April 22, 1941. H. J. FANGER 2,238,892

BURNER CONTROL APPARATUS

Filed March 27, 1937 2 Sheets-Sheet 1

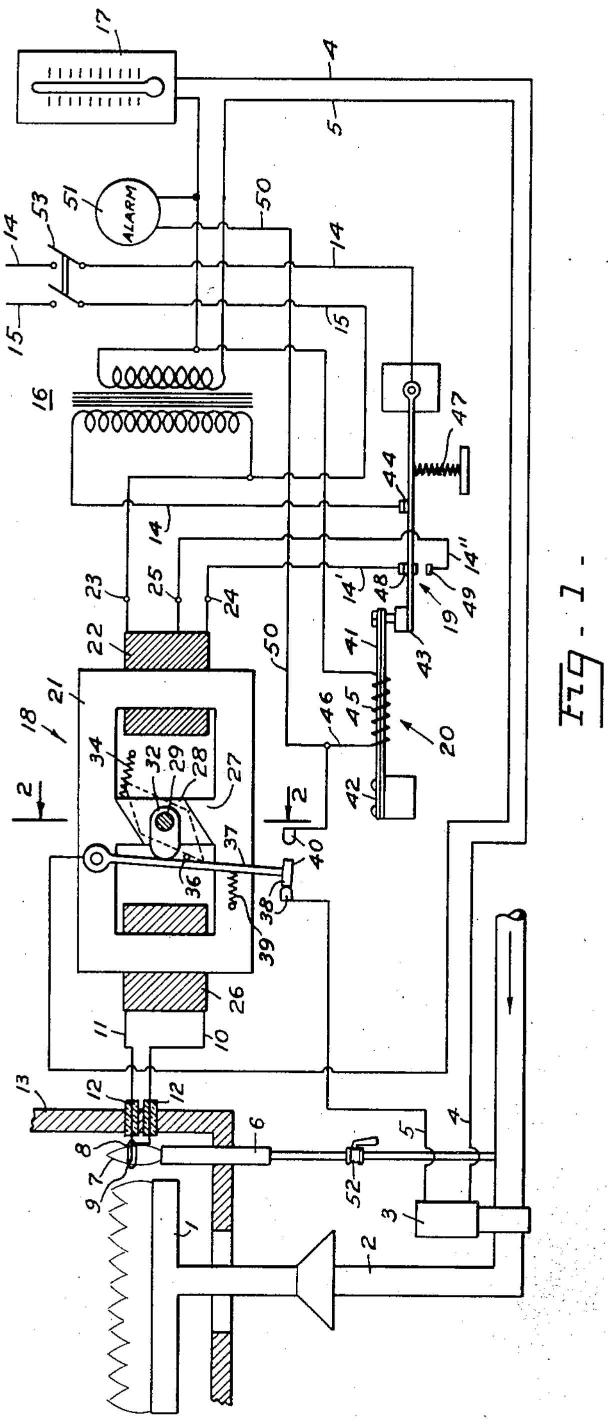

Fig. 1.

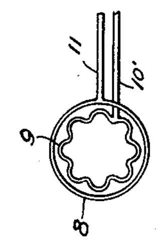

Fig. 3.

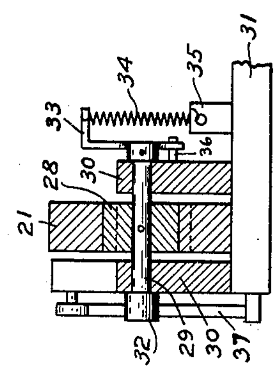

Fig. 2.

INVENTOR.
HERMAN J. FANGER

BY J. A. Bried

ATTORNEY.

