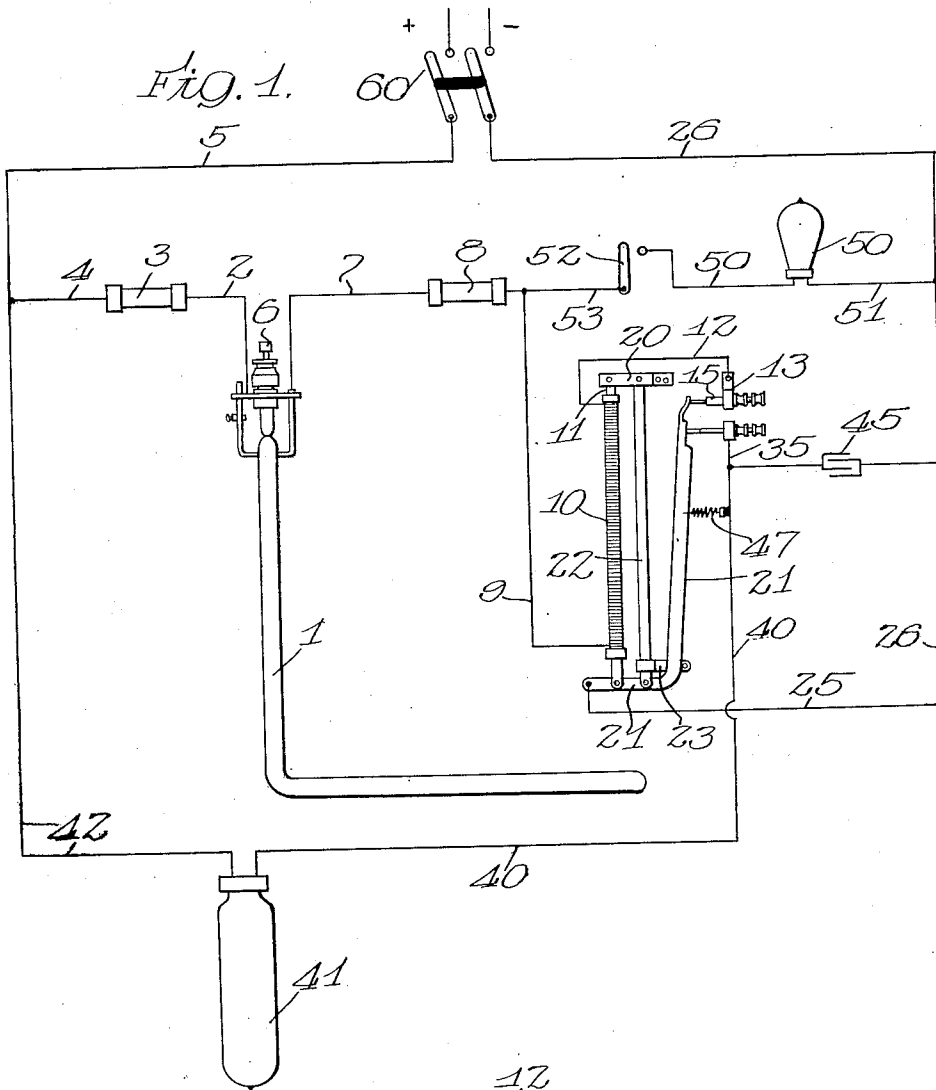
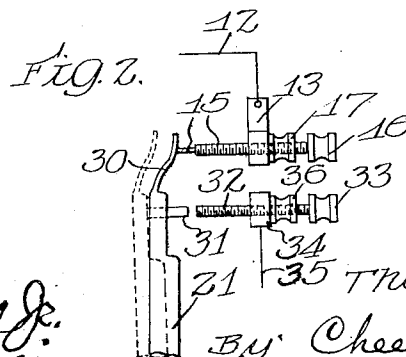


T. B. FREAS.
THERMAL RELAY.
APPLICATION FILED DEC. 4, 1911.

1,111,789.

Patented Sept. 29, 1914.



Witnesses:
G. W. Dumas Jr.
Max F. Rosenzweig

Inventor:
Thomas B. Freas
BY Cheever & Cox
Attys.

UNITED STATES PATENT OFFICE.

