April 3, 1945 F. W. STUART 2,372,863

STOKER DAMPER CONTROL

Filed Aug. 9, 1939 2 Sheets-Sheet 1

Fig:1

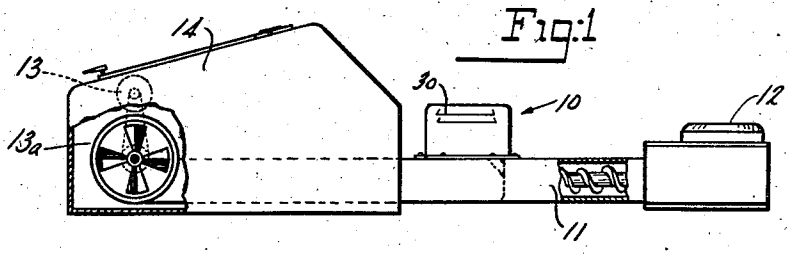


Fig:7

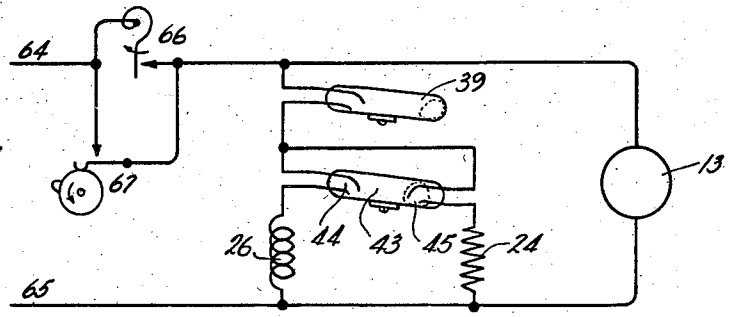
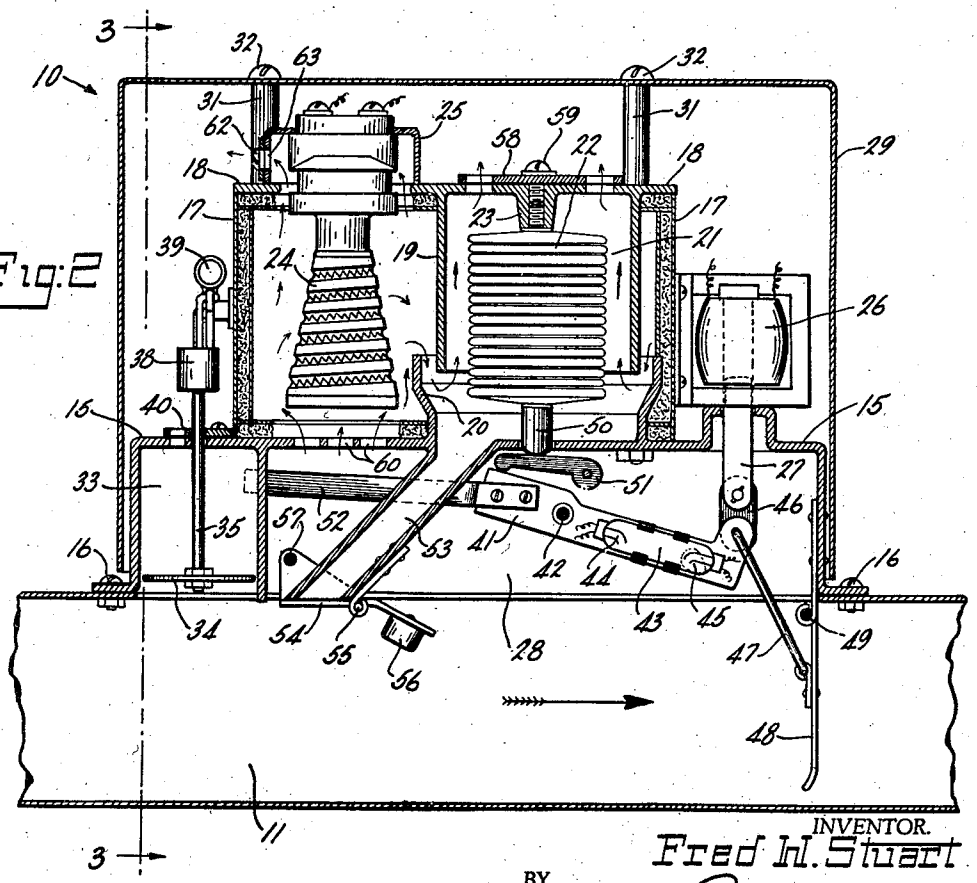


