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(54) **ADVANCED MATERIAL OVERFLOW TRANSFER PUMP**

FORTSCHRITTLICHE MATERIALÜBERSTRÖMUNGSTRANSFERPUMPE

POMPE INNOVANTE DE TRANSFERT DE TROP-PLEIN DE MATÉRIAU

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Description

BACKGROUND

5 **[0001]** The present exemplary embodiment relates to pumps for pumping molten metal, and will be described with particular reference thereto. The present pump embodiment may find particular use in handling molten aluminum, zinc, lead, and/or magnesium and alloys thereof. However, it is to be appreciated that the present exemplary embodiment is also amenable to other like applications.

10 **[0002]** Pumps for pumping molten metal are used in furnaces in the production of metal articles. An example of such a molten metal pump is known from US/2013/101424 A1. Currently, many metal die casting facilities employ a main hearth containing the majority of the molten metal. Solid bars of metal may be periodically melted in the main hearth. A transfer pump can be located in a separate well adjacent the main hearth. The transfer pump draws molten metal from the well in which it resides and transfers it into a ladle or conduit and from there to die casters that form the metal articles. The present invention relates to pumps used to transfer molten metal from a furnace to a die casting machine, ingot mould, DC caster or the like. The subject pump may similarly be used as transportable apparatus for on-demand use and/or for emergency pump out situations.

BRIEF DESCRIPTION

20 **[0003]** According to one embodiment of this disclosure, a molten metal pump according to claim 1 is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

25 **[0004]** The following description and drawings set forth certain illustrative implementations of the disclosure in detail, which are indicative of several exemplary ways in which the various principles of the disclosure may be carried out. The illustrated examples, however, are not exhaustive of the many possible embodiments of the disclosure. Other objects, advantages and features of the disclosure will be set forth in the following detail description of the disclosure when considered in conjunction with the drawings, in which:

30 FIGURE 1 is a perspective view showing a molten metal transfer system including the pump disposed in a furnace bay;
 FIG. 2 is a perspective partially cross-sectional view of the system of FIG. 1;
 FIG. 3 is a side cross-sectional view of the system shown in FIGS. 1 and 2;
 FIG. 4 is a perspective view of the pumping chamber;
 FIG. 5 is a top view of the pumping chamber;
 35 FIG. 6 is a view along the line A-A of FIG. 5;
 FIG. 7 is a representative impeller design;
 FIGS. 8(a) and 8(b) depict a bottom end of a suitable pumping chamber from a cross-sectional perspective view and a cross-sectional plan view, respectively;
 FIG. 9 is a schematic cross-sectional plan view of an alternate pump configuration;
 40 FIG. 10 is a schematic cross-sectional plan view of a further alternate pump configuration;
 FIG. 11 is a detailed cross-sectional perspective view of the pump of FIG. 10;
 FIGS. 12(a) and 12(b) depict an impeller suitable for use in the subject pump;
 FIGS. 13(a), (b), (c), (d) are respectively a perspective view of an alternative pump configuration, a detailed view of the volute chamber, a perspective view of the RFM pump body, and an end view of the pump body;
 45 FIG. 14 is a side elevation view (partially in cross-section) of a further alternative pumping chamber configuration;
 FIG. 15 is a bottom view of the pumping chamber of FIG 9; and
 FIG. 16 is a perspective view of a crucible configured to include the transfer pump of the present disclosure.

DETAILED DESCRIPTION

50 **[0005]** The exemplary embodiment has been described with reference to the preferred embodiments. Modifications and alterations will occur to others upon reading and understanding the detailed description. It is intended that the exemplary embodiment be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims.

55 **[0006]** The present pump is designed for gently transferring molten metal from crucibles or melting/holding furnaces. It has particular usefulness with foundry and cast house applications, such as transfer of metal from a furnace to a crucible, emptying a crucible, and/or transfer to casting machines/crucible and furnace to furnace. The pump can empty small crucibles because the pump can be manufactured to be relatively compact (e.g. bowl metal immersion depth:

1100 or 800 mm; bowl diameter: from 275 (top) to 235 mm (bottom)).

[0007] In addition, by utilizing the lay-up technique of RFM manufacture, it is feasible to construct an elongated pump chamber having a substantially constant diameter for example, a 185mm or smaller internal diameter and/or a 235mm or smaller external diameter. Given the high strength and thermal shock resistance of RFM, it is similarly possible to construct a relatively thin walled pump chamber (e.g. <50mm). As such, a pump capable of insertion into tight spaces, for example, a space less than 25 cm. in diameter is feasible.

[0008] The pump advantageously has a main body constructed from a composite ceramic material that is both tough and tolerant of mechanic abuse, making the system's bowl very durable, rigid and user-friendly. These materials are referred to herein as reinforced fiber materials (RFM).

[0009] The benefits of constructing the pumping chamber of RFM include improved safety: eliminates manual emptying procedures, tilting or using tapping ports; improved metal quality; increased productivity; and minimal pre-heating is necessary.

[0010] RFM provides at least the following additional benefits:

- A. the system is easy to remove and reinsert into the molten metal because of its light weight (the system could be permanently mounted, but, it is not necessary).
- B. Can design a thinner wall (contributing to the lighter weight and low thermal mass).
- C. Good thermal shock resistance.
- D. No preheat needed - After warming the system (above 100°C) to insure no residual moisture in the refractory the RFM can be directly immersed into the molten metal without preheat.
- E. Can be used for transfer from foundry crucibles to other vessels.

[0011] Advantageously, the present pump construction allows for 40% or more of the elongated tube to extend above the metal line.

[0012] With reference to FIGS. 1-3, the molten metal pump 30 of the present invention is depicted in association with a furnace 28. Pump 30 is suspended via metallic framing 32 which rests on the walls of the furnace bay 34 (a transportable version is depicted in FIGS. 13(c) - (d) wherein supportive framing is not required). A motor 35 rotates a shaft 36 (comprised of graphite or ceramic, for example) and the appended impeller 38. A reinforce fiber material (RFM) body 40 forms an elongated generally cylindrical pump chamber or tube 41. Although the pump chamber and tube are generally depicted herein as cylindrical, it is noted that other shapes are also contemplated. For example, cylindrical is intended to encompass shapes such as elliptic, parabolic and hyperbolic cylinders. Furthermore, it is envisioned that the pump can function with chamber cross-section geometries such as rectangular or square. In addition, it is envisioned that the cross-section geometry can vary throughout the length of the pumping chamber.

[0013] Body 40 includes an inlet 43 which receives impeller 38. Bearing rings 44 can be provided to facilitate even wear and rotation of the impeller 38 therein. In operation, molten metal is drawn into the impeller through the inlet (arrows) and forced upwardly within tube 41 in the shape of a forced ("equilibrium") vortex. At a top of the tube 41 a volute shaped chamber 42 is provided to direct the molten metal vortex created by rotation of the impeller outwardly into trough 44. Trough 44 can be joined/mated with additional trough members or tubing to direct the molten metal to its desired location such as a casting apparatus, a ladle or other mechanism as known to those skilled in the art.

[0014] Although depicted as a volute cavity, an alternative mechanism could be utilized to divert the rotating molten metal vortex into the trough. In fact, a tangential outlet extending from even a cylindrical cavity sized equally and concentric to tube 41 can achieve tangential molten metal flow. However, a diverter such as a wing extending into the flow pattern or other element which directs the molten metal into the trough may be beneficial.

[0015] In addition, in certain environments, it may be desirable to form the base of the tube into a general bell shape, rather than flat. This design may produce a deeper vortex and allow the device to have improved function as a scrap submergence unit.

[0016] The pump 30 includes a metal frame 108 surrounding the top portion (outlet chamber) of the RFM tube 41, and includes a motor mount 102 which is secured to the pump 30. A compressible fiber blank (not shown) can be disposed between the steel frame and the refractory bowl to accommodate variations in thermal expansion rates. Furthermore, the outlet chamber is provided with an overflow notch 123 to safely return molten metal to the furnace in the event of a downstream obstruction which blocks trough 44. Overflow notch 123 has a shallower depth than trough 44.

[0017] Turning now to FIGS. 4-6, the body 40 is shown in greater detail. FIG. 4 shows a perspective view of the RFM body. FIG. 5 shows a top view of the volute design and FIG. 6 displays a cross-sectional view of the elongated generally cylindrical pumping chamber. These views show the general design parameters where the pumping chamber 41 is at least 1.1 times greater in diameter, preferably at least about 1.5 times, and most preferably, at least about 2.0 times greater than the impeller diameter. However, for higher density metals, such as zinc, it may be desirable that the impeller diameter relative to pumping chamber diameter be at the lower range of 1.1 to 1.3. In addition, it can be seen that the pumping chamber 41 is significantly greater in length than the impeller is in height. Preferably, the pumping chamber

length (height) is at least 0.9 m (three feet), or at least 1.5 m (five feet), or at least 2.1 m (seven feet). It is envisioned that the height of the pump from inlet to outlet can be less than 6 m (20 feet), or less than 4.2 m (14 feet). Without being bound by theory, it is believed that these dimensions facilitate formation of a desirable forced ("equilibrium") vortex of molten metal as shown by line 47 in FIG. 6.

