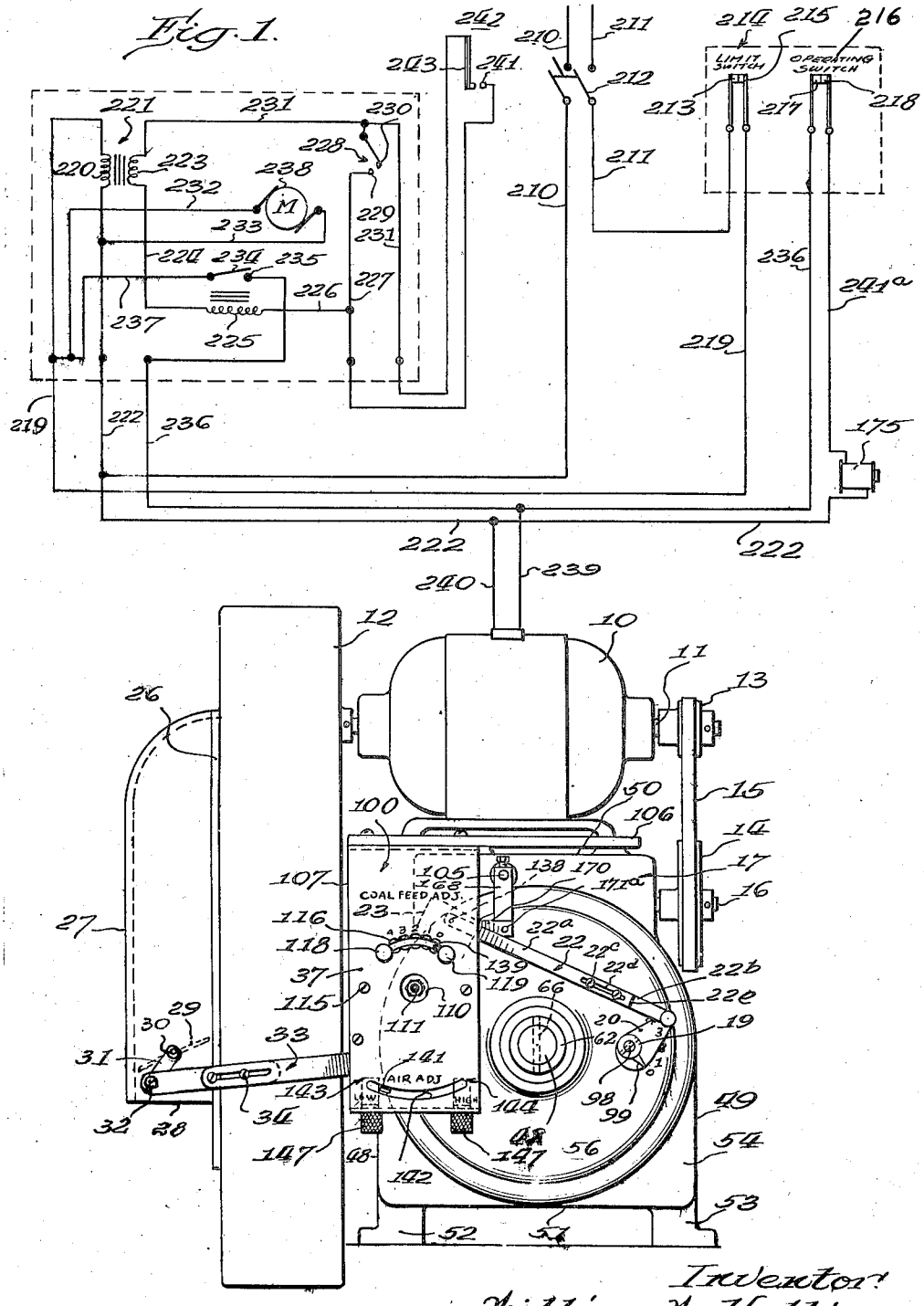
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STOKER CONTROL

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Fig. 1.

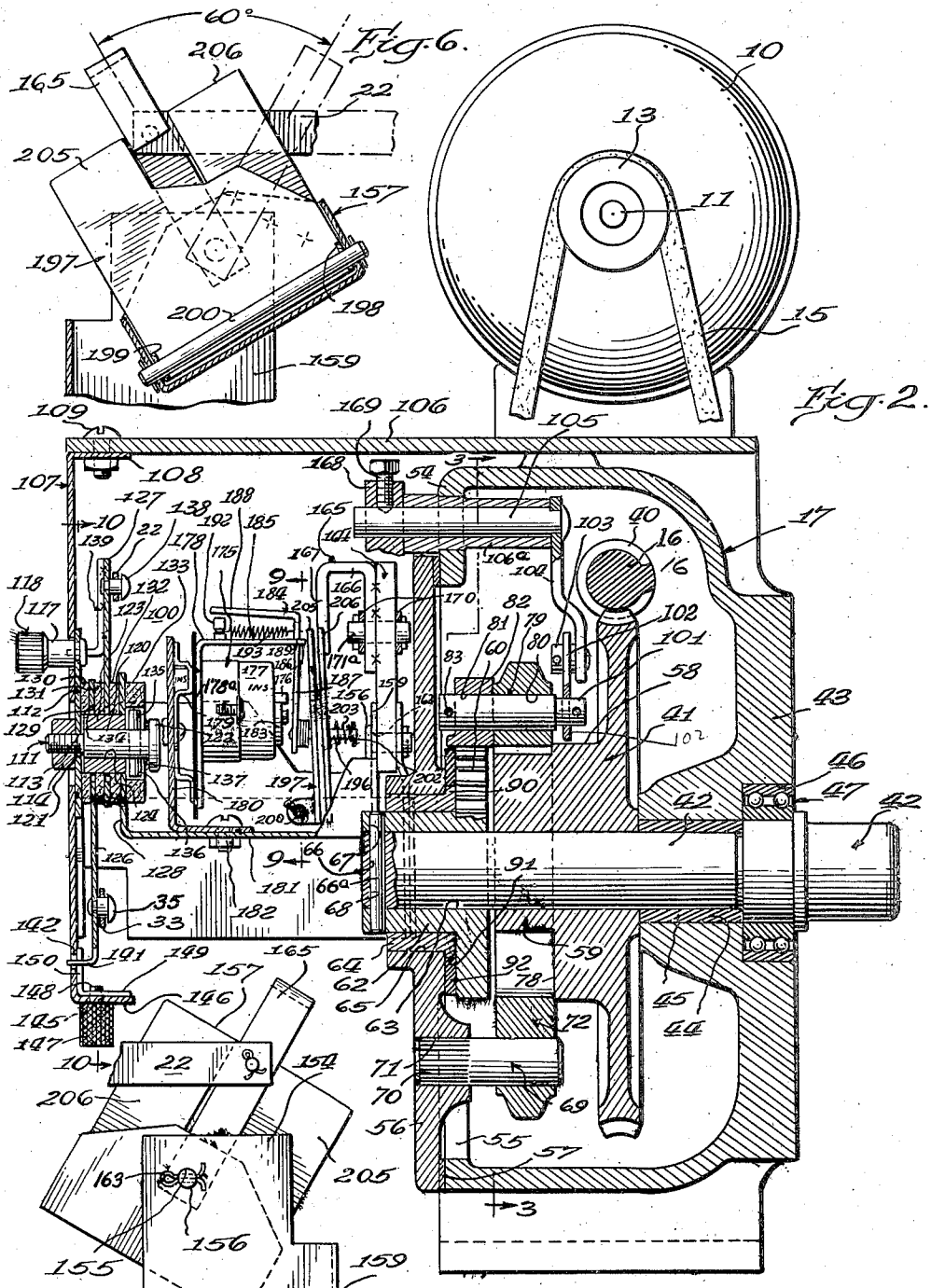


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STOKER CONTROL

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STOKER CONTROL

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Fig. 3.

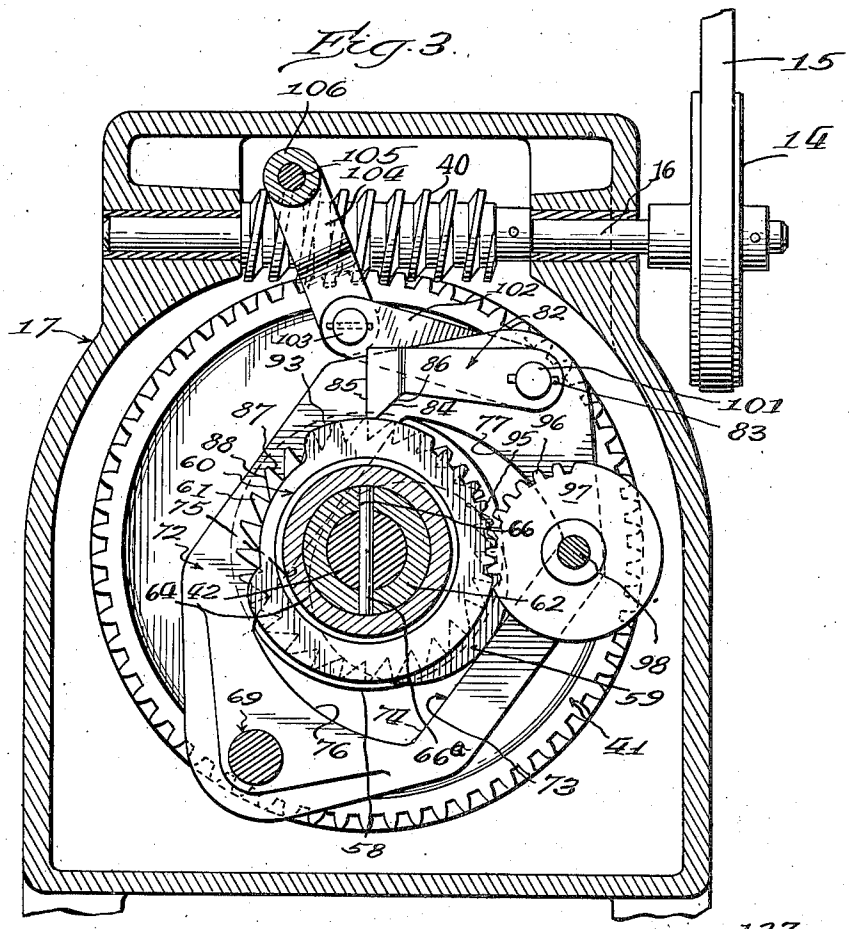


Fig. 4.

