United States Patent

[11] **3,562,466**

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[54] **MAKE-AND-BREAK COMPOSITE ELECTRICAL CONTACTS**
6 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **200/166**
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[50] **Field of Search** 200/166C, 146, 147, 148.7

[56] **References Cited**

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2,499,420	3/1950	Sakatos	200/166(C)(X)
2,736,830	2/1956	Savage	200/166(C)(X)
3,258,829	7/1966	Gwyn, Jr.	200/166(C)(X)
3,290,472	12/1966	Savage	200/166(C)

FOREIGN PATENTS

525,244	8/1940	Great Britain	200/148(.7)

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ABSTRACT: A composite electrical contact construction having a compressible carbon matrix with silver or a similar metal embedded therein. The silver area is recessed a slight distance below the carbon area on the contacting surface of the contact construction.

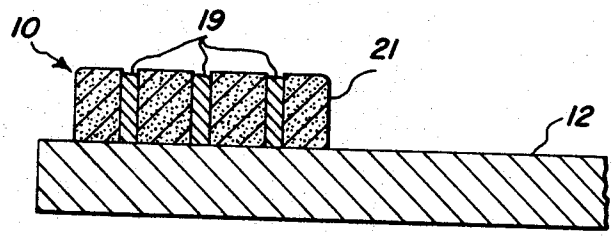


FIG. 1

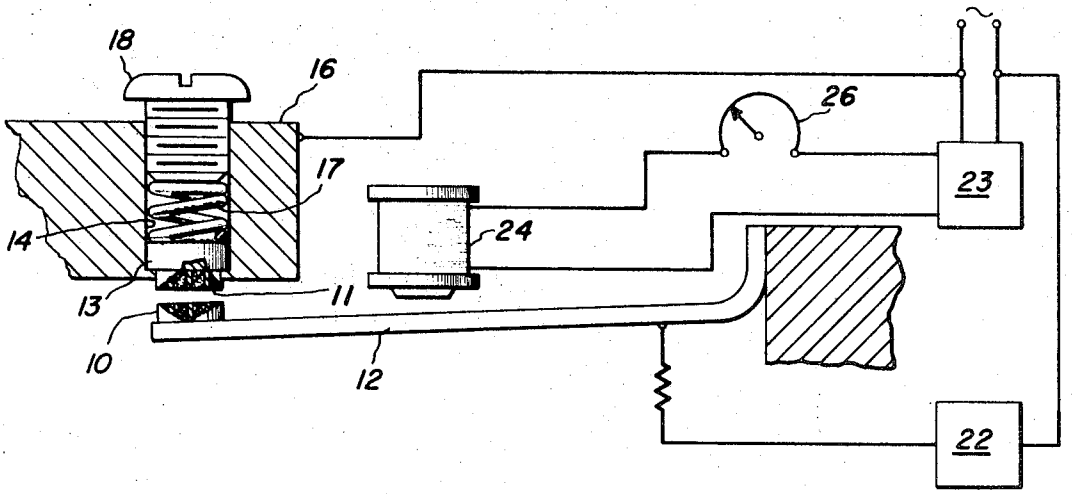
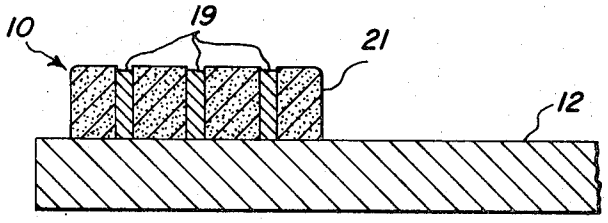


FIG. 2



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MAKE-AND-BREAK COMPOSITE ELECTRICAL CONTACTS

A composite electrical contact construction for make-and-break contacts is described comprising a carbon matrix (in the shape of a right cylindrical solid, for example,) in which is embedded at least one superior electrically conducting metal pin extending from a slight distance below the contact surface of the carbon to the opposite face of the carbon matrix for making electrical and, if desired, supporting connection thereto. In a make-and-break switch, when mirror-image mating composite contacts first touch, the contact is carbon-to-carbon. Thereafter, the recessed outer end of the metal pin is urged into electrical contact with the recessed end of a similar metal pin in alignment therewith by compressing the carbon matrices. By means of this construction the initial current and the separation current are carried by carbon-to-carbon contact, while the steady-state current is carried by the secondary electrical contact occurring between the metal pins.

