Oct. 10, 1933. R. JACUZZI 1,929,496

CENTRIFUGAL FORCE PUMP

Filed May 22, 1929 2 Sheets-Sheet 1

Fig. 1.

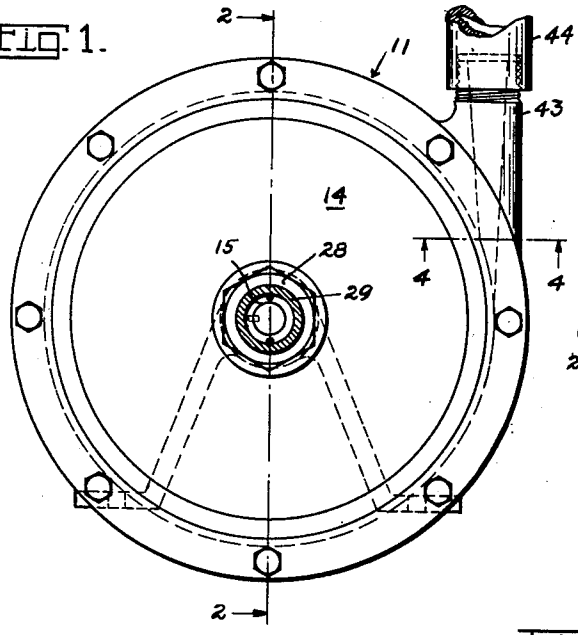


Fig. 2

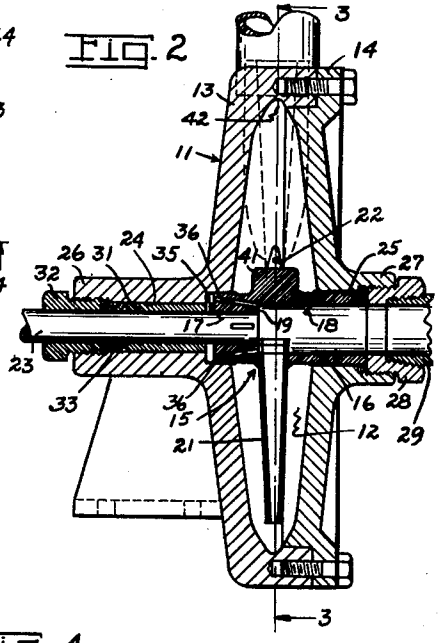


Fig. 4

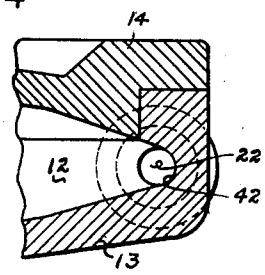


Fig. 3

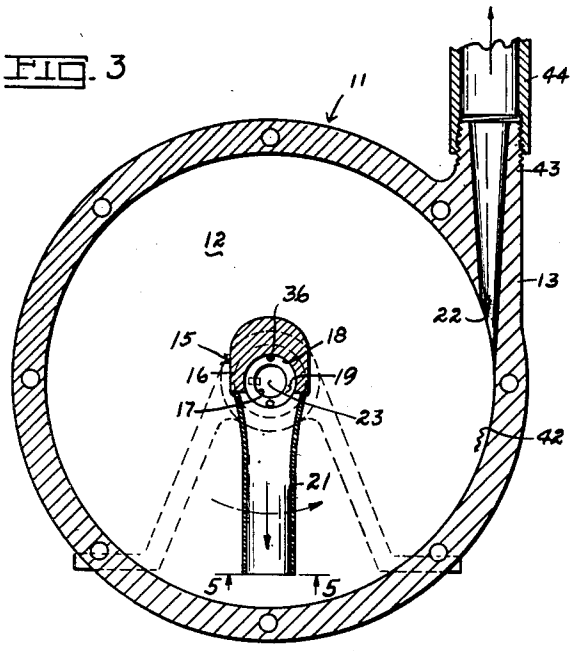
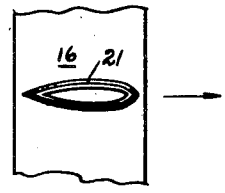