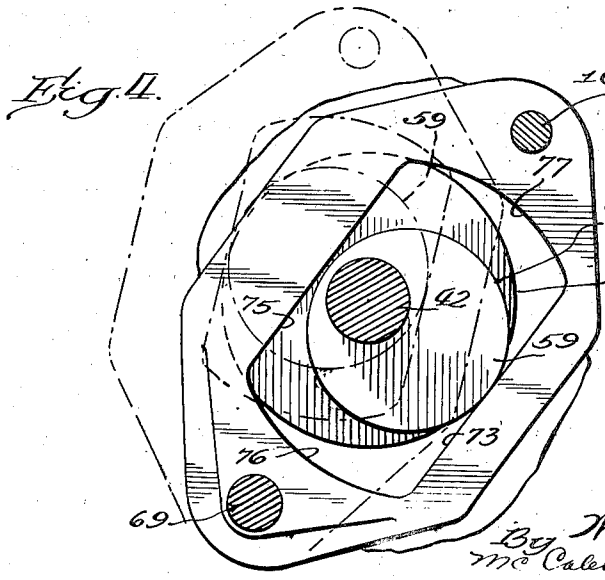
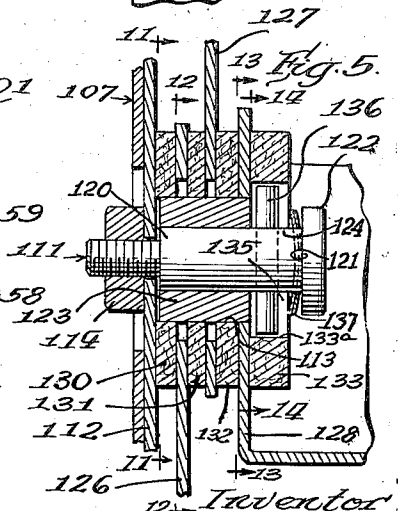


Fig. 5.



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Fig. 16

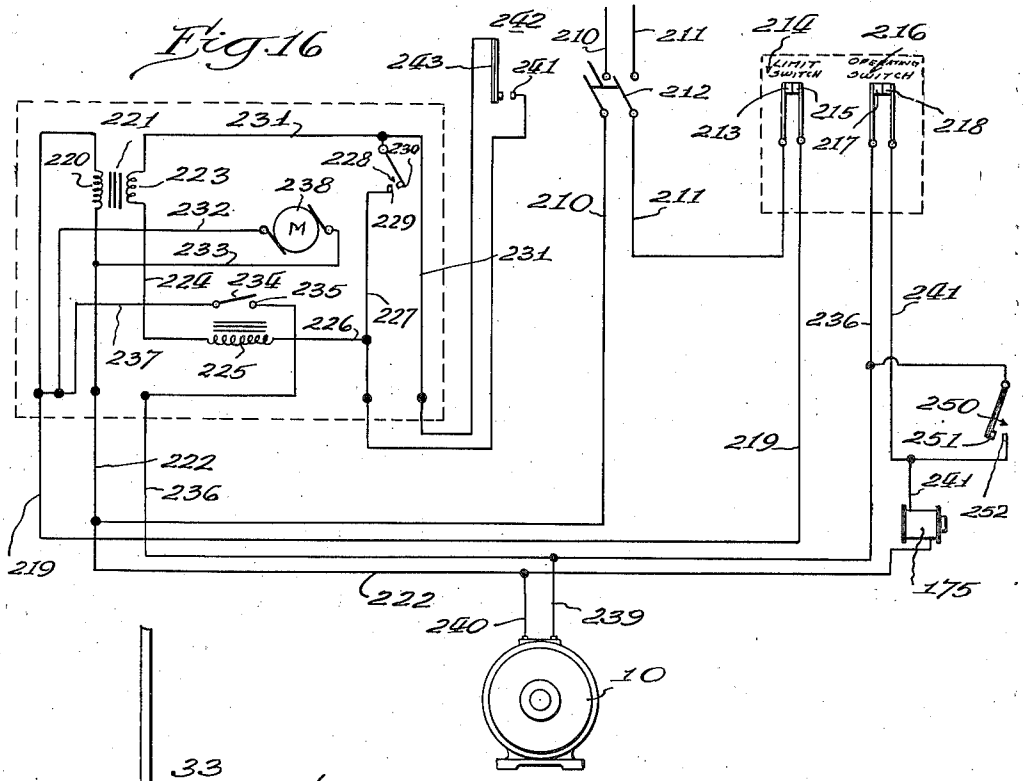


Fig. 8.

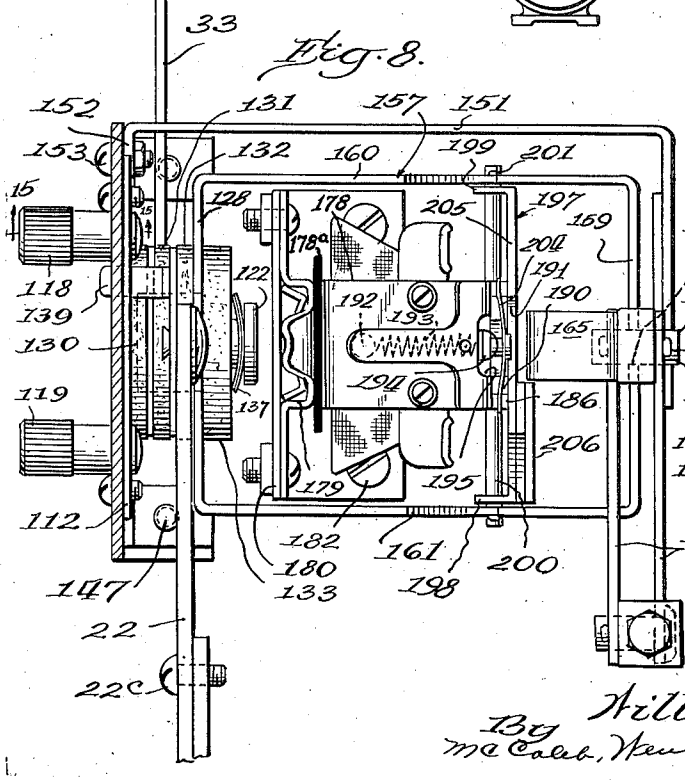
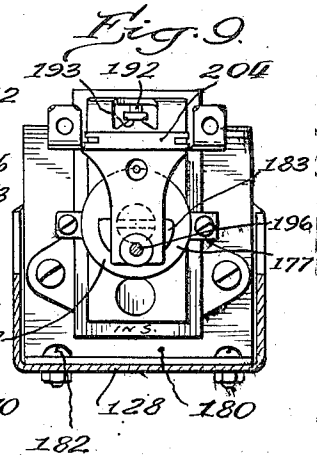


Fig. 9.



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Fig. 10.

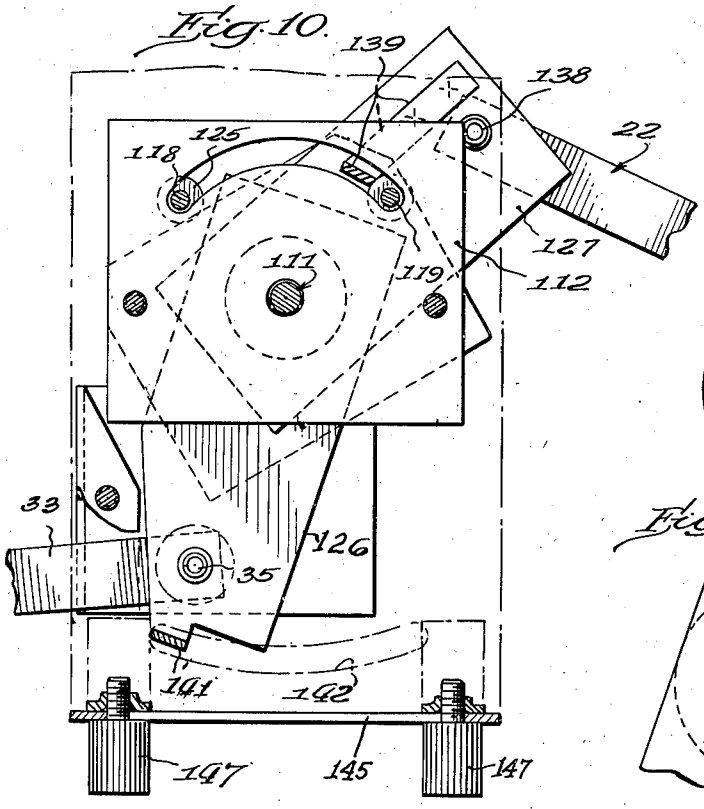


Fig. 11.

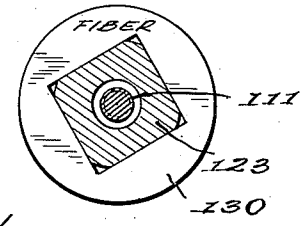
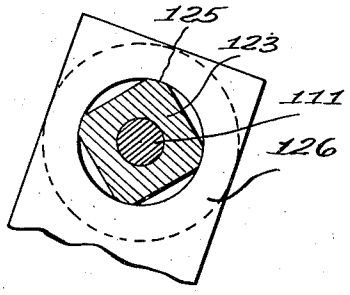


Fig. 12.



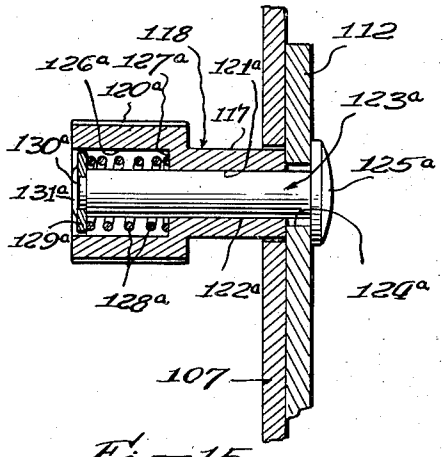


Fig. 15.

Fig. 13.

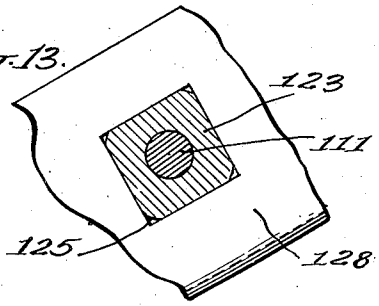
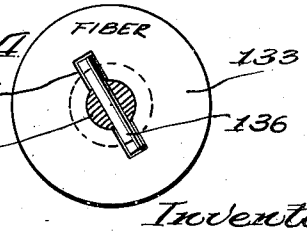


Fig. 14.



