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FUEL BURNER CONTROL SYSTEM

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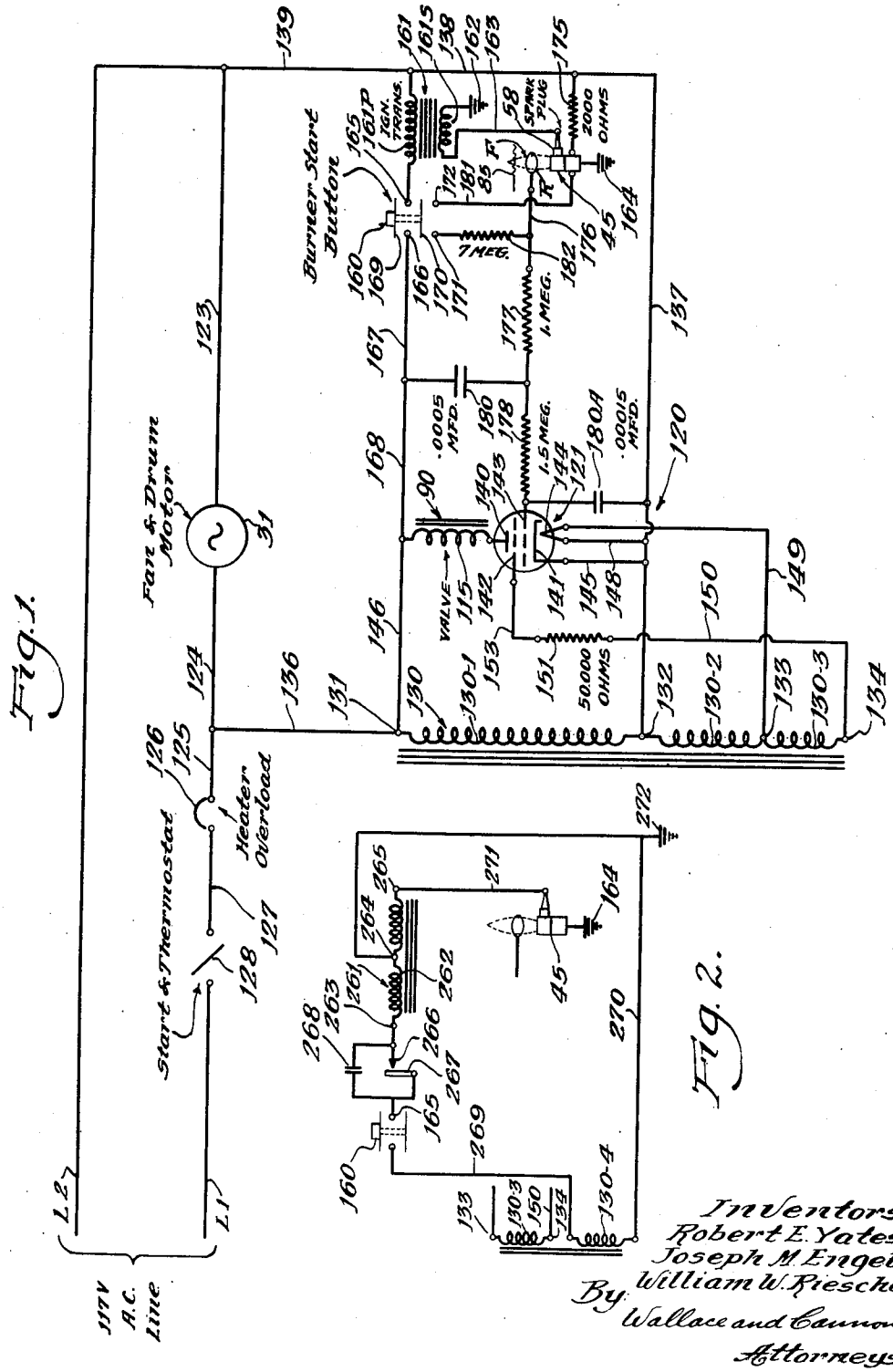


Fig. 1.

Fig. 2.

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FUEL BURNER CONTROL SYSTEM

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7 Claims. (Cl. 158—117.1)

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This application is a division of our copending application, Serial No. 785,488, filed November 12, 1947, now matured into Patent 2,538,952 issued on January 23, 1951.

