

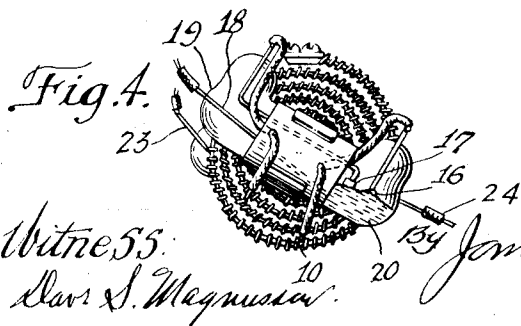
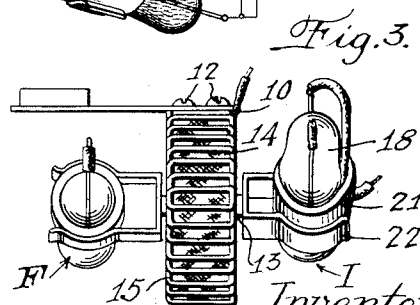
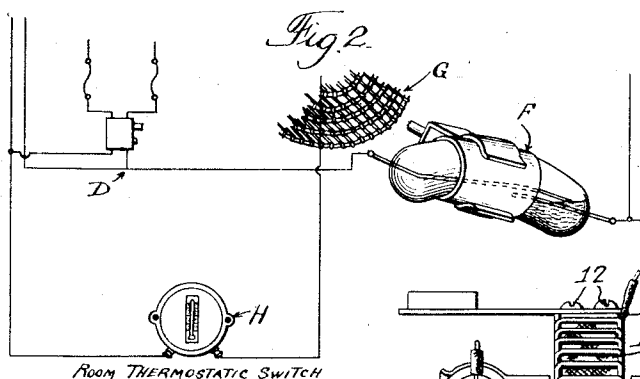
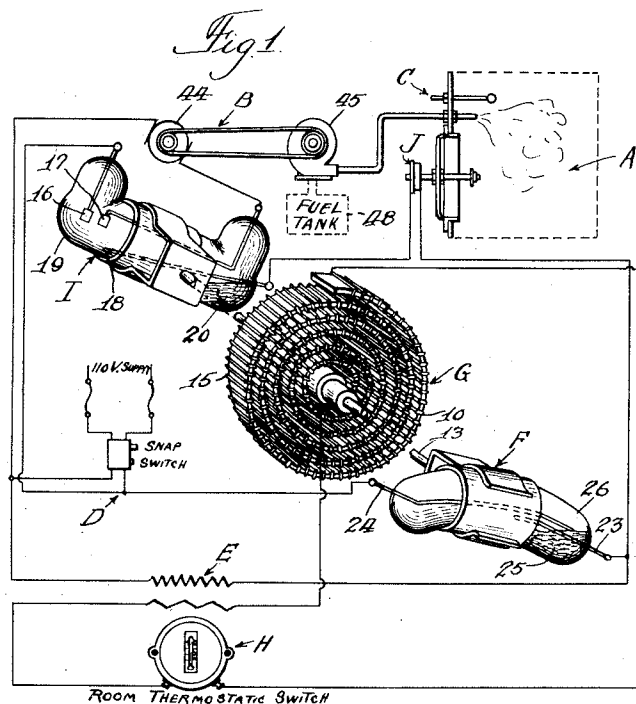
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L. A. M. PHELAN ET AL

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THERMALLY OPERATED CIRCUIT BREAKER

Original Filed Jan. 29, 1923



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UNITED STATES PATENT OFFICE

LOUIS A. M. PHELAN, OF ELKHART, INDIANA, AND CLIFFORD HOTCHKISS, OF MILWAUKEE, WISCONSIN, ASSIGNORS, BY MESNE ASSIGNMENTS, TO TIME-O-STAT CONTROLS COMPANY, OF ELKHART, INDIANA, A CORPORATION OF MARYLAND

THERMALLY-OPERATED CIRCUIT BREAKER

Original application filed January 29, 1923, Serial No. 615,530. Divided and this application filed December 5, 1927. Serial No. 237,637.

