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Talento

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[54] **CONTACT STRUCTURE FOR AN ELECTRIC CIRCUIT BREAKER**

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[51] **Int. Cl.** **H01h 1/02**

[58] **Field of Search**.......200/166 C, 144 B; 29/630 C

[56] **References Cited**

UNITED STATES PATENTS

3,610,859	10/1971	Schreiner et al.	200/166 C
2,247,754	7/1941	Hensel et al.	29/198 X
2,975,255	3/1961	Lafferty	200/144 B
3,143,626	8/1964	Schreiner et al.	200/166 C
3,305,324	2/1967	Krock et al.	29/182.1
3,411,902	11/1968	Krock et al.	75/208
2,975,255	3/1961	Lafferty	200/166 C X
2,975,256	3/1961	Lee et al.	200/166 C X

FOREIGN PATENTS OR APPLICATIONS

892,339	3/1962	Great Britain	200/166 C
1,071,664	6/1967	Great Britain	200/144 B

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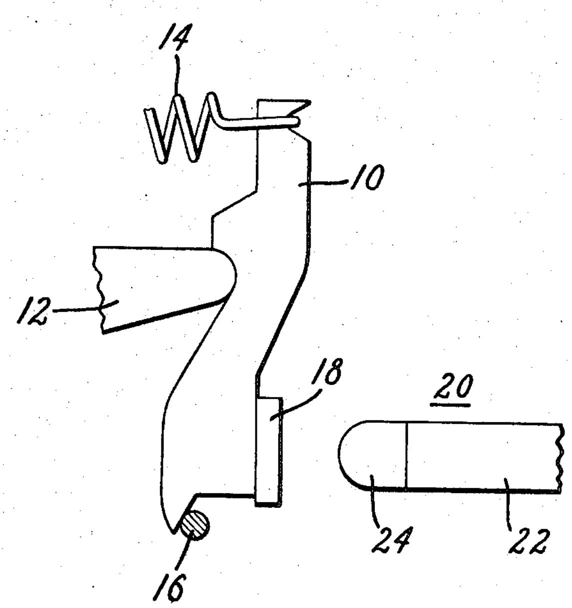
[57] **ABSTRACT**

Discloses a circuit breaker with a pair of contacts that are located in a fluid medium and are relatively movable into and out of engagement with each other. Each of these contacts comprises a porous skeleton of a refractory material, such as tungsten or tungsten carbide, and an alloy of silver and bismuth filling the pores of the skeleton. The percentage of bismuth is less than 2 percent by weight of the silver-bismuth alloy.

9 Claims, 1 Drawing Figure



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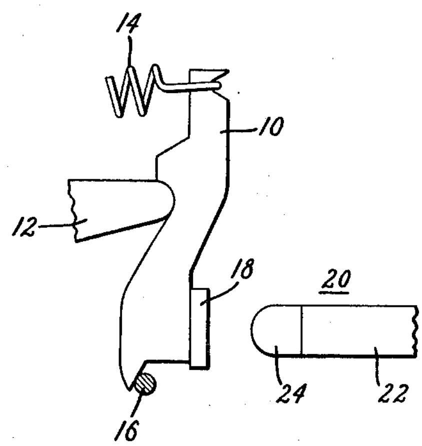

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CONTACT STRUCTURE FOR AN ELECTRIC CIRCUIT BREAKER

This invention relates to contact structure for an electric circuit breaker of the type in which the contacts operate in air or some other fluid and, more particularly, relates to contacts of this type that are made of a refractory conductive material skeleton infiltrated with a high conductivity silver-base metal.

A widely-used contact material comprises a porous skeleton made of a refractory conductive material, such as tungsten or tungsten carbide, and a high conductivity metal filling the pores of the skeleton. For contacts that are to be operated in air or some other oxide-forming medium, a high conductivity metal that has excellent properties for use as the infiltrant is silver. Silver has the highest electrical and thermal conductivity of all metals, has the lowest contact resistance, and will not form stable oxides on its surface.