Fig:2



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Fig:6

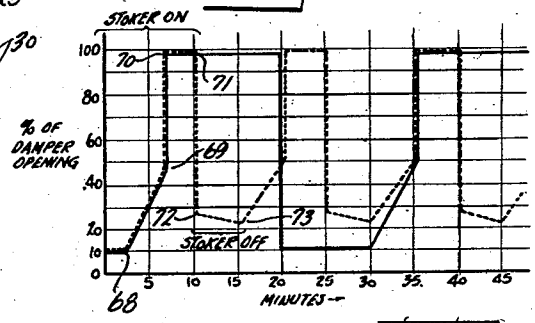


Fig:3

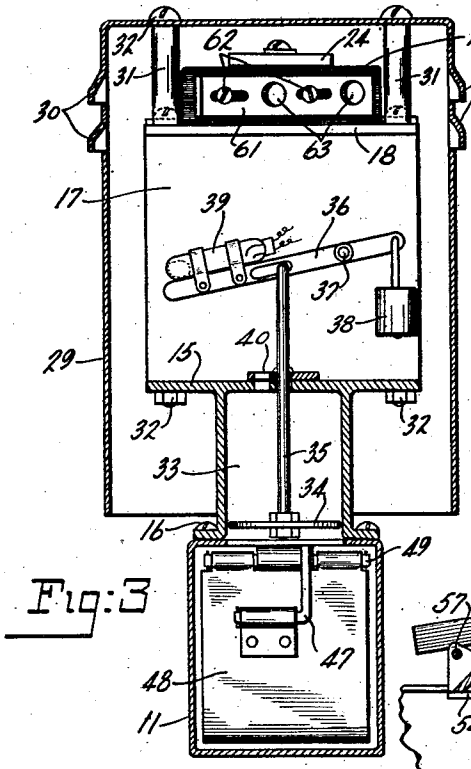


Fig:5

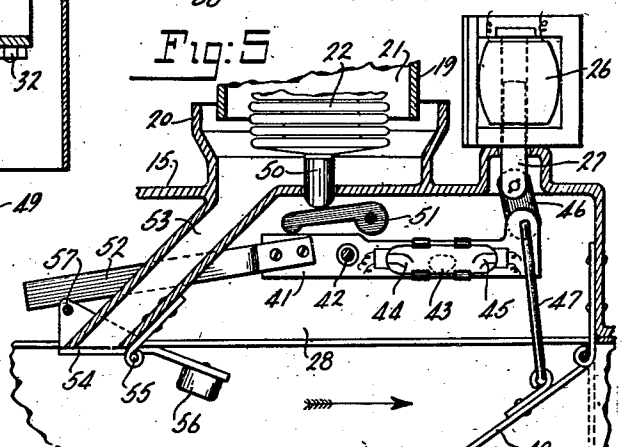
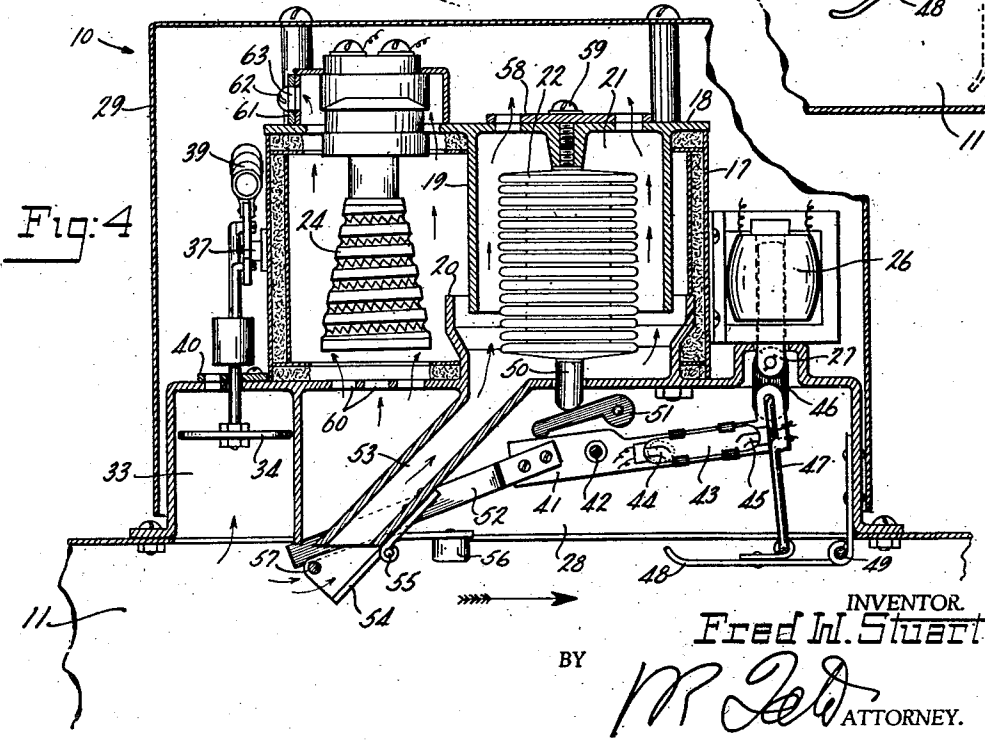


Fig:4



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UNITED STATES PATENT OFFICE

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STOKER DAMPER CONTROL

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Application August 9, 1939, Serial No. 289,157

29 Claims. (Cl. 110—72)

The present invention relates in general to automatic air damper controls for furnace stokers and the principal object of the invention is to design an improved air damper control for regulating the amount of combustion air delivered to the furnace retort.

In the usual type of stoker equipped furnace it is customary to provide a constant speed fan for delivering forced combustion air to the retort of the furnace and which operates each time the stoker motor is automatically actuated to feed fuel to the retort. During the intervals that the stoker is not operating sufficient air for natural draft is provided to maintain the fire. In the initial operation of the fan the blast of air through the comparatively low fire bed blows "fly ash" through the furnace which is extremely objectionable and renders the furnace less efficient in operation by depositing the ash throughout the furnace structure and pipes. This fly ash likewise pollutes the air and is objectionable from a health standpoint.

It is an object of this invention to eliminate the fly ash disadvantage by providing a retard air damper valve or shutter for restricting the amount of air delivery from a stoker fan to the fire bed during the initial operation of the stoker and which gradually opens and permits maximum air volume after the stoker has been operating for a while.

A further object is to provide a simple and efficient control means for controlling the operation of a stoker air damper, whereby the damper is gradually brought to its full open position and positively maintained in its open position during continued stoker operation.

A further object is to provide a static air pressure responsive means whereby the damper control means is prevented from actuating the damper until the fuel bed in the retort has been built up to proper thickness for efficient firing.

An additional object of the invention is to provide a simple, economical and easily installed air damper device which greatly increases the efficiency of stokers and at the same time minimizes the production of fly ash difficulties.

A further object is to design an improved heat motor type control for actuating the stoker damper in the manner aforesaid.

