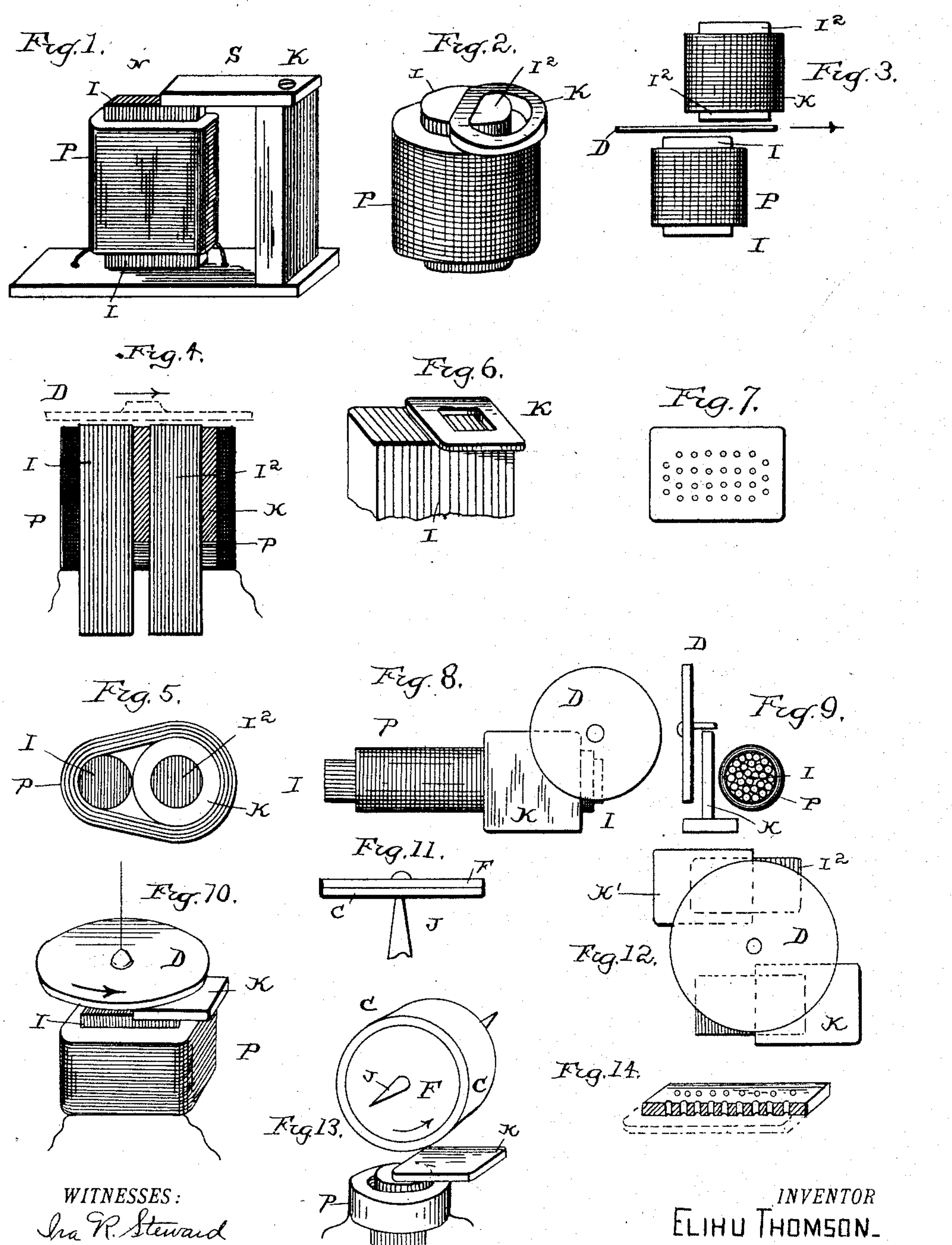
(No Model.) 2 Sheets—Sheet 1.

E. THOMSON.

ALTERNATING CURRENT MAGNETIC DEVICE.

No. 428,650. Patented May 27, 1890.



WITNESSES:

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ELIHU THOMSON.

