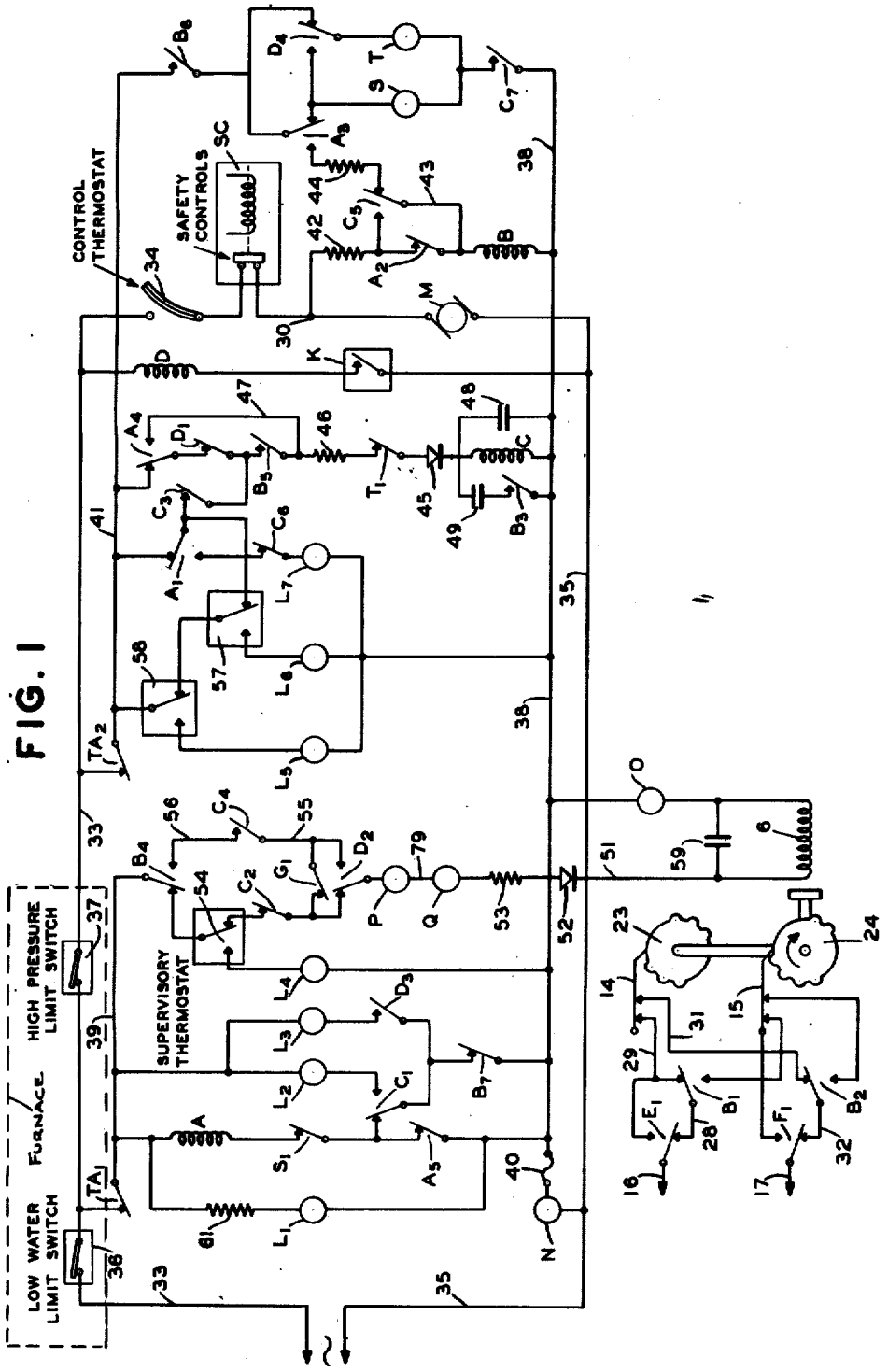
Sept. 24, 1957 F. C. EVANS ET AL 2,807,318

SUPERVISORY SIGNAL SYSTEM FOR AUTOMATIC FUEL BURNER

Filed Dec. 2, 1953 2 Sheets-Sheet 1

FIG. 1



SUPERVISORY SIGNAL SYSTEM FOR AUTOMATIC FUEL BURNER

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FIG. 2

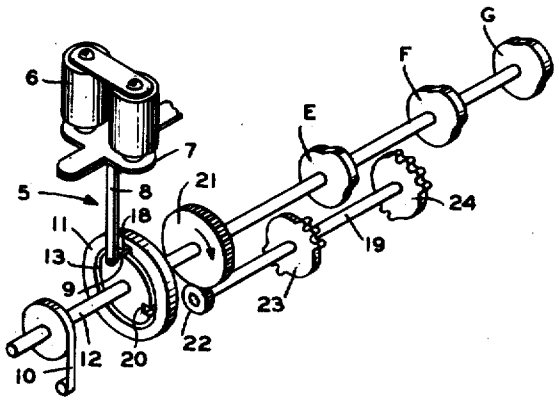
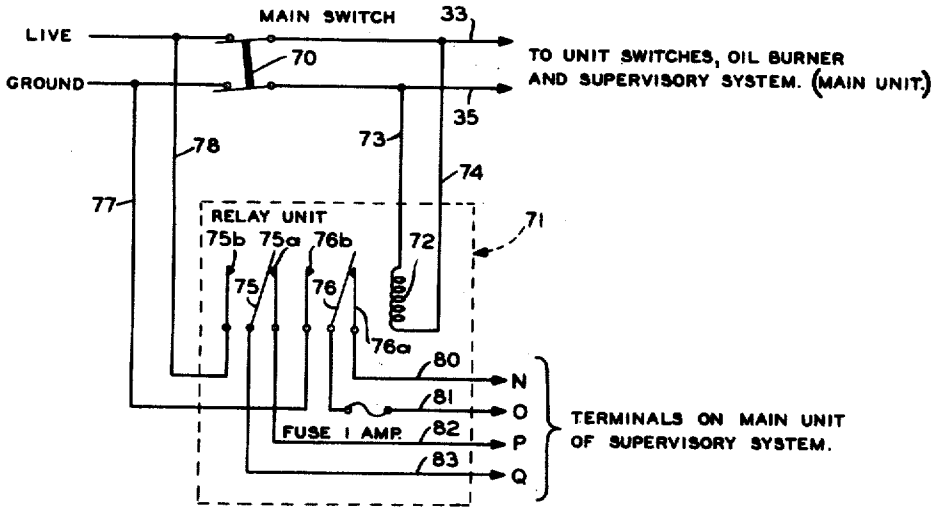


