

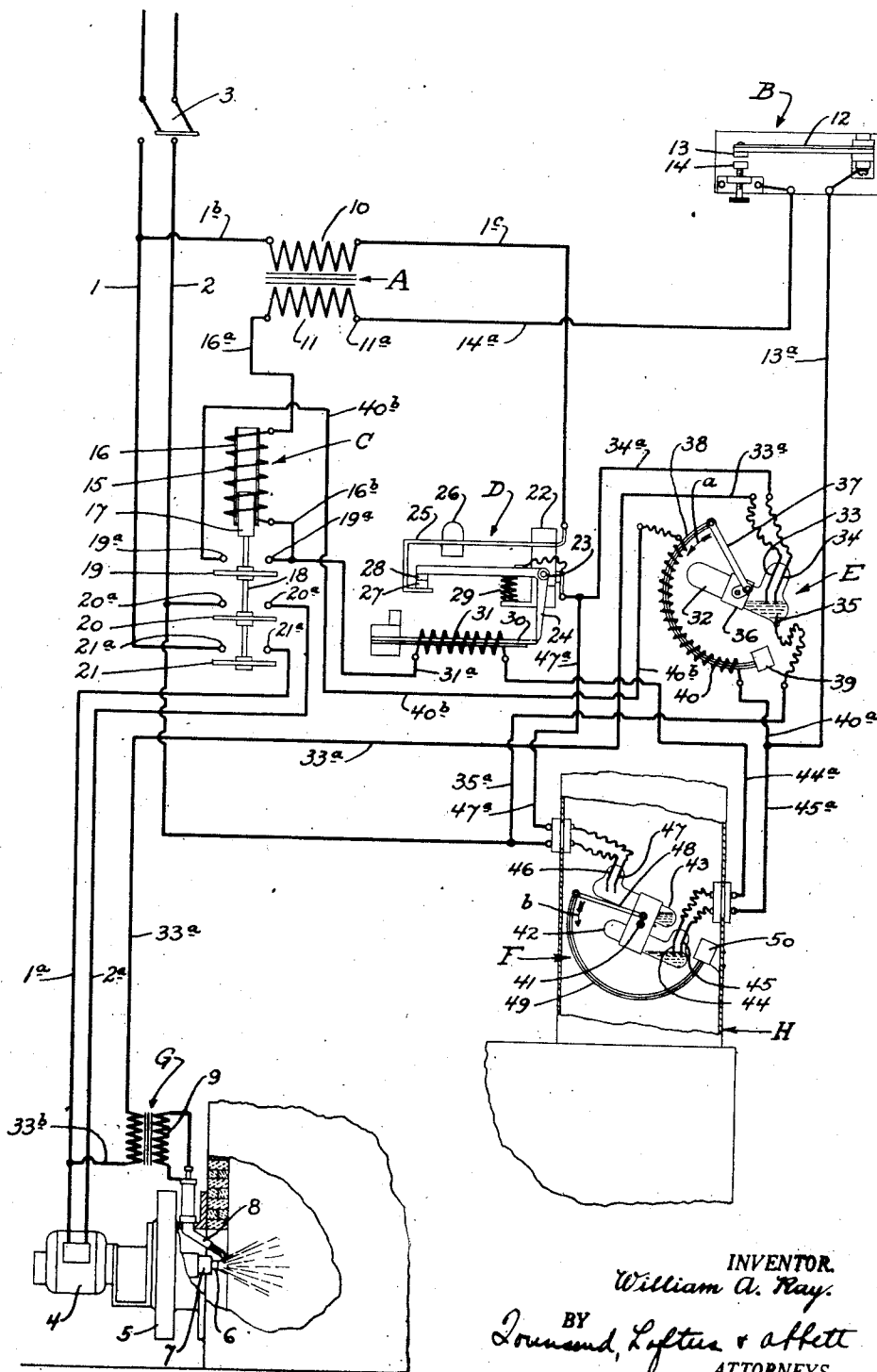
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AUTOMATIC OIL BURNER CONTROL SYSTEM

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AUTOMATIC OIL-BURNER-CONTROL SYSTEM

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This invention relates to control systems for oil burners, and especially to a system which is automatically actuated.

