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(54) Title:
PROTECTIVE CIRCUIT AND PROTECTIVE PLUG FOR TELECOMMUNICATION INSTALLATIONS

(57) Abstract:
The invention relates to a protective circuit for the protection of the user from overvoltage and overcurrent, in particular for telecommunication instalaations. Prior art protective circuits comprise a fuse connected into the line connection, and a surge arrester with a current path of the line connection and the earth conductor, the heat-sensitive protection device disconnecting the cross path in case of excessive power, and connecting it to the earth conductor. In the protective circuit according to the invention, aresponse of the heat-sensitive protection device (5, 6) will cause disconnection of the cross path of the surge arrester(1, 2) and closing of a shortcircuit cross path (7, 8) behand the fuse (3, 4) between the line connection (a, a'; b, b') and the earth conductor (E). the protective citcuit can be accommodated in a miniature plug for application in telecommunication installations.

The invention relates to a protective circuit for the protection of the user from overvoltage and overloads, in particular for telecommunication installations. More particularly the protective circuit is of the type comprising a fuse connected into the line connection and a surge arrester, protected by a heat-sensitive protection device and forming a cross path between the line connection and the earth conductor.

Protective circuits are known in the art (from DIN VDE 0845, part 1, October 1987), wherein each cable conductor is protected by a surge arrester to earth. In order to protect the latter from damage due to persisting current loads, it is frequently provided with a heat-sensitive protection device short-circuiting the surge arrester, in cases of excessive heating. Since the cable conductor may be damaged by the short-circuit current, a melt fuse is incorporated in series with the surge arrester, said melt fuse cutting the current off under appropriate current conditions.

It is disadvantageous herein that such fuses must be resistant against surge currents so to withstand the surge currents occurring in normal operating conditions, and for this purpose, the fuses have to be rather voluminous.

From DE-OS 38 31 935, a protective circuit is known, also comprising a fuse in the cable conductor and a cross path between cable conductor and earth conductor connected behind the fuse, the cross path being composed of a surge arrester and heat-sensitive protection device thermally coupled therewith. An excessive thermal load on the surge arrester will lead to a response from the heat-sensitive device, disconnecting the cross path. With permanent current load, the fuse will disconnect the current conduction. Thus, the system side (consumer) is not protected anymore against short overvoltages, therefore, if the fuse does not disconnect, and will be subjected to the overcurrent until the fuse actually disconnects. The fuse has to be, therefore, resistant against surge currents, which requires a large volume. After a response from the heat-sensitive protection device and the subsequent disconnection of the fuse, if any, the input of the system side will no longer be at a defined potential, so that the destruction of sensitive components cannot be excluded.

Accordingly a need exists, to provide a protective circuit for the protection against overvoltage and overloads, which protects the surge arrester against excessive thermal loads, and which disconnects current conduction in case of excessive current loads in a way that is safe for the system side and will prevent the risk of fires.

The present invention provides a protective circuit as set out in the opening paragraph, wherein a response of the heat-sensitive protection device causes disconnection of the cross path of the surge arrester and closing of a short-circuit cross path behind the fuse between the line connection and the earth conductor. The protective circuit comprises a fuse connected in series with the current line, a surge arrester connected between the current line and the earth line, provided with a heat-sensitive protection device and, located relative to the direction line side/system side, behind the fuse, a short circuit cross path, open in the operating condition. When overvoltages exist for an excessive period of time, the surge arrester will heat up, and will operate, thus, the heat-sensitive protection device. The latter disconnects the cross path of the surge arrester, and closes, simultaneously, the short-circuit cross path behind the fuse, so that the current line can then be disconnected by the fuse. Due to the short-circuit cross path, the input of the system side is then at a defined potential, namely earth.

In the event of an inadmissibly high current loading, which may occur, e.g., with an overvoltage on the current line, without the surge arrester being tripped, the current line is disconnected. Since, in this case, the heat-sensitive protection device does not respond, the short-circuit cross path is not closed, so that here as well no fire risk exists due to excessive currents in the short-circuit line.

In a specific embodiment the cross path of the surge arrester is arranged in advance of the fuse, in relation to the direction line side-system side, the branch of the cross path of the surge arrester precedes the fuse, relative to the direction line side-system side, the fuse is not loaded by current surges and may be kept small. If the heat-sensitive protection device is operated, the short-circuit cross path behind the fuse is closed, so that the latter will disrupt the current line when correspondingly high currents occur. Since tripping of the heat-sensitive protection device causes interruption of the cross path of the surge arrester, a further operation of the surge arrester is prevented.

According to a preferred embodiment of the protective circuit, the cross path of the surge arrester and the short-circuit cross path are provided behind the fuse, and the fuse is bridged by a short circuit switch, which is disconnected when disconnecting the cross path of the surge arrester. As in the previous embodiment, the surge current load is likewise kept away from the fuse. The fuse is disposed before the branch of the surge arrester and of the open short-circuit cross path. It is parallely bridged with a short-circuit switch, so that, in operating condition, only the smaller portion of the currrent flows through it. Tripping of the heat-sensitive protection device will lead to an opening of the short-circuit, bridging the fuse, and to a closing of the short-circuit cross path between current line and earth line, so that the fuse is activated.

