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M. O. HUFF ET AL
WELDED RIVET CONSTRUCTION FOR ELECTRICAL
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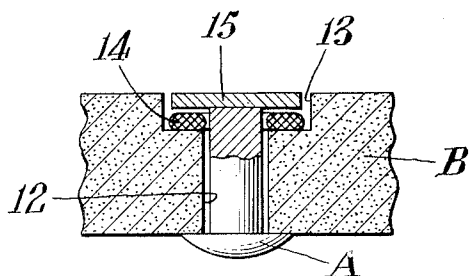


Fig. 1.

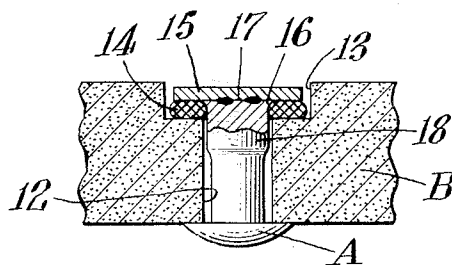


Fig. 2.

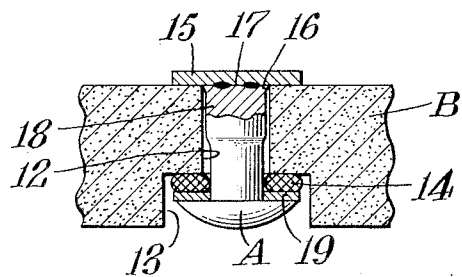


Fig. 3.

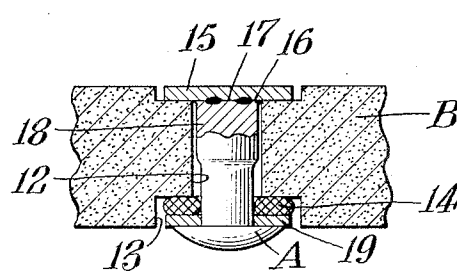


Fig. 4.

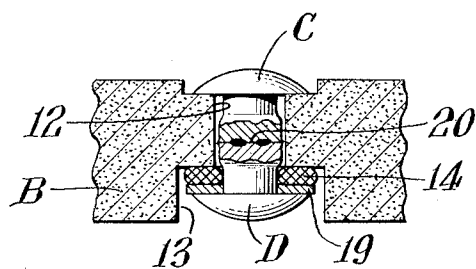


Fig. 5.

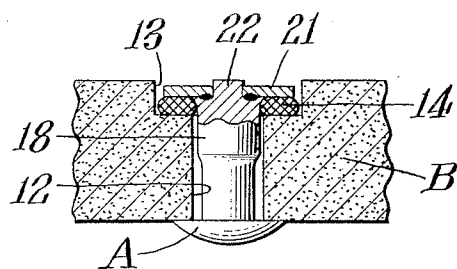


Fig. 6.

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WELDED RIVET CONSTRUCTION FOR ELECTRICAL BRUSHES AND CONTACTS

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5 Claims. (Cl. 171—326)

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This invention relates to the art of fastening electrical conductors to frangible conducting materials and more particularly to the fastening of conductors such as lugs or pigtail connections to frangible electrical contact brushes such as are commonly employed in motors, generators, and the like.

Heretofore it has been the general practice to fasten metal parts to contact brushes by mechanical riveting. According to this practice a conductor provided with a hole of suitable diameter, such as a connector lug or a looped pigtail, is positioned on a short metal tube or rod known as a rivet which fits in a suitable hole in the contact brush. In some instances the metal tube or rod may have a head on one end in which case the conductor to be attached is usually positioned between the head and the corresponding surface of the brush; or, if a headless rivet is used, the conductor is placed over either projecting end of the rivet. In either case, the conductor is clamped to the brush by enlarging the protruding shank portion of the rivet so as to form a head. Heads on hollow rivets are generally formed by spinning, whereas solid rivets are more often mechanically upset.

A major disadvantage of the method described is the absence of positive control over the mechanical tightness of the connection, since the compressive load on the brush is dependent on the operator's skill. With contact brushes of carbon or similarly frangible materials such as are widely used in the electrical industry, excessive rivet tightness frequently results in breakage of the brush during assembly or in subsequent use. Insufficient tightness on the other hand, causes poor electrical contact or may lead to frictional wear of the loose parts whereby the contact resistance may become increased to the point of excessive localized heating or arcing and ultimate failure.