An interval timer is usually provided to maintain the fire alive during periods in which the room thermostat is not calling for heat. Upon the operation of the interval timer during such "hold-fire" periods the fire bed is usually at a very low stage and to pass the full volume of forced air into the low fire bed of the retort at this time would result in rapidly burning out the fire before sufficient fuel could be fed into the retort and also would result in blowing fly ash through the furnace. It is accordingly a further object of the invention to provide a stoker air damper in which a delayed opening of the damper takes place upon initial stoker operation under control of a room thermostat while during "hold-fire" periods when an interval timer takes control to maintain the fire, the opening of the damper does not take place.

Other objects and advantages reside in certain novel features of construction, operation, arrangement and combination of the parts which will be hereinafter more fully described and particularly pointed out in the appended claims.

This invention is in the nature of an improvement upon my prior Patent No. 2,122,050 issued June 28, 1938.

The invention is illustrated in its preferred form in the accompanying two sheets of drawings in which:

Fig. 1 illustrates the application of the control device upon a stoker installation;

Fig. 2 is a cross sectional side elevation of the control mechanism;

Fig. 3 is a left end view of Fig. 2 taken along the line 3—3 of Fig. 2;

Fig. 4 is a similar view as Fig. 2 showing the control device in its fully operated position;

Fig. 5 is another view of the control device in an intermediate operated position;

Fig. 6 is a chart indicating the operating characteristics of the control device; while

Fig. 7 is a schematic wiring diagram of the stoker control system.

The control device indicated generally at 10 is preferably supported upon the air conduit or duct 11 of a conventional stoker unit between the retort 12 and the air fan 13a. The stoker coal hopper is indicated at 14 and also preferably encloses the fan 13a and the operating portion of the stoker screw fuel feeding mechanism. The fuel feeding mechanism or conveyor such as a feed screw may be arranged along the side of duct 11 or inside of it. The motor 13 for operating the stoker gear mechanism is usually arranged to also operate the fan 13a and is preferably of the constant speed type. The air inlet for the fan 13a may be arranged to be adjustable as shown in Fig. 1 in order to restrict the supply of combustion air to any desired amount. The retort 12 of the stoker unit is suitably posi-

tioned in the combustion chamber of a heating furnace or boiler not shown.

The control device 10 includes a metal casting 15 for supporting the various control elements thereon. The supporting casting 15 is secured over an opening in the air duct 11 by means of a number of bolts 16. A sheet metal casing 17 of generally rectangular shape rests on top of supporting casting 15 and is completely lined on its inside surface as shown with suitable thermal insulating material such as asbestos. A metal cover plate 18 rests on top of the casing 17 for closing the top thereof. Formed integral with the cover plate 18 and projecting downward therefrom is a cylindrical bellows partition 19 which is also arranged to project slightly into a circular baffle wall 20 projecting upward a short distance from the bottom of the supporting casting 15. The bellows partition 19 forms a bellows compartment 21 within which there is arranged an expansible and contractable bellows or heat responsive element 22 which is suitably filled with a volatile gas or liquid which has the property of expanding when subjected to the action of heat. The upper end of the bellows 22 is provided with a threaded stud whereby the bellows may be suitably supported from a boss 23 formed in the cover plate 18.

Arranged adjacent to the bellows 22 and in thermal relation thereto is an electrical heat producing heater 24. This heater may be of any conventional form and comprises a resistance wire wound around an insulated base member as shown. Heater 24 is supported by a bracket member 25 fastened to the top of cover plate 18 by screws as seen in Fig. 3. The supporting end of heater 24 may be made of porcelain and carries a pair of terminal screws for the attachment of the connecting terminal wires for the heater. The combination of the electric heater 24 and the bellows 22 responsive thereto, constitutes a heat motor whose function is to perform certain work as will be pointed out.

An electromagnetic means such as a solenoid 26 is also arranged on top of supporting casting 15 and is preferably supported as shown by means of a pair of screws threaded into the sides of the casing 17. The solenoid 26 is provided with an operating armature 27 which is adapted to move upward when the solenoid 26 is energized.

The bottom side of the supporting casting 15 is arranged to form an air chamber 28 immediately above the opening in the air duct 11. A sheet metal protective cover 29 for the control device is provided having a series of louvres 30 as seen in Fig. 3 to permit the hot air to escape, as will be pointed out. The cover 29 is supported by means of a number of sleeves 31 and bolts 32 secured to the supporting casting 15 and the cover 18. These bolts 32 also hold the cover 18 and the casing 17 in place onto the casting 15.

Formed integral with the supporting casting 15 is a static pressure cylinder casing 33. A pressure responsive means such as plunger or static pressure disc 34 is arranged for reciprocal movement within the cylinder 33 (See Fig. 3). The side clearance between the disc 34 and the casing 33 provides for free movement of the disc in response to pressure variations in the duct 11, but the fit is sufficiently close to prevent passage of appreciable amounts of air about the disc 34. The pressure disc 34 is carried on the end of a rod 35 entering the top of the cylinder 33 and has its upper end slidably arranged in a slot of a switching lever 36 which is pivoted by a pin 37 in the side of casing 17. A counter balance weight 38 is carried on the short end of lever 36 while a mercury switch device 39 is supported upon the other end of the switching lever 36 beyond its connection with the rod 35. An air adjustment means 40 for regulating the response of the disc 34 is adjustably arranged on top of the supporting casting 15 around the rod 35.

Arranged within the air chamber 28 and below the supporting casting 15 is an operating lever or arm 41 pivoted by a pin 42 to the sides of casting 15. One end of the operating lever 41 is arranged to carry in a suitable manner, as shown, a mercury switch 43 having two sets of contacts arranged therein; one set, 44, controlling the operation of the solenoid 26, while the other contact set, 45, is adapted to control the circuit to the heater element 24. A short link member 46 connects the contact end of operating lever 41 with the armature 27 of the solenoid 26. A second link member 47 connects the same end of operating lever 41 with a flat air damper valve or shutter 48 which in turn is pivoted by a pin 49 to the side of casting 15 as shown. The damper 48 normally and substantially obstructs the air duct 11 as shown in Figs. 2 and 3.

