

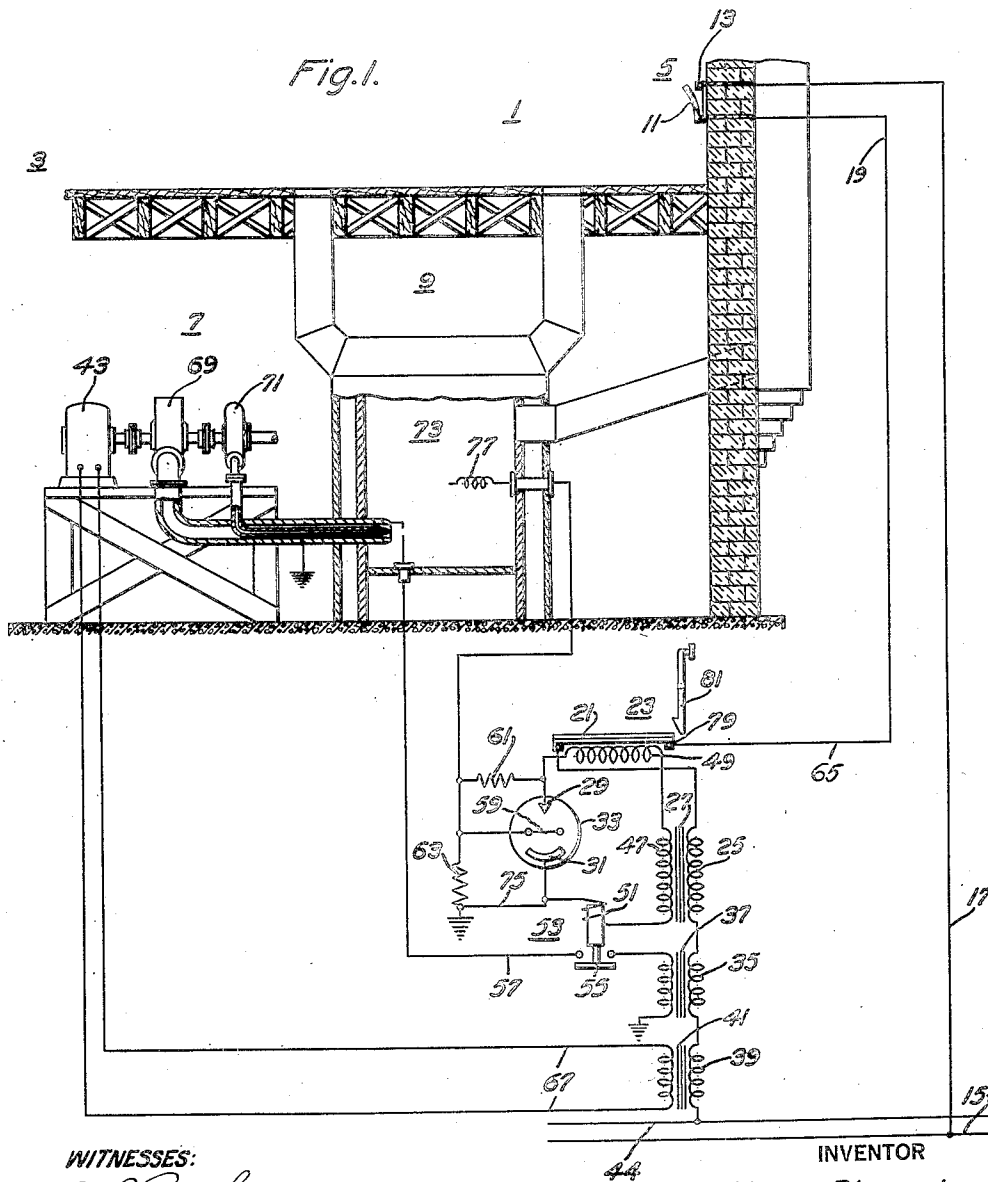
Nov. 28, 1933.