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

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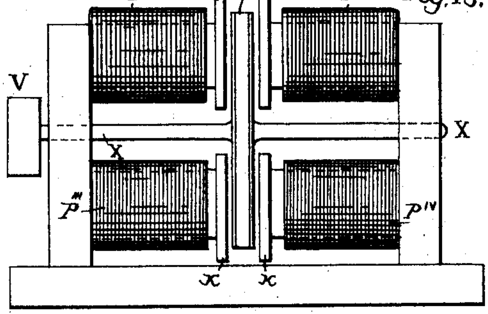

Fig. 15.

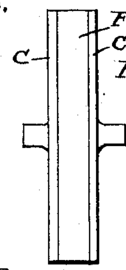

Fig. 16.

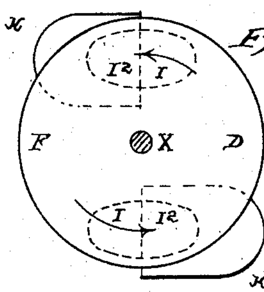

Fig. 17.

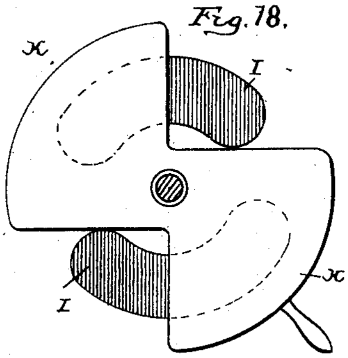

Fig. 18.

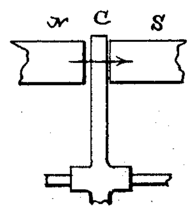

Fig. 19.

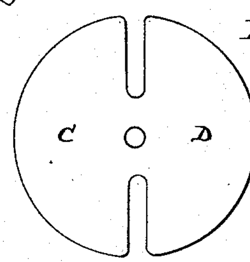

Fig. 20.

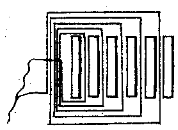

Fig. 27.

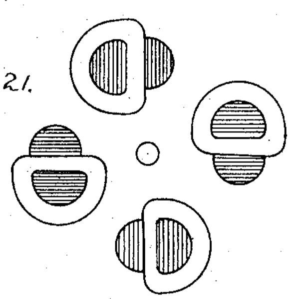

Fig. 21.

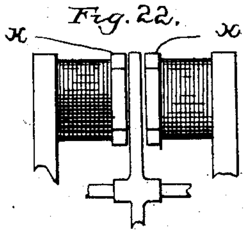

Fig. 22.

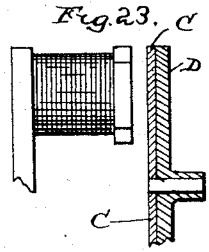

Fig. 23.

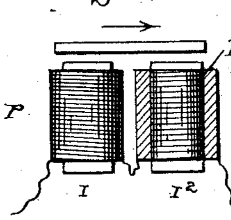

Fig. 25.

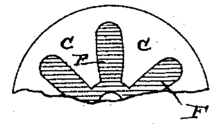

Fig. 24.

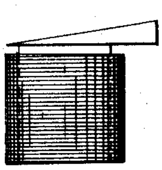

Fig. 26.

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ALTERNATING-CURRENT MAGNETIC DEVICE.

SPECIFICATION forming part of Letters Patent No. 428,650, dated May 27, 1890.

Application filed August 8, 1888. Serial No. 282,284. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Alternating-Current Magnetic Devices and Motor Mechanisms, of which the following is a specification.

The object of my invention is to produce from the same alternating-current circuit coil or source an alternating inductive field or source of alternating inductive effect in which there shall be two or more sets of alternations different or displaced in phase.

My invention is an extension or modification of a joint invention of M. J. Wightman and myself, which involves the use, broadly, of a closed-circuit conductor which operates upon a part of the field of induction set up by an alternating or pulsating current coil or circuit to produce a retardation of the alternations, thereby producing from a single current or source a compound field having two or more sets of alternations, one of which differs or is displaced from the other by a part of a phase of alternation.

The present invention relates more particularly to the disposition of the induction-modifier acting on a part of the field; and it consists in the particular way of disposing the closed-circuit retarder or lagging device, the effect of which is in most cases to produce portions of alternating field displaced in phase over a free magnetic pole of the alternating coil.

