United States Patent [19]

Kawabata et al.

[11] **3,722,523**

[45] **Mar. 27, 1973**

[54] **GAS WATER HEATER**

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[22] Filed: **Oct. 14, 1970**

[21] Appl. No.: **80,733**

Related U.S. Application Data

[62] Division of Ser. No. 794,746, Jan. 28, 1969, abandoned.

[52] **U.S. Cl.** **137/94,** 126/351, 137/484.2, 137/502, 137/504

[51] **Int. Cl.**.....**F23n 1/00**

[58] **Field of Search** .126/351; 236/25; 137/502, 504, 137/94, 484.2; 122/448

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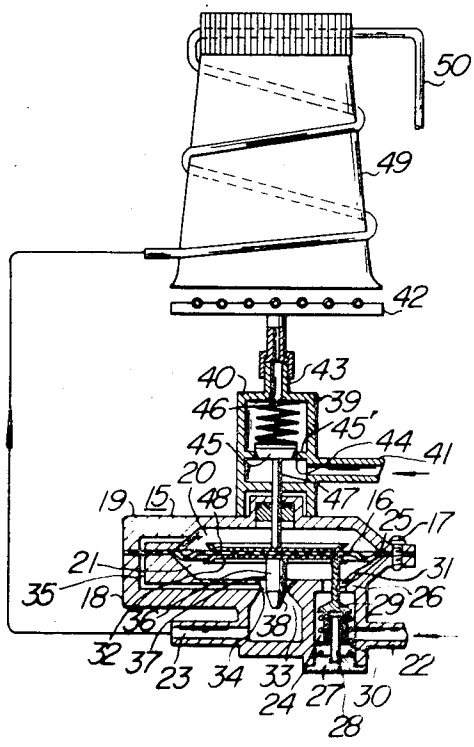
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[57] **ABSTRACT**

This invention relates to a gas water heater wherein a diaphragm for opening a gas valve utilizing the water flow is provided in the course of water supply passage to a heat exchanger, the low pressure chamber of said diaphragm is communicated with a low pressure Venturi portion formed by the aid of increasing the flow velocity in the water supply passage, and a control element is proceedably and recedably provided in the Venturi portion to automatically regulate the aperture of the Venturi portion corresponding to the variation of amount of water flow, intended for automation of water amount control and promoting the enlargement of range of adjusting water temperature and simplification of operation.

3 Claims, 10 Drawing Figures



PATENTED MAR 27 1973

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SHEET 1 OF 3

FIG. 1

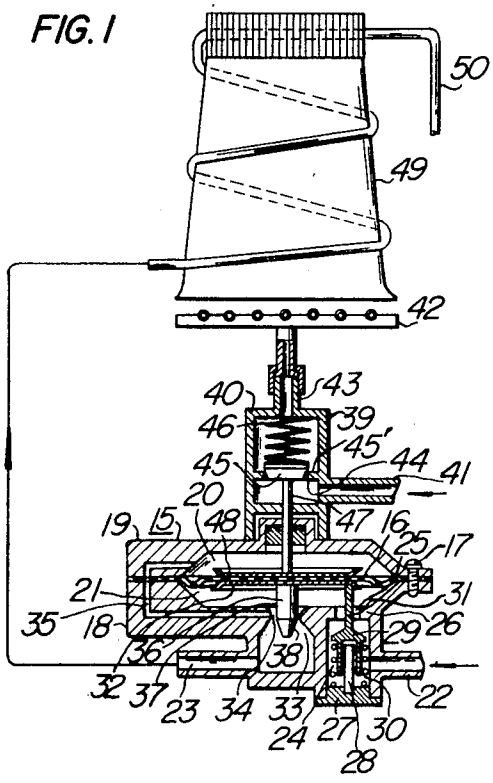


FIG. 2a

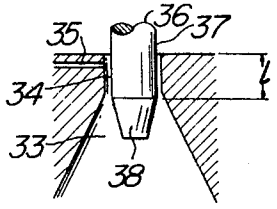


FIG. 2b

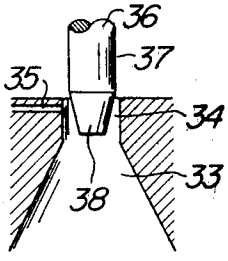
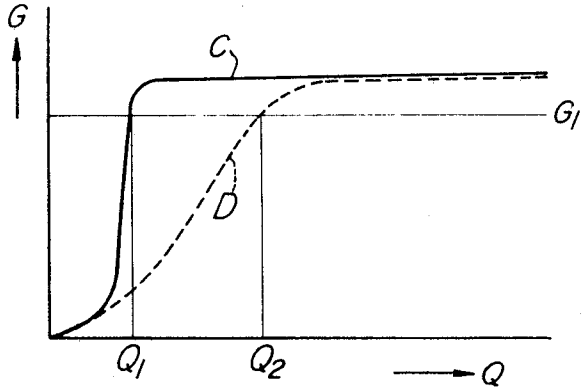


