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(72) Kobold, Klaus, DE
(73) Kobold, Klaus, DE

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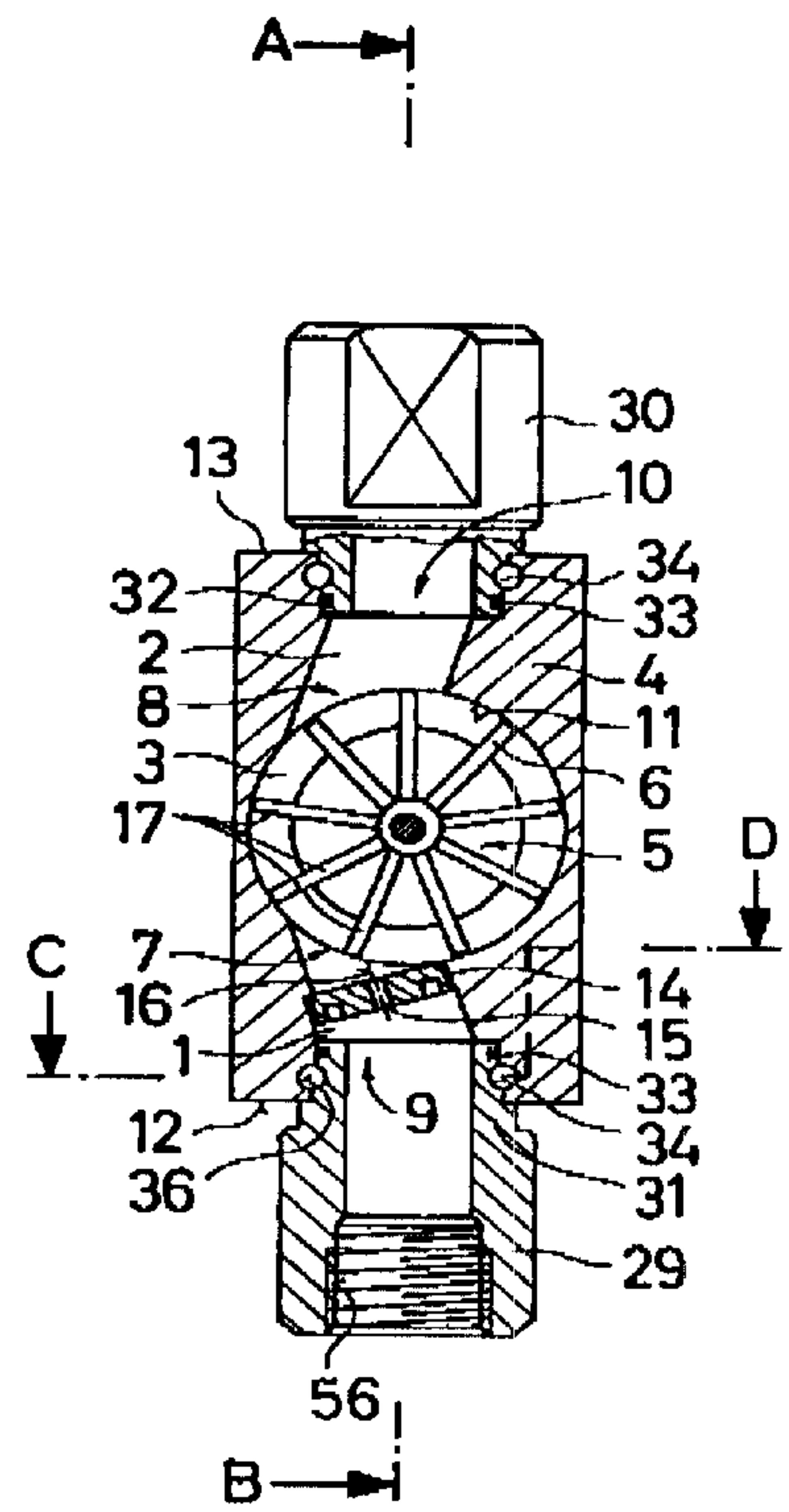
(54) **INDICATEUR DE DEBIT OU DEBITMETRE**
(54) **FLOW INDICATOR OR FLOWMETER**



(57) The present invention relates to a flow indicator or flowmeter with an impeller which is rotatably mounted in an essentially circular-cylindrical flow chamber of a flow housing which has an inlet channel and an outlet channel. To be able to use such an indicator and measuring device to achieve a high accuracy of measurement for a wide measuring range without any calibration, the present invention provides that a nozzle plate (14), having a nozzle hole (15) of a pre-determined cross-section, can be inserted so as to be exchangeable, e.g. can be screwed, into the inlet channel (1) and/or the outlet channel (2), and that the diameter D (in mm) of the nozzle hole (15) can be fixed as a function of the lower limit R_1 (in litres of water/min) of the measuring range such that the diameter D increases with the increase in the value of the ratio $V = R_1/D$, whereby V has a value of about 0.075 litres of water/mm.min if the diameter D amounts to about 1.25 mm and a value of about 0.3 litres of water/mm.min if the diameter amounts to about 20 mm.

(Translation)

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Flow indicator or flowmeter

Abstract:

The present invention relates to a flow indicator or flowmeter with an impeller which is rotatably mounted in an essentially circular-cylindrical flow chamber of a flow housing which has an inlet channel and an outlet channel. To be able to use such an indicator and measuring device to achieve a high accuracy of measurement for a wide measuring range without any calibration, the present invention provides that a nozzle plate (14), having a nozzle hole (15) of a pre-determined cross-section, can be inserted so as to be exchangeable, e.g. can be screwed, into the inlet channel (1) and/or the outlet channel (2), and that the diameter D (in mm) of the nozzle hole (15) can be fixed as a function of the lower limit R_1 (in litres of water/min) of the measuring range such that the diameter D increases with the increase in the value of the ratio $V = R_1/D$, whereby V has a value of about 0.075 litres of water/mm.min if the diameter D amounts to about 1.25 mm and a value of about 0.3 litres of water/mm.min if the diameter amounts to about 20 mm.

The present invention relates to a flow indicator or flowmeter with an impeller rotatably mounted in an essentially circular-cylindrical flow chamber of a flow housing which has an inlet channel and an outlet channel.

Flow indicators or flowmeters of this type are known. They yield a direct indication of flow in that the impeller, which rotates with the flow, is visible from the outside, or they serve as flowmeters, counters and metering devices in that the impeller is equipped with alternately polarized magnets at the ends of the impeller blades. The magnets trigger voltage impulses in a fixed position pick-up coil. These electric impulses can be amplified and counted in an electronic circuit from which the quantity of flow (or flow rate) is determined and displayed on a display panel by means of light-emitting diodes in units of liters or liters per minute. Such impeller flow indicators or meters have, for example with respect to some floating member flow meters, the advantage of almost viscosity-independent indication or measurement results. The known devices of this type, as illustrated and described for example in DE 37 33 862 A1, are however only designed for a specific range of flow and must be completely replaced and/ or re-calibrated if the measuring range is changed, which takes time and work. In addition, this is a source of errors and thus possibly has a negative effect on the accuracy of measurement.

It is the object of the present invention to design a flow indicator or flowmeter of the type described at the beginning in such a way that it can be used to achieve a high accuracy of measurement for at least a wide measuring range without any calibration.

This object is solved according to the invention essentially in that in accordance with the characterizing portion of claim 1 a nozzle plate, having a nozzle hole of a pre-determined cross-section, can be inserted so as to be exchangeably, e.g. can be screwed, into the inlet channel and/or the outlet channel, and that the diameter D (in mm) of the nozzle hole can be fixed as a function of the lower limit R_1 of the measuring range such that the diameter D increases with the increase in the value of the ratio $V=R_1/D$, whereby V has a value of about 0.075 liters of water/mm.min if the diameter D amounts to about 1.25 mm and has a value of about 0.3 liters of water/mm.min if the diameter amounts to about 20 mm. The nozzle plate can thus be easily replaced with another nozzle plate with an appropriate nozzle hole diameter, whereby the device can be designed for different measuring ranges to achieve a high accuracy of measurement.

In an advantageous embodiment of the invention a particularly high accuracy of measurement for additional measuring ranges is achieved in that the nozzle hole diameter of the nozzle plates is staggered in fine steps as a function of the value of the ratio $V=R_1/D$, as indicated in the table below:

D (mm)	V (litres of water/mm.min)
1.25	~ 0.075
1.90	~ 0.090
2.55	~ 0.15
7.60	~ 0.20
12.70	~ 0.22
15.25	~ 0.25
19.05	~ 0.30

In known flow indicators, which are equipped with magnets of alternating polarity mounted to the blades of the impeller, an even number of blades is required. However, this can lead to undesired resonances and starting difficulties for the impeller. The resonances result in a significant load on the bearing of the impeller, which is further increased by the fact that the magnet-induced inert mass of the impeller is at a relatively large radial distance from the axis of rotation. An advantageous further development of the invention therefore provides that the impeller has an uneven number of blades.

To further reduce the flow resistance of the new device, the peripheral distance between the centre point of the inlet opening of the inlet channel of the flow chamber and the centre point of the outlet opening of the outlet channel of the flow chamber is only about 180° or less, preferably between 180° and 160°.

In a further embodiment of the invention the inlet channel and the outlet channel are preferably fluidically connected to the housing openings formed in opposing faces of the flow housing.

Starting difficulties of the impeller can be avoided with certainty if at least the inlet channel ends obliquely to the radial direction, preferably at an angle of less than between 10° and 80° to the radial direction, in the cover of the flow chamber. This ensures that despite the compact construction the flow will definitely impinge an impeller blade vertically to the blade of the impeller.

The outlet channel can also lead obliquely to the radial direction, preferably at an angle of less than between 10° and 80° to the radial direction, away from the cover of the flow chamber. With this design, the fluid to be measured can be fed through the flow chamber starting from either side, depending on the space requirements.

In order to obtain favourable flow conditions, it is also proposed with respect to the present invention that the openings of the housing for the inlet channel and/or the outlet channel be in the centre of the opposing faces of the flow housing.

The flow direction, determined by the central longitudinal axis of the nozzle hole, in the inserted, for example screwed in position of the nozzle plate preferably leads, independent of the direction of the inlet channel, obliquely to the radial direction, preferably at an angle of less than between 10° and 80° to the radial direction, into the (imaginary) cover of the flow chamber so that starting of the impeller is always ensured.

