

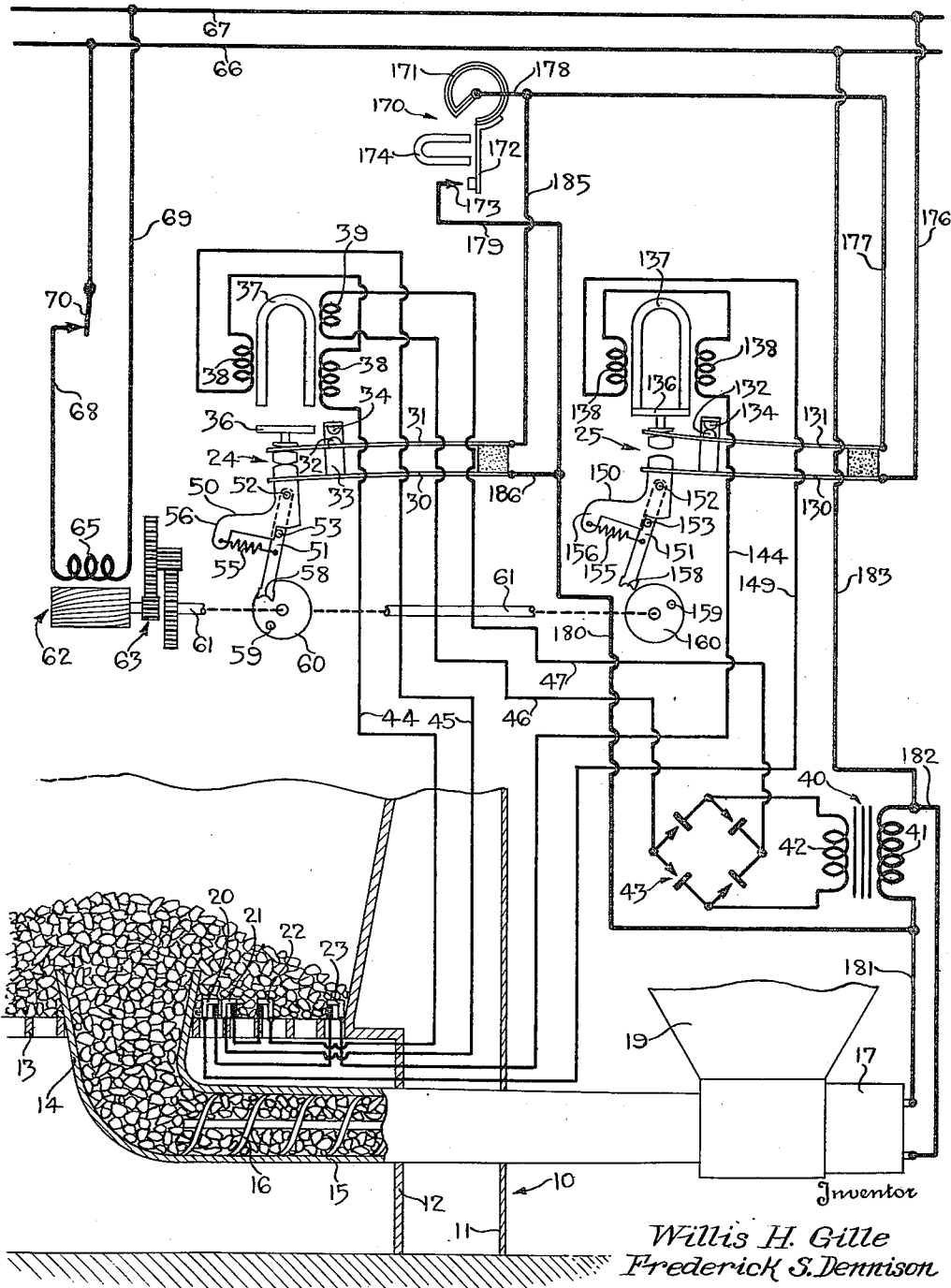
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STOKER CONTROL

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STOKER CONTROL

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The present invention relates to a stoker control and more particularly to one employing temperature sensitive elements located in the fuel bed.

