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(54) A valve unit for automatically regulating the flow-rate of a fuel gas

(57) The valve unit described is for automatically regulating the flow-rate of a fuel gas to a device for heating a fluid in dependence on variations in the flow-rate of the fluid through the heating device. The unit comprises means (36) for bringing about, in the fluid, a pressure differential correlated with the flow-rate of fluid flowing through a pipe (36a), actuator means (35a) which are supplied with the pressure differential in order to generate a signal correlated with the pressure-differential value, and means (4,10), controlled by the actuator means (35a), for regulating the flow-rate of fuel gas in order to vary the flow-rate of gas in a manner correlated with the fluid-pressure differential; the means for regulating the flow-rate of gas comprise a pressure regulator (4, 10) with a diaphragm (19), and the actuator means (35a) act on the regulating means by means of the control mediated by the pressure regulator (4, 10).

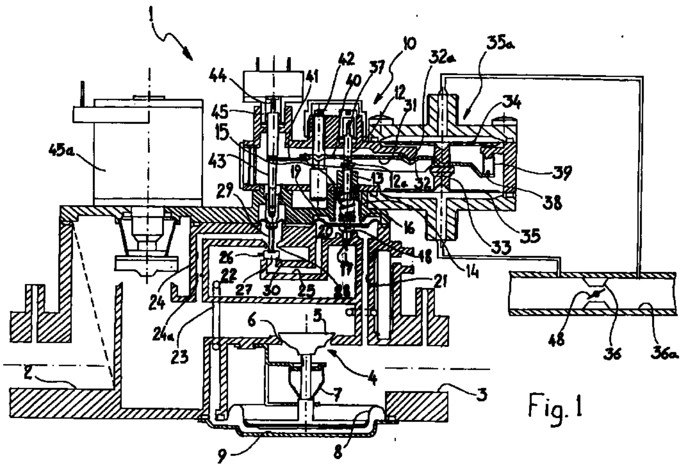

Fig. 1

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Description

[0001] The present invention relates to a valve unit for automatically regulating the flow-rate of a fuel gas to a device for heating a fluid in dependence on variations in the flow-rate of the fluid flowing through the heating device, in accordance with the preamble to main Claim 1.

[0002] Within the specific technical field of the present invention, there is a need to regulate the flow-rate of gas supplied to water-heating devices such as domestic water-heaters or boilers in dependence in variations in the flow-rate of water flowing through the heating device. The regulation of the flow-rate of fuel gas, which is performed in a manner correlated with and proportional to the flow-rate of water flowing through the heating device, advantageously enables a temperature of the water output from the heater device to be kept substantially uniform and such as to ensure adequate comfort for the user.

[0003] A first known system for automatically regulating the flow-rate of gas provides for the use of an actuator with a diaphragm supplied with a pressure differential which is brought about in the pipe through which the water flows and is correlated with the flow-rate thereof. The diaphragm actuator supplied with this water-pressure differential generates a displacement signal which is transferred directly to the closure member of a valve located in the gas-supply duct so as to regulate the flow-rate of fuel gas in a manner correlated with the flow-rate of water required by the user.

[0004] Amongst the disadvantages found in this regulation system is the fact that, because the pressure differential brought about in the water pipe is correlated proportionally with the square of the flow-rate of water, the law governing the variation of the lifting of the closure member of the gas-supply duct is not linear and consequently renders the regulation of the fuel-gas flow rather complex. Moreover, this law may vary in dependence on the geometry of the closure member and is also variable in dependence on the type of gas used. Compensation systems may be used to solve these problems partially, but these systems are quite complex and expensive so that their use is in any case not justified in apparatus such as gas water-heaters or boilers for domestic use.

[0005] A second known system for automatically regulating the flow-rate of gas provides for the diaphragm actuator, which is supplied with the water-pressure differential, acting on the means for regulating the gas flow-rate by means of the control mediated by a pressure regulator device. An example of such a system is known from the abstract of the Japanese patent application published with No. 58024756. The pressure regulator device disclosed therein comprises a servo-valve located in a gas-supply duct and having a closure member with a diaphragm control, the diaphragm being subject to the gas-delivery pressure on one side and to a reference pressure established in a pilot chamber of the servo-valve on the other side, and a modulation valve, the diaphragm of which is subject, on one side, to the gas delivery pressure and, on the other side, to the resilient load exerted directly, by means of the diaphragm actuator, by the pressure differential which is brought about in the fluid and is correlated with the flow-rate thereof. Since the diaphragm actuator acts directly on the control rod of the modulation valve, friction and consequent hysteresis phenomenons opposing the movement of the lever are generated, particularly in the areas of the hydraulic seals provided as separation of the gas from the water. Such hysteresis phenomenons have influence on the law of proportionality between the water pressure differential and gas delivery pressure, by reducing the accuracy in the control and gas regulation.