It is also proposed in a further embodiment of the invention to align the central longitudinal axis of the inlet channel or the nozzle hole with the radial outer end sections of the passing impeller blades in order to exert a high torque on the impeller.

The blades of the impeller can be perforated radially within the radial outer end sections of the blades, whereby the mass of the impeller and the resistance during rotation within the filled flow chamber is reduced.

The distance between the radial outer end sections of the blades of the impeller and the cover of the flow chamber is as small as possible, at any rate is less than one millimeter, preferably less than 0.5 mm, so that a seal is almost provided between the blades and the flow chamber. Due to less leakage, the accuracy of counting and measuring is increased.

So that the device can be used not only as a flow indicator but also as a flowmeter, the impeller has a number of peripherally spaced magnets, ferrite cores or similar pulse-generating elements. In comparison to the state of the art wherein the magnets are provided on the radial outer ends of the blades, the pulse-generating elements are preferably provided in accordance with the invention in the vicinity of the axis of the impeller. This significantly reduces the moment of inertia of the impeller. The bearings thus have less of a load imposed on them. In addition, the magnets are not provided in the blades or even their ends, so that despite the uneven number of blades an even number of magnets with alternating polarity can be provided to interact with a fixed Hall probe or ferrite cores can be provided to interact with a fixed coil.

The pulse-generating elements are thereby preferably combined in a sector plate, whereby one pulse-generating element is arranged in each sector.

The sector plate can be part of the hub of the impeller or it can be fixed to the hub.

Furthermore, it is advantageous for the pulse-generating elements be to arranged adjacent a flat side wall of the flow housing, namely adjacent that side wall behind which the Hall probe, the coil or a proximity sensor for generating the electric pulses is provided. Relatively large electric pulses are obtained in this manner.

The impeller can be mounted on a fixed shaft, but this requires adequate lubrication. It is of greater advantage if, in accordance with the invention, the impeller is fixedly accommodated on a shaft which is rotatably mounted in the two opposing flat side walls of the flow housing.

According to a further feature of the invention, the bearing for the shaft is formed by two bearing elements, one of which is axially mounted in a fixed position in one side wall and the other of which is axially adjustable, preferably from the outside, in the other side wall. In this way the impeller can be assembled quickly and safely and long-term functionability is assured.

Simple assembly is also facilitated if at least one of the flat side walls of the flow housing is formed at least partially by a removable, fastened housing cover, as is already known.

At least one of the flat side walls, which are parallel to the impeller and preferably receive the bearing elements for the impeller, or at least one of the housing covers, which have the same position and function, is made of a transparent material so that rotation of the impeller due to fluid flow is visible from the outside and so that a flow indication is given without an electronic circuit. If both side walls or housing covers are transparent, it can be optically determined from both sides whether or not there is a flow in the line in which the flow housing is connected.

The flow housing can be reliably sealed and easily assembled if the housing covers project with a projection into a recess of the side walls and are radially sealed there by means of a packing ring.

The flow housing according to the present invention can have connecting sleeves for the inlet channel or the outlet channel which permit a pipe connection either via a thread or a flange. To permit a simple installation of a pipe connection via a thread, the connecting sleeves, which are equipped with internal threads for example at their outer ends, are inserted into a threadless hole of the inlet channel or the outlet channel to form a seal with a sleeve section by means of a packing ring and the sleeve section has a groove with a round bottom, opposite which lies a corresponding groove of the threadless hole formed by a section of at least one hole of the housing accessible from the outside. A locking pin, which is designed for example as a threaded pin, is then inserted into the respective hole of the housing. In this way, the connecting sleeves cannot be displaced axially but are rotatable relative to the flow housing, thus producing a simple screw connection to the connecting line. The connecting sleeves can also be moved relative to the flow housing during operation of the device without having a negative impact on the seal of the connecting sleeves. A further structural and functional advantage is achieved through this.

To obtain as compact a device as possible, the flow housing in a further embodiment of the invention fits into a recess of the housing of the device designed to receive the electronic circuit.

The outer configuration of the flow housing is thereby preferably designed with an essentially cuboid shape and in the position of the flow housing inserted in the housing of the device the free outer surfaces of the flow housing preferably align with the adjacent outer surfaces of the housing of the device. Thus, a complete compact device with overlapping outer surfaces is created. If the device is only to be used as a flow indicator, the flow housing with the impeller and the connecting sleeves can be used alone. If, however, the device is also to be used as a flowmeter, it is thus integrated into the housing of the device of the complete housing. This integration can also be achieved later if, by a purely visual display of a flow, the quantity of flow is to be measured by means of magnets, ferrites or similar pulse-generating elements and an electronic circuit and a display is by means of light-emitting diodes and/or digital signals.

When the flow housing is integrated into the housing of the device, it is in particular proposed that the outer surface of the one flat side wall of the flow housing align with the front outer surface of the housing of the device. The flat side wall of the flow housing in question or the housing cover forming it are perferably made of transparent material so that the device can be used not only for measuring the quantity of flow but also for merely visual display of flow.

Since the electronic circuit should be not subjected to temperatures above 100°C, but the fluids to be measured may at times have higher temperatures, it is also proposed that when integrating the flow housing into the housing of the device, the flow housing in the position inserted into the housing of the device be thermally insulated with respect to the housing of the device, for example by means of the intermediate layer of thermal insulating panels.

To be able to modify the device according to the invention to provide varying ranges of measurement, the front outer surface of the housing of the device can be equipped with an exchangeable graduated plate.

Simple manufacture and assembly of the device is ensured in that the housing of the device is designed as section of a hollow extrusion profile.

To minimize the possibility of exceeding the maximum temperature in the housing of the device, the outer surfaces of the housing of the device can be profiled, for example can be provided with ribs or grooves which extend in the longitudinal direction of the extrusion so that the individual housings of the device can be simply cut off during continuous hollow extrusion.

Further aims, features, advantages and applications of the present invention are set forth in the following description of the exemplary embodiments on the basis of the attached drawings. All the features that are described or illustrated thereby form either alone or in any appropriate combination the subject matter of the present invention, also independent of their combination in the claims or their dependency.

Figure 1 shows an embodiment of the device according to the invention in the vertical section A-B of Figure 3,

Figure 2 shows the device according to Figure 1 in a horizontal section C-D of Figure 3,

Figure 3 shows a vertical section E-F of the inventive device according to Figure 2,

Figure 4 shows a section corresponding to Figure 1 of another embodiment of a device according to the invention (section A-B of Figure 6),

Figure 5 shows a horizontal section C-D according to Figure 6 of the inventive device according to Figure 4,

Figure 6 shows a vertical section C-D of Figure 5 of the inventive device according to Figure 4,

Figure 7 shows a device designed as a flowmeter in the vertical section A-B of Figure 9,

Figure 8 shows a horizontal section E-F of Figure 8 of the inventive device according to Figure 7,

Figure 9 shows a vertical section E-F of Figure 8 of the inventive device according to Figure 7,

Figure 10 shows a vertical section A-B corresponding to Figure 7 for another embodiment of an inventive device designed as a flowmeter,

Figure 11 shows a horizontal section C-D of Figure 12 of an inventive device according to Figure 10,

Figure 12 shows a vertical section E-F of Figure 11 of an inventive device according to Figure 10, and

Figure 13 shows an oblique view of a flow indicator and flowmeter according to the invention in which the flow housing is inserted into a recess of the housing of the device to create a compact device.

Figures 1 to 3 illustrate a flow indicator according to the invention, comprising a flow housing 4 with an essentially circular-cylindrical flow chamber 3 in which an impeller 5 is rotatably mounted. The flow chamber 3 is equipped with an inlet channel 1 and an outlet channel 2. The peripheral distance between the centre point of the inlet opening 7 of the inlet channel 1 of the flow chamber 3 and the centre point of the outlet opening 8 of the outlet channel 2 of the flow chamber 3 is less than 180°. The inlet channel 1 and the outlet channel 2 are fluidically connected to housing openings 9, 10 arranged in opposing faces 12, 13 of the flow housing 4. The housing openings 9, 10 for the inlet channel 1 and the outlet channel 2 are arranged in the centre of the opposing faces 12, 13 of the flow housing 4. From the housing opening 9, the inlet channel 1 leads obliquely to the radial direction by means of the inlet opening 7 into the cover 11 of the flow chamber 3. The outlet channel 2 leads obliquely to the radial direction from the outlet opening 8 away from the cover 11 of the flow chamber 3. A nozzle plate 14, which is equipped with an external thread and a nozzle hole 15 of a pre-determined cross-section, is screwed into the inlet channel 1 equipped with an internal thread. The nozzle plate 14 is provided with two external engaging openings for a lathe tool. The central longitudinal axis 16 of the nozzle hole 15, like that of the inlet channel 1 is thereby aligned with the radial outer end sections 17 of the blades 6 of the impeller 5 travelling past the inlet opening 7. As indicated in Figure 1, the blades 6 of the impeller 5 can thereby also be perforated. The distance between the radial outer end sections 17 of the blades 6 of the impeller 5 and the cover 11 of the flow chamber 3 is as small as possible so that fluid leakage at the cover 11 is as low as possible.

The impeller 5 is fixed to a shaft 23 which is rotatably supported in the two opposing flat side walls 22, 24 of the flow housing 4. The bearing for the shaft 23 is formed by two bearing elements 25, 26, one of which is axially mounted in one side wall 22 and the other of which is axially adjustable from the outside in the other side wall 24. Both flat side walls 22, 24 of the flow housing 4 are formed by removable housing covers 27, 28 fastened by means of screws 55. The housing covers 27, 28 can be made of transparent material. The housing covers 27, 28 project with a projection 51, 52, which receives the bearing elements 25, 26 for the shaft 23 of the impeller 5, in a recess of the side walls 22, 24. The projections 51, 52 are radially sealed against the flow housing 4 by means of packing rings 53, 54.

The inlet channel 1 and the outlet channel 2 are provided with connecting sleeves 29, 30. The connecting sleeves 29, 30 are inserted into a threadless hole of the inlet channel 1 or the outlet channel 2 such that a seal is formed with the sleeve sections 31, 32 by means of packing ring 33. The respective sleeve section 31, 32 has a groove 34 with a round bottom, opposite which are two corresponding grooves 36 of the threadless hole of the inlet channel 1 or the outlet channel 2 which are formed by holes 35 of the housing accessible from the outside. A locking pin 37, which is designed as a threaded pin, is inserted into each hole 35 of the housing. In this way the connecting sleeves 29, 30 are axially fixed but rotatable with respect to the flow housing 4.

