C. A. VAN DUSEN.

COMMUTATOR AND PROCESS OF PRODUCING THE SAME.

APPLICATION FILED FEB. 12, 1919.

1,329,277.

Patented Jan. 27, 1920.

2 SHEETS—SHEET 1.

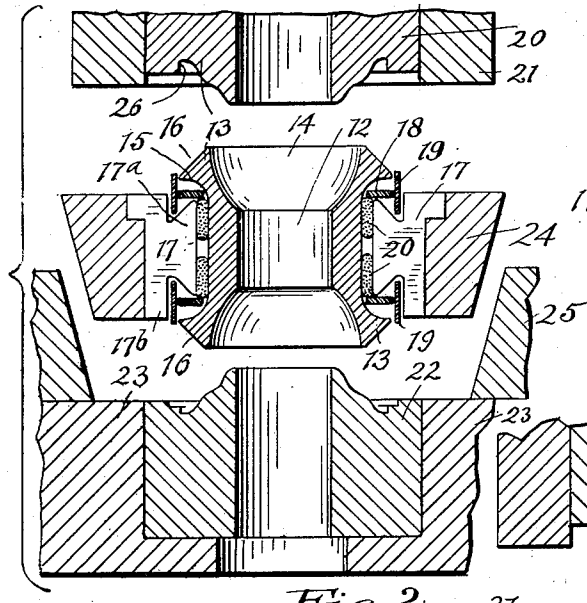


Fig. 2.

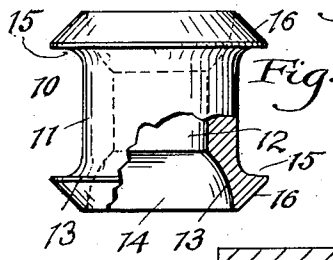


Fig. 1.

Fig. 6.

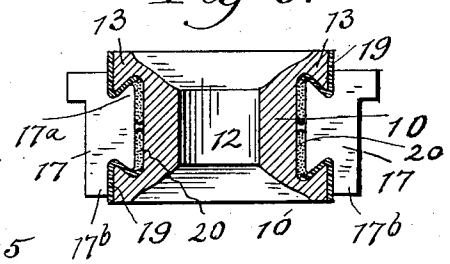


Fig. 4.

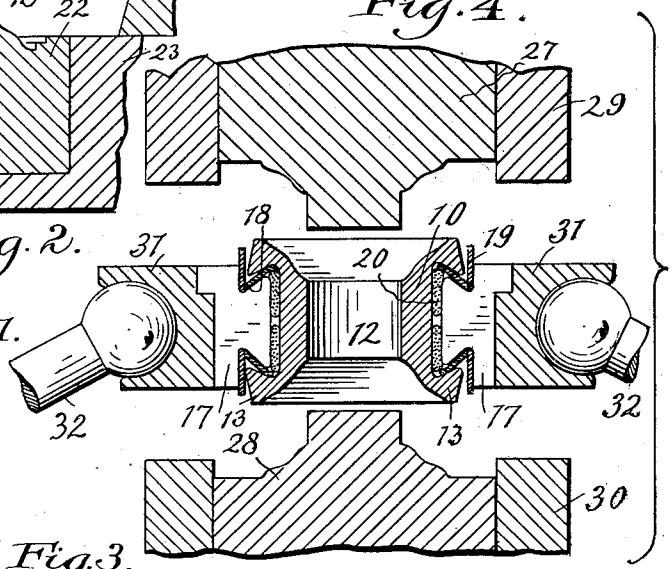


Fig. 3.

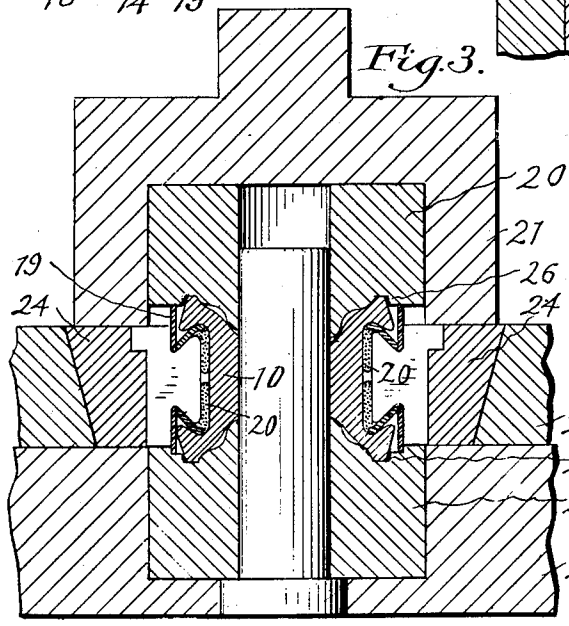
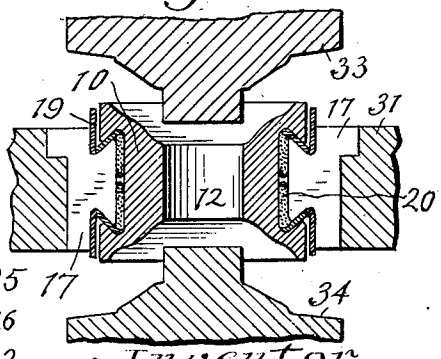


Fig. 5.



