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(54) Gas boiler with means for accumulating and maintaining hot water for domestic use

(57) A boiler for producing hot water for heating and for domestic use, of the type comprising a first hydraulic circuit (1) for heating the water destined for a heating system, said first circuit comprising means (2) for the forced circulation of the water through said first circuit, first means (3, 16) for generating heat and transferring it to the water, valve means (4) for conveying the heated water to a delivery pipe (7) or to second heat exchanger means (25) arranged to transfer at least part of the heat of the heated water to the water for domestic use circulating through a second hydraulic circuit (5), expansion means (17) for automatically adjusting the pressure of the water circulating through the primary circuit as its temperature varies, and means for accumulating and maintaining a predetermined quantity of heated water in the primary circuit within a predetermined temperature range, said accumulating and maintaining means being connected to the primary circuit in such a manner as to make available to the second heat exchanger means (25) said predetermined quantity of heated water at least during an initial stage in the heating of the water for domestic use circulating through the second circuit; wherein the expansion means (17) comprise means (20, 21, 23) for integrating into the expansion means said means for accumulating and maintaining the heated water.

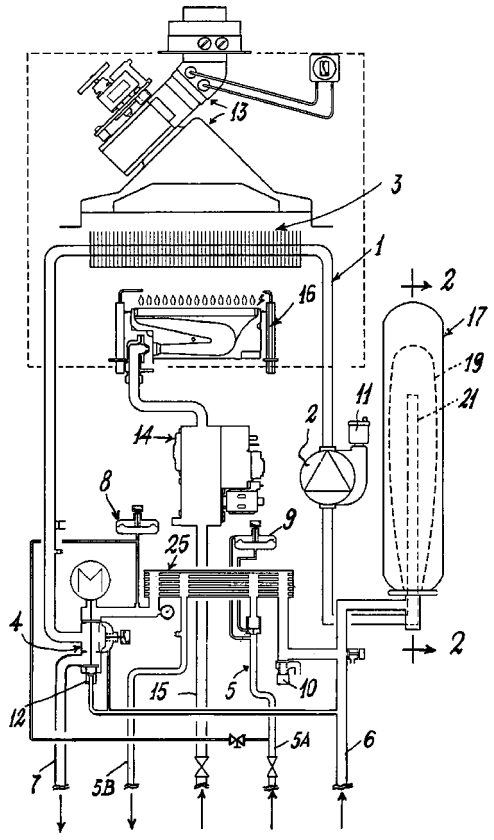

Fig. 1

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Description

[0001] This invention relates to a boiler for hot water production in accordance with the pre-characterising part of the main claim.

[0002] Gas boilers of the aforesaid type have been known for some time. One of the main drawbacks of these boilers is related to the fact that they are unable to immediately provide hot water for domestic use.

[0003] In this respect, when the user requires hot water to circulate through the secondary hydraulic circuit of the boiler, ie through the circuit for water for domestic use, the boiler has first to heat the water present in the primary circuit (ie in the circuit for supplying heating water), so that the water heated in this manner heats water for domestic use on passing through the second boiler heat exchanger, which is generally a plate heat exchanger.

[0004] In known boilers at least one minute is generally required to obtain water at about 50-60°C at the exit of the boiler domestic circuit from water entering at about 10-15°C.

[0005] It should also be noted that in known boilers the immediate unavailability of hot water for domestic use also negatively affects the water consumption of the domestic plant. In this respect, with known boilers water must be allowed to flow from a tap of the plant until it has reached the required temperature.

[0006] Moreover known boilers generally do not ensure stable delivery of hot water for domestic use.

[0007] To obviate this drawback it has up to now been considered to add to traditional boilers small vessels (for example with a capacity of 3-6 litres) in which to accumulate hot water to be used in the initial heating stage of the water for domestic use. However this type of boiler is generally too bulky (and/or complex), as an additional vessel has to be provided compared with traditional boilers. Moreover these accumulation boilers require not only the vessel but other additional components, for example members for heating the water present in the vessel, which complicate their overall structure in addition to increasing the boiler assembly time and construction cost.

[0008] A object of this invention is to provide a boiler for producing hot water for domestic use and for heating, which ensures immediate availability and stable delivery of hot water for domestic use, without the need to provide bulky additional components and/or components involving additional heating elements.

[0009] A further object is to provide a boiler with a time and cost of assembly comparable to those of traditional boilers and which does not require additional maintenance.

