(No Model.)

I. H. FARNHAM.

ELECTRIC INSTRUMENT PROTECTOR.

No. 360,570. Patented Apr. 5, 1887.

Fig. 1.

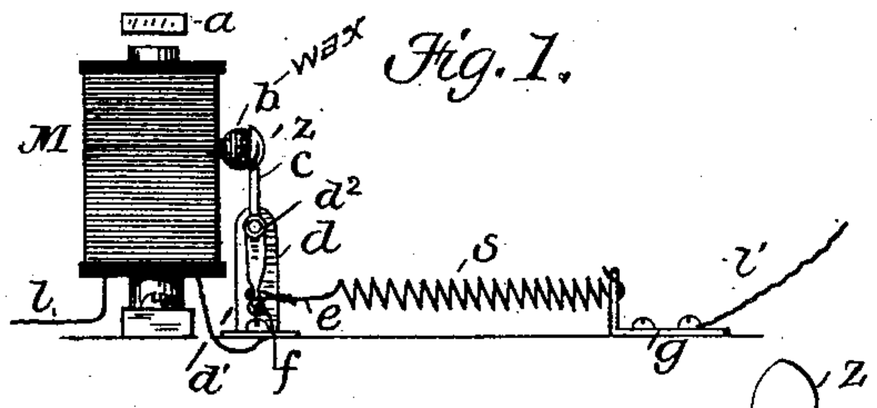
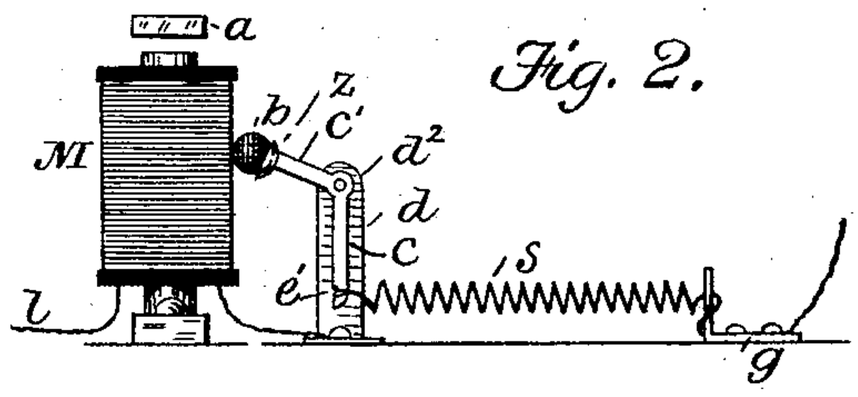


Fig. 2.



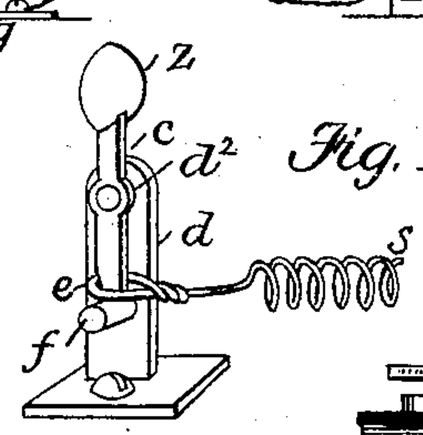


Fig. 1a

Fig. 3.

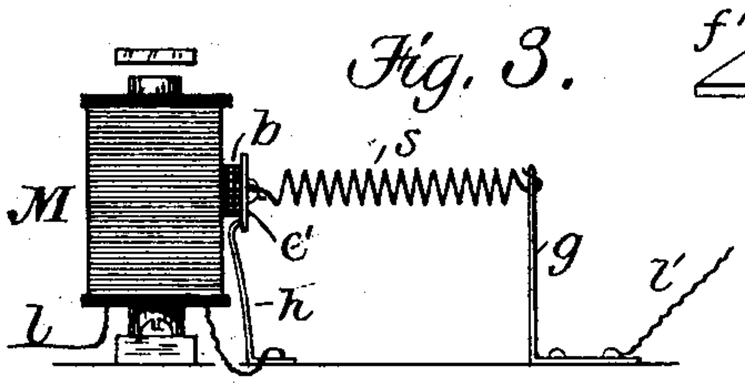


Fig. 4.