H. DIAMOND
FUEL BURNER SYSTEM

1,936,784

Filed Dec. 19, 1930

2 Sheets-Sheet 1



WITNESSES:

M. D. Fowler
Wm. C. Grooms

INVENTOR

Hymen Diamond
BY *Charles E. Carr*
ATTORNEY

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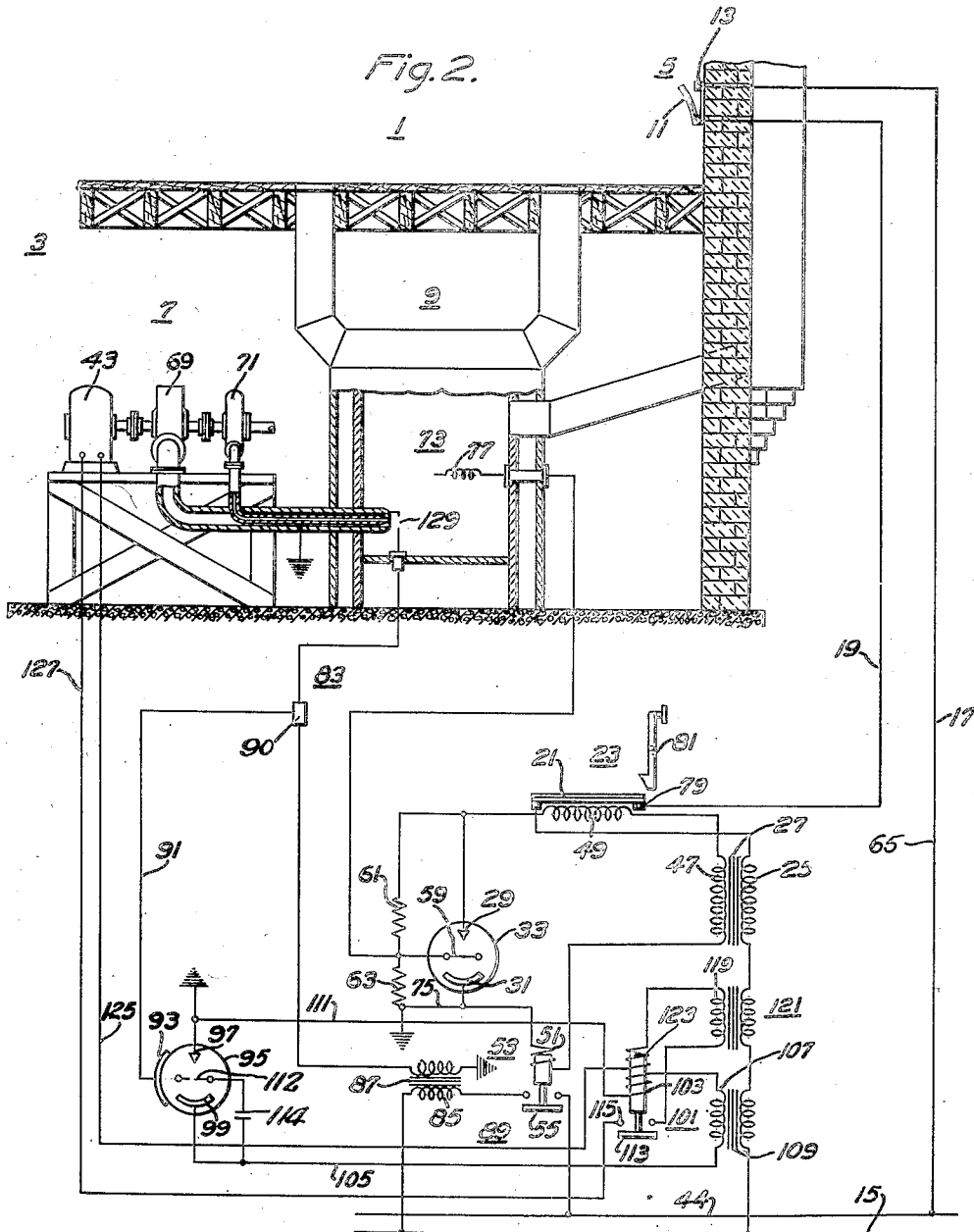
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M. D. Fowler.
Chas. C. Groome

INVENTOR

Hymen Diamond

BY
Wesley E. Barr
ATTORNEY

UNITED STATES PATENT OFFICE

1,936,784

FUEL BURNER SYSTEM

Hymen Diamond, Pittsburgh, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, a corporation of Pennsylvania

Application December 19, 1930
Serial No. 503,386

10 Claims. (Cl. 158—28)

My invention relates to fuel burners and has particular relation to control systems for regulating the activity of burners.

