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(54) Title: FLUID FLOW METER

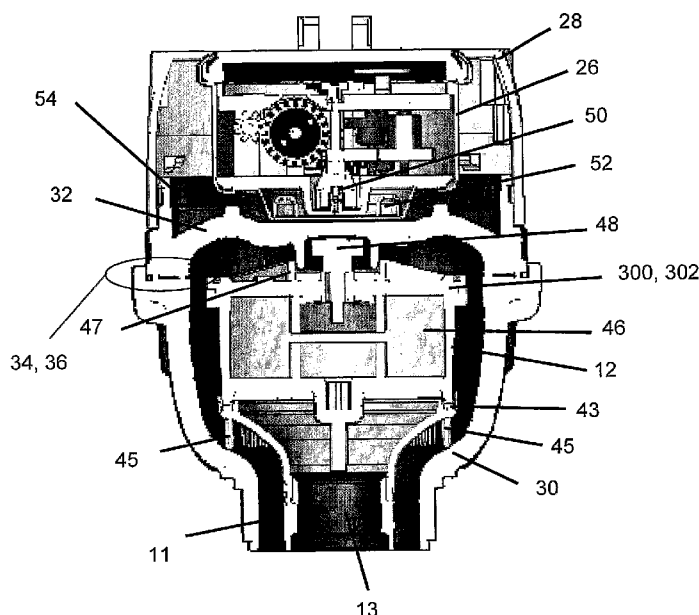


Figure 3

(57) Abstract: A fluid flow meter comprising an outer casing having flow connections adapted to be connected so that in operation fluid to be measured flows through the casing, and a mechanical flow measuring unit (12) disposed in the casing to measure said flow through the casing, the casing being of plastics material and in at least two parts (30, 32) which are permanently bonded or connected together (at 34, 36) to enclose the measuring unit.





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FLUID FLOW METER

This invention relates to fluid flow meters, such as mechanical or electromagnetic, fluid oscillator or ultrasonic flow meters, and to a method of manufacturing same. By "mechanical" we mean a flow meter which has a moving part, the movement of which is utilised as a measure of the flow. The moving part may be a rotor which in the case of a volumetric flow meter successively transfers defined volumes of fluid from an inlet to an outlet. The rotation of the rotor thus is directly proportional to the volume of fluid passing through the meter. The invention has particular relevance to precision measuring devices (whether or not they contain moving parts) held within a pressure vessel.

Volumetric flow meters are supplied in large numbers for water metering applications, particularly for domestic consumers. It thus is important that the unit cost of such meters is kept low, that they are reliable throughout their long service lives, and that they are non-polluting.

The preferred embodiments of the invention seek to address these requirements.

In a first aspect, the invention provides a fluid flow meter comprising an outer casing having flow connections adapted to be connected so that in operation fluid to be measured flows through the casing, and a mechanical flow measuring means disposed in the casing to measure said flow through the casing, the casing being of plastics material and in at least two parts which are permanently bonded, or connected, together to enclose the measuring means, wherein at least one of the casing parts bears upon the measuring means.

The term "permanently" preferably includes any form of permanent bond (or connection), and in particular connotes an irreversible bond (or connection), for example welding. The connection preferably includes connections such as bolting, screwing or riveting.

Preferably, the mechanical flow measuring means comprises at least one of a piston, a rotor and a vane.

Preferably, the casing part bears upon the measuring means to seal it against means defining a flow path between the measuring means and at least one of said flow connections.

- 5 Preferably, the measuring means comprises a rotor, rotation of which is indicative of the flow, and means for communicating said rotation or a measurement thereof non-mechanically to a register means. More preferably, the rotation or a measurement thereof is communicated via one of a magnetic coupling, a mechanical coupling, or an inductive coupling.

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Preferably, the rotor is disposed in a chamber, the chamber having an opening in an end face thereof, the defining means sealing against said end face.

- 15 Preferably, the flow measuring means includes a housing for the flow measuring means, said housing being in at least two parts, and disposed in the outer casing; said outer casing bears on each said part of said housing, and the at least two parts of the outer casing, by being permanently bonded or connected together, both enclose said housing and seal said at least two parts of the housing together.

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- In a second aspect, the invention provides a fluid flow meter comprising an outer casing having flow connections adapted to be connected so that in operation fluid to be measured flows through the casing; and flow measuring means, including a housing for the flow measuring means, said housing being in at least two parts, and disposed in the outer casing to measure said flow through the outer casing, wherein said outer casing bears on each said part of said housing, and the outer casing is of plastics material and in at least two parts which are permanently bonded or connected together both to enclose said housing, and to seal said at least two parts of the housing together.

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Preferably, each of said at least two outer casing parts includes at least one formation to bear on a respective one of said at least two housing parts. More preferably, each said at least one formation is a protrusion or a slender web.

- 35 Preferably, the formation comprises at least 3, more preferably 5, slender webs.

Preferably, the formation is substantially annular.

5 Preferably, at least one of said formations is so formed as to both bear on, and positionally locate, said measuring means.

10 Preferably, by bearing on said at least two housing parts said outer casing applies a compression force on such housing parts, and said compression force is borne as a tension force acting through said bond or connection.

15 Preferably, said formation on a first outer casing part has a corresponding formation on a second outer casing part, such that such pair of formations bears on said housing parts without generating a moment of the bearing force on the housing.

20 Preferably, each said housing part comprises a flange portion, each said flange portion cooperating with the other, and said casing parts bear on said flange portions.

25 Preferably, the measuring means is an electromagnetic flow meter.

30 Preferably, said outer casing parts bear on said measuring means to form a sealable flow path from an inlet, through the measuring means, to an outlet of the flow meter.

35 Preferably, said outer casing parts bear on said measuring means to seal said measuring means against the outer casing to resist flow leakage past the measuring means.

40 Preferably, said at least two outer casing parts are permanently bonded or connected together around their edges.

45 Preferably, said at least two outer casing parts form a sealable vessel to enclose the measuring means.

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Preferably, one said outer casing part is a container for receiving the measuring means and a second said outer casing part closes the container to form a sealable vessel. More preferably, the container is cup-shaped and the second outer casing part forms a lid therefore, and/or the second outer casing part is a pressure plate as herein defined.

Preferably, the bonded or connected together casing parts positionally locate the measuring means within the casing.

Preferably, the bond or connection is formed of the same material as said outer casing.

Preferably, the at least two outer casing parts are welded together. More preferably, the at least two outer casing parts are hot-plate welded together.

Preferably, the material in the region of the bond or connection is positioned generally exterior to the interior surface of the at least one outer casing part.

Preferably, the material in the region of the bond or connection is positioned generally interior to the exterior surface of the at least one outer casing part, and is preferably at least partly concealed by the at least one outer casing part.

Preferably, the material in the region of the bond or connection extends into a cavity in the at least one outer casing part.

Preferably, said flow connections are manifold connections.

Preferably, the meter further comprises a register means disposed outside the casing for recording, displaying, processing or transmitting an output from the measuring means.

According to a further aspect of the present invention there is provided a kit of parts for use in manufacturing a flow meter according to any of the preceding claims.

In a third aspect, the invention provides a method of manufacturing a flow meter comprising (i) providing an outer casing having flow connections adapted to be connected so that in operation fluid to be measured flows through the casing, the casing being in of plastics material and in at least two parts (ii) disposing flow
5 measuring means in the outer casing to measure said flow through the outer casing, the flow measuring means including a housing in at least two parts, (iii) compressing the outer casing parts together such that the outer casing bears on each part of the housing, and (iv) permanently bonding or connecting together said at least two parts of the outer casing both to enclose said housing, and to
10 seal said at least two parts of the housing together.

Preferably, two said parts are permanently bonded or connected together around their edges.

15 One said part may be a container for receiving the measuring means and a second said part closes the container to form a sealed vessel.

The container may be cup-shaped and the second part may form a lid therefor.

20 The second part may be pressure plate. The pressure plate may be a structure formed to be relatively weak so as to fracture if the water (or other fluid) in the meter freezes, and as such it may have defined weakening formations, though this is not usually preferred unless there is a specific reason to have a sacrificial component.

25 Preferably, said outer casing part is a container for receiving the measuring means, the method comprising bonding a second said outer casing part to the first outer casing part to close the container to form a sealed vessel.

30 Preferably, the method further comprises causing a said outer casing part to bear upon the measuring means to seal it against means defining a flow path between the measuring means and a said flow connection.

35 Preferably, the method further comprises bonding the two outer casing parts together by welding. More preferably, hot-plate welding the two parts together.

Preferably, said outer casing parts are compressed together until a predetermined limit is reached. More preferably, said predetermined limit is at least one weld stop.

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Preferably, at least one formation of material on at least one outer casing part, positioned in the region to be permanently bonded, is used to bond or connect said outer casing parts together.

- 10 Preferably, the method further comprises determining the efficiency of the measuring means with varying compression of the housing.

Preferably, the method further comprises using trial and error to substantially achieve the maximum efficiency of the measuring means when the outer casing is bonded together. More preferably, said trial and error process trials at least one of the following parameters to substantially achieve said maximum efficiency: temperature; casing material; bonding material; amount of bonding material; and weld stop position.

15

- 20 Preferably, the measuring means is a mechanical flow meter or an electromagnetic flow meter.

Register means may be disposed outside the casing for recording, displaying, processing or transmitting an output from the measuring means.

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The measuring means may comprise a rotor, rotation of which is indicative of the flow, and means for communicating said rotation or a measurement thereof non-mechanically to the register means.

- 30 The rotation or the measurement thereof may be communicated via a magnetic coupling.

The bonded-together parts may positionally locate the measuring means within the casing.

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Thus, a said part may bear upon the measuring means to seal it against means defining a flow path between the measuring means and a said flow connection.

5 The rotor may be disposed in a chamber, the chamber having an opening in an end face thereof, the flow-defining means sealing against said end face.

The said flow connections may be manifold connections.