In the illustrations in the joint application the compound field is in general made of parts lying beside one another in the general direction of the magnetic axis or extension of the magnetic axis of the coil; but in my present modification the two or more subfields of different or displaced phase lie beside one another or are in a plane or line transverse to the magnetic axis.

My present invention consists, essentially, in applying an induction modifier or retarder to a part of the field of induction lying to one side of the general magnetic axis of the inductor. Thus, for instance, in the case of a modifier whose plane of circulation of currents is transverse to the general magnetic axis the closed conductor would be eccentric to said axis instead of concentric therewith.

My invention consists, further, in details of construction and combinations of parts, to be more particularly described, and then specifically claimed.

In the accompanying drawings, Figure 1 represents the combined elements of my invention irrespective of those which produce motion. Fig. 2 is a modification of such elements; Fig. 3, a further change in the disposition of the elements. Figs. 4, 5, 6, 7, 8, and 9 show different arrangements. Figs. 10, 11, 12, and 13 show the application of the principles of my invention in different ways. Fig. 14 is a modified detail. Fig. 15 shows one of the ways in which my invention may be employed in the construction of an alternating-current motor. Figs. 16, 17, 18, 19, and 20 show details of such a motor. Figs. 21, 22, 23, 24, 25, 26, and 27 show further details and modification of the parts.

P indicates a coil through which rapidly pulsating or alternating currents from any source pass, and I a core for said coil, said core being preferably made of a bundle of iron wires or a pile of iron plates.

K indicates a plate, of copper or other good conducting material, suitably supported so as to lie in the path of a part of the lines of magnetic force emanating from the pole of the magnet, thereby intercepting or shading, as it were, a part of the magnetism, leaving the other or unshaded or differently-shaded part of the core free to set up a magnetic field with no or a less degree of modification. By this arrangement the development of an alternating field takes place freely over the unshaded portion of the core; but the waves or pulsations are retarded or modified or made to lag over that part shaded or covered by the conductor K. This retardation or lagging I attribute to the fact that each wave or pulsation of magnetism in the core I is attended by or produces a powerful induction-current in the plate K, which tends to prevent the passage of magnetic lines outward, and thus retards the production of the magnetic field. At each reversal of magnetism in the inductor or core I the current continuing to exist in the plate K acts now to oppose the withdrawal and reversal of the magnetic field just previously established over the plate. Thus, for instance, at the moment the inductor changes north and tends to develop a corresponding magnetism in the portion of magnetic field over its unshaded portion the portion of field over plate K which has just previously been south will tend to remain south, owing to the continuance in plate K of the current which attended or corresponded to a south polarity of field over K, the change being thereby resisted. As the north magnetism of the inductor prevails, a north field will finally be established over the whole inducing portion; but owing to the retardation and resistance just mentioned the portion of field over the unshaded part of the inductor will acquire its maximum north sooner than the part over the shaded part, where the development is retarded. As the influences tending to produce the north condition of the field continue, the strength of the field over the shield or shade will gradually reach its maximum, although such maximum magnetism may not occur until the magnetism begins to fall in the inductor, and may even be delayed until the cessation of north, or may even overlap into the south of the inductor if the plate K is sufficiently thick. In other words, the lag may be so great that when a north polarity exists in the field over the unshaded portion of the pole a south polarity may at the same time exist over the shaded portion. The effect of these actions is to cause in contiguous portions of the field sets of waves or pulsations of magnetism whose phases overlap one upon the other, or which, in other words, if represented graphically, would appear as overlapping one upon the other. This condition occurs at the moment of first production of north polarity in the upper end of the core by the coil P, and as such polarity strengthens the south polarity, generated by the closed currents in the plate K, gradually disappears and the whole of the pole becomes north, but far more feeble, over the plate K, where the development of polarity is retarded. If again the reversal takes place, the upper part of the pole which is unshaded will become of south polarity before that portion shaded is able to lose its north polarity, owing to the currents in the plate K lagging.

In Fig. 2 the closed band or circuit K passes through a central slot in the end of the core I I, as shown, so that the lagging portion of the pole I^2 is surrounded by such a band, while the free portion I is not so surrounded. The effect of the band K so placed is to do for the end of the pole I^2 what was done in Fig. 1—that is, to retain or lag its polarity and not allow it to follow the changes of current in the coil P as closely as the unshaded portion I.