FIG. 3



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SUPERVISORY SIGNAL SYSTEM FOR AUTOMATIC FUEL BURNER

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This invention relates to supervisory signaling systems and more particularly to a system for supervising the operation of automatic fuel burners.

In the operation of fuel burners, conditions of a dangerous nature may sometimes arise. Though burner systems are customarily provided with safety devices that cause the system to shut down upon the occurrence of a malfunction, the possibility exists that these devices might not function properly. Also, it is often desirable to supervise a number of burners from a central point. The present invention is directed to the general type of system that will supervise the burner control apparatus and, upon the detection of an abnormal condition, transmit a signal to a central control point.

Various abnormal conditions that a supervisory system may be designed to respond to may be conveniently classified into "trouble" conditions and "hazardous" conditions. Those of the former are as follows: (*a*) the burner shuts down through the action of its own controls because the flame has disappeared for some accidental reason, i. e., a safety shut-down; (*b*) a failure in the source of power for a predetermined period of time; (*c*) the control thermostat fails to call for heat; (*d*) the thermostat's call for heat does not start the burner; (*e*) the burner shuts down due to the operation of the low water limit switch; (*f*) the burner shuts down due to the operation of the high pressure limit switch.

Conditions that may be classified as "hazardous" are as follows: (*a*) the burner fails to shut down within a predetermined period after the flame has disappeared for some accidental reason or the combustion detector fails to operate with the flame on; (*b*) excessive pressure and the burner does not shut down; (*c*) low water level in the boiler and the burner does not shut down; (*d*) the contacts of the burner's combustion detector fail to open when the burner shuts down and the controls do not prevent the oil burner from starting again under this condition.

Accordingly, it is an object of this invention to provide an improved supervisory system wherein code signals are transmitted in accordance with abnormal conditions in a fuel burning unit.

Another object of this invention is to provide means at the supervised unit to indicate the particular abnormal condition present.

Another object of the invention is to provide for the normal shutting down of the supervised unit without transmission of a power failure signal.

These and other objects of the invention will become apparent from the following description taken in conjunction with the accompanying drawings in which—

Fig. 1 is a schematic circuit diagram of the supervisory signaling system;

Fig. 2 is a representation of the transmitter unit employed with the present system, and

Fig. 3 is a schematic circuit diagram of a relay unit associated with the main power switch of the burner unit.

Supervisory systems contemplated by the present invention are especially suitable for use with automatic fuel burners utilizing fluid fuel. In the present illustrative disclosure, the apparatus is shown in conjunction with an automatic oil burner system. This invention is suitable for use with fuel burners utilizing other fluid fuels, such as gases as well as other liquid fuels. A conventional burner system, as will be more fully pointed out hereinafter, includes a furnace, indicated diagrammatically, having a burner motor M. The present invention will be described in detail as used with such a system. However, the burner system may include other elements. For example, in a burner system utilizing a gaseous fuel the electrical controls of a valve may take the place of motor M in the circuit; the valve being located in the gas feed line. Furthermore, as will be apparent, certain features of the present invention render use of the same highly desirable in connection with still other types of fuel burners such as those utilizing solid fuels.

Referring now to Figs. 1 and 2, **5** indicates a transmitter of a well known type wherein a holding coil **6** selectively releases to permit code wheels to interrupt a circuit. The holding coil **6** has an armature **7** with a depending portion **8** and a cam follower **9** secured to the lower end thereof. A cam wheel **11** fixed on a shaft **12** has a cam slot **13** cut in one face. The outer wall of the slot **13** has a recess **18** adapted to receive the cam follower when holding coil **6** is energized thereby preventing rotation of shaft **12**. When the holding coil is deenergized, the armature falls by gravity out of recess **18** to permit a conventional spring motor **10** to rotate the shaft in the direction indicated. A second recess **20** is located in the inner wall of the cam slot approximately 240° from recess **18** in the direction of rotation. A gear **21** secured to shaft **12** meshes with a gear **22** fixed to shaft **19**. The ratio of gear **21** to gear **22** is approximately three to one. Code wheels **23**, **24** are fixed on shaft **19** while cams E, F and G are fixed on shaft **12**.

With the transmitter in the initial position shown, the release of coil **6** will allow cam follower **9** to fall out of recess **18** into slot **13** to permit rotation of the code wheels and cams. After 240° of rotation, the cam follower will be received by recess **20** to arrest rotation. During this time, the code wheels will have completed two revolutions. Upon reenergization of the holding coil, cam follower **9** will be retracted from recess **20** to permit 120° rotation of shaft **12** until recess **18** is again aligned with the cam follower, at which point rotation is again stopped. This second rotation of shaft **12** will rotate the code wheels through one revolution whereby a restoration signal is transmitted as will become apparent hereinafter.