THOMAS B. FREAS, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO V. WEBER & COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

THERMAL RELAY.

1,111,789.

Specification of Letters Patent.

Patented Sept. 29, 1914.

Application filed December 4, 1911. Serial No. 463,951.

To all whom it may concern:

Be it known that I, THOMAS B. FREAS, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Thermal Relays, of which the following is a specification.

My invention relates to thermal relays.

Generally speaking, my apparatus consists of a main or controlled circuit and a relay or controlling circuit, the relay or controlling circuit being itself controlled preferably by a thermo responsive switch.

One of the objects of the invention is to provide means for procuring certainty of operation of the main switch.

Another object is to provide means to prevent overheating of the resistance coil which operates the main switch. In the form illustrated my invention is adapted for a constant temperature bath and the main circuit energizes a lamp or other heater which is located near enough to the thermo responsive switch to influence it. In this specific form the thermo responsive switch is a mercury tube adapted to open and close the relay or controlling circuit, and the heater is located in the same chamber as the tube so that the temperature of the chamber will determine whether the tube shall hold the relay circuit open or closed.

One of my objects is to obtain a constant temperature bath which is electrically heated and which has the characteristics above mentioned, to wit, a sure acting main switch and a protection against overheating of the resistance coil by which the main switch is operated.

In the accompanying drawings, Figure 1 is a general wiring diagram of the parts, and Fig. 2 is a detail showing the preferred form of switch arm and contacts of the heat-actuated switches.

In the controlling circuit is a thermo responsive switch consisting of a mercury tube 1 containing mercury, which is at all times in electrical contact with the conductor 2 provided with a fuse 3 and leading through a conductor 4 to one of the main supply conductors 5. A conductive needle 6 is so arranged in the tube that its lower end will be contacted by the mercury whenever the heat

of the air or other medium surrounding the mercury tube causes the mercury to rise to a predetermined level. It is unnecessary to describe the precise construction here, as the construction of this switch is not an essential feature of this invention, and the form here shown is described in detail in my co-pending application filed January 4, 1912, Serial Number 669,344, (Case D). Furthermore thermo responsive switches of this general character have heretofore been shown, as, for example, in my issued Patents Number 999,710, dated August 1, 1911 and Number 1,024,565 dated April 30, 1912.

The needle 6 which constitutes one of the terminals of this thermo responsive switch is connected by a conductor 7 and fuse 8 and conductor 9 to one end of a heating coil 10. Coil 10 surrounds a rod 11 preferably hollow and composed of brass, the arrangement being such that when the coil is energized and the resistance of the coil produces heating, the heating and cooling of the coil will cause the corresponding heating and cooling of the rod with a consequent increase and decrease in the length of the rod, thus furnishing motive power for operating the switches presently to be described. The remaining end of the coil is connected by a conductor 12 to a terminal block 13 containing a contactor 15, best shown in Fig. 2. Said coil is bifilar; that is, the wire thereof is doubled back upon itself so that the coil as a whole is noninductive. The result is that sparking is avoided when the circuit through it is opened and hence delicate needle points might, without harm to them, be substituted for the mercury contact in the tube 1.

The contactor 15 is a screw with a knurled head 16 and screws into block 13 and remains in electrical contact with conductor 12. Said contactor may be set to any desired adjustment by means of the lock nut 17.

Rod 11 above mentioned is rigidly secured at one end to a stationary bracket 20. At the other end it is articulately connected to a lever 21 which is fulcrumed upon a rod 22 rigidly secured to the bracket 20. Near the point of connection to said lever the rod 22 is guided by a bracket 23. It is clear

that the heating and cooling of rod 11 under the action of the heating coil will produce a movement of the lever 21 about its fulcrum. But rods 11 and 22 are made similar to each other and are connected to the same bracket 20 and at the other end to the same lever 21, hence changes in temperature of the atmosphere will affect them both equally and therefore produce no movement of the lever. Consequently the rods compensate each other in so far as changes in atmospheric temperature are concerned.

