July 22, 1952 N. FELICI 2,604,502

COMMUTATOR

Filed April 6, 1950

Fig. 1

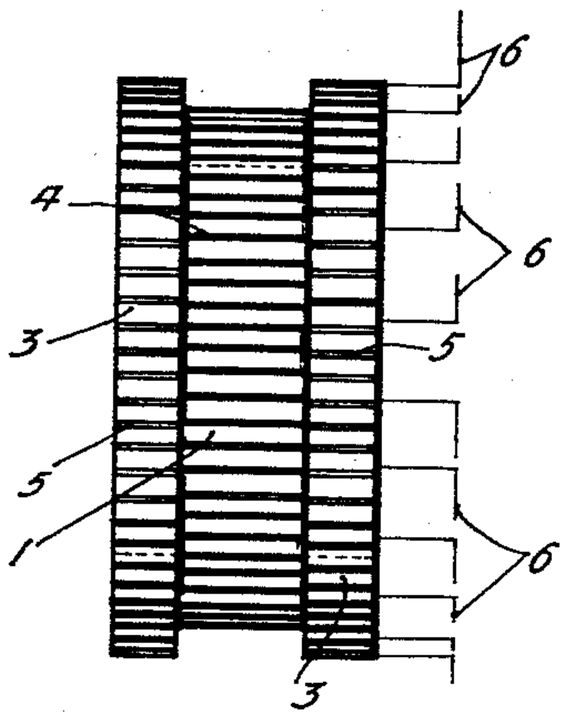


Fig. 2

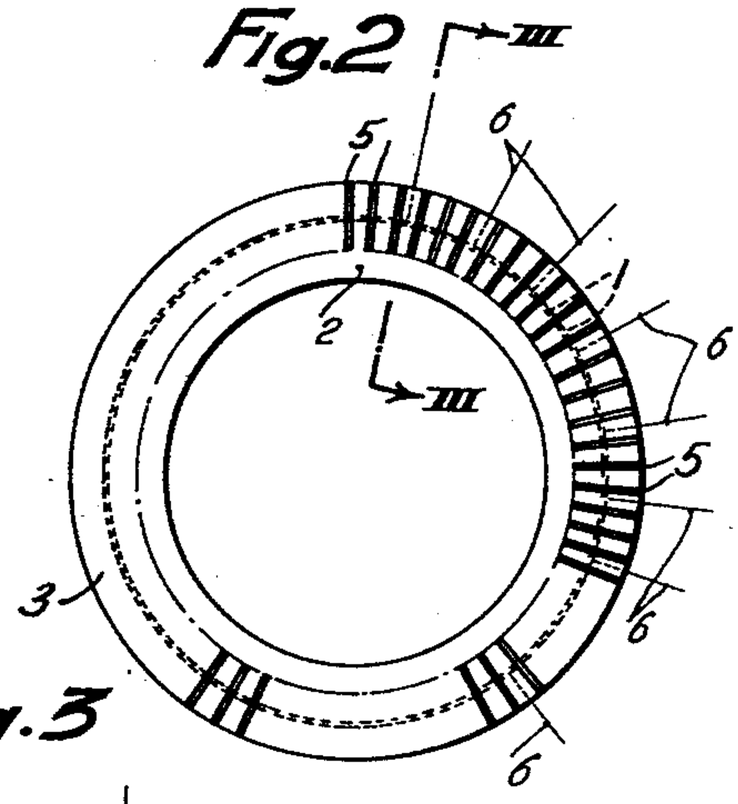


Fig. 3

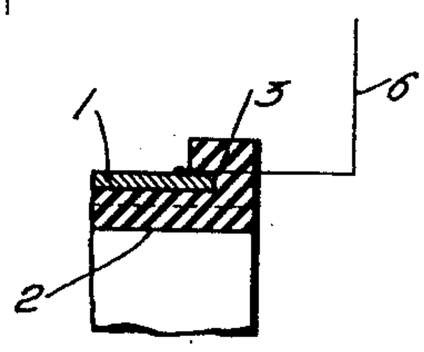
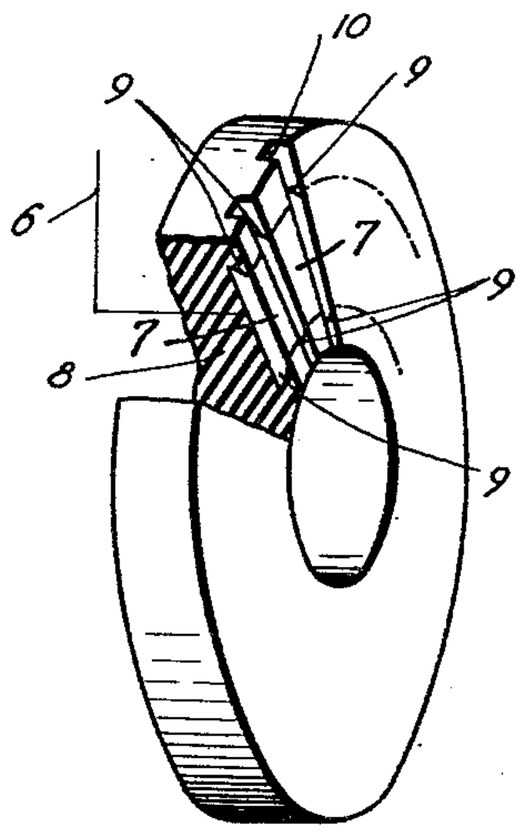


