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(71) Applicant: **Nippon Seisen Cable, Ltd.**
Tokyo (JP)

(72) Inventors:
- **Nakaji, Fumihiro**
  Nippon Seisen Cable, Ltd.
  Gumma-ken (JP)
- **Lee, Jae Sung**
  Nippon Seisen Cable, Ltd.
  MInato-ku, Tokyo (JP)
- **Ishii, Wataru**
  Nippon Seisen Cable, Ltd.
  Gumma-ken (JP)
- **Shimano, Terumi**
  Nippon Seisen Cable, Ltd.
  Gumma-ken (JP)
- **Kabazawa, Kazuaki**
  Nippon Seisen Cable, Ltd.
  Gumma-ken (JP)

(74) Representative: **Fuchs**
Patentanwälte
Söhnleinstraße 8
65201 Wiesbaden (DE)

(54) **Surface-mount current fuse**

(57) A current fuse includes a case (10), a pair of metal terminals (30), and a fuse element assembly (40). The case (10) includes a pair of terminal insertion holes (12, 13). Each metal terminal (30) has a loop-like apex portion (31), a pair of first linear portions (32a, 32b) and a pair of second linear portions (33a, 33b). The pair of first linear portions (32a, 32b) is inserted in the pair of terminal insertion holes (12, 13). The fuse element assembly (40) has a glass fiber bundle (41) which is wound with a fuse wire (42) spirally. Each apex portion (31) is located inside the case (10), both end portions of the fuse element assembly (40) are inserted and held in the interior of the apex portion (31) and the fuse wire (42) is joined electrically to the pair of metal terminals (30).

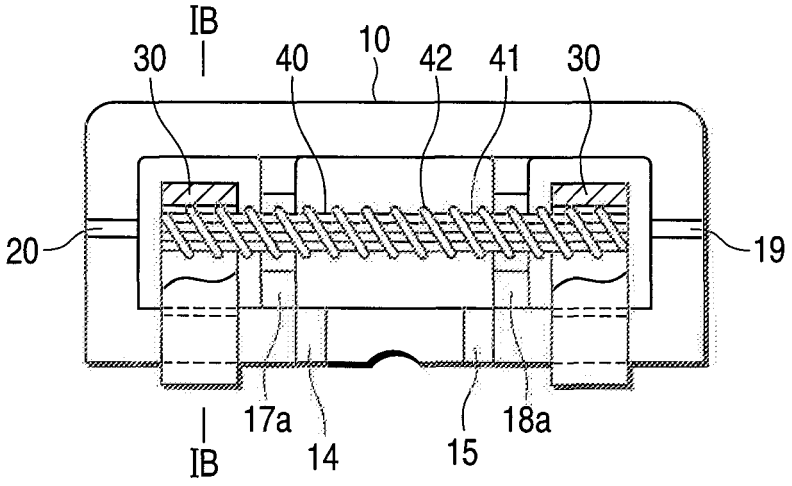

FIG. 1A

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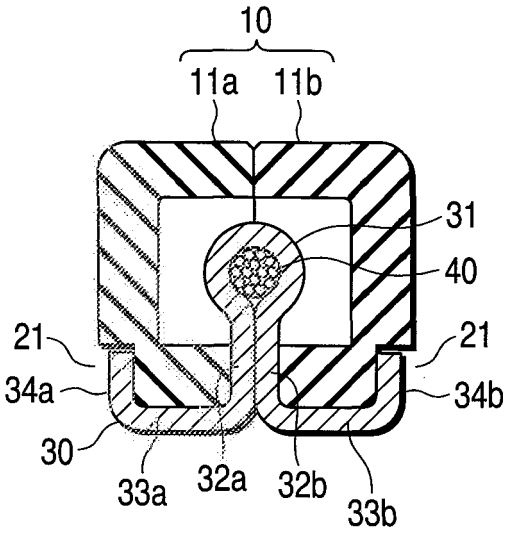
10
11a
11b
31
40
21
21
34a
34b
30
33a
32a
32b
33b

FIG. 1B

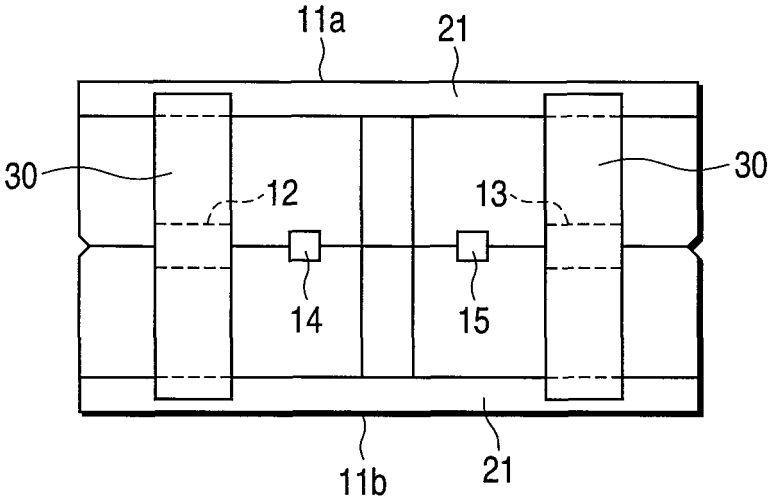
11a
21
30
12
13
30
14
15
11b
21

FIG. 1C

Description

[0001] The present invention relates to a surface-mount current fuse mounted on, for example, a printed circuit board.

