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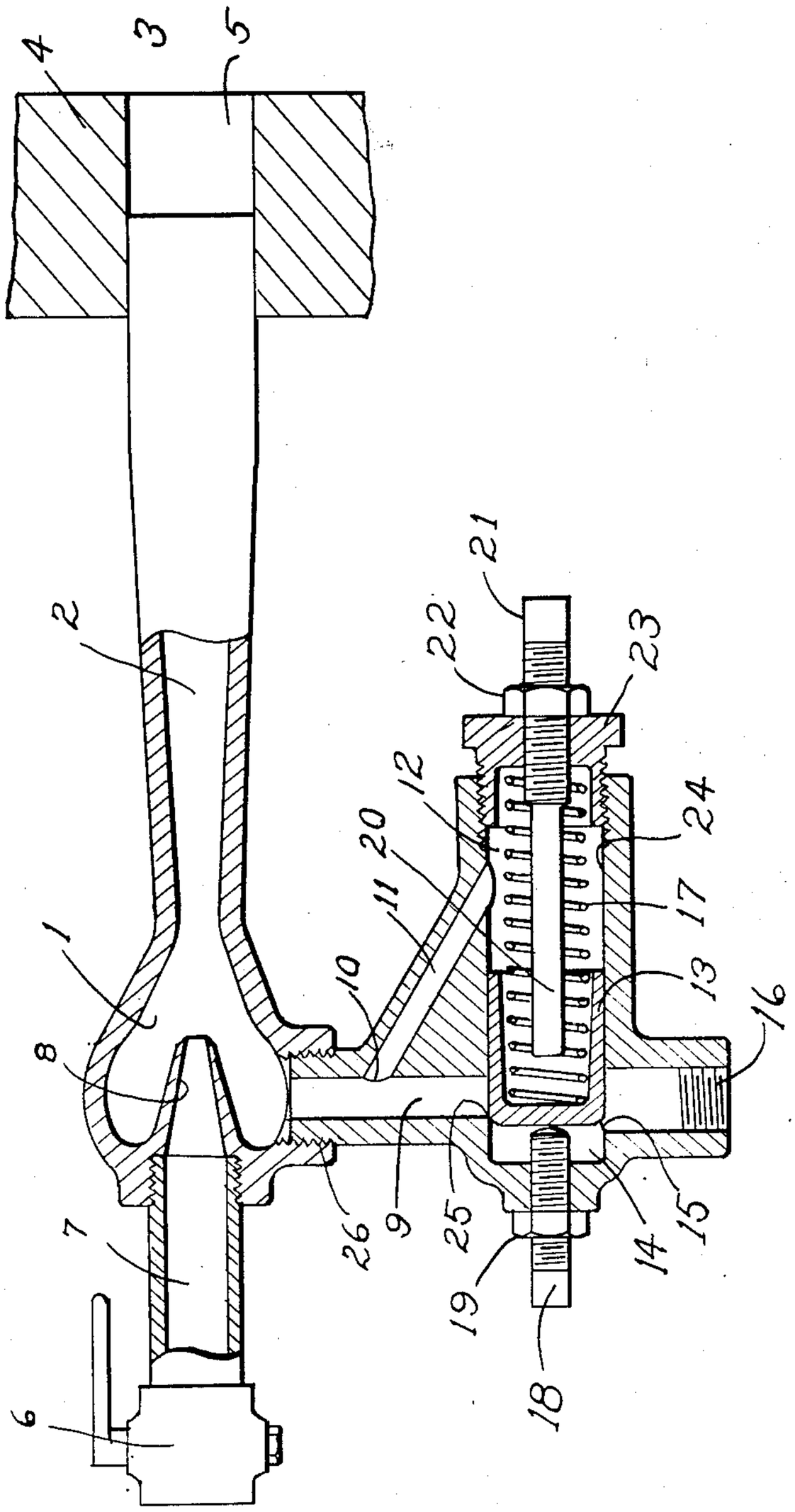

F. W. Hornbruch INVENTOR

BY

Thomas Howe ATTORNEY

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FREDERICK W. HORNBRUCH, OF ROSELLE PARK, NEW JERSEY, ASSIGNOR TO AMERICAN GAS FURNACE COMPANY, OF ELIZABETH, NEW JERSEY, A CORPORATION OF NEW JERSEY

GAS CONTROLLED VALVE OPERATED BY SUCTION

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This invention relates to an improved apparatus for controlling the mixture of a fluid or more particularly a gas which is combustible with another which supports combustion such as air, oxygen etc. The principal object is to control the flow of the gases one by the other, so that in case the flow or supply of one gas varies the other will be automatically controlled thereby in a more efficient and simple way.