[0018] FIG. 7 depicts an impeller 38 which includes top section 68 having vanes 65 (or passages) supplying the induced molten metal flow and a hub 50 for mating with the shaft 36. An inlet guide section 70 defines a hollow central portion 54. Bearing rings 56 can be provided to provide smooth rotation of the impeller within body 40. The impeller can be constructed of graphite or other suitable refractory material such as ceramic. It is envisioned that any traditional molten metal impeller design having a bottom inlet and side outlet(s) would be functional in the present overflow vortex transfer system.

[0019] FIGS. 8(a) and 8(b) provide a detailed view of one exemplary base end of the pump chamber 41. In these illustrations, the base end 80 includes side wall 82, bottom wall 84, and an RFM bearing ring 86 (not shown in the preceding figures). An impeller receiving inlet 88 is formed in the bottom wall 84 and the bearing ring 86 through which molten metal is received.

[0020] The RFM material used to construct selected pump components including body 40 can include a ceramic matrix material with a fiber filler material. The ceramic matrix material can be a blend of, for example, Wollastonite and colloidal silica. An exemplary fiber filler material is fiberglass. These materials are blended together to form a slurry.

[0021] The body can be constructed in a series of layers, by laying precut grades of woven cloth onto a mandrel, adding the slurry and working it into the cloth to ensure full wetting of the fabric. This is repeated to build up successive layers of cloth and matrix material, until a desired thickness is achieved. An exemplary cloth material is glass.

[0022] Once the product has achieved the desired thickness, it is machined in green (unfired) form to shape the outer surface of the tubular body. The tubular body is then removed from the mandrel and placed in a furnace to dry. A non-stick coating, for example of boron nitride may be applied.

[0023] The present pump can be considered a portable overflow pump having particular suitability for the foundry market. The pump can be designed to gently raise and transfer molten metal from small crucibles or melting or holding furnaces. It can be used in foundry and cast house applications, such as pumping metal from a furnace to a crucible, emptying a crucible, transferring metal to casting machines and moving metal from one furnace to another.

[0024] The pump's compact size makes it easily transported from one vessel to another, and its RFM construction allows for quick metal insertion due to minimal preheating requirements. Its design efficiently raises and transfers molten metal, yielding less dross than traditional transfer methods. It is safer to use than traditional transfer methods that require operators to manually empty, tilt or use tapping ports.

[0025] Design benefits of the RFM Overflow Pump include the reduction of dross formation during the transfer process and a constant metal flow rate. Though it has a small diameter footprint, its design allows it to proficiently empty a small crucible of about 500 kilograms (1100 pounds) in less than about one minute.

[0026] The pump is lightweight and has excellent mechanical strength, is non-wetting to molten aluminum and has better heat retention and service life compared to cast iron, fibre laminated board stock and other precast ceramic materials. RFM can reduce downstream oxides and inclusions, help prevent dross buildup, contribute to lower furnace holding temperatures and yield higher quality castings. It also can be formed into complex designs and is highly resistant to thermal shock.

[0027] The inorganic material used to make the matrix (RFM) can be of any type provided that it is compatible with the fabric that is embedded therein; it can be molded or thermo-formed; and it is rigid, strong and sufficiently heat-resistant to handle molten metal and remain rigid at molten metal temperature.

[0028] The inorganic material can be a glue made from colloidal silica like the one sold under the tradename QF-150 and 180 by Unifrax. It can also be a sodium or potassium silicate slurry or a zircon-based coating like the one sold under the tradename EZ 400 by Pyrotek, Inc.

[0029] In one example, the RFM can comprise 8 to 25% by weight of an aqueous phosphoric acid solution having a concentration of phosphoric acid ranging from 40 to 85% with up to 50% of the primary acidic function of the acid phosphoric acid neutralized by reaction with vermiculite. It also encompasses from 75 to 92% by weight of a mixture containing wollastonite or a mixture of wollastonite of different grades, and an aqueous suspension containing from 20 to 40% by weight of colloidal silica, such as the one sold under the trademark LUDOX HS-40 by Sigma-Aldrich. The weight ratio of the aqueous suspension to the wollastonite within the mixture can range from 0.5 to 1.2.

[0030] To prepare the tube, one may prepare a slurry of the selected RFM and impregnate an open weave fabric with the slurry either by direct application or by dipping. The resulting product may then be left in a mold of preselected shape until the matrix has hardened. The rigid tube can be unmolded in less than two hours, without need of any drying and/or heating steps even though a 10 hour drying step at ambient temperature followed by a several hours of firing at elevated temperature (such as 375°C) may be beneficial.

[0031] While the pump and impeller designs depicted in FIGS. 2-8(b) (a first embodiment) are highly effective in achieving the transfer of molten metal from a furnace, its usefulness may be most effective with furnace environments

in which the molten metal is at a high temperature, for example, above 760°C (1400 °F). In environments where the molten metal temperature is less than, for example, 10°C (50 °F), above the melting point of the metal being transferred, an alternative design may be desirable. Moreover, in a relatively low temperature molten metal environment it is feasible that the relatively high mass base and impeller components of the first embodiment can cause a decrease of molten metal temperature within the pump body that results in hardening of the metal and potential damage to the pump assembly.

[0032] For example, testing was performed using the first pump embodiment equipped with external and internal thermocouples in the base region. The pump was immersed into molten metal at a temperature of 732°C (1350 °F). The Table below summarizes the recorded temperatures from immersion, wherein the temperatures in °C can be calculated from the temperatures in °F using following formulae: $^{\circ}\text{C} = (^{\circ}\text{F} - 32)/1.8$.

Time	Temperature		Condition
	Internal	External	
0	1247°	1317°	without graphite impeller
0	1126°	1332°	with graphite impeller
4 min.	1118°	1330°	with graphite impeller
6 min.	1134°	1331°	with graphite impeller
9 min.	1154°	1330°	with graphite impeller

[0033] As the skilled artisan will discern, the initial insertion of the pump into the molten metal can cause a significant decrease of the molten metal temperature inside the pumping chamber. This decrease in temperature is enhanced by the presence of the impeller. If the molten metal being transferred is maintained by the associated furnace at a temperature relatively close to the metal solidus temperatures, freezing of the pump is a possibility.

[0034] In accord with an example which is not part of the present invention, the RFM bottom wall 84 (see FIGS. 8(a) and (b)) has been removed. The RFM bearing ring 86 has also been removed and the mass of the impeller has been reduced.

[0035] With particular reference to FIG. 9, a base region of a pump chamber 100 receives an impeller 102. Rather than form an interface between the impeller and a bottom wall of the elongated tube, a dynamic seal 104 is formed between a top surface 106 of the impeller main body 108 and a bottom edge 110 of a tube body 112.

[0036] The impeller 102 can include a hub 114 receiving a shaft 116. Vanes 118 extend from the hub on the top surface 106. An inlet 120 is provided in a bottom surface 122 with passages (not shown) extending through the main body 108 to transport metal from outside the pump to the pumping chamber 100.

[0037] As utilized herein, the term "dynamic seal" is intended to reflect a seal formed between the rotating impeller and the tube body. The dynamic seal is intended to encompass a range of fluid tightness from substantially absolute wherein a lubricating molten metal film is formed between the impeller and the tube body but through which substantially no molten metal flow occurs during operation to a situation wherein a measureable amount of molten metal can pass between the impeller and the tube body. However, it is desirable that the maximum quantity of molten metal entering the pumping chamber through the dynamic seal is less than the quantity entering through the impeller inlet. Moreover, it may be most desirable that the tube body act as a bearing surface during impeller rotation.

[0038] Turning to FIGS. 10 and 11, an alternative configuration is depicted wherein a dynamic edge seal 150 is formed between the radial edge 152 of the impeller 102 and an internal wall 156 of the tube body 112. In either example which is not part of the present invention, it is conceivable that the impeller include a radial bearing ring 158, but such bearing ring is optional, particularly if the impeller is constructed of a ceramic material. Also contemplated but not illustrated is a slight underhang (e.g. "j" shaped terminal portion) of the tube body configured to form a dynamic seal with a bottom facing corner of the impeller.