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UNITED STATES PATENT OFFICE

2,393,680

STOKER CONTROL

William W. Hallinan, Mendota, Ill.

Application April 11, 1942, Serial No. 438,627

14 Claims. (Cl. 110—101)

The present invention relates to stoker controls, and is particularly concerned with improved systems and devices for controlling the operation of coal stokers in such manner as to utilize the coal more efficiently and to reduce temperature overrun to a minimum.

One of the objects of the invention is the provision of an improved controlling unit for controlling and actuating the gears of the coal feed and the supply of air for combustion, which is adapted to permit the independent adjustment of the limits of operation of the air adjustment and coal feed adjustment, although both are actuated by the same actuating device.

Another object of the invention is the provision of an improved controlling unit of the class described, which is adapted to control the supply of air for combustion and the ratchet type gear case for the coal feed in such manner as to permit the provision of two definite rates of coal feed, one of which may be zero, and two definite rates of feed of air, both of which may be separately and independently adjusted.

Another object of the invention is the provision of an improved control system for stokers of the class described, in which the controlling mechanism for changing the air and coal feed is driven from the same motor which drives the combustion blower and the coal feed, thereby eliminating the necessity for providing two separate motors or actuating devices.

Another object of the invention is the provision of an improved stoker controlling unit of the class described, which is simple, sturdy, capable of being adjusted at any time, whether operating or not operating, and adapted to be used for a long period of time without any necessity for repair.

Another object is the provision of an improved stoker controlling system which is adapted to eliminate the use of deep fuel beds and to regulate the coal feed and the air feed according to the steam pressure or bonnet temperature.

Another object of the invention is the provision of an improved air conditioning and heating unit and controlling system which is adapted to eliminate the room temperature over-run above the thermostat setting that is commonly present in the stoker fired units of the prior art, thus conserving fuel and raising the overall efficiency of the heating unit to a maximum.

Another object of the invention is the provision of an improved heating system which is adapted to operate at a high rate of fuel and air feed when the bonnet temperature or steam pressure is below a predetermined value and which is also adapted, as soon as the steam pressure or water temperature or bonnet temperature reaches such value, to change the fuel feed and air supply in such manner that air will continue to be supplied to burn up the excess fuel that has been forced into the fire pot on high feed, thus maintaining efficient combustion without excessive coal feed until the fuel previously supplied has been burned up and the fire bed is reduced to a minimum depth, unless the steam pressure, water temperature, or bonnet temperature drops below the predetermined minimum again, in which case the stoker is fired at high coal and air feed.

Another object of the invention is the provision of an improved stoker controlling system which is adapted to be controlled responsive to the temperature outside the house in such manner that the stoker may be operated on low coal and air feed at all times when the outside temperatures are moderate and high coal and air feed is not used at all until the outside temperature reaches a predetermined point, such as, for example 40 degrees F.

Another object of the invention is the provision of an improved controlling unit for stokers of the class described which is capable of being manufactured at a much lower cost by virtue of the elimination of one of the motors of the type employed in my prior application, Serial No. 422,400, filed December 10, 1941, on Stoker controls, Patent No. 2,354,517, issued July 25, 1944.

Another object of the invention is the provision of an improved air conditioning and heating unit and controlling system for it, by means of which the fuel feed may be cut off before the room thermostat is satisfied and the furnace operated at reduced combustion air supply, in order to consume all of the fuel previously forced into the burner, thus reducing the fuel bed depth to a minimum at this time or just about the time when the thermostat will be satisfied for the purpose of eliminating the regular room temperature overrun above the thermostat setting.

The solid fuel burners of the prior art with which I am familiar operate with either a full fuel feed or a full air feed, or a combination of both, until the room thermostat is satisfied, thus causing an overrun of the thermostat setting and a stopping of the burner by the thermostat when there is a large fuel bed in the furnace.

This large fuel bed produces smoke and wastes the fuel at this time because the combustion air is also shut off in the devices of the prior art, when the fuel feed is stopped.

Another object of the invention is the provision of an improved controlling system for stokers which so controls the combustion that coke trees are fully consumed when a coking fuel is used.

Another object of the invention is the provision of an improved stoker controlling system in which the same motor may be used for driving the air circulating blowers for the air which is discharged into the space to be heated and for the air of combustion and in which the supply of air for combustion is not completely shut off, but may be merely reduced so that whenever the motor is operating, the fuel bed in the furnace is still provided with a reduced supply of air to reduce smoking and to produce a more perfect combustion.

The present application is related to my prior application, Serial No. 422,400, filed December 10, 1941, for Stoker controls, Patent No. 2,354,517, issued July 25, 1944, in that the present application discloses a structure capable of producing the same results, but for which it is only necessary to provide one electric motor.

The present application is also related to my prior application, Serial No. 346,763, filed July 22, 1940, for Combined air conditioning and heating unit, Patent No. 2,323,034, issued June 29, 1943.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views.

Referring to the drawings:

Fig. 1 is a diagrammatic elevational view of the stoker controlling unit shown in connection with a wiring diagram embodying the present improved system of stoker control;

Fig. 2 is a vertical sectional view taken on the plane of the axis of shaft **42** of Fig. 1, looking toward the left in the lower part of Fig. 1, showing the details of construction of the control unit;

Fig. 3 is another vertical sectional view taken on the plane of the line **3—3** of Fig. 2, showing the mode of drive of the coal feed and its connection to the devices which are adapted to change over from low feed to high feed, or vice versa;

Fig. 4 is a fragmentary sectional view showing the coal feed cam in two of its positions;

Fig. 5 is another fragmentary sectional view, being an enlargement of a part of Fig. 2, showing the details of construction of the clutch which permits a positive actuating device to move the coal feed and air feed levers to high or low feed, although positive stops are also employed for adjustment of the range of high and low coal and air feed;

Fig. 6 is a fragmentary vertical sectional view taken on the plane of the axis of shaft **200** of Fig. 2, showing the electromagnet supporting frame in two of its alternative positions;

Fig. 7 is a similar fragmentary end view of the same frame in one of its positions;

Fig. 8 is a top plan view of the control unit, with the coal and air feed levers broken off;

Fig. 9 is a vertical sectional view taken on the plane of the line **9—9** of Fig. 2, showing details of construction of the electromagnet which is used to control coal and air feed;

Fig. 10 is a fragmentary sectional view taken on the plane of the line **10—10** of Fig. 2, looking in the direction of the arrows;

Fig. 11 is a sectional view taken on the plane of the line **11—11** of Fig. 5, looking in the direction of the arrows;

Fig. 12 is a fragmentary sectional view taken on the plane of the line **12—12** of Fig. 5, looking in the direction of the arrows;

Fig. 13 is a fragmentary sectional view taken on the plane of the line **13—13** of Fig. 5, looking in the direction of the arrows;

Fig. 14 is a sectional view taken on the line **14—14** of Fig. 5, looking in the direction of the arrows;

Fig. 15 is a fragmentary sectional view, taken through one of the adjustable stops for controlling the range of coal feed;

Fig. 16 is a wiring diagram of a modified circuit for a controlling system in which the coal feed is also controlled responsive to the outside temperature, that is, the temperature outside of the house being heated.

The present controlling devices and controlling system are adapted to be used in connection with the combined air conditioning and heating unit disclosed in my prior application, Ser. No. 346,763, filed July 22, 1940, Patent No. 2,323,034, issued June 29, 1943; and the present controls may be substituted for those which are disclosed in that application.

In some embodiments of the invention the same driving motor may also be used for driving the blower which circulates the air through the bonnet of the furnace and for driving a pump which may circulate the water in a hot water system.

In the embodiment which has been selected to illustrate the invention the latter actuating devices have been omitted, and the motor is disclosed as actuating the blower for supplying the air of combustion and driving the gears which actuate the coal feed.

Referring to Fig. 1, this is a diagrammatic view showing the improved controlling unit for the stoker in connection with a wiring diagram. In this figure the driving motor is indicated by the numeral **10**, and its shaft **11** may project from both ends for purpose of driving a blower or impeller carried in a blower housing at one end and for driving the coal feed from the other end of the shaft.

For this purpose the shaft **11** carries a V pulley **13** at its right end, which drives a pulley **14** by means of a V belt **15**, the pulley **14** being mounted on a driven shaft **16** extending into the gear housing **17**.

The gear housing **17** contains any standard form of speed reduction gears connecting the shaft **16** with the driving feed screw of the screw conveyor in the conveyor tube of the stoker.

The speed of operation of the feed screw is determined by the position of the shaft **19**, which has the usual adjustments, as indicated, for permitting the drive of the screw at a number of different speeds from zero, indicating no drive, to speed No. 4.

This mechanism may be so adjusted that the controlling system can drive the screw at high feed or low feed, and the rate of speed is controlled by the angular position of the shaft **19**.

The gear box **17** is provided with the indicia **0**, **1**, **2**, **3**, and **4**, merely because it is the same gear box utilized in my prior application. The positions and stops of the coal feed are, however, located and indicated by the controlling unit **100**, of which the face plate **37** forms a part.

The shaft **19** is adapted to be actuated by the crank arm **20**, which is pivotally connected to a

connecting rod 22, and the connecting rod 22 preferably consists of two strips of sheet metal 22a and 22b joined together by means of a pair of screw bolts 22c which are threaded into the lever 22b and which pass through the slot 22d in the lever 22a.

As the control unit 100 is located somewhat in advance of the gear box 17, there is an offset in the lever 22b at 22e so as to bring the crank arm 20 into a plane located just outside the gear box 17.

The connecting rod 22 is pivotally connected at its left end by means of a rivet 138 to a coal feed lever 127, further to be described.

The blower housing 12 may have its inlet located at 26, surrounding the shaft 11, and the inlet 26 may be connected to a pipe 27, open at its lower end 28, but adapted to be controlled by a butterfly air valve 29. The butterfly valve 29 is carried by a shaft 30, having a crank arm 31 located outside the pipe 27, and the crank arm 31 is pivotally connected at 32 to a connecting rod 33, comprising two sections slotted and secured together by bolts 34 so that the connecting rod is of adjustable length.

The connecting rod 33 has its opposite end pivotally connected by means of a rivet 35 to an air supply lever 126 (Fig. 10, further to be described), also actuated and controlled by the motor 10.

In the present controlling unit the air and coal feed adjustments are controlled by means of an electromagnet 175, which is not visible in Fig. 1 because it is located behind the face plate 37, but it is shown diagrammatically at 175 in the wiring diagram at the top.

