

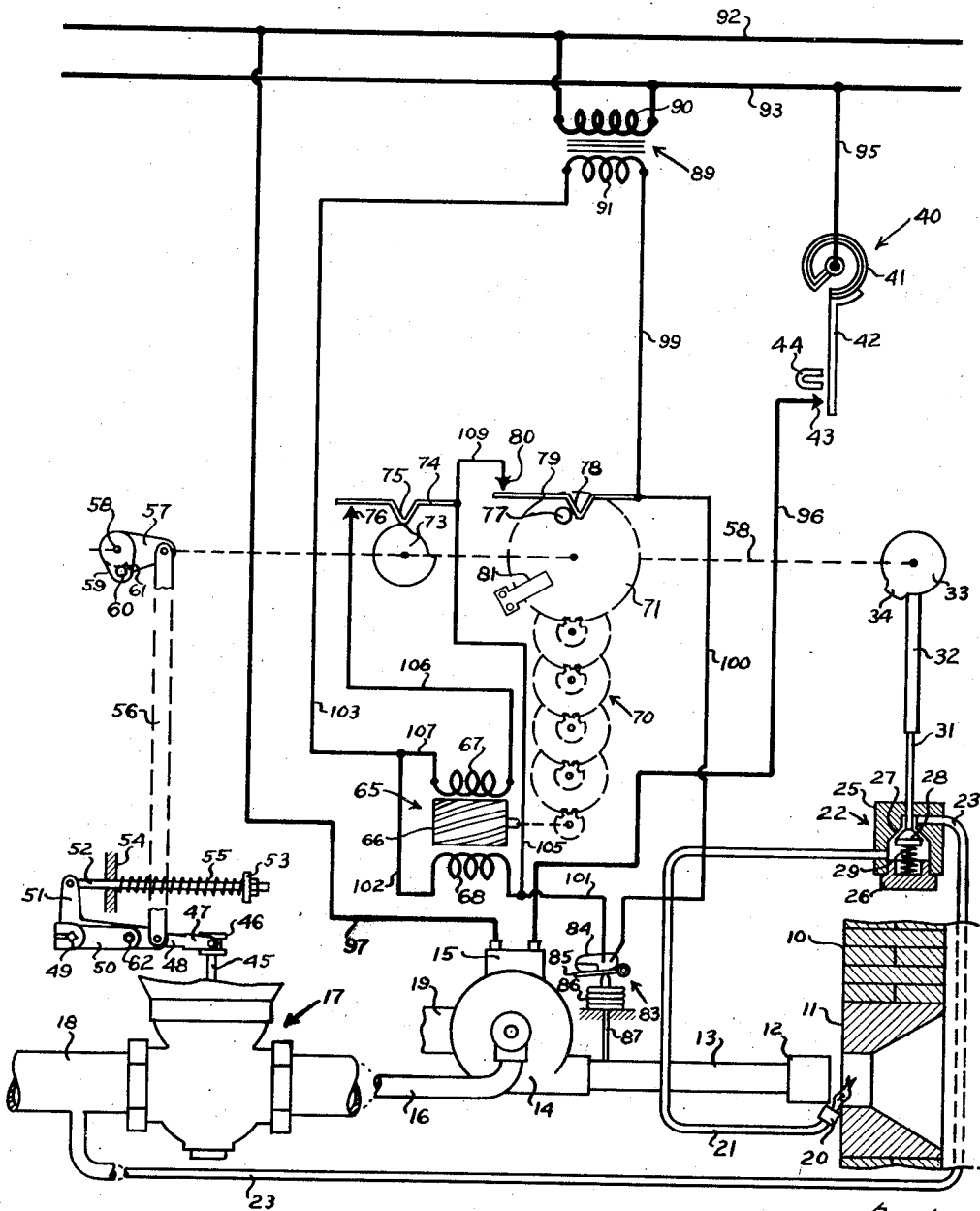
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FLUID FUEL BURNER CONTROL SYSTEM

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FLUID FUEL BURNER CONTROL
SYSTEM

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The present invention relates to a fluid fuel burner control system and more particularly to one employing a fuel valve which is opened very slowly.

