(No Model.) 2 Sheets—Sheet 1.

# H. V. HAYES.

## THERMAL PROTECTOR.

No. 441,066. Patented Nov. 18, 1890.

Fig. 1.

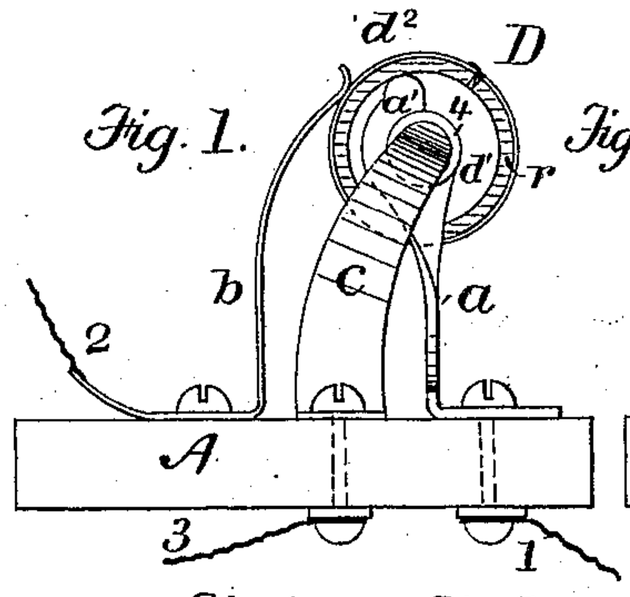



Fig. 3.

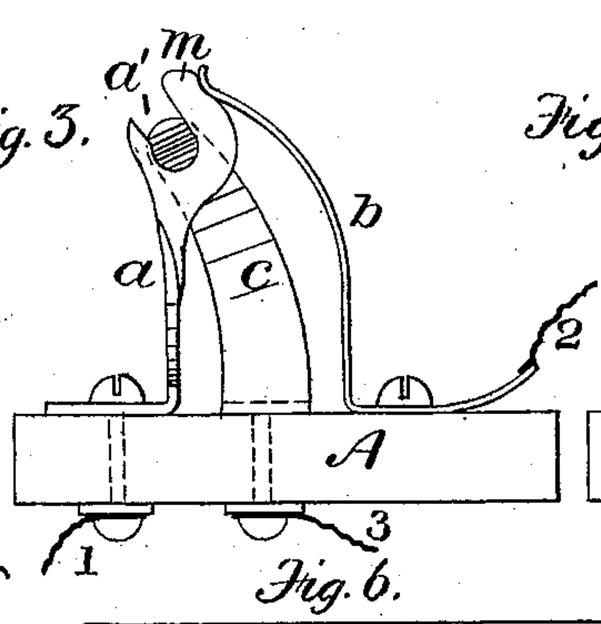



Fig. 2.

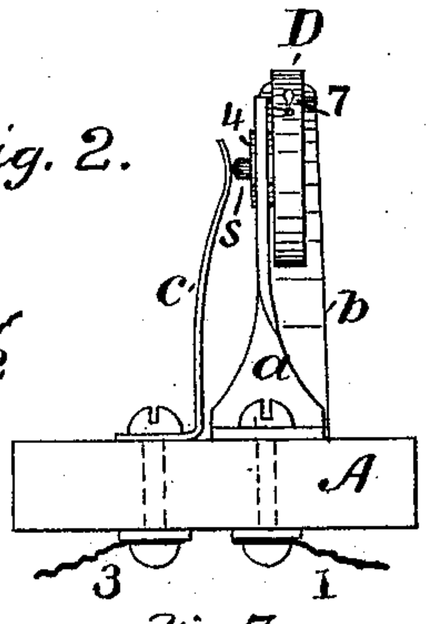



Fig. 4.

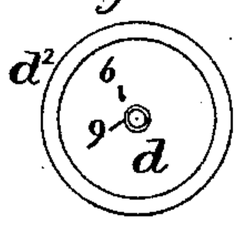



Fig. 5.

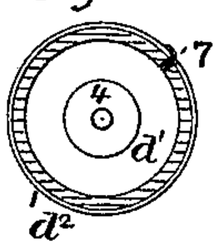



Fig. 6.

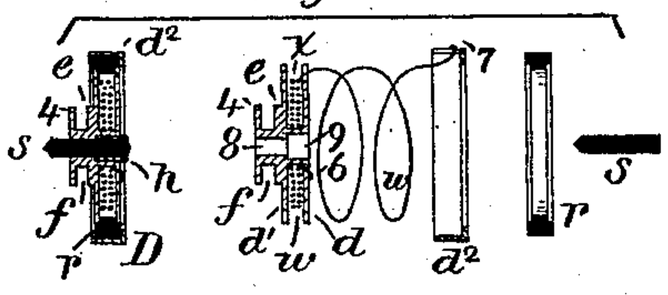



Fig. 7.

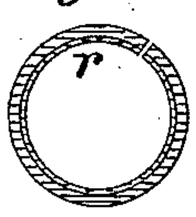



Fig. 8.

