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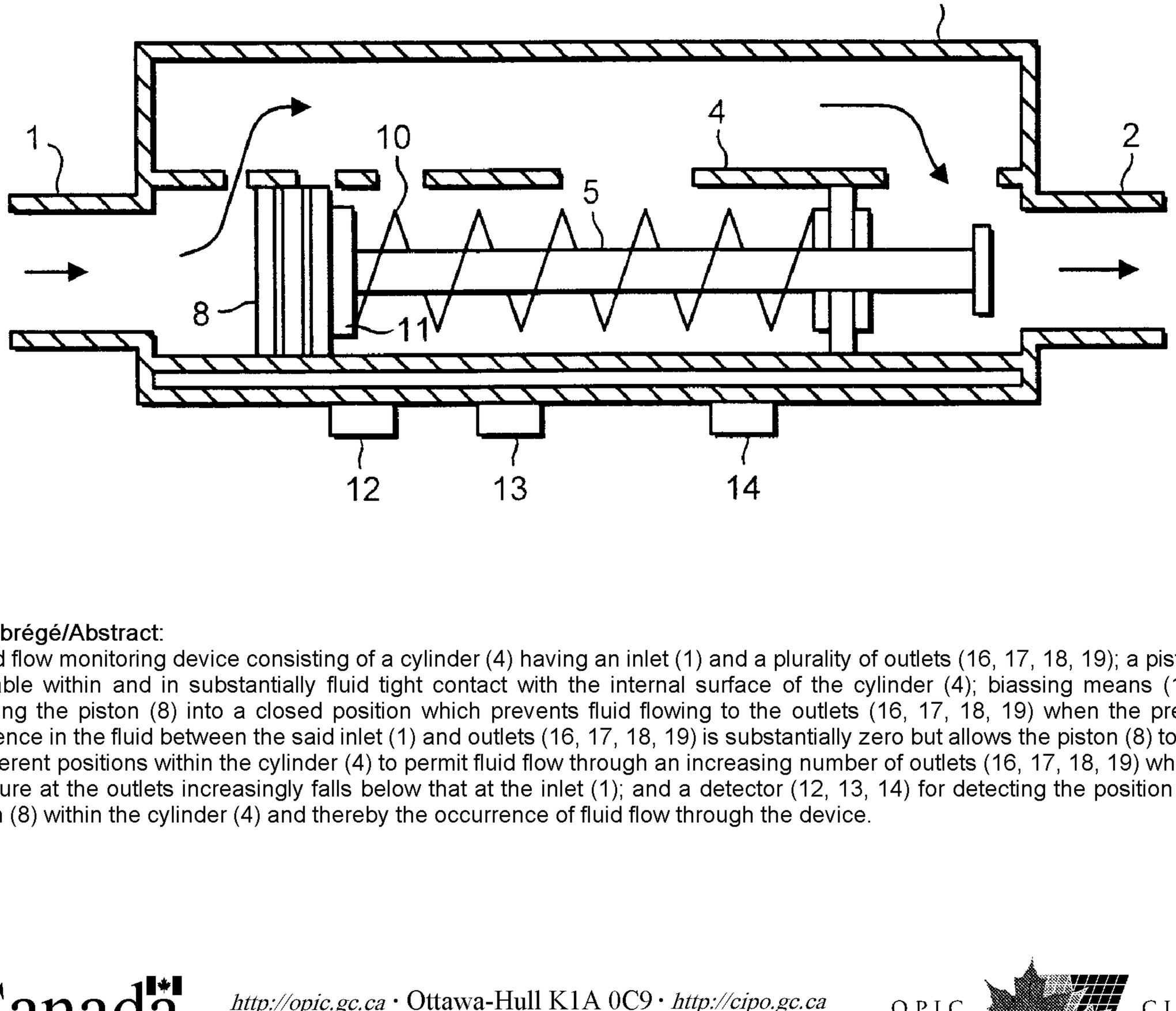
(54) Title: MONITORING DEVICES AND CONTROL SYSTEMS



(57) Abrégé/Abstract:
A fluid flow monitoring device consisting of a cylinder (4) having an inlet (1) and a plurality of outlets (16, 17, 18, 19); a piston (8) slideable within and in substantially fluid tight contact with the internal surface of the cylinder (4); biassing means (10) for biassing the piston (8) into a closed position which prevents fluid flowing to the outlets (16, 17, 18, 19) when the pressure difference in the fluid between the said inlet (1) and outlets (16, 17, 18, 19) is substantially zero but allows the piston (8) to move to different positions within the cylinder (4) to permit fluid flow through an increasing number of outlets (16, 17, 18, 19) when the pressure at the outlets increasingly falls below that at the inlet (1); and a detector (12, 13, 14) for detecting the position of the piston (8) within the cylinder (4) and thereby the occurrence of fluid flow through the device.

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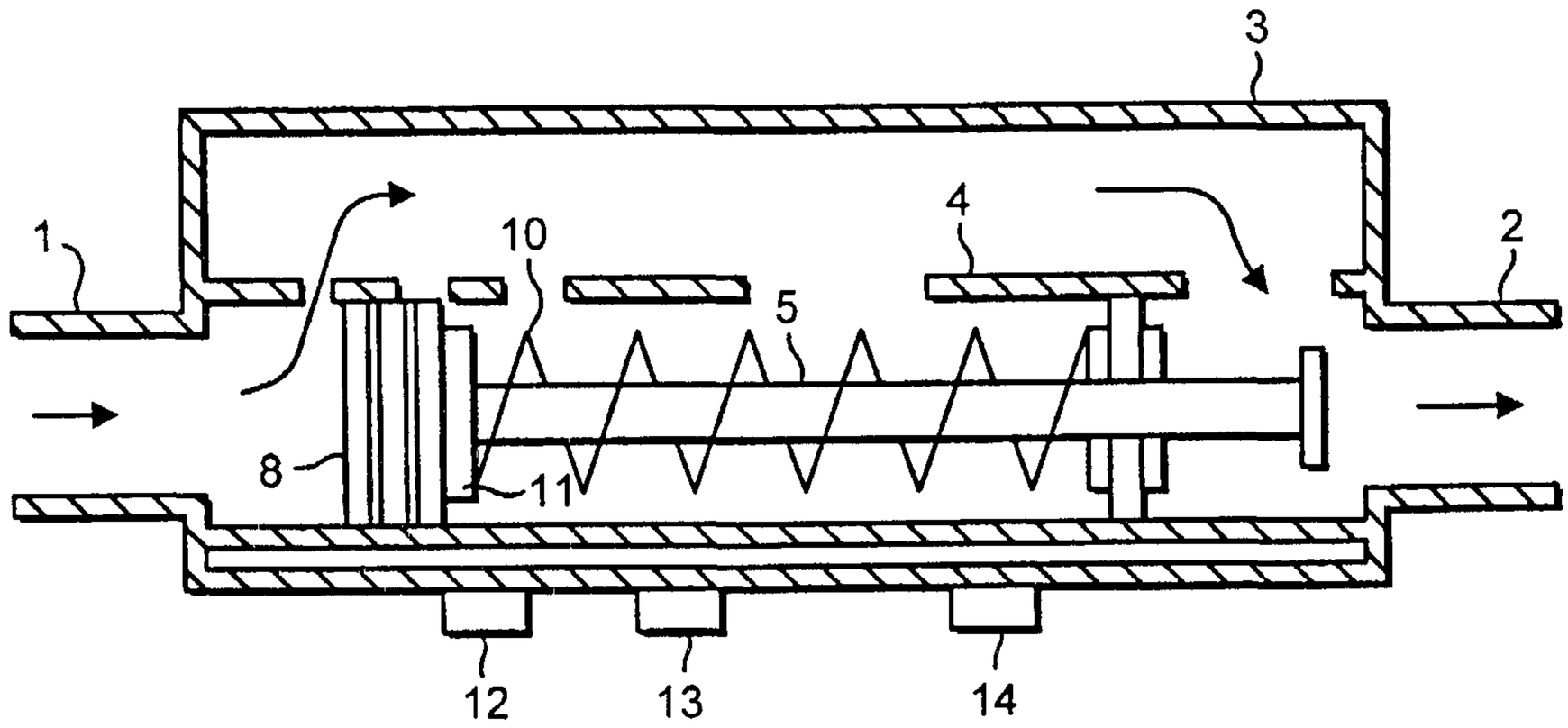

