

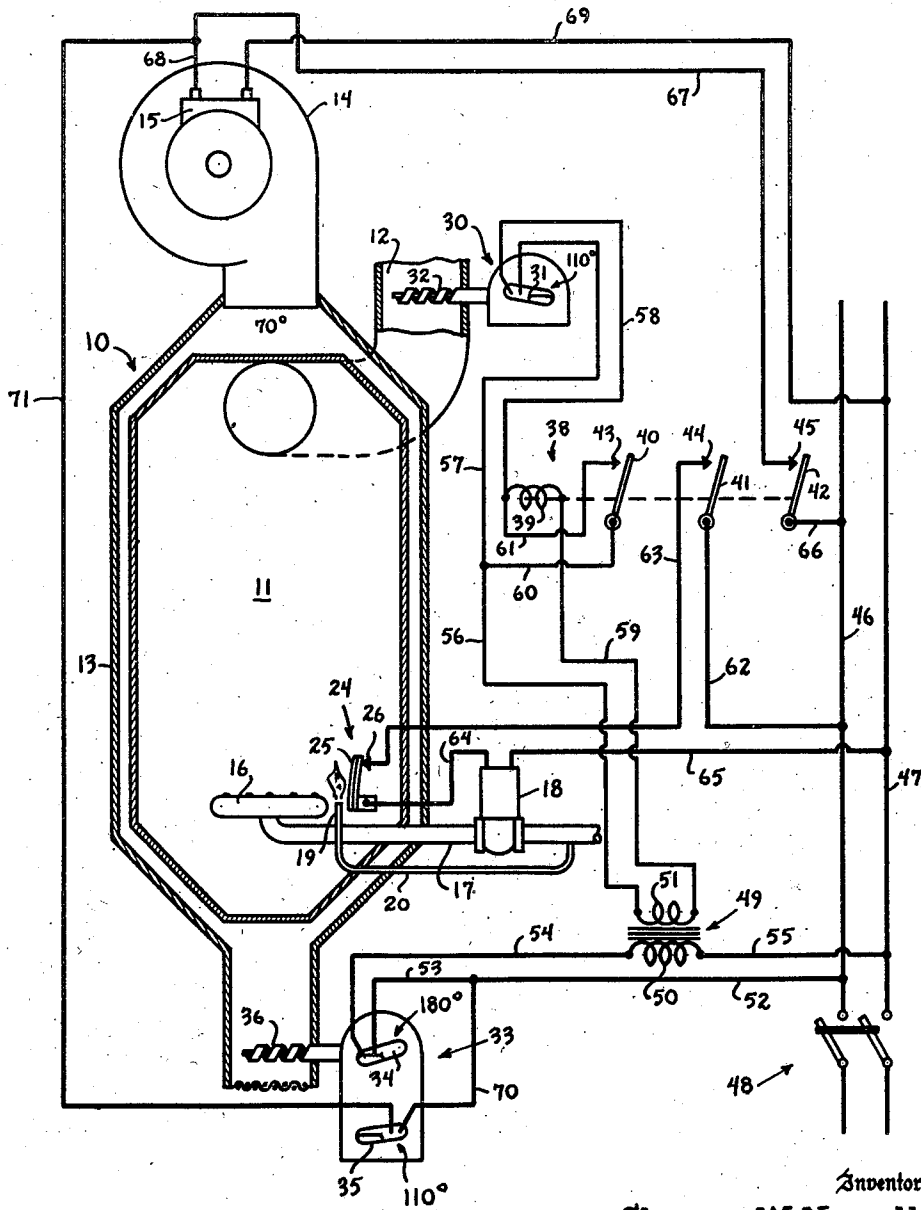
July 7, 1942.

