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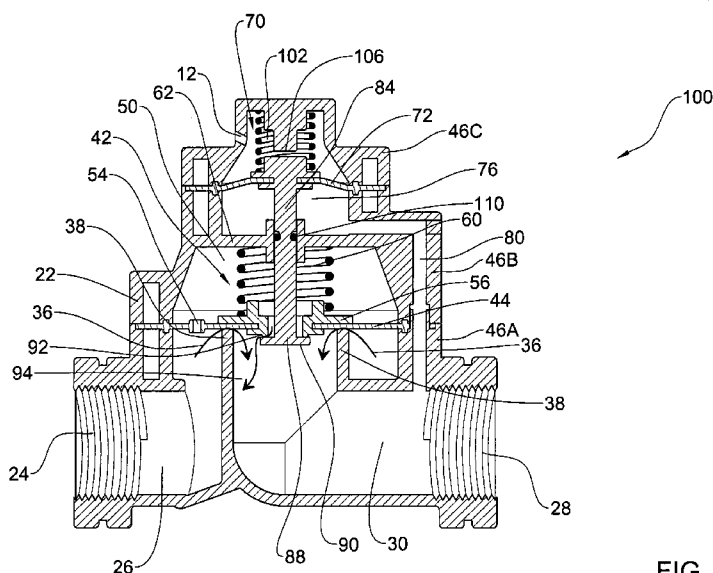


FIG. 1

(57) Abstract: A two-stage valve comprises a housing fitted with an inlet port extending to an inlet chamber and configured for coupling to an upstream liquid supply line, and an outlet port extending from an outlet chamber and configured for coupling to a downstream supply line; a high flow-rate path extending between the inlet chamber and the outlet chamber fitted with a hydraulic element configured for selectively admitting liquid flow therebetween at a demand position defined by substantially high flow; a pressure regulating unit configured for controlling a pressure regulating flow path providing direct or indirect flow communication between the inlet chamber and the outlet chamber for allowing liquid flow therebetween at a leak position defined by substantially low flow rates.



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FLOW CONTROL VALVE

FIELD OF THE INVENTION

The present disclosed subject matter is concerned with a flow control valve. More particularly the disclosed subject matter is concerned with a self regulated two-stage flow control valve.

5 BACKGROUND OF THE INVENTION

It is not un-common for buildings, either domestic or public structures, office buildings, factories and the like, that leaks occur at the water supply pipes or at plumbing fixtures such as faucets, toilets, irrigation equipment and the like. Such liquid supply pipes and plumbing fixtures are typically fed with pressurized liquid (depending
10 for example on municipal supply pressure, elevation, etc.) and are hereinafter in the specification and claims are referred to collectively as '*downstream consumers*'.

A *leak*, by nature, is referred to as an undesired flow of liquid, at a substantially low flow rate, through a downstream consumer, and usually deliver relatively small amounts of liquid.

15 However, a dreadful scenario is an event of a *burst* of a liquid supply pipe or a pipe coupling or any other downstream consumer. A burst is defined as an undesired flow of liquid delivering liquid at a substantially high flow rate.

Leaks and bursts, either detected at an early stage or after a while, may cause large scale damage to the structure (floor, ceiling, walls), to carpets and parquets,
20 furniture, electric, electronic, telecommunication and computer equipment, personal belongings etc. This is considered as one of the major losses for insurance companies. Evenmore so, where fresh water supply is problematic (e.g. at remote locations or where fresh water is not found), a significant burst (long-lasting and at substantially high flow rate), this may result in temporary shortage of water supply.

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Municipalities or any other water (liquid) suppliers, will supply the water at a pressure sufficient to reach the most remote and elevated consumers. Thus, many consumers are supplied with water at high pressure, significantly higher than that in fact required for their location. Yet, at certain hours of the day consumption is very low (e.g. at night), whilst at other hours consumption reaches a peak, requires that water be supplied to meet peak time pressure requirements.

SUMMARY OF THE INVENTION

According to the present disclosed subject matter there is provided a spontaneous, self regulated two-stage flow control valve, and a method employing same.

The valve is configured such that to provide the following effects:

A. At no consumption - i.e. there is no demand of liquid downstream of the valve (manually by individuals or by automated liquid supply systems) and there are substantially no bursts at a downstream consumer. At this state the valve is configured to reduce downstream pressure (i.e. lower than an upstream, supply pressure, wherein $P_{out} < P_{in}$) and thus reduce the likelihood of leaks or bursts to take place.

B. At consumption – the valve is configured to allow substantially high flow rate, wherein $P_{out} \cong P_{in}$.

Leak prevention/reducing – the valve reduces downstream pressure by generating a low pressure, thus reducing the flow rate through a leaking unit/s, and preventing deteriorating of the leak into a burst.

Burst prevention/reducing – reducing the downstream pressure reduces the likelihood for bursts to occur.

A two-stage valve according to the present disclosed subject matter comprises an inlet port for coupling to an upstream liquid supply line, a high flow rate hydraulic faucet in flow communication with the inlet port, a low flow rate pressure regulating unit being in flow communication with the high flow rate hydraulic faucet and with an outlet port for coupling to a downstream supply line.

The valve is configured for spontaneous, self control of the outlet pressure (measured at the outlet port), responsive to fluid flow and flow demand patterns.

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According to the presently disclosed subject matter two-stage valve comprises a housing fitted with an inlet port extending to an inlet chamber and configured for coupling to an upstream liquid supply line, and an outlet port extending from an outlet chamber and configured for coupling to a downstream supply line; a high flow-rate path
 5 extending between the inlet chamber and the outlet chamber fitted with a hydraulic element configured for selectively admitting liquid flow therebetween at a demand position defined by substantially high flow; a pressure regulating unit configured for controlling a pressure regulating flow path providing direct or indirect flow communication between the inlet chamber and the outlet chamber for allowing liquid
 10 flow therebetween at a leak position defined by substantially low flow rates.

Hereinafter in the specification and claims, the following symbols are used:

P_{in} – designates the pressure at the inlet port and respective inlet chamber of the valve;

P_{out} - designates the pressure at the outlet port and respective outlet chamber of
 15 the valve;

P_{mc} - designates the pressure at the main chamber: and

P_{cc} – designates the pressure at the control chamber.

The arrangement is such that at initial state of the valve (*'fully closed state'*), upon closing all downstream consumers, the hydraulic faucet seals the high flow rate
 20 path (extending between the inlet chamber and the outlet chamber) and the pressure regulating flow path is sealed too, wherein momentarily $P_{out} \cong P_{in} \cong P_{mc} \cong P_{cc}$.

Gradually, as a leak takes place at the downstream consumers (*'leak position'*), the pressure P_{out} slowly drops ($P_{out} < P_{in}$), as well as the pressure supporting the control diaphragm, giving rise to displacement of the control plunger to facilitate fluid flow at a
 25 low flow rate from the inlet chamber, via the bleed aperture at the main diaphragm, into main chamber, through the pressure regulating flow path and out through the outlet chamber and outlet port to the downstream consumers.

When high flow rate is in demand by the downstream consumers (*'demand position'*), e.g. opening a tap or the like, the pressure at the main chamber droops ($P_{out} < P_{mc} < P_{in}$) resulting deformation of the main diaphragm to open the high flow rate path
 30 facilitating high flow-rate flow between the inlet and outlet of the valve, and wherein the pressure regulating flow path is widely open ($P_{out} = P_{mc} < P_{in}$). When the downstream

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consumers stop the demand of liquid the system returns to the initial state of the valve, as discussed hereinabove.

A restricting arrangement is provided, to restrict axial displacement of the control plunger in order to ensure that the pressure regulating flow path opens to facilitate high flow rate thereabout and thus to prevent 'fluctuations' through the system. Namely, when the high flow-rate path opens, the pressure increases whereby the low flow-rate pressure regulating unit (which is configured for handling substantially low flow rates) tends to close and thus the control plunger displaces axially in direction to close the pressure regulating flow path, whereupon the high flow-rate path would close. For that reason it is desired to restrict axial displacement of the control plunger. It is appreciated that in pressure equilibriums illustrated herein, the force of the biasing spring is taken into consideration in addition to surface area ratios at both surfaces of the diaphragm, respectively.

Any one or more of the following features and configurations may be embodied in a valve and valve system according to the present disclosed subject matter:

- The two-stage valve comprises a housing fitted with an inlet port extending to an inlet chamber and configured for coupling to an upstream liquid supply line, and an outlet port extending from an outlet chamber and configured for coupling to a downstream supply line; a high flow-rate path extending between the inlet chamber and the outlet chamber fitted with a hydraulic element configured for selectively admitting liquid flow therebetween at a demand position defined by substantially high flow; a pressure regulating unit configured for controlling a pressure regulating flow path providing direct or indirect flow communication between the inlet chamber and the outlet chamber for allowing liquid flow therebetween at a leak position defined by substantially low flow rates;
- The valve further comprises a mechanism for opening said high flow-rate path upon a demand for liquid downstream.
- The high flow-rate path fitted with a hydraulic faucet comprising a main diaphragm extending between the inlet chamber and the outlet chamber configured for selectively admitting said liquid flow therebetween at substantially high flow rates.

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- The valve further comprises a main chamber extending at one face of the main diaphragm and configured with a restricted flow path extending between an inlet chamber and the main chamber.
- 5 • The pressure regulating unit is further configured for mechanically releasing pressure from said main chamber at said high flow rates.
- The pressure regulating unit is further configured for hydraulically releasing pressure from said main chamber at said high flow rates.
- 10 • The valve further comprises a pressure releasing mechanism separated from said pressure regulating unit and configured for mechanically releasing pressure from said main chamber at said high flow rates.
- The valve further comprises a pressure releasing mechanism separated from said pressure regulating unit and configured for hydraulically releasing pressure from said main chamber at said high flow rates.
- 15 • The pressure regulating unit is configured with a control chamber fitted with a control diaphragm having one face in normally open flow communication with the outlet chamber and at an opposite face thereof is vented to the atmosphere.
- The pressure regulating unit is configured with a control plunger, wherein said control diaphragm and control plunger are configured for controlling a pressure regulating flow path, and extends in flow communication between 20 the main chamber and the outlet chamber.
- The hydraulic faucet and the low flow-rate pressure regulating unit are integrated in a uniform housing, said hydraulic faucet and low flow-rate pressure regulating unit extending coaxially on top or below one another, at one side of the housing or at two sides thereof, or at a side-by-side configuration 25 configuration
- The pressure regulating flow path is configured with an annular sealing portion fitted at the main diaphragm and a control plunger comprising a flow control end with a respective sealing head for sealing engagement of 30 the annular sealing portion.
- The low flow-rate pressure regulating unit extends coaxially to hydraulic faucet, wherein a control plunger of the pressure regulating unit extends through the outlet chamber and displaces towards sealing of the pressure

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regulating flow path in direction against the sealing direction of the main diaphragm.

- 5 • The low flow-rate pressure regulating unit extends coaxially to hydraulic faucet, wherein a control plunger of the pressure regulating unit extends through the main chamber and further through said annular sealing portion fitted at the main diaphragm, and displaces towards sealing of the pressure regulating flow path in direction against the sealing direction of the main diaphragm.
- 10 • The pressure regulating flow path is governed by displacement of a control plunger of the pressure regulating unit, whilst the main diaphragm does not play a role in governing of the pressure regulating flow path.
- The main diaphragm is spring biased into sealing engagement of the high flow rate path and the control plunger being spring biased in direction to allow flow through the pressure regulating flow path.
- 15 • The main diaphragm is configured with an annular sealing portion, wherein the annular sealing portion is configured for press sealing against an annular sealing shoulder defining the high flow-rate flow path.
- The main diaphragm's annular sealing portion is provided with a cylindrical sealing extension configured for sealing engagement with a corresponding
20 cylindrical seat of the high flow-rate path.
- The pressure release is performed by restricting member configured to restrict axial displacement of a control plunger of the pressure regulating unit, at an open state of the high flow-rate path.
- The hydraulic pressure release is performed by an intermediate chamber
25 with an intermediary diaphragm having one side in flow communication with the inlet chamber and another side in flow communication with the main chamber; and wherein said intermediary diaphragm is articulated with the control plunger of the pressure regulating unit such that pressure differential over the intermediary diaphragm entails corresponding
30 displacement of the control plunger.
- The main diaphragm is formed with one or more apertures extending opposite said annular sealing shoulder, such that at a fully closed position and at the leak position said one or more apertures remain sealingly engaged

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by the annular sealing shoulder, and at the demand position of the system, as the diaphragm begins to deform into its open position, the one or more apertures disengage from their sealing engagement with the annular sealing shoulder, thus increasing further deformation.

- 5 • The apertures are disposed about a circle coextending with the said annular sealing shoulder open upon even a minor displacement of the main diaphragm, thereby assisting in reaching pressure equilibrium between the main chamber and the outlet chamber, to thereby get the system into stabilization.
- 10 • A hydraulic pressure release unit is provided between the main chamber and the outlet chamber, for selectively equalizing pressure between the main chamber and the outlet chamber.
- 15 • The hydraulic unit is a hydraulic faucet configured with a release diaphragm, being in flow communication with the inlet chamber and configured for selective controlling fluid flow between the main chamber and the control chamber of the low flow-rate pressure regulating unit which in turn is in flow communication with the outlet chamber or directly between the main chamber and outlet chamber.
- 20 • The low flow-rate pressure regulating unit is disposed offset the hydraulic faucet with the regulating flow path extending coaxial with said low flow-rate pressure regulating unit, wherein a flow path extends between the main chamber and one face of the sealing head of a control plunger of the pressure regulating unit, a flow path extends between the control chamber and an outlet chamber, where the control plunger extends through an
25 intermediate chamber with an intermediary diaphragm thereof having one side in flow communication with the inlet chamber and another side in flow communication with the main chamber and having articulated thereto a plunger seat being coaxially displaceable responsive to pressure differential over said intermediary diaphragm.
- 30 • A high pressure regulating mechanism is provided, comprises of a dynamic restricting plunger and a coiled spring, which regulates outlet pressure during high flow rates by adjusting displacement of the control plunger of

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the pressure regulating unit so as to limit the opening of the common pressure regulating and pressure release flow path during demand position;

- A low-pressure regulating valve and an electric faucet extending in parallel flow relation to one another, each having an inlet being in flow communication with the inlet port and outlet being in flow communication with the outlet port; and a flow sensor extending upstream of said outlet port or else extending downstream of said inlet port and configured for generating a flow control signal responsive to fluid flow and transmitting said signal to said electric faucet;
- The high flow rate through the flow sensor results in generating a control signal to open the electric faucet and low flow rate through flow sensor entails shutting said electric faucet and resulting in directing low flow through the low-pressure regulating valve;
- A restricting member is provided to restrict axial displacement of the control plunger at an open state of the pressure regulating flow path;
- A pressure reducer valve may be fitted, in line before or after the two-stage valve, for setting the outlet pressure to a predetermined substantially fixed pressure. Such a pressure reducer valve provides constant downstream pressure, regardless of the upstream pressure and regardless of flow rate through the valve;
- The restricting mechanism operates by restricting axial displacement of the control plunger, wherein the main diaphragm continues to displace into its open position, whereby pressure at the main chamber and the outlet chamber substantially equalizes ($P_{out} = P_{mc}$), resulting in a minor head loss owing to the biasing effect of the main diaphragm biasing spring;
- It is appreciated that at demand position there exists a head-loss between the inlet pressure and the outlet pressure (typically between about 0.2-0.4 atm.). Such head-loss is considered as a minor loss.
-

According to another aspect of the presently disclosed subject matter there is provided a two-stage valve comprises a housing fitted with an inlet port extending to an inlet chamber and configured for coupling to an upstream liquid supply line, and an outlet port extending from an outlet chamber and configured for coupling to a

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downstream supply line; a high flow-rate path fitted with a hydraulic faucet comprising a main diaphragm extending between the inlet chamber and the outlet chamber for selectively admitting liquid flow therebetween at substantially high flow rates; a main chamber extending at one face of the main diaphragm and configured with a restricted flow path extending between an inlet chamber and the main chamber; a low flow-rate pressure regulating unit being in flow communication with the outlet chamber and configured with a control chamber fitted with a control diaphragm having one face in normally open flow communication with the outlet chamber and at an opposite face thereof is vented to the atmosphere; said control diaphragm is configured for controlling a pressure regulating flow path, and extends in flow communication between the main chamber and the outlet chamber.

According to another aspect of the present disclosed subject matter there is provided a two stage flow control valve comprising an inlet port and an outlet port, a low-pressure regulating valve and an electric faucet extending in parallel flow relation to one another, each having an inlet being in flow communication with the inlet port and outlet being in flow communication with the outlet port; and a flow sensor extending upstream of said outlet port or else extending downstream of said inlet port and configured for generating a flow control signal responsive to fluid flow and transmitting said signal to said electric faucet.

The high flow rate through the flow sensor results in generating a control signal to open the electric faucet and low flow rate through flow sensor entails shutting said electric faucet and resulting in directing low flow through the low-pressure regulating valve.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal section through a two-stage flow control valve in accordance with the disclosed subject matter;

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Figs. 2A to 2D are longitudinal sections illustrating different flow states of the valve of Fig. 1;

Figs. 3A to 3C illustrate a two-stage valve in accordance with a different configuration of the disclosed subject matter, at different flow states thereof;

5 **Fig. 4A** is a longitudinal section through a different example of a valve in accordance with the present disclosed subject matter;

Fig. 4B is a top, planar view of a main diaphragm used in the valve of Figs. 4 and 5;

10 **Figs. 5A to 5C** are longitudinal sections of the valve illustrated in Fig. 4A, at different flow conditions thereof;

Figs. 5A' to 5C' are enlargements of portions identified in Figs. 5A-5C, respectively;

Figs. 6A and 6B illustrate two respective flow states of a valve in accordance with yet another example of the valve subject of the present disclosed subject matter;

15 **Figs. 7A and 7B** are respective flow states of a valve in accordance with another example of the present disclosed subject matter;

Figs. 8A to 8C are longitudinal sections illustrating different flow states of a valve in accordance with an example of the present disclosed subject matter;

20 **Figs. 9A to 9E** are longitudinal sections illustrating different flow states of a valve in accordance with an example of the present disclosed subject matter;

Figs. 10A to 10D are schematic representations of longitudinal sections through valves in accordance with different configurations in accordance with the disclosed subject matter;

25 **Fig. 11A** is a schematic longitudinal section of a valve in accordance with another example of the present disclosed subject matter;

Figs. 11B to 11F are schematic representations illustrating different flow states of the valve illustrated in Fig. 11A;

Fig. 12A is a longitudinal section through a valve in accordance with yet another example of the present disclosed subject matter;

30 **Figs. 12B to 12D** are longitudinal sections of the valve of Fig. 12A illustrating different flow states thereof;

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Figs. 13A to 13E are longitudinal sections through a valve in accordance with still an example of the present disclosed subject matter at different flow states thereof; and

Figs. 14A to 14E are a block diagram schematically illustrating a control valve system in accordance with yet an example of the present disclosed subject matter.

DETAILED DESCRIPTION OF EMBODIMENTS

Turning first to Fig. 1 of the drawings there is illustrated a two-stage valve generally designated **100** comprising a housing **22** configured with an inlet port **24** configured for coupling to an upstream liquid supply line (not shown) and extending into an inlet chamber **26**, an outlet port **28** configured for coupling to a downstream supply line (not shown) and extending from an outlet chamber **30**. The downstream supply line may be a single consumer or a plurality of consumers adjacent or remote from the valve **100** and collectively referred to hereinafter in the specification and claims as downstream consumers.

It is noted that the inlet port **24** and the outlet port **28** are configured with internal threading for coupling to appropriate piping (not shown) however this being one of different possible coupling solutions.

The valve **100** is a globe-type valve and comprises a high flow-rate flow path represented by arrowed lines **36**, extending over an annular sealing shoulder **38** extending from the outlet chamber **30**. The high flow-rate flow path **36** is configured with an hydraulic faucet **42** comprising a main diaphragm **44** clampingly secured between a bottom housing portion **46A** and top housing portion **46B**.

The main diaphragm **44** rests over the annular sealing shoulder **38** in a sealing fashion defining above it a main chamber **50** which is in flow communication with the inlet chamber **26** via a bleed aperture **54** formed on the main diaphragm **44**.

The main diaphragm **44** is fitted with a rigidified annular sealing portion **56** supported over a central aperture over the main diaphragm **44** and radially projecting, slightly beyond the annular high flow-rate path **36**, said rigidified annular sealing portion being in the present case integrated with the main diaphragm **44** though in accordance with a different configuration (not shown) it may be integrally manufactured therewith.

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A faucet coiled spring **60** bears at its lower end against a top surface of the rigidified annular sealing portion **56** and at its upper end against a bottom face of a partition wall **62** extending within the housing, said coiled spring **60** imparting the main diaphragm **44** with a biasing effect such that it normally sealingly engages the high
5 flow-rate flow path **36** thus retains it at the so-called closed position at its normal state, as will be discussed hereinafter in further detail.

Further received within the housing **22** there is a low flow-rate pressure regulating unit generally designated **70** comprising a control diaphragm **72** clampingly secured within the top housing member **46B** and a top cover portion **46C**, thus defining
10 a control chamber **76** extending below said control diaphragm **72** and being in fluid flow communication with outlet chamber **30** via a duct **80**, normally open such that a pressure equilibrium extends between the control chamber **76** and the outlet chamber **30**. The control diaphragm **72** is articulated with a control plunger **84** configured with a sealing head **88** at its lower end with a top face thereof **90** sealingly engaging an annular
15 downwardly projecting sealing shoulder **92** of the rigidified annular sealing portion **56** defining together a pressure regulating flow path represented by arrowed line **94**, and which in Fig. 1 is illustrated at the closed position.

As can further be seen in Fig. 1, the control diaphragm **72** has its top face exposed to atmospheric pressure via a venting aperture **12** fitted at the top cover portion
20 **46C** and further there is provided a coiled spring **102**, bearing at its bottom end against a top portion of the control plunger **84** and a top end of the coiled spring **102** bearing against a top portion of the top cover portion **46C**, thereby biasing the control plunger **84** into a normally downward position.

As can further be seen, the top cover portion **46C** is fitted with a restricting
25 projection **106** downwardly projecting, and configured for restricting upward displacement of the control plunger **84**, as will be discussed hereinafter.

Further noticed there is provided a O-ring **110** over the control plunger **84**, for facilitating axial displacement of the plunger **84** within the partition wall **62**, however providing adequate sealing between the main chamber **50** and the control chamber **76**.

30 Further attention is now directed to Figs. 2A-2E exemplifying the different flow conditions and operation of the valve disclosed in connection with Fig. 1 and the general principles of a two-stage valve in accordance with the disclosed subject matter.

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Fig. 2A illustrates the valve at an initial state thereof namely a fully-closed state promptly upon closing all downstream consumers. As can be seen, at this state the high flow-rate flow path 36 is sealingly closed by virtue of the main diaphragm 44 sealingly bearing over the annular sealing shoulder 38. Likewise, the pressure regulating flow path 94 is closed by virtue of top face 90 of the control plunger 84 sealingly bearing against the sealing shoulder 92. The main diaphragm 44 is configured for press sealingly against the annular sealing shoulder 38.

In this situation all chambers and passages of the valve extend at the same pressure namely the pressure P_{in} at the inlet chamber 26 extends also at the main chamber 50 (pressure designated P_{mc}) and at the outlet chamber 30 P_{out} and at the control chamber 76 P_{cc} , owing to pressure equalizing through the bleed aperture 54 extending between the inlet chamber 26 and the main chamber 50 and via duct 80 extending between the outlet chamber 30 and the control chamber 76.

However, the state illustrated in Fig. 2A is a momentarily and occurs upon the sudden shutdown of the downstream consumers causing a momentarily increase at the outlet chamber 30 and corresponding at the control chamber 76 being at constant flow communication with one another through duct 80.

The effective cross sectional area acting at the bottom side of the main diaphragm 44 from both its faces is substantially equal and the coiled spring 60 thus provides the force for displacing the main diaphragm 44 and maintaining it at the closed position.

The pressure regulating flow path 94 remains sealed by virtue of the high pressure residing within the control chamber 76, resulting in deformation of the control diaphragm 72 to bulge upwardly, entailing axial displacement of the control plunger 84 in an upward direction of arrow 85.

It is an assumption that owing to pressure at the pipe system at the downstream consumers, leaks, even minor by nature, take place constantly. As a result of such leaks, the pressure P_{out} at the outlet chamber 30 slightly drops, entailing corresponding change in pressure at the control chamber 76, as a result of which the control diaphragm 72 is biased into its normal position (Fig. 2B) under influence of the coiled spring 102, resulting in axial downward displacement of the control plunger 84 whereupon the pressure regulating flow path 94 opens, facilitating slow flow-rate fluid flow from the inlet chamber 26, via the lead aperture 54, through the main chamber 50 and then out

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through the outlet port **28** to the downstream consumers (not shown) as represented by the arrowed line **101**.