[0002] With miniaturization and intensification of mounting density of electronic devices accelerated, the miniaturization and intensification of the mounting density have been demanded for a surface-mount current fuse to be mounted on a printed circuit board. As this kind of a conventional surface-mount current fuse, for example, a type disclosed in Jpn. Pat. Appln. KOKAI Publication No. 9-63455 has been known. In this fuse, pair of metal electrodes which hold a fuse wire are attached to its box-shaped main body at both ends and a lid portion is pressed down to a position where it is sunk slightly from the top surface of the main body. The lid portion is bonded and fixed to the main body with adhesive agent so as to seal the interior, so that the fuse wire is stretched in a floating condition in an interior space of the main body.

[0003] In the fuse having such a structure, adhesive agent is used for fixing of the lid portion considering a gas pressure when it is broken out, treatment of exhaust gas, fixing of the terminal and the like. Therefore, this kind of fuse has disadvantages in terms of manufacturing with automatic equipment and manufacturing cost. Further, because the fuse wire is stretched in the floating condition in the interior space of the main body, it is likely to be affected by vibration and shock thereby leading to reduction in reliability.

[0004] The present invention has been achieved in views of the above-described circumstances and an object of the invention is to provide a surface-mount current fuse which can be manufactured with automatic equipment, allows its manufacturing cost to be reduced and is hardly affected by vibration and shock, thereby securing high reliability.

[0005] According to one aspect of the present invention, there is provided a surface-mount current fuse comprising: a case which is constructed by melting and joining together end faces of a pair of insulation case members each having a substantially rectangular parallelepiped box shape and is provided with a pair of terminal insertion holes at the bottom portion thereof; a pair of metal terminals each having a loop-like apex portion, a first linear portion extending from the apex portion and a second linear portion which is bent substantially at right angles at a terminal end of the first linear portion; and a fuse element assembly in which fuse wire is wound around bundled rod-like glass fiber materials spirally at a predetermined pitch, wherein the apex portions of the pair of metal terminals are located inside the case, both end portions of the fuse element assembly are inserted and held in the apex portions of the pair of metal terminals while the fuse wire is joined electrically to the pair of metal terminals at each apex portion, the first linear portion of the pair of metal terminals penetrates the pair of terminal insertion holes provided in the bottom portion of the case so that the pair of second linear portions are exposed out of the case, and the second linear portions are located along the bottom portion of the case thereby constituting an electrode terminal.

[0006] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIGS. 1A to 1C are a front view, sectional view and bottom view showing the entire configuration of a surface-mount current fuse according to a first embodiment of the present invention;

FIG. 2 is a perspective view showing the structure of one of a pair of insulation case members shown in FIG. 1;

FIG. 3 is a perspective view for explaining a method for assembling a fuse element assembly;

FIGS. 4A to 4C are a front view, sectional view and bottom view showing the entire configuration of a surface-mount current fuse according to a second embodiment of the present invention;

FIGS. 5A to 5C are a front view, sectional view and bottom view showing the entire configuration of a surface-mount current fuse according to a third embodiment of the present invention; and

FIGS. 6A to 6C are a front view, sectional view and bottom view showing the entire configuration of a surface-mount current fuse according to a fourth embodiment of the present invention.

(First embodiment)

[0007] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawing.

[0008] FIGS. 1A to 1C show the entire structure of a surface-mount current fuse according to the first embodiment of the present invention. FIG. 1A is a partially broken front view thereof, FIG. 1B is a sectional view of FIG. 1A, and FIG. 1C is a bottom view thereof. The surface-mount current fuse of this embodiment includes a case 10, a pair of metal terminals 30 and a fuse element assembly 40.

[0009] The case 10 is configured by melting and joining open end faces of a pair of molded insulation case members 11a, 11b having a substantially rectangular parallelepiped box shape.

[0010] FIG. 2 is a perspective view showing one of the pair of insulation cases 11a, 11b. Recesses 12a, 13a (or 12b, 13b) for terminal insertion holes 12, 13 are formed at corresponding positions of the bottom portion of the pair of insulation case members 11a, 11b, so that when the pair of insulation case members 11a, 11b are joined together, the pair of terminal insertion holes 12, 13 are formed in the bottom portion of the case 10, as shown in FIG. 1C. Further, recesses 14a, 15a (or 14b, 15b) for exhaust holes 14, 15 are formed at corresponding posi-

tions of the bottom portion of the pair of insulation case members 11a, 11b, so that when the pair of insulation case members 11a, 11b are joined together, the pair of exhaust holes 14, 15 having a smaller diameter than the terminal insertion holes 12, 13 are formed in the bottom portion of the case 10, as shown in FIG. 1C.

[0011] Pair of wall portions 17a, 18a (or 17b, 18b) is formed by being molded integrally with the insulation case members at opposed positions within the pair of insulation case members 11a, 11b in order to hold the fuse element assembly 40 as shown in FIG. 2. Further, recesses 19a, 20a (or 19b, 20b) for exhaust holes 19, 20 are formed so as to form a pair of exhaust holes 19, 20 in a pair of side faces of the case 10 when the pair of insulation case members 11a, 11b are joined together. The size of the recesses 19a, 20a (19b, 20b) is substantially the same as the size of the recesses 14a, 15a (or 14b, 15b). As shown in FIG. 1A, the side faces of the case 10 in which the exhaust holes 19, 20 are to be formed are side faces opposed to end faces of both end portions of the fuse element assembly 40.

