This Invention relates to a safety control system for use with a combustion device having a draft stabilizer for controlling the combustion or a stand-by damper for preventing heat losses during the stand-by period.

In combustion devices such as boilers, it is usual to provide draft stabilizers between the boiler and the stack to regulate the amount of draft passing through the boiler. These draft stabilizers are usually operated according to the amount of draft in the stack so that when an increase in stack draft the draft stabilizer is moved to one position to restrict the amount of draft through the boiler and upon a decrease in stack draft the draft stabilizer is moved to another position to increase the draft through the boiler. By using draft stabilizers, the combustion in the boiler may be quite accurately controlled to give a greater efficiency in boiler operation.

Also, in combustion devices such as boilers, it is usual to provide a stand-by damper between the boiler and the stack to prevent heat losses from the boiler during stand-by periods. When the combustion device is placed in operation this stand-by damper is opened either mechanically or by the draft to allow escape of the gases of combustion into the stack. When the combustion device is placed out of operation during stand-by periods, this stand-by damper is moved to a closed position to prevent the escape of the hot gases from the combustion device. In this manner, heat losses in the combustion device are greatly minimized.

However, frequently these draft stabilizers or stand-by dampers become stuck in the closed or draft restricting position which closes off the draft through the boiler. Upon the sticking of the draft stabilizer or stand-by damper in this draft preventing position, there is no escape for the combustible gases from the boiler. The accumulation of large amounts of combustible gases in the boiler becomes exceedingly dangerous in that if they are sufficiently ignited serious explosions may occur or they may escape from the boiler into the surrounding atmosphere and contaminate the same.

Therefore, as a safety feature, some means must be provided to prevent operation of the firing means in case the draft stabilizer or stand-by damper becomes stuck in the closed or draft restricting position.

Consequently, it is an object of this invention to provide a safety control for a boiler utilizing a draft stabilizer or a stand-by damper to prevent firing of the boiler in case the draft stabilizer should become stuck in closed or draft restricting position.

Another object of this invention is to provide a safety control for a boiler utilizing a draft stabilizer or a stand-by damper and a time controlled safety device which prevents operation of the firing means in case combustion is not established upon starting wherein a draft stabilizer or a stand-by damper safety device coacts with the time control safety device to prevent operation of the firing means in case the draft stabilizer or stand-by damper becomes stuck in a closed or draft restricting position.

A further object is to provide a safety control for a boiler utilizing a draft stabilizer or a stand-by damper and a time controlled safety device which prevents operation of the firing means in case the draft stabilizer or stand-by damper becomes stuck in closed position but which will not prevent operation of the firing means if the draft stabilizer or stand-by damper is only momentarily moved to closed position.

A still further object is to provide a switching mechanism operated by a draft stabilizer or a stand-by damper to control the operation of the firing means of a boiler.

Other objects and advantages will become apparent to those skilled in the art upon reference to the accompanying specification, claims, and drawing in which:

Fig. 1 is a diagrammatic illustration of a boiler with one form of my invention associated therewith;

Fig. 2 is a perspective view of a conventional draft stabilizer with the switch of my invention attached thereto for operation thereby;

Fig. 3 is a perspective view of a conventional stand-by damper for preventing heat losses through the stack during stand-by periods with the switch of my invention attached thereto for operation thereby; and

Fig. 4 is a diagrammatic view of a portion of the system disclosed in Fig. 1 showing the stand-by damper safety control applied thereto.

Although my invention may be applied to any type of heating system or power system, it is shown to be applied to a boiler heating system wherein a steam or hot water boiler is designated at 10. Steam or hot water is led from the boiler 10 by means of a pipe 11 for use at some remote point, and 12 designates a return...
pipe delivering the used fluid back to the boiler 10. The steam or water is heated in the boiler 15 preferably by means of an electrically operated oil burner 15, having a nozzle 14 extending into the combustion chamber of the boiler 10. Expended gases of combustion are exhausted from the boiler 10 by means of a flue or bridge 15 extending into a conventional stack 16. The gases are drawn from the combustion chamber or boiler 10 by means of the draft existing in the stack 16.

