

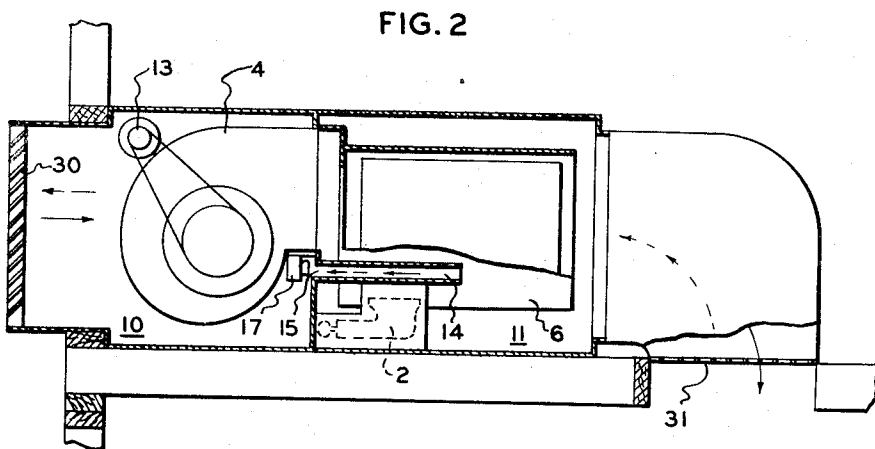
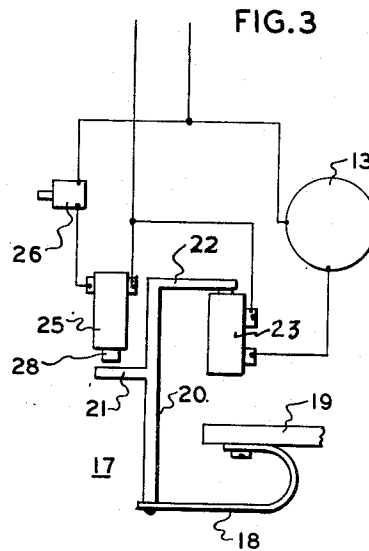
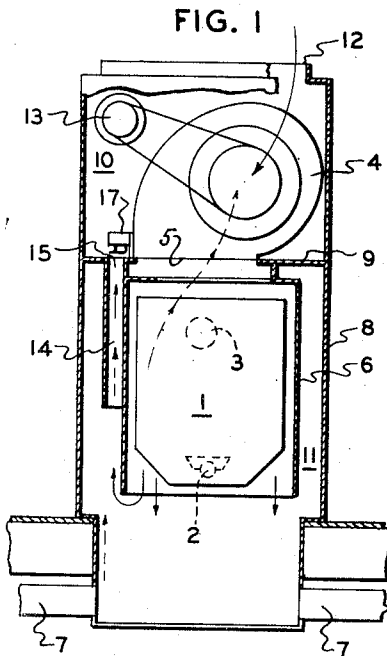
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DOWNFLOW FORCED AIR HEATING SYSTEMS

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DOWNFLOW FORCED AIR HEATING SYSTEMS

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3 Claims. (Cl. 236—11)

The present invention relates to downflow forced air heating systems or furnaces and is particularly concerned with control means for controlling the operation thereof.

In downflow furnaces and the like, the air to be heated is forced to flow over the heater in a direction which is the reverse of that which would be obtained by gravity circulation. For this reason the downflow furnaces involve control problems not present in the usual heating systems in which the forced circulation is in the same direction as the gravity circulation. For example in the case of the switch mechanism controlling the operation of the air circulating blower, the heat sensing element must be located so that it senses radiant heat from the heater before air circulation is established and must not be affected by the cold air from the blower after the forced circulation has once been established. The problem is further complicated when it is desired to incorporate in one control mechanism both the fan operating means and the limit control since the limit control must stop the burner when the discharge air temperatures become excessive. Since forced circulation in the downflow furnace is the reverse of gravity circulation, two limit controls are frequently employed to prevent excessive temperatures of fan motors, belts, bearings, heating elements and so forth. One of the limit controls is positioned to sense the temperature of the discharge air under forced air circulation while the second is positioned at a different point in the heating system for the purpose of sensing excessive temperatures in the gravity circulated air in the event the forced air circulation system fails for any reason.

