(No Model.) 2 Sheets—Sheet 1.

E. THOMSON.

ALTERNATING CURRENT MOTOR.

No. 471,155. Patented Mar. 22, 1892.

FIG. 1.

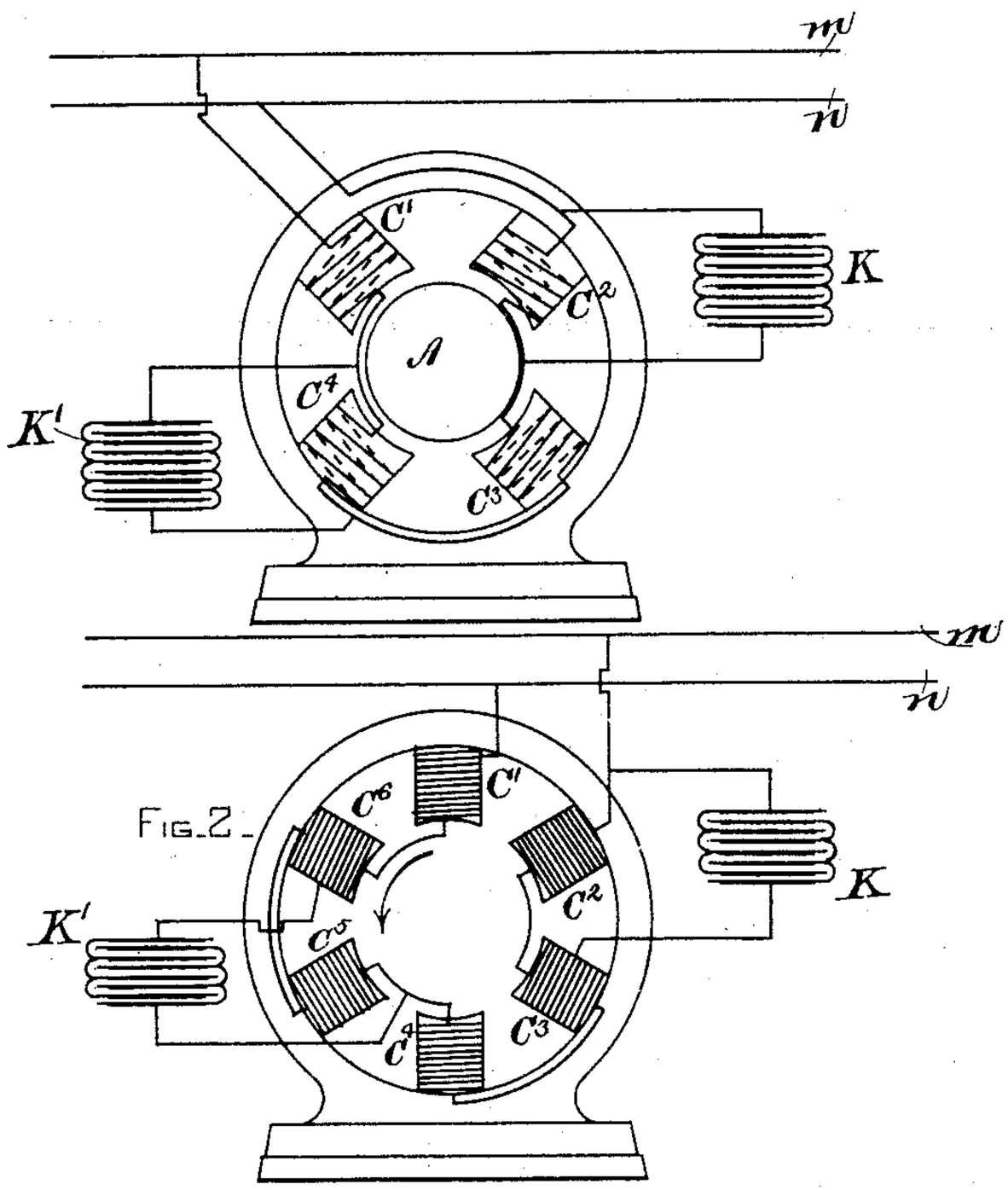


FIG. 2.

FIG. 3.