This invention relates to safety control means and particularly to such safety control means for use with gas burners.

Safety control mechanisms for gas burners and the like have been used quite extensively in industrial burner installations, but in recent years there has been a tendency to utilize gas burners in domestic appliances where the cost of the control system is an important factor. One instance in which the use of a safety control system is highly desirable is in domestic clothes dryers, but heretofore it has been considered that such safety systems have been too costly to justify their use in such devices. It is, however, apparent that where a gas burner is utilized in a domestic clothes dryer, the operation of such a burner should be rendered extremely safe, and it is, therefore, an important object of the present invention to afford control means for such burners so that such safe operation may be attained. A related object is to afford a control means operating on an electronic principle, and so constructed and arranged that it may be economically utilized in controlling the gas burner of a domestic clothes dryer or the like.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiment, and the principles thereof and what we now consider to be the best mode in which we have contemplated applying those principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is a schematic wiring diagram illustrating the control circuit of the present invention; and

Fig. 2 is a fragmentary wiring diagram showing another form of ignition means.

For purposes of disclosure, the present invention is illustrated in Fig. 1 as associated with a burner 45 which is adapted to be supplied with fuel such as gas by a valve indicated diagrammatically at 90, and the fuel thus supplied is arranged to pass through a metallic sensing ring R

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and into and through a re-igniter 85 in the form of a wire mesh, as described in detail in our aforesaid parent application. This flame F is lighted by means including a spark plug 58, and is utilized as described in such parent application to heat air that is forced through a clothes drier unit by a fan that is driven by the fan and drum motor 31, shown in Fig. 1.

The operation of the fuel valve 90 is governed by a burner safety control system 120, Fig. 1, which includes an electron tube 121, and the power for the control system 120 as well as for the driving motor 31 is controlled by a common thermostatic switch means which operates to stop the cycle of operation of the machine upon completion of the drying cycle. Thus, in Fig. 1, a source of alternating current is afforded by wires L1 and L2, the wire L2 being connected to one terminal of an overload switch 126. The other terminal of the overload switch 126 is connected by a wire 127 to one terminal of a combination starting and thermostatic cutout switch 128, the other terminal of which is connected to the wire L1. The combination starting and thermostatic switch 128 is of conventional construction and the thermostatic element thereof is mounted in association with the air outlet passage as described in our aforesaid parent application so as to open the switch 128 when the temperature of the outgoing air becomes unduly high due to completion of the drying action upon the clothes in the machine. Thus, when the machine is to be started, the switch 128 is closed so as to thereby start the motor 31, and the control system 120 is arranged to be supplied with power only during the time when the switch 128 remains closed.

The control system 120 includes means for affording the necessary power and bias for the electron tube 121, and in the present instance such means comprise an autotransformer 130 having sectional windings defined by terminals 131, 132, 133 and 134. The terminals 131 and 132 are disposed at opposite ends of a section 130—1 of the transformer winding, the terminals 132 and 133 are disposed at opposite ends of the winding section 130—2 while the terminals 133 and 134 are disposed at opposite ends of a section 130—3 of the transformer winding, such sections of the transformer winding being in series so that the terminals 131 and 134 are at opposite ends of the complete winding. The terminal 131 is connected by a wire 136 at the junction between the wires 124 and 125, while wires 137, 138 and 139, in a series, connect the terminal 132 with

the line wire L2. Thus when the switch 128 is closed, the transformer winding is energized, and the line wires are connected so as to afford plate circuit power for the plate circuit of the electron tube 121, as will now be described. This electron tube 121 may take the form of a type 2D21 Thyratron, and this tube has an anode 140, a cathode 141, a shield grid 142, and a control grid 143. The tube also has a heater filament 144. The cathode 141 of the tube is connected by a wire 145 to the wire 137, while the anode or plate 140 is connected to one terminal of the operating coil 115 of the valve 90, the other terminal of this coil being connected by a wire 146 to the terminal 131 of the transformer 130. The operating coil 115 of the fuel valve 90 is thus included in the plate circuit of the tube 121, and the coil 115 will be energized whenever plate current flows in the plate circuit of the tube 121.