[0010] These and other objects which will be apparent to an expert of the are attained by a boiler in accordance with the characterising part of the main claim.

[0011] The invention will be more apparent from the accompanying drawing, which is provided by way of non-limiting example and on which:

Figure 1 is a frontal schematic view of the components of a boiler according to the invention;
Figure 2 is a schematic section taken on the line 2/2 of Figure 1;
Figure 3 is a view similar to Figure 1, but of a variant of the invention;
Figure 4 is a partly sectional side view of a part of the boiler of Figure 3; and
Figure 5 is an enlarged view in the direction of the arrow A of Figure 4.

[0012] With reference to Figures 1 and 2, a boiler of the invention comprises a first hydraulic circuit 1, or primary circuit, containing a pump 2, a first heat exchanger 3 for heating the water circulating through the circuit, a three-way valve 4 and a second heat exchanger 25 for transferring heat to the water circulating through a second hydraulic circuit 5. The primary circuit 1 is connected to a heating system via a return pipe 6 and an exit or delivery pipe 7. Water for domestic use circulates through the second circuit, on passing through the second heat exchanger 25 it being heated as required. This second circuit comprises a delivery pipe 5B and a return pipe 5B.

[0013] The boiler also comprises usual safety members 8, 9, 11, 12 and a safety valve 10, known flue gas conveying and control means 13, and regulator means 14 for a gas flow fed through a pipe 15 to a known burner 16. The boiler also comprises a usual control unit (not shown) for the boiler operation. This unit is connected to and controls all the internal members of the boiler.

[0014] The aforedescribed components are all of conventional type and will therefore not be described in detail hereinafter. The boiler also comprises a member 17 acting simultaneously as an expansion tank and as an accumulation vessel for hot water of the primary circuit.

[0015] The expansion and accumulation member 17 comprises (Figure 2) a shell 18 of substantially parallelepiped shape, defining an internal space divided into two parts 18A, 18B by an elastically deformable element 19 (formed for example of an elastomer) provided within the shell 18 and having for example the shape of an inverted jug. The shell 18 comprises upperly a through hole 24A sealed by a plug 24 and lowerly a tubular connector 20 arranged to close a shell aperture on which this connector is positioned, and to sealedly retain the edges of the elastic element 19 against the edges of said aperture. The connector 20 is advantageously connected to the edge of the shell 18 by seaming. The tubular element 20 comprises a water inlet aperture 20A and an outlet aperture 20B. This latter is connected to a tubular element 21 inserted into the elastic element 19 and dimensioned such that its upper end 21A is positioned in correspondence with the upper

portion S of the elastic element when this contains water at ambient temperature (Figure 2). In correspondence with the lower portion I of the elastic element 19, the tubular element 21 comprises a plurality of holes 22. A probe 23 of conventional type is provided within the tubular element to measure the temperature of the water contained in the element 19. The signal obtained by the probe is transmitted to the outside (to the aforesaid control unit) via a cable 23A. The probe could also be positioned within the space between the elastic element 19 and the tubular element 21 (as shown by dashed lines in Figure 2). Alternatively, the temperature of said water can be measured by the control unit in another manner, for example indirectly via a probe measuring the temperature of the shell 18.

[0016] The outlet 20B of the expansion and accumulation member 17 is connected to the pump 2, the inlet 20A being connected to a connection pipe connected both to the heating water inlet pipe 6 and to the outlet of the second heat exchanger 25.

[0017] To form the expansion and accumulation member 17 the conventional expansion members already present in known boilers can be advantageously used. In this respect, such members are totally identical to that shown in Figure 2 with regard to the shell 18 and the elastic element 19, so that commercially available shells and elements can be used for its construction. However, known expansion members have a different lower connection and closure element from the aforedescribed (with only one aperture acting both as inlet and outlet for the water provided in the elastic element) and do not possess the tubular element 21 or the temperature measurement probe 23. Generally, in known boilers the expansion members are connected to the inlet or outlet branch of the second heat exchanger 25.

