(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 295 384 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
10.07.2024 Bulletin 2024/28

(21) Application number: **22707309.5**

(22) Date of filing: **16.02.2022**

(51) International Patent Classification (IPC):
H01H 37/04 *(2006.01)* ***H01H 37/76*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
H01H 37/04; H01H 37/765

(86) International application number:
PCT/US2022/016615

(87) International publication number:
WO 2022/178002 (25.08.2022 Gazette 2022/34)

(54) THERMAL CUT-OFF DEVICE HAVING A SINGLE-SIDED SILVER-PLATED HOUSING

THERMISCHE TRENNVORRICHTUNG MIT EINSEITIG VERSILBERTEM GEHÄUSE

DISPOSITIF DE COUPURE THERMIQUE COMPORTANT UN LOGEMENT MONOFACE PLAQUÉ D'ARGENT

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **18.02.2021 CN 202110187989**
15.02.2022 US 202217671755

(43) Date of publication of application:
27.12.2023 Bulletin 2023/52

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Application claims priority from Application 2021101879891, filed on February 18, 2021 in China and Application 17/671,755, filed on February 15, 2022 in the United States of America.

FIELD

[0002] The present disclosure relates to a temperature control device, and in particular to a thermal fuse (e.g., a thermal cut-off device (TCO)) and a single-sided, silver-plated metal housing.

BACKGROUND

[0003] This section provides background information related to the present disclosure which is not necessarily prior art.

[0004] In order to protect industrial or household electronic and electrical equipment from overheating and damage, thermal fuses are used.

[0005] A thermal fuse is a protection component that senses the temperature of the device and quickly cuts off the circuit when abnormally overheating. It has a wide range of application scenarios, including various home appliances, mobile equipment, communication equipment, office equipment, vehicle equipment, power adapters, and chargers, motors, batteries and other electronic components.

[0006] Because the conductivity of silver is relatively high, silver can be used as the plating layer of the copper shell of the thermal fuse, and the inner surface and the outer surface of the shell of the thermal fuse are plated with silver. An exemplary thermal fuse and a metal casing for a thermal fuse are for instance known from document JP S63 66814 A.

[0007] However, typical silver-plated thermal fuse components use a large amount of silver and the amount of silver used is unreasonable, wasteful and unduly increases costs.

[0008] Regarding the problem of the unreasonable silver content in the thermal fuse in the related technology, no effective solution has been proposed yet.

SUMMARY

[0009] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0010] In order to solve the above problems, a thermal fuse according to claim 1 and a metal shell according to claim 8 used for the thermal fuse are provided.

[0011] In one aspect, a thermal fuse is provided, including a housing extending from a first end to a second end along a longitudinal axis. The housing defines an inner space, and the housing has an electrically conductive inner surface and an outer surface.

[0012] A first conductive member is disposed at the first end of the housing and extends from the housing in a first direction along the longitudinal axis. The first conductive member is electrically connected to the inner surface of the housing.

[0013] A second conductive member is provided at the second end of the housing and extends from the housing in a second direction along the longitudinal axis. The second conductive member includes a contact surface at a distal endin the internal space of the housing.

[0014] A thermally responsive member is disposed in the inner space of the housing and located between the distal end of the second conductive member and the first conductive member. The thermally responsive member is formed from a non-conductive material, and the non-conductive material changes from a solid physical state to a non-solid physical state when reaching a temperature at or greater than a threshold temperature.

[0015] A conductive movable contact member is provided inside the inner space of the housing and located between the thermally responsive member and the distal end of the second conductive member. A perimeter part of the movable contact member is in direct contact with the inner surface of the housing.

[0016] A first biasing member is disposed between the thermally responsive member and the movable contact member. The first biasing member acts on the movable contact in a first direction along the longitudinal axis.

[0017] A second biasing member is disposed between the movable contact member and the second end of the housing and is positioned opposite to the first biasing member. The second biasing member acts on the movable contact member in a second direction along the longitudinal axis opposite to the first direction.

[0018] When the thermally responsive member is lower than the threshold temperature, the biasing force of the first biasing member is greater than the biasing force of the second biasing member, and the movable contact member is in direct contact with and electrically connected to the distal end of the second conductive member. When the second conductive member is in direct contact with the moveable contact member, the thermal fuse is operable to flow current through the thermal fuse, wherein the current path through the thermal fuse is from the first conductive member to the housing to the inner surface of the housing, then to the movable contact member, and then to the second conductive member.

[0019] Wherein, when the temperature of the thermally responsive member is at or higher than the threshold temperature, the biasing force of the first biasing member is less than the biasing force of the second biasing member, and the movable contact member moves away from the and out of contact with the distal end of the second conductive member. When the distal end of the second conductive member is separated from the movable contact member, the peripheral portion of the movable contact member remains in contact with the inner surface of the housing but the movable contact member is no longer electrically connected to the second conductive member. As such, the current path through the thermal fuse is interrupted and the thermal fuse is no longer operable to flow current through the thermal fuse.

[0020] The housing includes a multilayer metal material. The multilayer metal material includes: a copper-based layer; a first nickel layer disposed on a first side of the copper-based layer and including the outer surface; a second nickel layer arranged on the second side of the copper base layer, and the second side and the first side are arranged opposite to each other; and the silver layer is arranged on the second nickel layer and includes the inner surface.

[0021] According to the invention, the thickness of the first nickel layer ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), the thickness of the second nickel layer ranges from 0.076 micrometers to about 0.635 micrometers (3 microinches to about 25 microinches), and the thickness of the silver layer ranges from 0.102 micrometers to about 2.54 micrometers (4 microinches to about 100 microinches).

[0022] Preferably, the thickness of the first nickel layer ranges from 0.381 micrometers to 0.635 micrometers (15 microinches to 25 microinches), the thickness of the second nickel layer ranges from 0.076 micrometers to 0.127 micrometers (3 microinches to 5 microinches), and the thickness of the silver layer ranges from 0.102 micrometers to 2.54 micrometers (4 microinches to 100 microinches).

[0023] Preferably, the thickness of the silver layer is less than 1.778 micrometers (70 microinches).

[0024] Preferably, the thickness of the silver layer is less than 0.762 micrometers (30 microinches).

[0025] Preferably, the thickness of the silver layer is less than 0.254 micrometers (10 microinches).

[0026] Preferably, the thickness of the silver layer ranges from 0.102 micrometers to about 0.152 micrometers (4 microinches to about 6 microinches).

[0027] Preferably, the roughness Ra of the outer surface of the shell is greater than 0.889 micrometers (35 microinches).

[0028] Preferably, the copper-based layer includes: copper, the content range is 84% to 86%, lead, the content range is less than or equal to 0.03%, iron, the content range is less than or equal to 0.05%, and cadmium, the content range is less than or equal to 0.007%, Nickel, the content range is less than or equal to 0.01 %, and the rest is zinc.

[0029] Preferably, the copper base layer includes H85 brass alloy.

[0030] Preferably, when the thermally responsive member is higher than the threshold temperature and the movable contact member moves, the peripheral portion of the movable contact member remains in contact with the inner surface of the housing, and The frictional force against the movement between the peripheral portion of the movable contact member and the inner surface of the housing is less than about 2.94 N (0.3 kilogram-force).

[0031] According to another aspect of the present invention, there is also provided a metal housing for a thermal fuse.

[0032] The thermal fuse includes a first conductive member disposed at a first end of the housing and extending from the housing in a first direction along a longitudinal axis of the housing. A second conductive member is provided at the second end of the housing, extends from the housing in a second direction along the longitudinal axis, and includes a contact surface at a distal end of the second conductive member disposed in the internal space of the housing. A thermally responsive member is included in the thermal fuse and is formed from a non-conductive material. The non-conductive material changes from a solid physical state to a non-solid physical state when reaching a threshold temperature or higher than the threshold temperature. The thermally responsive member is disposed in an internal space of the housing, and is located between the first conductive member and the distal end of the second conductive member.

[0033] A conductive movable contact member is provided inside the housing and located between the thermally responsive member and the distal end of the second conductive member. A perimeter part of the movable contact member is in contact with the inner surface of the housing.

[0034] A first biasing member is disposed between the thermally responsive member and a first side of the movable contact member and acts on the movable contact in a first direction along the longitudinal axis.

[0035] A second biasing member is disposed between the second end of the housing and a second side of the movable contact member andis positioned opposite to the first biasing member. Thre second biasing member acts on the movable contact in a second direction along the longitudinal axis.

