Oct. 1, 1957 R. E. BRESSLER 2,808,209

FUEL BURNER CONTROL APPARATUS

Filed June 30, 1953 2 Sheets-Sheet 1

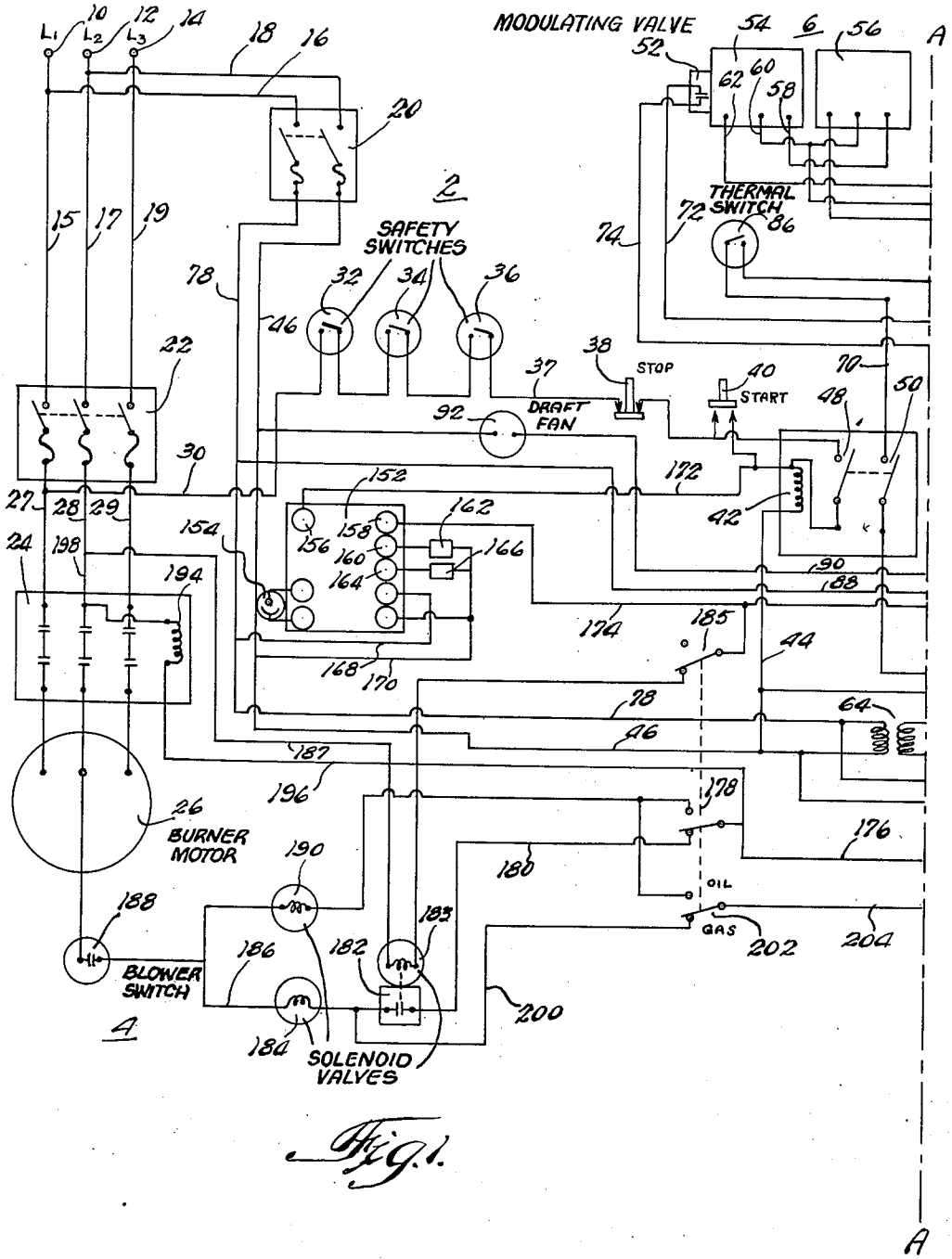


Fig. 1.