In accordance with a specific embodiment of the invention, the protective circuit for protecting two line connections of a double conductor is symmetrically doubled, both surge arresters, upon a response of a heat-sensitive protection device being disconnected, from the earth conductor by way of a common change-over switch, and both short-circuit cross paths being closed. The protective circuit is doubled and is installed into a double conductor as is commonly done in telecommunication. Between each of the two current lines a and b and the common earth line E', the protective function is achieved such that, upon tripping of only one heat-sensitive protection device, the common safety function is activated, both surge arresters are disconnected from the earth line, and both short-circuit cross paths are closed. Instead of two separate surge arresters, a three-pole surge arrester can also be employed.

A specific embodiment relates to an addition of a fine protection to the protective circuit, so that according to VDE 0845, part 1, October 1987, a dual-stage protection including coarse and fine protection is obtained.

The fine protection may comprise a PTC resistor connected into the line connection and a varistor connected transversely thereto between the line connection and the earth conductor, said varistor being thermally closely coupled to the PTC resistor. It thus comprises a PTC resistor and a varistor thermally closely coupled. Such devices are known in the art from DE-OS 32 31 066. Such a fine protection permits the protection against quick transient events and against overvoltages and overloads, to which the coarse protection does not respond. The voltage-dependent resistor (varistor) guarantees limiting the voltage to the desired maximum level, and is designed to operate very quickly with response times in the order of nanoseconds. The temperature-dependent PTC resistor (PTC = positive temperature coefficient) in the longitudinal branch serves for decoupling the voltage limiting means in the coarse protection from those in the fine protection, serves for limiting the duration of currents which are larger than the normal and admissible operating currents by the heating-up of the PTC resistor due to the current flowing. Finally, the PTC resistor serves for overload protection of the voltage limiting in the fine protection (varistor), on the one hand, by self-heating of the PTC resistor by the current flow and resultant increase of the resistance, and, on the other hand, by the increase of the resistance due to the heating-up of the PTC resistor by the thermal coupling of the PTC resistor with the varistor.

Preferably in each line connection a measuring and disconnecting position is connected in series behind the stepwise protection. Providing such a measuring and disconnecting position behind the stepwise protection, permits a partial testing of the functions of the protective circuit and of the current line with incorporated protective circuit. In telecommunication it is particularly advantageous to adapt such protective circuits as protective plugs.

The invention also provides a protective plug comprising a protective circuit as set out above, including a change-over switch which takes the form of a slider supported in a housing, the one end of said slider being connected via a solder connection, to the earth plate of a surge arrester fixed in the housing, said surge arrester being spring-loaded in a direction facing away from the surge arrester, and slidably bearing against an earth plate, and the slider comprising contact projections which are contactless in the operating condition, and which contact the current lines and connect them to earth potential after fusing of the solder connection by heat action and the resulting displacement of the slider under spring action.

Further advantageous embodiments of the invention are dealt with in what follows:

In the following, the invention will be described by way of preferred embodiments with reference to the drawings. There is shown in:

Fig. 1 the circuit diagramme of an embodiment of the protective circuit provided with a fuse arranged therebehind for application in double conductors, in the operating condition,

Fig. 2 the protective circuit according to Fig. 1 in tripped condition,

Fig. 3 the circuit diagramme of a further embodiment of a protective circuit with bridged fuse arranged therebefore,

Fig. 4 the circuit block diagramme of yet a further embodiment in the form of a dual-stage protector with measuring and disconnecting position,

Fig. 5 the circuit diagramme of the dual-stage protection, in accordance with Fig. 5.

Fig. 5a the circuit diagramme of a fourth embodiment of the protective circuit.

Fig. 6 a longitudinal section through a protective plug according to the invention including the protective circuitry,

Fig. 7 a top view of the circuit board of the protective plug in Fig. 6,

Fig. 8 a cross section through the protective plug along line A-B in Fig. 6,

Fig. 9 a cross section through the protective plug along the line C-D in Fig. 6,

Fig. 10 a bottom view of the protective plug with removed circuitry board,

Fig. 11 a top view of the protective plug,

Fig. 12 a side view of a connector bank of a telecommunication installation with five inserted protective plugs, with a mounted earth rail and a set-up signal bracket to be operated by the signalling lugs of the protective plugs,

Fig. 13 a front view of the connector bank according to Fig. 12 with inserted protective plugs and signal bracket in not folded-down condition, and

Fig. 14 a front view according to Fig. 13 with folded-down signal bracket.