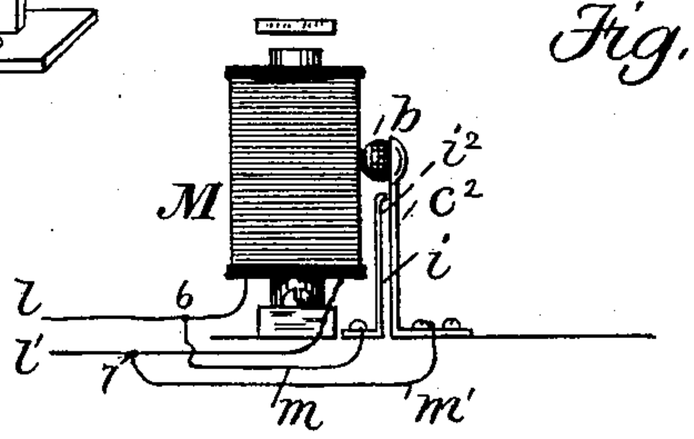


Fig. 5.

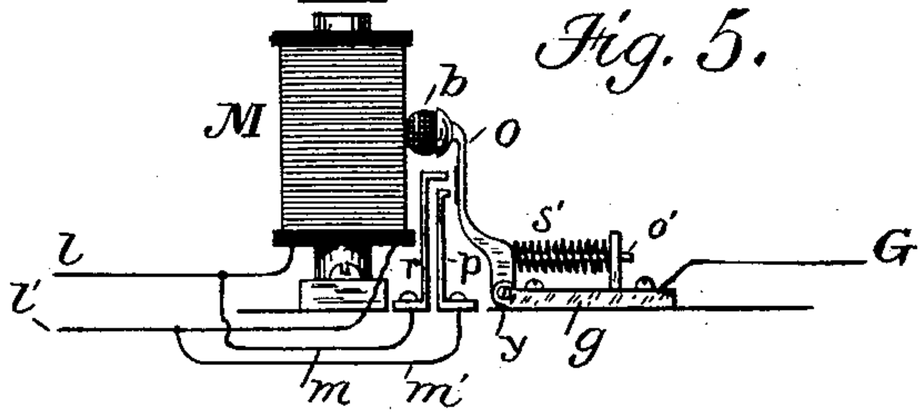


Fig. 6.

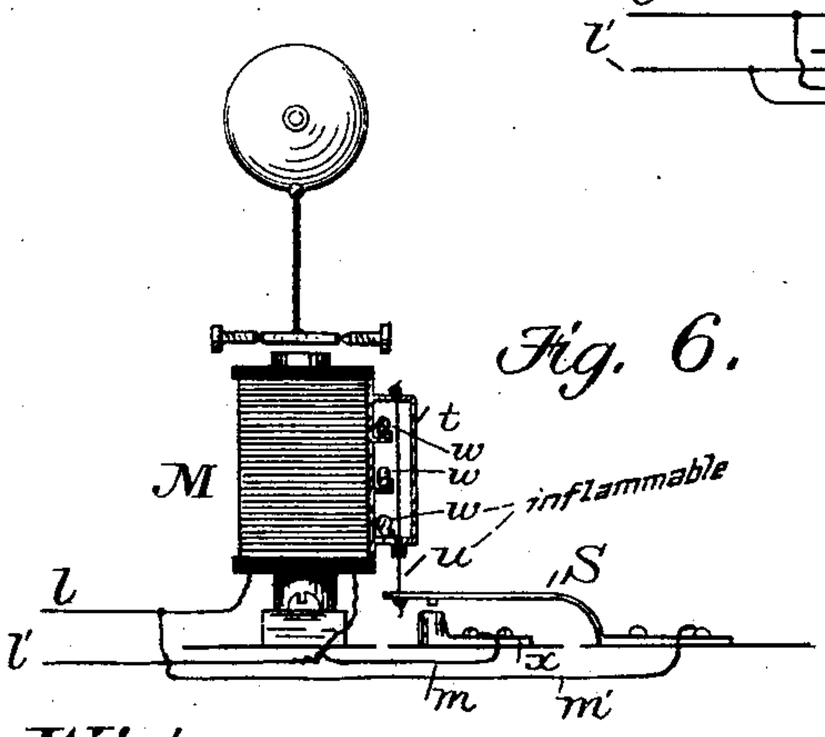
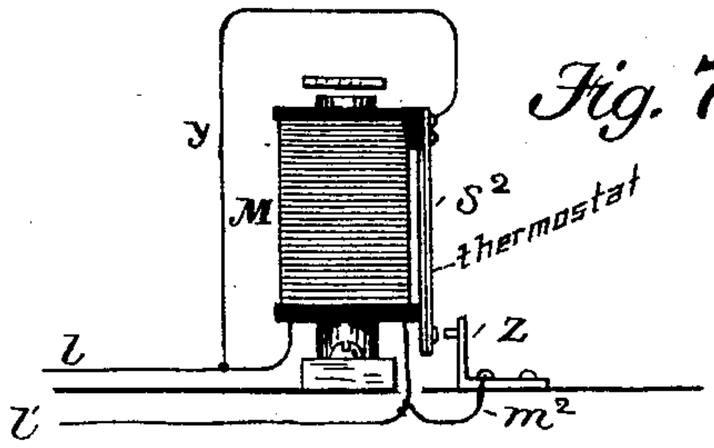