The control system disclosed in this application is particularly intended for use in conjunction with motor driven centrifugal atomizing oil burners of the type disclosed in Patent Number 1,253,422, entitled "Oil burner" and issued January 15, 1918. Burners of this character are usually automatically controlled from a room thermostat or the like. If, for instance, a uniform room temperature of 72° F. is desired, and the temperature exceeds 72°, the circuit through the motor driven burner is broken by means of the thermostat and the burner is stopped. Conversely, if the temperature drops below 72° F., the circuit through the motor is closed, the burner is started again, and so on.

Automatic control systems employing a room thermostat require additional apparatus such as relays, stack switches, an ignitor device, etc. The thermostat switch and other apparatus used is, however, so connected and arranged that failure of one or more parts of the control system will not always render all of the control system inoperative, thus it is possible that the burner may start and the ignitor fail, in that case causing flooding of the furnace with oil. Again the ignitor may operate but the burner fail to start, etc.

The object of the present invention is to generally improve and simplify the construction and operation of control systems of the character described; to provide a control system which includes a thermostat switch, a pair of transformers, a safety switch, a stack switch, a timing switch, a relay and an ignitor device; and further to so arrange and connect the several switches, transformers and relay, etc., that failure of any part of the control system to operate properly will render the control system inoperative.

The invention is shown by way of illustration in the accompanying drawing which is a diagrammatic view showing the several circuits and apparatus employed.

Referring to the drawing A indicates a suitable form of step-down transformer, B a room thermostat, C a relay switch, D a

safety switch, E a timing switch, F a stack switch, and G a high tension transformer.

The control illustrated is connected with power or service wires, indicated at 1 and 2, and a circuit through the wires is controlled by a service switch generally indicated at 3. The oil burner to be controlled is of the centrifugal atomizing type. Briefly stated it consists of an electric motor 4, which drives a fan 5 and an atomizing cup 6. The oil to be burned is delivered to the cup 6 in any suitable manner and it is atomized by being centrifugally projected from the cup, and it is further atomized by a blast of air created by the fan 5 and discharging through a nozzle 7 surrounding the cup. The burner is, in this instance, shown as provided with a spark plug 8 or like device whereby the oil is ignited when the burner is started. The spark plug is connected with a secondary winding 9 of the high tension transformer indicated at G, the primary side of the transformer being connected with the power circuit wires 1a and 2a, as will hereinafter be described.

The primary side of the step-down transformer indicated at 10 is also connected with the power circuit wires, while the secondary side of the transformer, indicated at 11, is connected with a control circuit hereinafter to be described.

The room thermostat employed may be of any suitable construction. It is merely diagrammatically illustrated in the present instance, and as illustrated consists of a bi-metallic strip or arm 12 which controls the circuit through a pair of contacts 13 and 14. The bi-metallic strip moves upwardly when a predetermined temperature is reached, thereby breaking the contacts and conversely it moves downwardly and closes the contacts 13 and 14 when the temperature drops below a predetermined temperature.

The relay switch indicated at C may be of any suitable construction but it is, in this instance, shown as consisting of a coil or winding 15 surrounding a spool 16. A core member 17 is vertically movable within the spool, and it is provided with a downwardly extending rod or arm 18 which carries three

switch members, such as shown at 19, 20 and 21.