Thus it is apparent that in the usual downflow furnace at least two air controls, that is, a combination fan and limit control plus a counterflow limit control, are required and in some cases a single fan control plus two limit controls might be necessary. Even when separate thermal elements are used for the fan control and the limit controls it is necessary or desirable that these various controls be interlocked either mechanically or electrically since otherwise the heating system may shut down due to the limit control operation before the fan control initiates operation of the blower.

Accordingly it is an object of the present invention to provide a downflow forced air furnace including control means operable by either forced or gravity air circulation.

A further object of the invention is to provide a single combination fan and limit control adapted to regulate the operation of the fan and heater independent of the direction of air travel through the heating system.

Further objects and advantages of the invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of the specification.

The term downflow as applied to furnaces and heating systems may be defined for the purposes of the present

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invention as covering heating appliances in which the forced air inlet or return opening is at an elevation higher than the forced air outlet or discharge opening under which conditions the normal or gravity circulation of air through the appliance is in a direction opposite to that effected by the blower or other forced air circulating means.

In accordance with the present invention there is provided a downflow forced air furnace including a heater and means including a blower or other air circulating means for circulating air over the heater and discharging the heater air into a duct system or space to be heated. To assure satisfactory operation of the furnace under either forced or gravity air circulation, there is provided an improved control means including a duct in heat exchange relationship with the air surrounding the heater with one end of the duct in communication with the inlet to the blower and the other end open to the heated air stream on the down stream side of the heater with reference to the direction of air travel under forced air circulation. In the path of the air flowing through the duct and above the heater there is positioned suitable furnace controls such as a combination fan and limit control in which position the controls are subjected to the heated air which passes over the heater under all conditions.

For a better understanding of the invention, reference may be had to the accompanying drawing in which:

Fig. 1 is a diagrammatic view partially in section of a vertical downflow forced air furnace;

Fig. 2 is a view of a horizontal type furnace operating on the downflow principle; and

Fig. 3 is a simple wiring diagram illustrating one means of applying the control system of the present invention.

In the modification of the invention shown in Fig. 1, the numeral 1 indicates a heater or combustion chamber including a fuel burner 2 which may for example be a gas burner or oil burner. The products of combustion from the combustion chamber 1 are removed through a stack 3. Air to be heated is circulated downwardly over the heater 1 by a blower 4 positioned above the heater. The blower 4 may have its outlet 5 connected to the inlet end of a shell 6 surrounding the heater 1, the purpose of the shell 6 being to confine and direct the air circulated by the blower 4 to the immediate vicinity of the heater. The air after being heated by the heater 1 is conducted downwardly to supply ducts 7.

The blower and heater are preferably enclosed in an outer casing 8 having a partition 9 dividing the casing into a blower compartment 10 and a heater compartment 11. The blower compartment 10 houses the blower 4 and the blower motor 13 and is provided with an opening 12 for admitting air to be heated to the inlet end of the blower 4.

In a furnace of this construction the normal or gravity flow circulation of air is upwardly through the furnace in the direction of the broken arrows, and out through the inlet of the blower, the blower compartment 10 and the opening 12 at the top of the blower compartment. On the other hand when the blower 4 is in operation the air flow is reverse and takes the direction of the solid arrows downwardly from the blower over the heater 1 and out of the bottom of the furnace into the duct system 7. Thus it is seen that any fan control of the temperature responsive type adapted to sense the temperature of the heater 1 must of necessity be so positioned that once it has sensed this temperature it must not again be affected by the cold air from the blower. Likewise limit control switches which sense excessive heater temperatures must be positioned to sense such excessive temperatures both under forced or gravity air circulation.

In the past safety requirements have necessitated at least two limit control switches in such furnaces, one responsive to the gravity air circulation and the other responsive to forced air circulation.

In accordance with the present invention there is provided control means requiring only a single limit control which is preferably also combined with the fan control. This control means comprises an open ended duct 14 in heat exchange relationship with the air surrounding the heater 1. This duct may for example be connected in thermal exchange relationship with the shell 6 if a shell is used. The duct 14 is shown as extending vertically with its upper open end 15 terminating in the blower compartment above the partition 9 and its lower end terminating at a suitable distance below the partition 9 in air flow relationship with the air stream which has been circulated over the heater by the blower 4. A combination fan control and limit control switch is positioned adjacent the upper or outlet end of the duct 14 above the heater and in the path of the air stream passing upwardly through the duct.

