United States Patent [19]

Zimmermann

[11] **3,802,804**

[45] **Apr. 9, 1974**

[54] **MAGNETICALLY COUPLED PUMP STRUCTURE**

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[73] Assignee: **March Manufacturing Company,** Skokie, Ill.

[22] Filed: **July 21, 1967**

[21] Appl. No.: **655,109**

[52] **U.S. Cl.** **417/360,** 417/420

[51] **Int. Cl.** **F04b 35/04**

[58] **Field of Search**....... 103/87, 87 M; 230/15 MC; 310/104; 64/28 M; 192/84 PM; 417/420, 360

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[57] **ABSTRACT**

Centrifugal pump apparatus of the magnetically-coupled type suitable for tank mounting and also including improvements in impeller and spindle structures of general application and for use with very hot liquids and corrosive chemicals. A cup-shaped motor mounting bell is provided for insertion, open side out, into a hole in the side of a tank and has a flange attaching to the tank wall. The motor is supported on mounting formations inside of the large well afforded by the bell. A smaller cup-shaped magnet well is formed by recessing inwardly on the bottom of the cup-shaped bell, which is also provided with sealing land closing and sealing with the open side of the pump housing. The driven coupling magnet of the pump fits into the small magnet well which is surrounded by the larger motor-driven magnet in the larger well. The pump impeller and magnet rotate on spindle means supported at both ends and which may be integrally conformed at one end with a part of the pump structure.

3 Claims, 9 Drawing Figures

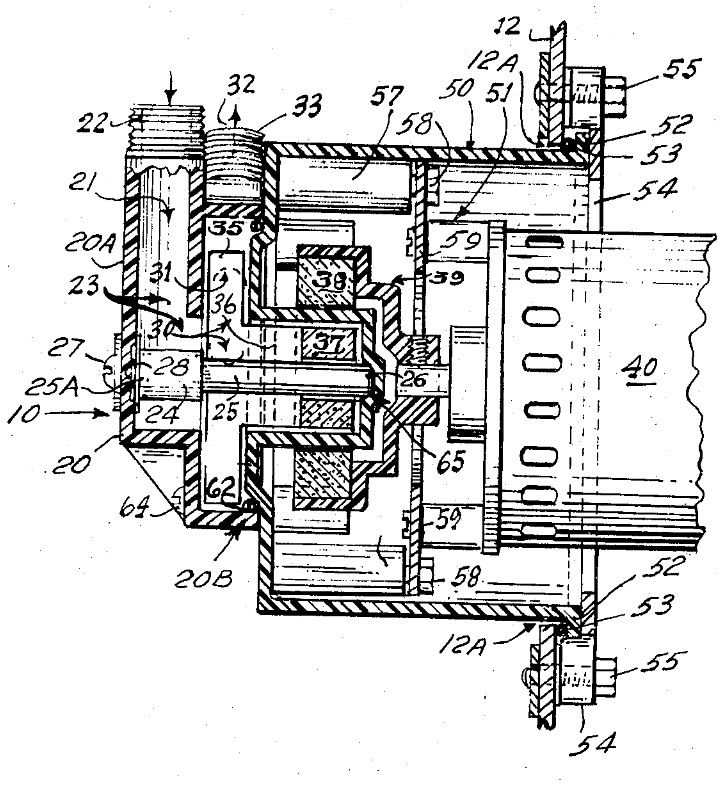


Fig.1.

