

June 17, 1930.

L. L. CUNNINGHAM

1,765,056

AUTOMATIC DEVICE

Original Filed Feb. 8, 1926

2 Sheets-Sheet 1

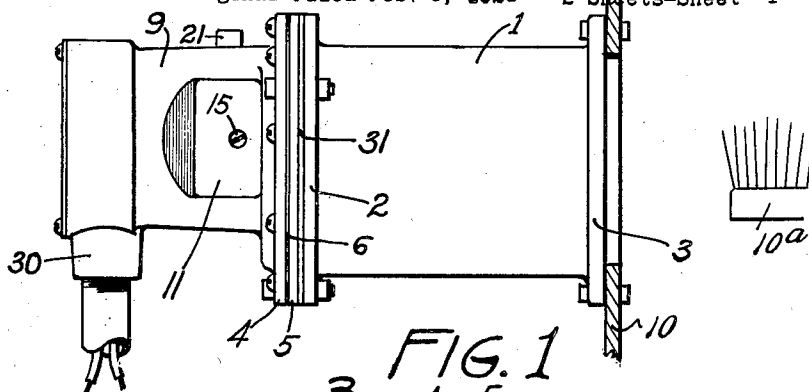


FIG. 1

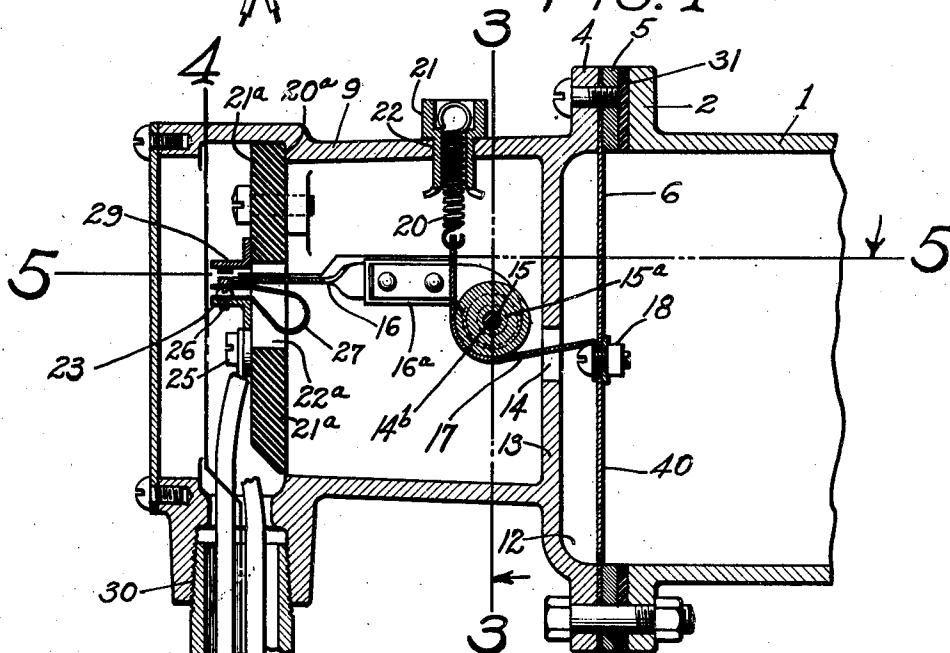


FIG. 2

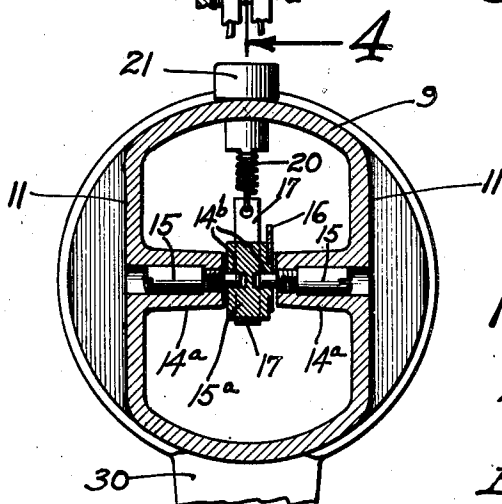


FIG. 3

INVENTOR
LEWIS L. GUNNINGHAM

By Paul Paul & Moore
ATTORNEYS

June 17, 1930.

