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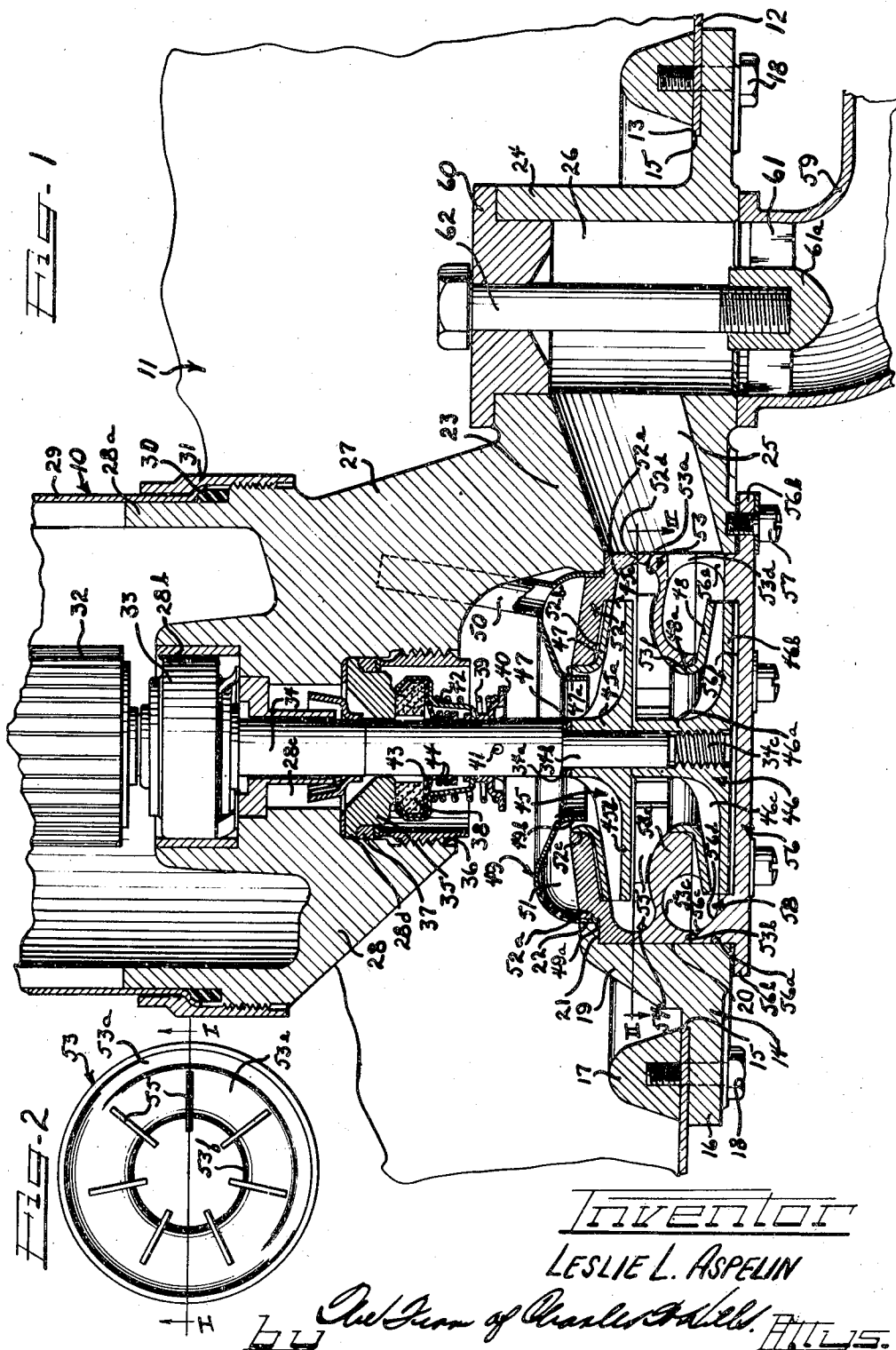
L. L. ASPELIN