At this position, the pressure/force equilibrium acting on the control plunger **84** consists of the pressure extending at the outlet chamber and acting on the bottom face **89** of the plunger and the pressure extending at the main chamber **50** and acting on the top face **90** of the plunger head **88**, and the force applied by the control spring **102** and the pressure extending at the control chamber **76** and acting on control diaphragm, which in turn acting on the control plunger **84**.

In addition, it is noted that the cross sectional area of the bleed aperture **54** is significantly smaller than the maximal opening of the pressure regulating flow path **94**.

In the illustration of Fig. 2B $P_{in} = P_{mc}$ and $P_{out} = P_{cc}$.

Turning now to Fig. 2C, there is illustrated a situation upon opening a tap or the like at the downstream consumers, namely a position where there is demand for liquid downstream, referred to as a "demand position".

At this position, the pressure P_{out} at the outlet chamber **30** drops even further, resulting in further decrease of P_{mc} at the main chamber **50** resulting in turn in increased fluid flow through the pressure regulating flow path **94** as illustrated by the arrowed line **103** (Fig. 2C) wherein $P_{out} < P_{mc} < P_{in}$.

This situation occurs since, even though the fluid flow through the pressure regulating flow path **94** is equal to the fluid flow through the bleed aperture **54**, there is significant head/pressure loss at the bleed aperture **54** caused by the increased flow velocity through bleed aperture **54**, resulting in control chamber pressure drop, therefore a decreased hydraulic force extending on the upper side of the main diaphragm, further resulting in deformation of the main diaphragm **44** upwards, into the position illustrated in Fig. 2D whereby the hydraulic faucet **36** now opens to facilitate high flow rate through the high flow-rate path **36** as illustrated by arrowed line **105** to supply flow rate pair demand of the downstream consumer. At this position the inlet pressure P_{in} at the inlet chamber **26** is higher than the pressure at the main chamber **50** and at the outlet chamber **30**, resulting in deformation of the main diaphragm **44** to an open position, against the biasing effect of the coiled spring **60**, wherein the pressure at the main chamber **50** is equal to the pressure at the outlet chamber **30** and at the control chamber **76** ($P_{mc} = P_{out} = P_{cc}$).

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As can be seen in Fig. 2D, a top surface **120** of the control plunger **84** engages a restricting projection **106** of the housing, thus preventing further axial displacement of the control plunger **84** in the upwards direction, to thereby maintain equal pressure at the main chamber **50** and at the outlet chamber **30**, namely $P_{mc} = P_{out}$ and further to prevent a conflict condition, namely hammering of the valve resulting in oscillating of the main diaphragm **40** which may enter the valve into an unstable condition.

In Figs. 3A to 3C there is illustrated a valve in accordance with a modification of the example illustrated in Figs. 1 and 2, generally designated **200** and wherein like elements are designated with like reference numbers, however shifted by 100.

10 In the example of Figs. 1 and 2, the main diaphragm **44** is configured for sealing engagement over the annular rigidified annular sealing member **38**, supported from above by the rigidified annular sealing member **56**.

However, in the example of Figs. 3A to 3C, the rigidified annular sealing member **156** with a downwardly extending tubular extension **157** fitted with an O-ring (or any radial sealing member) **159** and configured for sealing engagement against the inner tubular-wall section **161** of the hydraulic faucet **142** constituting the high flow-rate flow path.

It is further noted that the downward extension **157** is configured with a chamfered edge **163** to facilitate smooth engagement of the tubular section upon displacement back into the sealing position, as will be discussed hereinafter.

In Fig. 3A the valve is illustrated at a leak position, namely a low flow-rate flow extends downstream, resulting in pressure decrease at the outlet chamber **130** wherein the pressure at the outlet chamber is substantially equal to the pressure at the control chamber **176** ($P_{out} = P_{cc}$), as a result of the open flow duct **180** extending therebetween. However the pressure P_{in} at the inlet chamber **126** is significantly higher, and at this stage substantially equal to the pressure P_{mc} at the main chamber **150**, whereby a low flow-rate flow takes place as illustrated by arrowed line **201** from the inlet chamber **126**, through the bleed aperture **154** into the main chamber **150** and then through the regulating flow path at **194** into the outlet chamber **130** and towards the downstream consumers. At this state, the annular portion **157** sealingly resides within the tubular portion **161**, wherein the high flow-rate path is closed.

Upon demand, as a downstream consumer now for example opens a tap, the pressure P_{out} at the outlet chamber **130** rapidly drops (with corresponding pressure

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decrease at the control chamber 176), however resulting in deformation of the main diaphragm 144 in an upwards direction, thus increasing the opening of the pressure regulating flow path 194 (the control plunger 184 at this stage still remains substantially at its position, wherein the cross sectional area of the flow path 194 increases owing to
5 deformation of the main diaphragm 144, facilitating increased fluid flow as designated by arrowed line 201. At this position, the pressure at the main chamber 150 is substantially equal to the pressure at the outlet chamber 130, namely $P_{mc} = P_{out} = P_{cc}$.

However, the pressure at the inlet chamber 126 is significantly higher than the pressure at the main chamber 150 and as the downstream consumer further demands
10 fluid flow, the pressure applied at the bottom surface of the main diaphragm 144 (P_{in}) will overcome the biasing effect of the main coiled spring 160 and pressure applied at the top of main diaphragm, resulting in disengagement of the annular sealing portion 157 from the tubular wall 161, giving rise to opening of the high flow-rate flow path 136, facilitating high flow-rate flow as illustrated by the arrowed line 203.

15 The configuration illustrated in Figs. 3A to 3C however provides a somewhat extended intermediate stage of leak by prolonging the required axial displacement required for opening the flow path (in fact axial displacement and time required for the tubular sealing portion 157 to disengage from the annular wall 161, is extended), thus increasing stability of the system, namely the likelihood of hammering as discussed
20 hereinabove.

It is noted that at the opened position, as in Fig. 3C, a top end 220 of the control plunger 184 engages a restricting surface 206 of the housing, thus preventing further upward displacement of the control plunger 184.

Closing the hydraulic faucet takes place as discussed hereinabove, in connection
25 with the example of Figs. 2A to 2D.

Turning now to Figs. 4 and 5, there is illustrated a valve generally designated 300, based on the same principles as disclosed in connection with the example of Figs. 2A-2D and wherein like elements are designated with like reference numbers, however shifted by 300.

30 Whilst the construction of the valve 300 follows the general construction of the valve 100 of Figs. 1 and 2 and valve 200 of Figs. 3, the valve 300 of Figs. 4 and 5 differs in that the main diaphragm 344 is configured with a plurality of small apertures 347 (best seen in Fig. 4B and in Figs. 5A', 5B' and 5C'), said apertures 347 being

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disposed about a circular path coextending with the annular sealing shoulder **338** of the hydraulic faucet.

The arrangement is such that at the closed position of the hydraulic faucet, namely when the main diaphragm **344** is at its normally closed position (Figs. 5A and 5A') the apertures **347** are sealingly engaged by the annular shoulder **338** prohibiting flow path therebetween.

At a leak position of the system, pressure at the outlet chamber **330** decreases along with corresponding pressure decrease at the control chamber **376**, whereby downstream pressure is controlled by the pressure regulating flow path **394** facilitating fluid flow along the arrowed line **401** (at this state the pressure at the inlet chamber **326** and at the main chamber **350** is higher than the pressure at the outlet chamber **330** ($P_{in} = P_{mc} > P_{out}$)).

Upon demand at a downstream consumer e.g. opening a tap or the like, as illustrated in Figs. 5B and 5B', the pressure at the outlet port **330** drops (with corresponding pressure change at the control chamber **376** via the duct **380**) resulting in deformation of the main diaphragm **344** upwardly wherein at a first instance of deformation of the main diaphragm **344** low flow rate commences through the apertures **347**, as indicated by arrowed line **379**, accelerating pressure drop at the main chamber **350** as compared with the pressure at the inlet chamber **326**, resulting in further deformation of the main diaphragm **344** to rapidly open the hydraulic faucet and facilitate high flow rate flow through the high flow rate path, as illustrated by the arrowed line **303**. At this position, the inlet pressure at the inlet chamber **326** is higher than the pressure at the main chamber **350** which in turn equals the pressure at the outlet chamber **330** and at the control chamber **376** ($P_{in} > P_{mc} = P_{out}$)).

Upon stabilization of the system (Figs. 5C and 5C'), the control plunger **384** reaches its uppermost position wherein the top surface thereof **320** engages the restricting surface **306** of the housing, against the biasing effect of the coiled spring **302**. In case that the top face **390** of the sealing head **388** of control plunger **384** sealingly engages the sealing shoulder **392** of the rigidified annular sealing member **356**, thereby sealing the regulating flow path **394**, the system still reaches stabilization wherein the apertures **347** still remain open to equalize pressures of main chamber and outlet chamber as illustrated by arrowed lines **397**, until stabilization of the system.

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Further attention is now directed to Figs. 6A and 6B of the drawings illustrating a two-stage flow control valve in accordance with the present disclosed subject matter, generally designated **400** and wherein elements similar to those disclosed in connection with Figs. 4 and 5 are designated with like reference numbers, however shifted by 100.

5 Whilst the construction of the valve is substantially similar to that disclosed in connection with Figs. 1 and 2, it is noted that the low flow-rate pressure regulating unit is configured with an adjustable restricting plunger **403**, axially displaceable within an aired chamber **405**, against a biasing spring **409**, normally biasing the restricting plunger **403** downwards. According to one particular example, a housing of the valve
10 **400** is configured with a cap **411** screw fitted at **413** to a neck portion **415** of the housing, whereby rotation of the cap **411** entails axial displacement thereof, against the coiled spring **409**, thereby increasing/decreasing the force applied thereby over the restricting plunger **403**. This configuration provides for a dynamic restricting member **403** providing adequate pressure control also at high flow rate upon downstream
15 consuming.

In the position of Fig. 6A the system is illustrated at a leak position wherein the resultant pressures/forces exerted on the control plunger **484** from the outlet direction, namely those acting on the bottom surface **489** of the control plunger **484** and those acting on control diaphragm connected to the control plunger **484** are in equilibrium
20 with those imparted by the control spring **460** and the pressure extending at the main chamber **450** and acting on the top face **490** of the control plunger **484**.

In the position of Fig. 6B the system is illustrated in a demand position wherein the downstream pressure P_{out} (at the outlet chamber **430**) is regulated upon sealing of the pressure regulating flow path **494**, thus preventing pressure equilibrium, wherein the
25 pressure at the main chamber **450** increases (by fluid flow facilitated through the bleed aperture **454**), as a consequence of which the main diaphragm **444** displaces back toward closed position, narrowing the high flow rate path.

When the main diaphragm **444** displaces into its open position (Fig. 6B) the pressure at the outlet chamber **430** increases corresponding entailing increase of the
30 pressure at the control chamber **476** (owing to the open fluid flow path **480** extending therebetween) resulting in the formation of the control diaphragm **472** upwards, entailing axial displacement upwardly of the control plunger **484** such that its top surface **520** engages the bottom surface **506** of the dynamic restricting plunger **403**, as a

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result of which the restricting plunger 403 displaces upwards against the biasing effect of the coiled spring 409.

It is thus noted that the resultant force acting on the control plunger 484 consists of the pressure applied at its bottom face 489 and by the control diaphragm acting
5 against the combined force of the control spring 460 and the coiled spring 409 of the dynamic restricting member 403, as well as and the pressure extending at the main chamber 450 and acting on the top face 490 of the control plunger 484.

It is appreciated that other features of the valve 400 and its operation, are substantially similar to those disclosed in connection with the examples.

10 Further attention is now directed to the example illustrated in connection with Figs. 7A and 7B illustrating a two-stage valve in accordance with a modification of the present disclosed subject matter, generally designated 500. For sake of clarification, elements which are similar by nature to those disclosed in connection with Fig. 1 are designated with like reference numbers, however shifted by 500.

15 In the examples illustrated hereinbefore, the low flow-rate pressure regulating unit appeared to extend coaxially above the hydraulic faucet with the control plunger extending through the main chamber and respectively through an aperture formed in the main diaphragm (wherein the control plunger was "pulled" upwards into sealing engagement with a bottom surface of the rigidified annular sealing portion). However,
20 in the example of Figs. 7A and 7B, the valve 500 is configured such that the low flow-rate pressure regulating unit designated 501 extends coaxially below the hydraulic faucet generally designated 503 and wherein the control plunger 585 in fact extends through the outlet chamber 530 and displaces towards engagement of the pressure regulating flow path (the rigidified annular sealing portion 592) in a direction against
25 the biasing effect of the main diaphragm biasing spring 560 namely, the control plunger 585 is "pushed" upwards into such sealing engagement.

The construction of the valve 500 is such that the housing 522 is configured with an inlet port 524 extending to an inlet chamber 526 and further comprises an outlet port 528 extending towards the outlet chamber 530. The valve 500 is a globe-type valve
30 wherein the high flow-rate flow path extends over an annular sealing shoulder 538 constituting a high flow-rate flow path 536 (arrowed line in Fig. 7B). The hydraulic faucet 503 comprises a main diaphragm 544 configured similarly as disclosed hereinabove for sealing engagement of the annular sealing shoulder 538 and is further

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configured with a bleed aperture **554**, said main diaphragm further configured with a rigidified annular sealing member **556** configured in turn with a central flow path **557** and being biased downwards by means of a coiled spring **560** extending within the main chamber **550**.

5 The low flow-rate pressure regulating unit **501** comprises a control chamber **576** being in constant open flow communication with outlet chamber **530** via a duct **580** and there is further provided a control diaphragm **572** biased away from engagement of the flow port **557** by means of a coiled control spring **602** extending within the vented chamber **575** (ventilation takes place through aperture **512**), wherein the control plunger
10 **584** is axially displaceable within a tubular support section **581** and is provided with a sealing O-ring **583**, said O-ring providing adequate sealing though enabling axial displacement of the control plunger **584**. The top face **589** of the control plunger **584** is configured for sealing engagement of the projecting annular shoulder **592** of the rigidified annular sealing member **556**.

15 Operation of the valve **500** is substantially similar to that disclosed in connection with the previous embodiments wherein at a leak position (Fig. 7A) fluid flow takes places from the inlet chamber **526**, through the bleed aperture **554** into the main chamber **550** and through the opening **557** towards the outlet chamber **530**. As the pressure at the main chamber **550** drops with respect to the pressure at the inlet chamber
20 **526**, the main diaphragm **544** deforms upwardly against the biasing effect of the coiled spring **560** (Fig. 7B) thus giving rise to opening of the hydraulic faucet facilitating high flow-rate flow along path **536** to supply demand at the downstream consumer.

As the pressure at the control chamber **576** increases, the control diaphragm **572** deforms upwardly entailing corresponding axial displacement of the control plunger
25 **585** until the plunger base engages a lowermost annular restricting portion of the tubular support **581**, thus preventing further axial displacement of the control plunger **585**, thereby preventing the system from entering the so-called unstable position (referred to hereinabove as hammering).

In Figs. 8A-8C there is illustrated a two-stage valve in accordance with yet
30 another example of the present disclosed subject matter, generally designated **600**, wherein like elements are designated with like reference numbers as in Fig. 1, however shifted by 600.

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The valve **600** is of a globe-type configuration, comprising an inlet port **624** extending into an inlet chamber **626**, and further comprising an outlet port **628** and an outlet chamber **630**. A high flow-rate hydraulic faucet is provided at **642** and comprises a main chamber **650** extending above a main diaphragm **644** configured for sealing engagement of an annular sealing shoulder **638**, wherein the diaphragm **644** is configured with a bleed aperture **654** and with a rigidified annular sealing member **656** bearing a bottom end of a coiled main spring **660**, in opposite end of said spring bearing against the top surface **661** of the housing **622**, said coiled spring **660** biasing the main diaphragm **644** into sealing engagement of the annular sealing shoulder **638**, thus sealing the high flow-rate flow path **638** (illustrated at its open position in Fig. 8C).

The diaphragm **644** is of a configuration similar to that disclosed in connection with Figs. 4 and 5, namely is configured with a plurality of small apertures **647** disposed about a filter path coextending with the annular sealing shoulder **638** of the hydraulic faucet **642** and operating in the same fashion.

A low flow-rate pressure regulating unit **601** comprises a control chamber **676** provided with a control diaphragm **672** extending below a chamber **678** vented to the atmosphere through an aired aperture **612**, said chamber **678** further accommodating a control biasing spring **702** bearing against a portion of the control plunger **684** extending through the control diaphragm **672**. The control chamber **676** is in constant flow communication with the outlet chamber **630** through open duct **680**.

It is thus noted that the low flow-rate pressure regulating unit **601** is disposed offset of the hydraulic faucet **642** with the regulating flow path **694** extending coaxial with the low flow-rate pressure regulating unit, and wherein a flow path **657** extends between the main chamber **650** and a top face **690** of the sealing head **688** of the control plunger **684**, with its bottom face **689** being in flow communication with and exposed to the outlet chamber **630** via a duct **647**.

Thus, the configuration illustrated in connection with Figs. 8A-8C illustrates a device in which the low flow-rate pressure regulating unit **601** is separated from the high flow-rate hydraulic faucet however wherein the valve operates substantially in the same manner disclosed hereinabove. At a leak condition, represented in Fig. 8A, low flow-rate takes place at the downstream consumers (e.g. a leak at a faucet, and the like), resulting in pressure drop at the outlet chamber **630** and corresponding pressure drop at the control chamber **676** whereby the decreased pressure at the control chamber **676**

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resulting in control plunger 684 open position facilitating flow at a low flow rate as illustrated by arrowed line 701 (referred to as "leak-flow"). In this position the pressured inlet chamber 626 is equal to the pressure at the main chamber 650 ($P_{in} = P_{mc}$) and likewise, the pressure at the outlet chamber 630 is equal to the pressure at the control chamber 676 and at the demi-chamber 659 below the plunger 684, however said pressure being lesser than the inlet chamber pressure. At this position, the main diaphragm 644 is disposed in its sealing position wherein the apertures 647 are sealed by the annular sealing shoulder 638.

Upon increasing flow demand (i.e. opening a faucet by one of the downstream consumers), the pressure at the outlet chamber 630 and main chamber 650 drops resulting in that the substantially higher pressure at inlet chamber 626 entails deformation of the main diaphragm 644, whereupon fluid flow commences through the apertures 647 (represented by arrowed line 697) gradually, fluid commences also above the annular sealing shoulder 638 as represented by arrowed line 699 whilst low flow-rate continues through the pressure regulating flow path 694 as represented by the arrowed line 701.

As the flow continues from the main chamber 650 into the outlet chamber 630, the pressure at the main chamber 650 drops and the pressure at inlet chamber 626 deforms the main diaphragm 644 against the biasing effect of coiled spring 660, giving rise to high flow-rate as represented by arrowed line 639 over the annular sealing shoulder 638. At this position the pressure at the main chamber 650 substantially equalizes with the pressure downstream, namely at the outlet chamber 630, control chamber 676 and at the demi-chamber 659 below the control plunger 684 whereby increase of pressure at the control chamber 676 entails deformation of the control diaphragm 672 upwardly entailing corresponding axial displacement of the control plunger 684 to thereby seal the low flow-rate flow path at 694.

Upon seize of the flow demand by the downstream consumers, the valve 600 will spontaneously shut as discussed hereinabove in connection with the previous examples.

Further attention is now directed to Figs. 9A-9E of the drawings illustrating a two-stage valve in accordance with a different example of the present disclosed subject matter.

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For sake of clarification, like elements which have been disclosed in connection with the example of Fig. 1 are designated with like reference numbers, shifted by 700.

Valve **700** comprises a housing **722** configured with an inlet port **724** extending into an inlet chamber **726**, and an outlet port **728** extending into an outlet chamber **730**.

5 The housing is a globe-type configuration and comprises a high flow-rate flow path configured with an hydraulic faucet **742** which is fitted with a main diaphragm **744** having a bleed aperture **754** being in flow communication with chamber **726** extending below the main diaphragm **744** and the main chamber **750** extending above the main diaphragm **744**, wherein a rigidified annular sealing member **756** is fixedly configured
10 with the main diaphragm **744** having at its bottom face a downwardly projecting sealing shoulder **792** defining a low flow-rate flow path **794** (sealed in Fig. 9A; opening Fig. 9B and represented by an arrowed line **801**).

A control chamber **776** extends at a top portion of the housing **722** and is provided with a control diaphragm **772** clampingly secured to the housing and biased
15 downwards by a coiled control spring **802** received within an aired chamber **778** vented to the atmosphere through aperture **800**. Articulated to the control diaphragm **772** there is a control plunger **784** axially displaceable within the housing and secured by a tubular wall segment **777** for axial displacement therewithin, though in a sealing fashion by an O-ring **810** provided on the control plunger **784**. The control chamber **776** is in flow
20 communication with the outlet **730** via the normally constantly open flow duct **780**, such that the pressure at the outlet chamber and at the control chamber is at equilibrium at all times.

Extending above the main chamber **750** there is a top chamber **820** with a release diaphragm **822** articulated to the control chamber **784** partitioning the top
25 chamber **820** from the main chamber **750** and further wherein the top chamber **820** is at constantly open flow communication with the inlet chamber **726** via a normally, constantly open communicating duct **828** such that the pressure at the top chamber **820** is identical with that at the inlet chamber **726**.

The control plunger **784** is configured at its bottom end with a plunger head **788**
30 with a top face thereof **790** configured for sealing engagement with the annular sealing shoulder **792** of the rigidified annular sealing member **756** (as illustrated in Fig. 9A) thus closing or opening the low flow-rate flow path as will be discussed hereinafter.

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At the position illustrated in Fig. 9A the valve 700 is shown upon shutting the downstream consumers, wherein the pressure when the system is temporarily at equilibrium, namely the inlet pressure at the inlet chamber 726 equals the outlet pressure at the outlet chamber 730 ($P_{in} = P_{out}$) and likewise, the pressure at the main chamber 750 equals the pressure at the top chamber 820 and at the control chamber 776, as illustrated at the temporary initial position of Fig. 9A.

It is noted in this position that the control diaphragm 772 is displaced upwards, against the biasing effect of the coiled spring 802 resulting in corresponding axial displacement of the control plunger 784 upwards into sealing engagement of the low flow-rate flow path, namely wherein the top face 792 sealingly engages the annular sealing shoulder 790.

As a leak takes place at any of the downstream consumers, pressure at outlet chamber 730 and consequently at the control chamber 776 decreases, resulting in displacement of the control diaphragm 772 downwards (Fig. 9B) entailing opening of the low flow-rate flow path between the annular shoulder 792 and the top face 790 of the sealing head 788 of the control plunger, facilitating low flow-rate 801 from the inlet chamber 726 through the bleed aperture 754 into the main chamber 750 and then through the low flow-rate flow path 794 out to the outlet chamber 730 and to the downstream consumers.

Upon demand at the downstream consumers, further pressure drop occurs at the outlet chamber 730 resulting in further decrease of the pressure at the main chamber 750 whilst the pressure at the inlet chamber 726 and correspondingly at the top chamber 820 remains constant, thus applying downwardly directed force on the surface 832 of the control plunger 784 and on the release diaphragm 822, resulting in further downward displacement of the control plunger 784 (Fig. 9C) thereby increasing fluid flow through the low flow-rate flow path 794 as represented by arrowed line 803, whereupon the pressure at the main chamber 750 continues to decrease into equilibrium with the pressure at outlet chamber 730 (Fig. 9D) wherein the low flow-rate flow path 794 is open to a maximum. At this stage the inlet pressure at the inlet chamber 726 overcomes the pressure at the main chamber 750, resulting in deformation of the main diaphragm 744 into its open position (Fig. 9E) facilitating fluid flow at the high flow-rate flow path represented by arrowed line 805, above the annular sealing shoulder 838

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whilst this position high flow-rate flow takes place between the inlet port 724 and the outlet port 728.

It is appreciated that the valve 700 can be configured with a restricting surface 806 within the vented chamber 776 configured for restricting upward axial displacement of the control plunger 784 upon engaging with the top surface 820, 809 thereof (not shown).

Figs. 10A and 10B schematically summarize the concepts of the two-stage valves disclosed in the preceding figures, excluding Fig 9. In Fig. 10A there is illustrated a valve 850 configured with an inlet port 852 extending into an inlet chamber 854 and an outlet port 856 extending from an outlet chamber 858. The valve can be, for example, a globe-type configuration and comprises a hydraulic faucet 860 configured with a main diaphragm 862 and can be, for example, spring biased by coiled spring 864 into sealing engagement of annular sealing shoulder 870 extending between the inlet chamber 854 and the outlet chamber 858 and constituting a high flow-rate flow path (sealed in Fig. 10A). A low flow-rate pressure regulating unit 875 is provided possibly within the housing of the valve and is in flow communication with the outlet chamber 858 through a duct 880. The low flow-rate pressure regulating unit 875 is also in flow communication with the main chamber 868 via a duct 884 which is further in flow communication with a flow restricting device 890 configured for generating a flow-dependent pressure drop i.e. moderately reduced pressure at low flow rates and significantly reduced pressure at high flow rates. It is however noted that apart of the fluid flow through the flow restriction device 890, there is substantially no fluid flow between the inlet chamber 854 and the main chamber 868

The configuration is such that the duct 880 facilitates for leak flow towards the outlet port 856 and further towards downstream consumers as well as for pressure release from the main chamber 868 to the outlet chamber 858, wherein pressure release is a main diaphragm's 862 displacement dependent. In this configuration the low flow-rate pressure regulating unit 875 facilitates both for fluid flow rate regulation during leak and for mechanical driven pressure regulation during demand by the downstream consumers.