FIG. 3



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FIG. 4

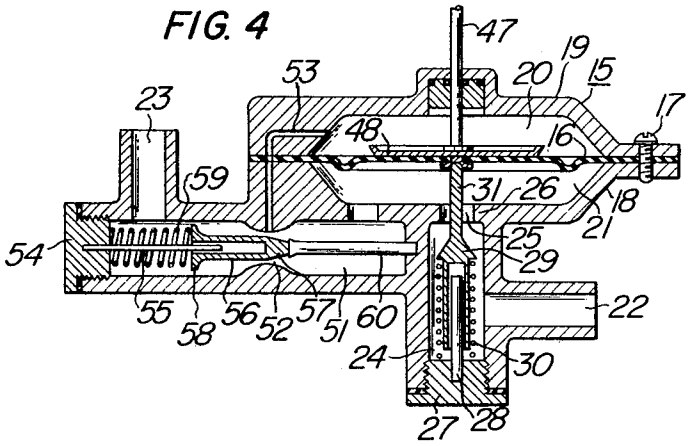


FIG. 5

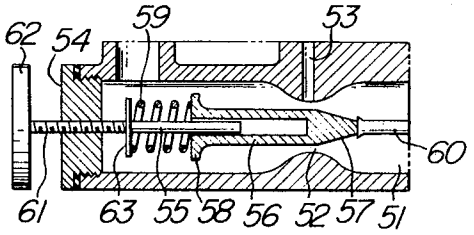
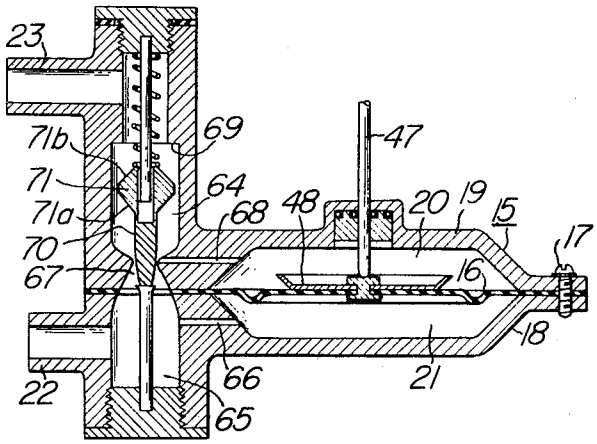


FIG. 6



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FIG. 7

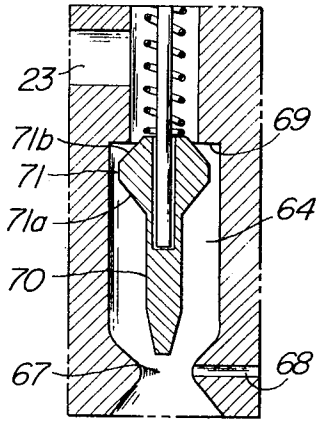


FIG. 8

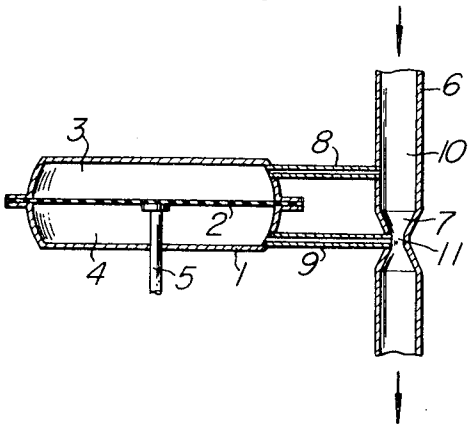
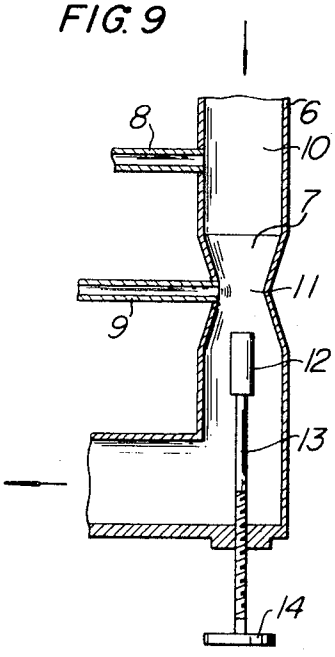


FIG. 9



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GAS WATER HEATER

This is a division of U. S. Pat. Application Ser. No. 794,746, filed Jan. 28, 1969, now abandoned.