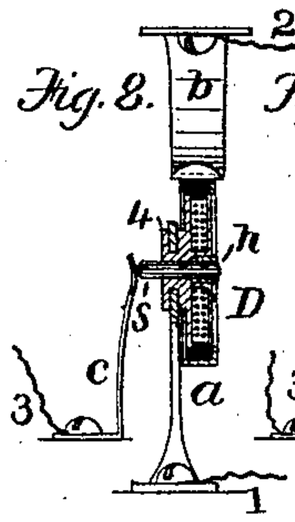



Fig. 9.

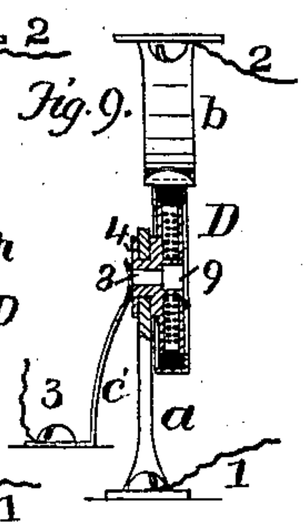



Fig. 10.

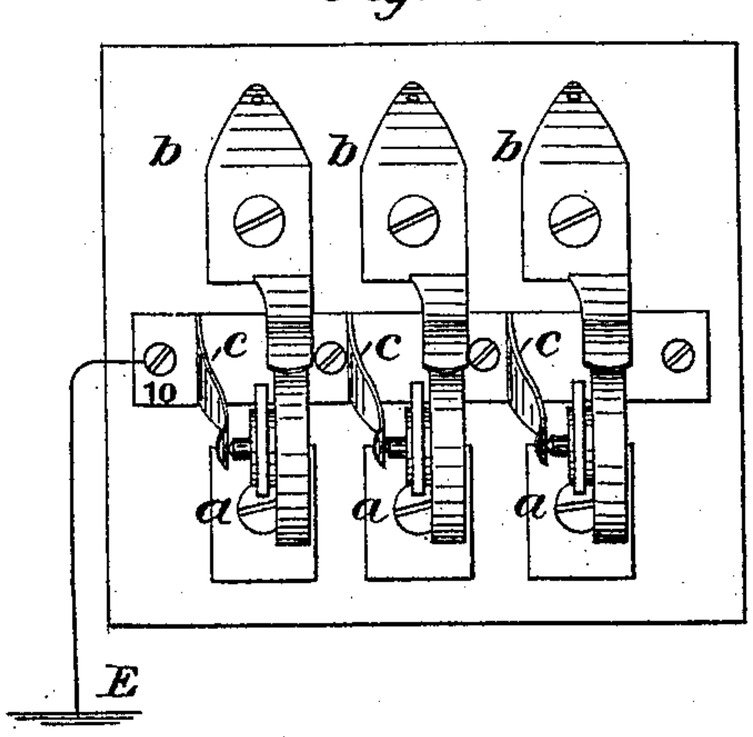
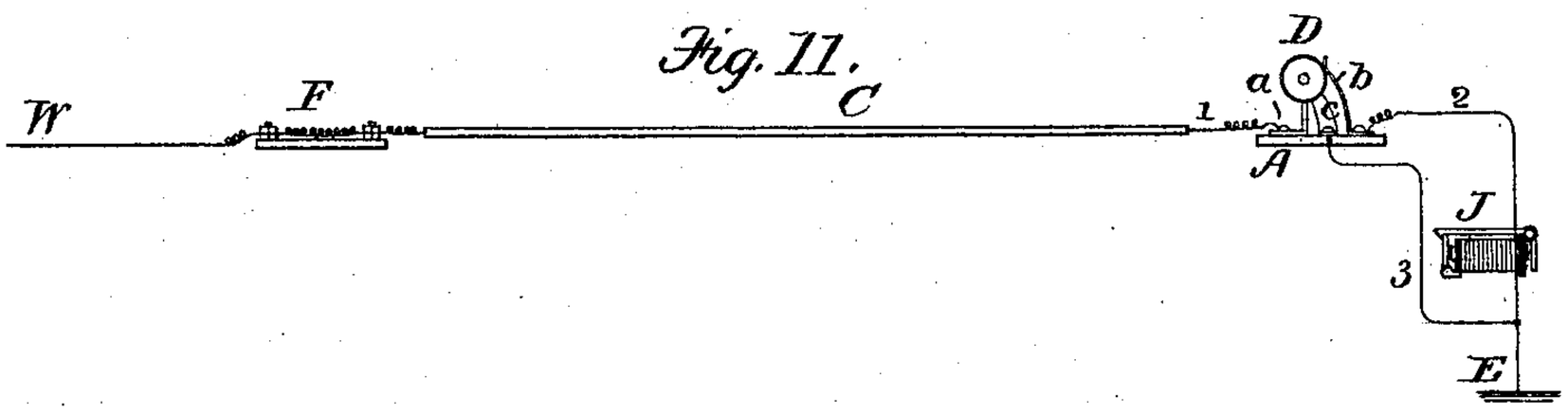



Fig. 11.




Witnesses.
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(No Model.) 2 Sheets—Sheet 2.

# H. V. HAYES.

## THERMAL PROTECTOR.

No. 441,066. Patented Nov. 18, 1890.

