May 14, 1940. R. E. BRESSLER 2,200,326

AUTOMATIC COMBUSTION CONTROL

Filed Jan. 23, 1939 2 Sheets-Sheet 1

Fig. 1.

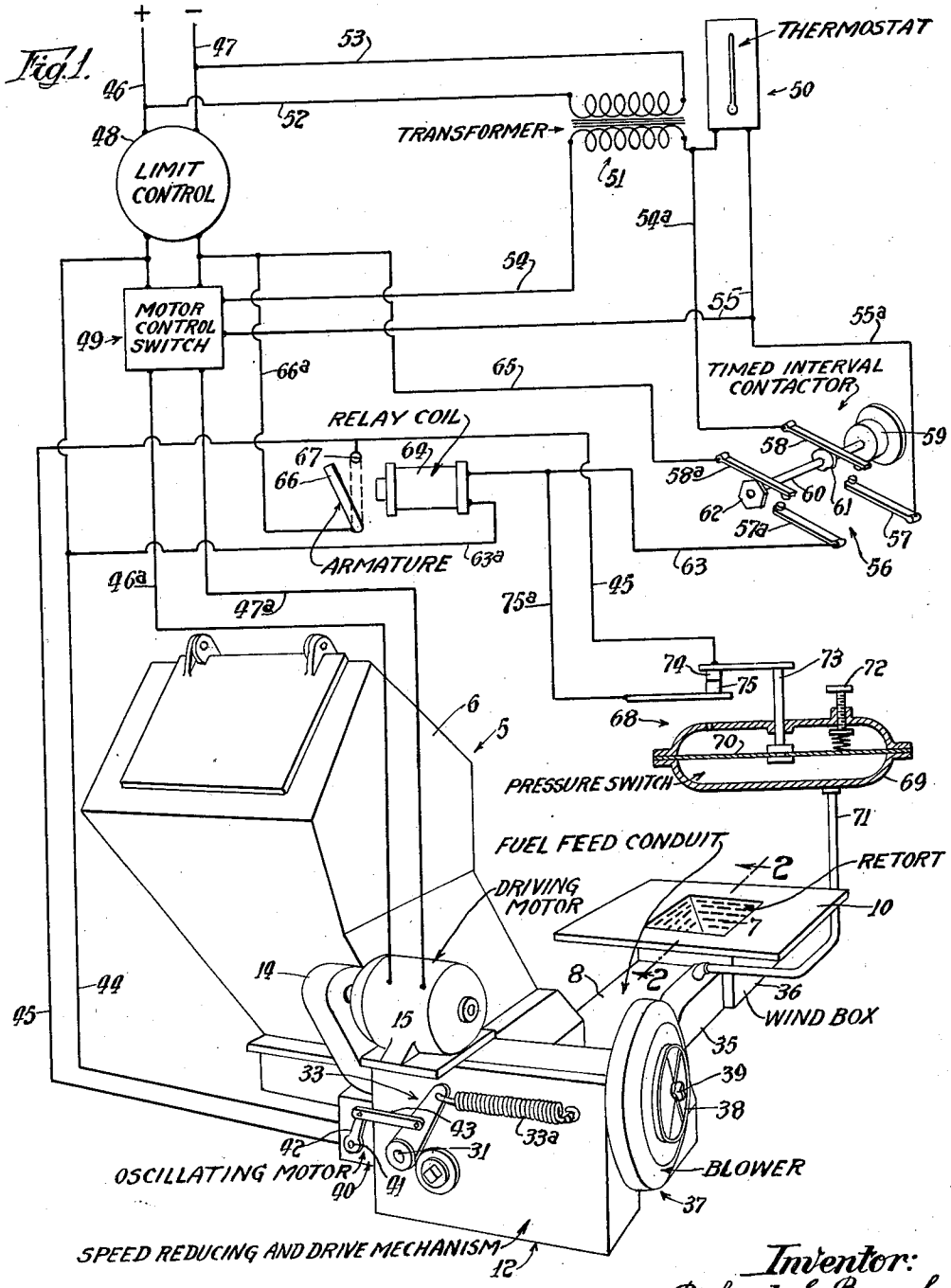

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Fig. 2.

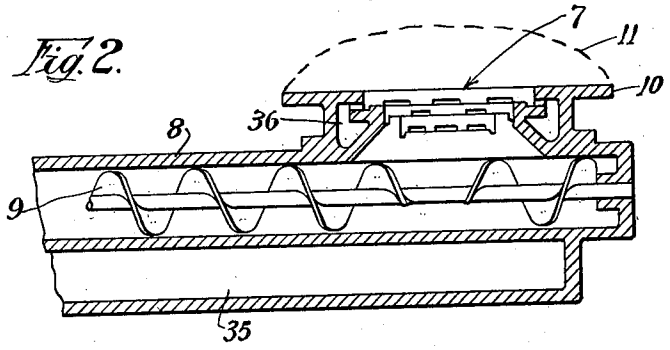


Fig. 3.