This invention relates to temperature control apparatus and more particularly to apparatus and devices used for controlling or regulating temperature by means of controlling the amount of combustion that takes place in a furnace using oil or other fluid as a fuel.

It is common practice to introduce into the fire boxes of furnaces a spray of oil or other liquid fuel by means of a nozzle and a conduit connected to a suitable source of supply which is maintained under pressure by a pump, preferably an electric motor operated pump.

One object of this invention is to provide a system for automatically regulating and controlling the operation of an electric motor operated pump when used in connection with the above indicated type of oil burning apparatus.

In former attempts to provide a regulating system of the above character, it has been the usual practice to make use of electromagnetic or motor operated relays. The use of such relays is undesirable in many cases because of their complicated structure, and because of the widely varying frictional losses occurring at their various mechanical bearings. Such types of relays moreover are usually fitted with commutators or contacting parts which are exposed to the atmosphere and are consequently very unreliable in operation since these contacting parts very readily become oxidized and contaminated.

A more particular object of this invention therefore is to provide an automatic system for regulating combustion which eliminates the use of magnetic and motor operated relays and which also eliminates the use of all exposed contacts.

A further object of this invention is to provide a reliable thermal relay capable of use in the above indicated type of control system.

Another object of this invention is to provide an improved circuit breaker comprising a heat sensitive member which, when adequately heated by the passage of an electric current through an electrical heating element disposed in thermal relation thereto, is actu-

ated to operate a liquid contactor, such as a mercury electric contactor. In one of its forms, the circuit breaker of this instant invention comprises a tiltable mercury contactor which, in one position causes the mercury to establish an electric circuit between the spaced electrodes of the contactor. This circuit includes the electrical heating element which influences the heat sensitive member which serves, when thus heated, to tilt the mercury contactor.

In certain types of oil burning systems as constructed at the present time, no provision is made for stopping the flow of the fluid fuel in case the intended ignition and combustion for any reason do not take place in the fire box. Consequently, it is possible for a great excess of combustible material to accumulate in the fire-box unless the system is very carefully and constantly attended. This may at times result in a serious fire hazard, as for instance, in case a gas pilot flame is used in the furnace for ignition purposes. If the pilot flame for any reason is accidentally extinguished and later the oil pump is started in operation, the fire box will become flooded with fuel.

Hence, another particular object of this invention is the provision of a device capable of use in the above indicated type of control system for positively stopping the operation of the fuel pump when ignition and combustion of the fuel do not actually take place.

A further object of our invention is to provide a system and apparatus of the above described character, which are comparatively simple in construction and easy to install and which do not readily get out of order.

Further objects and advantages of the invention will appear upon reference to the following specification and appended claims, taken together with the drawings, in which—

Figure 1 is a diagrammatic view of the system comprising the invention as used in connection with a heating furnace and also showing in a perspective view certain devices used in connection with the system;

Fig. 2 is a diagrammatic view showing a portion of the system in a manner similar to the showing in Fig. 1, but showing the system

connected without the use of a transformer;

Fig. 3 is an elevation view of the thermostatic relay device, which is shown in perspective in Fig. 1; and

Fig. 4 is an end view of the device shown in Fig. 5.

The system as shown in Fig. 1, and its operation, will first be outlined in a general way before proceeding with a more detailed description of its parts and operation.

Some of the elements of the system as used in connection with the control of the combustion fuel oil in an ordinary type of domestic heating equipment include a fire box or combustion chamber —A—, in which a spray of oil supplied by an oil pumping equipment —B— is burned upon being ignited by a gas or other pilot light —C—. The oil pumping equipment —B— is preferably electrically driven from a source of power —D—, such for example, as the ordinary 110 volt lighting mains which are initially connected to the primary winding of a step-down transformer —E— through a switch —F—.

