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(54) **INJECTION UNIT FOR A HYDRAULIC DIE-CASTING MACHINE, PROVIDED WITH A DEVICE FOR THE ELIMINATION OF PRESSURE PEAKS AT INJECTION**

GIESSEINHEIT FÜR HYDRAULISCHE DRUCKGIESSMASCHINE MIT EINER VORRICHTUNG FÜR ENTSTÖRUNG VON DRUCKSPITZEN WÄHREND DER GIESSUNG

ENSEMBLE D'INJECTION POUR MACHINE A COULER SOUS PRESSION HYDRAULIQUE, POURVU D'UN DISPOSITIF SERVANT A ELIMINER LES POINTES DE PRESSION A L'INJECTION

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GB-A- 2 050 889

- **MACHINERY AND PRODUCTION ENGINEERING vol. 122, no. 3153, April 25, 1973,**
- **BURGESS HILL pages 558 - 561; PF HARRISON: 'Die Casing: The Wotan Multiject injection system ' see column 2, line 27 - column 5, line 7**

EP 0 530 244 B1

Description

The present invention relates to an injection unit for a hydraulic die-casting machine, provided with a device for the elimination of pressure peaks at injection.

According to the known art such injection units comprise an injection cylinder, an injection piston slidably housed in the cylinder and valve means suitable for sequentially placing in communication with the cylinder first a fluid supply pump for a possible slow advancement stage of the injection piston and subsequently a fluid accumulator for a second fast advancement stage of the injection piston. Such units also comprise a pressure multiplier which has the function of subsequently raising the pressure of the fluid acting on the injection piston for a third short advancement stage at slow speed and high pressure. The latter stage allows the molten metal to reach and fill with adequate compactness the most distant and difficult interstices of the casting cavity.

DE-C-3 123 498 discloses an injection unit of this kind, further including an auxiliary cylinder/piston unit associated to the injection cylinder to dampen the pressure peaks caused by the pressure multiplier.

Such known art has the drawback that at the end of the fast advancement stage of the piston the latter is left facing a mass of molten metal which completely fills the front chamber of the injection bush and thus determines a sharp impact of the piston itself with a consequent pressure peak which at one and the same time is inevitable and uncontrollable.

The object of the present invention is to overcome this drawback by accomplishing an injection unit in which such pressure peak is eliminated.

According to the invention such object is attained with an injection unit for a hydraulic die-casting machine, comprising an injection cylinder, a hydraulically-operated injection piston, a fluid accumulator for the operation at high speed of the injection piston during the injection stroke, a pressure multiplier for the operation at low speed and high pressure of the piston at the end of the injection stroke of the piston and an auxiliary cylinder/piston unit, characterized in that said auxiliary unit is interposed between the injection piston and the accumulator to allow the advancement of the auxiliary piston under the action of the accumulator and the advancement of said injection piston in accordance with that of said auxiliary piston, the cross-section of said auxiliary cylinder being larger than the cross-section of said injection cylinder.

In such a way the difference between the cross-sections of the injection piston and of the auxiliary piston is such that the auxiliary piston moves at a speed that is lower than that of the injection piston and reaches the end of the stroke in a controlled manner so as to avoid the creation of pressure peaks on the injected metal.

The features of the present invention shall be made more evident by two embodiments illustrated as a non-limiting example in the enclosed drawings, wherein:

Fig. 1 illustrates the unit at rest in one embodiment;

Fig. 2 illustrates the unit during the injection stage;

Fig. 3 illustrates the unit during the pressure multiplication stage;

Fig. 4 illustrates the unit during the return stage from the injection;

Fig.s 5 - 8 illustrate another embodiment according to the invention in the sale operating stages of Fig.s 1 - 4.

With reference to Fig.s 1 - 4, the injection unit comprises a high-speed accumulator 1 consisting of a cylindrical chamber 14 in which a piston 15 slides. The upper part of the cylindrical chamber 14 is filled with nitrogen 2 under pressure from a cylinder 19, while the lower part is filled with fluid 30 which, pushed by the piston 15, through a connecting conduit 5, under the action of valve means constituted by a valve shell 31 and by a variable-action breech 32, causes the advancement of a piston 7 of an auxiliary cylinder/piston unit 6, 7 provided with a linear speed transducer 71. The cylindrical chamber 6 is filled in the front with fluid 40 which, pushed in a conduit 8 provided with a unidirectional valve 60 by the movement of the piston 7, causes the advancement of an injection piston 10 into a corresponding injection cylinder 9 provided with a rapid discharge valve 65 (of a type known in itself).

With the injection cylinder/piston unit 9, 10, provided with an injection stem 42, there is connected through a line 11, provided with a unidirectional valve 61, a pressure multiplier 12. The latter comprises an accumulator 13 consisting of a cylinder/piston 16, 17. The upper part of the cylindrical chamber 16 is filled with nitrogen under pressure 18 which causes the sliding action of the piston 17, while the lower part of the chamber 16 is filled with fluid 50 which, pushed by the piston 17, through the line 51 under the action of valve means constituted by a valve shell 20 and a variable-action breech 21, causes the advancement of a cylinder/piston pair 53, 52 which in turn with fluid 54 causes the sliding action of the injection piston 10 in the corresponding cylinder 9.

As shown in succession in Fig.s 1 - 4, starting from the situation illustrated in Fig. 1, wherein the pistons 15, 17, 7, 52, 10 are in their at rest positions in the corresponding cylinders 14, 16, 6, 53, 9, the opening of the breech 32 starts the injection stage, illustrated in Fig. 2, during which the piston 15, moved towards the lower part of the corresponding chamber 14 by the nitrogen under pressure 2, pushes the fluid 30 present in the lower part of the chamber 14, through the line 5 provided with valve means 32, 31, into the auxiliary cylinder 6 to cause the advancement of the auxiliary piston 7. During its motion the piston 7 pushes the fluid 40 through the line 8 into the injection cylinder 9, thus causing the rapid advancement of the injection piston 10, while, in the meantime, the discharge valve 65 has opened. During this stage the molten mass present in the injection cylinder 9 is compressed by the stem 42 in the proximity of the injection mouth (not shown). The larger diameter of the auxiliary

cylinder 6 with respect to the injection cylinder 9 causes the speed of the auxiliary piston 7 during its stroke to be lower than that of the injection piston 10 and thus easily controllable.

