Dec. 4, 1962 G. R. ZAMBOLDI ET AL 3,067,319

METAL-GRAPHITE BRUSH WITH WELDED SHUNT

Filed Nov. 10, 1959

Fig. 3

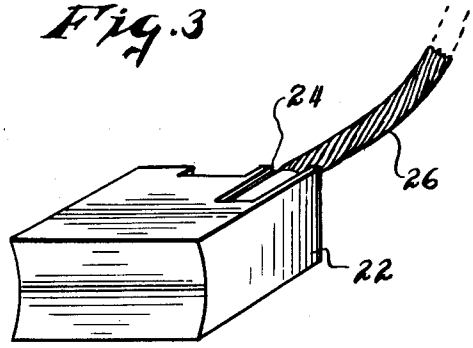


Fig. 1

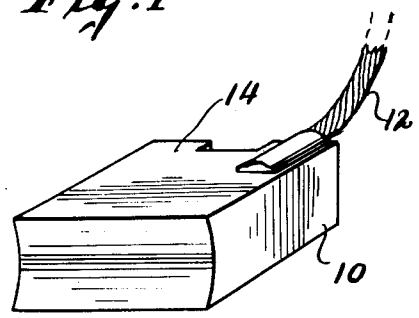


Fig. 4

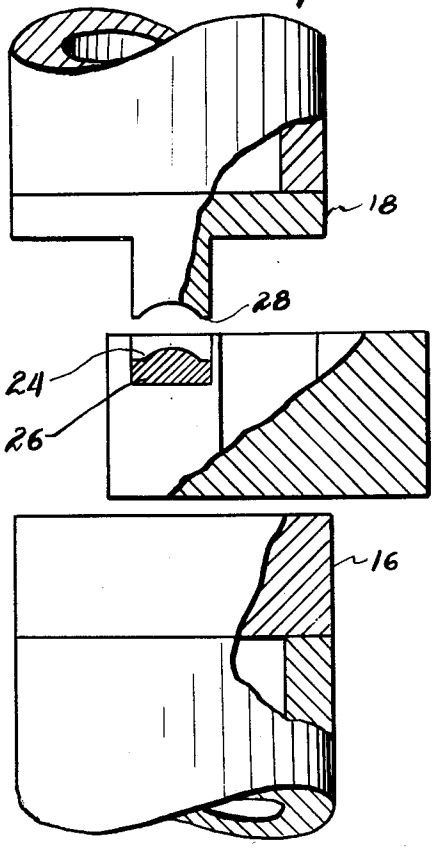
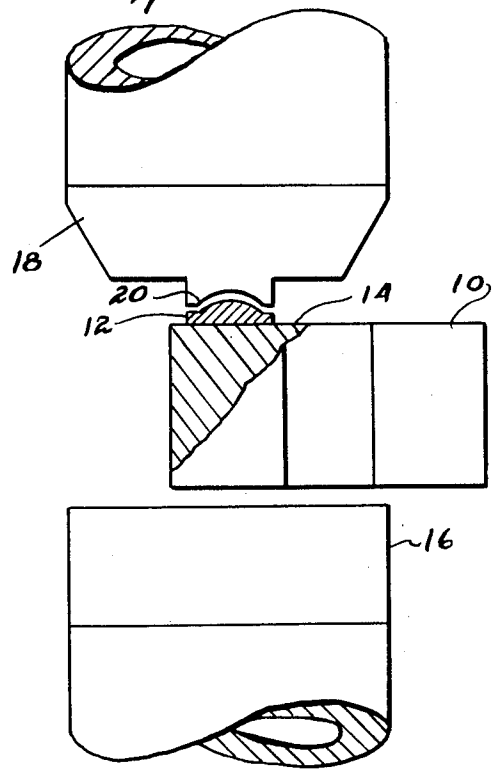


Fig. 2



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METAL-GRAPHITE BRUSH WITH WELDED SHUNT

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This invention relates to an improved brush assembly comprising a metal-graphite brush with an attached shunt, and to an improved method of fabricating such brush assemblies.

Metal-graphite brushes are known to the art. The brush is formed from a mixture of powdered metal and powdered graphite molded into the desired final form, or cut into the desired final form from a larger block of material. The powdered metal may be entirely copper, although other metallic particles, such as tin, lead, zinc and silver, may be used in combination with copper.

Such brushes offer the requisite low conductivity, current handling capability and suitable contact resistance. The graphite particles in the brush lubricate the bearing surface of the brush as it rides on the contact surface, such as a commutator, and prevent welding of the brush to the surface by the intermittent arcs encountered in operation.

In order to bring electrical connections from the brush to the operating equipment, a shunt or wire conductor is affixed to the brush.

