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Amagami et al.

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[54] **HOT WATER CONTROLLING DEVICE**

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[51] **Int. Cl.** **G05b 11/44;** F24d 3/08

[58] **Field of Search** ..... 237/8 R, 8 D, 19; 236/80; 137/804, 805

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[57] **ABSTRACT**

In a hot-water circulation system in which a by-pass passage is connected between the forward passage and the backward passage of the hot-water circulation system which includes a heat exchanger heated by a burner, a circulation pump and a heating radiator to prevent the condensation at the heat exchanger and to heat the water to be supplied, a fluid device is provided at the diverging portion of the forward passage and the by-pass passage to control the hot-water without depending on a mechanical switch.

5 Claims, 7 Drawing Figures

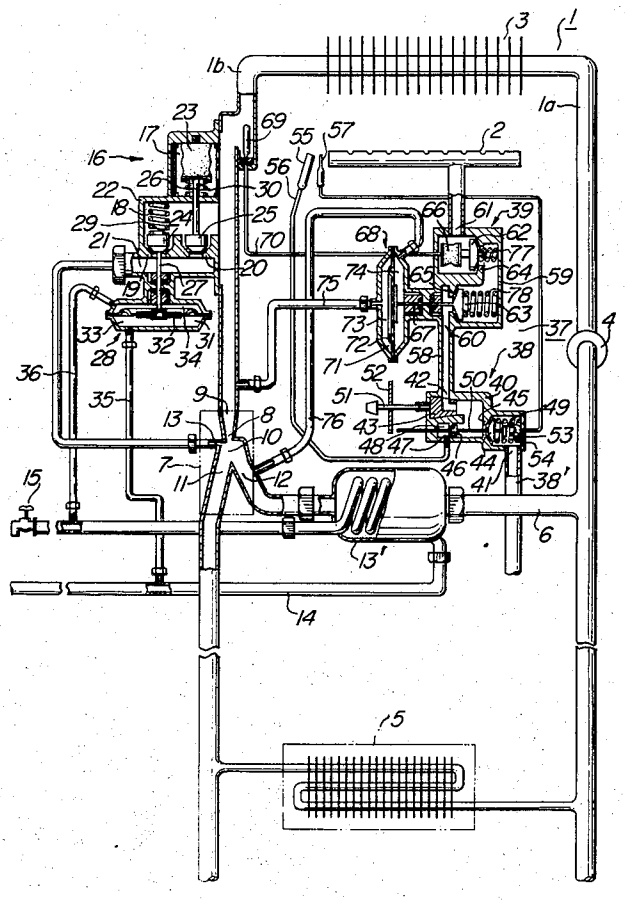
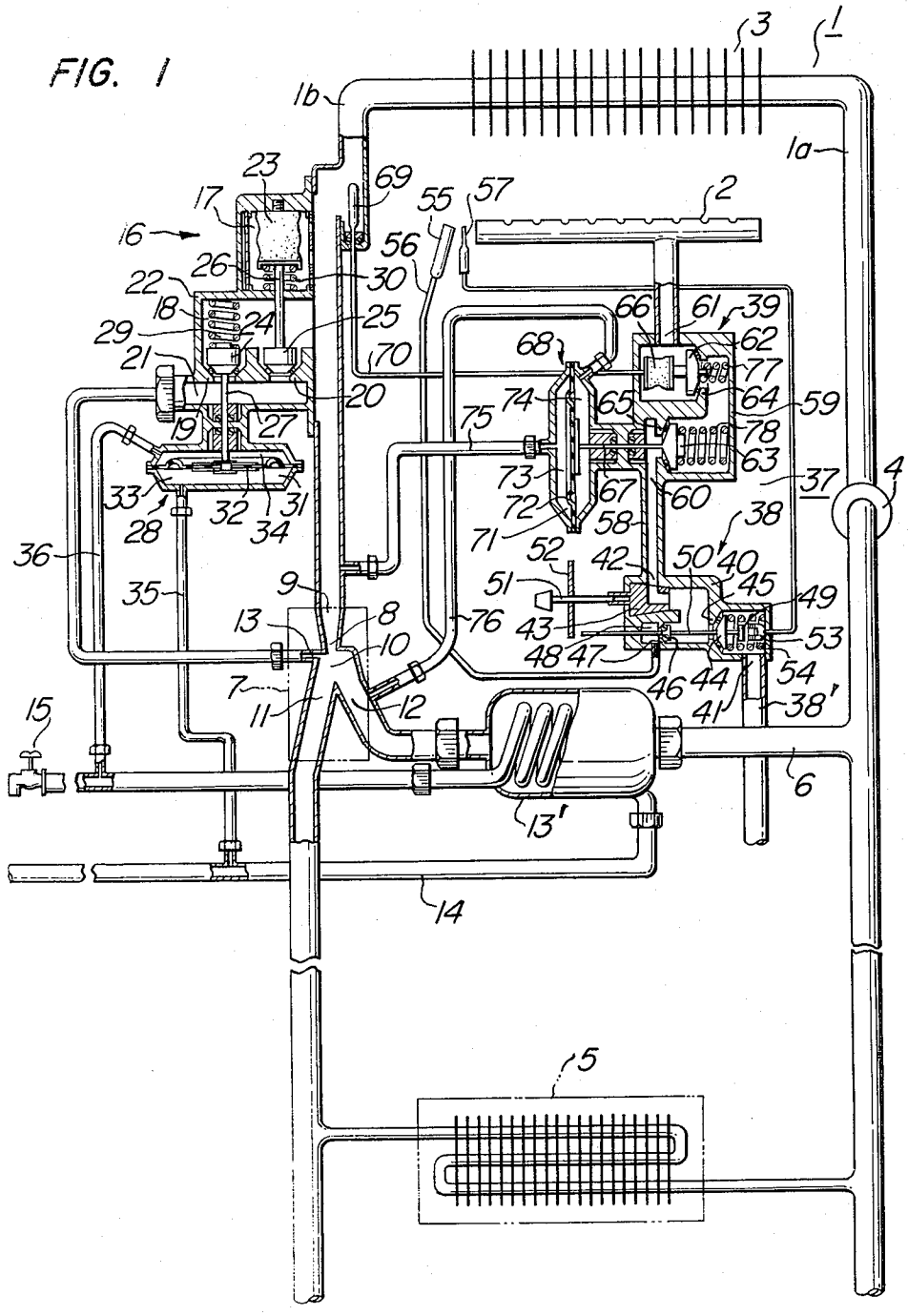


