April 8, 1952 P. W. NIPPERT 2,592,172

METHOD OF MANUFACTURING COMMUTATORS

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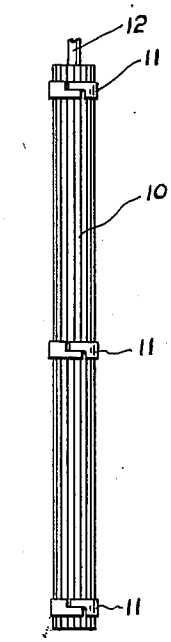


FIG. 1.

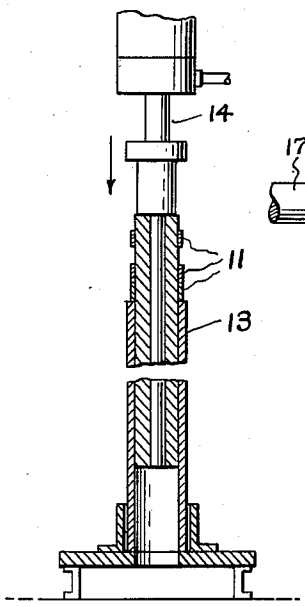


FIG. 2.

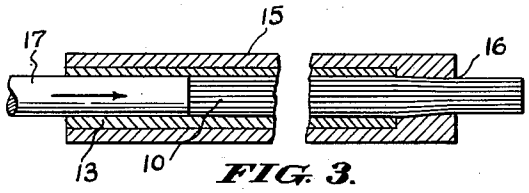


FIG. 3.

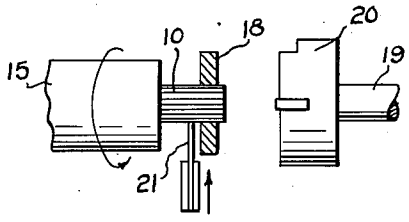


FIG. 4.

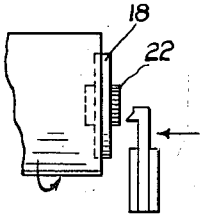


FIG. 5.

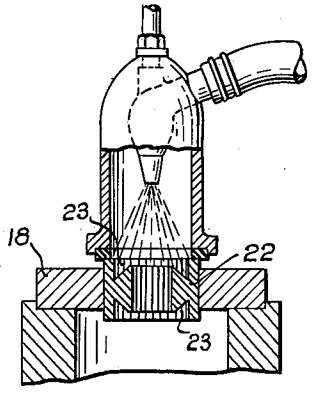


FIG. 6

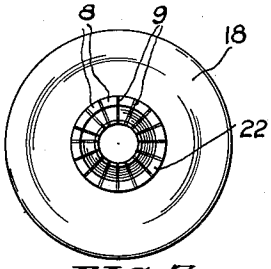


FIG. 7.

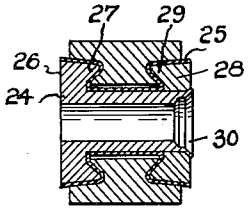


FIG. 8.

Inventor

Paul W. Nippert

By W. S. McDowell

Attorney

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METHOD OF MANUFACTURING COMMUTATORS

Paul W. Nippert, Columbus, Ohio

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3 Claims. (Cl. 29—155.54)

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The present invention relates to the production of commutators for electrical motors and similar dynamo-electric machines.

Heretofore, in the production of commutators, various methods have been employed to provide a commutator formed from a plurality of radially positioned brush-engaging segments separated by means of insulating material disposed between adjacent segments. The primary objective in the production of commutators of this type is to provide means whereby the individual segments and insulation material are prevented from displacement or detachment from the commutator body when the same is undergoing rotation at relatively high speeds. Further, the commutator must be capable of withstanding relatively heavy wear, occasioned by the frictional engagement of the outer surface thereof with the associated commutator brushes, without disintegration or displacement of the individual segments thereof. Many of the previously employed methods of constructing commutators have realized the objectives heretofore outlined, but such methods were generally characterized by relatively high production costs and expenditure of labor. It follows therefore, that the general object of this invention is to provide improved methods for the construction of dynamo-electric commutators, and decreases the labor time ambient to such production.