5 It has been found desirable to control a motor operated stoker for a coal fired furnace by conditions in the furnace as well as by conditions in the space being heated. Thus, it has been found desirable in the prior art to provide an "out fire" control wherein the operation of the stoker motor is prevented when combustion has ceased or become diminished to such a point that additional fuel, if supplied, would not be ignited. It has further been proposed to provide a "hold fire" control wherein the stoker motor is placed in operation regardless of the demand of the room thermostat whenever combustion has reached such a low point that it is imperative that fuel be added in order to continue the fire. It has also been proposed to provide some means responsive to excess temperature conditions to prevent the operation of the stoker motor when such conditions prevail.

25 In the usual prior art installations of the type previously referred to, the various controls responsive to conditions in the furnace are located remote from the fuel bed, being responsive to such conditions as stack temperature. Since all of the various conditions referred to are primarily conditions within the fuel bed itself, such location of the controlling instruments at other points results in an indirect measurement of the controlling conditions which may often lead to unsatisfactory operation. While it has been proposed in one instance to locate the temperature responsive elements in the fuel bed itself, these elements have all been located at substantially the same position and were made dependent upon a variation in temperature in this location. Even this is not a direct measurement of the conditions which it is desired to have controlled by the stoker motor. For example, in the case of an "out fire" control, it is not so important what the temperature is in some normally constant temperature zone but rather whether combustion is taking place at a point where combustion will always take place if there is any combustion whatsoever. Similarly, in the case of the "hold fire" control, the important question is how far combustion has spread rather than what the temperature is in a normally constant temperature zone.

55 An object of the present invention is to provide a stoker control wherein the control of the stoker

is, in part at least, determined by the extent to which combustion has spread in the fuel bed.

A further object of the present invention is to provide a stoker control employing a plurality of temperature responsive devices located in the fuel bed at various points from the center of combustion so as to indicate the extent of the zone of combustion.

A further object of the present invention is to provide a stoker control employing thermo-couples embedded in the fuel bed and acting as temperature responsive elements to control a stoker motor.

A further object of the present invention is to provide an electrical device, the energization of which is controlled by a pair of opposed thermo-couples so that upon the junction of either one of the thermo-couples being heated, the device is energized but upon the junction of either both or none of the thermo-couples being heated, the device is deenergized.

A further object of the present invention is to provide a switch with means to oscillate the switch without changing the circuit controlling position until a holding means is effective to cause the switch to be moved to a different circuit controlling position by the oscillating means and wherein upon the switch being so moved, the oscillating means is not effective upon said switch even though it continues to operate.

A further object of the present invention is to provide means in a thermo-couple energized controller for temperature changing apparatus which is effective to require a differential in temperature between energized and deenergized conditions of the said controller.

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

In the single view of the drawing the stoker control of the present invention is shown schematically.

Referring to said drawing, a portion of a coal furnace is shown in section and is designated in its entirety by the reference numeral 10. The furnace comprises an outer jacket 11 and an inner jacket 12, which inner jacket serves to support a grate 13 in the usual position. Extending through a center portion of the grate 13 is the flared end 14 of a conveyor duct 15 which serves to supply coal to the furnace, feeding it onto the grate 13. The coal is moved through duct 15 by a conveyer screw 16 which is driven by a motor 17. The coal is stored in a hopper 19 from which it passes into duct 15.

Extending through the grate are a plurality of thermo-couples 20, 21, 22, and 23. As will be noted from the drawing, the thermo-couples 21 and 22 are connected in opposition and are adapted to cooperate to control a switch 24. Similarly, thermo-couples 20 and 23 are also connected in opposition and are adapted to cooperate to control a switch 25. Each of these thermo-couples comprises a pair of members of different thermo-electric characteristics, the junction of which is located in the fuel bed.

This junction would constitute the hot junction of the thermo-couple if the thermo-couple were not connected in opposition with another thermo-couple. Due to the fact, however, that when the thermo-couples are so connected the junction of one thermo-couple may actually constitute a cold junction of the group, the point in each unit at which the two members of different thermo-electric characteristics are physically connected together is referred to hereinafter merely as the junction of that thermo-couple.