The energizing circuit for the filament 144 is afforded by connecting the same across the section 130—2 of the transformer, and for this purpose a wire 148 extends from the wire 137 to one terminal of the filament 144, while the other terminal thereof is connected by a wire 149 to the terminal 133.

The tube 121 is normally biased to a non-conductive state by bias voltage applied to the shield grid 142, and when the tube 121 is to be rendered conductive, an appropriate positive voltage is applied to the control grid 143 as will hereinafter be described. In affording the desired negative or blocking bias for the shield grid 142, a wire 150, a resistance 151 and a wire 153 are extended in a series from the terminal 134 to the shield grid 142. Thus the negative voltage from the terminal 134 which is more negative at the critical time than the cathode voltage taken from the terminal 132, is applied to the shield grid 142 in what may be termed the positive cycles of the alternating current or, in other words, in those cycles when the plate 140 is positive with respect to the cathode 141, and the magnitude of the negative bias that is thus afforded is such that in the absence of an appreciable positive potential on the control grid 143, the tube 121 will be non-conductive. Moreover, even when the tube 121 is conductive, the most common failure that may occur in the tube, which failure involves burning out of the filament 144, will cause the tube to become non-conductive so as to result in what is usually termed a "safe failure."

When the switch 128 is closed so as to thereby start the motor 31, the burner operation is not initiated or started until a separate starting switch means in the form of a starting button 160 is operated. The starting button 160 is arranged as will hereinafter be pointed out to cause the tube 121 to become conductive, so as to thereby open the fuel valve 90 and also to cause the ignition means which include the spark plug 58 to be energized. The transformer 161 has a secondary coil 161S and a primary coil 161P. The secondary coil 161S has one terminal grounded at 162 while the other terminal thereof is connected by a wire 163 to the spark plug 58. The other side of the spark plug 58 is, of course, grounded to the burner 46 and this ground connection is indicated in Fig. 1 at 164. The primary coil 161P has one terminal thereof connected to the wire 139, while the other terminal thereof is connected to a stationary switch contact 165 of the switch 160. A cooperating stationary contact 166 of the switch 160 is connected by wires 167 and 168 to the wire 146, and a conducting cross arm 169 on

the switch 160 may thus be engaged with the contacts 165 and 166 to energize the ignition transformer 161. The switch 160 also has a second conducting cross bar 170 that may be engaged with stationary contacts 171 and 172 when the starting button 160 is pressed, and these contacts are effective, as will hereinafter be described, to apply positive voltage to the control grid 143 so as to thereby cause the fuel valve 90 to be opened. In attaining this action, the switch means afforded by the bar 170 and the contacts 171 and 172 completes a circuit which effectively simulates the presence of a flame at the burner 45, and for this reason the normal action of the control system will first be described.

The flame sensing ring R is arranged and associated with the electron tube 121 in such a way that when a flame is present so as to extend between the burner 45 and the flame sensing ring R, a positive voltage will be applied to the control grid 143 so as to render the tube 121 conductive. In attaining this result, the burner 45 is connected to the line wire L2 by a resistance 175 and the wires 138 and 139. The flame sensing ring R in turn has a wire 176 extended therefrom to one end of a resistor 177, the other end of this resistor being connected to a resistor 178. The other end of the resistor 178 is connected to the control grid 143. At the juncture of the resistors 177 and 178, one terminal of a condenser 180 is connected at the juncture of the wires 167 and 168.

When a flame F extends between the burner 45 and the flame sensing ring R, a circuit is completed through the flame F and the resistance of the flame constitutes a circuit element of a circuit that extends from ground at 164, or cathode potential, to the wire 168 through the condenser 180. As will be hereinafter explained, this is effective during the forward or positive cycles to cause a positive voltage to be applied to the control grid 143. Through the use of electrical values in the circuit of the order hereinafter set forth, this voltage on the control 143 may be made effective to cause the tube 121 to become conductive. In the starting operation, this action is attained through the switch bar 170, the contact 172 being connected by a wire 181 to the burner 45 while the contact 171 is connected through a resistor 182 to the wire 176. A stabilizing condenser 180A is connected between the grid 143 and the wire 137 so as to produce uniformity of operation.

