March 19, 1929. G. R. RADLEY 1,706,042

ELECTRORESPONSIVE SWITCH

Filed June 18, 1920

Fig. 1

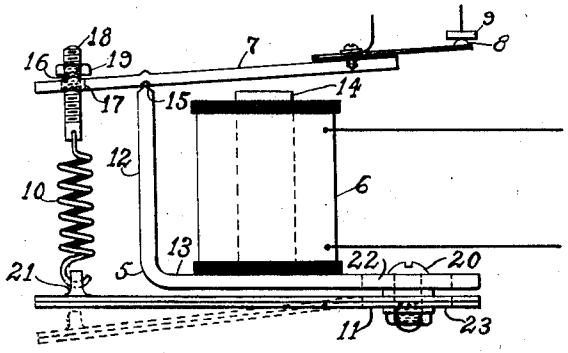


Fig. 2.

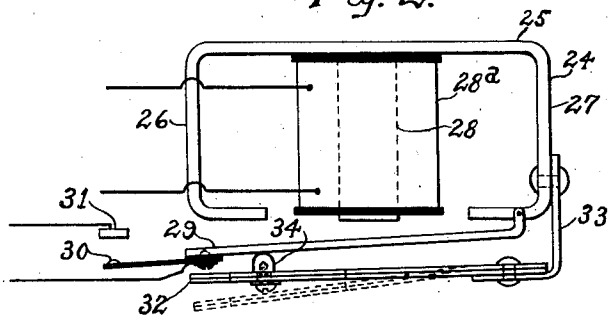
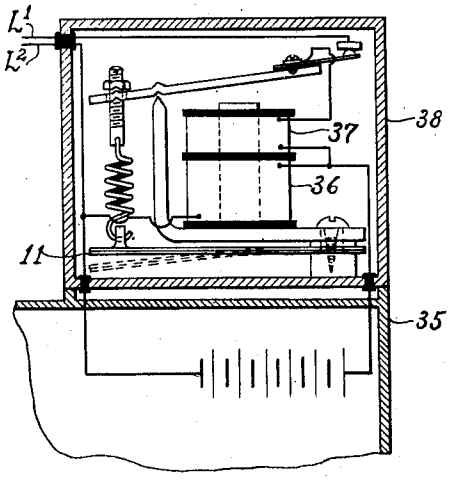


Fig. 3.



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Patented Mar. 19, 1929. 1,706,042

UNITED STATES PATENT OFFICE.

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ELECTRORESPONSIVE SWITCH.

Application filed June 18, 1920. Serial No. 389,863.

This invention relates to electro-responsive switches.

More particularly the invention relates to such switches having means for selecting or varying the electrical conditions under which response thereof is effected.

One object of the invention is that of providing for varying automatically, and in accordance with temperature variations, the conditions under which such switches are adapted to respond.

Another object is that of providing a switch of the character aforestated which is adapted to terminate the supply of charging current to a battery with precision upon attainment of a given state of charge, irrespective of changes in internal resistance of the battery due to variation in temperature thereof and of other variable conditions.

Other objects and advantages will hereinafter appear.

The accompanying drawing illustrates certain of the forms which the invention may assume in practice and the same will now be described, it being understood that the invention is capable of embodiment in numerous other forms.

In the drawing,

Figure 1 is a diagrammatic view illustrating a proposed embodiment of the invention.

Fig. 2 is a similar view of a slightly modified construction thereof; while

Fig. 3 is also a diagrammatic view illustrating a proposed adaptation of the invention to the control of a battery circuit.

Referring to Fig. 1 of the drawing, the same illustrates an electro-responsive switch comprising a magnetic frame 5, having an energizing winding 6, an armature 7 medially pivoted upon a portion of said frame for oscillation relative thereto and a contact 8 carried at one end of said armature for oscillation therewith to cooperate with a relatively fixed contact 9. Said armature is biased to cause engagement of said contacts by means of a tension spring 10 having one end secured to the free end of said armature member, while a thermostatic element 11, having one end secured to the frame 5 and its opposite end adapted to move with reference to said armature under thermic influence provides a point of securement for the opposite end of the spring.

