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(54) Linear fiber armature for electromagnetic launchers.

(57) An armature, for conducting very large DC currents between a pair of electrically conductive rails while being driven along the rails under the influence of electromagnetic forces generated by the application of the currents, including a plurality of spiraled conductive fibers. The fibers pass through a sleeve and are compacted to a maximum packing density within the sleeve to form a single solidified connection. A brush assembly formed by the sleeve and fibers is mounted on an insulating support structure adapted to slide between the rails of an electromagnetic launcher.

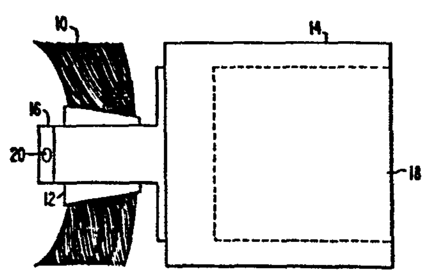

FIG. 1

EP 0 182 947 A1

Croydon Printing Company Ltd.

LINEAR FIBER ARMATURE FOR ELECTROMAGNETIC LAUNCHERS

This invention relates to armatures for conducting very large currents between parallel rails of electromagnetic launchers and more particularly to such armatures employing multiple conducting fibers to conduct current between the launcher rails.

In the electromagnetic propulsion of projectiles, a very large DC current is injected into the breach end of a pair of parallel conductive rails. A sliding conductive armature serves to conduct current between the rails and is subjected to an electromagnetic force which propels the armature and an associated projectile toward the muzzle end of the rails. Because of the high currents involved in the electromagnetic propulsion of projectiles, sliding conductive armatures must be designed to minimize electrical contact resistance, to have sufficient contact force to maintain a low contact voltage drop in order to prevent rail damage caused by arcing, to have sufficient compliance to accommodate both its own ware and changes in the distance between the launcher rails, and to minimize damage resulting from resistive heating.

According to the present invention, an armature, for conducting large D.C. currents, between a pair of electrically conductive rails, comprises an insulating support structure, a plurality of conductive fibers, a sleeve having an opening in which said conductive fibers are positioned said conductive fibers being compacted to a maximum packing density within said sleeve, and means for mounting said sleeve on said support structure.

Conveniently, a plurality of cantilevered conductive fibers of this structure are angled and spiralled for low contact load. Maximum packing density of the fibers within the sleeve produces a uniform current distribution which eliminates excessive current density concentrations and prevents gross armature melting.

This invention also encompasses a fiber brush assembly which is suitable for making sliding contact with a slip ring conductor. A high current brush constructed in accordance with this invention comprises: a plurality of conductive fibers; a sleeve having an opening through which said conductive fibers pass; and wherein said conductive fibers are compacted to a maximum density within said sleeve.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a top view of an armature assembly in accordance with one embodiment of this invention;

Figure 2 is a side view of the armature assembly of Figure 1; and

Figure 3 is a top view of an armature brush assembly for use in the armature assembly of Figure 1.

Figure 1 shows a top view of an armature assembly. A brush assembly comprising a plurality of conductive fibers 10 pass through an opening in sleeve 12, is attached to an insulating support structure 14 by a brush holder mounting means 16. The insulating support structure 14 is sized to slide between a pair of parallel launching rails in an electromagnetic launcher and serves to position the brush assembly between the rails. In this embodiment, an opening 18 is shown within insulating support structure 14 for receiving a projectile. However, the insulating support structure 14 may itself be the projectile, may lie adjacent to a projectile, or may be associated with a projectile in some other manner. The sleeve 12 of the brush assembly passes through an opening in mounting means 16 and is held in place by a set screw 20.

Figure 2 is a side view of the armature assembly of Figure 1. This embodiment uses two fiber brush assemblies each of which contains ten bundles of 0.006" copper fibers such as those used to form flexible commercial welding type cable. Each bundle contains 1,100 wire fibers. These bundles were inserted into openings of cylindrical annealed copper sleeves 12. The copper sleeves were then rotary swaged until conductive fibers 10 reached a maximum packing density within each sleeve and thereby formed a single solidified connection. The sleeves 12 were inserted into an aluminum mounting block 16 and secured by way of set screws 20. A bolt 22 serves as means for attaching mounting block 16 to insulating support structure 14.

Figure 3 is a top view of the brush assembly of the armature assembly of Figure 1. Each end of sleeve 12 is beveled at an angle 24 of 10° to form a narrow side 26 and a wide side 28. When the brush assembly is mounted onto the armature assembly, the narrow side 26 of sleeve 12 is mounted closest to the insulating support structure 14. Multiple conductive fibers 10 pass through an opening in sleeve 12 and are spiralled with respect to the axis of sleeve 12. The conductive fibers 10 have been bent as a whole to an angle 30 of 40° at the trailing edge and an angle 32 of 10° at the forward edge. In addition, the ends of conductive fibers 10 are cut along two planes which lie perpendicular to the axis of sleeve 12. To improve electrical contact between conductive fibers 10 and the projectile launching rails of the launcher, the ends of conductive fiber 10 are polished to a flat surface.