[0012] The pair of metal terminals 30 is formed by bending a metal sheet or a round linear material (metal sheet in this example). As shown in FIG. 1B, the pair of metal terminals 30 are constituted of loop-like apex portions 31, a pair of first linear portions 32a, 32b extending in the same direction from the apex portion 31, a pair of second linear portions 33a, 33b extending in opposite directions after being bent substantially at right angles at each terminal end of the pair of first linear portions 32a, 32b and a pair of third linear portions 34a, 34b extending in a direction toward the apex portion 31 after being bent substantially at right angles at each terminal end of the pair of second linear portions 33a, 33b. That is, each of the pair of metal terminals 30 has a substantially Ω shape.

[0013] As shown in FIG. 1A, the fuse element assembly 40 is configured by winding a fuse wire 42 spirally around a rod-like glass fiber bundle 41 at a predetermined pitch. In the fuse element assembly 40, the fuse wire 42 is heated by Joule heat produced when a current larger than a rated one (abnormal current produced by an eddy current or a circuit problem) flows so that it is melted in a predetermined time. Thus, the fuse wire 42 is different in diameter and material depending on the rated current, and designed and set to satisfy each characteristic.

[0014] The fuse element assembly 40 is constructed so that both end portions thereof are inserted and held in the interior of each apex portion 31 of the pair of metal terminals 30, and the fuse wire 42 is connected electrically to the pair of metal terminals 30 at each apex portion 31 by spot welding, soldering or the like.

[0015] The pair of first linear portions 32a, 32b of each of the pair of metal terminals 30 are inserted through each of the pair of terminal insertion holes 12, 13 in the bottom portion of the case 10 so that the apex portions 31 of the pair of metal terminals 30 are located within the interior of the case 10 when the fuse element assembly 40 is assembled.

[0016] As shown in FIG. 1B, the pairs of the second linear portions 33a, 33b and the third linear portions 34a, 34b of each of the pair of metal terminals 30 are exposed out of the case. The second linear portions 33a, 33b are located along the bottom portion of the case 10 thereby constituting an electrode terminal for use at the time of joining to a printed circuit board by soldering. The third linear portions 34a, 34b are located along the external shape of the case side faces to sandwich the case from both sides. For the third linear portions 34a, 34b not to be projected from the external surface of the product, as shown in FIG. 1, recess portions 21 are formed in the pair of insulation case members 11a, 11b. The third linear portions 34a, 34b can be used as a test terminal for confirming conduction of the fuse wire 42 after being joined to a printed circuit board.

[0017] The pair of wall portions 17a, 18a (17b, 18b) molded integrally with the insulation case member are provided at opposed positions in the interior of the pair of insulation case members 11a, 11b in order to hold the fuse element assembly 40. The pair of wall portions 17a, 18a (17b, 18b) are bored into a substantially semicircular shape agreeing with the external shape of the assembly 40 at a portion which makes contact with the fuse element assembly 40, thereby taking a role as a guide for preventing the fuse element assembly 40 from being bent at the time of manufacture and preventing vibration or shock from being applied to the fuse element assembly 40 after manufacture so as to improve the reliability of the product. Further, the pair of wall portions 17a, 18a (17b, 18b) take a role of blocking scattering of arc gas produced when the current fuse is shut down. Generally, if a large current (short-circuit current) flows, the fuse wire is melted substantially at a central portion where the temperature of the fuse element assembly 40 reaches a highest point with a rapid temperature rise of the fuse element assembly 40. Arc gas produced at this time contains metallic vapor, thereby deterioration of insulation being likely produced after the shutdown. This is an important technical problem which should be solved in a small-size, small-volume product like the surface-mount current fuse of the present invention. In the pair of wall portions 17a, 18a (17b, 18b), when arc gas is scattered, a portion which acts as a shadow acts effectively in a scattering direction of arc gas, thereby suppressing deterioration of the insulation after the shutdown.

[0018] Pair of small exhaust holes 14, 15 is formed in the bottom portion of the case 10. The exhaust holes 14, 15 have an effect of reducing the pressure of the arc gas at the time of the shutdown. Further, the pair of small exhaust holes 19, 20 are formed in the side faces of the case 10. The exhaust holes 19, 20 also have the effect of reducing the pressure of the arc gas at the time of the shutdown.

[0019] The surface-mount current fuse of this embodiment is manufactured as follows. That is, as shown in FIG. 3, the pair of metal terminals 30 is formed in a condition in which the loop-like apex portion 31 is open to

some extent and both end portions of the fuse element assembly 40 are automatically inserted into the apex portions 31 of the pair of metal terminals 30. After that, the first linear portions 32a, 32b are pressed against each other to come into contact with each other, so that they are formed into a substantially Ω shape, which is a predetermined shape, and the fuse wire 41 is welded or soldered to the apex portion 31 while the shape thereof is fixed.

[0020] With the fuse element assembly 40 assembled, the apex portions 31 of the pair of metal terminals 30 are accommodated within the insulation case member 11a (or 11b) on one side and the pair of first linear portions 32a, 32b of each of the pair of metal terminals 30 is inserted into the recesses 12a, 13a in the insulation case member 11a. After that, the other insulation case member 11b (or 11a) is mounted so that the fuse element assembly 40 and the pair of metal terminals 30 are positioned. After that, the open end faces of the pair of insulation case members 11a, 11b are melted and joined together so as to build up the case 10. As a result of this joining, the pair of metal terminals 30 is sandwiched by the case 10 so as to stabilize the position thereof.

[0021] The surface-mount current fuse of this embodiment can be manufactured with automatic equipment because it has a structure suitable for the manufacturing with the automatic equipment. Further, because it does not need the use of an adhesive agent as is conventional, manufacturing cost thereof can be reduced.

