Nov. 4, 1941. A. H. LOCKRAE 2,261,585

STOKER CONTROL SYSTEM

Filed Dec. 13, 1937 2 Sheets-Sheet 1

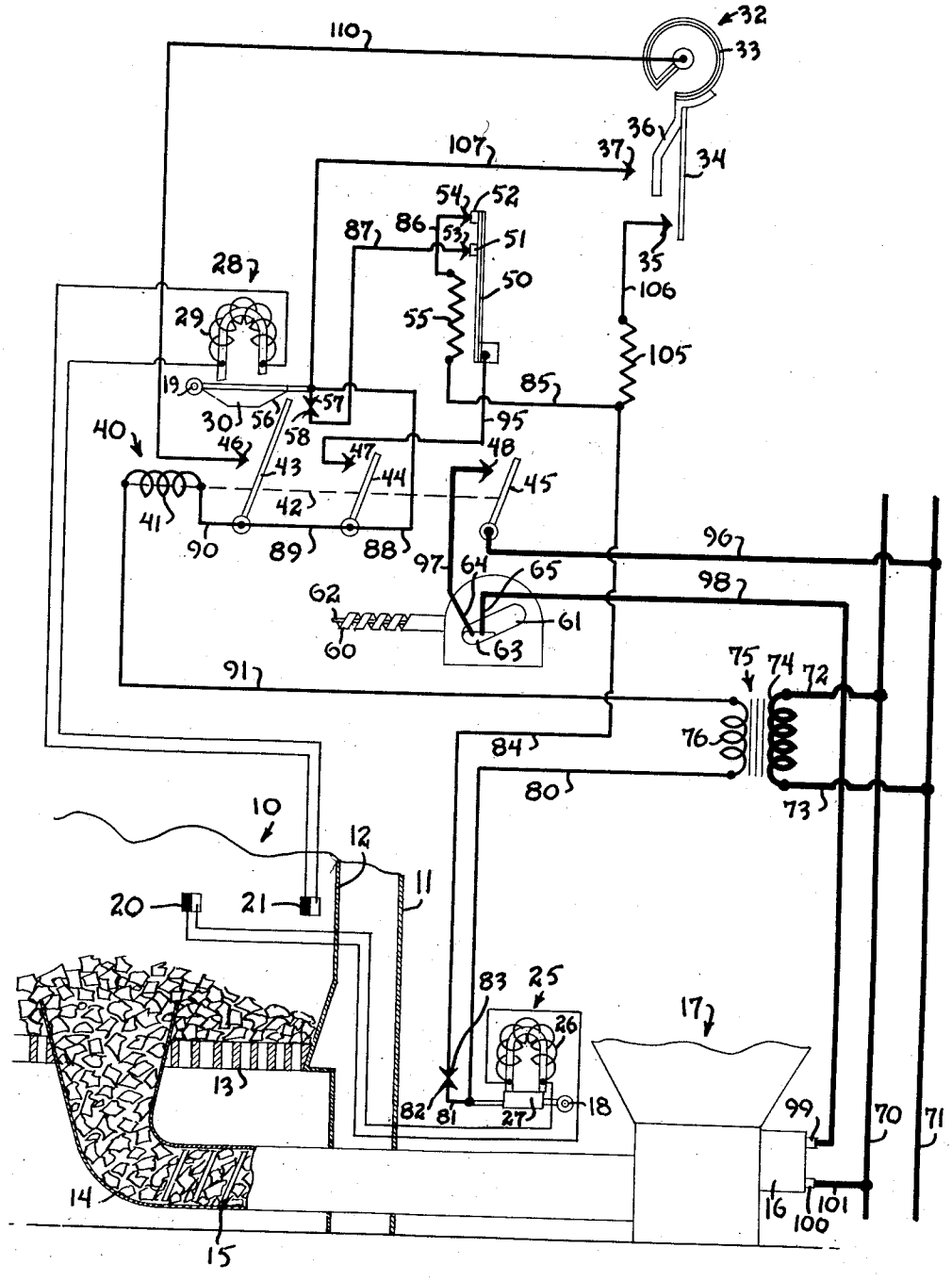


Fig. 1

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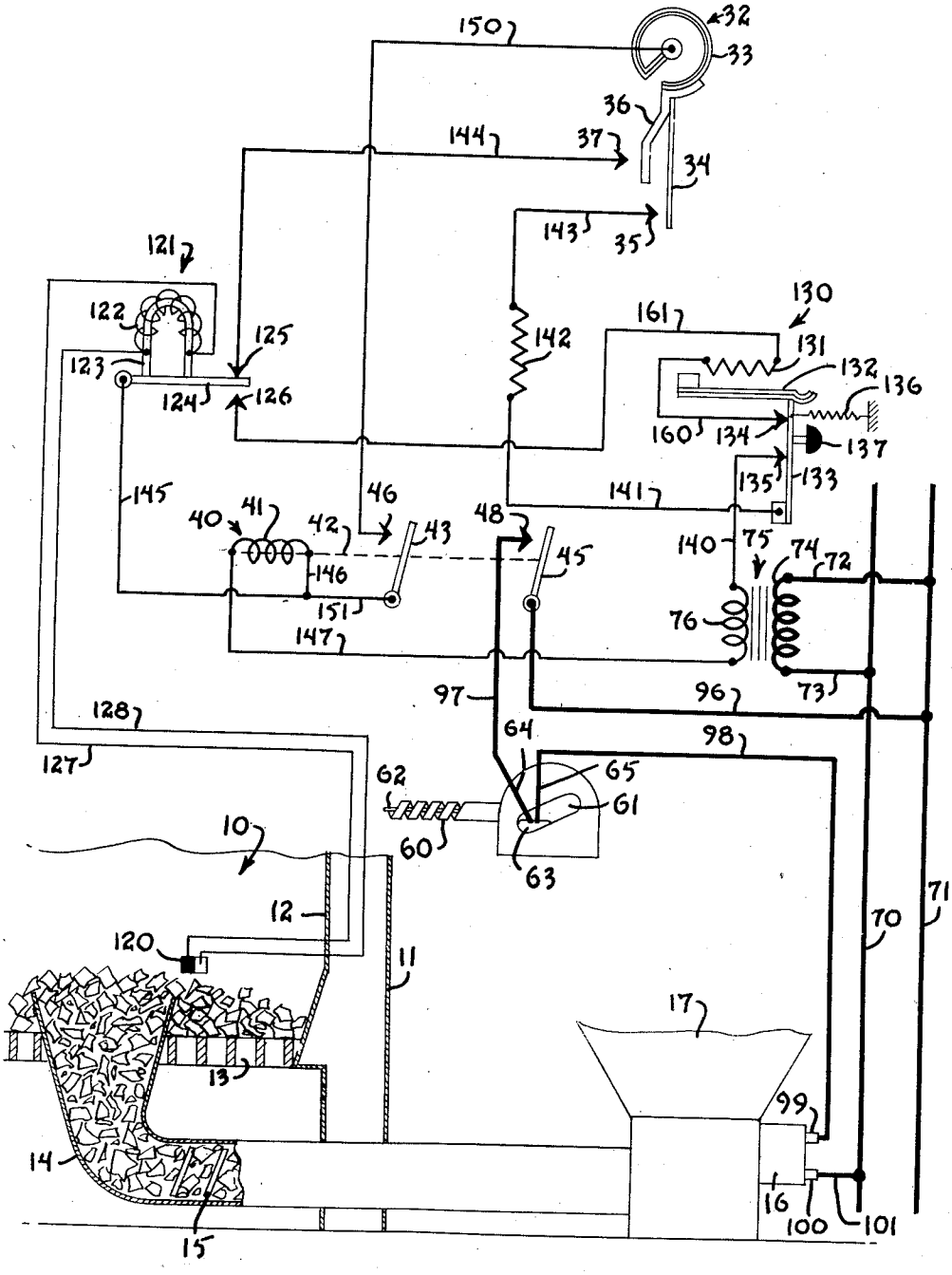


Fig. 2

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UNITED STATES PATENT OFFICE

2,261,585

STOKER CONTROL SYSTEM

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Application December 13, 1937, Serial No. 179,501

11 Claims. (Cl. 236—9)

This invention relates to a stoker control system, and more particularly to one wherein thermo-couples located within the furnace are in control of the stoker motor.

It is customary to control the operation of a stoker motor by a temperature responsive device located in a space to be heated, as well as by means responsive to conditions within the furnace. Were a stoker controlled only by a room thermostat, there would be times during the heating season in mild weather when the room thermostat would call for heat, and consequently cause operation of the stoker, only at infrequent intervals. If the stoker operated only in response to a demand for heat within the space, the combustion in the furnace might reach such a low point between operations of the stoker that the fire might burn out. For this reason it is customary to provide a device responsive to temperature conditions within the furnace, as for example, in the stack to cause operation of the stoker whenever the temperature in the furnace reaches such a low point that a need for the addition of more fuel to maintain the fire, is indicated. It is also customary to provide a second temperature responsive device which prevents operation of the stoker whenever the temperature within the furnace reaches such a low point that it indicates that the fire has burned out. This prevents operation of the stoker upon a call for heat in the space, when the fire has burned out for some reason or other, since obviously the stoker should not be operated when the fuel being supplied to the furnace will not be ignited.

