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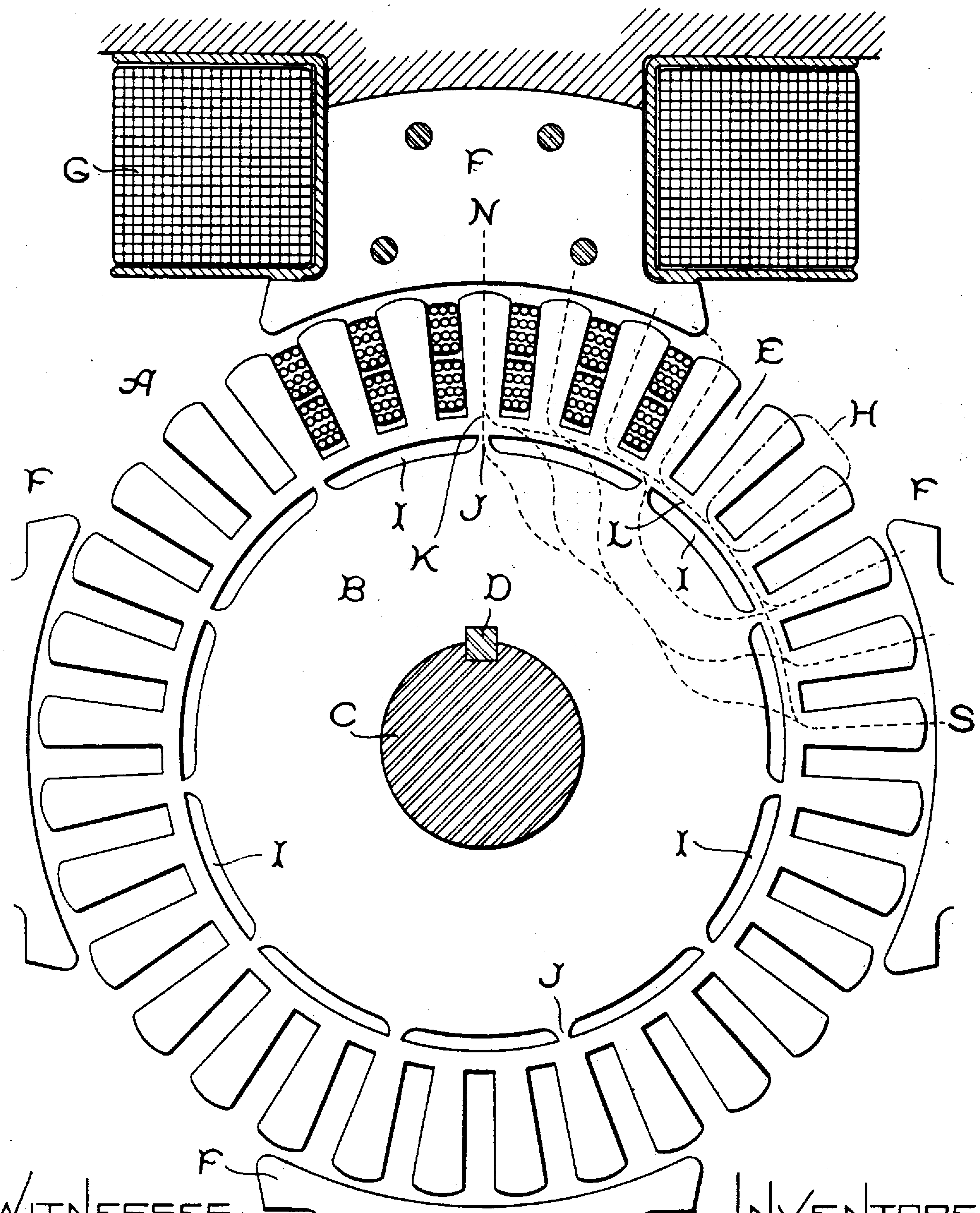
E. H. ANDERSON & D. P. THOMSON.

ARMATURE FOR DYNAMO ELECTRIC MACHINES.

(Application filed Jan. 8, 1898.)

(No Model.)



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UNITED STATES PATENT OFFICE.

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ARMATURE FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 608,277, dated August 2, 1898.