A fuel-burner-control system, constructed and operated according to the teachings of the prior art with which I am familiar, ordinarily comprises a fuel-supply system, including an oil tank and a power-driven device for delivering the oil from the tank in atomized condition, an ignition system for the atomized fuel and a system of relays whereby the activity of the fuel-supply apparatus and the ignition device is regulated.

The control systems provided by the earlier prior art are not entirely satisfactory. The earliest devices depended, for their regulation, on thermostats, heated by the flame in the furnace and by the flue gases. Thus, the thermostat in the flame actuates a system of relays to deenergize the ignition, while the thermostat in the flue actuates a second system of relays to transfer the burner system to a permanently operating condition from the temporary condition in which it operates before its capability of operating properly is established.

Control systems of this type have the disadvantage that they are comparatively slow in response. In an enterprise wherein the apparatus has as much potentiality of doing damage, as in liquid-fuel burners, the producers can hardly depend upon a slow-acting device for their safety feature.

Accordingly, the developments of the later prior art follow an entirely different line of attack upon the problem. In the systems of this class, the devices that actuate the control apparatus depend on the ionization of the flame, and on the high-frequency effect produced by the ignition, for their operation.

However, in this connection, considerable difficulties have developed. The current through an ionized flame is comparatively small, unless considerable voltage is impressed across the flame. The risk, and the inconvenience involved, in the utilization of comparatively high potentials for any considerable length of time, renders a system, depending directly upon the ionization current, almost as undesirable as a system depending upon thermostats.

An attempt has been made to improve the regulation systems of this type by utilizing the ignition spark for checking the condition of the fuel in the burner. However, this method, of checking the condition of the furnace, has proved unsatisfactory by reason of the deleterious effect that the arc, produced in the flame, has on the

spark terminals, and also by reason of the fact that, in the present connection, a comparatively high potential is necessary for operation of the arc. Finally, to extinguish the arc, when the furnace attains its running condition, is simply to render the flame-checking device unresponsive to the condition of the flame after it has once been ignited. Such a situation is highly undesirable, since the flame in a furnace may be choked out after having burned for a certain period of time. In such an emergency, the temporary spark flame-checking device is useless.

Recently, a more satisfactory system has been developed of a type wherein the ionization current in the flame is utilized to operate an electric-discharge relay. The conductive path of the flame provides a leak for the blocking current that collects on the grid of a grid-controlled electric-discharge tube, and, consequently, enables the tube to become energized and to energize, in turn, the necessary relays.

The only disadvantage of systems of this type resides in the fact that the tube has a limited life, and, while it will run for a considerable length of time, it will eventually become unresponsive to the condition of the flame.

It is, accordingly, an object of my invention, to provide a fuel-burner-control system of a type incorporating an electric-discharge device, wherein the device is so related to the remainder of the apparatus as to be active only when the fuel burner is being started.

An additional object of my invention is to provide, for a fuel burner, a flame-checking device that shall be active only during the period of ignition of the flame.

A further object of my invention is to provide, for a fuel burner of the type incorporating a fuel-supply system and a fuel ignition system, an electric-discharge device that shall be energized to regulate the activity of the fuel-ignition system and that shall be deenergized by the ignition of the fuel in the burner.

Another object of my invention is to provide, for a fuel burner of the type incorporating a fuel supply device, an ignition device and a time-controlled device for interrupting the activity of the fuel-supply system, an electric-discharge device for regulating the activity of the time-controlled device.

A still further object of my invention is to provide, for a fuel burner of the type incorporating a power supply system for actuating the necessary elements of the burner, such as ignition and fuel supply, a time-controlled device

for interrupting the activity of the power-supply system and an electric-discharge device that shall be responsive to the condition of the fuel within said burner for regulating the activity of the time-controlled device.