[0036] Wherein, when temperature of the thermally responsive member is lower than the threshold temperature, the biasing force of the first biasing member is greater than the biasing force of the second biasing member, and the movable contact member is in direct contact with and electrically connected to the second conductive member. When the distal end of the second conductive member is in direct contact with the moveable contact member, the thermal fuse is operable to flow current through the thermal fuse, wherein the current path through the thermal fuse is from the first conductive member to the inner surface of the housing, then to the movable contact member, and then to the second conductive member.

[0037] Wherein, when temperature of the thermally responsive member is at or higher than the threshold temperature, the biasing force of the first biasing member is less than the biasing force of the second biasing member, and the movable contact member moves away from and out of contact with the distal end of the second conductive member. When the distal end of the second conductive member is separated from the the movable contact member, the peripheral portion of the movable contact member remains in contact with the inner surface of the housing but the movable contact member is no longer electrically connected to the second conductive member. As such, the current path through the thermal fuse is interrupted and the thermal fuse is no longer operable to flow current through the thermal fuse.

[0038] Wherein, the housing includes a multilayer metal material The multilayer metal material includes: a copper-based layer; a first nickel layer disposed on a first side of the copper-based layer and including the outer surface; a second nickel layer arranged on the second side of the copper base layer, and the second side and the first side are arranged opposite to each other; and the silver layer is arranged on the second nickel layer and includes the inner surface.

[0039] According to the invention, the thickness of the first nickel layer ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), the thickness of the second nickel layer ranges from 0.076 micrometers to about 0.635 micrometers (3 microinches to about 25 microinches), and the thickness of the silver layer ranges from 0.102 micrometers to about 2.54 micrometers (4 microinches to about 100 microinches).

[0040] Preferably, the thickness of the first nickel layer ranges from 15 microinches to about 0.381 micrometers to 0.635 micrometers (15 microinches to 25 microinches), the thickness of the second nickel layer ranges from 0.076 micrometers to 0.127 micrometers (3 microinches to 5 microinches), and the thickness of the silver layer ranges from 0.102 micrometers to 2.54 micrometers (4 microinches to 100 microinches).

[0041] Preferably, the thickness of the silver layer is less than 1.778 micrometers (70 microinches).

[0042] Preferably, the thickness of the silver layer is less than 0.762 micrometers (30 microinches).

[0043] Preferably, the thickness of the silver layer is less than 0.254 micrometers (10 microinches).

[0044] Preferably, the thickness of the silver layer ranges from 0.102 micrometers to about 0.152 micrometers (4 microinches to about 6 microinches).

[0045] Preferably, the roughness Ra of the outer surface of the shell is greater than 0.889 micrometers (35 microinches).

[0046] Preferably, the copper-based layer includes: copper, the content range is 84% to 86%, lead, the content range is less than or equal to 0.03%, iron, the content range is less than or equal to 0.05%, and cadmium, the content range is less than or equal to 0.007%, Nickel, the content range is less than or equal to 0.01 %, and the rest is zinc.

[0047] Through the technical solution provided by the present invention, the housing of the thermal fuse includes multiple layers of metal materials, including a copper base layer, a first nickel layer, a second nickel layer, and a silver layer. The silver layer is arranged on the second nickel layer and includes an inner surface. Only the inside of the housing, therefore, is silver-plated, and the outer surface is a nickel layer, so that the use of silver as an electrically conductive medium is minimized but still provides that the thermal fuse can complete the interruption performance.

[0048] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0049] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. 1 is a front cross-sectional view of a thermal cut-off device as is well-known in the art; and

FIG. 2 is a schematic diagram of a multilayered metal material structure of a housing for a thermal cut-off device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0050] Example embodiments will now be described more fully with reference to the accompanying drawings.

[0051] It should be noted that the embodiments in this application and the features in the embodiments can be combined with each other if there is no conflict.

[0052] A thermal fuse (or thermal cut-off device) construction is well-known and is shown in FIG. 1. The thermal fuse 10 includes a housing 12 (e.g., a metal casing) extending from a first end 14 to a second end 16 along a longitudinal axis X, the housing 12 having an inner space 18, and the housing 12 having an inner surface 20 and an outer surface 22.

[0053] A first conductive member 24 (e.g., a pin) is provided at the first end 14 of the housing 12 and extends from the housing 12 in the direction along the longitudinal axis X.

[0054] A second conductive member 26 is arranged at the second end 16 of the housing 12, extends from the housing 12 in a direction along the longitudinal axis X, and includes a contact surface 28 at a distal end 30, which is arranged in the inner space 18 of the housing.

[0055] A thermally responsive member 32 (e.g., a thermal pellet) is provided in the inner space 18 of the housing 12 and is formed from a non-conductive material. The non-conductive material changes from a solid physical state to a non-solid physical state when the temperature of the thermally responsive member 32 reaches (or exceeds) a threshold temperature..

[0056] A conductive movable contact member 34 (e.g., a star contact) is disposed inside the housing 12 and located between the thermally responsive member 32 and the distal end 30 of the second conductive member 26. The movable contact member 34 includes a peripheral portion 36 in contact with the inner surface 20 of the housing 12.

[0057] A first biasing member 38 (e.g., a first compression spring) is disposed between the thermally responsive member 32 and the movable contact member 34. The first biasing member 38 acts on the movable contact member 34 in a first direction (arrow X1) along the longitudinal axis X.

[0058] A second biasing member 40 (e.g., a second compression spring or trip spring) is disposed between the movable contact member 34 and the second end 16 of the housing 12. The second biasing member 40 acts on the movable contact member 34 in a second direction (arrow X2) along the longitudinal axis X that is opposite to the first direction (arrow X1).

[0059] When the temperature of the thermally responsive member 32 is lower than the threshold temperature, the thermally responsive member 32 has a solid physical state. The first biasing member 38 is biased between the thermally responsive member 32 and the movable contact member 34 and the second biasing member 40 is biased between the movable contact member 34 and the second end 16 of the housing 12. In this condition, the biasing force of the first biasing member 38 is greater than the biasing force of the second biasing member 40. As such, the movable contact member 34 is in direct contact with the distal end 30 of the second conductive member 26 and the inner surface 20 of the housing 12. The thermal fuse 10 is operable to allow current to flow through the thermal fuse 10, wherein the current path through the thermal fuse is from the first conductive member 24 to the inner surface 20 of the housing 12, then to the movable contact member 34, and then to the second conductive member 26.

[0060] When the temperature of the thermally responsive member 32 is at or higher than the threshold temperature, the thermally responsive member 32 changes its physical state from a solid physical state to a non-solid physical state. In this condition, the first biasing member 38 is relaxed such that the biasing force of the first biasing member 38 is less than the biasing force of the second biasing member 40. The second biasing member 40 then causes the movable contact member 34 to move away from the distal end 30 of the second conductive member 26. Whenthe components are separated, the peripheral portion 36 of the movable contact member 34 remains in contact with the inner surface 20 of the housing 12, but the electrical connection between the second conductive member 26 and the the movable contact member 34 is broken. In this condition, the thermal fuse 10 cannot be operated to conduct current through the thermal fuse 10.

[0061] According to the principals of the present disclosure and as best seen in FIG. 2, a housing 120 for an improved thermal fuse is formed from a multilayer metal material that includes a copper-based layer 100; a first nickel layer 102, which is arranged on the first side of the copper-based layer 100 and includes the outer surface 220 of the housing 120; and a second nickel layer 104, which is arranged on the second side of the copper-based layer 100 opposite to the first side. A layer of silver 106 is arranged on the second nickel layer 104 and includes the inner surface 200 of the housing 120.

[0062] In this preferred embodiment, the housing 120 uses multiple layers of metal materials, including a copper-based layer 100, a first nickel layer 102, a second nickel layer 104, and a silver layer 106. The silver layer 106 is arranged on the second nickel layer 104 and includes the inner surface 200 of the housing 120, so that only the inner surface 200 of the housing 120 (and not the outer surface 220 of the housing 120) is silver-plated. The outer surface 220 is a nickel layer, so that the use of silver can be minimized while still maintaining the condition that the thermal fuse can complete the interruption performance.

[0063] According to the invention, the thickness t1 of the first nickel layer ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), the thickness t2 of the second nickel layer ranges from 0.076 micrometers to about 0.635 micrometers (3 microinches to about 25 microinches), and the thickness t3 of the silver layer ranges from 0.102 micrometers to about 2.54 micrometers (4 microinches to about 100 microinches). Preferably, the thickness t1 of the first nickel layer ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), the thickness t2 of the second nickel layer ranges from 0.076 micrometers to 0.127 micrometers (3 microinches to 5 microinches), and the thickness t3 of the silver layer ranges from 0.102 micrometers to 2.54 micrometers (4 microinches to 100 microinches).

