

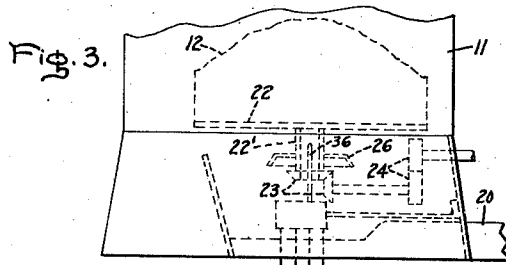
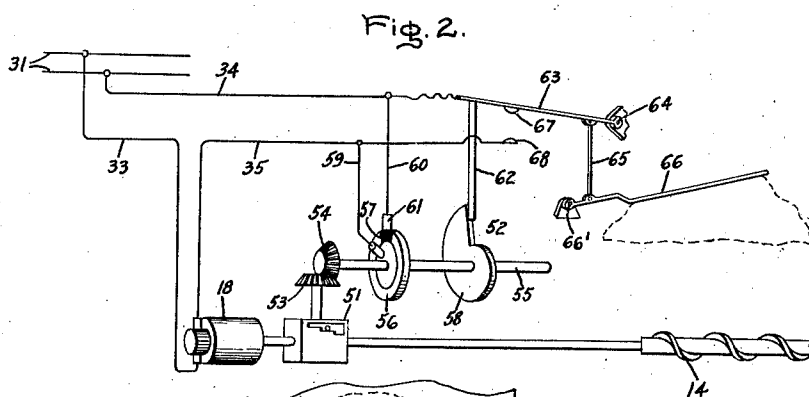
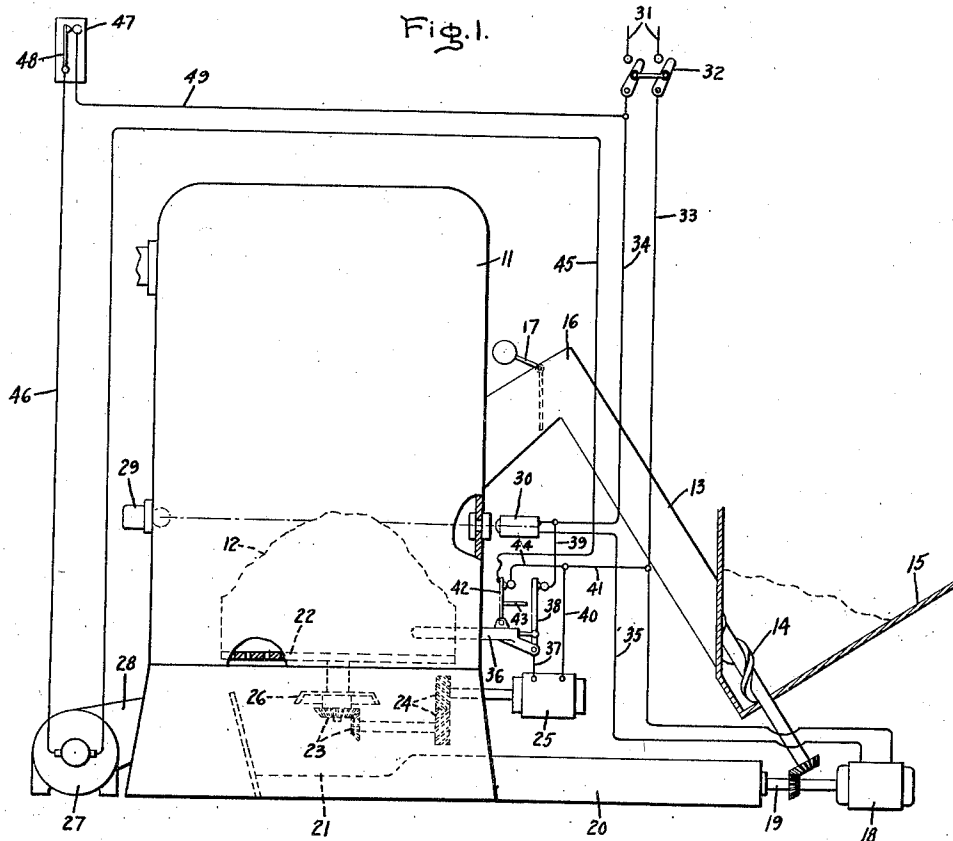
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FURNACE CONTROL SYSTEM

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FURNACE CONTROL SYSTEM

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1 Claim. (Cl. 110—101)

My invention relates to furnace control systems and more particularly to control of furnaces of the type utilizing solid fuel and a forced or induced draft.