[0039] Turning now to FIGS. 12(a) and 12(b), an impeller 175 (comprised of graphite or ceramic, for example) without a bearing ring (comprised of silicon carbide, for example) is depicted. The impeller 175 includes a disc shaped body 177 having an upper surface 179 upon which a plurality of vanes 181 are disposed. Vanes 181 extend from a hub 183 in which a shaft (not shown) can be received. Hub 183 can be configured to include recesses 185 for receiving dowels that provide an interface through which the shaft imparts torque to the impeller. Impeller 175 further includes an inlet 187 in a bottom surface 188 in fluid communication with a plurality of passages 189 via which molten metal passes through the disc-shaped body 177 for discharge adjacent upper surface 179 where it is acted upon by the vanes 181 to impart the desired radial flow that creates the vortex through which molten metal is lifted upwardly within the tube for eventual discharge at the elevated outlet

[0040] As a visual comparison between the impeller of FIG. 7 and the impeller of FIGS. 12(a) and (b) will demonstrate, a significant quantity of impeller mass has been eliminated by providing an open top vane architecture and an inwardly recessed inlet. In certain instances it may be desirable for the RFM tube adjacent the impeller to have an internal diameter between about 15 and 30 centimeters and for the impeller to have a volume of between about 500 and 1,500 cubic centimeters. As an example, it may be desirable to characterize this relationship as a ratio of impeller volume to tube cross-section area as less than about 3:1. Furthermore, it may be desirable for the walls of the RFM tube adjacent the impeller to be in a range between about 1.27 and 3.81 centimeters in width. In addition, it may be desirable to provide an impeller having vanes spaced from the walls of the pump tube to a greater extent than the portion of the impeller forming the dynamic seal to increase the quantity of molten metal resident therein. For example, the vanes may extend less than 75% of a distance between the hub and the radial edge of the disc-shaped body.

[0041] Referring now to FIGS. 13(a), (b), (c), (d), the advantages of utilizing an RFM tube are readily apparent. More particularly, in the depicted design, the pump 200 is constructed to be selectively movable between locations requiring lifting and transfer of molten metal. More particularly, the tube 201 can be constructed with a relatively thin wall, for example between about 18 and 50 mm due to the high strength and structural integrity of the RFM material. Furthermore, the tube can be constructed to have a cylindrical shape of at least substantially uniform diameter throughout its length. This is advantageous for insertion of the pump into tight spaces. In the depicted embodiment, a motor mount 203 overlays the volute chamber 205 and posts 207 secure the motor mount to a metal cladding 209 bound to a top edge of the volute chamber. Motor 211 is secured to the motor mount 203. A shaft 212 extends between the motor and an impeller (not shown) disposed in base region 214.

[0042] Three lifting eyes 213 are provided on the motor mount 203 to facilitate the movement of the pump 200 between desired locations. Moreover, pump 200 can be lifted via eyes 213 using a fork lift or ceiling hoist and transported to a crucible or furnace well for removal of molten metal. The pump 200 can be temporarily positioned by the lift mechanism in the apparatus being emptied and removed when the desired amount of molten metal has been removed.

[0043] With reference to FIG. 13(c) and (d), the pump body shows inlet 220 in base region 214. Inlet 220 includes an RFM bearing ring 221. The pump body further includes three legs 223 which allow the pump 200 to rest on the furnace/crucible floor while positioning inlet 220 above the floor to avoid ingestion of an excessive amount of solids. The volute end 225 of the pump is also illustrated and includes volute chamber 227 and outlet 229. Overflow spillway 231 is also illustrated.

[0044] In operation, powering motor 211 rotates shaft 212 and the provided impeller wherein rotation of the impeller draws molten metal through inlet 220. The impeller ejects the molten metal radially within the tube 201 (the internal diameter of the tube being larger than the external diameter of the impeller at the impeller outlet). The radially ejected molten metal forms a rotating vortex of molten metal that climbs the walls of the tube, reaching volute chamber 227 where it is directed horizontally outward through outlet 229.

[0045] Turning next to the embodiment of FIGS. 14 and 15, an alternative construction of the pump chamber is depicted. More particularly, the pump chamber 300 has been constructed of RFM and includes three legs 301 which can be utilized to elevate the chamber 300 above the floor of the molten metal inclusive vessel, which has been found to reduce tendency for clogging. In addition, in this embodiment the chamber 300 is provided with a plurality of bores 303 oriented to receive bolts 305 provided for retaining an RFM bearing ring 307, positioned to mate with a corresponding bearing ring of an impeller (not shown).

[0046] Turning next to FIG. 16, the inventive pump concepts contained within this disclosure are applied to a crucible configured. Moreover, crucible 400 is provided includes a tubular column 401 adjacent a side wall 403. Tubular column 401 will include an inlet 402 in fluid communication with the main molten metal containing region 404 of the crucible. The crucible and/or the tubular column can be constructed of RFM. The tubular column 401 is provided with a volute top portion 405 facilitating the discharge of molten metal from the crucible via a spout 407. A selectively removable motor 409, motor mount 410, shaft 411 and impeller 412, collectively assembly 413, can be introduced to the tubular column 401, where upon rotation of the impeller by the motor creates the vortex of molten metal within the tubular column 401, lifting the molten metal to the volute top portion 405 for ultimate discharge via the spout 407.

[0047] Crucible side wall 403 can be equipped with posts 415 configured to receive and releasably mate with the motor mount 410. In this manner, the assembly 413 can be selectively associated with a crucible for molten metal removal and then detached as desired. Advantageously, the assembly can be utilized to service multiple crucibles.

[0048] This design has many advantages in that its design creates an equilibrium vortex at a low impeller RPM, creating a smooth surface with little to no air intake. Accordingly, the vortex is non-violent and creates little or no dross. Moreover, the present pump creates a forced vortex having a constant angular velocity such that the column of rotating molten metal rotates as a solid body having very little turbulence.

[0049] Other advantages include the elimination of the riser component in traditional molten metal pumps which can be fragile and prone to clogging and damage. In addition, the design provides a very small footprint relative to the traditional transfer pump base and has the ability to locate the impeller very close to the bay bottom, allowing for very low metal draw down. As a result of the small footprint. The device is suitable for current refractory furnace designs and

will not require significant modification thereto.

[0050] The pump has excellent flow tune ability, its open design structure provides for simple and easily cleaning access. Advantageously, only shaft and impeller replacement parts will generally be required. In fact is generally self-cleaning wherein cross formation in the riser is eliminated because the metal level is high. Generally, a lower torque motor, such as an air motor, will be sufficient because of the low torque experienced.

[0051] Optional additions to the design include the location of a filter at the base of the inlet of the pumping chamber. It is further envisioned that the pump would be suitable for use in molten zinc environments where a very long, pull (e.g. 4.2 m (14 feet)) is required. Such a design may preferably include the addition of a bearing mechanism at a location on the rotating shaft intermediate the motor and impeller.

Claims

1. A molten metal pump (30) comprising an elongated tube having a base end (80) and a top end, a shaft (36, 116, 212, 411) disposed within said tube and an impeller (102, 175, 412) rotatable by said shaft (36, 116, 212, 411), said impeller (102, 175, 412) disposed proximate said base end (80), said base end (80) including an inlet (120, 220) and said top end including an outlet (229), **characterised in that** said elongated tube is comprised of a reinforced fiber material, RFM, and **in that** said pump (30) further includes a bearing ring (44, 56, 86, 221, 307) comprised of reinforced fiber material, RFM, and disposed in the inlet (120, 220).
2. The molten metal pump of claim 1 wherein said elongated tube includes a sidewall thickness of between about 18 and 50mm.
3. The molten metal pump of claim 2 wherein said elongated tube includes a length of at least two meters.
4. The molten metal pump of claim 1 wherein said shaft (36, 116, 212, 411) and impeller (102, 175, 412) form an assembly, said assembly be selectively removable as a unit from said tube.
5. The molten metal pump of claim 1 including at least three legs (223, 301) projecting from the base end (80).
6. The molten metal pump of claim 1 further comprising at least three holes configured for mounting a bearing ring (44, 56, 86, 221, 307).

Patentansprüche

1. Schmelzmetallpumpe (30), die ein längliches Rohr, das ein Basisende (80) und ein oberes Ende aufweist, eine Welle (36, 116, 212, 411), die in dem Rohr angeordnet ist, und ein Flügelrad (102, 175, 412), das durch die Welle (36, 116, 212, 411) gedreht werden kann, umfasst, wobei das Flügelrad (102, 175, 412) direkt an dem Basisende (80) angeordnet ist, wobei das Basisende (80) einen Einlass (120, 220) aufweist und wobei das obere Ende einen Auslass (229) aufweist, **dadurch gekennzeichnet, dass** das längliche Rohr aus einem faserverstärkten Material (RFM) besteht und dass die Pumpe (30) ferner einen Lagerring (44, 56, 86, 221, 307), der aus einem faserverstärkten Material (RFM) besteht und in dem Einlass (120, 220) angeordnet ist, umfasst.
2. Schmelzmetallpumpe nach Anspruch 1, wobei das längliche Rohr eine Seitenwanddicke im Bereich von etwa 18 bis etwa 50 mm aufweist.
3. Schmelzmetallpumpe nach Anspruch 2, wobei das längliche Rohr eine Länge von wenigstens 2 Metern aufweist.
4. Schmelzmetallpumpe nach Anspruch 1, wobei die Welle (36, 116, 212, 411) und das Flügelrad (102, 175, 412) eine Baueinheit bilden, wobei die Baueinheit wahlweise als eine Einheit von dem Rohr entfernt werden kann.
5. Schmelzmetallpumpe nach Anspruch 1, die wenigstens drei Füße (223, 301) umfasst, die von dem Basisende (80) vorstehen.
6. Schmelzmetallpumpe nach Anspruch 1, die ferner wenigstens drei Löcher umfasst, die für die Montage eines Lagerrings (44, 56, 86, 221, 307) konfiguriert sind.

