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BURNER SAFEGUARD CONTROL APPARATUS

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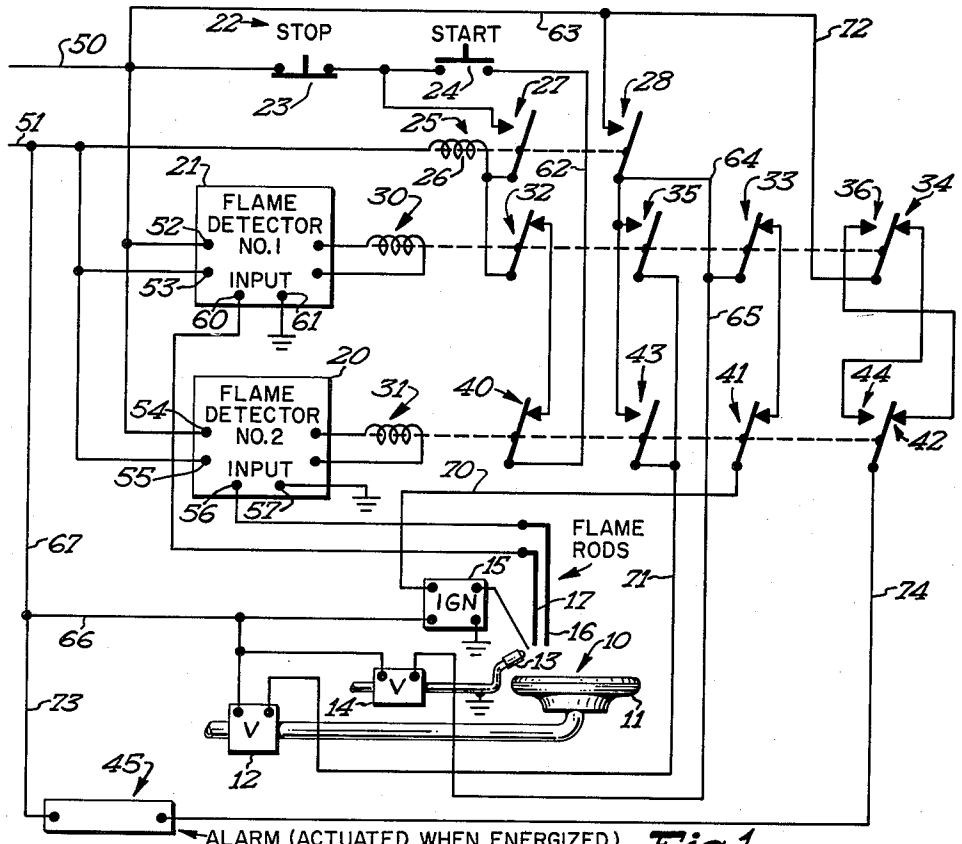


Fig 1

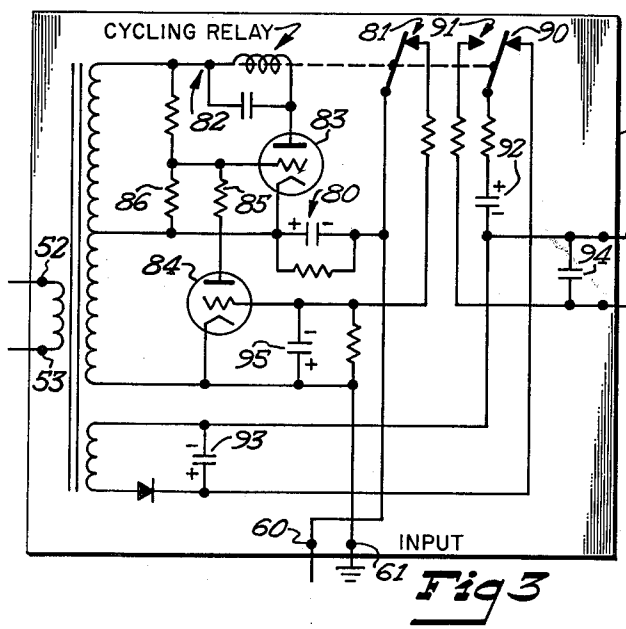


Fig 3

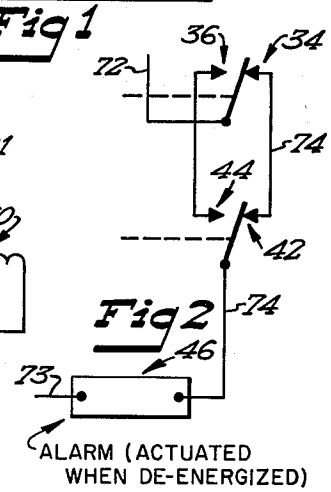


Fig 2

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BURNER SAFEGUARD CONTROL APPARATUS

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The present invention is concerned with an improved control apparatus, particularly a control apparatus adapted for use as a combustion safeguard means to monitor the proper operation of an associated fuel burner installation.

