May 11, 1943. H. C. GRANT, JR 2,318,607

THERMO-RESPONSIVE DEVICE

Filed June 29, 1940 4 Sheets-Sheet 1

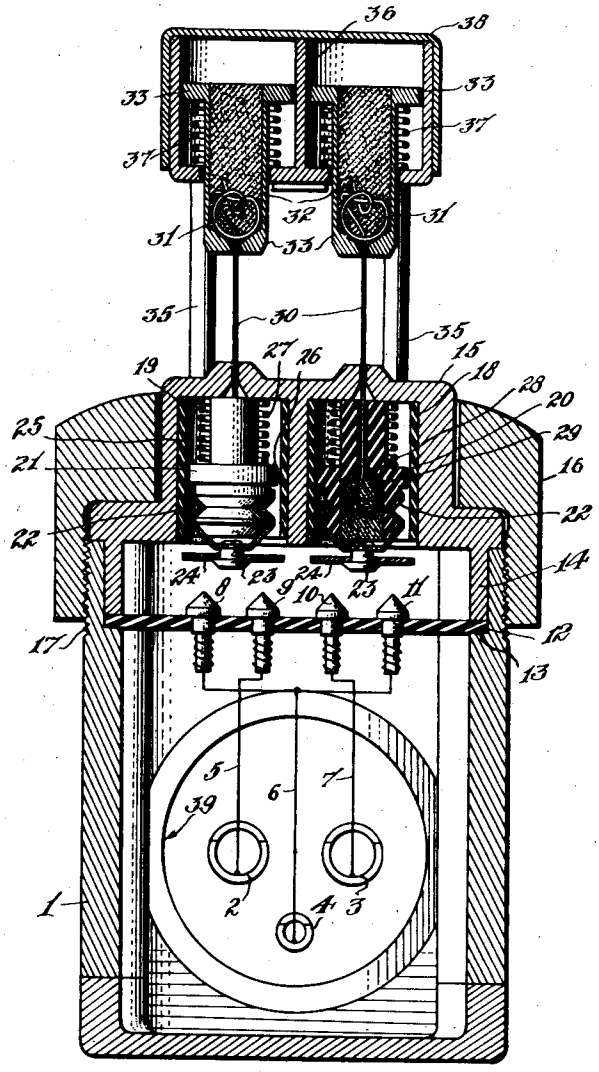


Fig. 1

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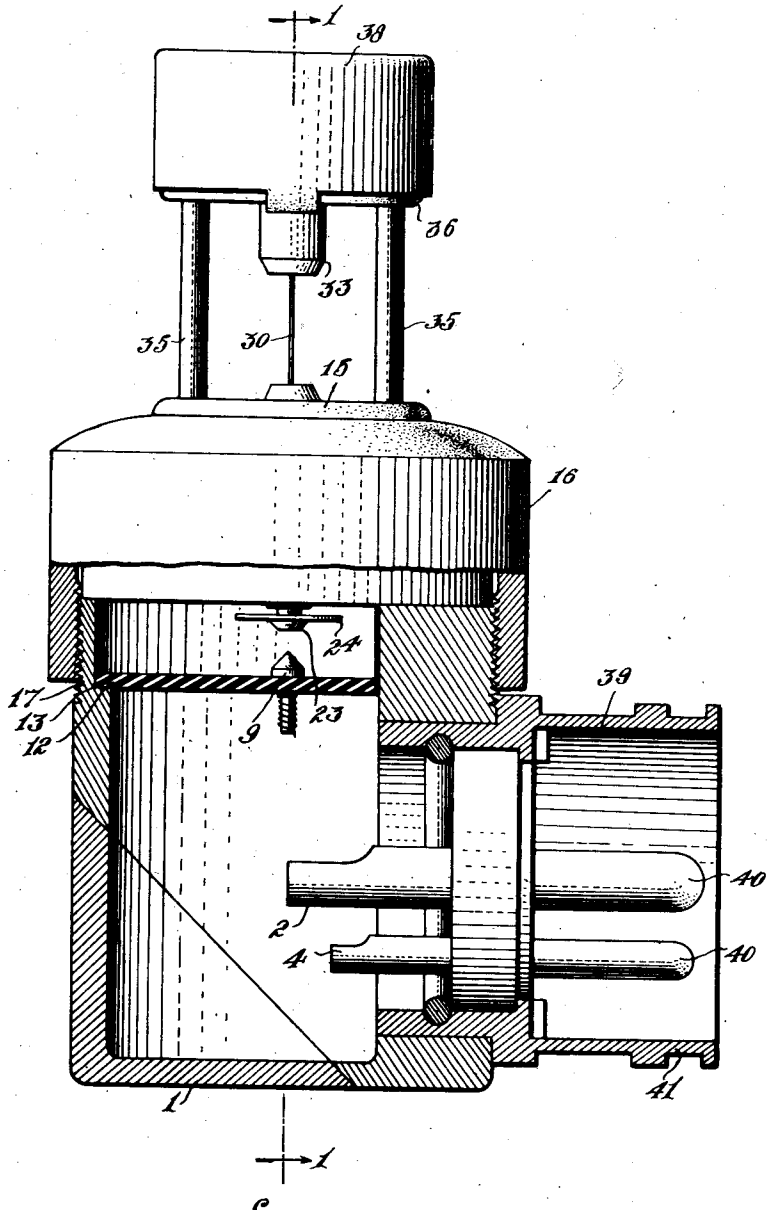


