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(54) Resistor device with fuse function

(57) Resistor device with fuse function comprising at least a resistive element (14) able to have current pass through, said resistive element (14) being enclosed between at least two containing insulating elements (18, 17), in at least one segment of at least one of said containing elements (17, 18) there being a localised zone of discontinuity characterised by a coefficient of heat exchange less than the coefficient of heat exchange of the remaining part of said at least one containing element (17, 18), said localised zone of discontinuity being able to create along said resistive element (14) a defined preferential melting point when the circulating current exceeds a pre-determined threshold value.

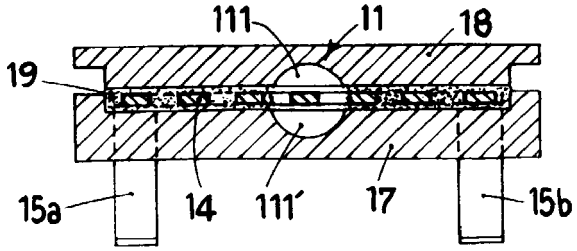

fig.2

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Description

FIELD OF THE INVENTION

[0001] This invention concerns a resistor device with a fuse function.

[0002] The invention is applied particularly, but not only, in the field of motor vehicles to provide a device which, when inserted into an electrical circuit, will serve the function of an electrical resistor and also as a fuse to interrupt the circuit in the case of overloads.

BACKGROUND OF THE INVENTION

[0003] In the field of motor vehicles, the state of the art includes the use of resistors to limit the current circulating in an electrical circuit, or to produce a fall in tension therein. For example, there are resistors used in the feeding circuits of the electric fans in motor vehicles in order to limit the tension supplied to the electric motor and therefore to vary the speed of rotation thereof.

[0004] At present, the state of the art includes layer resistors, ceramic resistors and wire resistors.

[0005] The use of layer resistors is limited only to those applications where the electrical currents are of low intensity and therefore only in low power electrical circuits or electronic circuits.

[0006] In applications which require high power, ceramic resistors or wire resistors are used. Ceramic resistors are reasonably priced and dissipate a considerable quantity of heat but, on the other hand, they are extremely fragile, particularly in correspondence with the joint areas, and therefore in the field of motor vehicles their use is extremely limited.

[0007] Wire resistors, on the contrary, are more complex and expensive to make and dissipate less heat. Another disadvantage of wire resistors is that the resistive wire is exposed, which limits their use especially in areas where there is a risk of water infiltration, such as for example the engine compartment of motor vehicles.

[0008] A further disadvantage of wire resistors is that if the electrical current circulating exceeds certain limit values, when for example in an electric ventilator the blades of the fan are accidentally jammed, the resistor itself overheats and may cause fires.

[0009] As a consequence, resistors such as are known to the state of the art are not reliable to use in the field of motor vehicles, especially from the safety point of view, and therefore they are usually associated with thermal fuses able to interrupt the electrical circuit when a pre-determined maximum temperature is reached.

[0010] This solution not only increases costs, but also it is not sufficiently reliable inasmuch as it may happen that the intervention times of the thermal fuse are not quick enough to ensure a speedy interruption of the electrical current.

[0011] Moreover, the inclusion of thermal fuses involves additional costs, requires cables, and above all it is necessary to reach resistor temperatures which are extremely high, in order to reach the melting temperature of the thermal fuse.

[0012] Thermal fuses, moreover, are subject to a rapid deterioration, since their continual exposure to high temperatures causes the progressive sublimation of the eutectic alloy inside, causing unwanted interruptions to the electric circuit. A further disadvantage is that it is difficult to connect the resistors and the thermal fuses to the electrical circuit.

[0013] The thermal fuses, for example, are associated with the resistor by means of calking, but this system is often not efficacious because it does not hold very well, due to the yielding which occurs in the area of the joints caused, for example, by an erroneous regulation of the mechanical press used to carry out the calking operation.

