

[54]	BURNER IGNITION CONTROL SYSTEM	3,470,386	9/1969	Potts et al.	431/66 X
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Related U.S. Application Data

[63]	Continuation-in-part of Ser. No. 165,966, Jan. 26, 1971, abandoned.	
[52]	U.S. Cl.	431/66
[51]	Int. Cl.	F23n 5/26, F23q 3/00
[58]	Field of Search.....	431/66, 67

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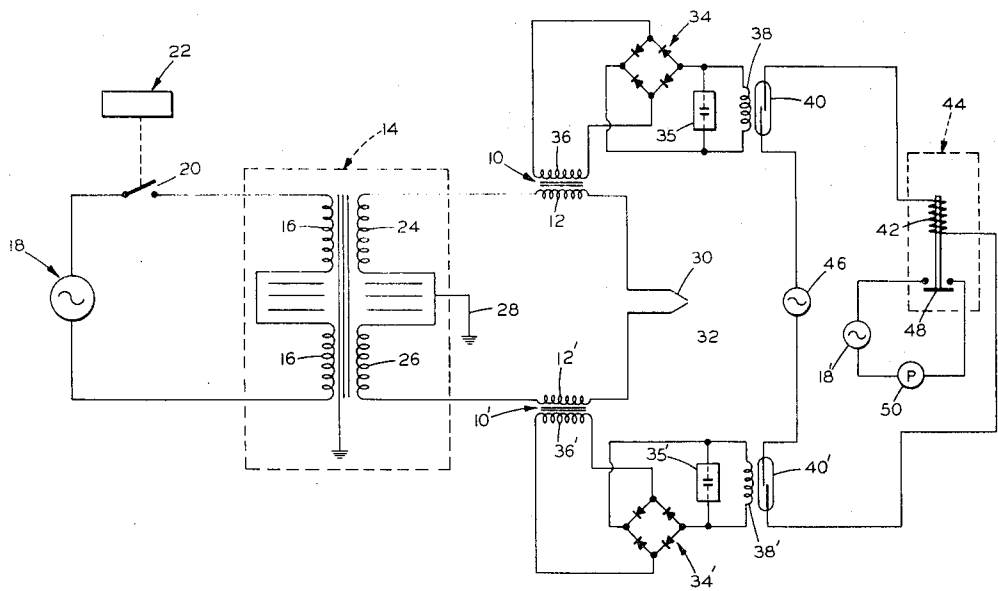
UNITED STATES PATENTS