April 22, 1941. H. J. FANGER 2,238,892

BURNER CONTROL APPARATUS

Filed March 27, 1937 2 Sheets-Sheet 2

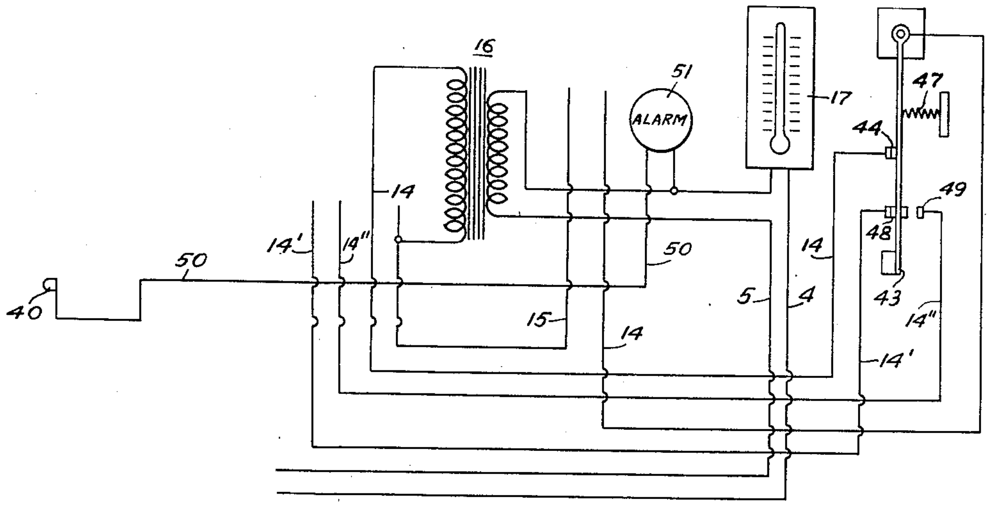

Fig. 4.

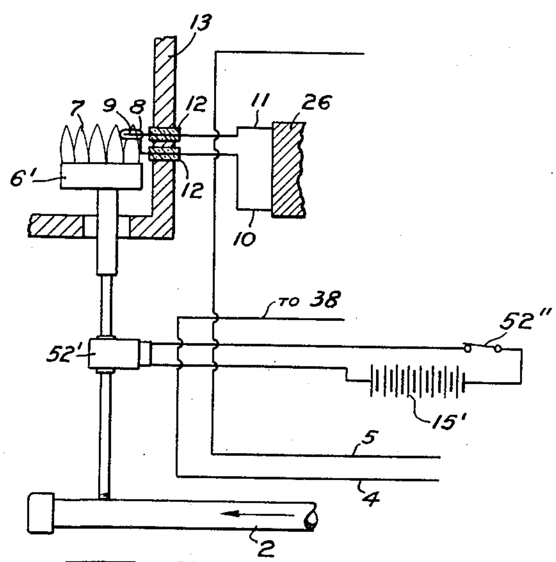

Fig. 5.

INVENTOR.
HERMAN J. FANGER
BY
J. A. Brief
ATTORNEY.

Patented Apr. 22, 1941

2,238,892

UNITED STATES PATENT OFFICE

2,238,892

BURNER CONTROL APPARATUS

Herman J. Fanger, Oakland, Calif., assignor, by direct and mesne assignments, to The Partlow Corporation, New Hartford, N. Y.

Application March 27, 1937, Serial No. 133,411

13 Claims. (Cl. 158—28)

This invention relates to automatic control of furnace and other burners, particularly though not necessarily such as use a pilot flame, and the principal object of the invention is to provide simple, reliable electric control apparatus for such burners. A further object is to utilize in an improved manner the flame or ionized gases in a heat zone as a path for the controlling circuit. A still further object is such a system which will insure reignition of the pilot under certain controlled conditions.

Other objects and advantages of the invention will appear in the following description and accompanying drawings.

In the drawings:

Figure 1 is a diagrammatic view of my improved burner control apparatus and circuits, and with the pilot and main burners shown in elevation;

Figure 2 is a vertical section of the relay as seen from line 2—2 of Figure 1;

Figure 3 is a plan view of the pilot flame electrodes or spark gap;

Figure 4 is a wiring diagram showing the use of a hand operated ignition switch;

Figure 5 is a wiring diagram showing a burner controlled by my invention, without use of a pilot.

Before describing the drawings, it may be said that broadly the control of a fuel burner by means of an electric circuit utilizing the pilot flame itself or the main burner flame, as an ionized path for the current is already known, and as exemplified in Patents No. 1,809,280 and No. 1,880,871, but such patents pass only an infinitesimal amount of current through the flame element and require the use of vacuum tube amplifiers, to secure an operating current, and which requirement is avoided in my simplified system yet without sacrifice of reliability and safety. The other advantages of my invention will appear hereinafter.

In my improved electric control, I preferably pass a continuous and substantial flow of current through the pilot or burner flame as a stream of sparks sufficient to reignite the gases if the flame momentarily goes out, yet not of high enough voltage to jump the gap after the heated gases have appreciably cooled. The breaking of the secondary or flame current circuit actuates a relay which shuts off the fuel valve to the main burner, and also may operate a switch for throwing a higher voltage into the ignition circuit so as to jump the cooled gap for relighting the flame.

