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INT CL⁴ H02H 9/02 9/04 9/06, H04M 19/00

(54) **Solid state station protector device**

(57) A device for protecting electronic equipment from damaging surges of voltage and current uses two solid state bidirectional voltage sensitive switches 38, 40 coupled across the electronic equipment with a ground terminal 50 therebetween, and two pairs of parallel connected variable resistance members 52, 54, 56, 58 which vary their resistance in proportion to the applied current located in series in ring and tip connection lines. The elements 38, 40, 52, 54, 56, 58 are enclosed in a common sealed plastics housing (76), (78), (Figs. 3 to 5), and are connected to input and output terminal studs (68*a*) to (68*d*) via input and output contact members (64), (64*a*), (66), (66*a*), (Figs. 3, 6, 7, 8) having contact spring elements (94), (100).

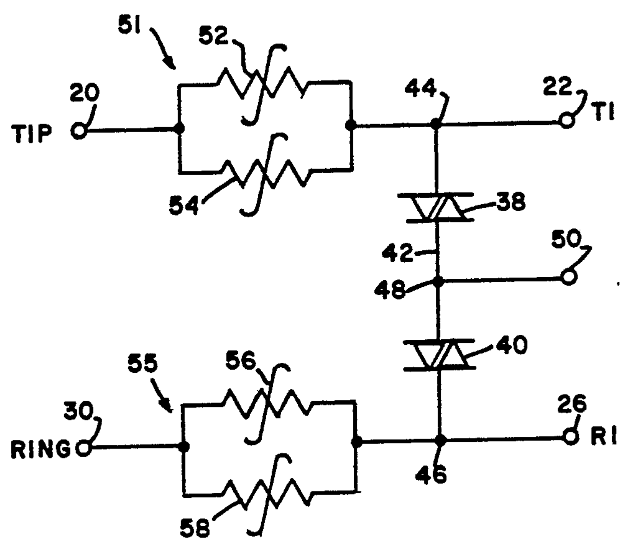

FIG. 2

GB 2 224 402 A

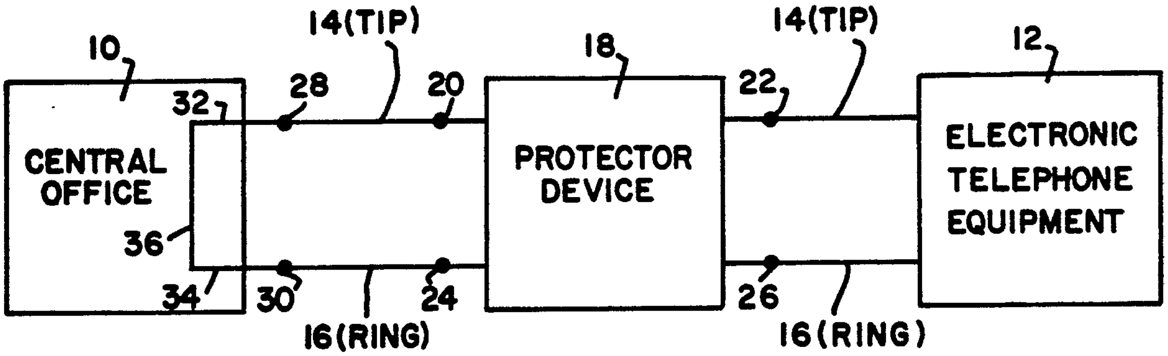
10
32
28
14(TIP)
20
18
22
14(TIP)
12
CENTRAL OFFICE
PROTECTOR DEVICE
ELECTRONIC TELEPHONE EQUIPMENT
36
34
30
24
16(RING)
26
16(RING)