The structure of switch 24 will first be described. The switch proper comprises two contact carrying blades 30 and 31. The contact carrying blade 31 has secured thereto a contact 32 and the contact carrying blade 30 is formed with a contact carrying member 33 which extends upwardly and forwardly over contact 32 and carries a contact 34 which is adapted to engage contact 32. Also secured to contact carrying arm 31 is an armature 36 which is adapted to cooperate with an electromagnet 37. The electromagnet 37 is provided with a main winding 38 and an auxiliary winding 39. The main winding 38 is connected through conductors 44 and 45 with the oppositely connected thermo-couples 21 and 22. When the junction of thermo-couple 21 is heated but the junction of thermo-couple 22 is not, winding 38 will be energized. When the junctions of both thermo-couples are subjected to flame, they will oppose each other and the winding 38 will be deenergized.

The auxiliary winding 39 is energized through a transformer 40, the primary 41 of which is connected in parallel with the stoker motor 17. The secondary 42 of transformer 40 is connected to the input terminals of a rectifier 43 which is shown for purposes of illustration as an ordinary bridge rectifier. The output terminals of rectifier 43 are connected through conductors 46 and 47 to auxiliary winding 39. It will be readily seen that inasmuch as the primary 41 of transformer 40 which controls the energization of auxiliary winding 39 is connected in parallel with motor 17 that winding 39 will be energized whenever the motor 17 is energized. The winding 39 is so connected to the output terminals of rectifier 43 that it will aid winding 38 when energized. The purpose of the rectifier is to insure that the current through winding 39 will be unidirectional and hence that winding 39 will always aid winding 38.

Secured to contact carrying blade 30 is a pusher member 50 which has an arm 51 pivotally secured thereto at 52. A pin 53 extends from arm 51 and engages a shoulder of member 50 so as to limit movement of arm 51 to the left. A spring 55 is secured at one end to arm 51 and at the other end to an extension 56 of pusher member 50 and serves to hold arm 51 in its extreme left-hand position with pin 53 in engagement with its cooperating shoulder portion. Arm 51 is provided with a curved end 58 which is adapted to cooperate with a pin 59 of a disc 60.

The disc 60 is secured to a shaft 61 driven by a motor 62 of any suitable construction, through a suitable reduction gearing 63. The motor 62 is provided with a winding 65 which is connected to line wires 66 and 67 through conductors 68 and 69. A manual switch 70 is preferably interposed in the conductor 68 to provide some means for interrupting the operation of motor 62 when it is desired to place the apparatus out of operation.

The contact carrying members 30 and 31 are biased to the position shown in the drawing. In this position, contacts 32 and 34 are separated. This is the position assumed when winding 38 and consequently magnet 37 is deenergized either by reason of both thermo-couples 21 and 22 being heated or by reason of neither of these thermo-couples being heated. As the apparatus is shown in the drawing, the deenergization of winding 38 is due to the fact that both of the thermo-couples 21 and 22 are subjected to the same temperature of combustion adjacent their hot junctions.

The motor 62 is effective to continuously rotate disc 60 in a clockwise direction with the result that pin 59 periodically engages the arm 51. Upon pin 59 engaging arm 51, the arm is moved upwardly and at the same time is pivoted about 52 due to the fact that the pin 59 is retained in engagement with the end 58 of arm 51 by reason of the inter-engaging curved surfaces. Before disc 60 has rotated to the point where pin 59 lies on a line extending between the center of disc 60 and pivot point 52, the armature 36 has been raised sufficiently to cause inter-engagement of armature 36 and electromagnet 37. Further movement of disc 60 in a clockwise direction will cause pin 59 to move from under the end of arm 50 and the spring 55 will be effective to return arm 51 to the radial position shown in the drawing. If the windings 38 are not energized when armature 36 is moved into engagement with the electromagnet, pusher members 50 will drop again allowing members 30 and 31 to move to the position shown in the drawing. In view of the fact that the member 31 is biased downwardly, any upward movement imparted thereto by reason of the pusher mechanism 50 will not cause the contacts 32 and 34 to be moved into engagement. Thus, armature 36 is moved into engagement with electromagnet 37 without disturbing the relative position of contacts 32 and 34. Similarly, when pusher member is released after armature 36 is not held by electromagnet 37, both contact carrying members 30 and 31 will move downwardly maintaining the same relative position of contacts 32 and 34. The result is that the contact carrying members 30 and 31 are continuously oscillated back and forth without changing the controlling position of switch 24 except when the armature 36 is held by the electromagnet 37. In view of the fact that switch 25 is identical in construction with switch 24, with the exception that no auxiliary winding is employed on the magnet, and is shown in the position in which armature 36 is held in engagement with magnet 37, this switch will now be described in order to obtain a clearer understanding as to the operation of the switch upon the armature being held by the electromagnet.