Examples for valves of the above configuration, i.e. comprising a low flow-rate pressure regulating unit and having a common duct between the outlet chamber and the

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main chamber, for leak flow, and which is mechanically kept open during demand, for pressure equilibrium, are shown in Figs. 1, 2, 3, 6 and 7.

Fig. 10B is principally similar to that disclosed in connection with Fig. 10A, and discloses a valve **900** further provided with a mechanically controlled, main diaphragm's **926** displacement dependent, pressure releasing unit **902** configured for opening/closing a duct **904** extending from the main chamber **906** to the outlet chamber **920**. It is also comprises of the low flow-rate pressure regulating unit **910** and the flow restricting unit **912**. In this configuration, duct **904** is in flow communication with the outlet chamber **920** and facilitates for obtaining pressure equilibrium during downstream demand whilst the duct **924** serves for leak flow, namely to facilitate low flow-rate into the outlet chamber **920** and down to the downstream consumers.

Examples for valves of the above configuration, where the mechanical pressure releasing unit is separate from the pressure regulating unit, and having separate ducts, one for a leak flow and the other one for pressure equilibrium between the outlet chamber and the main chamber, are shown in Figs. 4,5 and 8.

Figs. 10C and 10D schematically illustrate further concepts of a two-stage valve in accordance with the presently disclosed subject matter. In general, the concept illustrated in Fig. 10C (described in detail with reference to Figs. 9 and 13) is similar to the concept of Fig. 10A, the only difference being in that the pressure releasing function of the pressure regulating unit is preformed hydraulically and not mechanically. The concept illustrated in Fig. 10D (described in detail with reference to Figs. 11 and 12) is similar to the concept of Fig. 10B, the only difference being in that the releasing unit is hydraulic and not mechanically linked to main diaphragm.

In Fig. 10C there is illustrated a valve **850'** configured with an inlet port **852'** extending into an inlet chamber **854'** and an outlet port **856'** extending from an outlet chamber **858'**. The valve can be, for example, globe-type configuration and comprises a hydraulic faucet **860'** configured with a main diaphragm **862'** and can be, for example, spring biased by coiled spring **864'** into sealing engagement of annular sealing shoulder **870'** extending between the inlet chamber **854'** and the outlet chamber **858'** and constituting a high flow-rate flow path (sealed in Fig. 10C). A low flow-rate pressure regulating unit **875'** is provided, possibly within the housing of the valve and is in flow communication with the inlet chamber **854'** through a duct **878'** and in flow communication with the outlet chamber **858'** through a duct **880'**. The low flow-rate

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pressure regulating unit **875'** is also in flow communication with the main chamber **868'** via a duct **884'** which is further in flow communication with a flow restricting device **890'** configured for generating a flow-dependent pressure drop i.e. moderately reduced pressure at low flow rates and significantly reduced pressure at high flow rates. The pressure regulating unit **875'** is in flow communication with the duct **878'**. It is however noted that apart of the fluid flow through the flow restriction device **890'**, there is substantially no fluid flow between the inlet chamber **854'** and the main chamber **868'**.

The configuration is such that the duct **880'** facilitates for leak flow towards the outlet port **856'** and further towards downstream consumers as well as for pressure equilibrium between the main chamber **868'** and the outlet chamber **858'** at demand position. In this configuration the low flow-rate pressure regulating unit **875'** facilitates both for fluid flow rate regulation during leak and for pressure regulation during demand by the downstream consumers.

Fig. 10D is principally similar to that disclosed in connection with Fig. 10C, and discloses a valve **900'** further provided with a hydraulic control unit **902'** configured for opening/closing a duct **904'** extending from the main chamber **906'** to the outlet chamber **920'** (pressure release path). It also comprises of the low flow-rate pressure regulating unit **910'** and the flow restricting unit **912'**. In this configuration, duct **904'** is in flow communication with the outlet chamber **920'** and facilitates for obtaining pressure equilibrium during downstream demand whilst the duct **924'** serves for leak flow, namely to facilitate low flow-rate into the outlet chamber **920'** and down to the downstream consumers.

The hydraulic unit **902'** operates responsive to pressure differential between the inlet chamber **911'** and the main chamber **906'** above the main diaphragm **926'**. Hydraulic unit **902'** makes use of the fact that upon pressure decrease within the main chamber **906'** there is a need for opening of the main flow path, namely high flow-rate path to provide demand flow for downstream consumers. Thus, upon sensing of a pressure differential, the hydraulic unit **902'** opens a flow passage between the main chamber **906'** and the duct **904'**, facilitating pressure equilibrium. It is however noted that apart for fluid flow through the flow restriction device **912'**, there is substantially no fluid flow between the inlet chamber **911'** and the main chamber **906'**.

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The arrangement disclosed in this example enhances pressure release from the main chamber **906'**, at constant pressure differential, regardless of the inlet pressure and regardless of initial displacement of the main diaphragm **926'** into its open position.

A practical application of the hydraulic unit example illustrated in Fig. 10D is disclosed hereinafter with reference to Figs. 11A-11F, using the same reference numbers as referred to in Fig. 10D.

In this example, the hydraulic unit **902'** comprises a release chamber **930** being in constant flow communication with the inlet chamber **911'** via normally open duct **934**, said chamber **930** extending above a release diaphragm **936** supporting a sealing member **938** which is spring biased by means of a coiled spring **940** upwardly, into sealing engagement with an annular sealing shoulder **944** of an intermediate chamber **946** which is in normal flow communication with the main chamber **906'** via a duct **950**.

The arrangement is such that the force that may reside as a result of downstream pressure at the outlet chamber **920'** is significantly low. When the pressure at the upstream (namely at inlet chamber **911'**) and the pressure within the intermediate chamber **946** (similar to that as in the main chamber **906'**) are substantially equal, the hydraulic unit **902'** is sealed whilst upon pressure differential, even significantly lower, the flow path between the intermediate chamber **946** and the duct **904'** opens, namely upon disengagement of the sealing member **938** from the annular sealing shoulder **944** as illustrated hereinafter (Fig. 11D). This arrangement is thus sensitive to pressure differential between the inlet chamber **911'** and the main chamber pressure at **906'**, and on the other hand is indifferent or less sensitive to pressure changes at the outlet chamber **920'** and absolute inlet pressure. This is obtained by the ratio of cross sectional areas over the release diaphragm **936**, having top face thereof exposed to the inlet pressure and a bottom face thereof exposed to the outlet pressure.

At a leak flow, as illustrated in Fig. 11B, where one of the downstream consumers leaks (substantially low flow rate) flow is facilitated from the inlet chamber **911'**, through the flow restricting device **912'**, and then out through the low flow-rate pressure regulating unit **910'** from where it flows through duct **924'** to the outlet chamber **920'** and then to the downstream consumers. It is noted that the main diaphragm **926'** remains sealed at this position and further it is seen that the pressure at the inlet chamber **911'** extends to the release chamber **930**, said pressure at the main

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chamber **906'** and at the intermediate chamber **946** (pressure regulated through the flow restricting device **912'**).

Upon demand, when a downstream consumer is opened to high flow rate (Fig. 11C) flow through the flow restricting device **912'** increases as well as flow through the low flow-rate pressure regulating unit **910'** resulting in pressure drop at the main chamber **906'** and at the intermediate chamber **946** whereupon the pressure release system comes into action owing to pressure drop at the intermediate chamber **946**. In this state (Fig. 11D) pressure at the release chamber **930** overrides the coiled spring **940**, the pressure at the intermediate chamber **946** and the pressure at a bottom chamber **939** exposed to the outlet chamber resulting in downward displacement of the release diaphragm **936** such that the sealing member **938** now disengages from the annular sealing member **944** opening the pressure release path as indicated by arrowed line **952** extending between the main chamber **906'**, the intermediate chamber **946** and out through the duct **904'** to the outlet chamber **920'**. This causes pressure drop at the main chamber **906'** and at the intermediate chamber **946**, resulting in maximal opening of the pressure release path between the annular sealing member **944** and the sealing member **938**, resulting in further decrease of pressure at the main chamber **906'** (Fig. 11E) which in turn results in deformation of the main diaphragm **926'** (Fig. 11F) into its open position, facilitating high flow-rate between the inlet chamber **911'** and outlet chamber **920'** as illustrated by arrowed line **960**.

At this position, the open pressure release path at **952** facilitates pressure equilibrium between the main chamber **906'** and the communicating intermediate chamber **946** and the outlet chamber **920'**, in virtue of the open duct **904'** and while flow-rate pressure regulating unit **910'** is sealed.

Figs. 12A-12D illustrate a specific, detailed example of a valve in accordance with the principles disclosed in connection with Figs. 10D and 11. The valve, generally designated **1000** comprises an inlet port **1002** extending into an inlet chamber **1004** and further comprises an outlet chamber **1006** extending to an outlet port **1008**. The valve is a globe-type valve comprising a hydraulic faucet configured of an annular sealing member **1010** sealingly engageable by a central diaphragm **1012** configured with a central bleed-opening **1016**. Integrated with the housing of the valve there is a pressure release unit generally designated **1020** comprising a release chamber **1021** extending above a release diaphragm **1022** articulated with a rigid sealing member **1026** and

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configured for sealing engagement with an annular sealing shoulder **1028** integrated with the housing. The sealing member **1026** is spring biased by coiled spring **1032** into sealing engagement with the annular sealing shoulder **1028**.

The release chamber **1021** is in constant open flow communication with the inlet
5 chamber **1004** via duct **1040**.

A low flow-rate pressure regulating unit generally designated **1050** comprises a control diaphragm **1052** extending between a vented chamber **1054** vented to the atmosphere through an aperture **1056** and extending above a control chamber **1058**, said diaphragm being spring biased downwardly by a coiled spring **1060** extending within
10 the vented chamber **1054** and supporting against the control plunger **1064**. The control chamber **1058** is in flow communication through duct **1068** with the bottom chamber **1070** extending below the release diaphragm **1022** and said control chamber **1058** is further in flow communication with outlet chamber **1006** via a constantly open duct **1074**.

The control plunger **1064** is configured with a sealing head **1078**, a top face thereof **1080** configured for sealing engagement with a downwardly projecting annular sealing shoulder **1082** of a housing, giving rise to a low flow-rate flow path **1088** extending into an intermediate chamber **1090** which in turn is in flow communication with outlet chamber **1006** via a duct **1092**, wherein the low flow-rate flow path **1088** is
15 in flow communication with the main chamber **1007** via a duct **1096**.

Fig. 12B illustrates the valve **1000** at a leak flow state, namely wherein a downstream consumer leaks, resulting in pressure drop at the outlet chamber **1006**. It is now appreciated that the pressure at the outlet chamber **1006** is substantially equal to the pressure at the control chamber **1058** and at the bottom chamber **1070** through ducts
25 **1074** and **1068**, respectively. The pressure drop at the outlet chamber **1006** and correspondingly at the control chamber **1058** entails downward displacement of the control plunger **1064** into opening of the low flow path **1088**, thereby facilitating low flow-rate flow from the inlet chamber **1004** via the flow restricting aperture **1016**, into the main chamber **1007**, through duct **1096**, into the intermediate chamber **1090** and
30 through duct **1092** out to the outlet chamber **1006** and out to the downstream consumers (not shown).

Demand at the downstream consumers results in pressure decrease at the outlet chamber **1006** increases and in pressure decrease at the main chamber **1007**. Pressure at

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the release chamber **1021** which is at pressure corresponding with the pressure at the inlet chamber **1004** exceeds the pressure at the intermediate chamber **1071**, resulting in deformation of the release diaphragm **1022** downwards, against the biasing effect of coiled spring **1032**, giving rise to opening the flow passage between the sealing member
5 **1026** and the annular sealing shoulder **1028**, such that the fluid flow extends along arrowed line **1099** and through duct **1068** into the control chamber **1058** and out through duct **1074** to the outlet chamber **1006** and out to any downstream consumers, as illustrated in Fig. 12C.

At demand position, the release diaphragm **1022** remains fully opened (Fig.
10 **12D**), facilitating fluid flow through the release passage **1098** whereupon pressure at the main chamber **1007** decreases to a level wherein the pressure at the inlet chamber **1004** is sufficient to deform the main diaphragm **1012** into its open position, against the biasing effect of the coiled spring **1009**, giving rise to high flow-rate between the inlet chamber **1004** and the outlet chamber **1006**, over the annular sealing shoulder **1010**, as
15 represented by arrowed line **1100**, however wherein the low flow-rate flow path at **1088** now displaced into its closed position.

Turning now to Figs. 13A-13E there is illustrated yet another example of a two-stage valve generally designated **1200**, in accordance with the disclosed subject matter.

The valve **1200** is configured with an inlet port **1202** extending into an inlet
20 chamber **1204** and further configured with an outlet port **1206** extending from an outlet chamber **1208**, in a globe-type configuration.

A hydraulic faucet **1212** constitutes a high flow-rate flow path between the inlet chamber **1204** and the outlet chamber **1208** and is configured with a main diaphragm **1216** configured for sealing engagement of an annular sealing projection **1218**
25 extending between the inlet chamber **1204** and outlet chamber **1208**, said main diaphragm **1216** being normally urged into sealing engagement with the annular sealing projection **1218** by a coiled compression spring **1220**.

The main diaphragm **1216** is further provided with a bleed aperture **1225** facilitating fluid flow between the inlet chamber **1204** and the main chamber **1226**
30 extending above the main diaphragm **1216**.

A low flow-rate pressure regulating unit **1240** comprises a control diaphragm **1242** extending above a control chamber **1244**, said control diaphragm **1242** extending below a chamber **1246** vented to the atmosphere through an aperture **1250**. The control

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diaphragm **1242** is articulated with a control plunger **1254** which is in the form of a hollow tubular member configured at its top end with an opening **1256** being in flow communication with the control chamber **1244** and having an open bottom end at **1258** opening into the outlet chamber **1208**. Extending above the top end of the control plunger **1254** there is a regulatable restricting member **1260** which is axially displaceable within a chamber **1262** opened to the atmospheric pressure through an aperture **1264**, said restricting plunger **1260** being urged downwards by means of a biasing spring **1268**, its bottom face **1270** configured for engagement with a top head face **1274** of the control plunger **1254** as will be discussed hereinafter.

10 A pressure release unit generally designated **1280** comprises a release diaphragm **1282** extending between a top chamber **1286** which is in flow communication with the main chamber **1226** via duct **1290**, and a bottom chamber **1294** extending below the release diaphragm **1282**, said bottom chamber **1294** being in flow communication with inlet chamber **1204** via duct **1298**.

15 The release diaphragm **1282** is articulated to an axially displaceable sleeve **1300** coaxially mounted over the control plunger **1254** and facilitating fluid flow at an annular interstice **1304** extending therebetween and facilitating a low flow-rate flow path between a lowermost annular sealing shoulder **1310** of the sleeve **1300** and a laterally projecting bottom head portion **1312** of the control plunger **1254**, said low flow-rate path illustrated by arrowed line **1316**. As can further be seen, the sleeve **1300** is biased downwards by means of a coiled spring **1320**.

In figure 13A the system is illustrated at a closed position. As leak commences (Fig. 13B), pressure at the outlet chamber **1208** drops wherein leak flow takes place from the inlet chamber **1204**, through bleed aperture **1225**, into the main chamber **1226**, through duct **1290** into the top chamber **1286**, and then, through the interstice **1304**, along a low-flow rate passage **1316** out towards the downstream consumers.

It is seen that in this condition the release diaphragm **1282** deforms downwards, entailing corresponding downward displacement of the sleeve **1300**, though not sealing the low flow- rate passage flow.

30 As a downstream consumer, e.g. a tap is opened (Fig. 13C) pressure at the outlet chamber **1208** drops, entailing corresponding pressure change at the control chamber **1244** resulting in the formation of the control diaphragm **1242** downwards, resulting in increase of the flow passage extending annular sealing shoulder **1310** and annular

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projecting sealing head **1312** and further whereby, the pressure at the upper chamber decreases as opposed to the pressure at the lower chamber (which actually remains constant), resulting in the formation of the release diaphragm **1282** upwards, entailing corresponding axle displacement of the sleeve **1300**, thereby increasing flow passage at
5 **1316**.

It is noted the sleeve **1300** displaces actually upwards until it reaches a restricting stopper **1313** preventing its further axle displacement.

The pressure differential over the main diaphragm **1216** entails its deformation, against the biasing spring **1220** (Fig. 13D) resulting in opening of the high flow- rate
10 path over the annular filling shoulder **1218**, as represented by the arrowed line **1333**, whereupon pressure at the outlet chamber increases, entailing upwardly directed displacement of the control plunger **1254** until it engages the bottom face **1270** of the restricting plunger **1260**, displacing together against the biasing effect of spring **1268**, wherein the downstream pressure P_{out} (at the outlet chamber **1208**) is regulated upon
15 sealing of the pressure regulating flow path **1316** wherein the pressure at the main chamber **1226** increases (by fluid flow facilitated through the bleed aperture **1225**) as a consequence of which the main diaphragm **1216** displaces back into closing the high flow rate path.

Upon the closing on the demand flow at the downstream consumers (Fig. 13E)
20 pressure throughout the system momentarily increases wherein, the pressure at the inlet chamber **1204** substantially equals to the pressure at the outlet chamber **1208** and the respective main chamber **1226**, control chamber **1244** and lower chamber **1294**.

Turning now to the example illustrated in the block diagram of Figs. 14A-14D there is illustrated a valve control system generally designated **1400** comprising an inlet
25 port **1402** and an outlet port **1404** wherein the inlet port **1402** splits into two parallel extending flow lines **1408** and **1410**, wherein the line **1410** is configured with a low-pressure regulating valve **1416** and the line **1408** is configured with an electric operated faucet **1418**. The two lines **1408** and **1410** join together after the respective device is fitted thereon into an outlet line **1422** fitted with a flow detector **1426** configured for
30 generating a control signal **1428** and transmitting said signal to the electric faucet **1418**.

At a leak state of the system (Fig. 14B) the flow detector **1426** does not generate an electric signal to the electric faucet **1418** whereby the electric faucet remains closed such that there is no flow through the line segment **1408**, whereby fluid flow takes place

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only through the line section **1410** and through the respective low-pressure regulating valve **1416** and then out through the outlet line **1422** towards the outlet port **1404**.

Figs. 4C and 4D illustrate the position upon demand at a downstream consumer, i.e. opening of a tap and the like. As the high flow rate commences, represented by
5 arrow **1432** the flow rate through the low-pressure regulating valve **1416** rises to whereupon the flow sensor **1426** senses the high flow-rate and generates a control signal **1428'** (Fig. 14D) to the electric faucet **1418**, whereupon the faucet opens and thus commences high flow-rate therethrough, represented by thickened arrows **1436**.

Upon seizing the demand at the downstream consumer (Fig. 14E) the flow
10 sensor **1426** senses the change of flow-rate and stops the signal at **1428** to the electric faucet **1418** wherein at a first stage the system reaches pressure equilibrium and shortly thereafter the leak flow regime takes place (represented by leak **1438**) whereby the system moves into the leak-flow condition as in Fig. 14B.

Whilst there have been shown some examples of the disclosed subject matter, it
15 is to be understood that many changes may be made therein without departing from the spirit of the invention, *mutatis mutandis*.

CLAIMS:

1. A two-stage valve comprising a housing fitted with an inlet port extending to an inlet chamber and configured for coupling to an upstream liquid supply line, and an outlet port extending from an outlet chamber and configured for coupling to a downstream supply line; a high flow-rate path extending between the inlet chamber and the outlet chamber fitted with a hydraulic element configured for selectively admitting liquid flow therebetween at a demand position defined by substantially high flow; a pressure regulating unit configured for controlling a pressure regulating flow path providing direct or indirect flow communication between the inlet chamber and the outlet chamber for allowing liquid flow therebetween at a leak position defined by substantially low flow rates.
2. A two-stage valve according to Claim 1, further comprising a mechanism for opening said high flow-rate path upon a demand for liquid downstream.
3. A two-stage valve according to Claims 1 or 2, wherein the high flow-rate path fitted with a hydraulic faucet comprising a main diaphragm extending between the inlet chamber and the outlet chamber configured for selectively admitting said liquid flow therebetween at substantially high flow rates.
4. A two-stage valve according to Claim 3, further comprising a main chamber extending at one face of the main diaphragm and configured with a restricted flow path extending between an inlet chamber and the main chamber.
5. A two-stage valve according to Claim 4, wherein the pressure regulating unit further configured for mechanically releasing pressure from said main chamber at said high flow rates.
6. A two-stage valve according to Claim 4, wherein the pressure regulating unit further configured for hydraulically releasing pressure from said main chamber at said high flow rates.
7. A two-stage valve according to Claim 4, further comprising a pressure releasing mechanism separated from said pressure regulating unit and configured for mechanically releasing pressure from said main chamber at said high flow rates.
8. A two-stage valve according to Claim 4, further comprising a pressure releasing mechanism separated from said pressure regulating unit and configured for hydraulically releasing pressure from said main chamber at said high flow rates.

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9. A two-stage valve according to any one of the Claims 1 to 8, wherein said pressure regulating unit is configured with a control chamber fitted with a control diaphragm having one face in normally open flow communication with the outlet chamber and at an opposite face thereof is vented to the atmosphere.
10. A two-stage valve according to Claim 9, wherein said pressure regulating unit is configured with a control plunger, wherein said control diaphragm and control plunger are configured for controlling a pressure regulating flow path, and extends in flow communication between the main chamber and the outlet chamber.
11. A two-stage valve according to any one of Claims 3 to 10, wherein the hydraulic faucet and the low flow-rate pressure regulating unit are integrated in a uniform housing, said hydraulic faucet and low flow-rate pressure regulating unit extending coaxially on top or below one another, at one side of the housing or at two sides thereof, or at a side-by-side configuration.
12. A two-stage valve according to Claim 11, wherein the pressure regulating flow path is configured with an annular sealing portion fitted at the main diaphragm and a control plunger comprising a flow control end with a respective sealing head for sealing engagement of the annular sealing portion.
13. A two-stage valve according to Claim 12, wherein the low flow-rate pressure regulating unit extends coaxially to hydraulic faucet, wherein a control plunger of the pressure regulating unit extends through the outlet chamber and displaces towards sealing of the pressure regulating flow path in direction against the sealing direction of the main diaphragm.
14. A two-stage valve according to Claim 12, wherein the low flow-rate pressure regulating unit extends coaxially to hydraulic faucet, wherein a control plunger of the pressure regulating unit extends through the main chamber and further through said annular sealing portion fitted at the main diaphragm, and displaces towards sealing of the pressure regulating flow path in direction against the sealing direction of the main diaphragm.
15. A two-stage valve according to claim 11, wherein the pressure regulating flow path is governed by displacement of a control plunger of the pressure regulating unit, whilst the main diaphragm does not play a role in governing of the pressure regulating flow path.

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16. A two-stage valve according to any of the Claims 10 to 15, wherein the main diaphragm is spring biased into sealing engagement of the high flow rate path and the control plunger being spring biased in direction to allow flow through the pressure regulating flow path.
17. A two-stage valve according to Claims 3 to 16, wherein the main diaphragm is configured with an annular sealing portion, wherein the annular sealing portion is configured for press sealing against an annular sealing shoulder defining the high flow-rate flow path.
18. A two-stage valve according to any one of Claims 3 to 17, wherein the main diaphragm's annular sealing portion is provided with a cylindrical sealing extension configured for sealing engagement with a corresponding cylindrical seat of the high flow-rate path.
19. A two-stage valve according to any of the Claims 10 to 18, wherein the pressure release is performed by restricting member configured to restrict axial displacement of a control plunger of the pressure regulating unit, at an open state of the high flow-rate path.
20. A two-stage valve according to any of the Claims 10 to 19 when dependent on Claim 6, wherein the hydraulic pressure release is performed by an intermediate chamber with an intermediary diaphragm having one side in flow communication with the inlet chamber and another side in flow communication with the main chamber; and wherein said intermediary diaphragm is articulated with the control plunger of the pressure regulating unit such that pressure differential over the intermediary diaphragm entails corresponding displacement of the control plunger.
21. A two-stage valve according to any of the Claims 17 to 19 when dependent on Claim 7, wherein said the main diaphragm is formed with one or more apertures extending opposite said annular sealing shoulder, such that at a fully closed position and at the leak position said one or more apertures remain sealingly engaged by the annular sealing shoulder, and at the demand position of the system, as the diaphragm begins to deform into its open position, the one or more apertures disengage from their sealing engagement with the annular sealing shoulder, thus increasing further deformation.
22. A two-stage valve according to Claim 21, wherein said apertures are disposed about a circle coextending with the said annular sealing shoulder open upon even a

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minor displacement of the main diaphragm, thereby assisting in reaching pressure equilibrium between the main chamber and the outlet chamber, to thereby get the system into stabilization.

