

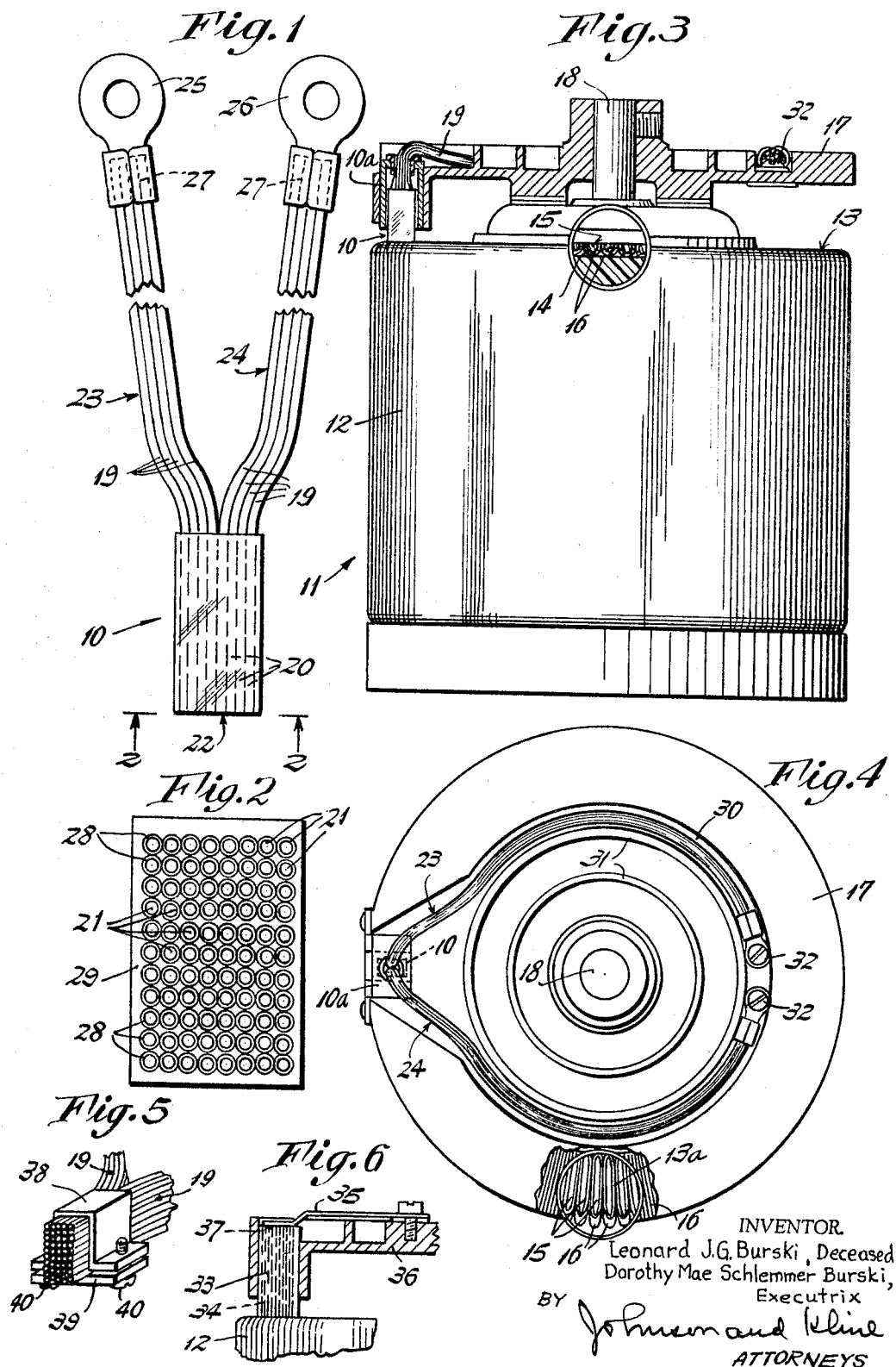
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COMMUTATING BRUSH

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3,270,306

COMMUTATING BRUSH

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The present invention relates to a commutating brush that maintains a slidable, electrical contact with a commutator surface and more particularly to such a brush that is advantageously employed in an adjustable voltage autotransformer having a commutator surface formed of separate portions with a voltage potential existing between each portion.