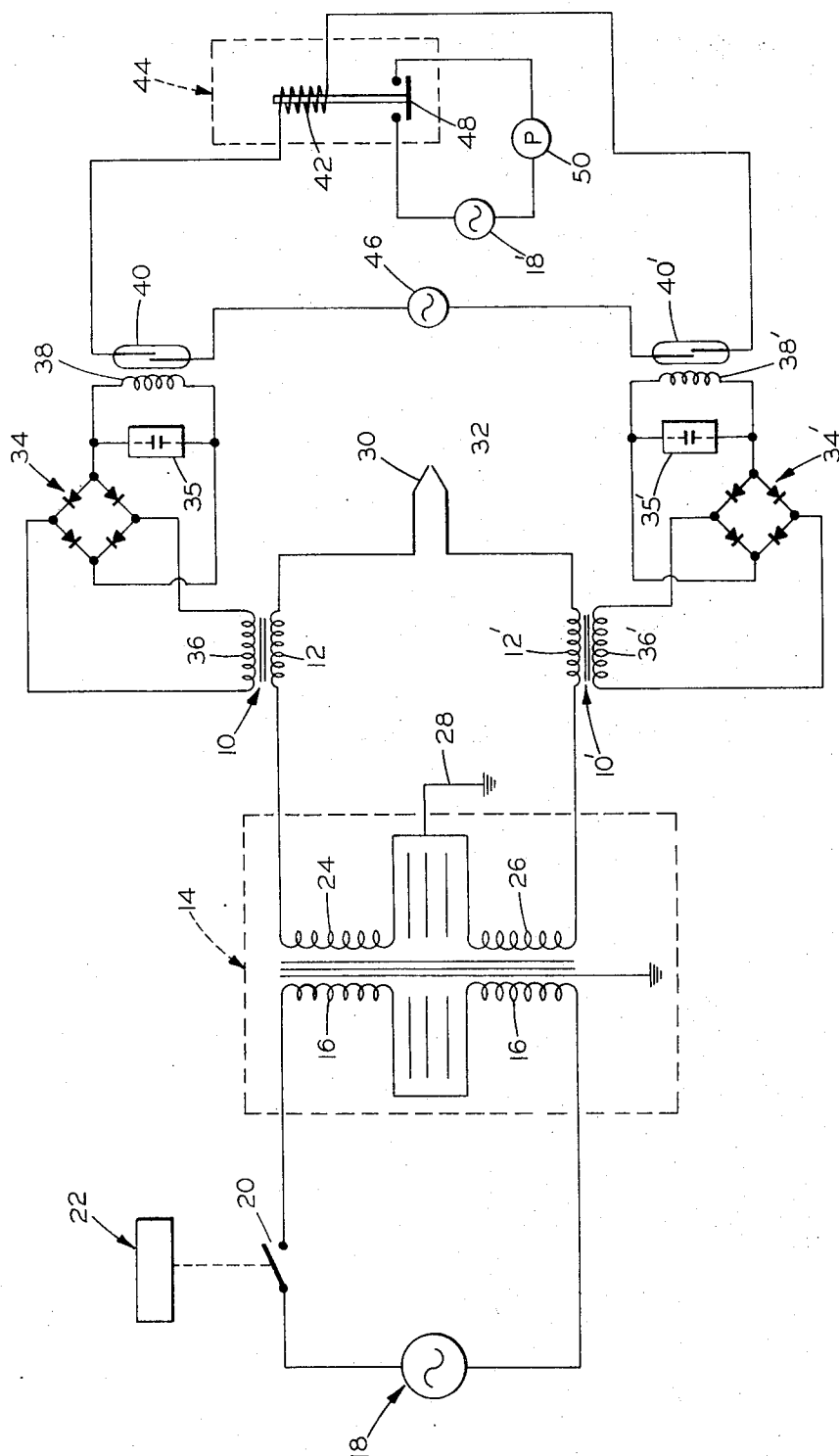
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ABSTRACT

An ignition control and safety system for a fuel consuming combustion apparatus, the system being characterized by establishment of a continuous arc during operation and including means for monitoring the arc and controlling operation of the fuel supply pump commensurate with the absence or existence of the arc.

16 Claims, 1 Drawing Figure





BURNER IGNITION CONTROL SYSTEM**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application is a continuation-in-part of Application Ser. No. 165,966 filed Jan. 26, 1971 and now abandoned.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

The present invention relates to burner ignition systems. More specifically, the present invention relates to enhancing the safety of ignition systems for combustion apparatus. Accordingly, the general objects of the present invention are to provide novel and improved apparatus and methods of such character.

2. Description of the Prior Art

While not limited thereto in its utility, the present invention is particularly well suited for use in a fuel combustion system, such as an oil burner system, wherein the fuel is completely turned off at times. Oil burner control systems, and particularly those typically employed in residential installations, will employ a high voltage circuit including a spark gap to ignite fuel delivered to the combustion chamber by a pump. Means must be provided in such burner systems to prevent the fuel pump from operating if, for any reason, there is an ignition or flame failure. Failure to provide such a safety means may result in the fire box being "flooded" with oil through continued operation of the pump and the subsequent generation of a spark will ignite the excess oil thereby causing the furnace door to be blown off and/or possibly resulting in a chimney fire and thus potentially causing smoke damage and air pollution.

Prior art ignition control systems will typically employ fire box mounted sensors which detect the absence of flame and operate through appropriate circuitry to cause a fuel pump shut down should there be an ignition failure. The ignition sequence will typically be instituted by a temperature sensitive device, such as a thermostat, which operates through appropriate circuitry to energize both the high voltage ignition transformer and the fuel pump energization relay. If the fire box sensor, which may be either a photoelectric flame scanner device or a temperature sensitive device such as a bimetallic switch, does not sense the existence of a flame, the system will automatically be shut down.