*Fig. 12.*

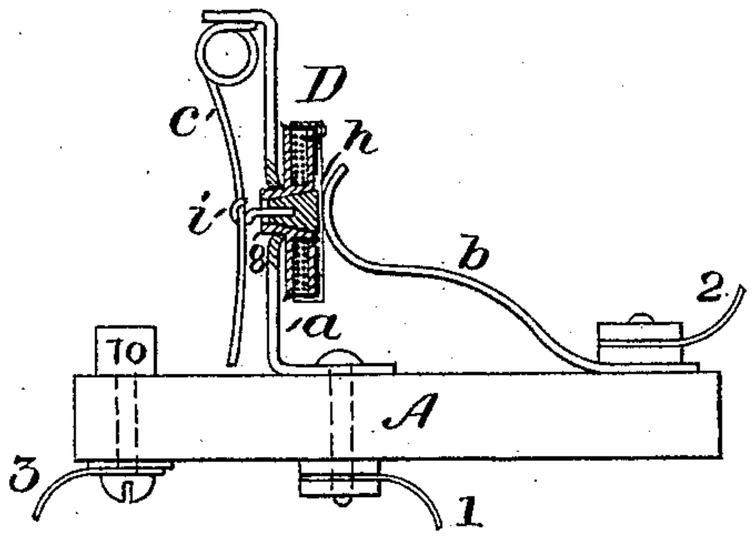



*Fig. 13.*

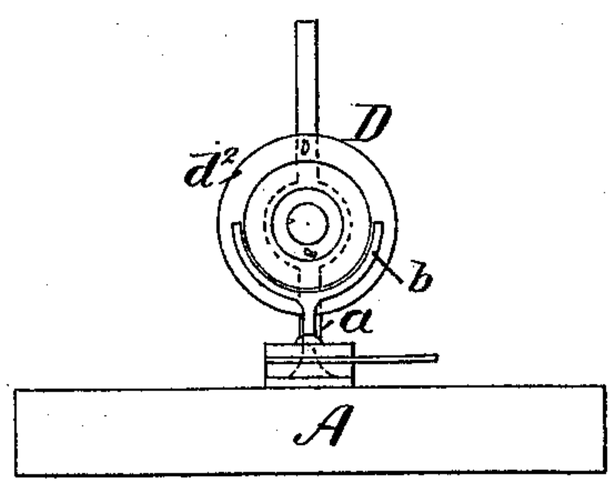



*Fig. 14.*

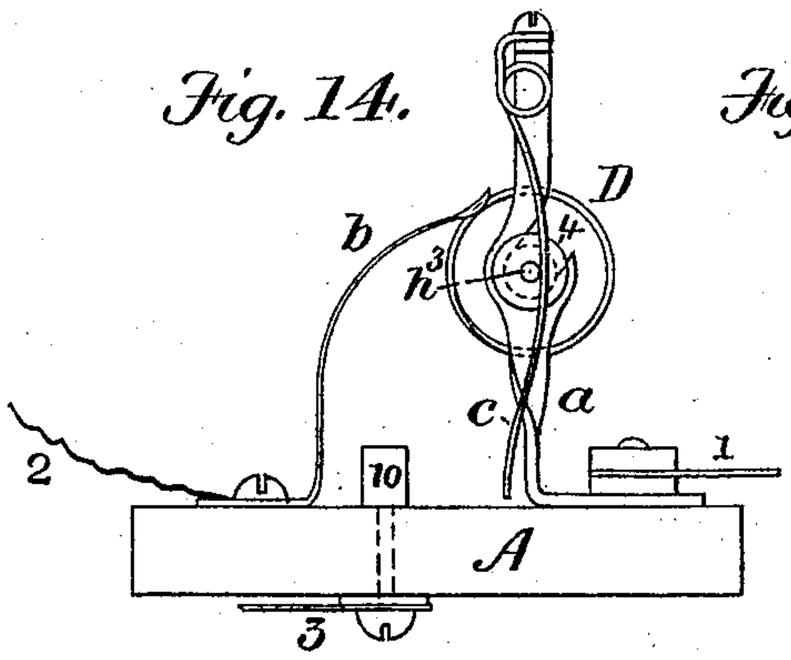
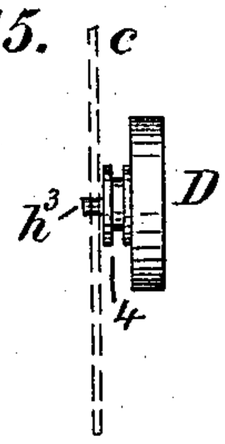



*Fig. 15.*




Witnesses.
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Hammond V. Hayes.

# UNITED STATES PATENT OFFICE.

HAMMOND V. HAYES, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF MASSACHUSETTS.

## THERMAL PROTECTOR.

SPECIFICATION forming part of Letters Patent No. 441,066, dated November 18, 1890.

Application filed July 17, 1890. Serial No. 359,073. (No model.)

*To all whom it may concern:*

Be it known that I, HAMMOND V. HAYES, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Thermal Protectors, of which the following is a specification.

The apparatus of telephonic and telegraphic circuits is exposed to great danger by reason of the wide and increasing employment in other systems of electrical currents of greater volume than those which are legitimately employed in the operation of such apparatus.