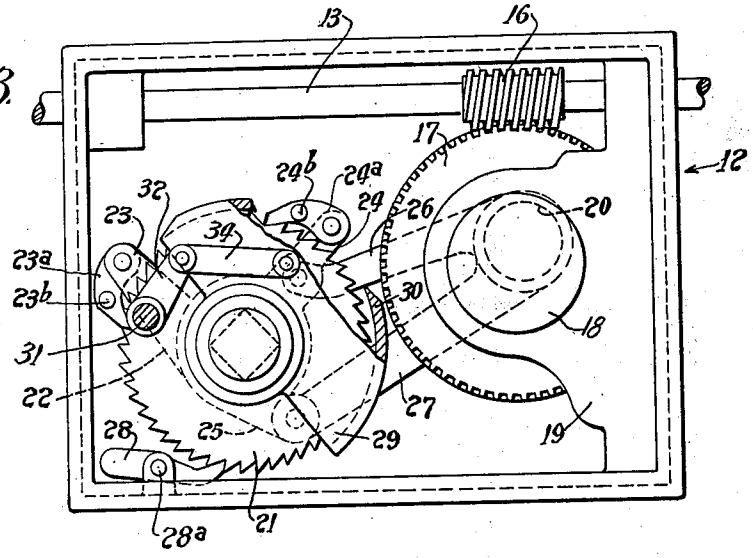
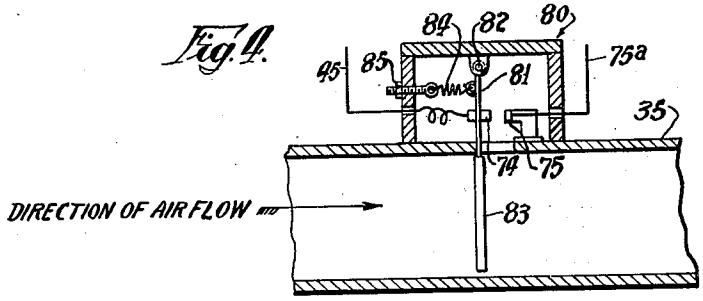


Fig. 4.



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Patented May 14, 1940

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UNITED STATES PATENT OFFICE

2,200,326

AUTOMATIC COMBUSTION CONTROL

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Application January 23, 1939, Serial No. 252,242

7 Claims. (Cl. 110—101)

This invention relates to improvements in automatic combustion controls and it consists of the matters hereinafter described and more particularly pointed out in the appended claims. The improved control is herein illustrated and will be herein described as used in connection with a stoker for feeding solid fuel, such as coal, to a fuel bed and for supplying the air necessary to support combustion.

In stoker fed furnaces, the amount of coal that will be burned by a certain volume of air varies materially with the condition of the fuel bed. Also, the amount of coal that will be fed by the stoker, as when the screw or other mechanism is operating at a certain rate will vary materially with several different factors. One of these factors is the amount of coal in the hopper which causes a different quantity thereof to be fed to the screw or other feed mechanism. The reason therefor is that the depth of the coal over the screw or other mechanism varies, and much more coal will be fed by a full hopper than by one only half full.

The size of coal that is being supplied to the stoker will also make a large variation in the amount of coal that would be fed. Even with prepared stoker coal, a variation of as much as 30% will be had in the amount of coal being supplied to the burner when the feed is set at the same setting when coarse or fine coal is being supplied.

For proper operation of a stoker, the fuel bed should be maintained at an approximately exact depth independent of the rate at which the coal is being burned.

With a given setting of the damper controlling the volume of air supplied by the blower to the fuel bed, which damper may be on either the inlet or discharge side of the blower, a certain velocity and a certain pressure will be generated or established in the duct leading to the windbox of the stoker and in the windbox itself dependent upon the particular resistance which that bed causes. Therefore, the slightest change in fuel bed resistance, due to the change in depth of the fuel bed, will change both the pressure and the velocity. With the fan damper setting remaining the same and with a decrease in fuel bed depth, the velocity increases and the pressure decreases and with an increase in fuel bed depth, the velocity decreases and the pressure increases. The relation between velocity and pressure in the duct is that the velocity varies as a function of the square of the pressure.

With the fuel bed remaining at the same depth, but with a change in the setting of the damper to provide a greater volume of air, there will be an increase in both pressure and velocity in the duct and windbox, but the ratio of pressure to velocity will remain constant and will still be on the ratio of the square as above mentioned.

Thus, as long as the control means which is used to maintain the fuel bed, is on the same ratio as the ratio of pressure to velocity, the change in the volume of air as controlled by the setting of the damper will make no difference in the operation of the stoker but will maintain the fuel bed at the same depth independent of the setting of the damper and consequent volume and pressure from resistance encountered.

