Dec. 15, 1942. W. L. McGRATH 2,305,544

FUEL BURNER CONTROL SYSTEM

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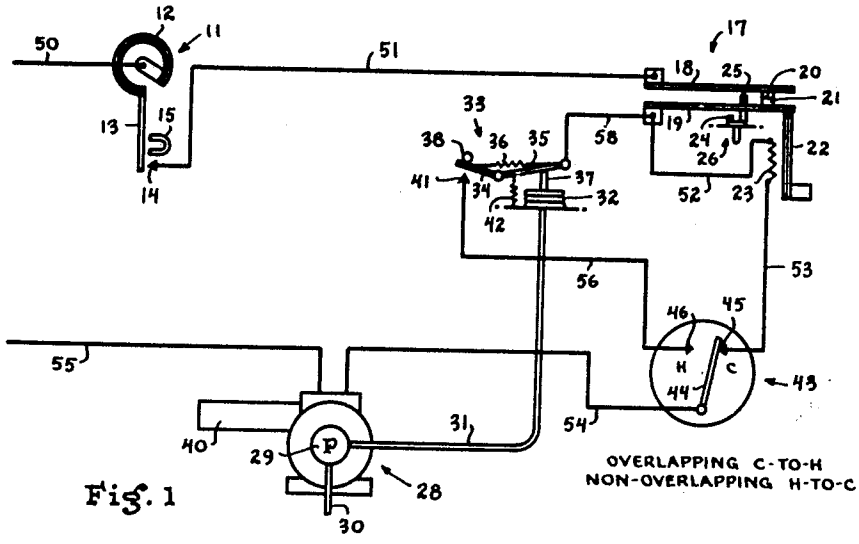


Fig. 1

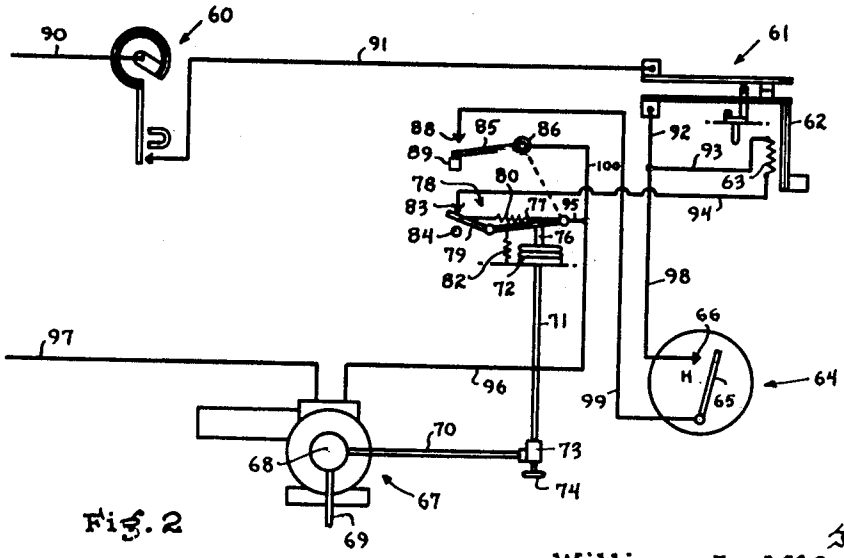


Fig. 2

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FUEL BURNER CONTROL SYSTEM

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8 Claims. (Cl. 158—28)

This invention relates broadly to automatic control systems, and more particularly to systems for automatically controlling the starting and stopping operations of fluid fuel burners.

In simplifying and reducing the expense of fuel burner control systems it is desirable in many instances to eliminate all electromagnetic relays. However, it has been found under these circumstances that the system has no protection against power failure; that is, on power failure the burner motor will stop delivering fuel and combustion will cease, but if power is returned again before the protective combustion responsive device has cooled sufficiently to open its hot contacts, then, upon the resumption of power, the burner motor will be immediately reenergized without the advantage of a scavenging period.

It is therefore a prime object of this invention to provide a system of the above type which has protection against a momentary power failure.

A further object of the invention is to provide a control system in which the running circuit for the burner motor is dependent upon the pressure developed by the burner motor so that a momentary failure of the power driving the burner motor will result in opening the running circuit.

A still further object is to provide, in a system of the above type, a means for delaying the reclosing of the starting circuit following a burner motor shut down whereby a scavenging period will be produced.