One of the most important features of the invention comprises the controlling unit, details of which are shown in Figs. 2 to 6, by means of which the ranges of movement of the coal feed control lever and the air feed control lever may be independently adjusted and independently controlled and by means of which the rates of feed of air and coal may be set for a predetermined high feed and a predetermined low feed, and for complete cut-off of the coal feed.

The present controlling arrangements are adapted to be used not only for the air conditioning and heating units shown in my prior application, above mentioned, but also for stokers which are installed in old furnaces, or boilers.

When these controlling arrangements are used in old furnaces, the coal feed would not be completely cut off, but would be merely reduced from high feed to low feed, such as a No. 1 feed on low.

In other embodiments of the invention the coal feed may be completely cut off when the air feed is cut to a minimum. This may be accomplished by setting the lower range of movement of the coal feed controlling lever at zero, a zero coal feed indicating zero speed of the operating screw, or no feed at all.

The electromagnet 175 is an A. C. magnet. It is adapted when energized to hold the coal and air feed on low, which, as described above, may be either a zero coal feed or a No. 1, or other setting; but, as to air feed, there is always some air feed when the motor is operating.

The air feed continues, at least in some measure, whenever the motor is operating, because the blower is directly connected to the motor, and the butterfly valve 29 does not completely shut off the intake to the blower.

Referring to Fig. 2, the details of construction of the controlling unit 100 and its relation to the driving mechanism of the stoker, which is included in the housing 17, are there shown in greater detail.

The shaft 16 is driven by the motor 10 at a substantially continuous speed when the motor 10 is energized, and it is provided with a driving worm or screw 40, which meshes with a worm gear 41 rotatably mounted upon the shaft 42.

The housing 17 has its rear wall 43 provided with a bore 44 for receiving the bearing 45 and with a counterbore 46 for receiving the ball bearing unit 47.

The housing 17 has a pair of forwardly projecting side walls 48, 49 and the top and bottom walls 50, 51, and is provided with a pair of elongated foot flanges 52, 53 (Fig. 1). The forward side of the housing 17 has a front wall 54, having a circular aperture 55 in it, which is closed by a cover plate 56, secured in place by suitable screw bolts with a gasket 57 interposed between ground surfaces so that the housing may be filled with semi-solid lubricant.

The worm gear 41 is provided with a cylindrical hub portion 58 (Figs. 2 and 3) and with a cylindrical but eccentrically located cam 59 carried by the hub 58. A ratchet wheel 60 (Fig. 2 and Fig. 3), provided with teeth 61, has an elongated cylindrical hub 62 for receiving the shaft 42, 63 indicates the bore of hub 62.

The hub 62 is rotatably mounted in a bearing bushing 64 carried in a cylindrical bore 65 in the cover plate 56. The hub 62 projects from the bearing 64 with the shaft 42, and the hub 62 is secured to the shaft by a through pin 66a, having a drive fit in the bores 66, 67, 68. This pin may be slightly tapered, and it secures the ratchet wheel 60 to the shaft 42.

The shaft 42 is the shaft which drives the coal feed mechanism, such as a feed screw (not shown). For example a gear or driving pulley for the feed screw may be mounted on the right end of shaft 42 in Fig. 2. This shaft is driven only through the intermediary of the ratchet wheel 60, since the worm gear 41 rotates freely upon the shaft 42. The cover plate 56 supports at its lower side a stub shaft 69, the knurled end 70 of which has a frictional fit in a cylindrical bore 71 of the cover plate 56.

The stub shaft 69 is adapted to support for pivotal movement an oscillating lever 72, which is actuated by the cam 59. The oscillating lever 72 may comprise a relatively wide metal member having a cam aperture 73 for receiving the off center cylindrical cam 59.

The cam aperture 73 has the two oppositely disposed straight sides 74, 75, and these straight sides are spaced by an amount equal to the diameter of the cylindrical cam 59.

The partially cylindrical end walls 76, 77 of the cam aperture 73 may take any desirable shape, but they are spaced from each other sufficiently to provide a clearance between these end walls and the cylindrical cam 59, as this cam rotates eccentrically on the shaft 42.

Thus the spacing between walls 76 and 77 must at least equal twice the radial distance from the center of the shaft 42 to the outside of the cam 59 at that point where the cam surface is farthest from the axis of the shaft 42. As the gear 41 rotates, the lever 72 is thus caused to oscillate back and forth in a clockwise and counterclockwise direction on shaft 69. The end surface 78 of gear hub 58 serves as a thrust surface for engaging the side of the oscillating lever 72.

At its upper end the oscillating lever 72 car-

ries a stub shaft 79, which has a pressed fit in a cylindrical bore 80 in the lever 72. The stub shaft 79 projects toward the left in Fig. 2 and has a pivotal fit in the cylindrical bore 81 of a pawl 82. A cotter pin 83 retains the pawl on the shaft. The pawl 82 is shown in Fig. 3, and it comprises a lever having a bore 81 at one end and having a chisel-like tooth 84 extending laterally downward from the other end.

The tooth 84 has a radially extending end shoulder 85 and a beveled camming shoulder 86. The teeth 61 of the ratchet wheel have a radially extending shoulder 87 opposing the end shoulder 85 of the pawl 82 and a beveled camming shoulder 88 which lifts the pawl 82 against the force of gravity when the pawl 82 is drawn toward the left over the ratchet wheel 60.

The maximum range of movement of the oscillating lever 72 is shown in the dotted line position in Fig. 4, as compared with the full line position in that figure; and during this maximum range of movement the pawl 82 may traverse a space on the periphery of the ratchet wheel 60 equivalent to four teeth when there are four positions of coal feed adjustment, excluding the zero feed.

The bearing bushing 64 has a radially extending flange 90 provided with a cylindrical surface 91, which is rotatably received in a complementary aperture in a cam disc 92. The cam disc 92 is shown in Fig. 3, and it has a partially cylindrical outer surface 93, which is suitably located so that it will pass under the tooth 84 of the pawl 82 and control the dropping of that tooth into the tooth spaces of the ratchet wheel 60. Thus the cylindrical surface 93 is at a radius equal to or slightly larger than the outer radius of the teeth 61 on the ratchet wheel 60, and the length of this cylindrical surface 93 on the periphery of the cam 92 is sufficient to cover four teeth in the embodiment illustrated, which has four coal feed adjustments.

In addition to the peripheral surface 93, the coal feed adjustment cam 92 has another toothed portion provided with teeth 95 for engaging the teeth 96 on a gear segment or partially toothed disc 97. Only sufficient gear teeth 95 and 96 need be provided on the members 92 and 97 to permit the rotative movement of the feed adjustment cam 92 to the extent described hereinafter.

The gear segment 97 is fixedly secured to a shaft 98, which is rotatably mounted in the front 56 of the housing, and which carries on its outer end the hub 19 of lever 20 (Fig. 1), previously described.

This hub 19 is provided with a pointer 99, which indicates the coal feed adjustment with respect to the numerals 0 to 4, inclusive, on the housing, but this indicia may be eliminated, since suitable indicia is now provided on the controlling unit 100.

The operation of the coal feed adjustment, just described, is as follows: When the lever 20 is arranged in the position shown in Fig. 1 at 0 coal feed adjustment, the gear segment 97 has rotated the coal feed adjustment cam 92 to such a position that it masks or covers all of the four tooth spaces of the ratchet wheel 60 into which the tooth 84 of pawl 82 could otherwise drop by gravity.

As a result of the interposition of the cylindrical surface 93 between the tooth spaces of the ratchet wheel 60 and the pawl 82, the pawl 82 merely slides back and forth on the surface 93, as the motor 10 rotates the shaft 16 continuously, and the cam 59 oscillates the lever 72 with its pawl 82.

When the coal feed adjustment lever 20 is moved until its pointer points to 1, this rotates the shaft 98 and the gear segment 97; by means of teeth 95 and teeth 96 the coal feed adjustment cam 93 is moved clockwise in Fig. 3 to such a position that one tooth space of the ratchet wheel 60 is exposed for receiving the pawl 82.

The members 20, 98, 97, and 93 are then held in fixed position or fixed adjustment, while the lever 72 oscillates as described before, through the same range of movement, carrying the pawl 82 with it. During three-fourths of its movement the pawl 82 slides on a cylindrical surface 93 and cannot drop into the teeth below it, but at the last portion of its movement toward the left (Fig. 3), pawl 82 is then permitted to drop into one of the tooth spaces of the ratchet wheel 60.

During this remaining one-quarter of its movement, the pawl 82 has its shoulder 85 engaging the shoulder 87 of one of the teeth 61 on the ratchet wheel 60, and it moves the coal feed ratchet peripherally through a distance of one tooth.

The shaft 42 is the one which drives the coal feed screw or other coal feeding mechanism, and thus when the coal feed adjustment is at No. 1, there is a minimum coal fed, step by step, equal to the amount which is brought about by rotation of the coal feed ratchet, a distance of one tooth for each oscillation of the lever 72, or for each rotation of the gear 41.

This is the slowest rate of coal feed, the zero coal feed corresponding to no movement of the coal feed.

In a similar way the coal feed adjustment may be made such that two teeth are engaged by the pawl in its oscillating movement, or three teeth, or four teeth.

The four toothed engagement of the pawl corresponds to a maximum coal feed.

It will thus be observed that the coal feed may be adjusted while the device is operating by merely rotating the lever 20, which in turn is actuated by the lever 22.

The stub shaft 79 has been provided with a cylindrical extension 101 (Fig. 2), which is pivotally connected at one end to a link 102. The link 102 carries at its other end a stub shaft 103, to which it is pivotally connected; and the stub shaft 103 is fixedly secured to the crank arm 104. The crank arm 104 is fixedly secured to the stub shaft 105, which is rotatably mounted in a bearing bushing 106a, carried by the upper front 54 of the housing 17.

The purpose of this mechanism just described is to take off power from the gear housing of the coal feed, to actuate the controlling unit 100 without the necessity for employing another motor.

As the stub shaft 79 is carried by the oscillating lever 72, it oscillates throughout an arc and moves the link 102 back and forth and with it the crank lever 104 is caused to oscillate, oscillating the shaft 105.

The control unit 100 may be carried by the motor mounting plate 106, which is located on top of the gear housing 17 and below the motor 10, to which part it is secured by suitable screw bolts. The entire control unit is carried by plate 106, through the intermediary of a face plate 107, which has its upper attaching flange 108

secured to the motor supporting plate 106 by screw bolts 109.

The face plate 107 is provided with a centrally located aperture 110 for passing the end of a stub shaft 111. The stub shaft 111 is carried by a supporting plate 112 (Fig. 5), which has an aperture 113 for passing the reduced threaded end of the stub shaft 111 for receiving a nut 114, which clamps the stub shaft to the plate 112.

