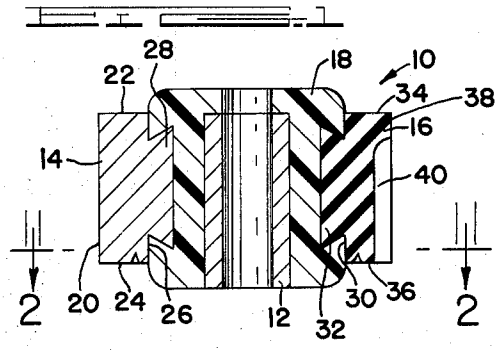
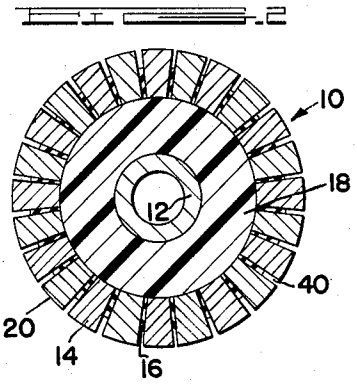
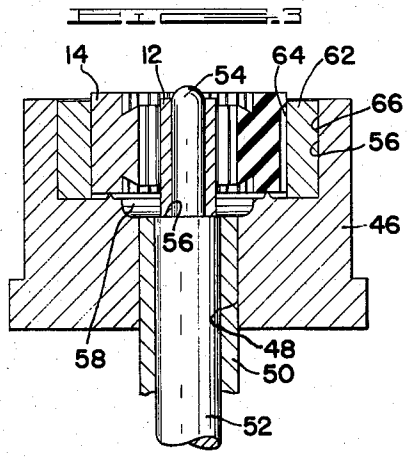
May 24, 1966 T. G. TAYLOR, JR 3,253,172

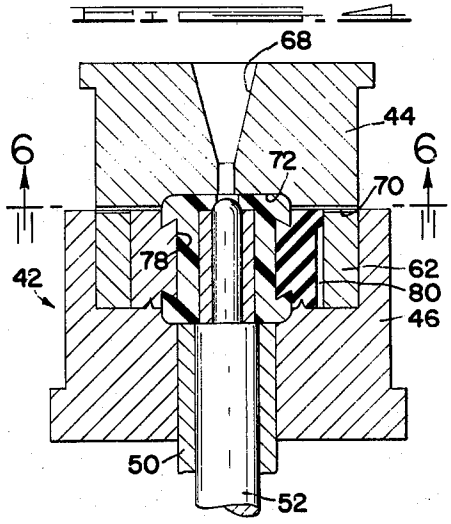
SUB-FLUSH COMMUTATOR

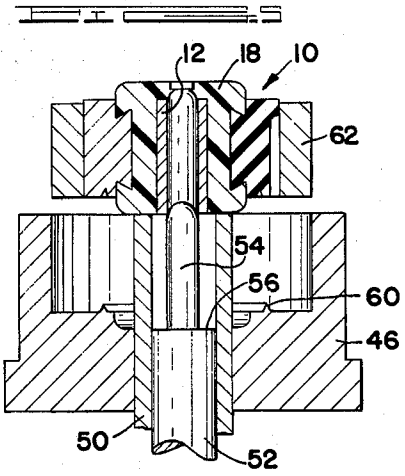
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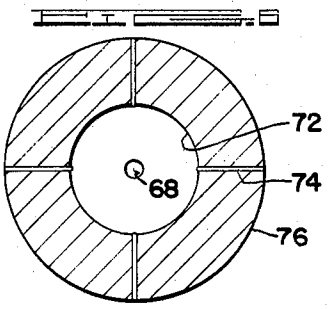












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SUB-FLUSH COMMUTATOR

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This invention relates generally to commutators and more particularly to an improved sub-flush commutator.

