March 11, 1969 H. V. VIND 3,432,786

ELECTRICAL SWITCHES HAVING A REST CONTACT AND SELF-HOLDING MEANS

Filed Oct. 4, 1966

Sheet 1 of 2

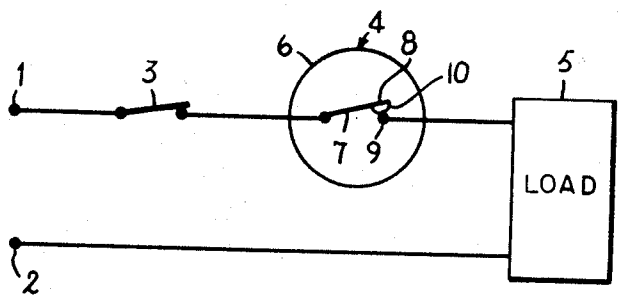


FIG. 1

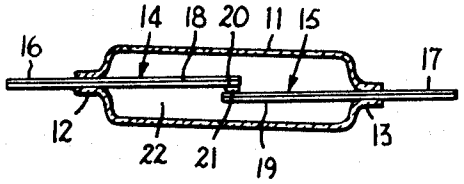


FIG. 2

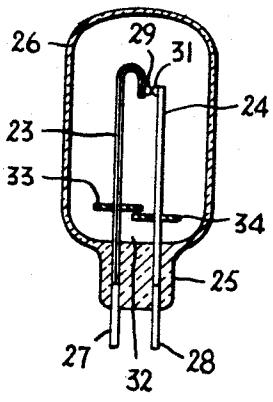


FIG. 3

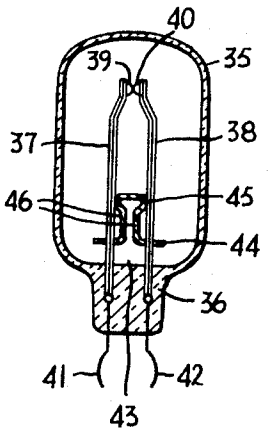


FIG. 4

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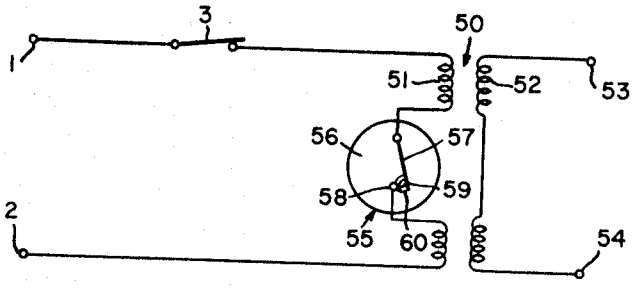


FIG. 5

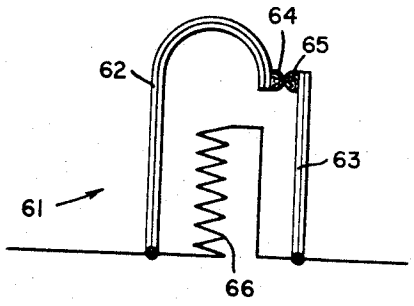


FIG. 6

United States Patent Office 3,432,78(
Patented Mar. 11, 196(

3,432,786

ELECTRICAL SWITCHES HAVING A REST CONTACT AND SELF-HOLDING MEANS

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U.S. Cl. 337—95 2 Claims
Int. Cl. H01h 61/17, 37/32

ABSTRACT OF THE DISCLOSURE

A circuit-breaking device comprising a switch having a movable bimetallic strip in contact with self-holding means and the strip has a layer of a material substantially insensitive to ion bombardment facing the other cooperating electrode for use in glow discharge devices. Another embodiment has non-conductive masks on the switch electrodes or strips to prevent formation of a short-circuit path due to metal vapor precipitations in operation in a glow discharge device.

This invention relates to a circuit-breaking arrangement, particularly for excess temperature, excess current or excess voltage protection, including a bimetal switch, which interrupts a circuit when an excess temperature, current or voltage occurs.