Each code wheel **23** and **24** is provided with a distinctive group of teeth or projections, so disposed as to actuate contact members **14** and **15** respectively upon rotation. Contacts B1 and B2 controlled by a circuit hereinafter described selectively connect members **14** and **15** to transmission lines **16** and **17** which extend to a central supervisory station. Actuation of member **14** by code wheel **23** causes a circuit including lines **16** and **17** to be interrupted in accordance with the number and spacing of the teeth on the code wheel, resulting in the transmission of a signal herein designated a trouble signal. Similarly, actuation of member **15** results in the transmission of a hazard signal over lines **16** and **17**. With contacts B1 and B2 in the position shown, contact member **14** completes a circuit from line **16**, contact E1 in the down position, wire **28**, contact B1, wire **29**, contact member **14**, wire **31**, contact B2, wire **32**, contact F1 in the down position to line **17**. Similarly, with

contacts B1 and B2 in the downward position, contact member 15 completes the transmission circuit.

Contacts E1, F1 are controlled by cams E and F respectively in such a manner that with the transmitter in the initial position and during the first 240° rotation of shaft 12, these contacts are in the downward position and during the next 120° of rotation in the upward position.

It is seen, therefore, that when holding coil 6 deenergizes, contacts E1 and F1 are in the downward position and contacts B1 and B2 determine whether contact member 14 completes the circuit of lines 16, 17 resulting in the transmission of a trouble signal or contact member 15 completes the transmission circuit resulting in a hazard signal. Reenergization of coil 6 will cause the restoration signal to be transmitted which comprises the interruptions caused by one revolution of code wheel 23 since contacts E1 and F1 are in the upward position at this time regardless of whether a trouble or hazard signal had been transmitted.

The burner motor M is energized from a source of power over line 33, two limit switches 36 and 37, control thermostat 34, safety control unit SC and line 35. The limit switches comprise a low water cut-off switch 36 and a high pressure cut off switch 37 which along with the control thermostat 34 and burner motor M form part of the system to which the present supervisory system is connected. These elements are of conventional construction and hence have been shown diagrammatically. The thermostat 34 is located in the controlled premises and is adapted to close its contacts when the temperature drops below a predetermined minimum to complete the burner circuit.

Throughout the description and drawings, the various relay contacts are designated by a letter and a number, the letter corresponding to the relay coil controlling the particular contact. Also, throughout Fig. 1 of the drawings, all contacts and switches are shown in the position they assume with the main source of power connected to the system and the burner motor deenergized due to the open contacts of the control thermostat.

A relay D is connected in series with a combustion detector K across lines 33 and 35. The combustion detector may be of any well known type such as a thermostatic heat detector that closes its contacts upon satisfactory ignition and combustion of fuel.

The various elements of the supervisory system are supplied with power over line 38 connected to power line 35 through fuse 40, and terminal N, and lines 39 and 41 connected to power line 33 through tamper switches TA1 and TA2 respectively. The tamper switches are constructed to open their contacts when the cabinet in which the equipment is housed is opened.

A reset timer S connects with line 38 through relay contact C7 and with line 41 through relay transfer contacts A3 and B6. A second reset timer T connects with line 38 through relay contact C7 and with line 41 through relay transfer contacts D4 and B6. These timers are motor operated and of a commercially available type wherein the timer starts to run upon energization of the motor. At the end of the time interval for which the timer is set it closes a contact and becomes stalled. If at any point the power is removed from the motor, the timer will reset to its initial position. A relay B connects to line 38 and through contact A2 and resistor 42 to junction 30.

With the control thermostat open as shown, relay B is deenergized. A wire 43 connects relay B with transfer contacts C5, which in the left position causes contacts A2 to be by-passed and in the right position connects with transfer contacts A3 through resistor 44.

Relay C connects to line 38 and to line 41 through the following circuit: rectifier 45, contact T1 of timer T, resistor 46, contact B5 of relay B, contact D1 of relay D and transfer contacts A4 of relay A. Wire 47 connects the junction of contact B5 and resistor 46 to one contact of transfer contacts A4. Relay C is paralleled by a filter capacitor 48 and a capacitor 49 in series with contact B3. The purpose of capacitor 49 is to effect a time delay in the release of relay C for a reason which will become apparent later in the description of the operation of the system. The transmitter coil 6 is connected to line 38 through terminal O and to line 39 through the following circuit: wire 51, rectifier 52, resistor 53, terminal Q, jumper 79, terminal P, transfer contacts D2 of relay D, contact C2 of relay C, supervisory thermostat 54 and transfer contacts B4 of relay B. The section of the latter circuit comprising contact C2 and thermostat 54 is paralleled by wire 55, make contact C4 and wire 56. Contact G1 connects these parallel circuits as shown and is controlled by cam G fixed on the transmitter shaft 12. Supervisory thermostat 54 is preferably located near control thermostat 34 and is set to actuate its transfer contacts at a temperature somewhat below that at which control thermostat 34 is set. Similarly, low water supervisory switch 57 and high pressure supervisory switch 58 are provided to supervise the operation of low water limit switch 36 and high pressure limit switch 37 respectively. The actuation of each of these switches will cause its transfer contacts to actuate to complete a circuit through their respective indicating lamps L6 and L5. Transmitter coil 6 is shunted by a capacitor 59 which provides a delay period when the transmitter energizing circuit is broken.

Relay A connects to line 39 and through contact S1 of timer S and contact A5 of relay A to line 38. A series combination of light L1 and resistor 61 connects directly to lines 38 and 39 whereby the light is normally energized when the power is on. Contact A5 is paralleled by transfer contacts C1 and contact B7.

NORMAL OPERATION

With power applied to the system and the contacts of control thermostat 34 open, the system is in the condition shown in Fig. 1. Relay A is energized through a circuit extending from power line 33, low water limit switch 36, tamper contact TA1, relay A, closed contact S1 of timer S, closed contact A5 of relay A, line 38, fuse 40, terminal N, and power line 35. Transmitter coil 6 is in its energized condition by way of a circuit traced through contacts D2, C2, 54 and B4 to line 39. Relay C is deenergized due to the open contact B5 and transfer contacts A4 in the left position. Relay D is deenergized due to the contact of combustion detector K being open, and relay B is deenergized due to the contact of the control thermostat 34 being open and transfer contacts A3 being in the right position.