Fig. 2

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Fig. 3

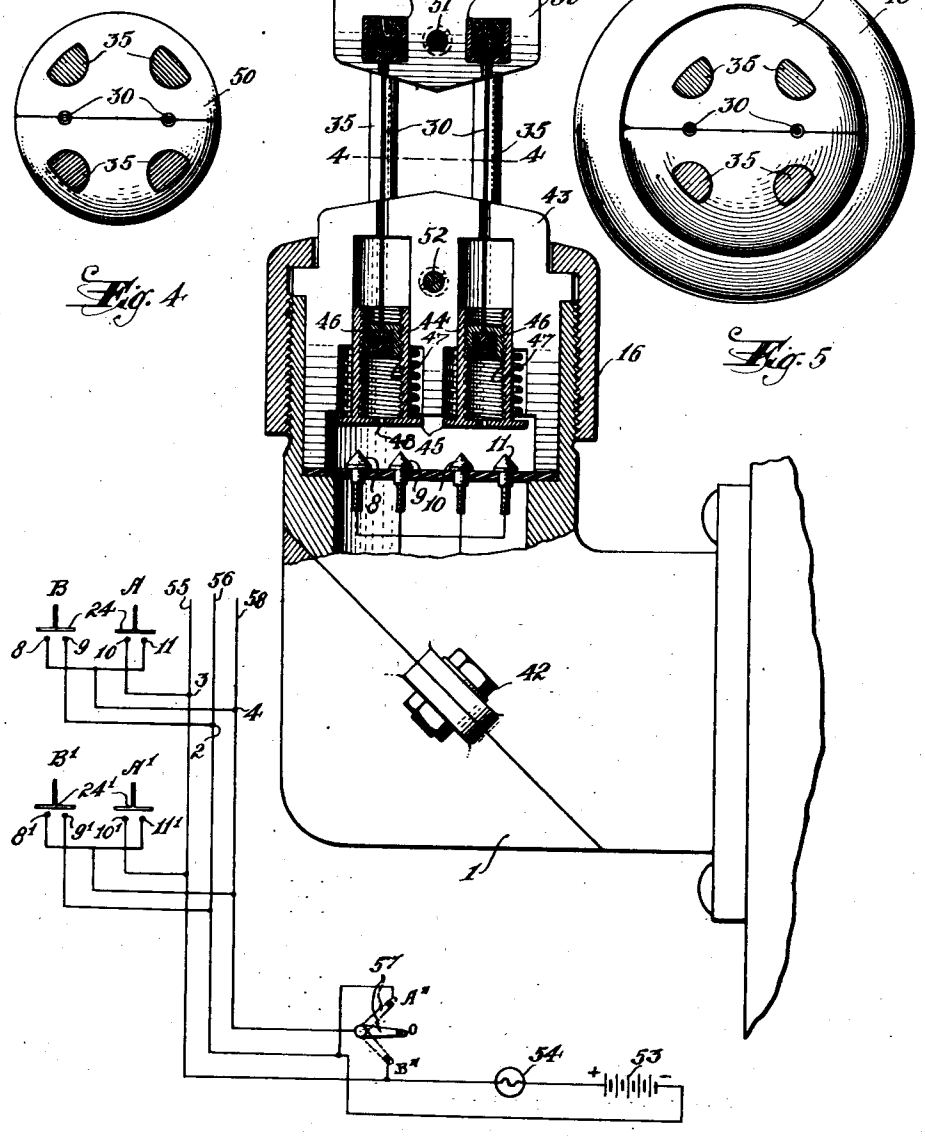


Fig. 4

Fig. 5

Fig. 6

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THERMO-RESPONSIVE DEVICE

Filed June 29, 1940 4 Sheets-Sheet 4

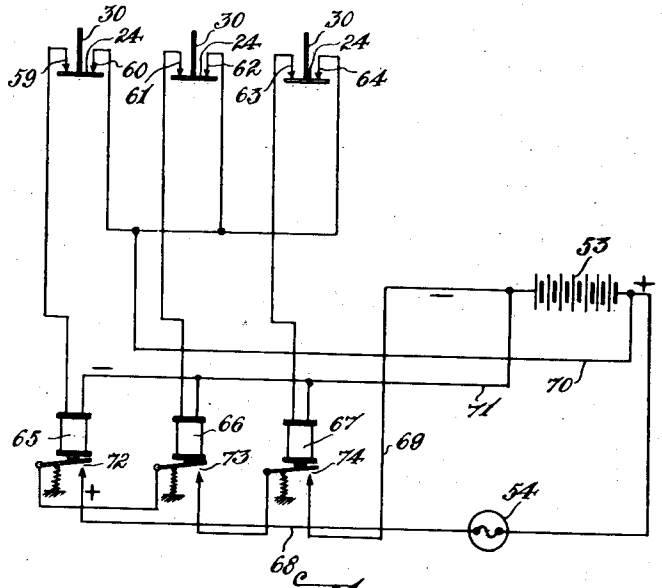


Fig. 8

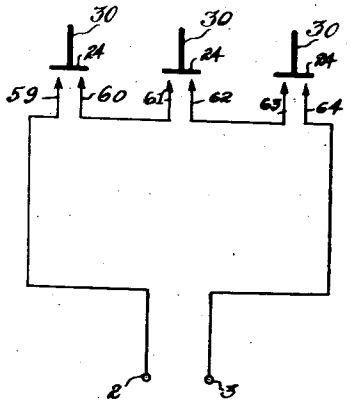


Fig. 7

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UNITED STATES PATENT OFFICE

2,318,607

THERMORESPONSIVE DEVICE

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Application June 29, 1940, Serial No. 343,271

16 Claims. (Cl. 200—142)

This invention relates generally to thermo-responsive devices of the type commonly used to control the opening or closing of electrical circuits such as are employed, for example, in electrically operated fire detecting, fire preventing and fire extinguishing systems.

More specifically the present invention has reference to thermo-responsive devices constructed to normally restrain a circuit closing or opening element from completing or interrupting a circuit, and which, upon attainment of a dangerous predetermined temperature, operate to affect the circuit at any one of a number of points wherever such devices have been placed, to thereby effect a suitable signal or other desired operation.

Known devices of this type are generally designed to utilize a natural or synthetic strand or fiber of some heat-sensitive material, which, when exposed to heat, disintegrates and thus permits the circuit-controlling element to operate.