FIG. 1



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FIG. 2

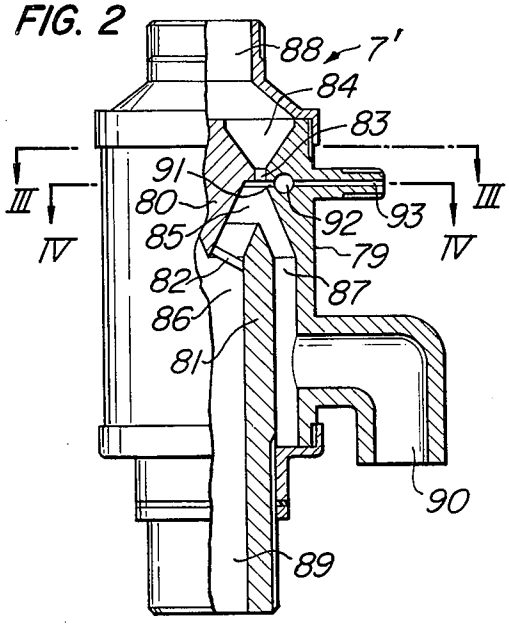


FIG. 3

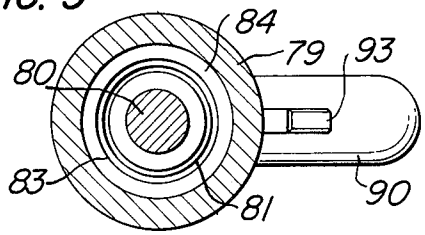


FIG. 4

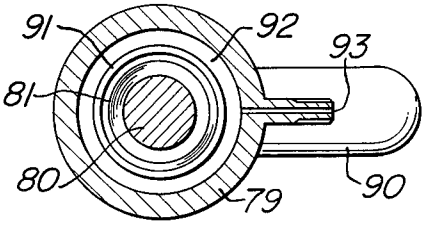


FIG. 5

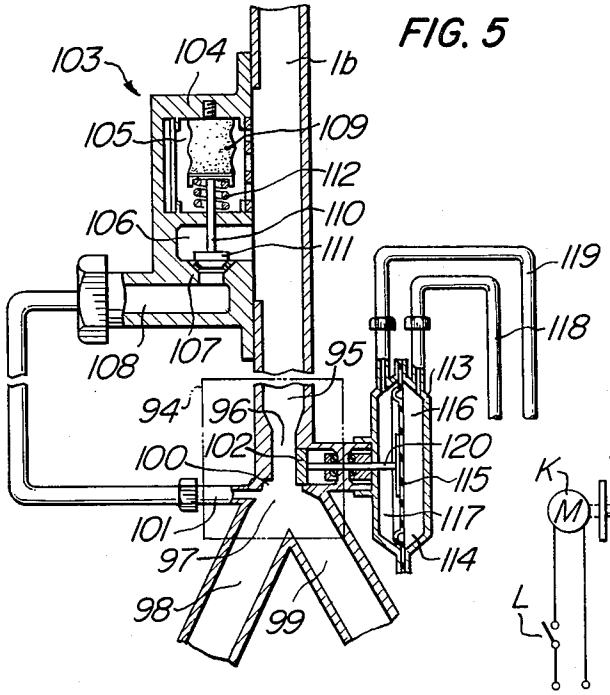
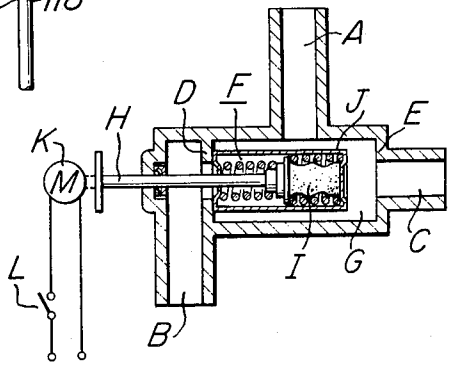


FIG. 7
PRIOR ART

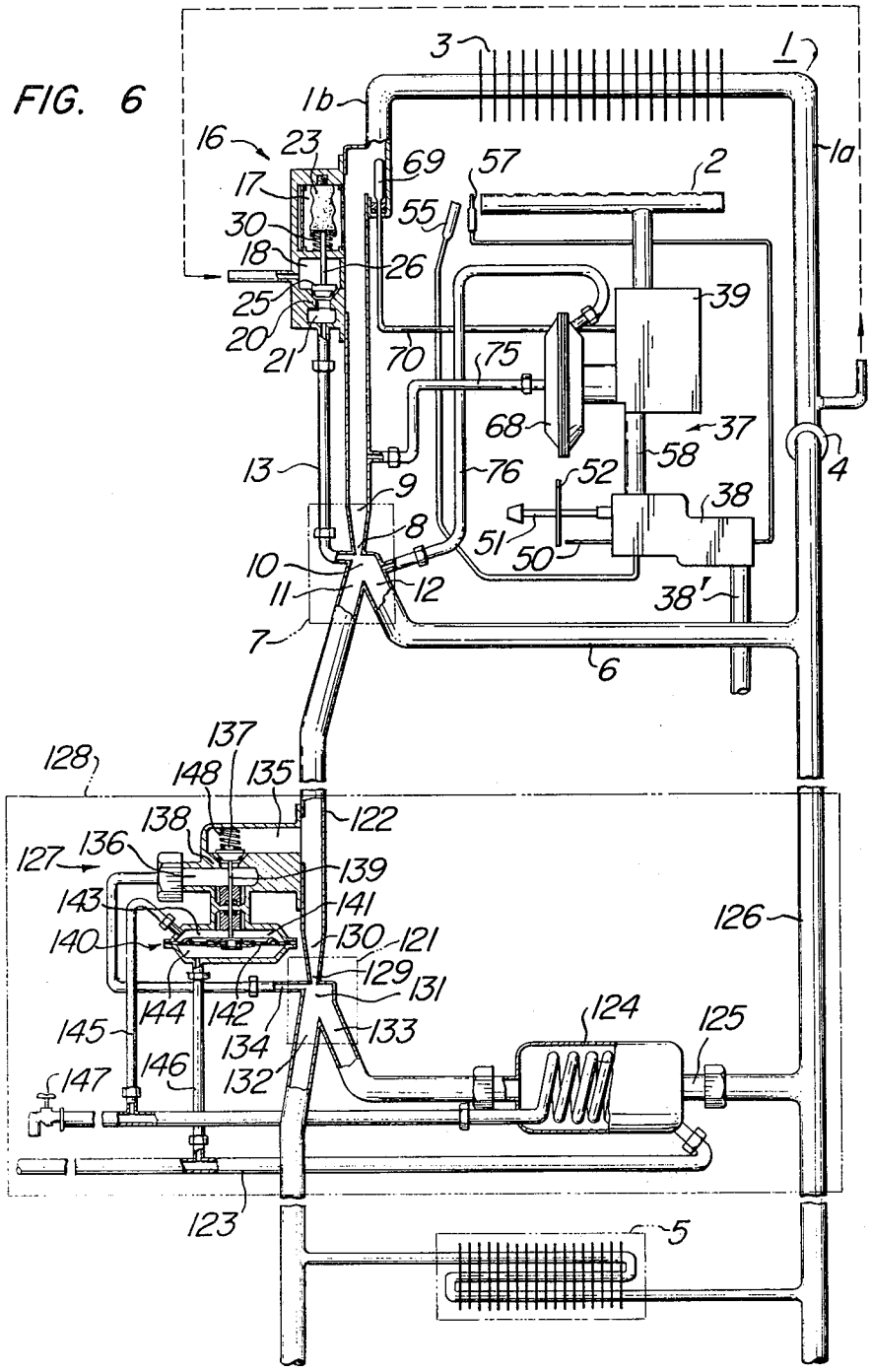


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FIG. 6



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HOT WATER CONTROLLING DEVICE

This is a division of application Ser. No. 163,608, filed July 19, 1971.

