May 7, 1968 R. LUHMANN ETAL 3,381,621

SELF-PRIMING PUMP

Filed Aug. 2, 1966 4 Sheets-Sheet 1

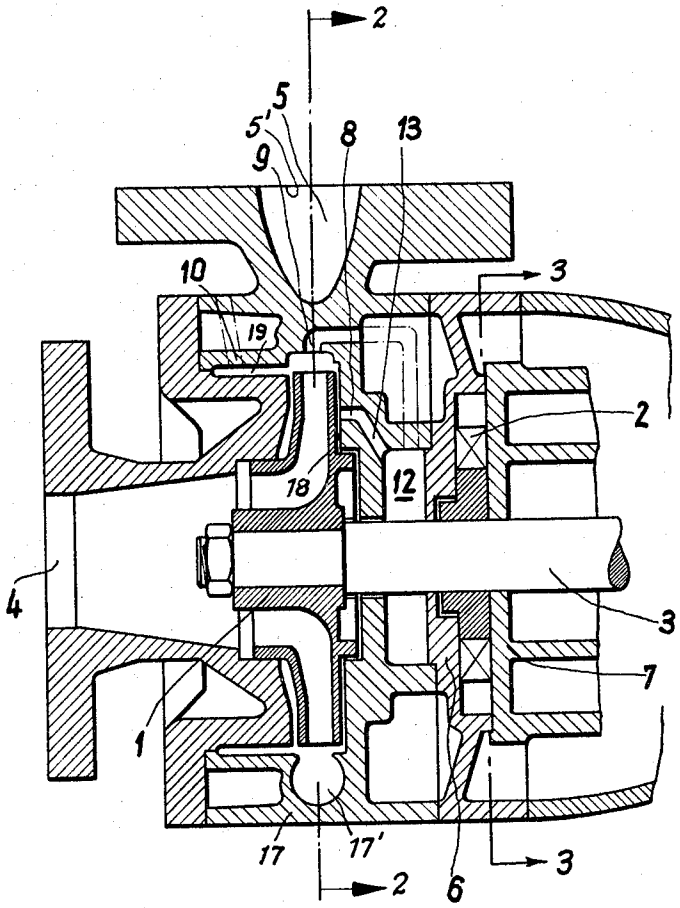

Fig. 1

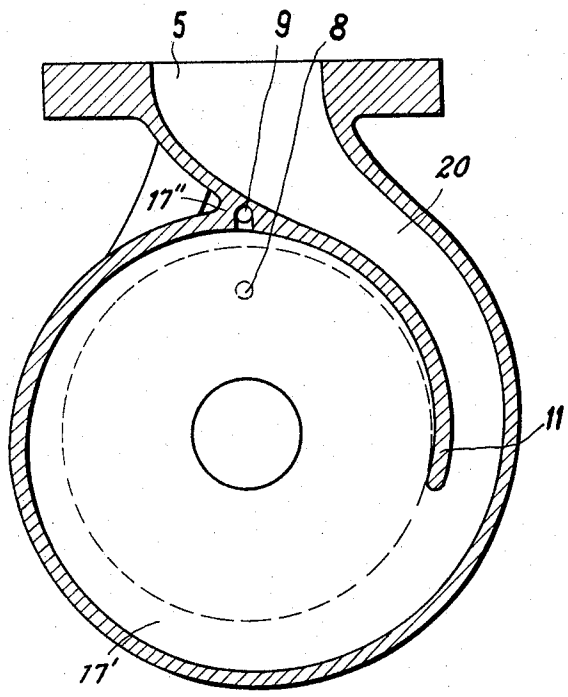

Fig. 2

SELF-PRIMING PUMP

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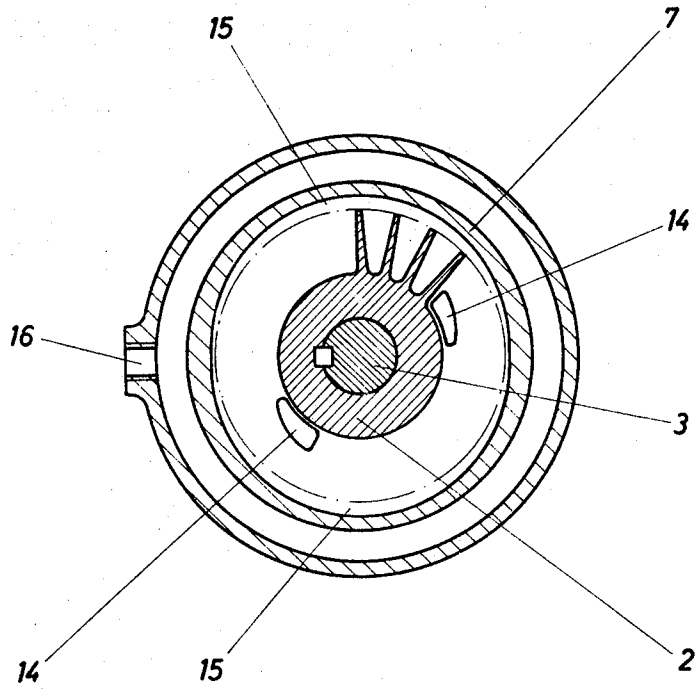

Fig. 3