Such prior devices have had a serious disadvantage in that the accidental failure of the strand would result in an undesired operation of the system, with the attendant danger of leaving the system unguarded.

The present invention solves this difficulty by providing a subdivision of the circuit controlling and the heat-responsive element corresponding thereto into a number greater than one, so that the failure of any one of the heat responsive elements or of a number less than the total is inconsequential so far as the operation of the device as a whole is concerned.

It is accordingly an object of this invention to eliminate the possibility of accidental operation by providing an arrangement for a thermo-responsive device of the type referred to, in the nature of a subdivided control element.

It is, furthermore, another object of the present invention to provide a device of the type stated having a subdivided circuit controlling element so constructed and arranged that an operation of all sections thereof is necessary to completely bridge or interrupt a given circuit.

Another drawback of prior devices may be ascribed to the fact that ordinarily the circuit controlling member is restrained from operation by the heat-sensitive element against the force of a spring, which, upon failure of said element provides the driving power to effect the operation. In connection therewith, the heat-responsive element, being under constant stress, has been known in many cases to become sufficiently deformed after a period of time to lead to an undesired operation of the device.

In view thereof, it is also an object to provide a device of the character described in which the danger of undesired operation due to stress fatigue of the heat-responsive element is eliminated.

It is a further object to provide a device as outlined above which is capable of being fully mounted and dismounted in a matter of seconds and with the utmost simplicity.

Another object is to provide a device of the above stated character, the destructible elements of which are quickly exchangeable as a unit, without the replacement of the device as a whole being necessary.

Still another object is to provide a device as above which is rugged, simple to supervise and to service, and is less liable to accidental failure and undesired operation than devices employed heretofore.

These and other objects of the invention, not specifically enumerated above, will be apparent as the invention is described in greater detail in connection with the accompanying drawings, wherein:

Figure 1 is a view in partial vertical section of a thermo-responsive circuit closing device in accordance with the present invention, the section being taken on line 1—1 of Figure 2 and looking in the direction of the arrows.

Figure 2 is a side view of the device of Figure 1, the lower portion being shown in section.

Figure 3 is a partly sectioned side view of an alternative construction of the device of Figures 1 and 2.

Figure 4 is a view of a horizontal section of the device of Figure 3 taken on the line 4—4 looking upwardly, while

Figure 5 is a view of the same section looking downwardly.

Figure 6 is a diagrammatic layout of a typical circuit incorporating the device of Figure 1.

Figure 7 shows schematically the arrangement of a device in accordance with the present invention having three subdivisions of the circuit controlling element, and

Figure 8 indicates diagrammatically a representative circuit controlled by a device of the closed circuit type and incorporating a circuit controlling member having three subdivisions.

In Figure 1 of the drawings, 1 represents the main receptacle or junction shell for the elements of the device connecting the device to the controlled circuit. Into this shell, there are led in

from the side of the device furthest from the observer electrical terminals 2, 3, and 4 which through wires 5, 6, and 7 are connected to contacts 8, 9, 10 and 11. These contacts are supported by a non-conducting contact plate 12, which is seated on a shoulder 13 formed in the wall of the shell 1. The contacts 8 and 11 are electrically tied to their common terminal 4 through the medium of the wire 6.

Ths contact plate 12 is held in place on the shoulder 13 by an annular extension 14 of a shell cover 15, a coupling piece 16 serving to unite the shell and cover through the medium of cooperating threads 17. The cover has suitable recesses 18 and 19 which accommodate two circuit closing plungers 20 and 21, made of non-conducting material. Each plunger comprises a plunger shell 22, and an electro-conductive contact member 24 loosely carried on a rivet 23 secured to shell 22. This loose arrangement is resorted to so as to obtain a good contact regardless of whether the plunger comes down squarely or not.