As illustrated in Fig. 3, at the end of this stage the auxiliary piston 7 reaches the end of its stroke in the cylinder 6 with a controlled speed. At this point the injection piston 10, no longer supplied through the stroke of the auxiliary piston 7, reduces its speed to the mere inertia determined by its mass.

In this way, while the auxiliary piston 7 reaches the end of its stroke with a limited speed, there is at the same time avoided a sharp blow of the injection piston 10 on the molten mass with the consequent elimination of undesired pressure peaks.

Another advantage that is not negligible is that the discharge of the accumulator 1 acts on a peripheral circular crown 70 of the auxiliary piston 7 so that the variation in pressure of the accumulator 13 is appreciably reduced and an energy saving is accomplished due to the lower recharge required. The lower speed of the piston 7 of the accumulator 13 also reduces the risk of seizure and of wear of the gaskets in the accumulator 13.

The action of the pressure multiplier 12 then follows in a controlled manner. As illustrated in Fig. 3, in this stage the piston 17, pushed by the nitrogen under pressure 18 present in the upper part of the cylinder 16, starts its stroke and pushes the fluid 50 into the line 51 under the action of the valve means 20, 21 and, through the cylinder/piston pair 53, 52 and the corresponding control fluid 54, causing the sliding action with the multiplication of the pressure of the injection piston 10 in the corresponding cylinder 9.

It should be noted that, given the reduced speed of the piston 7 at the end of the previous stage, the increase in pressure that occurs during this stage does not create undesired pressure peaks on the injection piston 10 and thus on the molten mass to be injected.

With reference to Fig. 4, at the end of this stage there is the restoration of the initial conditions for the pistons 15, 7, 10, 52, 17 in the respective cylinders 14, 6, 9, 53, 16.

There is shown in Fig.s 5 - 8 a similar injection unit which differs from that just described in that the auxiliary piston 7 also operates in the ambit of the pressure multiplier 12.

More precisely, the piston 7 has a part with a smaller diameter which co-operates with the cylinder 6 supplied with fluid 30 from the accumulator 1 through a unidirectional valve 85 and communicating with the injection cylinder 9 through a valve 87 with a floating breech 88 and a part with a larger diameter which co-operates with a cylinder 86 supplied with fluid 50 from the accumulator 13 through the valve 20 with controlled breech 21 and communicating with the injection cylinder 9 through the unidirectional valve 61.

For the completeness of the drawings Fig.s 5 - 8 also show two unidirectional valves 91 and 92 destined to the supply of fluid under pressure for recharging the accumulators 1 and 13 and a valve 93 with a floating breech 94 for discharging the fluid sent back by the injection piston 10 during the stages when it returns to the at rest position.

During operations, starting from the at rest position of Fig. 5, the movement of opening of the breech 32 causes the supply of fluid 30 through the unidirectional valve 85 into the cylinder 6, where the piston 7 is thus caused to move forward so that, in turn, through the unidirectional valve 61, it causes the advancement of the injection piston 10 inside the injection cylinder 9 (with the valve 65 open) for the stage of injection of the metal into the casting cavity (Fig. 6).

Almost at the end of the injection stroke of the piston 10 the breech 21 is caused to open, allowing the transfer of high-pressure fluid from the accumulator 13 to the auxiliary cylinder 86, where the above fluid causes the auxiliary piston 7 to move backward and, due to the difference in area, the consequent creation of a multiplied pressure in the cylinder 6, which opens the valve 87 and goes to supply the injection piston 10 (Fig. 7). This creates the pressure multiplier effect on the molten metal pushed by the piston stem 42.

When the casting has been executed, the valves 31, 32 and 21, 10 close again and thanks to the valve 65 the injection piston 10 is caused to return, thus discharging fluid through the valve 93 (Fig. 8).

Claims

1. Injection unit for a hydraulic die-casting machine, comprising an injection cylinder (9), a hydraulically-operated injection piston (10), a fluid accumulator (1) for the operation at high speed of the injection piston (10) during the injection stroke, a pressure multiplier (12) for the operation at low speed and high pressure of the piston (10) at the end of the injection stroke of the piston (10) and an auxiliary cylinder/piston unit (6, 7), characterized in that said auxiliary unit (6, 7) is interposed between the injection piston (10) and the accumulator (1) to allow the advancement of the auxiliary piston (7) of said auxiliary unit under the action of the accumulator (1) and the advancement of said injection piston (10) in accordance with that of said auxiliary piston (7), the cross-section of said auxiliary cylinder (6) being larger than the cross-section of said injection cylinder (9).

2. Injection unit according to claim 1, characterised in that between said accumulator (1) and said auxiliary cylinder/piston unit (6, 7) there are interposed valve means (31, 32) which can be controlled so as to regulate the flow of fluid (30) for controlling said piston (7).

3. Injection unit according to claim 2, characterised in that said auxiliary piston (7) is conformed so as to be supplied with fluid (30) from said accumulator (1)

at one of its faces having a smaller diameter, while one of its opposite faces of larger diameter is in fluid communication with said injection piston (10).

4. Injection unit according to claim 2, characterised in that said auxiliary piston (7) also operates as a pressure multiplier (12) together with an accumulator (13) with which one of its faces of larger cross-section can be put into fluid communication, while another of its faces having a smaller cross-section can be put into fluid communication with said accumulator (1) mentioned first through said valve means (31, 32) and with said injection piston (10) through further valve means (87) sensitive to pressure.