A still further object is to make the running circuit to the burner motor dependent upon the fuel pressure developed by the burner motor so that if the burner motor or fuel pressure should fail for any reason the burner motor will be immediately shut down and not reenergized until the elapse of the proper scavenging period.

These and other objects will readily become apparent as the following specification is read in the light of the accompanying drawing in which

Figure 1 is a diagrammatic representation of one form of my invention, and

Figure 2 is a diagrammatic representation of a modified form.

Referring now to Figure 1 of the drawing, the reference numeral 11 indicates a space thermostat comprising a bimetallic element 12 and switch arm 13. The thermostat is so arranged that on a decrease in temperature the bimetallic element 12 will move the switch arm 13 into engagement with the stationary contact 14. If desired, a permanent magnet 15 or some equivalent device may be used for obtaining a snap action.

Indicated generally at 17 is a safety switch which comprises a pair of resilient contact blades 18 and 19 which are biased downwardly, as seen in Figure 1, and which carry contacts 20 and 21, respectively. A bimetallic thermostat 22 is normally latched beneath the free end of blade 19 thereby holding the contacts 20 and 21 in engagement. If the bimetallic element 22 is heated to a predetermined extent by means of the electric heater 23, it will warp toward the right and free the resilient arm 19. The arms 19 and 18 will therefore flex downwardly until they engage the legs 24 and 25, respectively, of the manual reset member 26. The leg 25 will hold the contact 20 out of engagement with the contact 21 thereby maintaining the safety switch in open circuit position. After the thermal element 22 has cooled, the switch may be manually reclosed by pushing the reset member 26 upwardly until the arm 19 is swung free of the thermal element 22. At this time the thermal element 22 is permitted to return to its normal cool position shown in Figure 1 and when the reset member 26 is released the parts will return to the position shown in Figure 1 in which the contacts 20 and 21 are in engagement. It will be noted that as the switch is being manually reset the leg 25 prevents engagement of contact 20 with contact 21 so that these contacts may never be manually held in engagement.

The control system is provided with the usual burner motor 28 which drives a fuel pump 29. The conduit 30 connects with a source of fuel supply and conducts it to the pump 29. A second conduit 31 is connected to the pressure side of the pump 29 and communicates with a pressure responsive bellows 32. The bellows 32 is adapted to actuate an over center snap switch generally indicated at 33 and comprising articulated links 34 and 35 and an over center spring 36. The bellows 32 is connected to the link 35 by a connecting means 37. When the pressure within the bellows 32 is at a relatively low value, the link 34 is held adjacent the stop 38 by spring 36, but when the pump 29 is energized to build up the pressure for delivering the oil to the burner nozzle indicated diagrammatically at 40, the pressure within the bellows 32 will increase, resulting in the switch 33 being snapped to its opposite position in which the link 34 engages the stationary contact 41. When the pump is stopped or the oil pressure fails for any reason, the bellows 32 will contract and the return spring 42 will return the snap switch to its original position as shown in Figure 1.

The control system is provided with the usual combustion control device indicated generally at 43. This device may comprise a bimetallic element inserted into the stack and control the switch arm 44 by means of a slip friction connection. The switch arm 44 is adapted to engage the stationary contacts 45 and 46. When the

stack thermal element is cool indicating an absence of combustion, the switch arm 44 is in engagement with its cold contact 45. As combustion is established and the stack thermal element heats up, it operates first to cause the switch arm 44 to engage the hot contact 46 and later to disengage the cold contact 45. When the combustion is terminated and the stack thermal element cools, it first causes the switch arm 44 to disengage the hot contact 46 and later to engage the cold contact 45. Due to the slip friction connection between the stack thermal element and the switch arm 44, the latter will engage and disengage the contacts 45 and 46 in response to changes in temperature rather than perform this function at any predetermined temperature value. Control devices of this type are well known to the prior art at this time and form no part of the present invention, and any device which actuates hot and cold contacts as described above in response to combustion may be used.

Operation

Figure 1 illustrates the system with the parts in the position which they will assume when the room thermostat is satisfied, thereby maintaining the switch blade 13 out of contact with the stationary contact 14. The room thermostat has been satisfied for a sufficient length of time to permit the stack thermal element to cause the switch arm 44 to disengage the hot contact 46 and engage the cold contact 45. Under these conditions, the room thermostat 11 prevents the delivery of electrical energy to the control system.