In order to regulate the rate at which the expended gases are taken from the boiler 10 and consequently the draft in the boiler 10, a draft regulator generally designated at 17 is provided in the flue or bridge 15. By referring to Fig. 2, it will be seen that the draft regulator or draft stabilizer 17 comprises a damper 18 movable in the flue 15. The damper 18 is secured to a shaft 19 for rotation therewith. The shaft 19 extends outwardly through the flue 15 and has secured on the end thereof an arm 20. A weight 21 is secured to the arm 20 in an adjustable manner to provide a means for urging the damper 18 towards open position. The other end of shaft 19 which also extends through the flue 15 carries a clamp 22 for rotation therewith. The clamp 22 carries preferably a mercury switch 23 of usual design.

The damper 18 is normally maintained in an open position by means of the biasing weight 21 but upon an increase in draft in the stack 16, the damper 18 will be drawn towards a closed position against the bias of the weight 21. In this manner, the amount of draft passing through the boiler 10 may be maintained substantially constant. The mercury switch 23 is so positioned with respect to the damper 18 that when the damper 18 is in a vertical or closed position, the mercury switch 23 is in open circuit position and that when the damper moves out of this closed position the mercury switch is tilted to circuit closed position.

In order to prevent heat losses through the stack 16 during stand-by periods, a stand-by damper generally designated at 17' is provided in the flue 15 (Fig. 4). By referring to Fig. 3, one type of stand-by damper is shown wherein it will be seen that the stand-by damper 17' comprises a damper 18' movable in the flue 15. The damper 18' is secured to a shaft 19' for rotation therewith. The shaft 19' extends outwardly through the flue 15 and has secured on the end thereof an arm 20'. A weight 21' is secured to the arm 20' in an adjustable manner to provide a biasing means for urging the damper 18' towards a closed position. The other end of the shaft 19' extends through the flue 15 and carries a clamp 22' for rotation therewith. The clamp 22' carries preferably a mercury switch 23' of usual design.

The damper 18' is normally maintained in a closed or draft restricting position by means of the biasing weight 21', but upon the starting up of the electrically operated oil burner 15, gases will be caused to flow through the flue 15 and the damper 18' will be pushed towards an open position against the bias of the weight 21'. In this manner, the flow is closed during stand-by periods when the oil burner 15 is not operating and is opened when the oil burner 15 is operating. Although I have shown a stand-by damper that is controlled by the flow of gases thereby, it is within the contemplation of this invention to use a mechanically operated damper to accomplish the same results. The mercury switch 23' is so positioned with respect to the damper 18' that when the damper 18' is in a vertical or closed position the mercury switch 23' is in open circuit position and that when the damper 18' moves out of this closed position the mercury switch 23' is tilted to circuit closed position.

Power is supplied to the control system hereinafter described by means of line wires 25 and 26 leading from some source not shown. Connected to line wire 25 is a wire 27 which leads to a stationary contact 28. Cooperating with the contact 28 is a switch arm 29 which is connected by means of wires 30 and 31 to a terminal box 32 of the electrically operated oil burner 13. The terminal box 32 is connected by means of wires 33 and 34 to the other line wire 26. Connected to wires 30 and 33 are wires 35 and 36 respectively which connect to opposite ends of a primary 37 of a step up transformer 38. The secondary 39 of the step up transformer 38 is connected by means of wires 40 and 41, respectively, to ignition electrodes 42 and 43.

From the above, it is seen that upon closing switch 29 circuits are completed to the terminal box 32 and ignition electrodes 42 and 43. The electrically operated oil burner 13 and to ignite oil delivered thereby to start and maintain combustion in the combustion space of the boiler 10. Combustion is stopped by opening the above circuits by moving switch arm 29 away from stationary contact 28.