In the drawings, Fig. 1 shows a protective circuit, arranged between the terminals a-a' and b-b' of line side L and system side S resp., a common earth conductor E being provided for carrying overcurrents off, which are generated by overvoltages relative to the earth potential. The protective plug comprises two surge arresters 1, 2 connected as cross paths between the terminals a and E or b and E, resp.. The fuses 3, 4 are connected in the connection lines between the terminals a, a' or b, b' behind the branches 12 of the surge arrester, 1, 2. The surge arresters 1, 2 are thermally controlled by heat-sensitive protection devices 5, 6. Fig. 1 shows the protective circuit in operating condition, i.e. the surge arresters 1, 2 contact a change-over switch 9, which is connected via a base 10 to the earth line E. The short-circuit cross paths 7, 8 are opened, and, in their operating condition are not connected to the change-over switch 9. Any overvoltages, the duration of which is sufficient to trip the surge arrester 1 or 2, are carried off to earth E via said surge arresters with the resulting overcurrent. The fuses 3, 4 are, therefore, not subjected to the surge currents.

In Fig. 2, the protective circuit according to Fig. 1 is represented with tripped fuse operation. An excessive thermal load of one of the two surge arresters 1, 2, i.e. an excessive current load, will operate the corresponding heat-sensitive protection device 5 or 6 resp., and cause an operation of the common change-over switch 9. This is shown here by the displacement thereof toward the right. Thereby, the short-circuit cross paths 7, 8 are connected to the earth line, and are closed. The cross paths of the surge arresters 1, 2 are disconnected. The fuses 3, 4 are activated now, and can disconnect the current lines between the terminals a, a' and b, b'. The terminals a', b' of the system side S are now at a defined potential, i.e. earth, so that protection of personnel and of sensitive electronic circuitry on the system side S is ensured. A fire risk arising from the protective circuit, is also prevented.

Fig. 3 shows another embodiment of the protective circuit with a modified arrangement of the fuses 3', 4'. A fuse 3' is arranged in the line connection between the terminals a, a' before the cross path of the surge arrester 1. The short-circuit cross path 7 arranged behind thereof is open in operating condition, whereas the 'cross path of the surge arrester 1 contacts the change-over switch 9, which is connected to the earth line E. The fuse 3' is short-circuited, a closed switch 11 being incorporated in this short-circuit. The heat-sensitive protection device 5 acts upon the change-over switch 9 and the switch 11 such that tripping of the heat-sensitive protection device 5 will cause opening of the cross path of the surge arrester 1 and closing of the short-circuit cross path 7. Simultaneously, the switch 11 in the short-circuit of the fuse 3' is opened, so that the fuse 3' is activated via the short-circuit cross path 7.

The diagramme of a division of the protective circuit into a coarse protection 20 and a fine protection 21 to provide stepwise, i.e. dual-stage protection, is shown by the protective circuit according to Fig. 4. This stepwise protection is extended by a measuring and disconnecting position 22 connected behind thereof.

Fig. 5 shows a specific embodiment of a stepwise protection according to the invention with a measuring and disconnecting locality. Into the double conductor of the line connection between the terminals a, a' and b, b' with the earth conductor E, the coarse protection 20, the subsequent fine protection 21 and the subsequent measuring and disconnecting positions 22 existing in each line connection are disposed, the coarse protection 20 comprising the cross paths with the surge arresters 1, 2 the subsequent fuses 3, 4, provided in the line connections, the short-circuit cross paths 7, 8, the heat-sensitive protection devices 5, 6 and the common change-over switch 9. The subsequent fine protection 21 comprises the PTC resistors 30, 31 provided in the respective line connection, and the varistors 32, 33 following thereupon, said varistors being connected in parallel between the respective line connection between the terminals a, a' and b, b'and the earth conductor E and the subsequent measuring and separating localities 34. The earth potential is passed outside as another measuring position 35, so that potential measurements between the measuring and disconnecting positions 34 and the measuring position 35 for the earth potential are possible.

Fig. 5a shows another embodiment of the protective circuit with a signalling device. The protective device comprises a three-pole surge arrester 1' between the line connections of the terminals a, a' and b, b', the central electrode 13, connected by way of a slide contact 14 to the change-over switch 9, adapted as a slider 45 and being at earth potential. The fuses 3, 4 are provided in the line connections behind the heat-sensitive protection devices 5, 6 and the short-circuit cross paths 7, 8 are designed in the same manner as in the previous embodiments. The earth conductor E contacts the change-over switch 9 by way of a slide contact 15. The measuring and disconnecting positions 34 in the line connections between the terminals a, a' and b, b' are provided as well.

At the end of the change-over switch 9, a contact maker 16 is provided, the connection line 17 of which may be connected to further protective plugs 99 and leads to an electronic signal transducer 18 connected via a resistor 19 to a line 24, wherein a signal transducer 25 for a central signal and an exchange battery 26 is provided. The protective circuit permits a central signalling, whether or not a protective plug 99 has been tripped in a protected field, e.g. of a main distribution frame of the communication system. The free end of the change-over switch 9 serves herein as a signalling lug 56, which, when the protective plug 99 has tripped, will come into contact with the contact maker 26 and will also adopt earth potential. If, in this context, the circuit is closed by way of the local signalling transducer 18, the tripping condition of the protective plug 99 can be indicated at the main distribution frame or in a field, and, if applicable, also at a connector block, by a lamp, LED, buzzer or by another signalling device. Contact making need not be permanent, but may have a type of trigger function. If applicable, power supply of the signalling device has to be performed by means of a DC/DC converter, since protective earth may adopt a high potential. Heavily loaded current lines, e.g. with frequent tripping, can be detected via interfaces to counting devices.