Another object is to inject a gas into a mixing chamber and producing the flow of another gas under constant pressure proportionate to the flow of the first gas substantially independent of the variation of resistance from the supply nozzle, mixing chamber or any of the other elements associated therewith. This resistance to flow may include any one of a number of different elements such as resistance of the nozzle, back pressure from the furnace or from the exhaust flue etc. The back pressure might be caused by unfavorable gusts of wind where the exhaust is into the open air, or by explosions within the fire-box itself. From fluctuations in temperature within the fire-box, and the consequent variations of the products of combustion, or from withdrawal of materials being heated, or from opening or closing of the doors or dampers, or from variations of pressures in the flue due to other causes, such as the variation in quality of the gases, there may result variations of pressure within the mixing chamber and within the fire-box.

Another object of this invention is to construct and arrange a device for regulating fuel control valves having a fewer number of moving parts than heretofore and of a simpler construction.

Another object is to arrange and construct a gas or fuel control valve in the form of a piston or slidable member arranged within a chamber, the outlet of this chamber providing a greater restriction to the flow of gases than the intake into said chamber.

Another object of this invention is to provide a controlling arrangement for automatically adjusting the proportions of a mixture of combustible material in which no pliable membranes are necessary which are liable to rot and become leaky and is further so arranged as to obviate any difficulty on account of leakage past the piston which might prevent local detonations or explosions in case of back-firing. The only passage leading to the confined control chamber is arranged through a small narrow duct which would not ordinarily conduct ignited gases because of its small size and therefore prevent undesirable pressures caused by local explosion.

A still further object of this invention is to provide an automatically controlled fuel valve for the control of fuel supply to a mixing chamber and thence to a fire box. Between this mixing chamber and fire box there is arranged a nozzle which has no unevennesses, holes or restrictions therein. The nozzle is in the form of a Venturi tube connected with the mixing chamber and as is well known varies the pressure and speed of gases at different points. It is important that this Venturi tube be arranged for free and easy passage of the gases without restriction which might collect carbon or other deposits from the gases themselves. It is also desirable to have the inside surface of this tube made as smooth as possible by machining and polishing.

It is another object of this invention to provide a mixing chamber with controlling ducts leading therefrom arranged as close as possible to the mixing chamber so that the best efficiency results therefrom and the least likelihood of fluttering or oscillation arises. The use of a piston in such an arrangement is more advantageous inasmuch as it provides means for the application of friction directly to the pressure-operated member to prevent such fluttering.

Another object of this invention is to provide a fuel control valve with adjustment for controlling the cut-off pressure of the combustion supporting gas at which the valve will operate and an adjustment for proportioning the amount of fuel gas to combustion supporting gas and a still further adjustment for controlling the maximum possible flow of fuel and also concurrent adjustment of the proportioning means and the maximum flow

adjustment means in order to simplify the control therefor.

Further and more definite objects will appear in connection with the following specification, claims and drawing in which the single figure represents a form of my arrangement.

In this figure 1 represents the mixing chamber where the fuel gases are mixed with the combustion supporting gas. 2 is the Venturi tube to the fire-box 3 shown diagrammatically as a simple sidewall construction 4 with an opening 5 for inserting the tube. 6 is a control valve through the operation of which the entire apparatus may be controlled and the supply of gas varied according to the adjustment of this valve. This valve 6 is in the form of an ordinary cut-off valve and controls the flow of air of comparatively high pressure to fluid supply tube 7 and to jet 8. Directly connected to the mixing chamber is a second fluid conducting tube 9 for conducting the flow of combustible gas or other materials thereto. This tube is of small cross section. Connected into the tube 9 at 10 is a small pressure controlling duct 11 which opens into a chamber 12 at the rear end of a piston 13 which acts in its position at the left as a shut-off for the tube 9. On the opposite end of this piston is a chamber 14 which is in direct connection through the opening 15 between the piston and the edge of the chamber 14 to a fluid supply tube 16 for a supply of combustible gas or other material. This supply of gas may be conducted through a larger diameter tube than the supply tube 9 and these two passages 9 and 16 constitute the low pressure feed tube.

This supply of gas at 16 is under a slight pressure so that it will pass through the pipe in the ordinary way. This pressure only amounts to 2 or 3 ounces over the ordinary atmospheric pressure such as exists in the ordinary gas main.