[0022] Although in this embodiment, a case of forming the pair of metal terminals 30 by bending a metal sheet has been described above, the pair of metal terminals 30 may be formed by bending a round wire material. In this case, it is permissible to leave the pair of first linear portions 32a, 32b in an original rounded shape and process the other portions, that is, the loop-like apex portion 31, the pair of second linear portions 33a, 33b and the pair of third linear portions 34a, 34b into a flat shape.

(Second embodiment)

[0023] FIGS. 4A to 4C show the entire structure of a surface-mount current fuse according to the second embodiment of the present invention. FIG. 4A is a partially broken perspective view thereof, FIG. 4B is a sectional view thereof and FIG. 4C is a bottom view thereof.

[0024] The surface-mount current fuse of this embodiment is different from the first embodiment shown in FIG. 1 in the shape of the pair of metal terminals 30. That is, each of the pair of metal terminals 30 is formed by bending a metal sheet or a rounded wire material (metal sheet in this example). As shown in FIG. 4B, the metal terminal is composed of a loop-like apex portion 31, a first linear portion 32a extending from this apex portion 31 and a second linear portion 33a bent substantially at right angles at a terminal end of the first linear portion 32a.

[0025] Also in this case, the fuse element assembly 40 is configured so that both end portions thereof are inserted and held in the interior of the apex portions 31 of the pair of metal terminals 30 and the fuse wire 42 is joined electrically to the apex portions 31 of the pair of metal terminals 30 by spot welding, soldering or the like.

[0026] Each first linear portion 32a of the pair of metal terminals 30 is inserted through each of the pair of terminal insertion holes 12, 13 in the bottom portion of the case 10, so that the apex portions 31 of the pair of metal terminals 30 are located within the interior of the case 10 when the fuse element assembly 40 is assembled.

[0027] As shown in FIG. 4B, the second linear portion 33a of the pair of metal terminals 30 is exposed out of the case and the second linear portion 33a is located along the bottom portion of the case 10, thereby constructing an electrode terminal for use in joining of this current fuse to a printed circuit board by soldering. In this case, the second linear portions 33a of the pair of metal terminals 30 are bent at a terminal end of the first linear portion 32a and extended in opposite directions to each other. That is, as shown in FIG. 4C, the second linear portions 33a of the pair of metal terminals 30 are located on a diagonal line as seen from the bottom side of the surface-mount current fuse.

[0028] In this embodiment, each of the pair of metal terminals 30 has one second linear portion 33a. Because this second linear portion 33a penetrates each of the pair of terminal insertion holes 12, 13 provided in the bottom portion of the case, the shape of the recesses 12a, 13a (or 12b, 13b) for the terminal insertion holes shown in FIG. 2 which constitute the terminal insertion holes 12, 13 is smaller than in FIG. 1.

[0029] Although in this embodiment, a case where the pair of metal terminals 30 are provided with no third linear portion 34a has been described, this embodiment may be modified by providing the third linear portion 34a like the first embodiment. This third linear portion 34a can be used as a test terminal for confirming conduction of the fuse wire 42 after this is joined to the printed circuit board.

(Third embodiment)

[0030] FIGS. 5A to 5C show the entire structure of the surface-mount current fuse according to the third embodiment of the present invention. FIG. 5A is a partially broken front view thereof, FIG. 5B is a sectional view of FIG. 5A and FIG. 5C is a bottom view thereof.

[0031] In the surface-mount current fuse of this embodiment, the second linear portions 33a of the pair of metal terminals 30 are bent at each terminal end of the first linear portion 32a and extended in the same directions, which is different from the second embodiment shown in FIG. 4. For example, as shown in FIG. 5C, the second linear portions 33a of the pair of metal terminals 30 are bent toward the insulation case member 11b on one side as seen from the bottom side of the surface-mount current fuse.

[0032] According to this embodiment, as in the second embodiment, each of the pair of metal terminals 30 has

one second linear portion 33a. Because this second linear portion 33a penetrates each of the pair of terminal insertion holes 12, 13 provided in the bottom portion of the case, the shape of the recesses 12a, 13a (or 12b, 13b) for the terminal insertion hole shown in FIG. 2 which constitute the terminal insertion holes 12, 13 is smaller than in FIG. 1.

[0033] Although in this embodiment, a case where the pair of metal terminals 30 are provided with no third linear portion 34a has been described, this embodiment may be modified to be provided with the third linear portion 34a like the first embodiment. This third linear portion 34a can be used as a test terminal for confirming conduction of the fuse wire 42 after this current fuse is joined to a printed circuit board.

(Fourth embodiment)

[0034] FIGS. 6A to 6C show the entire configuration of a surface-mount current fuse according to the fourth embodiment of the present invention. FIG. 6A is a partially broken front view thereof, FIG. 6B is a sectional view of FIG. 6A, and FIG. 6C is a bottom view thereof.

[0035] In the surface-mount current fuse of this embodiment, the pair of wall portions 17a, 18a (17b, 18b) is omitted from the first embodiment shown in FIG. 1. Instead, a pair of wall portions 22a, 23a (22b, 23b) formed integrally with the insulation case members are provided to hold each apex portion 31 of the pair of metal terminals 30. The pair of wall portions 22a, 23a (22b, 23b) are bored into a substantially semicircular shape which agrees with the external shape of the apex portion 31 at a portion which makes contact with the apex portion 31. This pair of wall portions 22a, 23a (22b, 23b) take a role as a guide for preventing the fuse element assembly 40 from being bent at the time of assembly and a role of improving the reliability by preventing vibration or shock from being applied to the fuse element assembly 40 after this current fuse is manufactured. Further, the pair of wall portions 22a, 23a (22b, 23b) take a role of blocking scattering of arc gas produced at the time of shutdown like the pair of wall portions 17a, 18a (17b, 18b) shown in FIG. 1.