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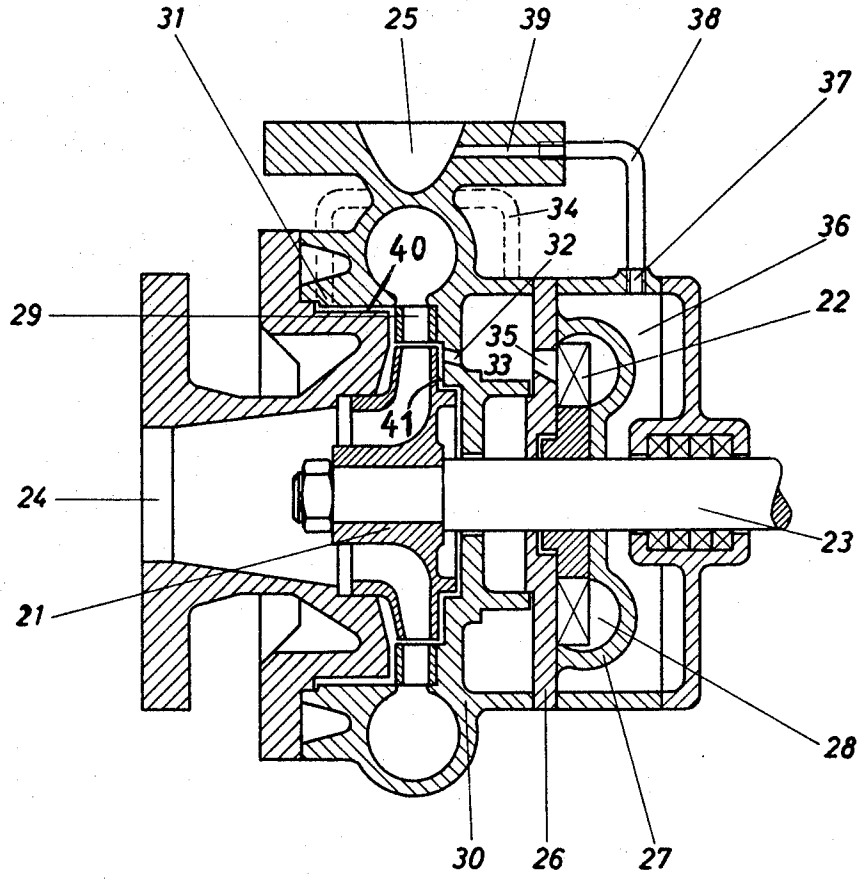

Fig. 4

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SELF-PRIMING PUMP

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This invention relates to a self-priming centrifugal pump with at least one full-admission, normal priming stage and one self-priming venting stage lying outside the impelling flow.

