No. 786,005. PATENTED MAR. 28, 1905.

F. B. COOK.

ELECTRIC PROTECTOR APPARATUS.

APPLICATION FILED APR. 11, 1904.

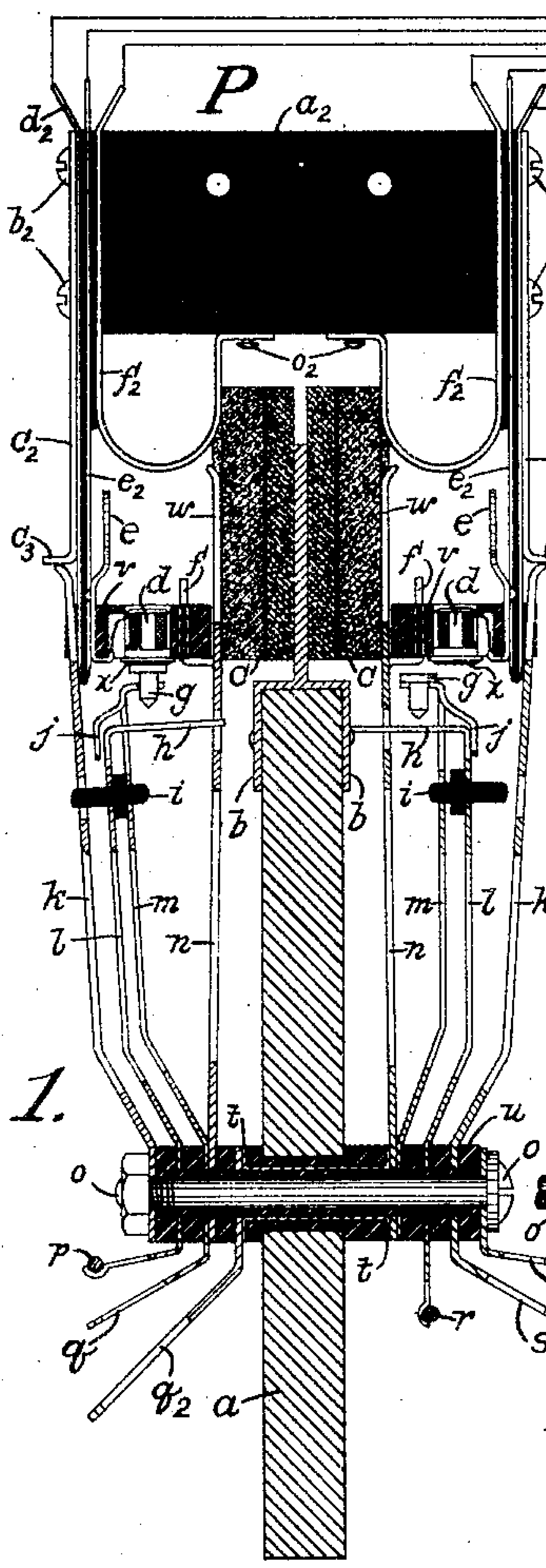


Fig. 1.

