No. 618,812. Patented Jan. 31, 1899.

D. J. CARTWRIGHT.

ELECTRICAL PROTECTOR.

(Application filed Jan. 11, 1897.)

(No Model.)

Fig. 1.

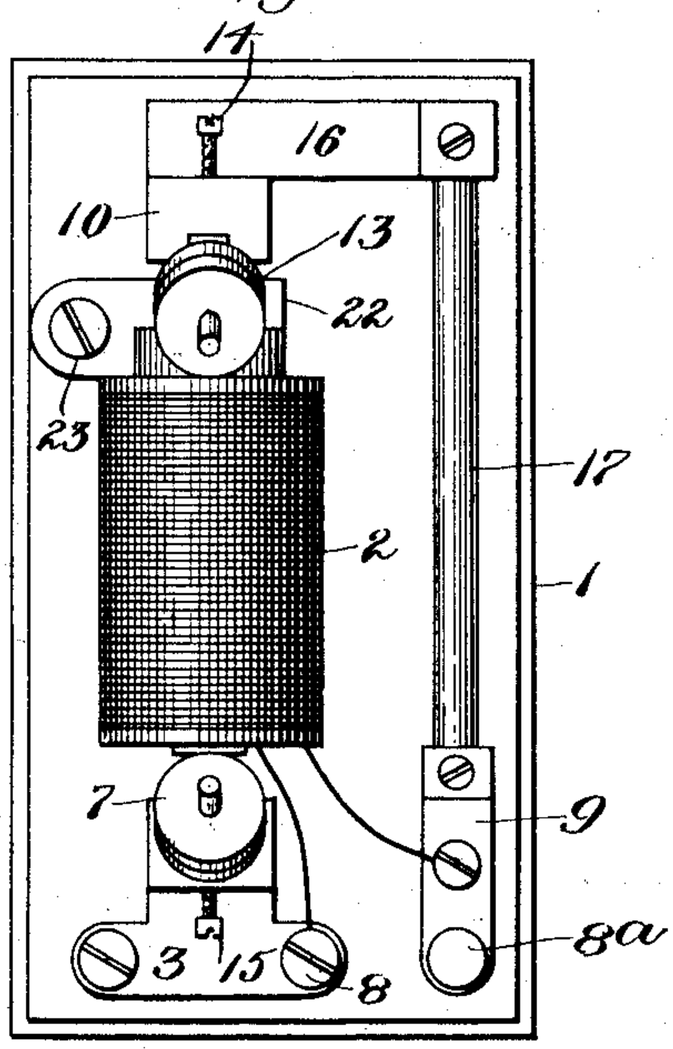

Fig. 2.