It is not essential that the closed band or circuit K surround a portion of the end of the core I, as a similar effect is producible by opposing to a portion of such core I I, Fig. 3, wound with a coil P, a second iron core I^2 I^2, surrounded by a closed coil or conductor K, and offsetting the core I^2 I^2, so that it does not oppose directly the whole magnetic effects of the core I I, but leaves a portion uncovered, as it were. As the core I^2 partakes of the magnetic condition of the field in which its polar end is placed, and will also influence by its own magnetic condition the magnetic condition or changes of magnetic condition in such field, it is obvious that the closed band or circuit K will operate in precisely the manner already described to slow or lag the alternations of magnetic condition in a part of the magnetic field of the core and coil I P. It is obvious, also, that in this case, as before, the center of rotation of the lagging currents is to one side of the general magnetic axis of the inductor. Should a plate of copper or other good conductor be placed between the cores, as shown at D, it will be found also that it will tend to move in the direction of the arrow, and such action will remain as a continuous tendency during the passage of alternating currents in the coil P. If the part D were of indefinite length and free to move, it would continuously progress in the direction of the arrow.

In Fig. 4 in vertical section and Fig. 5 in plan view the core surrounded by the coil P is shown divided into two sections, one I I surrounded only by the coil P P, and the other I^2 I^2, in addition to the coil P, having a closed band or circuit K placed thereon at some portion or portions of its length. In this case, as in the former cases, the development of polarity of any name, north or south, in the portion of field over I^2 will be retarded or prevented by the closed band K acting in opposition through the production in it of currents E opposite to those which flow in the coil P P, tending to magnetize both cores. The core I I, however, is free to be magnetized, and is so magnetized. If a conducting metal disk D, of copper or of iron, or both, be placed in front of the cores, the development of the pole opposite thereto by the core I, through the passage of the alternating currents, will be attended with the production in the disk of closed current-circuits, and the tendency to develop in like manner magnetic polarity in the core I^2 I^2 will at the same time be attended by the development of currents in the closed band or circuit K surrounding said core. The magnetic currents induced in the disk D by I will be the same in direction as those induced in the band K; but, not being directly superposed when so produced, there is at once a tendency for such currents of like direction to place themselves in a superposed or exactly parallel position. This results in a movement of the disk D in the direction of the arrow, or at least a tendency to move in that direction.

The manner of the application of the shading piece or closed-circuit piece K and its form may very greatly vary without departing from the spirit and essence of the invention. It may take the form of a simple plate of good conducting metal, of a plate perforated with holes at or near its center, as in Fig. 17, or of a plate with its center cut away, as in Fig. 6; or it may be wound up of a number of insulated wires into a closed band; or it may be constructed of superimposed washers or flat plates until the desired thickness is obtained; or it may be made of rings of rectangular pieces of metals of continually-decreasing diameters set one within the other, the only object being to make it the seat of powerful induced currents under the action of the alternating field tending to pass through it.

The fraction of the magnetic field which is shaded, or in which the closed-circuit conductor is placed, is a matter of no consequence except that a portion be left unshaded or less shaded; but it will be generally found that a division into nearly two equal parts or portions will be effective—that is, a portion of the magnetic field nearly equal to half of its extent not having the closed band placed over it. If the magnetizable bars I I be laid upon its side, the closed-circuit plate K, Fig. 8, may also be laid laterally against it in position shown, and a laterally-shaded pole will thus be obtained. A disk D, free to move, suitably placed, as shown, will rotate in the direction of the arrow in the figure.

Fig. 9 shows an end view of the structure Fig. 8, with the parts similarly lettered.

The mode in which my apparatus may be used to obtain rotary motion is exhibited in Fig. 10, the construction embodying that shown in Fig. 1—to wit, a magnetizing-coil, its core, and the local-circuit piece K. The disk D is mounted so as to overhang the end of the magnetizing-core, as shown in Fig. 10.

