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SELF-PRIMING PUMPING APPARATUS

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2 Sheets-Sheet 1

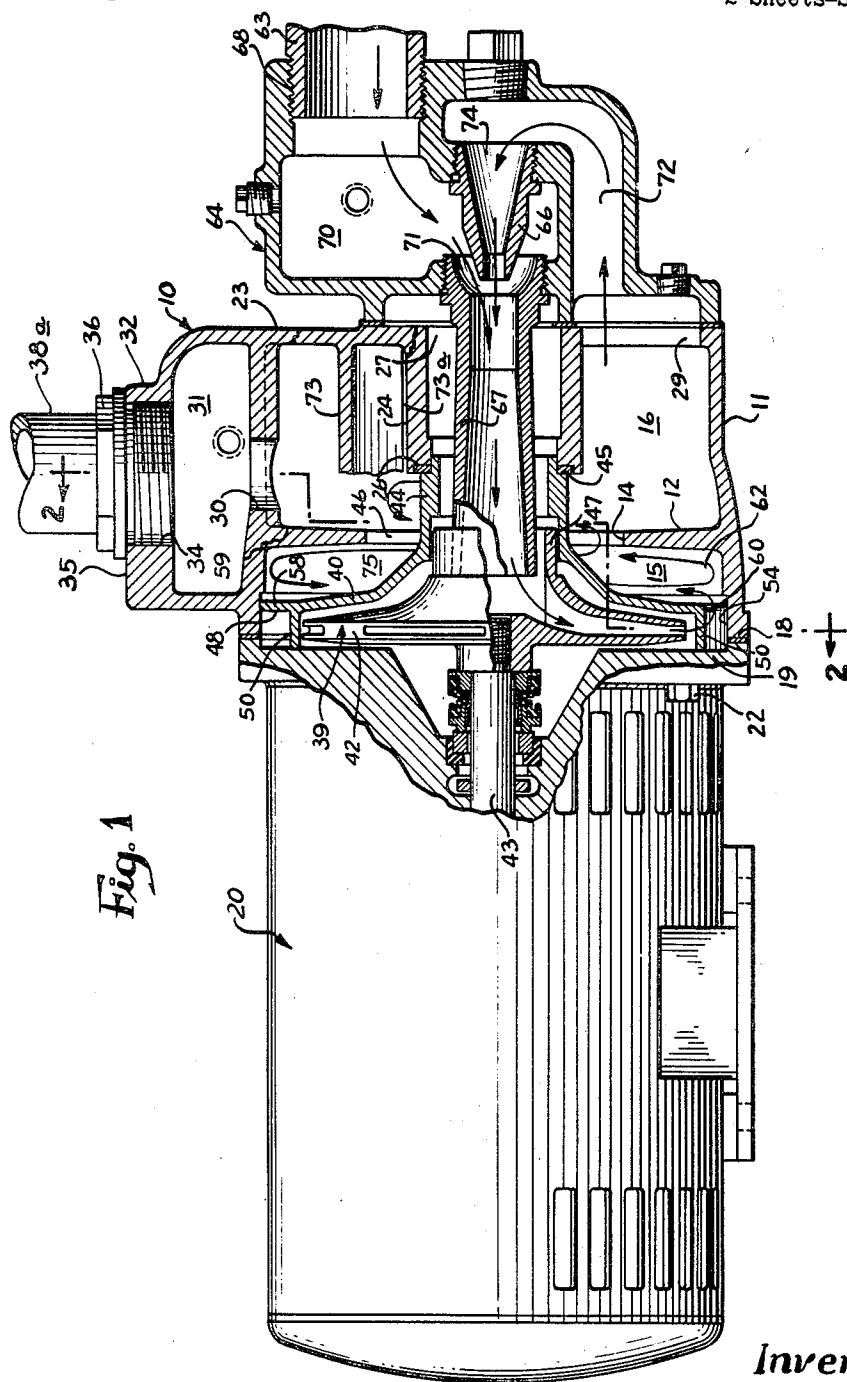


Fig. 1

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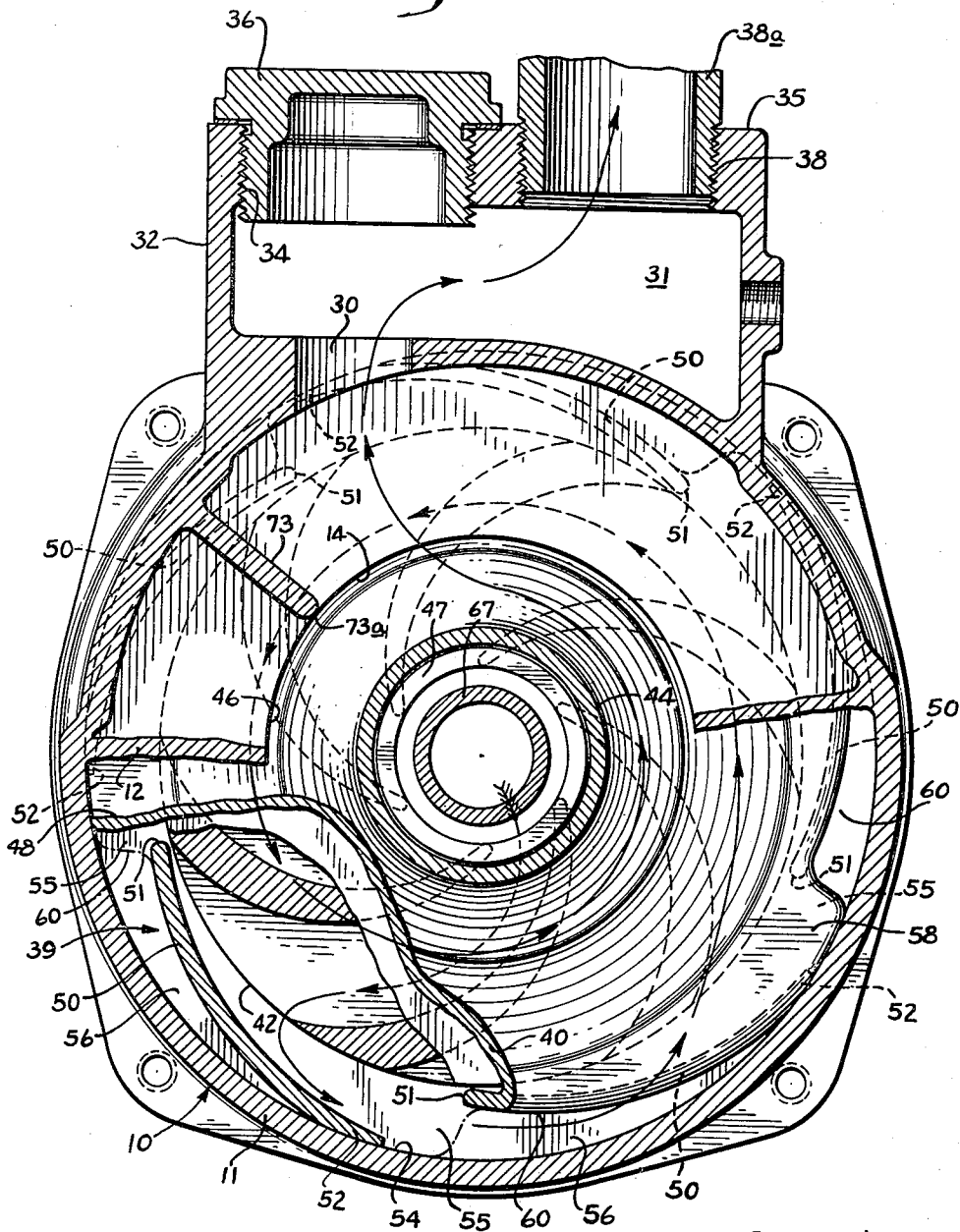
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Fig. 2



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SELF-PRIMING PUMPING APPARATUS

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This invention relates to improvements in fluid pumping apparatus, and more particularly to an improved self-priming pump characterized by an effective and rapid priming function, with continuous removal of air and gases from the apparatus.