The general object of this invention is to provide an automatic combustion control for use in connection with a stoker having a variable rate fuel feeding means and which control makes use of the fact that the relation between the velocity and the pressure of the air delivered to the fuel bed to support combustion thereof is a constant one that varies as a function of the square of the pressure caused by fuel bed resistance to control the fuel feeding means as to the rate of fuel fed thereby to the fuel bed.

Another object of the invention is to provide an automatic combustion control for use in connection with a stoker including a fuel feeding means having two feeding rates, one lower than the minimum burning rate and one at least as high as the maximum burning rate, and which control is caused to function through the pressure and velocity of the air delivered to the fuel bed for causing the feed of fuel at the maximum rate when said air pressure is low and at the minimum rate when said air pressure is high.

A further object of the invention is to provide an automatic combustion control which, though simple in construction for low cost of manufacture, maintains a constant fuel bed depth within narrow limits and supplies that amount of air to the bed for the most efficient combustion thereof.

The above-mentioned objects of the invention, as well as others, together with the several advantages thereof, will more fully appear as the specification proceeds.

In the drawings:

Fig. 1 is a diagrammatic view of the preferred form of the invention, in connection with a stoker for controlling the operation thereof.

Fig. 2 is a longitudinal vertical sectional view on a somewhat enlarged scale through the burner

or retort end of the stoker as taken on the line 2—2 of Fig. 1.

Fig. 3 is a view in front elevation of the drive mechanism for the fuel feeding screw, the cover plate of the casing of said mechanism being omitted for a better illustration of said mechanism.

Fig. 4 is a longitudinal detail sectional view illustrating a velocity operated switch which may be employed in the system instead of the pressure operated one in Fig. 1, as will later appear.

Referring now in detail to Figs. 1, 2 and 3 of the accompanying drawings, 5 indicates as a whole a conventional stoker, including a fuel hopper 6, a burner or retort 7, and a coal feed conduit or tube 8 leading from the hopper to the burner. In the conduit 8 is a screw 9 (see Fig. 2) for moving the fuel along the conduit into the burner with an underfeed action to pile up therein over the dead plates 10 to provide the fuel bed 11 of the desired depth.

One end of the feed screw 9 extends into a casing 12 in which is located mechanism for driving the feed screw step by step and which mechanism best appears in Fig. 3. A horizontal shaft 13 is so journalled in the top part of said casing that its ends project through the side walls of the casing. One end of said shaft is driven by means of a suitable transmission 14 from a motor 15 supported upon the top of said casing at one side thereof. A worm 16 is fixed on the shaft 13 within the casing 12 so as to drive a worm gear 17 in the casing. This gear is carried by a shaft 18 of substantial diameter and which is journalled at one end in a bracket 19 and at its other end in the rear wall of the casing. A crank arm 20 is carried by the shaft 18 and the purpose of said crank arm will soon appear.

A ratchet wheel 21 is operatively connected to that end of the feed screw 9 extending into the casing 12. Journalled on the hub of said ratchet wheel is a spider 22 including three arms 23, 24 and 25 respectively, the arms 23—24 carrying ratchet wheel actuating pawls 23*a* and 24*a*, respectively. Each pawl carries a lateral stud 23*b* and 24*b* respectively. The arms 24 and 25 have one end of a pair of pitman rods 26—27 pivotally connected thereto, the other end of said rods each carrying a strap for engagement with the crank arm 20. A pawl 28 is pivoted at 28*a* at the bottom of the casing, for holding the ratchet wheel 21 against backward movement. It is apparent that when the worm gear 17 is being driven, the crank arm 20 operates through the rods 26—27, the three arms of the spider 22 and the pawls 23*a*—24*a* to feed the ratchet wheel 21 and the feed screw 9 one step.

Means is provided whereby the amount of step by step movement of the ratchet wheel may be varied regardless of the throw of the crank arm 20 which remains constant. Such means is as follows: A semi-circular guard plate 29 is journalled on the hub of the ratchet wheel 21 for a rocking movement. This plate carries a flange 30 along a part of one of its edge portions so as to stand in the path of the pawl stud 24*b*, the other of its edge portions standing in the path of the pawl stud 23*b*. When the plate 29 is in one position, both pawls 23*a*—24*a* are in operative engagement with the ratchet wheel 21 for driving the same. When the plate 29 is turned in one direction from said position to a second position, the stud 23*b* is engaged by a part of the edge of said plate so as to hold the pawl 23*a* out of engagement with the ratchet wheel 21 in the swing of the arms carrying said pawls. Thus in the forward swing of said arms, the pawls are ineffective to impart a movement to the ratchet wheel 21 which accords with the full swing of the arms carrying said pawls. Therefore, by moving the guard plate in one direction or the other, it is possible to adjust the amount of turning movement of the ratchet wheel 21 without effecting the full swing of the spider 22 and thereby the feed of the fuel to the retort 7 by the screw 9 may be varied.