[0014] JP-A-11126556 discloses a miniaturised fuse of the microchip type consisting of a fuse body made of thin metal film, that is, by a deposit of metal paste, for example by serigraphy.

[0015] This fuse comprises an insulating base and a protective layer, with the fuse body being arranged in an intermediate position between the base and the protective layer.

[0016] The protective layer is conformed so as to define a space, insulated from outside, where most of the fuse body is housed.

[0017] The fuse body is flat at the ends and curved in the centre. This conformation serves mainly to prevent the thin film, as the current passes through, from having variations in temperature, and therefore in behaviour, deriving from contact with the mass of the elements which contain it.

[0018] The document refers to microchips with a size of a few millimetres, and not to fuses of the type for motor vehicles comprising one or more resistive elements associated with a dissipater.

[0019] The space wherein the microchip fuse is housed is configured to prevent contact with the walls of the insulating elements, but it does not provide a localised zone of discontinuity in the heat conductivity, with the purpose of creating a preferential and controllable melting point, so that the fuse intervenes also when the temperature on the remaining part of the fuse body is much lower than the intervention temperature.

[0020] US-A-5,606,301 discloses a miniaturised microchip fuse identical to that shown in JP-A-11126556, which comprises a thin film arranged inside two insulating layers defining an empty intermediate space where most of the body of the thin film is housed. In this case too, the space is created to prevent contact between the fuse body and the mass of the containing elements and thus guarantee a constant temperature, and therefore a constant behaviour when the current passes through.

[0021] In this case too, around the fuse body there

are no localised points of interruption defined by a definite zone of variability in the heat conductivity.

[0022] The present applicant has designed and embodied this invention to achieve a resistor able to overcome all these shortcomings, and to obtain further advantages.

SUMMARY OF THE INVENTION

[0023] The invention is set forth and characterised in the main claim, while the dependent claims describe other characteristics of the idea of the main embodiment.

[0024] The purpose of the invention is to provide a resistor device which can be used particularly in the field of motor vehicles, and which will also be suitable to serve the function of a fuse so as to interrupt the electrical current in the circuit where it is inserted, when the current exceeds a pre-established value.

[0025] Another purpose of the invention is to provide a reliable, safe, inexpensive and versatile resistor device.

[0026] The resistor device according to the invention, moreover, can be used in electrical circuits which dissipate electrical powers much greater than those which are normally used when traditional type resistors are employed.

[0027] The device according to the invention consists of a resistive element made of a conductor material and developing substantially on a plane according to a desired path.

[0028] The ends of the resistive element cooperate with terminals connecting to the electrical circuit which feeds the desired load, for example the electric fan of the radiator.

[0029] According to one embodiment of the invention, the terminals are of the fast-on type.

[0030] In the preferred embodiment of the invention, the resistive element develops, for at least part of its length, according to a fretted path.

[0031] According to a variant, the resistive element develops, for at least part of its length, according to a coiled path, or with another desired shape.

[0032] The resistive element is enclosed inside a containing structure comprising at least a pair of elements made of electrically insulating material, one functioning as a base or bottom and one functioning as a cover, which contain and enclose the resistive element so as to define a configuration of the so-called "sandwich" type.

[0033] In one embodiment of the invention, the resistive element is made solid with the relative containing elements by means of a filling material functioning as a binder, such as cement or similar.

[0034] The purpose of the containing elements, together with the afore-said filling material, is also to dissipate the heat which develops along the resistive element during the passage of the electric current. In a preferential embodiment, the containing elements are made of ceramic material or similar.

[0035] In a preferential embodiment, the combination of the resistive element and the two containing elements is enclosed inside a container or metal box, preferentially made of aluminium, from which only the terminals which connect to the electric circuit emerge.

[0036] The metal container performs a protective function - anti-wear and anti-knocks - for the ceramic containing elements, and also provides a contribution to the dissipation of the heat generated on the resistive element.

[0037] According to the main characteristic of the invention, in at least one defined and localised segment of at least one of the containing elements there is a zone characterised by a coefficient of heat exchange which is much less than the coefficient of heat exchange of the remaining part of the at least one containing element.

