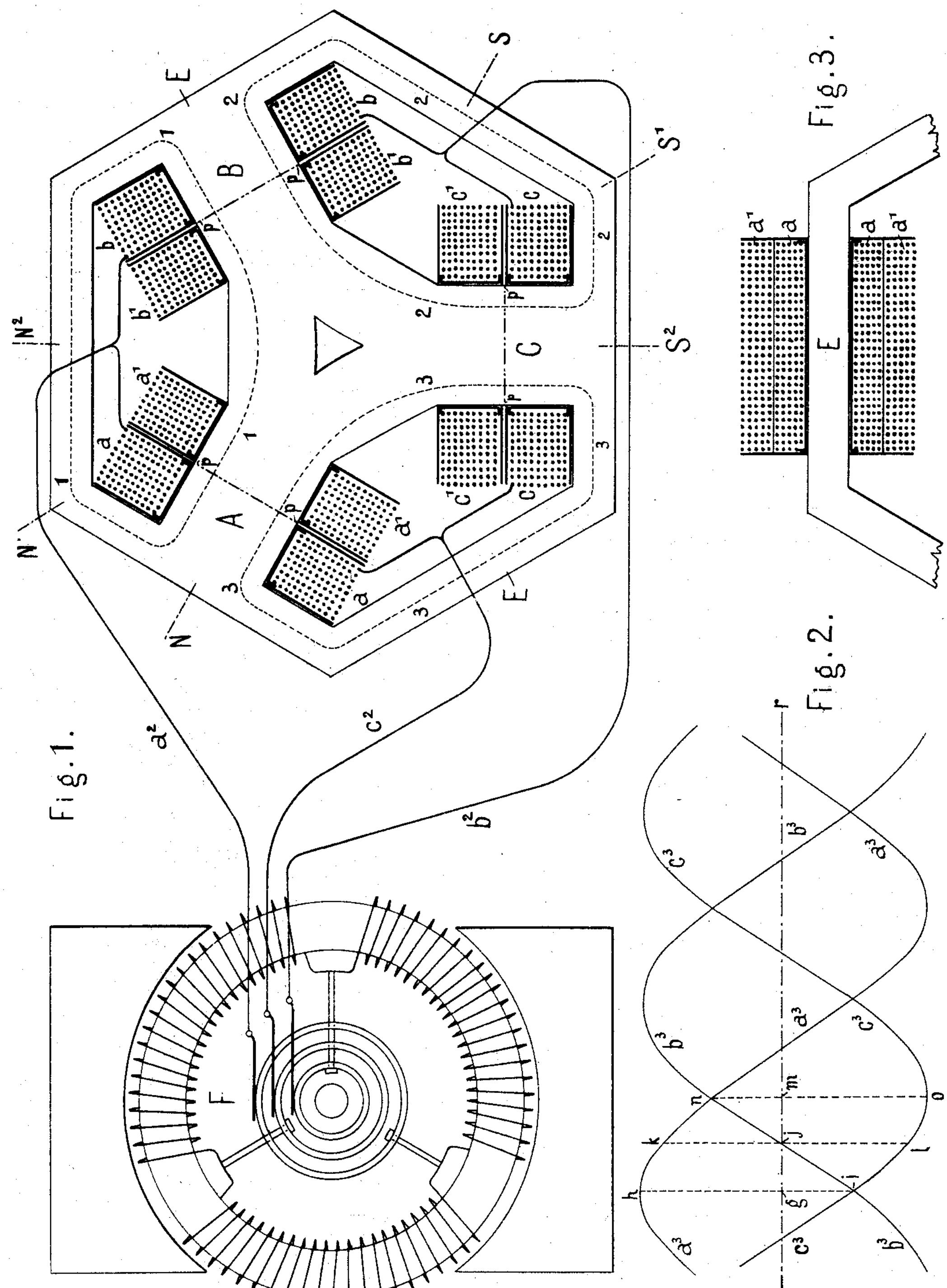
(No Model.)

