

[54] ELECTRICAL PROTECTORS AND METHODS OF ASSEMBLING THE SAME

[75] Inventor: **Thomas Georgopulos, Chicago, Ill.**

[73] Assignee: **GTE Automatic Electric Laboratories, Incorporated, Northlake, Ill.**

[22] Filed: Mar. 19, 1973

[21] Appl. No.: 342,662

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 245,462, April 19, 1972, abandoned.

[52] U.S. Cl..... 337/32, 337/17, 337/199

[51] Int. Cl. H01h 39/00

[58] **Field of Search** 337/17, 18, 20, 28, 29,
337/31, 32, 33, 34, 35, 79, 199; 317/15, 61,
66, 71

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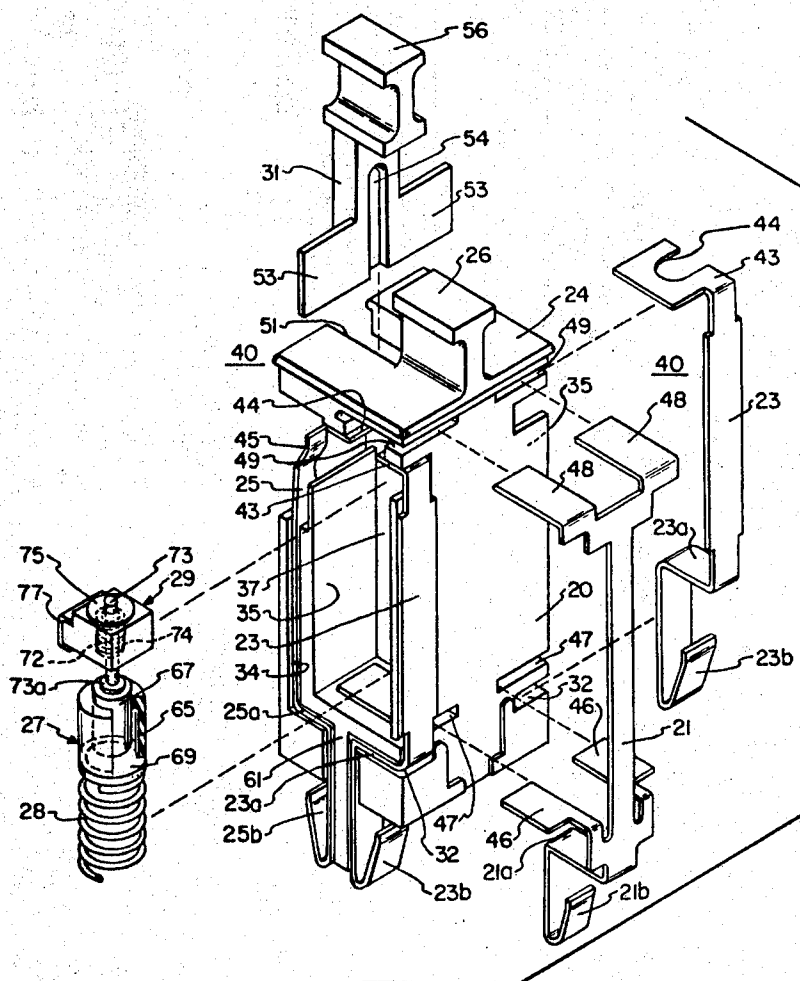
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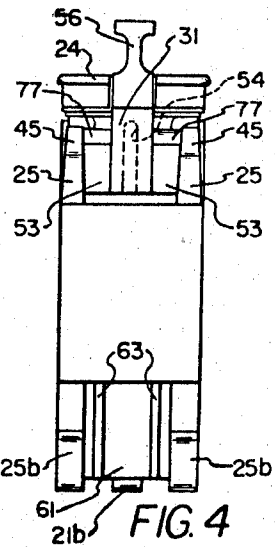
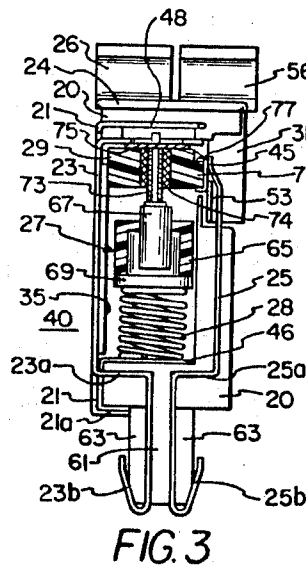
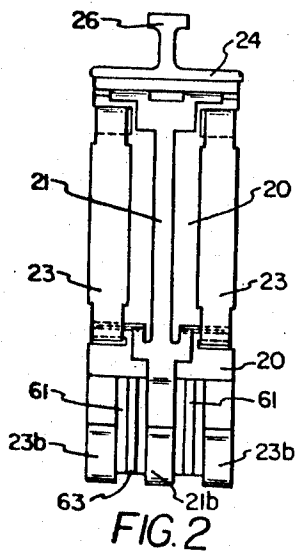
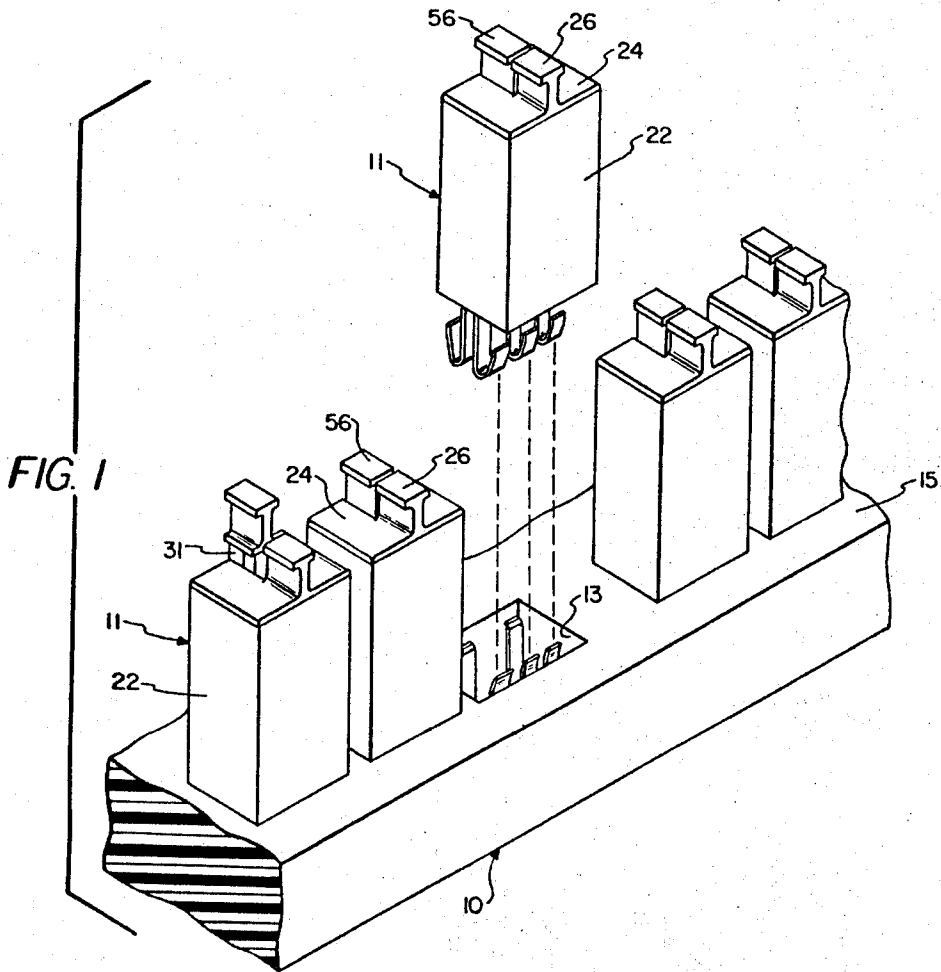
Primary Examiner—A. T. Grimley
Attorney, Agent, or Firm—Lester N. Arnold

