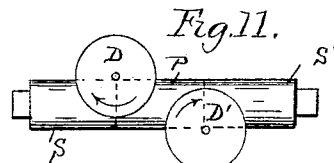
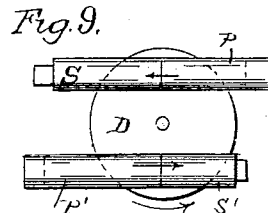
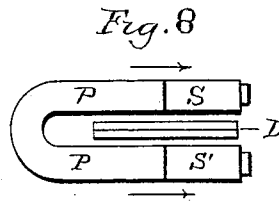
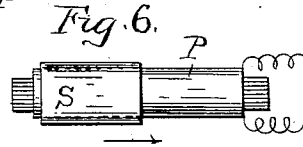
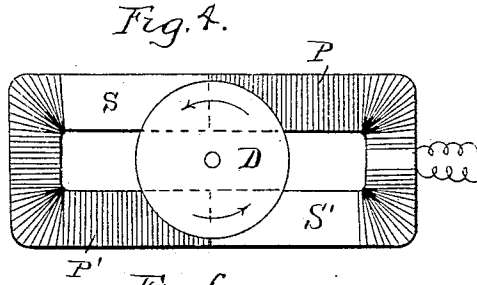
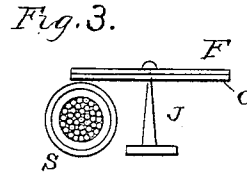
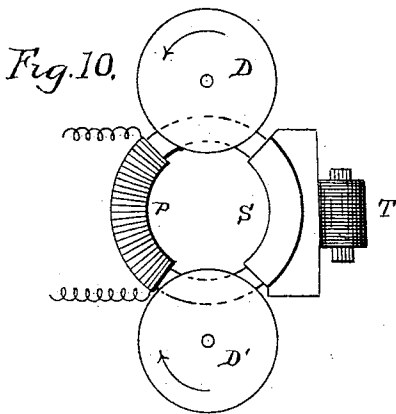
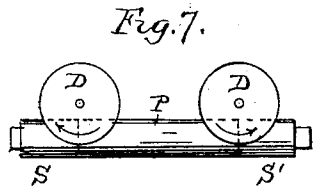
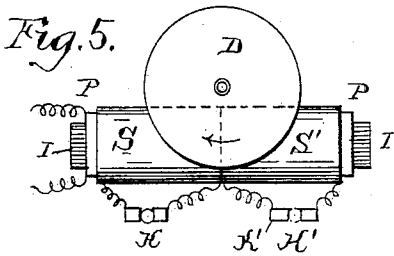
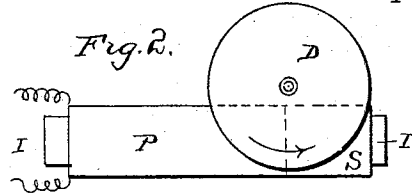
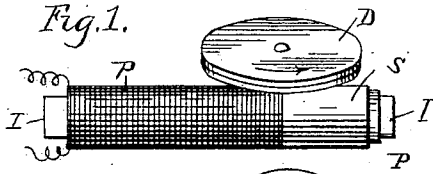


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ALTERNATE CURRENT INDUCTOR.

No. 399,801.

Patented Mar. 19, 1889.



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Fig. 12.

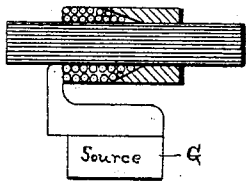


Fig. 13.

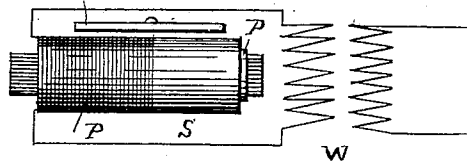


Fig. 14.

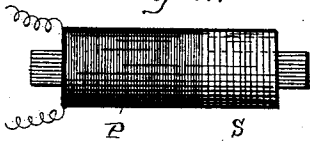


Fig. 15.

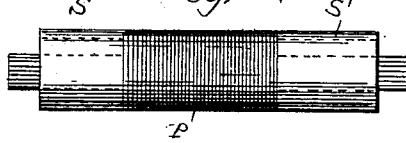


Fig. 16.