2,480,435

MULTISTAGE PUMP

Filed March 9, 1946

2 Sheets-Sheet 1



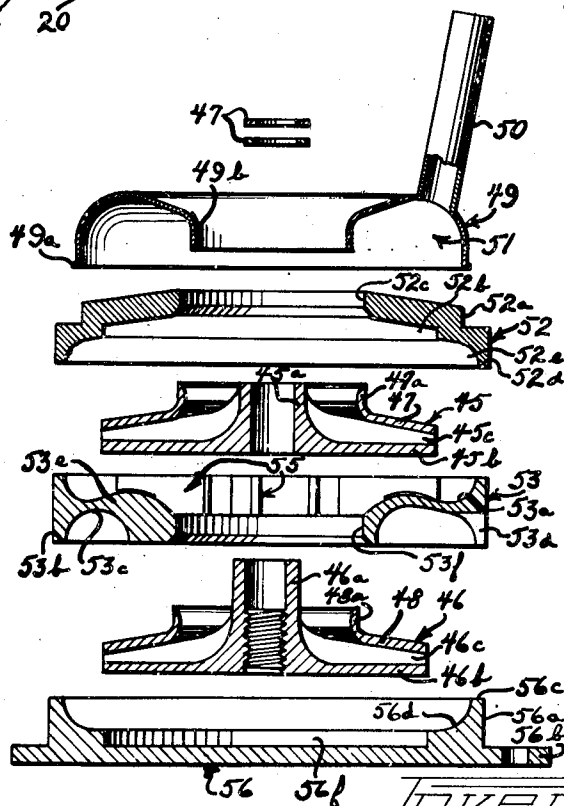
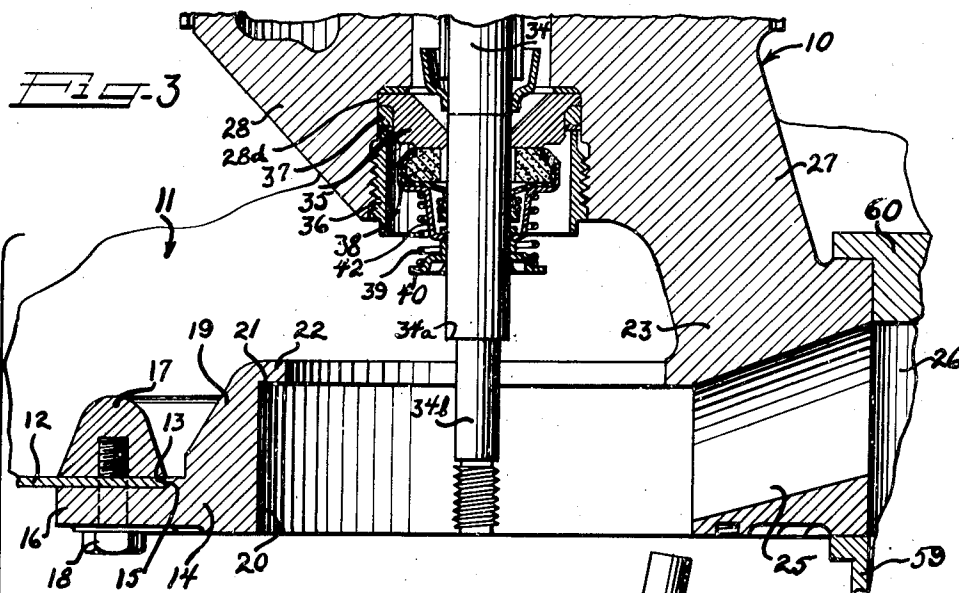
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UNITED STATES PATENT OFFICE

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MULTISTAGE PUMP

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8 Claims. (Cl. 103—113)

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This invention relates to a multi-stage pump construction adapted for mounting on the wall of a tank to be submerged in fluid contained in the tank and having a removable cover cap accessible from outside of the tank for giving access to all of the pumping chambers and impellers of the pump. Specifically the invention deals with a submerged electric motor and multi-stage pump unit having a removable end cap coacting with a shouldered chamber in the main body of the pump for housing and retaining all of the pumping chamber defining portions and impellers of the pump whereby said portions and impellers are readily removable without interfering with the submerged mounting for the unit.