The flow indicator of the invention according to Figures 4 to 6 differs from that illustrated in Figures 1 to 3 for the most part only in that the connecting sleeves 29', 30' for the inlet channel 1 and the outlet channel 2 do not have an internal thread 56 for a pipe connection, rather have a flange 57, 58 for a flange connection. In addition, the connecting sleeves 29', 30' are in this case welded to the flow housing 4.

The exemplary embodiment of the device according to Figures 7 to 9 is similar to that illustrated in Figures 1 to 3. However, the device illustrated in Figures 7 to 9 is equipped as a flowmeter which offers not only an optical flow indication due to the transparent material of the one housing cover 27 (housing cover 28 is missing here), but also an electric measurement indication for the quantity of flow. For this purpose the impeller 5 has a number of peripherally spaced magnets, ferrite cores or similar pulse-generating elements 18 which are combined and enclosed in the immediate vicinity of the axis 19 of the impeller 5 in a sector plate 20 which is made, for example, of plastic, whereby one pulse-generating element 18 is arranged in each sector. The sector plate 20 forms part of the hub 21 of the impeller 5. The pulse-generating elements 18 are arranged directly adjacent the flat side wall 22 of the flow housing 4, a Hall generator, a coil or a proximity circuit element, none of which is illustrated, for generating an electric voltage or current signal being arranged on the outside of the flow housing. The flow housing 4 can be fixed by means of screws 59 in the recess 38 of a housing 39 of the device, as is shown in Figures 8 and 13.

The embodiment of a device of the invention according to Figures 10 to 12 corresponds essentially to that illustrated in Figures 7 to 9. However, the connecting sleeves 29, 30 provided for a threaded connection are here again replaced by connecting sleeves 29' and 30' with flanges, these connecting sleeves being welded to the flow housing 4 similar to the embodiment illustrated in Figures 4 to 6. The construction is otherwise identical.

Figure 13 shows in oblique view a complete device with a flow housing 4 which fits in the recess 38 of the housing 39 of the device and is integrated with it in compact manner. The connecting sleeves 29, 30 or 29', 30' are not illustrated. The housing cover 27 is made of transparent material so that the device can be used both as a flow indicator as well as a flowmeter with the aid of the electronic circuit housed in the housing 39 of the device. The recess 38 of the housing 39 of the device has a cuboid design corresponding to the outer shape of the flow housing 4 such that the free outer surfaces 40 - 43 of the flow housing 4 align with the adjacent outer surfaces 44 - 47 of the housing 39 of the device. The outer surface 40 of the one flat side wall 22 of the flow housing 4 aligns in particular with the front outer surface 44 of the housing 39 of the device. The flow housing 4 is also thermally insulated with respect to the housing 39 of the device in that thermally insulating panels are placed between the flow housing 4 and the housing 39 of the device. The front outer surface 44 of the housing 39 of the device is equipped with an exchangeable graduated plate 50 which indicates in analog or digitally the quantity of flow, for example by means of light-emitting diodes. In this case, additional functions, such as reaching or exceeding a pre-determined limiting value, the operating state (on/off) of the device, the signal range (in mA), can be indicated and actuating members for adjusting the range of measurement and the like can be provided.

The housing 39 of the device is designed as a section of a hollow extrusion profile and its outer surfaces 40 - 49 are profiled, for example with ribs or grooves extending in the longitudinal direction of the hollow extrusion.

CLAIMS:

1. A device for indicating flow of a fluid which flows at a rate within a range of flow rates having a flow rate R_1 as its lower limit, comprising:

a flow housing having defined therein a substantially cylindrical flow chamber, an inlet channel and an outlet channel, both said inlet channel and said outlet channel being in fluid communication with said flow chamber such that the fluid can flow through said inlet channel, said flow chamber and said outlet channel;

an impeller rotatably mounted within said flow chamber for rotation about a rotational axis; and

at least one nozzle plate mounted respectively within at least one of said inlet and outlet channels, said at least one nozzle plate having a nozzle hole of a predetermined diameter D formed therein, the diameter of said nozzle hole being predetermined in dependence on a ratio $V=R_1/D$, such that the higher the lower limit R_1, the higher the value of said ratio V, and the larger the predetermined diameter D, wherein the value of said ratio V is approximately 0.075 litres of water/mm.min when the diameter D is approximately 1.25 mm and the value of said ratio V is approximately 0.3 litres of water/mm.min when the diameter D is approximately 20 mm.

2. A device as recited in claim 1, wherein:

said impeller has an odd number of blades.

3. A device as recited in claim 1, wherein:

said inlet channel includes an inlet opening into said flow chamber, and said outlet channel includes an outlet opening into said flow chamber, said inlet opening being spaced circumferentially about a periphery of said flow chamber from said outlet opening by less than 180°.

4. A device as recited in claim 3, wherein:

said inlet channel has an external opening from said flow housing through a first external face of said flow housing, and said outlet channel has an external opening from said flow housing through a second external face of said flow housing, said second external face being diametrically opposed to said first external face with respect to said flow chamber, and said external opening of said inlet channel being diametrically opposed to said external opening of said outlet channel with respect to said flow chamber.

5. A device as recited in claim 4, wherein:

said impeller has a plurality of blades, each of which has a side face; and

a central longitudinal axis of said inlet opening extends obliquely relative to a radial direction of said flow chamber and a central longitudinal axis of said outlet opening extends obliquely relative to a radial direction of said flow chamber, such that fluid flowing into said fluid chamber impinges on said side faces of said blades of said impeller.

6. A device as recited in claim 5, wherein:

said inlet and outlet channels are angled, respectively, by 10° to 80° relative to a radial direction of said flow chamber.

7. A device as recited in claim 5, wherein:

said inlet opening is spaced circumferentially about the periphery of said flow chamber by 160° to 180° from said outlet opening.

8. A device as recited in claim 1, wherein:

said at least one nozzle plate is detachably mounted by screw threads within said at least one of said inlet and outlet channels, respectively.

9. A device as recited in claim 1, further comprising:

a plurality of impulse-creating elements mounted circumferentially about the rotational axis of said impeller in spaced apart relation adjacent said rotational axis.

10. A device as recited in claim 9, wherein:

said plurality of impulse creating elements are mounted on a sector plate which is mounted for rotation with said impeller.

11. A device as recited in claim 1, wherein:

said flow housing includes sidewalls spaced apart on axially opposing sides of said impeller.

12. A device as recited in claim 1, wherein:

said flow housing includes a transparent cover on at least one side of said flow chamber.

13. A device as recited in claim 12, wherein:

said cover is removably mounted to said flow housing.

14. A device as recited in claim 1, further comprising:

connecting sleeve means mounted to each of said inlet and outlet channels for connecting the device into a fluid flow line.

15. A device as recited in claim 14, wherein:

each of said connecting sleeve means has an external groove formed therein;

each of said inlet channel and said outlet channel has an internal groove therein alignable respectively with said external grooves of said connecting sleeve means; and locking pins are provided for receipt in corresponding ones of said external and internal grooves when said corresponding external and internal grooves are mutually aligned to maintain said connecting sleeve means in said inlet and outlet channels, respectively.

16. A device as recited in claim 1, further comprising:

a device housing having a recess formed therein, said flow housing being engaged in said recess of said device housing such that external faces of said flow housing align with corresponding external faces of said device housing to form a substantially cuboid-shaped structure.

17. A device as recited in claim 16, wherein:

said device housing includes an exchangeable graduated plate on an external face thereof.

18. A device as recited in claim 17, wherein:

said device housing comprises a hollow, profiled extrusion.

19. A device as recited in claim 18, wherein:

said hollow, profiled extrusion has ribs formed therealong on the external faces thereof.

20. A device as recited in claim 1, wherein:

said blades of said impeller are perforated.

21. A device as recited in claim 1, wherein:

said impeller has a plurality of blades which extend radially outwardly to within one millimeter of an inner circumferential wall of said flow chamber.

22. A device as recited in claim 21, wherein:

said blades extend radially outwardly within 0.5 millimeters of said inner circumferential wall of said flow chamber.

23. A device as recited in claim 1, wherein:

said impeller is fixedly mounted to a shaft;

said flow housing includes sidewalls spaced apart on axially opposing sides of said impeller; and

said shaft is rotatably mounted to said spaced apart sidewalls.

24. A device as recited in claim 23, wherein:

a fixed bearing element is mounted in one of said sidewalls;

an axially adjustable bearing element is mounted in the other of said sidewalls; and

said shaft is rotatably mounted in said fixed bearing and said adjustable bearing element.

25. A device as recited in claim 1, wherein:

the value of said ratio V is approximately 0.09 litres of water/mm.min when the diameter D is approximately 1.90 mm, the value of said ratio V is approximately 0.15 litres of water/mm.min when the diameter D is approximately 2.55 mm, the value of said ratio V is approximately 0.20 litres of water/mm.min when the diameter D is 7.60 mm, the value of said ratio V is approximately 0.22 litres of water/mm.min when the diameter D is approximately 12.70 mm, and the value of said ratio V is approximately 0.25 litres of water/mm.min when the diameter D is approximately 15.25 mm.

26. A method for indicating flow of a fluid which flows at a rate within a range of flow rates having a flow rate R_1 as its lower limit, comprising the steps of:

providing a flow housing having defined therein a substantially cylindrical flow chamber, an inlet channel and an outlet channel, both said inlet channel and said outlet channel being in fluid communication with said flow chamber such that the fluid can flow through said inlet channel, said flow chamber and said outlet channel;

providing an impeller rotatably mounted within said flow chamber for rotation about a rotational axis;

choosing a nozzle plate, having a nozzle hole of a particular diameter D defined therein, on the basis of the diameter D of said nozzle hole, the particular diameter of said nozzle hole being determined in dependence on R_1, such that the higher the lower limit of R_1 of the range of flow rates, the higher the value of D and the higher the value of a ratio $V=R_1/D$, and mounting said nozzle plate within one of said inlet and outlet channels.