The lever 21 is a conductor and is connected at one end by a conductor 25 to the main line conductor 26. At the free end of said lever is a flexible contact 30 adapted to impinge the contact 15. It also has an inflexible contact 31 adapted to impinge the contact screw 32 which is provided with a knurled head 33 and screws into the stationary block 34. Block 34 makes electrical contact with the conductor 35 and screw 32 is set in proper position by means of lock nut 36. Under normal adjustment the parts are so arranged that when the lever 21 is moving toward the contacts 15 and 32 the flexible portion 30 will engage the screw 15 before the rigid portion 31 engages the screw 32. As the portion 30 is yieldable, however, it does not prevent the lever continuing its movement and bringing the parts 31 into engagement with the screw 32. Conversely when the lever is moving toward open position, the flexible contactor 30 will remain in contact for a definite period after the contactor 31 has left the contact 32 and continue the heating of the coil after the switch 31, 32 which controls the controlled circuit is open. As the elements are adjustable this period of lag may be regulated as desired.

Conductor 35 is connected by the conductor 40 to the heating lamp 41 or other translating device, the remaining terminal of the device being connected by conductor 42 to the main line conductor 5. By preference, a condenser 45 is connected between the conductors 35 and 26 to prevent sparking across the contact points 31 and 32. The adjustable tension spring 47 constantly urges the lever 21 toward closed position, and serves to absorb any back lash that might otherwise be present.

A desirable adjunct of my apparatus is shown in the upper right corner of Fig. 1 and consists of a tell-tale lamp 50^a connected by a conductor 51 to the main line conductor 26 and by a conductor 50 to a hand switch 52 connected by a conductor 53 to the conductor 9. This lamp is for aiding in the adjustment of the needle 6 and when switch 52 is closed the lamp 50 will glow the moment contact is made between the needle and the mercury and will cease

to glow the moment contact is broken. The operator may thus readily determine the exact moment when the contact is made and broken. Under normal operating conditions after the needle 6 had been adjusted the switch 52 will remain open.

To facilitate an explanation of the operation of the parts, let it be assumed that mercury tube 1 is located within and subject to the temperature of a constant temperature bath. Let it be assumed also that heat for the bath is furnished by the lamp 41. When the bath is cold the mercury in tube 1 will be down out of contact with needle 6, and the circuit through the heating coil 10 will therefore be broken at this point. The rod 11 will be contracted and will hold the lever 21 in closed position. When it is desired to start the operation of the bath the operator closes the main switch 60 thus causing the lamp 41 to be energized and raise the temperature of the bath. As soon as the bath temperature has been raised to a predetermined degree the mercury in tube 1 will contact the needle 6 and thus establish electrical connection between the conductors 2 and 7. Current will now pass through the resistance coil 10 and heat it, thus heating rod 11 and causing it to elongate and move the lever 21 toward open position. Contact 32 is so adjusted that the contactor 31 will leave it almost immediately after coil 10 begins to heat. This breaks the circuit through the heater 41 and consequently shuts off the supply of heat to the bath. But for a period the length of which may be regulated, the contactor 30 remains in engagement with its contact 31 and thus continues the heating of the coil. It is here that the advantage of my apparatus becomes most evident.

It has been found by experience that switches sometimes stick for various causes or do not open wide enough or are not supplied with sufficient power to actuate them with certainty; for example, when the switch in the controlled circuit is operated by an electromagnet, as in my Patent 999,710, the maximum pull is exercised the moment the magnet is energized and if the pull is insufficient the apparatus fails to work. In my present apparatus the circuit through the heating coil remains closed after the moment when the switch in the controlled circuit is supposed to open, and the pulling action of the heating coil continues. It is obvious that great force may be generated by the heating coil and lever, and consequently by adjusting the contact 15 properly almost any amount of pulling force may be obtained. The delayed opening of this electrothermally operated switch 15, 30, therefore, produces a high degree of certainty of operation and there is no danger of this switch remaining closed too long because when the

lamp 41 has been shut off long enough to permit the temperature in the bath to drop below the prescribed point the mercury in tube 1 will drop and cause the circuit 5 through the heating coil to be opened whether the switch 15, 30 is open or not. The time lag of the opening of switch 15, 30 may, therefore, be increased to any reasonable extent without endangering the operation of the parts as a whole. But even if 10 the mercury tube should not open the circuit through the coil 10, said coil would be protected, for under ordinary adjustment the heat of the coil would expand rod 11 enough 15 to bring the switch 21 out of engagement with the contact 15 before said coil would be overheated or the insulation thereof damaged.

