Dec. 20, 1938. I. E. McCABE 2,140,708

FLUID FUEL BURNER IGNITION CONTROL

Filed April 15, 1937 4 Sheets-Sheet 1

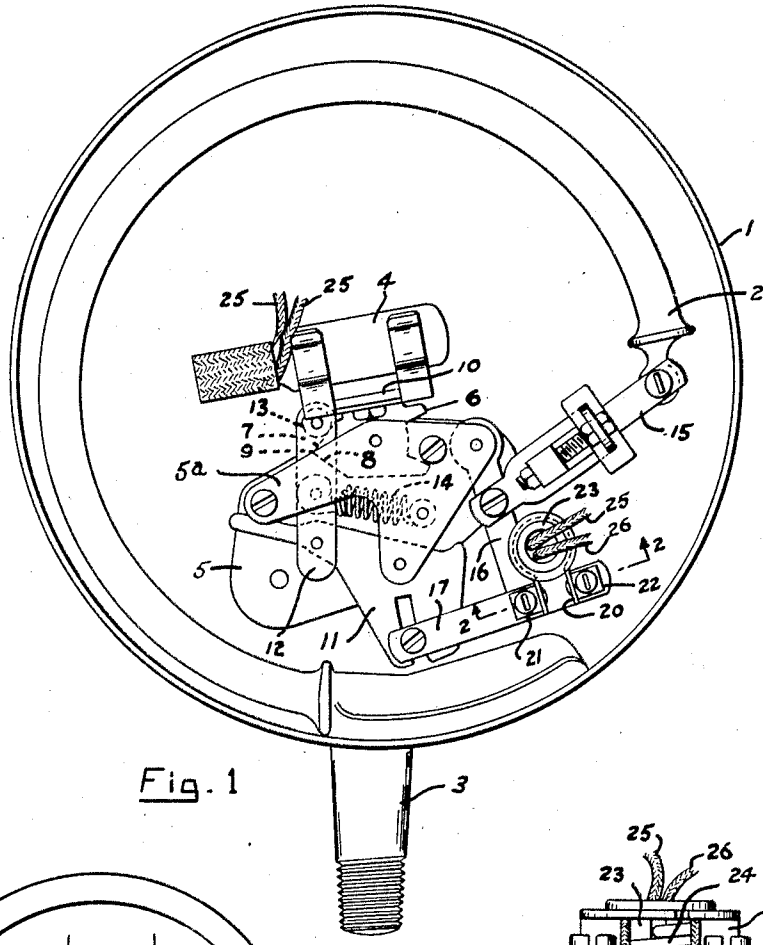


Fig. 1

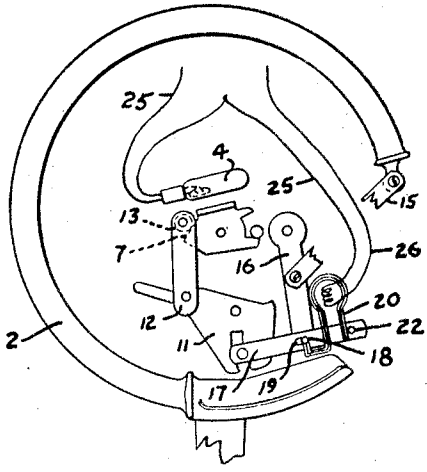


Fig. 3

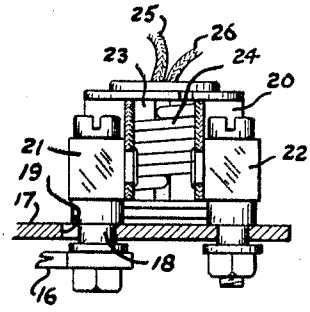


Fig. 2

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Dec. 20, 1938. I. E. McCABE 2,140,708