FETHERSTONHAUGH & CO.
OTTAWA, CANADA

PATENT AGENTS

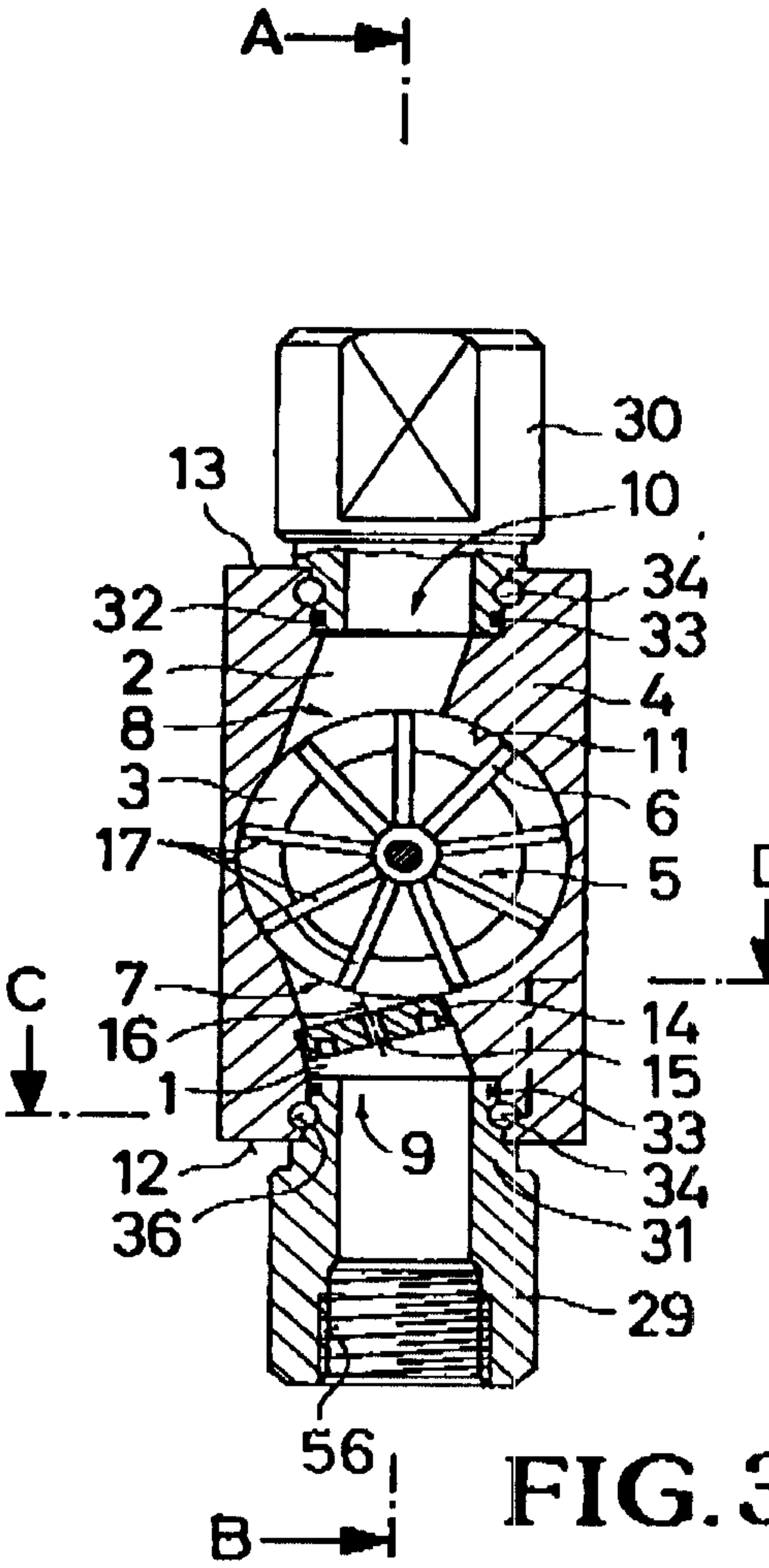


FIG. 3

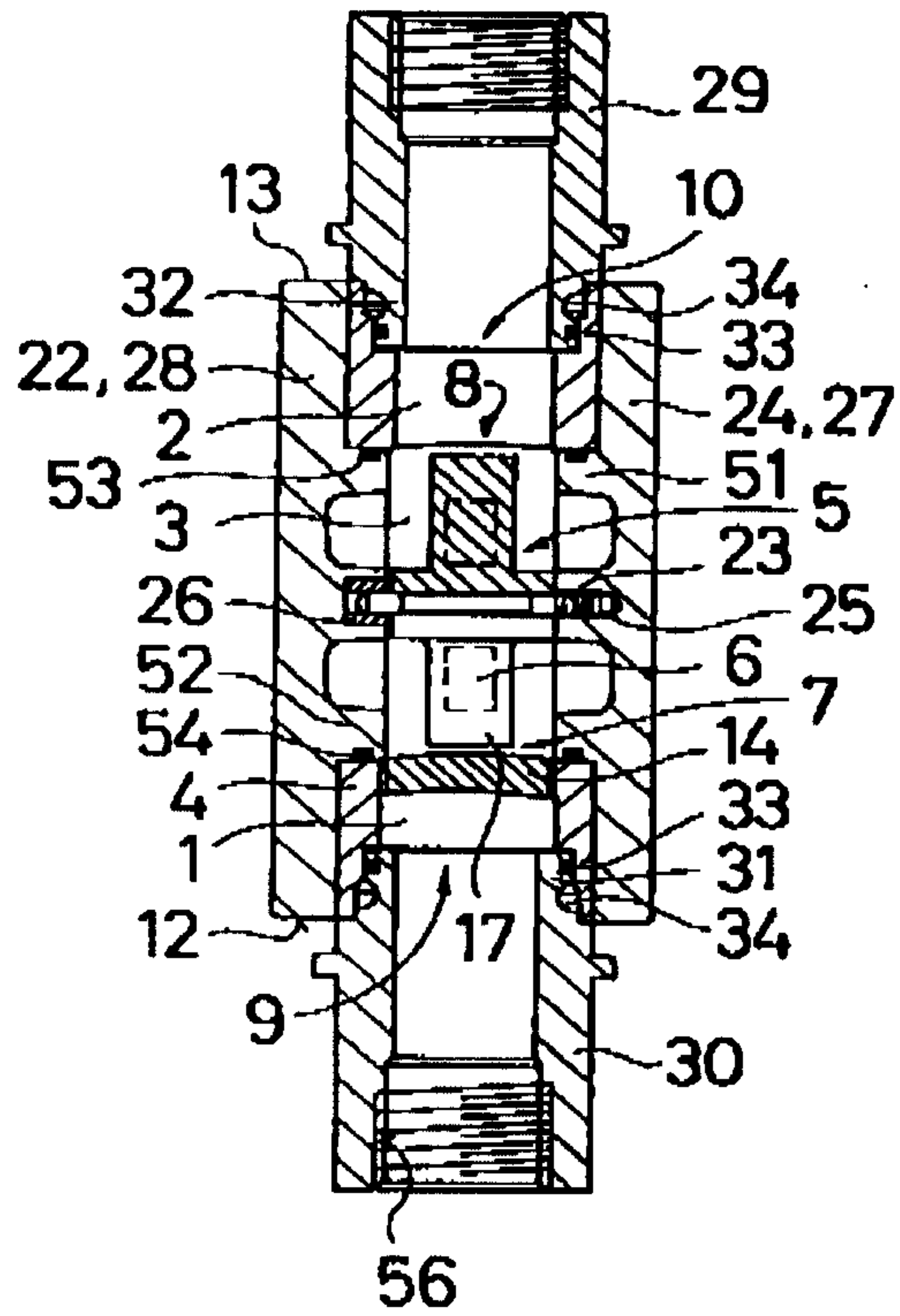


FIG. 1