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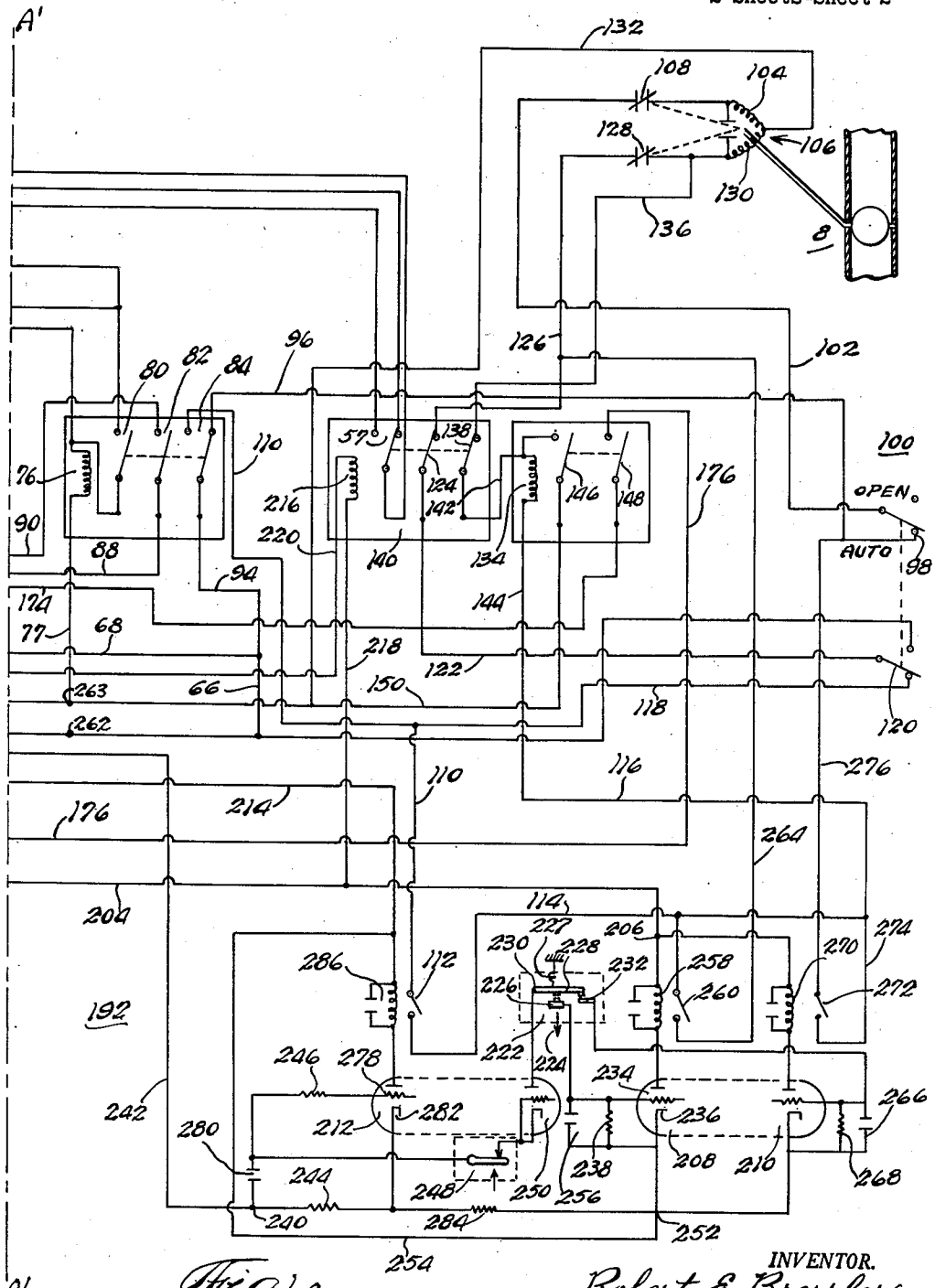


Fig. 1A.

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2,808,209

Patented Oct. 1, 1957

2,808,209

FUEL BURNER CONTROL APPARATUS

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Application June 30, 1953, Serial No. 365,057

12 Claims. (Cl. 236—1)

This invention relates to fuel burner control apparatus and more particularly to an improved control device for effecting the sequential operation of the various elements of a fuel-burning system.

It is an important object of this invention to provide an improved burner control for maintaining optimum efficiency and safety in a fuel-burning system.

Systems of burner control have heretofore been proposed, designed primarily to insure safe operation of the system under varying conditions and in the event of failure of particular elements in the system. These have generally included a flame detector, either a flame electrode or photocell, adapted to energize an electronic circuit to indicate the existence of a flame in the burner. In the event of flame failure the apparatus was automatically adapted to close the fuel valves to prevent a dangerous accumulation of fuel in the burner. Some systems have heretofore been proposed which automatically control the damper position in a fuel-burning system whereby an optimum fuel-air ratio is maintained during the burning portions of an operating cycle. Such systems have not, however, provided for optimum damper positioning during the quiescent or inoperative periods of the burner.

It is therefore a further object of this invention to provide a burner sequence control which will control the draft within such a burner for optimum performance during burning and quiescent portions of an operating cycle.

It is another object of this invention to provide an improved burner control system adapted for use with any common fuel such as oil, coal, or gas.

It is another object of this invention to provide a damper control in an improved burner control system which will maintain a minimum draft during quiescent periods in an operating cycle whereby stack temperature will be maintained near the operating level between burning cycles.