One common design of an adjustable voltage autotransformer that is generally commercially available includes a toroidal winding wound on an annular iron core with a portion of each turn of the winding being bared to form a commutator surface. A commutating brush is slidable on the surface and is in electrical engagement therewith so that movement of the brush along the surface provides for adjusting the output voltage of the autotransformer. Such an autotransformer is disclosed in the Karplus et al. Patent No. 2,009,013 and in said patent there is set forth the requirement that there be a resistance interposed in the output circuit of the autotransformer that while being a hindrance to the output current, is necessary in order to limit the short-circuit current that occurs when the brush is spanning the commutating portion of adjacent turns of the winding as the potential between the turns causes the short-circuit current to pass from one turn through the brush to the other turn. The resistance as taught in the above-noted patent and in commercially available autotransformers, should be a contact resistance that exists between a graphitic brush and the commutator surface but while limiting the short-circuit current the contact resistance also has the output current flowing there-through and thus is produces heat at the contact between the brush and commutator surface. As the heat is very localized and difficult to dissipate, it substantially causes the temperature of the brush and commutator surface contacted by the brush to achieve such a value that the temperature places a limitation on the power handling capability of the autotransformer as a maximum temperature should not be exceeded at the brush and commutator surfaces irrespective of the ability of the autotransformer without such brush heating to have a higher power handling capability.

It is accordingly an object of the present invention to provide a commutating brush that limits short-circuit current without undue hindrance to an output current but which substantially minimizes the localized heat produced at the contacting surfaces of the brush and the commutator surface and thus the temperature thereat.

Another object of the present invention is to provide a commutating brush of the above type which while having the necessary resistance to limit short-circuit current, broadly spreads the heat developed by the resistance so that it may be easily dissipated.

A further object of the present invention is to provide a commutating brush that is simple in construction, reliable in use and relatively durable.

A feature of the present invention resides in forming a commutating brush from a plurality of individual electrical conducting wires, each wire being formed of metal and having a relatively small diameter. A terminal portion of each of the wires is held in parallel alignment and the end surface of each wire is made to provide a substantially planar contact surface. The brush, in use, has its planar end surface slidable on and in electrical

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engagement with the commutator surface and as the wires and the commutator surface are of conducting metal, the contact resistance therebetween is substantially minimized. However, in order to insert the required short-circuit resistance in the turns of the winding that are spanned by the brush, the metal of the wires is selected to have a specific resistance which is sufficient, depending upon their length, to provide the required resistance. Accordingly, the heat produced by the resistance is spread throughout the length of the wires.

In order to prevent conduction between the wires, the present invention provides for electrically insulating each wire from the other except at their other end, the planar surface being the first end where there is a common connection, by employing wires having an insulating covering. Thus output current flows throughout the length of each wire while short-circuit is forced to flow twice the length of each wire, thereby in effect doubling the resistance of the brush to short-circuit current as compared to its resistance to the output current.

Other features and advantages will hereinafter appear. In the drawing:

FIGURE 1 is a plan view of a brush construction according to the present invention with the wires being shown substantially enlarged for clarity.

FIG. 2 is an end view taken along the line 2—2 of FIG. 1.

FIG. 3 is an elevation, partly in section and having a magnified portion, of an adjustable voltage autotransformer in which the brush of the present invention is advantageously incorporated.

FIG. 4 is a plan of the autotransformer of FIG. 3 with portions broken away, also having a magnified section.

FIG. 5 is a modification of the brush of the present invention with the wires again being shown substantially enlarged.

FIG. 6 is a further modification of the brush of the present invention.