Revendications

1. Pompe pour métal fondu (30) comprenant un tube allongé ayant une extrémité de base (80) et une extrémité de sommet, un arbre (36, 116, 212, 411) disposé au sein dudit tube et une turbine (102, 175, 412) pouvant être mise en rotation par ledit arbre (36, 116, 212, 411), ladite turbine (102, 175, 412) étant disposée à proximité de ladite extrémité de base (80), ladite extrémité de base (80) comportant une entrée (120, 220) et ladite extrémité de sommet comportant une sortie (229),
caractérisée en ce que ledit tube allongé est composé d'un matériau de fibre renforcé, RFM, et **en ce que** ladite pompe (30) comporte en outre une bague de roulement (44, 56, 86, 221, 307) composée de matériau de fibre renforcé, RFM, et disposée dans l'entrée (120, 220).
2. Pompe pour métal fondu selon la revendication 1, dans laquelle ledit tube allongé comporte une épaisseur de paroi latérale entre environ 18 et 50 mm.
3. Pompe pour métal fondu selon la revendication 2, dans laquelle ledit tube allongé comporte une longueur d'au moins deux mètres.
4. Pompe pour métal fondu selon la revendication 1, dans laquelle ledit arbre (36, 116, 212, 411) et ladite turbine (102, 175, 412) forment un ensemble, ledit ensemble pouvant être sélectivement retiré sous forme unitaire dudit tube.
5. Pompe pour métal fondu selon la revendication 1, comportant au moins trois jambes (223, 301) en saillie depuis l'extrémité de base (80).
6. Pompe pour métal fondu selon la revendication 1, comprenant en outre au moins trois trous configurés pour le montage d'une bague de roulement (44, 56, 86, 221, 307) .