On a decrease in temperature in the space in which the thermostat 11 is located, the bimetallic element 12 will contract and move the switch arm 13 into engagement with the stationary contact 14. This will establish the following electrical circuit: from supply conductor 50, bimetallic element 12, switch arm 13, contact 14, conductor 51, resilient arm 18, contacts 20 and 21, arm 19, conductor 52, electric heater 23, conductor 53, contact 45, switch arm 44, conductor 54, burner motor 28 and supply conductor 55. This circuit will simultaneously energize the heater for the thermal actuator 22 of the safety switch 17 and the burner motor 28 which drives the oil pump 29. As a result of the operation of the oil pump 29, the oil pressure will be built up on the pressure side of the pump and the bellows 32 will immediately expand and cause the arm 34 to engage the stationary contact 41. This action at the present time establishes no additional electrical circuit because the stationary contact 46 which is connected to the contact 41 by means of conductor 56 is not in engagement with the switch arm 44. If combustion is not established, the stack thermal element will remain cold and therefore the switch arm 44 will not be moved. This means that the electric heater 23 will continue to heat the safety switch thermal actuator 22 and after a predetermined time the latter will warp toward the right as seen in Figure 1 and release arm 19, thereby opening the safety switch contacts 20 and 21 as described above. This will break the circuit to the burner motor and the oil pump will be stopped. Bellows 32 will therefore contract and return switch 33 to open position. The condition which prevented combustion being established must then be corrected and the safety switch manually reset to closed position.

If the room thermostat is still calling for heat, the starting circuit traced above will be re-established upon the closing of the safety switch and the burner motor will again be energized to operate the oil pump, and as a result of the operation of the oil pump the bellows 32 will cause the arm 34 to engage stationary contact 41. If combustion is successfully established, the stack thermal element will heat and cause the switch arm 44 to engage the hot contact 36. This will establish a shunt circuit around the safety switch heater 23 from the resilient arm 19 through conductor 58, links 35 and 34, contact 41, conductor 56, and hot contact 46 to the switch arm 44. At this time therefore, the safety switch heater 23 will be shunted out of control and a running circuit for the burner motor 28 is established independently of the heater 23 and cold contact 45, through the pressure switch 33 and hot contact 46. Further heating of the stack thermal element will cause the switch arm 44 to disengage the cold contact 45. This is the running condition of this system.

When the space thermostat 11 is satisfied, the bimetallic coil 12 will expand and cause the switch arm 13 to disengage the stationary contact 14, thereby cutting off the supply of electrical energy to the control system. This will deenergize the burner motor stopping the fuel pump and the bellows 32 will immediately contract and open the snap switch 33 returning it to the position shown in Figure 1. As a result of the cessation of combustion, the stack thermal element will cool, immediately disengaging the switch arm 44 from the hot contact 46, and after a predetermined length of time sufficient to properly scavenge the combustion chamber the switch arm 44 will reengage the cold contact 45.

If a flame failure should occur while the system is in running condition, the stack thermal element will cool and cause the switch arm 44 to disengage the hot contact 46. This will break the running circuit to the burner motor and as the starting circuit has already been broken at the cold contact 45 the burner motor will be deenergized. After a predetermined time interval, the switch arm 46 wil reengage the cold contact 45, thereby reclosing the starting circuit. If combustion is successfully established, the system will return to its running condition. If not, the thermal element 22 will be heated to a predetermined temperature by the heater 23 and unlatch the safety switch 17, thereby shutting the system down until it is manually reset.

It will be seen that when the system is in running condition, the continued operation of the burner motor and fuel pump is dependent upon the maintenance of the fuel pressure by the pump to keep the bellows 32 expanded. If this pressure should drop due to a power failure or a failure in the fuel supply, then the switch arm 34 will disengage the contact 41, breaking the running circuit to the burner motor 28. An immediate return of power or fuel will not result in the immediate reenergization of the burner motor because once the running circuit has been broken the burner motor cannot be reenergized until the original starting circuit has been reclosed by the combustion responsive switch arm 44 engaging its cold contact 45, and as explained above, this will not occur until the proper scavenger period has elapsed. As the fuel pressure to which the bellows 32 responds will drop immediately, the burner motor is deenergized due to power failure. It will be seen that the present system protects

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against a momentary power failure by preventing reenergization of the burner motor until after the combustion chamber has been scavenged.

The modified control system disclosed in Figure 2 is provided with a room thermostat 60 and a safety switch 61. The safety switch 61 has the usual thermal actuator 62 and electric heater 63 therefor. The room thermostat and safety switch of Figure 2 are identical with those of Figure 1, and therefore it is not deemed necessary to describe them again in detail.

