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ELECTRIC GENERATOR ROTOR

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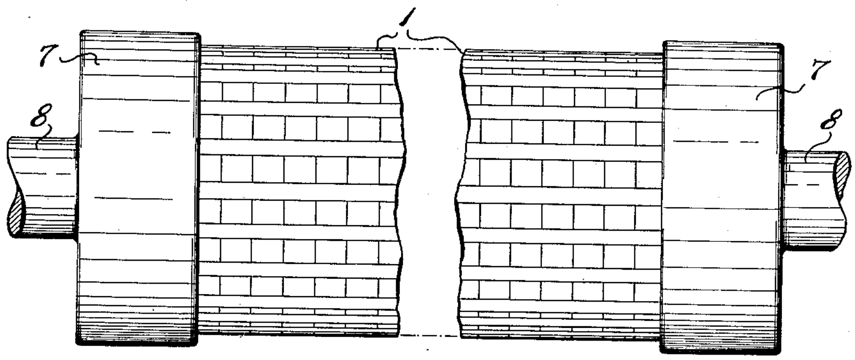

Fig. 1

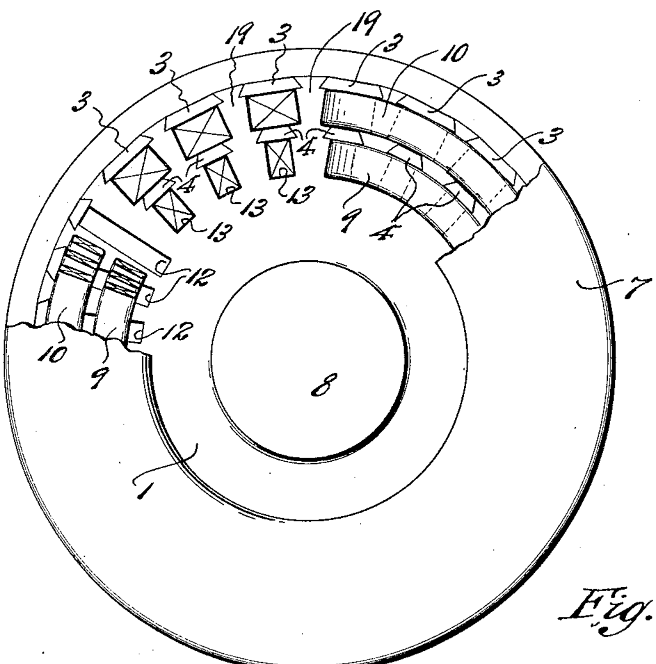

Fig. 2

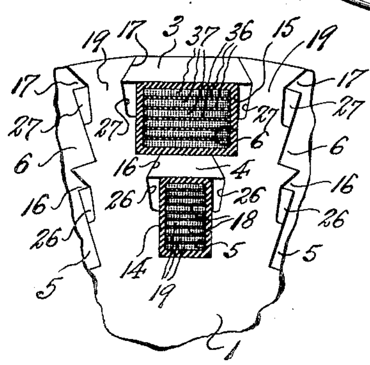

Fig. 3

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ELECTRIC GENERATOR ROTOR

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Application September 7, 1938, Serial No. 228,750

4 Claims. (Cl. 171—252)

This invention relates to improvements in rotors of high speed electrical generators, and in the arrangement and mounting of the magnetizing windings of said rotors.

It is generally the practice to turn high speed rotors from a solid steel forging. The forging is turned down to a smooth cylinder and, for a two pole machine, something more than two diametrically opposite quarters of the circumference have each an even number of slots milled in them to receive the copper magnetizing coils. These copper magnetizing coils are generally wound and pressed to exactly fit into their slots. After the coil has been baked and pressed into position, the slot is closed at the top by bronze wedges which engage in grooves or ways shaped in the outer portions of the rotor teeth. The teeth being those portions of the rotor which remain between the milled slots.