10 The two casing parts may be welded, preferably hot-plate welded, together.

Further features are disclosed in dependent claims.

15 Apparatus and method features may be interchanged as appropriate, and may be provided independently one of another. Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa.

20 The invention will be described, merely by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is an exploded view of a conventional volumetric water meter;

25 Figure 2 is an exploded view of a meter according to the invention;

Figure 3 is a section through an assembled meter as shown in Figure 2;

30 Figure 4 is a section through an alternative version of a meter according to the present invention;

Figure 5 is an enlarged view of the bond area of a meter as shown in Figure 4;

35 Figure 6 is an isometric view of a pressure plate according to the present invention;

Figure 7 is an isometric view of an outer casing part according to the present invention;

5 Figure 8 is a section through an alternative version of the meter according to the present invention, showing the fluid flow path through the meter;

Figure 9 is an enlarged view of the bond area of a meter as shown in Figure 8;

10 Figure 10 is an isometric view of an outer casing part of a meter as shown in Figure 8;

Figure 11 is an alternative section through a meter as shown in Figure 8;

15 Figure 12 is enlarged view of the bond area of a meter as shown in Figure 11; and

Figure 13 diagrammatically illustrates a method according to the invention.

20 Referring to figure 1, this conventional meter is shown in order to demonstrate the simplification achievable by means of the present invention.

The meter comprises a cup-shaped brass body or casing 10 which has concentric inlet and outlet manifold connections in its base for connecting the meter to a standard manifold fitting. The casing contains a measuring chamber
25 assembly 12 to which flow passages are defined by an adaptor 14 to the outer (inlet) manifold connection 11 and the inner (outlet) manifold connection 13.

30 A seal is provided by an O-ring 16 between the measuring chamber assembly 12 and the adaptor 14 to avoid a leakage between the inlet and outlet passages.

The canister 12 and a rotor contained within it are similar to those described in our earlier specification WO94/07111, to which the reader is referred. Indeed the meter of figure 1 is generally very similar to the one illustrated in figure 9 of the earlier specification, except that the latter has in-line rather than manifold
35 connections.

The chamber 12 is located in the casing 10 by a stainless steel pressure plate 18 which bears upon the top of the chamber 12 via a spacer ring 20 and O- ring 22. A polymer screw ring 24 threadedly engages the top of the casing 10 to load the pressure plate 18, spacer 20, chamber 12 and adaptor 14 axially against the casing 10 to maintain their relative dispositions and in particular to maintain the integrity of the O-ring seals 16, 22.

A register 26 such as described in our earlier specification (GB 2422933-A) is provided above the pressure plate to sense and record rotation of the rotor, and is protected from the environment by a cover or shroud 28.

The casing 10 is a casting machined where necessary to provide complementary threads and in the case of the casing 10 also to provide mating surfaces for the adaptor 14 and the external manifold connector 11, 13. The pressure plate 18 is a stamping.

Referring to figure 2, the simplification achieved by the present invention is evident. Corresponding parts which are unchanged in function have the same reference numerals throughout. The casing 30, instead of being a machined brass casting, is an injection moulded plastics component of a thermoplastic material, such as Acetyl, Nylon or Polyphenylene Sulfide (PPS) based plastics material. It generally requires no machining (except for example for machining feeds and the like), and is used essentially in its as-moulded condition. The prior art steel pressure plate 18, the spacer 20, the seal 22 and the screw ring 24 are replaced by a single pressure plate component 32 which performs the function of all four. The pressure plate 32 is of the same plastics material as the casing 30, and is permanently hot-plate welded to it as described hereafter around facing edge surfaces (weld surfaces) 34, 36 of the two components as shown in figure 3.

The rotor 46 within the chamber 12 is coupled via its mounting spindle to a two-pole magnet 48. This magnet forms a magnetic coupling with a further magnet 50 mounted on an input drive spindle of the register within the canister containing the register 26; a mild steel ring 52 prevents tampering with the register by

shielding it from external magnetic fields. Alternatively, the rotor 46 is coupled to the input drive spindle of the register mechanically or inductively.

5 The shroud 28 is a snap-fit on an upstanding flange 54 of the pressure plate and is fitted with a tamper-evident seal to prevent interference with the register.

10 The surface 34 of the casing 30 has four upstanding lugs 38 which may be used during installation of the flow meter. The pressure plate 32 has a number of downwardly-depending formations 606 which bear on the measuring chamber housing 12. The formations locate the housing 12 radially within the outer casing, and act to compress the housing parts, and seal them together. In addition, the formations 606 locate the housing radially within the outer casing. The compression force applied to the housing parts 402, 404 is borne by a tensile force acting through the weld.

15

The weld surfaces 34, 36 are softened during the hot-plate welding step and when the pressure plate 32 is compressed onto the casing 30 are spread to form a continuous pressure-tight weld between those surfaces 34, 36. The annular bonding enables the casing to be rigid, and prevents distortion that otherwise might occur if mechanical fixing means were used. Once welded together the outer casing parts form a sealable vessel, and once installed in situ the meter forms a sealed fluid path from the inlet to the outlet.

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25 The compression step is carefully controlled so that the pressure plate 32 and the casing 30 are correctly positioned axially relative to each other, and the aforementioned formations 406 bear to the correct extent on flanges 300, 302 of the chamber 12 to load it and the adaptor 14 axially against the casing 30. Applying a clamping force to the chamber flanges assists in creating a watertight seal, without distorting the chamber or the measuring mechanism. The clamping force applied to the chamber is controlled to be neither too high that the chamber is distorted, nor too low that the chamber leaks when containing liquids under high pressure, such as 15 or 16 bar, or 25 bar, or even 50 bar ($5 \times 10^6 \text{ N/m}^2$). The chamber 12 is located axially and radially on the adaptor 14 by four lugs 43 which engage conforming recesses 44 in the top of the adaptor. The adaptor 14 has a downwardly extending annular flange 45 which contacts the lower internal

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surface of the casing 30. Thus the assembly of the pressure plate 32, chamber 12, adaptor 14 and casing 30 are accurately clamped together.

5 In the initial testing stages prior to mass-production, the correct clamping force is determined empirically. First, the variation in flow meter efficiency with increasing clamping force applied to the annular flange of the flow meter chamber is determined experimentally. Additionally, the variation of the clamping force applied to the chamber with increasing force used in the hot-plate welding process may be determined, to allow an optimal force to be used during mass
10 manufacture. The expected deflections of the casing may also be calculated, using a technique such as finite element modelling, to determine the expected clamping force when the hot-plate welding force is removed, and/or to determine the required strength of the assembly. These values, and in particular the efficiency values, are later used to optimise the welding process to obtain the
15 optimal efficiency of the flow meter (as described further in the second step below).

Secondly, and again during the initial testing stages, given that the hot-plate weld strength is dependent on the force applied during the welding process, the force
20 applied during the hot weld process itself is optimised for both weld strength and flow meter performance. This is accomplished by varying and thus optimising the parameters of the hot-plate weld process, such as: the weld temperature; casing material; formation 601, 602 size; and weld stop position. These parameters will be discussed in further detail below with reference to Figure 13. Once the
25 optimal parameters are found they are used in the mass-manufacturing process, and in this way a very robust process can be developed that can produce consistently accurate flow meters.

Figure 4 shows a section through an alternative version of a meter, with radial
30 fluid flow as opposed to axial fluid flow. The arrows designate the direction of fluid flow through the meter; not all of the internal flow passages are visible in this particular section. The two parts of the measuring chamber housing 402, 404 are positioned within the outer casing 30, 32 using web formations 406. As described above, the web formations 406 are used to bear on the flanged portions of the
35 housing parts 402, 404 to seal the two portions together. An enlarged view of the

weld area between the two parts of the outer casing can be seen in Figure 5. The web formation 406 can be seen bearing on the flanged portion of the housing part 402, and a corresponding formation 500 bears on the flanged portion of the second housing part 404. In this embodiment, the corresponding formation 500 is in the form of an annulus that bears directly on the flanged portion of the housing part 404, around its entire perimeter. This allows the housing parts to be sealed together without distortion. In an alternative embodiment both of the web formations 406 and 500 are annuli adapted to act on the entire flange of the chamber housing.

Figure 5 also shows the cavities 502, 504 where the excess weld material flows during the hot-plate welding process. The cavities 502, 504 prevent the excess weld from being seen in the case of the external cavity, and from impinging on the fluid flow in the case of the internal cavity. In addition, Figure 5 shows a strainer 506 used to prevent debris fouling the measuring chamber. The strainer is located within the outer casing using an extension of the web formation 406.

Figure 6 shows a detailed isometric view of a version of the pressure plate 32. In particular, the web formations 406 can be seen extending radially from the formation 602 of the pressure plate 32. The web formations 406 have filleted upstanding protrusions 606 that act to locate the chamber housing 12 (not shown) radially, and flat portions adjacent the upstanding protrusions to bear on the chamber housing 12 to create a seal between the two housing parts 402, 404 (not shown). The centre annulus 602 has notches 604, and is used to prevent the fluid flow directly impinging on the spindle 48. In addition, the centre annulus 602 is used as a strengthening member, given that the pressure plate 32 is thinnest in this region to allow the rotor magnet to communicate with the corresponding magnets in the register. The notches 604 aid in allowing trapped air and particulate matter to escape the void created by the annulus 602 when the flow meter is connected to the fluid flow.

Figure 7 shows an isometric view of a version of the meter body 30. The inlet 11 and outlet 13 are shown, together with the fluid flow path (indicated by the arrows). In addition, an annular sacrificial layer 601 can be seen on the weld surface 36.

Figure 8 is an alternative version of the meter shown in Figures 2 and 3, and shows the fluid flow through the meter.

5 Figure 9 is an enlarged view of the bonding region of the meter shown in Figure 8. This figure shows the web formation 406 bearing on the flanged portion of the housing part 402, and the respective web formation 500 bearing on the flanged portion of the housing part 404. The cavities 502, 504 to receive the excess weld material during the hot-plate weld process are as described above.

