No. 659,716. Patented Oct. 16, 1900.

E. THOMSON.

ADJUSTING RELUCTANCE OF MAGNETIC CIRCUITS.

(Application filed July 20, 1898.)

(No Model.)

FIG. 1.

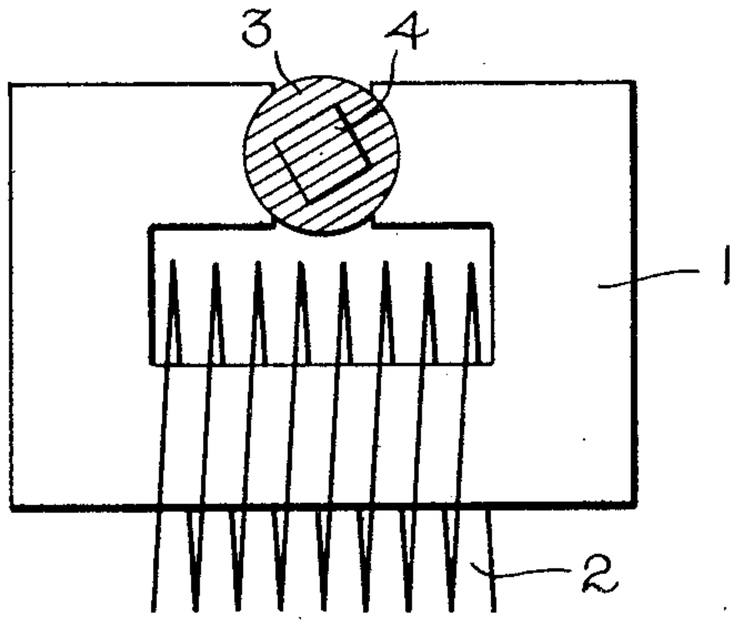


FIG. 2.

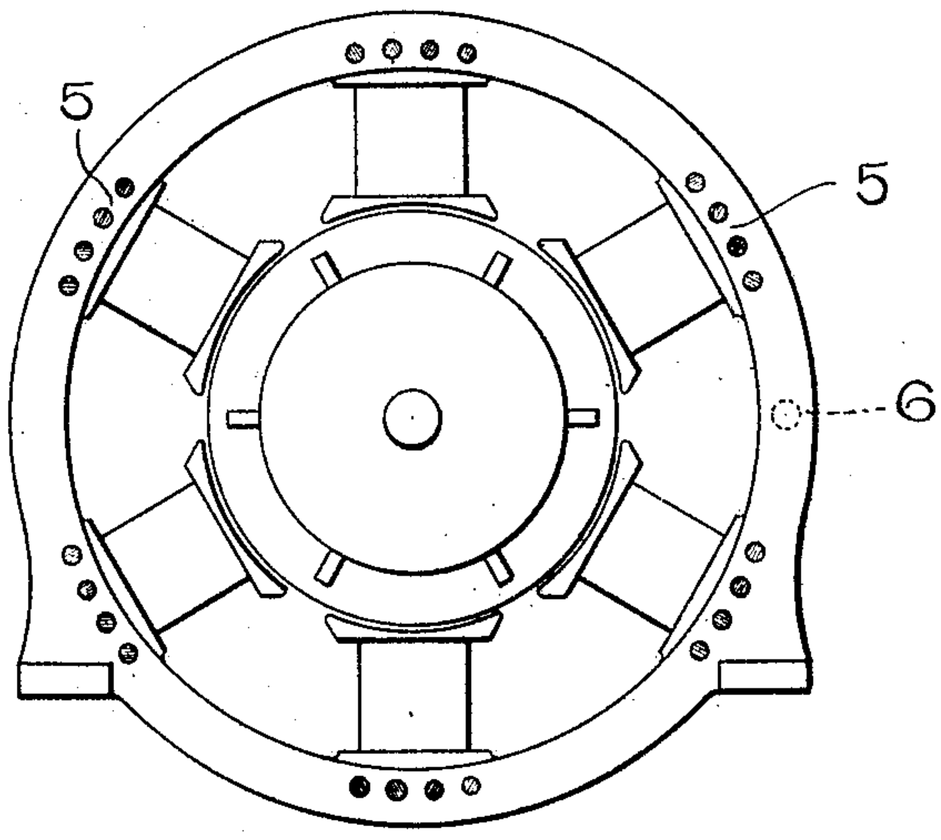
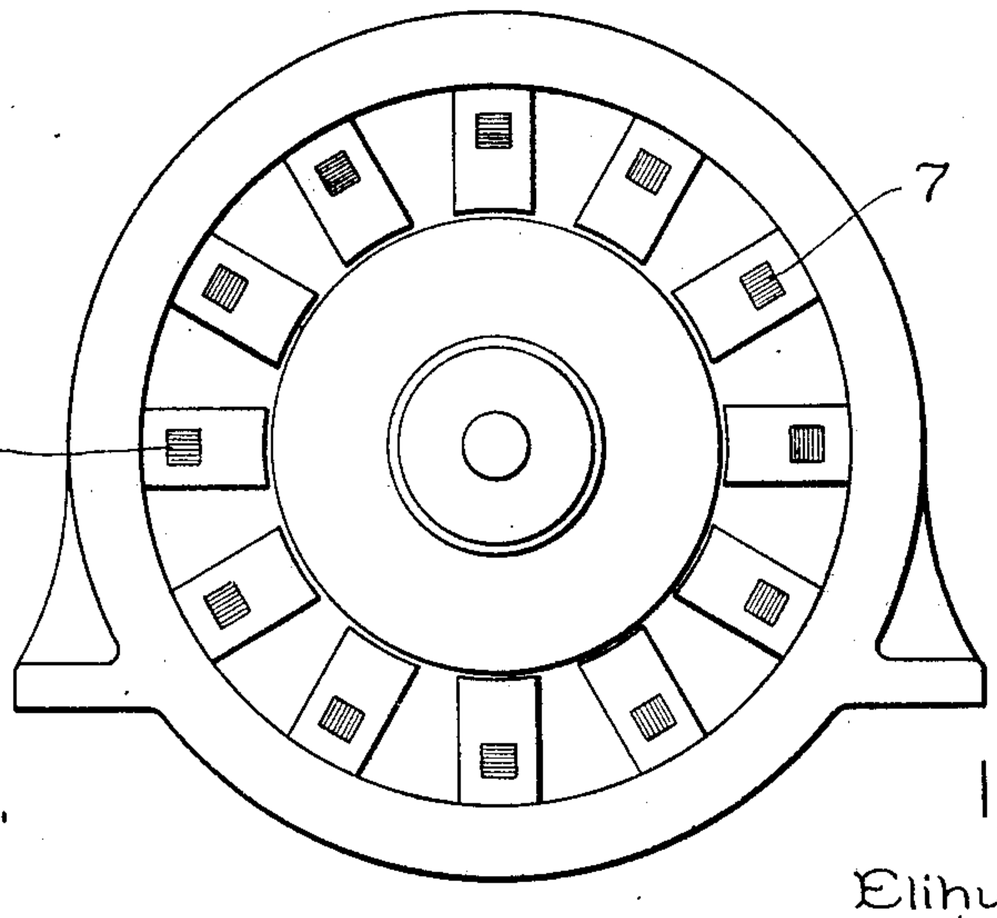


