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(54) **Surge arrester provided with a device signalling the degraded condition thereof**

(57) A surge arrester is disclosed, comprising a first and a second terminal (1, 2) for connection to the active leads of an electric plant, between which a protection element (3) is inserted, provided with a pair of electrodes (4) electrically connected to said connection terminals, said protection element (3) being temperature-degradable depending on time, and between said first terminal (1) and an electrode (4) of the protection element (3) a disconnector being provided, the arrester further comprising a signalling device (30-39) of the state of degradation of said protection element (3), comprising at least movable means (30, 33), having a pressure element (30a) being biased by elastic means (35) against a cushion (H) made of temperature-variable viscosity material, signalling means (36) being connected with said movable means, which signalling means (36) make evident the level of degradation depending on their displacement caused by the sinking of said pressure element (30a) of said movable means (30) into said cushion (H).

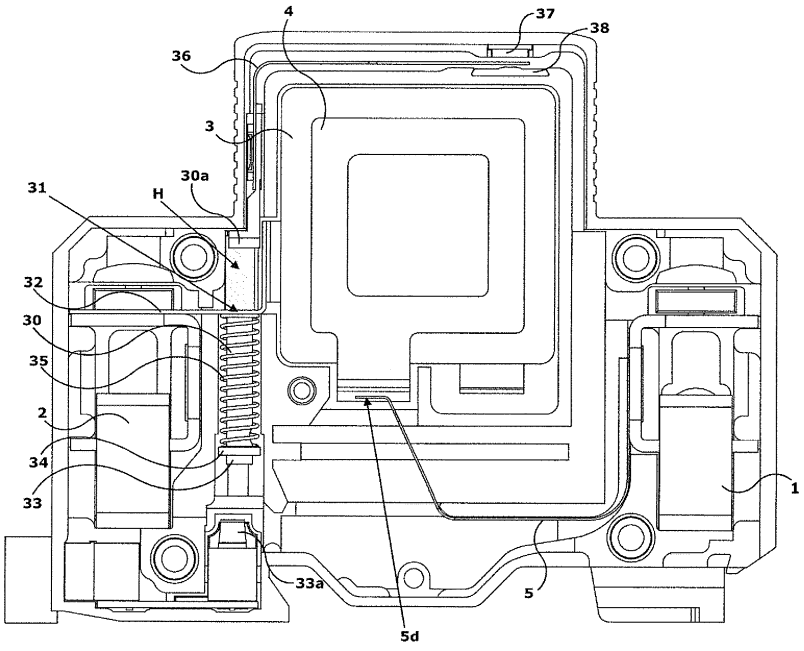

Fig. 1

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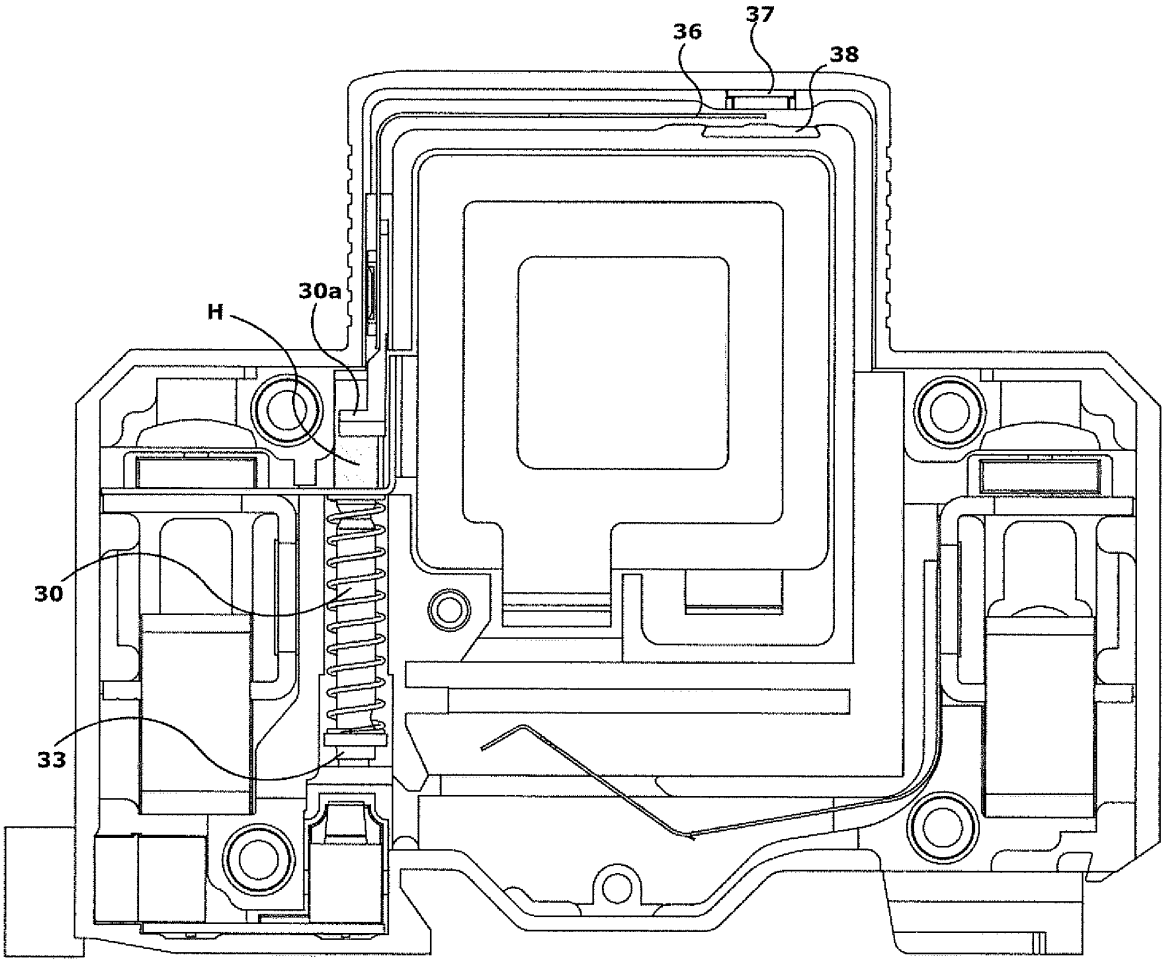