23. A two-stage valve according to any of the Claims 9 to 19 when dependent on
5 Claim 8, wherein a hydraulic pressure release unit is provided between the main chamber and the outlet chamber, for selectively equalizing pressure between the main chamber and the outlet chamber.

24. A two-stage valve according to Claim 23, wherein the hydraulic unit is a
10 hydraulic faucet configured with a release diaphragm, being in flow communication with the inlet chamber and configured for selective controlling fluid flow between the main chamber and the control chamber of the low flow-rate pressure regulating unit which in turn is in flow communication with the outlet chamber or directly between the main chamber and outlet chamber.

25. A two-stage valve according to any one of Claims 10 to 19 when dependent on
15 Claim 6, wherein the low flow-rate pressure regulating unit is disposed offset the hydraulic faucet with the regulating flow path extending coaxial with said low flow-rate pressure regulating unit, wherein a flow path extends between the main chamber and one face of the sealing head of a control plunger of the pressure regulating unit, a flow path extends between the control chamber and an outlet chamber, where the control
20 plunger extends through an intermediate chamber with an intermediary diaphragm thereof having one side in flow communication with the inlet chamber and another side in flow communication with the main chamber and having articulated thereto a plunger seat being coaxially displaceable responsive to pressure differential over said intermediary diaphragm.

26. A two-stage valve according to any of the Claims 10 to 19 when dependent on
25 Claim 5 or 6, wherein a high pressure regulating mechanism is provided, comprises of a dynamic restricting plunger and a coiled spring, which regulates outlet pressure during high flow rates by adjusting displacement of the control plunger of the pressure regulating unit so as to limit the opening of the common pressure regulating and
30 pressure release flow path during demand position.

27. A two-stage valve according to Claim 2, wherein a low-pressure regulating valve and an electric faucet extending in parallel flow relation to one another, each having an inlet being in flow communication with the inlet port and outlet being in flow

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communication with the outlet port; and a flow sensor extending upstream of said outlet port or else extending downstream of said inlet port and configured for generating a flow control signal responsive to fluid flow and transmitting said signal to said electric faucet.

5 **28.** A two stage flow control valve according to claim 27, wherein the high flow rate through the flow sensor results in generating a control signal to open the electric faucet and low flow rate through flow sensor entails shutting said electric faucet and resulting in directing low flow through the low-pressure regulating valve.

10 **29.** A two-stage valve comprises a housing fitted with an inlet port extending to an inlet chamber and configured for coupling to an upstream liquid supply line, and an outlet port extending from an outlet chamber and configured for coupling to a downstream supply line; a high flow-rate path fitted with a hydraulic faucet comprising a main diaphragm extending between the inlet chamber and the outlet chamber for selectively admitting liquid flow therebetween at substantially high flow rates; a main
15 chamber extending at one face of the main diaphragm and configured with a restricted flow path extending between an inlet chamber and the main chamber; a low flow-rate pressure regulating unit being in flow communication with the outlet chamber and configured with a control chamber fitted with a control diaphragm having one face in normally open flow communication with the outlet chamber and at an opposite face
20 thereof is vented to the atmosphere; said control diaphragm is configured for controlling a pressure regulating flow path, and extends in flow communication between the main chamber and the outlet chamber.

25 **30.** A two stage flow control valve comprising an inlet port and an outlet port, a low-pressure regulating valve and an electric faucet extending in parallel flow relation to one another, each having an inlet being in flow communication with the inlet port and outlet being in flow communication with the outlet port; and a flow sensor extending upstream of said outlet port or else extending downstream of said inlet port and configured for generating a flow control signal responsive to fluid flow and transmitting said signal to said electric faucet.

30 **31.** A two stage flow control valve according to claim 30, wherein high flow rate through the flow sensor results in generating a control signal to open the electric faucet and low flow rate through flow sensor entails shutting said electric faucet and resulting in directing low flow through the low-pressure regulating valve.

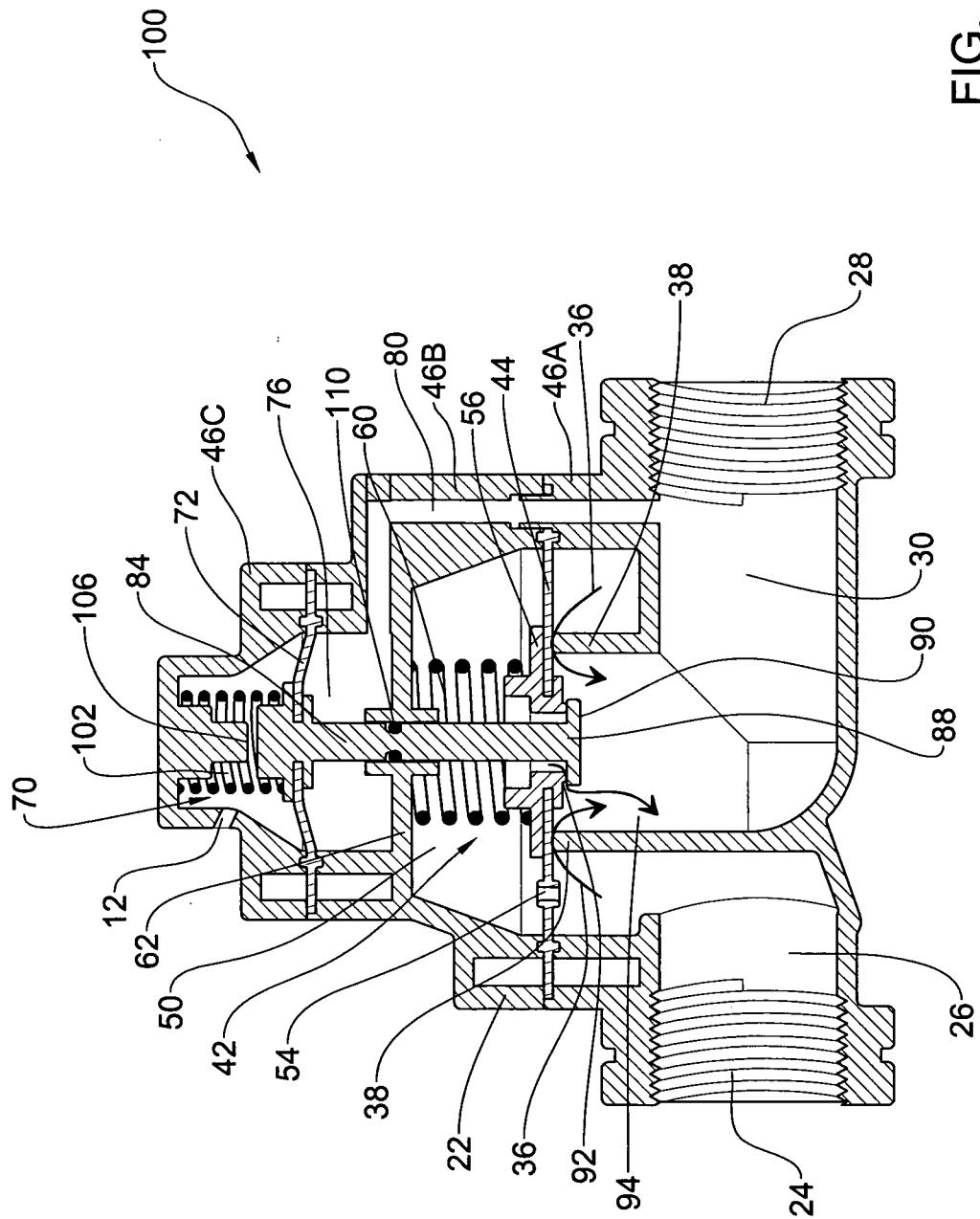


FIG. 1

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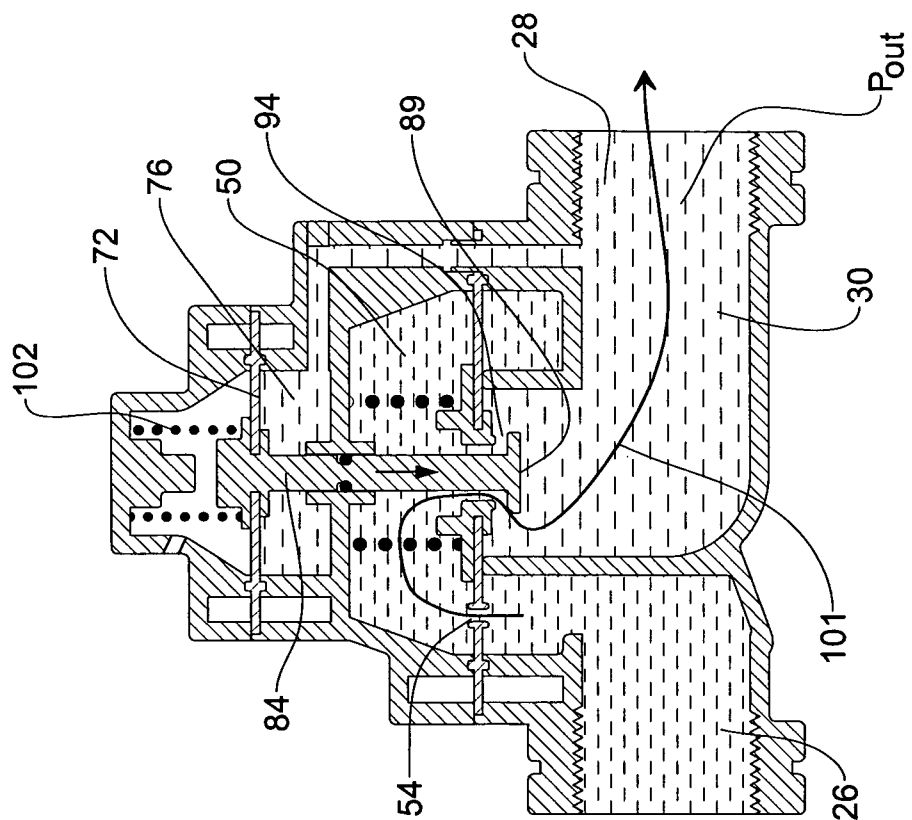


FIG. 2B

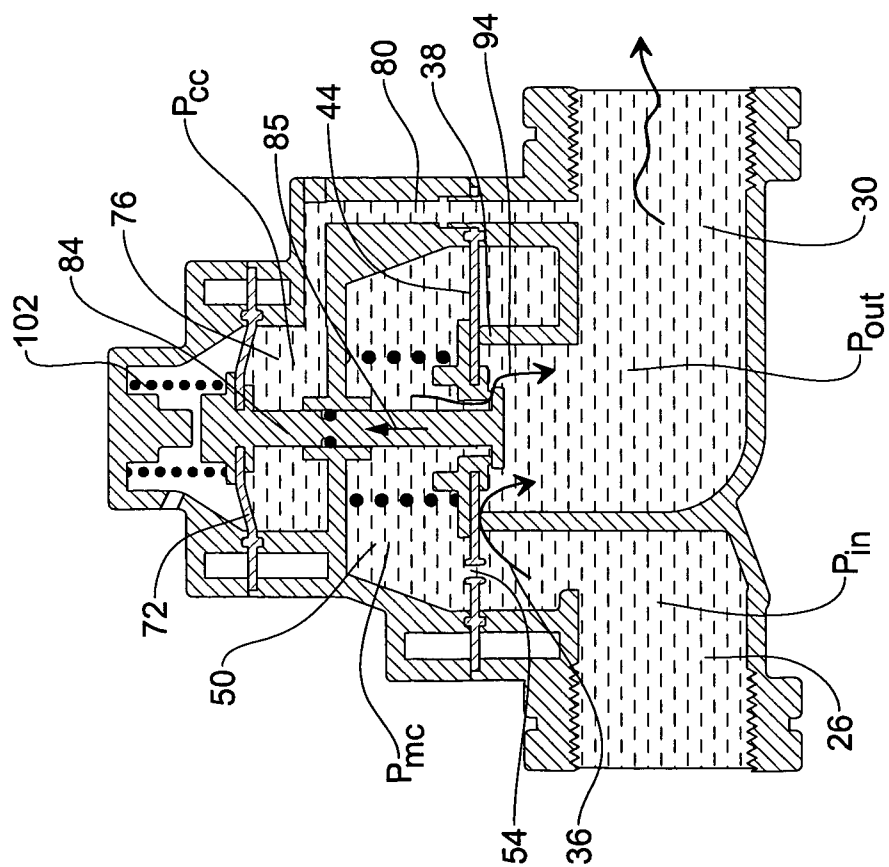


FIG. 2A

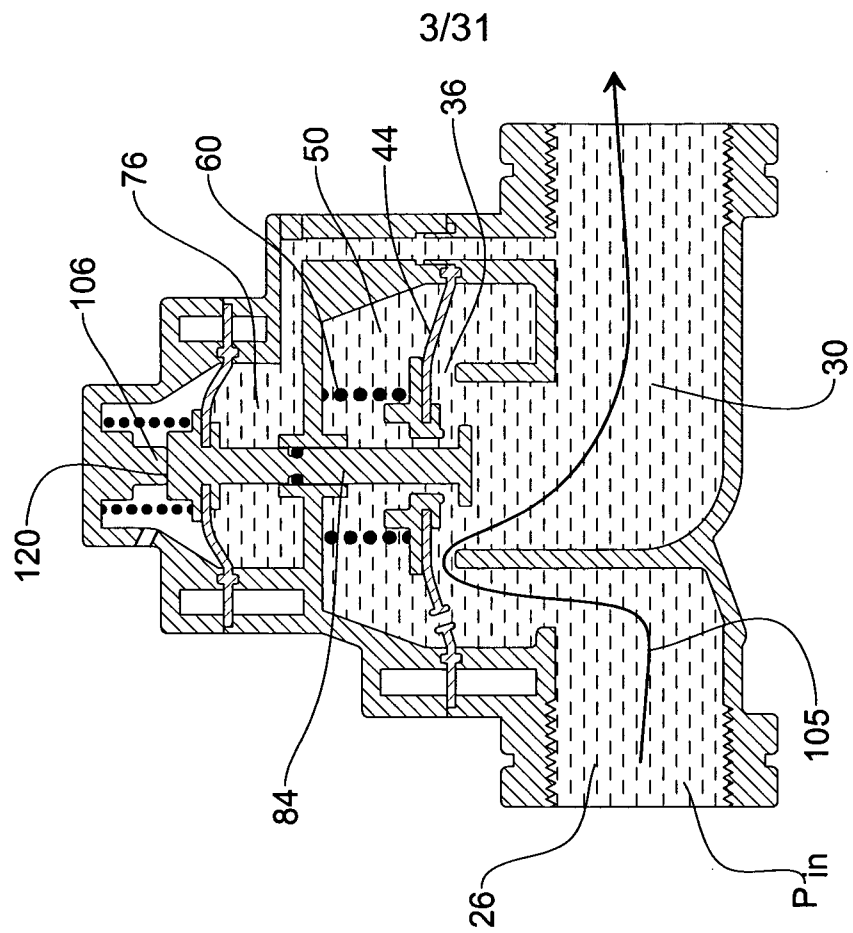


FIG. 2D

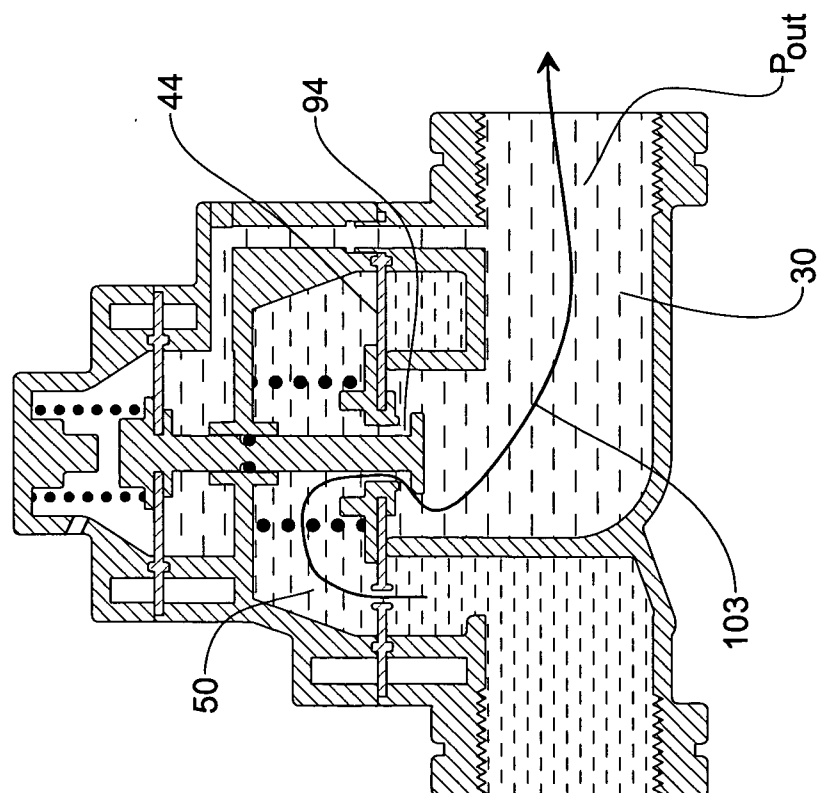


FIG. 2C

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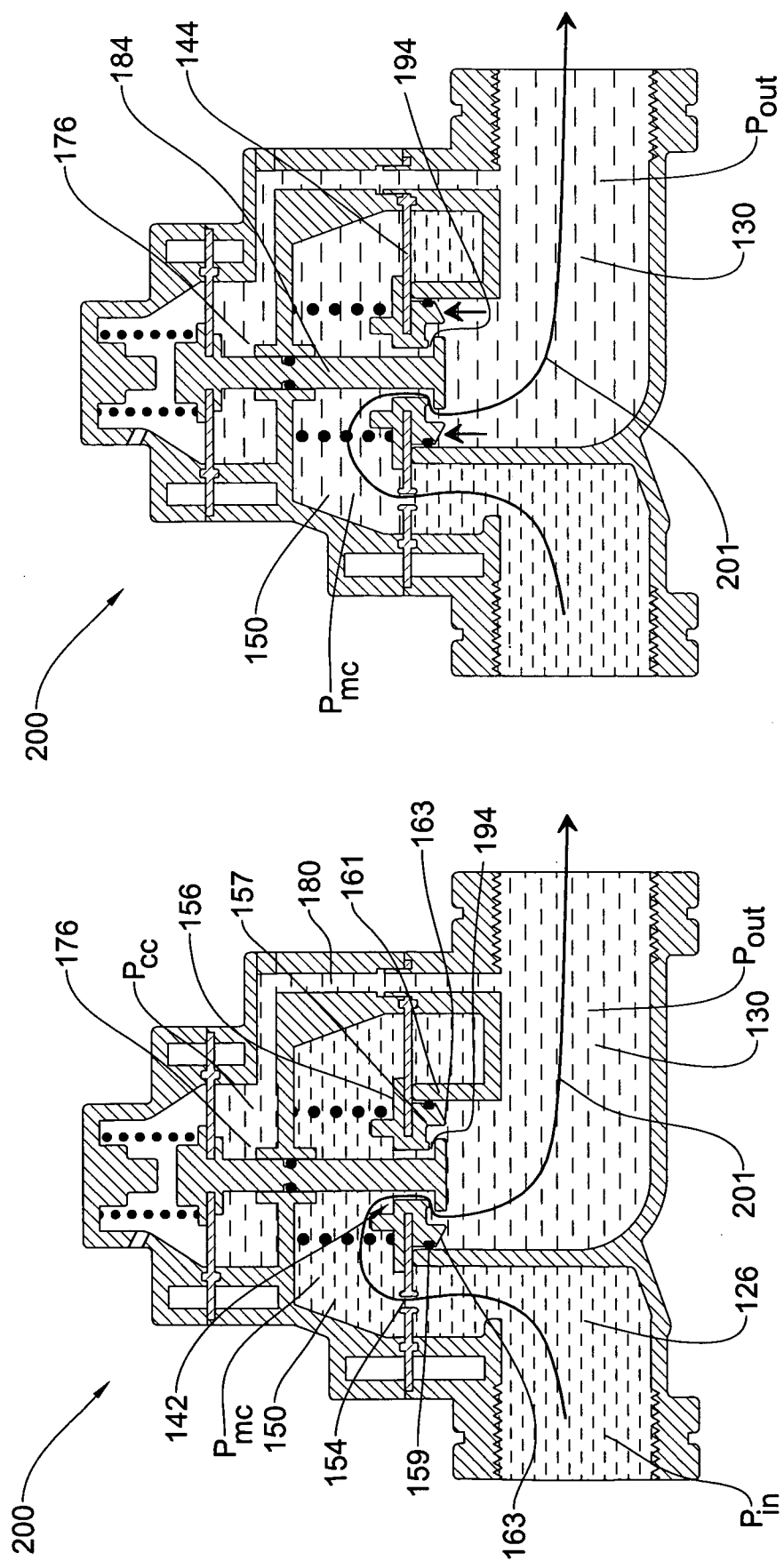


FIG. 3B

FIG. 3A

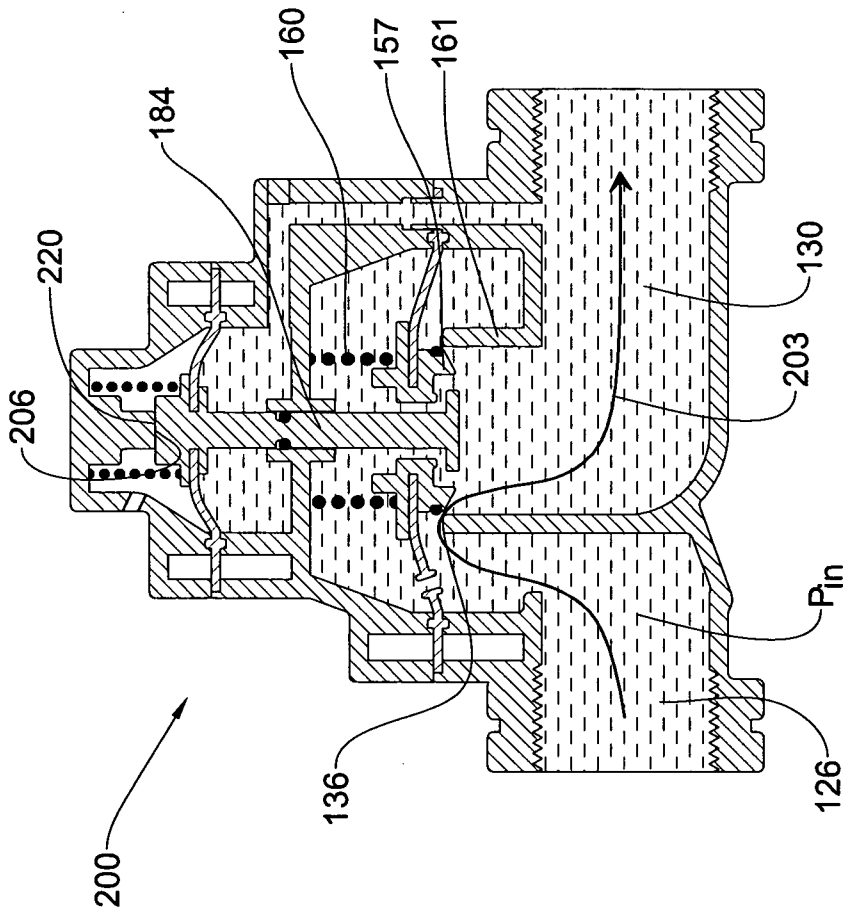


FIG. 3C

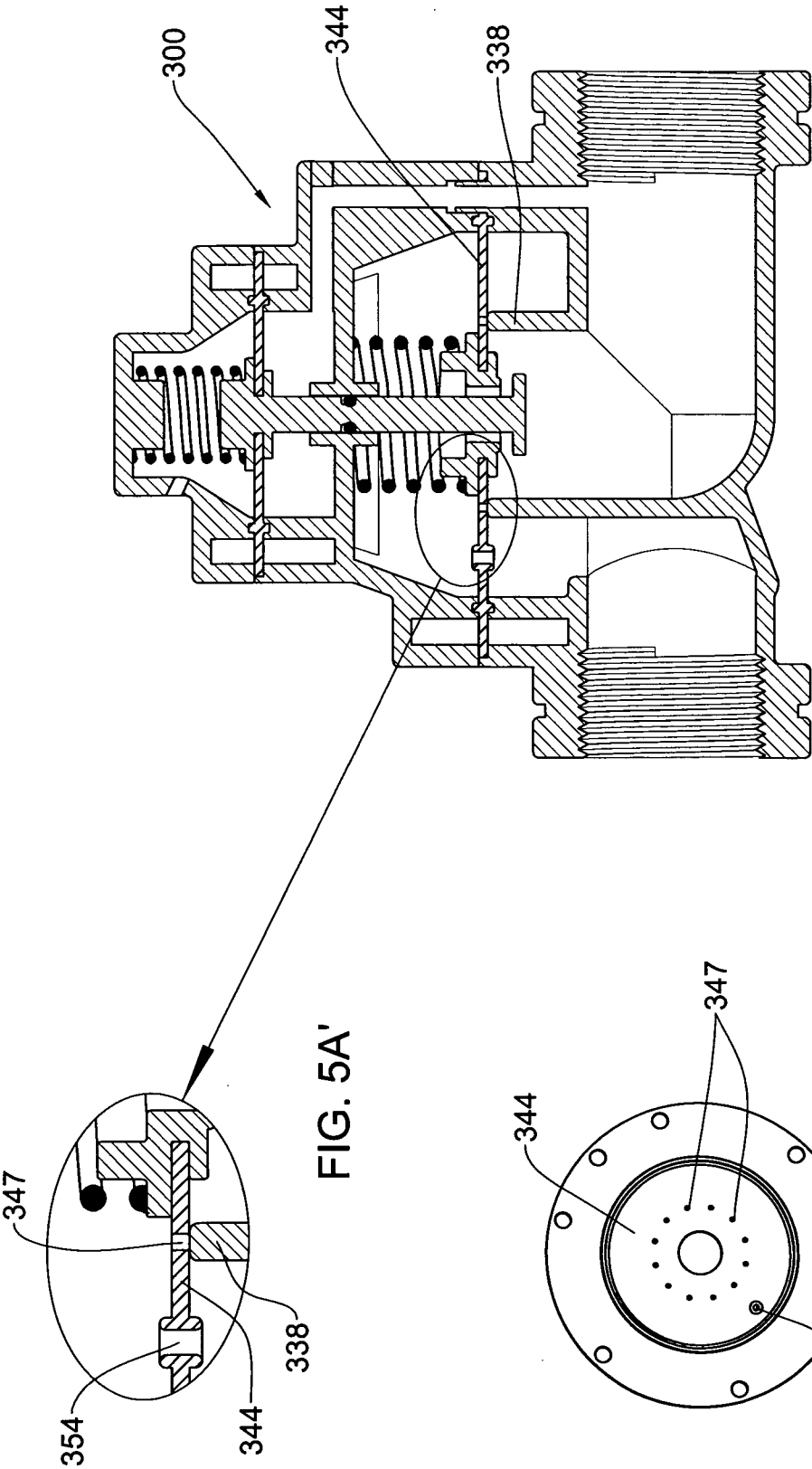


FIG. 4A

FIG. 4B

FIG. 5A'