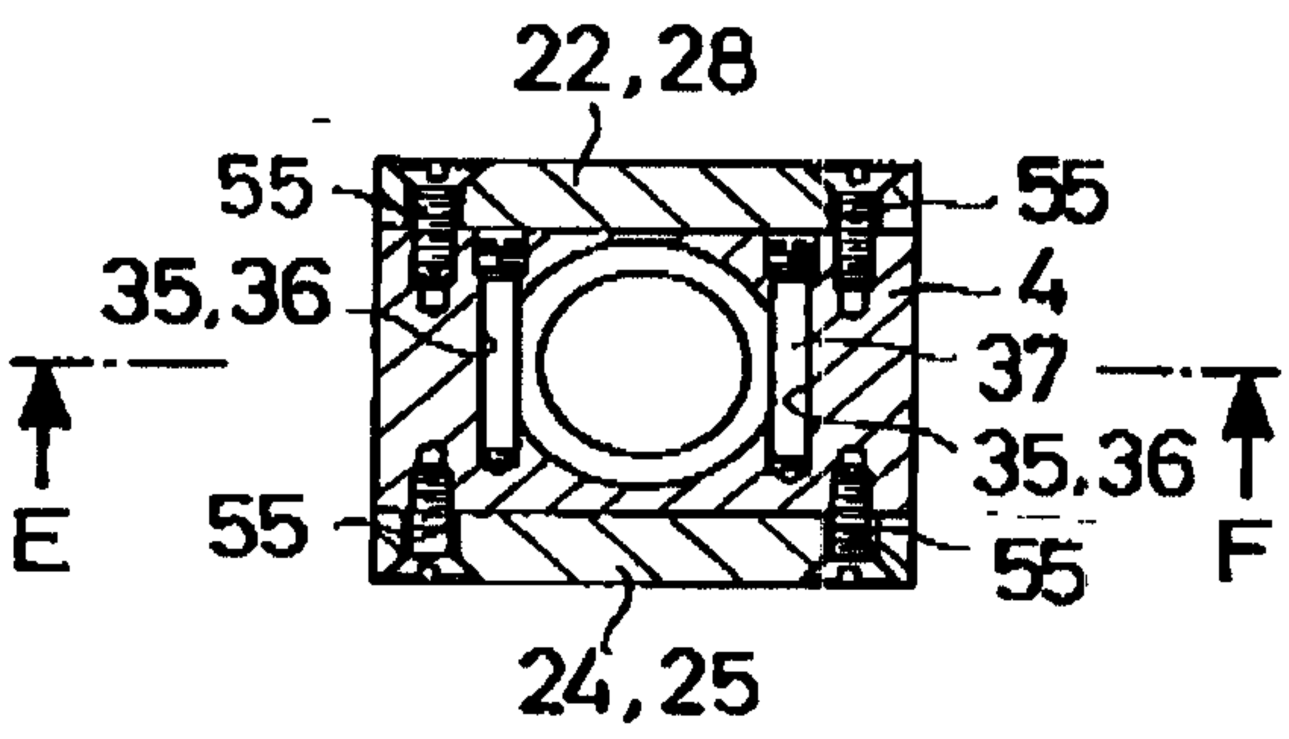


FIG. 2

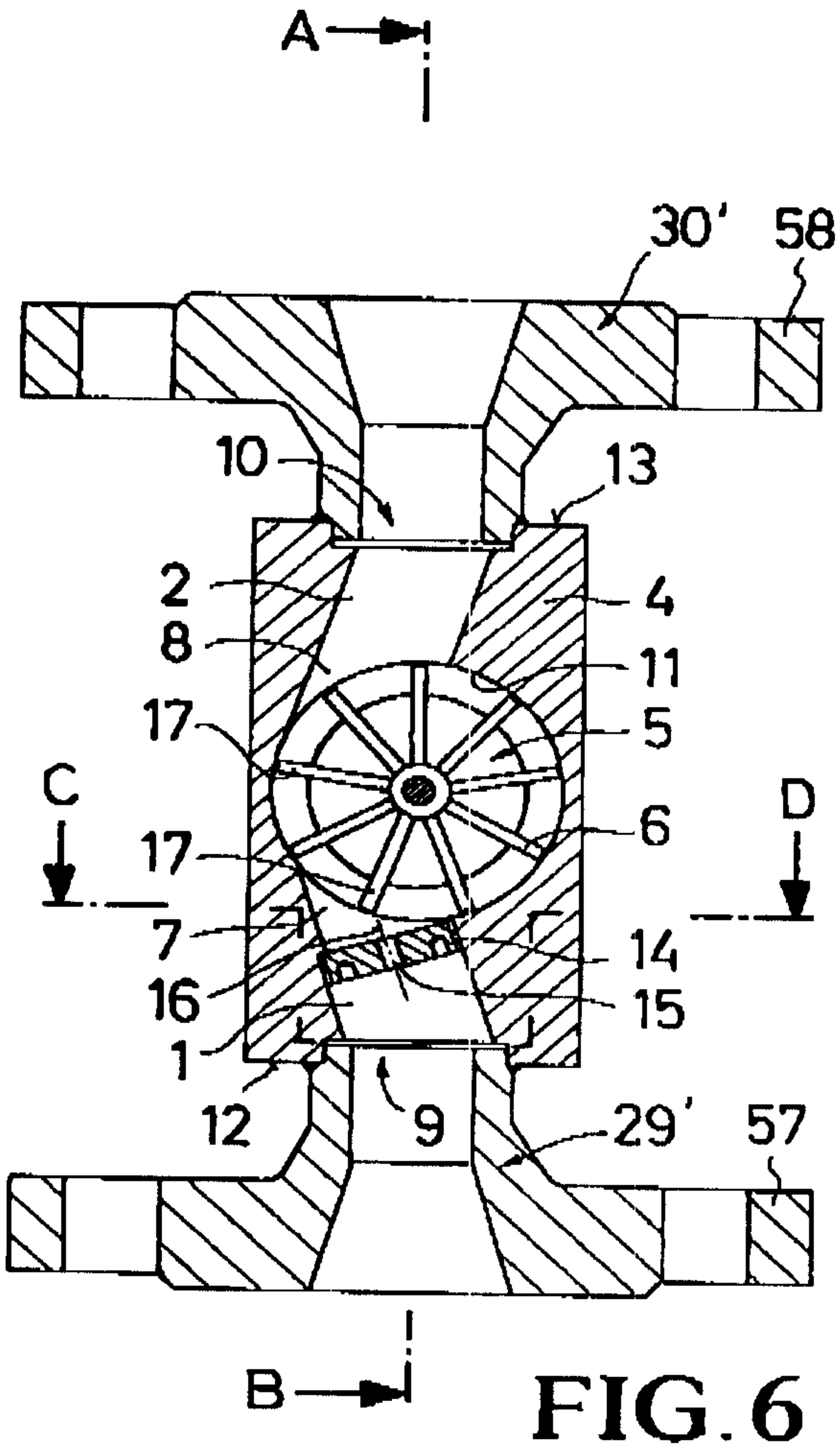


FIG.6

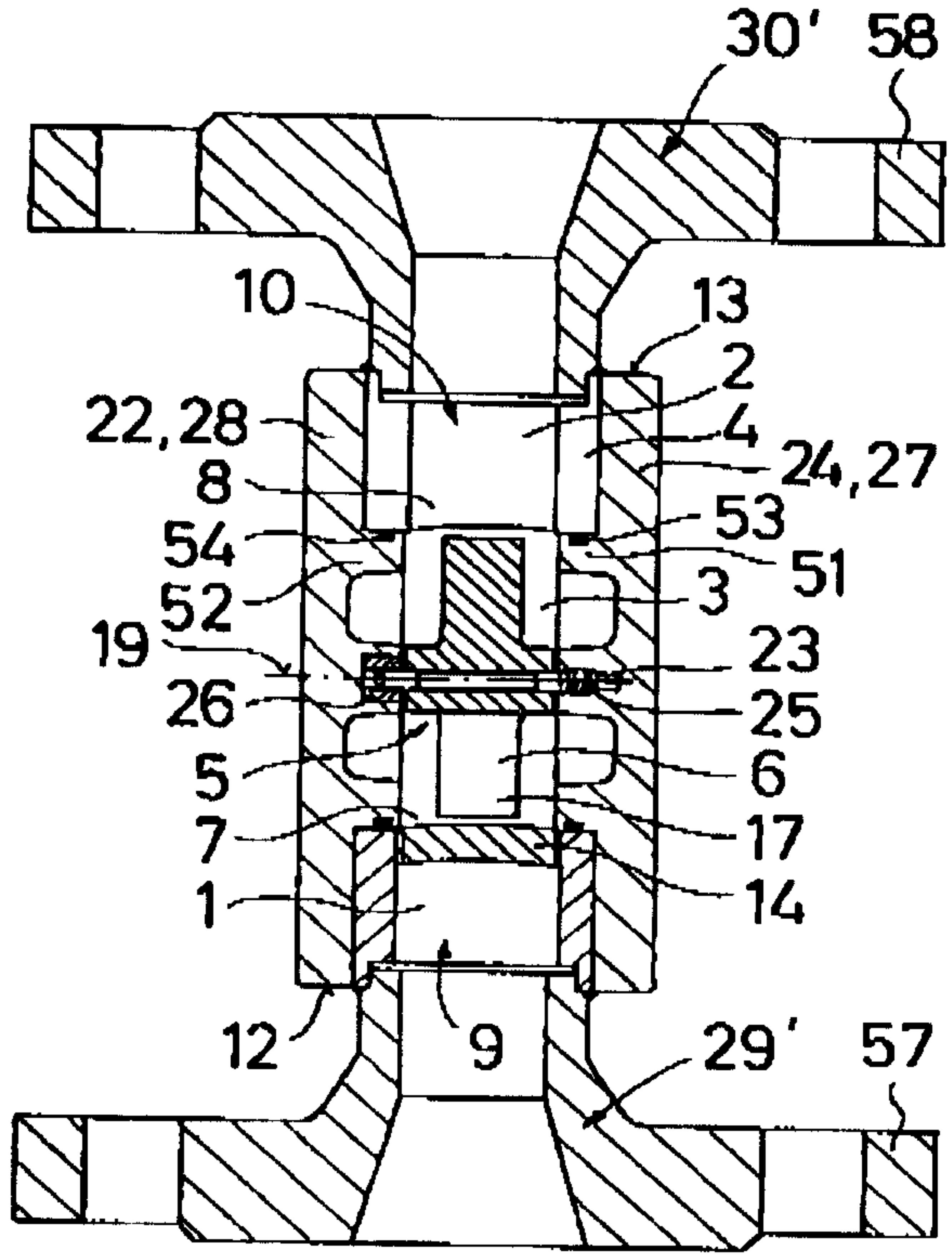
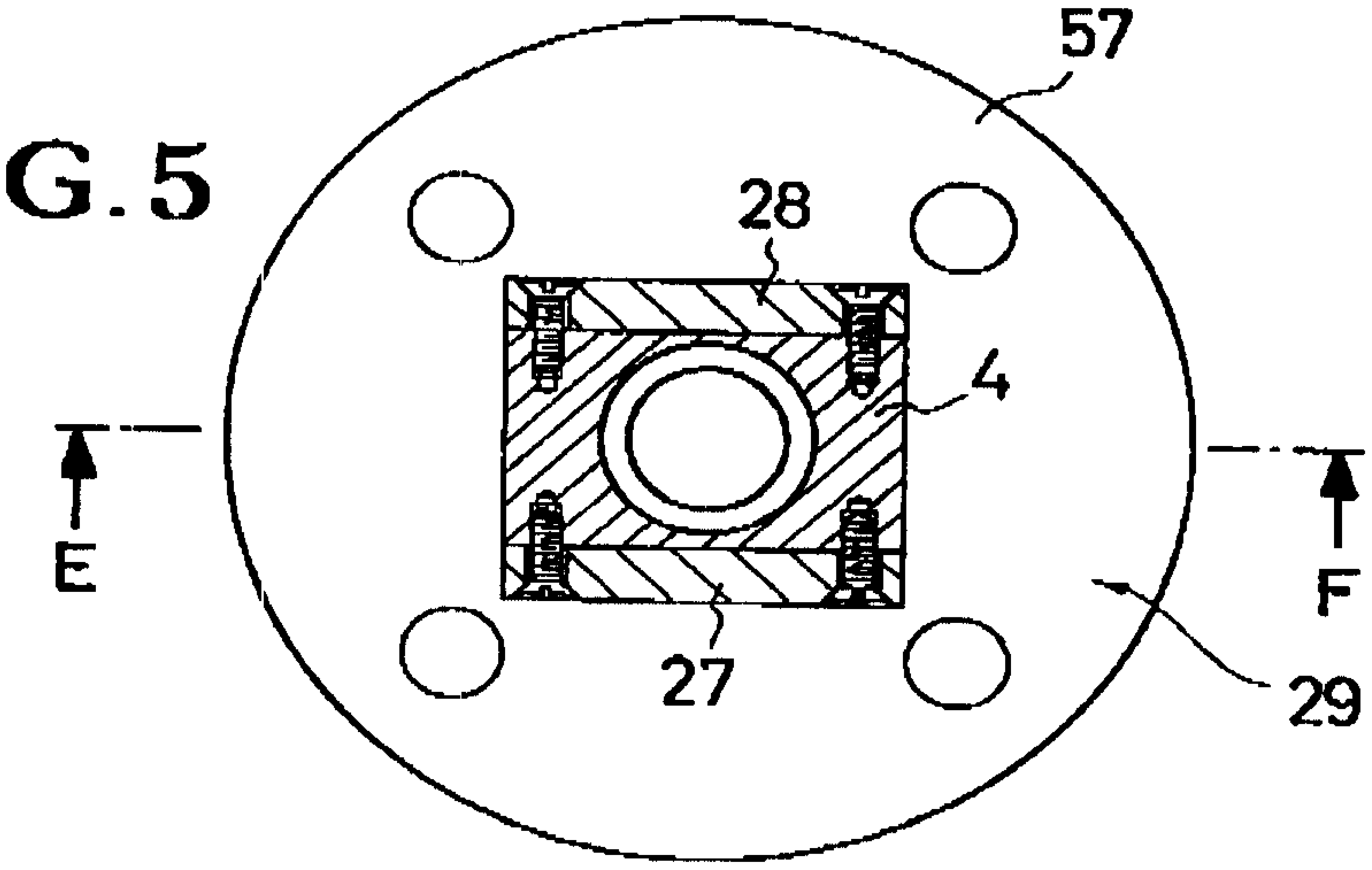