Specifically, the present invention is concerned with providing a combustion safeguard apparatus particularly adapted for use with fuel burner installations of the type required to operate for extended periods of time without shutdown. For example, fuel burners in electrical power stations, or fuel burners providing heat for certain manufacturing processes, are normally ignited and remain in an operative condition, producing the required heat for either the generation of power or the control of the manufacturing process, for extended periods of time, perhaps for periods of months. All during this time it is necessary that the proper operation of the burner be monitored and supervised to prevent unsafe operation. Unsafe operation which may result in an explosion or the like is of course an expensive and disastrous occurrence to the individuals and organization controlling the fuel burner installation. However, another event which may occur, and also results in a considerable loss of time and money is that of a nuisance shutdown.

To understand what is meant by a nuisance shutdown, it is necessary first to consider the features of various combustion safeguard apparatus now provided to monitor the presence or absence of flame at a fuel burner unit. Such combustion safeguard apparatus normally provides one way or another of component check. That is, an arrangement is used whereby the combustion safeguard apparatus checks to determine that, should a flame failure occur, the combustion safeguard apparatus is operative to detect the occurrence of this flame failure. If a component failure should occur, rendering the combustion safeguard apparatus inoperative to detect a subsequent flame failure, then this component failure results in the shutdown of the entire burner, not due to a fault in the burner itself but rather due to a fault in the combustion safeguard apparatus. While such a shutdown is necessary for safe operation, it is classified as a nuisance shutdown by virtue of the fact that the fuel burner unit which is being monitored has not developed a fault, but rather the combustion safeguard apparatus itself has developed this fault.

As a specific example, a maximum safety combustion safeguard apparatus is now marketed which consists of essentially a flame detector having an arrangement to cyclically simulate the absence of flame such that the flame detector first detects the actual presence of flame and then detects the simulated absence of flame. The output of the flame detector is responsive only to a continuous cycling between these states and thereby the ability of the flame detector to properly detect not only the absence of flame but the actual presence of flame is cyclically checked. Thus, even though such a flame detector is used with a fuel burner installation operating for many months at a time, the operability of the flame detector is continuously checked.

However, in the case of this maximum safety combustion safeguard apparatus, a component failure within the apparatus rendering the apparatus inoperative to detect the simulated absence of flame, causes the fuel burner unit to be shut down, this being the above described nuisance shutdown.

The present invention is concerned with an improved control apparatus which is constructed and arranged to prevent the above mentioned nuisance shutdown, while retaining the maximum safety necessary for component failure protection. Specifically, the present invention utilizes a first and a second flame detector, each having its own independent output means and input means such that each of the flame detectors independetnly senses the presence or absence of flame at an associated fuel burner unit. The control means, controlling the operativeness of the fuel burner unit, is jointly controlled by the output of the first and second flame detectors to render the fuel burner unit operative so long as at least one of the flame detectors detects the presence of flame. Thus, should one of the flame detectors experience a component failure, which would normally result in a nuisance shutdown, the nuisance shutdown is averted by virtue of the fact that the fuel burner unit remains under the control of the other flame detectors. Our invention further provides a component failure responsive means, for example an alarm, which is connected to be controlled by the output means of the first and second flame detectors to indicate such a component failure when the flame detectors fail to jointly detect the presence or absence of flame at the fuel burner unit. Thus, an alarm is sounded, indicating to the attendant at the fuel burner unit that one of the flame detectors has experienced a component failure. This flame detector can be found by visual inspection and can be replaced. During this operation, the fuel burner unit remains under the control of the other flame detector which properly monitors the presence or absence of flame. Once the defective flame detector has been replaced, the improved control apparatus of our invention again functions to provide the maximum in safe operation of the associated fuel burner unit, and at the same time the occurrence of a nuisance shutdown has been avoided, without the sacrifice of the features of safety.