Circuit-breaking arrangement or fuses of this type can be influenced directly by a temperature being monitored, or by the thermal representation of some other physical manifestation, for example electric current or voltage. They serve to switch off the cause of the excess temperature directly or indirectly.

A disadvantage with known apparatus of this type is the fact that the bimetal switch closes again some time after responding, since when the cause of the excess temperature is switched off the temperature of the bimetal falls. It can therefore happen that in spite of the defect, the installation is set in operation again and the cycle of the bimetal switch is repeated once, or several times more, before the defect is noticed. The circuit-breaking arrangement could be held mechanically in the release position, but this measure cannot be used where the excess temperature circuit-breaking arrangement is installed in an inaccessible or remote position, for example, in the winding of an electrical machine.

An object of the invention is therefore to design an excess temperature circuit-breaking arrangement which can be installed in an inaccessible position while allowing reclosure to take place only after suitable measures have been taken externally.

This object is achieved, according to the invention, by connecting a holding device in parallel with the bimetal switch so that, as long as the operating voltage is effective, the holding device is energized to produce a force which holds the switch open, once said switch has been opened.

In particular, a heating device can be connected in parallel with the bimetal switch which, as long as the operating voltage is effective, imparts to the bimetal switch a force which is sufficient to hold the switch, once the switch has been opened.

The holding device is short-circuited and therefore ineffective when the bimetal switch is closed, but when the switch is opened, the full operating voltage or a substantial portion thereof is applied to the holding device, which then holds the bimetal switch open. This state is only eliminated if the operating voltage is interrupted by external measures, for example, manually. If the bimetal switch has a magnetic material and the holding device is

formed by an electromagnet, the bimetal returns immediately to the rest position upon removal of the operating voltage. When using a heating device, the bimetal switch cools down and after a certain time reaches its rest position. Thereafter the installation can be set in operation normally by re-connecting the voltage. In the meantime, the operator has the opportunity to eliminate the cause of the excess temperature.

In a preferred embodiment, the holding device is a heater. A heater requires no movable parts and can be produced cheaply. It can quite easily impart to the bimetallic strips the force required to hold open the bimetal switch by utilizing the heat energy.

It is very advantageous in this connection to use a heating device which has a glow discharge formed between the contacts of the bimetal switch. With a glow discharge of this type no thin-wired and therefore sensitive heater winding is required. If the glow discharge is allowed to form between the contacts of the bimetal switch, automatic adjustment of the heat output results; for the closer the contacts are to each other the stronger is the heat output. The ignition of the glow discharge is not critical, even with ageing, since when the switch opens a spark is always produced on separation of the contacts which brings the glow discharge into action.

A glow discharge device embodying the invention is simply connected to the mains in series with the load to be switched off. When the switch responds and opens, almost the full supply of voltage is connected to the switch and produces a glow discharge which holds the switch open. When selecting the construction characteristics of the device, i.e. type of gas, gas pressure, electrode gap in the open state, etc., the designer is relatively free, since when the switch opens, a circuit-breaking spark occurs which ensures reliable ignition of the glow discharge. Ageing phenomena are, therefore, of only minor importance. The whole switch with the self-holding means therefore consist of a single element, for example, a small gas-filled glass bulb with a bimetal switch fixed in the pinched base.

All known measures can be considered for the actuation of the bimetal switch. When monitoring current, it is advantageous to allow the bimetal to be heated by the current flowing through it so as to open when a current limit value is exceeded, but the bimetal switch can also be actuated by means of an additional heating resistor or by the ambient temperature. If magnetic material is used in the bimetal switch, it can be opened magnetically. In all cases it is ensured that it holds itself open automatically after opening.

Glow discharge devices usually have a stabilization drop resistor of considerable magnitude. Having regard to the object of the invention, such a stabilization drop resistor would disturb normal operation. For many applications the bimetal can therefore be exposed to a very strong gas ion bombardment, tending to the knocking out of metal ions, which in the form of a metal vapor precipitate, can form a short-circuit path between lead-in conductors. It is therefore a feature of the invention that the glow discharge device is provided with means to prevent the formation of a short-circuit path due to metal vapor precipitations.

