The present invention relates to an improved safety device for apparatus using fuel gases. So-called "positive safety" devices are defined as devices comprising an assembly of parts in which any deterioration, misregulation, or defect in the apparatus, which is distinct from the actual heating apparatus must produce automatically:

(1) The stopping of the operation of the heating apparatus and

(2) The preventing of the restoration of operation of such apparatus.

This definition implies that in the event the actual heating apparatus is inoperative, it is possible that the assembly does not fulfill its proper function. This actual heating apparatus which is not specifically described in the definition, consists practically of that part of the apparatus, the function of which directly ensures the admission or stoppage of the fuel gas to the main burner of the apparatus using it (such as the valve, vanes, tap etc.), the operation of which is controlled by the assembly of other apparatus comprising the present device.

It is one object of the present invention to provide a safety device for apparatus using fuel gases which includes in the apparatus an assembly which includes means causing automatically stoppage of the fuel gas flowing to the main burner of the apparatus concerned in case of deterioration, misregulation or defect.

It is another object of the present invention to provide a device which comprises at least two apparatus which are connected in series, that is to say in such a way that the closing of one of them is sufficient to cut off the supply of gas to the main burner.

It is still another object of the present invention to provide a device which, in every manual or automatic action operative on the admission or stoppage of the fuel gas to the main burner of the apparatus in use will involve simultaneously each of the two apparatus, these latter being connected together in such a way that if any of them is not in operative condition, the operation of the apparatus in use is discontinued. It should be emphasized that by "discontinued" it is understood the impossibility of opening or reopening the apparatus and by "disturbance" it is understood a non-dangerous disturbance in the operation of the apparatus in use but of sufficient importance that the use thereof must be safely prevented. Deterioration of any single apparatus for performing its function being under these conditions infallibly shown or made apparent, there is obtained a positive integral safety device.

In practice every manual or automatic action controlling the admission or stoppage of the fuel gas to the main burner is preferably applied directly to a first apparatus for performing the function and transmitted therefrom to the following apparatus for performing the function always subject to the condition that the said first apparatus for carrying out the function operates correctly. At least one apparatus for performing the function is subject to an auxiliary detector member for faulty conditions which, when brought into action, prohibits the operation of the said apparatus.

When such an auxiliary member for faulty detection comes into action upon occurrence of a defect in one or the other of the apparatus for carrying out the function, reopening of the apparatus for performing the function subject thereto requires manual intervention.

A device constructed according to the present invention can only be in the faulty condition, if all the elements of the apparatus for performing the function simultaneously themselves become defective during the period between the consecutive actions brought manually or automatically by the admission or interruption of the gas flow to the main burners of the apparatus in use. If the case is considered in particular of a boiler provided with a thermostat of which the actions of stoppage and opening are normally timed several minutes apart, the probability of the device to be defective is infinitesimally small.

The apparatus for performing the function capable of being embodied in the apparatus according to the present invention may be obviously of any type (such as pneumatic, electric or bi-metallic valves, motor valves, etc.) or with a direct action, or controlled by one or more auxiliary apparatus such as safety devices, thermostats, temperature or pressure limiters, etc.

It is a further object of the present invention to provide a device in which the auxiliary apparatus (other than the apparatus for performing the function) may be of any number and of suitable types for the openings required by the assembly of parts comprising the device.

With these and other objects in view, which will become apparent in the following detailed description, the present invention will be clearly understood in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view in section of a device according to the present invention based mainly on a pneumatic apparatus for performing the function and a device for performing the function controlled directly by an expandable element such as a bi-metal strip;

Fig. 2 is a similar diagrammatic view of another embodiment of construction comprising two pneumatic apparatus for performing the function; and

Fig. 3 is an axial section of a temperature limiting device.

According to the method of construction selected and shown in Fig. 1, the device comprises two structures for performing the function connected in series between a gas inlet pipe 1 and an outlet pipe leading to the main burner 2. The first structure is a pneumatic valve arrangement on the downstream side of the main, manually controlled valve 3 in a valve body 4. The valve element 5 of this valve controls the opening or closing of the principal gas circuit in cooperation with a double lip seat 6, 7. This valve is rigid with a fluid tight flexible diaphragm 8. An orifice 9 of small open cross-section connects the spaces disposed respectively on the two sides of the valve seat 6, 7. An orifice 12 of small open cross-section and a pipe 13, which may be merely a passage cut in the body 4, connects with the chamber 10 and the container 14 disposed above the diaphragm 8. The second structure for performing the function comprises a body 15 and a valve 16, the rod of which is controlled by a temperature sensitive element 17 arranged in such a way that when it is cold the valve 16 is closed and vice versa. This element 17 is located in front of a jet 18 producing a flame 19 which is intended to heat the element 17. The jet 18 is fed by a pipe 20 which takes the gas from between the two lips, 6, 7 of the seat of the valve 5. This pipe 20 is connected with the nozzle 18 through the intermediary of a binary cylinder 21 for limiting the temperature which cuts off the supply to the nozzle 18, that is to say the heating flame 19 for
the temperature sensitive element 17, when the temperature of the mass of water heated by the main burner exceeds the limiting temperature provided for the range of the normal regulating thermostat. This cut off element 21 may be a device with manual and non-automatic resetting. It may be economically based on the use of a metal which melts at a low temperature (darect metal for example) which metal when fused closes the gas passage. This metal of low melting point is shown as member 22, which upon melting drops to the bottom and closes the outlet of pipe 20.

