May 7, 1929. E. HEDIGER 1,712,477

ELECTRICAL CONNECTION

Filed May 3, 1926

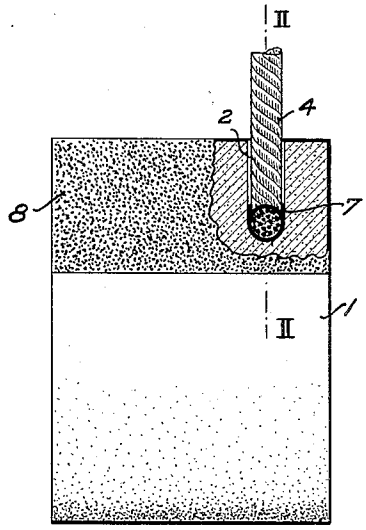


Fig. 1

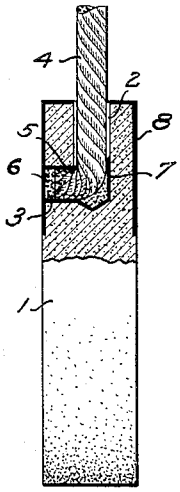


Fig. 2

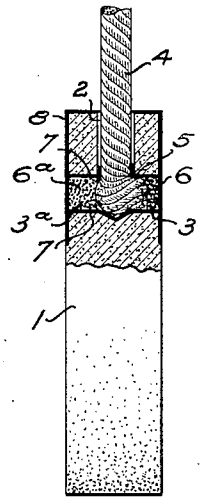


Fig. 3

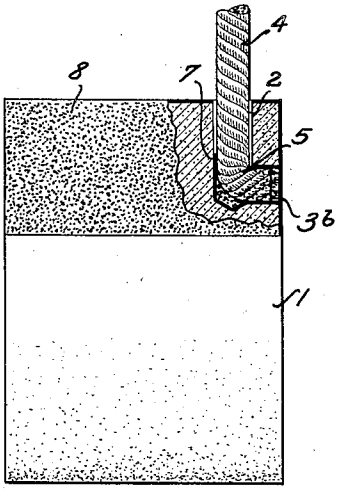


Fig. 5

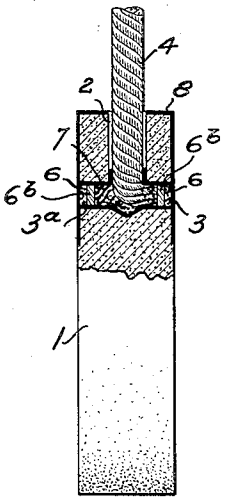


Fig. 4

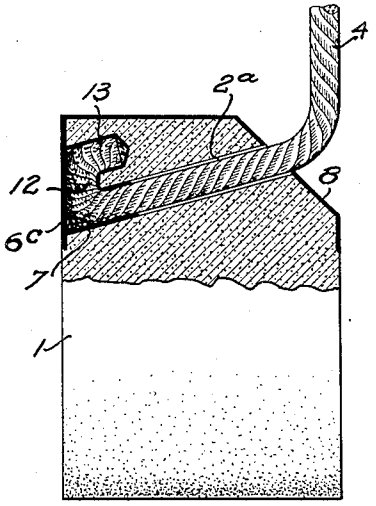


Fig. 6

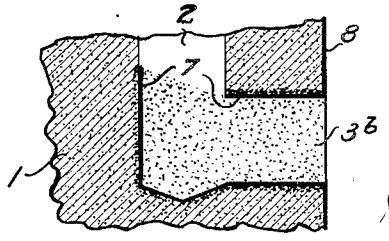


Fig. 7

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UNITED STATES PATENT OFFICE.

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ELECTRICAL CONNECTION.

Application filed May 3, 1926. Serial No. 106,281.

This invention relates in general to electrical connections, more particularly to that class of electrical connections involving the connection of a highly conductive member, especially of a flexible character, such as a "pig-tail" conductor, to a carbon or carbonaceous block or element, such as a current-collecting brush as ordinarily used on a dynamo-electric machine.

Various means and methods have heretofore been suggested for providing a mechanically and electrically desirable form of connection between a flexible conductor, such as a "pig-tail", and a carbon or carbonaceous body, such as is used as a current-collecting brush; but such prior art devices and methods which offer most in the matter of securing desirable mechanical connection between the parts are liable to involve elements of weakness, such as a liability of cracking or fracture of the brush or an imperfect electrical connection between the parts, and the prior art devices and methods which offer more advantages in the matter of desirable electrical connection have elements of weakness in the matter of securing a satisfactory mechanical connection of the flexible conducting element to the brush.