5 The primary object of my invention is the provision of a new and improved furnace control having means for automatically feeding the fuel to maintain a predetermined fuel level above the furnace grate and eliminating ashes
10 to maintain a predetermined ash level above the furnace grate combined with an automatic control of the draft to obtain an even regulation of combustion and providing adequate protection against operating hazards.

15 In furnaces of the type mentioned difficulties have been experienced because of the fact that the grate bars are likely to be deleteriously affected or even melted when subjected to high temperatures occasioned by excessive lowering
20 of the ash level and an artificial draft and, accordingly, it is an object of my invention to provide means for preventing the occurrence of such extreme temperatures that would melt the grate.

25 In carrying out my invention I provide a device responsive to the level of fuel within the furnace to control the feeding of fuel thereto and a device responsive to the ashline or grate temperature for controlling the removal of ashes
30 from the grates of the combustion chamber. A second thermostat is placed in the room or space to which heat is supplied and it is arranged to control the operation of a draft producing motor in response to variations in room temperature.
35 The fuel level responsive device and ashline or grate thermostat thus maintain a constantly burning fire, under predetermined normal basic conditions of fuel level and ash level on the grates within the combustion chamber
40 and when additional heat is required the blower is energized to increase the intensity of the fire.

On the occurrence of high temperatures occasioned by lowering of the ash level, the ashline thermostat is adapted to stop removal of
45 ashes from the furnace. This usually is sufficient to reduce the temperature at the normal ash level to a nominal value but not under certain conditions, as when the fire is being started or when excessive demands are made on the
50 furnace. To safeguard the grate bars under these conditions I provide an additional switch in the blower motor circuit that is adapted to be opened by the ashline or grate thermostat
55 on the occurrence of temperatures at the nor-

mal ash level above a certain predetermined dangerous value.

Accordingly, it is an object of my invention to provide means controlled by the ashline thermostat of the furnace for controlling the removal
5 of ashes from the grates of the combustion chamber and preventing operation of the draft producing means when the ashline falls so low that the grate temperature becomes excessive.

My invention will be better understood from
10 the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claim. In the drawing, Fig. 1 discloses a schematic diagram of my improved
15 furnace control; Fig. 2 illustrates a modified form of a fuel level responsive device for controlling the feeding of fuel to the furnace; and Fig. 3 is a modification of Fig. 1 showing the
20 ashline or grate thermostat positioned to be responsive to the grate temperature.

In Fig. 1 of the drawing, I have illustrated my improved control system in connection with a furnace 11 that may be of any well-known
25 type. Since my invention is not restricted to any type of furnace, the latter has not been disclosed in detail but it will be obvious to those skilled in the art that any desirable furnace structure may be used. The furnace is provided
30 with the usual combustion chamber into which fuel is fed in a manner hereinafter to be described. The fuel is indicated by reference numeral 12 and is fed into the furnace through a
35 conduit 13 provided with a screw type conveyor 14. Fuel of the solid type is fed into the furnace from a hopper 15 from which it is carried
40 upwardly by the screw conveyor. The coal is conveyed to the apex 16 of the conduit and from there it falls into the combustion chamber past a pivoted fuel gate 17 arranged in the conduit.

The screw conveyor 14 is driven by any suitable motive means such as an electric motor 18. The motor is connected by means of rotatable
45 shaft 19 to a second screw conveyor 20, the function of which is to remove ashes from within an ash pit 21.

To support the ash bed and the superposed fuel bed within the combustion chamber there is provided a rotary grate 22 suitably mounted
50 within the furnace structure. The grate is rotated to remove ashes therefrom by a pair of pinion gears 23 driven through a second pair of gears 24, one of which is rotated by any suitable means such as an electric motor 25. Gears 23
55 may be protected from the hot ashes by a shield-

ing member 26 adapted to intercept any ashes that might fall upon them.

The combustion chamber is provided with an artificial draft by means of a blower driven by an electric motor 27, the blower being suitably connected to the combustion chamber through a conduit 28. My invention is applicable equally well to systems utilizing either a forced or induced draft, and so the apparatus illustrated may be considered as being either type.