FIG.1

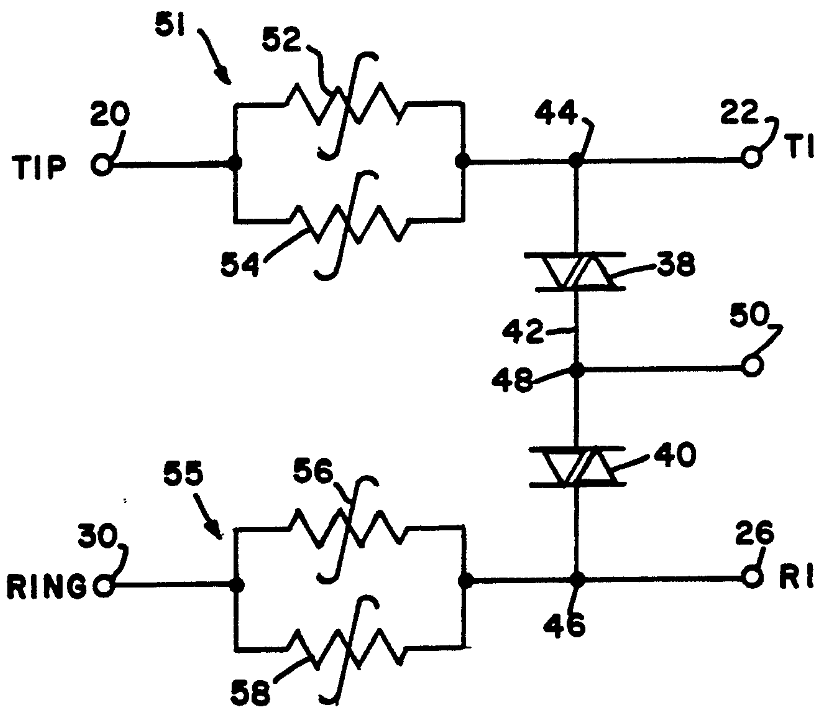
51
52
20
TIP
44
22
TI
54
38
42
50
48
40
55
56
30
RING
26
RI
46
58

FIG.2

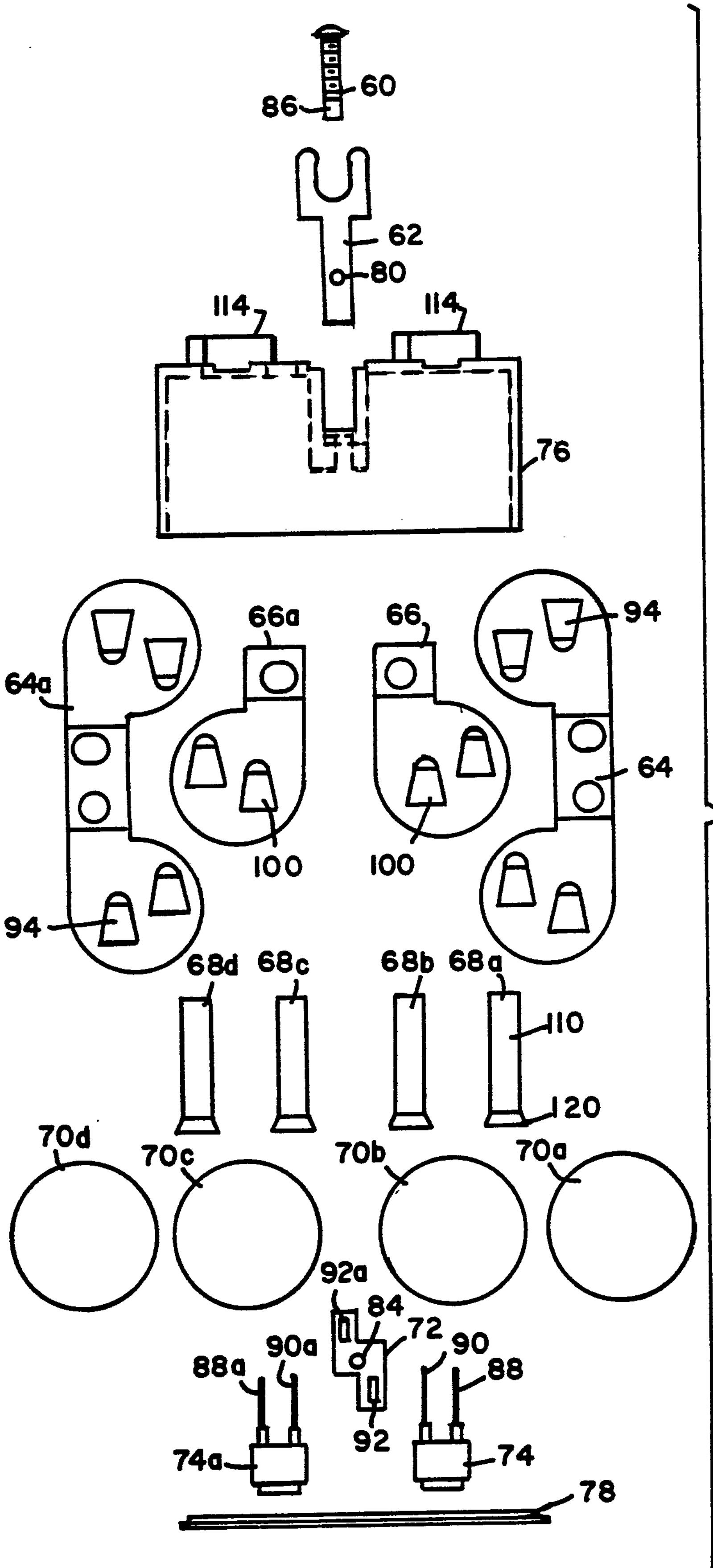
60
86
62
80
114
114
76
66a
66
94
64a
64
100
100
94
68d
68c
68b
68a
110
120
70d
70c
70b
70a
92a
84
72
90
88
90a
88a
92
74a
74
78