It is still another object of this invention to provide an improved burner control system wherein the damper determining burner draft will automatically be placed in a maximum draft position prior to the commencement of a burner cycle, whereby excess fuel or combustion products which might be contained within the burner chamber will be purged therefrom.

It is still another object of this invention to provide an improved burner control which will, in the event of flame failure, close the fuel supply valve to the burner and place the damper or draft control in such a position that maximum draft is provided, thus preventing the accumulation of excess unburned fuel in the chamber.

It is an additional object of this invention to provide an improved burner control utilizing an electronic device for positioning a draft-modulating damper, which includes time delay apparatus whereby the pressure within the burner stack may be maintained at an optimum level corrected to maintain the draft with less variation than the normal fire pulsations.

It is still another object of this invention to provide an improved burner sequence control which will regulate the draft in the system to within a pressure variation of ±.005 inch of water.

It is another object of this invention to provide improved apparatus for burner control wherein the motion of a draft-controlling damper to the substantially open position actuates all subsequent operations necessary to place the system in a burning cycle.

It is a further object of this invention to provide means to sense a draft condition below a predetermined minimum which will place the system in a quiescent state and so maintain it until the condition is corrected.

It is a further object of this invention to provide a fuel burner control which will always commence a burning cycle with a predetermined minimum fuel flow.

Further and additional objects of this invention will become manifest from a consideration of this description, the accompanying drawings, and the appended claims.

In one form of this invention control apparatus is provided which continuously controls a draft-modulating and fuel-modulating device during both the burning and quiescent portions of an operating cycle. More particularly, the subject sequence-control system provides means for maintaining a damper in the optimum position at all times which is in a substantially closed position to produce minimum draft during quiescent periods when energy is not being demanded from the burner. When an energy demand is placed upon the burner control means is actuated to move the damper to a substantially open position and to energize an induced draft fan whereby the air and gases contained within the burning chamber are purged therefrom prior to initiation of a burning cycle. During a burning cycle switch means is actuated to energize the damper control motor from a pressure-sensitive switch whereby the damper will be positioned to produce an optimum predetermened draft within the burner stack for maximum burning efficiency. Time delay means is provided to prevent the continual hunting of the draft control motor in response to short duration changes in the stack draft such as are produced from normal fire pulsation. By the use of such a time delay means the customary snap action switches heretofore utilized in draft control systems are eliminated and a sensitive pressure-responsive switch substituted therefor.

Means is also provided for checking the presence of a flame in the burner, and if the pilot valve and ignition means are functioning properly the flame will be proved and the main fuel valves opened in response to damper opening, whereby full burner operation begins. The fuel-modulating valve will be placed in a position for minimum flow at initiation of a burning cycle to minimize the danger of a puffback resulting from insufficient air in the combustion chamber.

For a more complete understanding of this invention reference should now be made to the accompanying drawings, wherein

Fig. 1 is a circuit diagram of certain portions of one embodiment of the burner control apparatus herein described, and

Fig. 1A is a circuit diagram of the remainder of the circuitry of the embodiment of Fig. 1.

Referring now to the drawings, one embodiment of this invention is illustrated which includes generally safety controls 2, fuel controls 4, fuel modulator 6, draft control 8, and electronic time delay means 192. The operation of the system, broadly stated, is as follows: Upon energization with electric power, if the system is not demanding energy, the fuel controls 4 are maintained closed and the draft control 8 positioned at a minimum

air flow setting. When the system calls for energy an induced draft fan is started and the damper or draft control is moved to a substantially open position to purge the burning chamber. When the flame is proved by the safety controls 2 and the damper 8 is in the fully open position, the main fuel controls 4 are opened, placing control of fuel flow in the fuel modulator 6 which is responsive to the demands of the system. Concurrently, the draft control 8 is placed in circuit with the pressure sensing and time delay circuit 192 which will function as a closed cycle or follow-up control to maintain the air motion within the burning chamber within sharply defined limits. In the event of a fault or failure at any point in the system, the draft control means 8 will move to the maximum open position and the fuel control 4 will be closed to provide maximum safety until the fault is corrected.

The energy necessary for the operation of the burner under consideration is provided from a three-phase commercial supply, the lines L_1, L_2, and L_3 being connected to the terminals 10, 12, and 14, respectively. Extending from the terminals 10 and 12 are conductors 16 and 18 which terminate in a double-pole, single-throw, fused manual control switch 20 which will be normally closed during burner operation. Conductors 15, 17, and 19 are connected from the three terminals 10, 12, and 14 of the three-phase system to a three-pole, single-throw, fused burner control switch 22, which is in turn connected to a solenoid operated three-phase switch 24 by conductors 27, 28, and 29. Conductors extending from the three-phase switch 24 are connected to a burner motor 26 which supplies the main source of mechanical power for operation of the burner.