A non-conducting cylinder 25 insulates the plunger assembly with respect to the shell cover 15. The plungers 20 and 21 are formed with a shoulder 26 to provide a supporting surface for an expansion spring 27 which with its other end bears against the inside of the top of the cover 15. The plungers are recessed axially at 28 to permit the cemented anchoring, at 29, of one end of a heat-responsive strand 30. This strand may be of any natural or synthetic filament-shaped material, such as cotton, silk, or Celluloid, or any other suitable material, that will disintegrate upon being exposed to a given high temperature. The filaments 30 of which there are shown only two in this case, through a suitable opening in the roof of the shell cover 15, pass upwardly and are held anchored at their upper ends at 31 in a recess 32 of plungers or anchor members 33.

It is to be understood that the number of strands shown herein is illustrated and is not meant to limit the scope of the invention, as will appear later.

Rigid uprights 35 positioned atop of the cover 15 serve to support an anchorage body 36 which carries the filament anchor members 33. Expansion springs 37 are placed between the body 36 and each of the anchor members 33 to provide a yielding support therebetween. A cap 38 is placed over the anchorage body 36 for its protection.

At this point it may be pointed out that the force of each upper spring 37 to that of each lower spring 27 is of the order of 2 to 1, so as to maintain the lower spring under constant compression in case of elongation of the strand which is under continuous tensile stress. It is thus seen that provision is made for automatic adjustment of any deformation of the strand so as to guard against any premature operation of the circuit closing member. Over a period of time, as the strand stretches, the upper and stronger spring takes up the slack with the result that each of the upper plungers 33 is lifted upwardly while each of the contact members 24 on the lower plungers is maintained at approximately the same distance from the contacts.

When the strand fails, the contact member carried by the lower plunger will act in a predetermined manner in spite of any possible elongation of the strand.

In Figure 2, the side view of the device of Figure 1 is shown sectioned in the main shell only, the reference numbers shown corresponding to the same elements as in Figure 1. The wiring in the shell has been left out as it would not add to the clarity of the view. An electrical outlet plug 39, having connecting studs 40 for the terminals 2, 3 and 4 is secured into the shell 1 and is provided with quick threads 41 for connection to a corresponding electrical circuit outlet.

In Figure 3, the shell 1 shown comprises two pieces held together by a bolt arrangement 42, so as to facilitate the assembly inside the device. The shell cover, in this case, is made of two separate halves, one of which is shown at 43. Plungers 44 and circuit bridging contact members 45 may be integrally formed, the shell cover 43 being non-conducting. It is, of course, understood that the contact member and the plunger may be made of two separate pieces in any one of a number of possible ways, and as already suggested in Figure 1. Anchors 46 for the lower ends of the strands 30 may be adjustable relative to the plungers by means of the threads 47 within the plungers, thus making possible regulation of the tension of the filaments. An aperture 48 through the contact members 45 permits the introduction of a tool therein to aid in such an adjustment. The upper ends of the strands are anchored in appropriate recesses 49 in an anchorage body 50 which also consists of two halves, one of which is shown. The spring support for the upper anchors has been here dispensed with, since in the case of a very short filament the elongation thereof is not as consequential as that of a long one, and the filament tension is capable of being regulated as shown.

At 51 and 52 are indicated cross bolts which serve to hold together the two halves respectively of the shell cover 43 and the anchor body 50.

Uprights 35, in this as well as in the construction of Figure 1 serve not only to support the upper anchorage body but also to give protection to the filaments against mechanical injury. The shape and nature of these protective and supporting members may take any desired form as long as they do not interfere with the primary function of the filaments which is to be properly exposed and responsive to a given ambient temperature.

In Figures 4 and 5, the reference numbers indicated relate to elements already explained.

In the diagrammatic circuit layout of Figure 6, A and B, and A' and B' have reference to the two subdivisions of two thermo-responsive devices as described above, 24 and 24' being the circuit bridging members as in Figure 1, adapted to bridge contacts 8 and 9, and 10 and 11; and 8' and 9', and 10' and 11', respectively. At 53 is indicated a source of E. M. F., and at 54 is seen a signal lamp, while 55 and 56 refer to the main circuit wires from the E. M. F. source to the lamp and back through contact bridges 24. The numeral 57 designates a test switch, ordinarily in its neutral position at 0, which, upon being placed into position A'' or B'' enables elements A, A', and B and B' to be tested for the failure of their heat-sensitive filaments through test wire 58 as will be shown at another point.

