O. E. BECKER.

LAMINATED BRUSH FOR ELECTRICAL MACHINES AND METHOD OF MAKING THE SAME.

APPLICATION FILED MAY 2, 1912.

1,117,965.

Patented Nov. 24, 1914

Fig. 1.



Fig. 2.

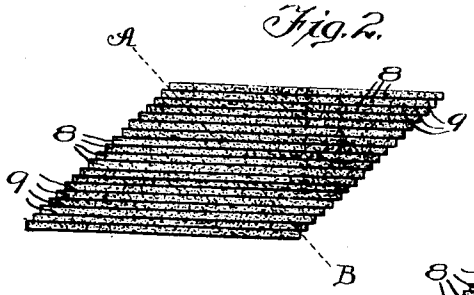


Fig. 3.

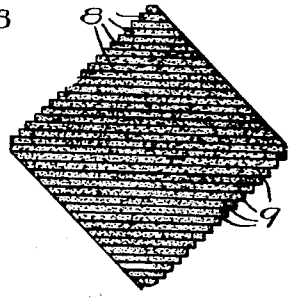


Fig. 6.

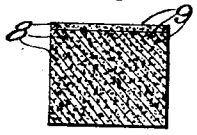


Fig. 4.

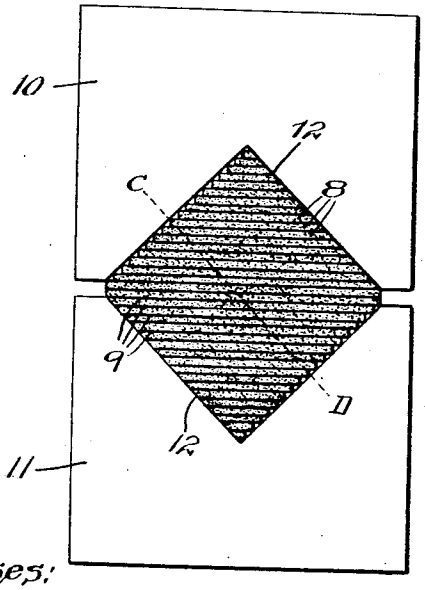
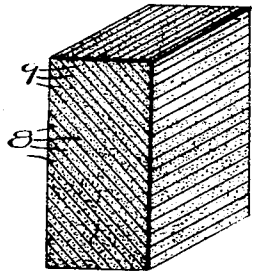


Fig. 5.



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LAMINATED BRUSH FOR ELECTRICAL MACHINES AND METHOD OF MAKING THE SAME.

1,117,965. Specification of Letters Patent. Patented Nov. 24, 1914.

Application filed May 2, 1912. Serial No. 694,697.

To all whom it may concern:

Be it known that I, OLIVER E. BECKER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Laminated Brushes for Electrical Machines and Methods of Making the Same, of which the following is a specification.

This invention relates to brushes for electrical machines, more particularly designated as laminated brushes of this class, consisting of alternate layers of material of relatively high and low conductivity intimately connected together and forming a solid block, and one of the principal objects of the invention is to make brushes of this class by a satisfactory and appropriate method.

A further object of the invention is to provide a brush of this class which has a high current carrying capacity without becoming unduly heated, high resistance from one end to the other, and good wearing qualities, without causing excessive wearing of the commutator to which it is applied.

A further object of the invention is to provide a brush of this class for dynamo electric machines which is mechanically strong, is readily constructed and formed, and is effective and efficient in operation.

For the attainment of these ends and the accomplishment of other new and useful objects, as will appear, the invention consists in the production of a brush of this class by a new and improved method, the construction of the brush being shown and a portion of the method being diagrammatically disclosed in the specification and shown in the drawing, but more particularly pointed out in the appended claims.