[57] **ABSTRACT**

Electrical protectors useful for protecting incoming line pairs in telephone main distributing frames including a pair of protector assemblies of redundant nature encased within common housing means. Each protector assembly includes two separate grounding paths through the provision of two spaced grounding contacts, circuit protective means for selectively providing at least one of the grounding paths, and first and second circuit contact means for providing a normal circuit current path through the assembly. Spring means, employed to maintain relative positions of assembly parts, are positioned between one grounding contact and the circuit protective means and comprise a portion of a first grounding path for the assembly. A projectible pin element is urged by the spring means toward direct engagement with the other grounding contact to establish a second grounding path for the protector assembly under particular circuit fault conditions. In one practice, current limiting means constitutes a portion of the normal circuit current path. In another practice, the normal circuit current path bypasses all parts of the circuit protective means. Circuit interruptive means are provided to remove a selected one of the circuit contact means from the normal current path to provide a detent position for the protector assembly.

18 Claims, 13 Drawing Figures





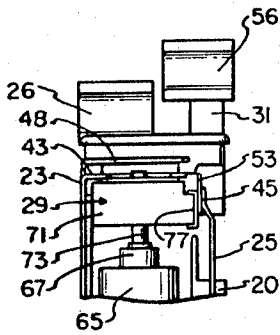


FIG. 5

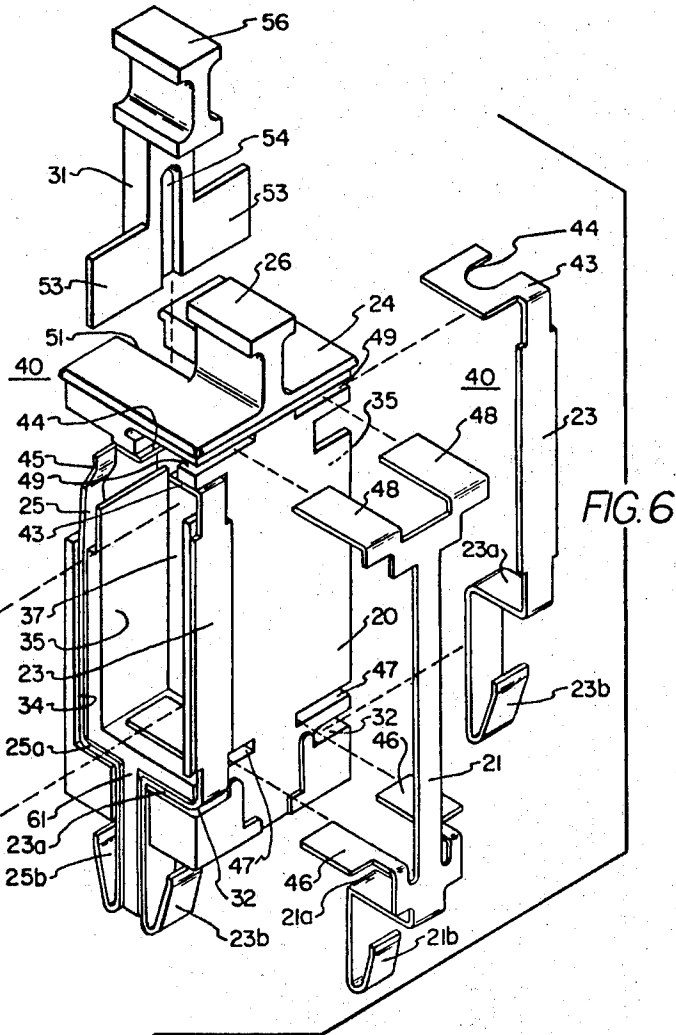
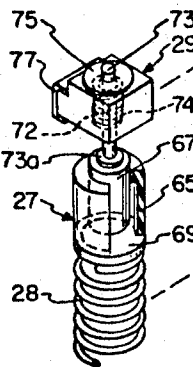