While contacts made of silver alone have an objectionable tendency to weld together relatively easily and to erode excessively in the presence of an arc, the skeleton of refractory material imparts considerable resistance to such welding and arc-erosion; and for most applications, satisfactory resistance to welding and arc-erosion is achieved with the refractory material-silver contacts. Moreover, this resistance is achieved without loss of the high conductivity properties of the silver since the silver and the refractory material are substantially insoluble in each other, and the conductive properties of the silver remain substantially unaffected by the presence of the refractory material.

There are certain applications, however, where even the refractory material-silver contacts do not have a sufficient resistance to contact-welding. For example, when closing against short circuits, the contacts will bounce slightly apart after initial impact and draw a high current arc therebetween before being driven back into engagement. This high current arc and the melting that it produces, together with the high pressure forces producing reengagement, tend to produce welding together of the contacts upon reengagement. Similarly, extreme high currents through engaged contacts can cause them to pop apart and then reengage under arcing conditions to produce a strong tendency to weld.

An object of my invention is to impart improved weld resistance to refractory material-silver contacts without significant loss of the desired high conductivity properties of the silver and without significantly impairing the ability of the contacts to withstand high impacts without fracturing or being otherwise mechanically damaged.

In carrying out the invention in one form, I provide a circuit breaker with a pair of contacts that are located in a fluid medium and are relatively movable into and out of engagement with each other. Each of these contacts comprises a porous skeleton of refractory conductive material and an alloy of silver and bismuth filling the pores of the skeleton. The percentage of bismuth is less than about 2 percent by weight of the silver-bismuth alloy.

For a better understanding of the invention, reference may be had to the following description taken in conjunction with the accompanying drawing, wherein the single FIGURE is a simplified showing of contact structure embodying one form of the present invention.

Referring now to the drawing, I show a portion of an electric circuit breaker that is designed to operate in air or some other fluid medium. More details of the circuit breaker are shown and claimed in U.S. Pat. No. 3,433,915—Baird, assigned to the assignee of the present invention. This circuit breaker comprises a contact arm **10** that is mounted for limited pivotal motion on a stationary fulcrum **12**. A tension spring **14** biases arm **10** in a counterclockwise direction about its fulcrum **12** into engagement with a stationary stop **16**. At its lower end arm **10** carries a contact element **18** brazed thereto. The structure **10**, **18**, though capable of limited movement, may be thought of as a stationary contact.

Movable into and out of engagement with the stationary contact is a movable contact **20**. This movable contact **20** comprises a contact arm **22** and a contact element **24** brazed to the surface of the contact arm facing the stationary contact **10**, **18**. When contact arm **22** is driven to the left, its contact element **24** engages stationary contact element **18**, thereby completing a circuit through the contacts. In response to the closing impact, the stationary contact **10**, **18** pivots in a clockwise direction about fulcrum **12** against the bias of spring **14** to provide for a small amount of contact wipe. The movable contact **20** follows the stationary contact **10**, **18** during such contact wipe, and the two contacts are in high pressure engagement with each other at the end of the closing operation. Contact pressure while the circuit breaker is closed is maintained by the spring **14**.

Opening of the circuit breaker is effected by driving the movable contact arm **22** to the right after the above-described contact engaging motion. This motion to the right separates the contacts, thereby establishing an arc therebetween. This arc is driven off the contacts into a suitable arc chute (not shown) where it is extinguished in a well-known manner.

The material heretofore found most satisfactory for the above-described contact elements has been a tungsten carbide-silver material comprising a skeleton of tungsten-carbide infiltrated with substantially pure silver. As pointed out in the introductory portion of this specification, this material is characterized by good resistance to arc erosion and contact-welding, by high electrical and thermal conductivity, and by low contact resistance. But there are certain switching applications that are especially severe from a contact-welding standpoint where these prior contacts have not provided enough resistance to contact-welding. Excessive forces have sometimes been required during an opening operation to fracture the weld between the contacts, particularly those welds which are formed by closing against high short circuit currents or by contact-popping in response to high short circuit currents.

For overcoming this problem, I incorporate into the silver that is used for infiltrating the tungsten-carbide skeleton a small percentage of bismuth, specifically a percentage no greater than 2 percent by weight of the silver-bismuth alloy. A preferred percentage of the bismuth is about one-half percent by weight of the silver-bismuth alloy.