A commutator of the type to which this invention relates consists generally of an axial bushing, copper commutator segments which are arranged in a circular formation about the bushing, insulating members which are positioned between the copper segments, and an insulating core which is secured to and extends between the bushing and the commutator segments. In a sub-flush commutator, the insulating members are recessed, over at least major portions of their lengths, relative to the radially outer edges of the commutator segments so that the insulating members are below the surface of the commutator on which the commutator brushes ride. A sub-flush commutator is desirable in some instances because commutation is improved and a longer life of the commutator brushes is obtained. However, manufacture of sub-flush commutators has heretofore been difficult to economically carry out because of the difficulty of maintaining an air gap between the copper segments at the outer edges of the insulating members, and the previous solutions to this problem involving internally finned molds and removable steel shims has been expensive and cumbersome. It is an object of this invention, therefore, to provide an improved sub-flush commutator in which the insulating core is molded and in which air gaps are provided between adjacent pairs of copper segments over major portions of their lengths and insulation is provided between adjacent pairs of commutator segments at one of their ends so that the segments will not be moved into engagement when the armature wires are staked into the segments.

In the manufacture of the improved sub-flush commutator of this invention, the copper segments and the mica insulating members, which are recessed at their outer edges, are arranged in a circular formation about an inwardly spaced axial bushing so that the recessed outer edges of the mica members form air gaps between the copper segments. Each air gap extends from one end of each segment to a position spaced from but adjacent the opposite end of the segment. The space between the radially inner edges of the segments and insulating members and the bushing is then filled with a hardenable insulating material concurrently with squeezing the segments and members adjacent opposite ends of the air gaps so as to positively prevent flow of insulating material into the air gaps. This sealing off of the air gaps is obtained by providing a squeeze ring which squeezes the segments and insulating members adjacent one end of each air gap and a knife edge shutoff ring which is formed in the mold so as to be in sealing engagement with the segments and members adjacent the opposite ends of the air gaps. An improved molded sub-flush commutator is thus obtainable with the method and apparatus of this invention and each commutator is provided with unrestricted air gaps between adjacent pairs of copper segments.

Further objects, features and advantages of this invention will become apparent from a consideration of the following description, the appended claims, and the accompanying drawing in which:

FIGURE 1 is a transverse sectional view of the sub-flush commutator of this invention showing a copper segment on one side of the commutator and an insulating member on the opposite side of the commutator;

FIGURE 2 is a sectional view of the commutator of this invention looking substantially along the line 2—2 in FIG. 1;

FIGURE 3 is a vertical sectional view of the lower portion of the apparatus used in manufacturing the commutator of this invention, showing the commutator bushing, segments and insulating members as they are initially assembled in the apparatus;

FIGURE 4 is a vertical sectional view of the commutator manufacturing apparatus of this invention showing a completed commutator formed therein;

FIGURE 5 is a vertical sectional view of the commutator manufacturing apparatus of this invention, illustrated similarly to FIG. 4, showing the top half of the apparatus removed and with the completed commutator in a position ejected from the apparatus; and

FIGURE 6 is a sectional view of a portion of the commutator manufacturing apparatus of this invention, looking substantially along the line 6—6 in FIG. 4.

With reference to the drawing, the commutator of this invention, indicated generally at **10**, is shown in FIGS. 1 and 2 as including an axial bushing **12**, which may be formed of brass or other suitable metal, commutator segments **14**, which are usually formed of copper, insulating segments or members **16** which are formed of mica or other suitable non-conducting material and are positioned between the commutator segments **14** so as to insulate the segments **14** from each other, and a molded core **18** of a hardenable plastic material, such as a phenolic or equivalent plastic material. Each of the commutator segments **14** is of a generally trapezoidal shape in cross section, as shown in FIG. 2, and has an outer edge surface **20** which is substantially parallel to the bushing **12**. Each segment **14** is also shaped so that it has a pair of ends **22** and **24**, which are hereinafter referred to as the upper and lower ends merely for convenience of description, and a radially inner edge **26** which is provided with a substantially dovetail projection **28**. Each of the insulating members **16** is of a generally flat form, and, in longitudinal section, is of generally the same size and shape as a commutator segment **14**, as shown in FIG. 1. Each insulating member **16** has a radially inner side **30** which is provided with a substantially dovetail shape projection **32** and opposite ends **34** and **36** which are likewise referred to hereinafter as the upper and lower ends, respectively, for convenience of description.