Let it be assumed that under these conditions, control thermostat 34 closes its contact, thereby calling for heat. Burner motor M will be connected to power lines 33, 35 and commences to pump fuel to the burner. Relay B is energized and closes contact B5 to energize relay C, and closes contact B6 which, with contact C7 closed by relay C, completes a circuit through the timers S and T to cause them to start running.

If the burner should shut down at this point due to the control thermostat readjusting and opening its contacts, relay B is deenergized opening its contact B5 to deenergize relay C which in turn opens contact C7. The system therefore reverts to its initial condition without producing any unnecessary signaling. The length of time between burner start up and shut down during which no signal is transmitted is determined by the period of timer S. This is the case since after timer S has completed its period contact S1 opens to deenergize relay A. This in turn causes contact A4 to transfer to the right to complete a circuit through relay C that by-passes contact B5. Hence deenergization of relay B and opening of contact B5 after timer S has completed its period does not result in the deenergization of relay C. As

will become apparent later, burner shut down after contact S1 has been opened by timer S does result in the transmission of a signal.

Continuing with the normal start operation, after timer S has run through the period for which it is set, contact S1 opens to break the circuit of relay A which thereupon transfers contact A3 to the left to deenergize timer S. The return of timer S to normal condition does not reenergize relay A since the latter has locked itself out by opening contact A5. The deenergization of relay A also transfers contact A4 to the right and contact A1 to its downward position whereby relay C is maintained energized through rectifier 45, contact T1 of timer T which is still closed since its period has not yet run, resistor 46, contact B5 now closed, contact C3 which is also closed and supervisory switches 57 and 58 to line 41. At this point contact A2 is open but relay B remains energized through contact C5 now in the left position.

As the fuel is fed to the burner, ignition takes place which causes combustion detector K to close its contact to energize relay D. Contacts D4 thereupon transfer to their left position to deenergize timer T which returns to its initial position without having completed its period, so that contacts T1 remain closed.

When the demand for heat is satisfied, control thermostat 34 opens its contact to cut off the supply of fuel to the burner and also deenergize relay B which will open its contacts B5, thereby deenergizing relay C. After the burner flame is extinguished, the contact of the combustion detector K opens on cooling of the detector's heat responsive element to deenergize relay D. Since relay B is deenergized before relay D, contact D1 is still open when contact B5 opens. Therefore, relay C is deenergized upon the opening of contact B5 and locks itself out by opening contact C3. The system is now in its initial position as shown in Fig. 1 with relays B, C and D deenergized and relay A and transmitter coil 6 energized.

TRANSMISSION OF TROUBLE SIGNALS

Considering now the operation of the system upon the occurrence of certain abnormal conditions, it is seen from the description so far that whenever transmitter coil 6 is deenergized, shaft 6 is released to rotate under the influence of spring motor 10 and coded signals are transmitted over lines 16 and 17. Whether the coded signals are trouble signals or hazard signals, depends upon the condition of relay B. When relay B is deenergized its contacts B1 and B2 are in the position shown in Fig. 1 in which case the trouble contact 14 controls the transmitted signals. If relay B is energized, and its contacts B1 and B2 are transferred to their downward position when transmitter coil 6 releases, the hazard contact 15 controls the transmitted signal.

A burner unit of the type for which the present supervisory control system is adapted, employs safety controls that operate to shut down the system by deenergizing the burner motor in the event of certain malfunctions such as failure of the flame to ignite, disappearance of the flame during operation, etc. These safety controls may be of various types, an illustration of one of which is found in Schneider Patent No. 2,293,474. Safety controls of this general type are well known and are disclosed diagrammatically in Fig. 1.

Fuel fails to ignite and the burner shuts down by action of the safety controls.—Should the fuel fail to ignite at the start of operation of the unit, the operation will be the same as described above under the heading "Normal operation" to the point where timer S completes its period and opens contact S1 to deenergize relay A. If the safety controls SC function properly to open the burner motor circuit, relay B is deenergized to open contact B5 and transfer contact B4 back to the left position. However, relay C remains energized because contact B5 is shunted by contacts D1 and A4. It is important to note that at this time contact A4 is in the right position due to the deenergization of relay A when timer S completed its period to open contact S1. If timer S had not completed its period, relay C would not remain energized upon relay B deenergizing, and signals would not be transmitted. It is seen therefore that timer S provides a period during which the system may momentarily cut in and shut off without unnecessary signaling. However, after the period of timer S, relay C remains energized as the safety controls SC open the circuit of relay B. Therefore, transmitter coil 6 is deenergized after a short delay provided by capacitor 59 since contact B4 is in its left position and contact C2 is open. The transmitter shaft 19 is released to rotate the code wheels thereby transmitting a coded signal as previously described. Since relay B is deenergized, contacts B1 and B2 are in the position shown in Fig. 1 and the signal transmitted is a trouble signal. Also, contact B7 is closed and contact C1 is transferred to the right, thereby completing a circuit through lamp L2 which will visually indicate the fault.

If, after this shutdown, the burner system recycles to energize relay B and transfer contact B4 to the right position (contact C4 is closed at this time) the transmitter coil 6 will nevertheless remain deenergized because contact G1 is now open. Contact G1 is controlled by cam G and is closed only when the transmitter is in its normal position as shown in Fig. 2. The transmitter will therefore remain in the trouble condition. If, however, upon recycling, the fuel should ignite and the combustion detector K close its contact to energize relay D, contact D2 transfers to the right. The transmitter will thereupon reenergize through contact D2, wire 55, contact C4 (now closed by energization of relay C), wire 56 and transfer contact B4 (now in the right position because relay B is energized). This reenergization will retract cam follower 9 from recess 18 to allow rotation of the code wheels and transmission of a restoration signal as previously described.