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Figure 10 shows an isometric view of the body in an alternative version of the meter shown in Figures 2 and 3. The formations 500 that bear on the housing part 404 (not shown) are in the form of indentations in the main body. In this embodiment, each web formation 406 has a respective corresponding formation 15 500 that is located directly beneath and in line with it. This allows the housing parts to be sealed together without distortion.

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Figures 11 and 12 show an alternative section through a meter as shown in Figure 8, and the corresponding enlarged view of the bond area. The features shown are as described above.

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Hot-plate welding is known *per se*. However, hot-plate welding has not been applied, for example, to the present technique of sealing the outer casing, and simultaneously sealing the internal measuring chamber. The technique as so applied is described with reference to figure 13, which is based on material available on the website of TWI Limited (www.twi.co.uk).

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In general terms, the kit of parts including the outer casing parts, measuring chamber housing parts (and associated mechanisms), and various inserts are brought together in the hot-plate welding process, and once the register is snapped in place the finished product is complete.

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In more detail, in the first stage (1) of the process the casing 30 and the pressure plate 32 (shown diagrammatically) are placed in upper and lower holding fixtures 56, 58. The chamber 12 and adaptor 14 (not shown) are placed in position inside

the casing 30. In the second stage (2) a heating plate 60 is inserted between the upper and lower fixtures. The plate typically has an internal electrical heating element and is coated with PTFE so that molten plastics material will not adhere to it. Although not illustrated, the plate 60 in practice is shaped to clear the top of the chamber 12. Indeed the plates conveniently can be annular.

In the third stage (3) the upper and lower fixtures are closed to press the circumferential faces 34, 36 of the casing and the pressure plate against the hot plate, to soften them. Melt stops 62 and weld stops 64 on the hot plate and the fixtures together limit the compression of the pressure plate and casing. In the fourth stage (4) the fixtures 56, 58 are opened, and the heating plates 60 is withdrawn. In the fifth stage (5), the fixtures are brought together to an extent limited by the weld stops 64 to compress the faces 34, 36 of the casing and pressure plate together, and to spread the formations 600, 601 and form a continuous pressure-tight welded joint between the faces 34, 36. During this stage of the operation the webs formations 406 of the pressure plate are brought into contact with the chamber 12 to load it and the adaptor 14 against the casing 30 so that together they provide a leak-proof fluid flow path from the manifold inlet 11 (figure 3), through the adaptor to the chamber, through the chamber and back through the adaptor to the manifold outlet 13. Thus, in a single process the flow meter casing, and the outer casing are sealed.

The weld stops 64 enable this assembly step to be achieved with precision and repeatably from meter to meter during production. Finally, in stage (6) the fixtures are opened, and the new assembled meter is removed and sent to have its register 26 and shroud 28 fitted.

The configuration of the layers of plastic material on the annular flange, shown as formations 600, 601, and sacrificed in the hot-plate welding process, is important. The sacrificial layers are heated by the hot-plate, and then used to permanently weld the two parts of the outer casing together. In order to ensure that the weld is of sufficient strength, but does not extend beyond the weld area, the width and height of the layer is controlled accurately. As can be seen in Figure 5, the sacrificial layers 600, 601 have a width X, and a height Y; the width of the sacrificial layers will generally be less than the wall thickness of the casing. For

example, if the casing wall thickness is 5mm, the width X might be 2mm, and the height Y might be 1mm. The sides of the sacrificial layers are sloped to aid in the welding process. In addition, the area surrounding the layers 600, 601 is adapted to allow the layers to extrude between the two parts of the casing without intruding inwardly into the main volume of the casing, and without extruding outwardly past the edges of the casing. This is accomplished using internal and external cavities 502, 504 to accept the weld bead.

The use of the invention as specifically described brings a number of advantages:

- reduced material cost compared to brass;
- no need for a machined threaded connection between the pressure plate 32 and the casing 30;
- the welded joint 34, 36 acts as a pressure seal, avoiding the need for an O-ring between the pressure plate and the casing;
- there is better control of the assembly and clamping of the chamber 12 and adaptor 14, avoiding the need for an O-ring between them;
- because the pressure plate 32 is not rotated during assembly there is no risk that the chamber 12 may become twisted, as sometimes happens during assembly of a conventional meter;
- the parts of the components 30, 32 adjacent the welded joint are substantially unstressed, unlike the threaded parts forming the mechanical joint in a conventional meter;
- the fixing of the pressure plate in a conventional meter lacks rigidity due to the presence of the O-ring. Here the fixing is encastré due to the welded joint, and a more rigid structure results; and
- the meter can be made almost entirely of plastics, and thus can more easily be made compliant with the EU Water Quality Directive, and is readily recyclable at the end of its life.

Although hot-plate welding is preferred, other methods of permanently bonding the pressure plate 32 to the casing 30 may be employed, depending on the material of which the components are made. For example an adhesive (either hot-melt or cold) may be used, or a solvent may be used to soften the faces 34, 36 and the formations 600, 601 which are then pressed together using fixtures

such as 56, 58. Then an effectively cold-welded joint results. Alternatively, an electronic welding process can be used to permanently bond the pressure plate to the casing.

- 5 If preferred, the chamber 12 and adaptor 14 may be inserted into the casing 30 at the fourth stage rather than the first stage of the welding process shown in figure 13.

- 10 Although described in the context of a volumetric (positive displacement) water meter, the invention may also be applied to other mechanical or electromagnetic meters, for example inferential, single jet, multi-jet and turbine types, and is suitable for both liquid and gas meters. Also other forms of register may be used, for example ones providing telemetry or other remote reading instead of or in addition to a local display, or an electronic rather than mechanical display.
- 15 Instantaneous flow rather than total flow (integrated) outputs also can be provided for process control applications.

- Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently
- 20 of other disclosed and/or illustrated features. In particular but without limitation the features of any of the claims dependent from a particular independent claim may be introduced into that independent claim in any combination.

- Statements in this specification of the "objects of the invention" relate to preferred
- 25 embodiments of the invention, but not necessarily to all embodiments of the invention falling within the claims.

- It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiments which are described by way of example
- 30 only, and modifications of detail can be made within the scope of the invention.

The text of the abstract filed herewith is hereby incorporated within the body of the specification.

CLAIMS

- 5 1. A fluid flow meter comprising an outer casing having flow connections adapted to be connected so that in operation fluid to be measured flows through the casing, and a mechanical flow measuring means disposed in the casing to measure said flow through the casing, the casing being of plastics material and in at least two parts which are permanently bonded,
10 or connected, together to enclose the measuring means, wherein at least one of said casing parts bears upon the measuring means.
2. A meter according to Claim 1, wherein at least one of said casing parts bears upon the measuring means to seal it against means defining a flow
15 path between the measuring means and at least one of said flow connections.
3. A meter according to claim 1 or 2, wherein the mechanical flow measuring means comprises at least one of a piston, a rotor and a vane.
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4. A meter according to claim 1, 2 or 3, wherein the measuring means comprises a rotor, rotation of which is indicative of the flow, and means for communicating said rotation or a measurement thereof non-mechanically to a register means.
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5. A meter according to claim 4, wherein the rotation or a measurement thereof is communicated via one of a magnetic coupling, a mechanical coupling, and an inductive coupling.
- 30 6. A meter according to claim 4 or 5 when dependent from claim 3, wherein the rotor is disposed in a chamber, the chamber having an opening in an end face thereof, the defining means sealing against said end face.
7. A meter according to any of the preceding claims, wherein:

the flow measuring means includes a housing for the flow measuring means, said housing being in at least two parts, and disposed in the outer casing;

said outer casing bears on each said part of said housing, and

5 the at least two parts of the outer casing, by being permanently bonded or connected together, both enclose said housing and seal said at least two parts of the housing together.

10 8. A meter according to claim 7, wherein each of said at least two outer casing parts includes at least one formation to bear on a respective one of said at least two housing parts.

15 9. A meter according to claim 8, wherein each said at least one formation is a protrusion.

10. A meter according to claim 8 or 9, wherein each said at least one formation is a slender web.

20 11. A meter according to claim 10, comprising at least 3, preferably 5, slender webs.

12. A meter according to claim 8 or 9, wherein said formation is substantially annular.

25 13. A meter according to any of claims 8 to 12, wherein at least one of said formations is so formed as to both bear on, and positionally locate, said measuring means.

30 14. A meter according to any of claims 7 to 13, wherein by bearing on said at least two housing parts said outer casing applies a compression force on such housing parts, and said compression force is borne as a tension force acting through said bond or connection.

35 15. A meter according to any of claims 8 to 14, wherein said formation on a first outer casing part has a corresponding formation on a second outer

casing part, such that such pair of formations bears on said housing parts without generating a moment of the bearing force on the housing.

- 5 16. A meter according to any of claims 7 to 15, wherein each said housing part comprises a flange portion, each said flange portion cooperating with the other, and said casing parts bear on said flange portions.
- 10 17. A meter according to any of claims 7 to 16, wherein the measuring means is one of an electromagnetic flow meter, a mechanical flow meter, or an inductive flow meter.
- 15 18. A meter according to any of the preceding claims, wherein said outer casing parts bear on said measuring means to form a sealable flow path from an inlet, through the measuring means, to an outlet of the flow meter.
19. A meter according to any of the preceding claims, wherein said outer casing parts bear on said measuring means to seal said measuring means against the outer casing to resist flow leakage past the measuring means.
- 20 20. A meter according to any of the preceding claims, wherein said at least two outer casing parts are permanently bonded or connected together around their edges.
- 25 21. A meter according to any of the preceding claims, wherein said at least two outer casing parts form a sealable vessel to enclose the measuring means.
- 30 22. A meter according to any of the preceding claims, wherein one said outer casing part is a container for receiving the measuring means and a second said outer casing part closes the container to form a sealable vessel.
23. A meter according to claim 22, wherein the container is cup-shaped and the second outer casing part forms a lid therefor.