More specifically, the frame member comprises an L-shaped member having a vertical leg 12, a horizontal leg 13, and a core 14 permanently secured medially of said leg 13 thereof and extending in parallel relation with the leg 12, said latter mentioned leg being terminally provided with the knife edge 15 upon which the armature 7 is pivoted. The movable contact 8 is permanently secured preferably in a resilient and insulated relation to the end of said armature member adjacent to fixed contact 9. The opposite end of said armature member is provided with a second knife edge 16 and is furthermore provided with an enlarged opening 17. A screw threaded stud 18 of lesser diameter than said opening 17 is located therein and provided on the outer side of said armature with a retaining and adjusting nut 19 having one or more notches to cooperate with the knife edge 16. The end of said stud upon the inner side of the armature member is preferably provided with an opening to receive the end of the spring 10.

The thermostatic element 11 which may advantageously comprise a bi-metallic strip, is arranged in parallel relation with the horizontal leg 13 of the frame 5 and anchored in spaced relation thereto by means of a bolt 20. The free end of said strip is furthermore provided with means indicated at 21 for securement of the adjacent end of the spring 10.

The contiguous portions of the frame 5 and the thermostatic element 11 are preferably provided respectively with registering elongated slots 22 and 23 permitting adjustment of the effective length of said element whereby the extent of movement of the free end thereof in response to given thermic change may be regulated.

In practice the foregoing structure is so located as to subject the thermostatic element 11 to the variable thermic conditions in accordance with which the same is desired to be responsive whereby the free end of said element is adapted under the influence of such thermic variations to change its position with reference to the knife edge 15, thereby varying the tension of the spring 10, and correspondingly varying the degree of energization of the coil 6 necessary to effect response of the switch.

Also assuming resilient mounting of the contact 8 upon the armature 7, the aforedescribed movement of the free end of the thermostatic element is adapted to change the angular position of said armature with reference to the magnetic core 14 thereby varying the length of the air gap between said elements for further varying the responsiveness of the switch in a like sense.

The characteristics of the regulating means may obviously be reversed by reversal of the thermostatic strip with reference to the frame, whereby the direction in which said element is adapted to bend in response to a given character of temperature variation is reversed, also by shifting the bolt 20 longitudinally of said element, the effective length of the latter is varied whereby the extent of movement of the free end of said element in response to a given value of temperature variation may be adjusted at will. Furthermore the screw stud 18 and the nut 19 provide means for calibrating the switch to respond to the desired degree of energization under given temperature conditions.

The construction illustrated in Fig. 2 is, in most essential respects analogous to that aforedescribed. In this construction the magnetic frame 24 is preferably of inverted U-shape, having a horizontal central section 25 and depending vertical legs 26 and 27 and being provided centrally of its horizontal section with a downwardly extending core 28 having an energizing coil 28^a. An armature 29 is pivotally supported at the lower terminal portion of the leg 27 of said frame, said armature carrying at its free end a contact 30 adapted to cooperate with a relatively fixed contact 31 but biased by gravity out of engagement therewith. A thermostatic element 32 is arranged below and substantially in parallel relation with the armature 29, said thermostatic element having one end thereof permanently secured to the leg 27 of said frame by means of an interposed angle bracket 33.

An adjustable stop member 34 is carried by the thermostatic element 32 to directly engage the armature 29 for limiting downward or outward movement of the latter, whereby the contour of said thermostatic element serves to determine the effective air gaps between said armature and the core 28 and leg 26 of the magnetic frame. Obviously as said thermostatic element changes its contour in response to thermic variations, the length of said air gaps and consequently the degree of energization of the coil 28^a necessary to effect response and closure of the switch are correspondingly varied.

The sensitiveness of this device to thermic variations may be varied by shifting the stop 34 longitudinally of the thermostatic element whereas the degree of energization required to effect response thereof at a given temperature may be adjusted by bending the angle bracket 33 to increase or decrease the normal length of the air gaps as desired.

While the aforedescribed switch mechanisms are adapted to use in various relations, the same may with peculiar advantage be employed in the control of storage battery circuits.

