(No Model.)

S. H. SHORT.

MULTIPOLAR DYNAMO, MOTOR, OR ROTARY TRANSFORMER.

No. 588,491. Patented Aug. 17, 1897.

Fig. 1.

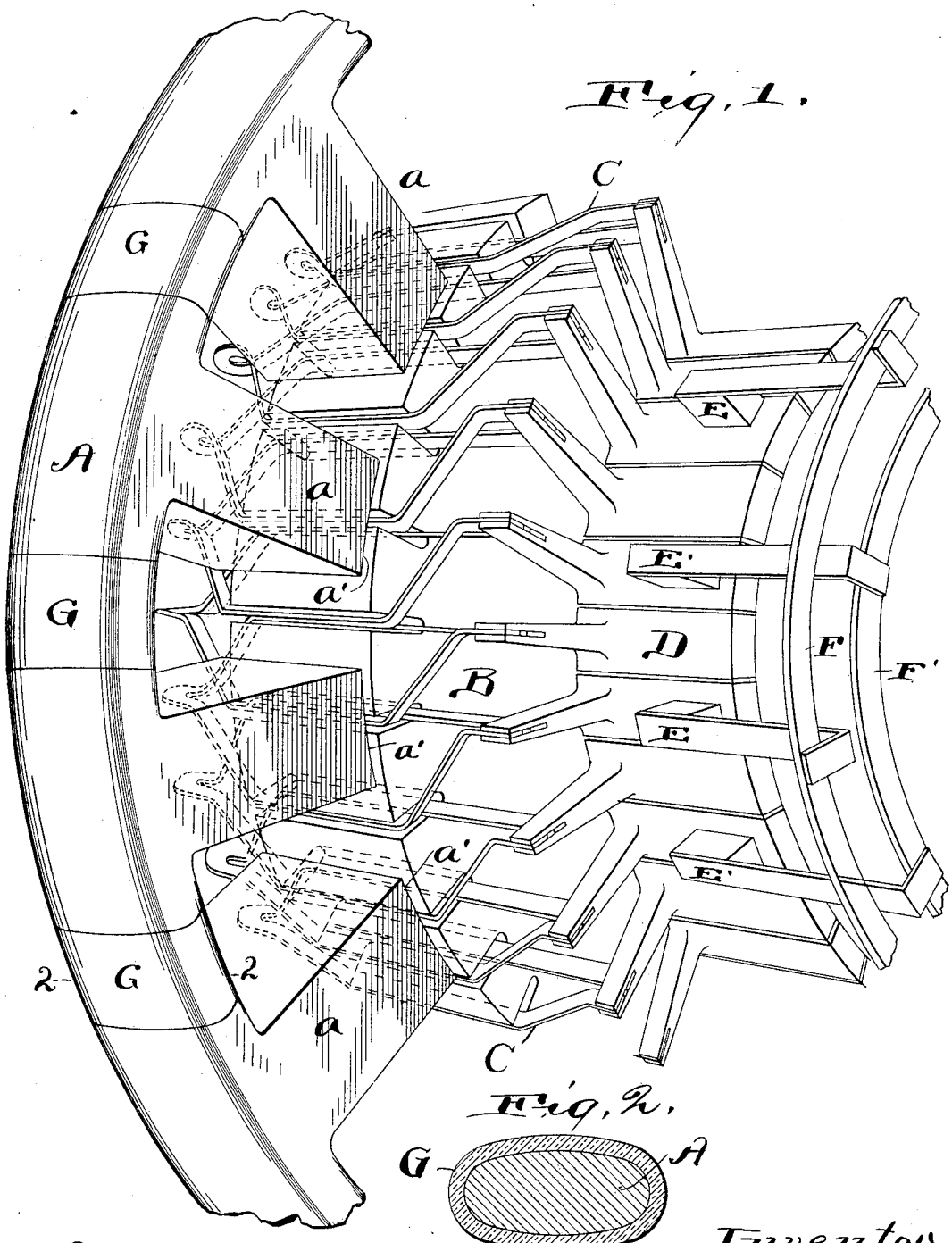


Fig. 2.

Witnesses:
E. B. Gilchrist
A. M. Rankin

Inventor:
Sidney H. Short
By his attorney
Thurston & Bates.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

SIDNEY H. SHORT, OF CLEVELAND, OHIO.

MULTIPOLAR DYNAMO, MOTOR, OR ROTARY TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 588,491, dated August 17, 1897.

Application filed March 12, 1897. Serial No. 627,171. (No model.)