L. L. CUNNINGHAM

1,765,056

AUTOMATIC DEVICE

Original Filed Feb. 8, 1926 2 Sheets-Sheet 2

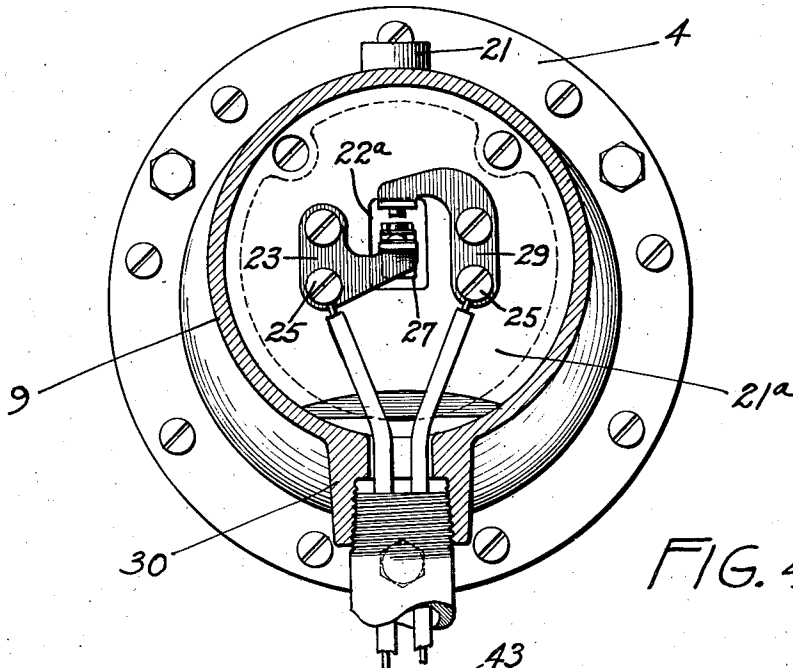


FIG. 4

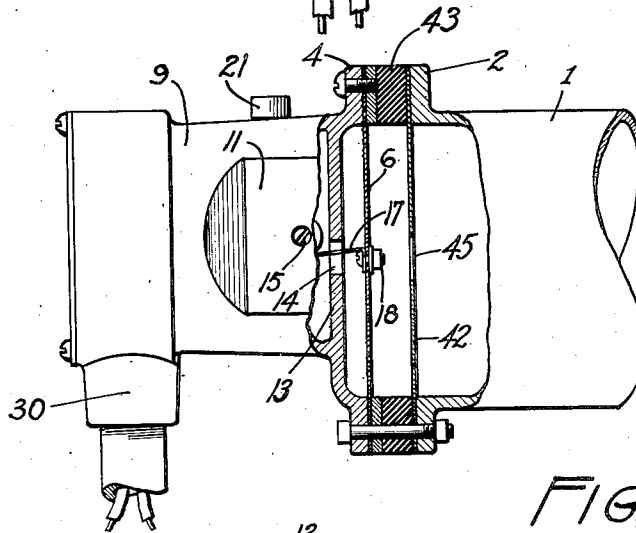


FIG. 6

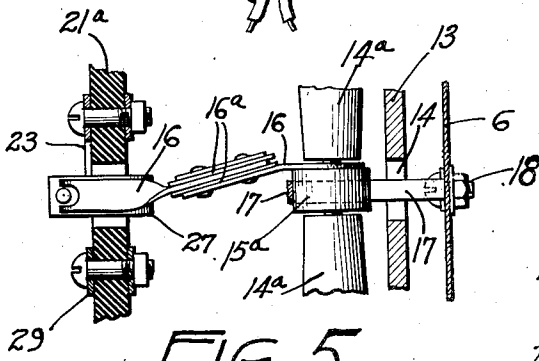


FIG. 5

INVENTOR
LEWIS L. CUNNINGHAM
By Paul Paul & Moore
ATTORNEYS

UNITED STATES PATENT OFFICE

LEWIS L. CUNNINGHAM, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, OF MINNEAPOLIS, MINNESOTA, A CORPORATION OF DELAWARE

AUTOMATIC DEVICE

Application filed February 8, 1926, Serial No. 86,849. Renewed April 15, 1929.