Energy for the initial actuation of the electronic control apparatus to be described hereinafter is supplied from the conductor 27 which is energized from L_1 through switch 22 and connected through conductor 30 to a low water cut-off switch 32 in series with various other safety control switches such as a fire cord switch 34 and limit control 36. A conductor 37 is connected from limit control 36 to a normally closed push button type switch 38 which is utilized as a Stop button and is in series with a normally open push button switch 40 constituting a Start button. The Start button 40 is in series with a relay coil 42, the other terminal of which is connected through conductors 44 and 46 to one pole of manual switch 20, connected through conductor 18 to terminal 12 and L_2. Thus to initiate operation the normally open push button switch 40 will be depressed, which will complete a circuit from L_1, through switch 22, conductor 30, safety controls 32, 34, and 36, push button switch 38, depressed push button switch 40, relay coil 42, conductors 44 and 46, switch 20, conductor 18, to terminal 12 and L_2. Thus, upon depressing push button 40, coil 42 is energized and associated switches 48 and 50 are closed. The switch 48 is connected in parallel with the push button 40 and will therefore lock in the coil 42, whereby it will remain energized until one of the safety controls 32, 34, or 36, the Stop button 38, or switches 20 or 22 is opened. The switch 50 is in a principal operating circuit which includes an operating control 86 and an end switch 52 on a modulating motor 54 adapted to control the flow of fuel to the burner. The modulating motor 54 is a bidirectional motor normally controlled by a modulating controller 56 which has three conductors 58, 60 and 62 extending therefrom, conductors 58 and 60 controlling forward motion of the motor 54 to close the included fuel valve and conductors 60 and 62 actuating the motor 54 for reverse motion to open the fuel valve. Conductor 58 interconnects motor 54 and controller 56 through transfer switch 57 for a purpose to be described.

If the system is not calling for heat or power, the controller 56 will have actuated the modulating motor 54 to reduce fuel flow to a minimum, whereby the end switch 52 will remain in the closed position. Though switch 50 and end switch 52 are closed, if the system is not demanding energy, the operation control 86 in series therewith remains open and the remainder of the control apparatus maintains quiescence. If the operation controller 86 calls for power or heat, contacts therein are closed completing a circuit through switch 50 and end switch 52 to energize relay coil 76. The energizing circuit may be traced from one terminal 262 of the secondary of a step-down transformer 64 through conductors 66 and 68, actuated switch 50, conductor 70, controller 86, conductor 72, end switch 52, conductor 74, coil 76, and conductor 77 to the other terminal 263 of the secondary of the transformer 64. Energization of coil 76 from the transformer 64, which is in this embodiment a 24-volt step-down transformer the primary of which is energized from terminals L_1 and L_2 through conductors 46 and 78, will close associated normally open switches 80 and 82 and actuate transfer switch 84. The switch 80 is in series with the operating control 86 which may be a thermostat or the like, and this serial combination is in parallel with the end switch 52. Therefore, once the system is set in operation as above described, subsequent opening of the end switch 52 will have no effect if the operating control 86 is still demanding energy and the coil 76 will remain energized. The switch 82 completes a circuit to an induced draft fan motor 92 through conductor 88 connected to L_1 through conductor 78 and conductor 90 connected to the fan, which is in turn connected to L_2 through conductor 46.

The moving element of transfer switch 84 is connected through conductor 94 to terminal 262 of the 24-volt transformer 64. In the normal unactuated position the movable contact of switch 84 is in engagement with a contact connected to conductor 96 which terminates at one fixed contact 98 of a manually operated transfer switch 100. The transfer switch 100 when in the position shown provides for automatic operation of the damper motor to be described, while, when actuated to the upper position in Fig. 1A, manually actuates the damper motor to move the associated damper 8 to the open position. The movable contact of switch 100, in engagement with fixed contact 98, has conductor 102 extending therefrom which is connected to the Close winding 104 of a bidirectional damper control motor 106. A limit switch 108 is provided between the winding 104 and conductor 102 to interrupt the supply of power to the motor when the motor has driven the damper to the fully closed position. Thus by this circuitry, during quiescent periods of burner operation the damper will be maintained in the fully closed position with limit switch 108 maintained open.

When operating control 86 and end switch 52 are closed, thus calling for energy, transfer switch 84 opens the circuit just described and completes a circuit from terminal 262 of the 24-volt transformer 64 through conductors 66 and 94, the actuated transfer switch 84, conductor 110, conductor 118, a second transfer switch 120 in the manual control 100, a conductor 122, normally closed switch 124, conductor 126, limit switch 128, damper motor winding 130, and conductor 132 to the other terminal of the 24-volt transformer 64. This circuit energizes the Open winding 130 of motor 106 and drives the damper 8 to the fully open position. Thus when the system is calling for energy, prior to opening the main fuel valve the damper is driven to the fully open position and the induced draft fan energized. Thereby the burning chamber is purged of any undesirable gases or unburned fuel which might be contained therein. This will prevent explosion of unburned gas, generally characterized as puffing or puffback, which is hazardous and generally causes excessive deterioration of the burning chamber.

