United States Patent

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Continuation-in-part of application Ser. No. 687,001, Nov. 30, 1967, now abandoned.

[54] MONITORING DEVICE
10 Claims, 3 Drawing Figs.

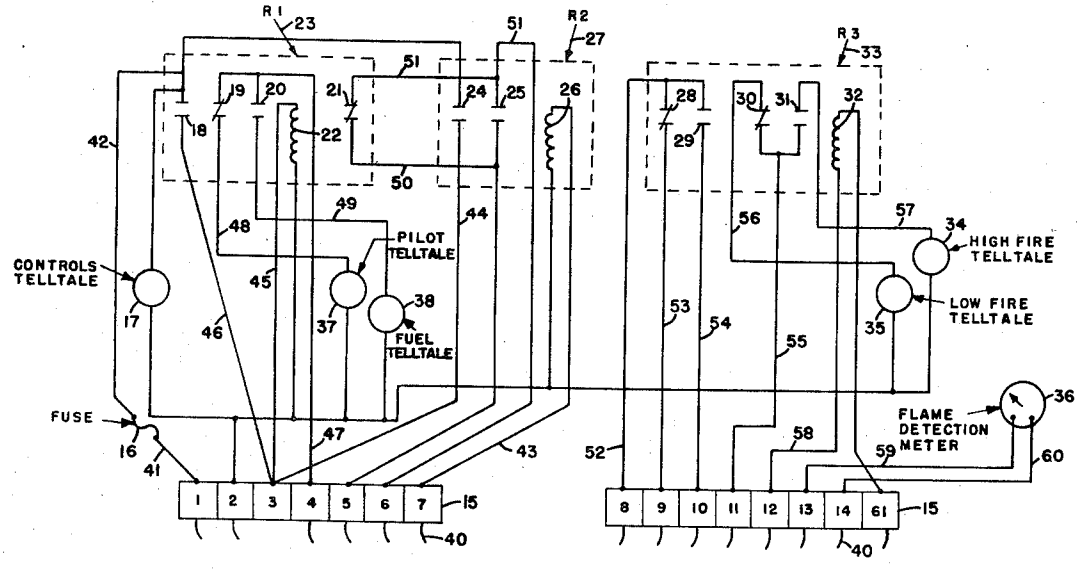
[52] U.S. Cl. 431/16, 431/79
[51] Int. Cl. F23n 5/24
[50] Field of Search 431/13, 16, 79

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ABSTRACT: Monitoring device for use with large commercial and industrial gas, oil and combination gas-oil burners and burner-boiler units and their associated combustion control devices to continuously monitor and indicate by means of cooperatively associated telltales not only their normal operation, but also to discretely indicate when, where and why a failure or malfunction occurred, comprising controls telltale, pilot telltale, fuel telltale, low-fire telltale and high-fire telltale.



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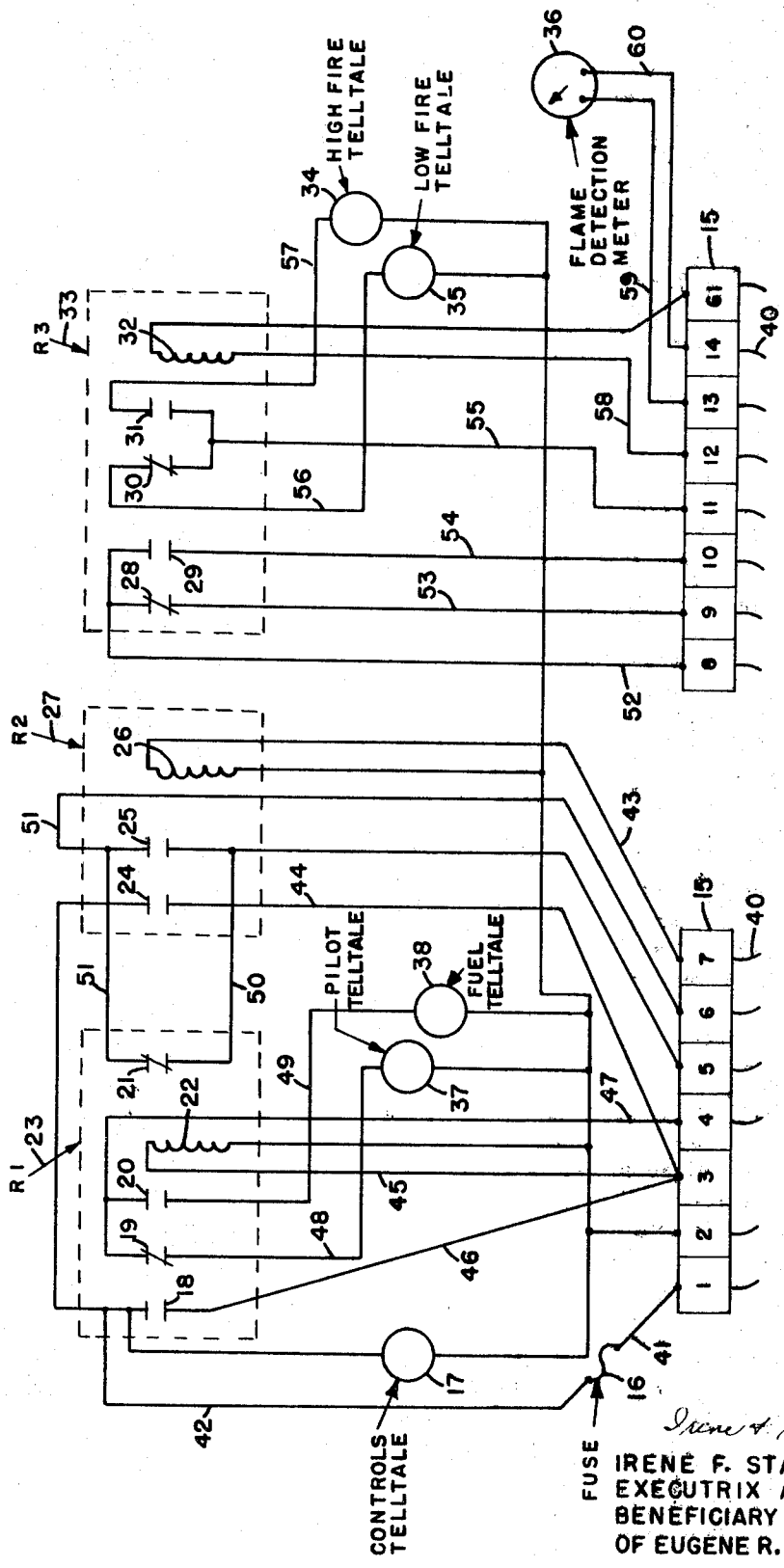


