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ELECTRIC CONTACT ELEMENT

Filed July 25, 1960

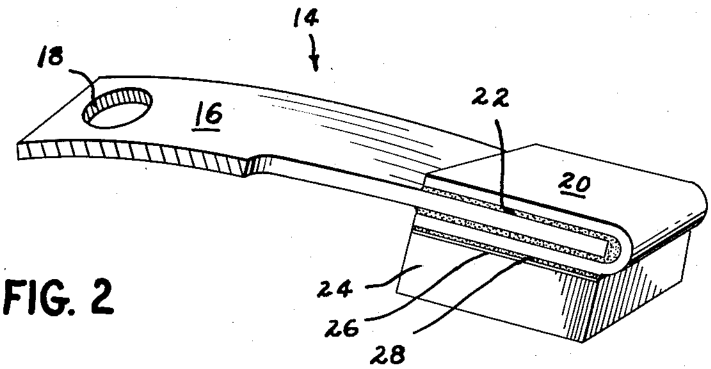
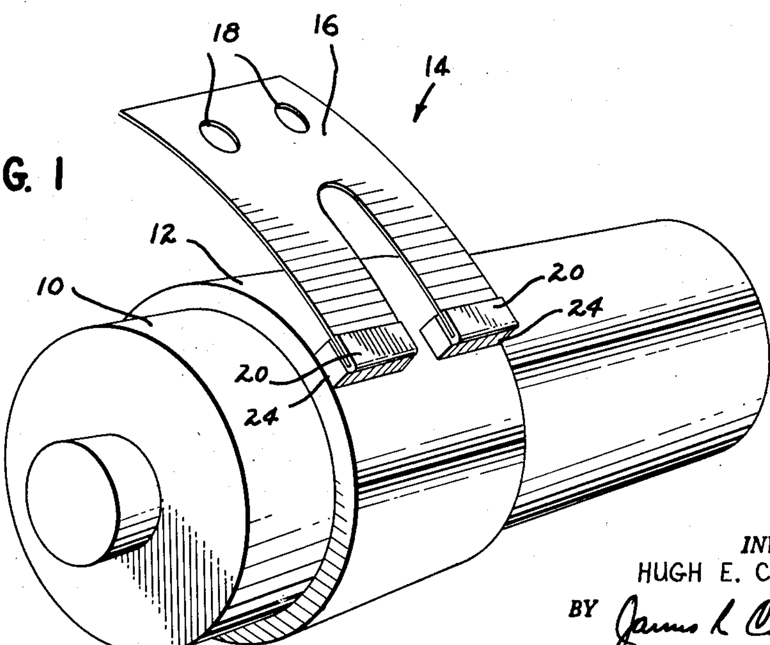


FIG. 2

FIG. 1



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ELECTRIC CONTACT ELEMENT

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The invention described herein relates to electric contact elements and more particularly to a leaf spring-carbon contact device useful with rotating equipment, especially dynamoelectric machines.

The design and arrangement of electric rotating parts often require electric contact elements consisting essentially of a current conductive contact button attached to the end of a leaf spring for transferring current to or from the rotating apparatus. This kind of design eliminates the need for a specially fabricated brush holder since the function of the combined leaf spring and contact element is to conduct current to the rotating elements while simultaneously acting as a spring for urging the contact button into engagement with the current transfer surface.

These electric contact elements have found wide usage in dynamoelectric machines and present designs often utilize metal-graphite contact buttons or a straight metal backing section made integral with the button at the time of manufacture. The metal associated with the contact button permits soldering it to the leaf spring, and since the coefficient of expansion of these metals closely approximate each other, little trouble is encountered in keeping the button attached to the spring. The disadvantage of metal-graphite buttons or brushes lies in the rapid rate at which the metallic constituents wear the current transfer surface, such as a slip ring or commutator. The contact button also wears rapidly and its unusually heavy weight causes excessive sparking and chattering at the current transfer surface.

Electro-graphitic materials are widely used in the contact buttons but it is necessary to provide a metallic surface on the carbon to which the leaf spring may be soldered. This usually is accomplished by applying a copper coating on the carbon by a flame spray method for example, which thereafter permits easy soldering of the contact button to the leaf spring. The disadvantage of this construction is that the solders have a relatively low melting point and are not mechanically strong so that when the contact element is operated in either a relatively high temperature environment or subjected to excessive vibration, the likelihood is great that the contact button may become detached from the leaf spring because of melting of the solder or through mechanical failure.

Higher temperature and harder soldering and brazing materials have been suggested but the difference in the coefficient of expansion between the carbon of the button and the materials in the leaf spring are such that the contact buttons become detached from the leaf spring when the device is cooled after soldering or brazing. This is not unexpected however, since typical values of the coefficient of expansion of carbonaceous materials range from 2×10^{-6} to about 5×10^{-6}"/inch/° C. Most metals have a higher coefficient of expansion, for example, different types of steel being in the order of 10×10^{-6} to 12×10^{-6}. A typical value for copper is 16×10^{-6}.

The difficulty with most known constructions is that they cannot be used for long periods of time without unduly wearing, scoring or otherwise deforming the surface of the electric rotating parts. Moreover, the contact element wears at an accelerated rate so that the device must be replaced frequently, thus causing the inconvenience of shutting down the motor and any associated

devices connected therewith. The differences in the coefficient of expansion of materials of the leaf spring and the contact buttons and the solders used in joining these parts together, result in premature fracture of the materials at their point of junction.

The primary object in my invention therefore is to minimize the disadvantages in the prior art by providing an inexpensive electric contact element capable of operating in high temperature environments and under stringent vibration conditions without failing mechanically or becoming deformed by expansion of the parts.

Another object of my invention is to provide an improved electric contact element wherein the expansion coefficients of the various materials form a system having an over-all coefficient approximating that of carbon.