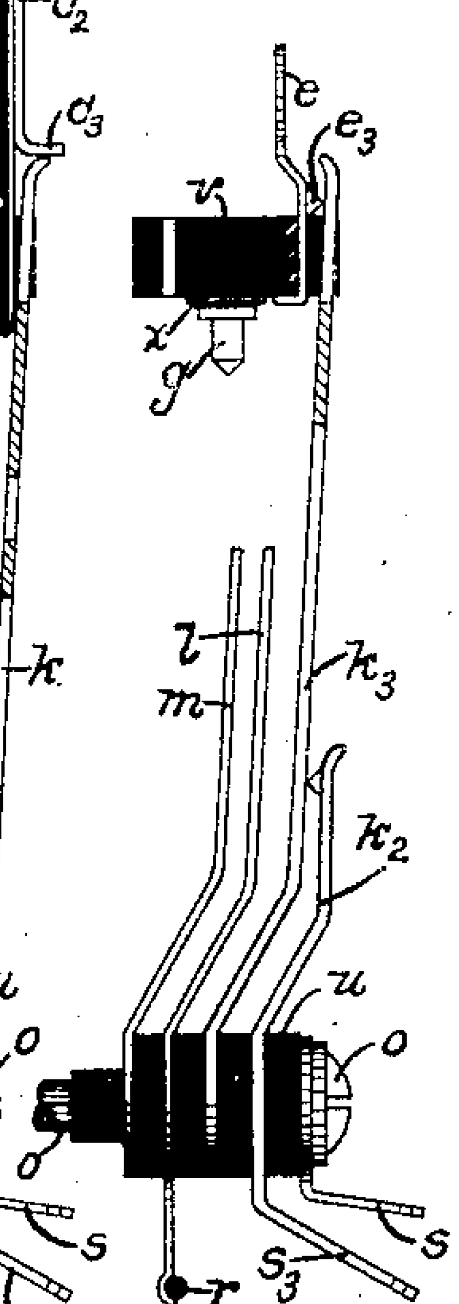
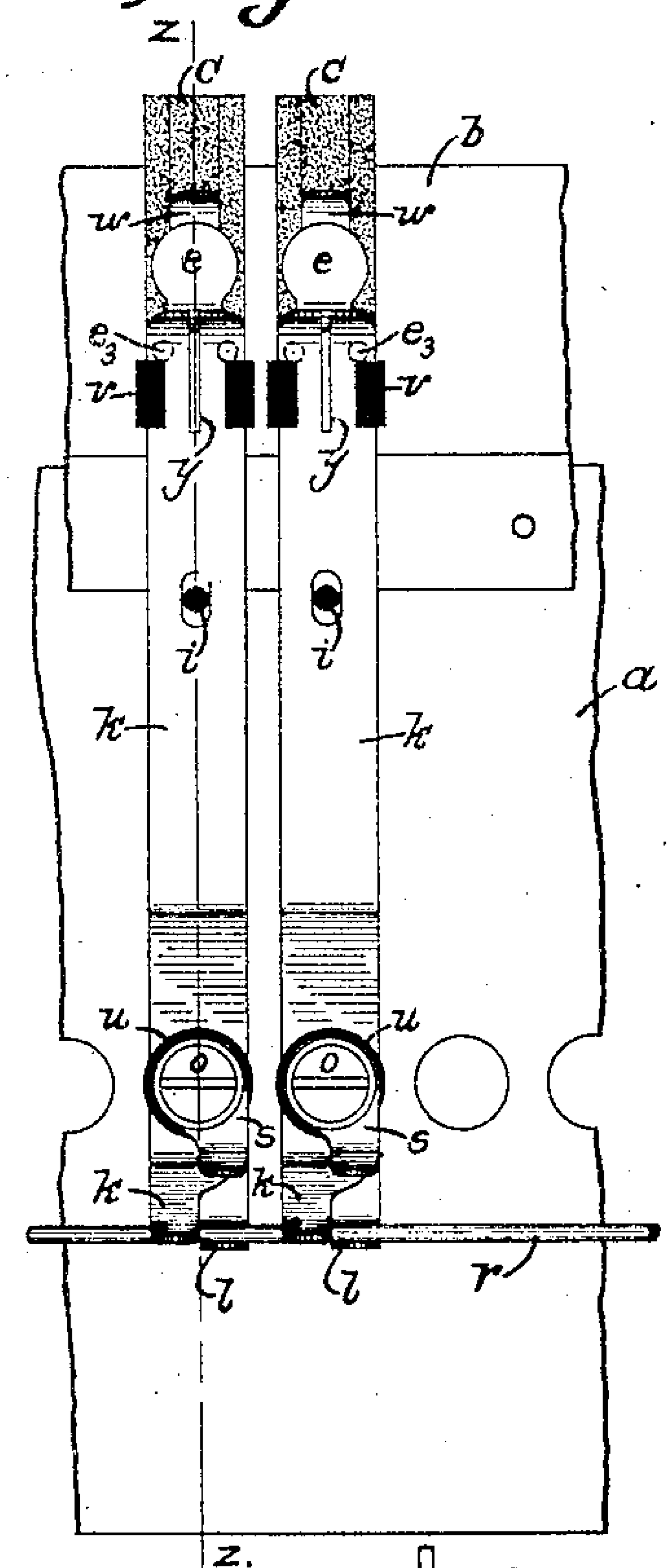


Fig. 4.

Fig. 2.