5 In relatively large fluid fuel burner control systems, particularly those in which the mixture of fuel and air is fed by pressure, it is desirable in starting up to admit the fuel to the burner gradually by opening the fuel valve very slowly. Since, for safety purposes, it is desirable that the valve close abruptly upon power failure, it is necessary that the valve be biased to closed position. Such a slow opening, power failure valve is disclosed in the copending application of Carl G. Kronmiller, Serial No. 88,781, filed July 3, 1936, which has matured into Patent No. 2,138,792 of November 29, 1938. In such a valve, the operating mechanism acquires such momentum when being moved by the biasing means in valve closing direction that it is necessary to provide means to permit the motion of the operating means to continue after the valve is closed in order to prevent the valve from rebounding from closed position. This, however, creates the difficulty, particularly with slow moving valves, that a long time elapses after the operating means is again rendered effective before the valve is lifted from its seat. In a system employing a forced draft, this time may be sufficient to permit the blower to cool the furnace walls excessively before combustion is established.

An object of the present invention is to provide such a system in which the continued movement of the operating mechanism is terminated shortly after the valve reaches closed position.

A further object of the present invention is to provide such a system in which the termination of such return movement is accomplished by momentarily rendering the operating means effective.

Other objects of the present invention will be apparent from a consideration of the accompanying specification, claims, and drawing.

5 In the single figure of the drawing the system of the present invention is illustrated in schematic form. The wall of a gas burning furnace is indicated by the reference numeral 10. A tuyère block 11 is mounted in an opening in the furnace wall. Positioned adjacent its opening is a burner nozzle 12 which is connected by means of a pipe 13 with a motor driven blower-mixer 14. The blower-mixer 14 is driven by a motor 15. Gas is applied to the mixer by a pipe 16 which extends from a valve 17, which valve is, in turn, connected to a gas supply pipe 18. Air

is introduced into the blower-mixer through a pipe 19.

Located adjacent to the burner nozzle 12 is a constantly burning pilot 20. This pilot is connected by means of a pipe 21 to a flare pilot valve 22. The flare pilot valve is, in turn, connected by a pipe 23 to the gas supply line 18 behind the valve 17. The pilot valve 22 comprises a valve housing 25 closed by a valve plug 26. A valve seat 27 is provided between the outlet of pipe 23 and the inlet of pipe 21. Coacting with this valve seat is a valve head 28 against which bears a biasing spring 29. The valve head 28 has connected thereto a stem 31 against which bears a pusher rod 32. The pusher rod is actuated by a cam 33, to be described in more detail later.

The energization of the blower motor 15 is controlled by a thermostat 40. This thermostat comprises a bimetallic element 41 to which is secured a contact arm 42 adapted to coact with a fixed contact 43. A magnet 44 is located adjacent the contact arm and serves to impart a snap action thereto. The thermostat 40 may be responsive to any desired temperature condition indicative of the demand for burner operation. In fact, in certain types of installations, a boiler pressure responsive switch may be employed in lieu of the thermostat 40.