A suitable combination fan and limit control switch 17 as shown in Fig. 3 comprises a bimetallic element 18 having one end fixed to a support 19 and having at the other end a rod 20 provided with two arms 21 and 22. Arm 22 operates a switch 23 in the fan motor circuit, which switch is adapted to close the fan motor circuit when the thermal element 18 becomes sufficiently heated by radiation and hot air rising through the duct 14. Arm 21 operates a limit control switch 25 which is in a circuit controlling a solenoid operated fuel valve control 26 and is normally closed so that the fuel valve control solenoid holds the fuel valve in an open position. In case of excessive temperatures adjacent the heater 1, which temperatures are transmitted by radiation and by the upwardly moving air stream in ducts 14 to the thermal element 18, an arm 21 engages the operating button 28 of the limit control switch so that this switch is opened and the solenoid valve 26 closed to cut off the supply of fuel to the burner 2.

From the arrangement of the duct 14 it will become apparent that the thermal element 18 of the combination fan and limit control 17 is heated by gravity air circulation upwardly through the duct 14 as a result of radiant and convected heat from the heating element 1 before forced circulation is established by the operation of the blower 4. This initial heating will start the furnace blower and establish the forced circulation. As soon as the forced circulation has been established, heated air is also drawn upwardly through the control duct 14 due to the pressure differential that has been established across the barrier 9 separating the blower compartment 10 from the heating compartment 11. In other words with the blower 4 in operation, the pressures existing within the blower compartment 10 are somewhat lower than the pressures existing below the partition 9 and particularly below the heater 1 with the result that part of the heated air passing over the heater 1 is drawn into the lower end of the duct 14 and upwardly through the duct into contact with the thermal element 18.

Should the discharge air temperatures from the furnace become excessive, the thermal element will sense this excessive temperature and the limit control switch 25 will operate to shut down the burners. On the other hand, if the blower 4 fails to start for any reason as for example due to failure of the motor 13, the temperature of the thermal element continues to rise due to radiation and the gravity circulation of the heated air upwardly through the duct 14 which also will cause the limit control to operate shutting down the burner and preventing excessive temperatures in the blower compartment 10.

In certain applications of horizontal type furnaces, either gas or oil fired, a problem similar to that of the

downflow furnace also exists in regards to reverse air circulation from either forced or gravity flow. For example in the horizontal furnace shown in Fig. 2 the flow of forced air is in a direction opposite to that of the natural or gravity circulation as shown by the solid and broken arrows. In the structure shown in Fig. 2 equivalent elements have been given the same reference numerals since they perform the same functions. In fact the only differences between the horizontal furnace of Fig. 2 and the vertical furnace of Fig. 1 is in the relative horizontal positioning of the blower and heater.

The furnace of Fig. 2 when located for example in an attic may take outside air in through a grille 30 and under the operation of the blower 4 force the air over the heater 1 and downwardly through a duct or grille-work 31 in the ceiling of the home. Since this outlet is at a lower elevation than the inlet grille 30, the natural or gravity air circulation is upwardly from the grille 31 through the heater and blower and outwardly through the outside grille 30. The duct 14 is arranged in a relatively horizontal position with its outlet end 15 in communication with the blower compartment 10 and its inlet in communication with the heater compartment 11 so that under either forced or gravity circulation the air passes through the duct 14 into the blower compartment 10. Hence under either forced or gravity air circulation the control 17 operates in the same manner as the control 17 of Fig. 1.

Like the vertical furnaces of Fig. 1, the downflow horizontal furnaces of the type shown in Fig. 2 are subject to the problem of faulty operation of fan and limit controls due to the fact that the circulation of air by gravity through the furnace is opposite to that caused by forced circulation. By positioning the duct in the path of either air flow with its outlet end terminating in the blower compartment, a single fan and limit control switch will serve to control the operation of the furnace under either normal or abnormal conditions.

While the present invention has been described with reference to certain specific embodiments thereof, it will be understood that various modifications may be made by those skilled in the art without departing from the invention. The appended claims are therefore intended to cover all such modifications as come within the true spirit and scope of the invention.

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

1. A downflow forced air furnace including a heater, means including a blower for circulating return air over said heater in a direction opposite to the normal gravity flow of air over said heater and discharging the heated air into a space to be heated, a duct positioned in heat exchange relationship with the air surrounding said heater having an outlet end communicating with the inlet to said blower and the other end open to the air being discharged into the space to be heated so that air flow through said duct in the direction of the outlet end thereof is effected both by gravity circulation and by forced circulation during operation of said blower, and temperature responsive means for controlling the operation of said blower and said heater, said temperature responsive means being positioned adjacent the outlet end of said duct in the path of air flowing through said duct.