Plate 112 is fixedly secured to the back of the face plate 107 by a pair of screw bolts 115 (Fig 1), which pass through plate 107 and are threaded into plate 112. The face plate 107 is provided with a generally arcuate aperture 116, (Fig. 1) which is located on an arc determined by a radius taken from the center of the shaft 111.

The arcuate aperture 116 does not have cylindrical walls, but has what appear to be scalloped walls, but which, in fact, are a plurality of cylindrical grooves formed in each of its side walls opposite to each other in such manner as to define portions of a socket for receiving the cylindrical portion 117 of a button 118.

Seven such partially defined sockets are provided in the arcuate aperture 116, two being occupied by the stop members 118 and 119 in Fig. 1, those unoccupied being indicated by the numerals 0, 1, 2, 3, and 4, in inverse order.

The structure of these stop members 118, 119 is illustrated in Fig. 15, where the stop member 118 is shown. This stop member 118, as previously stated, has a cylindrical portion 117. It also has a head 120*a* with a cylindrical knurled surface.

The stop member 118 has a cylindrical bore 121*a* passing axially through it and adapted to slidably receive the cylindrical shank 122*a* of an elongated rivet 123*a*. The rivet 123*a* passes through an arcuate aperture 124*a*, which is formed on concentric curves, having as their center the axis of the shaft 111.

The arcuate aperture 124*a* guides the shank 122*a* of the rivet 123*a* as the stop is being shifted, and the rivet 123*a* has its head 125*a* engaging behind the plate 112. The stop member 118 has a larger counterbore 126*a* at its outer end to provide an annular shoulder 127*a* for engaging one end of a helical compression spring 128*a*. The other end of the helical spring engages the inner face of a washer 129*a*, which fits on the reduced cylindrical end 130*a* of the shank 122*a* and is secured by the riveted portion 131*a*.

The spring 128*a* constantly urges the stop member 118 toward the head 125*a* of the rivet 123*a* and holds the stop member in any one of the seven sockets previously described and shown in the face plate 107 in Fig. 1.

Thus the stop members 118, 119 may be located at any of the positions indicated in Fig. 1, or the two end positions, which have no indicia. These stop members define the range of coal feed adjustment, and the coal feed adjustment may be held at zero or may be extended between the stop members 118, 119, in any of the positions shown.

As the normal operation of the device contemplates a low and a high coal feed adjustment, the stop members 118, 119 will usually be farther than one space apart; but it is possible to adjust the device so that it will be constantly kept on high coal feed or low coal feed or in intermediate feed.

The face plate preferably has the words "Coal Feed Adjustment" on it, above the arcuate slot 116; and it also has stop members 118, 119 to distinguish it from the air adjustment, which is at the bottom of the unit 100.

The stub shaft 111 (Fig. 5) preferably has an enlarged cylindrical shank 120, and it is clamped in place by the nut 114, which draws the annular shoulder 121 against the back of the plate 112. At its opposite end the stub shaft has a head 122, and it rotatably supports a rectangular block 123, having a centrally located cylindrical aperture 124.

The block 123 preferably has its corners cut off and slightly rounded, as indicated at 125 (Fig. 12), and it rotatably supports a plurality of metal plates 126, 127, 128, each of which has a cylindrical aperture, all of the apertures being indicated by the same numeral, 129. The aperture is of a suitable diameter so that the plates are rotatably mounted on the rounded corner portions 125 of the metal block 123.

There are a plurality of fiber washers made of suitable material, such as indurated fiber, carried by the rectangular block 123, and the fiber washers are indicated by the numerals 130, 131, 132, and 133. These washers 130—133 may be circular in shape, and they are provided with a centrally located squared aperture, all of these apertures being indicated by the numeral 134 so that the washers fit on the rectangular block 123 and rotate with it, whereas the plates rotate on the rectangular block, but are engaged by the washers in the manner of a friction clutch.

The washer 133 is thicker than the washers 130—132, and it is provided with a cylindrical aperture 133*a*, which receives the cylindrical shank 120 of the stub shaft 111, in addition to a slot 135 for receiving a transverse pin 136, which passes through an aperture in the shaft. Pin 136 is positioned in an aperture in the shank 120 and is located in the slot 135 in the washer 133 to hold this washer against rotation and fixed with respect to the shaft.

Thus the end washer 133 is keyed to the shaft by means of the pin 136 so that this washer does not rotate with the block 123. It differs in this action from the washers 130—132 because, while they are fixedly secured on the block 123, they may rotate with the block on the shaft 111.

A spring washer 137 is interposed between the head 122 and the rear face of washer 133 so that all of the plates and fiber washers are placed under a predetermined resilient compression and kept in engagement with each other.

The plate 127 comprises a rectangular steel plate, the longest dimension of which may be two or three times its width. The plate 127, as previously described, is pivotally secured by means of a stud 138 riveted in the plate to a connecting rod 22. The plate 127 may also be called a coal feed lever, and at a point suitably spaced from the center of the shaft 111 the plate 127 is provided with a stop member 139.

This stop member may consist of a strip of metal bent at right angles so that one portion may form an attaching flange welded to lever 127, and the other portion projects forwardly through the slot 116 in the face plate in position to engage the stops 118, 119.

The relation of the coal feed lever 127 and its connection to the connecting rod 22 and the crank 20 are such that when the stop member 139 is located underneath one of the indicia, the crank 20 of the gear box is in a corresponding position of coal feed adjustment.

The other plate 126 may be of similar construction, comprising a substantially rectangular strip

of steel, which is pivotally secured by means of a rivet 35 to the connecting rod 33, which controls the butterfly air valve 29.

In this case the lower end of the air feed lever 126 has a projecting ear, which is bent at right angles, and indicated at 141 (Fig. 2). This ear forms a stop member, which projects through the arcuate slot 142 in the face plate in position to be engaged by the stop members 143, 144.

The words "Air adjustment" appear on the face plate above the slot 142. If desired, suitable indicia may also be included to show the degree of opening of the butterfly valve 29.

The stop members 143 and 144 may be identical in construction. They are slidably mounted in a slot 145, located in the backwardly turned flange 146 on the lower end of the face plate 137.

The slot 145 extends over almost the full width of the face plate so that the arcuate slot 142 may be utilized to its fullest amount. The two stop members 143, 144 are similar in construction, and each comprises a knurled cylindrical thumb screw 147, having a smaller cylindrical threaded screw bolt 148.

The screw bolt 148 passes through the slot 145, in each case, and is threaded into the horizontal flange 149 of the stop member 143 or 144, as the case may be. The upwardly extending flange 150 of each stop member is long enough to extend into the path of the stop 141 carried by the air feed lever. Thus the stop members 143, 144 are adapted to define limits of movement of the air feed lever and to determine to what degree the air conduit 27 shall be shut off and to what degree it shall be opened at its maximum opening.

The face plate 107 is preferably provided with a supporting frame for the controlling mechanism, which may comprise a substantially rectangular strip of sheet steel 151 (Fig. 8), having its front end 152 bent to form an attaching flange, which is secured to the face plate by a plurality of screw bolts 153.

At its rear end the frame plate 151 is bent at right angles and provided with a laterally extending portion, which has an aperture 155, serving as a bearing for a stub shaft 156.

The controlling mechanism for the unit is preferably mounted in a frame or housing 157, which may take the form of an upwardly open box of sheet metal. The box or housing 157 has end walls 128, 159, and side walls 160, 161; and the end walls are used for its pivotal support on the controlling unit.

Thus the end wall 159 has an aperture 162 for receiving the stud bolt 156. The head of the stud bolt engages the inner side of the end wall 159, and a cotter pin 163 may pass through the stud bolt to act as a thrust bearing at its other end. The stud bolt 156 also preferably pivotally supports an actuating lever 164, which preferably comprises a relatively thick bar of steel or other suitable metal, having an aperture for receiving the stud bolt 156.

The actuating lever 164 has an engaging member 165 secured to its upper end, and this engaging member may consist of a forwardly extending flange 166 and a depending flange 167.

The actuating lever 164 is so connected to the driving mechanism in the gear housing that it is constantly oscillated back and forth on its pivotal support, that is, the stud bolt 156; and it is adapted to move the controlling mechanism under certain conditions when the engaging member 167 is in a predetermined position.

The connection between the actuating lever 164 and the mechanism in the gear housing may consist of a shaft 105, which projects from the gear housing, being rotatably mounted in the bearing 106a in Fig. 2. Fixedly secured to the end of the shaft 105 there is a lever 168, which may be secured to the shaft by a set screw 169.

The lever 168 is pivotally connected to a pair of connecting links 170 by means of another stub shaft 171, having a head and a cotter pin. The pair of connecting links 170 are pivotally connected to the actuating lever 164 (Fig. 2) by a stub shaft 171a, having a cotter pin at each end. In other words, the depending end of lever 168 is pivotally connected to a link 170, which is pivotally connected to the lever 164 by stub shaft 171.

The end wall 128 corresponds to the metal plate 128, previously described, and has a square opening for engaging the block 123. Thus the complete housing 157 is pivotally supported on this end by means of the end wall 128 and the block 123, since the block 123 is fixed on stub shaft 111.

Of course, the stub shafts 111 and 156 are coaxial. Located in the housing 157 there is an electromagnet 175 consisting of a soft iron core 176, carrying suitable insulated winding coils 177. The core 176 passes through the coils 177 and is carried by a soft metal bracket 178, which forms a continuation of the magnetic circuit. The bracket 178 has a vertical flange, which is fixedly secured to a supporting spider 179 (Fig. 8), which in turn is carried by the upwardly extending flange 180 of a supporting bracket 181. 178a indicates a sheet of fiber board insulation interposed between the spider 178 and the bracket 178.

The supporting bracket 181 is fixedly secured to the bottom of the housing by bolts and nuts 182. The magnet 175 is preferably arranged for energization by alternating current; and therefore it has its core or pole piece 176 split, and half of the pole piece is surrounded by a copper ring 183 (Fig. 9), which causes such a lag in the changing flux that the armature is constantly held when the windings are energized, irrespective of the changing intensity of energization.

The electromagnet 175 has an armature 184, comprising a member of soft iron, having a depending portion adapted to be attracted to the pole piece 176. The armature 184 is movably mounted on the bracket 178, which comprises part of the magnetic circuit, as follows:

The bracket 178 has a rearwardly extending flange 185, which terminates in a pair of narrow ears 186 (Fig. 8), one of which is at each side of the flange 185. The armature has a vertical flange 187 and a horizontal flange 188. The vertical flange has a slot 189 at each side for receiving each ear 186.