In usual construction above mentioned, the slot is of constant width from bottom to top, i. e. throughout the depth of the slot, and, since the slots are milled in a cylinder, the intermediate teeth are considerably thicker at their outer ends than at their roots. The width of a slot must be so determined that the material left at the roots of the bordering teeth is ample to support the weight of the tooth mass itself, as well as its share of the coil load, with an excess margin or safety factor to permit of the highest rotor speeds that may ever be experienced in practice.

In the present invention the magnetizing winding is divided into two parts. First, an inner winding, preferably made of copper, located in the bottom of a slot and held in position by bronze wedges which engage in the grooves or ways therefor which are shaped in the sides of the teeth approximately half way between the roots and outer ends of the teeth which terminate at the circumference of the rotor. Second, an outer winding, preferably made of aluminum, and held independently of the inner winding by its wedges likewise engaging in grooves or ways shaped in the outer end portions of the teeth in the usual way. The slots are milled relatively narrow in the inner portions containing the copper windings, and relatively wide in the outer portions containing the aluminum windings.

It will be obvious to one skilled in the art, that due to the relatively narrow width of the slots adjacent to the roots of the teeth, said roots are very wide and strong, and this strength is needed, since each tooth at its root must carry its share of the mass of the tooth itself, the inner winding and its wedges, as well as the upper winding and its wedges. On the other hand, by reason of the widened portions of the slots near the circumference of the rotor, each tooth at the bottom or inner part adjacent the wider portions of the slots is relatively very thin, but this is permissible since it need only carry its share of the upper light aluminum winding, the wedge required to support this light aluminum winding against centrifugal force, and the relatively thin and light outer portion of the tooth mass.

It is well known in the art that the very high centrifugal force operating on those winding turns lying close to the periphery of the rotor, taken in cooperation with continual expansion due to temperature changes, causes these turns to distort and take a permanent set and after a series of heat cycles and running and stationary cycles, the rotor winding may be distorted to such an extent that it is of no further use and must be replaced.

It will be obvious to one skilled in the art that since each pole winding of the present invention is divided radially into two portions, each of which is independently supported against centrifugal force, it is possible for a rotor designed according to the present invention to pass through a much greater number of cycles and these cycles of much more extreme temperature changes before damage is likely to be experienced.

It is an object of the present invention to improve the space factor available for windings in a high speed generator rotor by providing a relatively narrow slot and thick tooth at the inner end of the tooth where total stresses are very great, and a relatively wide slot and narrow tooth where the total stress in the butt of the narrowed tooth portion is relatively small, and to provide means for supporting the coils in the narrow portion of the slot so that the centrifugal force developed by the inner winding is carried by the inner thick tooth portions and is not transmitted radially outwards to be carried by the thin outer tooth portions.

It is an object of the present invention to employ materials for conducting the magnetizing current in a high speed rotor winding having a minimum cross section per unit of conductivity for that portion of the winding lying in the bottom of the slot where a wide tooth and narrow slot is compulsory in combination with a conducting material having a minimum weight per unit of conductivity for that section of the winding nearest the circumference where the tooth may be narrow and the slot very wide.

It is a further object of the present invention to so proportion the relative width of inner and outer portions of the slots in the rotor that a maximum space for magnetizing windings is provided and at the same time the stress in the rotor teeth due to centrifugal force is held to a minimum, whereby a relatively large rotor diameter may be used.

It is a further object of the present invention to so proportion the rotor teeth from the root portions to the circumferentially terminate portions that the tooth width is no greater than is required to fulfill its necessary function.

It is a still further object of the present invention to provide a more efficient use of the winding region in a high speed generator rotor whereby a greater power output may be obtained from a rotor of given size.

Other objects of this invention, not at this time more particularly enumerated, will be clearly understood from the following description of the same.

The invention is clearly illustrated in the accompanying drawing, in which:

Fig. 1 is a schematic side elevation of a high speed generator rotor.

Fig. 2 is an end elevation of the rotor, with parts broken away, this view being drawn on an enlarged scale.

Fig. 3 is an enlarged fragmentary cross section through one of the winding coil containing slots of the rotor.

Similar characters of reference are employed in all of the herein described views to indicate corresponding parts.

Referring now to said drawing, the reference character **12** indicates longitudinal ventilating slots which are cut in the rotor for ventilation purposes, and which are more particularly described in my pending U. S. patent application Serial No. 228,751, filed September 7, 1938.

