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FLUID FUEL COMBUSTION APPARATUS AND CONTROL THEREFOR

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2 Sheets-Sheet 1

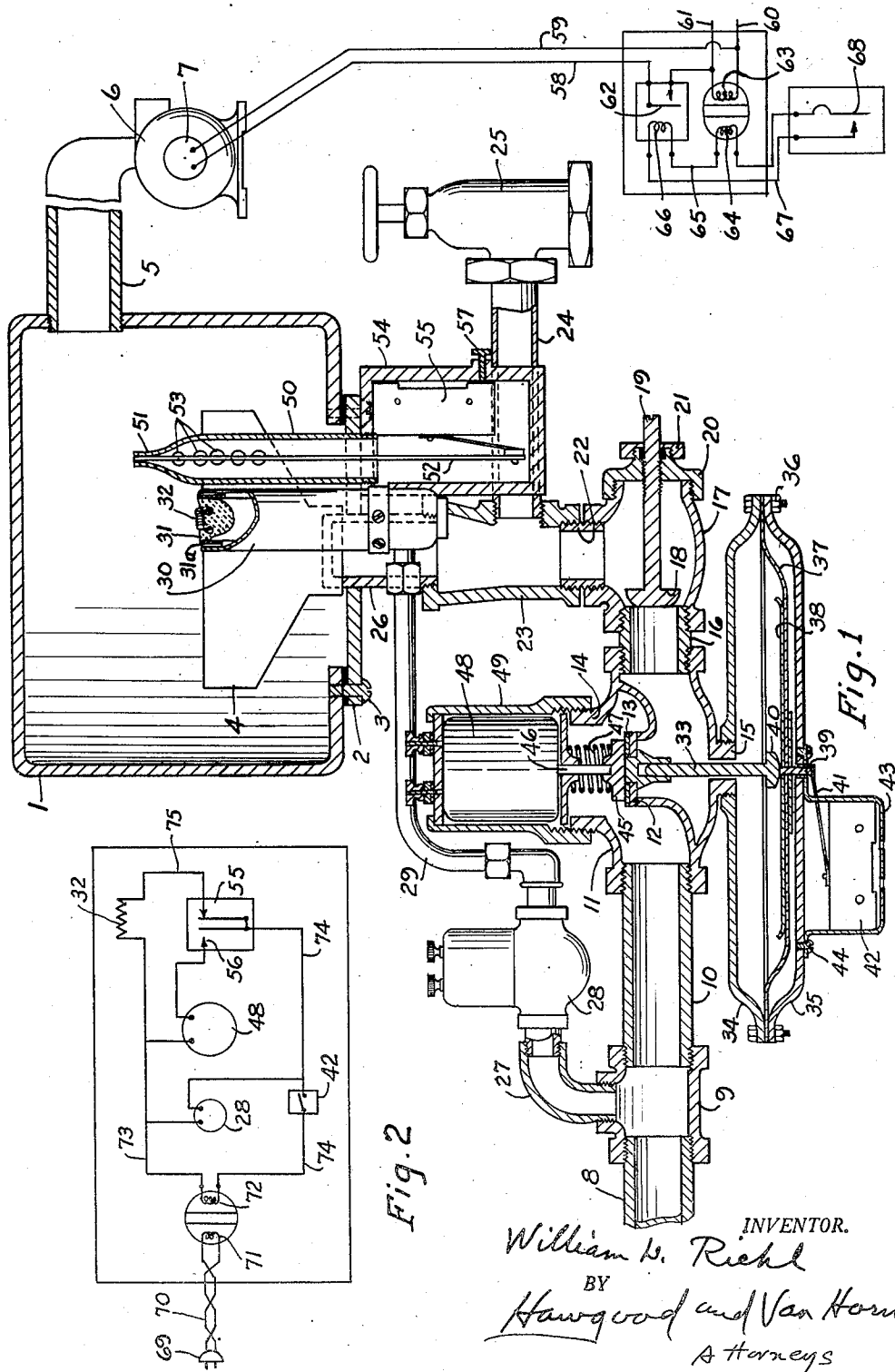


Fig. 2

Fig. 1

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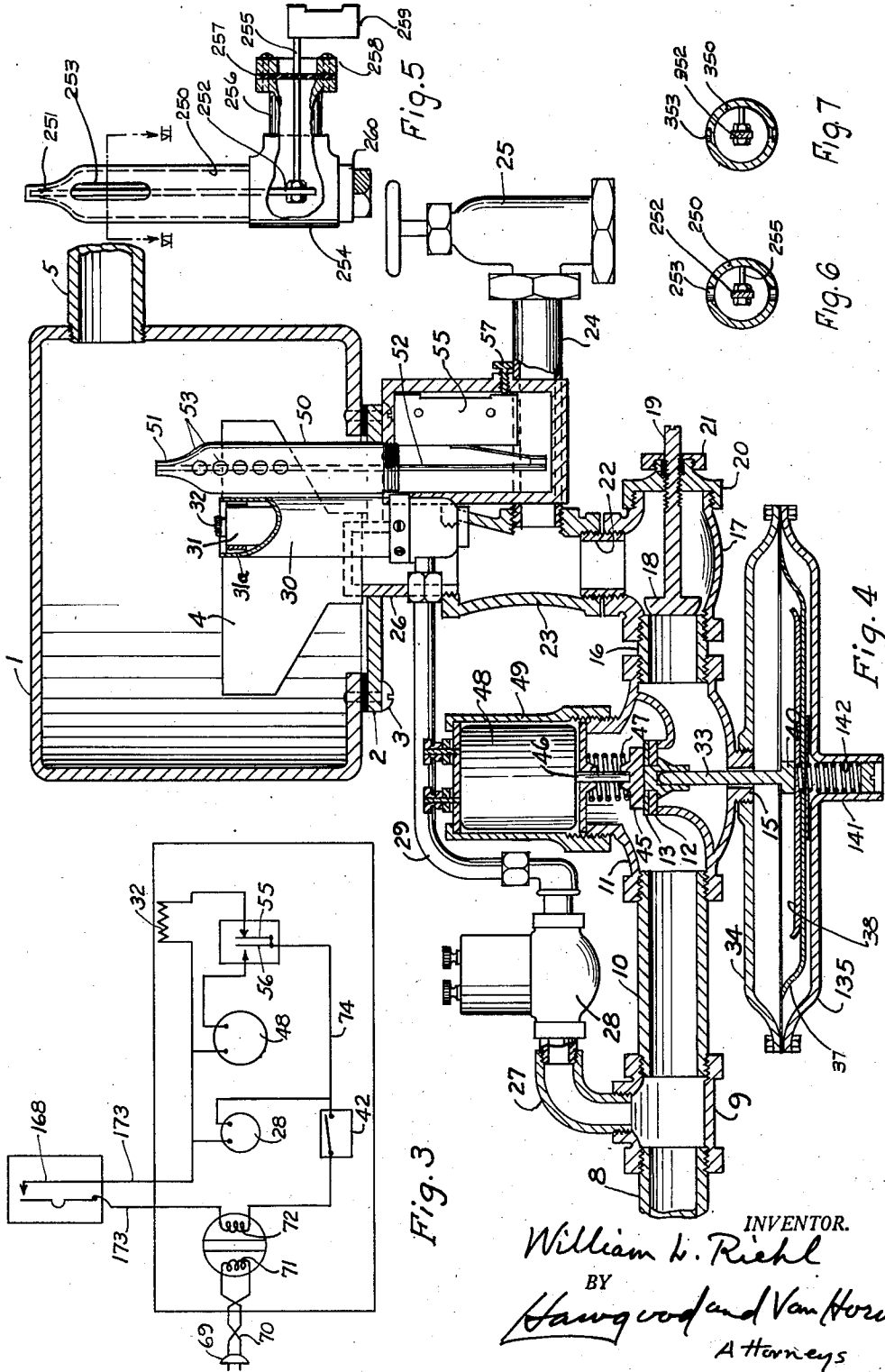
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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FLUID FUEL COMBUSTION APPARATUS
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This invention relates to combustion apparatus and is particularly useful for such apparatus when supplied with fluid fuel.

An object of the invention is to provide an improved combustion apparatus which will insure efficient combustion of fuel.

Another object is to provide an improved combustion apparatus which will be composed of few and simple parts.

Another object is to provide an improved combustion apparatus which may be easily and economically manufactured.

Another object is to provide an improved combustion apparatus which will control combustion accurately in accordance with heat requirements.

Another object is to provide an improved combustion apparatus which will be extremely safe.

Another object is to provide an improved combustion apparatus which will be fully automatic in its operation.

Another object is to provide an improved combustion apparatus which will effect its control through a single valve.