Fig. 5

Fig. 4



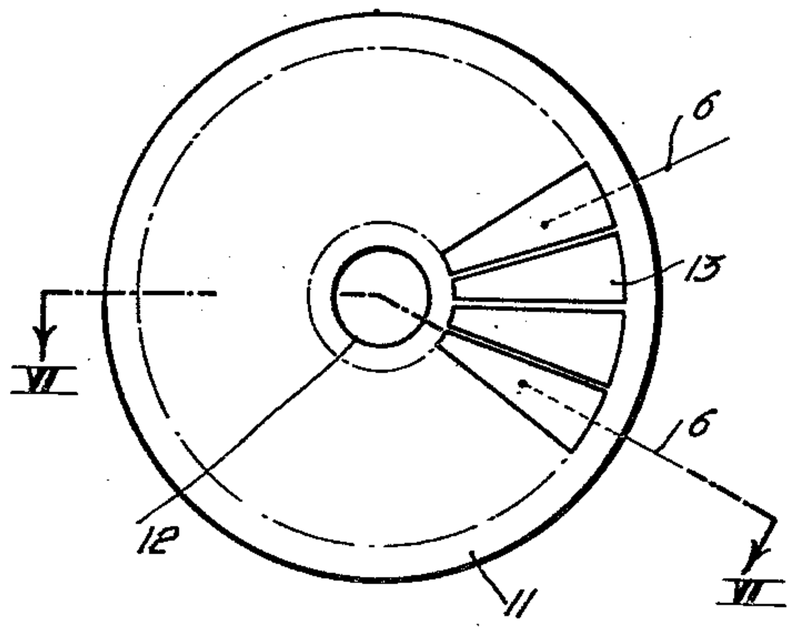
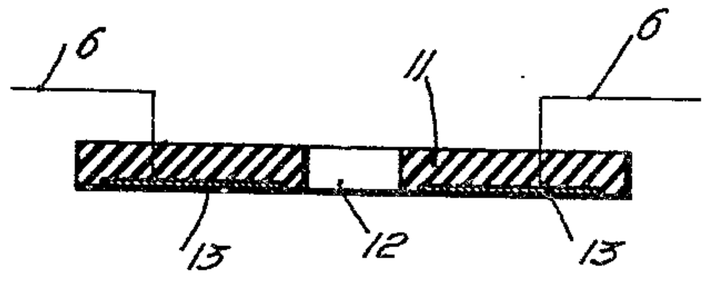


Fig. 6



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COMMUTATOR

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9 Claims. (Cl. 171—321)

1

The present invention relates to commutators or similar devices for electrical machines. The invention especially relates to a commutating device of the type which provides for periodically or intermittently electrically connecting, as by means of brushes cooperating with the commutator, a fixed electrical conductive part of the machine to a conductive part moving during operation of the machine. The device of the invention is particularly adapted for effecting commutation or change of the connection between two such moving conductive parts and a fixed part when the potential difference between the two moving parts is high, such as may occur in an electrostatic machine.

It is well known that the potential at which breakdown or sparking occurs in a given dielectric medium varies considerably according to the distribution of the electric field in the dielectric medium. Some gases, for example air, can withstand an extremely strong electric field without breaking down when the field is distributed properly in a confined space. In conventional commutating devices ordinarily the requisite or desirable distribution of the field is not readily secured because of the necessary form of the conductive parts to suit the mechanical construction.