Fig. 7.



Witnesses.

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ELECTRIC-INSTRUMENT PROTECTOR.

SPECIFICATION forming part of Letters Patent No. 360,570, dated April 5, 1887.

Application filed January 20, 1886. Serial No. 189,155. (No model.)

To all whom it may concern:

Be it known that I, ISAIAH H. FARNHAM, residing at Malden, in the county of Middlesex and State of Massachusetts; have invented certain Improvements in Electric-Instrument Protectors, of which the following is a specification.

My invention relates to the protection of telegraphic and telephonic instruments or apparatus from the damage or destruction which has been found to result from the contact of circuits in which they are included with other circuits through which electric currents of greater volume than those which traverse the circuits to be protected are passing.

The object of my invention is to provide an efficient, economical, and easily-attached appliance for the prevention of such results, which, after having been operated by the passage of the abnormal current, can be reset, without expense, by any person, however unskilled in electrical manipulation.

I am well aware that various methods and appliances have heretofore been proposed and employed in the attainment of this end, and that the form which has assumed the most prominence and has become most extensively used therefor comprises a thin strip of metal foil, inclosed in a tube or other non-conducting casing and mounted at its end with metallic attachments, whereby the strip (which is easily fusible) may be included in the same electrical circuit with the instruments to be protected, and I recognize the state of the art by citing the patent issued July 14, 1885, No. 322,214, to Theodore N. Vail, as a reasonable exponent of this class of invention. Practical and efficient as this protector has proved itself in general to be, I have found that it is not so well adapted for attachment to apparatus which is to be located at outstations as it should be, partly on account of the extreme delicacy and fragibility of the fusible conductor, and partly because it is so sensitive to discharges of lightning that it deflagrates and requires to be replaced after lightning-storms even of a comparatively slight intensity.

It must be understood that electrical appliances are ordinarily provided with special lightning-arresters so arranged that their operation will not impair the integrity of the circuit. It is therefore not usually desirable that the protectors against abnormal currents shall be responsive to discharges of atmospheric electricity. On the contrary, the evil I desire to provide against is of comparatively rare occurrence, and appliances designed to meet that emergency may, in view of this infrequency, be arranged to temporarily open the circuit without undue detriment to the service, whereas, if this temporary rupture of the circuit should occur by reason of lightning, much time is lost in restoring communication. A good example of these conditions is seen in the well-known telephone-exchange. The fusible strip-protector may profitably be employed in connection with each line at the central-station end, because there it is at all times under the supervision of the proper authorities, while it is not altogether suitable for sub-stations, because of its supersensitiveness to every form of electrical discharge, and because it is not easy to maintain in such locations the close inspection requisite for prompt renewal. It has been found, also, rather expensive to maintain such a sensitive protector, in view of the frequent necessity of renewal.

The invention which constitutes the subject of my present application I believe to be well adapted for use at any point of an electric circuit where there is apparatus to be protected, since it is very sensitive to the presence of strong currents of electricity of comparatively low or medium electro-motive force—such as those developed by a battery or dynamo-electric machine—and will operate under the influence of such currents when they are not of sufficient strength to render a fusible strip-protector responsive. I believe it, however, to be especially adapted for use at outlying points—such as telephone sub-stations—because, in addition to the property which I have already described, I have found that it does not operate under the influence of a discharge of atmospheric electricity, and thus is not open to the objection which I have hereinbefore stated.