More specifically stated, it is an object of my invention to provide a fuel-burner-control system, of the type incorporating an electric-discharge device adapted to check the presence of the flame, wherein the device shall be energized for initiating the flame, but shall be deenergized by the ionized condition thereof.

According to a preferred embodiment of my invention, I provide a fuel-burner system, of a type incorporating an electric-discharge device, wherein the device is rendered active simultaneously with the fuel-supply device and, in turn, causes the ignition device to become active. The electric-discharge device is subsequently rendered inactive by the ionization of the flame produced by the ignited fuel and, in turn, renders the ignition device inactive.

The power supply, for the excitation of the electric-discharge device, for the fuel-supply system and for the ignition device, is delivered through a transformer, the primary of which is in series with a bi-metal contactor heated from a coil that is in series with the principal electrodes of the electric-discharge device. The bi-metal is, consequently, heated as long as the electric-discharge device is in an energized condition. If the fuel should not be ignited, the bi-metal would eventually be heated to such point as to open the primary circuit, and hence, to interrupt the activity of the elements of the system. On the other hand, when the electric-discharge device becomes deenergized by reason of the flame ionization, the current through the heating coil of the bi-metal is discontinued, and the elements of the system continue in their active condition for a time regulated by the heat supply that is desired.

In a modification of my invention, the fuel-supply system is not energized directly from the primary of the power-transmission transformer but is in a circuit that can only be closed when the ignition spark is in suitable condition for igniting the fuel. It is thus seen that the latter system incorporates, not only a flame-checking device, but also an ignition-checking device.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view illustrating a preferred embodiment of my invention, and Fig. 2 is a diagrammatic view illustrating a modified embodiment of my invention.

The apparatus shown in Fig. 1 comprises a section of a room 1 of a house wherein a temperature-responsive thermostat 5 is disposed, and a section of the basement 7 of the house 1 wherein a heating equipment 9 is located.

The thermostat 5 is so regulated that when the temperature of the room 1 attains a predetermined lower limit, its movable element 11 engages a fixed contact 13 to close a circuit from one power-supply bus line 15, through a lead 17, to the fixed contact 13 of the thermostat 5, through the movable bimetallic element 11 of

the thermostat 5, another lead 19, the bimetal 21 of a time-delay contactor 23, the primary 25 of a transformer 27, adapted to impress a voltage between the principal electrodes 29 and 31 of a grid-controlled electric-discharge device 33, the primary coil 35 of an ignition transformer 37 and the primary coil 39 of a transformer 41 that supplies power to a motor 43, to the remaining power-supply bus line 44. This circuit is termed the primary circuit 65.

The secondary coil 47 of the transformer 27 that supplies the power for operating the electric-discharge tube 33 is connected to the anode 29 of the tube through the heating coil 49 of the time-delay bimetal contactor 23, and to the cathode 31 of the tube 33 through the exciting coil 51 of a relay 53, equipped with a movable contactor 55 that is adapted to close the ignition circuit 57.

The anode 29 of the discharge device 33 is connected to the control electrode 59 of the device through an impedance 61, and the cathode 31 of the device is connected to the control electrode 59 through a second impedance 63. The impedances 61 and 63 are so related in magnitude that the tube 33 is energized when the primary circuit 65 is closed by the room thermostat 5.

The excitation of the tube 33 causes a current to pass through the heating coil 49 of the time-delay contactor 23 and through the exciting coil 51 of the ignition relay 53. As a result, the ignition is immediately initiated.

The secondary of the motor circuit 67, on the other hand, is in closed condition, and the motor is excited by the closing of the primary circuit 65. In rotating, the motor 43 drives a pressure blower 69 and an oil pump 71 that supply the fuel, in atomized condition, to the combustion compartment 73 of the burner.

The lead 75, connecting the cathode 31 to the impedance 63 disposed between the cathode 31 and the control electrode 59, is grounded, and the metallic elements of the compartment 73 are grounded in such manner that a flame within the compartment provides a leakage path between a flame terminal 77, connected to the control electrode 59 of the electric discharge device 33, and ground. The leakage path is thus an impedance path in parallel with the impedance 63 connected between the control electrode 59 and the cathode 31 of the tube 33.