Inventor:
Charles A. Van Dusen
By
Thurston & Kiver
attys.

C. A. VAN DUSEN.

COMMUTATOR AND PROCESS OF PRODUCING THE SAME.

APPLICATION FILED FEB. 12, 1919.

1,329,277.

Patented Jan. 27, 1920

2 SHEETS—SHEET 2.

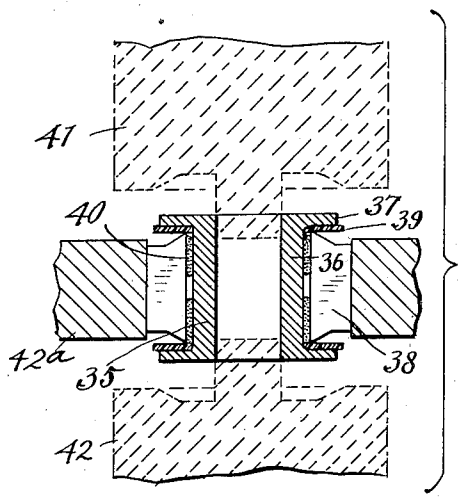


Fig. 7.

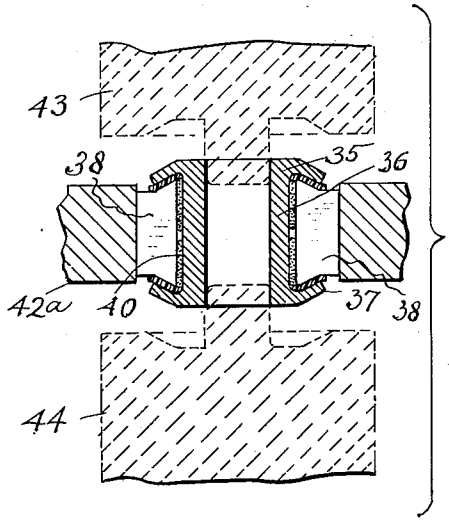


Fig. 8.

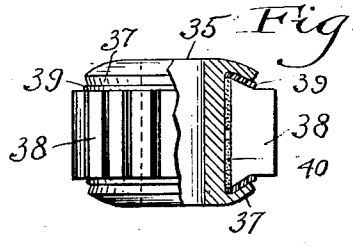


Fig. 9.

Inventor:
Charles A. Van Dusen
By
Thurston & Rowe
attys.

UNITED STATES PATENT OFFICE.

CHARLES A. VAN DUSEN, OF TOLEDO, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE TOLEDO STANDARD COMMUTATOR COMPANY, A CORPORATION OF OHIO.

COMMUTATOR AND PROCESS OF PRODUCING THE SAME.

1,329,277. Specification of Letters Patent. **Patented Jan. 27, 1920.**

Application filed February 12, 1919. Serial No. 276,461.

To all whom it may concern:

Be it known that I, CHARLES A. VAN DUSEN, a citizen of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented a certain new and useful Improvement in Commutators and Processes of Producing the Same, of which the following is a full, clear, and exact description.

This invention relates to certain new and useful improvements in commutators for dynamo electric machines and to the process of producing the same, this application being a continuation in part of my prior application, Serial No. 200,653, filed November 7, 1917.

Prior to my invention, it has been the universal practice in producing cylindrical commutators of the type wherein the segments are clamped and held in position by metal retaining or clamping rings, to utilize a holder for the segments, consisting of a barrel or spool with at least one end clamping ring made separate from the barrel. In some constructions, both rings were separate from the barrel, and in other constructions the barrel had one integral ring and the other separate, but in either event the segments after being assembled about the barrel of the holder were secured in place with a moderate degree of pressure by forcing one or both the rings inwardly and by securing the movable ring at one or both ends of the barrel in clamping position by a nut or equivalent expedient such as by upsetting the end of the barrel over the outer side of the ring.

Thus the holder was always composed of at least two parts, generally more, and had at least one end clamping ring which was required to be secured in place to effect the clamping pressure against the tangs of the segments.