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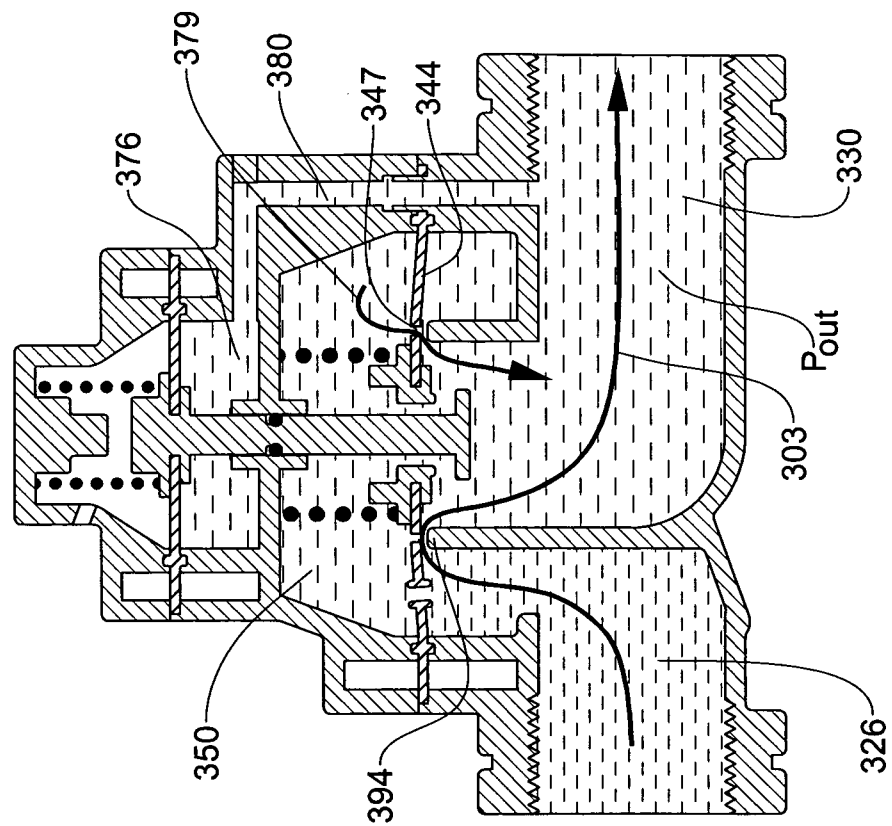


FIG. 5B

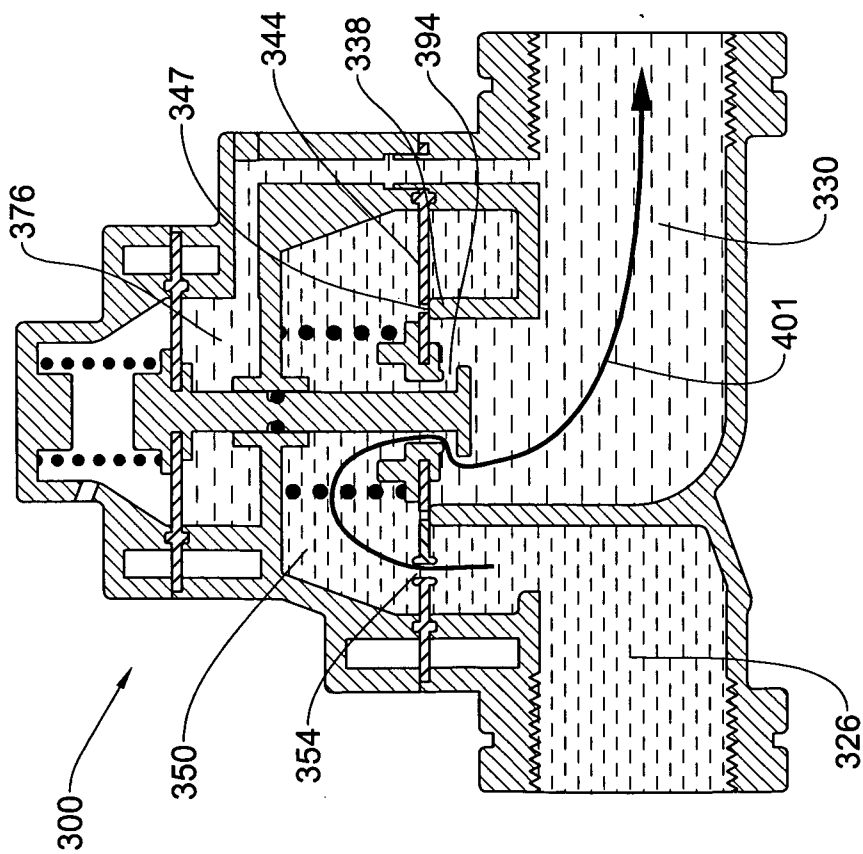
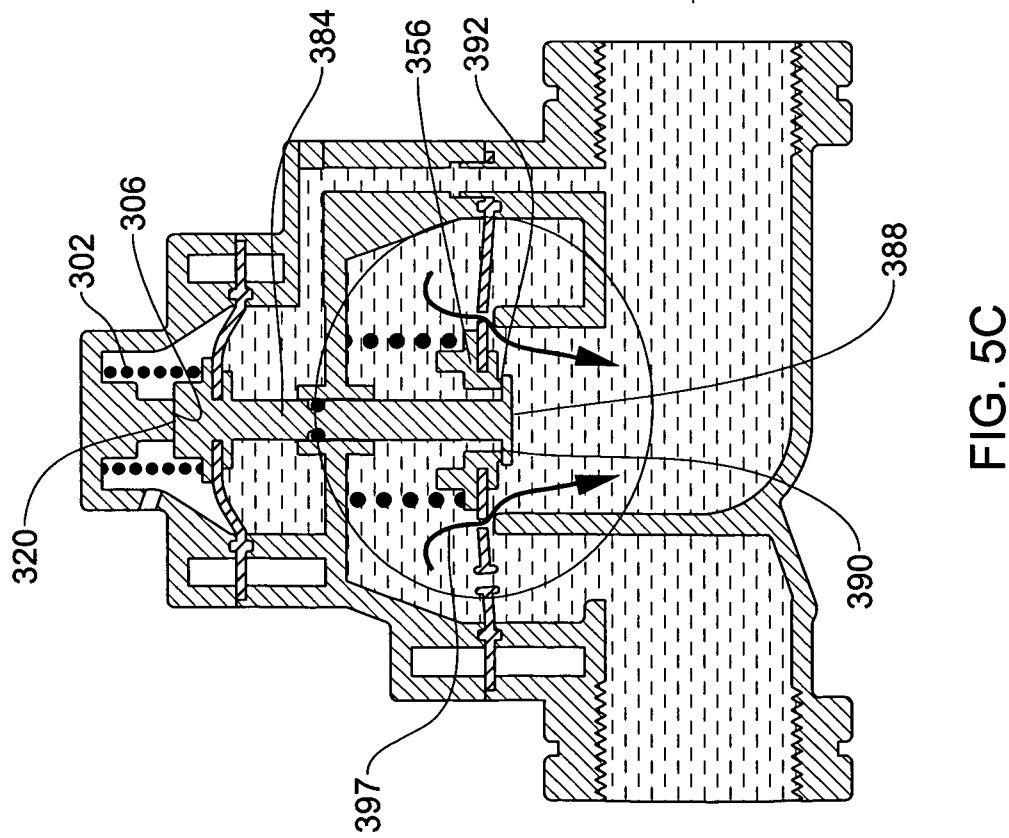
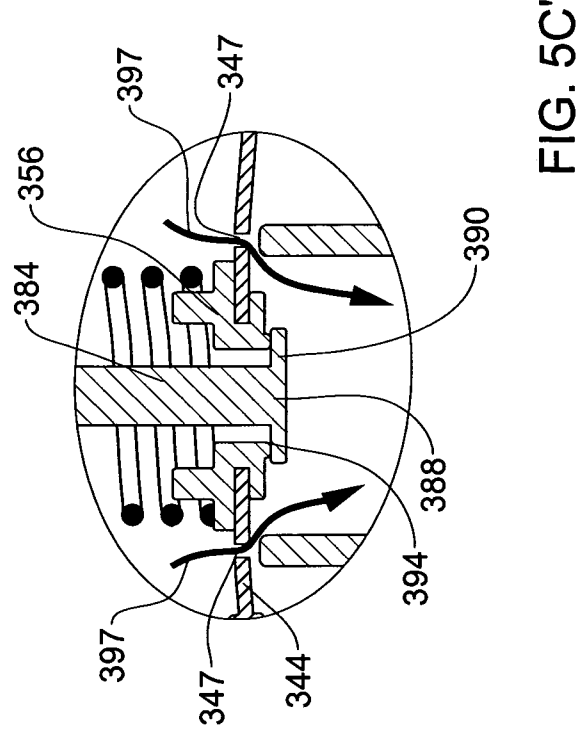
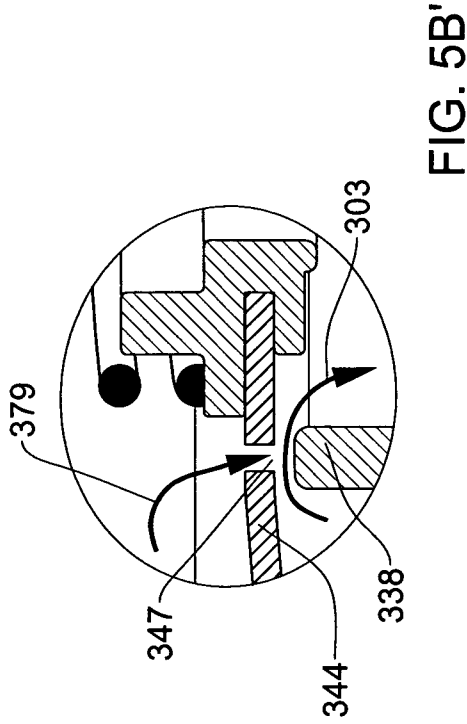


FIG. 5A



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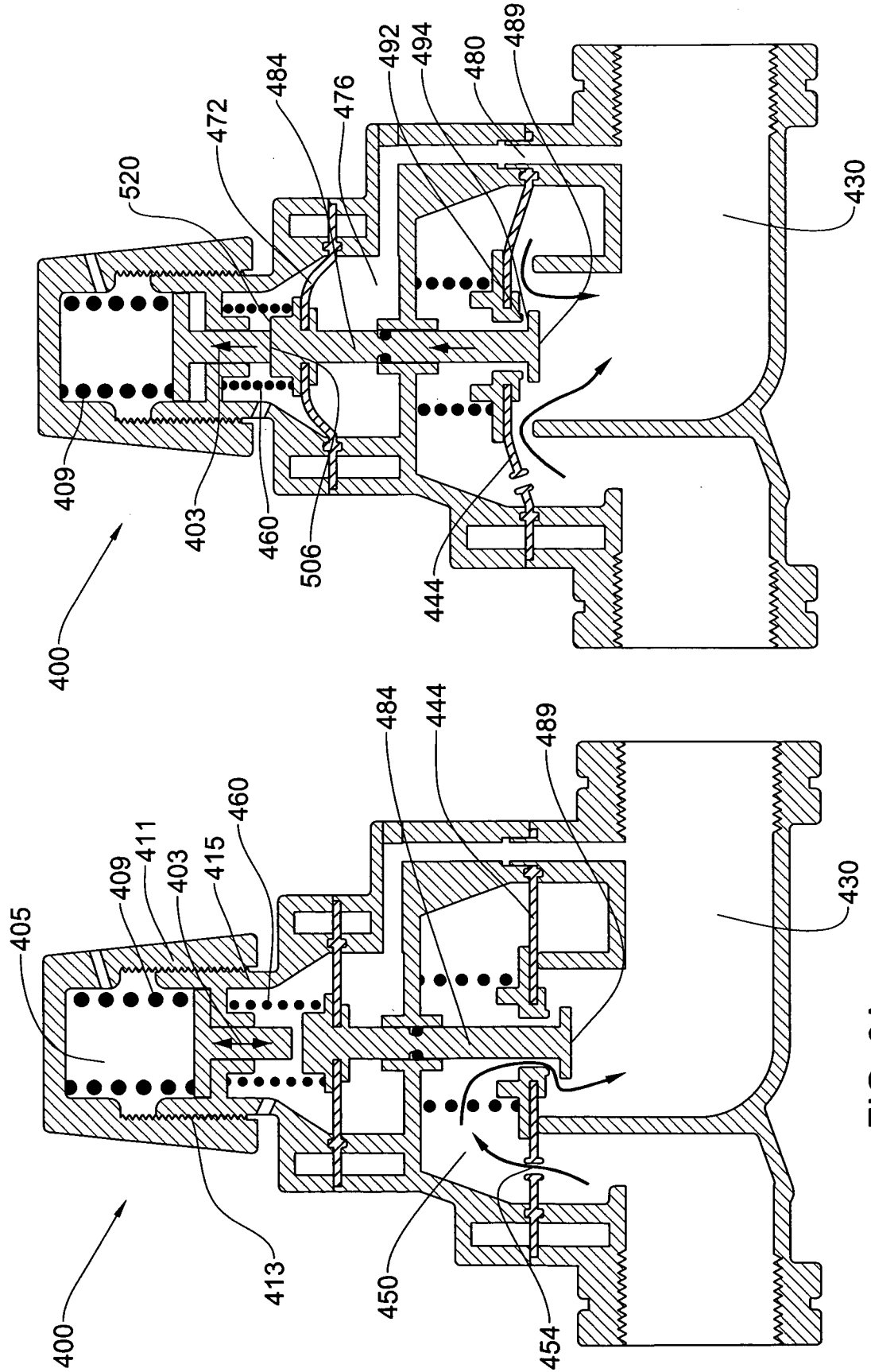


FIG. 6B

FIG. 6A

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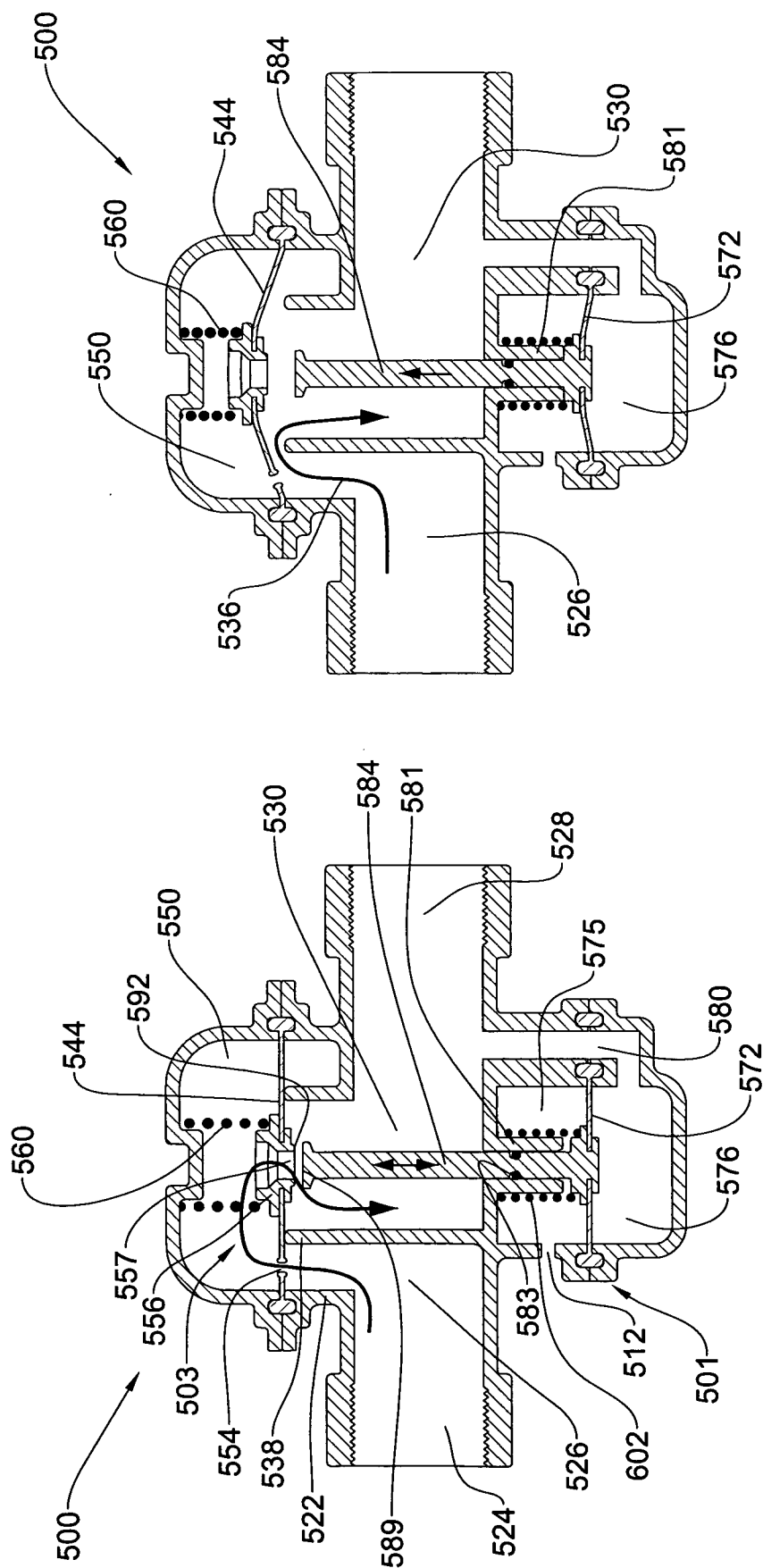