Adjacent its upper end **34**, each commutator insulating member **16** is of a width corresponding substantially to the width of a commutator segment **14** so that it has an outer edge **38** which is spaced substantially the same distance from the projection **32** as the edge **20** is spaced from the projection **28** on a segment **14**. Between the edge **38** and the lower end **36**, the insulating member **16** is formed with a longitudinally extending recess or cut-out **40** which extends over a major portion of the length of the member **16**. The recess **40** extends the full thickness of each insulating member **16** and extends through the end **36** thereof but is spaced from the end **34** for a purpose to appear presently.

The insulating core **18** has the dovetail projections **28** and **32** embedded therein so that the projections **28** and **32** are spaced radially outwardly of the bushing **12** so that they are insulated from the bushing **12**. The core **18** is also formed so that it is of a length to extend axially beyond the ends of the segments **14** and the members **16** to thereby additionally strengthen the support of the segments **14** and members **16** on the bushing **12**.

The apparatus for manufacturing the commutator **10**, indicated generally at **42**, is shown in FIGS. 3 to 6, inclusive, as including upper and lower mold members **44** and **46**, respectively. The lower mold member **46** has an opening **48** extended substantially axially therethrough

and a tubular ejector sleeve **50** is slidably positioned therein. A stationary core pin **52** is positioned in the sleeve **50** and is formed at its upper end with a reduced diameter portion **54** and a horizontal shoulder **56***a* at the lower end of the reduced portion **54**. The lower mold member **46** is formed with an upwardly opening cylindrical cavity **56** which surrounds the pin portion **54**, and the lower end of the cavity **56** communicates with a recess **58** which is of a reduced diameter and is of a shape corresponding to the shape of one end of the insulating core **18**. Radially outwardly of the recess **58**, the lower mold member **46** is formed with an upwardly projecting shutoff ring **60**, which is in the form of a knife edge projection. A steel squeeze ring **62**, which is of a predetermined length and diameter, and has an inner surface **64** which is of a diameter corresponding precisely to the desired diameter of the commutator **10**, is positioned in the cavity **56** so that it engages the cavity wall **66** and is positioned radially outwardly of the shutoff ring **60**.

The top mold member **44** has an axial passage **68** formed therein and in its lower end **70** is formed with a recess **72**, which is of the shape desired for one end of the commutator core **18** and communicates with the passage **68**. Radially extending vent passages **74** extend between the recess **72** and the outer edge **76** of the upper mold member **44**. The passages **74** are illustrated as being four in number, but it is to be understood that the number of passages **74** is dependent upon the viscosity of the material from which the core **18** is molded and may be more or less than four.

In the use of the apparatus **42** to form the commutator **10**, the bushing **12** is initially positioned about the pin portion **54** so that it is supported on the shoulder **56***a* which is located at the lower end of the recess **58** (FIG. 3). The squeeze ring **62** is positioned in the lower mold cavity **56** and the segments **14** and members **16** are arranged in an alternating relation and in a circular formation or assembly, as shown in FIG. 2, within the squeeze ring **62**. By virtue of the trapezoidal shape of the segments **14**, the circular formation of a predetermined diameter corresponding to the inner diameter of the squeeze ring **62** is readily obtained, without any tendency of the segments **14** and the members **16** to move radially inwardly of the squeeze ring **62**. The engagement of the outer edges **20** and **38** of the segments **14** and members **16**, respectively, with the inner surface **64** of the squeeze ring **62** prevents movement of the segments **14** and members **16** radially outwardly of the desired positions.

The segments **14** and members **16** are initially supported on the shutoff ring **60**, as shown in FIG. 3, so that they project substantially above the squeeze ring **62**. The upper mold member **44** is then moved downwardly so that its lower end **70** engages the upper ends **22** and **34**, respectively, of the segments **14** and members **16**. Pressure is applied to the upper mold member **44** so as to force the segments **14** and members **16** downwardly on the knife edge shutoff ring **60** so that the shutoff ring **60** bites into the lower ends **24** and **36**, respectively, of the segments **14** and members **16**, as shown in FIG. 4. The length of the squeeze ring **62** is slightly less than the length of the segments **14** and members **16** so that the squeeze ring **62** does not interfere with the continued application of pressure to the segments **14** and members **16** by the upper mold member **44**, as shown in FIG. 4.