FIG. 1.

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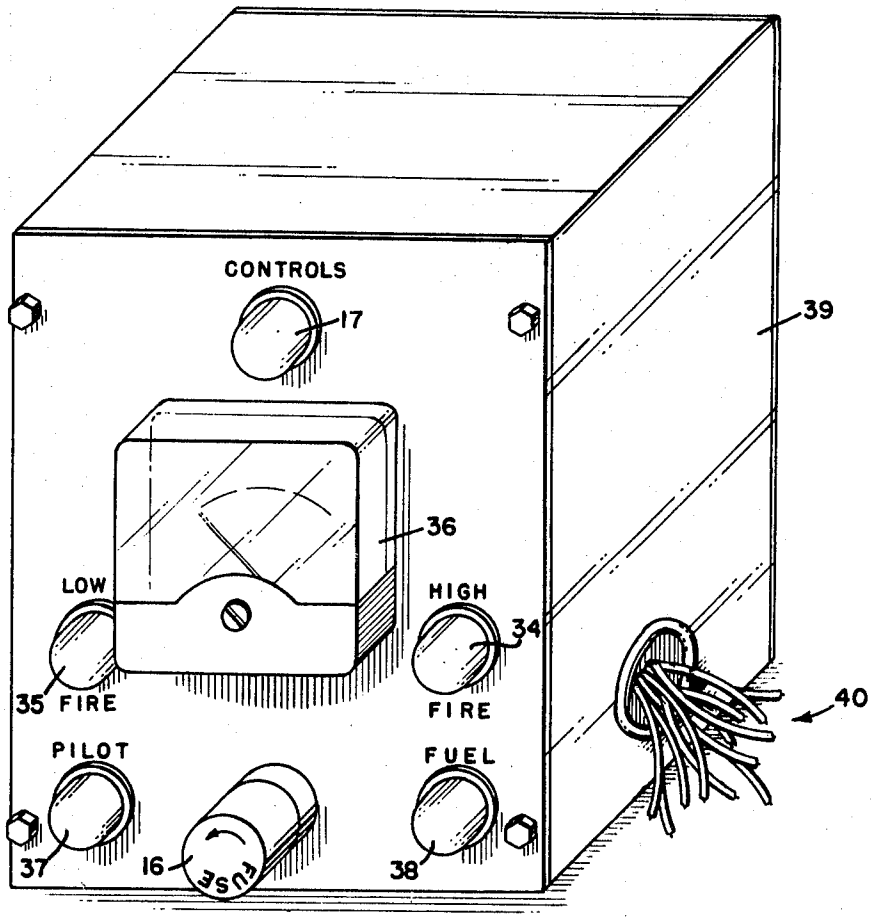
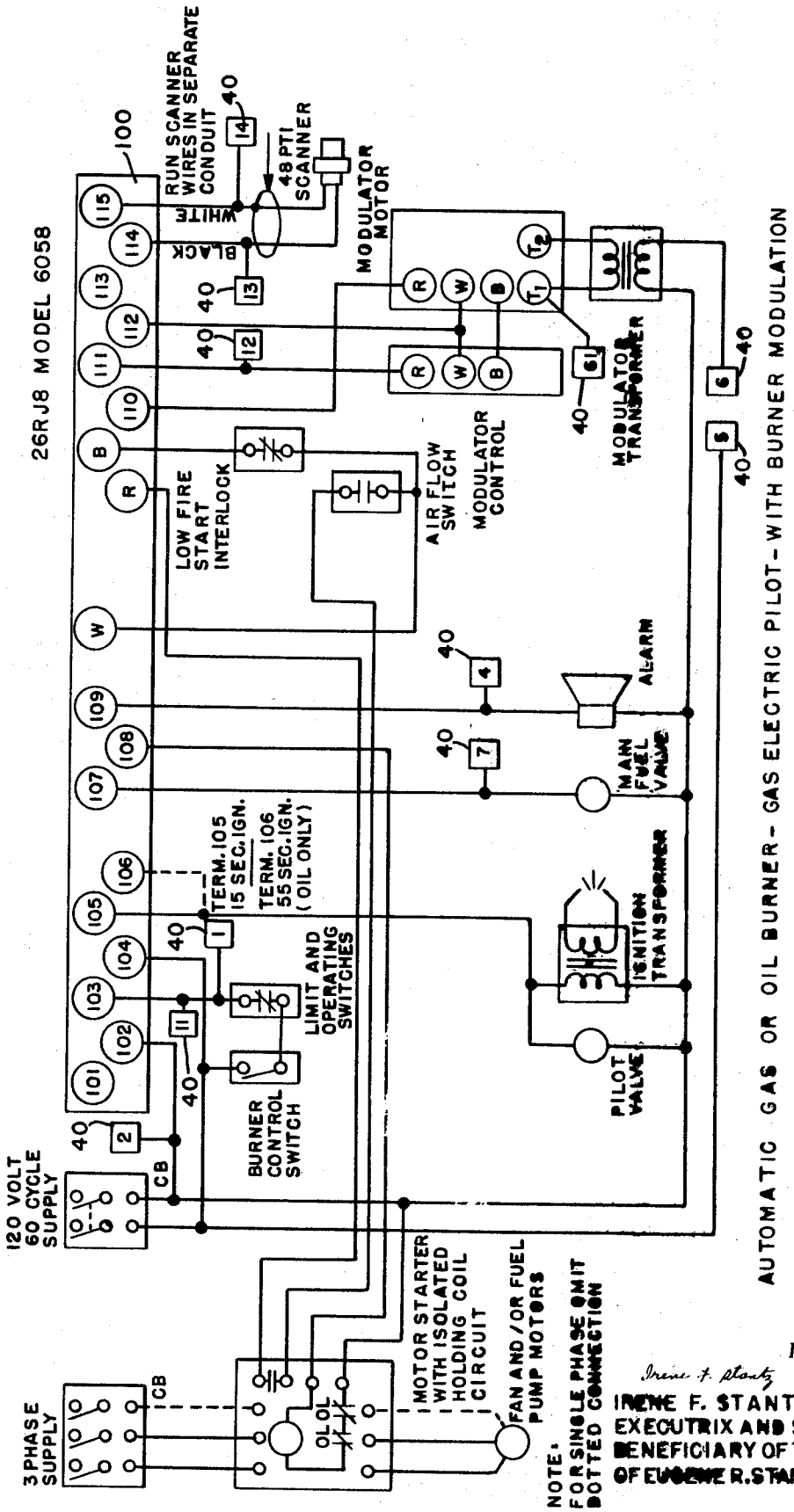


FIG. 2.

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AUTOMATIC GAS OR OIL BURNER - GAS ELECTRIC PILOT - WITH BURNER MODULATION

FIG. 3.

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MONITORING DEVICE

This application is a continuation-in-part with respect to the subject matter disclosed in the copending application of Eugene R. Stantz, since deceased, for Monitoring Device, Ser. No. 687,001, filed Nov. 30, 1967 and now abandoned.

This invention relates to a monitoring device for use with large commercial and industrial gas, oil, and combination gas-oil burners and burner-boiler units and their associated combustion control devices (hereinafter referred to generally as "equipment") to continuously monitor and indicate not only the normal operation of such equipment, but also, when a failure or malfunction occurs, to discretely indicate for trouble-shooting purposes when, where and why such failure or malfunction occurred.