In the drawing Figure 1 represents a single lamina of material covered with a material of different conductivity; Fig. 2 is a view of a number of the laminæ shown by Fig. 1, superposed and overlapping at one end with a dotted diagonal line showing the direction in which this stack is to be cut; Fig. 3 is a block formed by placing the bases of the stack when cut on the diagonal line A—B of Fig. 2 face to face; Fig. 4 is a view of a block as illustrated by Fig. 3, positioned between two clamping blocks or members; Fig. 5 is a view of a completed brush representing a portion of the block as cut on the line C—D of Fig. 4, properly squared off and polished ready for use; and Fig. 6 is a view of a short brush with a cap plate.

When carbon brushes, which are the kind principally used at the present time, are operated at a current density of over 40 amperes per square inch on commutators, it is found that the brushes become exceedingly hot, causing the wear to unduly increase as the commutation of the machine to which they are applied under these conditions is very poor. On machines of comparatively high voltage, little difficulty is experienced in the design of commutators to take care of the flow of current through the brushes and other current carrying devices, but on machines of low voltage, such, for example, as electro plating machines, individual cell charging outfits of storage batteries, and collector rings of rotary converters, and in other places where a comparatively large amount of current must be carried, design limitations make it highly desirable that the current density in brushes be increased to at least double the permissible current density in carbon brushes.

Experience and practice have shown that copper brushes of the leaf and other types not permitting of lubrication cause excessive wear of the commutator or collector rings and make the commutation unsatisfactory because of the low transition resistance of the brushes at their contact surface.

Many different systems have been devised to make a brush which will have low energy loss for comparatively high current density, for example, as high as 200 amperes per square inch. The development of the art has brought forth brushes consisting of a combination of carbon and bronze and other similar materials. These brushes have many desirable qualities, but still cause excessive wear, far above that of the carbon brush of the most approved design and construction, and they have the further defect that there is no difference between the resistance per unit of volume longitudinally of the brush and laterally. In other words, brushes of the above mentioned type have too low transverse resistance for satisfactory commutation provided the longitudinal or total resistance of the brush has been reduced to the desired quantity. Brushes have also been designed and produced which

employ conductors running lengthwise from the connected end of the brush to the contact surface thereof. The failure of this type of brush is due largely to the fact that when copper sheets or rods are placed contiguous to carbon to form a unit at a connection made at the connected end and also between the surface of the brush and the commutator, comparatively the entire current flows directly through the metal, and a negligible amount through the carbon in contact with the metal. Due to this action of the brush the copper burns away at the surface of the brush next to the commutator and burns away much more rapidly than the carbon, which is unable to prevent the formation of arcing vapor due to the passage of excessive currents in small conductors. The above described action is clearly explainable when it is considered that the resistance of carbon is several thousand times that of copper which represents the difference in resistance of the two paths in parallel of the two materials in a brush of this design. To obviate these difficulties a brush has been designed, consisting of alternate strips or sheets of material of relatively high and low resistance, such, for example, as carbon and copper, for the reason that these are the most satisfactory materials and the materials most used, the sheets being disposed at an angle to the surface of the brush next to the commutator. By these means the current from the connected end of the brush has no direct metallic path from this end to the commutator, but it nevertheless reduces the resistance of the carbon to a sufficiently large extent to allow a current density in the carbon brush of 150 amperes per square inch, as compared to 40 amperes per square inch in the pure carbon brush.