When the device is not in operation a spring 17 normally holds piston 13 against the shut-off adjustment 18. This adjusting screw is held in a definite position by means of lock-nut 19 and controls the closing position of the plunger 13 so that it may close the opening of tube 9 and leave the opening from the supply of gas 16 sufficient as shown at 15 to permit the gas pressure to operate upon one side of the piston 13 so that it may be moved against the action of the spring biasing means 17 whenever the atmospheric pressure is removed at the other end by means of the vacuum created in the mixing chamber 1 transmitted through the duct 11.

As is well known in the operation of the Venturi tube, when a fluid is forced through such a tube, a vacuum is created at one point while the pressure is built up at another point in the tube. The mixing chamber is so designed as to take advantage of this effect and the nozzle 8 forces the air or other fluid into the throat of the tube creating a vacuum in the mixing chamber 1. This vacuum withdraws some of the gases through the duct 11 and thereby operates the piston 13 through the pressure of the gas against the end of the piston.

In order that the piston will not be thrown too far against the action of the spring 17 as might occur in case of such application of sudden pressure, a stop 20 is provided on the end of an adjusting screw 21 which is held in adjusted position by means of lock member 22. This adjusting means is supported by means of a second adjusting cap 23. This adjusting cap not only serves for adjusting purposes but also closes the end of the cylinder 24 in which the piston 13 slides. Rotation of the adjusting nut 23 also controls the pressure of the spring 17 and its tension against the piston 13. Whenever this adjusting nut 23 is rotated it will be seen that the adjusting screw 21 is also carried to a position which is controlled by the position of the adjusting nut 23. It can therefore be seen that with a given setting of tension on the spring 17 a definite amount of gas will be supplied to the tube 9 for a given amount of vacuum created in the mixing chamber 1.

It is also true that the amount of vacuum created in the chamber 1 is proportional throughout the useful range to the amount of flow of fluid through the nozzle 8. This being so, it can be seen that the adjustment of the spring 17 will control the proportions of the flow of combustible gas to the flow of combustion supporting gas in tube 7. The parts are so proportioned that the proper ratio of combustible gas will be maintained throughout the working range of the apparatus.

In addition to adjusting the tension of the spring 17 the movement of adjusting member 23 also controls as explained before the position of the stop 20. This is an advantageous arrangement inasmuch as increase in pressure of the spring 17 causes a reduction in the supply of combustible gas through the passageway 9 and therefore it is not so essential that the piston 13 be withdrawn completely in its fully operated position. This concurrent adjustment therefore permits a decrease in the range of movement of the piston 13 which is automatically compensated for by the fact that the adjusting screw 21 with its abutment 20 is moved at the same time that the adjusting nut 23 is changed to control the tension on the spring 17.

It has also been found to be advantageous to use a piston 13 inasmuch as the friction between it and the walls of the cylinder 24 prevent rapid fluctuation or fluttering of the combustible gas control valve. It has

also been found that in order to provide a free and easy movement of the piston 13 some clearance between it and the cylinder 24 must be provided, and that this clearance may permit some slight amount of the combustible gas to flow into the chamber 12 rather than through the opening provided at 25 into the tube 9. However, this would not prove to be detrimental inasmuch as the duct 11 is directly connected to the tube 9 and therefore any gas which finds its way into the chamber 12 is conducted by means of suction produced in mixing chamber 1 through the duct 11 and out to the fire-box in the ordinary way.

The fact that the plunger 13 is suction operated also permits of a greater amount of leeway and clearance between the adjusting nut 23 and the side walls of the cylinder 24 so that if any leak occurs in this construction, no gas will escape but it will flow, during the operation of the arrangement, through the duct 11 and out to the fire-box as explained before. The same is true of any other gas which enters into the chamber 12 due to the suction from any opening which may exist between the screw 21 and the nut 23. In this way, all of the advantages of a piston control arrangement are retained while the disadvantages of any leaking past the piston are overcome.

If desired the adjusting screw 18 may be so set as to provide a slight opening at 25 when the piston 13 is in the extreme position to the left. This may be advantageous at times when it is desired that there be provided a small pilot flame in the fire-box even though the supply of gas which supports combustion is interrupted. Such an arrangement would be advantageous in preventing explosions due to the accumulation of combustible gas in the fire-box whenever the supply of combustion supporting gas were cut off so as to cause the flame to become extinguished. If the supply of combustion supporting gas were later turned on then a large amount of combustible and explosive mixture might be withheld in the fire box and if an attempt were made to ignite it an explosion would follow.

With the present arrangement it is possible to maintain complete control of the flame by means of the valve 6 and with no further or additional adjustments. Once the adjustments 18, 21 and 23 are set for a certain grade or type of combustible gas then it is possible to control the apparatus automatically by the valve 6.