C. W. NESSELL

2,289,206

UNIT HEATER

Filed Aug. 31, 1939



Inventor
Clarence W. Nessel

By George H Fisher
Attorney

UNITED STATES PATENT OFFICE

2,289,206

UNIT HEATER

Clarence W. Nessell, Minneapolis, Minn., assignor
to Minneapolis-Honeywell Regulator Company,
Minneapolis, Minn., a corporation of Delaware

Application August 31, 1939, Serial No. 292,903

10 Claims. (Cl. 236—11)

My invention relates to the automatic control of heating appliances commonly known in the art as unit heaters, and is especially concerned with the control of high capacity unit heaters wherein air is forced downwardly over the heating element. Heating units of this latter type are used more commonly in large industrial establishments and the like where there are large spaces to be heated, and in order to do so with a small compact unit, it must be a high capacity heater with a high rate of air flow over the unit. Usually the air is directed downwardly and a high air velocity is used to insure that the floor area is properly heated and that as wide a range as possible is covered.

The problem of controlling a unit of the type described is a more or less specialized one, there being various limitations to be met. Due to the high heating capacity of the unit, the air circulating means must be operated whenever heating is in progress to avoid damage to the unit from overheating. There is limited space for application of controls to the units and for efficiency there should be proper cycling operation, it being desirable that the unit cool off after each cycle before the next cycle is begun.

With my control arrangement, a cycle is started when the stack temperature indicates that the unit has cooled down suitably after the preceding cycle. An air circulating fan begins operating as soon as heating commences. Heating continues until the discharge temperature reaches a predetermined value at which a switch opens. There is normally a definite rise in temperature of the air as it passes through a unit of the type described, and the said switch is set to open at a temperature value equal to the desired space temperature plus the amount of the known rise through the unit. Heating will terminate therefore when the air going to the unit reaches the desired space temperature. I provide for continued fan operation after heating has been terminated until the unit cools down considerably.

An object of my invention is to provide improved control means for a heating unit wherein there is normally a definite rise in air temperature through the unit, the control means shutting down the unit when the discharge air temperature is at a value substantially equal to the desired temperature plus the amount of the rise through the unit.

Another object of the invention is to produce efficient cycling operation of a unit heater by

starting the unit from a temperature indicative that the unit has properly cooled down, and shutting down the unit in response to a discharge air temperature value indicative that the proper temperature of air being heated has been reached.

Another object is to prevent excessive temperatures in high capacity unit heaters by starting an air circulating fan at the same time that heating is started, and terminating heating from the temperature of air being heated.

Another object is to improve the efficiency and render the operation of unit heaters more satisfactory by means of novel control arrangements therefor.

Other objects will appear from the accompanying drawing and detailed specification.

The single figure of the drawing represents diagrammatically a unit heater with the control arrangement of my invention applied thereto.

The unit heater itself is designated by numeral 10 on the drawing. It comprises a combustion chamber 11 having a stack 12 and an air jacket or casing 13 enclosing the combustion chamber. The clearance between the air jacket and the combustion chamber is relatively small, this unit heater being one having a high capacity wherein there is a relatively high velocity of air there-through and consequently a relatively high rate of heat transfer between the combustion chamber and the air being heated. For forcing a circulation of air through the air jacket I provide a fan 14 which is driven by an electric motor 15, the fan drawing air from the space which is to be heated and discharging it into the casing 13.

In the lower part of the combustion chamber is a gas burner 16 to which gas is supplied through a conduit 17, there being an electric control valve 18 interposed in the conduit 17. Adjacent the burner 16 is a small pilot burner 19 to which gas is continually fed through a tube 20 communicating with the conduit 17 ahead of the valve 18. Numeral 24 designates a safety pilot of conventional type comprising a bimetal element 25 which is normally flexed into engagement with an electrical contact 26 by heat from the flame of the pilot burner 19. Whenever the flame of the pilot burner is extinguished the switch formed by the safety pilot opens.