From the secondary winding of the transformer —E—, power is furnished to a circuit including a winding on a thermostatic relay element —G— and a room thermostatic switch —H—. Providing the room thermostat switch —H— is closed, the current through this circuit will at first cause heating in the thermostatic relay element —G— which will in a short time serve to rotate the switch —F— into an open circuit position and also at the same time serve to rotate a switch —I— into a closed circuit position. The switch —I— will then serve to connect the motor of the pumping equipment —B— directly in series with the power supply at —D— and thus the pump will be put into operation.

The switch —F— now being in open circuit position, current through the primary of the transformer —E— must be supplied through another circuit if the thermostatic relay element —G— is to remain heated sufficiently to hold the switch —I— in its closed circuit position, as required for the continued operation of the fuel pump. In order to serve this purpose and also to provide a safety device another thermostatic switch —J— is mounted at the combustion chamber —A— and is arranged to maintain a closed circuit condition only while combustion is actually taking place within the combustion chamber —A—. It will be seen from the diagram in Fig. 1 that the initial circuit connection through the switch —F— is thus later replaced by a connection through the switches —J— and —I— but, if for any reason the fuel within the combustion chamber —A— does not ignite, this circuit will remain open and the thermostatic relay element —G— will not continue to be heated. As a consequence, the switches —F— and I— will be

gradually turned back to their initial positions, as illustrated in Fig. 1, when the thermostatic relay element —G— becomes cooled. This action will result in the stopping of the motor pumping equipment and thus the accidental accumulation of large amounts of fuel in the fire box will be avoided.

The thermal relay as used with this system is shown in detail in Figs. 3 and 4 and by a schematic perspective view in Fig. 1 and comprises a spirally wound bi-metallic ribbon 10 which is fixed at one end to a support such as at 11 by screws 12. The spiral ribbon 10 may be composed of superimposed strips of any two different metals or elements, preferably brass and iron which are selected because of their widely different coefficients of expansion. When the temperature of the spiral ribbon 10 is altered, its shape will also be altered due to the different coefficients of expansion of the metals of which it is made. To the other end of the spiral ribbon 10 a stub shaft 13 is fixed in any suitable manner as by soldering. Upon the stub shaft 13, one or more switches as indicated at —F— and I— may be mounted. In Fig. 1 the stub shaft 13 is shown in extended and broken form for clearness of illustration.

The spiral ribbon 10 before being wound into the spiral shape illustrated is first covered with an insulating fabric 14, such for example as asbestos cloth saturated with any desirable insulating heat resisting adhesive, such as thick linseed oil. After being covered with this insulating fabric, the ribbon 10 is then provided with a resistance winding 15 through which an electrical current may be passed for causing heating and consequent deformation of the spiral ribbon. The dimensions of the resistance winding 15 may be designed to accommodate the particular current which is used and also to give the desired speed of operation or sensitivity to the device. If a resistance winding producing a small heating effect is used, an appreciable time lag may be secured in the operation of the relay.

The switches —F— and I— as shown comprise hermetically sealed fluid type contactors which serve to make and break circuits by the movement of a body of conducting liquid, such as mercury, into and out of bridging relation with fixed electrodes within the switch containers. The switch —I— is provided with a pair of fixed electrodes 16 and 17, which may be of substantial dimensions capable of carrying the full current used for operating the motor of the pumping equipment above described. This motor circuit may be termed the main circuit while the circuit in which the resistance winding 15 is included may be termed a control circuit. This switch —I— as shown is also provided with a third fixed electrode 18 of somewhat lighter

construction than the electrodes 16 and 17 and which is used at certain times for the purpose of conducting current to the resistance winding 15 of the thermostatic relay element —G— in the above described system. Thus the switch —I— is common to two circuits. The electrodes 16, 17, and 18, as shown, are fixed in the walls of a container 19, preferably formed of glass and containing a body of mercury 20 which may come into bridging relation with all three of the electrodes 16, 17 and 18, when the container 19 is tilted the proper amount. As shown in Fig. 4, the container 19 is tilted to an angle such that the body of mercury 20 is in bridging relation with all of the electrodes while in Fig. 1 the mercury is in bridging relation with none of the electrodes. The container 19 is preferably surrounded with protecting means, such as a rubber band 21, which in turn is embraced by a spring clip 22 mounted upon the stub shaft 13.