Armature assemblies in accordance with this invention have been constructed and tested in an electromagnetic launcher. One of these armature assemblies having a brush assembly comprising 7,700 copper fibers, each having a diameter of 0.006", was used to accelerate a 317 gram projectile to a speed of 4.2 kilometers per second with a pulsed current of 2.1 million amperes. Despite being subjected to a peak acceleration of 236,000 g's., the projectile and armature assembly left the barrel intact and went through the center of a ¼" thick steel witness plate before being destructively caught in a catch tank. Rail damage was minimal, with two smooth dime-shaped holes about 2 millimeters deep having been produced approximately 15 centimeters from the breech of the launcher. The remainder of the rails and insulation showed no damage although all interior surfaces were coated with a thin layer of soot.

Localized armature melting was eliminated through the use of a plurality of electrical contacts, each having sufficient compliance in a directional normal to the projectile launching rails to minimize resistive heating. Thermal transfer through the solidified center segment of the conductive fibers and through the aluminum brush holder improved heat dissipation. Low contact resistance at extreme current densities was achieved through the use of spiralled conductive fibers which provided an adequate normal force on each of the fibers. This spiral design compensates for variations in rail spacing and permits adequate mechanical compliance for the polished conductive fiber tips to remain in contact with the rail surface. It also provides for continued contact with the conductive rails when the fibers erode as they travel through the barrel. The brush assembly of this invention can be assembled without the need for soldering or metal joining procedures. The spiralled fibers provide self support and limit deflection while in the presence of high electromagnetic fields. Spiralling allows compliance to variations along the contact rails as the armature travels to maintain good electrical contact, thereby reducing the destructive effects of arcing. Through the use of flexible conductive fibers, low contact forces are required to make good electrical contact, thereby resulting in low friction losses.

For example, although the brush assembly of the armature assembly of this invention has been as an efficient linear sliding contact during a pulsed application, it can also be used as a continuous operating brush on a slip ring surface. Because the conductive fibers have been solidified within the sleeve of the brush assembly, soldering or joining heavy electrical conductors to the brush is possible and can readily be made when required.

CLAIMS:

1. An armature for conducting large DC currents between a pair of electrically conductive rails while being driven along the rails under the influence of electromagnetic forces generated by the application of said very large DC currents, said armature comprising an insulating support structure, a plurality of conductive fibers, a sleeve having an opening in which said conductive fibers are positioned said conductive fibers being compacted to a maximum packing density within said sleeve, and means for mounting said sleeve on said support structure.

2. An armature as claimed in claim 1, wherein each end of said sleeve is beveled at an angle of 10° such that said sleeve has a narrow side and a wide side with the narrow side being closer to said support structure.

3. An armature as claimed in claim 1 or 2, wherein said conductive fibers are bent at an angle between 10° and 40° with respect to the axis of said sleeve, with said conductive fibers which are closest to said support structure being bent at an angle of 10° and said conductive fibers which are farthest from said support structure being bent at an angle of 40°.

4. An armature as claimed in any one of claims 1 to 3, wherein said sleeve is a cylindrical tube.

5. An armature as claimed in any of claims 1 to 4, wherein said means for mounting said sleeve on said support structure comprises a mounting block having an aperture for receiving said sleeve.

6. An armature as claimed in claim 5, wherein said mounting block is substantially of aluminum.

7. An armature as claimed in any one of claims 1 to 6, wherein said conductive fibers are spirally disposed.

8. An armature as claimed in any one of claims 1 to 7, wherein one end of each of said conductive fibers is cut along a first plane perpendicular to the axis of said sleeve and the other end of each of said conductive fibers is cut along a second plane perpendicular to the axis of said sleeve.

9. An armature as claimed in any one of claims 1 to 8, wherein said plurality of conductive fibers comprises approximately 11,000 conductive fibers.

10. An armature as claimed in claim 9, wherein said conductive fibers are copper strands.

11. An armature as claimed in any one of claims 1 to 10, wherein said sleeve comprises an annealed copper cylinder having been swaged to compact said conductive fibers.

12. An armature as claimed in any one of claims 1 to 11, wherein said conductive fibers are polished on each end in a plane perpendicular to the axis of said sleeve.

13. A high current brush, for an armature as claimed in any one of claims 1 to 12, in which the brush comprises a plurality of conductive fibers, a sleeve having an opening through which said conductive fibers pass, and said conductive fibers are compacted to a maximum density within said sleeve.