FIG.3

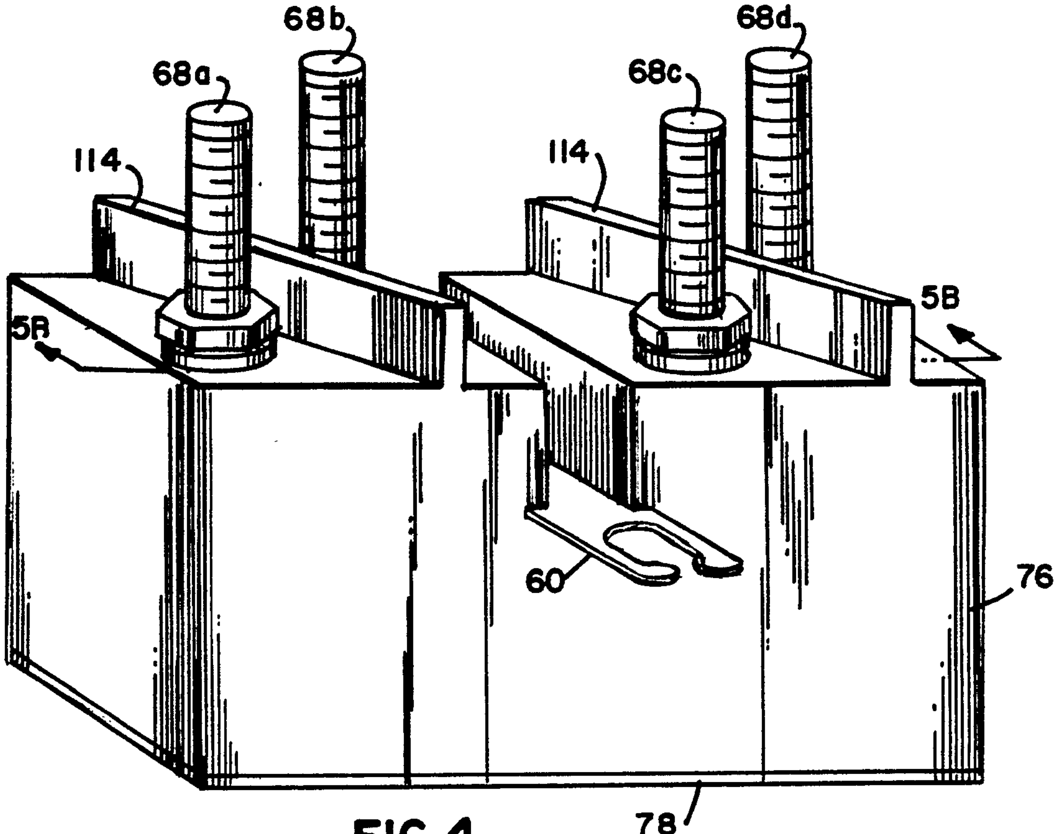
68b
68a
68d
68c
114
114
5B
5B
60
76
78

FIG.4

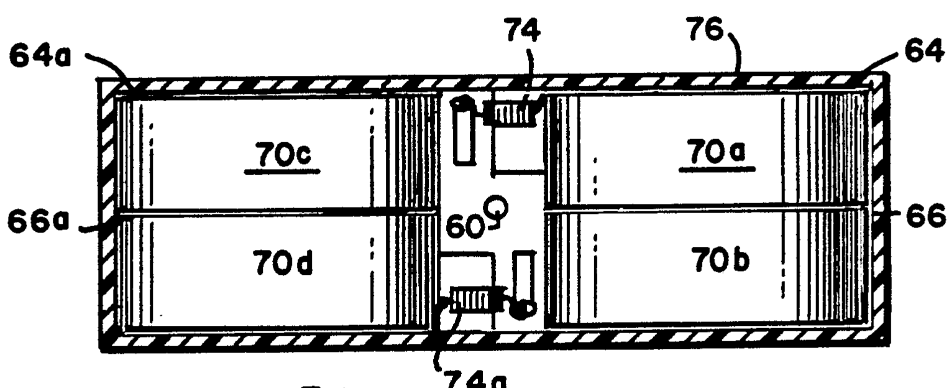
64a
74
76
64
70c
70a
66a
60
66
70d
70b
74a