The dielectric strength of a given dielectric medium, that is the potential difference per unit of the space between the electrodes across which the potential difference is developed, other things being equal, is much higher if the dielectric medium is maintained between two electrodes or similar conductive parts which define therebetween a narrow space than if the space is relatively wide. While the potential difference necessary to produce a spark across the narrow space, of course, is less than that to produce a spark across a wide space in the same dielectric medium, it may be shown that the summation of the potential differences necessary to produce breakdown or spark between consecutively arranged electrodes separated by narrow spaces is greater than the potential difference necessary to produce breakdown or spark across the space equal to the summation of the narrow spaces between the electrodes.

The commutator or similar device of the present invention takes advantage of these phenomena and is characterized by the fact that primary bars are provided therein which may be connected, for example, to movable conductive electrical parts of the machine and which are adapted to make contact in succession with a collecting brush or similar member connectible to a fixed conductive part, e. g. a terminal, these primary bars being separated by additional or auxiliary bars which are insulated from each other and from the primary bars. The spaces between adjacent bars in the series or succession of bars spaced in the direction of movement thereof are occupied by suitable dielectric material which may be a dielectric fluid such as air. As only every other bar or every third bar or bars otherwise spaced in the series are connected as primary bars to the electrical parts of the machine which may be at substantially different potentials, the dielectric gaps or spaces are multiplied and at the same time may be of such reduced width that their summation is less than the single gap or space directly between the primary bars required to prevent breakdown of the dielectric material under a given potential difference between the primary bars. The available dielectric strength and resistance to sparking between adjacent bars is greatly increased for the reasons stated above and commutation upon changing of contact of a brush from one primary bar to another primary bar is greatly improved.

2

The construction of the machine is simplified since the conductive parts between which a high potential must be maintained or is developed are not in such close proximity to each other that sparking therebetween may readily occur and these parts need not be formed with pronounced rounding but may be more or less sharp edged, thus being more easily manufactured. The additional or auxiliary bars may be given the same width as the primary bars or they may have a different width to suit different conditions.

The following description presents by way of example and by reference to the drawings three embodiments of the commutator of the invention intended for a high voltage machine.

Fig. 1 shows a view in elevation of one embodiment of a commutator construction according to the invention;

Fig. 2 shows an end view from the right in Fig. 1;

Fig. 3 shows a fragmentary sectional view taken along line 3—3 looking toward the right in Fig. 2;

Fig. 4 is a perspective view of another embodiment of the invention;

Fig. 5 shows a view in elevation of a third embodiment of the invention;

Fig. 6 is a sectional view taken on line 6—6 of Fig. 5.

As carried out according to the embodiments of Figs. 1 to 3 inclusive the commutator comprises metal bars 1 which are carried on the outer circumferential surface of a ring 2 of plastic material and are maintained in place by two flanges 3 formed at the ends of the ring integrally therewith. As shown in Fig. 3 the material of the flanges extends over upon the ends of the bars to hold these bars against movement endwise thereof as well as in spaced relation circumferentially with respect to each other. The bars 1 thus mounted circumferentially about the ring 2 are separated from each other by air gaps 4.

Every third bar in the embodiments of Figs. 1, 2 and 3 has connected thereto a conductor 6 which may extend through the portions of the flanges which overlie the bars 1 or may extend through slits formed in the flange which are in alignment with the air gaps between the bars 1. In either case between two bars 1 connected to conductors 6 the two auxiliary bars are not provided with conductors and are always insulated from each other and from the primary bars.

The commutator as shown in Figs. 1 to 3 inclusive may be manufactured in a very simple manner by mounting a metallic sleeve upon the ring 2 during the mauufacturing operation. This may be accomplished, for example, by a molding operation in which the plastic or other insulating material of the ring 2 is molded internally of the metallic sleeve and the flanges 3 also are formed extending over the edges of the metallic sleeve to hold this sleeve in place. This assembled ring and sleeve then may be machined to cut slots 5 longitudinally parallel to the axis of the ring and in spaced relation circumferentially about the axis. The depth of the cuts forming these slots is such that in the central part of the ring between the flanges thereof the metal of the sleeve is cut through to separate the sleeve into a plurality of bars insulated from each other by the material of the ring and with air gaps between the adjacent edges of consecutive bars. It will be apparent that although the material of the flange also is cut through in such a machining operation, nevertheless the remaining portions of the flanges 3 extend over the ends of the bars thus produced to hold these bars in place as above stated.

The commutator shown in Fig. 4 comprises conducting members 7 carried on one of the faces transverse to the axis of a ring 8 of insulating material. These members 7 are regularly spaced with respect to each other about the axis of the ring. As will be seen in Fig. 4 the members 7 are of dovetail form, that is with beveled end edges, and are set into the material of the ring 8 with the longer face of the member 7 inset so that the material of the ring 8 overlies the bevels 9 to insure secure fastening of the members 7 in the ring. The overlying portions of the ring 8 in this embodiment are disposed adjacent the outer and inner circumferences of the ring 8. The radial extent of these portions may be sufficient to provide mechanical holds for the bars 7 against movement radially as well as circumferentially about the axis of the ring 8.