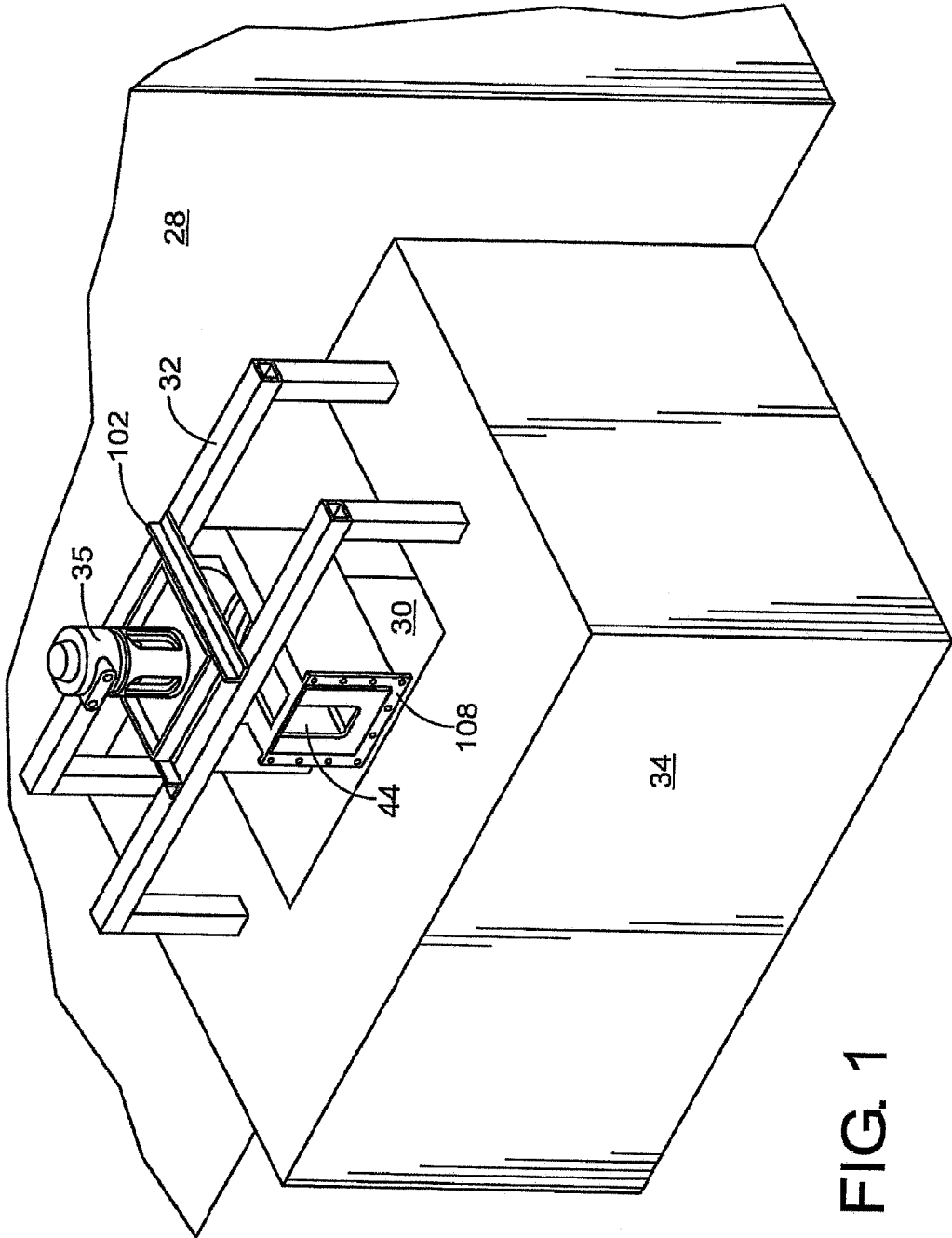


FIG. 1

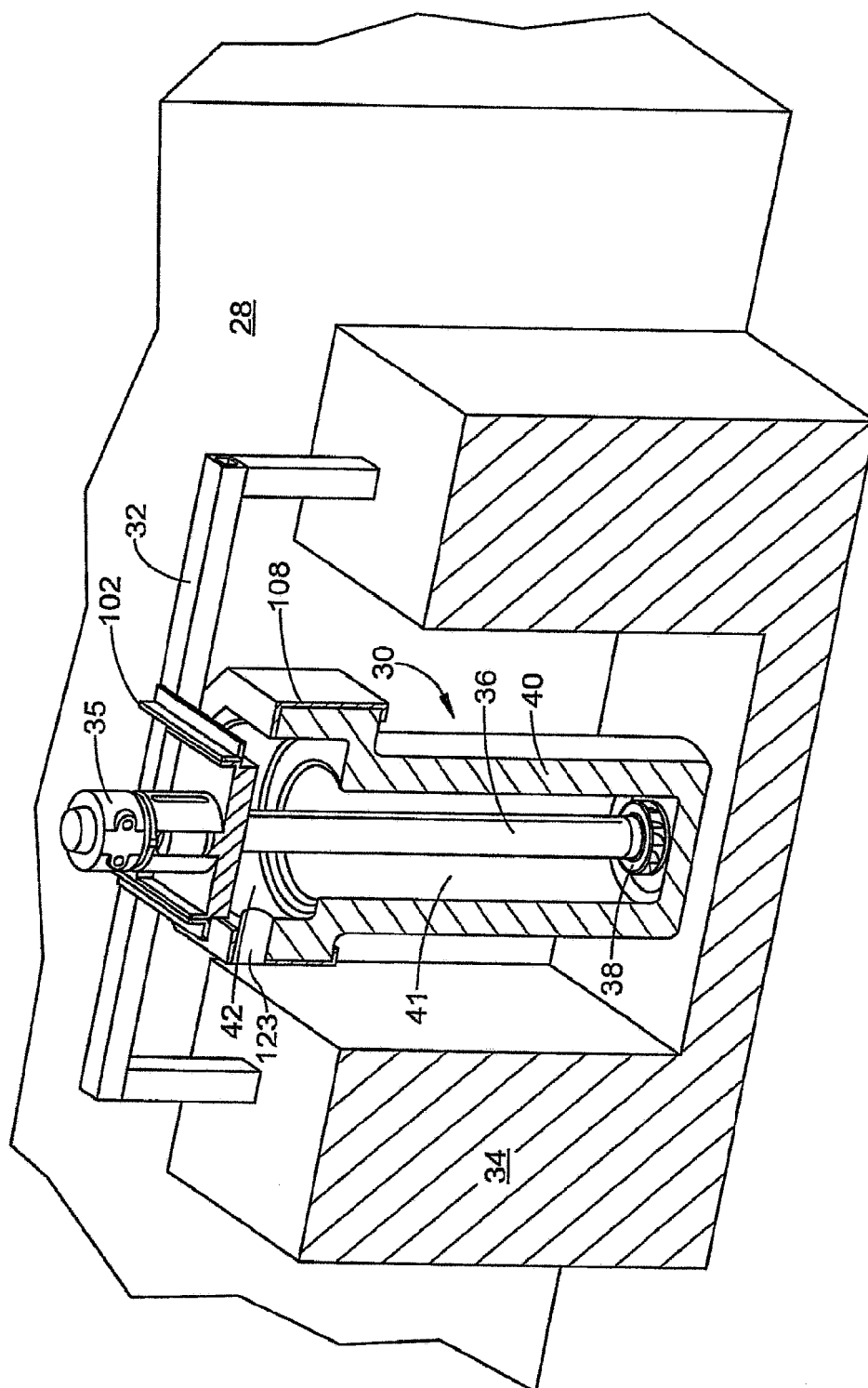


FIG. 2

FIG. 3

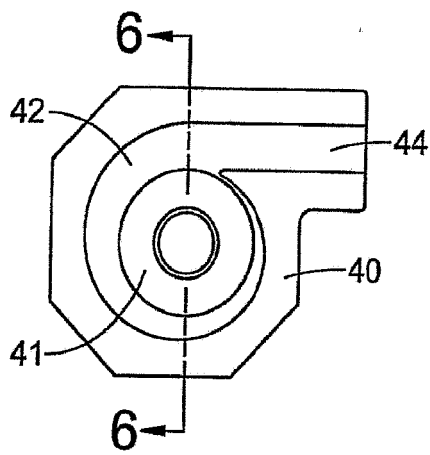
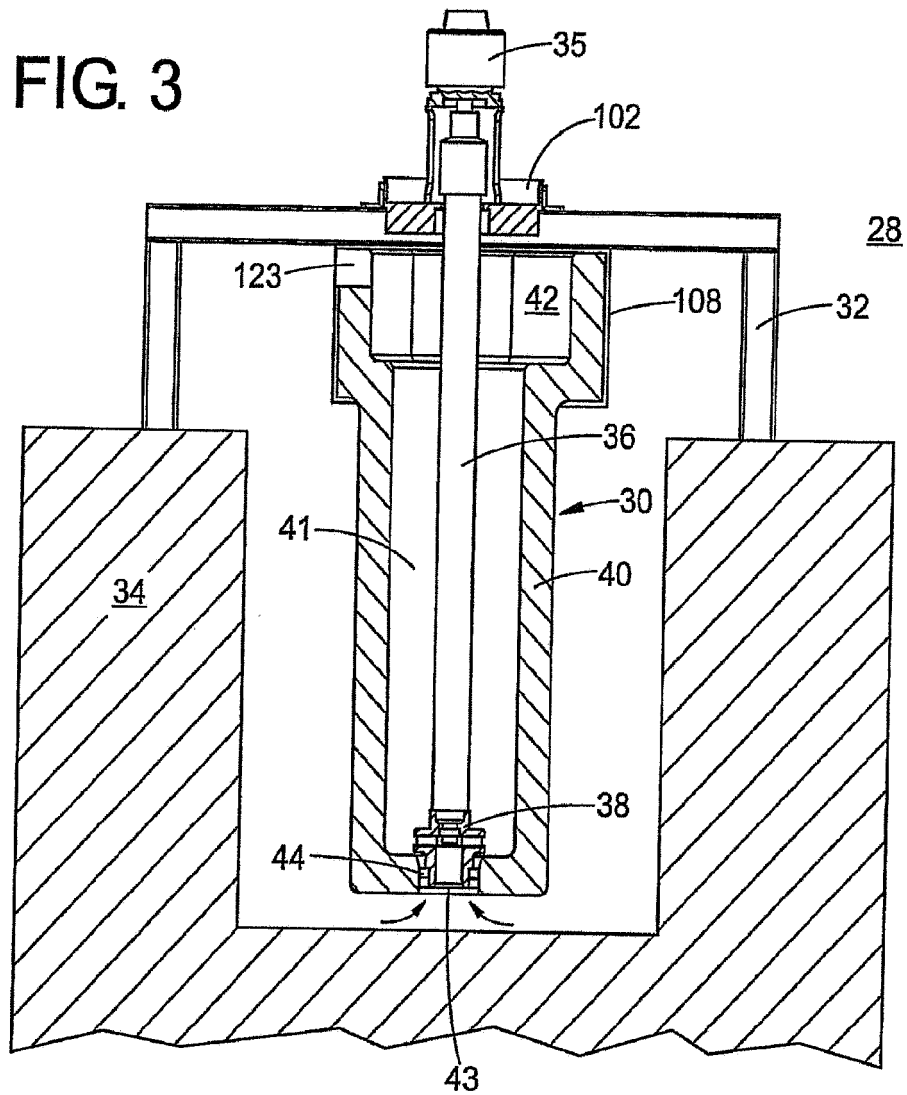