Other objects will hereinafter appear.

The invention will be better understood from the description of two practical embodiments thereof, illustrated in the accompanying drawings, in which:

Figure 1 is a somewhat fragmentary sectional view of a control apparatus designed for the handling of gaseous fuel and for burning this fuel under sub-atmospheric pressures, electrical circuits being shown diagrammatically, and parts of the apparatus broken away;

Figure 2 is a diagrammatic representation of certain parts of the apparatus of Figure 1 showing their control circuits;

Figure 3 is a wiring diagram similar to Figure 2, but showing control circuits as they may be arranged when a plurality of units are used together connected to a single source of sub-atmospheric pressure or for one or more units arranged for combustion above atmospheric pressure;

Figure 4 is a view similar to Figure 1 showing a modified form of apparatus arranged for burning fuel at pressures above atmospheric;

Figure 5 is a fragmentary elevational view of a modified form of thermostat mechanism similar to that shown in Figures 1 and 4;

Figure 6 is a transverse sectional view taken on the line VI—VI of Figure 5; and

Figure 7 is a view similar to Figure 6 of a still further modification of the thermostatic device.

Referring first to Figures 1 and 2, a sealed combustion chamber is shown at 1, this being pro-

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vided with a removable bottom or plate 2, secured to the chamber as by screws 3, which furnishes means of access by which the burner 4 may be inserted or removed from the combustion chamber.

A conduit 5 leads from the combustion chamber to a means for reducing the pressure within the combustion chamber and withdrawing gases therefrom, shown as a blower or pump 6 driven by an electric motor 7.

Gas or other combustible fluid is supplied through a conduit or pipe 8 to a control apparatus which regulates its passage to the burner 4.

The gas in conduit 8 is delivered at a pressure somewhat above atmospheric, and its flow is restricted by the control apparatus, so that when this fuel, mixed together with air, reaches the ports or slots at the top of burner 4, it will be drawn through these ports by the vacuum existing in the combustion chamber at a rate which will maintain combustion sufficient to take care of the heat requirements to be met by the apparatus.

Connected to the end of conduit 8 is a T-fitting 9, one branch of which is connected by a short piece of pipe or nipple 10 to a valve body 11.

This valve body is in general in the shape of the conventional globe valve, having a seat 12 engageable by valve 13 and having upwardly and downwardly extending threaded bosses 14 and 15 for parts of the control.

The outlet of the valve body is connected by a short nipple 16 to an orifice valve body 17, in general similar to the conventional angle valve. This angle valve body has a valve 18 carried by threaded shank 19 threaded through a cap 20, the cap being threaded to the branch of the body opposite to that connected to the nipple 16, and provided with a lock nut 21, so that valve 18 may be adjusted toward or from the end of nipple 16 by means of its threaded shank and may be clamped in any adjusted position by the lock nut.

The outlet branch of valve body 17 is connected by a nipple 22 to a generally T-like fitting 23, the lateral branch of which is connected to a piece of pipe 24 carrying at its end a valve or stopcock 25, by which air may be admitted and its admission regulated.

The remaining branch of fitting 23 is connected by means of a tube 26 to the bottom of the burner 4.

From T 9, a street elbow 27 connects with an electrically controlled valve 28 and from this valve a tube 29 extends to the outer sleeve 30 of

a pilot burner, thus bypassing fuel around valve 13.

In the interior of this burner is secured a cylindrical ceramic holder 31, substantially concentric with sleeve 30, which carries a coil of resistance wire 32, the sleeve and holder being spaced apart throughout their peripheries and the wire being so positioned that a film of gas may pass up through the annular space between the sleeve 30 and central holder 31, issuing through ports into spacer 31a at the upper end of the pilot in a tubular sheet where it may easily be ignited by the incandescence of coil 32.

The spacer 31a may be a series of lugs on the exterior of holder 31, or may be separate therefrom, as a ring of corrugated sheet metal.

Depending from the valve 13 is a stem 33 which extends through a somewhat larger perforation in the boss 15 into the space within a casing secured to this boss, the casing consisting of an upper part or top 34 and a lower part or bottom 35, these parts being secured together by means of bolts 36 extending through their marginal flanges and clamping between these flanges a diaphragm 37.