The device shown in the diagram of Figure 7, is essentially the same as that described before, except that it is shown to comprise three subdivisions of the circuit control element rather than two as before. The numbering of the elements corresponds to that of the previously described figures, where 2 and 3 are the main circuit terminals, 30 the thermo-responsive strands, and 24

the circuit bridging members, as before. The circuit bridging contacts are numbered 69 to 64.

In Figure 8, the schematic circuit layout incorporating a closed circuit and a triple-element device, has reference to elements similar to those of the preceding figures, except that the indicating lamp circuit, comprising wires 68 and 69, is controlled through the medium of electromagnetic relays 65, 66 and 67, rather than directly by means of members 24 as before which are biased toward open circuit in this case. Wires 70 and 71 through the normally closed circuit bridging members 24 supply current from the E. M. F. source 53 to the three relays, thus holding open contact points 72, 73 and 74.

The operation of the device is quite apparent, an exposure to a given high temperature, having as a consequence the practically instant failure of all the strands 30, with the result that the circuit between terminals 2 and 3 is bridged by means of elements 24, causing an indication by lamp 54. From inspection of Figure 6, it will be seen that the failure of both strands of either device is necessary in order to bring about complete bridging of the circuit between wires 55 and 56. Although the accidental failure of one of the strands is possible at any time, the desired indication in case of fire is still obtainable as the remaining strand will operate and thus complete the circuit. It is, of course, obvious that within practical limits, the number of strands and circuit control member subdivisions may be increased to any desired extent, naturally, including appropriate modifications in the general design of the device and the attendant circuits.

Should, after operation of the device, a replacement of the filaments become necessary, a loosening of coupling member 16 will permit replacement, as a unit, of the shell cover 15 including the plunger and upper anchorage assembly, enabling the system to be made ready for another indication on very short notice and without the necessity for any particular skill.

With safety systems of the type referred to, it is generally the custom to subject them periodically to check-over tests for the purpose of ascertaining their state of preparedness. Since, in the embodiment of the invention as shown in Figure 1, the failure of both filaments is indicated automatically, it is only necessary to obtain an indication when desired, of the failure of either of the strands. This is accomplished by means of the test switch 57 and the wire 58 to which are connected the contacts 8 and 11, as in Figure 6. It is seen that an indication will be obtained, for instance, if portion A of the device has operated by shifting the switch 57 to position A'', the current going from one side of the E. M. F. source through the lamp 54, the terminal 3, the contact 10, the control member 24, the contact 11, to the terminal 4, through the wire 58, the switch 57, the contact A'', and back to the other side of the source 53. Similarly, an indicating circuit is established through the contact B'', should the portion B of the device have operated due to failure of its filament.

The function of the device of Figure 7 is obviously to close the circuit between terminals 2 and 3 when failure of all three strands 30 has occurred, while the circuit of Figure 8 requires all three circuit bridging elements 24 to move into open circuit position to interrupt the three parallel relay circuits between wires 70 and 71 in order to cause the contacts 72, 73 and 74, normally held open by the energized relays 65, 66 and 67 to close the circuit through indicating the lamp 54.

From the foregoing it will be seen that the invention as described above embodies the important objects pointed out at the beginning, providing, as it does, a thermo-responsive device for the detection of fire and high temperatures which is exceptionally dependable; which, by the expedient of subdividing the thermo-responsive circuit controlling element provides an insurance against accidental failure, an indication of a predetermined condition being almost always obtainable; which, by incorporating filament tension adjustment facilities prolongs the dependable life of the device and materially reduces the possibility of premature operations; a device which is easily put into a state of preparedness after having operated and without the necessity of disturbing any circuit connections, and which lends itself to simple and effective supervision.