Fig. 2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an improved structure of a surge arrester, also defined as surge limiter or more synthetically SPD (Surge Protection Device). By these terms those electric/electronic devices are referred to which, arranged between the active leads of the electric plant and the ground, provide to discharge to the ground surge peaks - such as the ones generated by atmospheric lightning and by switching manoeuvres - which could otherwise cause serious damages to the electric plant and to the apparatuses thereof.

STATE OF THE PRIOR ART

[0002] Direct lightning phenomena are the main sources of devastating destructive effects on electric plants; indirect discharges and switching surges are also the sources of faults, the origin of which is not easy to identify, but the effects of which are equally terrible for sensitive plants and in which running continuity is paramount. The duration of these phenomena varies from few microseconds to a few hundreds of milliseconds, but in this very short time they concentrate an extremely high energy content. These phenomena must be suitably intercepted in order to protect the plants connected to the network and thus guarantee the integrity thereof and the functions thereof. in the modern era, with the growing use of electric and electronic equipment and with the exponential increase of the integration level of semiconductors, ever growing attention to this issue has become necessary, compared to the past. The awareness that transient surges represent a relevant factor in the "mean time between failures" (MTBF) feature of a plant or apparatus, has caused the need to adopt increasingly greater and more effective safety measures.

[0003] All that has led to increasing attention in the sector which has caused, on the one hand, an effort by the manufacturers in the development of ever more performing equipment and, on the other hand, an effort by the rule-issuing bodies in the definition of ever more accurate national and international requirements and standards which meet technological developments.

[0004] The present invention relates to the manufacture of surge protection apparatuses - referred to in the following as arresters - the application of which is regulated, for example, by the CEI EN 62305-1/4 Ed. 2 (2011-02), IEC 60364-4-44-443 Ed.2 (2007) and CLC/TS 50539-12 (2010-03) standards for the protection against lightning and switching surges. The requirements and the proof methods refer to the IEC 61643-11 Ed. 1 (2011-03) and to the CEI EN 50539-11 (2013-02) standards.

[0005] In particular, in this context it will be dealt with the arresters of the most recent prior art, comprising a protection element in the form of a varistor and meant in particular to LV plants (low voltage, that is, nominal tension up to 1000 V AC and 1500 V DC) and to photovoltaic plants (AC side and DC side).

[0006] The varistor employed in the arresters is an already largely known component; the behaviour thereof matches that of a variable (non-linear) resistance in the voltage/current ratio. Once the reference voltage has been exceeded, for example when a short-lived surge peak occurs, the varistor abruptly lowers the resistance thereof, so that the current peak can be easily discharged therethrough, to the ground, and does not continue to other, higher-resistance parts of the plant. A varistor typically consists of a mass of semiconductor material (for example, ZnO) enclosed sandwich-like between two opposite metal surfaces, which make up the electrodes to which the contacts of the terminals for connection to the arrester are electrically joined. Typically, in these devices, the two terminals are then connected to a phase lead and to the protection lead and/or to the neutral lead, respectively.

[0007] In the inner circuit of the arrester, in series to the protection element in form of a varistor, a "disconnector' is typically provided, that is a complex releasing device, with protective functions in case of failure of the protection element.

[0008] A particularly effective disconnector is described for example in EP 14160969.3 in the name of the same Applicant, the contents of which is hereby considered recomprised by reference.

[0009] In standard conditions, that is, in the absence of surges, the protection element has such a high impedance as to represent a circuit interruption to the ground and the current circulating within the arrester is not significant. Consequently, no current circulates to the ground which may generate dangerous conditions for people's safety. This system, widely known, operates in a highly effective way as long as the protection element (for example the varistor) is fully operative.

[0010] Following various overloads due to large transient currents discharged to the ground, to an excessive number of operations or to abnormal conditions of the supply network, the protection element (typically the varistor) undergoes such an aging and degradation process following which it gradually begins to reduce the impedance thereof and hence to discharge to the ground, even in the absence of surges, growing and ever more significant current values. As long as the impedance reduction is small, as is the value of the groundbound current, the operation of the arrester is still acceptable, but beyond certain values the arrester becomes unusable and dangerous for the users. At this point it must necessarily be switched off (disconnected) from the plant.