24. A meter according to claim 22 or 23, wherein the second outer casing part is a pressure plate as herein defined.

25. A meter according to any of the preceding claims, wherein the bonded or connected together casing parts positionally locate the measuring means within the casing.

26. A meter according to any of the preceding claims, wherein the bond or connection is formed of the same material as said outer casing.

27. A meter according to any of the preceding claims, wherein the at least two outer casing parts are welded together.

28. A meter according to claim 27, wherein said at least two outer casing parts are hot-plate welded together.

29. A meter according to any of the preceding claims, wherein the material in the region of the bond or connection is positioned generally exterior to the interior surface of the at least one outer casing part.

30. A meter according to any of the preceding claims, wherein the material in the region of the bond or connection is positioned generally interior to the exterior surface of the at least one outer casing part, and is preferably at least partly concealed by the at least one outer casing part.

31. A meter according to any of the preceding claims, wherein the material in the region of the bond or connection extends into a cavity in the at least one outer casing part.

32. A meter according to any of the preceding claims, wherein said flow connections are manifold connections.

33. A meter according to any of the preceding claims, further comprising register means disposed outside the casing for recording, displaying, processing or transmitting an output from the measuring means.

34. A kit of parts for use in manufacturing a flow meter according to any of the preceding claims.

5 35. A method of manufacturing a flow meter comprising:

providing an outer casing having flow connections adapted to be connected so that in operation fluid to be measured flows through the casing, the casing being of plastics material and in at least two parts;

10 disposing flow measuring means in the outer casing to measure said flow through the outer casing, the flow measuring means including a housing in at least two parts;

compressing the outer casing parts together such that the outer casing bears on each part of the housing; and

15 permanently bonding or connecting together said at least two parts of the outer casing both to enclose said housing, and to seal said at least two parts of the housing together.

36. A method according to claim 35 comprising permanently bonding or connecting the two said outer casing parts together around their edges.

20

37. A method according to claim 35 or 36, wherein said at least two outer casing parts form a sealable vessel to enclose the measuring means.

38. A method according to claim 35, 36 or 37, wherein a said outer casing part is a container for receiving the measuring means, the method comprising bonding a second said outer casing part to the first outer casing part to close the container to form a sealed vessel.

25

39. A method according to claim 38, wherein the container is cup-shaped and the second outer casing part forms a lid therefor.

30

40. A method according to claim 38 or claim 39, wherein the second outer casing part is a pressure plate as herein defined.

41. A method according to any of claims 35 to 40 comprising bonding the two outer casing parts together to locate the measuring means positionally within the outer casing.
- 5 42. A method according to any of claims 35 to 41 comprising causing a said outer casing part to bear upon the measuring means to seal it against means defining a flow path between the measuring means and a said flow connection.
- 10 43. A method according to any of claims 35 to 42, comprising bonding the two outer casing parts together by welding.
44. A method according to claim 43 comprising hot-plate welding the two parts together.
- 15 45. A method according to any of claims 35 to 44, wherein said outer casing parts are compressed together until a predetermined limit is reached.
46. A method according to claim 45, wherein said predetermined limit is at least one weld stop.
- 20 47. A method according to any of claims 35 to 46, wherein at least one formation of material on at least one outer casing part, positioned in the region to be permanently bonded, is used to bond or connect said outer casing parts together.
- 25 48. A method according to any of claims 35 to 47, comprising determining the efficiency of the measuring means with varying compression of the housing.
- 30 49. A method according to claim 48, comprising using trial and error to substantially achieve the maximum efficiency of the measuring means when the outer casing is bonded together.

50. A method according to claim 49, wherein said trial and error process trials at least one of the following parameters to substantially achieve said maximum efficiency: temperature; casing material; bonding material; amount of bonding material; and weld stop position.
- 5
51. A method according to any of claims 35 to 50, wherein the measuring means is a mechanical flow meter.
- 10
52. A method according to any of claims 35 to 50, wherein the measuring means is an electromagnetic flow meter.
53. A fluid flow meter substantially as herein described with reference to any of figures 2 and 3, or 4 to 7, or 8 to 12, of the accompanying drawings.
- 15
54. A method of manufacturing a fluid flow meter substantially as herein described with reference to figure 13 of the accompanying drawings.

1/13

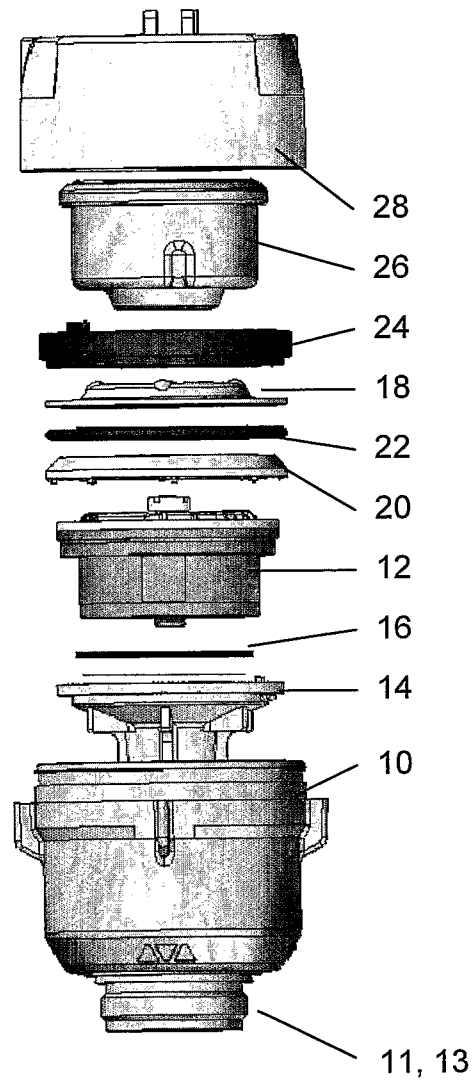


Figure 1 (prior art)