Electrical currents developed for the purposes of illumination and for the distribution of power are conducted extensively from one point to another by means of overhead conductors, which are frequently either bare wires or wires whose protecting-envelope is formed of material which is but an imperfect insulator. Telephonic, telegraphic, and other circuits operating with comparatively small currents and provided with instruments of comparatively delicate character having helices of fine insulated wire included in such circuits are of course liable to become crossed at any time with adjacent light or power wires, and are in bad weather liable also to receive a portion of the currents traversing them by means of leakage over intervening matter. When such electrical connection occurs between a telephone or telegraph wire and a bare wire carrying a light or power current by actual contact or otherwise, a considerable portion of the said current is of course diverted from the latter to the former and flows thereover from the point of contact to the termini thereof, and experience has demonstrated that even when such light or power wire is covered with an envelope said to be non-conducting such covering cannot be relied upon as a protection, especially in wet weather, or except when quite new, and that in the event of a cross of a telephone or telegraph wire therewith a transfer of electricity will take place, often with results extremely disastrous to the instruments and cables of the said telephone or telegraph wires. Apparatus connected with such telephone and telegraph wires and in circuit therewith is often totally destroyed by the heat developed in them by the passage of currents due to crosses with foreign wires occurring in the way I have stated, and in many other cases have been seriously damaged. Experience has also demonstrated that foreign currents of very great volume or developed under a high electro-motive force are really not more to be dreaded, and are often easier to provide against than are those which, while of much less volume or strength, are still greater than currents which properly traverse the helices of telegraphic and telephonic appliances. These currents of medium strength are often popularly termed "sneak-currents," because they usually pass the main-line conductors and many forms of protectors without manifesting heat in the one or operating the other, and, reaching masses of office-wires and instrument-coils, develop at first a low degree of heat therein, causing the insulation to smoulder, and this where wires are concealed may go on for a long time without discovery, ultimately, however, raising the heat to the combustion point and causing a flame to break out and to consume the apparatus. Where but a single instrument is exposed, the damage is of course confined thereto, its insulation, however, being invariably injured and sometimes irretrievably ruined.

The subject of my present invention is an appliance designed to operate under a moderate electro-motive force and with such a comparatively weak current as that to which I have last referred, and to protect apparatus from the destructive effects of such currents, since it is obvious that an ordinary fuse inserted in the main-line circuit will be effective against currents of great strength, and that the usual lightning-arrester may ordinarily be expected to ward off the evil effects of currents and discharges noticeable chiefly for their high electro-motive force.

The instrument I have invented has proved its efficiency with a current as small as twenty-five one-hundredths of an ampère, while it is of course more quickly responsive to stronger currents.

The object of my invention is to provide a

device simple in construction, easy of attachment, occupying small space, and efficient in operation, which can absolutely be relied upon to protect electrical instruments from injury due to heating caused by the passage through the helices of insulated wire forming part of such instruments of any currents materially stronger than those for which such helices are designed. To this end I have devised a thermal circuit-changer or cut-out which includes a switching device or movable contact-piece controlling an alternative circuit and capable of connecting said alternative circuit with the main circuit, but normally prevented from coming into action by means of a mechanical obstacle responsive to a suitable degree of heat when the same is directed thereon, and means for concentrating the major portion of the heat developed by an electric current traversing the circuit within which the circuit-changer is placed, and for directing it upon the said mechanical obstacle, whereby the said obstacle is permitted to be displaced, and the switching device is thereupon allowed to come into action and to divert the dangerous current away from any instrument in the main circuit which requires protection therefrom.

An efficient way of carrying out this invention is to wind a small coil of insulated wire of high specific resistance or of higher comparative resistance than the remaining portions of the circuit—such as German silver, platinum, or iron—on a metal bobbin of such dimensions and form as will receive and distribute to a core of easily-fusible metal or alloy or to a like easily-fusible setting of a non-conducting core in the shortest possible time whatever heat may be developed in the coil by the passage through it of a current of electricity. The core, which is placed in the center of the bobbin and coil, has a projection which serves as the mechanical obstacle to which I have referred and against it presses a spring, which may either itself be the free terminal of a circuit alternative to that leading through the instrument to be protected or which may be a branch of the main circuit, held normally away from a fixed contact-piece constituting the terminal of such alternative circuit. When sufficient heat is developed in the coil on the bobbin to soften the fusible core or setting, the pressure of the spring is enabled to overcome the same, and the said spring closes the alternative circuit. The coil on the bobbin is of course included in the main circuit at a point external to the instrument which is to be protected, and the circuit-changing spring-contact must be so arranged that the alternative circuit will join the main line at a point external to the said bobbin-coil, so that when the connection is made the said coil will no longer remain heated. Any dangerous trespassing current coming into the circuit must before reaching the instruments pass through the coil of high specific resistance, and the heat it develops in the circuit will be largely concentrated there and will at once be distributed through the substance of the metal bobbin upon the fusible core. The said coil is so made as to suffer the passage of the regular currents of the circuit without sufficient heating to operate the protector, this matter being regulated by the specific resistance of the material and the length and size of the wire. I have found about ten feet of German-silver silk-covered wire .0077 of an inch thick to answer perfectly in practice for the protection of telephone apparatus.