The valve 17 is provided with a valve stem 45 to which is secured a flanged collar 46. Coacting with the flanged collar is a yoke portion 47 of an arm 48 secured to a shaft 49. Rigidly secured to the shaft 49 is an arm 50 which is connected at 62 to a bell-crank lever 51 pivoted about the same axis as arm 50. The bell-crank lever 51 is provided with a horizontal and a vertical leg. The vertical leg is connected to a rod 52 having a collar 53 adjacent its outer end. Interposed between the collar 53 and a stationary wall 54 is a biasing spring 55. The biasing spring serves to bias lever 51 in a clockwise direction. Connected to the horizontal arm of the bell-crank lever 51 is a link 56 which is pivotally connected to an arm 57, which arm is, in turn, pivotally mounted on a shaft 58. Rigidly secured to the shaft 58 is an arm 59 which is provided with a pin 60 adapted to engage a shoulder 61 of the arm 57. Upon rotation of the shaft 58, which is shown in dotted lines, in a counterclockwise direction the pin 60 engages the shoulder 61 and serves to rotate arm 57 in a counter-clockwise direction. This counter-clockwise movement is imparted to bell-crank lever 51, from this lever to arm 50, from arm 50 to arm 48 to open the valve 17. The shaft 58 is driven by a motor 65, which motor is shown for

- the purposes of illustration as an induction motor having a rotor 66 and lifting and holding field windings 67 and 68. The motor 66 is connected through a relatively long gear train 70 to the shaft 58, the last gear in this gear train being designated by the reference numeral 71. This gear train is capable of a very large amount of speed reduction so that the valve 17 is opened very slowly.
- 10 The shaft 58 has connected to it the cam 33, which as previously explained, operates the flare pilot valve pusher rod 32. It will be noted that this cam 33 is provided with a toe portion 34 which extends for a short distance around
- 15 the periphery of the cam. Upon opening of the valve, the counter-clockwise rotation of shaft 58 serves to impart a counter-clockwise rotation of cam 33 so as to cause the toe portion 34 to engage the pusher rod 32 and depress the same.
- 20 It will be noted that in the position of the pilot valve head 28 shown in the drawing, this valve head is slightly spaced from its seat so as to permit a small quantity of gas to flow to the pilot burner. Upon the toe portion 34 engaging
- 25 the pusher rod 32, valve head 28 is moved further from its seat to permit an increased flow of gas to the burner. This increased flow of gas is terminated before the valve is opened by reason of the toe portion 34 moving off of the pusher
- 30 rod 32.
- Secured to the shaft 58 is also a cam 73. This cam, it will be noted, is provided with an elongated recessed portion. Cooperating with this cam 73 is a switch blade 74 provided with a
- 35 cam follower 75. The switch blade 74 is adapted to cooperate with a contact 76. In the position shown, the cam follower 75 is resting upon the higher portion of the cam 73 and the switch blade 74 is disengaged from the contact 76. It
- 40 will be obvious that upon rotation of cam 73 in a counter-clockwise direction, the cam follower 75 will move down into the recess of the cam 73 to effect engagement of switch blade 74 with contact 76.
- 45 The gear 71 is provided with a pin 77. This pin is adapted to cooperate with a cam follower 78 of a switch blade 79. The switch blade 79 is adapted to be moved into engagement with a contact 80. It will be apparent that such engagement is effected by the pin 77 moving in a
- 50 clockwise direction to raise the cam follower portion 78 of switch blade 79. The pin 77 is also adapted to engage with a fixed stop 81 to terminate opening of the valve 17.
- 55 Controlling the energization of the valve motor is a pressure responsive switch 83. This switch comprises a mercury switch 84 which is mounted on a pivoted support 85 against which bears a bellows element 86. The bellows element is connected by means of a pipe 87 to the line 13 leading from the blower. Upon the blower obtaining full speed, pressure in the outlet line is sufficient to expand the bellows element enough to tilt the mercury switch 84 to closed position.
- 60 Power for the system is supplied by a step-down transformer 89. This transformer comprises a line voltage primary 90 and a low voltage secondary 91. The primary 90 is connected to line wires 92 and 93 leading to any suitable source of power (not shown).

Operation

The various elements are shown in the position occupied when there is no demand for

75 burner operation by the thermostatic device 40.