The safety switch indicated at D may also be of standard construction, but it is in the present instance shown as consisting of a bracket 22 on which is pivotally mounted, as at 23, a trip lever 24. The bracket also supports a spring arm 25, on which is mounted a push button 26, this spring arm also carrying a contact 27 which cooperates with the contact 28 secured on the trip lever 24. A spring 29 is interposed between the bracket 22 and the trip lever and normally tends to separate the contacts 27 and 28. The trip lever is, however, normally held in the position shown in the drawing by means of a bi-metallic arm 30. This arm is surrounded by a heating coil 31. When a current passes through the heating coil for a predetermined period of time arm 30 moves downwardly and releases the trip lever, thereby breaking the circuit through contacts 27 and 28. Conversely, if the circuit through the heating coil 31 is broken prior to the release of trip lever 24, the trip lever will not be released and the circuit through contacts 27 and 28 will not be broken. Again, if the circuit is broken, it is possible to close it by depressing the spring arm 25 through means of the button 26 so as to return the trip arm into engagement with the bi-metallic arm 30.

In other words, the safety switch can only be manually reset after it has been tripped.

The timing switch indicated at E may be of suitable construction. As here illustrated it consists of a tube 32 partially filled with mercury and provided with a set of three contacts, as indicated at 33, 34 and 35. The tube is mounted in a clip 36, and this in turn is pivotally mounted and connected with a crank arm 37, the crank arm being connected to a bi-metallic arm 38 secured at the point 39, and the bi-metallic arm being surrounded by a heating coil 40. When current passes through the heating coil the bi-metallic arm is heated and will, in that instance, move in the direction of arrow *a*. Crank arm 37 being connected with the bi-metallic arm will move in the same direction and tube 32 will thus be tilted so as to break the circuit through the contacts 33, 34 and 35.

Conversely, if the circuit through the heating coil 40 is broken, bi-metallic arm 38 cools, the tube 32 is returned to the position shown, thereby closing a circuit through the contacts 33, 34 and 35.

The stack switch indicated at F may be constructed in any suitable manner, but as here illustrated consists of a pivotally mounted clip 41 in which is secured a pair of tubes 42 and 43. The tube 42 carries a pair of contacts 44 and 45, and tube 43 carries a pair of contacts 46 and 47. Both tubes are partially filled with mercury and when they assume the position shown in the drawing a cir-

cuit is closed through the contacts 44 and 45, while the circuit through the contacts 46 and 47 is broken.

The clip is connected through means of a crank arm 48 with a bi-metallic arm 49 secured at the point 50. If the bi-metallic arm is heated by flue gases it moves in the direction of arrow *b* and swings the clip about its pivot a sufficient distance to tilt the tubes 42 and 43, thereby breaking the circuit through the contacts 44 and 45 and closing the circuit through the contacts 46 and 47.

The relay, the several transformers and switches described are connected with the power circuit and the control circuit in the following manner:

The primary side 10 of the step-down transformer A is connected with wire 1 through the wire 1*b*. The other side of the primary is connected through a wire 1*c* with the contact 27 of the safety switch. The other contact 28 of the safety switch has two connections, one indicated at 34*a* and the other indicated at 47*a*. Wire 47*a* connects with the contact 47 of the stack switch, while the wire 34*a* connects with contact 34 of the timing switch.

Contact 46 of the stack switch has two connections, one with the power circuit through the wire 2, and the other with the contact 35 of the timing switch through wire 35*a*.

The secondary side 11 of the step-down transformer has two connections, one through wire 16*a* which connects with the coil of the relay switch, and one through wire 14*a* which connects with contact 14, of the room thermostat.

The other contact 13 of the room thermostat is connected with a wire 13*a* and this wire in turn is connected with one wire 40*a* to one terminal of the heating coil 40, and with another wire 45*a* which connects with the contact 45 of the stack switch. The contact 44 of the stack switch is connected through a wire 44*a* with one terminal of the heating coil 31 of the safety switch, the other terminal of the heating coil being connected through a wire 31*a* with one of a pair of contacts 19*a* on the relay switch, wire 31*a* being also connected through wire 16*b* with the other terminal of the relay coil.

The opposite terminal of the heating coil 40 of the timing switch is connected through a wire 40*b* with one of the terminals 19*a* of the relay switch. Terminal 33 of the timing switch is connected through wire 33*a* with one terminal of the primary side of the high tension transformer. The other terminal is connected through wire 33*b* with wire 1*a* of the power circuit.