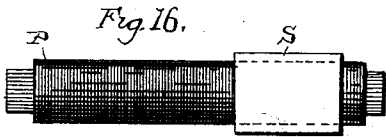


Fig. 17.

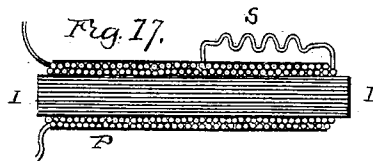


Fig. 18.

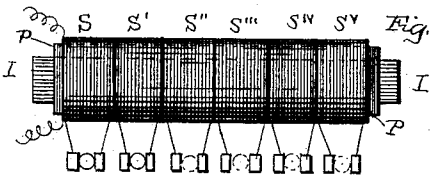


Fig. 19.

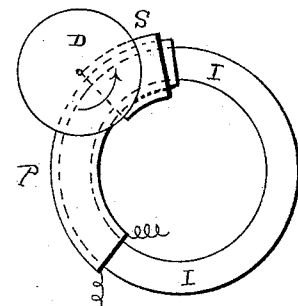
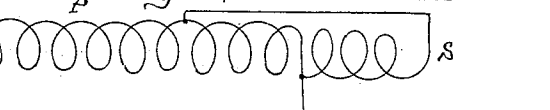
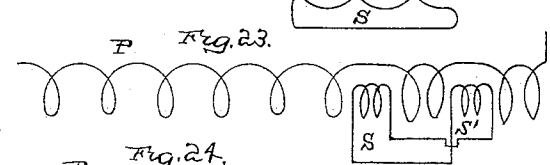
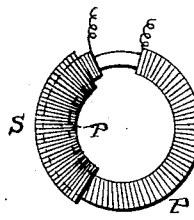
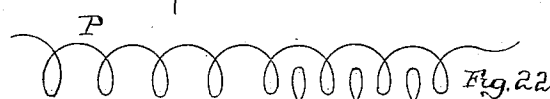
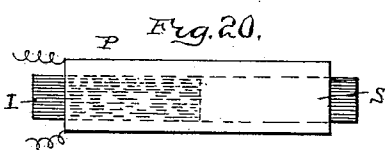


Fig. 20.



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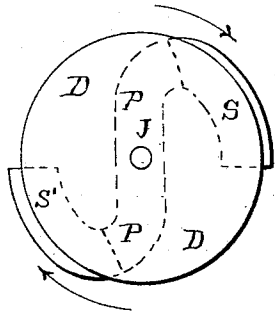


Fig. 25.

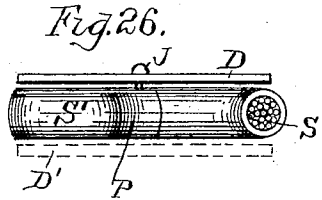


Fig. 26.

Fig. 27.

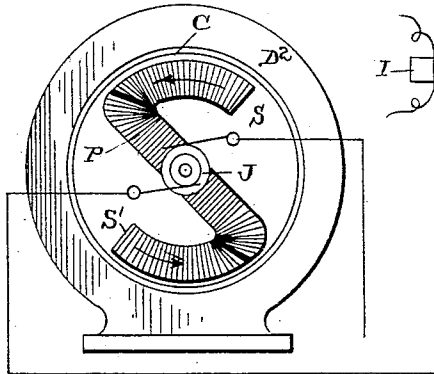


Fig. 28.

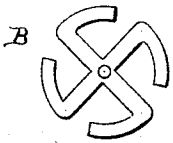


Fig. 29.

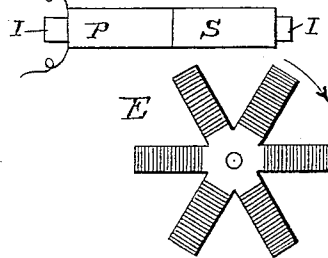


Fig. 30.

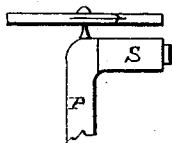
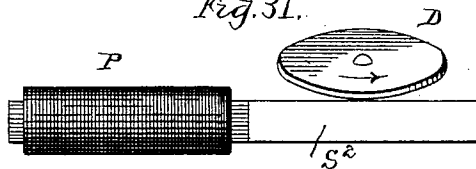


Fig. 31.