FIG. 6

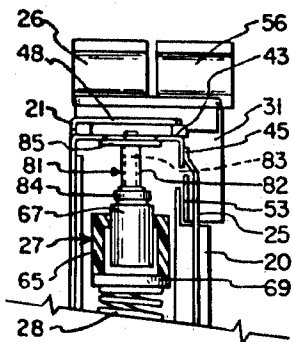


FIG. 7

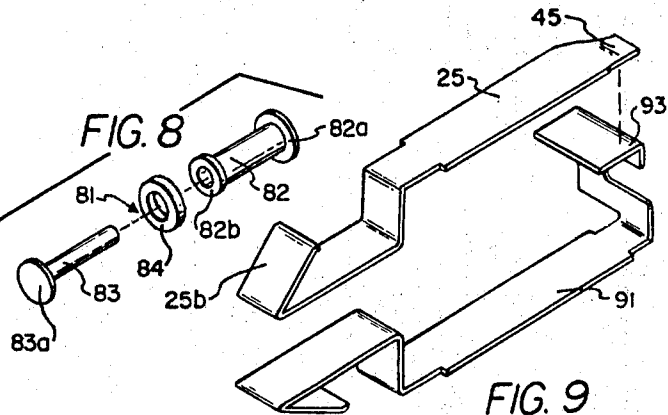


FIG. 9

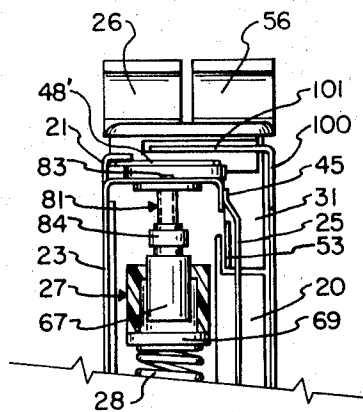


FIG. 10

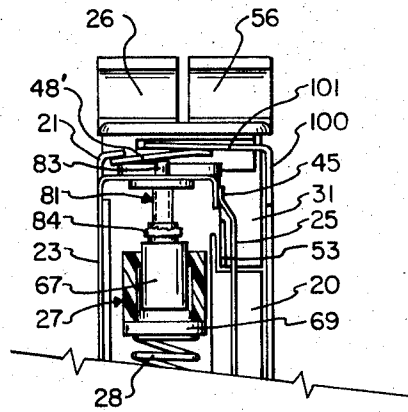


FIG. 11

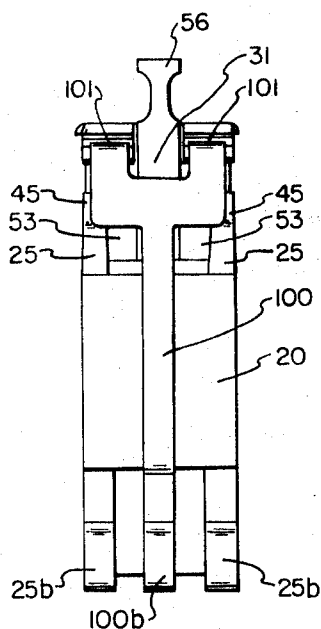


FIG. 12

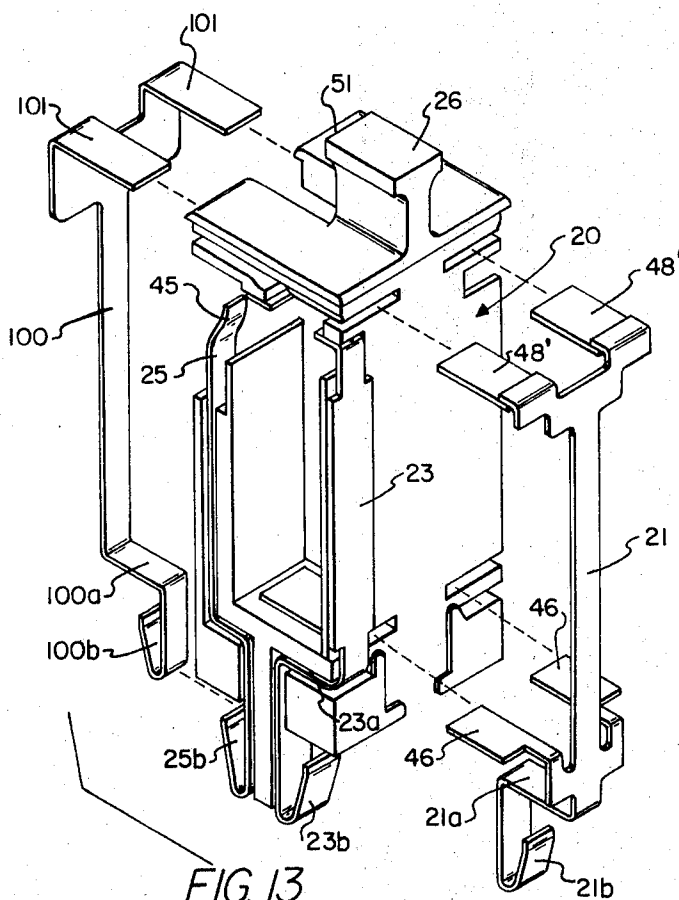


FIG. 13

ELECTRICAL PROTECTORS AND METHODS OF ASSEMBLING THE SAME

CROSS REFERENCE

This application is a continuation-in-part of copending application U.S. Ser. No. 245,462, now abandoned filed Apr. 19, 1972, having common inventorship and assigned to a common assignee.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to electrical protectors and more particularly, relates to an assembly for an electrical protector which provides improved grounding under circuit fault conditions and a module detent position for interrupting the normal circuit current path and methods of assembling these protectors.

2. Description of the Prior Art

Typically in a central office forming part of a telephone transmission network, incoming tip and ring (T and R) line circuits for subscriber telephone lines are initially routed through main frame connectors having multiple electrical protector modules mounted thereon, respectively, before being permitted to extend to critical central office distributing equipment. Each protector normally includes a pair of like protector assemblies employing circuit protective means in various forms of excessive current and/or excessive voltage responsive devices for both the T and R lines. Current responsive or limiting means for these electrical protectors commonly provide a coil or wire strap of a predetermined current conductive capacity normally referred to as a heat coil. The heat coil consists primarily of a fine resistance wire wound on a metal sleeve inside of which a projectible pin element is held in a given position by low-melt solder. In its operation, the current-limiting means is well understood to generate heat in the heat coil upon the occurrence of excessive currents which melt the solder and release the pin. A spring biasing force is ordinarily employed to urge the pin into direct contact with a carbon block which, in turn, engages a grounding contact to complete a ground connection for the incoming line and thus protect the central office equipment.

Excessive voltages, such as result from lightning surges or equipment malfunctions on the line, are shunted to ground by so-called spark-gap protectors or gas tubes which commonly provide a pair of electrodes separated by an open-gap (the electrodes of the gas tube are situated in an hermetically sealed gas environment). One of the electrodes is normally connected to ground and the other to the incoming telephone lines. High voltages impressed on the line will cause a spark or arc across the open-gap to ground to protect the central office equipment. A sustained high voltage condition will result in continuous arcing across the open-gap to ground, resulting in heat generation within the protector assembly. When projectible pin means are present in the assembly, the continuous arcing will occasion excessive heat levels and actuate (release) the captured pin element to provide a permanent ground connection.

In the assembly of parts of the circuit protector disclosed in U.S. Pat. No. 3,573,695, Geyer, et al, inventors, and patented on April 6, 1971, there is shown both current limiting and excessive voltage protection

wherein a single coil spring is used to urge a pin element toward its associated grounding surface. This protector utilizes a common ground connection for both over-current and over-voltage conditions and provides when the pin element is released a ground contact through a carbon block over a spark-gap. This arrangement while comprising an improvement over previously existing protector assemblies, inserts an added resistance value into the grounding circuit path which would be better eliminated. Additionally, the coil spring constitutes a part of the normal circuit current path for the protector which is undesirable in that added circuit resistance and heat generation result.