Application filed January 8, 1898. Serial No. 666,016. (No model.)

To all whom it may concern:

Be it known that we, EDWARD H. ANDERSON and DAVID P. THOMSON, citizens of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Armatures for Dynamo-Electric Machines, (Case No. 671,) of which the following is a specification.

The present invention has for its object to improve the construction of armatures, whereby their efficiency is increased and the sparking at the brushes and the heating reduced.

It is necessary from a production point of view to reduce the amount of iron and copper used in a dynamo-electric machine to a minimum. To accomplish this, most machines are built to work with high-density pole-pieces and armature-teeth, resulting in an armature having a greater self-induction than can readily be taken care of by the commutator-brushes. Sparking at the commutator-brushes is chiefly due to the inductance kick caused by the local magnetic flux set up in the armature-teeth at the instant the coil passes the point of commutation and the direction of current changes. This is particularly noticeable in cores having teeth of low magnetic reluctance.

A smooth-core machine, considered from a sparking standpoint, possesses many advantages over the tooth construction; but the advantages of a toothed construction, as regards the matter of winding, more than offset its disadvantages. The sparking at the commutator-brushes of a toothed armature can be reduced to a certain extent by decreasing the cross-section of the iron forming the teeth. This, however, is limited by the necessity of providing a strong mechanical structure to support the coils. We propose to increase the reluctance of the local magnetic circuit in the teeth without altering their size. This is accomplished by providing air-gaps in the core, so arranged that two magnetic circuits arranged in multiple are provided, one of restricted area and high reluctance, through which passes the high-density field-flux and also the local flux of the teeth, and the second of high reluctance, due to the air-gap, and of low density on account of the increased cross-section. By this arragement a good magnetic path is provided for the main flux; but the path of the local flux in the teeth is so restricted at certain portions and the iron is worked at such high density that the magnetic motive force tending to set up the local flux has only a negligible effect.

In the accompanying drawing we have shown our invention applied to the armature of a four-pole railway-motor; but it is equally applicable to other types of dynamo-electric machines.

The armature A comprises a number of toothed laminæ B, assembled on a shaft C and secured against rotation by key D. For the purpose of illustration the winding has been omitted except under the upper pole-piece, and here it is shown in section. The particular form of winding employed forms no part of our invention; but we have found that the well-known Eickemeyer winding works very satisfactorily. Slots E in the core are provided with parallel sides and are of sufficient depth to receive the top and bottom layers of the armature-winding. The outer ends of the teeth are slightly rounded, so that they will enter and leave the field under the pole-pieces in a smooth and gradual manner.

Situated at equidistant points around the armature are pole-pieces F, which may or may not be wound with field-coils G. We have shown laminated pole-pieces having enlarged pole-faces on account of the increased benefits to be derived therefrom; but any other form of pole-piece may be employed.

In machines having toothed laminated armature-cores a reactance voltage is developed the instant the current in a coil is reversed. This reversal takes place at the points of commutation. The reactance voltage is due to local magnetic fluxes set up in the armature-teeth, as shown by the broken and dotted line H. It is of course understood that the same action takes place for each coil as it passes the point of commutation. If the reactance voltage rises above a certain amount, it causes prohibitory sparking at the commutator-brushes. To reduce the reactance voltage to a minimum, we propose to increase the magnetic reluctance of the teeth without decreasing the mechanical strength. This is accomplished by punching air-gaps I under the bottom of the slots and so arranging them that the sectional area of metal at the point L, under slots E, is less than that of the teeth. By varying the cross-section of metal at this point the magnetic reluctance of the local circuit can be varied within wide limits and the reactance voltage reduced to a minimum. The amount of iron J left between the air-gaps I is determined by the required mechanical strength of the armature.

Considering for convenience one portion only of the armature, the magnetic flux going from pole N to pole S passes through the teeth, as indicated by the dotted line, to point K, where the magnetic circuit divides, one path being of limited cross-section, as at L, and working at high density on account of the restricted area, the other path being from point K through portion J and across air-gaps I to the main body of the core, which, on account of its increased cross-section, works at a low density. By the arrangement shown the two paths for the field-flux have about equal magnetic reluctance. This is occasioned in one case by the limited cross-section of metal at L and in the other case by air-gaps I and limited cross-section of metal J. By varying the air-gaps the magnetic reluctance of the second path can be changed as desired; but we have found that the most satisfactory results are obtained when they are substantially equal.