The combustion responsive device 64 is provided with a switch arm 65 connected to a thermal element through the usual slip friction connection. In this modification, the switch arm 65 has no cold contact but cooperates only with the hot contact 66. This modification also has a burner motor 67 and fuel pump 68. A conduit 69 connects the low pressure side of the fuel pump 68 with a source of fuel supply and the conduits 70 and 71 connect the high pressure side of the fuel pump 68 with the pressure responsive bellows 72. The conduits 70 and 71 are connected by means of a restriction 73 which is in the form of an adjustable bleed valve 74. Due to the restriction 73, when the pump 68 is energized the bellows 72 expands slowly over a predetermined period of time rather than expanding immediately as in the case of Figure 1. The bellows 72 is connected by a connecting means 76 to a link 77 of an over center snap switch 78. The link 77 is pivotally connected to the link 79 which is snapped back and forth by means of an over center spring 80 as the bellows 72 expands and contracts. The link 77 is provided with a return spring 82 to return the switch upon contraction of the bellows 72. When the bellows 72 is contracted, the arm 79 engages the stationary contact 83, and when the bellows expands the switch is snapped to the position where the arm 79 engages stop 84.

The bellows 72 operates a second switch arm 85 by means of a slip friction connection 86 diagrammatically illustrated in the drawing. The switch arm 85 is adapted to oscillate between the stationary contact 88 and a stop 89. The travel of the arm 85 is adjusted to be very slight, and due to the slip friction connection the arm 85 is adapted to engage and disengage the stationary contact 88 immediately the bellows starts to move, whereas the over center switch 78 is actuated only after the bellows has contracted or expanded substantially its full amount. Therefore the switch arm 85 will always engage or disengage its stationary contact 88 before the switch arm 79 will disengage or engage its contact 83. It will be apparent that by adjusting the restriction 73 by means of the valve 74 the time required for the bellows 72 to expand and contract its full amount may be varied. Therefore the time interval between energization of the burner motor 67 and the opening of the switch 78 may be increased by further restricting the opening at 73 and may be decreased by enlarging the opening. Inasmuch as the arm 85 has a very slight travel and is operated through a slip friction connection, the time necessary to operate the switch 85—88 will not be materially affected by adjusting the valve 74.

The system is shown in Figure 2 with the parts in the position which they assume when the thermostat 60 is satisfied and has been satisfied for a sufficient length of time to permit the bellows 72 to contract its full amount and for the switch arm 65 to disengage the hot contact 66 and assume its cold position. On a decrease in room temperature the room thermostat 60 will cool and establish a circuit from supply conductor 90 through the room thermostat 60, conductor 91, safety switch 61, conductors 92 and 93, heater 63, conductor 94, stationary contact 83, links 79 and 77, conductors 95 and 96, burner motor 67, and back to the other supply conductor 97. This circuit will simultaneously energize the burner motor 67 and the electric heater 63 for the safety switch thermal element 62. The energization of the burner motor operates the pump 68 and the bellows 72 will immediately start to expand and at first cause the switch arm 85 to engage the stationary contact 88. This will not establish an additional circuit at the present time due to the contact switch arm 65 is not in engagement with the hot switch contact 66.

In order for this system to be safe, the time necessary for the bellows 72 to expand sufficiently to operate the snap switch 78 must be greater than the time necessary for the heater 63 to heat the thermal element 62 sufficiently to open the safety switch 61. Therefore, if combustion is not established when the above starting circuit is closed, the thermal element 62 will open the safety switch and lock the system out before the bellows 72 causes the arm 79 to disengage the stationary contact 83. The opening of the safety switch 61 will cut off the supply of power to the burner motor 67 and the bellows 72 will contract to its original position to cause the switch arm 85 to separate from the stationary contact 88.

However, after combustion is successfully established, the combustion responsive device will cause the switch arm 65 to engage the stationary contact 66 and establish a holding circuit for the burner motor through the safety switch 61, conductors 92 and 98, contact 66, switch arm 65, conductor 99, contact 88, switch arm 85, conductors 100 and 96 to the burner motor 67. This circuit shunts the safety switch heater 63 and establishes a running circuit for the burner motor 67 independently of the switch 79—83 which is subsequently opened by means of the further expansion of bellows 72.