To swing the guard plate 29 into the desired position, a stud shaft 31 is journalled in the front cover plate of the casing 12 and fixed to the ends of said shaft within and without the casing is an arm 32 and a lever 33 respectively. A link 34 (see Fig. 3) is connected at one end to the arm 32 and is connected at its other end to the guard plate 29. When the lever 33 is swung in one direction or the other, it is apparent that the guard plate 29 is likewise swung into a position which determines the amount of feeding movement imparted to the ratchet wheel 21 for each cycle of movement of the crank arm 20. A spring 33*a* so connects the lever 33 to the cover plate of the casing 12 as to swing the lever 33 clockwise into that position which corresponds to the minimum amount of feeding movement of the feed screw 9.

Associated with the coal or fuel conduit 8 is an air delivery duct 35 formed at one end to provide a chamber or windbox 36 in which the burner 7 is disposed in a manner whereby air in said chamber or windbox passes into the burner and up through the fuel bed therein to support combustion. The other end of the duct 35 is operatively connected to a blower 37. The impeller (not shown) of said blower is operatively connected to the other end of the shaft 13 in the casing 12 so as to be driven at a relatively high speed thereby. To control the volume of the air output of the blower, a damper 38 is associated with the inlet side of the blower, and is pivoted as at 39 on the blower so that it may be swung into that position providing the necessary volume of air desired to be produced by the blower. It is not essential in the present instance that the damper be associated only with the inlet side of the blower because the same results can be obtained when the damper is associated with the outlet side of the blower, as for example at some point along the duct 35.

The lever 33 is actuated against the action of the spring 33*a* toward and into that position giving the maximum rate of feed for the screw 9 by means of an electric motor 40 of the oscillating motor type and which can be purchased in open market for the actuation of dampers and the like. Therefore, it is not necessary to illustrate said motor in detail nor to describe the same in detail. A convenient place for mounting the motor 40 is upon that end of the casing 12 bearing the motor 15 but at an elevation below the same as best appears in Fig. 1. The motor 40 includes a horizontally disposed, oscillatable or rockable shaft 41 to which is fixed one end of a rock arm 42, the other end of said arm being connected by a link 43 to the lever 33. When the motor 40 is energized, it acts through the arm 42 and link 43 to swing the lever 33 counterclockwise against the action of the spring 33*a*, toward and into that position that corresponds to the maximum rate of feed for the screw 9. When the motor 40 is deenergized, the spring 33*a* contracts and restores the lever 33 to that position that corresponds to the minimum

rate of feed for the screw 9. Lines 44 and 45 are connected to the motor 40 to supply electrical energy thereto and these lines are connected in circuit as will later appear.

As before stated, the motor 15 drives both the feed screw 9 and the blower 37 and preferably the operation of said motor is controlled as follows: 46—47 indicate a pair of main current conductors leading from a suitable source of supply. The conductors 46—47 pass through a limit control 48 and then to one side of a motor control switch 49. Conductors 46a—47a lead out from the other side of the switch 49 to the motor 15. The limit control is usually associated with the bonnet of a hot air furnace, when the stoker 5 is employed with such a furnace. When the limit control 48 (which in fact is a safety switch) and the motor control switch 49 are closed, the motor 15 is energized to drive both the screw 9 and the blower 37. When either control 48—49 is open, no current can pass to the motor 15 so that the motor is stopped.

A temperature responsive device 50 in the nature of a thermostat is preferably arranged in the room or space to be heated, for controlling the circuit for the motor 15, through the motor control switch 49 and consequently the periods of operation of the stoker as a whole. Associated with the thermostat 50 is a transformer 51, the primary winding of which is connected at its ends by lines 52—53 to the main current conductors 46—47. The secondary winding of the transformer is connected at one end to one side of the thermostat 50 and at its other end by a line 54 to the switch 49. The other side of the thermostat is connected by a line 55 to the switch 49. When the thermostat is calling for heat, it functions through the transformer to energize the switch 49 which closes the circuit to the motor 15 unless the limit control 48 is in its "off" condition.

56 indicates a time switch which at certain periodic intervals, under certain conditions, closes the circuit for the motor 40 and which at certain other periodic intervals closes the circuit to the motor 15 to function as a hold fire control. The time switch 56 includes a pair of fixed contacts 57—57a respectively and a second pair of contacts 58—58a respectively, periodically movable toward and away and into and out of engagement with the first mentioned contacts. As shown herein, said switch also includes a motor 59 that drives a shaft 60 which carries cams 61 and 62 respectively. In the rotation of the shaft 60, these cams so engage the contacts 58—58a as to cause them periodically to engage and disengage the contacts 57 and 57a respectively. The cam 62 is of such formation that the contacts 57a—58a engage once every 10 minutes for about ½ a minute. If desired, said cam 62 could be made with a formation as to cause said contacts 57a—58a to engage once every 5 minutes for a half a minute. The cam 61 is of such a formation that the contacts 57—58 engage once every 60 minutes for about a minute.