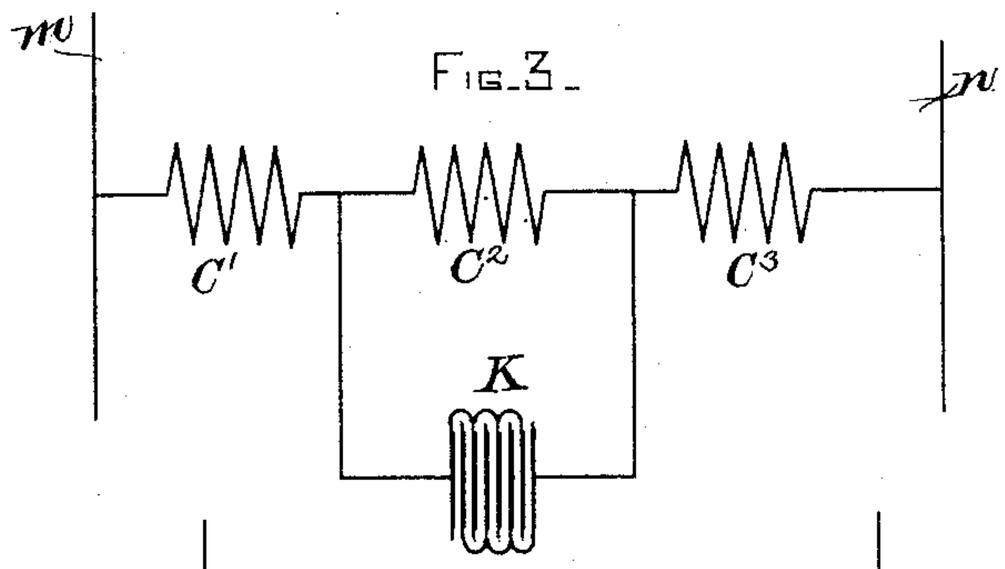
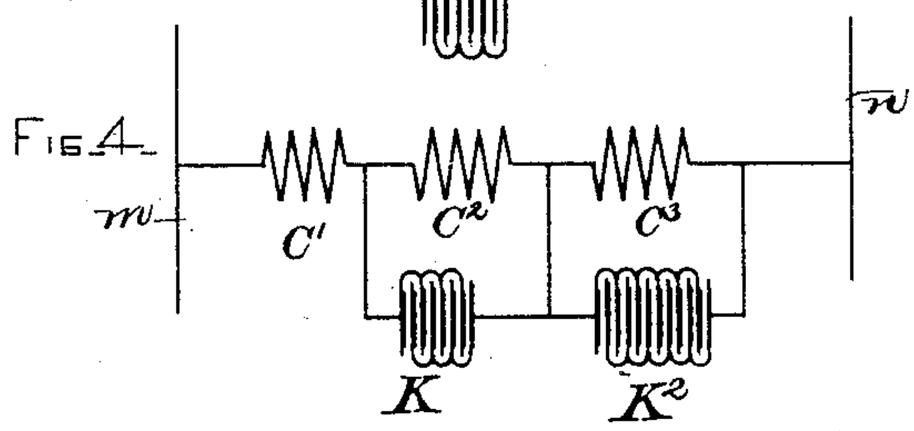


FIG. 4.



WITNESSES.

A. F. Macdonald.

A. O. Orne

INVENTOR.

Elihu Thomson

By Benjamin Blodgett

Atty.

(No Model.) 2 Sheets—Sheet 2.

E. THOMSON.

ALTERNATING CURRENT MOTOR.

No. 471,155. Patented Mar. 22, 1892.

FIG. 5.

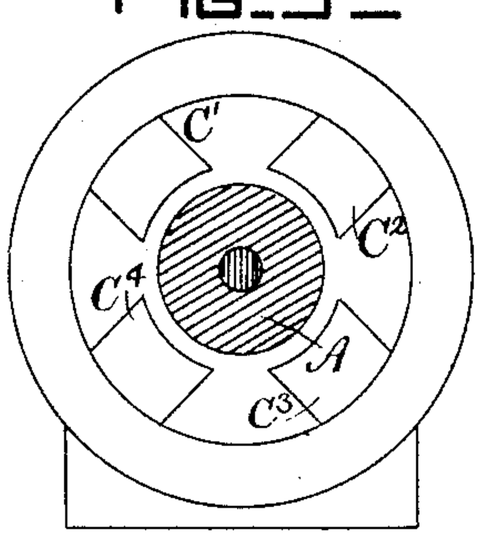


FIG. 6.