This switch is preferably a time delay switch to insure time for any combustible main burner fumes to have been dissipated.

The relighting of the pilot flame at once drops the ignition circuit voltage to a predetermined continuous running value, and opens the delay time switch and closes the circuit to the main burner fuel valve so as to again open the same.

A further feature of the system is the provision of an audible or visible alarm, positioned at any convenient point, to clearly indicate that the main burner valve is turned off and that the apparatus is attempting to reignite the pilot so that if for any reason the pilot will not reignite in a short time (such for instance as due to there being no gas in the pilot line), this fact will be made known so that the cause of the trouble may be investigated.

A particular feature of the invention is the manner of using the variation in magnetic flux in the ignition transformer resulting from the variation of the output current, to operate the burner valve operating circuit.

In the drawings 1 indicates a main burner which may be any type of gas or liquid fuel burner suitably supplied with fuel from a pipe 2 provided with an electrically operated shut-off valve 3 here indicated as a solenoid valve normally closed as by gravity and/or a spring, and held open when the electric circuit 4, 5, to it is closed.

Adjacent the main burner is a pilot burner 6 of any type but here indicated as the usual Bunsen gas burner receiving its fuel supply from the main fuel line 2 if a gas main, at a point before valve 3, or from an independent source of gas fuel if the main burner uses an oil or liquid fuel.

The flame of the pilot is indicated at 7 and in position to be impinged by it are two spaced electrodes 8 and 9 which may be of the usual or spark plug type, or other type, but which in the drawings are indicated of concentric ring construction as best shown in Figure 3, wherein the electrode 8 is a ring of non-oxidizable metal and spaced within which is a star-shaped or multispoked ring 9 constituting the other electrode and providing thereby a multitude of spark gaps between the two rings.

The electrodes are both indicated as supported at the ends of high tension circuit conductors 10, 11, extending in porcelain insulators 12 through side 13 of the furnace, but they may be otherwise supported in the pilot or main burner flame, and one may be grounded by supporting on the pilot or main burner if desired.

The system includes the following further elements:

A source of operating current such as the usual 110 A. C. house lines 14, 15. A stepdown transformer 16 with an output circuit 4, 5, of about 24 volts in series with a room thermostatic switch 17, and passing through a relay generally designated 18. A starting switch for initially lighting the pilot is indicated at 19, and a time delay actuator therefor is indicated at 20, and certain wiring and details of the relay 18 to be described.

The relay 18 includes a step-up transformer provided with a figure 8 core 21, primary windings 22 at one end leg of the core with end and intermediate taps 23, 24, 25, which may include about 2500 turns, and a secondary winding 26 of about 35,000 turns. The relation of the windings may vary, depending on the gap used and voltage of the line current.

The central leg 27 of the core is cut away at an angle to provide a central bridge portion 28 of rhomboidal form which is securely mounted on a shaft 29 (see Figure 2) supported in bearings 30, all preferably secured with the core 21 to a suitable plate or base 31. The bridge may be on an end leg and the windings on the others.

To one end of the shaft 29 is secured a cam 32 and to the other an arm 33 from which extends a tension spring 34 hooked at its other end to a bracket 35 secured to the supporting plate 31 or other fixed member, so that the normal position of the core bridge portion 28 due to the pull of the spring, is as per dotted position shown in Figure 1, and against a suitable stop 36 so as to maintain a substantial gap at both ends to impede the flow of magnetic flux through the central leg of the figure 8 core.

The slanted ends of the bridge piece 28 and fixed pieces 27 are finished to meet nicely when the bridge piece is turned on its pivot to bridging position for the flux against the tension of spring 34. The bridge when closed forms a shunt path for the magnetic flux.

Cam 32 operates against a switch 37 to close contacts 38 and thereby open fuel valve 3 when the bridge 28 is in closed position, while a compression spring 39 tending to open the switch (from the position shown) operates upon release of the cam to break the valve circuit 4, 5, and close contacts 40 to operate the delay actuator 20 for closing the starting switch 19.

