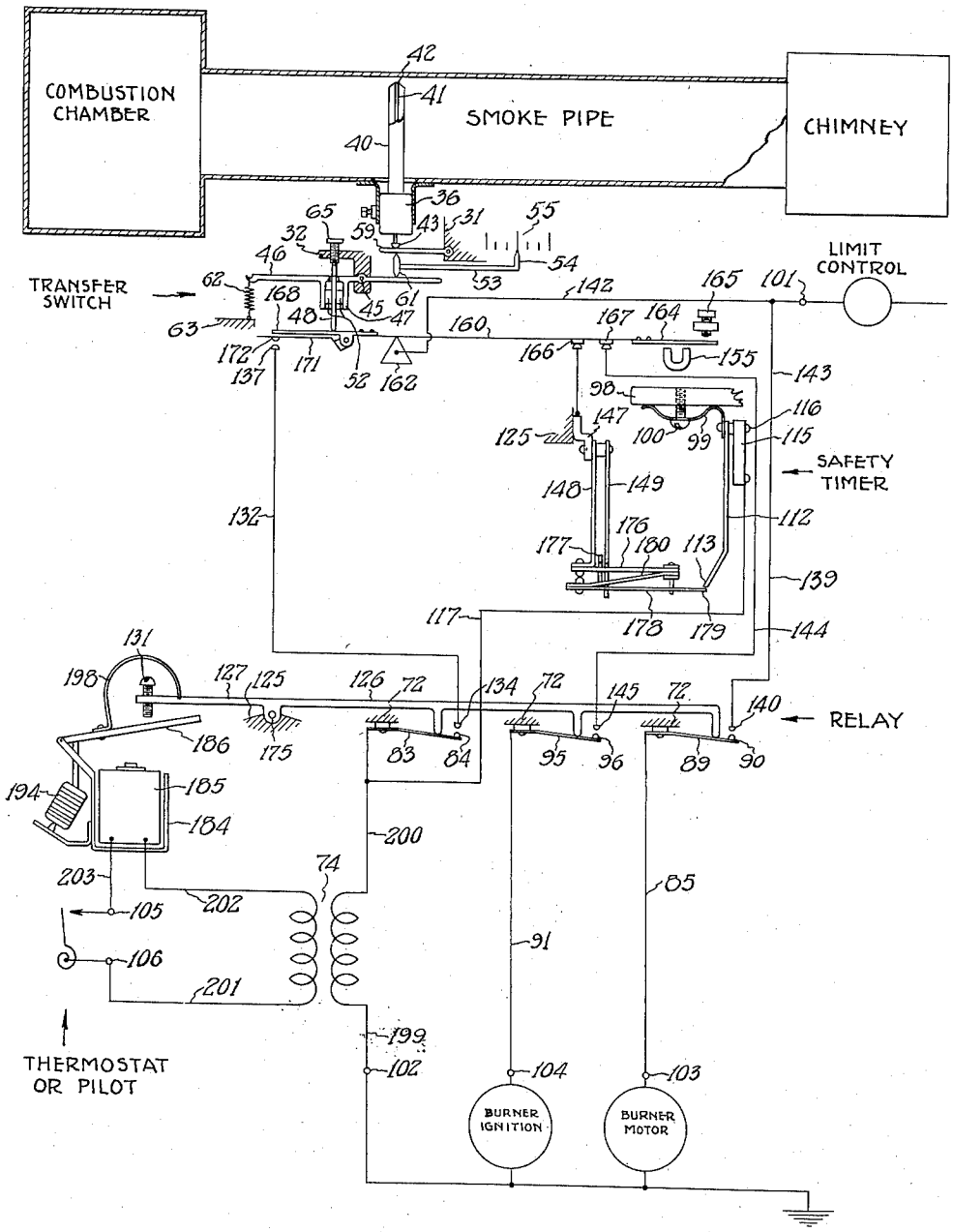
Jan. 8, 1952 L. L. CUNNINGHAM ET AL 2,581,636

OIL BURNER SAFETY CONTROL SYSTEM

Filed April 9, 1948



INVENTORS
LEWIS L. CUNNINGHAM
ALBERT L. JUDSON

BY E. B. Richenbrand.