This arrangement is of particular importance where the burner system recycles by itself after a safety shutdown. The restoration signals are not transmitted upon recycling, but only when the flame appears and normal operating conditions exist.

Flame disappears during normal operation and the burner shuts down by action of the safety controls.—Should the flame disappear for some accidental reason during operation of the burner, the combustion detector K will open its contact thereby opening the circuit of relay D. With the safety controls operating properly, the motor M and relay B will also be deenergized. The detector K and safety controls SC are so adjusted that detector K opens contact before operation of the safety controls. Therefore, relay D being immediately responsive to the combustion detector will close contact D1 before contact B5 opens due to the deenergization of relay B. Hence relay C remains energized through contact A4 in the right position (relay A is deenergized during normal operation) and closed contact D1. The condition of relay C energized and relay B deenergized will cause a trouble signal to be transmitted as described above in regard to the safety shutdown at the start of operation.

Power failure during operation.—Should the power fail during operation, the transmitter is deprived of current and will release to transmit a signal. If the interruption of power is of a duration shorter than the time delay provided by capacitor 59, the transmitter will remain energized. However, an interruption of power of two or three seconds will cause the transmitter to deenergize. Also, relay B will deenergize and then relay C will deenergize. This sequence is assured by capacitor 49 shunted across relay C as long as contact B3 is closed. Since relay B is deenergized at the time the transmitter

releases, contacts B1 and B2 are in the position shown in Fig. 1 to provide a trouble signal. Also, power failure extinguishes lamp L1 which is normally on when power is supplied to the system. When the power is restored, the transmitter will energize and send a restoration signal as hereinbefore described.

Low water or high pressure condition.—With the low water limit switch **36** interposed in the power line **33** as shown, the opening of this switch has the same effect as a power failure. The result of a low water condition opening switch **36** will therefore be a trouble signal as described above in regard to a power failure. The high pressure limit switch **37** can open without affecting the transmitter since it is located in the power line **33** on the load side of the connection to line **39**. Opening of this switch during operation will deenergize relays B and C but this condition of these relays does not deenergize the transmitter coil. Switch **37** may be located in power line **33** on the source side of the connection with line **39** in which case the actuation thereof will result in the transmission of a trouble signal in a manner similar to a power failure.

Control thermostat calls for heat and the burner does not start.—A defect in the system may prevent the burner from responding to a call for heat from the control thermostat. Relays B and C will therefore remain in their initial deenergized condition and their respective contacts will be in the positions shown in Fig. 1. Supervisory thermostat **54**, which is set to open its contacts at a temperature slightly less than control thermostat **34** will transfer its contact to the left position to break the energizing circuit of transmitter coil **6** and complete a circuit through lamp **L4**. The release of coil **6** will transmit a signal which will be controlled by trouble code wheel **23** since relay **B** is deenergized to cause contacts B1 and B2 to assume the position shown. When the defect is cleared, the system will go through the normal start sequence previously described energizing relays B, C and D. In this condition, an energizing circuit for transmitter coil **6** may be traced as follows: from line **38** through terminal O, coil **6**, wire **51**, rectifier **52**, resistor **53**, terminal Q, jumper **79**, terminal P, contact D2 now in the right position (contact G1 is open because the transmitter is not in its initial energized position), contact C4 now closed, wire **56**, contact B4 now in the right position, to line **39**. When coil **6** thus energizes, cam follower **9** is retracted from recess **20** to permit transmission of a restoration signal.

The cabinet in which the system is housed is provided with tamper switches TA1 and TA2 adapted to open their contacts upon opening of the cabinet. When these contacts open the supervisory system including transmitter coil **6** and relay B are deenergized to transmit a trouble signal as hereinbefore described. Closing of these contacts will reenergize the transmitter coil to send the restoration signal.

TRANSMISSION OF HAZARD SIGNALS

The operation of the system when hazard conditions exist to transmit a hazard signal will now be considered.

Fuel fails to ignite and the safety controls fail to shut down the burner.—When the control thermostat calls for heat, motor M is energized to feed fuel into the combustion chamber. Should this fuel fail to ignite, combustion detector K will not close its contacts and the safety controls will normally open the motor circuit to shut down the system. This action also results in the transmission of a trouble signal as previously set forth. However, if the safety controls SC fail to function, the fuel continues to feed to the combustion chamber resulting in a particularly hazardous condition. The system will function as described under the heading "Normal operation" to the point where relay D would normally energize. However, in the present case since the combustion detector K does not close its contact, relay D is not energized. Hence contact D4 remains in the right position, and since contacts B6 and C7 are closed (relays B and C energize at the start of a cycle) timer T remains energized to complete its period and open contact T1. The energizing circuit for relay C is thereby broken to deenergize relay C which locks itself out by opening contact C3 (contact A4 is in the right position at this time) and deenergizes timer T by opening contact C7. Contact C4 also opens to deenergize transmitter coil **6** since contact B4 is in the right position because of energized relay B. Contacts B1 and B2 are in the downward position at this time so that the release of coil **6** results in the transmission of a hazard signal. Relay B locks in through wire **43**, contact C5 in the position shown, contact A3 in the left position (relay A is deenergized because timer S has run through its period) and closed contact B6. This condition also completes a circuit through lamp L7, contact C6, contact A1 (now in the down position), contacts **57** and **58** in the right position to line **41** to energize the lamp thereby indicating the faulted condition. A maintainer will then open the main switch of the burner system and clear the malfunction. When the main switch is thereafter closed, the transmitter will energize to send the restoration signal providing the control thermostat is not calling for heat. If heat is called for, relay B immediately energizes to transfer contact B4 to the right (contact G1 is open because the transmitter is not in the initial position) and the transmitter does no reenergize until contact D2 is transferred to the right when detector K is actuated by ignition of the fuel.