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UNITED STATES PATENT OFFICE.

ELIHU THOMSON AND MERLE J. WIGHTMAN, OF LYNN, MASSACHUSETTS.

ALTERNATE-CURRENT INDUCTOR.

SPECIFICATION forming part of Letters Patent No. 399,801, dated March 19, 1889.

Application filed August 8, 1888. Serial No. 282,278. (No model.)

To all whom it may concern:

Be it known that we, ELIHU THOMSON and MERLE J. WIGHTMAN, citizens of the United States, and residents of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Alternating-Current Inductor, of which the following is a specification.

The object of our invention is to produce from a single alternating-current circuit, source, or coil an alternating magnetic or electric field of inductive action having adjoining portions displaced or differing from one another by a part of a phase of alternation.

Our invention consists, essentially, in the combination, with an alternating inductor, of a locally-applied modifier or retarder of the inductive action applied directly or indirectly to a part of the field of inductive action directly or indirectly set up by said inductor, whereby a lagging of the alternations of inductive action produced by such part behind those of an adjoining part or parts will be produced, thus giving the effect of two or more adjoining sets of alternations of induction differing or displaced (more or less) in phase.

Our invention is suitable for use in producing motive effects, as will be hereinafter described, or for application to any other conditions where the effect of two or more fields of inductive action operating together for a common object and displaced in phase is desired.

The inductor may be of any desired form, and may be simple or compound—that is to say, may be, essentially, a single integral structure traversed by the alternating-current, or may be in two or more parts combined for a common operation, but both excited by the common circuit, source, or current.

The modifier or retarder which produces a lagging in the alternations of a portion of the field of induction, electric or magnetic, may consist of a conductor of any desired shape or form adapted to be the seat of electrically or magnetically induced currents produced by the inductor or a portion of the exciting-circuit or field of magnetism thereof. The conductor acts to retard or cause a lagging in the development of field or extension of field of the inductor at each alternation. In those portions of the magnetic field on which the

retarder does not act the alternations of polarity will obviously occur at a different time, because a portion of the field is produced by the inductor-coil without any direct retardation or lagging, or with a less degree of retardation or lagging than is the case at that portion of the field where the operation of the retarder is felt. It is obvious that the closed induced circuit operating as the retarder or lagger need not be of uniform thickness, but may gradually diminish, and may even be extended when so graduated in such way as to affect the whole field of induction. In this case the retarding or modifying effect would be graduated over the whole field of induction; but the alternations of field or current over the main portion of the modifier—that is to say, where it is the thickest—would be retarded beyond the alternations over the thinner portions.

The operation of the retarder in the manner hereinafter described we attribute to the fact that it becomes the seat of induced currents, which, by their self-induction, tend to continue flowing even after the phase of alternation, which would be due solely to induction from the inductor-current has become opposite or reversed, though we do not wish to be understood as limiting ourselves to any particular theory of action.

Some of the ways of carrying out our invention and some of the special combinations and applications of the same will be first described in connection with the accompanying drawings, and will then be more specifically stated in the claims.

When the retarding or lagging conductor is applied concentrically with the magnetic axis of the alternating coil, which sets up the alternating electric or magnetic field, said lagging-conductor may be obviously placed over or under that portion of the coil of the inductor where a lagging of the field is desired, or may be applied to a core or magnetic extension of the core for said coil.

In the accompanying drawings, Figures 1, 2, and 3 show different views of one of the simplest embodiments of the invention; Fig. 4, an extension or duplication of parts; Figs. 5 and 6, modifications in the arrangement to secure reversibility of action; Figs. 7, 8, and 9, further modifications consisting chiefly in

duplication or multiplication of parts. Fig. 10 shows the invention applied to a circular device. Fig. 11 is a still further modification. Figs. 12, 13, 14, 15, 16, 17, 18, 19, 20, and 21 show modifications in the form and dispositions of the elements upon which our invention is primarily founded. Figs. 22, 23, and 24 illustrate modes of connection which fulfil the objects of our invention. Figs. 25 and 26 show a simple form of motor arrangement embodying our invention. Figs. 27, 28, and 29 show other forms of motor. Figs. 30 and 31 illustrate modified actions.