FLUID FUEL BURNER IGNITION CONTROL

Filed April 15, 1937 4 Sheets-Sheet 2

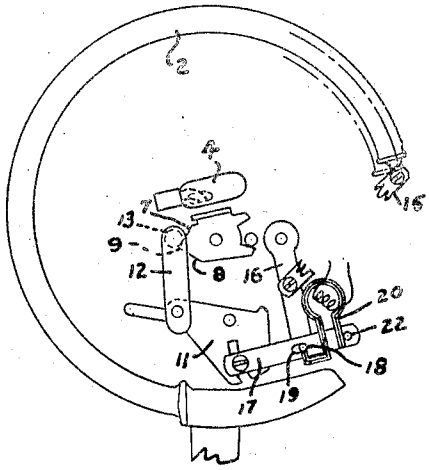


Fig. 4

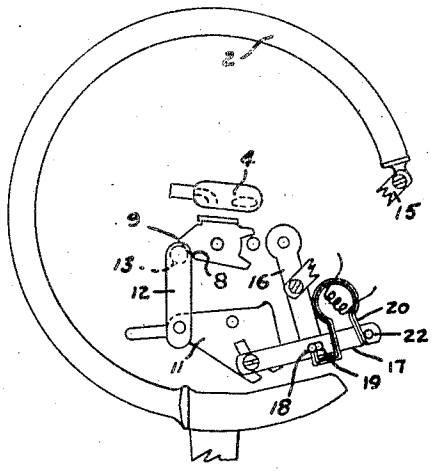


Fig. 5

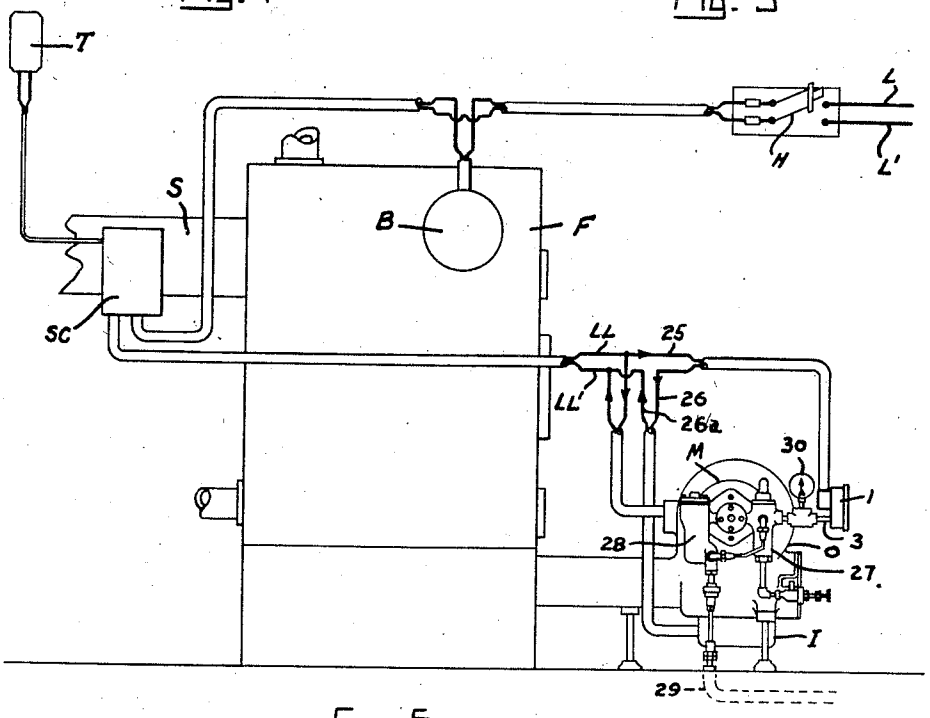


Fig. 6

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FLUID FUEL BURNER IGNITION CONTROL

Filed April 15, 1937 4 Sheets-Sheet 3

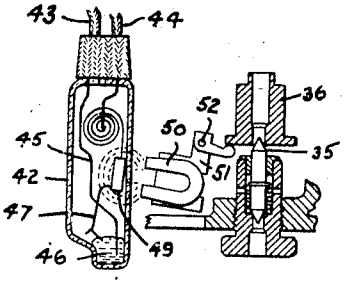


Fig. 8

Fig. 7

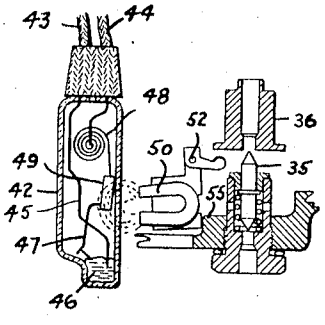


Fig. 9

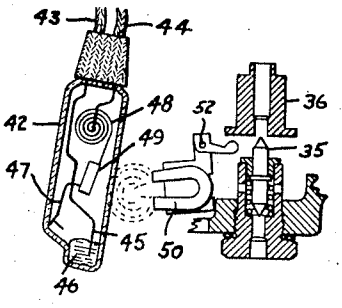


Fig. 10

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Dec. 20, 1938. I. E. McCABE 2,140,708