As a preventive measure, in a first embodiment of the invention, the layer of the bimetal facing the co-operating electrode consists of a material which is in a high degree insensitive to ion bombardment, for example, tungsten. Other materials can also be considered if they have a higher emission energy than the bimetal materials otherwise used.

In a second embodiment, provision is made for the bimetal to have at least on the side facing the co-operat-

ng electrode, a protective coating of a material which is in a high degree insensitive to ion bombardment, for example, metal oxide or bright carbon.

Protection against metal vapor deposit can also be obtained by providing a mask of insulation material arranged on the bimetal or bimetals, preferably near the point of attachment, which shields the area threatened by the formation of a short-circuit bridge of metal deposit. Reference is directed to the examples described hereinafter.

If the glow discharge circuit-breaking device is installed in a position which is visible from the outside, it can also be used as an optical indicator.

When the excess temperature circuit-breaking arrangement is installed in the winding of an electrical apparatus, in spite of re-closure being possible from outside, it need not be accessible. In an electric motor, when the rotor is jammed, repeated attempts to switch the motor on again, which are otherwise usual with thermal circuit-breaking arrangements, are ineffective. In an alternating current electric motor, each phase can be monitored separately with a circuit-breaking arrangement. Particularly in a single phase motor, for example a drive motor for a coolant compressor, circuit-breaking arrangement can be built into the main and auxiliary windings which are arranged for different response temperatures.

The invention is described in greater detail hereinafter with reference to preferred embodiments shown by way of example in the accompanying drawings, in which:

FIG. 1 shows a wiring diagram for the application of a circuit-breaker according to the invention.

FIG. 2 is a diagrammatic view of the first embodiment of the circuit-breaker.

FIG. 3 is a diagrammatic view of a second embodiment.

FIG. 4 is a diagrammatic view of a third embodiment.

FIG. 5 is a wiring diagram of a transformer monitored according to the invention, and

FIG. 6 shows another embodiment of an excess current release arrangement.

In FIG. 1, any desired load **5** is connected to the main terminals **1** and **2** by way of a main switch **3** and a switch **4** embodying the invention. The switch **4** consists of a glow discharge tube **6** with a gas filling and a bimetal switch **7**, the movable contact **8** of which lies opposite a fixed contact **9**. As soon as the bimetal switch **7** opens for any reason, for example, if the current flowing through it and heating it becomes too great, the switch opens and ignites a glow discharge **10**, the heat output of which is sufficient to hold the bimetal in the outward position, i.e. the open position of the switch **7**. The glow discharge **10** is fed by almost the full mains voltage, since the voltage drop at the resistor of the load **5** is only slight because of the limited current.

FIG. 2 illustrates what a simple form a switch embodying the invention can take. A glass envelope **11** is provided at both ends with pinched bases **12** and **13** in each of which a bimetal **14** and **15** respectively, is fixed. The outwardly projecting ends **16** and **17** of the bimetals each serve as a connecting lug. The inwardly projecting ends **18** and **19** carry movable contacts **20** and **21** respectively. The inner chamber **22** of the glass envelope is filled with a gas which is usual for glow discharge lamps, for example, helium, neon, argon or the like. The pressure is approximately 10 torr. The bimetals **14** and **15** are so arranged that when using a mains voltage of 220 v. a contact gap of approximately 4 mm. is set.

In the embodiment shown in FIG. 3, a bimetal strip **23** and a fixed contact holder **24** are fixed in a common pinched base **25** of a glass envelope **26**. Their free ends project outwards as pins **27** and **28**. The movable contact **29** is attached to a curved over end **30** of the bimetal strip **23** and rests against the fixed contact **31**.

In a glow discharge, metal ions are knocked out of the bimetal by ion bombardment; they generally migrate along the two contact holders **23** and **24** and in the course of time form a short-circuit path by precipitation on the top

32 of the pinched base **25**. For this reason, a mask **33** of insulating material is fitted on the metal strip **23** and a mask **34** of insulating material on the contact holder **24** near the point of attachment. These masks intercept the metal vapor precipitate and therefore shield the threatened area **32**.