[0006] Electronically-controlled gas-flow regulation systems which detect the temperature of the water flowing through the heater device and electronically regulate the flow-rate of fuel gas supplied to the device are also known. However, these are more complex and sophisticated than the above-mentioned known systems and involve quite expensive applications which are unsuitable for inexpensive use in the above-mentioned apparatus.

[0007] The problem upon which the present invention is based is that of providing a valve unit for automatically regulating the flow-rate of a fuel gas which is designed structurally and functionally so as to prevent all of the problems complained of with reference to the prior art mentioned.

[0008] This problem is solved by the invention by means of a valve unit formed in accordance with the following claims.

[0009] The characteristics and the advantages of the invention will become clearer from the following detailed description of a preferred embodiment thereof, described by way of non-limiting example, with reference to the appended drawings, in which:

- Figure 1 is a schematic view showing a valve unit according to the invention, in section,
- Figure 2 is a view corresponding to that of Figure 1, showing a variant of the invention,
- Figure 3 is a partially-sectioned view of a variant of a detail of the valve unit of Figure 1,
- Figure 4 is a functional diagram of apparatus equipped with the valve unit of the present invention.

[0010] With reference to Figure 1, a valve unit, generally indicated 1, is for automatically regulating the flow-rate of a fuel gas delivered to a water-heating device such as, for example, a domestic water-heater or boiler, not shown in the drawings, in dependence on variations in the flow-rate of water flowing through the heating device. The gas is supplied to the valve unit by a supply duct 2 and is output by the valve unit through a delivery duct 3 to a burner of the heating device, not shown in the drawing.

[0011] The ducts 2, 3 are separated by a servo-valve 4 comprising a first closure member 5 which is urged resiliently into closure on a first seat 6 by the resilient load of a spring 7 and which can be opened by a first diaphragm 8 which is sensitive to the pressure differential existing between the pressure Pu in the delivery duct 3 on one side, and the pressure Pt in a pilot chamber 9 on the other side. The pressure Pt in the pilot chamber 9 is controlled by the control mediated by a diaphragm pressure-modulation valve, indicated 10, constituting, with the servo-valve 4, a servo-assisted, diaphragm pressure-regulator.

[0012] The pressure-modulation valve 10 comprises a control rod 12 screwed into a cup-shaped element 13 which is kept in abutment with a stationary structure of the valve unit by the resilient load of a first spring 14. A second spring 15 acts between the cup-shaped element 13 and a plate 16 carrying a closure member 17 which can shut off a seat 18. The plate 16 is fixed to a diaphragm 19 of the modulation valve which is subject to the load exerted by the control rod 12 on one side and to the pressure existing in a chamber 20 on the other side. The chamber 20 is in communication with the delivery duct 3 through a transfer duct 21, and with a second chamber 22 through the valve seat 18. The second chamber 22 is always in communication with the pilot chamber 9 through a second transfer duct 23, whereas it communicates selectively with a duct 24 for tapping off the gas supplied to the input of the valve unit and with a duct 25 communicating with the chamber 20 through an on-off valve 26. The valve 26 comprises a closure member 27 which is urged into closure on a third seat 28 and is movable, by the action of a control rod 29 of the closure member, so as to close onto a fourth seat 30 in a manner such that, when the third seat 28 is closed, the fourth seat 30 remains open and vice versa. In the duct 24, there is a constriction 24a such as to bring about a loss of pressure in order to derive the piloting pressure Pt from a fraction of the gas flow tapped off, at the input of the valve unit, from the flow supplied through the duct 2.

[0013] The control rod 12 of the modulation valve acts on the diaphragm 19 by means of a first-order lever 31 pivotable, in an intermediate position of the lever, on a fulcrum 32 associated with a bracket 32a fixed to the stationary structure of the valve unit 1. The lever 31 acts directly on a shoulder 12a of the control rod 12 which is adjustable by screwing. This adjustment enables the distance between the shoulder 12a and the portion of the lever 31 which acts on the shoulder to be varied so as consequently to adjust the pressure-modulation activation threshold of the valve 10.

[0014] On the opposite side of the fulcrum 32 to the control rod 12, the lever 31 is movable by means of a rod 33 having opposite ends fixed to respective diaphragms 34, 35 of a diaphragm actuator indicated 35a. The diaphragms 34, 35 are subject to the pressures detected in adjacent portions of a water-supply pipe 36a, downstream and upstream of a constriction 36 of the pipe 36a, respectively. The actuator 35a is thus supplied with the pressure differential brought about in the pipe 36a and generates a load which is transferred directly to the rod 33 by the diaphragms 34, 35, and which is correlated with the pressure-differential value.

[0015] In a variant shown in Figure 3, the actuator 35a comprises a single diaphragm 35b which is subject, on its opposite sides, to the pressures detected upstream and downstream of the constriction 36, respectively. The single diaphragm 35b is fixed to one end of a rod 33a to the opposite end of which the lever 31 is connected. The end portion of the lever 31 facing towards the rod 33a is surrounded by a sealing element 33b. The sealing element is fitted on the lever 31 and its opposite ends are connected in a hydraulically leaktight manner to the lever and to the stationary portion of the valve unit, respectively. The hydraulic seals provided are thus advantageously static and such as to permit the pivoting movement of the lever about its fulcrum without generating substantial friction opposing the movement of the lever.