In view of the fact that, as previously mentioned, the structure of the switches 24 and 25 is identical, with the exception of the auxiliary winding, the elements of switch 25 corresponding to those of switch 24 have been assigned

reference numerals which are exactly one hundred higher than the corresponding elements of switch 24. Further, in view of the fact that the character of the elements referred to by these reference numerals is obvious in view of the preceding description of switch 24, it is deemed unnecessary to specifically describe this structure except as is incidentally done in connection with a description of the operation thereof.

In a manner similar to the method in which switch 24 is oscillated, the switch 25 is actuated by reason of a pin 159 on a disc 160 driven by shaft 61 periodically engaging the curved end 158 of arm 151. As in the case of switch 24, contact 132 carried by contact carrying member 131 is not moved into engagement with the contact 134 carried by contact carrying member 130 during such oscillation of the switch through disc 160 and pusher member 150, unless armature 136 is held by the magnet 137. As previously mentioned, armature 136 is so held in the position shown in the drawing. Upon member 136 having been initially moved into engagement with magnet 137 by the pin 159 acting on arm 151 and consequently pusher 150, contacts 132 and 134 are still separated. Upon the armature 136 being so held, contact carrying member 131 is held against downward movement. As soon as the pin 159 has rotated sufficiently in a counter-clockwise direction to ride from underneath the curved end 158 of arm 151, pusher member 150 is released permitting contact carrying member 130 to move downwardly until the contact 134 is moved into engagement with contact 132. Further downward movement of contact carrying member 130 is prevented by reason of the engagement of contacts 132 and 134.

It will be noted that the curved end 158 of arm 151 is in a position wherein pin 159 will not engage the same. This is due to the fact that member 130 is held in an elevated position by reason of the engagement of contacts 132 and 134 with the result that pusher member 150 is also held in an elevated position. The apparatus is so designed that when the pusher member 150 is held in such an elevated position and the arm 151 is retracted by reason of the spring 155 secured between extension 156 and arm 151, the curved end 158 will be raised sufficiently to be out of the path of pin 159. If this were not done, contact member 130 would be oscillated by member 160 after engagement of contacts 132 and 134 causing the periodic disengagement of these contacts.

In addition to the controlling switches 24 and 25, a thermostatic switch 170 is provided. This thermostatic switch may take any desired form and may preferably be located in the space being heated, functioning as a room thermostat. The thermostat 170 is shown for purposes of illustration as comprising a bimetallic element 171 to which is secured a contact blade 172 adapted to cooperate with a fixed contact 173. A magnet 174 is designed to cooperate with contact blade 172 and hold the same slightly when the blade is moved into engagement with contact 173, thus preventing immediate disengagement of blade 172 from contact 173 upon the temperature rising.

In general it may be stated that switch 25 is connected in the circuit of stoker motor 17 in series with both thermostatic switch 170 and switch 24 while switches 24 and 170 are connected in parallel. Further, it may be stated that switch

25 functions as a combined "out fire" and "high limit" switch whereas switch 24 functions as a "hold fire" switch.

As previously indicated, the various elements are in the position assumed when combustion has spread to a point where the junctions of both thermo-couples 21 and 22 are heated. Moreover, combustion has not reached the point where the junction of thermo-couple 23 is heated. In other words, combustion has spread sufficiently far that it is above the minimum range during which the hold fire switch is closed and is below the maximum at which the high limit switch is open, so that the stoker motor is under the sole control of the thermostat 170. The thermostat 170 is moreover shown in open position, or in other words, it is shown in the position assumed when the temperature in the space being heated is at or above the desired value. Upon the temperature falling below the value for which the thermostat is set, the contact blade 172 will be moved into engagement with contact 173, being held in engagement therewith by magnet 174. Upon this taking place, the following circuit is established to stoker motor 17: from line wire 67 through conductor 176, switch 25, conductors 177 and 178, thermostat 170, conductors 179, 180, and 181, stoker motor 17, and conductors 182 and 183 to line wire 66.