The present invention contemplates the provision of intimate electrical engagement between the flexible wire or like conductor and the portion of the brush or the like associated therewith, either directly or through an intermediate conductive connection, through the use of a method or means which insures extremely intimate union of particles of the flexible conductor and particles of the brush over an extended area of these parts, for the purpose of providing a desirably low resistance electrically conductive path between the brush and the metallic conductor, and which also insures such a thorough and secure mechanical union between the brush and the flexible conductor as satisfactorily avoids the tendency of the conductor to become separated from the brush due to vibration or shock incidental to ordinary operation or handling.

It is an object of the present invention to provide an improved form of connection between an electrically conductive metallic element and a carbonaceous article, such as a current-collecting brush or the like.

It is a further object of the present invention to provide an improved connection between a metallic connector and a carbonaceous article involving the uniting of the metallic connector to the carbonaceous article through the medium of a homogeneous metallic mass having particles thereof intimately united to particles of the carbonaceous article within surface pores thereof.

It is a further object of this invention to provide an improved type of connection of the character described, between a flexible metallic connector and a current-collecting brush of carbonaceous material, involving the use of an intermediate conductive metallic mass having particles thereof penetrating and embedded beneath surface portions of the brush.

It is a further object of the present invention to provide an improved form of connection of the character described, between a multi-strand flexible conductor and a current-collecting brush of carbonaceous material, wherein a portion of the connector is disposed in a recess in the brush and is mechanically and electrically secured thereto through the intermediary of an originally fluent metallic mass projected into intimate union with individual strands of the flexible connector and interior portions of the brush.

It is a further object of this invention to provide a novel method of producing an improved connection between a carbonaceous body or the like and a flexible stranded element.

It is a further object of this invention to provide an improved method of uniting a flexible conductor to a carbonaceous brush, involving the insertion of a portion of the flexible conductor in a recess in the brush and the building up of a highly conductive mechanical and electric connection between the material of the conductor and the brush, the built-up connection including the impregnation of surface portions of the brush with particles of a fluent conductive mass which is projected in the form of minute particles onto surface portions of the brush.

These and further objects and advantages are secured by the present invention, various novel features of which will be apparent from the description and drawings,

disclosing several embodiments of the invention, and will be more particularly pointed out in the claims.

In the drawings:

Fig. 1 is a view in elevation, with a portion broken away, showing details of the connection of a flexible conductor to a current-collecting brush, embodying features of the present invention.

Fig. 2 is a sectional elevation in the plane of the line II—II of Fig. 1.

Figs. 3 and 4 are views similar to Fig. 2 showing modifications of the embodiment of the invention disclosed in Figs. 1 and 2.

Fig. 5 is a view similar to Fig. 1, showing a further modified embodiment of the invention.

Fig. 6 is a view in elevation, with a part broken away, showing a further modification of the invention.

Fig. 7 is an enlarged broken sectional view of the device shown in Fig. 5.

In accordance with the disclosure of the drawings, 1 indicates a formed or molded body of carbon or carbonaceous material presenting minute pores or interstices, preferably being considered as a brush of carbonaceous material such as is ordinarily used for current-collecting purposes on a dyamo-electric machine. The brush is provided with a cavity or recess 2, by originally molding or by drilling, in the form of a hole extending into the brush from the upper end thereof. The lower end of the hole or aperture 2 is intersected by the inner end of a transverse recess or aperture 3 extending from the front face of the brush, the aperture 3 being preferably of the same or slightly larger cross-sectional area than the aperture 2. A flexible conductor 4, preferably formed of braided or stranded conductive threads, is of such size to be easily inserted into and loosely fit in the aperture 2, and its inner end is turned at an angle, as indicated at 5, and extends into, and to an appreciable extent toward the open end of, the aperture 3, this bent-over portion at the end of the conductor serving to some extent as a means for temporarily anchoring the conductor in position in the brush. The end of the flexible conductor which extends into the aperture 3, preferably has its strands unravelled or splayed out to such an extent as to appreciably separate a considerable number of the outer individual strands.