[0036] The pair of wall portions 22a, 23a (22b, 23b) for use in the surface-mount current fuse of this embodiment may be used in the surface-mount current fuse of the second and third embodiments.

[0037] Although the present invention has been described with reference to the embodiments, the present invention is not restricted to the above-described embodiments but may be modified in various ways within a scope not departing from the gist of the invention. Further, the above embodiments contain various stages of the present invention and other embodiment of the present invention can be extracted by an appropriate combination of the disclosed plural components. Even if some components are deleted from all the components indicated in the above embodiments, as long as at least one of the problems which the present invention intends to solve is solved and at least one of the effects which are mentioned as the effects of the present invention is obtained, the configuration excluding the deleted components may be picked up as another embodiment of the present invention.

Claims

1. A surface-mount current fuse **characterized by** comprising:

a case (10) which is constructed by melting and joining together end faces of a pair of insulation case members (11a, 11b) each having a substantially rectangular parallelepiped box shape and is provided with a pair of terminal insertion holes (12, 13) at the bottom portion thereof;
a pair of metal terminals (30) each having a loop-like apex portion (31), a first linear portion (32a) extending from the apex portion and a second linear portion (33a) which is bent substantially at right angles at a terminal end of the first linear portion; and
a fuse element assembly (40) in which fuse wire (42) is wound around bundled rod-like glass fiber materials (41) spirally at a predetermined pitch, wherein the apex portions (31) of the pair of metal terminals (30) are located inside the case (10), both end portions of the fuse element assembly (40) are inserted and held in the apex portions (31) of the pair of metal terminals (30) while the fuse wire (42) is joined electrically to the pair of metal terminals (30) at each apex portion (31),
the first linear portion (32a) of the pair of metal terminals (30) penetrates the pair of terminal insertion holes (12, 13) provided in the bottom portion of the case (10) so that the pair of second linear portions (33a) are exposed out of the case (10), and
the second linear portions (33a) are located along the bottom portion of the case (10) thereby constituting an electrode terminal.

2. The surface-mount current fuse according to claim 1, **characterized in that** each of the pair of metal terminals (30) has a third linear portion (32b) extending in the same direction as the extending direction of the first linear portion (32a) from the loop-like apex portion (31) and a fourth linear portion (33b) which is bent in an opposite direction to the second linear portion (33a) at a terminal end of the third linear portion.

3. The surface-mount current fuse according to claim 1, **characterized in that** the pair of insulation case members (11a, 11b) have a pair of wall portions (17a, 18a, 17b, 18b) which hold the fuse element assembly

(40) and are molded integrally with the insulation case member at positions opposed to each other inside the case (10).

4. The surface-mount current fuse according to claim 1, **characterized in that** exhaust holes (14, 15, 19, 20) for reducing a gas pressure when the fuse wire (42) is shut down are provided in the bottom portion and the side faces of the case (10).

5. The surface-mount current fuse according to claim 1, **characterized in that** the pair of insulation case members (11a, 11b) have a pair of wall portions (22a, 23a, 22b, 23b) which are molded integrally with the insulation case member and hold the apex portion (31) of the pair of metal terminals (30) at positions opposed to each other inside the case (10).

6. The surface-mount current fuse according to claim 1, **characterized in that** the second linear portions (33a) of the pair of metal terminals (30) are bent substantially at right angles at the terminal end of the first linear portion (32a) and extend in opposite directions to each other.

7. The surface-mount current fuse according to claim 1, **characterized in that** the second linear portions (33a) of the pair of metal terminals (30) are bent substantially at right angles at the terminal end of the first linear portion (32a) and extend in the same direction.