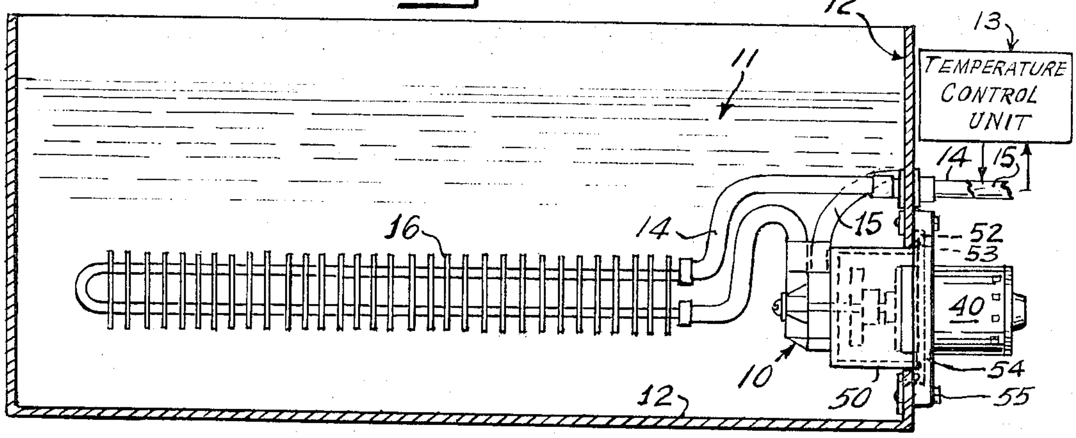
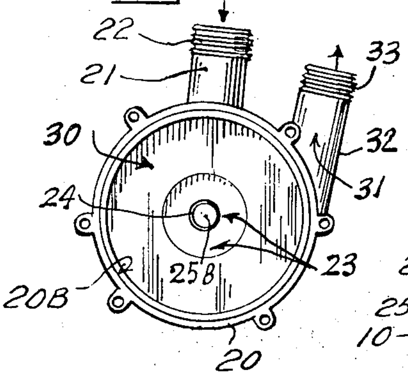


Fig.3.



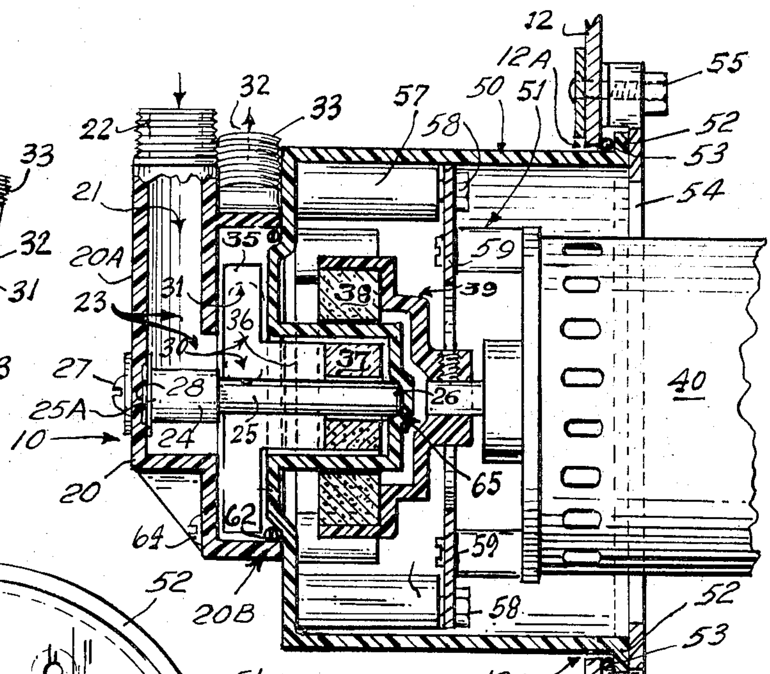


Fig.2.

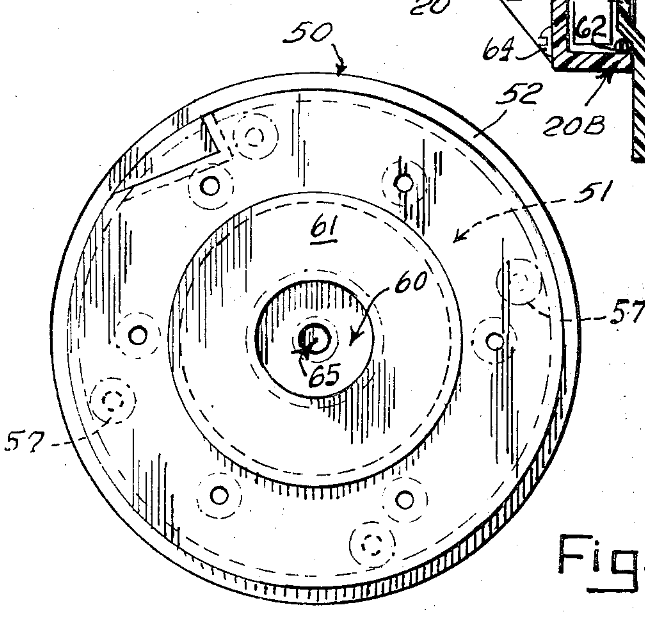


Fig.4.