Fig. 6 shows a central longitudinal section through a protective plug 99 adapted as a miniature plug provided with a protective circuit, adapted as a stepwise protection with measuring and disconnecting position 22. The miniature switch finds applications particularly in telecommunication installations.

An external housing 40, the underside of which is formed by a circuit board 41, includes a three-pole double surge arrester 42, the central electrode of which contacts a sheet-metal part 43. Such a double surge arrester 42 comprises a left-hand and a right-hand external electrode 27, 28 and a common central electrode 13, so that two spark gaps are formed between the external electrodes 27, 28 and the central electrode 13. The sheet-metal part 43 is conductively connected by way of a solder position 44, to a downwardly directed lug 46 of a metal slider 45, said lug being guided in a guide slot 81 of the sheet-metal member 43 and in the circuit board 41. The slider 45 rests with contact projections 47, 48, one of which only is visible in the sectional view of Fig. 6, on the circuit board 41. The slider 45 is spring-loaded at its side directed toward the surge arrester 42 by a spring 88 mounted on a guide pin 49. The spring 88 is supported, on the opposite side, on an internal housing wall 50, forming, together with an internal housing top wall 51 and the left-hand transverse wall 52 of the housing, provided on the side of the surge arrester 42 in Fig. 6, a cavity 107 for receiving and embracing the surge arrester 42. The surge arrester 42 is thus enclosed between the walls 50, 51 and 52. The slider 45 is contacted, at its top, by an earth plate 53 adapted as a resilient member. This earth plate 53 passes into a hollow section 55 formed by the internal top wall 51 and the external top wall 29 of the housing 40, and which is open toward the external transverse wall 52 of the housing 40, serving for receiving an earth plug or an earth rail 98 resp.. For reliably contacting, the earth plate 53 is provided in the hollow section 55 with a spring tongue 54.

The slider 45 forming the change-over switch 9 comprises, at its side remote from the spring 88, a signalling lug 56, which, in the tripped fuse situation, passes through an opening 87 of the right-hand transverse wall 57 of the housing.

In the transverse wall 57, another opening 58 is provided, defined by the circuit board 41. This opening 58 serves for receiving a non shown measuring and disconnecting plug, and comprises spring tongues 59, 60 contacting the circuit board 41 in the normal condition, i.e. without a measuring and disconnecting plug being introduced.

Fig. 7 shows the circuit board 41, forming the base of the housing 40 of the protective plug 99 and being adapted, at its (left-hand) end, as a contact tongue 61. On the shown side of the circuit board 41 , contact areas 62, 64 are provided for contacting the line-side terminals a, b, and which merge into external circuit tracks 63, 65. On the opposite side of the circuit board 41, identical contact areas, which are not illustrated, for contacting the system-side terminals a', b' are provided. These are connected, via through-contacts 66, 68 to the circuit tracks 67, 69 extending internally in parallel to the circuit tracks 63, 65. In the incoming circuit tracks 63, 65 narrow sections 70, 71 forming the fuses 3, 4, are provided.

The circuit tracks 63, 65, 67, 69 terminate blindly on the side of the circuit board 41 opposite to the contact tongue 61 each in rectangular, oblong contact zones 72, 73, 74, 75. In each of the contact zones 72, 75, two bores 76, 77 or 78, 79 each are provided. These bores 76 to 79 serve for receiving vertically disposed contact plates 96, 97. Approximately in the middle of the circuit board 41, a recess 80 for receiving the sheet-metal part 43 is provided. Furthermore, a guide slot 81 is provided, which is directed from a recess 80 to the side of the circuit board 41 remote from the contact tongue 61, and which serves for receiving the lug 46 of the slider. The points 82, 83 denote the positions, where the contact projections 47, 48 of the slider make contact in the operating condition. These are arranged in the region of the narrow fuse sections 70, 71 of the circuit tracks 63, 65. Accordingly, in the operating condition, the contact projections 47, 48 will not have contact with the circuit tracks 63, 65. The contact positions 84, 85 provided on the contact zones 72, 75 denote the position of the contact projections 47, 48 in the tripped condition of the fuses 3, 4.

The fuse function of the protective circuit is tripped by the fusing of the solder position 44, connecting the slider 45 to the contact plate 43 of the surge arrester 42. The contact plate 43 provided for a close thermal contact. Fusing of the solder position 44, due to the pre-tensioned spring 88, effects a movement of the slider 45. The latter moves away from the surge arrester 42, and disconnects the contact of the surge arrester 42 to the earth plate 53. The contact projections 47, 48 leave their non-contacting support positions 82, 83 and after such movement rest on the contact positions 84, 85. Therefore, a direct short-circuit between the earth plate 53 and the circuit tracks 63, 65 is established behind the narrow fuse sections 70, 71 forming the fuses 3, 4. The signalling lug 56 projects from the opening 87 in the transverse wall 57.