This invention relates to a gas water heater provided with a controller which automatically operates depending on the change of the amount of water flow through a hydraulic pressure responding portion that opens or closes a gas valve, making it possible to obtain water at temperatures in wide range from high temperature to low temperature merely by regulating the amount of warm water at the supply outlet of warm water.

In general gas water heaters, the regulation of gas supply to the gas combustion portion is usually performed by utilization of the water flow flowing to a heat exchanger. FIG. 8 shows a basic principle of that type of gas regulation, wherein 1 is a diaphragm operating chamber divided into a high pressure chamber 3 and a low pressure chamber 4 by means of a diaphragm 2, 5 is a valve rod whose one end passes through the low pressure chamber 4 of said diaphragm operating chamber and whose end portion contacts with one face of the diaphragm 2 and the axial movement of the valve rod 5 opens or closes a gas valve (although this is not shown in the figure), 6 is a water supply pipe to a heat exhanger having a Venturi portion on the way, 8 and 9 are connecting pipes connecting a large diameter portion 10 of said Venturi portion 7 and a constricted portion 11 of Venturi portion 7 to the high pressure chamber 3 of the diaphragm operating chamber and to the low pressure chamber 4 of the diaphragm operating chamber, respectively.

Now, when water flows as shown by the arrowhead in FIG. 8, a pressure difference represented by Bernoulli's theorem is generated between the large diameter portion 10 and the constricted portion of the Venturi portion and this pressure difference is transmitted between the high pressure chamber and the low pressure chamber of the diaphragm operating chamber through connecting pipes 8 and 9. Consequently, the diaphragm 2 bends downward in the figure because of this pressure difference and presses a valve rod 5, thus opening the gas valve. In this case, a considerably large amount of force is required to move the gas valve in consideration of the restoring force of the diaphragm 2 of the restoring force after closing the gas valve. When the flow rate at Venturi portion 7 is small, the constricted portion 11 needs only to reduce in diameter in order to obtain the desired pressure difference. However, if the constricted portion 11 reduces in diameter, the resistance to flow increases and the amount of warm water supply exceeding a certain extent can not be obtained from the gas heater device as a whole. On the other hand, if the constricted portion 11 increases in diameter in order to supply a large amount of water, the pressure difference produced between the high pressure chamber and the low pressure chamber becomes very small and brings forth an inconvenience that a force is not obtained enough to open the gas valve. To eliminate this inconvenience it has heretofore been modified so that the diameter at the constricted portion 11 can be varied by providing a piece 12 enabling to vary Venturi tube adjacent to the constricted portion 11 through a screw rod 13 as shown in FIG. 9, said varying piece being displacable from outside by means of a disc 14.

According to this structure the flow area of the constricted portion 11 is variable, and so the flow area of said constricted portion 11 may be increased for a small flow of water; conversely the flow area may be reduced for a large flow of water. However, the amount of water supply of the gas water heater is generally very variable and the flow area of the constricted portion 11 must be adjusted from outside by a disc 14 for each use of warm water, and this adjustment is very difficult. Sometimes, the diameter of constricted portion 11 is too much increased and gas fails to fire, or the flow area is too much reduced and the amount of water flow is lowered to extreme extent. Thus this manipulation has been so difficult.

Also in general housekeeping, the water supply to a gas water heater is branched into other water supply appliances such as water faucets for sinks in the kitchen and for toilets, and the amount of water used in these water supply appliances can vary the amount of water supply to the gas water heater. Consequently, in the case that the flow area of Venturi portion is adjusted manually as in conventional gas water heater, the amount of warm water supply necessarily varies depending on the conditions of water use in other appliances even if the aperture of this outlet of warm water is constant. It sometimes occurs that the pressure difference of the hydraulic responding portion varies depending on said variation of water supply and can not be noticed, or it can occur that the pressure difference at Venturi portion is too much reduced and the gas valve is shut carelessly, or the gun valve is controlled so that the flame formed in the gas combustion portion becomes small and the condition of combustion is so unstable that it can be put out by wind. For example, and in extreme cases the danger such as the leakage of unburned gas can be considered seriously.