A more accurate way to control the operation of the stoker is to provide a device responsive to conditions in the fire-bed instead of a device responsive to conditions elsewhere in the furnace and my invention is concerned with the use of such means. By the use of thermo-couples located in proximity to the fire-bed, one of which controls the stoker when fuel is necessary to support combustion and another which prevents operation of the stoker when the fire is so low that further combustion cannot take place even if additional fuel is supplied, the stoker may be very accurately controlled. These thermo-couples may energize relays which directly control the operation of the stoker motor and while these thermo-couples must supply sufficient energy to hold the relay armatures in, they need not supply enough energy to pull the armature in. I have therefore provided unique means to operate the relay which controls the operation of the stoker when the addition of fuel is necessary to support combustion and to cause operation of the stoker at these times for predetermined periods only, in a manner to be hereinafter set forth.

It is also possible to provide a single thermo-couple in combination with a thermal timer to control the stoker. This thermo-couple may be of a type which creates sufficient energy to pull the relay armature in as well as to hold the armature in. When combustion falls to such a point as to indicate a need for additional fuel, the relay armature drops out and causes operation of the stoker. If combustion does not then increase to such a point that the relay armature is pulled in under the influence of the thermo-couple within a predetermined period of time, it is an indication that combustion has dropped to such a point that the addition of further fuel will maintain combustion. The thermal timer may therefore be energized when the relay controlled by the thermo-couple is deenergized, and if the relay remains deenergized for a predetermined period of time, the thermal timer opens the circuit to the stoker, thereby preventing further operation thereof, the switch operated by the timer being of the manual reset type.

It is therefore an object of my invention to provide an improved stoker control system.

A further object of my invention is to provide an improved stoker control system wherein the operation of the stoker motor is controlled by one or more thermo-couples suitably located within the furnace.

More specifically, it is an object of my invention to provide a stoker control system wherein a first thermo-couple located within the furnace operates to cause operation of the stoker for a predetermined length of time whenever the temperature in the furnace drops to a point indicative of a condition wherein additional fuel must be supplied to support combustion, and to provide a second thermo-couple within the furnace which prevents operation of the stoker whenever the temperature of the furnace drops to a value so low that it indicates that the fire has substantially burned out and can no longer support combustion.

Another object is to provide a stoker control system wherein a thermo-couple is suitably located within a furnace for causing operation of the stoker whenever the temperature in the furnace drops to a point indicative of a condition wherein additional fuel must be supplied to support combustion, and wherein the stoker continues to operate until combustion increases to

a desired value, but should this value not be attained within a predetermined time, a manual reset switch opens the circuit to the stoker under the influence of a thermal timer, this time being so chosen that if combustion has not risen to the desired value within this period of time, it is an indication that the fire has dropped so low that it cannot support further combustion, and further operation of the stoker is impossible until the above mentioned switch has been manually reset.

A further object is to provide a novel control means for a relay, wherein a thermo-couple is provided to cause the energization of said relay, and other means are provided to move the relay and to hold the relay in energized position for a certain period, at the end of which period the relay will remain in its energized position if the temperature at which the hot junction of the thermo-couple is located has reached a sufficiently high value.

Other objects will become apparent upon a study of the specification and claims together with the appended drawings in which are illustrated two embodiments of my system and in which:

Figure 1 illustrates in diagrammatic form one embodiment of my invention, and

Figure 2 illustrates a second embodiment of my invention.

Referring more particularly to Figure 1, a section of a furnace indicated generally by the reference character **10** is illustrated. This furnace comprises an outer jacket **11** and an inner jacket **12**, a grate **13** for supporting the fuel to be burned, and a delivery pipe **14** for feeding fuel to the furnace and onto the grate. Within the pipe **14** is a feed screw **15** for feeding the fuel through the pipe and to the furnace, this feed screw being driven by means of a motor **16**. A hopper **17** is provided for holding the fuel to be fed to the furnace.

Within the furnace and preferably located in proximity to the fire-bed are a pair of thermo-couples **20** and **21**. While it is preferable that these thermo-couples be located near the fire-bed it will be understood that they may be located in any suitable part of the furnace wherein a change in temperature indicates a change in the condition of the fire. These thermo-couples each comprise two different kinds of metals having different thermal characteristics and joined together at one end, these junctions being termed the "hot" junctions and being located within the furnace.