Let it be assumed now that the temperature to which this thermostat is subjected falls to a point such that contact arm 42 is moved into engagement with contact 43. When this happens a circuit will be established to the blower motor 15 as follows: from line wire 93 through conductor 95, bimetal 41, contact arm 42, contact 43, conductor 96, blower motor 15, and conductor 97 to the other line wire 92. The establishment of this circuit to the blower motor will cause operation of the blower-mixer to build up a pressure in the outlet pipe 13. This pressure will be transmitted to the bellows 86 to move mercury switch 84 to closed position. As soon as mercury switch 84 has been moved to closed position, a circuit is established to the motor field winding 68 as follows: from the right-hand terminal of secondary 91 through conductors 99 and 100, mercury switch 84, conductor 101, field winding 68, and conductors 102 and 103 to the left-hand terminal of secondary 91.

The establishment of the above traced circuit to the field winding 68 causes the motor 16 to rotate the shaft 58 until the lost motion between pin 60 and shoulder 61 is taken up. The field winding 68 is employed as a holding winding and by itself is incapable of moving the valve to open position against the biasing action of spring 55. The initial rotation of shaft 58 produced by the energization of holding winding 68 is sufficient, however, to permit cam follower 75 to ride down in the depressed portion of cam 73 and effect the engagement of switch blade 74 with contact 76. As soon as such engagement is effected, a circuit is established to the lifting winding 67 as follows: from transformer secondary 91 through conductors 99 and 100, mercury switch 84, conductors 101 and 105, switch blade 74, contact 76, conductor 106, lifting winding 67, and conductors 107 and 103 to the other terminal of secondary 91.

It will be noted that the holding winding 68 and the lifting winding 67 are now connected in parallel. The two windings are able to lift the valve 17 so that the valve is very slowly moved to open position by reason of the pin 60 engaging the shoulder 61 of arm 57 and moving the valve towards open position in the manner previously described. Just shortly before the valve is opened, the push rod 32 is moved downwardly to increase the flow of gas to the pilot burner and hence give an increased flame for lighting purposes. After the valve has moved an appreciable distance towards open position so that it is assured that the burner will be properly ignited, the toe portion 34 moves off of the push rod 32 permitting the valve head 28 to move back to the position in which it is shown in the drawing, in which position a minimum flame is maintained.

Shortly before the pin 77 would engage the stop pin 81, the cam 73 has rotated to a point where the depressed portion thereof is no longer under the cam follower 75 so that switch blade 74 is moved away from contact 76. This results in the lifting winding 67 being deenergized so that further rotation of shaft 58 in opening direction is terminated. In view of the considerable friction in the gear train and in the various linkage connections in the operating mechanism, considerable less power is required to hold the valve in open position than is required to move the same to open position. Consequently, the holding winding 68 is capable of holding the valve 17 in open position when the lifting winding 67 is deenergized.

When the temperature condition to which thermostat 40 is responsive rises sufficiently to cause separation of contact blade 42 from contact 43, the previously traced circuit to blower motor 15 is interrupted so that the blower-mixer 14 no longer operates. As a result, the pressure in the pipe 13 is reduced with the result that the pressure in bellows 86 drops and permits switch 84 to open. The opening of switch 84 results in the deenergization of the holding winding 68.

As soon as the holding winding 68 is deenergized, the biasing spring 55 acting through bell-crank lever 51 is able to move the valve to closed position and to rotate the shaft 58 and the gear train 70 and the motor rotor 66 in the opposite direction to that in which they moved during opening of the valve. It will be obvious that these various elements will acquire considerable momentum as they rotate in valve closing direction so that unless some means were provided for permitting these elements to move independently of the valve, the valve would be forced against its seat with considerable force and would rebound therefrom several times admitting a puff of gas to the furnace each time. It is very likely that these puffs of gas would not be properly ignited at first and might be later ignited with explosive violence. Furthermore, the force with which the valve would hit its seat would eventually cause the valve facing material to be injured. In order to overcome this, the one-way connection between arms 57 and 59 is provided. Thus as soon as valve 17 reaches closed position so that the movement of arm 57 is terminated, the arm 59 and all of the elements directly connected thereto including the gear train 70 and the rotor 66 can continue to rotate in the valve closing direction.

