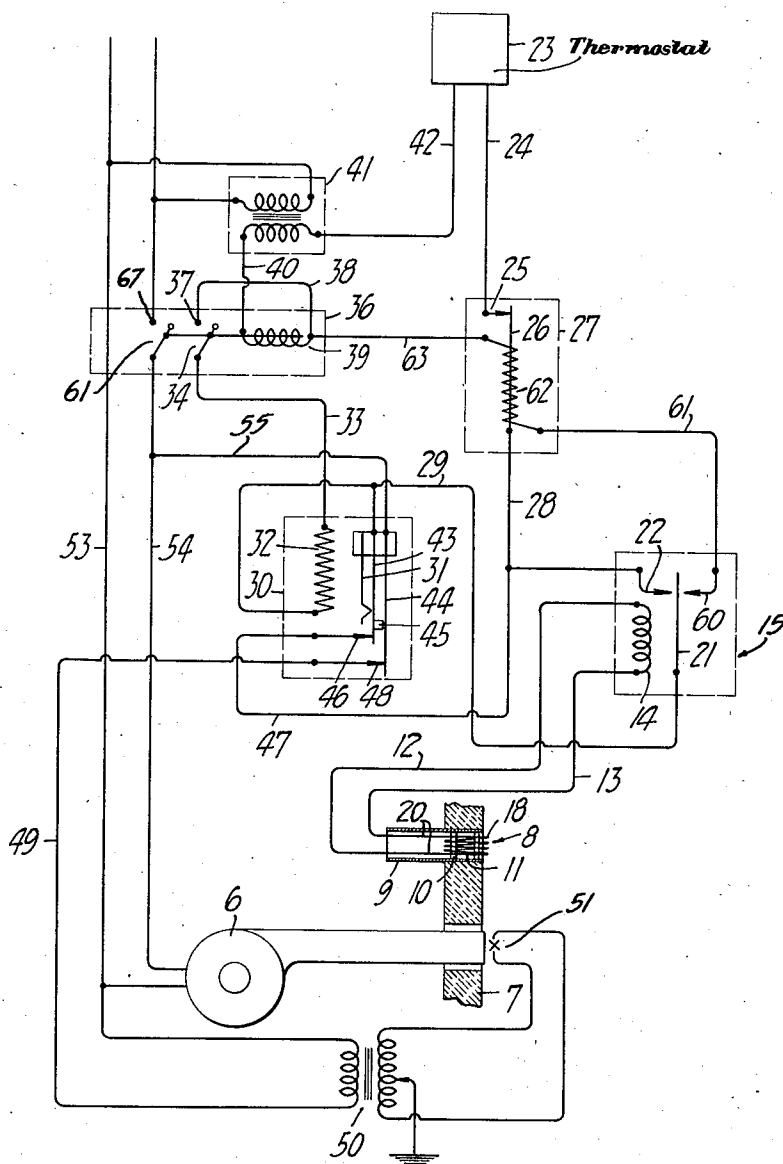




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## UNITED STATES PATENT OFFICE

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## CONTROL UNIT

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This invention relates to a control unit, particularly one useful in conjunction with a conditioning means giving off heat by conduction and convection and radiant heat. The invention is particularly concerned with the control and operation of an oil burner, and will therefore be particularly described in conjunction therewith.

It is in general the broad object of the present invention to provide a novel, simple and inexpensive control unit.

A further object of the invention is to provide an improved thermopile control for use in conjunction with a furnace and a relay.

The invention includes other objects and features of advantage, some of which, together with the foregoing, will appear hereinafter, wherein the present preferred form of control unit is disclosed.

Referring to the drawing, I have shown in the single diagrammatic figure an oil burner 6 as discharging into a fire box 7. Positioned above the burner so as to be out of the direct contact with the flame, is a thermopile structure indicated generally at 8. The thermopile I have found should be exposed to radiant heat from the burner on only one side thereof, while subject substantially equally throughout its extent to heating by conduction and convection. By observing this, the effective current generated is sufficient to operate a relay or other control unit.