[0016] With further reference to the valve unit of Figure 1, the lever 31 is moved relative to the fulcrum 32 by the load exerted as a result of the pressure differential supplied to the diaphragm actuator 35a. Since the flow-rate of water in the pipe 36a is correlated proportionally with the pressure differential acting on the diaphragms 34, 35, as explained further below, for each value of the water flow-rate, the position of the control rod 12 of the modulation valve is controlled directly by means of the lever 31, in a correlated manner, by the water-pressure differential brought about in the pipe 36a.

[0017] A minimum adjustment screw associated with the control rod 12 of the modulation valve is indicated 37. The travel of the rod 12 is adjusted by means of the screw 37 so as to ensure a minimum resilient load on the spring 15 and consequently a minimum pressure value of the valve.

[0018] The lever 31 is extended, on the same side of the fulcrum 32 as the rod 33, by an appendage 38 which is acted on resiliently by a respective spring 39 the resilient load of which serves to keep the lever in abutment with a shoulder of the rod 33.

[0019] On the same side of the fulcrum 32 as the control rod 12, the lever 31 is further extended by first and second adjacent portions 40, 41. The first portion 40 bears against a shoulder of an adjustment screw 42 for regulating the maximum pressure value permissible for the modulation valve.

[0020] The second portion 41 is constituted by a resilient plate fixed to one end of the lever and in abutment at its opposite end with a catch projection of a control rod 43 of the closure member 27. The rod 43 in turn acts on a control element of a snap-action switch indicated 44, the operating threshold of which is adjustable by the screwing of a bush 45. The switch 44 is acted on by the resilient load of the plate 41 and, for a predetermined value of this load, the rod 43 is moved, as a result of the snap action of the switch 44, with a predetermined travel such as to snap the closure member 27 into closure on the seat 30.

[0021] In operation, as a result of a reduction in the required flow-rate of water, the pivoting of the lever 31 is such as to reduce the resilient load exerted by the spring 15 on the diaphragm 19 and, conversely, to increase the resilient load exerted by the plate 41 on the rod 43. When a predetermined threshold value of the flow-rate, equal to the minimum permitted flow, is reached, the resilient load of the plate operates the snap-action mechanism of the switch 44, the control element of which moves the rod 43 with a travel the length of which is such as to switch the on-off valve 26 and to bring the closure member 27 into closure on the seat 28. The diaphragm 8 is thus subject to the same pressure on both sides and the closure member 5 is operated by the spring 7 so as to close the seat 6, shutting off the flow of gas through the valve unit.

[0022] During lighting or extinguishing, the snap-action switch 44 also performs the function of a control element for devices (not shown) which are normally provided in apparatus equipped with the valve unit of the invention for lighting the burner and monitoring the flame.

[0023] The switch 44 may additionally be arranged to bring about the closure of a solenoid valve 45a disposed upstream of the valve unit, by means of the signal produced by the snap action, so as to shut off the main gas flow supplied through the duct 2.

[0024] In Figure 1, the valve unit 1 is shown in an operative condition in which the closure member 27 is closed onto the seat 30 so that the gas pressure tapped off through the duct 24 acts in the pilot chamber 9 through the transfer duct 23 and the chamber 22, as well as in the chamber 20 of the pressure-regulator 10. In this condition, the closure member 5 is acted on so as to open the seat 6 partially, so as to ensure delivery of the gas to the output of the valve unit 1.

An increase in the flow-rate of water required by the user causes a proportional increase in the water-pressure differential to which the diaphragms 34, 35 are subject (from a fluid-dynamics point of view, the flow-rate is proportional to the square root of the pressure differential) which acts on the control rod 12 by means of the lever 31, producing a resilient load on the spring 15. This load presses the diaphragm 19, which partially closes the closure member 17 in the corresponding seat 18. This partial closure brings about an increase in the pressure Pt existing in the chamber 22 and, through the transfer duct 23, in the pilot chamber 9. This increased pressure Pt acts on the diaphragm 9, opening the closure member 5. The partial opening of the closure member 5 as a result of a reduction in the pressure loss brings about an increase in the delivery pressure Pu. This pressure Pu also acts, through the duct 21, on the side of the membrane 19 facing the chamber 20 so as consequently to balance the resilient load exerted by the spring 15. A pressure and a gas flow-rate correlated proportionally with the pressure-differential and the flow-rate of water detected in the pipe 36a is thus achieved for each value of the resilient load on the diaphragm 19.