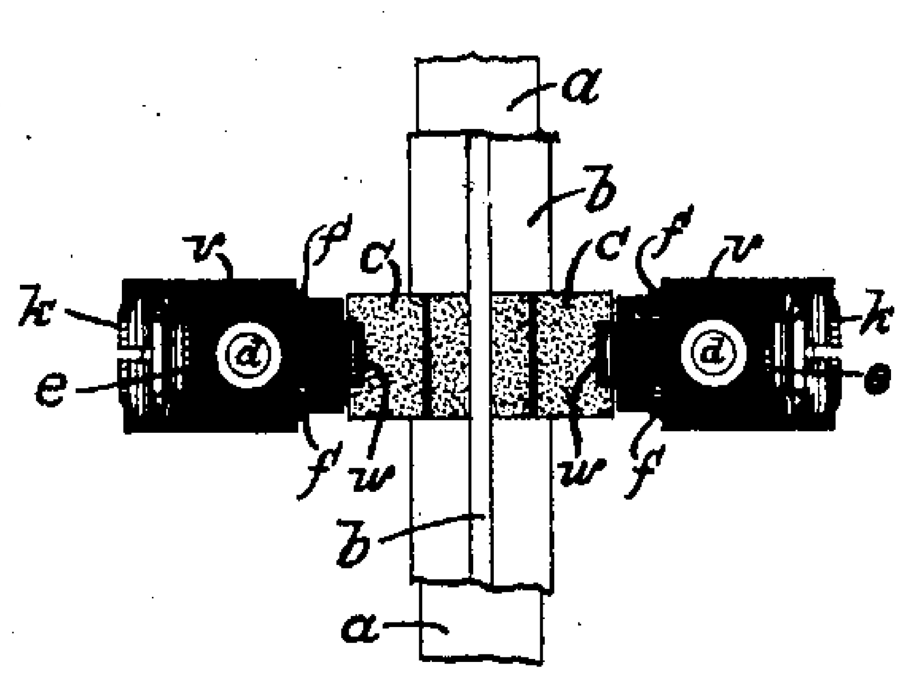


Fig. 3.

Fig. 5.

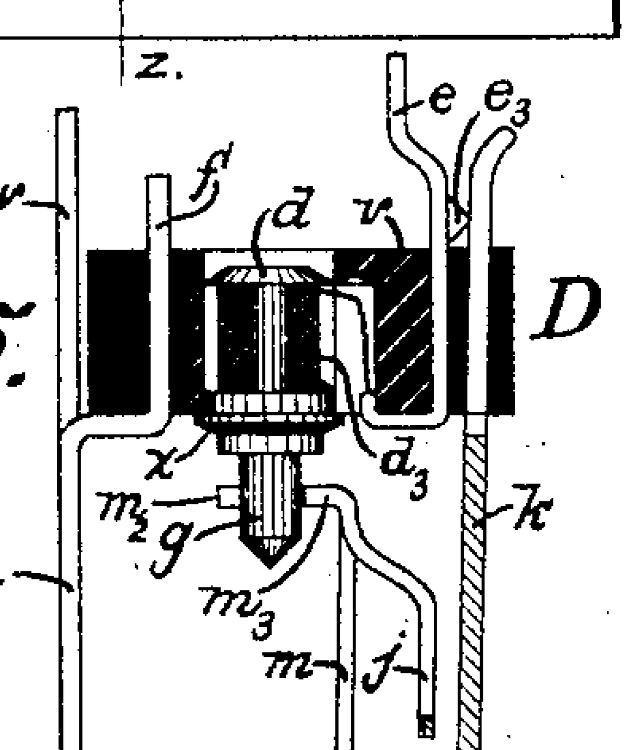
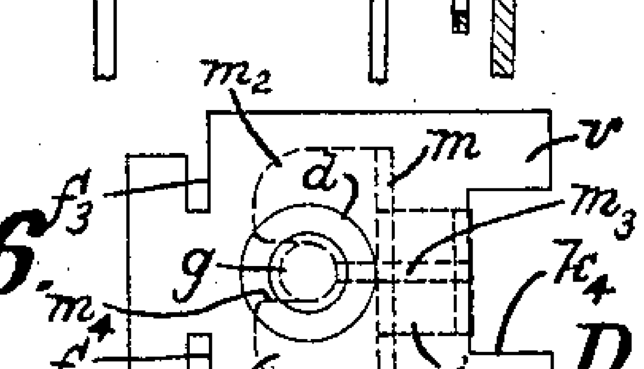


Fig. 6.



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ELECTRIC PROTECTOR APPARATUS.

SPECIFICATION forming part of Letters Patent No. 786,005, dated March 28, 1905.

Application filed April 11, 1904. Serial No. 202,652.

To all whom it may concern:

Be it known that I, FRANK B. COOK, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Electric Protector Apparatus, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to apparatus for protecting electrical circuits and instruments against injury from abnormally large currents, my object being, first, to provide an improved and highly-efficient form of protective apparatus adapted more particularly for use in telephone-circuits; second, to provide an improved and highly-efficient form of heat-coil protector; third, to provide a construction and arrangement whereby the usual testing of the different circuits through the apparatus may be accomplished without the necessity of removing the heat-coils from their supports; fourth, to provide an improved construction and arrangement of spring members for closing the circuit of an alarm which is sounded when a heat-coil is operated by an excessive current; fifth, to provide means for transposing the conductive circuits of certain spring members to connection-terminals on opposite sides of the mounting-plate, and, sixth, to provide certain features of construction which tend to increase the general efficiency of a combined thermal protector and lightning-arrester apparatus and to cheapen the manufacture of same.