BACKGROUND OF THE INVENTION

Composite carbon/metal current carrying members are disclosed in U.S. Pat. No. 473,195 to Meyer and in U.S. Pat. No. 3,290,472 to Savage, however, neither of these patents discloses the simple, reliable construction of the present invention for minimizing metal erosion and metallic bridge formation in make-and-break contacts.

The Meyer patent is directed to a commutator brush construction in which a series of metal/carbon composite pencils (metal core/carbon shell) are mounted in an array in order to provide a plurality of current-collection paths such that at any one time no more than one of the composite pencils may be displaced from contact with the commutator. By employing this construction there is alleged to be a reduction in current interruption, sparking between parts and heat generation. The ends of the metal center and the carbon shell of each composite appear to lie in a common surface, which undoubtedly becomes curved (to conform to the curvature of the commutator) during operation.

A spring urges each composite pencil toward the commutator with enough force to secure "close contact" therebetween. The movement occurring between the composite pencil and the commutator surface is, of course, not the same as with a make-and-break device and, for that reason, the electrical problems differ. It would appear that the carbon is relied upon to reduce the friction between the parts, whereby the heat and wear generated by friction during operation are minimized.

Savage discloses a make-and-break switch device employing a composite button contact (metal rim around a carbon core) affixed to a flexible spring-like arm adapted to be forced against a second contact, comprising a depressible metallic element and a stationary metallic element. Upon closure of the switch device electrical contact is first made between the carbon core of the composite button contact and the depressible metallic element of the second contact. The depressible contact element is thereupon forcibly depressed until the metal rim portion of the composite contact button is brought into direct contact with the face of the stationary portion of the second contact. Breaking of the circuit is accomplished without arcing, because as the annular metal rim of the composite contact button separates from the stationary metal portion of the second contact, there continues to be electrical contact between the carbon core of the composite button contact and the depressible element of the second contact.

SUMMARY OF THE INVENTION

The carbon contact button of this invention has at least one metal pin, or wire, embedded therein, the exposed end of the metal pin being recessed slightly below the carbon surface. The metal pins are made of silver, copper or similar metal exhibiting electrical conductivity significantly greater than the electrical conductivity of the carbon matrix (preferably graphite) employed.

Mating composite contact buttons first engage over the carbon surfaces thereof. Under a biasing force the carbon portions compress the slight amount required and the juxtaposed ends of aligned metal pins in the mated contacts are urged into electrical engagement. In this manner superior electrical conductivity is made available during the dwell period. Upon release of the biasing force, the carbon portions relax from the compressed state, the metal pin contacts separate and, finally, the carbon surfaces disengage as the composite contact buttons move to the open position.

BRIEF DESCRIPTION OF THE DRAWING

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawing in which:

FIG. 1 schematically illustrates the use of the composite make-and-break contacts of this invention in a switching device; and

FIG. 2 is a vertical cross section through one of these contact members illustrating the composite construction thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 there is illustrated a pair of opposed composite contact members **10, 11** affixed in juxtaposition on support members by means of brazing or soldering. For example, contact member **10** is affixed to flexible springlike metal contact arm **12** and contact member **11** is affixed to movable metal support disc **13** biased outwardly of the recess **14** of stationary member **16** by spring **17**. The force, which is exerted by spring **17** to position contact **11**, is dependent on the setting of screw **18**. The force may, therefore, be varied for reasons to be explained hereinafter. Each of contacts **10, 11** comprises at least one recessed pin **19** embedded in carbon matrix **21** and the contacts **10, 11** are arranged relative to each other so that recessed pins **19** of the opposed contacts are brought into alignment with each other, when the contacts are brought together. Thus, support disc **13** will preferably be provided with means to enable rotational adjustment for selective positioning of contact member **11**. Such means (none shown) may, for example, comprise an angularly relocatable dog, or key, to engage a vertical slot in the wall of recess **14**. Alignment of pins **19** would be facilitated by the provision of indexing markings (not shown) on matched contact members.