A step down transformer is designated at 47, the primary 48 of which is connected by means of wires 45 and 46 to the line wires 25 and 26 respectively. The step down transformer 47 has a secondary 49. A safety switch is designated generally at 50, preferably of the type shown and described in Patent No. 1,956,081 to Frederick S. Denison, patented May 8, 1934. The safety switch 50 comprises spring pressed contacts 51 and 52 that are normally urged apart and which are held latched into engagement with each other by means of the bimetal strips 53 and 54. 55 designates a heater resistance which, when energized, gives off heat to warp the bimetal strip 53 to the left out of engagement with the contact 51 to permit separation of contacts 51 and 52. The bimetal strip 54 which is not affected by the heating element 55 warps in an opposite direction with respect to the bimetal strip 53 to compensate for ambient temperature changes.

When the bimetal 53 has been warped by the action of heating element 55 to release contact 51, contact 51 can be made to engage contact 52 only by manual resetting of the switch in the manner pointed out in the Denison patent.

A condition responsive device is designated at 56 and is preferably in the form of a thermostat which is secured in place by means of a binding post 57. The thermostat device carries contacts 58 and 59 which engage at predetermined temperature conditions with stationary contacts 60 and 61 r espectively. The distance between contacts 58 and 60 is less than the distance between contacts 59 and 61 so that upon movement of thermostat 56 to the left, contact 58 engages contact 60 before contact 59 engages contact 61.

A relay coil is designated at 62 and by means 70 of suitable connections the relay coil upon energization thereof will move a switch arm 63 into engagement with a contact 64 and the switch arm 28 into engagement with the contact 28. Upon deenergization of relay coil 62, the switch arm...
63 and 29 will be moved out of engagement with contacts 64 and 28 respectively by some means such as gravity or springs not shown.

Located in the flue 15 between the boiler 10 and the draft stabilizer 17 is a thermostatic stack switch 65 preferably of the type disclosed in Patent No. 1,946,698 to Daniel G. Taylor and patented February 13, 1934. The thermostatic stack switch 65 has a bimetal bell extending into the flue 15 so that temperature changes will operate a slip friction device designated at 66. The slip friction device moves switch arm 61 between the contacts 68 and 69. Upon a decrease in temperature in the flue 15, the bimetal and slip friction device 66 will move the switch arm 61 into engagement with the cold contact 68 and upon an increase in temperature in the flue 15, the bimetal and slip friction device 66 will move the switch arm 61 into engagement with the hot contact 69.

One end of the secondary 49 of the step down transformer 47 is connected by means of a wire 70 to the contact 61 of the safety switch 50. The safety switch 50 is connected by means of a wire 71 to the stationary contact 60 of the thermostat 56. The stationary contact 61 of the thermostat 56 is connected by means of a wire 72 to the cold contact 68 of the thermostatic stack switch 65. The switch arm 61 of the thermostatic stack switch 65 is connected by means of a wire 73 to a wire 74 which is in turn connected to one end of the heating element 55 of the safety switch 50. The other end of the heating element 55 is connected by means of a wire 75 to one end of the relay coil 62. The other end of the relay coil 62 is connected by means of a wire 76 to the other end of secondary 49 of the step-down transformer 47.

Upon a decrease in temperature affecting the thermostat 56, contact 58 will engage contact 59 and upon a further decrease in temperature contact 58 will engage contact 61. When both contacts 58 and 59 engage stationary contacts 60 and 61, a starting circuit is completed from the secondary 49 of the step-down transformer 47 through wire 70, contact 61, contact 52, wire 71, contact 50, contact 58, contact 61, contact 58, contact 52, and wire 75 to one end of the relay coil 62. The other end of the relay coil 62 is connected by means of a wire 76 to the other end of secondary 49 of the step-down transformer 47. Upon completion of such circuit the heating element 55 is energized and the relay coil 62 is energized to move switch arms 63 and 29 into engagement with contacts 64 and 28 to start operation of the oil burner 13. The bimetal 53 will not be immediately affected by the energization of the heating element 55, some time lag being necessary to warp the bimetal sufficiently to open contacts 51 and 52.