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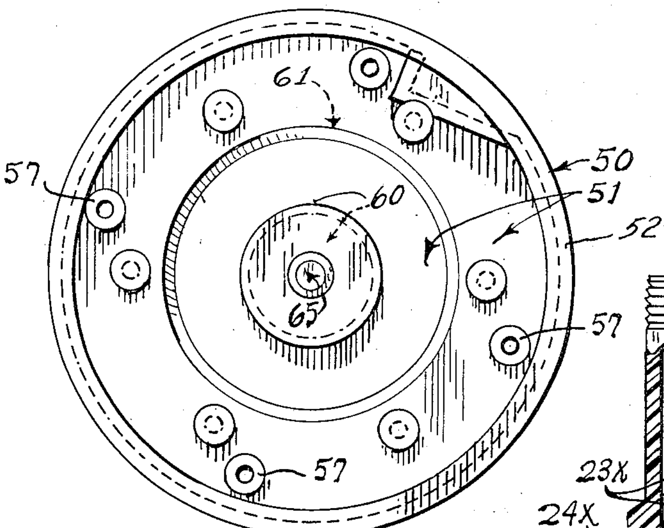

Fig. 5.

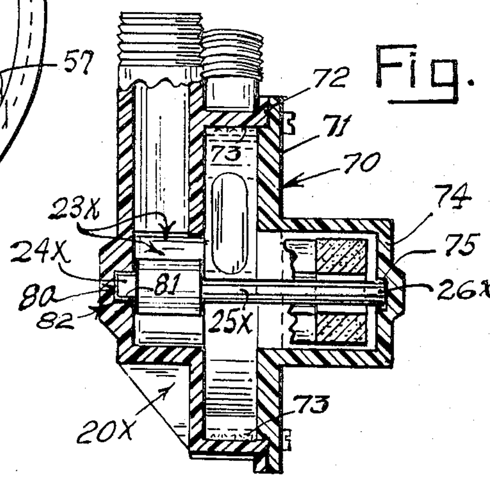

Fig. 6.

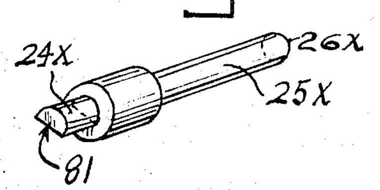

Fig. 7.

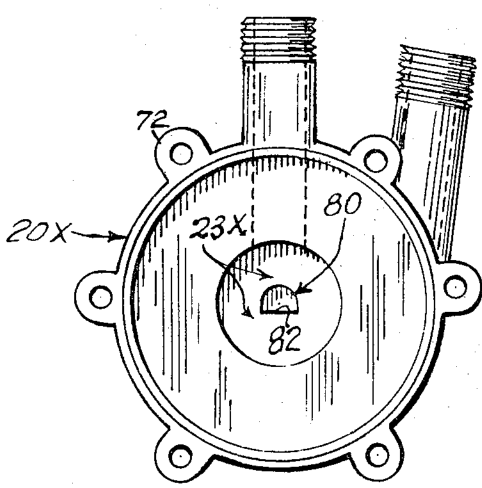

Fig. 8.

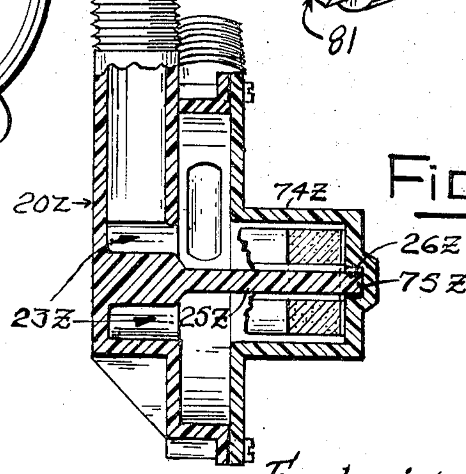

Fig. 9.