In the schematic representation shown in FIG. 1 motor panel **22** is activated in response to the demands of timer mechanism **23**, such as may be employed in an automatic washing machine. Timer **23** receives power from the **110** volt power source, which services motor panel **22**. Upon demand from timer **23** solenoid **24** is actuated pulling the flexible contact arm **12** toward it, first bringing the outer (carbon) faces of contacts **10, 11** into engagement and then continuing to force contacts **10, 11** toward each other to compress each carbon matrix **21** and bring the juxtaposed ends of aligned recessed pins **19** into engagement. The amount of force available for carbon matrix compression may be varied by changing the setting of rheostat **26** to increase or decrease the current passing through the coil of solenoid **24**. The positioning of screw **18** and the spring constant of spring **17** must, of course, be such as to enable the support disc **13**/contact **11** combination to resist the force applied by solenoid **24**. Any significant increase in the temperature of contacts **10, 11** when engaged will be indicative of failure to bring the recessed ends of metal pins **19** into engagement. This may be cured by increasing the compressive force until the temperature discontinuity is eliminated indicating the establishment of the desired electrical current path through engaged pins **19** rather than through the higher electrical resistance carbon matrix **21**.

As described, initial electrical contact (make) occurs between carbon matrices **22, 21** of the mating contacts **10, 11**. Thereafter, as carbon compression occurs, electrical contact is made between aligned metal pins **19** and the function of

conducting most of the 21, through the switch is assumed by this metalbto-metal contact.

As dictated by timer 23, breaking of the circuit occurs with cessation of the current flow through solenoid 24 followed in sequence by (a) release of the compressive force holding the ends of pins 19 in engagement, (b) separation thereof without arcing, because the faces of carbon matrices 21, 21 remain in contact as they decompress and then finally (c) separation of the opposed faces of carbon matrices 21, 21 as the contact arm 12 moves back to its unstressed position as shown in the drawing. Thus, with the make-and-break sequence described the make and the break functions are executed with carbon-to-carbon interaction while the dwell, or steady-state, electrical load is carried through metal pins 19.

Composite contacts according to this invention may be readily fabricated by selecting an appropriate carbon material and fashioning the button of a shape and size to accommodate the electrical load requirememt. Holes of slightly smaller diameter than the pins 19 to be employed are drilled in the carbon. Metal pins 19 are easily press-fitted into the undersized holes. Initially the carbon surface and the outer ends of pins 19 are, preferably, made flush (in a common surface), as by grinding, or polishing, for example. For any given carbon/metal pin combination it is preferable to determine the requisite distance of recess of the metal pins below the carbon surface by subjecting the composite contacts 10 to the conditions of use. To this end, the carbon contacts 10 are affixed and cycled through make-and-break operations with a pre-set service compression loading.

This break-in sequence causes preferential erosion of the metal pins 19 to occur until each end is recessed to a set distance below the carbon (uncompressed) surface. This recess distance, once stabilized, is a constant for a given set of conditions, e.g. particular carbon used, electrical loading, compression loading, particular metal pin material. Thereafter, in subsequent manufacture of this particular rating of composite button contact, the predetermined depth of recessing of the metal pins may be accomplished by controlled chemical etching. The operating behavior of both the "self-seating" (in-service recessed) or "chemically-etched" composite contacts is the same.

In an exemplary construction 30 mil diameter silver pins were press-fitted into 28 mil diameter holes drilled into ¼-inch diameter, ½inch high rods of spectroscopic rod (electrode graphite). The carbon and pins were ground to a flush surface and a pair of these composite contacts were affixed on make-and-break contact arms with the pins aligned. The contacts were cycled (about 1000 times) under a biasing force of about 600 grams under a 115 volt, 1500 watt electrical load. The silver pins eroded to an equilibrium depth of 75—150 microns in this cycling period remaining substantially constant throughout an additional 10^5 test cycles. The carbon surfaces of these contacts did not wear uniformly, but cratered slightly all over the surface of the carbon rod. However, the depth, area and number of craters developing thereon was much less than the cratering which occurred with solid carbon buttons tested under comparable conditions.