Ignition of the flame 19 is effected whenever the jet 18 is supplied with gas by continuous or pilot light flame 22 which also ensures ignition of the main burner 2. The pilot light 22 is constantly fed through a pipe 23 leading to a gas inlet of small dimensions 24 at the upstream side of the main valve 3. A valve 25 permits the feed to this pilot light flame 22 to be permanently stopped.

The normal control of the temperature of the mass of water heated by the main burner 2 is ensured by a thermostat indicated diagrammatically. This thermostat of a normal type is assumed to embody a flap valve which is open when the control temperature is less than the desired temperature and vice versa and this flap valve is connected in series in a pipeway 27, 23 which connects the container 14 above the diaphragm 8 of the valve 5 to the feed pipe 23 of the pilot light 22 on the upstream side of the valve 25.

The operation of the present device is performed as follows:

When the device is cut off, the valves 3 and 25 are closed, since the two valve faces 5 and 16 rest in the respective valve seats. When the valves 3 and 25 are open, the pilot light 22 is ignited. The distance z for the outlet of valve body 4 is so calculated that for the maximum gas pressure it is incapable of lifting the valve 5 against the pressure of the diaphragm 8 and the valve 5 accordingly rests on its seat. The gas fills, however, the enclosure 11 through the orifice 9 and the pressure in the enclosure 11 beneath the diaphragm 8 reaches slowly that of the chamber 10. The pressure in the container 14 is near atmospheric pressure since the total of the two cross-sectional areas 12 and 24 is less than the cross-section of the flame jet 22. The cross-section of the diaphragm 8 is so calculated that under these conditions the gas pressure lifts the valve 5 and the tube 20 is supplied with gas. The flame 19 is then ignited by means of the pilot light 22. The temperature sensitive element 17 is heated and opens the valve 16. Gas is admitted to the burner 2 which is ignited by the pilot light 22 arranged as in the normal way adjacent the burner 2. When the thermostat 26 becomes operative due to reaching a predetermined temperature, the container 14 ceases to be in communication with the atmosphere and the gas continuing to arrive from the orifice 12, the supply pressure is increased above the diaphragm 8 and the valve 5 returns to its seat by its own weight. The gas is cut off from the burner 2 of the boiler. Since the tube 20 is no more supplied with gas, the flame 19 will be extinguished and the temperature sensitive element 17 cools off and closes the valve 16. The whole system has now returned to the position preceding the ignition and when the thermostat opens again, the ignition operations are repeated as above.

If for any reason the valve 16 is left open while the valve 5 is closed, the enclosure 15 is brought into communication with the atmosphere by borings or any other suitable means as the connection with the burner 2 and the valve 5 is maintained in its closed position. Only the orifice 9 of very small cross-section supplies gas to the main burner 2 which is insufficient and not dangerous.

If on the other hand the valve 5 cannot close for any reason, the thermostat does not operate and the boiler rises in temperature whereupon the cut-off device 21 operates, bringing about the closure of the valve 16 and the locking thereof in the closed position, upon melting the metal 25a of low melting point.

Fig. 2 is a second embodiment of the present invention, which comprises two apparatus for performing the function consisting of pneumatic valves. The same references designate in this figure the same elements corresponding exactly to those of Fig. 1. The second structure for performing the function here comprises a body 30 which contains a flap valve 31 rigid with a diaphragm 32. An orifice 33 of small cross-section brings the container 34 above the diaphragm 32 into communication with the enclosure 11. Likewise the container 14 above the diaphragm 8 of the first valve is connected, as in the previous embodiment, through the conduit 27, 23 with the feed pipe 23 for the continuous flame or pilot light 22 through the intermediary of the thermostat 26 and the container 34 above the diaphragm 32 of the second valve is connected, in the present case, with the same pipe 23 by means of a pipe 35, in which is inserted a valve 36 controlled by a thermo-sensitive element 37.

This apparatus 14, 19, 21, 22 as arranged in such a way as to open the valve 36 when it is heated by this flame and to close it when the flame 19 is extinguished.

In order that the valve element 31 of the second valve can open in the present case, the container 34 above the diaphragm 32 must be brought into communication with the atmosphere which is effected, in like manner for the container 14 of the first valve, through the jet of the continuous flame or pilot light 22; it is thus necessary for this apparatus that the pilot light 19 should be preliminarily ignited by opening the first valve 5 and this produces the opening of the valve 36 by heating the thermo-sensitive element 37.

Apart from this difference, the ignition is effected as in the previous embodiment and the operation is similar.