The problem in the art to which this invention relates is the fact that such equipment is becoming increasingly complex, in part, for safety reasons in conformance with government, insurance company and industrywide standards for such equipment. Such equipment has, in point of face, progressed to such a degree of complexity that the associated service industry servicing such equipment has a shortage of competent, skilled technicians qualified to service such equipment. The result is that, today, the jurisdictional regions in which such equipment is installed and serviced are vast and range in hundreds of miles, and, in some cases, over several states. One servicing center normally services such equipment in its jurisdictional region. It is therefore common for servicing technicians to travel in excess of a hundred miles to service such equipment when an equipment breakdown occurs, whether major or minor in nature. The travel time alone on servicing calls often necessitates overnight stays by the servicing technicians. The owner of such installed equipment necessarily and understandably is charged not only for the time spent in servicing such equipment, but also travel time to and from the owner's place, as well as the charge for overnight stay by the servicing technician. Accordingly, the charges for service are reaching the prohibitive stage. The owners utilizing such equipment are industrial plants, government buildings, schools, hospitals, and those needing such large commercial and industrial equipment for their heating needs. Such equipment because of its built-in, technological complexity cannot be "tinkered with" by any of the maintenance staff as evidenced by past attempts by untrained personnel with resulting front-page stories of disastrous explosions causing loss of lives and widespread property damage.

The object of this invention, therefore, is to help solve the problem in the art to which this invention relates at least by minimizing the expense involved in servicing calls when the breakdown is of a minor nature. The monitoring device constantly monitors such equipment and discretely indicates not only the normal operation of such equipment, but also indicates for troubleshooting purposes an indication or indications of what the trouble is. Hence, in many cases of breakdown, the installed monitoring device allows the servicing technician, by means of information relayed through a telephone call, the opportunity to make a diagnosis of what the trouble may be which caused the breakdown and whether the trouble is of a major or minor nature. The servicing technician is therefore afforded the opportunity in the situation of minor trouble to instruct unqualified personnel by telephone of simple checkout procedures to restore such equipment to normal operation. For example, cleaning of dirty contacts or correction of insufficient draft by untrained personnel could save the owner hundreds of dollars in service calls.

FIG. 1 is a schematic representation of the components of the invention;

FIG. 2 is a perspective view of the cabinet 39 housing the components of the invention; and

FIG. 3 is a schematic diagram of conventional, commercial burner system with its associated, conventional, combustion control system, and demonstrates how the monitoring device of this invention is utilized therewith.

The lead wires 40 in FIG. 1 are individually connected at connectors 1, 2, 4–7, 11–14 and 61 of terminal block 15 with various conventional components shown in FIG. 3. These connections are shown in FIG. 3 as boxed-in numerals corresponding to the numerals representing the connectors in FIG. 1.

This invention is to be used in conjunction with a combustion control unit. One unit with which this invention can be utilized, for example, is shown in FIG. 3 which is a schematic diagram of a conventional, commercial burner system with its associated, conventional, combustion control system such as is found in a "Fireye," 26RJ8 Model 6058 system.

The Fireye control system contains a timer assembly which closes different sets of electrical contacts thereby energizing different electrical components such as fans, fuel-pump motors and valves, all of which are component parts of a complete heating system. In addition, the Fireye unit contains an "electric eye" or "photocell" which is sensitive to or responds to the heat and light emitted by a flame. The flame sensor is an integral part of the system and is used to detect the presence of and continuously monitor the flame. Should the flame be extinguished during a typical heating cycle, or fail to be present during initial portions of the heating system's "turn-on" cycle, the combustion control system will sense the malfunction, shut down or turn off the various burner motors, close oil valves, etc. and is capable of energizing an alarm system. The control system is then permanently locked out and cannot be restarted until reset manually and the trouble has been located.

The combustion system includes components such as the fan and/or fuel motors, pilot fuel valve, ignition transformer, main fuel valve, etc. The combustion control system, such as the Fireye system, as shown in FIG. 3, is represented by terminal block 100 containing a number of electrical terminals to which are connected the various components of the combustion system, as shown.

low to general terms, the Fireye combustion control system turns "on" and "off" the various heating system components at certain prescribed times and according to a predetermined schedule which has been incorporated into the timing assembly.

The lead wire at connector 1 is the last connection in series with the limit switches of the combustion controls series circuit calling for heat and is wired into such circuit. Electric power is applied to connector 1 when the combustion controls for such equipment call for heat.

The lead wire at connector 2 is the ground for the 120-volt circuit of such equipment, or may be the opposite phase in the situation of equipment employing a 208, 220, or 240 circuit.

Connector 3 is a splice junction.

The lead wire at connector 4 is from the safety lockout on the combustion control device and electric power is applied to connector 4 when the safety lockout is activated stopping the burner.

The lead wire at connector 5 is the "hot" wire of the electric power that is always applied to connector 5.

The lead wire at connector 6 is the "hot" wire of the fire-regulating transformer.