The relay switch is provided with three sets of contacts, one set indicated at 19*a*, a second set indicated at 20*a*, and a third set indicated at 21*a*. Wire 1*a* of the power circuit is connected with the motor 4 at one end

and at the opposite end with one of the contacts 21a, the opposite contact 21a being directly connected with the power circuit wire 1. Power circuit wire 2a is connected at one end to the motor 4, and at the opposite end to one of the contacts 20a, the other contact being connected direct with the power circuit wire 2.

There are two main circuits employed, first the power circuit and secondly the control circuit. The parts of the apparatus directly actuated by the power circuit are the primary side of the step-down transformer, indicated at A, and second the primary side of the high tension transformer indicated at G, the circuits through the primary sides of the transformers mentioned being controlled by the contacts 33, 34 and 35 of the timing switch, and the contacts 27 and 28 of the safety switch indicated at D being in the circuit of the primary of transformer a. These circuits can be traced as follows:

Commencing with the power circuit wire 1 the current passes through wire 1b, the primary 10 of the step-down transformer wire 1c, contacts 27 and 28 of the safety switch, wire 34a, contacts 34 and 35 and wire 35a which connects with the other side of the power circuit indicated by the wire 2. This completes the circuit through the primary side of the step-down transformer and it may be stated that this circuit is continuously maintained whether the burner is in operation or not, as long as the service switch 3 is closed.

The circuit through the primary side of the high tension transformer indicated at G can be traced as follows:

Commencing with wire 2 of the power circuit, the current passes through wire 35a, contacts 35 and 33, and wire 33a which connects with the primary side of the high tension transformer. The current then passes through wire 33b and contacts 21 and 21a of the relay switch. If this switch is closed the circuit may be completed as the opposite contact 20a is connected with the power circuit wire 1. But if the switch is open no circuit will be established through the primary side of the high tension transformer.

The control circuit is supplied with current from the secondary side 11 of the step-down transformer and it is controlled by the room thermostat indicated at B. For the purpose of description it will be assumed that a room temperature of 72° is to be maintained. If the temperature is 72° or above, switch B will remain open and the control apparatus as a whole will remain inoperative. On the other hand, if the temperature drops below 72°, the room thermostat will close the contacts 13 and 14, or in other words, the control circuit. This circuit can be traced as follows:

Commencing with the terminal 11a of the secondary side of the step-down transform-

er, current passes through wire 14a, contacts 14 and 13, bi-metallic arm 12, wire 13a, wire 45a, contacts 45 and 44, wire 44a, heating coil 31 of the safety switch, wire 31a, wire 16b, the winding 15 of the relay coil, and wire 16a, which connects with the opposite terminal of the secondary side of the step-down transformer. This completes the control circuit controlled by the room thermostat and all that is accomplished is the closing of a circuit through the heating coil of the safety switch and the closing of a circuit through the winding of the relay switch. However, closing of a circuit through the relay switch instantly causes energization thereof, and the vertically movable core 17 is accordingly lifted, thereby causing closing of circuits through the several sets of contacts indicated at 19a, 20a and 21a. These circuits are first, a circuit through the motor 4, secondly, a circuit through the primary side of the high tension transformer G and third, a circuit through the heating coil 40 of the timing switch.

The motor circuit can be traced as follows: Commencing with the power wire 1, the current passes through the switch member 21 and the contacts 21a, wire 1a, the winding of the motor 4, wire 2a, contacts 20a and switch member 20 and the motor circuit is there completed, as one of the contacts 20a is connected with the other side of the power circuit indicated by the wire 2.

The second circuit established, to wit, through the primary side of the high tension transformer can be traced as follows:

Commencing with the power wire 2, the current passes through wire 35a, contacts 35 and 33, and wire 33a which connects with the primary side of the high tension transformer. The current then passes through the winding and wires 33b and 1a, which are connected with contacts 21 and 21a of the relay switch, the circuit being completed through the opposite contact 21a and wire 1.