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MAGNETICALLY COUPLED PUMP STRUCTURE

This invention relates to improvements in magnetically-coupled pumps of the centrifugal type wherein an impeller is rotated in a sealed chamber by means of concentric ring magnets or the like, one of which is fixed on the impeller hub and the other of which is external to the sealed chamber and driven by motor means.

Because the impeller shaft need not penetrate the sealed chamber, such pumps are free of leakage of the displaced liquid and are commonly used in wholly submerged installations to circulate chemicals and very hot liquids for which purposes the impellers and pump bodies are frequently constructed of molded plastic materials.

The presently-disclosed improvements relate particularly to a type of construction in which the impeller rotates upon a spindle fixed in cantilever fashion at only one end on a wall portion of a pump body which is made in two separable sections, one section constituting a closure for the other. Such a spindle may be integrally formed with the pump body whether the latter be made of metal or non-metallic plastic materials; but extreme working temperatures, particularly in the case of plastic materials, can cause the spindle to skew out of alignment and disable the pump whether the spindle is of the integral type or a separate metallic member fastened to a wall of the pump body.

In order to utilize the advantages of the type of construction described, including especially the internally-supported and isolated spindle means, the invention provides as one of its features that that one of the two body members of the pump housing assembly to which the spindle is not attached shall be provided with means for receiving and supporting the free or unattached end of the spindle when the two body members are fitted together, whereby the alignment of the spindle is fixed.

The present disclosures further utilize and afford improvements in the type of pump body and motor mounting structure described in a copending application Ser. No. 584,171, now abandoned, wherein one of two complementary body members, which in assembly comprise the pump housing, serves as a closure for an open side portion of the other body member and is formed with two axially-aligned but oppositely-opening and mutually sealed-off wells, one of which closes the open side of the other body member and contains the inner or driven coupling magnet, while the outer well contains the driving magnet and supports the motor externally, the present improvement residing in the formation of the outer well with a depth to receive part (or all) of the motor, and the further provision at the rim of this outer or motor-mounting well of a sealing and clamping flange affording a means for mounting the entire assembly in a hole in the side of a tank in which the pump will be submerged while the motor unit will be exposed for access exteriorly of the tank.

In the novel pump structure the pump impeller rotates on a stationary spindle primarily supported at one of its ends on a wall portion of the pump body, and the opposite end thereof removably engages a stabilizing support means, such as a socket or recess formed in a closure member for an opposite open side portion of the pump body to prevent skewing of the spindle, especially in the case of synthetic plastic constructions subject to softening or distortion from extreme temperatures or chemical action in the circulated liquid. Further features are:

1. the closure member includes as part thereof oppositely-opening wells having common imperforate separating wall portions, the driven magnet of the impeller being fitted into one of the wells and the driving magnet and driving motor being contained and supported in the other well;

2. the spindle stabilizing support means for the opposite end of the spindle is a recess formed in the bottom of the appertaining one of the wells;

3. the closure member is in the form of a cylindrical bell housing with the two wells respectively opening into opposite axial ends thereof, and that one of the wells which contains the driving magnet and motor is provided with a mounting flange adapted for clamping and sealing the entire structure in a hole in the side of a tank with the motor unit exposed exteriorly of the tank and the pump submerged in the tank contents;

4. the spindle may be separable from or integral with that one of the pump body members providing the primary support, and has its opposite end removably fitting into an imperforate receptacle or socket formed in the other body member.