P indicates a coil of wire traversed by alternating electric currents derived from any suitable source. The coil may be wound upon an iron bar, I, forming a core for said coil and made up of sheets or wires of iron assembled in a bundle. The core in the form of our invention shown in Fig. 1 simply serves to enhance the effects, and may of course be dispensed with where but slight effects are required.

S indicates the induction modifier or retarder applied in accordance with our invention. This retarder consists in the present instance of a closed electric circuit concentric or substantially concentric with the magnetic axis and formed either of a band of some conducting material or of a number of turns of conductor having its opposite ends joined to form a closed electric circuit. The conductor S is applied to a portion only of the circuit of the inductor P, and may be external to said coils or all within the same. If made of a conducting-wire, it may even alternate with the coils of P, as will be hereinafter more particularly described.

When the alternating currents flow in the conductor P, alternations of current are set up in the conductor S; but the phase of the latter alternations will obviously, owing to retardation of self-induction, differ more or less from the phase of alternations in the coil P itself. The difference in phase of alternation may be even so great that when the currents in the coil P are passing in one direction the currents in the closed circuit S will always circulate in the other direction. The consequence of this is that the alternations of the inductive field, of whatever nature that field may be, over or in proximity to the conductor S will be retarded from the time of development of the field of the inductor at those points not influenced by said conductor S or where the coil S is not applied, so that in effect there is produced in juxtaposition a compound field of induction having alternations with a displaced development of field or phase. The retarder S is preferably applied, as shown, at or near one end of the inductor P.

The effect of the retarder applied to a part of the inductor as shown may also be considered as resulting in the production of a consequent pole or magnetic pole, which is the resultant of the currents in the inductive band

or circuit S and in the coil P, such magnetic pole, however, changing constantly in intensity or position, while at the same time the magnetic effects develop themselves during the flow of alternating currents in the coil P in different times or intensities at various parts of said coil.

If with the arrangement just described a small disk, D, or otherwise-shaped piece of copper or other good conductor be mounted, so as to be free to turn in a position where it will be subjected to the action of the two parts of alternating field produced by the modifying action of the conductor S, and by the operations of the portions of conductor P not subjected to the action of S, or subjected in a less degree to such action, currents will be induced in said disk, which will result in the rotation of the same. The disk D may be made of copper or other good conductor simply, but is preferably a compound disk consisting in part of a plate of iron, F, Fig. 3, faced with conducting material C, such as copper.

The action of the compound inductive field in producing rotation of the disk D we explain as follows, although we do not wish to be understood as limiting ourselves to organizations in which the action suggested may alone exist. By the action of the two portions of alternating inductive fields over the part of the inductor shaded by the conductor S, and over the unshaded portion of said conductor, alternating currents will be set up in the disk D, or, rather, in the conducting portion of it—viz., the copper facing C.

These currents induced in the copper of the rotating disk D by the currents in a portion of conductor at one side of S are free to act unmodified by S, and the currents induced in the closed circuit or band, or closed circuits or bands S, will be in the same or principally in the same direction as those in the disk D, but the strength of the magnetic or inductive action upon the disk will be rather in the direction of that part of inductor P where the same is free from the influence of S, and the induction will be somewhat shaded just where the closed circuit S exists. The consequence of this will be that the currents of like direction in S and D will not be as near together as it is possible for them to come. They can approximately obtain this position by a relative movement of the disk D or the inductor P; but as the disk D is made movable that portion of it to one side of S which has been subjected to the unmodified inductive influence turns or moves so as to pass over that portion where the closed conductor S is applied or where the field of inductive action is of displaced phase. The constant repetition of this movement results in a brisk rotation of the disk, since it receives an impulse on every alternation of the current supplied to the coil or circuit P. The coil or circuit P may be fed from an alternating-current line of any description, such as the sec-

ondary circuit of a transformer, or the primary circuit, or directly from alternating-current generators such as are commonly used in electric lighting.

5 Having now described the simplest form of apparatus embodying the invention, we will proceed to show in what way this may be modified.