FLUID FUEL BURNER IGNITION CONTROL

Filed April 15, 1937 4 Sheets-Sheet 4

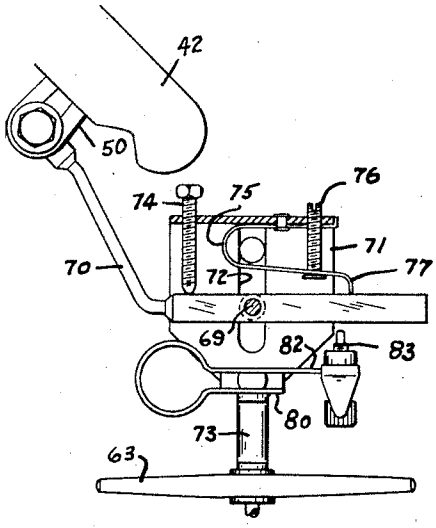


Fig. 13

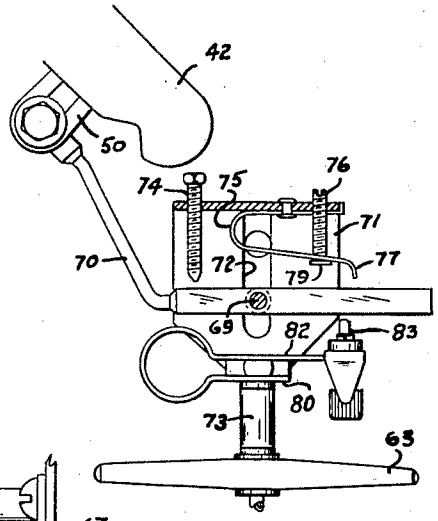


Fig. 14

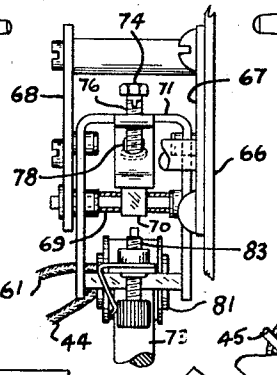


Fig. 12

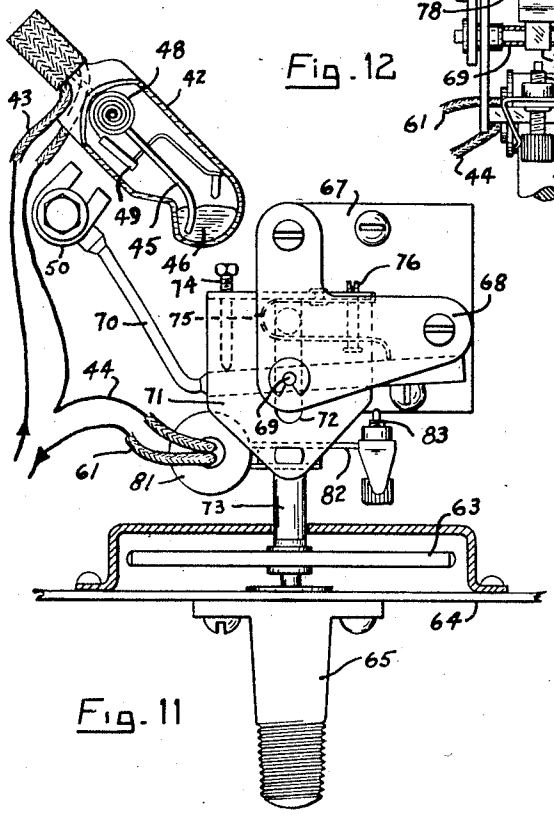


Fig. 11

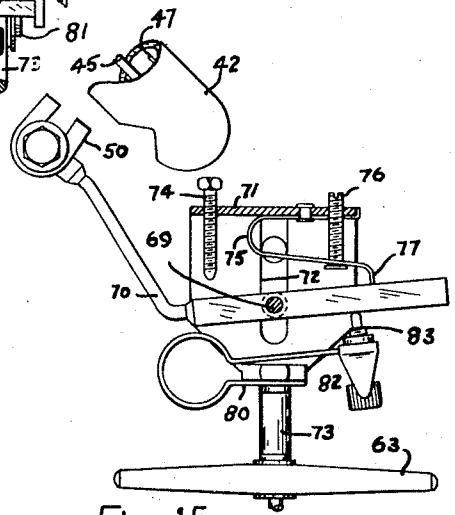


Fig. 15

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Patented Dec. 20, 1938 2,140,708

UNITED STATES PATENT OFFICE

2,140,708

FLUID FUEL BURNER IGNITION CONTROL

Ira E. McCabe, Chicago, Ill.

Application April 15, 1937, Serial No. 136,975

32 Claims. (Cl. 158—28)

This invention relates to improvements in electrically operated and controlled fluid fuel burning devices and more particularly to a device of this character including electrical ignition means with an improved mechanism for discontinuing the ignition means after operation of the burner mechanism has been initiated and the pressure of the fluid fuel has reached a predetermined pressure.

This invention is a further development of the means for discontinuing the operation of the ignition means when the pressure of the fluid fuel has reached a predetermined degree as disclosed in the Moje and McCabe Patent No. 1,642,937 of September 20, 1927.

It is an object of this invention to partially operate the ignition-discontinuing means by the pressure of the fluid fuel and employ the passage of an electric current for a predetermined time thereafter to complete the operation and discontinue the ignition means.

With these and other objects in view, reference is made to the accompanying sheets of drawings which illustrate preferred forms of this invention, with the understanding that detail changes may be made in the same without departing from the scope of the invention.

In these drawings:—

Figure 1 is a view in front elevation of one form of this invention;

Figure 2 is an enlarged detail view in section taken on the line 2—2 of Figure 1 looking in the direction of the arrows, with parts shown in front elevation;

Figures 3, 4 and 5, respectively, are diagrammatic views illustrating the respective positions of the device shown in Figure 1 when the burner is idle, after the operation of the burner has been initiated and the pressure of the fluid fuel has reached a predetermined degree to partially operate the ignition-discontinuing means and when the continued passage of the current through the ignition circuit has resulted in the discontinuance of the ignition circuit;

Figure 6 is a schematic diagram illustrating the application of this control to an oil burner of commercial form applied to a commercial domestic heating furnace, showing the wiring to the various controls in diagram;

Figure 7 is a view in central vertical section of a fluid fuel regulating valve to which has been applied another form of this invention;

Figures 8, 9 and 10 are fragmentary detail views illustrating in central vertical section with parts shown in front elevation of the positions assumed by the operating parts shown in Figure 7 when the oil burner is idle with the valve closed and ignition switch closed, when the valve is opened, and when the passage of the current through the ignition circuit has resulted in the opening of the ignition circuit, respectively;

Figure 11 is a detail view, partly in front elevation and partly in section, of another form of this invention;

Figure 12 is a detail view in end elevation of Figure 11 with parts removed; and

Figures 13, 14 and 15 are fragmentary detail views partly in front elevation and partly in section illustrating the positions assumed by the operating parts when the operation of the burner mechanism is initiated, when the pressure of the fluid fuel has reached a predetermined degree, and when the continued passage of the current through the ignition circuit has resulted in the discontinuance of the ignition circuit.

The embodiment of this invention illustrated in Figures 1 to 6, inclusive, includes a construction similar to that disclosed in said Moje and McCabe Patent 1,642,937 of September 20, 1927, and which operates in part in the same manner as disclosed in said patent. The operating parts are mounted upon the back of a cylindrical casing 1 and include a Bourdon tube 2 closed at one end and connected at the other end through the nipple 3 to the pipe feeding the fluid fuel from the pump of the burner mechanism, whereby increase in pressure of the fluid will cause the Bourdon tube to straighten out, imparting a movement to the closed end thereof, and upon reduction in pressure cause to Bourdon tube to contract and impart a reverse movement to the closed end thereof.

The circuit to the electrically operated ignition device passes through the mercury tube switch 4, preferably of the type disclosed in this applicant's prior Patent No. 1,757,436 of May 6, 1930. This switch 4 may be termed the ignition switch and is opened and closed by a snap mechanism actuated by movement of the Bourdon tube 2 in the manner disclosed in this applicant's prior Patent No. 1,734,016 of October 29, 1929.