ATTORNEY

Patented Jan. 8, 1952

2,581,636

UNITED STATES PATENT OFFICE

2,581,636

OIL BURNER SAFETY CONTROL SYSTEM

Lewis L. Cunningham, Sherman Oaks, Calif., and Albert L. Judson, Portland, Oreg., assignors to Iron Fireman Manufacturing Company, Portland, Oreg.

Application April 9, 1948, Serial No. 20,008

4 Claims. (Cl. 158—28)

1

This invention relates generally to electrically operated and controlled oil burners and more particularly to the control of the driving motor and the ignition mechanism of such a burner.

An electrically operated oil fired heating system generally requires the use of a temperature or pressure responsive limit control, a condition responsive control, and a combustion temperature responsive primary control including relay and safety functions. Limit controls such as pressure controls and furnace switches are well known as are also condition responsive controls such as pressure regulators and thermostats. Instruments of these types are used with the primary control of this invention but are not part of the invention.

It is an object of this invention to provide a primary control having a direct, reliable and greatly simplified circuit scheme which can be readily understood by a service man.

The methods and mechanisms for accomplishing these and other objects are explained in the following description referring to the single figure of the attached drawing which shows diagrammatically the circuits and mechanism of this invention.

Referring to the single figure of the drawing there is shown a combustion chamber connected by a smoke pipe to a chimney. For purposes of description it is assumed that the combustion chamber is surrounded by a chamber through which is circulated a heating medium such as air or water which is transported in the usual way to a space to be heated. The thermostat instrument is assumed to be in the space or medium whose temperature is to be controlled and the limit control is assumed to be so situated as to be responsive to the temperature of the heating medium surrounding the combustion chamber.

As shown in the figure, tension spring 62 acting through lever 46, adjustable fulcrum 61, and lever 59, biases temperature insensitive stem 41 toward the smokepipe where it bottoms on the inner end of temperature sensitive tube 40. As the temperature in the smokepipe increases stem 41 recedes in the smokepipe and the left end of lever 46 is moved downward by spring 62. As temperature in the smokepipe decreases, tube 40 contracts forcing stem 41 downward and the left end of lever 46 upward against the bias of spring 62. The relative movements of stem 41 and lever 46 is adjustable by right or left movement of fulcrum 61 and is indicated by pointer 54 on scale 55. Held in lever 46 are friction blocks 52 which frictionally engage stem 48 and cause stem 48 to travel with lever 46 within the range of movement determined by the adjustable top 65 in the cooling direction and by the limit of throw of resilient switch arm 160, to which lever 168 is secured, in the heating direction. Resilient switch arm 160 is biased towards the open position of contacts 137, 172 and towards the closed positions of contact pairs 166 and 167 by the action of permanent magnet 155 on armature 164 secured to arm 160. Arm 160 is stiff enough for the lever action of blade 168, when forced by stem 48, to cause armature 164 to overcome the biasing action of magnet 155 and come to rest against adjustable stop 165.

2

The safety timing switch has two bimetal blades 149 and 112 substantially parallel and similarly affected by ambient temperature. Additionally blade 112 is affected by its associated electric resistance heater 115 when the circuit in which the heater is connected is energized. Resilient blade 148 carries insulating rigid bar 176 to which it is riveted with silvered rivets. Bar 176 is secured with a hollow rivet to conducting resilient leaf spring 180. Leaf spring 180 is secured with silvered rivets to stiff conducting bridge 178. A depending tongue on bimetal blade 149 inserts through slots in bar 176, leaf 180 and bridge 178 and bears laterally on bridge 178 to compensate for the effect of ambient temperature on blade 112 and therefore to maintain the proper relation of the right hand end of bridge 178 with the lower end of blade 112 with which it is normally engaged. When electric current passes through resistance heater 115 for a predetermined time bimetal blade 112 warps to the right sufficiently to slide off the end of bridge 178 the right end of which is biased upwardly by both support 148 and leaf 180. When this occurs the circuit from blade 148 to blade 112 is interrupted both at the junction of bridge 178 and blade 112 and by the separation of the rivet heads at the left end of bridge 178 from the rivet heads at the lower end of blade 148. To reset the switch it is necessary to allow blade 112 to cool and then manually to press the right end of bridge 178 downward until blade 112 can spring back into place over the right end of bridge 178.