For purposes of automatic control of the unit heater I provide a thermostatic stack switch 30. The switch 30 is of a known type comprising a mercury switch 31 actuable by a helical thermostatic element 32 disposed in the stack 12. The switch 31 closes when the temperature in the

stack falls to a value which may be for example 110° for this particular unit and opens when the stack temperature has risen to 150°. Another control device 33 is provided which comprises two mercury switches 34 and 35 both of which are actuable by a helical thermostatic element 36 disposed in the discharge duct of the air casing 13. The mercury switch 35 closes upon a rise in temperature in the discharge duct to 110° for example and serves to control the fan 14 as will presently be described. The mercury switch 34 normally acts to cut off the supply of gas to the burner, this switch opening at a temperature in the discharge duct of 180° for example, in this particular unit. Numeral 38 designates an electrical relay comprising a winding 39 cooperating with an armature arranged to actuate switch blades 40, 41, and 42, the switch blades moving to the left when the winding 39 is energized, into engagement with fixed electrical contacts 43, 44, and 45, respectively.

Power for the system is supplied by line conductors 46 and 47 there being a double pole single throw switch 48 controlling the power in the line conductors. Low voltage for operation of the relay 38 is provided by a transformer 49 which is of the step-down type having a primary winding 50 and secondary winding 51, the primary winding having a greater number of turns than the secondary winding.

Due to the high capacity of the unit heater 10, there normally being a high velocity of air flow therethrough during operation, it is necessary that the fan be operating whenever heating is in progress in order to prevent the temperature of the heater from rising to excessively high values. Even momentary stopping of the fan while heating is in progress would be apt to cause the temperature to rise to such a high value as to damage the heater. With this unit heater the air normally experiences a definite rise in temperature as it passes through the heater, the rise in this particular unit being 110°. In operation the unit is started from the switch 30, this switch closing at a temperature, as pointed out above, of 110°, for example, which indicates that the heat generated during the previous operating cycle has been substantially dissipated from the heater, the average temperature of the heater being around 90° when switch 30 closes. At the time that switch 30 closes, mercury switch 34 will be in closed position because at this time the air in the discharge duct has had an opportunity to fall to a value substantially below 180°. The primary of transformer 49 will therefore be energized through the following circuit: from line conductor 46, through a wire 52, wire 53, mercury switch 34, wire 54, primary winding 50, and wire 55 back to line conductor 47. Closure of mercury switch 31 will now complete a circuit energizing relay winding 39 as follows: from secondary winding 51 of transformer 49 through wire 56, wire 57, mercury switch 31, wire 58, winding 39, and wire 59 back to secondary winding 51. As soon as winding 39 is energized switch blades 40, 41 and 42 are moved into engagement with their respective fixed contacts. Closure of switch 40 completes a maintaining circuit for relay winding 39 so that the energization of this winding becomes independent of switch 30, the circuit being as follows: from secondary winding 51 through wire 56, wire 60, switch blade 40, fixed contact 43, wire 61, winding 39, and wire 59 back to secondary winding 51. Closure of