However, while the invention has been described in connection with the details of construction shown in the accompanying drawings, it will be apparent to those skilled in the art that the invention can be embodied in other forms of construction without departure from the scope of the invention, and for this reason I do not wish to be strictly limited to the disclosure but rather to the scope of the appended claims.

I claim:

1. A thermo-responsive device comprising in combination, electrical current conducting means composed of a plurality of separately additive portions forming an operative unitary whole, electrical circuit contacts associated with each of said portions, means urging said subdivisions into an ultimate desired position with respect to said contacts, and a separate substantially identical thermo-responsive member associated with each of said portions normally restraining said subdivisions from assuming said ultimate position, whereby upon the exposure of said members to predetermined temperature conditions all of said portions assume the desired position with respect to said contacts to complete a desired operative position of said conducting means.

2. A thermo-responsive device comprising in combination, electrical current conducting means composed of a plurality of separately additive portions forming an operative unitary whole, electrical circuit contacts associated with said portions, means urging said subdivisions into an open circuit relation with respect to said contacts, and a separate substantially identical thermo-responsive member associated with each of said portions normally restraining said subdivisions from assuming said open circuit position, whereby upon the exposure of said members to predetermined temperature conditions all of said portions assume said open circuit position with respect to said contacts to effect a complete open circuit operation.

3. A thermo-responsive device comprising in combination, electrical current conducting means composed of a plurality of separately additive portions forming an operative unitary whole, electrical circuit contacts associated with said portions, means urging said subdivisions into a closed circuit relation with respect to said contacts, and a separate substantially identical thermo-responsive member associated with each of said portions normally restraining said portions from assuming said closed circuit position, whereby upon the exposure of said members to predetermined temperature conditions all of said

portions assume said closed circuit position with respect to said contacts to effect a complete closed circuit operation.

4. A thermo-responsive device comprising in combination, a pair of electrical circuit terminals, electrical current conducting means formed with a plurality of separate subdivisions adapted together and additively to form a conducting bridge between said terminals, means urging said subdivisions into a circuit bridging position with respect to said terminals, and a separate thermo-responsive member associated with each of said subdivisions adapted to restrain said subdivisions from assuming a circuit bridging position with respect to said terminals against the force of said last recited means, whereby only upon the operation of all of said members under predetermined conditions an electrical current conducting bridge is formed between said terminals.

5. A thermo-responsive device comprising in combinaiton, a support, filament means adapted to disintegrate upon being exposed to a given temperature, retaining means for each end of said filament means, being slidably disposed in said support for at least one end of said filament means, spring means interposed between said slidably disposed retaining means and said support, electrical contacts disposed in said support, electric current conducting means on the retaining means of one end of said filament means adjacent said contacts adapted to bridge said electrical contacts normally held out of touch therewith by said filament means, and electric current terminals in said support operatively connected to said contacts adapted for connection to an electric circuit.

6. A thermo-responsive device comprising in combination, a support, two independent fully exposed filaments adapted to disintegrate upon being subjected to a given temperature; a retaining member for each end of said filaments, being slidably disposed in said support for at least one end of each of said filaments, spring means interposed between said slidably disposed retaining members and said support, whereby said filaments are constantly maintained under yielding stress, a pair of electric circuit terminals disposed in said support, an independent electric current conducting member on each of two of said retaining members held in a non-actuated position by said filaments, and electric contacts adjacent to said conducting members in said support electrically connected to said terminals adapted in combination with said two conducting members to form a circuit bridge across said terminals upon disintegration of said filaments.

7. In a thermo-responsive device of the type having thermo-responsive filament means, and electric circuit controlling means restrained by said filament means from assuming an ultimate operative position, the combination of retaining means for each end of said filament means of which the retaining means for one end of the filament carries said circuit controlling means, and spring supporting means for each of said retaining means, the spring support for the retaining means carrying the controlling means being weaker than the other spring means, whereby any elongation of the filament means is taken up by the stronger spring, the weaker spring being maintained under constant stress.