This invention is directed to the elimination of many defects in conventional type of gas water heaters, by providing a Venturi portion on the water passage leading to a heat exchanger, by inserting a control element automatically advancing or receding in conjunction with the variation of water flow in the constricted portion of this Venturi portion to open or close a gas valve by the pressure difference between the large diameter portion and the constricted portion of said Venturi portion, and by constructing the hydraulic responding portion so that the control element advances or recedes to vary the aperture area of Venturi portion depending on the amount of water flow, the warm water in wide range from low temperatures to high temperatures is obtainable and the combination in the gas combustion portion is very stable merely by adjusting the warm water outlet, and a highly reliable gas water heater for handy use is provided.

Another object of this invention is to obtain a gas water heater for use in wide range from small amount to large amount of water, that is, from low temperature to high temperature, by smoothening the flow of a large amount of water making the aperture area of the constricted portion to be large as a result of the retreat of the control element from the constricted portion of Venturi portion in case the amount of water flow is large and the flow velocity of water is sufficiently high, or by increasing the flow velocity of water at Venturi portion owing to the decrease of the aperture area as

the result of advancing of the control element to the constricted portion of Venturi portion in case the amount of water flow is small and the flow velocity is low, and by thus obtaining the pressure difference sufficient to open and close the gas valve.

Another important object of this invention is to obtain warm water in all temperature range by merely adjusting the amount of warm water from the warm water outlet without any other operation as a result of automatic operation of the operator in connection with the variation of water flow, maintaining securely the combustion condition of the combustion portion and eliminating careless closing of a gas valve or leakage of unburned gas even if the water supply pipe leading to the gas water heater is branched to other water supply appliances and the amount of water supply to the gas water heater varies with the condition of use of those water supply appliances.

Another object of this invention is a good stabilization of gas combustion in the gas combustion portion by the assured displacement of the operator by a certain length which is initially determined by the cylindrical portion parallel on periphery of the control element projected into the constricted portion of Venturi portion because of entry of a slight amount of water.

Further another object of this invention is to eliminate the occurrence of eddy in Venturi portion by forming a certain length of tapered portion in the end of cylindrical portion of the control element in the type wherein a control element is directly connected to a diaphragm, further smoothing the water flow and maintaining securely the pressure difference produced in Venturi portion.

Further another object of this invention is to provide a gas water heater of a type wherein a control element is provided independently of diaphragm and prevents dropping of pressure difference or damage of water heating devices in simple construction by regulating water supply at times of abnormal water pressure through the control element serving also as a water governor.

Other various objects and advantages of this invention will be understood further clearly by the following detailed explanation with reference to the accompanying drawings.

FIG. **1** is a schematic view of a gas water heater showing in cross-section a hydraulic corresponding portion of an embodiment of this invention;

FIGS. **2***a* and **2***b* are an explanatory views showing the action of an operator in a hydraulic corresponding portion of FIG. **1**;

FIG. **3** is a characteristic diagram of a gas valve;

FIG. **4** is a cross-section showing a hydraulic corresponding portion of another embodiment of this invention;

FIG. **5** is a cross-section of the essential part showing a modification of FIG. **4**;

FIG. **6** is a cross-section of a hydraulic corresponding portion of the other embodiment of this invention;

FIG. **7** is a cross-section of a hydraulic corresponding portion of FIG. **6**; and

FIGS. **8** and **9** are cross-sections of a hydraulic pressure corresponding portion in a conventional gas water heater.

Referring to FIGS. **1** to **3**, one embodiment of a gas water heater of this invention will be explained.