The present invention relates to a hot-water control device in which a forward passage and the backward passage of a heating hot-water circulating system including a water heating means are connected together by way of a by-pass passage wherein a fluid device is provided at the diverging portion of the forward passage and the by-pass passage thereof. The fluid device is controlled by the temperature of the hot-water or by the flow of the water to be supplied so that the condensation at the heat exchanger is prevented and the switching between heating and water supplying is conducted efficiently.

In a hot-water heating device of the type in which the water of low temperature flowing backward through a backward passage in a hot-water circulating system for heating is heated by a heat exchanger disposed above a burner and is fed into a forward passage thereof so that the heat thereof may be radiated through a radiator, there is a troublesome problem in condensation occurs at the heat exchanger at the beginning of the operation.

That is, if all the water of low temperature is introduced into the heat exchanger at the beginning of the heating operation, there occurs condensation in the heat exchanger particularly at a fin thereof based on the temperature difference caused by heating by a burner due to the slow rise of the temperature in the heat exchanger.

If the condensation occurs in the heat exchanger, the gas such as sulfurous acid gas contained in the exhaust gas of the burner is liable to stick to the surface of the heat exchanger. Therefore, the heat exchanger corrodes due to chemicals such as sulfuric acid made from the sulfurous acid gas reacting with water for example. Thus, the life of the heat exchanger has been shortened by the condensation.

It is understood that the above described condensation can be prevented by making the rise from the low temperature to the high temperature fast.

The most general method conventionally known to prevent the condensation has been to provide a connection between the forward passage and the backward passage in the heating circulating system at the portion near the heat exchanger so as to form a short circulation to prevent the condensation. Such a construction for preventing the condensation has included a heat responsive valve means which mechanically operates at the diverging portion of the forward passage and the by-pass passage so that the valve introduces water of low temperature in the forward passage into the by-pass passage when the temperature of the water for heating is under a predetermined temperature and thereby makes the temperature of the heating water rise fast due to the short circulation.

The present invention will be better understood in comparison with the prior art by referring to the drawing in which the prior art and the present invention are shown wherein:

FIG. 1 is a side sectional view showing the construction as a whole of the hot water controlling device in accordance with an embodiment of the present invention,

FIG. 2 is a half sectional elevational view showing an embodiment of the fluid device employed in the present invention,

FIG. 3 is a sectional view taken along the line III — III of FIG. 2,

FIG. 4 is a sectional view taken along the line IV — IV of FIG. 2,

FIG. 5 is a sectional elevational view showing another embodiment of the fluid device employed in the present invention,

FIG. 6 is a side view partly in section showing the construction as a whole of the hot water controlling device in accordance with the present invention in which a condensation preventing means and a hot water supplying means are separated from each other, and

FIG. 7 is a sectional view showing a prior art construction for preventing the condensation.

Now referring to FIG. 7 which shows an example of the prior art heat responsive valve, the reference character (A) indicates an inlet of hot water, (B) and (C) indicate outlets of hot water connected to the inlet (A) through valve seats (D) and (E) respectively. The inlet (A) of the hot water is connected with the upstream of the forward passage and one of the outlets (B) is connected with the downstream of the forward passage and the other outlet (C) is connected with the by-pass passage of the hot water circulating system for heating. The reference character (F) indicates a valve mechanism disposed in a chamber (G) formed with the valve seats (D) and (E). The valve mechanism (F) comprises a bellows (I) fixed to the end of an actuating rod (H) and a valve member (J) enclosing the bellows (I) and having good heat transfering property. The end of the bellows (I) is in contact with the internal surface of the valve member (J). When water of low temperature flows into the chamber (G) from the inlet (A), the bellows (I) is shortened by the compression of the liquid therein and the valve member (J) abuts against the valve seat (D). Therefore, the water of low temperature in the chamber (G) flows towards the outlet (C) from the other valve seat (E) and forms a short circulation of hot water including a by-pass passage, whereby the temperature of the hot water quickly rises up to the temperature at which no condensation occurs in the heat exchanger. When the temperature of the hot water rises over a predetermined temperature, the bellows (I) is extended to make the valve member (J) abut against the valve seat (E). Thus, the hot water flows through the inlet (A), chamber (G), valve seat (D) and outlet (B) in this order, and flows toward the downstream of the forward passage to form a prescribed heating circulating system.

Further, the prior art construction shown in FIG. 7 has a heating hot water supplying switching means operated in the case where a heat exchanger for supplying water is provided in a by-pass passage. That is, the reference character (K) indicates a driving motor driven by closing a hot water supplying switch (L) to compulsorily make the valve member (J) abut a valve seat (D) through the actuating rod (H). As the result of this, the hot water flowing through the forward passage flows through the by-pass passage to heat the heat exchanger for supplying hot water however high may it be.

However, in the construction in which the system employs a mechanical switching means for hot water controlling as described above, there is trouble peculiar to the mechanical construction which is inflexible while

water is running therethrough. Due to this mechanical inflexibility, there have been various troubles according to fluctuation in the load in the hot water passage. For example, even if the hot water flow passage is checked by a trouble in the hot water circulating system, the heat responsive valve switching device does not open the by-pass side opening the forward passage, and accordingly the pressure in the circulating system abruptly rises, whereby the hot water circulating pump may be broken or the wall of the circulating passage may be broken or in the heat exchanger the hot water may boil.

In the present invention, the above described various problems are solved by using a fluid device instead of the conventional mechanical switching valve device.

The primary object of the present invention is to provide a hot water control device in which a by-pass passage is connected between the forward passage and the backward passage in the hot water circulation at a portion near a heat exchanger heated by a burner. A fluid device is disposed at a diverging portion of the forward passage and the by-pass passage, the fluid device being controlled to be opened and closed in response to the variation in temperature of the hot water, whereby the reliability of the hot water control is improved and the hot water flowing system is made flexible with respect to the fluctuation in load in the hot water passage so as to prevent the burning of the pump and break down of the hot water passage.