[0064] Preferably, as a preferred embodiment, the thickness t3 of the silver layer is less than 1.778 micrometers (70 microinches).

[0065] Preferably, the thickness t3 of the silver layer is less than 0.762 micrometers (30 microinches).

[0066] In some embodiments, the thickness t3 of the silver layer is less than 0.254 micrometers (10 microinches).

[0067] In some preferred embodiments, the thickness t3 of the silver layer ranges from 0.102 micrometers to about 0.152 micrometers (4 microinches to about 6 microinches).

[0068] It should be noted that the foregoing embodiment is an example of the thickness of the silver layer, and those skilled in the art can select an appropriate thickness of the silver layer according to actual needs to ensure the cutting performance of the thermal fuse and optimize the reasonable amount of silver used.

[0069] Preferably, the roughness Ra of the outer surface 220 of the housing 120, Ra>0.889 micrometers (35 microinches).

[0070] In this preferred embodiment, the roughness Ra of the outer surface 220 of the housing 120 is greater than 0.889 micrometers (35 microinches). In this way, the roughness of the outer surface 220 of the thermal fuse can be increased, which helps to improve the quality of any printing or template applied or affixed to the outer surface 220 of the housing 120 (e.g., a part no.).

[0071] As a preferred embodiment, the copper-based layer 100 includes: copper, the content range is 84% to 86%, lead, the content range is less than or equal to 0.03%, iron, the content range is less than or equal to 0.05%, and cadmium, the content range is less than or equal to 0.007%, nickel, the content range is less than or equal to 0.01%, and the rest is zinc.

[0072] In the above embodiment, the copper-based layer 100 includes brass H85Cu H85 brass alloy.

[0073] Preferably, when the temperature of the thermally responsive member is at or higher than the threshold temperature and the movable contact member moves, the peripheral portion 36 of the movable contact member 34 remains in contact with the inner surface 200 of the housing 120, and any force resulting from friction between the peripheral portion 36 of the movable contact member 34 and the inner surface 200 of the housing 120 is less than about 2.94 N (0.3 kilogram-force).

[0074] In this preferred embodiment, a smaller frictional force can improve the interruption performance of the thermal fuse, making the use of the thermal fuse safer and more reliable.

[0075] Through experiments, when the thermal fuse is opened during the current interruption (CI) test, the higher the roughness of the outer surface 220 of the housing 120, the better the printing performance; the lower the roughness and friction of the inner surface of the housing 120, the better the current interruption performance.

[0076] It should be noted that those skilled in the art can design the roughness of the outer surface 220 of the housing 120 and the frictional coefficient of the inner surface 200 of the housing 120 according to actual needs.

[0077] Based on the same concept, this embodiment also provides a metal housing 120 for a thermal fuse, including: a first conductive member 24 disposed at the first end 14 of the housing 120 and extending from the housing 120 in the direction along the longitudinal axis X of the housing 120.

[0078] The second conductive member 26 is arranged at the second end 16 of the housing 120, extends from the housing 120 in a direction along the longitudinal axis X, and includes a contact surface 28 at the distal end 30, which is arranged in the inner space 18 of the housing 120.

[0079] The thermally responsive member 32 is located between the first and second conductive members 24, 26 and includes a non-conductive material. The non-conductive material changes from a solid physical state to a non-solid physical state when the temperature of the thermally responsive member 32 is at or above the threshold temperature.

[0080] The conductive movable contact member 34 is arranged inside the housing 120 and located between the thermally responsive member 32 and the distal end 30 of the second conductive member 26. The movable contact member 34 includes a peripheral portion 36 in contact with the inner surface 200 of the housing 120.

[0081] The first biasing member 38 is disposed between the thermally responsive member 32 and the movable contact member 34, and the first biasing member 38 acts on the movable contact member 34 in a first direction X1 along the longitudinal axis X.

[0082] The second biasing member 40 is disposed between the movable contact member 34 and the second end of the housing 120, and the second biasing member 40 acts on the movable contact member 34 in a second direction X2 along the longitudinal axis X that is opposite to the first direction X1.

[0083] When the temperature of the thermally responsive member 32 is lower than the threshold temperature, the physical state of the thermally responsive member is solid, the biasing force of the first biasing member 38 is greater than the biasing force of the second biasing member 40, the movable contact member 34 is in direct contact with the distal end 30 of the second conductive member 26, and the thermal fuse is operable to allow current to flow through the thermal fuse along the current path from the first conductive member 24 to the inner surface 200 of the housing 120, then to the movable contact member 34, and then to the second conductive member 26.

[0084] When the temperature of the thermally responsive member 32 is at or higher than the threshold temperature, the physical state of the thermally responsive member 32 is non-solid, the biasing force of the first biasing member 38 is less than the biasing force of the second biasing member 40, and the movable contact member 34 moves away from the distal end 30 of the second conductive member 26 and no longer contacts or conducts electricity with the second conductive member 26. The second conductive member 26 and movable contact member 34 components are separated, the peripheral portion 36 of the movable contact member 34 remains in contact with the inner surface 200 of the housing 120 and the thermal fuse cannot be operated to conduct current through the thermal fuse.

[0085] The housing 120 includes a multilayer metal material, the multilayer metal material includes: a copper-based layer 100; a first nickel layer 102, arranged on the first side of the copper-based layer 100 and including an outer surface 220; and a second nickel layer 104 arranged on the second side of the copper-based layer.100 opposite to the first side. The silver layer 106 is arranged only on the second nickel layer 104 and includes the inner surface 200 of the housing 120.

[0086] In this preferred embodiment, the housing 120 uses multiple layers of metal materials, including a copper-based layer 100, a first nickel layer 102, a second nickel layer 104, and a silver layer 106. The silver layer 106 is arranged on the second nickel layer 104 and includes the inner surface 200 of the housing 120, so that only the inner surface 200 of the housing 120 is silver-plated, and the outer surface 220 is a nickel layer As such, the use of silver can be minimized provided that the thermal fuse can complete the interruption performance.

[0087] According to the invention, the thickness t1 of the first nickel layer ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), the thickness t2 of the second nickel layer ranges from 0.076 micrometers to about 0.635 micrometers (3 microinches to about 25 microinches), and the thickness t3 of the silver layer ranges from 0.102 micrometers to about 2.54 micrometers (4 microinches to about 100 microinches). Preferably, the thickness t1 of the first nickel layer ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), the thickness t2 of the second nickel layer ranges from 0.076 micrometers to 0.127 micrometers (3 microinches to 5 microinches), and the thickness t3 of the silver layer ranges from 0.102 micrometers to 2.54 micrometers (4 microinches to 100 microinches).

[0088] Preferably, as a preferred embodiment, the thickness t3 of the silver layer is less than 1.778 micrometers (70 microinches).

[0089] Preferably, the thickness t3 of the silver layer is less than 0.762 micrometers (30 microinches).

[0090] In some embodiments, the thickness t3 of the silver layer is less than 0.254 micrometers (10 microinches).

[0091] In some preferred embodiments, the thickness t3 of the silver layer ranges from 0.102 micrometers to about 0.152 micrometers (4 microinches to about 6 microinches).

[0092] It should be noted that the foregoing embodiment is an example of the thickness of the silver layer, and those skilled in the art can select an appropriate thickness of the silver layer according to actual needs to ensure proper performance of the thermal fuse while simultaneously reducing the amount of silver used in construction of the thermal fuse.

[0093] Preferably, the roughness Ra of the outer surface 220 of the housing 120 is Ra>0.889 micrometers (35 microinches).

[0094] In this preferred embodiment, the outer surface 220 roughness of the housing 120 is Ra>0.889 micrometers (35 microinches), and a surface roughness of the silver-plated layer 106 is minimal. The high roughness enables the outer service 220 to have good decorative performance and improve the quality of the template but not affect the performance of the thermal fuse which is improved by the minimal surface roughness of the inner surface 200.

[0095] As a preferred embodiment, the copper-based layer 100 includes: copper, the content range is 84% to 86%, lead, the content range is less than or equal to 0.03%, iron, the content range is less than or equal to 0.05%, and cadmium, the content range is less than or equal to 0.007%, nickel, the content range is less than or equal to 0.01%, and the rest is zinc.

[0096] In the above embodiment, the copper-based layer 100 includes H85 brass alloy.