In the construction of brushes of this class the following method is employed: A number of plates or laminæ of material of which the brush is to be constructed, such, for example, as carbon, are used in each brush. These plates are first brushed in water in order to remove loose dust, and are then introduced into a plating bath and covered with a thick deposit of metal. In the present method the plates are introduced into a cyanid plating bath and are covered with a deposit of copper. In order to remove the plating solution, the plates covered with the copper are then washed in water, and are then boiled for a time, say about twenty minutes, in an acid solution, such, for example, as a solution formed by adding one ounce of tartaric acid to sixteen ounces of water, and dried over steam coils for about fourteen hours. After this treatment the coating of copper is found in some instances to be considerably discolored, but no difficulty is experienced in the subsequent tinning or solder which is readily accomplished by rapidly dipping the dry plates in soldering flux and then into molten solder. Before tinning in solder the plates must be thoroughly dry, and must not be allowed to soak up the soldering flux when dipping. Dipping the wet plates in molten solder will cause an expansion due to the sudden vaporization of the moisture under the copper coat, and this is the reason for drying the plates for such a long time. After being tinned the plates are stacked up in such a way that a line drawn diagonally across the end of the stack from the corner of one outside plate to the opposite corner of the other outside plate is substantially at right angles to the ends of the stack. Clamped or otherwise secured in this position the plates are sawed through on the diagonal line, forming two stacks of a triangular cross section. The bases of these stacks are then placed face to face and the block thus formed is clamped between blocks of the proper shape and form to contain the laminated block. The laminated block is then heated in any desirable way until the solder flows. This heating may be accomplished by the application of the block to a suitable heating agency, or an electric current may be passed through the block. In the latter instance electric terminals are then clamped on the ends of the laminated block thus formed, and a very high current, say about 500 amperes, is passed for approximately ten minutes through the block or until the solder flows. The clamp on the block is then drawn up to force out the excess solder and to bring the plates into intimate contact, the current is shut off and the block is then allowed to cool. After cooling the block is cut so that the layers of material will be deposited at an angle to the surface of the brush, which is designed to be in contact with the commutator.

Referring now more particularly to the drawing, Fig. 1 represents a single plate or lamina of material 8, such, for example, as carbon, covered with a coating 9 of a material of different conductivity, such, for example, as copper, the coating being intimately connected to the carbon by introducing the plate of carbon into a suitable plating bath, where the metallic coating is deposited upon the plate. The plates are then washed and dried, and are dipped in a soldering flux and then into molten solder, forming a thin coating of solder upon the plates, which is not shown by the drawing. These plates 8 are then stacked one upon the other in such a way that a line drawn diagonally from one corner of the uppermost plate to the opposite corner of the lowermost plate is substantially at a right angle to the ends of the stack, for example, as shown in Fig. 2. The stack thus formed

is then cut or made on the line A—B, forming two separate stacks triangular in cross-section. These separate stacks are then placed with their bases face to face, so that they present the appearance shown in Fig. 3. The block of material thus formed is then passed between blocks 10 and 11 having V-shaped notches 12, so that the block of laminated material as shown in Fig. 3 may be disposed in the V-shaped grooves with the plates substantially parallel with the top and bottom of the blocks 10 and 11. In this position the laminated block is heated by any suitable means, and pressure is applied to the blocks 10 and 11. A suitable means for heating the block of laminated material is by passing a comparatively large current of electricity through the block from end to end, so that the block is heated, thereby causing the solder to flow, whereupon the pressure of the blocks 10 and 11 upon the laminated block will press the excess solder therefrom and will cause the separate plates of material to be intimately connected and held together. The current is then cut off and the blocks allowed to cool, after which the laminated block may be cut as on a line C—D of Fig. 4, and the rough edges smoothed off and polished, leaving one portion substantially of the size shown by Fig. 5, in which it will be noted that the layers are inclined to the ends thereof.

By means of the angular disposition of the separate copper and carbon sheets, it is also possible to put many more sheets of material into the brush than if the sheets were arranged perpendicularly of the surface of the brush in contact with the commutator. This is due to the fact that the length of the brush used is preferably made so that it is considerably more than its thickness. Although a much larger number of copper sheets can be put into one brush, as described, the number of sheets in contact with the surface is relatively small, which is desirable so long as the total resistance of the brush has been reduced to the desired amount. Also with the angular disposition of the sheets of copper with reference to the surface of the brush in contact with the corner, the contact area per layer is greater in metal contact than the cross section of the copper sheet measured transversely. This angular disposition also allows that the copper sheets do not coat the commutator as much as if the sheets were not angularly disposed, for the reason that the brushes are inclined away from the surface of the commutator in its direction of rotation. It is common also to treat the carbon between the metal sheets with an impregnating compound which will render slightly less the abrasion of the carbon than without treating, and will also reduce the abrasion of the copper sheets running against the copper of the commutator.