The several features above described and other aspects of novelty and utility are more particularly described in the following specification taken in view of the annexed drawings in which:

FIG. 1 is a vertical section through a temperature control tank employing the improved pump structure, parts being shown in elevation and diagrammatically;

FIG. 2 is a vertical sectional detail of the pump structure, parts being shown fragmentally and in elevation to enlarged scale;

FIG. 3 is an elevational detail of the open side of the pump body drawn to reduced scale;

FIG. 4 is an elevational view of the outer face of the pumpmounting bell or housing;

FIG. 4 is a view into the bell from the outer side obverse to that of **FIG. 4**;

FIG. 6 is a cross-section of a pump body, similar to that of **FIG. 2**, showing a modified form of the closure and spindle support;

FIG. 7 is an enlarged perspective detail of the spindle of **FIG. 6**;

FIG. 8 is an elevational view of the pump body of **FIG. 6** at the open side thereof;

FIG. 9 is a sectional detail similar to **FIG. 6** but showing a modified spindle structure.

The improved pump structure is illustrated in **FIG. 1** in conjunction with temperature control apparatus wherein the pump **10** is wholly submerged in a temperature regulating bath **11** contained in a tank **12** for the purpose of circulating a tempering liquid from a source **13** via inlet and outlet ducts **14** and **15** through a heat-exchanging means **16** in order to change the temperature of the bath through a considerable range of **158°** or more, responsive to temperature sensing and control means (not shown) serving among other functions to control the pump motor **40**.

As seen to larger scale in **FIG. 2**, the pump **10** is of a magnetically-coupled type which completely isolates the pumping chamber from an external driving means so that there can be no possible contamination of the tank contents by the circulated tempering liquid as a result of any leakage from the pump spindle.

Such a pump may be of the character disclosed in U.S. Pat. No. Re.26,094 with additional features disclosed in a copending application Ser. No. 584,171, and will comprise a pump body **20** having an inlet passage **21** leading from a port or hose-coupling nipple **22** toward an inlet zone **23** confronting the axis at one end **24** of a fixed spindle **25** supporting a rotary impeller **35.**

The spindle is fixed at one of its ends **25A** on a wall portion **20A** of the pump body in the aforesaid inlet zone, either as an integral part of the body casting or by means such as the screw **27** and recessed O-ring seal **28,** and is thus in effect fixed at one end in a cantilever fashion to project into the pumping chamber with its free end **26** terminating still farther beyond in a well **60** which receives a hub portion and a driven coupling magnet, as will more fully appear.

The pump body includes an impeller chamber **30** (FIG. **3** also) of annular shape having an outlet passage **31** communicating into a discharge duct **32** and outlet port or hose nipple **33,** the side of the pump body opposite the inlet zone being open and preferably of annular shape, also, for conjunction with a closure means.

An impeller **35** rotates on the spindle **25** and has a hub **36** on which is fitted an annular permanent magnet **37** cooperable with a larger external annular driving magnet **38** held in a rotating carrier **39** fixed on the shaft of a motor **40.**

A liquid-impervious means for mounting the pump within the tank comprises a special housing or bell **50** having the cylindrical shape seen in FIGS. **4** and **5** with a large well **51** terminating in a flange **52** adapted to fit against the exterior of the tank at the margins **12A** of a suitable opening formed in the sidewall of the tank, this housing bell being clamped onto the tank against suitable sealing or gasket means such as an O-ring **53,** by means of a clamp ring **54** secured by bolts **55,** as in FIG. **2.**

In the illustrative example described, the housing bell is formed of a molded plastic material, for example Polysulfone or the like, suitable to withstand the chemical action and wide temperature ranges obtaining in the tank, the inner wall portions of this structure including large post formations **57** having tapped bores to receive mounting bolts **58** by which the motor-mounting ring **59** is secured, together with smaller posts **56** for the pump mounting bolts **64.**

On the bottom wall of the bell is formed an inwardly and axially-aligned magnet well **60** which opens into an annular land **61,** the diameter of which is slightly smaller than that of the open side of the pump housing so that the latter fits down about the margins of the land, the annular rim of the pump housing having a groove **20B** molded therein to accommodate an O-ring **62** which seals the pump about the land when the pump mounting bolts **64** are pulled in.