This thermopile is made up of pipe 9 inserted through the wall 5 of the firebox and having a plurality of thermocouples 11 connected together in a cumulative relationship. It is to be noted that the thermopile is made up of a plurality of elements, usually dissimilar materials such as a heavy iron and constantan wire (0.0625 inch) threaded back and forth through opaque insulating washers 10 about four times with dissimilar ends joined. The elements constituting the several thermocouples are relatively short, so that they are subject to relatively the same degree of heat by conduction and convection throughout their length. A thermopile made up with a number of thermocouples suffices to generate sufficient current, I have found, to operate relay 15, and in the drawing I have shown wires 12 and 13 connected to relay coil 14 and to thermopile 8 at 20. Relay 15 is any one of the small low current snap action relays available commercially today. Of course, if the thermopile is made up of two rather large and heavy pieces of the dissimilar materials, this will suffice, and the invention is not limited to

any number, size or length of the elements of dissimilar materials so long as a sufficient current is generated thereby, and so long as the thermopile is subject throughout its extent to substantially the same degree of conduction and convection heat from the furnace. In the drawing the length of the thermopile has been exaggerated to enable a clear showing of its relation to the other elements. In practice, the elements of the thermopile are made about one inch in length.

When the burner is operating, the thermopile throughout its entirety will be subject to the same degree of heat by conduction and convection, but the exposed ends 18 of the thermopile will be subject to the radiant heat from the furnace, thus making the thermopile unequally thermally energized so that a current is generated. This makes the thermopile independent of the ambient furnace temperature and responsive only to burner operation. Thus the thermopile is equally effective upon burner operation even though the furnace temperature varies between 0° F. and 2000° F.

In the attached drawing I have shown the thermopile as utilized with a novel control circuit. Of course the thermopile can be used with other circuits, but the present circuit, being simple, accurate and quite responsive, utilizing a minimum of equipment, is one which I prefer.

The control circuit and the operation of the thermopile will probably be best understood by considering the actual operation. Let us assume that the burner 6 is not operating and that control device 23, such as a thermostat, calls for operation of the burner 6. Closing of the control device as thermostat 23 results in a circuit being closed through line 42 connected to the secondary of the transformer 41. Current then flows through line 40 and through relay coil 39 of relay 36, through line 63 and heating coil 62 of closed safety trip switch 27. The heating coil 62 is connected by line 61 to contact 60, which, when the furnace is cold, is engaged by arm 21 of the relay operated by thermopile 8. Arm 21 is connected by line 29 to arm 43 of control device 30. Arm 43 cooperates with a contact 46, which is in turn connected by line 47 to arm 26 of the closed safety trip switch 27. Arm 26 engages contact 25, this contact being connected by line 24 to the control device as thermostat 23. When current flows through the relay coil 39 of the relay 36, the contact arms 34 and 61 are moved into engagement with their respective con-

tacts 37 and 67, to complete other circuits presently disclosed.

If the relay does not operate, full current will continue to flow through the coil 62 which heats the bimetal arm 26 and causes it to move and disengage the contact 25, thus interrupting the primary control circuit.

When the contact 67 is engaged by the arm 61, a circuit through lines 53 and 54 to the oil burner motor is completed and the oil burner starts into operation. At the same time, a circuit through lines 53 and transformer primary 50 is completed so that a high tension current is furnished to spark gap 51 to ignite the burner. This circuit is completed through contact 48 and arm 44 connected by line 55 to line 54. We thus have the blower motor operating and a high tension spark being supplied so that the furnace is started into operation and heat is supplied thereto.

Engagement of relay arm 34 with contact 37 results in heating coil 62 being placed in parallel with heating coil 32 for bimetal arm 31, so that the rate of heating of heating coil 62 is reduced and the safety trip switch remains closed for a longer period than otherwise. Relay coil 39 is connected by line 40 to one side of the secondary of the transformer 41. The other side of the relay coil 39 is connected by line 38 to contact 37, while arm 34 is connected by line 33 to the heating coil 32 in the control device 30. Heating coil 32 is effective to heat the bimetal strip 31 and move contact arms 43 and 44, there being an intermediate insulating strip 45 between the two arms so that arm 43 can move arm 44.