(57) Abstract

A fluid flow monitoring device consisting of a cylinder (4) having an inlet (1) and a plurality of outlets (16, 17, 18, 19); a piston (8) slideable within and in substantially fluid tight contact with the internal surface of the cylinder (4); biassing means (10) for biassing the piston (8) into a closed position which prevents fluid flowing to the outlets (16, 17, 18, 19) when the pressure difference in the fluid between the said inlet (1) and outlets (16, 17, 18, 19) is substantially zero but allows the piston (8) to move to different positions within the cylinder (4) to permit fluid flow through an increasing number of outlets (16, 17, 18, 19) when the pressure at the outlets increasingly falls below that at the inlet (1); and a detector (12, 13, 14) for detecting the position of the piston (8) within the cylinder (4) and thereby the occurrence of fluid flow through the device.

Monitoring Devices and Control Systems

This invention concerns monitoring devices and control systems for monitoring and controlling fluid flows, and in particular devices for monitoring and controlling water supplies.

The cost of water is increasing throughout the world, even in countries where rain fall is relatively high, and with usage increasingly being charged according to meter readings, leakages can become very expensive to the consumer. Furthermore, leakages require water utilities to supply more water than is otherwise needed, and this can add a considerable overhead in countries where water supplies are obtained by the desalination of sea water.

US4518955 describes a method and apparatus for detecting leakages in fluid conduit systems, for example for water supplies, which consist of a flow detector, a signal from which being passed to a microcomputer which generates an alarm if the duration of the flow has been pre-set as being abnormal. The flow sensor consists of a piston which is slid in a cylinder between a zero flow position to a flow position against the

force of a spring, magnetic sensors being used to detect the position of the piston within the cylinder.

US5503175 describes a water safety system for detecting and shutting off water flow which includes a flow detector consisting of a piston movable within a cylinder by the water flow, a magnet attached to the piston being moved by the flow past a magnetically sensitive detector. As with the system of US4518955, this system only responds to flow or no flow.

US5228469 describes a fluid control device including a sensor including a piston including a magnet which is moveable within a cylinder by the fluid flow against a spring, a plurality of magnetically sensitive sensors on the outside of the cylinder indicating the position of the piston within the cylinder and thereby providing an indication of fluid flow rate.

According to the present invention there is provided a fluid flow monitoring device comprising:-

(a) a cylinder having an inlet and a plurality of outlets;

(b) a piston slideable within and in substantially fluid tight contact with the internal surface of the cylinder;

(c) biassing means for biassing the piston into a closed position in which the piston prevents fluid flowing to the outlets when the pressure difference in the fluid between the said inlet and outlets is substantially zero but allows the piston to move to different positions within the cylinder which permit fluid flow through an increasing number of outlets when the pressure at the outlets increasingly falls below that at the inlet; and

(d) detector means for detecting the position of the piston within the cylinder and thereby the occurrence of fluid flow through the device.

Devices in accordance with the present invention can be used to monitor a wide range of fluid flow rates. Furthermore, this can be with virtually zero loss of pressure at very high flow rates, for example by the use of relatively large apertures

Devices in accordance with the present invention are of particular value in controlling water supplies, for example to minimise water losses and/or damage caused by broken pipes or taps being left open.

The apertures in the cylinder through which the fluid flows preferably increase in size in the direction of movement of the piston as the fluid flow increases.

The biassing means is preferably in the form of a spring, usually of a corrosion resistant metal, and is particularly preferred to use a spring with a non-linear compressibility.

The detector means preferably includes a magnet which is moved by movement of the piston within the cylinder, and this magnet can then be used to actuate one or more magnetically actuatable sensors, these usually being located on the outside of the device.

Devices in accordance with the present invention are preferably adapted to monitor the flow of water in water supplies, for example to commercial or domestic premises.

The present invention also provides fluid flow monitoring systems comprising a fluid flow monitoring device according to the present invention, and timer means for timing the duration of fluid flow through the device.

It is generally preferred to include valve means and actuating means for actuating the valve means to cut off the fluid flow after a predetermined period of time as determined by the timer means.

The timer means can be arranged to enable a number of different flow rates to be monitored, with the valve means being actuatable in response to such different flow rates.

Systems according to the present invention preferably include an alarm which is activated after a predetermined time interval as determined by the timer means, and the alarm can be used to provide an audible or a visual indication of an abnormal fluid flow.

Systems according to the present invention are preferably adapted to control the flow of water in water supplies, for example to commercial or domestic premises.

Embodiments of devices and systems in accordance with the present invention will now be described with reference to the accompanying diagrammatic drawings in which:-

Fig. 1 is a longitudinal section through a first embodiment of flow monitoring device with no water flow;

Fig. 2 is a view similar to that of Fig. 1 but with a very low flow rate;

Fig. 3 is a view similar to that of Fig. 1 but with a medium flow rate;

Fig. 4 is a view similar to that of Fig. 1 but with a high flow rate;

Fig. 5 is a schematic diagram of the control unit of a system incorporating the device of Figs. 1 to 4;

Fig. 6 is a longitudinal section through a second embodiment of monitoring device with no water flow;

Fig. 7 shows water flow paths for the device of Fig. 6 with maximum water flow rate;

Fig. 8 is a part cut away view of the device of Fig. 6 with a low flow rate;

Fig. 9 corresponds to Fig. 8 but with a medium flow rate;

Fig. 10 corresponds to Fig. 8 but with a high flow rate; and

Fig. 11 shows changes in the water flow rate through the device of Figs. 6 to 10 as a function of the displacement of the piston within the device.

Referring to Fig. 1, the illustrated flow monitoring device is of essentially tubular construction with a water inlet 1 and a water outlet 2. The diameters of the inlet 1 and the outlet 2 can be selected according to the water supply with which the device is to be used, and they can, if desired, be provided with compression fittings to facilitate their installation into an existing water supply.

Between the inlet 1 and the outlet 2 is a cylindrical portion 3 of larger diameter than that of either the inlet 1 or outlet 2, the inlet 1 and outlet 2 being off-set from the axis of the portion 3.

Within the cylindrical portion 3 is an apertured tube 4 which is of larger diameter than the inlet 1 or the outlet 2, but it is substantially concentric with both of them.

A grooved piston 8 is mounted on a rod 5 which is guided along the axis of the tube 4 through a bulkhead 7 having a guide 6 on either side thereof. The grooves 9 in the piston 8 have a self-cleaning action when the piston and the rod 5 move within the tube 4. A spring 10 around the rod 5 serves to urge the piston 8 into the closed position shown in Fig. 1. Also mounted on the rod 5 is a magnet 11 which moves with the piston 8 within the tube 4.

On the outside of the tube 3 are three reed switches 12, 13 and 14 which are connected to a timer unit 30.