In order to obtain in repetitive manufacturing processes, a consistently safe contact pressure, it has been proposed to use a threaded member with a recessed end which may be upset over a nut after the latter has been tightened the desired amount. Such a method, however, requires relatively expensive parts and does not lend itself well to rapid production.

The object of the present invention is to provide an inexpensive, rapid, and readily reproducible method of fastening metal parts to a frangible electrical contact brush with a predetermined degree of tightness. Another object is to provide frangible contact brushes with at-

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tached lugs or pigtails, which brushes are free from excessive residual compressive stresses imposed by the fastening means that would tend to promote fracture of the brush in service.

The invention comprises a frangible electrical contact brush affixed to a metal body by a procedure which includes forming a hole through said brush adapted to receive only the shank portion of a headed rivet, inserting the shank portion of a headed rivet in said hole, exerting pressure between said metal body and at least a portion of the end face of the shank of said rivet, heating the joint between said shank and said body by passing an electric current there-through while under pressure, thus causing said metal body to be welded to said rivet and the welded structure thus formed to be shortened until substantially all of said pressure is borne by said frangible member, and maintaining said pressure until the weld has solidified, said pressure being sufficient to effect, upon cooling, a good electrical contact between said metal body and said frangible member but insufficient to set up excessive residual stresses in said member conducive to the fracture thereof in normal service.

In the drawings:

Fig. 1 represents a cross-sectional view of the unwelded assembled parts for one modification of attaching a conductor to a frangible brush in accordance with the invention.

Fig. 2 represents a cross-sectional view of the parts shown in Fig. 1 after the application of electrical welding heat and pressure.

Figs. 3 to 6, inclusive, represent cross-sectional views of other modifications of attaching a conductor to a frangible brush in accordance with the invention.

The method of preparing the article of the invention will be described by referring to Figs. 1 and 2. In Fig. 1, a hole 12 adapted to receive the shank portion of a rivet A with a slight amount of clearance is drilled or otherwise formed through the body of the brush B at an appropriate location. If desired, the hole 12 may be enlarged at one end to form a recess 13 so that the conductor and its associated metal body will not project beyond the outer surface of the brush normal to the rivet axis. A headed rivet A is then inserted in the hole and the pigtail conductor 14, preferably looped at the end, is placed over the shank end of the rivet. Following this, a metal body in the form of a disc or other hardware 15 is positioned over the conductor 14 and joined by electric resistance welding means to

the end face of the shank of the rivet. The welding pressure used in this step is substantially less than the crushing strength of the brush so that the brush and conductor upon cooling will be firmly clamped without the brush experiencing excessive residual compressive stresses conducive to fracture during assembly and normal service. As shown in Fig. 2, under the influence of axial pressure and the localized heating produced by the application of electrical power over an appropriate interval of time, the welded structure shortens with an accompanying extrusion of molten or plastic metal 16 from the interface 17 and radial expansion of the adjacent shank portion 18 of the rivet until substantially all the applied pressure is borne by the brush. When this occurs and the weld has solidified, the pressure is removed. With a rivet of proper length, the amount of metal extruded is so small that no provisions for it need be made other than normal clearance for the shank of the rivet.

In general, it is advisable to interrupt the welding current somewhat earlier than the pressure in order to maintain the proper elastic compression in the members between the ends of the welded structure during and after solidification of the weld.

The following examples will serve to illustrate the effect of welding pressure on the quality of a connection of the type shown in Figs. 1 and 2. In each case a pigtail connection was attached to a lampblack base carbon brush using an annealed copper rivet having a shank diameter of $\frac{1}{8}$ in., a head diameter of $\frac{1}{2}$ in., and a nominal length of $\frac{3}{8}$ in. One second was allowed for the application of pressure, one-half second for current flow while under pressure, and one-half second for solidification under pressure. An ordinary electronic relay scheduling timer afforded a highly accurate control for the various steps and enabled substantially identical results to be obtained in automatic operation. With an applied force of 196 lbs. and a current density sufficient to produce a strong weld, the connections became loosened in normal use. When the force was increased to 784 lbs., no brushes were broken during welding, nor did the connections loosen in normal use; this was the optimum welding pressure for the given conditions. A further increase in the applied force to 1176 lbs. caused all brushes to be broken.