Binding post 57 of thermostat 56 is connected by means of a wire 77 to the contact 64 and the switch arm 63 is connected by means of a wire 78 to the wire 74. By means of wires 77 and 74 and by means of closing of switch 63 with contact 64 upon energization of the circuit above described, a second or holding circuit is completed from one end of the secondary 49 of step-down transformer 47 through wire 76, contacts 51 and 52, wire 71, contacts 60 and 58, thermostat 56, binding post 51, wire 71, contact 64, switch arm 63, wire 78, wire 74, heating element 55, wire 78, relay coil 62, and wire 76 back to the secondary 49 of step-down transformer 47. By reason of this holding circuit, the cold contact 68 of the stack switch 65 is shunted out, relay coil 62 is maintained energized to maintain the switch arms 29 and 63 in engagement with the contacts 28 and 64 respectively to continue heating of the heating element 55 of the safety switch 50 and to continue operation of the electrically operated fuel burner 13.

The hot contact 69 of the thermostatic stack switch 65 is connected by means of a wire 80 to one of the electrodes of the mercury switch 23 or the mercury switch 23' operated by the draft stabilizer 17 or by the stand-by damper 17'. The other electrode of the mercury switch 23 or the mercury switch 23' is connected by means of a wire 81 to the connection of wire 75 and relay 62. (See Figs. 1 and 4.)

If the fuel supplied by the fuel burner 13 is properly ignited by the ignition means 42 and 43 and combustion has been established in the combustion chamber of the boiler 10, the temperature of the combustion gases passing through the flue 15 will increase, which increase will move switch arm 61 out of engagement with the cold contact 68 and into engagement with the hot contact 69. Also, if the draft stabilizer 17 or the stand-up damper is opened and not in a draft restricting position, the electrodes of mercury switch 23 or mercury switch 23' will be engaged by the usual mercury contained therein.

Assuming now that combustion has been established and has been properly reflected by the thermostatic stack switch 65 to move switch arm 61 into engagement with the contact 68, and that the draft stabilizer 17 or stand-by damper 17 is not stuck in a closed or draft restricting position so that contact between the two electrodes of mercury switch 23 or mercury switch 23' is made by the mercury contained therein, a safety switch shorting circuit will be completed from secondary 49 of the step-down transformer 47 through wire 78, contacts 51 and 52, wire 71, contacts 60 and 58, thermostat 56, binding post 57, wire 77, contact 64, switch arm 63, wire 78, wire 73, switch arm 67, contact 69, wire 80, the electrodes and mercury of mercury switch 23 or of mercury switch 23', wire 81, relay 62; and wire 76 back to the secondary 49 of step-down transformer 47. By reason of this safety switch shorting circuit, the heating element 55 of safety switch 50 is shunted out so that the bimetal 53 will not be warped to open contacts 51 and 52. This safety switch shorting circuit includes the relay coil 62 to maintain the same energized to maintain switch arms 29 and 63 in engagement with contacts 28 and 64 to maintain the oil burner 13 in operation.

Should the temperature in the flue 15 decrease by reason of a failure in combustion in the boiler 10 by accident or other reason, this decrease in temperature will operate the slip friction device 66 to move the switch arm 67 out of engagement with the hot contact 69 to break this safety switch shorting circuit which would then cause energization of heating element 55 to warp the bimetal 53 to break the contacts 51 and 52 to de-energize the relay coil 62 to stop operation of the fuel oil burner 13. Likewise, should the draft stabilizer 17 or the stand-by damper 17' become stuck in closed position or in a draft restricting position, contact between the electrodes of mercury switch 23 or mercury switch 23' would be broken to break the safety switch shorting circuit which would cause energization of heating element 55 of safety switch 50 to warp the bimetal element 53. If the draft stabilizer 17 or the stand-by damper 17' should be maintained in a
draft restricting or closed position for a period longer than required to warp sufficiently the bi-metallic strip 53 upon heating of heating element 55, then contacts 51 and 52 will be separated to deenergize relay coil 62 to open switch arms 29 and 63 with respect to contacts 28 and 64 to stop operation of the oil burner 13. However, if the draft stabilizer 17 or stand-by damper 17' should be moved to closed or draft restricting position only momentarily or for a time less than that required to completely warp bi-metal 53 to break contacts 51 and 52 to cause shut down, there will be no shut down.