This invention relates to improvements in automatic safety devices and particularly to a safety device operable by radiant heat or energy, and adapted for controlling other devices such as electrical circuits, valves, etc. The invention is an improvement upon an apparatus disclosed in a pending application of Lewis L. Cunningham for improvements in automatic devices, filed July 24, 1925, Serial No. 45,835. To distinguish the present device from the ordinary thermostatic devices, which would not be effective for applicant's preferred use, it is necessary to state and to show that these portions of applicant's device through which control is effected by radiant heat or energy do not respond to any particular predetermined temperature, but to differences in temperature, between the control element, and adjacent control element supporting means illustrated in a preferred embodiment herein described.

The broader aspect of function of applicant's control device, is prompt response to the presence or absence of heat or radiant rays, such for example, as is furnished by a gas, oil or coal flame.

The present invention provides a device in which the proper controlled deflection of a circuit controlling diaphragm is constantly maintained as long as the diaphragm is receiving a supply of heat. In other words, the proper deflection of the diaphragmatic control element is maintained in a predetermined degree as long as heat is being received. The device is so constructed that it will withstand high temperatures over long periods. It is further constructed so that a draft cannot pass therethrough, and therefore no deposit of carbon upon the diaphragmatic element in that amount which will prevent proper operation of the diaphragm will take place.

The features of invention include the manner of mounting the controlling element or diaphragm, with the material of the supporting elements and diaphragm having the same coefficient of expansion; to the diaphragm per se having its receiving side blackened and its opposite side polished, to

reduce radiation and increase conduction effects; to the construction of a contact making and breaking device operable by and connected with the diaphragmatic control element; and to the use of a second diaphragm as a heat shield and focusing device for preventing undue heating of the control element.

Other objects and certain advantages will appear from the description of the drawings forming part of this specification and in said drawings:

Figure 1 is a side elevation;

Figure 2 is a longitudinally vertical section;

Figure 3 is a cross section on line 3—3 of Figure 2;

Figure 4 is a cross section on line 4—4 of Figure 2;

Figure 5 is a plan section on line 5—5 of Figure 2; and

Figure 6 is a fragmentary vertical longitudinal section illustrating a modification in which a second diaphragm as a shield and focusing device is employed.

The device comprises two substantially tubular hollow, cylindrical members respectively 1 and 9. In practice the member 1 is of iron, and the member 9 of cast brass, as a good conductor of heat. The member 1, as a support, is flanged at each end as at 2, 3, and the flange 3 is attached either to the door of a furnace or the pipe may be elongated and be disposed partially within the furnace or other heat supplying apparatus. The outer member 9 is flanged as at 4, and a ring 5 of spring bronze is interposed between the members. Between this ring 5 and flange 4 is inserted a diaphragm 6, in practice made of spring bronze, as a good conductor of heat. This diaphragm, as well as the flange 4, and the ring 5 are made therefore of material having substantially the same coefficient of expansion. The flame safety device as a unit, including the casing 9 in which the contact device is mounted, the radiating ring 5 and diaphragmatic element 6, is first connected together as follows.

The relatively thin diaphragm 6 is engaged flatly against the outer side of the

flange 4 of the casing, and a conducting ring 5, relatively thick cross-sectionally, is then placed against the opposite side of the diaphragm. The three elements are secured together by a series of screws. As before stated, the material of the casing, diaphragm and conducting ring have the same or substantially the same coefficient of expansion and therefore the diaphragm can always be maintained at a higher temperature than the adjacent supporting elements, because radiation and conduction through the casing and ring is more rapid. The numeral 10 indicates the fire box door of a furnace, and the numeral 10^a indicates a source of flame or heat within the heater or furnace. It is to be understood that the device of this invention is disposed at the outer side of the fire box, so that radiation can take place, to maintain the element 6 in a condition hereinafter to be described. It will be noted that the element 1 is elongated only to that extent which will limit the amount of heat delivered to the diaphragm in the desired degree. The elongation is for the purpose of preventing delivery of too much heat. The casing 9 is provided to exclude air, and to provide sufficient radiation, so that the temperature at the inner side of the diaphragm can be maintained at higher degree than that of the outside. For this purpose, the outer casing not only forms a radiating member but acts to exclude air.