Patentansprüche

1. Spritzeinheit für eine hydraulische Spritzgußmaschine, welche einen Spritzzylinder (9), einen hydraulisch betriebenen Spritzkolben (10), einen Fluidsammler (1) zum Betrieb des Spritzkolbens (10) mit hoher Geschwindigkeit während des Spritzhubs, einen Druckvervielfacher (12) zum Betreiben des Kolbens (10) mit einer niedrigen Geschwindigkeit und einem hohen Druck am Ende des Spritzhubs des Kolbens (10) und eine Hilfszylinder/Kolben-Einheit (6, 7) aufweist, **dadurch gekennzeichnet**, daß die Hilfseinheit (6, 7) zwischen dem Spritzkolben (10) und dem Sammler (1) angeordnet ist, um eine Vorlaufbewegung des Hilfskolbens (7) der Hilfseinheit unter der Wirkung des Sammlers (1) und eine Vorlaufbewegung des Spritzkolbens (10) nach Maßgabe der Vorlaufbewegung des Hilfskolbens (7) zu ermöglichen, und daß der Querschnitt des Hilfszylinders (6) größer als der Querschnitt des Spritzzylinders (9) ist.

2. Spritzeinheit nach Anspruch 1, **dadurch gekennzeichnet**, daß zwischen dem Sammler (1) und der Hilfszylinder/Kolben-Einheit (6, 7) Ventileinrichtungen (31, 32) angeordnet sind, welche derart steuerbar sind, daß der Strom des Fluids (30) zur Steuerung des Kolbens (7) regulierbar ist.

3. Spritzeinheit nach Anspruch 2, **dadurch gekennzeichnet**, daß der Hilfskolben (7) derart angepaßt ist, daß er mit Fluid (30) von dem Sammler (1) an einer der Flächen mit einem kleineren Durchmesser beaufschlagbar ist, während eine der gegenüberliegenden Flächen mit größerem Durchmesser in Fluidverbindung mit dem Spritzkolben (10) steht.

4. Spritzeinheit nach Anspruch 2, **dadurch gekennzeichnet**, daß der Hilfskolben (7) auch als ein Druckvervielfacher (12) zusammen mit einem Sammler (13) arbeitet, dessen eine Fläche mit größerem Querschnitt in Fluidverbindung stehen kann, während die andere Fläche mit kleinerem Querschnitt in Fluidverbindung mit dem erstgenannten Sammler (1) über die Ventileinrichtungen (31, 32) und mit dem Spritzkolben (10) über eine weitere Ventileinrichtung (87) stehen kann, welche auf Druck anspricht.

Revendications

1. Ensemble d'injection pour machine à couler sous pression hydraulique, comprenant un vérin d'injection (9), un piston d'injection (10) à fonctionnement hydraulique, un accumulateur de fluide (1) pour le fonctionnement à grande vitesse du piston d'injection (10) pendant la course d'injection, un multiplicateur de pression (12) pour le fonctionnement à basse vitesse et haute pression du piston (10) à la fin de la course d'injection du piston (10), et un ensemble vérin/piston (6, 7), caractérisé en ce que ledit ensemble auxiliaire (6, 7) est interposé entra la piston d'injection (10) et l'accumulateur (1) pour permettre l'avancement du piston auxiliaire (7) dudit ensemble auxiliaire sous l'action de l'accumulateur (1) et l'avancement dudit piston d'injection (10) d'après celui dudit piston auxiliaire (7), la section transversale dudit vérin auxiliaire (6) étant plus grande que la section transversale dudit vérin d'injection (9).

2. Ensemble d'injection suivant la revendication 1, caractérisé en ce qu'entre ledit accumulateur (1) et ledit ensemble auxiliaire de vérin/piston (6, 7), est interposé un élément soupape (31, 32) qui peut être commandé de façon à réguler le débit de fluide (30) servant à commander ledit piston (7).

3. Ensemble d'injection suivant la revendication 2, caractérisé en ce que ledit piston auxiliaire (7) a une forme telle qu'il reçoit le fluide (30) dudit accumulateur (1) sur une de ses faces ayant un plus petit diamètre alors qu'une de ses faces opposée de plus grand diamètre communique par fluide avec ledit piston d'injection (10).

4. Ensemble d'injection suivant la revendication 2, caractérisé en ce que ledit piston auxiliaire (7) fonctionne aussi comme multiplicateur de pression (12) avec un accumulateur (13) avec lequel une de ses faces ayant une plus grande section transversale peut être mise en communication par fluide tandis qu'une autre de ses faces qui a un plus petit diamètre peut être mise en communication par fluide avec ledit accumulateur (1), qui a été mentionné en premier, par ledit élément soupape (31, 32), et avec ledit piston d'injection (10) par un autre élément soupape (87) sensible à la pression.