If, upon starting up of the oil burner in the manner above described, the draft stabilizer 17 or the stand-by damper 17' should be stuck in a closed or draft restricting position, operation of the oil burner 13 will after a time be prevented. With the draft stabilizer or stand-by damper in such a position, the starting and holding circuits would be completed to start operation of the oil burner 13 but the safety switch shorting circuit could not be completed whereby heating element 55 would cause warping of the bimetal 53 to break contacts 51 and 52 to deenergize the relay 62 to open switch 63 with respect to contact 28 to stop operation of oil burner 13. Therefore, if the draft stabilizer 17 or the stand-by damper 17' is stuck in closed position at starting, the oil burner 13 is only run for a period of time that is required to warp bimetal 53 under the action of heating element 55.

From the above, it is seen that I have invented a safety control system for a boiler utilizing a draft stabilizer or a stand-by damper and a time control safety device which prevents operation of the firing means in case combustion is not established at starting wherein a draft stabilizer or a stand-by damper safety device coacts with the time control safety device to prevent operation of the firing means in case the draft stabilizer or stand-by damper becomes stuck in closed position at starting and to stop operation after starting in case the draft stabilizer or stand-by damper becomes stuck in closed position but which will not prevent operation of the firing means if the draft stabilizer or stand-by damper is only momentarily moved to closed position by some brief condition affecting the flow of gases through the flue.

Various modifications may be made in the system embodying my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or art set forth in the appended claims.

I claim as my invention:

1. In a system of the class described, a heater, firing means for the heater, a draft switch closed upon the occurrence of normal draft conditions in the heater, a combustion responsive switch closed upon the establishment of combustion, a safety switch including a heater, a control switch, circuit connections between the control switch, safety switch, safety switch heater and firing means to cause operation of the firing means and heating of the safety switch heater, and circuit connections between said control switch, safety switch, draft switch, combustion responsive switch and firing means for shutting said safety switch heater to maintain the firing means in operation upon the establishment of combustion and during normal draft conditions.

2. In a system of the class described, a heater, firing means for the heater, a damper positioned for controlling the draft through the heater, and control means for controlling the operation of the firing means for preventing operation of the firing means upon failure of combustion or upon movement of the damper to a draft preventing position for a predetermined time interval but permitting operation of the firing means if the damper is moved only momentarily to a draft preventing position.

3. In a system of the class described, a heater, firing means for the heater, a damper positioned for controlling the draft through the heater, a timing means operatively associated with the firing means and operative to stop operation of the firing means following operation of the firing means for a predetermined time interval, control means for said firing means and said timing means for placing said firing means and said timing means in operation, means responsive to the establishment of combustion for stopping operation of the timing means to continue operation of the firing means, and means to continue operation of the timing means to stop operation of the firing means when the damper is maintained in a draft preventing position.

4. In a system of the class described, a heater, firing means for the heater, a damper positioned for controlling the draft through the heater, a timing means operatively associated with the firing means and operative to stop operation of the firing means following operation of the firing means for a predetermined time interval, control means for said firing means and said timing means in operation, means responsive to the establishment of combustion for stopping operation of the firing means to continue operation of the firing means to stop operation of the firing means when the damper is maintained in a draft preventing position for a predetermined time.

5. In a system of the class described, a heater, firing means for the heater, a damper positioned for controlling the draft through the heater, a timing means operatively associated with the firing means and operative to stop operation of the firing means following operation of the firing means for a predetermined time interval, control means for said firing means and said timing means in operation, means responsive to the establishment of combustion for stopping operation of the firing means to continue operation of the firing means to stop operation of the firing means in case said damper is maintained in a draft preventing position.