Fig. 5



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Fig. 7

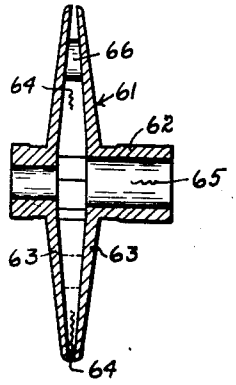


Fig. 6

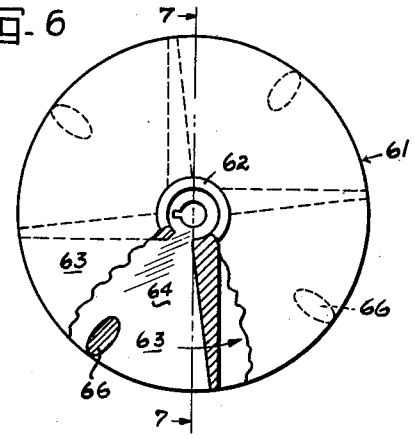


Fig. 9

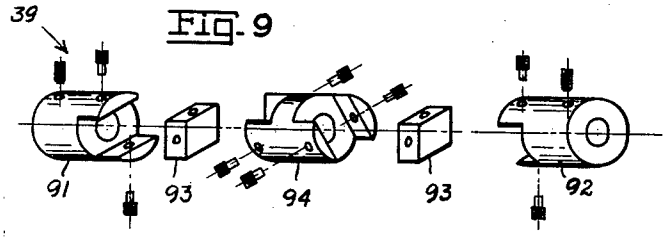


Fig. 10

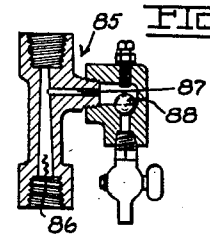
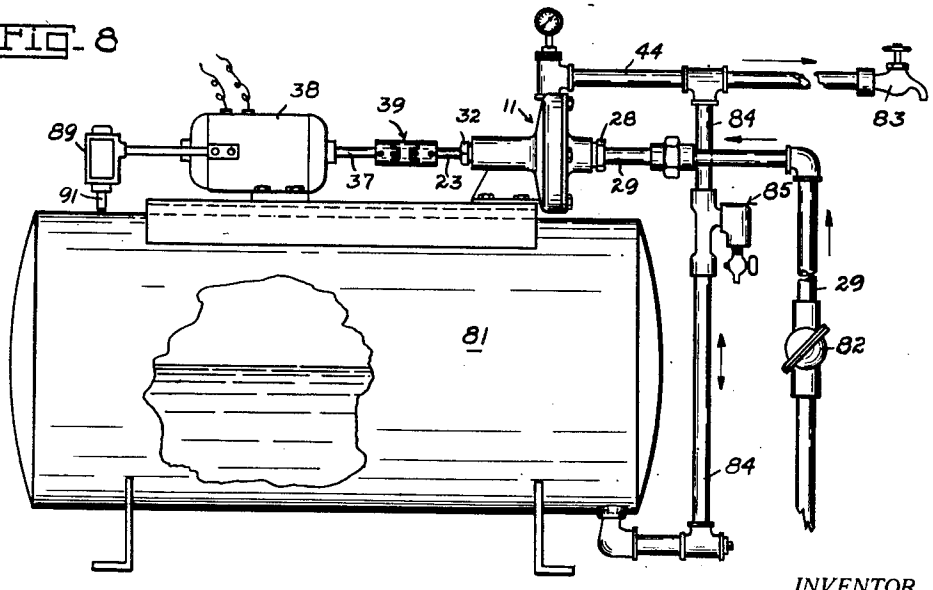


Fig. 8



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL FORCE PUMP

Rachel Jacuzzi, Berkeley, Calif., assignor to Jacuzzi Bros., Incorporated, Berkeley, Calif., a corporation of California

Application May 22, 1929. Serial No. 365,063

1 Claim. (Cl. 103—103)

The invention relates to a centrifugal pump particularly designed for use in automatically controlled systems for pumping liquids and discharging the same under pressure.

An object of the invention is to provide a single stage pump of the class described which is arranged to discharge fluid at a particularly high pressure for such pumps.

Another object of the invention is to provide a centrifugal pump in which the fluid in the chamber thereof is not circulated therein at the same rate as is the pump rotor, but moves at a much slower rate.