[0011] Since the arrester degradation does not have a linear trend, a device must be provided for quickly disconnecting it from the plant, should the values of current discharged to the ground suddenly become high. Such a device is indeed the disconnector mentioned above.

[0012] However, this type of arrangement operates re-

gardless of the ability to identify beforehand the actual state of degradation of the arrester. It must in any case be considered that a prior signal of the degradation progress would instead be advantageous and desired to be able to prepare in a timely manner the replacement of the arrester still operating, before the functionality thereof is ultimately impaired. This prior activity, as logical, is by all means desirable in order to be able to always have the plant in superior operating conditions.

[0013] It must not be forgotten that an arrester operating in degraded conditions cannot carry out effectively its protection function when it is stressed by the maximum impulsive currents for which is designed and installed. This is a particularly insidious condition because current law requirements provide a whole series of rules for safety installation, but they state nothing on the sensitive matter of the ability to guarantee the surge protection function in the presence of reduced-efficiency situations. In other words, if the protection function is not performed effectively, the rules just provide, afterwards, the obligation to replace the component, but as a precautionary measure nothing is prescribed.

[0014] On the other hand, there is no doubt that the life of an arrester cannot be determined beforehand, since it is affected by multiple factors, primarily by the number and by the intensity of the current discharges which run through it and which progressively cause the internal impedance to decay: as a matter of fact, it is known that the decay of an arrester is always associated with a Joule-effect heating, increasing over time, caused by small leakage currents which run through it (on a new one, they are below 1 mA, in degraded conditions the order of magnitude becomes of a few mA).

[0015] For a punctual verification, in theory such current could hence be measured, but that is difficult in practice to be accomplished in technical and economic terms in the allowed application and spaces. Also the temperature detection, as an index of the degradation state, would be a viable and more direct solution, but it would be necessary to measure the complex quantity "temperature over time". As a matter of fact, in the impulsive discharge processes the varistor temperature rises abruptly, but the subsequent cooling process begins at once: a strong thermal stress is hence at work for a short period of time; on the contrary, a degradation process derives from a less intense thermal stress, which, however, extends indefinitely over time. The monitoring of such a quantity over time is a technically difficult and expensive task.

[0016] In some installations it has been proposed to count the number of impulsive discharges, as an approximate index of the potential degradation of the arrester, but the result is not fully reliable and hence very early replacements must be provided with respect to the functionality which the arrester could instead guarantee.

[0017] The Applicant has addressed this issue, considering that the correct indicator of the degradation of an arrester cannot be but the leakage current and the related heating lasting over time, while poor attention can be given to the number of the repeated impulsive phenomena which trigger degradation.

SUMMARY OF THE INVENTION

[0018] The problem at the base of the invention is therefore to propose an arrester structure which overcomes the difficulties mentioned above and which allows to provide a reliable and realistic indication, in real time, of the actual degradation state of the arrester. These objects are achieved through the features set forth in essential terms in the attached claims.

[0019] In particular, according to a first aspect of the invention it is supplied a surge arrester comprising a first and a second terminal for connection to the active leads of an electric plant, between which a protection element is inserted, provided with a pair of electrodes electrically connected to said connection terminals, said protection element being temperature-degradable depending on time, and between said first terminal and an electrode of the protection element a disconnector being provided, further comprising a signalling device of the state of degradation of said protection element, comprising at least movable means, having a pressure element being biased by elastic means against a cushion made of temperature-variable viscosity material, signalling means being connected with said movable means, which signalling means make evident the level of degradation depending on their displacement caused by the sinking of said pressure element of said movable means into said cushion. In particular, said movable means is a moving slider. Preferably, said moving slider is in the shape of a rigid rod, slidable along the longitudinal axis thereof under the preload of said elastic means, and said signalling means are in the shape of a signalling strip visible from outside a casing of the surge arrester through a window.

[0020] According to a preferred aspect of the invention, the arrester furthermore is provided with a contrast plate hidden from view, through said window, by the end of said signalling strip and progressively made visible upon the displacement of said signalling strip.

[0021] Preferably, said signalling means comprises a microswitch apt to trigger a warning signal and which is actuated when said movable means has performed a pre-set travel.

[0022] According to another aspect, said cushion is laid in between said pressure element of movable means and a fixed abutment integral with a casing of the surge arrester.

[0023] According to a preferred aspect, said cushion is made of a hot-melt resin. In particular, said hot-melt resin has a softening temperature ranging between 90C° and 140C°.

[0024] According to a an aspect of the invention, said cushion (H) is obtained *in situ* through the injection of a hot-melt resin mass in a fluid state and caused to solidify while keeping said elastic means in a preloaded status.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Further features and advantages of the invention are in any case more evident from the following detailed description of a preferred embodiment, given purely as a nonlimiting example and illustrated in the attached drawings, wherein:

fig. 1 is a schematic side elevation view, with parts removed, of the structure of an arrester provided with a degradation signalling device according to the invention; the arrester is shown in a properly operative condition and
with new degradation signalling device;
fig. 2 is a view similar to that of fig. 1, but with the degradation signalling device in a medium condition; and
fig. 3 is a view similar to that of fig. 1, but with the degradation signalling device in a final state (device to be replaced).

