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(71) Applicant: **Cernicka, Jozef**
949 01 Nitra (SK)

(72) Inventor: **Cernicka, Jozef**
949 01 Nitra (SK)

(74) Representative: **Musil, Dobroslav**
Cejl 38
602 00 Brno (CZ)

(54) **Method and device for overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current**

(57) The invention relates to the method of overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, at which in the device for overvoltage protection the current path in the point (X) of intentional cutting off the current path is disconnected. During cutting off the current path in the point (X) between the current path elements being disconnected the value of electric current is limited, through which occurrence of uncontrolled electric arc between the current path parts being disconnected is suppressed.
The invention also relates to the corresponding device, which comprises contacts (00) for connection of electric conductors of protected circuit, between the contacts (00) there is arranged the current path with at least one varistor (1), between the varistor (1) and one contact (00) there is created the point (X) of intentional cutting off the current path with soldered joint of surface of the fixed element of the current path and of surface of moving element of current path.

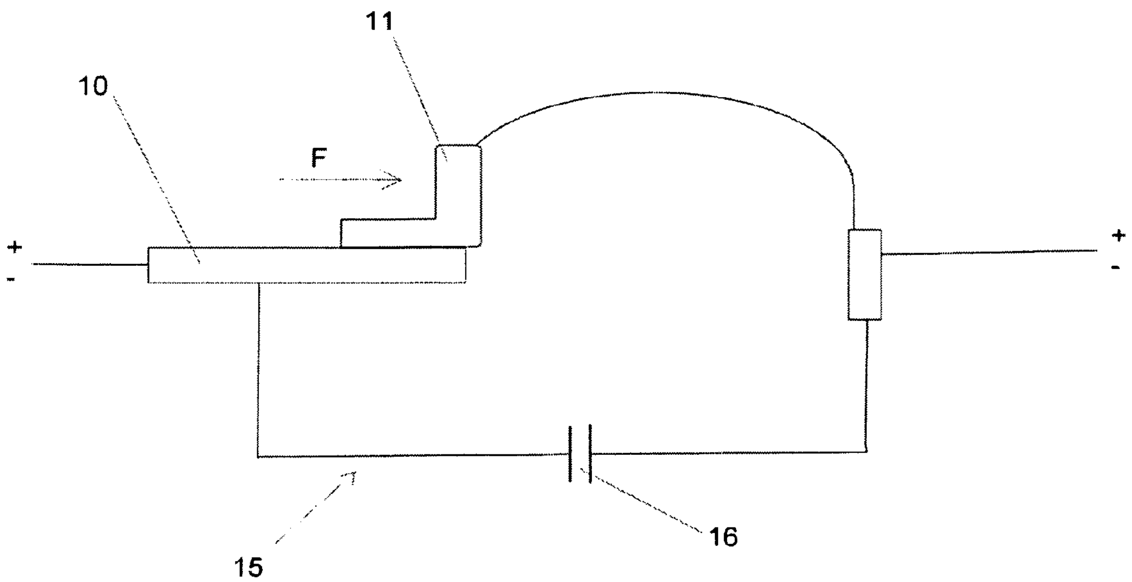

Fig. 2

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Description

Technical field

[0001] The invention relates to the method of overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, at which in the device for overvoltage protection the current path is cut off in the place (X) of intentional cutting off the current path.

[0002] The invention relates to the device for overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, which comprises the contacts (00) for connection of electric conductors of protected circuit, between the contacts (00) the current path is arranged with at least one varistor (1), between the varistor (1) and one contact (00) there is created a point (X) of intentional cutting off the current path with soldered joint of surface of fixed element of current path and surface of moving element of current path, to the point (X) of intentional cutting off the current path there is assigned thermal initiated cut-out mechanism (3) with spring-loaded moving action member, which applies a force (F) towards the moving element of the current path in direction parallel with plane of the soldered joint of surface of the fixed element of current path and surface of moving element of current path.

Background art

[0003] It is generally known, that upon disconnecting the current path in direct current electrical circuits the electric arc occurs in a situation, when the basic conditions of minimum electric voltage between the disconnected parts of the current path and minimum values of electric current in the point of disconnecting are met. If these conditions are not met, the electric arc is not created between the parts of current path being disconnected.

[0004] The document DE 10 2007 015 933 (analogy of DE 20 2007 018 507) discloses the device for overvoltage protection of photovoltaic sources of direct-current electrical circuits, which comprises between the terminals for connection to protected circuit an inserted switched discharger and cutting-off discharger. Parallel to both dischargers between the terminals for connection to protected circuit there is connected a non-linear resistance element, which in the represented example of embodiment is formed of a pair of varistors. The device further comprises a control circuit working as a co-ordinating and supervising unit and comprising a number of further parts.

[0005] The disadvantage of this arrangement is a considerable complexity and price of the device, as the device requires installation of a number of parts, including the complex and costly control circuit.