To all whom it may concern:

Be it known that I, SIDNEY H. SHORT, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Multipolar Dynamos, Motors, or Rotary Transformers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The object of my invention is to provide a multipolar dynamo, motor, or rotary transformer in which there shall be combined two advantages which I believe have hitherto been deemed incompatible—viz., a very low reluctance or magnetic resistance and an absence of the hitherto consequent counter-currents in the armature which cause bucking when the same is being started.

In order that the desirability of low reluctance, as well as the disastrous effects of bucking, may be fully appreciated and the purpose and operation of my improvement thereby the better understood, I will first describe somewhat fully the previous method of constructing multipolar dynamos, motors, or rotary transformers and the evils which were there encountered.

The earlier armatures were wound with wires on their surface and had no projections of iron between the windings and toward the pole-pieces of the stationary field-magnets. These armatures were known as "smooth-core" armatures. In this construction considerable space, sometimes amounting to an inch, existed between the face of the iron of the armature-core and the face of the pole-piece. This air-gap caused very great reluctance or resistance to the magnetic lines of force circulating in the field-magnets and armature-core. To produce the proper magnetic lines of force against this great reluctance, it was necessary to wind a large amount of wire about the field-magnet. In order to reduce this reluctance, and thereby reduce the amount of field-winding and save the expense of copper wire, armatures were made with cores having on their surface teeth and notches, and the conductors were placed in the notches, and thus between the teeth. With such construction it is possible to bring the pole-pieces and armature-core into much closer juxtaposition. This construction reduces the amount of field-winding, as stated, and it also produces a larger magnetic flux through the magnetic circuit, and thereby reduces the number of armature-inductors, so that it saves copper in the armature as well as in the field. It also increases the efficiency of the machine, as less current is used in exciting the fields.

Theoretically with an armature so wound the approach of the pole-pieces to the armature-core is only limited by the play required to prevent actual contact, but when it was attempted to reduce the reluctance to this extent a new difficulty presented itself. The iron or steel forming the magnet-cores and pole-pieces is necessarily not absolutely homogeneous. The material varies in hardness and the magnetic properties in the different magnets are different. It therefore happens that when the excitation of the fields ceases the magnet-cores will have a residual magnetism differing in intensity in different magnets. One pair of poles may therefore have a considerable permanent magnetism, while the next pair have practically or relatively none. If now the armature is rotated, there will be current set up in the armature-inductors underneath the pair of poles having the residual magnetism. This current will flow around through the armature, out through the commutator to the brush, and around the brush-ring to the next brush and back through it and its commutator-bar to the armature-coils beneath the next magnet. The effect of this current at this point will be to induce magnetic lines between the armature and the second magnet in the wrong direction, so that they will tend to turn the armature as a motor in the direction of rotation of the armature, while the former pair of magnets, which are generating current, would tend to hold the armature back or keep it from rotating in the direction in which it is driven. Now the current produced in the armature by the generating-magnets reduces the magnetic flow in that magnetic circuit, while the current flowing through the armature under those magnets which are acting in the manner of a motor increases the magnetic flow in the magnetic circuit at that point. The result is that

the generating-magnet gradually becomes weak and the second magnet becomes strong until the magnetic lines which already flow in the first magnet are stopped. Then the second magnet immediately begins to generate current in the armature-inductor beneath it and a strong current flows in the opposite direction. A complete reversion has therefore taken place. This reversion will again take place and with greater intensity and rapidity, because the iron in these magnetic circuits does not have time to entirely drop its flux. The result is that as the machine continues to alternate in its action and the magnetic flux rises and falls the intensity increases and soon produces such tremendous current in the armature-inductors as to burn them out, or such enormous eddy-currents in the magnet core and yoke as to heat them in a few minutes to a dangerous point. Not only this, but these fluxes become so great and vibrate so rapidly that it sets the whole mass of magnet cores and yoke to vibrating and bending, so that the machine may pull itself loose from its foundations and even spring the magnetic yoke to such an extent in its oscillations as to make the pole-pieces strike the armature-face and destroy the machine, or if the dynamo should happen to be built strong enough to prevent this it will stop the engine against its full steam-pressure and the momentum of its fly-wheel. It will be understood that all this operation is entirely independent of the windings of the field-magnets. No current passes to these windings, as it is all used up within the armature, as described. Hence it is impossible to automatically start one of these low-reluctance machines. Should the fields be separately excited, the trouble would not arise, as the magnets would all be then arranged in the proper direction by means of their electromagnetism and the small residual magnetism would be immaterial; nor could these difficulties be encountered in a bipolar dynamo. They are peculiar to the multipolar machine. So far as I am aware, no method of obviating this inhibiting result has been discovered except that of increasing the magnetic reluctance or the resistance in the armature-circuit. The former may be done by allowing more space between the pole-face of the magnets and the armature or by making the teeth on the armature narrower, thus increasing the air-gap, while the latter may be accomplished by introducing a large resistance between the brushes. These all decrease the efficiency of the machine while increasing the expense of construction. Means may be provided for throwing out of circuit, after the fields are excited, the extra resistance introduced into the armature-circuit, but this destroys the automatic starting of the machine.