The operation of the thermostat 26 is identical with that in the embodiment shown in Fig. 1. It will readily be seen that the locking in the closed position is effected in the same way when one of the two valves remains in the open position. It should also be noted that provided the orifice 33 has a slightly larger cross-section than the orifice 9 although of much smaller cross-section than that of the outlet orifice for the pilot light 22, the apparatus is locked even when the container 34 remains in the open position, since leakage through the orifice 33 makes the establishment of the supply pressure in the enclosure 11 impossible.

Finally a further precaution should be taken in the construction to prevent accidental or arbitrary reopening of the valves in the case where the orifice 33 should accidentally become blocked.

It is sufficient to choose the cross-section of the two diaphragms 8 and 32 and the respective weights of the two valves 5 and 31 in such manner that only when atmospheric pressure is present on the upper face of the two diaphragms 8 and 32, the valve 31 opens for pressure supplied on the lower face of the diaphragm 32 above the pressure also applied on the lower face of the diaphragm 8 which produces the opening of the valve 5.

In this way, when the thermostat opens, the orifice 9 fills the enclosure 11 until the valve 31 opens. At this moment the enclosure 11 is in communication with the atmosphere by the partial opening of the valve 31 and the pressure cannot rise therein to a value greater than that which just produces the opening of the valve 31. From the constructional arrangement this pressure is insufficient to produce the opening of the valve 5 and the latter is thus locked in the closed position.

Referring again to Fig. 2, supplies gas 3, a special embodiment of the temperature limiting device is disclosed. It comprises again a cut off element 21 which has outer thread 39 for securing the element 21 to the connecting pipes. An opening 41 provides for the gas inlet into a first bore
and a second opening 49 for the gas outlet from a second bore. A metal member 23a of a low melting point is disposed in a third bore between the first and second bores. A channel connects the first and second bores and permits free flow of gas through the first and second bores. Upon melting of the metal member 23a, the molten metal closes the gas flow in the connecting channel.

In all the possible constructions of the invention, various other auxiliary members (for example pressure regulators, control devices for various control members) may be provided without departing from the scope of the invention.

The two embodiments described above show that for the device to be faulty, it is necessary that two apparatus for performing the order shall themselves become defective simultaneously during a period of time separating two consecutive operations of the thermostat and it may be readily seen that the probability of such occurrence is quite negligible.

A number of other embodiments of the invention may be envisaged without departing from the scope of the invention, for example, the assembly may be constructed with an electric valve and a pneumatic valve or an electric valve and a valve controlled by an expansible element or the like and likewise power operated electric valves with thermo-couples or the like may be used.

While I have disclosed several embodiments of the present invention, it is to be understood that these embodiments are given by example only and not in a limiting sense, the scope of the present invention being determined by the objects and the claims.

What I claim is:

1. In a device for controlling the flow of gas in a main conduit to a main burner, a control apparatus for gas operated water heating equipment comprising an assembly including at least two operatively interconnected gas control members disposed in series in said main conduit to said main burner, the closure of either of said gas control members cutting off the feed of gas to said main burner, said gas control members comprising a first and a second control valve, means including a thermal element for operating said second valve, and means for opening and closing, respectively, said first valve in response to the requirements of heat from said heating equipment, means responsive to the opening of said first valve to heat said thermal element to cause said second valve to open, dependent upon said first valve, a container for said first valve and a diaphragm disposed across said container and carrying a valve element of said first valve, said first valve including a gas inlet duct terminating in a seat for said valve element, said diaphragm being chosen to retain said valve element in closed position upon subjecting only the latter to the gas pressure from said duct and to open said valve element upon subjecting the same side of said diaphragm in addition to said valve element to said gas pressure, to create a sufficient pressure difference in said container above said diaphragm to lift said valve element from its seat, if said second valve is closed and to retain said valve element in closed position if said second valve is opened, and a cut-off means co-operating with said thermal element causing closure of said second valve, if as a result of a defect both valves have remained open.

2. The device, as set forth in claim 1, which includes a pilot burner and wherein said cut-off means comprises a fusible alloy stopping said pilot burner, the latter causing operation of said second valve, so that said pilot burner cannot be reignited until said alloy has been replaced.

3. In a device for controlling the flow of gas in a main conduit to a main burner, an apparatus for gas-operated heating equipment comprising a body having a gas inlet and a gas outlet and two valves disposed in series between said inlet and said outlet, a thermostat responsive to the temperature of said heating equipment controlling the position of the first of said two valves in the direction of the feed of said gas, a flame jet and a thermal element responsive to the temperature of said flame jet controlling the position of said second of said valves, means to supply gas to said flame jet upon opening of said first valve, thereby opening said second valve and providing a gas passage from said inlet to said outlet, means preventing initial opening of said first valve unless said second valve is in its closed position, and cut-off means responsive to an excessive rise in temperature of said heating equipment rendering said flame jet inoperative independently of the position of said first valve.

4. The device, as set forth in claim 3, wherein said cut-off means cut off the feed of gas to said flame jet, thereby cooling said thermal element and closing said second valve.

5. In the device, as set forth in claim 3, wherein said first valve includes a seat having a port disposed within said seat and connected with a conduit feeding gas to said flame jet.

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