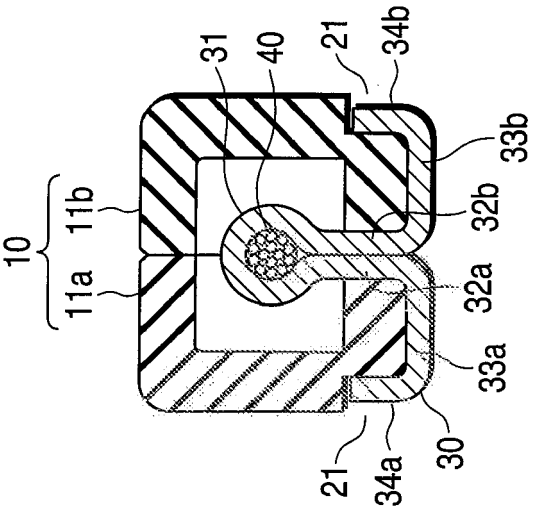

FIG. 1B

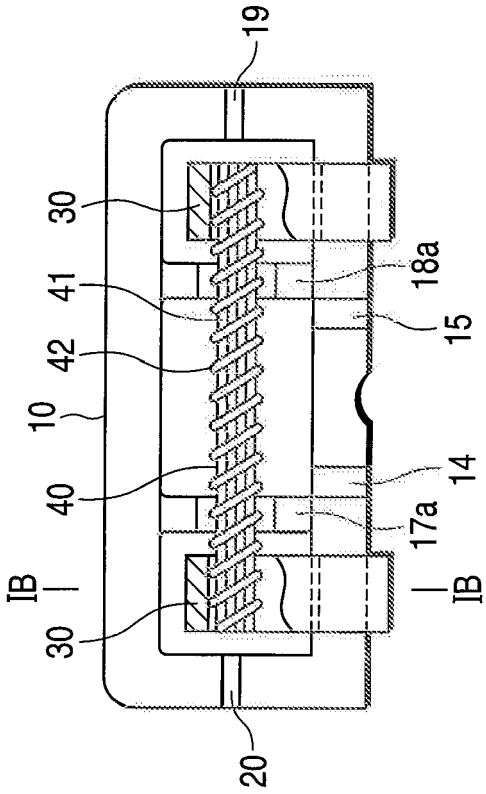

FIG. 1A

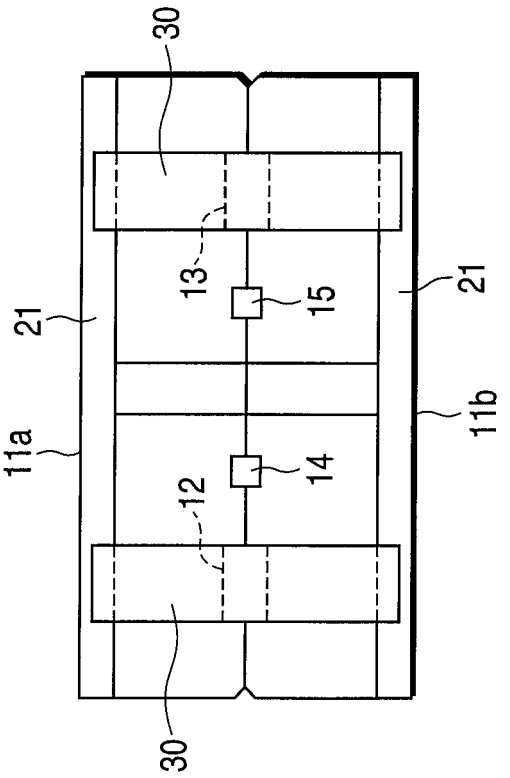

FIG. 1C

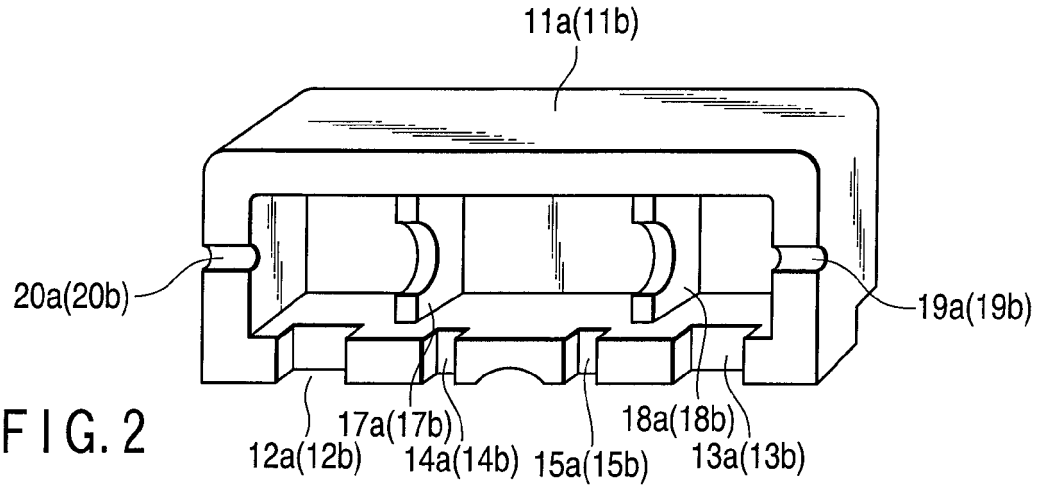
11a(11b)
20a(20b)
19a(19b)
12a(12b)
17a(17b)
14a(14b)
15a(15b)
18a(18b)
13a(13b)