2/13

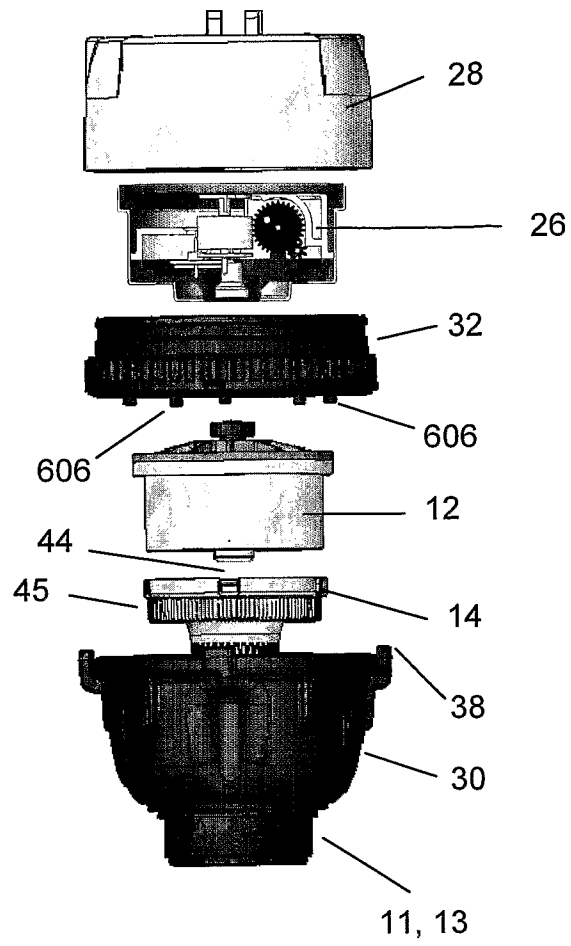


Figure 2

3/13

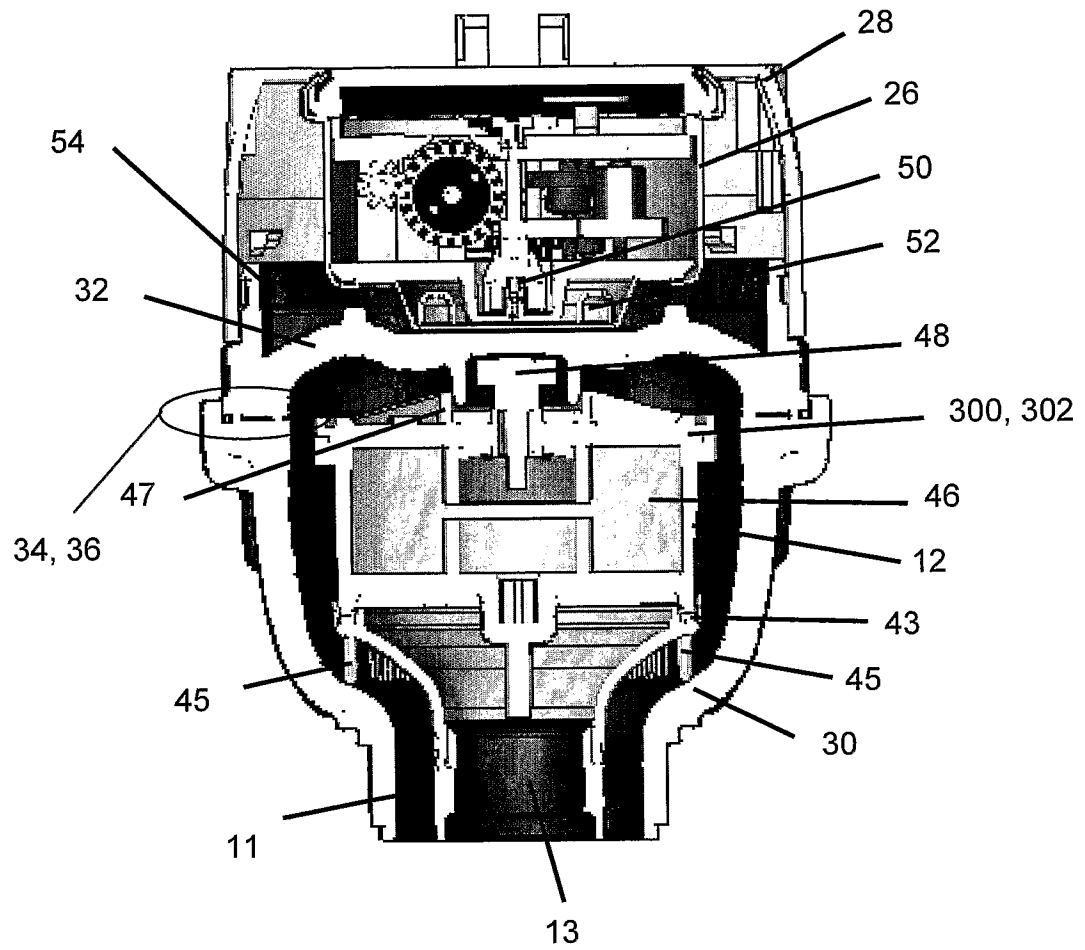


Figure 3

4/13

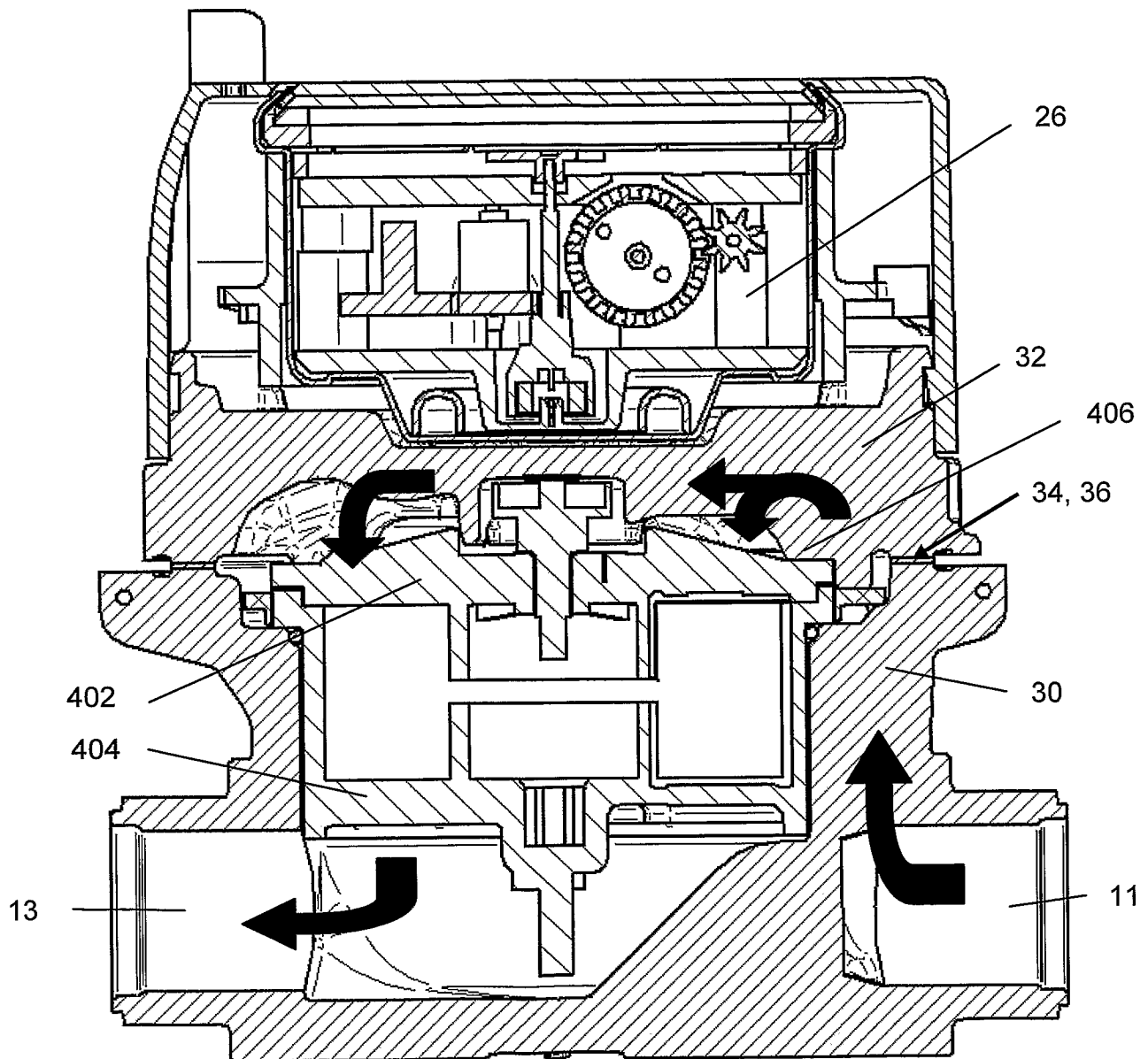


Figure 4