Pumps of this kind are already known in the most varied forms of construction, but there have always been difficulties with the arrangement of the self-priming stage in relation to the full-admission stage or stages. Here it is primarily a question of the problem of shifting from the self-priming stage to the other stage or stages and inter alia of the problem of gas suction or of the problem of the point at which the gas drawn-off from the self-priming stage should be impelled further.

It is known, for example, to arrange the self-priming stage on the suction side of the pump and the gas or air being drawn off from the suction chamber of the particular first full-admission impeller. The gas or air sucked from the self-priming stage can be impelled back into the suction vessel or can flow to atmosphere or into the pressure chamber of the pump or into any suitable chamber in the pump. With the first construction a separate pipe must be provided to lead from the venting stage to the suction vessel and during the flow of liquid this stage sucks liquid from the suction vessel and impels it back therethrough. With discharge into atmosphere the outlet aperture should be provided with a valve, which during the flow of liquid prevents the escape of liquid impelled from the self-priming stage into the atmosphere. In this case the self-priming stage would be filled with liquid after venting of the suction pipe and always travels against the closed pressure side. With the third possibility, drawn-off air or the gas sucked out of the suction pipe to be impelled into the pressure pipe of the pump, or at another suitable point of the pump it can happen that with normal liquid flow the pressure head of the full-admission stage or stages is so large, that the self-priming stage can no longer overcome this pressure drop and flows through opposite to its normal direction of flow, therefore an active current is formed which unnecessarily loads the self-priming stage even further.

Further known constructions provide that the self-priming stage is arranged on the pressure side of the pump instead of on the suction side and is connected in parallel with the particular last full-admission impeller. The air or gas would then be sucked out of the pump and suction pipe from the suction chamber of the last full-admission impeller and again led back at any desired point—as already mentioned above. A favourable circumstance provided by this arrangement is the possibility of sucking the air or gas through the compensation bores of the particular last full admission impeller into the gas-impelling stage. The difficulties and problems with regard to passing on the drawn-off gas are the same however as with a pump in which the gas-impelling stage is arranged on the suction side.

A further disadvantage of these constructions is that the venting of the suction pipe, especially with pumps having the venting stage on the suction side and with one-stage pumps, takes a very long time and the flow of the liquid impelled by the pump at first begins only intermittently. The liquid sucked in does not fill the whole

pump suction chamber suddenly, it instead enters the pump casing turbulently on account of the movement of the column of liquid in the suction pipe, it first arrives in the self-priming stage and interrupts the flow of gas or air until the flood of liquid has passed through the stage.

In accordance with the invention these disadvantages are now obviated in that the suction of the air from the pump takes place in the case of an impeller pump in the slot chamber lateral to a full-admission impeller, and in the case of a helical casing pump in a slot chamber lateral to a full-admission impeller and/or in the first half (viewed from the rear) of the helical casing of a full-admission impeller.

It has been proved that with this arrangement the liquid first enters fully in the full-admission stage, before the gas or air flow of the venting stage is interrupted by any water turbulence occurring. Moreover the advantage arises here that at the suction point for the gas or air in the slot chamber lateral to the full-admission impeller or in the first half (viewed from the rear) of the helical casing also during the normal liquid flow there exists such a high pressure, that the venting stage can without difficulty impel the drawn-off liquid into the pressure connection member or into the pressure pipe of the pump. The pressure drop from this point to the pressure connection member or to the pressure pipe is so small that it is easily overcome by the venting stage. A return flow through the venting stage, such as would otherwise disadvantageously occur with other constructions, does not take place.

Furthermore it is particularly advantageous if the self-priming stage is formed as a side channel or liquid annulus stage, as this stage is then easily in a position to impel the liquid present after the venting of the suction pipe. In order to compensate for the radial force produced by these stages on the pump shaft, it is recommended to make this self-priming liquid annulus or side channel stage double-acting.