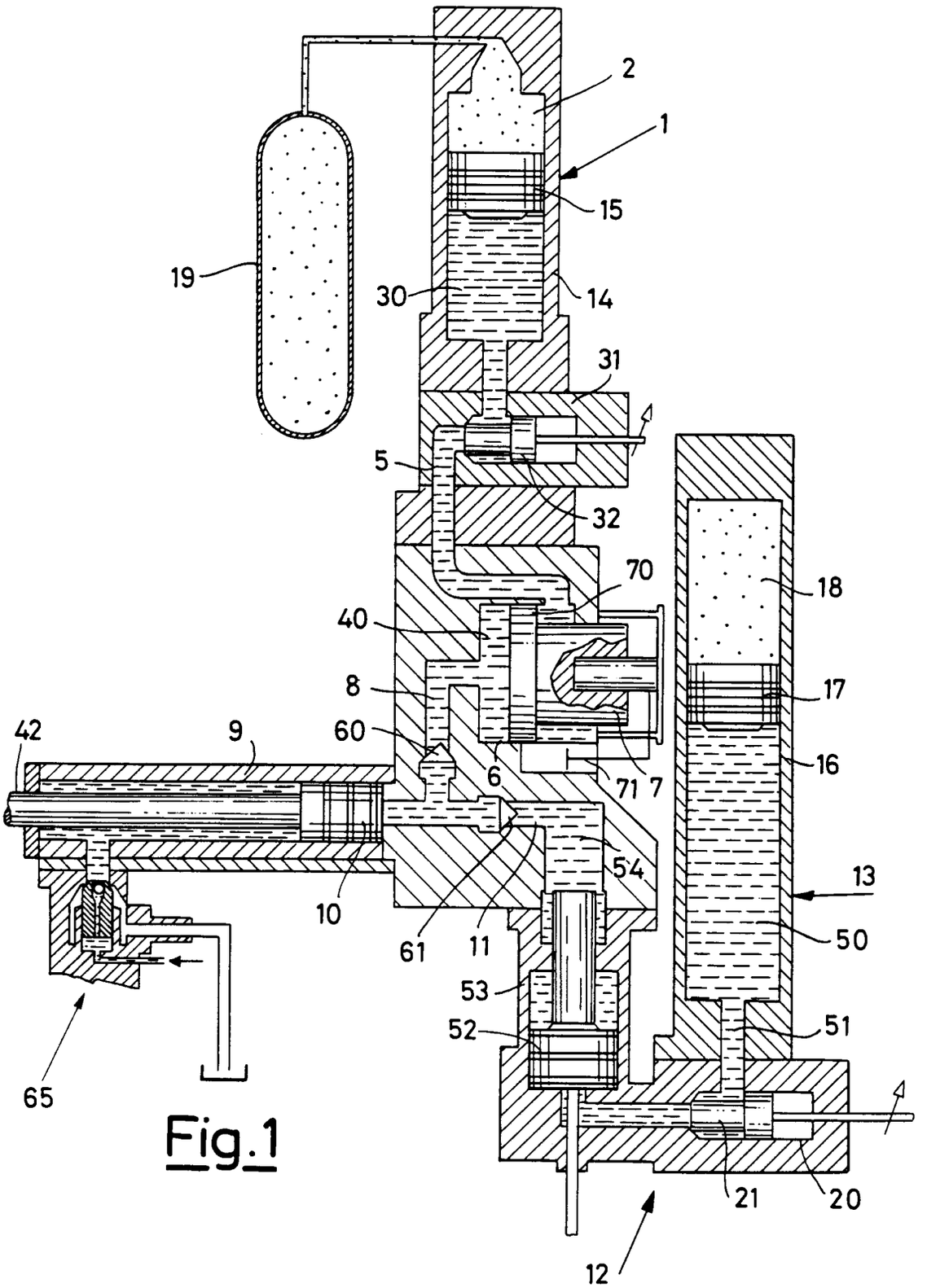
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Fig.1

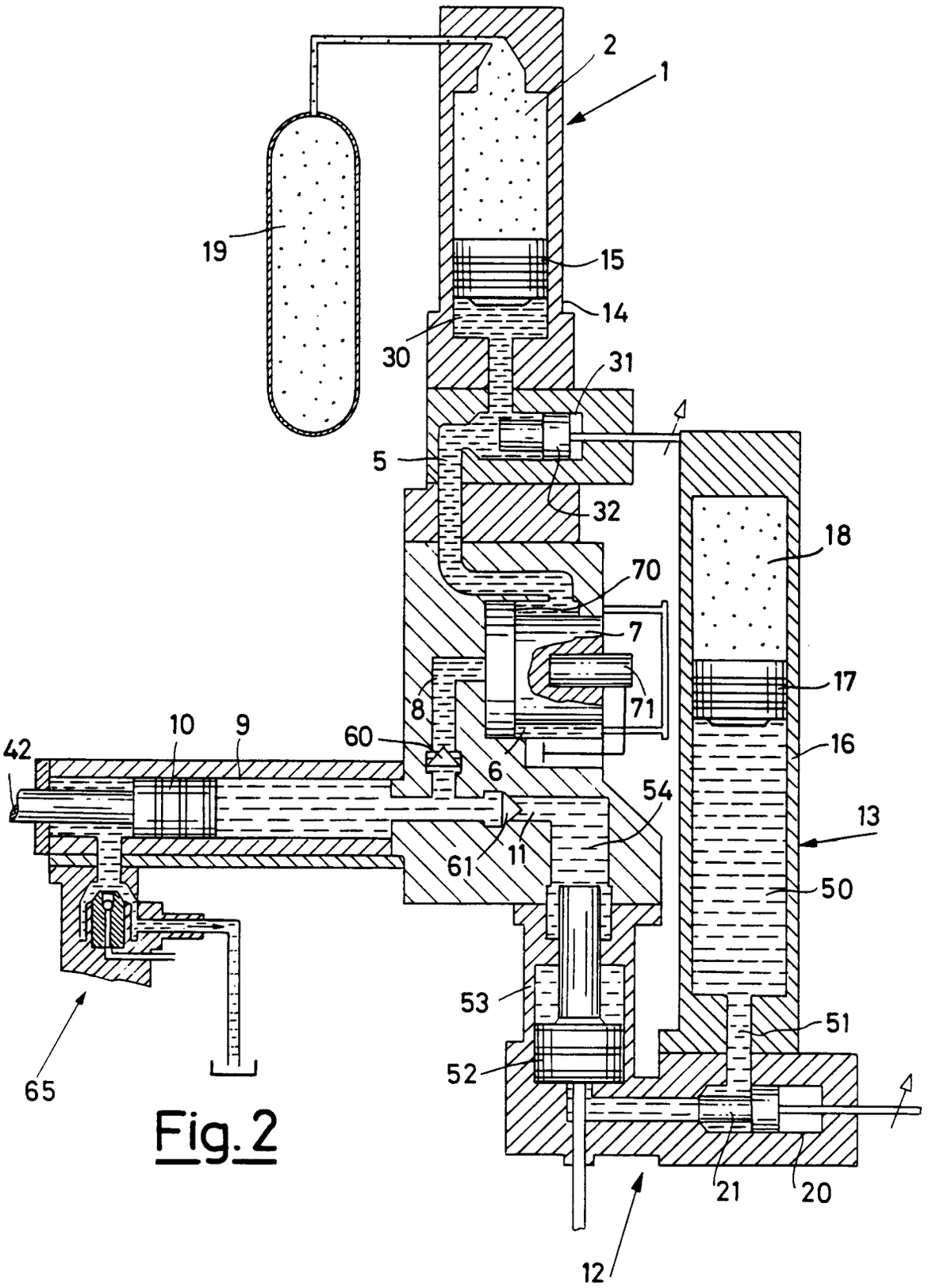
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Fig. 2

