July 14, 1953 P. A. MARSAL 2,645,733

COMMUTATOR

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Fig. 1.

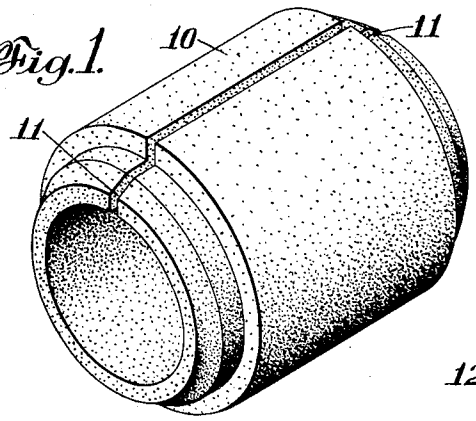


Fig. 2.

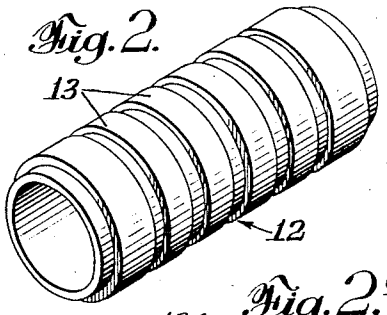


Fig. 2a

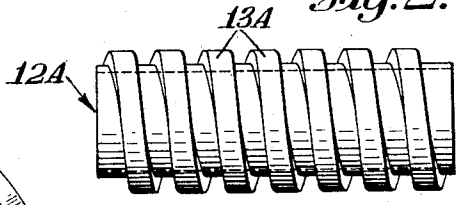


Fig. 3.

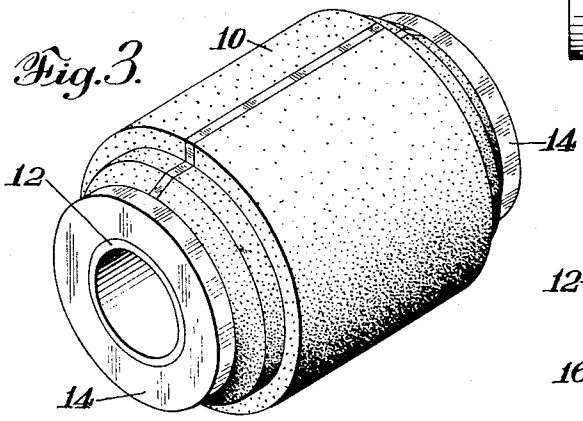


Fig. 5.

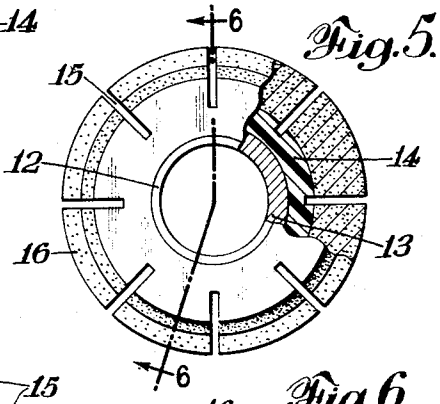


Fig. 4.

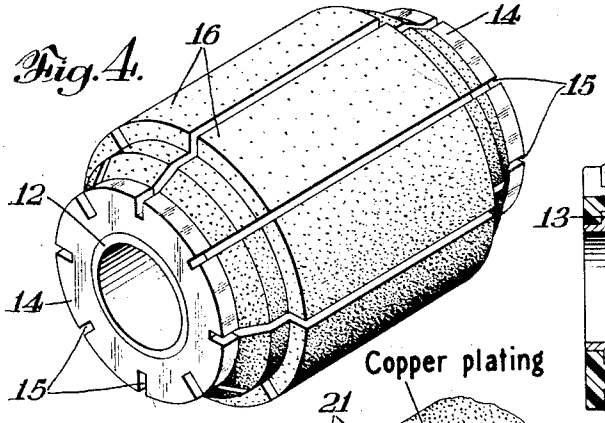


Fig. 6.

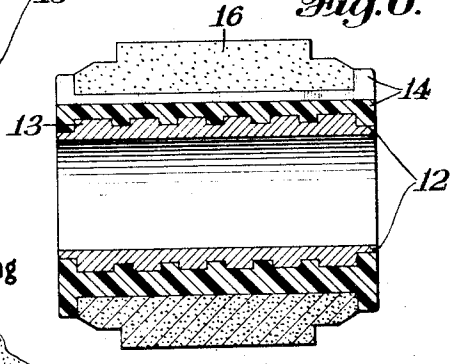
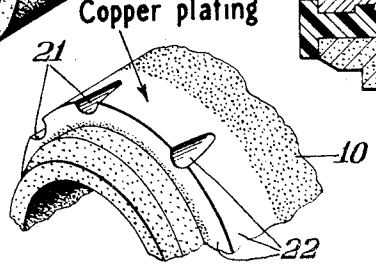


Fig. 7.