According to this invention a main body member is provided with a base having a mounting flange therearound for attachment to the wall of a tank. The base includes a chamber defining portion adapted to project through an opening in the wall of the tank. A leg projects from the chamber defining portion to carry a motor support. The shaft of a motor on the motor support extends into the chamber defining portion to drive the impellers of the pump. These impellers are surrounded by pump chamber or volute chamber defining rings removably seated in the chamber of the base. An end cap on the base holds the pump chamber defining rings in the base chamber. The base has a discharge passageway extending laterally from the chamber defining portion thereof into an upstanding passageway provided by an open ended boss on the base. One end of the boss is adapted to be closed by a cap and the other end of the boss is adapted to receive a conduit fitting. This conduit fitting can be mounted externally of the tank or inside of the tank as desired since one end of the boss communicates with the outside of the tank and the other end of the boss communicates with the inside of the tank.

A feature of the invention includes the provision of a single ring between two adjacent stages or pumping chambers of the pump for defining portions of both pumping chambers, for providing a communicating passageway between the pumping chambers, and for carrying flow directing vanes to guide the fluid from one pumping chamber to the next pumping chamber. This single ring thus performs a triple function and in addition is readily removable from the chamber of the base member in which it is mounted.

It is then an object of this invention to provide a multi-stage pump and motor unit that is readily mounted on a tank wall to be submerged in

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the contents of the tank and when so mounted has all of the pump parts thereof readily accessible from outside of the tank by removal of an end cap on the main base of the unit.

Another object of the invention is to provide a multi-stage pump having the various stages thereof defined by readily removable rings and wherein an intermediate ring defines portions of the pumping chambers of two adjacent stages.

Another object of the invention is to provide a multistage pump with a main casting having a mounting base with a cylindrical bore extending inwardly from the outer face thereof to an annular flange providing an inlet to the bore and wherein this bore receives removable rings and a closure cap secured to the base for defining the pumping stages of the multi-stage pump.

A further object of this invention is to provide a submerged electric motor driven centrifugal type multi-stage pump having pumping parts readily accessible from outside of a container in which the pump is mounted and having bubble directing means inside of the container coacting with the inlet of the pump for removing bubbles of gas and vapor generated by the pump away from the pump inlet.

Another object of the invention is to provide an improved multi-stage pump having an intermediate ring member carrying radially extending flow directing vanes which overhang the pump impeller of the next adjacent stage of the pump.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of preferred example only illustrate one embodiment of the invention.

On the drawings:

Figure 1 is a vertical cross sectional view of a multi-stage pump and electric motor unit according to this invention mounted on a tank wall and illustrating a ring of the pump along the line I—I of Fig. 2.

Figure 2 is a top plan view of a ring of the pump taken along the line II—II of Fig. 1.

Figure 3 is a fragmentary vertical cross sectional view similar to Fig. 1 but illustrating the manner in which parts of the pump can be removed by removal of an end cap of the unit without disturbing the mounting of the unit on the tank.

As shown on the drawings:

As best shown in Fig. 1 a multi-stage pump and electric motor unit 10 of this invention is mounted in a tank 11 on the apertured bottom wall 12

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thereof and the pump base closes the aperture 13 in the bottom wall 12. The unit 10 includes a base portion 14 having an annular shoulder or pilot 15 therearound for snugly fitting in the aperture 13 of the tank wall 12. A flange 16 on the base 14 underlies the bottom wall 12 of the tank around the aperture 13. A mounting ring 17 is provided in the tank 11 on the bottom wall thereof in surrounding relation to the aperture 13. Cap screws 18 extend through the flange 16 and tank wall 12 to be threaded into the mounting ring 17 for securing the unit 10 to the tank wall.