Thermo-couple **20** controls the energization of a relay generally indicated by the reference character **25**, this relay including a winding **26** and an armature **27** pivoted at **18**. A second relay **28** including a coil **29** and an armature **30** pivoted at **19** is controlled by the thermo-couple **21**. As illustrated, thermo-couple **21** is located near the inside wall of the furnace or away from the hottest part of the fire so that when the temperature at this point drops to a certain predetermined value, the thermo-couple will cool down and cause operation of the stoker, as will be hereinafter described, to supply enough fuel to support proper combustion. Thermo-couple **20** is located near the entrance of the feed pipe **14** to the furnace or at a point where the fire is generally quite hot. The temperature at this point will not drop substantially until the fire is so low that it will not support combustion upon the supply of additional fuel. It should be understood that these thermo-couples, may, if desired, be located at the same point within the furnace and be so constructed that they will respond to different temperatures at said point to properly control the stoker motor **16**. These thermo-couples do not create sufficient energy to pull in armatures **27** and **30** when the hot junctions are heated up, but they do furnish sufficient energy when heated up to maintain armatures **27** and **30** pulled in if they have been moved to this position by some other means. Since relay **25**, as will be hereinafter explained, must be pulled in, in order to permit operation of the stoker, it will be apparent that upon starting the fire this relay must be held in by some external means until the fire has reached such a point that the thermo-couple **20** will hold it in. This means for holding the relay in at this time forms no part of my invention and is therefore not being illustrated.

Located in a space being heated is a thermostat generally indicated by the reference character **32**, this thermostat including a bimetallic element **33**, a flexible blade **34** cooperating with a fixed contact **35** and a relatively stiff blade **36** cooperating with a fixed contact **37**. Arm **34** is spaced closer to contact **35** than is arm **36** with relation to contact **37**. Upon a drop in temperature arm **34** first engages contact **35** and upon a further drop in temperature this arm will flex and permit the engagement of arm **36** with contact **37**. Upon a rise in temperature in the space, the arms will move out of engagement with their respective contacts in the reverse order.

Under the control of the thermostat **32** and also the relay **28** is a relay indicated generally by the reference character **40**. This relay includes a coil **41**, an armature **42**, arms **43**, **44**, and **45** cooperating with contacts **46**, **47**, and **48**, respectively. When said relay is deenergized the arms are in the positions illustrated, and upon energization of the relay, the arms move into engagement with their respective contacts.

Arm **43** is made long enough to engage the armature **30** of relay **28**, if this relay is in its deenergized position as illustrated. It will be noted that armature **30** includes an inclined surface **56** and when arm **43** moves into engagement with surface **56** it causes movement of the armature **30** into engagement with the core of the relay **28**. Contact **57** is operated by the armature **30**, and upon upward movement of said armature the contact **57** is moved out of engagement with the fixed contact **58**.

A bimetallic element **50** is provided for additionally controlling relay **40**, this element including contacts **51** and **52** which cooperate with fixed contacts **53** and **54**, respectively. In series with the contact **54** is a heater element **55**, the function of which will be later described.

Suitably mounted in the bonnet or other suitable portion of the furnace is a bimetallic element **60** which operates a mercury switch **61** by means of a rod **62** in a manner well known in the art. Switch **61** includes a mercury element **63** and contacts **64** and **65**. This switch is normally in the position illustrated wherein the contacts **64** and **65** are connected by the mercury element **63**, and upon attainment of excessive temperature in the bonnet of the furnace, the bimetallic element **60** causes the switch **61** to be tilted in the other direction thus breaking the circuit through the contacts **64** and **65**.

Line wires **70** and **71** are provided for energizing the motor **16**, these lines being connected

to a suitable source of power (not illustrated). Connected to the lines 70 and 71 by means of conductors 72 and 73, respectively, is a line voltage primary 74 of a step-down transformer 75. This transformer also includes a low voltage secondary 76 which functions to energize the various relays.

Operation of Figure 1

Assume that the fuel within the furnace 10 is in a state of combustion and is sufficiently hot so that the relay 25 is energized but is not hot enough to cause energization of relay 29 by the thermo-couple 21. This condition indicates that more fuel should be supplied to the furnace. Since relay 28 is in its deenergized position, contacts 57 and 58 are in engagement with one another and thereby cause the relay 41 to be energized through the following circuit: from one side of the secondary 76 of transformer 75 through conductors 80, 81, contacts 82 and 83, conductors 84 and 85 through the heating element 55, conductor 86, contacts 54, 52, the bimetallic element 50, contacts 51 and 53, conductor 87, contacts 58, 57, conductors 88, 89, 90, coil 41 of relay 40, and conductor 91 to the other side of secondary 76. Energization of coil 41 causes arms 43, 44, and 45 to move into engagement with contacts 46, 47, and 48, respectively. Movement of arm 43 into engagement with contact 46 causes armature 30 of relay 28 to move upwardly, thus opening contacts 57 and 58 and breaking the aforedescribed energizing circuit for the coil 41. Movement of arm 44 into engagement with contact 47 establishes a holding circuit for the relay 41, this circuit being through the heater 55 and bimetallic element 50 as follows: from the secondary 76 through conductors 80, 81, contacts 82 and 83, conductors 84, 85, heater 55, conductor 86, contacts 54, 52, bimetallic element 50, conductor 95, contact 47, arm 44, conductors 89, 90, relay coil 41 and conductor 91 to the other side of the secondary 76. It will therefore be apparent that as long as this holding circuit is established the relay 40 will remain energized. After a predetermined time interval however the heating element 55 will attain such a temperature that it will cause bimetallic element 50 to be flexed, thereby moving contact 52 out of engagement with contact 54 and breaking this holding circuit.