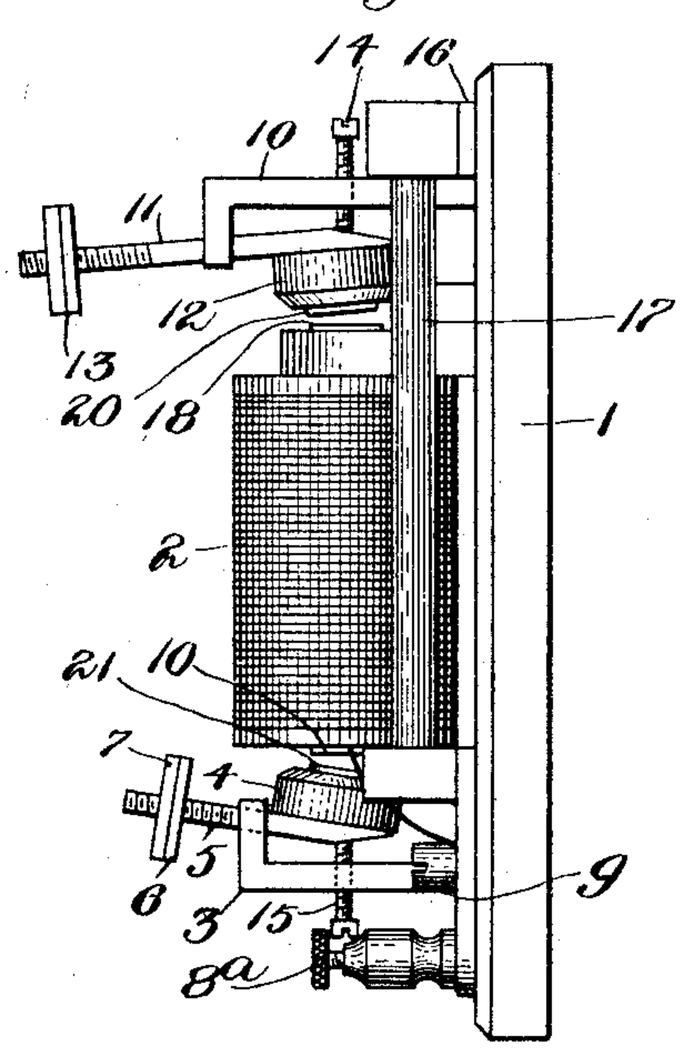

Fig. 8.

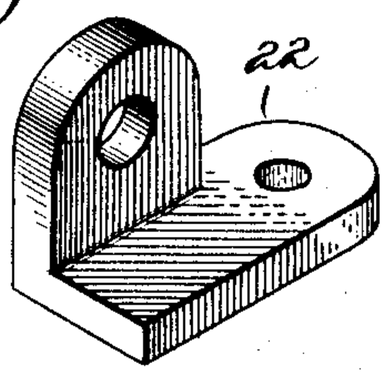

Fig. 3.

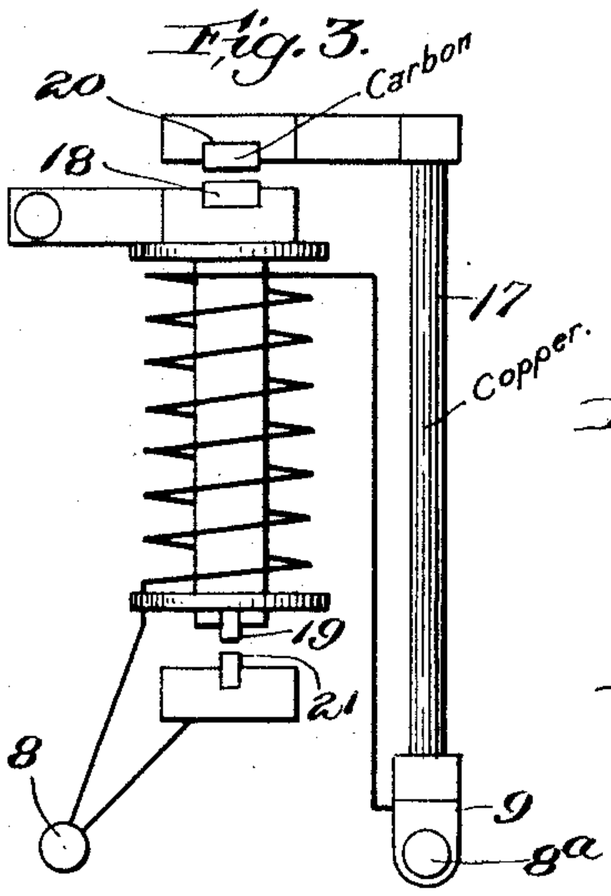

Fig. 7.

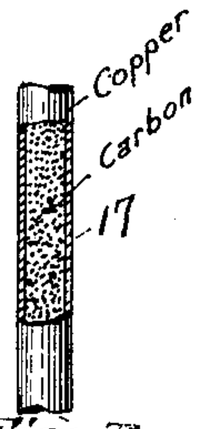

Fig. 4.

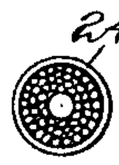

Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE.

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ELECTRICAL PROTECTOR.

SPECIFICATION forming part of Letters Patent No. 618,812, dated January 31, 1899.

Application filed January 11, 1897. Serial No. 618,738. (No model.)

To all whom it may concern:

Be it known that I, DAVID J. CARTWRIGHT, of Boston, in the county of Suffolk and State of Massachusetts, have invented a new and useful Improvement in Electrical Protectors, of which the following, taken in connection with the accompanying drawings, is a specification.