My invention further consists in the details of construction of the protector which I am about to describe; also, in the combination of an electric circuit the instruments whereof are to be protected; with shunting or circuit-changing devices, an easily fusible obstacle or an obstacle controlled by an easily fusible setting normally preventing the said devices from coming into action, a coiled section of said main circuit having, compared with other conductors of said circuit, a high resistance, whereby the heat developed by the passage of a strong electric current through said circuit may be practically concentrated in said coiled section, and means, as described herein, for the ready conduction of said heat from the said high-resistance section to the fusible part of said obstacle; also, in the combination of a main electric circuit including instruments to be protected and an alternative circuit constituting a shunt or earth-branch circuit therefor having a free terminal located at a point on said main circuit external to the point of connection of said instruments with a circuit-changing appliance having a normal tendency to effect the union of said main and branch circuits, and interposed mechanical obstacle formed of or held in place by a setting of easily fusible metal alloy or like material normally preventing the said circuit-changer from acting upon its tendency to effect said connection, a relatively-high-resistance section of said main circuit placed at a point between the instruments to be protected and the junction point of the main and branch circuits, and a mass of metal supporting both high-resistance section and the said easily fusible obstacle or setting and acting to conduct heat developed in the former through its substance to the latter for the purpose of freeing the circuit-changer and of permitting it to connect the alternative circuit to the main circuit, and thereby to divert any dangerously-strong current from the instruments, as well as from the high-resistance section itself.

In the accompanying drawings, Figures 1 to 10, Sheet 1, are different views and details of one form of thermal circuit-changing protector embodying the above principles. Figs. 1 and 2 are respectively side and end elevations of my protector complete. Fig. 3 is an opposite side elevation, the heat-concentrating helix and its incasing-bobbin having been de-

tached. Figs. 4 and 5 are respectively the two side views of the said detachable metal bobbin. Fig. 6 is a central cross-sectional edge view together with the same in a dissected condition. Fig. 7 is a side view of a non-conducting ring interposed between the wire wound on its reel and the outer metallic flange therefor, another view of said ring being shown as one of the parts of Fig. 6. Figs. 8 and 9 are views, partly in section, of the electrical connections before and after action, the representations being in some degree distorted, so as to more clearly disclose the operation. Fig. 10 is a plan view of a number of my protectors mounted on a common base and indicating the small amount of space required by them. Fig. 11 is a diagram showing the arrangement of the device in a main circuit. Figs. 12 and 13 are respectively a side elevation, partly in section, and an end view of a modification in form; and Figs. 14 and 15, respectively, are a side elevation and an edge detail of another modification.

Considering together Figs. 1 to 9, it will be seen that my protector is composed of a metal reel D, containing the heat-concentrating device, which is detachably mounted edgewise on a standard *a*, arranged for connection with the line-wire. A curved pressure-spring *b* presses on the edge of the reel and continues the circuit to the regular instruments. A second spring *c* constitutes the normally-free terminal of an earth or shunt circuit, and has a tendency to press against the flat side of the flange 4 of the metal reel, which tendency is, however, normally prevented from being carried out by the interposition of a stop or holder in its path—namely, the end of a pin of vulcanite or like non-conducting substance—which forms a core for the bobbin, and which is ordinarily fixed in the center thereof in a manner and for a purpose to which I will presently refer. The standard *a* may conveniently be made of brass, and the contact-springs *b* and *c* are preferably formed of German silver, and all three are suitably fixed, as shown, by screws and bolts upon a non-conducting base A.

As indicated in the diagram Fig. 11, the standard *a* is adapted for connection by wire 1, and, if desired, through the cable C and heavy-current fuse F with the main-line wire W. In like manner the contact-spring *b*, which, when the bobbin D is in place, presses on its edge, is adapted for connection by means of the wire 2 with the instrument J to be protected, the circuit passing thence to an earth-terminal E, or to its well-known equivalent, a return-wire. The contact-spring *c*, mechanically pressing upon, but normally insulated from, the bobbin D, is adapted by means of its connecting-wire 3 to constitute the terminal of a normally-incomplete alternative circuit forming an earth branch or shunt, which, when the stop or holding piece *s* is removed, connects with the main circuit by the contact of the end of the spring *c* with the flange-face 4, and this, as will be seen, at a point not only external to the instrument which is to be protected, but also outside of the heat-concentrating device contained in the bobbin D.

The size shown in the drawings of the various elements of my invention is convenient for actual use. I have now described the relative character and position of the different parts of the device, and will now, so far as seems necessary, describe some of them in detail.

The essential feature of the appliance is the bobbin D and its contents. These are particularly indicated in Figs. 4, 5, 6, and 7.