With the parts of the apparatus **42** and the parts of the commutator **10** positioned as shown in FIG. 4, the insulating material of which the core **18** is to be formed is injected through the passage **68** into the irregularly shaped cavity **78** formed by the mold recesses **58** and **72** and the space between the segments **14** and **16** and the bushing **12**. As shown in FIG. 4, by virtue of the recess **40** formed in the insulating members **16**, an air gap or space **80** is formed between each adjacent pair of commutator segments **14**. The space **80** extends over the major portion of the length of each insulating member **16** between the lower end **36** thereof and a position spaced from and adjacent the upper end **34** thereof.

The projection of the knife edge shutoff ring **60** into the lower ends of the segments **14** and members **16** provides an effective seal to positively prevent any flow of the insulating material from the cavity **78** into the lower ends of the air gaps **80**. The upper ends of the air gaps **80** are effectively sealed from the cavity **78** by the tight engagement of the outer edges **20** and **38** of the segments **14** and the members **16** with the inner surface **64** of the squeeze ring **62**. The pressure of the insulating material in the cavity **78** additionally effects a tight engagement of the edges **20** and **38** with the inner surface of the squeeze ring **62**. The vent passages **74** provide for a radially outward flow of any insulating material which might otherwise tend to enter the upper ends of the air gaps **80** since the insulating material will tend to follow the path of least resistance and it is easier for the insulating material to flow through the vent passages **74** than it is for it to flow into the air gaps **80** between the edges **20** and **38** and the squeeze ring surface **64**.

Following hardening of the insulating material in the cavity **78**, so as to form the core **18**, the completed commutator is removed from the apparatus **42** by first removing the upper mold member **44**. The ejector sleeve **50** is then moved upwardly relative to the stationary pin **52** so as to move the commutator **10** with the squeeze ring **62** thereon out of the lower mold **46**. After final hardening and any heat treating operations which may be desirable, the squeeze ring **62** is removed from the commutator **10**.

From the above description it is seen that this invention provides a mica molded commutator in which an air gap **80** is provided between each pair of adjacent commutator segments **14**. The configuration of the insulating members **16** so that they project outwardly, adjacent the ends **22** of the segments **14**, distances sufficient to position their outer edges **38** such that they are flush with the outer edges **20** of the segments **14** is advantageous because the insulating members **16** then prevent the segments from being deformed into engagement when the armature wires are staked into the segments **14** adjacent their ends **22**. By virtue of the provision of the squeeze ring **62** and the shutoff ring **60** the air gaps **80**, which are desirable in a sub-flush commutator, are maintained free of restrictions during manufacture of the commutator **10**. The cavity **78** is shaped so that the core **18** extends axially outwardly beyond the ends of the segments **14** to thereby provide increased support for the segments **14** on the bushing **12** to prevent accidental separation of the segments **14** from the bushing **12**.

It will be understood that the sub-flush commutator which is herein disclosed and described is presented for purposes of explanation and illustration and is not intended to indicate limits of the invention, the scope of which is defined by the following claims.

What is claimed is:

1. In a commutator having an axis, a plurality of spaced commutator segments arranged in a circular formation about said axis and spaced radially outwardly from said axis, each of said segments being shaped so that it has an inner edge and an outer edge which is substantially parallel to said axis, a projection on said inner edge, a plurality of insulating members disposed between said commutator segments, each of said insulating members being shaped so that it has an inner edge and an outer edge which over a minor portion of its length adjacent one end of the member is substantially flush with the outer edges of the segments on opposite sides thereof and over the remainder and major portion of its length is recessed relative to said portion, a projection on the inner edge of each of said insulating members, and a one-piece generally tubular shape core having said projections embedded therein for retaining said segments and members in predetermined fixed positions relative to said axis, said core being formed of a moldable insulating material.

2. The invention according to claim 1 in which said segments and insulating members are formed with an annular knife edge groove at the end of said commutator remote from the end at which said insulating members are substantially flush with the outer edges of said segments, said groove being continuous and substantially concentric with said axis.

3. The invention according to claim 1 further including an axial bushing secured to and positioned concentrically within said core, said core extending axially outwardly of said bushing at the end of said core corresponding to the ends of said insulating members which are substantially flush with the outer edges of said segments.

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