This invention relates to that class of electromagnetic cut-outs in which there are two armatures, one of which is attracted by the effect of any increase of current beyond that which the protected device or devices can bear without injury and acts when attracted to shunt the current through the core of an operating-electromagnet, and the other armature is attracted by a stronger current and acts when attracted to establish connection with a shunt containing a resistance, thus obtaining a protecting device which will be sufficiently sensitive to take care of comparatively feeble abnormal currents—as, for example, those known as "sneak-currents"—and which will also be able to carry much stronger currents without injury and without opening the normal circuit.

The object of this invention is an increase of the efficiency and durability of this class of electromagnetic cut-outs and to obtain simplicity of construction with diminished cost, and also the production of an instrument which will be an efficient protector against alternating as well as continuous currents. These results are accomplished by the device illustrated in the accompanying drawings, in which—

Figure 1 is a front view of the protector. Fig. 2 is a side view of the same. Fig. 3 is a diagrammatic view of the protector, showing the connections. Fig. 4 is a sectional view of the core of the electromagnet. Fig. 5 is a sectional view of the tubular metallic resistance. Fig. 6 is a sectional view of another form of resistance in which a metallic tube is filled with compacted hard carbon. Fig. 7 is another view of this device, a part of the metal being broken away. Fig. 8 is a perspective view of the pole-piece.

Referring to the drawings, 1 is the base-plate, made of some suitable insulating material, preferably slate, and which base-plate, when the protector is fixed in position for use, stands in a vertical position.

2 is the electromagnet fixed to the base-plate and parallel to the same, and for the instruments which are intended to be used for protecting fire-alarms or police-telegraph circuits is preferably wound with No. 18 insulated copper wire; but the size of the magnet, the size of the wire, and the number of layers and turns on the helix can be varied according to the purpose for which the protector is used.

3 is a standard of metal secured to the base-plate, and 4 is an armature attached to the end of a lever 5, pivoted to this standard. The other arm of the lever carries an adjustable weight 6 and balances the armature 4, the position of this weight determining the sensitiveness of the armature to the current passing through the electromagnet 2. A suitable check-nut 7 secures the weight in position at any adjustment.

One terminal of the instrument to be protected is electrically connected to the standard 3 by the binding-post 8 or in any other suitable manner, and to the binding-post or to any other part of the standard 3 is connected one of the terminals of the helix of the electromagnet 2. The other terminal of this helix is electrically connected to a metallic plate 9, secured to the base-plate near the standard 3, but separated therefrom, and this plate is connected to the line. Suitable binding-posts are preferably used for making these connections, the connection with the line being preferably made by the binding-post.

To prevent the current from breaking through the coil and passing to the core before passing through the helix, the terminal of the outer layer of the helix is connected to the line and the terminal of the inner layer of the helix is connected to the standard, thus interposing the resistance of the several layers and enabling the counter electromotive force produced in the helix by the alternations of the current to act as a force counteracting any tendency of the increased current to break through the insulation of the coils to the core. Opposite to the other end of the electromagnet 2 is another metallic standard

10, to which is pivoted the lever 11, one arm of which carries the armature 12 and the other arm the adjustable weight 13 and its suitable check-nut. The armature 12 is heavier than the armature 4, and for that reason and by the adjustment of the weight 13 the currents which will magnetize the electromagnet sufficiently to attract the armature 12 must be stronger than those which produce sufficient magnetism in the electromagnet to attract the armature 4. A metallic plate on the base-plate is attached to the standard at right angles thereto. The ratio between the respective weights and adjustments of the two armatures will be dependent upon the strength of the currents which the protected devices can bear, the power of the electromagnet, the resistance of the shunt, and the strength of the current which the electromagnet of the protector is intended to bear without undue heating, but it must be such that the armature 4 will respond to any current of greater strength than the protected device will bear and that the armature 12 will not respond to any current which is not strong enough when divided between the resistance in the shunt and the helix of the electromagnet to maintain the armatures in contact with the poles of the electromagnet.

A suitable set-screw 14 and 15 or other suitable device is placed in each standard for the purpose of determining the extent of the movement of the armature-lever pivoted on each standard, and these set-screws may be provided with check-nuts.