[0097] Preferably, when the thermally responsive member 32 is higher than the threshold temperature and the movable contact member 34 moves, the peripheral portion 36 of the movable contact member 34 remains in contact with the inner surface 200 of the housing 120, and any force resulting from friction between the peripheral portion 36 of the movable contact member 34 and the inner surface 200 of the housing 120 is less than about 2.94 N (0.3 kilogram-force).

[0098] In this preferred embodiment, a smaller frictional force can improve the interruption performance of the thermal fuse, making the use of the thermal fuse safer and more reliable.

[0099] Through experiments, when the thermal fuse is opened during the current interruption (CI) test, the higher the roughness of the outer surface 220 of the housing, the better the printing performance; the lower the roughness and friction of the inner surface 200 of the housing 120, the better the current interruption performance.

[0100] It should be noted that those skilled in the art can design the roughness of the outer surface of the housing and the frictional coefficient of the inner surface of the housing according to actual needs.

[0101] Through the above embodiments, a thermal fuse is provided.

[0102] Through this technical solution, the following technical effects are achieved: the surface roughness of the housing can be different between the silver-plated layer only on the inner surface and the nickel layer on the outer surface so the thermal fuse has a good balance of decorative performance and current interruption performance.

[0103] New circuits with capacitors and resistors may slow down the speed of the CI test. During the CI test, the DC voltage between the two ends of the thermal fuse according to the present disclosures increases and significantly improves the performance of the CI thermal fuse in DC applications.

[0104] The newly designed single-sided electroplated case can improve the current interruption performance of the thermal fuse.

Claims

1. A thermal fuse (10), which comprises:

a housing (12, 120), the housing extending from a first end (14) to a second end (16) along a longitudinal axis (X), the housing having an inner space(18), and the housing having an inner surface (20 and an outer surface (22);

a first conductive member (24) disposed at the first end of the housing and extending from the housing in a direction along the longitudinal axis;

a second conductive member (26) disposed at the second end of the housing, and extending from the housing in the direction along the longitudinal axis, and including a contact surface (28) provided at a distal end (30) thereof;

a thermally responsive member (32) disposed in the inner space of the housing and located between the first conductive member and the distal end of the second conductive member, the thermally responsive member including a non-conductive material, wherein the non-conductive material changes from a solid physical state to a non-solid physical state when a temperature of the thermally responsive member reaches a threshold temperature;

a conductive movable contact member (34) disposed in the inner space of the housing and located between the thermally responsive member and the distal end of the second conductive member, the movable contact member including a peripheral portion (36) in contact with the inner surface of the housing;

a first biasing member (38) disposed between the thermally responsive member and the movable contact member, the first biasing member acting on the movable contact member with a first biasing force in a first direction (X1) along the longitudinal axis;

a second biasing member (40) disposed between the movable contact member and the second end of the housing, the second biasing member acting on the moveable contact member with a second biasing force in a second direction (X2) along the longitudinal axis opposite to the first direction along the longitudinal axis;

wherein, when the temperature of the thermally responsive member is lower than the threshold temperature, the thermally responsive member is in a solid physical state, the first biasing force is greater than the second biasing force, the movable contact member is electrically connected to the second conductive member and the distal end of the second conductive member is in direct contact with the movable contact member, and the thermal fuse is operable to conduct current through the thermal fuse, wherein a current path through the thermal fuse is from the first conductive member to the inner surface of the housing, to the movable contact member, and to the second conductive member;

wherein, when the temperature of the thermally responsive member is at or higher than the threshold temperature, the thermally responsive member is in a non-solid physical state, the first biasing force is less than the second biasing force, the movable contact member is electrically disconnected from the second conductive member and the movable contact member is separated from the distal end of the second conductive member, the peripheral portion of the movable contact member remains in contact with the inner surface of the housing, and the thermal fuse is inoperable to conduct current through the thermal fuse;

wherein

the housing comprises a multilayer metal material construction comprising:

a copper-based layer (100) having a first side and a second side that is opposite to the first side;

a first nickel layer (102) disposed on the first side of the copper-based layer and comprising the outer surface of the housing;

a second nickel layer (104) disposed on the second side of the copper-based layer; and

a silver layer (106) disposed on the second nickel layer and comprising the inner surface of the housing;

characterised in that

a thickness of the first nickel layer (t1) ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches),

a thickness of the second nickel layer (t2) ranges from 0.076 micrometers to about 0.635 micrometers (3 microinches to about 25 microinches),

and a thickness of the silver layer (t3) ranges from 0.102 micrometers to about 2.54 micrometers (4 microinches to about 100 microinches).

2. The thermal fuse according to claim 1, wherein the thickness of the silver layer is at least one of: less than 1.778 micrometers (70 microinches); less than 0.762 micrometers (30 microinches); and less than 0.254 micrometers (10 microinches).

3. The thermal fuse according to claim 1, wherein the thickness of the silver layer ranges from micrometers to about 0.152 micrometers (4 microinches to about 6 microinches).

4. The thermal fuse according to claim 3, wherein the outer surface of the housing has a roughness Ra, Ra>0.889 micrometers (35 microinches).

5. The thermal fuse according to claim 4, wherein the copper-based layer comprises: copper, with a content ranging from 84% to 86%, lead, with a content ranging less than or equal to 0.03%, iron, with a content of less than or equal to 0.05%, cadmium, with a content less than or equal to 0.007%, nickel, with a content less than or equal to 0.01%, and a remainder zinc.

6. The thermal fuse according to claim 5, wherein the copper-based layer comprises H85 brass alloy.

7. The thermal fuse according to claim 6, wherein when the temperature of the thermally responsive member is at or higher than the threshold temperature and the movable contact member is separated from the distal end of the second conductive member, the peripheral portion of the movable contact member remains in contact with the inner surface of the housing, and a frictional force at the peripheral portion of the movable contact member and the inner surface of the housing and opposed to the second biasing force is less than about 2.94 N (0.3 kilogram-force).

8. A metal casing (12, 120) for a thermal fuse (10), the thermal fuse comprising:

a first conductive member (24) disposed at a first end (14) of the metal casing and extending from the metal casing in a first direction along a longitudinal axis (X) of the thermal fuse;
a second conductive member (26) disposed at a second end (16) of the metal casing, and extending from the metal casing in a second direction along the longitudinal axis, the second conductive member comprising a contact surface (28) provided at a distal end (30) thereof;
a thermally responsive member (32) disposed in an internal space (18) of the metal casing and located between the first conductive member and the distal end of the second conductive member and comprising a non-conductive material, wherein the non-conductive material changes from a solid physical state to a non-solid physical state at or above a threshold temperature;
a conductive movable contact member (34) provided in the internal space of the metal casing and located between the thermally responsive member and the distal end of the second conductive member, the movable contact member comprising a peripheral portion (36) in contact with an inner surface (20) of the metal casing;
a first biasing member (38) disposed between the thermally responsive member and the movable contact member, the first biasing member acting on the movable contact with a first biasing force in a first direction (X1) along the longitudinal axis;
a second biasing member (40) disposed between the movable contact member and the second end of the metal casing, the second biasing member acting on the movable contact with a second biasing force in a second direction (X2) along the longitudinal axis opposite to the first direction;
wherein, when a temperature of the thermally responsive member is lower than the threshold temperature, the first biasing force is greater than the second biasing force, and the movable contact member is electrically connected to the second conductive member and the distal end of the second conductive member is in direct contact with the movable contact member, the thermal fuse is operable to conduct current through the thermal fuse, wherein a current path through the thermal fuse is from the first conductive member to the inner surface of the metal casing, to the movable contact member, and to the second conductive member;
wherein, when the temperature of the thermally responsive member is greater than or equal to the threshold temperature, the first biasing force is less than the second biasing force, the movable contact member is electrically disconnected from the second conductive member and the movable contact member is separated from the distal end of the second conductive member, the peripheral portion of the movable contact member remains in contact with the inner surface of the metal casing, and the thermal fuse is inoperable to conduct current through the thermal fuse; and
wherein the metal casing comprises a multilayer metal material, the multilayer metal material comprises: a copper-based layer (100); a first nickel layer (102) disposed on a first side of the copper-based layer and including an outer surface (22) of the metal casing; a second nickel layer (104) disposed on a second side of the copper-based layer opposite to the first side of the copper-based layer; and a single silver layer (106) disposed only on the second nickel layer and comprising the inner surface of the metal casing; **characterised in that**
a thickness of the first nickel layer (t1) ranges from 0.381 micrometers to about 0.635 micrometers (15 microinches to about 25 microinches), a thickness of the second nickel layer (t2) ranges from 0.076 micrometers to about 0.635 micrometers (3 microinches to about 25 microinches), and a thickness of the silver layer (t3) ranges from 0.102 micrometers to about 2.54 micrometers (4 microinches to about 100 microinches).