The thickness of the metal sheets between the carbon plates is materially less than the thickness of the insulation between the segments of the commutator, and this is a very important point, since if the sheets of metal were long, or nearly approximately as great in thickness as the insertion between the commutator segments, unsatisfactory commutation results will be obtained, owing to the fact that the segments of the commutator will be short-circuited by a very low resistance, therefore it is important that the sheets of metal be of extreme thinness.

Where very short brushes are to be used which do not admit of employing standard stock without getting a direct metallic path from the connected end of the brush to the contact surface thereof with the commutator, it is preferable, as shown by Fig. 6 to employ a thin lamina or plate 13 of carbon coated with metal on one side, this side being secured to the top of the brush in a manner similar to that with which the copper sheets of the brush proper are secured to the carbon sheets. Above this plate at the top of the brush a suitable contact terminal can be placed in such a manner that the desired division of current can be obtained between the carbon and copper sheets.

While copper and carbon are specifically mentioned in the present instance, it is obvious that other materials may be similarly used and employed, and it is also evident that a number of coatings of metal may be used on top of the carbon. In some instances where the electrolytic action of the current in metallized brushes is excessive, it is preferable to use a mixture of aluminum and copper of suitable proportions, and it is evident that the use to which the brush may be put will control the material to be used in this construction.

It is evident that others skilled in the arts to which this relates may make brushes of this class substantially in accordance with my improved method, without departing from the spirit and scope of my invention, and I desire therefore not to be limited to the exact materials or structure as above described.

I claim—

1. A brush of the class described consisting of alternate layers of material of relatively high and low resistance arranged at an oblique angle to the bearing surface and extending transversely so that the layers of high resistance break the low resistance path from the bearing surface to the opposite end.

2. A brush of the class described, consisting of carbon laminæ each with a metallic covering and all secured together forming a solid block with the laminæ arranged at an

oblique angle to the contact face and at such an inclination that no lamina will extend from the contact face through to the opposite side.

3. The method of forming laminated brushes which consists in coating separate sheets of material with metal, in stacking the coated sheets in a pile, in cutting the stacked pile at an angle to the laminations, and in uniting the sheets by means of the metal to form a solid block.

4. The method of forming laminated brushes which consists in covering separate plates of carbon with metal, in subjecting a stack of the covered plates under pressure to the action of heat to fuse the metals together whereby a block is made composed of alternate sheets of material of high and low conductivity, and in cutting the block thus formed at an angle to the sheets, so that the material of high conductivity breaks the direct path of the material of low conductivity from end to end of the brush.

5. The method of forming laminated brushes which consists in coating carbon plates with copper, in stacking the coated plates one upon the other, in uniting the plates into a compact block by fusing the metal of the separate plates together, and in cutting the block thus formed at an oblique angle to the plates to form separate brushes each of which has alternate layers of carbon and copper extending from the contact face at an angle thereto and terminating short of the other end so that no direct copper path is presented from one end of the brush to the other.

6. The method of forming laminated carbon brushes which consists of coating carbon brushes with metal, in stacking the coated plates in an oblique pile, in cutting the pile from one upper corner to the opposite lower corner transversely of the plates, in placing the lowermost plate on the uppermost plate, in subjecting all of the plates to heat and pressure simultaneously to form a solid block of material, and in cutting the block thus formed at an oblique angle to the separate plates, to form brushes of alternate layers of high and low conductivity, which extend obliquely from the contact face of the brush and terminate short of the opposite end thereof so that no direct low resistance path is formed from one end of the brush to the other.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, on this 29th day of April A. D. 1912.

OLIVER E. BECKER.

Witnesses:
C. H. SEEM,
K. W. WONNELL.