The central portion of the diaphragm is reinforced by a dished-plate 38 to which is secured the depending end 39 of valve stem 33, the end projecting through the plate and diaphragm. The end 39 also extends through an opening in the casing bottom 35 and engages an arm 41 of a switch 42 carried within a housing 43 which is secured by screws 44 to the bottom casing section.

The upward movement of the valve stem 33 which permits the closing of switch 42 before valve 13 opens, is permitted by the clearance provided by the slidable telescopic arrangement of the upper end of valve stem 33 and its reception in the recess of the depending hub of valve 13.

Thus, it will be seen that the space between the diaphragm 37 and upper housing section 34 is subjected to the reduced pressure which exists in the discharge side of the valve body 11 and that the bottom of the diaphragm is exposed to atmospheric pressure entering through the perforation around valve stem end 39.

Consequently, a differential pressure tending to move the diaphragm up exists only when a sub-atmospheric pressure is present in the combustion chamber, from which it is transmitted to the discharge side of valve 13.

Above valve 13 and directly in alignment therewith is a disc or plunger 45 carried by rod 46, the disc being pressed toward the valve by a spring 47, and capable of being retracted therefrom by an electric motor 48 contained within a housing 49, threaded on boss 14 of valve body 11.

The tension of spring 47 must, of course, be sufficient to overcome the valve-opening force of diaphragm 37, and the motor 48 must have enough power to retract the plunger 45 against the pressure of the spring, so that the plunger 45 constitutes closing and holding means which is capable of both closing and holding closed the valve 13.

Extending out of the combustion chamber through plate 2 and adjacent the igniter is a thermostatic device consisting of a tube 50, having its top flattened as indicated at 51, and to the top is attached rigidly a depending arm or bar 52.

The sides of the tube are perforated as indicated at 53, to impede the conduction of heat through the tube. The tube may be of any ex-

pansible material, and stainless steel is found to be very satisfactory for this part.

The bottom of the tube is threaded into the top of a housing 54 secured to plate 2, and the housing carries two switches 55 and 56 which may be adjusted toward and from the depending arm or lever 52 by means of set screws 57.

The upper perforated part of tube 50 is, of course, in very close proximity to the flame of the pilot burner which emanates from the top of tube 30, so that the side of the tube 50 closest adjacent this flame will, while the flame is burning, be heated to a higher temperature than the side remote therefrom, and the differential expansion of the two sides of the tube cause it when heated to bend slightly to the right as seen in Figure 1, moving the lower end of lever arm 52 to the left, and thus opening switch 55 and closing switch 56. The motion of the tube top is magnified by lever 52 which is substantially longer than the tube, as shown.

In the absence of flame from either the pilot or main burner, tube 50 again resumes its vertical position, opening switch 56 and closing switch 55.

Current is supplied to motor 7 by conductors 58 and 59, the current coming from power lines 60 and 61, the former of which is connected directly to line 59 and the latter of which is connected through an electro-magnetically controlled switch 62 to conductor 58.

Arranged in parallel with switch 62 is the primary 63 of a transformer, the secondary 64 of which is connected by conductor 65 to the coil 66 which actuates switch 62, this coil being connected in turn by conductor 68 to a room thermostat 68, the opposite side of which is connected to secondary 64.

Thus, it will be seen that whenever heat is required, the contacts of thermostat 68 close, completing the circuit through secondary 64 and coil 66, closing the circuit to motor 7, while as soon as the temperature has risen sufficiently to open the contacts of thermostat 68, switch 62 is opened, discontinuing the supply of current to motor 7.

Figure 2 shows the circuits controlling the supply of fuel, these circuits being supplied by current from the main power line through a plug 69 and conductors 70 which convey this current to the primary 71 of another transformer.

From the transformer secondary 72 extend conductors 73 and 74. In conductor 74 is interposed switch 42, and this conductor terminates at the switches 55 and 56. Connected to conductor 73 and to conductor 74 between switch 42 and switches 55 and 56 is the coil of valve 28, while valve motor 43 is connected between conductor 73 to switch 56.

Conductor 73 terminates at the ignition coil 32, from which a conductor 75 extends to switch 55.

The operation of the device described is as follows:

Until there is a demand for heat, thermostat 68 remains open and the motor 7 cannot operate. In this condition, there is atmospheric pressure in the combustion chamber and above diaphragm 37, so that the diaphragm remains in its lowermost position (as shown in Figure 1), holding switch 42 open and preventing any current from passing through the circuits of Figure 2.