An object of the invention is to provide improved pumping apparatus including a pressure pump unit which may be of the centrifugal type, wherein the apparatus embodies novel and effective means for causing separation of air and other gaseous particles from the fluid or liquid in discharge from the pump unit, and the removal or evacuation of the separated air and gas.

Another object is to provide improved pumping apparatus including a centrifugal pump unit, which is constructed and arranged to establish displacement of the liquid in discharge from the pump unit, in a circular or annular path wherein air separation takes place with the separated air collecting toward the central or axial region of the path, and to provide a pressure chamber receiving the separated air together with liquid from such central region of the aforesaid path and wherein separation of residual air takes place, the chamber having an outlet for the discharge of separated air together with liquid.

A further object is to provide improved pumping apparatus of the character stated in the foregoing objects, which includes a jet pump energized by air-free liquid under pressure from the pressure chamber, and associated with the suction conduit means delivering liquid to the pump unit from a well or other source.

A still further object is to provide improved pumping apparatus of the character indicated, which provides a first chamber of circular form and associated with a centrifugal pump unit such as to receive the pump discharge in the outer or peripheral region of the chamber, with a component of such discharge directed tangentially of the chamber whereby rotary displacement of the discharge liquid occurs in the chamber in such degree as to tend to produce a vortex-forming displacement thereof, such vortex displacement resulting in air separation from the liquid and displacement of the separated air toward the central or eye region of the vortex; the apparatus providing further, a second or pressure chamber arranged to receive the separated air and liquid from the vortex eye region in the first chamber and wherein separation of residual air in the liquid takes place, a main discharge outlet through which the separated air together with liquid passes, and suction conduit means for supplying liquid to the pump unit from a source of supply, wherein the suction conduit means includes a jet pump which is energized by air-free liquid taken from a lower region of the second chamber.

Other objects and advantages of the present invention will appear from the following description of a preferred embodiment thereof, as illustrated in the accompanying drawing, wherein:

Fig. 1 is a view in longitudinal sectional elevation, of a preferred form of the pumping apparatus according to the present invention (the view being taken such as to

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show, in part, a chamber baffle constituting one of the features of the present invention) and

Fig. 2 is a view thereof in transverse section as taken along the line 2—2 in Fig. 1.

The word "air" in such terms as "separation of air," "separated air" and the like as employed herein and in the appended claims, is to be understood as meaning not only air alone, but also other gaseous and vaporous matter which may be contained in the liquid handled by the present pumping apparatus or otherwise entering the apparatus.

Referring to the preferred embodiment as shown by Figs. 1 and 2, 10 is a housing or casing which may be a unitary casting providing a circumferential wall 11, an interior transverse wall element 12 centrally apertured at 14 and dividing the casing interior into separate chambers 15 and 16. Chamber 15 is the first or vortex chamber (hereinafter to be explained) which is of circular form, and has its otherwise open end 18 closed by the end wall 19 of an electric motor or other power device indicated generally at 20, provided for operating the pump unit of the apparatus. The casing 10 preferably is carried by the motor, in supported connection to end wall 19 as through mounting bolts 22.

The second chamber 16 which may be of generally circular form is shown as having a somewhat larger volume than that of chamber 15. The end wall 23 of this chamber is formed to provide an inwardly directed tubular extension or member 24 open at its inner end 26 and opening at 27 through the wall. Below member 24, the wall 23 has an opening or port 29 to the lower or bottom region of the chamber 16, as for a purpose to appear. In the casing wall 11 is a port 30 communicating the upper or top zone of the chamber 16 with a discharge chamber 31 formed by casing extension 32. Port 30 preferably is in axial alignment with an opening 34 in the top wall 35 of casing extension 32, opening 34 serving as a priming filler opening and normally being closed by a removable plug or cap 36, as shown in Fig. 2. Also in top wall 35 is a second opening 38 (Fig. 2) through which the discharge of the pumping apparatus passes, as through a conduit system (not shown) including pipe 38a in connection to opening 38, to service or other use.