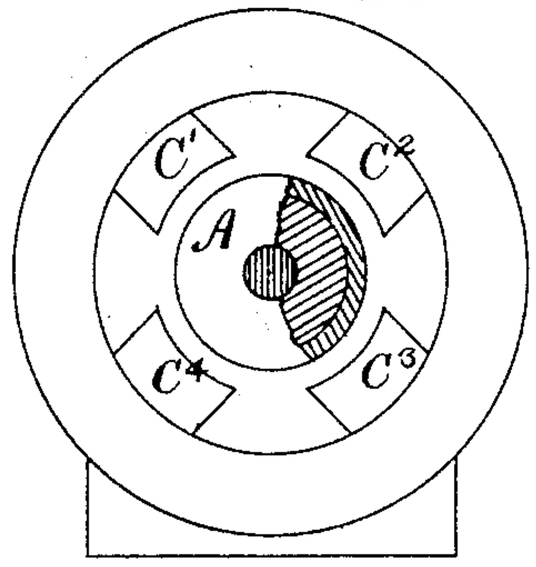


FIG. 7.

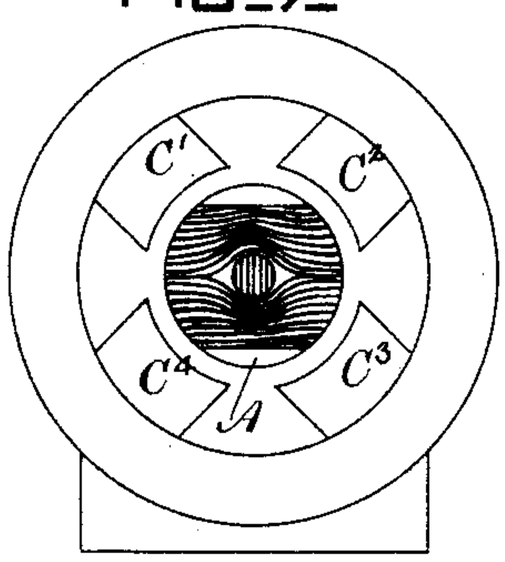
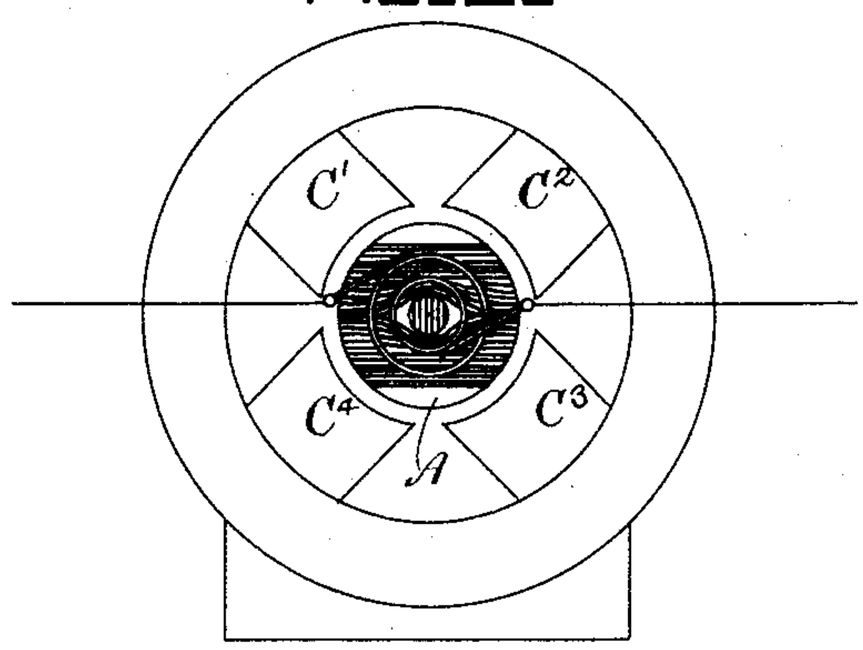


FIG. 8.



WITNESSES

A. D. Covne
H. J. Livermore

INVENTOR

Elihu Thomson
By Bentley & Knight
Attorneys

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

ALTERNATING-CURRENT MOTOR.

SPECIFICATION forming part of Letters Patent No. 471,155, dated March 22, 1892.

Application filed August 17, 1891. Serial No. 402,838. (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, and State of Massachusetts, have invented a certain new and useful Improvement in Alternating-Current Motors, of which the following is a specification.