Irrespective of the degree of care and skill exercised by manufacturers of commutators of the type referred to, having the multi-part holders, as explained above, such commutators have not been entirely satisfactory, for not only was the percentage of loss to the commutator builder very high, due to short circuiting or some other defect such as imperfect clamping action on the segments, but the commutators frequently failed when in use on dynamo electric machines, due to displacement of the segments or of the insulation, and, in fact, experience has shown that the commutators have given rise to more trouble and have been the greatest factor in the failure of such dynamo electric machines than any other parts thereof. The ineffectiveness and the imperfections of commutators embodying the old and well-known constructions became more apparent and more serious as the operating speeds of the dynamo electric machines were increased, the segments, due to the action of heat and high centrifugal forces being very frequently displaced, necessitating the repairing or replacement of the commutator.

While commutators made as above described, and having the disadvantages explained, have been in use for a great many years, more recently a great advance was made in the art by S. N. Sloan, by certain improvements by which the clamping pressure between the end rings and the segments could be greatly increased over what was possible prior to his improvement, and this was accomplished by Sloan by providing between the inner edges of the segments and the barrel of the spool or holder, an unyielding insulating medium which serves as a support for the segments and prevents slippage of the mica insulation, and thus enables the clamping pressure which is exerted on the end rings to be safely increased many times over the maximum pressure which prior to his improvements could be exerted. These improvements in the commutator, and the process by which it is produced, invented by, and put into practice under the direction of the said S. N. Sloan, are claimed in pending applications, Serial No. 152,239, filed March 3, 1917, and Serial No. 232,087, filed May 2, 1918.

By the present invention which may be, and preferably is utilized with the Sloan inventions I still further improve the construction of the commutator by reducing the number of parts, the chief object being to provide a one-piece holder which will result in a strong, tight and solid commutator admirably adapted for high speeds and to provide a process by which a one-piece spool or holder with integral clamping flanges at both ends may be utilized effectively in the production of commutators,

Further the invention aims to form a commutator by swaging inwardly over the tangs of the segments the integral flanges of the holder in such a manner that the flanges will remain permanently in the desired clamping relation without any appreciable back-spring of the flanges when the clamping pressure is removed, and it is still another object to so form the commutator that when the flanges are swaged inwardly they will completely fill the openings provided in the ends of the assembly of segments and within the overhanging portions on the ends of the segments, irrespective of variations in the size of the openings.

Still further, the invention aims to reduce the cost of production of the commutator, as well as to reduce the number of parts and to provide a tight unit which will safely resist the highest centrifugal stresses met in practice.

The invention may be briefly summarized as consisting in certain novel details of construction and combinations of parts of the commutator assembly, and in the steps of the process by which the commutator is produced.

In the accompanying sheets of drawings, Figure 1 is a view partly in elevation and partly in section of one form of spool or holder which may be utilized to advantage in carrying out my invention; Fig. 2 shows the commutator assembly in section utilizing the spool of Fig. 1, placed in a closing die which may be employed in the first of several closing operations to which the assembly is preferably subjected; Fig. 3 is a similar view at the end of the first closing operation; Fig. 4 is a view similar to Fig. 2, showing the assembly after the completion of the first closing operation and in the closing die preferably utilized in the second closing operation; Fig. 5 is a similar view with the assembly ready for the final closing operation; Fig. 6 is a sectional view of the assembly after the final closing operation, and in completed form except for truing and finishing; Fig. 7 shows a commutator assembly ready for the first closing operation, with a spool or holder of a different form than that shown in the preceding figures to form a commutator whose segments do not overhang the clamping flanges of the holder; Fig. 8 is a similar view after the completion of the first closing operation with the assembly in the closing die ready for the second and final closing operation; and Fig. 9 is a sectional view through the completed commutator after the last closing operation.

In carrying out my invention, spools or holders with integral clamping flanges of a variety of different forms may be used, and have been used by me in practice, but in the drawings I have shown only two forms of the spools, that shown on sheet 1 of the drawings being most frequently used, as the resulting commutator produced with this spool is extremely satisfactory for dynamo electric machines used for many different purposes.

It will be observed that this spool or holder which is designated by the reference character 10, is of novel and peculiar construction, this spool having a cylindrical barrel 11, with a central shaft opening 12, and being provided at its ends with integral clamping flanges 13 which extend outwardly in a general direction such that they make an angle near, but in this instance, somewhat less than forty-five degrees with respect to the longitudinal axis of the spool. Additionally, the ends of the spool have peculiar shaped recesses 14, concentric with respect to the axis, these recesses being in this instance, partly spherical and partly conical, the object of this particular shape of recess being to give such a shape to the flanges that the metal will bend at the desired points when the pressures are applied in the several closing operations.