A common characteristic of prior art ignition control systems is that there will be a time delay of 70-200 seconds between the start of the ignition sequence and pump shut down if there is no ignition. This time delay is provided so as to enable a plurality of start attempts within each cycle, that is to permit generation of a plurality of sparks, and also to compensate for the relatively slow response time of the fire box mounted sensor devices. If ignition is not achieved within the period established by the built-in system delay, there may be recycling of the system and if ignition is achieved on a subsequent cycle there will be an excess amount of fuel in the fire box which, at the very least, when ignited will cause an initial period of excessive smoke emission and may cause a minor explosion which will damage components such as the fire box mounted sensors.

A further disadvantage of previous ignition control systems resided in the nature of the sensors employed. Bimetallic switches by nature have a slow response time and the switch contacts are subject to degradation

with time. The typical flame scanner tube has a distinct disadvantage in that it typically fails in a "flame present" mode. Accordingly, while perhaps useful as back-up or secondary safety systems, prior art ignition monitoring apparatus for burner control systems of the spark gap type do not in fact provide the requisite safety.

A further deficiency of some prior art burner control systems resides in the fact that they are designed to provide intermittent ignition and the ignition promoting arc is present for a short time only. Accordingly, should a flame-out occur, for example as caused by an unusually strong down-draft in the exhaust stack, cold fuel would still be pumped into the hot combustion chamber. The delivery of cold fuel to the combustion chamber may cause an explosion as the cold fuel heats up to its flash point. This, of course, is a potentially hazardous condition which also adds to air pollution problems.

SUMMARY OF THE INVENTION

The present invention overcomes the above briefly discussed and other disadvantages and deficiencies of the prior art by providing a novel ignition control system for a fuel fed combustion apparatus. A particularly important characteristic of the present invention is that the safety of apparatus employing the invention is enhanced through actual monitoring of the ignition promoting arc as opposed to the prior art techniques of attempting to sense the results of a successful ignition.

In accordance with the present invention, a continuous ignition arc is produced whenever combustion is desired. An arc monitor senses the current which flows whenever the continuous arc is established and, through control circuitry, either completes or interrupts the current path between a power supply and the pump which delivers fuel to the combustion apparatus. The arc monitor includes a pair of step down transformers having their primary windings connected in series with the electrodes between which the ignition arc is established, means for rectifying the voltages induced in the monitoring transformer secondary windings and means for establishing a magnetic field commensurate with each rectified secondary winding voltage. The magnetic fields, which are thus commensurate with the existence of an arc, are detected by series connected field responsive devices which control a relay circuit having contacts connected in the current path to the fuel supply pump.

BRIEF DESCRIPTION OF THE DRAWING

The present invention may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying Drawing which is a schematic showing of a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An arc monitor in accordance with the present invention comprises, in part, a pair of step down transformers which are indicated generally at 10 and 10'. Transformers 10 and 10' respectively have their primary windings 12 and 12' connected in series with secondary windings 24 and 26 of a high voltage transformer 14. The primary winding 16 of high voltage transformer 14 is connected across an alternating current source, indi-

cated generally at 18, which will typically be the a.c. power main. The primary winding 16 of high voltage transformer 14 is energized by the closing of the normally open contacts of a solenoid operated switch 20. The contacts of switch 20 will be closed through use of suitable circuitry which does not comprise part of the present invention. The control for switch 20 will typically include a thermostat or thermostats positioned throughout a building structure. Accordingly, switch 20 is operated, in a manner well known in the art, in response to the sensing of a preselected condition by a connection responsive system 22 which may include one or more thermostat type switches.

As briefly noted above, transformer 14 will typically have a pair of high voltage secondary windings 24 and 26. First ends of each of windings 24 and 26 will be interconnected and typically grounded as shown at 28. The transformer 14 will, in most cases, be a ferroresonant transformer and the point of interconnection of the secondary windings will be grounded to minimize shock hazard and voltage breakdown potential.