9. The metal casing of claim 8, wherein the thickness of the silver layer is less than 1.778 micrometers (70 microinches).

10. The metal casing of claim 8, wherein the thickness of the silver layer is less than 0.762 micrometers (30 microinches).

11. The metal casing of claim 8, wherein the thickness of the silver layer is less than 0.254 micrometers (10 microinches).

12. The metal casing of claim 8, wherein the thickness of the silver layer ranges from 0.102 micrometers to about 0.152 micrometers (4 microinches to about 6 microinches).

13. The metal casing for a thermal fuse according to claims 12, wherein the outer surface of the metal casing has a roughness Ra, Ra>0.889 micrometers (35 microinches).

14. The metal casing of claim 13, wherein the copper-based layer comprises:

copper, with a content ranging from 84% to 86%;
lead, with a content ranging less than or equal to 0.03%;
iron, with a content less than or equal to 0.05%;
cadmium, with a content less than or equal to 0.007%;
nickel, with a the content less than or equal to 0.01%; and
a remainder zinc.

15. The metal casing of claim 14, wherein the copper-based layer comprises H85 brass alloy.

Patentansprüche

1. Thermosicherung (10) umfassend:

ein Gehäuse (12, 120), wobei das Gehäuse entlang einer Längsachse (X) von einem ersten Ende (14) zu einem zweiten Ende (16) verläuft, wobei das Gehäuse einen Innenraum (18) aufweist und das Gehäuse eine Innenoberfläche (20) und eine Außenoberfläche (22) aufweist;
ein erstes leitfähiges Element (24), das an dem ersten Ende des Gehäuses angeordnet ist und sich von dem Gehäuse in eine Richtung entlang der Längsachse erstreckt;
ein zweites leitfähiges Element (26), das an dem zweiten Ende des Gehäuses angeordnet ist und sich von dem Gehäuse in der Richtung entlang der Längsachse erstreckt und eine Kontaktfläche (28) aufweist, die an einem distalen Ende (30) davon bereitgestellt ist;
ein thermisch ansprechbares Element (32), das in dem Innenraum des Gehäuses angeordnet ist und zwischen dem ersten leitfähigen Element und dem distalen Ende des zweiten leitfähigen Elements angeordnet ist, wobei das thermisch ansprechbare Element ein nichtleitendes Material enthält, wobei das nichtleitende Material von einem festen Aggregatzustand in einen nicht-festen Aggregatzustand übergeht, wenn eine Temperatur des thermisch ansprechbaren Elements eine Schwellentemperatur erreicht;
ein leitfähiges bewegliches Kontaktelement (34), das in dem Innenraum des Gehäuses angeordnet ist und zwischen dem thermisch ansprechbaren Element und dem distalen Ende des zweiten leitfähigen Elements angeordnet ist, wobei das bewegliche Kontaktelement einen Randteil (36) in Kontakt mit der Innenoberfläche des Gehäuses aufweist;
ein erstes Vorspannelement (38), das zwischen dem thermisch ansprechbaren Element und dem beweglichen Kontaktelement angeordnet ist, wobei das erste Vorspannelement mit einer ersten Vorspannkraft in einer ersten Richtung (X1) entlang der Längsachse auf das bewegliche Kontaktelement wirkt;
ein zweites Vorspannelement (40), das zwischen dem beweglichen Kontaktelement und dem zweiten Ende des Gehäuses angeordnet ist, wobei das zweite Vorspannelement mit einer zweiten Vorspannkraft in einer zweiten Richtung (X2) entlang der Längsachse, die der ersten Richtung entlang der Längsachse entgegengesetzt ist, auf das bewegliche Kontaktelement wirkt;
wobei, wenn die Temperatur des thermisch ansprechbaren Elements niedriger als die Schwellentemperatur ist, das thermisch ansprechbare Element in einem festen Aggregatzustand vorliegt, die erste Vorspannkraft größer als die zweite Vorspannkraft ist, das bewegliche Kontaktelement elektrisch mit dem zweiten leitfähigen Element verbunden ist und das distale Ende des zweiten leitfähigen Elements in direktem Kontakt mit dem beweglichen Kontaktelement vorliegt und die Thermosicherung funktionsfähig ist, Strom durch die Thermosicherung zu leiten, wobei ein Stromweg durch die Thermosicherung von dem ersten leitfähigen Element zu der Innenoberfläche des Gehäuses, zu dem beweglichen Kontaktelement und zu dem zweiten leitfähigen Element verläuft;
wobei, wenn die Temperatur des thermisch ansprechbaren Elements bei der oder höher als die Schwellentemperatur liegt, das thermisch ansprechbare Element in einem nicht-festen Aggregatzustand vorliegt, die erste Vorspannkraft kleiner als die zweite Vorspannkraft ist, das bewegliche Kontaktelement elektrisch von dem zweiten leitfähigen Element getrennt ist und das bewegliche Kontaktelement von dem distalen Ende des zweiten leitfähigen Elements getrennt

ist, der Randteil des beweglichen Kontaktelements in Kontakt mit der Innenoberfläche des Gehäuses bleibt und die Thermosicherung nicht funktionsfähig ist, Strom durch die Thermosicherung zu leiten;
wobei das Gehäuse eine mehrschichtige Metallmaterialkonstruktion umfasst, umfassend:

eine Schicht auf Kupferbasis (100) mit einer ersten Seite und einer zweiten Seite, die der ersten Seite gegenüberliegt;
eine erste Nickelschicht (102), die auf der ersten Seite der Schicht auf Kupferbasis angeordnet ist und die Außenoberfläche des Gehäuses umfasst;
eine zweite Nickelschicht (104), die auf der zweiten Seite der Schicht auf Kupferbasis angeordnet ist; und
eine Silberschicht (106), die auf der zweiten Nickelschicht angeordnet ist und die Innenoberfläche des Gehäuses umfasst;
dadurch gekennzeichnet, dass
eine Dicke der ersten Nickelschicht (t1) in dem Bereich von 0,381 Mikrometer bis etwa 0,635 Mikrometer (15 Mikroinch bis etwa 25 Mikroinch) liegt,
eine Dicke der zweiten Nickelschicht (t2) in dem Bereich von 0,076 Mikrometer bis etwa 0,635 Mikrometer (3 Mikroinch bis etwa 25 Mikroinch) liegt,
und eine Dicke der Silberschicht (t3) in dem Bereich von 0,102 Mikrometer bis etwa 2,54 Mikrometer (4 Mikroinch bis etwa 100 Mikroinch) liegt.

2. Thermosicherung gemäß Anspruch 1, wobei die Dicke der Silberschicht wenigstens eines ist von: kleiner als 1,778 Mikrometer (70 Mikroinch); kleiner als 0,762 Mikrometer (30 Mikroinch); und kleiner als 0,254 Mikrometer (10 Mikroinch).

3. Thermosicherung gemäß Anspruch 1, wobei die Dicke der Silberschicht in dem Bereich von 0,102 Mikrometer bis etwa 0,152 Mikrometer (4 Mikroinch bis etwa 6 Mikroinch) liegt.

4. Thermosicherung gemäß Anspruch 3, wobei die Außenoberfläche des Gehäuses eine Rauigkeit Ra von Ra > 0,889 Mikrometer (35 Mikroinch) aufweist.

5. Thermosicherung gemäß Anspruch 4, wobei die Schicht auf Kupferbasis umfasst: Kupfer in einem Gehalt in dem Bereich von 84 % bis 86 %, Blei in einem Gehalt in dem Bereich von kleiner als oder gleich 0,03 %, Eisen in einem Gehalt von kleiner als oder gleich 0,05 %, Cadmium in einem Gehalt von kleiner als oder gleich 0,007 %, Nickel in einem Gehalt von kleiner als oder gleich 0,01 % und einen Rest Zink.

6. Thermosicherung gemäß Anspruch 5, wobei die Schicht auf Kupferbasis H85-Messinglegierung umfasst.

7. Thermosicherung gemäß Anspruch 6, wobei, wenn die Temperatur des thermisch ansprechbaren Elements bei der oder höher als die Schwellentemperatur liegt und das bewegliche Kontaktelement von dem distalen Ende des zweiten leitfähigen Elements getrennt ist, der Randteil des beweglichen Kontaktelements in Kontakt mit der Innenoberfläche des Gehäuses bleibt und eine Reibungskraft an dem Randteil des beweglichen Kontaktelements und der Innenoberfläche des Gehäuses, der zweiten Vorspannkraft entgegengerichtet, kleiner als etwa 2,94 N (0,3 Kilogramm-Kraft) ist.