The flanges 13 are provided with inner, substantially parallel clamping faces 15, which as will subsequently appear, are designed to clamp down over the wedge-shaped or dove-tail shaped tangs of the segments, and from the outer circumference of these faces 15, the flanges have faces 16 which taper downwardly and outwardly, and in this instance are at an angle of about forty-five degrees with respect to the axis of the spool. These faces 16, as will subsequently appear, are designed to be clamped against the overhanging or projecting portions of the segments which overhang the tangs (a suitable insulation, of course, intervening). It will be observed also, by reference to Fig. 2, that the distance between the faces 15 of the two flanges is considerably greater than the overall length of the segment tangs, this feature being provided in order that these flanges may be manipulated in the closing operations, and may be made to assume the right shape and to have the right locations in the completed commutator assembly.

In making the assembly with a spool such as illustrated, the copper segments 17 whose ends are notched to form the tangs 17^a and overhanging ends 17^b, are assembled about the barrel of the spool with mica or other suitable insulation separating the segments 17, any suitable assembling rig being used to assemble and hold the copper and mica segments while being placed about the barrel of the spool.

Between each flange 13 of the spool and the tangs 17^a of the segments is placed a ring 18 of insulation, preferably of mica, and inside the overhanging portions 17^b of the segments are placed bands 19 of mica or other suitable insulation, it being understood

that when segments of the type here shown are employed, each with a somewhat triangular shaped notch at its end, these notches form continuous annular grooves in the ends of the cylindrically arranged or assembled segments.

It was previously stated that the present invention may be used to advantage with the Sloan improvements which involve the use of an unyielding insulating support such as bakelite for the inner edges of the segments, and in illustrating my commutator and the steps of the preferred process by which it is produced, I have shown the unyielding support proposed by Sloan as aforesaid, and substantially as claimed in his applications before mentioned. While this unyielding support for the inner edges of the segments may be provided between the latter and the barrel of the spool in different ways, I prefer that bakelite in plastic strip form be wrapped around the barrel of the spool before the segments are assembled around it, and in this instance, two strips 20 of bakelite are provided with a relief space near the center, into which the yieldable bakelite may spread when the pressure is applied in the closing dies. It will be understood that while I prefer to employ bakelite for the purpose stated, other insulating materials having the necessary characteristics to answer the purpose may be employed.

After the parts are assembled on the spool, as illustrated in Fig. 2, several closing operations are performed, in the first of which the flanges 13 are bent inwardly sufficiently to prevent the segments and other pieces falling apart. In this step of the process pressure is applied axially on both ends of the spool, and I prefer also that pressure be applied radially on the segments, and for this purpose I may employ a closing die or press such as illustrated in Fig. 2, the closing die being here shown conventionally and in part only, inasmuch as the die itself forms no part of the present invention. The closing die or apparatus includes an upper die 20 mounted in a suitable holder 21, which in practice is carried by a vertically movable plunger, and it includes also, a lower die 22 in a suitable holder 23. Between the two dies there is a vertically movable or yieldable multi-piece segment clamping ring 24, which receives the assembly as shown in Fig. 2, and is designed to be closed in so as to exert pressure on the segments radially, the periphery of the blocks or pieces forming this ring being on a taper coinciding with the taper of a lower one-piece receiving ring 25 into which the multi-part clamping ring 24 is driven when the plunger is lowered.

The faces of the upper and lower dies 20 and 22 which engage the flanges in the closing operation must be appropriately shaped to bend the flanges in the proper direction or directions, and to the desired positions, and with a spool shaped substantially as that shown, both these dies must be provided with suitable means for restraining the outward movement of the flanges, or more properly, to limit the outward movement so that the wedge-shaped outermost portions of the flanges will not scrape and injure or dislodge the mica bands 19. In brief, when the die is closed, by the lowering of the plunger, the upper die member 20 engages the top of the spool, driving the assembly and the multi-part clamping ring 24 downwardly, and during the final portions of the stroke the flanges are both bent outwardly in a lateral direction and then forced inwardly in an axial direction to the position shown in Fig. 3, and at the same time, the parts of the clamping ring 24 are forced together as they are driven into the tapered recess or socket formed in the ring 25, causing an inward or radial pressure on the segments, it being understood that the closing and bending effects produced by the upper and lower die members 20 and 22 on the two flanges of the spool are precisely the same. In this operation, the extreme ends of the die members 20 and 22 enter the recesses 14, and as these die members come together, they first engage the upper and lower ends of the flanges, first driving them laterally outward as just stated, and when they are driven outward to a predetermined point, the outward movement is stopped by shoulders 26, formed by grooves in the faces of the dies, which shoulders catch the ends of the flanges restraining their further outward movement so as to avoid injuring the bands 19 as before explained, so that the further inward movement of the dies drives these flanges axially inward with the tapered portions of the flanges formed between the surfaces 15 and 16 driven part way into the V-shaped grooves at the ends of the assembled segments.