FIG.4

FIG.5



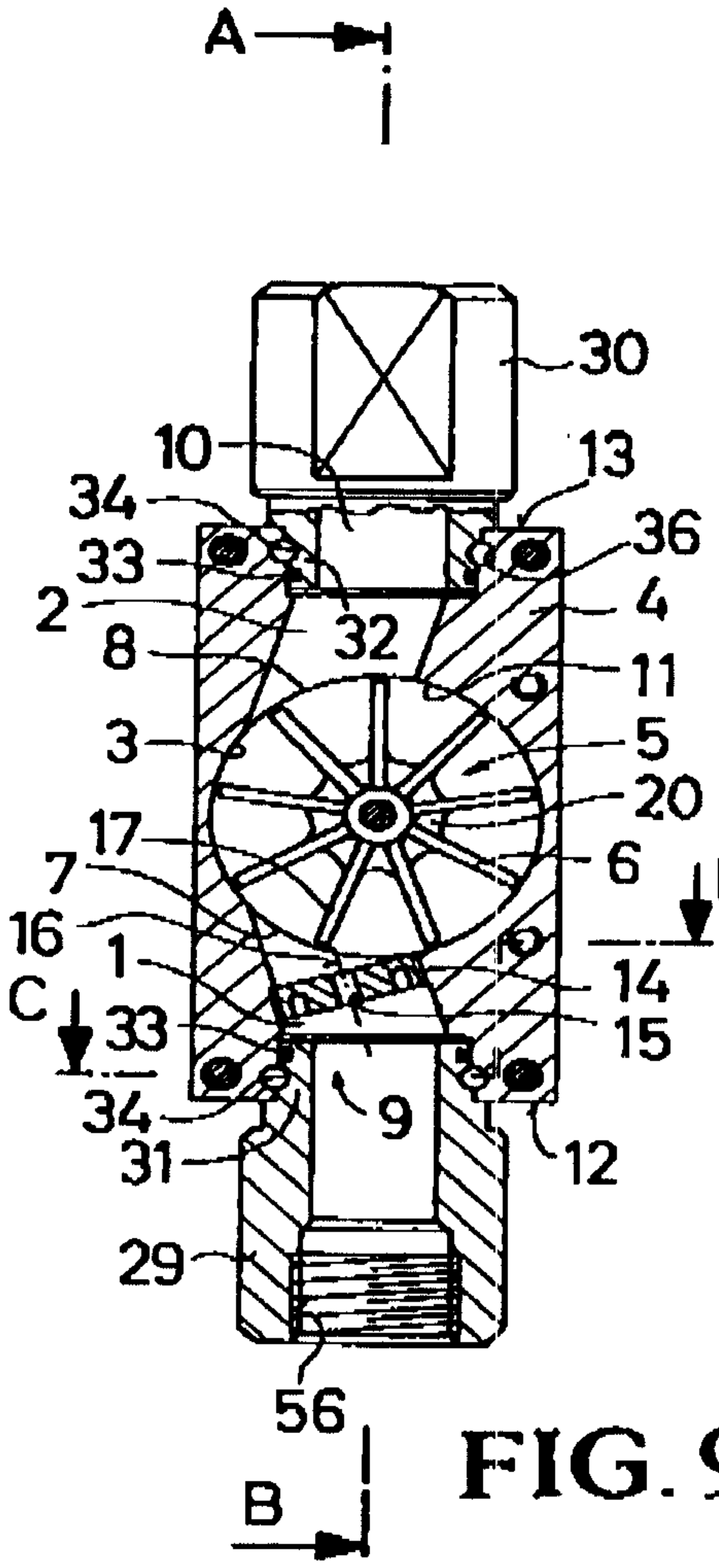


FIG. 9

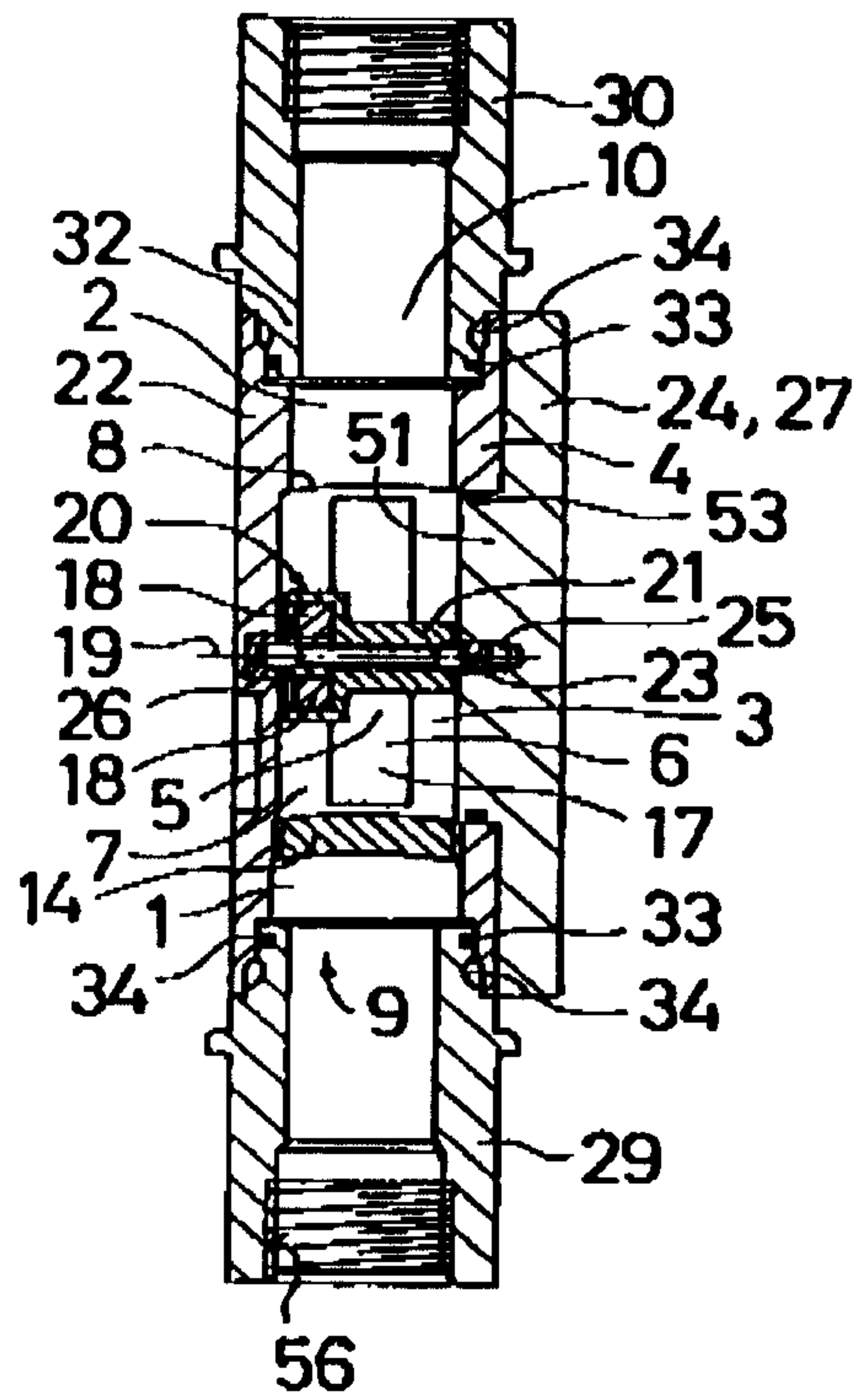


FIG. 7

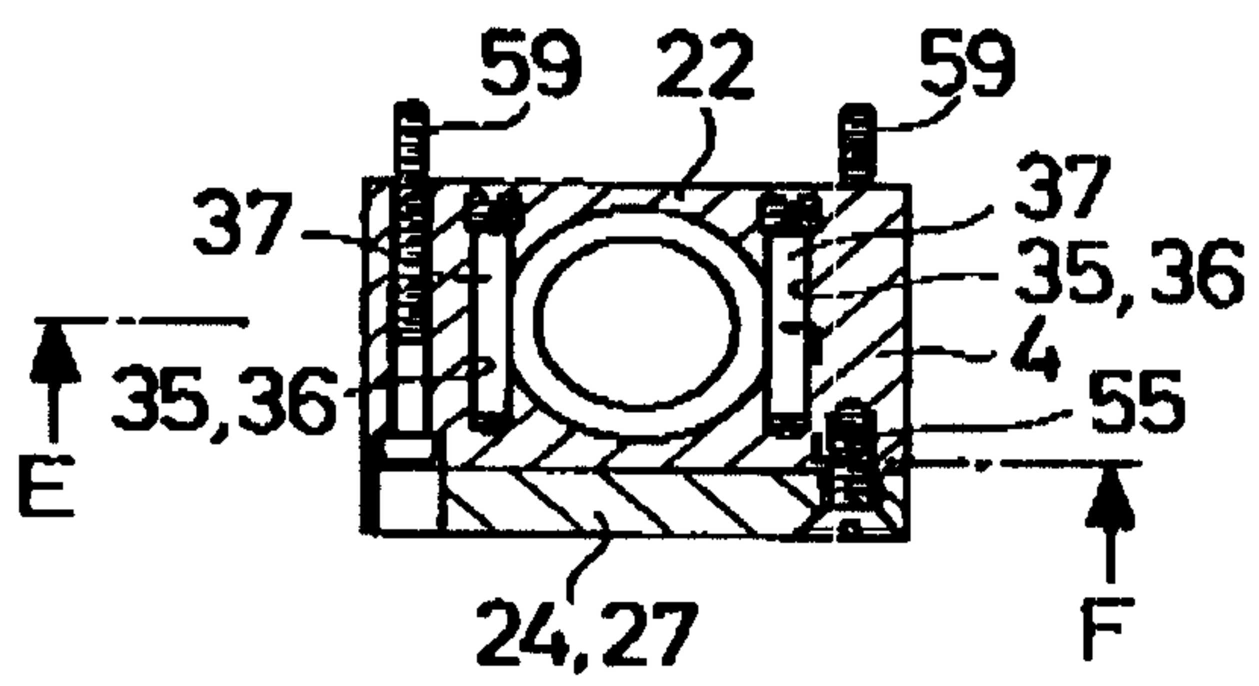


FIG. 8