Another object of this invention is to provide improved and efficient methods for the construction of commutators which provides efficient means for maintaining the individual brush engaging surfaces or segments in insulated order, and which embodies means whereby these segments are held in a compressed and compact state against separating forces imparted by high speeds of rotation during operation.

These and additional objects and advantages of the method set forth in the present invention will become more readily apparent with reference to the following detailed description and the accompanying drawings wherein:

Figure 1 is an elevational view of an assembled sheaf of alternately insulated commutator bars, and illustrating the initial step in the manufacture of commutators formed in accordance with the methods presented in this invention.

Fig. 2 is a vertical sectional view taken through the sheaf of commutator bars as the same is undergoing insertion within a work tube;

Fig. 3 is a vertical sectional view illustrating the sheaf undergoing compaction and diameter reduction within a restricted throat;

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Fig. 4 is a side elevational view illustrating the steps of cutting the compacted portion of the sheaf into individual commutator annuli;

Fig. 5 is a diagrammatic view illustrating the commutator annulus undergoing machining operation;

Fig. 6 is a vertical sectional view taken through a machined annulus as the same undergoes abrasive action in the presence of a sand blast;

Fig. 7 is an elevational view of the machined annulus positioned within a work ring;

Fig. 8 is a transverse vertical sectional view taken through a completed commutator formed in accordance with the present invention.

The first step in the construction of commutators formed in accordance with the present invention, is to assemble into sheaf like formation a plurality of elongated longitudinally disposed commutator segment-forming bars 8 with strips of insulation 9 disposed between adjacent bars. It will be understood that each of the commutator segment bars possess a substantially V-shaped cross-sectional configuration, and have their upper edges rounded in order that a substantially continuous circular sheaf may be formed. The strips of insulation interposed between adjacent bars are of substantially normal rectangular configuration, and may be formed from any suitable insulating material such as mica, paper or various other dielectric compounds. To facilitate the assembly of the assembly of the individual bars and strips of insulation, a circular cross-sectional shaft or tubular core 12 is provided to form the axial opening of the sheaf. The individual bars and insulation strips are stacked either by hand or mechanical operation around the outer surface of the central shaft to form the tubular sheaf bearing the numeral 10, and possessing a substantially circular cross-sectional configuration. After the initial assembly of the required number of bars and strips of insulation, use is made of a plurality of clamping rings 11 which serve to hold the individual bars and insulation in stacked arrangement upon the axially disposed forming tube 12, and to prevent separation of the bars during handling operation.

The second step in the formation of the commutator annulus, consists in placing or pressing the assembled sheaf 10 into a metallic work tube 13, and simultaneously removing the axially disposed core 12 and the outer clamping rings 11. This operation, as shown in Fig. 2, may be easily accomplished by means of a hydraulic or manually operated press indicated by the numeral

14. It will be understood, that the pressing of the preformed sheaf within the tube 13 serves only to initially shape the sheaf into a substantially true circular form. In pressing the stacked sheaf into the work tube 13, the individual copper bars and strips of insulation are initially positioned in substantially closely fitting radially disposed order, and all unnecessary spacing and irregularities between bars and strips of insulation are eliminated.

The third step in the construction of the commutator annulus is depicted diagrammatically in Fig. 3 of the drawing, and consists in placing the preformed sheaf, positioned within the work tube 13 within a forming tube 15 which is formed at one end with a tapered and relatively restricted throat 16. The tube 15 is formed with a tubular chamber adapted to receive in closely fitting order the outer surface of the work tube 13, and the restricted throat 16 is formed at its inner opening to correspond in size to the outer diameter of the preformed sheaf 10, whereas the outer opening of the restricted throat possesses a diameter which is relatively less than the diameter of the preformed sheaf, and which, corresponds to the desired diameter of a finished commutator annulus. After the work tube 13 and the sheaf 10 are positioned within the forming tube 15, the end portion of the sheaf 10 is forced outwardly through the restricted throat, preferably by means of a hydraulic ram indicated at 17, in order to reduce the outer diameter of the end portion of the sheaf, and at the same time compacting or compressing the individual segment bars and strips of insulation into closely and tightly fitting order. It will be understood, that due to the general wedge-shape of the individual commutator bars, the bore diameter of the sheaf will only be slightly decreased, with the compaction taking place largely between the individual segments to arrange the same in closely and tightly fitting order. Also the extrusion of the compressed portion of the sheaf is preferably intermittent in order that a portion corresponding in width to that of a finished commutator annulus may be extruded with one application of pressure of the hydraulic ram 17. Simultaneous with the operation of extrusion of the compressed portion of the sheaf, is the application of a retaining ring 18 to the outer surface of the extruded portion. As depicted in Fig. 4, the retaining ring 18 is held adjacent the opening of the restricted throat 16, by means of a second hydraulic ram 19 carrying upon its outer end a socket adapter 20. The sequence of operation of the two hydraulic rams 17 and 19 is such that the retaining or work ring 18 is applied adjacent the opening of the restricted throat 16 just prior to the extrusion and compression of the end portion of the commutator sheaf, and as the latter moves outwardly from the restricted throat the compressed segments are held within the bore of the ring and prevented from splaying outwardly.