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Fig. 8.

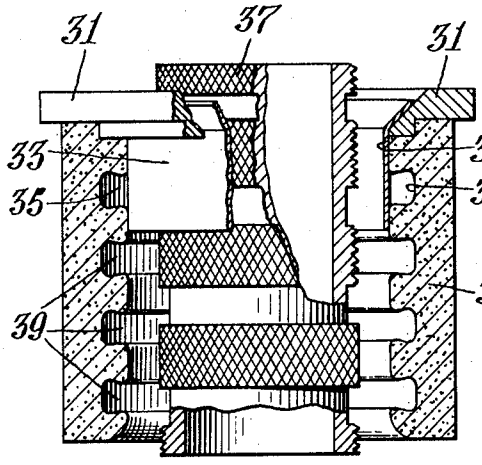
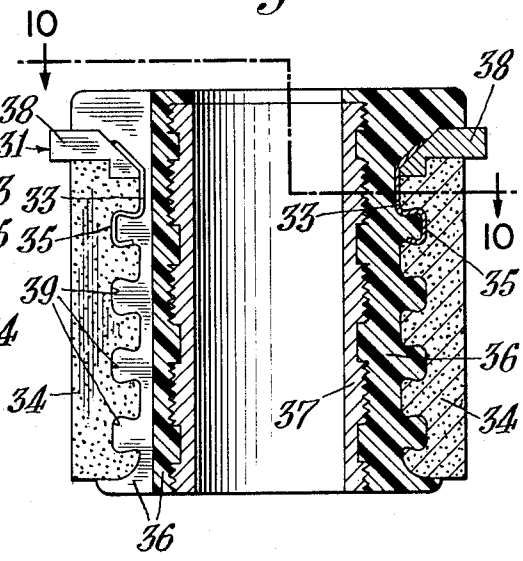


Fig. 9.



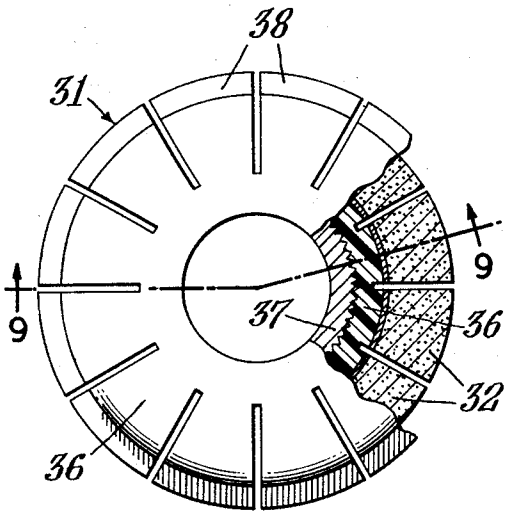


Fig. 10.

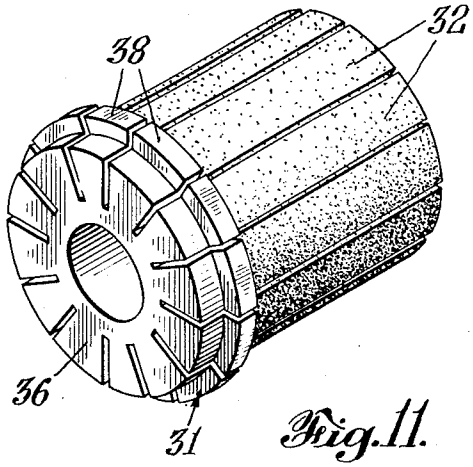


Fig. 11.

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UNITED STATES PATENT OFFICE

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COMMUTATOR

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Application October 23, 1950, Serial No. 191,533

5 Claims. (Cl. 310—235)

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This invention relates to improvements in the construction of commutators for electric motors and generators. More particularly, it relates to improvements in the construction of commutators for small, high-speed, electric motors wherein the commutator segments are rigidly positioned in a mass of molded insulating material.

