(No Model.)

H. A. RHODES.

THERMAL CIRCUIT CHANGER AND PROTECTIVE APPLIANCE.

No. 484,822. Patented Oct. 25, 1892.

Fig. 1.

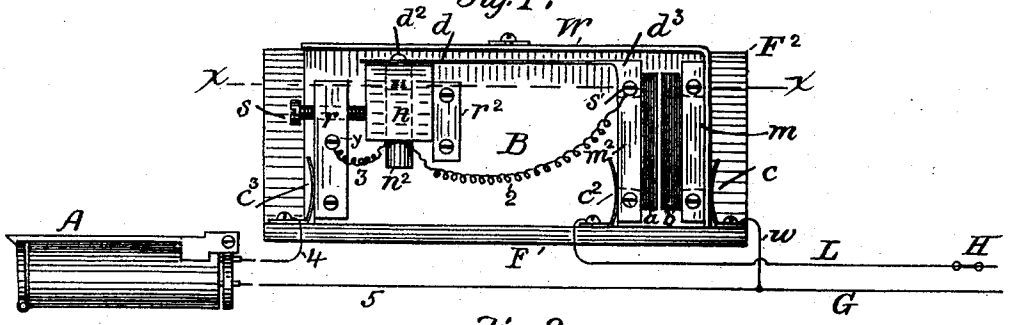


Fig. 2.

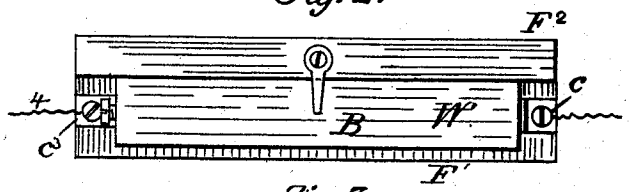


Fig. 4.

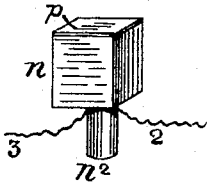


Fig. 3.

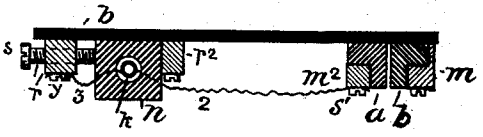


Fig. 7.

Fig. 5.

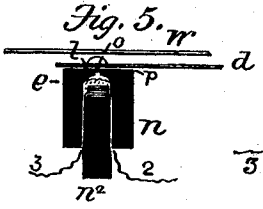


Fig. 4.a

Fig. 6.

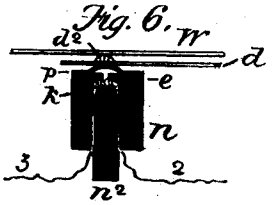


Fig. 8.

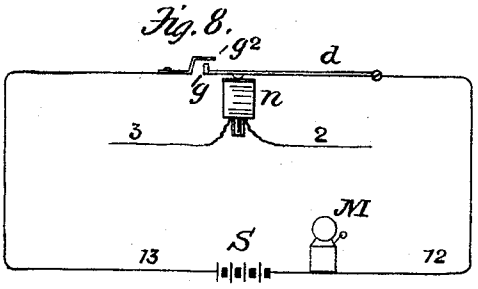
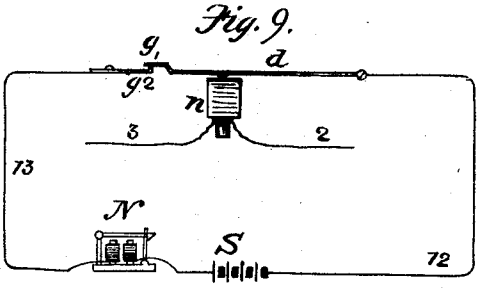


Fig. 9.



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UNITED STATES PATENT OFFICE.

HARRY A. RHODES, OF DENVER, COLORADO.

THERMAL CIRCUIT-CHANGER AND PROTECTIVE APPLIANCE.

SPECIFICATION forming part of Letters Patent No. 484,822, dated October 25, 1892.

Application filed March 11, 1892. Serial No. 424,539. (No model.)

To all whom it may concern:

Be it known that I, HARRY A. RHODES, residing at Denver, in the county of Arapahoe and State of Colorado, have invented certain Improvements in Thermal Circuit-Changers and Protective Appliances, of which the following is a specification.

My invention relates to the protection of electrical apparatus and stations from the destructive effects of unduly-strong electrical currents which may at any time reach and traverse the circuits with which such electrical apparatus is associated by reason of an undesigned contact of the said circuits with others which properly conduct the said destructive currents for the supply of electric-lighting or power-translating devices or other analogous systems requiring for their operation currents of great strength and volume.