The ungrounded or opposite ends of secondary windings 24 and 26 of transformer 14 are connected, through respective secondary windings 12 and 12' of arc monitoring transformers 10 and 10', to respective electrodes 30 and 32 which define a spark gap therebetween. Electrodes 30 and 32 may be the components of a conventional oil burner ignitor system and will be comprised of a suitable conductive metal; such as 430F stainless steel, Nichrome or Kanthal; mounted in a ceramic holder. Electrodes usable with the present invention may be obtained from Dielectric Company of Jersey City, N. J.

Rectifier devices, which may comprise diode bridge circuits as shown generally at 34 and 34', are connected across the secondary windings 36 and 36' of respective arc monitoring relay transformers 10 and 10'. The direct current voltage developed across rectifier devices 34 and 34' is applied, via respective filters 35 and 35', to the coils 38 and 38' of a pair of electromagnets. Filters 35 and 35' may comprise merely tantalum capacitors. The electromagnets which include coils 38 and 38' will typically have air cores.

The presence of magnetic fields generated by the passage of direct current through coils 38 and 38' will be sensed by field responsive devices positioned in proximity of the coils. As shown in the drawing the field responsive devices comprise normally open reed type switches 40 and 40'. Switches 40 and 40' are connected in series with a suitable current source 46 and together control the energization of the solenoid 42 of a relay which is indicated generally at 44.

Relay 44 includes the normally open contacts of a switch 48 which connects the a.c. source to a fuel pump 50. To facilitate understanding of the invention the a.c. source 18 has been shown at 18' in series with pump 50.

To fully appreciate operation of the present invention the prevalent causes of ignition failure in oil burner systems must be understood. Ignition failure, presuming that fuel is available, may be almost universally attributed to one of two faults. The most common fault is the build up of carbon on electrodes 30 and 32 to the point where the electrodes are effectively open circuited thereby preventing the generation of an arc. The other common cause of lack of ignition is a failure in the insulation of the high voltage transformer. A trans-

former insulation break-down typically results in a short circuit to ground of one of the high voltage secondary windings of the transformer. As in the case of the carbon build up on the electrodes, transformer failure will also prevent the generation of an arc.

In operation, when the thermostat system 22 calls for heat, the contacts of switch 20 will be closed and the a.c. voltage from source 18 applied across the primary winding of transformer 14. Current flow through the primary winding of transformer 14 will result in the induction of a high voltage, typically 5,000 volts at 25 milliamps, across each of secondary windings 24 and 26 of the high voltage transformer. With the exception of the small voltage drop across primary windings 12 and 12' of arc monitoring relay transformers 10 and 10', the entire voltage, for example 10,000 volts, will be applied across the spark gap between electrodes 30 and 32. Except in cases where one of the common failures discussed above has occurred, the impression of this high voltage across the electrodes will result in the generation of a continuous arc which will, if fuel is present, cause ignition thereof.

The amount of current flow through the primary windings 12 and 12' of transformers 10 and 10' will, of course, be a function of the voltage induced in respective secondary windings 24 and 26 of transformer 14 and also of the impedance introduced into the circuit by the spark gap between electrodes 30 and 32. If there is a partial or complete failure at the transformer 14, for example, an open or short circuit effecting either of secondary windings 24 and 26, there will be insufficient voltage applied across the electrodes to cause establishment of an arc. Accordingly, there will be no current flow through the circuit including the primary windings of the arc monitoring relay transformers. Similarly, should there be a build up of carbon deposits on electrodes 30 and 32, resulting in an equivalent open circuit condition, there will be insufficient arcing to cause ignition and, accordingly, reduced or zero current flow through the arc monitoring relay transformer primary windings.

It is to be noted that, in accordance with the present invention, a continuous arc will be generated between electrodes 30 and 32 during all times the condition responsive system 22 is calling for combustion and there is no ignition system fault. Continuous ignition will prevent carbon build up on the electrodes.