# M. VON DOLIVO-DOBROWOLSKY.

## ELECTRICAL INDUCTION APPARATUS OR TRANSFORMER.

No. 422,746. Patented Mar. 4, 1890.

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# UNITED STATES PATENT OFFICE.

MICHAEL VON DOLIVO-DOBROWOLSKY, OF BERLIN, GERMANY, ASSIGNOR TO THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT, OF SAME PLACE.

## ELECTRICAL INDUCTION APPARATUS OR TRANSFORMER.

**SPECIFICATION** forming part of Letters Patent No. 422,746, dated March 4, 1890.

Application filed January 8, 1890. Serial No. 336,290. (No model.)

*To all whom it may concern:*

Be it known that I, MICHAEL VON DOLIVO-DOBROWOLSKY, a subject of the Emperor of Russia, residing at Berlin, Kingdom of Prussia, have invented new and useful Improvements in Electrical Induction Apparatuses or Transformers, whereof the following is a specification.

My invention relates to electric induction apparatuses or transformers whereby an alternating current of given tension is converted into a current of different tension, and its object is to raise the useful effect of such apparatuses. The apparatuses of this kind as heretofore employed consist, substantially, in two coils, one for the primary and one for the secondary or induced current, and a core or envelope of iron common to both coils, which is magnetized by the action of the primary current, and whereby the strength of the magnetic field of the latter is increased. The magnetism thus produced is alternating, like the primary current—*i. e.*, the polarity of the core is rapidly changed by every alternation of the current—one-half of each phase of the same producing a north pole at one end and a south pole at the other end of the core, while the other half-phase produces poles of opposite denomination. By this constant and rapid changing of the poles a considerable portion of the energy of the primary coil is uselessly converted into heat, and consequently wasted.

For the purpose of avoiding this loss of energy I proceed as follows: A plurality of pairs of coils, each pair consisting of a primary and a secondary coil, are placed upon as many cores of iron, forming three or more closed or nearly closed magnetic systems, and preferably arranged in a circle, and the primary coils are connected to a dynamo-electric machine which produces a number of alternating currents whose phases are shifted in respect to each other by a fraction of a phase, so that the maximum impulsions acting in the individual coils succeed each other, and which currents on leaving the dynamo unite to form a single current or groups of currents. Preferably the coils are placed in the same order in which the phases of the different currents whereby they are excited follow one another. Under these conditions the total amount of magnetism in the system of combined cores will always be the same, while the magnetic axis is continuously shifted forward. The magnetism of each core consequently increases and decreases and changes its polarity with comparative slowness, so that the heating of the cores and loss of effect is considerably reduced. The means for producing currents of the said kind may be such as are set forth in the specification of another patent application of mine filed on the same day as the present one.

In the annexed drawings, Figure 1 is a sectional view of a transformer of my invention in connection with a dynamo for producing alternating currents of continuously-shifting phases. Fig. 2 is a diagram serving to explain the operation of the apparatus. Fig. 3 shows a modification of the latter.

A B C, Fig. 1, are three iron cores, *a b c* three primary coils, and *a′ b′ c′* three secondary coils placed on the respective cores A B C. The said cores are connected together at one end directly and at the other end by means of the bars E, so that three closed magnetic circuits are formed, which are indicated in the figure by the broken lines 1 2 3.