Its object is to provide an efficient automatic thermal circuit-changer adapted to respond to the passage of a sufficiently-strong current through an electric circuit with which it is connected through the intermediation of the heat developed by the passage of such current and thereupon to close, open, or otherwise change the condition of a second or auxiliary circuit or to change the condition of the actuating-circuit itself, which circuit-changer, moreover, shall be capable of automatically reversing its operation and restoring the original condition of the circuit or circuits upon the cessation or disappearance of the current to which its initial action was attributable.

A further object of my invention is to provide a satisfactory and trustworthy protective appliance for electric, and particularly for telephonic, apparatus and circuits which shall be prompt and certain in its operation, sure in result, and automatic both in coming into and going out of action, and which, furthermore, shall be capable of exercising its protective functions a great number of times without disarranging its own mechanism and without requiring attention or adjustment. It is well known that stray currents of the greatest strength are not the most dangerous and that such as are merely of strength sufficient to gradually heat the magnet-wires of telegraphic and telephonic apparatus or office-wires in masses have proved in practice to be such as it is most necessary to specially guard against. These are technically termed "sneak-currents," and their presence in circuits made up of conductors and apparatus which are not of sufficient specific conductivity to conduct them without being gradually heated has been found to produce most disastrous results. Heavy currents—say having a strength of several ampères—can be guarded against by properly-proportioned fuses. Experience and trial has demonstrated that sneak-currents are best guarded against by either thermal or electro-magnet appliances; but if applied to telephonic circuits electro-magnets interpose a very considerable apparent resistance, consisting in part of true resistance and in part of the counter electromotive force of self-induction, and for this reason, and also for the reason that thermal protectors properly constructed are extremely responsive, I prefer them.

My invention consists in combining a substance having a high coefficient of expansion under varying temperature, and which is elastic—such as mercury or alcohol—inclosed in a vessel or chamber of adjustable capacity having a side or wall which is elastic and highly expansible, but of very considerable rigidity or stiffness whether in its expanded or normal condition, with an attenuated and concentrated section of an electric circuit embedded in or closely approximated to the said inclosed substance, so as readily to subject the same to changes of temperature as the strength of the current flowing in the circuit varies, and with a circuit-changer adapted to be mechanically acted upon by the said elastic side or wall of said chamber and to move in one direction when the heat of the attenuated section of conductor rises in correspondence with an increase of current strength in the circuit and in the other direction as such current and its accompanying heat diminishes.

It consists, also, in a specific construction of an appliance embodying the above characteristics and comprising a non-conducting chamber, a flexible and expansible diaphragm or membrane closing the same, mercury or alcohol inclosed therein, a heat-concentrat-

ing section of insulated conductor of small volume embedded in or in close juxtaposition to the said expansible inclosed body and adapted to be connected in and with an electric circuit, and a switch or circuit-changer which may form a part of the circuit within which is included the said insulated conductor, form part of an independent circuit, or which may be simply a mechanical switch-operating or mechanism releasing-lever.

It consists, also, in certain other combinations of electric apparatus and details of construction more fully described in the several clauses of claims which are appended to this specification.

In the drawings, Figure 1 is a side elevation of my appliance shown as being associated with an electric circuit for the protection of a call-receiving apparatus. Fig. 2 is a top view thereof. Fig. 3 is a horizontal section on the line x x of Fig. 1. Fig. 4 is a detached view of one form of the expansible-conductor-containing chamber. Fig. 5 is a sectional elevation of the same associated with the approximate parts of a switch adapted to be actuated by the expansible inclosed medium. Fig. 6 is also a sectional elevation as it appears after having come into operation. Fig. 4^a shows the heat-concentrating section of conductor in its actual size; Fig. 7, a portion of an associated lightning-arrester or disruptive-discharge-protective device; and Figs. 8 and 9 show my appliance associated with two circuits in such a way that an undue rise of current strength in one is enabled to produce a definite change in the condition of the other.

The drawings represent, substantially, the actual size of a complete appliance which has been successfully employed in practice.

In Figs. 1 and 2, F is a base-board of wood or like material, and F^2 is an upright wall or partition of the same material secured thereto.

The several elements of the appliance B may be all mounted on the upright partition F^2; but I prefer to secure the parts to a background plate of hard rubber or similar material b and to connect the electric parts thereof with the circuit by providing suitable contact-surfaces and by arranging that these shall register with contact-spring c, which leads to a ground-wire w; c^2, which virtually is the line-terminal leading into the appliance, and c^3, which is the continuation line-terminal leading out to the instrument or apparatus to be protected and to the ground-wire or return-conductor.