Movement of arm 45 of relay 40, upon energization of the same, into engagement with contact 48 causes a circuit to be established through the stoker motor 16 as follows: from the line 71 through conductor 96, arm 45, contact 48, conductor 97, contacts 64 and 65 of switch 61, conductor 98, terminal 99 of the motor 16 through the motor to terminal 100 and conductor 101 to the line 70. Fuel will now be fed to the furnace 10 through the pipe 14 as long as relay 40 remains energized. At the end of a certain period, the heater 55 will cause relay 40 to be deenergized as explained above, thus causing the arms to move back to their original positions and deenergizing the stoker motor 16. If the temperature of the furnace has reached such a point that thermo-couple 21 causes energization of the relay coil 29, armature 30 will remain in its raised position, thus maintaining contacts 57 and 58 in their open position. If the temperature of the furnace has not reached a sufficient value, armature 30 will return to the position illustrated, contacts 57 and 58 will reengage, and after the heating element has cooled sufficiently the contacts of bimetallic element 50 will engage their respective contacts 53 and 54 and the above described cycle will be repeated.

Assume now that the relay armature 30 is held in, but the temperature of the space being heated falls to a value which causes arms 34 and 36 to engage contacts 35 and 37, respectively. A circuit is now established through the relay coil 41 as follows: from the secondary 76 through conductors 80, 81, contacts 82, 83, conductor 84, resistance element 105, conductor 106, contact 35, blades 34 and 36 of thermostat 32, contact 37, conductors 107, 88, 89, 90, relay coil 41 and conductor 91 to the other side of the secondary 76. A circuit is now established through the relay 40 which is independent of the engagement of arm 36 with contact 37 so that said relay will not be deenergized until arm 34 has moved out of engagement with contact 35, thus providing proper operating differential for the system. This holding circuit is as follows: from the secondary 76 through conductors 80, 81, contacts 82 and 83, conductor 84, resistance element 105, conductor 106, contact 35, arm 34, bimetallic element 33, conductor 110, contact 46, arm 43, conductor 90, coil 41 and conductor 91 to the other side of secondary 76. It will be noted that as long as or as soon as the relay is energized a second holding circuit through the heating element 55 and bimetallic element 50, similar to that described above, is established through the relay coil 41. It would be undesirable to have this holding circuit remain established after the room thermostat is completely satisfied and for this reason the resistance 105 is provided in the circuit through the thermostat 32 so that sufficient current will pass through heater 55 during the existence of these parallel paths through the relay, so that the circuit through the heater 55 will be broken before the room thermostat is satisfied, thus assuring that the relay 40 will be deenergized as soon as the room thermostat 32 is satisfied.

Since the circuit through the stoker motor 16 is through the switch 61, it will be apparent that should the temperature in the bonnet of the furnace reach an excessive value before the room thermostat 32 is satisfied, this switch will cause the motor 16 to be deenergized and thus interrupt the supply of fuel to the furnace until the temperature therein drops to a safe value.

If for any reason the fire in the furnace 10 should get so low that combustion cannot be sustained any longer, even though more fuel be added, the hot joint of thermo-couple 20 will cool down sufficiently so that relay 25 becomes deenergized and armature 27 drops out, thus causing contact 82 which is actuated thereby to move out of engagement with contact 83. Since all the circuits through the relay 40 must pass through these contacts, the opening of the same will obviously cause the relay 40 to become deenergized, thus preventing operation of the stoker motor 16. In order to again put the system in operation a new fire must be started and relay 25 will be manually held in until the temperature in the furnace reaches a value high enough so that thermo-couple 20 will hold relay 25 in.

It will therefore be seen that with this system, operation of the stoker by the thermostat is supplemented by thermo-couples 20 and 21 controlling relays 25 and 28, respectively, so that the stoker will be operated whenever addition of more fuel to the furnace is necessary to sup-

port combustion and to prevent operation of the stoker motor whenever the fire in the furnace goes out. I am thus able to obtain the same results which have heretofore been automatically attained only by the use of more complicated and elaborate equipment.