8. In a thermo-responsive device of the type having thermo-responsive filament means, and electric circuit controlling means restrained by said filament means from assuming an ultimate operative position, the combination of a plurality of filaments, and an equal number of separate subdivisions for said circuit controlling means associated with said filaments, said subdivisions adapted together and additively to form said circuit controlling means.

9. In a thermo-responsive device of the type having thermo-responsive filament means, and electric circuit controlling means restrained by said filament means from assuming an ultimate operative position, the combination of a receptacle, a structure supporting the filament and circuit controlling means, and coupling means, said receptacle and said supporting structure being separately united by said coupling means to form a unitary structure.

10. A thermo-responsive electric circuit controlling device comprising a pair of circuit terminals, circuit terminal subdivision means for each terminal, electro-conductive bridging means for each of said subdivisions urged toward an operative position with respect to said subdivisions, thermo-responsive means having subdivisions, one associated with and restraining each of said bridging means from assuming said operative position, and supporting means for said thermo-responsive means.

11. A thermo-responsive electric circuit controlling device comprising in combination, a receptacle having terminals adapted for coupling into an electric circuit, intermediate terminal means in said receptacle for said terminals, conductive bridging means comprised of subdivisions for each of said intermediate terminal means being urged toward an operative position with respect thereto, thermo-responsive means having subdivisions, one restraining each of said subdivided bridging means, and supporting means for said thermo-responsive means.

12. A flame detector comprising in combination a receptacle; a pair of main terminals adapted for coupling to an electric circuit, intermediate terminals connected to said main terminals, common median terminal means for said intermediate terminals, all said terminals and terminal means disposed in said receptacle; supporting means, said last named means supporting a member to conductively bridge each of said intermediate terminals with said median means, means urging said bridging member into a bridging position, a flame sensitive filament for each of said bridging members and normally restraining said members, and retaining means for the ends of said filaments; whereby upon the exposure of said filaments to a flame, a conductive bridge is formed between said main terminals comprised of conductive subdivisions.

13. In a thermo-responsive device of the type having thermo-responsive means, and electric circuit controlling means restrained by said responsive means from assuming an ultimate operative position, the combination with a pair of main terminals, of intermediate terminals, and bridging means therefore adapted to form separately operable bridging sections, said sections together forming a conductive bridge for said main terminals.

14. In a thermo-responsive device of the type having thermo-responsive means, and electric circuit controlling means restrained by said responsive means from assuming an ultimate operative position, the combination with a pair of main terminals, of bridging means for said terminals comprising a plurality of separately operable bridging sections, and a thermo-respon-

sive member for each of said bridging sections, the operation of all of said responsive members being necessary to completely bridge said main terminals.

15. A device for the control of an electric circuit, comprising thermo-responsive means having independent subdivisions, circuit control means comprised of independent control members, one associated with each of said subdivisions to be restrained thereby from assuming an ultimate operative position, said control being effective only when all of said subdivisions have operatively released said control members into their ultimate position.

16. A flame detector comprising in combination, receptacle means, containing a pair of main circuit terminals, a median circuit terminal, and four intermediate terminals, two of said intermediate terminals being conductively connected to each other and to said median terminal, the two other intermediate terminals being each connected to one of said main terminals; and supporting means, said supporting means supporting a member each, for conductively bridging a pair of said intermediate terminals, each pair of said intermediate terminals including one of said conductively connected terminals, means urging each of said bridging members into a bridging position, and a flame sensitive filament associated with each of said bridging members normally adapted to restrain said members from assuming a bridging position.

HARRY C. GRANT, JR.

CERTIFICATE OF CORRECTION.

Patent No. 2,318,607. May 11, 1943.

HARRY C. GRANT, JR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 42, for the word "illustrated" read --illustrative--; page 3, second column, line 36, and line 40-41, claim 1, line 52 and line 56-57, claim 2, and line 68, claim 3, for "subdivisions" read --portions--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of November, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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(Seal)