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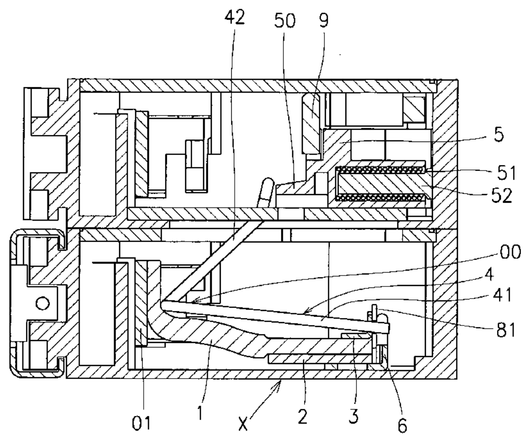

Fig. 1

(57) Abstract: The invention relates to the device for overvoltage protection comprising terminals for connection to protected circuit, between which there is arranged the current path, in which the protective element is connected, and in the current path there is created (X) point of intentional cutting off the current path performed through connection of one end of the flexible electric conductor (1) with one end of the fixed electric conductor (2) by means of first solder, and with flexible electric conductor the cut-out device is coupled, while the device further comprises the device for signalling the status of overvoltage protection and an additional thermal cut-out with adjustable parameters of melting. The additional thermal cut-out is performed by a second solder arranged between the flexible electric conductor (1) and the fixed electric conductor (2) parallel to the (X) point of intentional cutting off the current path and outside the joint of flexible electric conductor (1) and fixed electric conductor (2) by means of the first solder, while the second solder is at least thermally conductively connected with the flexible electric conductor (1) and with the fixed electric conductor (2), and the first solder and the second solder feature the same or approximately the same temperature of melting.

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Device for overvoltage protection

Technical field

The invention relates to the device for overvoltage protection comprising terminals for connection to protected circuit, between which there is arranged the current path, in which the protective element is connected, and in the current path there is created a point of intentional cutting off the current path performed through connection of one end of a flexible electric conductor with one end of fixed electric conductor by means of first solder, and with flexible electric conductor the cut-out device is coupled, while the device further comprises the device for signalling the status of overvoltage protection and an additional thermal cut-out with adjustable parameters of melting.

Background art

From WO 2007/017736 A1 and documents mentioned in the background art of WO 2007/017736 A1 there are known the devices for overvoltage protection comprising a protective element formed of a non-linear resistance element - varistor. Varistor due to its loading by electric current and by an impulse loading of a protected network gradually decreases the value of its electric resistance. Due to this, the current running through varistor is increasing and its warming up increases as well. Therefore the overvoltage protection is provided with thermal cut-out device (hereinafter referred to as TCD) which once a certain temperature of varistor is achieved cuts-out the current path of the device for overvoltage protection, through which varistor is disconnected from the protected circuit or network (hereinafter referred to as network only), which secures that due to flowing current no further warming of varistor above the permissible limit may occur.

Cutting off the varistor from the network is signalled, namely optically directly on the device for overvoltage protection and possibly through remote control by means of transmitting a suitable signal. Once the varistor is disconnected from the network, this network is further not protected and so it is necessary to restore the protected status by replacement of the device for overvoltage protection, or of its part comprising the disconnected protective element. The whole effect of gradual heating of varistor through its "ageing" is expressively a long-term effect, by minimum several orders longer than the undesirable effects in electrical network, against whose effects varistor protects the connected devices. The period of "ageing" of varistor nevertheless depends also on a quantity of impulse loads incurred by overvoltage in the network, when during a very short period relatively great current is flowing through the current path and which also reduce the service life of varistor.

In electric network also other effects occur when TCD is subject to action of considerably different conditions, which it must manage in a manner securing a safe operation of an instrument (device for overvoltage protection) even in situations when the protective elements (varistors) are overloaded and their voltage failure occurs. In such situation it is required, that even at a high short-circuit current, declared for the given instrument, the TCD is not disconnected, but the circuit in the overcurrent protection positioned in the circuit before the device for overvoltage protection is cut off. Disconnection of TCD could cause occurance of electric arc between the disconnected elements with danger of fire.