Of course, the valve 13 is closed upon its seat 12, and the spring 47 presses the disc 45 tightly down upon it to hold it there. Consequently, no gas can pass through the main line to the burner.

Similarly, valve 28 is closed, as no current is

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supplied to its coil and no gas can enter through the pipe 29 to the pilot burner 30.

As soon, however, as the temperature drops to permit the contacts of thermostat 68 to close, switch 62 is closed and motor 7, driving blower 6, reduces the pressure within the combustion chamber and, consequently, exhausts the space down through the burner, through conduit members 23, 22, 17, 16 and 11, to the space within housing 34 above diaphragm 37.

This reduction in pressure above the diaphragm permits the atmospheric air pressing upon its lower surface to raise the diaphragm slightly until the end of valve stem 33 contacts valve 13, which allows switch 42 to close.

Current now may travel through the coil of switch 28 and switch 42, causing the valve at 28 to open and admit a pilot supply of gas to the tube 30.

At this stage, thermostat tube 50 is cool, hence switch 55 is closed and switch 56 is open.

Current, therefore, cannot pass through motor 48, but does pass through ignition coil 32, conductor 75, switch 55, back to conductor 74, causing the ignition coil to become incandescent and to ignite the gas which emerges from tube 30.

The pilot flame, heating thermostat tube 50, causes this to bend to the right, swinging the lower end of arm 52 to the left and thus opening switch 55 and closing switch 56.

The opening of the former switch breaks the circuit through the ignition coil, while the closing of the latter completes the circuit through motor 48 which immediately retracts the stem 46 and disc 45 from valve 13, permitting this valve to function freely as the diaphragm 37 rises with the increase of suction above it.

Thus, gas is admitted not only to the pilot burner, but to the main burner, which latter flow is ignited by the flame of the pilot burner, and valve 13 is controlled by the suction as long as these conditions obtain.

As soon, however, as the need for heat has been met, the contacts of thermostat 68 open, and motor 7 is stopped. Immediately the pressure within the combustion chamber rises and is transmitted to the upper side of diaphragm 37, causing it to drop and to open switch 42, breaking the circuits through valve 28 and motor 48, and thus closing both the pilot valve 28 and the main valve 13.

As soon as the flame within the combustion chamber has burned out, thermostat 50 moves to the left, again closing switch 55 and opening switch 56, so that the parts are ready to function through their cycle again upon the next actuation of thermostat 68.

It will be noted that no gas may be admitted through valve 13 or 28 unless the proper operation of the suction fan has commenced, and that no gas may pass valve 13 unless a flame exists at the pilot burner. Gas may be admitted to the pilot burner only when a proper vacuum exists and simultaneously with the supply of current to the ignition coil.

The valve 13 being controlled by the diaphragm 37 which is actuated by the pressure differential between the atmosphere and the pressure in the conduit beyond the valve acts as a regulator of flow or pressure in that portion of the conduit between it and the orifice valve 18, so that it is in effect a combined pressure regulator and main fuel valve. Its operation on atmospheric pressure and vacuum make it also a vacuum safety valve.

The speed with which the valve functions is,

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of course, dependent upon the time necessary to exhaust gases from the space above diaphragm 37, and so may be determined by the amount of space which is left in the opening through the boss 15 and around shank 33. If it is desired to insure the valve operating slowly, without abrupt jar, it is only necessary to restrict the opening about the stem 33, it only being necessary that there be sufficient space for gas to be drawn along-side the stem.

In Figure 3 is shown a modification of the circuit of Figure 2, the only change being the insertion of the room thermostat 168 in the line 173 immediately adjacent the secondary 72 of the transformer.

This circuit is intended for use where a number of units such as shown in Figure 1 are connected to a common blower which is operated continuously.

In these circumstances, when the need for heat arises, thermostat 168 closes and completes the circuits through the pilot control valve 28, the motor 48 and the ignition coil 32 directly, instead of through creating the suction. The switch 42 prevents any undesired supply of gas, should the common blower be out of operation, but otherwise the cycle of operation is precisely the same as that above described.

In Figure 4 is shown an arrangement of the control of Figure 1 which has been adapted to systems which are not operated below atmospheric pressure.