[0025] Conversely, for a reduction in the flow-rate of water required by the user, the pressure differential detected in the water pipe reduces proportionally and a corresponding load is transmitted to the control rod 12 and, from the control rod 12 to the diaphragm 19, by means of the spring 15. In this case, the reduction in the resilient load of the spring 15 causes partial opening of the seat 18 and a consequent reduction of the pilot pressure Pt existing in the chambers 22 and 9. The closure member of the servo-valve 4 therefore partially closes the seat 6 so as to bring about a reduction in the delivery pressure Pu owing to the increase in the pressure loss. This delivery pressure acts in the chamber 20 through the duct 21, balancing the resilient load acting on the diaphragm 19, thus achieving a value of the gas pressure delivered as well as a flow-rate value which are correlated proportionally with the water-pressure and flow-rate differential detected in the pipe 36a.

[0026] The delivery pressure Pu of the gas thus varies in direct proportion to the water-pressure differential detected in the supply pipe 36a. Upon the assumption that the gas-pressure differential at the output of the valve unit is substantially equal to the delivery pressure (since it is related to atmospheric pressure), the ratio between the water-pressure differential and the gas delivery pressure consequently remains substantially constant with variations in the required flow-rate of water. Since the flow-rates vary proportionally with the pressure differential (substantially with the square root of the pressure differential), the ratio between the gas flow-rate and the water flow-rate is kept constant in operation. This constant ratio between the gas and water flow-rates consequently ensures a substantially constant temperature differential between the water input to and output from the heater device. Since the water-input temperature can be considered approximately constant or at most variable in a limited manner and over long time intervals (for example, seasonal temperature variations), the water-output temperature remains substantially constant and such as to ensure adequate comfort for the user in all operating conditions.

[0027] According to a further characteristic of the valve unit according to the invention, a throttle element 48 is provided in the constriction 36 of the supply pipe, the various positions of this throttle element enabling different pressure losses and consequently different values of the pressure differential generated in the region of the constriction 36 to be brought about for a given flow-rate of water passing through the pipe 36a. It is thus possible to vary the ratio between the pressure differential and the gas-delivery pressure so as to vary the gas-delivery flow-rate selectively and consequently to vary the temperature of the water output by the heating device for a given flow-rate of water required by the user. The throttle element thus constitutes an element for regulating the ratio between the water pressure differential and the gas delivery pressure. Alternatively, the throttle element 48 may be disposed in the gas-supply pipe, downstream of the valve unit 1, in order to perform the function of an element for regulating the ratio between the pressure differentials and hence between the water and gas flow-rates, as described above.

[0028] Figure 2 shows a variant of the valve unit of the invention, generally indicated 50, in which parts corresponding to those of the preceding embodiment are marked with the same reference numerals. The valve unit 50 is suitable, in particular, for applications in which a user such as an instantaneous water heater for domestic use is associated with a gas central-heating boiler. Figure 4 is a functional diagram of a combined installation of the aforesaid type. The installation provides for a first water circuit with heating elements R such as room radiators, connected to a boiler C with an associated burner B supplied by a fuel-gas delivery line G. A second circuit is also provided for supplying washing water to a corresponding heating device such as a heat-exchanger S. The water is supplied to the user by means of a line W for supplying water to the heat exchanger S through which the fluid of the first circuit, diverted by means of a three-way valve V, is made to flow.

[0029] With particular reference to Figure 2, the valve unit 50 differs from the unit of the previous embodiment in that a second servo-valve 51 is provided, in addition to the modulation valve 10. The servo-valve 51 has a diaphragm 52 fixed to a plate 53 carrying a closure element associated with a corresponding valve seat 54. The diaphragm 52 is subject, on one side, to a load exerted by a spring 55 and adjustable by screwing of a spring-holder 56 and, on the other side, to the pressure existing in a chamber 60. The chamber 60 is in communication with the chamber 22 through the valve seat 54 and with the pilot chamber 9 through the transfer duct 23. The chamber 60 also communicates selectively with the duct 21 through the valve seat 30, which is opened by the on-off valve 26. In this variant of the invention, the valve 26 constitutes a switching valve which can switch operation alternatively from the servo-valve 51 to the modulation valve 10, as elements for modulating the gas-delivery pressure.

[0030] In Figure 2, the valve unit is shown in an operative condition in which the delivery pressure Pu, and consequently the gas flow-rate, is regulated by the servo-valve 51 and the modulation valve 10 is excluded from operation. In this condition, the chamber 60 is in communication with the duct 21 through the valve seat 30 and the pilot pressure Pt is obtained from the balance between the pressure Pu acting on the diaphragm 52 and the resilient load acting thereon by means of the spring 55. Adjustment of the travel of the spring holder 56 regulates the maximum permissible value of the delivery pressure (and flow-rate), which is selected in dependence on the power of the heating device of the installation. In this operative condition, water is flowing through the heating elements R, whereas the flow to the heating device S of the washing-water circuit is shut off by the closure of the three-way valve. As a result of a request for washing water by the user and hence of a flow of water along the supply line W, the water-pressure differential detected by the diaphragm actuator 35 brings about switching of the valve 26 by means of the lever 31 in the manner provided for in the valve unit 1, by means of the snap-action switch 44 and the resilient plate 41. As a result of the switching, the delivery pressure Pu, and hence the gas flow-rate, are regulated by the modulation valve 10 and the servo-valve 51 is excluded from operation. The pressure Pu is regulated in the manner described above with reference to the valve unit 1 and, for each value of the water flow-rate required, the gas-delivery pressure varies in direct proportion to the water-pressure differential detected in the supply pipe. In this second operative condition, the switching brought about by the valve 26 opens, by means of the switch 44, the three-way valve V by means of which the water flow of the first circuit is diverted towards the heat-exchanger S for heating the washing water.