Actuator 20 may be any type of delay switch device but is here shown as a thermostatic warping element 41 anchored at one end at 42 and with its free end arranged to depress a movable switch element 43 and cut out part of the primary windings 22 by transferring the connection of circuit wire 14 from the end terminal 24 through wire 14′, to the center terminal 25 through wire 14″, by breaking contacts 48 and closing contacts 49, while at the same time breaking the connection at 44 of the power circuit line 14 leading to the step-down transformer 16 so that when actuator 20 is warped to bring the high voltage connections of ignition transformer 21 into operation, the low voltage lines 4, 5, are dead.

Thermostatic actuator 20 is heated by a heating coil 45 in a branch line 46 energized when contacts 40 are closed, and the heating coil and element 41 may be more or less enclosed in heat insulation to set up the time interval required, so that upon breaking the heating circuit at contacts 40, the warped element 41 will remain warped for a few seconds to hold ignition switch 19 closed for the high tension spark, for a similar length of time to insure ignition, then return to the position shown in the figure. Switch element 43 is returned to position shown by a suitable spring 47, gravity, or other automatic means.

Actuator heating coil 45 is of a size and nature to require preferably from about 30 to 60 seconds or more to develop sufficient heat to warp element 41 enough to close contacts 49, and by this lapse of time permit the escape of any combustible fuel vapors which may be in the furnace as a result of the flame going out from any cause, or fuel in the burner pipe between the burner and valve 3.

When heater 45 is energized a shunt line 50 extends around it to line 4 at a point ahead of the room thermostat 17 and preferably in the same general location where it actuates a suitable signal 51, which as previously stated, may be either a bell or a lamp, to give warning that the pilot flame is out.

The operation of the apparatus will be generally understood from the preceding description of the various parts and manner of functioning, but may be summarized as follows:

Main wall switch 53 is closed. This will energize the entire primary windings 22 and hence the voltage output of the secondary 26 will not be high enough to jump the cold spark gap. The core flux will find a ready closed path through the two outer legs of the figure 8 core, and will not be strong enough to close the bridge piece 28 against the pull of spring 34, which consequently will be in the dotted position with cam 32 turned so that contacts 40 will be closed and heater 45 will slowly begin to heat to operate switch 19.

After closing switch 53 (or before will do no harm) pilot valve 52 (which may be manually or electrically operated) is opened. The automatic depressing of switch 19 by element 41 opens contacts 44 and 48. Opening of contacts 44 deenergizes the heater 45, but the residual heat of the actuator 20 is sufficient to continue the warping of element 41 which then closes contacts 49 cutting out part of the primary 22 to thus raise the winding ratio between primary and secondary of the ignition transformer and thereby raise the secondary voltage to a value which will send a stream of sparks through the pilot gap and ignite its flowing gas. This flow of current through the secondary circuit 10, 11, forces more of the flux to pass in the intermediate leg of core 21 so that it draws the bridge piece closed with considerable force to the full line position to break contacts 40 and close contacts 38.

However, as the slow moving or delay element 41 holds the high tension spark on for a few seconds, and since contacts 44 are then broken, transformer 16 is out of circuit and there is no current in lines 4, 5, to open the main gas valve 3 and it remains closed until the delay element 41 cools and moves far enough to permit opening of contacts 49 and closing of contacts 48 and 44 to the position shown in Figure 1. The opening of contacts 49 permits the bridge piece to open, thus opening contacts 38 and closing contacts 40. The heating coil 45 is not reenergized, however, until contacts 44 close. The closing of contacts 44 re-establishes the low voltage in the spark gap which still finds a ready path for the current through the ionized flame gases as a continuous series of sparks or small arc sufficient to reignite the gas if it were momentarily extinguished, but of insufficient voltage to jump the gap a few moments after the pilot flame has gone out and the spark electrodes have cooled.

The lower secondary voltage drops the current to the lower sparking value through the flame element, but still causes enough flux in the intermediate leg of core **21** to return the bridge piece **28** to closed position, and with cam **32** re-closing contacts **38**, and since contacts **44** have in the meantime been closed by return of starting switch element **43**, transformer **16** is connected, lines **4** and **5** are energized and main fuel valve **3** opens so that the main burner **1** is supplied with fuel to be ignited from the burning pilot flame 7.