By reference first to Fig. 6, a disk-shaped bobbin is provided, comprising the side plates *d* and *d'*, between which is formed the thin flat space *x*. On the side *d'*, I form a shoulder or offset *e* and the flange 4, and between these the groove or neck *f*. All of this is metal. The bobbin has a hole through its center, which, however, is narrower as it passes through the neck at 8 than it is where it passes through the main reel at 9. A pin or stud *s*, of hard rubber or similar material, loosely fitting the smaller part 8 of the axial hole, is placed in the said hole, as shown, and is sufficiently long to project a short space beyond the flange 4, while the other end may be substantially flush with the surface of the bobbin-plate *d*. This pin *s* is fixed in place by means of a small amount of some suitable easily fusible alloy *h*, which is filled in round one end in the wider part 9 of the hole. The pin is held firmly by means of said alloy as long as the same is not sufficiently heated to fuse or soften. A suitable length of high-resistance insulated wire *w*—such as that to which I have already referred (German silver being preferred as being perfectly efficient and at the same time not being too costly)—is wound in the thin flat space between the two sides of the bobbin, one end thereof being soldered, as at 6, to the bobbin-shell. After winding, the other end of the wire is brought out at the edge and connected by soldering or otherwise at 7 to a metal edge or ring or rim $d^2$, which is slotted to allow the egress of the wire end, and which serves the double purpose of forming an inclosing-ring for the bobbin and a contact for the pressure-spring *b*. A ring *r*, of hard rubber, split to give it elasticity and to facilitate manipulation, is first placed within the groove *x* round the outermost layer of the wire *w*, and over this is placed the metal-edge ring $d^2$, which thus encircles the whole, holding the wire in place. It will now be seen that the edge ring $d^2$ on which the instrument terminal—viz., the spring *b*—presses is in electrical connection with the body of the reel D through the wire *w*, and that therefore the entire body of said reel can be regarded as being on one side and the said ring on the other side of said wire.

When such high-resistance section of wire is placed in an electric circuit, the other conducting-sections of which, length for length,

are relatively of lower resistance, it is well known that on passing a given current through said circuit the major part of the heat developed by such current will be concentrated in the high-resistance section. The appliance I have described placed in circuit operates in this way: Subjected to a current for which its circuit is designed, although such heat as is developed is concentrated therein, it does not reach a sufficiently high point to become active. When an unduly strong current passes through the circuit, a considerable amount of heat is developed therein, and, being mainly concentrated in the high-resistance section of wire, the temperature of said wire is rapidly raised, and from the peculiar form of the bobbin the said heat is imparted thereto and distributed throughout its substance, rapidly reaching the center, where it operates to fuse or soften the cement of easily fusible alloy surrounding the pin *s*.

The sides of the bobbin being flat and of considerable extent, and the space between them being thin, it is evident that any heat developed in the coil will be propagated to the substance of the bobbin with great rapidity.

The bobbin with its contents constitutes in itself a complete and finished article, which is easily and quickly attachable and detachable. The standard *a*, as clearly shown in the drawings, has at its upper end two arms and between them a space *a'*.

When the bobbin is not in place, the appliance is in the condition shown in Fig. 3, the instrument terminal spring *b* being in contact with the edge of the larger arm *m* of the standard *a*. Therefore when a bobbin is from any cause disabled it may temporarily be detached; but the circuit is not thereby opened, being closed through the contact between the arm *m* and the spring *b*. The spring *c*, when the bobbin is withdrawn, does not reach any other part of the appliance.

To place the heat-concentrating bobbin in position, it is only necessary to slide its neck *f* edgewise into the fork *a'*, when its body at once connects with the main circuit represented by the standard *a*, while its edge ring $d^2$ connects with the spring *b*, pushing the said spring at the same time away from its contact with the arm *m*. The bobbin is obviously detachable with equal ease by the reverse operation. Figs. 1 and 2 represent it as being in place and ready for operation, and Fig. 8 indicates also the same condition, but is distorted to better show the working parts. It is evident that the spring *c* presses with considerable force upon the end of the non-conducting stud *s*, which therefore acts as a stop, preventing it from making contact with the metal flange-face 4. When now, in consequence of the passage of a current of abnormal strength, the section of high-resistance wire has become heated, and when the said heat has distributed itself throughout the bobbin and has softened the fusible alloy which cements the pin *s* in place, the said pin, submitting to the pressure continuously exercised thereon by the spring *c*, is promptly forced thereby farther into the hole, and the spring *c* brings up against the flange-surface 4 of the bobbin, closing the alternative circuit and establishing an earth branch or shunting the instrument J, according as the circuits are originally arranged. The condition of the appliance when it has thus come into action is indicated clearly by Fig. 9, where the spring *c* is shown as being in contact with the flange-surface 4, the pin *s* having been driven out.

The facility with which the pin yields to the pressure of the spring *c* depends to a great extent on the strength of the heating-current, and it has been experimentally found that the strength of such current can be determined with approximate accuracy by the time required to bring the protector into action.

Many of my appliances can be mounted in an extremely small space, as will be seen by Fig. 10, where three are mounted on the same base, which is not more than two inches and three-quarters wide. Of course, as also shown in this figure, any number can be mounted upon the same base, and the same shunt or grounding circuit may be utilized for a large number. In the drawings all of the springs *c* communicate with a single earth-plate 10.

Figs. 12, 13, 14, and 15 present certain modifications in construction.