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0026] The different side views of the drawings herewith attached represent an arrester which, in its general configuration, corresponds to the one described in the above-cited application EP14160969.3. It comprises a box-like body or module C, of such dimensions to be housed in a single standard module and wired within a switchboard for electric plants in LV.

[0027] In this module C two opposite terminals are housed - a first terminal 1 for the connection of the phase lead and a second terminal 2 for the connection of the protection or neutral lead - among which a protection element is arranged (typically a varistor), schematised by a plate 3, on the opposite surfaces of which respective conducive electrodes are provided (in the drawings an electrode 4 only is shown, the other one being on the opposite side is not visible in the drawing).

[0028] Electrode 4 is electrically connected to phase terminal 1, while the opposite electrode is connected to the ground or neutral terminal 2. The connection between electrode 4 and phase terminal 1 is accomplished through conductor means making up an element of the disconnector.

[0029] In particular, such conductor means of the disconnector is in the shape of a flexible lamina, 5, which is elastically preloaded and joined to electrode 4 through a suitable low-melt welding in the point marked as 5d.

[0030] The material used for carrying out the low-melt welding typically belongs to the group of alloys with a tin, lead, bismuth, indium base in binary or ternary, euteptic and non-euteptic formulations, with melting intervals ranging between 120 and 180 C°.

[0031] In the exemplifying configuration illustrated in the drawings, the lamina 5 of the disconnector is generically folded into an S or a U shape.

[0032] During standard operation (rest condition of the disconnector), this configuration ensures electric continuity between connection terminal 1 and the electrode 4 of the varistor, through lamina 5.

[0033] In the module C a guide 6 is furthermore formed along which a slider can move longitudinally, biased and pushed by preloaded elastic means, for example a precompressed spring, for the interrupting function of the electric circuit better described in the cited application EP14160969.3.

[0034] With this arrangement, in the rest condition of the disconnector, when footpiece 5d is welded to electrode 4, the slider is retained in its home position, against the precompression bias of the spring. This is the condition of integrity of the arrester (shown also in fig. 1).

[0035] When, due to the slow degradation of the protection element in the form of varistor, current begins to flow (even of low intensity, but continuously) through the lamina 5 of the disconnector, said current ends up heating the welding point between electrode 4 and footpiece 5d, until melting the welding material and interrupting hence the constraint. That triggers the disconnector action, according to the mode widely described in application EP14160969.3.

[0036] According to the invention, close to the arrangement of the disconnector, a degradation indicator is provided, based on materials with temperature-dependent viscosity.

[0037] In particular, the degradation indicator according to the invention consists of a signalling, movable means, like a slider, which is biased by elastic means against a cushion made of resin, with temperature-dependent viscosity, in particular a resin of the family called "hot-melt resins".

[0038] These resins, already known and used (in specific formulations) in hot-gluing processes, are solid at room temperature, but take up a progressively less viscous behaviour as the temperature increases, until full fluidification.

[0039] Suitable hot-melt resins are thermoplastic polymers which consist of a polymer base in addition to a variety of additives (pigments, stabilisers, plasticisers, ..). The polymer base typically consists of polymers such as copolymers of ethyl vynyl-acetate (EVA), ethylen-acrylate, polyolefins (PO) and amorphous polyolefins (APO, APAO), polyethylen (LDPE, HOPE), polypropylen (PP, APP), polybuthene-1 and copolymers thereof, polyamides, polyesters, polyurethane (PUR), thermoplastic polyurethane (TPU), styrenebased copolymers (SBC, SBS, SIS, SEBS, SEP), polycarbonates and fluoropolymers.

[0040] Normally the thermoplastic bonds within these resins are reversible, unless they undergo curing processes: hence, upon undergoing a sufficient thermal load, they tend to soften and liquefy, losing cohesion and strongly reducing this viscosity, even after a first solidification.

[0041] The application temperatures of hot-melt resins

typically lie in the interval between 160°C and 220°C, in which the corresponding viscosity rapidly decays from 3000 mPa to less than 2000 mPa. A fundamental feature of these materials, especially with reference to the context of the present application, is the softening temperature (softening point), at which the viscosity of the material begins to significantly decay.

[0042] Surge arresters are meant to work at maximum outer temperatures not above 120°C but, at the same time, they must be able to be maintained at the temperature of about 80°C without undergoing alterations: therefore, according to the invention, the variable-viscosity materials (hot-melt resins) are chosen so that the softening temperature (that is, the temperature above which the viscosity decays below predetermined, conventionally established values) lies in the interval 90-140°C.

[0043] Returning to the specific configuration of interest for the invention, it must be noticed that penetration resistance, which a hot-melt resin cushion offers to an elastically biased movable means, like a slider, is hence inversely proportional to the temperature which such cushion is exposed to: the slider progressively sinks into the cushion, the more so the lesser the cushion viscosity and the longer the time elapsed, hence performing a travel or displacement proportional to the temperature and to the exposal time to such temperature.

[0044] Exploiting this behaviour, the solution proposed by the present invention is that of arranging a hot-melt resin cushion between a part of the electric circuit subject to being heated by the dispersion currents and a movable equipment subject to the action of bias means which push it against said resin cushion.