F is a dynamo connected to the coils *a b c* by the respective wires $a^2$ $b^2$ $c^2$, and which produces alternating currents whose phases of vibration are shifted in respect to each other by one-third of a phase, as shown by Fig. 2, in which the wave-line $a^3$ indicates the vibrations and phases of the current generated in one of the coils of the dynamo and the lines $b^3$ $c^3$ those of the second and third currents induced in the other two coils of the said dynamo, the parts of the wave-lines above the horizontal line *q r* representing the positive portions of the currents and the parts below this line the negative-current portions. The machine by which these currents are obtained will not be described here, as it does not form any part of my present invention. Supposing, now, the coils *a b c* to be arranged in such manner that a positive current circulating in any one of them will produce a north pole at the outer end of the core of the same, and starting from the moment indicated on the line *q r*, Fig. 2, by point *g*, the condition in which the apparatus is at the time will be the following: The first current represented by the wave-line $a^3$ is at its positive maximum, measured by the ordinate $g\ h$, while the currents $b^3$ and $c^3$ are negative and of the inferior but equal strength determined by the line $g\ i$. The coil $a$ therefore produces a strong north pole at the outer end of the core A and the coils $b\ c$ south poles of less but equal force at the outer ends of the cores B C. The resultant magnetic center line or magnetic axis of the system of cores will therefore in this case pass lengthwise through the core A and in the middle between the cores B and C, as indicated by the line N S, Fig. 1, N and S being, respectively, the north pole and the south pole. At the next moment (indicated by the point $j$, Fig. 2) the positive current $a^3$ has decreased and the negative current $c^3$ has increased in strength, so as to be proportionate to the respective ordinates $j\ k$ and $j\ l$, (which are equal,) while the current $b^3$, being at its changing-point from negative to positive, is zero. Consequently there is then a north pole at the outer end of core A and a south pole at the outer end of core C, while the core B is not acted upon by the coil $b$. The magnetic axis will therefore have the position N′ S′. At the moment indicated by point $m$, Fig. 2, the negative current $c^3$ is at its maximum, measured by ordinate $m\ o$, the positive current $a^3$ has decreased further, so as to be proportionate to the ordinate $m\ n$, and the current $b^3$ has become positive again and is of like strength as current $a^3$. There will therefore then be a strong south pole at the outer end of core C and north poles of lower but equal strength at the ends of the cores A B. This causes the magnetic axis to assume the position $N^2\ S^2$. The said axis is thus continuously shifted forward or rotated about the center of the magnetic system. Besides, if the collective strength of all the currents is maintained uniform, as is actually the case in my arrangement, the total value of the magnetism produced thereby will be the same at every moment. By the said shifting of the magnetic axis currents are induced in the secondary coils $a'\ b'\ c'$, which may be employed either separately or conjunctively.

It is evident that the described transformer may have any number of cores from three upward; but there must be at least as many cores as there are alternate currents acting on the same.

In Fig. 1 the primary and secondary coils are shown arranged in juxtaposition. They may, however, also be placed one around the other, and, instead of being located on the cores A B C, &c., they may be disposed on the peripheral bars E, as shown by Fig. 3. The only difference in the latter case is that the distribution of the poles of the cores relatively to the coils will be modified. Moreover, the body of iron forming the system of cores may be made in two or more pieces placed close to or in contact with each other. Thus, for instance, it may be divided on the lines $p\ p$, Fig. 1, and in such case the magnetic system, instead of being a perfectly-closed one, may be called "nearly closed."

In consequence of the described construction of my improved transformer and of its combination with a machine for producing alternating currents of shifted phases, the total amount of magnetism present in the magnetic system remains constant and the polarity of the system is changed comparatively smoothly. The energy required for such changing is therefore less, a considerably smaller amount of energy is lost by conversion into heat, and a higher useful effect is obtained. For the purpose of securing the best effect it is, however, necessary to provide means for avoiding Foucault or eddy currents by constructing the aforesaid cores of thin iron plates or in other known manner.

I claim as my invention—

An induction apparatus consisting in a number of cores of iron, forming together three or more closed or nearly closed magnetic systems, primary and secondary coils placed on said cores, electric circuits connected to the primary coils, and means for creating in the said circuits alternating currents of successive phases for the purpose of causing a continuously-progressive shifting of the magnetic axis and maintaining nearly constant the total amount of magnetism, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

MICHAEL VON DOLIVO-DOBROWOLSKY.

Witnesses:
OSCAR VON GOEBEN,
FRITZ DELLMAR.