Present commutators of this type employ a metal segment material. As good electrical conductivity is required of the segments, copper is most frequently used. However, metal segment materials do not form a sufficiently strong bond with the molded insulating material to withstand the forces exerted thereon under operating conditions which may include a commutator speed as high as 15,000 R. P. M. and a temperature as high as 200° C. For this reason, the segments, or the cylindrical body of segment material from which the segments are subsequently cut, are provided with inwardly projecting fins, ribs, or tongues which are of dove-tail or other mechanical keying configuration, and extended radially into the mass of molded insulating material in order to securely fasten the segments thereto.

While mechanical keying is reasonably effective in securing the commutator segments, it has several disadvantages. It requires machining the tongues or other mechanical locking device. This not only adds considerable expense to the construction cost, but constitutes a difficult operation where the machining must be done on the inner surface of a small cylindrical body of segment material against which the insulating mass is to be molded. This machining operation increases in difficulty as the commutator decreases in size or the number of segments increase. In addition, any machining must be done accurately because a poor segment weight distribution is very detrimental to commutator life at high speeds.

One object of this invention is to provide a commutator of the type described wherein no special mechanical configuration is necessary to secure the segments to the mass of insulating material, the segments being secured solely by the bond between the segment material and the insulating material.

An additional object is to provide a commutator which, while efficient and durable in use, is simple and economical to construct.

This invention is based on the discovery that when carbon is used as a segment material and a phenol-formaldehyde condensation resin is employed as an insulating material, the resin may be molded against the carbon by the application of heat and pressure to form a joint which is mechanically and thermally stable, even under high-speed commutator operating conditions, without any mechanical keying.

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In the drawings:

Fig. 1 is a perspective view of a cylindrical tube of carbon commutator segment material.

Figs. 2 and 2A are perspective views of two types of metal bushings suitable for use in the proposed commutator.

Fig. 3 is a perspective view of the cylindrical body of carbon commutator segment material with the metal bushing coaxially aligned therein and the interstice filled with a mass of molded, heat-hardened, insulating resin.

Fig. 4 is a perspective view of the assembly of Fig. 3 with the commutator segments cut therein.

Fig. 5 is an end view of the commutator shown in Fig. 4 with a portion thereof cut away.

Fig. 6 is a section on lines 6—6 of Fig. 5.

Fig. 7 is a view of one type of terminal which may be employed in soldering leads to the individual segments.

Fig. 8 is a view, parts being broken away, showing the parts of a modified commutator assembled in preparation for the introduction of the resin into the opening around the bushing.

Fig. 9 is a sectional view, taken along the line 9—9 shown in Fig. 10, of the modified commutator.

Fig. 10 is an end view, parts being broken away along the line 10—10 shown in Fig. 9, of the modified commutator.

Fig. 11 is a perspective view of the fully assembled modified commutator.

Referring to the drawings, a cylindrical carbon tube 10 of suitable diameter is cut to the desired length of the proposed commutator segments. Preferably, the carbon tube has one side longitudinally slit at 11 to enable it to be compressed slightly while inserting it into a mold in preparation for a subsequent molding operation. A metal bushing 12 or 12A is provided for insertion within the carbon tube 10 in coaxial alignment therewith. Flanges 13 or 13A or other suitable irregularities on the external surface of the bushings 12 and 12A serve to securely lock the bushing in the mass of insulating material which is subsequently molded thereabout.

With the bushing 12 coaxially aligned within the cylindrical carbon tube 10, the assembly is secured within a mold and the space between the bushing and carbon tube filled with insulating material 14. The insulating material employed in this invention is a heat-hardenable, phenol-formaldehyde condensation resin, which may be combined with the usual amount of fillers, such as asbestos, paper, carbon and the like, if desired, the amount and technique of employing fillers being well known in the resin molding art. The insulating mass 14 is subjected to sufficient heat and pressure to convert it to an infusible state. Preferably, the insulating material is preformed and heated to the smoking point by means of high frequency induction heating. The

preforms are then loaded into a hot transfer cylinder and forced into the mold by means of a hydraulic press. A satisfactory molding was obtained for a commutator 1⅝ inches in diameter and 1 inch long using the following procedure:

Insulating material	Asbestos-filled, phenol-formaldehyde molding compound (about 65% by weight asbestos)
Preform weight	78 grams
Mold temperature	380° F.
Transfer cylinder temperature	380°–400° F.
Plunger temperature	180° F.
Compression time	30 seconds
Curing time	2 minutes
Curing pressure	3500 pounds gauge on a 20 ton Elmes press

After removal from the mold, the unit is cut longitudinally to form the commutator segments 16, separated by the slots 15. If the carbon tube 10 was cut initially (11) to facilitate insertion in the mold, one slot 15 should be made to coincide with this cut. A carbon commutator thus made is very strong and the segments are securely fastened to the phenolic insulating material despite the absence of mechanical keying.