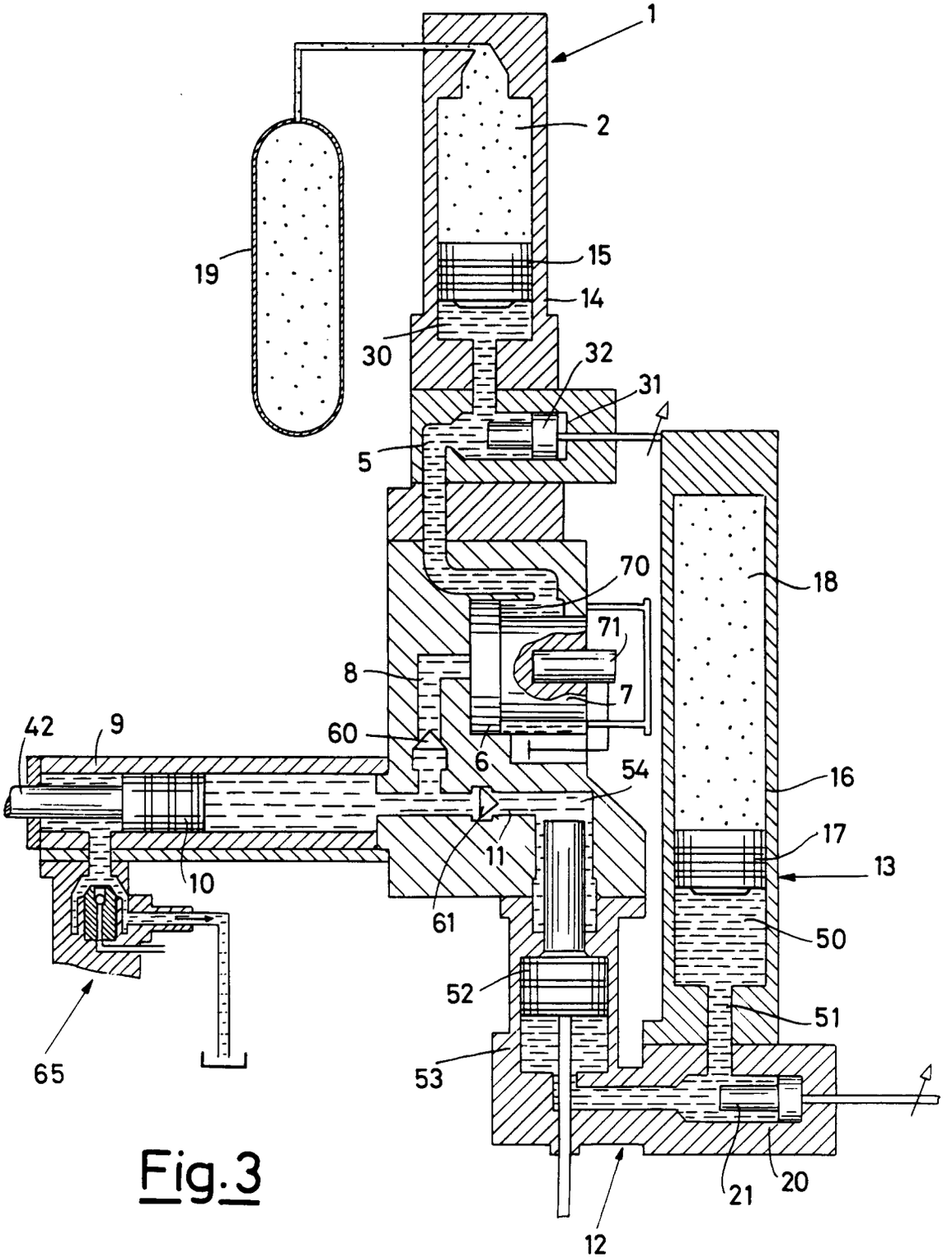
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Fig.3