Located in chamber 15 is a pressure pump unit 39, shown as a centrifugal type pump, having a unitary pump casing and outlet diffuser member 40 and a pump impeller 42 preferably of shrouded type, the impeller being in driven support on the shaft 43 of motor 20. Member 40 provides an axial inlet hub portion 44 which extends centrally through the aperture 14 of casing wall 12 to a lapped fit connection with the end 26 of casing extension 24, such connection being sealed as by a seal ring or gasket 45 of suitable sealing material. Hub portion 44 in extension through wall aperture 14, defines with the margin of aperture 14 an annular port 46 communicating the central regions of the chambers 15 and 16. Moreover, the axial inlet or suction eye portion 47 of the impeller has a running fit in the pump case hub 44, as shown in Fig. 1.

The diffuser portion 48 of pump casing 40 provides curved wall elements 50 (Fig. 2) peripherally overlying the impeller 42, each such wall element extending from a point 51 near the impeller periphery to engagement at its end 52 with the circumferential wall portion 54 of chamber 15 at one end thereof, as the motor end of the chamber. The end 52 of each wall element 50 forms with the inner end or point 51 of the next adjacent wall element, a diffuser discharge port 55 which opens to the space 56 between the wall portion 54 and the underlying wall element 50 adjacent such port (Fig. 2). Moreover diffuser portion 48 provides an annular side wall 58 laterally spanning the wall elements 50 and facing the open

area of chamber 15 (Fig. 1), such wall extending radially to abutment at 59 with the wall portion 54 (Fig. 1). Provided in the annular side wall 58 are a plurality of discharge openings or ports 60, one for each of the spaces 56 associated with the diffuser discharge ports 55, opening to the chamber 15 adjacent the outer circular or peripheral region 62 thereof. The character and manner of discharge by the pump unit to chamber 15 through the diffuser and port arrangement above described, will appear presently.

Suitably detachably mounted on the end wall 23 of casing 10 is a suction inlet fitting 64 which, in the present example, is constructed to include a jet pump provided by the nozzle 66 in axial alignment with a venturi tube 67. In mounted condition of the fitting, the venturi tube extends centrally through the wall opening 27, casing extension 24 and pump casing hub 44, to and part way into the suction inlet or eye 47 of the pump impeller 42. The fitting 64 has a threaded opening at 68 for connection with a conduit (not shown except for pipe end 63) leading from a well or other source of fluid supply (not shown), the opening 68 leading to fitting chamber 70 which extends about the jet pump nozzle 66. As shown, the inlet end 71 of jet pump venturi tube 67 is open to fitting chamber 70, while the tip of the nozzle projects part way into the tube inlet. Also, the fitting includes a passage 72 which in the mounted position of the fitting, connects the inlet 74 of the nozzle 66 and the port 29 of chamber 16, for jet pump energizing delivery of pressure liquid from the chamber to the nozzle.

While the fluid entering chamber 16 through port 45 from vortex chamber 15, tends to rotate therein as indicated by the flow arrows in Fig. 2, in order to reduce turbulence in chamber 16 to a minimum the chamber is provided with a baffle wall 73. Baffle 73, as shown in Figs. 1 and 2, extends longitudinally across the chamber and projects from the chamber circumferential wall at the left hand side below the outlet port 30 (Fig. 2) to a straight terminal margin 73a substantially in line with the margin of port 46, or stated otherwise, on a line intersecting the port margin. Such baffle in the position indicated, effectively reduces turbulence and thereby enables effective residual air separation to occur in chamber 16.