This invention relates to improvements in those alternating-current motors wherein the armature is moved by the action of a shifting or rotating magnetic field produced by changes of magnetism acting successively or dissimultaneously in different portions of the field. This requires the electric changes which produce the magnetic changes to be correspondingly successive or displaced in character; and the object of my invention is to produce such lagging or displacement of electric and magnetic action without the use of more than one supply-circuit.

In the accompanying drawings, Figure 1 is a diagram of one form of alternating-current motor embodying my invention. Fig. 2 shows another form of such motor. Figs. 3 and 4 are diagrams illustrating the principle of the invention. Figs. 5, 6, 7, and 8 show various forms of armatures which may be used.

In Fig. 1, *m* and *n* is an alternating-current supply circuit or line from which a branch is taken to a motor. A is the revolving armature, whose construction may be variously modified, as well known in this art. It may consist of a solid block of iron mounted on a shaft and nearly filling the space, as shown in Fig. 5, or it may consist of a laminated body of iron with a shell of copper surrounding the same, as shown in Fig. 6, or it may consist of a laminated body of iron with a winding on the exterior passing diametrically over the same with the coils on closed circuit, as shown in Fig. 7, or it may consist of an armature-core which is given a definite polarity by continuous currents passing around it, producing magnetic poles on opposite diameters thereof, particularly when the apparatus has reached its normal speed, as shown in Fig. 8, with any of the above-mentioned forms of armature, as well as with other well-known equivalents therefor. A rotation of the armature may be effected by successively energizing the alternate or successive poles, so that the changes in magnetism in the several sets of pole-pieces are dissimultaneous, one set lagging behind the other. My invention consists in shunting certain of the field-coils—in this case the alternate ones—by condensers in order to effect such lagging.

In Fig. 1 the coils of the field-winding are shown in series, there being four coils C′, C^2, C^3, and C^4, and the direction of winding is such that in C′ and C^3 north and south polarity would be reversely produced as presented to the armature and that, disregarding any lagging effects in C^2 and C^4, similar north and south poles would be produced in coils C^2 and C^4 if the armature were to be revolved in a right-handed direction, or south and north poles, respectively, if the armature were to be revolved in the opposite direction. The coil C^2 is shunted by a condenser K, whose capacity is selected by experiment, as is also the coil C^4 by a condenser K′. The effect of of these condensers is to allow an alternating impulse, which, for example, has passed over the line *m* through the coil C′, producing a magnetic state in the core or portion of the field-magnet which it affects to virtually shunt the coil C^4 through the condenser K′ to pass to and through the wire C^3, affecting its magnetism simultaneously with that of C′, and to virtually shunt coil C^2 by condenser K reaching the line *n*. At the completion of wave of alternating current, however, the self-induction of the coils C^4 and C^2, which opposed the passage of current and caused the condensers K and K′ to charge, will fall off and the condensers will begin to discharge through the coils C^4 and C^2; but meanwhile the reversed wave of alternating current begins to pass from the line *m n* through the system of coils. The result of this will be that the development of magnetic force by the coils C^2 C^4 will be lagged and subsequent to the same development in the coils C′ and and C^3. The effect, therefore, is that the magnetism shifts from one pole to the other. It is to be understood that while these coils are shown as wound on separate poles it is not necessary to so arrange them, as they might be wound consecutively on a ring-field. By adjusting the capacities of the condensers K and K′ the effects of lag or shifting of the

phase of magnetism in the cores, respectively, may be made such that it virtually amounts to a rotation of a set of north and south poles around the armature.

In Fig. 2 the arrangement is somewhat modified, in that there are six coils shown and the coil C′ is without any condenser-shunt, while the coil C^6 is partially shunted—that is, a fraction of its turns are shunted, such as one-half its turns, by the condenser K′, which shunts all of the turns of the coil C^5, the direction of winding being such that if the condensers were not present an impulse sent through the system would make the coils C′, C^6, and C^5 of one polarity, while coils C^4, C^3, and C^2 would be of the opposite polarity. The arrangement of the coils C^2 and C^3 is like that of C^6 and C^5, in that C^3 is partly shunted by a condenser K, while C^2 is wholly shunted thereby. The effect of this is that the intermediate coils C^6 and C^3, which are only partially shunted, will be intermediate in their changes of magnetism between the coils C′ C^5 or C^4 and C^2, respectively, or, in other words, that if a north pole develops after a south pole at C′ a north pole will successively develop to a maximum force in C^6 and C^5. This would give a left-handed rotation to the armature, as indicated by the arrow, no armature, however, being shown, as its construction may be greatly modified.