The tube 4 also has a series of radially opening apertures 15, 16, 17, 18, 19 and 20, the functioning of which will now be described.

Fig. 1 shows the device in its state with no water flow through it, the piston 9 being urged by the spring 10 to the extreme left hand position as shown in the diagram.

As water is drawn from the supply, it flows in the direction of the arrows as shown in Fig. 2, through the inlet 1, the apertures 16 and 20, and the outlet 2, the reduced pressure at the outlet 2 compared with that of the supply in the inlet 1 causing the water to force the piston 8 and its guide rod 5 against the resistance of the spring 10.

Greater flow rates cause the piston 8 to move to the position shown in Fig. 3, in which all of apertures 16, 17 and 18 allow water to flow from the inlet 1 to the outlet 2, and finally with a completely open outflow the piston 8 assumes the position shown in Fig. 4.

Comparing Figs. 1 to 4, it can be seen that the magnet 11 assumes different positions relative to the reed switches 12, 13 and 14. In Fig. 1, the magnet 11 is not near enough to activate any of these switches. However, in the position shown in Fig. 2, the magnet 11 is close enough to the reed switch 12 to activate it, and in the positions shown in Figs. 3 and 4 the magnet 11 is in a position to activate the reed switches 13 and 14 respectively.

Fig. 5 shows the control system for the device, and it consists of a timer unit 30, a valve 31 for shutting off the water through the flow monitoring device, an alarm 32, a visual display 33, 34, and a reset module 35.

The three reed switches 12, 13 and 14 are connected to the timer unit 30. Although all three of these switches can be connected to a single timer, it is particularly preferred for each of the three switches to be connected to its own timer within the timer unit 30, this allowing different timing criteria to be used with each of the switches. Once one of the switches 12, 13 and 14 has been activated by the magnet 11, the associated timer is started. If all of the switches are turned off as a result of the magnet 11 being returned to its position shown in Fig. 1, which results when water flow through the flow monitoring device ceases, the timer(s) are stopped and reset to zero. However, if water continues to flow through the flow monitoring device for more than a predetermined time, the timer unit 30 sends a signal to the alarm 32 and the visual display 33. At the same time or after a further pe-set period the signal is sent to the valve 31 which cuts off the supply of water to the flow monitoring device shown in Figs. 1 to 4.

The visual display 33, 34 provides a first display 33 which indicates whether there has been time over-run caused by drips, leaks or a flood as sensed by reed switches 12, 13 and 14 respectively, and a second display 34 which provides an indication of the cost per day of the water leakage up to the time the water was cut off by the valve 31.

The reset module 35 enables the alarm 32 to be switched off, the valve 31 opened, and the timer(s) in the timer unit 30 to be reset.

In general, the timer(s) in the timer unit 30 will be set so that normal water use will not activate the valve 31 and the alarm 32. However, abnormal flows such as are caused by a burst pipe, leaving a tap on unattended for long periods, or even a dripping tap can be monitored and used to turn off the water supply, thereby not only saving water and the associated cost, but also possible damage caused by uncontrolled water leakage.

As will be appreciated, the valve 31 can be placed in the fluid flow either before or after the flow monitoring device, it generally being preferred that it be placed before the monitoring device.

A modified but essentially similar flow monitoring device to that described with reference to Figs. 1 to 4 is shown in Figs. 6 to 10. Because of these similarities, similar parts in this second device have been given the same reference numerals to those given for the embodiment of Figs. 1 to 4.

The essential differences between the monitoring device shown in Figs 6 to 10 and that shown in Figs. 1 to 4 is that the line of radially opening apertures 15-20 through the tube 4 of the latter are replaced by radially opening apertures which are distributed over the surface of the tube rather than being in a line. The result is that movement of the grooved piston 8 within the tube 4 as a consequence of changes of water flow through these apertures can be varied by changing the distribution of apertures through the tube 4, and a greater flexibility of distribution can be achieved as a result. As can be seen from Fig. 7, a plurality of large diameter apertures near to the limit of movement of the piston 8 in the tube 4 can result in a large increase in output flow for little movement of the piston 8. This can be seen more clearly from Fig. 11 which illustrates how the water flow through the flow monitoring device varies with the distance moved by the piston 8 from its position at zero water flow.

The bulkhead 7 of the embodiment of Figs. 6 to 10 has a pressure relief aperture 30 therethrough, and it has been found that the size of this aperture can affect the rate of response of the device to changes in fluid pressure between the inlet 1 and the outlet 2.

The flow monitoring device shown in Figs. 6 to 10 also includes more reed switches than are shown in Figs. 1 to 4, thus enabling the flow rate through the flow monitoring device to be monitored

more closely. In addition, whilst these monitors are shown in a line in Fig. 6, it will be appreciated that they can be distributed at various positions over the surface of the external portion of the cylindrical portion 3.

Although the present invention has been particularly described in relation to the control of water flows, it can be used to control the flow of other fluids, for example other liquids, e.g. oil, or gases.

Claims

1. A fluid flow monitoring device comprising:-

(a) a cylinder having an inlet and a plurality of outlets;

(b) a piston slideable within and in substantially fluid tight contact with the internal surface of the cylinder;

(c) biassing means for biassing the piston into a closed position in which the piston prevents fluid flowing to the outlets when the pressure difference in the fluid between the said inlet and outlets is substantially zero but allows the piston to move to different positions within the cylinder which permit fluid flow through an increasing number of outlets when the pressure at the outlets increasingly falls below that at the inlet; and

(d) detector means for detecting the position of the piston within the cylinder and thereby the occurrence of fluid flow through the device.

2. A device according to claim 1, wherein the said apertures are of increasing size in the direction of movement of the piston by the fluid flow from the said closed position to positions of increasing flow rate.

3. A device according to either of the preceding claims, wherein the biassing means comprises a spring.

4. A device according to any of the preceding claims, wherein the detector means includes a magnet which is moved by movement of the piston within the cylinder.

5. A device according to claim 4, wherein the detector means includes one or more magnetically actuatable sensors which are actuated by movement of the said magnet.

6. A device according to any of the preceding claims adapted to monitor the flow of water in a water supply.

7. A system for monitoring the flow of a fluid, the system comprising flow monitoring means according to any of the preceding claims, and timer means for timing the duration of the flow.

8. A system according to claim 7, including valve means for cutting off the fluid flow through the device, and further including actuating means for actuating the valve means to cut off the flow after a predetermined period of time as determined by the timer means.

9. A system according to claim 8, wherein the timer means enables different flow rates to be monitored and the valve means is actuatable in response to such different rates.

10. A system according to and of claims 7 to 9, including an alarm which is activated after a predetermined time interval as determined by the timer means.