The relay switch comprises three stationary contacts 134, 145, and 140 and three moving contacts 84, 96, and 90, carried respectively on resilient switch blades 83, 95, and 89, formed to bias the moving contacts towards their respective stationary contacts. The relay operator comprises frame 184, coil 185, armature 186 hinged to frame 184 and toggle compression spring 194 biasing armature 186 to the open position of the switch contacts as shown. Operating lever 126 linked to

armature 186 by adjustable stop screw 131 and arcuate spring 198 allows the switch contacts to close when coil 185 is energized and opens the switch contacts due to the action of spring 194 overcoming the bias of blades 83, 95, and 89 when coil 185 is de-energized.

In actual use with an oil fired heating system, the primary control is usually mounted with heat responsive tube 40 extending into a smoke pipe connecting a combustion chamber with a chimney. The primary control is supported on tube 36 which extends into a close fitting flanged collar attached to the smoke pipe. The electric service will usually be single phase, 110 volt, 60 cycle having two service wires one of which will be at earth potential. The service will be supplied through a fused switch and then the grounded line will be brought in to terminal 102 of the primary control while the hot line will be connected through a suitable limit control and then connected to terminal 101 of the primary control. The oil burner driving motor will be connected between terminals 103 and 102 of the primary control and the oil burner ignition transformer will have its primary (110 volt) winding connected between terminals 104 and 102 of the primary control. A condition responsive instrument which will usually be a thermostat in the space to be heated is connected across terminals 105 and 106 of the primary control.

When there is no call for heat the thermostat will be in open circuit position, no current will be drawn from the low voltage winding of transformer 74, the relay coil 185 will be un-energized, toggle spring 194 will have forced armature 186 upward taking with it tail 127 of relay lever 126 which will be forced downward and by pressure on contact-carrying and closing springs 83, 89, 95 will have opened the three pairs of relay contacts 84—134, 90—140 and 96—145. The smoke pipe is cool or cooling and heat responsive tube 40 has been contracting, forcing head 43 of heat insensitive tube 41 against lever 59 which in turn presses button 61 against lever 46 overcoming force of spring 62 and through friction of block 52 raising stem 43 thus allowing magnet 155 by its attraction of armature 164 to rotate switch blade 160 clockwise, opening contacts 137—172 and closing contacts 166 and 167 against their respective mating stationary contacts.

The only closed circuit through the primary control is from terminal 101, through 142, hinge 162, blade 160, contact 166, conductor 147, support 148, rivet head contacts between 148 and 178, contacts 179, 113, bimetal 112, bolt 116, resistance 115, conductor 117, conductor 200, primary winding of transformer 74, and conductor 199 to terminal 102. Only the small magnetizing current of transformer 74 will be flowing through this circuit.

It particularly should be noted that contact blade 171 is frictionally hinged to blade 168 and that the motion of blade 171 is limited between an upward stop and contact 137. This novel arrangement combined with the magnetically biased action of the right end of blade 160 assures the essential relative action of the contacts at the two ends of blade 160, which is that as blade 160 rotates clockwise contact 172 will leave contact 137 before contacts 166 and 167 "make" their respective stationary contacts and that as blade 160 rotates counterclockwise contact 172 will "make" contact 137 before contact 166 and 167 leave their respective stationary contacts.