FIG. 7B

FIG. 7A

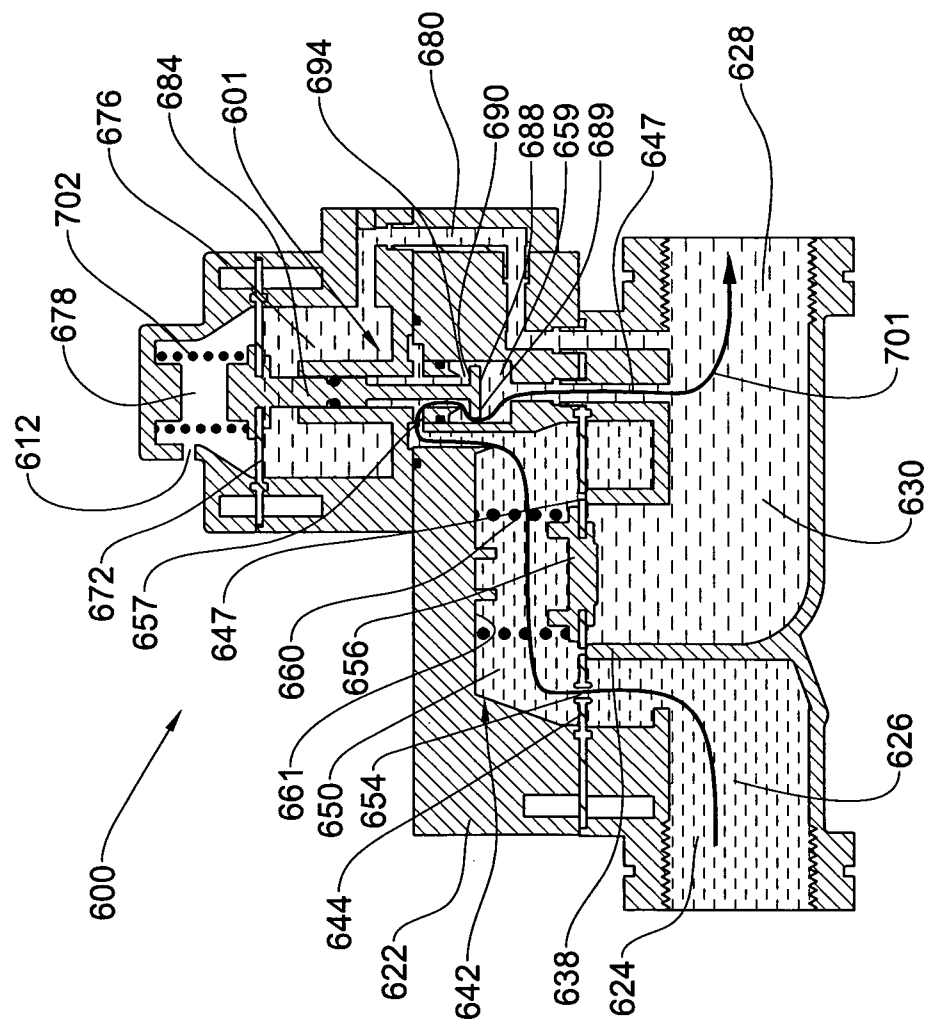


FIG. 8A

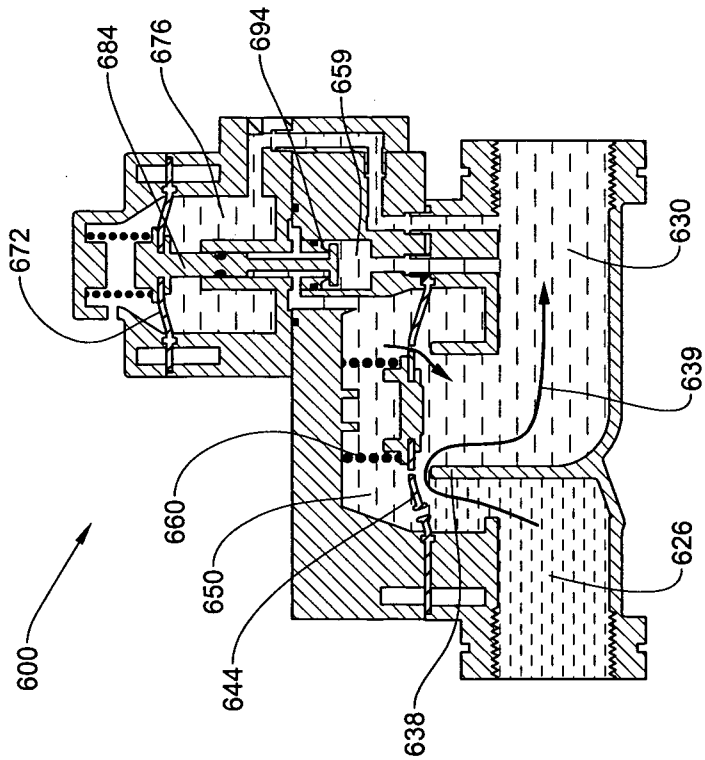


FIG. 8C

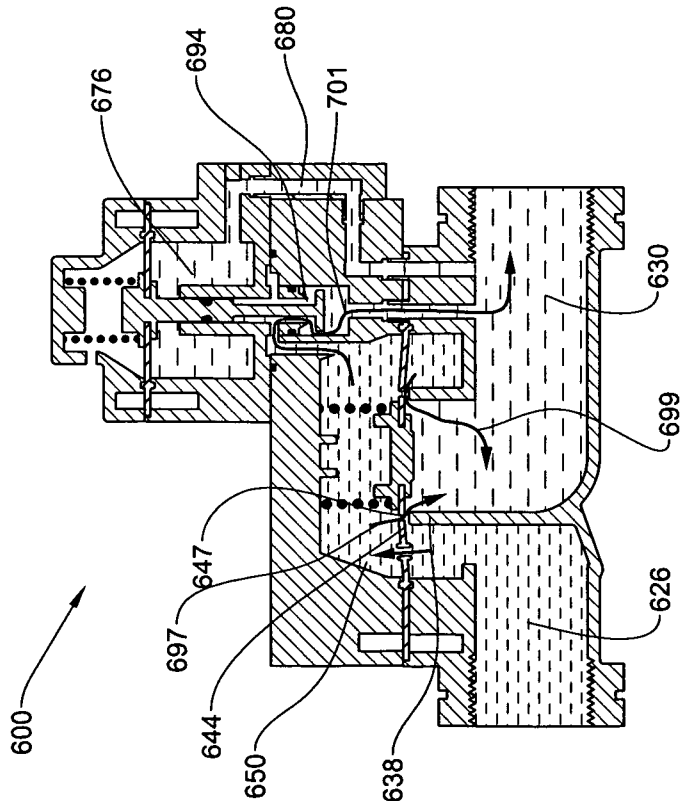


FIG. 8B

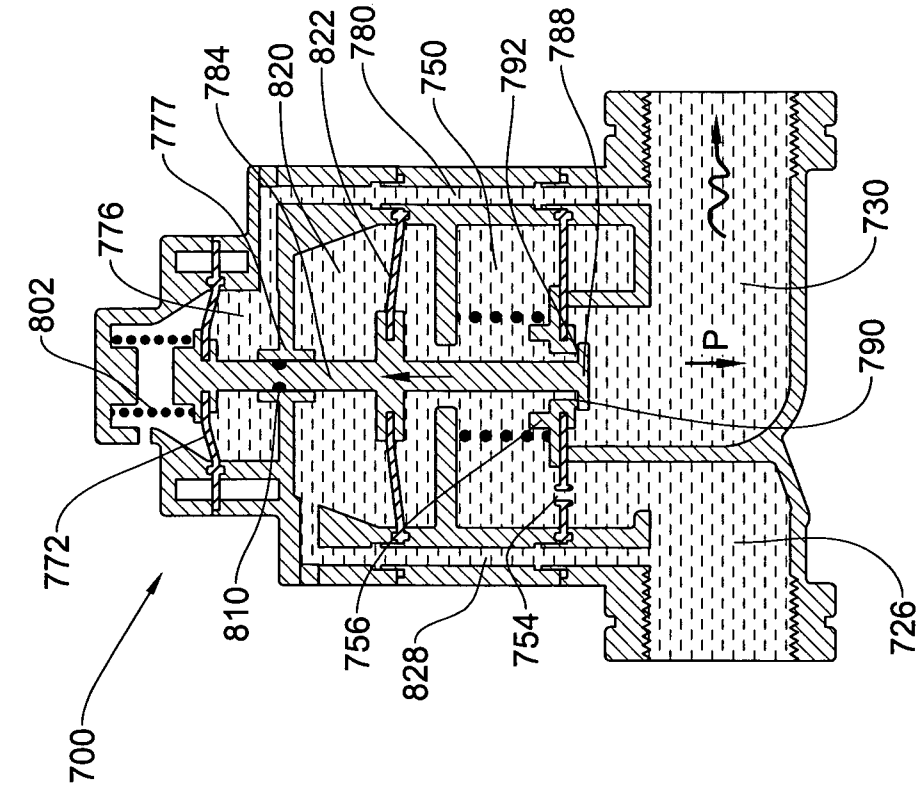


FIG. 9A

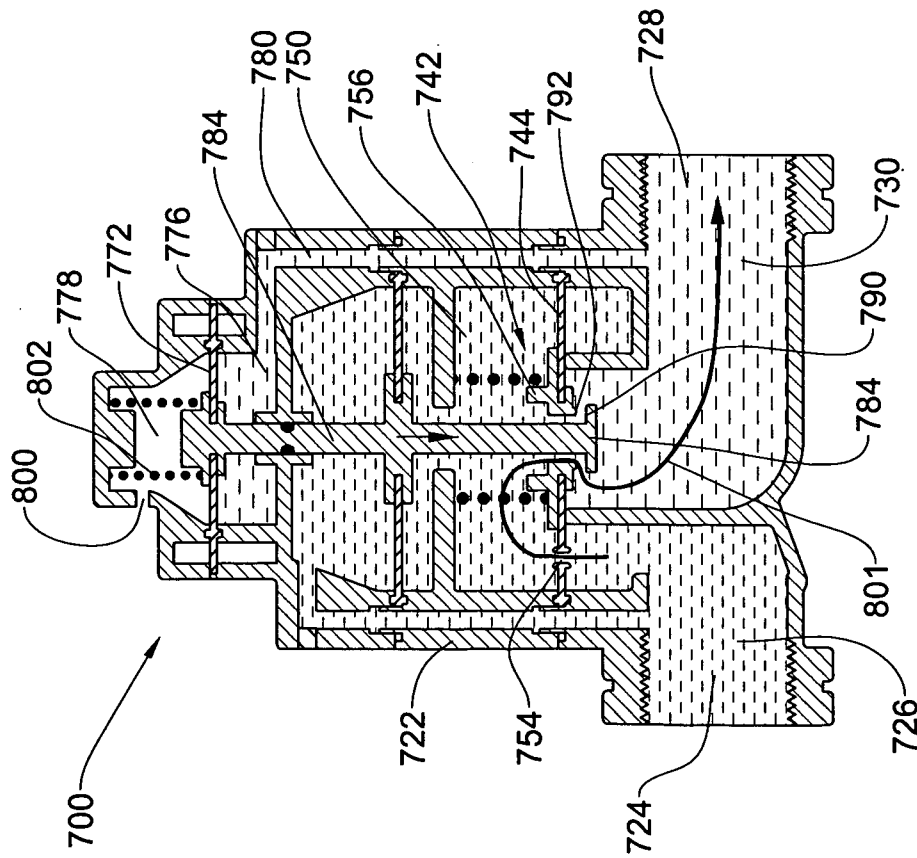


FIG. 9B

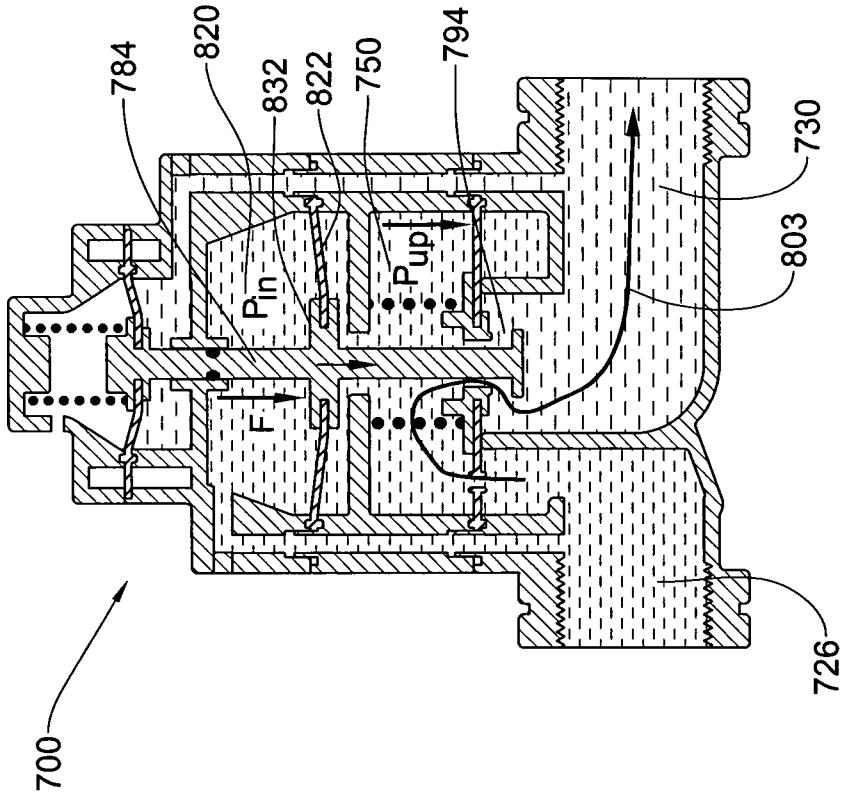


FIG. 9C

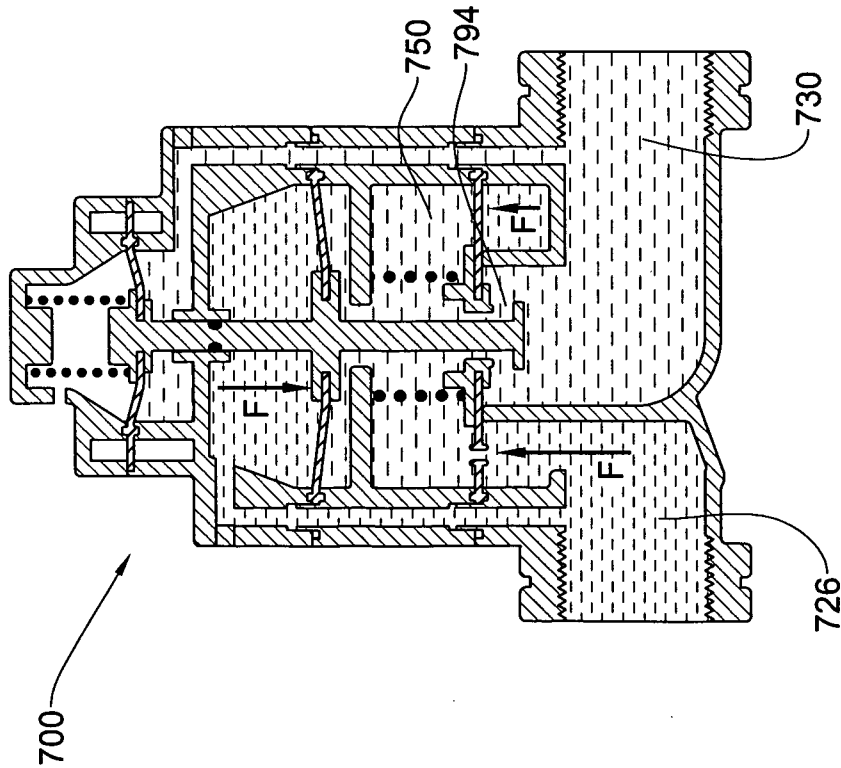


FIG. 9D

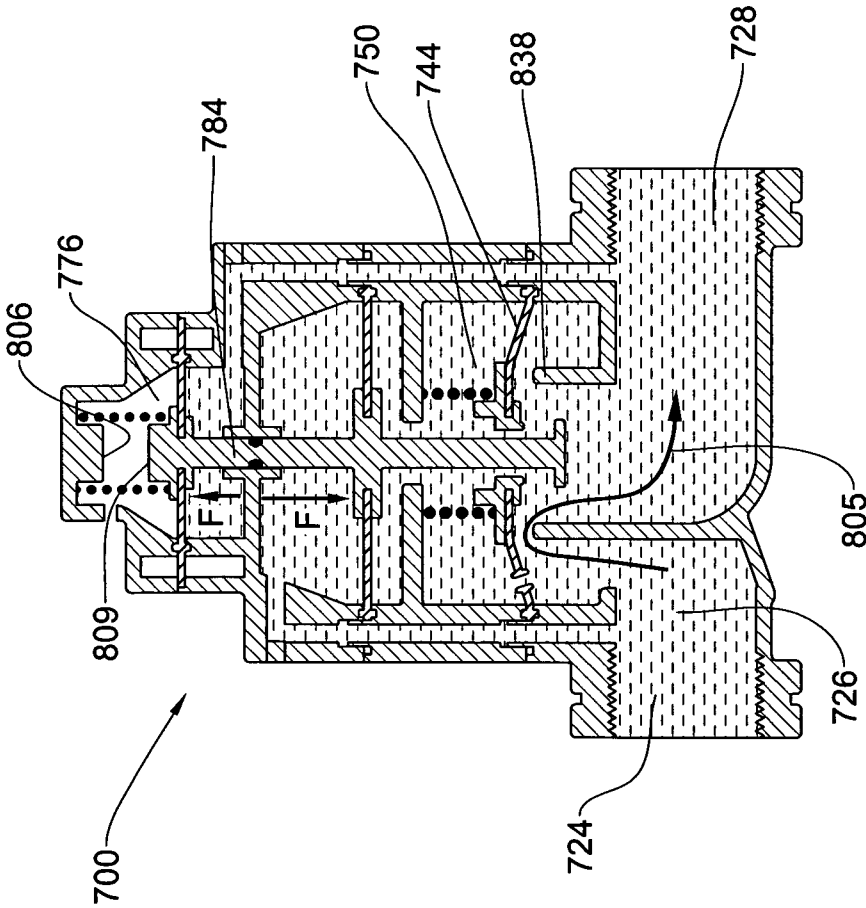


FIG. 9E

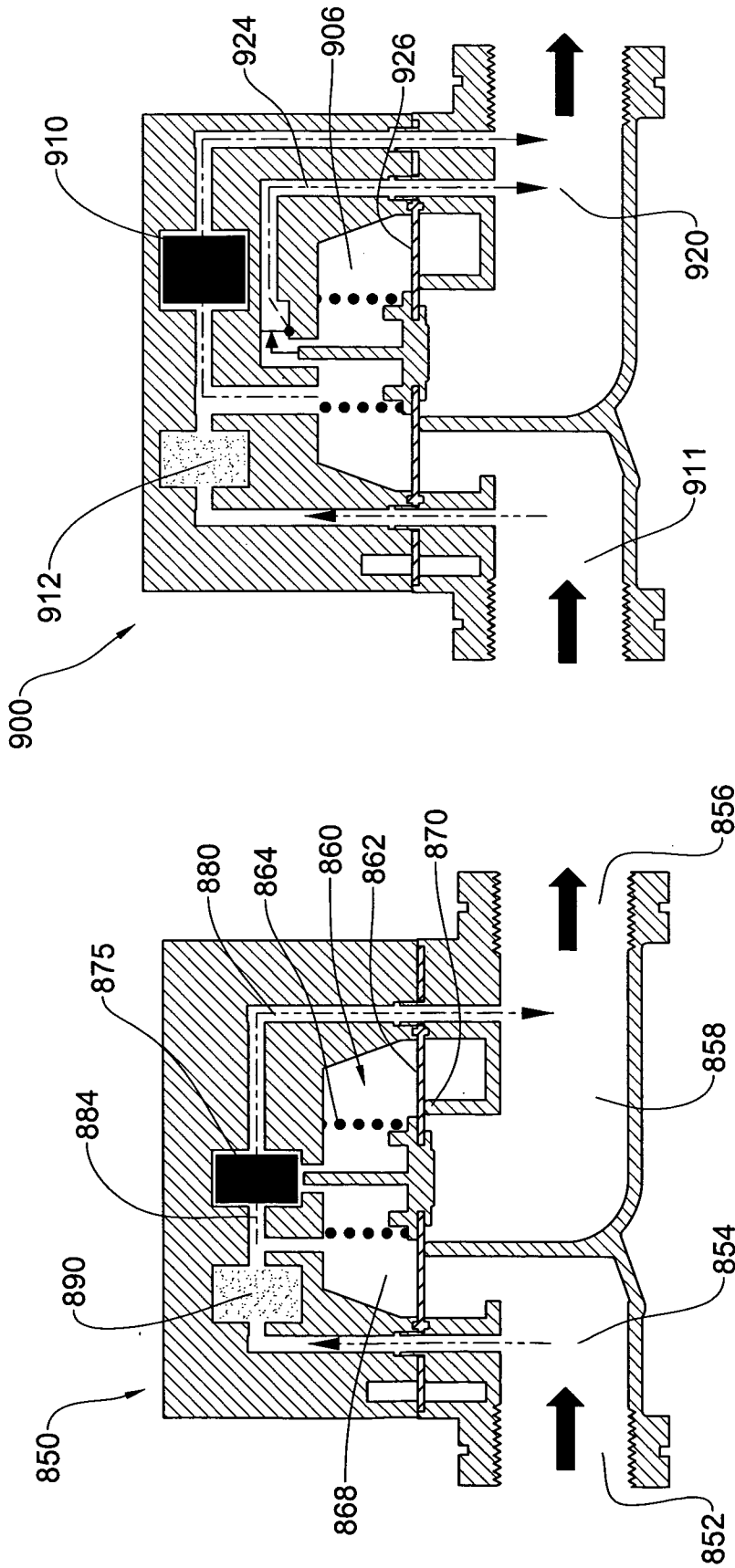


FIG. 10A

FIG. 10B

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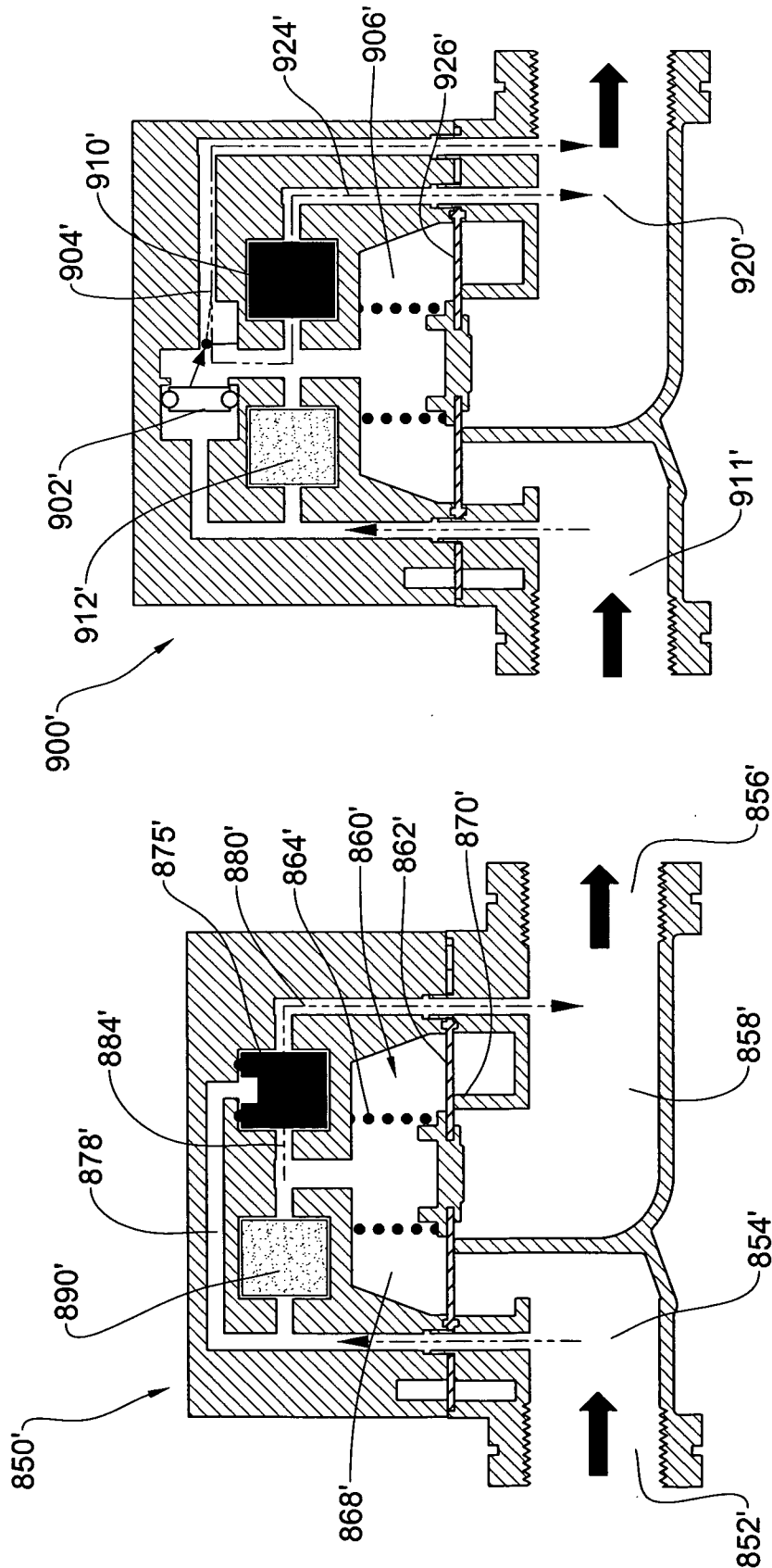


FIG. 10D

FIG. 10C

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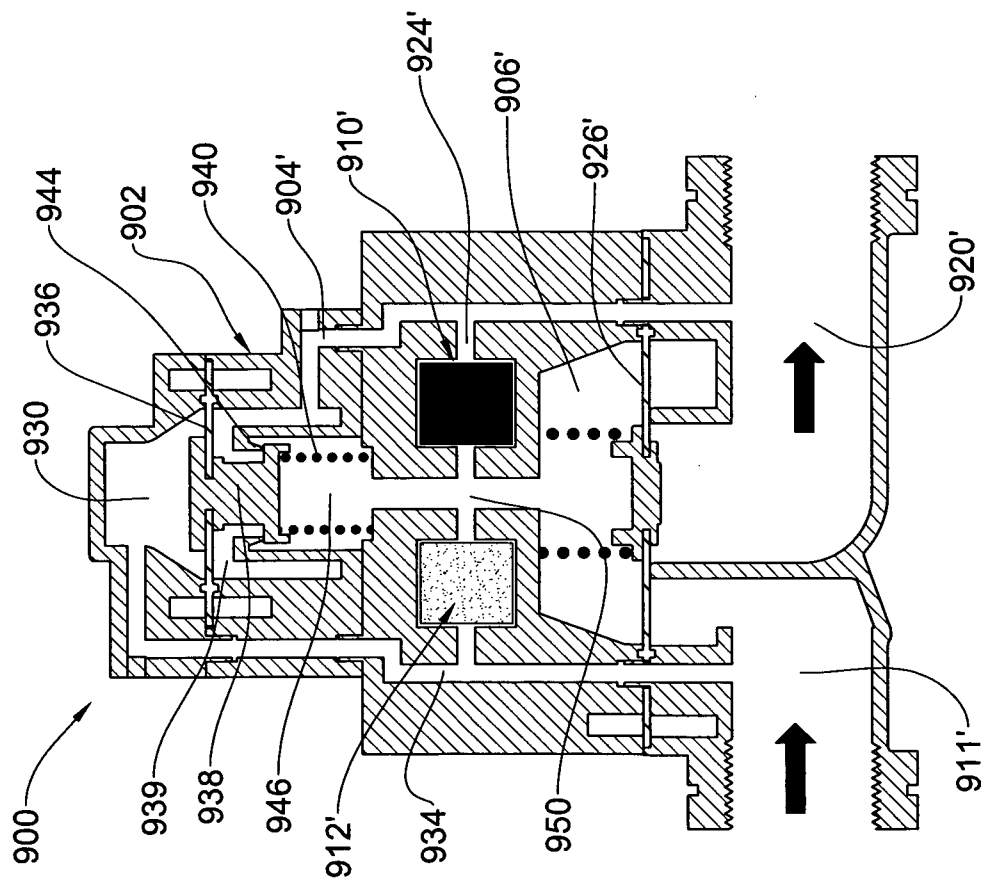


FIG. 11A

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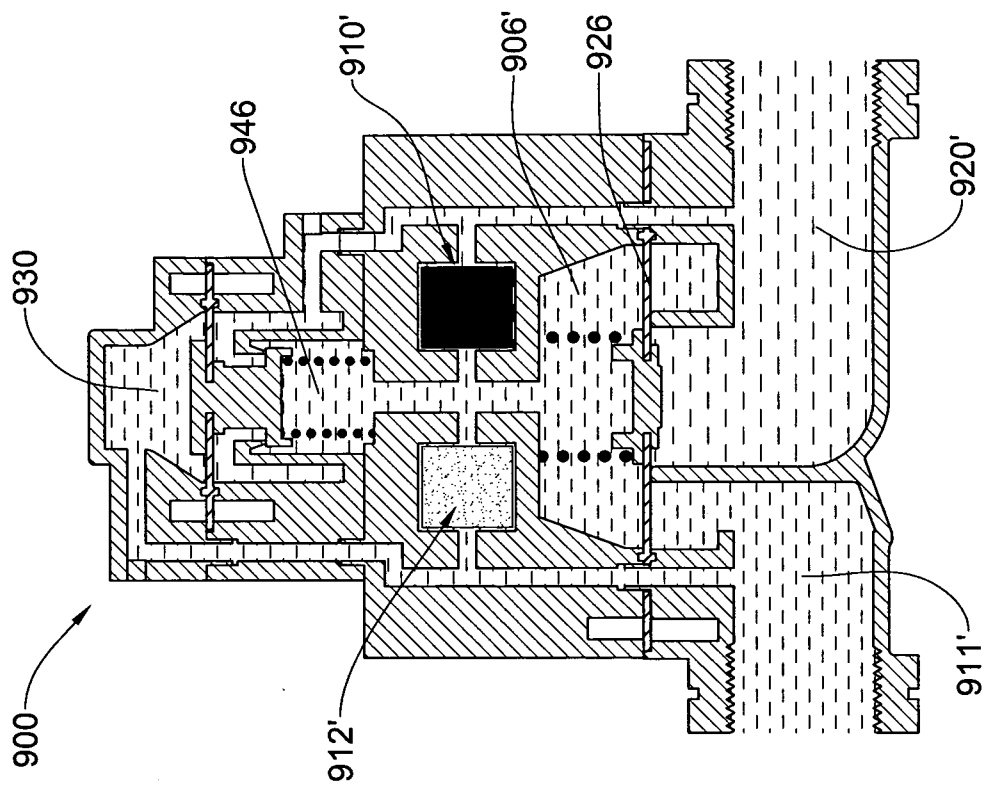