Our invention will be apparent to those skilled in the art upon reference to the following specification, claims, and drawings, of which:

FIGURE 1 is a schematic representation of our invention,

FIGURE 2 is a showing of a modified form of an alarm circuit to be incorporated into the arrangement of FIGURE 1, and

FIGURE 3 is a schematic representation of one of the flame detectors represented in block diagram form in FIGURE 1.

Referring specifically to FIGURE 1, reference numeral 10 designates a fuel burner unit installation having a main fuel burner 11 with an associated valve 12, a pilot burner 13 with an associated valve 14, ignition means 15 in the form of a conventional ignition transformer, and flame sensing means in the form of flame rods 16 and 17. As is well known, energization of the pilot valve 14 and ignition means 15 is effective to produce a flame at flame burner 13. This flame is sensed by flame rods 16 and 17, in conjunction with flame detectors 20 and 21, as will be described, and as a result the main burner valve 12 is energized to admit fuel to the main burner 11 where it may be ignited by the pilot burner 13.

The primary control of the fuel burner unit 10 is achieved by means of a start-stop station identified generally by means of reference numeral 22, this start-stop station having a stop push button 23 and a start push button 24. The start push button 24 is effective, upon closing of the switch associated therewith, to energize a control relay 25 having a winding 26 and first and second normally open switches 27 and 28.

Relay 25 is connected in circuit with circuit means controlled by the output means of the flame detectors 21 and

22, this output means consisting of flame relays 30 and 31. Relay 30 includes normally closed switches 32, 33 and 34 as well as normally open switches 35 and 36. Flame relay 31 includes normally closed switches 40, 41 and 42 as well as normally open switches 43 and 44.

As has been mentioned, our invention includes means also characterized as a fault output, to energize a component failure responsive means, for example an alarm identified by reference numeral 45 of FIGURE 1. As indicated by the legend, alarm 45 is of the type which is actuated when energized. In FIGURE 2 reference numeral 46 designates a similar alarm, this alarm being of the type which is actuated when de-energized. In FIGURE 2 the switches 34 and 36 of flame relay 30 and the switches 42 and 44 of the flame relay 31 are shown interconnected in a manner to provide similar operation for the alarms 45 and 46 of FIGURE 1 and FIGURE 2 respectively, this operation being such that the alarm is sounded upon failure of the flame detectors 20 and 21 to jointly indicate the presence or the absence of flame at the fuel burner unit 10.

Reference numerals 50 and 51 designate power input conductors adapted to be connected to a source of alternating voltage, not shown. Power input terminals 52 and 53 of flame detector 21 are connected to conductors 50 and 51, as are the power input terminals 54 and 55 of flame detector 20.

As has been mentioned, flame rods 16 and 17 are the flame sensing means associated with the flame detectors 20 and 21 respectively. Flame rod 16 is connected to the signal input terminal 56 of flame detector 20, the other signal input terminal 57 being connected to ground potential. Flame rod 17 is connected to the signal input terminal 60 of flame detector 21, the other signal input terminal 61 being connected to ground potential. One flame rod could be used, connected to the inputs in parallel.

Thus far, we have described only the major components of our invention. They are interconnected as shown in FIGURE 1 in which the apparatus of our invention is shown in the standby condition wherein flame is not present at the fuel burner unit 10 and the start button 24 is in an open position. The flame detectors 20 and 21, which will be described in detail in connection with FIGURE 3, are energized from the power line conductors 50 and 51.

If it is assumed that a need for operation of the fuel burner unit 10 is now evidenced by the closing of the start button 24 by the attendant at the fuel burner unit, the control relay 25 is energized by virtue of a circuit which can be traced from power line conductor 50 through the start-stop station 22, conductor 62, normally closed switches 40 and 32 of flame relays 31 and 30 respectively, and winding 26 to power line conductor 51. From this circuit it can be seen that initial energization of relay 25 is dependent upon the flame detectors 20 and 21 jointly indicating the absence of flame at the fuel burner unit 10. Should a component failure exist within one of the flame detectors such that it improperly indicates or detects the presence of flame at the fuel burner unit, then energization of relay 25 is not possible and the defective flame detector must be replaced before operation of the fuel burner unit 10 can be instituted.

Energization of relay 25 completes a holding circuit for this relay including its normally open switch 27, this switch bypassing the start button 24 as well as switches 32 and 40 of the flame detectors 21 and 20.

Energization of relay 25 also completes an energizing circuit for pilot valve 14 and ignition means 15. The energizing circuit for pilot valve 14 can be traced from power line conductor 50 through conductor 63, switch 28 of relay 25, conductors 64 and 65, pilot valve 14, and conductors 66 and 67 to power line conductor 51. The energizing circuit for the ignition means 15 can be traced from power line conductor 50 through conductor 63, switch 28, conductor 64, switches 33 and 41 of flame relays 30 and 31 respectively, conductor 70, ignition means 15, and conductors 66 and 67 to power line conductor 51.

By virtue of these circuits, a flame is normally established at pilot burner 13 and this flame is detected by the means including the flame detectors and the flame rods. As a result, the flame relays 30 and 31 are energized. It is to be expected that one of the flame relays will be energized a short period of time before the other one is energized, by virtue of the slight differences in component values and the like to be found in the two flame detectors 20 and 21. As can be seen from the circuits including switches 32 and 40 of the flame relays 30 and 31, the first flame relay to be energized opens the initial energizing circuit for control relay 25. Also, the first of the switches 33 and 41 to be opened opens the energizing circuit for ignition means 15.

Now that the flame at the pilot burner 13 has been proven, it is proper to energize the main valve 12. An important feature of our invention resides in the energizing circuit for this valve which includes the parallel connected switches 35 and 43 of the flame relays 30 and 31. The energizing circuit for valve 12 can be traced from power line conductor 50 through conductor 63, switch 28, flame relay switches 35 and 43 in parallel, conductor 71, valve 12, and conductors 66 and 67 to power line conductor 51. From this energizing circuit it can be seen that the first of the flame relays to be energized causes valve 12 to be energized. Furthermore, it can be seen that it order for valve 12 to be subsequently de-energized it is necessary that both of the flame relays 30 and 31 become de-energized. As will be apparent upon reference to FIGURE 3, the deenergization of both of the flame relays 30 and 31 is indicative of the absence of flame being sensed by not only flame detector 21 but also by flame detector 20. If only one of these flame detectors detects the absence of flame, then the main valve is not de-energized and a nuisance shutdown is averted. Such a condition, that is the failure of flame relays 30 and 31 to jointly indicate the presence of flame at the fuel burner unit 10, is indicative of a component failure in one of the flame detectors. The switches 34, 36, 42 and 44 of the flame relays 30 and 31 are interconnected in a circuit to signal such a component failure.

This circuit can be seen by tracing a circuit from power line conductor 50 through conductors 63 and 72, to the movable switch blade associated with the switches 34 and 36 of relay 30. Power line conductor 51 is connected by virtue of conductors 67 and 73 to alarm 45 which is then connected by virtue of conductor 74 to the movable switch blade associated with the switches 42 and 44 of flame relay 31. It can be seen that the normally open switch of one of the flame relays is connected with the normally closed switch of the other flame relay. Thus, a circuit is not completed between the movable switch blades of the respective flame relays until such a time as the flame relays 30 and 31 fail to jointly indicate either the presence of flame at the fuel burner unit or the absence of flame at the fuel burner unit. For example, assume for the moment that the apparatus as shown in FIGURE 1, that is in the standby condition, is modified as it would be should flame detector 21 experience a component failure falsely indicating the presence of flame. Flame relay 30 is thus energized and switch 36 is closed. An energizing circuit for alarm 45 can now be traced from power line conductor 50 through conductors 63 and 72, switch 36, switch 42, conductor 74, alarm 45, and conductors 73 and 67 to power line conductor 51.

In FIGURE 2 we have shown a circuit embodying the concept disclosed in FIGURE 1, modified to the extent that the alarm is of the type which is actuated when de-energized. In this figure it can be seen that an alarm 46 is continuously energized so long as the switches associated with the flame relays remain in step. However, should one of the flame relays be energized while the other

is de-energized, then the circuit between conductors 72 and 73 maintaining alarm 46 continously energized is broken and the alarm is actuated to indicate a component failure.

