producing a discharge pressure of 125 pounds per square inch, this pressure will be communicated through the intake chamber 59 to the inlet passage 61. As a result fluid under pressure will be found in the passage 61, which is resisted only by intake pressure and therefore the automatically operable valve 122 will quickly swing tightly closed and remain closed during series operation of the pump.

As the pressure entering the impeller 66 is already at 125 pounds per square inch, fluid will be discharged into the volute 75 and into the volute discharge passage 77 at substantially 250 pounds per square inch pressure. This pressure will be communicated through the casing portion 15 into the discharge manifold 27. Simultaneously the fluid under pressure will be communicated through the passage 116 to hold the valve 120 in tightly closed position. The valve 120 will remain closed throughout series operation of the pump, as there is but 125 pounds per square inch pressure on one side of the valve and substantially twice this pressure on the other side there-

of. Obviously these pressures are only stated for the purpose of illustration.

Thus with reference to Figure 9 of the drawings, when the valve 65 is turned into position to close the intake passage 64 and to open the passage 117, the fluid will flow from the outlet of the first impeller 67 to the inlet of the second impeller 66. The remaining inlet passage 61 will be automatically closed as will the valve 120 between the outlet of the impeller 67 and the inlet of the impeller 66. The volume of fluid pumped by the pump will obviously be decreased to substantially one-half the amount pumped during parallel operation as indicated in Figure 8, but the outlet pressure of the fluid will be substantially doubled. As soon as the valve 65 is turned into the position illustrated in dotted outline in Figure 5, the outlet pressure will be substantially cut in half but the volume of fluid pumped will be substantially doubled.

The convenient form of construction of my pump A permits quick repair or replacement of any of the parts thereof, due to the fact that the upper half of the pump casing can be removed from the lower half thereof to expose the impeller shaft, the impellers, and the various internal mechanisms. The impellers themselves can be readily removed when necessary, together with the impeller shaft 26. The valve arrangement is such that the operation of a single valve 65 will automatically change the operation of the impellers from parallel operation to series operation and vice versa, the remaining necessary valves operating automatically as a result of the operation of the single valve 65.

In accordance with the patent statutes, I have described the principles of construction and operation of my pump, and while I have endeavored to set forth the best embodiments thereof, I desire to have it understood that obvious changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A centrifugal pump comprising a pair of impellers, a volute for each of said impellers, a discharge for each of said volutes, a pair of inlet manifolds to said impellers, means connecting said inlet manifolds, a passage connecting the outlet of one of said volutes to the intake of the impeller in the other of said volutes, a valve in said last named passage operable selectively to connect said impellers in series by opening said passage and simultaneously closing an inlet manifold or in parallel by closing said passage and simultaneously opening said inlet manifold, and valve means in the intake manifold to the impeller in the other of said volutes to close and to disconnect the intake manifolds.

2. A centrifugal pump comprising a first impeller, a first volute therefor, a first discharge passage therefrom, and a first intake manifold to said impeller, a second impeller, a second volute therefor, a second discharge therefrom, and a second intake manifold to said second impeller, a passage connecting said first discharge passage to said second intake manifold, valve means in said passage, said valve selectively opening said passage and simultaneously closing said second intake manifold, and vice versa, means connecting said first and second inlet manifolds, and valve means selectively closing the connection between said first and second inlet manifolds.

3. A centrifugal pump comprising a first im-

5 peller, a first intake manifold leading thereto, a first discharge passage leading therefrom, a second impeller, a second intake manifold leading thereto, a second discharge passage leading therefrom, a passage connecting said first discharge passage with said second intake manifold, valve means in said last named passage, said valve means operable selectively to open either said passage or said second intake manifold, means connecting said intake manifolds, and valve means in said connecting means to selectively close the connection between said first and second intake manifolds.

4. A centrifugal pump comprising a first impeller, a first inlet manifold leading thereto, a first discharge passage leading therefrom, a second impeller, a second inlet manifold leading thereto, a second discharge passage leading therefrom, passage means connecting said first discharge passage to said second inlet manifold, valve means in said connecting passage, said valve means operable selectively to open either said passage means or said second intake manifold, means connecting said inlet manifolds, and check valve means in said connecting means to close said second inlet manifold from said first manifold when the pressure in said second inlet manifold exceeds the pressure in said first inlet manifold.