Furthermore, it is desirable to provide a detent disconnect position for a given protector wherein it has been heretofore popular to arrange the pluggable exterior line terminals for the modular protector unit so that incoming pairs of line terminals extend axially beyond outgoing pairs of line terminals or vice versa. This offset connector terminal arrangement is intended to permit the entire housing of the protective unit to be partially withdrawn from its connector base so that the line terminals of longer axial length remain in electrical contact with the connector base while the shorter line terminals are disconnected. A disadvantage results in that the mounting integrity of the protective unit to the connector base is somewhat deteriorated and probabilities of dislodging the protective unit are greatly enhanced. Heretofore, due to the compactness of parts and limited size of the housing, it has not been convenient to provide an interiorly mounted detent actuator in previously existing protector assembly configurations.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an electrical protector unit having a more judicious assembly of parts enabling the protector unit to be constructed of similar overall size and compactness to that of existing protector units while having improved grounding connections and an interiorly positioned detent actuator.

It is another object of the invention to provide an improved grounding path for circuit protective means within the protector assembly under circuit fault conditions through providing two separate grounding paths.

It is another object to provide for an improved normal circuit current path through the component parts of the protector assembly which is of low resistance and more conveniently interrupted.

It is still another object to provide improved circuit interruptive means in the form of a detent actuator conveniently movable between two positions to interrupt the normal circuit current path when so desired.

An electrical protector assembly for protecting a selected electrical circuit against undesirable electrical transients and surge conditions is comprised of a housing of modular type structure, a grounding terminal, incoming and outgoing line terminals, multi-element circuit protective means, resilient biasing means and a detent actuator for interrupting or breaking the normal circuit current path. The housing includes a pair of electrically isolated internal cavities wherein a pair of protector assemblies have their component parts supported in an assembled relation, respectively. In one

practice of the invention, each pair of protector assemblies comprises a pair of grounding contacts spaced apart within the internal cavity, first and second circuit contact means associated with the incoming and outgoing lines, respectively, multi-element circuit protective means held in proper alignment and position within the assembly by spring means, and a dielectric contact member of the detent actuator. The spring means are held in a compressed position between one of the grounding contacts and a spark-gap device of the circuit protective means. Current limiting means having a heat coil and a projectible pin element are then held between the spark-gap device and a first contact surface of the first circuit contact means. The pin element is actuatable and is urged by the spring means to directly engage the other grounding contact of the protector assembly. The heat coil completes the electrical conductive continuity of the normal circuit current path through interconnecting the incoming and outgoing line terminal straps comprising the first and second circuit contact means. The detent actuator is mounted for movement with respect to the housing and includes an exterior handle member for moving the detent actuator between an inner position and an outer extracted position. In the movement of the handle to the extracted position, the dielectric contact member is caused to move against the contact surface of the outgoing line terminal to break electrical contact.

THE DRAWING

FIG. 1 is an enlarged frontal perspective view of a fragmentary portion of a larger connector base having a plurality of electrical protectors mounted thereon and showing one particular unit removed from said connector base;

FIG. 2 is an enlarged front plan view of an individual protector unit with an outer shell of the housing removed to exhibit the assembly of internal parts for the protector;

FIG. 3 is a side plan view of the protector unit of FIG. 2 further showing the assembly of internal parts thereof;

FIG. 4 is a rear plan view of the protector unit;

FIG. 5 is a fragmentary side plan view of an upper portion of the protector unit and showing a detent actuator in an extracted position with respect to the housing for positioning an internally disposed dielectric contact member in a circuit interrupted position with respect to a circuit contact means;

FIG. 6 is an exploded perspective view of the protector unit showing among other things some parts assembled on the housing, other parts removed therefrom and circuit protective means and spring means removed from one of the two internal cavities within the housing;

FIG. 7 is a fragmentary side plan view similar to FIG. 5 but showing an alternative embodiment for the circuit protective means;

FIG. 8 is an exploded perspective view of a projectible pin element used in the alternative embodiment of the circuit protective means of FIG. 7;

FIG. 9 is an exploded perspective view of an alternative embodiment for the circuit contact means utilized in the protector unit;

FIG. 10 is a fragmentary side plan view similar to FIG. 7 but showing an alarm terminal strap for use with the protector unit;

FIG. 11 is the side plan view of FIG. 10 showing the projectible pin element in an actuated position producing an alarm circuit connection;

FIG. 12 is a rear plan view similar to FIG. 4 but showing the manner of mounting the alarm strap onto the protector unit; and

FIG. 13 is an exploded perspective view of the protector unit similar to FIG. 6 showing the assembly of the alarm and grounding terminal straps onto the housing structure for the protector unit.

DETAILED DESCRIPTION

FIG. 1 shows a fragmentary portion of a connector base or block 10 having a plurality of electrical protector units or modules 11 mountable thereon in plug-in fashion within socket receptacles or apertures 13. FIG. 1 shows only a few of the protector modules 11 and only a small section of the connector base 10; nonetheless, it should be understood that there are many other protector modules similar to those shown and that the connector base 10 is of a common configuration wherein it has a length dimension generally greater than its width dimension. The connector base 10 and the electrical protector modules 11 are of the type employed in main frame distributing panels of central office telephone stations.

One popular size for the connector base 10 would typically provide mounting accommodations for 100 protector modules 11, each of which would then provide electrical protection for a subscriber line pair comprised of tip and ring telephone transmission lines. It is well known to connect the tip and ring subscriber lines which comprise incoming line pairs to individual protector modules 11, respectively, before connecting the same to critical central office telephone station equipment via outgoing line pairs. The connector base 10 would also further include multiple electrical terminals such as wire wrapped solderless terminals (not shown) for connecting incoming subscriber line pairs to the connector base 10 and then to the protector modules 11 and from the protector modules 11 to the outgoing central office line pairs. It is not thought to be required as a part of this description to include a further explanation of the connector base 10 except as may pertain to the configuration of the apertures 13.

In mounting an individual electrical protector 11 on the connector base 10, the base portion of the protector module is provided with a plurality of spring-action electrical terminals, as will be more fully described hereinafter, which are pluggable into an associated aperture 13, FIG. 1. The aperture 13 is provided with a corresponding plurality of electrical terminals which could be provided in a spring-action configuration and which are engageable with those electrical terminals on the protector module 11 to complete the desired electrical interconnection. The protector module 11 includes housing means in the form of an inner main housing body 20 specially designed to support the component parts of the protector module 11 in their intended relationship. The component parts of the protector module 11 generally comprise grounding means in the form of a grounding terminal strap 21; first and second circuit contact means in the form of at least a pair of elongated main terminal straps 23, 23 and 25, 25 associated with incoming tip and ring subscriber line and an outgoing tip and ring central office line, respectively; multi-element circuit protective means in the

form of over-voltage and/or over-current protective devices such as at least a pair of spark-gap devices 27, 27 and a pair of current-limiting heat coil units 29, 29; resilient biasing means or spring means in the form of at least a pair of coil springs 28, 28; and circuit interruptive means in the form of a detent actuator 31.