In Fig. 4 the iron core or laminated bar is made in the form of a rectangle and wound all over, preferably, with the coil P, and the closed conductors S S' placed, as shown, and overlying or underlying a portion of the winding P, modifying the condition of the alternating field over the part of the inductor to which they are applied by becoming the seat of induced currents of considerable volume, flowing principally in a direction opposing those in the winding P. A rotatable disk, D, in proximity to the ends of the closed winding or closed circuits S S', as shown by dotted lines, and overlying both the parts S S', and the unshaded portions of the coils P P will be briskly turned. The disk has preferably a construction such as has been described, though it may be any rotatable mass of metal in which induced currents may flow. The position given to the disk may be varied from the positions mentioned without substantially affecting the result, except, perhaps, in degree of rotative power manifested. The actions are simply the doubling up of the actions specified in relation to Figs. 1, 2, and 3, and the disk D rotates in the direction of the arrow, constantly tending to bring those portions of the disk which have been alone subjected to the action of the coil P P near to or over those portions of the field of inductive action established by P, at which the closed circuits S S' exist. The disk D will rotate in the direction shown in any case in which alternating currents are passed through the coil.

In Fig. 5 two closed circuits or bands, S S', are applied to the inductor, the closure of which circuits or bands is controlled by switches or plugs K K', respectively. The disk D, when the circuit S is closed, will rotate in the direction shown; but if the plug at K' be inserted and that at K removed, the rotation of the disk D will be reversed. The same action may be accomplished by moving the closed band S, Fig. 6, to different positions over the coil P, so as to make it take the place of either the one or the other band, S S', Fig. 5, thereby varying the position of the field of modified induction with relation to the armature. If both circuits S S', Fig. 5, be closed, the disk D will not rotate; or if the band S, Fig. 6, be placed with its center underneath the disk D, the disk D will also not rotate.

The two ends of the inductor may, as in Fig. 7, be provided with closed circuits S S' overlying or underlying or adjacent to the winding P, and two disks, D D', may thereby be rotated, but in opposite directions. Such a bar, however, bent over into a horse-

shoe shape, as in Fig. 8, may have a copper or other metal disk, D, placed between its limbs, as shown, and its rotative power will be due to the conjoint or assisting actions occurring on its two sides, the direction of rotation being such that that portion of the disk between the poles external to the horse-shoe-magnet thus constituted moves away from the bend of the horseshoe. Two separate inductors may be placed to act on one disk, (shown in Fig. 9 in plan,) with the effect of exerting a rotative force on opposite diameters, or producing, as it were, a couple made up of the rotative efforts of two simple inductors of the kind described.

In Fig. 10 we show a ring-core wound with the inductor-coil P, and opposite thereto on the portion of ring forming a magnetic extension of the core of the coil is placed the closed band S, in whose circuit may be placed a self-inductive coil, T, of greater or less amount, as needed. The coil T varies the self-induction of the circuit of which S forms a part, and thereby varies the lag of the alternations in the part of the field of induction upon which S acts.

The device Fig. 10 is capable of rotating two disks in the same direction by placing the pivots on opposite sides of the bar.

Fig. 11 shows the form indicated in Fig. 7 with the disks or armatures differently disposed. The band or closed circuit S may be of the form shown in Fig. 12, its modifying influence in such case tapering toward the conductor P. The taper might, obviously, extend from one end to the other of P, as indicated in Fig. 13 by the dotted lines.

In Fig. 13 the conductor is supposed to overlie the coil P its whole length. The coil or conductor S may be, in fact, simply a piece of tubing or a solid shell of copper, the coil P being attached to the alternating-current source G, while the band or copper casing S inductively receives current from the circuit P. The band S may be a piece of copper tubing slipped over a portion of the coil P, wound to a reduced diameter, and a transformer, W, may be used to feed currents to the coil P, which is connected with its secondary, as shown in Fig. 13.

Fig. 14 shows that the closed band S may be composed of a number of thin rings of copper instead of a solid tube or a closed coil. In this case each ring becomes of itself a separate closed circuit, and there will be as many such closed circuits as there are rings which go to make up the bulk of the compound band S.

Figs. 15 and 16 illustrate the placing of one or more copper cylinders or tubes in varying positions on the core, it being supposed that in such a structure the position selected may either be fixed or movable. The same effect, however, as will be seen, can be obtained by short-circuiting either directly or through a resistance a portion of the winding P itself, as

in Fig. 17, where a short wire connects one half of the outer layer into a closed circuit. The result is as before.