The base 14 has an annular thickened portion 19 projecting into the tank 11 and defining a cylindrical chamber 20 opening through the bottom of the base 14 and having a shoulder 21 at its upper end provided by an end wall 22 defining an aperture opening into the upper end of the chamber 20. The thickened portion 19 has a laterally extending portion 23 thereon merging with an upstanding tubular boss 24 formed integral with the base 14. The portion 23 has a passageway 25 therethrough joining the chamber 20 with an open ended chamber 26 in the boss 24.

An integral upstanding leg 27 is provided on the portion 23 between the portion 19 and the boss 24. This leg 27 carries a motor support ring 28 in spaced overlapping relation to the thickened portion 19 of the base. It should be understood of course that the base member including the flange, the thickened portion, the boss, the upstanding leg and the motor support ring is a one-piece casting.

A cup-shaped motor casing 29 surrounds an upstanding neck 28a of the ring 28 and is pressed against the seal ring 30 bottomed on the ring 28 by means of a collar 31 which is threaded to the ring 28.

A motor in the casing 29 includes an armature 32 rotatably supported by a bearing such as 33 carried in a well 28b of the support ring 28. A motor shaft 34 depends from the bearing 33 through a passageway 28c in the ring 28 and through an open bottom well 28d in the ring 28. The well 28d receives a seal ring 35 loosely embracing the shaft 34 and fixedly held in the bottom of the well by a threaded sleeve 36 which is threaded into the ring 28 and thrusts against a washer 37 acting on the seal ring 35. A rotating seal ring 38 rides on the stationary ring 35 and is spring urged against the ring 35 by means of a coil spring 39 surrounding the shaft and bottomed on a retainer 40 pinned to the shaft by means of a pin 41 and a cap member 42 surrounding the seal ring 38. A rubber sleeve 43 is sealingly engaged on the shaft 24 by means of locking wires such as 44 and has a diaphragm portion extending over the seal ring 38 and clamped around the periphery of this ring 38 by the cap 42. Leakage along the shaft 34 is thereby effectively stopped by the diaphragm member 43 and by the riding contact of the seal rings 35 and 38.

The motor shaft 34 extends into the chamber 20 of the thickened portion 19 and receives a pair of impellers 45 and 46 thereon.

The motor shaft 34 has a shoulder 34a slightly above the thickened portion 19 of the base 14. A reduced diameter portion 34b extends from the shoulder into the chamber 20. This portion 34b has a threaded end 34c adjacent the bottom of the chamber 20. Shims or spacing washers 47 are bottomed on the shoulder 34a and the

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first impeller 45 has a hub 45a embracing the reduced diameter portion 34b of the shaft and bottomed on the shims or spacing washers 47. A flat disk portion 45b radiates from the hub 45a of the impeller 45 and upstanding pumping vanes 45c are provided on the top face of the disk portion 45b. These vanes merge into the hub 45a of the impeller.

The second impeller 46 has a hub portion 46a bottomed on the under face of the impeller 45 and threaded on the portion 34c of the shaft. This impeller 46 has a flat disk portion 46b radiating from the hub 46a thereof and pumping vanes 46c are provided on the disk portion 46b. These vanes merge into the hub 46a.

A shroud ring 47 is provided for the impeller 45. This ring 47 is mounted on the radially outward portions of the upstanding vanes 45c and terminates flush with the outer peripheral portion of the disk 45b. The shroud ring 47 has an upstanding annular rim or hub 47a spaced radially outward from the hub 45a of the impeller. The hub 47a defines an inlet to the impeller.

The impeller 46 also has a shroud ring 48 thereon carried by the radially outward portions of the vanes 46c thereon. This shroud ring 48 has an upstanding rim or hub portion 48a spaced radially outward from the hub 46a thereon. The hub 48a defines an inlet to the impeller.