FIG.5A

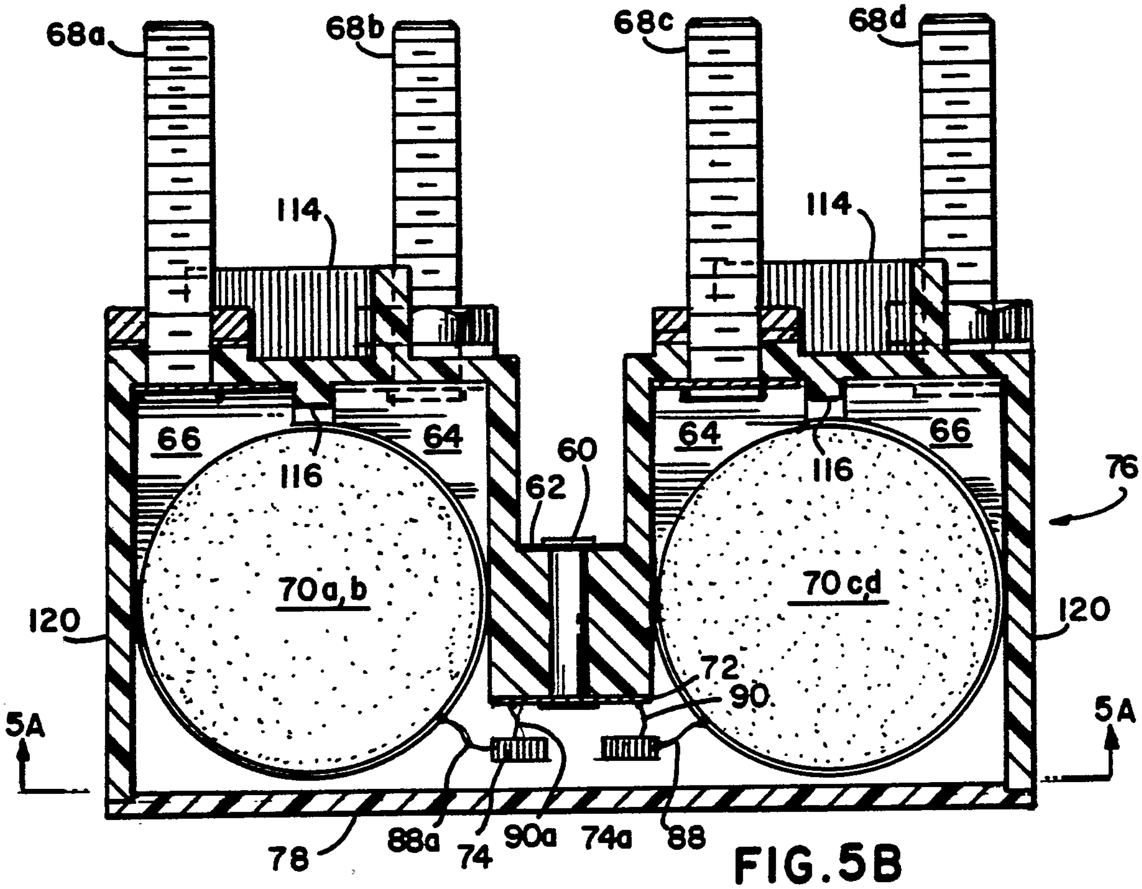
68a
68b
68c
68d
114
114
66
64
64
66
116
116
60
62
76
70a,b
70cd
120
120
72
90
5A
5A
78
88a
74
90a
74a
88