11. A system according to claim 10, wherein the alarm provides an audible or a visual indication of abnormal fluid flow.

12. A system according to any of claims 7 to 11, adapted to control the flow of water in a water supply.

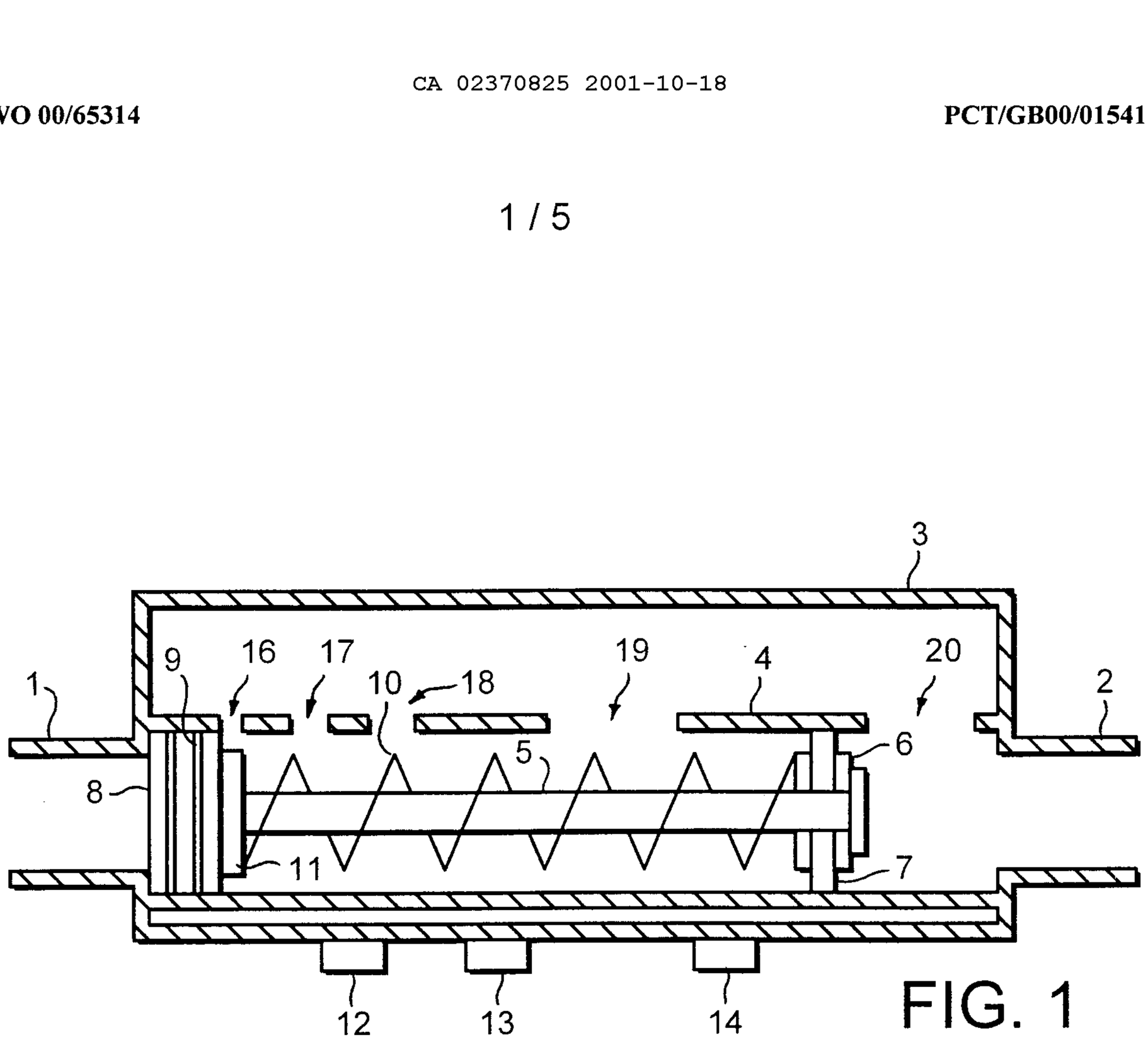

