Sept. 8, 1942. E. J. KREH, JR 2,295,409

COMMUTATOR

Filed July 17, 1941

Fig. 1.

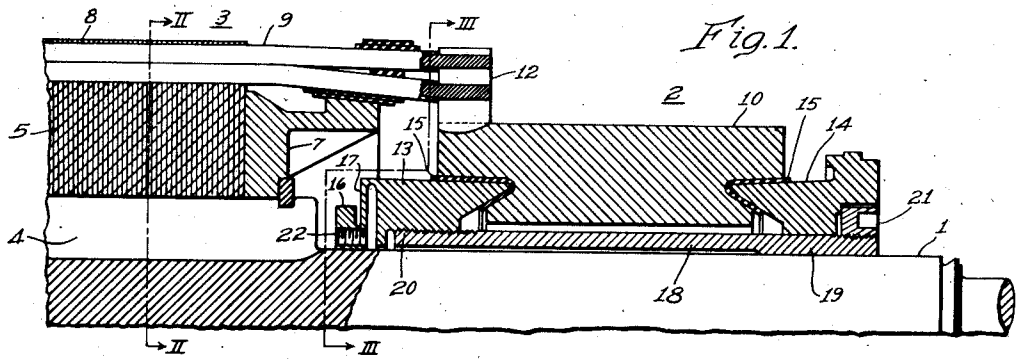


Fig. 2.

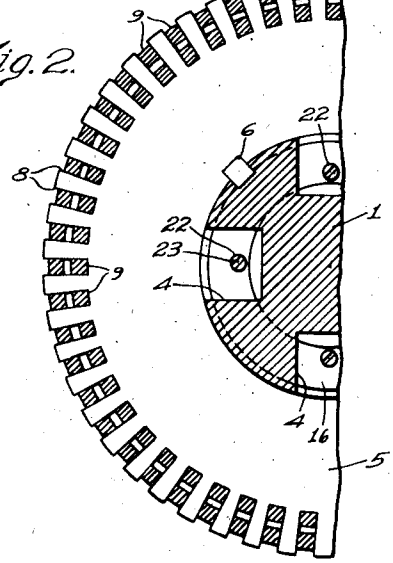


Fig. 3.

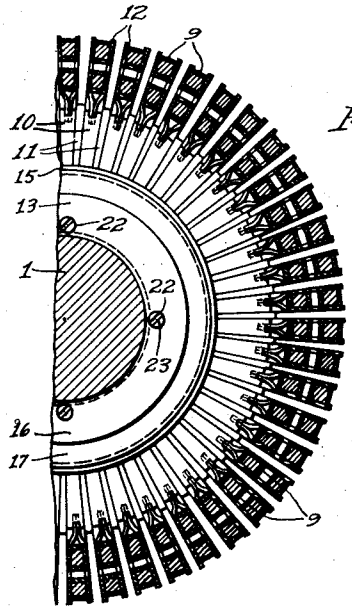
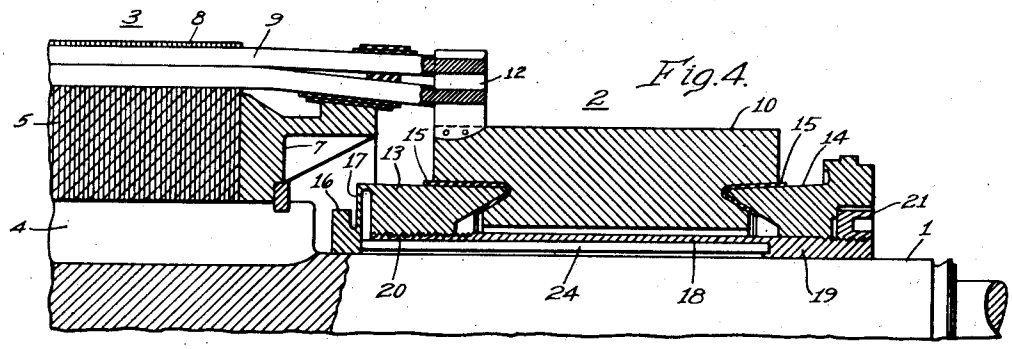


Fig. 4.



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2,295,409

COMMUTATOR

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Application July 17, 1941, Serial No. 402,724

7 Claims. (Cl. 171—321)

The present invention relates to the mechanical construction of commutators of dynamo-electric machines and, more particularly, to the construction of high speed commutators of relatively small outside diameter.