Electrical transmitting-lines—as, for example, telephone or telegraph systems—are liable to suffer from the encroachment of abnormally large currents. These trespassing currents may be of distinctly different forms, and consequently a protective device which will effectually guard instruments or circuits against the encroachment of an intruding current of one character will be ineffective as far as protecting the circuits and instruments against a current of another character is concerned. For example, there are certain intruding currents which are only slightly in excess of the normal and which are commonly known as "sneak-currents." Again, there are intruding currents of high potential which result from lightning discharges or severe electrical storms.

In my present invention I have provided an arrangement of apparatus comprising a thermal protector and a lightning-arrester and suitable mounting and operating springs therefor, adapted to protect electrical circuits and instruments against both sneak-currents and high-potential currents or discharges. The thermal protector which I preferably employ comprises a heat-producing coil and a separable conductor normally held together by a heat-susceptible material, but which is separated by a force which shears one portion from the other when the heat-susceptible material is softened, and thereby operates a circuit-controlling means. The lightning-arrester employed consists of the usual carbon blocks, with an interposed dielectric. I also provide a socket-switch connected in circuit with the thermal protector and adapted to receive a testing-plug, the said switch providing means for testing the different circuits through the apparatus without necessitating the removal of the thermal protector. I preferably mount the protective apparatus in duplicate sets or pairs upon a ground-plate, the duplicate sets of each pair being on opposite sides of the said plate and adjacent to each other. The mounting-bolts and respective sleeves therefor are used to transpose certain connection-terminals to opposite sides of the ground-plate.

I will more particularly describe my invention by reference to the accompanying drawings, illustrating same, in which—

Figure 1 is a transverse section through the protective apparatus, taken on line *z z* of Fig. 2, showing a pair of protectors mounted upon opposite sides of a ground-plate, one being in an operated position with portions shown in elevation and a test-plug inserted into the apparatus. Fig. 2 is a side elevation of a number of protectors shown in Fig. 1 mounted upon a ground-plate. Fig. 3 is a top end view of Fig. 1 without the test-plug. Fig. 4 shows a modified form of socket-switch for a test-plug. Fig. 5 is a cross-section through the thermal protector, taken on line z z of Fig. 2, with portions shown in elevation; and Fig. 6 is a top view of the protector shown in Fig. 5, with spring *m* and tongue *j* shown in dotted lines.

Like characters refer to like parts in the several figures.