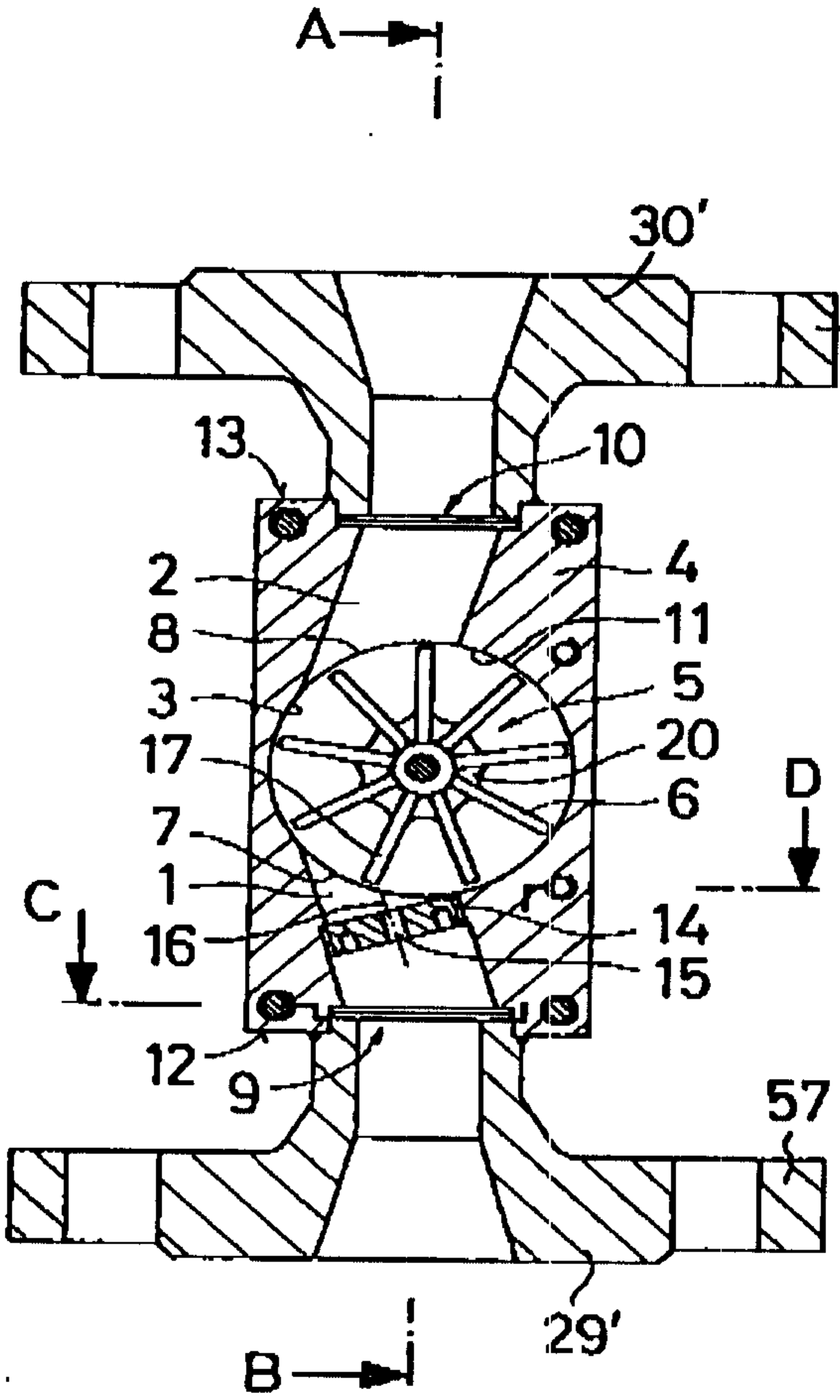


FIG. 12

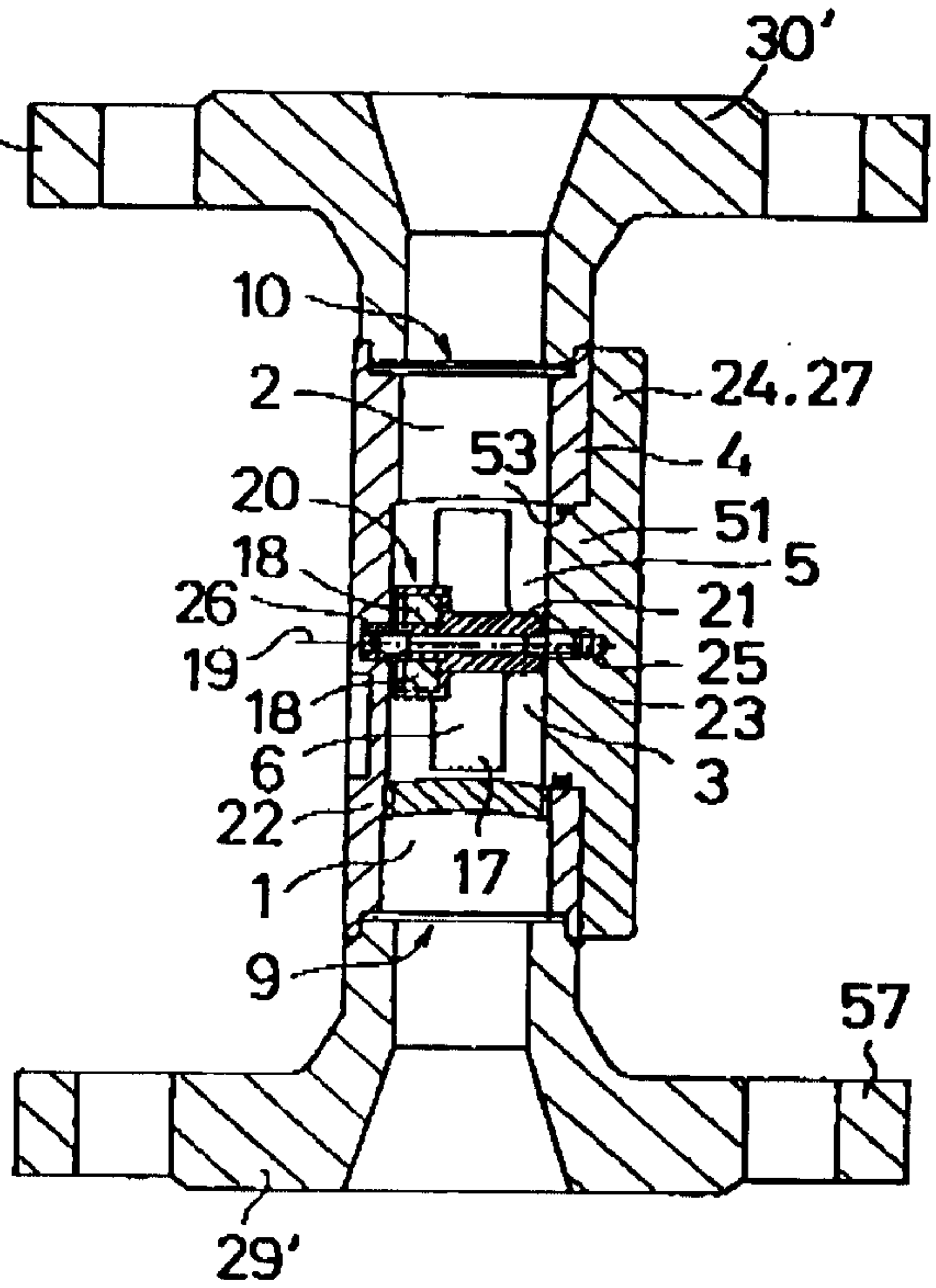


FIG. 10

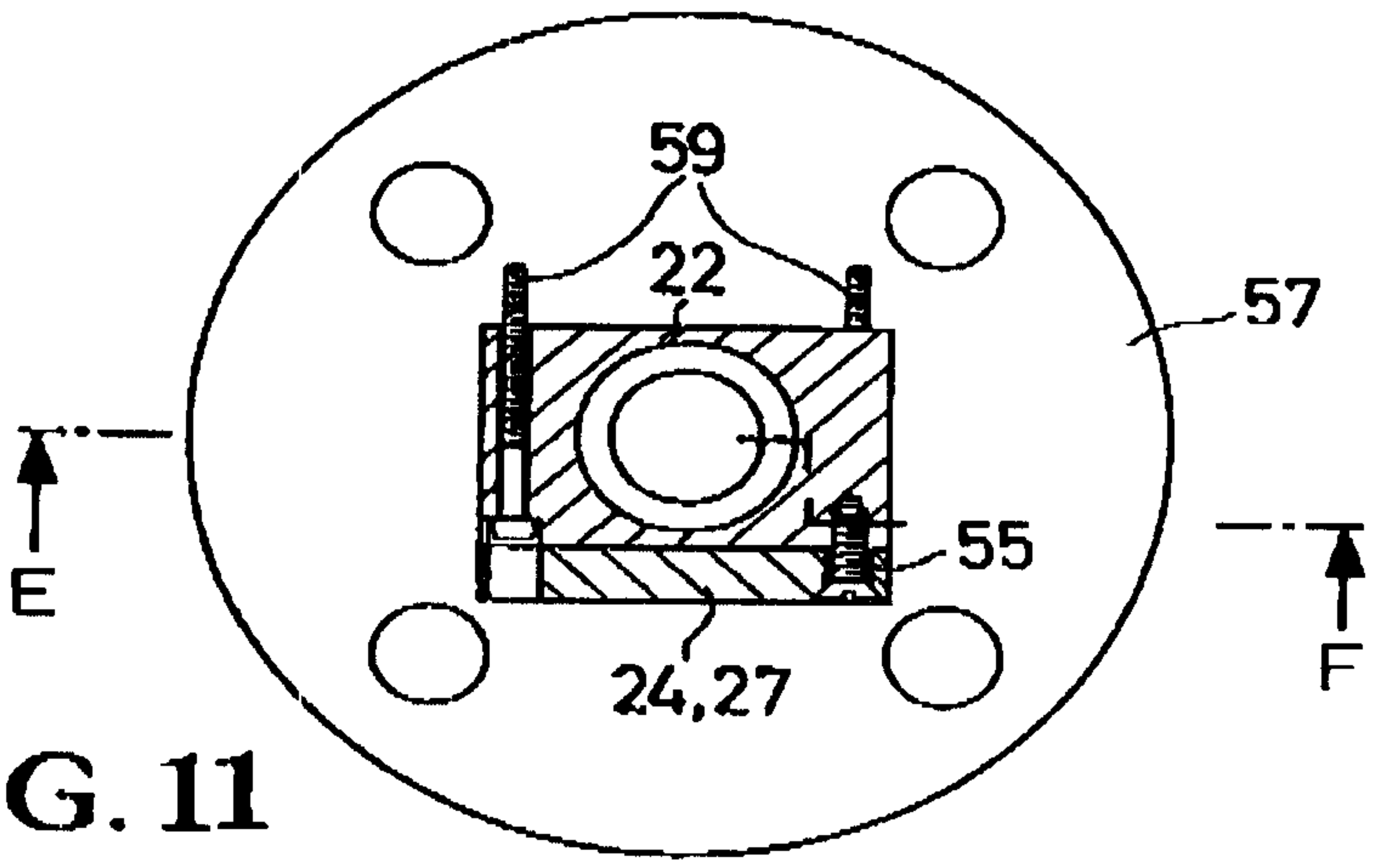


FIG. 11

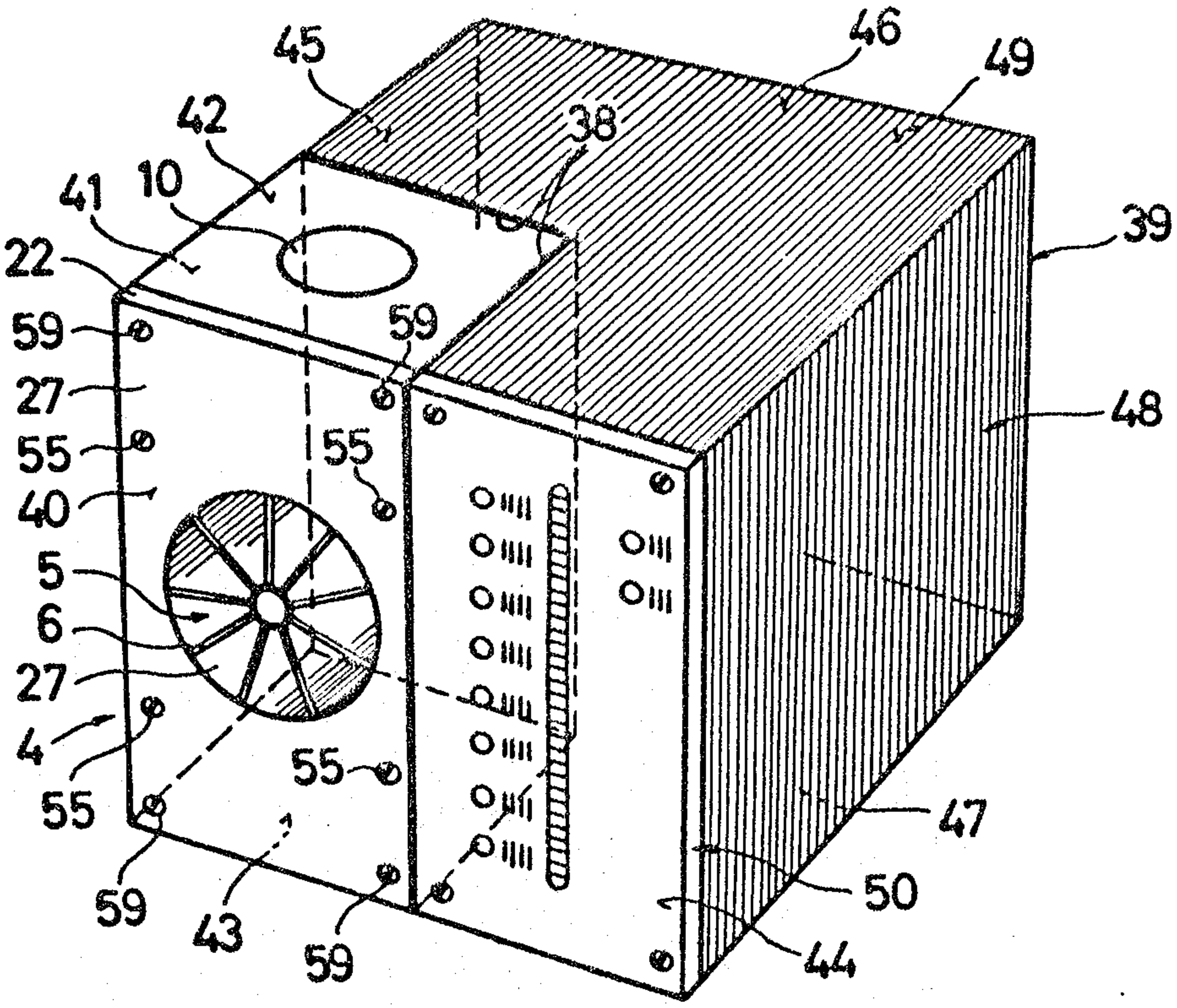


FIG.13