The next step in the operation consists, as shown in Fig. 4, in transversely cutting the compressed portion, which is held within the work ring 18, from the body portion of the sheaf. This may be accomplished by means of applying rotation to the forming tube 15 which produces a relatively high speed rotation within the sheaf, at which time a cutting edge 21 may be brought into engagement with the compressed portion of the sheaf, extending from the restricted throat 16 to effect severance thereof. Upon

severance a commutator annulus of the desired length is formed, which annulus is held within the bore of the work ring 18. The operations of extrusion and applying of the work ring 18 are repeated until a number of annuli or rings are formed from the assembled sheaf, and when relatively high speed machinery is utilized in these combined operations, a relatively large rate of output is obtained. After the complete removal of the sheaf from within the work tube 13 by the operation of the hydraulic ram 17, the work tube is then removed from the forming tube 15, and a similar tube containing another preformed and assembled sheaf is inserted whereupon the operation may be repeated.

After severance of the compressed and compacted annulus, indicated generally by the numeral 22, the same is placed with its work ring 18 upon a lathe, or other suitable revolving instrument, and machined, as depicted in Fig. 5, to form annular dove-tailed grooves 23 in the end faces of the annulus. These dove-tailed grooves form a seating region about the bore of the annulus, the functions of which will be hereinafter more fully described.

The penultimate step in the production of commutators in accordance with this invention, consists in removing burrs or smears of copper from the outer surfaces of the machined annulus. It will be noted, that in machining the annulus to form the dove-tailed grooves 23, minute or microscopic particles of copper are imbedded within the strips of insulation disposed between the adjacent copper segments, and if such particles are allowed to remain in the insulation, the dielectric efficiency thereof is greatly reduced, and in many instances the commutator will fail to withstand operating voltages without arcing between adjacent segments, which results in the overall failure of the commutator. To insure against this contingency, the outer or machined surfaces of the annulus are subjected to an abrading action to remove the machined particles of copper. A sand blasting operation, as illustrated in Fig. 6, has been found very efficient in effecting the removal of such particles, but it will be understood, that this abrading step is intended to include not only sand blasting operations, but any mechanical means of removing the machined or smear over particles of copper by abrasive action, such as subjecting the annulus to a carborundum blast, or to the flow or blast of a liquid, such as water, which contains an abrasive compound or element. By such operation, it is only necessary that the annulus be subjected to the abrasive for a relatively short period of time, approximating five seconds. During the sand blasting operation, the exterior surfaces of the dove-tailed grooves 23, while appearing to be smoothed, are actually roughened to a slight degree, which is an advantageous feature, in that a more efficient frictional union may be had between the copper segments and the layer of insulation interposed between the individual segments and the metallic fastening devices subsequently utilized to hold the segments and strips of insulation in their annular disposition, to be hereinafter more fully described.