The shunt is generally a rope-stranded conductor formed of copper strands, tin-coated copper strands, or zinc-coated copper strands. The size and type of wire is determined by the application intended, and the wire is selected primarily on the basis of strength, current carrying capacity and flexibility. In a few applications it has been found desirable to use a solid instead of a stranded conductor.

In order to connect the shunt to the brush with the requisite mechanical strength and with the requisite low resistance bond, the art has resorted to drilling a hole in the brush, inserting one end of the shunt therein, and tamp-packing the hole with a powder such as copper powder, or silver-coated copper powder. While such tamped shunt connection may give the requisite mechanical and electrical bond, such method of assembly results in brush of higher than desired expense.

The art has also resorted to riveting or bolting the shunt to the brush, or to attaching the shunt to a conductive contact which is riveted or bolted to the brush.

While all of these methods give the requisite firm mechanical attachment of the shunt to the brush with a connection of low electrical resistance, it is apparent that the complications of assembly thereof increase the cost of the brush.

It is therefore one object of this invention to provide a brush assembly comprising a metal-graphite brush and a shunt affixed thereto by spot welding.

It is a further object of this invention to provide improved method of attaching a shunt to a metal-graphite brush.

The graphite particles in the brush composition serve to prevent welding of the commutator to the brush in the equipment for which the brush is designed. Therefore, it would seem that the graphite content of the brush would also preclude welding of the shunt thereto. Surprisingly, however, we have found that the shunt can be welded to the brush with the desired mechanical and electrical bond. This startling and unusual result is unexpected and offers important advantages over the processes used by the art.

In a preferred embodiment of this invention there is provided a brush formed of metallic and graphite particles formed into the shape desired for the application intended. A shunt of rope stranded copper wire is welded thereto.

To practice the method of this invention the metal-graphite brush and the shunt are placed between the electrodes of a spot welder. The electrodes then are closed over the brush and the shunt, and a welding current passed between the electrodes. The copper conductor is thus welded to the copper in the brush to provide a brush assembly of low fabrication cost.

A brush assembly and the method of fabrication thereof may best be understood by reference to the following description taken in conjunction with the accompanying drawings of which:

FIGURE 1 is a perspective view of a brush assembly in accordance with this invention.

FIGURE 2 is a partially sectioned perspective view of a brush assembly within a spot welder illustrating the method of fabrication of the brush assembly shown in FIGURE 1.

FIGURE 3 is a perspective view of another embodiment of a brush assembly in accordance with this invention, and,

FIGURE 4 is a partially sectioned perspective view of a brush assembly within a spot welder to illustrate the method of fabricating the brush assembly shown in FIGURE 3.

In FIGURES 1 and 2 there is shown a brush 10 to one side surface of which is to be attached a shunt 12.

The brush may be formed from a mixture of powdered metal and powdered graphite molded in the shape desired for the application intended. The powdered metal used in fabricating the brush will comprise copper. However, other materials may be used in combination with the copper, such as tin, lead, zinx and silver. Illustrative of compositions used in typical brushes employed by the art are the compositions set forth in Table I.

Table I

(1) 77% copper, 18% lead, 5% graphite
(2) 93% copper, 7% graphite
(3) 75% copper, 10% tin, 8% lead, 7% graphite
(4) 77% copper, 15% lead, 8% graphite
(5) 85% copper, 5% tin, 10% graphite
(6) 82% copper, 5% tin, 3% zinc, 10% graphite
(7) 84% copper, 3% lead, 13% graphite
(8) 75% copper, 25% graphite

As will be noted from Table I, the majority of brushes are formed with a relatively high percentage of metallic component. These brushes are widely used by industry.

The shunt to be attached to the brush may be a copper wire. In the usual case the shunt is a flexible rope stranded copper conductor selected primarily on the basis of strength, current carrying capacity and flexibility needed for the application intended. For example, a copper 7—43—.005 shunt may be employed for certain brushes. The numerals identify respectively the number of ropes, the number of strands or wires in each rope, and the diameter of each strand (e.g. 7 ropes, each having 43 strands of 0.005-in. diameter wire).

In the application shown in FIGURES 1 and 2 the shunt is to be affixed to one side of the brush. To do this, one end of the shunt 12 is merely placed on a face 14 of the brush. The brush itself rests on one electrode 16 of the spot welder; the other electrode 18 of spot welder being positioned so that the shaped face thereof 20 is vertically above the shunt lead 12. The electrodes 16 and 18 may be formed of tungsten, molybdenum or other suitable material in conventional fashion.