5/13

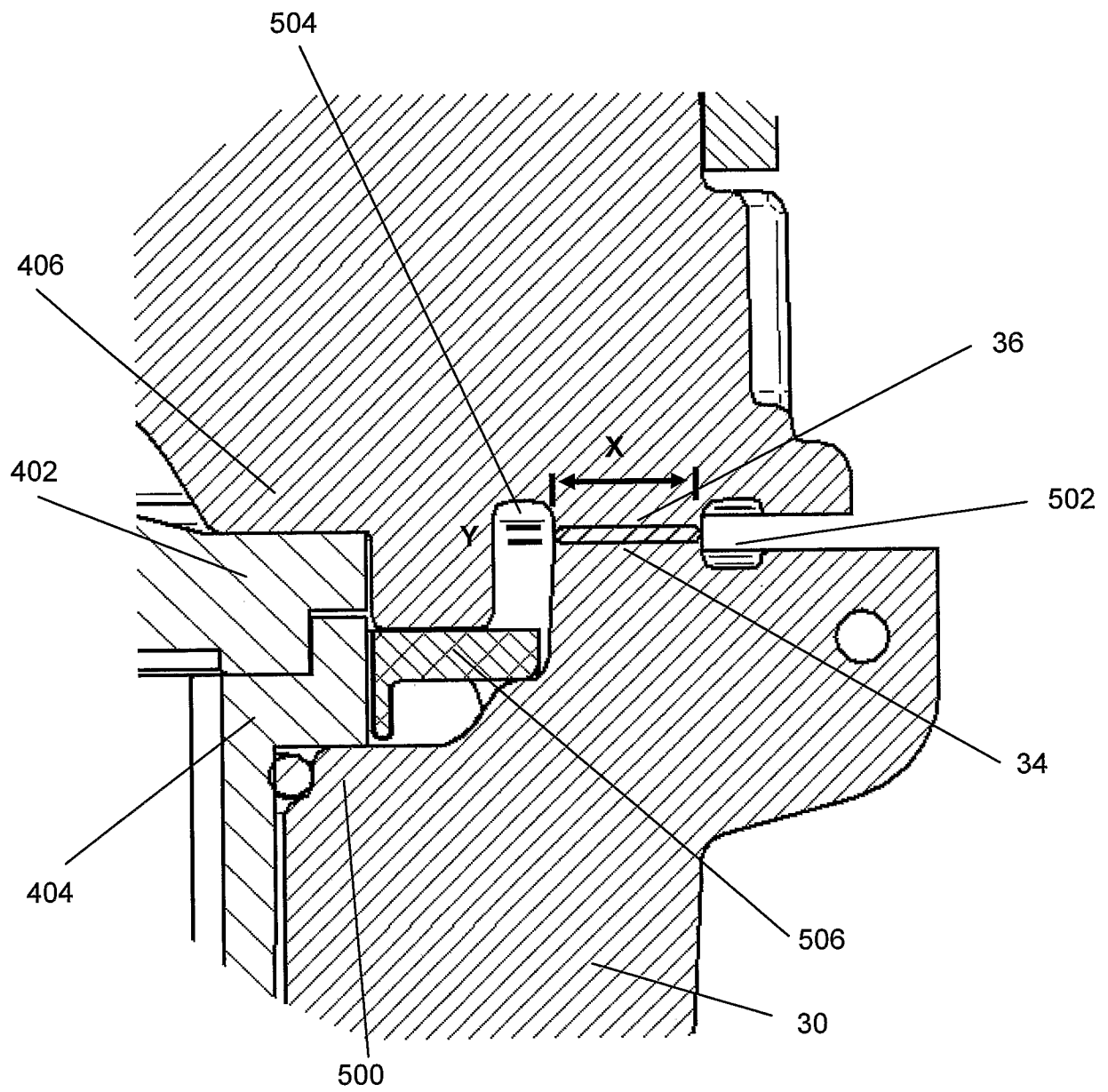


Figure 5

6/13

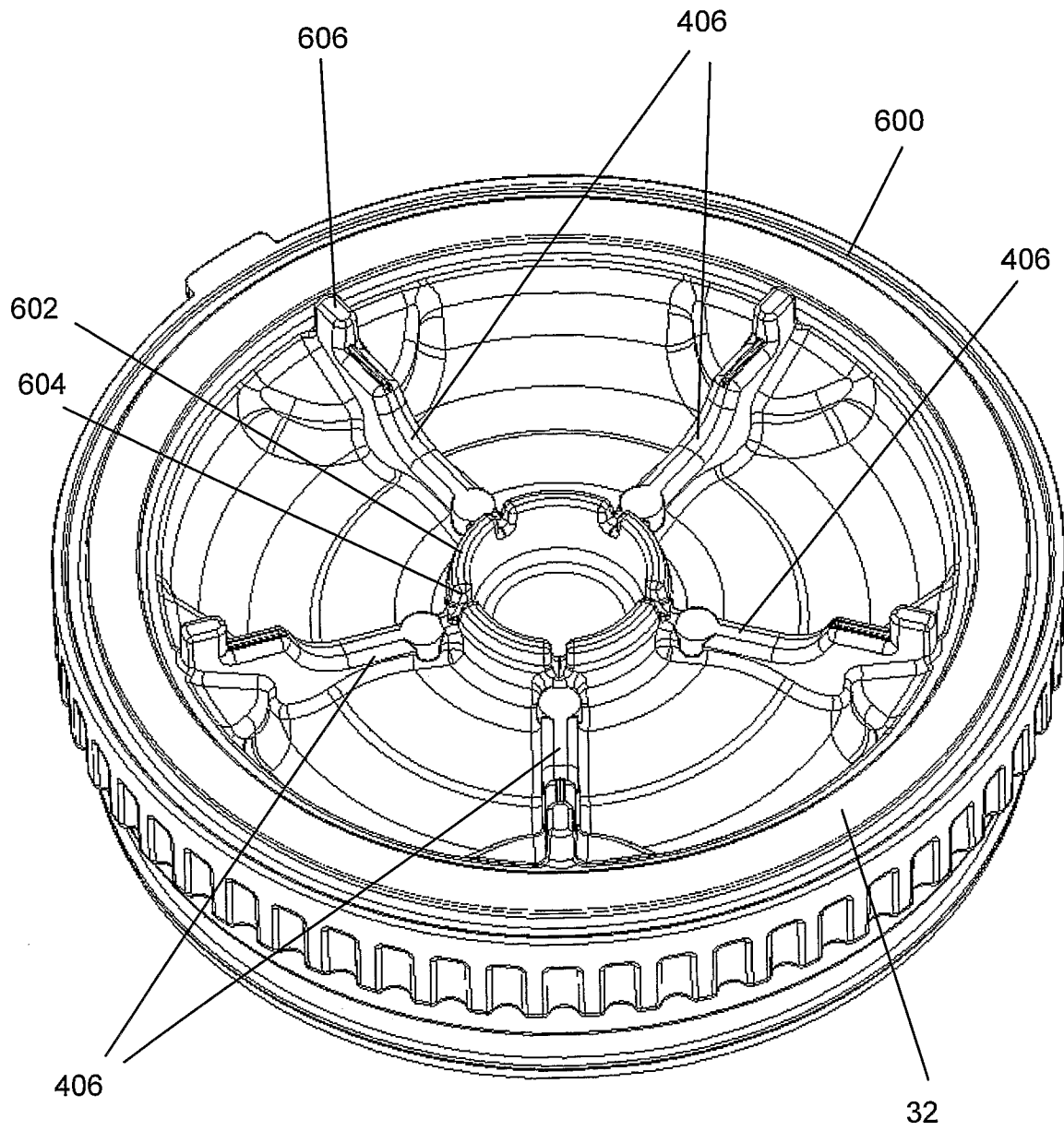


Figure 6

7/13

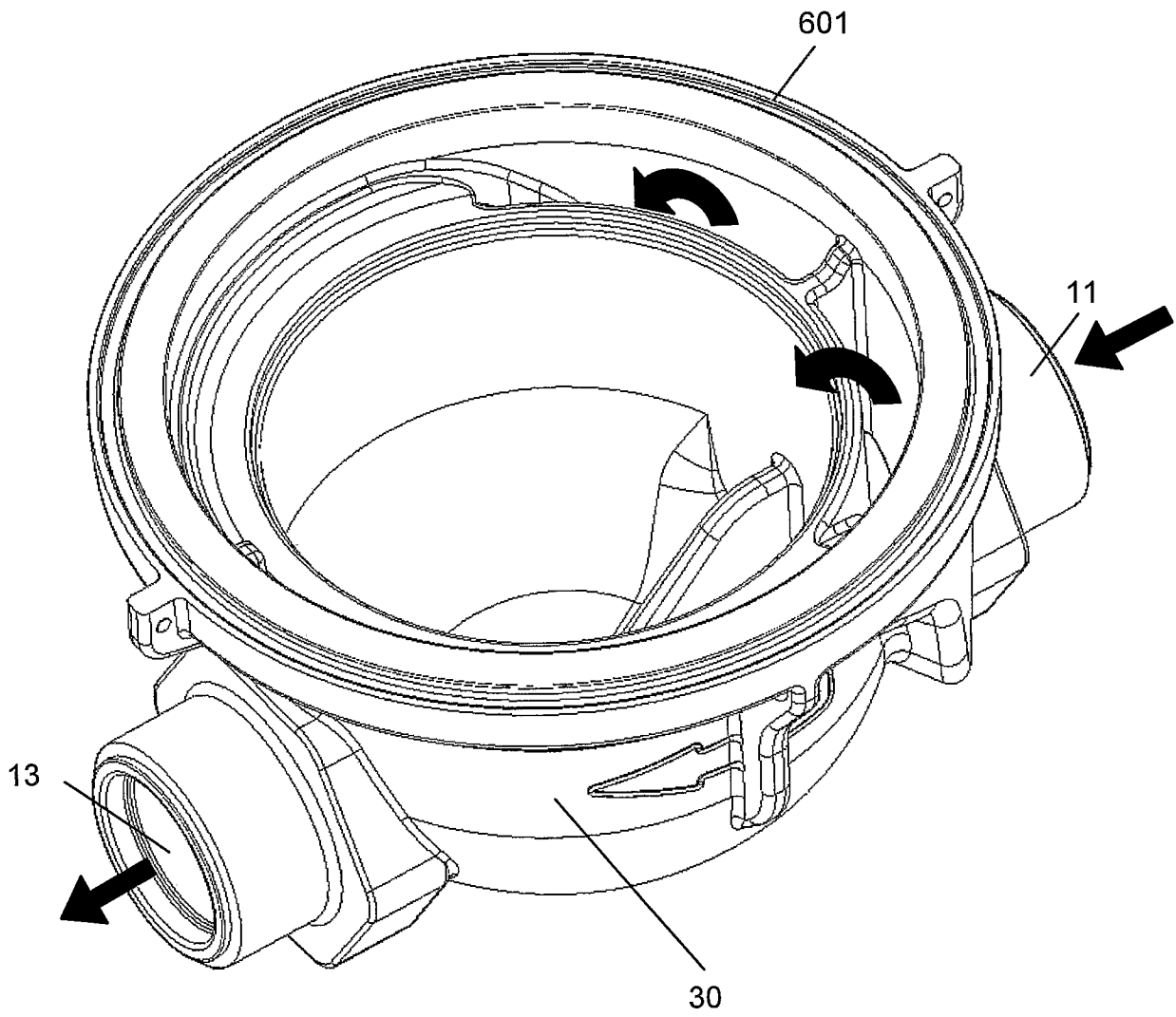


Figure 7