In carrying out my invention, I shape a fernico strip into the general configuration of a U and subsequently solder both ends of this strip over the end of a bronze leaf spring by utilizing a high temperature solder. An exposed surface of the carbon contact button is coated with a copper plating to a thickness sufficient to readily permit its attachment to the fernico strip by a bonding agent. The design and selection of the materials in the parts permit establishment of a system of expansion coefficients approximating that of carbon, thereby precluding the parts breaking away from each other or warping out of position during operation.

While the specification concludes with a claim particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawing in which:

FIGURE 1 is a perspective view of an electric contact element placed in association with a shaft mounted slip ring; and

FIGURE 2 is a sectional view in elevation of the electric contact element shown in FIGURE 1.

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, there is shown a shaft or other cylindrical element **10** supporting a ring **12** attached thereto as by a shrink fit. The ring may be composed of any kind of material capable of conducting an electric current. An electric contact element **14** is shown in a position illustrating how contact is made with the shaft for transferring current to or from the ring **12**.

The contact element **14** comprises a beryllium copper or bronze leaf spring **16** having openings **18** provided in one end for receiving the ends of electric terminals. A strip of fernico **20** shaped in the configuration of a U is positioned over the exposed end of the bronze leaf spring **16** and is securely bonded thereto by a silver-copper alloy **22** with or without the addition of phosphorous.

The size of the parts illustrated in FIGURE 2 is approximately five to seven times normal size and therefore it will be evident that in the actual device, the solder is barely visible since during welding, the fernico U-shaped strip is pressed into firm and intimate engagement with the bronze spring positioned therein. Although sufficient solder is present to fully effect a complete bonding between the spring and opposite legs of the U-shaped strip, the bonding layer between the parts is so thin that it has little, if any, effect on the expansion characteristics of the mass of parts comprising the contact element.

In order to attach the carbon button or brush **24** to the leaf spring with its attached fernico strip, the carbon button surface to be mounted on the spring, is coated with a copper surface **26** by any conventional method, as electroplating or a flame spray process. The copper or other material used for this purpose must be compatible with the solder **28** used during bonding and in the preferred form, the solder used is the same as that employed in soldering the fernico strip to the bronze spring.

The use of different metals in the organization can cause undesirable bending of the parts, particularly in the area where the carbon button is attached to the fernico strip, and between the fernico and the bronze spring. The fernico, however, has a coefficient of expansion closely resembling that of carbon so that the likelihood of fracture occurring between the carbon button and fernico strip in the area of the weld is remote. Since opposite sides of the fernico strip are firmly bonded to the bronze spring and since the parts are relatively thick, the forces tending to cause bending are not of a value sufficient to distort or otherwise deform the parts.

As a result of the selection of materials, the bronze, fernico and carbon form a system of expansion coefficient such that distortion and consequent fracture of parts at their areas of junction do not occur. Since the copper plating on the carbon button and the solder joining the parts is of such thin layers, their effect upon the bronze, fernico and carbon from an expansion standpoint is only minimal.

If, for example, a carbon of expansion coefficient 4×10^{-6} and Young's modulus of 10^6 is bonded to a bronze of expansion coefficient 18×10^{-6} and Young's modulus 15×10^6, by a solder of melting point 650° C., a stress of the order of 10,000 p.s.i. would be developed in the carbon as the system cools provided the carbon remained intact. Since this exceeds by several-fold the strength of the carbon used, it would invariably crack.

To keep the stress below the strength of carbon, it is necessary to match the coefficient of thermal expansion to within $\pm3.5\times10^{-6}$ in./in./° C. A closer match is desirable since it will minimize initial stress in the carbon and thus reduce the chance of breakage as result of service stresses.

It will be evident that many different types of materials may be used in lieu of the fernico. One well known material consists of 54% iron, 17% cobalt and 29% nickel. An alloy of nickel and iron alone where the nickel content ranges between 30%–50% may be used. The specific material which provides a coefficient of expansion in the desired range comprises 42% nickel and 58% iron. The particular advantage derived from fernico is that it is readily available, and is an inexpensive material comparable with most alloy compositions used as solders.

The substitutes for the bronze may consist of any material having spring-like characteristics and which can conduct current and otherwise perform the same functions as the bronze leaf spring disclosed herein.

Any one of a number of solders may be used for bonding the leaf spring to the carbon contact button. Cadmium silver solder is useful in lower temperature ranges of about 400° C. but a solder of copper, silver and phosphorous is more desirable for use in high temperature applications. It has a much higher melting point 640° C. and greater mechanical strength. Obviously, lead-silver, silver-cadmium and other low temperature solders having a melting point around 300° C.–350° C. can be used only in those applications where high temperature operation is not requisite to successful performance of the device.

It is apparent that the U-shaped fernico strip could be separated to have one part located on the upper side of the spring and the other part on the lower side and still obtain substantially the same high degree of operation. The fernico strip could be made thicker than the U-shaped piece and be positioned on only one side of the spring if this kind of construction were desired. It has been found however, that if a 15 mil thick section of fernico is placed on one side of a bronze spring of 10 mil thickness, bending will occur. The parts therefore must be chosen in proportions such to preclude the possibility of bending when the contact element is subjected to heat.

In view of the above, it will be evident that many modifications and variations are possible in light of the above teachings. It therefore, is to be understood that within the scope of the appended claim, the invention may be practised otherwise than as specifically described.

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

A contact element for use with electrical apparatus comprising a bronze leaf spring having an end positioned in a U-shaped fernico strip and firmly bonded thereto, a carbon contact button sprayed with a copper surface on one side attached to said strip, and a solder of copper, silver and phosphorous interposed between said strip and said spring and between said strip and said button for bonding the parts together in an integral mass.

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