The spot welder electrode 18 is then moved down to contact the wire shunt 12. The shaped face 20 ensures an evenly distributed pressure contact against the round

shunt. When the electrodes are closed, welding current is passed therebetween to weld the shunt to the brush.

As an example of a specific welding operation, but not by way of limitation of this invention, a copper 7—43—.005 shunt was welded to a brush formed of 93 percent copper and 7 percent graphite. The welding current employed was 9,000 amperes. The force between the welding electrodes was 175 pounds. Welding current was applied for four cycles (1/15 sec.) with a total hold time of 30 cycles (½ sec.). Brush assemblies so fabricated were found to have a maximum electrical resistance at the bond of 64 micro ohms. The mechanical bond required a force of at least 50 pounds to separate the shunt from the brush. It should be noted that in the separation, the brush material was fractured indicating that the welded bond was even stronger than the separation strength material of the brush itself. It will further be noted that these values equal or exceed those obtained with a tamped connection of same materials.

It should further be noted that contrary to expectations no preliminary preparation of the brush or of the shunt lead is necessary to effect proper welding.

Thus, this welding operation can be performed on assembled brushes without added preparation even if an oil film is left on the surface by treatment of the brush in manufacture thereof. The brush surface need not be cleaned or otherwise mechanically prepared, and the brush assembly can be made quickly and economically.

Although it would be expected that the graphite would prevent an adequate welding bond, the shunt is apparently welded to the metallic particles in the brush to provide a mechanical and electrical bond between the brush and the shunt. This conclusion is supported by the fracturing of the brush material when the shunt is pulled from the brush. While this conclusion seems justified by observation of the results, the startling results obtained by this invention and the departure of the invention from the practices of the prior art caution against acceptance of this conclusion as the full explanation. However, whatever the reasons, the results are not disputable.

From such conclusion it follows that the mechanical and electrical bond is weaker when the percentage of copper in the brush is lowered. The conclusion is supported by test results. While the method may be successfully employed with brushes having a lower percentage of metallic particles, if the percentage of metal is lower than 50%, it is usually impossible to obtain the mechanical strength necessary to satisfy the dictates of operational environmental conditions. Fortunately, the application requiring high bond strength also usually require a brush of high metallic content.

In those applications requiring smooth brush sides, the embodiment shown in FIGURES 3 and 4 may advantageously be employed.

In FIGURES 3 and 4 there is shown a brush **22** molded from a mixture of powdered metallic particles and powdered graphite and having a slot **24** molded or cut in the face thereof. The shunt **26** is positioned within the slot. In order to ensure contact during spot welding the upper electrode **18** is provided with an electrode tip **28** which will fit into the slot and contact the shunt over the peripheral surface thereof.

During assembly the shunt **26** is placed within the slot **24** of brush **22**. The welding electrodes are closed upon

the assembly and a welding current passed between the electrodes to spot weld the shunt to the brush. It has been found that if the slot width is approximately equal to the diameter of the shunt lead that the shunt will also be welded to the sides of the slot thereby increasing the weld area. The increase of weld area is advantageous in providing greater mechanical strength and increased electrical conductivity over the embodiment wherein the shunt is welded to the side of the brush.

It will of course be noted that the position of the weld, the size of the shunt, and the shape of the slot will determine the shape of the welding tip used. Further, these factors will primarily be dictated by the application intended.

While the invention has been described with particular reference to welding leads to metal-graphite brushes, it is applicable also to attaching leads to metal-graphite articles intended for other applications.

This invention may be variously modified and embodied within the scope of the subjoined claims.

What is claimed is:

1. The method of attaching a metal shunt to a brush consisting of a block made of a mixture of powdered metal and powdered graphite and being at least 50% metal and having a substantial quantity of graphite that prevents welding of the brush to a commutator as the result of electric arcs between the brush and commutator when the brush is in service, which method comprises pressing a metal shunt against a surface of the mixture of powdered metal and graphite by means of an electrode and with an evenly distributed pressure and with sufficient pressure to obtain a substantial area of surface contact between the shunt and the brush, the pressure being less than that which will crush the block, uniting the shunt to particles of powdered metal, exposed at said area of surface contact, by electric resistance welding produced by a flow of high density current through the shunt and brush while the shunt and brush are held together under pressure, applying the current to the shunt from a source of current and over an outer surface of the shunt opposite the surface of the shunt that is pressed against the brush and over an area that keeps the current density low enough to prevent fusing and welding of said outer surface of the shunt to the electrode.

2. The method described in claim 1 and in which a stranded metal shunt is attached to the brush and the strands of the shunt are held between the brush and the electrode while the welding current is passed through the shunt.

3. The method described in claim 1 and in which a copper shunt is welded to a brush made up of at least 50% copper.

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