In accordance with a further feature of the invention the passage of liquid from the full-admission stage, from which the air-suction is effected, into the associated pressure chamber, takes place in the lower part of the pressure chamber. This step is therefore advantageous, because then at the end of the helix there is formed a good hydraulic seal with the other parts of the pump and a correspodingly large liquid seal is formed in the flow channel extending from the lower part of the pressure chamber to the pressure connection member as well as in the adjoining part of the pressure pipe.

With a pump made in accordance with the invention it is also easily possible, as already described above, to guide the gas sucked from the slot chamber lateral to the full-admission impeller or the gas sucked in the first half of the helical casing into the pressure chamber or pressure connection member of the full-admission impelling stage, from the slot or helical chamber of which the gas is sucked out. Return flows of liquid with normal liquid flows are not to be feared because of the small difference in pressure between the suction point and the point at which the gas is readmitted into the pressure pipe. Furthermore it has proved advantageous to guide the air or gas being sucked in the pump from the point of suction in the slot chamber or in the helical casing through ducts or simple borings inside ribs which for constructional or hydraulic reasons are required in the pump casing. In this way additional cast-on members in the casing are spared.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 shows a longitudinal cross-section through a base support pump made according to the invention, and illustrates an embodiment in which the full-admission stage includes a volute casing and the venting stage is in the form of a liquid annulus pump.

FIGURE 2 shows a section taken along the line 2—2 in FIGURE 1 through the helical volute casing part of the pump.

FIGURE 3 shows a section taken along line 3—3 in FIG. 1 and illustrates the venting stage of the pump.

FIGURE 4 shows a longitudinal section through a modified base support pump according to the invention, in which the full- admission stage includes a guide wheel or diffusion vane casing and the venting stage is in the form of a side channel pump.

Referring to FIG. 1, a full-admission impeller **1** and a partial-admission impeller **2** of the self-priming liquid annulus stage are supported on a shaft **3**. A suction pipe is attached to a suction connecting member **4** and a pressure pipe is connected to a pressure connection member **5** which has a main outlet opening **5'** therein. The impeller **2** of the self-priming stage rotates between control discs **6** and **7**. Volute or helical casing **17** has an axis disposed in a horizontal plane so that the casing includes an upper portion and a lower portion with respect to this plane.

In accordance with the invention the self-priming stage can suck the gas before the start of the liquid flow out of the suction pipe and suction member **4** and a volute impelling chamber **17'** of the full-admission stage through one or more auxiliary outlet openings or bores **8**, **9** or **10**. The bore **9** is situated in the first half of the helical casing **17** (viewed from the spine **11** in the direction of rotation) the volute chamber **17'** increasing in cross-section (in the direction of rotation of the impeller) from its initial smallest area at the spine **11** towards the main outlet opening **5'**. The bores **8** and **10** are situated in slot chambers **18**, **19** lateral to the full-admission impeller **1** and like the bore **9** are in this embodiment permanently connected to a suction chamber **12** of the self-priming stage. The slot chambers 18, 19 are portions of extensions of the impelling chamber **17'** and are of substantially U-shaped cross-section. The bore **8** opens out into a further bore **13**, which is formed in the helical pump casing and which does not necessitate any special alterations to the pump. The bores **9** and **10** are connected by corresponding pipe guides with the suction chamber **12** of the self-priming stage. If desired, the pipe guide relating to the bore **10** can be arranged outside the pump. As shown in FIG. 2, the auxiliary outlet opening or bore **9** is positioned in an area of the volute or helical casing **17**, in which at any rate the wall thickness is necessarily increased by a rib-like portion **17''** since the casing is a cast part. Here again, no special change in the shape of the volute casing is required to accommodate the auxiliary outlet opening **9**.