In order to mechanically and electrically secure the flexible conductor 4 in operative position within the brush 1, a spray or jet of minute particles of conductive metal, such as copper or brass, or the like, is forced through the aperture 3, under considerable pressure, and preferably in molten condition, ordinarily this pressure being such as drives these particles into intimate contact with and within the pores or surface interstices of the walls of the apertures or recesses in the brush, and, likewise, into intimate surface contact with the individual strands of the end portion of the conductor 2. Preferably, the pressure with which the jet or spray of minute metal particles is projected into intimate contact with the walls of the apertures of the brush in such that, even if the metal particles are not projected while in molten condition, the energy of impact of the particles on the walls of the apertures in the brush and on the conductor serves to melt or soften the metal and causes welding thereof to previously projected metal particles and surface portions of the conductor. Satisfactory results in the matter of applying a spray of metallic particles under pressure are secured through the use of such an apparatus as is commercially well known as the "Schoop gun".

This metal union, indicated at 6 as a hardened mass, between the brush 1 and the flexible connector 4, is preferably projected by apparatus which serves to render the metal in molten condition, and then delivers the metal in the form of an atomized or the like jet or spray of separate minute particles under high pressure, the arrangement preferably being such as to insure, between the original heat of the projected particles and the energy of impact thereof on the walls of the apertures in the brush and the surface of the flexible conductor 4, that there is a forcing of these particles beneath surface portions of and into the body of the brush where they become anchored, and that later applied particles are welded or united to the previously projected particles or to portions of the flexible conductor.

In order to facilitate the production of the most desirable form of anchoring and union of this conductive coating to surface and sub-surface portions of the walls of the apertures 2, 3 in the brush, a preliminary application of the metal spray is made on these walls, through the aperture 3, before the end of the conductor 4 is inserted in the apertures in the brush. Then, with a layer of the metal coating thus applied to the walls of the recesses, as shown in the drawing by the darkened surface portion 7 of these apertures and shown more in detail in Fig. 7, the conductor 4 is inserted to position within the recesses 2, 3, and the end of the conductor is splayed out, as described hereinabove. An amount of metal particles is then projected into the aperture 3, as described hereinabove, the effect being such as to cause these metal particles to further coat the walls of the apertures in the brush and unite with or become welded to the previously applied metal and fill all of the interstices between the strands of the metal connector and the space between the conductor and the walls of the recesses 2, 3, and to form a plug of conduc-

tive material 6 which consists of a large number of minute particles welded together and to the material of the connector and intimately united with and anchored within pores or surface interstices of the brush and forming a mechanically and electrically secure connection between the flexible conductor and the brush and, likewise, one wherein, because the connection between the conductor 4 and the brush is wholly adjacent the inner end of the aperture 2, the permitted flexibility or bending of the conductor at the point where it leaves the brush is a maximum.

Preferably, the entire upper portion of the body of the brush has applied thereto a relatively thin coating, indicated at 8, of highly conductive metal which may be similar to and applied in the same manner as that projected onto the walls of the apertures 2, 3. Where this coating 8 is intended to be of appreciable thickness, the walls of the brush may be correspondingly recessed to a slight extent, so that the outer surface of the coating will be flush with the surface walls of the body portion of the brush. A coating of this character on the brush constitutes an effective conductive coating for the upper end of the brush and may serve to conduct the current from the upper portions of the brush body to that portion thereof in intimate contact with the flexible connector 4.

In the modification shown in Fig. 3, the transverse aperture 3 in the brush is extended wholly through the brush to provide a portion, as indicated at 3^a, at the rear of the bent inner end of the flexible conductor 4. With the walls of the apertures 3, 3^a preliminarily coated, as described above, and the flexible conductor in position as indicated, conductive metal may be projected into the open end of the aperture 3 to form the conductive union or connection 6 between the flexible conductor and the body of the brush, as described hereinabove; and, likewise, a mass of this metal may be similarly projected into the aperture 3^a, forming a plug of welded or united metal particles 6^a which is intimately united with surface portions of the walls of the aperture in the brush and with the individual strands of the flexible conductor 4 at the bend thereof. The general arrangement of Fig. 3 serves to considerably increase the area of contact or union between the brush and the end of the flexible connector.

As indicated in the modification shown in Fig. 4 the end of the flexible conductor 4 may be divided and, instead of all of the strands coming out at one side, as indicated in Fig. 3, a portion of the strands may be turned into the aperture 3 and the remainder turned into the aperture 3^a. Plugs of conductive metal 6 may be projected in the form of minute particles as described hereinabove into both of the apertures 3 and 3^a to intimately secure and electrically unite the separate strands of the divided end of the flexible conductor to the body of the brush, on the previously applied metal coating 7, as described hereinabove. If desired, a portion of the plugs 6 may be made up of metal inserted in powdered form and compacted by a tool into a plug 9. It will be apparent that, in accordance with the disclosure of Fig. 4, the area of contact of the particles of the metal masses 6 with the walls of recesses in the brush and the strands of the flexible connector is probably a maximum, the projected metal entering more thoroughly into the strands of the flexible conductor to a greater extent, so as to more effectively secure, both electrically and mechanically, the flexible conductor in position.