In the drawings, **15** is a diaphragm operating chamber consisting of a base and a cover tightly integrated by rivets with the peripheral portion of a diaphragm **16** placed therebetween. Above said diaphragm **16** is a low pressure chamber **20** and below said diaphragm is a high pressure chamber **21**. **22** and **23** are a water supply inlet and a water feed outlet communicating with said high pressure chamber **21** and formed in the base **18**. **24** is a governor operating chamber provided between the water supply inlet and the high pressure chamber and separated from this high pressure chamber **21** by a partition wall **26** having a water passage hole, and the portion opposing this partitioning wall **26** is usually closed by a plug body **27**. **28** is a guide rod fixed to said plug body **27** at its one end, and opposing to a water passage hole **25** of the partition wall **26** at the other end. **29** is a governor slidably fixed onto the guide rod **28** and usually urged toward a water passage hole **25** by a spring **30** whose projected portion **31** projected from the end fits with clearance in the water passage hole **25** of the partition wall **26** and contacts at its end portion with a lower receiving plate **32** of said diaphragm **16**. When the water supply pressure becomes abnormally high, said governor **29** is displaced upward in FIG. **1** by the upward bending of the diaphragm **16** as well as by the action of the spring **30** so as to close the water passage hole **25** of the partition wall **26**, thus preventing the damage and abnormal behavior of diaphragm **16** and other accessory machines and apparatuses. **33** is a Venturi portion formed in the connecting portion of the high pressure chamber **21** and the water outlet, and a constricted portion **34** opposes the middle portion of said diaphragm **16** and communicates with the low pressure chamber **20** through a communicating passage **35**. **36** consists of a cylindrical portion **37** with a periphery in parallel and tapered portion **38** formed on the end thereof. The base end of the cylindrical portion **37** is fixed to the middle of the lower receiving plate **32** in the diaphragm **16**, and the other end portion of the cylindrical portion **37** and the tapered portion constitute a control element loosely fitted into the constricted portion **34** of said Venturi portion **33** and there usually exists a small clearance between the cylindrical portion **37** and the constricted portion **34**.

39 shows a gas regulating portion. **40** is a valve case having a gas supply outlet **45** to a gas burner **42** and forming a valve seat **45'** having a gas opening **44** between said gas supply inlet **41** and gas supply outlet **43**, **45** is a gas valve always urged by a spring **46** so as to close a gas passage hole **44**, and **47** is an operating rod slidably passing through said valve case **40** and the cover **19** of the diaphragm operating portion and engaging with an upper receiving plate **46** of the diaphragm **16** at one end and with the gas valve **45** at the other end, respectively. **49** is a heat exchanger heated by the combustion heat of said gas burner **42**, and **50** is a warm water supply pipe mounted on said heat exchanger **49** and having a plurality of warm water faucets (not shown in the figure). This warm water supply pipe **50** is connected to the water feed outlet **23** in the base **18** forming a part of a diaphragm operating chamber **15**, and the water inlet **22** of the base **18** is connected to the water supply pipe through a check valve, etc.

In a device according to one embodiment of this invention comprising above structures, if water is supplied to this high pressure chamber **21** from the water supply inlet **22** of the diaphragm operating chamber **15** through the governor **29** and then to the heat exchanger **49** through Venturi portion **33** and the water feed outlet **23**, the control element **36** rushes into the constricted portion **34** of Venturi portion **33**. Since the aperture area of this constricted portion **34** is small, the pressure across this area falls as indicated by Bernoulli's theorem, making the pressure lower in the low pressure chamber **20** through communicating passage **35**. Accordingly, the diaphragm **16** bends upward because of the pressure difference between the high pressure chamber **21** and the low pressure chamber **20** of the diaphragm operating chamber, thereby lifting the control element **36** within the constricted portion **34**.

The aforesaid bending condition of the diaphragm **16** is established when the pressure difference A between the high pressure chamber **21** and the low pressure chamber **20** is balanced by the sum B of the elasticity of spring **46** and the restoring force of the diaphragm itself. When the diaphragm **16** bends as described above causing the control element to move so that the tapered portion **38** faces the constricted portion **34** of Venturi portion **33** as shown in FIG. **2***b*, the aperture of said constricted portion becomes larger and consequently the flow velocity of water decreases so that the pressure difference A between the high pressure chamber **21** and the low pressure chamber **20** becomes smaller.

And, when the aperture of the constricted portion reaches a certain value the diaphragm is held in equilibrium.

The operating rod **47** relieves the gas valve **45** of the gas passage hole **44** of the valve seat **45'** resisting the spring **46** by the bending of said diaphragm **16**, thereby supplying gas to the gas burner. The combustion of the gas burner **42** heats the heat exchanger **49** and warm water is obtained through the faucet of the warm water pipe **50**.

When said warm water faucet is adjusted to vary the amount of warm water supply, i.e., when the temperature of warm water is adjusted, the amount of water flow varies naturally.

In this case, the condition of opening of the gas valve **45** by the bending of diaphragm **16** is automatically maintained accurately since the control element **36** automatically proceeds or recedes into or out of the Venturi portion corresponding to the amount of water flow.