The reference character **13** indicates the winding coil containing slots which constitute one of the novel features of the present invention. The end windings of the rotor **1** are held in place by the heavy alloy head rings **7, 7**. These end windings are formed in the usual manner with the exception that at each end there are outer end windings **10** and inner end windings **9**. As shown in Fig. 2, the alloy end ring **7** has been broken away to show at one point these end windings **9** and **10** in elevation, while at another point the windings **9** and **10** are broken away to show the slots **13, 13, 13** with the winding coils therein in section. The shaft ends **8** are preferably forged integral with the rotor body **1**, and the slots **12** and **13** are milled and shaped in the rotor forging **1** after it has been finished to desired cylindrical shape. The winding spacer blocking which is of standard design is omitted between the coil end windings **9** and **10** and between the end winding **10** and the alloy head **7**.

In Fig. 3 more particularly, a slot **13** is shown to comprise an inner portion **5** which is preferably filled with conducting material having a high conductivity per unit cross section, such as copper. The turns **19, 19** are spaced apart by insulating strips **18, 18**, and the whole group of turns is surrounded and insulated from ground by the cell of insulation **14**. After the space **5** has been completely filled by the turns **19, 19** and the winding has been baked in place, a series of wedges **4, 4** are driven in from each end so as to completely close the outer side or top of the slot portion **5**. These wedges **4, 4** engage in the grooves or ways **16, 16** shaped in the sides of the teeth bordering the slot.

The outer portion **6** of the slot **13** is much wider than the lower portion **5**. Turns of conducting material **37, 37** formed of very light metal, such for instance as aluminum, are insulated between turns by the strips of insulation **36, 36**. The entire group of turns is surrounded and insulated from ground by an insulating cell **15**. After these turns **37, 37** of comparatively light material have been wound, baked and pressed into place, the entire top of the slot portion **6** is closed by a plurality of wedges **3, 3** driven in from each end. These wedges **3, 3** engage in grooves or ways **17, 17** formed in the sides of the narrow portions **19, 19** of the teeth. It is obvious that the additional slots or lateral enlargements **26, 26** adjacent the narrow slot portion **5**, and the additional slots or lateral enlargements **27, 27** adjacent the wide slot portion **6** may be formed in the rotor teeth whereby the same will be made still lighter without reducing undesirably the required strength thereof.

This invention operates as follows. The inner slot portions **5, 5** of slot **13, 13** are proportioned in width so that the roots of the inner portions **18, 18** of the teeth are amply strong to properly sustain the entire weight of each tooth mass as well as that portion of the upper and lower coil windings and wedges **3** and **4** located in the slots. It follows that the space **5** for windings is very restricted as to width. On the other hand, the portions of the teeth **19, 19** lying outwardly beyond the wedges **4, 4** only need be strong enough at their roots or butts to carry the mass of the outer tooth portions **19**, the windings located in the upper slot space **6, 6** and the upper light bridging blocks **3, 3**. Each tooth portion **19** may therefore be relatively narrow at its root or butt. The winding space **6** therefore may be made relatively very wide, both because of the narrowing of the adjacent teeth and by reason of the fact that this outer winding space **6** lies in the area of greatest rotor circumference.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a high speed electric machine rotor having a slot to hold windings, said slot being formed to provide a narrow portion at its bottom and a wide portion at its top, slot bridges affixed across the top of said narrow portion, and slot bridges affixed across the top of said wide portion.

2. A winding for the rotor of a high speed electric machine comprising an outer coil group formed of material having a minimum weight for a given conductivity and an inner coil group formed of material having a maximum conductivity for a given cross section.

3. A winding for the rotor of a high speed electric machine comprising an outer coil group and an inner coil group in the same slot, and means in the slot portion of said coil group for supporting each winding against centrifugal force independently of the other winding.

4. In the rotor for a high speed electric machine a winding slot having a narrow inner portion and a wide outer portion and turns of high conductivity material secured in place in said narrow portion and turns of light weight conducting material secured in place in said wide portion.

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