The lead wire at connector 7 is from the main fuel valve contact on the combustion control device of such equipment. When the main fuel valve opens, the circuit to connector 7 is closed and electric power is applied to connector 7.

The lead wires at connectors 8, 9 and 10 are the respective color-coded red, white and blue wires from outdated, high-low fire motor. These lead wires would not be utilized with the equipment shown in FIG. 3 but with conventional equipment of outdated systems.

The lead wire at connector 11 is the last connection in series with the limit switches of the combustion controls series circuit calling for heat and is wired into such circuit. Electric power is applied to connector 11 when the combustion controls for such equipment call for heat.

The lead wire at connector 12 is the color-coded red wire of the modulator control. Therefore, power is applied to connec-

tor 12 in the normal sequence of the flame control of the combustion control device from low-fire to high-fire.

Lead wires at connectors 13 and 14 are connected to the meter jacks of the combustion control device.

The lead wire at connector 61 is connected to terminal T1 of the Modulator Transformer in FIG. 3.

When the combustion control device is activated, i.e., calls for heat, electric power is applied to connector 1 of terminal block 15 with the power path flowing through wire 41, 3-amp fuse 16, wire 42, lighting controls telltale 17 and returning to the ground side of the power circuit at connector 2. Power is also applied to one side of the normally open contacts 18 of relay 23 (R1) and to one side of the normally open contacts 24 of relay 27 (R2).

Opening of the main fuel valve applies electric power to connector 7 with the electric power path flowing through wire 43 to and energizing coil 26 of relay 27 (R2) and returns to the common ground at connector 2. Energization of coil 26 closes normally open contacts 24 and 25 of relay 27 (R2). Closure of contacts 24 completes a power path through wire 41, fuse 16, wire 42, contacts 24 and wire 44 spliced to the junction connector 3. This in turn completes another power path from connector 3, wire 45, to an energizing coil 22 of relay 23 (R1) and returns to the common ground at connector 2. Energization of coil 22 closes normally open contacts 18 and 20 of relay 23 (R1) and opens normally closed contacts 19 and 21 of relay 23 (R1). Closure of contacts 18 completes a power path from connector 1 flowing through wire 41, fuse 16, wire 42, contacts 18, wire 46 to splice junction connector 3, wire 45, coil 22 and returning to common ground at connector 2. This latter described power path is an independent, holding power path thereafter whether or not power continues to be applied to connector 7. In the event the main fuel valve closes while the combustion control device is calling for heat, power no longer will be applied to connector 7 but will continue to be applied to connector 1. Nevertheless, the described power path to energized coil 22 renders same independent of the power path commencing from connector 7. Hence, energized coil 22 will maintain contacts 18 and 20 closed, and contacts 19 and 21 open, despite the deenergization of coil 26 opening contacts 24 and 25.

When the burner fails on its trial for pilot flame or there is a failure of flame detection in the combustion control device, the safety lockout on the combustion control device is activated applying power to connector 4. If such failure occurs before the main fuel valve opens applying power to connector 7, the power path will flow from connector 4 through wire 47, normally closed contacts 19, wire 48, lighting pilot telltale 37 and returning to the common ground at connector 2. Should the failure of flame occur after the trail for pilot and the main fuel valve has opened—contacts 20 closed by energized coil 22 as previously described—the power path from connector 4 will flow through wire 47, closed contacts 20, wire 49, lighting fuel telltale 38 and returning to the common ground at connector 2.

Power applied at connector 5 flows through wire 50, normally closed contacts 21 of relay 27 (R2) and wire 51 to connector 6. When the main fuel valve opens to apply power to connector 7, normally open contacts 24 and 25 of relay 27 (R2) will be closed through the energization of coil 26, and normally open contacts 18 and 20 of relay 23 (R1) will be closed and normally closed contacts 19 and 21 of relay 23 will be opened through the energization of coil 22. Thence the power path will be from connector 5, through wire 50, closed contacts 25, wire 51 to connector 6. When power is applied to connector 1 and to connector 7 for reasons as previously described, contacts 18 and 20 are closed, contacts 19 and 21 are open, and contacts 24 and 25 are closed, and the power path through contacts 18 is an independent, holding power path which holds contacts 21 open. Thereafter should the main fuel valve close or other malfunction occur in the main fuel valve to effect an open circuit to connector 7, coil 26 will be deenergized opening contacts 24 and 25. Hence, there will be an open circuit in the power path of connector 5, through wire 5 because of open contacts 21 and 25, thereby causing the high-low fire or modulating motor to stop somewhere in its low-fire position, between its low-to high-fire position or in its high-fire position.