In the form illustrated by Figs. 12 and 13, while the appliance is based upon the same principles, there are some modifications in construction. The reel D, containing the heat-concentrator, is mounted across the standard *a* instead of being placed edgewise thereon. The central perforation consists of a conical hub 8, which is secured to the said standard. Fitted within this is a conical piece of fusible alloy *h*, which has embedded in its smaller end a hook *i*, which hook engages the spring *c*, the said spring being in the present instance affixed by one end to the upper part of the standard *a*. When freed in any way from the fusible plug *h*, its resiliency will cause it to spring outwardly until its free end makes contact with an earth-plate or shunt-plate 10. The spring *b*, which is the terminal of the instrument extension, is bifurcated, and, as shown in Fig. 13, presses against the overlapping flange of the edge ring $d^2$. The operation does not materially differ from that described. When the heat of the bobbin D softens the fusible alloy *h*, either the hook *i* is forcibly wrenched away therefrom or the plug itself is drawn through the narrow end of the cone, and in either event the spring *c*, which here is a branch of the line, makes contact with 10 and is caused to close the derived circuit through the said plate 10 and wire 3.

In Figs. 14 and 15 the bobbin D is mounted edgewise. In this instance, also, the spring *c* is a spring-wire forming a branch of the main line. The conical plug *h* of fusible al-

loy is inserted in a conical socket as before. In place of the hook *i* the said plug has a stud $h^3$ projecting across the path of the spring-wire *c*. When the spring is pulled back and engaged by the said projection, it is of course held away from the terminal plate 10 of the safety-circuit; but by reason of the heat concentrated in the bobbin D when a dangerous current passes the fusible plug softens and the spring easily wrenches itself away from the said stud and makes a connection with the plate 10.

Since in the modified forms which are shown and described the circuit-changing arm is normally connected with the main line, it is evident that the interposition of an insulating-stud in the fusible mass is not required.

In the use of any of the forms which I have described, as soon as the appliance has acted the alternative path, so created for the dangerous current, drains, so to speak, the said current away from the instrument D, which the appliance was designed to protect by presenting a line of incomparably low resistance, and the heat-concentrating coil itself, after causing the movable part of the circuit-changing (the spring *c*) to come into action, is also short-circuited instantly, and thus is also preserved from harm. Should it, however, become damaged from any cause, it is but the work of a moment to slip one out of the fork *a'* and another in. In all of the said forms, also, it will have been observed that the shunt or safety circuit has been formed without any rupture of the main circuit, and this construction is usually preferable. The circuit-connections can, however, be readily arranged by persons skilled in the art to open the main circuit, if that be found desirable.

I claim—

1. A thermal circuit-changing protector or cut-out, comprising a movable switching-arm or contact-piece tending to connect an alternative with a main circuit, but normally maintaining disconnection, a stop or holder therefor formed wholly or in part of easily fusible metal, alloy, or like material holding the said switching-arm in its normal or disconnection position, and a heat-concentrating device comprising a high-resistance coil of wire wound on a metal bobbin, whereby the heat developed in the said main circuit by an electric current of undue strength traversing the same may be concentrated at one point, said bobbin serving to conduct the said heat to the said stop or holder, whereby the said stop is fused or softened, permitting the release of the movable switching-arm, which thereupon connects the alternative to the said main circuit, substantially as and for the purposes described.

2. An electro-thermal protector for the instruments of an electric circuit, comprising a section of said circuit having a resistance comparatively greater than that of other parts of the circuit, whereby the heat developed in said circuit by a trespassing current may be concentrated in said section, a movable switching-arm controlling the connection of a shunt or earth branch with said main circuit and normally maintaining disconnection between them, a stop or holder therefor formed of or set in easily fusible metal or alloy normally engaging the said switching-arm and forcibly holding the same in its disconnection position, and a connection of heat-conducting material, such as metal, between the said heat-concentrating device and the stop or holder adapted to propagate the heat concentrated in the former rapidly to the latter, whereby the switch-arm may be promptly caused to connect the branch and main circuits and to divert from the said main circuit the major part of a current sufficiently strong to heat the said high-resistance section to a dangerous point.

3. The combination, substantially as hereinbefore described, in an appliance for protecting electrical instruments from the injurious effects of abnormally-strong trespassing currents, of a thin and flat metal bobbin centrally perforated and having an insulated conducting-edge ring, a section of insulated wire of relatively-high resistance wound upon said bobbin having one of its ends connected therewith and its other end connected with the said edge ring and being thereby adapted to be introduced into an electric circuit, a metal standard supporting the said bobbin and furnishing an electrical main-circuit connection therefor, a contact-spring pressing upon the said edge ring and electrically connecting the same with the instruments to be protected, an independent contact-spring controlling the connection of said main circuit with an alternative or derived circuit at a point external to the said high-resistance section and tending by its resiliency to effect the said connection, and a core or pin made of or cemented in easily fusible metal or alloy fixed in the central perforation of said metal bobbin and projecting therefrom to one side to form an obstacle in the path of said independent spring, the said pin normally engaging the said spring and preventing the same from connecting the derived and main circuits, but adapted when softened or fused by heat conducted thereto through the metal bobbin from the said high-resistance section to yield to the pressure thereof and to permit the said connection to be effected.