FIG. 3.



WITNESSES.

A. H. Abell.

A. F. Macdonald.

INVENTOR.

Elihu Thomson,

by Albert G. Davis
Atty.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

ADJUSTING RELUCTANCE OF MAGNETIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 659,716, dated October 16, 1900.

Application filed July 20, 1898. Serial No. 686,412. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Means for Adjusting the Reluctance of Magnetic Circuits, (Case No. 881,) of which the following is a specification.

The present invention comprises, broadly, the idea of interposing in any magnetic circuit a body of laminated magnetic material, so arranged that the laminæ may be placed either parallel with or at any desired angle to the lines of force of the circuit. By placing the laminæ parallel to the lines of force or in the line of magnetic induction the reluctance is least, while if placed at an angle the reluctance is increased and becomes a maximum when the angle is ninety degrees.

My invention is capable of many embodiments, and in the drawings forming a part of this specification I have shown, by way of example, three modes of applying the same.

Figure 1 illustrates the use of my invention in connection with a reactance-coil. Fig. 2 shows an application of my invention for the purpose of balancing up the field-magnets of dynamo-electric machines. Fig. 3 shows another mode of applying the invention.

In many cases it is desirable to have an adjustable reactance-coil. Fig. 1 is a conventional representation of such a device. The core consists of a laminated structure of any suitable form, as 1. This core either has an opening formed therein, as in Fig. 2, or is entirely interrupted, as shown in the drawings, Fig. 1. The openings or cuts made in the core are such as to intercept the lines of force produced by current in the exciting-coil 2. A body of laminated magnetic material 3 is arranged so as to be capable of assuming different angular relations to the lines of force or line of magnetic induction in the core. By varying the position of the core the reluctance of the magnetic circuit will be correspondingly varied, as is evident. The body of magnetic material may be in the form shown in Fig. 1, or it may be any regular-sided prism—as, for instance, square in cross-section, as shown in Fig. 3. If the plug is cylindrical, it may be mounted in various ways so as to turn. If desired, the walls of the opening itself may form the bearing, in which case the plug may be provided with a squared or other angular projection 4, by which it may be turned in its bearings for purposes of adjustment. If desired, however, the laminated magnetic material may be mounted on a shaft carried in suitable bearings, in a manner analogous to that of the armature of a dynamo-electric machine. The construction is so obvious that no illustration is deemed necessary.