To insure opening of the damper prior to opening of the fuel valve, a unique control for subsequent operations is provided by this invention. When the damper motor reaches the fully open position, limit switch 128 is opened,

which places relay coil 134 in series with the damper motor winding 130 across the secondary of 24-volt transformer 64. The relay coil 134 will be a high impedance device and will thus require little energy for actuation, whereby the current flowing in motor winding 130 will not be sufficient to cause motion of the motor though actuating the switches 146 and 148 associated with coil 134.

The circuit for energization of coil 134 may be traced as follows: From one terminal 263 of the secondary of transformer 64, through conductor 132, motor winding 130, conductor 136, normally closed switch 138 of relay 140, conductor 142, coil 134, conductor 144, conductors 116 and 114, closed no-draft switch 112, conductor 110, actuated transfer switch 84, and conductors 94 and 66 to the other terminal 262 of the secondary of transformer 64. Switch 146 is a lock-in device whereby coil 134 will be energized even though the circuit traced above is deenergized by subsequent operation of the damper motor from the full open position. This lock-in circuit may be traced from the terminal 263 of the secondary of transformer 64, through conductor 150, switch contacts 146, coil 134, conductors 144, 116, and 114, no-draft switch 112, conductor 110, transfer switch 84, and conductors 94 and 66, to the terminal 262 of the transformer secondary.

The switch 148 in conjunction with safety control 152 constitutes the main burner control. A typical safety control is indicated by block 152 in Fig. 1, which may be any one of several well-known commercial types. One particular protective device here applicable is the Minneapolis Honeywell R890B relay. Such a safety control generally includes a photocell 154 or a flame electrode substituted therefor which will sense the presence of a pilot flame in the burner chamber. When such a pilot flame is detected a voltage is generated which is amplified by the safety control and after a predetermined time delay will close switch contacts in the main fuel valve circuit and open the igniting circuit.

In the block herein utilized, terminals 156 and 158 are the main valve switch terminals, terminal 160 controls the energy to the ignition transformer 162, and terminal 164 controls the application of energy to the pilot valve 166. The safety control 152 is provided with power from conductors 168 and 170 which are in turn connected to L_1 and L_2 through conductors 78 and 46, respectively. Thus if a flame has been proved by detection through photocell 154, the ignition transformer 164 is deenergized and a circuit completed between terminals 156 and 158. Closing of these contacts in cooperation with the closure of switch 148 will complete a circuit from L_1 through switch 22, conductors 27 and 30, safety controls 32, 34, and 36, push button 38, closed contacts 48, conductor 172, safety control 152, conductor 174, closed switch 148, conductor 176, fuel selector switch 178, conductor 180, auxiliary switch 182, to energize the main fuel valve 184 which is connected through conductor 186, burner blower switch 188, electromagnetic switch 24, and manually operated switch 22, to terminal 12. Burner blower switch 188 may be any pressure-sensitive switch adapted to open whenever the burner pressure falls below a predetermined minimum. Auxiliary switch 182 is closed by the energization of coil 183 whenever the main switches are closed and the flame has been proved through safety control 152. The circuit for auxiliary switch coil 183 is from L_1 through safety switch 152, a pair of contacts 185 on the fuel selector switch, coil 183, conductor 187, to conductor 28 which is connected indirectly to L_2. While main gas valve 184 is a very slow acting valve, auxiliary safety shut-off valve 183 is a snap action valve requiring manual reset for maximum safety.

Completion of the circuit above described will open the main fuel valve and will further supply voltage to the time delay mechanism 192 and relay coil 194 in the burner control switch 24. These circuits may be traced as follows: For the coil 194 of switch 24, from L_1 to terminal 156 of safety control 152 through the safety control, which includes a completed circuit as a result of the proved flame, to terminal 158 which is connected through conductor 174, closed switch 148, conductors 176 and 196, coil 194, conductor 28, and switch 22 to L_2. Conductor 176 is also connected through fuel selector switch 178, conductor 180, auxiliary switch 182, conductor 200, contacts 202 of the selector switch 178, and conductor 204, to a common terminal 206 which provides plate voltage for the tube elements 208 and 210 of the timer 192.