8. Metallgehäuse (12, 120) für eine Thermosicherung (10), wobei die Thermosicherung umfasst:

ein erstes leitfähiges Element (24), das an einem ersten Ende (14) des Metallgehäuses angeordnet ist und sich von dem Metallgehäuse in eine erste Richtung entlang einer Längsachse (X) der Thermosicherung erstreckt;
ein zweites leitfähiges Element (26), das an einem zweiten Ende (16) des Metallgehäuses angeordnet ist und
sich von dem Metallgehäuse in eine zweite Richtung entlang der Längsachse erstreckt, wobei das zweite leitfähige Element eine Kontaktfläche (28) umfasst, die an einem distalen Ende (30) davon bereitgestellt ist;
ein thermisch ansprechbares Element (32), das in einem Innenraum (18) des Metallgehäuses angeordnet ist und zwischen dem ersten leitfähigen Element und dem distalen Ende des zweiten leitfähigen Elements angeordnet ist und ein nichtleitendes Material umfasst, wobei das nichtleitende Material bei oder über einer Schwellentemperatur von einem festen Aggregatzustand in einen nicht-festen Aggregatzustand übergeht;
ein leitfähiges bewegliches Kontaktelement (34), das in dem Innenraum des Metallgehäuses bereitgestellt ist und zwischen dem thermisch ansprechbaren Element und dem distalen Ende des zweiten leitfähigen Elements angeordnet ist, wobei das bewegliche Kontaktelement einen Randteil (36) in Kontakt mit einer Innenoberfläche (20) des Metallgehäuses umfasst;
ein erstes Vorspannelement (38), das zwischen dem thermisch ansprechbaren Element und dem beweglichen Kontaktelement angeordnet ist, wobei das erste Vorspannelement mit einer ersten Vorspannkraft in einer ersten Richtung

(X1) entlang der Längsachse auf den beweglichen Kontakt wirkt;

ein zweites Vorspannelement (40), das zwischen dem beweglichen Kontaktelement und dem zweiten Ende des Metallgehäuses angeordnet ist, wobei das zweite Vorspannelement mit einer zweiten Vorspannkraft in einer zweiten Richtung (X2) entlang der Längsachse entgegengesetzt zu der ersten Richtung auf den beweglichen Kontakt wirkt;

wobei, wenn eine Temperatur des thermisch ansprechbaren Elements niedriger als die Schwellentemperatur ist, die erste Vorspannkraft größer als die zweite Vorspannkraft ist, das bewegliche Kontaktelement elektrisch mit dem zweiten leitfähigen Element verbunden ist und das distale Ende des zweiten leitfähigen Elements in direktem Kontakt mit dem beweglichen Kontaktelement vorliegt, die Thermosicherung funktionsfähig ist, Strom durch die Thermosicherung zu leiten, wobei ein Stromweg durch die Thermosicherung von dem ersten leitfähigen Element zu der Innenoberfläche des Metallgehäuses, zu dem beweglichen Kontaktelement und zu dem zweiten leitfähigen Element verläuft;

wobei, wenn die Temperatur des thermisch ansprechbaren Elements höher als die oder gleich der Schwellentemperatur ist, die erste Vorspannkraft kleiner als die zweite Vorspannkraft ist, das bewegliche Kontaktelement elektrisch von dem zweiten leitfähigen Element getrennt ist und das bewegliche Kontaktelement von dem distalen Ende des zweiten leitfähigen Elements getrennt ist, der Randteil des beweglichen Kontaktelements in Kontakt mit der Innenoberfläche des Metallgehäuses bleibt und die Thermosicherung nicht funktionsfähig ist, Strom durch die Thermosicherung zu leiten; und

wobei das Metallgehäuse ein mehrschichtiges Metallmaterial umfasst, wobei das mehrschichtige Metallmaterial umfasst: eine Schicht auf Kupferbasis (100); eine erste Nickelschicht (102), die auf einer ersten Seite der Schicht auf Kupferbasis angeordnet ist und eine Außenoberfläche (22) des Metallgehäuses umfasst;

eine zweite Nickelschicht (104), die auf einer zweiten Seite der Schicht auf Kupferbasis gegenüber der ersten Seite der Schicht auf Kupferbasis angeordnet ist; und

eine einzige Silberschicht (106), die nur auf der zweiten Nickelschicht angeordnet ist und die Innenoberfläche des Metallgehäuses umfasst;

dadurch gekennzeichnet, dass

eine Dicke der ersten Nickelschicht (t1) in dem Bereich von 0,381 Mikrometer bis etwa 0,635 Mikrometer (15 Mikroinch bis etwa 25 Mikroinch) liegt,

eine Dicke der zweiten Nickelschicht (t2) in dem Bereich von 0,076 Mikrometer bis etwa 0,635 Mikrometer (3 Mikroinch bis etwa 25 Mikroinch) liegt,

und eine Dicke der Silberschicht (t3) in dem Bereich von 0,102 Mikrometer bis etwa 2,54 Mikrometer (4 Mikroinch bis etwa 100 Mikroinch) liegt.

9. Metallgehäuse gemäß Anspruch 8, wobei die Dicke der Silberschicht kleiner als 1,778 Mikrometer (70 Mikroinch) ist.

10. Metallgehäuse gemäß Anspruch 8, wobei die Dicke der Silberschicht kleiner als 0,762 Mikrometer (30 Mikroinch) ist.

11. Metallgehäuse gemäß Anspruch 8, wobei die Dicke der Silberschicht kleiner als 0,254 Mikrometer (10 Mikroinch) ist.

12. Metallgehäuse gemäß Anspruch 8, wobei die Dicke der Silberschicht in dem Bereich von 0,102 Mikrometer bis etwa 0,152 Mikrometer (4 Mikroinch bis etwa 6 Mikroinch) liegt.

13. Metallgehäuse für eine Thermosicherung gemäß Anspruch 12, wobei die Außenoberfläche des Metallgehäuses eine Rauigkeit Ra von Ra > 0,889 Mikrometer (35 Mikroinch) aufweist.

14. Metallgehäuse gemäß Anspruch 13, wobei die Schicht auf Kupferbasis umfasst: Kupfer in einem Gehalt in dem Bereich von 84 % bis 86 %;

Blei in einem Gehalt in dem Bereich von kleiner als oder gleich 0,03 %;

Eisen in einem Gehalt in dem Bereich von kleiner als oder gleich 0,05 %;

Cadmium in einem Gehalt in dem Bereich von kleiner als oder gleich 0,007 %;

Nickel in einem Gehalt in dem Bereich von kleiner als oder gleich 0,01 %; und einen Rest Zink.

15. Metallgehäuse gemäß Anspruch 14, wobei die Schicht auf Kupferbasis H85-Messinglegierung umfasst.

Revendications

1. Fusible thermique (10), qui comprend :

une enveloppe (12, 120), l'enveloppe s'étendant d'une première extrémité (14) à une deuxième extrémité (16) le long d'un axe longitudinal (X), l'enveloppe ayant un espace interne (18), et l'enveloppe ayant une surface interne (20) et une surface externe (22) ;