[0018] The known expansion members are arranged to automatically adjust the water pressure in the primary circuit as its temperature varies. In known members the chamber 18A of the shell 18 is filled through the hole 24A with a gas (inert, for example nitrogen) at a determined pressure (for example at a pressure of 1 bar) whereas the elastic element, being connected to the primary hydraulic circuit of the boiler, is filled with water at ambient temperature. Under these conditions the elastic element fills until the pressure in its interior equals the pressure within the remaining part of the chamber (under such conditions the elastic element generally occupies a space equal to that indicated in Figure 2). When the primary circuit water is heated the volume of the elastic element increases, and simultaneously the gas present in the chamber 18A is compressed until a new equilibrium situation is attained (when the water in the elastic element is at its maximum temperature, this element can for example have the shape indicated by the dashed line M in Figure 2). The aforedescribed type of operation is usual in known boilers and is in no way altered by the expansion and accumulation member of the invention.

[0019] According to the invention the elastic element 19 is however also used for accumulating hot water to be used for the initial heating of the water of the secondary circuit 5 in the heat exchanger 25. For this purpose, when the probe 23 senses that the temperature of the water contained in the elastic element 21 has fallen below a predetermined value (for example 40°C) the unit controlling the various boiler components operates the three-way valve 4 to close the flow of water from the primary circuit to the outlet pipe 7 and instead direct it to the heat exchanger 25, and activates the pump 2 and burner 16. The water of the primary circuit is heated until the probe 23 inserted in the elastic element 19 senses the attainment of a predetermined temperature (for example 55°C).

[0020] It should be noted that during this water heating stage the second heat exchanger 25 does not operate as a heat exchanger but simply as a passive element for connecting the valve 4 to the expansion and accumulation member 17. In a variant (not shown), a dedicated pipe and valve could also be provided for this purpose.

[0021] Advantageously, during this water heating stage the boiler control unit operates the burner 16 at reduced power to prevent stressing of the primary hydraulic circuit 1 which has a reduced capacity, so preventing overheating.

[0022] In this manner when the control unit detects a request for hot water for domestic use (this being usually detected by the member 9 which feeds a signal to the control unit), with the boiler of the invention under normal operating conditions the expansion and accumulation member 17 contains a quantity of hot water sufficient to provide immediate heating of the water for domestic use circulating through the circuit 5.

[0023] In this respect, when the control unit receives a signal relative to a request for hot water, this unit, as also happens in known boilers, activates the pump 11 and burner 16, and closes the valve 4 so that the water of the circuit 1, taken from the member 17, circulates towards the heat exchanger 25 and not towards the pipe 7. Hence with the boiler of the invention it is no longer necessary to wait for the water of the primary circuit 1 to heat up before transferring heat via the heat exchanger 25 to the water circulating through the domestic circuit 5. In this respect, by virtue of the hot water accumulated within the member 17 in the primary circuit 1, hot water is immediately available, with corresponding immediate heat transfer between the water of the primary circuit 1 and the water of the secondary circuit 5.

[0024] It has been found experimentally that in a traditional boiler more than 60 seconds are required to raise the temperature of the water for domestic use leaving the pipe 5B from 20°C to 50-60°C whereas in a boiler of the invention about 5 seconds are sufficient.

[0025] The holes 22 present in the tubular element

22 have proved of particular use when hot water for domestic use is requested but the accumulated water in the element 19 is at a low temperature, close to the limiting temperature measured by the probe 23. Under these conditions the expansion and accumulation member feeds the heat exchanger 25 with water able to transfer a limited quantity of heat to the water for domestic use. Moreover in this situation if the holes 22 were absent, the water volume present in the elastic element 19 would slow down the heating of the water. However the holes 22 enable the water volume present in the elastic element to be by-passed; most of the water to be heated by the burner 16 follows the path indicated by the arrow F. Hence even under said critical conditions the water for domestic use is heated more rapidly than with traditional boilers.

[0026] It should be noted that the boiler of the invention achieves the same results as known boilers comprising an additional hot water accumulation vessel and additional means for heating the water present in the vessel, without the need to use a greater number of components and without varying the overall size compared with traditional boilers without hot water accumulation.

[0027] Moreover, in contrast to the accumulation vessels of known boilers, the aforedescribed expansion and accumulation member 17 does not require insulation. In this respect, the air present in the part 18A of the shell 18 provides sufficient insulation.

[0028] The control unit of the boiler according to the invention has not been described as it is of conventional type to the expert of the art.