The operation of the pumping apparatus now will be described. With the casing chambers 15 and 16 and the pump unit initially liquid-filled (which may be assured by admitting liquid through the priming filler opening 34), the motor 20 is operated to rotate the impeller 42. At starting and in the priming phase, the liquid (as water) in circulation in the pumping apparatus and as drawn thereinto from the suction conduit (not shown) through fitting chamber 70, may and usually does contain air and gaseous particles. Now in the present pumping apparatus, the discharge from the pump impeller 42 is directed by the curved wall elements 50 of the diffuser, somewhat tangentially of the impeller periphery toward and through the diffuser ports 55 into the spaces 56. The liquid under impeller discharge pressure, then passes from the spaces 56 through the ports 60 into the peripheral region of chamber 15, the liquid entering the chamber in the same direction angularly thereinto, as shown by the flow arrows (Fig. 2), such that the chamber-entering flow at each port 60 has a component tangential to the circular periphery of the chamber. This produces and establishes an appreciably rapid rotational displacement of the liquid in chamber 15, tending to result in a swirling or vortex-forming movement of the liquid in the outer or peripheral region of the chamber, as confined thereto by the wall element 12. Chamber 15 then is, and may be referred to as, the vortex chamber wherein due to the vortex-forming displacement of the pump discharge liquid therein, it is found that air separation takes place in very considerable degree. The lighter air separating from the swirling liquid in vortex movement, is forced or tends to collect toward the central or eye region of the vortex,

corresponding to the central region 75 of chamber 15 substantially registering with the annular port 46 in wall 12. As air separation takes place in chamber 15, such separated air together with liquid passes through port 46 into chamber 16. The liquid under pressure in chamber 16 is in a less turbulent condition, as effected in part by the baffle wall 73 positioned as hereinbefore described, so that the separated air readily rises to the upper or top region of the chamber. Moreover, separation of residual air in the liquid takes place in this chamber, with the separated residual air rising to the top of the chamber. The separated air thus attaining the upper region of chamber 16, is removed or evacuated along with pressure discharge of liquid, through the port 30, discharge chamber 31 and opening 38 to and through the service system (not shown) to ultimate discharge.

In the present embodiment, suction supply of liquid to the pump unit from a well or other source through pipe 63 and fitting 64, is assisted by the jet pump. Such pump is energized through nozzle 66 which injects into venturi tube 67, liquid under pressure received from the lower region of chamber 16 (where the liquid is substantially air-free) through port 29 and passage 72. Thus a portion of the pump discharge is recirculated through the pump by way of the jet pump, and this facilitates the function of the pumping apparatus particularly in the priming stage, to assure ultimate substantially complete separation of air from the liquid handled by the apparatus.

It will be appreciated from the foregoing description of structure and operation of the presently improved pumping apparatus, that in the priming stage with the pump unit and chambers 15 and 16 liquid-filled, the liquid is continuously recirculated through the pump unit until substantially all air in such liquid and in the suction supply system is removed in the manner described. Whereupon the pumping apparatus being then primed, is in condition for full suction intake of liquid from the well or other supply source and pressure delivery of liquid at pump capacity through the service system. The jet pump, of course, continues to return pressure liquid from chamber 16 to the pump unit, in normal pumping operation, as to maintain the suction lift to the pump intake.

The present pumping apparatus affords a rapid and effective self-priming function in the priming stage, wherein the time required for producing a full-primed condition is found to be very appreciably shorter than is experienced with comparable self-priming pumps of known and prevailing forms. The improved priming result is here due in marked degree, to the present novel provision of the vortex chamber 15 and its particular functional relation to the pump discharge porting and the chamber 16, and to the turbulence reducing baffle wall 73 in chamber 16. The liquid in pressure discharge by the pump unit, enters the peripheral region of the chamber 15 in a direction having a component tangential to the peripheral chamber wall, which results in a rapid, vortex-forming rotation of the liquid therein. Being a continuous flow both in recirculation in the priming stage and in service delivery from chamber 16 (with part recirculation through the jet pump), the pump discharge is only in relatively momentary vortex rotation in chamber 15 before its passage to chamber 16 and to service. However, it is found that even though such vortex rotation is momentary or of short duration in respect of each increment of the incoming liquid, it is sufficient to result in a desirable high degree of air separation in the chamber 15.

Air separation thus is continuous, with separated air continuously collecting toward the central or eye region of the vortex in chamber 15, and passing with liquid through port 46 into chamber 16 for ultimate removal in the manner described. Since the separation process is continuous not only in the priming stage, but throughout operation of the pumping apparatus, any air which is entrained or contained in the incoming suction liquid during normal pump operation will be separated and re-

moved in like manner. Also, it is to be noted that liquid energizing supply to the jet pump nozzle 66, is taken from the bottom region of chamber 16 wherein the pressure liquid is substantially air-free. This, as is known, facilitates efficient functioning of the jet pump.