The snap action mechanism includes a base plate 5 mounted upon the back of the casing 1 and a top plate 5a, suitably held in spaced relationship from the base plate 5. Upon and between these plates there is mounted the movement parts which operate the mercury switch 4 to open and closed position. The upper central portion of these plates pivotally supports a switch operating member 6 having two incline surfaces

7 and 8 meeting at an apex 9, and a right-angular clip-supporting extension 10 for supporting a mercury switch 4. A switch operating plate 11 is pivotally mounted below and to one side of the pivot of the switch-operating member 6. The pivoted switch-operating plate 11 pivotally mounts one end of a switch-actuating link 12 which mounts upon its free end a roller 13 adapted to travel over the incline surfaces 7 and 8 of the switch-operating member 6. The roller 13 of the switch-operating link 12 is caused to maintain contact with one or the other of the said incline surfaces by a spring 14. The movement of the closed end of the Bourdon tube is transmitted to the switch-operating plate 11 through the adjustable link 15 pivotally connected to an operating lever 16 pivoted at one end to the base plate 5 and having a pivotal connection at its other end to an actuating link 17, one end of which is pivotally and adjustably connected to the switch-operating plate 11. The above snap action mechanism so far described is similar to that disclosed in said Patents Nos. 1,642,937 and 1,734,016, with the exception of the adjustable feature of the link 15 which is utilized in this invention to vary the relationship of the movement and Bourdon tube, by shortening or lengthening the bar, to establish the point where actuation will be accomplished, in preference to the method disclosed in Patent No. 1,734,016.

This invention contemplates connecting the operating lever 16 to the actuating link 17 by a stud 18 carried upon the free end of the operating lever 16 and passing through a slot 19 formed in the actuating link 17. The actuating link 17 mounts a thermal actuating element 20, of bi-metallic metal responsive to temperature changes, with one end secured to an extension 21 of the stud 18 upon the upper side of the actuating link 17 and the other end secured to a stud 22 carried upon the free end of the operating link 17. It is preferable to form this thermal member 20 to embrace a spool 23 of insulating material about which is wrapped a portion of the resistance wire 24 which is connected in the ignition circuit by wires 25 and 26, in series with switch 4. The normal cold position of the thermal member 20 is such that the part 18 is drawn against the end of the slot 19 most adjacent the stud 22. When the end of the outward movement of the Bourdon tube 2 has completed the movement transmitted through the link 15 to the lever 16 to position the roller 13 adjacent the apex 9 of the switch-operating member 6, the expansion of the thermal member 20 caused by the passage of the current to the ignition circuit will impart an additional movement to the actuating link 17 in the same direction to bring the other end of the slot 19 against the stud 18 and thereby carry the roller 13 over the apex 9. By means of the adjustable feature on link 15 the device may be adjusted so that when the pressure of the fluid fuel to the burner reaches its normal operating pressure, the roller 17 will be adjacent the apex 9 and by so constructing the heating coil 24, the thermal element will cause the operation of the switch a predetermined time thereafter.

As shown diagrammatically in Figure 3, the ignition switch 4 is in its closed position and the roller 13 is at the end of its travel upon the incline surface 7 of the switch-operating member 6, which is the position normally assumed when the burner is idle, and the stud 18 is at the end of its movement most adjacent the stud 22. Figure 4 illustrates the position assumed by the parts when the fluid fuel has reached its normal operating pressure and has expanded the Bourdon tube 2 to cause the roller 13 to assume a position upon the incline surface 7 adjacent the apex 9 of the switch-operating member 7 with the stud 18 still at the end of its travel most adjacent the stud 22. Figure 5 illustrates the position assumed by the parts after the heating element 24 has expanded the thermal element 20 to extend the link 17 to cause the end of the slot 19 to bring its end most distant from the stud 22 into engagement with the stud 18 and thereby cause the roller 13 to travel over the apex 9 and ride down upon the incline surface 8 of the switch-operating member 6 to throw the mercury switch 4 to its open position to break the ignition circuit.

In the disclosure of this invention just described the relationship between the Bourdon tube and thermal element is such that the greater part of the movement imparted to the actuator for operating the switch-tilting mechanism is obtained from the Bourdon tube, leaving the thermal element to provide but little movement in order to complete the switch-tilting process. It therefore follows that by proper arrangement of the switch mechanism for tilting the switch the cooling of the thermal member can be rendered insufficient to return the switch to closed position and on the other hand the arrangement can also provide for reclosing the switch upon a drop in pressure above that point where fuel is cut off at the burner nozzle, regardless of whether the thermal member is in a heated or cooled state.

This feature is important in providing protection against the possibility of the injection of fuel into the combustion chamber following the extinguishment of the burner flame due to a drop in pressure below the atomizing point and thereafter being ignited after a delayed period. With this invention the ignition cutoff mechanism is partially actuated by means responsive to the fuel pressure being delivered at the burner nozzle and the cut-off completed by a timed thermal actuator and further provides for the restoration of the ignition circuit prior to fuel cut-off at the burner nozzle upon flame extinguishment.

The diagram shown in Figure 6 illustrates an application of this improved ignition control to a domestic heating system in which an oil burner O of commercial design is shown applied to a domestic heating furnace F having a stack S leading to the chimney. The wires L and L' from the source of commercial electricity pass through a hand switch H, and the incoming current of line L passes through a boiler control B of commercial construction to a stack control SC of commercial construction responsive to the stack temperature, and from thence by wires LL and LL' to the burner motor M. From wire LL a wire 25 branches off to the ignition switch 4 and heating element 24 of the ignition control and from thence by wire 26 to the ignition transformer I and thence by wire 26a to the return line LL' which in turn is connected to line L' within the stack control SC. A room thermostat T of commercial construction is connected to the mechanism of the stack control SC which responds to a call for heat in the building to initiate the operation of the oil burner. The nipple 3 of the Bourdon tube 2 is connected to the casing 27 of a regulating valve through which

the fuel passes to the burner mechanism from the fuel pump 28 which is connected by the pipe 29 to a source of fuel supply, and it is preferable to provide a pressure gauge 30 between the nipple 3 and casing 27 to indicate the pressure of the fluid fuel before it enters the burner mechanism.