Tests were run in order to compare the strength of the welds formed with the tungsten carbide-silver contacts with those formed under corresponding conditions with the tungsten carbide-silver-bismuth contacts. In each of these tests, a pair of engaged contacts corresponding to those illustrated were traversed by high currents that caused them to pop apart, immediately following which they were forced to reengage under arcing conditions, with resultant welding together of the contacts. The strength of each weld was established by determining the pounds of force subsequently required to break the weld to separate the contacts. With the prior contacts, i.e., the WC-Ag contacts, welds having a strength of 280 to 480 pounds were formed. But with contacts of tungsten carbide-silver-bismuth containing only one-half percent bismuth by weight of the silver-bismuth, the strength of the welds formed under substantially the same conditions of operation was drastically reduced to only 15 to 35 pounds. In both of the above contact materials, the tungsten carbide was present in an amount of about 50 percent by weight.

The maximum amount of bismuth that can be used is limited by the minimum permissible impact strength of the resultant contacts. For establishing the impact strength of contacts containing various percentages of bismuth, specimens of rectangular cross-section bar form, each thirteen-sixteenths inch long, one-fourth inch wide, and one-eighth inch deep, were prepared and subjected to an Izod or Standard Impact Test. The energy required to fracture each specimen was measured and recorded. The results of these tests may be tabulated as follows:

Material	Required	Approximate Impact Energy for Fracture in Inch-pounds
1. 50% Ag - 50% WC		8
2. 50% (99.8% Ag - 0.2% Bi) - 50% WC		8
3. 50% (99.5% Ag - 0.5% Bi) - 50% WC		4
4. 50% (99% Ag - 1% Bi) - 50% WC		3
5. 50% (97% Ag - 3% Bi) - 50% WC		2

The minimum impact strength acceptable appears to be about 2½ inch-pounds, and to maintain the impact strength above this level, the bismuth content should be limited to about 2 percent by weight of the Ag-Bi alloy.

The above contacts were made by first providing the various ingredients in powdered form in the weight percentages desired for the final contact. Then, all of the bismuth powder is mixed with part of the silver powder, and this mixture is pressed into a blank of suitable form, which is reserved for use later in the process. All of the tungsten carbide powder is thoroughly mixed with the remainder of the silver powder, and this mixture is pressed and sintered at a temperature of approximately 2,300° F in a hydrogen atmosphere to provide a rigid structure. This structure is cooled and then reheated in hydrogen to a temperature above the melting point of silver, at which time the silver-bismuth blank previously formed is placed in contact with the WC-Ag structure, causing the blank to melt and infiltrate the WC-Ag structure. Thereafter, the resulting composite is cooled and machined to size.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects; and I, therefore, intend herein to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A circuit breaker comprising a pair of contacts located in a fluid medium and relatively movable into and out of engagement with each other, at least one of said contacts comprising a porous skeleton of a refractory material and an alloy consisting essentially of silver and bismuth filling the pores of said skeleton, the percentage of bismuth being less than about **2** percent by weight of the silver-bismuth alloy.

2. The circuit breaker of claim **1** in which said refractory material is tungsten carbide.

3. The circuit breaker of claim **1** in which the percentage of bismuth is less than about 1 percent by weight of the silver-bismuth alloy.

4. The circuit breaker of claim **1** in which said refractory material is tungsten carbide, and the percentage of bismuth is less than about **1** percent by weight of the silver-bismuth alloy.

5. The circuit breaker of claim **1** in which said refractory material is tungsten carbide, and the percentage of bismuth is about ½ percent by weight of the silver-bismuth alloy.

6. The circuit breaker of claim **1** in which both of said contacts are of the composite material defined in claim **1**.

7. The circuit breaker of claim **2** in which both of said contacts are of the composite material defined in claim **2**.

8. The circuit breaker of claim **3** in which both of said contacts are of the composite material defined in claim **3**.

9. The circuit breaker of claim **4** in which both of said contacts are of the same composite material defined in claim **4**.

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