The switch —F— as used in the above described system is also for the purpose of making and breaking the current supplied to the circuit through the resistance coil 15 at certain times and is provided with a pair of electrodes 23 and 24, which are adapted to be bridged by a body of mercury 25, as is best shown in Fig. 1. The electrodes 23 and 24 are also fixed in the walls of a container 26, preferably formed of glass and mounted upon the stub shaft 13 in a manner similar to the mounting of the container of the switch —I—.

As will be readily understood when the current is passed through the resistance winding 15, the spiral ribbon 10, because of the heat generated, will become altered in shape in a manner such that the shaft 13 and the switches —F and I— will be rotated through a small angle about their axes. It will be noted that the switches —F and I— are attached to the stub shaft 13 at an angle such that the switch —F— will be in its closed circuit position at times when the switch —I— is in its open circuit position and conversely that when the switch —I— is turned to its closed circuit position, the switch —F— will be in its open circuit position.

It will be also noted in Fig. 1 that the container 26 of the switch —F— is formed in a slightly arched or curved shape so that the container must be tilted a considerable amount beyond the horizontal before the body of mercury 25 will roll to the opposite end of the container. This construction permits the actuation of the switch —F— at a predetermined time interval after the actuation of the switch —I— and for particular reasons to be stated hereinafter.

The room thermostatic switch —H— may be of any desired suitable type, such for example as is shown and described in the copending application of Louis A. M. Phelan

and Clifford Hotchkiss, Serial No. 544,589, filed March 17, 1922. This switch serves to open an electrical circuit when the temperature of the room or compartment in which it is located rises to a desired predetermined value and also serves to close the circuit again after a predetermined drop in the temperature occurs.

In certain instances it may be cheaper and more convenient to install wiring to the room thermostatic switch which is particularly designed for a lower voltage than is used for the motor circuit. The transformer —E— shown in Fig. 1 makes possible the use of lower voltage in the circuit of the room thermostatic switch, if desired. However, the use of the transformer —E— is not essential to the operation of the system and may be dispensed with by using the connections shown in Fig. 2, where all of the circuits make use of power at the same voltage.

The complete operation of this system will now be described by outlining the successive action of each of the devices upon placing the system in operation.

Assuming that the system has been put into proper order, as shown in Fig. 1 and that the gas pilot —C— has been lighted, it is merely necessary for the operator to push a snap switch in order to have combustion take place in the fire box —A—. From the snap switch current is led through the switch —F—, now closed, and through the primary winding of the step-down transformer —E—. From the secondary winding of the transformer —E—, current will be led through the room thermostatic switch —H— (now assumed to be closed since the room to be heated is cold) and also through the resistance winding 15 upon the thermostatic element —G—. The current through the resistance 15 will cause a heating of the spiral element 10 and the resulting change in shape of this element will serve to gradually turn the switches —I and F—. As the switch —I— just passes its horizontal position, the body of mercury 20 will roll into bridging relation with the three electrodes 16, 17 and 18. The bridging of the electrodes 16 and 17 will place a pump motor 44 in series with power from the snap switch. In the meantime the switch —F— will also be turned and the body of mercury 25 will roll out of bridging relation with the electrodes 23 and 24 into the open circuit position. The motor 44 now being in operation, a spray of fuel will be supplied by a fuel pump 45 from a tank 48 to the fire box —A— and in the ordinary course this spray would be ignited by the pilot flame —C—. The heat of the burning spray of fuel will serve to actuate the thermostatic switch —J— and permit it to turn into a closed circuit position, as above described. The circuit to the primary of the transformer —E— through the switch

—F— having already become interrupted because of the turning of the switch —F— will now be resumed through the thermostatic switch —J— in connection with the switch —I—, the circuit through the switch —I— following through the electrode 18, the body of mercury 20 and the electrode 16 to the snap switch.