An annular bonnet or cap 49 has an outer side wall extending into the aperture provided by the end flange 22 of the thickened portion 19 together with an outturned rim flange 49a seated in a groove provided in the shoulder 21 of the thickened portion 19. The end cap or bonnet 49 extends beyond the top of the thickened portion 19 and then slopes inwardly to a depending hub or rim 49b extending into the hub or rim flange 47a of the impeller shroud 47. The top of the bonnet 49 carries an upstanding tube or pipe 50 which is positioned alongside of the leg 27 and terminates at a level materially above and outwardly from the thickened portion 19. The cap or bonnet 49 defines a vapor trap chamber 51 which is vented through the pipe or tube 50.

A throat ring 52 is mounted in the chamber 20 and is bottomed on the shoulder 21. The throat ring has a pilot portion 52a extending into the outer side wall of the cap or bonnet 49 to clamp the outer wall of the bonnet against the flange 22 of the thickened portion 19. The throat ring 52 overlies the shroud ring 47 of the impeller 45 and has a recess 52b in its bottom face receiving the shroud ring 47 together with an aperture 52c receiving the rim or hub portion 47a of the shroud ring. The throat ring 52 has close running clearance relation with the shroud ring of the impeller.

The throat ring 52 has a flat bottom wall 52d extending radially inward from the cylindrical side wall of the chamber 20 to an annular recess 52e of rounded contour.

An intermediate ring 53 snugly fitting the chamber 20 is bottomed on the bottom wall 52d of the ring 52 and has a recess 53a in its upper face complementary with the recess 52e of the ring 52 and cooperating therewith to define a whirlpool chamber 54 receiving fluid from the impeller 45. The ring 53 has a flat bottom wall 53b with an annular recess 53c therein. The recess 53c is spiral or scroll shaped. The side wall of the ring 53 aligned with the passage 25 has an opening 53d therethrough joining the recess 53c with the passage 25.

The recesses 53a and 53c of the intermediate

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ring 53 are separated by a partition wall portion 53e of the ring. This portion 53e has a central aperture 53f receiving the hub 48a of the shroud ring 48 therein. The top face of the partition is curved upwardly from the bottom of the recess 53a and thence downwardly to the aperture 53f. The bottom face of the partition wall is flat and flush with the bottom 53b of the ring. The underside of the partition wall of course is recessed to provide the scroll-like chamber 53c.

A plurality of upstanding flow directing vanes 55 are secured on the upper face of the partition wall portion 53e of the ring 54. As shown in Fig. 2, seven radially extending vanes are provided. These vanes have outer peripheral edge portions spaced radially inward from the outer wall of the chamber 54 and have inner peripheral edge portions spaced radially inward from the aperture through the hub 48a of the shroud ring 48. The vanes 55 are effective for directing the whirling liquid in the whirlpool chamber 54 along straight radially inward converging paths which eliminate whirling of the fluid as it enters the hub 48a of the second impeller 46.

The chamber 20 is closed by an end cap 56 which has a cylindrical side wall 56a snugly fitting the bore of the chamber and has a radially extending bottom flange 56b underlying the base 14 around the open bottom mouth of the chamber 20. Cap screws 57 extend through the flange 56b and are threaded into the base 14 to secure the bottom cap 56 in position. Cap 56 has a top edge 56c seated on the bottom edge 53b of the ring 53 and includes a rounded recess portion 56d cooperating with the recess portion 53c of the ring 53 to define a volute or scroll chamber 58 receiving liquid from the second impeller 46. The side wall 56a of the cap 56 is apertured at 56e to mate with the aperture 53d of the ring 53 for joining the scroll or volute chamber 58 with the passageway 25.

The cap 56 is also recessed in its bottom face at 56f to receive the disk portion 46b of the impeller 46.

The open ended passage 26 of the boss 24 receives a conduit fitting 59 on one end thereof and a closure cap 60 on the other end thereof. Conduit fitting 59 has an internal spider 61 carrying an internally threaded boss portion 61a for receiving the threaded end of a bolt 62 which extends through the boss 24 and has a head seated on the cap 60. The bolt clamps the cap 60 and the conduit 59 into sealing engagement with opposite ends of the boss 24 so that fluid from the passage 25 will flow through the passage 26 into the conduit fitting 59. If desired, the conduit fitting 59 could be mounted inside of the tank 11 and the cap 60 could then close the bottom end of the passage 26.