The heating of coil 10, and consequently 20 the movement of the lever 21, continues until either the contactor 30 has left the contact 15 or the mercury in tube 1 has dropped down low enough to leave the needle 6. As soon as either one or both of these actions 25 has occurred the circuit through coil 10 is broken and the rod 11 begins to contract and thereby move the lever again toward closed position. If at the time the contactor 30 meets the contact 15 the temperature in the bath is above the prescribed point and the 30 mercury in the tube is touching the needle 6, the coil 10 will again heat and prevent the contactor 31 from closing until the temperature in the bath has dropped sufficiently to 35 open the circuit in the mercury tube.

It will be noted that this apparatus will operate on either direct or alternating current.

Having thus described my invention, what 40 I claim as new and desire to secure by Letters Patent is:

1. A thermal relay comprising a main circuit, a relay circuit, a thermal switch controlling said relay circuit, and means 45 operated by said relay circuit for interrupting first the main circuit and then the relay circuit with an appreciable lapse of time intervening, whereby the relay circuit remains energized long 50 enough to insure the interruption of the main circuit and the relay circuit is finally interrupted for its own protection.

2. In combination, a main circuit, a relay circuit, a switch arm in series in the main 55 circuit, a contact in the main circuit adapted to be engaged by said switch arm, an expansion rod adapted to operate said switch arm, a heating coil adapted to heat said rod for opening said switch arm, said heating coil 60 being in series with the relay circuit, and a circuit breaker in said relay circuit operated by said switch arm, the parts being so timed that the switch arm in moving to open position opens first the main circuit and then

the relay circuit, whereby the opening of 65 the main circuit is insured and the heating coil in the relay circuit is protected against overheating.

3. In combination, two parallel electrical circuits, one forming a controlling circuit 70 and the other a controlled circuit, a translating device in the controlled circuit, a main switch adapted to open and close both of said circuits, a coil in series in the controlling circuit adapted to operate said 75 switch, a thermo responsive switch also located in said controlling circuit, said main switch, in moving toward closed position, closing first the controlling circuit and then the controlled circuit and in moving to open 80 position opening first the controlled circuit and then the controlling circuit.

4. The combination with the supply mains of an electric circuit, of two contacts, a normally closed switch arm electrically connected 85 to one of said mains and when in completely closed position engaging both of said contacts, said arm being adapted to leave first one and then the other of said contacts in moving to open position, a translating 90 device electrically connected to the first-to-be-left-contact and electrically connected to the remaining supply main, a thermo responsive switch connected to the last-to-be-left-contact and to said remaining supply 95 main, and an electrically operated device in circuit relation with said thermo responsive switch and controlled thereby for moving said switch arm to open position.

5. In an electric heater, a controlling circuit, a controlled circuit, a contact in series 100 in each of said circuits, a main switch common to said circuits and adapted to be in engagement with both of said contacts at the same time, said switch being resilient and 105 adapted to remain in engagement with one of said contacts after it has left the other, a heating element in the controlled circuit, a coil located in the controlling circuit and arranged to operate the main switch and a 110 thermo responsive switch also located in the controlling circuit for opening and closing the same.

6. In an electric heater, a heating circuit 115 provided with a contact, a controlling circuit also provided with a contact, a resilient switch arm normally in engagement with both of said contacts, a heating coil located in the controlling circuit and adapted upon 120 being heated to cause the switch arm to leave first the contact in the heater circuit and then the contact in the controlling circuit, and a thermo responsive switch in the controlling circuit for opening and closing 125 the same.

7. In a heater, the combination with a heating element and a circuit therefor, of a circuit breaker for breaking the heater cir-

cuit, and controlling means for said circuit breaker, said controlling means embracing an electrically operated retractor having a resistance coil and an expansion and contraction rod heated thereby for urging the circuit breaking element to open position, an electric circuit for said retractor, and a thermostatic switch arranged to open and close the circuit of said retractor having said coil connected therein, said thermostatic switch being subjected to the heat of said heating element.