At the end of this operation, the segments are not tightly clamped, but all parts are now held together with a certain degree of pressure, and the flanges have been so manipulated, bent or deformed, that the assembly is now ready for the second closing operation in which more severe pressure both axially and radially is applied. For this operation and also for the third operation I prefer to employ a closing die substantially as shown in the patent granted to Louis A. Alexander July 9, 1918, No. 1,272,176. Briefly considered, this closing die, the principal portions of which are shown in Fig. 4, includes upper and lower dies 27 and 28, carried by suitable holders 29 and 30, the former being actuated by a

suitable plunger, and the latter yieldably mounted on a base, and the die further includes a multi-part ring 31, the parts of which are moved inwardly by toggle members 32 so as to press the segments inwardly in a radial direction at the same time that the flanges are swaged or bent inwardly by the upper and lower dies 27 and 28.

In this second closing operation in which axial pressure is applied to the flanges, and radial pressure to the segments, the flanges are driven inwardly substantially but not entirely to their final positions, fairly heavy pressure being applied through the flanges onto the segments, substantially as great as the greatest pressure to which segments made by the old processes were subjected, though in this step of the process the actual pressure is far less than the final axial pressure to which the holder is subjected in the final closing operation shortly to be described. In this second closing operation the bakelite is still in a soft or yieldable condition and cannot serve as a support though the bakelite is compressed, causing it to conform more nearly than before to the space between the segments and the holder. The faces of the dies employed in this second closing operation are so shaped that they engage the proper parts of the flanges to bend the flanges to nearly their final positions, or to precisely the positions desired for this step of the process.

In the next step of the process the commutator assembly is placed in an oven and is heated or baked until the bakelite 20, which as before explained, is placed between the barrel of the spool and the inner edges of the segments, is thoroughly hardened or is converted from its plastic condition into a hard, unyielding support for the segments. During this baking process the bakelite expands and more completely fills small interstices on the inside of the assembly as explained in the second Sloan application.

After the baking process is completed, the assembly is then again placed in the closing die of Fig. 4, which is now provided with upper and lower closing dies 33 and 34 illustrated in Fig. 5, appropriately shaped for the final closing operation, the radial clamping ring 31 being preferably the same as in the second closing operation. In this final closing operation an axial pressure, much greater, and generally, many times greater than that utilized in the second closing operation, is exerted on the flanges 13 of the holder by the closing dies, though the radial pressure may be substantially that utilized in the second closing operation, this exceedingly severe axial pressure being rendered possible, of course, through the provision of the unyielding support for the inner edges of the segments.

In this final closing operation the segments are pressed firmly inward against the bakelite support, and the flanges are driven axially inward firmly against the tapered insulated ends of the segment tangs. Not only are the flanges thus bent inwardly, so that they tightly grip the tangs and hold the segments solidly against the bakelite support, but two additional highly important results are obtained. First, due to the severity of the axial pressure and the shape of the dies there is an actual flow of the metal of both flanges firmly forcing the faces 16 of the flanges outward against the mica bands 19 inside the overhanging portions of the segments so that the flanges completely fill the V-shaped spaces or grooves formed in the ends of the segments. The second important result, aside from the swaging or bending of the flanges inwardly, resulting as I believe, from this flowing of the metal, is that there is eliminated practically entirely any tendency of back-springing of the flanges when the pressure is released by moving the end closing dies. Thus by causing the metal of the flanges to flow, there is an action akin to a molding operation, causing the flanges to completely fill the openings at the ends of the segments and to bear solidly against the insulation lining the overhanging portions of the segments as well as the tangs, and this is true, irrespective of variations in the size of the openings, which variations occur in practice.

The commutator is now complete except for such finishing and truing as it is desired to give to the assembly, and after the third closing operation, appears as shown in Fig. 6. In this commutator the segments are supported and tightly clamped at every point from one extreme end of the segment to the other, *i. e.* along the inner surfaces of the overhanging ends, along the tapered edges of the tangs and along the inner edges where they are firmly pressed by the flanges against the bakelite support. There is thus produced a commutator which is absolutely solid, without any openings, so that there is scarcely any possibility of the segments becoming loose. Furthermore, in subjecting the assembly to the severe pressure above explained, there is no rupture or slipping of the mica, one of the results derived from the use of the hardened insulating support between the inner edges of the segments and the barrel of the spool, and in consequence none of the segments are short circuited.