The contact 57 is connected by a line 55a to the line 55 while the contact 58 is connected by a line 54a to the line 54 at a point between the thermostat 50 and the secondary coil of the transformer 51. The contact 57a is connected by a line 63 to one side of the coil of a relay 64 and the other side of the said coil is connected by a line 63a to the line 44 which connects one side of the motor 40 to the conductor 46 at a point between the limit control 48 and the motor control switch 49. The contact 58a is connected by a line 65 to the line 47 at a point between said limit control 48 and the motor control switch 49.

Associated with the relay coil 64 is an armature 66 which when said coil is energized, is attracted thereby to move into engagement with a contact 67 electrically connected to the line 45. The armature 66 is connected by a line 66a to the line 65.

68 indicates a switch which functions in accordance with the pressure condition of the air in the duct 35 and windbox 36. Said switch is in the nature of a casing 69 containing a flexible diaphragm 70 open to atmosphere on one side and responsive on the other side to the pressure in the duct 35 and windbox 36 by reason of a conduit 71 which connects one side of the casing to said duct. The switch 68 may be mounted on the stoker hopper 6. A tension device 72 is carried by the casing 69 to adjust the pressure necessary to cause the switch to function under different conditions. A stem 73 is carried by the diaphragm and this stem carries a contact 74 that is movable out of and into engagement with a fixed contact 75 according to pressure conditions existing in the duct 35 and windbox 36. The contact 75 is connected by a line 75a to the line 63 while the contact 74 is connected to the line 45 before mentioned.

In the operation of the control system, assume that the limit control is functioning within its temperature range as a closed switch and that the motor control switch 49 is open. Also assume that the contacts 57a—58a of the time switch 56 are disengaged and that the thermostat 50 is in its off condition wherein it is not calling for heat. At this time, the motor 15 is deenergized and stopped and the pressure in the duct 35 and windbox 36 approximates atmospheric pressure so that the contacts 74—75 of the pressure switch 68 are engaged.

Now assume that the temperature in the space to be heated is such that the thermostat 50 calls for heat and therefore closes. As the thermostat is closed, current flows through the secondary of the transformer 51, the thermostat 50 and lines 54—55 thus energizing the motor control switch 49 to close, connecting the lines 46—47 to the lines 46a—47a which energizes the motor 15. This drives both the blower 37 and the feed screw 9 through the drive mechanism in the casing 12 to feed fuel to the bed on the retort and to supply air to the fuel bed to support combustion. Assume that the stoker has been started after a stand-by period and that therefore the fuel bed is well burned down and thin. Thus the velocity of the air delivered to the fuel bed will be high and its pressure low so that the contacts 74—75 remain engaged.

If, at this time the relay coil 64 be energized through the switch 56 engaging the contacts 57a—58a as will later appear, its armature 66 will have been attracted thereby and brought into engagement with the contact 67. Thus a circuit is established to energize the motor 40, from the line 46, line 44, motor 40, line 45, contact 67, armature 66, line 66a to a part of line 65 to line 47. With the motor 40 thus energized, it will oscillate or rock its shaft 41 counterclockwise and through the arm 42 and link 43, swing the lever 33 clockwise against the action of the spring 33a, to cause the pawl and ratchet mechanism in the casing 12 to drive the screw 9 at the maximum feeding rate.

The relay coil 64 will be held in its energized condition with its armature 66 in engagement

with the contact 67 so long as the contacts 74—75 of the switch 68 are engaged due to the relatively low air pressure condition in the windbox. With the contacts 74—75 engaged, current flows from the conductor 46, through a part of the line 44, to line 63a, then coil 64, part of line 63, to line 75a, contacts 75—74, part of line 45, to contact 67 therein, then through armature 66, line 66a to a part of the line 65 and then to line 47. This holds the circuit for the relay coil 64 closed.

With the stoker in operation, fuel is being fed at its maximum rate to the retort or burner 7 and air under pressure is being delivered to said burner or retort to support combustion. With this maximum feed of fuel to the burner and which is at a rate higher than the maximum burning rate, the fuel bed increases in depth so as to produce increased resistance to the passage of air therethrough. This manifests itself in an increase in pressure in the windbox or chamber 36 and duct 35 and a decrease in the velocity of the air in said chamber and duct.

When the fuel bed is at the desired depth, the resistance presented to the air passing therethrough builds up a pressure which through the duct 71 is also present in the bottom of the casing 29 beneath the diaphragm 71 therein. This pressure, when exerted upon the diaphragm 70 lifts the stem 73 that carries the contact 74 and causes the latter to disengage from the contact 75. This opens the holding circuit for the relay coil 64 so that it becomes deenergized and its armature 66 drops out of engagement with the contact 67 thus breaking the circuit to the motor 40.