[0006] From EP 2 132 752, WO 2006/120522, PCT/IB2010/000528, W02007/017736 and further documents there are known the devices for overvoltage protection, which use varistors as non-linear resistance elements. These devices are built-in into a unified box installed on a standard unified installation slat. Inner space of the box usable for mounting of all necessary elements is considerably restricted. The box comprises contacts for connection to protected electrical circuit. Between contacts in the box there is arranged the current path, in which at least one varistor or a group of parallel connected varistors is connected. Contacts of varistor are flat, while one contact of varistor is electrically conductively coupled with one contact of the device for overvoltage protection, and the second contact of varistor is on its surface connected by means of a solder with opposite surface of the first end of flexible electrically conductive means, through which a point of intentional cutting off the current path is created. The flexible electrically conductive means is with its second end electrically conductively coupled with second contact of the device for overvoltage protection. To the first end of the flexible electrically conductive means the spring-loaded moving element is assigned, which to the first end of the electrically conductive means develops a force F in direction parallel with solder connected surfaces of the second contact of varistor and the first end of flexible electrically conductive means. Due to ageing of varistor the value of relatively small values of electric current running through varistor and the current path increases, thus even through the point of intentional cutting off the current path. Then due to overvoltage a short-circuit of varistor occurs, as a result of which through varistor and also through current path, thus through the point of intentional cutting off the current path, the short-circuit current having values often of tens of amperes is flowing. Due to flowing of electric current and spreading of heat from varistor the parts of current path in the point of intentional cutting off the current path are being warmed and solder connecting the second contact of varistor and the first end of flexible electrically conductive means is molten, this soldered joint loses its strength and the first end of flexible electrically conductive means is by action of the spring loaded moving element pushed off in a sliding movement on surface of the second contact of varistor and in direction being parallel with surface of the second varistor contact up to the space outside contact with the second varistor contact, and the current path is cut off. At usage of this solution in circuits with alternate voltage at this cutting off the current path, at which the moving disconnected part of current path is gradually accelerated to a final speed for cutting off, while still for a certain time, when the first end of flexible electrically conductive element in a sliding manner already moves for the purpose of cutting off, there still flows electric current between the second contact of varistor and the first end of flexible electrically conductive means, which is caused by presence of a molten solder between non-moving second contact of varistor and the moving first end of flexible electrically conductive means, no electric arc is induced between the disconnected parts of current path not even at short-circuit of varistor due to overvoltage, which is caused first of all by a speed with which the first moving end of flexible electrically conductive means moves in a moment of disconnecting the current path, when the insulation strength of an air gap increases very rapidly. From movement of spring loaded moving element also an optical and possibly remote status signalling of device for overvoltage protection is derived. Nevertheless at usage of this solution in direct-current electrical circuits at short circuit of varistor due to overvoltage, when short-circuit current in tens of amperes is flowing, an uncontrolled electric arc occurs at these devices, which is not permissible according to the safety regulations. In experiments it was verified, that at these devices an uncontrolled electric arc does not occur at values of electric current in units of amperes, which does not meet requirements of practice.

[0007] Known is also device for overvoltage protection, which comprises the current path with point of intentional cutting off, which is performed as a change-over switch of the current path between the branch with varistor and the short-circuit branch with a fuse cut-out, when in initial status the current path is lead through the branch with varistor. If in the point of intentional cutting off the current path is disconnected, between the parts of current path being disconnected an electric arc develops, and simultaneously the moving section of the current path being disconnected moves into a contact with the free end of the short-circuit branch with the fuse cut-out, then after connection of moving part of the current path being disconnected with free end of the short-circuit branch with fuse cut-out the varistor is in a short circuit, the above mentioned electric arc switches off and through melting the fuse cut-out electric current is cut off.

[0008] The goal of the invention is to remove or at least minimise shortcomings of the background art at direct-current electrical circuits, especially at photovoltaic sources of electric current, at which in case of a short circuit of varistor the flowing currents achieve the values of even tens of amperes.

Principle of the invention

[0009] The goal of the invention has been achieved through the method of overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, whose principle consists in that during cutting off the current path in the point (X) between the current path elements being disconnected the value of electric current is limited, through which occurrence of uncontrolled electric arc between the current path parts being disconnected is suppressed.

[0010] Principle of the device for overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, consists in that to the point (X) of intentional cutting off the current path the capacitor is assigned in parallel manner.

[0011] This invention enables in simple and price affordable means to realise a safe cutting off the current path in the device for overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, this both at values of current under 10 A even above 10 A, which meets the requirements of praxis and requirements of the draft (DRAFT) of the norm prEN 50539-11. Another advantage is that only for a short time of heating the current path in a point "X" the electric current flows through the device for overvoltage protection and the protected circuit e.g. the photovoltaic source of electric current after cutting off the current path is fully functional. Another advantage is, that it is not necessary to insert into the current path of the device for overvoltage protection a fuse for direct current as it is in the background art, because the fuse for direct current including the holder is relatively expensive, so that the invention enables besides also to reduce price of the device for overvoltage protection. Another advantage is that the capacitor for the whole service life of the device for overvoltage protection without voltage, through which its voltage loadability for the whole period of service life of the device for overvoltage protection is preserved. Voltage on the capacitor is acting only from the moment of cutting off the current path in the point X till the moment the varistor insertion is replaced.

[0012] Advantageous embodiments of the invention, especially the structure of the current path of the device for overvoltage protection are described in description of exemplary embodiments and are the subject of patent claims.

Description of the drawing

[0013] The invention is schematically represented in the drawing where the Fig. 1 shows a ground plan of one device for overvoltage protection, the Fig. 1a an example of another arrangement of the device for overvoltage protection, the Fig. 2 exemplary embodiment of the point X of intentional cutting off the current path of the device for overvoltage protection with parallel assigned capacitor, the Fig. 3a to 3d an exemplary embodiment of the point X with parallel assigned capacitor and a temporary serial resistance and the individual phases of concurrence of these elements and the Fig. 4 a time course of electric voltage and of electric current at the method according to the invention.

Examples of embodiment

[0014] The method of overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, consists in that the current path is cut off in a place of intentional cutting off the current path, at the same time at this cutting off the conditions unfavourable for occurrence of uncontrolled electric arc are created, so that in the moment when between the current path elements being disconnected a nonzero interval is created, value of electric current in the point of cutting off is limited, by which occurrence of uncontrolled electric arc between the current path elements being disconnected is prevented. The value of electric current in the point of cutting off is limited due to increase of voltage through rerouting the flow of electric current to parallel current path formed of capacitor (condenser or a group of condensers). The capacitor at moment of creation of the nonzero interval between the current path elements being disconnected represents only a minor electric resistance, because the voltage on capacitor corresponds to the status before creation of the nonzero interval between the current path elements being disconnected and it is being increased in dependence on capacity of the capacitor and the value of current. Speed of mutual shifting away the current path elements being disconnected is so high, that the breakdown strength of air gap between the mutually shifting away elements of the current path being disconnected increases quicker than voltage on the capacitor, which increases due to charging the capacitor by a incoming electric charge from the rerouting flow of electric current, and this voltage grows up to the height of maximum voltage of the source of the direct-current electric current.