In the embodiment shown in FIG. 4, in a glass envelope **35** with a pinched base **36** a pair of bimetal strips **37** and **38** are arranged, the contacts **39** and **40** of which engage each other. Connecting wires **41** and **42** are led to the outside. For protection against metal vapor precipitation on the top **43** of the pinched base **36**, there is attached to each bimetal strip near the point of attachment a mask **44**, the central section **45** of which is provided with two webs **46**, but projects laterally beyond the latter. In this way, both the area **43** is protected and also the formation of a metal precipitate on the central webs **46** is provided.

As an alternative or additional means for inhibiting the formation of a short-circuit path, by metal vapor condensation, the layer of the bimetal strip facing the other electrode is formed of a material having a high degree of insensitivity to ion bombardment, for example, tungsten. Alternatively the strips carrying the contacts may be provided, at least on the side facing the co-operating contact, with a protective coating of a material having a high degree of insensitivity to ion bombardment, for example, metal oxide or bright carbon.

In the circuit shown in FIG. 5 the terminals **1** and **2** of an alternating current supply are connected by a main switch **3** to the primary winding **5** of a transformer **50**, the secondary winding **52** of which leads to high-tension terminals **53** and **54**. A glow discharge tube **55** is inserted into the primary winding so as to be subjected to the heat of the winding. In the evacuated inner chamber **56** of this tube there is a bimetal switch **57**, which opens when the temperature of the winding **51** is excessive. It is preferably so arranged that it is dependent to the least possible degree on the winding current flowing through it.

As soon as the switch opens, there occurs between the fixed contact **58** and the movable section **59** of the bimetal switch a glow discharge **60** the heat output of which imparts to the bimetal switch a force which is sufficient to hold the switch **57** open. Substantially the full operating voltage is available at the terminals **1** and **2** for the production of the glow discharge, since the voltage drop inside the winding **51** is negligible.

The glow discharge persists until the main switch **3** is opened. Only then can the winding thermostat cool down and return to its rest position. Thereafter the arrangement can be set in operation again, if necessary after elimination of damage, by closing the switch **3**.

In the embodiment shown in FIG. 6, a bimetal switch **61** is used as an excess current release arrangement which has two bimetal strips **62** and **63** with movable contacts **64** and **65**, whereby the excess current heats both bimetal strips. The bimetal strips **62** and **63** are arranged to separate the contacts **64** and **65** when the bimetal strips **62** and **63** are heated to a selected temperature. As soon as the switch has opened, almost the full mains voltage is applied to a heating resistor **66** which is connected across the contacts and which transmits heat to the bimetal strips so that the contacts remain open until the voltage of the whole installation is switched off.

Many modifications can be made to the embodiments described, without departing from the basic concept of the invention. For example, a holding device can be used which works magnetically. For this purpose, it is only necessary for a layer of the bimetal to consist of ferromagnetic material or for a piece of magnetic material to be attached to the bimetal. When the bimetal device is sealed inside an envelope, a magnetic actuating means can be provided inside or outside the envelope. Moreover, it will be understood that compatible features of the several illustrated examples are mutually interchangeable

and that other modifications may be made within the scope of the appended claims.

What I claim is:

1. A circuit-breaking device comprising, a pair of electric contacts, a bimetallic strip carrying one of said contacts biased to close said contacts and operable against said bias in response to heat to open said contacts, means for connecting said bimetallic strip and contacts in series with a voltage supply and a load to cause said bimetallic strip to open the contacts when a predetermined current value is exceeded, self-holding means to hold the bimetallic strip heated and the contacts open and comprising means rendered effective when said contacts open, and said bimetallic strip comprising a layer of material facing a cooperating contact, said layer comprising a material which is in a high degree insensitive to ion bombardment.

2. A circuit-breaking device comprising, a pair of electric contacts, a bimetallic strip carrying one of said contacts biased to close said contacts and operable against said bias in response to heat to open said contacts, means

for connecting said bimetallic strips and contacts in seri with a voltage supply and a load to cause said bimetall strip to open the contacts when a predetermined curre value is exceeded, self-holding means to hold the bimeta lic strip heated and the contacts open and comprisir means rendered effective when said contacts open, ar a mask of insulating material on the bimetallic strip order to inhibit of a short-circuit path thereon.

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