Fig. 8 shows a section through the protective plug 99 along the sectional plane A-B in Fig. 6. The protective plug 99 is surrounded by the housing 40 and the circuit board 41. The slider 45 comprises two L-shaped metal slider portions 90, 91 which are combined to a T-piece, such that the long legs 90′, 91′ forming the cross web of the T-piece, are tensioned relative to each other, and form an acute-angled V-shaped spring.

At the respective ends of the short legs 90′′, 91′′ forming the flange of the T-piece, on the side remote from the V-shaped spring, are the downwardly directed contact projections 47, 48 resting on the circuit board 41. The slider 45 forming the change-over switch is contacted at its top by the earth plate 53, due to its spring force.

At each side of the web formed by the long legs 90′, 91′ of the portions 90, 91 of the slider 45, a disc-shaped varistor 32, resp. 33, a separating contact plate 94, resp. 95, a PTC resistor 30, 31 and an external contact plate 96 resp. 97 are provided, the contact projections 92, 93 pressing by the spring action of the long legs 90′, 91′ forming the web of the slider 45, onto the varistors 32, 33, thereby establishing electrical contact. The contact projections 92, 93 are disposed on that side of the long legs 90′, 91′ of the L-shaped slider portions 90 resp. 91 which faces outwardly of the V and into the housing. The PTC resistors 30, 31 have a rectangular shape, the heights of the cylinders being smaller than their diameters. One varistor 32, 33 each and one PTC resistor 30, 31 each are electrically connected at their base surfaces by means of a separating contact plate 94, 95. Due to the large contact areas, the thermal contact is also very good.

Fig. 9 shows a cross-section through the protective plug 99 along line C-D in Fig. 6. The housing 40 is shown with the circuit board 41. The contact plates 96, 97 follow the outlines of the internal side walls of the housing 40. Reaching out therefrom the contact plate 96 is soldered vertically into the circuit board 41, by means of the bores 76, 77. Likewise the contact plate 97 is soldered vertically into the bores 78, 79. In an inward direction the cavities 100, 101 follow for receiving the left-hand and the right-hand PTC resistors 30, 31. Then, moving still further inward, the separating contact plates 94, 95 follow, electrically connecting the PTC resistors 30, 31 to the varistors 32, 33. This is followed by the receiving spaces 102, 103 for receiving the varistors 32, 33. In the central region the signalling lug 56 of the slider 45 is shown. Between the receiving spaces 102, 103 for the varistors 32, 33 and the circuit board 41, the spring tongues 59, 60 of the measuring and disconnecting contact springs are provided. The cavities 100, 101 for receiving the PTC resistors 30, 31 and the cavities 102, 103 for receiving the varistors, the separating contact plates 94, 95 and the spring contact tongues 56, 60 are formed in an appropriately moulded body 104. It comprises at its front another cavity 105 for the passage therethrough of the signalling lug 56 of the slider 45.

Fig. 10 represents a bottom view of the protective plug 99, the circuit board 41 having been removed. The contact spring tongues 59, 60 serving for contacting on the contact areas 73, 74 of the circuit board, are rigidly connected each with one of the separating contact plates 94, 95. Thereby, the connections between the line-side terminals a, b and the system-side terminals a', b' are established via the PTC resistors 30, 31, without inserting a measuring and disconnecting plug. Also shown are the cavities 100, 101, resp. 102 and 103 for receiving the PTC resistors and the varistors 30, 31, resp. 32, 33. Centrally, the slider 45 with the contact projections 92, 93 is provided, the flange side of which is formed by the short legs 90'', 91''of the members 90, 91. At the ends of the flange 90'', 91'', the contact projections 47, 48 are attached at the bottom side. The guide lug 49 of the compression spring 88 projects through the internal housing wall 50. On the other side of the housing wall 50, the receiving space 110 for receiving the double surge arrester 42 is provided.

Fig. 11 shows a top view of the protective plug. There are shown the contact plates 96, 97, the separating contact plates 94, 95 with the associated cavities 100, 101, resp. 102, 103 for receiving the PTC resistors 30, 31 and the varistors 32, 33 resp.. The earth contact spring 53 partially projects beyond the aforesaid cavities 100 to 103 and the receiving space 110 of the surge arrester 42 with the spring tongue 54. This spring tongue serves for contacting the earth rail 98 , which is not illustrated and will be described further below.

Instead of the varistors 32, 33, voltage-limiting semiconductor elements may be employed. Such varistors, diodes and the other components can be changed for type modifications of the basic embodiment in the course of production (modular design).

Fig. 12 shows a connector block 89 of the telecommunication with five mounted protective plugs 99 and one earth rail 98. At both front sides of the connector block 89, a U-shaped signal bracket 36 is supported on pivot bearings 37. The legs 38 of the signal bracket 36 are slightly longer than the height of the mounted protective plugs 99 over the connector block 89. The connection piece 39 of the signal bracket 36 is, therefore, in the active zone of the tripped signalling lugs 56 of the protective plugs 99. On the internal side of the long connection piece 39 of the signal bracket 36, an electrically conductive contact strip 106 is provided, connected via the connection line 17 shown in Fig. 5a to the central signalling system. Fig. 13 shows the front view of the connector block 89 with signal bracket 36 arranged thereupon in the operating condition. Fig. 14 shows the front view according to Fig. 13 with the signal bracket folded-down, so as to permit replacing the protective plugs 99 and allowing for an easy access to the measuring and disconnecting contact. Folding-down of the signal bracket 36 is necessary, since otherwise the protective plugs 99 could not be pulled out. Folding-down of the signal bracket 36 is also possible in the opposite sense from the one shown in Fig. 14, if further connector blocks 89 provided on the one side of the connector block 89 with mounted protective plug 99 would obstruct folding-down.