In accordance with one embodiment of the invention, approximately 125 volts is developed across each of primary windings 12 and 12' of transformers 10 and 10'. Transformers 10 and 10' are step down transformers and approximately 25 volts will be induced in their respective secondary windings 36 and 36' under normal operating conditions. The relatively low a.c. voltage induced in the second windings of transformers 10 and 10' will be rectified and the resulting direct current will flow through coils 38 and 38' thus generating a pair of magnetic fields.

In response to the establishment of the magnetic fields, in the manner discussed above and commensurate with the creation of an arc between electrodes 30 and 32, reed switches 40 and 40' will be closed thereby energizing solenoid 42 and causing the closing of contacts 48 of relay 44. The closing of relay contacts 48 will result in the energization of pump 50 and fuel will be delivered to the combustion chamber and ignited.

To summarize operation of the invention, the magnetic field producing devices 38 and 38' will be energized in response to current delivered to sustain the arc discharge across electrodes 30 and 32. In the absence of an arc between electrodes 30 and 32 there will be no current flow, the energization circuit for relay 42 will not be closed and pump 50 will remain deenergized. Thus, oil can not be pumped into the furnace without there first being a spark available for causing ignition. Accordingly, it may be seen that the present invention monitors the high voltage ignition arc in order to control operation of the fuel pump.

An added safety feature inherent in the employment of the present invention is that a constant ignition arc is required in order to supply fuel to the combustion chamber. Thus, should a flame-out occur there would be immediate re-ignition since the arc between electrodes 30 and 32 is present whenever the thermostat system 22 is calling for heat. This mode of operation may be favorably contrasted with the prior art which relies on intermittent ignition. As a further safety feature a pair of ignition monitoring relay transformers are employed to insure pump deenergization in the unlikely event of a short to ground occurring in those portions of the circuit disposed between either of the electrodes and the monitoring relay transformer primary winding to which it is connected.

While a preferred embodiment has been shown and described various modifications and substitutions may be made thereto without departing from the spirit and scope of the present invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

What is claimed is:

1. A control for combustion apparatus, the combustion apparatus including electrically operated fuel supply means and means for establishing an electric arc for igniting the fuel, said control comprising:

transformer means, said transformer means having a primary winding connected in series with the means for establishing an electric arc whereby a current commensurate with the arc current will be induced in the secondary winding of said transformer means;

means connected across the secondary winding of said transformer means for generating a signal commensurate with the current induced therein; means connected to said means for generating a signal commensurate with induced current for providing a control signal commensurate with arc current; and

switch means responsive to said control signal for interrupting the supply of electric power to the fuel supply means during periods when no arc current is sensed.

2. The apparatus of claim 1 wherein said transformer means comprises:

a step-down transformer.

3. The apparatus of claim 2 wherein said means for generating a signal commensurate with the current induced in the secondary winding of said step-down transformer comprises:

rectifier means connected across the secondary winding of said step-down transformer, a direct current signal commensurate with ignition arc current being provided by said rectifier means.

4. The apparatus of claim 3 wherein said control signal providing means comprises:

means connected to said rectifier means for generating a magnetic field commensurate with said direct current signal commensurate with ignition arc current; and

means responsive to the generation of said magnetic field for producing a control signal.

5. The apparatus of claim 4 wherein said magnetic field responsive means comprises:

a current source; and

normally open magnetic field responsive switch means connected in series with said current source.

6. The apparatus of claim 4 wherein said switch means for interrupting the supply of power to the fuel supply means comprises:

normally open relay means, said relay means having a solenoid connected in series with said magnetic field sensitive switch and current source.

7. The apparatus of claim 1 wherein said control signal providing means comprises:

field generating means connected to said means connected across said transformer means secondary winding, said field generating means producing a magnetic field commensurate with said signal commensurate with the induced current commensurate with arc current; and

means responsive to the generation of said magnetic field for producing a control signal.

8. The apparatus of claim 7 wherein said magnetic field responsive means comprises:

a current source; and

normally open magnetic field responsive switch means connected in series with said current source.