[0045] Making now reference to the attached drawings, a preferred embodiment is illustrated, in which the degradation signalling device consists of a slider 30, sliding in a guiding ring 31, in turn integral with a conducive terminal 32 of the arrester. For such purpose, terminal 32 has a hole through which slider 30 passes, the slider being preferably in the shape of a circular-section rod.

[0046] On slider 30 a ring nut 34 or other stopping element is fastened, against which a first end of a spiral spring 35 abuts, the other end of which rests against ring 31, that is the terminal 32 which acts as fixed abutment element. Due to this mounting of spring 35, slider 30 is elastically biased in the direction of the free end 33 thereof, that is, downwards in the drawing of fig. 1.

[0047] According to the invention, between a pressure element 30a integral with slider 30 and a fixed abutment part, for example the same terminal lead 32, a cushion H of temperature-related viscosity resin, typically hot-melt resin, is arranged. Cushion H, when it is in its solid state, maintains the pressure element 33a of slider 30 spaced apart from fixed abutment 32, against the bias promoted by spring 35. This spacer function, against the action of the spring 35, is performed as long as the hot-melt resin cushion has a solidity or viscosity sufficient to prevent pressure element 30a from penetrating into the resin.

[0048] Pressure element 30a, for example, is in the shape of a short arm which protrudes transversally from slider 30.

[0049] The mass of cushion H preferably extends on a volume of at least 400 mm^3, so as to determine a slider intervention travel of at least 6 mm.

[0050] Cushion H may be manufactured separately and then installed on-board of body C in the solid phase, after having brought spring 35 into preload. Alternatively, cushion H may be manufactured in situ: initially, pressure element 30a of slider 30 is caused to move backwards, bringing spring 35 into compression and then a molten hot-melt resin mass is injected directly in its seat within the body C, for example through a glue gun. Once the mass of cushion H has been injected, it is waited that the resin cools down and solidifies and then slider 30 can be released, so that spring 35 brings pressure element 30a into abutment on the solidified cushion.

[0051] The mass of cushion H may also be wound around part of slider 30, which should nevertheless be free to slide through.

[0052] According to another embodiment, it can be provided that the mass of resin H be enclosed in a suitable envelope the volume of which is caused to vary by the movement of pressure element 30a, which hence acts as plunger. In such case, the envelope furthermore has a calibrated outflow opening, from which the viscous mass of resin H can exit: thereby the displacement of slider 30 can be furthermore controlled by acting both onto resin composition, and on the dimension and conformation of the outflow opening.

[0053] Preferably, in a position opposite to the distal end 33 of slider 30 a fixed, travel-end abutment 33a is provided: advantageously on travel end 33a a microswitch may be provided, for the function which will be illustrated in detail further on.

[0054] At the proximal end of slider 30, opposite to the distal end, a signalling strip 36 is fastened, consisting for example of a thin flexible lamina, which runs along a first segment, substantially oriented according to the axis of slider 30, and then along a second segment, perpendicular to the first one, until in correspondence of a signalling window 37.

[0055] Signalling strip 36 is preferably in the form of a polycarbonate lamina, for example coloured in green.

[0056] Signalling window 37 is substantially an opening or a clear area in the casing of body C, such as to make visible from the outside the underlying portion of the device.

[0057] The terminal portion of signalling strip 36 is located behind window 37 and hides an underlying contrast plate or tape having a very different appearance from that of signalling strip 36, for example being orange colour. In standard operation conditions, through window 37 only signalling strip 36 is visible, for example green colour, which entirely covers underlying contrast tape 38. When, following the displacement of slider 30, also the end of signalling strip 36 is dragged and displaced with

respect to window 37, at least part of contrast tape/plate 38 is cleared by the strip and becomes visible, in a possible orange colour.

[0058] The extension of contrast tape/plate 38 which is visible outside, through window 37, gives an indication of the extent of the displacement performed by slider 30 and, in the last analysis, of the degradation which the device may have undergone.

[0059] During operation the signalling device according to the invention has the following operating mode.

[0060] Whenever the arrester device experiences overheating, especially if of a significant duration over time, the hot-melt resin mass of cushion H reduces its viscosity and produces a certain penetration of pressure element 30a of the slider, which results in a corresponding displacement of slider 30 and hence of travel of signalling strip 36. Repeated heating cycles of this type produce a travel of signalling strip 36 sufficient to make the phenomenon visible from the outside, through the appearance of contrast tape/plate 38 through window 37, in a way the more evident the more the heating has caused cushion H to soften (and hence device degradation).

[0061] In an initial degradation phase, this travelling of strip is moderate and hence the green part of strip 36 is still, at least partly visible through window 37. However, the orange colour of plate 38 is - at least in part - already visible. That is clearly shown in fig. 2 and indicates that degradation has commenced.

[0062] It is evident that the system user is able to intervene in the replacement of the apparatus as soon as the orange coloured part takes on dominant relevance through window 37.

[0063] Fig. 3 finally shows the final arrangement of the signalling device, that is, when signalling strip 36 has been entirely displaced and has made fully visible the sole orange contrast tape 38. In this condition the replacement of the apparatus is mandatory.

[0064] In this terminal phase of the signalling process, the end 33 of slider 30 ends its travel against the fixed travel-end abutment 33a. Should abutment 33a be provided with a microswitch, it is also possible to generate an electric signal which can drive a full-degradation remote warning (in addition to the evidence locally obtained on the window 37 of the arrester device).