Commutators for dynamo-electric machines consist of a large number of copper bars which are separated by mica spacers and assembled into a cylinder which is mounted on the shaft of the machine. In the so-called V-ring construction, the bars have U-grooves in their ends and are clamped between V-rings under heavy pressure, the V-rings being supported from the shaft of the machine. When such a commutator is in operation, its temperature rises and the parts tend to expand. The copper bars, however, have a higher coefficient of thermal expansion than the V-rings and other supporting parts, which are normally made of steel, and thus the bars tend to expand more than the supporting elements between which they are clamped. This effect is aggravated by the fact that the bars reach higher temperatures than the supporting elements because of the friction of the brushes which ride on the bars and the heating effect of the currents which flow in the bars. Thus the copper bars tend to expand more than the steel supporting and clamping elements, and stresses are set up which would tend to cause buckling and distortion of the bars if no provision were made to permit this expansion. This greater expansion of the bars with respect to the supporting elements has made it necessary in medium and large size commutators to devise constructions in which a certain amount of flexibility or resilience is provided in the clamping elements to permit them to yield or move slightly as the bars expand and contract, and thus follow up the expansion and construction of the bars without releasing or substantially changing the clamping pressure on them.

One construction of this type which has been found satisfactory for some types of machines is shown in the patent to G. W. Penney, No. 2,045,405, issued June 23, 1936, and assigned to Westinghouse Electric & Manufacturing Company. In the construction shown in this patent, the commutator bars are clamped between V-rings which are mounted on a bushing supported on the shaft. One of the rings is mounted on the bushing by means of a flexible annular plate which permits it to yield and follow the expansion and contraction of the bars, and the V-rings are drawn together by means of through bolts extending in the annular space between the commutator bars and the bushing. These bolts serve to maintain the clamping pressure between the V-rings, and are sufficiently resilient longitudinally to permit the slight movement of the flexibly mounted V-ring which is necessary to permit the expansion of the bars.

In the case of high speed commutators, such as are used on turbogenerator exciters, for example, the outside diameter of the commutator must be kept as small as possible in order to avoid excessive peripheral speeds, since such machines are usually driven at high speeds, such as 3600 R. P. M. The shaft diameter in machines of this type is also relatively large, and there is not sufficient room to place the through bolts and through bushing of the construction just described between the shaft and commutator bars without exceeding the permissible limit for the outside diameter of the commutator. For this reason, it has been necessary in the past in machines of this type to use the shrink ring type of commutator in which the bars are held onto a sleeve on the shaft by means of steel rings shrunk in position over the bars. This type of construction is considerably more expensive than the V-ring type, and the present invention provides a construction by which the V-ring type of commutator can be used on high speed machines.

The principal object of the invention, therefore, is to provide a commutator construction which is especially suitable for high-speed commutators of relatively small diameter.

A further object of the invention is to provide a commutator construction of the V-ring type having sufficient flexibility to permit thermal expansion of the commutator bars, and which requires a minimum of space so that the outside diameter of the commutator can be kept small.

A more specific object of the invention is to provide a V-ring commutator construction in which sufficient flexibility is provided to permit expansion of the commutator bars, and which requires no through bolts or through bushing so that the space required is relatively small.

Another object of the invention is to provide a V-ring type of commutator construction in which one of the V-rings is flexibly mounted directly on the shaft, and in which provision is made for assembling the commutator on the shaft without permitting deflection of the flexible mounting during such assembly.

Other objects and advantages of the invention will be apparent from the following detailed de-

scription, taken in connection with the accompanying drawing, in which—

Figure 1 is a longitudinal sectional view of a commutator embodying the present invention and a portion of the machine with which it is used;

Fig. 2 is a partial transverse sectional view approximately on the line II—II of Fig. 1;

Fig. 3 is a partial transverse sectional view approximately on the line III—III of Fig. 1; and

Fig. 4 is a longitudinal sectional view similar to Fig. 1, showing a modified embodiment of the invention.

The invention is shown in the drawing as applied to a commutator for a high speed dynamo-electric machine, such as a turbogenerator exciter, which has a shaft 1 on which are mounted the commutator 2 and armature 3. In the particular machine selected for the purpose of illustration, the central portion of the shaft, on which the armature 3 is mounted, is of larger diameter than the end portion, and has a plurality of longitudinal grooves or flutes 4 cut in it which function as channels for the circulation of ventilating air. The armature core is built up of annular laminations 5 which are pressed on the shaft 1 and secured to it by means of a key 6, the laminations being clamped between suitable end plates 7. The armature core 3 has slots 8 formed in its periphery, and the armature conductors 9 are placed in these slots in the usual manner.