FIG.5B

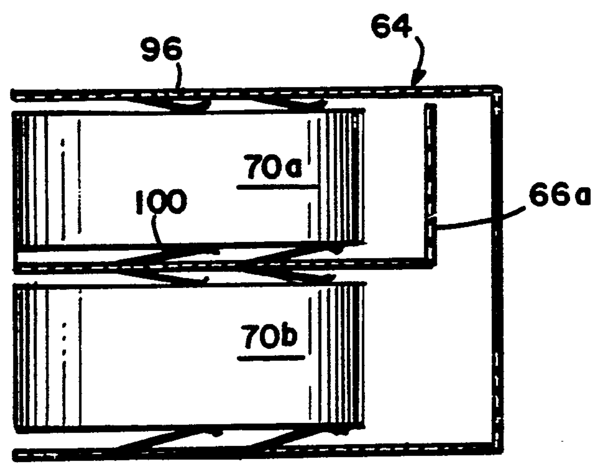
96
64
70a
100
66a
70b

FIG.8

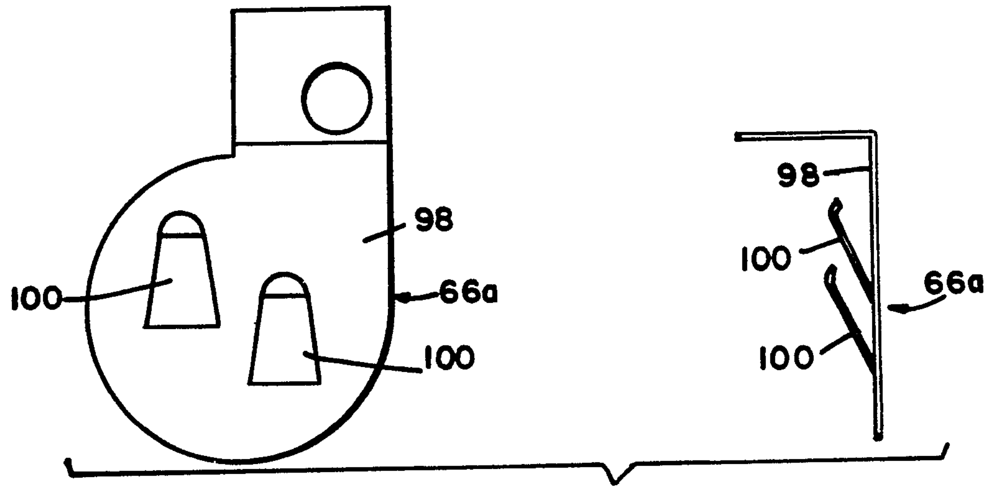

FIG.6

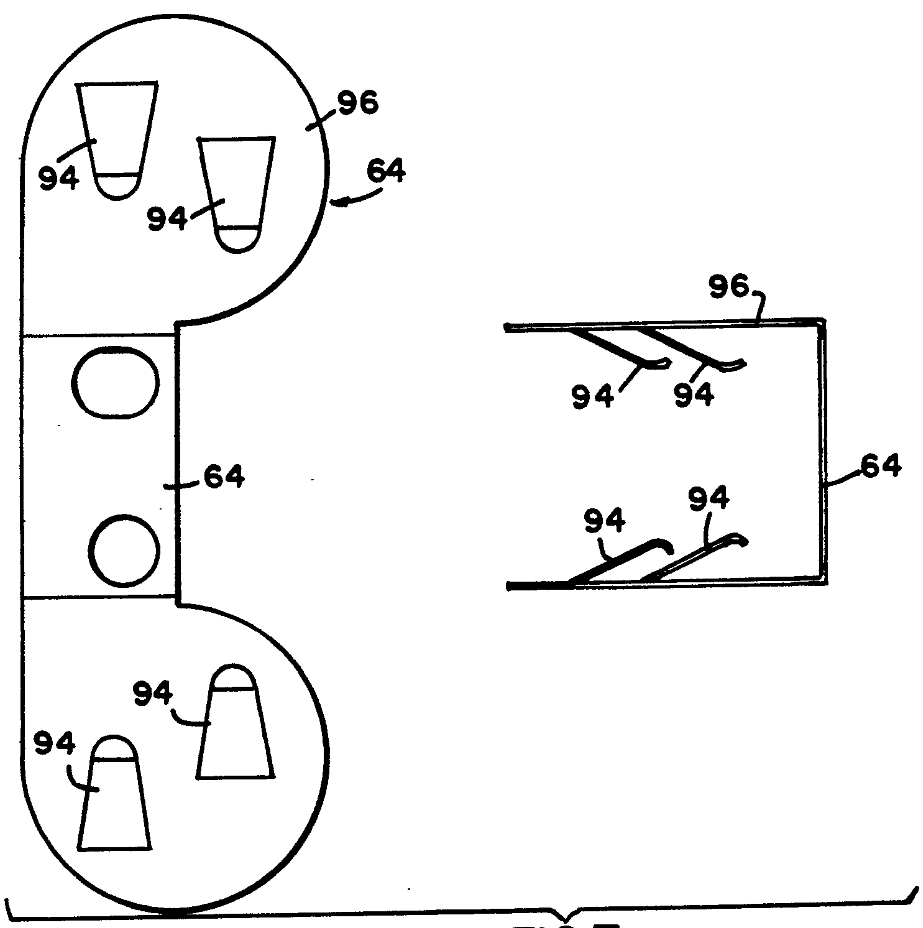

FIG.7

SOLID STATE STATION PROTECTOR DEVICE

The present invention relates generally to the field of telephony, and more particularly to a new and improved solid state protector device for protecting the solid state electronic circuits of telephone equipment from high voltage transients and abnormal currents.

Electronic circuits using small signal transistors and integrated circuits are easily damaged by high voltage transients that may appear on the line due to lightning, switching transients or power line induction. Accordingly, some form of transient and over voltage protection must be used to protect the circuits, for example, in the electronic telephone sets.