Before describing the operation of the furnace a brief detailed description of the control will be given. The level of the fuel bed within the combustion chamber is maintained at a predetermined value by suitable control means comprising a light source 29 connected to a suitable source of alternating current supply and adapted to emit light of a frequency different from the frequency of light emanating from the combustion chamber. The light emitted from this source is adapted to effect the operation of a circuit controlling device 30 in the manner disclosed in Letters Patent No. 1,971,191 granted to Harold W. Lord and assigned to the assignee of the present application. The circuit controlling device consists of a photo-electric cell and a vacuum tube device, adapted to conduct during half cycles of the alternating current, determining the frequency of the light source and means, such as a shutter interposed between the two, permitting only light of the predetermined frequency to affect the photo-electric cell. When a steady light is thrown upon the photo-electric cell of the device 30 the device will not operate to close its associated circuit. It is sensitive only to light impulses which are synchronous with the alternating current and which have the proper phase relationship with respect to the half waves thereof. The control is so arranged that when the level of the fuel within the combustion chamber is high enough to intercept the beam of light as indicated in Fig. 1, the control device 30 will de-energize the feed motor 18 and when the fuel level is below the level indicated then motor 18 will be energized. Motor 18 is supplied with power from a suitable source 31 through a manually operated switch 32 and conductors 33, 34, and 35. While I have chosen to illustrate the above type of fuel level controlling device in Fig. 1, any other type may be used and an alternative control device is illustrated in Fig. 2. The device illustrated in the latter figure will be described later.

The ashes are removed from the grates of the combustion chamber by means controlled by an ashline or grate thermostat indicated at 36. In Fig. 3 I have illustrated the thermostat placed in a hollow grate bar driving shaft 22'. It is obvious that it may be positioned in either place because of the fact that under normal basic operating conditions the ashline temperature bears a certain ratio to the temperature of the grate bars. The thermostat may be made, in the customary manner, of materials having different coefficients of expansion and it is adapted to control the position of a movable contact member 38, moving the latter to the left on an increase in temperature and to the right on a decrease in temperature. The thermostat controls the energization of the grate operating motor 25 through a circuit consisting of conductor 37, contact member 38, and conductors 39, 40, and 41. It may be seen from the drawing that conductors 39 and 41 are connected directly across the power supply lines 33 and 34.

Associated with the ashline thermostat, as the thermostat 36 will be called hereafter, is a movable contact carrying member 42 adapted to be opened upon a predetermined movement of movable contact 38 when the latter engages a projection 43 affixed to the former. The stationary contact associated with movable contact carrying member 42 is connected to the one side of the source of power through an electrical conductor 44 and the previously mentioned conductor 41. Movable member 42 itself is connected to one terminal of the blower motor through an electrical conductor 45. The other terminal of the blower motor is connected to a room thermostat 47 comprising a thermal responsive element 48 and an associated fixed contact. The latter is connected to the other side of a source of power through an electrical connection 49.

A description of the operation of the arrangement just described will now be given. When it is desired to place the system into operation manual switch 32 is first closed to connect conductors 33 and 34 to the source of power 31. Whenever the fuel level within the combustion chamber falls below a predetermined level, the light from source 29 will render the control device 30 effective to energize feed motor 18 through a circuit which is as follows: conductor 33, motor 18, conductor 35, control device 30 in circuit closing position, and conductor 34. It will be noted that the arrangement is such that the feeding of coal is controlled only by the fuel level responsive device. Consequently, the level of fuel within the furnace will be maintained at a constant value under all operating conditions.

The removal of ashes is in turn controlled by the ashline thermostat 36 which controls the grate operating motor 25 to maintain a predetermined ash level within the combustion chamber. Thus, if the level of ashes rises and effects a reduction in temperature at the normal ashline, thermostat 36 will move to the right and actuate movable contact 38 into engagement with its associated stationary contact, as illustrated in Fig. 1, thereby energizing motor 25. The grate is rotated by the motor until the level of ashes within the combustion chamber falls to a point where the temperature at the normal ashline increases to such a value that thermostat 36 operates its movable contact 38 to the left a sufficient extent to disengage the contacts. Upon disengagement of the contacts the motor 25 is de-energized.

From the above it will be seen that I have provided means for maintaining a constant level of fuel within the combustion chamber as well as means for maintaining a constant level of ashes within the combustion chamber. This arrangement provides what may be termed a basic fuel bed and ash bed condition that is maintained when no heat is called for by the room thermostat. Whenever the thermostat within the room or space being heated does call for heat then the heating rate is increased by operation of the blower. On a call for heat by thermostat 47 blower motor 27 is energized from conductors 33 and 34 through a circuit which is as follows: conductors 41 and 44, movable contact carrying member 42 in the position indicated wherein it is in engagement with its associated fixed contact, conductor 45, motor 27, conductor 46, thermostatic element 48 in engagement with its stationary contact and conductor 49. In this manner a draft is created in the combustion

chamber and the heating effect of the fire is increased. During this period the fuel will be consumed with greater rapidity and, as a result, the fuel is fed into the furnace at an increased rate as determined by operation of the control means 29 and 30 and ashes will, therefore, be removed from the furnace more often as determined by the operation of the ashline thermostat 36.

The operation of the furnace and its control will ordinarily take place in the manner just described but under certain conditions the termination of operation of the grate operating motor is not enough to prevent the occurrence of temperatures sufficiently high to damage the grate bars. Such conditions occur under unusual conditions that may result when the fire is being started or in response to unusually heavy demands on the furnace.