Before referring in detail to the operative parts of my invention as combined in a protective appliance I will describe them first without regard to any such combination and will show their adaptation to the operation of circuit-changers generally.

Referring to Figs. 4, 4^a, 5, and 6, an inclosing chamber n is made of vulcanite or hard rubber, vulcanized fiber, or some similar suitable material which is a non-conductor of heat and electricity and is provided with a closely-fitting plug n^2 of like material, which enters the said chamber to a greater or lesser extent, and thus regulates the internal size and capacity of such chamber.

Fig. 4 well represents in perspective the size and shape of an inclosed chamber which has been made and satisfactorily used in connection with a working appliance. There is no need, however, of making it with square and rectilinear sides, except that when so made it is easily and conveniently secured, as in Figs. 1 and 3, where it is shown as being fixed in position against the abutting bar r^2 by means of the screw s, which passes through a threaded hole in the abutting plate or post r. The chamber bored in the non-conducting block n may be bored entirely through it; but I prefer to form the same leaving a thin wall l of the substance of the block at the end, which is then perforated or pierced by a smaller hole o, through which, the closing-plug n^2 being in place, a medium which elastically expands when heated is, if it be a fluid, introduced. Either mercury or alcohol will answer; but I have found mercury to be peculiarly efficient, and a single drop or globule answers well. Before putting in the plug n^2 a device capable of speedily becoming heated upon the passage of an electric current which is even but slightly stronger than that for which the circuit is designed and which for the said passage of the current must be a conductor and a portion of the main circuit is placed within the chamber, and its terminals are allowed egress down the sides of the plug. A well-known contrivance for this purpose and one which I have found useful is a small coil k of fine insulated wire of some material having a high specific resistance. Iron, German silver, or platinum will answer. I have found that a coil of No. 36 German-silver wire sufficiently long to have a resistance of about twenty-five ohms and insulated with two coverings of silk, asbestus, or other insulating material which can withstand a considerable rise in temperature. The said coil of fine wire k when in place lies within the chamber between its end and the end of the inclosing plug, resting on the latter, and is embedded in the mercury or alcohol e, which surrounds it and permeates its interstices. The upper end of the block n is closed by an expansible and elastic or flexible diaphragm p, made of thin sheet-rubber or like material, which is secured thereto by bicycle-tire or other adhesive cement or, if desired, by a perforated screw-cap or gland. This, while securely sealing the mercury, expands outwardly as the mercury expands, as shown in Fig. 6, and furnishes a direct and rigid drum-head or mechanical contact capable of raising a lever d, a weight, or other device which it is desired to actuate. At the same time it automatically regulates the capacity of the chamber, keeping the pressure of the mercury upon the heating-coil uniform and causing the same (regardless of any position in which the de-

vice may be placed) to return when cool to its usual and normal position in the chamber.

Recapitulating, it now appears that n is the hard-rubber case or chamber; n^2, its adjustable closing-plug; k, the heat-concentrating coil, having ends 2 and 3 for attachment with the circuit; e, a drop of mercury or alcohol placed in the chamber upon and around the coil, and p the elastic diaphragm closing the chamber on the side opposite to the plug n^2. The coil of fine insulated wire k can by its ends 2 and 3 be included in any desired main circuit L. In Fig. 5 it is assumed that such current as may be flowing in said circuit is normal, and hence does not develop sufficient heat in the coil k to expand the mercury and bulge out the expansible diaphragm; but in Fig. 6 the contrary is the case and the expansible and elastic diaphragm p is shown as having been bulged outwardly by the enlargement of the chamber within n made necessary by the expansion of the mercury and the increased pressure brought to bear on said diaphragm. A light circuit-changing spring d is fixed at one end d^3 and movable at the other end, where it lies close to the surface of the diaphragm p and free to be moved outwardly by the outward expansion thereof. It may be provided with a convex contact-piece d^2, as shown in Figs. 5 and 6, where said contact-piece in Fig. 5 is out of contact with a fixed contact-bar W and in Fig. 6 has been moved by the expansion of the diaphragm p into contact with said bar. It may, moreover, be a portion of an electrical circuit or may be simply a portion of a mechanism.

In Fig. 8 the expansion of the diaphragm p and the consequent elevation of the spring d tends to close a normally-open alarm-circuit, a movable contact-point g, carried by said spring, being adapted thereby to be pressed against a fixed contact and limit-stop g^2. The circuit of the battery S is thus closed through wire 13, fixed contact g^2, movable contact g, spring d, wire 12, and bell M and an alarm will be given.

In Fig. 9 the same expansion and elevation of the spring d tends to open a normally-closed circuit, the said spring lifting the movable contact g from the fixed contact g^2, and, the armature of the annunciator N being released, its shutter will fall, giving a visual signal.