In many cases difficulty is experienced in setting up a multipolar dynamo-electric machine so that the electromotive forces generated between the different sets of brushes shall be the same. Owing to some accidental difference in the quality of iron used, or to a slightly eccentric placing of the armature with respect to the pole-pieces, or to various other causes, it may happen that the flux due to one set of poles may differ from that due to another. In such a case, if the machine is a generator, one circuit may furnish more current than another, and in exaggerated cases the current may even be reversed in some of the circuits. In the case of a motor under similar circumstances the counter-electromotive force of the different circuits would be different, whereby some circuits would take an excessive current and others but very little. To obviate these difficulties, I provide openings in some suitable portion of each of the magnetic circuits of the machine. The openings are preferably circular in cross-section, as shown in Fig. 2, and may be located at the base of each pole-piece, as shown at 5, or, if desired, the openings may be made in the yoke between the pole-pieces, as indicated, for example, at 6. Into these openings are inserted plugs of laminated magnetic material, with the laminæ arranged longitudinally of the openings, so as to intercept the lines of force. An end view of the laminæ is shown at 5. By turning the plug by any suitable means—such as shown at Fig. 1, for example—or by withdrawing the plug and inserting it at a different angle the magnetic reluctance of the circuit is changed, and consequently the flux. By suitable adjust-

ment in the manner described the flux per pole in a mulipolar machine may be equalized or otherwise altered or adjusted.

Fig. 3 shows a slightly-different application of the invention. In this case the pole-pieces of a dynamo-electric machine are provided with openings transverse thereto and preferably square. By inserting a square plug 7 of laminated material so that the laminæ are either parallel to or lie across the lines of force, or by omitting the plug entirely I am enabled to obtain an effect equivalent to inserting an air-gap of different lengths into the magnetic circuit. The air-gap becomes operative when the reduced section of the pole-piece becomes saturated. A bend in the saturation curve is produced at the point where the air-gap becomes operative. Above the bend in the curve the magnetization is no longer proportional to the magnetomotive force, and the operation of the machine is thus rendered less sensitive to change in the current in the field-winding. In this latter application of my invention I prefer to make the laminations of soft iron and separate them by paper or other non-magnetic material of suitable thickness.

Generally speaking, the laminæ may all be formed of the same material and suitably separated from each other by sheets of non-magnetic material, or they may be formed of material of different permeability, such as soft iron and hard steel, and suitably intermingled. If desired, the use of sheets of non-magnetic material may be omitted, the unavoidable air-spaces between the laminæ being in many cases sufficient to secure the desired lack of symmetry in permeability of the laminated body.

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

1. The combination with a multipolar dynamo-electric machine, of adjustable means for producing a relative variation of the respective reluctances of two or more of the magnetic circuits of the machine.

2. The combination, with a multipolar dynamo-electric machine, of adjustable means for varying the reluctance of two or more of the magnetic circuits of the machine and thereby equalizing the fluxes in said circuits.

3. A reluctance-adjusting device consisting of intermingled plates of magnetic material of different permeability.

4. A reluctance-adjusting device composed of laminated magnetic material in the form of a solid of revolution, and with laminæ arranged parallel to the axis.

5. The combination of a body of magnetic material forming part of a magnetic circuit and having an opening therein, and a body of laminated magnetic material of the same cross-section as the opening adapted to assume different positions in said opening and with the laminæ arranged longitudinally of the opening for each position.

6. The combination of a body of laminated magnetic material having the configuration of a surface of revolution and with the laminæ parallel to the axis, and a body of magnetic material with an opening therein to receive said laminated body.

7. The combination of a body of magnetic material forming part of a magnetic circuit and having an opening therein, and a body of laminated magnetic material adapted to fill said opening in all positions and assume different positions therein, thereby varying the reluctance of the magnetic circuit.

8. The combination of a body of magnetic material forming part of a magnetic circuit and having an opening therein, and a body of laminated magnetic material of the same cross-section as the opening and adapted to assume different positions therein.

In witness whereof I have hereunto set my hand this 16th day of July, 1898.

ELIHU THOMSON.

Witnesses:
A. F. MACDONALD,
ALEXANDER D. LUNT.