

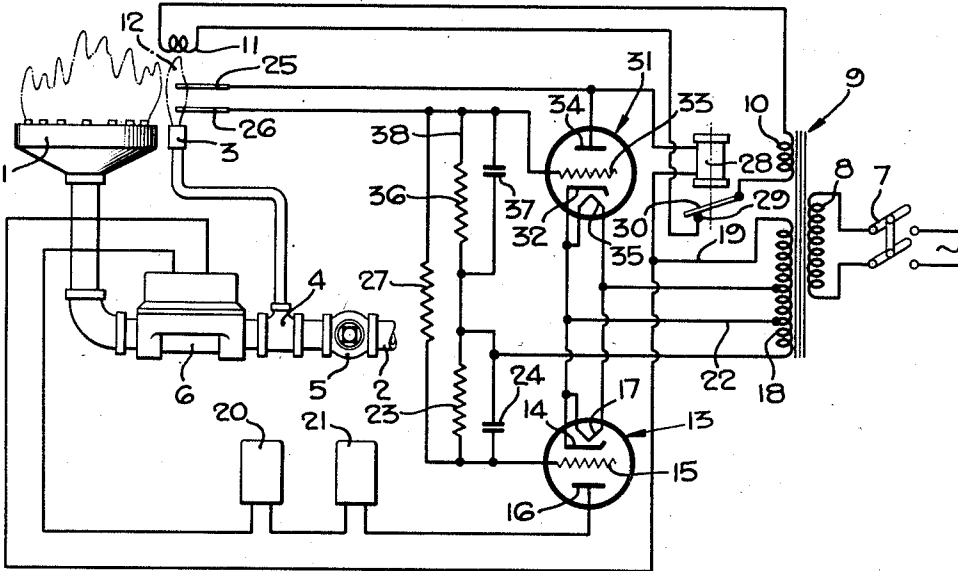
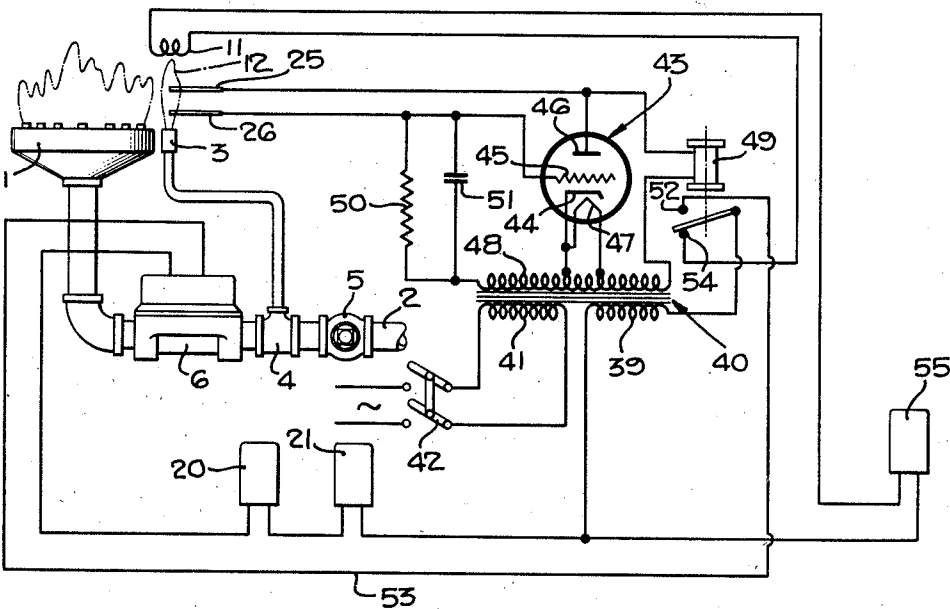
June 2, 1953