The oil burner illustrated diagrammatically in Figure 6 may be fed from a tank of fluid fuel located in the basement and so arranged that the fuel will flow by gravity from the tank to the burner mechanism; or, the fuel may be stored in a tank at a distance from the oil burner and at a lower level requiring a pump to pump the fuel from the tank to the oil burning mechanism as by the pump 28 of Figure 6. Where the fuel is to be delivered in an atomized condition it is customary to employ a fluid pressure pump as a part of the oil burning mechanism, and, in many instances, the oil burning mechanism is supplied with a regulating valve as at 27 for insuring a constant flow of fuel from the pump to the oil burning mechanism.

Figures 7 to 10, inclusive, illustrate the application of this invention in which the switch in the ignition circuit is partially actuated by the movement of the oil-regulating valve usually interposed between the pump and the burner mechanism.

Figure 7 depicts a commercial type of regulating valve in which the side of the casing 31 opposite the inlet 32 is enlarged to form a chamber 33. As is customary in valves of this type, the outlet port 34 is controlled by a needle valve 35 normally held in closed position by a reciprocating plunger 36 mounted in line therewith and held thereagainst by a coiled spring 37, the tension of which is adjusted by the adjustable abutment 38. When the pressure of the incoming oil through the inlet 32 is sufficient to overcome the resistance of the spring 37, the plunger is forced upwardly allowing the spring 39 to act upon the needle valve 35 to open the port 34, as shown in Figure 9. The commercial types of valves of this character are usually provided with a by-pass so that when the pressure of the incoming oil becomes greater than the amount at which the valve is set it causes the plunger 36 to continue its upward movement to uncover a port 40 in the plunger 36 whereby the excess pressure is relieved through the by-pass outlet 41 and the excess oil returned to the storage tank.

In applying this invention to a regulating valve, it is preferable to employ a mercury tube switch 42 of the type disclosed in the allowed application of Karl Hunciker, Serial No. 665,628, filed April 12, 1933, which became Patent No. 2,085,316 on June 29, 1937; in which the tubular container of the switch 42 is normally mounted with its axis in a vertical plane. As seen from Figures 7, 8, 9, and 10, the lead-in wires 43 and 44 enter the upper end of the container 42 and are connected to the electrodes therein, one of which, 45, is stationary and terminates in a pool of mercury 46 in the lower end of the container 42. The other electrode 47 is movable into and out of contact with the pool of mercury 46 and includes a resilient coil 48 which will normally maintain the electrode 47 out of contact with the mercury pool 46, as shown in Figure 10. The movable electrode 47 also includes intermediate its length an armature 49 of magnetic metal which will respond to an exterior magnetic force when brought within the field thereof to close the circuit to the switch by causing the electrode 47 to engage the mercury pool 46.

As shown in Figure 7, a switch of this type is mounted exteriorly of the wall 31 of the chamber 33 of the regulating valve. A permanent magnet 50 is adjustably mounted within the chamber 33 upon a bracket 51 pivotally mounted upon a stud 52 secured to the side walls of the chamber 33. The bracket 51 is provided with a finger 53 extending from the pivotal point 52 on the side opposite the magnet 50. The end of the finger 53 is engaged by the under side of the reciprocating plunger 36 of the regulating valve. The magnet 50 is adjustably mounted upon the bracket 51 and is so arranged that when the regulating valve is closed and the plunger 36 is at the end of its downward movement it will engage the finger 53 to cause the magnet to approach in close proximity to the side wall 31 of the chamber 33. The switch 42 is positioned on the opposite side of the wall 31 with its armature 49 in line with the magnet 50 so that when the magnet is in the position shown in Figures 7 and 8, the magnetic field of the magnet will act upon the armature 49 to cause the electrode 47 to close the circuit through the switch. Upon initiation of the operation of the burner mechanism the fuel pump will deliver fuel through the regulating valve causing the plunger 36 to travel upwardly. A spring 54 is carried by the bracket 51 to engage the side wall 31 of the chamber 33 and cause the finger 53 to follow the upward movement of the plunger 36 and thereby rotate the magnet bracket 51, moving the magnet 50 away from the armature 49 as shown in Figure 9. It is preferable to provide a stationary abutment 55 in the valve casing within the chamber 33 which will be engaged by the bracket 51 to limit the rotation of the magnet 50. If desired, the bracket 51 may be provided with an adjustable stop to be engaged by the abutment 55. The movement of the magnet 50 away from the armature 49 when in the closed circuit position is adjusted so that when the abutment 55 is engaged the armature 49 will be within the outer limits of the magnetic field sufficiently to maintain the circuit closed in the switch 42.

In order to open the ignition circuit the mercury tube switch 42 is adapted to be moved away from the influence of the magnet as shown in Figure 9 to the position shown in Figure 10, whereby the circuit is broken through the switch. The switch is carried by a switch carrier 56 having a depending portion for embracing and supporting the switch and adapted to rotate about a pivot 56a supported by brackets mounted upon the base 59 secured to the outer wall 31 of the casing 33. The switch carrier normally holds the switch tube 42 with its axis in a vertical plane, and the side of the switch adjacent the armature 49 against the wall opposite the magnet 50 when the regulating valve is normally closed. Adjacent the switch carrier, an actuator therefor is located consisting of a thermal member 57 of bi-metallic metal. The thermal actuator is secured at one end to a stud 58 mounted on the plate 59 with its free end adapted to engage an adjustable pin 62 carried upon the switch carrier 56. The intermediate portion of the thermal member 57 embraces a spool 60, similar in construction to the spool 23 shown in Figure 2, about which a section of resistance wire is coiled, one end of which is connected to the ignition circuit by lead 61 and the other end of which is connected by lead 44 to the electrode 47 of the switch 42. When the circuit to the burner motor is established, the operation of the oil pump will