The metal plate *a* may be of any suitable character and may be mounted upon a support in any desired position. The protective apparatus for a metallic circuit is arranged in duplicate sets upon opposite sides of the plate *a*. Each heat-coil device or thermal protector D is connected with a line-spring *m*, supported upon a bolt *o*, which extends transversely through the said plate *a*. The line-springs *m m* are conductively connected with the respective line-terminals *q* and q^2, one line-spring *m* being connected to terminal q^2 through a conducting-sleeve *t*, which is insulated from the bolt *o*. The switchboard-springs *k k*, which are arranged outside of the line-springs *m m*, one on each side of the plate *a*, are also supported by the said bolt *o* and conductively connected with the respective switchboard-terminals *s* and s^2, one switchboard-spring *k* being connected to terminal *s* through the bolt *o*. Thus the said springs are arranged in pairs, each pair being composed of one line-spring and one switchboard-spring and are all insulated from each other and from the ground-plate *a* at their mounting by suitable insulating-sleeves and washers *u*, mounted upon the said bolt *o*. The auxiliary line-springs *n n* are associated, respectively, with the oppositely-arranged pairs of springs and are, as shown, electrically connected with the respective line-springs *m m*. Consequently both the line-springs *m m* and the auxiliary line-springs *n n* are electrically connected with the the line-terminals *q* and q^2. By "line-terminals" it will be understood that these are the terminals to which the line conductors of the subscriber's line are connected, and by "switchboard-terminals" it will be understood that these are the terminals to which the conductors leading to the switchboard are connected. In addition to the auxiliary line-springs *n n* there is also an alarm-spring *l*, associated with each pair of springs. Normally electrical contact between an alarm-spring *l* and its line-spring *m* is prevented by means of a piece of insulation *i*. The free end of each alarm-spring *l* is provided with a bent portion *h*, adapted to project through an opening in its auxiliary line-spring *n* and adapted to make contact with the ground-strip *b* when the heat-coil operates, as shown upon the right of Fig. 1. The free end of each line-spring *m* is provided with a bent portion m^2, Figs. 5 and 6, adapted to engage a portion *g* of the thermal protector, and with a bent portion *j*, adapted to make contact with the alarm-spring *l* when the heat-coil operates. Each auxiliary line-spring *n* is provided with upturned portions *f f*, adapted to engage the thermal protector D, and thereby hold same in place. A block of insulation *v* of the protective device D is inserted between the free ends of each pair of auxiliary line and switchboard springs *n* and *k*, respectively, the portions *f f* of spring *n* engaging the block *v* in respective notches f^3 f^3 and spring *k* engaging the block *v* in a notch k^4. Each block *v* is provided with a metal portion *e*, adapted to serve as a handle and also to make contact with the adjacent switchboard-spring *k* and with a hole therethrough adapted to receive a heat-coil device *d*. Each heat-coil device preferably consists of a metallic spool-shaped portion *d*, containing a heat-producing winding d^3, the upper end of the spool *d*, Fig. 5, being beveled, so as to form a sharp edge adapted to catch in the insulation *v*, and thus hold the spool in place within the block *v*. The beveled end of spool *d* forms a tight fit in the hole in block *v*, the other end of spool *d* being provided with a shoulder adapted to limit the insertion of spool *d* into block *v*. One terminal of winding d^3 is connected to spool *d*, while the other terminal thereof is connected to the handle *e*. The pin *g* is conductively secured to the enlarged end of spool *d* by a layer of solder or other heat-susceptible material *x*, as shown in Fig. 5. When the spool *d* is seated in the opening in the block of insulation *v* and the latter is inserted in place between a pair of springs *k* and *n*, the pin *g* is adapted to engage the opening or recess m^4 in the portion m^2 of the free end of the adjacent line-spring *m*, which is under tension when so engaged, the tension in *m* tending to shear the heat-susceptible material *x*, and thereby separate the pin *g* from the spool *d*, as shown upon the right of Fig. 1. The winding d^3 of each heat-coil is preferably of sufficient resistance to enable it to generate considerable heat upon the passage of a current therein only slightly in excess of the normal. The switchboard-springs *k k* normally bear against the metal portions *e e*, respectively, as shown in Fig. 5, thus connecting the winding d^3 and fusible material *x* of each heat-coil in a series circuit with a switchboard-spring *k* and a line-spring *m*. Thus currents traversing the two limbs of a subscriber's line must pass through the line and switchboard springs *m m* and *k k*, respectively, and also through the windings d^3 d^3 and heat-susceptible material *x x* of the two heat-coil devices. In other words, there is a pair of springs and a heat-coil device located in each side of the subscriber's circuit. Should a current only slightly in excess of the normal show its presence in the circuit, the heat generated by either of the heat-coils will be sufficient to soften the fusible material *x* thereof, and thereby allow the tension in the adjacent spring *m* to force the separable conductor *g d* apart, as shown upon the right of Fig. 1, and thereby open the circuit through the protector. When the circuit is thus disrupted, the trespassing current cannot of course find a conducting-path to the delicate apparatus of the switchboard. When a line-spring m is released, as by the operation of a heat-coil, the portion j thereof makes contact with the adjacent alarm-spring l, and the portion h of spring l then makes contact with the mounting-strip b. As this strip b is of metal and as the plate a is preferably grounded, it is obvious that a conducting-path is at once established between the line and ground. Thus each heat-coil in addition to being capable of disrupting the line-circuit upon the passage of a current slightly in excess of the normal is also capable when operated of establishing a conducting-path to ground.

Now with the construction thus described and illustrated it will be seen that a separable connection exists between each switchboard-spring k and its adjacent heat-coil device. In other words, each switchboard-spring k is capable of being bent away from its adjacent metallic handle e, so as to open the circuit. With this arrangement the contacts of the testing-plug P may be readily inserted between the switchboard-springs k k and their respective contact-pieces e e, thus enabling the different circuits through the apparatus to be readily tested without removing the heat-coil devices from their supports. In other words, the arrangement comprises a normally closed spring-switch, which is interposed between each switchboard-conductor and the heat-coil allotted thereto and which is in the nature of a spring-jack with normally closed contacts adapted to be opened by the insertion of the test-plug. With this arrangement the switchboard-circuits and line-circuits through the heat-coils may be tested with but one insertion of the test-plug. Ordinarily heretofore it was necessary to remove the heat-coils from their supports in order to test the line-circuits, and this necessitated testing the latter and heat-coils separately. With my improvement, however, it will be seen that it is no longer necessary to remove the heat-coils and that each circuit may be tested without the necessity of removing any portion of the protective apparatus.