Description of Figure 2

Referring now to Figure 2, a single thermo-couple 120 is provided in the furnace 10. This thermo-couple may be located at any suitable place in the furnace, as for example, near the entrance of feed pipe 14, or at a location near the fire-bed which is ordinarily hot if proper combustion is being supported, but should the fire-bed become cool at this point it indicates a need for the addition of further fuel. This thermo-couple controls the energization of a relay 121, this relay comprising a winding 122, a core 123, and an armature 124. Coil 122 is connected to the thermo-couple 120 by means of conductors 127 and 128. Armature 124 engages a contact 125 when the relay 121 is energized, but upon deenergization of the relay, the armature 124 drops into engagement with a contact 126. Thermo-couple 120 is of such a character that when the junction thereof is sufficiently hot, sufficient energy is created thereby to move the armature 121 into engagement with the core 123 and hold it in this position as long as the hot junction of the thermo-couple is at a sufficiently high temperature.

A manual reset thermal timer 130 is arranged to be heated when the relay 121 is deenergized as will be hereinafter set forth. This thermal timer includes a heater 131, a bimetallic element 132, a switch arm 133, and contacts 134 and 135 which are bridged by the arm 133 when in the position illustrated. Spring 136 biases the arm 133 in a direction to interrupt the flow of current through contacts 134 and 135. It will be apparent that as the heater 131 heats up, bimetallic element 132 is gradually moved upwardly, and after a predetermined time moves out of engagement with the arm 133, which arm is then moved by the spring 136 out of engagement with contacts 134 and 135. A handle 137 is provided for moving the arm 133 into engagement with contacts 134 and 135.

The operation of the stoker motor 16 is normally controlled by a room thermostat 32 which may be of the same type as that illustrated in Figure 1, said thermostat including bimetallic element 33, contact arms 34 and 36 cooperating with contacts 35 and 37, respectively, in the manner set forth in the description of Figure 1.

A relay 40, the energization of which causes operation of the stoker, is provided, this relay comprising a coil 41, an armature 42, and arms 43 and 45 cooperating with contacts 46 and 48 as in Figure 1.

A limit switch 61 similar to that shown in Figure 1 is provided for interrupting the circuit to the stoker motor upon the attainment of an excessive temperature within the furnace.

Operation of Figure 2

The operation of the system disclosed in Figure 2 is as follows: assuming the temperature within the fire-bed at the location of the thermo-couple 120 to be high enough so that the thermo-couple is furnishing sufficient energy to maintain the relay 121 in its energized position, this indicates that there is sufficient fuel within the furnace to properly support combustion. Should the temperature within the space being heated fall to such a value that contacts 35 and 37 are engaged by arms 34 and 36, relay 40 will be energized by the following circuit: from one side of the secondary 76 of transformer 75 through conductor 140, contact 135, arm 133 of the thermal timer 130, conductor 141, a resistance 142, conductor 143, contact 35, arms 34 and 36 of the thermostat 32, contact 37, conductor 144, contact 125 of relay 121, arm 124, conductors 145, 146 through relay coil 41 and conductor 147 to the other side of secondary 76. Arms 43 and 45 of relay 40 are now caused to move into engagement with contacts 46 and 48, respectively. Engagement of arm 43 with contact 46 creates a holding circuit for relay coil 41 which circuit is as follows: from one side of the secondary 76 of transformer 75 through conductor 140, contact 135, arm 133, conductor 141, resistance 142, conductor 143, contact 35, arm 34 of thermostat 32, bimetallic element 33, conductor 150, contact 46, arm 43, conductors 151, 146, coil 41 of relay 40 and conductor 147 to the other side of secondary 76. Relay 40 accordingly remains energized until arm 34 of thermostat 32 moves away from contact 35 since this holding circuit is independent of the engagement of arm 36 and contact 37.

Current now flows through the stoker motor 16 by the following circuit: from the line 71, conductor 96, arm 45, contact 48, conductor 97, contact 64, mercury element 63, contact 65, conductor 98 terminal 99 of motor 16 through the motor to terminal 100 and conductor 101 to the line 70. The stoker now starts operating and feeding coal to the furnace 10 until the temperature of the space being heated reaches a predetermined value whereupon the arm 34 moves away from contact 35 thus interrupting the operation of the stoker.