The slots and ears have suitable clearance to permit a limited pivotal movement. The ears 186 have inwardly projecting lugs 190, which engage outside of a spring plate 191, which itself has a slot at each end for receiving the ears 186. The spring plate 191 may be bowed forwardly from its ends to engage the vertical flange 187 of the armature and hold it on the flange 185.

The horizontally extending flange 188 of the armature comprises a narrow strip which engages a vertically extending stud or stop member 192 (Fig. 2) carried by the core frame 185 to limit the movement of the armature flange 187, away from the pole piece 176.

The stud 192 also carries one end of the closed loop of a helical spring 193, the other end of which is hooked about an upwardly projecting

ear 194 (Fig. 8), which is located in an aperture 195 in the armature 184. The spring 193 urges the armature into a position away from the pole piece 176 with the flange 188 engaging stop 192.

The lower end of the armature may have riveted to it a connecting pin 196 (Fig. 2), which serves as a connecting member for connecting the armature to a controlling plate, indicated in its entirety by the numeral 197.

This controlling plate may consist of a piece of sheet metal, which has bearing ears 198, 199 turned at right angles adjacent its lower side. The bearing ears 198, 199 have apertures for receiving the rod or pintle 200, which passes through these bearing ears and through the side walls 160, 161 of the housing 157.

Cotter pins 201 are located in the pintle 200 at each of its ends outside the housing. Thus the controlling plate 197 is mounted at its lower end for pivotal movement toward and away from the electromagnet.

The pin 196 carried by armature 184 has a thrust washer 202 at its outer end, and the washer engages a spiral spring 203, the other end of which engages the controlling plate 197. Any suitable number of washers may be interposed between the spring 203 and the controlling plate 197 or between the controlling plate 197 and the armature flange 187 so that the controlling plate is properly located to accomplish its purpose when the armature is in released position and in contracted position.

The controlling plate in elevation is substantially rectangular in shape, but is formed with a slot 204 extending into its upper edge midway between the sides. The upper flanges 205, 206 on each side of the slot 204 are in different planes.

This may be accomplished by making the controlling plate of a plurality of plates welded together, as shown in Fig. 8, or the upwardly extending flanges 205, 206 may be bent so as to be offset from each other into different planes. The width of the slot 204 is sufficient to pass the depending flange 167 of the contacting member 165. That is, the slot is wider in a horizontal direction than this flange 165.

The flanges 205 and 206 (Fig. 8) are offset into different planes only sufficiently in relation to the thickness of the contacting flange 167 so that as the contacting flange 167 oscillates back and forth it must engage one or the other of the upwardly extending flanges 205 or 206. In the contracted position of the armature the flange 206 is in the path of the oscillating lever 165.

In the released position of the armature the upwardly extending flange 205 is in the path of the contacting member 167 on the oscillating lever 164. The spring and pin connection 196, 203 between the armature and the controlling plate 197 is for the purpose of eliminating chatter, due to the use of alternating current, by means of a resilient connection between the armature and the controlling plate.

The operation of that portion of the mechanism included in the controlling unit 100 is as follows:

It has already been shown in connection with the description of the gear box mechanism that a source of power is taken off this gear box by means of the projecting shaft 105 so that the crank arm 168 and the connecting links 170 cause the actuating lever 164 to oscillate back and forth through a predetermined arc at all times when the motor is operating.

The purpose of the controlling unit is to utilize this motion and control it electrically so that it may be used to move the coal feed adjustment to high or low and the air feed adjustment to high or low, irrespective of the range of adjustment.

When the armature is released, the control plate 197 moves away from the armature to such a position that the part 167 carried by the oscillating lever 164 strikes the upwardly extending flange 205, which is in the plane nearest to the electro-magnet.

Then the oscillating lever 164 clears the flange 206 in its oscillating movement, but engages the flange 205; and as a natural result the oscillating lever pushes the flange 205 of the control plate in a counterclockwise direction in such manner as to pivot the entire box 157 on its stub shafts 111 and 156 to a maximum counterclockwise position. Thereafter the lever 164 continues to oscillate as long as the motor is energized and the gears are rotating in the coal feed box; but as long as the armature is deenergized the oscillating lever 164 causes no further movement of the control plate 197 because the only flange 205 which it could engage has already been moved counterclockwise beyond the range of movement of the oscillating lever 164.

In a similar way, when the armature is energized, the control plate 197 is pivoted counterclockwise in Fig. 2 toward the electromagnet. The flange 205 is moved out of the plane of movement of the flange 167 on oscillating lever 164, but the flange 206 is moved into the plane of movement of the flange 167 on the oscillating lever 164.

On the next movement of the oscillating lever 164 in a clockwise direction, looking at it from the front, the lever 164 will have its contacting member 165 engage the flange 206 of the control plate 197. This will pivot the entire box in a clockwise direction to its position of maximum clockwise movement.

Thus the driving mechanism is adapted to move the housing 157 to either of two positions, which may correspond to maximum coal and air feed and minimum coal and air feed.

The movement of the housing 157 into these maximum positions does not necessarily mean that the coal feed and air feed levers are moved to the same extent. The housing wall 128 is frictionally engaged between the fiber plates or discs 132, 133.

Therefore, whenever the housing rotates it tends to move both of these discs. The disc 133 is keyed to the stub shaft 111, with which it moves; but the disc 132 tends to move with the end wall 128 of the housing, with the following results.

The disc 132 tends to rotate the plate 127 with it, which engages the disc 131, which tends to rotate the plate 126 with it. These coal and air feed levers 127 and 126 have their range of movement determined by the stops 118, 119, and 143, 144, respectively.

Since the coal feed and the air feed levers are driven through the intermediary of friction discs like a clutch, these feed levers are moved until they engage the stops 118, 119 or 143, 144; and then they stop, each being independently controlled by its stop members.

Whenever a coal feed or air feed lever stops at any position, it does not hinder the housing 157 from moving onward to its maximum counterclockwise or clockwise position.

Thus the coal and air feed are moved to any adjusted maximum coal and air feed when the electromagnet 175 is de-energized, and kept in that position as long as the magnet is de-energized. When the magnet is energized, the coal and air feed are moved to the adjusted minimum coal and air feed, and kept there as long as the magnet is energized.

Referring now to Fig. 1, this diagram also includes a circuit diagram for controlling the electric motor 10, which drives the coal feed and the electromagnet 175.

The present circuit is adapted to be energized by ordinary 110 volt 60 cycle A. C. lighting circuit 210, and numerals 210, 211 indicate the supply conductors for energizing the present circuit. A double pole disconnect switch is shown at 212, interrupting the conductors 210, 211.

The conductor 211 is connected to one of the contact arms 213 of a limit switch 214, which may consist of any thermostatically actuated switch located, for example, in the bonnet of the furnace. The other contact of the limit switch is indicated by numeral 215. 216 indicates in its entirety an operating switch which comprises a thermostatic switch member having a pair of contacts 217, 218.

These may be thermostatic switches arranged in the same housing and located to be actuated from heat derived from the temperature of the air in the bonnet of the furnace or adapted to be actuated at a predetermined steam pressure in the boiler by means of a pressure responsive bellows located in the boiler or having a bulb in the boiler.

In hot water systems these may be thermostatically actuated switches 214, 216, which are actuated responsive to the temperature of the water in the boiler.

The operating switch 216 is arranged so that it closes on high bonnet temperature, and the limit switch 214 is so arranged that it opens on high temperature. The other contact 215 of limit switch 214 is connected by conductor 219 to one terminal of the primary 220 of a step-down transformer 221.

The other terminal of the primary 220 is connected by conductor 222 to conductor 210, which is the other side of the line. Thus the limit switch is arranged to operate at 110 volt energization, and to open the entire energizing circuit when the temperature reaches a predetermined limit.

The transformer 221 has a secondary 223, which provides current at a lower potential for control of relays and the like, and one terminal of the secondary 223 is connected by conductor 224 to the coils of a relay 225. The other end of the coils of the relay 225 is connected by conductor 226 to a conductor 227.

The time switch is indicated in its entirety at 228, one contact 229 being connected to conductor 227, and the other contact 230 being connected to conductor 231, which leads to the other terminal of the secondary 223. This time switch 228 is controlled by a synchronous clock 238. Thus the time switch 228 controls the relay 225.

A synchronous electric clock motor 238 is indicated in the upper part of the circuit by a circle and by the numeral 238, and it has its terminals connected to two conductors 232, 233. The motor 238 is a 110 volt A. C. motor, and conductor 232 is connected to one side of the line by being connected to the line conductor 219. The other conductor 233 is connected to the conductor 222.

Thus the synchronous clock motor is constantly connected to the 110 volt energizing circuit, through the limit switch.

The relay 225 controls a pair of contacts 234, 235, and the contact 235 is connected by the conductor 236 to the contact 217 of the operating switch. The contact 234 of the relay is connected by the conductor 237 to the conductor 219.

The conductor 236 has a branch 239 extending to the terminal of the motor 10, and the conductor 222 has a branch 240 extending to the terminal of the motor 10. By tracing this circuit it will be noted that the motor 10 is controlled by the contacts 234, 235 of the relay 225. The contact 217 of the operating switch 216 is connected to the conductor 236. The contact 218 of the operating switch 216 is connected by the conductor 241a to the electromagnet 175, which forms a part of the control unit 100. The other terminal of the electromagnet 175 is connected to the conductor 222.

Thus it will be seen that the operating switch 216, which closes on high bonnet temperature, is in series with the electromagnet 175 so that whenever this operating switch is closed or the bonnet reaches a predetermined temperature, the electromagnet 175 is energized. The effect of this energization is to draw the control plate 197 over toward the magnet by means of armature 184 (Fig. 2) to the position of Fig. 2, and the reciprocating actuating member 164 will then strike the upwardly extending flange 206 and move the housing 157 from the full line position of Fig. 6 to the dotted line position at the right. That is, the housing moves over to the minimum air feed and minimum coal feed position, carrying with it the air feed and coal feed levers.

The stoker motor 10 is in the 110 volt A. C. circuit by reason of its connection through conductor 240 to conductor 222 to power line conductor 210. On the other terminal the motor is connected to conductor 239, conductor 236, relay contacts 234, 235, 237, and 219, limit switch 214, line conductor 211. Thus the motor 10 is controlled by the limit switch 214 and by the relay 225.