FIG. 1

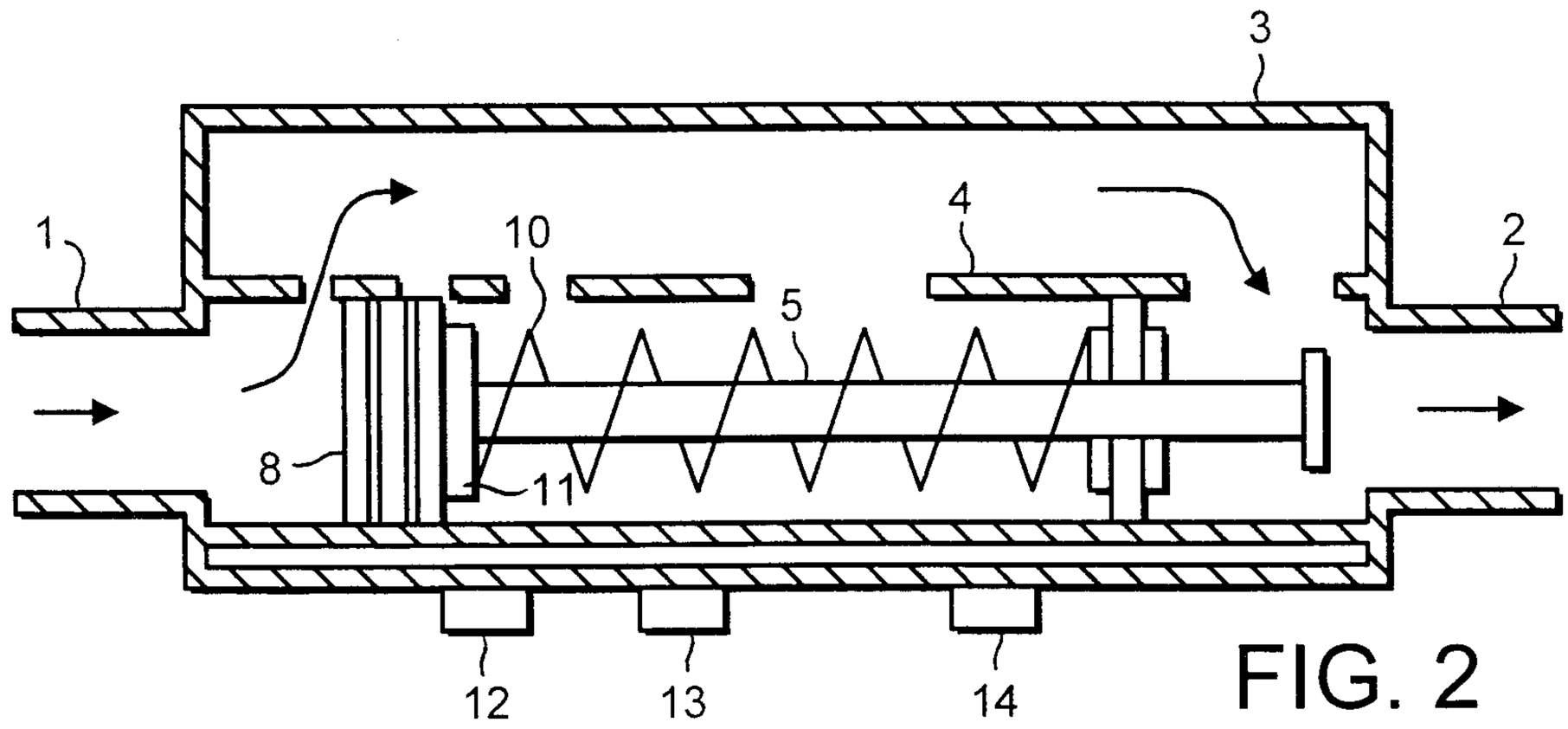

FIG. 2

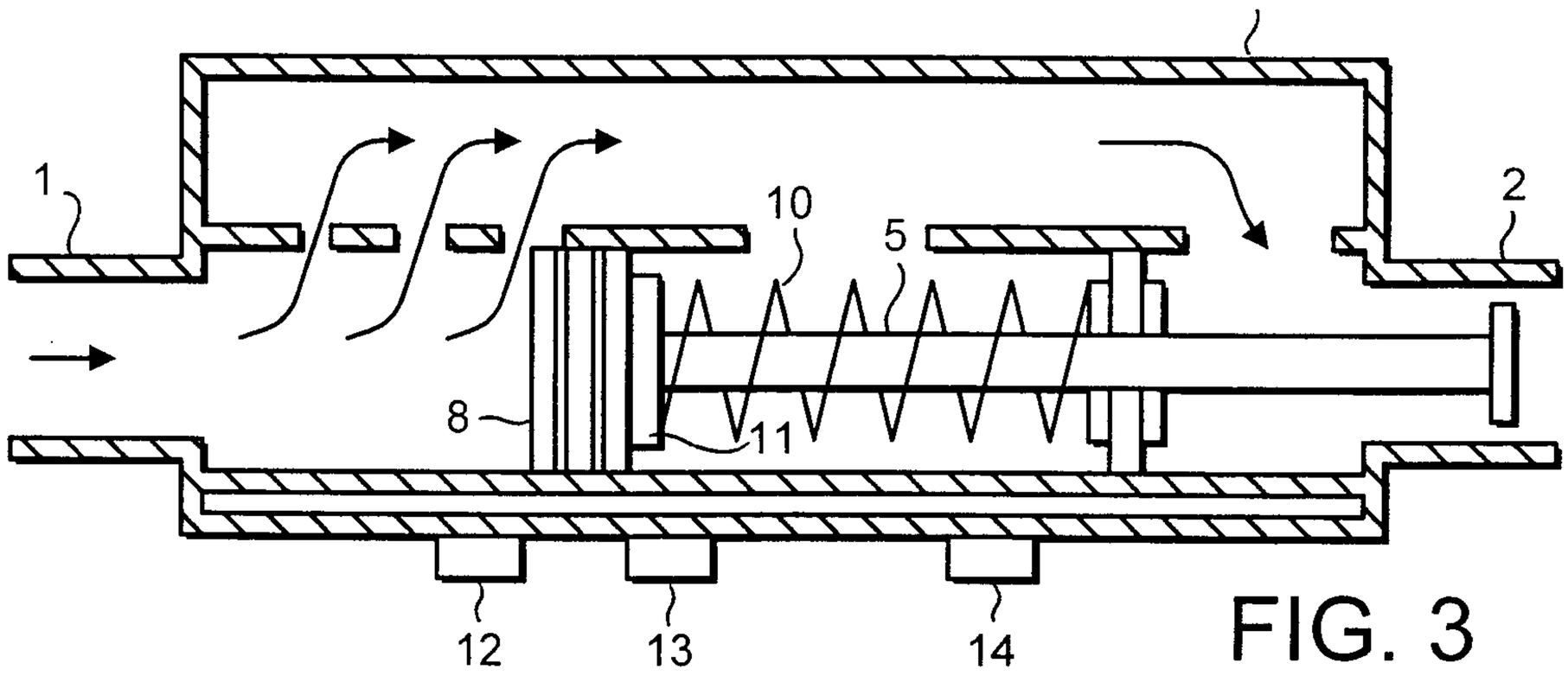

FIG. 3

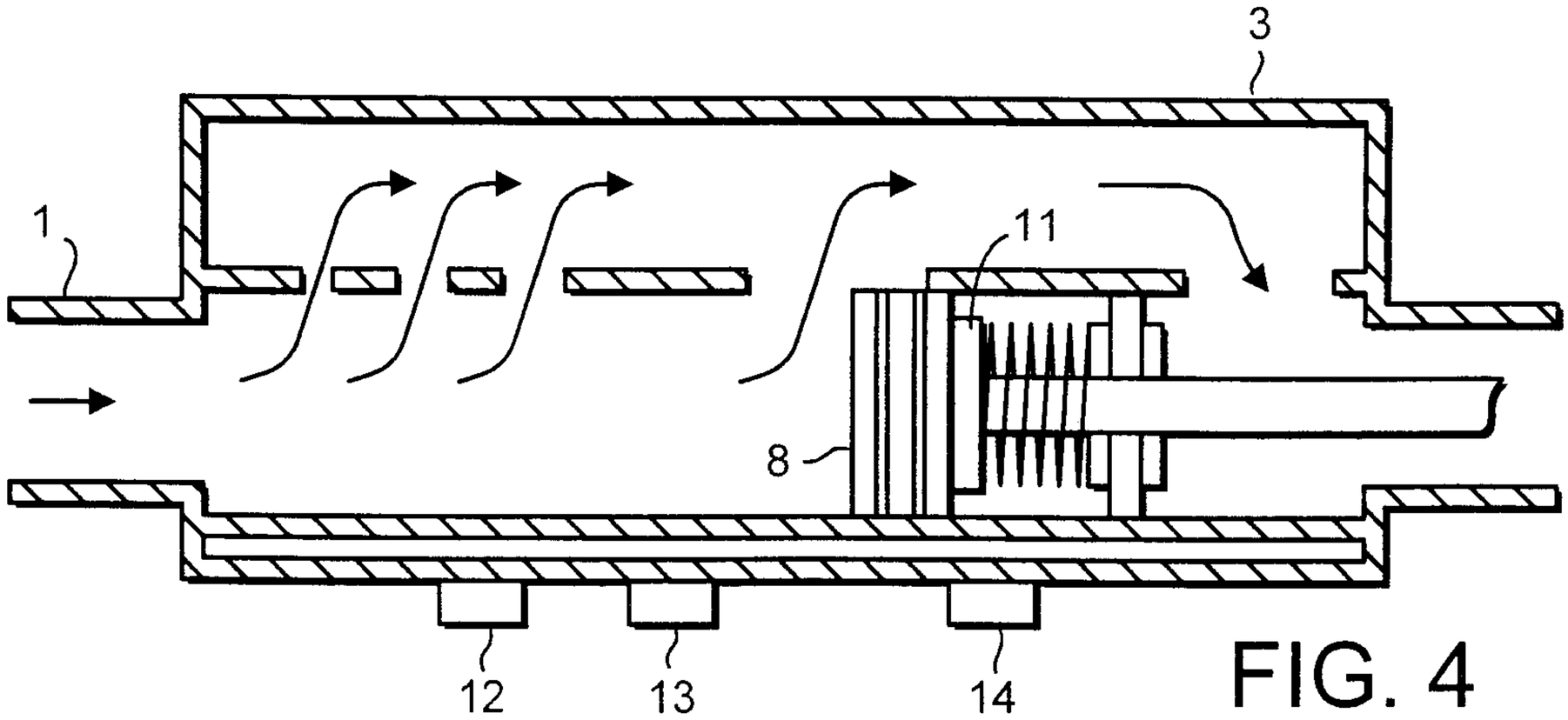

FIG. 4

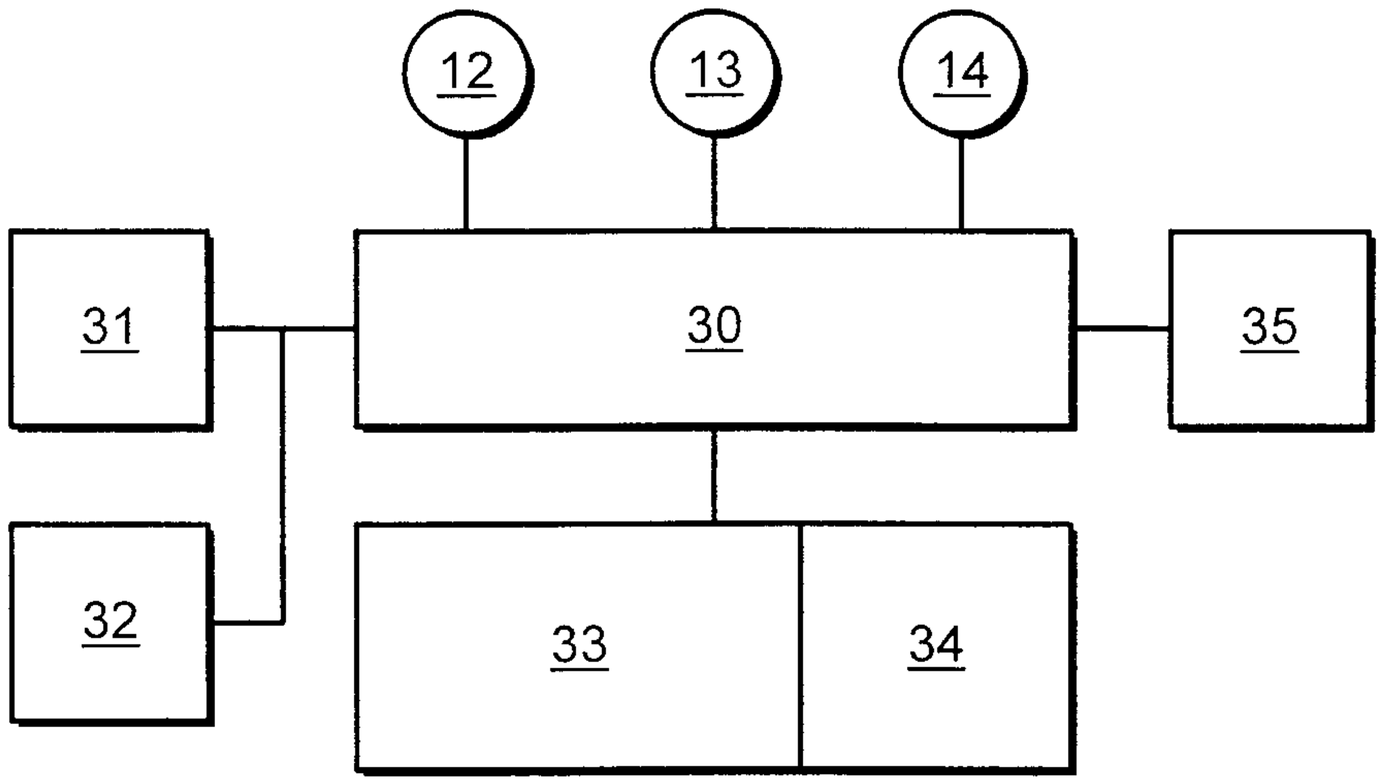
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FIG. 5