Fig. 3 is an explanatory diagram showing the principle of operation only. Between *m* and *n* are shown several coils C′, C^2, and C^3 in series. One of these—C^2, for example—is shunted by a condenser K, which of course is not a real shunt, but an electrostatic shunt acting for very short intervals. An impulse passed through the coils—that is, such an impulse as an alternating wave or a set of alternating waves—would be met by a self-induction in the coils C′ C^2 C^3; but the current would be forced by the potential of the line to pass a certain amount through C′ and C^3 at the beginning of any impulse, while C^2 would be, as it were, saved from the necessity of such passage by the current which had passed C′ and C^3 finding sufficient capacity in condenser K to permit the formation of a condensed charge. The capacity of the condenser K being soon exhausted, the coil C^2 would begin to take current; but at this moment or shortly thereafter a tendency to change the direction of the impulse is transmitted from the sides of the circuit *m n*, which is opposed to the self-induction of the coils C′ and C^3, but assisted in such coils C′ and C^3 by the condenser-charge in K. The charge in K is soon exhausted in feeding current through the coil C^2 and in taking reversed currents through the coils C′ and C^3 from the line. It recharges in the opposite direction while the magnetism of C′ and C^3 is reversing. It then repeats the actions before detailed at a later time than the coil C′, causing its magnetic actions to be behind time or lagged beyond those of the other coils.

Fig. 4 is also an explanatory diagram and shows the coil C′ shunted by a condenser K, while the coil C^3 is shunted by a condenser K^2 of greater capacity. By this arrangement the development of a similar magnetic state in the three coils C′, C^2, and C^3 would be successive, and such coils might be mounted to produce, as in the former figures, a traveling or moving magnetic system suitable for rotation or giving motion to a proper armature mounted within its influence.

In both Figs. 2 and 4 the arrangement is such that there is what may be termed a "leading" set of field-coils C′ C^4, and also a series of other sets of coils, the changes in which lag or are displaced behind those in the leading set in a successively-increasing manner for the successive sets of coils, and in each case this is effected by causing the condensers to have a successively-increasing shunting effect on such coils.

In using the term "set of coils" I mean any number of coils, whether one, two, or more, which represent a certain type or arrangement of circuit connection, so that in the case of two or more coils the magnetic charges therein will be effected simultaneously.

The size of the condensers is to be selected in relation to the currents to be taken up, and will be dependent on the alternations of the current of the line, the self-induction of the several coils, the potential of the line, and the character of retardation of magnetic effect in the coils required in accordance with principles at present easily understood.

What I claim as new, and desire to secure by Letters Patent, is—

1. An alternating-current motor comprising an armature and field-coils inductively acting on said armature and connected to a single supply-circuit and a condenser shunting some of such field-coils, whereby they are caused to lag behind the other coils in magnetic changes.

2. An alternating-current motor comprising an armature, field-coils presented to different portions of such armature and connected in series to a single supply-circuit, and a condenser shunting some of such field-coils, whereby the magnetic changes therein are retarded.

3. In an alternating-current motor comprising two or more sets of field-coils arranged in inductive relation to different portions of the armature and connected in series to a supply-circuit and means of relatively displacing the phase of alternation in said coils, consisting of condensers shunting one or more of such sets of coils.

4. In an alternating-current motor, the combination, with an armature, of field-coils arranged around and in inductive relation to such armature and condensers shunting some of such coils, whereby the magnetic effects therein are made to lag behind the changes in the other coils.

5. In an alternating-current motor, the com-

bination of an armature and field-coils connected to a single supply-circuit and acting on said armature by alternations of magnetism successively set up in such coils and one or more condensers shunting the coils in which the magnetic changes are to be retarded.

6. In an alternating-current motor, the combination of an armature, a number of sets of field-coils, including a leading set and two or more lagging sets successively arranged around the armature and connected in series to a single supply-circuit, and condensers shunting the successive lagging sets of coils in a successively-increasing manner.

In testimony whereof I have hereto set my hand this 14th day of August, 1891.

ELIHU THOMSON.

Witnesses:
JOHN W. GIBBONEY,
BENJAMIN B. HULL.