2. A downflow forced air furnace including a heater, means including a blower for circulating air downwardly over said heater and discharging the heated air into a space to be heated, a duct in heat exchange relationship with the air surrounding said heater having an upper outlet end communicating with the inlet to said blower and the lower end open to the air being discharged into the space to be heated, and temperature responsive means for controlling the operation of said blower and said heater, said temperature responsive means being positioned adjacent the outlet end of said duct in the path of the air stream flowing through said duct.

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3. A downflow forced air furnace including a heater, a shell having an air inlet end and an air outlet end surrounding and spaced from said heater, a blower compartment, a blower within said compartment having an inlet opening communicating with said compartment and a discharge opening communicating with one end of said shell and means for controlling the operation of said furnace in response to the temperature of the heater, said control means including a duct positioned in heat exchange relationship with the heater with one end of said duct terminating in said blower compartment and the other end in air flow relationship with the air outlet end of said shell so that air flow through said duct in the direction of the blower compartment end thereof is effected both by gravity circulation and by forced circulation during operation of said blower and temperature responsive switching means adjacent said one end of said duct in the path of air flowing through said duct.

4. A downflow forced air furnace comprising a heating compartment including a combustion chamber, a blower compartment, a blower within said compartment having an inlet opening communicating with said compartment and a discharge opening communicating with one end of said heating compartment to effect a flow of forced air through said heating compartment in a direction opposite to that effected by gravity circulation, and means for controlling the operation of said furnace in response to the temperature of the combustion chamber, said control means including a duct in heat exchange relationship with said combustion chamber with one end in air flow relationship with the discharge end of said heating compartment and the other end communicating with said blower compartment to discharge heated air into said blower compartment by both gravity and forced air circulation and temperature responsive switching means adjacent the lower compartment end of said duct in the path of air issuing from said duct.

5. A reverse flow heating system including a heater, means including a blower for forced circulation of air to be heated over said heater in a direction which is the reverse of the normal air flow over said heater due to gravity circulation, an air duct in heat exchange relationship with said heater, said duct having its outlet end communicating with the inlet end of said blower and its inlet end communicating with the heated air which has been circulated over said heater whereby heated air is discharged from its outlet end under both forced circulation and normal air flow conditions, and temperature responsive means responsive to the temperature of heated air passing through the outlet end of said duct for controlling the operation of said blower and said heater under either forced or gravity air circulation.

6. A reverse flow heating system including a heater,

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means including a blower for forced circulation of air to be heated over said heater in a direction which is the reverse of the normal air flow over said heater under gravity circulation, an air duct in heat exchange relationship with said heater and having its upper outlet end communicating with the inlet of said blower and its lower inlet end communicating with the heated air which has been circulated over said heater by said blower, and temperature responsive means in the path of air flowing through the outlet end of said duct for controlling the operation of said system under either forced or gravity air circulation.

7. A downflow forced air heating system including a heater, a vertical shell surrounding said heater having an air inlet at the top thereof and an air discharge opening at the bottom, a blower compartment above said shell, a blower in said compartment having its outlet connected to the inlet of said shell and its inlet within said compartment, a duct extending vertically in heat exchange relationship with the air within said shell and having its upper end terminating in said blower compartment in communication with said blower inlet and its lower end in communication with the shell discharge opening whereby heated air passes upwardly through said duct both by gravity circulation and by forced circulation during operation of said blower, and means responsive to the temperature of the heated air passing through the outlet end of said duct for controlling the operation of said blower and said heater.

8. A downflow forced air heating system including a heater, a vertical shell surrounding said heater having an air inlet at the top thereof and an air discharge opening at the bottom, a blower compartment above said shell, a blower in said compartment having its outlet connected to the inlet of said shell and its inlet within said compartment, a duct extending vertically along and in contact with said shell in heat exchange relationship with said heater and having its upper end terminating in said blower compartment in communication with the blower inlet and its lower end in communication with the shell discharge opening whereby heated air passes upwardly through said duct both by gravity circulation and by forced circulation during operation of said blower, and means positioned adjacent the blower end of said duct and responsive to the temperature of the air issuing from said blower end of said duct for controlling the operation of said blower and said heater.

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