In setting up the control thus described, the following values for the various circuit elements have been found to be satisfactory:

Condenser 180A	microfarads	.00015
Condenser 180	do	.0005
Resistance 151	ohms	50,000
Resistance 178	megohms	1.5
Resistance 177	do	1.0
Resistance 175	ohms	2,000
Resistance 182	megohms	7

When dryer is to be started, the start switch 128 is moved to its closed and latched position so as to thereby start the motor 31 and energize the transformer 130. The connections from the transformer section 130—2 serve to heat the cathode 141, while the negative bias applied to the screen grid 142 serves to block the tube 121 and prevent flow of plate current therein. In this respect it should be noted that prior to the starting or ignition of the burner 45, the only power connection to the control grid 143 is

through the condenser 180 and the resistor 178 from the side of the transformer winding that is connected to the anode. Under such circumstances there is no current flow through the condenser 180, for although one side of the condenser is connected to the same terminal of the transformer 130 as the anode 140, the other side of the condenser 180 may be said to be floating because all of the circuit branches from such other side of the condenser 180, are at this time in an open circuit relation. Thus the switch bar 170 of the start switch is in an open relation, while the branch through the flame sensing ring R is open due to the lack of a flame F. The other branch circuit through the resistor 178 to the control grid 143 is also open, since the tube is blocked by the highly negative shield grid bias, so that there is no flow of cathode-control grid current. Moreover, the impedance of the stabilizing condenser 180A is high so that there is no current flow therethrough and the effect is the same as an open circuit at this point. Thus, although one side of the condenser 180 is connected so as to be positive in those half cycles when the anode or plate is positive, the lack of current flow, or the extremely small current flow across the condenser 180 in such forward half cycles, assures that positive grid bias will not be applied to the control grid at this time.

As a result of this circuit arrangement, the tube 120 remains non-conductive until such time as the start button 160 is actuated. This, of course, operates the ignition means so as to produce igniting action at the spark plug 58, and in addition, a circuit is closed from the ground side of the line through the resistors 187 and 177 and the condenser 180 to the hot side of the line. In this respect it may be noted that the value of the resistor 182 is such as to simulate the resistance of a flame between the burner 45 and the sensing ring R, and hence the effect on the bias of the control grid 143 is the same as when a flame is sensed. Thus the circuit that is established between the line wires L1 and L2 includes the condenser 180, the resistance 177, and the flame-simulating resistance 182, and this circuit acts as a voltage divider from which the control grid bias is tapped through the limiting resistor 178. The point at which the control grid is thus tapped is such that the grid 143 is rendered sufficiently positive to cause firing of the tube 121 throughout a substantial portion of each forward cycle so long as the resistance in the voltage dividing circuit is kept within a certain range.

When the firing of the tube 121 in response to operation of the start button 160 has caused opening of the fuel valve 115, and the fuel fed to the burner 45 has been ignited, the presence of a flame F will be sensed by the sensing ring R. This completes a circuit that is in parallel with the resistor 182 and which includes the resistance of the flame F and at this time the start button 160 may be released so as to place the system under sole control of the flame sensing means. The flame resistance has been found to vary from about two to seventy megohms, and throughout this range, the voltage dividing network will be effective to maintain a firing bias on the control grid 143. If, however, the flame F is extinguished, or if the sensing ring R becomes grounded, the positive bias voltage on the control grid 143 will be reduced or changed in such a way as to enable the negative bias of the shield grid 142 to regain control and render the tube 121 non-conductive.

In the case of a grounding of the sensing ring, the resistance at the flame gap is reduced to zero so that the effective position of the control grid tap will be so changed in an electrical sense as to reduce the control grid bias to such a point that it is below the positive value required to fire the tube, and hence the shield grid 142 will regain control in the next inverse cycle.

Flame failure will of course return the system to its original condition insofar as biasing voltage on the control grid 143 is concerned, and hence the shield grid will resume control, and the tube will become non-conductive. In either event, the valve 115 will be de-energized, and will close so as to shut off the supply of fuel to the burner 45.