The third circuit established by the closing of the relay switch, to wit, a circuit through the heating coil 40 of the timing switch, can be traced as follows:

Commencing with the terminal 11a of the secondary side 11 of the step-down transformer, the current passes through wire 14a, contacts 13 and 14 of the room thermostat, arm 12, wire 13a, wire 40a, heating coil 40 of the timing switch, wire 40b, contacts 19a and switch member 19 of the relay switch, wire 16b, winding 15 of the relay switch, and wire 16a which connects with the opposite terminal of the secondary side 11 of the step-down transformer. This completes the third circuit established by the relay switch.

The closing of these three circuits, first of all causes the motor to start. It secondly produces a spark at the gap of the plug 8 of sufficient intensity to ignite the oil, and third

starts heating of the bi-metallic arm 30 of the safety switch, and partial heating of the bi-metallic arm 38 of the timing switch. In other words, the oil burner is started, and the oil is ignited.

The spark which ignites the oil should only be maintained in operation for a sufficiently long period of time to insure ignition of the oil. Actual practice has determined that the spark may be stopped a short time after ignition has taken place. It is accordingly desirable to break the circuit through the high tension transformer a short time after ignition has taken place as the burner is then operating and has been running a sufficiently long period of time to raise the temperature of the fire box high enough to maintain combustion. The timing switch serves the function of breaking this circuit. It will not, however, operate until the stack switch has operated, as sufficient current to heat the bi-metallic arm 38 of the timing switch is not available until the circuit through the heating coil 31 of the safety switch is broken. This circuit breaks when the stack switch operates and the full current is then directed through the heating coil 40.

In actual practice it takes approximately one minute of time to heat the bi-metallic arm 38 of the timing switch through means of the heating coil 40 to a sufficient degree to cause tilting of the tube 32. The tube tilts a sufficient amount within one minute's time to break the circuit through the contacts 34 and 35, thus not only breaking the circuit through the primary side of the high tension transformer, but also breaking the circuit through the primary side 10 of the step-down transformer, as this is controlled through the contact 35.

It may here be stated that the circuit through the primary side of the step-down transformer may be broken or established at three different points, first through the contacts 34 and 35 of the timing switch, secondly through the contacts 46 and 47 of the stack switch, and third through the contacts 27 and 28 of the safety switch.

It has been stated that the stack switch always operates before the timing switch, hence establishing a circuit through the primary 10 of the step-down transformer through the contacts 46 and 47 before the circuit is broken by the timing switch through the contacts 34 and 35.

The circuit through the contacts 46 and 47 can be traced as follows:

Commencing with the power circuit 1, current passes through wire 1b, primary winding 10 of the step-down transformer, wire 1c, contacts 27 and 28 of the safety switch, wire 47a, contacts 47 and 46, and wire 2 which represents the other side of the power circuit. Hence breaking of the circuit through the primary side of the step-down transformer

through means of the timing switch will cause no interruption in the operation of the control apparatus as the circuit through the primary side of the step-down transformer has already been established through the contacts 46 and 47 of the stack switch.

In actual operation, if the burner has been started and the flame ignites it is obvious that hot gases will discharge through the stack indicated at H, and that the bi-metallic arm 49 of the stack switch will instantly commence to heat up.

In actual practice, it takes approximately from $\frac{1}{4}$ to $\frac{1}{2}$ minute to heat up the bi-metallic arm 49 of the stack switch sufficiently to cause it to tilt the tubes 42 and 43. When the tubes are tilted, due to the discharge of the hot gases through the stack, the circuit through the contacts 44 and 45 is broken and the circuit through the contacts 46 and 47 is closed. The contacts 44 and 45 control the circuit through the heating coil 31 of the safety switch only, and accordingly breaks this circuit. This is essential, as continuation of said circuit would cause the safety switch to trip and this is not intended unless something is wrong with the system, as will hereinafter be described.