The test-plug P, which I preferably use for testing the circuits through the protective apparatus, is shown, described, and claimed in a separate application for patent on test-plug for protective apparatus, filed with this application April 11, 1904, Serial No. 202,653, and comprises pairs of spring-contact members d^2 d^2, e^2 e^2, and f^2 f^2, respectively, all mounted on an insulating-block and properly insulated from each other. The springs of each pair are preferably duplicates and are mounted upon opposite ends of the block a^2. Springs d^2 d^2 and e^2 e^2 are adapted to be inserted between the switchboard-springs k k and their respective contact-pieces e e, as shown in Fig. 1, springs d^2 d^2 engaging springs k k, respectively, and springs e^2 e^2 engaging contact-pieces e e, respectively. Springs f^2 f^2 are preferably bent so that their free ends are loosely held to the block a^2 by pins o^2 and are adapted to spring apart slightly and fit into grooves in the respective carbon lightning-arresters c c when the plug is inserted. Stops c^3 c^3 are provided to limit the insertion of the test-plug into the protective apparatus. The test-plug is prevented from lateral displacement by the notches k^4 k^4 in the insulation v v of the respective heat-coil devices, as shown in Fig. 6, which provide strips of insulation at each side of the socket-switches, and by the grooves in the lightning-arresters c c, in which the springs f^2 f^2 fit. Springs d^2, d^2, e^2, e^2, f^2, and f^2 are connected to conductors 1, 2, 3, 4, 5, and 6, respectively, which may lead to any suitable testing instrument.

The circuits to be tested are as follows: first, from conductors 1 and 2 through springs d^2 d^2, springs k k, bolt o, terminals s and s^2, and the switchboard-circuit, which is connected to terminals s and s^2; second, from conductors 3 and 4 through springs e^2 e^2, contact-pieces e e, heat-coil windings d^3 d^3, Fig. 5, spools d d, fusible material x x, pins g g, springs m m, conducting-sleeve t, terminals q q^2, and the line-circuit, which is connected to terminals q and q^2; third, from conductors 5 and 6 through springs f^2 f^2, carbon blocks c c, springs n n, conducting-sleeve t, terminals q q^2, and the line-circuit, which is connected to terminals q and q^2; fourth, from conductor 3 through spring e^2 on the left of Fig. 1, contact-piece e, heat-coil winding d^3, spool d, fusible material x, pin g, spring m, spring n, carbon block c, and spring f^2 to conductor 5, and, fifth, from conductor 4 through spring e^2 on the right of Fig. 1, contact-piece e, heat-coil winding d^3, spool d, fusible material x, pin g, spring m, spring n, carbon block c, and spring f^2 to conductor 6. Thus it will be seen that the switchboard-circuit, the line-circuit through the heat-coils, the line-circuit direct, or either heat-coil and its contacts may be tested independently of each other without removing the protective devices from the protective apparatus. The switchboard-circuit or line-circuit direct may be tested whether the heat-coils have operated or not.

With further respect to the construction of the heat-coil devices it will be seen that the tension of the line-spring m is directed in such a manner that the circuit will be disrupted instantly upon the initial softening of the fusible material x. In other words, the tension of spring m in each case is utilized to slide the two sections of the separable conductor one upon the other rather than to pull them directly apart. In fact, the separable conductor of each heat-coil device is normally subjected to a lateral or shearing stress. This, as stated, results in making the heat-coil device exceedingly sensitive and readily responsive to currents slightly above the normal, due to the fact that two surfaces, which are held together by a partially-melted solder or similar material, can be more easily and quickly separated by sliding one surface on the other or by subjecting them to a shearing stress than by attempting to pull them directly apart.

The alarm-conductors *l l* are normally held out of contact with springs *m m*, respectively, and ground-strip *b* by insulating-pins *i i*, extending through the springs, and are provided with portions *h h*, respectively, adapted to make contact with the ground-strip *b* when the heat-coils operate, the portions *j j* of springs *m m* then making contact with springs *l l*, as shown upon the right of Fig. 1. With all of the alarm-springs connected in common by conductors *p* and *r* the operation of any one of the heat-coils will result in closing the alarm-circuit, which includes the strip *b* and the ground-plate *a*, upon which all of the springs and devices are mounted. It will be seen that the abnormally large currents in the line-circuit may as soon as a heat-coil device operates pass from the line through the line-spring *m* and its portion *j* to the adjacent alarm-spring *l*, and thence through the portion *h* of spring *l* to the strip *b* and through the plate *a* to ground.