In Fig. 11 the disk is shown in edge view as composed of a mass of iron F and a covering of copper mounted upon a bar pivoted at J, though the disk can be made of iron or of copper separately, or other good conductor, the design being that it shall be the seat of induced currents due to the magnetizing action of the magnet-pole opposite which it is placed. The induction of the free or unshaded part of the pole upon the material of the disk generates currents therein, and at the same time the local-circuit plate K has currents generated in it in the same direction and in the same way; but as the currents in the disk D and the plate K are alike in direction, but not exactly superposed, the disk tends to turn so as to bring the currents in it directly parallel to and in the same direction with those induced in the plate K. The result, however, is a constant renewal of the conditions, such as to produce a rotation of the disk D in the direction shown, bringing new portions of the disk over the pole I and carrying them subsequently over the plate K.

In Fig. 12 a plan view of a rotating disk acted upon by two cores I and I′, with plates K and K′ half covering each core, respectively, is shown. Any convenient means for alternating the condition of the cores or poles is suitable. In this case a double action occurs, and the disk rotates, as shown by the arrows, or exerts a continual tendency to so rotate. The form of the disk and its disposition may be very widely varied, as it is only necessary that it shall present new magnetic-field material in which closed-circuit currents can be set up by the alternating-current magnetic field. It might, therefore, take the form, as indicated in Fig. 13, of a roll or cylinder of wood or iron F, faced or covered with a shell of copper C; or the shell of copper C might be replaced by a number of closed coils mounted upon the face of the cylinder, or by a number of strips or bars short-circuited upon themselves in a suitable manner for the setting up of induced currents. The plate K may, for further perfection of action, be drilled full of holes, as in Fig. 14, and the holes filled with iron rivets or short iron wires or bars, as there indicated, for carrying more easily the magnetic influence tending to pass upward through the plate under the inductive action of the magnetic pole or field below it.

My invention is applicable to the production of continuously-rotating motors operated by alternating currents, and I herein propose to show one form of such motor, reserving more elaborate forms as the subjects of future applications.

In Fig. 15, X is a shaft with a motor-pulley V mounted thereon, and carrying a compound armature consisting of a central plate of iron faced on each side with copper, as is more definitely shown in Fig. 16. The iron portion may be omitted and the copper plate alone used in some cases, especially when the magnetic influence of the coils which induce the currents are such that the polarities presented to opposite sides of the disk are opposite in name, as north and south, respectively, the iron disk F being necessary when opposing poles of like polarity are presented oppositely to the side of the disk at any point. Suitable laminated cores with magnetizing-coils p' p^2 p^3 p^4, which coils are included in an alternating circuit, have their poles presented to opposite sides of the disk F revolving between. Each of these poles is provided also with a shading-piece K K, in which the local-circuit current is developed, placed as shown in Fig. 12 and more definitely in Fig. 17, where F D is a revolving plate composing the armature or rotating portion, X the shaft sustaining the same, K K the local circuit-pieces, and I^2 I and I I^2, in dotted lines, the poles of the magnets upon which the coils P′ P^3 are wound, all of the plates K K being arranged with respect to the poles to cause a rotation of the disk conjointly in the same direction. Powerful alternating currents thus give rise to a rapid and vigorous rotation of the disk by the accumulation of actions already described in connection with the preceding figures. The plates K can be, as shown in Fig. 18, a single piece of copper with an opening for the passage of the shaft, and with cut-away portions exposing halves of the poles I I, the plate being suitably held in place.

The rotation of the disk is always, as said before, from the unshaded portion of the pole to the shaded portion. This fact permits the reversal of the motor to be easily accomplished by causing the plate K K, Fig. 18, to be made rotatable around the shaft, and in fact this movement may be made to govern the direction or power of the motor, as when the plate is placed directly over the poles the effect of the motor is *nil*, and a motion one way or the other takes place, according as the shading-piece, is moved to one side or the other from this position.

Fig. 19 shows the relation of the poles when the disk C revolving between them is made of copper, the direction of polarization in such case being through the disk, the magnet's poles being of unlike name at any time.

The armature-disk or revolving disk has hitherto been described as a plate circular in form; but it may be slotted from the center outwardly, as shown in Fig. 20, or otherwise modified in disposition or shape, without departing from the essence of the invention. An armature constructed with the slots, as in Fig. 20, has a tendency to synchronize with the alternations when its speed nearly approaches that of the alternations.