9. The apparatus of claim 8 wherein said switch means for interrupting the supply of power to the fuel supply means comprises:

normally open relay means, said relay means having a solenoid connected in series with said magnetic field sensitive switch and current source.

10. The apparatus of claim 1 wherein said control further comprises:

a step-up transformer, the primary winding of said step-up transformer being connected across an alternating current source; and

means connecting high voltage terminals of the secondary winding of said step-up transformer to a pair of electrodes whereby a continuous arc may be established between the electrodes, the primary winding of said transformer means being connected between one of the electrodes and a first high voltage terminal of said step-up transformer secondary winding.

11. The apparatus of claim 10 wherein said step-up transformer means comprises:

a ferro-resonant transformer having a primary winding and a pair of secondary windings; and means interconnecting first ends of the secondary windings of said ferro-resonant transformer means.

12. A control for combustion apparatus, the combustion apparatus including electrically operated fuel supply means and means for establishing a continuous electric arc between a pair of electrodes for igniting the fuel, said control comprising:

step-up transformer means, the primary winding of said transformer means being connected across an alternating current source;

means connecting the high voltage terminals of the secondary winding of said step-up transformer means to the pair of electrodes whereby a continuous arc may be established between the electrodes; arc current sensing transformer means, said arc current sensing transformer means having a primary winding connected between one of the electrodes and a first high voltage terminal of said step-up transformer means secondary winding; means connected to the secondary winding of said arc current sensing transformer means for providing a control signal commensurate with arc current; and switch means responsive to said control signal for interrupting the supply of electric power to the fuel supply means during periods when no arc current is sensed.

13. A control for combustion apparatus, the combustion apparatus including electrically operated fuel supply means a pair of electrodes and means for establishing an electric arc between the electrodes for igniting fuel, said control comprising:

step-up transformer means, said transformer means having a primary winding adapted to be connected across an alternating current source and a secondary winding, a high arc producing voltage being established across said step-up transformer secondary winding;

a first step-down transformer, the primary winding of said first step-down transformer being connected between a first end of said step-up transformer means secondary winding and one of said electrodes;

a second step-down transformer, the primary winding of said second step-down transformer being connected between a second end of said step-up transformer means secondary winding and the second of said electrodes;

rectifier means connected across the secondary winding of each of said step-down transformers, direct current signals commensurate with ignition arc current being provided by each of said rectifier means;

means connected to each of said rectifier means for providing a control signal commensurate with the

arc current induced in the secondary winding of each of said step-down transformers; and switch means responsive to said control signals for interrupting the supply of electric power to the fuel supply means during periods when both of said rectifier means are not providing direct current signals commensurate with ignition arc current.

14. The apparatus of claim 13 wherein said control signal providing means comprises:

means connected to each of said rectifier means and responsive to the direct current signal provided thereby for generating magnetic fields commensurate with said signals commensurate with arc current;

normally open magnetic field responsive switch means positioned in operative relationship to each of said field generating means;

a current source; and

means for connecting said normally open field responsive switch means and said current source in series whereby the closing of both of said switch means will cause generation of said control signal.

15. The apparatus of claim 14 wherein said switch means for interrupting the supply of power to the fuel supply means comprises:

relay means, said relay means having a pair of normally open contacts and a solenoid, said relay means solenoid being connected in series with said series connected field responsive switch means and current source whereby generation of said control signal causes closing of the normally open contact of said relay means by permitting current to flow through said relay means solenoid, said relay means contacts being connected in series with the fuel supply means and a source of energizing current therefore.

16. A method for controlling a combustion apparatus which includes a pair of spaced electrodes across which a fuel igniting arc is established including the steps of: sensing the arc current at two points respectively associated with each electrode; delivering fuel to the combustion apparatus only when ignition current is sensed at both sensing points.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,762,856 Dated October 2, 1973

Inventor(s) Ralph D. Alessio

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 14, (Claim 6) change "4" to -- 5 --.

Signed and sealed this 19th day of March 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents