Sept. 27, 1966 J. R. GAGE ETAL 3,275,058

OIL BURNER CONTROL SYSTEMS

Filed Nov. 27, 1963 3 Sheets-Sheet 1

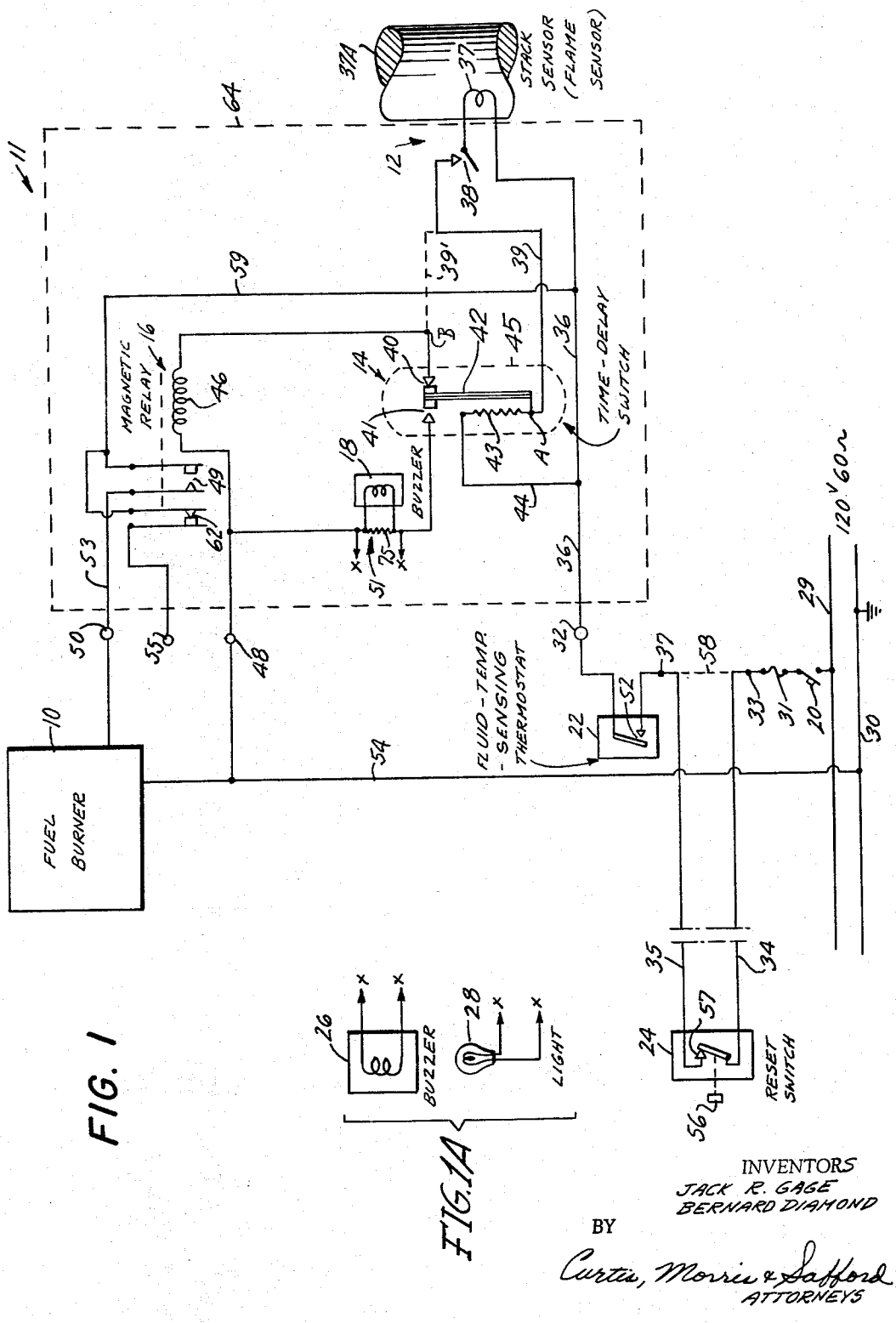


FIG. 1

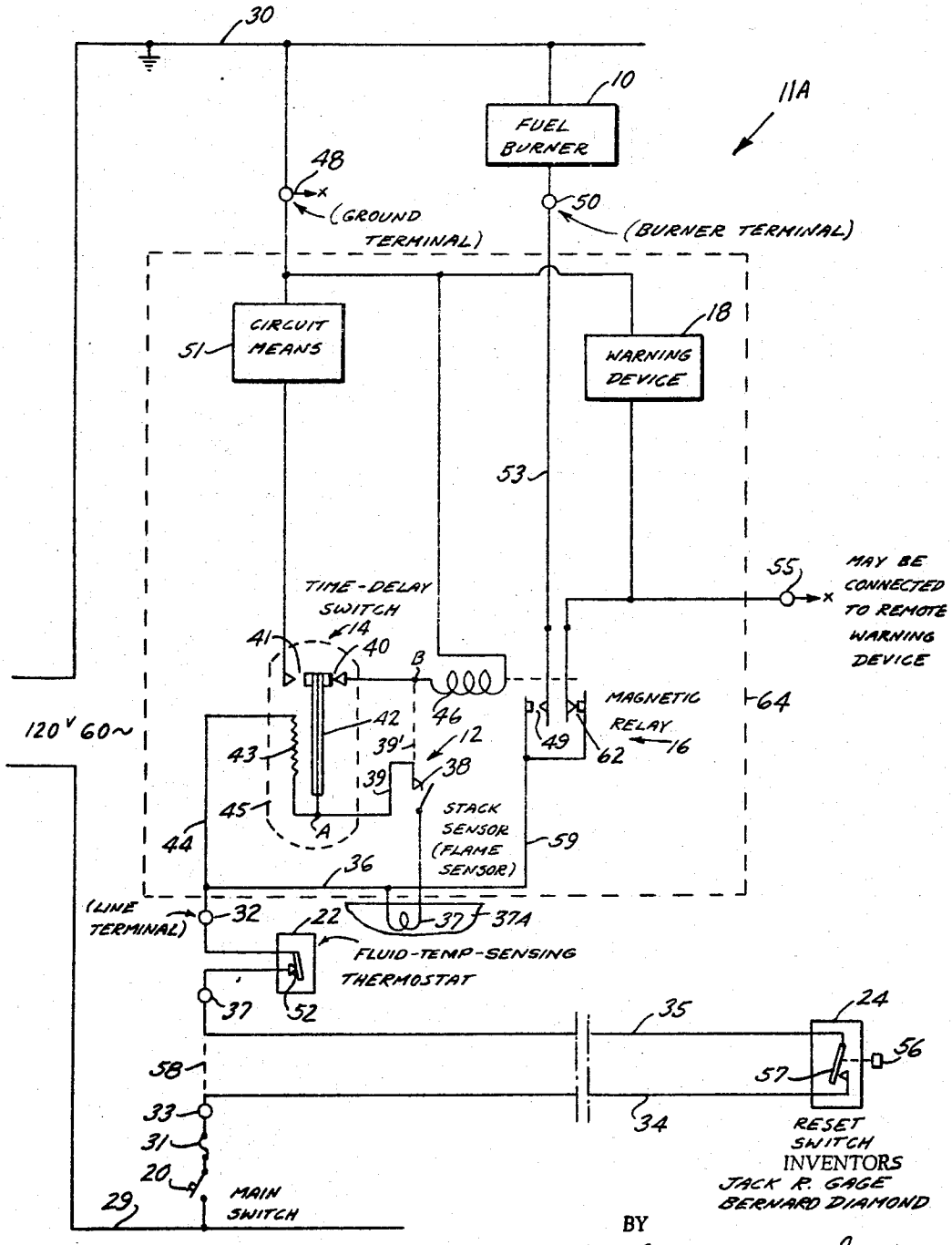
FIG. 1A

INVENTORS
JACK R. GAGE
BERNARD DIAMOND

BY

Curtis, Morris & Safford
ATTORNEYS

FIG. 2



INVENTORS
JACK R. GAGE
BERNARD DIAMOND

BY
Curtis, Morris & Safford
ATTORNEYS

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OIL BURNER CONTROL SYSTEMS

Filed Nov. 27, 1963 3 Sheets-Sheet 3

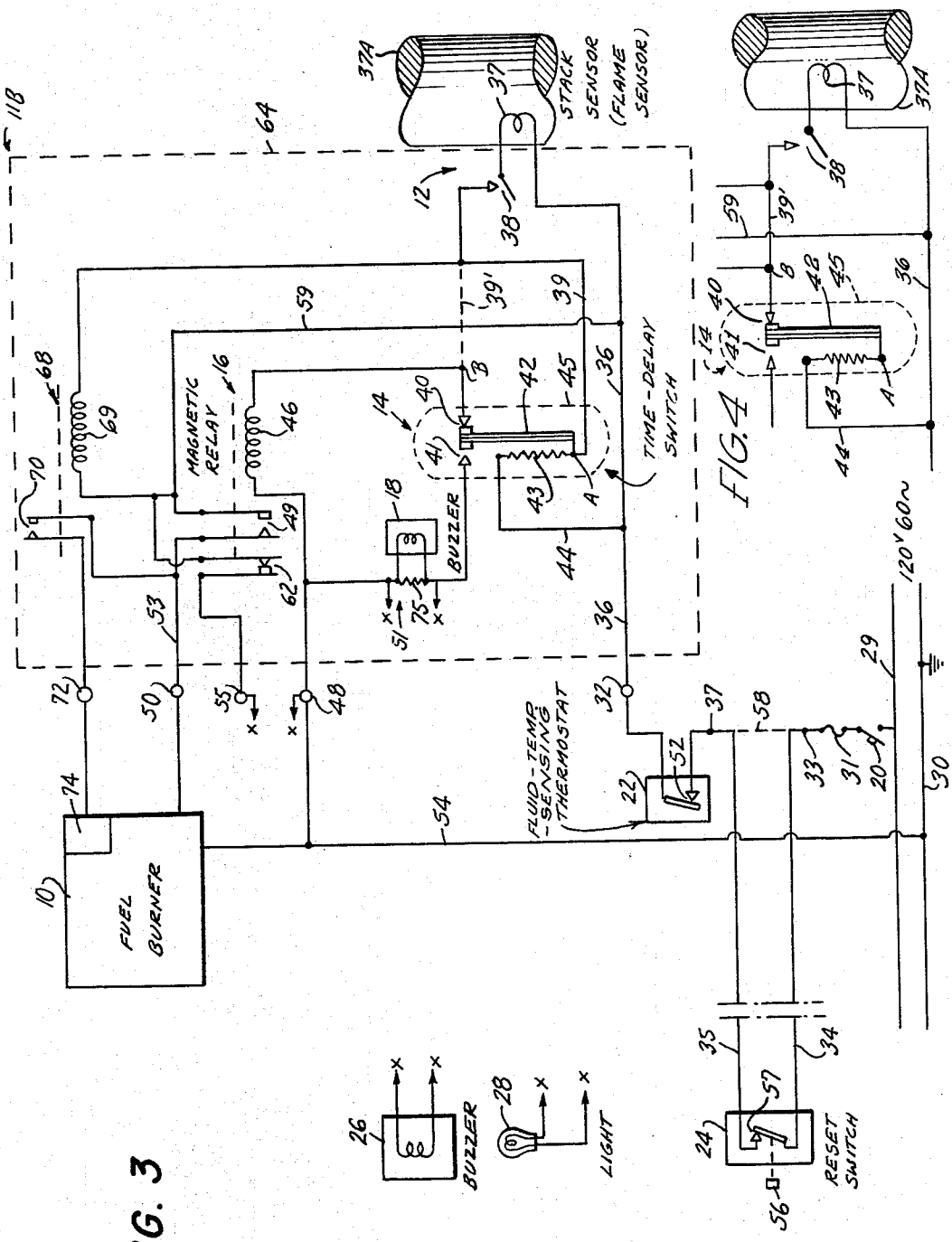


FIG. 3

FIG. 4

INVENTORS
JACK R. GAGE
BERNARD DIAMOND

BY

Curtis, Morris & Safford
ATTORNEYS

United States Patent Office 3,275,058 Patented Sept. 27, 1966

3,275,058

OIL BURNER CONTROL SYSTEMS

Jack R. Gage and Bernard Diamond, Hicksville, N.Y., assignors to D-G Controls, Inc., Hicksville, N.Y., a corporation of New York

Filed Nov. 27, 1963, Ser. No. 326,501
13 Claims. (Cl. 158—28)

This invention relates to oil burner control systems and more particularly to primary control systems which sense the presence of combustion in an oil-fired burner and serve to shut down the burner in the event that the burner should malfunction for any reason.

Among the many advantages of oil burner control systems embodying the present invention are those resulting from the fact that they are safety systems having fail-safe characteristics, namely that they shut down the oil burner in the event of a malfunction either in the burner or in the control system itself. Moreover, these control systems may include a warning device as an integral part of the system so as to provide a warning signal whenever a burner malfunction does occur. In addition, these control systems enable the emergency shut-off switch, which is located remotely from the burner to be used as reset control means for resetting the system. This emergency switch is often a toggle-type switch and is usually located at a convenient point in the living quarters such as in the kitchen or in a hallway near the top of the cellar stairs, and the present invention enables the control system to be reset by the homeowner from this convenient point by turning this switch off for a brief period of time. Also, control systems embodying the present invention are extremely reliable in operation and are easy to service whenever the occasion arises.

The control systems embodying the present invention are adapted to lock themselves electrically into the condition wherein the burner is de-energized after a malfunction has occurred, and when the homeowner interrupts the circuit at a remote point the system resets itself into condition to attempt to initiate proper operation of the burner.

The domestic oil supply industry in most areas of this country undertakes the responsibility of servicing domestic oil burner installations and of maintaining them in proper operation condition. For many years this industry has been plagued with the fact that most service calls are received early in the morning or in the evening hours. The reason for this is that in most conventional systems there is no warning provided to the homeowner when the oil burner malfunctions. Consequently, whenever the burner shuts down during the night the homeowner usually does not know about it until he arises in the morning to find that the house is unpleasantly chilly or that there is no hot water for the morning shower. In many homes having oil burners for space heating the domestic hot water supply is also heated by this same burner. During the daylight hours when the outside temperature is usually higher than at night the house often will maintain a sufficiently comfortable temperature so that a malfunction of the oil burner is not noticed until suppertime or after supper when the hot water is required in the kitchen or for bathing. Thus, the service calls tend to occur most often in the early morning hours or evening hours. This places a severe burden upon the service personnel and causes delays in response to some of the service calls, as well as raising the costs of oil service.

Moreover, in conventional domestic oil burner installations the reset button actuates a mechanical lock-out release and is located on the stack switch unit itself which is on the exhaust duct to one side of or behind the top of the furnace. In order to reset the oil burner the user must move around the furnace and find this button to actuate it.

This is often awkard or difficult, and in many cases the exhaust duct is sooty so that the homeowner hesitates to seek the reset button. In situations where the oil supply service operator is fortunate enough to be called by someone who is familiar with oil burner furnaces, the service operator may suggest that he will wait by the telephone while the user goes to the furnace to try to locate and actuate the reset button; so that if the burner does not begin operation again, the user will have saved the time of wating for service and the service operator will have avoided an unnecessary trip. But in many instances the user is unfamiliar with the equipment or hesitates to probe about the equipment, in which case the service operator must arrange for a service trip.

In oil burner control systems embodying the present invention the reset button is enabled to be located in the kitchen or in a hallway or some other convenient point remote from the oil burner itself. Thus, advantageously, the user of the equipment can actuate this reset switch whenever he finds that the oil burner has malfunctioned. The warning signal prompts him to actuate this reset switch immediately after the burner has malfunctioned. If the burner resets and starts operating, then the user is saved the trouble of making a service call and avoids the inconvenience of a cold house or cold water. If the burner does not begin proper operation then the service call is likely to be made at once, thus in the aggregate avoiding the tendency for service calls to occur during the morning or evening time periods discussed above. Also, many unnecessary service calls are thus avoided because those users who are hesitant to probe around the oil burner equipment will not hesitate to follow a suggestion to press a button which is conveniently at hand.

Following interruption of electrical power, for example after a severe storm, many conventional stack switch units which are in use today must be manually reset when the electrical power has been resumed. This requirement often involves hundreds of service calls for oil supply companies and considerable delay for customers. Advantageously, with the systems embodying the present invention they automatically reset themselves whenever there is an interruption of electrical power so that the burner resumes its normal operation as soon as the electrical power is restored, thus avoiding any trouble and delay for the user.

It is among the objects of the present invention to provide more convenient and safer oil burner stack switch control systems.

It is among the further objects of the present invention to provide oil burner stack switch control systems which are less complex than many in use today and which are easier to service and more reliable in operation.

In this specification and in the accompanying drawings are described and shown fuel burner control systems embodying the invention, and it is to be understood that this disclosure is not intended to be exhaustive nor limiting of the invention, but is set forth for purposes of illustration in order that others skilled in the art may fully understand the invention and the manner of its application in practical use.

The various objects, aspects, and advantages of the present invention will be in part pointed out and in part apparent from the following description of illustrative embodiments of this invention when considered in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic circuit diagram of a fuel burner control system embodying the present invention;

FIG. 1A illustrates remotely located warning signal devices which may be connected in the system of FIG. 1;

FIGURE 2 is a schematic diagram of an alternative embodiment of the system of FIGURE 1;

FIGURE 3 is a schematic circuit diagram of a modified embodiment of the present invention; and

FIGURE 4 is a partial schematic diagram of a modified embodiment of the present invention. The circuit of FIGURE 4 is identical to the circuit of FIGURE 3, except that the connection 39' is shown in solid lines with the connection 39 being omitted from FIGURE 4.

In the system of FIGURE 1 is shown a domestic heating fuel burner 10 and an electrical control system 11 including a combustion sensor 12 or heat probe for sensing the presence of energy of combustion in the burner, a thermal time-delay switch 14, a magnetic relay 16, which has its contacts in circuit in series with the fuel burner circuit, a buzzer warning device 18, a main power switch 20 which may serve as the reset switch, and a fluid sensing thermostat 22 which may be responsive to the temperature of the fluid being circulated to the living space which is being heated. Advantageously, the control system 11 is shown as including a remote reset control switch 24, and additional elements which may also be included in this control system are remote warning devices, for example such as an audible signal device 26 and a visible signal device 28.

The control system 11 is energized from a suitable electrical source, for example shown as alternating current power lines 29 and 30 for supplying 120-volt A.C. at 60 cycles. In such A.C. home distribution circuits it is customary to ground one of the lines, and the line 30 is shown as being grounded. It is preferable to have the main power switch 20 connected to the "hot" line 29, with a fuse 31 in series with this switch. Beyond the fuse 31 is a connection point 33 with an electric wire 34 extending to a remotely located switch 24. This switch 24 may be the emergency burner shut-off switch which is in existence in many homes, or it may be a switch which is especially installed to serve the reset purposes as described further below. In any event, the present invention enables the burner control system to be reset from a convenient switch remotely located, which is operated to reset the control system following malfunctioning of the burner. An electric line 35 extends from the other side of the reset switch 24 to a connection point 37 which is connected to the one side of the fluid-sensing thermostat 22. The hot "line" terminal 32 of the control system 11 is connected to the other side of the thermostat 22, and from this "line" terminal 32 a supply line 36 extends to the heat sensor 12 which includes a thermostat element 37, for example, such as a bimetallic element of helical construction, and a pair of normally open contacts 38 which become closed in response to heating of the sensor 12. In this system the combustion energy sensor 12 is illustratively shown as located in a duct 37A which serves to carry away the hot gases, products of combustion, from the burner 16. It will be understood, however, that this sensor 12 may be located at any suitable point in relation to the burner 10 so as to respond to the presence of energy resulting from combustion, such as heat energy or light energy resulting therefrom. The contacts 38 are connected by a lead 39 so that the contacts 38 are in circuit in shunt relationship to a heating element 43 of the thermal time-delay switch 14.

The thermal time-delay switch 14 is a snap-acting single-pole double-throw switch including a pair of normally closed contacts 40 and a pair of normally open contacts 41. A bimetallic snap-acting armature element 42 is in heat exchange relation with a resistance heater 43 which is connected in series with the movable contacts and with a connection 44 to the line 36. In the operation of this switch the heater 43 warms the bimetal armature element 42 and after an appropriate time-delay period in the range from 10 to 90 seconds the armature element 42 swings over so that the contacts 41 become closed while the contacts 40 are opened. The reason for using a snap-acting switch is to avoid any open-circuit hesitation between the opening of contacts 40 and the closure of contacts 41. This same avoidance of hesitation is provided by a make-before-break switching action, so that a make-before-break switch can be used in lieu of the snap-acting switch as shown. In this example the switch 14 is housed within an air-tight envelope 45 and is of a type such as can be obtained commercially from Electronic Fittings Corporation under the model designation 26.5–60–G.

From the normally closed contacts 40 a connection is made through a solenoid winding 46 of the magnetic relay 16 to a terminal 48, which is the "ground" terminal of the control system 11, and this ground terminal is adapted to be connected to the opposite side of the electrical source from the line terminal 32. The normally open contacts 49 of the relay 16 are in series with a terminal 50 of the control system, which is called the "burner" terminal of the control system 11 and serves to energize the burner 10 when these contacts 49 are closed.

The normally open contacts 41 are connected by circuit means 51 to the ground power terminal 48. The circuit means 51 provide an electrical connection between the contacts 41 and the power terminal 48 and may include the warning device 18 as shown in FIGURE 1. Alternatively, the warning device 18 may be included in association with the magnetic relay 16, as shown in FIGURE 2, in which event the circuit means 51 may not include a warning device. The magnetic relay 16 as shown in FIGURE 1 usually does include a set of normally closed contacts 62 which may be used to control a remote warning device as indicated by the connection arrows *x*, *x*, to terminals 55 and 48.

In operation of this burner system there are a variety of sequences of events which might arise to cause a malfunction, and these various sequences are reviewed hereinafter to show how this system provides fail-safe assurance to the user.

First will be explained the normal operating sequence, followed by the various possible sequences if there is a malfunction of the fuel burner, failure of electrical power service, or even if the control system itself should break down, showing how this system is fail-safe in operation under many different circumstances.

In normal operation of the burner 10 and control system 11 the main power switch 20 remains closed at all times, and when the temperature of the living space drops to the set level of a room thermostat (not shown), then the room thermostat is actuated so as to "call for" more heat. This room thermostat serves to initiate operation of a fluid circulator (not shown) for circulating a warm fluid from the furnace to the living space which is to be heated so as to supply heat to this space. This circulating fluid may be any suitable heat-transporting gas or liquid, for example, such as air, water, mixtures of water and an anti-freeze agent, or liquid anti-freeze agents without water. The most common circulating fluids used are, of course, air and water, in which cases the fluid circulator is a blower or a pump, but it is to be understood that the present invention is applicable to fuel burning domestic heating systems of all types, regardless of the type of fluid which is used to distribute the heat from the furnace to the space to be heated.

When the room thermostat calls for heat, then the fluid circulator produces circulation of the heat-transporting fluid, and this fluid becomes reduced in temperature as the heat is abstracted therefrom. The fluid-temperature-sensing thermostat 22 is normally open, and it is responsive to the temperature conditions in the heating system. For example, in a warm air heating system this thermostat 22 senses the temperature of the air being circulated, and in a warm water circulating system this thermostat 22 senses the temperature of the circulated water. When the temperature of this fluid drops to the set level of the thermostat 22, then the contacts 52 of

the thermostat 22 close to that the burner 10 is turned on, as will be explained further below.

Also, there are heating systems wherein the domestic hot water supply is heated by the furnace, and in such systems there is a thermostat such as at 22 which is arranged to be responsive to the temperature of the water supply source. In such cases there may be two thermostats 22 in parallel, one for sensing the circulating fluid and one for sensing the hot water supply. When the temperature of either fluid drops below the set level of its thermostat 22, then the contacts 52 of the thermostat 22 are closed to turn on the burner 10.

Thus, the thermostat contacts 52 become closed "calling for" heat by completing a circuit passing through the time-delay switch 14 and the relay coil 46.

This circuit is traced from the hot line 29 through the main switch 20, the fuse 31, connection 33, line 34, remote reset switch 24, line 35, connection 37, now closed contacts 52, line terminal 32, supply line 36, connection 44, heater 43, contact arm 42, normally closed contacts 40, relay winding 46, ground terminal 48, and lead 54 extending to the ground power line 30. Consequently, the relay winding 46 is energized so as to close its contacts 49 and thus to energize the burner 10 to place it in operation. The circuit for energizing the burner 10 is traced from the supply line 36 through a lead 59 to the now-closed contacts 49 and through a connection 53 to the burner terminal 50 and thence to the burner 10, with the opposite side of the burner being connected through the wire 54 to the power line 30. In normal operation as being discussed here the burner 10 ignites, and combustion continues so as to begin warming up the heat sensor 12. Thus, the flame sensor contacts 38 become closed before the time-delay period of switch 14 has elapsed, and hence current flow is established through these contacts 38 and through connection 39 to the movable arm 42 and through the contacts 40 to the relay coil 46 so as to maintain the relay contacts 49 closed. The heating element 43 of the time-delay switch 14 is now by-passed by the contacts 38, and hence the heater 43 stops heating, and so the switch 14 does not trip. The burner 10 continues to function until the thermostat 22 is satisfied, at which time the thermostat contacts 52 open, causing the relay contacts 49 to open so as to shut off the burner 10.

In this example the burner 10 includes a fuel source and ignition circuit, which become actuated so as to initiate and then continue combustion as long as the relay contacts 49 are closed.

In one possible type of malfunction the burner 10 may fail to ignite. During this sequence the thermostat contacts 52 close, calling for heat as discussed above, by completing a circuit through the time-delay switch 14 and through the relay coil 46 so as to close the relay contacts 49. Since the burner fails to ignite, the heat sensor 12 remains cool and its contacts 38 remain open. After the time-delay period has elapsed, the contacts 41 become closed by the heating action of the element 43 so as to complete a circuit through the circuit means 51 to the warning buzzer 18, and the contacts 40 become opened so as to de-energize the relay coil 46, thus shutting off the energizing circuit to the burner 10.

The warning signal continues until the main power switch 20 is either opened or until a reset button 56 is pushed so as to open the reset-switch contacts 57. Either of these switches 20 or 24 interrupts the current flow so as to allow the heater 43 to cool, and hence the time-delay switch 14 returns to its initial position as shown. When the respective switch 20 or 24 is again closed, then the burner 10 is again energized, because the thermostat 22 is continuing to call for heat. If the burner now ignites properly and continues to burn then the sequence of operation is normal as discussed above. But if the burner fails to ignite a second time, then the warning signal again occurs as before, and so the user will make a telephone call to the burner service organization.

The warning device 18 is shown as a buzzer, but it is to be understood that any suitable audible or visual warning device or combinations of them may be used. They may be connected for simultaneous operation, for example being connected in parallel, and may include devices such as a light 28, an electric horn, bell and the like. Also, these warning devices 26 and 28 may be located remotely from the burner by making connections at the respective points *x*, *x* as indicated, and one or more of them may be used in parallel, such as an audible device plus a visual device.

In this example the reset switch 24 is shown as being included, but it may be omitted by making a jumper connection 58 directly between the connection points 33 and 37 in which case the main power switch 20 is used as the reset switch. This main power switch 20 may be located on an electrical service panel near the incoming electrical power service connections for the home. However, it is usually desirable to have the main power shut-off switch 20 in the same room as the burner or in the vicinity of the burner for safety, and so that anyone who is servicing the burner can be sure that the switch remains off. For these reasons it is advantageous to include a reset switch 24 in addition to the main switch 20, with this reset switch being in circuit in series with the fluid-temperature-sensing thermostat 22. In some installation the reset switch 24 is located in the living quarters adjacent to a room thermostat which is responsive to the temperature of the living quarters, and the reset switch 24 may be incorporated as part of the room thermostat control. Advantageously, this reset switch 24 may comprise an emergency shut-off switch which is now-existent in many homes at a convenient location remote from the burner, thus enabling this existing switch to reset the control system 11.

The above discussion reviewed (1) normal operation of the burner and (2) failure of the burner to ignite. A third possibility is that the burner becomes extinguished after proper combustion has occurred for a while and during the time while the fluid-sensing thermostat 22 is still calling for heat. In this event the heat sensor 12 cools off so as to open its contacts 38. Then, after the time-delay period has passed the switch 14 energizes the warning signal and deenergizes the relay 16 so as to shut off the electrical circuit to the burner.

A fourth possible chain of events involves the failure of a component of the control system 11. Should the heater 43 burn out or should contacts 40 remain open or should relay coil 46 become open-circuited, then the burner 10 could not be initially energized, because the relay contacts 49 cannot become closed. These contingencies all lead to a fail-safe result. Should the heat sensor 12 fail to operate, then its contacts 38 remain open, and at the end of the time-delay period, the switch 14 shuts off the burner and actuates the alarm, which is a fail-safe result.

Lastly, should the electrical power fail, then the control circuit 11 automatically resets itself in readiness to start the burner as soon as the electrical power is restored. Cessation of the electrical power has the effect of opening the relay contacts 49 while allowing the heat sensor 12 and the time-delay switch 14 to return to or to remain in their initial ready positions as shown in FIGURE 1. This is an automatic, safe, and convenient result.

Although domestic oil burners have been discussed, it will be appreciated that the control system 11 may be adapted as a safeguard and convenience for use with other types of fuel burners and for commercial and industrial applications, involving burners.

In the control circuit of FIGURE 1, it is to be understood that the warning device may be connected to the normally closed contacts 62 of the relay 16. It is noted that the warning device 18 is shown as being an integral part of the control system unit, which is surrounded by

the dotted line 64. This unit 64 may be included in a casing adapted to be connected in a suitable place on the furnace so that the thermostatic element 37 of the flame sensor responds to the heat of combustion, for example, the unit 64 is mounted on the side of the burner stack duct with the sensing element 37 projecting into the stream of exhaust gases passing through the duct.

In the control circuit 11 of FIGURE 1 the contacts 38 of the stack-switch sensor 12 are in circuit in shunt with the heater element 43. It is possible to disconnect the lead 39 from the point A and to reconnect the lead 39 to the point B so that the contacts 38 are in shunt with both the heater 43 and the normally-closed time-delay contacts 40, as is shown by the dotted line 39'. With this 39' connection arrangement the contacts 38 are effectively in shunt with the heater 43 and so the B-connection 39' will operate almost as well as the A-connection 39. The A-connection 39 is preferred for the reason that it is more reliably fail-safe than the B-connection 39'. When using the B-connection 39', there is a remote possibility of an undesired coincidence, namely, that the stack switch contacts 38 might close themselves just at the end of the time-delay period when the contacts 40 are about to be opened. In this unlikely coincidence situation the stack switch contacts 38 would remain closed, thus maintaining the burner in operation, even though the contacts 41 have now become closed so as to produce a warning signal. Thus, the homeowner might be induced to operate the reset switch, or to make a telephone call asking for service for the burner, even though the burner itself is actually continuing to function satisfactorily. This coincidence of closure and opening can be avoided by making the time-delay period assuredly longer than the closure period of the stack-switch contacts 38. However, the A-connection 39 places the contacts 40 in series with the contacts 38 and thus closure of the stack-switch contacts 38 will maintain the burner in operation only if the contacts 40 remain closed, thus avoiding any possibility for this coincidence to occur.

It is to be noted that either the A-connection 39 or the B-connection 39' places the contacts 38 effectively in shunt with the heater element 43, but the A-connection 39 is preferred for the reasons discussed immediately above.

The system 11A of FIGURE 2 is identical with the system of FIGURE 1, except that the warning signal apparatus 18 is connected in series with a pair of normally closed contacts 62 which are operated by the magnetic relay 16. As long as the relay 16 is energized, then the contacts 62 are held open so that the warning apparatus 18 remains de-energized. One other difference between the system 11A and system 11 is that the circuit means 51 may have the warning device omitted therefrom.

Before describing the system of FIGURE 3 in detail it is to be noted that there are two common types of ignition systems generally utilized in domestic oil burners. One is termed constant ignition, wherein the ignition transformer continually produces a spark to ignite the oil during the whole of each time period that the burner is in operation. The second type of ignition system is variously termed as interrupted or intermittent ignition. In this second type the ignition circuit operates for a short initial time period so as to initiate combustion. After this initial time period has passed, the transformer of the ignition circuit is turned off and the combustion in the burner continues by being self-sustaining.

The control system 11B shown in FIGURE 3 is generally similar to the system 11 of FIGURE 1 and similar to the system 11A of FIGURE 2, except that a second magnetic relay 68 is included having a coil 69 connected in parallel with the heater 43. This relay 68 includes a pair of contacts 70 which are in circuit connected between the burner terminal 50 and another terminal 72, which is designated as the terminal for connection to an ignition circuit 74 of the burner.

The operation of the control system 11B is generally the same as the systems 11 and 11A, except for the control of the ignition circuit 74, and hence only the additional functions will be described.

Whenever the heater 43 is energized (which occurs during the initial phase of each normal burner starting operation) then the relay coil 69 is also energized so as to close the contacts 70, thus supplying electricity to the ignition circuit 74. When the heat sensor contacts 38 close upon detection of a rise in temperature, then the relay coil 69 is by-passed, resulting in the opening of contacts 70 to produce de-energization of the ignition circuit 74 and the burner continues self-sustaining combustion until the thermostat 22 has been satisfied.

Should a flame-out occur during operation, the cooling of the heat sensor 12 causes its contacts 38 to open, thereby energizing both the heater 43 and relay coil 69.

The ignition circuit 74 becomes re-energized and the ignition spark continues during the time-delay period while the heater 43 remains energized and while the contacts 40 are still closed. If the flame is re-established, during this period, then the system 11A reverts back to its normal operation with the burner continuing self-sustaining combustion until the thermostat 22 has been satisfied. However, if the flame is not re-established, then the the time-delay switch closes its contacts 41 and opens its contacts 40 so as to provide a warning signal and to de-energize the burner terminal 50, thus shutting off the whole burner including a shut-off of the ignition circuit 74.

It is is be noted that the relay coil 69 and the heater 43 are shown in parallel, but the circuit can also be made to operate with the relay coil 69 in series with the heater 43. The parallel arrangement is preferred because it avoids any balancing of the series circuit so as to assure proper current values through these two components. In the parallel connection as shown the relay coil 69 is arranged to have a sufficiently high electrical impedance relative to the heater 43 for assuring adequate current flow through the heater, thus providing fail-safe operation.

The sensor 37 which responds to energy resulting from combustion may be a photoconductive material which provides a very high resistance in the absence of light energy. This high resistance is equivalent to the presence of open contacts 38. When light energy from the combustion flame is present, then this photoconductive material provides a very low resistance, which is equivalent to closure of the contacts 38 so as to by-pass the time-delay element 43. Thus, it is to be understood that the purpose of the combustion energy sensor 12 is to by-pass current around the time-delay element 43 when combustion is present, and so the use of photoconductive material is equivalent to heat sensing means 37 plus contacts 38. In installations wherein it is desired to use a minimum time-delay period of the order of 10 seconds or so, for example, in larger furnaces wherein the fuel comsumption rate is above 5 gallons per hour, then it is an advantage to use such photoconductive material as the combustion energy sensor 12, because it provides a more rapid response to the presence of proper combustion than does a thermostat probe in the exhaust duct. In this way the burner is de-energized very soon after failure to ignite or after extinguishing of the flame, and so only a minimum amount of unburned oil is introduced into the burner. The amount of unburned fuel which is introduced when combustion is not present but fuel is being pumped to the burner is a function of the product of time-delay period times fuel consumption rate, and hence the desire for rapid response is more urgent in larger burner installations.

It is noted that the circuit means 51 may include a resistor 75 in parallel with the warning device 18. This resistor 75 serves to maintain the time-delay switch 14 electrically locked in the burner-deenergized condition

by maintaining current flow through the time-delay means **43** even though the warning device **18** may become burned out. Thus, it is seen that the circuit means **51** provides the function of electrically locking the system in the condition wherein the burner remains de-energized, until current flow through the circuit including elements **43** and **51** is interrupted.

From the foregoing it will be understood that the oil burner stack switch control systems described herein as illustrative embodiments of the present invention are well suited to provide the advantages set forth and that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense and that in certain instances some of the features of the invention may be used without a corresponding use of other features or may be modified into equivalent elements, all without departing from the scope of the invention as defined by the following claims.

What is claimed is:

1. A safety oil burner control for controlling the operation of an oil burner system and for de-energizing the burner in the event of malfunction of the system, said control comprising at least three terminals, one of these terminals being designated the burner terminal and being adapted to be connected to the oil burner, another of these terminals being designated the thermostat terminal and being adapted to be connected through a thermostat to one side of a source of electrical power, another of these terminals being designated a ground terminal and being adapted to be connected to the opposite side of the electrical source from the thermostat terminal; an electrical relay having normally open contacts and a coil for closing said contacts in response to a flow of electrical current through said coil, said relay contacts being in circuit between said thermostat terminal and said burner terminal for interrupting the supply of electrical power to said burner terminal when said relay contacts are open; a time-delay thermally-actuated switch having normally open and normally closed contacts and a resistance heating element for closing the normally open contacts and for opening the normally closed contacts after an appropriate time delay, said heating element, said normally-closed contacts of the time-delay switch and said relay coil being in a first circuit in series relationship between said thermostat terminal and said ground terminal; combustion energy responsive means being effectively shunted across said heating element for by-passing electrical current around said heating element when said combustion-energy responsive means is actuated by energy resulting from combustion; and a warning device, said heating element, said normally-open contacts of the time-delay switch and said warning device being in a second circuit in series relationship between said thermostat terminal and said ground terminal, said second circuit conducting electrical current actuating said warning device and keeping said heating element heated for maintaining said normally-open contacts in their closed position after said normally-open contacts have closed.

2. A safety oil-burner stack switch control system comprising a burner control terminal adapted to be connected to an oil burner; first and second power connections adapted to be connected to opposite sides of a source of electrical power; an electrical relay having normally open contacts and a coil for closing said contacts in response to a flow of electrical current through said coil, said relay contacts being in circuit with said burner control terminal for interrupting the supply of electrical power to said burner terminal when said relay coil is de-energized; a fluid-temperature-sensing thermostat having normally open contacts and means for closing said contacts upon a drop in temperature of the fluid to a set limit; a reset switch having normally closed contacts and manually operable control means for opening said reset contacts; a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner, said stack-switch contacts and said relay coil and said thermostat contacts and said remote reset switch contacts being in circuit in series between said first and second power connections; a time-delay thermally-actuated switch having normally open and normally closed contacts and a resistance heating element for closing the normally open contacts and for opening the normally closed contacts after an appropriate time delay, said heating element, said normally-closed contacts, said relay coil, said thermostat contacts and said remote reset contacts being in circuit in series between said first and second power connections; circuit means connecting said stack-switch contacts effectively in shunt relationship with said heating element for by-passing current around said heating element when said stack-switch contacts are closed; and electrically conducting circuit means connected in said system in series with said heating element for energization of said heating element when said normally-open contacts of said time-delay switch are closed maintaining said heating element heated for maintaining said normally-open contacts closed.

3. A safety oil-burner stack switch control system comprising a burner control terminal adapted to be connected to an electrical circuit of an oil burner for controlling the burner and for de-energizing the burner in the event of malfunction in the system, an electrical relay having normally open contacts and a winding for closing said contacts in response to a flow of electrical current through said relay winding, said contacts being in circuit in serial relationship with said control terminal for interrupting the supply of electrical power to the burner terminal whenever said contacts are open, a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner, said stack-switch contacts and said relay winding being in circuit in serial relationship, a time-delay thermally-actuated switch having normally open contacts and also having normally closed contacts and a resistance heating element for closing the normally open contacts and for opening the normally closed contacts after an appropriate delay time, first circuit means connecting said heating element and said normally closed contacts in serial relationship with said relay winding with said stack-switch contacts in circuit in shunt relationship with said heating element, and second circuit means including a warning device connecting said resistance element and said normally open contacts in circuit relationship with said warning device, said second circuit means maintaining said resistance element heated sufficiently upon closure of said normally-open contacts to maintain said normally-open contacts closed.

4. A safety oil-burner stack-switch control system controlling the operation of an oil burner and for de-energizing the burner in the event of malfunction; said control system comprising at least three connections, one of these connections being the burner connection and being adapted to be connected to the oil burner, another of these connections being the line connection and being adapted to be connected to the "hot" side of a source of electrical power, another of these connections being a ground connection and being adapted to be connected to the opposite side of the electrical source from the line connection; a remotely located switch having contacts and switch means for opening said contacts; a fluid-temperature sensing thermostat having normally open contacts adapted to be closed by a drop in temperature of the fluid to a set value; circuit means for connecting said remotely located switch and said thermostat contacts in serial relationship between the hot line and said line connection; an electrical relay having normally open contacts and a coil for closing said contacts in response to a flow of electrical current through said relay coil, said relay contacts being in

circuit between said line connection and said burner connection for interrupting the supply of electrical power to said burner connection when said relay coil is de-energized; a time-delay thermally-actuated switch having normally closed contacts and electrically actuated opening means for opening the normally-closed contacts after an appropriate time delay, said opening means, said normally-closed contacts of the time-delay switch and said relay coil being in circuit in serial relationship between said line connection and said ground connection; a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner, said stack-switch contacts being effectively shunted across said opening means for by-passing electrical current around said opening means when said heat-responsive means of the stack switch is warmed from the heat of combustion, and circuit means maintaining current flow through said opening means maintaining said normally-closed contacts open when the time-delay period elapses before said stack switch contacts become closed.

5. A safety oil burner control system for controlling the operation of an oil burner and for de-energizing the burner in the event of malfunction; said control system comprising at least three connections, one of these connections being the burner connection and being adapted to be connected to the oil burner, another of these connections being the line connection and being adapted to be connected to the "hot" side of a source of electrical power, another of these connections being a ground connection and being adapted to be connected to the opposite side of the electrical source from the line connection; a remotely located switch having contacts and switch means for opening said contacts; a fluid-temperature-sensing thermostat having normally open contacts adapted to be closed by a drop in temperature of the fluid to a set value; circuit means for connecting said remotely located switch contacts and said thermostat contacts in serial relationship between the hot line and said line connection; an electrical relay having normally open contacts and a coil for closing said contacts in response to a flow of electrical current through said relay coil, said relay contacts being in circuit between said line connection and said burner connection for interrupting the supply of electrical power to said burner connection when said relay coil is de-energized; a time-delay switch having normally closed contacts and normally open contacts and delay means for opening the normally-closed contacts and for closing the normally-open contacts after an appropriate time delay, and for maintaining said normally-open contacts closed solely by the flow of electrical current through said delay means, said delay means, said normally-closed contacts of the time-delay switch and said relay coil being in circuit in serial relationship between said line connection and said ground connection; combustion energy responsive means having normally open circuit condition and being placed in closed circuit condition in response to energy resulting from combustion in said burner, said combustion-energy responsive means being effectively shunted across said delay means for by-passing electrical current around said delay means when said combustion energy responsive means is actuated by energy resulting from combustion; and circuit means connected in serial relationship with said normally-open contacts of said time-delay switch and said delay means between said line connection and said ground connection for electrically locking said time-delay switch with said normally-open contacts closed by maintaining current flow through said delay means.

6. A safety oil-burner stack switch control system comprising first, second, and third terminals, said first terminal being adapted to be connected to an oil burner, said second and third terminals being adapted to be connected to opposite sides of a source of electrical power, a warning device, a thermostat switch, an electrical relay having normally open contacts and a coil for closing said contacts in response to a flow of electrical current through said coil, said contacts being in circuit in series with said first terminal for interrupting the supply of electrical power to said first terminal when said contacts are open, a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner, said stack-switch contacts, said relay coil, and said thermostat switch being in circuit in series between said second and third terminals, a time-delay thermally-actuated switch having normally open and normally closed contacts and a resistance heating element for closing the normally open contacts and for opening the normally closed contacts after an appropriate time delay, said resistance element and said normally closed contacts being in series and being shunted across said stack-switch contacts, and circuit means connecting said warning device, said resistance element and said normally open contacts in series shunted across both said stack-switch contacts and said relay coil, said circuit means maintaining said resistance element heated sufficiently to maintain said normally-open contacts closed.

7. A safety oil-burner stack switch control system comprising a burner control terminal adapted to be connected to an oil burner; first and second power connections adapted to be connected to opposite sides of a source of electrical power; an electrical relay having normally open contacts and a coil for closing said contacts in response to a flow of electrical current through said relay coil; a fluid-temperature-sensing thermostat having normally open contacts and means for closing said contacts upon a rise in temperature of the fluid to a set limit; a remote reset switch having contacts and manually operable control means for opening said reset contacts; first circuit means connecting said remote reset contacts, said thermostat contacts, and said relay contacts in serial relationship between said first power connection and said burner control terminal for de-energizing the burner when any of the aforesaid contacts are open; a time-delay switch having normally open and normally close contacts and delay means for closing the normally open contacts and for opening the normally closed contacts after an appropriate time delay; second circuit means connecting said remote reset contacts, said thermostat contacts, said delay means, said normally-closed contacts of the time-delay switch, and said relay coil in serial relationship between said first and second power connections; a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner; third circuit means connecting said stack-switch contacts effectively in shunt relationship with said delay means for by-passing current around said delay means when said stack-switch contacts are closed; a warning device; and fourth circuit means connecting said warning device between said normally-open contacts of the time-delay switch and said second power connection, said fourth circuit means actuating said delay means to maintain said normally-open contacts closed.

8. A safety oil-burner stack switch control system comprising a burner control terminal adapted to be connected to an oil burner; first and second power connections adapted to be connected to opposite sides of a source of electrical power; an electrical relay having normally open contacts and also normally closed contacts and a coil for closing said normally-open contacts and for opening said normally-closed contacts in response to a flow of electrical current through said relay coil; a fluid-sensing thermostat having normally open contacts and means for closing said contacts upon a rise in temperature of the fluid to a set limit; a remote reset switch having contacts and manually operable control means for opening said reset contacts; first circuit means connecting said remote

reset contacts, said thermostat contacts, and said normally-open relay contacts in serial relationship between said first power connection and said burner control terminal for de-energizing the burner when any of the aforesaid contacts are open; a time-delay switch having normally open and normally closed contacts and delay means for closing the normally open contacts and for opening the normally closed contacts after an appropriate time delay; second circuit means connecting said remote reset contacts, said thermostat contacts, said delay means, said normally-closed contacts of the time-delay switch, and said relay coil in serial relationship between said first and second power connections; a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner; third circuit means connecting said stack-switch contacts effectively in shunt relationship with said delay means for by-passing current around said delay means when said stack-switch contacts are closed; a warning device; fourth circuit means connecting said warning device between said normally-open contacts of the time-delay switch and said second power connection, said fourth circuit means conducting sufficient current maintaining said delay means actuated to maintain the normally-open contacts closed; and a terminal connected to said normally-closed relay contacts adapted to be connected to a remote warning device.

9. A safety oil burner stack switch control system comprising a burner control terminal adapted to be connected to an electrical circuit of an oil burner for controlling the burner and for de-energizing the burner in the event of malfunction in the system, an electrical relay having normally open contacts and a winding for closing said contacts in response to a flow of electrical current through said relay winding, said contacts being in circuit in serial relationship with said control terminal for interrupting a supply of electrical power to the burner terminal whenever said contacts are open, a stack switch having normally open contacts and heat-responsive means for closing said stack-switch contacts in response to heat of combustion in said burner, said stack-switch contacts and said relay winding being in circuit in serial relationship, a time-delay thermally-actuated switch having normally open contacts and also having normally closed contacts and a resistance heating element for closing the normally open contacts and for opening the normally closed contacts after an appropriate delay time, first circuit means connecting said heating element and said normally closed contacts in serial relationship with said relay winding, with said stack-switch contacts in circuit in shunt relationship with said heating element, and second circuit means for connecting said resistance heating element and said normally open contacts in serial relationship with a supply of electrical power for maintaining said heating element heated sufficiently to maintain said normally-open contacts closed for electrically locking said time-delay switch with said normally-open contacts closed, thereby to maintain said burner de-energized.

10. A safety oil-burner control for electrically de-energizing an oil burner in the event of malfunction of the burner and for electrically locking the burner in its de-energized condition until the system is conveniently reset by interrupting the flow of electricity in the system, said safety control including relay means having a set of normally open contacts and a terminal connected thereto for electrically energizing the burner in response to energization of said relay means and for de-energizing the burner in response to de-energization of said relay means, time-delay switch means having first and second conditions of operation and being connected to said relay means for energizing said relay means during a time-delay period while said time-delay switch means is in said first condition and electrical resistance heating means thereafter switching said time-delay switch means into its second condition, circuit means connected to said time-delay switch means for maintaining said resistance heating means heated sufficiently to maintain said time-delay switch means in said second condition, combustion energy sensing means connected in circuit with said relay means for effectively shunting said time-delay switch means in response to the presence of combustion in said burner for maintaining energization of said relay means, and a second terminal connected in circuit with said time-delay switch means for being connected to remote reset control means for interrupting the flow of electricity in said resistance heating means thereby to reset said time-delay switch means in the first condition in readiness for attempting to initiate proper operation of the burner.

11. A safety oil-burner control for controlling the ignition circuit of an oil burner and for electrically de-energizing an oil burner in the event of malfunction of the burner and for electrically locking the burner in its de-energized condition until the system is conveniently reset by interrupting the flow of electricity in the system, said safety control including first relay means having a terminal connected thereto for being connected to an oil burner for electrically energizing the burner in response to energization of said first relay means and for de-energizing the burner in response to de-energization of said first relay means, time-delay switch means having first and second conditions of operation and electrical resistance heating means, said time-delay switch means being connected to said relay means for energizing said first relay means during a time delay period while said time-delay switch means is in said first condition and said heating means thereafter switching said time-delay switch means into its second condition, circuit means connected to said time-delay switch means for electrically heating said heating means sufficiently to maintain said time-delay switch means in said second condition, combustion energy sensing means connected in circuit with said first relay means for effectively shunting said time-delay switch means in response to the presence of combustion in said burner for maintaining energization of said first relay means, and, second relay means connected to said time-delay switch means, said second relay means having a second terminal connected thereto for being connected to the ignition circuit of the burner for energizing the ignition circuit when said time-delay switch means are energized in the first condition, and a third terminal in circuit with said time-delay switch means for being connected to remote reset control means for interrupting the flow of electricity in said time-delay switch means, thereby to reset said time-delay switch means in the first condition in readiness for attempting to initiate proper operation of the burner.

12. A safety oil burner control comprising a burner control terminal adapted to be connected to an electrical circuit of an oil burner for controlling the burner and for de-energizing the burner in the event of malfunction in the system, a warning terminal adapted to be connected to a warning device for providing a warning signal when said warning terminal is energized, an electrical relay having normally open contacts and a winding for closing said contacts in response to a flow of electrical current through said relay winding, said contacts being in circuit in serial relationship with said control terminal for interrupting a supply of electrical power to said control terminal whenever said contacts are open, said relay also having normally closed contacts in circuit in serial relationship with said warning terminal for closing an electrical circuit to said warning terminal when said relay winding is de-energized, a combustion sensor having normally open circuit condition and heat-responsive means for closing said open circuit condition in response to combustion in said burner, said combustion sensor and said relay winding being in circuit in serial relationship, a time-delay thermally-actuated switch having normally open contacts and also having normally closed contacts and a resistance

heating element for closing the normally open contacts and for opening the normally closed contacts after an appropriate delay time, first circuit means connecting said heating element and said normally closed contacts in serial relationship with said relay winding and connecting said combustion sensor in circuit in shunt relationship with said heating element, and second circuit means for connecting said resistance element and said normally open contacts in serial relationship with a supply of electrical power for electrically heating said resistance element sufficiently to maintain said time-delay switch with said normally-open contacts closed, thereby to maintain said burner de-energized.

13. A safety oil-burner control for electrically de-energizing an oil burner and for electrically locking the burner in its de-energized condition comprising relay means having a relay winding for de-energizing the burner, thermal time-delay switch means having a resistance heater, a normally closed switch and a heat-responsive element opening said switch after a time-delay period in response to the heat from said heater, said relay winding being connected to said normally closed switch, combustion energy sensing means connected in shunt relationship to said heater, said sensing means being normally open-circuit in the absence of combustion and becoming closed-circuit when combustion is present, said sensing means effectively by-passing said heater when combustion is present, and circuit means maintaining current flow through said heater when said normally closed contacts are opened for solely electrically locking said normally closed switch open to de-energize the burner, by all of which the burner can be remotely reset into energized condition by interrupting said circuit means to stop current flow through said heater.

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JAMES W. WESTHAVER, *Primary Examiner.*