July 26, 1966 H. M. PFLANZ ET AL 3,263,050

ELECTRICAL CONTACT COMPRISING A PLURALITY OF FLEXIBLE CURVED WIRES

Filed Nov. 25, 1964

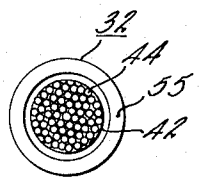


Fig.3

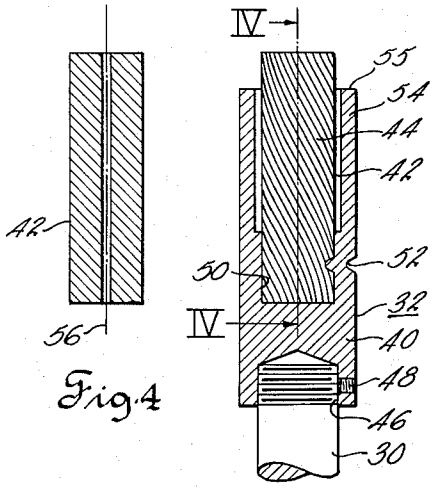


Fig.4

Fig.2

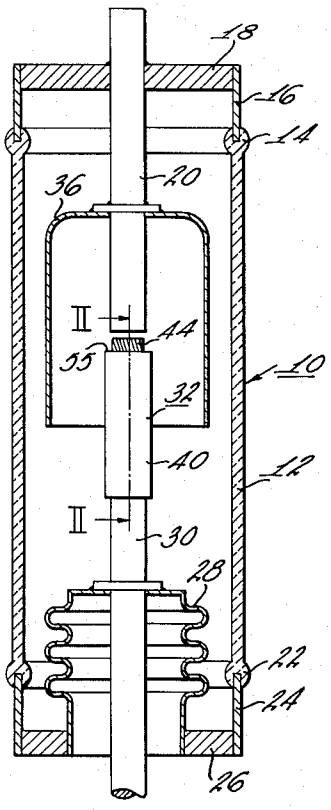


Fig.-1

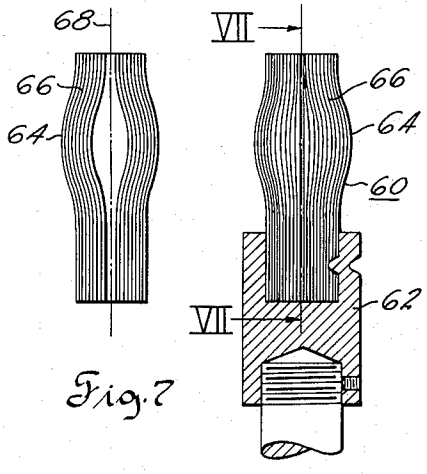


Fig.7

Fig.5

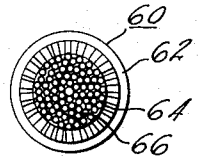


Fig.6

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United States Patent Office 3,263,050 Patented July 26, 1966

3,263,050

ELECTRICAL CONTACT COMPRISING A PLURALITY OF FLEXIBLE CURVED WIRES

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Filed Nov. 25, 1964, Ser. No. 413,805
6 Claims. (Cl. 200—166)

This invention relates generally to contacts for electric circuit breakers. More particularly, it relates to multipoint contacts comprising a plurality of electrically conductive wires or filaments bundled together.

Some electric circuit breakers and vacuum switches employ butt type contacts which, for example, take the form of a pair of solid cylindrical members which are brought together end to end during contact closure. Such contacts have a high mass and are subject to rebound upon closure. The faces of such contacts are also subject to pitting caused by arcing and to the formation of oxide films and other electrical resistance films. In addition, such contacts are solid and are difficult to degas if they are intended for use in vacuum switches. It is desirable, therefore, to provide new and improved contacts which overcome the aforesaid disadvantages and have additional advantages.