A further object is to provide an improved means for centrifugally discharging the fluid from the rotor into the pump chamber.

An additional object is to provide an improved rotor structure which is subjected to a minimum of frictional resistance in the pump chamber.

Yet another object is to provide a pump of the class described which is arranged for high-speed operation.

A still further object is to provide in a pump of the class described a discharge port which is operative to further increase the discharge pressure from the pump.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of a preferred form of the invention which is illustrated in the accompanying drawings, in which

Figure 1 is a side face view of a pump embodying the invention, said view being taken at the intake face of the pump.

Figure 2 is a section at the line 2—2 in Figure 1.

Figure 3 is a section at the line 3—3 in Figure 2.

Figure 4 is an enlarged fragmentary section taken at 4—4 in Figure 1.

Figure 5 is an enlarged end view of a fluid discharge arm of the pump rotor, said view being taken at 5—5 in Figure 3.

Figure 6 is a side view of an alternative rotor for use in the pump, a portion of the structure being broken away to disclose the internal arrangement thereof.

Figure 7 is a section taken at the line 7—7 in Figure 6.

Figure 8 is an elevation showing the operative installation of the pump as part of an automatic water pumping and distributing unit.

Figure 9 discloses the details of a novel shaft coupling which is utilized in the unit of Figure 8, elements of the coupling being separated.

Figure 10 is a vertical section of a breather valve of the unit of Figure 8.

As particularly disclosed in Figures 1 to 5 inclusive, the present invention is incorporated in the structure of a pump 11 having an annular runner chamber 12 defined by and between axially separable casing sections 13 and 14 and about a rotor, or runner, 15, mounted in the casing. The rotor 15 is seen to include a hub 16 provided with an axial bore having portions 17 and 18 of different diameters to define an annular face 19 at their junctures. Fixed to the hub 16 to extend radially therefrom in the chamber 12 is a tubular arm 21 having the passage thereof connected with the larger hub bore portion 18, it being noted that said arm and bore portion provide the sole inlet for the chamber. An outlet port 22 is provided through the casing portion 13 at the periphery of the chamber 12, said port preferably being tangentially directed from the chamber and being of a special form as will hereinafter be brought out. The rotor 15 is mounted at the extremity of a shaft 23 fixedly engaged in its smaller bore portion 17.

Openings 24 and 25 are respectively procvided in the casing sections 13 and 14 to extend axially from the casing space, the shaft 23 extending through the opening 24 while the opening 25 provides the inlet to the pump. Preferably, and as shown, integral tubular bosses 26 and 27 are respectively provided on the casing sections 13 and 14 respectively whereby the openings 23 and 24 are elongated. As shown, the outer end of the opening 25 is internally threaded to receive a coupling sleeve 28 which in turn receives an inflow pipe 29. A bearing bushing 31 is mounted in the opening 24 for the journalled reception of the shaft 23, said bushing being preferably long enough to provide the primary bearing for supporting the shaft for rotation about a fixed axis. Means are preferably provided for sealing the aforesaid shaft bearing against the escape of fluid therealong; as shown, a gland ring 32 threadedly engages the outer end of the bore of the boss 26 and the opposed bushing end is spaced from the gland to provide a space for soft packing 33.

The hub 16 is preferably of cylindrical outline as shown, and is axially longer than the chamber 12, one end of the hub being rotatably engaged in an opposed counterbore portion of the opening 24 of the casing section 13 while the other end rotatably engages the bore of the opening 25 of the casing section 14. The end face of the hub portion fitting the opening 25 is

arranged to bearably engage the inner end of the coupling sleeve 28; it is noted, however, that when the pump is operating, the thrust of inflowing fluid is arranged to shift the rotor axially to prevent an actual bearing engagement of these members, a slight axial freedom being allowed the rotor for the purpose. Preferably, more clearance is allowed between the inner end of the counterbore and the opposed hub end than is necessary to provide the aforesaid axial freedom, and the bushing 31 terminates at the counterbore end; in this manner, an annular space 35 is defined about the shaft 23, at the inner end of the counterbore. As shown, passages 36 lead from the hub bore face 19 to the hub end within the counterbore whereby the effective pressure of incoming fluid to create an end thrust on the rotor is minimized. The hub is preferably formed of a relatively soft metal such as brass or bronze.