8. In combination, a main circuit, a relay circuit, a switch arm in series with both of said circuits, a main circuit contact adapted to be engaged and disengaged by said arm for closing and opening the main circuit, a heating coil in series in the relay circuit adapted to operate said switch arm, and a relay circuit contact, also adapted to be engaged and disengaged by said switch arm for closing and opening the relay circuit, said coil when heated causing said arm to leave first the main circuit contact and subsequently the relay circuit contact.

9. In combination, a main circuit, a relay circuit, a switch for controlling said circuits, an expansion and contraction rod for operating said switch, and a heating coil in the relay circuit arranged to heat said rod, said rod being rectilinear and homogeneous, whereby said rod lengthens longitudinally when heated and shortens longitudinally when cooled, the lengthening of the rod causing the switch to move toward open position, and said switch in moving toward open position breaking first the main circuit and then the relay circuit.

10. In a thermal relay, the combination of a main circuit, a relay circuit arranged parallel thereto, a thermo-sensitive device in said relay circuit for opening and closing the same, a switch common to both of said circuits, a resistance coil in said relay circuit and an expansion and contraction rod heated by said coil and connected to said switch for operating the same, said rod being held stationary at one end and at the other end being connected to said switch and being substantially rectilinear and composed of metal of such character that when heated the rod lengthens and when cooled shortens thereby varying the length of the rod in accordance with variation in temperature and causing the operation of the switch, said switch in moving toward open position breaking the main circuit and the relay circuit successively, in the order named with an appreciable lapse of time intervening.

11. In combination, a main circuit having a contact in series therein, a switch arm in series with said main circuit and adapted to engage and disengage said main circuit

contact for closing and opening the main circuit, an expansion rod for operating said switch arm, a relay circuit, a heating coil in series in said relay circuit, said coil being adjacent to said rod for heating it and thereby operating said switch arm, a relay contact adapted to be also engaged and disengaged by said switch arm for opening and closing the relay circuit, said switch in moving to open position leaving first the main circuit contact and subsequently the relay circuit contact whereby the relay circuit may remain closed for heating the coil until the main circuit has been broken but in case the current continues to flow through the heating coil after the main circuit has been opened, the relay circuit will finally be opened and the heating coil thus protected from overheating.

12. In combination, two parallel electrical circuits, one forming a controlling circuit and the other a controlled circuit, a heater in the controlled circuit, a main switch adapted to open and close both of said circuits, a coil in series in the controlling circuit adapted to operate said switch, said switch in moving toward open position opening first the controlled circuit and then the controlling circuit, and a thermo responsive switch located in said controlling circuit in position to be influenced by the heat of said heater, said thermo responsive switch opening said controlling circuit when heated to a predetermined maximum.

13. In combination, a main circuit having a translating device therein, a relay circuit, an expansion rod, a heating coil in said relay circuit for heating said rod, and two circuit breakers, one for controlling the main circuit and the other for controlling the relay circuit, said rod being mechanically connected to said circuit breakers for actuating them, said rod during expansion opening first the circuit breaker which controls the main circuit and subsequently the circuit breaker which controls the relay circuit.

14. Means for controlling an electric circuit comprising a main circuit to be controlled, a relay circuit, a switch in said relay circuit, electrically operated means in said relay circuit at a point remote from the aforesaid switch, said electrically operated means being adapted to open first the main circuit and subsequently the relay circuit, and adjusting means operative upon said electrically operated means for varying the period elapsing between the opening of the main and relay circuits.

15. In combination, a main circuit having a translating device therein, a relay circuit, an expansion rod, a heating coil in said relay circuit for heating said rod, two circuit breakers, one for controlling the main cir-

cuit and the other for controlling the relay
circuit, said rod being mechanically con-
nected to said circuit breakers for actuating
them, said rod during expansion opening
5 first the circuit breaker which controls the
main circuit and subsequently the circuit
breaker which controls the relay circuit, and
means for adjusting said circuit breakers
for regulating the amount of time elapsing
10 between the opening of the main circuit cir-

cuit breaker and the relay circuit circuit
breaker.

In witness whereof, I have hereunto sub-
scribed my name in the presence of two
witnesses.

THOMAS B. FREAS.

Witnesses:

L. WILLARD DECKER,
GENIEVE D. DECKER.