In Fig. 2 of the drawings an alternative form of ignition means have been illustrated whereby the use of a relatively expensive ignition transformer 167 may be avoided and in this embodiment of the invention a spark coil 261 of substantially conventional construction is utilized. The spark coil 261 is auto-wound to afford a winding 262 having terminals 263, 264 and 265, and a contact 266 extended from the terminal 263 has a vibrating armature contact 267 associated therewith to act in the usual manner as a periodic circuit breaking means. The contacts 266 and 267 have a condenser 268 connected thereacross, and the contact 267 is connected to the contact 165 of the start switch 160. The other contact 169, instead of being connected to the wire 167, is connected by a wire 269 to the wire 150, and another and separate winding section 130—4 that is afforded in the transformer 130 to afford the usual 6-volt source for the spark coil 261. A wire 270 extends from the other end of the winding 130—4 to the tap 264 on the spark coil winding. The section of the spark coil winding between the taps 264 and 265 constitutes the secondary, and the tap 265 is connected by a wire 271 to the spark plug 58 while the tap 264 is grounded at 272. With the structure thus afforded, the required ignition means functions in a highly satisfactory manner, and yet may be provided at a reasonable cost.

The values specified hereinabove for the circuit elements are of course what we consider to be optimum values, but it will be recognized that such values may vary within certain limits while still producing safe operation of the burner. Thus the condenser 180 may be varied between about .0003 and .0007 microfarad, while the condenser 180A may be varied between about .000075 and .0002 microfarad. Similarly, the total value of the resistances 177 and 178 may be varied between one and five megohms, and if desired, the resistance 178 and 177 may be combined and placed between the condenser 180 and the control grid 143. When this is done, the flame constitutes the sole resistance for cooperation in series with the condenser 180 in affording the voltage dividing network from which the control grid voltage is tapped.

From the foregoing description it will be evident that the present invention enables a gas burner to be safely utilized in a rapidly moving current of air such as the air that is forced through a clothes dryer or the like, and this is accomplished through the use of structure that is extremely simple in character.

Thus, while we have illustrated and described the preferred embodiments of our invention, it is to be understood that this is capable of variation and modification, and we therefore do not wish

to be limited to the precise details set forth, but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims:

We claim:

1. In a burner safety control system, a gas filled electron tube having an anode, a cathode, a heater, a shield grid and a control grid, a gas burner, a normally closed power operated control valve for supplying gaseous fuel to said burner, an electrically operable device governing said control valve and having one terminal thereof connected to said anode, an autotransformer having a winding having first and second terminals defining the ends of a first section, a third terminal defining one end of a second section that is extended from said second terminal, and a fourth terminal defining the end of a third section that is extended from said third terminal, an alternating current power source having a hot lead connected to said first terminal of said transformer and to the other terminal of said device, and having a grounded lead connected to said second terminal and said cathode, means connecting said second and third terminals across said heater, means connecting said fourth terminal to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current when said first terminal is positive, means connecting said burner to ground, a flame sensing element disposed in position to be enveloped by a flame issuing from said burner, a resistance and a small capacity condenser connected in series between said sensing element and said hot lead with said resistance located electrically adjacent to said sensing element, and a relatively high resistance connected between said control grid and the juncture of said condenser and said first mentioned resistance.

2. In a burner safety control system, a gas filled electron tube having an anode, a cathode, a heater, a shield grid and a control grid, a gas burner, a normally closed power operated control valve for supplying gaseous fuel to said burner, an electrically operable device governing said control valve and having one terminal thereof connected to said anode, an autotransformer having a winding having first and second terminals defining the ends of a first section, a third terminal defining one end of a second section that is extended from said second terminal, and a fourth terminal defining the end of a third section that is extended from said third terminal, an alternating current power source having a hot lead connected to said first terminal of said transformer and to the other terminal of said device, and having a grounded lead connected to said second terminal and said cathode, means connecting said second and third terminals across said heater, means connecting said fourth terminal to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current when said first terminal is positive, means connecting said burner to ground, a flame sensing element disposed in position to be enveloped by a flame issuing from said burner, circuit means including a relatively large electrical resistance connected between said sensing element and said control grid, and a relatively small capacity condenser connected between said hot lead and said circuit means at such a point as to locate at least a substantial portion of said resistance between said point and said control grid.