FIG. 5

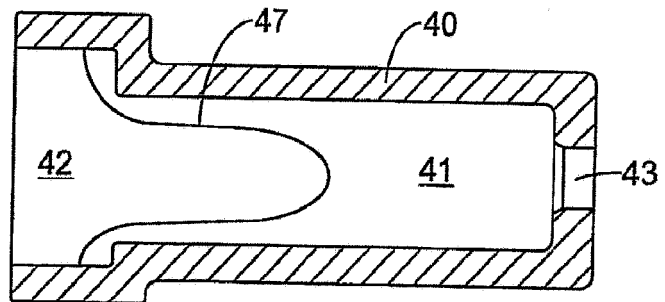


FIG. 6

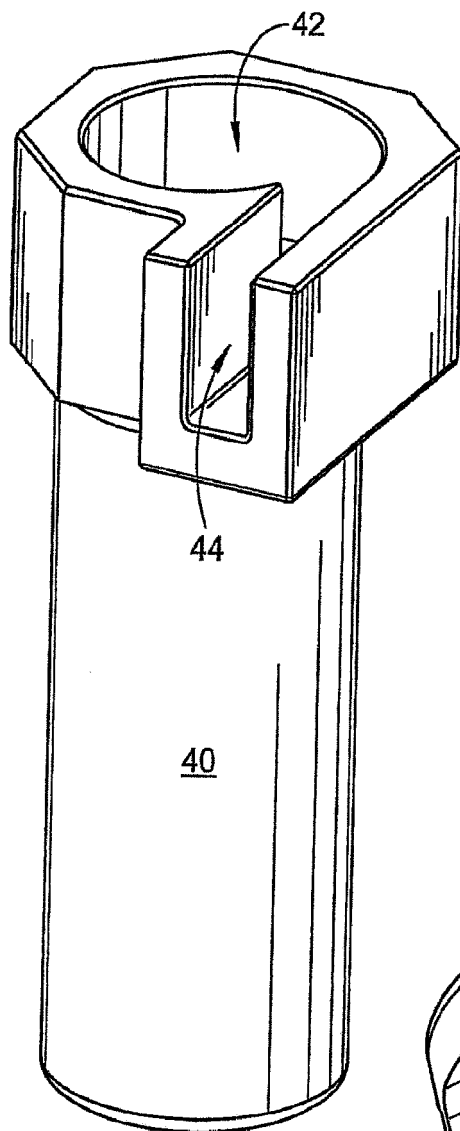


FIG. 4

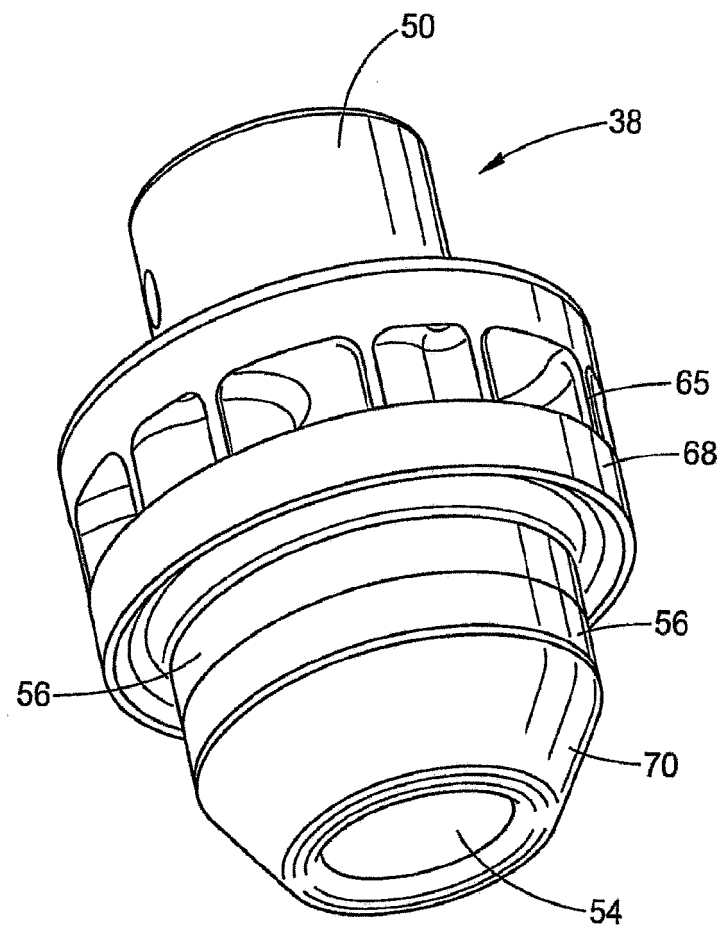
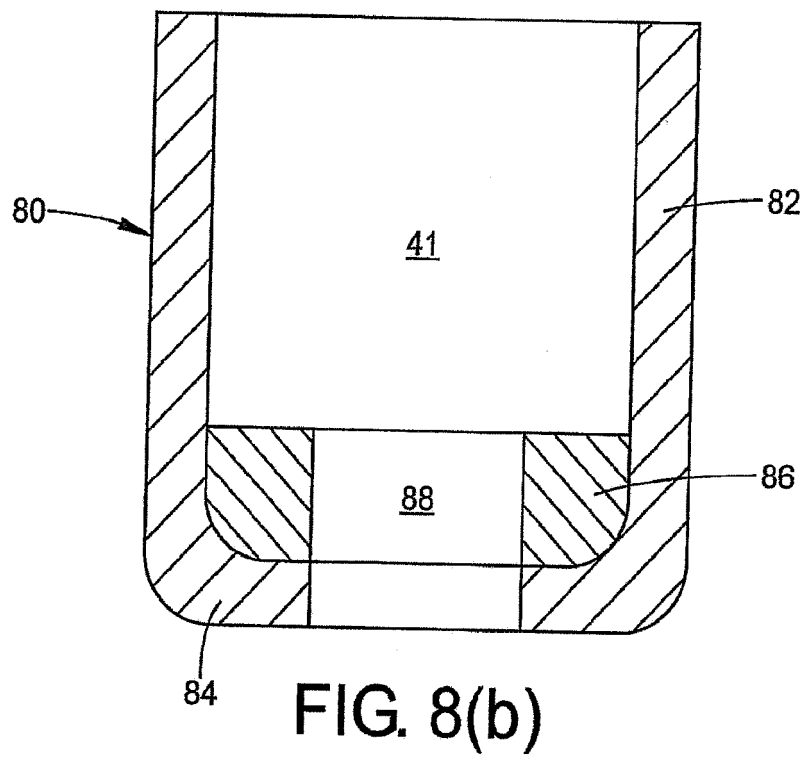
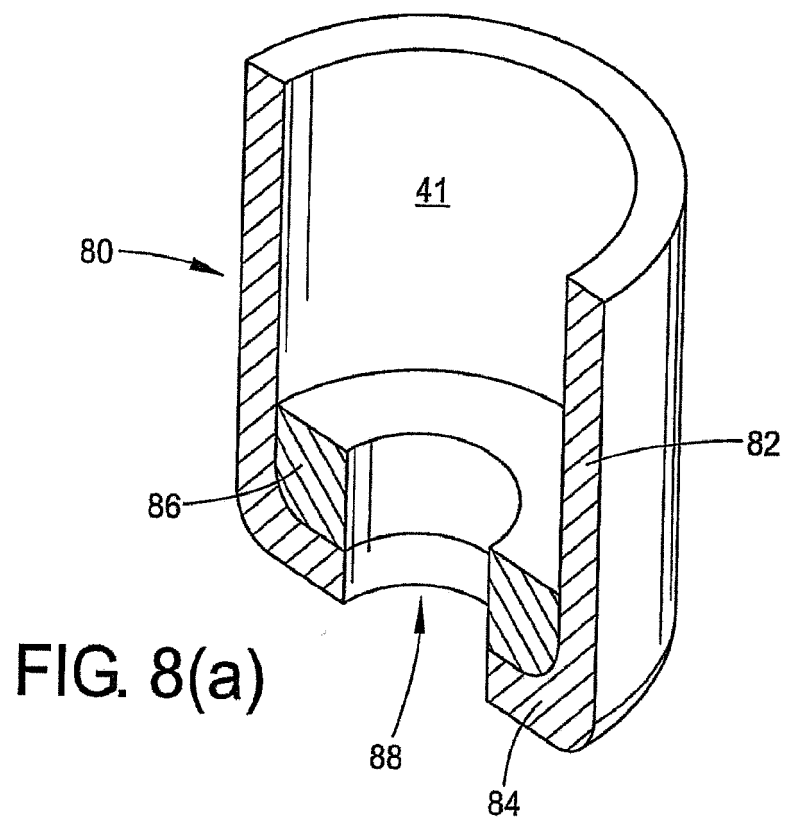


FIG. 7



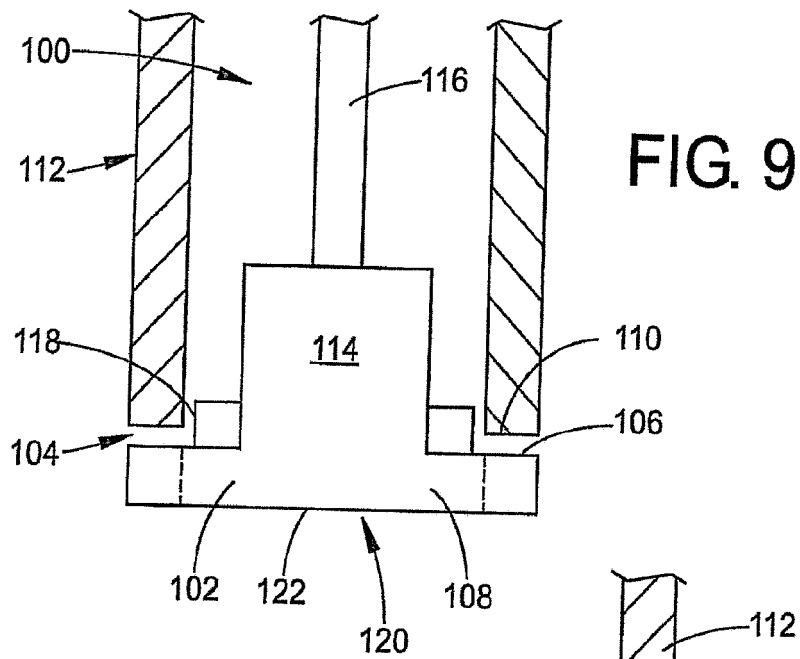


FIG. 10

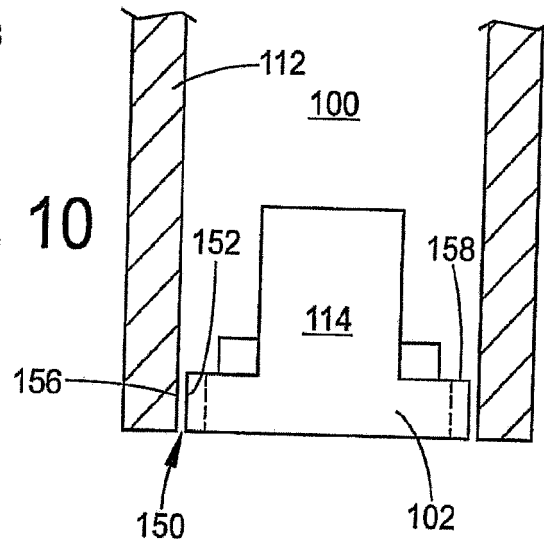
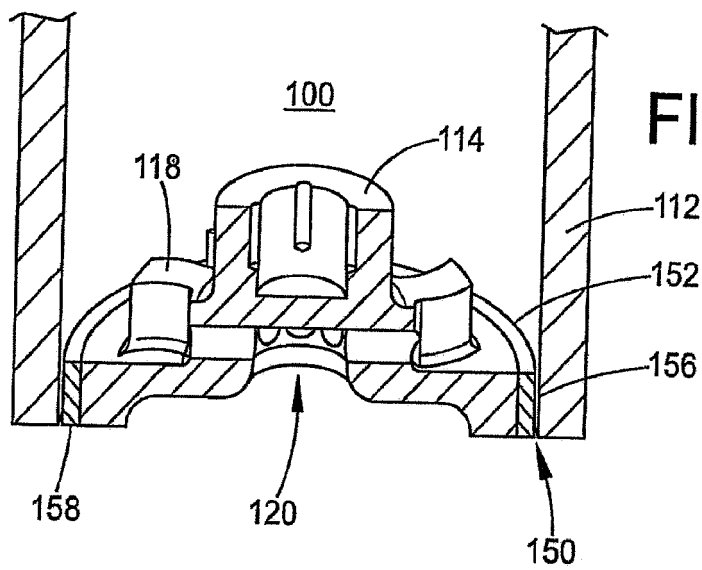