4. The combination, in an electro-thermal protector, of a metal standard constituting a main-circuit terminal and having a forked upper end, a metal reel or bobbin containing a heat-concentrating device detachably mounted edgewise on the fork of said standard by means of a neck on one side fitted to the said fork, and a curved pressure-spring constituting the terminal of the instrument extension of said main circuit pressing upon the edge of said reel when in place (the circuit being then directed through the said heat-

concentrating device) and adapted to press when the said reel is detached upon the fork of said standard, whereby the continuity of the main circuit is at all times maintained independent of the presence of said reel.

5. The combination, in an electro-thermal protector, of a metal standard constituting a main-line terminal and forked at its upper extremity and a contact-spring adapted to bear by its free end on one of the elements of said fork, constituting a terminal of an extension of said circuit and by its contact with said standard to maintain the continuity of said main circuit through said extension with a thin and flat metal bobbin having on one side a shoulder and neck to fit said forked end and closed peripherally by an insulated conducting-edge ring and inclosing and having wound therein an insulated fine wire of high specific resistance connected at one end with its substance and at the other end with the conducting-edge ring, the said bobbin being adapted to be easily connected with or disconnected from the main circuit by sliding it into or withdrawing it from the standard-fork, the said contact-spring being arranged when the bobbin is in place to be lifted thereby from the said standard and to rest upon the edge ring of said bobbin, the circuit being thereby made continuous irrespective of the presence or absence of said bobbin.

6. As a new article of manufacture, the detachable protecting attachment for electric circuits and apparatus, comprising a flat and thin centrally-perforated metal bobbin, a coil of fine insulated wire of high comparative resistance wound therein and connected at one end to said bobbin, an insulated conducting-edge ring for said bobbin inclosing the said coil and connected with the other end thereof, and a non-conducting pin cemented in the central perforation of said bobbin by means of a setting of easily fusible metal or alloy, the whole adapted to be interposed in an electric circuit between a contact-spring adapted to bear on the edge ring, and a fixed surface connecting with the body of the bobbin, substantially as described.

7. In a protector of electrical apparatus, the combination, substantially as hereinbefore described, of a metal standard having a forked upper end and forming a main-circuit terminal, a contact-spring forming the terminal of an extension of said circuit leading from the instruments to be protected and capable of making contact with the fork of said standard or of being forced away therefrom by an interposed body, and an independent contact-spring forming the terminal of a normally-disconnected alternative or derived circuit—such as an instrument-shunt or earth branch—combined with a metal reel or bobbin having a neck whereby it may be mounted in said standard-fork and thereby connected with the main circuit, an insulated conducting-edge ring adapted to slide under and make contact with the instrument-extension terminal, a central perforation and a non-conducting pin or stop fixed therein and set in easily fusible metal or alloy, the said stop projecting to one side and normally preventing the said shunt-terminal spring from making contact with the side of the bobbin, and a heat-concentrating device consisting of a coiled section of fine insulated high-resistance wire—such as German silver—wound on said bobbin and connected at one end with the substance thereof and at the other with the insulated conducting-edge ring thereof and thereby adapted to be included in the circuit, the said bobbin being of such size and form as to readily absorb the heat developed in the said section of high-resistance wire on the passage of an unduly strong current and to transmit the same to the said easily fusible central core, whereby the said core being softened or fused is caused to yield to the pressure of the branch-circuit spring, allowing the same to make contact with the side of said bobbin, thus establishing said alternative circuit and acting to direct the major part of such current through such alternative circuit, for the purposes specified.

8. In combination with a main electric circuit and instruments requiring protection connected therewith, shunting or switching devices whereby a derived circuit may be closed round said instruments, a non-conducting stop mounted in a setting of easily fusible material normally preventing the said devices from coming into action, a coiled section of said main circuit having, compared with the other conductors of said circuit, a high resistance, whereby the heat developed by the passage of a strong electric current through said circuit may be practically concentrated in said coiled section, and means, as described herein, for the ready conduction of said heat from the said high-resistance section to the fusible setting of said stop, substantially as and for the purposes specified.

9. The combination of a main electric circuit, instruments included therein and requiring protection from trespassing currents liable to traverse said main circuit, and a normally discontinuous shunt or earth branch of said main circuit constituting a path for currents alternative to that through the instruments and adapted to connect with said main circuit at a point thereon external to the point of connection of said instruments, with a switching-arm or movable contact-piece having a normal tendency to effect the union of said main and branch circuits, an interposed insulating-stop held in place by a setting of easily fusible metal or alloy normally holding said switching-arm and preventing the same from closing the branch circuit, a relatively-high-resistance section of said circuit placed at a point between the instruments to be protected and the junction between the main and branch circuits, and adapted for the concentration of the heat developed in the circuit, and an interposed

mass of metal of suitable size and form supporting both high-resistance section and the said easily fusible stop-setting and acting to transfer the heat developed in the former through its substance to the latter, whereby the switching-arm may be freed and permitted to unite the alternative circuit to the main ciruit, and thereby to divert any injuriously-strong current from the instrument as well as from the said high-resistance section, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 15th day of July, A. D. 1890.

HAMMOND V. HAYES.

Witnesses:
THOMAS D. LOCKWOOD,
V. M. BERTHOLD.