Flame goes out during operation and the safety controls fail to shut down the burner.—Should the safety controls SC fail to open the motor circuit and deenergize relay B to send a trouble signal, disappearance of the flame will result in a hazard signal condition. Combustion detector K opens its contact to deenergize relay D thereby transferring contact D4 to the right position to energize timer T (relay contacts B6 and C7 are closed during normal operation). After timer T runs through its period the operational sequence is the same as described above in regard to the condition when the "fuel fails to ignite and the safety controls fail to shut down the burner."

Low water limit switch fails to respond.—The low water limit switch **36** is set to open and shut down the system upon the supply of water reaching a predetermined minimum. The low water supervisory switch **57** is pre-set to respond to a somewhat lower water level than the limit switch **36**. Should the limit switch fail to respond during normal operation of the burner, the supervisory switch **57** will transfer its contact upon the water level falling to the point for which this switch is set. Since contact A4 is in the right position and contact A1 in the downward position during normal operation, the transfer of contact **57** of the low water supervisory switch to the left will result in the deenergization of relay C. The subsequent action is the same as that described for flame failure when the safety controls fail to function except that in the present case lamp L6 is energized through contact **57** in the left position and contact **58** in the right position.

High pressure limit switch fails to respond.—The high pressure supervisory switch **58**, connected in series with the low water supervisory switch **57** functions in a similar manner. Should the pressure in the burner system reach the point for which switch **58** is set to open, relay C will deenergize and lamp L5 will light. With relay C deenergized and relay B energized, the circuit through transmitter coil **6** is broken and a hazard signal is transmitted.

The combustion detector fails to open when the burner shuts down.—When the burner shuts down because the demand for heat is satisfied, the flame disappears and combustion detector K normally then opens its contact. However, if a defect prevents the contact from opening

and the safety controls do not prevent the system from recycling, the next cycle as when heat is once again called for will result in the transmission of a hazard signal as follows: control thermostat **34** closes its contact to call for heat and thereby energize relay B to close contact B5. Since contact D1 is open due to the continuing energization of relay D, relay C will remain deenergized. Consequently a hazard signal will be transmitted in the usual manner. When the system initially shuts down leaving contact K closed, lamp L3 energizes through contact B7 (relay B deenergizes upon shutdown) and contact D3 (now closed because contact K maintains relay D energized).

When the oil burner shuts down at the end of its cycle, the restoration signal is sent provided the defect is cleared and the combustion detector opens its contact.

Failure of the combustion detector to close its contact at the start of a cycle when the flame appears causes the system to operate in the same manner as when the flame fails to appear upon a call for heat. If the safety controls function properly to shut down the burner, a double signal is transmitted. Should the safety controls fail to function, a hazard signal is transmitted.

MAIN SWITCH RELAY

In order to service the system, and for other reasons, it is sometimes necessary to open the main line. Since this action has the same effect as a power failure, signals would normally be transmitted. To prevent such unnecessary signaling, a novel relay arrangement is provided at the main switch as shown in Fig. 3.

A double pole single throw switch **70** is interposed in the main supply lines **33** and **35**. A relay unit generally indicated by numeral **71** has a coil **72** connected by wires **73**, **74** to the main lines on the load side of switch **70**. With coil **72** in its normally energized condition, tongues **75** and **76** are held against contacts **75***a* and **76***a* respectively. Contacts **75***b* and **76***b* are connected by wires **77** and **78** to the main lines on the source side of switch **70**.

To employ the main switch unit with the system of Fig. 1, jumper **79** is disconnected from terminals P, Q and wires **82** and **83** respectively are connected thereto. Fuse **40** is removed to open the circuit between supply line **35** and line **38**, and wire **80** is connected to terminal N. Wire **81** connects directly to terminal O.

With switch **70** closed, coil **72** is energized to cause tongues **75**, **76** to assume the position shown in Fig. 3. In this position line **38** is connected to power line **35** over a circuit from terminal O, wire **81**, tongue **76**, contact **76***a*, line **80**, terminal N and power line **35**. Terminals P and Q are effectively joined by wire **83**, tongue **75**, contact **75***a* and wire **82**. This is the condition for normal operation and the system will function as hereinbefore described.

When the system is shut down by opening switch **70**, coil **72** deenergizes to allow tongues **75**, **76** to engage contacts **75***b* and **76***b* respectively. The portion of power lines **33**, **35** on the load side of switch **70** are now disconnected and the system is deenergized. However, transmitter coil **6** is maintained energized over wire **77**, contact **76***b*, tongue **76**, fuse, wire **81**, terminal O, transmitter coil **6**, wire **51**, rectifier **52**, resistor **53**, terminal Q, wire **83**, tongue **75**, contact **75***b* and wire **78**. The transmitter is therefore prevented from sending a signal when the main switch is opened.

While the invention has been described with reference to a specific embodiment, it is understood that this is not to be considered as limiting the appended claims.

What is claimed is:

1. In a supervisory system for a furnace having a fuel burner unit as well as safety control means and other control means each normally automatically operable in response to respective furnace heating conditions which have safe and unsafe magnitudes, a burner unit circuit adapted to be energized for operating said burner unit in response to a demand for heat and adapted to be deenergized by any one of said control means for shutting down said burner unit upon response of said control means to the occurrence of its respective unsafe magnitude, a first current path means, a first relay operated by said first current path means, means adapted to close said first current path means upon energization of said burner unit circuit, means adapted to interrupt current flow through said first current path means upon operation of said safety control means, a second current path means, a second relay operated by said second current path means, means adapted to close said second current path means upon energization of said burner unit circuit, means adapted to interrupt current flow through said first and second current path means upon operation of said other control means, supervisory means each responsive to the occurrence of unsafe magnitudes of respective ones of said furnace heating conditions greater than said first mentioned magnitudes, means whereby current flow through said second current path means is interrupted upon operation of said supervisory means, a transmitter having signaling means for selectively transmitting two mutually distinct signals upon deenergization thereof as well as a further restoration signal upon reenergization thereof and a normally energized control circuit which while energized holds said signaling means inoperative to transmit signals, one of said signals indicating the occurrence of said unsafe magnitude of any one of said furnace heating conditions and deenergization of said burner unit circuit and the other of said signals indicating the occurrence of said unsafe magnitude and continued energization of said burner unit circuit, means governed by said first relay for controlling selection of the signal to be transmitted by said signaling means whereby deenergization of said first relay results in selection of said one signal and energization of said first relay results in selection of said other signal, and means governed by said first and second relays for deenergizing said control circuit when only one of said relays in operative.