In the instrument as constructed for fire-alarm circuits the lighter armature is attracted by currents of one-fifth of one ampere over the normal current, and when the heavier armature is attracted by a current of greater strength the protector will carry a current of twenty-five amperes for any length of time without unduly heating the magnet or the resistance in the shunt. These limits are amply sufficient for practical purposes, as abnormal currents entering the line rarely exceed fifteen amperes, and a safety-fuse will be placed in the circuit for protection against abnormal currents of greater strength than twenty-five amperes.

Should the safety-fuse be inoperative at the strenght of current for which it is intended, the shunting out of the resistance of the protected device by the operation of the protector will increase the strength of the current through the safety-fuse, so that the latter will be more likely to become operative, and thus protect the building to which the core is connected from overheated wires, the fuse being always placed at the entrance of the line to the building.

The resistance that is interposed between the metallic plate 9 and the metallic extension 16 of the standard 10 in electromagnetic cut-outs of this class has been a rod of hard carbon, and this material has been used for the reason that the resistance of carbon diminishes as its temperature increases, and consequently the amount of current which will pass to the ground through the shunt formed by this carbon rod and the larger armature when this armature is attracted will increase as the current increases, and therefore even with a very strong abnormal current there will be but little possibility of such an amount of current passing through the coils of the electromagnet as will unduly heat them; but this diminution of the resistance of the carbon rod caused by its increased temperature may cause the diversion from the coils of the electromagnet of such an amount of current that both armatures will fall back with the consequent reëstablishment of the circuit through the instruments which it is desired to protect or that the armatures will vibrate or "chatter," and, moreover, unless the heavier armature and the opposite end of the core or pole-piece are provided with contacts of a hardly-fusible conducting material, preferably hard carbon, these parts may become welded together by the heat produced by the increased current and which the diminished resistance of the carbon rod permits to pass through the parts to the ground. In addition the use of a rod of hard carbon is objectionable, for the reason that this material is brittle, and therefore the carbon rod is liable to accidental fracture and also to fracture due to the rapid contraction and expansion of the carbon rod caused by the heating effect of a strong abnormal current, and as this fracture may take place within the sockets in which the ends of the carbon rod are inserted it may escape notice, so that an instrument though valueless as a protector will be placed in position for use or will become valueless in service.

For the reason that the value of an electrical protector depends upon its reliability and absolute certainty of efficient operation when subjected to the action of a current dangerous to the instruments to be protected a protecting device is of little value, which though apparently perfect is liable to contain a defect which renders it useless.

Most metals increase in resistance in proportion to their temperature. They are in general not easily frangible, and therefore in order to avoid the possibility of the diversion from the electromagnet as the current increases of an undue proportion of the current, with a consequent weakening of the attracting power of the electromagnet, to prevent the undue production of heat at the contact of the heavier armature with the core or pole-piece, and to insure the production of an instrument which, having been found perfect after manufacture, can be so furnished with absolute certainty and can be depended upon when placed in position for use I place a resistance of copper or any other metal whose resistance increases as its temperature increases between the extension 16 and the plate 9, and for the purpose of increasing the

radiating-surface of this resistance and preventing it from becoming so much heated by the current that owing to its increased resistance such an amount of the current will pass through the coils as to heat them to such an extent as to impair their insulation or otherwise injure them I prefer that this resistance should be a tube, and in order that the tube may be further cooled by currents of air passing through the same I also prefer that the tube should be open at both ends. This tube is preferably made of copper as a suitable material and is shown at 17. It is suitably secured between the plate 9 and the extension 16—as, for example, by insertion of its ends in suitable sockets in the plate and extension, respectively.

In electrical protectors of this class the circuit is never broken between the terminals of the same; but the protected instrument is shunted and the circuit grounded by the abnormal current is divided between the resistance and the electromagnet, for the purpose before stated.