My invention is based upon the well-known fact in electro-technics that when a strong current of electricity is caused to traverse a

circuit which includes one or more electro-magnets, if the wire composing said magnets is considerably finer or smaller than that of the main-line and connecting wires, (as is usually the case with telephone or ordinary telegraphic instruments,) the said fine wire is the first and generally the only part of the circuit adversely affected by the undue strength of current, which, by reason of the greater resistance offered by the said fine wire, is in the electro-magnet coils transferred into heat. In other words, the first effect of all abnormally-strong currents, lightning excepted, is to heat the said magnet-coils in a relatively gradual manner, and if the said heat can be dissipated, checked, or arrested before it reaches a dangerous or damaging intensity no destructive result will ensue. Lightning discharges, being of enormous electro-motive force, will not usually follow the long route through the wire coils, but will seek the earth by shorter and more direct ways, even though the absolute resistance be greater. I utilize the heat so developed in the electro-magnet coils, before a dangerous degree is reached, to control, change, or break the main circuit, so as to withdraw the current either entirely or in part from the said coils, and thus to protect them from damage. Thus, instead of disrupting the circuit by the direct and violent action of the heat, I am enabled to employ that heat at a much lower temperature to operate or actuate a mechanical device to break the main circuit, to connect it to earth, shunting the apparatus to be protected, or to shunt the said apparatus without grounding the circuit, as may be desired.

For the attainment of these purposes my invention comprises a mechanical circuit-changer, which, as hereinbefore stated, may be caused to act in a variety of ways upon the main circuit; the electro magnet or magnets to be protected and an intervening body capable of becoming moderately plastic or of inflaming when the temperature of the coils of the magnet rises to a comparatively slight extent, which plasticity or inflammability actuates the circuit-changer or allows it to become operative; or, in lieu of the latter element, I may constitute the circuit-changer itself in a thermostatic form, the essence of my invention being to utilize the heat developed in the helices of the electro-magnet itself, before it reaches a damaging height, to effect such a change in the circuit as will totally prevent the occurrence of detriment or danger therefrom.

In accordance with the above statement of invention, this specification is illustrated by drawings, in which—

Figures 1, 2, 3 represent several ways in which my invention may be used to break the main circuit. Fig. 1ª is a detail in perspective of Fig. 1. Fig. 4 shows the utilization of the same principle to close a derived or shunt circuit round the electro-magnet helices. Fig. 5 is illustrative of a mode of connection whereby the electro-magnet is shunted and the main circuit simultaneously put to earth. Fig. 6 shows a form of apparatus in which the circuit-changer is adapted to be operated by the sudden inflammation of suitable substances, and Fig. 7 shows a form in which the circuit-changer itself is made in the form of a thermostat. These figures, respectively, indicate the best forms which I have so far found in which to embody my invention.

In Fig. 1, M is the electro-magnet of the instrument to be protected, and *a* the armature thereof. *l* is the incoming line-wire, which is connected with one terminal of the said electro-magnet. Upon a suitable standard, *d*, fixed near the electro-magnet, is mounted a lever, *c*, fulcrumed near its center at *d'*. The lower end of this lever has a portion of its edge cut off, so as to form a shoulder, while the end thus narrowed is brought quite near to a fixed pin, *f*, which, however, it does not touch. A spring, *s*, has one end fixed to a standard, *g*, while the other end terminates in a loop, *e*, and the said spring is extended and maintained tense by slipping the loop *e* over the narrow end *d'* of the lever *c*, where, when in position, it is held between the said lever end *d'* and the pin *f*. It is obvious that the spring *s* thus maintains a constant strain on the pivoted lever, tending to pull its lower end away from the electro-magnet, and consequently to bring its upper arm nearer to the said magnet. This tendency is, however, resisted and the lever is maintained in place during a normal state of affairs by the interposition between the upper extremity of the lever, which, for this purpose, is shaped like a spoon or spatula, and the surface of the magnet-coils of a piece of any suitable substance which, although solid and hard at an ordinary temperature, becomes plastic under the influence of a moderate rise in temperature, such as sealing-wax, fusible alloys, or any of the well-known compounds of Burgundy pitch, shellac, resin, beeswax, &c. I have found sealing-wax to answer perfectly. I make this substance in the form of a small ball or pellet, and such a ball, *b*, is shown in the drawings placed between the spatula-shaped end *z* and the exterior of the magnet-coil. This is made of the required size to maintain the lower end of the lever exactly opposite the pin *f*, and while it prevents the spring from pulling the lever out of place, the said spring in turn, by its pressure upon the hard ball *b*, keeps that in place. The standard *g* is connected with the outgoing line-wire *l'*, which may of course lead either to another station or to a ground-terminal, and the circuit from the leading-out wire of the electro-magnet to the said standard *g* is through the standard *d*, to which the said wire is attached, and then by the fixed pin *f* and the extended spring *s* to the final standard *g* of the out wire. The stretched condition of the spring thus serves an additional purpose in maintaining a perfect electrical contact between the pin *f* and loop *e*. An electrical instrument fitted with