switch 41 completes a circuit for energizing and opening the valve 18 as follows: from line conductor 46 through wire 62, switch blade 41, fixed contact 44, wire 63, safety pilot 24, wire 64, valve 18, and wire 65 back to line conductor 47. As soon as valve 18 is opened heating commences and at the same time, by reason of closure of switch 42 a circuit is completed for energizing the fan motor 15 as follows: from line conductor 46 through a wire 66, switch blade 42, fixed contact 45, wire 67, wire 68, motor 15, and wire 69 back to line conductor 47. Heated air being discharged through the discharge duct of the casing 13 will cause the thermostatic element 36 to operate in a direction tending to close mercury switch 35, and at a temperature in the discharge duct of 110°, for example, for this particular unit, mercury switch 35 will close completing a circuit for the fan motor 15 which is independent of the relay 38, this circuit being as follows: from line conductor 46 through wire 52, wire 70, mercury switch 35, wire 71, wire 68, motor 15, and wire 69 back to line conductor 47. Heating will continue until the temperature in the discharge duct reaches 180° at which temperature mercury switch 34 will be opened. Switch 31 opens at a stack temperature of 150° for example. After switch 31 has opened relay 38 will remain energized through its holding circuit but after relay 38 is deenergized it cannot be reenergized until the stack temperature has fallen enough to close switch 31. When the temperature in the discharge duct is at this value the air in the spaces to be heated has reached the desired value. That is, for example, if it is desired that the space temperature be 70°, when the air at this temperature is being admitted or forced into the unit by fan 14 it will experience a rise of 110° in passing through the unit as pointed out above so that its temperature in the discharge duct will be 180°. When mercury switch 34 opens transformer 49 is deenergized thereby discontinuing the supply of power for relay 38 which causes deenergization of the relay. All of the circuits except the fan motor circuit controlled by mercury switch 35 are now interrupted. Heating will be discontinued as far as operation of burner 16 is concerned but the fan will continue in operation until the temperature in the discharge duct has fallen to approximately 110°, at which mercury switch 35 will open and fan operation will be terminated. In mentioning temperature values at which the various switches are operated it is to be understood that these switches have normal operating differentials as well understood in the art. When the stack temperature has again cooled down sufficiently to cause closure of mercury switch 31 the cycle will be repeated as above described. When it is desired to control the heater from the line switch 48 it will be seen that whenever the unit is cold as indicated by the mercury switch 31 being closed, and the line switch 48 is then closed heating will at once commence and fan operation will also begin. The operating cycle will then be as described above.

From the foregoing it should be apparent to those skilled in the art that I have devised a control arrangement and sequence particularly adapted to unit heaters, the arrangement having a number of outstanding advantages. My particular control system insures that the cycling operation will be efficient and with the arrangement a uniform temperature may be maintained

in a relatively large space by means of a small high capacity unit heater. The arrangement utilizes a simple combination of controls but produces a maximum in operating advantages in that the danger of overheating of the unit is precluded and the desired temperature is maintained without departing from desirably efficient cycling operation.

The single embodiment of my invention which I have disclosed is representative and the scope of the invention is not to be limited by my disclosure but only in accordance with the appended claims.

I claim as my invention:

1. In apparatus of the character described, for heating a fluid medium to a desired temperature, in combination, a fluid heating unit adapted to heat said fluid medium, means for circulating said fluid medium in heat exchange relation with said unit, said fluid medium undergoing a definite temperature rise in passing said unit, automatic means for initiating an operating cycle by accelerating heating at said unit, said automatic means starting said fluid circulating means at the same time that heating is accelerated, and control means including a device responsive to the temperature of fluid medium being discharged from said unit, said device controlling heating after initiation of an operating cycle, said device being arranged to decelerate heating at a first predetermined temperature value equal to the desired temperature of said medium plus the amount of the definite rise through the unit, and means responsive to heat generated at said unit for causing said fluid circulating means to continue in operation after heating is decelerated until the temperature of the fluid medium being discharged has dropped to a second temperature value.

2. In apparatus of the character described, in combination, a heating unit comprising a combustion chamber having a stack and fuel supplying means, means comprising a fan for circulating air in heat exchange relation with said unit, control apparatus comprising means responsive to the temperature of said stack and means responsive to the temperature of air being discharged from said unit, said control means being arranged to start the supply of fuel to said combustion chamber and the operation of said fan at a predetermined temperature of said stack, the supply of fuel continuing under control of said means responsive to discharge air temperature, and said last means causing termination of the fuel supply at a temperature value equal to the desired air temperature plus the amount of the rise in air temperature in passing the unit.

3. In apparatus of the character described in combination, an air heating unit, fuel supplying means for said unit, means for circulating air in heat exchange relation with the unit, automatic means effective only for starting a cycle of operation of said unit, and control means including a device responsive to temperature of the air heated by said unit, said control means being effective only to control operation of said unit after it has been started by said automatic means and being operable to terminate the supply of fuel by said fuel supplying means.