By reason of the decrease in impedance between the control electrode 59 and the cathode 31 of the electric-discharge device 33, engendered by the ionized path of the flame, the potential between the control electrode and the cathode is decreased, and the electric-discharge device 33 is deenergized. The heating current, through the coil 49 associated with the time-delay contactor 23, as well as the exciting current through the ignition relay coil 51, is interrupted, and the ignition is, in turn, interrupted.

Under the above conditions, the burner 9 continues to operate until the room thermostat 5 is opened and, in turn, opens the primary circuit 65 of the motor 43, by means of which the fuel is supplied to the furnace.

On the other hand, if the fuel fails to become ignited, the electric-discharge tube 33 remains in an energized condition until the coil 49 associated with the thermostatic time-delay contactor 23 heats the movable element 21 thereof to such point that it disengages the corresponding fixed contact 79, and engages a hook 81, whereby

it is held in fixed position until the operator, who examines the condition of the furnace and of the ignition, disengages it.

If desirable, the hook 81, whereby the movable element 21 of the time-delay contactor is engaged, may be connected to a signal lamp which indicates that the contactor has become disengaged. The signal thus, immediately serves notice to the owner of the furnace that it requires servicing.

If the flame in the furnace 9 should become extinguished while the furnace is running, the electric-discharge tube 33 immediately becomes energized, and the ignition is excited and remains in such condition until the flame is either reignited or the time-delay contactor 23 opens the primary circuit 65.

The apparatus shown in Fig. 2 includes the feature of ignition check.

The electric-discharge tube 33, utilized in checking the flame, in the type of apparatus illustrated in this view, is connected in substantially the same circuit as the apparatus illustrated in Fig. 1. However, the ignition circuit 83 is excited through the primary 85 of a transformer 87 included in an independent circuit 89 and adapted to be actuated by the excitation of the tube 33.

The ignition current is electrostatically coupled through the metallic shell 90 to a lead 91 that is connected to a metallic shield 93 enveloping a second electric-discharge device 95. The principal electrodes 97 and 99 of the electric-discharge device 95 are in the form of concentric cylinders, the anode 97 being the innermost cylinder. A series of condensers is thus formed between the metallic envelope 93 and the cathode 99 and the anode 97.

If the ignition spark has the necessary properties for ignition, a high-frequency potential is established between the metallic envelope 93 and the anode 97, since the two condensers in series offer a small impedance to the passage of a high-frequency current. In such case, the electric-discharge tube 95 becomes energized, and one exciting coil 103 of a relay 101 in series with the principal electrodes 97 and 99 of the tube 95 is energized by the current flowing through the tube. The exciting current for the relay 101 flows from the anode 97 to the cathode 99, through a lead 105, the secondary 107 of a power transmission transformer 109, the exciting coil 103 of the relay 101 and a lead 111, to the anode 97 of the tube 95.

Preferably the tube 95 should be of the grid-controlled type and to facilitate the operation of the ignition-checking device, the control electrode 112 of the device 95 is connected to the cathode through an impedance 114 (preferably a capacitor). The impedance 114 may be so selected that excitation of the device 95 by the field from the spark is facilitated by reason of the fact that the control electrode 112 is thus maintained at a potential in the region of but less than the ignition potential.

By reason of the excitation of its coil 103, the movable element 113 of the relay 101, associated with the electric-discharge tube 95, engages a plurality of corresponding fixed elements 115 and closes a second circuit from one terminal of the secondary 119 of a power-transmission transformer 121, excited from the main line, through a second exciting coil 123 of the relay 101, a lead 125, the windings of the motor 43, whereby the fuel is supplied, a second lead 127 and the movable

contact 113 of the relay 101, to the remaining terminal of the secondary 119.

The motor 43 is, therefore, energized, and fuel is supplied to the chamber 73. When the fuel becomes ignited, the flame-checking electric-discharge device 33 is deenergized, and the relay coil 51, associated with the ignition transformer 87, as well as the heating coil 49 of the time-delay contactor 23, are opened. The system is now in its permanent operative condition, and the heating continues until the room thermostat is opened.