cause the magnet 50 to move away from the armature 49 until it strikes the abutment 55, as shown in Figure 9, and the continued passage of the current through the heating element upon the spool 60 will act upon the thermal member 57 to cause the free end to strike the pin 62 and rotate the switch carrier 56 and the switch tube 42 away from the wall 31 of the chamber 33 and thereby carry the armature 49 outside of the field of the magnet 50, as shown in Figure 10. The movable electrode 47 is thereby released and it will assume the open position, as shown in Figure 10, and the circuit through the ignition device will be broken. It is preferable to provide the adjustable pin 62 in order to predetermine the length of the ignition period following the establishment of the ignition circuit. When the ignition circuit is broken by action of the thermal actuator 57 the thermal element will cool and return the mercury switch, in open circuit position, to the position shown in Figure 9, but so long as the burner continues to operate and the fuel pressure is maintained the power of the magnet will not be sufficient from its removed position to attract the armature 49. With the stopping of the burner and resulting drop in pressure the plunger 36 descends to advance the magnetic field of the magnet to embrace the armature 49 and restore the switch circuit as shown in Figure 7.

The disclosure of this invention represented by Figures 7 to 10, inclusive, incorporates the same method of ignition control as that shown by Figures 1 to 6, inclusive, only in modified form.

In this last-discussed form the power of the magnet is such that it will attract the magnetic switch armature to close the switch circuit, upon an abnormal fuel pressure drop, prior to the cut-off of fuel at the burner nozzle whether the switch is in the position it normally assumes upon burner starting, or in the removed position in which it is sometimes placed by the thermal actuator. It is further preferable in normal operation that the movement of the magnet away from the switch be such as to render it ineffective to close the switch when, upon the opening of the switch by the thermal actuator, the switch is returned to its normal starting position, upon cooling of the actuator.

Figures 11 to 15, inclusive, illustrate another form of this invention controlled by the pressure of fluid delivered to the burner nozzle by the fuel burning mechanism in which the ignition switch 42 is normally open and requires an initial pressure to be created by the operation of the burner mechanism after the establishment of the motor circuit to close the ignition circuit, prior to the establishment of the pressure at which fuel is delivered to the burner nozzle, and thereafter when or before the fluid pressure reaches the normal operating pressure the device will move the thermally-operated member into operative position and a predetermined time thereafter will allow the thermal mechanism to break the ignition circuit.

In the course of burner operation the fuel pump may lose its prime, or air or water may be present in the fuel line whereupon a delay will occur in establishing the normal fuel operating pressures, whereby if the thermal member is energized at the initiation of the burner operation it may cut off ignition prematurely after normal operating pressures have been attained.

In this third form an additional modification is disclosed which provides for the measurement of the ignition period from the point at which fuel pressure suitable for normal burner operation is established, insuring a full period of ignition in which to establish normal burner operation.

Another advantage offered by this form is the separation of the ignition circuit, if desired, from all other circuits, made possible by the fact that the ignition circuit is open when the burner is idle, eliminating the need of control of ignition by any of the other burner control switches, thus reducing the total load carried by some of the switches.

As shown in Fig. 11, the mercury switch tube 42 is of the same type as that illustrated in Figure 7. The device is mounted on the back of a casing not shown, with the switch 42 in the position shown. The device includes an expansible and contractible capsule 63 mounted upon the bottom 64 of the casing. The interior of the capsule is connected by the nipple 65 to the pipe conveying the fuel under pressure to the fuel burning mechanism. The back 66 of the casing mounts spaced-apart plates 67 and 68 which support between them a pivotal stud 69 upon which an arm 70 is mounted with one end mounting the magnet 50. An inverted U-shaped bracket 71 having slots 72 on its opposite sides to allow the bracket to reciprocate between the plates 67 and 68 and over the stud 69 is provided with a depending central post 73 secured to the upper central portion of the capsule 63 so that the bracket 71 will move upwardly as the capsule expands and downwardly as the capsule contracts.

The bracket 71 is provided with an adjustable abutment stud 74 on the side of the slot 72 adjacent the magnet 50 to engage the arm 70, upon a predetermined decrease in pressure, and move the magnet away from the switch 42 to open the circuit. On the opposite side of the slot the bracket 71 is provided with a leaf spring 75 bent back upon itself within the bracket and normally tending to urge the magnet toward the tube as the pressure increases and the force exerted through the stud 74 is relieved. The arm 70 and magnet 50 are such that upon closing the circuit in switch 42 the magnetic force of the magnet is sufficient to maintain the circuit closed without the aid of the spring 75. The members 74 and 76 are so adjusted that when the fuel burner mechanism is idle and the capsule 63 contracted with the bracket 71 at the lowest end of its travel, the adjustable abutment 74 will contact the upper portion of the pivoted arm 70 and rotate it about its pivot against the tension of the spring 75 to withdraw the magnet and its magnetic field from the armature 49 of the switch 42, as shown in Figure 11, whereby the circuit through the switch 42 is opened. Upon the establishment of operation of the fuel burning mechanism the capsule 63 will expand in response to the pressure in the fuel line, causing the bracket 71 to move upwardly, allowing the tension of the spring 75 to cause the arm 70 to rotate about its pivot 69 and move the magnet 50 into contact with the switch 42, as shown in Figure 13, to close the circuit and will allow further expansion of the capsule 63 without changing the relation of the positions of the magnet 50 and switch 42.