F. E. CAIRNS, JR
SAFETY FUEL BURNER CONTROL SYSTEM
UTILIZING FLAME CONDUCTION

2,640,920

Filed July 9, 1949

2 Sheets-Sheet 1



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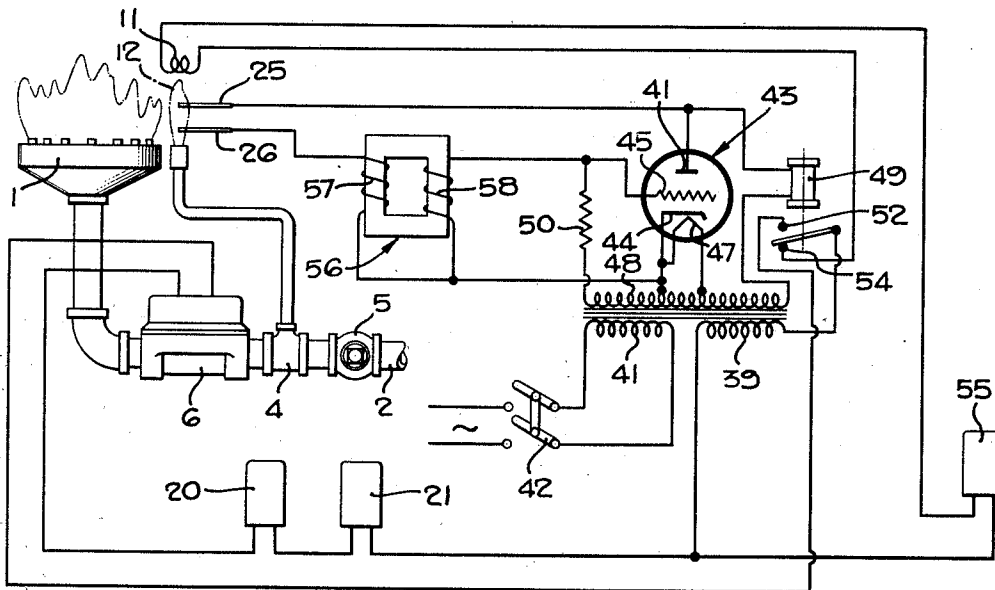
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Fig. 3.



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SAFETY FUEL BURNER CONTROL SYSTEM
UTILIZING FLAME CONDUCTIONFred E. Cairns, Jr., North Hollywood, Calif., as-
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2 Claims. (Cl. 250—27)

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This invention relates generally to a system referred to in an application filed concurrently herewith, in the name of Fred E. Cairns, Jr. Serial No. 103,767, and entitled Fuel Burner Safety Control Using Flame Conduction.

In that application, the flame of a pilot burner serves while it is in existence, to provide a conducting path between a pair of electrodes spaced within the flame and in the direction of flame propagation. While the flame is in existence, electric power is supplied to hold a fuel valve open. This power is supplied conveniently by the aid of an electronic emission device operating to produce a controlling space current. When the pilot flame is extinguished, either accidentally or otherwise, the circuit between the flame electrodes is interrupted, and this causes a reduction of the flow of power. The valve accordingly closes.

The flame electrodes are so arranged that they control the flow of a space current when the flame is in existence by causing a connection to be completed to the control electrode of the electronic emission device.

The flame conductivity is greater in one direction along the flame than in the opposite direction of current flow. This unilateral effect is utilized effectively in the system.

In accordance with the present invention herein described, the pilot flame is caused to be automatically ignited when the operation of the system is initiated. It is one of the objects of this invention to effect such automatic response, and yet ensure that the main burner cannot be placed into operation until after the pilot flame is ignited and in existence.

It is still another object of this invention to ensure that the ignition of the pilot burner and the main burner are definitely interlocked by the aid of the flame electrodes.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic representation of one embodiment of the invention;

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Figs. 2 and 3 are views, similar to Fig. 1, of modified forms of the invention.

In Fig. 1 a main gas burner 1 is illustrated adapted to be supplied with fuel, as by aid of a pipe or conduit 2. A pilot burner 3 is also supplied from pipe 1 through a T-connection 4. A main shut-off valve 5 is interposed in the pipe 2.

Control of the flow of fuel to the main burner 1 is effected by an electromagnetically operated valve structure 6.

Power for operating the valve structure 6 is derived from a source of alternating current controlled by a switch 7 and connected to the primary winding 8 of a transformer 9. A secondary winding 10 of transformer 9 is arranged to energize an electric igniter 11 disposed near the burner 3 to light the pilot flame 12. This pilot flame 12 is shown in dot-and-dash lines to indicate that the system in the position shown is not in operation.

Power for the valve 6 is controlled by an electronic emission device 13 having an electrically heated cathode 14, a control electrode 15, and an anode 16. The heater 17 for the cathode 14 is connected to a section of a main secondary winding 18 of the transformer 9.