The outer or diaphragm supporting casing 9 is a substantially tubular casting having the flange 4, is tangentially flattened or constricted as at 11 providing a cross sectionally elongated tubular formation. The casting further provides a depression 12 extending in an axial direction inwardly from the flange 4. A wall 13 divides the member 9 into large and small chambers, the small chamber 12 being immediately adjacent the diaphragm 6. The wall 13 has an opening 14 therein leading to the larger or outer chamber. Bearing-forming lugs 14^a extend transversely of the constricted portion from opposite sides and partially thereacross. The lugs are bored for the reception of trunnion screws 15, the ends of which engage corresponding depressions 14^b in opposite sides of the hub 15^a of the contact control lever or arm 16. This arm 16 is thus pivoted between the lugs for oscillation, and the hub 15^a extends laterally of the arm and provides a relatively broad periphery, flatly against a portion of which, a length of copper ribbon 17 is disposed, with one end of the ribbon attached substantially centrally of the diaphragm as at 18. At the opposite end, the ribbon is attached to a coil spring 20 which in turn is attached under tension to a headed plug 21 engaging an opening 22 of the casing 9. Means for adjusting the tension of the spring to maintain

yieldable frictional contact between hub and ribbon may be provided. By the use of this ribbon yieldably tensioned and connected to the diaphragm, a slight deflection of the diaphragm will cause a relatively large movement of the outer end of the lever, and moreover inasmuch as the tensioned ribbon exerts a slight deflection-producing action upon the diaphragm, the same will be caused to deflect in direction of tension of the spring, when radiant energy impinges its opposite side. The casing 9 is shouldered as at 20^a and engaged against the shoulder is a disc 21^a of non-conducting material having an opening 22^a. Across this opening projects the arm of a terminal element 23 suitably connected by a screw to the disc and having a binding screw 25 engaged therewith for securing a terminal wire. This arm has a terminal extension, upon which is secured by one arm as at 26, a substantially U-shaped contact or circuit-making spring 27. The opposite unattached arm of this spring has a contact knob or button engageable with a similar button carried by a terminal extension of a second terminal element 29 secured in a manner similar to element 23, and also having a binding screw. The outer end of the arm 16 is engaged against this spring, normally in a manner to keep the contact buttons from engaging to close the circuit. The arm 16 is electrically insulated as at 16^a and is suitably secured to the hub 15, preferably by being attached to one face of the same. The contact spring 27 is normally held compressed by engagement of the outer end of the arm 16 therewith, and the outer end of said arm is preferably slotted providing prongs lying on each side of the button, see Figure 5. As the diaphragm is deflected in direction of the hub, the arm is rotated in clockwise direction to release the upper arm of the spring for making contact.

The outer chamber of the member 9 has a boss 30 threaded to receive a pipe in which the electric wires are housed.

The spring 20 is normally under slight tension such as to condition the diaphragm to travel in a direction away from the source of radiant energy. In this instance, the spring travels upwardly and a depression of the spring breaks electrical contact. The spring 20 acts to maintain the frictional contact between the band and the hub of the lever and yet permits slippage between the two when the travel of the lever is greater than is needed, this in order to prevent breakage. Thus it will be seen that if the movement of the diaphragm in a direction away from the source of radiant energy is greater than that needed for the upward movement of the outer end of the lever, slippage will take place and prevent breakage of the lever. The means thus provided

is compensatory in nature and at the same time provides for the positive operation of the contact devices, by the diaphragm.

It will be seen that if heat is applied to the diaphragm 6 at the inner side so as to raise its temperature to a degree greater than that of the flange and ring, the spring exerting a pull on the ribbon will rotate the arm as before mentioned. If the diaphragm continues to expand or deflect after the contact is made, the spring will continue to contract and the ribbon will slip upon the hub. However, when the diaphragm cools and therefore contracts or straightens, it will exert sufficient pull to extend the spring, and by means of frictional engagement of the strip with the hub, the arm will be rotated in counter-clockwise direction and the contact broken by depression of the spring. If the diaphragm should continue to contract, the spring would be extended as in the first instance, and the arm would continue to travel until stopped by the bracket, and upon continued contraction of the diaphragm, slippage between the hub and ribbon will again take place to prevent breakage of the arm.