[0038] The zone of reduced heat exchange defines a zone of discontinuity with respect to the normal heat exchange which occurs between the remaining part of the body of the resistive element and the surrounding containing elements, so as to define a preferential point of melting of the resistive element when the circulating current exceeds a pre-determined threshold value. The zone is characterised by a higher heat resistance, and thus by a lower conductivity, compared with the adjacent zones, and therefore causes a localised modification, substantially in one point, of the heat flow dissipated by the containing element.

[0039] In a preferential embodiment of the invention, the zone of reduced heat exchange is defined by a localised reduction in section of a segment of at least one of the containing elements.

[0040] The reduction in section, defining a localised recess of air around the relative segment of the resistive element, causes at that point a variation in the heat resistance due to the fact that the air has a much lower heat exchange coefficient than that of the material which makes up the containing elements.

[0041] To be more exact, the presence of the air recess causes a consequent localised increase in the heat resistance (θ_t)of the resistive element.

[0042] Since the heat resistance of a conductor element is connected to the power dissipated and the temperature of the equation $W \cdot \theta_t = T\ (^{\circ}C)$, the localised increase in the heat resistance entails, given the same power dissipated, a corresponding increase in temperature. By sizing the air recess properly, we therefore create a localised segment of the resistive element wherein the passage of an electric current causes an increase in temperature which is much more accentuated than in the remaining part of the resistive element, which is completely enveloped, continuously and homogeneously, by the relative containing elements.

[0043] Thus we obtain that the resistive element can perform the function of a fuse since, in correspond-

ence with its segment facing the air recess, the conductor material has a point of discontinuity with modified heat characteristics which can melt when the circulating current exceeds a pre-determined threshold value following a malfunction in the electric circuit.

[0044] This happens without the temperature on the remaining part of the resistive element having to reach excessively high values, but which remain, on the contrary, far from the resistor element's point of intervention, that is, when it melts.

[0045] In a preferential embodiment, the air recesses are made on both the containing elements in a reciprocally facing position, which reduces the influence of the positioning of the resistor device, whether horizontal, vertical or upside down, on the melting temperatures.

[0046] According to another embodiment of the invention, at least one of the containing elements of the resistive element has one or more inserts, arranged facing the resistive element itself and made of a material having a higher heat resistance than the material with which the containing elements are made.

[0047] The inserts define several localised zones of discontinuity of the resistor device characterised by a different coefficient of heat exchange and therefore suitable to define points wherein the resistive element can melt without reaching high temperatures over its whole extension.

[0048] By sizing the inserts differently, it is possible to obtain several zones defining values of temperature which are different due to the localised melting of the resistive element.

[0049] In one embodiment of the invention, the resistive element is produced by shearing a plate or strip made of resistive material.

[0050] According to a variant, the resistive element and/or the containing structure cooperate with means to dissipate heat.

[0051] According to a further variant, the containing structure contains more than one resistive element, each of which can be electrically insulated, connected in series or parallel to the other resistive elements.

[0052] According to the invention the containing structure comprises at least two parts which can be joined together. According to a variant, the at least two parts can be associated by gluing or by using hardware elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] The attached Figures are given as a non-restrictive example and show some preferential embodiments of the invention wherein:

Fig. 1 is an exploded view of a possible form of embodiment of a resistor device according to the invention;

Fig. 2 shows a partial and enlarged transverse section of the resistor device according to the invention;

Fig. 3 shows a variant of Fig. 2;

Fig. 4 shows the resistor device in its assembled configuration.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0054] The resistor device with fuse function 10 shown in Fig. 1 comprises at least a resistive element 14, made of a conductor material, which lies substantially on a plane and develops according to an open path.

[0055] In the embodiment shown, the resistive element 14 develops for at least part of its length in a fretted path.