Requirements for a safe functioning of overvoltage protection are shown in respective state or international norms (standards), e.g. ČSN EN 61643-11, which also specifies conditions for correct functioning of the device for overvoltage protection in situation of voltage failure of varistor, for maximum short-circuit current in the point of connection of the device for overvoltage protection. ČSN EN 61643-11specifies these requirements including evaluation of results of tests in paragraph 7.7.3. of the above mentioned norm.

Another situation arises from the point of view of TCD disconnection, if after varistor voltage failure the short-circuit current is considerably lower than the maximum short-circuit resistance of the device for overvoltage protection. Reaction of overcurrent securing elements which are positioned before the device for overvoltage protection is significantly prolonged and manner of loading the TCD is considerably changed. This fact has been reflected in A11 change of the ČSN EN 61643-11 norm, which comprises extended testing of short-circuit resistance of the device for overvoltage protection. This extension is specified in paragraph 7.7.3.b) of the mentioned norm and its changes are designated as „testing by low short-circuit current".

This new testing in an expressive manner enlarges requirements as to parameters of TCD, especially at the devices for overvoltage protection on basis of varistor for higher energies (category I, type I). This testing requires a long-term (seconds in order) acting of low short-circuit current, which substantially changes thermal loading of the whole current path of the device for overvoltage protection. The current path including TCD is considerably warmed-up. This warming results in that, even during flowing the low short-circuit current, the TCD may be disconnected, which may cause occurrence of electric arc with possible fire. As for the TCD there is by a norm prescribed maximum temperature, at which its disconnection must occur, with respect to this condition for connection of elements of current path such low-fusing solders are used, whose temperature of melting lies considerably lower, than the melting temperature of the remaining elements of the current path.

Taking into account that the low-fusing solder connects elements of the current path, it is required that it features the best electrical conductivity which is of course lower than at other elements of current path, which usually are made of copper (of course with exception of varistor, that fulfils its strongly non-linear characteristic protective function of overvoltage protection).

The solder connecting elements of current path, with respect to lower electric conductivity when compared with other elements of current path, also gets quicker warmer due to flowing electric current, which may to a certain level be compensated by a size of soldered area connecting the elements of current path. It is generally known that electrical conductivity at metals strongly correlates with temperature conductivity. This results into a fact, that if the soldered surface is sufficiently thin, during warming the solder also heat removal from the solder into elements of current path occurs simultaneously. This thermal mechanism ensures relatively low temperature of the solder only at the situation, when temperature of elements of the current path is relatively low.

If, nevertheless this temperature raises to the level of temperature of solder melting, there occurs an undesirable disconnection of TCD instead of cutting off the circuit in overcurrent protection, which is positioned before the device for overvoltage protection.

These shortcomings of the background art were eliminated or at least considerably reduced by a device for overvoltage protection according to the application of the CZ PV 2009-164 invention. The principle of this solution consists in that, the device for overvoltage protection comprises terminals for connection to a protected circuit, while between the terminals there is arranged the current path, in which the protective element is connected. In the current path there is created the point of intentional cutting off the current path, to which a device for signalling the protection status is assigned. In the point of intentional cutting off the current path there is further created an additional fusing thermal cut-out with preset parameters of melting. The elements of current path being intentionally disconnected are connected by means of first solder and additional fusing thermal cut-out with preset parameters of melting is formed by second solder. The second solder has the same or approximately the same temperature of melting as the first solder, but simultaneously the second solder has lower, or depending on structural embodiments and selected materials also the same value of thermal conductivity, than the first solder. This device functions so that it prevents the disconnection of TCD immediately after melting the first solder which connects the elements of the current path, so that temperature of this first solder, which is already in liquid status, may further raise up to the boiling point of the first solder, as melting of the second solder takes longer time with respect to the greater dimension of the second solder, that must be heated and molten. In this way the time of current flow through TCD is prolonged without undesirable disconnection of TCD, which enables to increase dimensioning of overcurrent protection, which is included before the device for overvoltage protection in compliance with requirements of provisions of the ČSN EN 61643-11 norm, revision A11, paragraph 7.7.3.b). With respect to the time span of action of a low short-circuit current and setting of conditions of its action, there even does not occur an excessive thermal effect to surroundings of TCD. The particular structural solution of this invention then describes a solution according to which the additional fusing thermal cut-out with preset parameters of melting is formed of a fusing pin, which is positioned in a through opening which is performed in current path elements being intentionally disconnected. Another particular structural embodiment is described by a solution at which the additional fusing thermal cut-out with preset parameters of melting is formed of a fusing rivet, which is positioned in a through opening which is performed in current path elements being intentionally disconnected, while the heads of fusing rivet abut against the outer exterior surfaces of current path elements being intentionally disconnected. In both particular structural embodiments there is also possible the preferred position of an additional fusing thermal cut-out in the ground-plan surface of current path elements being intentionally disconnected or in the nose, which projects from the current path elements being intentionally disconnected, by which it is possible to further influence or set the period of melting the second solder with the lower thermal conductivity.

Though the principle of the invention as such shows to be very efficient and enables a safety application of the device for overvoltage protection on basis of varistor even for higher energies (category I, type I), nevertheless the concrete structural embodiments according to the application of the CZ PV 2009-164 invention show certain restrictions in their application for higher energies than the particular structural solutions according to the CZ PV 2009-164 enable, which is especially given by the structure of current path at concrete structural embodiments of solution according to the application of the CZ PV 2009-164 invention.

The goal of this invention is to further enhance the limit for applicability of the device for overvoltage protection on basis of varistor from the point of view of energetic loading.

Principle of the invention

The goal of the invention has been achieved by a device for overvoltage protection, whose principle consists in that, the additional thermal cut-out is performed by a second solder arranged between the flexible electric conductor and the fixed electric conductor parallel to the point of intentional cutting off the current path and outside the joint of flexible electric conductor and fixed electric conductor by means of the first solder, while the second solder is at least thermally conductively connected with the flexible electric conductor and with the fixed electric conductor, and the first solder and the second solder feature the same or approximately same temperature of melting.

The preferred embodiments of the invention are the subject of dependent patent claims.

Description of the drawing

The invention is schematically represented in the drawing where the Fig. 1 shows a cross-section of exemplary embodiment of the device according to the invention in functioning status, the Fig. 2 a cross-section of exemplary embodiment of the device according to the invention in disconnected status, the Fig. 3 the detail "P" from the Fig. 2.

Examples of embodiment

The invention will be described on particular examples of embodiment of the device for the overvoltage protection on basis of varistor. The device comprises the frame **0** in the form of lockable box, in which the current path of the device is arranged. The current path of the device for overvoltage protection is finished with not represented terminals for electric connection of the device for overvoltage protection to protected circuit. Individual parts of the device are dimensioned towards expected great energy, to meet those by the norms specified requirements, in compliance with declared parameters of the device.

In the current path of the device for overvoltage protection there is connected at least one not represented varistor or a group of parallel connected varistors, possibly the varistor or a group of varistors is besides connected in series with a discharge arrester (discharger).

In the current path of the device for overvoltage protection there is situated the point X of intentional cutting off the current path, to which the thermal initiated cut-out mechanism is assigned. The point X of intentional cutting off the current path is performed in the point of contact of lower surface of one end of flexible, e.g. copper, electric conductor 1 and of upper surface of fixed electric conductor 2, while end of the flexible electric conductor 1 and end of the fixed electric conductor 2 are connected by means of the first solder with required temperature of melting. End of the flexible electric conductor 1 connected with end of the fixed electric conductor 2 is strengthened through stiffening.

Second end of the flexible electric conductor 1 is electrically conductively by means of auxiliary conductor 01 connected with one terminal for electric connection of the device for overvoltage protection to protected circuit. The fixed electric conductor 2 in the represented example of embodiment is directly created by electrode of varistor, which is in a not movable manner mounted in the frame 0 of the device and whose second, not represented electrode is directly or via other conductive elements in electric conductive manner connected with the second terminal for electric connection of the device for overvoltage protection to protected circuit.

The flexible electric conductor 1 on its upper surface is provided with the plate 3, e.g. by means of welding, etc., through which is passing the first end 40 of spatially shaped cut-out lever 4, which with its bending 41 is resting on the supporting surface 00, which in the represented example of embodiment is formed of surface of the flexible electric conductor 1 in area of connection of the flexible electric conductor 1 and the auxiliary conductor 01. In the not represented example of embodiment the supporting surface 00 is performed on the wall of the frame 0. The second end 42 of the cut-out lever 4 is situated before the protrusion 50 on the face side of spring-loaded shifting part 5, which is slideably mounted in the frame 0. The spring-loaded shifting part 5 in the represented example of embodiment is spring loaded with the pressure spring 51 slipped on the stud 52 mounted on the frame 00 of the device. In the not represented example of embodiment the spring-loaded shifting part 5 is spring loaded in another suitable manner, i.e. by means of another suitable structural solution. The spring-loaded shifting part **5** is provided with profiled groove for one end **9** of the lever of optical signalling of device status, i.e. overvoltage protection, possibly it is further provided with mating surface for functional element of the device for remote signalling of device status, i.e. overvoltage protection.

To the fixed electric conductor **2** there is assigned the auxiliary plate **6** bent in direction to the first end **40** of the cut-out lever **4** and provided with a groove in area of the first end **40** of the cut-out lever **4**, the first end **40** of the cut-out lever **4** is passing through this groove as it is represented in the Fig. 1. This section of auxiliary plate **6** with groove is situated in distance from the face side of end of the flexible electric conductor **1** and of the plate **3**. The first end **40** of the cut-out lever **4** by means of the second solder is attached to the auxiliary plate **6**. The second solder features the same or approximately the same melting temperature as the first solder, and simultaneously the second solder features the same or lower value of thermal conductivity when compared with value of thermal conductivity of the first solder, preferably at least by one order. Moreover, thickness of layer of the first solder is in tens of millimeter, while dimension of the second solder, which must be totally heated and molten, is significantly greater.

In represented examples of embodiment between the auxiliary plate **6** and the fixed electric conductor **2** there is positioned the second cutting off means **82** and between a portion of the auxiliary plate **6** with groove and the opposite walls of the flexible electric conductor **1** and the plate **3** the first cutting off means **81** is positioned. The function of the cutting off means **81** and **82** first of all is to reduce passage of heat and passage of electric current between the neighbouring elements of the device, this specially for the reason of better setting of parameters of total melting of the second solder. In the not represented example of embodiment the device is performed without cutting off means **81**, **82**.

During common operation due to ageing of varistor its voltage decreases and varistor begins to let through the current, as a result of which the varistor slowly becomes warm, from varistor also the fixed electric conductor **2** becomes warm and once this gets warm sufficiently, the first as well as the second solder get molten, the spring-loaded shifting part **5** moves in direction to the left, with its protrusion **50** presses to the second end **42** of the cut-out lever **4**, which turns on the supporting surface **00**, by which the first end **40** of the cut-out lever **4** rises and by means of the plate **3** it pushes off the end of flexible electric conductor **1** from the fixed electric conductor **2**, through which in the point **X** the current path is cut off and varistor is disconnected from the protected circuit. By shifting the spring-loaded shifting part **5** there is also signalled a change in status of overvoltage protection from the status „functioning protection " to the status „non-functioning protection".

Upon short circuit, at which smaller current is passing through the current path than in case of occurrence of maximum overvoltages declared for the given instrument, but this lower current is passing through the current path for a longer period, and the accompanying effect is a quick warming of current path, there happens that due to a quick warming of current path and owing to a small thickness of the first solder the first solder gets quickly molten and loses its strength, at the same time the first solder still leads electric current between the flexible electric conductor **1** and the fixed electric conductor **2**. Owing to a considerably greater dimension of the second solder, which must be completely warmed and molten, and due to slower warming of the second solder, the time of melting of the second solder in its entire volume is considerably longer than the period of melting of the first solder, because the second solder gets warmer slower than the first solder by gradual leading of warm through the auxiliary plate **6**, through the plate **3** , the first end **40** of cut-out lever **4**, which is possibly also modified, e.g. slowed down upon usage of the cutting off means **81**, **82**. Through a suitable selection of material difference of the first solder and the second solder, e.g. with respect to their value of electric and heat conductivity, in combination with selection of a warmed and molten dimension of each from solders, through selection of positioning the second solder, selection of dimension and shape of contact surfaces of individual elements, through selection of material, size and shape in cross-section of elements of the current path etc., it is then possible to influence and in its principle directly in advance to set parameters of melting, especially time of melting, of the second solder in its entire cross-section, or dimension, thus to influence or directly in advance to set the period between generating the short circuit in the protected circuit and the moment of intentional cutting off the current path in the point **X**. Hence, it is possible to achieve relatively easily, that the period between initiating the short circuit in protected circuit and the moment of intentional cutting off the current path in the **X** point is longer than the period defined and necessary for cutting off the protected circuit in overcurrent protection, which is positioned before the device for overvoltage protection. By this it is also secured that there occurs the defined cutting off the whole protected circuit in the specified point, i.e. in the front-end overcurrent protection, outside the device itself for overvoltage protection, which enables to involve device for overvoltage protection on basis of varistors also for high energies, and it also enables to increase dimensioning of the front-end overcurrent securing of the device for overvoltage protection in compliance with requirements specified by the norm cited in the background art.

By means of this invention it is also possible to create even without increased costs for special solders such a device for overvoltage protection which completely meets the ROHS regulation, i.e. entirely without usage of lead solders, as the structure according to this invention enables to suitably combine the present leadless solders with appropriate electric and thermal conductivity. It is also apparent that the invention may without exerting any creative effort, i.e. in the scope of abilities of a common skilled person, be used also in other particular embodiments, e.g. in embodiment with replaceable slide-in protective elements or as so called monoblock or as a body of totally different shape and dimension, or at totally new embodiments of device for overvoltage protection.

Applicability

The invention is applicable in protection of electric circuits against overvoltage.

List of referential markings

0	frame of device
00	supporting surface
01	auxiliary conductor
1	flexible electric conductor
2	fixed electric conductor
3	plate
4	cut-out lever
40	first end of cut-out lever
41	bending of cut-out lever
42	second end of cut-out lever
5	spring-loaded shifting part
50	protrusion
51	pressure spring
52	stud
6	auxiliary plate
81	first cutting off means
82	second cutting off means
9	end of lever of optical signalling of overvoltage protection status
X	point of intentional cutting off the current path

CLAIMS

1. The device for overvoltage protection comprising terminals for connection to protected circuit, between which there is arranged the current path, in which the protective element is connected, and in the current path there is created (X) point of intentional cutting off the current path performed through connection of one end of a flexible electric conductor with one end of fixed electric conductor by means of first solder, and with flexible electric conductor the cut-out device is coupled, while the device further comprises the device for signalling the status of overvoltage protection and an additional thermal cut-out with adjustable parameters of melting, **characteristic in that, the** additional thermal cut-out is performed by a second solder arranged between the flexible electric conductor (1) and the fixed electric conductor (2) parallel to the (X) point of intentional cutting off the current path and outside the joint of flexible electric conductor (1) and fixed electric conductor (2) by means of the first solder, while the second solder is at least thermally conductively connected with the flexible electric conductor (1) and with the fixed electric conductor (2), and the first solder and the second solder feature the same or approximately the same temperature of melting.

2. The device according to the claim 1, **characterised in that,** in the second solder the first end (40) of cut-out lever (4) and one end of auxiliary plate (6) is mounted, while the cut-out lever (4) is coupled with flexible electric conductor (1) and its second end (42) is coupled with the spring-loaded shifting part (5) of the cut-out device slideably mounted in the frame (0) of the device, and the second end of the auxiliary plate (6) is assigned to the fixed electric conductor (2).

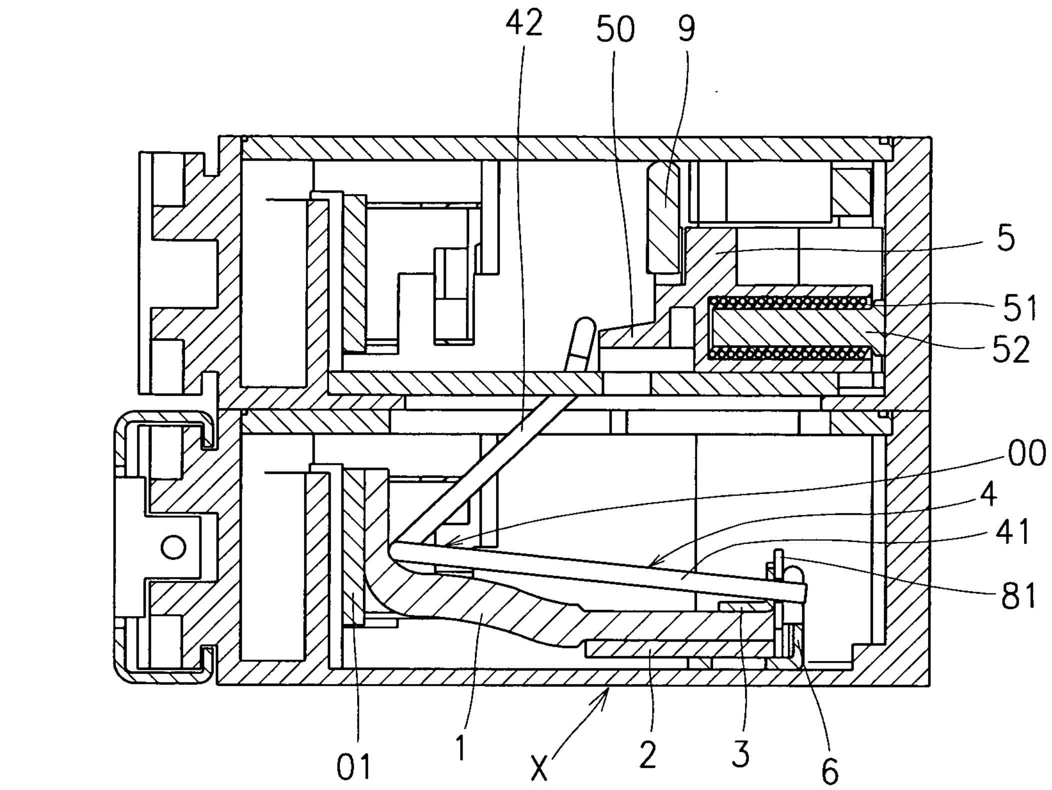
3. The device according to the claim 2, **characterised in that,** on the flexible electric conductor (1) there is mounted the plate (3) with a through opening, through which the first end (40) of the cut-out lever (4) is passing.

4. The device according to the claim 2, **characterised in that, the** auxiliary plate (6) is connected with the lower surface of the fixed electric conductor (2) and it is bent in direction to the first end (40) of the cut-out lever (4), where it is provided with a groove, through which the first end (40) of the cut-out lever (4) is passing, which is here by means of the second solder connected with the auxiliary plate (6).

5. The device according to the claim 4, **characterised in that,** between the auxiliary plate (6) and the adjacent section of the flexible electric conductor (1) and the plate (3) the first cutting off means (81) is situated.

6. The device according to the claim 4, **characterised in that,** between the auxiliary plate (6) and the fixed electric conductor (2) the second cutting off means (82) is situated.

7. The device according to any of the claims 1 to 6, **characterised in that, the** fixed electric conductor (2) is formed of electrode of varistor.


42
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X
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6

Fig. 1

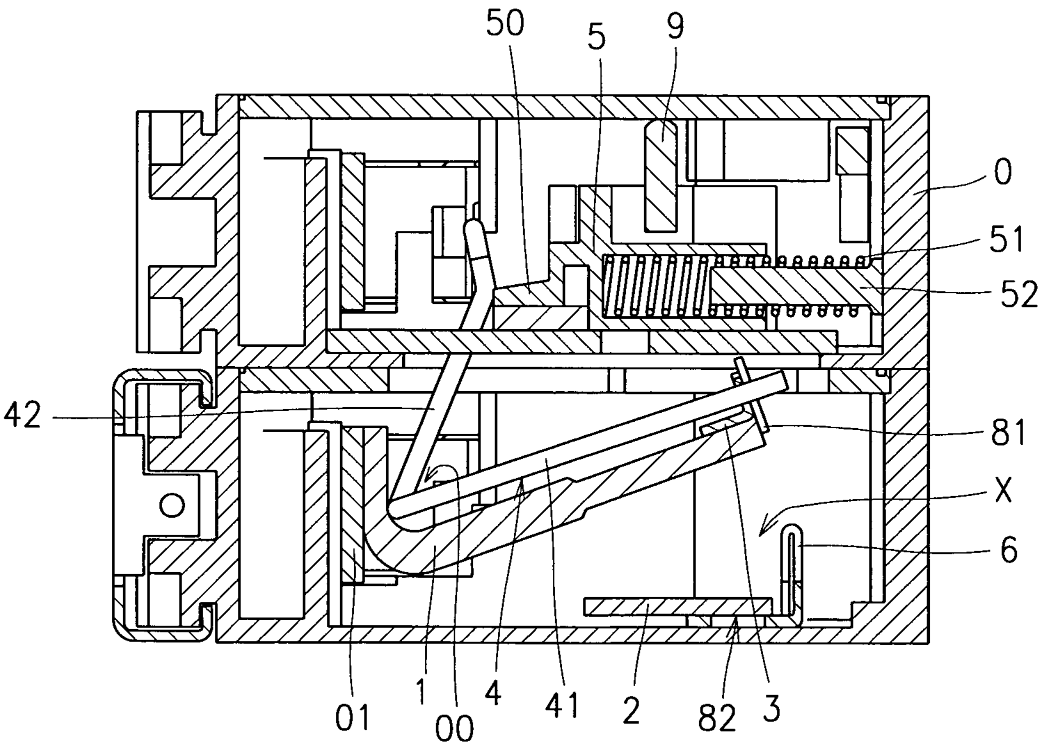
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Fig. 2

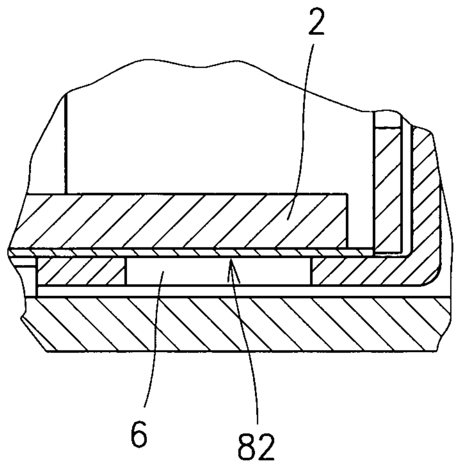

Fig. 3