The contacts 46 and 47 control only one circuit, to wit, the second circuit established through the primary side of the step-down transformer, which has already been described. If everything is functioning properly, the stack switch will continue to remain in a position where a circuit through the contacts 46 and 47 and the primary side of the step-down transformer remains closed. The motor circuit will remain closed, and so will the circuit through the heating coil of the timing switch.

The first circuit established through the primary side of the step-down transformer through means of contacts 34 and 35 will, however, remain broken and so will the circuit through the heating coil 31 of the safety switch and the circuit through the primary side of the high tension transformer. The moment, however operation of the burner causes the temperature in the room to reach 72° , or more in temperature, contacts 13 and 14 separate and the control circuit will break. The entire apparatus will, in that case, become inoperative as breaking of the control circuit by opening of the contacts 13 and 14 first of all breaks the circuit through the secondary side of the step-down transformer. This in turn causes de-energization of the relay switch C, and when this becomes de-energized it breaks the circuit through the motor 4 and the heating coil 40 of the timing switch.

The circuit through the primary side of the step-down transformer will also momentarily break, as the stack switch rapidly returns to the starting position shown in the drawing,

but it will be re-established in approximately two minutes time as the timing switch will also return to the starting position shown in the drawing, and when this position is reached the circuit through the primary side of the step-down transformer is again closed through the contacts 34 and 35. This is essential as the control circuit would be inoperative unless a circuit was continuously maintained through the primary side of the step-down transformer.

There are a number of things that might happen with a system of this character.

1. Failure of the room thermostat to close the contacts 13 and 14. This is of no particular importance as the burner and the control apparatus would merely remain operative and the house would gradually cool down.

2. If the room thermostat functions properly and closes the control circuit, the burner will start, but the ignition may fail, either through a break in the circuit, shorting of the spark plug, or whatever the case may be. Again it is possible that there might be a stoppage in the oil line, so that no oil would be delivered. In this case, the stack switch would fail to operate and the circuit through the heating coil 31 of the safety switch would therefore not be broken. In that case, the motor would continue to operate until the safety switch tripped, when the entire apparatus would become inoperative, as breaking of the circuits through the safety switch breaks the circuit through the primary side of the step down transformer.

Furthermore, it would be impossible to start the apparatus after the safety switch has been tripped until it has been manually reset, as there are no other means of resetting it. In fact, tripping of the safety switch would indicate that something was radically wrong and required repair, adjustment or whatever the case might be.

The relay switch, together with the transformers and switches employed are so arranged that failure of any one to function will render the entire apparatus inoperative. For instance, if the relay switch fails to operate several circuits including the motor circuit will remain open and nothing will happen. If the timing switch fails to operate, the worst that could happen would be that the terminals of the spark may burn up as the circuit through the high tension transformer will not be broken.

If the stack switch fails to operate the apparatus as a whole will become inoperative, as the circuit through the heating coil 31 of the safety switch will remain closed and this will trip and thereby render the apparatus inoperative. Accordingly, it will be noted that as long as the several parts of the apparatus are functioning properly, the burner will be automatically shut off and turned on

as required. On the other hand, if any part of the control mechanism or the oil delivery to the burner should fail, the apparatus as a whole will shut down and will remain so until the proper repair or adjustment has been made, hence eliminating all danger of flooding the fire box, creating explosion, etc.

If the burner has been shut off for a period of time and the timing switch sticks or fails to return to normal starting position, then it will be impossible to start the burner as the current through the primary side of the step-down transformer will be broken through the contacts 35 and 34. Also it will be noted that if the burner is operating and a flame failure should occur from oil stoppage etc., then the current through the primary side of the step-down transformer will be broken between contacts 46 and 47—the parallel contacts 35 and 34 will already be broken by virtue of the timing switch being in running or open position, hence current flow through the transformer will stop, causing de-energization of the relay switch and breaking the motor circuit, etc.