FIG. 11



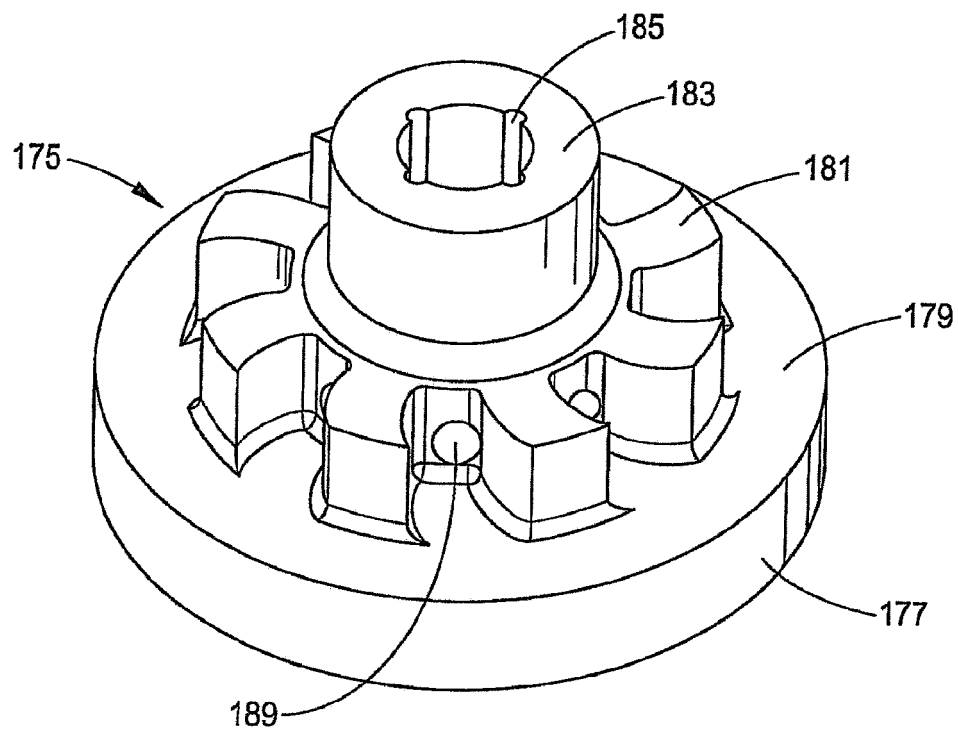


FIG. 12(a)

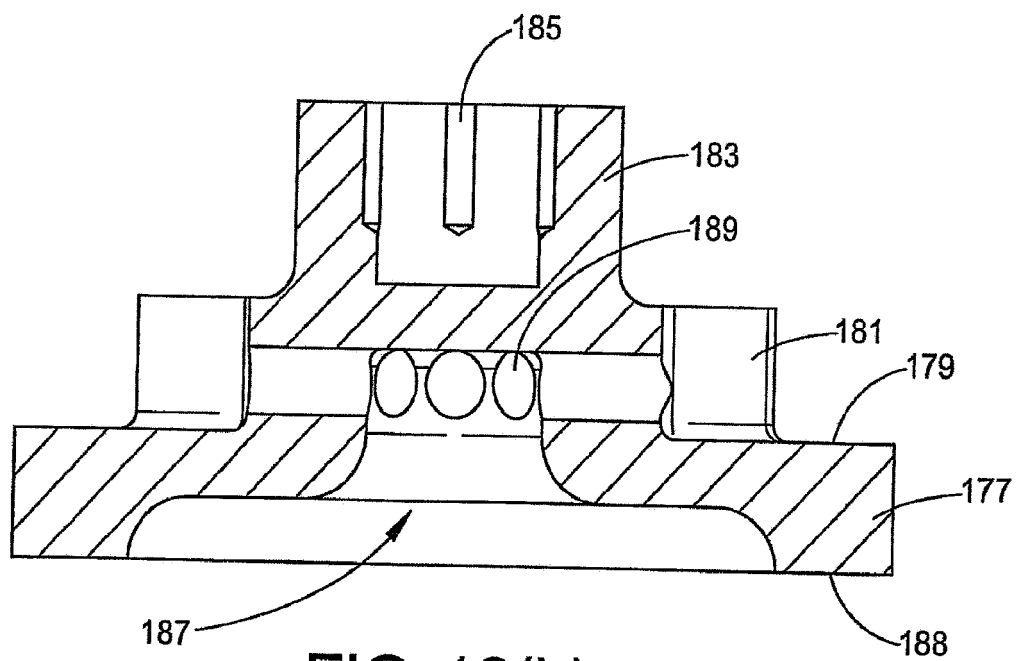


FIG. 12(b)

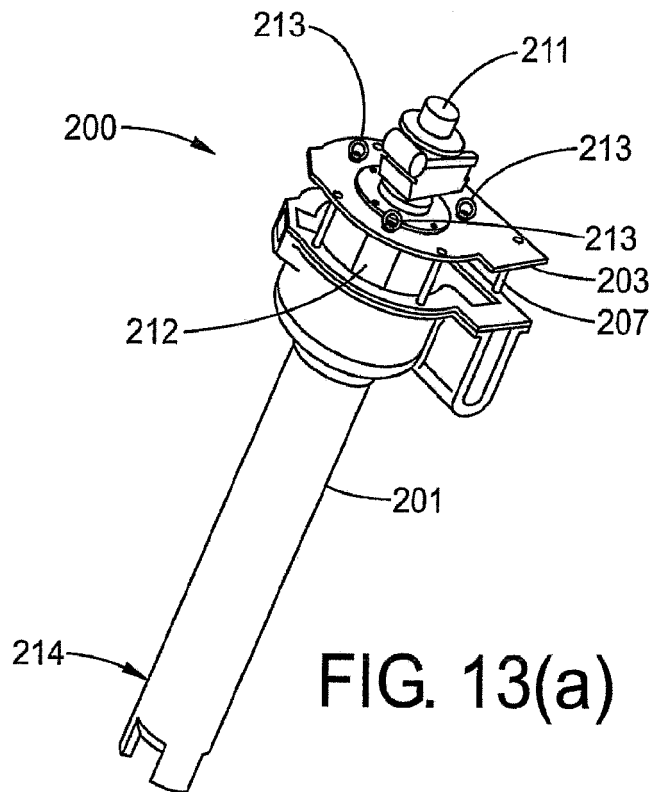


FIG. 13(a)

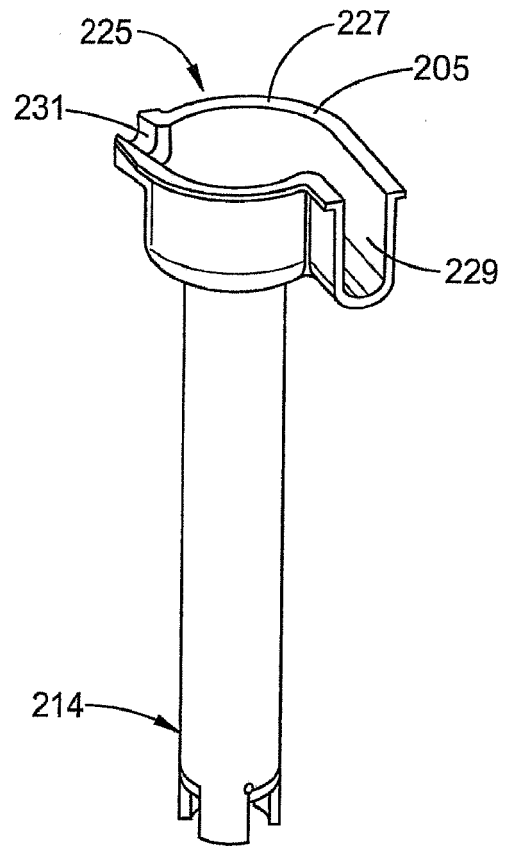


FIG. 13(c)