3. In a burner safety control system, a gas filled electron tube having an anode, a cathode, a heater, a shield grid and a control grid, a gas burner, a normally closed power operated control valve for supplying gaseous fuel to said burner, an electrically operable device governing said control valve and having one terminal thereof connected to said anode, an autotransformer having a winding having first and second terminals defining the ends of a first section, a third terminal defining one end of a second section that is extended from said second terminal, and a fourth terminal defining the end of a third section that is extended from said third terminal, an alternating current power source having a hot lead connected to said first terminal of said transformer and to the other terminal of said device, and having a grounded lead connected to said second terminal and said cathode, means connecting said second and third terminals across said heater, means connecting said fourth terminal to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current when said first terminal is positive, means connecting said burner to ground, a flame sensing element disposed in position to be enveloped by a flame issuing from said burner, a relatively high value resistance and a small capacity condenser connected in series between said control grid and said hot lead and circuit means connected between said control grid and the juncture of said condenser and said first mentioned resistance.

4. In a burner safety control system, a gas filled electron tube having an anode, a cathode, a heater, a shield grid and a control grid, a gas burner, a normally closed power operated control valve for supplying gaseous fuel to said burner, an electrically operable device governing said control valve and having one terminal thereof connected to said anode, an autotransformer having a winding having first and second terminals defining the ends of a first section, a third terminal defining one end of a second section that is extended from said second terminal, and a fourth terminal defining the end of a third section that is extended from said third terminal, an alternating current power source having a hot lead connected to said first terminal of said transformer and to the other terminal of said device, and having a grounded lead connected to said second terminal and said cathode, means connecting said second and third terminals across said heater, means connecting said fourth terminal to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current when said first terminal is positive, means connecting said burner to ground, a flame sensing element disposed in position to be enveloped by a flame issuing from said burner, a resistance of between one and five megohms and a condenser of from .0003 to .0007 microfarad capacity connected in series between said hot lead and said control grid, and circuit means connected between said sensing element and the juncture of said condenser and said first mentioned resistance.

5. In a burner safety control system, a gas filled electron tube having an anode, a cathode, a shield grid and a control grid, an electrically operable control device having one terminal connected to said anode, an alternating current power source having a grounded lead connected to said cathode and a hot lead connected to the other terminal of said device, means operatively

associated with said power source and connected to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current during which said anode is positive, a small capacity condenser and a high value resistor connected in series between said hot lead and said control grid, a small capacity stabilizing condenser connected between said control grid and cathode, a burner electrically connected to ground and to which gaseous fuel may be supplied, a flame sensing element disposed in an insulated relation and in the path of a flame issuing from said burner, and means including a relatively high value resistor connecting said sensing element to the juncture of said first mentioned resistor and condenser.

6. In a burner safety control system, a gas filled electron tube having an anode, a cathode, a shield grid and a control grid, an electrically operable control device having one terminal connected to said anode, an alternating current power source having a grounded lead connected to said cathode and a hot lead connected to the other terminal of said device, means operatively associated with said power source and connected to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current during which said anode is positive, a small capacity condenser and a high value resistor connected in series between said hot lead and said control grid, a burner electrically connected to ground and to which gaseous fuel may be supplied, a flame sensing element disposed in an insulated relation and in the path of a flame issuing from said burner, and means including a relatively high valve resistor connecting said sensing element to the juncture of said first mentioned resistor and condenser.

7. In a burner safety control system, a gas filled electron tube having an anode, a cathode,

a shield grid and a control grid, an electrically operable control device having one terminal connected to said anode, an alternating current power source having a grounded lead connected to said cathode and a hot lead connected to the other terminal of said device, means operatively associated with said power source and connected to said shield grid to apply a blocking negative bias to said shield grid in the forward cycles of the alternating current during which said anode is positive, a condenser having a capacity of from about .0003 microfarad to about .0007 microfarad and a resistor having a value of from one to five megohms connected in series between said hot lead and said control grid, a stabilizing condenser having a capacity of from .00075 to .0002 microfarad connected between said control grid and cathode, a burner electrically connected to ground and to which gaseous fuel may be supplied, a flame sensing element disposed in an insulated relation and in the path of a flame issuing from said burner, and means connecting said sensing element to the juncture of said resistor and said first mentioned condenser.

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