[0015] Such behaviour of the device for overvoltage protection may be achieved by a suitable structure of the device for overvoltage protection with respective dimensioning of individual elements.

[0016] Exemplary embodiment of the device for overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, comprises the box **0**, in which individual functional elements of the device for overvoltage protection are built-in. The device for overvoltage protection comprises contacts **00** for connection of electric conductors of protected circuit. Between the contacts **00** there is in the box **0** arranged the current path, in which as a protective element at least one nonlinear resistance element is integrated, for example varistor **1** or a group of parallel integrated varistors **1**.

[0017] In the current path the point **X** of intentional cutting off the current path is arranged. The point **X** in the represented example of embodiment is performed in the contact place of the upper surface of the lower electrode **10** of varistor **1** and of the lower surface of the first end of flexible electric conductor **11**. Both these contact surfaces are connected by means of solder **12**. Function of cutting off the current path in the point **X** is realised by means of thermal initiated cut-out mechanism **3**, which is assigned to the point **X**, and which in the represented example of embodiment is formed of a spring loaded moving action member, which on the flexible electric conductor **11** develops the force **F** in direction parallel with upper surface of the lower electrode **10** of varistor **1** and with lower surface of the first end of the flexible electric conductor **11**. The force **F** is either developed directly in direction parallel with upper surface of the lower electrode **10** of varistor **1** and with lower surface of the first end of flexible electric conductor **11** or it acts in this direction, e.g. thanks to production deviations etc., as a component of totally acting force. The force **F** after melting the solder **12** as a result of increased temperature of varistor pushes off the first end of flexible electric conductor **11** from the lower electrode **10** of varistor **1** by a shearing action on the molten solder **12**, i.e. by sliding motion of the first end of flexible electric conductor **11** on the lower electrode **10** of varistor **1**, so that the first end of flexible electric conductor **11** at the moment of creation of nonzero interval between it and the lower electrode **10** of varistor **1** already develops a relatively high speed. Solder **12** is molten and the thermal initiated cut-out mechanism **3** is initiated by means of a heat, which is partly developed by a non-linear resistance element (varistor **1**) integrated in the current path, and which is also developed by passage of electric current through the current path.

[0018] Thermal initiated cut-out mechanism **3** is coupled with means for optical and/or remote signalling of status of the device for overvoltage protection. For optical signalling of status of the device for overvoltage protection the device is provided with swing lever **4**, which is coupled with thermal initiated cut-out mechanism **3**.

[0019] In the Fig. 2 to the current path of the device for overvoltage protection in vicinity of the point **X** there is assigned the parallel current path **15** with the capacitor **16**. The capacitor **16** is in parallel manner to the current path through the point **X** connected between the lower electrode **10** of varistor **1** and the non-moving section of the flexible electric conductor **11** only after the first end of the flexible electric conductor **11**.

[0020] In the Fig. 3a to 3d to the current path of the device for overvoltage protection in vicinity of the point **X** there are assigned the parallel current path **15** with the capacitor **16** and the serial temporary resistance element **P**, which since the moment of beginning of the sliding disconnecting movement of the first end of flexible electric conductor **11** has a longer time of electric current conduction than is the conduction time of electric current through the current path through the point **X** since the moment of beginning of the sliding disconnecting movement of the first end of flexible electric conductor **11**, when the sliding disconnecting movement is started after melting of the solder **12** through action of the force **F**. At the end of the lower electrode **10** of varistor **1** distant from the first end of the flexible electric conductor **11** there is electrically in a conductive manner attached the auxiliary electric conductor **13**, which has distinctly higher electric resistance, than the lower electrode **10** of varistor **1** and a flexible electric conductor **11** have, e.g. it is formed of a strip made of stainless steel of a small thickness. The auxiliary electric conductor **13** runs along the lower surface of the lower electrode **10** of varistor **1** up to a free space in distance **A** from the edge of the lower electrode **10** of varistor **1,** where it finishes with a contact edge **130** situated in a free space behind the first end of flexible electric conductor **11** outside the contact with flexible electric conductor **11.** At the same time the distance **A** is smaller than the length of the first end of flexible electric conductor **11.** Between the auxiliary electric conductor **13** and the lower electrode **10** of varistor **1** there is, with exception of the place of connection of the auxiliary electric conductor **13** to the lower electrode **10** of varistor **1,** situated electric insulation **14,** e.g. insulation foil. Capacitor **16** is parallel to the current path through the point **X** connected between the lower electrode **10** of varistor **1** and the non-moving section of the flexible electric conductor **11** still after the first end of flexible electric conductor **11.**

[0021] The Fig. 3a represents full functioning status of the device for overvoltage protection without occurrence of a failure status. Solder **12** is in a solid status and holds the first end of flexible electric conductor **11** and the lower electrode **10** of varistor **1** together. The capacitor **16** shows voltage U_0.

[0022] The Fig. 3b represents the status when solder **12** has already been molten and the spring-loaded moving action member of thermal initiated cut-out mechanism **3** has already begun to push off the first end of flexible electric conductor **11** in direction of actioning the force **F** parallel with surface of the lower electrode **10** of varistor **1.** The first end of the flexible electric conductor **11** moves in gradually increasing speed, at the same time it is still in electric contact with the lower electrode **10** of varistor **1** and it newly has entered into electric contact with contact edge **130** of auxiliary electric conductor **13.** The capacitor **16** shows voltage U_{01}.

[0023] The Fig. 3c represents status when the spring-loaded moving action member of thermal initiated cut-out mechanism **3** has already pushed off the first end of the flexible electric conductor **11** in a still increasing speed parallel with surface of the lower electrode **10** of varistor **1** totally outside electric contact with lower electrode **10** of varistor **1,** nevertheless the first end of flexible electric conductor **11** remains in electric contact with contact edge **130** of auxiliary electric conductor **13.** The capacitor **16** shows voltage U_2. The Fig. 3d represents status of total cutting off the current path of the device for overvoltage protection in the point **X,** when the spring-loaded moving action member of thermal initiated cut-out mechanism **3** has pushed off the first end of the flexible electric conductor **11** totally outside electric contact with contact edge **130** of the auxiliary electric conductor **13.** The capacitor **16** shows voltage U_3.