[0029] Finally it should be noted that the aforedescribed embodiment is provided by way of example only, and that numerous variants are possible all falling within the same inventive concept. Thus for example, the expansion and accumulation member 17 could be provided in another position of the circuit 1, for example upstream of the heat exchanger 25, or the elastic element 19 could be formed differently from that shown. For example, the element 19 could have the form of a flat membrane to sealedly separate the chamber into two parts of variable volume, one for water and the other for pressurized gas.

[0030] Such an embodiment is shown in Figures 3, 4 and 5 (where parts corresponding to those of Figures 1 and 2 are indicated by the same reference numerals) in which the member 17 comprises an element 19 in the form of a flat membrane, as stated. When not caused to expand by the water of the primary circuit (heating water), this membrane rests substantially on a rigid baffle 33 which divides the internal space of the shell 18 into two chambers 18A, 18B of predefined volume when the water in the chamber 18B is at low temperature. The baffle 33 comprises holes 34 enabling the water of the chamber 18B to displace the membrane 19 within the chamber 18A when said water heats up, so increasing its pressure.

[0031] The member 17 shown in Figures 3, 4 and 5 enables the boiler to operate as already described in relation to Figures 1 and 2, while enabling a minimum volume of water (for example 2 litres) to be always maintained in this member when at relatively low temperature. This is achieved by providing the baffle 33, which defines a minimum volume of the chamber 18B to which the heating water inlet pipe 20A and outlet pipe 20B are connected. These pipes can be positioned at opposite ends 17A and 17B of the member 17 or (as in Figure 4) on the same side or end (for example 17A) of this latter. Again in this case, as in the case of Figures 1 and 2, the outlet 20B is connected to and communicates with the tubular element 21.

Claims

1. A boiler for producing hot water for heating and for domestic use, of the type comprising a first hydraulic circuit (1) for heating the water destined for a heating system, said first circuit comprising means (2) for the forced circulation of the water through said first circuit, first means (3, 16) for generating heat and transferring it to the water, valve means (4) for conveying the heated water to a delivery pipe (7) or to second heat exchanger means (25) arranged to transfer at least part of the heat of the heated water to the water for domestic use circulating through a second hydraulic circuit (5), means for automatically adjusting the pressure of the water circulating through the primary circuit as its temperature varies, and means for accumulating and maintaining a predetermined quantity of heated water in the primary circuit within a predetermined temperature range, said accumulating and maintaining means being connected to the primary circuit in such a manner as to make available to the second heat exchanger means (25) said predetermined quantity of heated water at least during an initial stage in the heating of the water for domestic use circulating through the second circuit, means being provided for controlling the operative components of the boiler, characterised in that the means for accumulating and maintaining a quantity of heated water to be made available to the second heat exchanger means (25) are the expansion means (17), for measuring the temperature of the water present in the expansion means there being provided means connected to the control means which on the basis of the measured temperature of the water present in the expansion means (17) act on the first hydraulic circuit (1) to maintain this temperature at a predetermined value at which heat transfer to the water for domestic use during the initial stage of its heating can take place effectively.

2. A boiler as claimed in claim 1, characterised in that the expansion means (17) are connected to the first

hydraulic circuit (1) by circulation means (20) such as to enable the water contained in them to move from and to said circuit (1) and to enable them to also be used as accumulation means.

3. A boiler as claimed in claim 1, characterised in that the expansion means (17) comprise a hollow shell (18) and an elastically deformable element (19) arranged to divide the internal space defined by said shell into two parts (18A, 18B) sealedly separated from each other, a closed first part (18A) being filled with a pressurized gas, the second part (18B) being connected to the primary hydraulic circuit (1) and being fillable, against the action of said pressurized gas, by the water of said primary circuit, said second part (18B) comprising a water inlet aperture (20A) and an outlet aperture (20B) and containing the water temperature measurement means (23).

4. A boiler as claimed in claim 3, characterised in that the elastically deformable element (19) is in the form of an inverted jug.

5. A boiler as claimed in claim 3, characterised in that the elastically deformable element (19) is in the form of a substantially flat membrane.

6. A boiler as claimed in claim 3, characterised in that the two chambers (18A, 18B) of the hollow shell (18) of the expansion means (17) are separated by a rigid baffle (33) provided with apertures (34) connecting said chambers (18A, 18B) together, in the chamber (18A) filled with gas there being positioned the deformable element (19) which, when the temperature of the water in the other chamber (18B) is low, rests on at least part of said baffle (33) and which, when said temperature increases, expands into said chamber (18A) to withdraw from said baffle (33).