Patent Agents
Fetherstonhaugh & Co.
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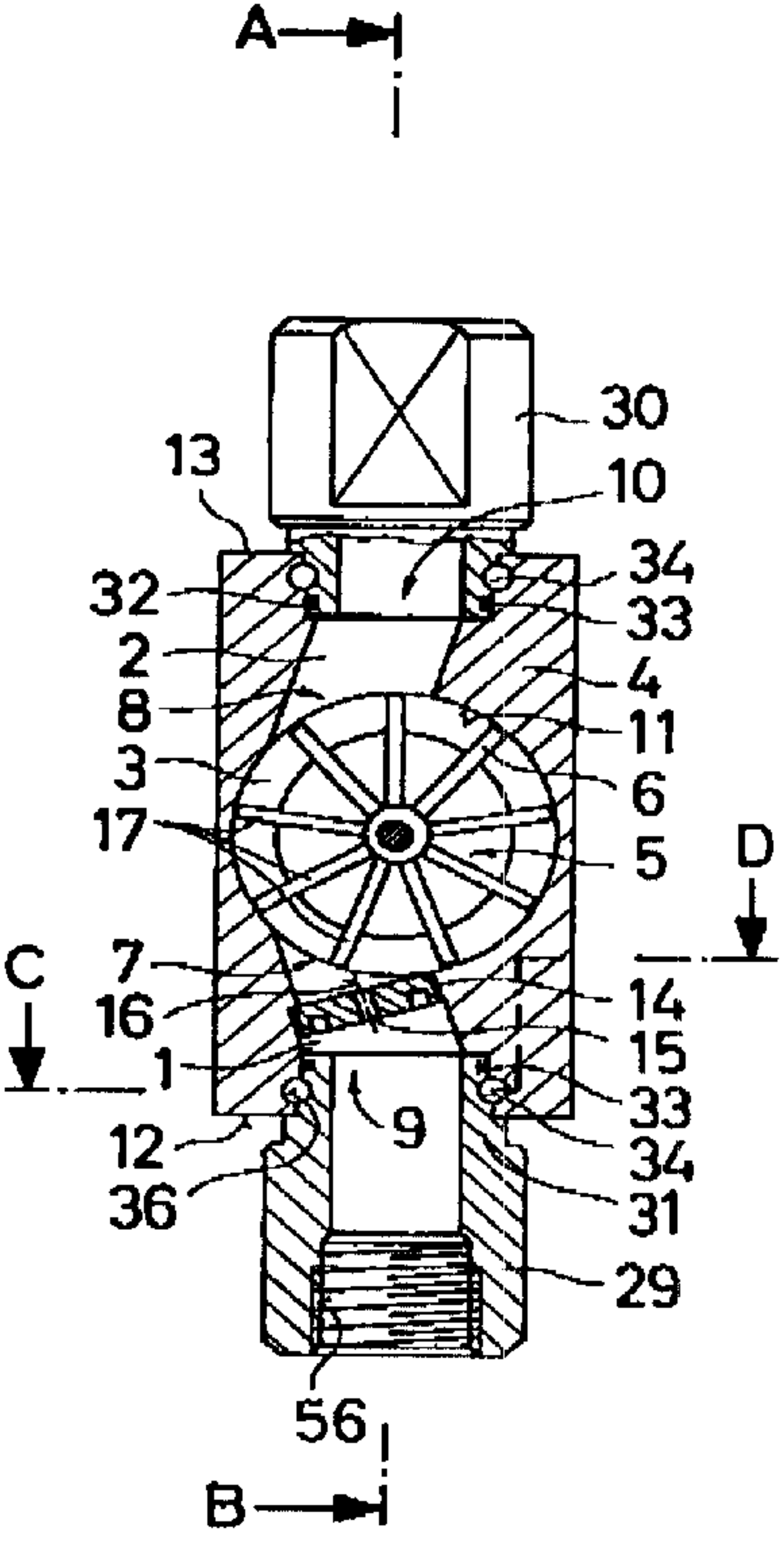
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