Upon completion of the sand blasting operation, the annulus must be provided with a permanent fastening means for joining the individual copper segments and insulating strips to firmly hold the segments of the annulus in their compacted and true circular disposition, and to prevent displacement of the segments or insula-

tion upon removal of the work ring 18. To this end, a circular and tubular core 24, provided upon its outer surface with a layer 25 of insulating material, is introduced within the axial bore of the annulus. The core 24 may be provided at one of its ends, as shown in Fig. 8, with an integrally formed circular end ring 26 which in turn is formed with an inwardlly directed annular dovetailed projection 27 adapted for interfitting engagement with one of the dove-tailed grooves 23 formed in the end faces of the annulus. In this case, the opposite end of the core 24 receives a free end ring 28 formed similarly to the first end ring 26, and provided with an inwardly extending annular projection 29 which engages the dove-tailed groove 23 formed in the opposite end face of the annulus. After the core and its end rings have been positioned with respect to the annulus, the end of the core which receives the free end ring 28 is flared or flanged outwardly as at 30, by a suitable revolving head, not shown, to firmly and rigidly lock the end rings within the respective dove-tailed grooves of the annulus, and to prevent subsequent removal of the free end ring 28. It will be understood, that the entire outer surfaces of the core and the end rings are provided with layers of insulation in order to prevent contact with the copper segments. It will also be understood. that the end ring 26 need not be formed integral with the core 24 to accomplish the desired union of the individual segments, but may be freely positioned upon the core, as in the case of the free end ring 28, in which case, it would necessarily follow that both of the ends of the core would be flared to firmly lock the rings within the dovetailed grooves and prevent separation from the core. In view of the interfitting engagement of the annular projections 27 and 29 with the dovetailed grooves 23, it will be seen that a wedge-lock is provided for each of the copper segments and the intervening strips of insulation, whereby the latter are prevented from becoming displaced either laterally or radially during subsequent operations, and it will here be understood that the term displacement is intended to include any relative movement of the individual segments of the commutator of the order of one-thousandth of an inch or more, otherwise, such displacement would result in defective commutator action.

After flaring the end of the core 24 to effectively lock the individual segments of the annulus, the work ring 18 is removed from the annulus without fear of separation, and the annulus is now ready for installation upon the shaft of an electric motor or similar machine.

In view of the foregoing, it will be seen that the present invention provides efficient and time saving methods for constructing commutators which possess improved characteristics ambient to their operational functions. By the passage of the preassembled sheaf of commutator segment forming bars through the restricted forming tube, the individual bars and intervening strips of insulation are compacted or compressed into tightly fitting order, and by the placement of the continuous work ring around the annulus, the individual segments are firmly held in such a compacted state until the permanent locking core is installed. Further, in subjecting the machined surfaces of the annulus to the abrasive action of a sand blast, all burrs and microscopic particles of copper which have become imbedded within the insulation during or before machining operations are efficiently removed to insure proper and efficient dielectric function of the insulating strips, and to prevent gaping between the individual commutator segments.

I claim:

1. In the construction of commutators, those steps which comprise assembling a plurality of elongated segment-forming strips with intervening strips of insulation into tubular sheaf formation in an encircling holder, axially forcing the sheaf from the holder and continuously subjecting the sheaf while being forced from the holder to inwardly and radially applied forces to produce compaction and reduction in diameter thereof, successively applying a retaining ring around successive end portions of the sheaf after the diameters thereof have been thus reduced, and transversely cutting successive reduced end portions from the body of the sheaf following the insertion of each reduced end portion within a retaining ring to continuously and successively form a series of commutator annuli.

2. In the construction of commutators, those steps which comprise assembling a plurality of elongated segment-forming strips with intervening strips of insulation into sheaf formation in an encircling holder, the sheaf having an axial bore extending from one end to the other, extruding the sheaf through a circular restriction while forcing the sheaf from the holder to produce inward radial compaction and reduction in diameter of the sheaf, successively applying a retaining ring around successive end portions of the sheaf after the diameters thereof have been thus reduced, and transversely cutting successive reduced end portions from the body of the sheaf following the insertion of each reduced end portion within a retaining ring to continuously and successively form a series of commutator annuli.

3. In the construction of a commutator, those steps which comprise assembling a plurality of elongated segment-forming strips with intervening strips of insulation about a core element to form a tubular sheaf, retaining the strips against radial outward movement, forcing the segment-forming and insulating strips while held in place by the core element into a tube and then removing the core, ejecting the sheaf from the tube and continuously subjecting the sheaf while being ejected to inwardly and radially applied forces to produce compaction and reduction in diameter thereof, successively applying a retaining ring around successive end portions of the sheaf after the diameters thereof have been thus reduced, and transversely cutting successive reduced end portions from the body of the sheaf following the insertion of each reduced end portion within a retaining ring to continuously and successively form a series of commutator annuli.

PAUL W. NIPPERT.

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