If the stack switch should fail to return to normal position after the burner is shut-down it will be impossible to again start the burner as the control circuit will be broken through the contacts 44 and 45, thereby preventing energization of the relay switch and closing of the circuits controlled thereby.

An important feature of the present invention is the fact that the burner cannot be started and reignited after it has once been shut down until a certain predetermined period of time has passed, this being important as it is essential to clear the fire box of any accumulated gases. If such gases were not removed before starting the burner again the spark of the plug 8 might ignite the gases and cause an explosion. In order to prevent this the apparatus functions as follows:

Supposing that the apparatus is functioning normally and that the burner is in operation. For some reason or other the oil flow is shut off, for instance by foreign matter forming an obstruction in the oil line. In that case the flame will be extinguished and the stack switch will immediately begin to return to normal position as hot gases are not discharging through the stack. The stack switch returns to normal position usually within half a minute and when it returns it breaks the primary circuit through the step-down transformer A, thus causing the relay to become de-energized and the several circuits, including the motor circuit to be broken. The burner is thus stopped.

The circuit through the heating coil 40 of the timing switch is also broken in that instance and the timing switch is so designed that it will require approximately two minutes for it to return to normal position so

as to reestablish a circuit through the primary side of the step-down transformer. The time required for the timing switch to return to normal position, as previously stated, is predetermined and it represents the time required to clear the fire box of gases. Hence if the burner is again started, there is no danger of an explosion.

Power failure on the main circuit will, of course, render the apparatus inoperative and shut off the motor. Momentary opening of the circuit through the room thermostat will also cause closing down of the apparatus as a whole, the main feature being that momentary or temporary failure of any character whatsoever causes the apparatus to close down for a predetermined period of time before it can again start, this period of time being determined by the time required to return the timing switch to starting position.

If serious trouble of any type is encountered, the apparatus is permanently shut down by tripping of the safety switch and as this can only be manually reset it is obvious that the operator will determine the cause of trouble before resetting.

While certain features of the present invention are more or less specifically described, I wish it understood that various changes may be resorted to within the scope of the appended claims, similarly that the materials and finishes of the several parts employed may be such as the manufacturer may decide, or varying conditions or uses may demand.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a control system of the character described a power circuit, an electric motor in said circuit; a step-down transformer and a high tension transformer, each having a primary and a secondary winding; the primary windings of both transformers being in the power circuit; an oil burner actuated by the motor; an ignition device actuated by the secondary of the high tension transformer; a control circuit supplied with current from the secondary of the step-down transformer; a relay in the control circuit; means actuated by the relay for making or breaking the power circuit through the motor and the primary of the high tension transformer; other means energized by the control circuit for automatically breaking the power circuit through the high tension transformer and the ignition device actuated thereby after ignition of the oil burner is insured; means in the power circuit for automatically breaking the power circuit through the primary of the step-down transformer if the flame of the burner becomes extinguished; said other means adapted to automatically re-establish the power circuit through the

primary of the step-down transformer a predetermined time period after said last named means has broken said circuit.

2. In a control system of the character described a power circuit, an electric motor in said circuit; a step-down transformer and a high tension transformer, each having a primary and a secondary winding; the primary windings of both transformers being in the power circuit; an oil burner actuated by the motor; an ignition device actuated by the secondary of the high tension transformer; a control circuit supplied with current from the secondary of the step-down transformer; a relay in the control circuit; means actuated by the relay for making or breaking the power circuit through the motor and the primary of the high tension transformer; a temperature actuated timing device energized by the control circuit adapted to automatically break the power circuit through the primary of the high tension transformer and the ignition device actuated thereby after ignition of the oil burner is insured; a stack switch adapted to automatically break the power circuit through the primary of the step-down transformer if the flame of the burner becomes extinguished; and means on the timing device for automatically re-establishing the power circuit through the primary of the step-down transformer a predetermined time period after said circuit has been broken by the stack switch.

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