The importance of rendering such control directly responsive to the exact state of charge of the battery is recognized, whereas it is also known that the temperature of a battery rises automatically during charging and that the battery internal resistance decreases proportionally to such temperature rise.

Thus the terminal voltage of a battery does not depend solely upon the actual chemical state of charge thereof, but on the other hand includes a component determined by the product of the internal resistance of the battery times the value of current flowing in the battery circuit, such component being additive during charging and subtractive during discharging. It is thus apparent that the degree of energization of a switch actuating coil connected across the battery terminals is influenced both by the temperature of the battery and by the magnitude of the current flowing in the circuit thereof.

Fig. 3 illustrates a proposed adaptation of the switch shown in Fig. 1 to terminate the supply of charging current to a battery upon attainment of a given state of charge and irrespective of variations in temperature of the battery or in value of the charging current.

In said figure is illustrated a switch, in general similar to that shown in Fig. 1, mounted directly upon and in close proximity to a storage battery 35, the latter to be supplied with charging current from lines L^1—L^2 subject to interruption of the charging circuit through action of said switch. The foregoing arrangement serves to subject the thermostatic element 11 of the switch to thermic conditions closely approximating those of the battery.

The switch is provided with a shunt winding 36 connected directly across the battery and with a series winding 37 arranged to oppose the pull exerted by said shunt winding to thereby compensate for variations in value of the charging current in a known manner, whereas the thermostatic element is adapted to automatically vary the degree of energization required to effect response of the switch to thereby compensate for the rise in temperature of the battery during charging, whereby the switch is adapted to open the charging circuit with precision upon attainment of a predetermined state of charge of the battery and substantially uninfluenced by the aforementioned variable conditions.

Further the time interval required for the thermostatic element to follow the temperature changes of the battery is advantageous in providing for a slight overcharge of the battery prior to interruption of the charging circuit.

The circuit connections of the aforedescribed construction are believed to be obvious whereas the switch may be calibrated and adjusted to meet practically any desired service conditions by the means hereinbefore described.

The type of switch illustrated in Fig. 2 may with similar advantage and in a manner obvious from the foregoing be arranged to interrupt a battery circuit upon attainment of a given state of discharge thereof. Also it may be observed that in either case the thermostatic element serves to compensate for variations in surrounding temperature as well as for internal temperatures of the battery.

In practice the switch when located above the battery as illustrated is preferably enclosed within a substantially hermetically tight housing indicated at 38 to protect the same from possible injury due to action of the gases liberated during charging.

What I claim as new and desire to secure by Letters Patent is:

1. In a device of the character described, the combination with an electromagnet comprising an energizing coil, a series compensating coil and an armature co-operating therewith, of a pivotal support for said armature, an adjustable tension spring for said armature, a bimetallic means adapted to independently adjust the tension of said spring and a pair of contact members co-operating with said armature.

2. In a device of the character described, a frame, an electromagnet comprising a plurality of coils and a movable armature actuated by said coils, a tension spring associated with said armature, adjusting means therefor, a temperature-compensation element connected with said adjusting means, a contact member carried by said armature, a second contact member co-operating therewith and supporting means for said second contact member.

3. In a device of the character described, the combination with a frame, an electromagnet mounted within said frame and having an energizing coil, a magnetizable core associated with said coil, a movable armature associated with said core, a tension spring secured to said armature, and an adjusting screw for said spring, of a bimetallic member connected with and adapted to vary the tension upon the spring for a given position of said armature in accordance with the temperature variations of said device.

4. In a device of the character described, the combination with an electromagnet having a shunt coil, a series coil, a movable armature associated with said coils, tension means associated with said armature and adjusting means therefor, of a bimetallic element connected with and adapted to vary the tension of said tension means in accordance with temperature variations in said device.

5. The combination with an electromagnet comprising an energizing coil, a series compensating coil and an armature co-operating therewith, of means for oscillably supporting said armature, an adjustable tension spring for said armature, a bimetallic means adapted to independently adjust the tension of said spring and a pair of contact members co-operating with said armature.

In witness whereof, I have hereunto subscribed my name.

GUY R. RADLEY.