Static discharges, such as lightning, may produce sufficient heat between the armatures and the core or pole-piece of the magnet to fuse these parts together, or sufficient heat may be produced by other currents, and if dust or dirt between the armatures and the core or pole-piece prevents perfect contact alternating currents meeting this resistance may produce arcs and fusion of the parts. Moreover, alternating currents, owing to their high electromotive force, may have a tendency to pass to the ground through the core by the formation of an arc at the end of the core. In order to prevent the fusing together of the core or pole-piece and armature by the heat produced by the static discharges or other currents and by the formation of arcs and also to prevent other injury caused by arcing or sparking, a block of some non-magnetic hardly-fusible material is inserted on the face of the opposite end of the core and similar blocks of similar material are inserted in the opposite face of each armature, and in order to prevent the formation of a connecting-ball of fused metal and for reasons hereinafter stated one of these blocks must be carbon; but it is preferable that both should be carbon. These contact-blocks are in a magnetic field at the poles of the electromagnet, and consequently the formation of an arc is prevented or the arc is dissipated by the well-known effect of magnetic forces upon an arc.

The maintenance within certain limits of a resistance of substantially constant strength, independent of the heat produced in the resisting materials by the current, can be secured by making the resistance of carbon and metal, for the reason that the opposite properties of the metal and carbon will compensate for one another in the effect of the increased heat of these materials or the resistance. The contact-block 18 on the pole-piece and the block 20 on the armature opposite this pole-piece form a part of the circuit through the metallic resistance to the ground when the current on the electromagnet becomes strong enough to attract the heavier armature, and one or both of these blocks being made of carbon the diminished resistance of the carbon as it becomes heated by the increased current compensates for the increased resistance of the metallic resistance as it also becomes heated by the increased current. A similar compensation will be produced if the metal tube is filled with carbon or if a carbon rod coated with copper or other suitable metal is used. The use of these two materials—carbon and metal—in the shunt through which a part of the increased current passes, whether separated or united, increases the reliability of the protector and renders it less liable to injury than if the entire circuit in the shunt were metallic. The resistance of the shunt is preferably less than the resistance of the electromagnet or electromagnets.

The tendency of the blocks 18 and 20 to become heated by the current diminishes as their size increases, and it is desirable, therefore, that these blocks should have considerable size, and they may be of the same diameter as the core, and in order to insure better contact they may be subdivided. Being situated where the lines of force are most closely together, and consequently where the magnetic field is the strongest, these non-magnetic blocks weaken the field to such an extent that in order to obtain the necessary prompt attraction of the heavy and coarsely-adjusted armature it is necessary to provide this core with a pole-piece, and in order to provide suitable means for securing the electromagnet to the base-plate and also to provide a path for the current divided between the electromagnet and the shunt to the ground the pole-piece is provided with a metallic plate at right angles thereto, which pole-piece rests upon the base-plate and is secured thereon. The means for securing it may be the binding-post 23. By means of this binding-post or any other suitable means a path is afforded for the current through the pole-piece, which path may be either direct to the ground or to the continuation of the line.

A suitable ratio between the resistance of the carbon blocks and that of the metallic resistance is eleven to one. A suitable ratio between the resistance of the helix of the electromagnet and lower contacts and core and that of the shunt containing the upper contacts and metallic resistance is five to one.

The carbon contact-blocks have a tendency to wear away, and inasmuch as the armatures are pivoted on an arm these armatures are preferably rounded or beveled off from the contact in order that when the contacts are worn down the edge of the armatures shall not make contact with the pole-piece or core when attracted.

The operation of the instrument is as fol-

lows: When the current on the line is not of sufficient strength to attract the armature 4, the current passes from the plate or connection 9 and the binding-post 8 or other suitable means to one of the terminals of the helix of the electromagnet 2, through the helix to the standard 3, and thence by the binding-post 8 or other connection to one of the terminals of the device to be protected, the other terminal being connected to the ground or line; but when for any reason—as, for example, the accidental entrance upon the line of a sneak-current from an electric-light or power circuit or of any other abnormal current—the current on the line becomes sufficiently strong to attract the armature 4 this armature makes contact with the core of the electromagnet, and owing to the low resistance of this core the greater part of the current is shunted from the device to be protected, but without breaking the circuit through said device, and passes through the standard 3, armature 4, core of the electromagnet 2, pole-piece and extension 22, and then through binding-post 23 or other armature to ground or line. When a stronger current comes on the line and one which is sufficient to attract the other armature 12, the standard 10 is thus electrically connected to the core and pole-piece and to the binding-post 24 or other connection on the pole-piece, and the current entering at the binding-post 8 on the plate 9 or other connection divides between the interposed resistance in the shunt in inverse proportion to the resistance of the electromagnet 2 and the resistance in the shunt, and while sufficient current will pass through the helix of the electromagnet 2 to maintain its armatures 4 and 12 in contact with the core not enough will pass to unduly heat this helix, for the reason that a large part of the current will pass through the resistance in the shunt.