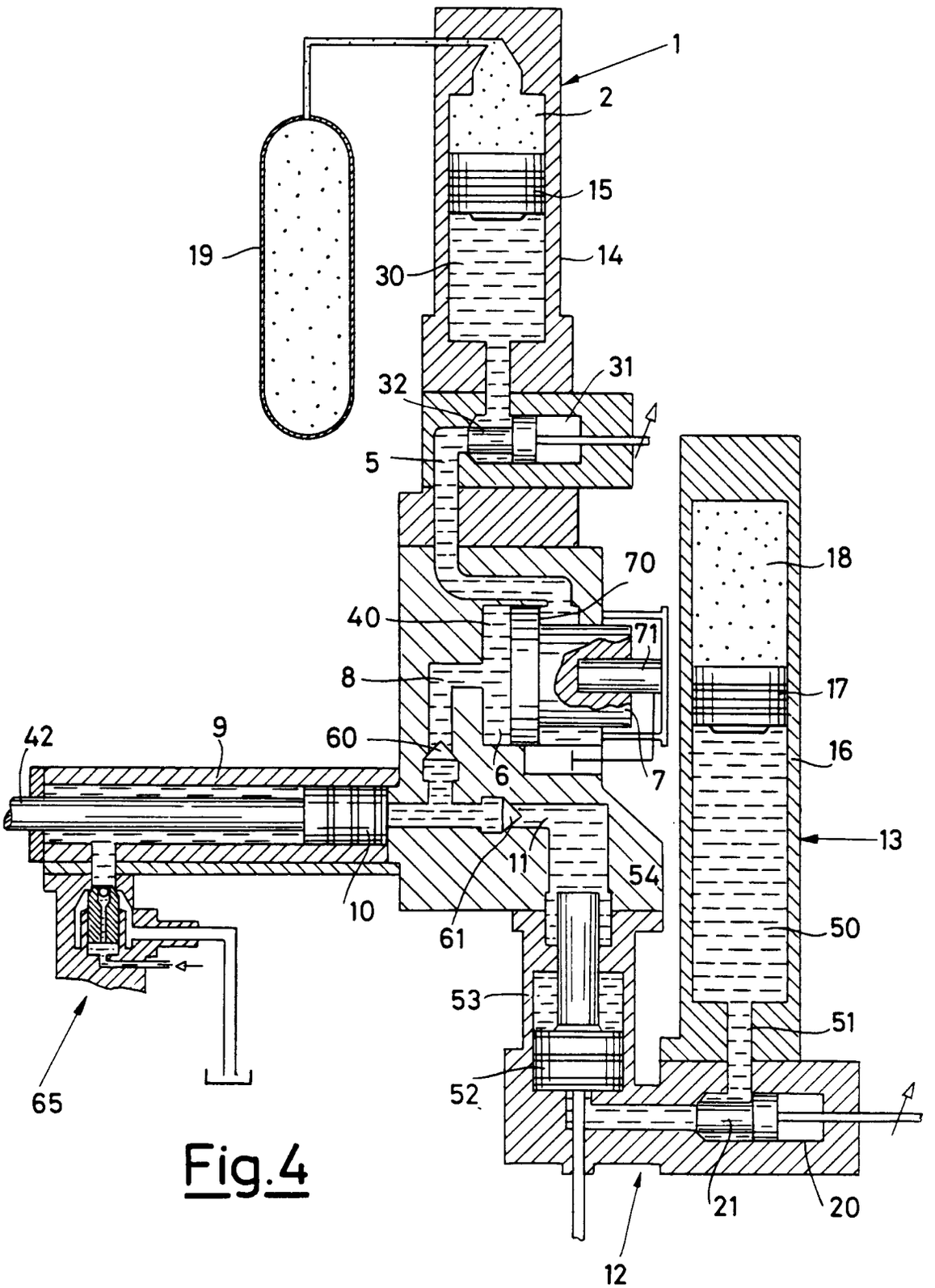
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Fig.4

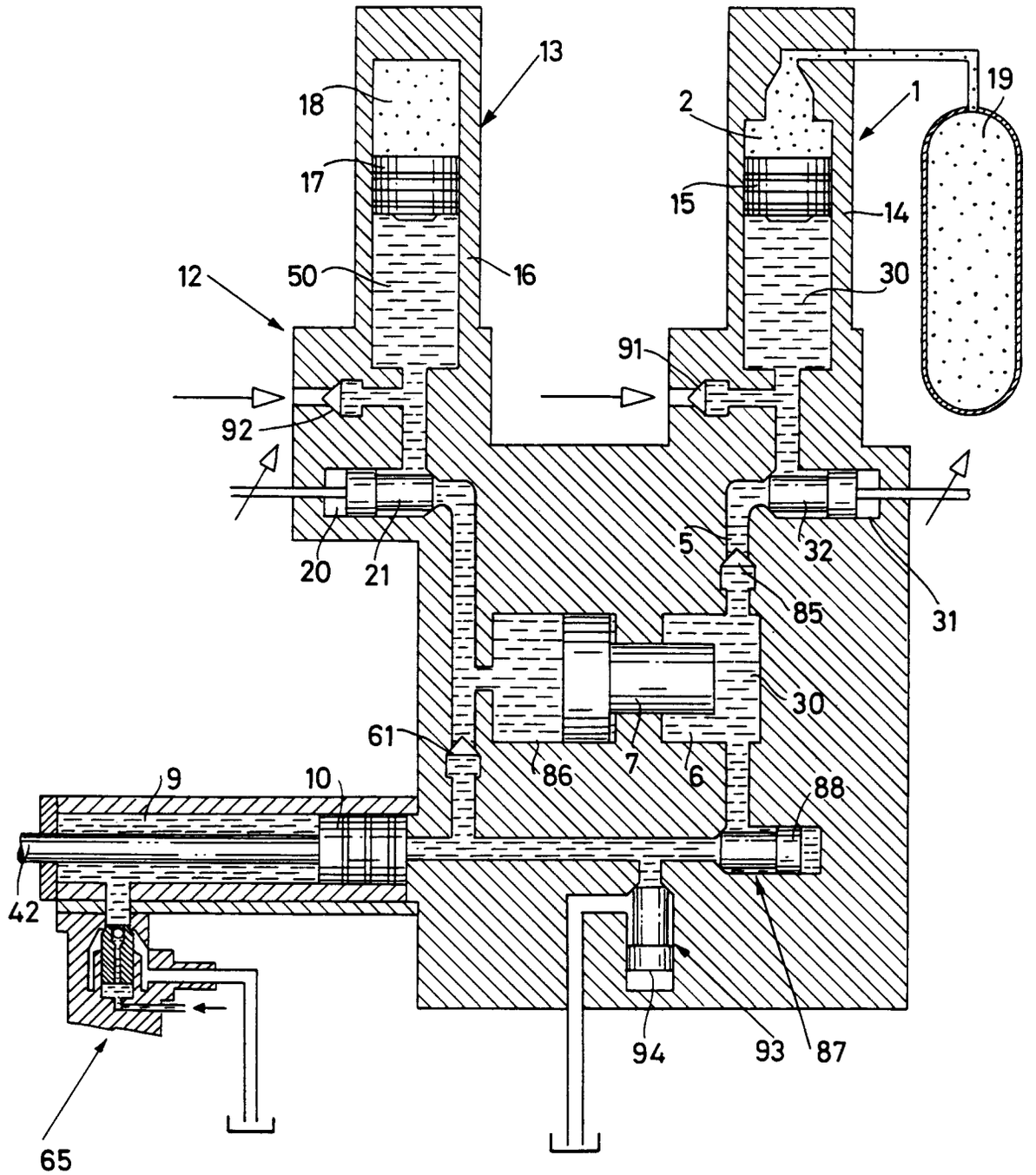
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Fig. 5