[0065] As is evident, the advantage of the described arrangement is given by the fact that the displacement of signalling strip 36 is progressive depending on the amount of heat developed by the system over time, hence, in other words, not only depending on the temperature reached or of the heating undergone in absolute value, but also depending on the time elapsed in the various heating conditions.

[0066] This displacement is furthermore connected to visual signalling means, which indicate, according to various ways, the degradation reached and hence the need to replace the arrester before the natural end-of-life thereof. This signalling lies temporally between the two signals provided by the rules, that is, that of regular operation and that of failure.

[0067] However, it is understood that the invention must not be considered limited to the special arrangement illustrated above, which makes up only an exemplifying embodiment thereof, but that different variants are possible, be they either internal or external with respect to the SPD, all within the reach of a person skilled in the field, without departing from the scope of the invention, as defined by the following claims.

[0068] For example, though the movable means are disclosed in the drawings as a slider, they may take up a different shape, like a pivoting lever or swinging flag, or other.

Claims

1. Surge arrester comprising a first and a second terminal (1, 2) for connection to the active leads of an electric plant, between which a protection element (3) is inserted, provided with a pair of electrodes (4) electrically connected to said connection terminals, said protection element (3) being temperature-degradable depending on time, and between said first terminal (1) and an electrode (4) of the protection element (3) a disconnector being provided, **characterised in that** it further comprises a signalling device (30-39) of the state of degradation of said protection element (3), comprising at least movable means (30, 33), having a pressure element (30a), being biased by elastic means (35) against a cushion (H) made of temperature-variable viscosity material, signalling means (36) being connected with said movable means, which signalling means (36) make evident the level of degradation depending on displacement thereof caused by the sinking of said pressure element (30a) of said movable means (30) into said cushion (H).

2. Surge arrester as claimed in claim 1, wherein said movable means is a movable slider.

3. Surge arrester as claimed in claim 2, wherein said movable slider is in the shape of a rigid rod (30), slidable along the longitudinal axis thereof under the preload of said elastic means (35), and said signalling means are in the shape of a signalling strip (36) visible from outside a casing (C) of the surge arrester through a window (37).

4. Surge arrester as claimed in claim 2 or 3, wherein it is furthermore provided a contrast plate (38) hidden from view, through said window (37), by the end of said signalling strip (36) and progressively made visible upon the displacement of said signalling strip (36).

5. Surge arrester as claimed in any one of the preceding claims, wherein said signalling means (36) comprises a microswitch apt to trigger a warning signal and which is actuated when said movable means (30) has performed a pre-set travel.

6. Surge arrester as claimed in any one of the preceding claims, wherein said cushion (H) is laid in between said pressure element (30a) of movable means (30) and a fixed abutment (32) integral with a casing (C) of the surge arrester.

7. Surge arrester as claimed in any one of the preceding claims, wherein said cushion (H) is made of a hot-melt resin.

8. Surge arrester as claimed in claim 7, wherein said hot-melt resin has a softening temperature ranging between 90C° and 140C°.

9. Surge arrester as claimed in claim 7 or 8, wherein said cushion (H) is obtained *in situ* through the injection of a hot-melt resin mass in a fluid state and caused to solidify while keeping said elastic means (35) in a preloaded status.