The high-low fire or modulating motor of such equipment is controlled by its described fire-regulating transformer to operate such motor in positions of low-fire or high-fire. Of course, when the circuit path from connectors 5 and 6 is interrupted, the motor is stopped in the position of its operation. When the monitoring device is used with an outdated, high-low fire motor, electric power is similarly applied to connector 8 completing a power path in position of low-fire through wire 52, normally closed contacts 28, wire 53 to connector 9. In the high-fire position of the motor, the power path is completed from connector 8, through wire 52, closed contacts 29, wire 54 to connector 10.

With power always being applied to connector 11, a power path flows through wire 55, normally closed contacts 30, wire 56 to light low-fire telltale 35 and returns to the common ground at connector 2. When contacts 31 are closed, the power path flows through wire 55, contacts 31, wire 57 to light high-fire telltale 34 and returns to the common ground at connector 2.

The lead wire at connector 12 applies power thereto in the normal sequence of change of flame control to high-fire. Hence, if the flame control sequence calls for high-fire, power will be applied to connector 12. Thence the power path flows through wire 58 to energize coil 32 of relay 33 (R3) and returns to the connector 61 wire to the secondary connection T1 of the modulator transformer in FIG. 3. When coil 32 is energized, the normally closed contacts 28 and 30 will be opened and the normally open contacts 29 and 31 will be closed.

Wire 59 from connector 13 is connected to flame detection meter 36 and wire 60 is connected from flame detection meter 36 to connector 14. Meter 36 indicates readings in either DC microamperes or DC voltage depending upon the type of equipment utilized. Such readings are sensed from the associated combustion control device. Flame detection meter 36 allows monitoring of the flame signal. Low and unsteady signal sensings would indicate marginal installation or defect in the flame detection circuit which would require correction.

As shown in FIG. 3, terminals 101 and 113 are not connected to the components of the combustion system. Upon power being applied to the Fireye system, power is similarly applied to terminals 102 and 104 of terminal block 100. When the system calls for heat, and if the burner control switch is "on" (i.e., closed), power will be applied to both terminal 103 and connector 1 electrically connected by lead wire 40.

Though not shown as such in FIG. 3, terminals 103 and W are electrically connected internally. The reason for this explained inaccuracy is the fact that FIG. 3 of the drawings depicts for all intents and purposes the schematic diagram with such inaccuracy found in bulletin CP–58 published by the Combustion Control Division of the Electronics Corporation of America, 1 Memorial Drive, Cambridge 42, Massachusetts and depicted as FIG. 11 on page 6 of such bulletin.

The low-fire start interlock, normally closed, allows power to be applied to terminal B which turns on the "master relay" in the combustion control device thereby starting the timer and initiating the cycle. Closure of this master relay also applies power to terminal 108 thereby starting the burner motor and the air-intake and/or exhaust or purging fan(s). After the fan(s) establish an air flow, the airflow switch is closed, thereby applying power to terminal R. Terminal R is part of the safety lockout system. Power is applied to terminal 108 until the end of the heating cycle.

Power is applied to terminal 105, 35 seconds after the start of the timer and is removed 60 seconds after the start of the timer with the main fuel valve opening 45 seconds after the start of the timer for a net time interval of 15 seconds for the application of power for flaming ignition.

Power is applied to terminal **106**, 35 seconds after the start of the timer and is removed at 100 seconds for a net time interval of 55 seconds ignition. The fuel valve opens at 45 seconds.

Terminal **107** applies power to the main fuel valve 45 seconds after the start of the timer and it is closed after the end of the heating or "furnace-on" period.

Contacts **110** and **111** are closed at the mutually dependent closure of both the "master relay" and "start of timer." This causes the modulator motor to be in the "low-fire" position. This low-fire condition is maintained for 60 seconds after which terminals **110** and **112** are connected together, and terminal contacts **110** and **111** are opened, causing the modulation to advance to the "high-fire" position.

This explanation completes the brief description of the Fireye control system. The monitoring device of this invention can be utilized with other combustion control systems which apply power in a somewhat different sequence to the various components. Some components may not be present in some heating systems. For example, in FIG. **3** terminal **105** is used for a 15-second ignition period, there being no 55-second ignition period. As shown in FIG. **3**, the monitoring device of this invention is connected by means of the lead wires to the components such as the limit switches, fuel valve, etc., themselves and not to the terminals of the terminal block **100** and therefore can be used with other combustion control systems. In the event a combustion control system does not have a photoelectric scanner such as shown in FIG. **3**, lead wires **40** will not be utilized to make electrical connection to connectors **13** and **14**, and, hence, the meter **36** will not be activated.

The fact that the low-fire telltale **35** or the high-fire telltale **34** is lighted, and with controls telltale **17**, pilot telltale **37** and fuel telltale **38** all out, may be a situation of normal operation. Assuredly, the situation is one of normal sequence if the lighted high-fire telltale **34** goes out and the low-fire telltale **35** becomes lighted.