The selector switch 178 is utilized to select between an oil and gas system of firing in this embodiment. As shown here, the switch is in the gas position, and operation utilizing an oil supply will be substantially the same as that herein described, differing only in the position of switch 178 and the use of an oil fuel valve 190 in substitution for the fuel valve 184 just described. The filaments associated with the tubes in the timer 192 will be heated in series by a circuit (not shown) energized from transformer 64. The tube 212 of timer 192 will normally have plate voltage applied thereto through conductor 214, which is connected to conductor 46 normally energized from L_2.

Also energized from L_1 through safety switch 152, switch 148, conductors 176, 180, auxiliary switch 182 and conductor 204 is relay coil 216 which is connected thereto by conductor 218. The other terminal of coil 216 is connected directly to conductor 46 by conductor 220 whereby voltage present at L_2 will be applied to coil 216 when the flame has been proved through safety control 152 and switch 148 has been closed by opening of damper 8 and consequent energization of coil 134. Energization of coil 216 will open switches 124 and 138, thus removing the voltage normally applied to the motor winding 130 which has placed the damper in the open position. Upon opening of switches 124 and 138 and the application of plate voltage to the timer tubes 208 and 210, the damper motor will be subsequently controlled by the position of a pressure-sensitive switch 222 in the electronic damper control 192. The pressure-sensitive switch is of a pure linear motion type not exhibiting any snap action characteristics and therefore may be designed to have any desired sensitivity. The motion of air in the combustion chamber may be measured by any convenient means but is generally measured by determining the degree of evacuation in the chamber as compared to the static boiler room pressure. The output of such a measuring device will be applied to the switch in the direction indicated by the arrow 224, whereby decreasing pressure will cause the contact 226 to move upwardly under the influence of spring 227 and engage the associated contact 228 which is pivotally mounted about point 230. Also upon energidation of coil 216, transfer switch 57 is actuated. In the unactuated position conductors 58 and 60 of the modulating motor 54 are shorted together which drives the motor to the minimum fuel flow position which is desirable during initiation of a burning cycle. Upon actuation, conductors 58, 60, and 62 are directly connected from the modulating motor 54 to the controller 56 and normal follow-up operation ensues.

When the pressure is such that contact 226 is in engagement with contact 228 but sufficient to prevent raising pivotally mounted contact 228 to open the circuit between said contact and the associated contact 232, the flow of air will be at the desired level. When this situation exists the grids of both control tubes 208 and 210 will be sufficiently negative to prevent conduction. Grid 234 of tube 208 will be maintained at a negative potential with respect to the cathode 236 by the biasing effect of current flowing in grid resistor 238. The circuit for such current flow is as follows: Terminal 240 is connected to terminal 10 and L_1 through conductors 16, 78, and

242 and will therefore comprise one alternating current terminal for operation of the timing mechanism. The current then passes from terminal 240 through voltage dividing resistor 244, triode 212, grid resistor 246, no-draft switch 248, rectifier tube 250, the contacts 228 and 226 of the pressure-sensitive switch, resistor 238, to terminal 252 which is connected to the other side of the AC line, L_2, by conductors 254, 214, 46, and 18. Tubes 250 and 212 each act as half-wave rectifiers whereby current is passed only in a single direction therethrough, and thus the terminal of resistor 238 which is connected to grid 234 is maintained at a voltage substantially negative with respect to the cathode terminal thereof and the tube 208 is normally not conducting. If the draft flow falls below the desired predetermined level, contact 226 falls in the direction indicated by arrow 224, opening the circuit just described, whereby the tube 208 will tend to begin conduction. A condenser 256 is in parallel with resistor 238, however, and has heretofore been charged to a negative potential and will remain so charged for a period of time depending upon the relative magnitudes of the condenser 256 and resistor 238.

The time during which the tube 208 will remain non-conducting is approximately determined by the product of the capacitance of the condenser 256 and the resistance of resistor 238. For example, in one particular embodiment of this invention a .01 microfarad condenser is provided in parallel with a 22 megohm resistor, thus providing a .22 second time delay before tube 208 will begin conduction. This is found to be a sufficient time to prevent sporadic hunting of the time delay and rapid reversals of damper motor torque in response to normal fire pulsation. When tube 208 is conducting, relay coil 258 is energized, closing contacts 260, which applies energy to the damper motor coil 130 to drive said damper toward the open position. This circuit may be traced as follows: From terminal 262 which is connected to one side of transformer 64, through conductors 66 and 94, actuated transfer switch 84, conductor 110, no-draft switch 112, conductor 114, closed contacts 260, conductor 264, conductor 126, closed limit switch 128, damper motor winding 130, and conductor 132, to conductor 150, which is connected to the other side of the secondary winding of transformer 64.