[0031] The invention thus solves the problem set, achieving the advantages set out above in comparison with known solutions.

Claims

1. A valve unit for automatically regulating the flow-rate of a fuel gas to a device for heating a fluid in dependence on variations in the flow-rate of the fluid through the heating device, comprising:

   - means (36) for bringing about, in the fluid, a pressure differential correlated with the flow-rate of fluid flowing through a pipe (36a),
   - actuator means (35a) which are supplied with the pressure differential in order to generate a signal correlated with the pressure differential, and
   - means (4,10), controlled by the actuator means (35a), for regulating the flow-rate of fuel-gas in order to vary the flow-rate of gas in a manner correlated with the fluid-pressure differential, said means for regulating the gas flow-rate comprising a pressure-regulator with a diaphragm (19), and said actuator means (35a) acting on the regulating means by means of the control mediated by the pressure regulator, said pressure regulator comprising:

- a servo-valve (4) located in a gas-supply duct (2) and having a closure member (5) with diaphragm control (8), the diaphragm of the servo-valve being subject to the gas-delivery pressure (Pu) on one side and to a reference pressure (Pt) established in a pilot chamber (9) of the servo-valve on the other side, and
- a modulation valve (10), including the diaphragm (19) of the pressure regulator, for controlling the reference pressure (Pt) in the pilot chamber (9), the diaphragm (19) of the modulation valve (10) being subject, on one side, to the gas-delivery pressure (Pu) and, on the other side, to the resilient load exerted directly, by means of the actuator means (35a), by the pressure differential which is brought about in the fluid and is correlated with the flow-rate thereof, characterized in that the resilient load exerted on the diaphragm (19) of the modulation valve (10) is generated by means of a first-order lever (31), the lever being acted on, on one side of its fulcrum point (32) by the actuator means (35a) and, on the other side of its fulcrum point by the spring (15) loading the modulation valve, so that the resilient load is correlated proportionally with the pressure differential supplied to the actuator means (35a).

2. A valve unit according to Claim 1, in which the actuator means comprise a diaphragm actuator (35a), the diaphragm actuator acting on the diaphragm (19) of the modulation valve (10) by means of a spring loading the diaphragm (19) of the modulation valve (10) in order to transfer to the diaphragm of the modulation valve a load correlated with the signal generated by the diaphragm actuator (35a) upon variations of the fluid-pressure differential.

3. A valve unit according to Claim 1 or 2, in which the diaphragm actuator is of the type with a single diaphragm (35b), the diaphragm being subject, on its opposite sides, to the pressures which define the pressure differential and which are detected in adjacent portions of the pipe (36b) through which the fluid flows.

4. A valve unit according to one or more of the preceding Claims, comprising a sealing element (33b) fitted on the lever (31) and having opposite ends connected in a hydraulically leaktight manner to a stationary portion of the valve unit and to the lever (31).

5. A valve unit according to Claim 4, in which the hydraulic seals are static seals.

6. A valve unit according to Claim 1 or 2, in which the diaphragm actuator (35a) comprises a pair of facing diaphragms (34,35) which are subject, respectively, to one and to the other of the pressures which define the pressure differential and which are detected in adjacent portions of the pipe (36) through which the fluid flows, the diaphragms (34,35) being connected to one another by means of a rod (33) connected to the lever (31), the lever being pivoted about its fulcrum (32) as a result of the movement of the rod which is acted on, by means of the pair of diaphragms, by the pressure differential supplied to the actuator (35a), the lever (31) being housed at least partially within a chamber which is disposed between the diaphragms (34,35) and which is closed in a leaktight manner without contact between the lever and the fluid.

7. A valve unit according to one or more of the preceding claims, further comprising an on-off valve (26) for shutting off the supply of gas to the pilot chamber (9), the on-off valve (26) comprising a closure member (27) movable selectively so as to close a first or, alternatively, a second valve seat (28,30), the closure member (27) being moved between the valve seats by a control element of a snap-action switch (44) acting on the control rod (43) of the closure member (27) of the on-off valve (26), the snap-action control element being activated by the resilient load of a resilient element (41) fixed to the lever (31).

8. A valve unit according to Claim 7, comprising a second servo-valve (51) with a diaphragm (52), the on-off valve (26)constituting a switching valve for switching operation alternatively from the second servo-valve (51) to the modulation valve (10) and consequently modulating the gas-delivery pressure (Pu).