Since technology used for making integrated circuits cannot provide high enough breakdown voltage, other devices are employed. For example, one or more external Zener diodes are placed across the line to provide over voltage protection. When the input voltage exceeds the Zener (breakdown) voltage, the Zener conducts and holds the voltage input to the electronic circuit at the rated Zener voltage. In other prior art devices, metal oxide varistors were connected from the protected line to ground on another line. Still other prior art devices employed ionization of a gas between two electrodes to provide a voltage breakdown device. Prior art protection against abnormal currents employ such mechanical devices as heat coils or fuses. Also standard enclosure have been developed in which such prior devices are mounted during use.

While such prior art devices provided results in the area intended, there still exists a great need for a new and improved protector device which employs existing components, while maximizing operating range and minimizing cost. Additionally, it is important that solid state protector devices be constructed to mount easily into standard enclosures which have been developed so as to provide improved protection for the enclosed components.

The present invention discloses a solid state protector device which protects the electronic circuits of telephone equipment (which are connected in the circuit loop between the central office equipment and the user's telephone equipment) from high voltage transients and abnormal currents that would damage the electronic circuits of the user's telephone equipment. The preferred embodiment of protector devices of the present invention comprises a new and improved casing containing two bidirectional solid state voltage sensitive switch devices with an associated ground terminal and four variable resistance devices which are constructed and arranged to form a complete unit suitable for retrofitted mounting in a standard enclosure of such protector devices.

The solid state components contained in the protector device of the present invention provides protection of electronic equipment from voltage surges by electronically switching the voltage surge from line to ground. Additionally, the protector device protects the electronic equipment and itself from high current surges on the line by increasing the impedance of the line, thereby reducing the current to the equipment to the desired value. Upon cessation of the high voltage or current surge, the activated protector device returns to the inactive or idle state while the line circuit continues to function in the usual manner.

Figure 1 is a schematic block diagram illustrating one application of the present invention to a standard telephone loop circuit;

Figure 2 is a schematic diagram of the basic circuit of the protector device of Figure 1;

Figure 3 is an elevational view illustrating the basic components (some enlarged) of a protector device in accordance with the present invention;

Figure 4 is a perspective view, partly broken away, of an assembled protector device utilizing the components of Figure 3;

Figure 5 is a bottom view off the protector device with the cover removed;

Figures 6 and 7 are elevational views illustrating the input and output contacts of Figure 3 before and after bending for assembly within the case of Figure 4; and

Figure 8 is a schematic representation illustrating the assembly of input and output contacts.

Before entering into a detailed description of the disclosed embodiment, a review of the basic operation of the interface connection (the local loop) between the central office that contains switching equipment, signaling equipment and power supply to operate a customer's termination unit would be considered useful in understanding the invention. Referring particularly to Figure 1 of the drawing, the central office equipment 10 and the customer's termination unit, for example an electronic telephone set 12, are interconnected through a local loop of two wire conductors 14 and 16 called a pair. One of the conductor wires 14 is called T (for Tip) and the other is called R (for Ring) which refers to the tip and ring parts of the plug used in manual switchboards. The protector device of the present invention is shown generally at 18. In accordance with standard basic operation, the central office 10 supplies 48 VDC (+/-2V) between the Tip 14 and Ring 16 connections at all times, with the Tip being at the more positive voltage potential.

As shown in Figure 1, the protector device 18 is electrically connected to the Tip conductor wire 14 at contact points 20 and 22 and similarly to the ring conductor wire 16 at contact points 24 and 26. The Tip and Ring conductors 14 and 16 are connected at contact points 28 and 30 to the electrodes 32 and 34 of current source 36 which may be an AC or DC source, as is well known.

Referring now more particularly to Figure 2, there is illustrated an enlarged schematic diagram of an embodiment of the protector circuit of the protector device of the present invention as applied to the loop circuit of Figure 1. As illustrated, the circuit comprises two solid state bidirectional voltage sensitive switches 38 and 40 connected on conductor 42 across the Tip and Ring conductors 14 and 16 at contact points 44 and 46. Connected at contact point 48 on conductor 42 between switches 38 and 40 is a common ground 50. Suitable voltage sensitive switches (VSS) can be, for example RCA "SURGECTOR" or an SGS LS5120. The protector circuit further includes a variable resistance device shown generally at 51 which is connected in series in the Tip line and a corresponding variable resistance shown generally at 55 connected in series in the Ring line before the respective voltage sensitive switches 38 and 40. Each one of the variable resistance devices 51 and 55 preferably comprises a pair of parallel connected variable resistance devices 52, 54, 56 and 58, respectively. The variable resistance devices are preferably positive temperature coefficient (PTC) resistance devices such as semiconductor ceramic discs having metal electrodes on both faces which vary their resistance in direct proportion to the applied current.