un premier élément conducteur (24) disposé à

la première extrémité de l'enveloppe et s'étendant depuis l'enveloppe dans une direction le long de l'axe longitudinal ;
un deuxième élément conducteur (26) disposé à la deuxième extrémité de l'enveloppe, et s'étendant depuis l'enveloppe dans la direction le long de l'axe longitudinal, et comportant une surface de contact (28) disposée à une extrémité distale (30) de celui-ci ;
un élément sensible à la chaleur (32) disposé dans l'espace interne de l'enveloppe et situé entre le premier élément conducteur et l'extrémité distale du deuxième élément conducteur, l'élément sensible à la chaleur comportant un matériau non conducteur, le matériau non conducteur passant d'un état physique solide à un état physique non solide quand une température de l'élément sensible à la chaleur atteint une température seuil ;
un élément de contact mobile conducteur (34) disposé dans l'espace interne de l'enveloppe et situé entre l'élément sensible à la chaleur et l'extrémité distale du deuxième élément conducteur, l'élément de contact mobile comportant une partie périphérique (36) en contact avec la surface interne de l'enveloppe ;
un premier élément de rappel (38) disposé entre l'élément sensible à la chaleur et l'élément de contact mobile, le premier élément de rappel agissant sur l'élément de contact mobile avec une première force de rappel dans une première direction (X1) le long de l'axe longitudinal ;
un deuxième élément de rappel (40) disposé entre l'élément de contact mobile et la deuxième extrémité de l'enveloppe, le deuxième élément de rappel agissant sur l'élément de contact mobile avec une deuxième force de rappel dans une deuxième direction (X2) le long de l'axe longitudinal opposée à la première direction le long de l'axe longitudinal ;
dans lequel, quand la température de l'élément sensible à la chaleur est inférieure à la température seuil, l'élément sensible à la chaleur est dans un état physique solide, la première force de rappel est supérieure à la deuxième force de rappel, l'élément de contact mobile est connecté électriquement au deuxième élément conducteur et l'extrémité distale du deuxième élément conducteur est en contact direct avec l'élément de contact mobile, et
le fusible thermique est utilisable pour conduire un courant à travers le fusible thermique, un chemin de courant à travers le fusible thermique allant du premier élément conducteur à la surface interne de l'enveloppe, à l'élément de contact mobile, et au deuxième élément conducteur ;
dans lequel, quand la température de l'élément sensible à la chaleur est égale ou supérieure à la température seuil, l'élément sensible à la chaleur est dans un état physique non solide, la première force de rappel est inférieure à la deuxième force de rappel, l'élément de contact mobile est déconnecté électriquement du deuxième élément conducteur et l'élément de contact mobile est séparé de l'extrémité distale du deuxième élément conducteur, la partie périphérique de l'élément de contact mobile reste en contact avec la surface interne de l'enveloppe, et le fusible thermique est inutilisable pour conduire un courant à travers le fusible thermique ;
dans lequel l'enveloppe comprend une construction de matériau métallique multicouche comprenant :

une couche à base de cuivre (100) ayant un premier côté et un deuxième côté qui est opposé au premier côté ;
une première couche de nickel (102) disposée sur le premier côté de la couche à base de cuivre et comprenant la surface externe de l'enveloppe ;
une deuxième couche de nickel (104) disposée sur le deuxième côté de la couche à base de cuivre ; et
une couche d'argent (106) disposée sur la deuxième couche de nickel et comprenant la surface interne de l'enveloppe ;
caractérisé en ce que
une épaisseur de la première couche de nickel (t1) va de 0,381 micromètre à environ 0,635 micromètre (15 micropouces à environ 25 micropouces),
une épaisseur de la deuxième couche de nickel (t2) va de 0,076 micromètre à environ 0,635 micromètre (3 micropouces à environ 25 micropouces),
et une épaisseur de la couche d'argent (t3) va de 0,102 micromètre à environ 2,54 micromètres (4 micropouces à environ 100 micropouces).

2. Fusible thermique selon la revendication 1, dans lequel l'épaisseur de la couche d'argent est : inférieure à 1,778 micromètre (70 micropouces) ; et/ou inférieure à 0,762 micromètre (30 micropouces) ; et/ou inférieure à 0,254 micromètre (10 micropouces).

3. Fusible thermique selon la revendication 1, dans lequel l'épaisseur de la couche d'argent va de 0,102 micromètre à environ 0,152 micromètre (4 micropouces à environ 6 micropouces).

4. Fusible thermique selon la revendication 3, dans lequel la surface externe de l'enveloppe a une rugosité Ra, Ra > 0,889 micromètre (35 micropouces).

5. Fusible thermique selon la revendication 4, dans lequel la couche à base de cuivre comprend : du cuivre, avec une teneur allant de 84 % à 86 %, du plomb, avec une teneur inférieure ou égale à 0,03 %, du fer, avec une teneur inférieure ou égale à 0,05 %, du cadmium, avec une teneur inférieure ou égale à 0,007 %, du nickel, avec une teneur inférieure ou égale à 0,01 %, et pour le reste du zinc.

6. Fusible thermique selon la revendication 5, dans lequel la couche à base de cuivre comprend de l'alliage de laiton H85.

7. Fusible thermique selon la revendication 6, dans lequel, quand la température de l'élément sensible à la chaleur est égale ou supérieure à la température seuil et l'élément de contact mobile est séparé de l'extrémité distale du deuxième élément conducteur, la partie périphérique de l'élément de contact mobile reste en contact avec la surface interne de l'enveloppe, et une force de frottement entre la partie périphérique de l'élément de contact mobile et la surface interne de l'enveloppe et opposée à la deuxième force de rappel est inférieure à environ 2,94 N (0,3 kilogramme-force).

8. Enveloppe métallique (12, 120) pour un fusible thermique (10), le fusible thermique comprenant :

un premier élément conducteur (24) disposé à une première extrémité (14) de l'enveloppe métallique et s'étendant depuis l'enveloppe métallique dans une première direction le long d'un axe longitudinal (X) du fusible thermique ;
un deuxième élément conducteur (26) disposé à une deuxième extrémité (16) de l'enveloppe métallique, et s'étendant depuis l'enveloppe métallique dans une deuxième direction le long de l'axe longitudinal, le deuxième élément conducteur comprenant une surface de contact (28) disposée à une extrémité distale (30) de celuici ;
un élément sensible à la chaleur (32) disposé dans un espace interne (18) de l'enveloppe métallique et situé entre le premier élément conducteur et l'extrémité distale du deuxième élément conducteur et comprenant un matériau non conducteur, le matériau non conducteur passant d'un état physique solide à un état physique non solide à ou au-dessus d'une température seuil ;
un élément de contact mobile conducteur (34) disposé dans l'espace interne de l'enveloppe métallique et situé entre l'élément sensible à la chaleur et l'extrémité distale du deuxième élément conducteur, l'élément de contact mobile comprenant une partie périphérique (36) en contact avec la surface interne (20) de l'enveloppe métallique ;
un premier élément de rappel (38) disposé entre l'élément sensible à la chaleur et l'élément de contact mobile, le premier élément de rappel agissant sur le contact mobile avec une première force de rappel dans une première direction (X1) le long de l'axe longitudinal ;
un deuxième élément de rappel (40) disposé entre l'élément de contact mobile et la deuxième extrémité de l'enveloppe métallique, le deuxième élément de rappel agissant sur le contact mobile avec une deuxième force de rappel dans une deuxième direction (X2) le long de l'axe longitudinal opposée à la première direction ;
dans laquelle, quand une température de l'élément sensible à la chaleur est inférieure à la température seuil, la première force de rappel est supérieure à la deuxième force de rappel, et l'élément de contact mobile est connecté électriquement au deuxième élément conducteur et l'extrémité distale du deuxième élément conducteur est en contact direct avec l'élément de contact mobile, le fusible thermique est utilisable pour conduire un courant à travers le fusible thermique, un chemin de courant à travers le fusible thermique allant du premier élément conducteur à la surface interne de l'enveloppe métallique, à l'élément de contact mobile, et au deuxième élément conducteur ;
dans laquelle, quand la température de l'élément sensible à la chaleur est supérieure ou égale à la température seuil, la première force de rappel est inférieure à la deuxième force de rappel, l'élément de contact mobile est déconnecté électriquement du deuxième élément conducteur et l'élément de contact mobile est séparé de l'extrémité distale du deuxième élément conducteur, la partie périphérique de l'élément de contact mobile reste en contact avec la surface interne de l'enveloppe métallique, et le fusible thermique est inutilisable pour conduire un courant à travers le fusible thermique ; et
dans laquelle l'enveloppe métallique comprend un matériau métallique multicouche, le matériau métallique multicouche comprend : une couche à base de cuivre (100) ; une première couche de nickel (102) disposée sur un premier côté de la couche à base de cuivre et comportant une surface externe (22) de l'enveloppe métallique ; une deuxième couche de nickel (104) disposée sur un deuxième côté de la couche à base de cuivre opposé au premier côté de la couche à base de cuivre ; et une seule couche d'argent (106) disposée uniquement sur la deuxième couche de nickel et comprenant la surface interne de l'enveloppe métallique ;
caractérisée en ce que
une épaisseur de la première couche de nickel

(t1) va de 0,381 micromètre à environ 0,635 micromètre (15 micropouces à environ 25 micropouces),
une épaisseur de la deuxième couche de nickel (t2) va de 0,076 micromètre à environ 0,635 micromètre (3 micropouces à environ 25 micropouces),
et une épaisseur de la couche d'argent (t3) va de 0,102 micromètre à environ 2,54 micromètres (4 micropouces à environ 100 micropouces).