As above described, the container 26 of the switch —F— is made in a curved form so that the body of mercury 25 rolls to the open circuit position only when a definite time interval has elapsed after the actuation of the switch —I—. This time interval is sufficient to permit the thermostatic element —G— to remain heated until after combustion takes place and the fire box —A— has become sufficiently heated to actuate the thermostatic switch —J—. After the actuation of the thermostatic switch —J—, the switch —F— is turned sufficiently to open the circuit there-through and without any prolonged interruption of the flow of current through the resistance winding 15.

When the room in which the thermostatic switch —H— is placed becomes heated to the desired temperature, the switch —H— will open the circuit through the resistance winding 15 and consequently permit the thermostatic element —G— to become cooled. As the thermostatic element —G— becomes cooled, current to the pump motor 44 will be interrupted by the actuation of the switch —I— which will now be turned to open circuit position. When the temperature of the room has dropped for a desired predetermined amount, the switch —H— will serve to close again the circuit through the resistance coil 15 and the operation of the system will be repeated as above described. In this manner after the operator merely has operated the single snap switch, the heating equipment and the room temperature will be entirely automatically controlled and regulated within defined limits, depending upon the sensitiveness of the thermostatic switch —H—. The automatic control may be stopped when desired by turning off the power at the snap switch.

It will be noted that when the switch —F— is restored to its normal position, as illustrated, the body of mercury 25 will flow into the position shown only when a certain time interval has elapsed after the movement of the body of mercury 20 in the switch —I—. This is because of the curved shape of the container 26 of the switch —F— and serves to introduce a substantial lag in the operation of the system thus preventing the starting and stopping of the pump motor 44 at too frequent intervals in case the thermostatic switch —H— is very sensitive to slight changes in temperature.

In the operation of the system as above described, it has been assumed that the in-

tended ignition and combustion have taken place in the fire box —A—. However, in case the snap switch is thrown at a time when the pilot light —C— is not lighted, or if for any other reason combustion of the fuel does not take place, the continued operation of the fuel pump would allow an excess of the fuel to accumulate within the fire box and thus create a very serious fire hazard. In the system as shown, when ignition does not take place, the thermostatic switch —J— will remain cold and in its open circuit position and consequently when the switch —F— is also turned to open circuit position, no means will remain for heating the resistance coil 15, and consequently the switches —F and I— will soon return to their initial positions thereby interrupting the circuit to the motor 44. It will thus be evident that the pump motor will at no time continue in operation for more than a short interval unless combustion takes place and the thermostatic switch —J— is heated sufficiently to turn to its closed circuit position. Hence, the possibility of accidental accumulation of large amounts of fuel in the fire-box is avoided.

From the foregoing description of the thermal relay it is apparent that the same constitutes a circuit breaker which comprises a heat sensitive element 10, and an electrical resistance element 15 associated therewith for warping the same. The contactor F is tilted about the stub shaft 13 which is rotated or rocked gradually by the heat sensitive element 10 when the temperature of it is changed by the electrical heating resistor 15. As hereinbefore explained, the contactor F is surrounded with protecting means, such as a rubber band, which, in turn, is embraced by the spring clip. The spring clip permits of the contactor being adjustable longitudinally therethrough.

This application which is directed to the construction of the thermostatically operated relay G in conjunction with the electric switching mechanism associated therewith and comprising the contactor F and the contactor I, is a division of our application, Serial No. 615,530, filed January 29, 1923, and entitled Temperature control apparatus.