As further shown in FIG. 2, the spine-shaped portion 11 of the casing is extended downward so that the transfer of liquid from the volute chamber **17'** to a discharge passage or pressure chamber **20** takes place in the lower part of casing **17**.

As indicated in FIG. 3, the venting stage comprising the impeller **2** is in the form of a double-acting liquid annulus pump. A pair of slots **14** are arranged in the control disc **7** at the delivery side of the pump and serve as the outlet openings for a pair of impelling chambers **15** of the venting stage. A bore **16** is provided for the discharge of air, gas or other fluid delivered by the impeller of the venting stage and to be removed from the pressure chamber thereof.

Referring now to the modified embodiment shown in FIG. 4, impeller **21** of the full-admission stage and impeller **22** of the venting stage are mounted on shaft **23**. In this embodiment, the venting stage is in the form of a side channel pump and the full-admission stage in the form of a guide wheel or diffusion casing pump. The latter stage has a suction connection member **24** and a pressure connection member **25**. The impelling chamber of the venting stage is enclosed by control discs **26** and **27**. The control disc **27** accommodates side channel **28**. Guide wheel or diffusion vane member **29** of the full-admission stage is secured to circular casing **30**.

In accordance with the invention, the venting stage is here again arranged to draw air or gas out of the suction connection and the impelling chamber of the full-admission stage through one or more auxiliary outlet openings or bores **31**, **32** before the delivery of liquid starts. Like the corresponding bores in the first embodiment, the auxiliary outlet openings **31**, **32** are positioned in slot chambers **40**, **41** laterally of the impeller **21** of the full-admission stage. Bore **32** is located in casing **30** and leads directly to suction chamber **33** of the venting stage. Bore **31** may be connected to the suction chamber **33** of the venting stage through an external duct **34** indicated in dotted lines in FIG. 4. Air or gas will be caused to pass from suction chamber **33** of the venting stage through a slot **35** in control disc **26** to the impelling chamber formed by the spaces between the vanes of impeller **22** in conjunction with the side channel **28** and will then pass from the impelling chamber to pressure chamber **36** of the venting stage. Finally, the air or gas drawn from the suction member and impelling chamber of the full-admission stage will be delivered through an opening **37**, a pipe **38** and a bore **39** to the pressure connection member **25** of the full-admission stage, that is, the stage out of the slot chamber or chambers of which the air or gas was drawn.

In both embodiments the hydraulic sealing of the suction side of the pump with respect to the pressure side can be effected by a liquid seal, which forms in the region in which the impelling chamber merges with the discharge passage or pressure connection member. In the case of a volute chamber, the spine **11** (FIG. 2) is drawn downwards to an extent such that sufficient space is left for the formation of a liquid seal below the outlet opening **5'**. It is however also possible to provide a non-return valve on the pump pressure connection member. The sucked-in air or gas must then however be impelled behind the non-return valve into the pressure pipe. Research has shown that the liquid forming a seal in the pressure connection member **5** or **25** and a part of the casing of the full-admission stage, does not reach the points at which in accordance with the invention the bleeder bores **8**, **9**, **10**, **31** or **32** are located, so that the air stage is not hindered in its impelling action by this liquid. The path of the air or aspirated gas sucked out of the pump casing may differ from the path shown in FIG. 4 and other possibilities of guiding this air are mentioned in the foregoing description. In a pump according to the invention there is no danger, during the impelling of the liquid after completion of the venting operation, of the liquid backflowing through the air stage in the reverse direction to the impelling direction, as the drop in pressure between the bores **8**, **9**, **10**, **31** or **32** at which the self-priming stage exerts suction, and the point towards which it is impelling (pressure connection member or adjoining pipe line), is only comparatively small, and can easily be produced from the self-priming stage during the pumping of liquid, even if the latter stage is in the form of a liquid annulus pump.

Here single-stage pumps have been selected as examples of the invention. The invention can however easily be applied even for multistage pumps, in which connection the self-priming stage can be arranged as desired either on the pressure side or on the suction side of the pump.