Our invention, as disclosed in FIGURE 1, is not to be limited to a specific type of flame detector. However, the over-all arrangement as disclosed in FIGURE 1 provides a higher degree of safety when the flame detectors 20 and 21 constitute the maximum safety flame detectors of the type disclosed in FIGURE 3. In this FIGURE, disclosing the electrical circuitry of a flame detector which may constitute flame detector 21 of FIGURE 1, the input terminals 60 and 61 are connected to charge a capacitor 80. Cycling relay 82 is connected to be energized from an electron discharge device 83, electron discharge device 83 being controlled by a further discharge device 84. Specifically, the presence of flame at the fuel burner unit is effective to charge capacitor 80 to the polarity shown. The charge on this capacitor is distributed to a further capacitor 95, through a circuit which includes the normally closed switch 81 of cycling relay 82, to provide a cutoff bias for discharge device 84. The plate load resistors 85 and 86 of discharge device 84 have a voltage thereacross in accordance with the state of conduction or nonconduction of discharge device 84. Resistor 86 is connected to the input circuit of discharge device 83, and by virtue of this connection, the nonconduction of discharge device 84 allows discharge device 83 to conduct, energizing relay 82. The energization of relay 82 opens its switch 81 and thus the cutoff bias applied from capacitor 80 to capacitor 95 when switch 81 is closed is no longer effective to maintain discharge device 84 nonconductive and this discharge device becomes conductive. A cutoff bias is then developed across resistor 86 and discharge device 83 is rendered nonconductive, once again de-energizing relay 82 and closing switch 81. In this manner, cycling relay 82 cycles between an energized and a de-energized condition so long as a signal indicative of the presence of flame at the fuel burner unit is applied to the input terminals 60 and 61. Specifically, with switch 81 closed, the electronic flame detector 21 is operative to detect the actual presence of flame at the fuel burner unit. With switch 81 opened, the electronic flame detector 21 is effective to detect the simulated absence of flame at the fuel burner unit. This mode of operation is continuously and cyclically repeated so long as a flame continues to be sensed at the fuel burner unit. Thus, even though the fuel burner unit remains operative for extended periods of time, the maximum safety flame detector is effective to periodically check its own operativeness. The output of flame detector 21, that is flame relay 30, is responsive only to a continuous cycling of relay 82. As this relay cycles, its switches 90 and 91 cycle to first charge a capacitor 92 from a power source constituted by a capacitor 93 and then connect this charged capacitor 92 to a further capacitor 94, this capacitor shunting the winding of relay 30. Thus, so long as relay 82 continues to cycle, capacitor 94 remains charged and relay 30 is continuously energized. Should the cycling relay 83 fail to cycle and as a result remain in either its energized or its de-energized condition, relay 30 is de-energized and, as above explained, the alarm 45 of FIGURE 1 or the alarm 46 of FIGURE 2 is actuated to indicate a component failure.

Should an actual flame failure be experienced at fuel burner unit 10, then both of the flame detectors 20 and 21 sense the absence of flame at the fuel burner unit and both of the flame relays 30 and 31 are de-energized. The de-energization of these relays opens the parallel connected switches 35 and 43 and thus the main fuel valve 12 is de-energized, causing a shutdown of the fuel burner system. Safe operation of the fuel burner unit is achieved.

From the above description, it can be seen that we have provided an improved control apparatus which not only provides the maximum in safety of the operation of an associated fuel burner unit, but also provides means to avoid a nuisance shutdown usually accompanying a component failure within an associated flame detector.

Other modifications of this invention will be apparent to those skilled in the art and thus it is intended that the scope of the present invention be limited solely by the scope of the appended claims.

We claim as our invention:

1. Control apparatus for use with a fuel burning installation, comprising;
a plurality of flame detectors each having output means and input means, said flame detectors being individually responsive to the presence or absence of flame at the fuel burning installation,
first control means including the output means of said plurality of flame detectors adapted to maintain a supply of fuel to the burning installation so long as at least one of said plurality of flame detectors detects the presence of flame,
component failure indicating means,
and second control means including the output means of said plurality of flame detectors adapted to control said component failure indicating means to indicate a component failure in at least one of said flame detectors when said plurality of flame detectors fail to jointly indicate the presence of flame at the fuel burning installation.

2. Control apparatus for use with a fuel burning installation, comprising;
a first and a second flame detector, each flame detector having output means and having input means adapted to be associated with the fuel burning installation to detect the presence or absence of flame thereat,
first control means including the output means of said first and said second flame detectors adapted to maintain a supply of fuel to the fuel burning installation so long as at least one of said flame detectors detects the presence of flame,
component failure responsive means,
and second control means including the output means of said first and said second flame detectors to control said component failure responsive means to indicate a component failure in one of said flame detectors when said flame detectors fail to jointly detect the presence of flame.