It is an object of the present invention to provide contacts comprising a plurality of electrically conductive filaments bundled together to provide improved multipoint contact against an abutting surface.

Another object is to provide contacts of the aforesaid character wherein the filaments are adapted to rotate or otherwise move upon contact closure to afford improved electrical contact and effect a wiping action against an abutting surface.

Another object is to provide contacts of the aforesaid character wherein contact rebound is reduced.

Another object is to provide contacts of the aforesaid character wherein the possibility of simultaneous dancing or vibration of individual filaments is reduced.

Another object is to provide contacts of the aforesaid character wherein the degassing thereof is more effectively accomplished in a shorter period of time.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawing illustrates several preferred embodiments of the invention but it is to be understood that the embodiments illustrated are susceptible of modification with respect to details thereof without departing from the scope of the appended claims.

In the drawing:

FIG. 1 is a view of a vacuum type electric circuit interrupter employing one embodiment of a contact constructed in accordance with the present invention;

FIG. 2 is an enlarged view partly in cross section, taken along the line II—II of FIG. 1;

FIG. 3 is a top end view of the contact shown in FIGS. 1 and 2;

FIG. 4 is a cross sectional view taken along line IV–IV of FIG. 2;

FIG. 5 is a view, partly in cross section, of another embodiment of a contact incorporating the present invention;

FIG. 6 is a top end view of the contact shown in FIG. 5; and

FIG. 7 is a cross-sectional view taken along line VII–VII of FIG. 5.

Referring to FIG. 1, the numeral **10** designates a vacuum type electric circuit interrupter or switch employnig a contact incorporating the present invention. It is to be understood, however, that contacts incorporating the present invention can be employed in types of circuit breakers or switches other than vacuum switches.

Vacuum switch **10** comprises a cylindrical envelope **12** which may be formed, for example, of a suitable vitreous material. One end of envelope **12** is provided with an annular rim **14** to which is rigidly secured in a vacuum tight connection thereto one end of a ring or flange **16**. A metallic cap **18** is sealed along its edge to the other end of flange **16**. Cap **18** supports a stationary contact **20** which is arranged to extend along the longitudinal axis of envelope **12** and is rigidly supported so as to be restricted against longitudinal or lateral movement. The opposite end of envelope **12** is provided with an annular rim **22** which is rigidly secured in a vacuum tight connection to one end of a ring on flange **24**. A tube or retainer **26** is sealed along its rim in a vacuum tight connection to flange **24**. A metallic cylindrically shaped flexible bellows **28** is rigidly secured in a vacuum tight connection at one end thereof to retainer **26**. The other end of bellows **28** surrounds and is rigidly secured in a vacuum tight connection to a movable contact support **30** which is arranged to extend through retainer **26** into envelope **12** and is in cooperating relationship with contact **20**.

The relatively movable cooperating contact **20** and contact support **30** may be made of a suitable electrically conductive material such as copper or the like. As shown in FIG. 1, contact support **30** is understood to be arranged for longitudinal movement a limited predetermined distance by a suitable contact actuating mechanism (not shown).

Contact support 30 is adapted to support a contact **32** hereinafter described in detail.

In order to control the arcing products emitted upon separation of the engaging surfaces of the contact **20** and contact **32**, a cylindrical cup shaped tube or shield **36** is provided which is rigidly secured to contact **20** and is arranged to extend beyond the adjacent ends of both contact **20** and contact **32** so as to surround the contacts **30** and **32** when the contacts are engaged and disengaged. Shield **36** may be formed of glass or any suitable metallic and/or nonmetallic material.

Upon actuation of movable contact support **30** in axial contact engaging or contact disengaging direction, bellows **28** deflects, allowing restricted longitudinal movement of contact **32**. The required range of movement of contact structure **32** is very small. For example, with only $\frac{3}{16}$ of an inch separation between engaging surfaces of contact **32** and contact **20** a current of several thousand amperes at an A.C. voltage of 18,000 can be safely interrupted. The switch can continuously conduct current of several hundred amperes.