The other end of the heating coil 32 is connected by line 29 to the relay arm 21 and thus to contact 60 and line 61, which extends to the heating coil 62, thus placing the two heating coils 62 and 32 in parallel. Heating of the coil 32 is effective to operate the bimetal strip 31 and move arms 43 and 44 so that the circuits they respectively control are opened. Thus the spark ignition of the burner is discontinued after a few minutes upon the opening of the circuit by arm 44 passing out of engagement with contact 48. This condition is of course maintained so long as arm 21 is in engagement with contact 60 because heaters 62 and 32 are in parallel. In this condition the burner motor 6 continues to operate, and heat is supplied to the furnace.

When the thermocouple structure indicated generally at 8 becomes heated by the radiant heat so that it generates sufficient current, relay coil 14 is energized and pulls arm 21 in a counterclockwise direction to engage contact 22, the arm 21 being preferably supported for a snap action. This results in cutting out the heating coil 62 and establishing a direct circuit through heating coil 32, maintaining the contact 34 in engagement with the contact 37 and the arm 61 in engagement with the contact 67. This is an indication of satisfactory operation. If the relay coil 14 is not energized, safety trip switch 27 remains in control and thermostat or control device 23 does not come into sole control. The burner 6 continues to operate so long as control device 23 determines. When it opens the circuit the burner 6 stops.

The control circuit quickly reconditions itself,

coil 32 cooling off to permit arms 43 and 44 to engage contacts 46 and 48. The thermopile ceases to generate current as soon as the radiant heat from the flame from the burner 6 ceases, and this is so even though the furnace including the wall and pipe 9 are very hot since this heat affects the thermopile equally. It is a feature of this invention that the thermopile is so placed that it is responsive very quickly to the burner operation while it is out of the direct flame; it is exposed to the fire but is not in it.

With the thermopile positioned in accordance with this invention, residual heat does not affect the effective available current since what causes heat generation by a thermopile is the difference in heat between the metal junctions. Thus, the thermopile will not generate any substantial current even though it be at a high temperature (say 400° F.) so long as it is uniform, but subject ends 18 to a temperature of 1800° F. and the remainder of the pile to a temperature of only say 550° F. and the pile generates sufficient current to operate relay 15. The term "ambient temperature" refers to the varying space temperature of the furnace and to the varying temperature of the furnace walls to which the thermocouple unit is subject as a whole substantially uniformly at all times. Thus, when the burner is not working, the space furnace temperature and the wall temperature drops, approaching atmospheric. When the burner operates, the space furnace temperature and the wall temperature, the fundamental temperatures affecting the entire thermocouple unit as a whole can vary between wide limits. However, because of the arrangement of the thermocouple in accordance with this invention, this ambient temperature does not cause current generation.

I claim:

1. In combination, a furnace wall, a burner for said furnace, and control means for controlling said burner including a thermocouple unit including a conduit in the furnace wall and open at least at that end in the furnace, a plurality of perforated walls in said conduit, a thermocouple including a hot and a cold junction provided by members passed through said walls with the hot junction at the open end of the conduit and exposed to radiant heat from a burner flame.

2. A thermopile comprising a tubular member, a pair of spaced opaque members supported in said tubular member, transversely thereof, and a plurality of thermocouples threaded between said pair of members with opposite ends thereof extending toward the ends of said tubular member.

3. In combination, a furnace having walls defining a fire space, a fuel burner for burning a fuel and providing a fire in said space, control means for controlling said burner including a thermocouple unit having a hot and a cold junction, and means positioning said unit in said furnace with said junctions subject to a substantially equal extent to heat by conduction and convection from said fire space and by conduction, convection and radiation by said walls and with only the hot junction exposed to radiant heat from the burner flame but not to direct heat by said flame.

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