The main fuel valve **3** is in the usual manner under control of the room thermostat **17** at all times, and shut off when it does not call for heat. Should the pilot flame momentarily go out for any reason, the stream of relatively low tension sparks will promptly ignite it, but should it stay out for a few moments, the sparks will not be able to jump the no longer ionized gap, and this breaking of the secondary circuit will cause a drop in the flux in core **21** to a point which will not be able to hold the bridge piece **28** closed against the force of spring **34**, hence it will at once snap to the dotted position, cam **32** will release switch **37**, to close main fuel valve **3**, and again close contacts **40** for operating the actuator **20** for recycling as explained. However, before the actuator **20** has had time to operate, the voltage of the spark gap momentarily jumps up considerably at the moment the bridge piece opens, to thus aid in instantaneous relighting of the frame.

If actuator **20** were not a slow acting or delay time device the high tension spark would snap on and off objectionably as well as the main fuel valve in case the pilot did not ignite.

Instead of providing the delay time actuator **20** the ignition switch **19** may be conveniently located in the room adjacent the room thermostat **17**, or near the burner, and closed by hand when the alarm **51** shows the pilot to have gone out. This arrangement is shown in Figure 4 of the drawings wherein the switch element **43** is close to the room thermostat **17** and is to be operated by hand as stated, and therefore the actuator **20** of Figure 1 and its branch wiring have been omitted. This figure is a portion of Figure 1 showing only the changed run of the wiring involved, and adjacent parts of the circuit to identify it with Figure 1, all numerals being the same as in Figure 1. All the remainder of the circuit not shown being the same as shown in Figure 1.

From the above description of the advantages and operation of my improved burner ignition system operating under control of an ionized pilot flame gap, it will be evident that it may also, with slight change, be employed with burners having no pilot, by using a portion of the main burner flame as the ionized gap, and also whether gas or oil burner.

As one example of a burner without pilot equipped with my igniter reference is made to Figure 5 which is a redrawn portion of the left-hand end of Figure 1 omitting burner **1** and its electric valve **3**, and enlarging the pilot burner as shown at **6'** to constitute the only or main burner. The electrodes **8**, **9**, overhang a portion of the flame **7'** and operate as described for Figure 1. Hand operated valve **52** has been replaced with an electric valve **52'** and which electric valve may receive its operating current from any hot leg of the circuit, for simplicity here indicated as a battery **15'**, and the valve to be operated by a switch **52''** situated preferably near the alarm signal **51**. All other parts of the circuit may be the same as shown in Figure 1, but it is preferable to cut down the delay action of actuator **20** to the minimum to hold a good ignition spark at the electrodes. If the gas flame goes out momentarily for some reason the instantaneous boost in voltage set out on this page, column one, lines 35 to 38, inclusive, will at once reignite it. If not the actuator **20** will boost the voltage as explained. If for any reason no reignition should take place (long absence of gas flow or broken ignition wire) the alarm signal **51** will indicate that no flame is burning and hence switch **52''** is to be pulled to close valve **52'** until the matter can be investigated. It is obvious that such a single burner may also be used with a hand operated switch **43** without the actuator as shown in Figure 4 if desired. Also that with the manually operated valve **52'** on a burner as shown in Figure 4 without pilot light the thermostat **17** would not be in use except to indicate the heat of the room from its thermometer face, and should therefore be set to call for heat at all times.

The two modifications shown in Figures 4 and 5 are merely given to show some of the several possible adaptions of my invention, for it must be distinctly noted that the heart of the invention is the automatic ignition voltage boosting relay **18** controlled by the current flow through the flame gap in the general manner set out, and that anyone skilled in the art can embody it in a variety of specific wirings to suit various installation requirements.

No claim is made herein to the structure shown in Figure 3, relating to the pilot flame electrodes or spark gap. This structure is shown and claimed in my copending application Serial No. 384,577, filed March 21, 1941, entitled Ignition means.

Having thus described my invention, what I claim is:

1. In a burner control system having a spark gap, an ignition transformer provided with primary and secondary windings and connections for varying the effective relation of the primary and secondary windings of said transformer for varying the voltage of the high tension secondary current produced at the gap, and means responsive to drop in magnetic flux in said transformer upon failure of the gap current arranged to connect the windings for producing the highest voltage secondary current of said transformer.

2. In a burner control system having a spark gap with electrodes positioned in a flame path, means for supplying a current to said electrodes of a voltage to cause the current to jump the gap when a flame is present but insufficient to traverse it when the gap is cooled, and means responsive to failure of said current upon cooling of the gap arranged to boost its voltage to cause the current to jump the cooled gap for reigniting the flame.