The situation is still normal for a refiring position if controls telltale **17** and low-fire telltale **35** are lighted, and pilot telltale **37**, fuel telltale **38** and high-fire telltale **34** are still out. The sequence thereafter would still be normal if the controls telltale **17** and high-fire telltale **34** are lighted, and pilot telltale **37**, fuel telltale **38** and low-fire telltale **35** are out.

A trouble situation would be indicated if the controls telltale **17**, the pilot telltale **37** and the low-fire telltale **35** are lighted, and the fuel telltale **38** and the high-fire telltale **34** are out. The indication may be that the burner failed on trial for pilot flame with the trouble being dirty flame detection in the combustion control, malfunction in combustion control or ignition. This situation may be minor or may necessitate a service call.

A trouble situation would be indicated if the controls telltale **17**, the fuel telltale **38** and the low-fire telltale **35** are lighted, and the pilot telltale **37** and high-fire telltale **34** are out. The indication is that at the instant of the main fuel valve opening there was a failure of the flame detection in the combustion control device. The situation may be corrected by the adjustment of the main fuel or air inflow, by correction of slippage of the linkage on the fuel equipment. Or the malfunction may be in the fuel valve itself. This situation may be minor or necessitate a service call.

A trouble situation would be indicated if the controls telltale **17**, fuel telltale **38** and high-fire telltale **34** are lighted, and the pilot telltale **37** and low-fire telltale **35** are out. The position of the modulating motor between low- and high-fire shows where the failure occurred. The burner and combustion control device of such equipment would be recycled to note what happens at such recurring lockout position of the motor. The trouble that needs correcting may be poor combustion, lack of draft or slippage of the fuel linkage on the fuel equipment.

A trouble situation would be indicated if the low-fire telltale **35** is lighted, and the controls telltale **17**, high-fire telltale **34**, pilot telltale **37** and fuel telltale **38** are all out, and there is no heat. The indication is that some control circuit is open such as low water, high water, low temperature, high temperature, low gas pressure, high gas pressure, thermostats, time clocks, etc.

Having thusly described my invention, I claim:

1. A monitoring device for use with large commercial and industrial gas, oil, and combination gas-oil burners and burner-boiler units and their associated combustion control devices (hereinafter referred to generally as "equipment") to continuously monitor and indicate not only the normal operation of such equipment, but also to discretely indicate for troubleshooting purposes when, where and why a failure or malfunction of such equipment occurred; said monitoring device comprising: controls telltale means to indicate when lighted a call for heat and when out either no call for heat or a malfunction in the combustion control series circuit of such equipment; pilot telltale means to indicate failure in the trial for pilot flame; fuel telltale means to indicate failure in the main flame or detection thereof; low-fire telltale means to indicate the flame control sequence of such equipment calling for low-fire; high-fire telltale means to indicate the flame control sequence of such equipment calling for high-fire; main fuel valve means to establish power paths from said controls telltale means, one of said power paths being established as an independent, holding power path, the other power path being dependent upon said main fuel valve means for its maintenance, to indicate by said fuel telltale means flame failure after opening of the main fuel valve of said equipment and to stop the high-low fire or modulating motor of such equipment somewhere in its low-fire position, between its low to high-fire position or in its high-fire position to indicate where and when such failure occurred.

2. A monitoring device in accordance with claim **1**, wherein said controls telltale means comprises a first connector, a controls telltale and a power path from said first connector to said controls telltale, wherein said equipment has a combustion controls series circuit calling for heat, wherein said combustion controls series circuit has limit switches, wherein said first connector is the last connection in series with said limit switches of said combustion control series circuit calling for heat wired into said circuit and wherein said controls telltale is lighted when said combustion controls call for heat thereby applying electric power to said connector.

3. A monitoring device in accordance with claim **1**, wherein said controls telltale means comprises a first connector, a controls telltale, a power path from said first connector to said controls telltale, a first set of normally open contacts of a first relay, a first relay coil, a first set of normally open contacts of a second relay, a second relay coil, wherein said main fuel valve means comprises a seventh connector, a power path from said seventh connector to said second relay coil, wherein said equipment has a combustion controls series circuit calling for heat, wherein said combustion controls series circuit has limit switches, wherein said first connector is the last connection in series with said limit switches of said combustion control series circuit wired into said circuit and wherein said controls telltale is lighted when said combustion controls call for heat thereby applying electric power to said first connector, wherein said seventh connector is wired to the main fuel valve contact on the combustion control device of such equipment such that when the main fuel valve opens the circuit to said seventh connector is closed and electric power is applied to said seventh connector energizing said second relay coil to close said first set of second relay contacts to establish a power path from said first connector dependent upon the continued energization of said second relay coil thereby establishing a power path to and energizing said first relay coil to close said first set of normally open first relay contacts thereby establishing an independent power path from said first connector to said first relay coil holding said first relay coil energized independent of continued energization of said second relay coil.