In operation the electric motor drives the shaft 34 to rotate both impellers 45 and 46. Liquid, such as fuel, in the tank 11 flows through the hub or opening provided by the flange 49b of the bonnet 49 into the hub or eye of the impeller shroud ring 47. The pumping vanes 45c of the impeller 45 centrifugally discharge liquid into the whirlpool chamber 54. Bubbles of gas or vapor created by agitation of the fuel due to the rotation of the impeller in the fuel will escape along the gap between the shroud ring 47 and the throat ring 52 into the chamber 51. This chamber 51 receives a high velocity bubble rich stream which would normally form a stream around the inlet mouth of the pump. Chamber 51 however traps off the bubble rich liquid and discharges

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the liquid through the tube 50 at a safe distance away from the pump inlet. As a result normal entrance of liquid into the pump is insured and bubble rich vapor leaking out of the pump is deflected away from the pump inlet. The liquid in the whirlpool chamber 54 is directed radially inward by the vanes 55 to the hub or eye of the second impeller 46. This impeller 46 in turn centrifugally discharges the liquid into the volute chamber 58 from which it flows through the passageway 25 into the passage 26 and thence outwardly from the pump and tank through the conduit fitting 59.

The pumps of this invention are especially useful for supplying a water-alcohol mixture to an injector for the water injection system of an internal combustion engine. The pump will develop sufficiently high pressure for the injection system and at the same time has all of the simplicity and efficiency of a centrifugal type of pump.

As shown in Fig. 3 of the drawings all of the internal pump parts can be removed for repair, inspection or replacement without removing the pump from the tank. The closure cap 56 is merely removed from the base 14, the impeller 46 unscrewed from the motor shaft 34, the separating ring 53 drops out of the chamber 20, the impeller 45 drops off of the shaft 34, and the throat ring 52 and bonnet or cap 49 drops out of the chamber 20. The removal of these impeller rings opens up a clear channel into the tank giving access to the seal parts of the pump and these parts can be replaced without dismantling the pump.

From the above descriptions it will be understood that this invention provides a multi-stage centrifugal type pump which is highly efficient, can be mounted on a tank and submerged in liquid contained in the tank and can have all of the pump parts removed therefrom without disturbing the main tank mounting and without removing the unit from the tank.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A multi-stage centrifugal type pump and motor unit adapted for attachment to a tank wall in submerged relation to liquids contained in the tank which comprises a base portion having an upstanding pilot shoulder adapted for insertion in the aperture of a tank wall, a mounting flange extending radially from said pilot shoulder for underlapping the tank wall, a thickened portion on said base for projecting through the aperture of a tank wall, said thickened portion having an open ended bore therethrough with an intumed end flange on the inner end of the bore, said thickened portion having a laterally extending portion with an upstanding leg thereon and an open ended hollow boss adjacent the leg, said leg carrying an integral motor support ring in spaced relation above the open ended bore of the thickened portion, a removable end cap for said base closing the open end of the bore, rings in said bore defining a series of annular pumping chambers, a motor on said support ring having a shaft extending into said bore, centrifugal impellers on said shaft operating in said pumping chambers, said laterally extending portion having an

aperture therethrough connecting the last pumping chamber with the upstanding boss portion, an end cap on one end of said upstanding boss portion, and a conduit fitting on the other end of the boss portion.

2. A combined electric motor and multi-stage pump unit adapted for submersion in a tank which comprises a mounting base adapted for attachment to a tank wall, said mounting base having an open ended chamber therein, an upstanding leg on the mounting base carrying a motor casing, a motor in said casing having a shaft depending into said chamber, a plurality of centrifugal impellers arranged in tandem on said shaft in said chamber, a plurality of rings in said chamber cooperating to define a series of pumping chambers, an end cap for said chamber closing the outer end of the chamber, and a discharge outlet on said base communicating with the last pumping chamber.