The lower end of operating bellows 22 is provided with an operating pin 50 adapted to engage the top side of a push lever 51 which in turn normally is in engagement with the short end of operating lever 41. An extension arm 52 is suitably fastened by screws, as shown, to the short end of operating lever 41.

Arranged within the air chamber 28 and formed integral with the supporting casting 15 is an air passage 53 having its lower end projecting into the top of the air duct 11. The bottom end of air passage 53 is provided with a scuttle or deflector 54 for closing the end thereof and is pivoted to the end of passage 53 by a pivot pin 55. A counter balance weight 56 is connected to the deflector 54 for normally maintaining the opening in passage 53 closed. A pin 57 adapted to be engaged by the end of extension lever 52 is arranged upon an up-turned portion of the deflector 54 so that when the lever 52 is operated the deflector 54 is opened.

An air adjusting plate or disc 58 for regulating the amount of air passing from the bellows chamber 21, is adjustably positioned by screw 59 on the top of cover plate 18 and immediately above the bellows chamber 21. A series of air openings 60 are formed in casting 15 below the heater 24 for a purpose to be described. A second air adjusting plate (see Fig. 3) is arranged above the electrical heater 24 and comprises a flat plate 61 adjustably supported by screws 62 upon supporting bracket 25. Several openings 63 in the plate 61 and in the supporting bracket 25 are arranged in coinciding relationship so that when the plate 61 is adjusted more or less air is permitted to pass through the openings 63.

Referring to Fig. 7, a circuit arrangement for operating the control device is illustrated. This includes a pair of line conductors 64 and 65 connected to a source of operating current, a conventional type of room thermostat 66 connected in series with line 64, and an interval timer 67 of any desired form connected in parallel with the room thermostat 66. The interval timer 67 may be clock driven and is arranged to close its contacts preferably for two or three minutes each half hour or each hour, or any other desired adjustable period. The purpose of this timer is to operate the stoker during "hold-fire" periods

when the room thermostat 66 is not calling for heat, in order to maintain the fire. The motor 13 for operating the fan 13a and stoker is connected across the line conductors for operation. Solenoid winding 26 is connected in series with contacts 44 of mercury switch 43 and in series with the pressure switch contacts 39, across the line conductors, while the heater 24 is connected in series with the mercury contacts 45 and the static pressure switch contacts 39 across the line conductors.

In describing the operation of the control device, its normal inactive position is that assumed as shown in Fig. 2 in which the air damper 48 substantially obstructs the air duct 11 by assuming a vertical position. In this position sufficient openings are provided around the air damper 48 to permit a small amount of air escapement to take place, for the purpose of providing a certain amount of natural draft to maintain fuel bed alive.

Assume now that the room thermostat 66 is operated to close its contacts upon a fall in room temperature. When this occurs the fan and stoker motor 13 is started into operation and the stoker screw begins to supply fuel to the fire bed. Assume also that the fire has been operating for some time under "hold-fire" conditions and consequently a considerable amount of burnt coal or ashes has accumulated in the retort. Under ordinary circumstances the starting of the stoker and the fan would immediately blow this fly ash through the furnace. This, however, is prevented by the invention in which a delayed time interval is provided before the full effect of the fan operation is permitted to exert itself upon the fuel bed. Under these conditions approximately 10 per cent of the full volume of air passes around the sides of the damper 48.

With the stoker screw now feeding green coal upon the fire, static air pressure in the air duct 11 is gradually built up by the accumulating thickness of the fuel bed. This air pressure eventually builds up to a certain or predetermined static pressure value in the duct and in front of the air damper 48. The pressure responsive disc or piston 34 within the static pressure cylinder 33 is thereby actuated responsive to the increasing static pressure, and moves in an upward direction forcing the connecting rod 35 upward so that the operating lever 36 is caused to move about its pivot 37 until a position is reached wherein the mercury switch 39 is tilted to close its contacts. The counterbalance 38 is provided for the purpose of balancing the weight of the mercury switch to render the device more sensitive.

The closing of the static pressure switch 39 establishes a circuit (see Fig. 7) for the electric heater 24 extending in series with the normally closed contacts 45 of mercury switch 43, the now closed static switch contacts 39, and the line conductors 64 and 65. From the foregoing it is seen that the closing of the circuit to the heater 24 is prevented until the static pressure in the air duct has been built up to a certain value, thereby indicating a certain thickness of the fuel bed on the retort. The resistance winding of the electric heater 24 being now energized, it gradually begins to emit heat. This heat emitted by heater 24 is arranged to effect the expansion of the bellows 22 by passing it by convection over the bellows. Since the partitions 19 and 20 separate the bellows from the heater, no direct radiant heat is transferred thereto. In order to circulate the heat in the most efficient manner over the bellows, the series of openings 60 is arranged to permit the entrance of a portion of the air from the air duct 11. This circulated air is passed around the heated element of heater 24 where it is heated and passed between the ends of baffle plate 20 and the end of bellows partition 19 as indicated by the arrows in Fig. 2. This heated air further passes within the bellows chamber 21 around the bellows 22, heating the same and then passing upward through the adjustable openings in the top of cover 18 and the adjusting plate 58. The air may further pass out of the enclosing cover 29 through the louvres 30 in the sides thereof. The openings 63 in the top of heater 24 are adjusted to pass a portion of the heated air.