When the circuit to the motor 40 is thus broken, it becomes deenergized, when the spring 33a (which was in its expanded condition) contracts and swings the lever 33 in a clockwise direction. This returns the pawl and ratchet feed mechanism to that condition wherein it functions at its minimum feeding rate of the fuel. With the thermostat still calling for heat, the motor 15 is still functioning to drive the fuel feeding means and the blower, for burning the fuel fed to the burner at the minimum rate which is less than that of the burning rate. Later reengagement of the contacts 74—75, as when the fuel bed has burned down, so that the pressure of the air in the duct 35 and windbox 36 has dropped to cause reengagement of the contacts 74—75 will not energize the relay coil 64 because there is no circuit to line 47 except when said coil is energized to engage the armature with the contact 67. Thus even though the windbox pressure may drop to cause engagement of the contacts 74—75, the motor 40 will not become energized to produce the maximum feed of the mechanism in the casing 12, until the relay coil 64 has been energized by another circuit.

Closing of the circuit for the relay coil 64 is accomplished periodically by the constantly running time switch 56. Every few minutes the cam 62 of said switch will cause engagement of the contacts 57a—58a so that current will flow from line 46, a part of line 44 to line 63a, through the relay coil 64, line 63, contacts 57a—58a and line 65 to conductor 47. This causes the coil 64 to become energized to attract its armature 66 into engagement with the contact 67 so that the motor 40 is energized to produce the maximum feeding rate for the screw 9 as before described. At this time the fuel bed is thin so that air pressure in the casing 69 is such as to leave the contacts 74—75 engaged and to hold the circuit for the relay coil 64 closed, even after separation of the contacts 57a—58a. With the fuel being fed at its maximum rate again for this short interval, the pressure in the casing 69 below the diaphragm builds up to disengage the contacts 74—75 to open the holding circuit for the coil. This, of course, breaks the circuit for the motor 40 so that the pawl and ratchet feeding mechanism in the casing 12 drops back to its minimum feeding rate.

It is pointed out at this time that the amount of fuel which can be consumed after the pressure switch 68 functions to separate the contacts 74—75 and previous to the time that the switch 56 will start another cycle of feeding of fuel to the fuel bed will not be sufficient to change the depth of the bed to any appreciable extent. It is desirable that the high rate of fuel feed be materially higher than the rate of the combustion of fuel. The reason therefor is in order to provide against the coking of the fuel in the retort or burner and to vary the depth of the fuel somewhat at each operation so that the amount of fuel being fed is sufficient to break up the fuel bed, each time fuel is being fed. The comparative short time which is permitted between operations by the switch 56 after the closing of the pressure switch contacts 74—75 is not sufficient to disturb the correct functioning of the stoker nor is the amount of fuel fed by the operation of the switch 56 should the switch 68 not be calling for fuel, be sufficient to disrupt operation of the stoker.

When the thermostat 50 is satisfied with heat, it opens the circuit for the motor control switch 49 so that the stoker stops.

In the operation of the time switch 58 it functions through the cam 61 to engage the contacts 57—58 which forms the "hold fire" control of the system. As these contacts are in parallel with the thermostat 50, the engagement of said contacts produces the same function as the closing of the thermostat when it calls for heat. Should the limit control 48 be in its "off" condition, current from the line 46 cannot pass to any of the before mentioned parts so that the stoker will not operate under that condition.

By operating the device 72 of the pressure switch 68 the diaphragm 70 may be set to function at the desired windbox pressure and which pressure may be determined by adjusting the damper 38 and thus determine the burning rate of the stroker.

After a standby period, if the fuel bed is thin, the stoker is caused to feed fuel at its maximum rate until the fuel bed has been brought up to its proper depth after which the fuel is fed only to an extent as will maintain that depth of fuel bed and to supply fuel in accordance with the amount thereof being burned with the volume of air being supplied.

As before pointed out, the pressure of the air in the casing 69 beneath the diaphragm is high when the fuel bed is thick at which time the velocity of said air will be low and conversely when the air pressure in said casing 69 beneath the diaphragm is low, when the fuel bed is thin, then the velocity of said air in the duct will be high.

It is apparent that after the motor 40 has been energized by a closing of the portion of the circuit through the switch 56, this portion of the circuit is held closed by the contacts 74—75 when engaged under a low pressure condition in the duct 71 and pressure switch 68. When said pres-

sure builds up to one which operates through the diaphragm 70, then said contacts 74 and 75 are separated and that part of the circuit associated with the motor 40 is opened. When this occurs, the motor 40 becomes deenergized and the spring 33a returns the mechanism in the casing 12 to its minimum feeding rate of the feed screw 9.