9. Enveloppe métallique selon la revendication 8, dans laquelle l'épaisseur de la couche d'argent est inférieure à 1,778 micromètre (70 micropouces).

10. Enveloppe métallique selon la revendication 8, dans laquelle l'épaisseur de la couche d'argent est inférieure à 0,762 micromètre (30 micropouces).

11. Enveloppe métallique selon la revendication 8, dans laquelle l'épaisseur de la couche d'argent est inférieure à 0,254 micromètre (10 micropouces).

12. Enveloppe métallique selon la revendication 8, dans laquelle l'épaisseur de la couche d'argent va de 0,102 micromètre à environ 0,152 micromètre (4 micropouces à environ 6 micropouces).

13. Enveloppe métallique pour un fusible thermique selon la revendication 12, la surface externe de l'enveloppe métallique ayant une rugosité Ra, Ra > 0,889 micromètre (35 micropouces).

14. Enveloppe métallique selon la revendication 13, dans laquelle la couche à base de cuivre comprend : du cuivre, avec une teneur allant de 84 % à 86 % ;

du plomb, avec une teneur inférieure ou égale à 0,03 % ; du fer, avec une teneur inférieure ou égale à 0,05 % ; du cadmium, avec une teneur inférieure ou égale à 0,007 % ;
du nickel, avec une teneur inférieure ou égale à 0, 01 % ; et pour le reste du zinc.

15. Enveloppe métallique selon la revendication 14, dans laquelle la couche à base de cuivre comprend de l'alliage de laiton H85.

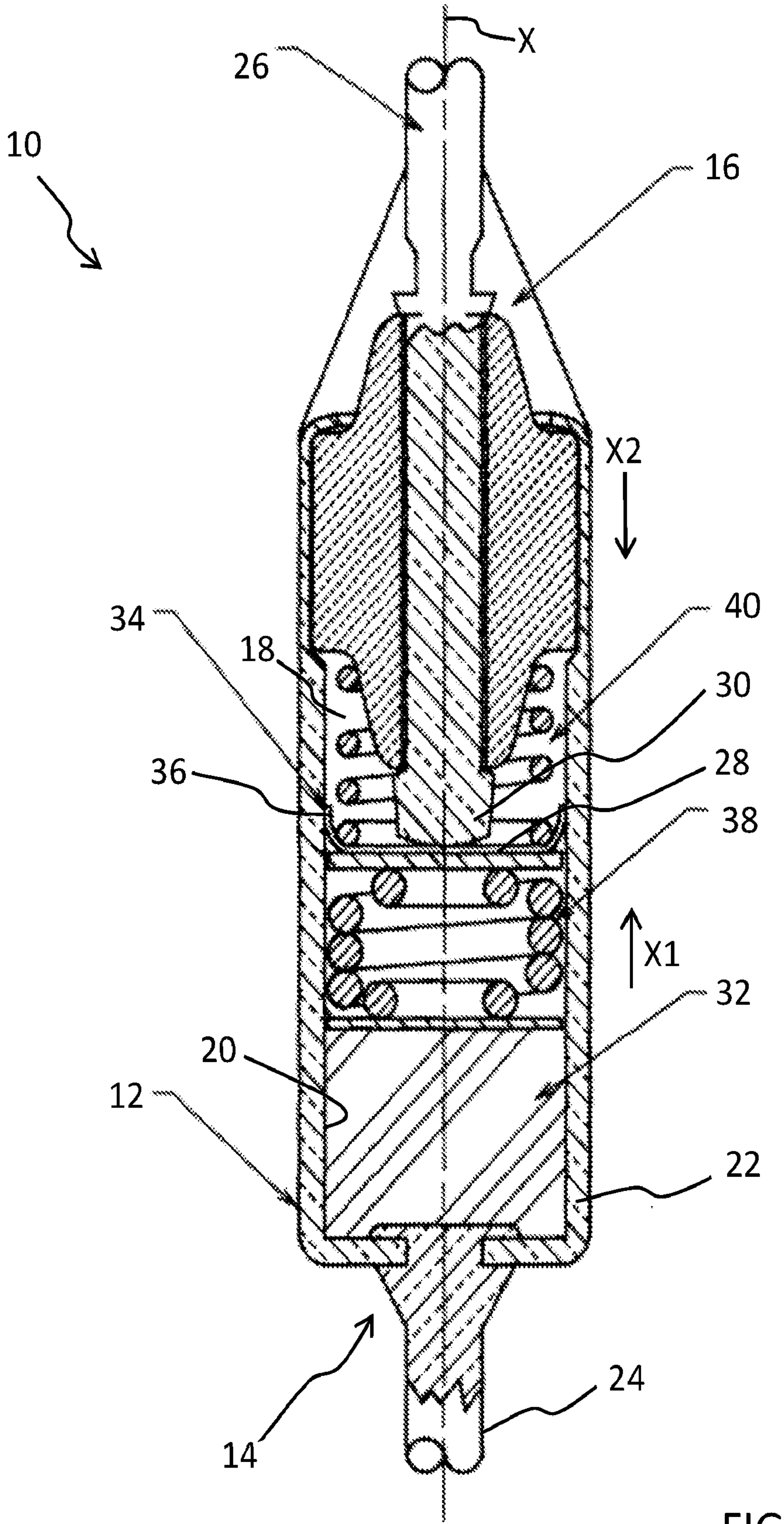

FIG. 1
PRIOR ART

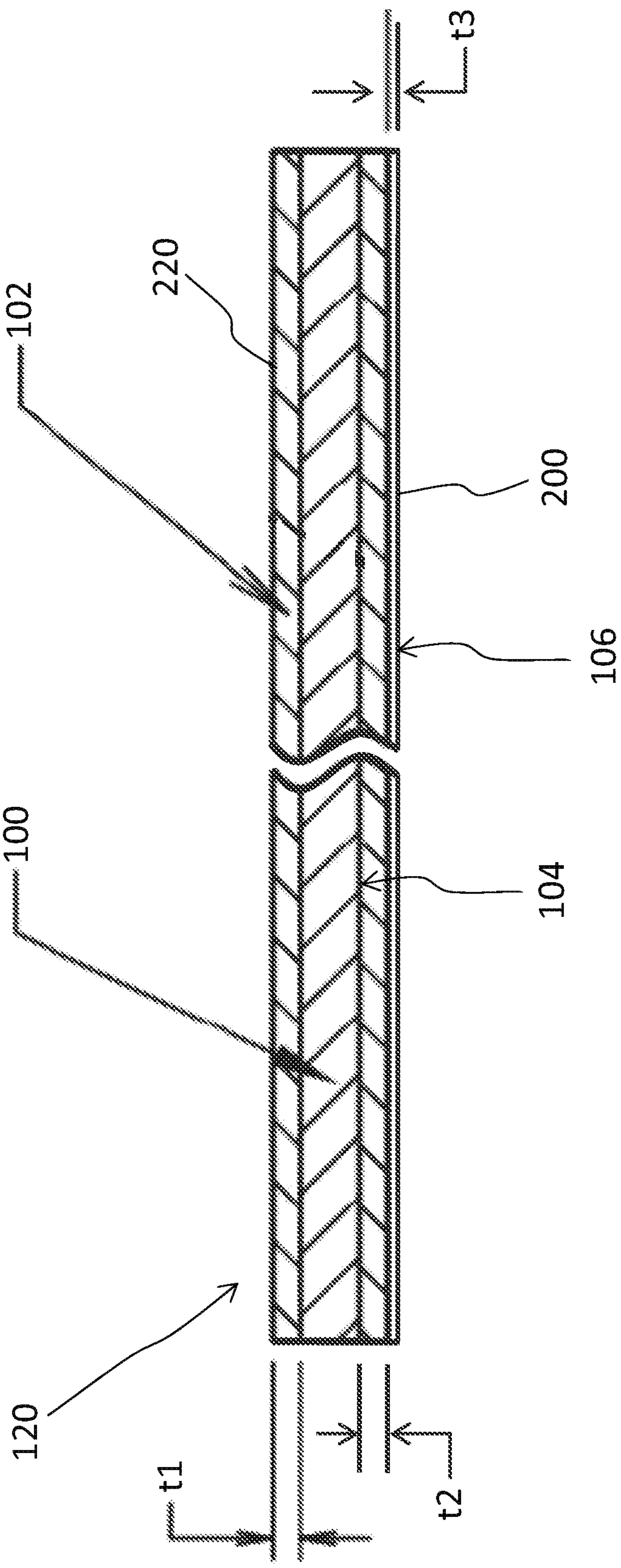

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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