In Figs. 7, 8 and 9 I have shown a simpler form of commutator embodying the features of my invention both as to the completed article and process. With this form of my invention I utilize a spool 35, with a cylindrical barrel 36, at the ends of which are integral radial or substantially radial flanges 37. This spool is utilized to form a commutator whose segments 38, do not

have end portions overhanging the dovetailed or wedge-shaped tangs.

To form this commutator, the parts thereof are assembled much as in the preceding case, *i. e.* the segments separated by mica or other suitable insulation are arranged about the barrel of the spool, rings of mica or other suitable insulation 39, are placed between the flanges and the segments, and the spool is wrapped with an insulating material 40 to form the insulating support for the inner edges of the segments, this material being preferably plastic bakelite as in the first instance.

To form this commutator, only two closing operations are necessary, the assembly being placed in a closing die which may be similar to that shown either in Fig. 2 or Fig. 4, and including upper and lower dies 41 and 42, suitably mounted, with the upper die plunger-operated, and preferably including also the multi-part closing ring, here designated 42A, for exerting pressure radially inward on the segments at the same time that pressure is exerted through the end dies, which ring may be closed in, either by having the ring enter a tapered socket as in Fig. 2, or through the medium of toggles, as in Fig. 4.

In Fig. 7 I have shown the assembly in the closing die ready for the first closing operation. On the downward movement of the plunger, the integral flanges 37 are swaged inwardly onto the insulated beveled surfaces formed by the tangs, and at the same time the segments are pressed radially inward by the contraction of the surrounding ring 42A. A heavy pressure is thus exerted, but not sufficient to bend the tangs or disrupt the mica. The assembly after the end of the first closing operation appears as shown in Fig. 8, which shows the assembly ready for the second and final closing operation.

After the first closing operation, the assembly is placed in the baking oven and baked until the bakelite insulation is hardened, as previously explained, and then it is again placed in the closing die and the final severe axial pressure is exerted on the flanges and the radial pressure on the segments, the end dies here designated 43 and 44 being so shaped that an exceedingly solid unit is produced as in the first instance, the axial pressure in the second closing operation being many times that of the first closing operation. In the final closing operation in forming this commutator there is, as in the first instance, an outward flowing of the metal of the flanges which minimizes or eliminates entirely the tendency for the flanges to spring back after the end closing dies are withdrawn, the commutator thus produced being illustrated in Fig. 9.

In any case, that is to say, in whatever form of spool is produced, it is preferably made of steel of such hardness or quality that the flanges can be swaged inwardly to clamping position.

By my invention, which I have described with considerable detail in its application to the production of two different forms of commutators, not only is there produced a commutator, which is superior to commutators having multipart segment holders as has been amply demonstrated by practice, due to the solidarity of the construction and the extremely efficient manner in which every segment of the assembly is tightly held in place and gripped at every point along the edge or margin inclosed by the holder, but at the same time by the provision of the one-piece holder I am enabled to materially reduce the cost of production for many reasons, including the following: Not only can the one-piece holder be readily produced on an automatic screw machine, but it can be turned more cheaply than a holder composed of two or more pieces; it requires less steel than a multi-part holder; the one-piece holder can be used with mica insulation of ring and tubular form to insulate the flanges from the tangs and overhanging portions of the segments, instead of the V-shaped pressed mica forms used with the old types of commutators; the loss due to scrapping by reason of defective insulation is less than is the case with holders having two or more pieces; the commutator having a one-piece holder such as herein described, may be given a shorter over-all length than a commutator of the old type having an equal width of brush surface; and finally, with the one-piece spool and the method herein described, of causing the flanges to fill the end grooves by swaging the flanges inwardly and causing the metal to flow as explained in the specification, the flanges are clamped against the insulation covering the overhanging portions of the segments without requiring that the outer edge of the groove or channel be tapered, thus effecting a considerable saving of copper over the old method of employing one or more separate clamping rings for with the latter the overhanging portions of the segments were tapered at an angle of about five degrees to permit the introduction of the rings into the grooves or channels.

Other ways of carrying out the principle of my invention may be employed, changes being made in the process or in the product as long as the steps of the process and structural features of the product recited in any of the following claims or their equivalents be employed.

Having described my invention, I claim:—

1. A cylindrical commutator comprising a group of segments insulated from each other and provided with tangs having pro-

jecting portions forming annular clamping surfaces with insulation overlying the same, and a one-piece holder comprising a cylindrical barrel provided at its ends with integral continuous inturned flanges permanently set in clamping position for holding the segments against axial and radial displacement, and solidly clamped against the insulated clamping surfaces thereof.