7. A boiler as claimed in claim 3, characterised in that the inlet aperture (20A) is connected to the base of the second part (18B) containing water, the outlet aperture (20B) being connected to an upper region of said second part (18B).

8. A boiler as claimed in claim 7, characterised by comprising an element (21) connecting the water outlet aperture (20B) to the upper region of the second part (18B) and arranged to enable the water entering from the base of said second part to flow out only after it has reached the upper region of said second part.

9. A boiler as claimed in claim 8, characterised in that the connection element (21) comprises a plurality of through holes (22) positioned in correspondence with the base of the second part (18B) and arranged to enable at least part of the water entering the second part to immediately flow from said second part.

10. A boiler as claimed in claim 1, characterised in that the expansion and accumulation means (17) are provided between the second heat exchanger means (25) and the means (2) for the forced circulation of the water.

11. A boiler as claimed in claim 1, characterised in that the temperature measurement means are a temperature probe (23) located inside the expansion means (17).

12. A boiler as claimed in claim 1, characterised in that the temperature measurement means are a probe measuring the temperature of the hollow shell (1) of the expansion means.

13. Expansion means for automatically adjusting the pressure of the water circulating through a boiler primary circuit (1) as the water temperature varies, said primary circuit, arranged to heat the water destined for a heating system, comprising: means (2) for the forced circulation of the water through said first circuit, first means (3, 16) for generating heat and transferring it to the water, valve means (4) for conveying the heated water to a delivery pipe (7) or to second heat exchanger means (25) arranged to transfer at least part of the heat of the heated water to the water for domestic use circulating through a second hydraulic circuit (5), and means for accumulating and maintaining a predetermined quantity of heated water in the primary circuit within a predetermined temperature range, said accumulating and maintaining means being connected to the primary circuit in such a manner as to make available to the second heat exchanger means (25) said predetermined quantity of heated water at least during an initial stage in the heating of the water for domestic use circulating through the second circuit, characterised by being formed in accordance with the characterising part of one of claims 1 to 7.