[0024] Function of the device according to the Fig. 2 is so that, once overvoltage occurs, this is eliminated by passage of electric current through varistor **1,** which is thus being warmed by which also the lower electrode **10** of varistor **1** becomes warm. Once the lower electrode **10** of varistor **1** reaches the temperature for melting the solder **12,** this becomes molten and releases motion of the spring-loaded moving action member of the thermal initiated cut-out mechanism **3** in direction parallel with surface of the lower electrode **10** of varistor **1.** The spring-loaded moving action member starts gradually with increasing speed in sliding manner to shift the first end of the flexible electric conductor **11** on surface of the lower electrode **10** of varistor **1,** while thanks to molten solder **12,** electric current still passes between the first end of flexible electric conductor **11** and the lower electrode **10** of varistor **1.** Once the nonzero interval occurs between the first end of the flexible electric conductor **11** and the lower electrode **10** of varistor **1,** voltage between the first end of flexible electric conductor **11** and lower electrode **10** of varistor **1** is increased, by which the flowing electric current re-routes into parallel current path **15** with capacitor **16,** which in this moment represents only minor electric resistance, because the voltage on capacitor **16** corresponds to status before occurrence of the nonzero interval between the current path elements being disconnected and it is increased depending on capacity of the capacitor **16** and value of the current. Thanks to sliding motion of the first end of the flexible electric conductor **11** on surface of the lower electrode **10** of varistor **1,** this first end of flexible electric conductor **11** at the moment of creation of the mentioned nonzero interval reaches still a sufficient speed of its motion, so that at its further shifting away from the lower electrode **10** of varistor **1** the interval being created increases, and with it also its breakdown strength quicker than the voltage is increased on capacitor **16,** which (voltage on the capacitor **16**) increases due to charging the capacitor **16** by the incoming electric charge from the re-routed flow of electric current. This voltage on capacitor **16** increases till the value of maximum voltage of the source of electric direct-current. At this arrangement there will not be even at values of electric current in tens of amperes occurrence of uncontrolled electric arc between the current path elements being disconnected at the point **X** of intentional cutting off the current path. Under the term "uncontrolled" electric arc it is understood a longer lasting electric arc. Experimentally it was proven, that upon cutting off the direct-current in values of tens of amperes using the device according to the invention being submitted, there was occurrence of only a sparkle between the first end of flexible electric conductor **11** and the lower electrode **10** of varistor **1** at the moment of creation of the nonzero interval between the first end of the flexible electric conductor **11** and the lower electrode **10** of varistor **1.** No uncontrolled electric arc was created.

[0025] Function of the device according to the Fig. 3a to 3d is following. The device is fully functional, see the Fig. 3a, no electric current flows through the varistor **1.** There is no movement of individual elements of the current path. Once overvoltage occurs, this is eliminated by passage of electric current through the varistor **1,** which is warmed this way, by which also the lower electrode **10** of varistoru **1** becomes warm. Once the lower electrode **10** of varistor **1** warms to the temperature for melting the solder **12,** this gets molten and releases motion of the spring loaded moving action member of thermal initiated cut-out mechanism **3** in direction parallel with surface of the lower electrode **10** of varistor **1.** The spring loaded moving action member starts gradually in an increasing speed to shift the first end of flexible electric conductor **11** on surface of the lower electrode **10** of varistor **1,** at the same time thanks to the molten solder **12** between the mutually moving elements of the current path, i.e. between the first end of the flexible electric conductor **11** and the lower electrode **10** of varistor **1** electric current is still passing. Consequently the first end of the flexible electric conductor **11** touches the contact edge **130** of auxiliary electric conductor **13,** while the first end of flexible electric conductor **11** is still in electrically conductive contact with the lower electrode **10** of varistor **1,** as it is represented in the Fig. 3b. Through creation of electrically conductive contact between the first end of the flexible electric conductor **11** and the contact edge **130** of auxiliary electric conductor **13** upon preservation of electrically conductive contact between the first end of flexible electric conductor **11** and the lower electrode **10** of varistor **1** , there occurs jump increase of electric resistance of current path at the point **X,** which results in that the flow of electric current is re-routed via capacitor **16,** which is being charged, the voltage $U_{01} \geq U_0$ and through the current path through the point **X** only fraction of original value of electric current is flowing. By further shifting the first end of the flexible electric conductor **11,** the Fig. 3c, electrically conductive connection of the first end of the flexible electric conductor **11** and of the lower electrode **10** of varistor **1** is cancelled, so that the point **X** is disconnected, most of electric current flows through capacitor **16,** which is being charged, the voltage $U_2 > U_{01} \geq U_0$, but simultaneously the voltage is $U_2 < U_{arc}$ (arc voltage), so that there is no uncontrolled electric arc between the elements of current path being disconnected in the point **X.** By further shifting the first end of the flexible electric conductor **11,** the Fig. 3d, also electrically conductive connection of the first end of flexible electric conductor **11** and of contact edge **130** of auxiliary electric conductor **13** is cancelled, while the moving first end of the flexible electric conductor **11** shows such speed of its motion, that the insulation strength of air gap between the first end of flexible electric conductor **11** and the contact edge **130** of auxiliary electric conductor **13** increases quickly and no uncontrolled electric arc occurs. It is obvious, that at embodiment according to the Fig. 3a to 3d the total resistance of the current path is increased, by which redistribution of current between the current path in the point **X** and the parallel current path **15** with the capacitor **16** is increased.

[0026] As it is seen from the Fig. 4, through the method and the device according to this invention an effective restriction of conditions necessary for creation of (uncontrolled) electric arc between the elements of current path being disconnected is achieved, as at increase of voltage there is significant drop in value of electric current.

Industrial applicability

[0027] The invention is applicable at overvoltage protection of direct current electric circuits with currents even in tens of amperes, especially of photovoltaic sources of direct current.

Claims

1. Method of overvoltage protection of direct-current electrical circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, at which in the device for overvoltage protection the current path in the point (X) of intentional cutting off the current path is disconnected, **characterised in that**, during cutting off the current path in the point (X) between the current path elements being disconnected the value of electric current is limited, through which occurrence of uncontrolled electric arc between the current path parts being disconnected is suppressed.

2. The method according to the claim 1, **characterised in that**, the value of electric current between the current path elements being disconnected is limited by rerouting the flow of electric current through the parallel assigned capacitor (16).

3. The method according to the claim 1, **characterised in that**, between the current path elements being disconnected during cutting off the interval is created at least at such a speed, at which an increase of breakdown strength of air gap between the current path parts being disconnected is greater than the increase of voltage on the capacitor (16).

4. The method according to the claim 2, **characterised in that**, during cutting off the current path in the point (X) the serial temporary resistance element (P) is connected, by which redistribution of flow of electric current between the current path elements being disconnected and capacitor (16) is increased.

5. The device for overvoltage protection of direct current electric circuits with currents even in tens of amperes, especially of photovoltaic sources of electric current, which comprises contacts (00) for connection of electric conductors of protected circuit, between the contacts (00) there is arranged the current path with at least one varistor (1), between the varistor (1) and one contact (00) there is created the point (X) of intentional cutting off the current path with soldered joint of surface of the fixed element of the current path and of surface of moving element of current path, to the point (X) of intentional cutting off the current path there is assigned thermal initiated cut-out mechanism (3) with spring-loaded moving action

member, which applies a force (F) towards the moving element of the current path in direction parallel with plane of the soldered joint of surface of the fixed element of current path and of surface of moving element of current path, **characterised in that**, to the point (X) of intentional cutting off the current path the capacitor (16) is assigned in parallel manner.

6. The device according to the claim 5, **characterised in that**, the capacitor (16) is parallel to the current path connected between the lower electrode (10) of varistor (1) and the non-moving section of the flexible electric conductor (11) after the first end of the flexible electric conductor (11).

7. The device according to the claim 5, **characterised in that**, to the point (X) of intentional cutting off the current path there is assigned the temporary serial resistance (P).

8. The device according to the claim 7, **characterised in that**, the temporary serial resistance (P) is formed of auxiliary electric conductor (13), which at one of its ends is electrically in a conductive manner connected with lower electrode (10) of varistor (1), and on its second end it is provided with contact edge (130) situated in the distance (A) from lower electrode (10) of varistor (1) in a free space after the first end of the flexible electric conductor (11) outside the contact with flexible electric conductor (11), at the same time the distance (A) is smaller than the length of the first end of the flexible electric conductor (11).

9. The device according to the claim 8, **characterised in that**, the auxiliary electric conductor (13) is formed of a steel strip made of stainless steel of a small thickness.

10. The device according to any of the claims 8 or 9, **characterised in that**, between the auxiliary electric conductor (13) and the lower electrode (10) of varistor (1) there is, with exception of the place of connection of the auxiliary electric conductor **13** to the lower electrode **10** of varistor **1,** situated electric insulation (14).

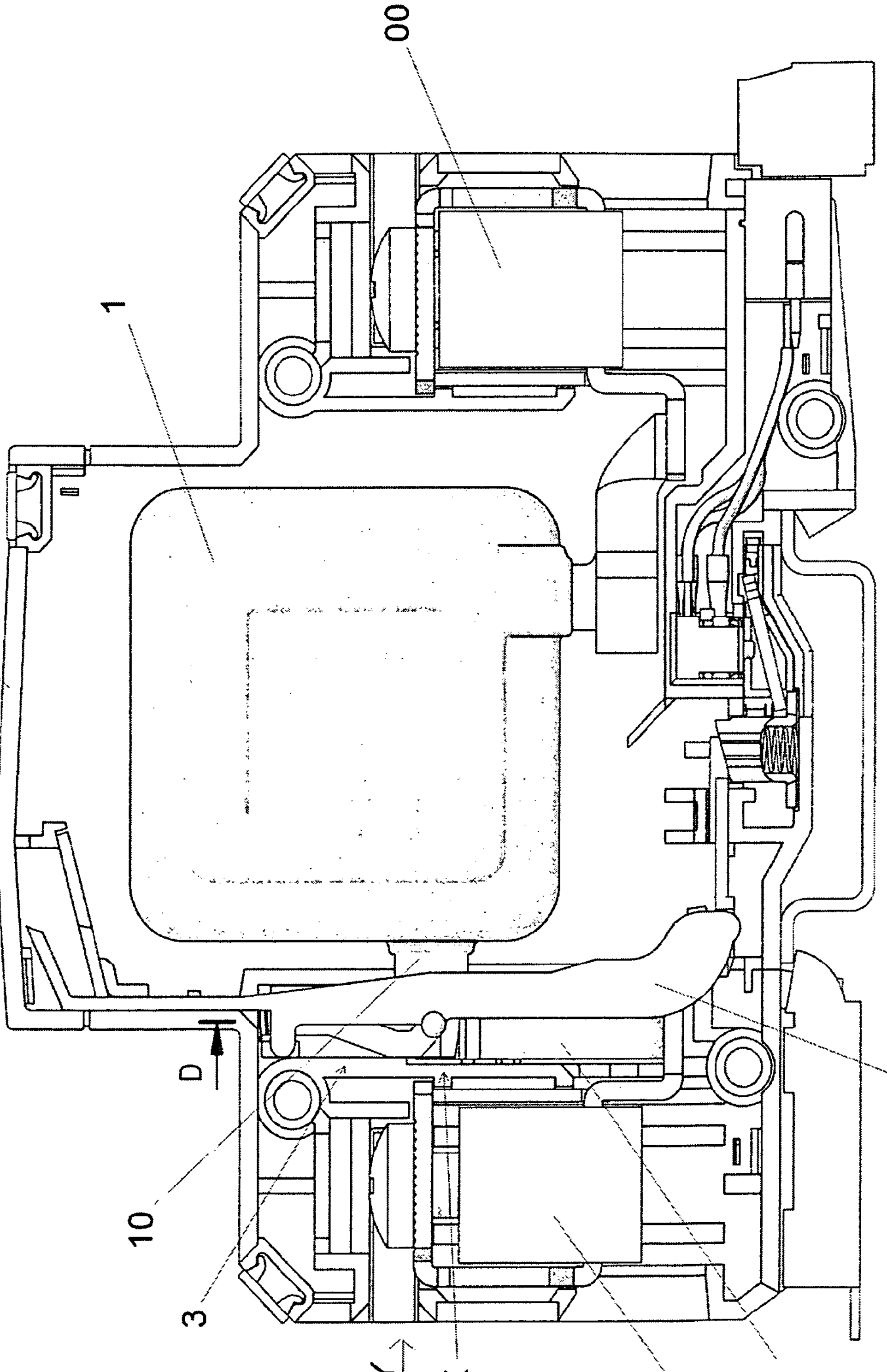

Fig. 1

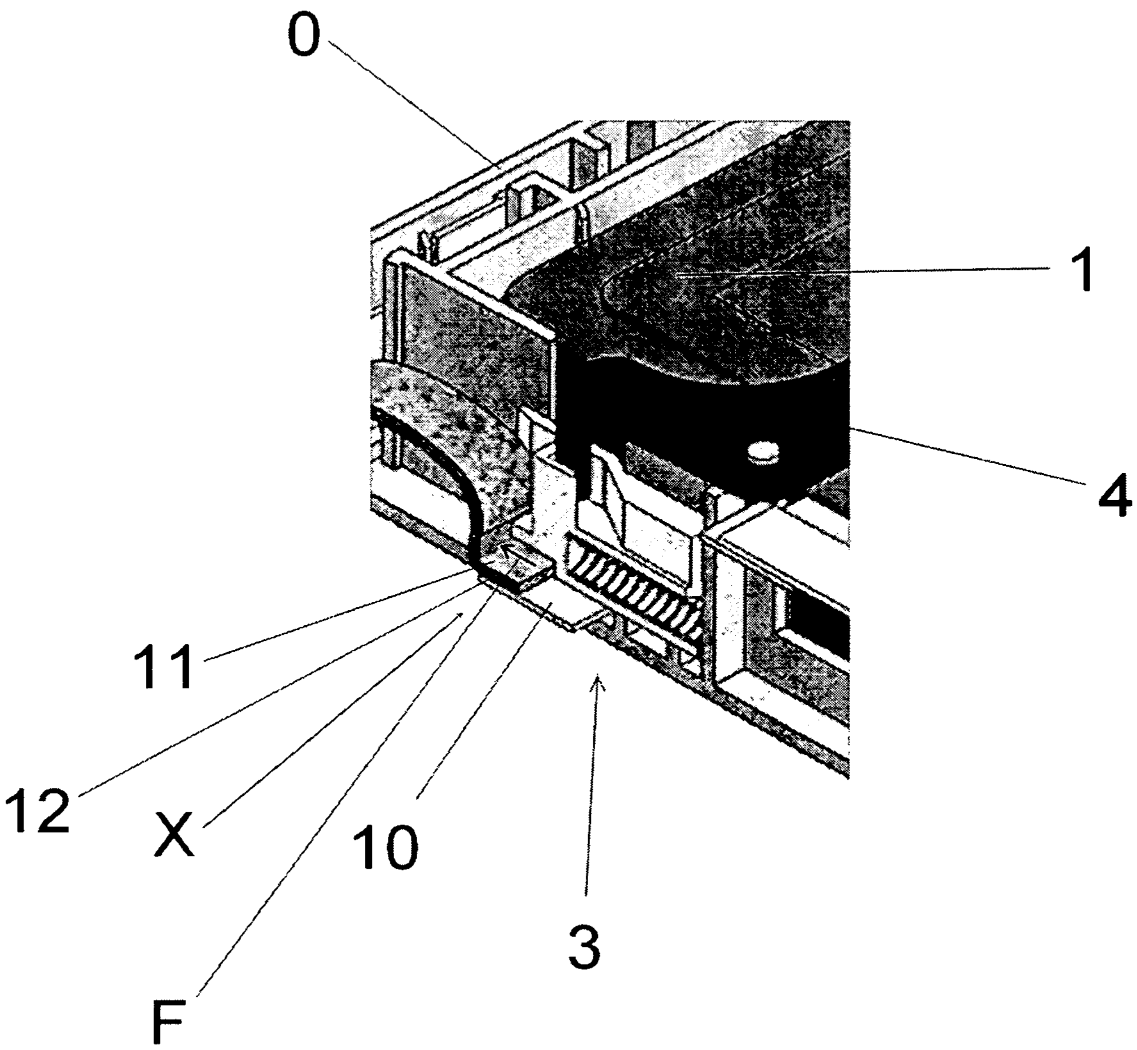

Fig. 1a

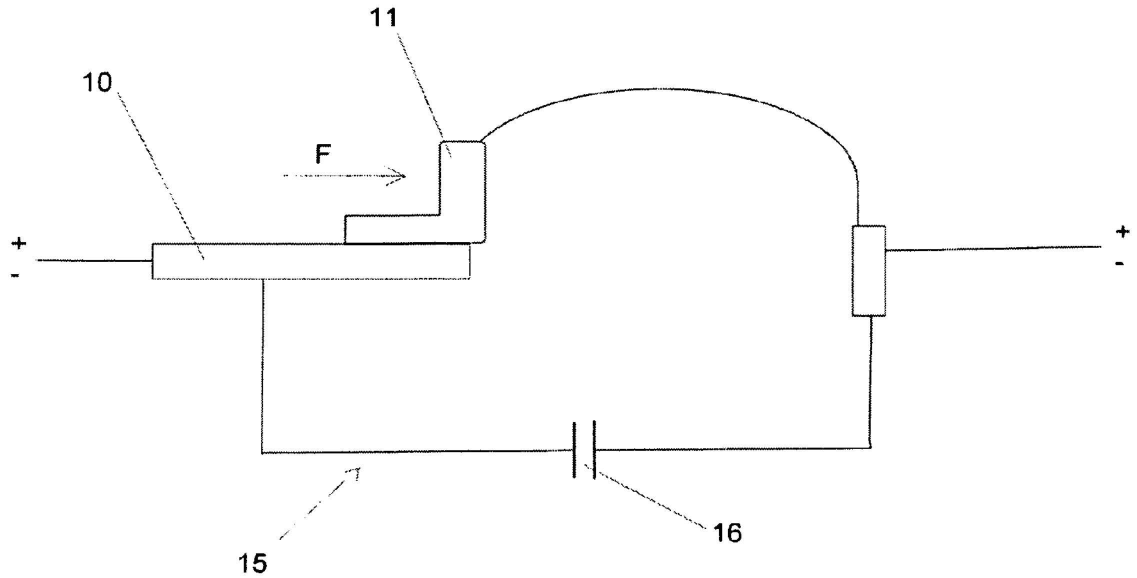

Fig. 2

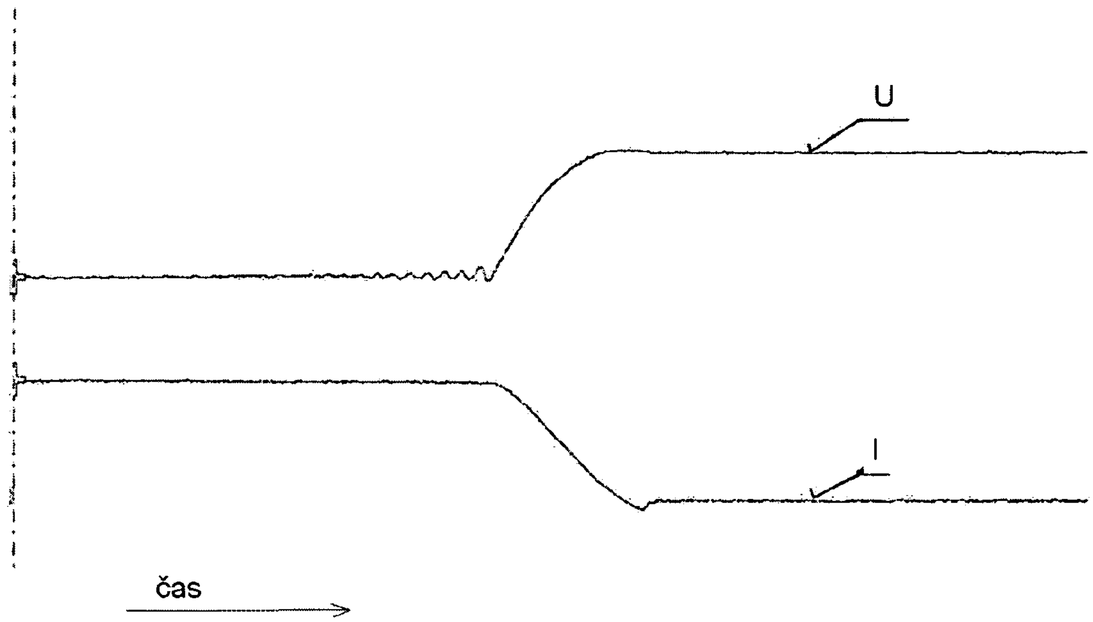

Fig. 4

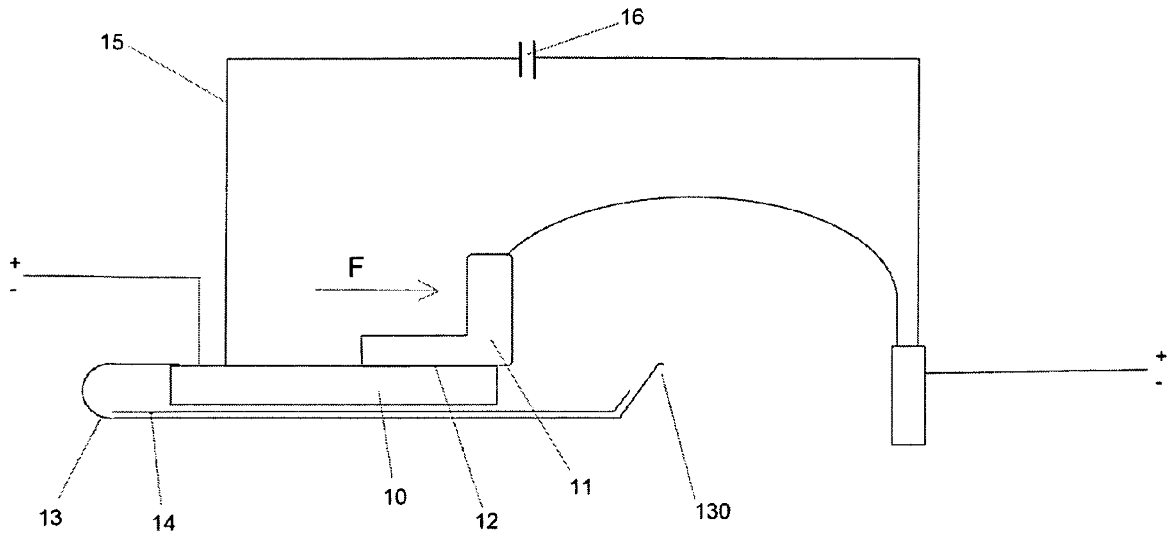

Fig. 3a

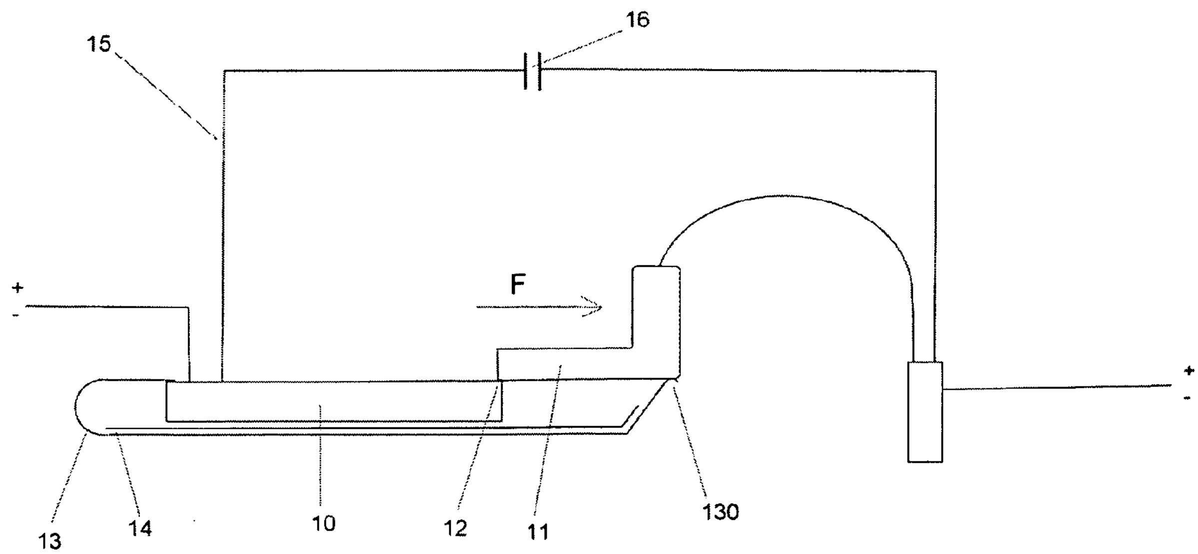

Fig. 3b

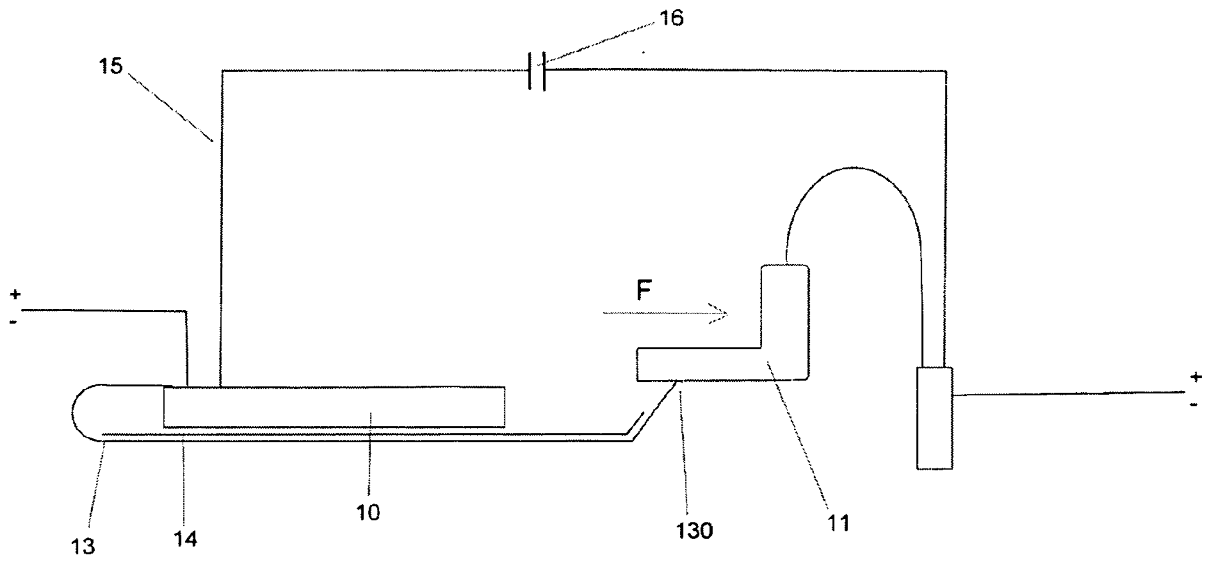

Fig. 3c

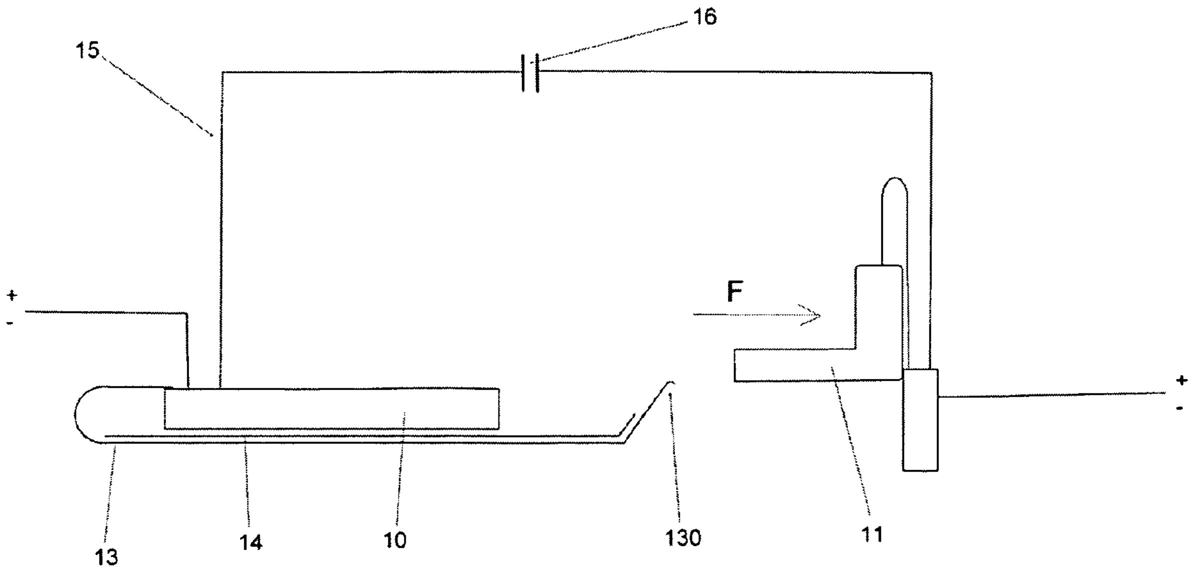

Fig. 3d

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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 4827

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