While the pilot flame 12 is not in existence, the electronic emission device 13 is in such condition that it is incapable of causing energization of the valve means 6. The output circuit of the device 13 includes the upper section of transformer winding 18, a connection 19, valve means 6, automatic switching devices 20 and 21, anode 16, cathode 14, and connection 22 to an intermediate point of the winding 18. The switching device 20 may be a thermostatic switch located in the medium to be heated, such as circumambient atmosphere in a room, or water heater, or the like. Automatic switch 21 may provide a limit as of temperature, or pressure, or the like. Either of these switching devices 20 and 21 may prevent energization of the electromagnetically operated valve means 6.

The control electrode 15 is connected, as by a large resistance, to the lower terminal of the winding 18. This resistance thus imposes a negative potential upon the control electrode 15 when the anode 16 is positive, and no substantial space current can flow through the output circuit. A conventional grid leak condenser 24 may bridge the resistance 23. During those half cycles in which anode 16 is negative, it is impossible for any output current to flow between the anode 16 and cathode 14.

In order to make it possible to energize the

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valve means 6, the control electrode 15 must have its potential raised. This is effected in response to the energization of the flame 12 by the aid of a pair of flame electrodes 25 and 26. These two electrodes are spaced in the direction of flame propagation, and the flame serves, as a substantially unilateral conductor, electrically to connect these two electrodes. Electrode 26 is connected to the control electrode 15 through a resistor 27. Electrode 25 is connected to a point of higher potential than the cathode 14. Accordingly, the control electrode 15 then permits the passage of an operative space current that permits energization of the valve means 6 should both of the switching devices 21 and 22 be closed.

The electrode 25 obtains its potential from the upper terminal of the winding 18 through connection 19 and a relay 28. When the upper terminal of the winding 18 is positive, the electrode 25 is also positive, and transmits positive potential to the electrode 15. Accordingly, during those half cycles in which the upper terminal or winding 18 is positive, an operative space current can flow to energize the valve means 6. This, of course, can only occur when the flame 12 is in existence, since the flame is in series with the circuit through resistor 27 that imposes the operating potential upon the control electrode 15.

The relay 28, when the system is inactive, is in deenergized position. Accordingly, the back contact 29 is closed by the movable arm 30. In this position, the igniter 11 is energized through the secondary winding 10 and the relay contacts 29 and 30.

However, as soon as the flame 12 is in existence, the relay 28 is energized and the igniter circuit is interrupted. The energization of this relay 28 is effected by the aid of another electronic emission device 31 having a cathode 32, a control electrode 33, and an anode 34. An electric heating means 35 is used for heating cathode 32, and is connected in parallel with the heater 17 of the device 13.

The relay 28 is included in the output circuit between the anode 34 and cathode 32 through the upper portion of the winding 18. The control electrode 33, while flame 12 is not in existence, is impressed with a potential from the lower terminal of winding 18 through a resistor 36 which is bridged by a grid leak condenser 37. This control electrode thus has a negative potential while anode 34 is positive. However, when the flame 12 is in existence, the control electrode 33 is connected by way of connection 38 and the flame 12 to the upper terminal of the winding 18. Accordingly, for those half cycles in which the upper terminal of secondary winding 18 is positive, a space current can flow through the output circuit and the relay 18.

In operation, the switch 7 is closed and the shut-off valve 5 is opened. The igniter 11 is energized and stays energized until the flame 12 is established. As soon as the flame 12 is established, the electronic emission device 13 permits flow of energy to the electromagnetically operated valve means 6.

At the same time, the electronic emission device 31 permits flow of energy to the relay 28 and the igniter 11 is automatically deenergized.

Upon flame failure, the system returns to inactive position. The valve means 6 closes, since control electrode 15 prevents passage of a substantial output current.

In the form of the invention illustrated in Fig. 75

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2, the pilot burner 3 and the main burner 1 are arranged as before. In this case, however, the valve means 6 is adapted to be operated by alternating current obtained from the secondary winding 39 of a transformer 40.

The primary winding 41 is controlled by a circuit controlling device 42.

An electronic emission device 43 for controlling the passage of current to the igniter 11 and the valve means 6 is shown as having a cathode 44, a control electrode 45, and an anode 46. Heater 47 for the cathode 44 is shown as connected across a section of a secondary winding 48. The right-hand portion of the secondary winding 48 is included in the output circuit of the device 43, by way of a relay 49. The left-hand end of the winding 48 is connected by high resistance 50 to the control electrode 45. The usual grid leak condenser 51 is placed in parallel with the resistors 50.