In carrying out this invention a thermal member 80 of bi-metallic metal is secured at one end to the post 73 preferably adjacent the under side of the bracket 71. The thermal member 80 is bent back upon itself to embrace a spool 81, with its free end 82 extending upon the other side of the post 73, terminating below the arm 71 and

opposite the end 77 of the spring 75, as shown in Figures 11 to 15, inclusive. The spool 81 mounts a heating element of resistance wire similar to the spool 23 of Figure 1. One end of the resistance wire of the heating element is connected by lead 44 in series with the switch 42. The switch 42 is connected by lead 43 to one line of the ignition circuit from the source of current while the other end of the resistance wire is connected by lead 61 to an ignition transformer interposed in the return line to the source of current. The free end 82 of the thermal member 80 is provided with an adjustable abutment 83. To permit actuation of the arm 70 by the thermal member 80 as well as to provide a positive action in breaking the switch circuit an adjusting member 76 mounted upon the bracket 71 passes through an aperture 78 in the leaf of the spring 75 and is provided with an enlarged head on the underside thereof whereby the spring may be flexed, after the ignition switch has been closed, to remove the end 77 from contact with the arm 70. A predetermined time after the ignition circuit has been closed through the switch 42 by the expansion of capsule 63 and after the bracket 73 has assumed the position shown in Figure 14, the continued passage of the current of the motor circuit through the heating element on the spool 81 will cause the free end 83 of the thermal element to move upwardly and contact the underside of the arm 70, and then cause the rotation thereof about the pivot 69 until the magnetic force of the magnet upon the armature is broken whereupon the magnet will fall away until stopped by the engagement of the far end of the arm with the free end 77 of the spring 75, as shown in Figure 15.

When the fuel burning mechanism again becomes idle, the capsule 63 will contract, causing the bracket 71 to move downwardly, whereupon the device assumes the position shown in Figure 11 with the ignition switch open.

What I claim is:

1. In an electrically operated and controlled fluid pressure burner mechanism including an electrical igniter, an ignition circuit, a switch in the ignition circuit, and means for operating the switch, includng a pressure-responsve means, and an electrically operated thermal means co-acting therewith and arranged upon initiation of operation of the burner mechanism to operate the switch a predetermined time thereafter.

2. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit, a normally closed ignition switch therein for establishing said circuit upon operation of the burner mechanism, means to open the ignition switch actuated a predetermined time after establishment of the ignition circuit including means to render the opening means partly effective dependent upon the establishment of the normal fluid fuel operating pressure and additional means to complete the opening of the switch, dependent upon the establishment of the ignition circuit.

3. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit, including therein a normally closed ignition switch when the burner is idle, means to open the ignition switch actuated a predetermined time after energization of the ignition circuit including means to render the opening means partly effective dependent upon the establishment of the normal fluid fuel operating pressure and additional means to complete the opening of the switch dependent upon the establishment of the ignition circuit.

4. The structure of claim 3 wherein said pressure means, when operative, is adapted to maintain the ignition circuit open when opened by said additional means.

5. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit including therein an ignition switch closed when the burner is idle, and means to open the ignition switch made operative by the progressive action of means operative upon the establishment of the normal fluid fuel operating pressure upon operation of the burner followed by the action of an electrically operated time actuator operative upon the energization of the ignition circuit.

6. The structure of claim 5 wherein said pressure operated means is adapted to maintain the ignition circuit open when opened by said time actuator.

7. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical ignition, an ignition circuit and a normally closed ignition switch therein when the burner mechanism is idle, means for tilting the switch to open the ignition circuit, means responsive to the pressure of the fluid fuel, a connection between the tilting means and pressure responsive means arranged upon an increase in fluid fuel pressure upon initiation of operation of the burner mechanism to partially operate the tilting means, and thermally operated means actuated by the passage of current through the normally closed ignition circuit to complete the tilting of the switch to open the ignition circuit.

8. The structure of claim 7 wherein said tilting means is responsive only to said pressure responsive means to close said switch.

9. The structure of claim 7 wherein the connection between the tilting and pressure means includes a link having a lost motion connection to one of said means rendered operative to complete the operation of the tilting means upon operation of the thermally operated means.

10. The structure of claim 7 wherein the thermally operated means includes a heating element in the ignition circuit and a thermal member arranged to be actuated thereby to impart additional movement to the said connection.

11. The structure of claim 7 wherein the thermally operated means is mounted upon said connection.

12. The structure of claim 7 wherein the connection between the tilting and pressure means includes a link having a lost motion connection to one of said means rendered operative to complete the operation of the tilting means upon operation of the thermally operated means, and wherein the thermally operated means includes a heating element in the ignition circuit and a thermal member mounted upon said connection adapted to be actuated by the heating element to impart additional movement to the said connection.

13. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical ignition device, an ignition circuit and a magnetically operated switch therein, a magnetic actuator therefor normally closing the ignition switch when the burner mechanism is idle, means responsive to the pressure of the fluid fuel arranged to engage said magnetic actuator and arranged upon an increase in fluid fuel pres-

sure upon initiation of operation of the burner mechanism to change the relation of the actuator to the switch, and thermally operated means actuated by the continued passage of the current through the normally closed ignition circuit to continue the change of the relation of the magnetic actuator to open the ignition switch.

14. The structure of claim 13, wherein the said magnetic switch includes a flexible electrode mounting an armature, and the magnetic actuator includes a source of magnetic energy arranged to close the switch when the relation of the actuator to the switch brings the armature within the operative field of the magnetic actuator.

15. The structure of claim 13, wherein the thermally operated means includes a heating element in the ignition circuit and a thermal member adapted to be actuated thereby to move the switch out of the operative influence of the actuator.

16. The structure of claim 13, wherein the magnetic actuator includes a source of magnetic energy mounted upon a swinging bracket engaged by the said pressure responsive member and a stop to limit its movement upon an increase in fluid fuel pressure.

17. The structure of claim 13, wherein the magnetic actuator includes a source of magnetic energy mounted upon a swinging bracket engaged by the said pressure responsive member and a stop to limit its movement upon an increase in fluid fuel pressure, and wherein the thermally operated means includes a heating element in the ignition circuit and a thermal member responsive thereto actuated by the heating element to move the switch out of the operative influence of the magnetic actuator.