In Fig. 18 the bar I I, underlying the core P P, is shown provided with a series of circuits, S S' S² S⁴ S⁵, with suitable switches or plugs to close any one of the circuits at will. This gives the ability to secure a closed band at any point or position on the core, and so modify the effects of the structure.

Fig. 19 shows a ring-core, I I, or closed magnetic circuit provided with a coil, P, and a closed band, S, in positions to give results substantially the same as those which have been described. In this instance the magnetic circuit of the inductor is completed by extending the two ends of the core for the coil P around until they meet.

In Fig. 20 the core is made of solid iron at one end and laminated or divided at the other, and the whole is surrounded by an inducing or actuating coil, P, in an alternating-current circuit. In this case the solid iron of the portion S acts, but in a feebler way, as the seat of induced currents which produce an effect like that of the closed band or circuit S, before described, to give an inductive field from the action of coil P, in which there are sets of alternations differing or displaced in phase.

Fig. 21 differs from Fig. 19 only in showing a coil, P, of much greater extent on the ring-core, the inductive band S being applied thereto in the same manner as shown in Fig. 19.

Fig. 22 is an outline of the circuits alone, showing that the coil or inductor P may have the closed band or circuit S interspaced with it in either underlying, overlying, or adjacent sections.

Fig. 23 shows similarly that interspaced with the coil P there may be two coils or sections, S S', connected in multiple. Even in this case, on account of the positions of the coils S S' with respect to the core being such as would give a different energy of induction to each, the currents induced, though opposite in tendency, will move in the direction of the stronger coil, so that the effect is as though moderately-sized closed bands were used in place of the two coils so connected.

Fig. 24 shows that the same action may be secured by simply connecting up a short portion of the coil P on itself. Thus, if a section, S, near the end of the core be thrown into parallel with the section adjacent thereto, but nearer the other end, P, there is an opportunity at once for short-circuiting in the coil, which gives rise to the same effects as though a separate band, S, Fig. 1, had been provided, as before described.

A variety of forms may be given to the bar or magnetizable support on which the coil or coils P P are placed. One of these is shown in Figs. 25 and 26, and is the same as though the bar Fig. 7 or Fig. 11, with two closed

bands, had been bent into an S shape. The S-shaped bar is wound with a coil, P P, Fig. 25, and its bent extremities have in addition the closed circuits referred to. Centrally placed on a pivot, J, is a disk, D D, which disk will revolve in the direction of the arrows shown, in accordance with the actions above described. Another disk, D', Fig. 26, could be placed on the other side of the S-shaped bar, and would receive a similar impulse of rotation.

A rotary motor may be constructed utilizing the S-shaped bar, as in Fig. 27. Here the bar itself is mounted upon a pivot or shaft and can be rotated, while alternating currents from any source are passed through the coil P by suitable collecting-rings, as is usual in such cases. A copper shell or conductor, C, surrounds the S-shaped bar, but is out of contact therewith and is stationary. Outside this shell is preferably another ring or shield, D², made of an iron mass—such as wrought or cast iron—and inclosing the copper piece C therein. The passage of alternating currents in this device results in the rotation of the S-shaped piece in the direction of the arrow, owing to the fact that currents are induced in the fixed copper-piece C just at the bend in the S-shaped piece. At the same time currents are induced in the closed bands S S' on the bent end of the bar. These currents, being the same in direction, tend to approach one another, and this brings that portion of the bent bar on which the closed circuit exists nearer the end of that portion of the outer copper-shell, C, which has been subjected to the inducing action of the bar itself just at its bend. No such inducing action takes place opposite that portion which is the bend S S', as such bands act as an effective shield for the time being.

Fig. 28 shows that a number of such S-shaped pieces might be combined in a form which would give a multiplication of the bent portions of the band, the bent bars being formed into a sort of cross.

Fig. 29 shows the bar I I, with its coil P and closed band S, as in Fig. 1, and also shows a rotating structure, E, which is not a disk, and has a number of polar projections each of which is provided with a tube or closed coil. In this case a rotation of the part E will take place in accordance with similar operations to those which have been already described.