The magnet well has an internal diameter just sufficient to freely admit the hub portion **36** of the impeller and its driven magnet **37** to permit rotary clearance for the latter while minimizing the magnetic gap between it and the outer circumambient driving magnet **38.**

Formed on the inner face of the bottom of the magnet well is a spindle-seating recess **65** which receives the free end **26** of the cantilever-supported spindle **25** in conjunction with the locating and securing interfit of the pump body rim about the land **61,** and by this means the pump spindle is prevented from warping or skewing from the axial alignment needed for the rotational clearances of both the impeller and the driven magnet. Such stabilization of the impeller spindle becomes of particular concern where the liquid circulated by the pump is at temperatures which will affect the rigidity and stability of the plastic material of the pump housing. In the illustrative application, the temperature of the bath ranges from about freezing to **190°F.** and it is difficult to keep the impeller spindle in sufficiently accurate alignment when the pump housing is formed of non-metallic plastic materials.

The stabilizing support for the free end of the spindle over which the impeller unit is to be fitted in assembling the pump may be utilized in forms of closure other than the motor mounting bell **50.** For example, the closure may be in the form of the body member **70,** shown in the modified construction of FIG. **5,** comprising an annular plate portion **71** having marginal screw lugs **72** aligning with the screw posts **73** on the pump body section shown in FIG. **8.** This closure plate is provided with an integrally-formed magnet well **74** having the imperforate spindle-receiving recess or socket **75** molded on the inner side of its bottom wall.

The plate type closure **70** may be employed with the type of pump body **20** depicted in FIG. **3,** in place of a mounting bell **50**; or, it may be used with the modified type of pump body **20X** illustrated in FIGS. **6** and **8,** which is substantially like the body member **20** except that the footing or fixation of the spindle at one end is achieved by provision of a second spindle-seating socket **80** situated in the inlet zone **23X** to embrace the stud end **24X** of the spindle as the primary support for the latter; and while the spindle may alternatively have its primary support in the magnet well, as disclosed in the aforementioned copending application Ser. No. 584,171, it is often preferable to keep the wall thicknesses of the magnet well minimal, and therefore to have the strength of the principal supporting seat or attachment for the spindle located in the inlet zone **23X** where the wall thickness need not be limited.

Means fixing the spindle **25X,** FIG. **6,** against rotation along with the impeller may take the form of the keying configuration shown in FIGS. **7** and **8** wherein the stud end at the foot of the spindle **25X** has a keying flat **81** formed therein to confront a companion flat **82** molded in the seating recess **80** formed at the inlet zone.

It will be apparent that as a result of the imperforate character of stabilizing support and socket structures such as **65, 75, 75Z,** the impeller chamber is leak proof so far as the rotational support and driving of the impeller are concerned; and while the spindle has support at both of its ends, principally in the inlet zone, and is thereby held in alignment, yet it may be fixed at one end against rotation, and also in attachment to the one of the two housing or body sections in which it is footed or fixed, so as to facilitate installation of the impeller and final assembly of the two housing or body sections. In the type of construction shown in FIG. **6** the fixed or principal mounting end **24X** of the spindle can be force-fitted into its seat, in consequence of which, as in the case of the screw-secured spindle of FIG. **2,** the spindles are held but optionally removable, so that a standardized body section may be equipped as necessary with spindles made from various materials or alloys for special requirements, as in the case of pumps for handling chemically active and corrosive liquids.

FIG. 9 illustrates a further modification of the construction of FIG. 6 wherein the spindle **25Z** is integrally formed as a part of one of the two pump housing sections, for example the body member **20Z**, conformably with the disclosures of the aforesaid copending application Ser. No. 584,171; and the free end **26Z** of this integral spindle is secured against misalignment in a stabilizing socket **75Z** formed in the face of the inner bottom wall of the magnet well **74A**. Such a construction has the advantage of permitting the use of a pump body and spindle molded in one piece from a choice of nonmetallic and synthetic plastic materials each suited to some particular working specification, such as might involve very hot or chemically reactive liquids having softening or corrosive effects on some but not other plastics.

It will be apparent that the Spindle mounting of FIG. **2** is such as to seize the spindle so that it will not rotate and will remain attached to the appertaining body member **20** for easy assembly of the impeller structure thereon; yet this spindle is removable for replacement as required. In the construction of FIG. **6**, the spindle is likewise secured against rotation, but may be optionally rendered loosely removable, or fixed, depending upon whether it is seized in its footing or seating socket, as by force-fit or like means. The integral construction of FIG. **9** obviously renders the spindle permanently fixed in attachment to the appertaining body member. But in each of the foregoing embodiments the free or opposite and secondarily-supported end of the respective spindle is removably fitted into its supporting or aligning recesses as the result of assembly of the two body members.