Another object of the present invention is to reduce fluid resistance in the hot water circulating system for heating as far as possible and to make the hot water flow smooth by utilizing pressure reduction of water in the nozzle portion of the fluid device for a water pressure responsive valve mechanism for a burner.

Still another object of the present invention is to provide a hot water control device in which a heat exchanger is provided in the by-pass passage diverging from the forward passage by way of a fluid device. A valve which is operated by the pressure difference in the hot water supplying passage is provided in the controlling passage for the fluid device in parallel with a heat responsive valve, whereby hot water for heating is automatically switched to hot water for supply so that fresh hot water may be supplied from a separate system independent of hot water for heating.

A further object of the present invention is to provide a hot water control device in which a nozzle of the fluid device and two output passages are connected in a loop so that the loss of the hot water is controlled as far as possible and a large number of radiators may be easily provided.

A still further object of the present invention is to provide a hot water control device in which the wall of the interaction region of the fluid device is made movable in response to the flow of water in the hot water passage to effectively switch the passage of the hot water supplied.

A still further object of the present invention is to form a single hot water supply unit by the use of a hot water supply circuit, a water pressure responsive device, a fluid device, a heat exchanger for supplying hot water and the like, and to make it possible for a conventional heating device to serve as a hot water supply system just by inserting the unit into a hot water circulation system of the heating device.

Various other objects and advantages of the present invention will be better and readily understood from the following detailed description thereof with reference to the accompanying drawings.

Now some preferred embodiments of the present invention will be described referring to the drawing.

In FIG. **1**, the reference numeral **1** shows a hot water circulating passage for heating in which a heat exchanger **3** heated by a burner **2** is provided and water of low temperature in the backward passage **1***a* is heated by the heat exchanger **3** and fed into the forward passage **1***b*. The reference numeral **5** shows a radiator and **6** shows a by-pass passage connected between the forward passage **1***b* and the suction side of a circulation pump **4** in the backward passage **1a** near the heat exchanger **3.** A fluid device **7** is situated in the forward passage **1b** to connect one of the output ports of the device with the downstream of the forward passage **1***b* and the other output port with the by-pass passage **6.** The fluid device **7,** which may be termed a pure fluidic device comprises a supply port **9** formed with a nozzle **8** at the end thereof, two output ports **11** and **12** diverging downstream the nozzle **8** with an interaction region **10,** and a control passage **13** opened to the output port **11** side of the interaction region **10.** The supply port **9** is connected with the upstream of the forward passage **1***b*, one of the output ports **11** is connected with the downstream of the forward passage **1***b* and the other of the output ports **12** is connected with the by-pass passage **6.** The reference numeral **13'** shows a heat exchanger provided in the water supply circuit **14** formed in the by-pass passage **6.** The reference numeral **15** shows a hot water supplying cock and **16** shows a fluid device control portion connected with the forward passage **1***b*. The fluid device control portion **16** or fluidic device control valve comprises an upper chanber **17** connected with the forward passage **1b** through a number of hot water holes, a lower chamber **18** directly connected with the forward passage **1***b*, and a discharge chamber **21** connected with the lower chamber **18** through a pair of valve seats **19** and **20.** The upper chamber **17,** lower chamber **18** and the discharge chamber **21** form an outer casing **22** of the body portion of the fluid device control portion **16.** The upper chamber **17** retains a heat responsive expandable member **23** therein which comprises a bellows filled with liquid having high heat expansion rate. In the valve seats **19** and **20** are provided valve members **24** and **25.** One of the valve members **25** is connected with the heat responsive expandable member **23** through a connecting rod **26,** and the other valve member **24** is connected with a water pressure responsive device **28** for supplying hot water hereinafter described through an actuating rod **27.** The reference numeral **29** indicates a spring for urging the valve member **24** in the closing direction, and **30** indicates a spring for urging the heat responsive expandable member **23** in the contracting direction. The control passage **13** of the fluid device **7** is connected with the discharge chamber **21** of the fluid device control portion **16.** The foregoing water pressure responsive device **28** for supplying hot water comprises a diaphragm chamber **31** divided into two compartments with a diaphragm **32,** one of which is a higher pressure chamber **33** and the other of which is a lower pressure chamber **34.** Further, the higher pressure chamber **33** is connected with the upstream of the water supply circuit **14** through a conduit **35,** and the

lower pressure chamber **34** is connected with the downstream of the water supply circuit **14** through a conduit **36.** When the hot water supplying cock **15** is opened to make water flow therethrough, the pressure of water downstream the portion in the circuit **14** where the cock **15** is diverged out naturally becomes lower than the upstream pressure due to the resistance at the passage wall and the heat exchanger **13'**. Therefore, by transmitting the pressure difference to the higher pressure chamber **33** and the lower pressure chamber **34** of the diaphragm chamber **31** in the water pressure responsive device **28** for hot water supplying, the diaphragm **32** is urged toward the lower pressure side and the valve member **24** is opened through an actuating rod **27.** The reference numeral **37** shows a fuel control device disposed in a fuel passage **38'** terminating at a burner **2,** which comprises a safety control portion **38** for stopping the supply of fuel at the time of emergency such as when the flame from burner **2** goes out and a responsive fuel control portion **39** which responds to water flow and temperature of the hot water circulating passage for heating. That is, the safety control portion **38** is provided with a rotatable cock **43** and a valve seat **45** which is opened and closed with a safety valve member **44** in the fuel passage extending from the fuel inlet **41** of the outer casing **40** to the outlet **42.** From this latter fuel passage diverges a small fuel passage **48** for a pilot burner having a small valve seat **47** which is opened and closed with a small valve member **46** for a pilot burner. The safety valve member **44** and the valve member **46** for a pilot burner are integrally fixed to a pressing rod **50** having a plate **49** made of magnetic material at the end thereof. The pressing rod **50** is projected out of the outer casing **40** and is opposed to a disc **52** fixed to a cock shaft **51** which is axially slidable and rotatable about the axis to rotate the cock **43.** The reference numeral **53** indicates an electromagnet disposed opposite to the plate **49** to attract it. The reference numeral **54** shows a spring to urge the safety valve member **44** and the valve member **46** for a pilot burner toward the valve seats **45** and **47,** the numeral **55** shows a pilot burner which is disposed in alignment with the burner **2** in the vicinity thereof and is connected with the fuel passage **48** through a fuel conduit **56,** and **57** shows a thermocouple which energizes the electromagnet **53** by electromotive force as a result of flame heat from burner **55.**