The only structural changes in the apparatus are that the casing bottom has been replaced with a casing bottom 135 which, instead of carrying a switch 42, has a depending central boss 141 carrying a spring 142 bearing directly on the lower diaphragm plate, from which pressure is transmitted to the head 40 at the lower end of the stem 33, and the switch 42 has been omitted. The gas pressure on the upper surface of diaphragm 37 acts against the atmospheric pressure on the lower side of this diaphragm, plus the pressure of spring 142, which, of course, is adjusted so that any excessive gas pressure will overcome the force of the spring and permit the valve to close. The pressure in the conduit beyond valve 13 is somewhat above atmospheric, as it must be sufficient to cause sufficient fuel to flow past the restricted portion of the conduit, as in the case of the first described embodiment. Beyond this section the velocity of the gas, as well as the draft created by the stack, are sufficient to draw in adequate air to support combustion.

The diaphragm 37, in this embodiment, serves to control the opening of valve 13 from its seat 12 according to the pressure which exists in conduit section 16, and the operating pressure may be varied by adjustment of the spring 142, so that it will be apparent that diaphragm valve 13 acts as a pressure regulator, while admission of gas to the main burner is controlled by motor 48 limiting the possible opening motion of valve 13 in accordance with the supply of current to the motor, which current in turn is controlled by room thermostat 168.

The control circuit, in this instance, is precisely the same as that shown in Figure 3, with the omission of switch 42.

It will be seen that the main valve is maintained closed unless a flame exists to ignite the fuel, and that the electric ignition is controlled as above described.

In Figure 5, a modification of the thermo-

static device of the preceding figures is shown, in which the tubular element has been provided with two elongated diametrically spaced slots instead of the series of perforations 53 of the preceding figures.

In this form, the tubular element is shown at 250, it having a closed upper end 251, and two diagrammatically disposed elongated axially extending slots 253.

The central lever 252 is clamped within the closed end 251, as in the first figure, but extends at its lower end into a fitting 254 in the form of a conventional pipe T, where it is connected to a rod 255 extending laterally through the side branch of the T and through a fitting 256, to which is clamped a diaphragm 257 by means of a ring 258, which seals the space about the rod 255. The end of the rod engages a switch 259, corresponding to switch 55 of the preceding figures.

The lower branch of the T is conveniently closed by a plug 260.

In Figure 7 the slots 353, are shown as penetrating nearly but not quite through the tubular element 350. The thin remaining portions of the wall where defined by these slots or slot-like grooves are so small that heat is not readily conducted through them, and the action is precisely the same as that of the preceding modifications, excepting that with this form of the device, the interior of the tubular element is sealed from the sub-atmospheric pressure of the combustion chamber, and the diaphragm 257 or other sealing means may, therefore, be eliminated.

While I have described the illustrated embodiments of my invention in some particularity, obviously many other embodiments, variations, and modifications will readily occur to those skilled in this art, and I do not, therefore, limit myself to the precise details shown and described herein, but claim as my invention all embodiments, modifications and variations coming within the scope of the appended claims.

I claim:

1. In a combustion apparatus including a combustion chamber, power operated exhausting means connected therewith, a burner in said chamber and fuel conducting means connected therewith, a valve interposed in said fuel conducting means, pressure responsive operating means operatively associated with said valve controlled by the difference in pressure between that existing at the burner and that of the atmosphere and capable of opening and closing the same, closing and holding means operatively associated with said valve, resilient means urging said closing and holding means into valve closing position, electrical retracting means capable of moving said closing and holding means from valve closing position, and control means for said closing and retracting means controlled by the presence or absence of a flame at said burner.

2. In a combustion apparatus including a combustion chamber, power operated exhausting means connected therewith, a burner in said chamber and fuel conducting means connected therewith, a valve interposed in said fuel conducting means, pressure responsive operating means operatively associated with said valve controlled by the difference in pressure between that existing at the burner and that of the atmosphere and capable of opening and closing the same, closing and holding means operatively associated with said valve, resilient means urging

said closing and holding means into valve closing position, electrical retracting means capable of moving said closing and holding means from valve closing position, and control means for said closing and retracting means controlled by the presence or absence of a flame at said burner, said pressure responsive means having limited movement independent of said valve, and a control actuated by said pressure responsive means during said limited movement preventing release of said valve holding means until the pressure responsive means has completed its limited movement.