Fig. 3 illustrates an alternative arrangement of parts wherein the pigtail conductor 14 is positioned at the head end of the rivet. It is desirable in such cases to insert a washer 19 between the rivet head and the conductor inasmuch as the underside of rivet heads are frequently not plane and may force the conductor outwardly under the influence of the welding pressure. If desired, the head of the rivet, which is generally rounded, may be allowed to protrude from the recess 13, while the metal disc 15 or other hardware may be recessed as shown in Fig. 4. Furthermore, as illustrated in Fig. 5, it is possible to confine the joint 20 entirely within the rivet hole by using two headed rivets C and D inserted from opposite sides.

Fig. 6 shows an arrangement whereby a washer 21 or other hardware having a hole therein of suitable diameter may be accurately centered over a boss 22 at the shank end of the rivet. The shoulder adjacent to the boss provides sufficient surface to effect a strong metal joint in accordance with the method of the invention.

The particular advantage of the article of the

invention results from the fact that the tightness of the electrical connection and the quality of the weld are governed by two quantities which, once they have been accurately predetermined for a certain set of conditions, can be repeated at will with the same degree of accuracy. These two quantities are the mechanical pressure and the total energy input, the latter being proportional to the product of the electrical power and the duration of its application. The composition of the rivet and the area of the shank end thereof are readily kept within close tolerances in the course of ordinary manufacturing methods and the influence of these factors is therefore inconsequential. The length of the rivet and the thickness of a conductor to be positioned along the shank of the rivet generally possess very much wider limits of tolerance. However, the effect of this is likewise inconsequential over a considerable range, since in accordance with the invention, the welding operation is continued until there is no further yield. Initial differences in rivet length or in the thickness of the conductor are evidenced only by more or less "flash" around the interface or radial expansion of the rivet shank. Since it is generally desirable to keep the flash and deformation as small as possible, the nominal length of the rivet is chosen accordingly.

While specific examples of the invention and various embodiments thereof have been described herein in detail, these examples are given by way of illustration merely, and it is to be understood that the invention is not limited thereby but encompasses all embodiments within the scope of the appended claims.

What is claimed is:

1. In a frangible electrical contact brush having a conductor in electrical contact therewith, a resistance welded structure comprising a first enlarged end portion bearing against a surface of said brush, an intermediate shank portion extending through a hole in said brush and in said conductor, and a second enlarged end portion bearing against said conductor, the resistance weld in said structure being in electrical contact with but not welded to said conductor and under the influence of residual tension such that the complementary pressure exerted by said welded structure upon said conductor and said brush is sufficient to establish good electrical contact.

2. In combination, a frangible electrical contact brush and a flexible conductor, each having a hole therethrough adapted to receive only the shank portion of a headed rivet and a welded structure comprising a headed rivet having a shank extending through the hole in said conductor and into at least a portion of the hole in said brush, and a metal body, incapable of passing through said hole, joined by a resistance weld to at least a portion of the end face of said shank but not to said conductor, the pressure exerted by said welded structure upon said conductor and said brush being sufficient to establish good electrical contact but insufficient to lead to fracture of said brush in normal service.

3. In combination, a frangible electrical contact brush and a conductor, each having a hole therethrough adapted to receive only the shank portion of a headed rivet, and a welded structure in electrical contact with but not welded to said conductor comprising a rivet having a head adjacent said brush and a shank extending through the hole in said brush and in said conductor, the end face of said shank being joined by a resist-

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ance weld to a metal body adjacent said conductor, the pressure exerted by said welded structure upon said conductor and said brush being sufficient to establish good electrical contact but insufficient to lead to fracture of said brush in normal service.

4. In combination, a frangible electrical contact brush and a conductor, each having a hole therethrough adapted to receive only the shank portion of a headed rivet, and a welded structure in electrical contact with but not welded to said conductor comprising a rivet having a head adjacent said conductor and a shank extending through the hole in said conductor and in said brush, the end face of said shank being joined by a resistance weld to a metal body adjacent said conductor, the pressure exerted by said welded structure upon said conductor and said brush being sufficient to establish good electrical contact but insufficient to lead to fracture of said brush in normal service.

5. In a combination according to claim 3, a

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welded structure comprising a rivet having a diametrically reduced end portion of the shank fitting into a hole in said metal body, the weld between said rivet and said metal body being located along the annular end face of said shank surrounding said reduced portion.

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