9. A valve unit according to one or more of the preceding claims, in which the means for bringing about the pressure differential in the pipe through which the fluid flows comprise a constriction (36) between adjacent portions of the pipe, the pressures defining the differential being detected in the adjacent portions and transferred to the actuator means (35a) in order to generate the signal correlated with the pressure differential, throttle means (48) being provided between the adjacent portions for selectively varying the cross-section for the flow of the fluid and consequently bringing about different pressure-differential values for a given flow-rate.

10. A valve unit according to Claim 8, comprising a three-way diverter valve (V) interposed between a first circuit and a second circuit for the fluid, for selectively diverting the flow of the fluid from the first circuit to the second, the first circuit being provided with room-heating elements (R), the second circuit being provided with a heat-exchanger (S) for heating washing water, lighting and flame-monitoring members being associated with a device for heating the fluid, the snap-action switch (44) constituting a control element for the lighting and flame-monitoring members and/or for the three-way valve (V) for selectively controlling the change from room-heating operation to washing-water-heating operation.

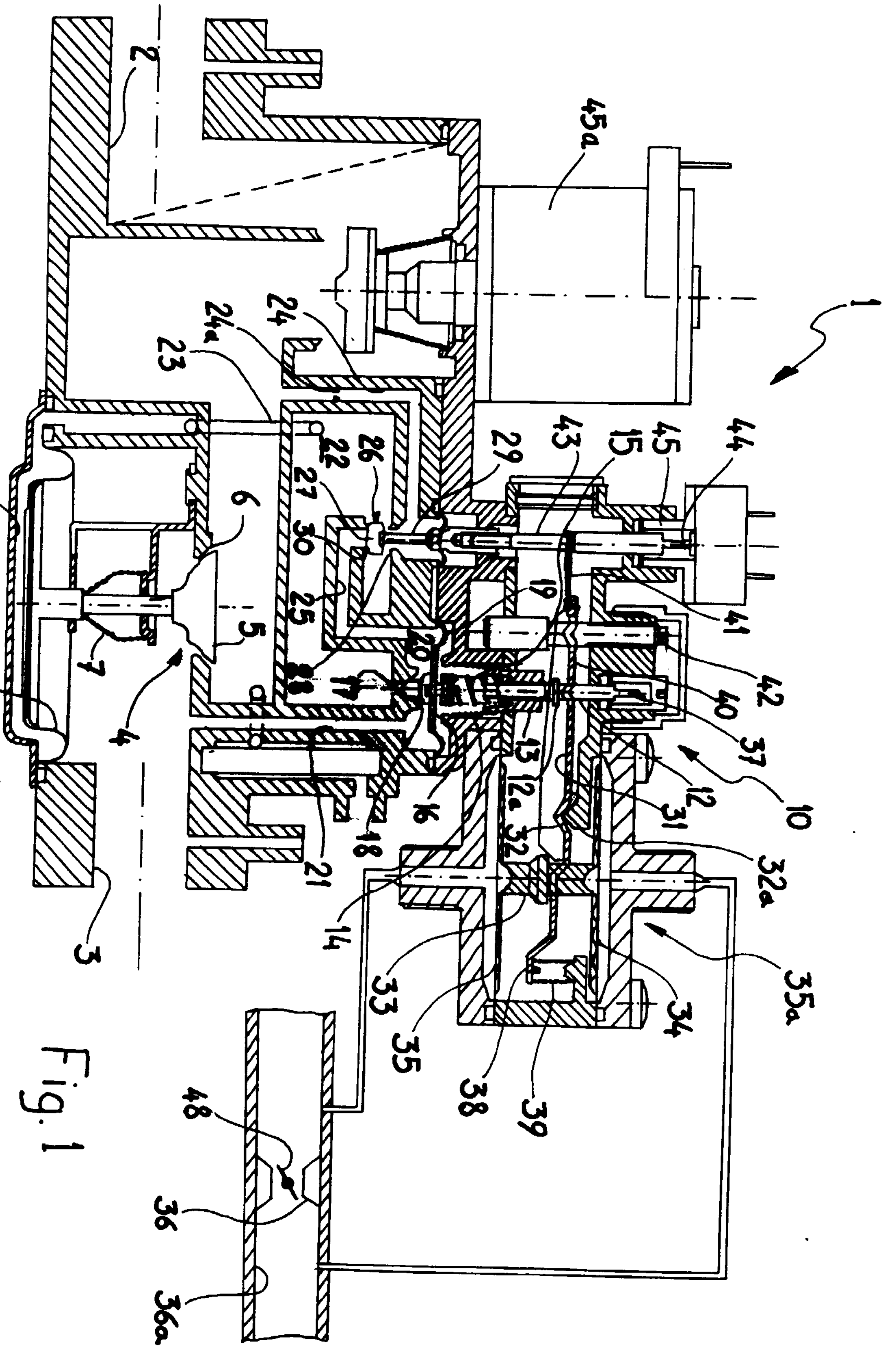

Fig. 1

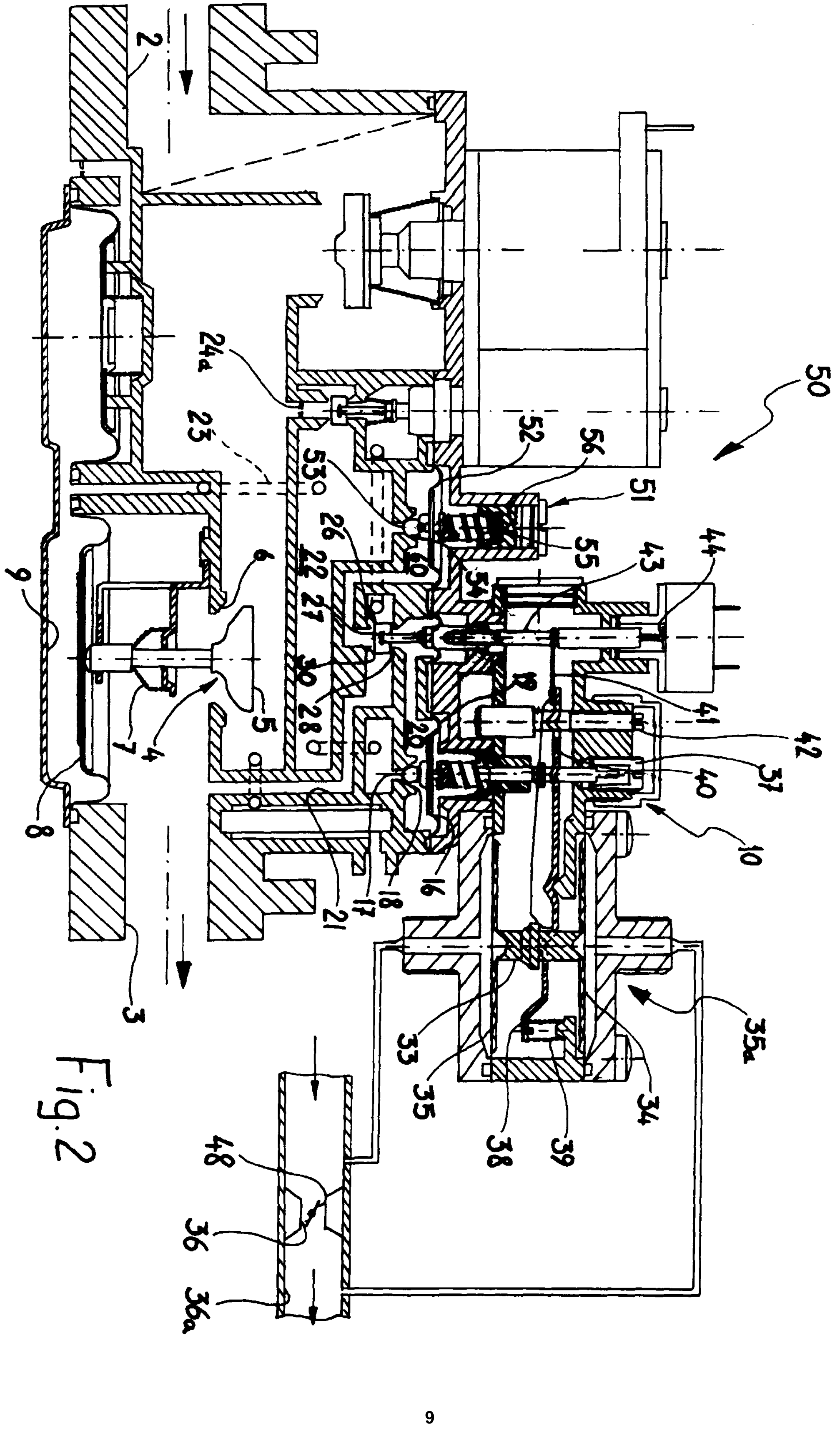
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Fig.2