FIG. 2

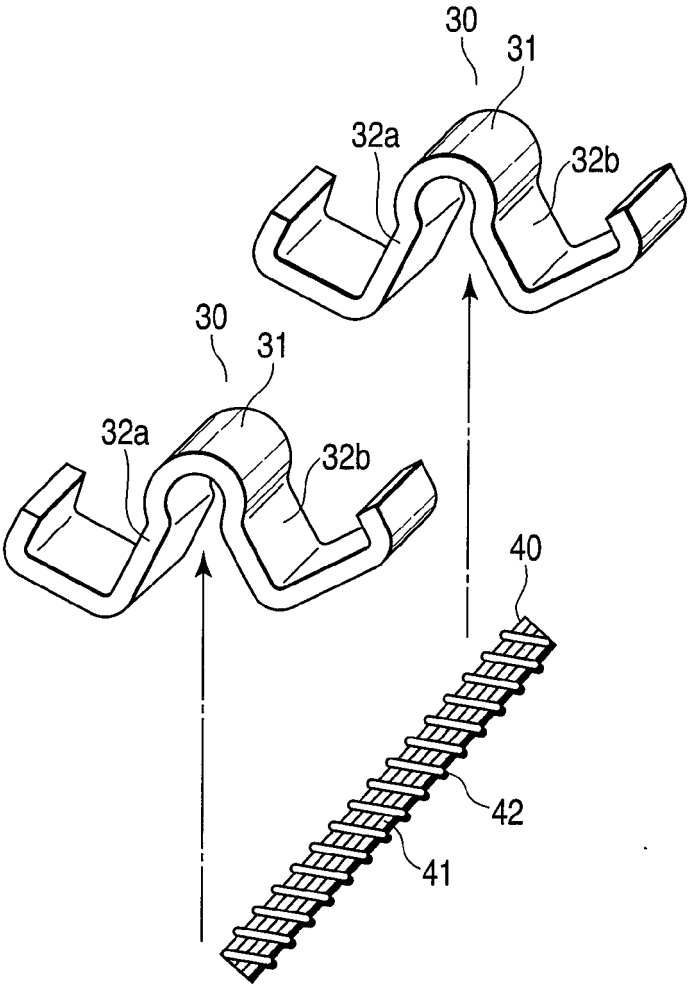
30
31
32a
32b
30
31
32a
32b
40
42
41

FIG. 3

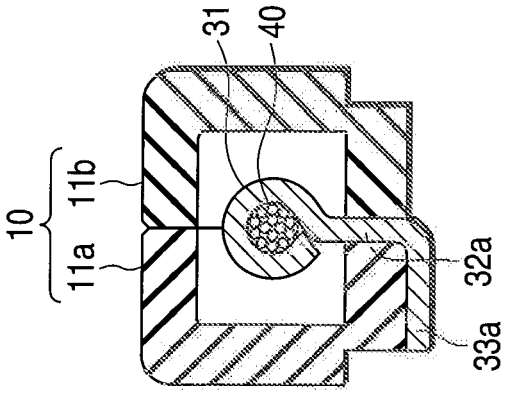

FIG. 4B

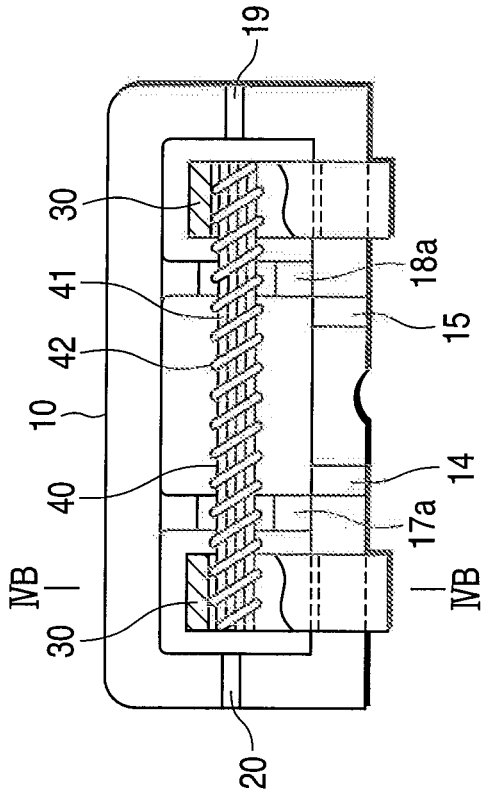

FIG. 4A

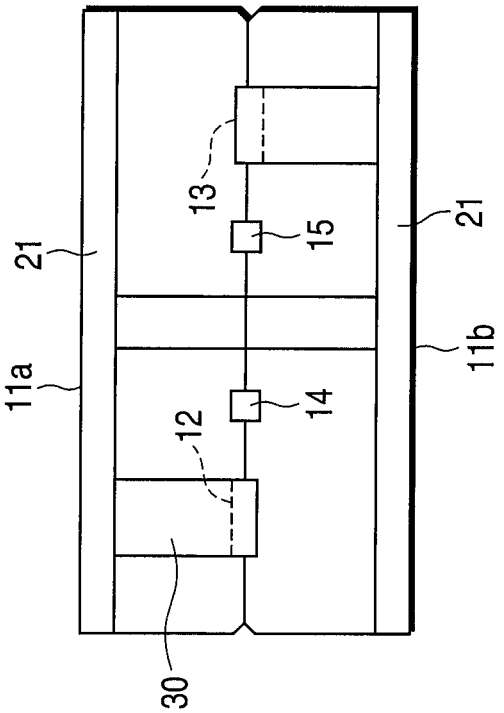

FIG. 4C

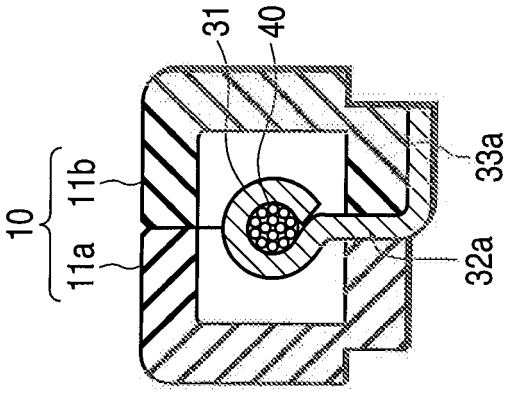

FIG. 5B

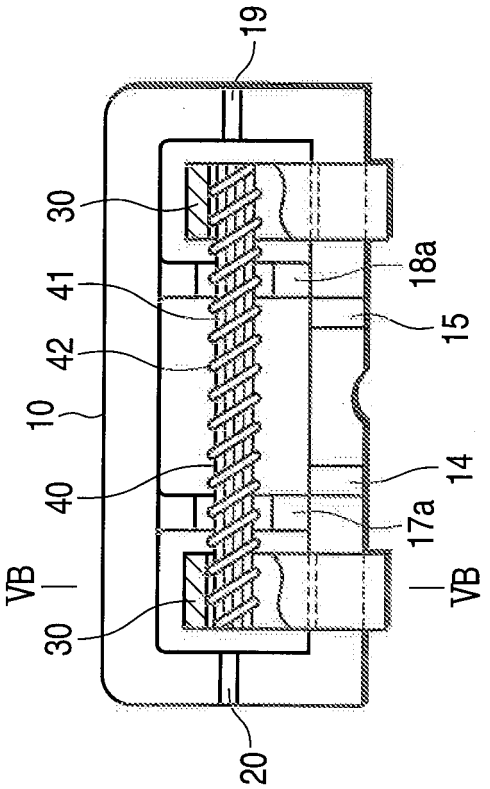