It is well to point out that in the apparatus described above, it is highly desirable that the device 33 should be of the type that fails (as it will after a comparatively long period of time) while active. A discharge device which fails while active continues to glow and, in consequence thereof, an additional convenient feature is added to the system, in that the operation of the burner is not rendered permanent if the regulating device is defective.

It is to be noted that the auxiliary coil 123, associated with the relay 101 that closes the motor circuit, is provided for the purpose of preventing the relay 101 from becoming deenergized when the primary circuit 89 of the ignition transformer 87 is opened.

It is well to point out that, if the spark gap 129 is so wide that a spark is not produced, the ordinary 60-cycle voltage is induced in the circuit leading to the metallic envelope 93 of the ignition-checking electric-discharge tube 95. The impedance offered to this voltage by the capacity, comprising the cathode 99 and the anode 97 of the tube 95, is large and the current that flows under the pressure of the voltage is short-circuited to ground through the secondary 107 of the transformer 109, whereby voltage is supplied between the electrodes of the tube 95 and the exciting coil 103 of the relay 101 that regulates the operation of the motor 43. However, since the tube 95 is unenergized in this state, sufficient current does not flow through the coil 103 of the relay 101 to close the contactor 115.

Furthermore, it should be noted that, if the spark gap is short-circuited, the current that is capacitatively induced in the lead 91 is comparatively small, and substantially no current flows in the circuit associated therewith.

It should be noted that while in the systems illustrated in the drawings, the transformers 27, 37, 41, 87, 109 and 121 are shown to be of the one-to-one type; the illustration is only symbolical and the transformers are ordinarily selected to properly suit the purpose for which they are to be applied. Thus in the ignition transformers 37 and 87, the output voltage is comparatively large and the ratio of turns of the secondaries to the primaries are rather large.

It will be apparent also that the particular connection of the transformers need not be exactly followed. The primaries 25, 35 and 39 of the transformers 27, 37 and 91 in the apparatus of the type shown in Fig. 1 may, for example, be connected in parallel with each other rather than in series with each other. The same modification may be applied with regard to the primaries of the transformers 27, 109 and 121 of the apparatus shown in Fig. 2.

I am well aware that an ordinary Geisler tube is responsive to a high-frequency potential in the vicinity thereof. However, it is to be noted that, by experiment, it has been established that a tube, of the type described hereinabove, has the prop-

erty of being considerably more reliable and uniform in its operation than is an ordinary Geisler tube. If uniformity of operation may be disregarded, a Geisler tube may be substituted for the device described in the present application.

My invention has hereinabove been described as applied to specific systems, and tubes of a specific type have been illustrated, as utilized in the systems.

It is well to note that fuel-burner systems of various types are illustrated and described in the literature relating to the subject. These systems incorporate modifications to which my invention is applicable and, when incorporated therein, serves the same purpose as it serves in the apparatus described hereinabove. My invention is, of course, to be regarded as including, within its scope of equivalents, its application to modified fuel-burner systems.

It is, moreover, understood that my improvement may be applied with tubes of other types than the device specifically illustrated in the described embodiments. Such devices, as hot-cathode grid-glow tubes, thermionic tubes, and other tubes of like nature, apparently apply. However, it should be remembered that the cold-cathode grid-controlled tube serves the purpose for which it is intended, in the present embodiment, most satisfactorily, and will possibly have a longer life than the other tubes mentioned.

Finally, it is pointed out, that my system, in its simplest form, embodies the feature of incorporating a combined flame-checking and terminal-leakage-checking device. A leakage path between the flame electrode and the ground, other than the flame itself, if such exists, provides the necessary shunting impedance which prevents the electric-discharge tube from operating and from initiating the operation of the ignition.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted, except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a fuel-burner system of the type including fuel-supply means, fuel-ignition means, a source of supply of energy for operating said fuel-supply means and said fuel-ignition means, a plural-electrode electric-discharge device for initiating the activity of said ignition means when it is energized and means for energizing said electric discharge device, means responsive to said ignition means for initiating the activity of said fuel-supply means, and means to cooperate with the flame of the fuel delivered by said fuel-supply means for interrupting the activity of said electric-discharge device.