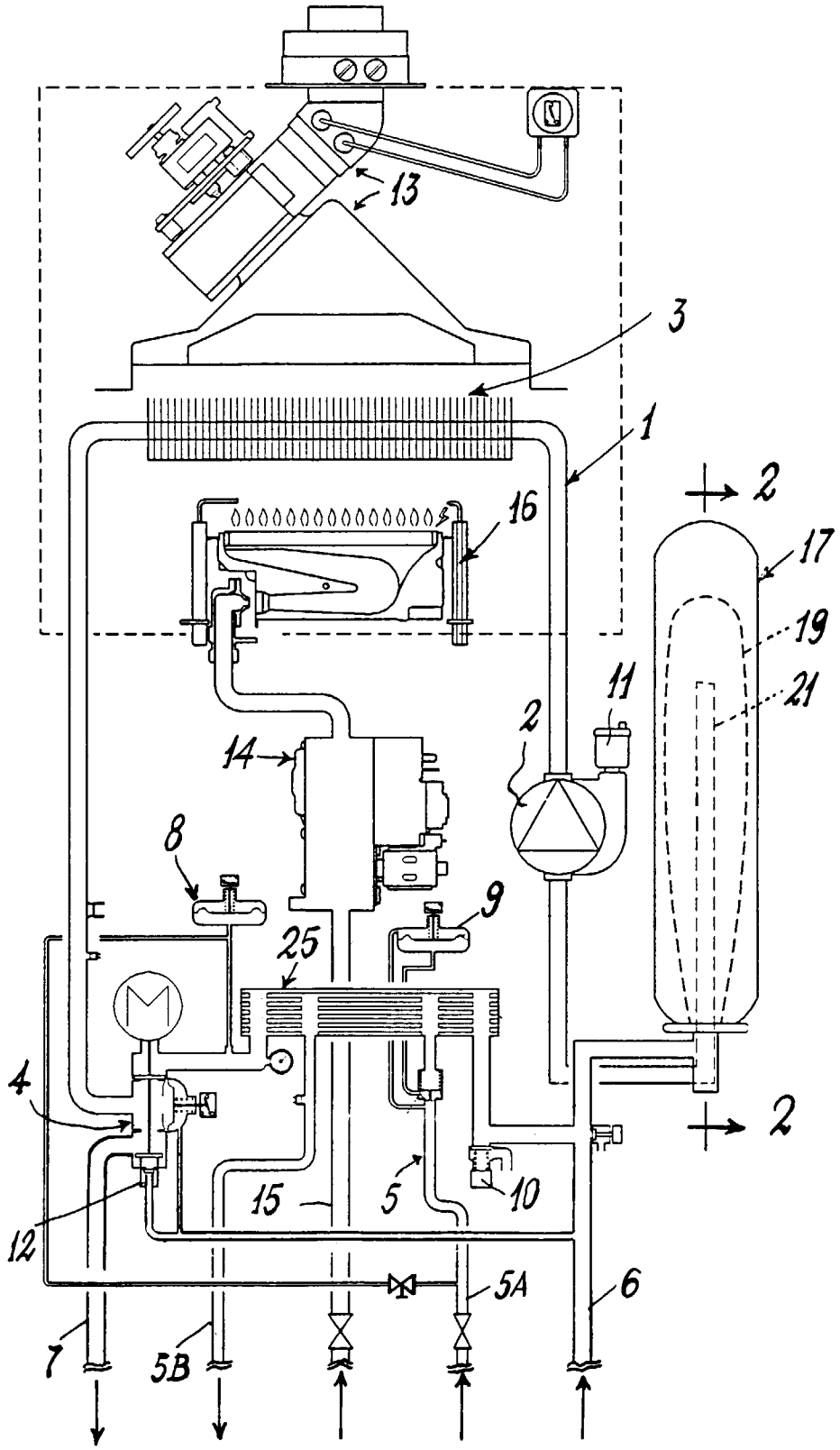

Fig. 1

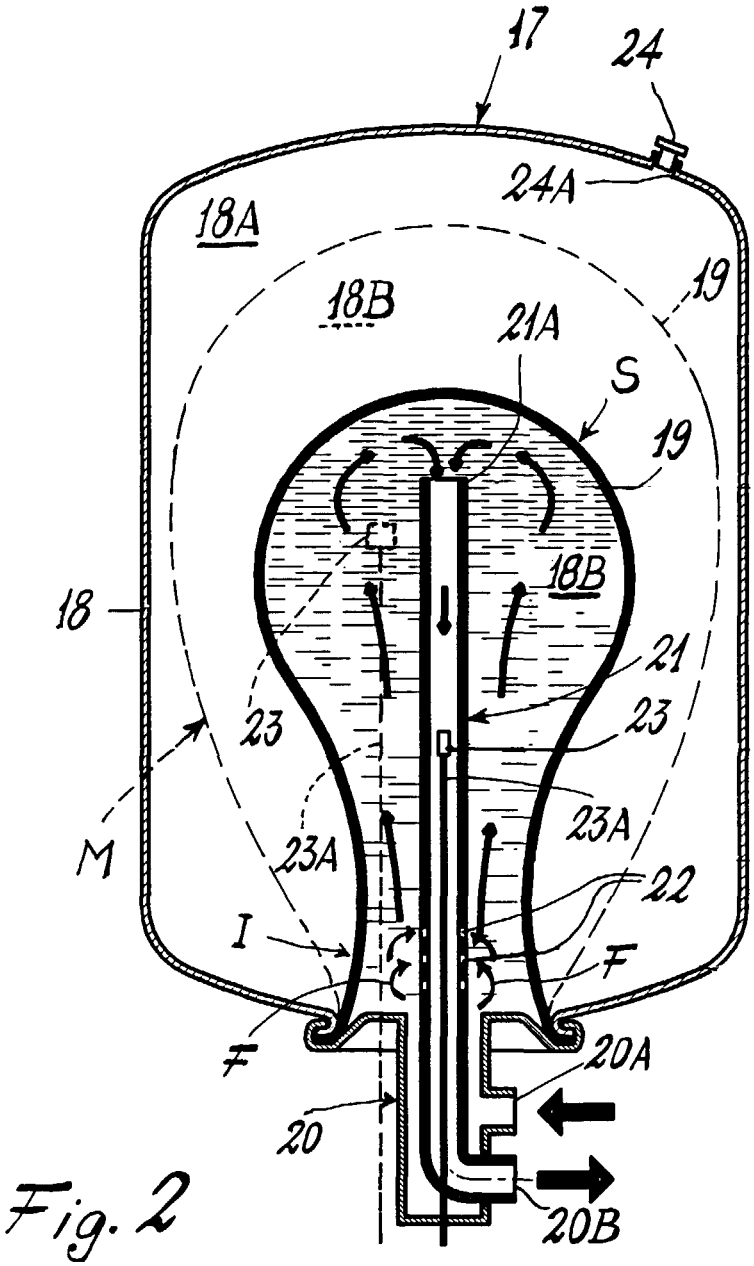
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Fig. 2