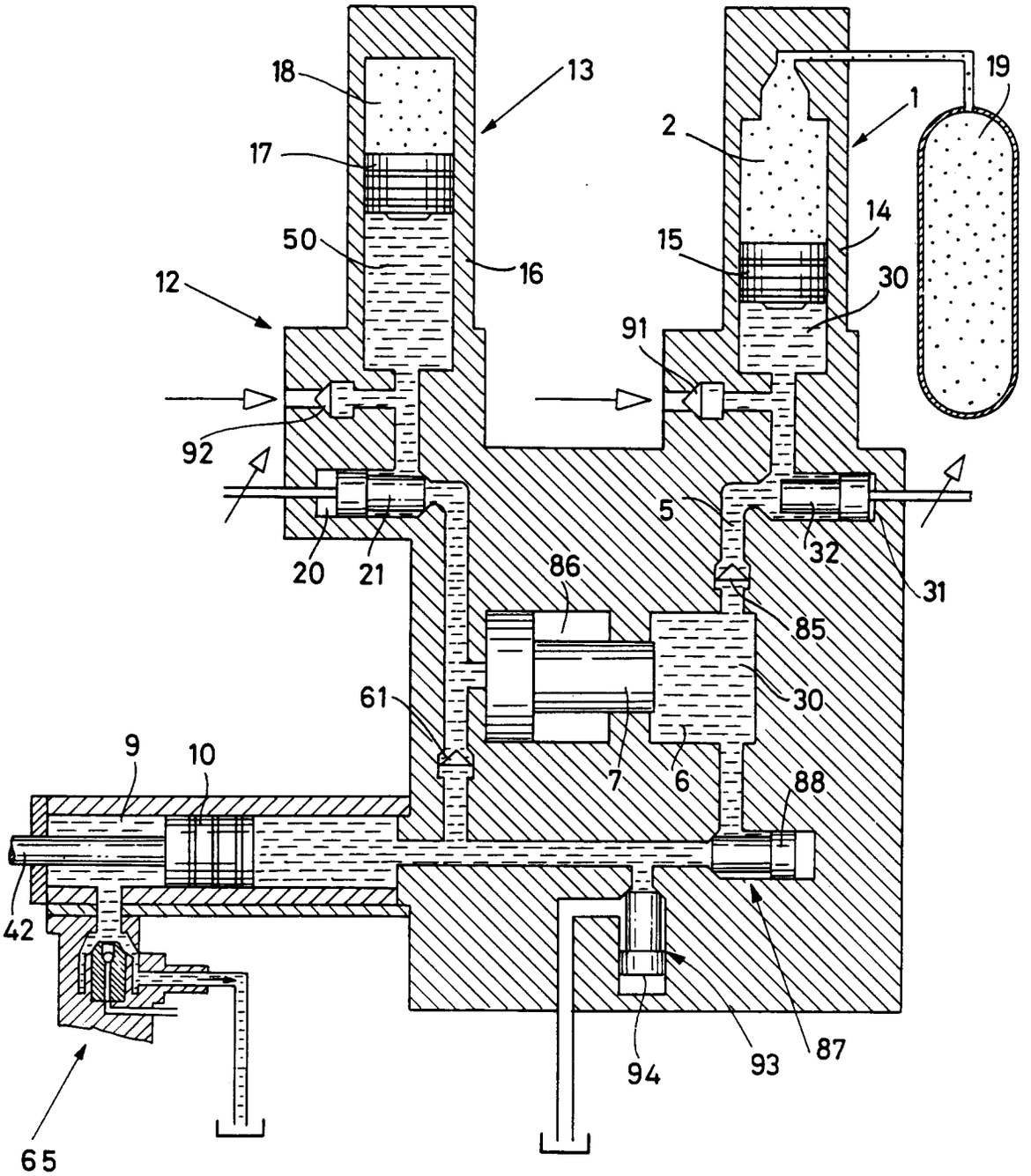
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Fig.6