We have found that by working only a small portion of the armature at high density and the remainder at low density we are enabled to obtain the benefits to be derived from high-density armatures, at the same time having a greatly-decreased core loss on account of the limited amount of high-density iron employed, thereby increasing the efficiency of the motor.

The local magnetic flux, (indicated by broken and dotted line H,) being small as compared with the field-flux and having comparatively little force, is choked back by that portion of the main field-flux which threads through the thin portion L under the slots, so that when the current reverses in any given coil the local flux set up thereby is so small that no destructive reactance voltage is created.

Machines have been constructed heretofore in which hollow-body armature-cores were employed. In other words, instead of having the core-disks solid from the bottom of the slots to the shaft they were provided with a central portion forming a hub and an outside ring supported from the hub by a number of arms formed integral with the hub, and between the hub and the ring were large openings. The object aimed at in this construction was to reduce the sparking, and within certain limits it was successful; but on account of having to work the whole core, as well as the teeth, at a high density it was not as efficient as the present construction, where only the portion of the core directly under the slots is run at a very high density, the remainder being comparatively low. For example, a machine was constructed and tested which was provided with a hollow core. The machine was then taken down and a new armature having a similar winding and an air-gap core substituted and tested. A comparison of the results of the tests showed that the core loss of the hollow-body armature amounted to two thousand three hundred and fifty watts, while that of the armature having an air-gap core amounted to only fifteen hundred and fifty watts, and that the maximum efficiency of the air-gap-core motor was two per cent. greater than the former.

What we claim as new, and desire to secure by Letters Patent of the United States, is—

1. An armature for a dynamo-electric machine, provided with two main paths for the field-flux, as distinguished from the several paths through the armature-teeth, which have practically the same magnetic reluctance, but which with a given field excitation work at different densities.

2. In a dynamo-electric machine, the combination of a field-magnet, an armature, and a core for the armature provided with a number of paths for the field-flux, which differ in their magnetic density, but have approximately the same reluctance when working in a given magnetic field.

3. In a dynamo-electric machine, the combination of a field-magnet with an armature having a toothed laminated core provided with two paths through which substantially all of the field-flux passes, the two paths having substantially the same magnetic reluctance, but varying in their cross-section.

4. In a dynamo-electric machine, the combination of a field-magnet, a toothed armature separated from the field-magnet at all points by an air-gap, and an air-gap in the body of the armature arranged to divide the field-magnet flux and reduce the local magnetic flux in the armature-teeth.

5. In a dynamo-electric machine, the combination of a field-magnet, an armature, a toothed core therefor separated from the field-magnet by an air-gap, and air-gaps in the armature-core arranged to divide the field-flux into two parts.

6. In a dynamo-electric machine, the combination of a field-magnet, an armature, a toothed core therefor separated from the field-magnet by an air-gap, air-gaps in the body of the core, and two main paths for the flux of each pair of poles, one of which includes the air-gaps in the core.

7. In a dynamo-electric machine, the combination of a field-magnet, an armature movable with respect thereto, a toothed armature-core, and openings in the core between the teeth and the main body of the core for limiting the cross-section of iron at this point.

8. In a dynamo-electric machine, the combination of a field-magnet, a toothed armature separated therefrom by an air-gap, and auxiliary air-gaps situated between the teeth and the main body of the core, the air-gaps being of greater length than the width of a single tooth.

9. In a dynamo-electric machine, the combination of a laminated armature-core having slots with parallel sides and a solid body with air-gaps made in the laminæ directly under the teeth and slots, the air-gaps being of greater length than depth.

10. In a dynamo-electric machine, the combination of a field-magnet, an armature separated therefrom by an air-gap, and an auxiliary air-gap in the body of the armature for decreasing the local magnetic flux which is created when a coil passes the point of commutation.

In witness whereof we have hereunto set our hands this 5th day of January, 1898.

EDWARD H. ANDERSON.
DAVID P. THOMSON.

Witnesses:
B. B. HULL,
E. W. CODY.