As a means for protecting the circuits against high-potential currents, such as result from lightning discharges or severe electrical storms, a number of lightning-arresters *c c* are arranged in two parallel rows along the metal strip *b*. Each lightning-arrester may be of the ordinary type, consisting of a pair of carbon blocks and an interposed dielectric. The lightning-arresters are held in place against the strip *b* by the free ends *w w* of the auxiliary line-springs *n n*, respectively. The high-potential currents or discharges may pass from the line, through the auxiliary line-spring *n*, the carbon blocks and dielectric of the lightning-arrester *c*, the metal strip *b*, and the plate *a*, to ground, the said currents arcing across the gap provided by the dielectric in a manner well understood. It will be seen that a lightning-arrester is associated with each side of the line-circuit, so as to provide protection for each line-conductor entering the exchange. Thus the electrical circuits and instruments are protected against lightning discharges and high-potential currents, as well as against "sneak-currents."

In Fig. 4 I have shown a modified form of the socket-switch or spring-jack for making the tests. In this form the socket-switch is arranged near the base of the springs instead of at the top. The switchboard-terminal s^3 is connected with the short switch-spring k^2, rather than to the spring k^3 or to the corresponding spring *k* of Fig. 1. With this arrangement of Fig. 4 a test-plug can be inserted between the spring k^3 and the short switch-spring k^2, thus placing the testing instrument in circuit for testing. In either case, however, it will be seen that the protective apparatus involves one or more spring-jacks or socket-switches for testing the different circuits through the apparatus and system and that in each case it is unnecessary to remove the heat-coil devices or lightning-arresters in making the tests.

As a matter of further and special improvement the free end of each line-spring *m* is preferably provided with a slot or cut m^3, which leads from the notch or recess m^4 of spring *m*, as shown in Figs. 5 and 6. With this construction the projecting end portion *g* of the heat-coil device can be crowded into the notch m^4, the bifurcated end of the spring *m* spreading sufficiently to allow the said portion *g* to be held firmly in place. In other words, the free end of each line-spring is adapted to grip and firmly hold the projecting end portion *g* of the adjacent heat-coil device. With this arrangement the pin *g* is firmly held by the bifurcated spring *m* after the heat-coil operates, and therefore no portion of the device is allowed to fall from the apparatus when the solder is melted by the passage of an abnormally large current in the circuit.

It will be observed that the construction enables all of the springs to exert whatever tension is necessary in an inwardly direction. None of the springs have any movement whatever in an outwardly direction or away from the ground-plate *a* when the protective devices operate.

While I have described and illustrated certain details of construction in this invention, I do not wish to limit same to such particular details.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A device for protecting electrical circuits against excessive current, comprising a spring member, a small block of insulation removably mounted upon said spring member, said block of insulation being provided with a metallic handle portion and also with an opening or socket, a separable conductor seated in said socket and provided with a heat-concentrating member, the sections of said separable conductor being held together by solder, a switch-spring engaging the metallic handle portion, and a spring normally under tension and arranged to engage the projecting end portion of said separable conductor, the said solder and heat-concentrating member and second and third mentioned springs all being connected in series, and the said metallic contact and second-mentioned spring constituting a normally closed spring-socket switch adapted to receive the connecting-plug of a testing instrument.

2. Apparatus for protecting electrical apparatus against excessive current, comprising a pair of springs, a block of insulation removably mounted upon one of said springs, and provided with a metallic contact normally engaging the other of said springs, a thermal protector seated in a socket in said block of insulation, and a line-spring normally subjecting the projecting end portion of said thermal protector to lateral pressure, the said metallic contact and its adjacent spring constituting a normally closed socket-switch for receiving the contact-plug of a testing instrument.

3. A combined lightning-arrester and thermal-protector apparatus comprising a metallic support, a number of carbon lightning-arresters mounted along the edge of said support, auxiliary line-springs holding said carbon lightning-arresters in place, a block of insulation removably mounted upon each auxiliary line-spring, a heat-coil device removably mounted in each block of insulation, line-springs normally subjecting the projecting end portions of said thermal protectors to lateral pressure, contacts on said blocks of insulation, and switchboard-springs engaging said contacts, said contacts and switchboard-springs constituting normally closed switches, and each switch being adapted to receive the connecting-plug of a testing instrument.

4. The combination of a thermal protector comprising a block of insulation, a spring upon which said block of insulation is mounted, a heat-concentrating member and separable conductor mounted on said block of insulation, fusible material connecting the sections of said separable conductor and adapted to be fused by the heat of said heat-concentrating member, a spring normally exerting a lateral pressure upon one section of said separable conductor, a flat contact mounted on said block of insulation and connected with said heat-concentrating member, and another spring normally bearing against said contact, said last-mentioned spring and said contact constituting a normally closed switch-socket adapted to receive a testing-plug.