Every third member 7 in this embodiment also has connected thereto a conductor 6 adapted to be electrically connected to an electrical part of the machine, such as a movable conducting conveyor in the case of an electrostatic machine or

to an armature coil in the case of an electromagnetic machine, while the other two members 7 are insulated from the connected member and from each other by the material of the ring 8. As shown in Fig. 4 the conductors 6 may extend from the inset face of the bar 7 generally parallel to the axis of the ring 8 through the material of this ring to the opposite face of the ring from that at which the bars are inset. In order suitably to provide for connection to the electrical part, conveyor or armature coil the conductors 6 may be bent at an angle as shown in Fig. 4 or may be otherwise suitably carried to the electrical part.

The commutator shown in Fig. 4 may be manufactured, for example, by a molding operation, by inserting a metallic annular member in a lateral face of the ring 8 transversely of the axis thereof in such a way that the surface of the annular member is flush with this transverse face of the ring and is exposed at this face. As the metallic annular member is formed with oppositely beveled edges at the outer and inner edges of the annulus, the material of the ring 8 may be molded about and extend over upon these beveled edges to hold the annular member in the ring 8.

The assembled ring and annular member then may be machined by cutting radial slots 10 in spaced relation about the axis of the ring and to such a depth from the transverse face of the annular member that the thickness of the annular member is cut through, thus to separate the annular ring into a plurality of the members 7 in spaced relation about the axis of the ring. These conducting members or bars 7 become insulated from each other by the material of the ring as well as by the air gaps therebetween while being held in place in the ring 8 by virtue of the material of the ring overlying the beveled edges of the respective members or bars 7.

The commutator shown in Figs. 5 and 6 comprises a solid circular insulating disc 11 except for an aperture 12 which may serve for mounting the disc on a rotatable shaft. On one of the faces of the disc transverse to the axis thereof and fastened by suitable means, metallic bars 13 of generally trapezoidal form are mounted in spaced relation to each other. The bars 13 may be mounted on the face of the disc 11 so as to provide air spaces between adjacent bars or these bars may be embedded in the insulating material of the disc with their faces flush with the face of the disc as shown in Fig. 6. In either case each bar is continuously insulated from the others.

Every third bar in this embodiment also has electrically connected thereto a conductor 6 adapted for connection to an electrical part of the machine while the two other bars are without such conductive connections. As shown in Fig. 6 the conductor 6 may extend from the back side of the bars 13 through the material of the insulating disc 11 and may be bent radially outwardly as shown in Figs. 5 and 6 or otherwise adapted for connection to the electrical parts of the machine.

It will be understood that the particular distribution and arrangement of the bars above described may be modified within the scope of the invention. For example, a commutator according to the invention may provide two primary bars adapted for electrical connection to an electrical part or parts of the machine, these primary bars being separated by a single auxiliary

bar insulated therefrom and without such connection. If desired, however, more than two such auxiliary bars may be provided between the primary bars which are connected to the electrical part or parts in order to suit a different condition.

Other types of mounting than those illustrated in the drawings may be adopted without departing from the invention while providing a plurality of conductive members or bars arranged in spaced relation one after the other and adapted for making electrical connection in succession to a conductive member such as a brush, certain of these bars as primary bars being connected or adapted to be connected to electrical parts of the machine between which substantial differences of potential may be maintained or developed and being separated by one or more auxiliary unconnected and insulated bars in spaced relation in such number that the potential difference therebetween is substantially less than the difference of potential between the primary bars connected to the electrical parts, this spacing, however, being sufficient to prevent electrical discharge between the interposed auxiliary bars themselves or between these bars and the primary bars. By such arrangement the potential difference which must be provided for upon commutation in the passing of the brush over the commutator bars is greatly reduced as compared with the condition that obtains if the commutation is effected by the brush directly making contact with the two primary bars which are connected to the electrical parts between which the potential difference is maintained or developed. All such modifications which embody these features of the invention are intended to be within the scope thereof and of the appended claims.

I claim:

1. A commutator or the like for an electrical machine which comprises a plurality of conductive members supported in insulated relation to each other and in spaced relation to each other in succession in the direction of said spacing, selected members being adapted to be respectively electrically connected to electrically conductive parts of the machine between which a substantial difference of potential may be maintained or developed, said selected members being spaced from each other by at least one other of said members therebetween in said succession maintained in said insulated relation, the summation of the several spaces between said members in said succession from one selected member to the next being less than the space directly between said selected members required for a given potential difference to prevent breakdown of the dielectric material providing said insulated relation.