In actual use, the protector device 18 does little to interfere with the normal operation of the telephone loop. The protector device places a very high impedance between the Tip and Ring conductors to ground, except when the voltage appearing across these conductors exceeds the selected breakdown voltage of the voltage sensitive switches 38 and 40. The protector device also places a relatively low impedance into the Tip and Ring conductors themselves, except when the loop current exceeds the selected switching current of the variable resistance devices 51 and 55. When an abnormal voltage or current occurs, the appropriate protection unit (voltage sensitive switch devices and/or the variable resistance devices) inside the protector device activates to prevent damage to the customer's equipment. When the fault condition is cleared, the protector unit returns automatically to its normal, "invisible" state.

It should be noted that each protection unit of the protector device operates independently of the other one contained in the device, so that the variable resistance device activates, whether or not the VSS activates, and vice versa.

Referring now to Figure 3, there is illustrated a preferred embodiment of the basic components of the protector device of the present invention. As shown, the components comprise a rivet 60, an external ground contact member 62, two output contact members 64, 64a (OCs), two input contact members 66, 66a (ICs), four stud terminal members 68 a to d, four PTC devices 70 a to d, an internal ground contact member 72, a pair of VSS devices 74, 74a, a case member 76 and cover 78. The VSS devices 74, 74a are preferably packaged in a two-lead plastic case, such as the Surgector as previously mentioned. The assembly of the protector device is best understood when the components are suitably divided into three main groups, namely: the grounding group, the PTC interconnect group and the external group.

The grounding group of components includes the rivet 60, the external ground contact (EGC) 62 and the internal ground contact (IGC) 72. The rivet 60 is forced through the hole 80 in the IGC, the hole 82 in the case 76 and the hole 84 in the IGC 72. The end 86 of rivet 60 is then preferably rolled over the IGC to hold these grounding components together to ensure the integrity of the ground connection in the event of a melted case. The rivet 60 is straight-line knurled along substantially the entire length, and it is forced through the metal contact. The knurling actually cuts into the metal, thereby forcing intimate contact between the metal components, and prevents them from rotating. Additionally, such rotation is further prevented since the rivet member also tends to "bite" into the plastic case which is preferably formed of a suitable plastic material as discussed hereinafter.

The connection of the VSS devices 74 and 74a to the ground is made by passing one of the two leads of each device through a slot in the IGC 72. For example, as best seen in Figure 3, the lead 90 of VSS device 74 would be passed through slot 92 of IGC member 72 and the lead 90a of VSS device 74a would be passed through slot 92a. The leads 90 and 90a can then be secured to the IGC member 72 by bending the leads back over the IGC member and then crimped, soldered or welded for permanent contact. The other leads 88 and 88a of VSS devices 74 and 74a are connected to the output contacts 64 and 64a respectively, as further described hereinafter.

The components of the PTC interconnect group comprise the two input contacts (IC) 66 and 66a, the two output contacts (OC) 64 and 64a and the four stud terminal members 68 a to d. Referring now more particularly to Figures 6, 7 and 8, the OC members 64 and 64a are provided with a plurality of contact spring members 94 which are angularly disposed to the inner surface 96. Similarly, the inner surface 98 of the IC members is provided with contact spring members 100. As can be best seen in Figure 8, the contact spring members 94 and 100 form the electrical connections between the PTC's 70a and 70b and the IC (66a) and OC (64a) members. Accordingly, the resiliency of the electrical contact members 94 and 100 must be sufficient to maintain electrical contact under various dimensional and environmental requirements and conditions. The IC members 66 and 66a require only one bend while the OC members 64 and 64a require two bends. It should be noted that the radius of the bends is minimized so as to prevent possible high-voltage arc-overs between the electrical contact members 94 and 100 and the opposite face (electrode) of the PTC inserted therebetween. The stud terminals are provided with a lower threaded portion 110 (which is preferably straight-line knurled) and an upper thin flat plate 111. The knurling performs the same function as the knurling described with respect to the rivet member 60. The knurled stud "bites" through the appropriate hole in the IC or OC members and then into the case. This arrangement prevents rotation after assembly and ensures the electrical integrity of the connection. The remaining external components include the case 76, the cover 78 and suitable standard nuts and washers.