The conductor 227 extends to one of the contacts 241 of a room thermostat 242, the other contact arm being 243. Contact arm 243 is connected to conductor 231. Room thermostat 242 is thus connected in parallel with the time switch 228, and the room thermostat 242 also controls the relay 225. The room thermostat 242 is so arranged that it opens the circuit on being heated to a predetermined point and closes the circuit on being cooled to a predetermined point.

Thus the motor may be operated either by the room thermostat 242 or the time switch 228, which is actuated by synchronous electric clock 238. The synchronous clock and time switch act as a pilot circuit for turning on the coal feed and air feed periodically at intervals which are sufficiently short to insure the maintenance of a fire.

The pilot cannot, however, turn on the coal and air feed when the limit switch is open because the synchronous clock 238 is in series with the limit switch 214, and the limit switch is open when the furnace is already too hot and needs no pilot firing.

The operation of the control system and the mechanism is as follows: There are three general types of heating plants in which the present control system may be used. When the heating plant is a hot air furnace, the limit switch 214 and the operating switch 216 would be thermostatical-

ly actuated switch members, including any standard type of thermostat.

These switches 214 and 216 would be disposed in the bonnet of the furnace, and would be actuated when the bonnet reaches the proper temperatures.

When the heating plant comprises a steam or vapor installation, the limit switch 214 and operating switch 216 may be actuated by pressure responsive devices which correspond to the pressure in the boiler, and these devices would have their pressure responsive bellows or a bulb connected to the bellows located inside the boiler.

When the system is a hot water system, the switches 214 and 216 would be actuated responsive to the temperature of the water in the system at the boiler. They would comprise thermostatically actuated switches, with the thermostat located to be heated from the water of the boiler.

The system is illustrated with the coal feed on low feed in Fig. 1. The control switch 212 should, of course, be closed in order to energize the electrical system. Suppose, for example, the installation is being used on a steam boiler. The operating switch 216 will be set to cut the coal and air feeds from high to low when the steam pressure reaches, for example, three pounds on an installation designed to operate from zero to five pounds.

The contacts 217, 218 of the operating switch 216 are closed because the steam pressure has reached three pounds, as the apparatus is illustrated in Fig. 1. This has energized the electromagnet 175 and moved the control plate 197 toward the electromagnet 175 so that the oscillating lever 164 has pulled the housing 157 toward the right to the dotted line position of Fig. 6, placing the device on low coal feed and low air adjustment.

It happens that the low coal feed has been set at zero, which means that no coal is being fed at all. If desired, the low coal feed may be made in any of the various adjustments indicated on the coal feed adjustment, and the zero coal feed would probably only be used in warm weather, while in colder weather the low coal feed might be raised to 1, so as to maintain a better fire all of the time except when the limit switch is open.

Suppose, under these conditions, the room thermostat 242 shows a demand for heat in that it is closed because it has cooled; and suppose the limit switch 214, which is set at five pounds steam pressure, is closed, as it would be if the boiler had not reached a pressure exceeding this predetermined maximum value.

The room thermostat switch 242 closes at a predetermined temperature, and then we say it is demanding heat. Under these conditions the relay coil 225 would be energized, and the contacts 234, 235 closed, to energize the motor 10 and the electromagnet 175, if the operating switch 216 is closed. The operating switch 216, of course, closes on high bonnet temperature.

If the steam pressure is below three pounds, the operating switch 216 will be open, and when the motor 10 is energized, causing the coal feed to commence, the reciprocating lever 164 will constantly oscillate back and forth. The electromagnet 175 will be de-energized because the operating switch 216 is open, and the control plate 197 (Fig. 2) will take a position farthest from the electromagnet 175.

The lever 164 will have its depending flange 167 engage the upwardly extending flange 205 and move the control housing 157 from the dotted line position of Fig. 6 to the full line position. In other words, this will move the coal feed stop 139 over to position 4, and the air adjustment lever 126 with its bent extension 141 to the right end of the air adjustment slot. The coal feed will be placed on high coal feed, and the air adjustment will be opened to maximum opening. If, under the same conditions, the steam pressure in the boiler has already reached three pounds and the room thermostat demands heat, the operating switch 216 will be closed and the electromagnet 175 will be energized.

Then the control plate 197 will be at its minimum distance from the electromagnet 175, and the housing 157 will remain in the dotted line position of Fig. 6 because the plate 197 is not in position to have the flange 205 engaged by the oscillating lever 164. Instead, the lever 164 has its flange 167 engaging the arm 206.

Then the demand of heat by the room thermostat will merely energize the motor 10 through the relay 225, and coal will be fed at low feed to provide an increased amount of steam or vapor pressure until the vapor pressure reaches maximum, when the limit switch will open and stop the motor from feeding coal or air.

Sometimes after such a cycle of operation as previously described, where the operating switch is open because the steam pressure is below three pounds, the steam pressure will continue to rise to, for example, four pounds, and sometimes to five pounds. This is due to the extra amount of coal which was put into the furnace during the previous cycle, before the limit of three pounds pressure was reached.

This amount of pressure over-run will vary, depending upon the length of time that the stoker has been off and depending upon how cold the furnace is and how cold the temperature is, and how low the temperature is in the house to be heated. For instance, if the stoker had been off all night, the plant would be cold, thus taking longer to build up three pounds. If it takes longer to build up three pounds pressure, the stoker would operate a longer time on high, due to this condition; and it would naturally build up a larger supply of coal in the furnace before the three pound pressure was reached.

Thus it would follow that, with a greater amount of coal in the furnace when the stoker was cut from high to low feed, plus the coal which may be continued to feed into the furnace on the low setting, the furnace might reach the five pound setting on the limit switch.

If this should happen, the limit switch 214 would open and stop the stoker until the steam pressure dropped to, for example, four pounds, when the stoker would restart; and then it would naturally be operating on the low coal feed and low air feed setting, because we have assumed a condition existing at the time the stoker was cut from high to low feed.

Ordinarily during the day the limit switch setting will never be reached because the stoker will be cut from high to low feed with a small enough fire or fuel bed to keep the steam pressure at approximately three to four pounds.

I have found that in most cases the stoker is invariably stopped by the room thermostat being satisfied after the stoker has been operating on low settings for a long enough period of time to have the fuel or fire bed very low. Thus a saving of from eighteen to thirty-three and one-third percent in fuel is accomplished, and at the same time the room thermostat is not overrun, as is

the case with the standard stoker devices of the prior art.

In the prior art devices, the feeds must be high enough to bring up the temperature and to maintain the load during the coldest weather; but this inevitably brings about a temperature overrun at the room thermostat with the devices of the prior art.

As distinguished from this, I have found that the present system will maintain the room temperature of my stoker fired system so uniform that it does not vary one-half degree F. during a twenty-four hour period of operation, while the outside temperature drops from 44 degrees F. to 12 degrees F. below zero.

Referring now to Fig. 16, this is a modified wiring diagram, which is in every respect the same as the diagram of Fig. 1, except that the operating switch circuit includes an outside temperature control, which is connected in parallel with the operating switch 217, 218. This outside switch is indicated by the numeral 250. This outside switch may consist of a thermostatic switch having contacts 251, 252 in series with the operating switch 216 and electromagnet 175.

The outside temperature control switch 250 opens when it is cooled and is set at about 40 degrees F. It is adapted to make the control of the furnace or boiler by the operating switch 216 subject to the temperature outside the house so that low coal feed and air feed adjustment are not used except when it is quite warm on the outside of the building.

The purpose of the outside switch 250 is to fire the stoker at full rate when the temperature is below forty degrees F. The switch 250 opens at this low temperature, and must be in parallel so that either the opening of this switch or the operating switch will control the change of the feed from low to high. A closed circuit is required in the circuit on the electromagnet 175 to put the feed on low.

The outside temperature control switch 250 is a useful adjunct for cold weather, as it tends to make the application of low coal feed subject to the existence of warm weather outside of the house.

One of the new results accomplished by the present system is that temperature overruns are eliminated because the green coal forced in on the high fire is substantially all burned up just before the thermostat is satisfied on the low firing. Suppose, for example, the stoker has been cut to low feed and the steam pressure drops one pound, but the temperature setting of the room thermostat has not been reached. Then the contacts of the operating switch 216 will open and the electromagnet will release the control plate 197, and the control unit housing will be moved over counterclockwise to the full line position of Fig. 6 to the high feed coal and air adjustment, where they will remain until the three pound pressure has again been reached.

At this point the operating switch 216 will again close, and operate the electromagnet 175 to set the coal and air feed on low until the pressure has dropped again to about one pound.

Thus the stoker is ordinarily operated between three and one pound pressure at all times except in the case of the cold boiler at the start, in which case the high or five pound limit setting might be reached.

When the system is installed in a hot air furnace, the limit switch 214 would comprise a thermostatic switch, having a setting of, for example, 350 degrees F. The operating switch 216 in the plenum chamber would be a thermostatic switch, having a setting of, for example, 150 degrees F. This would mean that if the temperature exceeds 150 degrees F., the coal and air feed would be moved over to low adjustment. If the temperature decreased below 150 degrees F., the coal and air feed adjustment would be moved over to high feed adjustment.

I desire it to be understood that the temperatures which are used as examples in this description are merely for the purpose of illustration, and the present device may be arranged to operate at any temperatures suitable for stoker fired heating plants.

The advantages of the present system as compared with my prior application are that only one motor is required, and the elimination of the control motor utilized in my prior invention greatly decreases the cost of the installation. Fewer operating switches and circuits are required, and the system has been simplified over my prior invention.

The advantages of the system which are also present in my prior device may then be summarized as follows:

1. Temperature overruns in the room to be heated are substantially eliminated, and the temperature is maintained within one-half degree of the room thermostat setting.

2. There is a substantial saving of from eighteen to thirty-three and one-third percent of fuel because the green fuel that is forced in on high feed is fully burned up afterward on low feed.

3. Less electric current is consumed, as the coal feed and air feed require less power when they are operated at low feed, as in the devices of the prior art.

4. Coke trees or large shafts of coke are eliminated, due to the cutting of the coal feed from high to low, during which low feed they are consumed.

5. The hard clinkers which usually form in the devices of the prior art over the burner and around the retort are broken up and moved over to the side or top of the fire because such clinkers as are formed on high feed are broken up by the continuance of the feed of fuel on low, and there is no opportunity for the clinkers to cool and settle down over the burner, as they do in the devices of the prior art, where coal is fed at high feed and then completely cut off.

6. The stoker retort will last indefinitely, or its life will, in any event, be greatly increased because when the burner is stopped there is no large hot mass directly over and around the retort. The coal fired in the retort and above it has been broken up into small pieces and cooled when operating on low feed, and the continuance of the flow of the cooling air has also served to keep the retort cool.