2. A cylindrical commutator comprising a group of segments insulated from each other and provided with inner tapered portions which collectively form clamping surfaces with insulation overlying the same, and a one-piece holder in the form of a spool comprising a barrel extending through the assembled segments, and having at its ends and integral therewith, oppositely disposed continuous inturned flanges for holding the segments against axial and radial displacement, and solidly clamped and set against the insulated clamping surfaces.

3. A commutator comprising a group of segments insulated from each other and arranged in cylindrical formation, said segments having inner tangs and outer portions overhanging the tangs, the tangs and overhanging portions being faced with insulation, forming in the ends of the assembled segments annular grooves and insulated clamping surfaces, and a one-piece holder comprising a spool having a barrel extending through the assembled segments, and provided at its ends with integral continuous clamping portions for holding the segments against axial and radial displacement, said portions projecting inwardly into said grooves and solidly set against the insulated clamping surfaces.

4. A commutator comprising a group of segments insulated from each other, and arranged in cylindrical formation, said segments being provided with tangs and overhanging portions forming in the ends of the assembled segments annular openings whose walls are lined with insulating material forming insulated clamping surfaces, and a one-piece holder comprising a spool having a barrel extending through the assembled segments and provided at its ends with integral flanges swaged inwardly, and solidly clamped against the inner and outer clamping surfaces formed by the tangs and overhanging portions of the segments.

5. A commutator comprising a group of segments insulated from each other and arranged in cylindrical formation, said segments being provided with beveled tangs and outwardly thereof overhanging portions forming in the ends of the assembled segments annular grooves, the inner and outer walls of which are lined with insulation and constitute insulated bearing surfaces, and a one-piece holder comprising a barrel extending centrally through the assembled segments and provided at its ends with integral inturned flanges filling said openings and bearing solidly against the inner and outer insulated walls of said annular grooves.

6. A cylindrical commutator comprising a group of segments insulated from each other and having tangs forming clamping surfaces with insulation overlying the same, a one-piece holder comprising a spool with a barrel extending centrally through the assembled segments and provided at its ends with integral annular flanges for holding the segments against displacement in any direction, and an unyielding insulating support between the barrel and the inner edges of the segments, said flanges being inturned and solidly clamped against the insulated clamping surfaces formed by the tangs, and in turn solidly clamping the inner edges of the segments against said insulating support.

7. A commutator for dynamo electric machines comprising a group of segments insulated from each other and arranged in cylindrical formation, the assembled segments being provided with end grooves lined with insulation forming insulated bearing surfaces, and a one-piece holder comprising a spool with a barrel extending centrally through the assembled segments and provided with a substantially unyielding insulating medium surrounding the same, the barrel being provided at its ends with integral annular inturned flanges solidly clamped against said insulated bearing surfaces and in turn solidly clamping the segments against the substantially unyielding medium surrounding the barrel of the spool.

8. A commutator comprising a group of insulated segments arranged in cylindrical formation, the assembled segments having grooves in their ends lined with insulation forming insulated inner and outer bearing surfaces, and a one-piece holder for the segments having a barrel extending through the segments and surrounded by a substantially unyielding insulating medium, and at its ends having inturned annular flanges filling said grooves and solidly clamped against the inner and outer insulated bearing surfaces thereof, and solidly clamping the inner edges of the segments against said insulating medium surrounding the barrel.

9. The process of making cylindrical commutators which comprises assembling the segments suitably insulated from each other, around the barrel of a cylindrical holder having at its ends integral annular segment clamping portions, and by pressure exerted axially in opposite directions on said portions swaging them inwardly over portions of the segments with sufficient pressure to permanently set them in clamping position.

10. The process of making commutators which comprises assembling the segments

suitably insulated from each other around the barrel of a spool which has at its ends integral segment holding flanges and by pressure exerted axially on both ends of the spool swaging said flanges inwardly onto and over insulated bearing surfaces of the segments with sufficient pressure to permanently set them in firm clamping position.

11. The method of forming a commutator which comprises assembling the segments suitably insulated from each other in cylindrical formation around the barrel of a spool which is provided at its ends with integral segment clamping flanges, pressing the segments radially inward and at the same time exerting axial pressure on the ends of the spool so as to swage the flanges inwardly over insulated projecting portions of the segments to set them in solid clamping position.

12. The process of making cylindrical commutators which comprises assembling the segments suitably insulated from each other in cylindrical formation around the barrel of a one piece spool or holder having at its ends integral segment clamping flanges, providing a substantially unyielding insulating support between the barrel and the edges of the segments, and swaging the flanges inwardly over the projecting tangs of the segments so as to firmly clamp the segments down onto said unyielding support.