When the cock shaft **51** is pressed and the pressing rod **50** is pressed inward by the disc **52** fixed to the former, the valve members **44** and **46** are opened and the plate **49** abuts against the electromagnet **53.** With the cock **43** being closed, fuel enters into the outer casing **40** through the inlet **41** but does not reach the outlet **42.** however, a part of the gas reaches the fuel conduit **56** through the fuel passage **48** for a pilot burner and is spouted out of the pilot burner **55.** Accordingly, combustion of the pilot burner **55** can be started with a proper ignition means. By the combustion of the fuel at the pilot burner **55,** the thermocouple **57** is heated and the electromagnet **53** is energized by the electromotive force thereof. Since the plate **49** is retained in the attracted position in contact with the electromagnet **53** by a magnetic force thereafter, the external force to press the pressing rod **50** can be removed. If the flame from the pilot burner **55** should be blown out or otherwise go out or and incomplete combustion occurs, the electromagnet **53** is deenergized due to inoperativeness of the thermocouple **57** and accordingly the valve members **44** and **46** automatically close the valve seats **45** and **47** by the effect of the spring **54.** The responsive fuel control portion **39** comprises a fuel passage connected between an inlet **60** of a casing **59** which is connected with an outlet **42** of the safety control portion **38** through a connecting conduit **58** and an oulet **61** of the casing **59** for the burner **2,** and two valve seats **64** and **65** connected in series with each other to be opened and closed with valve members **62** and **63** in said fuel passage. One of the valve members **62** is directly connected with a heat responsive expandable member **66,** and the other of the valve members **63** is associated with a water pressure responsive device **68** through an actuating rod **67.** The heat responsive expandable member **66** is associated with a heat responsive member **69** inserted into the forward passage **1b** of the hot water circulating circuit **1** with the intervention of a capillary tube **70** so that the valve member **62** may be urged to the valve seat **64** by the expansion of the heat responsive expandable member **66** caused by expansion of the liquid within the capillary tube **70** when the temperature of the hot water in the forward passage **1*b*** exceeds a predetermined maximum temperature. The water pressure responsive device **68** associated with the valve member **63** is of the same construction as the foregoing water pressure responsive device **28** for heating and comprises a diaphragm chamber **71** divided into a higher pressure chamber **73** and a lower pressure chamber **74** by a diaphragm **72.** A connecting conduit **75** extending from the higher pressure chamber **73** opens into the upstream of the forward passage **1*b*** terminating at the port **9** of the fluid device **7,** and a connecting conduit **76** extending from the lower pressure chamber **74** opens into one of the output ports **12** of the fluid device **7.** The fluid device **7** has a nozzle **8** at the end of the port **9** so as to increase the flow speed of the fluid. The fluid device **7** takes out the pressure difference at the water pressure responsive device **68** as the pressure increases between the upstream and downstream of the nozzle **8.** Thus, a pressure reduction can be accomplished without providing an orifice at another position in the hot water circulating circuit **1** and the increase of fluid resistance can also be controlled. The reference numeral **77** shows a spring for urging the valve member **62** in the opening direction, and **78** shows a spring for urging the valve member **63** in the closing direction.

Now the operation of the above described construction will be described in detail.

Before starting the heating, the pilot burner **55** is ignited. This ignition can be conducted by opening the valve members **44** and **46** by pushing and rotating the cock shaft **51** of the safety control portion **38** as explained hereinabove. At the same time, fuel passes through a cock **43** toward the outlet **42,** and further to the inlet **60** of the responsive fuel control portion **39** through a connecting conduit **58.** When the circulation pump **4** is driven to flow the eater from the backward passage **1*a*** to the forward passage **1*b***, the heat responsive expandable member **23** of the fluid device control portion **16** is contracted by the force of the spring **30** since the temperature of water in the forward passage **1*b*** is low. Therefore, at this time, the valve member **25** is in the open position. Accordingly, a part of the flowing water in the forward passage **1*b*** flows into the control passage through the lower chamber **18** of the fluid

device control portion **16**, the valve seat **20**, and the discharge chamber **21**. On the other hand, the main water flow in the forward passage **1***b* enters into the port **9** of the fluid device **7** is spouted out of the nozzle **8** and accelerated into the interaction region **10**. Since the interaction region **10** of the fluid device **7** is connected with a control passage **13** in the output port **11** side, and there is no effect of pressure reduction in this side, the spouting water into the interaction region **10** flows into the by-pass passage **6** through the output port **12** due to a phenomenon whereby the fluid sticks to the internal wall of the output port **12** (Coanda effect) and due to the power of the control water ejected out of the control passage **13**. In other words, the forward passage **1***b* and the backward passage **1***a* are shorted through a bypass passage **6** at a portion near the heat exchanger **3** and a very short circulation is formed there. Further, in the short water circulation, a pressure reduction occurs in the nozzle **8** of the fluid device **7**. Therefore, a pressure difference arises between the higher pressure chamber **73** and the lower pressure chamber **74** of the water pressure responsive device **68** connected with the upstream and downstream of the nozzle **8** through the connecting conduits **75** and **76** respectively, which results in curving of the diaphragm **72** to open the valve member **63**. Further, the heat responsive expandable member **66** is in the contracted condition by the force of the spring **77** due to the low temperature of the water flow through the forward passage **1***b*, and accordingly, the other valve member **62** is also opened. Since the two valve members **62** and **63** of the responsive fuel controlling device **39** are opened, the fuel which has been sent up to the inlet **60** flows through the valve seats **65** and **64** and then the outlet **61** to be spouted out of the burner **2**. Thus, the burner **2** is ignited by the pilot burner **55** and starts combustion. The circulating water which is heated when it flows through the heat exchanger **3** heated by the burner **2** from the backward passage **1***a* to the forward passage **1***b* can be quickly heated if the water circulates in the short by-pass passage **6**. Thus, the rise of the water temperature is improved and accordingly the condensation in the heat exchanger **3** is prevented and corrosion caused by the reaction between water and the combustion exhaust gas can be prevented.

In response to the quick rise of the water temperature made by the short circulation, the heat responsive expandable member **23** is expanded to close the valve member **25** against the force of the spring **30**. Since the control passage **13** of the fluid device **7** is closed thereby, the hot water in the interaction region **10** takes the next flowing process. That is, when the control passage **13** is closed, a pressure reducing factor in the output port **11** side in the interaction region **10** is recovered and the water spouted out of the nozzle **8** sticks more to the wall of the output port **11** side rather than the output port **12** side. Consequently, the hot water which has been flowing through the output port **12** changes the flow to the output port **11**. Thus, the short circulation through the by-pass **6** is changed to the ordinary circulation through the radiator **5**. On the other hand, even after the hot water flow has been changed to the output port **11** side circulation, the pressure within the output port **12** is maintained negative by the effect of the hot water flow through the output port **11** and the suction effect by the circulation pump **4**, and the water pressure responsive device **68** keeps on operating. Of course, if the temperature of the hot water flowing through the forward passage **1***b* exceeds the predetermined maximum temperature, the heat responsive expandable member **66** is expanded by the effect of the heat responsive member **69** and the valve member **62** is closed to stop temporarily the combustion in the burner **2**.