For instance, when the flow changes from a small amount to a large amount, the pressure at the constricted portion **34** of Venturi portion **33** reduces to increase the pressure difference A because of the increase of flow velocity of the water, thereby bending the diaphragm **16** more upward. Because of this bending of the diaphragm **16** the smaller portion of tapered portion **38** of the control element **36** faces the constricted portion **34** and when the pressure difference A is balanced by the sum of the restoring force of diaphragm **16** and the elastic force of spring **46**, the bending action of the diaphragm **16** is stabilized.

In such a case as temperature control by regulating the amount of water, the diaphragm **16** does not reach the stabilized bending position at one time. When the increase or decrease of the amount of flow changes the pressure at the constricted portion **34** of Venturi portion **33** to produce the pressure difference between the high pressure chamber **21** and the low pressure chamber **20**, the diaphragm **16** operates by that pressure difference, thereby causing the control element **36** to move in the constricted portion **34**. Accordingly, the pressure in the constricted portion **34** varies in a smaller range than the previous value, and consequently the diaphragm **16** behaves as if vibrating within this range and finally is stabilized in a certain bent condition.

The gas valve **45** must always be opened sufficiently independently of the amount of water.

For this purpose, a means is provided how to fit the control element **36** to the constricted portion **34** at the time of interruption of water flow and said requirements are satisfied. If, as shown in FIG. **2***a*, the cylindrical portion **37** of the control element **36** is projected into the constricted portion **34** as long as **1** during interruption of water supply, the aperture of the constricted portion **34** does not vary so long as said cylindrical portion faces the constricted portion; consequently, even if a small amount of water flows, the diaphragm **16** bends more as much as the control element **36** moves more than **1**. Assume that the whole control element is tapered, the aperture of the constricted portion changes even by a slight action of the control element and a great magnitude of movement of the diaphragm can not be obtained by a small amount of water. Consequently, if the cylindrical portion **37** of the control element **36** is intruded by the length **1** into the constricted portion **34** of Venturi portion **33** as in this invention, the diaphragm **16** bends at least and more than **1** and the gas valve **45** can be relieved instantaneously by this variant value **1**.

FIG. **3** shows the relation of the water amount Q to the aperture G; according to this diagram, in the case of this invention the cylindrical portion **37** of the operator **36** is projected into the constricted portion **34** of Venturi portion **33** by a certain value of length and a characteristic curve C is obtained and a small amount of water completely opens the gas valve **45** instantaneously. In the case that the whole control element is tapered, the gas valve is not completely opened unless the water amount exceeds a certain value as shown by D, and it will be understood the valve is gradually opened until the certain value is reached.

As well known, in the gas combustion equipment, if the amount of gas supply is small compared with the combustion capacity, the fire will be easily put out by wind, etc. and stable combustion is not obtained.

In FIG. **3**, let G_1 be the minimum aperture of a gas valve required for gas supply necessary to complete combustion, then it will be understood that the gas valve aperture for complete combustion is obtained at a very small amount of water Q_1 for the characteristic curve c according to this invention and that a large amount of water is necessary for the characteristic curve D of the whole tapered control element.

Accordingly, the combustion of gas is very stable when the amount of water flow is small for this invention; it is not only of high reliability but also able to widen the variation of water amount, i.e., the adjustable range of temperatures of warm water.

In FIGS. 1 and 2 showing one embodiment of this invention, the control element 36 which varies the aperture of the constricted portion 34 of Venturi portion 33 may have a wholly cylindrical form without a tapered portion 38 at its end and this form of control element works any way. In this case, the aperture of the constricted portion 34 is established by the fact that how far the end of the cylindrical portion 37 of operator 36 is distant from the constricted portion 34.

In this case, however, the water passing between the constricted portion 34 and the cylindrical portion 37 generates eddies because the end face of the cylindrical portion 37 is a large flat plane; it is apparent therefore that a difficulty will be caused in the reduction of the pressure at the constricted portion 34.

If the tapered portion 38 is formed on the cylindrical portion 37, it is effective in smoothing the flow of water passing through the constricted portion 34 and there is no occurrence of eddies, assuring the pressure difference.

To express briefly the feature of the device of one embodiment according to this invention, it can change the temperature of warm water merely by the adjustment of water amount from the warm water outlet and be operated very easily; the water supply passage leading to this device is branched into other water supply appliances, and even if the water supply to this device varies depending on the amount of water used in these other water supply appliances, it does not occur that the gas valve is closed inadvertently or that unburned gas leaks because of extinguishment of gas combustion, thus exhibiting an excellency in terms of safety.

To explain another embodiment of the hydraulic responding portion, FIG. 4 is different from previous embodiments and shows an example wherein a diaphragm and a control element are not directly connected but exist independently of each other.