In a device such as herein described, a thin sheet of metal as a diaphragmatic element is used, which heats up rapidly, and it is desirable to have the diaphragm 6 so constructed and mounted or supported that the diaphragm will always be at a higher temperature than the ring 5 or flange 4. For the purpose of obtaining heat absorption by the diaphragm the side facing the flame is coated with such a substance that will increase the heat absorption, such as carbon paint or lamp black. This substance, because of its thinness, is not shown in the drawing, but its location is designated by the numeral 40. The opposite side of the diaphragm is left in its natural condition or is burnished to prevent radiation to assist conduction to the ring and flange. It has been found that when this side is not left in its natural state or brightened as by polishing, conduction and radiation is, under some conditions, so rapid that the diaphragm cannot be constantly maintained at the proper degree of deflection to obtain the desired perfection of operation.

A section of heat insulating material 31, in this instance asbestos, although it will be understood that other non-heat-conducting substances may be used such as lava, is interposed between the ring 5 and the flange 2, and the ring 5 and flange 4 act as partial conductors and radiators for heat which is absorbed by the diaphragm 6. The casing 9, however, acts as the main conducting and radiating element.

In some instances, it may be found necessary to use a disk 42 of insulating material having an opening in the center, the disk

being substantially the same diameter as the diaphragm and being placed between the insulating ring 43 and the receiving tube. This construction is illustrated in Figure 6. The opening 45 is of the proper size so that the radiant energy passing therethrough will be localized substantially at the center of the diaphragm, so that more efficient use is made of the heat, while at the same time, the total amount of heat received by the diaphragm is materially reduced, thus eliminating the need for great heat dissipation by the reception tube and thus necessarily maintaining the housing at a much lower final temperature. In practice, the size of the opening and the amount of insulation should be such that the final temperature of the housing will not exceed 300° Fahrenheit.

The function of the flame safety unit herein described is to respond promptly to the presence or absence of flame. In this device the control element immediately responds by full deflection, with the oncoming of the flame and the deflection immediately decreases with the disappearance of flame. Inasmuch as the thin diaphragmatic element absorbs a large amount of heat, it will expand more rapidly when exposed to the flame. At the same time some of the heat received by the diaphragmatic element must be dissipated or radiated and this is accomplished by the use of the outer casing 9 and ring 5 as radiator elements. Thus the temperature of the diaphragmatic element is always maintained at a higher temperature than that of the flange 4 and ring 5, and, therefore, the temperature at its inner side is always greater than that at its outer side. It will further be noted that a relatively large radiating surface is provided by the flange 4. It will be noted that the device responds only to a difference in temperature between the diaphragm 6 and its supporting members 4 and 5 and since the supporting members and diaphragm have the same coefficient of expansion the temperature of the diaphragm can always be maintained at a higher degree than that of its supporting elements, thus assuring controlling deflection of the same.

I claim as my invention:

1. A device of the class described comprising a hollow member, a heat-conducting diaphragm attached crosswise of the member and arranged to be deflected by radiant rays incident thereupon, a radiator member engaging the diaphragm on the opposite side, the material of said radiator members and diaphragm having substantially the same coefficient of expansion, and an element interposed between the diaphragm and one of the radiator members to prevent heat conduction.

2. A device of the class described comprising a tubular member, an asbestos ring engaged against one end of the tube, a dia-

phragm substantially closing the tube, an annular radiator member interposed between the diaphragm and asbestos ring, a second radiator member at the opposite side of the diaphragm, means clampingly holding said members together, the material of said radiator members and diaphragm having substantially the same coefficient of expansion.

3. A device of the class described comprising a hollow member, heat insulating means disposed terminally of the member for reducing conduction, a conducting and radiating ring abutting said heat insulating means, a diaphragm abutting said conducting ring, and a casing having one end abutting said diaphragm at that side remote from the attaching member, said ring, diaphragm and casing being formed of material having substantially the same coefficient of expansion.