[0056] At the ends of the resistive element 14 respective terminals 15a and 15b are associated or made; these allow a rapid connection of the device 10 to any electric circuit whatsoever which feeds a load in a motor vehicle, for example the electric fan in a radiator.

[0057] The resistive element 14 is enclosed between two containing elements, respectively upper 18 and lower 17, made of insulating material so as to define a sandwich-type configuration.

[0058] The terminals 15a and 15b emerge from the lower containing element 17.

[0059] The containing elements 17 and 18 electrically insulate the resistive element 14 with respect to the outside and fulfil the function of at least partly dissipating the heat which develops on the resistive element 14 when the current passes through.

[0060] Between the containing elements 17 and 18, in this case, a binding material 19 is inserted, for example cement, which makes the components solid and also carries out a heat dissipation function. The combination of the resistive element 14 and the containing elements 17 and 18 is inserted inside a box-like container 13, preferably made of aluminium, which constitutes the casing to house and protect the resistor device 10.

[0061] The box-like container 13 in this case is made in a single piece and comprises a closing cover 13a and a base 13b; it could however be made in two pieces which can be closed, by welding, by slotting together or by hardware elements.

[0062] The primary function of the box-like container 13 is to protect the containing elements 17 and 18 from wear and knocks; it also supplies an auxiliary contribution to the dissipation of the heat generated when the current passes through the resistive element 14.

[0063] To this end, in an embodiment not shown here, the cover 13a of the container 13 can be provided with fins or corrugations suitable to improve the heat dissipation capacity.

[0064] As can be seen in Fig. 4, in the assembled configuration the resistor device 10 appears like a

closed container 13 from which only the connection terminals 15a and 15b emerge.

[0065] Fig. 1 shows a plastic base 12 which can be used optionally to assemble the resistor device 10 inside the vehicle.

[0066] According to the invention, as can be seen in Fig. 2, in a defined segment the upper containing element 18 has a reduction in section 11 defining a localised recess of air 111 around a corresponding and defined segment of the resistive element 14. The presence of the air recess 111, which modifies in that area the ability of the upper containing element 18 to remove heat from the remaining part of the resistive element 14, causes a localised modification of the ability to dissipate heat from the resistive element 14.

[0067] Since in the presence of the air recess 111 a point of discontinuity is obtained wherein the heat flow is less than where there is no air recess 111, the resistive element 14 reaches, in correspondence with said segment, a much higher temperature than in its remaining part, given the same current circulating and therefore of power transmitted.

[0068] Therefore, by properly sizing the air recess 111, we define a localised segment of the resistive element 14 which reaches its melting temperature even if the remaining part of the resistive element 14 is at a much lower temperature than the melting temperature.

[0069] When the localised segment melts, it is possible to interrupt the electric current of the circuit immediately, which safeguards the other components from overloads and prevents generalised overheating of the resistor device 10 which can even cause fires.

[0070] In this case, there is also an analogous air recess 111' on the lower containing element 17, facing that 111 on the upper containing element 18.

[0071] This embodiment not only causes a further reduction in the heat flow removed, and therefore causes the corresponding segment of the resistive element 14 to melt with currents circulating of an even lower value, but also makes substantially irrelevant the direction in which the resistor device 10 is positioned with respect to its assembly seating.

[0072] According to the variant shown in Fig. 3, the upper containing element 18 and the lower containing element 17 include inserts of material 16 facing the resistive element 14 and opposite each other, characterised by a coefficient of heat exchange which is different from that of the material of the elements 17 and 18.

[0073] The inserts 16, which may both be made of the same material, or even of different materials, define a localised zone of discontinuity characterised by a different behaviour of the heat exchange between the resistive element 14 and the outside.

[0074] This allows to achieve a condition which permits the resistive element 14 to melt with a value of temperature which can be selected according to the material used and to the sizing of the insert 16.

[0075] The inserts 16 can also be removable and replaceable, so as to create, with a single resistor device 10, a modifiable variety of melting conditions according to the specific application. According to a variant which is not shown here, the device 10 has more than one resistive element 14, each of which can be electrically insulated or connected in series and/or parallel to the other resistive elements.