2. A control system for apparatus by the activity of which an ionized region is produced comprising a plural electrode electric discharge device, means for energizing said device, means, to be actuated by said device when it is so energized, to initiate the activity of said apparatus and means, responsive to the ionization produced when said apparatus is active, to deenergize said electric discharge device.

3. A control system for apparatus by the activity of which an ionized region is produced, said apparatus incorporating a priming device to initiate the activity thereof, comprising a plural-electrode electric discharge device, means for energizing said electric-discharge device, means to be actuated by said device when

it is so energized to energize said priming device and thus to initiate the activity of said apparatus and means, responsive to ionization produced when said apparatus is active, for deenergizing said electric discharge to deenergize said priming device.

4. A control system for apparatus by the activity of which a state of ionization is produced in a region comprising an electric discharge device having a control electrode and a plurality of principal electrodes, a source of supply of power for energizing said device, an impedance connected between said control-electrode and at least one of said principal electrodes to maintain said control electrode at a potential such that said device becomes energized when power is applied thereto, means, to be actuated by said device when it is energized, for energizing said apparatus and means for connecting the ionization path produced by the activity of said apparatus between said control electrode and at least one of said principal electrodes to apply a potential to the control electrode of said device such that said device is deenergized when said apparatus is energized.

5. A control system for apparatus by the activity of which a state of ionization is produced in a region comprising an electric discharge device having an anode, a cathode and a control electrode, a source of supply of power for energizing said device, means for impressing potentials between said control electrode and said anode and cathode of said electric discharge device such that said device becomes energized when power is applied thereto, means, to be actuated by said device when it is so energized, for energizing said apparatus and means for connecting the ionization path produced by the activity of said apparatus between said control electrode and said cathode to apply a potential to the control electrode of said device such that said device is deenergized when said apparatus is energized.

6. In fuel-burner apparatus of the type including fuel-supply means, an electric discharge device, means for energizing said electric discharge device, means to be actuated by said electric discharge device when it is so energized for energizing said fuel-supply means, means for igniting said fuel when it is supplied and means operative by the combustion of the fuel within said burner to deenergize said electric discharge device after said fuel has been ignited.

7. In fuel burner apparatus of the type including fuel-supply means, an electric discharge device having a control electrode and a plurality of principal electrodes, means for energizing said electric discharge device, means, to be actuated by the current transmitted between the principal electrodes of said electric discharge device when it is so energized, for energizing said fuel supply means, means for igniting said fuel when it is supplied and means operative by the combustion of the fuel within said burner to impress a potential between the control electrode and the principal electrodes of said electric discharge device to deenergize said electric discharge device after said fuel has been ignited.

8. In fuel-burner apparatus of the type including fuel-supply means, an electric discharge device, having a control electrode and a plurality of principal electrodes, means for energizing said electric discharge device, means to be actuated by the current transmitted between the principal electrodes of said electric discharge device when it is so energized for energizing said fuel-

supply means, means for igniting said fuel when it is supplied, means operative by the combustion of the fuel within said burner to deenergize said electric discharge device after said fuel has been ignited and means for deenergizing said electric discharge device to deenergize said fuel-supply means if said fuel fails to become ignited within a predetermined interval of time.

9. In fuel-burner apparatus of the type including fuel-supply means and means for igniting the fuel supplied by said fuel-supply means, an electric discharge device, means for energizing said electric discharge device, means to be actuated by said electric discharge device when it is so energized for energizing said ignition means, means to be actuated by said ignition means when it is energized for energizing said fuel-supply means and means operative by the combustion of the fuel when it is ignited for deenergizing said electric discharge device.

10. In fuel-burner apparatus of the type including fuel-supply means, an electric discharge device, means for energizing said electric discharge device, means to be actuated by said electric discharge device when it is so energized for energizing said fuel-supply means, means for maintaining said fuel supply means energized independently of said electric discharge device after it has been energized, means for igniting said fuel when it is supplied and means operative by the combustion of the fuel within said burner to deenergize said electric discharge device after said fuel has been ignited.

HYMEN DIAMOND.

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