Now assume that there is a call for heat and the thermostat closes the secondary circuit of transformer 74 through the relay coil 185. Relay armature 186 is attracted downward taking with it tail 127 of lever 126 which lifts and allows spring members 83, 95 and 89 to close relay contacts 84—134, 96—145, and 90—140. The burner motor is energized through circuit 101, 143, 139, 140, 90, 89, 85, and 103. The ignition transformer is energized through circuits 101, 142, 162, 167, 144, 145, 96, 95, 91, and 104. Since current is flowing through the transformer secondary an equivalent load current will traverse the primary winding and this relatively large increase over the small charging current previously flowing will greatly augment the heating effect of resistance 115 on bimetal 112. Screw 109 previously has been adjusted so that with the transformer load current through resistance 115 bimetal 112 will absorb enough heat to flex to the right and slip point 113 off the end of tongue 179 in approximately ninety seconds (or any other chosen value of time) if the current continues to flow.

Assuming that fuel is available and the burner is working properly the products of combustion will flow from the combustion chamber to the chimney through the smoke pipe and surrounding heat sensitive element 40. As the temperature of the products of combustion rises element 40 elongates and element 41 retracts allowing spring 62 to pull stem 43 downward through frictional engagement with bracket 47 of lever 46. Strap 168 moves downward under the influence of blade 43 and takes with it switch blade 171 and contact 172 which closes on contact 137 and thus closes a circuit between blade 160, 168, 171, 172, 137, 132, 134, 94, 93, and 200, and by-passes the transformer primary current around the circuit of heater 115 so that bimetal 112 starts to cool. Further downward motion of blade 171 by strap 168 is stopped and taken up in the frictional hinge betweeen 171 and 168, but as strap 168 is further depressed by blade 43, due to a further rise in temperature of the stack gases, blade 160 is strained over hinge support 162 and armature 164 is suddenly lifted away from magnet 155 and contacts 166 and 167 are freed from contact with their respective mating contacts. After this only two circuits are complete through the control, one to the burner motor through relay contacts 140, 90 and the other through the transformer primary of transformer 74 through transfer switch contacts 172, 137 and relay contacts 134, 84. Ignition is no longer necessary and this circuit is interrupted by the raising of contact 167. After this with everything running normally which means, essentially, that the stack gas temperature is stationary or trending upward the burner will continue to operate as long as the pull of the relay coil on armature 186 is greater than the armature opening thrust of spring 194. Spring 194 will open the relay if the line voltage (and therefore the relay coil voltage) becomes less than sufficient to safely operate the burner motor or if the thermostat is satisfied and opens the low voltage circuit to the relay coil. Should the thermostat not be satisfied but the relay opens due to low voltage all circuits through the control will be interrupted and even though the proper voltage is again immediately available the burner will not start until the stack temperature has dropped sufficiently first to open contacts 172, 137 and then close contacts 166 and 167 against their respective mating contacts, thus returning the control to its original starting condition.

Again assume that the burner has been started as before but that due to lack of fuel, or other fuel or air difficulty, or due to a fault in the ignition system, the fire is not ignited and the stack gases do not rise in temperature. Friction stem 43 does not move down and transfer switch blade 160 does not move. Transformer primary current continues to traverse heater 115 and the temperature of bi-metal 112 increases until after about ninety seconds point 113 moves to the right enough to slip off the end of tongue 179 of bridge 178. Biasing spring leaf 148 tips insulator 176 upward and to the right and due to gravitational unbalance as well as the biasing action of leaf spring 180, bridge 178 falls away at its left end and breaks the circuit contact between the rivets holding 148 to 176 and the rivets holding 178 to 180. Bridge member 178 remains supported from insulator 176 by the loose rivet at its right end and the T-shaped ear near its left end extending through the central slot in insulator 176 and with its T head resting on the top of insulator 176 at each side of the slot. With the transformer primary circuit thus broken at both ends of bridge 178 the relay drops open and the burner motor stops. Nor can a circuit through the control be reestablished until bi-metal 112 cools and moves to the left sufficiently for point 113 to be in position to latch with tongue 179 of bridge 178. This relatching of 113 and 179 can only be done manually and is accomplished by means of manually turnable knurled knob 205 to which is secured crank 206 journalled in switch cover 121 and biased in a counterclockwise direction by spring 207. Crank 206 is limited in its rotation by forward stop 208 and backward stop 209 molded on the inside of cover 121. When cover 121 is in position over switch base 72, crank arm 206 extends into the space above insulator 176 and between bi-metal elements 112 and 149. Due to biasing spring 207, arm 206 normally rests against back stop 209. But when knob 205 is rotated to the right, arm 206 contacts the top of insulator 176 and further movement crowds tongue 179 past point 113 which then springs back into position and latches bridge 178 in its heater circuit closing position.