So long as the limit of the zone of combustion remains between the hot junction of thermo-couples 22 and 23, the stoker will be under the sole control of the thermostat 170 and stoker motor 17 will operate only so long as thermostatic switch 170 is closed. Upon the temperature rising sufficiently that contact arm 172 is moved away from contact 173 against the action of magnet 174, the previously traced circuit to the motor 17 will be interrupted so that motor 17 will be placed out of operation. During normal action of the stoker, the making and breaking of the previously traced stoker motor circuit in the manner just described is substantially the only controlling operation taking place.

If, however, due to an excessive heat loss such as caused by a window being open or for some other reason, the thermostat 170 continues to "call for heat" for an excessively prolonged period, it may well happen that combustion reaches such an excessively high value that the junction of thermo-couple 23 is heated. When this takes place, the thermo-couples 20 and 23 will be generating electromotive forces which are in opposition to each other. The result is that the energization of winding 138 will be decreased to such a point that the electromagnet 137 is not effective to hold armature 136. When this happens, both contact arms 130 and 131 move downwardly until they assume the position in which the corresponding elements of switch 24 are shown. In this position, contacts 132 and 134 will be separated so that switch 25 is opened. In view of the fact that switch 25 is in series with both switch 24 and thermostat 170, it is impossible to establish a circuit to the stoker motor 17 so long as switch 25 is open. In this manner, it is assured that in the event of combustion spreading to an excessive extent, the further operation of the stoker motor is prevented. Since the thermo-couple is located in the fuel bed and is dependent upon the spread of combustion, it is able to detect a condition leading to excessively high temperatures before the high temperature has actually been produced. In this manner, it functions to anticipate an undesirable condition in-

stead of acting only after the undesirable condition has been produced.

The condition which has just been described is that arising when thermostat 170 is closed an excessive amount of the time. If, on the other hand, the thermostat 170 only seldom "calls for heat," such as might be the case in mild weather, it is possible for the coal supplied to the furnace to be insufficient to support continued combustion. Since it would be highly desirable to prevent the fire from going out under such conditions, the thermo-couples 21 and 22 are provided, which function as a "hold fire" control. In a manner similar to the "hold fire" controls of the prior art, these thermo-couples are effective to cause the closing of a switch in parallel with a thermostat when combustion has been reduced to the point that it is imperative that more coal be added to prevent extinguishing of the fire. In the present case, the switch in parallel with the thermostat is switch 24. If combustion recedes to the point where the temperature of the junction of thermo-couple 22 is reduced substantially, the winding 38 will be energized in view of the fact that the electromotive force produced by thermo-couple 21 is not appreciably opposed by that produced by thermo-couple 22. The result is that electromagnet 37 is energized and upon armature 36 being moved into engagement therewith through the action of the mechanism including disc 60 and pusher member 50, previously described, the armature 36 will be retained thereby. This will cause contacts 32 and 34 to be moved into engagement in the manner described in connection with switch 25 so that switch 24 is closed. A circuit will then be established to stoker motor 17 as follows: from line wire 67 through conductor 176, switch 25, conductor 177, conductor 185, switch 24, conductors 186, 180 and 181, stoker motor 17 and conductors 182 and 183 to the other line wire 66. It will be noted that the circuit just traced is independent of thermostat 170 so that stoker motor 17 is operated even through thermostat 170 is satisfied. The circuit just traced will be maintained until coal has been supplied to the fuel bed and combustion has spread sufficiently to cause the junction of thermo-couple 22 to again be heated.

In order to insure that switch 24 will not be rapidly closed and opened by reason of a slight variation in combustion around thermo-couple 22, the arrangement comprising auxiliary winding 39 is provided. As soon as switch 24 is closed by reason of the energization of winding 38, the motor 17 is placed in operation as previously described. Upon this occurring, the transformer 40 is also energized with the result that winding 39 is energized in a direction to aid winding 38. The winding 39 exerts a sufficient holding action that it is necessary for the temperature of junction 22 to cool appreciably below the point at which closing of switch 24 was effected before switch 24 will open. In other words, by reason of the winding 39, it is insured that a differential in temperature is required between the closed and open positions of switch 24.