Since electrical leads can not be attached to the carbon segments readily, some provision must be made for fastening the leads thereto. One method is to cut notches 21 in one end of the cylindrical carbon tube 10 prior to assembling the commutator, one such notch being provided for each proposed segment lead. Each notch area is coated with molybdic acid which is allowed to dry and then fired in a reducing atmosphere at about 1200° C. for about one minute. The molybdic carbide formed is readily wet by a solder-wettable metal, preferably copper 22. This copper coated notch provides an excellent terminal for soldering leads.

In the modified commutator shown in Figs. 8, 9, 10, and 11, a metal flange 31, preferably of brass, is provided as a means for connecting the lead wires and the commutator segments 32. To secure good electrical contact between the flange 31 and the carbon segments 32, the flange 31 is attached to or made integral with a thin metal tube 33, preferably of brass, which fits snugly into the carbon tube 34. In the preferred embodiment of the invention, an annular groove 35 is cut in the inner surface of the carbon tube 34, and the metal tube 33 is extended along the carbon tube 34 covering, at least in part, the annular groove 35. The metal tube 33, being thin and of a malleable metal in the preferred embodiment, is made to conform to the annular groove 35 in the carbon tube 34 when the insulating, phenol-formaldehyde resin 36 is introduced under pressure into the interstices between the bushing 37 and the carbon tube 34 and metal tube 33. This serves to lock the metal tube 33 and flange 31 in place and insure good electrical contact between the flange 31 and carbon tube 34. When the commutator segments 32 are cut, as shown in Fig. 11, the cut portions or segments 38 of the flange 31 provide a surface which can be wet by solder and to which leads may be conveniently attached.

A joint of sufficient strength for most commutating conditions is obtained by hardening the phenol-formaldehyde resin, as described, against the relatively smooth inner surface of the carbon tube. If additional strength is required, annular grooves 39 may be provided in the carbon tube 34. These grooves increase the area of contact between the carbon tube and the resin, thus increasing the strength of the joint.

This application is in part a continuation of my co-pending application Serial No. 128,214, filed November 18, 1949, now abandoned.

I claim:

1. A method of manufacturing commutators which comprises coaxially aligning within a cylindrical tube of carbon a bushing, the outer diameter of said bushing being smaller than the inner diameter of the carbon tube, filling the interstice between the bushing and tube with a phenol-formaldehyde condensation resin and subjecting the same to heat and pressure until it becomes infusible, after said resin has been rendered infusible, radially slicing through the carbon tube in a longitudinal direction to form the commutator segments, positioning a substantially annular, solder-wettable conductor, prior to the step of slicing through said carbon tube, in electrical contact with one end of said tube and in fixed relationship with said tube, and, when the carbon tube is sliced, cutting said conductor into a number of segments each of which is in electrical contact with one and no more than one carbon commutator segment.

2. A method of manufacturing commutators which comprises coaxially aligning within a cylindrical tube of carbon a bushing, the outer diameter of said bushing being smaller than the inner diameter of the carbon tube, filling the interstice between the bushing and tube with a phenol-formaldehyde condensation resin and subjecting the same to heat and pressure until it becomes infusible, after said resin has been rendered infusible, radially slicing through the carbon tube in a longitudinal direction to form the commutator segments, coating one end of said carbon tube, prior to the step of slicing through said carbon tube, with a layer of molybdic carbide, superimposing on the molybic carbide a layer of solder-wettable metal, and, when the carbon tube is sliced, cutting said layers of molybdic carbide and metal into a number of segments each of which is in contact with one and no more than one carbon commutator segment.

3. A commutator comprising a bushing, an insulating core of a heat-hardened phenol-formaldehyde condensation resin, and carbon commutator segments, one end of said segments being disposed in electrical contact with a conductor capable of being wet by solder and adapted to receive electrical leads.

4. A commutator comprising a bushing, an insulating core of a heat-hardened phenol-formaldehyde condensation resin, and carbon commutator segments, at least a portion of one end of each commutator segment being coated with molybdic carbide on which a coating of solder-wettable metal is superimposed.

5. A commutator comprising a bushing, an insulating core of a heat-hardened, phenol-formaldehyde condensation resin, and carbon commutator segments, one end of said segments being held in electrical contact with metal segments by said insulating core, said metal segments presenting a suitable surface for the attachment of leads.

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