Should the fire get so low during a time that the room thermostat is not calling for heat that the supply of additional heat is necessary to support combustion, then relay 121 becomes deenergized by reason of the fact that the junction of thermo-couple 120 cools to a point where it does not furnish sufficient energy to the relay to hold it in energized position. Relay coil 31 will now be energized as follows, it being understood that arm 124 of the relay 121 is in engagement with contact 126: from secondary 76 of transformer 75 through conductor 140, contact 135, arm 133, contact 134, conductor 160, heater 131, conductor 161, contact 126, arm 124, conductors 145, 146, relay coil 41, and conductor 147 to the other side of secondary 76. Energization of relay 40 causes operation of stoker motor 16 as previously described. The flow of current through the heater 131 will cause the temperature of said heater to start rising and if the flow of current through this heater continues for a predetermined period, as for example twenty minutes, the bimetallic element 132 will be moved upwardly to release the arm 133 and interrupt the aforementioned energizing circuit for the relay 40. This condition will exist only when the fire has dropped to such a low point that combustion will not be sustained even with the addition of further fuel. The period of time it takes heater 131 to cause the release of arm 133 is so chosen that if there is proper combustion within the furnace, relay 121 will be energized by the thermo-couple 120 before said arm is released. If the addition of fuel to the furnace raises the temperature to a sufficient value,

thermo-couple 120 will cause the energization of relay 121 whereupon arm 124 moves out of engagement with contact 126 and back into engagement with contact 125, thus interrupting the circuit through the heater 131 and placing the stoker again under the control of thermostat 32. If, however, the fire does not come up sufficiently, the addition of further fuel will be ineffective to maintain the fire, and the release of arm 133 from engagement with contacts 134 and 135 by the heater 131 will interrupt the circuit to the relay 40 thus causing stoker motor 16 to stop. Since the circuit to relay 40 which is energized by the thermostat 32 is dependent upon the engagement of arm 133 with contact 135, it will be clear that when this arm moves away from contact 135, the operation of stoker motor 16 will be discontinued even though the thermostat 32 should later start calling for heat in the space. In order to start the system up again it will be necessary to manually move arm 133 back into engagement with contacts 134 and 135 which will be done by the attendant after a new fire has been built within the furnace 10.

If at the time that relay 121 is deenergized indicating the necessity for adding fuel to the fire, the room thermostat should also call for heat it will be noted that besides the energizing circuit for relay 40 which includes the heater 131 there is also a circuit through the previously described holding circuit through coil 41 which includes the thermostat 32. Resistance 142 is accordingly provided in this circuit so that the heater 131 may draw sufficient current to properly heat up within the predetermined time, this resistance corresponding to resistance 105 described in connection with Figure 1.

It will accordingly be seen that in this form of the invention, results similar to those obtained in the form shown in Figure 1 are produced with the use of a single thermo-couple and a single thermo-couple relay. The operation of the stoker is normally under the control of the thermostat 32, the operation of the stoker when additional fuel is required in the furnace during periods when the room thermostat is not calling for heat is controlled by the thermo-couple 120, and the shut-down of the system during such times that the fire is out or is too low to support combustion is controlled by the thermal timer 130. It will accordingly be seen that I have provided a very simple and effective system for controlling a stoker by the use of a minimum of parts and one which is relatively inexpensive to install.

Having described the preferred forms of my invention it will be apparent to those skilled in the art that it is capable of further modifications and I wish it to be understood that my invention is limited only by the scope of the appended claims.

I claim as my invention:

1. A control system for a motor operated stoker comprising a relay, a second relay, means responsive to energization of said second relay for energizing said motor, means responsive to deenergization of said first relay for causing the energization of said second relay, means responsive to energization of said second relay for causing said first relay to move to energized position and to stay in said position as long as said second relay is energized, a holding circuit for said second relay to hold the same energized for a predetermined period only after it has been energized in response to the deenergization of said first relay, and means responsive to the attainment of a predetermined condition for energizing said first relay.

2. In a system of the class described, a fuel burning apparatus, means for feeding fuel to said apparatus, control means for said feeding means including a first relay, a second relay, means responsive to energization of said second relay for causing operation of said feeding means, means responsive to deenergization of said first relay for causing energization of said second relay, means responsive to energization of said second relay for causing said first relay to be moved to energized position and to be maintained in said position as long as said second relay is energized, means creating a holding circuit for said second relay for a predetermined time only upon energization of the same, means responsive to the attainment of a high predetermined temperature in said apparatus for causing energization of said first relay, and additional means responsive to the attainment of a low predetermined temperature in a space to be heated for causing energization of said second relay independently of the first relay.

3. In a system of the class described, a thermo-couple including a hot junction subjected to varying degrees of temperature, a relay, means causing said relay to be energized by said hot junction upon the attainment of a predetermined high temperature to which said junction is subjected, said thermo-couple creating insufficient energy to pull the relay armature in but creating sufficient energy to hold the armature in after it has been pulled in, a second relay, means responsive to deenergization of said first relay to energize said second relay and means responsive to energization of said second relay to cause the first relay to be put in energized position.