It will now be noted that suitable thrust bearings might be operatively disposed in the space 35 for taking up the operating end thrust referred to. In the present instance, however, it is preferred to provide anti-friction bearings for resisting said thrust externally of the pump structure, whereby said structure is simplified. As particularly disclosed in Figure 8, the shaft 23 is connected in end-to-end relation to the shaft 37 of an electric motor 38 by means of a coupling 39 whereby the motor bearings (not shown) are arranged to take up said end thrust. The coupling 39, it is noted, is of a special structure, and will be hereinafter described in detail.

Referring now to the arm 21, it is seen that the axial width thereof is very much less than the axial width of the chamber whereby the arm does not partition the chamber 12 as do the impeller blades of centrifugal pumps generally. In fact, it is desired that the arm 21 act to a minimum extent for effecting a rotative circulation of fluid in the chamber 12, and the sectional outline of said arm transversely thereof is accordingly of streamline or air-foil shape throughout its length; an external end view of the arm is disclosed in Figure 5. To further minimize the fluid circulating effect of the arm 21, the latter may also taper toward its tip, and the passage through the arm 21 is of similar form to the arm exterior whereby the arm may be of minimum size for a passage of given discharge capacity. In view of the foregoing, the arm 21 is seen to constitute a radial centrifuging tube rather than an impeller.

The rotor 15 is arranged to be operated at not less than about three thousand revolutions per minute and enough clearance should be provided between the arm 21 and the chamber walls to minimize frictional drag whereby the fluid in the chamber is arranged to acquire a relatively slow circulation rate and the frictional resistance to the rotor rotation is primarily the friction of the arm 21 in the fluid in the chamber which has been minimized by the use of the streamline arm structure described and shown. The exact streamline section of the arm 21 is of course determined by such factors as the operating speed of the rotor, the clearance allowed the arm, and the density and viscosity of the fluid to be pumped; the present specific showing is accordingly intended as merely illustrative. In the interest of minimizing the resistance to the rotation of the rotor, but one arm 21 is provided therein, and said arm is counterbalanced by means of an integral radial extension 41 of the hub 16 whereby rotor vibration is avoided at the high operative speeds for which the pump is particularly designed.

As particularly disclosed, the opposed chamber end walls are conically concave and terminate at their outer edges in a trough 42 opening radially inwardly and lying in the plane of rotation of the arm 21. The trough 42 is seen to be of substantially semi-circular cross-section and its diameter is substantially that at the mouth of the discharge port 22. In this manner, the proper spacing of the arm 21 from the casing walls is provided and a race-way for the outside portion of the fluid stream in the casing is provided for guiding the fluid into the port 22 at the chamber periphery.

Referring now to the discharge port 22, it is seen that said port is in the form of a Venturi orifice having its throat at its inner end. Preferably, and as shown, the port 22 is directed tangentially from the chamber trough 42 and its Venturi portion is provided entirely within the limits of the casing section 13. The port 22 is proportioned in accordance with well known principles so that the velocity-head of liquid entering the same is reduced and the static pressure is correspondingly increased whereby to increase the effective discharge pressure from the pump. The throat of the port is of less section than the outlet at the extremity of the arm whereby to create a discharge pressure in the chamber 12; as particularly shown, the ratio of these openings is substantially one to two, this ratio having been determined as a most satisfactory one when the tubular centrifuging arm 21 is in use in the casing. The port 22 is seen to terminate in a boss 43 for connection to a discharge pipe 44.

In Figures 6 and 7, views are shown of an alternative rotor 61 for mounting in the casing chamber 12. The hub 62 of this rotor is seen to be formed generally as before, but the centrifuging passages are defined between axially separated plates 63 having a plurality of radial and axial partitions dividing the space between them into discharge passages 64, the hub being radially perforated at the inner end of said passages to supply the fluid from within its axial bore 65. Additional tie partitions 66 secure the plates 63 together adjacent their peripheries at the outer ends of the passages 64. The rotor 61 is similar in outline to the chamber 12 but is considerably smaller than said chamber whereby it is arranged to be freely rotated in the chamber space and is not an impeller with respect to the fluid therein. For a discharge port 22 of given size, the rotor 61 will require more power for driving it at a given speed than will the previously described rotor, but will create a greater discharge pressure or deliver more fluid at such speed, it being noted that the pressures attainable with either form of rotor, is very much greater than that attainable by single-stage pumps now generally used.