In Fig. 5, the transverse aperture or recess 3^b opens from the end wall or face of the brush rather than from the front or rear face. However, with the preliminary conductive coating 7 applied as described above, and the end of the flexible conductor 4 inserted to the position shown, the remaining portion of the conductive uniting plug 6 is applied as described hereinabove.

In Fig. 6, the recess 2^a extends transversely throdugh the brush in a direction slightly inclined to one end wall thereof, and a recess 12 is provided at such end wall extending upwardly from the end of the aperture 2^a to a recess or aperture 13 extending into the brush for a short distance parallel to the aperture 2^a. The aperture 13 and the recess 12 are of such size as to receive easily with a loose fit, the bent-over end of the flexible conductor 4. After applying a preliminary conductive coating 7 to the walls of the recesses 12 and 13, in the manner described above, with the incidental coating of the adjacent portion of the aperture 2^a, the end of the flexible conductor 4 is inserted to the position indicated; and conductive uniting material is projected, from the open side of the recess 12, over the exposed portions of the flexible conductor and the walls of the aperatures 2^a, 12 and 13, to form the conductive connection and union 6^b between the brush and the flexible conductor 4.

It will be apparent that the transverse or intercepting cavity or recess may extend to the inner portion of the main cavity 2 or 2^a from any lateral face of the brush, or even from the same face from which the main cavity and the connector extend, providing the intercepting cavity is suitably inclined to the main cavity.

Through the means and method described hereinabove, the mechanical connection of the flexible conductor 4 to the body of the brush is secured substantially wholly at the inner end of the conductor within the aper-

ture 2 or 2^a, and there is no rigid connection of the flexible conductor to the walls of these apertures adjacent the outer ends thereof; and through this loose fit of the flexible conductor in the outer portion of the aperture, and a firm union of the conductor to the brush at the inner end of the aperture, a most desirable mechanical and electrical union is secured with a minimum of hindrance to the desired flexibility of the connection between the flexible conductor and the brush.

It should be understood that the invention claimed is not limited to the exact details of construction and methods shown and described herein, for obvious modifications will occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. A carbonaceous article provided with a cavity, a conductor inserted in said cavity, and means for electrically and mechanically uniting said conductor to said carbonaceous article, said means including a mass of metallic particles welded together within said cavity, and having portions thereof resultant from pressure spray deposition in intimate union with the material of said article.

2. A carbonaceous article provided with a cavity and a recess intersecting said cavity, a flexible conductor within said cavity and having a portion adjacent and accessible through said intersecting recess, and means for electrically and mechanically uniting said conductor to said article, said means including a mass of intimately united metallic particles having filamentary portions thereof within surface interstices of the wall of said intersecting recess and having characteristics of intimate union with said wall resultant from the deposition of the metal particles as a finely divided molten spray under pressure.

3. The method of securing a conductor within a recess in a carbonaceous article and in conductive connection with said article, which comprises projecting conductive material in the form of a spray of finely divided particles under pressure into said recess and into intimate union with the material of said article and said conductor.

4. The method of securing a conductor within a recess in a brush of carbonaceous material, which comprises forcing a mass of conductive metal into the space between a portion of the conductor within said recess and the wall thereof and into surface pores of said wall by projecting a stream of finely divided molten particles of said metal under pressure into said space.

5. The method of securing a conductor within a recess in a brush of carbonaceous material, which comprises separating strands of a portion of the conductor within said recess, and forcing a mass of conductive metal into the space between said portion of the conductor and the wall of said recess and into the surface pores of said wall and between separate strands of the conductor by projecting a stream of finely divided molten particles of said metal under pressure into said space and between the separate strands of the conductor.

6. The method of securing a flexible stranded conductor within intersecting recesses in a brush of carbonaceous material, which comprises forcing a mass of conductive metal in the form of a finely divided stream of molten particles projected under pressure into surface interstices of and upon the wall of one of said recesses to form an intimately united conductive coating therefor, inserting said conductor in the other recess with a portion of the conductor bent over in said first recess, and forcing a mass of conductive metal into the space between said bent-over portion of the conductor and the metal surface coating on the wall of said first recess by projecting a stream of finely divided particles of metal under pressure into said space.

In testimony whereof, the signature of the inventor is affixed hereto.

ERNST HEDIGER.