It should be noted that unheated bi-metal strip 149 has a narrow tongue at its lower end which extends through slots in insulator 176 and bridge 178. When insulator 176 is pushed downward by crank 206 against the bias of conducting spring leaf support 148, all members supported by leaf 148 are moved to the left and the right edge of the slot in insulator 176 contacts the tongue of bi-metal 149. Bi-metal 149 as well as bi-metal 112 are influenced by the same ambient temperature and with bi-metal 149 biased against the right edge of the slot in insulator 176 it is seen that all of the parts supported from leaf 148 are constrained by bi-metal 149 to take a lateral position responsive to the ambient temperature of bi-metal 149. Since bi-metal 112 is subject to the same ambient temperature it is seen that the degree of overlap of point 113 and tongue 179 is not affected by ambient temperature and therefore the timing of the release of tongue 179 by point 113 is affected only by the heat received from resistor 115 by bi-metal 112. We believe this to be a new and effectively compensated safety timing switch for a primary control.

Now assume that the burner has started normally as above described, the smoke pipe temperature has come up to operating normal and the transfer switch has cut off the burner ignition system. Then assume that something happens to the fire such as running out of oil, partial clogging of the oil nozzle, water in the oil, etc., so that the flame is interrupted and if the burner were to continue to operate a dangerous condition might develop. Any of these conditions would be indicated by a temporary or a continued reduction in the temperature of the products of combustion which would be felt immediately by temperature responsive element 40 and transfer switch contacts 172, 137 would separate thus dropping out the relay and shutting down the burner, after which there would have to be a sufficient time delay for the stack gases to cool sufficiently for transfer switch contacts 166, 167 to close against their respective mating contacts before the burner would again be startable. In restarting if the flame trouble had been corrected the burner would start normally and continue to operate but if the difficulty persisted and the flame did not come up normally within the safety time (say ninety seconds), heater 115 would influence bi-metal 112 to shut the burner down as previously described.

Having thus fully disclosed the circuit of our invention and forms of mechanisms which can be used therewith, and having described the operation thereof, we have defined the invention by the appended claims.

We claim:

1. In a control system for an oil burner, a first circuit including a first pair of relay switch contacts and a burner motor, a second circuit including a first pair of transfer switch contacts, a second pair of relay switch contacts and ignition means for said burner, a third circuit including a second pair of transfer switch contacts, a normally closed safety timing switch, an electrically energized actuator for said timing switch and the primary coil of a transformer, a fourth circuit including a third pair of transfer switch contacts and a third pair of relay switch contacts, a fifth circuit including the secondary coil of said transformer, a relay operating coil and condition responsive means for closing said fifth circuit to energize said relay coil, means for closing said relay contacts when said relay coil is energized and opening said relay contacts when said relay coil is de-energized, said first, second, and third circuits being connected in parallel across a source of electric power, said fourth circuit being connected in parallel across the transfer switch contacts and the safety switch of said third circuit, and oil burner combustion temperature responsive means for sequentially closing said third pair of transfer switch contacts and opening said first and second pairs of transfer switch contacts when said combustion temperature is trending upward and for sequentially opening said third pair of transfer switch contacts and closing said first and second pairs of transfer switch contacts when said combustion temperature is trending downward.