In the case where the heating operation is desired to be changed into a hot water supplying operation, all that needs to be done is to open the hot water supply cock **15** to provide a water flow through the water supply circuit **14**. By the water flow through the water supply circuit **14**, the water pressure responsive device **28** for supplying hot water is operated to open the valve member **24**. Accordingly, a part of the hot water flowing through the forward passage **1***b* flows into the control passage **13** through the lower chamber **18**, valve seat **19** and discharge chamber **21** of the fluid device control portion **16**. Then, the hot water spouted out of the nozzle **8** after flowing through the supply port **9** of the fluid device **7** flows into the by-pass passage **6** through the output port **12**. Thus, the water flowing through the water supply circuit **14** is heated by the heat exchanger **13'** for hot water supply disposed on the way of the by-pass passage **6** and then flows out of the cock **15** as fresh hot water. Further, when the hot water supply operation is stopped, the water pressure responsive device **28** for supplying hot water is brought into a non-operating condition and the valve member **24** is closed. Therefore, the hot water flows in the output port **11** side in the fluid device **7** and the heating operation is automatically started again.

The significance of particularly using a fluid device as a hot water switching means in the above described hot water control device will be made clear from the following description.

Since the fluid device **7** has no mechanical element in the fluid (hot water) switching portion thereof, there occurs no mechanical trouble. When the system is operated by mistake to heat valves in the radiator **5** closed, the water flows through the output port **12** since a load is exerted on the interaction region **10** of the fluid device. In other words, in the fluid device the fluid flowing direction is flexible even if it is set in advance to one of the output ports **11** and **12**. Therefore, even when the hot water flow through the forward passage **1***b* or the by-pass passage **6** is blocked, there occurs no break down or burning of the circulation pump **4** due to excess load and the heat exchanger **3** can be certainly prevented from breaking down.

Furthermore, a great significance is recognized in making the water pressure responsive device **68** operate by utilizing variation in water pressure in the nozzle **8** of the fluid device **7**. That is, in constrast to the conventional water pressure responsive device in which an orifice is formed on the way of the hot water circulation to utilize the water pressure variation at the orifice, in the fluid device **7** employed in the present invention a nozzle **8** is provided for the purpose of accelerating the water flow and the nozzle **8** also serves as an element to make the water pressure variation. Accordingly, the fluid resistance is not increased unreasonably as by providing a separate orifice. This is apparently advantageous in increasing the number of radiators **5**.

In order to reduce the resistance at the nozzle of the fluid device, it is preferred to use a fluid device 7' as shown in FIGS. 2 to 4.

Referring to FIGS. 2 to 4, the reference numeral 79 shows a cylindrical outer casing, 80 shows an inner member provided in the outer casing 79, and 81 shows a cylindrical compartment having an acute top end to which the inner member 80 is fixed with a plurality of arms 82. The internal surface of the outer casing 79 and the external surface of the inner member 80 are inclined to form an annular Venturi portion and an annular nozzle 83 is provided in the Venturi portion at a position where the diameter is shortest. Upstream from the nozzle 83 is provided an annular supply port 84, and downstream from the nozzle 83 are provided inner and outer output ports 86 and 87 divided by the cylindrical compartment 81 through an interaction region 85. In the interaction region 85, a phenomenon that the fluid sticks to the wall (Coanda effect) is set to occur stronger in the outer output port 87 than the inner output port 86. A hot water inlet 88 connected with the supply port 84 is connected with the upstream of the forward passage 1*b* shown in FIG. 1. The reference numeral 89 shows a hot water outlet connected with the inner output port 86, and 90 shows another outlet of the hot water connected with the outer output port 87. The former outlet 89 is connected with the bypass passage 6 and the latter outlet 90 is connected with the downstream of the forward passage 1*b*. The reference numeral 91 shows a control port opened to the whole periphery of the outer output port 87 of the interaction region 85. The control port 91 is provided with an annular branch groove 92 having a larger cross section at the outer periphery thereof so that a control pressure may uniformly effect on the whole of the outer output port 87 of the interaction region 85. The branch groove 92 is connected at a portion thereof with a control passage 93.

In the above described construction, when the controlling passage 93 is opened, a control flow enters into the branch groove 92 from the control passage 93 and then is spouted into the interaction region 85 uniformly out of the whole area of the control 91. Therefore, the hot water flowing into the supply port 84 from the inlet 88 and accelerated by the nozzle 83 is subject to the Coanda effect and the power of the controlling flow toward the inner output port 86, and thus flows into the inner output port 86. The hot water flowing into the inner output port 86 further flows into the by-pass passage 6 shown in FIG. 1 through the inner outlet 89. Then, when the control passage 93 is closed, the pressure reducing factors in the outer output port 87 side of the interaction region 85 are recovered and the outer output port 87 side shows a stronger Coanda effect than the inner output port 86 side. Accordingly, the hot water spouted out of the nozzle 83 is switched to the outer output port 87 and flows toward the downstream of the forward passage 1b shown in FIG. 1 from the output 90 of the hot water.

The feature of the fluid device 7' as described above is that a nozzle 83 is formed in an annular shape so that the resistance for the hot water is small and it may sufficiently respond to the fluctuation in the flowing quantity of the hot water.

Another embodiment of the fluid device employed in the present invention in which the construction of the interaction region is varied is shown in FIG. 5. The reference numeral 94 shows the varied fluid device, in which 95 shows a supply port provided with a nozzle 96 at the end thereof, and 97 shows an interaction region provided adjacent to the nozzle 96 from which two output ports 98 and 99 diverge. In the interaction region 97, an offset 100 is provided on the side of the output port 98 control passage 101 is opened in the downstream of the offset 100. Further, a part of the wall on the side of the other output port 99 is a movable wall 102 which may be moved inward and outward in the interaction region 97. The supply port 95 is connected with the upstream of the forward passage 1*b*, one output port 98 is connected with the downstream of the forward passage 1*b* and the other output port 99 is connected with the by-pass passage in a manner similar to the fluid device shown in FIG. 1. The reference numeral 103 shows a fluid device control portion in which the numeral 104 shows a body portion outer casing including an upper chamber 105 connected with the forward passage 1*b*, a lower chamber 106 connected with the forward passage 1 *b* and a discharge chamber 108 connected with the lower chamber 106 through a valve seat 107 and connected with the control passage 101. The upper chamber 105 is provided with a heat responsive expandable member 109 and the lower chamber 106 is provided with a valve member 111 for opening and closing the valve seat 107. The valve member 111 is associated with a heat responsive expandable member 109 through an interconnecting rod 110. The reference numeral 112 shows a spring for urging the heat responsive expandable member 109 in the contracting direction.