The pump now described will effectively pump gases, but the use for which it has been particularly designed is in connection with domestic water systems for discharging water under pressure, a typical installation being disclosed in Figure 8. As particularly shown, the pump 11 is mounted on a fluid tank 81 and the pipe 29 is connected with a source of water, as a shallow well (not shown); said pipe having an automatic one-way valve 82 interposed therein. The discharge pipe 44 runs to a delivery system of piping, said system being here shown represented by one faucet 83 thereof. A branch pipe 84 con-

nects the pipe 44 with the bottom of the tank 81 and a breather valve 85 is interposed in the pipe 84. As is particularly shown in Figure 10, the valve 85 is arranged to operate to admit air to the pipe 84 only when water is moving toward the tank at a rapid rate, said valve including a Venturi orifice 86 into which a branch passage 87 leads, the latter passage being controlled by a gravity seated ball valve 88. The operation of the motor 38 is arranged to be controlled through a pressure operated switch mechanism 89, said mechanism being connected to the top of the tank cavity by a conduit 91; the tank cavity, it is noted, will always contain air at the top thereof.

With the faucet 83 open, the motor 38 will operate the pump, to effect a constant discharge of water at the faucet. If, now, the faucet 83 be closed, the continued operation of the motor will build up the pressure in the system and water will be forced through the pipe 84 into the tank 81 to increase the air pressure therein and finally, through the pressure-operated switch 89, shut off the motor. If the said flow of water through the pipe 84 be rapid enough, some air will be entrained thereby from the breather valve for delivery in the tank 81; in this manner, the quantity of air in the tank is arranged to be kept constant. If the faucet 83 be again opened the expansion of air in the tank 81 will start the water flow from the faucet and the lower pressure will permit the motor switch to close the motor circuit whereby the original condition in the system will be restored.

In an installation such as that shown, a direct connection of the pump shaft 23 with the motor shaft 37 would require an exact axial alignment of these shafts and so involve a high degree of accuracy in mounting the motor in cooperative relation to the pump; by the use of the coupling 39, however, said alignment need be only approximate. By reference to Figures 8 and 9, it is seen that the coupling 39 comprises yoke blocks 91 and 92 set on the opposed ends of the respective shafts 23 and 37 and each carrying a block 93 pivoted between its arms. An intermediate floating block 94 is provided, said block providing yokes at opposite ends thereof between the arms of which the blocks 93 are pivoted for movement about axes intersecting and perpendicular to their pivotal axes in the blocks 91 and 92. The coupling 39 thus provided permits both an angular and offset relation of the shafts while coupled thereby. In connecting the shafts with the coupling, the pump rotor hub would be disposed against the pipe coupling sleeve 28 and the yoke blocks 91 and 92 then set to the respective shafts. When installed, the coupling 39 is of constant length longitudinally thereof whereby the end thrust of the rotor previously referred to is transmitted to the motor bearings as has hereinbefore been brought out.

From the foregoing description taken in connection with the accompanying drawings, the advantages of the construction and method of operation will be readily understood by those skilled in the art to which the invention appertains, and while I have described the principle of operation, together with the device which I now consider to be the best embodiment thereof, I desire to have it understood that the device shown is merely illustrative, and that such changes may be made, when desired, as fall within the scope of the appended claim.

Having thus described my invention, I claim as new and desire to secure by Letters Patent of the United States the following:

In a centrifugal pump, a casing defining an annular chamber having an outlet port directed tangentially from the periphery thereof, a rotor freely rotatable through the fluid in said chamber and arranged to centrifugally discharge fluid into the chamber through a radial discharge passage thereof for building up a liquid pressure at the chamber periphery, said outlet port comprising a Venturi orifice with the throat thereof at its inner end and in the plane of discharge of said passage, the cross-section at said throat being less than the smallest cross-section in said passage and said smallest passage cross-section being at the discharge end of the passage.

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