Both thermo-couples 20 and 21 are located sufficiently close to the point at which fuel is supplied to the fuel bed that the junctions of both of these thermo-couples are normally maintained heated. If, however, for some reason or other, the zone of combustion is so reduced that even these thermo-couples are not energized,

the operation of stoker motor 17 is again prevented. This is desirable because under these conditions the addition of further fuel is undesirable since it would not be ignited. If some means were not provided for stopping the operation of the stoker motor, the thermostat or the hold fire control would continue to call for operation of the stoker and coal would be supplied continuously to the furnace. When the temperature of the junction of thermo-couple 22 is reduced due to the zone of combustion receding in the manner previously described, winding 138 will be deenergized due to the fact that the junction of neither thermo-couple 20 nor 23 is being heated so that no electromotive force is being produced in the circuit including winding 138. Under these conditions, switch 25 is opened. As previously described, since switch 25 is in series with the switches 24 and 170, the opening of this switch prevents operation of stoker motor 17 regardless of whether thermostat 170 or switch 24 is closed.

It will be seen that means has been provided for controlling a stoker motor wherein the temperature responsive means is responsive to the spread of combustion rather than to a change of temperature at any point. In this manner, the conditions which should control are measured directly. Furthermore, a stoker control has been provided employing thermo-couples which are of particular adaptability to the high temperature encountered in the fuel bed of a furnace. Moreover, there has been provided a novel arrangement wherein a pair of thermo-couples are connected in opposition to energize an electrical instrument so that upon either one of the thermo-couples being subjected to a temperature differential between its hot and cold junctions, the device is energized but upon both or none of the thermo-couples being subjected to such a differential, the device is deenergized. Furthermore, there has been provided in a switch which is oscillated without changing its circuit controlling position until a holding means is effective to change the circuit controlling position, means for preventing the oscillating means from being effective after the circuit controlling position of the switch has changed. It will further be noted that there has been provided a novel arrangement for providing a differential between the energized and deenergized positions of a thermo-couple operated instrument.

While there has been shown a certain specific embodiment of the invention, it is to be understood that this is for purposes of illustration only and that the invention is to be limited only by the scope of the appended claims.

I claim as my invention:

1. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, and means controlling the operation of said fuel feeding means including a plurality of temperature responsive devices each responsive to the temperature, at a predetermined point, of the fuel located on said fuel supporting surface, said temperature responsive devices being disposed at varying distances from the point at which fuel is supplied to said surface so as to control said fuel feeding means in accordance with the extent to which said fuel is ignited.

2. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, and means

controlling the operation of said fuel feeding means including a pair of opposed thermo-couples each responsive to the temperature, at a predetermined point, of the fuel located on said fuel supporting surface, said thermo-couple devices being disposed at different distances from the point at which fuel is supplied to said surface so as to control said fuel feeding means in accordance with the extent to which said fuel is ignited, only one of said thermo-couples generating an appreciable electromotive force when the boundary of ignited fuel is between the thermo-couples and both generating an electromotive force when ignited fuel is adjacent both thermo-couples.

3. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, electrically operated means controlling the operation of said fuel feeding means and effective when energized to cause fuel to be supplied by said fuel feeding means, energizing means for said controlling means including a pair of opposed thermo-couples disposed to extend into fuel located on said fuel supporting surface, one of said opposed thermo-couples having the junction thereof located adjacent the point at which fuel is supplied to said surface so as to be energized so long as there is any combustion whatsoever and the other of said thermo-couples having the junction thereof located adjacent a point on said supporting surface sufficiently remote from the point at which fuel is supplied thereto so as to be energized only when combustion has reached a predetermined high limit.

4. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, electrically operated means controlling the operation of said fuel feeding means and effective when energized to cause fuel to be supplied by said fuel feeding means, energizing means for said controlling means including a pair of opposed thermo-couples disposed to extend into fuel located on said fuel supporting surface, one of said opposed thermo-couples having the junction thereof located adjacent the point at which fuel is supplied to said surface so as to be energized so long as there is any combustion whatsoever and the other of said thermo-couples having the junction thereof located adjacent a point on said supporting surface sufficiently remote from the point at which fuel is supplied thereto so as to be energized only when combustion has extended sufficiently far to insure continued combustion without the immediate addition of further fuel.

5. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, electrically operated means controlling the operation of said fuel feeding means and effective when energized to cause fuel to be supplied by said fuel feeding means, energizing means for said controlling means including a pair of opposed thermo-couples disposed to extend into fuel located on said fuel supporting surface, one of said opposed thermo-couples having the junction thereof located adjacent the point at which fuel is supplied to said surface so as to be energized so long as there is any combustion whatsoever and the other of said thermo-couples having the junction thereof located adjacent a point on said supporting surface sufficiently remote from the point at which fuel is supplied thereto so as to be energized only when combustion has

extended sufficiently far to insure continued combustion without the immediate addition of further fuel, and further means responsive to a different controlling condition for controlling the operation of said fuel feeding means after combustion has extended sufficiently to cause the energization of said last named thermo-couple.

6. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, electrically operated means controlling the operation of said fuel feeding means and effective when energized to cause fuel to be supplied by said fuel feeding means, energizing means for said controlling means including a pair of opposed thermo-couples disposed to extend into fuel located on said fuel supporting surface, one of said opposed thermo-couples having the junction thereof located adjacent the point at which fuel is supplied to said surface so as to be energized so long as there is any combustion whatsoever and the other of said thermo-couples having the junction thereof located adjacent a point on said supporting surface sufficiently remote from the point at which fuel is supplied thereto so as to be energized only when combustion has extended sufficiently far to insure continued combustion without the immediate addition of further fuel, and further means responsive to the condition of a space heated by said fuel burning device for controlling the operation of said fuel feeding means after combustion has extended sufficiently to cause the energization of said last named thermo-couple.

7. In combination, a fuel burning device comprising a fuel supporting surface, means for feeding fuel onto said supporting surface, electrically operated means controlling the operation of said fuel feeding means and effective when energized to cause fuel to be supplied by said fuel feeding means, energizing means for said controlling means including a pair of opposed thermo-couples disposed to extend into fuel located on said fuel supporting surface, one of said opposed thermo-couples having the junction thereof located adjacent the point at which fuel is supplied to said surface so as to be energized so long as there is any combustion whatsoever and the other of said thermo-couples having the junction thereof located adjacent a point on said supporting surface sufficiently remote from the point at which fuel is supplied thereto so as to be energized only when combustion has extended sufficiently far to insure continued combustion without the immediate addition of further fuel and means responsive to a temperature produced by said device for terminating the operation of said fuel feeding means when said temperature reaches a value above a predetermined upper limit.

8. In combination, a fuel burning device, means for regulating the admission of fuel to said device, means including an electromagnet for controlling said fuel regulating means and adapted when energized to cause said fuel regulating means to supply fuel to said device, and means comprising a plurality of opposed thermo-couples for controlling the energization of said electromagnet, one of said thermo-couples being responsive to a condition indicative of the presence or absence of any combustion and the other to a condition accompanying a temperature above a predetermined upper limit.

9. In combination, a fuel burning device, means for regulating the admission of fuel to said device, said means comprising a plurality of opposed thermo-couples one of said thermo-couples being responsive to a condition indicative of the presence or absence of any combustion and the other to the existence of a condition accompanying a temperature above a predetermined upper limit, said thermo-couples generating counter electromotive forces when both are indicating the presence of combustion.

10. In combination, a fuel burning device, means for regulating the admission of fuel to said device, means including an electromagnet for controlling said fuel regulating means and operative upon energization of said electromagnet to cause said fuel flow regulating means to supply fuel to said device, a thermo-electric device operative upon the presence of combustion to cause said electromagnet to be energized and a second thermo-electric device operative upon the existence of a condition accompanying a temperature above a predetermined upper limit to oppose the action of said first thermo-electric device and deenergize said magnet.