FIG. 11B

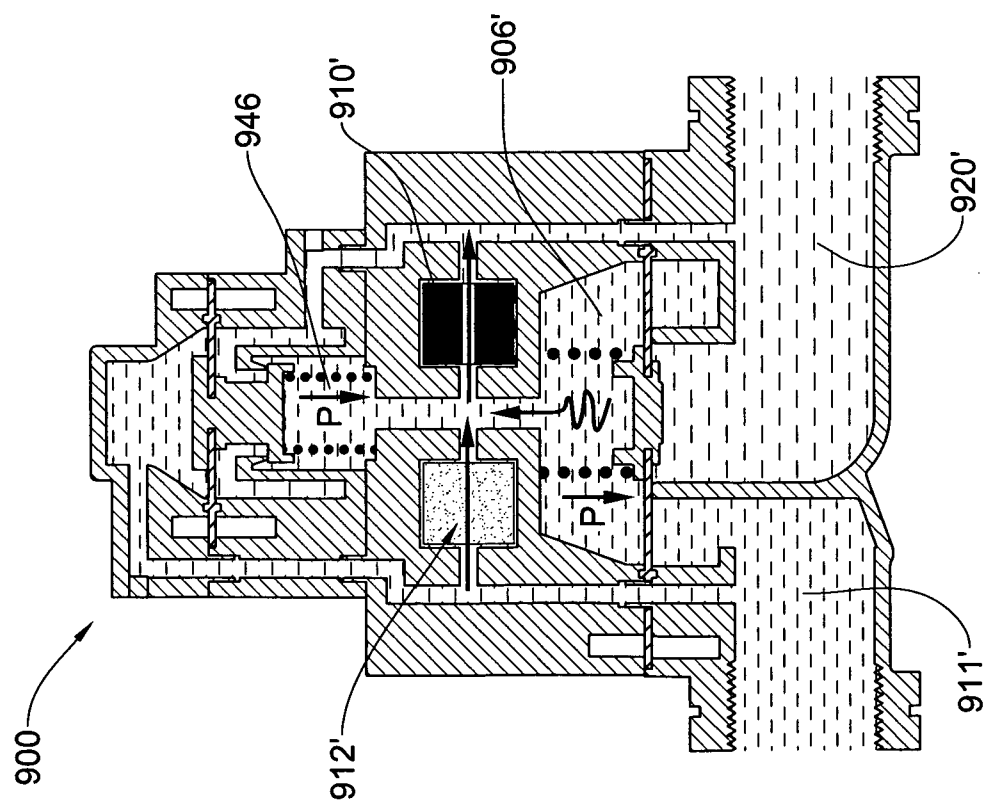


FIG. 11C

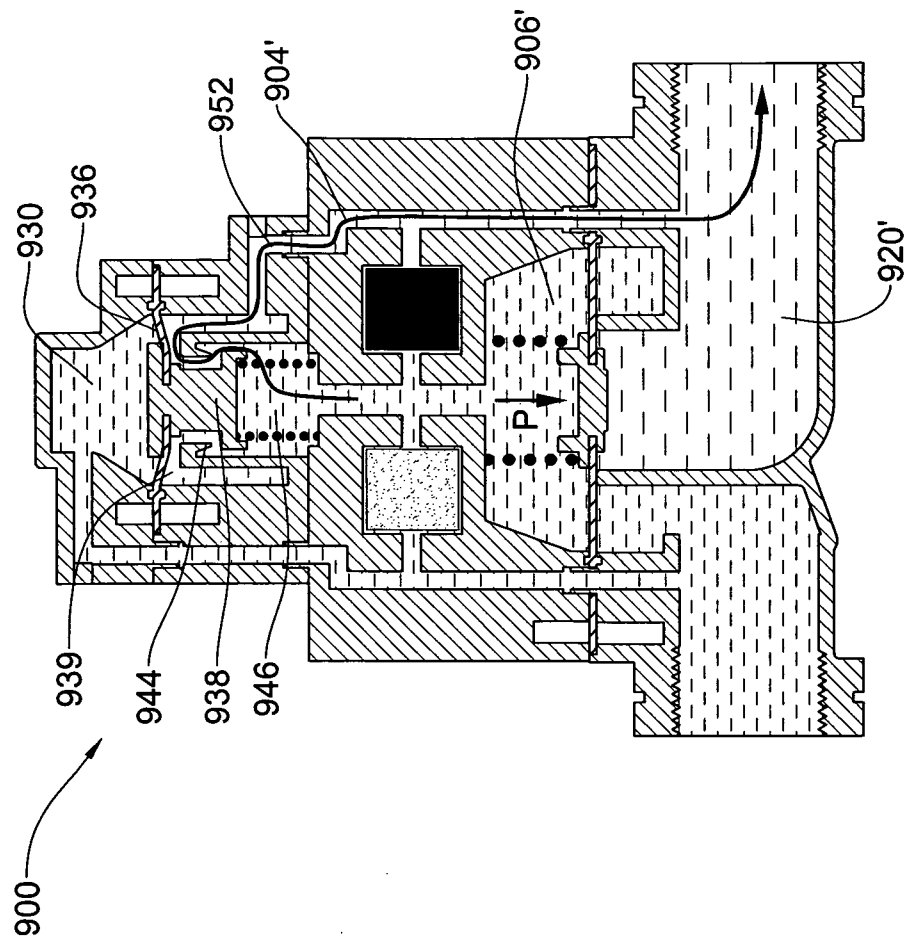


FIG. 11D

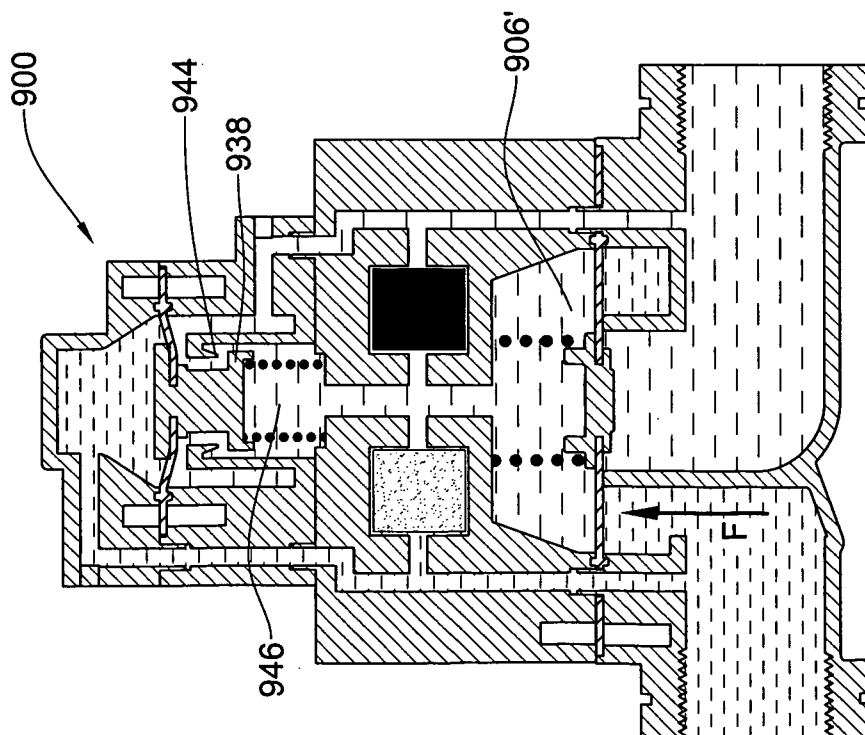


FIG. 11E

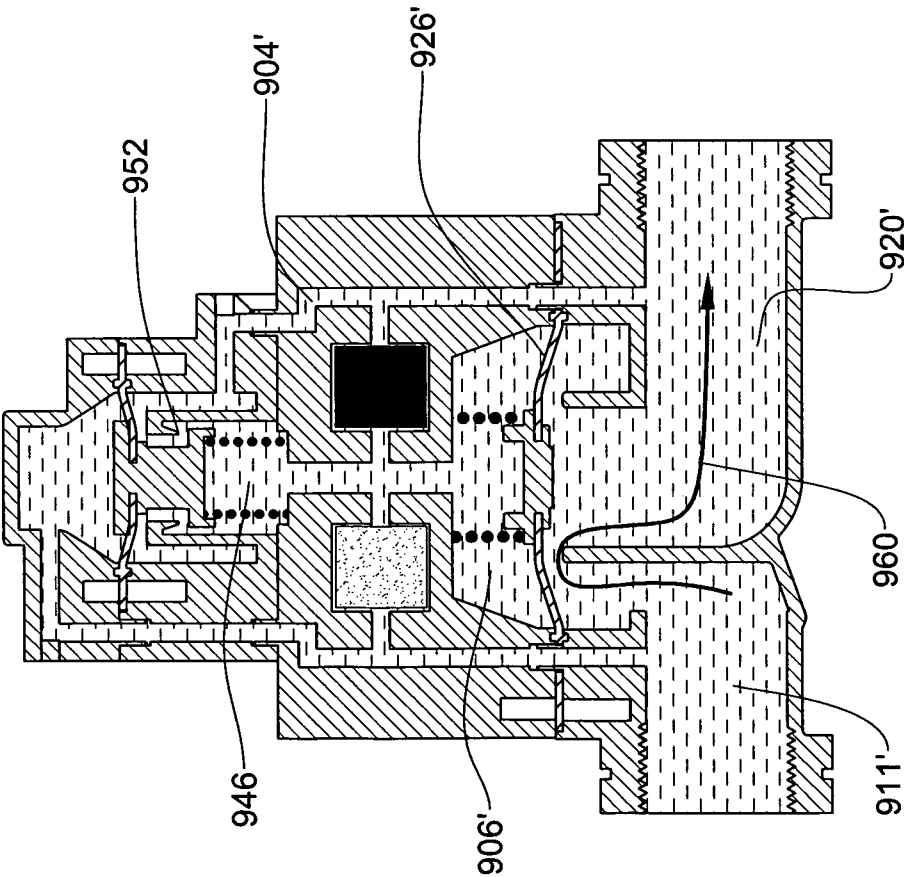


FIG. 11F

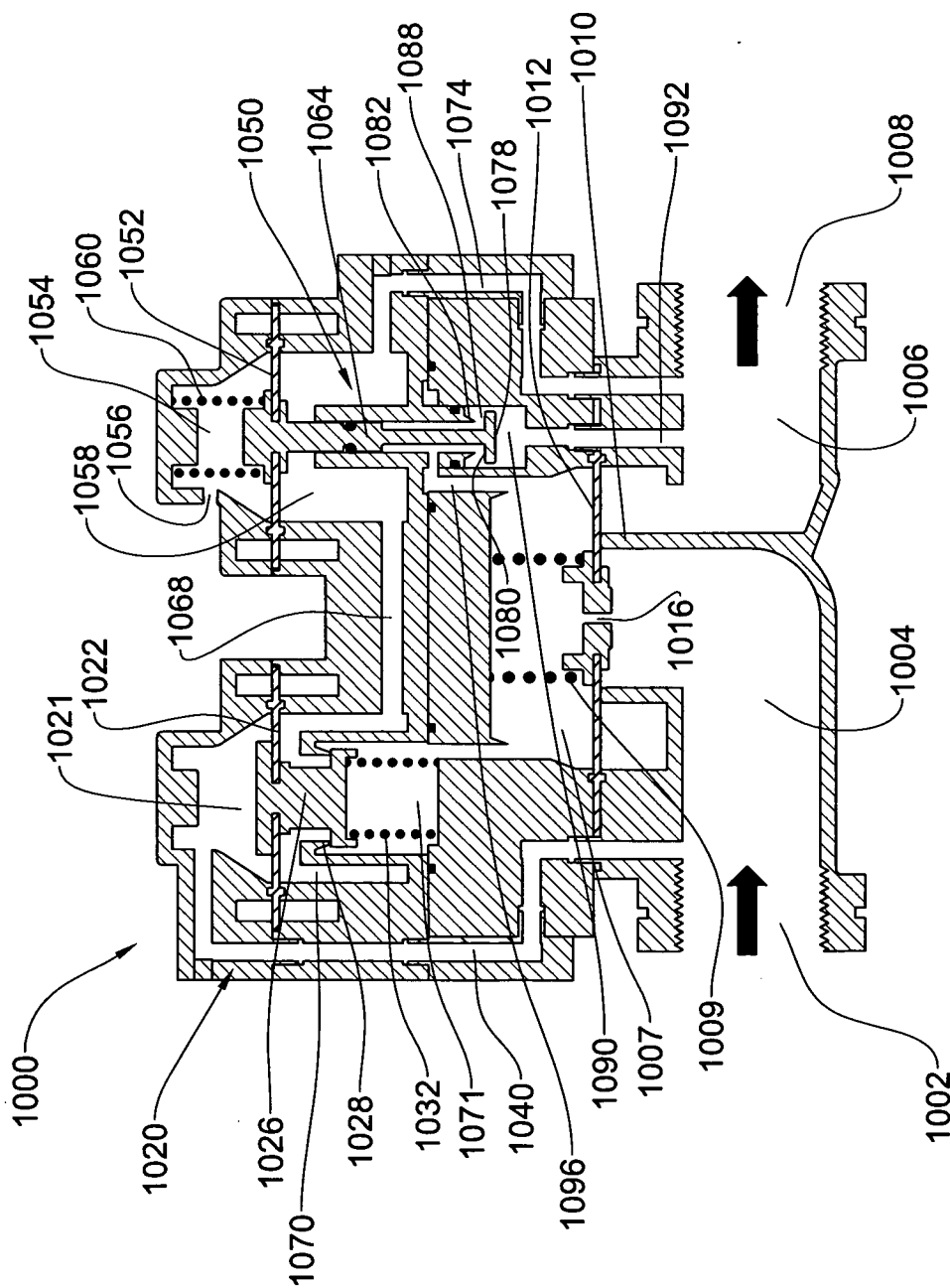


FIG. 12A

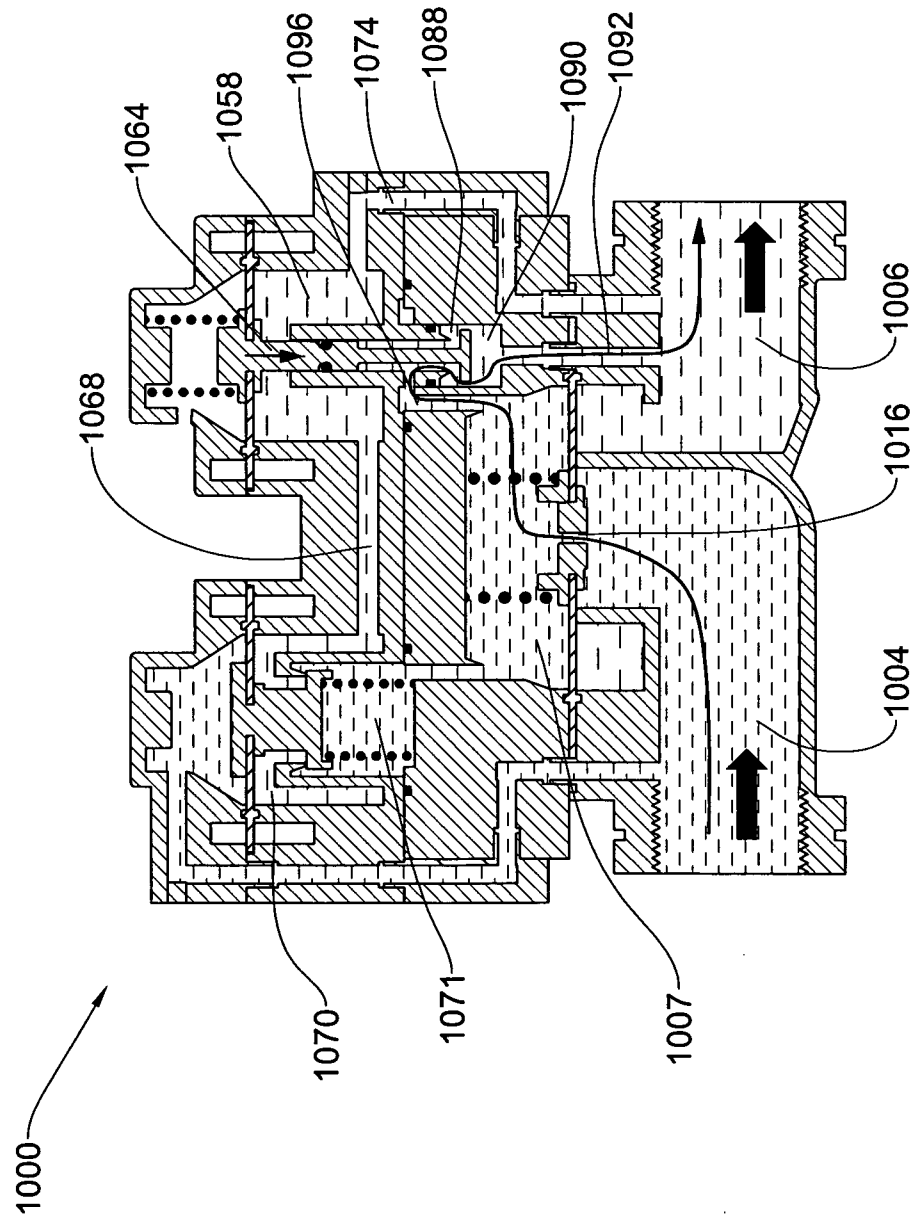


FIG. 12B

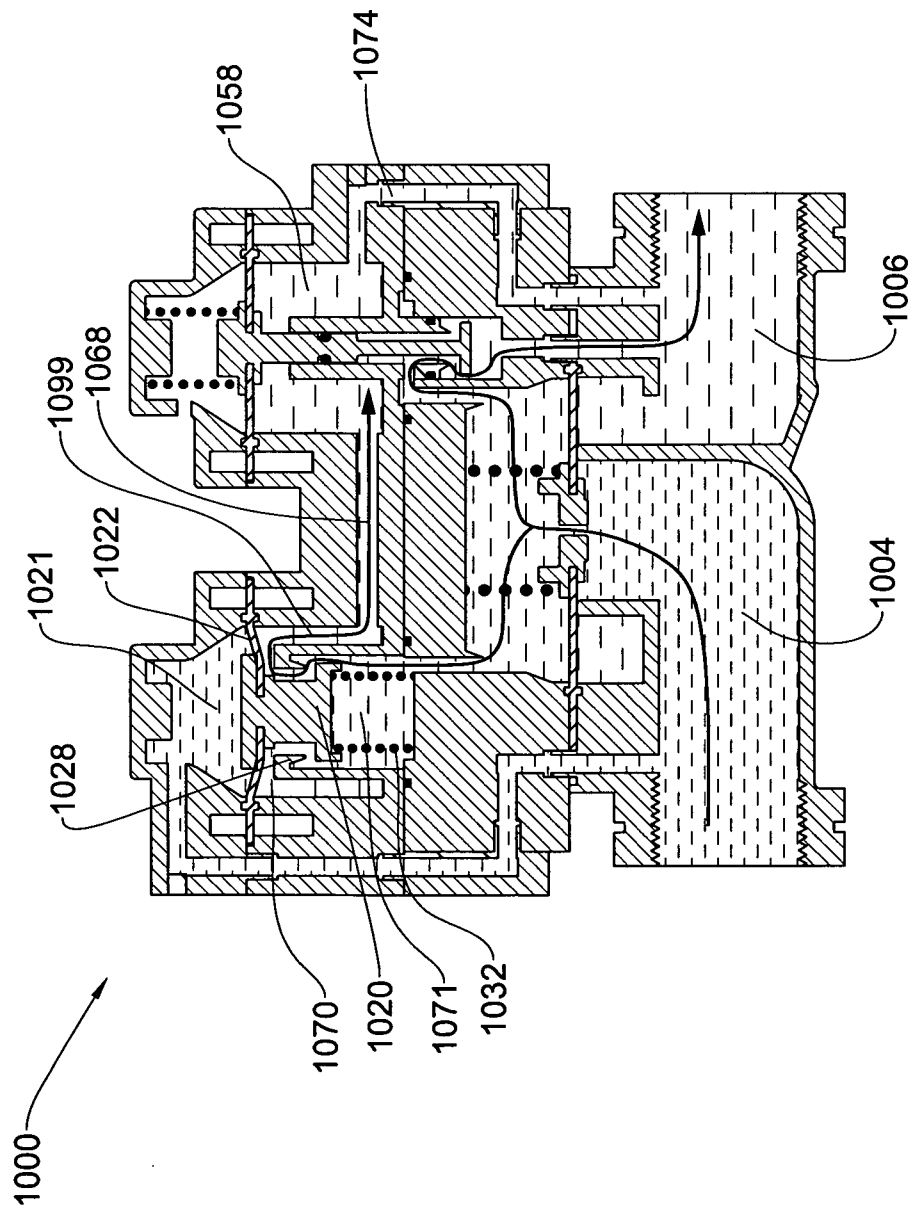


FIG. 12C

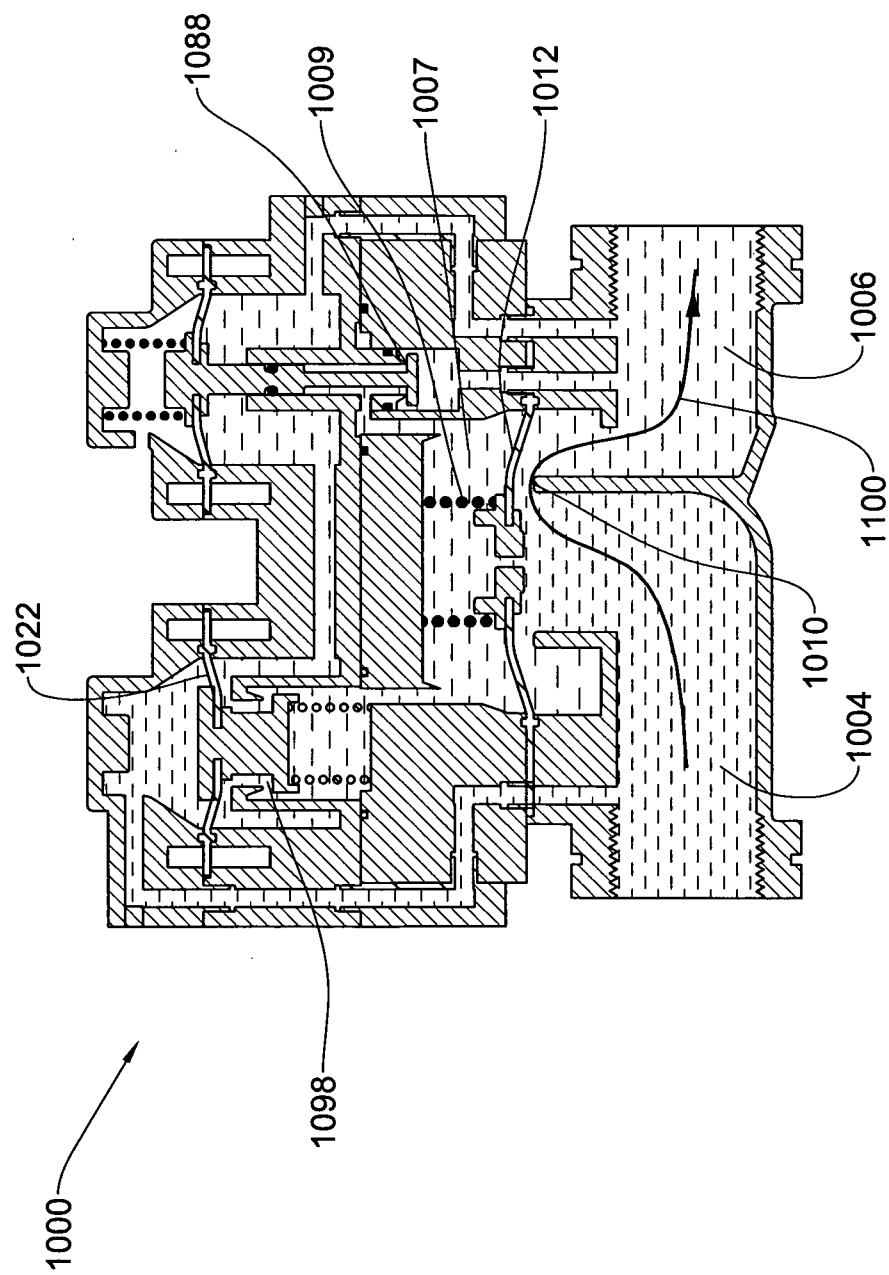


FIG. 12D

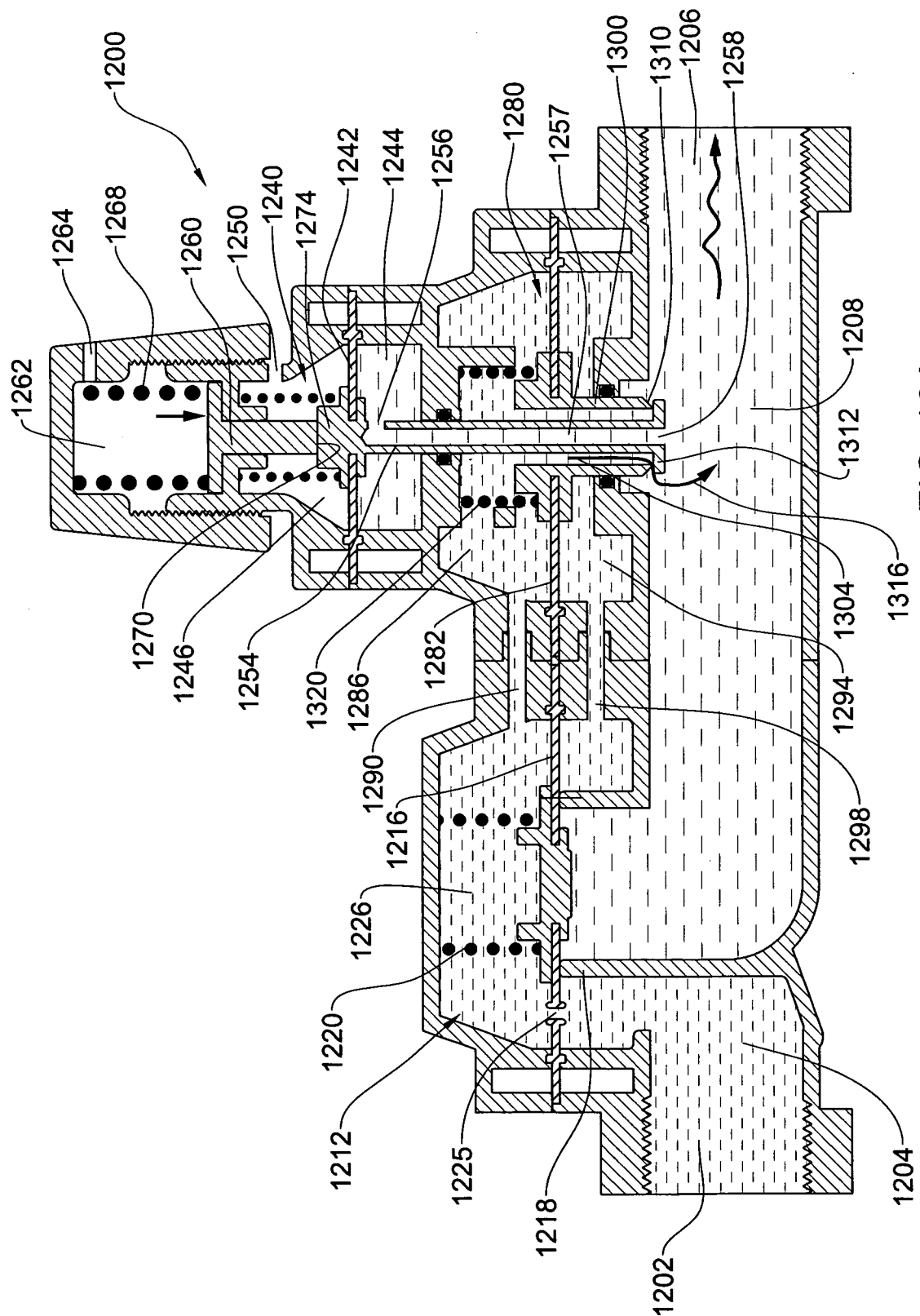


FIG. 13A

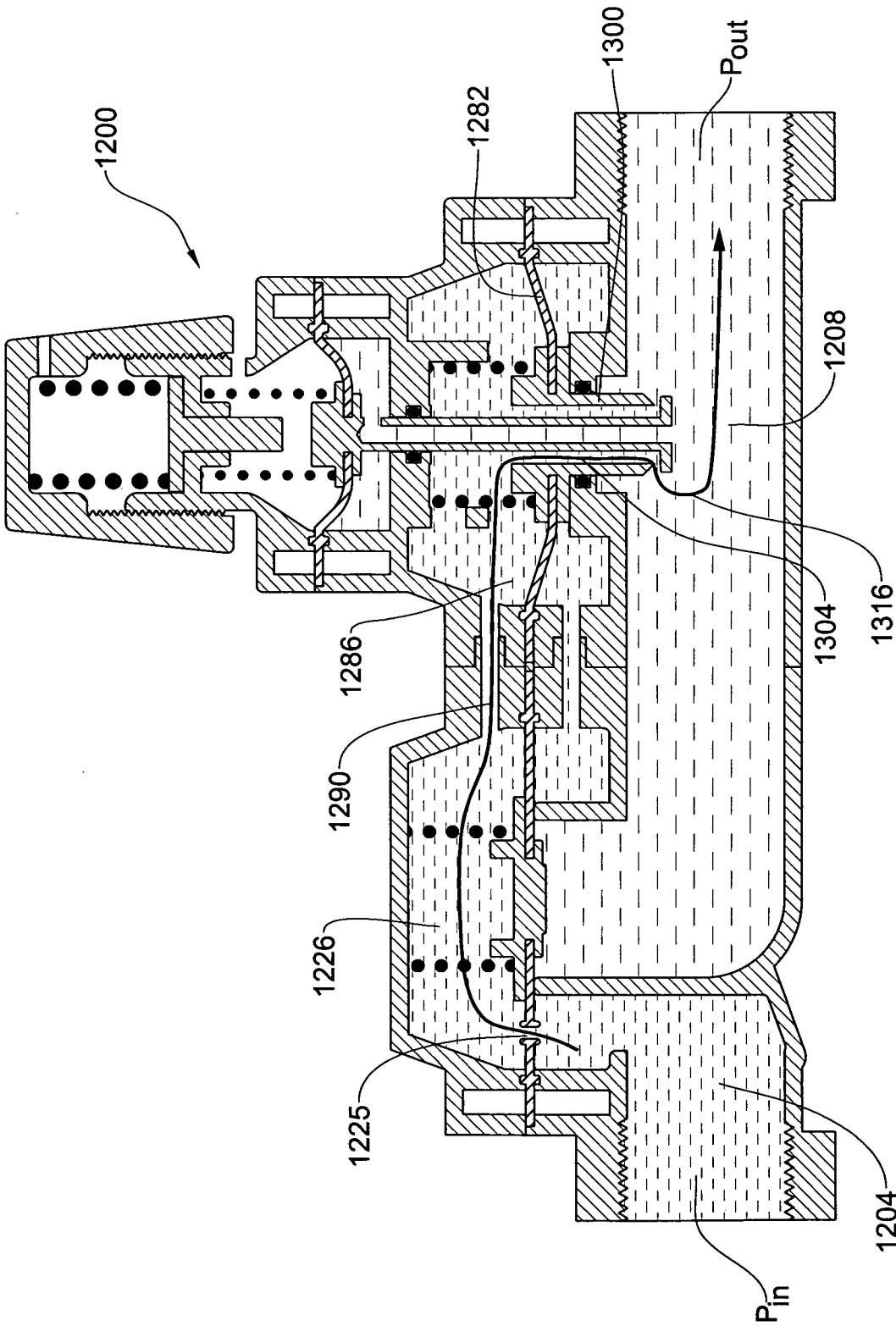