4. A device of the class described comprising a tubular member, an annular insulating element engaging one end of the tube, a cross-sectionally thick annular radiating member engaging the insulation, a cross-sectionally thin diaphragmatic element engaging said radiator member and closing the tubular member, and a second tubular member engaging the diaphragm at the opposite side and adapted to increase conduction effects, said conducting element and diaphragm having substantially the same coefficient of expansion.

5. A device of the class described comprising a hollow member, a heat insulating ring disposed terminally against the member, a relatively thick annular conducting element abutting said heat insulating member, a relatively thin diaphragm abuttingly engaged against said conducting elements, and a second relatively thick annular conducting element abutting the diaphragm at the opposite side, said conducting elements and diaphragm having substantially the same coefficient of expansion whereby radiant energy impinging the diaphragm will be dispersed to constantly maintain the diaphragm substantially at the same degree of deflection, and at a temperature greater than the conducting elements.

6. A device of the class described comprising a hollow member, a heat insulating ring terminally disposed against the member, and an annular conducting element abutting said heat insulating member, a diaphragm abuttingly engaged against said conducting element, a second annular conducting element abutting the diaphragm at the opposite side, said conducting element and diaphragm having substantially the same coefficient of expansion, whereby radiant energy impinging the diaphragm will be dispersed by the conducting element to constantly maintain the diaphragm at the same degree of deflection and at a temperature greater than said conducting elements, said diaphragm

being blackened upon its receiving side and being polished upon its opposite side.

7. A device of the class described comprising a tubular member, a diaphragm closing the member, a ring of heat insulating material interposed between the tubular member and the diaphragm, a casing arranged at the outer side of the diaphragm, in opposition to the first mentioned member, means securing the members and elements together.

8. A device of the class described comprising a tubular member, a diaphragm closing one end of the member, the periphery of the diaphragm being thickened to increase conduction, a non-heat conducting element arranged between the diaphragm and the tubular element and a radiating element arranged at the outer side of the diaphragm.

9. A device of the class described comprising a support having an opening, a diaphragm closing the opening, an asbestos ring abutting the support and diaphragm, to reduce conduction, and a casing arranged at the opposite side of the diaphragm as a conductor of heat, a switch in said casing and elements connecting the diaphragm and the switch for operating the same when the diaphragm is deflected and means for producing heating effects at that side of the diaphragm opposite the casing.

10. A support providing a passage, a diaphragm of heat conducting material closing the passage, a device interposed to reduce conduction of heat from the support to the diaphragm, and means at the outer side of the diaphragm for dissipating heat.

11. A device of the class described comprising an element as a support, arranged to permit maintenance of a greater temperature inside than outside of it, and providing a passage, a metallic diaphragmatic element closing the passage, a device for reducing conduction of heat between the support and the diaphragm and an element arranged at the outer side of the diaphragm for conducting heat therefrom.

12. A device of the class described comprising a hollow member, an element capable of heat absorption and of expansion as the result of such absorption connected to the hollow member in a manner to receive radiant energy directed to the inside of said member, and means interposed between said element and member to reduce heat conduction.

13. A device of the class described comprising a hollow member, an element capable of heat absorption and of expansion as the result of such absorption connected to the hollow member in a manner to receive radiant energy directed to the inside of said member, means interposed between said element and member to reduce heat conduction, said element being thickened periph-

erally in a manner to increase radiation at the outside of the hollow member.

14. A device of the class described comprising a hollow member, an element capable of heat absorption and of expansion as the result of such absorption connected to the hollow member in a manner to receive radiant energy directed to the inside of said member, means interposed between said element and member to reduce heat conduction, said hollow member and element having substantially the same co-efficient of expansion.

15. A device of the class described comprising a hollow member, a heat-sensitive element attached to the member in a manner to be deflected by radiant energy incident thereupon, and means interposed between said heat-sensitive element and said member to reduce heat conduction.

In witness whereof, I have hereunto set my hand this 15th day of January, 1926.

LEWIS L. CUNNINGHAM.