In the present arrangement the control apparatus is maintained in as close relation to the mixing nozzle 1 as is possible and no tubes or ducts are led from this flame supporting Venturi tube 1 so as to form an obstruction or unevenness where carbon deposits may accumulate and thereby interfere with the operation of the apparatus. Often times when such carbon deposits accumulate they may become accidentally ignited and thereby cause what is known as a flare-back to ignite all of the gases within the mixing chamber 1 and the Venturi tube 2.

This is undesirable inasmuch as it is likely to be maintained for some considerable time and cause damage to the structure due to heat or increased pressure. The fact that the control chamber is located closely to the mixing chamber permits the automatic operation of the piston 13 whenever a flare-back causes back pressure within the mixing chamber. This immediately cuts off the supply of gas for a sufficient length of time to allow a supply of air through the jet 8 to blow the ignited gas outside of the chamber and back to the fire-box. The inside of the Venturi tube 2 may be machined or polished as desired so as to overcome any difficulties arising from adherence of carbon deposits.

It can also be seen that the automatic control arrangement can be readily applied to existing gas burners which have a Venturi tube 2 and a mixing chamber 1. The control apparatus may be screwed into the mixing chamber 1 as is shown at 26 and the supply of gas conducted into the opening 16. No other control pipes or other devices are required to complete the automatic operation of the arrangement. Also the fact that a single piston 13 is the only movable part which is subject to wear and the fact that it can be readily withdrawn at the end of a bore 24 adds to the simplicity and efficiency of the arrangement.

It is not intended to be limited to the exact structure described and shown but a full range of equivalents is intended in the interpretation of the following claims and the structure shown is one of the preferable designs.

What I desire to claim is:

1. In combination with a gas and air mixing chamber, an injecting nozzle therein, a Venturi tube into which the nozzle discharges for causing a partial vacuum in the chamber, said chamber having a single opening and a delivery conduit leading to said opening, a tubular housing, a valve piston arranged to operate in said tubular housing to control the flow of gas through said delivery conduit, the housing having an opening therein at the rear of said piston, and a duct providing open communication between said delivery conduit and said rear opening.

2. In combination with a gas and air mixing chamber, an injecting nozzle therein for compressed air, a Venturi tube receiving the discharge from the nozzle and cooperating with the nozzle for causing a partial vacuum in the chamber, a single opening being provided in said chamber, a delivery conduit

leading to said opening, a gas-supply conduit, a tubular housing, a valve piston arranged to operate in said tubular housing to control the flow through said delivery conduit, the housing having an opening therein at the rear of said piston, a duct providing open communication between said delivery conduit and said rear opening, means for biasing said piston toward closing position, so tensioned as to be operative by the degree of vacuum produced in the chamber, and capable of closing the delivery conduit, said piston leaving the gas-supply conduit open while the delivery conduit is closed, and a stop for the piston.

3. In a fuel gas burner supply system, a supply inlet for gas under low pressure, a tubular housing connected to and arranged at an angle with the inlet, a piston valve slidable in said housing, the housing on one side of the piston opening into the gas supply inlet, the latter being nearly closable by said piston, and a gas delivery conduit located in the path of and adapted to be closed by the piston, the gas delivery conduit being closable by said piston while said supply inlet remains slightly open, the piston being subject to opening movement by pressure of gas in said supply inlet while said delivery conduit is closed by said piston.

4. In a fuel supply system, a fluid supply inlet, a tubular housing connected to and arranged at an angle to the inlet, a piston valve slidable in said housing, the housing on one side of the piston opening into the fluid supply inlet, a fluid delivery conduit located within the path of and adapted to be closed by the piston, whereby the piston is subjected to the pressure in said supply inlet but not in said delivery conduit, means for biasing said piston toward a closing position, and an adjustable stop for preventing said piston from closing said supply inlet.

5. In combination in a fluid supply system, a tubular housing, a piston valve slidable therein, a fluid supply passage entering one side of the housing near one end thereof and extending through the other side to form a delivery conduit, said supply passage being of greater cross-sectional area than said delivery conduit, means for biasing said piston to such a position as to close said delivery conduit, and adjustable means for preventing the closing of the supply passage.

6. In a fuel gas supply system for a gas burner, a gas supply inlet, a tubular housing connected to and arranged at an angle to the inlet, a piston valve slidable in said housing, the housing on one side of the piston opening into the gas supply inlet, the latter being nearly closable by said piston, and a gas delivery conduit located within the path of and adapted to be closed by the piston, the gas delivery conduit being closable by said piston while said supply inlet remains slightly open, the piston being movable by the pressure of gas in said supply inlet while said delivery conduit is closed, and means for biasing said piston toward a closing position.