FIG. 5A

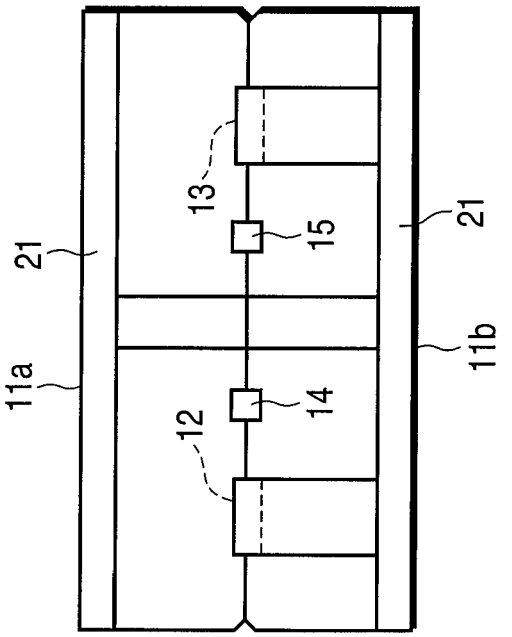

FIG. 5C

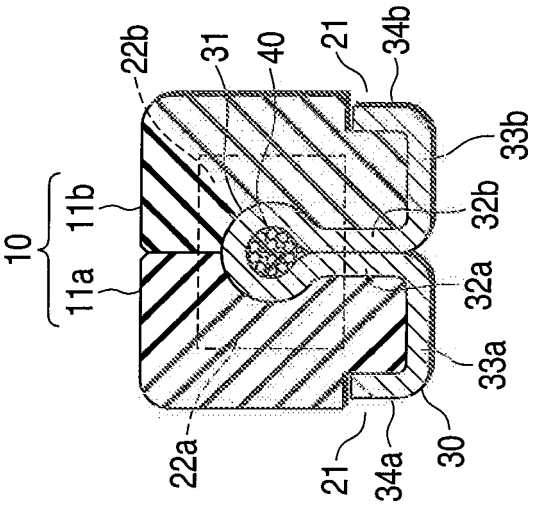

FIG. 6B

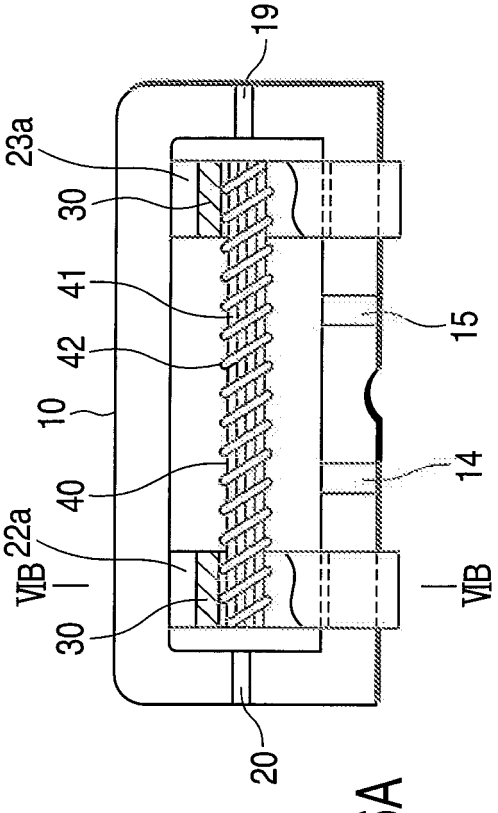

FIG. 6A

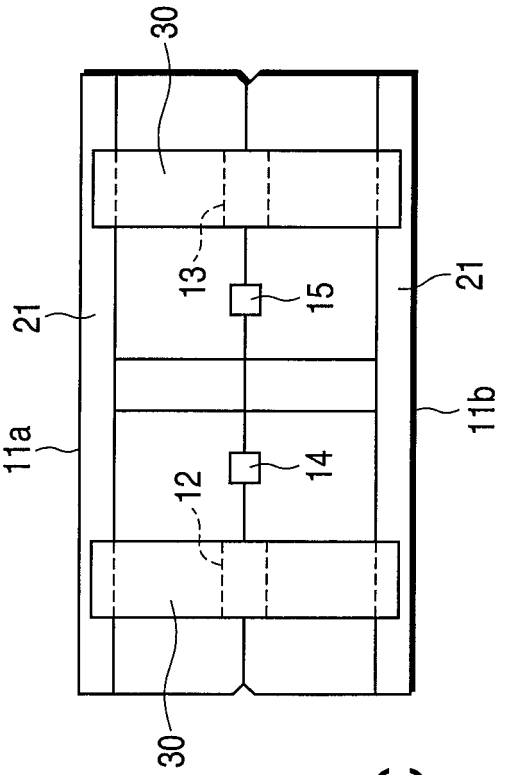

FIG. 6C

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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