Having now described the present invention in connection with a preferred embodiment thereof, as illustrated in the drawing, it will be understood that such embodiment is not to be limited to the details shown, but is capable of modification and variation within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A pumping apparatus comprising, in combination, a first air separation chamber having a generally circular periphery, a second air separation chamber having a main discharge outlet, the chambers including a common chamber separating wall having a central opening, a pressure pump in said first chamber and having pressure fluid discharge outlet means open to said first chamber in the peripheral region thereof, said pump having a suction inlet hub portion extending through said wall opening and cooperating with the opening-defining margin of the wall to form an annular port providing the discharge outlet from said first chamber to said second chamber, and means for delivering fluid from a source of supply and from said second chamber to said suction inlet of the pressure pump.

2. A pumping apparatus comprising, in combination, a first air separation chamber having a generally circular periphery, a second air separation chamber having a main discharge outlet in the upper region thereof, a baffle in the second chamber in the peripheral region thereof below said outlet, a pressure pump in said first chamber and having a suction inlet hub portion, said pump providing pressure fluid outlet means opening into the first chamber in the peripheral region thereof, said chambers including a common chamber-separating wall cooperating with said pump suction inlet hub portion to form an annular port about the hub portion, providing the discharge outlet from said first chamber to said second chamber, and means for delivering fluid from a source of supply to said suction inlet hub portion of the pressure pump.

3. A pumping apparatus comprising, in combination a first air separation chamber having a generally circular periphery, a second air separation chamber having a main discharge outlet, a pressure pump in said first chamber having a suction inlet hub portion extending in the central region of the first chamber and into said second chamber, said pump providing pressure fluid discharge outlet means opening into the first chamber in the peripheral region thereof, said chambers including a common chamber-separating wall cooperating with said pump suction inlet hub portion to form an annular port about the hub portion, providing the discharge outlet from said first chamber to said second chamber, suction conduit means including a jet pump having a nozzle, extending in said second chamber to connection with said pressure pump suction inlet hub portion, and a fluid flow connection between said second chamber and said jet pump nozzle.

4. A pumping apparatus comprising, in combination, casing means providing a first circular chamber, a sec-

ond circular chamber and a separating wall between the chambers, said wall having a central circular margin defining an opening centrally therein, a pressure pump in the first chamber and having pressure fluid discharge outlet means open to said first circular chamber in the peripheral region thereof, said pump having a suction inlet hub portion extending through said opening and cooperating with said central circular margin of said wall to define an annular port constituting the discharge outlet from said first circular chamber to said second circular chamber, suction conduit means including a jet pump having a nozzle, extending in said second circular chamber to connection with said pressure pump suction inlet hub portion, said casing having main and auxiliary outlets from said second circular chamber, and means connecting said auxiliary outlet to said nozzle of the jet pump.

5. A pumping apparatus comprising, in combination, casing means providing first and second air separation chambers of generally circular form about a common horizontal axis, and a vertical separating wall between the chambers, said wall having a circular opening centrally therein for communicating said chambers, a pressure pump in said first chamber, said pump including a pump housing having a suction inlet hub extending through said wall opening and discharge port means opening to the first chamber in the peripheral region thereof, and a rotary impeller in the housing having a suction inlet in said housing hub, said casing means providing a tubular member in said second chamber opening through a wall of the latter and having its inner end connected to said hub of the pump housing, suction conduit means for delivering fluid from a source of supply to said suction inlet of the pressure pump impeller, said suction conduit means including a jet pump having a tube element extending through said tubular member and said housing inlet hub to said suction inlet of the rotary impeller, and a nozzle in alignment with said tube element, said casing means providing main and auxiliary discharge outlets from said second chamber, and means connecting said auxiliary discharge outlet to said jet pump nozzle.

6. A pumping apparatus according to claim 5, wherein the said second chamber includes a baffle wall extending longitudinally in the chamber near the said main discharge outlet from the second chamber.

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