The commutator 2 consists of a plurality of copper bars 10 of generally wedge-shaped cross-section, which are assembled to form a commutator cylinder, as shown in Fig. 3, the individual bars being separated by spacers 11 of mica, or other suitable insulating material. Necks or risers 12 are provided at one end of the bars and the armature conductors 9 are connected to the necks. The commutator bars 10 have V-grooves formed in each end, and the commutator cylinder is clamped between V-rings 13 and 14 which engage in these V-grooves, and which are insulated from the bars 10 by mica V-rings 15.

The rear V-ring 13 is intended to be mounted directly on the shaft 1, and for this purpose it is provided with a mounting-portion 16, which is bored to fit on the shaft 1 with a press fit so that the portion 16 is adapted to be rigidly mounted on the shaft. The V-ring 13 is connected to its mounting portion 16 by a thin section 17 which forms a flexible annular plate, thus permitting a certain amount of axial movement of the ring 13 without disturbing its rigid mounting on the shaft.

The V-rings 13 and 14 are connected by a tension member 18, which is preferably a hollow bushing extending between the V-rings, and having sufficient axial resilience to permit the slight axial movement of the V-ring 13. The internal diameter of the bushing 18 for most of its length is made large enough so that it fits over the shaft 1 with a small clearance, but at its end opposite to the V-ring 13, it has a portion 19 of reduced internal diameter which is adapted to fit on the shaft 1 with a press fit to secure the bushing 18 to the shaft. The bushing 18 may be attached to the V-ring 13 in any suitable manner. As shown in the drawing, the V-ring is internally threaded at 20 and the bushing 18 has corresponding threads cut on it and is screwed into the V-ring 13 or otherwise made unitary therewith, in effect, by other suitable means. The V-ring 14 is slidably mounted on the opposite end of the bushing 18, and means are provided on the bushing for forcing the V-ring 14 against the commutator bars to apply clamping pressure between the V-rings. This clamping means preferably consists of a ring-nut 21 which is threaded on the end of the bushing 18 and engages in an annular recess in the V-ring 14.

In assembling the commutator, the bushing 18 is first attached to the V-ring 13 by means of the threads 20, or other suitable means, and the commutator bars 10 are then assembled between the V-rings. The bushing 18 is then rigidly held by a support (not shown) against its portion 19 and clamping pressure, which may be as high as 23 tons, or more, is applied to the V-ring 14, so that the commutator bars are securely clamped between the two V-rings, the V-ring 14 sliding on the bushing portion 19 under the intense applied pressure. The retaining ring-nut 21 is then screwed tightly against V-ring 14 for maintaining the commutator bars under pressure after the assembling external clamping pressure is removed. Since the bushing 18 is rigidly secured to the ring 13, the bushing 18 will be in tension and will serve as a tension-member between the V-rings to maintain the desired clamping pressure on the commutator bars. After the commutator has been assembled and seasoned, it is placed on the shaft 1 of the machine by pressing it axially into position, the mounting-portion 16 of the V-ring 13 and the portion 19 of the bushing 18 securing the commutator to the shaft with a press fit. The press action between the shaft 1 and the bushing-portion 19 causes the bushing to expand and results in a press fit between the V-ring 14 and the bushing-portion 19, anchoring it thereto.

It has been found that, in the case of turbo-generator exciters, which are driven directly from the turbine which drives the generator, it is not necessary to key the commutator to the shaft, since there is no torsional vibration or pulsation in a turbine drive and no slippage of the commutator on the shaft occurs. For other applications in which torsional vibration or pulsating torques may be applied to the shaft 1, it may be desirable to key the portion 19 of the bushing 18 to the shaft in order to prevent circumferential displacement of the commutator.