Upon the occurrence of high temperatures at the normal ashline the ashline thermostat will first de-energize the grate operating motor. If the temperature at the normal ashline rises to a still higher value, movable contact member 38 will be moved further to the left and to engage projection 43 and effect disengagement of the contact carried by member 42 from its associated fixed contact to de-energize the blower motor. Thus, the latter cannot be operated again until the temperature at the normal ashline falls to a safe value.

It may be that under some conditions the temperature obtaining at the normal ashline within the combustion chamber is of such value that it would not be desirable to initiate operation of the blower. It will be seen from the drawing and above description that if an excessive ashline temperature obtains operation of the blower motor will be prevented. This results from the fact that under these conditions the motor energizing circuit will be broken by switch 42.

In Fig. 2 I have disclosed a modified form of control for obtaining intermittent feeding to the furnace to maintain a predetermined level of fuel in the combustion chamber. In this modification I have provided an electrical motor 18 adapted to drive the screw conveyor 14 through a change-speed device 51. Motor 18 is supplied with energy from the source 31 through electrical conductors 33, 34, and 35. The circuit between conductors 34 and 35 is adapted to be closed when the level of fuel within the combustion chamber falls below a predetermined value.

In this modification I have shown mechanical means, indicated generally at 52, for closing this circuit. The mechanical means 52 thus takes the place of the light source 29 and the light responsive circuit controlling device 30 illustrated in Fig. 1. Through the medium of the change-speed device 51 I drive a pinion gear 53 adapted in turn to drive a second pinion gear 54. The latter drives the shaft 55 to which are affixed a conducting circuit controller 56, provided with an insulated portion 57, and a cam 58. The conducting portion of the circuit controller is connected to conductor 35 through a conductor 59 and a second conductor 60 is connected to a contact brush 61 adapted to ride on the outer periphery of the circuit controller. The cam 58 co-operates with a cam follower 62 co-operating with a pivoted contact carrying arm 63, suitably pivoted at 64. The latter member is connected by

a rod 65 to a second pivoted lever 66 whose position is controlled part of the time by the level of the fuel within the furnace. The latter member is suitably pivoted as at 66'.

In operation, when the level of the fuel falls to a predetermined value arm 66 moves in a clockwise direction, causing movement of pivoted arm 63 in a counter-clockwise direction and engagement of contacts 67 and 68. Engagement of these contacts energizes motor 18 through a circuit that is as follows: conductor 33, motor 18, conductor 35, contacts 67 and 68 in their closed position, and conductor 34. Energization of motor 18 in turn effects rotation of screw 14 for feeding fuel to the furnace. Simultaneously, pinion 53 is rotated through the change-speed device 51, effecting in turn rotation of pinion 54 and shaft 55 in a clockwise direction. Rotation of shaft 55 effects rotation of circuit controller 56 and cam 58. Rotation of the circuit controller closes a shunt circuit across contacts 67 and 68 through conductors 59, 60, contact brush 61, and the conducting portion of circuit controller 56. Motor 18 thus is maintained energized until the circuit controller 56 is rotated to the position indicated in Fig. 2 wherein the circuit is broken by engagement of contact brush 61 with insulated portion 57. The rotation of shaft 55 through 360° also rotates cam 58 and moves the floating arm 66 counter-clockwise so that it will be out of contact with the coal during the feeding period.

The length of the feeding period may be adjusted so that motor 18 will operate through several cycles before the level of coal within the combustion chamber is raised sufficiently to prevent contacts 67 and 68 from engaging each other. This is accomplished by adjustment of the change-speed device 51 to vary the speed of rotation of gear 53. On the other hand, the rate of fuel feeding may be chosen so that it will be necessary to go through the above described cycle but once to raise the level of coal to the desired value.

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

The combination of a furnace having an operable grate supporting an ash bed and a superposed fuel bed in which the consumption of fuel results in variation in the relative height of the ash bed and fuel bed, means for operating the grate to decrease the height of said ash bed, means for supplying fuel to said furnace to increase the height of said fuel bed, means for supplying said furnace with combustion air to control the consumption of fuel, means responsive to the fuel level within said furnace for controlling said fuel feeding means, thermal responsive means located in the space heated by the furnace for selectively controlling the operation of said combustion air supply means in accordance with variations in the space temperature, and thermostatic means responsive to a temperature dependent upon the height of said ash bed above said grate for selectively controlling the operation of said grate operating means upon variation of said temperature between predetermined values and having a separately operable control means for preventing operation of said air supply means when said temperature exceeds a predetermined higher value.

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