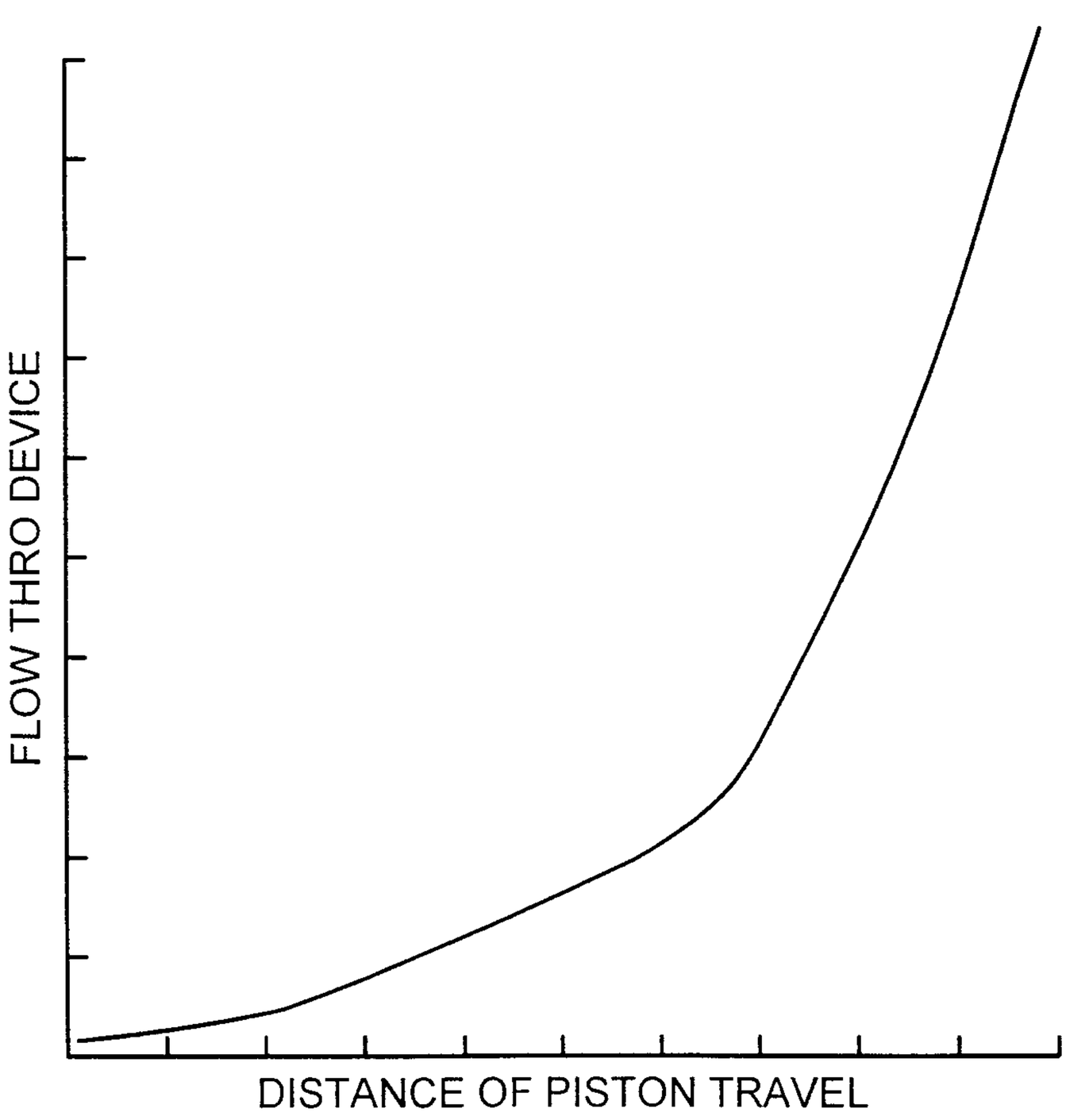

FLOW THRO DEVICE
DISTANCE OF PISTON TRAVEL

FIG. 11

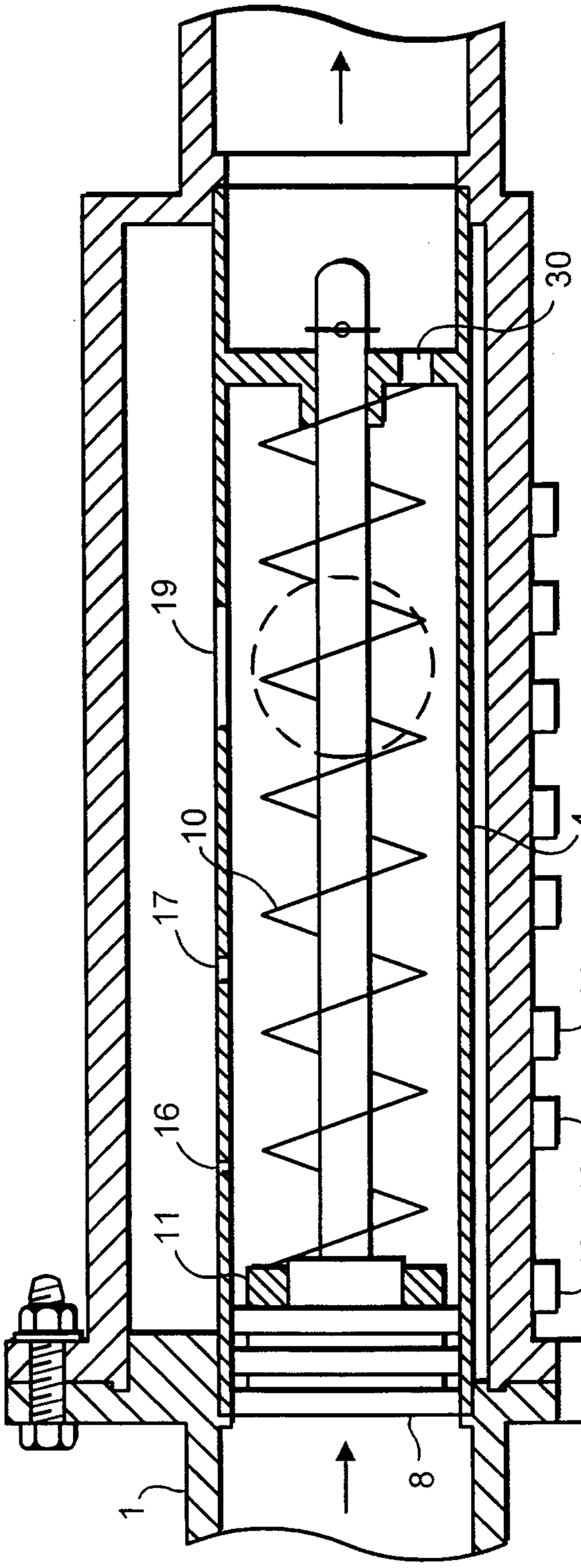


FIG. 6