5. A thermal protector comprising a block of insulation, and a pair of springs between which said block of insulation is removably inserted, a heat-concentrating member and a separable conductor mounted in said block of insulation, a contact mounted on said block of insulation and connected with said heat-concentrating member, fusible material connecting the sections of said separable conductor and adapted to be fused by the heat of said heat-concentrating member, said contact being normally engaged by the outer of said springs, and a third spring normally exerting lateral pressure upon one section of said separable conductor, said last-mentioned spring, heat-concentrating member, the contact, and said outer spring, being adapted to be connected in series in a circuit.

6. Apparatus for protecting electrical apparatus against excessive current, comprising a thermal cut-out and a spring-socket switch in circuit therewith, said switch having normally closed contacts and being adapted to receive the connecting-plug of a testing instrument, a support upon which the whole is mounted, and the structure including portions of insulation projecting at each side of said contacts to prevent lateral displacement of the plug.

7. A protective apparatus constructed with a plurality of spring-socket switches, each having normally closed contacts adapted to be included in a line-circuit, and each adapted to receive the connecting-plug of a testing instrument, protective devices in circuit with the said switches, a support upon which the whole is mounted, and portions of insulation projecting at each side of said contacts to prevent lateral displacement of the plug.

8. Apparatus for protecting electrical circuits against excessive current, comprising thermal cut-outs and spring-socket switches, the said switches having normally closed contacts and being adapted to receive the connecting-plug of a testing instrument, and portions of insulation projecting at each side of the said contacts to prevent lateral displacement of the plug.

9. A protective apparatus constructed with a plurality of spring-socket switches adapted to receive the connecting-plug of a testing instrument, each said switch having normally closed contacts adapted to be included in a circuit, and portions of insulation projecting at each side of the said switches and adapted to prevent lateral displacement of the plug.

10. The combination with a ground-plate, of a pair of spring members for each side thereof, mounted thereon and insulated therefrom and from each other, a block of insulation removably inserted between each pair of springs, a thermal protector comprising a heat-producing member, a separable conductor, and a contact member, mounted on each block of insulation, the said contact member forming a normally closed socket-switch with the outer spring of the pair, a grooved lightning-arrester removably mounted between the inner spring of each pair and the ground-plate, a third spring for each separable conductor and adapted to engage the latter and thereby subject same to a lateral pressure, a test-plug adapted to be inserted into the socket-switches and grooves of the lightning-arresters, and held against lateral displacement by the said grooves and means at each side of the said switches, and means for grounding one spring of a pair and closing an alarm-circuit, upon the operation of a thermal protector, substantially as described.

11. In protective apparatus for electrical circuits, the combination of a supporting-plate; a pair of springs mounted upon said plate but insulated therefrom and from each

other; a thermal protector comprising a heat-producing member, a separable conductor and a contact member; said protector being removably inserted between said pairs of springs so that the said contact member forms a normally closed socket-switch with one of said springs; a third spring adapted to engage a portion of said separable conductor and to laterally separate same under abnormal conditions; and an alarm-spring between the said pair of springs and adapted to control a circuit when the said protector operates.

12. In protective apparatus for electrical circuits, the combination of a ground-plate; a pair of springs mounted upon said plate but insulated therefrom and from each other; a thermal protector comprising a heat-concentrating member, a separable conductor and a metallic handle portion; said protector being removably inserted between the said pair of springs so that the said handle portion forms a normally closed socket-switch with one of said springs; a lightning-arrester inserted between one of said springs and the ground-plate, a third spring adapted to engage a portion of said separable conductor and to laterally separate same under abnormal conditions; and an alarm-spring between said pair of springs and adapted to close an alarm-circuit and ground one of said pair of springs, when the thermal protector operates.

13. In apparatus of the class described, a pair of conducting members, a piece of insulating material mounted upon one of said conducting members and provided with a conductive portion normally engaging the other conducting member, a thermal protector seated in said piece of insulation, and a spring member engaging said protector and being adapted to control a circuit under abnormal conditions.

14. In apparatus of the class specified, a block of insulation suitably mounted on a support, a thermal protector seated in said insulation, and a conducting member and a spring member in circuit with said protector, the said spring member being allowed to control a circuit upon an abnormal current in the protector.

15. In apparatus of the class specified, a conducting member and a piece of insulation carried thereby, a spring member, and a thermal protector seated in said insulation and electrically in circuit with said conducting member and said spring member, the device being adapted to open the said circuit upon an abnormal current therein.

16. In apparatus of the class specified, a conducting member and a piece of insulation carried thereby, a spring member, and an excess-current operable device seated in said insulation and electrically in circuit with said conducting member and said spring member, the latter being arranged to control a circuit upon the operation of the device.

As inventor of the foregoing I hereunto subscribe my name this 8th day of April, A. D. 1904.

FRANK B. COOK.

Witnesses:
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