The case and cover are preferably formed or molded from a high temperature plastic that is also resistant to moisture, chemicals and cracking at low temperatures. The case is designed to have external barriers and internal offset steps, as best seen in Figures 3 and 9. The barriers 114 lengthen the electrical conduction path between the two adjacent stud terminals, again to inhibit arcovers. The barrier gives the device a longer life since more material (dust, oil, etc.) must be deposited before a short circuit is formed. The barrier also reduces inadvertent contact between the spade terminals (not shown) that are connected to the stud terminals. The internal offset members 116 serve to offset the PTC devices thereby providing space for the IC and OC members. The cover 78 is a suitable plastic plate which can be sealed to the case by bonding with a suitable adhesive sealant such as silicone or by ultrasonic welding as is well known. In this respect, it is preferable to seal the stud terminal holes as well as the rivet hole to seal the contents of the protector device from the environment.

Figure 4 is an illustration of the external view of the preferred embodiment for the present invention. As shown, the case 76 is comprises of a top wall 118, side walls 120 and the bottom wall (or cover) 78. Disposed through the top wall 118 are input terminal studs 68b and 68c, and output terminal studs 68a and 68d. Disposed through one of the side walls is the ground terminal 62. The input and output terminal allow connection of the unit to the Tip and Ring conductors of the telephone loop, while the ground terminal provides the capability of easily connecting to the local earth ground.

Figure 5 shows the inside of the protector device as seen with the cover 78 of Figure 4 removed. As shown are the PTC devices 70a, 70b, 70c, 70d, internal ground contact 72, along with portions of the VSS 74, 74a, and input contacts 66 and 66a and output contacts 64 and 64a. Figure 6 shows the finished shape of the input contacts, and Figure 7 shows the finished shape of the output contacts. Figure 8 shows an assembly of a single input contact, a single output contact, two PTC devices, and an input and output terminal. The preferred embodiment utilizes two of these assemblies.

CLAIMS

1. A solid state protector device for electronic equipment connected in a circuit loop having a Tip line portion and a Ring line portion and at least two electrodes from a source of current comprising:

a pair of input terminals;

a pair of output terminals;

a variable resistance means disposed in series with each of said input terminals;

a pair of voltage sensitive switch means connected in series across said output terminals; and

a ground terminal connected between said voltage sensitive switch means.

2. A solid state protector device as claimed in Claim 1 wherein said variable resistance means is a positive temperature coefficient resistance means.

3. A solid state protector device as claimed in Claim 1 wherein said variable resistance means comprises a pair of parallel connected positive temperature coefficient resistance means.

4. A solid state protector device as claimed in any one of Claims 1-3 wherein said voltage sensitive switch means comprises a bidirectional solid state switch means selectively controllable between conductive and non-conductive states in response to selective levels of current and voltage.

5. A solid state protector device for electronic equipment connected in a circuit loop having a Tip line portion and a Ring line portion and at least two electrodes from a source of current comprising:

a non-conductive casing having top, bottom and side walls;

a pair of input terminals disposed in said top wall and extended therethrough;

a pair of output terminals disposed in said top wall adjacent said input terminals and said casing containing;

a pair of variable resistance means connected in series with each of said input terminals;

a pair of voltage sensitive switch means connected in series across said output terminals; and

a ground means connected between said voltage sensitive switch means.

6. A solid state protector device for eletronic equipment connected in a circuit loop having a Tip line portion and a Ring line portion and at least two electrodes from a source of current comprising:

a non-conductive casing having top, bottom and side walls;

first input and output terminals means disposed adjacent each other in one portion of said top wall and extending therethrough;

second input and output terminal means disposed adjacent each other in another portion of said top wall and extending therethrough;

an external ground contact means disposed in said top wall;

said casing containing:

a first output contact means connected to said first output terminal means;

a second output contact means connected to said second output terminal means;

a pair of voltage sensitive switch means connected in series across said first and second output contact means;

and internal ground means connected between said voltage sensitive switch means and to said external ground contact means;

a first input contact means connected to said first input terminal means;

a second input means connected to said second input terminal means; and

a variable resistance means connected in series with each of said input contact means.

7. A solid state protector device as claimed in Claim 6 wherein said casing further includes non-conducting barrier means disposed between the portions of adjacent input and output terminals exterior to said top wall.

8. A solid state protector device as claimed in Claim 6 or 7 wherein said variable resistance means is a positive temperature coefficient resistance means.

9. A solid state protector device as claimed in Claim 6 or 7 wherein said variable resistance means comprises a pair of parallel connected positive temperature coefficient resistance means.

10. A solid state protector device as claimed in any one of Claims 6-9 wherein said voltage sensitive switch means comprises a bidirectional solid state switch means selectively controllable between conductive and non-conductive states in response to selective levels of current and voltage.

11. A solid state protection device as claimed in any one of Claims 6-10 where said casing further includes a non-conducting offset step means disposed between the portions of adjacent input and output terminals interior to said top wall.

12. A solid state protector device substantially as described herein with reference to the accompanying drawings.

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