As shown most clearly in FIGS. 1 and 6, the main housing body 20 is provided with an elongated dimension in a direction generally perpendicular to the mounting surface 15 of the connector base 10 and defines a pair of open-sided internal cavities 35, 35 which are separated by a central interior wall 37, FIG. 6. Each protector module 11 includes a pair of protector assemblies 40, 40 associated with the pair of internal cavities 35, 35, the assemblies 40, 40 being merely duplicative of each other in their operational features and assembly of parts. Therefore, both internal cavities are shown in the drawing without a distinction of reference numerals as applied to the parts of the two assemblies 40, 40 in order to afford the reader a complete view of all sides of the protector module 11 while attempting to avoid unnecessary views of the module.

The main housing body 20 may be constructed of any suitable insulating material and preferably is insertable into a hollow open-ended box-like housing cover 22, FIG. 1. A top wall 24 (when viewing the protector module 11 in the upright orientation of FIG. 6) of the main housing body 20 is provided with an exterior handle member 26 by which to grasp the protector module 11 when inserting or removing the same from its associated aperture 13. The incoming and outgoing main terminal straps 23, 23 and 25, 25 of the assemblies 40, 40 are supported with respect to the main housing body 20 in shallow recesses or tracks 32, 32 and 34, 34, respectively. Each of the terminal straps 23, 23 and 25, 25 is a generally elongated narrow strip of a suitable conductive material and, as indicated in FIGS. 3 and 6, contains an inwardly directed offset portion 23a, 23a and 25a, 25a, respectively, disposed in the base portion of the housing body 20 within the tracks 32, 32 and 34, 34, respectively.

Each pair of the main terminal straps 23, 23 and 25, 25 have their bottommost, FIGS. 3 and 6, end portions doubled back to present spring-action electrical connecting terminal end portions 23b, 23b and 25b, 25b, respectively. The terminal end portions 23b, 23b and 25b, 25b can then be understood to exert a force within the associated socket 13 tending to spread the engaging electrical terminals of the socket 13 so as to provide a high-integrity plug-in electrical connection. At their uppermost end portions, the main terminal straps 23, 23 and 25, 25 are provided with first contact surfaces 43, 43 and 45, 45, respectively. The contact surfaces 43, 43 and 45, 45 are positioned so as to be accessible to the circuit protective means within the internal cavity 35, as by providing suitable openings in the side walls which define the internal cavities 35, 35. The first contact surfaces 43, 43, of the terminal straps 23, 23 are provided with open-ended slots or apertures 44, 44 for purposes to be set forth hereinafter.

Next, the grounding terminal strap 21 contains an inwardly directed offset portion 21a similar to the parts 23a, 23a and 25a, 25a and has its bottommost end portion doubled back to define a spring-action connecting terminal end portion 21b similar to the parts 23b, 23b and 25b, 25b of the main terminal straps 23 and 25, respectively. Further, the grounding strap 21 includes a

pair of spaced grounding contact surfaces 46, 46 and 48, 48 for the assemblies 40, 40. The grounding contact surfaces 46, 46 and 48, 48 are insertable into the internal cavities 35, 35 through the provision of slots 47, 47 and 49, 49, respectively (FIG. 6), in the adjacent side walls of the main housing body 20.

The detent actuator 31 is slidably received within an opening 51 in the top wall 24 of the main housing body 20 and includes an interior key-way or guide slot 54 to aid in controlling the respective motion between the two bodies and for maintaining the proper alignment during actuator movement. The detent actuator 31 has generally an inverted T-configuration with an attached handle member 56 which permits the actuator 31 to be easily grasped for effecting its movement. The cross-member of the T-shaped actuator comprises a pair of flanges which constitute dielectric contact breaking surfaces 53, 53 for use in the protector assemblies 40, 40. FIGS. 3 and 4 show the detent actuator 31 in an inner position with respect to the housing body 20 wherein it can be seen that the contact breaking members or surfaces 53, 53 are positioned directly below the first contact surfaces 45, 45 of the outgoing main terminal straps 25, 25. In this position, the detent actuator 31 is ineffective to break or interrupt the electrical conductive continuity that exists between the current-limiting units 29, 29 and the first contact surfaces 45, 45. FIG. 5 then shows the detent actuator removed to an outer extracted position with respect to the housing body 20 wherein the contact breaking surfaces 53, 53 are interposed between the contact surfaces 45, 45 and the current-limiting units 29, 29. This position, of course, interrupts the electrical conductive continuity of the normal circuit current path through the protector assemblies 40, 40. Therefore, the outer extracted position of the detent actuator 31 provides a detent mode or position for both assemblies 40, 40 of the protector module 11 wherein the normal circuit current path can be interrupted without partially disconnecting the entire housing body 20 from its socket 13 as is required for some types of presently available protector modules.

The base portion of the main housing body is provided with a laterally extending wall portion 61 having perpendicularly intersecting abutments or fins 63 spaced laterally therealong, each abutment 63 extending in the common direction of the main terminal straps 23, 23 and 25, 25 and the grounding terminal strap 21. The wall portion 61 and the abutments 63 define a compartmentalized arrangement designed to provide electrical isolation between the respective terminal straps. The walls 61 and 63 also can provide aid in properly aligning the protector module 11 with respect to the connector base socket 13.

FIGS. 3 and 6 show cross-sections of the spark-gap devices 27, 27, which devices 27 comprise over-voltage protectors for the circuit protective means. Referring therefore to a single spark-gap device 27, the device 27 is comprised of a tubular ceramic sleeve 65 within which is fixed a cylindrical carbon insert 67. The ceramic sleeve 65 abuts a carbon disc 69 which is separated from the lower extremity of the carbon insert to provide an air gap of approximately 2 or 3 mils. The carbon disc 69 provides a seat against which an upper end of an associated one of the coil springs 28, 28 abut. The lower ends of the coil springs 28, 28 abut against the grounding contacts 46, 46 positioned near the

lower extremity of the internal cavities 35, 35. When excessive voltages are impressed upon the normal circuit current path through the protector module 11, which current path is traceable through the incoming straps 23, 23, the current-limiting heat coil units 29, 29, and the outgoing terminal straps 25, 25, arcing will occur across the air gap between the respective carbon inserts 67, 67 and the carbon discs 69, 69. Electrical arcing currents are then transferred to ground connections through the coil springs 28, 28 and the grounding contacts 46, 46. These comprise first grounding paths for the protector assemblies 40, 40.