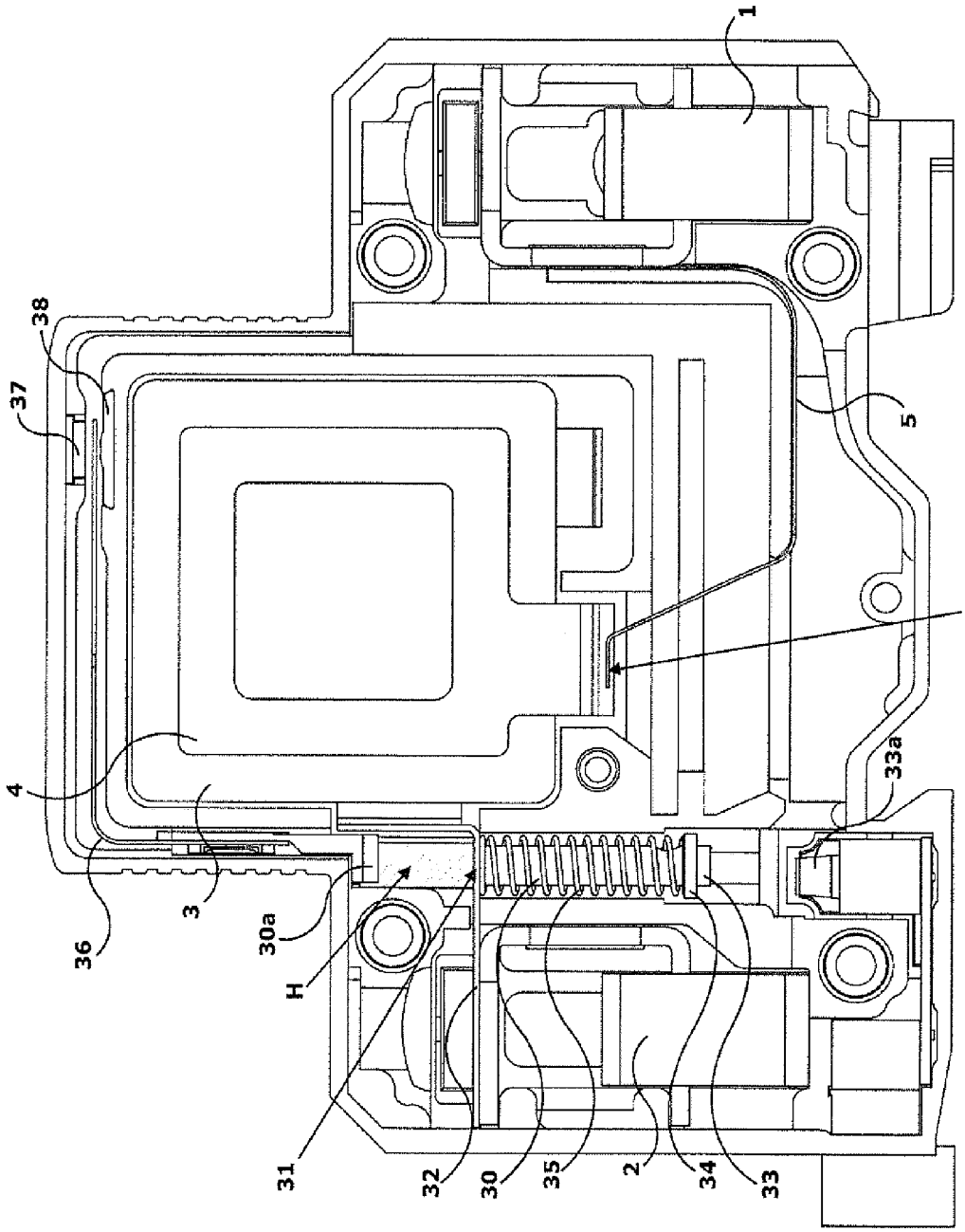

Fig. 1

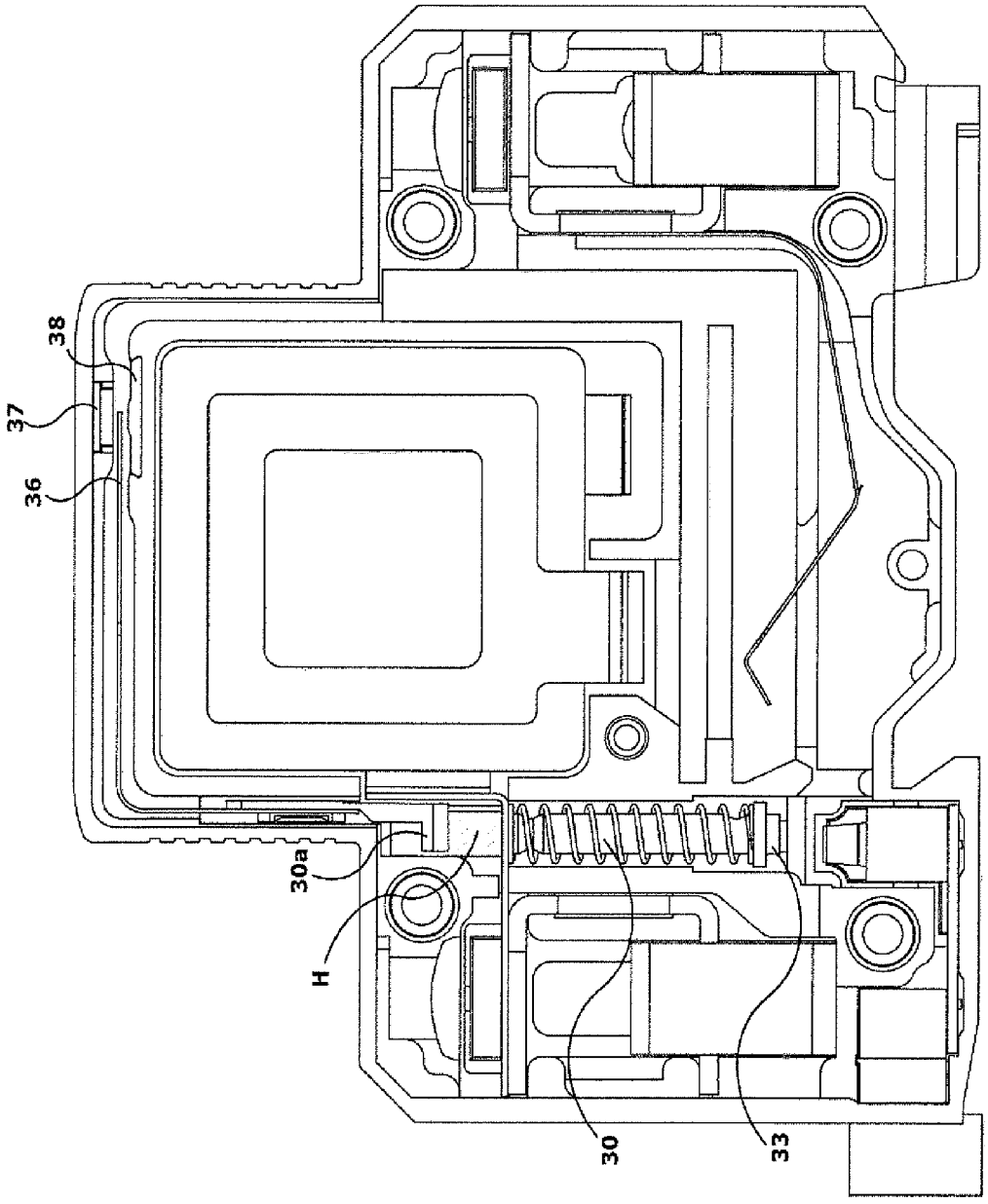

Fig. 2

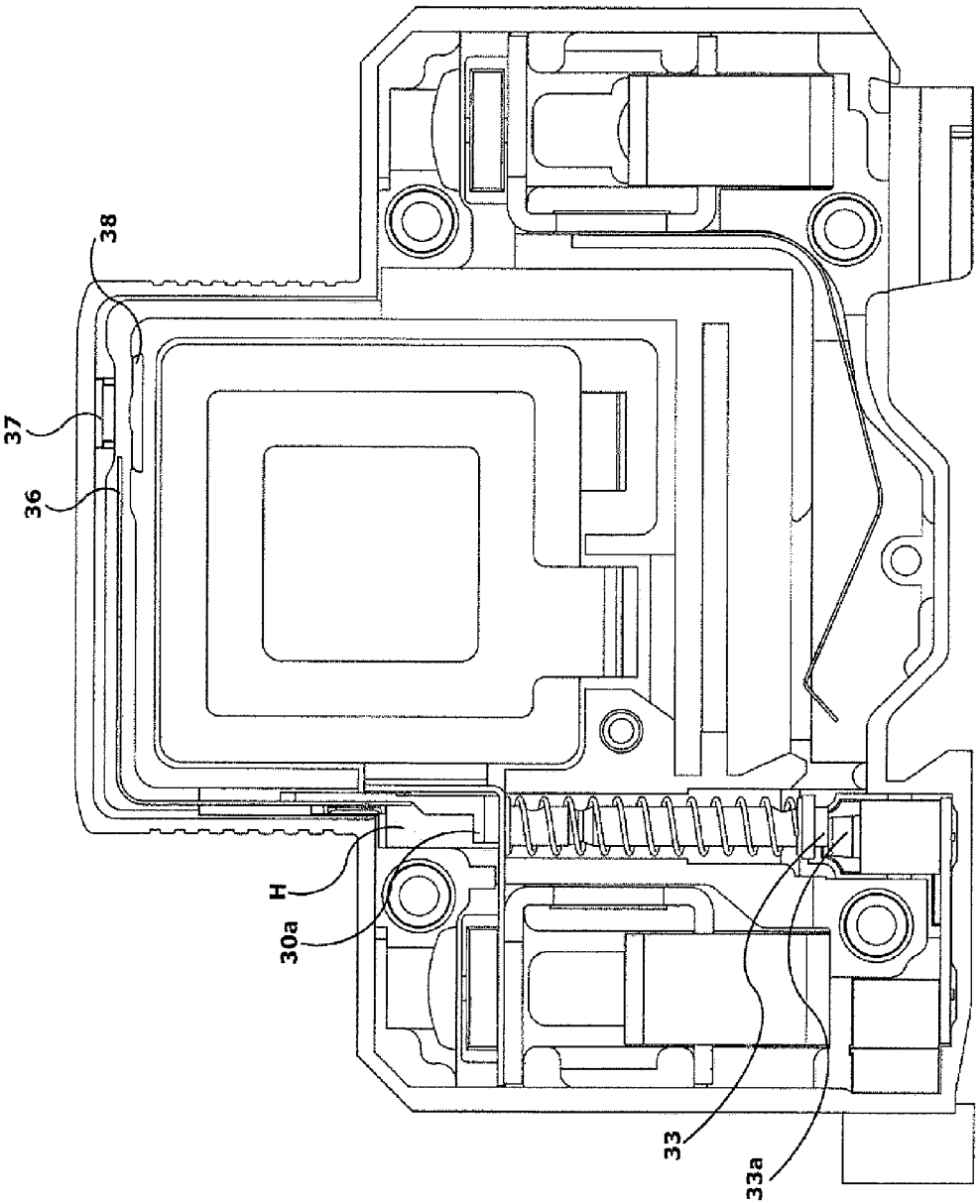

Fig. 3

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 5431

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2008/019073 A1 (LAGNOUX ALAIN R R [FR] LAGNOUX ALAIN RENE ROBERT [FR]) 24 January 2008 (2008-01-24) * page 2, paragraph 35 - page 5, paragraph 85; figures 2-6 *	1-9	INV. H01C7/12 H01T1/14 H01H37/76
A	US 2011/032651 A1 (DEPPING CHRISTIAN [DE] ET AL) 10 February 2011 (2011-02-10) * page 4, paragraph 33 - paragraph 37; figures 2-4 *	1-9	
A	WO 2005/096464 A1 (DEHN & SOEHNE [DE]; ZAEUNER EDMUND [DE]; GAECK FLORIAN [DE]; WITTMANN) 13 October 2005 (2005-10-13) * page 8, line 22 - line 33; figure 4 *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)

H01C
H01T
H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 September 2014	Frias Rebelo, Artur

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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