As this device is intended to be used with alternate currents, the core of the magnet is laminated. The form of laminated core which I prefer to use in my device is made up of a bundle of soft-iron wires, as shown in section in Fig. 4, and in order to prevent the current in the helix from breaking through to the core I surround this core with a sheathing 25 of some suitable insulating material, preferably fiber.

I am aware that it is not new to use laminated cores in electromagnets which are excited by alternating currents.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In an automatic electromagnetic strong-current protector for electrical devices the combination, substantially as described, of an electromagnet included in the circuit through the protected device or devices, an armature for said electromagnet adapted to be attracted only when the current in the above-named circuit becomes stronger than the protected device, or devices, can bear, means becoming operative when the armature is attracted whereby without breaking the circuit a path for the current is established in a shunt between the terminals of the device or devices, to be protected, a tube of hard copper or other suitable metal open at both ends and of a resistance less than the resistance of the electromagnet or electromagnets of the protector and connected by one end to the line outside of the said electromagnet or electromagnets, an armature adapted to be attracted only when currents enter the line stronger than those which determine the attraction of the first-named armature and a conducting-path from the other end of the conducting-tube on the attraction of the second armature whereby the current is divided between the electromagnet or electromagnets of the protector and the said tube and the electrical connections therewith.

2. In an automatic electromagnetic strong-current protector for electrical devices, the combination, substantially as described, of an electromagnet included in the circuit through the protected device or devices, an armature for said electromagnet adapted to be attracted only when the current in the above-named circuit becomes stronger than the protected device or devices can bear, means becoming operative when the armature is attracted whereby, without breaking the circuit, a path for the current is established in a shunt between the terminals of the device or devices to be protected, a resistance of metal and carbon connected by one terminal to the line outside of the said electromagnet or electromagnets, an armature adapted to be attracted only when currents enter the line stronger than those which determine the attraction of the first-named armature and a conducting-path established from the other terminal of the metal and carbon resistance on the attraction of the second armature whereby the current is divided between the electromagnet or electromagnets of the protector and the said resistance.

3. In an automatic electromagnetic strong-current protector for electrical devices, the combination, substantially as described, of an electromagnet, a block of hard carbon on the end of the same and connected to and forming part of a circuit when the armature of the magnet is attracted, an armature attracted by said electromagnet, a block of hard carbon on the armature and opposite to the other carbon block and a resistance of copper or other metal whose resistance increases as its temperature increases electrically connected to said armature and forming part of a circuit through a shunt established when the said armature is attracted.

4. In an automatic electromagnetic strong-current protector for electrical devices, the combination, substantially as described, of an electromagnet, a base-plate supporting the same, a laminated core for the same, a pole-

piece of magnetic metal on the core, a block of hardly-fusible electric conducting non-magnetic material secured on the pole-piece and a metallic piece extended at right angles from the pole-piece and attached to the base-plate and forming part of a circuit through the magnetic pole-piece and contact-block secured therein.

5. In an automatic electromagnetic strong-current protector for electrical devices the combination, substantially as described, of an electromagnet included in the circuit through the protected device or devices and having its core electrically connected to the ground or to the continuation of the circuit, an armature which is attracted only when the current approaches a strength greater than the protected device or devices can bear and thereby without breaking the current connecting the terminals of the protected device or devices in a shunt, an electrical connection between the terminal of the outer coil of the helix of the electromagnet and the circuit outside of the protected device or devices and an electrical connection between the terminal of the inner coil of said helix and a terminal of the protected device.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, on this 8th day of January, A. D. 1897.

DAVID J. CARTWRIGHT.

Witnesses:
CHAS. A. KELLOGG,
ALEX. L. HAYES.