[0076] It is obvious that modifications and variations may be made to this invention, but they shall remain within the field and scope thereof.

[0077] It is also obvious that, although we have shown and described as examples embodiments of a resistor device 10 according to the invention, a skilled person in the field will be able to achieve other equivalent forms of a resistor device which come within the field and scope of this invention.

Claims

1. Resistor device with fuse function, used in an electric circuit in order to provoke a fall in tension, comprising at least a resistive element (14), able to have current pass through, made of a conductor material and developing substantially on one plane, the ends of said resistive element (14) cooperating with terminals (15a, 15b) connecting to said electric circuit, the resistive element (14) being enclosed between at least two containing insulating elements, respectively upper (18) and lower (17), the function of which is at least to dissipate heat, the device being characterised in that in at least one segment of at least one of said containing elements (17, 18) there is a localised zone of discontinuity characterised by a coefficient of heat exchange less than the coefficient of heat exchange of the remaining part of said at least one containing element (17, 18), said localised zone of discontinuity being able to create along said resistive element (14) a defined preferential melting point when the circulating current exceeds a pre-determined threshold value.

2. Device as in Claim 1, characterised in that said zone of lesser heat exchange has a higher heat resistance, and therefore a lower conductivity, than the adjacent zones, and is suitable to cause a localised modification of the heat flow dissipated by the relative containing element (17, 18).

3. Device as in Claim 1 or 2, characterised in that said zone of lesser heat exchange is defined by a reduction in section (11) suitable to define an air recess (111, 111') around a corresponding segment of the resistive element (14), said air recess (111, 111') causing a localised variation in the ability to dissipate heat from the resistive element (14).

4. Device as in Claim 3, characterised in that said air

recess (111) is present on the upper containing element (18).

5. Device as in Claim 3 or 4, characterised in that said air recess (111') is present on the lower containing element (17) in a position facing that (111) on the upper containing element (18).

6. Device as in Claim 1 or 2, characterised in that said zone of lesser heat exchange is defined by an insert (16) arranged facing the resistive element (14) and made of a material characterised by a higher heat resistance than the material of which the containing elements (17, 18) are made.

7. Device as in Claim 6, characterised in that said inserts (16) are arranged in a reciprocally opposite position in both the containing elements (17, 18).

8. Device as in Claim 6 or 7, characterised in that said inserts (16) are removable and replaceable.

9. Device as in any claim hereinbefore, characterised in that a binding material (19) is inserted between the containing elements (17, 18) and the resistive element (14).

10. Device as in any claim hereinbefore, characterised in that the resistive element (14) develops, for at least part of its length, according to a fretted path.

11. Device as in any claim from 1 to 9 inclusive, characterised in that the resistive element (14) develops, for at least part of its length, according to a coiled path.

12. Device as in any claim hereinbefore, characterised in that it comprises a metal box-like container (13) suitable to contain the combination consisting of the resistive element (14) and the containing elements (17, 18).

13. Device as in Claim 12, characterised in that the box-like container (13) comprises at least a closing cover (13a) and a base (13b), said cover (13a) including heat-dissipating fins or corrugations.

14. Device as in any claim hereinbefore, characterised in that it comprises an assembly base (12).

15. Device as in any claim hereinbefore, characterised in that it includes more than one resistive element (14), each resistive element (14) being able to be electrically insulated, connected in series or parallel to the other resistive elements (14).