In Figs. 1, 2, 3, and 7, which refer more particularly to the use of my invention in a protective appliance for telephonic apparatus, it is associated, usually, with a lightning-arrester or a discharger consisting of two closely-approximated plates a and b, preferably of carbon, connected, respectively, with the two sides or conductors L and G of the circuit. These may conveniently be held in place by making them in the form of angle-plates f, Fig. 3, and by placing metal plates m and m^2 within the angles and securing the whole to the rubber base by screws. The said metal plates also serve to make good contacts with the terminal springs c and c^2. One of the wires 2 of the heat-concentrating coil k is attached by one of the screws s' to the metal plate m^2, and the other wire 3 is united to a screw y in the metal post r. The incoming wire L of the main circuit, after passing a fuse H of sufficient capacity—say five ampères—connects with spring c^2. This presses against metal plate m^2, and from thence the circuit continues by wire 2, coil k within the chamber n, wire 3, metal post r, spring c^3, wire 4, annunciator A, and wire 5 to return-conductor or earth wire G. The movable contact-spring d is fixed at one end d^3 to the plate m^2, and its free end, furnished with a contact-piece d^2, lies upon or immediately over the expansible diaphragm p of the mercury-inclosing chamber. This spring is therefore a normally-discontinuous branch of the main circuit, connected therewith at a point outside of the annunciator and also outside of the heating-coil k. A light pivoted lever may of course be substituted for said spring. A metal plate W is connected metallically at one end with the carbon-holding plate m and extends along the top of the entire appliance immediately over but not in contact with the spring d. The spring c, which presses against the side of the plate m, is connected by wire w with the return-conductor or earth wire G. Thus the plate W is literally an earth branch. Whenever the spring d by its contact-piece d^2 is forced into contact with the plate W, the annunciator A and protective coil k are evidently short-circuited and the circuit is put to earth.

In operation as long as the current is normal the spring contact-piece d^2 will not touch the plate W; but the moment that an unduly-strong current passes through the circuit the heat of said circuit will concentrate in the fine-wire coil k and will pass therefrom to the mercury. This will expand and, if the heat becomes intense, will volatilize, although the appliance is so prompt and sensitive that the latter rarely can happen. In either case the sheet-rubber diaphragm p is expanded and bulges outwardly, assuming a hemispherical form. In its expansion it necessarily pushes the spring d before it, and thus causes the piece d^2 to make contact with the plate W, switching the dangerous current from the annunciator and protective coil to earth and concentrating its entire energy upon the fuse H, which, if the current be of sufficient strength, will be destroyed and will open the circuit.

It has been found in practice that currents of less than half an ampère readily and promptly cause my appliance to operate, and, furthermore, that, having operated, it is not destroyed, but is capable by reason of the prompt contraction of the mercury or other inclosed agent of automatically restoring the normal condition of the apparatus upon the cessation of the fault, provided that the ultimate current is not so strong as to blow out the fuse and is also capable of effecting its

protective function a large number of times without damaging its own mechanism and without attention.

I claim—

1. In a thermal protective appliance, a main conductor of an electric circuit, an earth or return conductor of the said electric circuit, a hollow cylinder or chamber of hard rubber or like material closed at one end and made of any desired normal capacity by a plug of the same material, an attenuated and concentrated section of the main conductor of said electric circuit—such as a coil of fine insulated wire of relatively-high resistance—inclosed within said chamber, a globule or drop of mercury placed, also, within said chamber upon and around said coiled conductor, an elastic, flexible, and expansible diaphragm closing the remaining end of said chamber and suitably secured thereto, a conducting-plate extending from the return-conductor to a point opposite to said expansible diaphragm, and a normally-discontinuous branch of the main conductor in the form of a light spring carrying a contact-point extending between the said plate and the said diaphragm and adapted upon the expansion of the latter to be moved into contact with the former, and thereby to unite the main and return conductors directly and short-circuit the inclosed coil of fine wire, substantially as described.

2. In a thermal protective appliance, a vulcanite inclosing cell closed at one end by a tightly-fitting plug whose depth of insertion regulates the capacity of said cell and closed at its other end by a diaphragm of thin sheet-rubber or equivalent substance, a heat-concentrating section of an electric circuit compressed into small bulk inclosed in said cell and extending therefrom by suitable connecting-wires, a drop of mercury also inclosed therein upon and around said heat-concentrating section and capable of being heated and expanded thereby and of exerting pressure upon said rubber diaphragm, and a switch bar, lever, or spring resting upon said diaphragm and moving therewith, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 2d day of March, 1892.

HARRY A. RHODES.

Witnesses:
E. B. FIELD,
E. M. BURGESS.