The reference numeral 113 shows a water pressure responsive device for supplying hot water which comprises a diaphragm chamber 114 divided into a higher pressure chamber 117 and a lower pressure chamber 116 with a diaphragm partition 115. The lower pressure chamber 116 is connected with the downstream of the hot water supply circuit through a connecting conduit 118, and the higher pressure chamber 117 is connected with the upstream of the hot water supply circuit through a connecting conduit 119. The foregoing movable wall 102 of the fluid device 94 is associated with the diaphragm 115 through an interconnecting rod 120.

In the above described construction, if the temperature of the flowing water in the forward passage 1*b* at the beginning of the heating operation is low, the heat responsive expandable member 109 contracts and opens the valve member 111 to let the controlling water flow through the control passage 101. Since, in response to this flow, the flowing direction in the fluid device 94 is set to the output port 99 side, the water flowing through the forward passage 1*b* flows through the by-pass passage and takes the shorter circulating passage and the rise of the temperature of the hot water is accelerated so as to prevent the condensation at the heat exchanger. Then, when hot water flows through the forward passage 1*b*, the valve member 111 is closed by the expansion of the heat responsive expandable member 109 and the controlling passage 101 is also closed. Therefore, thereafter, the hot water accelerated by the nozzle 96 in the side of fluid device 94 induces a negative pressure at the offset 100 on the output port 98 in the interaction region, which results in sticking of the hot water to the wall on the output port 98 the flowing of the hot water toward the downstream of the for-

ward passage 1b. Thus, the hot water flows through an ordinary hot water circulating circuit for heating.

Further, in the event that water flow is made through the hot water supply circuit while the system is under the heating operation, the diaphragm **115** is curved to the lower pressure chamber side by the pressure difference between the upstream and the downstream of the hot water supply circuit, and the movable wall **102** of the fluid device **94** is moved to be depressed in the interaction region **97.** Then, the movable wall **102** in the depressed position in the interaction region **97** forms another offset portion on the side of output port **99** at the position nearer the nozzle **96** than the offset **100** on the side of output port **98.** Therefore, the hot water spouted from the nozzle **96** induces a negative pressure at the offset portion formed with the movable wall **102** before it reaches the offset **100,** so that the hot water flows into the by-pass passage by sticking to the wall on the output port **99** in the interaction region **97.** Then, the water in the hot water supply circuit is heated by the heat exchanger for supplying hot water provided in the by-pass passage and flows out of the hot water supply cock as hot water.

Although the fluid device shown in FIG. **5** switches the fluid by directly operating the wall of the device in the interaction region, the movement of the wall never switches the flow direction of the fluid mechanically and directly but switches the fluid flow direction by controlling the phenomenon that the fluid sticks to the wall (Coanda effect).

Now reference is made to FIG. **6** which shows an embodiment of the device in accordance with the present invention which can be added to a conventional heating system including a hot water circulation system to make it possible to have the conventional heater also serve as a hot water supplying device. In other words, in the device shown in FIG. **6,** only a portion for supplying hot water is separated from the whole construction for heating and supplying hot water as shown in FIG. **1** and is put into a unit which is adaptable to any kind of the conventional heater utilizing hot water circulation. In the heating device side, the by-pass passage **6** is utilized only for the purpose of preventing condensation in the heat exchanger **3.** Further, since the fluid device **7** is controlled only by the temperature of the hot water in the forward passage 1b, the fluid device control portion **16** also has only the function to respond to the temperature of the hot water. The control passage **13** of the fluid device **7** in FIG. **6** is connected with the discharge side of the circulation pump **4** that is positioned where the pressure is the highest in the hot water circulating passage, and the valve member **25** is adapted to open and close the mid portion of the control passage **13.** By connecting the control passage **13** to the discharge port of the circulation pump **4,** the power of the controlling flow spouted into the interaction region **10** is strengthened and the fluid control can be conducted with more certainty.

Of course, this concept can be adapted to the embodiments shown in FIGS. **1** through **5** also.

On the other hand, the hot water supply part comprises a fluid device **121,** a connecting conduit **122** on the forward passage side, a connecting passage **125** provided with a heat exchanger **124** for the water supply circuit **123,** a connecting conduit **126** on the backward passage side, and a fluid device control portion **127.** These parts are all united in a hot water supply unit **128.** The hot water supply unit **128** will now be described in detail. The fluid device **121** comprises a supply port **130** having a nozzle **129** adjacent thereto, and two output ports **132** and **133** diverging from the supply port **130** through an interaction region **131.** The interaction region **131** is connected with a control passage **134** at the output port **132** side thereof. The supply port **130** is connected with the upstream of the forward passage connection tube **122,** one output port **132** is connected with the downstream of the forward passage connection tube **122,** and the other output port **133** is connected with the connecting passage **125.** Further, the fluid device control portion **127** includes an upper chamber **135** connected with the forward passage side connection **122,** and a lower chamber **136** connected with the control passage **134.** The upper chamber **135** and the lower chamber **136** are connected with each other with an intervention of a valve seat **138** opened and closed with a valve member **137** to which a water pressure responsive device **140** for supplying hot water is connected through an actuating rod **139.** The water pressure responsive device **140** comprises a diaphragm chamber **141** divided into a lower pressure chamber **143** and a higher pressure chamber **144** with a diaphragm partition **142.** The lower pressure chamber **143** is connected with the downstream of the water supply circuit **123** through a connecting conduit **145,** and the higher pressure chamber **144** is connected with the upstream of the water supply circuit **123** through a connecting conduit **146.** The reference numeral **147** shows a hot water supply cock provided at the end of the water supply circuit **123,** and **148** shows a spring for urging the valve member **137** to the closing direction.

In the above described construction, the hot water supplying-heating switching operation is just the same as that described hereinbefore. That is, when water is passed through the water supply circuit **123,** the valve member **137** is opened by the operation of the water pressure responsive device **140** to make the control flow pass through the controlling passage **134.** Therefore, the hot water having passed through the forward passage 1*b* and the forward passage side connection tube **122** then flows into the connecting passage **125** through the output port **133** of the fluid device **121** and then heats the heat exchanger **124** for supplying hot water. Then, when the water flow is stopped in the water supply circuit **123,** the valve member **137** is closed and the control passage **134** is blocked so that the hot water in the fluid device **121** is set to flow in the direction through the output port **132** and the system is driven to serve as a heater.

As described above, by using a unit as shown in FIG. **6,** a hot water supplying function can be easily added to the conventional heater utilizing the hot water circulation, just by connecting the connecting conduits **122** and **126** of the hot water supply unit **128** to the forward passage 1*b* and the backward passage 1*a.*

Although a heat responsive expandable member has been used to open and close the control passage of the fluid device in response to the variation in temperature of the hot water in the foregoing embodiments, various other means can be employed instead thereof such as a bimetal, an electromagnetic valve provided with a thermostat for detecting the temperature of the hot water inserted into an electric circuit, and the like.