Fig. 30 shows that no difference of effect is to be expected even though the bar itself be bent, as there shown, and the disk placed over the short-circuited winding, as before. A similar effect is also producible by the use of an iron or steel bar, S², Fig. 31, which is a continuation of the core for the coil P. In this case the bar S² is the seat itself of induction-currents, and at the same time a sort of magnetic retarding action takes place in the changing or alternating of the magnetic po-

larity by the influence of the coil P and its core, but which actions are sufficient of themselves to cause rotation of the disk D.

It will be seen from the foregoing that the parts of the alternating field of induction which have their phases displaced are generally those which adjoin one another in the general direction of the magnetic axis of the coil or circuit; or, in other words, the lines of division between the two parts of the field of induction, if such lines may be supposed to exist, are transverse to the general line of the magnetic axis. We do not wish to be understood, however, as limiting ourselves to applying the modifier or induction-retarder to any particular portion of the field of magnetic or current induction, as the invention consists, broadly, in modifying or retarding the alternations of a part of the field for the purpose of obtaining, as it were, a compound alternating field of induction, in a part of which the phase of alternations shall be displaced from the alternations of another or adjoining part; nor do we wish to be understood as limiting ourselves to that kind of rapidly varying or pulsatory magnetic or electric condition which consists of alternations or reversals of electric or magnetic polarity, since, as will be obvious, the same effect of displaced wave of pulsation would be produced if the changes of condition involved simply an increase and decrease of strength without reversal.

What we claim as our invention is—

1. The combination, with a pulsating or alternating inductor, of a modifier or retarder of the inductive action applied in the field of said inductor for causing a lagging of the pulsations in a portion of the field or fields of induction, thus producing a compound field of induction having inductive waves or pulsations displaced in phase.

2. The combination, with an alternating-current coil or conductor, of a closed-circuit conductor subjected to the action of a part of the field of induction of said coil or conductor and concentric or substantially concentric with the magnetic axis, whereby the field of induction may have adjoining parts whose phases of alternation are displaced, as and for the purpose described.

3. The combination, with an alternating inductor consisting of a coil or conductor traversed by alternating currents, of a locally-applied modifier or retarder of the alternations placed in the field of action of said inductor for producing a compound field having sets of alternations displaced in phase, as described, and an armature in the influence of both phases of alternations of said compound field.

4. As a means for producing a field of electric or magnetic induction having two sets of alternations whose respective phases are displaced, a coil traversed by alternating electric currents and a closed-circuit conductor concentric with the magnetic axis or extension

of the magnetic axis in said coil and applied to the part thereof over which the portions of field having its alternations retarded are to be produced.

5. The combination, with an alternating-current coil, of a closed induced circuit applied to a part of the magnetic field or electric field of induction of said coil and concentric with the magnetic or extension of the magnetic axis, and an armature in the influence of the parts of field thus produced and which have alternations displaced in phase.

6. The combination, with an alternating-current coil and an induction-retarder concentric with the magnetic axis or extension of magnetic axis for said coil, of a closed-circuit armature mounted so as to be within the inductive field or extension of the inductive field of the retarder and the coil.

7. The combination, with the alternating inductor, of two retarders each consisting of a closed inductive circuit, an armature, and means for closing either inductive circuit at will to determine the direction of revolution of the apparatus.

8. A single alternating-current coil or conductor having adjoining fields of induction, electric or magnetic, displaced or differing in phase, in combination with an armature acted upon by portions of said field differing in phase.

9. The combination, with an alternating coil having an iron core, of a closed induced circuit concentric with said core or extension thereof and a closed-circuit armature in the field of said induced-circuit conductor as well as the field of a free portion of the alternating-current coil.

10. The combination of an alternating-current coil, a closed-circuit conductor in which alternations are set up directly by said coil, and an armature exposed simultaneously to the alternating inductive actions whose alternations are the resultant, respectively, of the action of the alternating coil and of the closed-circuit conductor in which said coil induces alternations.

11. The combination, with the alternating inductor having a closed-circuit modifier, of the closed-circuit armature and means for changing the relation of the closed-circuit modifier and armature, as and for the purpose described.

12. The combination, with an alternating inductor, of a local phase distorter or modifier and an armature subjected to the simultaneous action of the inductor and the distorter or modifier.

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

ELIHU THOMSON.
MERLE J. WIGHTMAN.

Witnesses:

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