It will be apparent that if such rotation were allowed to continue, the pin 60 would become so far displaced from the shoulder 61 that a long time would be required after reenergization of the valve motor before the pin 60 would engage the shoulder 61 and start to raise the valve 17. In view of the fact that the blower action of the blower-mixer 14 is started simultaneously with the call for burner operation by thermostat 40, a current of air would be forced through the furnace during this entire period, cooling off the walls thereof. As indicated above, the present invention contemplates the provision of means for terminating this return movement of the motor gear train and shaft 58 shortly after the valve is seated. It will be noted that the pin 77 which is shown in the position corresponding to substantially closed position of the valve is engaging the cam follower 78 so that very slight movement of the same to the right will cause switch blade 79 to be moved into engagement with contact 80. Upon return motion of the gear train, such movement of switch 79 into engagement with contact 80 will be effected shortly after the valve 17 has reached closed position. This engagement of switch arm 79 with contact 80 results in the following circuit being established to holding winding 68: from the right-hand terminal of secondary 91 through conductor 99, switch blade 79, contact 80, conductors 109 and 105, holding winding 68 and conductors 102 and 103 to the other terminal of secondary winding 91. The establishment of this circuit results in the motor suddenly being energized in valve opening direction causing a very forceful braking action of the motor and gear train. This braking action, however, while very quickly effective

does not impart undue shock to the gear train by reason of the fact that the motor electrically absorbs a certain amount of the shock through slippage between the rotor and the field winding.

The reenergization of field winding 68 causes the gear train and shaft 58 to again be driven in valve opening direction until the pin 77 has moved sufficiently in a clockwise direction that switch blade 79 separates from contact 80. When this happens, further rotation of the motor is terminated until such time as there is another call for burner operation. When such call occurs, the pin 60 will be relatively close to the shoulder 61 as indicated in the drawing so that very little time will elapse before the valve 17 starts to open.

It will be seen that with the arrangement of the present invention, I have overcome the defects of prior systems of this type in an extremely simple and effective manner. With this arrangement the benefits of a power failure valve in which there is no rebounding of the valve from its seat are obtained without at the same time the disadvantage of excessive time being required to start opening the valve upon reenergization of the operating means.

While I have shown a specific embodiment of my invention for the purpose of illustration, it is to be understood that I am limited only by the scope of the appended claims.

I claim as my invention:

1. In combination with a fluid fuel burner, a blower for forcing a mixture of air and fluid fuel to said burner, means responsive to a condition indicative of a demand for burner operation for causing the operation of said blower, a valve controlling the flow of fuel to said blower and biased to closed position, operating means including a motor movable in one direction for slowly opening said valve against its bias, said valve moving the operating means in the opposite direction on movement of the valve to closed position due to its bias, the valve operating means having sufficient mass and being moved at such a rate of speed through a large enough range during valve closing movement that the resulting momentum would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and operating means for allowing continued motion of the latter in valve closing direction after the valve has closed, and means for rendering said motor effective a short distance thereafter to terminate such continued motion.

2. In combination with a fluid fuel burner, a blower for forcing a mixture of air and fluid fuel to said burner, means responsive to a condition indicative of a demand for burner operation for causing the operation of said blower, a valve controlling the flow of fuel to said blower and biased to closed position, operating means movable in one direction for slowly opening said valve against its bias, said valve moving the operating means in the opposite direction on movement of the valve to closed position due to its bias, the valve operating means having sufficient mass and being moved at such a rate of speed through a large enough range during valve closing movement that the resulting momentum would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and operating means for allowing continued motion of the latter in valve closing direction after the valve has closed,

and means for temporarily rendering said operating means effective a short distance thereafter to terminate such continued motion.