The present invention has been described in detail with particular embodiments thereof, but it will be understood that various modifications can be effected within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A hot water control device comprising a burner; a hot water circulating passage having a radiator, a first heat exchanger which is heated by the burner, a forward passage connecting one end of said heat exchanger with one end of said radiator, a backward passage connecting the other end of said first heat exchanger with the other end of said radiator, and a circulation pump in the mid-portion of the circulating passage; a bypass passage connected between said forward passage and said backward passage for forming a short hot water circulating circuit near said first heat exchanger, said bypass passage including said circulation pump; a first fluid device disposed in said forward passage, said first fluid device including an annular supply port connected with the upstream of said forward passage, an annular nozzle formed adjacent to said supply port, an annular interaction region, first and second output ports which diverge from said nozzle as an inner and an outer port through said interaction region, said first output port being connected with the downstream of said forward passage and said second output port being connected with said bypass passage, and a control passage connected to said interaction region for providing control water to said interaction region; a control device for said first fluid device for detecting the temperature of the water in said forward passage and opening and closing said control passage of said first fluid device depending on the water temperature; a hot water supply circuit including a second heat exchanger for providing hot water in the hot water supply circuit, said second heat exchanger being connected to said bypass passage; a water pressure responsive device which operates according to the water pressure difference between the upstream and the downstream of the hot water supply circuit, said control device including a heat responsive means responsive to the temperature variation of the water in said forward passage, said water pressure responsive device including means, in parallel with said heat responsive means, for opening and closing said control passage; and a control port connected with said control passage, said control port being formed on the whole portion of one of said output ports in said interaction region.

2. A hot water control device including a burner comprising a hot water circulating passage having a radiator, a first heat exchanger which is heated by the burner, a forward passage connecting one end of said first heat exchanger with one end of said radiator, a backward passage connecting the other end of said first heat exchanger with the other end of said radiator, and a circulation pump in the mid-portion of the circulating passage; a bypass passage connected between said forward passage and said backward passage for forming a short hot water circulating circuit near said first heat exchanger, said bypass passage including said circulation pump; a fluid device disposed in said forward passage, said fluid device including a supply port connected with the upstream of said forward passage, a nozzle formed adjacent to said supply port, an interaction region, first and second output ports which diverge from said nozzle through said interaction region, said first output port being connected with the downstream of said forward passage and said second output port being connected with said bypass passage, and a control passage connected to said interaction region for providing control water to said interaction region; a control device for said fluid device for detecting the temperature of the water in said forward passage and opening and closing said control passage of said fluid device depending on the water temperature; a hot water supply circuit including a second heat exchanger for providing hot water in the hot water supply circuit, said second heat exchanger being connected to said bypass passage; and a water pressure responsive device which operates according to the water pressure difference between the upstream and the downstream of the hot water supply circuit, said fluid device including a movable wall, adjacent to said interaction region so that said movable wall may be moved into and out of said interaction region, said movable wall being connected with said water pressure responsive device.

3. A hot water control device including a burner comprising a hot water circulating passage having a radiator, a first heat exchanger which is heated by the burner, a forward passage connecting one end of said heat exchanger with one end of said radiator, a backward passage connecting the other end of said heat exchanger with the other end of said radiator, and a circulation pump in the mid-portion of the circulating passage; a bypass passage connected between said forward passage and said backward passage for forming a short hot water circulating circuit near said first heat exchanger, said bypass passage including said circulation pump; a first fluid device disposed in said forward passage, said first fluid device including a first supply port connected with the upstream of said forward passage, a first nozzle formed adjacent to said first supply port, a first interaction region, first and second output ports which diverge from said first nozzle through said first interaction region, said first output port being connected with the downstream of said forward passage and said second output port being connected with said bypass passage, and a first control passage connected to said first interaction region for providing control water to said first interaction region; a control device for said first fluid device for detecting the temperature of the water in said forward passage and opening and closing said first control passage of said first fluid device depending on the water temperature; a hot water supply unit having a forward passage conduit connected with said forward passage of said hot water circulating passage and a backward passage conduit connected with said backward passage of said hot water circulating passage for heating, said hot water supply unit including a hot water supply circuit having a connecting passage extending between said forward passage conduit and said backward passage conduit, said connecting passage having a second heat exchanger for providing hot water for said hot water supply circuit; a second fluid device disposed in the forward passage conduit, said second fluid device including a second supply port connected with the upstream of the forward passage conduit, a second nozzle formed adjacent to said second supply port, a second interaction region adjacent said second nozzle, third and fourth output ports diverging out of said second interaction region, said third output port being connected with the downstream of the forward passage conduit and said fourth

output port being connected with said connecting passage, and a second control passage connected with said second interaction region; and a water pressure responsive device for opening and closing said second control passage by detecting the water pressure difference between the upstream and downstream of said hot water supply circuit.

4. A hot water control device comprising:

a. a hot water circulating passage for heating comprising a forward passage extending to a radiator from a first heat exchanger heated by a burner and a backward passage extending to said first heat exchanger from the radiator, and having a circulation pump in mid course thereof;

b. a bypass passage for shorting said forward and backward passages;

c. a second heat exchanger for a hot water supply circuit, provided in said bypass passage;

d. a pure fluidic device at a diverging portion of said forward passage and bypass passage, and comprising (i) a supply port connected with the upstream of said forward passage, (ii) a nozzle formed ahead of said supply port, (iii) first and second output ports diverging ahead from said nozzle through an interaction region, said first output port being connected with the downstream of said forward passage, and said second output port being connected with said bypass passage, and (iv) a control passage;

e. a fluidic device control valve for adjusting the degree of opening of said control passage of said pure fluidic device in response to a stream of fluid in said hot water supply circuit, and

f. a heat sensitive valve, operable in response to the temperature of hot water in said forward passage, provided in said control passage of said pure fluidic device in parallel with said fluidic device control valve.

5. A hot water control device comprising:

a. a hot water circulating passage for heating comprising a forward passage extending to a radiator from a first heat exchanger heated by a burner and a backward passage extending to said first heat exchanger from the radiator, and having a circulation pump in mid course thereof;

b. a bypass passage for shorting said forward and backward passages;

c. a second heat exchanger for a hot water supply circuit, provided in said bypass passage;

d. a pure fluidic device at a diverging portion of said forward passage and bypass passage, and comprising (i) a supply port connected with the upstream of said forward passage, (ii) a nozzle formed ahead of said supply port, (iii) first and second output ports diverging ahead from said nozzle through an interaction region, said first output port being connected with the downstream of said forward passage, and said second output port being connected with said bypass passage, and (iv) a control passage;

e. a fluidic device control valve for adjusting the degree of opening of said control passage of said pure fluidic device in response to a stream of fluid in said hot water supply circuit, and

f. a fuel valve co-operating with a pressure responsive device and provided in a fuel supply passage led to the burner, said pressure responsive device having higher pressure and lower pressure chambers which are connected respectively with the upstream and downstream separated by the nozzle of said pure fluidic device.

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