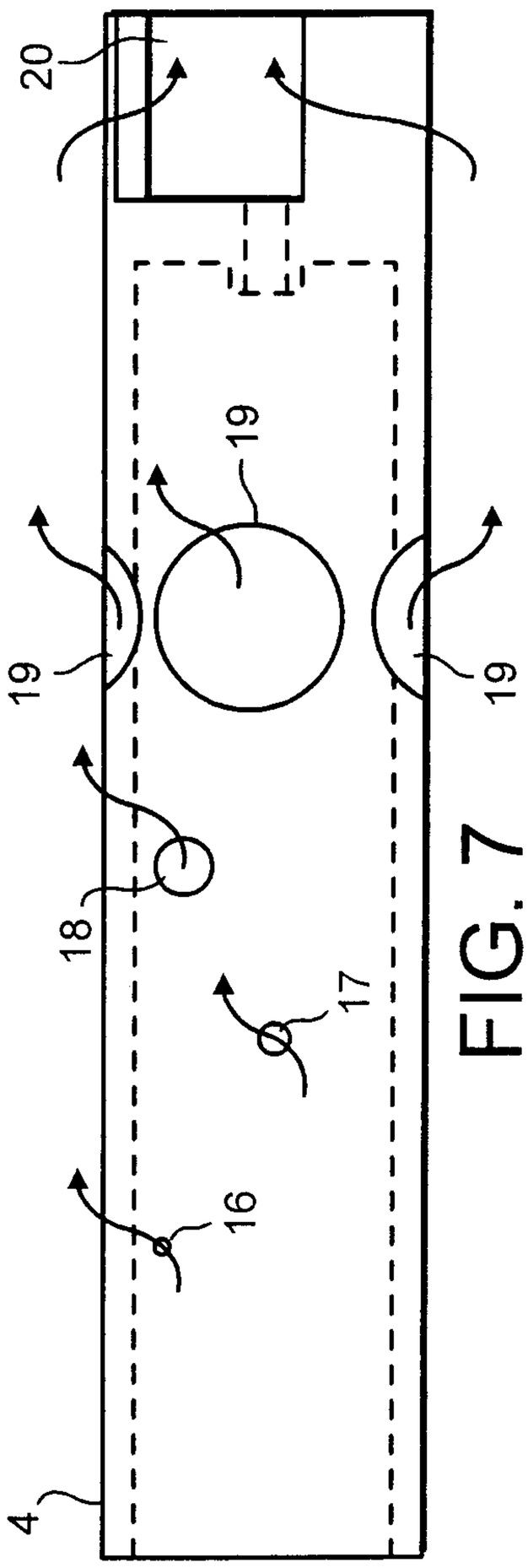


FIG. 7

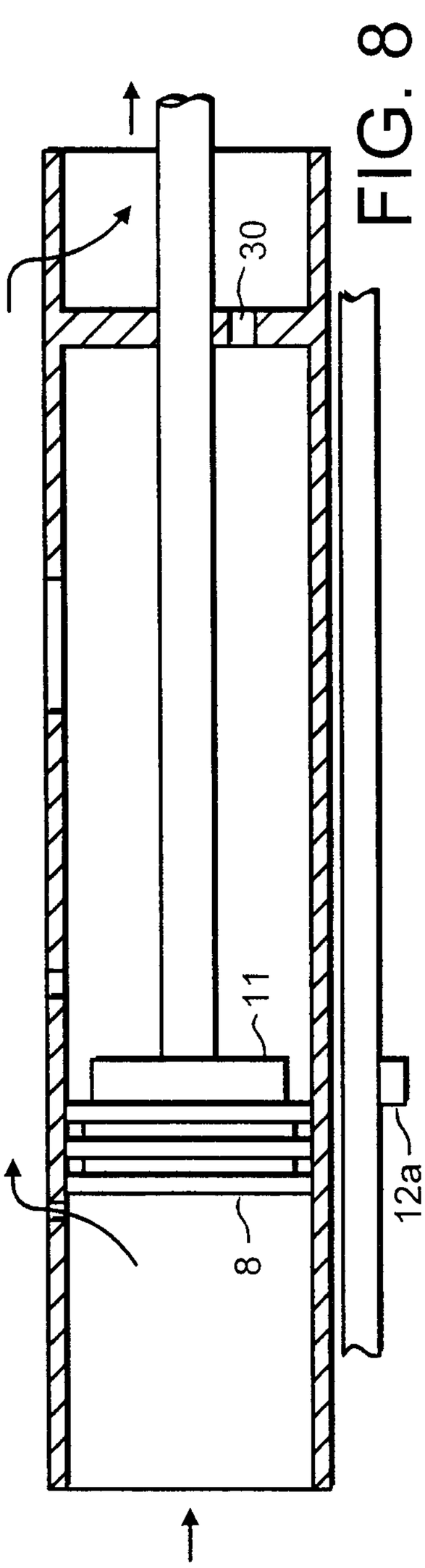


FIG. 8

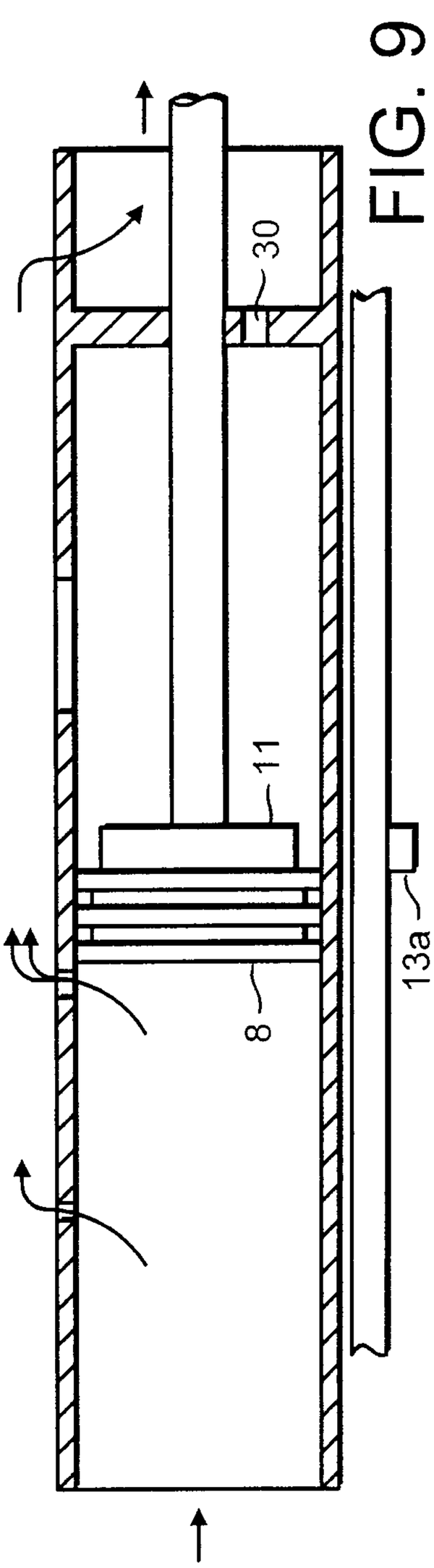


FIG. 9