The expansible fluid in the bellows 22 is affected by the passage of heat over the bellows and accordingly tends to expand the bellows so that the operating pin 50 is caused to exert a downward thrust against the short lever 51. This effort is transmitted by lever 51 to the short end of operating lever 41, thereby causing it to be rotated in a counter-clockwise direction about pivot pin 42. Eventually, after a time interval, an intermediate position is reached in which the operating lever 41 assumes a horizontal position as shown in Fig. 5 wherein the mercury in switch 43 disengages itself from contacts 45. During this same movement the long end of the operating lever 41 forces the armature 27 through link 46 into the core of the solenoid 26 for a short distance. Also the connecting link 47 moves the air damper 48 substantially to the intermediate position shown in Fig. 5. In this position of the air damper 48 a greater amount of air is caused to pass through the air duct 11 from the fan 13a, and since the fuel bed on the retort 12 has been built up to some substantial thickness in the meantime, this increased air flow causes the fire to be expanded to a considerable extent, thereby increasing combustion. It is seen that this increased combustion takes place only after fresh fuel has been fed upon the fire and when the possibility of blowing fly ash through the furnace has ceased to exist.

It will be appreciated that the time interval which it has taken the damper to assume the foregoing position may comprise a substantial period, of for example several minutes, due to the time required to build up pressure in the cylinder 33 and the lag in the time required to heat the element of heater 24 and for the bellows to respond. This timed period is sufficient to prevent the blowing of fly ash through the furnace.

When the operating elever 41 assumes the position shown in Fig. 5 with the contacts 45 disengaged, the circuit for the electric heater 24 extending therethrough is disconnected and the heat generated by heater 24 is terminated. Due to the lag in the cooling of this element, the bellows 22, however, may continue to expand a further slight amount.

The mercury switch 43 is designed to open contacts 45 and immediately close contacts 44 and the position of the mercury in switch 43 shown in Fig. 5 is merely a transitory one. The expansion of the bellows 22 eventually tilts the operating lever 41 so that the mercury switch 43 closes its contacts 44 as shown in Fig. 4. At this time the extension lever 52 of operating lever 41 is almost in engagement with the deflector pin 57. Referring to Fig. 7 the closure of contacts 44 electrically connects the winding of solenoid

26 to the line thereby operatively energizing the same. As a result the solenoid 26 immediately operates its armature 27 to the full extent into its core thereby immediately and rapidly moving the long end of operating lever 41 upward and out of control of the bellows 22 which, however, may continue to expand and follow a further slight amount since the load has now been removed from it. This action also pulls the link member 47 further in an upward direction thereby opening the air damper 48 to its fullest extent and permitting the full force or volume of air delivery from the fan to pass through the air duct 11 and affect the fuel bed so as to greatly increase the size of the fire.

As a further result of the energization of solenoid 26, the end of extension lever 52 engages the deflector pin 57, forcing it downward and rotating the deflector 54 about its pin 55 so that the air passage 53 now is opened. The deflector 54, it is seen, projects a slight distance into the forced air stream passing through the air duct 11 and serves to scoop up a portion of this air and divert it through the passage 53 and around the outside of the bellows 22, through the bellows chamber 21, and out through the adjustable openings in the top of this chamber and the adjusting plate 58 where it is permitted to escape. This cool air tends to quickly restore the bellows 22 to its retracted position, within a shorter period than would be required for it to cool in the ordinary course as by convection. At this time cool air is also permitted to pass through the chamber 28 and the holes 60, around the heating element 24 and out of the adjustable openings 63 to further assist in cooling off the heating element to more quickly restore the heater to a relatively cooled state.

The stoker is now operating to its fullest extent, feeding fuel to the hot fire while the fan is feeding forced combustion air at its fullest volume to the now open air duct 11. The control device will remain in the operated position shown in Fig. 4 as long as these conditions exist.

From the foregoing operations of the control device it will be seen that because of the relatively distant thermal relationship of the bellows to the heater in the starting operation due to the inter-position of the walls 19 and 20, it requires an appreciable time interval for the full action of the bellows to take effect upon the air damper 48, while when the solenoid 26 has taken control, the damper is immediately opened to its fullest extent. The heater 24 and the bellows 22 are gradually cooled off by the passage of the forced cooled air through the passage 53 and the openings 60.

After the heat generated by the furnace has reached the vicinity in which the thermostat 66 is located, the thermostat operates to open its contacts thereby disconnecting the solenoid 26 from its operating current source and at the same time stopping the operation of the stoker motor 13. The stopping of the motor 13 stops the fan 13a from forcing air through the air duct 11 thereby permitting the disc 34 in the static pressure chamber 33 to drop downward to its normal position shown in Fig. 2, and opening the mercury switch contacts 39. As a further result the armature 27 of solenoid 26 is released causing the air damper 48 to pivotally drop downward and assume the position shown in Fig. 2 in which it substantially obstructs the air passage of the air duct 11. Due to the relatively long end of operating lever 41 and the weight of the air damper linked thereto, the extension lever 52 is moved in an upward direction disengaging itself from the deflector pin 57 and permitting the deflector 54 to close the end of the diverting air passage 53 by reason of the counter balance weight 56. During the time it may have taken for the room thermostat 66 to respond to the heat of the stoker operation, the bellows 22 has been cooled to its normal contracted state while the heater 24 has likewise been cooled off as shown in Fig. 2. The control device remains in the aforesaid dormant position until another call for heat takes place.

Under ordinary circumstances, after the room thermostat has actuated the stoker until it has become satisfied and remains so for a considerable time interval, the fire would become extinguished if it were not for the provision of the interval timer 67 which at periodic time intervals closes its contacts as has been pointed out to operate the stoker and maintain the fire alive. The action of this interval timer 67 upon the control device, however, is arranged so that the control device is not actuated to its fullest extent because of the short time, for example three minutes, in which the timer maintains its contacts closed and then opens them. If the full volume of air were immediately forced into the comparatively small fire, it would burn too quickly and therefore may burn itself out before sufficient fuel were fed into the retort by the motor 13. This short time interval is not sufficient for the static switch 39 to operate to its fullest extent or if it should operate the heater 24, the heat generated thereby would not be completely effective upon bellows 22 to operate it due to the relative lag in the response of these devices. Therefore the air damper 48 is not actuated from its vertical position as shown in Fig. 2. The forced air from the operation of the fan is substantially prevented from passing into the stoker retort by the air damper but the stoker feeds fresh fuel upon the fire for the full three minutes of operation of the interval timer. After the operation of the interval timer the stoker is stopped and the natural draft of air passing around the sides of the air damper 48 in the duct 11 maintains the fire bed active with the additional fuel fed to the fire.