Graphite modified by the rapid melting-quick cooling process described in U.S. Pat. No. 3,332, 747 to Bundy is preferred, because of its superior crystalline orientation resulting in electrical resistivity as low as about 200 microohm centimeter. However, regular spectroscopic rod graphite, SP-1 graphite (National Carbon Company), B344 graphite (contains 0.2—0.3 percent by weight of boron carbide), pyrolytic graphite (properly oriented with respect to the path of the electrical current) and natural graphites may be employed. The aforementioned useful graphites may vary in electrical resistivity from about 200 to about 1000 microohm centimeter and from a density of about 1.4 to about 2.1 g/cm^3.

The depth below the surface of carbon matrix 21 to which the pins 19 are eroded in "self-seating" is a substantially constant value depending upon the electrical load characteristics, the compressive force, the ratio of metal pin area to carbon area, the electrical conductivity of the metal pin material and the pressure ambient to the make-and-break operation. Once "self-seating" equilibrium has been reached, further erosion does not occur unless the extend of recessing has been altered e.g. gradual erosion or wear of the carbon matrix.

Some minimum force is required to effect the necessary amount of compression in the carbon to overcome the recess dimension for each carbon/pin metal combination. This may be routinely determined as described hereinabove by the pressure or absence of temperature discontinuity in the carbon matrix.

In certain DC switching devices it is feasible to employ a layered, or laminated, matrix 21 (not shown) with a more dense carbon contact layer overlying a less dense, more easily compressible layer of carbon (or other electrically conducting material). As in the construction described the recessed metal pins are conveniently directly connected to the contact support (e.g. contact arm 12) as by brazing. In this manner force applied to the more dense layer will compress the less dense layer and expose the ends of the metal pins by sliding movement of the carbon layers relative to the metal pins. Also, in the case of DC switching devices it is not necessary that both contact members be of composite construction. Thus, one may be of the composite construction described herein while the second contact member may be of a single material, preferably metal.

If the compressive load is large, it may be of advantage to gird the carbon matrix with reinforcing means, however, this is not ordinarily required.

In addition to minimizing erosion of the metallic portions of the contact, the metallic pins prevent the generation of heat in the carbon portions by greatly reducing the electrical load taken thereby and, as a result, reducing thermal damage thereto. This is evidenced by the greatly reduced cratering occurring in the carbon.

Although the preferred embodiment has been described and illustrated, it is to be understood that this invention also includes the inverse construction wherein a carbon core is surrounded by a metal rim, which is set back from the outer face of the carbon, in the same manner and for the same reasons as in the preferred embodiment. In the interest of economy, the metal rim would be very thin, when silver is employed as the metal rim. Reliance is placed on carbon compression in both the preferred embodiment and the above-described construction to effectuate metal-to-metal electrical contact.

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

I claim:

1. A make-and-break switch for selectively interrupting and permitting the passage of electric current comprising in combination first and second opposed relatively movable contacts, first and second electrically-conducting means supporting said first and second contacts, respectively, means effecting separation of said first and second contacts and means for bringing the outer faces of said contacts into direct contact relationship, in said make-and-break switch the improvement of having as said first contact a composite carbon/metal body presenting at the outer face thereof discrete areas of carbon and metal, the metal area being the outer end of at least one longitudinally-extending metal element (a) extending from a position recessed below the level of the carbon area to said first support in the "break" position of said make-and-break switch and (b) extending from the level of the carbon area itself to said first support in the "make" position of said make-and-break switch.

2. The improvement as recited in claim 1 wherein the means for bringing into direct contact exerts a force to compress the carbon area and move the outer face thereof toward said first support a distance sufficient to include in said outer face the outer end of said metal area.

3. The improvement as recited in claim 2 wherein the material employed for the metal area construction is silver.

4. The improvement as recited in claim 2 wherein the carbon area employed is graphite.

5. The improvement as recited in claim 1 wherein the carbon area of the composite body encloses the metal area.

6. The improvement as recited in claim 5 wherein the metal area of the composite body is a plurality of metal pins.