Since the commutator is assembled on the shaft by pressing it into position axially from the right-hand end of the shaft, as viewed in Fig. 1, it is apparent that the flexible plate 17 would be deflected by the axial pressure on the mounting-portion 16 of the V-ring 13 and would be collapsed against the body of the ring. In order to prevent this effect, a plurality of internally threaded holes 22 are provided in the mounting-portion 16, the number and position of these holes corresponding to the number and position of the flutes 4 in the shaft 1, or other suitable opening in the armature spider. Prior to assembling the commutator on the shaft, suitable set-screws 23 (Figs. 2 and 3) are inserted in the threaded holes 22 and tightened against the V-ring 13 to maintain the flexible plate 17 in its undeflected position while the commutator is being pressed on the shaft. After assembly of the commutator on the shaft, the set-screws can readily be removed since they are easily accessible through the flutes 4 of the shaft or spider, as clearly shown in Fig. 2.

With some shaft and armature core designs, however, it might not be possible to locate the

holes 22 in such a position that the set-screws placed in them would be accessible after the commutator is placed on the shaft. In such cases, the holes 22 may be omitted and the construction shown in Fig. 4 may be employed. In this embodiment of the invention, the construction of the commutator is the same as that previously described, except that a plurality of struts or pressure-bars 24 are placed in longitudinal grooves cut in the internal surface of the bushing 18. The lengths of these struts 24 are such that they normally engage the mounting-portion 16 of the V-ring 13. The bushing 18 is still free to stretch under increased load due to copper-expansion, since it is attached to the struts only at the end 19. The struts prevent deflection of the flexible plate 17 during the pressed-fit assembly of the commutator on the shaft.

The effect of the construction described herein will be readily apparent. When the commutator is in operation and the copper bars 10 become heated, they tend to expand more than the steel supporting members, and the flexible plate 17 of the rear V-ring 13 permits this ring to move axially sufficiently to allow the expansion of the bars. The bushing or tension member 18 is made of sufficiently thin cross-section so as to have enough axial resilience to permit this movement of the ring 13 to take place, and thus the ring is permitted to move a small amount back and forth and follow the expansion and contraction of the commutator bars 10 without releasing or materially changing the clamping pressure on them. Since one of the V-rings is mounted directly on the shaft, no through bushing is required for the commutator, and no through bolts are necessary since the tension member 18 performs the function for which such bolts have been used in prior constructions. Thus, the radial space required between the shaft and the bars for the supporting and clamping elements of the commutator is reduced to a minimum, making possible the use of V-ring type commutators on high speed machines in which the outside diameter of the commutator must be kept small. The use of the bushing 18 is also advantageous in that it avoids the concentrations of stress which occurred around the heads of the previously used bolts and thus effects a uniform distribution of stress around the circumference of the V-rings. It will be apparent, therefore, that the new construction offers many advantages in that it is very compact and occupies a minimum of space, so that the relatively inexpensive V-ring type of construction can be used for high speed commutators, and also that it has sufficient flexibility to permit expansion of the copper bars, thus allowing the commutator to adjust itself to any thermal condition.

It is to be understood that the invention is capable of various modifications and embodiments, and is not restricted to the particular constructional forms shown in the drawing for purposes of illustration. The invention is not restricted, therefore, to the specific details of construction shown and described, but in its broadest aspect it includes all equivalent modifications and embodiments which come within the scope of the appended claims.

I claim as my invention:

1. A commutator stucture for mounting on the shaft of a dynamo-electric machine, comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, oppositely disposed V-rings engaging in the V-grooves of said commutator cylinder, one of said V-rings having a mounting-portion adapted to be mounted directly on the shaft and having a flexible portion which permits it to move axially as the commutator bars expand and contract under the influence of temperature changes, a cylindrical tension-member extending between the V-rings inside the commutator cylinder, means for removably but rigidly connecting one end of said tension-member to said flexibly mounted V-ring, the other end of said tension-member being mounted on the shaft, the second V-ring being supported by said tension-member, and means on said tension-member for holding the second V-ring against the commutator bars whereby said commutator bars are maintained clamped between the V-rings.

2. A commutator structure for mounting on the shaft of a dynamo-electric machine, comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, oppositely disposed V-rings engaging in the V-grooves of said commutator cylinder, one of said V-rings having a main V-ring body-portion engaging the V-groove at its end of the commutator, and also having a mounting-portion mounted directly on the shaft, and still further having a flexible portion joining said main body-portion and said mounting-portion whereby to permit said main body-portion to move axially as the commutator bars expand and contract under the influence of temperature changes, a tension-member extending between the V-rings inside the commutator cylinder, one end of said tension-member being rigidly connected to the main body-portion of said flexibly mounted V-ring, and its other end being mounted on the shaft, said tension-member encircling the shaft and having sufficient axial resilience to allow said movement of the flexibly mounted V-ring, the second V-ring being supported on said tension member, and means on the tension-member for holding the second V-ring against the commutator bars whereby said commutator bars are maintained clamped between the V-rings.