5. A centrifugal pump comprising a first impeller, an inlet manifold leading thereto, a discharge passage leading therefrom, a second impeller, a second inlet manifold leading thereto, a second discharge passage leading therefrom, means connecting said first discharge passage to said second inlet manifold, valve means in said connecting passage, said valve means operable selectively to open either said passage means or said second intake manifold, means connecting said inlet manifolds, check valve means in said last named connecting means operable when the pressure in said second inlet manifold exceeds the pressure in said first named inlet manifold to close the connection therebetween, means connecting said discharge passage, and check valve means in said last named connecting means operable when the pressure in said second discharge passage exceeds that in the first discharge passage to close the connection between said discharge passage.

6. A pump comprising a first pumping element, an intake passage thereto, a discharge passage therefrom, a second pumping element, a second intake passage thereto, a second outlet passage therefrom, a passage connecting said first discharge passage with said second intake passage, and valve means in said last named passage, said valve means operable selectively to open either said last named passage or said second intake passage.

7. A pump comprising a first pumping element, a first intake passage thereto, a first outlet passage therefrom, a second pump element, a second intake passage thereto, a second discharge passage therefrom, a connecting passage connecting said first discharge passage with said second intake passage, valve means in said connecting means, said valve means operable selectively to open either said passage means or said second intake manifold, means connecting said first and second intake passages, and valve means operable to close said last named connecting means to cut off said second intake passage from said first intake passage.

8. A pump comprising a first pumping element, 75

a first inlet passage thereto, a first discharge passage therefrom, a second pumping element, a second inlet passage thereto, a second discharge passage therefrom, means connecting said first discharge passage with said second inlet passage, valve means in said connecting passage, said valve means operable selectively to open either said passage means or said second intake manifold, connecting means connecting said first and second inlet passages, valve means in said connecting passage operable when the pressure in said second inlet passage exceeds the pressure in said first inlet passage to close said valve, connecting means connecting said discharge passage, and means operable when the pressure in said second discharge passage exceeds the pressure in said first discharge passage to close said connecting means.

9. A pump comprising a first pumping element, a pair of first inlet manifolds leading thereto, a first discharge passage leading therefrom, a second pumping element, a pair of second inlet manifolds leading thereto, a second discharge passage leading therefrom, a passage connecting said first discharge passage with one of said second inlet manifolds, valve means selectively operable to connect either said connecting passage or said one inlet manifold to said second pumping element so that said second pumping element may receive fluid either from the discharge of said first pumping element or from said one inlet manifold of said second pair of inlet manifolds, means connecting said one inlet manifold of said second pair of inlet manifolds with one inlet manifold of said first pair of inlet manifolds, means connecting the other manifolds of said pairs of inlet manifolds, and valve means in said last named connecting means operable when pressure in the other inlet manifold of said second pair of inlet manifolds exceeds the pressure in said first inlet manifolds.

10. A pump comprising a first pumping element, a first inlet chamber associated therewith, a first double ended inlet manifold connected to said first inlet chamber, a first discharge passage leading from said first pumping element, a second pumping element, a second inlet chamber associated therewith, a second double ended inlet manifold connected to said second inlet chamber, a second discharge passage connected to said second pumping element, a connecting passage connecting said first discharge passage with said second inlet chamber, valve means selectively connecting said second inlet chamber either with said connecting passage or with one end of said second double ended inlet manifold, a common intake connection connecting the other ends of said first and second double ended inlet manifolds, and valve means in said common intake connection and operable when the pressure in said second inlet chamber exceeds the pressure in said first inlet manifold to close the connection therebetween.

11. A pump comprising a first pumping element, a first inlet chamber associated therewith, a first double ended inlet manifold connected to said chamber, a first discharge passage connected to said first pumping element, a second pumping element, a second inlet chamber connected to said second pumping element, a second double ended inlet manifold connected to said second inlet chamber, a second discharge passage connected to said second pumping element, a passage connecting the discharge of said first pumping element to said second intake chamber, a

valve means selectively closing the passage from said second inlet chamber to said connecting passage or to one end of said second double ended intake manifold, means connecting the other ends of said double ended inlet manifolds, check valve means operable when the pressure in said second inlet chamber exceeds the pressure in said first double ended inlet manifold to close the connec-

tion between said double ended inlet manifolds, means connecting said discharge passages, and valve means in said connecting means operable when the discharge pressure of said second pumping element exceeds the discharge pressure of said first pumping element to close the connection between said discharge passages.

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