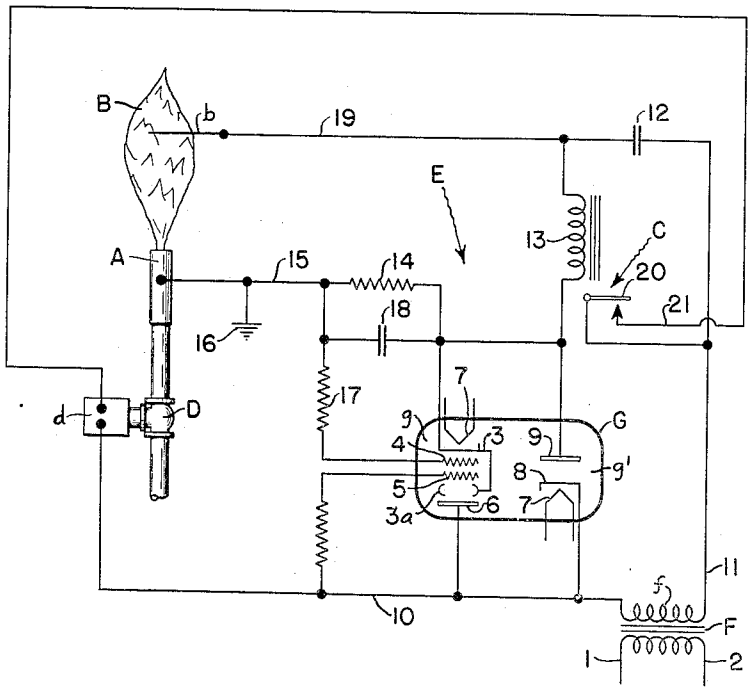
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CONTROL APPARATUS

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CONTROL APPARATUS

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7 Claims. (Cl. 250—27)

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The general object of the present invention is to provide improved means for producing different control or signal effects, accordingly as a flame having predetermined characteristics is, or is not, maintained. More specifically, the object of the invention is to provide a safety control system for a fuel burner in which use is made of a circuit network including a diode and a multi-grid valve which are associated with the fuel burner and its flame and are operatively dependent upon the characteristics of the flame, and including relay means controlled by said valves and operating to interrupt the fuel supply to the burner when the character of the flame is abnormal.

This application is a division of my prior application Serial No. 541,576 filed June 22, 1944, on which Patent No. 2,514,918 was granted July 11, 1950, and which discloses and claims novel subject matter disclosed but not claimed herein.

The subject matter of this application is also disclosed in my copending application bearing Serial No. 422,041, which was filed on April 9, 1954.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawing and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

The one figure of the drawing is a diagram illustrating a control system actuated by flame variations.

In the drawing, I have illustrated an embodiment of the present invention in the form of a safety control system for a fuel burner A, and in which the rectifying action of the flame B from the burner A is used in controlling a relay mechanism C to close the fuel supply valve D for the burner A, when the burner flame is extinguished or becomes abnormal. The operation of the relay mechanism C is controlled through a circuit network E, which has one terminal connected to the burner body, and has a second terminal connected to an electrode *b* extending into the flame. Said network includes two valves *g* and *g'* enclosed in a tube G, and is energized by a transformer F having the terminals of its primary winding connected to alternating current supply conductors 1 and 2.

The tube G may be of the commercially available type and form known as a rectifier-beam power amplifier tube 117N7-GT. The tetrode valve *g* in the tube G comprises a cathode 3 and associated beam plates 3*a*, a control grid 4, a screen 5, an anode or plate 6, and a filament 7 for heating both the cathode 3 of the valve *g* and the cathode 8 of the valve *g'*, the latter being a diode. The diode cathode 8 and the tetrode anode 6 are each connected to an energizing conductor 10. The latter is connected to one terminal of the secondary winding *f* of the transformer F. The other terminal of the winding *f* is connected through a conductor 11, a condenser 12, and a relay coil or winding 13 to the diode anode 9 of the diode valve *g'* and to the cathode 3 of the tetrode valve *g*.

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As shown in the drawing, the diode plate 9 and the cathode 3 of the multi-grid valve *g* in the tube G, which are connected to one terminal of the control winding 13, are also connected through a resistance 14 and a conductor 15 to the body of the burner A and to a ground connection 16. The grounded burner body is connected through the conductor 15 and a resistance 17 to the control grid 4 of the valve *g*. A condenser 18 is connected in shunt to the resistance 14. The control winding 13, and a conductor 19 in series therewith, connect the plate 9 and cathode 3 to the electrode *b*. The latter extends into the space which is occupied by the tip portion of the flame B when the condition of the latter is normal.

The screen grid 5 of the valve *g* is connected to the conductor 10 through a suitable screen grid resistor. The filament 7 of the tube G is adapted to be connected to a suitable source of filament energizing current, not shown.

As is known to those skilled in the art, with the electrode *b* extending into the tip of the flame B, as it does in the normal condition of the flame, the latter provides a path for current flow between the terminals formed by the electrode *b* and the body of the burner A which is more highly conductive for current flow in the direction opposite to that of flame propagation, i. e. in the direction from the electrode *b* to the burner A, than for current flow in the opposite direction. This rectifying action is explained by the fact that the combustion reaction maintaining the flame is attended by, or results in, ionization, and in a concentration of positive ions adjacent to the burner body and a concentration of negative ions or electrons at the tip portion of the flame.