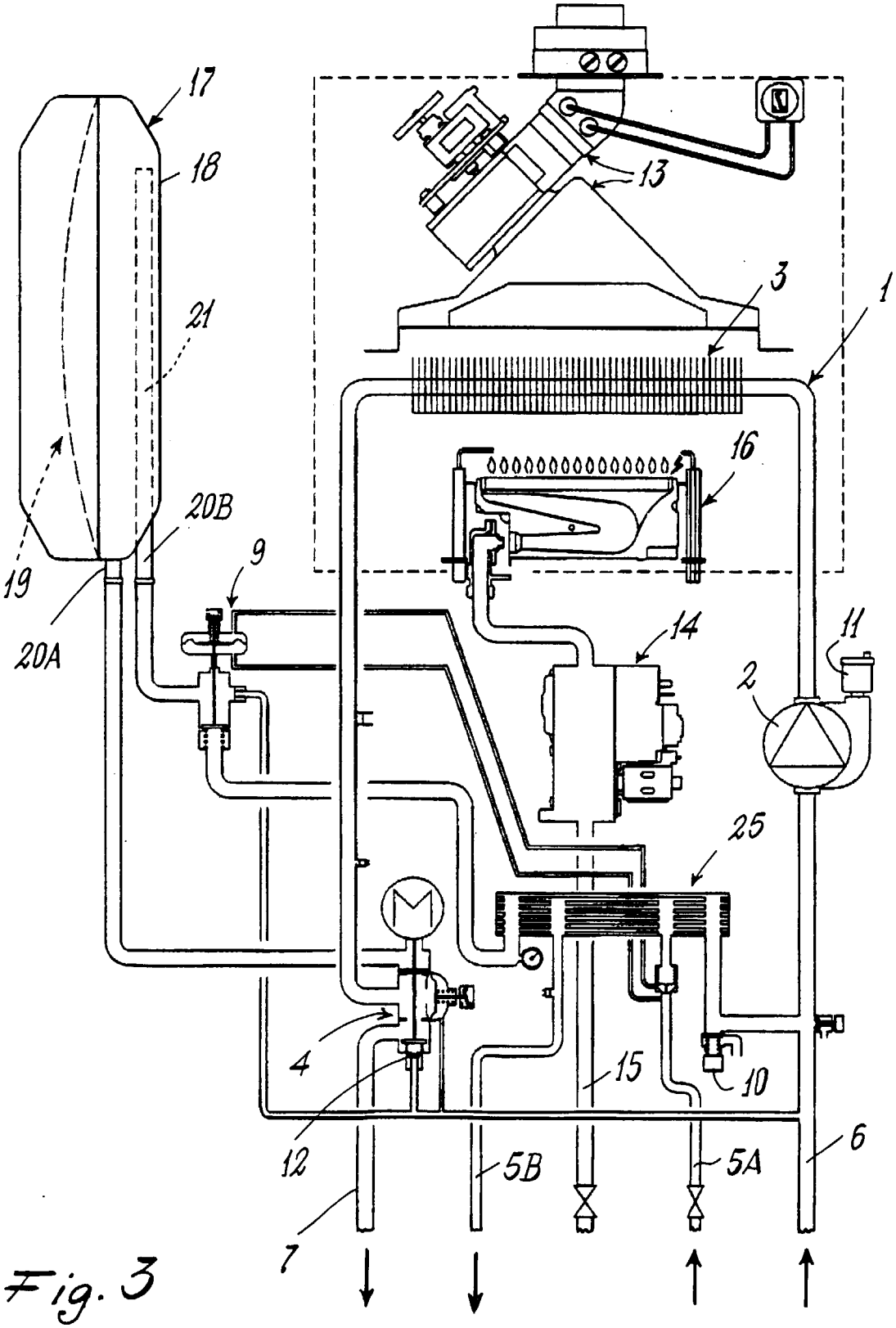

Fig. 3

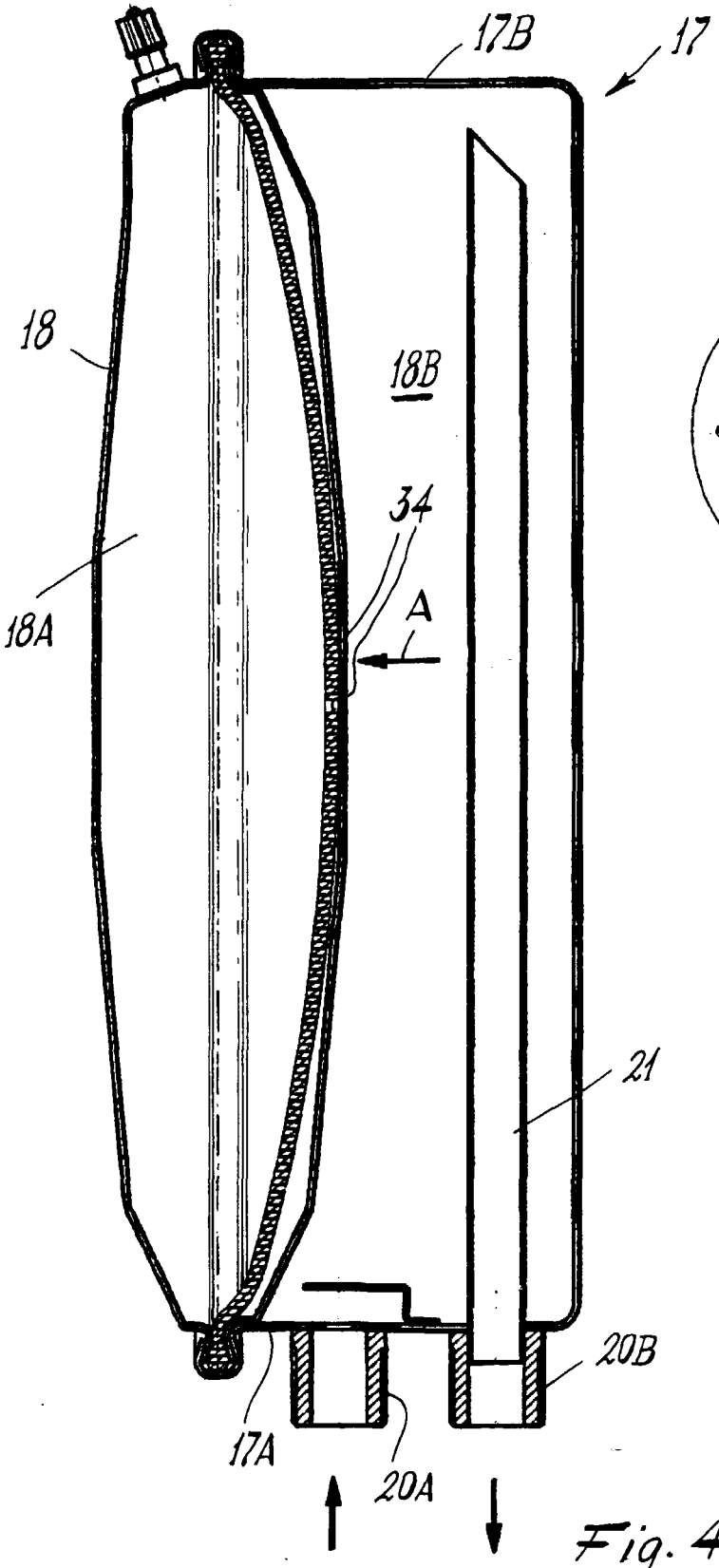

Fig. 4

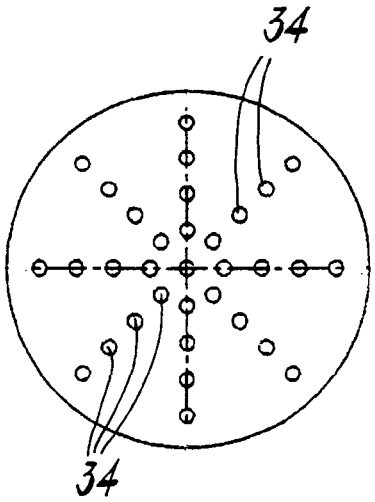

Fig. 5