Referring to the drawing, the commutating brush of the present invention is generally indicated by the reference numeral 10 and is shown employed in an autotransformer 11. The autotransformer, as disclosed in the above-mentioned Karplus et al. patent includes a winding 12 of insulated wire toroidally wound about an annular magnetic iron core (not shown) with a commutator surface 13 formed on an axial end of the winding by removing insulation 14 and flattening as by grinding, a common portion 15 of each of the turns 16 of the winding. It will be appreciated that, as shown in FIG. 3, each of the portions 15 is separated slightly from adjacent portions so that a gap 13a exists therebetween. Moreover, as is well known, a potential difference exists between each of the portions 15 when the autotransformer is energized.

The brush 10 is mounted in a brush holder 10a of any convenient design provided on a radiator disk 17 that is secured to a rotatable shaft 18 so that current may be conducted from the commutator surface to the brush, to the radiator and through appropriate slip ring connections to an output terminal (not shown) as is well known in the art. It will thus be seen that, by rotation of the shaft 18 which carries the radiator disk and the brush, the brush is caused to slide in electrical engagement over the commutator surface 13 formed by the portions 15 and by so doing adjust the output voltage of the autotransformer.

The brush of the present invention, as shown in FIG. 1, includes a plurality of lengths of wire 19 of substantially equal lengths, each having a terminal portion 20 with the portions 20 being held in parallel alignment and with the end 21 of each wire being positioned to form a substantially planar surface 22. From the terminal portions 20,

the plurality of wires 19 are separated into two groups 23 and 24 with each group terminating in a connecting clip 25 and 26 respectively. The clips 25 and 26 are thus electrically connected to the other ends 27 of the wires. As shown in FIG. 2, each of the wires preferably has an insulating covering 28 in order to prevent conduction therebetween except at the ends 27. The terminal portions in the embodiment shown in FIGS. 1 and 2 are encased by a hardened material 29, such as an epoxy resin having the shape shown, in order to hold them in parallel alignment and to form the terminal portions into a rigid structure which may be clamped to the radiator disk 17. Moreover, as shown in FIG. 1, the end 21 of each wire is exposed and located in the planar surface 22 and if desired may project a slight distance beyond its insulation 28 and encasing material 29. But normally the insulation extends to the planar surface to thus provide rigidity for the wire ends.

The diameter of each of the wires is substantially the same and preferably relatively small, on the order of .003 inch. While it is contemplated that wires having different diameters may be employed, in any event the diameter of each wire must be less than the gap 13a that exists between each of the portions 15 of the commutator surface so that one wire 19 is incapable of simultaneously being in contact with two commutating portions 15.

In carrying out the present invention, wherein it is required that there be a resistance to limit short-circuit current, as taught by the Karplus et al. patent, each wire is formed of a material that is selected to have a specific resistance that provides the necessary value of resistance. Thus, for example, high brasses may be used or other resistive metals which by reason of their diameter, specific resistance and length provide the necessary value of resistance. It is presently preferred to make each wire identical as to length, material and diameter so that the resistance of each wire will be the same and hence the wires will conduct current evenly.

It will be appreciated that the planar surface 22 of the brush 10 that slides on the commutator surface 13 is metallic as are the portions 15 that form the commutator surface and hence by reason of the metal to metal contact, there is minimum contact resistance between the commutator surface and the brush. As each wire 19 that carries current has a resistance, with the resistance being constant throughout the length of the wire, then the heat developed by the resistance is spread throughout the length of the wire. This feature of the present invention is advantageously employed when the brush is utilized in an adjustable voltage autotransformer where, as shown in FIG. 3, the brush 10 is clamped in the radiator disk to engage the commutator surface 13 and the two groups 23 and 24 are positioned within circular ways 30 formed on the radiator disk 17 by upstanding arcuate heat dissipating flanges 31. Thus, with the thermal contact between the wires and the radiator disk, the heat from the wires is easily conducted to the radiator disk for dissipation. As in conventional autotransformer construction the radiator is also employed as a conducting member and hence the clips are secured thereto as at 32.