In FIG. 4, the high pressure chamber 21 of a diaphragm operating chamber 15 serves also as a middle part of a water supply passage and forms a Venturi portion 51 between the high pressure chamber 21 and a water outlet 23. The constricted portion 52 of this Venturi portion 51 communicates with the low pressure chamber 20 of the diaphragm operating chamber 15 through a communicating passage 53. Said Venturi portion 51 has an opening closed by a plug body 54 at one axial end, and the base end of a guiding rod 55 facing the central portion of the Venturi portion 51 is fixed to said plug body 54, the end of said guiding rod 55 reaching near the constricted portion 52. 56 is a control element fitted loosely in Venturi portion 51 in the condition that it is mounted slidably onto the guiding rod 55, and has a tapered portion 57 on its one side and a flange 58 projected outward on the other end. 59 is a spring urging the control element 56 to protrude into the constricted portion. 60 is a stopper which determines the position of the operator 56. When water does not flow, the control element 52 contacts with the end of this stopper 60 and takes its position where the portion of largest diameter opposes to the constricted portion 52.

In the above device, the water flowing in from the water supply inlet 22 reaches the diaphragm operating chamber 15 through a governor 29 and is then sent to a heat exchanger through Venturi portion 51 and a water outlet 23. In this case, a part of the water passing through Venturi portion 51 collides against the flange 58 of the control element 56 and the element 56 resists the spring 59 by this water pressure so that the tapered portion 57 slides in such a direction as to come out of the constricted portion 52. And this sliding stops at a point where the repulsive force of the spring 59 and the hydraulic pressure acting on the flange 58 acting in opposing directions to each other are balanced, thereby stabilizing the control element 56. Consequently, the aperture of constricted portion 52 of Venturi portion 51 is automatically set to the optimum value corresponding to the amount of water at that time and can securely cause the pressure drop of the constricted portion 52. Because of this pressure drop in the constricted portion 52, the low pressure chamber 20 of the diaphragm operating chamber 15 becomes low in pressure through the communicating passage 53, causing the diaphragm 16 to bend upward owing to the pressure difference between the low pressure chamber 20 and the high pressure chamber 21, opening a gas valve with an operating rod 47. In case the amount of water flow varies by adjusting the warm water outlet, the hydraulic pressure acting on the flange 58 of the operator 56 and the repulsive force of the spring 59 become unbalanced and the control element 56 accordingly moves to a position where said two forces are balanced, securing the aperture of the constricted portion 52 corresponding to the amount of water at that time. For instance, if the warm water amount is controlled in order to obtain water of a high temperature, the consequent decrease of the amount of water flow reduces the hydraulic pressure acting on the flange 58 of the operator 56, and the repulsive force of the spring 59 at that time reduces said hydraulic pressure. Consequently, it follows that the operator 56 moves so that its tapered portion 57 protrudes into the constricted portion 52; and when the operator stops to move after balancing again the repulsive force of the spring against the hydraulic pressure, the tapered portion of larger diameter faces the inside of the constricted portion. As a result, the aperture of this constricted portion is smaller than it was before and the flow velocity of water in the constricted portion is kept high and a sufficient pressure drop is obtained regardless of the decrease of the amount of water.

The most important matter in the above device is the mutual relation of forces comprising the hydraulic pressure acting on the flange 58 of the operator 56 and the repulsive force of spring acting in the opposite direction. If the repulsive force of the spring 59 is too large, the increase of the amount of water flow, and therefore, a larger hydraulic pressure acting on the flange 58 of the control element 56 does not shift said element, so that the aperture of the constricted portion 52 becomes small relative to the amount of water flow, and the flow resistance of water will apparently increase remarkably. On the other hand, if the repulsive force of the spring 59 is too small, the hydraulic pressure acting on the flange 58 becomes larger than the repulsive force of the spring 59 even when the amount of water flow is very small so that the control element 56 moves in such a direction as to come out of engagement with the constricted portion 52, and consequently the aperture 52 is large for a small amount of water and

sufficient pressure will not be obtained. Therefore, when the pressure acting area of the flange **58** and the repulsive force of the spring **59** are selected, the range of variation of water flow and the range of variation of aperture of the constricted portion **52** must be considered in connection with this; if the repulsive force of the spring is made to be adjustable, it is very advantageous in adjusting minute balance.