a protector so arranged allows currents of normal strength to pass without changing its condition; but if a current of abnormal strength (lightning or sudden discharges excepted) passes over the circuit by reason of a cross with a light or power circuit, even if it should not be sufficiently strong to be dangerous, the energy of the said current will partly be transformed in the electro-magnet coils to thermal energy, which at once acts on the ball of sealing-wax or like material, softening the same. The tension of the spring now acts, also, upon the ball thus softened and tends to flatten it against the side of the magnet; but the flattening thus performed permits the lower end of the lever *c* to recede from the magnets, and thus unlatches the loop of the spring *s*, which, by its own resiliency, is promptly and effectually retracted, thus opening the circuit widely and freeing the electro-magnet from the dangerous current, which, having no circuit to traverse, ceases to exist. I have found that the degree of compression of the sealing-wax required to trip the latch and to release the spring is very trifling, and that the instrument is in practice very sensitive.

Fig. 2 is a modification in which, instead of the compound latch I have described, I employ an angle-lever, *c*, the upper arm of which, *c'*, projects from the center or pivot d^2 toward the electro-magnet and ends, as in Fig. 1, in a spatula-shaped cup, between which and the electro-magnet M is placed the ball of easily-softened material. The spring *s* is hooked at its free end to a notch, *e'*, at the lower end of the downwardly-projecting arm. In this form it will be observed that the upper arm, *c'*, is not sufficiently long to impinge upon the side of the electro-magnet when the wax *b* becomes so soft by reason of the heat in the coils as to fail to hold it. Hence, as soon as the support afforded by the said pellet of wax is removed, the lever yields completely to the force exerted by the spring *s* and swings round, in turn disengaging the said spring *s*, and thus opening the circuit. It is to be noted that in both of the foregoing forms, as well as in other forms where a loose ball of the sealing-wax is employed, the apparatus can be reset when the danger is over simply by placing in position a second ball of like size with the original one.

In Fig. 3 a piece of metal, *c'*, is held by ordinary sealing-wax or like material, *b*, against the coils of the electro-magnet, and is also held against the free end of a contact-spring, *h*, which is screwed to any convenient point in proximity to the magnet. To the metal plate *c'* is attached one end of a metal spring, *s*, the other end of which is fixed to a standard, *g*. The circuit passes from the electro-magnet to the contact-spring *h*. This bears at its free end upon the metal plate *c'*, and the circuit thus passes to the spring *s*, bracket or standard *g*, and out by wire *l'*. The operation in this case, as in the others, depends for the initial step upon the heating of the magnet-coils. The wax becomes softened and releases the plate *c'*, which is at once drawn away by the spring *s*, opening the circuit between the said plate and the contact-spring *h*.

In Fig. 4 I show an apparatus based upon the same principle, but arranged to shunt the electro-magnet by a wire of sufficient size not to become itself heated instead of breaking the circuit. In this case the main circuit leads directly to the electro-magnet through the coils thereof and out by the wire *l'*. A branch wire, *m*, extends from a point, 6, on the main wire *l*, external to the electro-magnet, to the base of a contact-spring, *i*, and a second branch wire, *m'*, in like manner leads from a point, 7, on the outgoing wire *l'* to a second contact-spring, c^2, which has a cup-shaped end. The first contact-spring has a contact-point, i^2, curving toward the second spring. The two springs have a tendency to come into contact with one another, but are kept apart by the interposition of the fusible ball *b*. When the ball softens and becomes plastic, the two springs are permitted to come together, and a shunt or derived circuit is then closed round the electro-magnet to be protected.