2. In a control system for an oil burner, a first circuit including a first pair of relay switch contacts and a burner motor, a second circuit including a first pair of transfer switch contacts, a normally closed safety timing switch, an electrically energized actuator for said timing switch and the primary coil of a transformer, a third circuit including a second pair of transfer switch contacts and a second pair of relay switch contacts, a fourth circuit including the secondary coil of said transformer, a relay operating coil and condition responsive means for closing said fourth

circuit to energize said relay coil; means for closing said relay contacts when said relay coil is energized and opening said relay contacts when said relay coil is de-energized; said first and second circuits being connected in parallel across a source of electric power; said third circuit being connected in parallel across the transfer switch contacts and the safety switch of said second circuit, and oil burner combustion temperature responsive means for sequentially closing said second pair of transfer switch contacts and opening said first pair of transfer switch contacts when said combustion temperature is trending upward and for sequentially opening said second pair of transfer switch contacts and closing said first pair of transfer switch contacts when said combustion temperature is trending downward.

3. An electric control system for liquid fuel burners comprising a high voltage supply, a step down transformer having a primary winding and a secondary winding, a first combustion responsive switch which is closed on lack of combustion and opened when combustion occurs, a second combustion responsive switch which is opened on lack of combustion and closed when combustion occurs, means for connecting said primary winding to said high voltage supply including said second combustion responsive switch and a first normally open switch, means for connecting said primary winding to said high voltage supply including said first combustion responsive switch a delay switch and an electrically energized operator for said delay switch, an ignition means, a third combustion responsive switch which is closed on lack of combustion and opened when combustion occurs, means for connecting said ignition means to said high voltage supply including said third combustion responsive switch and a second normally open switch, a burner motor, means for connecting said burner motor to said high voltage supply including a third normally open switch, a relay having an operating coil, means for connecting said relay coil to said secondary winding including a condition responsive switch and thereby loading said primary winding of said transformer with the equivalent load of said relay coil on said secondary winding, and means operatively associated with said relay coil for closing said first, second and third normally open switches when said relay coil is energized, whereby when said primary winding is energized through said first combustion responsive switch said delay switch and said delay switch operator, and said condition responsive switch is closed, said delay switch operator will cause said delay switch to open unless said first combustion responsive switch is opened by an increase in combustion within the delay time for which said delay switch is pre-set.

4. In a control system for an oil burner: a first circuit including a burner motor and a first normally open switch; a second circuit including a first pair of transfer switch contacts, a normally closed safety timing switch, an electrically energized actuator for said timing switch and an electric load; a third circuit including a second pair of transfer switch contacts and a second normally open switch; and means for sequentially closing said second pair of transfer switch contacts and opening said first pair of transfer switch contacts on a rise of combustion temperature, and for sequentially opening said second pair of transfer switch contacts and closing said first pair of transfer switch contacts on a decrease in combustion temperature; said first and second circuits being connected in parallel across a source of electric power; said third circuit being connected in parallel with that part of said second circuit which includes said transfer switch contacts, said safety timing switch and said actuator; and said electric load including means operable for closing and opening said first and second normally open switches in response to a condition.

LEWIS L. CUNNINGHAM.
ALBERT L. JUDSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,366,731	Hoeschen	Jan. 25, 1921
1,376,462	Robertshaw	May 3, 1921
1,834,288	McCabe	Dec. 1, 1931
1,941,540	Denison et al.	Jan. 2, 1934
1,948,938	Lawton	Feb. 27, 1934
1,991,185	Williams	Feb. 12, 1935
2,021,407	Erickson	Nov. 19, 1935
2,022,188	Denison	Nov. 26, 1935
2,117,021	Cotea	May 10, 1938
2,195,649	Hallenbeck	Apr. 2, 1940