2. A supervisory system as set forth in claim 1, comprising means whereby said control circuit is deenergized upon operation of said other control means.

3. A supervisory system as set forth in claim 1, comprising means for interrupting the flow of current in said second current path means at the end of a predetermined interval after start of operation of said burner unit.

4. A supervisory system as set forth in claim 1, and wherein said first relay closes said second current path means upon start of operation thereof and for a predetermined interval thereafter governs said second current path means, and means whereby said second current path means is rendered independent of said first relay after said predetermined interval.

5. A supervisory system as set forth in claim 4, comprising means for interrupting the flow of current in said second path means at the end of a second predetermined interval following said first interval.

6. A supervisory system as set forth in claim 1, comprising means governed by said first relay for maintaining said second relay operative until the end of a predetermined interval.

7. A supervisory system as set forth in claim 1, comprising means including means governed by said first and second relays for maintaining said first relay energized upon operation of said supervisory means to deenergize said second relay.

8. A supervisory system as set forth in claim 1, comprising means including a main switch for connecting said current path means and said control circuit to a source of electromotive force, and means responsive to operation of said main switch for maintaining said control circuit energized.

9. A supervisory system as set forth in claim 8 wherein said last mentioned means comprises a further relay con-

nected to the load side of said main switch and held energized when said switch is closed, and means whereby said control circuit is maintained energized upon opening of said main switch and deenergization of said further relay.

10. In a supervisory system for a furnace having a fuel burner unit as well as safety control means and other control means each normally automatically operable in response to respective furnace heating conditions which have safe and unsafe magnitudes, a burner unit circuit adapted to be energized for operating said burner unit in response to a demand for heat and adapted to be deenergized by any one of said control means for shutting down said burner unit upon response of said control means to the occurrence of its respective unsafe magnitude, a first current path means, a first relay operated by said first current path means, means adapted to energize said first relay upon energization of said burner unit circuit, means adapted to interrupt current flow through said first current path means upon operation of said safety control means, a second current path means, a second relay operated by said second current path means, means governed by said first relay whereby said second current path means is closed upon energization of said burner unit circuit, a third relay, a combustion detector device and means adapted to connect said third relay to said combustion detector device so that operation of said combustion detector device upon proper fuel combustion energizes said third relay and failure of proper fuel combustion deenergizes said third relay, a fourth relay, a third current path means normally maintaining said fourth relay energized, means whereby current flow through said third current path means is interrupted at the end of a predetermined interval after energization of said burner unit circuit thereby deenergizing said fourth relay, means forming a loop current path governed by said third and fourth relays for holding said second relay energized upon deenergization of said first, third and fourth relays, means adapted to deenergized said first and second relays upon operation of said other control means, supervisory means each responsive to the occurrence of unsafe magnitudes of respective ones of said furnace heating conditions greater than said first mentioned magnitudes, means whereby said second relay is deenergized upon operation of said supervisory means, a transmitter having signaling means for selectively transmitting two mutually distinct signals upon deenergization thereof and a further restoration signal upon reenergization thereof and a normally energized control circuit which while energized holds said signaling means inoperative to transmit signals, one of the signals indicating the occurrence of said unsafe magnitude of any one of said furnace heating conditions and deenergization of said burner unit circuit and the other of said signals indicating the occurrence of said unsafe magnitude and continued energization of said burner unit circuit, means governed by said first relay for controlling selection of the signal to be transmitted by said signaling means whereby deenergization of said first relay results in selection of said one signal and energization of said first relay results in selection of said other signal, and means governed by said first and second relays for deenergizing said control circuit when only one of said first and second relays is energized.

11. A supervisory system as set forth in claim 10 wherein said other control means includes a water level device, and means adapted to connect said water level device to said control circuit so that said control circuit is deenergized upon operation of said water level device thereby freeing said signaling means to transmit.

12. A supervisory system as set forth in claim 10, comprising another means for deenergizing said second relay at the end of a second predetermined interval following said first interval, and means governed by said third relay for arresting action of said another means prior to the end of said second predetermined interval upon energization of said third relay.

13. In an automatic fuel burner system having a furnace with a burner unit and control means normally automatically operable in response to furnace heating conditions which have safe and unsafe magnitudes, circuit means for operating said burner unit in response to a demand for heat and normally responsive to said control means for shutting down said burner unit upon the occurrence of said unsafe magnitude, signaling means for selectively transmitting two mutually distinct signals one indicative of the occurrence of said unsafe magnitude and operation of said circuit means to shut down said burner unit and the other indicative of the occurrence of said unsafe magnitude and non-operation of said circuit means to shut down said burner unit, said signaling means also being adapted to automatically transmit a further signal for indicating restoration of the circuit means to an operative state following transmission of one of said signals, signal selector means responsive to the condition of said circuit means and for selecting said one signal for transmission when the condition of said circuit means corresponds to that calling for shutdown of said burner unit and for selecting said other signal for transmission when the condition of said circuit means is that calling for operation of said burner unit, supervisory means responsive to the occurrence of unsafe magnitudes of said furnace heating conditions greater than said first mentioned unsafe magnitudes, and a control circuit normally holding said signaling means inoperative to transmit and responsive to any one of said control means and supervisory means for rendering said signal means operative to transmit.