Similar in some respects is the form shown in Fig. 5. In this form both of the branch circuit-wires are led to independently-fixed contact-springs *r* and *p*, having their free ends in the same vertical or horizontal plane. On the same base is a hinged lever, held in place by an easily-fusible ball, *b*, as in the foregoing cases. This is hinged to a fixed block *g* at *y*, and is subject to the pushing action of a compressed spring, *s'*, which operates between a shoulder of the hinged lever and an abutment, *o'*. Normally the two springs *r* and *p* of the shunt-circuit *m m'* are discontinued; but when the ball *b* becomes plastic they are united through the metal of the lever, and as the block *g*, upon which the latter is mounted, is connected with a ground-wire, G, the result is that not only is a shunt circuit closed round the electro-magnet, but the main line is simultaneously grounded, and the abnormal current is thus diverted from the magnet-coils and permitted to escape to earth.

The modification shown in Fig. 6 shows one of the shunt-wires, *m*, as leading from the main wire *l'* to a metallic anvil or fixed contact-point, *x*, the other wire, *m'*, leading from the other main wire to a spring-contact, S, which, when left to its natural uncontrolled position, rests upon the anvil *x*, closing the shunt-circuit. A nearly air-tight metal box or tube is fixed to the side of the electro-magnet M, and through it passes a thread or fiber, *u*, the lower end of which supports the spring S, holding it away from the anvil *x*. In the box are placed one or more pieces, *w*, of some substance having a very strong affinity for oxygen—such as phosphorus or an easily-ignitable substance or compound—which is preferably mixed with some qualifying material, to prevent its too ready ignition, in a manner well understood by those skilled in the manufacture of matches. This will readily respond

to an increased temperature in the coils, and will inflame and set fire to the twine or string *u*, consuming the same and permitting the spring to make the contact with the anvil.

Fig. 7 represents a thermostat, s^2, which may be made of strips of dissimilar metals or metallic alloys—such as steel and brass—brazed or soldered together. This, under the influence of the heated magnet-coils, expands outwardly and comes in contact with the fixed point *z*, closing the shunt-circuit $y\ m^2$ round the magnet-coils.

In practice the thermostat would be mounted closer to the magnet-coils, but is shown as in the drawings for greater clearness.

It is obvious that in the forms shown by Figs. 1, 2, and 3 I am not restricted to a spiral retracting-spring, although such a spring is, in the majority of instances, preferable; but in some cases it may be regarded as advisable to substitute a flat spring held from its natural position by the mechanical opposing forces described, such a change being entirely within the scope of my invention. It is furthermore preferable in practice to attach the material which is capable of being fused, softened, or ignited to that one of the electro-magnetic helices, if there be more than one, which is connected nearest to the external circuit, as this is theoretically the helix which first experiences the heating effect of the current.

Although I have in this specification described the magnet M as being the electro-magnet of the apparatus to be guarded, it is not, therefore, essential to use a special protector for each electro-magnet in the same station. If the line terminates at any station it is only necessary in practice to connect a protector to one of the electro-magnets, even though there may be several included in the circuit at that station. If, however, the line passes through the said station to others, it will be requisite, in order to obtain the highest degree of protection, to attach one of the guards to one magnet at each station.

A great advantage of this protector is that no additional electro-magnet is required, since the attachment may be fixed to and operated by one of the electro-magnets embodied in or belonging to the apparatus to be protected.

When either of the first forms are employed, the spring, upon being suddenly released, is, by means of its own resiliency, thrown back to such an extent that an arc cannot follow or be maintained.

I may also state that another advantage of this form of protector is that the balls of wax or similar substance need not be rigidly attached, but may be kept in stock and readily inserted at any time, being held in place by the compression of the lever and spring.

Having now described my invention, what I desire to claim is—

1. A protector for electric circuits and apparatus, consisting of an electro-magnet, a circuit-controller changer adapted to alter the circuit of said electro-magnet as described herein, and an interposed mass of suitable material, solid at ordinary temperature, but capable of fusing or becoming plastic upon an undue increase of temperature, the said mass being supported in contact with or in close proximity to the electro-magnet coils and acting normally to hold the circuit-controller quiescent, but allowing the said circuit-controller to become operative upon a dangerous increase of temperature in the magnet-coils, substantially as described.