8/13

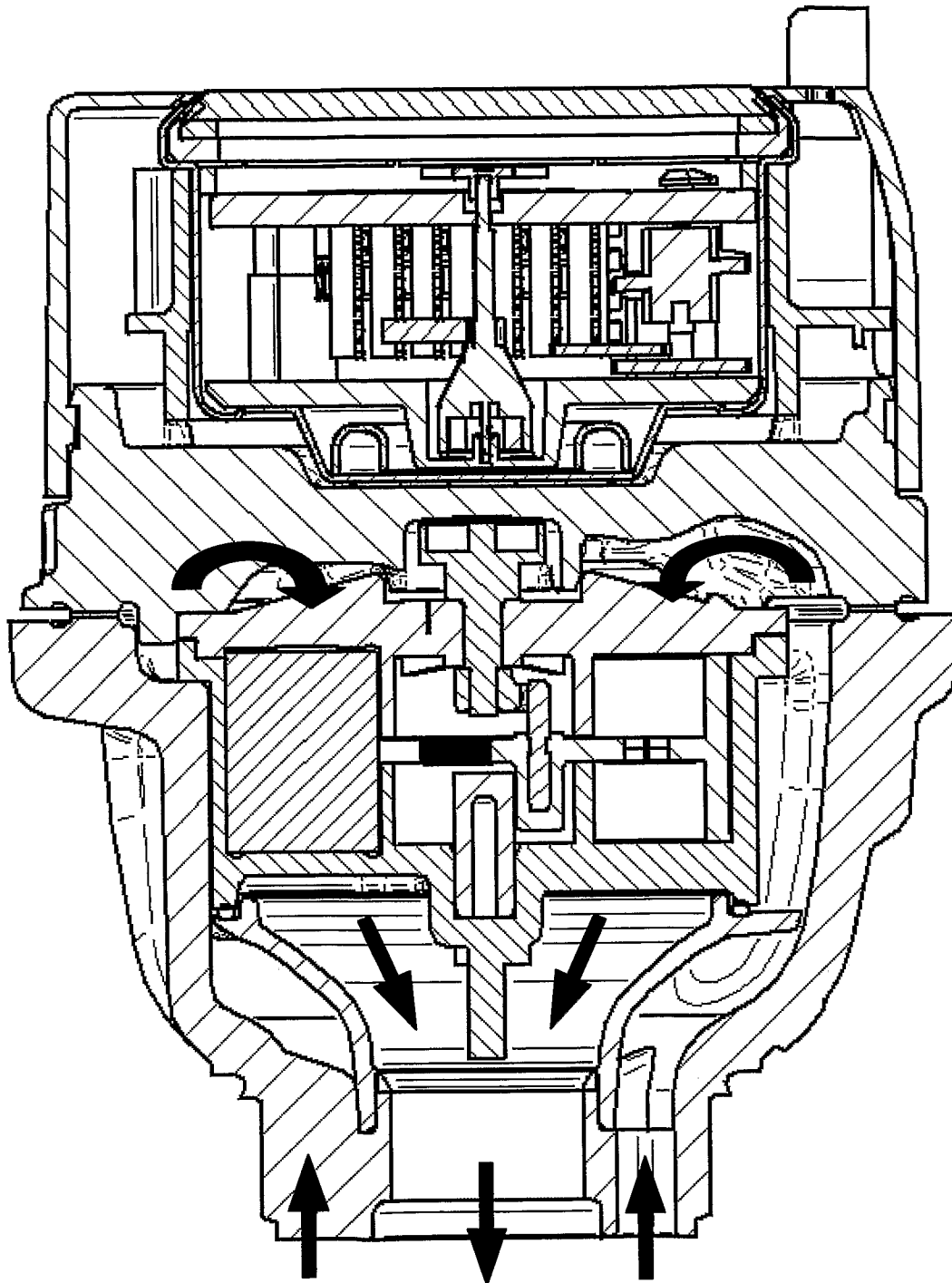


Figure 8

9/13

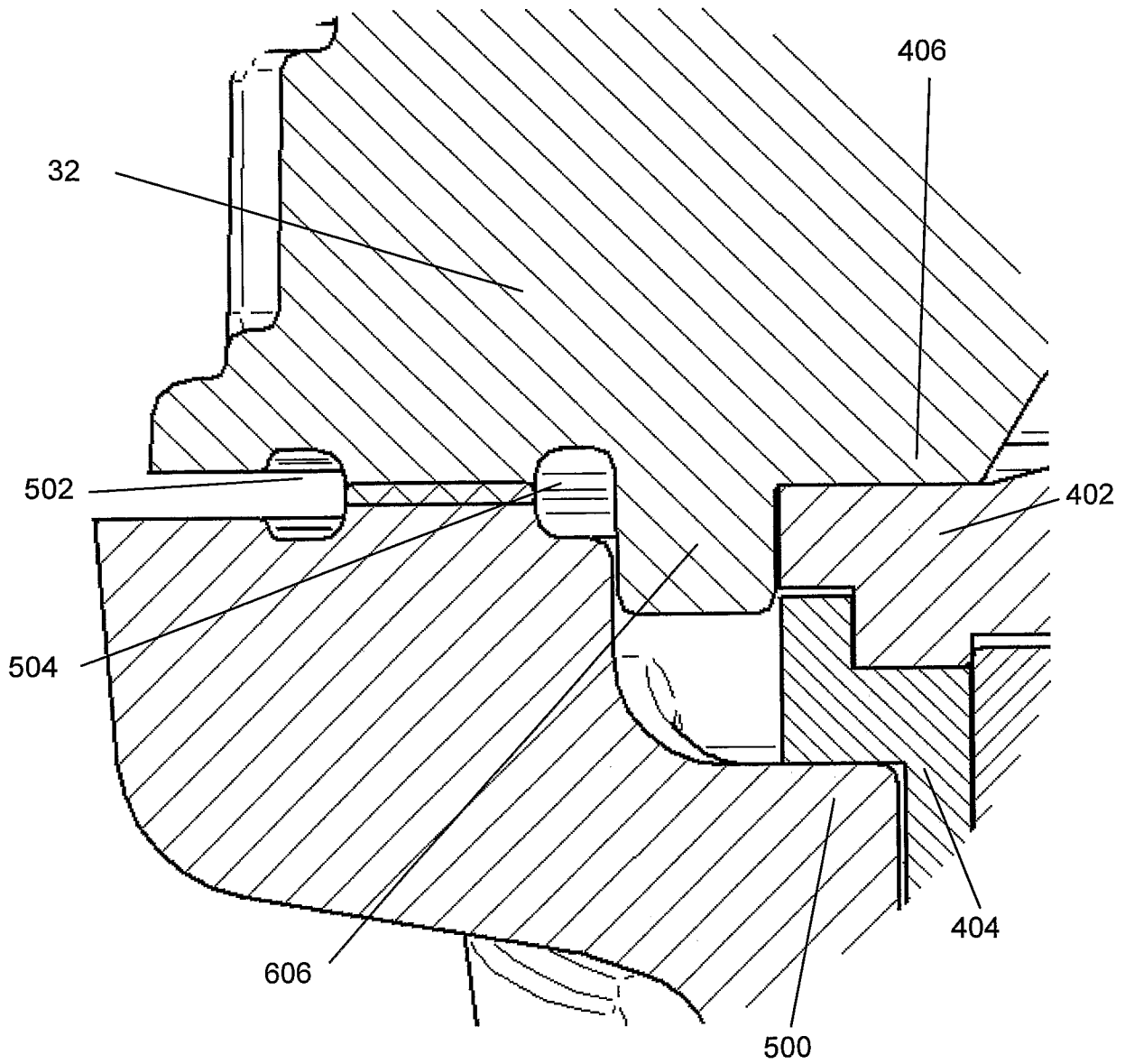


Figure 9

10/13

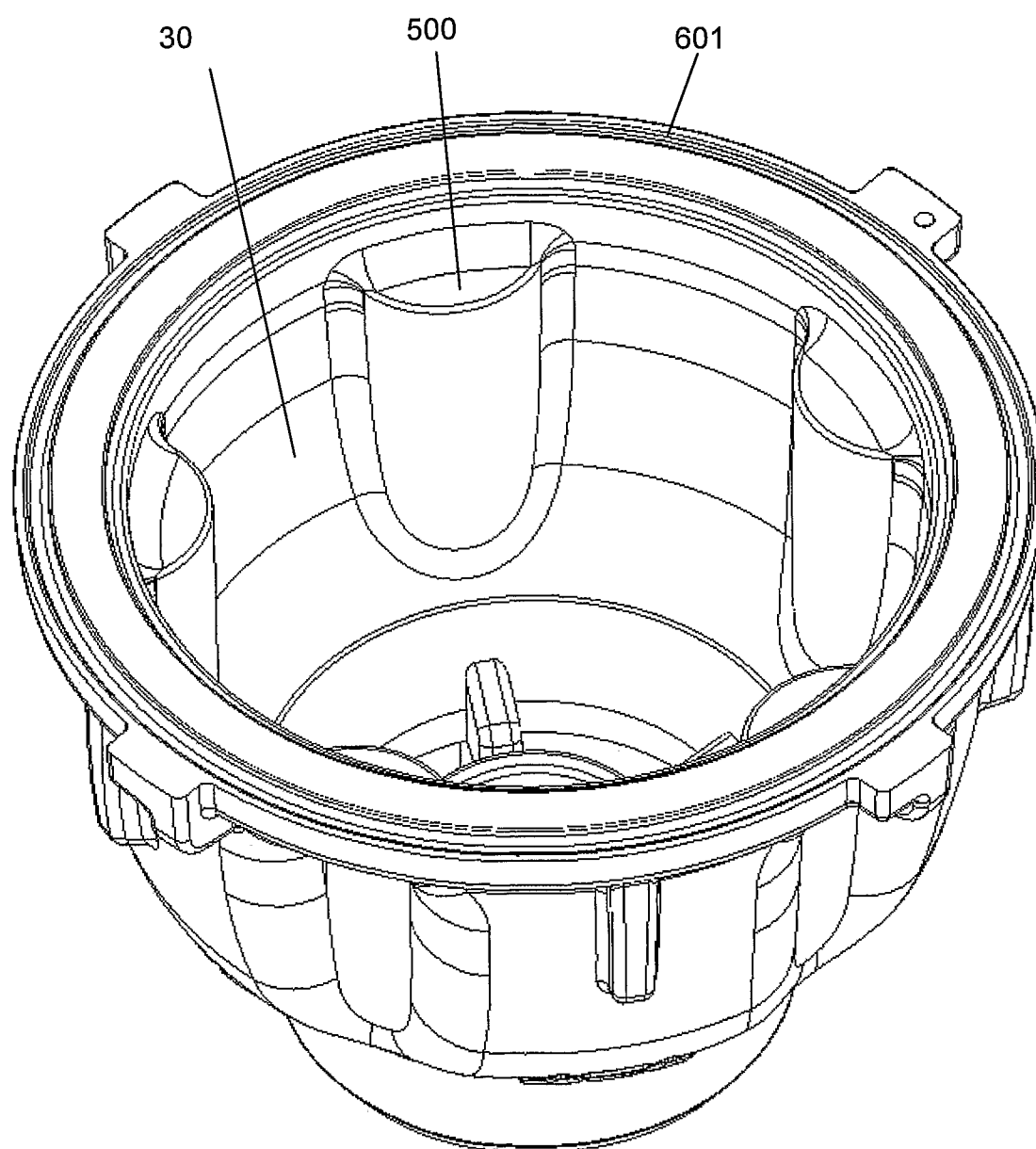


Figure 10