FIG. 13B

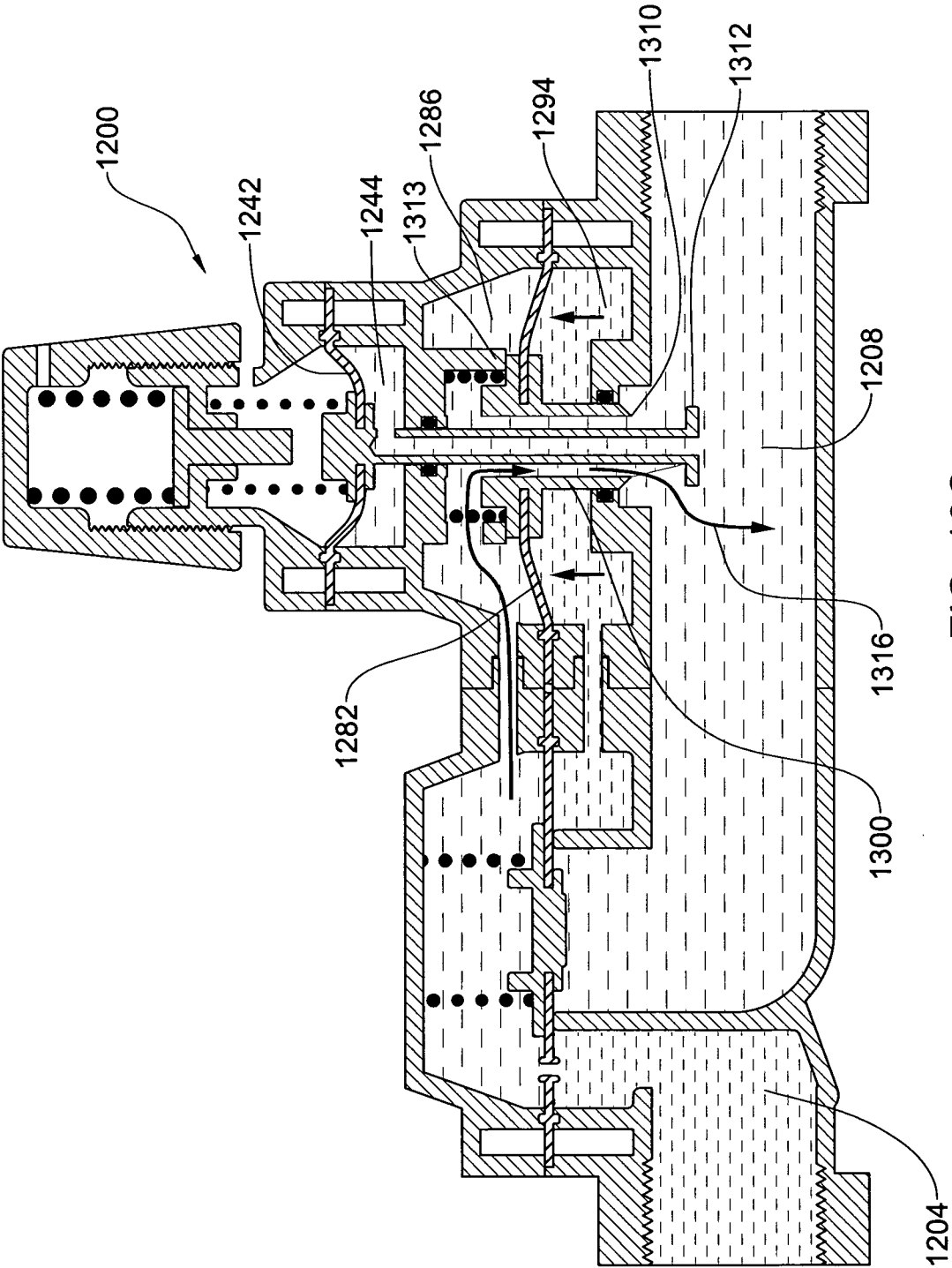


FIG. 13C

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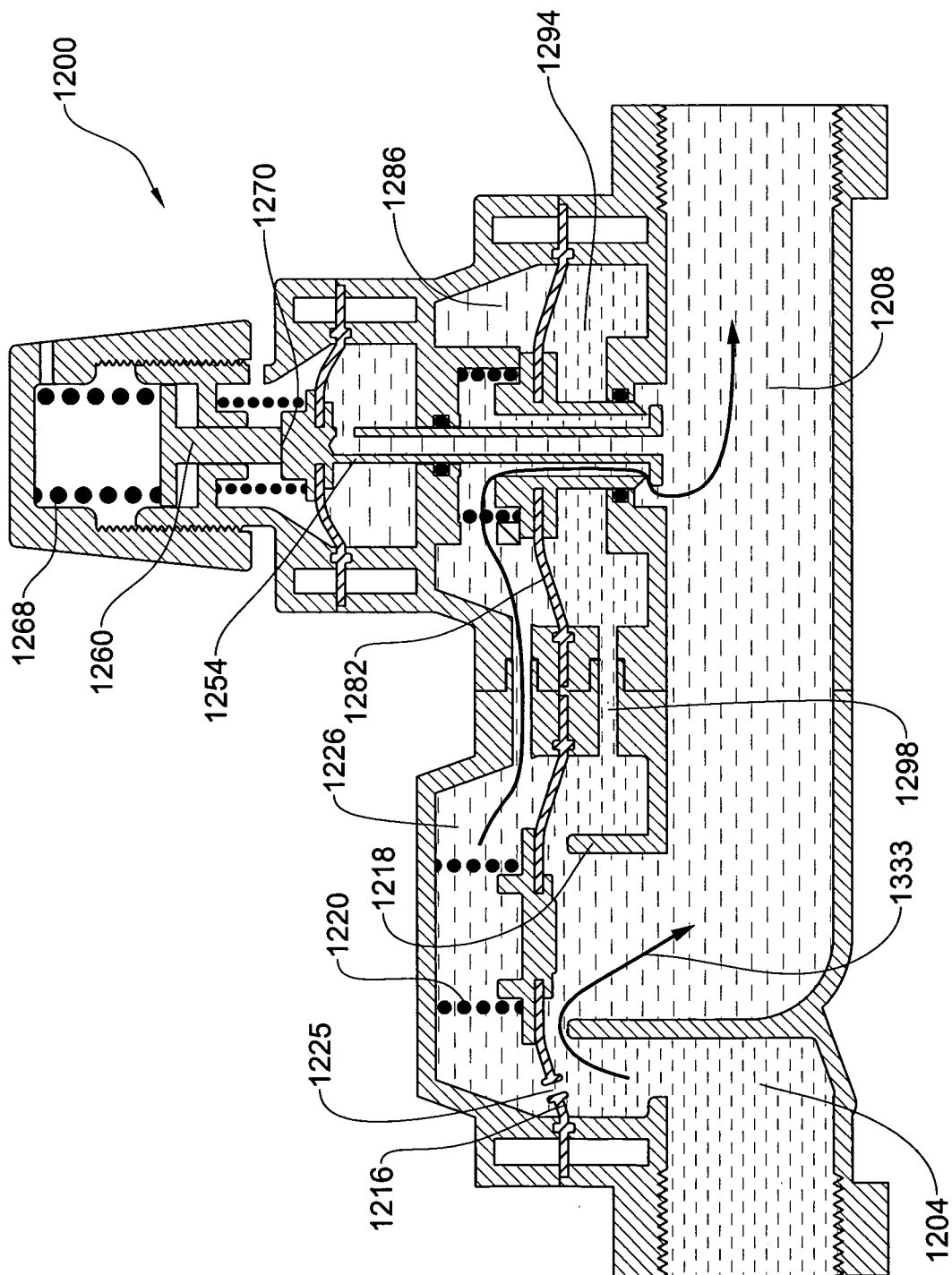


FIG. 13D

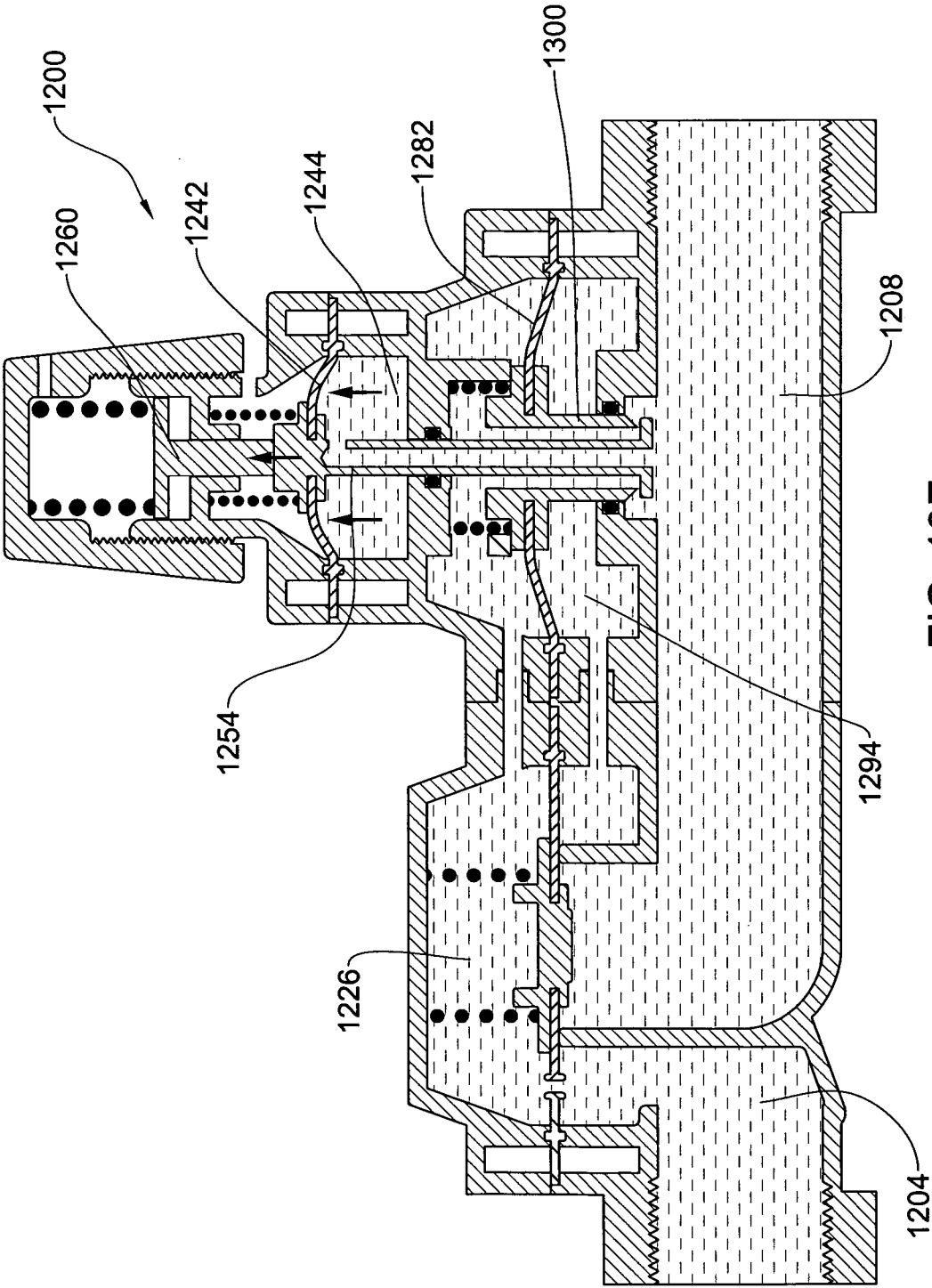


FIG. 13E

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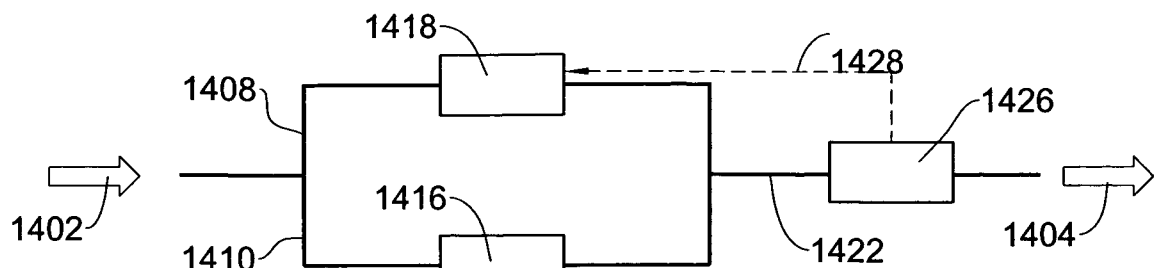


FIG. 14A

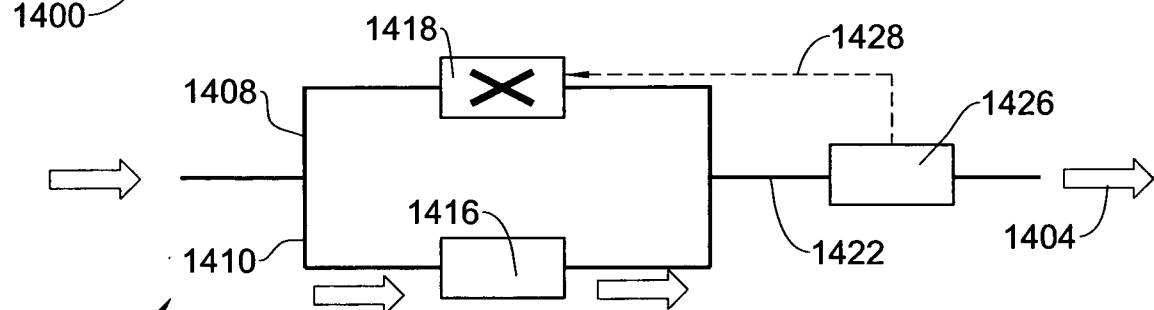


FIG. 14B

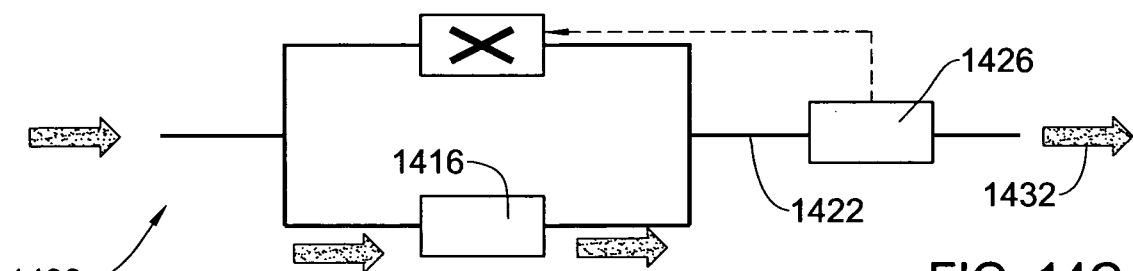


FIG. 14C

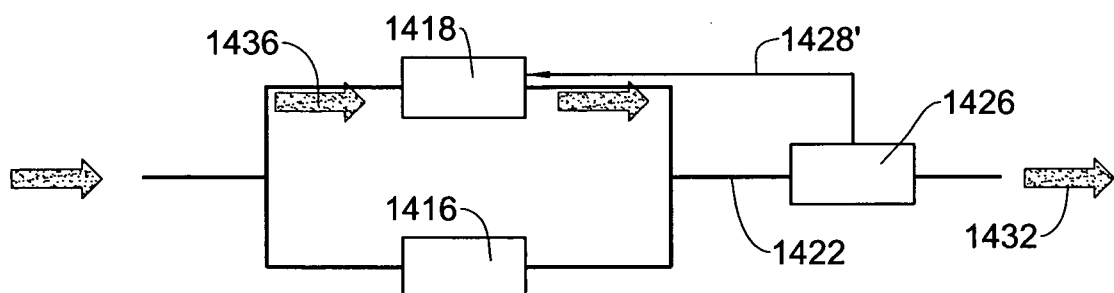


FIG. 14D

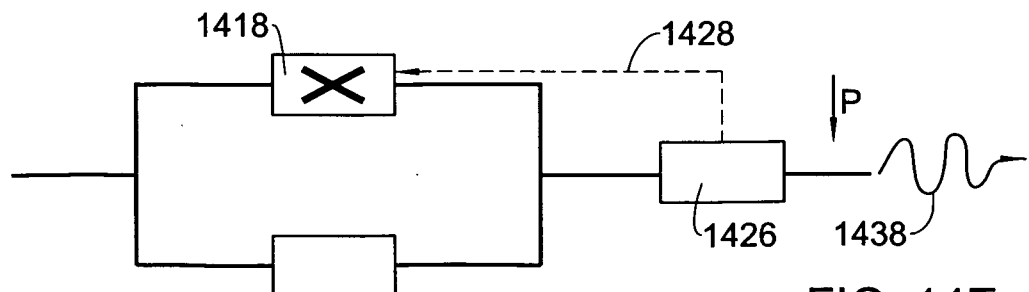


FIG. 14E