7. In combination in a fuel gas supply system for a gas burner, a tubular housing, a piston valve slidable therein and a stop therefor, and a gas inlet passage entering one side of the housing and extending to form a delivery conduit from the other side, said inlet passage being of greater cross-sectional area than said delivery conduit, and the stop and piston being constructed to close said delivery conduit while leaving the inlet passage open.

8. In combination in a fuel gas supply system, a tubular housing, a piston valve slidable therein and a stop therefor, a gas inlet passage entering one side of the housing and extending to form a delivery conduit from the other side, said inlet passage being of greater cross-sectional area than said delivery conduit, and the stop and piston constructed to close said delivery conduit while leaving the inlet passage open, and means for biasing said piston to such a position as to close said delivery conduit.

9. In combination, a tubular housing, a piston valve slidable therein and a stop therefor, a gas supply conduit entering one side of the housing near one end and extending through the other side to form a delivery conduit, means for biasing said piston to such a position as to close said delivery conduit, and a duct connected between the delivery conduit and the housing at the opposite end from the supply conduit; said stop and piston being constructed to close said delivery conduit while leaving said gas supply conduit open.

10. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a duct connecting one end of the housing to said feed delivery conduit, a piston in said housing located between said low-pressure gas conduit and said duct and having a spring that tends to close the delivery from said housing to the feed delivery with sufficient tension to counteract the low pressure, but not sufficient to oppose said suction produced by the high

pressure, a tension adjusting means for varying the relative proportion of pressures necessary to operate the piston through a given movement against the pressure of the spring, and means for preventing the piston from closing the communication between said low-pressure conduit and said housing.

11. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a duct connecting one end of the housing to said feed delivery conduit, and a piston in said housing acting to restrict the area of the low-pressure conduit.

12. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a piston acting normally by means of a tension device to tend to close the low-pressure gas conduit, and a duct connected in the portion of the feed delivery conduit adjacent to its delivery end for controlling the position of the piston according to the pressure in that portion.

13. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber being provided at one end with a jet in which said air conduit merges, and having at the other end a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a piston acting normally by means of a tension device to tend to close the low-pressure gas conduit, and a duct connected in the portion of the feed delivery conduit adjacent to its delivery end for controlling the position of the piston according to the pressure in that portion, said feed delivery conduit being of smaller cross-sectional area than said low-pressure gas conduit and closable by said piston while the low-pressure conduit is partially open.

14. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a duct connecting one end of the housing to said feed delivery conduit, and a piston in said housing located between said low-pressure gas conduit and said duct and having a spring that tends to close the delivery from said housing to the feed delivery with sufficient tension to counteract the low pressure, but not sufficient to oppose said suction produced by the high pressure.

15. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a duct connecting one end of the housing to said feed delivery conduit, a piston in said housing located between said low-pressure gas conduit and said duct and having a spring that tends to close the delivery from said housing to the feed delivery with sufficient tension to counteract the low pressure, but not sufficient to oppose said suction produced by the high pressure, and an adjustable stop for preventing said piston from closing the entrance of said low-pressure gas conduit to said housing.

16. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a duct connecting one end of the housing to said feed delivery conduit, a piston in said housing located between said low-pressure gas conduit and said duct and having a spring that tends to close the delivery from said housing to the feed delivery conduit with sufficient tension to counteract the low pressure, but not sufficient to oppose said suction produced by the high pressure, and a tension-adjusting means for varying the relative proportion of pressures necessary to operate the piston to a given movement against the pressure of the spring.

17. In a fuel gas and air mixing system, a mixing chamber, a conduit for air under high pressure, a feed delivery conduit, and a conduit for gas under low pressure, leading into said feed delivery conduit, said air and feed delivery conduits communicating with said mixing chamber, a manual pressure control valve for said high-pressure air conduit, said mixing chamber at one end thereof being provided with a jet into which said air conduit terminates, and at the other end with a Venturi tube into which said jet discharges for producing suction through the low-pressure conduit, a tubular housing connected to said low-pressure conduit, a burner to which the Venturi tube delivers, a duct connecting one end of the housing to said feed delivery conduit, a piston in said housing located between said low-pressure gas conduit and said duct and having a spring that tends to close the delivery from said housing to the feed delivery conduit with sufficient tension to counteract the low pressure, but not sufficient to oppose said suction produced by the high pressure, a tension-adjusting means for varying the relative proportion of pressures necessary to operate the piston to a given movement against the pressure of the spring, and means for preventing the piston from closing the communication between said low-pressure conduit and said housing.

In testimony whereof I have signed this specification this seventh day of April, 1927.

FREDERICK W. HORNBRUCH.