In Fig. 12, a protective plug 99 with projecting signalling lug 56 is shown. This indicates that due to an interference with subsequent heating, the solder position 44 has been desoldered, and the slider 45 has been pushed out from the housing 40, under the action of the spring 88. The optical signalling lug 56 now touches the contact strip 106, and closes the signal circuit, shown in the circuit diagramme of Fig. 5a, against the earth conductor E. An additional signalling is also feasible by closing the signal circuit according to Fig. 5a, even when the signal bracket 36 is folded down according to Fig. 14. This would avoid an inadmissible switching-off of the signallization by a folded-down signal bracket 36, i.e. even during folding-down of the signal bracket 36, a signal is given by a contact which is not shown. The signal bracket 36 itself may incorporate a signalling element, e.g. an LED, a lamp or the like, in order to facilitate tracing a fault.

The claims which follow are to be considered an integral part of the present disclosure. Reference numbers (directed to the drawings) shown in the claims serve to facilitate the correlation of integers of the claims with illustrated features of the preferred embodiment(s), but are not intended to restrict in any way the language of the claims to what is shown in the drawings, unless the contrary is clearly apparent from the context.

Claims

1. A protective circuit for protection against overvoltage and overloads, in particular for telecommunication installations, comprising a fuse (3, 4) connected into the line connection (a-a'; b-b') and a surge arrester (1, 2), protected by a heat-sensitive protection device (5, 6) and forming a cross path between the line connection (a-a'; b-b') and the earth conductor (E), wherein
a response of the heat-sensitive protection device (5, 6) causes disconnection of the cross path of the surge arrester (1, 2) and closing of a short-circuit cross path (7, 8) behind the fuse (3, 4) between the line connection (a-a'; b-b') and the earth conductor (E).

2. A circuit according to claim 1, wherein the cross path of the surge arrester (1, 2) is arranged in advance of the fuse (3, 4), in relation to the direction line side-system side (L-S).

3. A circuit according to claim 1, wherein the cross path of the surge arrester (1, 2) and the short-circuit cross path (7, 8) are provided behind the fuse (3', 4') and the fuse (3', 4') is bridged by a short circuit switch (11), which is disconnected when disconnecting the cross path of the surge arrester (1, 2).

4. A circuit according to any one or more of the preceding claims wherein the protective circuit for protecting two line connections (a-a'; b-b') of a double conductor is symmetrically doubled, both surge arresters (1, 2), upon a response of a heat-sensitive protection device (5, 6), being disconnected from the earth conductor (E) by way of a common change-over switch (9), and both short-circuit cross paths (7, 8) being closed.

5. A circuit according to any one or more of the preceding claims, wherein a fine protection (21) for achieving a stepwise protection composed of coarse protection (20) and fine protection (21) is connected into the line connection (a, a'; b, b').

6. A circuit according to claim 5, wherein the fine protection (21) comprises a PTC resistor (30) connected into the line connection (a, a'; b, b') and a varistor (32, 33) connected transversely thereto between the line connection (a, a'; b, b') and the earth conductor (E), said varistor being thermally closely coupled to the PTC resistor (30, 31).

7. A circuit according to claim 6, wherein in each line connection a measuring and disconnecting position (34) is connected in series behind the stepwise protection.

8. A protective circuit, substantially as hereinbefore described with reference to or as illustrated in the accompanying drawings.

9. A protective plug comprising a circuit according to any one or more of claims 1 to 8, wherein the change-over switch (9) takes the form of a slider (45) supported in a housing (40), the one end of said slider being connected via a solder connection (44), to the earth plate (43) of a surge arrester (42) fixed in the housing (40), said surge arrester being spring-loaded in a direction facing away from the surge arrester (42), and slidably bearing against an earth plate (53), and wherein the slider (45) comprises contact projections (47, 48) which are contactless in the operating condition, and which contact the current lines and connect them to earth potential (E) after fusing of the solder connection (44) by heat action and the resulting displacement of the slider under spring action.

10. A protective plug according to claim 9, wherein the slider (45) is formed of two slider portions (90, 91) having an L-shaped cross section, so combined in a T-configuration that the two legs (90', 91') forming the cross web of the T are slightly pre-tensioned relative to each other, so that a V-shaped spring is formed and wherein at the outer side, remote from the V, of each

of the legs (90'', 91''), where they form a flange, an outwardly directed contact projection (47, 48) is provided and at the side of each of the legs (90', 91'), where they form the cross web, contact projections (92, 93) are provided which are outwardly directed in relation to the V.

11. A protective plug as claimed in claim 10, wherein the leg portions (90', 91') forming the V are longer than the leg portions (90'', 91'') forming the flange.

12. A protective plug according to claim 10 or 11, wherein the housing (40) is closed, on its one side, by a circuit board (41), which is adapted, at its one end, as a contact tongue (61) projecting beyond the housing (40) and comprising contact positions (62, 64) on both sides, and comprising circuit tracks (63, 65, 67, 69) on the side directed toward the inside of the housing (40).

13. A protective plug according to claim 12, wherein the fuses (3, 4) on the circuit board (41) are each adapted as narrow sections (70, 71) of the respective circuit tracks (63, 65).

14. A protective plug according to any one or more of claims 9 to 13, wherein the slider (45) comprises a signalling lug (56) showing in the direction of a

transverse wall (57) of the housing (40), said signalling lug, after tripping of the fuse, projecting outwardly through an opening (87) of the housing (40), providing a tripping signal.

15. A protective plug according to any one or more of claims 9 to 14, wherein on each of both sides of the slider (45), centrally extending in the housing (40), a varistor (32, 33), a contact plate (94, 95), a PTC resistor (30, 31) and an external contact plate (96, 97) is provided, such that all elements are electrically interconnected.

16. A protective plug according to any one or more of claims 9 to 15, wherein at the transverse wall (52) of the housing (40) directed toward the contact tongue (61), an opening (55) for introducing an earth rail (98) is provided for being contacted in the interior of the housing (40) by a spring (54).

17. A protective plug according to any one or more of claims 9 to 16, wherein at the housing wall (57) directed toward the signalling lug (56), an opening (58) for introducing a measuring and disconnecting plug is provided which, in the intèrior of the housing (40), lifts a spring contact (59, 60) connecting the incoming circuit track (63, 65) behind a PTC resistor (30, 31) to the outgoing circuit track (67, 69), off the

outgoing circuit track (67, 69).

18. A protective plug according to any one or more of claims 9 to 17, wherein a signal bracket (36) is provided, which is disposed a small distance from the front-side transverse wall (57) of the protective plug (99), and which is adapted to be contacted by the signalling lug (56) of the protective plug (99), the signal bracket (36) being provided with a contact strip (104) for delivering a signal to a signalling device.

19. A protective plug according to claim 18, wherein the signal bracket (36) is U-shaped, and is adapted to be folded down with its legs (38) over pivot bearings (37) at a connector block (89).

20. A protective plug, substantially as hereinbefore described with reference to or as illustrated in the accompanying drawings.

21. A method for testing the operability of a protective plug (99) comprising the line-side terminals (a, a') and the system-side terminals (b, b') and an earth conductor (E) according to any one or more of claims 9 to 20 , wherein by supplying a low current, which will not trigger the operating of the fuses (3, 4; 70, 71), into the respective line connections (a-a'; b-b', a-E and b-E), the voltages and thus the respective con-

ducting resistances are determined.

22. A method as claimed in claim 21, substantially as hereinbefore described.

23. Telecommunication installation, when adapted for and equipped with the means as claimed in any one or more of claims 1 to 20.

DATED AT PRETORIA THIS 13TH DAY OF AUGUST 1991

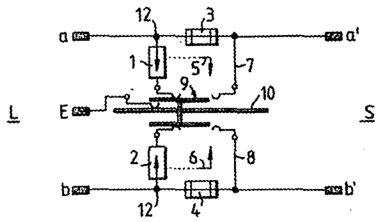

FIG.1

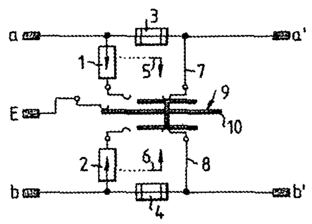

FIG.2

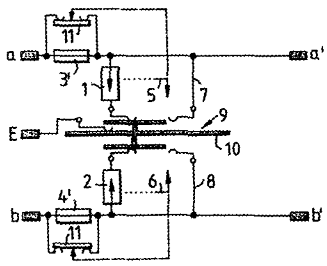

FIG.3

FIG.4

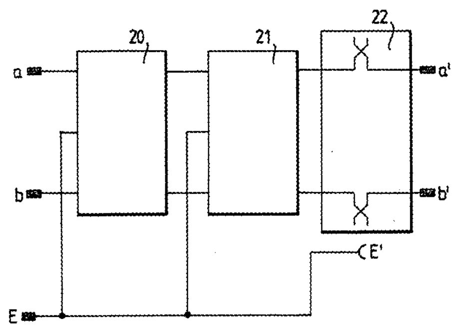

FIG.5

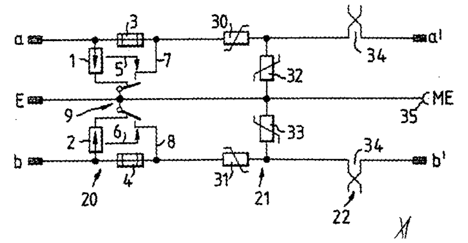

FIG.6

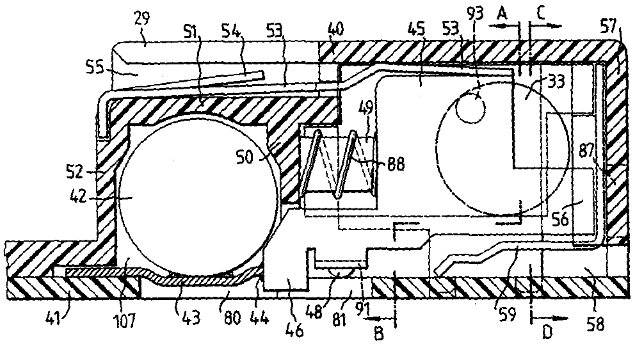
29
51
54
53
40
45
53
93
A
C
57
55
33
49
50
88
52
87
42
56
41
107
43
80
44
46
48
81
91
B
59
D
58

FIG.7

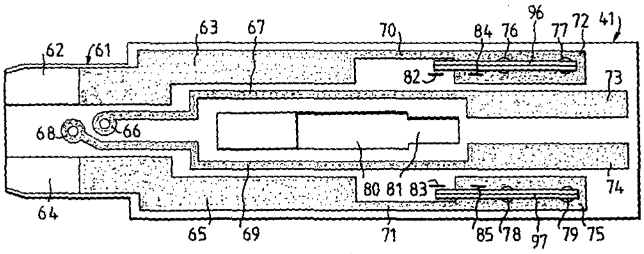
62
61
63
67
70
84
76
96
77
72
41
82
73
68
66
80
81
83
74
64
65
69
71
85
78
97
79
75

FIG.8

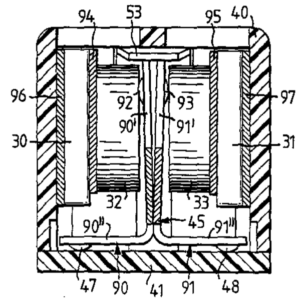
94
53
95
40
96
92
93
97
90'
91'
30
31
32
33
45
90''
91'''
47
90
41
91
48

FIG.9

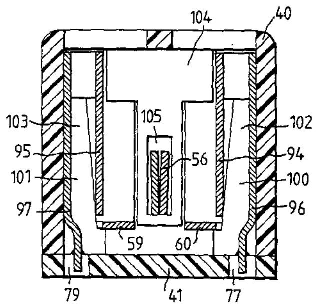
104
40
105
103
102
95
94
56
101
100
97
96
59
60
79
41
77

FIG.10

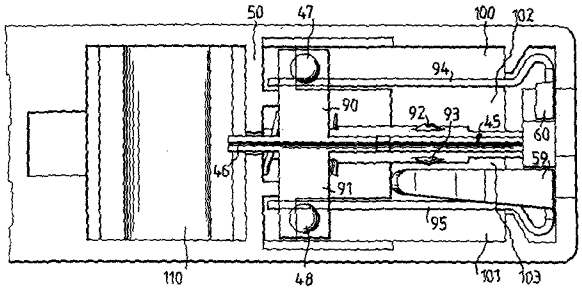
50
47
100
102
94
90
92
93
45
60
59
46
91
95
110
48
101
103

FIG.11

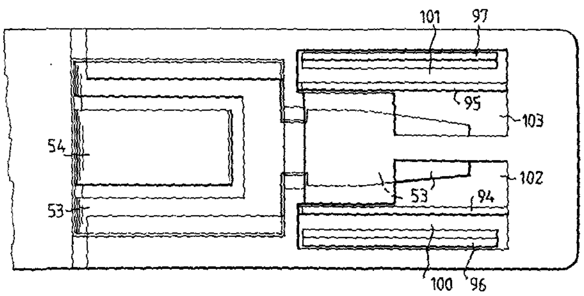
101
97
95
103
54
102
53
94
53
100
96

FIG.5a

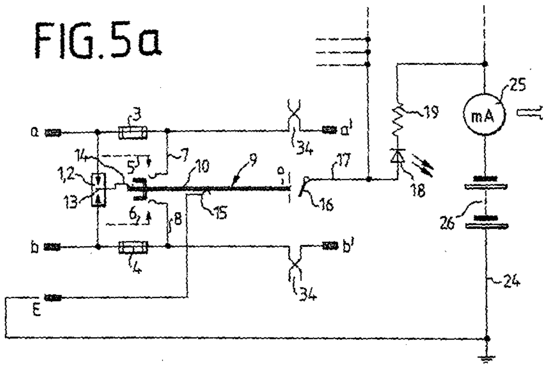

FIG.12

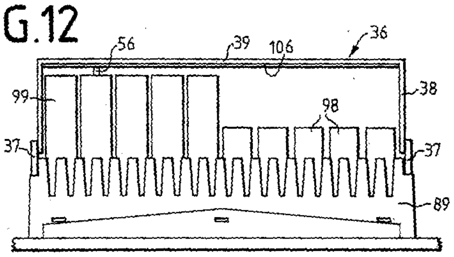

FIG.13

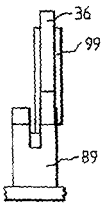

FIG.14