Also shown in FIG. 3 is a cross-section of one of the current-limiting heat coil units 29, 29, an individual unit 29 being comprised of a dielectric base 71 having a central tubular sleeve 72 extending therethrough within which a projectible pin element 73 is inserted. The pin element 73 has a widened flange portion 73a on the lowermost end thereof which abuts an associated one of the carbon inserts 67, 67. A heat coil 74 in the form of a fine strand of wire is wound about the central portion of the tubular sleeve 72 within the base 71 and completes an electrical circuit path between a top-mounted contact plate 75 on the base 71 and a side-mounted contact plate 77 on the base 71. In the normal orientation of parts for the assemblies 40, 40, the top contact plates 75, 75 abut the first contact surfaces 43, 43 of the incoming terminal straps 23, 23 while the side contact plates 77, 77, abut the first contact surfaces 45, 45 of the outgoing terminal straps 25, 25. The normal circuit current paths through the assemblies 40, 40 are therefore completed through the incoming terminal straps 23, 23, the heat coils 74, 74 to the outgoing terminal straps 25, 25.

Each projectible pin element 73 is permanently fixed with a low-melt solder connection in a selected position with respect to its encompassing tubular sleeve 72 so as to have an uppermost end advanced above the base 71. The pin element 73 is then aligned to extend upon being propelled by the associated coil spring 28 through the associated aperture 44 of the adjacent first contact surface 43, and thereby to engage the grounding contact 48 which is positioned in parallel space relation to the first contact surface 43 of the terminal strap 23. Each of the coil springs 28, 28 urge the projectible pin elements 73, 73 towards the upper grounding contacts 48, 48. When excessive currents are carried by the associated heat coil 74 causing the low-melt solder connection to at least partially melt, the pin elements 73, 73 are propelled into abutment with the upper grounding contacts 48, 48 to provide permanent and second grounding paths for the assemblies 40, 40.

An alternative embodiment for the circuit protective means is shown in FIGS. 7 and 8 wherein the current-limiting unit 29 for a given protector assembly 40 is replaced with a projectible pin apparatus 81. The purpose of the pin apparatus 81 is to provide for the permanent and second grounding path for an individual protector assembly 40 in the type of circuit protective means which contains no current-limiting protection but only provides over-voltage protection. The pin apparatus 81 is shown in use with one of the spark-gap devices 27, 27 but just as well could be combined with alternative over-voltage protectors such as gas tube type over-voltage devices (not shown).

The pin apparatus 81 is comprised of a tubular sleeve 82 having a widened flange portion 82a on one of its extreme ends, a projectible pin element 83 having a widened flange portion 83a on one of its extreme ends, and a tubular sleeve 84 comprised of low-melt solder and referred to hereinafter as a solder joint. In its proper orientation within the associated circuit protective means, the pin apparatus 81 has the flange portion 82a abutting the underside of the first contact surface 43 to provide electrical contact. The flange portion 83a of the pin element 83 abuts the carbon insert 67. The pin element 83 is of a reduced diameter with respect to the sleeves 82 and 84 so that the pin element can be received therethrough when orienting the parts as shown in FIG. 8.

The solder joint 84 serves as a spacer between the flange portion 83a of the pin element 83 and a flange portion 82b on the sleeve 82, which flange 82b is enlarged to prevent its insertion through the solder joint 84. Upon the occurrence of excessive or continuous arcing conditions in the spark-gap device 27, the low-melt solder joint 84 will be at least partially melted, thus allowing the projectible pin element 83 under the urging of the coil spring 28 to be propelled further through the sleeve 82 until the pin 83 abuts the grounding contact surface 48. Thus, with the use of the pin apparatus 81 a permanent and second grounding path is provided for the associated assembly 40 when employing solely over-voltage protection as the circuit protective means.

FIG. 9 shows an alternative embodiment wherein the outgoing terminal strap 25 is combined with a modified incoming terminal strap 91. The terminal strap 91 is in all respects like that of terminal strap 23 except that a depending flange 93 is added to the first contact surface 43 of the strap 23 and assembled on the housing frame 20 so as to abut the surface 45 of the strap 25. The flange 93 comprises an extension of the first contact surface 43 and is provided as a substitute for the side contact plate 77 of the heat coil unit 29 when current-limiting protection is not provided as a part of the circuit protective means. The operation of the detent actuator 31 with respect to this alternative combination of over-voltage protection is the same as described in connection with the heat coil unit 29 except that the contact breaking surface 53 is now effectively inserted between the first contact surfaces 43 and 45 of the terminal straps 23 and 25, respectively, when the actuator 31 is moved to its extracted detent position.

FIGS. 10-13 show the use of an alarm terminal strap 100 in connection with the electrical protector module 11 wherein an alarm signal can be provided when a permanent ground connection is made by the actuated pin element 83. The alarm terminal strap 100 is provided with an inwardly directed offset portion 100a similar to parts 21a, 23a and 25a of the drawing and a spring-action connecting terminal end portion 100b similar to parts 21b, 23b and 25b of the drawing. It is apparent that the spring-action end portion 100b can be used to provide an electrical connection to an alarm circuit whereby a warning device can be used to signal the presence of a permanent ground condition in one or both of the protector assemblies 40, 40. Further, the alarm strap 100 includes a pair of spaced contact surfaces 101, 101 which are insertable into the internal cavities 35, 35 through the provision of suitable slots as is shown in FIGS. 10-13.

In the proper assembly of parts, the alarm strap 100 fits onto the housing body 20 with its lowermost end portion as shown in FIGS. 12 and 13, received generally oppositely from the corresponding lowermost end portion of the grounding strap 21. The alarm contact surfaces 101, 101 are assembled in closely spaced overlapping relationship to a pair of modified grounding contact surface 48', 48' which are provided as flexible tines for the purpose of being deformed by the projecting pin elements 83, 83 into physical contact with adjacent alarm surfaces 101, 101 as is clearly shown in FIGS. 10 and 11. FIGS. 10 and 11 illustrate the use of the alarm strap 100 in connection with the alternative over-voltage projectible pin apparatus 81 of FIG. 7, but the current-limiting heat coil unit 29 could as well be utilized. FIG. 11 shows the pin apparatus 81 in an actuated position in which the flexible tine 48' is pressed into contact with the alarm surface 101 so as to provide electrical continuity between the ground strap 21 and the alarm strap 100. It should be noted that the socket aperture 13 of FIG. 1 would be provided with an additional contact terminal than is shown in that figure for providing an electrical connection to the alarm strap 100.