It is also to be observed that in each of the aforesaid spindle-mounting arrangements the primarily fixed or foot end of the spindle is located in the corresponding inlet zone **23, 23X** or **23Z** for the purposes and in accordance with the disclosures of the aforementioned copending application, which, briefly stated, provide for influx of the fluid at the principally stressed axial end of the impeller with such primary spindle support in the low-pressure zone of the entering fluid but at the end of the impeller axis at which the major stress will appear owing to the proximity of the displacing blades and the loading on the spindle which results at this end of the axis.

It will be further understood that, whereas the motor mounting bell **50** has been illustrated in dimensions of an adaptation which disposes the motor **40** only partially within the larger, outer well thereof, the depth of this well may be made great enough to receive and house the entire motor unit for those installations requiring an enclosed motor.

The detailed constructions disclosed and specifically described are illustrative of the character of the improvements and are not to be construed as limiting except as the appended claims may particularly provide.

I claim:

1. A tank-mounting bell with combination driving motor and magnetically-coupled pump driven thereby, said bell comprising a molded plastics material shell of cylindrical form having one end closed by an integrally conformed end wall and an opposite open end; a plurality of post configurations disposed in angularly spaced relation in integral conformation with said material about the internal periphery of the shell cavity, certain of said post formations having end portions integrally terminating in said end wall, and others of said post formations having conterminous end portions disposed within the cavity away from said end wall toward said open end and constituting mounting lands; a motor mounting plate member seated against said lands and secured to the appertaining post formations; a pump driving motor having an end portion, at least, confronting and secured to said plate member with a predetermined substantial part, at least, of the motor body disposed within said cavity; a tank-mounting flange formation subtending said open end of the shell and constituting an integral configuration with the material thereof; a pump having a body engaged with the external side of said end wall and secured thereto by means engaging into said certain post formations, said pump being adapted to be drivingly coupled with said motor by magnetic means which does not perforately penetrate said bell material.

2. The construction of claim **1** wherein said tank-mounting flange formation extends radially outwardly of the shell and is adapted to seat against wall portions of a tank subjacent to the margins of a hole through which the bell is entered into the tank to a limit determined by engagement of said flange formation with said subjacent wall portions, and the bell is secured in sealed engagement with said subjacent wall portions by fastening means engaging both the flange and said last-mentioned tank wall portions.

3. A motor-mounting bell for use with a magnetically-coupled rotary pump of the type comprising a pump housing having a rotary impeller and coaxially rotatable driven magnet situated in a salient magnet chamber of the housing structure such that an annular outer driving magnet can be rotated about the outside periphery of the magnet chamber, improvements consisting in the combination with a pump housing of the aforesaid type having an opening through which the driven magnet of the impeller is a motor-mounting bell structure in the form of a one-piece cup-shaped member with a motor cavity open at one end for entry of a motor unit therein and having a bottom wall closing its opposite end and adapted to fit in sealing attachment to the pump housing in position to close off said opening thereof, said bottom wall having a chamber for the driven magnet which chamber is recessed inwardly of said cavity and impervious to fluid passage from the pump housing and into which the drive magnet projects; and means formed as an integral part of said bell member in the motor cavity thereof for supporting engagement with a motor unit received therein and including an annular driving magnet rotatable thereby with the axis of rotation of such magnet concentric with the axis of rotation of the driven magnet and the outer wall of said magnet chamber, whereby said annular driving magnet is disposed for rotation about the outer periphery of the outer wall of the magnet chamber as aforesaid, to impart driving torque to the driven magnet therein.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,802,804 Dated April 9, 1974

Inventor(s) Frederick N. Zimmermann

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 40, "FIG. 4" should read --FIG. 5--; and column 6, line 42, after "impeller is", insert --exposed of: --.

Signed and Sealed this

Third Day of August 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks