EUROPEAN PATENT SPECIFICATION

RESETTABLE AUTOMOTIVE CIRCUIT PROTECTION DEVICE
RÜCKSTELLBARE SCHUTZVORRICHTUNG FÜR EINE FAHRZEUGSCHALTUNG
DISPOSITIF DE PROTECTION DE CIRCUIT AUTOMOBILE REARMABLE

Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

Date of publication and mention
of the grant of the patent:

Application number:
97920011.0

Date of filing:
27.03.1997

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Description

Technical Field of the Invention

[0001] The present invention is a unique application of variable resistance materials, like positive temperature coefficient (PTC) materials, preferably to automotive circuit protection devices. However, some aspects of the invention have a broader application.

[0002] Unlike present automotive fuses which generally have meltable fuse links which require replacement when they are blown, the devices of the present invention have elements, which will occasionally be referred to as fuse links, which have a variable resistance. The resistance changes from a low resistance to a resettable high resistance state when hazardous prolonged overload or short circuit current flows through the fuse link. These devices preferably, but not necessarily, return to their normal low resistance state automatically when the prolonged overload or short circuit condition is abated. In any event, they can be reset so that they are reusable in the circuits which they are intended to protect.

[0003] The expression "fuse link", unless more narrowly defined herein, will mean that portion of a circuit protection device located between the main terminals or conductive extensions of the terminals of the device. That portion includes a body or layer of material which, upon the flow of a potentially hazardous prolonged overload or short circuit current, will present a high resistance to the circuit involved and to the conductive elements which immediately feed current to and from the body or layer.

Background of the Invention

[0004] Automotive fuses commonly comprise a synthetic plastic housing containing an all metal piece stamped from a strip of meltable fuse metal to form relatively rigid terminal blades. When the fuse is assembled in an insulating housing, these terminals project in the same plane from the bottom of the housing. Current-carrying extensions of the terminal blades located in the housing are interconnected within the housing by a relatively fragile fuse link which melts and opens the circuit upon hazardous prolonged overload or short circuit conditions. Such a fuse is disclosed in U.S. Patent No. 4,635,023, granted on January 6, 1987. The preferred form of the present invention utilizes a housing and terminal blade extensions similar to those disclosed in this patent. In such cases, the present fuse has a resettable, rather than a meltable, fuse link extending between the current-carrying extensions of the terminals. In the preferred form of the invention, the resettable fuse link is a positive temperature coefficient (PTC) material.

[0005] Resettable circuit protection devices having a PTC fuse link are now available on the market. They are sold in various different configurations, none of which is like those of the present invention. Some of these prior art resettable circuit protection devices include a PTC element having a plate-like appearance and comprising a thin layer of a PTC material having a pair of thin coatings of metal forming terminals or electrodes on the opposite faces of the PTC layer. A pair of thin wire leads are electrically secured by solder to the opposite conductive faces of the PTC layer.

[0006] A variety of PTC elements like that just described are referred to as resettable fuses and are sold under the registered trademark Polyswitch® by the Raychem Corporation of Menlo Park, California. The maximum continuous, non-hazardous current of these Polyswitch® fuses that will not cause the PTC element at 20°C to switch from its low to its high resistance state, referred to as the "holding current," presently spans the current range of about 0.9-9.0 amps. The range of trip currents, which is the minimum continuous current that will cause the Polyswitch® fuses to be switched or tripped to a high resistance circuit-protecting state at 20°C, varies from about 1.8 to 18 amps. This high resistance circuit-protecting state is maintained by a small self-heating current. The largest fault current which such devices can interrupt without being damaged varies from about 50 - 100 amps. The initial minimum resistance of these circuit protection devices varies from about .02 to .20 ohms.

[0007] The PTC materials believed to be used in these Polyswitch® fuses are disclosed in US Patent Nos. 4,237,441 and 4,545,926. These types of PTC materials include a mixture of organic crystalline polymers in which are distributed conductive particles which may include carbon black. With such materials, as current flow therethrough progressively increases they are progressively heated until the current reaches the trip current level. At this level, the resistance suddenly increases to a substantially higher level due to the fact that the material suddenly expands. This expansion separates the conductive particles by larger distances, providing a greatly increased resistance through the particles.

[0008] The configurations in which these PTC resettable fuse devices have been commercially available are not suitable for automotive fuse applications.

[0009] DE 38 39 868A discloses a thermistor device comprising an organic PTC thermistor element and electrode layers deposited on opposite faces of the thermistor element, in which non-electrode regions of these faces are displaced in position with respect to each other. The electrode layers are elastically engaged by elastic terminal members.

Summary of the Invention

[0010] The preferred forms of the present invention utilize plate-like PTC elements, such as those disclosed in pending Application Serial No. 08/437966, filed on May 10, 1995, and also in U.S. Patent Nos. 4,237,441, 4,545,926, 4,689,475 and 4,800,253. These elements may be used singly, or for the highest current ratings, in
a uniquely arranged sandwich of such elements, mounted between flexible current-feeding arms. These arms are conductively connected to the extensions of coplanar plug-in terminal blades like that shown in U.S. Patent No. 4,635,023. The flexible arms and the one or more PTC elements mounted between the flexible arms are sometimes referred to as the fuse link of the claimed circuit protection device.

[0011] In the preferred single PTC element embodiment of the invention, the flexible current-feeding arms are cantilevered and project in opposite directions from the spaced confronting margins of the current-carrying extensions of the terminal blades. To aid in the low cost, mass production of the circuit protection devices of the invention, both the terminal blades and their current-carrying extensions thereof, and the cantilevered, flexible, current-feeding arms, are preferably initially stamped from the same sheet of metal. In such case, the ends of the stamped current-feeding arms are initially coplanar, but spaced apart. The arms are then flexed to permit the insertion therebetween of the plate-like PTC element, with the opposite conductive faces of the PTC element resiliently sandwiched between the flexed, current-feeding arms. To assure a desired flexibility of the current-feeding arms, the arms can be stamped from a skived or thinned portion of sheet metal. The plug-in terminal blades and their current-carrying extensions are stamped from the thicker portions of the sheet metal, so that they form rigid plug-in portions of the device.

[0012] In a less preferred form of the invention, the current-feeding arms can be separate flexible wires or the like, which are soldered or welded to the current-carrying extensions of the terminal blades. In this form of the invention, the ends of these current-carrying wires may be in different planes but confront in overlapped relation.

[0013] In both forms of the devices just described, if the layer of PTC material of the PTC element is of the type which must expand when it is heated by the trip current, the flexibility of the current-feeding arms is necessary to permit that expansion so that the conductive particles dispersed thereon can be further separated to provide the desired high resistance condition of the element in its tripped condition.

[0014] As previously indicated, another unique feature of the invention utilizes a sandwich or stack of a number of plate-like PTC elements, like those disclosed in pending Application Serial No. 08/437966, filed on May 10, 1995, and also in U.S. Patent Nos. 4,237,441, 4,545,926, 4,689,475 and 4,800,253. These PTC elements are electrically connected in parallel. This multiplies the current rating of the device by the number of elements so connected. Where there is a stack of three such PTC elements, one of the conductive faces of the central element and the inner conductive face of one of the outer elements are connected together and to the outer conductive face of the other outer element. The other conductive face of the central element and the inner conductive face of the latter element are connected together and to the outer conductive face of the first mentioned outer element. All these elements are identically oriented so that the conductive faces of the plate-like PTC elements are in parallel planes, thus, expansion of the elements under increased current flow is in the same direction. The outer conductive faces of the outermost elements are then sandwiched between flexible current-carrying arms. This forms a package of three PTC elements connected in parallel.

[0015] In accordance with another feature of this parallel embodiment of the invention, heat sinks, which may be copper plates, are respectively located between each of the inner conductive faces of the outer PTC elements and the adjacent conductive faces of the central element. They also form conductive paths which connect the PTC elements in parallel.

[0016] An essential discovery of the inventors is that the PTC elements must be allowed to expand for this invention to be effective. Such expansion is permitted.

[0017] The above and other features of the invention will become apparent by reference to the specification, claims, and drawings.

Description of the Drawings

[0018] Figure 1 is a perspective view of a preferred resettable automotive circuit protection device of the invention with confronting plug-in terminals, and using one PTC element;

Figure 2 is a vertical sectional view through the device of Figure 3;

Figure 3 is a horizontal sectional view through Figure 2, taken along section line 3-3;

Figure 4 is a fragmentary and greatly magnified sectional view through the plate-like PTC element of Figure 3;

Figure 5 illustrates the different steps in the manufacture of the fuse shown in Figure 2;

Figure 6 is a vertical sectional view through a less preferred, single PTC-element automotive circuit protection device of the invention, with confronting plug-in terminals;

Figure 7 is a vertical sectional view through a modified single PTC element automotive circuit protection device of the invention with confronting plug-in terminals;

Figure 8 is a vertical sectional view through a still further modified single PTC element automotive circuit protection device of the invention with confronting plug-in terminals;

Figure 9 is a vertical sectional view through another modified, single PTC element automotive circuit protection device of the invention, but where the plug-in terminals extend longitudinally from opposite sides of the housing;
Figure 10 is a vertical transverse sectional view through Figure 9, taken along section line 10-10 of Figure 9;
Figure 11 is a horizontal sectional view through Figure 9 taken along section line 11-11 of Figure 9;
Figure 12 is a vertical sectional view of a three PTC-element automotive circuit protection device of the invention, taken along section line 12-12 in Figure 13;
Figure 13 is a horizontal sectional view through Figure 12, taken along section line 13-13;
Figure 14 is a vertical sectional view through Figure 12, taken along section line 14-14 of Figure 12;
Figure 15 is an enlarged horizontal sectional view through the metal portions of the circuit protection device shown in Figure 12, taken along section line 15-15 of Figure 12 and before the metal portions have been encapsulated in an insulating base;
Figure 16 is an automotive circuit in which the device of Figures 12-15 is inserted.
Figure 17 is an exploded perspective fragmentary view of another embodiment of the automotive circuit protection devices of the present invention prior to their final assembly;
Figure 18 is a horizontal sectional view of a single automotive circuit protection device illustrated in Figure 17, taken along section line 18-18;
Figure 19 is a vertical sectional view of a single automotive protection device illustrated in Figure 18;
and,
Figure 20 is an exploded fragmentary view of the interface between the plate-like PTC element and the electrode of the single automotive circuit protection device illustrated in Figure 18.

Detailed Description of the Invention

Exemplary Form of the Invention Shown in Figures 1-5

[0019] Figures 1-5 show the most preferred form of the circuit protection device 2 of the present invention, using a single PTC element 10. The device 2 is made initially of only three separate parts. These are an open bottom insulating housing 4, the PTC element 10 and a pair of sheet metal pieces 6-6' respectively forming a pair of spaced, parallel, rigid, confronting, coplanar terminal blades 6a-6a' and current-carrying extensions 6b-6b'. Projecting from the confronting margins of the current-carrying extensions are thinner, flexible cantilever current-feeding arms 6c-6c'. The terminal blades 6a-6a', current-carrying extensions 6b-6b' thereof, and the cantilevered arms 6c-6c' were originally portions of a single strip 12 of sheet metal shown in Figure 5. The strip unwinding from a roll (not shown) is moved to a series of processing stations. This includes metal stamping stations S1-S2, a station S3 at which the PTC element 10 is inserted between the confronting faces of the cantilevered arms 6c-6c' and is soldered thereto, and a station S4 which inserts the open-bottom housing 4 over the end of the strip before the end portion of the strip is severed to form an almost completely finished device 2.

To increase the flexibility of the arms 6c-6c', the strip 12 is skived in the center thereof, to provide a thin region 12" between shoulders 12'-12' from which region the arms 6c-6c' are stamped. Since the arms 6c-6c' are fragile and spaced apart, the integrity of the strip is maintained by webs 11 of material extending between the terminal blades 6a-6a' of the various segments of the strip. Each web 11 is subsequently severed from the terminal blades 6a-6a'.

[0020] The PTC element 10 may be a thin plate-like element which comprises a central layer 10b (Figure 4) on the opposite flat faces of which are applied thin layers or coatings of metal 10a-10a', forming electrodes for the PTC element 10. Preferably, the PTC elements and methods for manufacturing them disclosed in pending Application, Serial No. 08/437966, filed on May 10, 1995, are to be used in the present invention. Specifically, central layer 10b may comprise 65% by volume high density polyethylene (manufactured by Quantum under the trade name Petrothene) and 35% by volume carbon black (manufactured by Cabot under the trade name BP 160-Beads). The composition which comprises central layer 10b may be produced by placing the high density polyethylene in a C.W. Brabender Plasti-Corder PL 2000 equipped with a Mixer-Measuring Head and fluxing it at 200°C for approximately 5 minutes at 5 rpm. At this point the polyethylene is in a molten form. The carbon black is then slowly dispersed into the molten polyethylene over a 5 minute period at 200°C at 5 rpm. The speed of the Brabender mixer is then increased to 80 rpm, and the polyethylene and carbon black are thoroughly mixed at 200°C for 5 minutes. The energy input, due to the mixing, will cause the temperature of the composition to increase to 240°C.

[0021] After allowing the composition to cool, the composition is then placed into a C.W Brabender Granu-Grinder where it is ground into small chips. The chips are then fed into the C.W Brabender Plasti-Corder PL 2000 equipped with the Extruder Measuring Head. The extruder is fitted with a die having an opening of 0.0051 cm (0.002 inch), and the belt speed of the extruder is set at 2. The temperature of the extruder is set at 200°C, while the screw speed of the extruder is set for 50 rpm. The chips are extruded into a sheet approximately 5.1 cm (2.0 inches) wide by 2.44 m (8.0 feet) long. This sheet is then cut into a number of smaller sample PTC sheets (preferably 5.1 cm (2.0 inches) x 5.1 cm (2.0 inches), and pre-pressed at 200°C to a thickness of approximately 0.025 cm (0.01 inch).

[0022] A polymer based thick film ink (CB 115, manufactured by DuPont Electronic Materials) can then be applied to the top and bottom surfaces of the sample PTC sheets. The thin layers or coatings of metal which form electrodes 10a - 10a' can include the silver-plated copper wire cloth (No 9224T39, distributed by McMas-
metal electrode 10a') is placed in a hot press for approxi-

mately four minutes at 27.58.10² kPa (400 p.s.i.) and

230°C.

If the metal electrodes 10a-10a' comprise the

silver-plated copper wire cloth material, the sandwich

structure (i.e., metal electrode 10a, central layer 10b,

metal electrode 10a') is placed in a hot press at a tempera-
ture of 235°C. The temperature of the laminate is mon-
tored until it reaches 220°C, at which point a pressure

of 20.68.10² kPa (300 p.s.i.) is applied to the laminate for

1 minute. The pressure in the press is then relieved.

The laminate is then exposed to 43.09.10² kPa (625 p.
s.i.) for 5 minutes, while maintaining the plates of the press at 235°C.

In either embodiment, the laminated sheet is removed from the press and allowed to cool without fur-
ther pressure. The laminated sheet is then sheared or

punched into a plurality of PTC elements 10. The size

of PTC element 10 will vary with the desired rating of
the element. U.S. Patent Nos. 4,545,926, 4,689,475,
4,237,441, and 4,800,253 also disclose PTC elements and
methods for manufacturing PTC elements which may
be used in the present invention.

When the PTC element 10 comprises a PTC

layer 10b where the material includes a crystalline pol-

ymer in which is dispersed conductive particles, it is es-

specially important that the cantilevered arms 6c-6c' be

flexible relative to the relatively rigid, thicker portions of

the terminal blades 6a-6a' and current-carrying exten-
sions 6b-6b' thereof with which the arms are associated.
When the temperature of the PTC layer 10b is raised to

the trip point where the polymer material suddenly ex-

pands, the flexibility of the cantilevered arms 6c-6c' per-

mits this expansion.

The housing 4 is preferably constructed as il-

lustrated, where it has a pair of spaced confronting ver-
sical side walls 4b-4b', a pair of vertical end walls 4a-4a'
extending between the outer vertical margins of the side
walls 4b-4b', and a top wall 4c having a pair of test

probe-receiving holes 4c-4c' (Figure 1). The housing
side walls 4b-4b' have relatively widely spaced central

portions 4b-1 and 4b-1' (Figure 3) which form a fairly

substantial clearance space 19 within which the cantil-

evered arms 6c-6c' and the PTC element 10 are lo-

cated. The size of the space 19 is such that the current-
carrying arms 6c-6c' will be substantially spaced from
these walls over the temperature range to which the

PTC layer 10b of the PTC element is exposed. The outer

margins of the side wall portions 4b-1 and 4b-1' merge

with recessed wall portions 4b-2 and 4b-2' (Figure 3)
which are closely spaced to form interior narrow mount-
ging slots or grooves 21-21' within which the current-car-
yring extensions 6b-6b' are closely confined. The upper
ends of the current-carrying extensions 6b-6b' terminate
in mounting tabs 7-7' which initially pass through narrow
slots 9-9' formed in the top wall 4c of the housing at
the bottom of the top wall test probes receiving holes 4c'-
4c'. The tabs 7-7' are then twisted to anchor the terminal
blade extensions 6b-6b' in place in the housing 4.

The end walls 4a-4a' of the housing 4 extend
into inwardly offset grooves 13-13' so that the outer mar-
gins of the housing end walls 4a-4a' are aligned with the

outer margins of the terminal blades 6a-6a'. Also, the

side and upper margins of each housing side wall 4b

and 4b' at 15 and 17-17 are in a common vertical plane
so that the devices 2 can be stably stacked side-by-side
when fed from magazines into sockets in fuse blocks by
automatic fuse mounting devices. The housing end

walls 4a-4a' are in vertical planes for the same reason,

namely, so that they can be stacked stably in end-to-end
relation in magazines for automatic feeding into fuse

block sockets.

The terminal blades 6a-6a' are plugged into

sockets (not shown) to connect the PTC element 10 in
series with a load resistance. This load resistance is 10
or more times greater than the resistance of the circuit

protector device. When a normal current flows through

that device, a modest amount of heat is generated in the

PTC element layer 10b as a result of this low resistance.
However, if the load resistance should be short circuited
or become substantially reduced so that an undesired
prolonged overload current flows through the PTC ele-

ment 10, the current will reach a level known as the trip
current of the PTC element 10. At this trip current level,
the resistance of the PTC element 10 will suddenly in-
crease by a large factor. The resulting higher resistance
of the PTC element 10 now limits flow of current to a
safe value. This limited current generated is nevertheless
sufficient to keep the PTC layer 10b in a high re-

sistance condition. If the load resistance should return
a normal low value, either by replacement of the load it-
self or by removal of the condition which caused the
high load, the current then flowing in the device 2 will be
reduced below the trip level and the fuse is automatically
reset to its original low resistance condition.

Embodiments of Figures 6 and 7

Figures 6 and 7 show less preferred forms of
the invention, which require an additional two separate
pieces to form the assembled circuit protection device.
The embodiment of Figure 2 included cantilevered
arms 6c-6c' which were formed as an integral part of the
terminal blades 6a-6a' and terminal blade extensions
6b-6b'. In contrast, in the embodiments illustrated in Fig-

ures 6 and 7, cantilevered current-feeding arms are
formed by separate conductive wire-like elements (a) 16-16' in the circuit protection device 2A of Figure 6; and (b) 18-18' in the circuit protection device 2B of Figure 7. The inner ends of these wire-like elements are soldered or otherwise connected to terminal blade extensions 6g-6g' of device 2B in Figure 6 and are soldered or otherwise connected to terminal blade extensions 6g-6g' of device 2B in Figure 7. The other ends of these wire-like elements 16-16' and 18-18' are respectively soldered to the opposite conductive faces of the PTC element 10A of the device 2A in Figure 6 and the PTC element 10B of the device 2B in Figure 7.

[0033] The devices 2A and 2B also differ in that the device 2A has the identical housing 4 used by the device 2 shown in Figures 1-4. Such a housing 4 of device 2A includes test probe-receiving openings 4c-4c' in which are exposed the twisted upper ends of the terminal blade extensions 6b-6b' of the terminal blades 6a-6a'.

[0032] The housing 4B of device 2B of Figure 7, however, does not have any test probe-receiving openings. Accordingly, its terminal blades 6f-6f' terminate in very short current-carrying extensions 6g-6g' leaving a much wider space above the terminal blade extensions for a horizontally elongated PTC element 10B, which extends almost the full width of the interior of the housing 4B.

[0033] In contrast, the PTC element 10A in the circuit protection device 2A shown in Figure 6 is a vertically elongated element which fits within the space between the confronting margins of the terminal blade extensions 6b-6b'.
The PTC elements are thus effectively connected in parallel with each other.

[0038] The sandwich 25 of PTC elements 35a-35c and the Z-shaped brackets 36-36’ are located in spaced relationship to a pair of main vertical spaced side walls 31a-31a’ of an insulating housing 31 open at the bottom thereof. The top of the vertical side walls 31a-31a’ join a horizontal top wall 31b and the side margins thereof join a pair of end walls 31c-31c’. The bottom of the housing end and side walls rest on and are secured to a ledge extending over the margins of a rectangular insulating base 41 made of a material molded around the tapered bottom portions of the extensions 34b-34b’ of the terminal blades 34a-34a’.

[0039] Assuming that the PTC elements 35a, 35b or 35c are each identical to the PTC element 10 shown in Figure 2, the current rating of the circuit protection device 30 shown in Figures 12-15 is three times that of the circuit protection device shown in Figure 2. This is because the load current will split evenly between the three PTC elements, 35a, 35b and 35c.

[0040] One exemplary specification for the PTC element sandwich is as follows:

- **PTC Elements 35a, 35b and 35c** - disclosed in US Patent No 4,800,253
  - Dimensions of each PTC Element:
    - Thickness = 0.0292 cm (.0115”)
    - Length x Height = 1.42 cm (0.560”) x 1.27 cm (.500”)
  - Copper Heat Sink Dimensions:
    - Thickness = 0.056 cm (0.22”)
    - Length x Height = 1.60 cm (0.630”) x 1.27cm (.500”)

[0041] Figure 16 shows the PTC elements 35a, 35b and 35c connected in parallel with each other and in series with a car battery 40 and an electrical device or devices 42, illustrated diagrammatically as a load resistance. This device which operates in the same manner as that of Figure 1-5, except that the load current will split evenly between the three PTC elements, 35a, 35b and 35c.

**Claims**

1. A circuit protection device (2) to be connected into a circuit presenting a given load resistance, said circuit protection device including a pair of terminal blades (6a - 6a’) to be electrically connected into said circuit, a pair of current-carrying extensions (6b - 6b’) of said terminal blades, and an initially low resistance current-limiting means extending between said current-carrying extensions, wherein said current-limiting means comprises:

   - a pair of current-feeding arms (6c - 6c’) having inner and outer end portions, said inner end portions thereof being electrically connected respectively to said current-carrying extensions of said terminal blades, and outer end portions thereof being connected with respect to said inner end portions thereof; and
   - a current-limiting PTC element (10) comprised
of a PTC material (10b) having conductive opposite faces (10a - 10a') between and soldered or ultrasonically bonded to said outer end portions of said current-feeding arms so that said PTC material carries current between said outer end portions of said current-feeding arms, said PTC material conducting a given range of currents at a given relatively low resistance value, and when current flow there through reaches a given trip level, said PTC material will expand to flex said current-feeding arms, permitting said PTC material to have a relatively high resistance value to limit current in said circuit.

2. The circuit protection device of Claim 1 wherein said current-feeding arms are integral with said current-carrying extensions of said terminal blends.

3. The circuit protection device of claim I wherein each of said current-feeding arms and the associated terminal blade and current-carrying extension thereof are cut from a single piece of metal.

4. The circuit protection device of claim 1 wherein said pair of current-feeding arms and the associated terminals and current-carrying extensions thereof are cut from a single piece of metal.

5. The circuit protection device of claim 1 wherein said current-feeding arms extend substantially perpendicularly to said current-carrying extensions.

6. The circuit protection device of claim 1 wherein there is provided at least two of said current-limiting PTC elements connected in parallel between said current-carrying extensions, forming an overall assembly with a normal current rating greater than one of said current-limiting PTC elements.

7. The circuit protection device of claim 1 combined with an insulating housing (4) from which said terminal blades extend and which encloses said current-carrying extensions and current-limiting means.

8. A circuit protection device to be connected into a circuit presenting a given load resistance, said device including a pair of terminal blades (34a - 34a') to be electrically connected into said circuit, a pair of current-carrying extensions (34b - 34b') of said terminal blades, and an initially low resistance current-limiting means extending between said current-carrying extensions, wherein said current-limiting means comprises:

   a plurality of PTC elements (35a, 35b, 35c) having two outermost PTC elements configured between a pair of flexible and cantilevered current-feeding arms (36a - 36'a) having inner and outer end portions, the inner end portion of said current-feeding arms respectively being electrically connected to said pair of current-carrying extensions, and the outer end portion of said current-feeding arms respectively being soldered or ultrason to said outermost PTC elements; and

wherein at least two of said PTC elements electrically connected in parallel to one another, each of said PTC elements being comprised of a crystalline polymer having conductive particles dispersed therein so that when current flow through said PTC elements reaches a given trip level, said PTC elements expand and flex said current-feeding arms.

9. The circuit protection device of claim 8 wherein between said plurality of PTC elements, a heat sink-forming body (38, 38') is located in both electrical and heat conducting relationship with one of said current-feeding arms.

10. The circuit protection device of claim 8 or claim 9 wherein each said current-feeding arm forms a substantially Z-shaped member in a single plane, each said member including an intermediate section and outer sections extending in opposite directions at opposite ends of said intermediate section, one of said outer sections of each of said Z-shaped member extending along and soldered or ultrasonically bonded to one of said outermost PTC elements and one of said outer sections of said other Z-shaped member extending along and soldered or ultrasonically bonded to the said other outermost PTC element.

**Patentansprüche**

1. Schaltungsschutzvorrichtung (2), die mit einer Schaltung verbindbar ist, die einen gegebenen Lastwiderstand darstellt, welche Schaltungs...
me eingespannt und flexibel mit Bezug auf die inneren Endbereiche hiervon; und ein Strom begrenzendes PTC-Element (10), das aus einem PTC-Material (10b) besteht, mit leitenden gegenüberliegenden Flächen (10a - 10a') zwischen den und gelötet an die oder durch Ultraschall verbunden mit den äußeren Endbereichen der Strom zuführenden Arme, so dass das PTC-Material einen Strom zwischen den äußeren Endbereichen der Strom zuführenden Arme führt, das PTC-Material einen gegebenen Strombereich bei einem gegebenen, relativ niedrigen Widerstandswert leitet, und wenn der Stromfluss hierdurch einen gegebenen Auslösepegel erreicht, dehnt sich das PTC-Material aus, um die Strom zuführenden Arme zu biegen, wodurch dem PTC-Material ermöglicht wird, einen relativ hohen Widerstandswert zu haben, um den Strom in der Schaltung zu begrenzen.

2. Schaltungsschutzvorrichtung nach Anspruch 1, bei der die Strom zuführenden Arme einstöckig mit den Strom führenden Verlängerungen der Anschlüsse (Messer) ausgebildet sind.

3. Schaltungsschutzvorrichtung nach Anspruch 1, bei der jeder der Strom zuführenden Arme und der verbundene Anschluss (Messer) und die Strom führenden Verlängerung hiervon aus einem einzelnen Metallstück geschnitten sind.

4. Schaltungsschutzvorrichtung nach Anspruch 1, bei der das Paar von Strom zuführenden Armen und die verbundenen Anschlüsse und Strom führenden Verlängerungen hiervon aus einem einzelnen Metallstück geschnitten sind.

5. Schaltungsschutzvorrichtung nach Anspruch 1, bei der die Strom zuführenden Arme sich im Wesentlichen senkrecht zu den Strom führenden Verlängerungen erstrecken.

6. Schaltungsschutzvorrichtung nach Anspruch 1, bei der zumindest zwei der Strom begrenzenden PCT-Elemente in Parallelanschluß zwischen den Strom führenden Armen vorgesehen sind, um eine Gesamtanordnung mit einem normalen Nennstrom zu bilden, der größer als der von einem der Strom begrenzenden PCT-Elemente ist.

7. Schaltungsschutzvorrichtung nach Anspruch 1, kombiniert mit einem isolierenden Gehäuse (4), von welchem sich die Anschlüsse (Messer) erstrecken und das die Strom führenden Verlängerungen und Strom begrenzenden Mittel umschließen.

8. Schaltungsschutzvorrichtung, die mit einer Schaltung zu verbinden ist, die einen gegebenen Lastwiderstand darstellt, welche Vorrichtung ein Paar von Anschlüssen (Messern) (34a - 34a'), die elektrisch mit der Schaltung zu verbinden sind, ein Paar von Strom führenden Verlängerungen (34b - 34b') der Anschlüsse (Messer) und ein Strom begrenzendes Mittel mit anfänglich niedrigem Widerstand, das sich zwischen den Strom führenden Verlängerungen erstreckt, enthält, worin das Strom begrenzende Mittel aufweist:

mehrere PTC-Elemente (35a, 35b, 35c) mit zwei äußersten PCT-Elementen, die zwischen einem Paar von flexiblen und einseitig eingespannten, Strom zuführenden Armen (36a - 36a') mit inneren und äußeren Endbereichen angeordnet sind, wobei der innere Endbereich der Strom zuführenden Arme jeweils elektrisch mit dem Paar von Strom führenden Verlängerungen verbunden ist und der äußere Endbereich der Strom zuführenden Arme jeweils an die äußersten PCT-Elemente gelötet oder durch Ultraschall mit diesen verbunden ist; und worin zumindest zwei der PTC-Elemente elektrisch parallel zueinander geschaltet sind, jedes der PTC-Elemente aus einem kristallinen Polymer mit darin verteilten leitenden Teilchen besteht, so dass, wenn ein Stromfluss durch die PTC-Elemente einen gegebenen Auslösepegel erreicht, sich die PTC-Elemente ausdehnen und die Strom zuführenden Arme biegen.

9. Schaltungsschutzvorrichtung nach Anspruch 8, bei der zwischen den mehreren PTC-Elementen ein Wärmesenke bildender Körper (38, 38') sowohl in elektrisch leitender als auch in Wärme leitender Beziehung zu einem der Strom zuführenden Arme angeordnet ist.

Revendications

1. Dispositif de protection de circuit (2) branché dans un circuit, présentant une résistance de charge donnée, ledit dispositif de protection de circuit comprenant une paire de lames de contact (6a-6a') à brancher électriquement dans ledit circuit, une paire d'extensions conductrices de courant (6b-6b') dessites lames de contact et un moyen de limitation du courant à basse résistance initiale, s'étendant entre lesdites extensions conductrices, dans lequel ledit moyen de limitation de courant comprend :

une paire de bras d'alimentation en courant (6c-6c') comportant des extrémités internes et externes, lesdites extrémités internes étant reliées électriquement auxdites extensions conductrices dessités lames de contact, lesdites extrémités externes desdits bras d'alimentation en courant étant en porte-à-faux et flexibles par rapport auxdites extrémités internes ; et un élément de limitation de courant PTC (10) constitué d'un matériau PTC (10b) comportant des faces conductrices opposées (10a-10a') assemblées par brasage ou soudées par ultrasons entre lesdites extrémités externes desdits bras d'alimentation en courant, de telle sorte que ledit matériau PTC transporte le courant entre lesdites extrémités externes desdits bras d'alimentation en courant, ledit matériau PTC conduisant une gamme déterminée de courant avec une valeur de résistance relativement faible, et lorsque le courant atteint un seuil de déclenchement déterminé, ledit matériau PTC se dilate pour plier lesdits bras d'alimentation en courant, lesdits extrémités internes et externes desdits moyens de limitation de courant sont sensiblement perpendiculaires auxdites extensions conductrices de courant.

2. Dispositif de protection de circuit de la revendication 1 dans lequel lesdits bras d'alimentation en courant font partie intégrante desdites extensions conductrices de courant dessités lames de contact.

3. Dispositif de protection de circuit de la revendication 1 dans lequel chacun desdits bras d'alimentation en courant, les lames de contact correspondantes et leurs extensions conductrices de courant sont découpés dans une pièce de métal.

4. Dispositif de protection de circuit de la revendication 1 dans lequel ladite paire de bras d'alimentation en courant, les lames de contact correspondantes et ses extensions conductrices de courant sont découpés dans une pièce de métal.

5. Dispositif de protection de circuit de la revendication 1 dans lequel lesdits bras d'alimentation en courant sont sensiblement perpendiculaires auxdites extensions conductrices de courant.

6. Dispositif de protection de circuit de la revendication 1 dans lequel au moins deux éléments PTC de limitation de courant sont connectés en parallèle entre lesdits bras d'alimentation en courant pour former un ensemble général avec un domaine de courant normal supérieur à celui d'un desdits éléments PTC de limitation de courant.

7. Dispositif de protection de circuit de la revendication 1 combiné avec un boîtier isolant (4) à partir duquel s'étendent lesdits lames de contact et qui contient lesdites extensions conductrices de courant et lesdits moyens de limitation de courant.

8. Dispositif de protection de circuit de la revendication 1 branché dans un circuit présentant une résistance de charge donnée, ledit dispositif comprenant une paire de lames de contact (34a-34a') à brancher électriquement dans ledit circuit, une paire d'extensions conductrices de courant (34b-34b') dessités lames de contact et un moyen de limitation de courant à faible résistance initiale s'étendant entre lesdites extensions conductrices de courant, dans lequel ledit moyen de limitation de courant comprend :

une pluralité d'éléments PTC (35a, 35b, 35c) comportant deux éléments PTC externes disposés entre une paire de bras d'alimentation en courant (36a, 36a') flexible et en porte-à-faux, ayant des extrémités internes et externes, l'extrémité interne desdits bras d'alimentation en courant étant respectivement branchée électriquement à une paire d'extensions conductrices de courant et l'extrémité externe desdits bras d'alimentation en courant étant respectivement assemblés par brasage ou soudés par ultrasons avec lesdits éléments PTC externes ; et dans lequel au moins deux desdits éléments PTC sont reliés électriquement en parallèle l'un par rapport à l'autre, chacun desdits éléments PTC étant constitués d'un polymère cristallin avec des particules conductrices dispersées à l'intérieur, de façon à ce que lorsqu'un courant qui traverse lesdits éléments PTC atteint un seuil de déclenchement déterminé, lesdits éléments PTC se dilatent et plient lesdits bras d'alimentation en courant.

9. Dispositif de protection de circuit de la revendication 8, dans lequel, entre ladite pluralité d'éléments PTC, un corps thermorétractable (38, 38') est en liaison électrique et thermique avec un des bras d'alimentation en courant.
10. Dispositif de protection de circuit de la revendication 8 ou la revendication 9, dans lequel ledit bras d'alimentation en courant forme un élément sensiblement en forme de Z dans un seul plan, chacun desdits éléments comprenant une section intermédiaire et des sections externes s'étendant dans des directions opposées au niveau d'extrémités opposées de ladite section intermédiaire, une des sections externes de chacun desdits éléments en forme de Z étant assemblée par brasage ou soudée par ultrasons le long de l'un desdits éléments PTC externes et une des sections externes dudit élément en forme de Z étant assemblée par brasage ou soudée par ultrasons le long de l'autre desdits éléments PTC externes.