4. A monitoring device in accordance with claim **1**, wherein said pilot telltale means comprises a fourth connector, nor-

mally closed contacts of a first relay and a pilot telltale, wherein said combustion control device has a safety lockout, wherein said fourth connector is wired to said safety lockout on said combustion control device and electric power is applied to said fourth connector lighting said pilot telltale when said safety lockout is activated stopping the burner.

5. A monitoring device in accordance with claim 3, wherein said fuel telltale means comprises a fourth connector, a second set of normally open first relay contacts and a fuel telltale, wherein said combustion control device has a safety lockout, wherein said fourth connector is wired to said safety lockout on said combustion control device and electric power is applied to said fourth connector when said safety lockout is activated stopping the burner, and wherein said fuel telltale is lighted when said first relay coil is energized closing said second set of normally open first relay contacts.

6. A monitoring device in accordance with claim 3, wherein is further provided a fifth connector, a sixth connector, normally closed contacts of said first relay and a second set or normally open contacts of said second relay, wherein said fifth connector is wired to the main power supply, wherein said equipment has a fire regulating transformer, wherein said sixth connector is wired to one leg of said fire regulating transformer, wherein a power path for said transformer is established from said fifth connector to said sixth connector through said normally closed contacts of said first relay or through closing of said second set of normally open second relay contacts, and wherein when power is applied to said first connector while power is no longer being applied to said seventh connector upon closing of said main fuel valve, said normally open first relay contacts will be maintained open by said first relay coil being energized and said second set of normally open second relay contacts will be opened by deenergization of said second relay coil thereby establishing an open circuit in the power path from said fifth and sixth connectors to said transformer to thereby stop said high-low fire or modulating motor somewhere in its low-fire position, between its low- to high-fire position or in its high-fire position.

7. A monitoring device in accordance with claim 1, wherein said low-fire telltale means comprises an eleventh connector, a set of normally closed contacts of a third relay, a low-fire telltale and a power path from said eleventh connector to said low-fire telltale, wherein said equipment has a combustion controls series circuit calling for heat, wherein said combustion controls series circuit has limit switches, wherein said eleventh connector is the last connection in series with said limit switches of said combustion controls series circuit calling for heat wired into said circuit and wherein electric power is applied to said eleventh connector so long as the main switch of the combustion control device is closed, thereby applying electric power to said eleventh connector and lighting said low-fire telltale.

8. A monitoring device in accordance with claim 1, wherein said high-fire telltale means comprises an eleventh connector, a set of normally open contacts of a third relay, a high-fire telltale, a power path from said eleventh connector to said high-fire telltale, a 12th connector, a relay coil of said third relay and a power path from said 12th connector to said third relay coil, wherein said equipment has a combustion controls series circuit calling for heat, wherein said combustion controls series circuit has limit switches, wherein said eleventh connector is the last connection in series with said limit switches of said combustion controls series circuit calling for heat wired into said circuit and wherein electric power is applied to said eleventh connector so long as the main switch of the combustion control device is closed, wherein said twelfth connector is wired to the normally color-coded red wire of the modulator control used for high-low or modulating fire, wherein electric power, in the normal sequence of change of flame control to high-fire, is applied to said 12th connector thereby energizing said third relay coil to close said set of normally open third relay contacts thereby lighting said high-fire telltale.

9. A monitoring device in accordance with claim 2, wherein said low-fire telltale means comprises an eleventh connector, a set of normally closed contacts of a third relay, a low-fire telltale and a power path from said eleventh connector to said low-fire telltale, wherein said equipment has a combustion controls series circuit calling for heat, wherein said combustion controls series circuit has limit switches, wherein said eleventh connector is the last connection in series with said limit switches of said combustion controls series circuit calling for heat wired into said circuit and wherein electric power is applied to said eleventh connector so long as the main switch of the combustion control device is closed, thereby applying electric power to said eleventh connector and lighting said low-fire telltale.

10. A monitoring device in accordance with claim 2, wherein said high-fire telltale means comprises an eleventh connector, a set of normally open contacts of a third relay, a high-fire telltale, a power path from said eleventh connector to said high-fire telltale, a twelfth connector, a relay coil of said third relay and a power path from said twelfth connector to said third relay coil, wherein said equipment has a combustion controls series circuit calling for heat, wherein said combustion controls series circuit has limit switches, wherein said eleventh connector is the last connection in series with said limit switches of said combustion controls series circuit calling for heat wired into said circuit and wherein electric power is applied to said eleventh connector so long as the main switch of the combustion control device is closed, wherein said 12th connector is wired to the normally color-coded red wire of the modulator control used for high-low or modulator fire, wherein electric power, in the normal sequence of change of flame control to high-fire, is applied to said 12th connector thereby energizing said third relay coil to close said set of normally open third relay contacts thereby lighting said high-fire telltale.