We claim:

1. In a self-priming centrifugal pump unit, at least one full-admission normal-priming stage having a main outlet opening, an impeller in said full-admission stage for rotation in a predetermined direction to produce a main flow of liquid to be pumped, a volute-type chamber arranged

in said full-admission stage for receiving liquid from said impeller during rotation thereof and connected to said main outlet opening for discharge of liquid, said volute-type chamber increasing in cross-section from its initial smallest area towards its connection with said main outlet opening and having an auxiliary outlet opening therein, a self-priming venting stage disposed outside said main flow of liquid, a suction chamber in said venting stage, and duct means permanently connecting said suction chamber of the venting stage to said auxiliary outlet opening of the full-admission stage for removing air and other gases from said full-admission stage to prime the latter, said auxiliary outlet opening being located in said volute-type chamber in the region extending from said initial smallest area of the volute-type chamber approximately halfway around said impeller in said predetermined direction of rotation thereof.

2. In a self-priming centrifugal pump unit, at least one full-admission normal-priming stage including a volute casing having a spine-shaped internal part terminating in a fluid cut-off end and a main outlet opening, said full-admission stage further including an auxiliary outlet opening and an impeller mounted in said casing for rotation in a predetermined direction to produce a main flow of liquid to be discharged through said main outlet opening; a self-priming venting stage disposed outside said main flow of liquid, a suction chamber in said venting stage; and connecting means extending from said suction chamber of the venting stage to said auxiliary outlet opening of the full-admission stage for removing air from said full-admission stage to prime the latter said auxiliary outlet opening being located in the surface of said spine adjacent the periphery of the impeller in the region extending approximately half way around said impeller in said predetermined direction of rotation from the end of said spine-shaped part.

3. The combination as defined in claim 2, wherein said volute casing has an axis disposed in a substantially horizontal plane and includes an upper portion and a lower portion with respect to said plane, said upper portion having said auxiliary outlet opening therein and said lower portion being connected to said main outlet opening.

4. The combination as defined in claim 2, wherein said self-priming stage is in the form of a double acting liquid annulus pump.

5. In a self-priming centrifugal pump unit, at least one full-admission normal-priming stage including a volute casing having a spine-shaped internal part and a main outlet opening, said full-admission stage further including an impeller mounted in said casing for rotation in a predetermined direction to produce a main flow of liquid to be discharged through said main outlet opening, one portion of said casing extending from said spine-shaped part halfway around said impeller in said predetermined direction of rotation and having an auxiliary outlet opening therein, said casing having ribs for reinforcing said casing and forming partitions therein; a self-priming venting stage disposed outside said main flow of liquid, a suction chamber in said venting stage; and duct means extending from said suction chamber of the venting stage to said auxiliary outlet opening of the full-admission stage for removing air from said full-admission stage to prime the latter, said duct means being disposed at least partially in said ribs of the casing.

6. In a self-priming centrifugal pump unit, a pump casing having ribs for reinforcing said casing and forming partitions therein, at least one full-admission normal-priming stage positioned in said casing and having a main outlet opening, a rotary impeller in said full-admission stage for producing a main flow of liquid to be pumped, an impelling chamber arranged in said full-admission stage for receiving liquid from said impeller during rotation thereof and connected to said main outlet opening for discharge of liquid, said impelling chamber having at least one slot-shaped portion postioned substantially laterally of said impeller, said slot-shaped portion being provided with at least one auxiliary outlet opening for permitting flow of fluid from said impelling chamber through said slot-shaped portion to said auxiliary outlet opening, a self-priming venting stage disposed in said casing outside said main flow of liquid, a suction chamber in said venting stage, and duct means extending from said suction chamber of the venting stage to said auxiliary outlet opening of the full-admission stage for removing air from and priming said full-admission stage, said duct means being disposed at least partially in said ribs of the casing.

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