13. The method of forming a commutator which comprises assembling the segments suitably insulated from each other and in cylindrical formation around the barrel of a one-piece spool or holder which is provided at each end with an integral segment clamping flange, providing a substantially unyielding insulating support between the barrel and the inner edges of the segments, pressing the segments radially inward and substantially simultaneously by pressure exerted in an axial direction swaging both flanges over projecting portions of the segments so as to firmly clamp the segments down onto said support.

14. The method of forming a commutator which comprises assembling the segments around the barrel of a one piece spool or holder having integral segment clamping flanges at its ends, insulation being provided between the segments and between the tangs of the segments and the flanges, and by a plurality of successive closing operations swaging the flanges of the spool firmly over the insulated tangs.

15. The method of forming a commutator which comprises assembling the segments around the barrel of a one piece spool or holder having integral clamping flanges at its ends, with the segments insulated from each other and by a plurality of successive closing operations wherein pressure is exerted radially inward on the segments, and axially on the flanges, swaging said flanges inward over the tangs of the segments to firmly hold the segments against movement in any direction.

16. The method of forming a commutator which comprises assembling the segments around the barrel of a one piece spool or holder having integral clamping flanges at its ends, subjecting the assembly to successive closing operations wherein the flanges are swaged inwardly over projecting portions of the segments, and prior to the final closing operations providing around the barrel of the spool a layer of hard insulation against which the inner edges of the segments are clamped by the inwardly swaged flanges.

17. The method of forming a commutator which comprises assembling the segments suitably insulated from each other around the barrel of a one piece spool or holder having integral clamping portions at its ends and by powerful pressure exerted axially on both said portions, swaging them axially inwardly over projecting portions of the segments and causing an outward flowing of metal thereof substantially as described.

18. The method of forming a commutator which comprises assembling the segments with notched ends around the barrel of a one piece spool or holder having integral segment clamping portions at its ends, the notches in the ends of the segments collectively forming annular grooves in the ends of the assembled segments, and swaging said clamping portions of the spool axially inward and also radially outward so as to fill said grooves.

19. The method of forming a commutator which comprises assembling the segments, each having a tang and end portions overhanging the tang, around the barrel of a one piece spool or holder having integral segment clamping portions at its ends, and swaging said clamping portions of the spool axially inward over the tangs and radially outward against insulating coverings provided for the tangs and said overhanging portions of the segments.

20. The method of forming a commutator which comprises assembling segments notched at their ends and insulated from each other around the barrel of a one piece spool or holder having at its ends integral segment clamping portions, providing insulation between said clamping portions of the holder and the ends of the segments and also between the inner edges of the segments and the barrel, and closing the assembly thus formed by swaging the clamping portion of the holder axially inward and also radially outward substantially as described so as to cause them to fill the

openings formed by the notched ends of the segments and bear firmly against the insulated walls of said openings and to press the segments solidly against the insulation between the latter and the barrel.

21. The method of making a cylindrical commutator, which comprises assembling the segments in cylindrical formation around the barrel of a one-piece holder having integral flanges at its ends, which comprises exerting pressure on opposite ends of the holder so as to bend and at the same time draw the flanges over insulated bearing surfaces of the segments and set them in tight clamping engagement therewith.

22. The method of making a cylindrical commutator, which comprises assembling the segments in cylindrical formation around the barrel of a one-piece holder having at opposite ends integral segment clamping flanges, bending the flanges axially inward over projecting portions of the flanges and during the bending process limiting the radially outward movement.

23. The method of forming a cylindrical commutator, which comprises assembling the segments around the body of a one-piece spool or holder provided at its ends with integral segment holding portions and with openings in the ends of the holder, which comprises driving the flanges inward so that they will hold the segments against displacement, and in so doing, enlarging said openings of the holder.

24. The method of making a cylindrical commutator, which comprises assembling the segments around the body of a one-piece holder having at its ends integral segment retaining portions, and then bending or swaging the portions inwardly to a position to hold the segments in place, and at the same time shortening the length of the holder.

25. The method of making a cylindrical commutator, which comprises assembling the segments around the body of a one-piece spool or holder provided at its ends with integral, flaring, segment clamping portions and with openings, which comprises swaging the segment clamping portions inwardly in such a way as to spread them or enlarge said openings and decrease the over-all length of the holder.

26. A cylindrical commutator comprising a group of segments in cylindrical formation, and a one-piece spool or holder having a cylindrical body extending through the segments, and integral flanges at its ends bent inward and drawn over insulated surfaces of the tangs, and thereby permanently set in tight clamping engagement therewith.

In testimony whereof I hereunto affix my signature.

CHARLES A. VAN DUSEN.