Referring to FIGS. 1 through 4, contact **32** comprises a base **40** on which a bundle **42** of electrically conductive resilient wires **44** are mounted. Base **40** is adapted to be removably mounted on contact support **30** by means of a threaded opening **46** which receives the threaded end of contact support **30**. A set screw **48** is provided in base **40** to lock the base securely in position against rotation. Base **40** is provided with a recess **50** in which one end of bundle **42** is inserted and the bundle is secured therein as by crimping the base at **52**. If preferred, bundle **42** could be secured to base **40** by some other means such as welding. In accordance with one aspect of the invention, base **40** is provided with a portion **54** which surrounds but is spaced from the intermediate portion of bundle **42**. Portion **54** of base **40** serves to afford added support to bundle **42** during contact closing, as hereinafter explained. In addition, the edge **55** of portion **54** of base **40** is sufficiently close to contact **20** during contact closed position so that upon contact parting the arc

initialed between contacts 20 and 32 will tend to force itself onto edge 55 which then serves as an arc terminal. This diminishes the tendency of the arc to burn on bundle 42 of contact 32 and cause deterioration of the ends of the filaments 44.

As FIGS. 2 and 4 best show, each filament 44 is curved between its stationary end and its free end. Specifically, each filament 44 defines a spiral or is helically curved around a longitudinal axis 56 through the center of contact 32. Thus, each filament 44 is able to rotate or otherwise move during contact closure, as will hereinafter appear. Although the filaments 44 are shown as being curved to the left with respect to FIG. 2, it is to be understood that they could be curved to the right instead. The filaments 44 are shown as being of the same diameter but they could be of differing diameters if such were desirable in order to cause them to vibrate at different frequencies in response to electromagnetic forces caused by current flow through contact 32 and mechanical closing forces.

FIGS. 5, 6 and 7 show a contact 60 which is another embodiment of the present invention. Contact 60 comprises a base 62 on which a bundle 64 of electrically conductive resilient wires or filaments 66 is mounted. Base 62 is similar to base 40 of contact 32 hereinbefore described except that it is not provided with a surrounding portion such as portion 54 in contact 32. Each filament 66 in bundle 64 of contact 60 is curved between its stationary end and its free end. Specifically, each filament 66 is convexly or outwardly curved in a plane which passes through a longitudinal axis 68 through the center of contact 60. Thus, each filament 66 is able to flex or otherwise move during contact closure, as will hereinafter appear. The filaments 66 are shown as being of the same diameter but they could have diameters differing from one another if such were desirable.

The embodiment of the invention shown in FIGS. 1, 2, 3 and 4 operates as follows. Assume that contacts 20 and 32 of vacuum switch 10 are initially in the contact open position shown in FIG. 1. Assume further that contact rod 30 is then moved axially toward contact 20 to contact closed position. As this occurs, the free ends of the filaments 44 in bundle 42 of contact 32 are brought into butting engagement with the face of contact 20 and multipoint contact is made. As contact closure continues the individual filaments 44 are compressed but because of their curvature or twist they are forced to rotate slightly. This twisting action of multipoint contact 32 results in improved point contact of a multiplicity of filament ends. The twisting action exerts a cleaning or wiping action on the face of contact 20 and on the free end of each filament 44 to overcome the adverse effect of pitting caused by arcing and to remove electrically resistant films.

As will be understood, contacts 20 and 32 are closed with great speed and force. However, the tendency of contact 32 and its contact support to rebound is effectively reduced because the energy thereof is dissipated in the friction or rubbing that takes place between the individual filaments 44 as they twist under compression. This friction is also increased in proportion to the square of the electrical current flowing through contact 32. More specifically, current flow through the many parallel filaments 44 of contact 32 results in an electromotive force which tends to drive the filaments closely together.