3. A multi-stage submerged type pump which comprises a one-piece casting defining an open ended chamber and having a mounting flange surrounding the chamber adapted for connection to a tank wall together with an upstanding tubular portion in spaced lateral relation from the chamber and joined therewith through a discharge passageway, an upstanding leg portion on the base having a motor support ring on its upper end, a motor carried by said ring having a shaft depending into said chamber, a plurality of impellers on said shaft, and a plurality of superimposed rings in said chamber surrounding said impellers and defining pumping chambers communicating with each other and with said discharge passageway.

4. In a multi-stage pump, the improvement of a one-piece ring between two adjacent stages, said ring having an aperture therethrough joining the two adjacent stages in flow communication, said ring having recessed top and bottom faces of predetermined annular contour between the periphery thereof and the aperture therethrough for defining surfaces of pumping chambers for the successive stages, and vanes carried by said ring in one of the recessed faces thereof and overlying the central aperture therethrough for directing fluid from one pumping stage through said aperture to the next pumping stage.

5. In a multi-stage pump, a base member having a cylindrical bore extending inwardly from one face thereof to an intumed shoulder portion and having a reduced diameter aperture through the other face thereof extending from said intumed shoulder, a bonnet member in said reduced diameter aperture, said bonnet member having a depending rim and annular chamber around said rim, an upstanding vent pipe on said bonnet for venting said annular chamber, a throat ring in said bore bottomed on said shoulder and extending into said bonnet for anchoring the bonnet to the base, said throat ring defining the upper portion of a first pumping stage for the pump, a separating ring in said bore bottomed on said throat ring, said separating ring having a top face cooperating with the throat ring to define the first pumping stage of the pump, said separating ring having a central aperture and a recessed bottom face partially defining the second stage of the pump, an end cap closing said

mouth of the bore and extending into the bore for cooperating with the separating ring to define the second stage of the pump, a motor shaft extending through said aperture of the bonnet and through said throat and separating rings, a first impeller on said shaft arranged for centrifugally discharging fluid received from the aperture of the bonnet, a second impeller on said shaft receiving fluid from the first pumping chamber and discharging said fluid into the second pumping chamber, and said separating ring and said end cap having apertures in the side walls thereof for discharge of fluids from the second pumping chamber.

6. A multi-stage centrifugal pump comprising a housing having a cylindrical bore with an intumed shoulder at one end thereof defining a reduced diameter aperture, a plurality of rings snugly seated in said bore and bottomed on said shoulder, said rings cooperating to define a pump inlet in said reduced diameter aperture and a series of annular pumping chambers in said bore, one of said rings including a closure cap for the mouth of said bore and having a flange underlying the housing, and means extending through said flange securing the closure cap to the housing.

7. In a multi-stage pump the improvement of a housing having an open ended chamber and a plurality of removable rings in said chamber including an inlet throat ring, a separating ring, and a removable end cap ring for closing one end of said chamber, each of said rings having mating recessed faces cooperating to respectively define a whirlpool chamber and a volute chamber in series relation, a pump impeller in said whirlpool chamber, flow directing vanes carried by one of said rings under said pump impeller to direct fluid radially inward from said whirlpool chamber to said volute chamber, and a pump impeller in said volute chamber for centrifugally discharging fluid received from said vanes.

8. A multi-stage pump comprising a housing, a plurality of superimposed removable rings seated in said housing and cooperating to define intercommunicating pumping chambers, the top ring having a central aperture defining a pump inlet, a bonnet seated in said housing and cooperating with said top ring to define a bubbles receiving chamber in communication with said top chamber, a vent extending upwardly from said bubbles chamber, a shaft extending into said housing, and impellers on said shaft arranged in tandem and surrounded by said rings for successively centrifugally discharging fluid into said pumping chambers.

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