The alarm strap 100 may be provided in those environments wherein a grounding alarm is desired. The flexible tine 48' desirably is comprised of a thin highly flexible leaf-like configuration and is of a much less rigid material than is the grounding strap 21. However, the spacing between the pin element 83, the tine 48' and the alarm surface 101 (while also considering the degree of flexibility of the tine 48') must be designed to provide operability through the available force of the actuable pin element 83 yet not to be so flexible as to cause inadvertent grounding or alarm signals through chattering action of the flexible tine 48'. The tines 48', 48' are shown as separate pieces attached as by suitable weld to the grounding strap 21; however, the applicant intends to include other equally equivalent and suitable means of providing flexibility to the uppermost contact areas of the grounding strap 21 including those obvious configurations of producing a flexible tine from the grounding contact surface 48, 48.

In a preferred manner for assembling the protector assemblies 40, 40, the main housing 20 is initially oriented in an inverted position with respect to the upright position shown in FIG. 6. The grounding terminal strap 21 is firstly positioned on the main housing frame 20 so that its grounding contact surface 46, 46 and 48, 48 are positioned in the internal cavities 35, 35 near the opposite extremities of the elongated dimensions of the cavities 35, 35. Next the incoming main terminal straps 23, 23 are positioned on the housing frame 20 with their first contact surfaces 43, 43 positioned in the respective internal cavities 35, 35 near the associated grounding contacts 48, 48 and with their offset portions 23a, 23a received in the assigned tracks 32, 32. Next the heat coil units 29, 29 are oriented so as to insert the contact plates 75, 75 into direct engagement with the apertured portions of the first contact surfaces 43, 43 of the straps 23, 23, and the contact plates 77, 77 to face oppositely from the straps 23, 23.

Now, the spark-gap devices 27, 27 are placed upon the heat coils 29, 29 with the carbon disc 69, 69 facing upwardly within the inverted cavities 35, 35. Next, the coil springs 28, 28 are inserted in a two-step process into the internal cavities 35, 35, wherein in an interme-

diate position each coil spring has one end portion resting upon one of the carbon discs 69, 69. The coil springs 28, 28 are then moved with a camming action simultaneously inwardly and downwardly into final positions, respectively, as can be understood from a consideration of FIG. 3, wherein the other end portions thereof directly engage the grounding contact surfaces 46, 46. Next, the detent actuator 31 is slidably mounted on the housing frame 20 in its inner non-interrupting position. Thereafter, the outgoing main terminal straps 25, 25 are positioned on the housing frame 20 with their first contact surfaces 45, 45 positioned to engage the contact plates 75, 75 of the heat coil unit 29, 29, and further with their offset portions 25a, 25a received within the assigned tracks 34, 34. The outer housing shell 22 is then slipped over the main housing frame 20 to complete the assembly of the structure.

The protector assemblies 40, 40 can also be provided with other combinations of internally mounted circuit protective parts such as gas tube units combined with heat coils, gas tubes only, no circuit protection combined with a direct switchthrough arrangement of strap 91 being engaged with strap 25, or a dummy protector module 11 having no circuit protection features nor direct switchthrough current path. Further, this invention has been described with reference to preferred embodiments and a variety of other equally useful configurations could no doubt be readily substituted by the skilled practitioner after becoming knowledgeable of the improved features of the present invention. Further, these various embodiments could no doubt be readily applied to other fields of application than telephone protectors. It is therefore the intent of the Applicant to cover any alternative embodiments having the improved features taught herein through the following claims, to wit:

I claim:

1. An electrical protector assembly for protecting a selected circuit against undesirable electrical transients and surge conditions, comprising:

housing means for supporting a desired orientation of said protector assembly and defining at least one internal cavity having an elongated dimension,
grounding means for said assembly including at least first and second grounding contact surfaces positioned in said internal cavity and spaced from each other by substantially the length of said cavity,
first circuit contact means for said assembly including at least a first contact surface positioned in said cavity, said first contact surface having an apertured portion thereof extending in closely spaced parallel relation to the first grounding contact surface of said grounding means,

second circuit contact means for said assembly for cooperating with said first circuit contact means to establish a normal circuit current path through said assembly, said second circuit contact means including at least a first contact surface in a path of electrical conductive continuity with said first contact surface of said first circuit contact means,

multi-element circuit protective means for said assembly positioned in said internal cavity generally between the first contact surface of said first circuit contact means and the second grounding contact surface of said grounding means, said protective means having at least a first element thereof di-

rectly engaging said apertured portion of the first contact surface of said first circuit contact means,

spring means for said assembly mounted in said internal cavity and urging said circuit protective means toward said first grounding contact surface and into engagement with said apertured portion of said first circuit contact means, respectively, said spring means being positioned in direct engagement with said circuit protective means and said second grounding contact surface, respectively, for providing a first grounding path, and circuit interruptive means for said assembly including at least one contact breaking surface movable between at least two positions with respect to said housing means, said contact breaking surface being effective to break the electrical conductive continuity between said first contact surfaces of said first and second circuit contact means when moved to a first of said two positions, and being electrically ineffective to break said electrical conductive continuity when moved to a second of said two positions.

2. An assembly as claimed in claim 1 wherein said multi-element circuit protective means includes at least one projectible pin element actuatable upon the occurrence of predetermined fault conditions, said pin element aligned with the opening of said apertured portion of said first circuit contact means and urged by said spring means when actuated to directly engage said first grounding contact surface of said grounding means for providing a second grounding path for said assembly.

3. An assembly as claimed in claim 2 wherein said multi-element circuit protective means includes current-limiting means, and said current-limiting means includes at least one wire strap of preselected current conducting capacity interconnected between the first contact surfaces of said first and second circuit contact means for providing said electrical conductive continuity therebetween.

4. An assembly as claimed in claim 2 wherein said circuit protective means includes voltage protective means comprising first and second electrodes positioned in closely spaced relationship with each other so as to define a spark-gap therebetween, said first electrode being connected in electrical series with said first element which engages said apertured portion of said first contact surface and said second electrode being connected in electrical series with said spring means for providing an over-voltage protective grounding path for said selected circuit through said first grounding path for said assembly.

5. An assembly as claimed in claim 4 wherein said first contact surface of said first circuit contact means directly abuts and is in electrical engagement with said first contact surface of said second circuit contact means for providing that said normal circuit current path through said assembly bypasses said voltage protective means.

6. An assembly as claimed in claim 2 wherein said circuit protective means includes a projectible pin apparatus having a tubular sleeve within which to receive said projectible pin element, said tubular sleeve comprising said first element in contact with said first contact surface of said first circuit contact means, and said pin apparatus further having spacer means gener-

ally comprised of a low temperature meltable material, said spacer means being determinative of the extent of reception of said pin element into said tubular sleeve.