14. In an automatic fuel burner system having a furnace with a burner unit and control means normally automatically operable in response to furnace heating conditions which have safe and unsafe magnitudes, circuit means adapted to be energized in response to a demand for heat for operating said burner unit and normally adapted to be deenergized by said control means for shutting down said burner unit upon the occurrence of said unsafe magnitude, signaling means for selectively transmitting two mutually distinct signals one indicative of the occurrence of said unsafe magnitude and deenergization of said circuit means and the other indicative of the occurrence of said unsafe magnitude and continued energization of said circuit means, said signaling means being adapted to automatically transmit a further signal for indicating restoration of the circuit means to an operative state following transmission of one of said signals, signal selector means responsive to the condition of said circuit means and for selecting said one signal for transmission when said circuit means is deenergized and for selecting said other signal for transmission when said circuit means is energized, supervisory means responsive to the occurrence of unsafe magnitudes of said furnace heating conditions greater than said first mentioned unsafe magnitudes, and a control circuit normally holding said signaling means inoperative to transmit and responsive to any one of said control means and supervisory means for rendering said signal means operative to transmit.

15. In an automatic fuel burner system having a furnace with a burner unit and control means normally automatically operable in response to furnace heating conditions which have safe and unsafe magnitudes, circuit means adapted to be energized in response to a demand for heat for operating said burner unit and normally adapted to be deenergized by said control means for shutting down said burner unit upon the occurrence of said unsafe magnitude, signaling means for selectively transmitting two mutually distinct signals one indicative of the occurrence of said unsafe magnitude and deenergization of said circuit means and the other indicative of the occurrence of said unsafe magnitude and continued ener-

gization of said circuit means, said signaling means being adapted to automatically transmit a further signal for indicating restoration of the circuit means to an operative state following transmission of one of said signals, signal selector means responsive to the condition of said circuit means and for selecting said one signal for transmission when said circuit means is deenergized and for selecting said other signal for transmission when said circuit means is energized, supervisory means responsive to the occurrence of unsafe magnitudes of said furnace heating conditions greater than said first mentioned magnitudes, a normally energized control circuit holding said signaling means inoperative to transmit, and means responsive to any one of said control means and supervisory means for deenergizing said control circuit upon the occurrence of said unsafe magnitudes and thereby releasing said signaling means.

16. In a supervisory system for a furnace having a fuel burner unit as well as a plurality of control means each normally automatically operable in response to respective furnace heating conditions which have safe and unsafe magnitudes, a burner unit circuit adapted to be energized for operating said burner unit in response to a demand for heat and normally adapted to be deenergized by any one of said control means for shutting down said burner unit upon response of said control means to the occurrence of its respective unsafe magnitude, first and second current path means connected to said burner unit circuit, first and second relays each operated respectively by said first and second current path means, a transmitter having a normally energized control circuit and a signaling circuit, said transmitter including signaling means for selectively transmitting two mutually distinct signals upon deenergization thereof and a further restoration signal when reenergized, one of said signals indicating the occurrence of said unsafe magnitude of any one of said furnace heating conditions and deenergization of said burner unit circuit and the other of said signals indicating the occurrence of said unsafe magnitude and continued energization of said burner unit circuit, means whereby said control circuit while energized normally holds said signaling means inoperative to transmit, circuit means whereby said first relay govern selection of the signal by said signaling means so that deenergization of said first relay causes selection of said one of said signals for transmission and energization of said relay causes selection of said other of said signals, means whereby said first relay for a predetermined interval after its operation governs said second current path means, means whereby said second current path means is rendered independent of said first relay after said predetermined interval, means whereby said first current path means is adapted to be deenergized upon operation of said control means to deenergize said burner unit circuit, a plurality of supervisory means each responsive to the occurrence of unsafe magnitudes of respective ones of said furnace heating conditions greater than said first mentioned magnitudes for interrupting the flow of current in said second current path means and thereby deenergize said second relay, and means governed by said first and second relays for deenergizing said control circuit when only one of said relays is operative and for maintaining said control circuit energized when both said relays are energized.

17. In a supervisory system for a furnace having a fuel burner unit as well as safety control means and other control means each normally automatically operable in response to respective furnace heating conditions which have safe and unsafe magnitudes, a burner unit circuit adapted to be energized for operating said burner unit in response to a demand for heat and normally adapted to be deenergized by any one of said control means for shutting down said burner unit upon response of said control means to the occurrence of its respective unsafe magnitude, first and second current path means connected to said burner unit circuit, first and second relays each operated respectively by said first and second path means, a transmitter having a normally energized control circuit and a signaling circuit, said transmitter including signaling means for selectively transmitting two mutually distinct signals upon deenergization thereof and a further restoration signal upon reenergization thereof, one of said signals indicating the occurrence of said unsafe magnitude of any one of said furnace heating conditions and deenergization of said burner unit circuit and the other of said signals indicating the occurrence of said unsafe magnitude and continued energization of said burner unit circuit, means whereby said control circuit while energized holds said signaling means normally inoperative to transmit signals, circuit means whereby said first relay governs said signaling means and while deenergized causing selection of said one of said signals for transmission and while energized causing selection of said other of said signals for transmission, means whereby said first relay for a predetermined interval after its operation governs said second current path means, means whereby said second current path means is rendered independent of said first relay after said predetermined interval, means for so connecting said safety control means to said first current path means that operation of said safety control means interrupts the flow of current in said first current path means and deenergizes said first relay, means for so connecting said other control means to said control circuit that operation of said control means deenergizes said control circuit, supervisory means each responsive to the occurrence of unsafe magnitudes of respective ones of said furnace heating conditions greater than said first mentioned magnitudes, means so connecting said supervisory means to said second current path means that operation of said supervisory means opens said second current path means and deenergizes said second relay, and means governed by said first and second relays for deenergizing said control circuit when only one of said relays is operative.

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