When the room thermostat 60 is satisfied, it opens the circuit between the conductors 90 and 91 and the burner motor 67 is deenergized and the parts returned to the position shown in Figure 2. It will be noted that the original energizing circuit for the burner motor cannot be reclosed until the bellows 72 has contracted sufficiently to close the snap switch 78. Therefore, the scavenging period for the system is timed by means of the bellows 72 and this timing, as explained above, may readily be adjusted by the valve 74. If the system is in running condition and a power failure should occur, the burner motor 67 will stop and the bellows 72 will immediately start to contract. As soon as this takes place, the bellows through its slip friction connection 86 will immediately cause the switch arm 85 to separate from the stationary contact 88, thereby breaking the running circuit to the burner motor 67. If power is now resumed the burner motor will not be reenergized until the bellows 72 has contracted sufficiently to reclose the snap switch 78.

On a flame failure it will be apparent that the stack thermal element will cause the switch arm 65 to separate from the hot contact 66 breaking the running circuit for the burner motor. After the starting circuit has been reclosed by the bellows 72 at the switch contacts 79—83, the system will recycle.

It will therefore be seen that I have designed a relatively simple and inexpensive oil burner control system involving the use of no electromagnetic relays but yet one which is rendered safe in the event of a momentary power failure through the use of a fuel pressure responsive switch in the running circuit to the burner motor. It is obvious that certain changes and modifications may be made in the details of the two systems disclosed without the use of invention, and I therefore desire it to be understood that I intend to be limited only by the scope of the appended claims.

I claim as my invention:

1. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a switch in said running circuit, means responsive to the pressure produced by said motor for closing said switch, a switch operated by the pressure produced by said motor for opening said starting circuit, and means for delaying the closure of said switch for a sufficient time following the failure of said pressure to provide for a proper scavenger period.

2. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a switch in said running circuit, means responsive to the pressure produced by said motor for closing said switch, a second switch in said running circuit, means responsive to the establishment of combustion for closing said second switch, a switch operated by the pressure developed by said motor for opening said starting circuit a predetermined time after its closure, and means for delaying the closure of said switch for a sufficient time following the failure of said pressure to provide for a proper scavenger period.

3. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a switch in said running circuit, means responsive to the pressure produced by said motor for closing said switch, a time delay switch for opening said starting circuit a predetermined time after its closure, and means for adjusting the timing of said time delay switch to provide for a proper scavenger period.

4. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a switch in said running circuit, means responsive to the pressure produced by said motor for closing said switch, a time delay switch for opening said starting circuit a predetermined time after its closure, said time delay switch being also operated by the pressure produced by said motor, and means for adjusting the timing of said time delay switch to provide for a proper scavenger period.

5. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a main control switch and a normally closed thermally actuated safety switch in control of both circuits, a heater for said safety switch in said starting circuit, a normally closed switch in said starting circuit, time delay means responsive to the pressure developed by said motor for opening said last named switch after a predetermined time interval, said time interval being greater than the timing of said safety switch, a switch in said running circuit closed by the pressure developed by said motor, and a second switch in said running circuit closed in response to the establishment of combustion.

6. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a main control switch and a normally closed thermally actuated safety switch in control of both circuits, a heater for said safety switch in said starting circuit, a normally closed switch in said starting circuit, time delay means responsive to the pressure developed by said motor for opening said last named switch after a predetermined time interval, said time interval being greater than the timing of said safety switch, a switch in said running circuit closed by the pressure developed by said motor, a second switch in said running circuit closed in response to the establishment of combustion, said time delay means introducing another time delay between the deenergization of said motor and the reclosing of said normally closed switch, and means for adjusting the timing of said time delay means.

7. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a normally closed switch in said starting circuit, a normally open switch in said running circuit, a chamber in which said motor, when energized, builds up a pressure, pressure responsive means in restricted communication with said chamber, lost motion means connecting said pressure responsive means to said normally closed switch for opening and closing said switch a predetermined time after the energization and deenergization of said motor, and slip friction means connecting said pressure responsive means to said normally open switch whereby the latter is closed and opened substantially immediately upon energization and deenergization of said motor.

8. A control system of the class described comprising in combination, a burner motor for delivering fuel under pressure at a point of combustion, a starting circuit and a running circuit for said motor, a normally closed switch in said starting circuit, a normally open switch in said running circuit, a chamber in which said motor, when energized, builds up a pressure, pressure responsive means in restricted communication with said chamber, lost motion means connecting said pressure responsive means to said normally closed switch for opening and closing said switch a predetermined time after the energization and deenergization of said motor, slip friction means connecting said pressure responsive means to said normally open switch whereby the latter is closed and opened substantially immediately upon energization and deenergization of said motor, and means for adjusting the degree of restriction to vary the timing of operation of said normally closed switch.

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