I have discovered that if I surround the magnetic circuit at some point in its length outside the armature with metallic bands or other closed conductors of very low electric resistance all these disastrous results of too low a reluctance in multipolar machines are overcome. The operation of the bands is this: If the magnetic flux in any one of the magnets attempts to increase or decrease, an electric current of large quantity will be induced in this low-resistance band in the direction which will oppose the change. The fluctuation of the flux with its disastrous consequences is by this simple means prevented. My invention consists of the combination of such a band or similar closed circuit with a multipolar machine, whereby the advantages of a low reluctance without its hitherto consequent disadvantages are obtained.

In the drawings, Figure 1 is a perspective view of a portion of an armature, commutator, yoke, and fields of a multipolar dynamo or motor; and Fig. 2 is a section of the yoke on line 2 2 of Fig. 1. These views clearly illustrate my invention.

A is a yoke having extending from it the magnet-cores *a*. The pole-faces *a'* of these magnet-cores approach the armature-surface as closely as is practicable without danger of contacting in operation. These pole-pieces may be simple straight extensions of the cores or may be additional pieces, causing the poles to flare toward each other. The latter is deemed the preferable construction, as the pieces thereby cover more of the armature and additionally reduce the reluctance, though the former construction is shown in the drawings for convenience of illustration. The magnet-spools are omitted not only for convenience of illustration, but to emphasize the fact that the operation and purpose of this invention are absolutely independent of them and produce their effects before they come into operation.

B represents a notched armature-core; C, the armature-inductors; D, the commutator; E and E', the brushes, and F and F' the corresponding brush-rings. It will be appreciated that the armature-notches are in reality much closer together and the commutator-bars much narrower than are here shown. Surrounding the yoke between the magnet-cores are the metallic bands G, having a low electric resistance. These bands may be of magnetic or non-magnetic material and may be in actual contact with the magnetic circuit or simply close to it. They may surround the magnetic circuit at any point in its length outside of the armature. It is only necessary that they form a closed circuit and are of low resistance, so that an electric current of large quantity may be induced in them. I regard, however, copper bands placed about the yoke as a very satisfactory arrangement. The bands may be first formed, having their peripheries the same in size and shape as the yoke is to be, and placed in the mold for the yoke. The yoke may be then cast and the bands will be embedded therein and will have their surfaces flush with the surface of the yoke. This is the construction illustrated in the drawings.

From what has been said it will be understood that an induced current results in a band in one direction when the magnetic flux is increased and in the opposite direction when it is decreased. This induced current reacts upon the magnet-core and reduces or increases the flux. These bands therefore stop the fluctuations of the magnetic flux and the consequent evils.

The above explanation applies with equal force to a motor. In considering a rotary transformer we may imagine a pair of collector-rings around the armature-shaft connected with the commutator bars or inductors, so that at a given time one ring is connected with those commutator-bars connected with the brushes of one brush-ring and the other collector-ring with the commutator-bars connecting with the other brush-ring. If in such an arrangement, the field-spools being left off, an alternating current be supplied to the collector-rings, the machine will become a synchronous motor, establishing its own field, and a direct current will be delivered from the brush-rings. In such a construction we have a rotary transformer in which, if it is ordinarily attempted to reduce the reluctance, we have the same bucking as in a dynamo or motor. My invention allows this reduction of reluctance and the corresponding saving in armature-windings and increase of efficiency, as hereinbefore explained.

Having described my invention, I claim—

1. The combination with a multipolar dynamo, motor, or rotary transformer having a plurality of magnets, and a low-reluctance magnetic circuit, of closed-circuit metallic bands or conductors of low electric resistance inclosing the section of the magnetic circuit at some point in its length outside the armature, for the purpose set forth.

2. In a multipolar dynamo, motor, or rotary transformer, a yoke having magnetic cores extending therefrom close to an armature whereby a magnetic circuit of low reluctance is provided, in combination with closed-circuit metallic bands or conductors of low electric resistance surrounding the yoke between the magnet-cores, for the purpose set forth.

In testimony whereof I affix my signature in presence of two witnesses.

SIDNEY H. SHORT.

Witnesses:
E. L. THURSTON,
ALBERT H. BATES.