When the pilot flame is not in existence, the control electrode 45 attains a potential which prevents flow of a space current during those half cycles in which the right-hand terminal of the winding 48 is positive. This is due to the connection 50 between the left-hand terminal of winding 48 and the electrode 45. Of course, during the alternate half-cycles in which anode 46 is negative, it is not possible under any circumstances for any current to flow in the output circuit.

When the flame 12 is in existence, electrodes 25 and 26 are electrically connected through the flame 12, acting as unilateral conductor. Electrode 25 is directly connected to anode 46 and electrode 26 is connected to the control electrode 45. Accordingly, a positive potential is impressed in this manner upon the electrode 45 for the half cycles in which the right-hand terminal of winding 48 is positive.

The relay 49 is thus energized and alternating current power may be transmitted to the valve means 6 through the secondary winding 39, front contact 52 of relay 49, and connection 53. At the same time, connection is broken at the back contact 54 of the relay 49. This interrupts energization of the igniter 11. The igniter circuit 11, while the flame 12 is not in existence, is completed through secondary winding 39 and through back contact 54 and a manual reset thermal cut-off device 55. This thermal cut-off device is included in the ignition circuit to ensure interruption of this circuit should the pilot burner 3 remain unignited. Such devices are now well known, and require manual resetting in order to start the series of operations. This manual reset device thus ensures against continuous energization of the ignition circuit, permitting this circuit to be completed for only a relatively short interval.

As before, upon failure of the pilot flame 12, the control electrode 45 returns to a condition in which no substantial output current can flow in the output circuit and, accordingly, relay 49 is deenergized, opening the circuit through which electrical energy may be passed to valve means 6.

In the form of the invention illustrated in Fig. 3, the ignition circuit is arranged in the same manner as before, and includes the manual reset thermal cutoff 55. The electronic emission device 43 has an output circuit substantially identical with that described in connection with Fig. 2. The input circuit, however, is modified in a manner now to be described.

A saturable core reactor device 56 is illustrated

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having the saturating direct current coil 57 and a reactor coil 58. With the pilot flame 12 extinguished, the resistance 50, as before, maintains the input circuit in such manner as to prevent substantial flow of output current through the relay 49. However, when the flame 12 is in existence, a direct current can flow through the saturating coil 57 by way of the flame 12 and electrodes 25 and 26. This direct current is derived from the right-hand terminal of winding 48, relay 49, to the cathode tap on the winding 48. Unilateral current is produced because of the rectifying function of the flame 12. Accordingly, with the flame 12 in existence, the reactance of the coil 58 is greatly reduced. Since this coil is connected directly between the cathode 44 and control electrode 45, the potential of the control electrode 45 is correspondingly raised and an output current can flow. In this case, the electronic emission device 43 is of such type as to permit the flow of space current unless control electrode 45 has a considerable negative potential with respect to cathode 44.

It is apparent that the coil 58 and the resistor 50 are in a series circuit across the left-hand section of winding 48. As the reactance of coil 58 is reduced, the difference in potential across it is correspondingly reduced, permitting a space current to flow.

What I claim is:

1. In a control device: an electronic emission device having a cathode, a control electrode and an anode; means impressing an alternating electromotive force between the cathode and anode; means supplying an alternating electromotive force between the cathode and the control electrode in such direction as to reduce the output current between the anode and the cathode; said latter means including a resistor; a saturable core reactor paralleling said latter means that supplies an alternating electromotive force between the cathode and the control electrode; a circuit responding to a condition for saturating

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the reactor core, said circuit including a pair of electrodes between which a current may pass; and load means operated by the space current of the electronic emission device.

2. In a control device: an electronic emission device having a cathode, a control electrode and an anode; means impressing an alternating electromotive force between the cathode and anode; means supplying an alternating electromotive force between the cathode and the control electrode in such direction as to reduce the output current between the anode and the cathode; said latter means including a resistor; a saturable core reactor paralleling the said latter means that supplies an alternating electromotive force between the cathode and the control electrode; a pair of electrodes adapted to be spaced in the path of a flame; a saturating coil for the reactor and in series with the electrodes, said electrodes and saturating coil being connected between the cathode and anode; and load means operated by the space current of the electronic emission device.

FRED E. CAIRNS, JR.

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