11/13

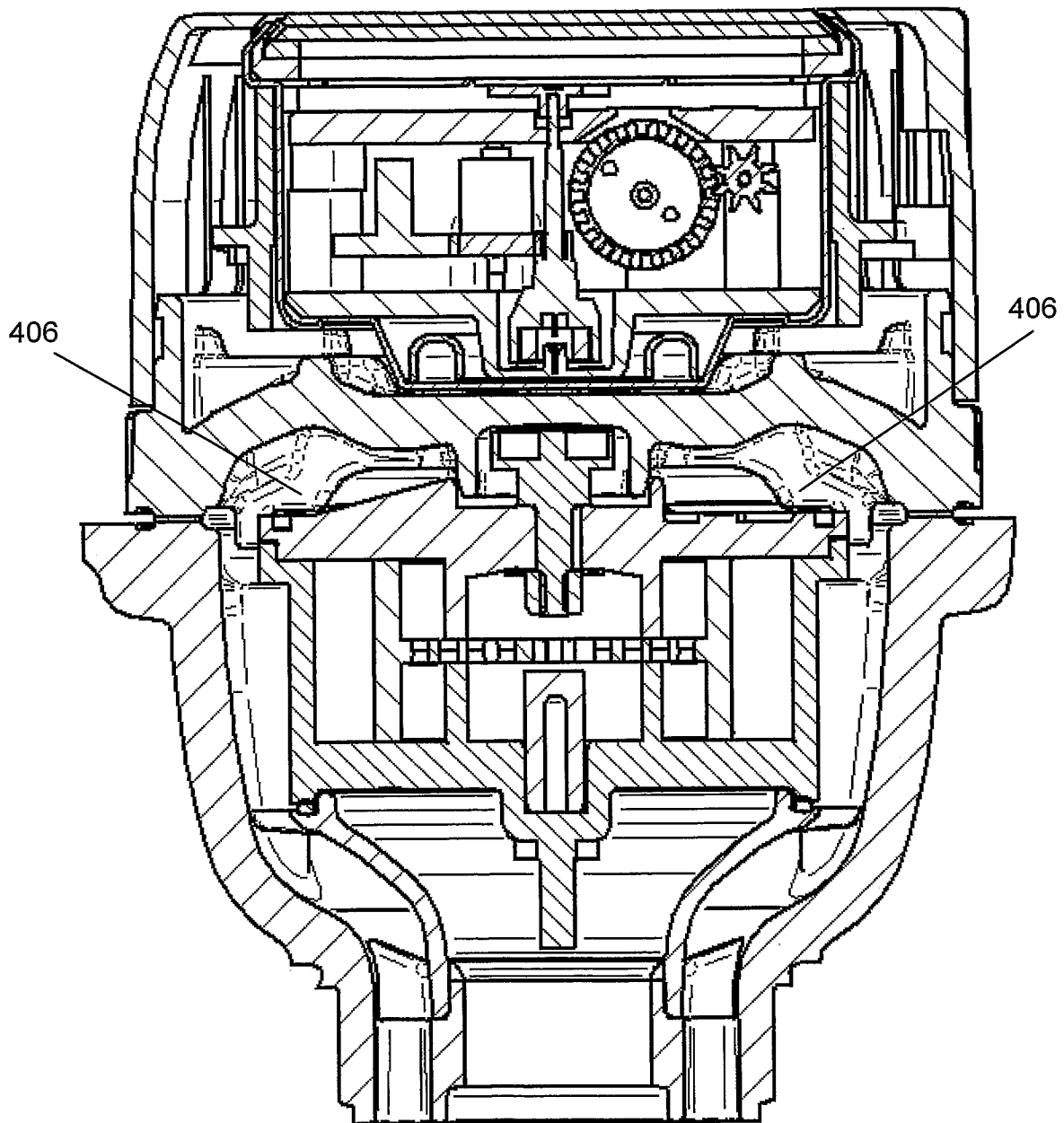


Figure 11

12/13

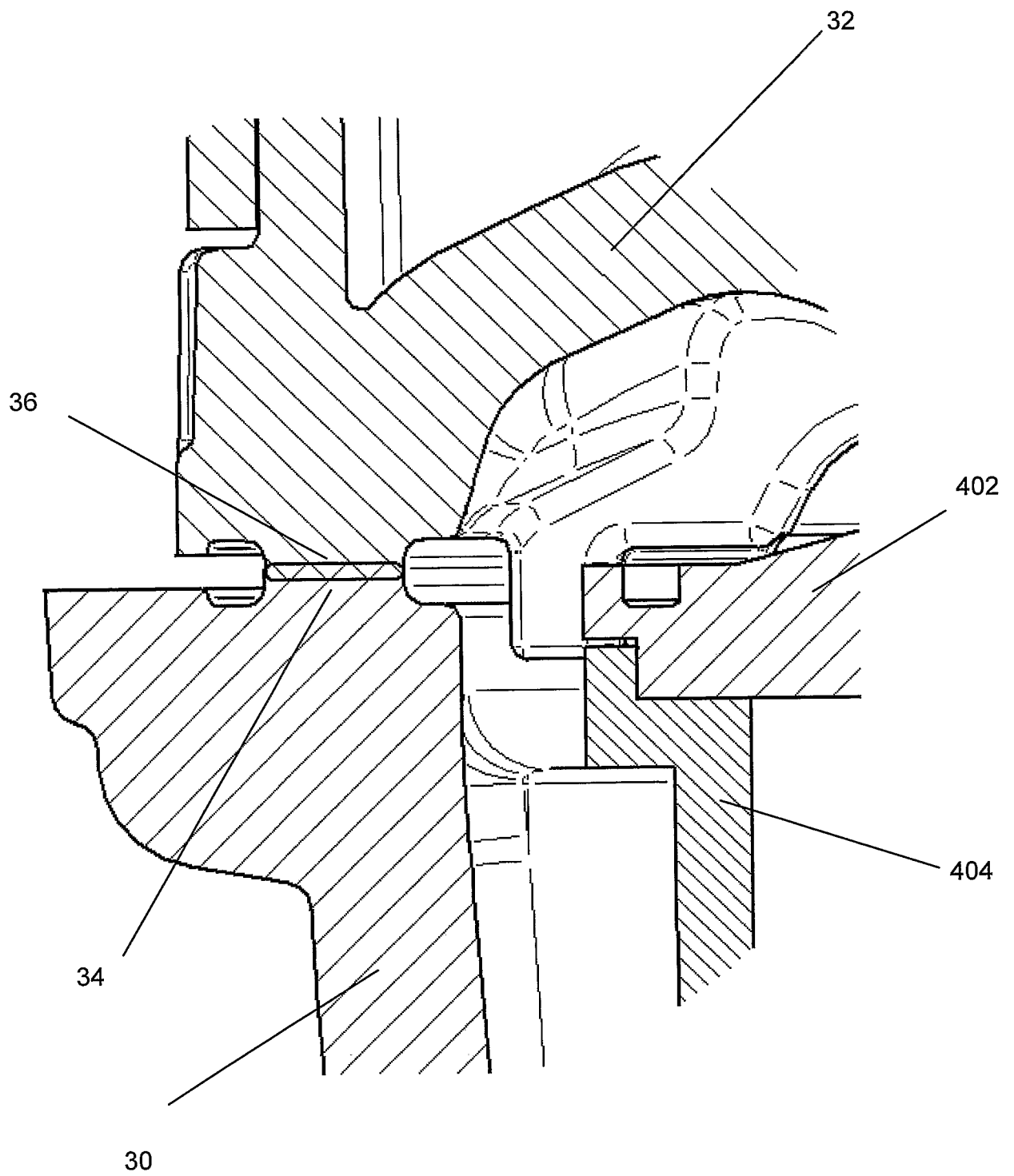


Figure 12

13/13

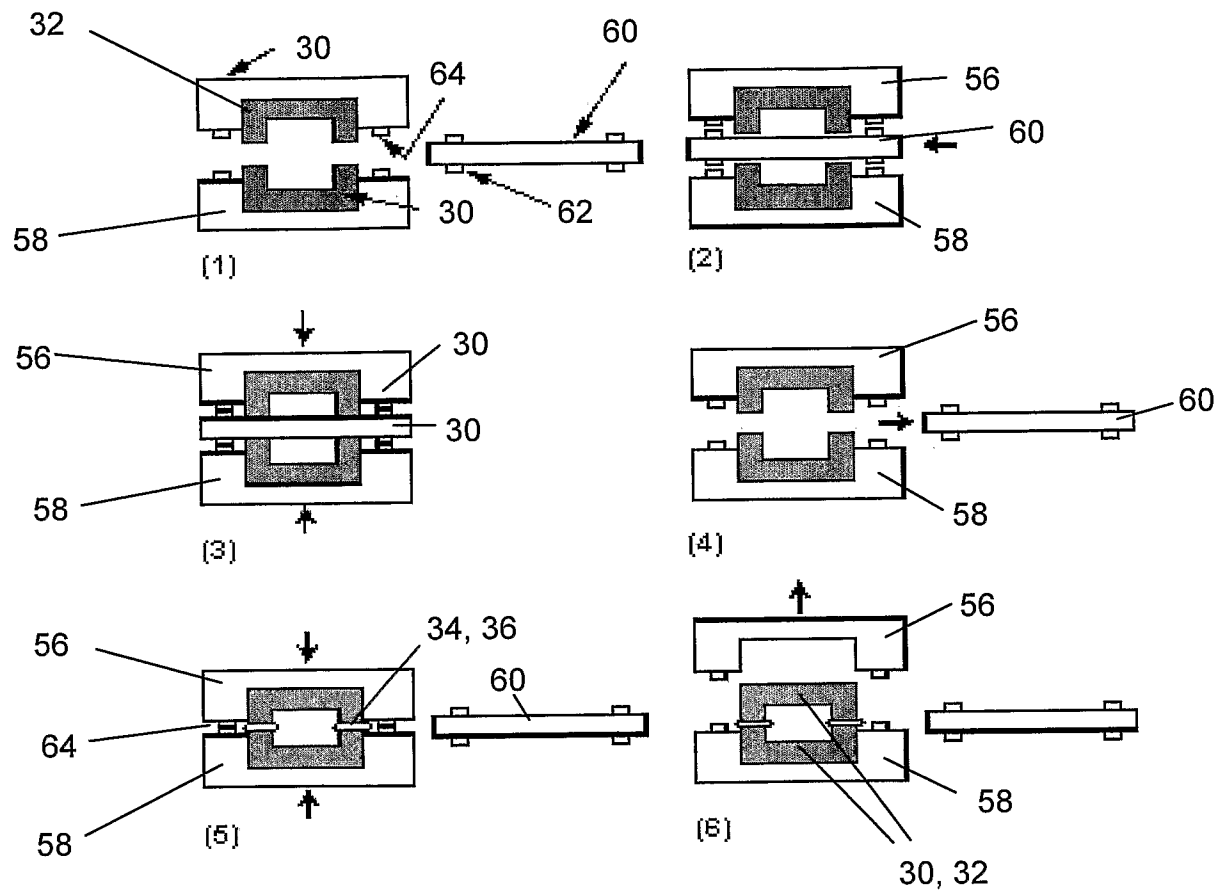


Figure 13