The charging current flow from the diode plate

element 9, during each of alternate half cycles, acts through the rectifier formed by the flame B, electrode *b*, and body of the burner A to maintain a potential on the control grid 4 which is more positive than that of the cathode 3 during each subsequent half cycle, in which the plate 6 of the grid valve *g* is positive. The grid valve then discharges the condenser 12 through the relay winding 13 and thereby effectively energizes the latter. The relay winding 13 is effectively deenergized by the extinction of the flame, and also by the development of an abnormal condition which has the effect of connecting the electrode *b* to ground directly or through an ohmic impedance substantially smaller than the impedance due to the flame when the latter is in normal condition. In either case, the potential of the control grid 4 is then more negative than it is when said grid is electrically connected to the condenser 12 through the flame. The current flow through the relay winding 13 is thus greater when the flame is in its normal condition, than when it is in an abnormal condition or is extinguished.

As diagrammatically shown in the drawing, the winding 13 is the energizing winding of an A. C. relay having an armature 20. When the relay winding 13 is deenergized, as a result of flame extinction or abnormality, the armature 20 connects a conductor 21 to the conductor 11, and thereby completes a circuit including the conductor 21, the actuator *d* of the valve D, the conductor 19, and the transformer secondary *f*. The completion of that circuit automatically closes the burner valve D.

While, in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In combination, a pair of terminals adapted for connection to a source of alternating current, a control device, a condenser, two electronic valves connected in parallel with one another and in series with said control device and said condenser between said terminals, one of said valves being a diode and having an anode and a cathode, the second of said valves having a control grid, having an anode connected to the cathode of said diode valve, and having a cathode connected to the anode of said diode valve for current flow through one of said valves during half cycles of the alternating current which alternate with those during which current flows through the other valve, and means for impressing a control voltage on said grid, comprising an electrode connected to said grid, and a second electrode connected to said condenser and adapted to be conductively connected to the first mentioned electrode by a flame of predetermined length with said second electrode extending to the tip portion of the flame.

2. A combination as specified in claim 1, in which the first mentioned electrode is connected to said grid through a resistance, and is connected to the cathode of said second valve through a second resistance and a condenser in shunt to said second resistance.

3. In combination, a pair of terminals adapted for connection to a source of alternating current, a control device, a condenser having two terminals one of which is connected to one of said pair of terminals, two electronic valves connected in parallel with one another and in series with said control device and said condenser and between the second terminal of the latter and the second terminal of said pair, one of said valves being a diode and having an anode and a cathode, the second of said valves having a control grid, having an anode connected to the cathode of said diode valve, and having a cathode connected to the anode of said diode valve for current flow through one of the valves during half cycles of the alternating current which alternate with those during which current flows through the other valve, and means for impressing a control voltage on said grid, comprising an electrode connected to said grid, and a second electrode separate from said first mentioned electrode and connected to said second terminal of said condenser and adapted to be connected to said first mentioned electrode by a flame.

4. Apparatus operative to produce a predetermined effect only upon the existence of a given condition, comprising a pair of terminals adapted for connection to a source of alternating current, a control device, a condenser, a current rectifying device connected in series with said condenser and said control device between said terminals and tending to pass current in one direction through said control device and said condenser to charge the latter during alternate half cycles of the alternating voltage of said source, said control device being operable to produce said predetermined effect only in response to continued substantial current flow through said condenser, controllable means connected in shunt with said current rectifying device and operative when in one condition to cause a substantial current to flow through said control device and said condenser, during the intervening alternate half cycles of said voltage, in the direction opposite to said one direction, thereby to tend to discharge said condenser during the last mentioned half cycles and hence to cause continued substantial current flow through said condenser, said controllable means being operative when in a second condition to prevent said current flow in said opposite direction, a control portion included in said controllable means and operative to cause the latter to assume said one or said second condition in accordance with the character of a signal applied to said control portion, an electrical path effectively connected between said terminals and exhibiting a rectifying characteristic when said path is subjected to said given condition, whereby a unidirectional current is caused to flow over said path when the latter exhibits said rectifying characteristic, an alternating current is caused to flow over said path when the latter is effectively short-circuited, and no current is caused to flow over said path when the latter is interrupted, impedance means included in circuit with said path to develop a control signal of a character depending upon the direction of the current flow over said path, and conductors connecting said impedance means to said control portion to apply said control signal thereto to cause said controllable to assume said one condition when and only when said path exhibits

said rectifying characteristic, and to cause said controllable means to assume said second condition when said alternating current or no current flows over said path.

5. Apparatus as specified in claim 4, wherein said path includes first and second electrode means having at least a portion of a flame therebetween when said path is subjected to said given condition.

6. Apparatus as specified in claim 4, wherein said controllable means is a controllable rectifier which is reversely connected across said current rectifying device.

7. Apparatus as specified in claim 6, wherein said current rectifying device has a cathode directly connected to one of said terminals and has an anode connected to the other of said terminals through said control device and said condenser in series in the order stated, wherein said controllable rectifier is an electronic valve having an anode connected to the cathode of said current rectifying device, and having a control electrode included with the last mentioned cathode in said control portion, wherein said impedance means comprises a resistor and a condenser connected in parallel with one another between the cathode and control electrode of said valve, and wherein said path is connected between the end of said impedance means connected to said control electrode and the junction between said control device and said condenser.

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