18. In an electrically operated and controlled fluid fuel pressure burner mechanism having an electrical ignition device, an ignition circuit therefor including a normally open ignition switch when the burner is idle, an electrically operated means included in the ignition circuit, and means actuated by the establishment of a predetermined fluid fuel pressure upon operation of the burner to close the ignition switch and upon a predetermined increase in pressure thereabeyond to render effective said electrically operated means to open the ignition switch, actuated a predetermined time after energization of the ignition circuit.

19. In an electrically operated and controlled fluid fuel pressure burner mechanism having an electrical ignition device, an ignition circuit therefor including a normally open ignition switch when the burner is idle, pressure responsive means actuated by a predetermined fluid fuel pressure developed upon operation of the burner mechanism to close the switch, an electrically operated time actuator included in the ignition circuit and means to open the switch made operative by the conjoint action of the pressure responsive means and the said electrically operated time actuator, the operation of the latter a predetermined time after energization of the ignition circuit rendered effective to operate the switch opening means by the supplementary actuation of the switching means by the pressure means responding to the fluid fuel reaching the normal burner operating pressure.

20. In an electrically operated and controlled fluid fuel pressure burner mechanism having an electrical ignition device, an ignition circuit and a magnetically operated switch therein, a magnetic actuator for opening and closing the ignition switch, means responsive to the pressure of the burner fuel, means interposed between the pressure responsive means and magnetic actuator to operate the same comprising in combination means operative upon a predetermined fluid fuel pressure being established upon operation of the burner to operate the magnetic actuator to close the switch, and thermally operated means actated by the passage of current through the ignition circuit, normally operating the magnetic actuator a predetermined time after the closing of the ignition switch to open said switch, said pressure actuated means including additional adjustable means limiting the opening of the ignition switch by said thermal means until the fluid fuel has attained normal operating pressure.

21. The structure of claim 20, wherein said magnetic switch includes a flexible electrode mounting an armature and the magnetic actuator includes a source of magnetic energy mounted upon a pivoted arm having sufficient magnetic intensity to normally hold the actuator when said armature is brought within the operative magnetic field to maintain the ignition switch closed.

22. The structure of claim 20, wherein the means interposed between the pressure responsive device and the actuator includes a reciprocable bracket operated by the pressure responsive means to engage the actuator when the burner mechanism is idle to open the switch.

23. The structure of claim 20, wherein the means interposed between the pressure responsive device and the actuator includes a reciprocable bracket operated by the pressure responsive means to engage the actuator when the burner mechanism is idle to open the switch, and yielding means opposing the action of the bracket to open the switch operable to operate the actuator to close the switch when the bracket frees the actuator.

24. The structure of claim 20, wherein said magnetic switch includes a flexible electrode mounting an armature, and the magnetic actuator includes a source of magnetic energy mounted upon a pivoted arm to normally hold the actuator when said armature is brought within the magnetic field, and wherein the thermally operated means includes a heating element in the ignition circuit and a thermal element provided with an abutment adapted to engage the said arm, said element actuated by the heating element to rotate the actuator arm to open the ignition switch.

25. The structure of claim 20, wherein said magnetic switch includes a flexible electrode mounting an armature, and the magnetic actuator includes a source of magnetic energy mounted upon a pivoted arm having an arm to normally hold the actuator when the said armature is brought within the magnetic field, wherein the means interposed between the pressure responsive device and the actuator includes a reciprocable bracket operated by the pressure responsive means to engage the actuator when the burner mechanism is idle to open the switch and to free the actuator upon an increase in fluid fuel pressure, and wherein the thermally operated means includes a heating element in the ignition circuit and a thermal element provided with an abutment adapted to engage the said arm, said element actuated by the heating ele-

ment to rotate the actuator arm to open the ignition switch.

26. In an electrically operated and controlled fluid pressure burner mechanism including an electrical igniter, an ignition circuit, a switch in the ignition circuit, and means for operating the switch including a pressure-responsive means, and an electrically operated thermal means coacting therewith and arranged for the pressure-responsive means, upon initiation of the operation of the burner mechanism to permit, a predetermined time thereafter, the operation of the thermal means to open the switch.

27. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit, an ignition switch therein for establishing said circuit upon operation of the burner mechansm, means to actuate the ignition switch, a timed actuator therefor operative upon establishment of the burner circuit, and of such limited action when operative as to normally have no effect upon said means, means responsive to the fluid fuel pressure delivered to the burner nozzle operating upon the establishment of the normal operating pressure to render the action of the timed actuator effective to open the switch.

28. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit, including therein a closed ignition switch when the burner is idle, means to actuate the ignition switch, a timed actuator therefor operative upon establishment of the burner circuit, and of such limited action when operative as to normally have no effect upon said means, means responsive to the fluid fuel pressure delivered to the burner nozzle operating upon the establishment of the normal operating pressure to render the action of timed actuator effective to open the switch, said pressure responsive means upon a loss of said normal pressure acting to close said switch.

29. The structure of claim 26 wherein said pressure responsive means upon a predetermined reduction in pressure acts to close said switch.

30. The structure of claim 27 wherein said pressure responsive means upon a loss of said normal pressure acts to close said switch.

31. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit, a normally closed ignition switch therein for establishing said circuit upon operation of the pressure mechanism, operating means for said switch, electrically operated means to partly actuate the switch operating means a predetermined time after the establishment of the ignition circuit, and means actuated by the establishment of the normal fluid fuel operating pressure to render the action of the first means, when operative, effective to open the switch.

32. In an electrically operated and controlled fluid fuel pressure burner mechanism including an electrical igniter, an ignition circuit, including a normally closed ignition switch when the burner is idle, operating means for said switch, electrically operated means to partly actuate the switch operating means a predetermined time after the establishment of the ignition circuit, and means actuated by the establishment of the normal fluid fuel operating pressure to render the action of the first means, when operative, effective to open the switch.

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