7. An assembly as claimed in claim 2 wherein said assembly includes alarm circuit contact means to be positioned in said cavity for engagement with said first grounding contact surface upon said actuated pin element engaging said first grounding contact surface.

8. An assembly as claimed in claim 7 wherein said first grounding contact surface includes a flexible end portion which is moved into engagement with said alarm circuit contact means upon said actuated pin element engaging said first grounding contact surface.

9. In an electrical protector assembly useful for protecting a selected circuit against undesirable electrical transients and surge conditions, housing means containing at least one elongated internal cavity, grounding means to be positioned in said cavity, first and second circuit contact means connectable in electrical series with each other so as to at least partially define a normal circuit current path through said protector assembly, multi-element circuit protective means to be positioned in said cavity and including at least an over-voltage protector device, spring means to be positioned in said cavity and being effective to retain said multi-element circuit protective means in said cavity, the improvement comprising at least a pair of space contact surfaces for said grounding means spaced apart within said cavity by substantially the elongated length of said cavity, a first contact surface for said first circuit contact means having a portion thereof extending in closely spaced parallel relation to one of the grounding contact surfaces, projectable pin means for said multi-element circuit protective means, said pin means abutting the said first contact surface and including a projectible pin element actuatable upon the occurrence of predetermined fault conditions, said spring means being positioned in said cavity between said over-voltage protector device and the other of said grounding contact surfaces and directly engaging each thereof for establishing a first electrical grounding path for said assembly extending from said first contact surface through said over-voltage protector device, and said spring means being effective to urge said pin element when actuated into direct engagement with said one grounding contact surface for establishing a second electrical grounding path for said assembly extending from said first contact surface through said projectable pin means, and circuit interruptive means having at least one movable contact, said contact being effective to interrupt the series current path between said first and second contact means when moved to a first position and being effective to reconnect said series current path when moved to a second and electrically neutral position.

10. An assembly as claimed in claim 9 wherein said circuit interruptive means comprises a dielectric detent actuator provided generally in the form of an elongated slide member supported by said housing means and movable between inner inserted and outer extracted positions with respect to said housing means, said actuator being additionally provided with an exteriorly accessible handle member useful for moving said actuator between said two positions, said movable contact comprises a dielectric contact member provided generally in the form of a relatively thin flange portion which is

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moved to said first position for providing a detent condition for said assembly, and which contact member is moved to said second and electrically neutral position when said actuator is moved to said inserted position.

11. An assembly as claimed in claim 9 wherein said second circuit contact means includes a first contact surface which is accessible for electrical connection to selected parts of said assembly within said cavity and is closely spaced to said first contact surface of said first circuit contact means, and said multi-element circuit protective means includes a current-limiting heat coil in the form of a continuously wound wire strap of a pre-selected electrical resistance, said heat coil being connected in electrical series with the first contact surfaces of said first and second circuit contact means for providing at least a first means for actuating said projectible pin element.

12. An assembly as claimed in claim 9 wherein said over-voltage protector device comprises a pair of closely spaced parallel oriented electrodes defining a spark-gap across which continuous arcing conditions will actuate said projectible pin element for providing a second means for actuating said projectible pin element.

13. An assembly as claimed in claim 9 wherein said second circuit contact means includes a first contact surface which is accessible for electrical connection to selected parts of said assembly within said cavity and which directly engages the first contact surface of said first circuit contact means for providing a direct electrical switchthrough path for said assembly.

14. A method for assembling the electrical protector assembly of claim 9 comprising the steps of:

positioning and grounding means on said housing means to insert said pairs of spaced grounding contact surfaces into a final position within said internal cavity,

positioning said first circuit contact means on said housing means to insert said first contact surface thereof into a final position within said internal cavity,

and selectively either firstly positioning said circuit interruptive means on said housing means to locate said movable contact thereof in said second position, secondly positioning said second circuit contact means on said housing means to locate the same in a final position with respect to said first circuit contact means, thirdly positioning said multi-element circuit protective means in said internal cavity with said projectible pin means directly abutting said first contact surface, fourthly positioning said spring means lengthwise in said internal cavity in an intermediate position with one end portion thereof directly abutting the over-voltage protector device of said multi-element circuit protective means, thereafter moving said spring means to a final and compressed position within said internal cavity for urging said projectible pin means into direct abutment with the first contact surface of said first circuit contact means, or firstly positioning said multi-element circuit protective means in said internal cavity with said projectible pin means directly abutting said first contact surface, se-

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condly positioning said spring means lengthwise in said internal cavity in an intermediate position with one end portion thereof directly abutting said over-voltage protector device, thirdly moving said spring means to a final and compressed position within said internal cavity for urging said projectible pin means into direct abutment with the first contact surface of said first circuit contact means, fourthly positioning said circuit interruptive means on said housing means to locate said movable contact thereof in said second position, and thereafter positioning said second circuit contact means on said housing means to locate the same in a final position with respect to said first circuit contact means.

15. An electrical protector assembly for protecting a selected circuit against undesirable electrical transients and surge conditions comprising housing means, grounding means within said housing including at least a first grounding contact surface, first and second circuit contact means positionable within said housing to establish a normal circuit current path for said protector assembly, multi-element circuit protective means positionable within said housing generally between the first circuit contact means and said grounding means, said protective means electrically engaging one of said first contact means and said grounding means, spring means positionable within said housing for urging said circuit protective means toward the other of said first circuit means and said grounding means, said spring means being contained in a grounding circuit path for said electrical protector assembly, and circuit interruptive means for said assembly including at least one contact breaking surface movable between at least two positions with respect to said housing means, said contact breaking surface being effective to interrupt electrical conductive continuity between said first and second contact means when said surface is moved to a first of said two positions, and being effective to reconnect said electrical conductive continuity between said first and second circuit contact means when said surface is moved to a second of said two positions.

16. An electrical protector assembly as claimed in claim 15 wherein said circuit interruptive means includes handle actuating means accessible exteriorly of said housing means, said handle actuating means being movable to actuate said contact breaking surface between said two positions thereof.

17. An assembly as claimed in claim 15 wherein said grounding means includes a first grounding contact surface, said multi-element protective means includes a projectible pin element actuable upon the occurrence of predeterminable fault conditions and aligned to engage said first grounding contact surface when actuated, and said assembly further includes alarm circuit contact means positionable in said housing means for engagement with said first grounding contact surface upon said actuated pin element engaging said first grounding contact surface.

18. An assembly as claimed in claim 17 wherein said first grounding contact surface includes a flexible end portion which is moved into engagement with said alarm circuit contact means upon said actuated pin element engaging said first grounding contact surface.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,825,867 Dated July 23, 1974

Inventor(s) THOMAS GEORGOPULOS

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 13, line 35 "and" should be -- said --

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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