Similarly, in the event that the draft flow increases to a predetermined magnitude, the circuit between movable contact 228 and contact 232 is opened, whereby the grid circuit of time delay triode 210 will be opened to operate in a manner identical with that above described with respect to tube 208. That is, if contacts 228 and 232 are open, grid condenser 266, which is charged to a high negative value, will discharge through grid resistor 268 in a time determined by the relative magnitudes of the condenser and resistor, at the end of which time tube 210 will conduct to energize relay coil 270 which is disposed in the plate circuit of tube 210 and will actuate damper-closing contacts 272. The circuit for closing the damper may be traced as follows: From terminal 262 through conductors 66 and 94, to actuated transfer switch 84, which is connected through conductor 110 to no-draft switch 112, and from there through conductors 114 and 274 to actuated switch 272, which is in turn connected through conductor 276 to manual control switch 100, conductor 102, closed limit switch 108, and closing motor armature winding 104, the other terminal of which is connected to conductor 132 and the other terminal 263 of the secondary of transformer 64. Thus it is believed apparent that the damper will be continuously controlled in response to the instantaneous magnitude of the draft within the burning chamber.

However, by providing the time delays described, sporadic hunting of the damper motor is avoided and more accurate control over a relatively long period of time is maintained. The no-draft switch 248 is provided in the timer 192 whereby complete failure of the induced draft fan, or any other component failure which would cause the draft within the burning chamber to fall below a predetermined minimum level, will open the grid circuit of the timer tubes 208 and 210 and will also remove the voltage from the grid 278 of triode 212 whereby the triode 212 will tend to cease conduction. However, the condenser 280, which is connected from terminal 240 to the grid 278 through resistor 246, will be charged positively with respect to the cathode 282 as a result of the grid current flowing through resistor 238 and/or resistor 268 and rectifier 250 and will thus maintain the tube 212 in conduction for a predetermined time subsequent to the opening of no-draft switch 248. The grid condenser 280 will be discharged through the path comprising voltage-dividing resistor 244 and grid resistor 246 to assume the voltage of terminal 240 while the cathode 282 of tube 212 will assume a voltage determined by the relative magnitudes of resistor 244 and associated voltage-dividing resistor 284 and will be so determined that tube 212 will cease conduction.

Thus relay coil 286, which is in the plate circuit of tube 212, will be deenergized and switch 112 will be opened, removing the voltage from the relays 260 and 272 and also removing the voltage from the coil 134 whereby the main burner circuit and fuel valve will be opened to place the entire burner system in quiescence. This will also cause the coil 216 to be deenergized, thus closing switch 124 to drive the damper to the fully opened position which will insure maximum safety until the fault which has caused the no-draft condition has been remedied.

It is believed manifest from the above description that a system of burner control and sequential operation is hereby provided which will insure maximum efficiency and safety during all phases of burner operation. The sequence control above described will maintain the damper in a closed position during quiescent periods, will operate the induced draft fan and open the damper prior to a burning cycle whereby the burning chamber is purged, will maintain the fuel flow at a minimum value during initial burning operations, will maintain a desired draft within extremely close limits for maximum burning efficiency during a burning cycle, and will, in the event of any failure within the system, insure maximum safety by opening the damper to its fully open position and isolating the fuel supply. While one particular embodiment is herein described, the novel sequence control which is taught may be accomplished in various manners which will be manifest to one skilled in the art, and such variations are believed clearly within the spirit and scope of this invention. When utilizing the above-described control system with a coal-burning furnace, for example, the damper will never be closed, even during quiescent periods but will be placed in a minimum draft position.

Without further elaboration, the foregoing will so fully explain the character of my invention that others may, by applying current knowledge, readily adapt the same for use under varying conditions of service, while retaining certain features which may properly be said to constitute the essential items of novelty involved, which items are intended to be defined and secured to me by the following claims.

I claim:

1. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising means to maintain said damper in a closed position when the burner is inactive and the fuel valve means closed, drive means to move the damper to an open position prior to the activation of said burner and opening of the fuel valve means, a switch controlled by the motion of said damper to the open position to stop said damper drive means and to operate said fuel valve means from the closed position, pressure-sensitive means to control continuously said damper to maintain a predetermined

draft in said burner subsequent to opening said valve, and means to move said damper to the open position if the flame of said burner fails.

2. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising means to maintain said damper in a closed position when the burner is inactive and the fuel valve means closed, drive means to move the damper to an open position in response to an indication of an energy need, a switch controlled by the motion of said damper to the open position to stop said damper drive means and to modulate said fuel valve means from said closed position, pressure-sensitive means to control continuously said damper to maintain a predetermined draft in said burner during modulation of said fuel valve means, and means to move said damper to the open position if the flame of said burner fails.

3. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising drive means to open said damper prior to opening said valve, and a switch controlled by the motion of said damper to the open position to actuate said fuel valve means and stop said damper drive means.

4. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising motor means to position said damper, switch means to energize said motor means and move said damper to the open position prior to opening said valve means when operation of the fuel burner is initiated, limit switch means actuated by the motion of said damper to the open position, to stop said motor means and control means actuated by said limit switch means to modulate the flow of fuel from said valve means.

5. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising means to maintain the damper in a substantially closed position when the burner is unenergized and the fuel valve means closed, means to produce an induced draft in said burner, means to move the damper to an open position, a switch actuated when said damper is in the open position to open said fuel valve, to stop said damper, and to energize said induced draft means substantially coincidentally in response to an indication of an energy need, means initiated by the motion of said damper to the open position to modulate said fuel valve means from said closed position, means to control said damper to maintain a predetermined draft in said burner during modulation of said fuel valve means, and means to move said damper to the open position if the flame of said burner fails.

6. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising means to maintain the damper in a substantially closed position when the burner is inactive and the fuel valve means closed, drive means to move the damper to an open position in response to an energy need, a switch controlled by the motion of said damper to the open position to stop said drive means, control means actuated by said switch to modulate said fuel valve means from said closed position, pressure-sensitive means to control said damper to maintain a predetermined draft in said burner during modulation of said fuel valve means, time delay means forming a part of said pressure-sensitive means whereby short duration pulsations will not move said damper, and means to move said damper to the open position and close said fuel valve means if the flame of said burner fails.

7. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising means to maintain the damper in a substantially closed position when the burner is inactive and the fuel valve means closed, drive means to move the damper to a substantially open position in response to an energy need, means to position said fuel valve means for minimum fuel flow in response to an energy need, means controlled by the motion of said damper to the substantially open position to stop said drive means and to modulate said fuel valve means from said minimum position, pressure-sensitive means to control said damper to maintain a predetermined draft in said burner during modulation of said fuel valve means, time delay means forming a part of said pressure-sensitive means whereby short duration pulsations will not move said damper, and means to move said damper to the substantially open position and close said fuel valve means for a fault in the system.

8. Control apparatus for a fuel burner having fuel valve means and a controllable damper, said apparatus comprising means to maintain said damper in a closed position when the burner is inactive and the valve means closed, means to move the damper to an open position in response to a demand for energy, a switch controlled by the motion of said damper to the substantially open position to operate said valve means from the closed position and to stop the damper moving means, and means to control said damper to maintain a predetermined draft in said burner subsequent to opening said valve.

9. A bidirectional controller for positioning an airflow modulator in a fuel burning system comprising a circuit controlling the forward energization of such a system to a minimum flow position, time delay means controlling said forward control circuit, a circuit controlling the reverse energization of such a system to a maximum flow position, time delay means controlling said reverse control circuit, condition-responsive means in said fuel burning system for selectively actuating said forward or said reverse energizing circuits to modulate said airflow for optimum burning, and a safety time delay means controlling said forward and reverse energization circuits whereby a failure in the controller or in the system existing for a predetermined time will effect deenergization thereof and will actuate said system to the maximum flow position.

10. A bidirectional controller for positioning an airflow modulator in a fuel burning system comprising drive means for said modulator, a circuit controlling the forward energization of said drive means toward a minimum flow position in response to a predetermined air pressure in said system, time delay means controlling said forward circuit a predetermined time interval after experiencing said predetermined pressure, a circuit controlling the reverse energization of said drive means toward a maximum flow position in response to an air pressure value less than said predetermined pressure, time delay means controlling said reverse circuit a predetermined time interval after experiencing said air pressure value, and condition responsive means in said fuel burning system sensing the air pressure therein for selectively actuating said forward or said reverse circuit time delay means.

11. A bidirectional controller for positioning an airflow modulator in a fuel burning system comprising a pressure sensitive device in said system sensing the air pressure therein for closing a control switch for pressure values above a predetermined maximum and for closing a second switch for pressures below a value less than said maximum, drive means for said modulator, a forward circuit including a time delay means controlling the forward energization of said drive means toward a minimum airflow position in response to said second switch, and a reverse circuit including a time delay means controlling the reverse energization of said drive means toward a maximum flow position in response to said control switch.

12. A bidirectional controller for positioning an airflow modulator in a fuel burning system comprising a pressure sensitive device in said system sensing the air pressure therein for closing a control switch for pressure values above a predetermined maximum and for closing a second switch for pressures below a value less than said

maximum, drive means for said modulator, a forward circuit including a time delay means controlling the forward energization of said drive means toward a minimum airflow position in response to said second switch, a reverse circuit including a time delay means controlling the reverse energization of said drive means toward a maximum flow position in response to said control switch, and a pressure-sensitive safety switch in said system including time delay means controlling said forward and reverse circuits whereby changes in said pressure beyond a predetermined range including said maximum and said value for a predetermined time will effect deactivation of said system.

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