In a contact made up of a plurality of filaments it is possible for the filaments to vibrate or dance individually. However, because of the friction resulting from the twist or curvature of the filaments 44 in contact 32 and from the electromotive forces, any tendency of the filaments to dance simultaneously is reduced. The tendency to dance can be further reduced by using filaments of various diameters in the bundle so that they have different periods of vibration.

Contact 32 also resists any tendency to open spontaneously because of the high ratio of the spring contact over the relative mass in each filament 44 and because of the twisting of bundle 42 as a whole upon closure. Any contact parting tendency is further reduced as current flow through contact 32 increases due to the increase in friction between the various filaments 44 and the general stiffening of bundle 42 which results.

Upon opening of the contacts 20 and 32, the compressive force on bundle 42 of filaments 44 is reduced and the filaments twist back to their initial position with the same beneficial wiping action hereinbefore described.

Contact 60 shown in FIGS. 5, 6 and 7 operates in a manner similar to contact 32 in that a wiping action occurs in the bundle 64 of filaments 66 as they are put under compression during contact closing. Similarly, there are mechanical and electromagnetic frictional forces existing between the various filaments 66 when contact 60 is abutting a contact such as contact 20 and current is flowing therethrough.

Contacts such as 32 and 60 hereinbefore described are especially well suited to undergo degassing to drive off impurities such as is required if they are to be used in vacuum switches. This is because the multiplicity of filaments have a maximum of surface area exposed as compared to an electrically equivalent solid butt type contact.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an electric circuit breaker, in combination, a pair of contacts movable into and out of engagement with each other, at least one contact of said pair of contacts comprising a plurality of resilient closely spaced electrically conductive filaments arranged around a central longitudinal axis, each filament having one end rigidly secured with respect to one end of the other filaments and each filament having a free end for engagement with the other contact of said pair of contacts, and each of said filaments being helically curved around said axis between its ends whereby said filament is able to flex upon engagement of its free end with said other contact.

2. The combination according to claim 1 wherein some of said filaments are of a predetermined diameter and the remaining filaments are of a diameter different from said predetermined diameter.

3. In an electric circuit breaker, in combination, a pair of movable electrically conductive contact rods, a butt type contact at the end of one of said rods, and a multipoint contact removably mounted at the end of the other of said rods, said multipoint contact comprising an electrically conductive base releasably mounted at the end of said other rod, said multipoint contact further comprising a bundle of resilient closely spaced electrically conductive filaments connected to said base at one end of said bundle, said filaments being arranged around a central longitudinal axis, each filament having a free end for engagement with said butt type contact, each of said filaments being curved in a spiral with respect to said axis, and said base having a portion which surrounds said bundle near the free ends of said filaments.

4. In an electric circuit breaker, in combination, a pair of movable electrically conductive contact rods, a butt type contact at the end of one of said rods, and a multipoint contact removably mounted at the end of the other of said rods, said multipoint contact comprising an electrically conductive base releasably mounted at the end of said other rod, said multipoint contact further comprising a bundle of resilient closely spaced electrically conductive filaments connected to said base at one end of said bundle, said filaments being arranged around a central longitudinal axis, each filament having a free end for engagement with said butt type contact, and each of said filaments being convexly curved with respect to said axis.

5. In an electric circuit breaker, in combination, a pair of contacts movable into and out of engagement with each other, at least one contact of said pair of contacts comprising a plurality of resilient closely spaced electrically conductive filaments arranged around a central lon-

gitudinal axis, each filament having one end rigidly secured with respect to one end of the other filaments and each filament having a free end for engagement with the other contact of said pair of contacts, and each of said filaments being convexly curved between its ends with respect to said axis whereby said filament is able to flex upon engagement of its free end with said other contact.

6. The combination according to claim 5 wherein some of said filaments are of a predetermined diameter and the remaining filaments are of a diameter different from said predetermined diameter.

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