While we have shown and described several embodiments of our invention, it is to be understood that many modifications may be made therein without departing from the spirit and scope of the appended claims, and we desire that only such limitations shall be imposed upon our invention as are specifically pointed out in the claims and such as are required by the prior art.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent in the United States, is—

1. A relay having a predetermined time lag comprising a thermosensitive element, a contactor operatively associated with said

element to open and close an electric circuit through said contactor, and an electrical heating element of predetermined dimensions disposed in thermal relation to said element to cause the latter to actuate said contactor, said
 5 contactor comprising a container, electrodes sealed therein which are adapted to be connected to an external electric circuit, and a movable conductor in said container controlling the electric circuit between said electrodes and said heating element being connected in series relationship with said electrodes.

2. A relay having a predetermined time lag comprising a thermosensitive element formed of a spirally wound bi-metallic ribbon having one end fixed and one end free to move, a contactor operatively associated with said movable end, and a resistance wire of predetermined dimensions disposed in thermal relation to said bi-metallic ribbon, said contactor comprising a container, electrodes sealed therein which are adapted to be connected to an external electric circuit, and
 15 a movable conductor in said container controlling the electric circuit between said electrodes and said heating element being connected in series relationship with said electrodes.

3. A relay having a predetermined time lag comprising a thermosensitive element formed of a bi-metallic element having one end stationary and one end free to move, an electrical resistance wire of predetermined dimensions disposed in thermal relation to said element to cause the latter to actuate and a tiltable contactor actuated by said movable end, said contactor comprising a container, electrodes sealed therein which are adapted to be connected to an external electric circuit, and a movable conductor in said container controlling the electric circuit through said electrodes and said heating element being connected in series relationship with said electrodes.
 20 45

4. A relay comprising a heat sensitive element having one fixed end and one end free to move, a tiltable contactor actuated by the movable end of said element, an electrical heating coil disposed in thermal relation to said element, said heating coil and said contactor being connected in series relation and said contactor comprising a container, electrodes sealed therein which are adapted to be connected to an external electric circuit, and a movable conductor in said container controlling the electric circuit through said electrodes.
 50 55

5. A circuit breaker comprising a heat sensitive element, an electrical resistance element associated therewith for warping the heat sensitive element, a rocking member connected with the heat sensitive element and gradually moved by the heat sensitive element in response to temperature changes, a sub-

stantially horizontal closed tube carried by the rocking member, a pair of spaced contacts within the tube adjacent one end and connected in series with the resistance element, and a free metallic globule within the tube and adapted to bridge the spaced contacts when the contact-carrying end of the tube is lowermost. 70

6. A circuit breaker comprising a heat sensitive element, an electrical resistance element associated therewith for warping the heat sensitive element, a rocking member connected with the heat sensitive element and gradually moved by the heat sensitive element in response to temperature changes, a substantially horizontal closed tube carried intermediately by the rocking member and adjustable longitudinally therethrough, a pair of spaced contacts within the tube adjacent one end and in series with the resistance element, and a free metallic globule within the tube and adapted to bridge the spaced contacts when the contact-carrying end of the tube is lowermost. 75 80 85

7. A circuit breaker comprising a heat sensitive element, an electrical resistance element associated therewith for actuating it, a rocking member connected with the heat sensitive element and moved by the latter in response to temperature changes, a liquid contactor housing carried by the rocking member, spaced electrodes disposed in said contactor housing and connected in series relationship with said resistance element, and an electrical conducting body within said housing and adapted to bridge the said electrodes when the contactor housing occupies circuit closing position. 90 95 100

8. A circuit breaker comprising a heat sensitive element, an electrical resistance element associated therewith for actuating the latter, a rocking member connected with the heat sensitive element and moved by the latter in response to temperature changes, a substantially horizontal liquid contactor housing carried by the rocking member and adjustable longitudinally therethrough, a pair of spaced electrodes within the contactor housing and connected in series relationship with said resistance element, and an electrical conductor within the contactor housing and adapted to bridge said spaced electrodes when the liquid contactor occupies circuit closing position. 105 110 115

In witness whereof, we have hereunto subscribed our names. 120

LOUIS A. M. PHELAN.
 CLIFFORD HOTCHKISS.