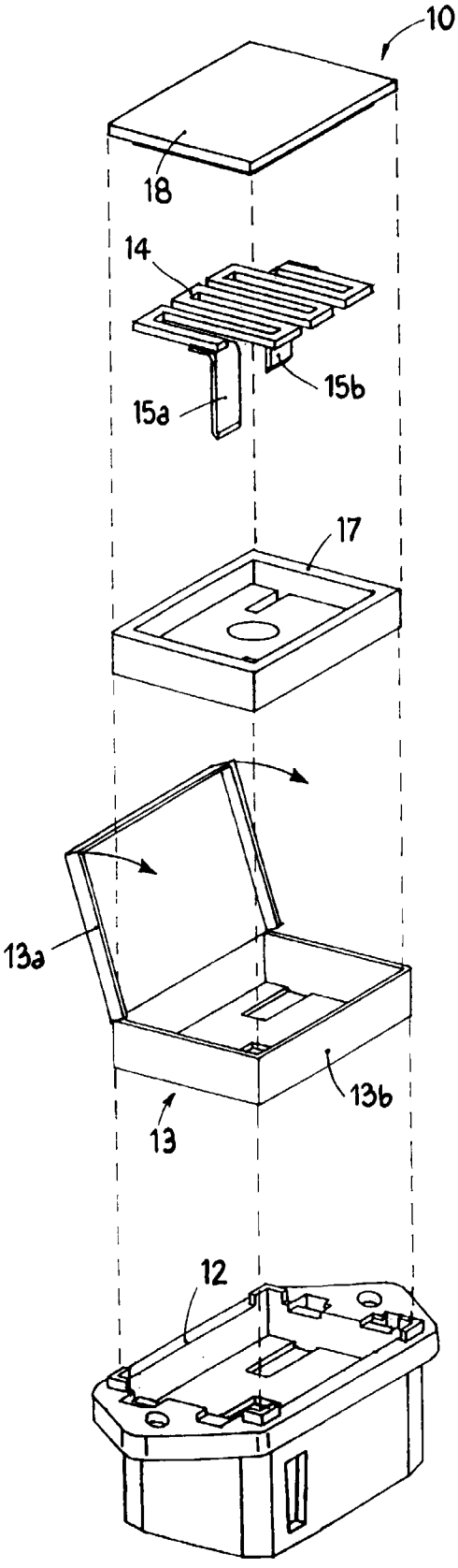

fig.1

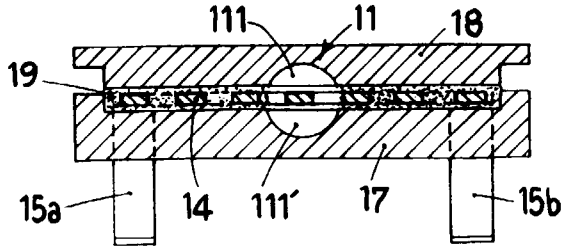

fig.2

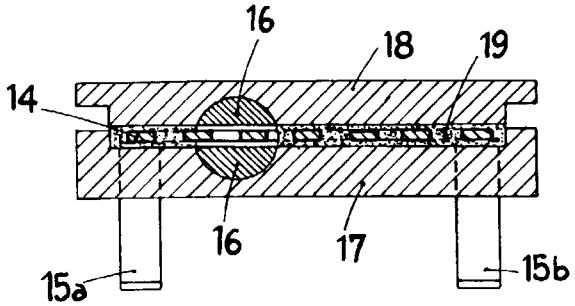

fig.3

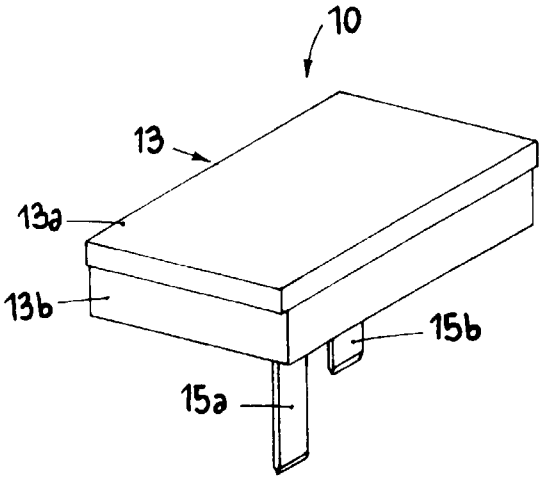

fig.4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 4282

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 August 2000	Odgers, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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