3. In combination,
a fuel burner system adapted to accommodate flame;
a first and a second flame detector, each operatively associated with said fuel burner system to individually detect the presence or absence of flame, and each having separate output means controlled in accordance therewith;
first means including said separate output means adapted to maintain a supply of fuel to said fuel burner system so long as at least one of said flame detectors indicates the presence of flame,
alarm means,
and second means including said separate output means to actuate said alarm means when said flame detectors fail to concurrently indicate the presence of flame.

4. Control apparatus for use with a fuel burner installation having fuel control means to control a given supply of fuel thereto, comprising;
a first flame detector having output means and having input means adapted to be operatively associated with the fuel burner installation,
a second flame detector having output means and having input means adapted to be operatively associated with the fuel burner installation,
first control means including the output means of said first and second flame detectors and adapted to control the fuel control means to maintain the given

supply fuel to the fuel burner installation so long as one of said first or second flame detectors detects the presence of flame,

and fault output means including the output means of said first and second flame detectors and operative when said first and second flame detectors fail to jointly detect the presence or absence of flame.

5. Control apparatus for use with a fuel burner installation having a valve controlling the flow of fuel to a given portion thereof, and alarm means, comprising;

a first and a second flame detector, each having output means and input means including sensing means adapted to be associated with the fuel burner installation to detect the presence or absence of flame,

control means,

initiating means including the output means of said first and second flame detectors effective to initially actuate said control means upon said first and second flame detectors jointly detecting the absence of flame,

maintaining means including said control means effective to maintain the actuation of said control means,

initiating means including the output means of said first and second flame detectors effective to open the valve upon one of said first or second flame detectors detecting the presence of flame,

and further means including the output means of said first and second flame detectors effective to actuate the alarm means upon failure of said first and second flame detectors to jointly detect the presence of flame.

6. In a combustion safeguard apparatus effective to monitor the proper operation of an associated fuel burner installation,

a first and a second flame detector, each having means to independently monitor the presence or absence of flame,

starting interlock means for the fuel burner installation including said first and second flame detectors to allow startup of the operation of the installation only when said first and second flame detectors jointly indicate the absence of flame,

holding means for the fuel burner installation including said first and second flame detectors to maintain operation of a portion of the fuel burner installation so long as at least one of said first and second flame detectors indicates the presence of flame,

failure responsive means,

and means including said first and second flame detectors to actuate said failure responsive means upon failure of said first and second flame detectors to jointly indicate the presence of flame.

7. In combination,

a main burner, a valve to control the supply of fuel to the main burner, pilot burner means to ignite the fuel at the main burner,

a first and a second flame detector, each having a flame relay and flame sensing means adapted to sense the the presence or absence of flame at the burners to control the flame relays in accordance therewith,

a control relay,

energizing circuit means for said control relay including means jointly controlled by the flame relays of said flame detectors to facilitate energization of said control relay only in the event that both of said flame detectors detect the absence of flame at the burners,

energizing means for the pilot burner means, controlled by said control relay,

energizing means for the valve jointly controlled by the flame relays of said flame detectors and by said control relay to supply fuel to the main burner in the event that one of said flame detectors detects the presence of flame at the burners,

means indicative of a component failure within one of said flame detectors,

and energizing means for said last named means jointly controlled by the flame relays of said flame detectors to energize said last named means to indicate a component failure within one of said flame detectors upon failure of said flame detectors to jointly indicate the presence or absence of flame at the burners.

8. Combustion safeguard apparatus for use to monitor the proper operation of an associated fuel burner unit which is operative for extended periods of time and to prevent nuisance shutdown of a portion of the fuel burner unit, the apparatus comprising;

a first and a second flame detector, each of which includes flame sensing means adapted to independently sense the presence or absence of flame at the fuel burner unit, and each of which may be characterized as a flame detector having means cyclically simulating the absence of flame and having output means responsive only to a continuous cyclic detection of the simulated absence of flame and the actual presence of flame, whereby the ability of said flame detectors to properly detect the simulated absence of flame and the actual presence of flame is cyclically checked,

first means jointly controlled by the output means of said first and second flame detectors effective to maintain the portion the fuel burner unit operative when at least one on said flame detectors is properly operative to cyclically detect the simulated absence of flame and the actual presence of flame,

further means to provide a fault output,

and second means jointly controlled by the output means of said first and second flame detectors effective to actuate said further means when one of said first or second flame detectors fails to cyclically detect the simulated absence of flame and the actual presence of flame.

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