The encasing compound is preferably insulating or poorly conducting material or material having a high contact resistance drop and moreover it is preferred and advantageous if it has a poorer wearing quality than the metal of the wires 19. Thus for example nylon, carbon with a resinous binder or graphite with an epoxy binder may be employed. Moreover, if desired, the encasing material may be impregnated with a lubricant, such as oil, to provide lubrication of the commutator surface. The insulating covering 28 of the wires 19 is preferably a varnish, such as that sold under the trade name "Formvar," which also has poor wearing qualities.

While the embodiment of the present invention shown in FIG. 1 has been found satisfactory, in some instances

the amount of heat produced and the heat conduction between the brush and the radiator disk may be such that the length of the wires required to dissipate the heat may be materially shortened. Thus, as shown in FIG. 6, a brush 33 in this embodiment comprises, in essence, just short lengths of wire 34 with a contact member 35 attached to the radiator disk 36 engaging the upper end 37 of the brush 33 for electrical conduction therebetween. The brush herein is, in essence, identical in construction to the terminal portion of the brush 10 shown in FIG. 1 and is clamped to the radiator disk so that the radiator supports the brush 33 and also serves to conduct heat therefrom. In this embodiment, it will also be appreciated that the heat dissipated by the resistance of the brush is located throughout the length of the wires forming the brush and not just at the contact surfaces between the brush and the commutator surface.

While both embodiments of the present invention heretofore described have been shown as having the terminal portion encased in a hardened compound, in the embodiment shown in FIG. 5 a rigid clamp consisting of a substantially U-shaped member 38, a closing member 39 and screws 40 may instead be employed to maintain the terminal portions of the wires in aligned parallel relation. Preferably the members 38 and 39 are of heat conducting metal.

It will thus be seen that the present invention of a commutating brush eliminates the localized heating that occurs at the brush and commutator surface in the heretofore taught concept of having the resistance for limiting short-circuit current be at the contacting surfaces. The present invention minimizes, if not substantially eliminates, the contact resistance between the brush and the commutator surface and employs the resistance of lengths of conducting wires to spread the heat created by the resistance throughout the length of the wires. In some embodiments the lengths of the wire may, in order to provide adequate spreading of the heat, be of substantial length while in others small lengths may be sufficient. While the brush heretofore disclosed for use in an autotransformer has just one terminal portion, the present invention where larger brushes may be required also contemplates making a plurality of separate small terminal portions instead of one large terminal portion.

It will be appreciated that the heretofore disclosed commutating brush may be advantageously employed in an adjustable voltage autotransformer, for obviating the limitation of the power handling capacity of an autotransformer because of the maximum temperature occurring at the contacting surfaces, thus enabling an autotransformer to handle more power. Moreover, by reason of the number of lengths of wire in a brush, for example 500, even though the autotransformer is handling a relatively large amount of current, for example 50 amperes, the amount of amperes per wire is accordingly small and hence sparking or arcing at the commutator surface is substantially decreased.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

What is claimed is:

1. In combination with an adjustable voltage autotransformer having a commutator surface formed of a plurality of separate commutating segments with a spacing between adjacent segments and with an electrical potential existing between adjacent segments, the improvement comprising a commutating brush formed of a substantial number of separate electrical conducting wires, each wire having a first end and a first terminal portion and a second end and a covering of electrical insulating material with the ends being free of insulating material, means for maintaining the terminal portions of the wires substantially rigid to have the first ends form a substantially planar electrically conducting surface free of insula-

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tion, means for electrically connecting together the second ends of the wires to a common connector, means for mounting the brush on the autotransformer to have the planar surface slidable on and in electrical engagement with the commutator surface, said planar surface being of a width to span at least two segments with the first end of each wire having a width less than the width of the spacing, said wires being dimensioned and formed of electrical resistance material to have the resistance of the wires between the ends substantially larger than the contact resistance between the first ends and the commutating surface whereby the passage of current through the wires generates substantially more heat along the length of the wires than at the engagement between the first ends and the commutating surface.

2. The invention as defined in claim 1 in which the means for mounting the brush includes a heat radiator

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having heat conducting surfaces, each wire extends substantially beyond its terminal portion, and means for dividing the wires into at least two groups and securing the lengths of the groups to the radiator to be in heat conductive relationship therewith.

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