3. A device of the class described, comprising
 5 in combination, a valve casing having an inlet and an outlet, a partition wall therebetween having a valve opening therein, a valve adapted to close said valve opening and biased to closed position, operating means movable in one direction
 10 for slowly opening said valve against its bias, said valve moving the operating means in the opposite direction on movement of the valve to closed position due to its bias, the valve operating means having sufficient mass and being moved at
 15 such a rate of speed through a large enough range during valve closing movement that the resulting momentum would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and operating means for allowing continued motion of the latter in valve closing direction after the valve has closed, and means for temporarily rendering said operating means effective a short distance thereafter to terminate such continued
 20 motion.

4. A device of the class described, comprising a valve biased to closed position, a rotating actuator for the valve, a gear train between said actuator and valve whereby the latter may be opened
 25 against its bias by the former upon operation thereof, the bias of the valve being sufficient to close the valve and rotate the actuator and gear train in the reverse direction at such a speed and through a large enough range that the resulting
 30 momentum built up in the gear train and actuator would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and the gear train for allowing continued motion of the actuator and gear train in valve closing direction
 35 after the valve has closed, and means for rendering said actuator operative a short distance thereafter to terminate such continued motion.

5. A device of the class described, comprising
 40 a valve biased to closed position, a rotating actuator for the valve, a gear train between said actuator and valve whereby the latter may be opened against its bias by the former upon operation thereof, the bias of the valve being sufficient to close the valve and rotate the actuator and gear train in the reverse direction at such a speed and through a large enough range that the resulting
 45 momentum built up in the gear train and actuator would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and the gear train for allowing continued motion of the actuator and gear train in valve closing direction after the valve has closed, and means for temporarily rendering said actuator operative a short distance thereafter to terminate such continued
 50 motion.

6. In combination with a fluid fuel burner, a blower for forcing a mixture of air and fluid fuel to said burner, means responsive to a condition
 55 indicative of a demand for burner operation for

causing the operation of said blower, a valve controlling the flow of fuel to said blower and biased to closed position, electrically energized operating means movable in one direction when energized for slowly opening said valve against its bias, said
 5 valve moving the operating means when deenergized in the opposite direction on movement of the valve to closed position due to its bias, the valve operating means having sufficient mass and being moved at such a rate of speed through a
 10 large enough range during valve closing movement that the resulting momentum would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and operating means for allowing continued motion of the latter in valve closing direction after the valve has closed, and means for temporarily energizing said operating means a short distance thereafter to terminate such continued motion.

7. A device of the class described, comprising a valve biased to closed position, electrically energized operating means movable in one direction when energized for slowly opening said valve against its bias, said valve moving the operating
 15 means when deenergized in the opposite direction on movement of the valve to closed position due to its bias, the valve operating means having sufficient mass and being moved at such a rate of speed through a large enough range during
 20 valve closing movement that the resulting momentum would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and operating means for allowing continued motion of the latter in valve closing direction after the valve has closed, and means for temporarily energizing said operating means a short distance thereafter to terminate such continued motion.

8. A device of the class described, comprising
 25 a valve biased to closed position, a rotary electrical motor for actuating the valve, a gear train between said motor and valve whereby the latter may be opened against its bias by the former upon energization thereof, the bias of the valve being sufficient to close the valve and rotate the
 30 actuator and gear train in the reverse direction at such a speed and through a large enough range that the resulting momentum built up in the gear train and actuator would be sufficient to cause the valve to rebound from closed position upon reaching the same, a connection between the valve and the gear train for allowing continued motion of the actuator and gear train in valve closing direction after the valve has closed, a main control switch for controlling the energization of the motor, an auxiliary switch controlling a circuit to said motor independently of said main control switch, and means carried by said gear train for closing said auxiliary switch when said gear train has moved in valve closing direction just past valve closed position whereby such continued motion of the motor and gear train is abruptly terminated.

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