4. In apparatus of the character described, in combination, an air heating unit comprising a combustion chamber having a stack, means comprising a fan for circulating air in heat exchange relation with the combustion chamber, control means comprising a temperature responsive

stack switch and a relay controlled thereby, said relay controlling heating at said unit and operation of said fan, a switch responsive to temperature of air being discharged from said unit, electrical connections whereby said stack switch can energize said relay, energization of said relay initiating a cycle of operation of said unit, and electrical connections whereby upon energization of said relay a maintaining circuit therefor is established through said discharge air temperature responsive switch.

5. In apparatus of the character described, in combination, an air heating unit comprising a combustion chamber having a stack, means comprising a fan for circulating air in heat exchange relation with the combustion chamber, control means comprising a temperature responsive stack switch and a relay controlled thereby, said relay controlling heating at said unit and operation of said fan, a switch responsive to temperature of air being discharged from said unit, electrical connections whereby said stack switch can energize said relay, energization of said relay initiating a cycle of operation of said unit, electrical connections whereby upon energization of said relay a maintaining circuit therefor is established through said discharge air temperature responsive switch, and another switch responsive to discharge air temperature for controlling said fan independently of said relay.

6. In apparatus of the character described, in combination, an air heating unit comprising a combustion chamber, fuel supplying means associated with the combustion chamber and means for circulating air around the outside of said chamber so as to absorb heat generated therein, said unit being adapted for cycling operation and being of a type wherein there is a definite rise in air temperature passing therethrough, a single means for starting a cycle of operation of said unit, said last means being responsive to a temperature indicative that the unit has substantially dissipated heat generated during the preceding cycle, means responsive to temperature of air being discharged from said unit, and control means whereby after a cycle of operation of said unit has been started control is transferred to said discharge air temperature responsive means, said last means discontinuing heating when the discharge air temperature is at a predetermined value indicative that the air being admitted to the unit is at the desired temperature which temperature plus the amount of the rise through the unit equals said value.

7. In apparatus of the character described, in combination, an air heating unit comprising a combustion chamber having a stack, means for circulating air in heat exchange relation with the combustion chamber, control means comprising a temperature responsive stack switch for initiating operation of said heating unit, means responsive to temperature of air being discharged from said unit, and means whereby after operation of said unit has been initiated it continues in operation until said means responsive to temperature of discharge air is satisfied.

8. A system for maintaining the temperature of a space at a desired value, comprising in combination, a heater, means for circulating the air of said space in heat exchange relation with said heater, said heater and said circulating means cooperating under normal conditions to produce a definite temperature rise in the air circulating past said heater, and control means

for causing cycling operation of said heater including a single switch for initiating operation of said heater, said switch being responsive to a condition indicative of the temperature within said heater, and a switch for maintaining said heater in operation, and a device responsive to the temperature of the air being discharged from said heater for opening said maintaining switch when said discharge air temperature is substantially equal to said desired value plus said definite temperature rise.

9. A system for maintaining the temperature of a space at a desired value, comprising in combination, a heater, means for circulating the air of said space in heat exchange relation with said heater, said heater and said circulating means cooperating under normal conditions to produce a definite temperature rise in the air circulating past said heater, and control means for causing cycling operation of said heater, said control means comprising a single switch responsive to a condition indicative of the temperature within said heater for initiating operation of said heater and said circulating means, a first switch

responsive to the temperature of the air discharged from said heater for terminating operation of said heater when said discharge air is above a first predetermined temperature, and a second switch responsive to said discharge air temperature for terminating operation of said circulating means when said heater is not operating and said discharge air is below a second predetermined temperature.

10. An air heating unit comprising in combination, a heater, means for circulating air downward over said heater, means including a duct for discharging heated air from said heater in a downward direction, means for simultaneously initiating operation of said heater and said circulating means, a thermostatic device responsive to the air temperature in said duct, a first control means operated by said device for stopping operation of said heater at a predetermined temperature, and a second control means operated by said device for stopping operation of said circulating means at a second predetermined temperature after said heater has been stopped.

CLARENCE W. NESSELL,