3. In a combustion apparatus including a combustion chamber, power operated exhausting means connected therewith, a burner in said chamber and fuel conducting means connected therewith, a valve interposed in said fuel conducting means, pressure responsive operating means operatively associated with said valve and responsive to pressure changes in the fuel conducting means between the valve and the burner, closing and holding means associated with said valve, including resilient means capable of closing the valve against the pressure responsive operating means and electrical means capable of moving said closing and holding means to position permitting the valve to open and controlled by the presence or absence of flame at said burner, said pressure responsive means having limited movement independent of said valve, and a control actuated by said pressure responsive means during said limited movement preventing release of said valve holding means until the pressure responsive means has completed its limited movement, branch conduit means from the fuel conducting means on the side of the valve remote from the burner to a pilot burner adjacent said first mentioned burner, and a control valve in said branch conduit means controlled by the pressure responsive means during its independent movement.

4. In a combustion apparatus comprising a combustion chamber, a main burner therein, a source of fluid fuel under pressure, a conduit connecting said source of fuel with said burner, a branch conduit from said first mentioned conduit, a pilot burner connected to said branch conduit and adjacent said main burner in said combustion chamber, a source of suction connected to said combustion chamber, a valve in said main conduit between the branch conduit and the main burner, a pressure responsive element operatively associated with said valve and having limited movement with respect thereto when the valve is seated, a valve contacting element arranged to engage the valve and urge the same toward its seat, a spring operatively associated with said valve contacting element and capable of pressing the valve against its seat and overcoming the pressure of the pressure responsive device, electro-magnetic retracting means connected to said valve contacting element and capable of retracting it against the pressure of the spring, and control means for said retracting element controlled in accordance with the presence or absence of flame at either burner.

5. In a combustion controlling apparatus a valve comprising a body having a seat, a valve having a head movable into and out of engagement with said seat, pressure responsive means operatively associated with said valve and capable of moving it from its seat, a plunger in alignment with said valve, a compression spring

urging the plunger against the valve, and electro-magnetic means arranged to retract the plunger against the pressure of the spring.

6. In a combustion controlling apparatus a valve comprising a body having a seat, a valve having a head movable into and out of engagement with said seat, a diaphragm operatively associated with said valve and capable of moving it from its seat, a plunger in alignment with said valve, a compression spring urging the plunger against the valve, and electro-magnetic means arranged to retract the plunger against the pressure of the spring.

7. In a combustion controlling apparatus a valve comprising a body having a seat, a valve having a head movable into and out of engagement with said seat, a diaphragm operatively associated with said valve and capable of moving it from its seat, a plunger in alignment with said valve, a compression spring urging the plunger against the valve, and electro-magnetic means arranged to retract the plunger against the pressure of the spring, the diaphragm being movable after the valve is seated, and means limiting the movement of said diaphragm.

8. In a combustion apparatus comprising a combustion chamber, a source of fluid fuel under pressure, a conduit from said source of fuel to said combustion chamber and terminating in a main burner, a branch conduit from said first mentioned conduit to said combustion chamber and terminating in a pilot burner, a valve in said conduit between the branch conduit and the main burner, pressure responsive means capable of opening said valve operatively associated therewith and having a limited movement independent of said valve, resilient valve holding means operatively associated with said valve and controlled by electrically operated retracting means, an electrically operated control valve in the branch conduit, a thermostat adjacent both burners, a switch operated by said thermostat, a second switch operated by the movement of the pressure responsive means independent of the valve, a control circuit including a source of power, the pressure operated switch and the branch conduit valve and a circuit in parallel with said branch conduit valve including the thermostatically actuated switch and the valve holder retracting means, a second switch actuated by the thermostat alternately with the first mentioned switch and an electrical igniter in circuit with said second thermostatically actuated switch.

9. In a combustion apparatus comprising a combustion chamber, a source of fluid fuel under pressure, a conduit from said source of fuel to said combustion chamber and terminating in a main burner, a branch conduit from said first mentioned conduit to said combustion chamber and terminating in a pilot burner, a valve in said conduit between the branch conduit and the main burner, pressure responsive means capable of opening said valve operatively associated therewith and having a limited movement independent of said valve, resilient valve holding means operatively associated with said valve and controlled by electrically operated retracting means, an electrically operated control valve in the branch conduit, a thermostat adjacent both burners, a switch operated by said thermostat, a second switch operated by the movement of the pressure responsive means independent of the valve, a control circuit including a source of power, the pressure operated switch and the branch conduit valve and a circuit in parallel with said branch conduit valve including the thermostatically actuated switch and the valve holder retracting means, a second switch actuated by the thermostat alternately with the first mentioned switch.

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