The switch 68 before mentioned functions in connection with the change in the pressure of the delivered air and holds the contacts 74—75 engaged when the pressure is low and the velocity is high. When said pressure is high and the velocity is low, then said pressure functions through the diaphragm to disengage said contacts.

Instead of providing the switch 68 which functions with the change in pressure of the delivered air, a switch which functions with the change in the velocity of the delivered air may be used and such a switch appears in Fig. 4.

In said figure said switch is located in a casing 80 shown as mounted on a part of the air duct 35 so as to be in communication therewith. 81 indicates an arm that is pivotally mounted at 82 in the top end of the casing so as normally to depend into the duct 35 where it is provided with a target or vane 83 that stands transversely in the duct. The contact 75 in this instance is fixed in the casing 80 and the contact 74 is carried by the arm, the contacts 74 and 75 having the lines 45 and 75a connected thereto as before and extending through and suitably insulated from the end walls of the casing. A rather light spring 84 is fixed at one end to the arm 81 and is fixed at the other end to a screw eye 85 adjustably mounted in the associated end wall of the casing. This spring normally tends to hold the arm 81 in such position that the contacts 74—75 are disengaged and this against the action of the low velocity of the air in the duct that moves in the direction of the arrow in Fig. 4.

When the velocity of the air in the duct is low so that the contacts 74—75 are disengaged, then the air pressure is high due to a relatively thick fuel bed. When the fuel bed burns down, the pressure will decrease and the velocity will increase and this increased velocity will cause the arm to swing counterclockwise against the action of the spring so that the contact 74 will engage the contact 75 and hold the associated part of the circuit of the system closed. When the fuel bed is increased in depth so as to cause an increase in the pressure of the air with a corresponding decrease in the velocity thereof, the spring 84 will cause the arm 81 to swing clockwise to disengage the contact 74 from the contact 75. By adjusting the screw eye 85 the tension of the spring 84 may be regulated to cause separation of the contacts 74—75 at the desired velocity of the air. Thus in one instance with the switch as shown in Fig. 1, pressure is the controlling factor and in the other instance with the switch as shown in Fig. 4, velocity is the controlling factor.

It is apparent from the above that through the control of the fuel feed to maintain a constant depth of bed, a fixed resistance to passage of air therethrough is obtained so that the windbox pressure is maintained constant and the constant resistance is obtained by the varying depth of fuel bed and this depth is maintained constant independent of the burning rate.

While in describing the invention I have referred in detail to the form, arrangement and construction of the various parts involved, the same is to be considered only in the illustrative sense so that I do not wish to be limited thereto except as may be specifically set forth in the appended claims.

I claim as my invention:

1. In combination with a retort for supporting a fuel bed, means capable of feeding fuel to said retort at a minimum and maximum rate and normally functioning at the minimum rate, means for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure and the velocity conditions of the air vary with the depth of the fuel bed, power means for driving said fuel feeding means and said air delivering means, electrical means associated with said fuel feeding means for increasing the feeding rate thereof from the minimum to the maximum feeding rate, an electric circuit for said power means and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting said power means, means arranged in said circuit and operating periodically at timed intervals for closing another part of said circuit to energize said electrical means and cause it to increase the feeding rate of said fuel feeding means to the maximum feeding rate, and means in said circuit and operating at one stage of one of the before mentioned conditions of the delivered air to hold said last mentioned part of said circuit closed so that said electrical means holds the fuel feeding means at said maximum feeding rate and operating at another stage of said one of said conditions to open said last mentioned part of the circuit to deenergize said electrical means so that said feeding means returns to its minimum feeding rate.

2. In combination with a retort for supporting a fuel bed, means capable of feeding fuel to said retort at a minimum and maximum rate and normally functioning at the minimum rate, means for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure of the air varies with the depth of the fuel bed, power means for driving said fuel feeding means and said air delivering means, electrical means associated with said feeding means for increasing the feeding rate thereof from the minimum to the maximum feeding rate, an electric circuit for said power means and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting said power means, means arranged in said circuit and operating periodically at timed intervals for closing another part of said circuit to energize said electrical means and cause it to increase the feeding rate of said fuel feeding means to the maximum feeding rate, and means in said circuit and operating at one pressure of the delivered air to hold said last mentioned part of said circuit closed so that said electrical means holds said fuel feeding means at said maximum feeding rate and operating at another pressure of the delivered air to open said last mentioned part of said circuit to deenergize said electrical means so that said feeding means returns to its minimum feeding rate.