2. A commutator or the like for an electrical machine which comprises a supporting member of insulating material, conductive members supported by said supporting member in individually insulated relation to each other and in circumferentially spaced relation to each other in succession about an axis, conductive elements supported by said supporting member and respectively electrically connected to selected conductive members for connecting said selected members to electrically conductive parts of the machine between which substantial differences of potential may be maintained or developed when said commutator is associated with said machine, said selected conductive members being spaced from each other by at least one other

of said conductive members therebetween in said succession maintained in said individually insulated relation to said selected conductive members and to said electrically conductive parts, the summation of the several spaces between said members in said succession from one selected member to the next being less than the space directly between said selected members required for a given potential difference to prevent breakdown of the dielectric material providing said insulated relation.

3. A commutator or the like for an electrical machine which comprises a supporting member of insulating material in the form of a cylinder having outwardly extending flanges adjacent the ends thereof, conductive members supported by said supporting member upon the circumference of said cylinder in circumferentially spaced individually insulated relation to each other in succession about the axis of the cylinder and arranged with an extent thereof parallel to the axis of the cylinder, said flanges being formed to engage the opposite ends of said conductive members to hold said members in place upon said supporting member, and conductive elements supported by said supporting member and respectively electrically connected to selected conductive members for connecting said selected members to electrically conductive parts of the machine between which substantial differences of potential may be maintained or developed when said commutator is associated with said machine, said selected conductive members being spaced from each other by at least one other of said conductive members therebetween in said succession maintained in said individually insulated relation to said selected conductive members and to said electrically conductive parts, the summation of the several spaces between said members in said succession from one selected member to the next being less than the space directly between said selected members required for a given potential difference to prevent breakdown of the dielectric material providing said insulated relation.

4. A commutator or the like for an electrical machine as defined in claim 3 in which said supporting member is formed of a molded material, said ends of said conductive members respectively being embedded in said flanges.

5. A commutator or the like for an electrical machine as defined in claim 3 in which said flanges are formed with slots extending parallel to said axis and respectively in alignment with the spaces between adjacent conductive members.

6. A commutator or the like for an electrical machine as defined in claim 2 in which a said supporting member of insulating material provides a face transverse to said axis, said conductive members being supported by said supporting member adjacent said face in insulated relation to each other and in circumferentially spaced relation to each other in succession about said axis, said conductive members having an extent thereof generally radially with respect to said axis exposed upon said face, said supporting member providing portions thereof which extend over upon the radially spaced ends of said conductive members to hold said conductive members in position upon said supporting member, said portions being separated by slots which respectively are in alignment with the radially

extending spaces between said conductive members.

7. A commutator or the like for an electrical machine which comprises a supporting member of insulating material having a face transverse to an axis of rotation extending therethrough, conductive members supported by said supporting member adjacent said face in individually insulated relation to each other and in circumferentially spaced relation to each other in succession about said axis, said conductive members having an extent thereof generally radially with respect to said axis exposed upon said face, said supporting member providing portions thereof which extend over upon the radially spaced ends of said conductive members to hold said conductive members in position adjacent said face of said supporting member, and conductive elements supported by said supporting member and respectively electrically connected to said selected conductive members for connecting said selected members to electrically conductive parts of the machine between which substantial differences of potential may be maintained or developed when said commutator is associated with said machine, said selected conductive members being spaced from each other by at least one other of said conductive members therebetween in said succession maintained in said individually insulated relation to said selected conductive members and to said electrically conductive parts, the summation of the several spaces between said members in said succession from one selected member to the next being less than the space directly between said selected members required for a given potential difference to prevent breakdown of the dielectric material providing said insulated relation.

8. A commutator or the like for an electrical machine as defined in claim 2 in which said conductive members extend generally parallel

to each other in a predetermined relation to said axis, said supporting member providing portions thereof extending over said conductive members outwardly thereof at respective opposite ends thereof to hold said members in place upon said supporting member and to leave a face of said conductive members exposed upon said supporting member, said portions of said supporting member being separated by slots extending respectively in alignment with the spaces between adjacent conductive members in said succession.

9. A commutator or the like as defined in claim 8 in which said slots are continuous in the portions of the supporting member generally underlying said conductive members to provide a depth of said slots transversely of the exposed faces of said conductive members greater than the depth of said conductive members transversely of said faces.

NOËL FELICI.

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