6. In a system of the class described, a heater, firing means for the heater, a damper positioned for controlling the draft through the heater, a timing means operatively associated with the firing means and operative to stop operation of the firing means following operation of the firing means for a predetermined time interval, control means for said firing means and said timing means in operation, means responsive to the establishment of combustion for stopping operation of the firing means to continue operation of the firing means to stop operation of the firing means in case said damper is maintained in a draft preventing position for at least a predetermined length.
of time and for preventing operation of the timing means to stop operation of said firing means in case said damper is not maintained in draft preventing position for said predetermined length of time.

7. In a system of the class described, a heater, firing means for said heater, a damper for said heater, a switch operated by said damper, a circuit controlled by said switch, means responsive to movement of said damper to closed position to operate said switch to open the circuit controlled thereby, and means responsive to the opening of said circuit to prevent operation of said firing means if said circuit remains opened a predetermined period of time but permitting operation of said firing means if said circuit is only momentarily opened.

8. In a system of the class described comprising, a heater, firing means for the heater, time delay means for controlling the operation of the firing means, control means including said time delay means for preventing operation of the firing means upon a failure of combustion for a predetermined length of time, and control means including said time delay means for preventing operation of the firing means in response to the existence of a different condition within said heater for a predetermined length of time, making the operation of the firing means unsafe, but permitting operation of the firing means if such condition exists for a short time only.

9. In a system for controlling the supply of fuel to a furnace, a switch for preventing the supply of fuel to the furnace and having an element which is required to be energized for a predetermined time interval before said switch will operate to prevent the supply of fuel, a combustion responsive switch, a furnace draft condition responsive switch, and means responsive to operation of said last named switches for causing the energization of said element and operation of said first named switch to stop the supply of fuel upon failure of combustion or operation of said draft condition responsive switch due to the continued existence of an improper furnace condition.

10. In a system for controlling the supply of fuel to a furnace, a switch for preventing the supply of fuel to the furnace and having an element which is required to be energized for a predetermined time interval before said switch will operate to prevent the supply of fuel, a combustion responsive switch, a furnace condition responsive switch, and means responsive to operation of said last named switches for causing the energization of said element and operation of said first named switch to stop the supply of fuel upon failure of combustion or operation of said condition responsive switch due to the continued existence of an improper furnace condition.

11. The combination, comprising means to control the supply of fuel to a furnace, a time delay means responsive switch, a combustion responsive switch, a furnace condition responsive switch, and means for operating said time delay switch to stop said supply of fuel in response to either operation of said combustion responsive switch or failure of said condition responsive switch due to the continued existence of improper furnace conditions for a predetermined time interval.

12. A control system for a heater having firing means, comprising in combination, a combustion responsive switch closed upon the establishment of combustion, a switch operated in response to a condition prevailing in the heater which, when abnormal, renders operation of the firing means undesirable, said switch opening upon the condition becoming abnormal, a safety switch including a heater, a control switch, circuit connections between the control switch, safety switch, safety switch heater and firing means to cause operation of the firing means and heating of the safety switch heater, and a shunt circuit for said responsive switch to cause opening of the safety switch to thereby shut down the firing means if the heater condition is abnormal for a predetermined period of time.

13. In combination, electrical means to feed fuel to a furnace, a normally closed safety switch which when open deenergizes said fuel feeding means and must be manually reclosed, a thermal element which when heated to a predetermined extent opens said safety switch, an electrical heating element for said thermal element, a main control switch for energizing said fuel feeding means and heating element upon a demand for heat, a combustion responsive switch, a switch controlled by a condition of the furnace, and electrical connections between the heating element, combustion switch and furnace condition switch to deenergize said heating element while permitting continued energization of said fuel feeding means when both combustion is established and said furnace condition is proper whereby if either combustion fails or said condition is improper the heating element is energized to cause opening of said safety switch after a time period to thereby stop said fuel feeding means.

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