3. A commutator structure for mounting on the shaft of a dynamo-electric machine comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, a V-ring engaging in the V-groove at one end of the commutator cylinder, means for flexibly mounting said V-ring directly on the shaft to permit it to move axially as the commutator bars expand and contract under the influence of temperature changes, a bushing fitting over the shaft inside the commutator cylinder, one end of said bushing being attached to said V-ring and the other end of the bushing being rigidly mounted on the shaft, a second V-ring supported on the bushing at its end opposite to said first mentioned V-ring and engaging in the V-groove of the commutator cylinder at that end, and means on the bushing for holding said second V-ring against the commutator bars whereby said commutator bars are maintained clamped between the V-rings.

4. A commutator structure for mounting on the shaft of a dynamo-electric machine comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, a V-ring engaging in the V-groove at one end of the commutator cylinder, means for flexibly mounting said V-ring directly on the shaft to permit it to move axially as the commutator bars expand and contract under the

influence of temperature changes, a bushing fitting over the shaft inside the commutator cylinder, one end of said bushing being attached to said V-ring and the other end of the bushing being rigidly mounted on the shaft, said bushing having a small clearance from the shaft and having sufficient axial resilience to permit said movement of the V-ring, a second V-ring supported on the bushing at its end opposite to said first mentioned V-ring and engaging in the V-groove of the commutator cylinder at that end, and means on the bushing for holding said second V-ring against the commutator bars whereby said commutator bars are maintained clamped between the V-rings.

5. A commutator structure for mounting on the shaft of a dynamo-electric machine comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, a V-ring engaging in the V-groove at one end of the commutator cylinder, a flexible annular plate mounted directly on the shaft and carrying said V-ring to permit axial movement of the V-ring as the commutator bars expand and contract under the influence of temperature changes, a bushing fitting over the shaft inside the commutator cylinder, one end of said bushing being attached to said V-ring and the other end of the bushing being rigidly mounted on the shaft, said bushing having a small clearance from the shaft and having sufficient axial resilience to permit said movement of the V-ring, a second V-ring supported on the bushing at its end opposite to said first mentioned V-ring and engaging in the V-groove of the commutator cylinder at that end, and means on the bushing for holding said second V-ring against the commutator bars whereby said commutator bars are maintained clamped between the V-rings.

6. A commutator structure for mounting on the shaft of a dynamo-electric machine comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, a V-ring engaging in the V-groove at one end of the commutator cylinder, a flexible annular plate mounted directly on the shaft and carrying said V-ring to permit axial movement of the V-ring as the commutator bars expand and contract under the influence of temperature changes, a bushing fitting over the shaft inside the commutator cylinder, one end of said bushing being attached to said V-ring and the other end of the bushing being rigidly mounted on the shaft, said bushing having a small clearance from the shaft and having sufficient axial resilience to permit said movement of the V-ring, a second V-ring supported on the bushing at its end opposite to said first mentioned V-ring and engaging in the V-groove of the commutator cylinder at that end, means on the bushing for holding said second V-ring against the commutator bars whereby said commutator bars are maintained clamped between the V-rings, and means effective during assembly of the commutator on the shaft of the machine for preventing movement of said flexible plate.

7. A commutator structure for mounting on the shaft of a dynamo-electric machine comprising a plurality of commutator bars disposed to form a commutator cylinder and having V-grooves in their ends, a V-ring engaging in the V-groove at one end of the commutator cylinder, a flexible annular plate mounted directly on the shaft and carrying said V-ring to permit axial movement of the V-ring as the commutator bars expand and contract under the influence of temperature changes, a bushing fitting over the shaft inside the commutator cylinder, one end of said bushing being attached to said V-ring and the other end of the bushing being rigidly mounted on the shaft, said bushing having a small clearance from the shaft and having sufficient axial resilience to permit said movement of the V-ring, a second V-ring supported on the bushing at its end opposite to said first mentioned V-ring and engaging in the V-groove of the commutator cylinder at that end, and means on the bushing for holding said second V-ring against the commutator bars to clamp them between the V-rings, said flexible plate having a plurality of threaded holes therein for the reception of screws during assembly of the commutator on the shaft of the machine to prevent movement of the flexible plate during such assembly.

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