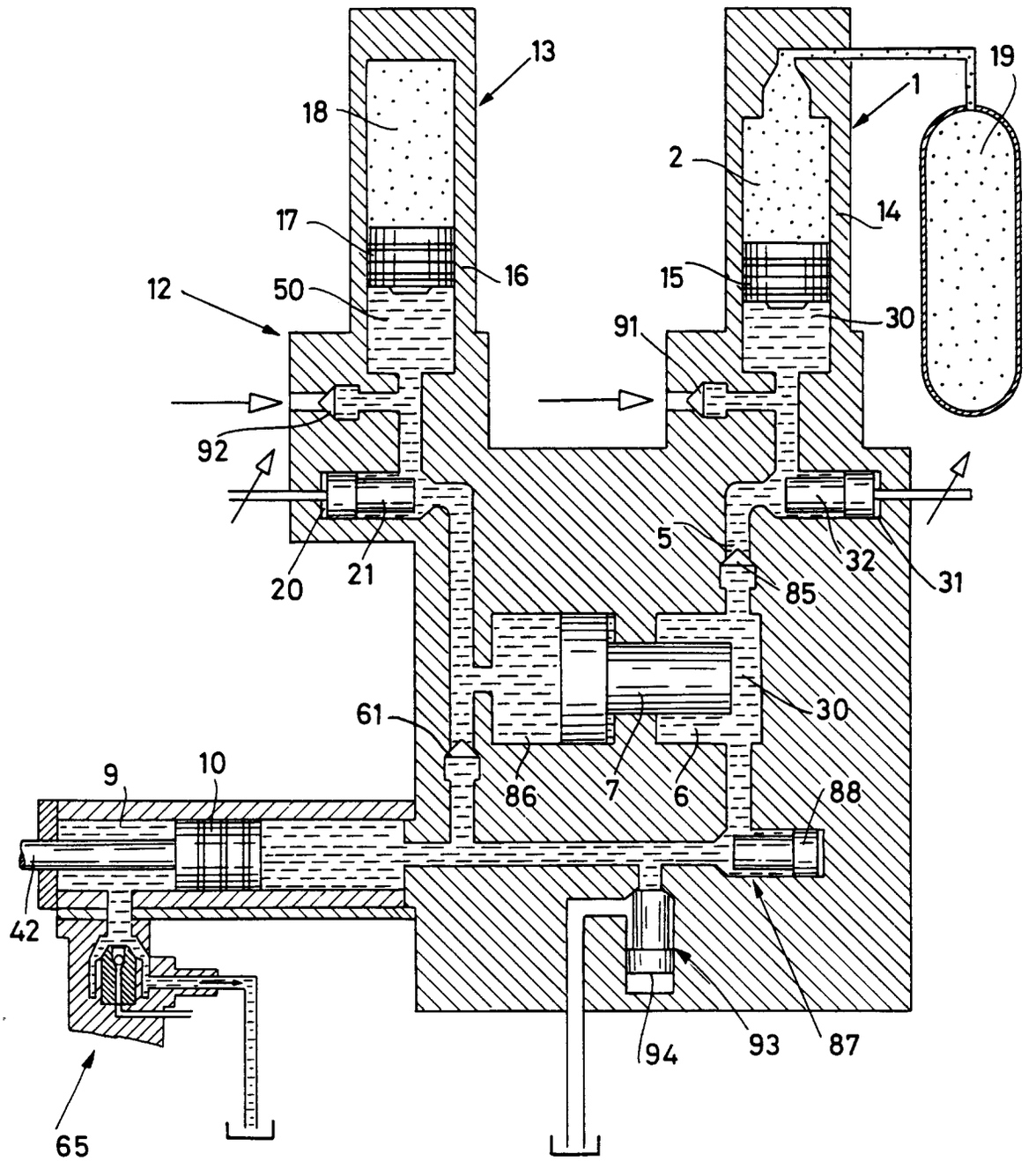
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Fig.7

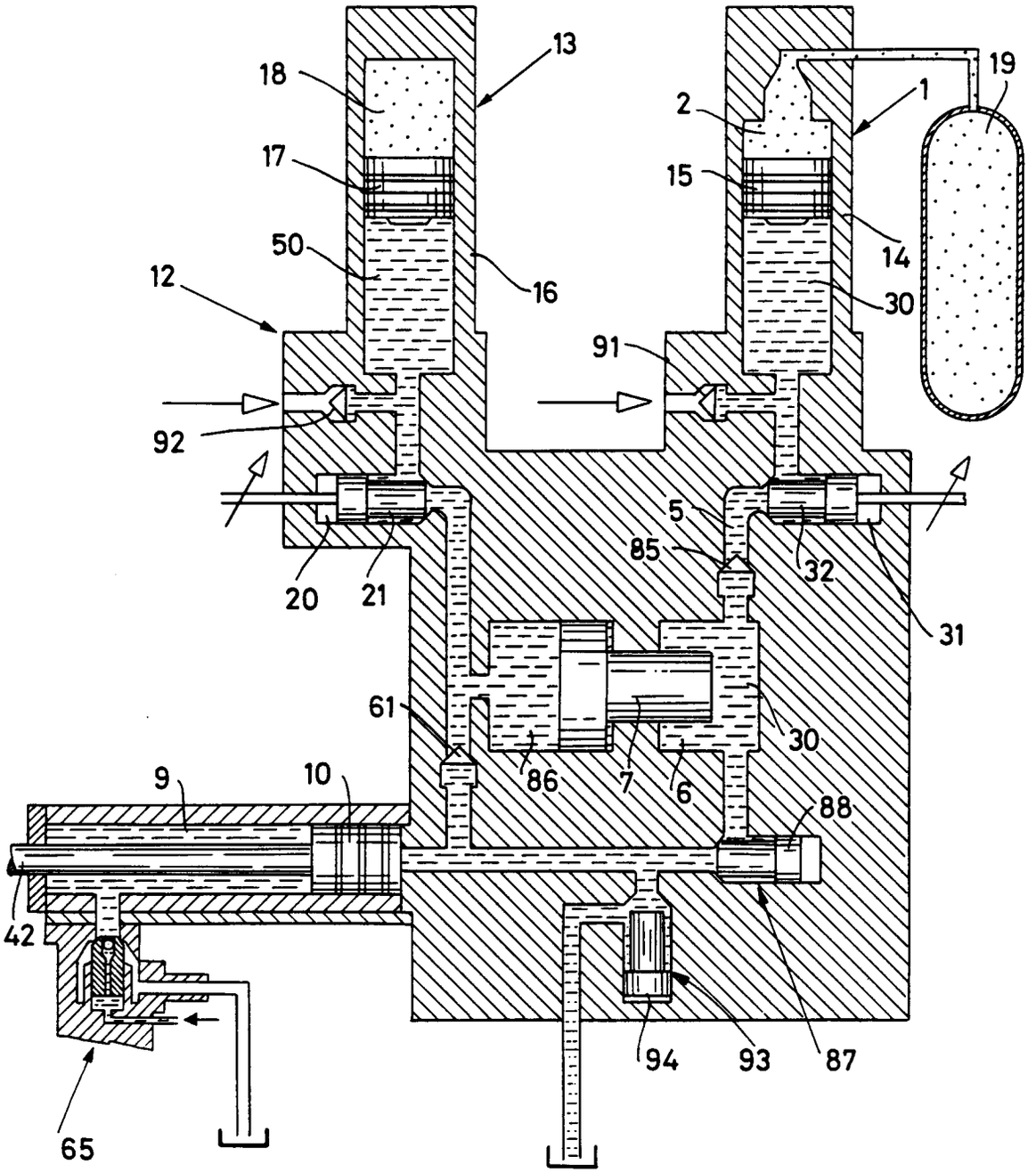
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Fig.8