3. In a burner control system having a spark gap with electrodes positioned in a flame path, means for supplying a current to said electrodes of a voltage to cause the current to jump the gap when a flame is present but insufficient to traverse it when the gap is cooled, and means

responsive to failure of said current upon cooling of the gap arranged to boost its voltage to cause the current to jump the cooled gap for reigniting the flame and to drop the voltage to its former value upon the flame being re-established.

4. In a burner control system having a spark gap with electrodes positioned in a flame path, means for supplying a current to said electrodes of a voltage to cause a stream of sparks across the gap when a flame is present but insufficient to cause the current to jump the gap when the flame is out and the gap is cooled, and signal operating means responsive to failure of said current serving to indicate that the gap is cooled.

5. In a burner control system having a main burner and a pilot flame, a spark gap with electrodes positioned in a flame path, means for supplying a current to said electrodes of a voltage to cause a stream of sparks across the gap when a flame is present but insufficient to cause the current to jump the gap when the flame is out and the gap is cooled, a main burner fuel valve, means responsive to failure of said current for boosting the voltage to cause the current to jump the gap when the flame is out, and means closing said valve during said boosting of the current voltage.

6. In a burner control system having a main burner and a pilot flame, a spark gap with electrodes positioned in the pilot flame path, means for supplying a current to said electrodes of a voltage to cause a stream of sparks across the gap when a flame is present but insufficient to cause the current to jump the gap when the flame is out and the gap is cooled, a main burner fuel valve, means responsive to failure of said current for boosting the voltage to cause the current to jump the gap when the flame is out, and means closing said valve during said boosting of the current voltage and opening said valve upon re-establishing of the lower voltage current.

7. In a burner control system, a spark gap with electrodes positioned in a pilot flame path, means for supplying a current to said electrodes of a voltage to cause the current to jump the gap when a flame is present but insufficient to traverse it when the flame is out and gap cooled, a main burner and controlling valve, means responsive to failure of said current to jump the gap arranged to close said valve, and means responsive to failure of said current for raising the voltage of said current for jumping said gap when cooled.

8. In a burner control system, a spark gap with electrodes positioned in a pilot flame path, means for supplying a current to said electrodes of a voltage to cause the current to jump the gap when a flame is present but insufficient to traverse it when the flame is out and gap cooled, a main burner and controlling valve, means responsive to failure of said current to jump the gap arranged to close said valve and for automatically raising the voltage of said current for jumping said gap when cooled.

9. In a burner control system as specified in claim 2, said last mentioned means provided with a delay element requiring a predetermined time for its operation.

10. In a burner control system having a spark gap with electrodes positioned in a flame path, means for supplying a current to said electrodes of a voltage to cause a stream of sparks across the gap when a flame is present but insufficient to cause the current to jump the gap when the flame is out and the gap is cooled, a burner fuel valve, time delay means for boosting the voltage to jump the gap when the flame is out, and means closing said valve during said boosting of the current voltage.

11. In a burner control system having a spark gap with electrodes positioned in a flame path, a transformer supplying a secondary current to said electrodes of a voltage to jump the gap when flame is present but insufficient to traverse it when the gap is cooled, and means responsive to variation in magnetic flux of said transformer upon the failure of said secondary current at once boosting the secondary voltage before said gap has cooled.

12. An electric ignition system for fuel burners, including a burner, a spark gap bridging the space for the flame of the burner, a source of electrical energy, a transformer having its primary connected therewith and its secondary connected across said spark gap so as to maintain a passage of sparks across the gap through a flame therein, said transformer characterized by the fact that its secondary potential is normally insufficient to jump the gap in the absence of a flame, and means for increasing the potential of the secondary of the transformer sufficiently to effect a passage of sparks across the gap for ignition, said means comprising means for shifting the connection of the source of electrical energy to pass through a lesser number of turns of the primary of the transformer and thereby produce an increased potential in its secondary winding.

13. A safety control and ignition system for fuel burners, including a burner with a spark gap bridging the flame space projecting from a fuel jet of the burner, a transformer having a primary winding, and a high potential secondary connected with said spark gap of the burner, a source of alternating current supply, means normally connecting said source of current supply with said primary winding of the transformer so as to produce a potential in the secondary winding sufficient only to produce a passage of sparks across the gap when a flame is present therein but operable to connect a lesser number of turns of the transformer primary winding with the source of current supply to increase the secondary potential for fuel ignition, and means dependent upon the current consumption of the transformer for controlling the supply of fuel to the burner.

HERMAN J. FANGER.