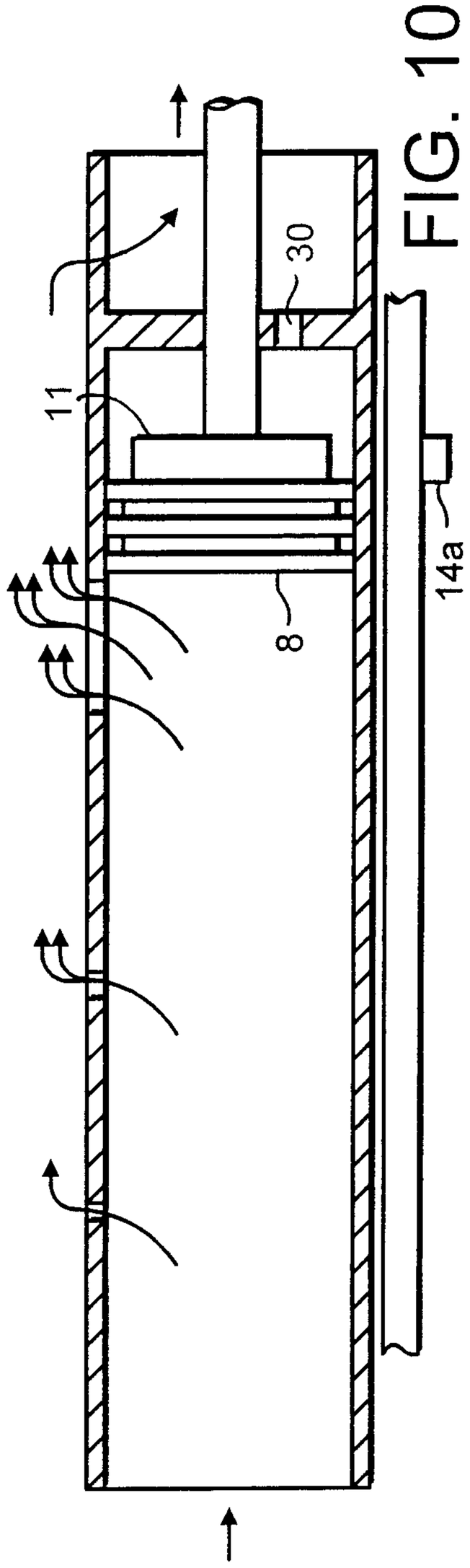
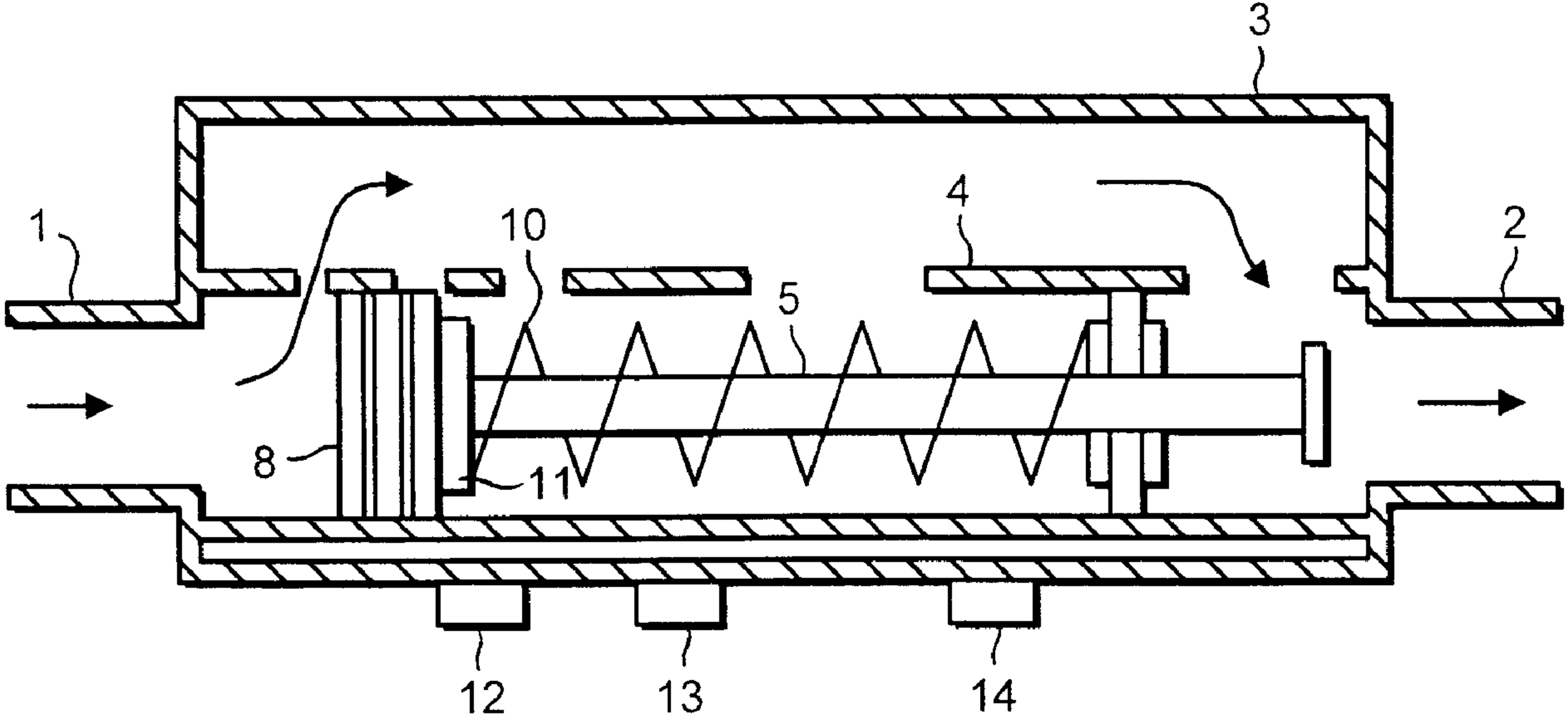


FIG. 10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