FIG. **5** shows an example of adjusting the repulsive force of the spring **59** wherein a threaded portion **61** is formed on the guiding rod **55**, this threaded portion **61** is screwed into the plug body **54** and on one end of the protruded threaded portion is mounted a disc **62**, one end of spring **59** is received by a spring receiver **63** provided on the way to the guiding rod **55** and the other end of spring **59** is arranged to be received by the end face of the flange **58** of the control element **56**.

In the above structure, if the guiding rod **55** is rotated through the disc **62** to advance, the spring **59** is compressed and its repulsive force increases. If the guiding rod retreats, the spring repulsive force decreases. As a result, the balance of the repulsive force of spring **59** against the hydraulic pressure on the flange **58** of the control element **56** can be kept optimum in connection with the range of variation of the amount of water flow and the range of variation of aperture of the constricted portion **52**. In addition, the fluctuation of elasticity of the spring **59** and the fluctuation of size of the control element **56** can be absorbed by adjusting the disc **62**.

It goes without saying that said disc **62** is all for adjusting the repulsive force of the spring **59** and essentially different from such a one as a conventional type of disc **14** for moving a control element itself. When the amount of warm water supply or the temperature of warm water is changed, the control element **56** of FIG. **5** of course moves automatically without any manipulation of the disc **62**.

FIGS. **6** and **7** show examples in which a control element serves also as a governor. A Venturi portion **64** is formed between a water supply inlet **22** and a water outlet **23**, and a large diameter portion **65** is connected to the high pressure chamber **21** of a diaphragm operating chamber **15** through a communicating passage **66**, and a constricted portion **67** is connected to the low pressure chamber **20** through a communicating passage **68**, and a valve seat **69** is formed in the communicating passage **68** of the constricted portion **67** with the water outlet **23**, and a control element **70** is formed by directing outward a flange having a hydraulic pressure acting portion **71***a* and an opening or closing valve portion **71***b*.

In the above device, the fundamental operation is the same as the device of FIG. **4** in that the control element **70** functions depending on the variation of the amount of water flow and the aperture of the constricted portion **67** is set automatically to a value suitable to the amount of water to obtain a secure bent condition of the diaphragm **16**. But in the device shown in FIGS. **6** and **7**, a high hydraulic pressure acts on the hydraulic pressure acting portion **71***a* of the flange **71** of the control element **70** when the hydraulic pressure becomes abnormally high, thereby advancing the control element **70** extremely forward. In this case, the valve portion **71***b* of the flange **71** approaches the valve seat **69** and regulates the flow of water to cause the hydraulic pressure to fall. Consequently, this device is very effective in use in the area where the water supply pressure is not stable. This device does not require a particular cover and can be built mechanically simple, and at the same time an extreme deformation of diaphragm, etc. because of extraordinary hydraulic pressure of the damage of copper tubes, etc. mounted on the heat exchanger portion locally low in strength can be prevented.

As above, embodiments of this invention were explained, but it is apparent that this invention can be variously modified without departure from the spirit of this invention and within the scope of this invention.

We claim:

1. A valve assembly for controlling the supply of water and gas to the heat exchanger portion of a gas water heater, comprising:

a diaphragm operating chamber divided into a high pressure chamber portion and a low pressure chamber portion;

a diaphragm disposed in said diaphragm operating chamber for separating said high pressure chamber portion from said low pressure chamber portion;

gas control means connected to said diaphragm for controlling the supply of gas to said heat exchanger portion;

governor means connected to said diaphragm for controlling the rate of flow of water into said valve assembly from a water supply inlet;

water flow path means communicating said high pressure chamber portion with said heat exchanger portion, said flow path means comprising a Venturi portion having a constricted region, a first passageway connecting the input of said Venturi portion with said high pressure chamber portion, and a second passageway connecting the output of said Venturi portion with said heat exchanger portion;

a further passageway, having a smaller cross-sectional area than said first passageway, connecting said Venturi portion with said low pressure chamber portion;

a control member having a tapered portion at one end which protrudes into the constricted region of said Venturi portion and an opposite end portion acted on by the hydraulic pressure of water flowing through said water flow path means;

means mounting said control member in said valve assembly independently of said diaphragm to be freely movable into and out of the constricted region of said Venturi portion; and

biasing means resiliently urging said control member normally in a direction opposite to the direction of and against the pressure of the flow of water in said water flow path means.

2. A valve assembly according to claim **1**, further comprising adjusting means for adjusting the biasing force of said biasing means.

3. A gas water heater as described in claim **1** characterized by forming a valve seat on water supply passage adjacent Venturi portion and integrating the valve portion cooperating with said valve seat and said control element opposing thereto.

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