14. A high current brush as claimed in claim 13, wherein said sleeve is a cylindrical tube.

15. A high current brush as claimed in claim 13 or 14, wherein said conductive fibers are spirally disposed.

16. A high current brush as claimed in any one of claims 13 to 15, wherein one end of each of said conduc-

tive fibers is cut along a plane perpendicular to the axis of said sleeve.

17. A high current brush as claimed in any one of claims 13 to 16, wherein said conductive fibers are copper strands each having a diameter of 0.006 inch.

18. An armature, for conducting large D.C. currents, constructed and adapted for use, substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

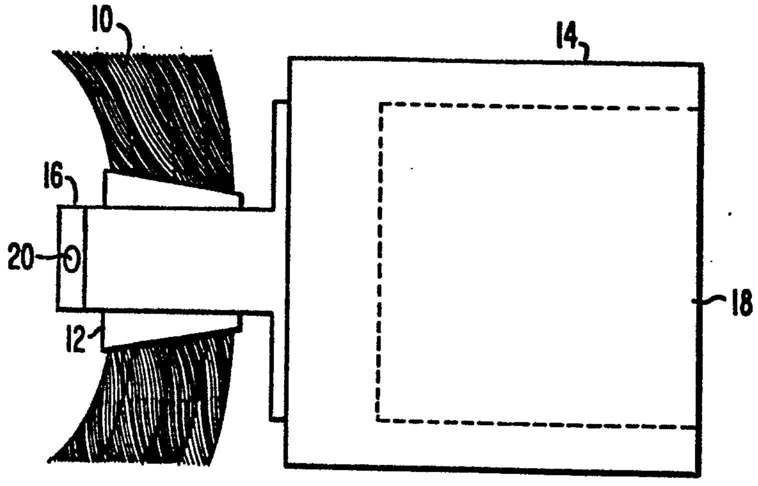

FIG. 1

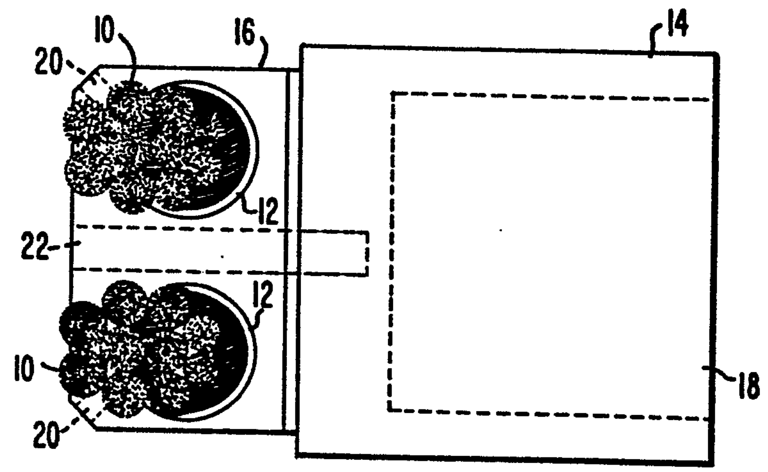

FIG. 2

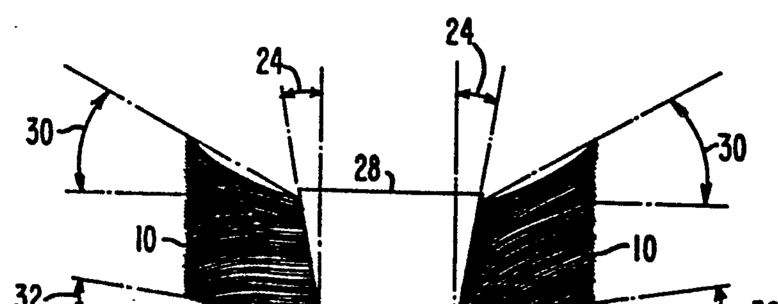

FIG. 3

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EUROPEAN SEARCH REPORT

0182947

Application number

EP 84 30 8277

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 457 205 (WESTINGHOUSE) * Column 2, line 48 - column 4, line 11; figure 1 *	1,3,7-10,12,13-18	F 41 F 1/02
A	US-A-3 917 995 (H.H. CLINTON) * Column 4, lines 27-53; figures *	1,3	
A	EP-A-0 054 380 (LITTON) * Page 2, lines 26-28; page 5, line 32 - page 6, line 1; page 8, line 36 - page 9; figures *	1,4	
A	DE-B-1 093 895 (E. NELKEN) * Whole document *	1,4	TECHNICAL FIELDS SEARCHED (Int. Cl.4) F 41 F H 01 R B 60 L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03-09-1985	RAMBOER P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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