3. In combination with a retort for supporting a fuel bed, means for feeding fuel to the retort to build up the fuel bed thereon to the desired depth, means connected to the feeding means and operable to change the feeding rate

from the minimum rate to the maximum rate and normally tending to hold the same at the minimum feeding rate, means for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure and the velocity conditions of said air vary with the depth of the fuel bed, power means for driving said fuel feeding means and said air delivering means, electrical means operatively connected to said means connected to the feeding means and operating therethrough when energized to cause said feeding means to feed at the maximum rate, an electric circuit for said power means and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting said power means, means arranged in said circuit and operating periodically at timed intervals for closing another part of said circuit to energize said electrical means and cause it to increase the feeding rate of the feeding means to the maximum rate, and means in said circuit and operating at one stage of one of the before mentioned conditions of the delivered air to hold said last mentioned part of the said circuit closed so that said electrical means holds the fuel feeding means at said maximum feeding rate and operating at another stage of said one of said conditions to open said last mentioned part of the circuit to deenergize said electrical means so that said feeding means returns to its minimum feeding rate.

4. In combination with a retort for supporting a fuel bed, means capable of feeding fuel to said retort at a minimum and a maximum rate and normally functioning at the minimum rate, a blower for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure and the velocity conditions of the delivered air vary with the depth of the fuel bed, a motor for driving both the fuel feeding means and the blower, electrical means associated with said fuel feeding means for increasing the feeding rate thereof from the minimum to the maximum feeding rate, an electric circuit for said motor and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting said motor, means arranged in said circuit and operating periodically at timed intervals for closing another part of said circuit to energize said electrical means and cause it to increase the feeding rate of the fuel feeding means to the maximum rate, and means in said circuit and operating at one stage of one of the before mentioned conditions of the delivered air to hold said last mentioned part of said circuit closed so that said electrical means holds the feeding means at the maximum feeding rate and operating at another stage of one of said conditions to open said last mentioned part of the circuit to deenergize said electrical means so that said feeding means returns to its minimum feeding rate.

5. In combination with a retort for supporting a fuel bed, means capable of feeding fuel to said retort at a minimum and a maximum rate and normally functioning at the minimum rate, a blower for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure of the delivered air varies with the depth of the fuel bed, a motor for driving both the fuel feeding means and the blower, electrical means associated with the fuel feeding means for increasing the feeding rate thereof from the minimum to the maximum feeding rate, an electric circuit for said motor and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting the motor, means arranged in the circuit and operating periodically at timed intervals for closing another part of said circuit to energize said electrical means and cause it to increase the feeding rate of the fuel feeding means to the maximum rate, and means in said circuit and operating at one pressure of the delivered air to hold said last mentioned means closed so that said electrical means holds the feeding means at the maximum feeding rate and operating at another pressure of the delivered air to open said last mentioned part of the circuit to deenergize said feeding rate.

6. In combination with a retort for supporting a fuel bed, means capable of feeding fuel to the retort, a blower for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure and the velocity conditions vary with the depth of the fuel bed, a drive mechanism for the fuel feeding means and the blower respectively, a motor for driving said mechanism, said mechanism being variable to drive the fuel feeding means at different rates of feed, said mechanism normally operating to drive the fuel feeding means at the minimum rate of feed, electrical means associated with said mechanism for causing said mechanism to drive the fuel feeding means at a rate of feed higher than the minimum rate, an electric circuit for said motor and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting said motor, means arranged in said circuit and operating periodically at timed intervals for closing another part of said circuit to energize said electrical means to cause the same to operate through said mechanism and drive the fuel feeding means at a feeding rate higher than said minimum rate, and means in said circuit and operating at one stage of one of the before mentioned conditions of the delivered air to hold said last mentioned part of said circuit closed so that said electrical means holds said feeding means at said higher rate and operating at another stage of said one of said conditions to open said last mentioned part of the circuit to deenergize said electrical means so that said mechanism returns the feeding means to its minimum feeding rate.

7. In combination with a retort for supporting a fuel bed, means capable of feeding fuel to the retort, a blower for delivering air to the fuel bed to support combustion thereof, said bed offering a resistance to the passage of air therethrough so that the pressure of the delivered air varies with the depth of the fuel bed, a drive mechanism for the fuel feeding means and the blower respectively, a motor for driving said mechanism, said mechanism being variable to driving the fuel feeding means at different rates of feed, said mechanism normally operating to drive the fuel feeding means at the minimum rate of feed, electrical means associated with said mechanism for causing said mechanism to drive the fuel feeding means at a rate of feed higher than the minimum rate, an electric circuit for said motor and said electrical means respectively, means dependent upon the demand for heat for closing a part of said circuit for starting the motor, means arranged in said circuit and operating periodi-

cally at timed intervals for closing another part of said circuit to energize said electrical means and cause the same to operate through said mechanism and drive the fuel feeding means at a rate higher than the minimum rate, and means in said circuit and operating at one pressure of the delivered air to hold said last mentioned part of the circuit closed so that said electrical means holds said feeding means at said higher rate and operating at another pressure of the delivered air to open said last mentioned part of said circuit to deenergize said electrical means so that said mechanism returns the feeding means to its minimum feeding rate.

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