7. The present control unit permits the independent setting of high air feed and low air feed, and high coal feed and low coal feed, so that the system is flexible and adaptable to all kinds of temperature conditions and all kinds of heating plants.

While I have illustrated a preferred embodiment of my invention, many modifications may be made without departing from the spirit of the invention, and I do not wish to be limited to the precise details of construction set forth, but desire to avail myself of all changes within the scope of the appended claims.

Having thus described my invention, what I

claim as new and desire to secure by Letters Patent of the United States, is:

1. In a controlling unit for coal stokers, the combination of an electric driving motor with a power takeoff from said electric motor and a controlling unit for controlling coal feed adjustment, said controlling unit having a movably mounted electric control magnet adapted to oscillate between a maximum and a minimum coal feed adjustment, a member having a pair of thrust surfaces controlled by said magnet, and means actuated by said power takeoff and selectively engageable with one or the other thrust surfaces of said member for moving said control magnet to either a maximum or minimum coal feed adjustment, depending upon the position of said magnet control member, and coal feed regulating means controlled by the maximum or minimum coal feed adjustment of said magnet.

2. In a controlling unit for coal stokers, the combination of an electric driving motor with a power takeoff from said electric motor and a controlling unit for controlling coal feed adjustment, said controlling unit having a movably mounted electric control magnet adapted to oscillate between a maximum and a minimum coal feed adjustment, a member having a pair of thrust surfaces controlled by said magnet, means actuated by said power takeoff and selectively engageable with one or the other thrust surfaces of said member for moving said control magnet to either a maximum or minimum coal feed adjustment, depending upon the position of said magnet control member, coal feed regulating means controlled by the maximum or minimum coal feed adjustment of said magnet, a friction clutch interposed between said coal feed regulating means and said magnet, and adjustable stop means to be engaged by said coal feed regulating means whereby one of the limits of motion of said coal feed regulating means may be determined by said stop means, said clutch permitting the full oscillating movement of said magnet.

3. In a controlling unit for coal stokers, the combination of an electric driving motor with a power takeoff from said electric motor and a controlling unit for controlling coal feed adjustment, said controlling unit having a movably mounted electric control magnet adapted to oscillate between a maximum and a minimum coal feed adjustment, a member having a pair of thrust surfaces controlled by said magnet, means actuated by said power takeoff and selectively engageable with one or the other thrust surfaces of said member for moving said control magnet to either a maximum or minimum coal feed adjustment, depending upon the position of said magnet control member, and air feed regulating means controlled by the movement of said magnet.

4. In a stoker controlling system, the combination of a coal feeding member, with a coal feed motor, selective speed driving means interposed between said coal feeding member and the drive shaft of said motor, a coal feed adjustment member adapted to change the adjustment of said means to provide coal feeds of predetermined amount, a coal feed controlling unit having a pair of adjustable stops, an operating switch subject to conditions produced at a heater, and an electromagnet controlled by said operating switch, an armature for said electromagnet, said armature having an engaging part, an oscillating member driven by said motor, said part engaging one side of said oscillating member when the electromagnet is energized and engaging the other side of said oscillating member when the electromagnet is de-energized, said electromagnet and armature being movably mounted for movement by said oscillating member, and drive means between said electromagnet and said coal feed adjustment member for moving said coal feed adjustment member from one to the other of said stops to provide high or low coal feed.

5. In a stoker controlling system, the combination of a coal feed with a motor and variable speed means for driving said coal feed, a combustion air blower, and an air valve for controlling the amount of air supplied by said blower, said blower being driven by said motor, a coal and air feed control unit having two adjustable stops for coal feed and two adjustable stops for air feed, and a feed adjustment unit adapted to be driven by said motor to either of two positions of high or low feed determined by the adjustment of said coal and air feed stops.

6. In a controlling unit for coal stokers, the combination of an electric driving motor with a power takeoff from said electric motor and a controlling unit for controlling coal feed adjustment, said controlling unit having a movably mounted electric control magnet adapted to oscillate between a maximum and a minimum coal feed adjustment, a member having a pair of thrust surfaces controlled by said magnet, means actuated by said power takeoff and selectively engageable with one or the other thrust surfaces of said member for moving said control magnet to either a maximum or minimum coal feed adjustment, depending upon the position of said magnet control member, and air feed regulating means controlled by the movement of said magnet, a friction clutch interposed between said feed regulating means and said magnet, and an adjustable stop member located to be engaged by said air feed regulating means whereby one of the limits of the range of air feed may be determined by the location of said stop member, said clutch permitting said magnet to oscillate through its full range of movement.

7. In a controlling system for solid fuel burners, the combination of an electric drive motor with a speed reduction gear system having a mechanical power take-off on said gear system, coal feed and air feed means adapted to be driven by said motor, and having means for changing the rate of coal feed and the rate of air feed, said power takeoff being operatively connected to the coal feed and air feed adjusting means to move the coal feed or air feed to high or low positions, electromagnetically actuated connecting means between said power take-off and the coal feed and air feed means, and thermostatic means controlled responsive to the production of heat for controlling the energization of said electromagnetically actuated connecting means and the position of its connecting means in moving the coal feed or air feed to high or low position.

8. In a controlling system for solid fuel burners, the combination of an electric drive motor with a speed reduction gear system having a mechanical power take-off on said gear system, coal feed and air feed means adapted to be driven by said motor, and having means for changing the rate of coal feed and the rate of air feed, said power take-off being operatively connected to the coal feed and air feed adjusting means to move the coal feed or air feed to high or low positions, electromagnetically actuated connecting means between said power take-off and the coal feed

and air feed adjusting means, and thermostatic means controlled responsive to the production of heat for controlling the energization of said electromagnetically actuated connecting means in moving the coal feed or air feed to high or low position, and clutch means interposed between said coal feed and said power take-off, and an adjustable stop determining one of the limits of motion of the coal feed adjustment whereby the coal feed adjustment may be predetermined by locating said adjustable stop at one of its limits without affecting the operation of the power take-off, the clutch permitting slipping after the coal feed adjustment has engaged said stop.

9. In an air feed adjustment controlling unit for furnaces, the combination of a support, an electromagnet movably mounted on said support, air feed controlling means actuated by movement of said electromagnet for regulating the amount of air feed to the furnace, a driving motor, a power take-off from said driving motor having an oscillating member, an armature movably mounted with respect to said electromagnet, a part carried by said armature and having offset shoulders facing in opposite directions, to be engaged by said oscillating member to move the armature and electromagnet in one direction to regulate the air feed when the electromagnet is energized and to move the electromagnet and armature in the other direction when the electromagnet is de-energized.

10. In a fuel feed adjustment controlling unit for furnaces, the combination of a support, an electromagnet movable mounted on said support, a fuel feed controlling means actuated by the movement of said electromagnet for regulating the amount of fuel feed to the furnace, a driving motor, a power take-off from said driving motor having an oscillating member, an armature movably mounted with respect to said electromagnet, a part carried by said armature and having a pair of offset shoulders alternately engageable with the oscillating member upon energization or deenergization of the electromagnet, whereby the fuel feed controlling means may be moved in one direction or the other, depending upon the energization of the magnet.

11. In an air feed adjustment controlling unit for coal stokers, the combination of a driving motor with an air pressure-creating unit, throttling means for controlling the flow of air through said latter unit, an oscillating member driven by said driving motor, a controlling member for controlling the position of said throttling means, said controlling member comprising an air feed adjustment lever, a selective lever adapted to be engaged in one position by the oscillating member to be moved in one direction and in another position to be moved in the opposite direction for actuating the air feed adjustment lever, slipping clutch means operatively connected to said selective means and said air feed adjustment lever, and an adjustable stop for said air feed adjustment lever for determining one of its limits of motion whereby the movement of the air feed adjustment lever to one of its positions may be controlled by said stop, the clutch permitting slipping and permitting the oscillating member to continue its full range of movement after the air feed adjustment lever has engaged its said stop.

12. In a coal feed system for stokers, the combination of a support with a driving motor, coal feeding means for said stoker and operative connections between said driving motor and said coal feeding means, whereby said coal feeding means may be driven at higher or lower rates of feed, a coal feed adjustment lever actuated by said operative connections and adapted to regulate the rate of coal feeding by movement of said coal feed adjustment lever, an oscillating member, a power take-off from said driving motor for driving said oscillating member through a constant amplitude, a selective member mounted for oscillating movement and adapted to drive said coal feeding adjustment lever to high or low coal feed position, a slipping clutch operatively connected to said selective member and said coal feed adjustment lever, said selective member being adapted to be positioned to engage one side or the other of said oscillating member whereby said selective member is driven to high or low coal feed adjustment position through a constant amplitude while the coal feed adjustment lever may move only a predetermined amount, the clutch slipping after the coal feed adjustment lever reaches the limit of its amplitude.

13. In a coal feed system for stokers, the combination of a support with a driving motor, coal feeding means for said stoker and operative connections between said driving motor and said coal feeding means, whereby said coal feeding means may be driven at higher or lower rates of feed, a coal feed adjustment lever connected to said operative means and adapted to regulate the rate of coal feeding by movement of said coal feed adjustment lever, an oscillating member, a power take-off from said driving motor for driving said oscillating member through a constant amplitude, a selective member mounted for oscillating movement and adapted to drive said coal feeding adjustment lever to high or low coal feed position, a slipping clutch operatively connected to said selective member and said coal feed adjustment lever, said selective member being adapted to be positioned to engage one side or the other of said oscillating member whereby said selective member is driven to high or low coal feed adjustment position through a constant amplitude while the coal feed adjustment lever may move only a predetermined amount, the clutch slipping after the coal feed adjustment lever reaches the limit of its amplitude, and an adjustable stop member for engaging said coal feed adjustment lever and determining one of its limits of motion, whereby the amount of coal feed may be adjusted by merely adjusting said stop member.

14. In a stoker controlling system, the combination of a coal feeding member with a coal feed motor, selective speed driving means interposed between said coal feeding member and the drive shaft of said motor, a coal feed adjustment member adapted to change the adjustment of said means to provide coal feeds of predetermined amount, a coal feed controlling unit having a pair of adjustable stops, an operating switch subject to conditions produced at a heater, and an electromagnet controlled by said operating switch, said drive means comprising a friction clutch operatively connected to said movable electromagnet and said coal feed adjustment member, whereby the adjustment of the stops may be made independent of the amount of movement of the electromagnet, for moving said coal feed adjustment member from one to the other of said stops to provide high or low coal feed.

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