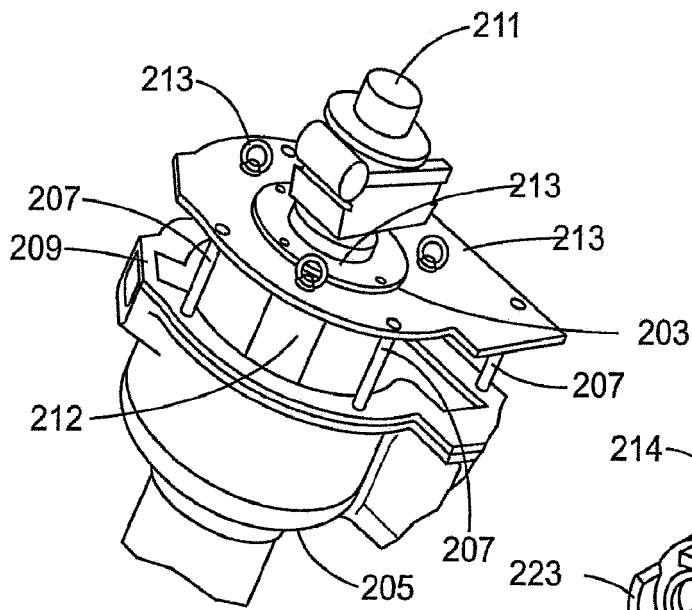


FIG. 13(b)

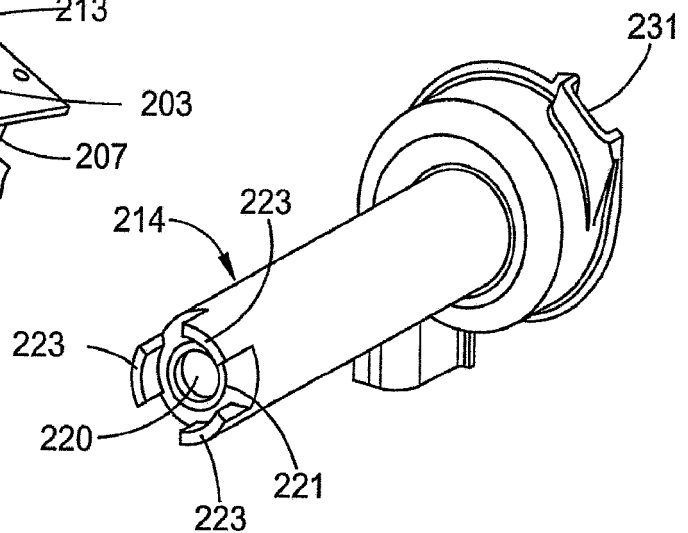


FIG. 13(d)

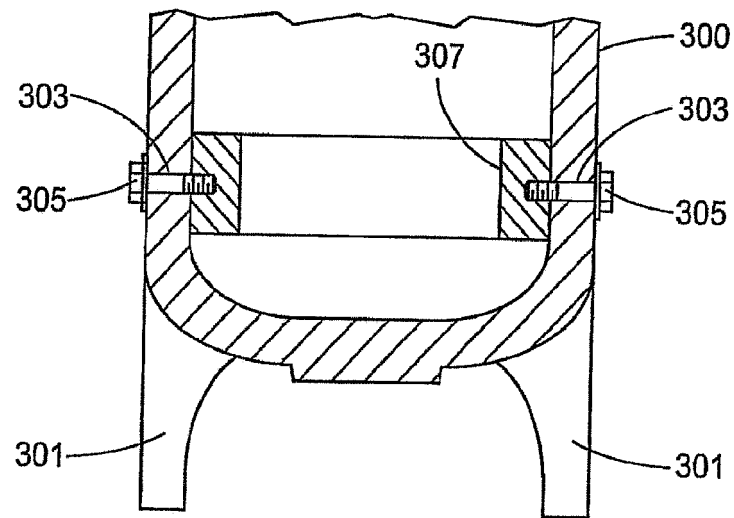


FIG. 14

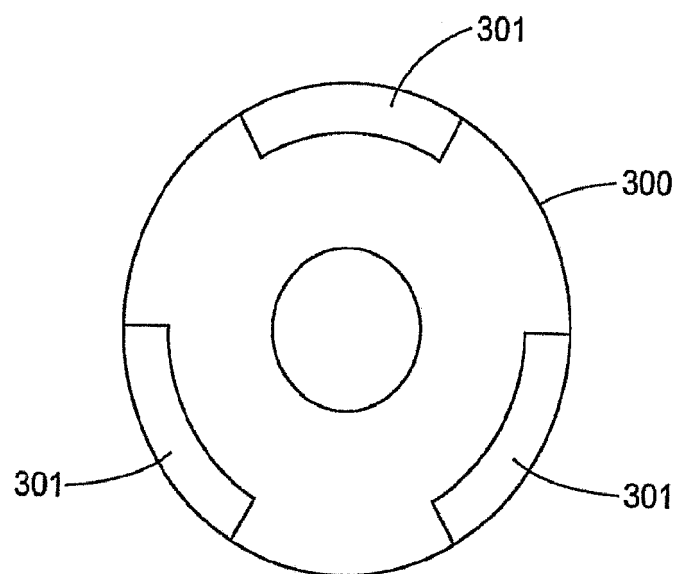


FIG. 15

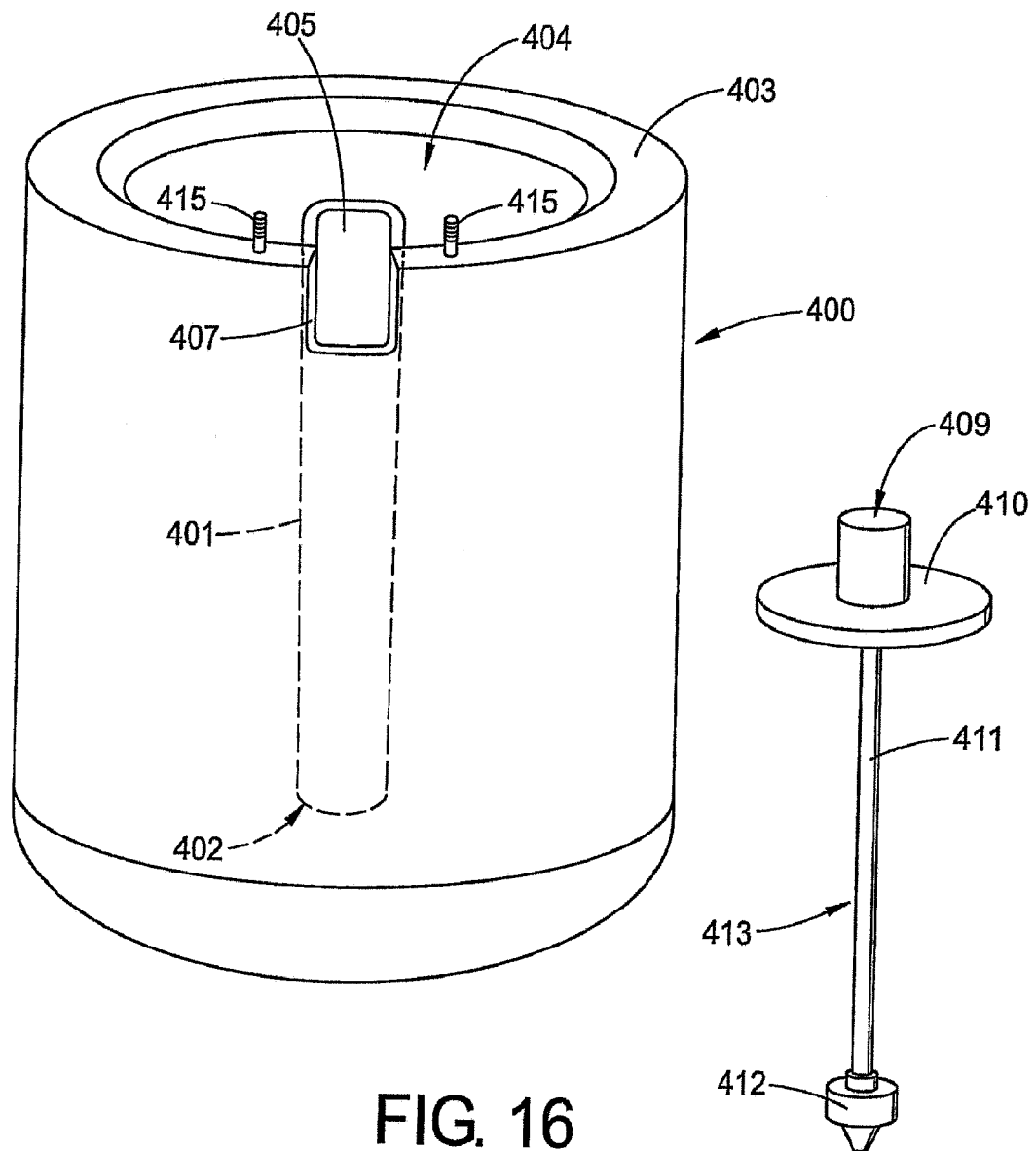


FIG. 16

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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