11. In a temperature regulating system, temperature changing means, means including an electromagnet controlling said temperature changing means and effective upon energization of said electromagnet to cause the operation of said temperature changing means, said electromagnet comprising a main winding and an auxiliary winding, a thermo-couple controlling the energization of said main winding, the junction of which when heated energizes said main winding, and means operative upon said temperature changing means being placed in operation by reason of the energization of said first winding to effect the energization of said auxiliary winding.

12. In combination, a fuel burning device having a zone of combustion which varies in extent, means for feeding fuel to said device, and means for regulating said fuel feeding means, said regulating means comprising temperature responsive devices responsive to the temperatures at various points in the path of the zone of combustion being successively traversable by burning fuel and operative to control said fuel feeding means in accordance with the extent of the zone of combustion.

13. In combination, a fuel burning device having a zone of combustion which varies in extent, means for feeding fuel to said device, and means for regulating said fuel feeding means, said regulating means comprising thermo-couple means located in the path of the zone of combustion at varying distances from the source of fuel supply and operative to control said fuel feeding means in accordance with the extent of the zone of combustion.

14. In combination, a solid fuel burning furnace, a stoker for supplying fuel to said furnace including a stoker motor, means for terminating operation of said stoker motor upon there being no combustion or excessive combustion and for causing the operation of said stoker motor when combustion is at a minimum value, said means comprising devices responsive to the presence or absence of combustion in the fuel bed at varying points from the center of combustion and accordingly responsive to the spread of combustion.

15. In a temperature regulating system, temperature changing means, a controller for said temperature changing means including a

thermo-couple for energizing the same, said controller being effective upon energization thereof to cause said temperature changing means to be brought into operation, and means effective upon energization of said controller and upon the resultant operation of said temperature means to additionally energize said controlling means so that the temperature difference between the hot and cold junctions of said thermo-couple must decrease below the value required to effect the energization of said controller before said controller is effectively deenergized.

16. In a temperature control system of the class described, temperature changing means, an electrically operated regulator therefor, a switch controlling said regulator and normally resting in a predetermined circuit controlling position, means to periodically move said switch back and forth without changing its circuit controlling position, said means comprising pusher means associated with said switch and comprising a pivoted arm biased to one position, continuously running means adapted to periodically engage said arm and move said switch through said pusher means, an electromagnet member and an armature member, one of said members being operated by said means to periodically urge the same against the other of said members, a thermo-couple responsive to a temperature of said system and operative when said temperature is above a predetermined value to energize said electromagnet sufficiently to maintain said members adjacent each other when so moved by said means but incapable of causing movement of said members adjacent to one another when they are spaced from each other, and means to move said switch to another circuit controlling position when said members are held adjacent each other by the action of said continuously running means to the position in which said members would otherwise be moved apart, said movement of said switch being effective to move the pusher means to a position wherein said arm when resting in the position to which it is biased will not be engaged by said continuously running means.

17. In combination, a fuel burning device having a zone of combustion which varies in extent, means for feeding fuel to said device, and means for regulating said fuel feeding means, said regulating means comprising temperature responsive devices responsive to the temperature at various points in the path of the zone of combustion, being successively traversable by burning fuel and operative to control said fuel feeding means in accordance with the extent of the zone of combustion, said temperature responsive devices being so constructed and mutually related as to produce a response when the boundary of the zone of combustion moves to a position between them so as to expose them to substantially different temperature.

18. In combination, a fuel burning device having a zone of combustion which varies in extent, means for feeding fuel to said device, and means for regulating said fuel feeding means, said regulating means comprising thermocouple means located in the path of the zone of combustion at varying distances from the source of fuel supply and operative to control said fuel feeding means in accordance with the extent of the zone of combustion, said thermocouple means being so mutually related as to produce a response when the boundary of the zone of combustion recedes or advances from a position between them so as

to expose them to temperatures of similar magnitude.

19. In combination, a solid fuel burning furnace, a stoker for supplying fuel to said furnace including a stoker motor, means for terminating operation of said stoker motor upon there being no combustion or excessive combustion and for causing the operation of said stoker motor when combustion is at a minimum value, said means comprising devices responsive to the presence or

absence of combustion in the fuel bed at varying points from the center of combustion and accordingly responsive to the spread of combustion, said devices being so constructed and mutually related as to produce a response when the boundary of the zone of combustion moves to or from a position between them.

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