2. The combination, with the electro-magnet of a telephone-bell or other electrical apparatus, of a circuit closing, breaking, or changing device, a lever or its mechanical equivalent normally controlling the said circuit-changer and maintaining it inert, and a mass of sealing-wax or similar substance, ordinarily solid, and hard, but capable of fusing or becoming plastic upon an undue increase in temperature, the said mass being interposed between the said lever and the electro-magnet coil and adapted to hold the former normally in place, but to release the same and allow the circuit-changer to become operative when the said coils become heated by the passage of a current of undue strength, substantially as herein described.

3. The combination, in a circuit-protector, of an electro-magnet included in a main circuit, a pivoted lever, a spring circuit-changer adapted to be latched thereby and to be maintained with the spring in tension and ready for operation, and a ball or pellet of wax or like material adapted to be interposed between the lever and the magnet-coils and by such interposition to hold the said lever in position to maintain its engagement with the spring, being itself held in position loosely by the compression of the said lever and spring, but adapted to soften or fuse under the heat developed in the coils upon the passage of an abnormal electric current, and thereupon to allow the lever to move and to unlatch the spring actuating the circuit-changer, substantially as described.

4. The combination, in the electrical-instrument protector herein described, of an electro-magnet, a circuit-changer consisting of a normally-stretched spring constituting a part of the electro-magnet circuit, a latch-movement comprising a pivoted lever and an abutting pin fixed close to one end thereof and adapted to hold the stretched spring when the end of said lever is directly opposite to the said pin, but to release the same instantly when the lever moves to either side of the said pin, and a ball or block of solid but easily-fusible material introduced between the opposite end of the lever and the electro-magnet, whereby the latch is held in place normally, but may be tripped when the said ball is softened by heat developed in the magnet-coils.

5. The herein-described latch-and-trip movement, comprising the pivoted lever *c* and the abutting pin *f*, in combination with the circuit-changing spring *s*, engaged by the said

latch, and a mechanical controller for the said latch, which controller normally holds the lever *c* in place, but which is responsive to an increase in temperature, and thereupon releases the said lever.

6. A protecting apparatus for electrical instruments, consisting of an electro-magnet adapted for inclusion in a main circuit, a circuit-breaker constituting a part of the same circuit, an actuating device for the said circuit-breaker, and a controlling device for the said actuator, which controlling device is supported upon or in close proximity to the magnet-coils and is sensitive to and becomes operative upon a moderate rise in temperature in the said coils, substantially as described.

7. A protecting device designed to guard electrical instruments from damage, comprising the following elements in combination: a circuit breaking or changing switch, means, as indicated, for maintaining the same normally inoperative, an electro-magnet, and a thermostatic device attached to the coils of said magnet, controlling the said means for maintaining quiescence and adapted to respond to a dangerous rise of temperature developed in the magnet-coils by an abnormal current passing therethrough and thereupon to bring the circuit-changer into operation, substantially as described.

8. An instrument for protecting telegraphic and telephonic circuits and apparatus from injury due to the passage of currents of dangerous strength, comprising an electro-magnet included in the said circuit, a metal spring adapted to be held in tension and to form a part of said circuit, a pivoted lever one end of which is adapted to engage the free end of said spring and to hold the same normally in tension, the other end thereof being adapted to hold a piece of sealing-wax or like solid and easily-fusible material against the coils of the electro-magnet, which fusible substance also serves normally to retain the said lever in position to maintain the engagement of said spring, all in combination, as described, whereby the circuit is maintained intact during the passage of ordinary electric currents and whereby it is broken upon the passage of unduly strong or abnormal currents which heat the electro-magnet coils, causing the fusible material attached thereto to fuse or soften and to allow the lever to move, thus disengaging the spring, which is thereupon retracted by its own resiliency, substantially as described.

9. The combination, with the electro-magnet of a telephonic or telegraphic instrument, of a circuit breaker or changer, included also in the main circuit, means, substantially as shown and described, for holding the said circuit-changer in position to maintain the main circuit normally closed through the electro-magnet and for releasing the same and thereby breaking the main circuit when an unduly strong current passes through the electro-magnet coils, said means comprising and depending upon the condition of a mass of material which easily becomes soft or fuses, which mass is supported upon or close to the electro-magnet coils and remains hard and solid when the temperature of the said coils is normal, but which becomes soft or fuses when heat is developed therein and before a dangerous point is reached.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 16th day of January, 1886.

ISAIAH H. FARNHAM.

Witnesses:
THOS. D. LOCKWOOD,
GEO. WILLIS PIERCE.