Fig. 21 shows the disposition of a number of poles alike in form to those of Figs. 2 and 4 arranged in number around a shaft which may bear the armature. This form of pole may replace those shown in Figs. 15 and 18. Fig. 22 shows the position of two such poles with their local circuits K K on opposite sides of a rotating disk of a good conducting material, and which may form the armature. Fig. 23 shows the abolition of one such set of poles and the substitution therefor, back of the copper disk, of an iron plate D; or, in other words, the armature is composed in this case of an iron plate faced with copper toward the magnetic pole.

It is sometimes desirable to so form the armature-disk D, Fig. 23, or the disk, Fig. 16, when the iron plate F is between the two copper portions, so that the iron projects through, a section F of the plate, Fig. 24, being of iron and the portion C of copper. The object of this is to cause a tendency to synchronism with the rate of alternations by having certain portions of the armature-surface incapable of causing such vigorous closed circuits as the portions provided with the copper facings.

In Fig. 24 a modification in the form of a disk or armature is shown. In this instance the slots extend radially outward from the center, but stop short of the periphery instead of extending inward from the periphery, as in Fig. 20.

Fig. 25 illustrates a modification in which the coil is divided into two parts P P′, both carrying the same alternating current and each having a core I I^2. The two cores act together to produce a common magnetic field of the same name with a current of any given polarity in the coil. The portion of field set up by the action of the coil P′ and core I^2 is modified or has its phase displaced by the action of the closed-circuit conductor K, applied to the core and coil P′ I^2. The principle is obviously the same as in the instances before described, the only difference being that the field is produced by a compound magnet. In this case, as before, it will, however, be seen that the conductor is applied eccentrically with relation to the general magnetic axis of the compound magnet P P′ I I^2.

It is not necessary that the induction-modifier, as the plate K, should stop short at any point over the core or in the magnetic field from said core; but such plate may taper continuously over its whole length, as indicated in Fig. 26. In this instance the retardation will be mainly at one side of the coil and will taper to the other side, where the effects will be less; but the same general effects of alternations of field displaced in phase will be produced.

Fig. 27 illustrates another way in which the graduation of the retarding or modifying effect of a closed conductor may be produced. In this instance the ends of the laminated core are shown with the laminations separated from one another to receive portions of the closed-circuit conductor K. The latter has its turns condensed or assembled together at one side of the core, while the opposite sides of the turns are distributed over the core, as indicated, so that a larger amount of closed-circuit currents will flow at one side of the core than at the other, with the general result before stated. Here, as in other instances, the average center of the paths for the current set up in the closed-circuit conductor is to one side of the magnetic axis.

What I claim as my invention is—

1. The combination, with an alternating inductor, of an induction modifier or retarder located to one side of the general magnetic axis, and serving to produce a compound field of alternating induction whose parts differ or are displaced in phase.

2. The herein-described method of producing two sets of magnetic alternations differing in phase at the free pole of an alternating coil or magnet, consisting in shading or inductively retarding the alternations in a part of said magnetic field to one side of the general magnetic axis, as and for the purpose described.

3. The combination, with an alternating

electro-magnet, of a closed induced circuit acting on a part of the magnetic polar field for said magnet in the manner described, so as to produce a lagging of the alternations, as and for the purpose described.

4. The combination, with an alternating current coil or coils and a core or cores therefor, of a closed-circuit conductor transverse to the general magnetic axis and eccentric to the same, as described, so as to modify or retard the alternations of a part of the magnetic field of induction at the polar end of said core or cores, as and for the purpose described.

5. The combination, with a magnet producing an alternating magnetic field having parts lying in the same general plane transverse to the general magnetic axis, differing or displaced in their phases of alternations, of an armature in the field of inductive influence of said magnetic field, as and for the purpose described.

6. The combination, with an alternating magnetic field, of a modifier or retarder operating upon a portion of the field to one side of the magnetic axis to produce a lagging in the alternations, and an armature placed within the compound field thus produced, which field has, as described, adjoining portions in which the alternations have their phases displaced.

7. The combination, with an alternating current coil or coils, of a lagging or retarding conductor adapted to be the seat of induced currents whose general center of rotation is eccentric to the general magnetic axis of the coil or coils, and an armature in the field of the coils and the lagging conductor.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 19th day of July, A. D. 1888.

ELIHU THOMSON.

Witnesses:
E. WILBUR RICE, Jr.,
J. W. GIBBONEY.