Fig. 3

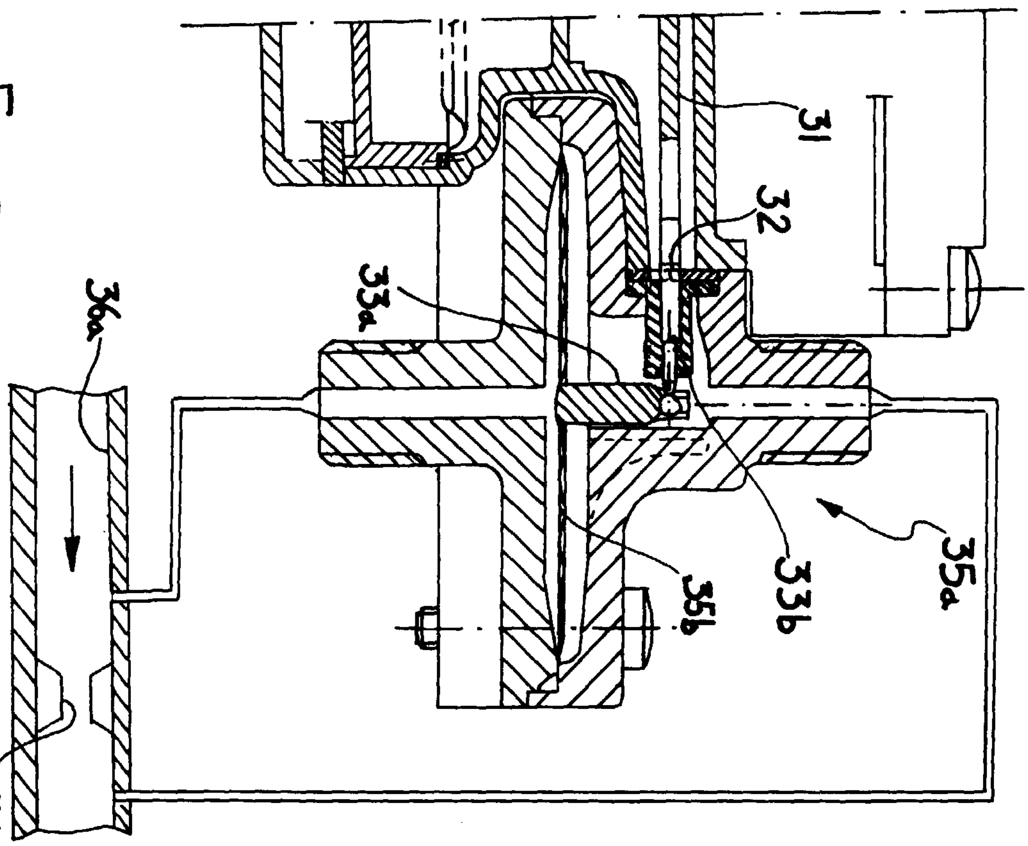
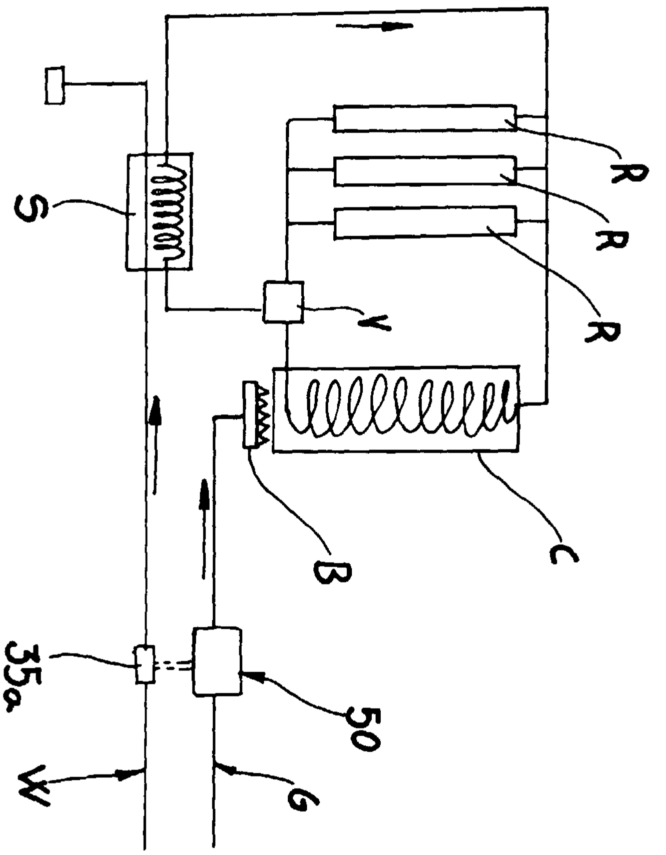


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 99 20 2043

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 007, no. 104 (M-212), 6 May 1983 (1983-05-06) & JP 58 024756 A (YOUEI SEISAKUSHO:KK), 14 February 1983 (1983-02-14) * abstract; figure * ---	1-3	F23N1/08
A	PATENT ABSTRACTS OF JAPAN vol. 004, no. 060 (M-010), 6 May 1980 (1980-05-06) & JP 55 025743 A (MATSUSHITA ELECTRIC IND CO LTD), 23 February 1980 (1980-02-23) * abstract; figure * ---	1	
A	EP 0 035 147 A (VAILLANT) 9 September 1981 (1981-09-09) * figures * ---	1-3,7	
A	PATENT ABSTRACTS OF JAPAN vol. 004, no. 060 (M-010), 6 May 1980 (1980-05-06) & JP 55 025742 A (MATSUSHITA ELECTRIC IND CO LTD), 23 February 1980 (1980-02-23) * abstract; figure * ---	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F23N
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 September 1999	Kooijman, F

CATEGORY OF CITED DOCUMENTS

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