It will be appreciated that by adjusting the openings by means of the adjustable plate 58 and the screw 59, the response of the bellows 22 may be regulated to any desired time interval by permitting more or less of the heated air from the bellows chamber 21 to escape out of these openings. Similarly, by adjusting the adjustment plate 61, any variable amount of air is permitted to escape from the heater chamber to assist in its cooling or to prevent its cooling too rapidly as desired. By thermally insulating the casing 17 the full effect of the heat from heater 24 is not permitted to escape by convection or radiation through the casing walls 17 and thereby assists in more readily regulating the response of the bellows 22.

Referring now particularly to Fig. 6, this drawing represents a chart showing the operating characteristics of the control device for two different operating periods for example. The dotted line indicates the operation of a stoker in which the room thermostat is arranged to operate the stoker for periodic cycles of 10 minutes "on" and 5 minutes "off." This periodic cycle operation of the room thermostat, it will be appreciated, will vary with weather conditions. In mild weather the "on" period will be short and the "off" period

will be long, while in cold weather the reverse will be true. The full line indicates cyclic operations for a stoker which is run for 20 minutes and stopped for 10 minutes. The per cent of damper openings in the air duct is charted against the timed periods in minutes. It will be noted from this chart that the air damper is arranged to always permit 10 per cent air delivery through the air duct where the stoker is operating. The point 68 indicates the time required, in this case two minutes, after the stoker is started, for the static pressure to build up in the air duct, plus the time it takes for the heater 24 to heat up and the bellows 22 to begin to respond thereto. As the bellows gradually expands, the damper is gradually opened and after an additional interval of five minutes as indicated at 69 it is opened for 50 per cent of its full openings in the air duct. At this time the solenoid 26 takes control and immediately opens the air damper to its full 100 per cent opening as indicated at 70. After a further run of the stoker for three minutes, during which the damper is open, the stoker is stopped by either the room thermostat or interval timer as the case may be, and the solenoid de-energized whereupon the air damper immediately drops from the point 71 to the point 72 which represents a damper opening of 30 per cent. The air damper is stopped in this position instead of the closed position indicated at 68 because of the residual heat remaining in the heater 24 and the lagging cooling response of the bellows 22, due to the comparatively short stoker operation (10 minutes) which does not allow the control device to be fully cooled and restored to its normal position as shown in Fig. 2. This prevents the fire from being "strangled" by completely shutting off the air flow after this comparatively short run, thereby preventing excess smoking. After an "off" period of five minutes, during which the residual heat in the bellows is being gradually dissipated, the point indicated at 73 is reached by the damper which represents an opening of slightly over 20 per cent.. At the point 73 the stoker is started again and the damper openings are progressively brought about as has been pointed out.

The full line on the chart indicates, as has been stated, an "on" period of 20 minutes and an "off" period of 10 minutes for the stoker. Due to the longer time intervals between stoker operations, it will be seen that the control device is fully restored to its normal cooled position as seen in Fig. 2 and the air damper is restored to its full air duct closing position after each operation.

From the foregoing description it will be seen that the control device comprises a simple and efficient arrangement whereby a delay is interposed between the feeding of fuel to a fire and the delivery of forced air to the fuel bed so that the objectional propagation of fly ash through a furnace is substantially eliminated. Moreover, the passage of forced air to the fuel bed is predicated upon the thickness of the bed of fuel so that only when the bed is of the proper thickness for efficient combustion is the forced air permitted to be passed to the fuel bed, thereby the air volume is regulated upon the initial actuation of the stoker. This tends to maintain a uniform fuel bed.

In addition the air damper is arranged so that it is held locked in its fully opened position as long as the stoker is operating. The arrangement of the deflecting air passage 53 enables the bellows to be retracted to its normal position more rapidly than would be the case were the bellows cooled simply by convection.

Should it occur that during an operation of the stoker with the air damper fully open, that a "blow-hole" manifest itself in the fuel bed, the forced air would immediately pass through this "hole" and rapidly burn the fire out. This is prevented however by the static pressure drop which would immediately occur in the air conduit and result in the static pressure switch restoring to normal thereby opening its switch 39. Switch 39 opens the circuit of the solenoid 26 and this closes the damper to shut off the air flow.

It will be appreciated that any number of modifications of the invention may be devised by those skilled in the art without departing to any great extent from the principles of the invention, and it is therefore desired that the invention be not strictly limited to the exact form of the disclosure pointed out, but only to the extent of the appended claims.

What is claimed is:

1. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a time delay mechanism actuated upon demand for change in operation of said stoker mechanism for shifting said controller to vary the air delivery after a period of time has elapsed, and holding means for normally preventing return of said controller to its initial position irrespective of said time delay mechanism.

2. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a time delay mechanism actuated upon demand for change in operation of said stoker mechanism for shifting said controller to vary the air delivery after a period of time has elapsed, and means actuated upon said controller being shifted to a predetermined new position for preventing return thereof while causing said time delay mechanism to return to its initial position.

3. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a time delay mechanism actuated upon demand for change in operation of said stoker mechanism for shifting said controller to vary the air delivery after a period of time has elapsed, means actuated upon said controller being shifted to a predetermined new position for preventing return thereof while causing said time delay mechanism to return to its initial position, and means for releasing said holding means upon an opposite change in operation of the stoker mechanism.

4. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, power operated means energized upon demand for change in operation of the stoker mechanism for actuating said controller, and means for preventing return of said

controller to its initial position while deenergizing said power operated means.

5. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, power operated means of the type which operates in one direction when energized and which is movable in the opposite direction when deenergized, said power operated means being arranged to shift said controller in said one direction, biasing means for biasing said controller in said opposite direction, means for energizing said power operated means upon demand for change in output from said stoker mechanism, means including holding means for preventing return of the controller to its initial position while deenergizing said power operated means, and means for releasing said holding means in response to demand for further change in output of the stoker mechanism.

6. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a first power operated means controlled upon demand for change in output of the stoker mechanism for actuating said controller toward a predetermined position, a second power operated means for shifting said controller to said predetermined position, and means actuated upon movement of said controller partially toward said position for causing said second power operated means to function.

7. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a first power operated means controlled upon demand for change in output of the stoker mechanism for actuating said controller toward a predetermined position, a second power operated means for shifting said controller to said predetermined position, and means actuated after initial movement of said controller by said first power operated means for causing operation of said second power operated means and for rendering said first power operated means inoperative.

8. In a control system for a stoker mechanism having a retort, fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from said stoker mechanism for placing the fuel feeding means and the air feeding means into and out of operation, an air flow controller for varying the delivery of air from the air feeding means to the retort, a temperature responsive means for positioning said flow controller, electric heating means for locally heating said temperature responsive means, and means for controlling the flow controller in accordance with the air fed to the retort, said last mentioned means including a device actuated to a substantial extent by the air passing from the air feeding means to the retort for controlling said electric heating means.

9. In a control system for a stoker mechanism having a retort, fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from said stoker mechanism for placing the fuel feeding means and the air feeding means into and out of operation, an air flow controller for varying the delivery of air from the air feeding means to the retort, a temperature responsive means for positioning said flow controller, electric heating means for locally heating said temperature responsive means, first control means controlled by the air passing from the air feeding means to the retort, second control means actuated in accordance with the position of the air flow controller, and means actuated by the first and second control means for controlling said electric heating means.

10. In a control system for a stoker mechanism having a retort, fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from said stoker mechanism for placing the fuel feeding means and the air feeding means into and out of operation, an air flow controller for varying the delivery of air from the air feeding means to the retort, a heat motor including a temperature responsive actuator and electric heating means for heating the same, said actuator being arranged upon heating thereof to move said controller in a manner to increase the delivery of air to the retort, a switch for controlling said electric heater, and means responsive to the pressure of the air delivered by said air feeding means for opening said switch upon fall in said pressure.

11. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, electric power actuated means for actuating said controller, said electric power actuated means being also controlled by said responsive means and serving to move said flow controller to increase the delivery of air when said motor is in operation, switching means for controlling said electric power actuated means, and means responsive to the static pressure of the air being delivered to the retort for actuating said switching means in a manner to cause decrease in air delivery upon fall in said pressure.

12. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, electric power actuated means for actuating said controller, said electric power actuated means receiving power from the motor circuit and adapted when energized to move the flow controller to a position increasing the delivery of air and to prevent return thereof to its initial position, a switch in circuit with said power actuated means, and a device responsive to the static pressure of the air being delivered to the retort for actuating said switch.

13. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an unbalanced damper for controlling the flow of air from said air feeding means to the retort, said damper tending to close due to the action of the air contacting it, means

including a thermostatic actuator and heating means therefor for actuating said damper toward open position upon energization of the heating means, means for deenergizing said heating means when the motor is deenergized and for energizing said heating means when the motor is energized, whereby the damper is substantially closed when the motor first starts and remains closed until the thermostatic actuator becomes heated at which time the damper is opened, and means responsive to the pressure of the air delivered by the air feeding means for causing said damper to move toward closed position when the air pressure falls below a predetermined value.

14. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an unbalanced damper for controlling the flow of air from said air feeding means to the retort, said damper tending to close at least partially due to the action of the air contacting it, means including a thermostatic actuator and heating means therefor for causing movement of said damper from substantially closed position toward open position upon change in temperature of the thermostatic actuator in one direction, means for controlling the heating means in accordance with operation and non-operation of the motor in a manner to cause the temperature of said thermostatic actuator to change in said one direction when the motor is started whereby the damper is substantially closed when the motor first starts and opens as the thermostatic actuator changes in temperature in said one direction, and means responsive to the pressure of the air delivered by the air feeding means for causing said damper to move toward closed position when the air pressure falls below a predetermined value.

15. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, control means including a pressure responsive device responsive to the pressure of the air being delivered to the retort and a thermostatic device having heating means therefor to control the position of said air flow controller, said control means being arranged to maintain the air flow controller in substantial flow preventing position for a period of time following starting of said motor and also to maintain said controller in substantial flow restricting position when the air delivery pressure is below a predetermined value.

16. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, control means including means responsive to the pressure of the air and a thermostatic device subject to the influence of heating means for controlling the position of said air flow controller, said control means being arranged to maintain the air flow controller in substantial flow preventing position for a period of time following starting of said motor and also to maintain said controller in substantial flow restricting position when the air delivery pressure is below a predetermined value, and holding means controlled by said responsive means for maintaining said air flow controller in position to permit flow of air, said holding means being released after the demand for heat from the stoker mechanism is satisfied.

17. In a control system for a stoker mechanism having a retort and a motor driven fan for supplying air to the retort, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, a damper biased toward closed position for controlling the flow of air to the retort, means for preventing opening of said damper for a period of time following starting of said motor while causing opening of the damper thereafter, said last mentioned means utilizing the air pressure produced by operation of the fan and preventing substantial opening of the damper until the air pressure builds up to a predetermined value, and holding means connected to and controlled by said responsive means for holding said damper in open position, said holding means being released after the demand for heat is satisfied for permitting said damper to move to substantially closed position.

18. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, electric power actuated means including a slow acting thermostatic element and electric heating means therefor adapted when energized to move said controller to a position increasing the delivery of air and to maintain the controller in said position, and means for supplying electric power continuously to said power actuated means upon demand for heat from said stoker mechanism.

19. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, a heat motor including a temperature responsive actuator and electric heating means for heating the same, said actuator being arranged upon heating thereof to move said controller in a manner to increase the delivery of air to the retort, means controlled by said responsive means for energizing said heating means upon demand for heat from said stoker mechanism, holding means adapted when energized to prevent return of said controller to its initial position, and switching means actuated a period of time following energization of the heat motor for deenergizing the same and for energizing said holding means.

20. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, a heat motor including a temperature responsive ac-

tuator and electric heating means for heating the same, said actuator being arranged upon heating thereof to move said controller in a manner to increase the delivery of air to the retort, means controlled by said responsive means for energizing said heating means upon demand for heat from said stoker mechanism, holding means adapted when energized to prevent return of said controller to its initial position, switching means actuated a period of time following energization of the heat motor for deenergizing the same and for energizing said holding means, and means actuated upon movement of the air flow controller for passing a portion of the air supplied by the air feeding means in heat exchange relationship with the heat motor for causing it to return to its initial position.

21. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a time delay mechanism including a temperature responsive device and heating means therefor for shifting said controller, the heating means being energized upon demand for change in output of the stoker mechanism, holding means for preventing return of said controller to its initial position, cooling means for cooling the temperature responsive device, and means actuated after movement of the controller for deenergizing said heating means and initiating operation of said cooling means.

22. In a control system for fuel burning means, in combination, a controller for varying the rate of combustion in the fuel burning means, a temperature responsive device for positioning said controller, electric heating means for locally heating said temperature responsive device, flow control means for controlling the flow of cooling medium in heat exchange relationship with said temperature responsive device, and means responsive to the demand for heat from said fuel burning means for controlling said heating means and flow control means.

23. In a control system for fuel burning means, in combination, a controller for varying the rate of combustion in the fuel burning means, a temperature responsive device for positioning said controller, electric heating means for locally heating said temperature responsive device, flow control means for controlling the flow of cooling medium in heat exchange relationship with said temperature responsive device, means responsive to the demand for heat from said fuel burning means for energizing said heating means upon demand for additional heat for thereby actuating said controller in one direction, and means for deenergizing said heating means and actuating said flow controller to cause cooling medium to flow in heat exchange relationship with said temperature responsive device to thereby permit movement of said controller in the opposite direction.

24. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, electric motor means including a thermostatic element and electric heating means therefor for positioning said air flow controller, means including switching mechanism for controlling said electric motor means, said switching mechanism having a first position causing said air flow controller to substantially prevent air flow and having a second position causing the motor means to move the air flow controller for supplying air to the retort, and means for moving said switching mechanism from its first position to its second position a period of time following starting of the motor and for returning said switching mechanism to its first position when the motor is placed out of operation.

25. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an air flow controller for varying the delivery of air to the retort, electric power actuated means for actuating said controller, said electric power actuated means adapted when energized to move the flow controller to a position increasing the delivery of air and to prevent return thereof to its initial position, a switch in circuit with said power actuated means, and a device responsive to the static pressure of the air being delivered to the retort for actuating said switch.

26. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, an unbalanced damper for controlling the flow of air from said air feeding means to the retort, said damper tending to close at least partially due to the action of the air contacting it, means including a thermostatic actuator and heating means therefor for causing movement of said damper from substantially closed position toward open position upon change in temperature of the thermostatic actuator in one direction, and means for controlling the heating means in accordance with operation and non-operation of the motor in a manner to cause the temperature of said thermostatic actuator to change in said one direction when the motor is started whereby the damper is substantially closed when the motor first starts and opens upon change in temperature of said thermostatic actuator in said one direction.

27. In a control system for a stoker mechanism having a retort, fuel feeding means, air feeding means, and an electric motor for driving at least one of said feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for placing said motor into and out of operation, a damper for controlling the flow of air to the retort, said damper being biased toward closed position and remaining in substantially closed position irrespective of increase in pressure on the downstream side thereof, means including a thermostatic actuator and heating means therefor for causing movement of said damper from substantially closed position toward open position upon change in temperature of the thermostatic actuator in one direction, means for controlling the heating means in accordance with operation and non-operation of the motor in a manner to cause the temperature of said thermostatic actuator to change in said one direction when the motor is started whereby the damper is substantially closed when the mo-

tor first starts and opens as the thermostatic actuator changes in temperature in said one direction, and means responsive to the pressure of the air delivered by the air feeding means for causing said damper to move toward closed position when the air pressure falls below a predetermined value.

28. In a control system for a stoker mechanism having fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from the stoker mechanism for controlling the operation thereof, a controller for varying the feeding of air, a time delay mechanism actuated upon demand for change in operation of said stoker mechanism for shifting said controller to vary the air delivery after a period of time has elapsed, holding means for preventing return of said controller to its initial position irrespective of said time delay mechanism, and means controlled by said heat demand responsive means for releasing said holding means.

29. In a control system for a stoker mechanism having a retort, fuel feeding means and air feeding means, the combination of, means responsive to the demand for heat from said stoker mechanism for placing the fuel feeding means and the air feeding means into and out of operation, an air flow controller for varying the delivery of air from the air feeding means to the retort, a temperature responsive means for positioning said flow controller, electric heating means for locally heating said temperature responsive means, and switching means controlled by the air passing from the air feeding means to the retort and by the position of the air flow controller for controlling said electric heating means, and means also controlled by said switching means to cause movement of the air flow controller toward flow increasing position in response to movement of the controller toward flow increasing position.

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