4. In a system of the class described, a thermo-couple including a hot junction subjected to varying degrees of temperature, a relay, means causing said relay to be energized by said hot junction upon the attainment of a predetermined high temperature to which said junction is subjected, said thermo-couple creating insufficient energy to pull the relay armature in but creating sufficient energy to hold the armature in after it has been pulled in, a second relay, means responsive to deenergization of said first relay to energize said second relay, means responsive to energization of said second relay to cause the first relay to be put in energized position, and means for holding the second relay in energized position for a predetermined time after the first relay has been put in its energized position.

5. In a system of the class described, a first relay, a second relay, condition responsive means for causing the energization of the second relay, means responsive to the deenergization of the first relay for causing the energization of the second relay, a second condition responsive means in control of the first relay, and means operative when the second relay is energized in response to the deenergization of the first relay for causing the second relay to be deenergized after a predetermined time.

6. In a system of the class described, fuel burning apparatus, means for feeding fuel to said apparatus, a first relay, means responsive to energization of said relay for causing operation of said fuel feeding means, means responsive to the temperature of a space being heated for controlling the energization of said first relay, a second relay, means responsive to deenergization of said second relay for causing energization of said first

relay independently of said temperature responsive means, a thermo-couple adjacent the fuel burning apparatus in control of said second relay and arranged to maintain the second relay energized unless the temperature to which said thermocouple is subjected drops to a predetermined value whereupon the second relay becomes deenergized, timing means in control of the first relay when said relay is energized by reason of the deenergization of the second relay, means responsive to deenergization of said first relay for causing the energization of said timing means, and means operated by the timing means for causing said first relay to remain energized in response to deenergization of the second relay for a predetermined time only.

7. In a system of the class described in combination, a fuel burning device, control apparatus comprising a thermostat and relay means controlled thereby for controlling the fuel burning device, electromagnetic means cooperating with said relay means in controlling said fuel burning device, a thermo-couple responsive to heat of burning fuel controlling said electromagnetic means, said electromagnetic means being movable to energized position by said relay means, and timing means operable to begin a timing period upon said electromagnetic means being moved to energized position and said timing means governing said relay means in a manner such that after a predetermined period said electromagnetic means becomes dependent upon said thermocouple for remaining in energized position.

8. In a system of the class described in combination, a fuel burning device, a thermostat and a relay energizable thereby controlling said fuel burning device, an electromagnetic device including an armature and having contacts for controlling said relay, a thermo-couple responsive to heat of burning fuel for controlling said electromagnetic device, means whereby said relay is operable to move said armature into energized position of the electromagnetic device, timing means operable to start a timing period whenever said relay is operated in response to said electromagnetic device, and said electromagnetic device and timing means periodically operating said relay if the said armature is not retained in energized position of the electromagnetic device in response to the thermo-couple.

9. In a system of the class described, in combination, a fuel burning device, a thermostat and a relay energizable thereby controlling said fuel burning device, an electromagnetic device including an armature and having contacts causing energization of said relay when the electromagnetic device is energized, a thermo-couple responsive to heat of burning fuel for energizing said electromagnetic device, means whereby said relay is operable to move said armature into energized position of the electromagnetic device when the relay is energized, said relay becoming energized through said contacts when said electromagnetic means is deenergized, a timing device having contacts in the circuit energizing said relay when said electromagnetic device is deenergized, means forming a maintaining circuit for said relay independent of said first mentioned contacts, said timing device controlling said maintaining circuit and operable to interrupt it to deenergize said relay at a predetermined time after said relay has become energized in response to deenergization of said electromagnetic device, said contacts of said timing device remaining open for an interval of time during which said relay does not become reenergized even though said electromagnetic device is deenergized whereby said relay is periodically energized at spaced intervals during the time said electromagnetic device is deenergized.

10. In a solid fuel burning apparatus, means for feeding solid fuel, means responsive to the attainment of a predetermined low temperature in said apparatus for immediately starting said feeding means, and timing means for causing said feeding means to operate for a given period of time independently of said responsive means after having been started, whereby the feeding means are not started unless said low temperature is attained and are then operated for a period of given duration.

11. In a solid fuel burning apparatus, means for feeding solid fuel, means responsive to the attainment of a predetermined low temperature in said apparatus for immediately starting said feeding means, and timing means for causing said feeding means to operate for at least a given period of time after having once been started, said timing means being arranged to repeatedly operate said feeding means for said given periods of time so long as said temperature remains at said predetermined low value.

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